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Status of Atlantic salmon (*Salmo salar* L.) in Campbellton River, Notre Dame Bay (SFA 4), Newfoundland in 2003

État du saumon atlantique (*Salmo salar* L.) de la rivière Campbellton, baie Notre Dame (ZPS 4), Terre-Neuve, en 2003

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Abstract

The status of Atlantic salmon in Campbellton River was determined from the number of juvenile and adult Atlantic salmon counted through two portable fish counting fences with the biological data collected at each fence site and from the recreational salmon fishery. In 2003, adult returns were 2,219 small and 152 large salmon, which is lower (19% and 45%, respectively) when compared to the 1993-02 average of 2,735 small and 278 large salmon. One aspect of stock status is the comparison of the actual egg deposition to conservation requirements. For Campbellton River, approximately 1,480 spawning adult fish are needed to produce 2.92 million eggs based on the available habitat. The percent of the conservation egg requirement achieved for Campbellton River in 2003 was 193% (5^{th} percentile=182 and 95^{th} percentile=282). On average, for the period of 1993-2002, Campbellton River achieved 241% of its conservation requirement. The mean freshwater survival from eggs to smolt from the 1993 to 1998 year classes is 0.54%, with an overall corrected mean smolt to grilse survival for the years 1993 to 2002 of 5.20% (corrected: for the presence of returning repeat spawners). Historical records indicated that circa.1800; about 12,000 adult salmon were captured at a harvesting weir (Taylor 1985). Since 1993, adult salmon returns to Campbellton River are less than 30% of historical migrations.

Résumé

Nous établissons l'état du saumon atlantique de la rivière Campbellton d'après le nombre de juvéniles et d'adultes dénombrés à deux barrières de dénombrement portatives et des données biologiques recueillies à chaque endroit ainsi que lors de la pêche sportive. En 2003, les remontes d'adultes se chiffraient à 2 219 petits et 152 gros saumons, soit des effectifs plus faibles (19 % et 45 %, respectivement) par rapport à la moyenne pour 1993-2002 de 2 735 petits et 278 gros saumons. L'état du stock est défini en termes de la ponte réelle par rapport aux besoins au titre de la conservation. Pour cette rivière, environ 1 480 reproducteurs sont requis pour produire 2,92 millions d'oeufs, d'après l'habitat disponible. En 2003, la rivière Campbelton a satisfait à 193 % de ses besoins au titre de la conservation (5^{e} centile = 182 et 95^{e} centile = 282). Pour la période 1993-2002, ce cours d'eau a satisfait en moyenne à 241 % de ses besoins à ce titre. Du stade ouf à saumoneau, le taux de survie moyen en eau douce des classes d'âge 1993 à 1998 se chiffre à 0,54 %, le taux de survie moyen corrigé global du stade saumoneau à madeleineau pour les années 1993 à 2002 se situant à 5,20 % (corrigé de sorte à tenir compte de la présence de reproducteurs à pontes antérieurs). Les données historiques révèlent que vers 1800; quelque 12 000 saumons adultes avaient été capturés dans une bordigue mouillée dans la rivière (Taylor, 1985). Depuis 1993, la rivière Campbelton n'est plus témoin que de moins de 30 % des anciennes remontes de saumons adultes.

Introduction

The Campbellton River (Indian Arm River) flows in a northeasterly direction emptying into the sea at Indian Arm, Notre Dame Bay. In total, Campbellton River has a drainage area of approximately 296 km^2 with an axial length of 40.22 km with a mean width of 7.4 km (Porter et al. 1974) and is about average size for salmon rivers along the northeast coast of insular Newfoundland. The drainage area is also a protected water supply area which provides domestic water for the town of Campbellton. The river is located in Salmon Fishing Area (SFA) 4, a very productive area for salmon (Figure 1). In this paper, we examine the status of Atlantic salmon in Campbellton River. Counts obtained from smolt and adult counting fences are used in conjunction with recreational fishery data and biological characteristic data to calculate total river returns and spawning escapements. Status of the Atlantic salmon stock is evaluated against a conservation requirement which is calculated in terms of available fluvial and lacustrine habitats.

Management Measures

In 1992, major changes were introduced to the management of Atlantic salmon. A five-year moratorium was placed on the commercial fishery in insular Newfoundland, while in Labrador fishing continued under quota until 1998 when the salmon fishery was also closed. These commercial salmon fishing closures were still in effect for 2003. All of these management measures were aimed at increasing river escapements, thus contributing to the increased numbers of upstream migrating adult salmon. Also, a moratorium on the Northern Cod Fishery in NAFO Divisions 2J and 3KL was implemented in early July of 1992 and followed by NAFO Divisions 3Ps, 3Pn and 4R in 1993. These closures should have resulted in the elimination of salmon by-catch in cod fishing gear in Salmon Fishing Areas (SFAs) 1 - 9 in 1992 followed by SFAs 10 - 14A in 1993. The commercial cod fishery moratorium continued in 1998 with the exception of a limited commercial fishery in 3Ps and, in some years, a recreational hand-line fishery in all areas. In 1999, the cod fishery re-opened in NAFO Divisions 2J and 3KL including test fisheries and Sentinel Surveys. Therefore, it is assumed by these closures that by-catches in cod fisheries around the island would have had little impact on salmon populations since 1991. However, studies indicate that adult salmon are caught overall in low numbers in herring nets used to catch bait for lobster pots (Reddin et al. 2002).

In the recreational fishery, in 1992 and 1993, a quota on the number of fish that could be retained was introduced in each SFA. The quota was assigned for an entire SFA and was not administered on an individual river-by-river basis. Only hook-and-release fishing was permitted after the quota was caught. In 1994, recreational fishery quotas were eliminated. In place of quotas, for insular Newfoundland, the seasonal bag limit for retained small salmon was lowered from eight to six fish, three to be caught prior to July 31 and three after that date up to the end of the fishing season. Hook-and-release was permitted throughout the fishing season. These measures remained in effect in 1997-2003 and applied to salmon angling on Campbellton River. However, due to low salmon returns in 1997, all rivers were closed to retention on July 28 and then on August 1st hook-and-release fisheries were closed. Also, during years of extreme low water levels and high temperatures, selected rivers were closed for short periods until suitable water conditions returned. In 1998, the retention of one fish was permitted during the initial part of the fishing season until an in-season review in July was completed allowing another three fish to be retained, thus giving a four fish retention limit. In 1999, a River Classification System was introduced for scheduled rivers on the island portion of the province. Campbellton River was designated as a Class II river which set the season retention limit at four salmon. The daily limits allow two fish to be retained and four to be hook-and-released. Barbless hooks was mandatory for all scheduled salmon rivers. As in previous years, retention of large salmon was not permitted in insular Newfoundland. The River Classification System was continued in 2003.

Methods

ANGLING FISHERY

Catch and effort data for Campbellton River as well as other rivers in Newfoundland and Labrador were collected by Department of Fisheries and Oceans (DFO) Fisheries Officers until 1996. Beginning in 1997, a License Stub Return System developed by DFO Science Branch was used to collect data directly from anglers in all SFAs of Newfoundland and Labrador with the exception of SFAs 1 and portions of SFA 2 in Labrador (O'Connell et al. 1998). Data for both methods were processed by DFO Science Branch staff. Procedures for the collection and compilation of angling data are described by Ash and O'Connell (1987) and O'Connell et al. (1998).

UNRECORDED MORTALITIES

Complete understanding of all life history factors including sources of mortality is an important part of any stock assessment (Ricker 1975). Mortalities due to fishing that are not recorded in catch statistics have been defined as non-catch fishing mortalities (Ricker 1976). Non-catch fishing mortalities should include those fish killed due to both illegal and legal fishing activities. Legal fishing mortalities of salmon in Newfoundland and Labrador include catches in food (First Peoples), angling, sentinel and commercial fisheries. Illegal mortalities include poaching in both the freshwater and marine environments. Illegal mortalities by their very nature are extremely difficult to quantify and generally go unrecorded. An indirect method of potentially quantifying removals by illegal means and by predators is by observation of net marks, scars and abrasions on salmon at enumeration facilities. During 1993-2003, fish with visible scarring marks or attached jigging hooks have been observed and recorded at Campbellton River by closed-circuit video and visual observations. These observations provide a minimum estimate of the incidence of marked fish because of low light conditions or minor scarring that render some marks invisible.

In addition, quantification of mortalities arising from the practice of hook-and-release fishing for salmon are also important for accurately assessing spawning escapement. A hook-and-release mortality study done in 2000 on the Conne River, Newfoundland resulted in a mortality rate of 8.2 % (four fish) out of a total of 49 fish (Dempson et al. 2002). Also, studies elsewhere have shown that mortality rates of hooked-and-released 'bright' salmon are also relatively low. Angling mortality is dependant in part on the skill of the angler, method of fishing and length of time the fish are handled, length of residence of the salmon in freshwater prior to angling, and most important the temperature of the water. Recent studies in New Brunswick indicate that rates of 10% and higher are possible but are strongly influenced by water temperature as well as the other factors mentioned above (Brobbel et al. 1996; Dempson et al. 1998; Anon. 1998b).

A very important source of unrecorded mortalities is from poaching above the counting fence as they result in an over-estimate of spawning escapement. However, due to the covert nature of poaching, the enumeration of the number of salmon caught illegally on Campbellton River is not possible. But because these additional removals potentially result in a lower than indicated number of spawners it is important to try alternate methods of deriving spawners. Another way of determining spawning escapement is based on counts of kelts (spawned salmon) at the fence the following spring.

SMOLT AND ADULT SALMON COUNTS

Smolt and adult counting fences were installed according to the description in Anderson and McDonald (1978) near the mouth of Campbellton River (Figure 2). The smolt fence was in place and fishing on the main stem of the river by 10 May, 2003, just above the site of the Old Horwood Dam (same site since 1993), which is 345 m upstream from the highway bridge at the mouth of the river. The entire fence was comprised of 38 sections, each 3 m in length, with a standard 2.1 x 2.1 m smolt trap installed across a 68 m section of the river to form a complete barrier. The substrate was mainly bedrock with large and small boulders and minor amounts of loose gravel. This site was chosen because it has a stable substrate and adequate water levels for fish passage during the smolt migration period. During the smolt run, the trap was checked and fish released regularly every 2-3 hours from 0600 hrs to 2230 hrs. Also, at each trap check several environmental parameters were measured, i.e. water temperature, air temperature, and water level. During the peak smolt run, two 30 cm openings were made in the fence on either side of the smolt trap by removing conduit. In order for fish to be clearly observed, a light colored plywood board (50 cm x 75 cm) was positioned and secured on the river bottom under the two openings to visually count fish passing through the fence on their migration downstream. This was only done during the latter part of the smolt migration when the numbers of other fish species were low, thus avoiding errors due to miss-identification of species when visually counting fish passing through the fence. The smolt fence was removed on 14th June. As in previous years, the end of the smolt migration was enumerated via the adult fence after the smolt fence was removed and is regularly done when a portion of the downstream smolt migration overlaps with the upstream adult salmon run. This procedure involves removing conduit and visually counting smolts as they passed downstream similar to the above description for the smolt fence. Generally, smolts counted through the adult fence accounted for less than 10 % of the total smolt run. The smolt enumeration for 2003 is considered a complete count.

The adult fence was situated just below the Old Horwood Dam, approximately 212 m from the mouth, on a narrow bedrock shelf in a 25 m wide section of the river. The adult fence consisted of 16 sections (3 m long) with a 2.1 x 2.1 m adult trap, and was operated for 88 days from 2nd June to 28th August, 2003. Although a complete count was not made due the early removal of the fence, less than 2% of the total run may have been missed when compared to counts of previous years. Fish were enumerated by two methods. A tunnel with a video camera system (VHS format) was installed in the trap giving a positive overhead view of salmon moving upstream. Videotapes were reviewed the next day to count salmon and the count verified by a second viewing. If necessary, a third viewing was made to resolve any discrepancies. This system has proven to be very successful since first installed in 1993 and has allowed salmon to move upstream through the fence unimpeded, especially during the night when visual monitoring becomes more difficult. Also, during daylight hours, a 0.5 m portion of the fence next to the trap was opened into a 1 x 2 m sampling trap and monitored manually to further facilitate upstream migration, to retrieve archival tags from adult salmon run and to obtain live specimens for biological sampling. All salmon counted were sized into three categories, viz. salmon less then 40 cm, small salmon less than 63 cm but greater then 40 cm and large salmon 63 cm or greater. This was achieved by placing parallel marks 40 and 63 cm apart on the floor of the trap/counting device.

SEA SURVIVAL & PREVIOUS SPAWNERS

Sea survival was determined from the number of returning adults in the current year (i+1) divided by the number of smolts in the preceding year (i). Adult salmon counted at the fence consist of several year classes including salmon spawning for the first time categorized as precocious postsmolts if they had spent only a couple of months at sea, grilse if they had spent at least one year at sea and salmon that had previously spawned. Because only the grilse originated from the smolt run of the previous year, sea survival calculated with upstream migrating previous spawners removed from small salmon counts will provide a more accurate measure of sea survival. The number of previous spawners in the returning adults was determined by mark-recapture. Kelts, were tagged in the spring when they left the river through the smolt fence, with Floy T-bar anchor tags using different colors and positions on the dorsal fin each year. Year of tagging could then be identified on the video screen by the location and colour of the tag or manually as they passed through the fence. Counts of small and large salmon were then adjusted for the number of previous spawners based on the ratio of tagged to untagged fish in the returning adult run and the number of outgoing kelts originally tagged.

ENVIRONMENTAL DATA

During field operations, environmental data were collected at both fence sites. Water temperatures were recorded in the river by a Vemco thermograph set at 1 m from the surface at the adult fence site. A thermograph placed in the shade near the cabin recorded air temperatures. Cloud cover, relative water levels, weather conditions and air temperatures were also recorded manually. Also, thermographs were set at two marine sites in Indian Arm, i.e. near the mouth of Campbellton River in 8 m of water and the other was just south of Steering Island in 35 m. At these sites, thermographs were set on a line to record temperatures at the surface and at one m from the bottom (Figure 2). All thermographs were set to record at 1 hour intervals.

EXPLOITATION RATES

Exploitation rates for the angling fishery were derived based on the number of small salmon counted at the fence and the number of salmon reported to have been caught by the angling fishery. Estimates of mortality by hook-and-release fishing were included.

BIOLOGICAL CHARACTERISTICS

Biological characteristics were collected from salmon caught in the angling fishery on Campbellton River from 1992-2003. The information collected included fork length, weight, sex, scales and ovaries which were preserved for fecundity analysis. The biological characteristics, viz. percentage female, mean weights, and fecundity from the sampling program were used to estimate egg depositions and to convert conservation requirements in eggs to spawning requirements in number of fish. Also, the percent of the conservation requirement egg deposition achieved was assessed.

Fecundity was determined from ovaries collected from the recreational fishery. Ovaries were stored in Gilson's fluid until transferred to 10% formalin. Eggs, which for the most part were in early stages of development, were counted visually. The relative fecundity value used to calculate egg deposition for both small and large salmon was 2,100 eggs per kg and was derived from the mean of 78 samples taken in Campbellton River, 1993-95.

CONSERVATION REQUIREMENTS

The accessible parr-rearing habitat for Campbellton River is 5,960 units (a unit being 100 m^2) of fluvial habitat and 4,037.3 ha of pond habitat (Reddin and Downton 1994). The ratio of lacustrine to fluvial habitat of 67.74 is lower than the mean of 87.11 for other SFA 4 rivers (O'Connell and Dempson 1991). However, the smolt lacustrine production levels may be much higher than seven smolt per hectare since many of the ponds are very shallow, making them more suitable for parr rearing. Reddin and Downton (1994) estimated potential smolt production for Campbellton River of 46,141 smolts by multiplying the amount of fluvial and lacustrine habitat by production parameter values of three smolts per unit (100 m^2) of fluvial habitat and seven smolts per ha of lacustrine habitat (O'Connell et al. 1991).

The conservation requirements for Campbellton River of 2,916,126 eggs was derived using egg deposition rates of 240 eggs per 100 m^2 for fluvial parr rearing habitat (Elson 1957) and 368 eggs per hectare for lacustrine habitat (O'Connell et al. 1991; Reddin and Downton 1994). Although these values may be habitat and river specific for systems from which they were derived, they represent a threshold or danger zone to be avoided (O'Connell et al.

1991). Conservation requirements (CR) in eggs were converted to adult small salmon by the following formula:

$$CR = (2{,}916{,}126 / (\text{Proportion female} * \text{mean weight female} * \text{fecundity})).$$

TOTAL RIVER RETURNS, SPAWNING ESCAPEMENT, AND EGG DEPOSITION

The egg deposition for small salmon was based on the number of spawning adult female salmon and biological information collected from the angling fishery, 1992-2003. Since large salmon cannot be retained in the angling fishery, default values for percent female and mean weight from several rivers in Notre Dame Bay were used (O'Connell et al. 1996).

Total river returns

Total river returns (TRR) were calculated as follows:

(1) $$TRR = RC_b + HRM_b + C$$

where,

RC_b = retained angling catch below counting fence

HRM_b = hook & release mortalities below counting fence assessed at 0.1 of the number hooked &released salmon

C = count of fish at counting fence.

Spawning escapement

Spawning escapement (SE) was calculated as the difference between the number of fish released from the counting fence (FR), the recreational catch retained above the fence (RC_a) and hook and release mortalities above the fence (HRM_a) as follows:

(2) $$SE = FR - RC_a - HRM_a.$$

Egg deposition

Egg deposition (ED) was estimated separately for small and large salmon and then summed as follows:

(3) $$ED = (SE \times PF \times RF \times MW)-PPS$$

SE = number of spawners
PF = proportion of females
RF = relative fecundity (No. eggs/kg)
MW = mean weight of females
PPS = precocious post smolts.

O'Connell and Dempson (1997) reported evidence demonstrating that atresia (non-development of eggs) occurs to varying degrees in insular Newfoundland salmon. This phenomenon has also been reported in Atlantic salmon in the Soviet Union (Melnikova 1964) and in France (Prouzet et al. 1984). Therefore, fecundity values should be regarded as potential values. Since the fecundity values used to derive conservation requirements are based on eggs in early stages of development, the occurrence of atresia in a given year on a particular river would result in a decrease in the number of eggs spawned and the conservation requirements met would be lower than reported.

ACCURACY OF EGG DEPOSITIONS

The accuracy of the estimates of annual egg deposition is very important as it describes the status of the salmon stock in Campbellton River. Because of its importance, it is worthwhile investigating the accuracy of the estimates, which was done by two different methods. First, by a simulation exercise, which investigated the effect of variability associated with the values of several parameters used in the calculations and the potential effect of this variability on egg deposition. In the calculation of egg deposition, only the number of small and large salmon returning to Campbellton River was known with certainty, and although point estimates from sampling programs were used for other values, these other values are in fact variable. In order to account for some of this uncertainty, we assumed a variation of ±10% for the values of fecundity, percentage female and mean weight of both small and large salmon. The egg depositions were recalculated 5000 times drawing values for input parameters from a uniform distribution. The frequency and probability distributions of the resulting egg deposition estimates were plotted to determine the median and the 5^{th} and 95^{th} percentiles.

The second method of investigating accuracy of egg deposition values was by recalculating the annual egg deposition from the biological characteristics of the upstream migrating adults sampled in the angling fishery compared to that derived from downstream migrating kelts measured at the smolt fence in the following year. The same equations are used for both estimates. If the number of samples were adequate to define biological characteristics of either group then the egg depositions from the two methods should be similar. Egg depositions from kelts are based on the number of eggs per cm whereas eggs per kg are used for the upstream migrating salmon.

SALMON POST-SMOLTS

Salmon post-smolts that return to spawn after only a couple of months at sea instead of at least a full year occur in some Newfoundland rivers. Beginning in 1995, a 40 cm mark was installed in the tunnel of the video counting chamber of the adult counting fence in

Campbellton River to enable enumeration of this class of salmon. Verification of the age class of these salmon as post-smolts was done by scale analysis. Data are available for 1995-2003.

Results

ANGLING FISHERY

In 2003, the recorded landings (retained + released) for the angling fishery on Campbellton River were 176 small salmon and no large (Figure 3, Table 1). Of these, 37 small and no large salmon were hooked and released. In 2000, 51 large salmon were reported as hooked and released which is the highest value since 1992. For small hook-and-release salmon, the highest values were recorded in 1996 at 372 small salmon. The higher annual recreational catches since 1992 compared to several years prior are attributed to increases in the salmon returns as a result of the moratoria on commercial salmon and cod fishing and to increased angling effort. However, catches have not reached levels of the early 1980s which was a period of sustained high catches.

Since 1993, during the adult fence operations, the river was closed to angling from 43 m above the counting fence at the Old Horwood Dam site to saltwater. However, a section of the river referred to as the "V" located at the Old Horwood Dam that received most of the fishing effort on the lower section of the river in years previous to the installation of the counting fence remained open. Another site of extensive angling was located near the lower part of Second Pond and resulted from an upgraded forestry road and new bridge which were constructed in 1992 providing easier access for anglers to this part of the river. The main stem between Fourth Pond and Indian Arm Pond and the lower portions of Indian Arm Brook and Neyles Brook were also popular fishing sites. Also, ongoing extension of existing and construction of new logging roads in the watershed has increased accessibility to the river which should result in an increase in angling effort.

Water temperatures and levels in 2003 were generally moderate for the first part of the angling season until mid-July (see *Environmental Data*). However as with many past years, during mid-July to mid-August very low water levels and high water temperatures occurred that restricted salmon still at sea from moving into the system. These events are a result of high air temperatures and low rainfall. In 1999, many salmon were noted swimming and jumping in the estuary just outside the bridge in salt water and it wasn’t until after heavy rainfall on August 15 that these fish entered the river. During a 5-day period after this rainfall, 14% of the total run for the season entered the river. Similar migration patterns due to low water levels and high temperatures have occurred at Campbellton River since 1993.

SMOLT AND ADULT SALMON COUNTS

In 2003, the smolt count of 35,089 at the downstream fence is considered to be complete (Table 2). In addition to smolt, there were 791 kelts and 108 precocious postsmolts that passed through the smolt fence in 2003. Other species such as brook trout, smelt, and eels were also counted. The peak of the smolt run occurred in standard week 23 (June 4 - June 10) which accounted for 42% of the total migration (Table 3). The daily cumulative counts indicate that the smolt run in 2003 was distributed similar to other years (Figure 4). Of the eleven years for which smolt counts are available, the 2003 smolt run was the third lowest in number and was considerably below the 1993-2002 mean of 43,647 (Figure 5). The smolt run doubled from 31,577 in 1993 to 62,050 in 1997 which was the highest run since the smolt migration has been monitored. A steady decrease in the total number of smolts counted occurred from 1998 to 2002 then increased slightly in 2003 (Figure 5). There was no significant trend over time for smolt counts (r=-0.22, p=0.46). The 2003 smolt count was lower then the potential smolt production value of 46,141 derived for Campbellton River.

In 2003, a total of 2,219 small and 152 large salmon were counted as they passed upstream through the adult fence (Table 4). The first adult salmon was counted on 14th June and the last fish was counted on 27th of August. Large salmon returning in 2003 represented 6.4% of the total run. Generally, the peak run for large salmon occurs after the peak for small salmon for Campbellton River as reflected in the 1993-2003 upstream migrations (Figure 6). Most large salmon return as repeat spawners. The number of small salmon returning to Campbellton River in 2003 was 4th lowest on record and for large salmon the 5th lowest (Figure 6). There was a significant decline in small salmon over time (r=-0.72, p=0.01) but not for large salmon (r=-0.21, p=0.54).

The run timing of both smolt and adult salmon at Campbellton River were about average in 2003 compared to the other eleven years (Figure 7). Both smolt and adult run timing were highly variable. For smolts, the 25th and 75th percentiles varied by 23 and 21 days over the eleven years of data while the median date varied by 22 days. The 10th and 90th percentiles were 18 and 28 days in the difference. Overall, 1999 was the earliest and 1997 was the latest in the time series. For small salmon, the 25th and 75th percentiles varied by 11 and 44 days over the eleven years of data while the median date varied by 19 days. The 10th and 90th percentiles were 10 and 50 days in the difference. Overall, 1998 was the earliest and 1997 was the latest in the time series. For large salmon, the 25th and 75th percentiles varied by 28 and 40 days over the eleven years of data while the median date varied by 39 days. The 10th and 90th percentiles were 12 and 50 days in the difference. Overall, 1998 was the earliest and 1997 was the latest in the time series.

Visual checks were done each year before the removal of the adult fence. In 2000, 48 salmon were counted just below the fence and is the first time that any significant numbers of fish were observed. Of these 48 salmon counted via snorkeling, 46 appeared to be less than 40 cm. Three of these small fish were taken and sampled. Scale ageing verified they were precocious postsmolt salmon. Also, in 2002, 78 salmon were counted below the fence of which 50 were categorized as precocious postsmolts. Although no salmon were counted below the fence before the removal in 2003, salmon were reported at sea near the mouth of the river.

SEA SURVIVAL AND PREVIOUS SPAWNERS

Smolt-to-adult survival (uncorrected for repeat spawners) for the 2002 smolt class (returns in 2003) from Campbellton River was 6.80%, an increase of 28% from the 2002 value of 5.31% (Table 5, Figure 8). This is the fourth highest in the time series for the 1993 to 2002 smolt year classes (return years 1994-2003). The mean uncorrected survival rate for the 10 years 1993-2002 was 5.3%. These values are overestimates of survival from smolt to 1SW (grilse) salmon because some of the small salmon migrating upstream are in fact previous spawners that survived from grilse migrating upstream in previous years. Kelts tagged passing through the downstream smolt fence allowed for correction of the number of previous spawners in the upstream run and calculation of sea survival rates for 1SW salmon exclusive of previous spawners. The results of the tagging study indicated that 11.5% of the small salmon returning to Campbellton River in 2003 were previous spawners (Table 6). For the 2002 smolt class returning as grilse in 2003, the corrected survival rate after removal of previous spawners was 6.02%. Average corrected sea survival for salmon returning to Campbellton River was 6.1% for smolt classes 1993-2002 which returned in 1994-2003. For 2003, the over-wintering survival measured as the adult count upstream in year *i* and the downstream migrating kelt in year *i+1* was 45% which was the lowest in the time series, 1994-2003. The average over-wintering freshwater survival for kelts in Campbellton River was 63% from 1994 to 2003. Due to the late installation of the counting fence in 1998, many kelts had already migrated out of the river and a complete count could not be obtained. Therefore in 1998, freshwater survival rates were derived from average of rates of previous years. The number in the population at sea is somewhat higher due to tagged kelts that were either taken at sea or migrated to other river systems. Returns from 3,372 tagged kelts from 1994 to 2000 indicated that 1.69% kelts strayed to other rivers mainly in Notre Dame Bay and 2.03% were caught at sea. One salmon, tagged at Campbellton River on 9 May, 1999 at 47 cm in length was gill netted at Kangamiut, West Greenland at 60 cm in length on 15 September, 1999. However in 2003, previous spawners only made up 11.5% of the upstream run of small adult salmon (Table 6). Analyses of the data from previous years indicated that kelts returned to Campbellton River after an average of 65 days at sea and put on between 4-6 cm in length. The mean return rates for previous spawners from 1994 to 2003 was 32% (Table 5).

ENVIRONMENTAL DATA

Water temperatures during the fence operation on Campbellton River for 2003 ranged from a low of 5.6°C on 13 May to a high of about 26.5°C on 19 July (Figure 9). After mid-June there were many days when temperature exceeded 18°C, the temperature at which hook-and-release mortalities begin to increase (Dempson et al. 2002). Similar to other years, low water and high water temperatures continued for most of the summer and well into the fall. Unfavorable freshwater conditions (low water levels and high water temperatures) which are becoming more and more common during summer months in Newfoundland can act as a barrier to salmon migration. During these periods, some salmon will remain in the estuary only ascending the river after sufficient rainfall has ameliorated freshwater conditions. These occurrences were predominant at Campbellton River in 1997 and 1999.

In 1999, 18.5% salmon ascended the river in a two day period during a heavy rainfall after a period of low water.

Estuary temperatures in 2003 taken from a thermograph located near the mouth of the river at a depth of 8 meters ranged from –0.3 to 19.9°C between 7 May to 22 September (Figure 9). Surface temperatures at Steering Island were higher then in the estuary at Campbellton River and increased over the season declining in the fall. Surface water temperatures reached a high of almost 20°C in mid-July. Water temperatures measured at the bottom at Steering Island were comparatively much colder than at the surface and estuary, barely rising above 0°C.

EXPLOITATION RATES

In 2003, a total of 2,219 small salmon passed through the counting fence and there was a recreational catch of 139 small salmon retained by the angling fishery above the fence. The river was closed to angling below the fence to salt water. The exploitation rate above the fence in 2003 was 6.3 % for small retained salmon (see text table below). Exploitation on small salmon (retained only) peaked in 1994 at 20.5% then declining to 6.3% in 2003. In 2001, low water conditions resulted in the river being closed for a period of time which reduced exploitation. In 1994, the exploitation rate for small released salmon was highest at 30.7% declining to 7.9% in 2003. Exploitation on large released salmon was highest in 2000 at 24.5% and then declined to 0% in 2002 based on angling data. Annual exploitation rates are shown in the following text table:

Year	Small retained	Small retained + released	Large released	Total
1993	7.9%	10.5%	-	10.1%
1994	20.5%	30.7%	22.0%	30.1%
1995	17.0%	24.3%	7.8%	23.2%
1996	18.5%	30.0%	4.6%	26.3%
1997	16.9%	22.0%	3.4%	19.4%
1998	10.3%	16.7%	1.0%	15.0%
1999	14.1%	21.9%	9.3%	20.2%
2000	12.6%	22.4%	24.5%	22.6%
2001	6.9%	8.2%	7.6%	8.2%
2002	6.9%	9.8%	4.9%	9.5%
2003	6.3%	7.9%	0.0%	7.4%

BIOLOGICAL CHARACTERISTICS

Smolts: The river ages of smolts sampled at the counting fence in 1993-2003 ranged from 2 to 6 years with the 3 and 4 river years representing the predominant classes and accounting for 95.9% of the samples (Table 7). From 1993 to 1997, river age 3 smolts represented the highest percentage of all river ages and then there was a change to river age 4 smolts in 1998-2000 and then back again to river age 3s in 2001. The percentage of river age 3 smolts increased from 1993 to 1995 and then declined during the 1996-2003 period. In 1998 to 2000, river age 4 smolts became the dominant class increasing to slightly over 50% of the run (Figure 10).

Approximately 0.5% of the smolt migration was sampled each year during 1993-2003, which represents an overall total of 2,556 fish. The mean whole weight of female smolts in 2003 of 53.1 g was slightly higher than the 49.3 g for males; whereas, the females were 3.3 mm longer in length (Table 8). The overall 1993-2003 mean fork length and whole weight for both sexes was 173.7 mm and 49.5 g with a mean river age of 3.46 years. Smolts sampled in 1993 produced the highest mean fork length and whole weight of 186.3 mm and 60.5 g, respectively. The Fulton condition factors calculated from the mean fork length and whole weight of smolt sampled from the smolt fence from 1993 to 2003 are presented in (Figure 11). Female smolt condition factors were higher for all years except in 1999. Also the condition factor for smolts appeared to drop as the density of juvenile salmon increased in the river except for 1999. The regression of fork length and whole weight of female and male smolts sampled at the counting fence from 1993-2003 resulted in an R^2 of 0.94.

Adult salmon: From 1992 to 2003, 427 adult salmon were sampled from the recreational fishery or at the counting fence. The overall mean fork length of grilse was 53.2 cm with a mean whole weight of 1.59 kg and river age of 3.34 years (Table 9). Thirty-nine (11%) of the small salmon that were sampled during 1992-2003 had previously spawned. Also, eight fish were sampled returning to freshwater in the same summer that they went to sea as smolts. River age of salmon sampled in the angling fishery and at the counting fence show a very high percentage of river age 3 salmon (64.6% to 56.5%) and a much lower percentage of river age 4 (30.2% to 39.8%) than the smolt sampling. The reasons for these differences are unclear but may be related to differential survival and some years with low sample sizes from the angling fishery. In total, 31 large salmon (=>63 cm) were sampled at the fence for length and age. The mean fork length was 69.2 cm and total number of spawning marks (TSM) ranged from one to five with those fish with two TSMs accounting for 56% of the fish and three large salmon had a complete year at sea after the first spawning mark. The relationship between fork length and whole weight for adult salmon caught either in recreational fishery or sampled at the fence resulted an R^2 of 0.86.

The biological characteristics of salmon sampled in the recreational fishery and at the counting fence were used to annually determine the number of eggs deposited in the system by female spawners and the percent of the conservation requirements met. Low numbers of salmon were sampled from the recreational fishery in several years; therefore sex ratios couldn't be determined. During years of low sample sizes, the average percent female and whole weight, from 1993-2003 were used to calculate the percent of the conservation requirements met for those years. The overall percent female from 1992-2003 was 75.69% from 362 fish that were sexed. There were no samples for large salmon available from Campbellton River due to the mandatory release of large salmon in the recreational fishery introduced in 1984, except for samples taken at the adult trap.

CONSERVATION REQUIREMENTS AND POTENTIAL SMOLT PRODUCTION

The conservation requirements for Campbellton River in terms of eggs as well as adult salmon were estimated as follows:

	Lacustrine	Fluvial	Total
Accessible habitat	4037.3 ha	5,960 units	-
Eggs (No. x 10^6)	1.486	1.430	2,916,126

Conservation requirements converted to numbers of small salmon (Reddin and Downton 1994):

$$= \frac{2{,}916{,}126 \text{ eggs}}{(\% \text{ female} * \text{mean wt female} * \text{fecundity})}$$

$$= \frac{2{,}916{,}126}{(0.739 * 1.55 * 2100)}$$

= ~ 1480 small salmon

The estimated potential smolt production was as follows:

Fluvial smolt = 3 smolts/unit * 5960 units = 17,880
Lacustrine smolt = 7 smolts/ha * 4,037.3 ha = 28,261

Total potential smolt production = 46,141

TOTAL RIVER RETURNS, SPAWNING ESCAPEMENT, AND EGG DEPOSITION

Total river returns and spawning escapement

In 2003, there were 2,219 small and 152 large salmon returning to Campbellton River with a potential spawning escapement of 1,929 small and 152 large salmon when corrected for angling removals.

Egg deposition

In 2003, egg deposition on Campbellton River was 5.641 * 10^6, the fifth lowest since 1993, and 28.5% higher than the lowest recorded in 2002. Thus, 193% of conservation requirements in eggs were achieved in 2003, decrease of 18% from the potential egg deposition obtained over the previous 10 years mean (1993-2002). Table 10 summarises updated information on egg deposition at Campbellton River for all years in which fish counting fences have been operated.

Freshwater survival from egg to smolt is available for year classes from 1993 to 1998. Freshwater survival was estimated by apportioning the annual egg depositions into their appropriate year classes based on the ages from the smolt samples. For example, the 1993 year class consisted of two year old smolts in 1996, three year olds in 1997, four year olds in 1998, five year olds in 1999, and six year olds in 2000. The egg depositions from year classes 1993 to 1998 are present in the table below. The smolt count for river age 5s and 6s in 2003 used the mean composition of smolts from 1993-2002 until they can be updated when the ages of the full smolt class are known. The estimated survival rate from egg to smolt in 1998 was 0.39 % and the mean from 1993 to 1998 was 0.54. Egg deposition and smolt output for Campbellton River indicates that with only six data points there is a poor relationship between egg deposition and smolts produced. In fact the highest egg deposition gave the highest and the lowest smolt output. However, the apparent trend in egg-to-smolt survival to eggs deposited influences smolt output as well (Figure 12). It may be that with a longer time series there will be a statistical relationship between egg deposition and smolts produced.

Year	Egg deposition	Smolt production	Egg to smolt survival
1993	9,077,421	62,778	0.69%
1994	6,034,653	49,120	0.78%
1995	7,712,616	40,899	0.53%
1996	9,204,899	26,504	0.29%
1997	5,257,962	37,994	0.72%
1998	9,173,933	35,490	0.39%
Mean	7,817,610	33,412	0.43%

ACCURACY OF EGG DEPOSITIONS

The results of recalculations of egg depositions using a variability of ±10% around mean parameter values indicated that a wide range of egg depositions were possible for Campbellton River. However, the river would have attained its conservation egg requirements at all of these possible egg deposition levels in 2003 (Figure 13). At the 50th median, 5.8 million eggs were deposited which met 198% of conservation requirement of 2,916,126 eggs. The corresponding 5th and 95th percentiles of the percentage of conservation requirement met varied from 170% to 230%.

The precision of annual egg deposition values was examined by deriving egg depositions from the biological characteristics of the upstream migrating adults sampled in the angling fishery (Table 10) compared to that derived from downstream migrating kelts measured at the smolt fence in the following year (Table 11). Comparison of values derived on fresh run versus kelts, is presented in the table below. The two methods were highly correlated (r = 0.98) although the egg depositions derived from kelts were lower on average by 20.5%. Because, the percentage of conservation requirements achieved is always slightly higher when based on fresh run salmon there may be a tendency to overestimate rather than underestimate the percent of conservation requirements achieved. However, the similarity of the two values suggests that the tendency to overestimate is low.

	Conservation Requirements based on	
Year	**Kelt (eggs per cm)**	**Fresh salmon (egg per kg)**
1993	304%	311%
1994	197%	216%
1995	238%	264%
1996	275%	316%
1997	169%	180%
1998	283%	315%
1999	262%	312%
2000	131%	152%
2001	146%	148%
2002	141%	138%
2003		193%
Mean	212%	235%

SALMON POSTSMOLTS RETURNING TO FRESHWATER

In 1995, anglers observed in a number of rivers, e.g. Southwest Brook in Bay St. George, a high number of very small salmon migrating upstream. In 1993 and 1994, a few very small (<40 cm) salmon were observed ascending Campbellton River at the counting fence. In the spring of 1994, several of these small salmon were sampled as kelts descending through the smolt counting fence. In total, out of 907 kelts sampled, there were four or 0.4% that had not completed a full year in the sea. Another twelve or 1.4% of the kelts had no complete sea year but showed two or more spawning marks. Overall, the proportion of the run that could be labelled as precocious postsmolts was relatively small.

In 1995, precocious postsmolts were observed ascending through the Campbellton River counting fence. The total upstream run was thirteen, out of 3,253 small and large salmon; thus, the upstream run consisted of 0.4% precocious postsmolts (Table 10). In 1998, the number of small salmon less than 40 cm was 51 fish and represented 1.6% of the small salmon at the counting fence. Four of these small fish were sampled at the adult fence and age interpretation of their scales indicated that all had an incomplete sea year before returning to the river to spawn (precocious postsmolts). In 2000, of the 2,006 upstream running salmon, 208 or 10.4% were precocious postsmolts with 46 or 2.2% counted on the last day before the fence was removed. From 1995 to 2003, there is an increasing trend for PPS counted at the counting fence (Figure 14). Generally, these fish are observed in the latter part of the upstream migration of adult salmon. Four precocious postsmolts were taken and sampled in September of 2000. The mean fork length and whole weight were 354 mm and 578 g, respectively. There were two females and two males and all were immature from examination of their gonads. However, a sample taken of a female precocious postsmolt from the smolt trap in May had retained eggs in the body cavity indicating that it had spawned sometime between the fall of 1999 and spring of 2000. The river age of three fish were four years and one was five, this is consistent with ageing of precocious postsmolts from previous years in that these fish tend to have a higher river age than the 1 sea-winter salmon. In 1997, the scale age reading of a precocious postsmolt kelt indicated that it had spawned at least seven consecutive times. Of 5,240 kelts sampled or tagged from 1993 to 2003, 41 were precocious postsmolts and produced a mean age of 4.2 years, of which thirteen were 5 years or greater. The number of these precocious postsmolts may be under estimated since only kelt of suitable size and condition were selected for tagging.

The PPS sampled in the spring had retained eggs in the body cavity indicating it had spawned. Upstream migrating PPS were smaller in length and weight (mean 354 mm and 630 g, n=4) when compared to grilse entering Campbellton River. Therefore, the potential egg deposition from these fish will be lower then the larger grilse and large salmon. The 208 PPS smolts if included in the 2000 upstream count would add 10.3% or 525,888 eggs to the total egg deposition. With a three year (1993-1995) mean egg to smolt survival of 0.637%, this could result in a total smolt reduction of 2,132 for the 2004 and 2005 migration combined, based on the modal 3+ and 4+ smolt ages. Using the overall mean smolt to adult corrected survival rate of 4.95 % from 1993 to 1999, the grilse run into Campbellton River could be reduced by 106 fish over the combined years of 2004-2005. So until we understand more about these fish and how they contribute to egg deposition, their eggs will not be included in egg deposition values for Campbellton River.

UNRECORDED MORTALITIES

At the Campbellton River fence, visible scars or marks on salmon were recorded on a daily basis. Overall in 2003, there were 177 out of 2,371 adult salmon migrating upstream with visible body scarring (Table 12). Thus, 7.47% of the population had visible scarring which is higher then the mean of 5.57% from 1994 to 2002. These marks were observed mainly on the head of the fish, which generally is consistent with that expected from small mesh nets, i.e. used to catch herring. Because the Campbellton counting fence is only 0.25 km from the sea, these marks had to have occurred sometime before the salmon entered freshwater. The mean percent scarring during the eleven years was 5.61% with the highest value occurring in 2000, at 11.37%. Also, during the eight-year period of sampling angled salmon, several fish had very distinct scarring that might be attributed to predation by seals. It is concluded that there is some mortality at sea due to predation and illegal fishing, although the overall magnitude is unknown and would be very difficult to quantify. A cautionary note on these results is that scars cannot be accurately attributed to predation separately from nets or net types. Therefore, while an increase in scarring rate means that there was a change in predation or encounters with nets at sea it does not necessarily mean increased mortality from predation or legal/illegal netting activities. However, the observations are consistent with an increase in one or all of these activities although we cannot separate the cause.

Discussion

At the conservation requirement of 1,480 spawners, it is expected that about 48,000 smolts would be produced by Campbellton River. At an average sea survival rate of 6% and if 25% of the total run were previous spawners then the 48,000 smolts would produce about 3,600 adult salmon annually. If Campbellton River still has similar freshwater habitat to that present in 1816 then perhaps the difference between the 3,600 adult salmon produced at conservation requirements and the 12,000 it produced in a more pristine state is it's maximum production. Since the percent of the conservation requirement achieved on average for Campbellton, 1993-2002 is about 236%, it would be interesting and potentially very informative to monitor adult returns in future years so that a stock-recruit relationship could be developed specifically for Campbellton River.

Atlantic salmon exhibit various life history patterns including several alternate habitat strategies. The entire life cycle can take place in freshwater; they can start life in the river, then migrate between river and estuary; they can migrate between river and estuary and then go to sea; or they can have the more typical anadromous life cycle of going to sea for one or more years before returning to freshwater (Power et al. 1987). In Newfoundland and Labrador, the most common life history strategy is for salmon to migrate to sea at two to seven years of age then return to freshwater after spending at least one or more years in the sea. Salmon that have spawned one or more times after one or more years in the sea are also quite common. As evidenced by scale reading of a few salmon sampled that were caught by anglers or at enumeration facilities, a small number of salmon exist in Campbellton River that spend only a couple of months at sea before returning to freshwater. Because they do not spend a full year at sea, these salmon are typically smaller than a grilse being less than 40 cm fork length. Also, as they are uncommon in occurrence, the salmon nomenclature does not have a separate name for this life stage and they would be labelled as postsmolts (Allan and Ritter 1977). However, in the context of this report, because they are returning or have returned to freshwater and may spawn, they are referred to as precocious postsmolts (PPS) since they are apparently maturing earlier than is normally the case.

Since the habitat in Campbellton River has not been completely surveyed, the conservation requirement may be not be accurate. The total number of adult salmon spawning in 2003 resulted in an egg deposition that was 193% of the conservation requirements. It was noted during the helicopter survey that many of the spawning areas on the main stem were located between relatively small shallow ponds. These shallow ponds may provide for an optimal utilization of rearing habitat and a higher rearing capacity may result. Therefore, caution must be used when referring to conservation requirements until a full habitat survey is completed.

For Campbellton River, the highest smolt production of 62,050 in 1997 is 134% above the calculated potential smolt production of 46,141. The modal smolt age for Campbellton River salmon in 2003 is three years (56.5%) and thus, the smolt run for that year is derived mainly from adults that spawned in the fall of 1999. During 1998- 2000, the modal smolt age was four years. For most Newfoundland rivers, spawning escapements were the lowest on record in the period 1989-91 (Dempson and O'Connell 1993). Escapements on northeast coast Newfoundland rivers increased in 1992 with the beginning of the commercial salmon fishing moratorium. Consequently, smolt production stemming from spawning escapements in the moratorium years may be much closer to this potential figure. Salmon returns to Campbellton River increased in 2003, although not as high as those in some earlier years. The increase in spite of lower smolt production was due to the smolt to 1SW salmon survival rate that increased in 2003 to 6% which is much higher than the rate of 3.66% in 2000.

Assumptions associated with the parameter values used to calculate the conservation spawning requirement have been discussed previously by O'Connell et al. (1991), O'Connell and Dempson (1991), O'Connell and Ash (1994) and will not be dealt with in detail here. The comments in O'Connell and Ash (1994) on further substantiation of parameter values for calculations related to egg deposition apply as well to Campbellton River. Also, it should be kept in mind that inaccuracies in catch statistics, losses due to poaching, losses due to hook-and-release mortality, and losses from natural mortality will potentially reduce spawning escapement.

In conclusion, due to the maintenance of strong adult returns in 1993 to 2003, the percent of conservation requirements being met on Campbellton River remains high in spite of lower than average sea survival in the last several years. Benefits of increased spawners released from commercial fisheries due to commercial fisheries moratoria, have not been fully reached, although increased smolt production has maintained strong adult returns.

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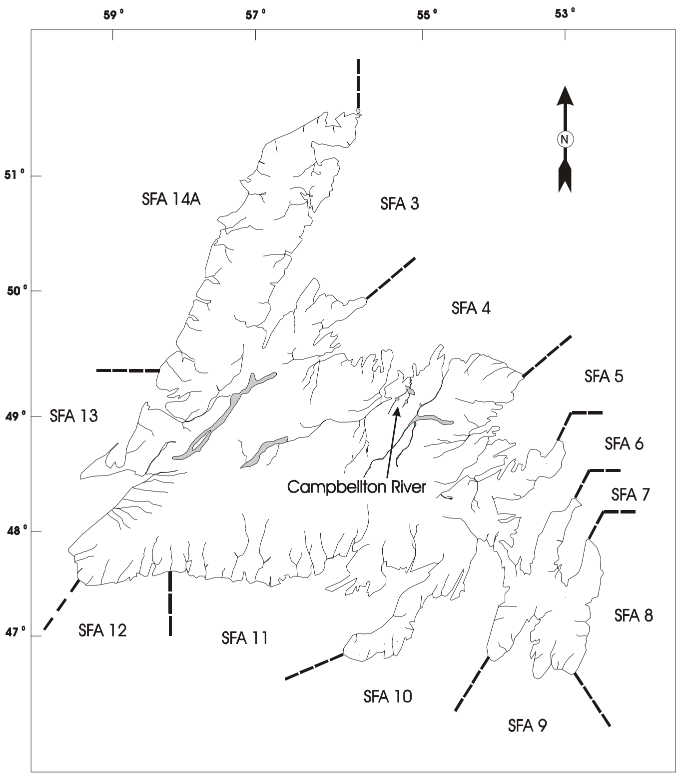

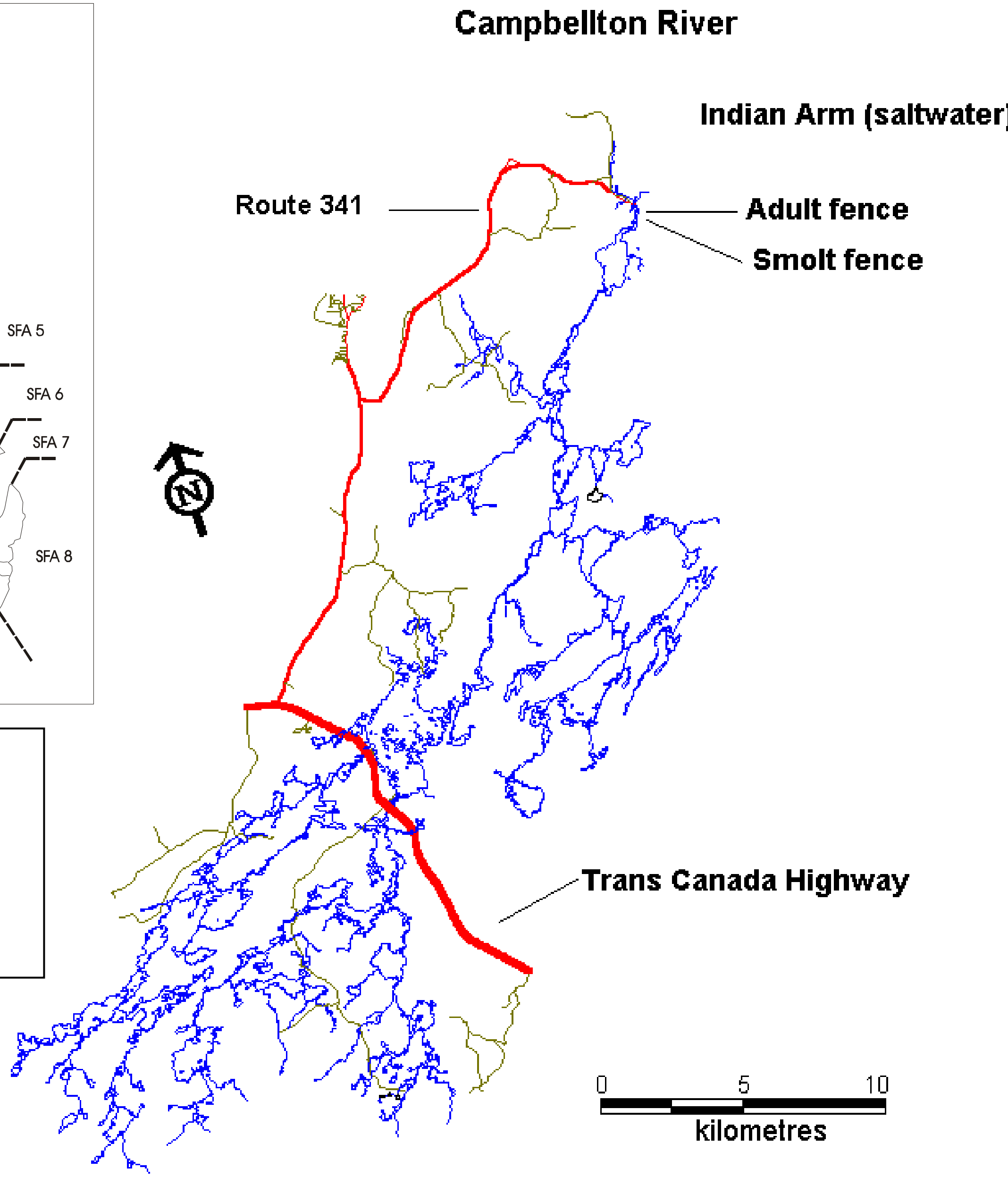

Drainage area	= 296 km^2
Axial length	= 40.22 km
Total area of standing water	= 40.37 km^2
Accessible rearing habitat	= 5960 units
Total length of streams	= 94 km
Slope of main channel	= 0.53 %
Mean width of drainage area	= 7.4 km

Figure 1. Location of Campbellton River in SFA 4 and, Adult and Smolt portable counting fences.

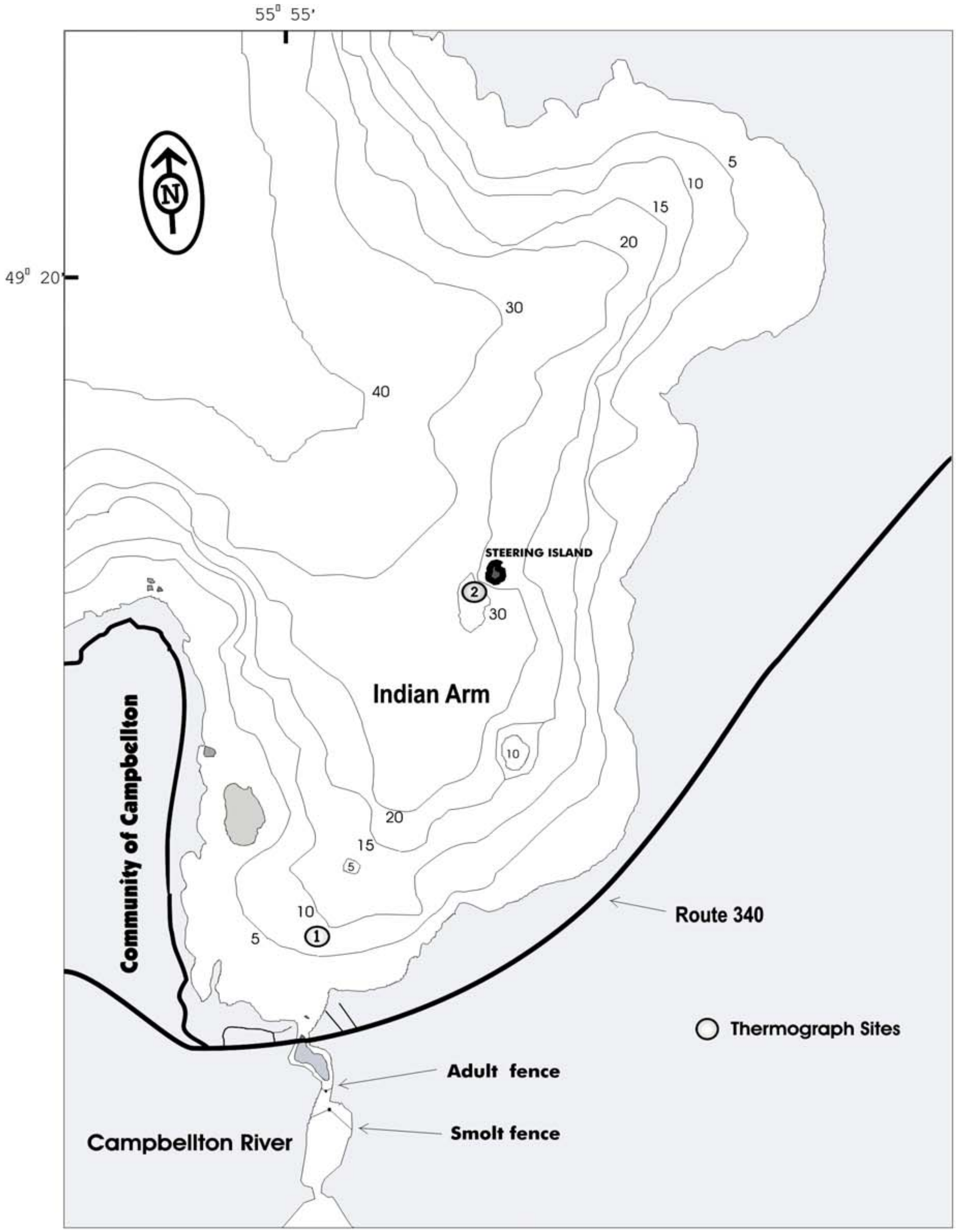

Figure 2. Location of counting fences and thermograph sites with depth contours (fathoms) for Indian Arm.

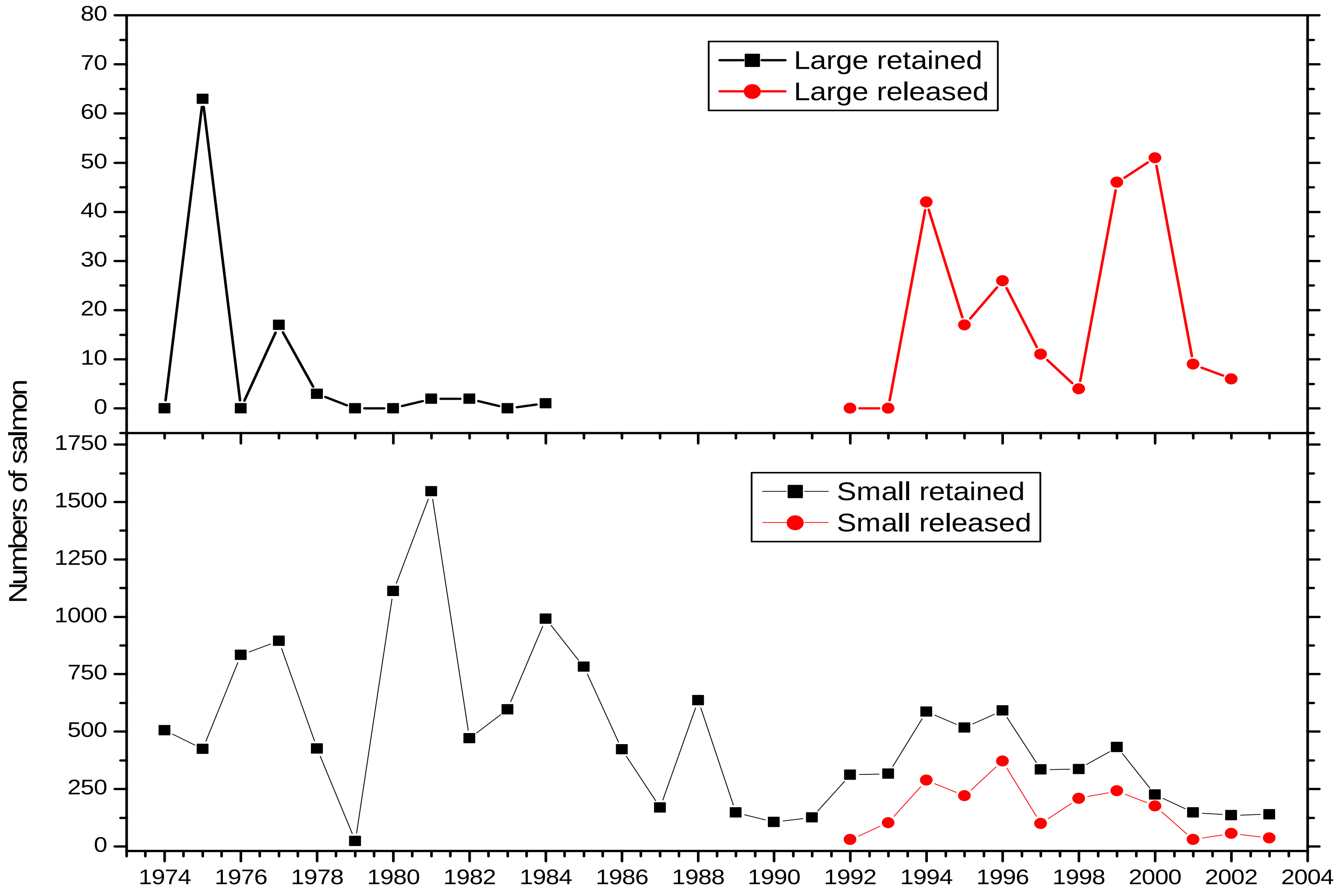

Figure 3. Angling data for Campbellton River, 1974-2003. Catches from 1974-1993 is DFO data and from 1994-2003 is License Stub Return System.

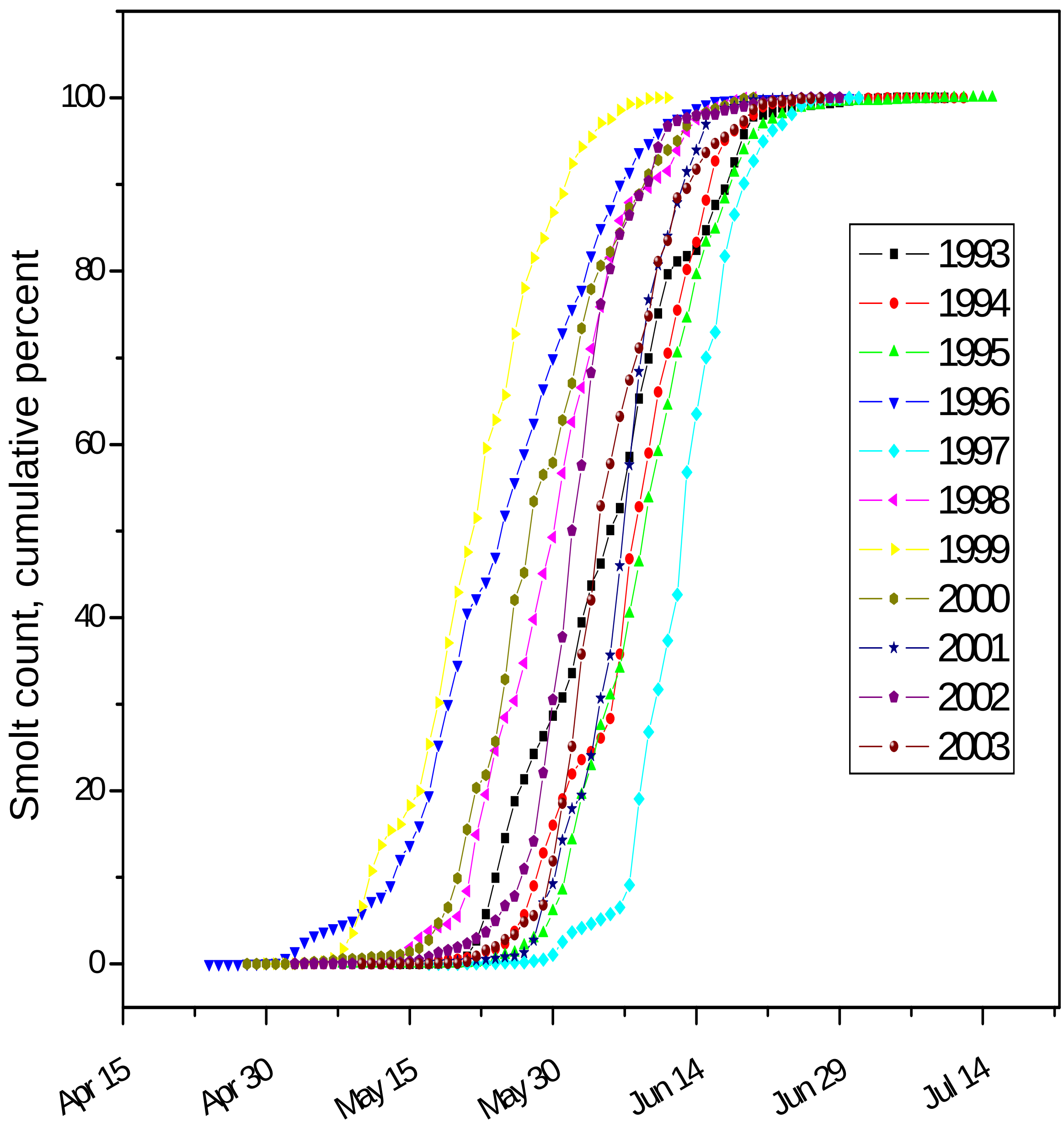

Figure 4. Daily cumulative smolt count for Campbellton River, 1993-2003.

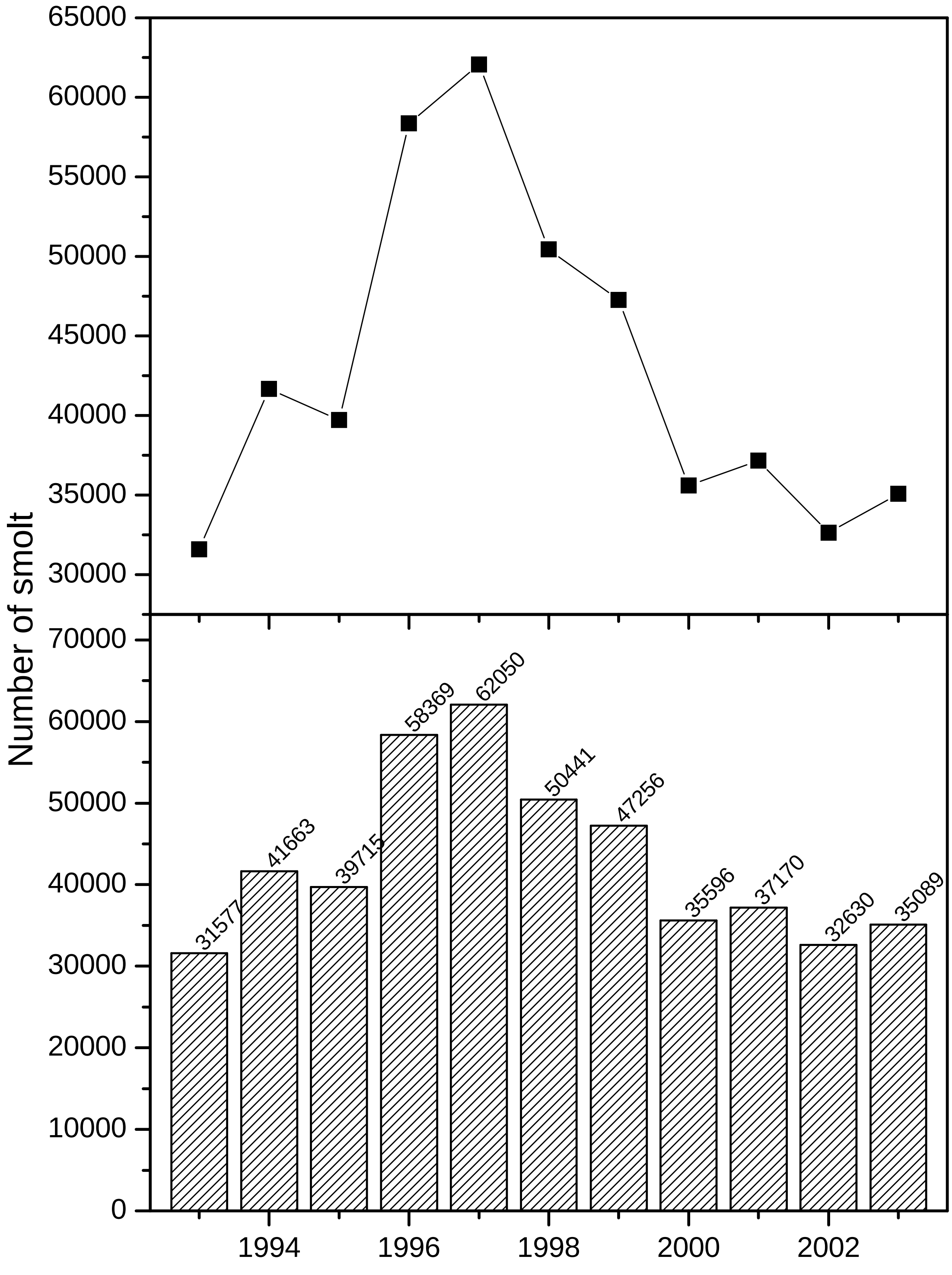

Figure 5. Annual smolt counts at Campbellton River, 1993-2003.

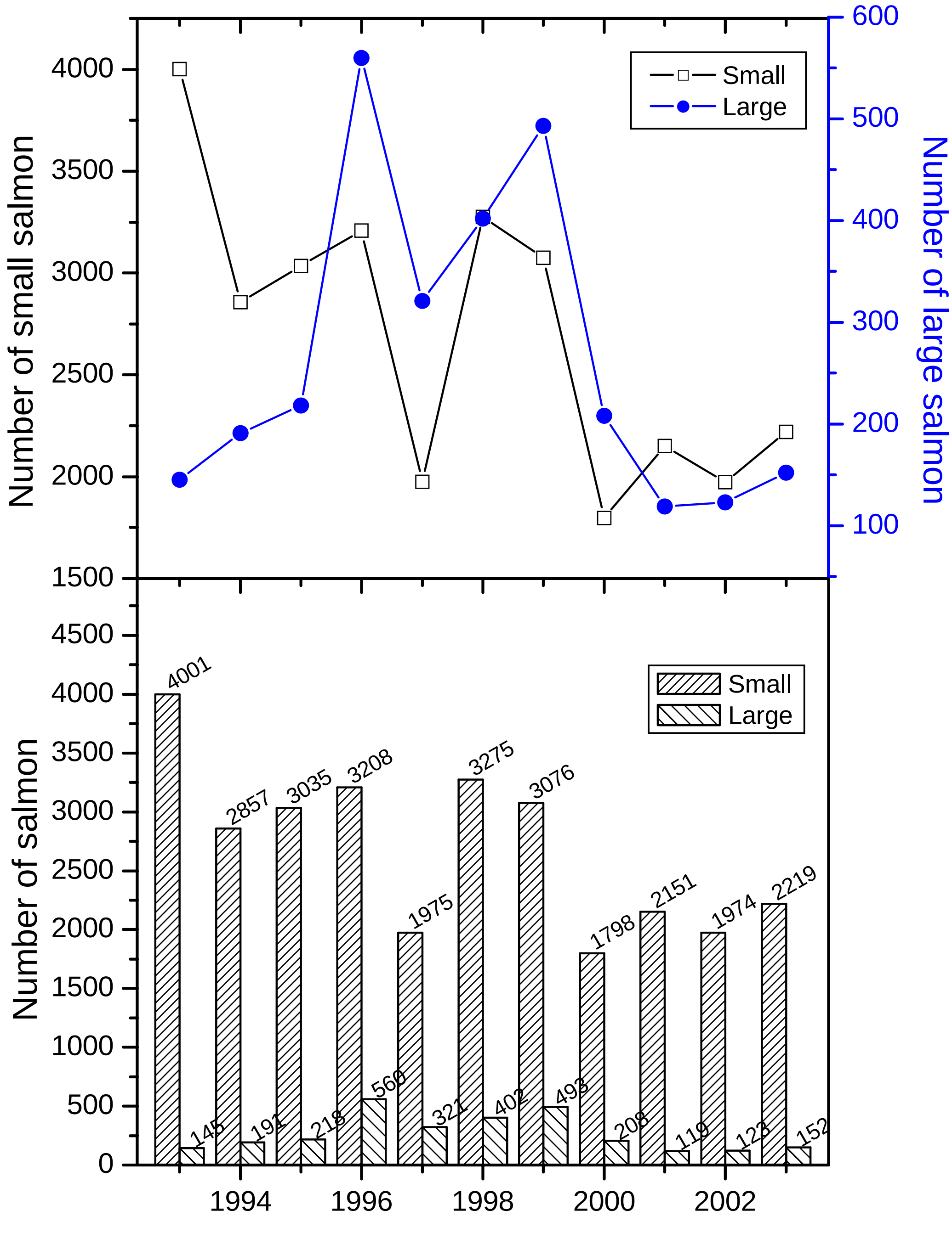

Figure 6. Daily adult counts at Campbellton River, 1993-2003.

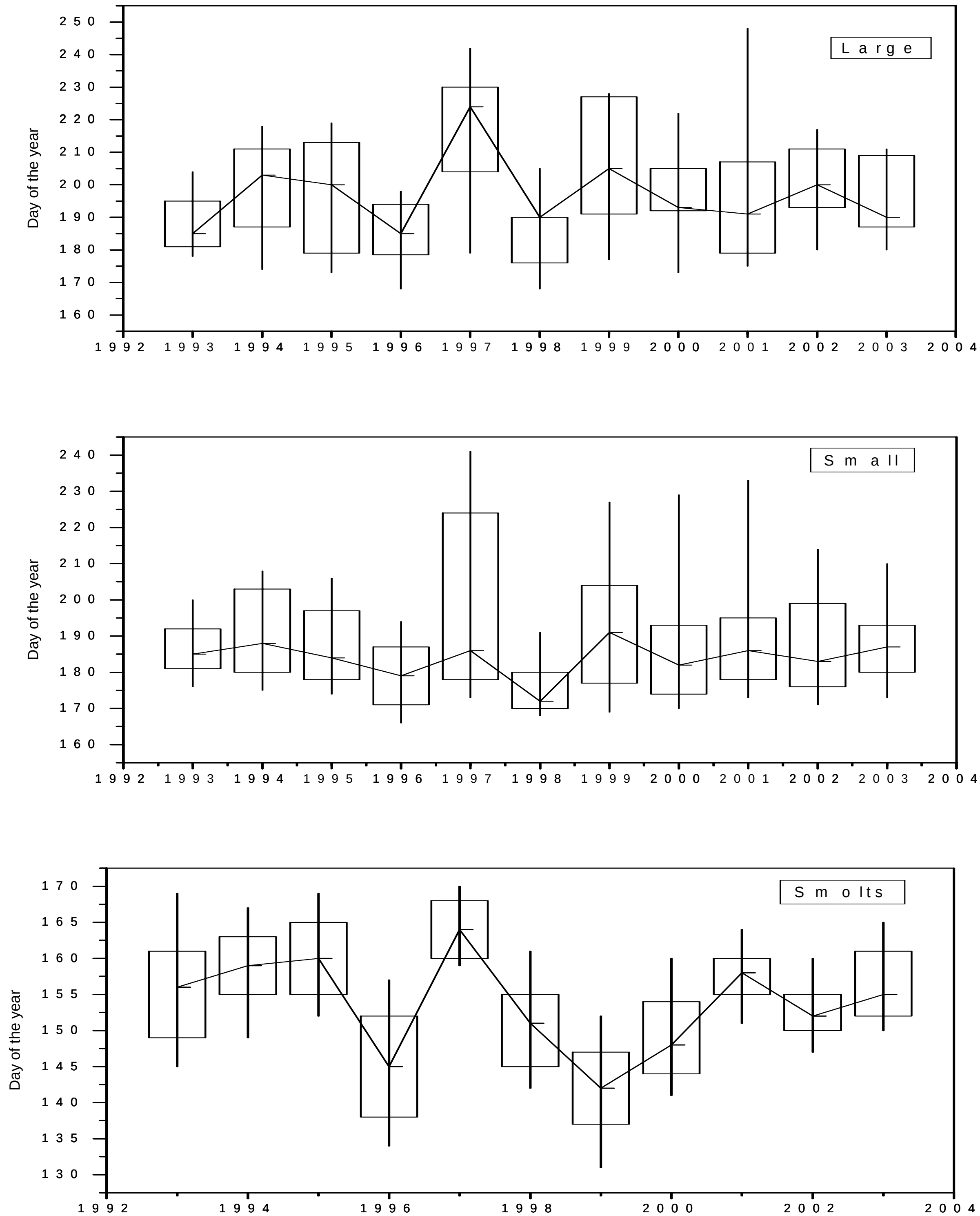

Figure 7. Annual variation in run timing at Campbellton River, Newfoundland, for Atlantic salmon smolts and returning small and large salmon. Vertical lines represent The 10th and 90th percentiles of the day of the year of migration, the rectangle is the 25th And 75th percentiles, and the marker within the rectangle is the median run timing value.

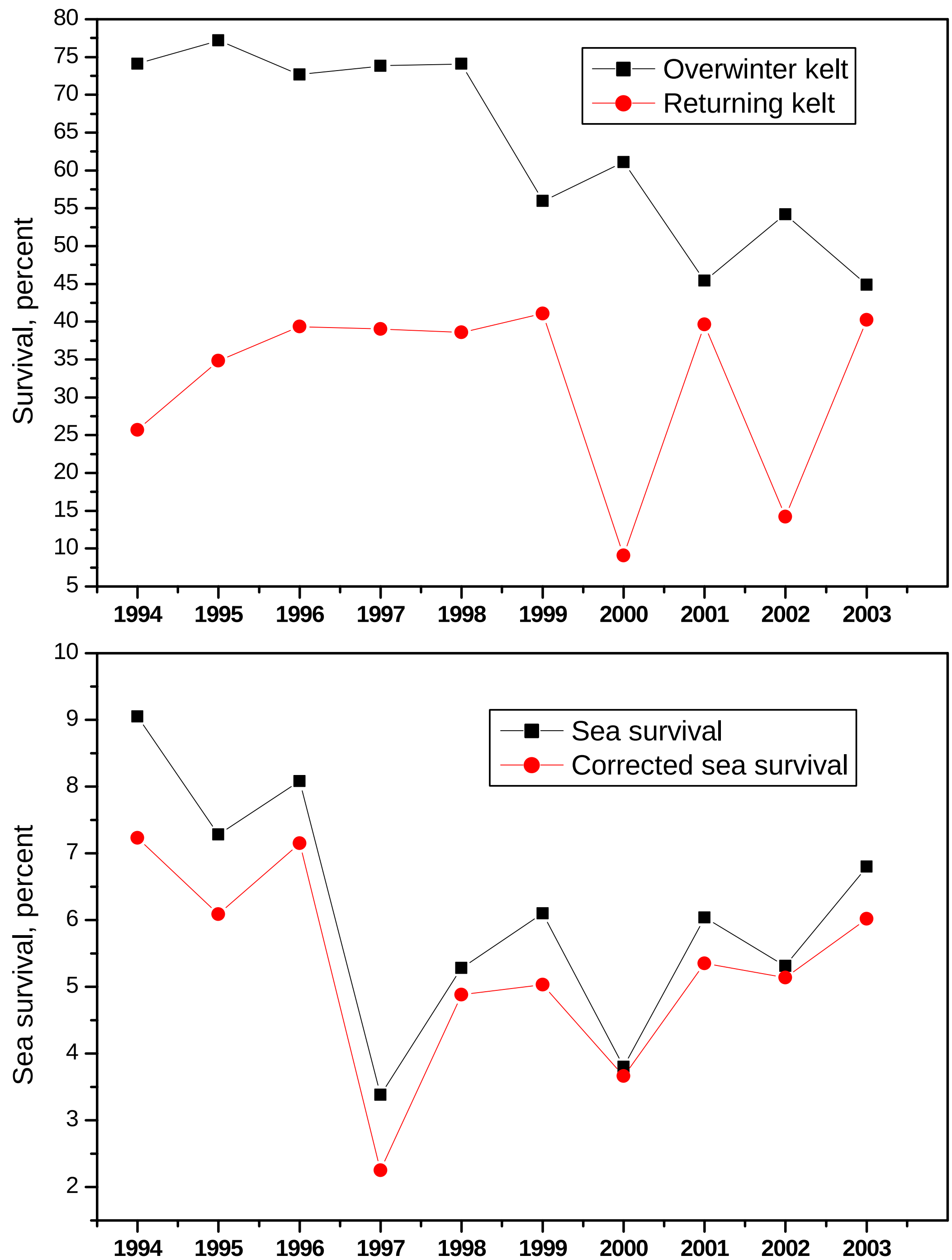

Figure 8. Survival rates for smolt to adult (corrected and uncorrected for numbers of returning previous spawners), kelt and previous spawners for Campbellton River, Newfoundland, 1994-2003. Year is year of return.

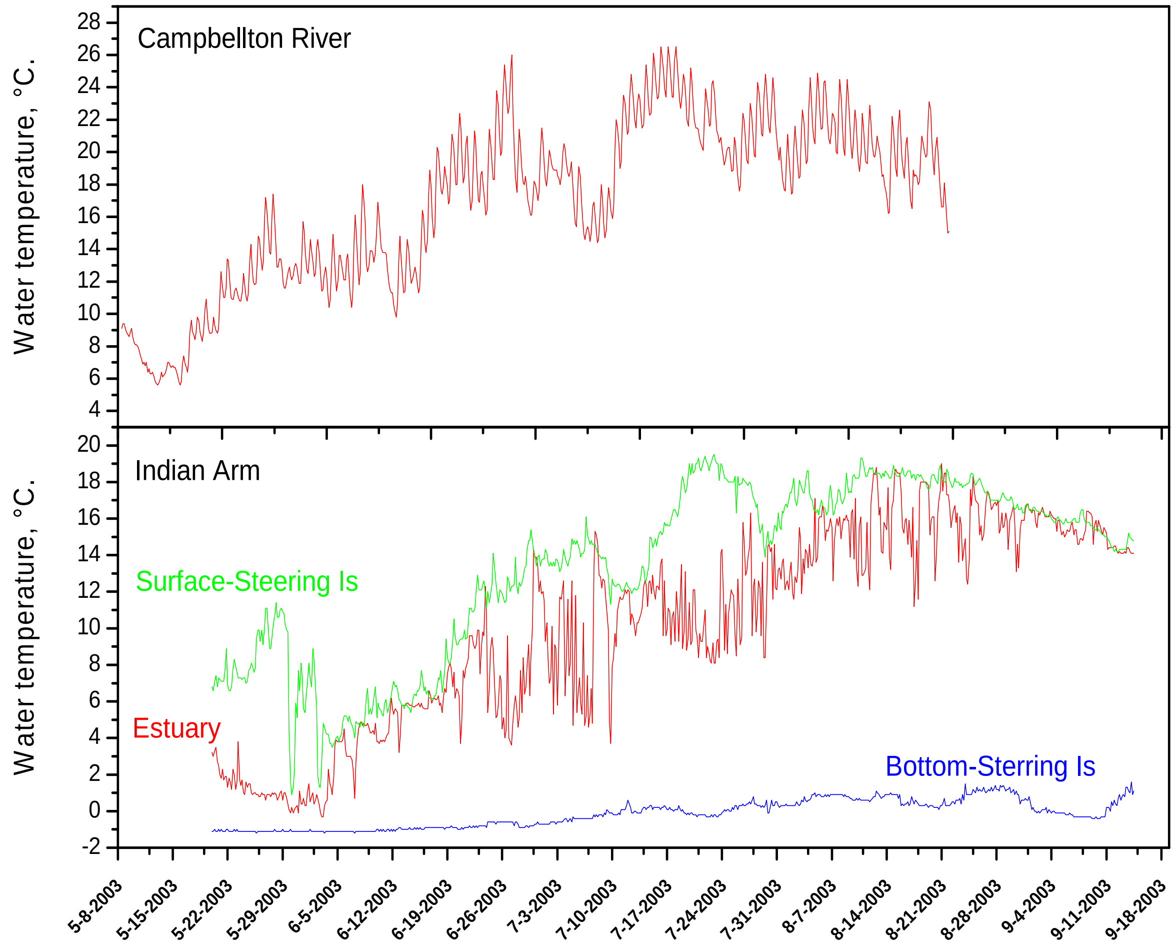

Figure 9. Water temperatures at Campbellton River counting fence (top) and at the estuary, surface and bottom at Steering Is, Newfoundland, 2003.

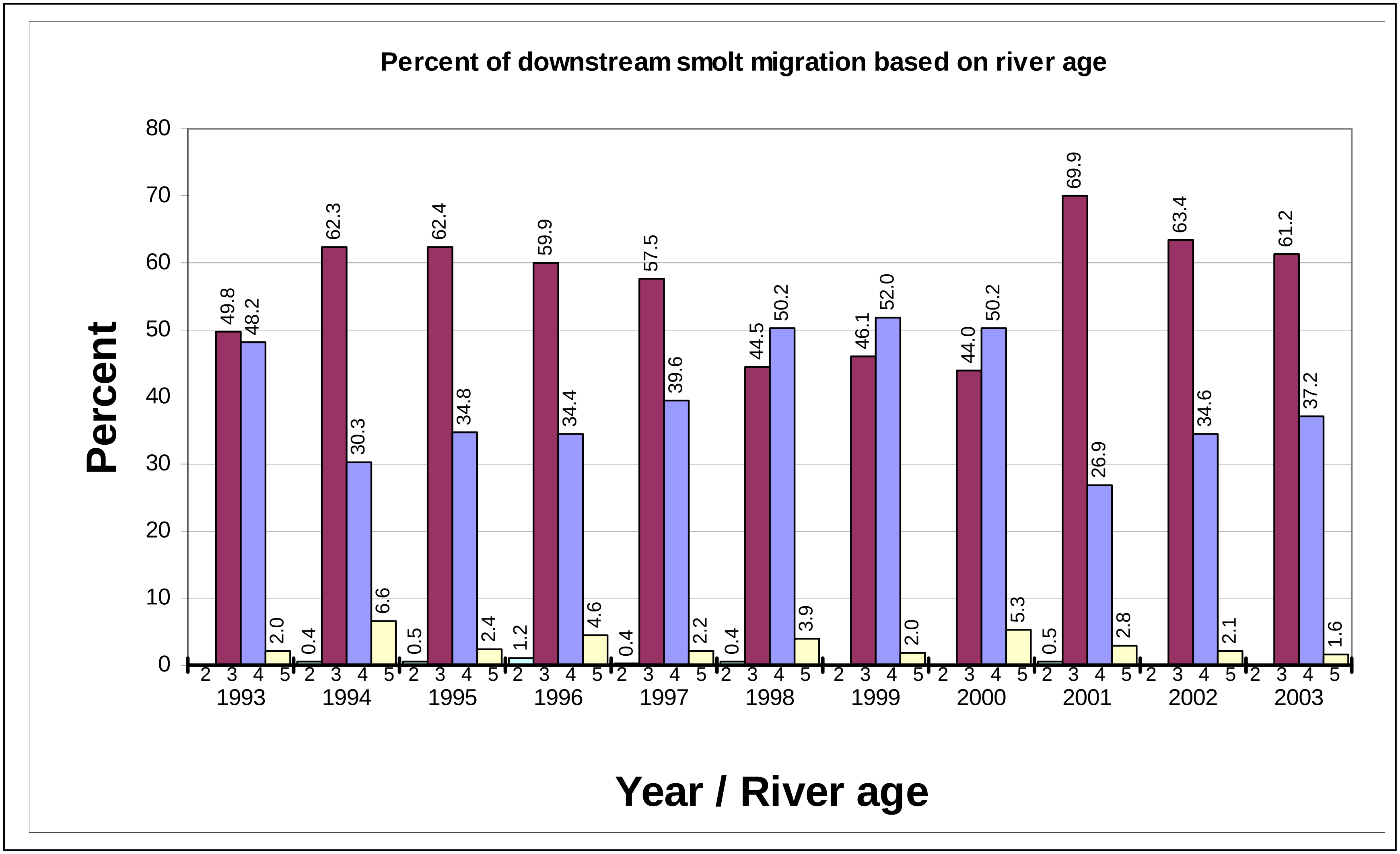

Figure10. Smolt age division of smolts sampled from the downstream migration at Campbellton River, 1993-03.

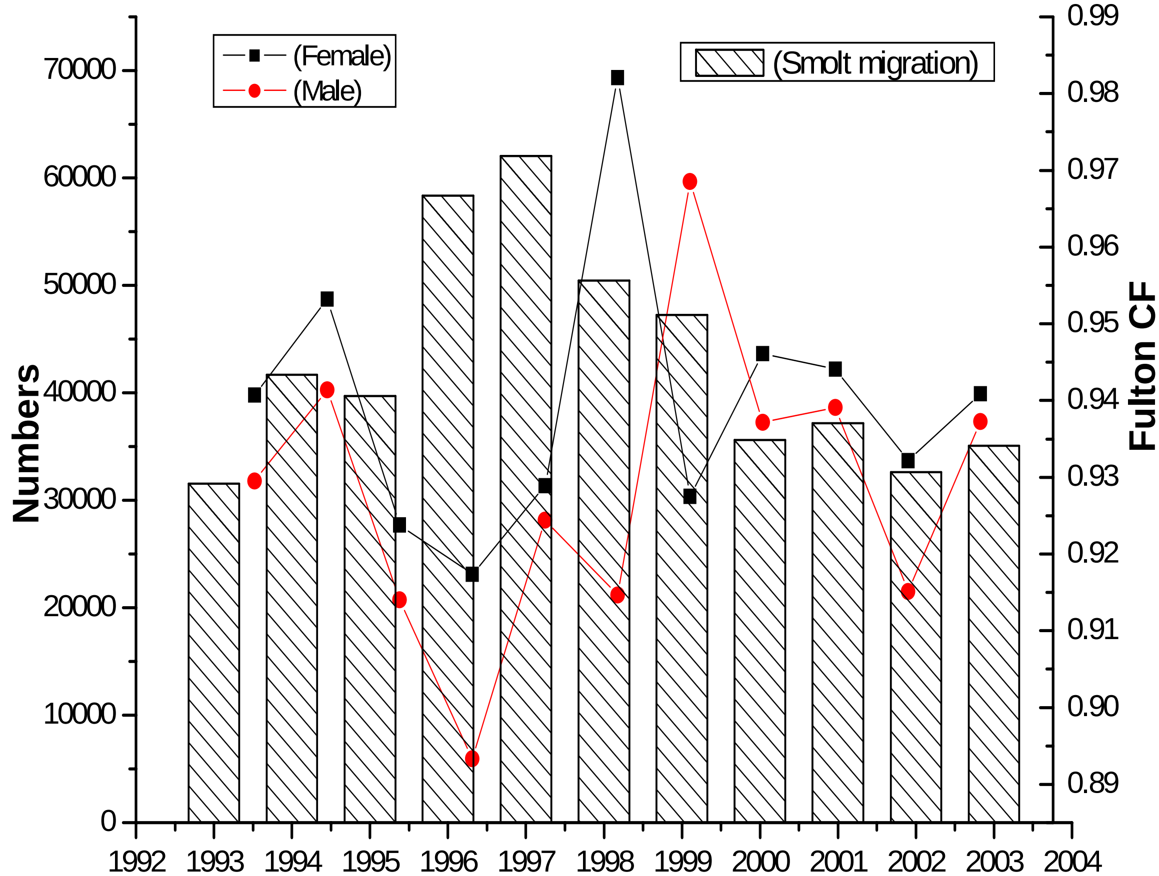

Figure 11. Fulton condition factors (CF) for male and female smolt and smolt count at Campbellton River, 1993-2003.

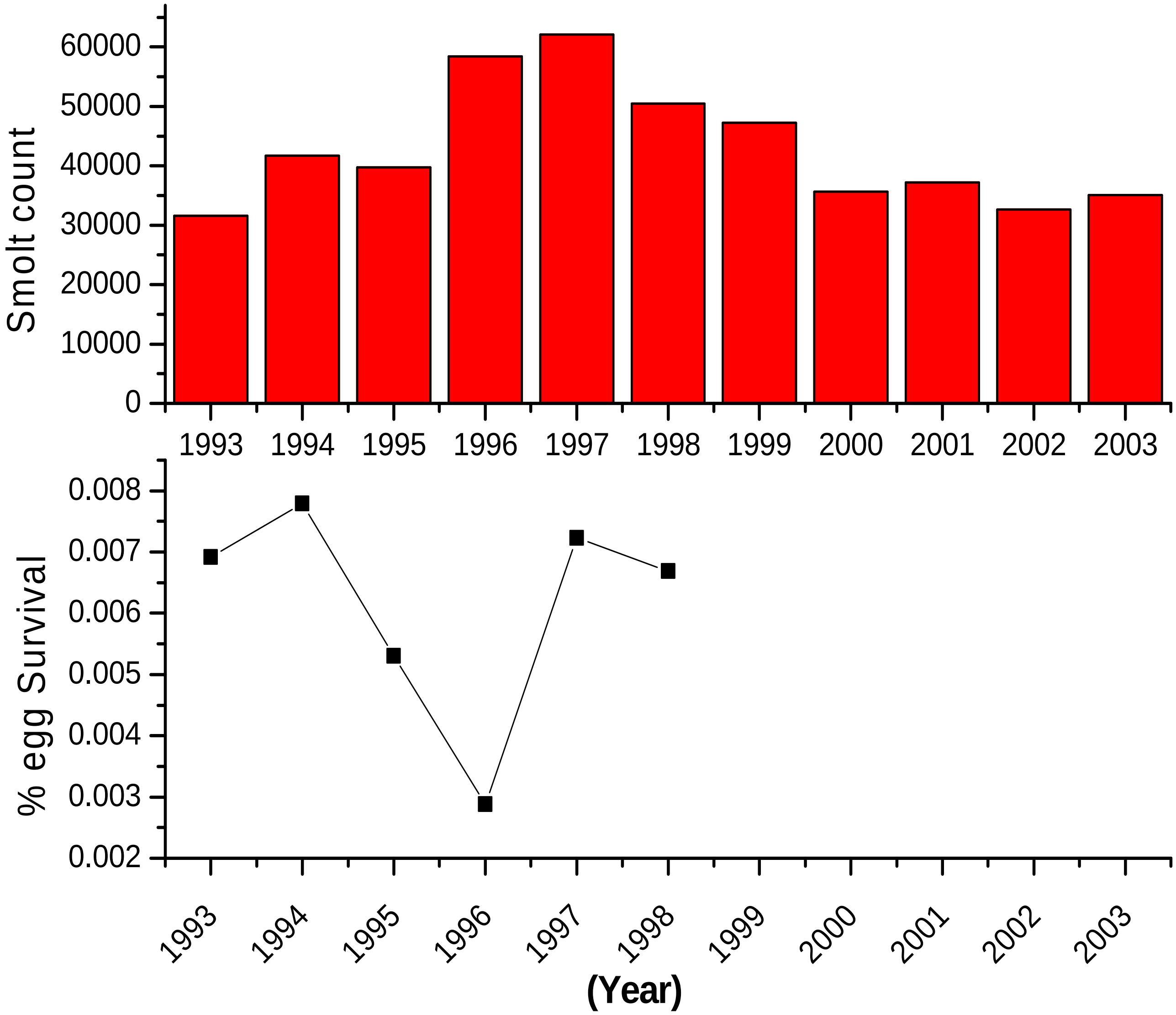

Figure 12. Egg to smolt survival and smolt counts at the fence for Atlantic salmon in Campbellton River, 1993-2003.

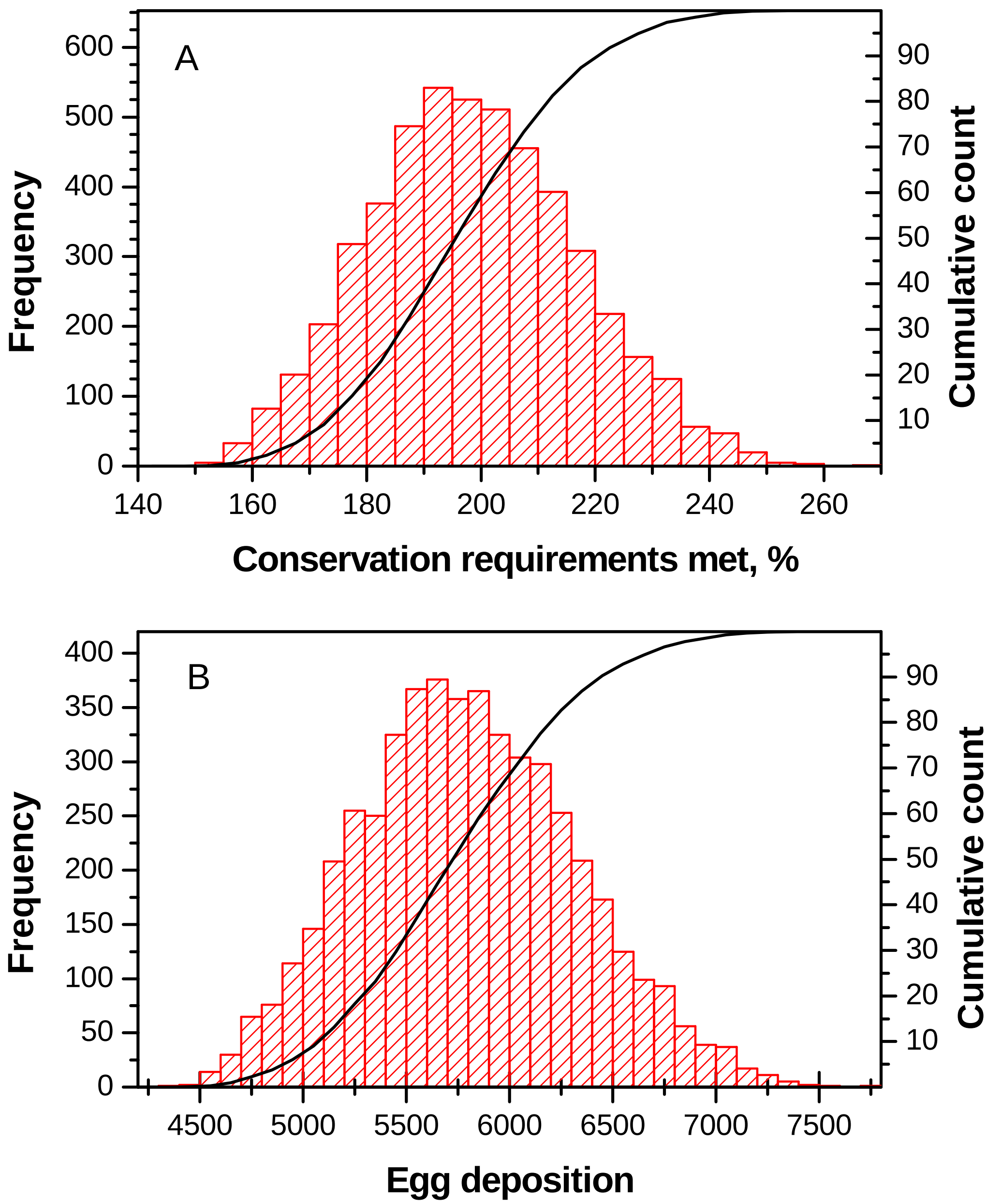

Figure 13. Graph A is frequency distribution and cumulative percent of conservation requirements met and Graph B is frequency distribution and cumulative percent of egg deposition. Both graphs are from simulation assuming a 10% variability about point estimates.

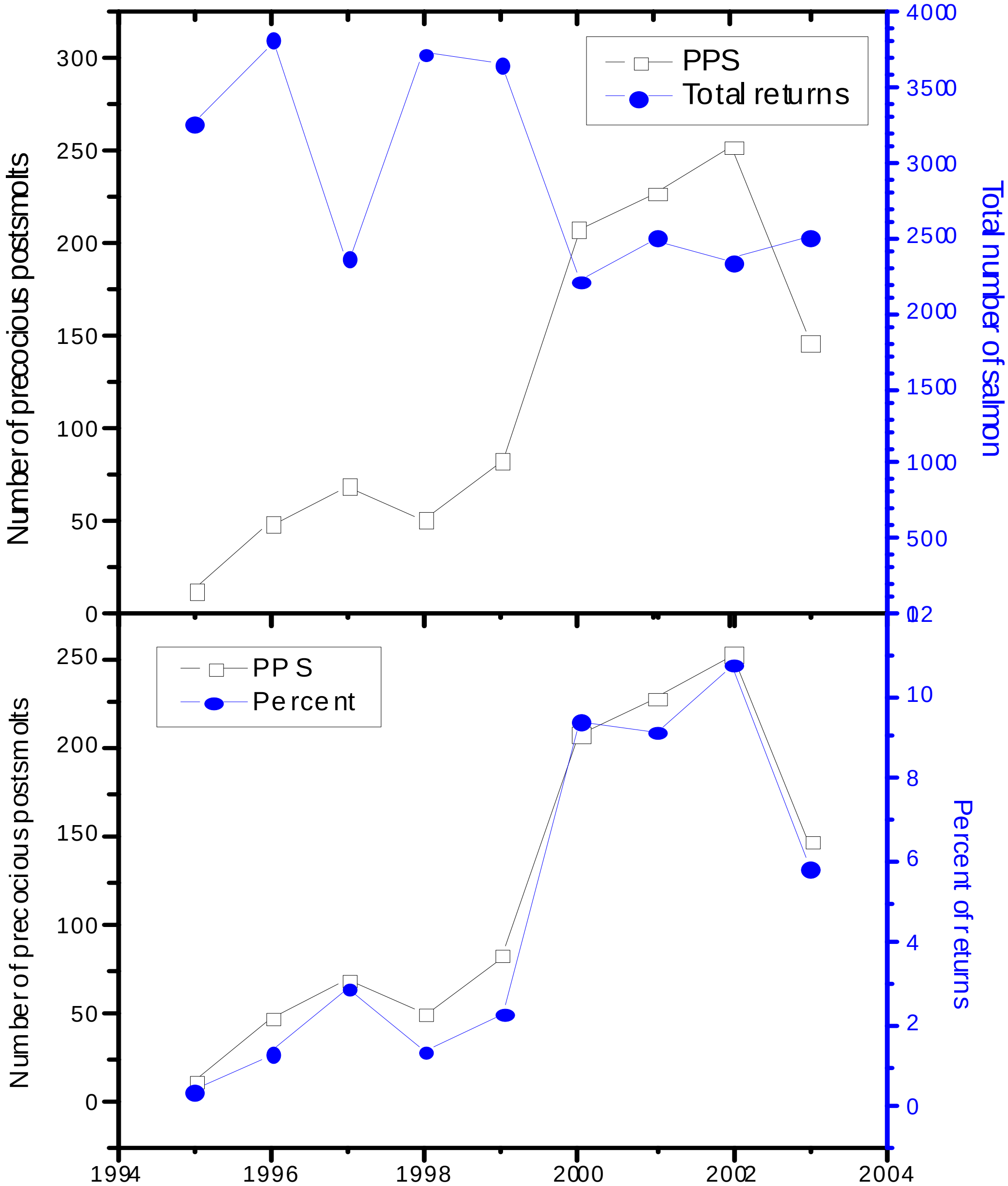

Figure 14. Numbers and percent of precocious postmolts returning to Campbellton River, 1995-2003.

Table 1. Recreational salmon angling catches for Campbellton River, 1992-2003.

Year	Effort Rod Days	Small (<63 cm) Retained	Small (<63 cm) Released	Small (<63 cm) Total	Large (>=63 cm) Retained	Large (>=63 cm) Released	Large (>=63 cm) Total	Total (Small + Large) Retained	Total (Small + Large) Released	Total (Small + Large) Total	CPUE
1992	916	311	30	341	*	0	0	311	30	341	0.37
1993	1355	316	103	419	*	0	0	316	103	419	0.31
1994	2823	587	289	876	*	42	42	587	331	918	0.33
1995	2458	517	220	737	*	17	17	517	237	754	0.31
1996	3076	592	372	964	*	26	26	592	398	990	0.32
1997	2046	334	100	434	*	11	11	334	111	445	0.22
1998	1531	337	209	546	*	4	4	337	213	550	0.36
1999	2961	433	242	675	*	46	46	433	288	721	0.24
2000	2037	226	176	402	*	51	51	226	227	453	0.22
2001	729	148	29	177	*	9	9	148	38	186	0.26
2002	1220	136	57	193	*	6	6	136	63	199	0.16
2003	637	139	37	176	*	0	0	139	37	176	0.28
1994-2002 mean	2098	368	188	556	.	24	24	368	212	580	0.28
95% CL	627	136	85	216	.	14	14	136	93	222	0.04
N	9	9	9	9	.	9	9	9	9	9	9

IN THE ABOVE TABLE A PERIOD INDICATES NO DATA FOR THAT YEAR.
CPUE IS IN TERMS OF SMALL AND LARGE SALMON COMBINED (RETAINED + RELEASED FISH).
* NOT ALLOWED TO RETAIN LARGE SALMON IN INSULAR NEWFOUNDLAND.
IN 1992-93 ANGLING DATA COLLECTED BY RIVER GUARDIANS

Table 2. Daily count of fish passing through the smolt counting fence on Campbellton River, 2003.

Date	Salmon Smolt	Salmon Kelt	Salmon Parr	Precicous Post Smolt	Brook trout	Smelt	Eel
10-May	1	8	1	1	3	31	0
11-May	0	6	3	2	1	37	0
12-May	0	2	1	0	1	265	0
13-May	2	1	0	0	0	105	0
14-May	0	1	1	0	0	178	0
15-May	4	1	3	1	0	76	0
16-May	1	2	4	0	1	199	0
17-May	7	9	5	1	4	493	0
18-May	9	1	10	0	5	660	0
19-May	5	0	4	0	0	1547	2
20-May	5	0	1	0	0	170	0
21-May	69	86	1	18	6	92	0
22-May	221	91	14	22	4	56	0
23-May	250	44	6	3	5	15	0
24-May	138	38	2	5	6	11	1
25-May	289	41	3	3	1	16	0
26-May	184	23	3	1	1	49	0
27-May	528	18	26	3	6	86	0
28-May	250	14	2	0	3	294	0
29-May	430	13	4	2	3	228	0
30-May	1785	12	2	3	5	233	0
31-May	2346	21	0	4	13	251	0
1-Jun	2295	59	3	5	3	280	0
2-Jun	3747	55	3	6	7	370	0
3-Jun	2187	63	3	8	6	231	0
4-Jun	3814	6	6	1	4	91	0
5-Jun	1696	14	2	4	3	96	0
6-Jun	1919	13	4	5	7	83	0
7-Jun	1481	35	3	1	3	111	0
8-Jun	1298	10	10	0	9	68	0
9-Jun	1294	11	3	1	4	34	0
10-Jun	2217	3	3	2	3	17	0
11-Jun	854	13	5	2	7	20	0
12-Jun	1716	15	7	2	5	15	0
13-Jun	393	12	0	0	0	2	0
14-Jun	771	26	8	2	3	7	0
15-Jun	681	16	5	0	0	2	0
16-Jun	358	2	0	0	0	0	0
17-Jun	262	3	0	0	0	0	0
18-Jun	312	3	0	0	0	0	0
19-Jun	344	0	0	0	0	3	0
20-Jun	454	0	0	0	0	0	0
21-Jun	226	0	3	0	0	0	0
22-Jun	87	0	1	0	0	0	0
23-Jun	53	0	0	0	0	0	0
24-Jun	27	0	0	0	0	0	0
25-Jun	59	0	0	0	0	0	0
26-Jun	11	0	0	0	0	0	0
27-Jun	9	0	0	0	0	0	0
Total	**35,089**	**791**	**165**	**108**	**132**	**6,522**	**3**

Table 3. Number and percent of smolt migrating downstream by standard week through the counting fence on the Campbellton River, 1993-2003.

Dates	Standard week	1993 Number	1993 Percent	1994 Number	1994 Percent	1995 Number	1995 Percent	1996 Number	1996 Percent	1997 Number	1997 Percent	1998 Number	1998 Percent	1999 Number	1999 Percent	2000 Number	2000 Percent	2001 Number	2001 Percent	2002 Number	2002 Percent	2003 Number	2003 Percent	Mean	Percent
April 23-29	17							44	0.08							6	0.02							25	0.06
May 30-06	18			1	0.00			2,146	3.68					109	0.23	108	0.30			2	0.01			473	1.05
07-13	19			16	0.04	3	0.01	3,152	5.40				0.00	7,185	15.20	232	0.65		0.00	34	0.10	1	0.00	1,518	3.38
14-20	20	125	0.40	224	0.54	15	0.04	14,833	25.41	20	0.03	2,772	5.50	12,984	27.48	3,183	8.94	102	0.27	576	1.77	33	0.10	3,170	7.06
21-27	21	6,607	20.92	2,137	5.13	826	2.08	14,243	24.40	90	0.15	14,743	29.23	16,592	35.11	12,554	35.27	387	1.04	2,959	9.07	1679	5.15	6,620	14.74
28-03	22	7,071	22.39	7,842	18.82	8,228	20.72	13,358	22.89	2,491	4.01	18,322	36.32	8,243	17.44	11,664	32.77	8,447	22.73	18,710	57.34	13040	39.96	10,674	23.77
June 04-10	23	9,915	31.40	17,297	41.52	14,409	36.28	8,264	14.16	14,017	22.59	9,957	19.74	2,143	4.53	5,296	14.88	21,059	56.66	8,483	26.00	13719	42.04	11,324	25.21
11-17	24	4,518	14.31	12,091	29.02	11,566	29.12	2,156	3.69	28,641	46.16	4,202	8.33			2,215	6.22	6,696	18.01	1,401	4.29	5035	15.43	7,852	17.48
18-24	25	3,012	9.54	1,876	4.50	4,020	10.12	121	0.21	14,908	24.03	445	0.88			338	0.95	479	1.29	388	1.19	1503	4.61	2,709	6.03
25-01	26	253	0.80	147	0.35	495	1.25	52	0.09	1883	3.03									77	0.24	79	0.24	427	0.95
July 02-08	27	76	0.24	32	0.08	98	0.25																	69	0.15
09-15	28		0.00		0.00	55	0.14																	55	0.12
Total		31,577		41,663		39,715		58,369		62,050		50,441		47,256		35,596		37,170		32,630		35,089		44,914	
Start date for fence		14-May		5-May		8-May		24-Apr		18-May		13-May		29-Apr		28-Apr		13-May		3-May		10-May			
End date for fence		10-Jul		12-Jul		15-Jul		30-Jun		1-Jul		20-Jun		10-Jun		20-Jun		24-Jun		29-Jun		27-Jun			

Table 4. Adult Atlantic salmon enumerated through the counting fence at Campbellton River, 2003.

Date	Small salmon < 63 cm	Large salmon > = 63 cm	Total
2-Jun-03	0	0	0
3-Jun-03	0	0	0
4-Jun-03	0	0	0
5-Jun-03	0	0	0
6-Jun-03	0	0	0
7-Jun-03	0	0	0
8-Jun-03	0	0	0
9-Jun-03	0	0	0
10-Jun-03	0	0	0
11-Jun-03	0	0	0
12-Jun-03	0	0	0
13-Jun-03	0	0	0
14-Jun-03	12	0	12
15-Jun-03	15	1	16
16-Jun-03	27	0	27
17-Jun-03	8	1	9
18-Jun-03	17	0	17
19-Jun-03	12	1	13
20-Jun-03	42	0	42
21-Jun-03	27	1	28
22-Jun-03	16	0	16
23-Jun-03	61	0	61
24-Jun-03	55	3	58
25-Jun-03	52	3	55
26-Jun-03	55	1	56
27-Jun-03	22	0	22
28-Jun-03	13	1	14
29-Jun-03	45	3	48
30-Jun-03	204	4	208
1-Jul-03	21	0	21
2-Jul-03	29	0	29
3-Jul-03	57	2	59
4-Jul-03	40	0	40
5-Jul-03	15	1	16
6-Jul-03	161	11	172
7-Jul-03	269	21	290
8-Jul-03	137	7	144
9-Jul-03	94	8	102
10-Jul-03	82	9	91
11-Jul-03	64	7	71
12-Jul-03	1	0	1
13-Jul-03	43	1	44
14-Jul-03	17	1	18
15-Jul-03	16	0	16
16-Jul-03	7	0	7
17-Jul-03	6	0	6
18-Jul-03	4	0	4
19-Jul-03	2	0	2
20-Jul-03	2	0	2
21-Jul-03	0	0	0
22-Jul-03	0	0	0
23-Jul-03	5	0	5
24-Jul-03	22	8	30
25-Jul-03	18	0	18
26-Jul-03	23	1	24
27-Jul-03	5	4	9
28-Jul-03	33	9	42
29-Jul-03	42	6	48

continued

Table 4. Continued.

Date	Small salmon < 63 cm	Large salmon > = 63 cm	Total
30-Jul-03	135	18	153
31-Jul-03	62	8	70
1-Aug-03	16	2	18
2-Aug-03	0	0	0
3-Aug-03	11	0	11
4-Aug-03	34	2	36
5-Aug-03	8	0	8
6-Aug-03	3	0	3
7-Aug-03	6	0	6
8-Aug-03	0	0	0
9-Aug-03	1	0	1
10-Aug-03	5	0	5
11-Aug-03	3	0	3
12-Aug-03	2	0	2
13-Aug-03	1	0	1
14-Aug-03	3	0	3
15-Aug-03	17	3	20
16-Aug-03	3	0	3
17-Aug-03	0	0	0
18-Aug-03	1	1	2
19-Aug-03	0	0	0
20-Aug-03	4	0	4
21-Aug-03	2	1	3
22-Aug-03	0	0	0
23-Aug-03	0	0	0
24-Aug-03	1	1	2
25-Aug-03	2	1	3
26-Aug-03	0	0	0
27-Aug-03	1	0	1
28-Aug-03	0	0	0
Total	2219	152	2371

Table 5. Summary of production and survival rates for Atlantic salmon at various life stages for Campbellton River 1993 to 2003.

	Year											
	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	Average
Smolt production	31,577	41,663	39,715	58,369	62,050	50,411	47,256	35,596	37,170	32,630	35,089	43,995
Adult returns Small	4,001	2,857	3,035	3,208	1,975	3,275	3,076	1,798	2,151	1,974	2,219	2,557
Large	145	191	218	560	321	402	493	208	119	123	152	279
Total	4,146	3,048	3,253	3,768	2,296	3,677	3,569	2,006	2,270	2,097	2,371	2,836
Egg production (million of eggs)	9,077,421	6,034,653	7,712,616	9,204,899	5,257,962	9,173,933	9,092,133	4,426,431	4,307,005	4,035,244	5,641,485	6,488,636
Kelt counted migrating downstream from smolt trap	1,386	2,838	1,874	1,971	2,315	*1,446*	1,857	1,597	706	1,084	791	1,648
Over-winter freshwater survival of spawning adults		74.29%	77.18%	72.68%	73.82%	74.12%	55.95%	61.09%	45.43%	54.20%	43.20%	63.20%
Percent survival of returning kelts to the river		25.67%	34.83%	39.38%	39.00%	38.56%	41.07%	9.09%	39.65%	14.20%	40.25%	32.17%
Percent of the adult run that were previous spawners		23.90%	20.07%	20.60%	39.32%	15.16%	21.37%	7.24%	12.33%	7.34%	13.43%	18.08%
Percent of adult run that were precocious post smolts			0.40%	1.30%	3.01%	1.39%	2.33%	10.37%	10.04%	12.06%	6.20%	5.23%
Uncorrected survival rate (for previous spawners) of smolt to grilse		9.05%	7.28%	8.08%	3.38%	5.28%	6.10%	3.80%	6.04%	5.31%	6.80%	6.11%
Corrected survival rate of smolt to grilse		7.23%	6.09%	7.15%	2.25%	4.88%	5.03%	3.66%	5.35%	5.14%	6.02%	5.28%
Survival rate from egg to smolt	0.69%	0.78%	0.53%	0.29%	0.72%	0.39%						0.43%

* Kelt migration in 1998 was estimated due to late installation of the smolt fence

Table 6 . Sea survivial rates for Campbellton River Atlantic salmon, 2003.

Sea survival rates for 2001 smolt class:

			Year		
Smolt count for			2002	= 32,630	
Adult count	Small =	2,219	2003	Total = 2,371	
	Large=	152			
Sea survival rate from smolt to small salmon			2002-2003	= 6.80%	(uncorrected)

Previous spawners:

Kelts (downstream)			2003	= 791
Tagged kelt releases (downstream)			2003	Total = 405
(in yr 2003 = (	379	)		
(in yrs 1994-02 =	26	)		
Percent tagged kelts released			2003	= 51.2%
Ratio untagged : tagged (total) kelts			2003	= 1.95
Recreational salmon catch	Small=	142	2002	= 143
(retained fish +hook & release mortality)	Large=	1		
Adult count	Small=	1,974	2002	= 2,097
	Large=	123		
Over-wintering kelt survival from			2002 to 2003	
with recreational catch removed =	(791) / (2,097 - 143)			= 43.18%

The following table is a summary of the estimated numbers of previous spawners in small and large categories:

	Upstream migration			
	Tagged returns 2003	Est. previous Spawners	Total 2003	Percent previous spawners
Small	131	256	2,219	11.53%
Large	32	62	152	41.12%
Total	163	318	2,371	13.43%

Sea survival rates with correction for pervious spawners:

Smolt count for the year	2002	=	32,630
Upstream small only count (previous spawners removed) for the year	2003	=	1,963
Previous spawners sea survival to freshwater returns in the year	2003	=	40.25%
Corrected sea survival rate from smolt to small salmon	2002-2003	=	6.02%

Table 7. River age and percent of sampled smolts from 1993-2003 applied to the downstream smolt migrations for Campbellton River, 1993-2003.

	River age											
	2		3		4		5		6			
Year	No.	%	No.	%	No.	%	No.	%	No.	%	Total enumerated at smolt fence	Total aged
1993			15,710	49.75	15,233	48.24	635	2.01			31,577	199
1994	171	0.41	25,935	62.25	12,620	30.29	2,766	6.64	171	0.41	41,663	241
1995	191	0.48	24,774	62.38	13,805	34.76	945	2.38			39,715	210
1996	671	1.15	34,975	59.92	20,050	34.35	2,673	4.58			58,369	262
1997	230	0.37	35,685	57.51	24,547	39.56	1,365	2.20	230	0.37	62,050	273
1998	217	0.43	22,441	44.49	25,326	50.21	1,947	3.86			50,441	233
1999			21,766	46.06	24,559	51.97	931	1.97			47,256	254
2000			15,648	43.96	17,883	50.24	1,890	5.31	171	0.48	35,596	207
2001	171	0.46	25,986	69.91	9,980	26.85	1,033	2.78			37,170	216
2002			20,671	63.35	11,274	34.55	682	2.09			32,630	191
2003			21,489	61.24	13,057	37.21	544	1.55			35,089	258
Mean	275	0.55	24,098	56.44	17,121	39.84	1401	3.22	190	0.42	42,869	231

Table 8. Mean fork length, whole weight and river age of salmon smolts taken randomly from the smolt fence at Campbellton River, 1993-2003.

		Fork length (mm)					Whole weight (grams)					Mean river age (years)				
Year	Sex	Mean	Number	STD	Min.	Max.	Mean	Number	STD	Min.	Max.	Mean	Number	STD	Min.	Max.
1993	Male	186.4	58	20.5	145	275	60.2	58	22.2	24.6	175.6	3.53	58	0.54	3	5
	Female	186.2	141	19.9	127	252	60.7	141	21.1	22	148.6	3.52	141	0.54	3	5
	All	186.3	199	20.1	127	275	60.6	199	21.4	22	175.6	3.52	199	0.54	3	5
1994	Male	172.1	49	14.2	140	200	48.0	49	12.5	24.7	88.2	3.40	48	0.64	3	5
	Female	173.0	196	18.6	135	267	49.4	196	18.0	21.8	174	3.46	193	0.64	2	6
	All	172.9	245	17.8	135	267	49.1	245	17.0	21.8	174	3.44	241	0.64	2	6
1995	Male	168.9	61	14.3	135	200	44.0	61	12.3	22.4	84.5	3.49	61	0.60	3	5
	Female	169.1	150	16.0	132	221	44.7	150	13.5	22.9	86.1	3.35	149	0.52	2	5
	All	167.1	211	15.5	132	221	44.5	211	13.1	22.4	86.1	3.39	210	0.54	2	5
1996	Male	174.0	80	16.5	147	227	47.1	80	15.3	24.8	116.9	3.49	79	0.60	3	5
	Female	176.0	183	20.6	130	256	50.0	183	19.7	19.1	155.6	3.39	183	0.60	2	5
	All	175.4	263	19.4	130	256	49.1	263	18.5	19.1	155.6	3.42	262	0.60	2	5
1997	Male	167.1	90	22.2	133	268	43.1	90	22.5	18.9	188.2	3.60	90	0.67	3	6
	Female	166.5	184	20.8	133	278	42.9	184	20.0	18.3	206.9	3.37	183	0.50	2	4
	All	166.7	274	21.3	133	278	43.0	274	20.8	18.3	206.9	3.45	273	0.57	2	6
1998	Male	171.7	57	13.7	144	209	46.3	57	12.3	26.5	92.3	3.58	57	0.60	3	5
	Female	170.3	176	22.2	122	250	48.5	176	21.6	17.5	152.5	3.57	176	0.57	2	5
	All	170.7	233	20.5	122	250	48.0	233	19.7	17.5	152.5	3.58	233	0.58	2	5
1999	Male	175.6	65	20.6	141	241	52.4	65	20.3	27.2	133.8	3.62	65	0.55	3	5
	Female	171.8	189	16.3	129	223	47.0	189	13.9	20.6	104.4	3.54	189	0.53	3	5
	All	172.8	254	17.5	129	241	48.4	254	15.9	20.6	133.8	3.54	254	0.54	3	5
2000	Male	177.3	61	20.6	116	247	52.3	61	21.0	14.6	157.3	3.59	61	0.59	3	5
	Female	174.6	147	21.6	116	260	50.4	147	21.1	12.6	166.5	3.61	147	0.69	2	6
	All	175.4	208	21.2	116	260	50.9	208	21.1	12.6	166.5	3.62	207	0.61	3	6
2001	Male	173.0	58	17.1	145	238	48.6	58	14.4	23.9	105.9	3.28	58	0.52	3	5
	Female	176.8	158	21.4	131	298	52.2	158	21.9	24.8	206.1	3.34	158	0.54	2	5
	All	175.8	216	20.4	131	298	51.2	216	20.2	23.9	206.1	3.32	216	0.53	2	5
2002	Male	175.3	56	14.9	145	213	49.3	56	14.1	28.7	95.4	3.27	56	0.45	3	4
	Female	178.6	137	22.2	135	290	53.1	137	24.6	23.3	235.9	3.44	135	0.55	3	5
	All	177.7	193	20.4	135	290	52.0	193	22.1	23.3	235.9	3.39	191	0.53	3	5
2003	Male	172.1	67	14.6	139	224	47.8	67	13.2	26.9	99.0	3.42	65	0.50	3	4
	Female	176.0	193	19.3	130	257	51.3	193	18.2	17.8	126.4	3.40	193	0.53	3	5
	All	175.0	260	18.2	130	257	50.4	260	17.1	17.8	126.4	3.40	258	0.52	3	5
1993-2003	Male	173.7	702	18.2	116	275	48.7	702	17.6	14.6	188.2	3.49	698	0.58	3	6
	Female	174.2	1854	20.5	116	298	49.8	1854	19.9	12.6	235.9	3.45	1846	0.57	2	6
	All	174.0	2556	19.9	116	298	49.5	2556	19.3	12.6	235.9	3.46	2544	0.57	2	6

Table 9. Biological characteristics of small salmon sampled in the recreational fishery at Campbellton River, 1992-2003.

		Fork length (cm)					Whole weight (kgs)					River age (years)				
Year	Sex	Mean	Number	STD	Min	Max	Mean	Number	STD	Min	Max	Mean	Number	STD	Min	Max
1992	Male	55.9	4	4.0	52.0	60.0	1.83	3	0.58	1.50	2.50	3.50	4	1.0	3	5
	Female	53.7	13	4.9	43.5	62.5	1.75	2		1.75	1.75	3.38	13	0.5	3	4
	All	54.2	17	4.7	43.5	62.5	1.81	4	0.47	1.50	2.50	3.41	17	0.6	3	5
1993	Male	53.0	23	3.5	48.0	62.0	1.55	23	0.29	1.16	2.50	3.09	23	0.3	3	4
	Female	52.4	64	2.5	46.0	57.5	1.47	60	0.21	0.98	1.92	3.03	61	0.4	2	4
	All	52.6	87	2.8	46.0	62.0	1.5	83	0.23	0.98	2.50	3.05	84	0.3	2	4
1994	Male	55.8	10	3.1	52.5	60.5	1.79	10	0.36	1.40	2.31	3.17	12	0.4	3	4
	Female	52.7	31	3.1	46.3	59.5	1.56	28	0.28	0.94	2.16	3.25	32	0.5	3	5
	All	53.5	41	3.4	46.3	60.5	1.62	38	0.31	0.94	2.31	3.23	44	0.5	3	5
1995	Male	53.7	10	3.6	49.0	61.0	1.72	9	0.38	1.13	2.30	3.30	10	0.5	3	4
	Female	52.5	45	3.4	43.0	62.0	1.55	38	0.32	0.97	2.42	3.30	44	0.5	2	4
	All	52.7	55	3.5	43.0	62.0	1.58	47	0.33	0.97	2.42	3.30	54	0.5	2	4
1996	Male	50.6	3	1.9	48.5	52.0	1.44	3	0.10	1.33	1.50	3.50	2	0.7	3	4
	Female	51.5	6	4.2	45.0	55.0	1.58	5	0.41	1.10	2.10	3.33	6	0.5	3	4
	All	51.2	9	3.5	45.0	55.0	1.53	8	0.33	1.10	2.10	3.38	8	0.5	3	4
1997	Male	53.1	4	3.8	49.5	58.0	1.65	4	0.35	1.23	2.00	3.50	4	0.6	3	4
	Female	52.1	18	4.0	40.0	56.5	1.43	17	0.28	0.91	1.93	3.33	18	0.5	3	4
	All	52.3	22	3.9	40.0	58.0	1.48	21	0.30	0.91	2.00	3.36	22	0.5	3	4
1998	Male	54.5	2	2.1	53.0	56.0	1.69	2	0.15	1.59	1.80	3.50	2	0.7	3	4
	Female	53.3	21	2.7	49.5	60.0	1.53	20	0.23	1.13	2.04	3.44	18	0.5	3	4
	All	53.4	23	2.6	49.5	60.0	1.54	22	0.30	1.13	2.04	3.45	20	0.5	3	4
1999	Male	55.2	12	3.9	50.8	61.0	1.77	12	0.42	1.36	2.90	3.90	10	0.7	3	5
	Female	54.5	29	3.3	48.0	60.5	1.68	32	0.37	1.10	2.50	3.61	31	0.5	3	4
	All	54.7	41	3.4	48.0	61.0	1.71	44	0.38	1.10	2.90	3.68	41	0.6	3	5
2000	Male		0					0					0			
	Female	54.6	7	2.4	51.5	57.5	1.69	6	0.29	1.42	2.10	3.71	7	0.5	3	4
	All	54.6	7	2.4	51.5	57.5	1.69	6	0.29	1.42	2.10	3.71	7	0.5	3	4
2001	Male	53.2	10	3.9	43.5	57.0	1.71	10	0.39	1.00	2.35	3.50	10	0.7	3	5
	Female	53.2	15	4.44	43.0	59.0	1.62	16	0.42	0.68	2.27	3.47	15	0.5	3	4
	All	53.2	25	4.15	43.0	59.0	1.66	26	0.40	0.68	2.35	3.48	25	0.6	3	5
2002	Male	55.3	8	3.17	50.0	59.0	1.81	6	0.21	1.60	2.14	3.38	8	0.5	3	4
	Female	53.6	14	2.75	46.0	56.5	1.63	14	0.26	1.30	2.10	3.50	14	0.5	3	4
	All	54.2	22	2.96	46.0	59.0	1.68	20	0.26	1.30	2.14	3.45	22	0.5	3	4
2003	Male		0					0					0			
	Female	54.0	2	1.41	53.0	55.0	1.78	2	0.25	1.60	1.96	3	2	0	3	3
	All															
1992-03	Male	54.0	86	3.58	43.5	62.0	1.68	82	0.35	1.00	2.90	3.35	85	0.57	3	5
	Female	53.1	267	3.59	40.0	71.0	1.58	241	0.37	0.68	3.97	3.33	264	0.57	2	7
	All	53.3	353	3.60	40.0	71.0	1.60	323	0.36	0.68	3.97	3.34	349	0.56	2	7

Table 10. Campbellton River adult salmon returns, spawning escapement and egg deposition, 1993-2003.

SPAWNING ESCAPEMENT **SE = (FR) - (PPS + RCT + HRM)**

SE= Spawning escapement
FR= Fish released by counting fence
PPS= Precicious postsmolts (Since precocious postsmolts are considered a separate category of small salmon they were substracted)
RCT= Recreational catch (retained from the upstream adult salmon migration)
RCL= Recreational catch (released)
HRM= Recreational mortality (RCL *0.1)

		Year													
		1993	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**MIN**	**MAX**	**Average (1993-2002)**
FR	**Small**	4001	2857	3035	3208	1975	3275	3076	1798	2151	1974	2219	1798	4001	2735
	Large	145	191	218	560	321	402	493	208	119	123	152	119	560	278
PPS	**Small < 40 cm**			13	49	69	51	83	208	228	253	147	13	253	119.25
RCL	**Small**	103	289	220	372	100	209	242	176	29	57	37	29	372	179.7
	Large	0	42	17	26	11	4	46	51	9	6	0	0	51	21.2
HRM	**Small**	10.3	28.9	22.0	37.2	10.0	20.9	24.2	17.6	2.9	5.7	3.7	2.9	37.2	18.0
	Large	0	4.2	1.7	2.6	1.1	0.4	4.6	5.1	0.9	0.6	0	0.0	5.1	2.12
RCT	**Small**	316	587	517	592	334	337	433	226	148	136	139	136	592	363
	Large	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SE	**Small**	3675	2241	2483	2530	1562	2866	2536	1346	1772	1579	1929	1346	3675	2259
	Large	145	191	218	557	320	401	491	203	118	122	152	118	557	277

EGG DEPOSITION **ED = SE * PF * RF * MW**

ED= Egg deposition
SE= Spawning escapement
PF= Proportion females
RF= Relative fecundity (eggs/kg)
MW= Mean weight of females

		Year													
		1993	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**MIN**	**MAX**	**Average (1993-2002)**
SE	**Small**	3675	2241	2483	2530	1562	2866	2536	1346	1772	1579	1929	1346	3675	2259
	Large	145	191	218	557	320	401	491	203	118	122	152	118	557	277
PF *	**Small**	0.736	0.727	0.818	0.776	0.776	0.776	0.739	0.776	0.615	0.652	0.776	0.615	0.818	0.739
	Large	0.769	0.769	0.769	0.769	0.769	0.769	0.769	0.769	0.769	0.769	0.769	0.769	0.769	0.769
RF	**Small**	2100	2100	2100	2100	2100	2100	2100	2100	2100	2100	2100	2100	2100	2100
	Large	2100	2100	2100	2100	2100	2100	2100	2100	2100	2100	2100	2100	2100	2100
MW **	**Small**	1.47	1.56	1.55	1.55	1.43	1.53	1.68	1.55	1.62	1.58	1.55	1.43	1.68	1.552
	Large	3.13	3.13	3.13	3.13	3.13	3.13	3.13	3.13	3.13	3.13	3.13	3.13	3.13	3.13
ED	**Small**	8,344,498	5,339,723	6,611,211	6,389,971	3,639,972	7,146,013	6,611,317	3,400,845	3,710,052	3,416,557	4,873,180	3400845	8344498	5461016
	Large	732,922	964,930	1,101,405	2,814,927	1,617,989	2,027,920	2,480,816	1,025,586	596,953	618,688	768,305	596953	2814927	1398214
	Total	9,077,421	6,304,653	7,712,616	9,204,899	5,257,962	9,173,933	9,092,133	4,426,431	4,307,005	4,035,244	5,641,485	3,997,797	9204899	6,859,230
	% Large	8.1%	15.3%	14.3%	30.6%	30.8%	22.1%	27.3%	23.2%	13.9%	15.3%	13.6%	14.9%	30.6%	20.4%
Conservation requirements		2,916,000	2,916,000	2,916,000	2,916,000	2,916,000	2,916,000	2,916,000	2,916,000	2,916,000	2,916,000	2,916,000	2,916,000	2,916,000	2,916,000
% requirements met		311%	216%	264%	316%	180%	315%	312%	152%	148%	138%	193%	137%	316%	235%

*The PF and MW for large salmon are default values calculated from several rivers in Notre Dame Bay (O'Connell et al.1996).

**During years of low recreational sampling (< 25 fish) the MW and PF are derived means from combining the data from 1992-2003.

CONSERVATION REQUIREMENT: 2.916 million eggs (~ 1,480 small salmon) calculated as fluvial area x 2.4 eggs/m² and lacustrine area x 368 eggs/ha.

Table 11. Summary of assessment of Campbellton River salmon stock based on downstream migrating kelts from the next year. Based on a conservation requirement of 2,916,000 eggs.

									Kelts											Percent of
	Fence count		Angling				Spawning escapement		Mean Fork length		Percent female		Fecundity (eggs/cm)		Egg deposition				Conservation	conservation
Year	Small	Large	Small		Large		Small	Large	Small	Large	Small	Large	Small	Large	Small	Large	Total		requirements	requirement
			Retained	Mortality	Retained	Mortality														
1993	4001	145	316	10.3	0	0	3675	145	51.9	66.4	0.736	0.769	59.97	59.97	8417849	444013.8	8861862.401		2,916,000	304%
1994	2857	191	587	28.9	0	4.2	2241	187	53.0	67.2	0.727	0.769	59.97	59.97	5178519	578904	5757422.869		2,916,000	197%
1995	3035	218	517	22	0	1.7	2496	216	51.1	68.0	0.818	0.769	59.97	59.97	6256808	678306.3	6935114.332		2,916,000	238%
1996	3208	560	592	37.2	0	2.6	2579	557	51.9	70.1	0.776	0.769	59.97	59.97	6228462	1801961	8030422.507		2,916,000	275%
1997	1975	321	334	10	0	1.1	1631	320	51.6	68.3	0.776	0.769	59.97	59.97	3916512	1007617	4924128.384		2,916,000	169%
1998	3275	402	337	20.9	0	0.4	2917	402	51.4	69.6	0.776	0.769	59.97	59.97	6977666	1289031	8266697.38		2,916,000	283%
1999	3076	493	433	24.2	0	4.6	2619	488	52.6	68.1	0.739	0.769	59.97	59.97	6104731	1533851	7638582.383		2,916,000	262%
2000	1798	208	226	17.6	0	5.1	1554	203	44.4	65.9	0.776	0.769	59.97	59.97	3211748	616634.5	3828383.028		2,916,000	131%
2001	2151	119	148	2.9	0	0.9	2000	118	52.5	69.9	0.615	0.769	59.97	59.97	3872756	380704	4253460.398		2,916,000	146%
2002	1974	123	136	5.7	0	0.6	1832	122	52.2	67.3	0.652	0.769	59.97	59.97	3739803	379889.1	4119692.163		2,916,000	141%
2003	2219	152	139	3.7	0	0	2076	152												
Mean	2688	267	342	17	0	1.9	2329	265	51.26	68.08	0.7391	0.769	59.97	59.97	5390485	871091	6261577		2916000	215%

Note: Mean fork length of kelts are used to represent fork length of upsteam migrating adults from the previous year.
Angling catch and mortality at 10%

Table 12. Flesh scarring and net marks observed on the upstream migration of adult salmon on the Campbellton River, 1994-2003.

Year	Upstream migration of adult salmon	Number of adult salmon that were scarred	Percent scarred
1994	3048	189	6.20%
1995	3253	173	5.32%
1996	3768	162	4.30%
1997	2296	99	4.31%
1998	3677	214	5.82%
1999	3569	147	4.12%
2000	2006	228	11.37%
2001	2270	113	4.98%
2002	2097	77	3.67%
2003	2371	177	7.47%
Total	28,355	1,579	5.57%