Fisheries and Oceans Canada
Science

Pêches et Océans Canada
Sciences

C S A S

Canadian Science Advisory Secretariat

S C C S

Secrétariat canadien de consultation scientifique

Research Document 2006/025

Document de recherche 2006/025

Not to be cited without
Permission of the authors *

Ne pas citer sans
autorisation des auteurs *

Assessments of Atlantic salmon stocks in southern and western New Brunswick (SFA 23), an update to 2005

Évaluations des stocks de saumon atlantique dans le sud-ouest du Nouveau-Brunswick – mise à jour pour 2005

R.A. Jones[1], L. Anderson[2], J.J. Flanagan[1]
and T. Goff[2]

Department of Fisheries and Oceans
Science Branch, Maritimes Region
[1]P.O. Box 5030, Moncton, NB E1C 9B6
[2]Mactaquac Biodiversity Facility, Kingsclear, NB E3E 2C6

ISSN 1499-3848

Canada

FOREWORD

This document is a product from a workshop that was not conducted under the Department of Fisheries Oceans (DFO) Science Advisory Process coordinated by the Canadian Science Advisory Secretariat (CSAS). However, it is being documented in the CSAS Research Document series as it presents some key scientific information related to the advisory process. It is one of a number of contributions first tabled at a DFO-SARCEP (Species at Risk Committee / *Comité sur les espèces en péril*) sponsored workshop in Moncton (February 2006) to begin the development of a 'Conservation Status Report' (CSR) for Atlantic salmon. When completed in 2007, the CSR could form the basis for a Committee on the Status of Endangered Wildlife in Canada (COSEWIC) status report, recovery potential assessment and recovery strategy, and most importantly, enable DFO to implement pre-emptive management measures prior to engagement in any listing process.

AVANT-PROPOS

Le présent document est issu d'un atelier qui ne faisait pas partie du processus consultatif scientifique du ministère des Pêches et des Océans, coordonné par le Secrétariat canadien de consultation scientifique (SCCS). Cependant, il est intégré à la collection de documents de recherche du SCCS car il présente certains renseignements scientifiques clés, liés au processus consultatif. Il fait partie des nombreuses contributions présentées au départ lors d'un atelier parrainé par le MPO-SARCEP (*Species at Risk Committee* / Comité sur les espèces en péril) à Moncton (février 2006) en vue de commencer l'élaboration d'un rapport sur la situation de la conservation du saumon atlantique. Lorsqu'il sera terminé, en 2007, ce rapport pourrait servir de base à un rapport de situation du Comité sur la situation des espèces en péril au Canada (COSEPAC), à une évaluation du potentiel de rétablissement et à un programme de rétablissement mais, avant tout, il permettra au MPO de mettre en œuvre des mesures de gestion anticipées avant même de s'engager dans un processus d'inscription.

ABSTRACT

Total one-sea-winter (1SW) (1,159) and multi-sea-winter (MSW) (350) returns destined for upriver of Mactaquac Dam on the Saint John River in 2005 were both the lowest on record since 1970. Wild origin fish comprised 74% of 1SW and 73% of MSW fish. Return rates for hatchery-released smolts were 0.38% (1SW) and 0.05% (2SW), an increase of 18% and a decrease of 54%, respectively, from the values in 2004. Spawners numbered 1,060 1SW and 273 MSW salmon, 22% and 6% of the respective requirements. The egg deposition estimate (80% from wild fish) was 6% of the requirement, the lowest value on record. An additional 5.2 million eggs (or 18% of requirement) were potentially deposited from captive-reared spawners in 2005.

Counts at the Nashwaak River fence resulted in a return of 731 1SW and 162 MSW salmon. Return rates for wild smolts to 1SW and 2SW fish in 2005 were 5.13% and 1.58%, a decrease of 20% and an increase of 25% from the previous year. Spawners represented 35% and 8% of the respective 1SW and MSW conservation requirements. An egg deposition of 16% of the requirement was similar to the previous year and slightly better than the five-year mean.

Counts of wild, hatchery and aquaculture origin salmon from fishways operated on the Magaguadavic and St. Croix rivers were 72 and 39 fish, respectively. Including the post smolts, ninety-six or 86% of the combined counts were deemed of aquaculture origin and denied access to both rivers. On the Magaguadavic River, five wild and four hatchery 1SW wild salmon were released upstream of the fishway which resulted in an estimated egg deposition of less than about 2% of the requirement. All hatchery salmon, two 1SW and four MSW fish, ascending the St. Croix River at Milltown were retained for broodstock purposes.

Total estimated returns and escapement of 1SW and MSW salmon to the Big Salmon River based on diver observations were 60 fish. The sixty fish represented less than 10% of the requirement and were three times greater than the returns the previous year.

Projected returns, based on the average returns of the previous five years, for populations originating upriver of Mactaquac Dam on the Saint John River in 2006 are 1,600 1SW (90% C.I.; 820 - 2,360) and 680 MSW (90% C.I.; 160 – 1,250) salmon. The probabilities of attaining the conservation requirement of 4,900 for both 1SW and MSW fish are near zero. Without a significant increase in both freshwater and marine survival, it is very unlikely that returns will be much greater than 2,000 fish in 2006.

Based on the five year average, 440 1SW (90% C.I.; 120 - 780) and 170 MSW (90% C.I.; 50 - 290) salmon are predicted to return to the Nashwaak River in 2006. Using the range (minimum and maximum) of smolt-to-1SW return rates observed since 1999 to the 2005 wild smolt estimate, the predicted 1SW returns to the Nashwaak in 2006 would be between 80 and 330 fish. Similarly, the predicted 2SW salmon return in 2006, from the 2004 smolt class, ranges from 40 to 210 fish. The probability of attaining the conservation requirement of 2,040 for both 1SW and MSW salmon is therefore near zero.

Wild and hatchery 1SW and MSW salmon returning to the Magaguadavic, St. Croix and Big Salmon rivers in 2006 are projected to be similar to the few fish that returned in 2005. There is a zero probability of attaining the conservation requirement in 2006.

RÉSUMÉ

Le nombre total de saumons unibermarins (UBM) (1159) et pluribermarins (PBM) (350) remontant vers l'amont du barrage Mactaquac sur le fleuve Saint-Jean en 2005 ont été les plus faibles enregistrés depuis 1970. Les poissons sauvages constituaient 74 % des poissons UBM et 73 % des poissons PBM. Les taux de remonte des saumoneaux d'écloserie se sont établis à 0,38 % (UBM) et à 0,05 % (2AM), pour une hausse de 18 % et un déclin de 54 % respectivement par rapport aux valeurs enregistrées en 2004. Le nombre de géniteurs a quant à lui totalisé 1060 individus pour les saumons UBM et à 273 individus du côté des saumons PBM, soit 22 et 6 % des besoins respectifs. L'estimation de la ponte (80 % provenant de poissons sauvages) représentait 6 % des besoins, la valeur la plus faible enregistrée jusqu'à présent. Un nombre supplémentaire de 5,2 millions d'œufs (ou 18 % des besoins) a pu être pondu par des géniteurs élevés en captivité en 2005.

Selon les dénombrements à la barrière de la rivière Nashwaak, une remonte de 731 saumons UBM et de 162 saumons PBM a eu lieu. Les taux de remontes des saumoneaux sauvages UBM et DBM en 2005 ont été de 5,13 et de 1,58 %, soit un déclin de 20 % et une hausse de 25 % respectivement par rapport à l'année précédente. Les géniteurs ont représenté 35 et 8 % des besoins respectifs en saumons UBM et de PBM pour la conservation. La ponte, correspondant à 16 % des besoins, a été similaire à celle de l'année précédente et légèrement en hausse par rapport à la moyenne quinquennale.

Les dénombrements de saumons sauvage, d'écloserie et d'origine aquicole effectués aux passes mogratoires des rivières Magaguadavic et Sainte-Croix se sont établis à 72 et 39 poissons respectivement. En incluant les postsaumoneaux, on estime que de 96 à 86 % des dénombrements combinés correspondaient à des poissons d'origine aquicole, qui n'avaient pas accès aux deux rivières. Sur la rivière Magaguadavic, les cinq saumons sauvages et les quatre saumons d'écloserie UBM relâchés en amont de la passe migratoire auraient assuré une ponte estimée à moins de 2 % des besoins. Tous les saumons d'écloserie, deux saumons UBM et quatre saumons PBM remontant la rivière St. Croix ont été prélevés à Milltown pour des fins de reproduction.

Le nombre total estimé de saumons UBM et PBM en remonte et en échappée vers la rivière Big Salmon, selon les observations de plongeurs, était de 60 individus. Ceux-ci représentaient moins de 10 % du besoin, mais leur nombre était trois fois supérieur à celui des remontes de l'année précédente.

D'après les remontes moyennes enregistrées au cours des cinq dernières années, les remontes prévues pour les populations originaires de l'amont du barrage Mactaquac sur le fleuve Saint-Jean en 2006 ont été de 1600 saumons UBM (IC de 90 %; 820-2360) et de 680 saumons PBM (IC de 90 %; 160-1250). Les probabilités d'atteindre les besoins en matière de conservation de 4900 saumons UBM et PBM sont quasi nulles. Si l'on n'observe pas une amélioration significative de la survie en eau douce et en mer, il est très improbable que les remontes soient bien supérieures à 2000 poissons en 2006.

Si l'on se fonde sur la moyenne quinquennale, on prévoit que 440 saumons UBM (IC de 90 %; 120-780) et 170 saumons PBM (IC de 90 %; 50-290) remonteront la rivière Nashwaak en 2006. Si l'on compare la fourchette (minimum et maximum) du nombre de poissons UBM en remonte observés depuis 1999 et l'estimation du nombre de saumoneaux sauvages en 2005, les remontes de saumons UBM vers la rivière Nashwaak en 2006 devraient osciller entre 80 et 330 individus. De la même manière, les prévisions de 2006 concernant la remonte de saumons DBM issus de la classe de saumoneaux de 2004 varient de 40 à 210 individus. Ainsi, la probabilité de combler le besoin en matière de conservation de 2040 poissons UBM et PBM est quasi nulle.

On prévoit que les remontes de saumons sauvages et d'écloserie UBM et PBM vers les rivières Magaguadavic, Sainte-Croix et Big Salmon en 2006 seront similaires aux faibles remontes de 2005. Il est par conséquent improbable que l'on comble les besoins en matière de conservation en 2006.

INTRODUCTION

This document assesses the status of Atlantic salmon (*Salmo salar*) populations for SFA 23. This comprises the outer Bay populations of the western part of SFA 23 including the **Saint John River upriver of Mactaquac Dam**, the **Nashwaak River** (a tributary to the Saint John River downriver of Mactaquac Dam), the **Magaguadavic River** and the **St. Croix River.** The **Big Salmon River** which is part of the “endangered” inner Bay of Fundy salmon populations is also included. The outer Bay salmon populations have declined significantly and have failed to attain egg conservation requirements for the last 20 years.

Data and analyses of Saint John River populations pertain primarily to populations originating upriver of Mactaquac Dam and the Nashwaak River. Data collections were made possible to a large extent because of collaborations with the Tobique Salmon Protective Association, Nashwaak Watershed Association, NB Power, as well as Kingsclear, Woodstock, Oromocto and Tobique First Nations. The data for the Magaguadavic River were provided by the Atlantic Salmon Federation and data for the St. Croix River were provided by the St. Croix International Waterway Commission. Data and analyses on the Big Salmon River were made possible from funds acquired from the Interdepartmental Recovery Fund and collaborations with Fort Folly First Nation, Fundy National Park, Atlantic Salmon Federation and New Brunswick Department of Natural Resources.

Projected returns for populations originating upriver of Mactaquac Dam on the Saint John River in 2005 were 1,630 1SW and 720 MSW salmon with probabilities of less than 1% of attaining the conservation requirement. Predicted returns to the Nashwaak River in 2005 were 400 1SW and 175 MSW salmon. The estimated smolt output from the Nashwaak River in 2004 along with the average smolt-to-1SW return rate, suggested that 1SW returns in 2005 would be 400 fish. 1SW and MSW returns to the Magaguadavic, St. Croix and Big Salmon rivers in 2005 were projected to be no greater than the few fish that returned in 2004 with a near-zero probability of attaining the conservation requirement.

Many of the outer Bay populations face a multitude of constraints. These include hydroelectric dams (with upriver passage facilities but most are devoid of safe downstream passage), artificial flow regimes, headponds, significant industrial and municipal effluents, run-off from intensive agricultural and forestry operations, and developing communities of invasive predators (i.e. muskellunge, smallmouth bass and rainbow trout). As well, juvenile and adult salmon escapes from the Fundy-Isle (NB) or Cobscook Bay (ME) aquaculture facilities are the most probable sources of aquaculture origin salmon identified at all primary counting facilities.

SAINT JOHN RIVER UPRIVER OF MACTAQUAC DAM

Physical attributes, salmon production area (updated in Marshall et al. 1997), barriers to migration, fish collection and distribution systems, the role of fish culture operations (updated in Jones et al. 2004) and biology of the populations of the Saint John River drainage (Fig. 1), have been previously described in Marshall and Penney (1983). In 1983, the status of the salmon populations, since 1970, were estimated (Penney and Marshall 1984) and continued through to 2003 (Jones et al. 2004). The assessment documents for the 1998 and 1999 returns were less detailed than those done previous to 1998 (Marshall et al. 1999a, Marshall et al. 1999b, and Marshall et al. 2000). Stock status in 2000, 2001 and 2002 has been reported in the Atlantic Salmon Maritime Provinces Overviews (DFO 2001, DFO 2002, and DFO 2003). The approach in this assessment of populations in southwest New Brunswick is similar to that of the last detailed assessment completed in 2003 (Jones et al. 2004).

Description of fisheries

The entire Saint John River has been closed to commercial fishing for Atlantic salmon since 1984, and the persistent failure of populations to achieve the conservation requirement has resulted in complete closures of the Aboriginal food and recreational fisheries since 1998. The recreational fishery has been closed since 1995 with the exception of a hook and release fishery that occurred from July 15 to August 12, 1997 (Marshall et al. 1998).

The Maritime Provinces' commercial salmon fishery has been closed since 1984 and, after several buy-backs of licences, has only four eligible but inactive licences remaining in the Saint John River area. The moratoria on commercial salmon fisheries since 1992 in insular Newfoundland and since 1998 in Labrador both continued in 2005.

Returns destined for upriver of Mactaquac Dam

Methods

The adjusted counts at Mactaquac Dam, estimates of removals in the main stem downriver of Mactaquac Dam and the assumed by-catch in May and early-June in downriver shad and gaspereau net fisheries are summed to give the total 1SW and MSW salmon returns (wild and hatchery origin) from upriver of Mactaquac Dam.

Counts at Mactaquac Dam consist of fish captured at the fish collection facilities at the Mactaquac Dam and at the smolt migration channel at the Mactaquac Biodiversity Facility. During 2005, the fish collection facilities at the dam and the migration channel at the biodiversity facility were operated from May 20 to October 25.

Returning salmon were sorted at the Mactaquac Biodiversity Facility sorting facility and were classified as being either of wild origin, hatchery origin or aquaculture escapes. Hatchery origin salmon that were released as 1-year smolts at the smolt migration channel at the Mactaquac Biodiversity Facility or as juveniles (essentially fall parr) released upriver of Mactaquac, were principally identified by the absence of an adipose fin. Fish with an adipose fin but with some fin erosion were classified as hatchery origin if interpretation of scale patterns confirmed they were not an aquaculture escape. Suspected aquaculture escapes were identified by considerable erosion and partial regeneration of fin rays on all fins including the upper and/or lower lobes of the caudal fin, the presence of an adipose fin and the interpretation of scale samples. All other fish were classified as wild origin including returns from hatchery origin unfed and feeding fry that were more likely to have unclipped, un-eroded fins, and are indistinguishable from wild origin fish.

Marshall and Jones (1996) described the difficulty in distinguishing between adult returns from natural versus artificial recruitment because of the increasing numbers of unmarked hatchery distributions in the early and mid 1990's. Since 1998, the majority of the fall fingerling parr and spring smolts released upriver of Mactaquac Dam have had the adipose fin removed (Appendix *i*, Appendix *ii*, Fig. 2a, Fig. 2b). Scale samples are taken from approximately every second hatchery and wild fish (exceptions include the complete sampling of all broodstock). The proportion of wild and hatchery origin in the count was adjusted based on interpretation of these scales. The procedures used to adjust counts in 2005 are identical to those used since 1995 and described in Marshall and Jones (1996). The adjusted counts at Mactaquac Dam were used to estimate the returns and return rates for hatchery fish released as age-1 smolts and some age-0+ parr.

As in previous years, salmon by-catch in the lower river and in the Saint John Harbour was monitored by DFO fishery officers. Consistent with previous assessments, the assumed catch rates were 1% of the 1SW and 2.5% of the MSW river returns. Catches of salmon destined for upriver of Mactaquac Dam and caught downriver were assumed to consist of hatchery and wild origin salmon in the same proportions as the adjusted counts at Mactaquac.

Results

Unadjusted counts of salmon at Mactaquac in 2005 totalled 1,126 1SW and 363 MSW salmon (Tables 1 and 2). Twenty-one (5.8%) of the 363 MSW salmon counted at Mactaquac were reassigned to 1SW category on the basis of scale interpretation (Table 1). Interpretation of scales shifted the hatchery component among 1SW fish from 23.5% (Table 1) to 25.5% and among MSW fish from 25.9% to 27.5%. The adjusted counts proportioned by age composition among hatchery and wild components since 1992 are tabled in Appendix *iii*. There were no aquaculture escapes identified in 2005.

There were no reports from DFO fisheries officers of illegal fishing in the main stem downriver of Mactaquac Dam in 2005. An estimated 12 1SW and 8 MSW salmon were ascribed to by-catch in the shad and gaspereau nets in the lower river and Saint John Harbour area (Table 1).

Adjusted wild origin and hatchery origin returns in 2005 were 1,159 1SW and 350 MSW fish (Table 1; Fig. 3). Both 1SW and MSW returns were the lowest in a 36-year time series (Table 3). Adjusted returns of wild origin 1SW salmon were similar to those of 2004, and the previous five and ten year means, but was the seventh lowest annual estimate since 1970 (Table 3). Adjusted returns of wild origin MSW salmon were the third lowest in 36 years and were well below the five and ten year mean estimates (Table 3). The return rate to Mactaquac Dam of 1SW fish released as 1-year smolts was 0.38% – a slight improvement from the previous two years (Table 4a; Fig. 4). The return rate of 1-year smolts to Mactaquac Dam as virgin 2SW salmon (Table 4b; Fig. 4) was 0.05% - second lowest on record and about half that of the previous year.

Removals of fish destined for upriver of Mactaquac Dam

Methods

Removals from the potential spawning escapement destined for the traditional production areas upriver of Mactaquac include: 1) the estimate of 1SW and MSW salmon ascribed to by-catch in the estuary, 2) salmon passed or trucked upriver of Tinker Dam on the Aroostook River (Fig. 1), 3) salmon retained at Mactaquac as broodstock, and 4) salmon estimated to have been lost to poaching/disease, or handling operations at Mactaquac.

Losses to poaching and disease include those estimated to have been taken in the net fishery on the Tobique River, and known mortalities from fishways (Beechwood, Tobique and/or Tinker Dam) or the Tobique Half Mile Barrier. If detailed information was not available for the losses, they were apportioned to hatchery/wild components on the basis of known or estimated stock composition of fish released upriver of Mactaquac.

Results

Reports from area fisheries officers indicated that there was illegal fishing activity near Tobique Narrows Dam in 2005 but the number of fish harvested was unknown. A fishing mortality estimate, derived from a fishway efficiency study (Jones et al. 2004) was applied to the number of fish passed upriver of Beechwood Dam and ascribed 60 fish in this illegal fishery. Unlike previous years, there were no adult salmon from Mactaquac transported to the Aroostook River upriver of Tinker Dam, although there were six 1SW and two MSW fish counted at the Tinker Dam fishway (Table 5). The area upriver of Tinker Dam was excluded from the "upriver of Mactaquac" conservation requirement (Marshall et al. 1997).

Total river removals from all sources were estimated at 99 1SW and 77 MSW fish (Table 5) of which 12 (10 males and two females) 1SW and 36 (twelve males and 24 females) MSW salmon were held at Mactaquac for broodstock. These early-run broodstock yielded about 161,000 eggs.

Conservation Requirements

The conservation requirement is based on an accessible salmon-producing rearing area of 13,472,200 m^2 >0.12% and <15.0% gradient (Amiro 1993) upriver of Mactaquac Dam. This excludes the Aroostook River, headponds, and 21 million m^2 of river with gradient <0.12% (Marshall et al. 1997). Based on an assumed requirement of 2.4 eggs/m^2 (Elson 1975), the conservation requirement is 32,330,000 eggs. The numbers of spawners necessary to obtain the conservation requirement are estimated at 4,900 MSW and 4,900 1SW salmon (Marshall et al. 1997). Similar to previous years, egg deposition and spawners in 2005 were estimated on the basis of length, external sexing and interpretation of age from scales collected from fish captured at the Mactaquac Dam fishway (Jones et al. 2004).

Escapement

Sea-Run

Collation of the total sea-run (excluding captive-reared spawners) returns (Table 1) and total removals (Table 5) of wild and hatchery fish indicates that escapement was 273 MSW salmon and 1,060 1SW salmon (Table 6).

Differences in biological characteristics from 2004 included a decreased proportion of females among hatchery 1SW salmon (-0.02) and an increase in mean length (+1.8 cm). The proportion of females among wild and hatchery MSW fish increased by 0.08 and 0.12, respectively, from 2004 (Table 7a). A decrease in mean length of wild (-1.8 cm) and hatchery (-1.6 cm) female MSW spawners was observed between 2004 and 2005. Proportion female and mean length of wild 1SW females in 2005 decreased from 2004 and the previous five year mean. Mean lengths, length-fecundity relationship, and estimated escapement indicate that the total potential deposition was 1.92 million eggs (0.142 eggs per m^2) or 6% of the requirement. This is half the value estimated for wild female spawners in 2003 and 2004 (Fig. 5a). Estimated eggs from wild and hatchery 1SW fish comprised 17% of the total deposition. Estimated eggs from hatchery origin 1SW and MSW salmon potentially contributed to 20% of the total deposition (Table 7a).

Captive-Reared

Adult releases from the captive-reared broodstock program were distributed to sites in the Tobique River and just downriver of the confluence with the main Saint John River near Perth-Andover in 2003, 2004 and 2005. In 2004, to assess spawning of the captive-reared fish, an experiment similar to the Pokiok study in 2003 was conducted (Jones et al. 2004). Fifteen males and 15 females were released to a 5 km stretch of river on the Odell tributary of the Tobique River. This section of river was not accessible to sea-run spawners because of an impassible falls. The captive-reared spawners were confined to the 5 km stretch of river by a counting fence (downstream) and another impassible falls further upstream. A redd survey was conducted and spawning activity was observed from the captive-reared releases. Further evidence of successful spawning was the presence of age-0+ or fry captured the following year by electrofishing.

To estimate the total egg contribution from the captive-reared releases in each year, a length-fecundity relationship was developed from 29 female, two-year captive-reared salmon that were retained at the Mactaquac Biodiversity Facility for the regular broodstock (compensation) program in 2005 (Fig. 5b). Using the mean length for each age category and the developed length-fecundity relationship ($eggs=337.93e^{0.0436Xfork\ length}$), the sexually mature females potentially produced another 5,206,000 eggs or an additional 16% of the conservation target in 2005 (Table 7b).

In-river Ecological considerations

Discharges at Mactaquac Dam from May to the end of June (2005) fluctuated above the mean value from 1995 to 2004, with high discharges in early May (Fig. 6). Plots of weekly 1SW salmon counts from the fish collection facilities at the Mactaquac Dam and from the smolt migration channel at the Mactaquac Biodiversity Facility indicate that the majority of 1SW salmon in 2005 were captured about one week earlier than the previous 10-year mean (Fig. 6). Higher than normal (1995-2004 mean) weekly catches were observed for wild 1SW salmon during a two week period in late September and early October and fluctuated around the 10 year mean for hatchery 1SW salmon. The majority of the MSW returns entered the fishway during warm water conditions in July when estimated mean daily water temperatures for the Mactaquac fishway fluctuated around $20^{o}C$ (Fig. 7). The 2005 mean daily water temperatures for Mactaquac fishway were estimated, because of water temperature recorder failure, using a relationship with an upriver site (just below Beechwood Dam). The peak arrival time for both the wild and hatchery MSW salmon returns in 2005 was similar to the previous 10-year mean (Fig. 7).

Tobique River Parr Densities

Methods

In 2004 and 2005, there was an increase in the number of electrofishing sites done with the intent to evaluate the efficacy of the captive-reared spawners released to the Tobique River. Subsequently a number of annually monitored sites in tributaries upriver of Mactaquac (Salmon (Vic. Co.), Shikatehawk, Meduxnekeag and Becaguimec rivers) were not completed. Assistance was provided by Tobique First Nation and Tobique Salmon Protection Association staff and included interns from the Federal Public Sector Youth Internship Program (FPSYIP). Densities (number of fish per 100 m^2 of habitat) of age-1+ and older parr at these open sites were either derived using 1) mark-recapture techniques using the adjusted Petersen method (Ricker 1975) or 2) a mean probability of capture derived in Jones et al. (2004). Numbers of parr by age were determined from stratified sampling of large parr in 0.5 cm length intervals. Generally one parr was scale sampled for each interval. For the mark-recapture sites, the number of age-0+ parr or fry for the site was determined by applying the capture efficiency for age-1+ and older parr to the number of fry captured during the marking pass.

Similar to 2003, a mean probability of capture was applied to sites done in 2004 and 2005 in which zero parr were marked or recaptured or if only the marking pass was completed (Jones et al. 2004).

To evaluate the status of juvenile salmon upriver of Mactaquac Dam, densities of fry and parr were analyzed using the mean of 20 sites done on the Tobique River periodically since 1979. In 2004 and 2005, 16 of the 20 historical sites were completed. An additional 42 sites were completed in both years in an attempt to evaluate the spawning success of the captive-reared releases.

With the exception of the 2004 (Table 8a) and 2005 (Table 8b) analyses, the densities presented are for wild (or adipose fin present) parr only. For the most part, prior to 1998 all fall fingerling parr and unfed fry were released unmarked (Fig. 2a and 2b) and suspected hatchery origin parr captured during electrofishing surveys were determined by observations of fin erosion or condition made by field staff. Since 1998, most of the fall fingerling parr released have been adipose clipped (with exception of 2004) and very few unfed fry (with exception of 2000) were released (Fig. 2a and 2b), making identification of wild parr more precise.

Results

Analysis of the historical mark-recapture data (1996-2003) using the empirical Bayes method determined that the mean probability of capture was 34.7% (Jones et al. 2004). This mean probability of capture was used for 11 of the 16 sites done and for 37 of the 42 other sites electrofished on the Tobique River in 2004 (Table 8a). In 2005, the mean probability of capture was used on 36 of the 42 sites completed including 9 of the 16 index sites (Table 8b).

The mean density of wild fry (age-0+) at 16 sites on the Tobique River in 2004 and 2005 was 7.8 and 5.3 per 100 m^2, respectively. Both values were an improvement from the density of 0.5 observed in 2003 (Fig. 8). With the exception of 1995, mean densities at the index sites have been below the “Elson norm” of 29 fry per 100 m^2 (Elson 1967). No wild fry were captured at 10 (17%) and 21 (36%) of the 58 electrofishing sites completed in 2004 and 2005, respectively (Table 8a, Table 8b).

Mean density of age-1+ and older wild parr at the 16 index sites was 5.4 parr per 100 m^2 in 2005. These values are well below Elson’s (1967) “normal index” of 38 small and large parr per 100 m^2 (Fig. 8). This value is above the mean density (2.6) observed in 2004, and reflects the improved mean fry density recorded in 2004 (Table 8a). Despite the low densities, parr appear to be well distributed throughout the watershed as only 10 sites in 2004 and 6 sites in 2005 sites were devoid of wild parr (Tables 8a, Table 8b).

Tobique and Beechwood Smolt Investigations

In collaboration with the Tobique Salmon Protective Association, NB Wildlife Trust and Atlantic Salmon Federation spring smolt investigations upriver of Mactaquac Dam have been conducted since 2000. Several sampling techniques and assessment methods are used. The objectives are: 1) to estimate the numbers of wild and hatchery smolts emigrating from the Tobique River, 2) to estimate the proportion of the total smolt output emigrating as spring smolts in conjunction with fall pre-smolt assessment activities, 3) to obtain data on the spring migration patterns of Tobique River smolts and 4) to collect juvenile salmon for the captive-reared program at the Mactaquac Biodiversity Facility.

Methods

In 2004, two rotary screw traps were installed in the main stem of the Tobique River just downriver of the confluence of Three Brooks tributary (Fig. 9) from April 26 until June 9. One rotary screw trap was constructed by E.G. Solutions (1.52 meters in diameter) and the second by Key Mill Construction Ltd. of Ladysmith, BC (1.82 meters in diameter) as described in detail in Chaput and Jones (2004). The wheels were continuously operated and checked once daily in the morning except on weekends when it was checked on either

Saturday or Sunday. All smolts were identified for origin (wild – adipose present or hatchery – adipose clipped or fin erosion), measured for fork length, marked with numbered streamer tags and scale sampled for later age determination. In 2004, to estimate the efficiency of the wheels, the majority of the captured smolts were released just downriver of the confluence of Burntland Brook (near Diamond Island); approximately 15 km upriver of the smolt wheels (Fig. 9). These smolts will be further referred to as "recycled" releases.

In 2005, one rotary screw trap (mark + release) was installed at the Plaster Rock site on May 7 and the other at the Three Brooks site (recapture + collection for captive-reared program) on May 9. Both were operational until June 9. In addition to the marked and released smolts captured at Plaster Rock, age-1 hatchery smolts from Mactaquac Biodiversity Facility were released upriver of the smolt wheels on three separate occasions to estimate the capture efficiency of the wheels (Jones et al. 2004).

In both years, hourly water temperature readings were recorded using a Vemco© [1] minilog installed in the main stem of the Tobique River at the Arthurette Bridge (Fig. 9). Environment Canada collected discharge data at a gauging station located in Riley Brook (Fig. 9). Discharge is affected by NB Power water storage facilities on four tributaries upriver of the Riley Brook gauging station.

Also in 2004 and 2005, the intake gatewells at the Beechwood Power Generating Station were sampled periodically for emigrating smolts during the spring migration period. A square nylon mesh net was used to capture smolts in the intake gatewells. Generally the net was left fishing for approximately 15 minutes in selected gatewells (Jones et al. 2004). All captured smolts were identified for origin (hatchery origin fish were adipose clipped or had some fin erosion), measured for fork length and weight, and approximately 20% of the smolts were scale sampled for later age determination. With the exception of a few mortalities the majority of smolts were released downriver of Beechwood Dam and the remainders were transported to the Mactaquac Biodiversity Facility for the captive-reared program.

Results

2004

The two Tobique River smolt wheels captured a total of 291 wild and 49 hatchery smolts in April and May (excludes recaptured smolts; Table 9). Only six of the 340 smolts were captured in June (Fig. 10). The largest wild smolt catches occurred on May 4 and 5, approximately two weeks earlier than the peak in 2003. Increases in both mean daily water temperature (Fig. 10) and discharge (Fig. 11) in the main stem of the Tobique River likely contributed to the peak catches during this time period. Seventy-eight age-1 parr were also captured during the sampling period.

Numerical streamer tags were applied to 275 wild and hatchery smolts prior to release upriver of the smolt wheels near Burntland Brook. The estimated capture efficiency of the two wheels in 2004, based on the recapture of 17 of the recycled smolts, was 6.2%. Mark-recapture data were incorporated into a Bayesian estimate procedure described by Gazey and Staley (1986) to determine the most probable estimate (the mode) of population size and a binomial distribution was assumed for random sampling error. The smolt run upriver of Three Brooks was estimated at 5,500 (2.5 and 97.5 percentiles; 3,785 - 9,875) (Fig. 12), or 4,710 wild and 790 hatchery smolts, a 41% increase from the 2003 spring estimate. The hatchery smolt originated from fall parr releases. Since run size estimates were not calculated during the fall of 2003 the proportion of the total wild Tobique River smolt output represented by the 2004 spring smolt estimate is unknown.

[1] Vemco Limited, Shad Bay, NS

Sampling at the Beechwood Dam intake gatewells occurred on June 16 and 18, 2004. A total of 234 smolts, including six smolts with streamer tags originally tagged and released in the Tobique River, were captured (Table 9, Fig. 10). As in the previous three years, greater than 85% were of wild origin. The six streamer tagged smolts were recaptured on average 30 days (min = 26 days; max = 33 days) after being released upriver near Burntland Brook. The average recap time observed in 2004 was 20 days greater than the mean recap time in 2003 (Jones et al. 2004). These six recaptured smolts represented 2.2% of the streamer tagged smolts available for recapture.

2005

A total of 88 and 64 unmarked smolts were captured during the five weeks of operation at Three Brooks and Plaster Rock, respectively (Table 9). Only five smolts were captured during the last week of operation. In general, catches in both smolt wheels were extremely low (<20 fish/day combined) making it difficult to relate catches with environmental factors in 2005 (Fig. 10, 11).

Only 62 smolts were tagged with numerical streamer tags and released from the Plaster Rock smolt wheel. One of the tagged smolts was recaptured in the smolt wheel at Three Brooks, resulting in an overall efficiency of 1.6%. The smolt run was not estimated using this data because of the small sample sizes.

A total of 1,400 age-1 hatchery smolts were released near Burntland Brook at the same location as the recycled smolts in 2004. Fifteen (1.07%) age-1 hatchery smolts from Mactaquac Biodiversity Facility were recaptured at Three Brooks and usually one-day after being released. It has been documented on the Tobique, Nashwaak and Big Salmon rivers, that using hatchery smolts released in the spring to estimate smolt wheel efficiencies can potentially overestimate the wild smolt run (Fig. 13). To account for the bias, an adjustment factor [0.5804 (calculations summarized below)] of the mean recapture rates of recycled wild versus spring released hatchery smolts was used to calculate the preferred spring smolt run estimate of 4,750 (2.5 and 97.5 percentiles; 3,640 – 7,120) (Fig. 12) or 3,400 wild and 1,350 hatchery smolts.

Tobique River data only	recapture rates	
(from Jones et al. 2004)	hatchery	recycled
2002	0.0412	0.0521
2003	0.0142	0.0432
mean	**0.0277**	**0.0476**
adjustment factor	**0.5804**	
(hatchery mean / recycled mean)		
Recaps at Three Brooks		15
Adjusted number of Recaps		**26**

Sampling at the Beechwood Dam intake gatewells also occurred with limited success in 2005. The sampling took place on June 6, 8 and 10 and a total of 16 wild and two hatchery smolts were captured (Table 9, Fig. 10). Only one streamer tagged smolt was recaptured four days after being tagged and released at Plaster Rock.

Biological Characteristics

The analysis of scales collected from the wild smolts sampled at the smolt wheels on the Tobique River indicated that the majority of the smolts were age-2; 76% in 2004 and 62%

in 2005. The mean length of all wild smolts combined has fluctuated annually between 14-15 cm since monitoring began in 2000 (Fig. 14). Wild smolts sampled on the Tobique River since 2000 were slightly smaller than those sampled on the Nashwaak River (Fig. 14). The highest proportion of the hatchery (released as fall parr) smolts sampled in 2004 (61%) and 2005 (62%) were age-1.

Outlook

Projected returns, based on the average returns of the previous five years, for populations originating upriver of Mactaquac Dam on the Saint John River in 2006 are 1,600 1SW (90% C.I.; 820 - 2,360) and 680 MSW (90% C.I.; 160 – 1,250) salmon. The probabilities of attaining the conservation requirement of 4,900 for both 1SW and MSW salmon are near zero for both forecasts. Based on escapement of 20% and 6% of conservation in 2001 and 2002 respectively, and Tobique smolt production in 2005, wild 1SW salmon returns for 2006 will only increase if marine survival improves from recent years. Hatchery smolt releases in 2005 were 48% higher than 2004 so there could be a slight improvement in the number of hatchery 1SW salmon returns for 2006. A 67% decrease in the number of hatchery smolts released in 2004 from 2003 suggests fewer hatchery 2SW returns in 2006.

Management Considerations

For the Saint John River populations upriver of Mactaquac Dam, egg depositions have been less than 50% of requirement for 11of the last 12 years. There is a near zero probability that MSW and 1SW returns will be adequate to meet the conservation requirement in 2006.

In an effort to maintain existing genetic integrity for potential recovery of the upriver populations and to reduce the number of wild sea-run removals for broodstock, a captive-reared broodstock program was initiated in 2001 at Mactaquac Biodiversity Facility (Jones et al. 2004). The first adult releases from this program occurred in 2003. There were significant potential contributions to egg depositions in 2004 and 2005 with the release of approximately 1,000 of these large salmon per year (Table 7b). The first adult (1SW salmon) returns from the 2004 releases are not expected until 2008.

NASHWAAK RIVER

With a drainage area of about 1,700 km^2, the Nashwaak River flows approximately 110 km in an easterly and southerly direction from Nashwaak Lake on the New Brunswick York/Carleton County line to its confluence with the Saint John River in Fredericton North (Figs. 1 and 15). It is the largest single salmon-producing tributary of the Saint John River downriver of Mactaquac Dam. The salmon production area of the Nashwaak River has been estimated from orthophoto measurements (Amiro 1993) at 5.69 million m^2 (gradient > 0.12%) or 28.5% of the total salmon production area downriver of Mactaquac Dam (Marshall et al. 1997). A salmon counting fence 23 km upriver from the confluence with the Saint John River (Fig. 15) was operated by DFO in 1972, 1973 and 1975 (Francis and Gallop 1979), and by DFO in cooperation with Aboriginal peoples from 1993 - 2005. In 2005, the fence was jointly operated by Kingsclear and Oromocto First Nations.

Returns

Methods

From June 9 until October 7, 2005, all fish captured at the counting fence were counted, measured for fork length, classified as hatchery or wild on the basis of fin deformities and/or presence of adipose fin, and marked with a hole punch of the caudal (hatchery fish) or adipose (wild fish) fin. All adipose clipped salmon (hatchery fish) and wild salmon (>= 60cm) were scale sampled along with every second wild fish (< 60 cm) to determine the age composition of the adult returns. Exceptions were made to the sampling routine when water temperatures at the fence exceeded 22°C. During these periods trap checks were made and fish were classified as 1SW or MSW salmon based on size, but no additional sampling occurred. No unmarked 1SW or MSW salmon were released upriver in 2005. Holding pools upriver of the fence were seined in early October so that mark-recapture procedures (Gazey and Staley, 1986) could be used to estimate the number of fish that may have bypassed the fence either before installation or when the fence could not operate properly due to high water.

Results

Unadjusted counts at the Nashwaak River counting fence in 2005 were 427 1SW and 95 MSW salmon. The start date was similar to previous years but the finish date was earlier than normal because of extremely high water levels that topped the fence - the fifth occasion in 2005 (Table 11).

After scale analysis, 1SW and MSW salmon components were slightly revised to 425 1SW and 97 MSW salmon (Table 2). The final hatchery counts were twenty 1SW and two MSW salmon and represented less than 5% of the total 1SW and MSW salmon counts. The fall high water events prevent any meaningful comparison of the run timing in 2005 to previous years but generally very few 1SW and MSW salmon were counted during the month of August and the first two or three weeks of September (Fig. 16). Scale samples revealed that sea-ages of the wild fish in 2005 were 81% 1SW fish, 17% virgin 2SW fish and 2% previous spawners. The proportion of 1SW and 2SW salmon returns is similar to values observed in seven of the last eight years; the exception being 1997 and 2001 (Fig. 17). Since 2000, the sea age of Nashwaak River wild salmon returns has been very similar to those wild salmon returning to Mactaquac Dam (Fig. 17). Previous spawners from 1993 - 2002 averaged about 25% of the returning Nashwaak River MSW salmon, but since 2002 have only comprised about 9% of the MSW returns. Very few virgin 3SW salmon were observed in either population (Fig. 17).

Seining and diver observations in 6 pools (Fig. 15) upriver of the salmon counting fence on October 6, 2005 resulted in the capture or visual observation of 14 small and 2 large salmon. Nine salmon of the 16 were previously adipose punched (marked) at the counting fence.

To estimate the total returns through October 5, 2005, it was necessary to determine the number of salmon moving upriver prior to fence installation and during time periods (Table 11) when the fence was not fishing due to high water. Mark-recapture data were incorporated into a Bayesian estimate procedure and this analysis indicates a population of 852 fish (2.5 and 97.5 percentiles; 648 -1,740); Fig. 18) or 701 1SW and 151 MSW salmon moved past the fence as of October 5, 2005. The sum of these estimates and adjusted fence counts after October 5 yielded a return estimate of 731 1SW (2.5 and 97.5 percentiles; 565 – 1,460) and 162 MSW (2.5 and 97.5 percentiles; 125 - 329) salmon. The 1SW salmon estimate was the fifth highest while the MSW return estimate was the third lowest since 1993 (Table 12). Because the fence did not operate during the high water flows that occurred after October 7 (Fig. 16) additional fish may have been missed. More than adequate discharge prior to October 7 and few (2.2%) wild returning adults to Mactaquac Dam after October 7 suggest a large portion of the run was accounted for. Similar events occurred in 2003, when multiple periods of high discharge caused the fence to be compromised before all the salmon returns could be accounted for (Fig. 16). It was indicated that estimates likely represented 95% of the total returns in that year (Jones et al. 2004).

Estimated wild returns in 2005 totalled 697 1SW and 159 MSW fish (Fig. 19). One-sea-winter returns, up slightly from 2004, were the highest estimated since 1998, and similar to the 10-year mean. Multi-sea-winter returns decreased 22% from 2004, and were only 58% of the 10-year mean, and the third lowest estimated total since 1993. The return rate of the 2004 wild smolt class as 1SW salmon in 2005 was 5.13% - the second highest return rate since wild smolt assessments were initiated in 1998 (Table 13). The return rate of the wild smolt class of 2003 as 2SW salmon in 2005 was 1.58% - the highest return rate observed since the 2SW returns in 2000 and more than 25% higher than the rate in 2004 (Table 13). Estimated hatchery returns in 2005 totalled 34 1SW and three MSW fish. One of these hatchery MSW salmon returns was later classified to be an aquaculture escape based on scale analysis.

As in previous years, no account has been made of salmon by-catch in the Saint John Harbour that may have been destined for the Nashwaak River.

Removals

Between June 24 and July 4, 15 1SW salmon and six MSW salmon were removed from the fence trap and transported to Mactaquac Biodiversity Facility for restoration initiatives by the Nashwaak Watershed Association Inc. Two 1SW salmon mortalities were recovered on June 24 and August 14 on the upriver side of the fence and two additional 1SW and one MSW salmon were dead inside the trap in September and were likely casualties of high water. DFO fishery officers reported no illegal activities targeting salmon destined for or within the Nashwaak watershed. Therefore, no corrections were made for illegal removals.

Conservation Requirements

Salmon production area upriver of the fence is estimated to be 5.35 million m^2 and the conservation requirement is 12.8 million eggs (Marshall et al. 1997). The numbers of spawners necessary to obtain the conservation requirement are estimated at 2,040 MSW and 2,040 1SW salmon (Marshall et al. 1997). Egg deposition and spawners in 2005 were estimated on the basis of length, external sexing and interpretation of age from scales collected from fish passing through the fence.

Escapement

Spawners upriver of the fence were estimated to be 712 1SW and 155 MSW salmon (Table 12). Sea-age, origin, female composition and mean length for spawners upriver of the fence are summarized below:

	1SW salmon		MSW salmon	
Biological characteristics	Wild	Hatchery	Wild	Hatchery
Number	678	34	152	3
Proportion female	0.433	0.350	0.862	0.500
Mean length female (cm)	57.8	54.1	78.3	74.4

Numbers of 1SW and MSW spawners were 35% and 8% of the conservation requirements, respectively. The number of 1SW spawners has steadily increased since 2001 while MSW spawners decreased by 27% from the spawners in 2004. Egg deposition was estimated at about 2,007,500 (0.38 eggs m^{-2} or 16% of the egg requirement), similar to 2004

(Table 12). One-sea-winter females contributed 52% of the total estimated egg deposition, compared to 28% and 41% in 2003 and 2004, respectively.

Parr Densities

Methods

Densities of juvenile salmon have been monitored annually at seven sites on the Nashwaak River since 1981 (Fig. 15). Densities prior to 1981 along with site characteristics and locations were reported by Francis (1980). Assistance was provided by Woodstock First Nation and interns from the Federal Public Sector Youth Internship Program (FPSYIP). Densities (number of fish per 100 m^2 of habitat) of age-1+ and older parr at these open sites were either derived using 1) mark-recapture techniques using the adjusted Petersen method (Ricker 1975) or 2) a mean probability of capture derived in Jones et al. (2004). Numbers of parr by age were determined from stratified sampling of large parr in 0.5 cm length intervals. Generally one parr was scale sampled for each interval. For the mark-recapture sites, the number of age-0+ parr or fry for the site was determined by applying the capture efficiency for age-1+ and older parr to the number of fry captured during the marking pass.

Similar to 2003, a mean probability of capture was applied to sites done in 2004 and 2005 in which zero parr were marked or recaptured or if only the marking pass was completed (Jones et al. 2004).

In 2004 and 2005, in addition to the seven sites continuously done since 1981, another 19 sites were added to the Nashwaak River juvenile surveys (Table 14a and 14b) and as a result a number of electrofishing sites historically monitored on the Keswick, Kennebecasis and Hammond Rivers were not completed by DFO.

With the exception of the 2004 and 2005 analyses (Table 14a, 14b), the densities presented are for wild (or adipose fin present) parr only. For the most part, prior to 1998 all fall fingerling and unfed fry were released unmarked and suspected hatchery origin parr captured during electrofishing surveys were determined through observations made by field staff of fin erosion or condition (Appendix *iv*). Since 1996, most fall fingerlings released were adipose clipped and there were fewer unfed fry releases, thereby making the identification of wild parr easier and more accurate.

Results

Analysis of the historical mark-recapture data (which included Nashwaak River data) using the empirical Bayes method determined that the mean probability of capture was 34.7% (Jones et al. 2004). This mean probability of capture was used for three of the seven sites (historical) done annually since 1981 and for eight of the 19 additional sites electrofished on the Nashwaak in 2005 (Table 14b).

Mean density of wild fry (age-0+ parr) at the seven historical sites in 2005 (one downriver and six upriver of the counting fence) was 5.8 fry per 100 m^2 and ranged from 0.0 to 15.0 fry per 100 m^2. This is slightly higher than the 2003 and 2004 mean densities (Fig. 20) and consistent with the higher egg depositions estimated in 2004 (Table 12). Since 1993, mean densities at the seven sites have been below the “Elson norm”, fluctuating around 9.0 fry per 100 m^2 (Fig. 20). Including data from the 19 additional sites raised the mean density to 7.7 fry per 100 m^2 and ranged from 0.0 to 30.5 fry per 100 m^2 in 2005.

Mean density of age-1+ and older wild parr at the seven historical sites was 5.1 fish per 100 m^2 (ranged from 0.0 to 11.3) and improved slightly to 6.0 fish per 100 m^2 (ranged from 0.0 to 24.5) when the 19 additional sites were included in the analysis. These values improved slightly from 2004 and were similar to the densities observed in the last decade, but are well below Elson's (1967) "normal index" of 38 small and large parr per 100 m^2 (Fig. 20).

Smolt Assessment

A collaborative project between DFO and the Nashwaak Watershed Association Inc. (NWAI) to estimate the wild smolt production of the Nashwaak River has been ongoing since 1998. The smolt production estimates are valuable in examining recent declines in salmon populations for the following reasons: 1) they contribute to the development of current expectations for and limitations to salmon production on the Nashwaak River and probably other tributaries of the Saint John River downriver of Mactaquac Dam, 2) they provide a marine survival estimate examined through smolt-to-adult return rates where adult returns are derived from data collected at the Nashwaak River counting fence, and 3) they provide a basis for evaluating freshwater production which can be examined through parr-to-smolt and egg-to-smolt survival rates when estimates of juvenile densities of salmon and eggs deposition are available.

Methods

A smolt wheel was installed and operated from April 20 until June 9, 2005 in the main stem of the Nashwaak River just downriver of Durham Bridge. As in previous years (Marshall et al. 1999b) the wheel was checked once daily except during the first and last weeks of operation when it was checked for six of the seven days (only once on weekends). All smolts were identified for origin (wild or hatchery), one in five wild unmarked smolts was measured for fork length, weighed, scale sampled and released 500 meters downriver of the wheel. In general, the remaining unmarked smolts were marked with numbered streamer tags and released upriver near the confluence of the Tay River (Fig. 15). Detailed sampling occurred on all hatchery smolts released as fall fingerlings.

Hourly water temperature readings were recorded using a minilog thermometer installed in the main stem of the Nashwaak River at the adult counting fence location (500 meters downriver of the smolt wheel). Environment Canada collected discharge data at a gauging station located near Durham Bridge.

Results

A total of 292 untagged smolts (255 wild; 37 hatchery-fall fingerling) were captured during smolt wheel operations. The highest wild smolt catch occurred on May 14, a couple of days after the mean daily water temperatures had exceeded 10°C (Fig. 21). The cooler spring water temperatures appeared to delay the smolt migration in 2005 different than six of the previous seven years (exception being 2003) when at least 50% of the cumulative smolt catch had occurred by May 9 (Fig. 21). High discharge put the smolt wheel out of operation from April 29 until May 1, 2005 but unlike water temperatures, smolt movements do not appear to be related to discharge on the Nashwaak River (Fig. 22). Only four wild and one hatchery smolts were captured during the last two weeks of operation.

One-hundred and eighty-three wild smolts were tagged with numbered streamer tags and released upriver of the smolt wheel at the mouth of the Tay River (Fig. 15). Nine (4.9%) of the recycled smolts were recaptured at the smolt wheel. This mark-recapture data generated a most probable Bayesian estimate of 5,200 wild smolts (2.5 and 97.5 percentiles; 3,200 - 12,600) emigrating from the Nashwaak River in 2005 (Table 13; Fig. 23). The total number of wild smolts decreased 62% from 2004, was only 40% of the five-year mean, and was the lowest estimated total since smolt assessment commenced in 1998 (Table 13). Using the capture efficiency of 4.9% from the wild smolts, an additional 750 hatchery smolts that had been released as fall fingerlings in 2002 and 2003 were estimated to have emigrated in 2005.

Biological Characteristics

The average fork length of all the wild smolts sampled in 2005 was 15.4 cm (n=63). This was the largest mean length value for the wild smolts since monitoring began in 1998 (Fig. 14). Ages of wild smolts were predominately age-2 (59%) with a mean length of 14.7 cm. The remaining wild smolts were age-3 and averaged 16.7 cm. Mean fork length values for age-2 smolts, in 2004 and 2005 were similar to those observed from wild smolts sampled since 1998, but mean length values for the age-3 smolts were the largest observed (Fig. 14).

Outlook

Predicted returns to the Nashwaak River in 2006 using the five year average are 440 1SW fish (90% C.I.; 120 - 780). There is a near zero probability that the 1SW requirement of 2,040 fish will be achieved. The forecast of MSW returns is 170 fish (90% C.I.; 50 - 290) and the probability that the conservation requirement of 2,040 MSW fish will be attained is also near zero. Appling the range (minimum and maximum) of smolt-to-1SW return rates observed since 1999 to the 2005 wild smolt estimate indicates the predicted 1SW returns to the Nashwaak in 2006 could be between 80 and 330 fish. This method has proven to be a more reliable forecast in comparison to the five year mean. The predicted 2SW salmon returns in 2006, from the 2004 smolt class, range from 40 to 210 fish using the observed smolt-to-2SW return rates. Despite slight improvements in the numbers of adult returns and subsequent spawners, particularly 1SW salmon, parr densities remain low and suggest that returns will not be adequate to achieve the egg conservation requirement for several years to come.

Management Considerations

The Nashwaak River population attained only about 16% of the conservation requirement in 2005. Total egg depositions were less than 25% of the conservation requirement for the last seven years and have steadily declined, along with the corresponding smolt classes, since 1996. Prospects for attaining the conservation requirement in 2006 are near zero, based on low parr densities and smolt estimates. The prospects for increased returns for the next several years are extremely poor although smolt-to-adult return rates have improved in 2004 and 2005. Unlike 1SW fish returning to Mactaquac Dam which have a low (<10%) component of female 1SW salmon, the Nashwaak River 1SW salmon averaged 37% female from 2001 to 2005. These females have contributed an average of 36% of the total Nashwaak River egg depositions over those same five years.

MAGAGUADAVIC RIVER

Originating in Magaguadavic Lake, the Magaguadavic River flows southeasterly for 97 km to the Passamaquoddy Bay, Bay of Fundy at St. George, N.B. (Fig. 24; Martin 1984). The 13.4m-high dam and 3.7 megawatt hydroelectric station (with 4 Francis turbines) located at the head-of-tide was replaced with a new 15 megawatt hydroelectric station (with 2 Kaplan turbines) in 2004. Upstream passage is provided by a fishway. A new downstream bypass and assessment facility was constructed in the new hydroelectric station. Assessment of the anadromous fish resources is done using a trap in the third pool from the top of the fishway. In 2005, the fishway trap was monitored for salmon from late April until early December. Salmon count data and analyses were provided by Atlantic Salmon Federation[2]. In 2005, similar to the previous year, no fish of aquaculture origin that were captured at the trap were released to the river. All salmon of suspected aquaculture origin were sacrificed for sampling of pathogens.

Wild returning salmon have been rapidly declining since 1992 and have averaged less than 15 fish per year since 1998. Aquaculture fish are escapes from aquaculture cages in the Fundy Isle area which, in 2005, produced approximately 35,000 tonnes of Atlantic salmon.

Returns

Counts of 1SW salmon in the trap numbered five wild and four hatchery fish. There were no wild or hatchery MSW salmon counted in 2005. Aquaculture escapes ascending the fishway in 2005 numbered six postsmolts, 62 1SW and one MSW salmon. It is possible that some of the “wild” salmon counted may be the result of early life stage juvenile escapes from any of the three private hatcheries in the drainage. Counts made since 1992, when aquaculture escapes were identified, and those in 1983 - 1985 and 1988, when escapes were largely unnoticed, are in Table 2. Total counts of both wild 1SW and MSW salmon were the highest observed since 2001 and higher than the mean for the last five years (Fig. 25). Counts of suspected aquaculture escapes were the second highest in the past five years (Table 2).

Removals

All aquaculture fish were sacrificed for disease testing. No fish tested positive for the ISA virus. No fish were removed for broodstock. There has been no commercial fishery since 1983, and the Aboriginal food fishery and the recreational fishery have been closed since 1998.

Conservation Requirements

The conservation requirement of 1.35 million eggs is based on an estimated 563,000 m^2 of juvenile rearing substrate (Anon 1978) and a deposition of 2.4 eggs per 100 m^2 (Elson 1975). The numbers of spawners necessary to obtain the conservation requirement are estimated at 230 MSW and 140 1SW salmon (Marshall and Cameron 1995).

Escapement

Nine 1SW salmon were released upriver of the fishway. Using the mean length-fecundity relationship for Saint John River salmon ($eggs=430.19e^{0.03605 X fork\ length}$; Marshall and Penney 1983) and the estimated number of females suggest a potential egg deposition of 7,500 eggs or

[2] Jon Carr- Atlantic Salmon Federation, PO Box 429, St. Andrews, NB, E0G 2X0

less than 2% of the requirement. Estimates of escapement and attainment of the conservation requirement have steadily declined since 1994 (Fig. 26).

Outlook

Wild 1SW and MSW returns to the Magaguadavic River in 2006 are projected to be no greater than the returns in 2005. There is a near zero probability of attaining the conservation requirement in 2006. Progeny of the last “disease free” wild adult returns in 1998 were distributed to the Magaguadavic watershed in 2003 as unmarked age-0+ parr (Appendix *v*) and are expected to contribute to adult returns in 2006 - 2007. This undertaking is a result of the action plan by the Magaguadavic Recovery Committee. Preliminary results from electrofishing surveys in 2003 indicate that the release of the 56 mature (35% female) captive reared broodstock in 2002 is unlikely to make a significant increase in adult returns in 2006 - 2007.

Management Considerations

The Magaguadavic River population has declined dramatically in the last decade. Returns of wild salmon to the Magaguadavic River in 2005 were near zero and outnumbered by aquaculture escapes. There is no chance that the conservation requirement will be achieved from natural production on these rivers in the immediate future. Actions have been initiated to address the pending extirpation of these salmon populations by Live Gene Banking the remnant wild stock at the Mactaquac Biodiversity Facility.

ST. CROIX RIVER

The St. Croix River, a USA/Canada international river bordering the State of Maine and Province of New Brunswick, drains southeasterly into Passamaquoddy Bay in the Bay of Fundy. Approximately 1,619 km^2 of the drainage basin is in New Brunswick and 2,616 km^2 is in Maine (Fig. 27). Historically a significant producer of Atlantic salmon, this salmon population has succumbed to industrial development - initially cotton mills, then pulp mills, and now dams and headponds at three hydroelectric facilities. The main stem and East Branch (84 km), the Chiputneticook lakes (66 km) and Monument Brook (19 km) determine 169 km of the international boundary (Anon 1988), the fluvial portions of which comprise the bulk of the potential rearing area for Atlantic salmon.

No natural returning adult salmon have been released upriver since 1997. Future returns are dependant on hatchery programs. Without a dramatic shift in sea survival, these conservation efforts are not expected to yield any significant number of naturalized salmon in the near future. Hatchery releases since 1981 are tabled in Appendix *vi*.

Returns

Counts of salmon at the Milltown fishway by St. Croix International Waterway Commission[3] near head-of-tide on the St. Croix River in 2005 numbered four MSW and two 1SW hatchery origin fish, three MSW and 33 1SW aquaculture escapes, and no wild fish (Table 2, Fig. 28). Aquaculture escapes were removed from the fishway trap, sacrificed for laboratory disease analysis and found to be negative for the ISA virus. All hatchery origin fish were live-tested for the ISA virus and also found to be negative. There have been no wild returning adult salmon to Milltown fishway since 2000 (Table 2).

[3] Lee Sochasky – St. Croix International Waterway Commission, St. Stephen, N.B. E3L 2Y7

Removals

All six returning hatchery salmon were removed from the fishway trap and retained on site for fish health assessment and then later transported to Mactaquac for broodstock purposes.

Conservation Requirements

The conservation requirement of 7,389,000 eggs is based on an area of 3.079 million m^2 of juvenile production habitat (Anon 1988) and an average requirement of 2.4 eggs 100 m^{-2} (Elson 1975). Adult requirements have been calculated on the basis of MSW salmon having a male to female ratio of 1:1 and females producing an average of 7,200 eggs. Adult requirements therefore total 2,052 MSW salmon. A re-evaluation of adult requirements in 1993 acknowledged the potential contribution to egg deposition by 1SW females and suggested 1,710 MSW and 680 1SW fish could potentially produce the egg requirement (Marshall and Cameron 1995).

Escapement

For the eighth consecutive year, no wild or hatchery returning 1SW or MSW salmon were released upriver of Milltown Dam to spawn naturally.

Eggs from the hatchery returns were estimated from the length-fecundity relationship ($eggs=430.19e^{0.03605X\text{fork length}}$) for salmon of the Saint John River (Marshall and Penney 1983). Since no male adult salmon were captured at the fishway, the six female salmon that were transported to the Mactaquac Biodiversity Facility were crossed with male adults from the Tobique River captive-reared program to provide an estimated 58,000 eggs.

Outlook

Returns to the St. Croix River in 2006 are unlikely to differ greatly from the mean value of 17 hatchery returns from 2001 to 2005. This is because all returning adults have been retained as broodstock since 1997 and the number of stocked juveniles from these collections has remained constant and low. Under any scenario for returns in 2006, there is no probability of attaining the conservation requirement.

Management Considerations

The salmon population of the St. Croix River has declined dramatically in the last decade. There have been no wild salmon returns since 2000 and hatchery returns have been less than 30 fish per year since 1997. There is little to no chance that the conservation requirement will be met from natural or hatchery production on this river in the near future.

BIG SALMON RIVER

Located in southern New Brunswick, the Big Salmon River (45° 25’0”N, 65° 24’0”W; Fig. 29) flows 27 km’s from the outlet of Walton Lake to the Bay of Fundy. It has a drainage area of 332 km^2 with an estimated 494,000 m^2 of accessible salmonid rearing habitat (Jessop 1975, 1986). Further characterisation of the river can be found in Jessop (1975, 1986). The Big Salmon River is home to a number of freshwater and diadromous fish species including the endangered inner Bay of Fundy (iBoF) Atlantic salmon (COSEWIC 2001), and is presently one of the key index rivers used in the recovery strategy for this unique salmon population. As such, references made to hatchery salmon in this section are more properly defined as those that were derived from the Live Gene Bank (LGB) at the Mactaquac Biodiversity Facility. Historical reviews of Atlantic salmon at all life stages in the Big Salmon River have previously been completed by Jessop (1975, 1986) and more recently by Gibson et al. (2003a, 2004).

Returns

Methods

All adult salmon information for the Big Salmon River in 2004 and 2005 was collected through periodic dive counts between July and October, and annual fall redd surveys conducted by New Brunswick Department of Natural resources[4]. The lower section of the Big Salmon River includes 14 pools over roughly 3.0 km from Miller Pool to Amateur Pool inclusive (Fig. 29, not all pools shown in lower stretch) and the annual redd surveys cover approximately 45% of the spawning habitat in the headwater area (Gibson et al. 2003a). When and where the numbers of adult salmon in a pool were sufficient, the pool was seined to catch fish and thereby collect biological information from as many salmon in the pool as possible. Information included; fork length, sex (visual distinction, when possible), scales to determine age, and tissue samples for genetic analysis. Population estimates were generated using a single census mark-recapture value (0.57) and assuming a binomial distribution of errors (i.e. fish can be observed more than once). This value originated from the observation of four of seven marked fish during the Big Salmon River adult surveys in 2003 (Gibson et al. 2004). Egg deposition estimates were determined from a length-fecundity relationship established for Atlantic salmon in the Stewiacke River, Nova Scotia (Amiro and MacNeill 1986); an iBoF river and an index river in the recovery strategy that best represents salmon of the iBoF.

Date	No. persons	Activitiy
2004		
July 27 - 28	6	- upper[a] and lower sections swam/observed
September 14 - 15	12	- upper[a] and lower sections swam/observed - seined Walton Dam and Miller pools
October 20	10	- upper, middle and lower sections swam/observed
2005		
August 3 & 5	7	- upper[a] and lower sections swam/observed - seined Walton Dam pool
September 7 & 8	5	- upper and lower sections swam/observed - seined Walton Dam and Mast Brow pools
September 14	9	- seined Katt pool

a - Mast Brow pool omitted from observation

Results

Usually, counts from the latest in-season observations were used to determine the population estimate of returning adults to the Big Salmon River. In 2004, three separate diver counts were conducted. During the July to September surveys, the majority of salmon were seen in the lower section of the Big Salmon River, but in the final dive count no salmon were observed in the middle and lower sections while four small and five large salmon were observed in the upper section (Table 15). Appling the single census mark-recapture value (0.57) to the nine fish suggested 16 adult salmon returned to spawn in 2004 (Fig. 30). Only one large salmon (age 2.2) was caught and sampled on September 15th (Table 16). A redd survey was conducted on November 10th and revealed a total of 43 redds in 2004. In 2005, the dive counts and seine surveys were conducted on three occasions between August and September. On August 3,

[4] John Blenis- New Brunswick Department of Natural Resources, Hampton, N.B.

twelve small and eight large salmon were observed in the upper and lower sections of the Big Salmon River and on the following survey (September 7) 23 small and 11 large salmon were observed (Table 15). Similar to 2004, only one hatchery salmon was observed in 2005 (Table 15). Using the single census mark-recapture rate from 2003 and the 34 fish observed on September 7, there was an estimated return of 60 adults to the Big Salmon River in 2005 - the largest estimated return since 2000 (Fig. 30). It should be noted however, that this is potentially a minimum estimate since high water conditions did not permit further observations or counts later in the season (i.e. October). The annual redd survey conducted on Nov 8th observed 70 possible redds in the headwater region of the Big Salmon River. Samples were collected from 23 adult salmon (Table 16); all but four were small salmon, and the majority (12/19) were males (the four fish sampled in August could not be sexually differentiated) (Table 16).

Conservation Requirements

Approximately 280 small salmon and 420 large salmon are required to achieve the conservation requirement of 2.2 million eggs established for the Big Salmon River by Marshall et al. (1992).

Escapement

It was estimated that 16 and 60 salmon returned to the Big Salmon River in 2004 and 2005, respectively (Fig. 30). Only one of the salmon (age = 2.2, fork length = 80.4 cm) was sampled in 2004 and therefore did not permit a reasonable estimation of the percentage of the conservation requirement that was achieved. In 2005, 23 salmon were sampled and a ratio of 19 1SW to four MSW salmon based on age was determined (Table 16). This resulted in 17.9% and 2.4% of the conservation requirement for the Big Salmon River (summarized below).

	1SW salmon	MSW salmon
Conservation requirement	280	420
Estimate	50	10
Percent of requirement	17.9%	2.4%

Additionally, sex was visually determined from 19 of the 23 salmon sampled and results suggested 29.4% (5/17) of the 1SW and all (2/2) of the MSW salmon were females (Table 16). Based on the length-fecundity relationship (eggs = $431.3e^{0.0368 \cdot \text{fork length}}$) from Amiro and MacNeill (1986), egg deposition estimates in 2005 were 47,648 eggs for the 1SW and 45,460 eggs for the MSW estimated salmon returns. Combined, this represents 4.2% of the conservation requirement for the Big Salmon River in 2005. Potential egg contributions from 13 (2004) and 62 (2005) female captive-reared adults released to the Big Salmon River were not estimated in this report (Appendix *vii*).

Parr Densities

Methods

Juvenile salmon surveys were completed at seven closed sites (barrier nets) and 11 open sites (spot-checks and mark-recapture) in the Big Salmon River in 2004 and 2005 (Fig. 31). Previous summaries of juvenile densities for the Big Salmon River have been completed by Amiro and Longard (1995) and Gibson et al. (2003a, 2003b, 2004). Density estimates (juvenile salmon per 100 m²) were determined for:

- open sites (spot-checks only) using a previously established catchability coefficient of 42.8% (Gibson et al. 2004),
- open sites (mark-recapture) using the adjusted Petersen method (Ricker 1975), and
- closed sites (barrier nets) using Zippen's (1956) maximum likelihood technique.

All parr captured were identified to origin by the presence (wild) or absence (hatchery) of an adipose fin and later confirmed through scale and tissue analysis. Age-0+ fish were considered 'wild' since their adipose fin is not removed prior to release as unfed fry. Subsequent extrapolation of wild or hatchery origin can be done, if captured, in future electrofishing surveys. Corresponding age and origin ratios were applied to the overall density at each site. For all parr at open sites, fork length and weight were measured, scales were removed (except from age-0+) and an upper portion of the caudal fin was removed for genetic analysis. At closed sites fork lengths were measured for all parr, scales were retained from a single parr in each 0.5cm fork length interval, and tissue samples from wild and hatchery parr (except age-0+) were pooled separately by site.

Results

In 2004 and 2005, the mean density (fish per 100 m^2) for wild salmon was greatest for age-0+ parr (14.0 in 2004 and 15.9 in 2005), and decreased as parr grew older (Table 17). For hatchery salmon age-1+ densities were 3.4 (2004) and 1.9 (2005), and for age-2+ parr were 0.3 in 2004 and 0.1 in 2005 (Table 17). The large fluctuations associated with the age-0+ wild densities in particular, are likely attributed to the location of sites in respect to unfed fry releases during a given year. Densities for all age classes were similar to those estimated since 2000 (Gibson et al. 2003b, 2004).

Smolt Assessment

Atlantic salmon smolt monitoring and assessments in the Big Salmon River were conducted using a rotary screw fish trap with the help of Fort Folly First Nation in 2004 and 2005. All data with respect to Big Salmon River smolt activities from 2001-2005 is not reported here, but can be found in Flanagan et al. (2006).

Outlook

Although the estimated number of adult returns to the Big Salmon River has increased slightly in 2005, it represents only 2.4% and 17.9% of the large and small salmon conservation requirement outlined by Marshall et al. (1992). In addition to current juvenile densities and smolt estimates, which are largely influenced by supplementation of unfed fry, fall fingerlings and spring smolts from the LGB, as well as the low marine survival, the inner Bay of Fundy population of Atlantic salmon in the Big Salmon River is likely to remain critically low.

Management Considerations

Recent results from the various monitoring and assessment activities at all life stages in the Big Salmon River has resulted in a mild shift in the release strategy for iBoF Atlantic salmon in which more LGB progeny are being released as unfed fry and fall fingerling, while reducing the number of spring smolts released (Appendix *vii*). The continuation of these activities is necessary to maintain the current knowledge base, persistence and eventual recovery of this important population of salmon.

ACKNOWLEDGEMENTS

The data and analyses were made possible only with the support of many co-workers, in particular field supervisors J. Mallery and C. Fitzherbert. Counts and detailed biological characteristic data of salmon captured at the Mactaquac Dam, essential to the assessment of this population, were provided by the staff at Mactaquac Biodiversity Facility, in particular D. MacDonald. Counts of salmon at the Tobique Narrows fishway were assisted by NB Power and Tobique Salmon Protective Association (TSPA). Counts of salmon at Beechwood Dam fishway were provided by NB Power and at Tinker Dam by WPS Canada Generation Inc. The Kingsclear and Oromocto First Nations operated the salmon counting fence on the Nashwaak River. Oromocto, Tobique, Woodstock First Nations, and the TSPA were active in the juvenile electrofishing surveys. L. Sochasky and D. McLean (St. Croix International Waterway Commission) provided counts and scales from salmon ascending the Milltown fishway. J. Carr, Atlantic Salmon Federation (ASF), provided counts and analyses for the Magaguadavic River. We thank the Nashwaak Watershed Association Inc. (NWA) (in particular P. Salonius) and the TSPA (in particular R. O'Donnell and C. McCluskey) for their participation and support of the Nashwaak and Tobique smolt projects and the ASF and the NB Salmon Council for use of the smolt wheels. Most of the monitoring projects benefited from having interns from the FPSYIP. The Big Salmon River data would not have been possible without the assistance received from staff at Fort Folly First Nation, Fundy National Park, Atlantic Salmon Federation, Woodstock First Nation, New Brunswick Department of Natural Resources and funding from the Interdepartmental Recovery Fund. Discharge data was provided by Environment Canada and NB Power. The authors also thank M. Bradford, D. MacDonald and L. Marshall for their helpful comments and suggestions on earlier versions of this document.

LITERATURE CITED

Amiro, P.G. 1993. Habitat measurement and population estimation of juvenile Atlantic salmon (*Salmo salar*). p. 81 - 97. *In* R.J. Gibson and R.E. Cutting [ed.]. Production of juvenile Atlantic salmon, *Salmo salar*, in natural waters. Can. Spec. Publ. Fish. Aquat. Sci. 118.

Amiro, P.G. and D.A Longard. 1995. Status of Atlantic salmon in Salmon Fishing Area 22, for 1994, with emphasis on inner Bay of Fundy stocks. DFO Atlantic Fisheries. Res. Doc. 95/81. 20p.

Amiro, P.G. and A.J MacNeill. 1986. Status of juvenile Atlantic salmon stocks of the Stewiacke River in 1984 and 1985 and forecasts of recruits to fisheries in 1986 and 1987. CAFSAC Res. Doc. 86/32. 40p.

Anon. 1978. Biological Conservation Subcommittee Report. Appendix B, Atlantic Salmon Review Task Force Review. 203p.

Anon. 1988. Long-term management plan for the diadromous fisheries of the St. Croix River. Can. Man. Rep. Fish. Aquat. Sci. No. 1969. vii + 68p.

Chaput, G.J. and R.A. Jones. 2004. Catches of downstream migrating fish in fast-flowing rivers using rotary screw traps. Can. Man. Rep. Fish. Aquat. Sci. 2688: v + 14 p.

COSEWIC. 2001. Canadian Species at Risk, November 2001. Committee on the Status of Endangered Wildlife in Canada, Canadian Wildlife Service, Environment Canada, Ottawa, ON. 38p. (http://www.cosepac.gc.ca)

DFO. 2001. Atlantic Salmon Maritime Provinces Overview for 2000. DFO Science Stock Status Report D3 - 14(2001) (revised).

DFO. 2002. Atlantic Salmon Maritime Provinces Overview for 2001. DFO Science Stock Status Report D3 - 14(2002).

DFO. 2003. Atlantic Salmon Maritime Provinces Overview for 2002. DFO Science Stock Status Report 2003/026.

Elson, P.F. 1967. Effects on wild young salmon of spraying DDT over New Brunswick forests. J. Fish. Res. Board Can. 24(4): 731 - 767.

Elson, P.F. 1975. Atlantic salmon rivers. Smolt production and optimal spawning requirements – an overview of natural production. Int. Atl. Sal. Found. Spec. Public. Ser. 6: 96 - 119.

Flanagan, J.J., R.A. Jones, and P. O'Reilly. 2006. A summary and evaluation of Atlantic salmon (*Salmo salar*) smolt monitoring and rotary screw fish trap activities in the Big Salmon River, 2001 – 2005. Can. Tech. Rep. Fish. Aqua. Sci. 2646: vii + 31p.

Francis, A.A. 1980. Densities of juvenile Atlantic salmon and other species, and related data from electroseining studies in the Saint John River system, 1968-78. Can. Data Rep. Fish. Aquat. Sci. No. 178. 102 p.

Francis, A.A. and P.A. Gallop. 1979. Enumeration of adult Atlantic salmon, *Salmon salar*, runs in 1972, 1973 and 1975 to the Nashwaak River, New Brunswick. Unpublished.

Gazey, W.J. and M.J. Staley. 1986. Population estimation from mark-recapture experiments using a sequential bayes algorithm. Ecology 67: 941 - 952.

Gibson, A. Jamie F., Ross A. Jones, Peter G. Amiro, J. Jason Flanagan. 2003a. Abundance of Atlantic salmon (*Salmo salar*) in the Big Salmon River, New Brunswick, from 1951 to 2002. DFO Can. Sci. Advis. Sec. Res. Doc. 2003/119: i + 55p.

Gibson, A.J.F., P.G. Amiro and K.A. Robichaud-LeBlanc. 2003b. Densities of juvenile Atlantic salmon (*Salmo salar*) in inner Bay of Fundy rivers during 2000 and 2002 with reference to past abundance inferred from catch statistics and electrofishing surveys. DFO Can. Sci. Advis. Sec. Res. Doc. 2003/121. ii + 61p.

Gibson, A.J.F., R.A. Jones, S.F. O'Neil, J.J. Flanagan and P.G. Amiro. 2004. Summary of monitoring and live gene bank activities for inner Bay of Fundy Atlantic salmon in 2003. DFO Can. Sci. Advis. Sec. Res. Doc. 2004/016. ii + 45p.

Jessop, B. M. 1975. Investigation of the salmon (*Salmo salar*) smolt migration of the Big Salmon River, New Brunswick. Technical Report Series No. MAR/T-75-1. Environment Canada, Fisheries and Marine Service. ix + 56p.

Jessop, B. M. 1986. Atlantic salmon (*Salmo salar*) of the Big Salmon River, New Brunswick. Can. Tech. Rep. Fish. Aquat. Sci. No. 1415. xii + 50p.

Jones, R.A., L. Anderson and T. Goff. 2004. Assessments of Atlantic salmon stocks in southwest New Brunswick, an update to 2003. DFO Can. Sci. Advis. Sec. Res. Doc. 2004/019. ii + 70 p.

Marshall, T.L. 1989. Assessment of Atlantic salmon of the Saint John River, N.B. 1988. CAFSAC Res. Doc. 89/77. vii + 24p.

Marshall, T.L. and J.D. Cameron. 1995. Assessment of Atlantic salmon stocks of Saint John River and southwest New Brunswick, 1994. DFO Atlantic Fisheries Res. Doc. 95/129. iii + 49p.

Marshall, T.L. and R. Jones. 1996. Status of Atlantic salmon stocks of southwest New Brunswick, 1995. DFO Atlantic Fisheries Res. Doc. 96/40. iii + 50p.

Marshall, T.L. and G.H. Penney. 1983. Spawning and river escapement requirements for Atlantic salmon of the Saint John River, New Brunswick. CAFSAC Res. Doc. 83/66. iii + 17p.

Marshall, T.L., R. Jones and T. Pettigrew. 1997. Status of Atlantic salmon stocks of southwest New Brunswick, 1996. DFO Atlantic Fisheries Res. Doc. 97/27. iii + 67p.

Marshall, T.L., C.J. Harvie and R.A. Jones. 1998. Status of Atlantic salmon stocks of southwest New Brunswick, 1997. DFO Can. Stock Assess. Res. Doc. 98/30. iii + 60p.

Marshall, T.L., P.G. Amiro, J.A. Ritter, B.M. Jessop, R.E. Cutting and S.F. O'Neil. 1992. Perfunctory estimates of allowable harvests of Atlantic salmon in 18 rivers of Scotia-Fundy Region. CAFSAC Res. Doc. 92/16. 28p.

Marshall, T.L., G.J. Chaput, P.G. Amiro, D.K. Cairns, R.A. Jones, S.F. O'Neil and J.A. Ritter. 1999a. Assessments of Atlantic salmon stocks of the Maritimes Region, 1998. DFO Can. Stock Assess. Res. Doc. 99/25. 77p.

Marshall, T.L., R. Jones and L. Anderson. 1999b. Follow-up assessments of Atlantic salmon in the Saint John River drainage, N.B., 1998. DFO Can. Stock Assess. Res. Doc. 99/109. 42p.

Marshall, T.L., R.A. Jones and L. Anderson. 2000. Assessment of Atlantic salmon stocks in southwest New Brunswick, 1999. DFO Can. Stock Assess. Res. Doc. 2000/010. 29p.

Martin, J.D. 1984. Atlantic salmon and alewife passage through a pool and weir fishway on the Magaguadavic River, New Brunswick, during 1983. Can. Man. Rep. Fish. Aquat. Sci. 1776: iii + 11p.

Penney, G.H. and T.L. Marshall. 1984. Status of Saint John River, N.B., Atlantic salmon in 1983 and forecast of returns in 1984. CAFSAC Res. Doc. 84/47. 34p.

Ricker, W.E. 1975. Computation and interpretation of biological statistics of fish populations. Fish. Res. Board Can., Bull. 191: 382p.

Zippen, C. 1956. An evaluation of the removal method of estimating animal populations. Biometrics. 8: 163-189.

Table 1. Estimated total (adjusted) homewater returns of wild, hatchery and aquaculture 1SW and MSW salmon destined for Mactaquac Dam on the Saint John River, N.B., 2005.

Sea-age	Components	Wild	Hatchery	Aquaculture	Total
1SW					
	Mactaquac counts[a]	862	264	0	1,126
	Mactaquac counts adjusted[b]	854	293	0	1,147
	By-catch[c]	9	3	0	12
	Totals	863	296	0	1,159
MSW					
	Mactaquac counts[a]	269	94	0	363
	Mactaquac counts adjusted[b]	248	94	0	342
	Native Food Fishery	0	0	0	0
	By-catch[c]	6	2	0	8
	Totals	254	96	0	350

[a]Hatchery/wild origin per external characteristics in previous assessments; fishway closed Oct. 25.
[b]Adjusted by analyses of scales from sampled fish (Marshall and Jones 1996).
[c]Estimated to be 1% of total 1SW returns and 2. 5% total MSW returns and is considered to include losses to poaching.

Table 2. Counts of wild, hatchery and aquaculture origin Atlantic salmon (as identified by fishway operators) trapped at fishways / fences of four rivers in southwest and central New Brunswick. The Saint John counts are provided by Mactaquac Biodiversity Facility sorting facility staff.

	Saint John				Nashwaak					Magaguadavic						St. Croix[c]					
	Wild		Hatchery		Wild		Hatchery		Dates of	Wild		Hatchery		Aquaculture		Wild		Hatchery		Aquaculture	
Year	1SW	MSW	1SW	MSW	1SW	MSW	1SW	MSW	Operation	1SW	MSW	1SW	MSW	1SW	MSW	1SW	MSW	1SW	MSW	1SW	MSW
1967	1,181	1,271	-	-																	
1968	1,203	770	-	-																	
1969	2,572	1,749	-	-																	
1970	2,874	2,449	94	-																	
1971	1,592	2,235	336	37																	
1972	784	4,831	246	583	259	859	-	-	8/18-10/29 e												
1973	1,854	2,367	1,760	475	596	1,956	-	-	6/10-11/05 e												
1974	3,389	4,775	3,700	1,907																	
1975	5,725	6,200	5,335	1,858	1,223	1,036	-	-	6/28-10/29 e												
1976	6,797	5,511	7,694	1,623																	
1977	3,504	7,257	6,201	2,075																	
1978	1,584	3,034	2,556	1,951																	
1979	6,234	1,993	3,521	892																	
1980	7,555	8,157	9,759	2,294																	
1981	4,571	2,441	3,782	1,089																	
1982	3,931	2,254	2,292	728												53	15	27	3		df
1983	3,613	1,711	1,230	299						282	607			21	30	33	62	2	28		df
1984	7,353	7,011	1,304	806						255	512					120	40	63	17		df
1985	5,331	6,390	1,746	571						169	466					36	250	12	46		df
1986	6,347	3,655	699	487												31	128	29	130		df
1987	5,106	3,091	2,894	344												43	147	181	21		df
1988	8,062	1,930	1,129	670						291	398					45	22	55	274		df
1989	8,417	3,854	1,170	437												46	19	95	73		df
1990	6,486	3,163	1,421	756 a												11	40	4	54		df
1991	5,415	3,639	2,160	587 a												30	83	42	52		df
1992	5,729	3,522	1,935	681 a						155	139			83	62 bd						
1993	2,873	2,601	1,034	379 a	72	113	11	42	8/19-10/12 de	112	125			96	52 bd	3	30	5	66		d
1994	2,133	1,713	1,180	493 a	376	251	27	23	7/15-10/25 de	69	61			1,059	81 bd	24	19	23	18	97	
1995	2,429	1,681	2,541	598 a	544	294	25	14	7/12-10/18 de	49	30			491	168 bd	7	14	7	19	7	6 d
1996	1,552	2,413	4,603	726 a	854	391	86	38	6/13-10/18 de	48	21			174	20 bde	10	32	13	77	15	5 d
1997	380	1,147	2,689	629 a	332	339	38	27	6/18-11/02 d	35	24			59	23 bd	7	8	26	2	11	16 d
1998	476	367	4,413	624 a	464	142	1	9	6/08-10/27 de	28	3			211	3 bd	12	6	20	3	14	11 df
1999	700	1,112	2,511	680 a	303	84	2	0	6/03-10/13 de	19	5			80	10 bd	7	2	1	3	23	0 df
2000	1,408	393	1,573	200 a	428	161	0	0	6/19-10/26 de	13	1			25	2 bd	0	0	15	5	30	0 df
2001	730	680	942	521 a	242	271	2	1	6/21-11/01 d	8	9			120	4 bd	0	0	13	7	33	23 df
2002	709	212	1,616	178 a	342	73	1	6	6/10-10/28 d	7	0			29	0 bd	0	0	14	6	2	4 d
2003	443	279	838	464 a	181	82	7	3	6/05-10/26 de	3	3			14	2 bd	0	0	13	2	3	3 df
2004	863	446	562	296 a	473	168	13	4	6/03-10/26 de	2	0			0	17 bd	1	0	5	4	0	4 d
2005	862	269	264	94 a	405	94	20	3	6/09-10/07 ade	5	0	4	0	62	1 bd	0	0	2	4	30	3 d

a- Small numbers of aquaculture fish, see Tables 3,4a & b. b- Aquaculture. c- Hatchery designation to be reviewed; sea-cage fish could be among hatchery fish prior to 1994.
d- Corrected by scale analysis. e- Partial count. f- breakdown changed from Jones et al. 2004

Table 3. Estimated total homewater returns of wild, hatchery and aquaculture 1SW and MSW salmon destined for Mactaquac Dam, Saint John River, 1970-2005.

	Wild		Hatchery		Total (W+H)		Aquaculture[a]	
Year	**1SW**	**MSW**	**1SW**	**MSW**	**1SW**	**MSW**	**1SW**	**MSW**
1970	3,057	5,712	100	0	3,157	5,712		
1971	1,709	4,715	365	77	2,074	4,792		
1972	908	4,899	285	592	1,193	5,491		
1973	2,070	2,518	1,965	505	4,035	3,023		
1974	3,656	5,811	3,991	2,325	7,647	8,136		
1975	6,858	7,441	6,374	2,210	13,232	9,651		
1976	8,147	8,177	9,074	2,302	17,221	10,479		
1977	3,977	9,712	6,992	2,725	10,969	12,437		
1978	1,902	4,021	3,044	2,534	4,946	6,555		
1979	6,828	2,754	3,827	1,188	10,655	3,942		
1980	8,482	10,924	10,793	2,992	19,275	13,916		
1981	6,614	5,766	5,627	2,728	12,241	8,494		
1982	5,174	5,528	3,038	1,769	8,212	7,297		
1983	4,555	5,783	1,564	1,104	6,119	6,887		
1984	8,311	9,779	1,451	1,115	9,762	10,894		
1985	6,526	10,436	2,018	875	8,544	11,311		
1986	7,904	6,128	862	797	8,766	6,925		
1987	5,909	4,352	3,328	480	9,237	4,832		
1988	8,930	2,625	1,250	912	10,180	3,537		
1989	9,522	4,072	1,339	469	10,861	4,541		
1990	7,263	3,329	1,533	575	8,796	3,904	8	221
1991	6,256	4,491	2,439	700	8,695	5,191	56	24
1992	6,683	4,104	2,223	778	8,906	4,882	34	16
1993	3,213	2,958	1,156	425	4,369	3,383	0	6
1994	2,276	1,844	1,258	503	3,534	2,347	0	28
1995	2,168	1,654	2,907	599	5,075	2,253	4	102
1996	1,326	2,309	5,394	1,002	6,720	3,311	3	10
1997	343	1,128	2,912	843	3,255	1,971	0	0
1998	341	320	4,641	647	4,982	967	0	4
1999	472	837	2,785	967	3,257	1,804	7	13
2000	1,343	277	1,725	267	3,068	544	3	3
2001	686	644	1,014	562	1,700	1,206	12	2
2002	634	199	1,724	177	2,358	376	5	8
2003	381	240	921	511	1,302	751	2	1
2004	864	400	623	312	1,487	712	0	1
2005	863	254	296	96	1,159	350	0	0

[a] 1990-94, 1SW and MSW classification based on lengths and count data; 1995-2005, count raised by estimated removals downstream of Mactaquac and adjusted according to ages from scale samples.

Table 4a. Estimated total number of 1SW returns to the Saint John River, 1975-2005, from hatchery-reared smolts released at Mactaquac, 1974-2004.

Releases			**Returns**									
		Prop	**Mactaquac**			**Native**	**Angled**	**By-**	**Com-**		**% return**	
Year	**Smolts**	**1-yr**	**Year**	**Mig ch (combined)**	**Dam**	**fishery**	**main SJ**	**catch**	**mercial**	**Total[a]**	**Unadj**	**Adj[bc]**
1974	337,281	0.00	1975	1,771	3,564	28	977	34		6,374	1.890	
1975	324,186	0.06	1976	2,863	4,831	219	1,129	32		9,074	2.799	
1976	297,350	0.14	1977	1,645	4,533	36	708	70		6,992	2.351	
1977	293,132	0.26	1978	777	1,779	49	369	70		3,044	1.038	
1978	196,196	0.16	1979	799	2,722	100	186	20		3,827	1.951	
1979	244,012	0.09	1980	3,072	6,687	335	640	59		10,793	4.423	
1980	232,258	0.12	1981	921	2,861	139	350		1,356	5,627	2.423	
1981	189,090	0.08	1982	828	1,464	64	267		415	3,038	1.607	
1982	172,231	0.06	1983	374	857	39	69		225	1,564	0.908	
1983	144,549	0.22	1984	476	828	36	63	48		1,451	1.004	0.976
1984	206,462	0.28	1985	454	1,288	82	128	66		2,018	0.977	0.920
1985	89,051	1.00	1986	64	635	53	93	17		862	0.968	0.868
1986	191,495	1.00	1987	152	2,063	74	222	52		2,563	1.338	1.170
1987	113,439	1.00	1988	(717)		15	46	16		794	0.700	0.672
1988	142,195	1.00	1989	(1,018)		0	107	23		1,148	0.807	0.763
1989	238,204	0.98	1990	(903)		0	57	20		980	0.411	0.401
1990	241,078	0.98	1991	(1,490)		88	108	35		1,721	0.714	0.649
1991	178,127	0.97	1992	(1,132)		26	135	26		1,319	0.740	0.688
1992	204,836	1.00	1993	(779)		11	60	17		867	0.423	0.406
1993	221,403	1.00	1994	(841)		37	0	18		896	0.405	0.393
1994	225,037	1.00	1995	(1,509)		15		15		1,539	0.684	0.661
1995 [d]	251,759	1.00	1996	(2,649)		215	0	29		2,893	1.149	1.140
1996	286,400	1.00	1997	(1,543)		58	0	16		1,617	0.565	0.558
1997	286,485	1.00	1998	(2,112)		0	0	21		2,133	0.745	0.745
1998	297,012	1.00	1999	(1,672)		0	0	17		1,689	0.569	0.468
1999	305,073	1.00	2000	(1,403)		0	0	14		1,417	0.464	0.464
2000	311,825	1.00	2001	(839)		0	0	8		847	0.272	0.272
2001	305,321	1.00	2002	(1,358)		0	0	14		1,372	0.449	0.449
2002	241,971	1.00	2003	(815)		0	0	8		823	0.340	0.340
2003	155,701	1.00	2004	(499)		0	0	5		504	0.324	0.324
2004	52,178	1.00	2005	(197)		0	0	2		199	0.381	0.381
2005	77,271	1.00	2006									

[a]Includes some returns from smolts stocked downriver of Mactaquac or escaped from sea-cages (Table 3: as determined from erosion of margins of upper and lower caudal fins).

[b]Adjusted return rates exclude smolts stocked downriver from Mactaquac (Marshall 1989) and fish of probable sea-cage origin. (Marginal numbers of returns from approx. 5,000 age 2.1 smolts, 1989-1991 are not included; no returns from tagged smolts released to the Nashwaak River, 1992 or 1997; 1997 count yielded 2 tagged 1SW fish from among 2,000 tagged smolts released to the Nashwaak in 1996 (9,017 smolts total).

[c]1997 adjustment to return years 1995-97, based on Ad-clipped age1.1 returns from age-0+ fall fingerlings stocked above Mactaquac, 1993-95. Total estimated returns number 22, 22 and 10 in 1995, 1996 and 1997, respectively.

[d] Revised "smolts released" includes 11,177 age-1 smolts released to the migration channel from Saint John Hatchery.

Table 4b. Estimated total number of virgin 2SW returns to the Saint John River, 1976-2005, from hatchery-reared smolts released at Mactaquac, 1974-2003.

Releases			Returns									
		Prop	Mactaquac			Native	Angled	By-	Com-		% return	
Year	Smolts	1-yr	Year	Mig ch	Dam	fishery	main SJ	catch	mercial	Total[a]		
				(combined)							Unadj	Adj[bc]
1974	337,281	0.00	1976	310	1,313	392	267	20		2,302	0.683	
1975	324,186	0.06	1977	341	1,727	206	417	34		2,725	0.841	
1976	297,350	0.14	1978	223	1,728	368	165	50		2,534	0.852	
1977	293,132	0.26	1979	145	747	210	65	21		1,188	0.405	
1978	196,196	0.16	1980	302	1,992	506	146	46		2,992	1.525	
1979	244,012	0.09	1981	126	963	252	125		1,262	2,728	1.118	
1980	232,258	0.12	1982	88	640	462	181		398	1,769	0.762	
1981	189,090	0.08	1983	44	255	76	17		712	1,104	0.584	
1982	172,231	0.06	1984	84	722	201	5	103		1,115	0.647	0.560
1983	144,549	0.22	1985	73	492	189	5	116		875	0.605	0.553
1984	206,462	0.28	1986	16	471	266	4	40		797	0.386	0.346
1985	89,051	1.00	1987	4	338	110	4	24		480	0.539	0.453
1986	191,495	1.00	1988	(511)		150	0	35		696	0.363	0.354
1987	113,439	1.00	1989	(379)		0	0	20		399	0.352	0.330
1988	142,195	1.00	1990	(480)		0	0	25		505	0.355	0.170
1989	238,204	0.98	1991	(359)		62	0	46		467	0.196	0.173
1990	241,078	0.98	1992	(590)		58	0	32		680	0.282	0.256
1991	178,127	0.97	1993	(242)		16	0	11		269	0.151	0.145
1992	204,836	1.00	1994	(303)		10	0	23		336	0.164	0.159
1993	221,403	1.00	1995	(398)		5	0	11		414	0.187	0.187
1994	225,037	1.00	1996	(567)		18	0	15		600	0.267	0.267
1995 [d]	251,759	1.00	1997	(412)		45	0	12		469	0.186	0.186
1996	286,400	1.00	1998	(229)		0	0	6		235	0.082	0.082
1997	286,485	1.00	1999	(554)		0	0	14		568	0.198	0.198
1998	297,012	1.00	2000	(173)		0	0	4		177	0.060	0.060
1999	305,073	1.00	2001	(462)		0	0	12		474	0.155	0.155
2000	311,825	1.00	2002	(142)		0	0	4		146	0.047	0.047
2001	305,321	1.00	2003	(443)		0	0	11		454	0.149	0.149
2002	241,971	1.00	2004	(265)		0	0	7		272	0.112	0.112
2003	155,701	1.00	2005	(78)		0	0	2		80	0.051	0.051
2004	52,178	1.00										

[a]Includes some returns from smolts stocked downriver of Mactaquac or escaped from sea-cages (Table 3: erosion of margins of upper and lower caudal fins).

[b]Adjusted return rates exclude smolts stocked downriver from Mactaquac (Marshall 1989) and fish of probable sea-cage origin. (Marginal numbers of returns from approx. 5,000 age 2.1 smolts, 1989-1991 are not included; no returns from tagged smolts released to the Nashwaak River, 1992; possibly 3 returns from 12,516 smolts >12cm to Nashwaak in 1993; no returns from 15,059 stocked in the Nashwaak in 1994 and 2 returns from 3,989 tagged [13,283 total] in 1995.

[c]1997 adjustment to return year 1997 based on Ad-clipped age 1.2 returns from age-0+ fall fingerlings stocked above Mactaquac in 1994. Total estimated returns numbered 9 fish in 1997.

[d]Revised "smolts released" includes 11,177 age-1 smolts released to the migration channel from Saint John Hatchery.

Table 5. Estimated homewater removals of 1SW and MSW salmon destined for Mactaquac Dam on the Saint John River, N.B., 2005.

	1SW			MSW		
Components	**Wild**	**Hatch**	**Total**	**Wild**	**Hatch**	**Total**
Passed above Tinker	4	2	6	1	1	2
Mortality @ Beechwood	0	0	0	2	0	2
Tobique Barrier Morts	0	16	16	0	2	2
Hatchery broodfish	12	0	12	34	2	36
mortalities, etc.	10	3	13	6	1	7
Poaching/disease	24	16	40	12	8	20
By-catch [a]	9	3	12	6	2	8
Totals	**59**	**40**	**99**	**61**	**16**	**77**

[a] Wild:hatchery composition per adjusted counts and assumed availability.

Table 6. Estimated homewater returns, removals and spawning escapement of 1SW and MSW salmon destined for upriver of Mactaquac Dam, Saint John River, 2005.

Sea-age	**Components**	**Wild**	**Hatch**	**Total**
1SW				
	Homewater returns	863	296	1,159
	Homewater removals[a]	59	40	99
	Spawners	804	256	1,060
	Conservation requirement			4,900
	% of requirement			22
MSW				
	Homewater returns	254	96	350
	Homewater removals[a]	61	16	77
	Spawners	193	80	273
	Conservation requirement			4,900
	% of requirement			6

[a] Refer to Table 5 for details.

Table 7a. Number, biological characteristics and estimated number of eggs from wild and hatchery 1SW and MSW salmon released upriver of Mactaquac, 1996 - 2005.

Sea-Age Origin	Year	Female Mean Length (cm)	Estimated Fecundity	Prop Female	Total (M+F) Counts Escape	Total Eggs	Prop Total
Wild 1SW							
	1996	58.8	3,587	0.132	1,082	512,310	0.03
	1997	61.3	3,927	0.061	313	74,979	0.01
	1998	58.5	3,550	0.135	311	148,573	0.03
	1999	62.3	4,066	0.109	432	192,076	0.02
	2000	59.8	3,717	0.177	1,208	795,471	0.22
	2001	59.6	3,692	0.112	548	225,894	0.03
	2002	59.9	3,728	0.126	544	254,698	0.14
	2003	59.7	3,701	0.137	281	142,091	0.04
	2004	59.2	3,635	0.120	759	330,803	0.10
	2005	58.2	3,506	0.068	804	190,824	0.08
	mean	**59.7**	**3,711**	**0.118**			**0.07**
Hatchery 1SW							
	1996	58.8	3,584	0.118	4,394	1,858,276	0.10
	1997	62.0	4,021	0.092	2,429	898,565	0.09
	1998	58.6	3,551	0.113	4,311	1,734,600	0.29
	1999	59.5	3,672	0.101	2,530	940,495	0.09
	2000	58.0	3,486	0.089	1,587	493,507	0.14
	2001	60.8	3,855	0.041	915	144,907	0.02
	2002	60.2	3,769	0.047	1,621	287,235	0.15
	2003	58.1	3,494	0.073	855	218,951	0.06
	2004	59.6	3,688	0.062	580	132,273	0.02
	2005	61.4	3,935	0.037	256	37,589	0.03
	mean	**59.7**	**3,706**	**0.077**			**0.10**
Wild MSW							
	1996	78.6	7,313	0.861	1,700	10,704,039	0.59
	1997	77.0	6,896	0.949	786	5,143,823	0.53
	1998	79.7	7,617	0.929	188	1,330,139	0.22
	1999	78.0	7,146	0.953	582	3,963,315	0.39
	2000	77.9	7,131	0.953	129	877,003	0.25
	2001	78.0	7,149	0.947	470	3,181,509	0.49
	2002	79.5	7,557	0.896	92	623,097	0.33
	2003	77.3	6,981	0.946	161	1,063,337	0.27
	2004	78.9	7,395	0.816	343	2,070,079	0.62
	2005	77.1	6,930	0.900	193	1,203,131	0.71
	mean	**78.2**	**7,212**	**0.915**			**0.44**
Hatchery MSW							
	1996	77.0	6,906	0.921	818	5,202,829	0.28
	1997	77.8	7,102	0.931	554	3,663,027	0.37
	1998	77.3	6,976	0.881	439	2,698,884	0.46
	1999	77.5	7,021	0.940	756	4,991,116	0.49
	2000	77.6	7,051	0.982	202	1,398,869	0.39
	2001	77.0	6,903	0.895	474	2,929,761	0.45
	2002	78.4	7,263	0.826	117	702,291	0.38
	2003	76.7	6,831	0.924	394	2,487,626	0.64
	2004	77.9	7,133	0.785	274	1,534,132	0.26
	2005	76.3	6,733	0.901	80	485,368	0.17
	mean	**77.3**	**6,992**	**0.899**			**0.39**

Table 7b. Number, biological characteristics and estimated number of eggs from captive-reared salmon released upriver of Mactaquac, 2003 - 2005.

Age	Year	Female Mean Length (cm)	Estimated Fecundity	Prop Female	Total (M+F) Counts Escape	Total Eggs	Prop Total
1 year adult							
	2003	48.6	2,817	0.588	386	639,459	1.00
	2004	51.6	3,205	0.426	223	304,475	0.10
	2005	48.3	2,776	0.569	202	319,240	0.06
	mean	**49.5**	**2,933**	**0.528**			**0.39**
2 year adult							
	2003						-
	2004	60.8	4,787	0.749	781 (a)	2,800,247	0.90
	2005	65.6	5,902	0.830	847	4,149,106	0.80
	mean	**63.2**	**5,345**	**0.789**			**0.85**
3 year adult							
	2003						-
	2004						-
	2005	66.0	6,006	0.906	128	696,696	0.13
	mean	**66.0**	**6,006**	**0.906**			**0.13**
Repeat Spawner	2003						-
	2004						-
	2005	73.0	8,141	0.128	39	40,705	0.01
	mean	**73.0**	**8,141**	**0.128**			**0.01**

(a) - 842 fish released but 781 estimated to have spawned.

Table 8a. Results of electrofishing surveys on the Tobique River, upriver of Mactaquac Dam, 2004.

	Marking		Recap [a] Time		Hatch Fry	Marking Run			Hatch Fry	Recapture Run			Mark Run	Wild Density / 100 m²			Hatchery Density / 100 m²			Mean [b] Efficiency
						Wild Fry	Parr			Wild Fry	Parr									
Site Name	Month	Day	(days)	Area (m²)	Count	Count	Marked	Mort	Count	Count	Unmark	Marked	MEfficiency	0+	1+	2+	0+	1+	2+	Used
Fyke Net	7	7	-	785	0	0	1	1	0	0	0	0	0.347	0.0	0.4	0.0	0.0	0.4	0.0	Yes
Ben's Pole Road	7	6	-	2696	0	48	12	0	0	0	0	0	0.347	5.1	1.1	0.2	0.0	0.0	0.0	Yes
Saddler Brook Road	7	7	2	728	0	0	28	2	0	0	14	10	0.448	0.0	0.0	0.4	0.0	8.8	0.0	No
South Branch	7	8	1	1017	0	2	27	0	0	0	13	9	0.429	0.5	1.6	2.0	0.0	2.6	0.0	No
Burma Road	7	8	-	1125	0	1	8	0	0	0	0	0	0.347	0.3	1.0	1.0	0.0	0.0	0.0	Yes
Campbell Landing	7	12	2	1043	0	93	57	1	0	81	25	14	0.374	23.9	9.0	2.0	0.0	3.9	0.0	No
River Dee Shingle Gulch	7	13	-	606	0	0	12	0	0	0	0	0	0.347	0.0	3.9	0.5	0.0	1.5	0.0	Yes
River Don Just above forks	7	12	-	775	0	38	12	1	0	0	0	0	0.347	14.2	3.7	1.1	0.0	0.0	0.0	Yes
Hazelton Landing	7	28	2	1783	0	118	54	0	0	151	26	14	0.362	18.3	6.4	1.1	0.0	0.9	0.0	No
Anvil Brook	7	28	-	1017	0	38	14	0	0	0	0	0	0.347	10.8	0.8	1.1	0.0	2.0	0.0	Yes
South Branch	7	21	2	1056	0	0	32	0	0	0	17	16	0.492	0.0	2.7	1.8	0.0	1.8	0.0	No
Pat's Crossing	7	21	-	1089	0	37	0	0	0	0	0	0	0.347	9.8	0.0	0.0	0.0	0.0	0.0	Yes
Above Lawson Brook	7	21	-	583	0	4	1	0	0	0	0	0	0.347	2.1	0.5	0.0	0.0	0.0	0.0	Yes
Above hw bridge on 109	7	20	-	1114	0	15	9	0	0	0	0	0	0.347	3.9	1.5	0.8	0.0	0.0	0.0	Yes
Kate finnamore's	7	20	-	1238	0	0	5	0	0	0	0	0	0.347	0.0	1.1	0.0	0.0	0.0	0.0	Yes
North branch steel tube	7	22	1	750	0	0	20	5	0	0	14	6	0.373	0.0	0.0	0.0	0.0	8.9	0.0	No
River Don Bridge to nowhere	7	14	8	696	0	4	31	1	0	7	17	10	0.395	1.4	7.3	0.2	0.0	4.0	0.0	No
10.5 km above barrier bdg	8	4	-	387	0	0	0	0	0	0	0	0	0.347	0.0	0.0	0.0	0.0	0.0	0.0	Yes
Nation House	7	29	-	732	0	124	2	1	0	0	0	0	0.347	48.8	0.8	0.4	0.0	0.0	0.0	Yes
Bob Barr	7	29	-	1879	0	3	3	0	0	0	0	0	0.347	0.5	0.3	0.2	0.0	0.0	0.0	Yes
Pearl Road	7	29	-	644	0	1	1	0	0	0	0	0	0.347	0.5	0.0	0.5	0.0	0.0	0.0	Yes
Nation House	8	5	-	851	0	44	5	0	0	0	0	0	0.347	14.9	1.6	0.0	0.0	0.0	0.0	Yes
Pig barn	8	5	-	1393	0	13	7	0	0	0	0	0	0.347	2.7	1.4	0.0	0.0	0.0	0.0	Yes
Across from civic #3782	8	5	-	995	0	12	1	0	0	0	0	0	0.347	3.5	0.3	0.0	0.0	0.0	0.0	Yes
Below riley brook bdg	8	12	-	981	0	13	14	0	0	0	0	0	0.347	3.8	3.8	0.0	0.0	0.3	0.0	Yes
Above two brooks	8	25	-	568	0	13	2	0	0	0	0	0	0.347	6.5	1.1	0.0	0.0	0.0	0.0	Yes
Across from blue mountain bk	8	5	-	815	0	61	2	0	0	0	0	0	0.347	21.6	0.7	0.0	0.0	0.0	0.0	Yes
Blue mountain camp site	8	10	-	498	0	11	0	0	0	0	0	0	0.347	6.4	0.0	0.0	0.0	0.0	0.0	Yes
Below ferry landing	8	12	-	944	0	17	2	0	0	0	0	0	0.347	5.2	0.6	0.0	0.0	0.0	0.0	Yes
O'gilvy rd mouth of little gulquac	8	10	-	1047	0	21	4	0	0	0	0	0	0.347	5.8	1.1	0.0	0.0	0.0	0.0	Yes
Below horse island bk	8	12	-	1142	0	32	0	0	0	0	0	0	0.347	8.1	0.0	0.0	0.0	0.0	0.0	Yes
Below kingfisher	8	10	-	529	0	4	3	0	0	0	0	0	0.347	2.3	1.7	0.0	0.0	0.0	0.0	Yes
Andre lavoie's	8	10	-	872	0	5	0	0	0	0	0	0	0.347	1.6	0.0	0.0	0.0	0.0	0.0	Yes
Steve Harrison's farm	8	25	-	488	0	17	0	0	0	0	0	0	0.347	10.0	0.0	0.0	0.0	0.0	0.0	Yes
Above kingfisher (O'gilvy rd)	8	25	-	511	0	6	0	0	0	0	0	0	0.347	3.3	0.0	0.0	0.0	0.0	0.0	Yes
Mouth of Sisson bk	8	25	-	441	0	4	1	0	0	0	0	0	0.347	2.7	0.7	0.0	0.0	0.0	0.0	Yes
Aiton's camp site	8	25	-	547	0	7	0	0	0	0	0	0	0.347	3.7	0.0	0.0	0.0	0.0	0.0	Yes
Opposite vincent rd	8	25	-	534	0	4	0	0	0	0	0	0	0.347	2.2	0.0	0.0	0.0	0.0	0.0	Yes
Little cedar	8	23	-	952	0	0	1	0	0	0	0	0	0.347	0.0	0.3	0.0	0.0	0.0	0.0	Yes
1 km above sisson branch	8	23	-	817	0	13	6	0	0	0	0	0	0.347	4.5	1.4	0.7	0.0	0.0	0.0	Yes
The bungalows	8	24	-	620	0	2	0	0	0	0	0	0	0.347	1.0	0.0	0.0	0.0	0.0	0.0	Yes
Bailey bridge	8	24	-	632	0	4	2	0	0	0	0	0	0.347	1.9	0.9	0.0	0.0	0.0	0.0	Yes
2.5 km below lawson bk site	8	24	-	578	0	1	1	0	0	0	0	0	0.347	0.5	0.5	0.0	0.0	0.0	0.0	Yes
1/2 km above barrier pool	8	27	-	285	0	188	11	0	0	0	0	0	0.347	190.2	10.2	1.0	0.0	0.0	0.0	Yes
Reardon gulch landing	8	26	1	395	0	26	25	0	0	20	13	9	0.424	15.4	10.6	4.3	0.0	0.0	0.0	No
Below m. Tomlinson camp	9	1	-	373	0	70	17	0	0	0	0	0	0.347	54.2	8.5	4.6	0.0	0.0	0.0	Yes
Above m. Tomlinson camp	9	1	-	415	0	32	8	0	0	0	0	0	0.347	22.2	4.8	0.0	0.0	0.7	0.0	Yes
1.4 km below campbell landing	9	2	-	384	0	57	17	0	0	0	0	0	0.347	42.7	10.5	2.3	0.0	0.0	0.0	Yes
River dee bridge	9	2	-	343	0	14	17	0	0	0	0	0	0.347	11.7	12.6	0.0	0.0	1.7	0.0	Yes
Below Trouser lake	7	13	2	641	0	4	20	2	0	5	16	8	0.373	1.7	4.8	3.1	0.0	1.2	0.0	No
Below oven-rock brook	9	3	-	559	0	14	5	0	0	0	0	0	0.347	7.2	1.5	1.0	0.0	0.0	0.0	Yes
River de chute lodge	9	3	-	588	0	6	3	0	0	0	0	0	0.347	2.9	0.5	1.0	0.0	0.0	0.0	Yes
Below forks	9	7	-	593	0	0	10	0	0	0	0	0	0.347	0.0	1.0	2.5	0.0	1.5	0.0	Yes
3 km above 4 mile brook	8	4	2	774	0	29	38	2	0	24	12	13	0.548	6.8	6.3	3.1	0.0	0.0	0.0	No
6.2 km above hazeltin landing	7	30	-	561	0	35	19	0	0	0	0	0	0.347	18.0	7.2	1.0	0.0	1.5	0.0	Yes
Below salmon hole	8	4	-	1023	0	26	5	0	0	0	0	0	0.347	7.3	1.1	0.0	0.0	0.3	0.0	Yes
South Branch Dingee brook landing	9	2	-	353	0	14	3	0	0	0	0	0	0.347	11.3	0.8	1.7	0.0	0.0	0.0	Yes
South Branch Below indian lake rood	9	8	-	295	0	0	17	0	0	0	0	0	0.347	0.0	2.9	13.7	0.0	0.0	0.0	Yes

[1] A dash (-) in the recap time (days) column indicates that a recapture pass was not completed for that particular site.
[b] Mean probability of capture of 0.347 was derived in Jones et al. 2004.

Table 8b. Results of electrofishing surveys on the Tobique River, upriver of Mactaquac Dam, 2005.

Site Name	Marking Month	Marking Day	Recap [a] Time (days)	Area (m^2)	Hatch Fry Count	Marking Run Wild Fry Count	Marking Run Parr Marked	Mort	Hatch Fry Count	Recapture Run Wild Fry Count	Recapture Run Parr Unmark	Recapture Run Parr Marked	Mark Run MEfficiency	Wild Density / 100 m² 0+	Wild 1+	Wild 2+	Hatchery Density / 100 m² 0+	Hatchery 1+	Hatchery 2+	Mean [b] Efficiency Used
Fyke Net	7	4	-	730	0	0	0	0	0	0	0	0	0.347	0.0	0.0	0.0	0.0	0.0	0.0	Yes
Ben's Pole Road	7	4	2	1980	0	0	33	1	0	0	17	13	0.45	0.0	3.4	0.1	0.0	0.3	0.0	No
Saddler Brook Road	7	5	-	719	0	0	11	1	0	0	0	0	0.347	0.0	4.9	0.0	0.0	0.0	0.0	Yes
South Branch	7	7	1	1015	0	0	21	0	0	0	3	12	0.81	0.0	2.4	0.0	0.0	0.2	0.0	No
Burma Road	7	19	-	390	0	0	9	0	0	0	0	0	0.347	0.0	6.7	0.0	0.0	0.0	0.0	Yes
Campbell Landing	7	13	2	1368	0	152	30	1	0	128	15	8	0.37	29.8	4.9	0.4	0.0	0.8	0.0	No
River Dee Shingle Gulch	7	13	-	760	0	0	10	0	0	0	0	0	0.347	0.0	3.8	0.0	0.0	0.0	0.0	Yes
River Don Just above forks	7	14	1	702	0	32	27	1	0	36	15	13	0.48	9.4	6.6	1.4	0.0	0.4	0.0	No
Hazelton Landing	7	26	2	1541	0	108	65	0	0	99	60	13	0.19	37.5	21.5	0.9	0.0	0.2	0.0	No
Anvil Brook	7	26	2	941	0	1	28	0	0	1	20	8	0.30	0.3	8.6	1.2	0.0	0.0	0.0	No
South Branch	8	15	2	662	0	0	40	0	0	1	14	15	0.53	0.0	5.5	3.0	0.0	3.0	0.0	No
Pat's Crossing	8	15	-	800	0	41	2	0	0	0	0	0	0.347	14.8	0.8	0.0	0.0	0.0	0.0	Yes
Above Lawson Brook	8	15	-	544	0	1	1	0	0	0	0	0	0.347	0.6	0.6	0.0	0.0	0.0	0.0	Yes
Above hw bridge on 109	7	5	-	1079	0	4	8	1	0	0	0	0	0.347	1.1	2.4	0.0	0.0	0.0	0.0	Yes
Kate finnamore's	9	7	-	482	0	11	3	0	0	0	0	0	0.347	6.6	1.9	0.0	0.0	0.0	0.0	Yes
North branch steel tube	7	22	-	667	0	0	19	1	0	0	0	0	0.347	0.0	0.0	0.0	0.0	8.7	0.0	Yes
River Don Bridge to nowhere	7	12	2	694	0	0	22	0	0	0	9	8	0.49	0.0	4.8	0.0	0.0	1.7	0.0	No
Nation House	7	27	-	763	0	0	17	0	0	0	0	0	0.347	0.0	6.4	0.0	0.0	0.0	0.0	Yes
Bob Barr	7	27	-	1830	0	0	14	0	0	0	0	0	0.347	0.0	2.2	0.0	0.0	0.0	0.0	Yes
Pearl Road	7	27	-	600	0	0	14	0	0	0	0	0	0.347	0.0	6.7	0.0	0.0	0.0	0.0	Yes
Nation House	7	21	-	413	0	40	6	0	0	0	0	0	0.347	27.8	4.1	0.0	0.0	0.0	0.0	Yes
Pig barn	8	17	-	520	0	28	8	0	0	0	0	0	0.347	15.6	4.4	0.0	0.0	0.0	0.0	Yes
Across from civic #3782	7	21	-	400	0	28	2	0	0	0	0	0	0.347	20.3	1.5	0.0	0.0	0.0	0.0	Yes
Below riley brook bdg	8	18	-	595	0	30	11	0	0	0	0	0	0.347	14.5	5.4	0.0	0.0	0.0	0.0	Yes
Above two brooks	8	18	-	560	0	36	1	0	0	0	0	0	0.347	18.6	0.5	0.0	0.0	0.0	0.0	Yes
Across from blue mountain bk	7	21	-	574	0	18	0	0	0	0	0	0	0.347	9.1	0.0	0.0	0.0	0.0	0.0	Yes
Blue mountain camp site	8	18	-	498	0	19	4	0	0	0	0	0	0.347	11.0	2.4	0.0	0.0	0.0	0.0	Yes
Below ferry landing	8	18	-	575	0	11	3	0	0	0	0	0	0.347	5.6	1.6	0.0	0.0	0.0	0.0	Yes
O'gilvy rd mouth of little gulquac	8	8	-	680	0	12	2	0	0	0	0	0	0.347	5.1	0.9	0.0	0.0	0.0	0.0	Yes
Below horse island bk	8	19	-	840	0	8	3	0	0	0	0	0	0.347	2.7	0.7	0.0	0.0	0.4	0.0	Yes
Below kingfisher	8	22	-	1050	0	5	10	0	0	0	0	0	0.347	1.3	2.8	0.0	0.0	0.0	0.0	Yes
Andre lavoie's	8	22	-	546	0	5	0	0	0	0	0	0	0.347	2.6	0.0	0.0	0.0	0.0	0.0	Yes
Steve Harrison's farm	8	19	-	561	0	33	0	0	0	0	0	0	0.347	16.9	0.0	0.0	0.0	0.0	0.0	Yes
Above kingfisher (O'gilvy rd)	8	8	-	435	0	7	0	0	0	0	0	0	0.347	4.6	0.0	0.0	0.0	0.0	0.0	Yes
Mouth of Sisson bk	8	8	-	383	0	0	1	0	0	0	0	0	0.347	0.0	0.8	0.0	0.0	0.0	0.0	Yes
Aiton's camp site	8	22	-	335	0	14	2	0	0	0	0	0	0.347	11.9	1.8	0.0	0.0	0.0	0.0	Yes
Opposite vincent rd	8	19	-	425	0	1	2	0	0	0	0	0	0.347	0.7	0.7	0.7	0.0	0.0	0.0	Yes
Little cedar	8	16	-	430	0	0	0	0	0	0	0	0	0.347	0.0	0.0	0.0	0.0	0.0	0.0	Yes
1 km above sisson branch	8	16	-	658	0	11	14	0	0	0	0	0	0.347	4.9	5.2	0.9	0.0	0.0	0.0	Yes
The bungalows	8	16	-	644	0	17	1	0	0	0	0	0	0.347	7.6	0.5	0.0	0.0	0.0	0.0	Yes
Bailey bridge	8	16	-	400	0	12	1	0	0	0	0	0	0.347	8.8	0.8	0.0	0.0	0.0	0.0	Yes
2.5 km below lawson bk site	8	15	-	435	0	0	1	0	0	0	0	0	0.347	0.0	0.7	0.0	0.0	0.0	0.0	Yes
1/2 km above barrier pool	7	21	-	494	0	94	8	0	0	0	0	0	0.347	54.9	4.1	0.6	0.0	0.0	0.0	Yes
Reardon gulch landing	8	9	2	450	0	52	23	0	0	39	15	5	0.28	41.8	16.5	1.9	0.0	0.0	0.0	No
Below m. Tomlinson camp	7	18	2	528	0	52	28	1	0	47	13	8	0.41	24.1	12.1	1.3	0.0	0.0	0.0	No
Above m. Tomlinson camp	7	18	2	540	0	148	28	0	0	68	16	7	0.33	84.3	14.5	1.4	0.0	0.0	0.0	No
1.4 km below campbell landing	7	14	-	468	0	39	17	0	0	0	0	0	0.347	23.9	8.0	1.2	0.0	1.2	0.0	Yes
River dee bridge	7	12	-	600	0	4	10	0	0	0	0	0	0.347	2.0	3.8	0.5	0.0	0.5	0.0	Yes
Below Trouser lake	7	12	-	691	0	0	9	0	0	0	0	0	0.347	0.0	3.4	0.4	0.0	0.0	0.0	Yes
Below oven-rock brook	7	6	-	1138	0	0	11	0	0	0	0	0	0.347	0.0	2.8	0.0	0.0	0.0	0.0	Yes
River de chute lodge	7	11	-	585	0	0	7	0	0	0	0	0	0.347	0.0	3.4	0.0	0.0	0.0	0.0	Yes
Below forks	7	6	-	1179	0	0	5	0	0	0	0	0	0.347	0.0	0.7	0.2	0.0	0.2	0.0	Yes
3 km above 4 mile brook	8	9	2	774	0	11	76	1	0	14	41	29	0.42	3.4	21.1	2.2	0.0	0.2	0.0	No
6.2 km above hazeltin landing	7	28	-	512	0	0	18	0	0	0	0	0	0.347	0.0	9.6	0.6	0.0	0.0	0.0	Yes
Below salmon hole	8	9	-	917	0	5	1	0	0	0	0	0	0.347	1.5	0.3	0.0	0.0	0.0	0.0	Yes
South Branch Dingee brook landing	7	7	-	385	0	3	8	1	0	0	0	0	0.347	2.3	6.0	0.0	0.0	0.8	0.0	Yes
South Branch Lombard rd	8	23	-	450	0	8	9	0	0	0	0	0	0.347	5.1	4.5	1.3	0.0	0.0	0.0	Yes
Above Forks Lake Branch	8	23	-	544	0	0	9	0	0	0	0	0	0.347	0.0	4.3	0.5	0.0	0.0	0.0	Yes

[1] A dash (-) in the recap time (days) column indicates that a recapture pass was not completed for that particular site.
[b] Mean probability of capture of 0.347 was derived in Jones et al. 2004.

Table 9. Total smolt catches at smolt wheel(s) and a trapnet on the Tobique River and in the intake gatewells at Beechwood Dam, from 2000 to 2005. The numbers of marked smolts released, recycled and/or recaptured are also indicated for each location.

Year	Catch and Releases	Details	Tobique Mark Gear (site)	Tobique Recap Gear (site)	Beechwood Intake Gatewells
			RST (Odell)	Trapnet (Headpond)	
2000	Catch [a]	Wild	70	6	n/a
		Hatchery Fall Fingerling (HFF)	8	-	n/a
		Hatchery Spring Smolt	-	16	n/a
	Marked	Released at RST - Wild/HFF	78	n/a	n/a
		Untagged - Hatchery Spring [b]	1,996	n/a	n/a
	Recaptures	Released at RST - Wild/HFF	n/a	-	n/a
		Untagged - Hatchery Spring	-	16	n/a
			RST (Three Brooks)	Trapnet (Headpond)	
2001	Catch [a]	Wild	176	27	585
		Hatchery Fall Fingerling	86	8	47
	Marked	Recycled - Wild/HFF	149	-	n/a
		Garment - Hatchery Spring [b]	n/a	n/a	n/a
	Recaptures	Recycled - Wild/HFF	11	2	7 [c]
		Garment - Hatchery Spring	n/a	n/a	n/a
			(Burntland)	RST (Three Brooks)	
2002	Catch [a]	Wild	n/a	318	289
		Hatchery Fall Fingerling	n/a	176	12
		Unknown Origin	n/a	2	-
		Garment - Hatchery Spring	n/a	97	32
	Marked	Recycled - Wild/HFF	422		n/a
		Garment - Hatchery Spring [b]	2,357		n/a
	Recaptures	Recycled - Wild/HFF	n/a	22	4
		Garment - Hatchery Spring	n/a	97	32
			(Burntland)	RST (Three Brooks)	
2003	Catch [a]	Wild	n/a	119	463
		Hatchery Fall Fingerling	n/a	50	32
		Unknown Origin	n/a	-	15
		Garment - Hatchery Spring	n/a	21	18
	Marked	Recycled - Wild/HFF	139		n/a
		Garment - Hatchery Spring [b]	1,483		n/a
	Recaptures	Recycled - Wild/HFF	n/a	6	6
		Garment - Hatchery Spring	n/a	21	18
			(Burntland)	RST (Three Brooks)	
2004	Catch [a]	Wild	n/a	291	220
		Hatchery Fall Fingerling	n/a	49	4
		Unknown Origin	n/a	-	4
	Marked	Recycled - Wild/HFF	275		n/a
		Garment - Hatchery Spring [b]	n/a	n/a	n/a
	Recaptures	Recycled - Wild/HFF	n/a	17	6
		Garment - Hatchery Spring	n/a	n/a	n/a
			RST (Plaster Rock)	RST (Three Brooks)	
2005	Catch [a]	Wild	47	63	16
		Hatchery Fall Fingerling	17	25	2
		Untagged - Hatchery Spring	13	15	-
	Marked	Released at RST - Wild/HFF	62		n/a
		Untagged - Hatchery Spring [b]	1,400		n/a
	Recaptures	Released at RST - Wild/HFF	n/a	1	1
		Untagged - Hatchery Spring	13	15	-

[a] RST catch excludes recyled recaptures since it would not be included in estimating populations.

[b] Hatchery released spring smolts (untagged and garment tagged) were released above the RST(s).

[c] One additional smolt, tagged as a presmolt the previous fall (October 2000), was also recaptured.

Table 10. Number and status of wild and hatchery juvenile Atlantic salmon collected during the spring and fall seasons, for the captive-reared broodstock program at Mactaquac Biodiversity Facility, from the Tobique River and at Beechwood.

		Pre-Smolt		Parr		Fry		Number	Adults	Current	Year of
Year	**Location**	**Wild**	**Hatchery [a]**	**Wild**	**Hatchery [a]**	**Wild**	**Total**	**on Hand [b]**	**Released [c]**	**Stage**	**Spawning**
2001	Nictau	603	3	756	2	48	**1,412**				
2001	Three Brooks	555	5	119	1	437	**1,117**				
Total (2001)		**1,158**	**8**	**875**	**3**	**485**	**2,529**	250	970	adult	2003,2004
2002	Nictau	338	1	298	23	5	**665**				
2002	Three Brooks	1,439	4	250		170	**1,863**				
2002	Beechwood	832	1	5			**838**				
Total (2002)		**2,609**	**6**	**553**	**23**	**175**	**3,366**	228	1,087	adult	2004,2005
2003	Nictau	1,005	57	726	22		**1,810**				
2003	Three Brooks	563	26	221			**810**				
Total (2003)		**1,568**	**83**	**947**	**22**		**2,620**	1,300	202	adult	2005,2006
2004	Nictau	536		367	1		**904**				
2004	Three Brooks	221		61			**282**				
Total (2004)		**757**		**428**	**1**		**1,186**	990	0	post smolt	2006,2007
2005	Nictau	878	2	331			**1,211**				
2005	Three Brooks	338		74			**412**				
2005	Three Brooks	63	[d]				**63**				
2005	Beechwood	15	[d]	1	[d]		**16**				
2005	Plaster Rock	2	[d]				**2**				
Total (2005)		**1,296**	**2**	**406**	**0**		**1,704**	1,623	0	pre-smolt	2007,2008
Grand Total		**7,388**	**99**	**3,209**	**49**	**660**	**11,405**	4,391	2,259		

[a] Stocked previous year as fall fingerling.
[b] Number of fish at Mactaquac Biodiversity Facility as of December 2005. Excludes mortalities and releases.
[c] Total # of fish released from that year class.
[d] Collected from spring projects at "smolt" stage

Table 11. Start and finish dates for the operation of an adult salmon counting fence on the Nashwaak River as well as the assessment technique used to estimate the total returns upriver of the fence site.

Year	Start and Finish Date	Days in which fence was not fishing 100%	Assessment Technique
1972	Aug 18 - Oct 29	Sept 4-6, Oct 8-9, Oct 25-28	
1973	Jun 10 - Nov 5	July 5-11, Aug 3-7	
1975	Jun 28 - Oct 29	Oct 21-22	
1993	Aug 19 - Oct 12		Historical Run Timing
1994	Jul 15 - Oct 25		Seining; Mark Recap
1995	Jul 12 - Oct 18		Historical Run Timing
1996	Jun 13 - Oct 18	July 9-10, July 14-31	Seining; Mark Recap
1997	Jun 18 - Nov 2		Count; No Washouts
1998	Jun 8 - Oct 27	Aug 12-14, Oct 2-5	Seining; Mark Recap
1999	Jun 3 - Oct 13	Sept 17-20, Sept 23-28	Seining; Mark Recap
2000	Jun 19 - Oct 26	Oct 10-11	Seining; Mark Recap
2001	Jun 21 - Nov 1	Aug 3-17 [a]	Count; No Washouts
2002	Jun 10 - Oct 28		Count; No Washouts
2003	Jun 5 - Oct 26	Aug 6-8, Oct 15-17, Oct 21-23	Seining; Mark Recap
2004	Jun 3 - Oct 26	Aug 31- Sept 2, Sept 9-12	Seining; Mark Recap
2005	Jun 9 - Oct 7	Jun 18-19, Aug 30-Sept 2, Sept 17-20 & 27-28	Seining; Mark Recap

[a] Fence was removed and base crib was raised 45 cm.

Table 12. Estimated returns, escapement, and percent of conservation attained for the Nashwaak River, 1993 - 2005.

	Estimated Returns		Escapement		% of Requirement		Total Egg Deposition
Year	1SW	MSW	1SW	MSW	1SW	MSW	% of Requirement
1993	954	555	866	555	42%	27%	31%
1994	661	388	610	349	30%	17%	26%
1995	940	436	940	436	46%	21%	33%
1996	1829	657	1804	641	88%	31%	48%
1997	370	366	364	362	18%	18%	23%
1998	1259	315	1238	309	61%	15%	31%
1999	665	275	658	269	32%	13%	19%
2000	509	192	489	189	24%	9%	15%
2001	244	272	224	266	11%	13%	16%
2002	343	79	320	69	16%	3%	6%
2003	297	113	280	109	14%	5%	7%
2004	590	207	569	201	28%	10%	17%
2005	731	162	712	155	35%	8%	16%
Conservation Requirement:					2040	2040	12.8 Million Eggs

Table 13. Estimates of the wild smolt emigration upriver of Durham Bridge, (and 2.5 and 97.5% percentiles) and smolt-to-adult return rates for the Nashwaak River, 1998 – 2005.

	Wild Smolt Estimate			Return Rate (%)	
Year	Mode	2.5 perc.	97.5 perc.	1SW	2SW
1998	22,750	17,900	32,850	2.91	0.67
1999	28,500	25,300	33,200	1.79	0.84
2000	15,800	13,400	19,700	1.53	0.28
2001	11,000	8,100	17,400	3.11	0.90
2002	15,000	12,300	19,000	1.91	1.26
2003	9,000	6,800	13,200	6.38	1.58
2004	13,600	10,060	20,800	5.13	
2005	5,200	3,200	12,600		
Mean 1998-05	**15,106**			**3.25**	**0.92**

Table 14a. Results of electrofishing surveys on Nashwaak River, 2004.

Site Name	Marking Month	Marking Day	Recap [a] Time (days)	Area (m²)	Marking Run Hatch Fry Count	Marking Run Wild Fry Count	Marking Run Parr Marked	Marking Run Mort	Recapture Run Hatch Fry Count	Recapture Run Wild Fry Count	Recapture Run Parr Unmark	Recapture Run Parr Marked	Mark Run MEfficiency	Wild Density / 100 m² 0+	Wild Density / 100 m² 1+	Wild Density / 100 m² 2+	Hatchery Density / 100 m² 0+	Hatchery Density / 100 m² 1+	Hatchery Density / 100 m² 2+	Mean [b] Efficiency Used
Penniac Stream Route 628	7	12	-	1157	0	6	8	0	0	0	0	0	0.347	1.5	1.3	0.8	0.0	0.0	0.0	Yes
Above Durham Bridge	7	6	-	1172	0	43	0	0	0	0	0	0	0.347	10.6	0.0	0.0	0.0	0.0	0.0	Yes
Taymouth Bridge To nowhwere	7	7	1	897	0	29	30	0	0	53	16	9	0.375	8.6	8.3	0.6	0.0	0.0	0.0	No
Above bridge Rte 620	7	26	2	727	0	12	19	0	0	4	10	9	0.487	3.4	4.1	1.3	0.0	0.0	0.0	No
Above bridge Rte 620	7	26	2	950	0	14	28	0	0	15	13	8	0.400	3.7	6.1	1.3	0.0	0.0	0.0	No
Zionville, above bridge	7	12	-	799	0	3	2	0	0	0	0	0	0.347	1.1	0.4	0.4	0.0	0.0	0.0	Yes
Youngs Brook	8	9	2	785	0	5	11	0	0	6	10	4	0.314	2.0	3.2	1.3	0.0	0.0	0.0	No
Above Nashwaak Bridge	7	6	-	1239	0	1	1	0	0	0	0	0	0.347	0.2	0.2	0.0	0.0	0.0	0.0	Yes
Cross creek station, Steel Bridge	7	13	2	1182	0	81	34	0	0	68	18	12	0.415	16.5	4.8	2.1	0.0	0.0	0.0	No
Cross Creek (middle)	8	9	2	1080	0	38	22	0	0	55	15	10	0.415	8.5	4.0	0.9	0.0	0.0	0.0	No
Bridge (Hwy 625)	7	14	1	800	0	57	33	0	0	73	20	12	0.388	18.4	6.4	4.2	0.0	0.0	0.0	No
Below Stanley & Mclaggan bridge	7	7	-	1238	0	1	0	0	0	0	0	0	0.347	0.2	0.0	0.0	0.0	0.0	0.0	Yes
Above Stanley on Ryan brk Road	7	13	-	1128	0	4	1	0	0	0	0	0	0.347	1.1	0.0	0.0	0.0	0.3	0.0	Yes
Ryan Brook	8	12	-	840	0	22	4	0	0	0	0	0	0.347	7.5	1.1	0.4	0.0	0.0	0.0	Yes
Middle Brook	8	12	-	629	0	6	2	0	0	0	0	0	0.347	2.7	0.0	1.0	0.0	0.0	0.0	Yes
Out from Mclean Brook	8	25	-	1007	0	4	4	0	0	0	0	0	0.347	1.2	0.6	0.6	0.0	0.0	0.0	Yes
Mclean Brook	8	25	-	714	0	11	4	0	0	0	0	0	0.347	4.5	1.3	0.4	0.0	0.0	0.0	Yes
Rocky Brook	8	25	-	733	0	0	18	0	0	0	0	0	0.347	0.0	0.4	6.7	0.0	0.0	0.0	Yes
Above Narrows Bridge	7	27	2	1115	0	18	18	0	0	26	20	5	0.222	7.3	3.8	2.5	0.0	1.0	0.0	No
Below Mcbean Brook	7	20	1	950	0	37	18	0	0	21	6	3	0.383	10.2	4.3	0.6	0.0	0.0	0.0	No
Above Mcbean Brook	7	20	-	1000	0	1	9	0	0	0	0	0	0.347	0.3	0.3	0.6	0.0	1.7	0.0	Yes
Napadogan Stream	7	27	2	836	0	59	20	0	0	36	18	6	0.270	26.1	6.1	2.6	0.0	0.0	0.2	No
Napadogan Stream(camps)	8	24	2	753	0	22	40	0	0	21	18	15	0.465	6.2	4.7	6.7	0.0	0.0	0.0	No
Above Cedar Bridge Nashriver road	7	19	2	1209	0	10	19	0	0	15	10	2	0.221	3.7	4.2	1.7	0.0	0.5	0.7	No
Doughboy Brook - Lower	7	19	2	1083	0	10	15	0	0	8	10	3	0.273	3.4	1.4	0.6	0.0	2.7	0.4	No
Doughboy Brook - Upper	7	19	2	592	0	4	6	0	0	8	6	1	0.222	3.0	3.8	0.0	0.0	0.8	0.0	No
Doughboy Brook	7	19	2	1675	0	14	21	0	0	16	16	4	0.231	3.6	2.5	0.4	0.0	2.2	0.3	No
Below Gorby Gulch	7	20	1	1113	0	23	16	0	0	62	32	6	0.170	12.1	7.7	0.4	0.0	0.4	0.0	No

[1] A dash (-) in the recap time (days) column indicates that a recapture pass was not completed for that particular site.

[b] Mean probability of capture of 0.347 was derived in Jones et al. 2004.

Table 14b. Results of electrofishing surveys on Nashwaak River, 2005.

Site Name	Marking Month	Marking Day	Recap Time (days) [a]	Area (m²)	Hatch Fry Count	Marking Run Wild Fry Count	Marking Run Parr Marked	Mort	Hatch Fry Count	Recapture Run Wild Fry Count	Recapture Run Parr Unmark	Recapture Run Parr Marked	Mark Run MEfficiency	Wild Density / 100 m² 0+	Wild Density / 100 m² 1+	Wild Density / 100 m² 2+	Hatchery Density / 100 m² 0+	Hatchery Density / 100 m² 1+	Hatchery Density / 100 m² 2+	Mean Efficiency Used [b]
Penniac Stream Route 628	7	6	2	1223	0	54	18	0	0	45	18	7	0.295	15.0	4.3	0.7	0.0	0.0	0.0	No
Above Durham Bridge	7	5	-	1260	0	8	0	0	0	0	0	0	0.347	1.8	0.0	0.0	0.0	0.0	0.0	Yes
Taymouth Bridge To nowhwere	7	12	2	1064	0	37	31	0	0	43	19	10	0.360	9.7	6.5	1.6	0.0	0.0	0.0	No
Above bridge Rte 620	7	19	2	785	0	0	25	0	0	4	7	12	0.649	0.0	2.3	2.7	0.0	0.0	0.0	No
Above bridge Rte 620	7	19	2	1142	0	0	37	0	0	2	23	19	0.457	0.0	6.0	1.1	0.0	0.0	0.0	No
Zionville, above bridge	7	12	2	1089	0	0	16	0	0	0	6	4	0.444	0.0	3.2	0.2	0.0	0.0	0.0	No
Youngs Brook	8	5	-	812	0	27	10	0	0	0	0	0	0.347	9.6	3.6	0.0	0.0	0.0	0.0	Yes
Above Nashwaak Bridge	7	7	-	1230	0	7	4	0	0	0	0	0	0.347	1.6	1.0	0.0	0.0	0.0	0.0	Yes
Cross creek station, Steel Bridge	7	11	2	1258	0	90	24	0	0	100	19	12	0.393	18.2	4.7	0.1	0.0	0.0	0.0	No
Cross Creek (middle)	9	12	1	973	0	93	18	0	0	127	4	7	0.643	14.9	2.5	0.4	0.0	0.0	0.0	No
Bridge (Hwy 625)	7	18	2	880	0	1	61	0	0	0	34	25	0.430	0.2	15.3	0.8	0.0	0.0	0.0	No
Below Stanley & Mclaggan bridge	7	6	-	1325	0	1	0	0	0	0	0	0	0.347	0.2	0.0	0.0	0.0	0.0	0.0	Yes
Above Stanley on Ryan brk Road	7	18	-	1091	0	3	2	0	0	0	0	0	0.347	0.8	0.5	0.0	0.0	0.0	0.0	Yes
Ryan Brook	7	20	-	910	0	27	5	0	0	0	0	0	0.347	8.6	0.9	0.6	0.0	0.0	0.0	Yes
Middle Brook	8	5	-	710	0	6	5	0	0	0	0	0	0.347	2.4	1.2	0.8	0.0	0.0	0.0	Yes
Out from Mclean Brook	9	7	-	809	0	8	9	0	0	0	0	0	0.347	2.8	2.5	0.7	0.0	0.0	0.0	Yes
Mclean Brook	9	7	1	649	0	19	16	0	0	53	9	6	0.421	6.9	5.2	0.7	0.0	0.0	0.0	No
Rocky Brook	9	6	-	627	0	4	7	0	0	0	0	0	0.347	1.9	1.8	1.4	0.0	0.0	0.0	Yes
Above Narrows Bridge	9	6	1	1190	0	15	27	0	0	7	15	5	0.278	4.5	6.4	1.8	0.0	0.0	0.0	No
Below Mcbean Brook	8	4	-	916	0	42	9	0	0	0	0	0	0.347	13.2	2.8	0.0	0.0	0.0	0.0	Yes
Above Mcbean Brook	7	28	-	945	0	6	7	0	0	0	0	0	0.347	1.8	1.8	0.3	0.0	0.0	0.0	Yes
Napadogan Stream	8	4	-	718	0	76	7	0	0	0	0	0	0.347	30.5	2.8	0.0	0.0	0.0	0.0	Yes
Napadogan Stream(camps)	9	6	2	787	0	72	60	0	0	81	50	22	0.311	29.5	21.2	3.3	0.0	0.0	0.0	No
Above Cedar Bridge Nashriver road	7	25	2	1190	0	7	55	0	0	10	18	12	0.414	1.4	10.0	1.2	0.0	0.0	0.0	No
Doughboy Brook - Lower	7	25	2	1063	0	43	37	0	0	38	19	8	0.316	12.8	9.2	1.2	0.0	0.0	0.6	No
Doughboy Brook - Upper	7	25	2	611	0	32	27	0	0	17	12	6	0.360	14.6	11.0	1.3	0.0	0.0	0.0	No
Doughboy Brook	7	25	2	1844	0	75	61	0	0	56	31	14	0.323	12.6	10.2	0.0	0.0	0.0	0.0	No
Below Gorby Gulch	7	26	2	1230	0	6	70	0	0	4	13	21	0.63	0.8	7.6	1.4	0.0	0.1	0.0	No

[a] A dash (-) in the recap time (days) column indicates that a recapture pass was not completed for that particular site.

[b] Mean probability of capture of 0.347 was derived in Jones et al. 2004.

Table 15. Numbers of Atlantic salmon observed and/or sampled during dive surveys in the Big Salmon River, New Brunswick, 2004 - 2005.

		Atlantic salmon						
	River	wild		hatchery		unidentified		Rainbow
Date	section	small	large	small	large	small	large	trout
2004								
July 27 - 28	upper	1	0	0	0	0	0	0
	lower	5	1	0	0	0	0	4
September 14 - 15	upper	2	1	0	0	0	0	0
	lower	4	1	0	0	0	0	0
October 20	upper	2	3	1	0	1	2	0
	middle	0	0	0	0	0	0	0
	lower	0	0	0	0	0	0	0
2005								
August 3 & 5	upper	3	4	0	0	0	0	0
	lower	8	4	1	0	0	0	8
September 7, 8 & 14	upper	14	2	0	0	0	0	0
	lower	9	9	0	0	0	0	7

Table 16. Biological information collected from adult salmon in the Big Salmon River, New Brunswick. Age is shown as FW.SW.FS, where FW is the number of years in fresh water, prior to smoltification, SW is the number of years in saltwater since smoltification, FS is the sea age of first spawning, and where 'na' is indicated the age at that point could not be determined. "Adipose punch" is a hole punch in the adipose fin – the resulting tissue is retained for DNA analysis.

Section	Pool	Date	Origin	Sex	FL (cm)	Age	Mark applied
2004							
Upper	Walton Dam	Sep-04	wild	F	80.4	2.2.0	-
2005							
Upper	Walton Dam	Aug-05	wild	-	68.0	2.2.1	Adipose punch
Upper	Walton Dam	Aug-05	wild	-	54.0	1.1.0	Adipose punch
Upper	Walton Dam	Aug-05	wild	-	62.0	3.1.0	Adipose punch
Upper	Walton Dam	Aug-05	wild	-	85.0	2.3.2	Adipose punch
Upper	Mast Brow	Sep-05	wild	F	57.0	2.1.0	Adipose punch
Upper	Mast Brow	Sep-05	wild	M	64.0	3.1.0	Adipose punch
Upper	Mast Brow	Sep-05	wild	M	58.0	3.1.0	Adipose punch
Upper	Mast Brow	Sep-05	wild	F	56.5	2.1.0	Adipose punch
Upper	Mast Brow	Sep-05	wild	M	58.0	3.1.0	Adipose punch
Upper	Mast Brow	Sep-05	wild	M	55.5	3.1.0	Adipose punch
Upper	Mast Brow	Sep-05	wild	M	60.5	3.1.0	Adipose punch
Upper	Walton Dam	Sep-05	wild	F	65.5	2.2.1	Adipose punch
Upper	Walton Dam	Sep-05	wild	M	62.5	3.1.0	Adipose punch
Upper	Walton Dam	Sep-05	wild	F	56.5	3.1.0	Adipose punch
Lower	Katt	Sep-05	wild	M	55.5	3.1.0	Adipose punch
Lower	Katt	Sep-05	wild	M	61.5	2.1.0	Adipose punch
Lower	Katt	Sep-05	wild	M	63.5	3.1.0	Adipose punch
Lower	Katt	Sep-05	wild	F	50.5	1.1.0	Adipose punch
Lower	Katt	Sep-05	wild	F	62.5	2.2.1	Adipose punch
Lower	Katt	Sep-05	wild	M	59.0	na.1.0	Adipose punch
Lower	Katt	Sep-05	wild	F	53.5	2.1.0	Adipose punch
Lower	Katt	Sep-05	wild	M	61.5	3.1.0	Adipose punch
Lower	Katt	Sep-05	wild	M	51.0	na.1.0	Adipose punch

[1] could not determine sex of fish visually.

[2] September 14, 2005 seine at Katt Pool was with a large hatchery seine and two SCUBA divers (Paul Brooking (ASF) and Levi Sabattis ((OFN)).

Table 17. Juvenile Atlantic salmon densities from 7 closed (barrier) sites, and 11 open (spot-check or mark-recapture) sites electrofished in the Big Salmon River, 2004 and 2005.

Big Salmon River 2004							Recap		Hatch	Marking Run			Hatch	Recapture Run				Wild					Hatchery		
	Site	Site		Marking		no of	Time		Fry	Wild Fry	Parr		Fry	Wild Fry	Parr		Mark Run	Density / 100 m²					Density / 100 m²		
Site Name	No.	Code	Type	Month	Day	sweeps	(days)	Area (m²)	Count	Count	Marked	Mort	Count	Count	Unmark	Marked	Efficiency	0+	1+	2+	3+	4+	0+	1+	2+
Catt's Park	2	EFBSR02	multi-pass	8	18	3	.	405		6								1.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Mast Brow	7	EFBSR07	multi-pass	8	18	3	.	235		10								4.3	3.0	0.8	0.0	0.0	0.0	0.0	0.0
Crow Brook	11	EFBSR11	multi-pass	8	17	3	.	225		65								29.0	2.5	1.6	0.0	0.0	0.0	1.0	1.1
Schoales Dam	13	EFBSR13	multi-pass	8	17	3	.	349		58								16.6	29.0	1.4	0.0	0.0	0.0	13.7	2.0
Anderson Brook	15	EFBSR15	multi-pass	8	16	4	.	443		385								86.9	42.5	1.8	0.0	0.0	0.0	0.4	0.0
NW Branch-Falls Brook	19	EFBSR19*	multi-pass	8	19	3	.	233	174									0.0	0.0	0.0	0.0	0.0	74.7	45.1	1.5
Manning Brook	3A	EFBSR3A	multi-pass	8	16	3	.	225		29								12.9	35.1	0.4	0.0	0.0	0.0	42.7	0.4
d/s Hearst Lodge	3	EFBSR03	SC	8	4	.	.	741	0	25	3	0					0.428	7.8	0.9	0.0	0.0	0.0	0.0	0.0	0.0
NW Branch confluence	6	EFBSR06	SC	8	10	.	.	700	0	2	6	0					0.428	0.7	1.3	0.0	0.0	0.0	0.0	0.3	0.3
Bridge Pool	8	EFBSR08	SC	8	3	.	.	400	0	12	7	0					0.428	7.0	2.3	1.1	0.0	0.0	0.0	0.6	0.0
b/t Manning and Crow brook	10	EFBSR10	SC	8	3	.	.	390	0	2	5	0					0.428	1.3	1.9	1.2	0.0	0.0	0.0	0.0	0.0
u/s Miller Pool	21	EFBSR21	SC	8	4	.	.	1011	0	1	4	0					0.428	0.2	0.7	0.2	0.0	0.0	0.0	0.0	0.0
NW Branch site 2	23	EFBSR23	SC	8	10	.	.	459	0	0	6	0					0.428	0.0	2.1	0.5	0.0	0.0	0.0	0.5	0.0
Falls Bk d/s Little Dam Falls	24	EFBSR24	SC	8	11	.	.	353	0	0	9	0					0.428	0.0	4.6	0.7	0.0	0.0	0.0	0.0	0.7
d/s Anderson Brook confluenc	25	EFBSR25	SC	8	12	.	.	344	0	0	10	0					0.428	0.0	2.0	2.7	0.0	0.0	0.0	2.0	0.0
Rody Bk near confluence	26	EFBSR26	SC	8	4	.	.	672	0	7	4	0					0.428	2.4	0.0	1.3	0.0	0.0	0.0	0.0	0.0
u/s confluence NW Branch	5	EFBSR05	X	8	10	.	2	1077	0	13	11	0	0	27	11	3	0.250	4.8	3.4	0.6	0.2	0.0	0.0	0.0	0.0
d/s Mary Pitcher Falls	22	EFBSR22	X	8	5	.	1	578	0	3	11	0	0	4	11	2	0.200	2.6	6.5	2.2	0.4	0.4	0.0	0.0	0.0

Big Salmon River 2005							Recap		Hatch	Marking Run			Hatch	Recapture Run				Wild					Hatchery		
	Site	Site		Marking		no of	Time		Fry	Wild Fry	Parr		Fry	Wild Fry	Parr		Mark Run	Density / 100 m²					Density / 100 m²		
Site Name	No.	Code	Type	Month	Day	sweeps	(days)	Area (m²)	Count	Count	Marked	Mort	Count	Count	Unmark	Marked	Efficiency	0+	1+	2+	3+	4+	0+	1+	2+
Catt's Park	2	EFBSR02	multi-pass	8	23	3	.	349		2								0.6	3.4	0.0	0.0	0.0	0.0	0.6	0.0
Mast Brow	7	EFBSR07	multi-pass	8	23	3	.	228		7								3.1	3.1	0.9	0.0	0.0	0.0	0.0	0.0
Crow Brook	11	EFBSR11	multi-pass	8	24	3	.	204		66								76.5	9.8	0.0	0.0	0.0	0.0	0.0	0.0
Schoales Dam	13	EFBSR13	multi-pass	8	25	4	.	284		1								0.4	16.0	5.3	0.0	0.0	0.0	10.4	0.0
Anderson Brook	15	EFBSR15	multi-pass	8	22	3	.	348		176								63.8	8.8	1.7	0.0	0.0	0.0	0.4	0.0
NW Branch-Falls Brook	19	EFBSR19*	multi-pass	8	25	3	.	200	34									0.0	0.0	0.0	0.0	0.0	17.0	29.5	13.0
Manning Brook	3A	EFBSR3A	multi-pass	8	24	3	.	186		132								97.3	14.8	0.0	0.0	0.0	0.0	8.2	0.0
u/s confluence NW Branch	5	EFBSR05	SC	8	16	.	.	803	0	11	21	0					0.428	3.2	5.2	0.3	0.0	0.0	0.0	0.6	0.0
NW Branch confluence	6	EFBSR06	SC	8	16	.	.	780	0	0	18	0					0.428	0.0	3.9	0.3	0.0	0.0	0.0	0.9	0.3
Bridge Pool	8	EFBSR08	SC	8	11	.	.	383	0	24	23	0					0.428	14.6	10.4	3.1	0.0	0.0	0.0	0.6	0.0
b/t Manning and Crow brook	10	EFBSR10	SC	8	11	.	.	437	0	6	8	0					0.428	3.2	2.2	0.0	0.0	0.0	0.0	2.2	0.0
u/s Miller Pool	21	EFBSR21	SC	8	15	.	.	916	0	0	7	0					0.428	0.0	0.7	0.0	0.0	0.0	0.0	1.0	0.0
d/s Mary Pitcher Falls	22	EFBSR22	SC	8	10	.	.	570	0	8	22	0					0.428	3.3	7.7	0.4	0.0	0.0	0.0	0.8	0.0
NW Branch site 2	23	EFBSR23	SC	8	16	.	.	492	0	0	13	0					0.428	0.0	1.9	0.9	0.0	0.0	0.0	3.3	0.0
Falls Bk d/s Little Dam Falls	24	EFBSR24	SC	8	9	.	.	396	0	0	21	0					0.428	0.0	10.0	2.4	0.0	0.0	0.0	0.0	0.0
d/s Anderson Brook confluenc	25	EFBSR25	SC	8	10	.	.	357	0	0	7	0					0.428	0.0	1.9	1.3	0.0	0.0	0.0	0.6	0.6
d/s Hearst Lodge	3	EFBSR03	X	8	15	.	2	760	0	6	18	0	0	0	16	7	0.321	2.5	7.0	0.2	0.0	0.0	0.0	0.2	0.0
Rody Bk near confluence	26	EFBSR26	X	8	15	.	2	628	0	1	18	0	0	0	8	7	0.486	0.3	4.1	0.5	0.0	0.0	0.0	1.1	0.2

***** EFBSR19 is above an impassable barrier so all salmon captured can be classified as LGB / hatchery
multipass = barrier or closed site
SC - Spot Check or open site
X - Mark-recapuure or open site

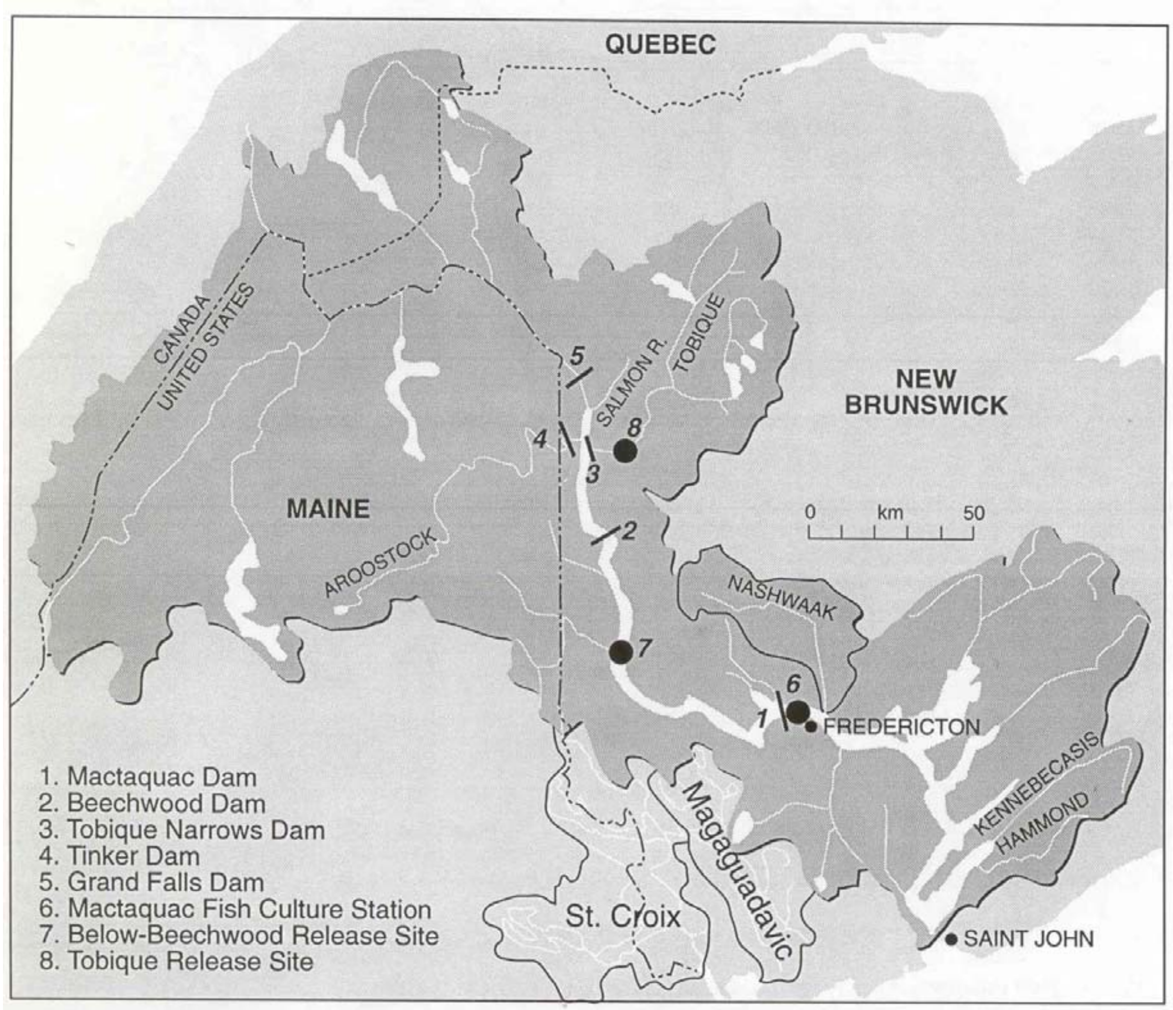
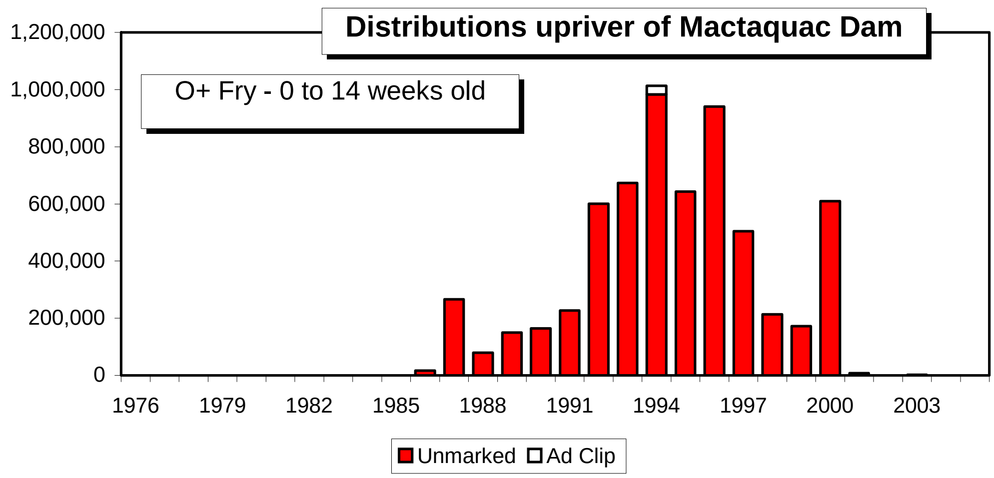


Fig. 1. Map of the Magaguadavic, St. Croix and Saint John River drainages including Tobique and Nashwaak rivers and other major tributaries, dams, and principal release sites for Atlantic salmon up river of Mactaquac Dam. Fish trapping locations on the Tobique and Nashwaak drainages are shown in Fig. 9 and Fig. 11. Note that the Mactaquac Fish Culture Station is now referred to as the Mactaquac Biodiversity Facility.



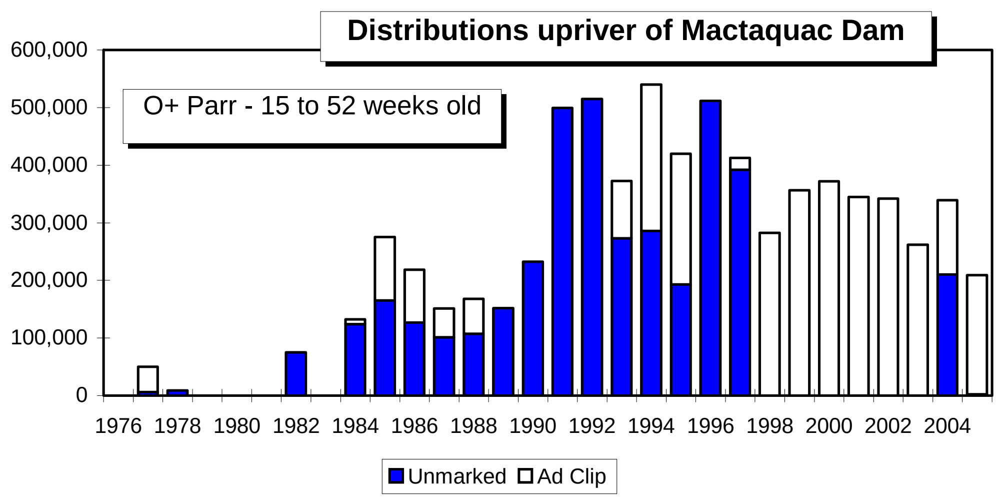
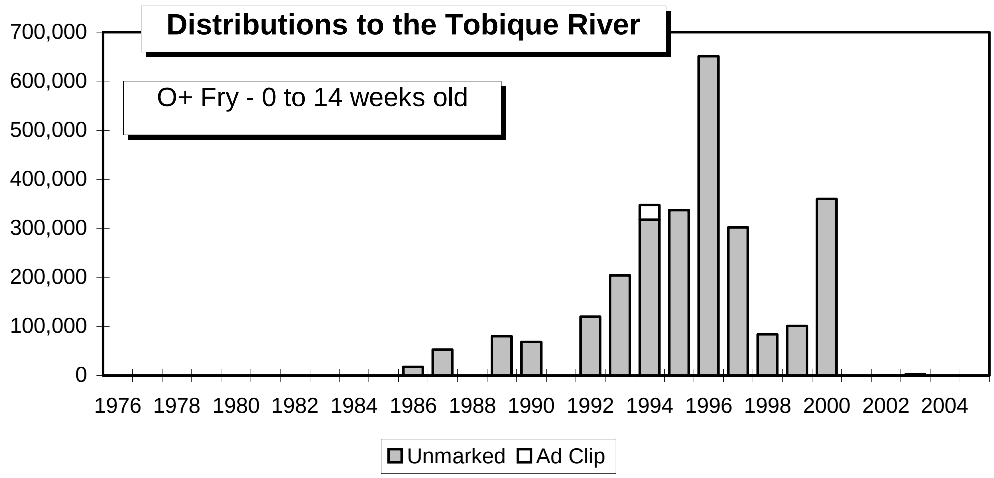


Fig. 2a. Number of juvenile salmon less than 52 weeks old (excludes age-1 smolts) released or distributed to tributaries up river of Mactaquac Dam, Saint John River, 1976 - 2005.



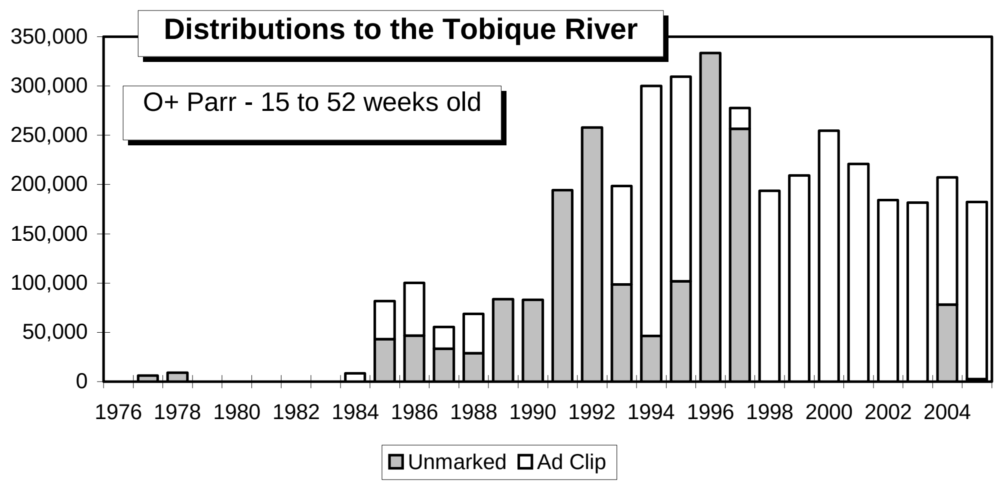
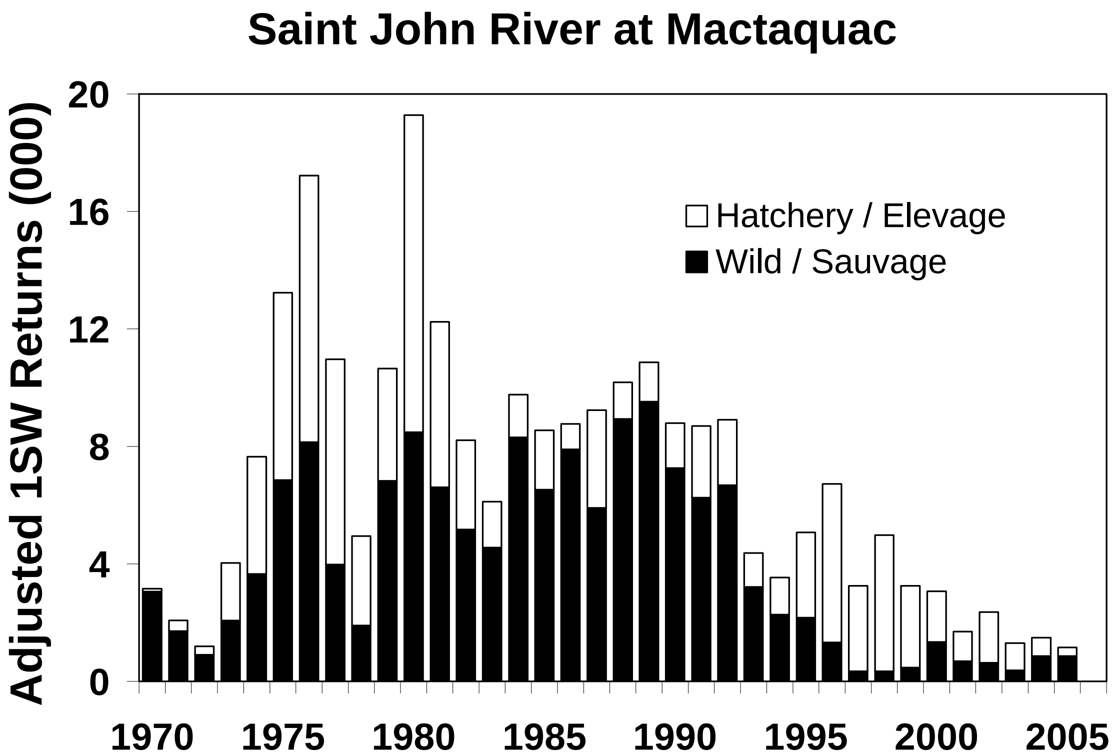


Fig. 2b. Number of juvenile salmon less than 52 weeks old (excludes age-1 smolts) released or distributed to the Tobique River, 1976 - 2005.



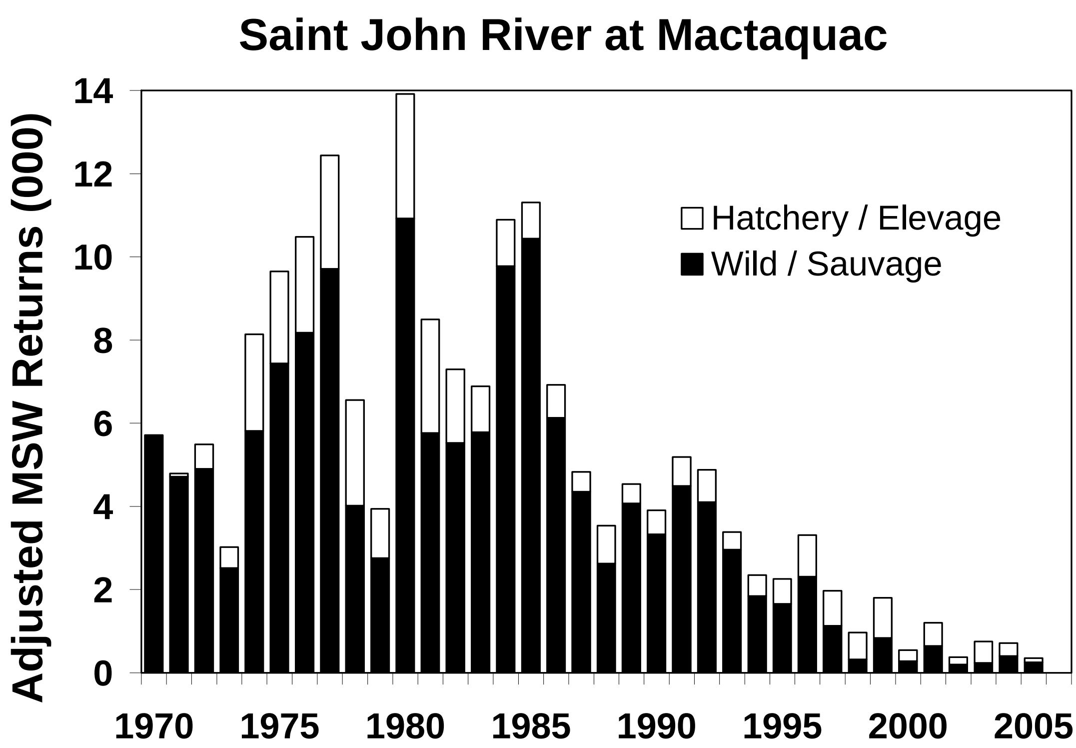


Fig. 3. Estimated total adjusted returns of wild and hatchery 1SW and MSW salmon destined for Mactaquac Dam, Saint John River, 1970 - 2005.

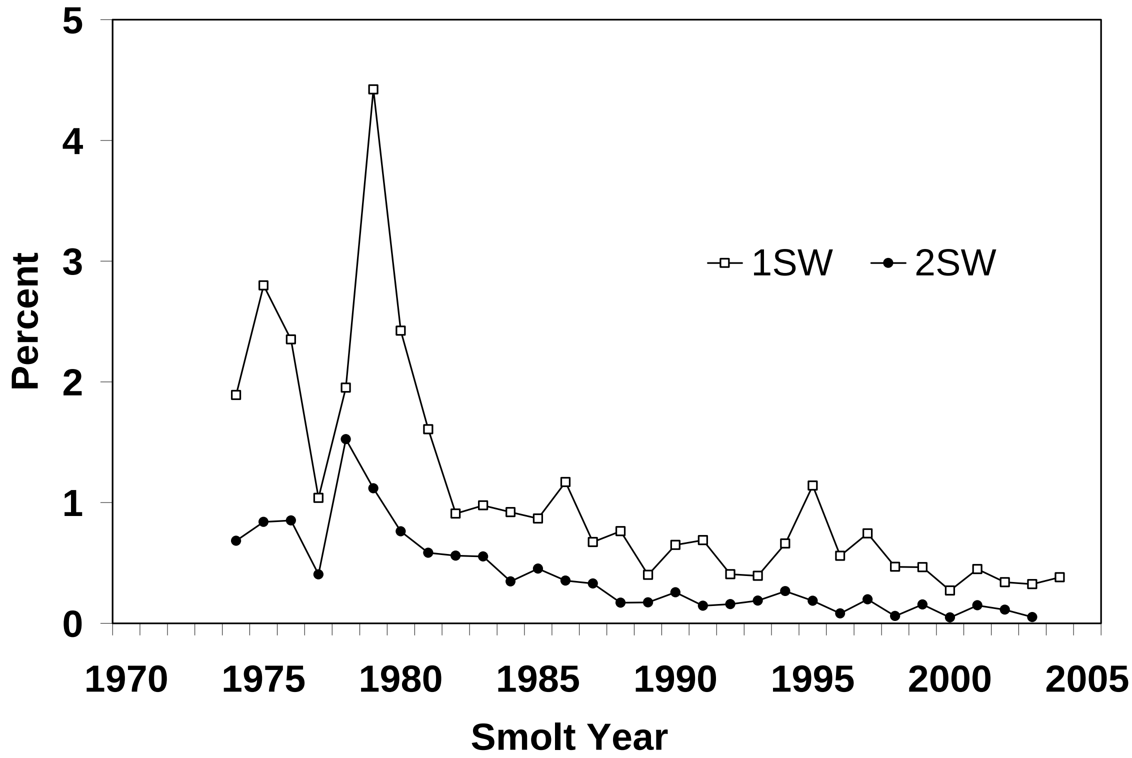


Fig. 4. Return rates of hatchery reared smolts to virgin 1SW and virgin 2SW salmon destined for Mactaquac Dam, Saint John River, by smolt year, 1974 – 2004.

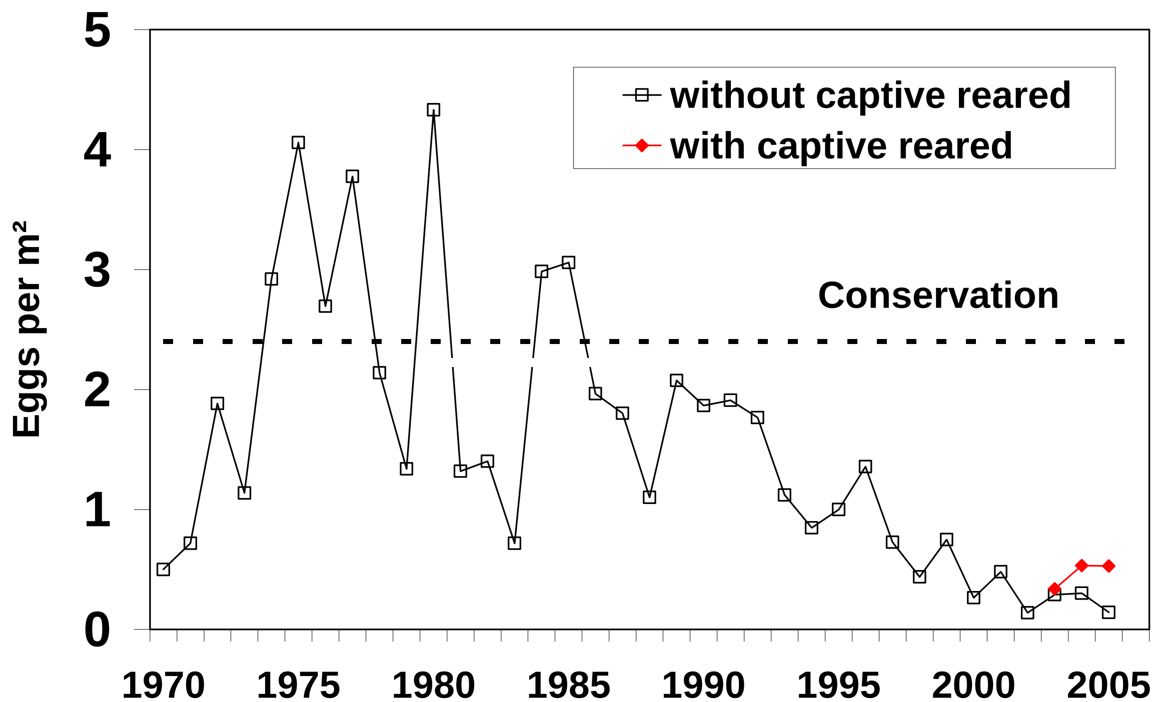


Fig. 5a. Estimated egg deposition up river of Mactaquac Dam, Saint John River, 1970 - 2005.

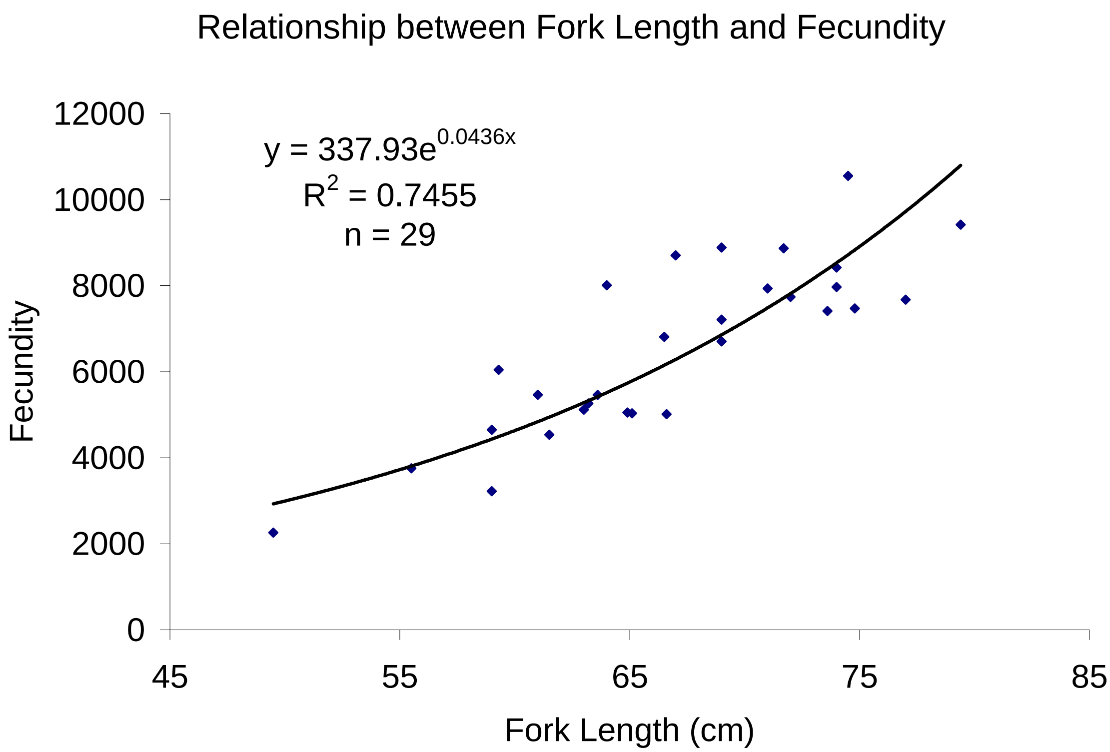


Fig. 5b. Relationship between female fork length (cm) and fecundity of 29 captive-reared salmon at the Mactaquac Biodiversity Facility, 2005.

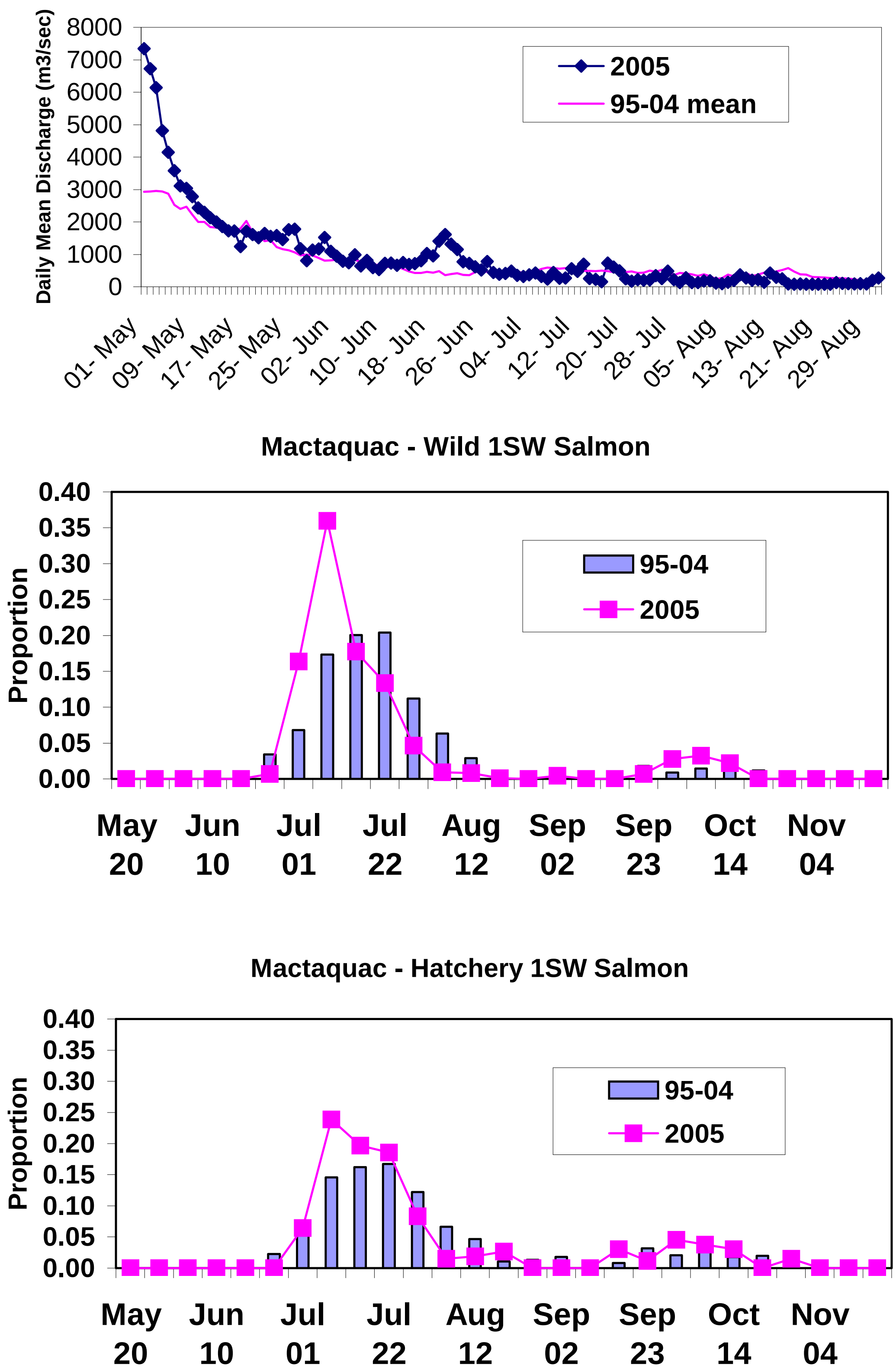


Fig. 6. Mean daily discharge (m^3/sec) from 1995 to 2004 and mean weekly counts (1995 to 2004) of wild and hatchery 1SW salmon at Mactaquac Dam compared to 2005.

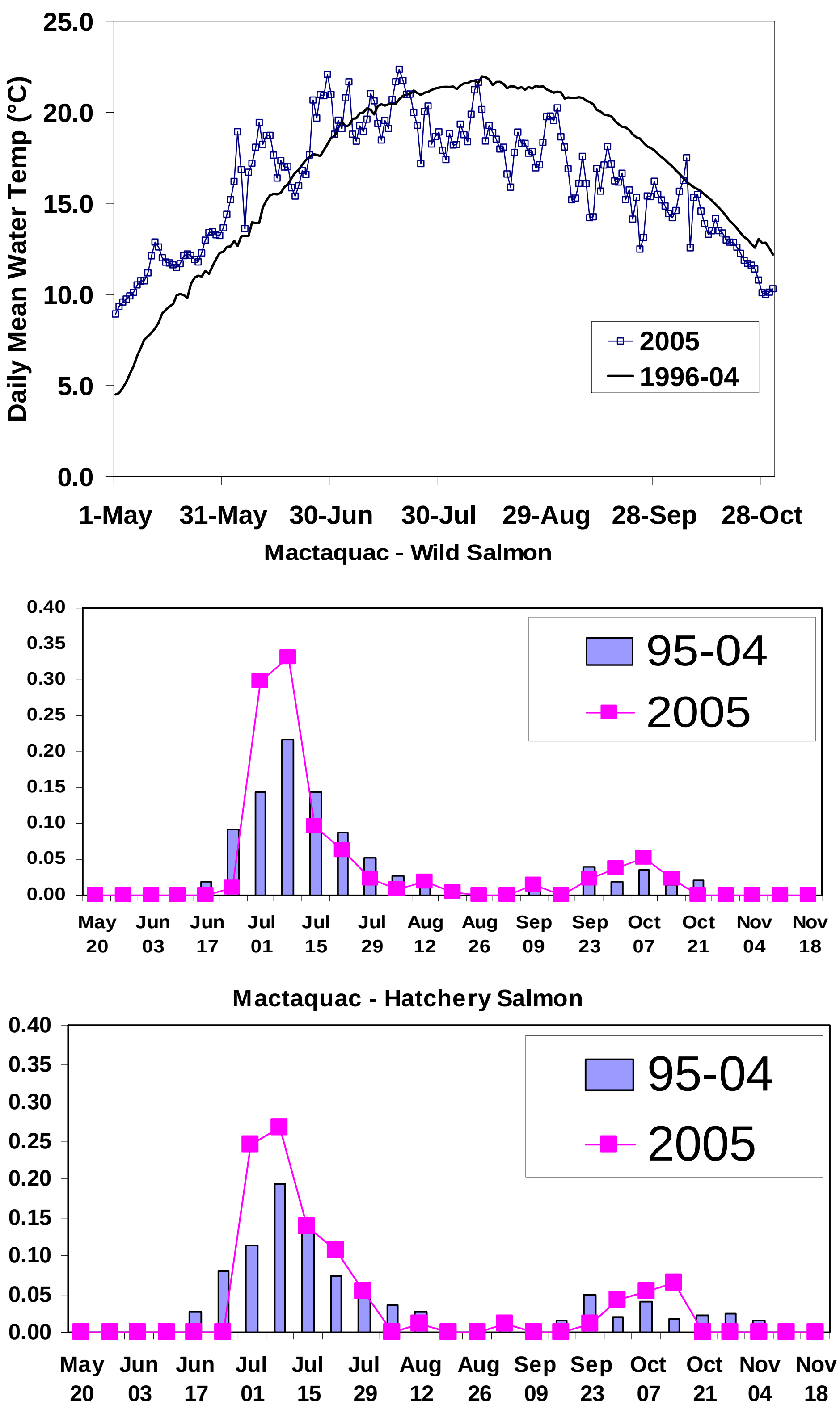


Fig. 7. Mean daily water temperatures (^{o}C) from 1996 - 2004 and mean weekly counts (1995 - 2004) of wild and hatchery MSW salmon at Mactaquac Dam compared to 2005. The 2005 mean daily water temperature was estimated from an upriver site just below Beechwood Dam.

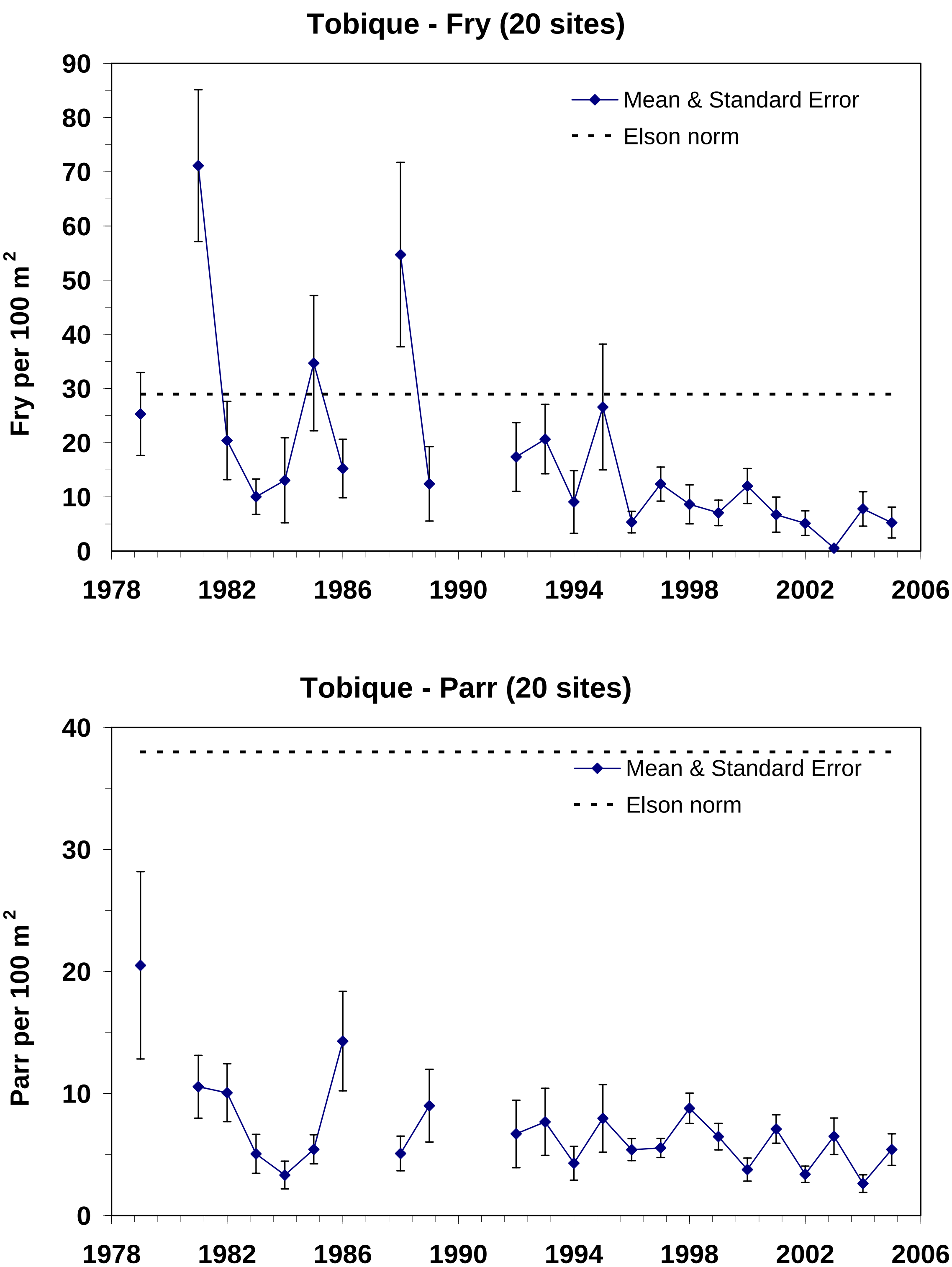


Fig. 8. Mean densities of age 0+ (fry) (upper panel) and age 1+ and older parr (lower panel) from electrofishing sites on the Tobique River in relation to the “Elson Norm” from 1978 to 2005.

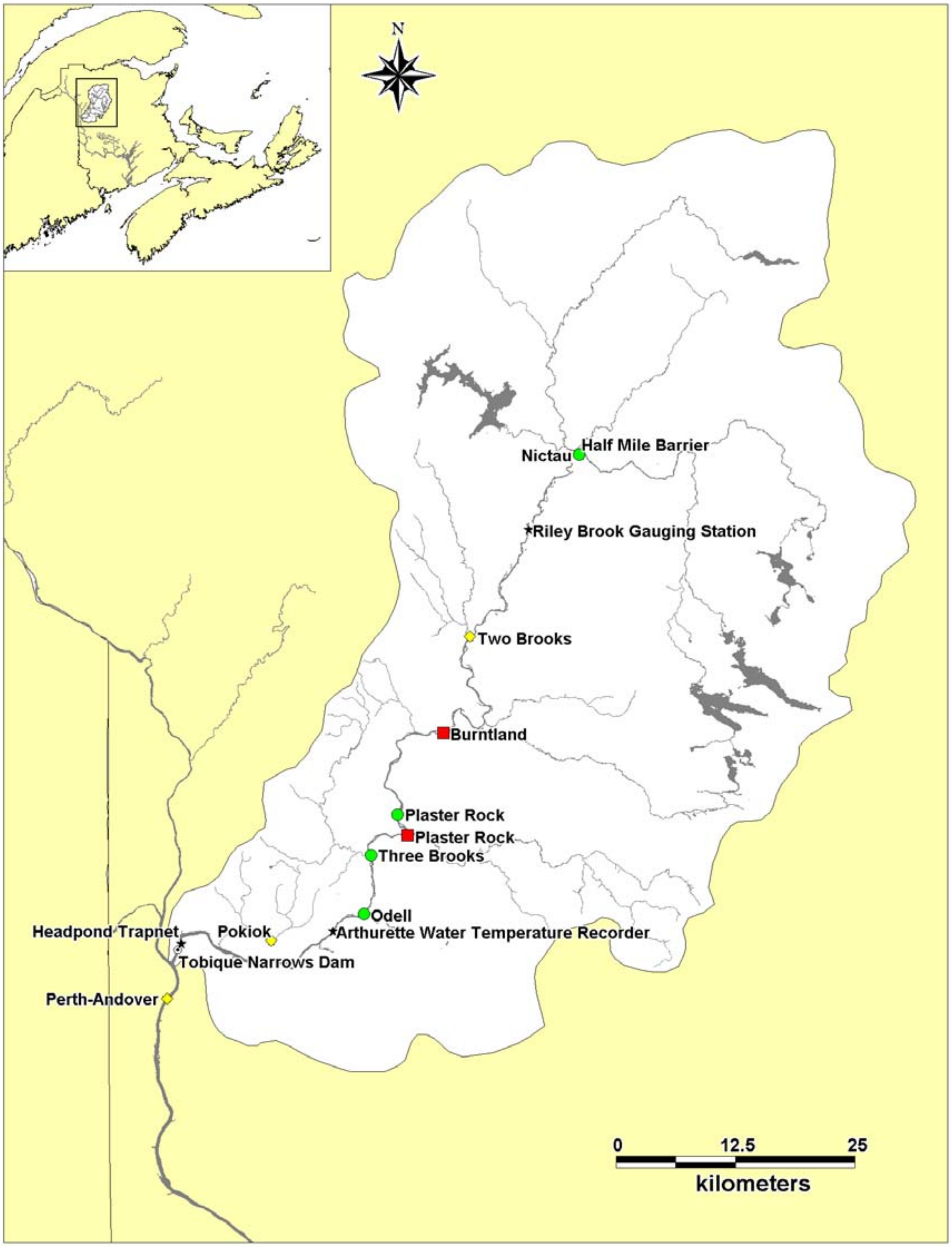


Fig. 9. Map of Tobique River showing the location of the rotary screw traps (circles), release sites for smolts (squares) and adults (diamonds), the temperature recorder (star), the trapnet (star), the half mile fish protection barrier (circle) and river gauging station (star) sites.

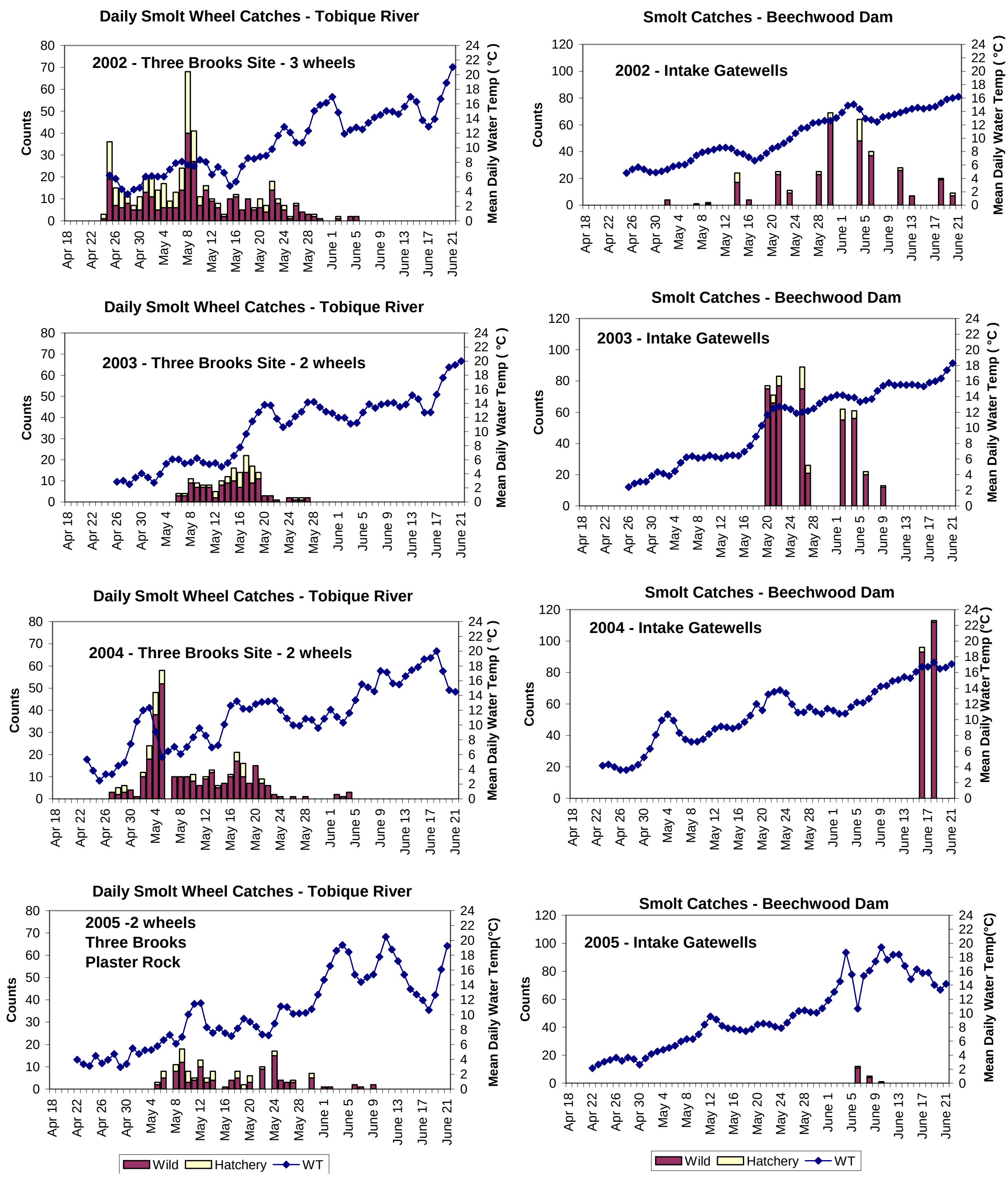


Fig. 10. Daily wild and hatchery smolt catches at smolt wheel(s) and Beechwood Intake Gatewells, 2002 – 2005. The mean daily water temperature (^{o}C) at Arthurette (Tobique plots) and Beechwood tailrace (Beechwood plots) is shown. The smolt catches are combined for the two smolt wheel sites operated in 2005.

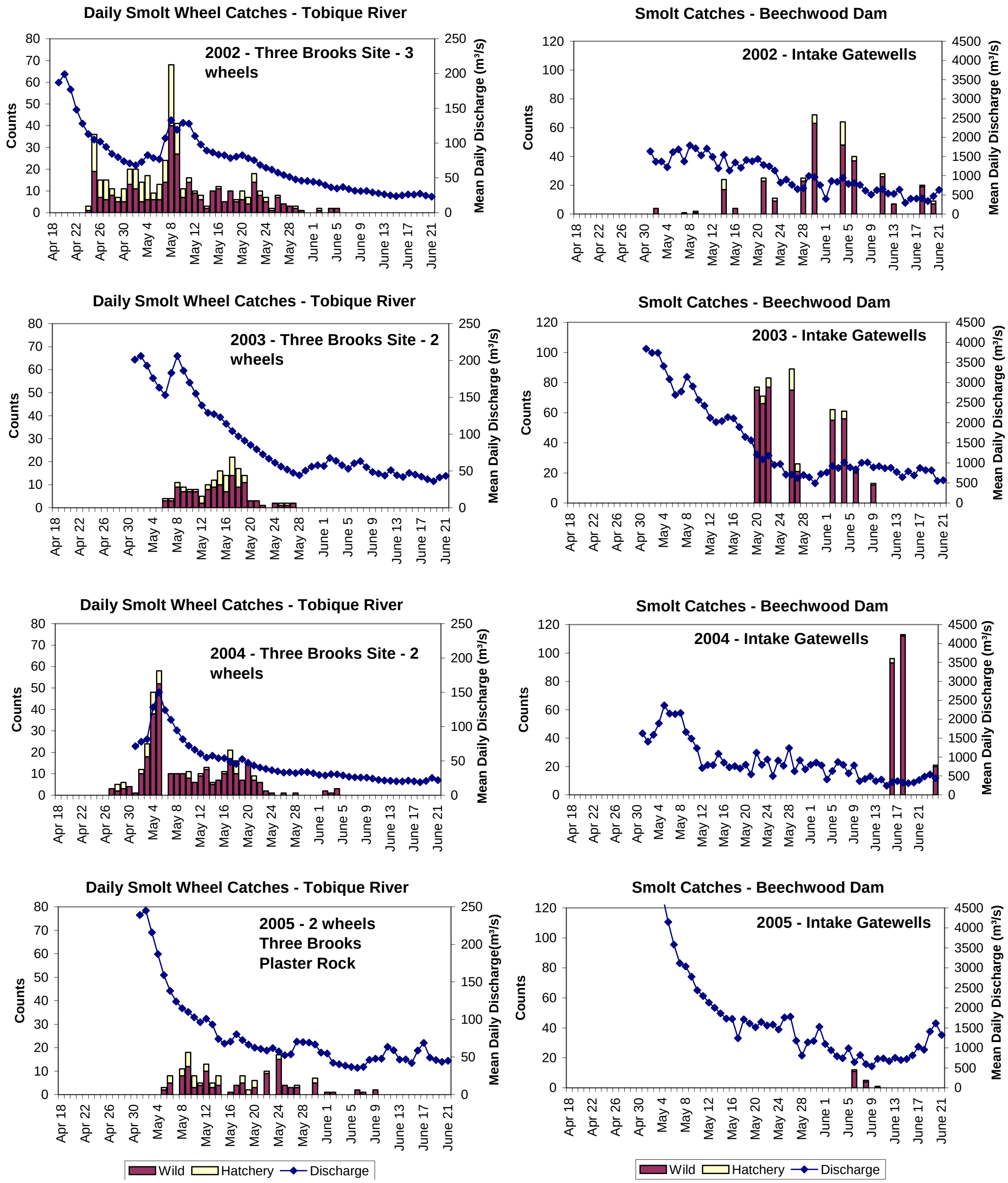
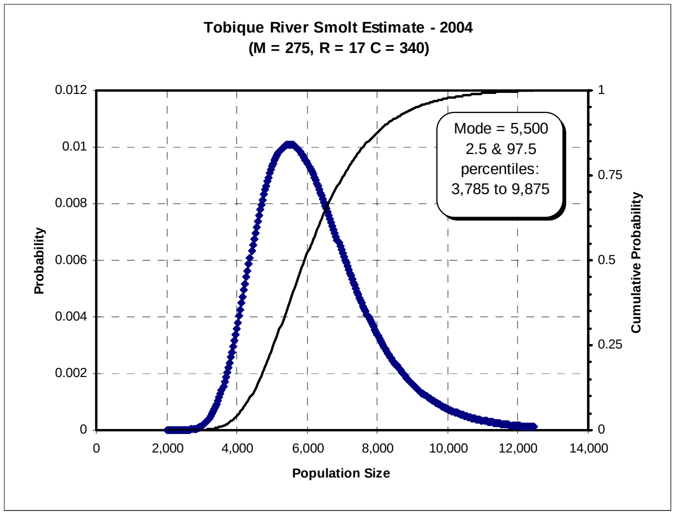
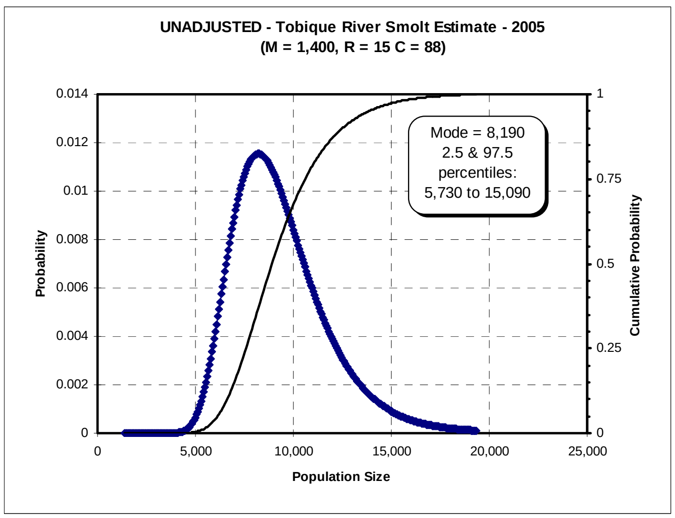


Fig. 11. Wild and hatchery smolt catches at smolt wheels on the Tobique River and at the intake gatewells at Beechwood Dam, 2002 - 2005. Mean daily discharge at Riley Brook (Tobique plots) and at Mactaquac (Beechwood plots) is shown. Mactaquac discharge is used as a proxy for Beechwood. The smolt catches are combined for the two smolt wheel sites operated in 2005.





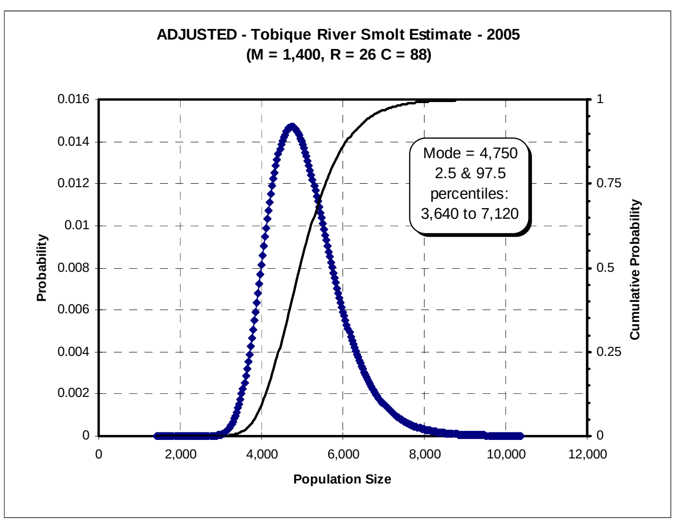


Fig. 12. Probability density (dots) and cumulative probability (black line), estimated using mark-recapture techniques, for the number of wild and hatchery Atlantic salmon smolts emigrating from the Tobique River (Three Brooks), 2004 - 2005.

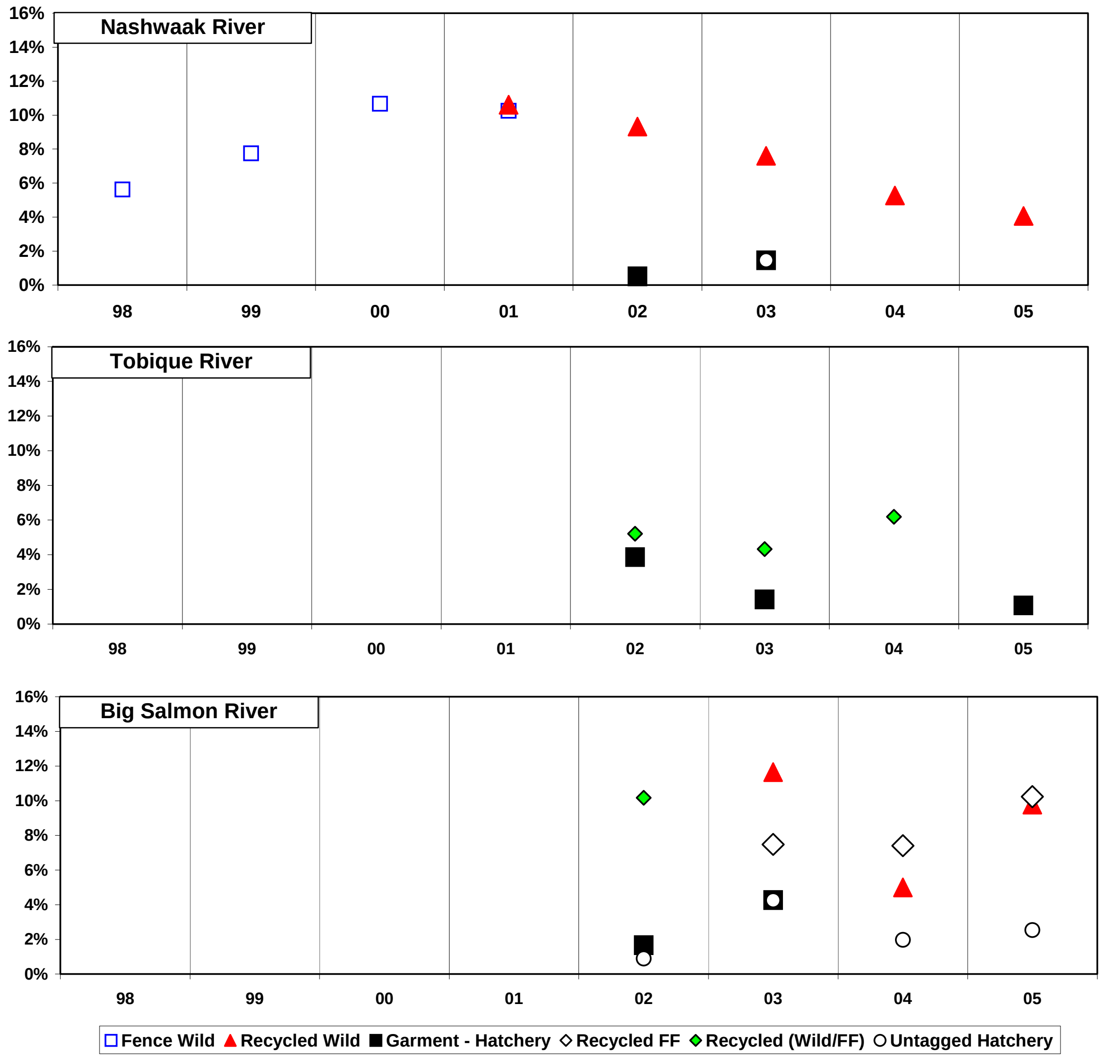


Fig. 13. Various rotary screw trap (or smolt wheel) capture efficiencies of wild, hatchery – fall fingerling (FF), hatchery -spring released (untagged and tagged) smolts from the Tobique, Nashwaak, and Big Salmon rivers (Big Salmon River data from Flanagan et al. 2006).

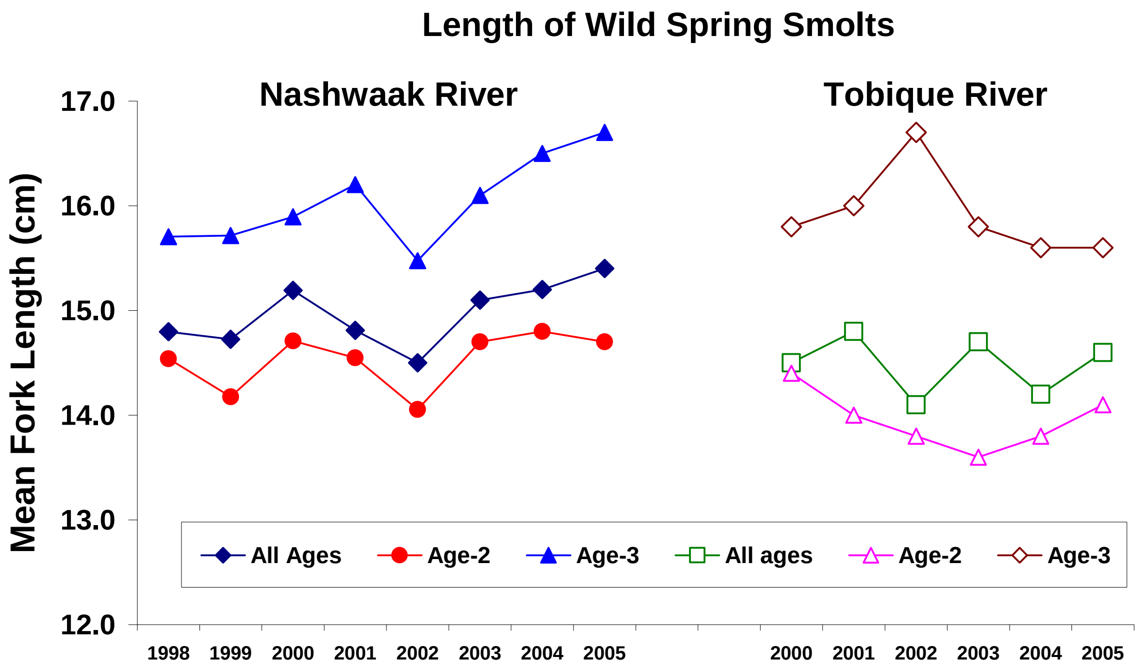


Fig. 14. Mean fork length, by age, for wild smolts sampled during assessment projects on the Nashwaak (1998 - 2005) and Tobique (2000 - 2005) rivers.

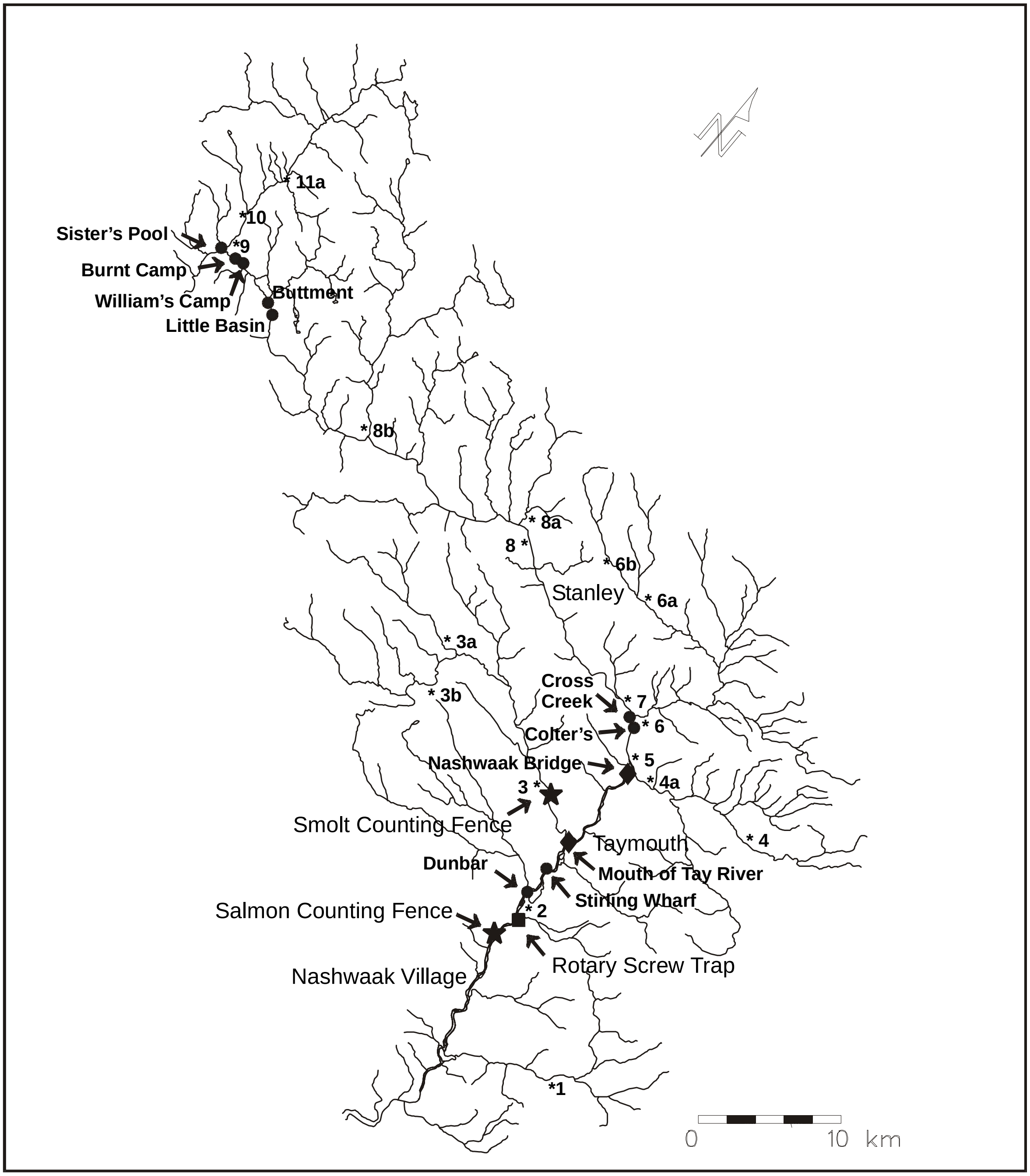


Fig. 15. Map of Nashwaak River, indicating adult counting fence site (star), rotary screw trap site (square), smolt fence (star), seined pools (circles), and electrofishing sites (*).

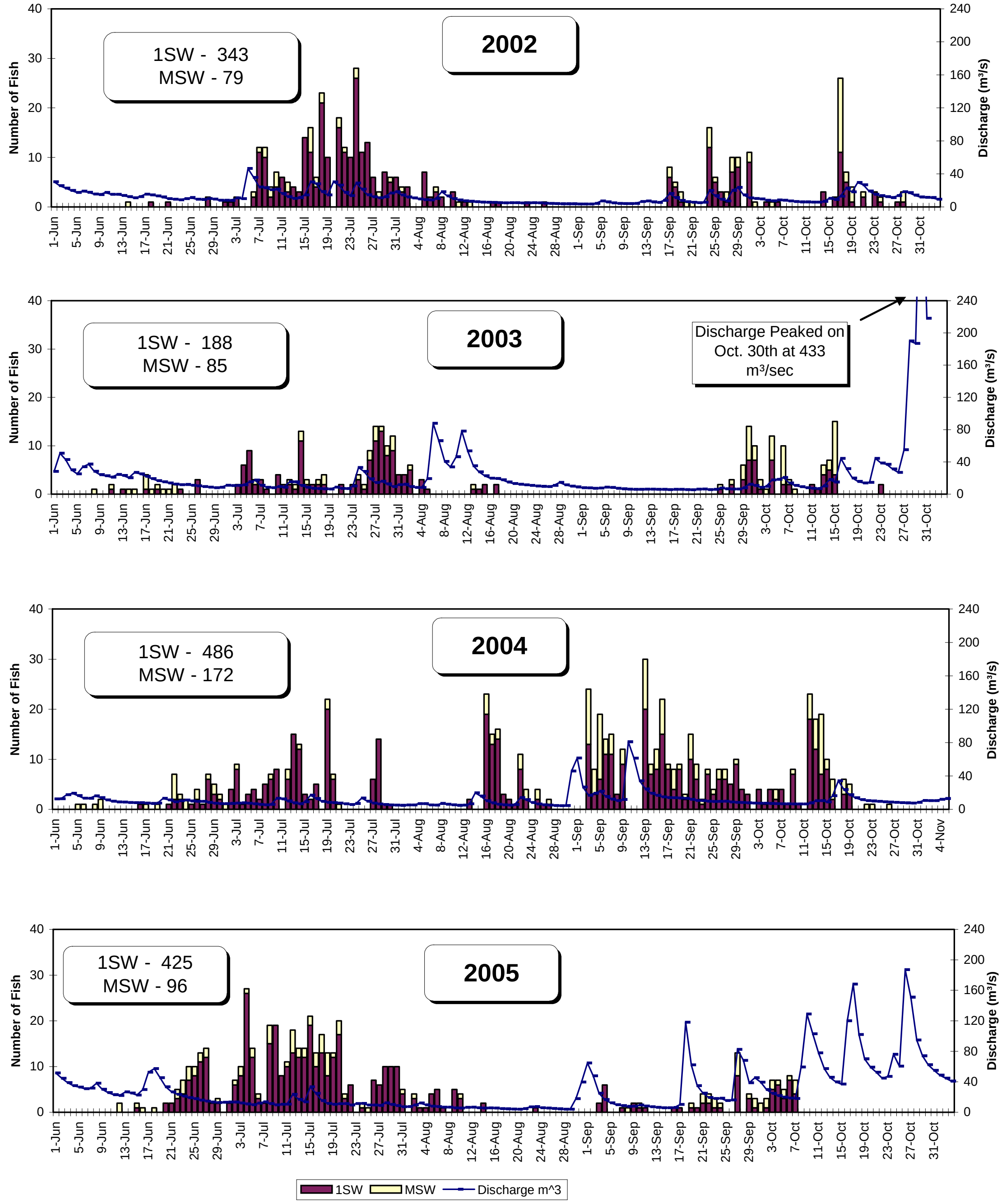
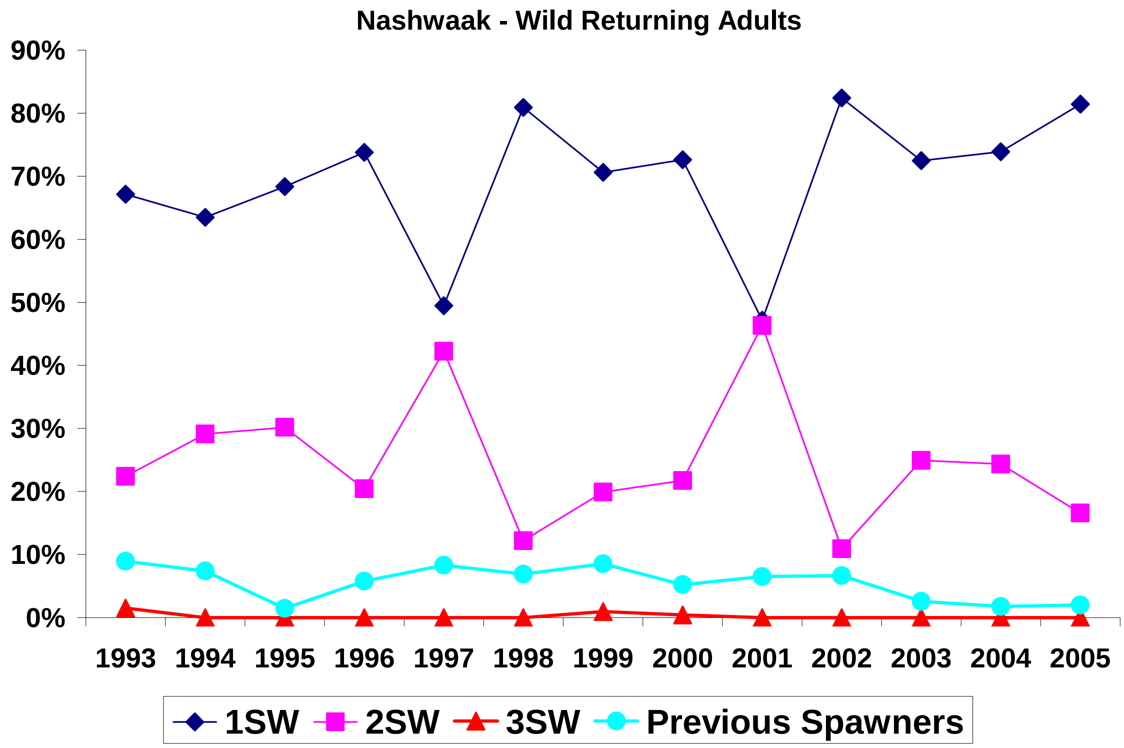


Fig. 16. Average daily discharge (m³/sec) at Durham Bridge and adjusted fence counts of 1SW and MSW salmon, Nashwaak River, 2002 - 2005.



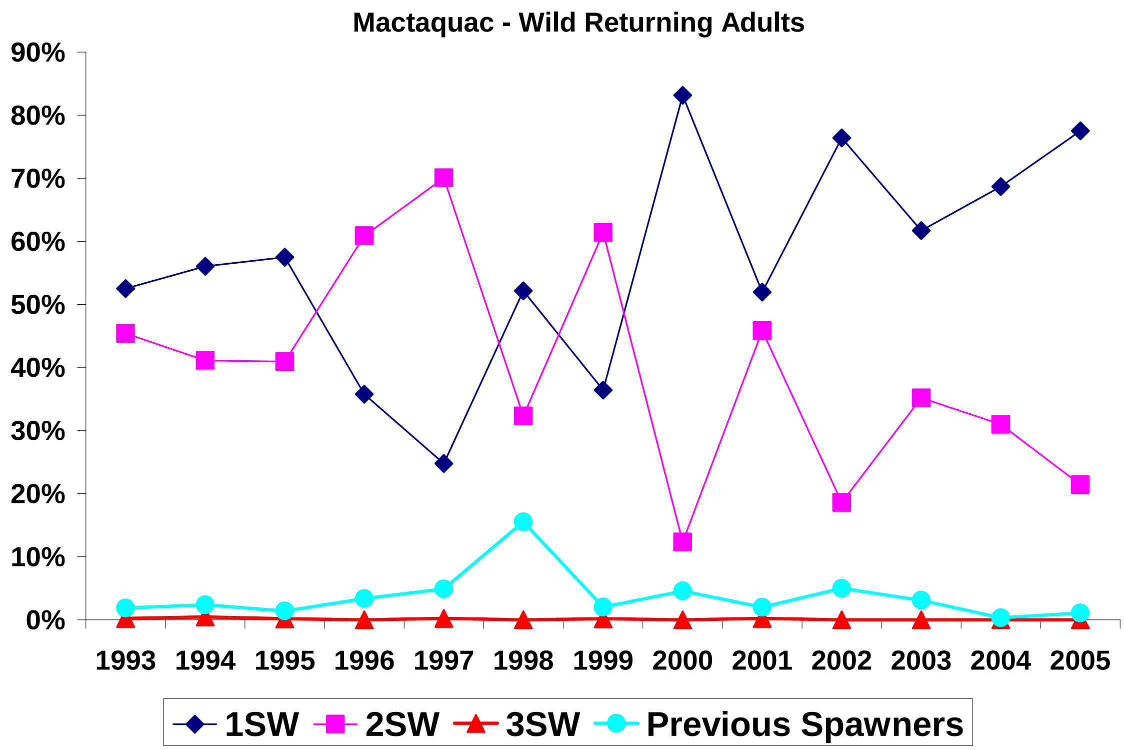


Fig. 17. The percentages of wild virgin 1SW, 2SW, 3SW and previous spawning (repeat spawning) Atlantic salmon in the total returns to the Nashwaak River and to Mactaquac, from 1993 to 2005.

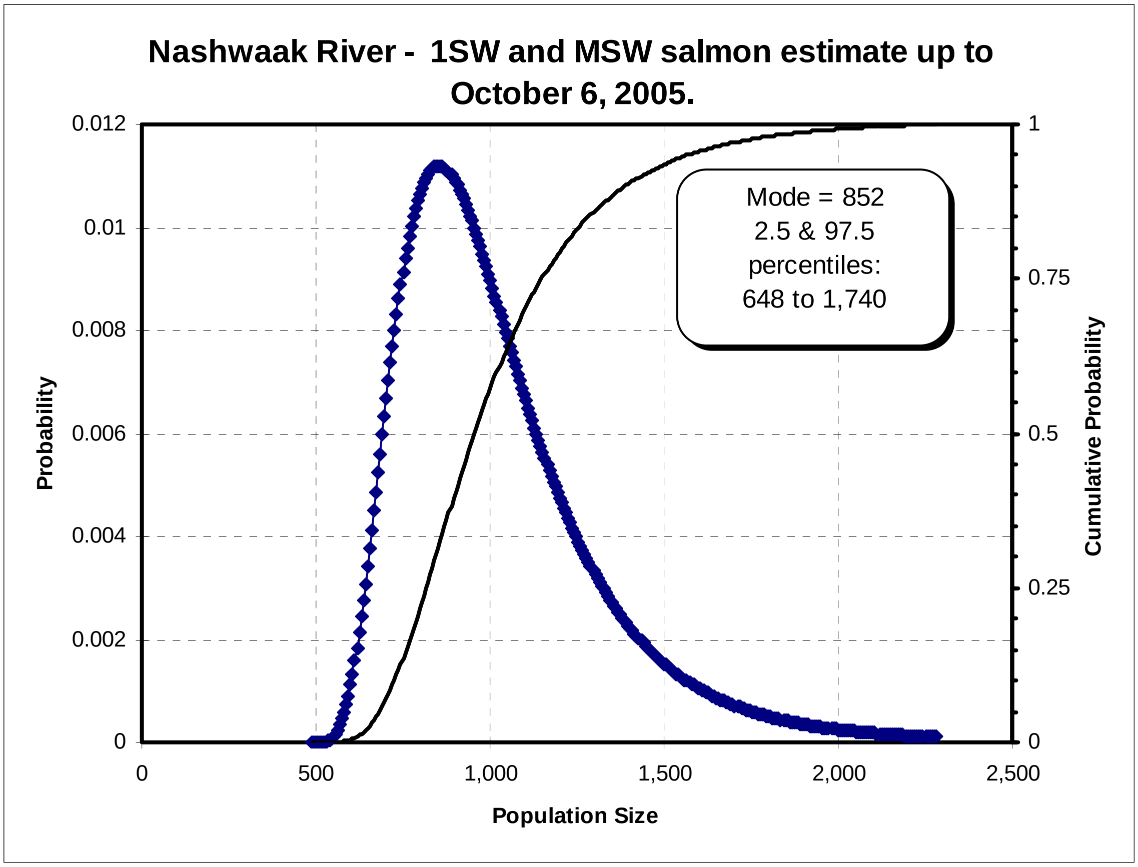


Fig. 18. Probability density (dots) and cumulative probability (black line) for the number of 1SW and MSW salmon returning to the Nashwaak River up to October 6, 2005, based on mark-recapture techniques.

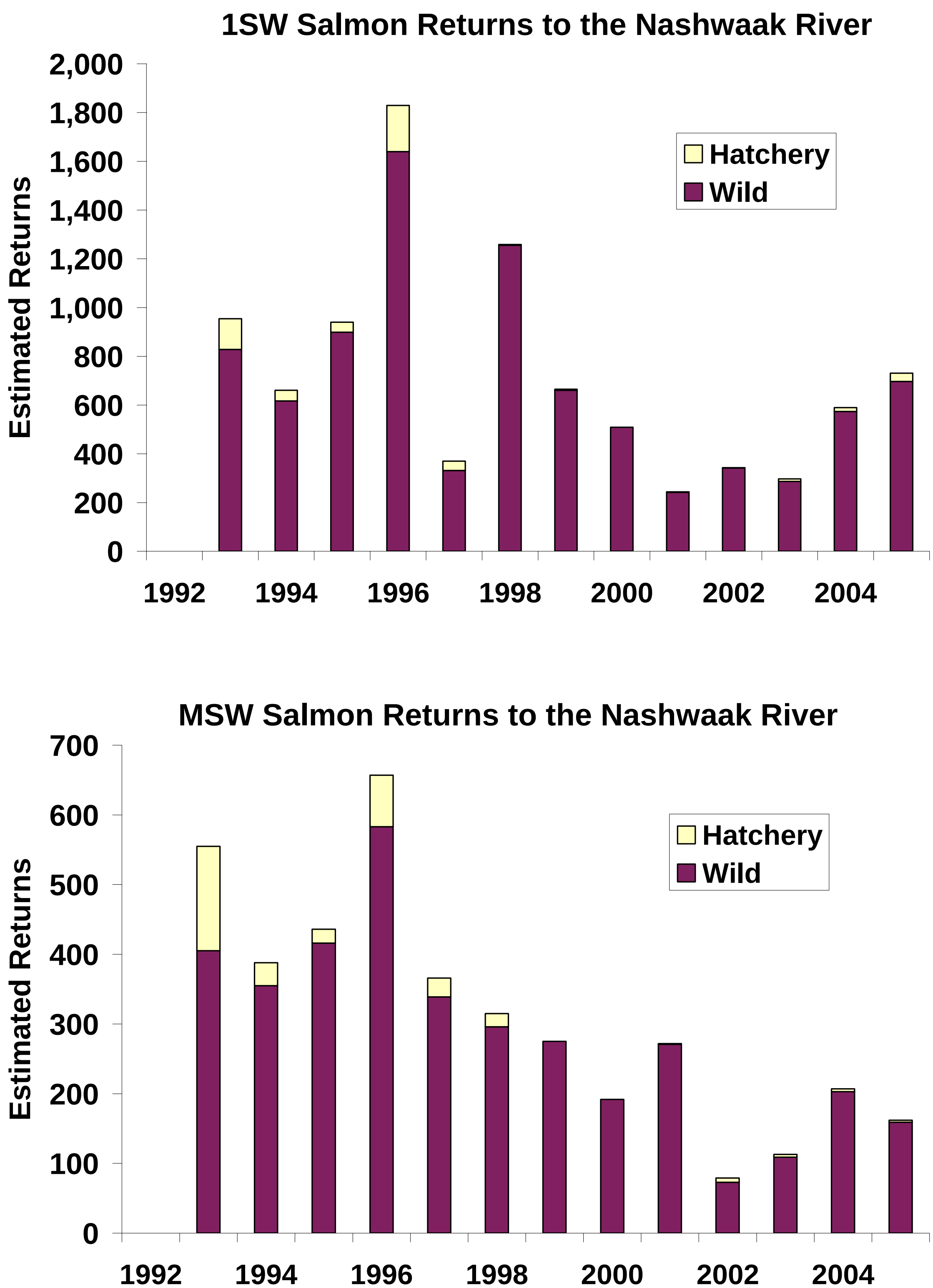


Fig. 19. Estimated wild and hatchery 1SW and MSW salmon returns to the Nashwaak River, 1993 to 2005.

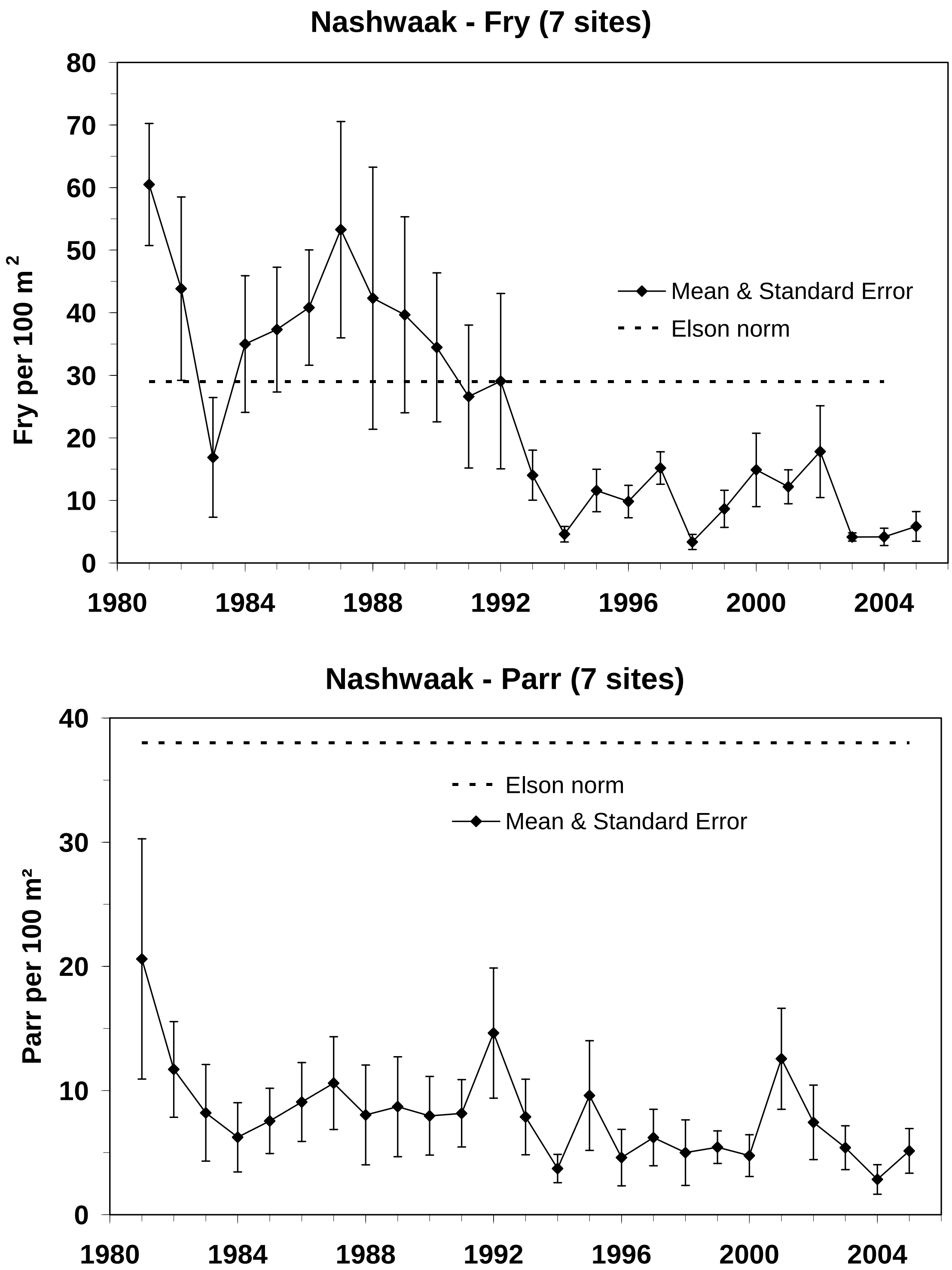


Fig. 20. Mean densities of age-0+ (fry) (upper panel) and age-1+ and older parr (lower panel) from electrofishing sites on the Nashwaak River in relation to the "Elson Norm" from 1981 to 2005.

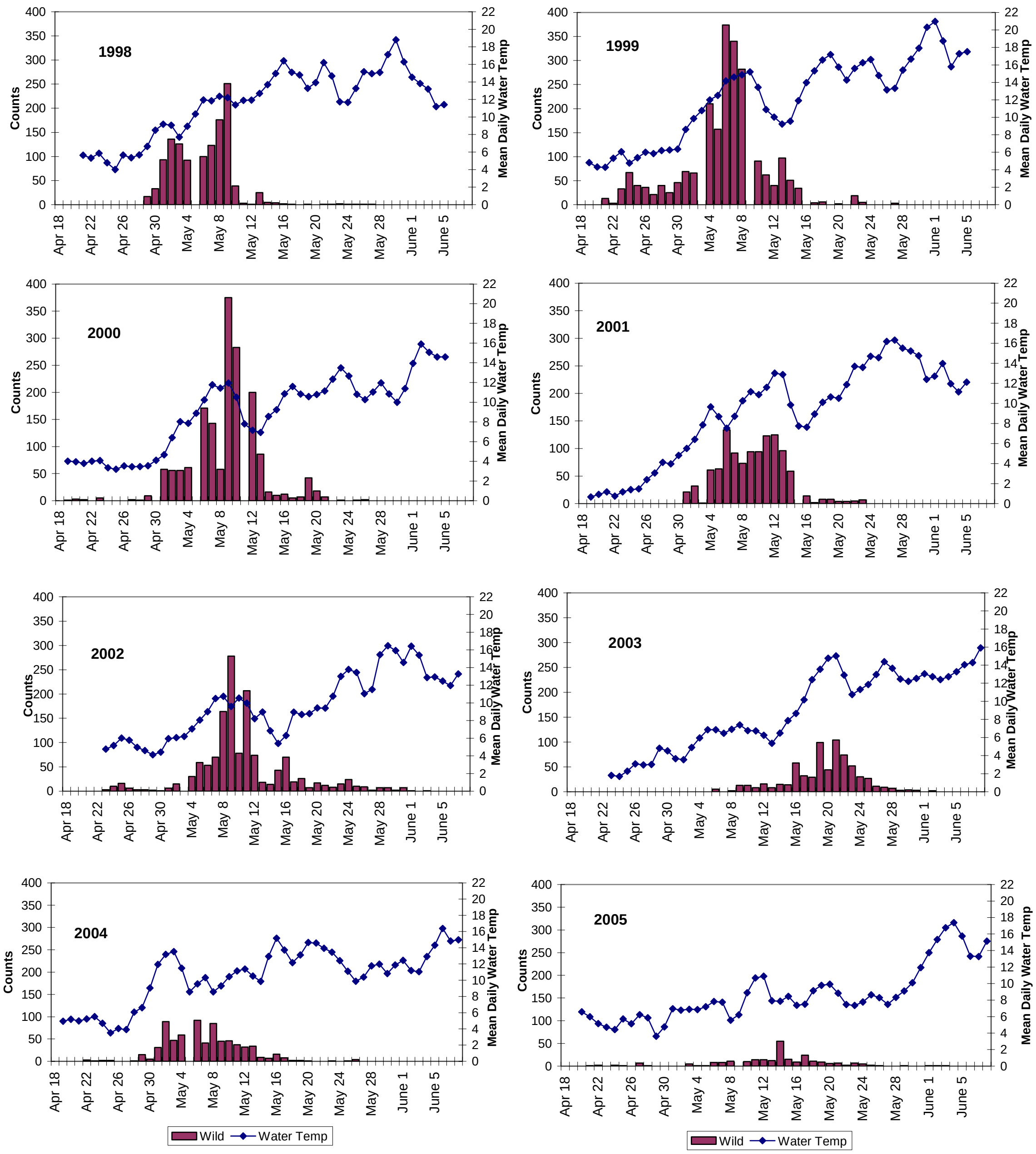


Fig. 21. Daily mean water temperatures (°C) and catches of wild smolts, Nashwaak River, 1998 – 2005.

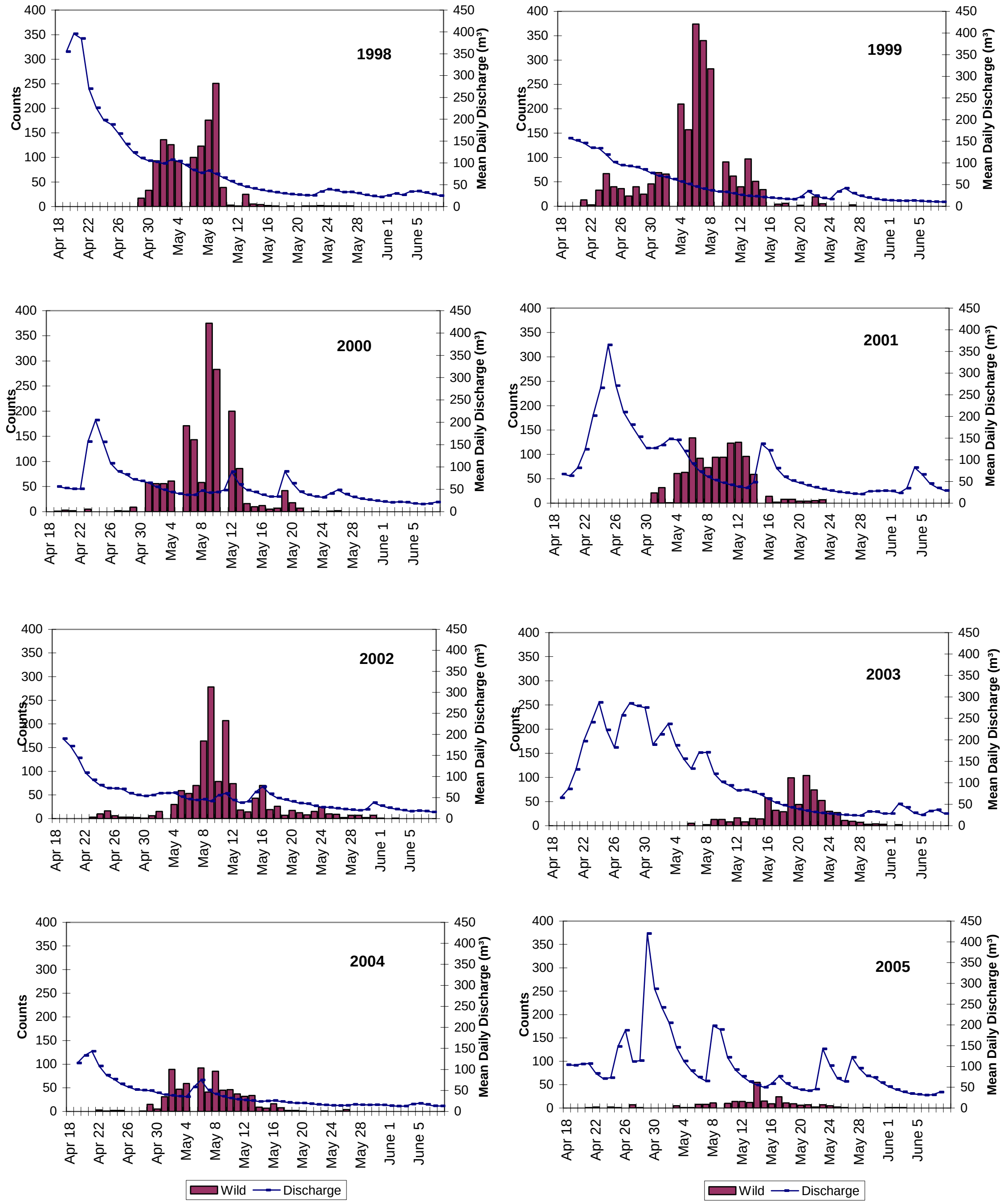
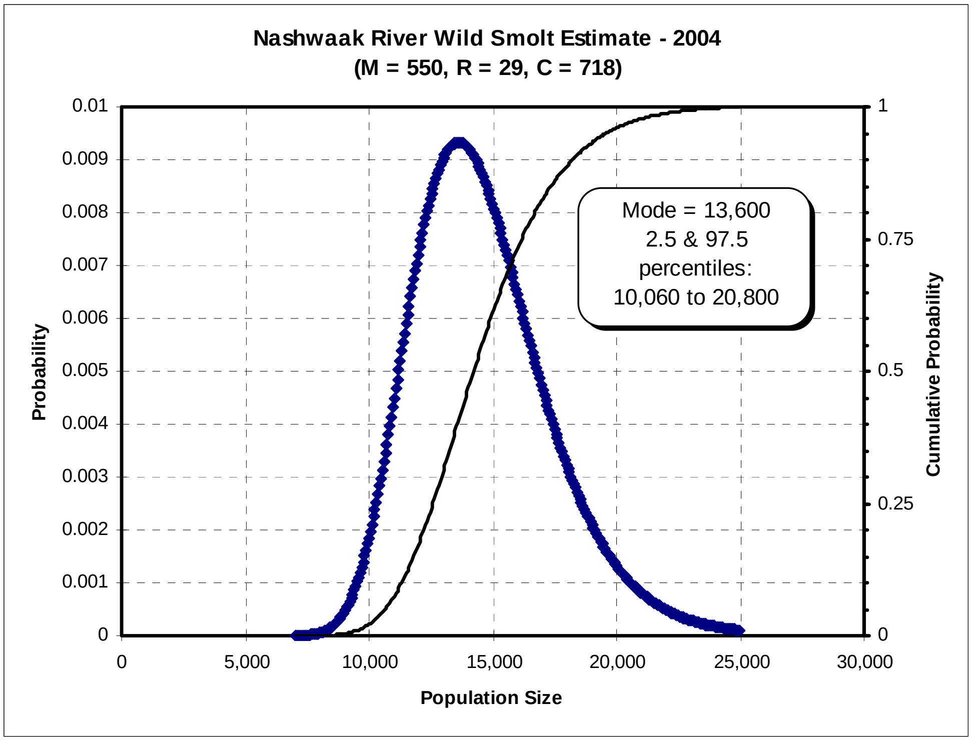


Fig. 22. Daily mean water discharge (m^3/sec) and catches of wild smolts, Nashwaak River, 1998 – 2005.



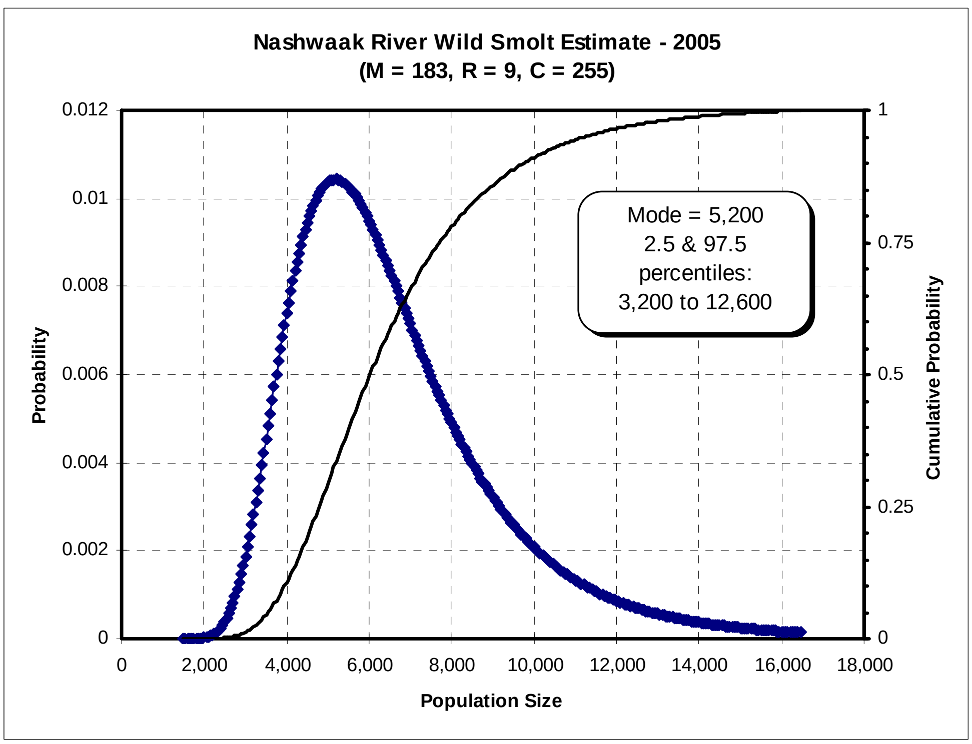


Fig. 23. Probability density (dots) and cumulative probability (black line), estimated using mark-recapture techniques, for the number for the number of wild Atlantic salmon smolts emigrating from the Nashwaak River, 2004 and 2005.

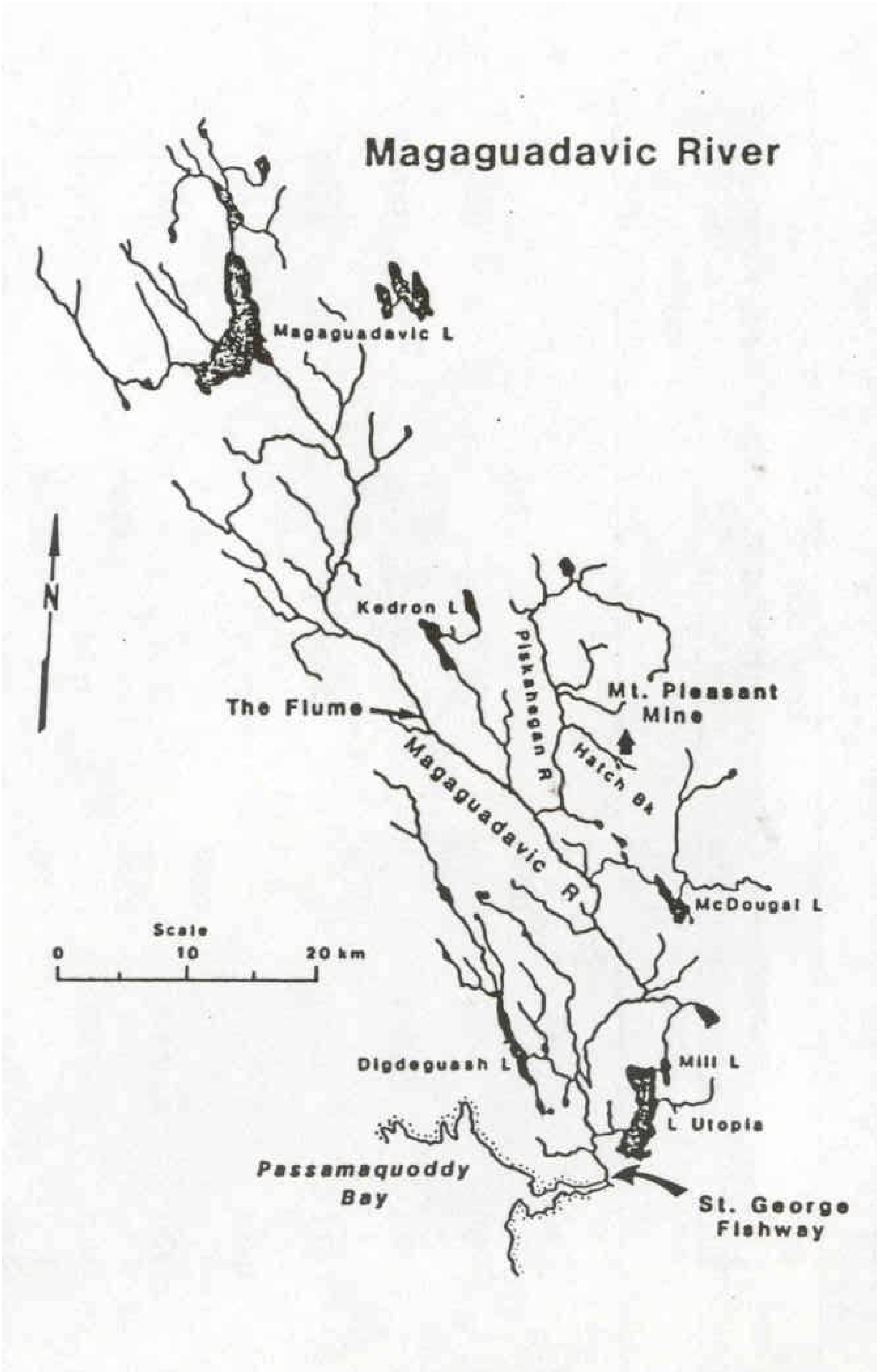
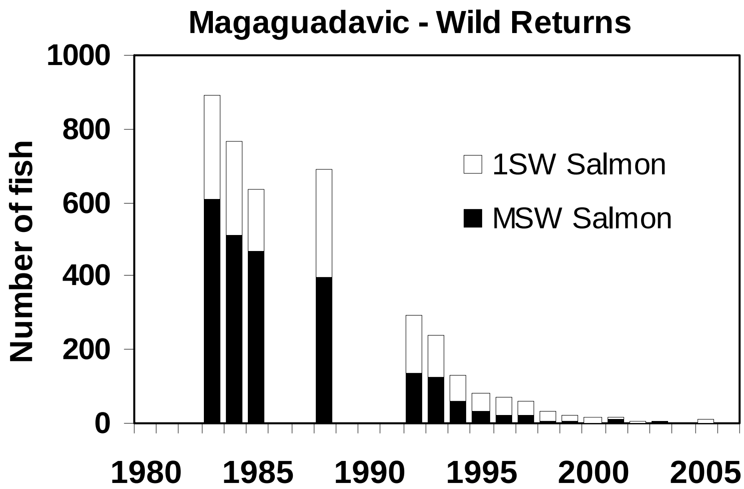


Fig. 24. Map of the Magaguadavic Watershed.



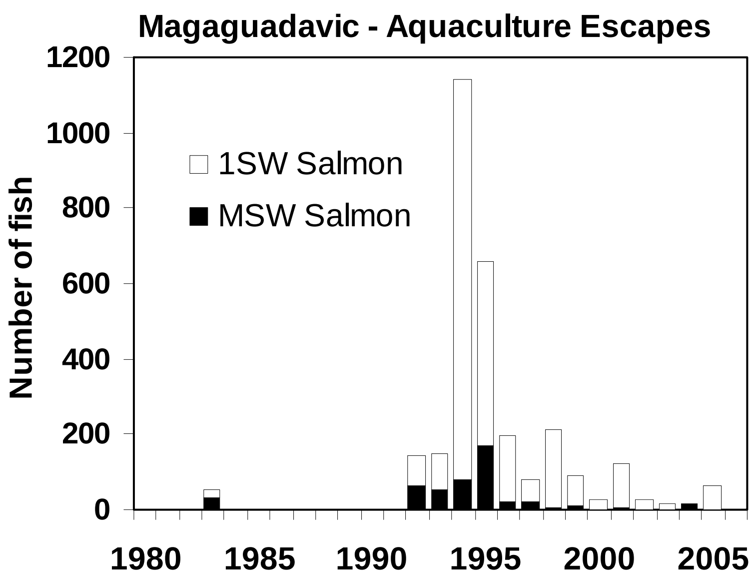


Fig. 25. The number of wild 1SW and MSW salmon returns and aquaculture escapes entering the Magaguadavic River, 1983-85, 1988, 1992-2005. The 2005 wild returns includes four hatchery origin fish.

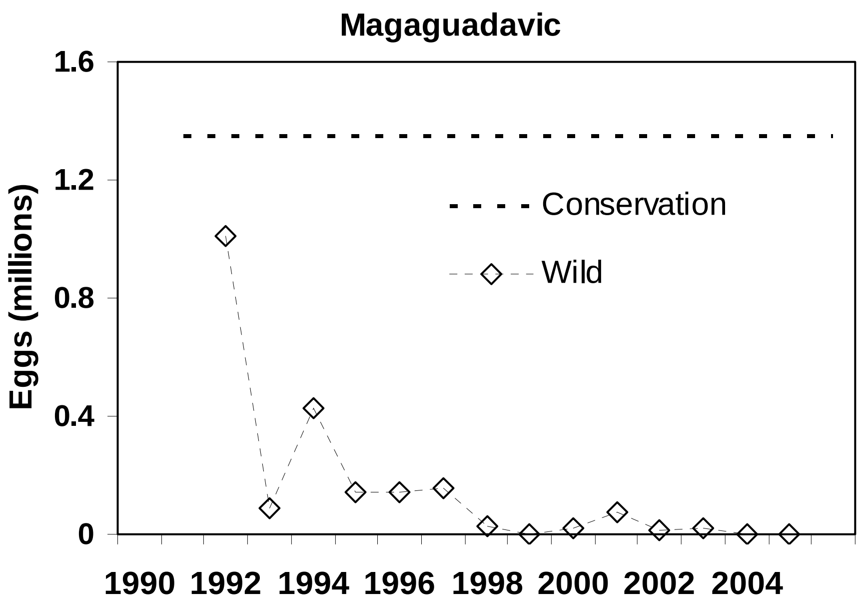


Fig. 26. Estimated egg depositions from wild 1SW and MSW salmon released up river of the fishway in the Magaguadavic River from 1992 to 2005. The 2005 estimated number includes eggs from both wild and hatchery origin fish.

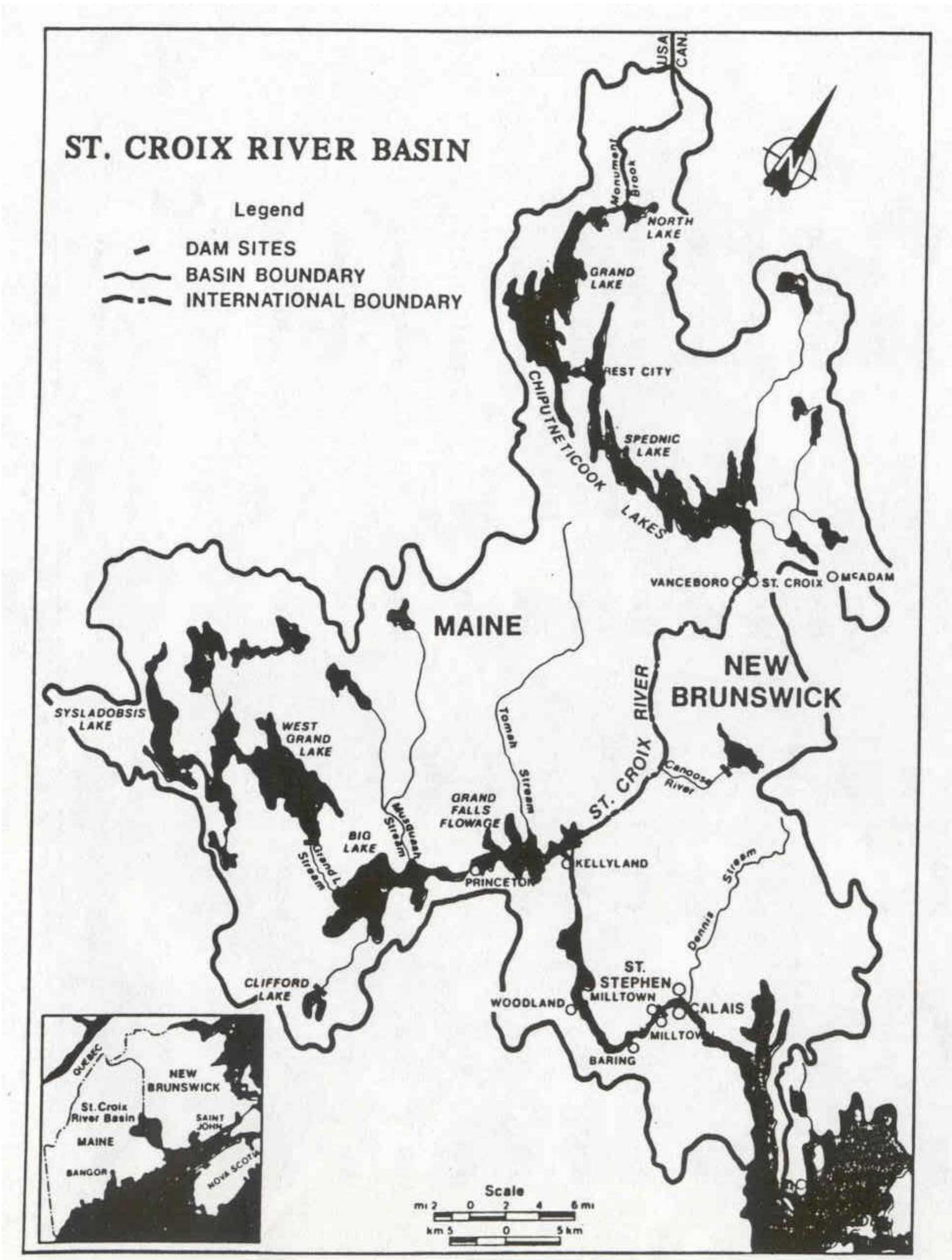


Fig. 27. Map of St. Croix Watershed.

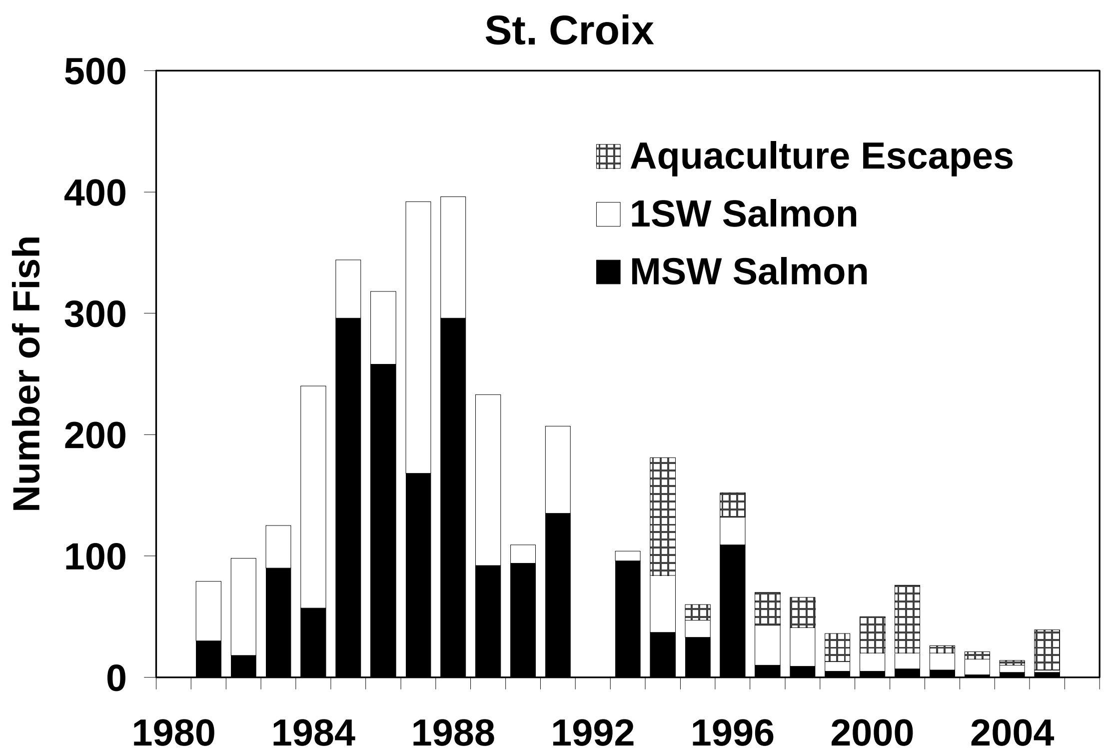


Fig. 28. The number of, wild and hatchery 1SW and MSW salmon returns and aquaculture escapes entering the St. Croix River from 1981 to 2005.

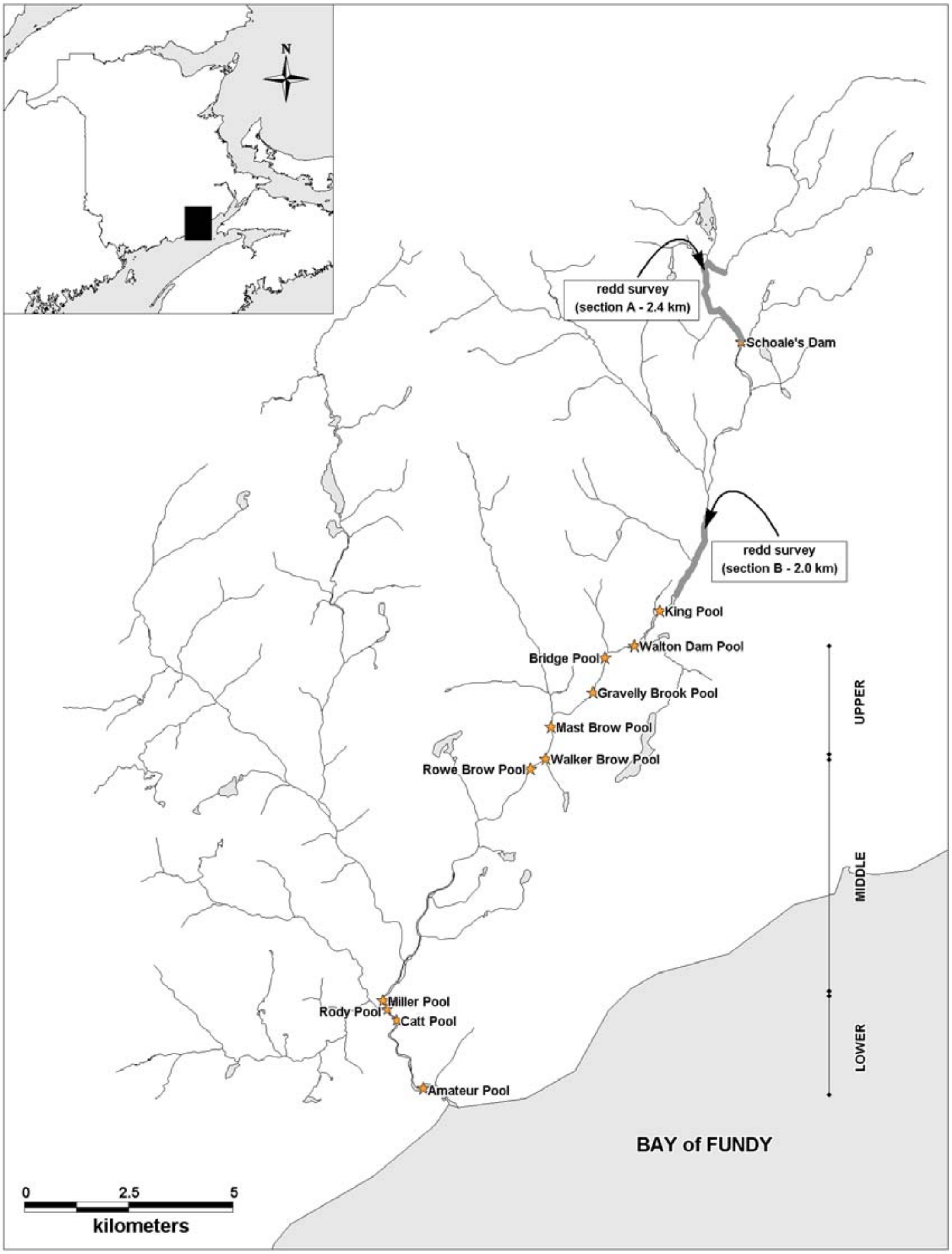


Fig. 29. Map of the Big Salmon River showing locations of pools (stars), area of redd surveys conducted by NBDNR (two shaded gray lines) and upper/middle/lower river stretches commonly observed during dive counts.

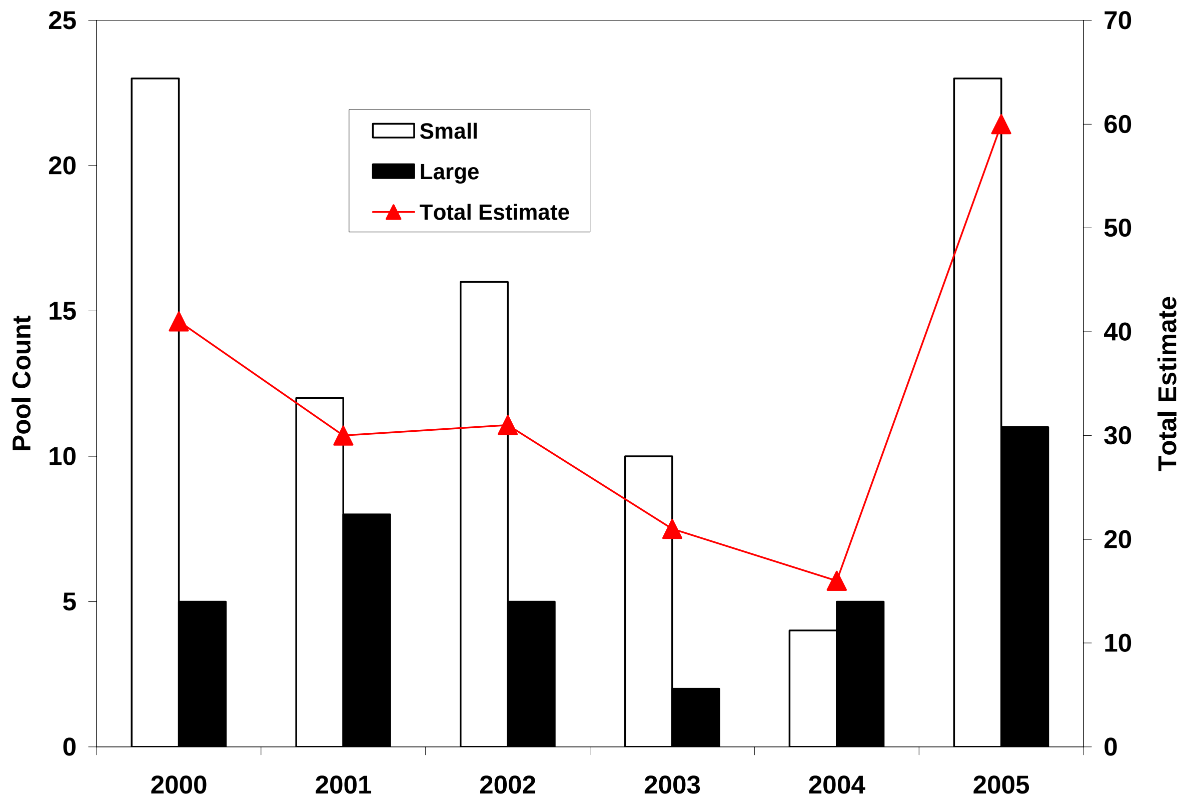


Fig. 30. Numbers of small and large salmon from dive counts and the yearly population estimate for the Big Salmon River, 2000 – 2005.

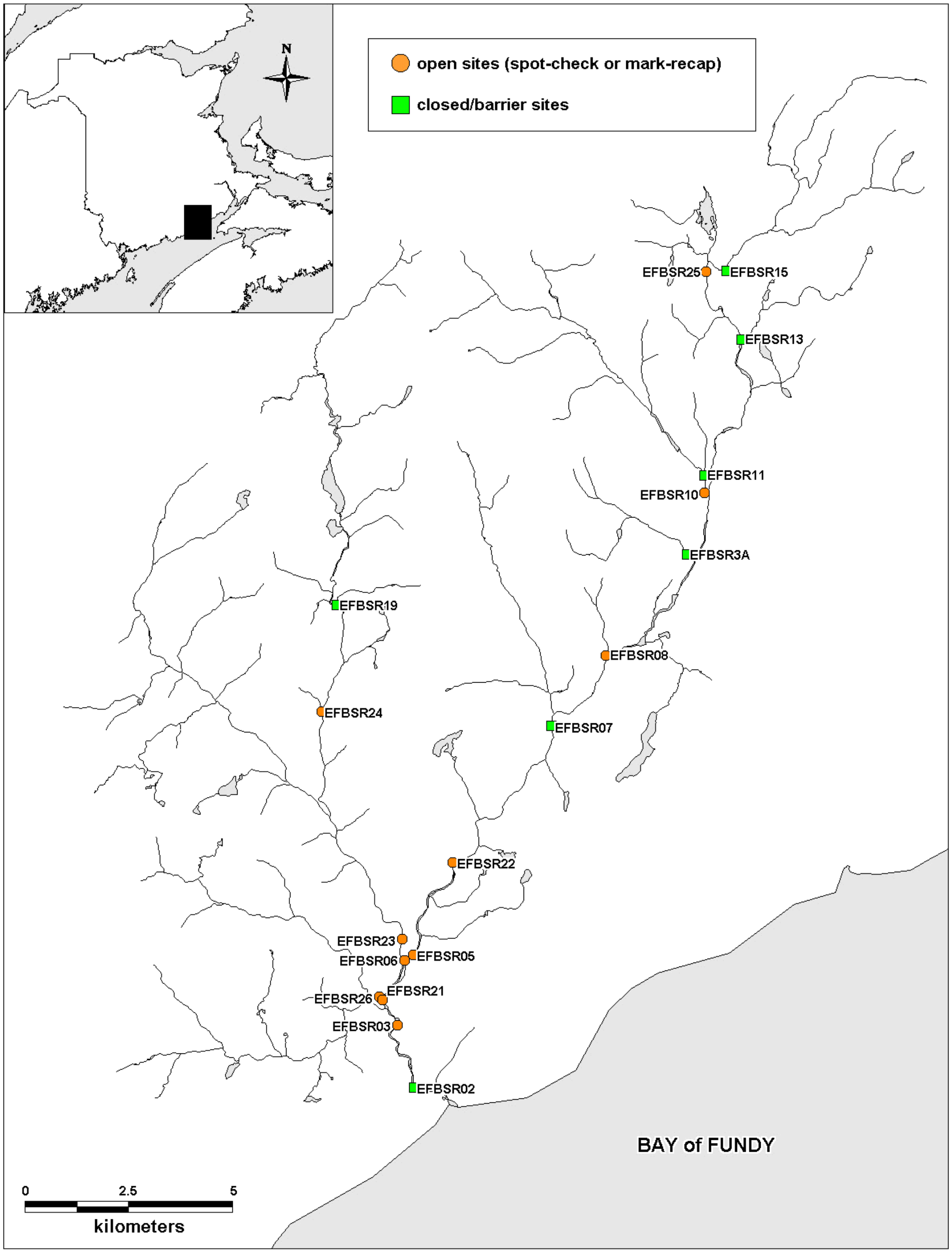


Fig. 31. Electrofishing sites on the Big Salmon River, 2004 – 2005.

Appendix *i*. Numbers of juvenile hatchery salmon distributed to sites up river of Mactaquac Dam (excluding distributions to the Aroostook River), 1976 - 2005. Fry are between zero to 14 weeks old, 0+ parr are at least 14 weeks old but less than one year old and 1+ parr are at least one year old but less than two years old.

	0+ Fry		**O+ Parr**		**1+ Parr**			**1 yr smolt**			**2 yr smolt**		
Year	**No Mark**	**Ad Clip**	**No Mark**	**Ad Clip**	**No Mark**	**Ad Clip**	**Tagged**	**No Mark**	**Ad Clip**	**Tagged**	**No Mark**	**Ad Clip**	**Tagged**
1976						52,662	5,000						
1977			6,042	44,021									
1978			9,163										
1979													
1980													5,995
1981													5,998
1982			75,210										
1983													
1984			123,757	8,517									
1985			164,947	110,569	24,544								
1986	17,300		126,692	91,808									
1987	266,257		101,052	50,283									
1988	79,948		107,478	60,472									
1989	150,384		151,562					4,680	30,011		20,000		
1990	164,005		232,291					2,877	24,026			17,140	
1991	227,535		499,130						30,181			19,646	
1992	600,408		514,662										
1993	672,797		272,824	99,939				819					
1994	983,549	30,000	285,988	253,730									
1995	642,830		193,208	226,391									
1996	940,962		511,771										
1997	504,488		391,860	20,991									
1998	213,973			282,491									
1999	172,220			356,635									
2000	609,802			371,751					1,996				
2001	8,330			344,618									
2002	500			342,176						2,357			
2003	2,723			261,852						1,483			
2004			210,075	129,147									
2005			2,500	206,533						1,400			
Total	**6,258,011**	**30,000**	**3,980,212**	**3,261,924**	**24,544**	**52,662**	**5,000**	**8,376**	**86,214**	**5,240**	**20,000**	**36,786**	**11,993**

Appendix *ii*. Numbers of juvenile hatchery salmon distributed to sites on the Tobique River, 1976 - 2005. Fry are between zero to 14 weeks old, 0+ parr are at least 14 weeks old but less than one year old and 1+ parr are at least one year old but less than two years old.

	0+ Fry		O+ Parr		1+ Parr			1 yr smolt			2 yr smolt		
Year	**No Mark**	**Ad Clip**	**No Mark**	**Ad Clip**	**No Mark**	**Ad Clip**	**Tagged**	**No Mark**	**Ad Clip**	**Tagged**	**No Mark**	**Ad Clip**	**Tagged**
1976							5,000						
1977			6,042										
1978			9,163										
1979													
1980													5,995
1981													5,998
1982													
1983													
1984				8,517									
1985			43,211	38,687									
1986	17,300		46,563	53,782									
1987	52,882		33,505	21,950									
1988			28,723	40,038									
1989	80,012		83,846					2,255	9,995				
1990	68,707		83,075					534	9,944				
1991			194,173						4,995			4,953	
1992	119,987		257,732										
1993	203,950		98,738	99,939				819					
1994	317,996	30,000	46,376	253,730									
1995	337,080		101,900	207,683									
1996	651,045		333,320										
1997	302,000		256,578	20,991									
1998	83,995			193,756									
1999	101,204			209,358									
2000	360,390			254,473					1,996				
2001				221,014									
2002	500			184,349						2,357			
2003	2,723			181,630						1,483			
2004			78,052	129,147									
2005			2,500	179,713						1,400			
Total	**2,699,771**	**30,000**	**1,703,497**	**2,298,757**	**0**	**0**	**5,000**	**3,608**	**26,930**	**5,240**	**0**	**4,953**	**11,993**

Appendix *iii*. Adjusted counts, by age, of wild and hatchery 1SW and MSW salmon to Mactaquac Dam, 1992 - 2005. The smolt age distribution for the 1992-1994 returns was completed without considering the monthly sampling differences so these numbers are likely to change slightly and should be considered temporary.

Category **Origin**	**Smolt.Sea Age**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
1SW Salmon															
Wild	2.1	2,573	1,865	993	957	601	150	147	150	823	485	368	270	404	549
	3.1	3,075	883	1,035	1,154	585	146	185	290	459	191	258	103	415	285
	4.1	80	74	42	43	28	32	7	27	48	3	2	4	36	20
Wild	Total	**5,728**	**2,822**	**2,070**	**2,154**	**1,214**	**328**	**338**	**467**	**1,330**	**679**	**628**	**377**	**855**	**854**
Hatchery	1.1	1,132	779	841	1,509	2,649	1,543	2,112	1,672	1,403	839	1,358	815	499	197
	2.1	527	240	214	834	1,354	521	968	480	207	129	263	83	98	79
	3.1	259	52	227	483	867	627	1,459	569	66	35	86	13	19	14
	4.1	17	1	13	2	69	88	56	36	32	1	0	1	1	3
Hatchery	Total	**1,935**	**1,072**	**1,295**	**2,828**	**4,939**	**2,778**	**4,595**	**2,757**	**1,708**	**1,004**	**1,707**	**912**	**617**	**293**
1SW Salmon	**Total**	**7,663**	**3,894**	**3,365**	**4,982**	**6,153**	**3,106**	**4,933**	**3,224**	**3,038**	**1,683**	**2,335**	**1,289**	**1,472**	**1,147**
MSW Salmon															
Wild	2.2	1,897	1,156	1,098	976	1,128	428	64	359	137	507	124	160	348	149
	3.2	1,297	1,247	413	523	925	473	145	412	58	91	29	55	38	87
	4.2	17	38	8	35	13	26	1	16	2	1	0	0		0
	Previous Spawners & 3SW	181	112	105	59	114	68	101	28	73	29	41	19	4	12
Wild	Total	**3,392**	**2,553**	**1,624**	**1,593**	**2,181**	**995**	**312**	**816**	**270**	**628**	**194**	**234**	**390**	**248**
Hatchery	1.2	590	242	303	398	567	412	229	554	173	462	142	443	265	78
	2.2	136	76	142	95	221	143	120	209	57	49	22	38	32	13
	3.2	82	97	19	47	137	158	177	158	19	9	2	10	5	1
	4.2	1	6	0	2	10	4	13	3	1	0	0	0	0	0
	Previous Spawners & 3SW	3	19	66	30	13	26	92	19	10	28	7	7	2	2
Hatchery	Total	**812**	**440**	**530**	**572**	**947**	**744**	**631**	**943**	**260**	**548**	**173**	**498**	**304**	**94**
MSW Salmon	**Total**	**4,204**	**2,993**	**2,154**	**2,165**	**3,128**	**1,739**	**943**	**1,759**	**530**	**1,176**	**367**	**732**	**694**	**342**
Total	**Total**	**11,867**	**6,887**	**5,519**	**7,147**	**9,281**	**4,845**	**5,876**	**4,983**	**3,568**	**2,859**	**2,702**	**2,021**	**2,166**	**1,489**

Appendix *iv*. Numbers of juvenile hatchery salmon distributed to sites within the Nashwaak River, 1976 - 2005. Fry are between zero to 14 weeks old, 0+ parr are at least 14 weeks old but less than one year old and 1+ parr are at least one year old but less than two years old.

	0+ Fry		0+ Parr		1+ Parr		1+ Smolt			2+ Smolt		
Year	**No Mark**	**Ad Clip**	**No Mark**	**Ad clip**	**No Mark**	**Ad Clip**	**No Mark**	**Ad clip**	**Tagged**	**No Mark**	**Ad Clip**	**Tagged**
1976	203,265		18,964		11,117	1,210						
1977	137,187	650	22,044		7,200	3,196						
1978			106,375		1,320							
1979			85,113		22,476							
1980	134,884				18,240							
1981					25,254	32,880				20,336		
1982			57,750							5,183	12,776	
1983											8,053	7,998
1984			47,129								12,158	8,005
1985	11,000		13,043		46,643	12,344			7,966			
1986			23,071				18,734					
1987	71,614		17,931				13,205		6,500			
1988	121,711		17,114				16,788		4,001			
1989	13,703		50,508				11,914					
1990	47,172		25,568				15,248		3,999			
1991	16,397		18,102				15,903		4,000			
1992	26,302		26,553				9,658		3,995			
1993	17,310		22,500				9,270		3,881			
1994	51,320		16,817				11,059		4,000			
1995	32,450		16,802				6,633		6,648			
1996							9,027 a		3,004			
1997												
1998												
1999	2,500			6,000								
2000	8,424			6,000								
2001	7,009			11,713								
2002				3,837					2,148			
2003	2,693		7,000	21,491				4,918	1,780			
2004												
2005	2,439			10,000								
Total	**907,380**	**650**	**592,384**	**59,041**	**132,250**	**49,630**	**137,439**	**4,918**	**51,922**	**25,519**	**32,987**	**16,003**

a - 3,014 one year old smolt were released from the Mactaquac Migration Channel.

Appendix *v*. Numbers of juvenile hatchery salmon distributed to sites within the Magaguadavic River, 1976 - 2005. Fry are between zero to 14 weeks old, 0+ parr are at least 14 weeks old but less than one year old and 1+ parr are at least one year old but less than two years old.

	0+ Fry		0+ Parr		1+ Parr		1+ Smolt			2+ Smolt		
Year	**No Mark**	**Ad Clip**	**No Mark**	**Ad clip**	**No Mark**	**Ad Clip**	**No Mark**	**Ad clip**	**Tagged**	**No Mark**	**Ad Clip**	**Tagged**
1976												
1977												
1978												
1979												
1980												
1981												
1982												
1983												
1984												
1985												
1986												
1987			14,644									
1988							2,034					
1989										5,771	5,000	
1990												
1991												
1992												
1993												
1994												
1995												
1996												
1997				2,767								
1998												
1999												
2000												
2001												
2002 a	29,033											
2003	20,556		5,000	7,336								
2004	24,873			8,434				1,828				
2005	6,656			2,007			644	896				
Total	**81,118**	**-**	**19,644**	**20,544**	**-**	**-**	**2,678**	**2,724**	**-**	**5,771**	**5,000**	**-**

a – Ninety-nine captive reared adults were released in 2002.

Appendix *vi*. Numbers of juvenile hatchery salmon distributed to sites within the St. Croix River, 1976 – 2005. Fry are between zero to 14 weeks old, 0+ parr are at least 14 weeks old but less than one year old and 1+ parr are at least one year old but less than two years old.

	0+ Fry		0+ Parr		1+ Parr		1+ Smolt			2+ Smolt		
Year origin	**No Mark**	**Ad Clip**	**No Mark**	**Ad clip**	**No Mark**	**Ad Clip**	**No Mark**	**Ad clip**	**Tagged**	**No Mark**	**Ad Clip**	**Tagged**
1976												
1977												
1978												
1979												
1980												
1981				9,800								
1982												
1983												
1984												
1985												
1986												
1987												
1988												
1989												
1990												
1991 Penobscot	51,025			40,001				60,205				
1992 Penobscot	85,307			71,474				50,342				
1992 St. Croix												
1993 St. Croix												
1993 Penobscot				100,950				40,110				
1994 St. Croix			38,600									
1994 Penobscot	87,200							60,600				
1995 St. Croix			20,962					17,537				
1995 Penobscot	400											
1996 St. Croix	1,525			52,120				15,583				
1996 Penobscot	364											
1997 St. Croix	1,025		103,000			19,720						
1997 Penobscot	1,236			400								
1998 St. Croix	520			31,870								
1998 Penobscot	1,553											
1999 St. Croix	580			22,450								
1999 Penobscot	1,406							21,314				
2000 St. Croix	145			18,963								
2000 Penobscot	1,266							19,984				
2001 St. Croix	300			6,299								
2001 Penobscot	834							8,146				
2002 St. Croix	197			15,404								
2002 Penobscot	. [a]							4,147				
2003 St. Croix	656			16,779								
2003 Penobscot	215							3,232				
2004 St. Croix	12			2,845								
2004 Penobscot	. [a]							4,098				
2005 St. Croix / Tobique				24,815								
2005 Penobscot	. [a]											
Total	**235,766**	**-**	**162,562**	**414,170**	**-**	**19,720**	**-**	**305,298**	**-**	**-**	**-**	**-**

[a] incomplete data - numbers not available

Appendix *vii*. Numbers of juvenile hatchery salmon distributed to sites on the Big Salmon River, 1976 - 2005. Fry are between zero to 14 weeks old, 0+ parr are at least 14 weeks old but less than one year old and 1+ parr are at least one year old but less than two years old.

	0+ Fry		O+ Parr		1+ Parr			1 yr smolt			2 yr smolt			1SW	MSW
Year	**No Mark**	**Ad Clip**	**No Mark**	**Ad Clip**	**No Mark**	**Ad Clip**	**Tagged**	**No Mark**	**Ad Clip**	**Tagged**	**No Mark**	**Ad Clip**	**Tagged**		
1976															
1977															
1978															
1979															
1980															
1981															
1982															
1983															
1984															
1985															
1986															
1987															
1988															
1989				10,538											
1990					5,218	41,229			26,815						
1991				10,755					2,993	5,317					
1992									11,861	3,997					
1993											10,578				
1994						21,614			1,524						397
1995									7,348						227
1996															
1997	46,000														
1998															
1999															
2000															
2001	185,523			77,718											
2002	138,682			34,062					16,136	3,589					
2003	296,818			54,000		21,025			11,634	2,016					15
2004	369,109			90,843		7,009			11,663						13
2005	258,873			69,862		892			1,295					28	56
Total	**1,295,005**	**-**	**-**	**347,778**	**5,218**	**91,769**	**-**	**-**	**91,269**	**14,919**	**10,578**	**-**	**-**	**28**	**708**