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Assessment of Atlantic Salmon of the Saint John River, N.B., above Mactaquac, 1989
by

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## ABSTRACT

Estimated river returns destined for Mactaquac, Saint John River, 1989, were 10,861 lSW and 4,541 MSW salmon. Homewater removals/losses of about 3,600 15 SW and $1,400 \mathrm{MSW}$ fish led to an estimated spawning escapement above Mactaquac of 72 percent of the target number of MSW spawners. Wild and hatchery lSW returns were within $6 \%$ of the forecast but for the third year in succession, MSW returns were significantly less (36\%) than forecast.

The forecast of 1990 homewater returns destined for Mactaquac is about 10,100 1SW fish ( 6,900 more than the target escapement) and 7,075 MSW salmon ( 2,675 fish more than the target escapement). However, allocation of the MSW forecast surplus in 1990, (and later) would be imprudent given both the shortfall of egg depositions since 1986 and recent over-predicting of the returns.

## Résumé

Les estimations de remontées de saumons allant à Mactaquac, fleuve Saint-Jean, en 1989 étaient de 10861 unibermarins et de 4541 redibermarins. Compte tenu de retraits/pertes dans les eaux d'origine d'environ 3600 unibermarins et 1400 redibermarins, $1^{\prime}$ échappée estimée de reproducteurs en amont de Mactaquc était d'environ $72 \%$ du nombre-cible de géniteurs redibermarins. Les remontées d'unibermarins sauvages et d'écloserie étaient conformes à la prévision, à $6 \%$ près, mais pour la troisième année de suite, les remontées de redibermarins étaient bien inférieures ( $36 \%$ ) a la prévision.

On prévoit que les remontées dans les eaux d'origine pour Mactaquac en 1990 s'établiront approximativement à 10100 unibermarins ( 6900 de plus que 1'échappée-cible) et de 7075 redibermarins ( 2675 de plus que l'échappéecible). Toutefois, il serait imprudent d'attribuer le surplus prévu de redibermarins en 1990 (et dans les années subséquentes) en raison, d'une part, du déficit constaté dans le dépôt d'oeufs depuis 1986 et, d'autre part, de la surestimation récente des remontées.

## INTRODUCTION

This document is background to the management of Atlantic salmon stocks of the Saint John River above Mactaquac, New Brunswick, and, as such, documents data and analyses available to early November 1989 relevant to stock status in 1989 and forecasts for 1990.

## BACKGROUND

Physical attributes of the Saint John River drainage, salmon production area, barriers to migration, fish collection and distribution systems, the role of fish culture operations and status of the salmon stocks since 1970 have previously been described by Marshall (MS 1989).

Forecasts made in 1988 suggested that 1989 homewater returns to both above and below Mactaquac portions of the river would number approximately $19,00015 W$ and $12,100 \mathrm{MSW}$ salmon. CAFSAC advised managers (CAFSAC Advisory Document $88 / 26$ ) that for 1989 there would in total be $11,40015 W$ and $2,000 \mathrm{MSW}$ salmon surplus to spawning requirements, including a surplus of $2,700 \mathrm{MSW}$ salmon originating at/above Mactaquac.

The Management Plan for 1989 was identical to that of 1988 in that there was a total ban on homewater commercial fisheries, a prohibition on the retention of MSW salmon captured in the sport fisheries and the same open seasons for sport fishing. The Kingsclear Indian Band guided a sport fishery and the Oromocto Band did not fish. In contrast, the Tobique Indian Band conducted an unsanctioned fishery between early-July and mid-September which, by various reports netted about 800 salmon. Summer discharges were sporadic with extensive flooding occurring in Victoria County on two occasions in August.

Unlike the 1988 assessment, the 1989 assessment is of returns, removals and a forecast for only those fish originating at/above Mactaquac Dam. Assessment of stocks below Mactaquac Dam had, since 1986 been based on the premise that wild returns to tributaries below Mactaquac were equal to the average proportion that wild downriver stocks were of the total river returns 1970-1983. This was necessary because catch statistics for lower river tributaries, which were used prior to 1986 to estimate returns independent of count data from Mactaquac Dam, became increasingly difficult to obtain by early November and to interpret. CAFSAC expressed concern over the constant proportion method as it allowed for neither a greater contribution by hatchery returns to recruitment of "wild" stocks above Mactaquac Dam, nor differential distant exploitation on the earlier-run stock components from above Mactaquac and later-run stock components from tributaries below Mactaquac. Thus, stock status and forecasts for tributaries below Mactaquac were discontinued.

## METHODS

## Returns destined for Mactaquac

Total returns of $1 S W$ and MSW salmon of both wild and hatchery origin from and above Mactaquac Dam consist of the summation of Mactaquac counts, estimated angling catches in the mainstem area immediately below the Mactaquac Dam (including Kingsclear) and estimated by-catch in downriver shad, gaspereau and "other" species fisheries.

Mactaquac counts consist of those fish captured at the fish collection facilities at the Mactaquac Dam and at the smolt migration channel at the Mactaquac Fish Culture Station. Because the facility was closed on Oct. 20 rather than at the end of October a 1984-1988 average of the proportion of the total run in the last $10-12$ days of the run was used to adjust the 'count' to that of a full season. The identification of $1 S W$ and MSW returns from l-year smolts released at Mactaquac and juveniles released above Mactaquac were dependent on fin erosion (principally dorsal fin). By-catch was estimated to be $2 \%$ of the $1 S W$ and $5 \%$ of the MSW river returns - values which approximate the mean estimates for the years 1981-1984. Both the by-catch and sport catch were assumed to consist of fish of hatchery and wild origins in the same proportion as those counted at Mactaquac.

## Removals of fish originating at/above Mactaquac

Removals include estimates of fish taken by the Tobique Indian Band, preliminary provincial, federal and native estimates of sport catch on the mainstem below Mactaquac, mainstem above Mactaquac (incl. Salmon River, Victoria Co., ) the Tobique River and a by-catch in the estuary. An estimate of the catch at Tobique Indian Reserve was obtained by a synthesis of information given on site and during negotiations for a Food Fishery Agreement. Additional removals include some fish; captured in the Mactaquac collection facilities and transferred to the Aroostook River, monitored through the newly operational fish-lift at Tinker Dam on the Aroostook River, retained at Mactaquac for broodstock, mortalities encountered during collection-handling operations and sacrificed for analysis. Losses of MSW fish to hook-and-release mortality were estimated at $2 \%$ of the run placed above Mactaquac, i.e., similar to a previously used 10\% loss on estimated MSW sport catch. Losses to poaching and disease ascribed in the 1988 assessments were used in 1989, i.e., $4 \%$ of $15 W$ and $10 \%$ of MSW fish placed above Mactaquac (exclusive of those estimated to have been taken by the Tobique Indians). For the most part, losses were apportioned to hatchery/wild components on the basis of estimated stock composition.

## Required Spawners

An accessible salmon-producing substrate of $12,261,000 \mathrm{~m}^{2}$ above Mactaquac, an assumed requirement of $2.4 \mathrm{egg} / \mathrm{m}^{2}$, a length-fecundity relationship ( $\log _{e}$ Eggs $=6.06423+0.03605$ Fork Length) applied to MSW and lSW fish, 1972-1982, and the 1 SW:MSW ratios in those years suggest that, on average, approximately 4,400 MSW fish are required above Mactaquac (Marshall and Penney MS 1983). Because 1 SW fish normally contribute so few eggs (usually fewer than 5\% females) a management philosophy limits lSW
requirements to that number which provides males for MSW females unaccompanied by MSW males, i.e., 3,200 fish (Marshall and Penney op. cit.).

## Stock Forecasts

## 1SW Wild

The forecast of wild lSW returns originating above Mactaquac was derived from a regression of total wild 1 SW fish returning to the Saint John River which were produced above Mactaquac, 1973-1987, on adjusted (method in Penney and Marshall MS 1984, with data updates, App. 1, 2 and 3 this paper) egg depositions in the Tobique River, 1968-1969 to 1982-1983.

Egg depositions for the period 1982-1983 were adjusted in the same manner as Penney and Marshall (MS 1984) using freshwater age composition from 475 wild lSW fish sampled at Mactaquac in 1989 (one-third of scales was unread at time of assessment). Adjustment of the 1985 and 1986 egg depositions, principal contributors to 1SW returns in 1990, was done with the use of angular-transformed mean proportions for age 2:1 and age 3:1 lSW fish in the 1969 to 1983 year-classes.

To make multiplicative effects of environment, competition, variability in recruits etc. amenable to linear regression analysis, the natural logarithms of the observed values were used (Ricker 1975). The geometric mean (GM) Y resultant of the logarithmic relationship was converted to an arithmetic mean (AM) by the formula $\log _{10}(A M / G M)=0.2172 \mathrm{~s}^{2}(\mathrm{~N}-1) / \mathrm{N}$, where s is the standard deviation from the regression line of the normally-distributed natural logarithms of the variates (Ricker 1975, p. 274).

## MSW Wild

A forecast of MSW returns to homewaters in 1990 which originated above Mactaquac was again examined through the regression of the estimated MSW returns destined for Mactaquac, 1971-1989, on the estimated numbers of 1SW fish originating above Mactaquac and returning to Saint John River in the previous year. Analysis included the use of natural logarithms and conversion of the GM to AM. Because the prediction from the regression had been very different from returns, 1987-88, the forecast for 1989, and again for 1990 is estimated as the product of wild 1SW returns destined for Mactaquac 1989, and the mean of $7 \mathrm{MSW} / 1 \mathrm{SW}$ ratios < 1.0 since 1980 .

## 1SW Hatchery

The release since 1985, of l-year smolts, as opposed to principally 2year smolts 1967-1984, prevented the forecasting of lSW or MSW hatchery returns by either the product of the long-term return rates and the number of smolts released or by regression technique. Instead, the return rate for age 1.1 fish returning to Mactaquac in 1990 was assumed to be the same as the mean (arcsine) of the 1986-1989 'adjusted' return rates (App.4). Age 1.1 returns were adjusted by removal of the estimated returns to Mactaquac from smolts released in tributaries below Mactaquac. Tag returns at Mactaquac were used to derive a mean (arcsine) proportion of adults that would return to Mactaquac from smolts released in tributaries below (App.5).

Additional lSW returns of age $3: 1$ and age $2: 1$ are expected at Mactaquac in 1990 from fall fingerlings (age $0^{+}$) culled from the l-year smolt program and released in tributaries above Mactaquac in 1986 and 1987. Returns were calculated as the product of return rates to Mactaquac of releases of fall fingerlings above Mactaquac in 1985 and 1986 and the numbers released (App. 6). Release of unfed fry were accorded one-tenth the return rate of fall fingerlings.

## MSW Hatchery

Returns as MSW fish from 1-year smolts released at Mactaquac in 1988 were estimated as the product of their number and adjusted mean (arcsine) return rate for l-year smolts released from Mactaquac 1985-1987 (App.4). As with 1 SW hatchery returns, MSW fish destined for Mactaquac from releases below were proportioned on the basis of tag returns 1985-1989 (App. 5).

As well, MSW returns of age $3: 2$ and age $2: 2$ were expected from fall fingerlings released above Mactaquac in 1985 and 1986. Returns of age 2:2 salmon were calculated as the product of their numbers and a return rate to Mactaquac of the 1984 and 1985 releases above Mactaquac (App. 6).

Maiden hatchery fish in 1988 and 1989 are also expected to contribute to repeat spawning MSW fish in 1990. This return was approximated by applying return rates of 0.05 (1SW) and 0.146 (MSW), for combined consecutive and alternate-year spawners (Marshall and MacPhail MS 1987) to 1989 adults of hatchery origin which were estimated to have spawned. This assumes that appropriate numbers of alternates would originate from the 1988 escapement.

RESULTS

## Returns destined for Mactaquac

Estimated homewater returns in 1989 totalled 10,861 1SW and 4,541 MSW fish (Table l). The removal by anglers in the mainstem immediately below Mactaquac is provisionally estimated at 1,005 lSW fish. Hatchery returns comprised $12 \%$ and $10 \%$ of the total 1 SW and MSW returns, respectively.

## Removals

Provisional sport lSW removals additional to those in the main stem consist of 1,299 fish above Mactaquac (Table 2). The Tobique Indian Band harvested an estimated 800 salmon. Fishing was conducted below the Dam (2-3 nets) and in the Headpond (6-8 nets) with gill nets of 38 m length and a mesh size of 102 mm . The catch was assumed to consist of hatchery and wild 1 SW and MSW fish in proportions similar to those placed in the Tobique Headpond and passed through the Tobique fishway.

MSW losses above Mactaquac to poaching and disease combined were set at $10 \%$ (exclusive of those taken by the Tobique Indians). ISW losses to poaching and disease were set at $4 \%$. Included in these losses are the dozen or so mostly MSW mortalities noted, heard-of or observed by provincial/federal officials working on the Tobique River and the 30 or so fish lost due to handling fish in the Tobique fishway. Fish sampled mostly from within the

Half-Mile barrier pool by NBDNRE personnel and submitted to analyses for viral and bacterial pathogens again revealed furunculosis. Losses were, however, few compared to 1988.

Removals by all factions were estimated at 3,618 1SW fish of which 165 made their way over Tinker Dam on the Aroostook River and 1,371 MSW salmon of which 55 were transferred over the Tinker Dam and 425 retained as broodfish at Mactaquac.

## Spawning Escapement

Collation of the total returns (Table 1), total removals (Table 2) and numbers of fish required on average to meet an egg deposition of $2.4 \mathrm{eggs} / \mathrm{m}^{2}$ indicate that $72 \%$ of the required MSW spawners were attained above Mactaquac, (Table 3). For lSW fish, 225\% of requirements were met above Mactaquac. An estimated $8 \%$ of wild and $2 \%$ of hatchery ISW fish were female and had the potential to deposit about 1.8 milli on eggs, $\left(0.15 / \mathrm{m}^{2}\right)$ or the equivalent of about 240 MSW females.

## Stock Forecasts

## 1SW Wild

The 1990 forecast of wild lSW fish returning to Mactaquac in the absence of homewater removals was based on the regression of returns to homewaters of 1SW fish which originated above Mactaquac on estimated Tobique River egg depositions adjusted for smolt age. The AM estimate for lSW returns in 1990 is 7,393 lSW fish ( $95 \%$ C.L. $5,601-9,757$ ) (Table 4). The method forecast 8,197 ( $5,846-11,493$ ) $15 W$ fish for $1989 ; 9,522$ fish were estimated to have returned.

## MSW Wild

A forecast of wild MSW fish destined for Mactaquac in 1990 was provided by the product of the mean ratio (0.664) MSW/1SW 1980-1981 through 1988-1989, exclusive of the high ratios, 1983-1984, 1984-1985, and 9,522 1SW returns in 1989. The method suggests that MSW returns to Mactaquac in 1990 should be 6,325 fish. The same approach in 1989 suggested that 6,232 MSW would return in 1989-4,072 (65\%) were actually accounted for. However, low sea-surface temperatures in the Labrador Sea in the winter of 1988-89 and unusual drift ice in W. Greenland in Aug-Sept of 1989 may foretell of at least an average to above average MSW:1SW ratio for 1990. Low sea temperatures of 1983-1984 coincided with high MSW:ISW ratios for 1984 and 1985. The regression $\log _{\mathrm{e}} \mathrm{Y}=$ $5.721+0.341 \log _{\mathrm{e}} \mathrm{X}\left(\mathrm{n}=19 ; \mathrm{r}^{2}=0.22 ; \mathrm{p}<0.05\right.$; Table 4) which has, since 1986, forecast MSW returns of double the actual and the 9,522 1SW returns to Mactaquac in 1989 provided an AM estimate of 7,530 MSW fish.

## 1SW Hatchery

The forecast of hatchery 1SW fish destined for Mactaquac in 1990 was in part calculated as the product of an estimated 238,2041 - and 2 -year smolts released at Mactaquac and an adjusted 0.00940 return rate (Table 5), i.e., 2,239 fish. Another 235 and 89 would return from smolts placed above and below Mactaquac, respectively. In addition, it was estimated that fall
fingerlings released above Mactaquac in 1986 and 1987 would contribute another 147 lSW fish (Table 5). The total forecast of hatchery $1 S W$ returns to Mactaquac is 2,710 lSW fish. The 1989 forecast, by these methods exceeded returns by about $35 \%$. A lower average return rate for this forecast and the release in 1989 of more larger smolts would likely suggest that the forecast for 1990 is conservative.

## MSW Hatchery

MSW returns destined for Mactaquac in 1990 were calculated as the sum of the product of an estimated return rate of 0.0038 and 142,195 smolts released at Mactaquac ( 540 fish) and 0.26 of returns from 71,812 smolts released below Mactaquac in 1988 ( 71 fish). Additional returns are expected from fall fingerlings released in 1985 and 1986 and a 0.0001 survival/return rate (Table 5). The forecast of total hatchery MSW returns to Mactaquac, including repeat spawners is 750 MSW fish (Table 5).

## Forecast Summary

The forecast of total homewater returns to Mactaquac, Saint John River in 1990 is 10,103 1SW ( 7,393 of wild and 2,710 hatchery origin) and 7,075 MSW fish ( 6,325 of wild and 750 of hatchery origin). Forecast returns minus the spawning requirements of 3,2001 SW and $4,400 \mathrm{MSW}$ salmon result in potential surpluses of $6,903 \mathrm{lSW}$ and $2,675 \mathrm{MSW}$ salmon.

DISCUSSION

Estimated returns in 1989 of 10,861 wild and hatchery $1 S W$ and 4,541 wild and hatchery MSW salmon were $106 \%$ and $64 \%$ of predicted returns. Comparisons of predicted and actual (estimated) returns for each of wild and hatchery fish since 1984 are as follows:

| Sea-age | Returns | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 |
| :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- |

Wild

| 1SW | Predicted | 6,616 | 7,063 | 5,075 | 4,989 | 6,054 | 8,197 |
| :--- | :--- | ---: | ---: | ---: | ---: | ---: | ---: |
|  | Returned | 8,311 | 6,526 | 7,904 | 5,909 | 8,930 | 9,522 |
|  | Ret/Pred | 1.26 | 0.92 | 1.56 | 1.18 | 1.48 | 1.16 |
|  |  |  |  |  |  |  |  |
| MSW | Predicted | 4,896 | 8,413 | 7,702 | 8,327 | 6,983 | 6,232 |
|  | Returned | 9,779 | 10,436 | 6,128 | 4,352 | 2,625 | 4,072 |
|  | Ret/Pred | 2.00 | 1.24 | 0.80 | 0.52 | 0.38 | 0.65 |


| Sea-age | Returns | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 |
| :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- |

Hatchery

| 1SW | Predicted | 3,106 | 4,292 | 117 | 2,319 | 2,165 | 2,080 |
| :--- | :--- | ---: | ---: | ---: | ---: | ---: | ---: |
|  | Returned | 1,451 | 2,018 | 862 | 3,328 | 1,250 | 1,339 |
|  | Ret/Pred | 0.47 | 0.47 | 7.37 a | 1.44 | 0.58 | 0.64 |
|  |  |  |  |  |  |  |  |
|  | MSW | Predicted | 1,342 | 873 | 1,134 | 2,654 | 1,023 |
|  | Returned | 1,115 | 875 | 797 | 480 | 912 | 469 |
|  | Ret/Pred | 0.83 | 1.00 | 0.70 | 0.18 a | 0.89 | 0.53 |

a First returns from 1-year smolts.

MSW returns, including fish of hatchery origin are the fourth lowest of a 15-year data set (Table 6). Returns of wild lSW fish above Mactaquac were $116 \%$ of predicted; wild MSW fish above were $65 \%$ of predicted values. Hatchery 1SW and MSW returns were $64 \%$ and $53 \%$ of forecasts. Despite the, lowest harvest of MSW fish in two decades (Table 7), and equally low losses (Table 2), spawning escapement of MSW fish was only $72 \%$ of requirement. Deficits in spawning escapement, 1986-1988 (82, 64, and 35\% of requirements, respectively), together with that of 1989 should deter managers from allocating predicted MSW surpluses during the next several years.

For the third year in a row, wild MSW returns have been low relative to both the period of record and those predicted. In contrast, wild lSW returns over the last few years have been high both with respect to the period of record and those predicted. Potential reasons for the resultant low MSW/1SW ratios (Table 4) including early (lSW) maturation of salmon which might otherwise have matured after two winters at sea and higher than normal natural mortality of those fish at sea during the second winter were discussed by Marshall (MS 1989). Early maturation/crossover to lSW fish is unlikely to be evident in sex ratio data for lSW fish (Marshall, op. cit.). However, the results have stimulated examination of other potential indices of marine survival/growth useful in a new/revised MSW forecast model. Until revised, predicted MSW values must be viewed with caution.

Predicted returns of hatchery-origin fish have had little reliability in most of the last six years. However, their predicted contributions to the run of hatchery and wild fish have in general been low ( $20 \%$ of 1 SW and $12 \%$ of MSW in 1989), just as have been the estimated returns ( $12 \%$ of 1 SW and $10 \%$ of MSW for 1989). Predictive capabilities for hatchery-origin fish are not only potentially impeded by the same operands affecting returns of wild fish but as well by the limited data set for returns from l-year smolts (1986-1989), fish that have not been hi-graded to support the building of the aquaculture industry (1989) and on-going efforts to improve smolt quality. Hence, improvements in predicting hatchery returns may benefit from investigations that would allow normalization of the survivability of all smolts released from Mactaquac over the last two decades.

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Table 1. Estimated total returns of wild and hatchery lSW and MSW salmon destined for Mactaquac Dam on the Saint John River, N.B., 1989.

| Seaage | Components | Wild | Hatch. | Total |
| :---: | :---: | :---: | :---: | :---: |
| 1SW |  |  |  |  |
|  | Mactaquac counts | 8,417 | 1,170 | 9,587 |
|  | Adj. to Nov. closea | 8,451 | 1,188 | 9,639 |
|  | Angled MS below Mact | 881 | 124 | 1,005 |
|  | By-catch ${ }^{\text {b }}$ | 190 | 27 | 217 |
|  | Totals | 9,522 | 1,339 | 10,861 |
| MSW |  |  |  |  |
|  | Mactaquac counts | 3,854 | 437 | 4,291 |
|  | Adj. to Nov. closea | 3,868 | 446 | 4,314 |
|  | By-catch ${ }^{\text {b }}$ | 204 | 23 | 227 |
|  | Totals | 4,072 | 469 | 4,541 |

a Fishway closed oct. 20, 10-12 days earlier than usual; 1984-88 proportions of run $0.004,0.0155,0.0035,0.0201$ used for $15 W$, wild, hatch \& MSW wild and hatch., respectively.
b Proportions of $2 \%$ total lSW returns and 5\% total MSW returns.

Table 2. Estimated homewater removals of 1 SW and MSW salmon destined for Mactaquac Dam on the Saint John River, N.B., 1989.

| Components | 1SW |  |  | MSW |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | Wild | Hatch | Total | Wild | Hatch | Total |
| Kingsclear Indians | 0 | 0 | 0 | 0 | 0 | 0 |
| Tobique Indians ${ }^{\text {b }}$ | 491 | 69 | 560 | 219 | 21 | 240 |
| Angled |  |  |  |  |  |  |
| Tobique River | 806 | 113 | 919 | - | - | - |
| Mainstem above Mact. | 333 | 47 | 380 | - | - | - |
| Mainstem below Mact. | 881 | 124 | 1,005 | 64 | - | 70 |
| Hook-release mort. ${ }^{\text {c }}$ | 0 | 0 | 0 | 64 | 6 | 70 |
| Trucked/passed to Aroost. | 145 | 20 | 165 | 52 | 5 | 55 425 |
| Hatchery broodfish | 32 | - | 32 | 348 | 77 | 425 8 |
| mortalities, etc. | - | - | - | 7 | 1 | 8 |
| Poaching/disease ${ }^{\text {d }}$ | 298 | 42 | 340 | 313 | 31 | 344 |
| By-catch | 190 | 27 | 217 | $\underline{204}$ | $\frac{23}{164}$ | $\underline{227}$ |
| Totals | 3,176 | 442 | 3,618 | 1,207 | 164 | 1,371 |

a Previous to significant federal and provincial input; wild:hatchery composition per estimated returns.
b Estimated at 800 fish, (approx. $10 \%$ exploit); 1 SW:MSW ratio similar to that of available fish,i.e., 0.70: 0.30.
c Estimated at $2 \%$ of MSW of salmon released above Mactaquac (exclusive of those to Tobique Indians).
d Estimated at $4 \%$ of all 1 SW and $10 \%$ of all MSW fish placed above Mactaquac (exclusive of those to Tobique Indians).

Table 3. Estimated homewater returns, removals and spawning escapement of 1 SW and MSW salmon destined for and above Mactaquac Dam, Saint John River, 1989.

| $\begin{aligned} & \text { Sea- } \\ & \text { age } \end{aligned}$ | Components | Wild | Hatch. | Total |
| :---: | :---: | :---: | :---: | :---: |
| 1SW |  |  |  |  |
|  | Homewater returns | 9,522 | 1,339 | 10,861 |
|  | Homewater removalsa | 3,176 | 442 | 3,618 |
|  | Retained below Mact. | 34 | 18 | 52 |
|  | Spawners | 6,312 | 879 | 7,191 |
|  | Target spawners ${ }^{\text {b }}$ |  |  | 3,200 |
|  | \% of target spawners |  |  | 225 |
| MSW |  |  |  |  |
|  | Homewater returns | 4,072 | 469 | 4,541 |
|  | Homewater removalsa | 1,207 | 164 | 1,371 |
|  | Retained below Mact. | 14 | 9 | 23 |
|  | Spawners | 2,851 | 296 | 3,147 |
|  | Target spawners ${ }^{\text {b }}$ |  |  | 4,400 |
|  | \% of target spawners |  |  | 72 |

a Includes broodfish for Mactaquac FCS (Table 2).
b Excludes broodfish for Mactaquac FCS (Table 2).

Table 4. Adjusted Tobique River egg deposition $/ 100 \mathrm{~m}^{2}$ (yr i \& i+1) recruiting to total wild ISW and MSW salmon which would have returned to Mactaquac in the absence of homewater removals in yr $i+5$ and $i+6$, resultant MSW:ISW salmon ratios, and forecast numbers of 1 SW and MSW fish to Mactaquac in the absence of homewater removals in 1990.

| Eggs/100 m² |  | Recruits |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | 1SW |  | MSW |  | $\begin{aligned} & \text { MSW/ } \\ & 1 \text { 1SW } \\ & (5) \end{aligned}$ |
| Years (1) | Number (2) | Year | Number (3) | Year | Number (4) |  |
| 1965-66 |  | 1970 | 3,057 | 1971 | 4,715 | 1.54 |
| 1966-67 |  | 71 | 1,709 | 72 | 4,899 | 2.87 |
| 1967-68 |  | 72 | 908 | 73 | 2,518 | 2.77 |
| 1968-69 | 23.95 | 73 | 2,070 | 74 | 5,811 | 2.81 |
| 1969-70 | 40.58 | 74 | 3,656 | 75 | 7,441 | 2.04 |
| 1970-71 | 74.35 | 75 | 6,858 | 76 | 8,177 | 1.19 |
| 1971-72 | 122.34 | 76 | 8,147 | 77 | 9,712 | 1.19 |
| 1972-73 | 85.39 | 77 | 3,977 | 78 | 4,021 | 1.01 |
| 1973-74 | 81.66 | 78 | 1,902 | 79 | 2,754 | 1.45 |
| 1974-75 | 371.61 | 79 | 6,828 | 1980 | 10,924 | 1.60 |
| 1975-76 | 330.50 | 1980 | 8,482 | 81 | 5,991 | 0.71 |
| 1976-77 | 244.80 | 81 | 5,782 | 82 | 5,001 | 0.86 |
| 1977-78 | 288.96 | 82 | 4,958 | 83 | 3,447 | 0.69 |
| 1978-79 | 167.00 | 83 | 4,309 | 84 | 9,779 | 2.27 |
| 1979-80 | 239.74 | 84 | 8,311 | 85 | 10,436 | 1.26 |
| 1980-81 | 219.60 | 85 | 6,526 | 86 | 6,128 | 0.94 |
| 1981-82 | 167.64 | 86 | 7,904 | 87 | 4,352 | 0.55 |
| 1982-83 | 88.97 | 87 | 5,909 | 88 | 2,625 | 0.44 |
| 1983-84 |  | 88 | 8,930 | 89 | 4,072 | 0.46 |
| 1984-85 |  | 89 | 9,522 | 1990 | 7,530c. | $6,325^{\text {d }}$ |
| 1985-86 | 270.65 | 1990 | 7,393b |  |  |  |

a See App. 1, 2 and 3 for derivation.
b Based on regression of lSW returns to Mactaquac, 1973-1987, (col. 3) on adjusted egg deposition in Tobique River, 1968-1969 to 1982-1983, (col. 2):
$\log _{e} Y=6.596+0.402 \log _{e} X ; n=15, r^{2}=0.45, p=0.008$
$Y_{1990}=7,393$ (AM); 95\% C.L. $=5,601$ to 9,757.
c Based on regression of MSW returns to Mactaquac, 1971-1989, (col. 4) on 1SW returns to Mactaquac 1970-1988 (col. 3):
$\log _{\mathrm{e}} \mathrm{Y}=5.7209+0.3409 \log _{8} \mathrm{X} ; \mathrm{n}=19, \mathrm{r}^{2}=0.22(\mathrm{p}<0.05)$
$Y_{1990}=7,530$ (AM).
d Product of mean ratio (0.664) MSW/lSW, 1980-1981 to 1988-1989, excl. of 1983-1984 and 1984-1985 and 9,522 returns in 1989.

Table 5. Forecasts of hatchery $1 S W$ and MSW returns to Mactaquac Saint John River, 1990, as estimated from numbers of various juveniles released at (At) or above (Abv) Mactaquac and estimated return rates.

| Release |  |  |  | Returns in 1990 |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Year | Loc. | Stage | Number | Rate | Age | 1SW | MSW |
| 1989 | At | 1-,2-yr smolt | 238,204 | $0.00940^{\circ}$ | 1-,2.1 | 2,239 |  |
| 1989 | Bl | 1-,2-yr smolt | 47,389 | $0.00940{ }^{\text {a }}$ @o.2b | 1-.2.1 | 2, 89 |  |
| 1989 | Abv | 1-,2-yr smolt | 50,000 | $0.00940^{\text {a }} \times 0.5$ | 1-,2.1 | 235 |  |
| 1987 | Abv | Fall fing. | 145,428 | $0.00050^{c}$ | - 2.1 | 73 |  |
| 1987 | Abv | Unfed fry | 266,257 | $0.00050 \mathrm{c} \times 0.1$ | 2.1 | 13 |  |
| 1986 | Abv | Fall fing. | 220,176 | $0.00028{ }^{\text {c }}$ | 3.1 | 61 |  |
| 1988 | At | 1-yr smolt | 142,195 | 0.0038 a | 1.2 |  | 540 |
| 1988 | Bl | l-yr smolt | 71,812 | $0.0038^{\text {a }}$ @ $0.26{ }^{\text {b }}$ | 1.2 |  | 71 |
| 1986 | Abv | Fall fing. | 220,176 | $0.00010^{c}$ | 2.2 |  | 22 |
| 1985 | Abv | Fall fing. | 289,000 | $0.00010^{\circ}$ | 3.2 |  | 29 |
|  |  | Adults 1989d |  | 0.05 (1SW) 0.146 | (MSW) various |  | 88 |
| Totals |  |  |  |  |  | $\overline{2,710}$ | 750 |

a Arcsine mean 1986-1989 adjusted return rate; proportions above and below (App. 4).
b App. 5.
c App. 6.
d Rates (Marshall and MacPhail MS 1987) applied to est. hatchery spawners (1989) i.e., 879 lSW and 296 MSW fish above Mactaquac.
-16-
Table 6. Estimated river returns of Saint John wild and hatchery lSW and MSW salmon destined for Mactaquac Dam, 1970-1989.

| Year | Wild |  | Hatchery |  | Total |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | 1SW | MSW | 1SW | MSW | 1SW | MSW |
| 1970 | 3057 | 5712 |  |  |  |  |
| 1971 | 1709 | 4715 |  |  |  |  |
| 1972 | 908 | 4899 |  |  |  |  |
| 1973 | 2070 | 2518 |  |  |  |  |
| 1974 | 3656 | 5811 |  |  |  |  |
| 1975 | 6858 | 7441 | 6374 | 2210 | 13232 | 9651 |
| 1976 | 8147 | 8177 | 9074 | 2302 | 17221 | 10479 |
| 1977 | 3977 | 9712 | 6992 | 2725 | 10969 | 12437 |
| 1978 | 1902 | 4021 | 3044 | 2534 | 4946 | 6555 |
| 1979 | 6828 | 2754 | 3827 | 1188 | 10655 | 3942 |
| 1980 | 8482 | 10924 | 10793 | 2992 | 19275 | 13916 |
| 1981 | 5782 | 5991 | 4730 | 2612 | 10512 | 8603 |
| 1982 | 4958 | 5001 | 2846 | 1531 | 7804 | 6532 |
| 1983 | 4309 | 3447 | 1445 | 581 | 5754 | 4028 |
| 1984 | 8311 | 9779 | 1451 | 1115 | 9762 | 10894 |
| 1985 | 6526 | 10436 | 2018 | 875 | 8544 | 11311 |
| 1986 | 7904 | 6128 | 862 | 797 | 8766 | 6925 |
| 1987 | 5909 | 4352 | 3328 | 480 | 9237 | 4832 |
| 1988 | 8930 | 2625 | 1250 | 912 | 10180 | 3537 |
| 1989a | 9522 | 4072 | 1339 | 469 | 10861 | 4541 |

a Preliminary

Table 7. Estimated landings (numbers) of Native, sport, commercial and by-catch of $1 S W$ and MSW salmon originating at or above Mactaquac on the Saint John River, 1970-1989.

| Year | Native ${ }^{\text {a }}$ |  | Sport ${ }^{\text {b }}$ |  | Commercial |  | By-catch ${ }^{\text {c }}$ |  | Total |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | ISW | MSW | 1SW | MSW | 1SW | MSW | 1SW | MSW | 1SW | MSW |
| 1970 |  |  | 392 | 333 | 105 | 3204 |  |  | 497 | 3537 |
| 1971 |  |  | 319 | 357 | 57 | 2391 |  |  | 376 | 2748 |
| 1972 |  |  | 311 | 770 |  |  | 41 | 6 | 352 | 776 |
| 1973 |  |  | 704 | 420 |  |  | 37 | 60 | 741 | 480 |
| 1974 | 27 | 569 | 2034 | 2080 |  |  | 26 | 8 | 2087 | 2657 |
| 1975 | 73 | 739 | 3490 | 1474 |  |  | 70 | 56 | 3633 | 2269 |
| 1976 | 526 | 2038 | 3580 | 2134 |  |  | 61 | 90 | 4167 | 4262 |
| 1977 | 64 | 1070 | 2540 | 3125 |  |  | 109 | 156 | 2713 | 4351 |
| 1978 | 92 | 1013 | 1151 | 899 |  |  | 114 | 129 | 1357 | 1429 |
| 1979 | 328 | 771 | 2456 | 589 |  |  | 55 | 69 | 2839 | 5195 |
| 1980 | 713 | 2575 | 3260 | 2409 |  |  | 105 | 211 | 4078 | 3195 |
| 1981 | 361 | 891 | 2425 | 1085 | 855 | 1228 | 165 | 485 | 3835 | 3689 3690 |
| 1982 | 235 | 2088 | 1880 | 921 | 554 | 469 | 58 | 212 | 2727 | 2539 |
| 1983 | 203 | 588 | 1453 | 637 | 378 | 1152 | 438888 | 162 | 2515 | 3031 |
| 1984 | 353 | 2135 | 1824 |  |  |  | 338 | 896 1771 | 3943 | 4297 |
| 1985 | 471 | 2526 | 3060 |  |  |  | 175 | 1771 | 2467 | 2746 |
| 1986 | 600 | 2400 | 1692 |  |  |  | 175 | 346 242 | 2115 | 1362 |
| 1987 | 280 | 1120 | 1650 |  |  |  | 185 | 177 | 2259 | 1377 |
| 1988 | 300 | 1200 | 1755 |  |  |  | 217 | 227 | 3081 | 467 |
| 1989 | 560 | 240 | 2304 |  |  |  | 217 | 227 |  |  |

a Kingsclear, 1974-88, Tobique 1988-89.
b DNRE and DFO sources, + calculated estimates (exploitation rates on known releases) for mainstem above Mactaquac.
c Guesstimates from various sources or assumed proportions of the run.

App. 1. Number of eggs/ $100 \mathrm{~m}^{2}$ deposited in the Tobique River, 1968-1986, and derivation of weighted number of eggs contributing to annual returns of wild lSW fish at Mactaquac, 1973-1987 and 1990 (explanation in Penney and Marshall MS 1984).

| Egg deposition |  | Proportion age at smoltification ${ }^{\text {a }}$ |  | Eggs/100 m² contributing to lSW fish |  | ```Total \\ wt'd egg contrib/ \(100 \mathrm{~m}^{2}\) to 1SW fish Q Mact. (yr)``` |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Year | Number | Age 2 | $\text { Age } 3$ | Yr i | $\text { Yr } i+1$ |  |
| 1968 | 5.7 | 0.207 |  |  |  |  |
|  |  |  | 0.793 |  | 4.55 |  |
| 1969 | 43.6 | 0.445 |  | 19.40 |  | 23.95 (1973) |
| 1970 | 60.9 | 0.269 | 0.555 | 16.38 | 24.20 | 40.58 (1974) |
|  |  |  | 0.731 |  | 44.52 |  |
| 1971 | 71.2 | 0.419 |  | 29.83 |  | 74.35 (1975) |
|  |  |  | 0.581 |  | 41.37 |  |
|  | 130.8 | 0.619 | 0.381 | 80.96 | 49.84 | 122.33 (1976) |
| 1973 | 86.5 | 0.411 |  | 35.55 |  | 85.39 (1977) |
|  |  |  | 0.589 |  | 50.95 |  |
| 1974 | 269.4 | 0.114 | 0.886 | 30.71 | 238.69 | 81.66 (1978) |
| 1975 | 368.2 | 0.361 |  | 132.92 |  | 371.61 (1979) |
|  |  |  | 0.639 |  | 235.28 |  |
| 1976 | 245.4 | 0.388 |  | 95.22 |  | 330.50 (1980) |
| 1977 | 309.2 | 0.306 | 0.612 | 94.62 | 150.18 | 244.80 (1981) |
|  |  |  | 0.694 |  | 214.58 |  |
| 1978 | 193.2 | 0.385 |  | 74.38 |  | 288.96 (1982) |
|  |  |  | 0.615 |  | 118.82 |  |
|  | 112.3 | 0.42 | 0.571 |  | 64.12 | 167.00 (1983) |
| 1980 | 362.1 | 0.485 |  | 175.62 |  | 239.74 (1984) |
| 1981 | 118.7 | 0.279 |  | 33.12 |  | 219.60 (1985) |
|  |  |  | 0.721 |  | 85.58 |  |
| 1982 | 139.8 | 0.587 |  | 82.06 |  | 167.64 (1986) |
|  |  |  | 0.413 |  | 57.74 |  |
| 1983 | 69.4 | 0.450 |  | 31.23 |  | 88.97 (1987) |
| 1984 | 385.5 |  |  |  |  |  |
| 1985 | 301.7 |  |  |  |  |  |
| 1986 | 220.0 | $0.380{ }^{\text {b }}$ | $\underline{0.620}$ | 83.60 | 187.05 | 270.65 (1990) |

a Derived from App. 2 and 3.
b Mean ( $\mathrm{n}=16$ ) calculated with angular transformation.

App. 2. Number of wild 1SW salmon and proportion of age 2:1's of the total that would have returned to Mactaquac for the 1969-1984 year-classes.

| Year- <br> class (i) | Number at age of $15 W$ returns to Mactaquac |  |  |  | Prop. 2:1's of total |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  | 2:1 (i+3) | $3: 1(i+4)$ | 4:1 (i+5) | Total |  |
| 1968 |  | 690 | 41 |  |  |
| 1969 | 127 | 451 | 37 | 615 | 0.207 |
| 1970 | 1,578 | 1,901 | 68 | 3,547 | 0.445 |
| 1971 | 1,718 | 4,465 | 212 | 6,395 | 0.269 |
| 1972 | 2,325 | 3,186 | 44 | 5,555 | 0.419 |
| 1973 | 4,749 | 2,887 | 40 | 7,676 | 0.619 |
| 1974 | 1,046 | 1,393 | 103 | 2,542 | 0.411 |
| 1975 | 469 | 3,257 | 398 | 4,124 | 0.114 |
| 1976 | 3,468 | 5,598 | 544 | 9,610 | 0.361 |
| 1977 | 2,486 | 3,619 | 298 | 6,403 | 0.388 |
| 1978 | 1,619 | 3,659 | 13+6 | 5,296 | 0.306 |
| 1979 | 1,001 | 1,503 | 91+6 | 2,601 | 0.385 |
| 1980 | 2,793 | 3,540 | 176 | 6,509 | 0.429 |
| 1981 | 4,679 | 4,790 | 187 | 9,656 | 0.485 |
| 1982 | 1,548 | 3,737 | 270 | 5,555 | 0.279 |
| 1983 | 3,980 | 2,724 | 73 | 6,777 | 0.587 |
| 1984 | 2,915 | 3,245 | 323 | 6,483 | 0.450 |
| 1985 | 5,612 | 4,990 |  |  |  |
| 1986 | 4,209 |  |  |  |  |

App. 3. Freshwater age and number of wild lSW fish (A) counted at Mactaquac fish passage facilities, Saint John River, 1976 -1989, and (B) that would have returned to Mactaquac had they not been exploited/within the river, $1976-1989$.

| Freshwater | Number of 1SW fish |  |  |  |  |  |  |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| age | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 19898 |
| A |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 2 | 3,962 | 922 | 391 | 3,166 | 2,214 | 1,280 | 794 | 2,348 | 4,140 | 1,264 | 3,196 | 2,513 | 5,066 | 3,720 |
| 3 | 2,658 | 2,545 | 1,160 | 2,974 | 4,986 | 2,861 | 2,902 | 1,264 | 3,132 | 3,913 | 3,001 | 2,349 | 2,930 | 4,411 |
| 4 | -177 | - 39 | 133 | -94 | 355 | 430 | 236 | 11 | 81 | 144 | 150 | 233 | 66 | 286 |
| 5 |  |  |  |  |  |  |  |  |  | 5 |  |  |  |  |
| 6 |  |  |  |  |  |  |  |  |  | 5 |  |  |  |  |
| Total | 6,797 | 3,506 | 1,584 | 6,234 | 7,555 | 4,571 | 3,932 | 3,623 | 7,353 | 5,331 | 6,347 | 5,095 | 8,062 | 8,417 |
| B |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 2 | 4,749 | 1,046 | 469 | 3,468 | 2,486 | 1,619 | 1,001 | 2,793 | 4,679 | 1,548 | 3,980 | 2,915 | 5,612 | 4,209 |
| 3 | 3,186 | 2,887 | 1,393 | 3,257 | 5,598 | 3,619 | 3,659 | 1,503 | 3,540 | 4,790 | 3,737 | 2,724 | 3,245 | 4,990 |
|  | 212 | 44 | 1,40 | 103 | - 398 | 544 | 298 | 13 | 91 | 176 | 187 | 270 | 73 | 323 |
| 5 |  |  |  |  |  |  |  |  |  | 6 |  |  |  |  |
|  |  |  |  |  |  |  | 4,958 | 4309 | 8,311 | 6,526 ${ }_{6}$ | 7,904 | 5,909 | 8,930 | 9,522 |
| Total | 8,147 | 3,977 | 1,902 | 6,828 | 8,482 | 5,782 | 4,958 |  |  |  | 7,904 |  |  |  |

a Preliminary

App. 4. Estimated total number of $1 S W$ and MSW returns to the Saint John River from hatchery-reared smolts released at Mactaquac, 1974-1989.

| Releases |  |  | Returns (1SW/MSW) |  |  |  |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | $\begin{aligned} & \text { Prop } \\ & 1-\mathrm{yr} \end{aligned}$ |  | Mactaquac |  | Kingsclear | Angled main SJ | $\begin{gathered} \mathrm{By} \\ \text { catch } \end{gathered}$ | $\begin{gathered} \text { Commer- } \\ \text { cial } \end{gathered}$ | \% return |  |  |  |
| Year | Smolts |  | Year | Mig ch | Dam |  |  |  |  | Totala | Unadj | Adj |  |
| 1974 | 337,281 | 0.00 | 1975 | 1,771 | 3,564 | 28 | 977 | 34 |  | 6,374 | 1.890 |  |  |
| 75 | 324,186 | 0.06 | 76 | 2,863 | 4,831 | 219 | 1,129 | 32 |  | 9,074 | 2.799 |  |  |
| 76 | 297,350 | 0.14 | 77 | 1,645 | 4,533 | 36 | 708 | 70 |  | 6,992 | 2.351 |  |  |
| 77 | 293,132 | 0.26 | 78 | 777 | 1,779 | 49 | 369 | 70 |  | 3,044 | 1.038 |  |  |
| 78 | 196,196 | 0.16 | 79 | 799 | 2,722 | 100 | 186 | 20 |  | 3,827 | 1.951 |  |  |
| 79 | 244,012 | 0.09 | 80 | 3,072 | 6,687 | 335 | 640 | 59 |  | 10,793 | 4.423 |  |  |
| 80 | 232,258 | 0.12 | 81 | 921 | 2,861 | 139 | 350 | 74 | 385 | 4,730 | 2.037 |  |  |
| 81 | 189,090 | 0.08 | 82 | 828 | 1,464 | 64 | 267 | 21 | 202 | 2,846 | 1.505 | 1.445 |  |
| 82 | 172,231 | 0.06 | 83 | 374 | 857 | 39 | 69 | 11 | 95 | 1,445 | 0.839 | 0.776 |  |
| 83 | 144,549 | 0.22 | 84 | 476 | 828 | 36 | 63 | 48 |  | 1,451 | 1.004 | 0.976 |  |
| 84 | 206,462 | 0.28 | 85 | 454 | 1,288 | 82 | 128 | 66 |  | 2,018 | 0.977 | 0.920 |  |
| 74-84 | 2,636,747 |  |  |  |  |  |  |  |  | 52,594 | 1.995 |  |  |
| 85 | 89,051 | 1.00 | 86 | 64 | 635 | 53 | 93 | 17 |  | 862 | 0.968 | 0.868 |  |
| 86 | 191,495 | 1.00 | 87 | 198 | 2,679 | 96 | 288 | 67 |  | 3,328 | 1.738 | 1.570 |  |
| 87 | 113,439 | 1.00 | 88 |  |  | 15 | 46 | 16 |  | 794 | 0.700 | 0.672 |  |
| 88 | 142,195 | 1.00 | 89b |  | 018) | 0 | 107 | 23 |  | 1,148 | 0.807 | 0.763 |  |
| 89 | 238,204 | 0.98 |  |  |  |  |  |  |  |  |  |  |  |
| 1974 | 337,281 |  | 1976 | 310 | 1,313 | 392 | 267 | 20 |  | 2,302 | 0.683 |  |  |
| 75 | 324,186 |  | 77 | 341 | 1,727 | 206 | 417 | 34 |  | 2,725 | 0.841 |  |  |
| 76 | 297,350 |  | 78 | 223 | 1,728 | 368 | 165 | 50 |  | 2,534 | 0.852 |  |  |
| 77 | 293,132 |  | 79 | 145 | 747 | 210 | 65 | 21 |  | 1,188 | 0.405 |  |  |
| 78 | 196,196 |  | 80 | 302 | 1,992 | 506 | 146 | 46 |  | 2,992 | 1.525 |  |  |
| 79 | 244,012 |  | 81 | 126 | 963 | 252 | 125 | 147 | 999 | 2,612 | 1.070 |  |  |
| 80 | 232,258 |  | 82 | 88 | 640 | 462 | 181 | 50 | 110 | 1,531 | 0.659 |  |  |
| 81 | 189,090 |  | 83 | 44 | 255 | 76 | 17 | 23 | 166 | , 581 | 0.307 | 0.285 |  |
| 82 | 172,231 |  | 84 | 84 | 722 | 201 | 5 | 103 |  | 1,115 | 0.647 | 0.559 |  |
| 83 | 144,549 |  | 85 | 73 | 492 | 189 | 5 | 116 |  | 875 | 0.605 | 0.553 |  |
| 84 | 206,462 |  | 86 | 16 | 471 | 266 | 4 | 40 |  | 797 | 0.386 | 0.346 |  |
| 74-84 | 2,636,747 |  |  |  |  |  |  |  |  | 19,252 | 0.730 |  |  |
| 85 | 89,051 |  | 87 | 4 | 338 | 110 | 4 | 24 |  | 480 | 0.539 | 0.453 |  |
| 86 | 191,495 |  | 88 |  |  | 150 | 0 | 35 |  | 696 | 0.364 | 0.354 |  |
| 87 | 113,439 |  | 896 |  |  | 0 | 0 | 20 |  | 399 | 0.352 | 0.330 |  |
| 88 | 142,195 |  |  |  |  |  |  |  |  |  |  |  |  |
| 89 | 238,204 |  |  |  |  |  |  |  |  |  |  |  |  |

a Includes returns from downriver stocking of smolts, 1981-1988; adjusted return rate removes downriver returns to Mactaquac (see App. 5).
b 1SW hatchery fish at Mactaquac were estimated at $0.857,0.082$ and 0.061 age 1.1, 2.l and 3.1. MSW hatchery fish at Mactaquac were estimated at $0.850,0.064,0.026$ and 0.06 age $1.2,2.2,3.2$ and 'repeats', respectively. All estimates are preliminary.

App. 5. Smolt release information background to the calculation of 'adjusted' return rates for smolts released at Mactaquac and adjustment of hatchery (1982-1989) and wild (1982-1989) returns below Mactaquac. A:-Number of tag returns, return rates and proportionate contribution to Mactaquac from smolts released at and below Mactaquac 1983-1988; B:-Total smolts released below Mactaquac which originated from Mactaquac F.C.S. (also numbers released at Mactaquac) and C: Calculation of adjusted return rate for 1988 smolts returning as lSW fish in 1989.

| A. Seaage | Return year | Mactaquac tags |  |  | Below' tags |  |  | Ratio |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | Ret'n | Smolts | Ret'n | $\overline{\text { Ret }} \mathrm{n}$ | Smolts | Ret'n |  |
|  |  | Mact. | released | rate (a) | Mact. | released |  |  |
| lSW | 1984 | 64 | 10,000 | 0.00640 | 7 | 13,000 | 0.00054 | 1:0.0844 |
|  | 1985 | 114 | 19,988 | 0.00570 | 26 | 15,996 | 0.00163 | 1:0.2860 |
|  | 1986 | 97 | 15,900 | 0.00610 | 13 | 11,952 | 0.00109 | 1:0.1787 |
|  | 1987 | 113 | 15,901 | 0.00711 | 20 | 4,975 | 0.00402 | 1:0.5654 |
|  | 1988 | 59 | 11,550 | 0.00511 | 8 | 13,277 | 0.00060 | 1:0.1174 |
|  | 1989 | 51 | 7,761 | 0.00657 | 6 | 7,938 | $\underline{0.00076}$ | $\frac{1: 0.1157}{1: 0.2032}$ |
|  | (arcsine) |  |  | 0.00615 |  |  | 0.0012 | 1:0.20 |
| 2SW |  |  |  | 0.00300 | 11 | 13,000 | 0.00085 | 1:0.28333 |
|  | 1985 | 24 | 19,988 | 0.00120 | 10 | 15,996 | 0.00063 | 1:0.52500 |
|  | 1987 | 41 | 15,900 | 0.00258 | 9 | 11,952 | 0.00075 | 1:0.29070 |
|  | 1988 | 26 | 15,901 | 0.00164 | 1 | 4,975 | 0.00020 | 1:0.12195 |
|  | 1989 | 14 | 11,550 | 0.00121 | 3 | 13,277 | 0.00023 | 1:0.19008 |
|  | rcsine) |  |  | 0.00186 |  |  | 0.00049 | 1:0.26344 |

B.

|  | No. smolts released |  |  |
| :---: | :---: | :---: | :---: |
| Year | Above | At | Below |
| 1981 |  | 189,090 | $44,918^{\mathrm{a}}$ |
| 1982 |  | 172,231 | 80,535 |
| 1983 |  | 144,549 | 48,706 |
| 1984 |  | 206,462 | 46,126 |
| 1985 |  | 89,051 | 56,992 |
| 1986 |  | 191,495 | 38,387 |
| 1987 |  | 113,439 | 39,445 |
| 1988 |  | 142,195 | 71,812 |
| 1989 | $50,000 \mathrm{~b}$ | $238,204^{\mathrm{b}}$ | $47,389 \mathrm{~b}$ |

a not 'incl' 21,200 from Minto
b incl. 2-yr smolts from Saint John Hatchery
C. Calculation of adjusted return rates for smolts released at Mactaquac
l. In 1989, 1, 148 lSW fish return to Mactaquac from 142,195 smolts released at Mactaquac and some of 71,812 released below Mactaquac (App.4).
2. From $A$ (above) smolts contributing to Mactquac were $(142,195 \times 1)+$ $(71,812 \mathrm{x} .1157)=150,504$.
3. Adjusted return rate $=1,148 / 150,504$ or 0.00763 (App. 4).

App. 6 Estimates of hatchery 1 SW and MSW returns to the Saint John River, 1989, based on various numbers of juveniles released at (At) or above (Abv) Mactaquac and returns to Mactaquac.

| Release |  |  |  |  | Returns in 1989 |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Year | Loc |  | Stage | Number | Rate | Age | 1SW | MSW |
| 1988 | At | 1-yr | smolt | 142,195 | 0.00763 a | 1.1 | 1,085 |  |
| 1988 | Bl | 1-yr | smolt | 71,812 | $0.00763 ¢ 0.116^{\text {b }}$ | 1.1 | 63 |  |
| 1986 | Abv | Fall | fing. | 220,176 | 0.082c $\times 1339 / 220,176$ | 2.1 | 110 |  |
| 1985 | Abv | Fall | fing. | 289,000 | 0.061c $\times 1139 / 289,000$ | 3.1 | 81 |  |
| 1987 | At | 1-yr | smolt | 113,439 | $0.00330{ }^{\text {a }}$ | 1.2 |  | 374 |
| 1987 | Bl | 1-yr | smolt | 39,445 | 0.00330 @ 0.19b | 1.2 |  | 25 |
| 1985 | Abv | Fall | fing. | 289,000 | 0.064c $\times 469 / 289,000$ | 2.2 |  | 30 |
| 1984 | Abv | Fall | fing. | 123,600 | $0.026^{c} \times 469 / 123,600$ | 3.2 |  | 12 |
|  |  | Repeat spawners. |  |  | 0.013 (28/2127 in 1988) |  |  | 2889 |
| Total |  |  |  |  |  |  | 1,339 | 469 |

a See App. 4
b See App. 5
c Footnote App. 4.

