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Status of Atlantic salmon, *Salmo salar*, in Conne River, SFA 11, Newfoundland, 2003

État du stock de saumon atlantique, *Salmo salar*, de la rivière Conne (SPS 11) à Terre-Neuve, en 2003

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Abstract

Results obtained from a fish counting fence provide the basis for the assessment of the Conne River Atlantic salmon stock. Total returns to home waters (river and estuary) ranged from a high of about 10000 salmon (small and large size components) in 1987, to a low of 1643 in 2001. The lowest returns of small salmon occurred in 2001 whereas 2003 marked the worst year to date for returns of large salmon. Overall, abundance of small and large salmon has declined dramatically over time. Conservation spawning requirements have been met or exceeded in 13 of 18 years (72.2%) but only once in each of the past three years. Egg-to-smolt (freshwater) survival has varied by a factor of 5, similar to that observed for smolt-to-adult 1SW (marine) survival. Marine survival has varied from a high of 10.0% (adult returns in 1988) to a low of 2.2% (adult returns in 2003), but in the past three years has averaged less than 3%. Biological characteristic information, aquaculture production statistics, and surveys of escaped farmed fish recorded at Conne River are updated in this report through to and including results from 2003.

Résumé

Les données recueillies à une barrière de dénombrement sont utilisées pour évaluer l'état du stock de saumon atlantique de la rivière Conne. Les remontes totales vers les eaux natales (rivière et estuaire) s'échelonnent entre un pic d'environ 10 000 saumons (petits et gros) en 1987 et un creux de 1 643 en 2001. La plus faible remonte de petits saumons s'est produite en 2001 tandis que 2003 était la pire année jusqu'à maintenant pour ce qui est des remontes de gros saumons. En général, l'abondance des petits et des gros saumons a énormément diminué au fil du temps. Les besoins en géniteurs propres à assurer la conservation du stock ont été satisfaits ou dépassés pour 13 de 18 années (72,2 %), mais seulement une fois au cours des trois dernières années. Le taux de survie à partir de l'éclosion des oeufs jusqu'au stade de smolt (eau douce) a varié par un facteur de 5, soit un niveau semblable au taux de survie entre le stade de smolt et le stade d'adulte unibermarin (eau de mer). Le taux de survie en mer a varié d'un pic de 10,0 % (remontes d'adultes en 1988) à un creux de 2,2 % (remontes d'adultes en 2003), mais se situait en moyenne à moins de 3 % au cours des trois dernières années. Les données sur les caractéristiques biologiques, les statistiques sur la production aquacole et les données de relevés des saumons d'élevage évadés capturés dans la rivière Conne sont mises à jour jusqu'à 2003 inclusivement.

Introduction

Conne River flows into Bay d'Espoir on the south coast of Newfoundland in Salmon Fishing Area (SFA) 11. It is primarily a one-sea-winter (1SW) Atlantic salmon (*Salmo salar*) river, with a reported drainage area of 602 km^2 and a total length of 193 km (Porter et al. 1974). The system is characterized by three major tributaries: Main stem - Conne River (51.7% of the drainage area); Twillick Brook (31.6% of the drainage); and Bernard Brook, the smallest component of the watershed area (16.7%). There are also more than 200 lakes within the Conne River system, with a total accessible area of 3187 ha. Overall, the ratio of lacustrine (L) to fluvial (F) habitat of Conne River (L/F expressed as m^2) is 24.1 (O'Connell and Dempson 1995). Juvenile salmon make extensive use of lacustrine areas in the Conne River watershed (Dempson et al. 1996; O'Connell and Dempson 1996). Previous investigations have noted genetic differences in salmon among the tributaries (Beacham and Dempson 1998). In addition to Atlantic salmon, the system also contains brook charr (*Salvelinus fontinalis*), rainbow smelt (*Osmerus mordax*), American eel (*Anguilla rostrata*), alewife (*Alosa pseudoharengus*), and threespine stickleback (*Gasterosteus aculeatus*). Since 1990, rainbow trout (*Oncorhynchus mykiss*) escaping from local aquaculture farms have been captured in Conne River, while several specimens of Arctic charr (*Salvelinus alpinus*) were first observed in 1999 (Dempson et al. 2000; Dempson et al. 2002).

Since 1986, a fish counting fence has been operated to enumerate the upstream migrating population of Atlantic salmon. Previously, estimates of total returns of small (< 63 cm) salmon have ranged from a low of 1503 in 2001 to a high of 10155 in 1987. Mark-recapture studies were initiated in 1987 to survey the number of out migrating smolts. Smolt production has varied from about 56 thousand in 1993 to over 100 thousand in 1997.

Conne River has been assessed relative to a management target (MT) as well as a conservation spawning requirement (CSR). The latter differs and is lower than the management target. The management target was based upon the estimated number of spawners required to produce the highest recorded returns to the river, which occurred in 1987 (Dempson et al. 2000).

The last full assessment of the Conne River stock considered information up to and including the year 2000 (Dempson et al. 2000). In this paper, we update the status of the stock by examining smolt production and returns of adult Atlantic salmon through to 2003. In addition to information associated with trends in abundance, we also update life-history and biological characteristic data, provide revised summaries of both freshwater (egg-to-smolt) and marine survival (smolt to adult, and consecutive spawning adult salmon) and summarize salmonid aquaculture production statistics from the Bay d'Espoir area. Information on the occurrence of escaped farmed steelhead (rainbow) trout and Atlantic salmon in Conne River is also noted.

Methods

1. Catch

Information on recreational or food fishery catches of Atlantic salmon was obtained from Department of Fisheries and Oceans (DFO) Fisheries Officers and by Native guardians from the Conne River Native Band Council. In recent years when the recreational fishing season has been opened for several weeks only, information on catches has been derived from both guardian records and DFO staff.

2. Aquaculture production

Bay d'Espoir is a site of salmonid finfish aquaculture operations. Production statistics for the Bay d'Espoir area for Atlantic salmon and steelhead trout from 1986 to 2002 were obtained from a Fisheries and Oceans Canada web site: www.dfo-mpo.gc.ca/communic/statistics/aqua/index_e.htm; preliminary data for 2003 were provided by Geoff Perry (Fisheries and Oceans Canada, Newfoundland Region, personal communication). Recently, aquaculture operations for salmon have been moved into Fortune Bay. Escaped farmed salmon or rainbow trout encountered at the Conne River fish counting fence are noted and recorded.

3. Biological characteristics

Biological characteristic data on adult salmon including fork length, whole weight, age (scales) and sex, were derived from sampling fish captured at the fish counting fence or from samples obtained from the recreational or in some cases, an Aboriginal salmon food fishery (1988, 1992, 1993, 1997). Biological data on Atlantic salmon smolts were obtained from specimens sampled at the downstream fish counting fence trap.

Salmon returning to the river were initially categorized as either small (< 63 cm) or large (≥ 63 cm) salmon. Scale data were used to identify various life-history spawning types (e.g. consecutive or alternate spawners), and to apportion returning small salmon into maiden versus first time repeat spawners in order to estimate the subsequent marine survival of this life-stage component. In determining respective survival of individual freshwater age groups of returning adult salmon, for example, river-age 3, 1SW fish (3:1), biological data from salmon caught in the Conne River salmon food fishery (1988, 1992, 1993, & 1997) were used to supplement information obtained from the fish counting fence and recreational fishery. Similarly, age sampling of smolts allows the apportioning of respective age classes from which individual year class production can be determined. By converting the number of female spawners (see below) into numbers of eggs deposited, estimates of egg-to-smolt (freshwater) survival can be obtained.

Condition of smolts was determined using Fulton's condition factor (K) as follows:

$$K = W \times C / FL^3$$

where, W = whole weight in grams; C = a constant; and FL = fork length in mm.

4. Estimated total returns and spawning escapement

Adult Atlantic salmon were enumerated at a fish counting fence, located about 1 km upstream from the mouth of the Conne River. Dates of fish counting fence operations are summarized in Table 1. The counting fence has been monitored as a co-operative project between Fisheries and Oceans and the Miawpukek Mi'kamawey Mawi'omi (Council of Conne River Micmacs).

Total river returns

Total river returns (TRR) of adult salmon were calculated as follows:

$$TRR = C + RC_b + Mb$$

where, C = the count of salmon at the counting fence
RC_b = recreational catch below the fence
Mb = known or estimated mortalities below the counting fence

Spawning escapement

Spawning escapement (SE) was calculated as:

$$SE = FR - Ma$$

where, FR = the number of fish released at the counting fence
Ma = the number of known mortalities (including angled salmon) above the fence

Consistent with the practise established in 1991, estimated egg deposition refers to the 'potential' deposition relative now to either the current management target or the conservation spawning (egg) requirement. That is, no additional adjustments have been made to account for any unknown or assumed mortality of fish up to the time of spawning. Thus, the potential egg deposition could overestimate the actual egg deposition.

Egg deposition

As in previous years, egg deposition (ED) was calculated separately for salmon < 63 cm and salmon ≥ 63 cm and then totalled.

$$ED = SE \times PF \times F$$

where, PF = proportion of females; F = fecundity at size

An estimate of fecundity was obtained from the relationship derived in 1987 (October 27-30) from ripe salmon (Dempson et al. 1987):

$$\text{Fecundity} = 0.1988(\text{fork length})^{2.3942} \qquad (r^2 = 0.48,\ P < 0.001)$$

where fork length (cm) was the mean length of female salmon < 63 cm. Since 2000, the fork length and proportion of females used were based on mean values ($\bar{x}$ = 50.9 cm; percentage female was 77.5%).

An estimate of the egg deposition from salmon ≥ 63 cm in size was obtained using the same length-fecundity relationship for salmon < 63 cm, with the same percent females (71%) and mean length (69.1 cm) as used in past years (Dempson et al. 2000).

The management target has been maintained as in past years at 7.8 million eggs, equivalent to about 4000 salmon < 63 cm in size.

The conservation spawning (egg) requirement (ER) was determined following the method summarized in O'Connell and Dempson (1995) for average potential smolt production:

fluvial habitat	=	13180	units	@ 3 smolt/unit
lacustrine habitat	=	3187	hectares	@ 7 smolt/unit

Corresponding egg deposition requirements were derived using egg-to-smolt survival rates of 0.0125 and 0.019 for fluvial and lacustrine habitats, respectively. The conservation spawning (egg) requirement is 4,337,358 eggs versus 7.8 million as a management target.

The equivalent total number of spawners (TNS) associated with the conservation spawning (egg) requirement has not changed and was calculated as follows:

$$TNS = \frac{ER}{[\,(PS \times PF_s \times F_s)\,]}$$

where,

PS	=	proportion small salmon (< 63 cm) in TRR, 1992-96 ($\bar{x}$ = 0.958)
PF_s	=	proportion female small salmon, 1992-96 ($\bar{x}$ = 0.769)
F_s	=	fecundity of small salmon at size ($\bar{x}$ length, 1992-96 = 50.5 cm, = 2379)

Thus, TNS = 2475 small salmon; large salmon are still considered a buffer to spawning requirements.

5. Smolt production

Mark-recapture is used to estimate the number of seaward migrating smolt. This component has been ongoing since 1986. Details of the field design are provided in Dempson and Stansbury (1991) while the estimator itself is described in Schwarz and Dempson (1994).

Results and Discussion

1. Catch

Recreational catch statistics are summarized in Table 2. Historically, removals of more than 2000 salmon were reported (e. g. 1980 – 1986), with catch and effort declining through to the end of the 1980s. Low returns resulted in river closures or quotas during the early 1990s. A moderately strong run resulted in increased catches in 2000. However, a management change was implemented in 2001 whereby the river was initially opened for a two-week fishery after which results from an in-season review of stock status would determine whether abundance was high enough to allow the fishery to re-open (conservation requirements likely to be met) or too low such that the fishery remain closed. Hence, from 2001 to 2003, Conne River was opened for a two week fishery only with the number of small salmon caught and retained ranged from 180 to 275 (Table 2). Catch and release statistics (see Dempson et al. 2002) are not recorded at Conne River. Aboriginal food fisheries have not been undertaken since 1997.

2. Aquaculture production

Production of farmed fish at Bay d'Espoir began in 1986. Combined production of salmon and steelhead trout remained low (< 100 t) until 1990. Production of more than 100 tonnes for each species occurred for the first time in 1993 (Table 3). By 2001, production in excess of 1000 tonnes of each species first occurred. Recently, salmon farming activities have expanded into Fortune Bay.

Tables 4 and 5 summarize the incidence of escaped farmed salmon and steelhead trout at Conne River in recent years. Information from past years has been summarized in previous Research Documents (Dempson et al. 1998, 1999, 2000, 2001). Escaped farmed salmon have not been identified since the year 2000, while steelhead (rainbow) trout are commonly observed. In 2001, besides the routine surveys and examination of fish and scale characteristic data to identify escaped farmed salmon, two additional studies were carried out to identify the incidence of escaped farmed salmonids.

In-river underwater snorkeling surveys – steelhead trout (June – July 2001)

Snorkeling surveys were carried out at periodic intervals when water level conditions permitted. In total, ten (10) separate snorkeling events were conducted and included areas downstream from the adult fish counting fence, and sections of Bernards Brook tributary and the main stem of Conne River. Details are provided in Table 5 (lower section). Approximately 16 km of stream were surveyed by underwater snorkeling and 19 escaped rainbow trout were observed. Only one (1) rainbow trout was found upstream of the Dashwoods Steady area.

Stable isotope analyses – Atlantic salmon

In this component, stable isotopes were used as a means by which farmed Atlantic salmon versus wild salmon could be identified. In this study (Dempson and Power 2004), stable isotopes of carbon and nitrogen ($\delta^{13}C$ and $\delta^{15}N$) were examined in 49 angled salmon and 99 fish sampled from the fish counting fence trap and were compared with isotopic signatures from known origin farmed salmon. The study illustrated that the technique could be used successfully to distinguish farmed from wild salmon, but in this particular year, none of the samples were found to be consistent with that characterized as escaped farmed fish.

Results of these project components are provided here as concerns have been raised as to the potential impact local fish farming activities could have on wild salmonid stocks in the Bay d'Espoir region (Pepper et al. 1998; Whoriskey 1999).

3. Biological characteristics

Table 6a summarizes annual biological characteristic data of smolt and 1SW Conne River salmon, 1986 – 2003. Similar information partitioned into small and large size groups, is provided in Table 6b for maiden 1SW and 2SW salmon, along with consecutive and alternate spawning life-history categories. Large salmon at Conne River are primarily alternate spawning fish.

Changes in mean length of 1SW salmon, separately for river age 3 and 4 fish, are illustrated in Figure 1. River age 4, 1SW fish (age 4:1) are often slightly larger than 3:1 salmon but overall, there is relatively little difference between the two groups. Mean length of 3:1 and 4:1 salmon has increased by about 1 to 1.5 cm in recent years (Fig. 1).

With respect to smolts, there is relatively little variation in size of river age 3 versus age 4 fish (Fig. 2). The smallest size smolts were recorded in 1995 but since then average length has generally increased. Condition of smolts has also varied over time (Fig. 2). Highest values were recorded in 1988 and declined steadily to the lowest recorded in 1992. From then until 1999, there was a general trend for increased condition of Conne River smolts followed by a slight reduction in recent years (Fig. 2).

O'Connell et al. (1997) examined inter-annual variation in fecundity for a variety of Newfoundland salmon rivers, including Conne River. Data (N = 582) from small salmon sampled during the early summer at Conne River are now available from nine years (1986 - 1988, 1990 – 1992, 1997, 2000 and 2001) and are expressed in terms of number of eggs per female, as well as relative fecundity in terms of weight and length (Table 7). It was previously noted that there was a substantial decline in fecundity from 1988 to 1992. As indicated in Table 7, following the low fecundity values during the early 1990's, fecundity in more recent years has again been moderately high.

Freshwater and marine survival

Estimates of the survival in freshwater, from eggs to subsequent smolt, are now available for 13 year-classes (1986 to 1998). Survival increased three-fold from the average of the 1986 to 1990 values (mean = 0.59%) to those estimated from 1991 to 1995 (mean = 1.86%) (Fig. 3). As noted in past reports, the dramatic increase in freshwater survival coincided with years of reduced egg depositions. Reasons for the wide variation in freshwater survival are unknown, but some information is suggestive of possible density-dependent causes. Further discussion and comparison with other studies is provided in Klemetsen et al. (2003) and Dempson et al. (2004).

Marine survival from smolt to adult small salmon or 1SW salmon has also varied widely (Fig. 3). Highest survivals occurred in the initial years of the project (late 1980s) and again with the return of adult salmon in 2000 (Table 8). The lowest survival recorded occurred with adult salmon returns in 2003 when only 2.19% of the fish returned as 1SW fish. High variability in survival results in irregular plots of smolts versus subsequent numbers of small salmon in the following, with no evidence of increased numbers of smolts resulting in more adult fish (Fig. 4). Similar lack of correspondence between smolt numbers and subsequent adult small salmon return has also been documented for other Newfoundland systems (Dempson et al. 2003).

Survival of repeat spawning salmon (consecutive, first-time spawners only) increased substantially from the late 1980s and early 1990s to the highest value recorded in the mid-1990s (Table 9; Fig. 3). It is noted that repeat spawner survival did not increase appreciably until several years after the commercial salmon fishery moratorium began. Survival of repeat spawning fish has remained at around 5% in each of the past two years, well below earlier values recorded.

A detailed analysis of survival in the context of run timing and smolt size has recently been completed (Dempson et al. 2003). At Conne River, longer or heavier smolt were inversely related to survival (Fig. 5) whereas there was a suggestion that smolt with higher condition could yield an overall greater return rate in the following year (Fig. 5). Patterns observed among other Newfoundland stocks are also inconsistent.

Run timing

Figure 6 illustrates the run timing of smolts and adult small and large salmon at Conne River. Variability in run timing is apparent for both groups with up to a 21 day difference in the 25th percentile of the run of smolts and 15 day difference in timing of small salmon returns. Median dates of the smolt run were typically later (7 days) during 1991- 1994 (May 21) in comparison with the pre-1990 period (May 14); the earliest smolt run occurred in 1996 while the latest run was in 1997. Smolt run timing in recent years has been somewhat consistent.

Median run timing of small salmon has also varied over time. Initial runs (1986 – 1989) were moderately early, with later runs in 1990 and again in 1991 (the latest recorded). This was followed by progressively early runs through to 1999. In recent years, run timing of small salmon has also been somewhat consistent (Fig. 6).

From 1986-1996, median run timing of large salmon was about 5 days earlier than small salmon. However, from 1997-2000, run timing of large salmon was been about 2 days later than that of small salmon with timing in more recent years being generally similar to that of small salmon.

4. Estimated total returns and spawning escapements

Numbers of salmon enumerated at the fish counting fence, estimated total returns and spawning escapement for small and large salmon are summarized in Tables 10 and 11. Highest returns of small salmon occurred in 1986 to 1988 following which abundance dropped dramatically (Table 10) and, with the exception of year 2000, has generally remained low, with the lowest total returns (1503) in 2001. Large salmon followed a similar pattern; highest abundance in the 1986 to 1988 period, followed by a sharp decline in returns. Numbers of large salmon rose in the late 1990s then declined to the lowest value ever (51) in 2003 (Table 11).

Scatter plots of total returns of small and large salmon are illustrated in Figure 7. In addition, non-linear changes in abundance were graphically highlighted by LOWESS regression (locally weighted regression scatterplot smoothing) (Cleveland 1979; Trexler and Travis 1993). Smoothing was done automatically (SAS 2000) using the Akaike information criterion (AICc). The severe decline in abundance over time is clearly illustrated by the LOWESS plots (Fig. 7) and highlights the lack of response by the Conne River salmon stock to the closure of the Newfoundland commercial salmon fishery in 1992. Low abundance in recent years (2001 to 2003) is directly associated with low marine survival of 1SW and repeat spawning fish (Fig. 3).

Conservation spawning requirements at Conne River have been met or exceeded in 13 or 18 years (72.2%) over the period 1986 to 2003 (Table 11). Years in which conservation requirements were not met are: 1991, 1992, 1994, 2001 (lowest) and 2003 when 81% were met.

5. Smolt production

Smolt production has ranged from a high of 100 thousand (1997) to a low of about 57 thousand (1990). Over all years, average production has been 71,918 (C.V. = 17.8%), approximately 28% less than the peak year of production. Smolts are predominately 3+ (73.3%) and 4+ (24.5%) (Table 12). An estimated 71479 smolts migrated out of Conne River in 2003 (95% confidence interval: 60388 – 82648). Based on the point estimate (71479) a marine survival of 3.46% would be needed in order for conservation requirements to be met in 2004.

Management Plan - 2004

Concerns related to the opening of the river for angling when conservation requirements were likely not going to be met in 2003 resulted in a change in the management plan for Conne River in 2004. First, the opening date of the recreational fishery was delayed until June 21. However, the river would not open unless at least 425 small plus large salmon had entered the river by June 20. Over the past 18 years, situations in which at least this number of fish were counted by June 20 always resulted in conservation requirements being achieved. Hence, this added requirement for 2004 was initiated to better ensure the conservation of this stock.

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Table 1. Summary of dates of operation for downstream smolt mark-recapture studies, and upstream adult salmon counts at Conne River, Newfoundland, 1986 - 2003.

Year	Smolt mark-recapture studies		Adult salmon counts	
	Start	Finish	Start	Finish
1986			May 12	Sept 10
1987	April 26	June 16	May 18	Sept 8
1988	May 9	June 14	May 21	Aug 29
1989	May 9	June 15	May 20	Aug 28
1990	May 3	June 20	May 23	Aug 6
1991	May 3	June 16	May 26	Aug 18
1992	May 10	June 15	May 26	Aug 10
1993	May 9	June 14	May 28	July 31
1994	April 28	June 18	June 1	Sept 25
1995	May 2	June 8	May 30	Oct 16
1996	April 26	June 11	May 21	Sept 23
1997	May 15	June 15	May 29	Sept 4
1998	April 30	June 5	May 19	Sept 20
1999	April 21	June 8	May 16	Sept 13
2000	April 20	June 8	May 22	Aug 19
2001	May 8	June 11	May 24	July 29
2002	May 1	June 9	May 22	Aug 4
2003	May 8	June 2	May 24	Aug 10

Table 2. Atlantic salmon landings (numbers of fish) in the Conne River recreational fishery, 1974 - 2003, and in the estuarine Aboriginal food fishery, 1986 - 1999. Note that the recreational fishery was closed from 1993 to 1996 and again from 1998 to 1999, while the food fishery was closed from 1994 to 1996 and continuously since 1998. There has been no estuarine Aboriginal food fishery in recent years.

	Recreational Fishery				Aboriginal Food Fishery (estuary)			
	Effort	Salmon catch				Salmon catch		
Year	rod-days	Small	Large	Total	Quota	Small	Large	Total
1974	4033	1988	17	2005				
1975	3800	1903	17	1920				
1976	3894	1931	27	1958				
1977	3375	1665	5	1670				
1978	3122	1735	7	1742				
1979	2147	1010	0	1010				
1980	3512	2238	14	2252				
1981	5029	2691	2	2693				
1982	5268	3302	24	3326				
1983	6972	2192	21	2213				
1984	6709	2343	0	2343				
1985	5202	2729	0	2729				
1986	6038	2060	0	2060	1200	519	3	522
1987	4979	1598	0	1598	1200	18	0	18
1988	5504	1544	0	1544	1200	607	2	609
1989	4414	1036	0	1036	1200	381	1	382
1990	2740	767	0	767	1200	948*	11	959
1991	679	108	0	108	1200	281	3	284
1992	1499	329	0	329	1200	483	5	488
1993	0	0	0	0	500	417	3	420
1994	0	0	0	0	0	0	0	0
1995	0	0	0	0	0	0	0	0
1996	0	0	0	0	0	0	0	0
1997		197	0	197	600	514	1	515
1998	0	0	0	0	0	0	0	0
1999	0	0	0	0	0	0	0	0
2000		730	0	730	0	0	0	0
2001		215	0	215	0	0	0	0
2002		275	0	275	0	0	0	0
2003		180	0	180	0	0	0	0

* Total for 1990 does not include approximately 50 fish found dead and partially destroyed in traps.

Quotas of 100 and 330 small salmon were in effect for the recreational fishery in 1991 and 1992, respectively.

Initial food fishery allocation pending an inseason stock status review was for 600 small salmon.

Table 3. Summary of Atlantic salmon and steelhead (rainbow) trout aquaculture production (tonnes) at Bay d'Espoir, Newfoundland, 1986 - 2003. Data for 2003 are considered preliminary. Data from 1986 to 2002 were obtained from: www.dfo-mpo.gc.ca/communic/statistics/aqua/index_e.htm

Year	Salmon	Steelhead	Total
1986	1	18	19
1987		20	20
1988	9	20	29
1989		20	20
1990		90	90
1991	66	76	142
1992	75	88	163
1993	100	118	218
1994	46	334	380
1995	115	447	562
1996	295	734	1029
1997	613	355	968
1998	401	1316	1717
1999	399	2078	2477
2000	670	842	1512
2001	1092	1719	2811
2002	1270	1600	2870
2003	1157	2136	3293

Table 4. Occurrence of escaped farmed Atlantic salmon at Conne River, Newfoundland, 1993 - 2003.

Year	Number of specimens examined	Number of farmed salmon identified	Percentage farmed origin	Life Stage	Location	Method of identification
1993	1	1	100	Adult	Food Fishery	Scales
1994	94	2	2.1	Adult	Conne River	Scales
		12		Smolt	Conne River	Scale identification and colouration
1995	120	0	0	Adult	Conne River	Scales
1996	97	0	0	Adult	Conne River	Scales
		59		Smolt	Conne River	Scale identification and colouration
1997	430	8	1.9	Adult	Conne River	External chacteristics
	235	2	0.9	Adult	Conne River	Scales
	480	4	0.8	Adult	Food Fishery	Scales
1998	191	2	1.0	Adult	Conne River	Scales
1999	174	1	0.6	Adult	Conne River	Scales
2000	221	5	2.3	Adult	Conne River	Scales
2001	189	0	0.0	Adult	Conne River	Scales
2002	279	0	0.0	Adult	Conne River	Scales
2003	181	0	0.0	Adult	Conne River	Scales

Table 5. Summary of rainbow trout occurrences and captures at Conne River, 2001 - 2003, with corresponding size data where available. Information from past years has been summarized in previous research documents (Dempson et al. 1999, 2000, 2001).

Year	Date	Location/gear	Number	Length (mm)
2001	May 8 - June 5	Camp 1 - Smolt fence	0	
	May 9 - June 11	Lower fence smolt trap	0	
	May 24 - July 29	Adult fence trap	12	298 to 530
	June 15	Lower fence - Angled	2	465, 430
	June 18	Lower fence - Angled	1	445
	June 20	Lower fence - Angled	1	435
	June 27	Lower fence - Angled	1	590
2002	May 8	Smolt fence trap	1	400
2003	May 17	Smolt trap	1	185
	May 25	Snorkeling - lower fence area	12	200 - 300
	June 9	Adult trap	1	370
	June 13	Snorkeling - lower fence area	3	< 300
	June 14	Angled - lower fence area	10	< 300
	June 17	Angled - lower fence area	1	~ 350
	June 24	Snorkeling - lower fence area	2	< 300
	June 26	Angled - lower fence area	1	320
	June 28	Adult trap	1	~ 250
	June 28	Snorkeling - lower fence area	4	200 - 400

	Escaped fish snorkeling survey - 2001			
Date	Area surveyed	Approximate Distance surveyed (km)	Number of rainbow trout observed	Approximate length of trout observed
June 5	Bernards Bridge to Conne Main stem	1	0	
June 17	Conne Pond to forest access road	4	0	
June 18	Camp 1 to Conne River highway bridge	3	1	30 - 40 cm
June 19	Conne highway bridge to transmission pole line	4	0	
June 29	Downstream of adult fish counting fence on main stem	0.5	2	30 - 60 cm
June 30	Above and below adult fish counting fence	1	7	30 - 60 cm
July 1	Brimstone pool (above Dashwoods Steady)	1	0	
July 9	Section below adult fish counting fence on main stem	0.5	3	30 - 60 cm
July 12	Section below adult fish counting fence on main stem	0.5	3	30 - 60 cm
July 30	Section below adult fish counting fence on main stem	0.5	3	30 - 60 cm

Table 6a. Summary of biological characteristics for Atlantic salmon samples from Conne River, Newfoundland (SFA 11), 1986 - 2003.

Lifestage	Year	Fork length (mm)					Whole weight (g)					River age (y)					Sex Ratio	
		N	Mean	SD	Min	Max	N	Mean	SD	Min	Max	N	Mean	SD	Min	Max	N	% female
Smolt	1987	271	144	16.5	106	198	271	29.1	9.9	11.5	73.8	271	3.32	0.54	2	5	270	77.0
	1988	328	147	15.7	102	201	328	32.3	10.4	12.4	78.8	328	3.41	0.51	3	5	327	72.8
	1989	288	152	21.3	98	238	288	35.0	14.0	9.8	123.2	288	3.25	0.53	2	5	288	79.2
	1990	271	148	21.2	100	253	271	30.5	13.1	10.3	122.8	271	3.29	0.49	2	5	271	73.8
	1991	246	153	19.9	104	244	246	33.5	13.6	12.6	112.5	246	3.19	0.44	2	5	245	65.7
	1992	169	149	15.6	116	189	169	30.1	8.9	14.9	59.2	169	3.28	0.51	2	5	169	71.0
	1993	246	149	16.5	114	198	246	31.6	10.3	15.7	71.7	246	3.26	0.45	3	5	246	66.7
	1994	208	148	15.1	116	190	208	29.6	8.3	16.0	59.2	208	3.20	0.41	2	4	208	74.0
	1995	249	143	15.2	103	179	249	28.6	8.3	10.3	50.6	249	3.31	0.51	2	5	249	72.7
	1996	243	151	16.0	102	224	243	32.9	10.2	16.3	93.8	243	3.16	0.47	2	5	243	72.8
	1997	380	148	16.2	114	233	380	30.9	11.0	14.9	105.8	380	3.21	0.45	2	5	380	75.3
	1998	282	147	14.8	110	233	282	30.8	9.4	12.4	106.0	282	3.23	0.48	2	5	282	70.9
	1999	257	148	15.3	110	188	257	32.1	9.2	13.5	62.8	257	3.19	0.41	2	4	257	73.9
	2000	258	152	18.5	111	226	258	34.4	12.1	15.0	95.6	258	3.27	0.50	2	5	258	74.4
	2001	288	154	16.1	106	218	288	34.4	10.4	12.7	93.9	288	3.21	0.46	2	5	288	73.3
	2002	257	151	15.3	119	221	257	32.8	9.9	15.8	97.0	257	3.18	0.48	2	4	257	76.3
	2003	250	150	13.6	112	185	250	32.3	8.6	14.3	59.0	250	3.28	0.46	3	5	250	71.6
TOTAL		4491	149	17.0	98	253	4491	31.9	10.8	9.8	123.2	4491	3.25	0.48	2	5	4488	73.2
1 SW	1986	357	506	23.0	440	570	357	1451	220.4	900	2900	357	3.38	0.57	2	5	356	76.1
	1987	398	509	23.2	430	580	398	1478	248.2	600	2600	398	3.22	0.48	2	5	352	79.3
	1988	267	506	26.1	440	600	267	1352	226.5	1000	2200	267	3.14	0.42	2	4	261	80.5
	1989	140	512	23.3	460	580	140	1411	201.7	1000	2000	140	3.18	0.50	2	5	135	79.3
	1990	174	508	23.4	449	575	142	1454	184.4	1100	2000	174	3.27	0.52	2	5	141	80.9
	1991	39	514	22.8	455	552	34	1362	172.4	1000	1700	39	3.18	0.39	3	4	33	69.7
	1992	77	505	22.4	453	580	36	1363	276.1	900	2000	77	3.18	0.53	2	5	43	79.1
	1993	39	513	30.8	475	620	0					39	3.05	0.32	2	4	0	
	1994 *	73	510	25.8	405	580	69	1272	193.9	800	1800	73	3.12	0.44	1	4	71	74.7
	1995 *	111	498	24.8	433	573	107	1144	184.4	800	1700	111	3.14	0.42	2	5	105	77.1
	1996	72	518	21.8	475	573	19	1523	219.1	1160	1920	72	3.22	0.51	2	5	2	100
	1997	163	514	22.1	460	590	39	1467	321.5	700	2000	163	3.24	0.48	2	5	39	82.1
	1998	135	502	22.3	420	560	0					135	3.08	0.42	2	4	0	
	1999	112	513	21.6	450	580	1	2300		2300	2300	112	3.15	0.43	2	4	1	100
	2000	193	517	23.4	460	580	110	1644	211.5	1100	2200	193	3.18	0.45	2	4	98	64.3
	2001	178	525	26.7	460	610	61	1698	311.3	1000	2700	178	3.17	0.54	2	4	60	80
	2002	217	517	20.7	440	580	107	1500	234.2	1000	2500	217	3.23	0.44	2	5	105	75.2
	2003	144	523	23.5	460	580	62	1714	291.2	1000	2700	144	3.17	0.44	2	4	63	68.3
TOTAL		2889	511	24.5	405	620	1949	1445	259.5	600	2900	2889	3.21	0.48	1	5	1865	77.2

* Samples of 1SW salmon in 1994 and 1995 were obtained from fish held for brood stock. Thus fish were sampled in September in each of these years.

Table 6b. Summary of biological characteristic information by life-history groups for small and large fish with corresponding notation for Conne River Atlantic salmon, 1986 - 2003.

Life-history group	Notation		Sample size N	Sample size Percent	Fork length (mm) N	Fork length (mm) Mean	Fork length (mm) SD	Fork length (mm) Min	Fork length (mm) Max	Whole weight (g) N	Whole weight (g) Mean	Whole weight (g) SD	Whole weight (g) Min	Whole weight (g) Max	Sex Ratio N	Sex Ratio % female
Small salmon (< 630 mm for length; N = 3088)																
Virgin grilse	1.1		1	0.03	1	531				1	1300				1	100.0
(N = 2889; 93.56%)	2.1		83	2.69	83	509	28.9	440	590	55	1425	281.1	600	2000	54	79.6
	3.1		2137	69.20	2137	510	24.3	405	610	1418	1437	257.5	700	2700	1351	78.0
	4.1		652	21.11	652	513	24.2	420	620	462	1471	263.0	800	2900	446	75.1
	5.1		16	0.52	16	523	26.0	490	590	13	1460	229.8	1000	1800	13	53.9
Consecutive spawning grilse	2.1.SM		5	0.16	5	552	20.5	520	570	3	1633	152.8	1500	1800	3	33.3
(N = 194; 6.28%)	3.1.SM		109	3.53	109	560	31.2	480	625	28	1700	295.6	1300	2400	29	75.9
	3.1.SM.SM		27	0.87	27	596	21.1	560	625	3	2100	360.6	1800	2500	3	100.0
	4.1.SM		46	1.49	46	557	29.1	480	610	7	1453	230.7	1070	1700	6	66.7
	4.1.SM.SM		6	0.19	6	583	28.1	550	625	1	2300				1	100.0
	4.1.SM.SM.SM		1	0.03	1	605										
Alternate spawning grilse	3.1.SM.1		2	0.06	2	613	17.7	600	625	1	2400				1	100.0
Virgin 2SW	2.2		1	0.03	1	600										
	3.2		2	0.06	1	623	3.5	620	625							
Total small salmon -			3088		3088	515	28.5	405	625	1992	1451	264.2	600	2900	1908	77.1
Large salmon (>= 630 mm for length; N = 202)																
Virgin 2SW	2.2		1	0.50	1	675										
(N = 15; 7.4%)	3.2		10	4.95	10	676	46.8	630	770	3	2667	57.7	2600	2700		
	4.2		4	1.98	4	700	35.6	670	7500							
Consecutive spawning large	2.1.SM.SM		2	0.99	2	670	14.1	660	680							
(N = 34; 16.8%)	2.1.SM.SM.SM.SM		1	0.50	1	640										
	3.1.SM		1	0.50	1	630										
	3.1.SM.SM		14	6.93	14	664	52.6	630	795							
	3.1.SM.SM.SM		7	3.47	7	686	28.7	640	730							
	3.1.SM.SM.SM.SM		2	0.99	2	690	0	690	690							
	4.1.SM.SM		5	2.48	5	650	10	640	660							
	4.1.SM.SM.SM		1	0.50	1	650										
	5.1.SM.SM.SM		1	0.50	1	640										
Alternate spawning large	2.1.SM.1		4	1.98	4	681	50.4	630	750							
(N = 153; 75.7%)	3.1.SM.1		123	60.89	123	695	30.6	630	780	2	3350	212.1	3200	3500		
	3.1.SM.SM.1	*	2	0.99	2	730	42.4	700	760							
	3.1.SM.SM.SM.1	*	1	0.50	1	680										
	4.1.SM.1		23	11.39	23	702	33.4	640	790							
Total large salmon -			202		202	690	35.6	630	795	6	2933	350.2	2600	3500	8	75

* These fish originally spawned consecutively, then remained at sea for a full year to return as an alternate spawner. These cases all occurred in salmon that returned in 1998.

Table 7. Mean number of eggs per female, length, weight data, and relative fecundity of Conne River Atlantic salmon.

Year		N	Number of eggs per female				Length (cm)				Weight (kg)				Relative Fecundity	
			Mean	STD	Min	Max	Mean	STD	Min	Max	Mean	STD	Min	Max	No. of eggs per cm	No. of eggs per kg
1987	*	30	2430	403	1796	3454	50.7	2.37	46	56	1.28	0.17	1.02	1.74	47.8	1907
1986		102	3494	682	1450	5590	50.9	2.37	45	56	1.48	0.23	1	2.9	68.7	2367
1987		136	3424	635	1287	5476	51.1	2.36	42	57.6	1.45	0.25	1	2.6	67.0	2364
1988		85	3196	568	2111	5054	50.2	2.5	46	60	1.35	0.24	1	2.2	63.7	2366
1990		93	2245	575	703	3544	51.1	2.09	46	57	1.45	0.18	1.1	2	44.0	1545
1991		22	2772	1241	595	5010	51.7	2.01	47	55.2	1.35	0.15	1	1.6	53.6	2046
1992		21	1768	498	1009	2545	50.6	2.15	45.3	55.2	1.38	0.25	0.9	1.9	35.0	1278
1997		33	3627	459	2929	5158	51.6	2.29	46	57.5	1.45	0.33	0.7	2	70.3	2504
2000		44	3591	678	2383	4768	52.8	2.1	47.5	57	1.69	0.22	1.3	2.1	68.0	2123
2001		46	3174	590	1665	4494	53.8	2.38	50	60	1.68	0.27	1	2.5	59.0	1893
Years Combined	**	582	3135	826	595	5590	51.3	2.48	42	60	1.47	0.2577	0.7	2.9	61.1	2132

* These 1987 data were obtained from ripe salmon sampled at the end of October. For other years, samples were obtained primarily in June and July.

** Information from years combined does not include data from ripe salmon sampled in 1987.

Table 8. Estimates of Atlantic salmon smolts from Conne River, 1987 - 2003, along with subsequent survival to both small salmon or 1SW salmon in year i + 1 to 1SW salmon (repeat spawning fish omitted).

Smolt Migration Year (i)	Number of smolts: Upper site Tagged & released	Number of smolts: Lower site Total number Captured	Number of smolts: Lower site Tag Recoveries	Population estimate N	Population estimate Confidence interval	Population estimate Coeffiicient of variation %	Total returns of salmon: Small year i + 1	Total returns of salmon: 1SW year i + 1	Marine Survival %: Small Salmon year i + 1	Marine Survival %: Small Salmon range	Marine Survival %: 1SW Salmon year i + 1	Marine Survival %: 1SW Salmon range
1987	4975	14314	990	74585	67597 - 81573	5.1	7627	7495	10.23	9.3 - 11.3	10.05	9.2 - 11.1
1988	3235	19515	1054	65692	59862 - 71522	4.8	4968	4764	7.56	6.9 - 8.3	7.25	6.7 - 8.0
1989	2699	16928	604	73724	66598 - 80850	5.1	5368	5277	7.28	6.7 - 8.1	7.16	6.5 - 7.9
1990	3719	13881	945	56943	52315 - 61571	4.4	2411	2239	4.23	3.9 - 4.6	3.93	3.6 - 4.3
1991	3753	9581	398	74645	62033 - 87527	9.0	2523	2463	3.38	2.9 - 4.1	3.30	2.8 - 4.0
1992	3758	10229	529	68208	61334 - 75052	5.4	2703	2685	3.96	3.6 - 4.4	3.94	3.6 - 4.4
1993	2456	15992	735	55765	51666 - 59864	3.9	1533	1286	2.75	2.6 - 3.0	2.31	2.1 - 2.5
1994	2366	11875	479	60762	53759 - 67765	6.2	3502	3440	5.76	5.2 - 6.5	5.66	5.1 - 6.4
1995	2558	12260	545	62749 *	55300 - 70197	6.3	4440	3552	7.20	6.4 - 8.3	5.70	5.0 - 6.5
1996	3373	14575	499	94088	79867 - 108309	8.0	3200	2966	3.40	3.0 - 4.0	3.15	2.7 - 3.7
1997	3715	18290	662	100983	92812 - 109154	8.4	2931	2489	2.90	2.7 - 3.2	2.46	2.3 - 2.7
1998	2952	8636	367	69841	60617 - 79064	13.8	2358	1956	3.38	3.0 - 3.9	2.80	2.5 - 3.2
1999	2179	7545	258	63658	53305 - 74011	16.8	5177	4946	8.13	7.0 - 9.7	7.77	6.7 - 9.3
2000	3361	6168	400	60777	51783 - 69771	8.1	1503	1462	2.47	2.2 - 2.9	2.41	2.1 - 2.8
2001	3143	12357	521	86898	71337 - 102458	2.5	2573	2460	2.96	2.5 - 3.6	2.83	2.4 - 3.4
2002	3214	7981	342	81806	67078 - 96534	9.6	1953	1791	2.39	2.0 - 2.9	2.19	1.9 - 2.7
2003	1335	5271	135	71479 **	60388 - 82648	8.0						

* Of these fish, 5016 smolt were transferred to sea cage holding facilities at Roti Bay of which 286 returned as adults in 1996. Survival value adjusted for this.

** Final estimate for 2003 based on mark-recapture (May 15 to end) plus extrapolation based on run timing for the period May 9 - 14.

Table 9. Total return of small and 1SW (small) salmon at Conne River, Newfoundland, along with the estimated spawning escapement and corresponding marine surivival (%) of first time consecutive spawners.

	Small salmon					
Year	Total Return	1SW Return	Spawning escapement	1SW escapement	First time consecutive spawner escapement	First time consecutive spawner survival (%) (from year i - 1)
1986	8302	8256	5428	5398	0	-
1987	10155	10004	7823	7707	116	2.2
1988	7627	7495	5567	5471	90	1.2
1989	4968	4764	3609	3461	148	2.7
1990	5368	5277	3765	3701	64	1.8
1991	2411	2239	2062	1915	147	4.0
1992	2523	2463	1783	1740	24	1.3
1993	2703	2685	2353	2337	16	0.9
1994	1533	1286	1435	1204	198	8.5
1995	3502	3440	3376	3316	60	5.0
1996	4440	3552	4402	3522	880	26.5 *
1997	3200	2966	2558	2371	149	4.2
1998	2931	2489	2926	2484	350	14.7
1999	2358	1956	2349	1949	313	12.6
2000	5177	4946	4431	4234	154	7.9
2001	1503	1462	1286	1258	7	0.2
2002	2573	2460	2295	2194	71	5.6
2003	1953	1791	1867	1712	119	5.4

* Consecutive survival value was not adjusted for 286 1SW salmon reared at Roti Bay

Table 10. Total estimated returns of small salmon to Conne RIver, Newfoundland, with a summary of mortalities and removals and estimated spawning escapement, 1986 - 2003.

	Year																	
	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Returns																		
* Food Fishery (estuary)	766	451	506	317	831	234	403	347	0	0	0	428	0	0	0	0	0	0
Angling below fence				180	213	70	137	0	0	0	0	95	0	0	420	140	200	85
Mortalities below fence	21	17	3	2	3	2	0	1	0	2	4	1	0	1	5	0	0	1
Count at fence	7515	9287	7118	4469	4321	2086	1973	2355	1533	3500	4436	2676	2931	2357	4708	1359	2352	1867
Estimated count		400				19	10								44	4	21	0
Total Returns	8302	10155	7627	4968	5368	2411	2523	2703	1533	3502	4440	3200	2931	2358	5177	1503	2573	1953
1 - Released at fence	7515	9687	7118	4469	4321	2105	1983	2355	1533	3500	4436	2676	2931	2357	4752	1363	2373	1867
Removals and mortalities																		
Mortalities above fence/or in trap	27	21	7	4	2	5	8	2	5	7	9	5	5	8	11	2	3	2
Angling above fence	2060	1598	1544	856	554	38	192	0	0	0	0	102	0	0	310	75	75	95
Brood stock removal	0	245	0	0	0	0	0	0	93	117	25	0	0	0	0	0	0	0
Farmed salmon removed	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0
Hook and release mortalities												8			0			
2 - Total	2087	1864	1551	860	556	43	200	2	98	124	34	118	5	8	321	77	78	97
Spawning escapement - Small salmon																		
(1) - (2)	5428	7823	5567	3609	3765	2062	1783	2353	1435	3376	4402	2558	2926	2349	4431	1286	2295	1770
Egg deposition - Small salmon																		
in millions of eggs	9.9	15.03	10.61	6.92	7.48	3.72	3.23	4.43	2.78	6	8.25	4.81	5.51	4.42	8.33	2.42	4.31	3.33
% of Management Target met	127	193	136	89	96	48	41	57	36	77	106	62	71	57	107	31	55	43
% of Conservation egg requirement met	228	346	245	160	172	86	75	102	64	138	190	111	127	102	192	55	99	77

* Food fishery includes fish caught in the estuary during tagging studies in 1986 and 1987. Proportions of Conne River origin salmon in 1986 and 1987 were 0.792 (N = 967) and 0.914 (N = 493), respectively. For remaining years, the weighted mean (0.833) was used.

Note: Results for 1994 are for wild fish only, and do NOT include any impact of the egg deposition 'equivalency' from fry reared in 1994-95. Count of small salmon in 1996 includes 286 fish that were derived from the release of the wild smolt aquaculture experiment.

Table 11. Total estimated returns of large salmon to Conne River, Newfoundland, with a summary of mortalities and removals, and estimated spawning escapement, 1986 - 2003. Total estimated egg deposition from small and large salmon are indicated along with the combined estimate of the percentage of the Management Target or Conservation spawning requirement achieved.

	Year																	
	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Returns																		
* Food Fishery (estuary)	14	18	2	1	11	2	4	2	0	0	0	1	0	0	0	0	0	0
Angling below fence	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	140	0	0
Mortalities below fence	1	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0
Count at fence	397	498	418	319	361	87	154	98	100	110	179	184	294	241	216	140	167	51
Estimated count																		
Total Returns	412	516	420	320	372	89	159	100	100	110	179	185	295	241	216	140	167	51
1 - Released at fence	397	498	418	319	361	87	154	98	100	110	179	184	294	241	216	140	167	51
Removals and mortalities																		
Mortalities above fence/or in trap	1	0	0	0	0	0	1	1	0	2	0	0	0	1	0	0	0	0
Angling above fence	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Brood stock removal		10							1	0	0	0	0	0	0	0	0	0
Farmed salmon removed												2						
Hook and release mortalities																		
2 - Total	1	10	0	0	0	0	1	1	1	2	0	2	0	1	0	0	0	0
Spawning escapement - Large salmon																		
(1) - (2)	396	488	418	319	361	87	153	97	99	108	179	182	294	240	216	140	167	51
Egg deposition - Large salmon																		
in millions of eggs	1.48	2.07	1.77	1.09	1.23	0.3	0.52	0.33	0.34	0.37	0.61	0.62	1.01	0.86	0.77	0.50	0.60	0.18
% of Management Target met	19	27	23	14	16	4	7	4	4	5	8	8	13	11	10	6	8	2
% of Conservation egg requirement met	34	48	41	25	28	7	12	8	8	9	14	14	23	20	18	12	14	4
Total egg deposition - Small and Large salmon	11.38	17.10	12.38	8.01	8.71	4.01	3.76	4.76	3.12	6.37	8.86	5.44	6.51	5.28	9.01	2.92	4.91	3.51
Egg deposition per unit fluvial habitat	864	1297	939	608	661	304	285	361	236	483	672	413	494	401	690	221	373	266
Total % Management Target met	146	219	159	103	112	51	48	61	40	82	114	70	84	68	117	37	63	45
Total % Conservation requirement met	262	394	285	185	201	93	87	110	72	147	204	125	150	122	210	67	113	81

* Food fishery includes fish caught in the estuary during tagging studies in 1986 and 1987. Proportions of Conne River origin salmon in 1986 and 1987 were 0.792 (N = 967) and 0.914 (N = 493), respectively. For remaining years, the weighted mean (0.833) was used.

One unit of fluvial habitat = 100 m^2.
Conne River has an estimated 13,180 units of accessible fluvial habitat.

Table 12. Estimated total number of migrating smolts in each age group by year, Conne River, Newfoundland, 1987 - 2003, along with the corresponding number of smolts produced by year-class relative to the year eggs were spawned. Lower chart indicates the percentage of smolts at each river age.

Year	River age (y) 2	3	4	5	Total	Year Class (eggs)	Smolt Production
1987	1417	49002	22823	1343	74585	1984	59606
1988	0	39875	25029	788	65692	1985	69023
1989	2285	52197	17915	1327	73724	1986	57500
1990	399	39917	16229	399	56943	1987	76279
1991	896	59492	13660	597	74645	1988	65236
1992	341	50065	16165	1637	68208	1989	54938
1993	0	41266	14276	223	55765	1990	68022
1994	304	47880	12578	0	60762	1991	58776
1995	502	42858	18636	753	62749	1992	95707
1996	2729	75553	14301	1505	94088	1993	98561
1997	808	79979	18884	1313	100983	1994	66139
1998	978	52241	15854	768	69841	1995	69099
1999	255	50799	12604	0	63658	1996	61099
2000	1155	42422	16714	486	60777	1997	85639
2001	1217	66651	18422	608	86898	1998	81441 *
2002	3190	60782	17834	0	81806		
2003	0	51751	19442	0	71479		

* 1998 year class complete to age 4 smolts in 2003

Year	Percent in each age group 2	3	4	5	Number of samples
1987	1.9	65.7	30.6	1.8	271
1988	0.0	60.7	38.1	1.2	328
1989	3.1	70.8	24.3	1.8	288
1990	0.7	70.1	28.5	0.7	271
1991	1.2	79.7	18.3	0.8	246
1992	0.5	73.4	23.7	2.4	169
1993	0.0	74.0	25.6	0.4	246
1994	0.5	78.8	20.7	0.0	208
1995	0.8	68.3	29.7	1.2	249
1996	2.9	80.3	15.2	1.6	243
1997	0.8	79.2	18.7	1.3	380
1998	1.4	74.8	22.7	1.1	282
1999	0.4	79.8	19.8	0.0	257
2000	1.9	69.8	27.5	0.8	258
2001	1.4	76.7	21.2	0.7	288
2002	3.9	74.3	21.8	0.0	257
2003	0.0	72.4	27.2	0.0	250
Average (1987 - 2003)	1.27	73.3	24.47	0.96	
N	57	3292	1099	43	4491

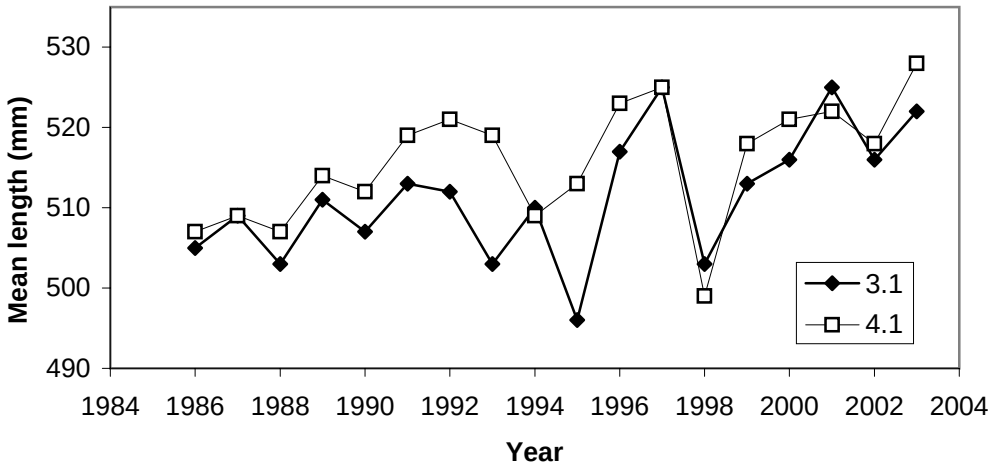


Figure 1. Trend in mean length of 1SW Conne River salmon, illustrated separately for river age 3 and 4 fish, 1986 to 2003.

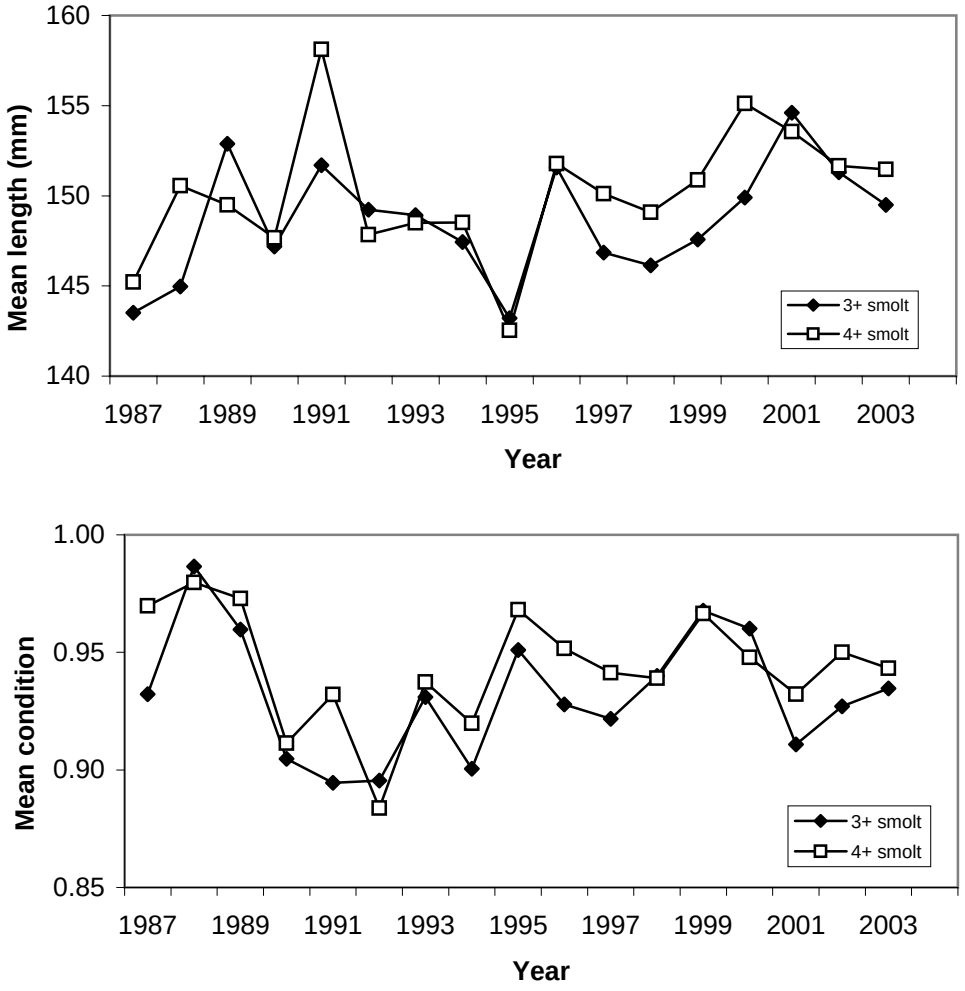
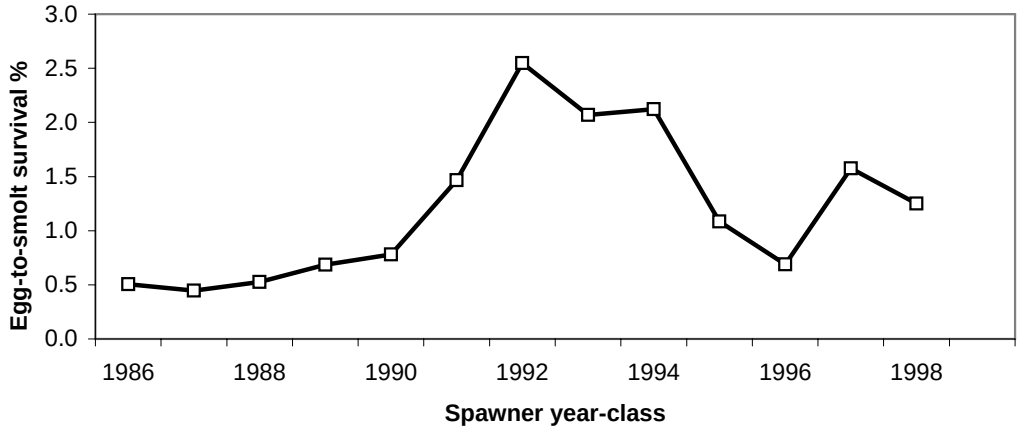
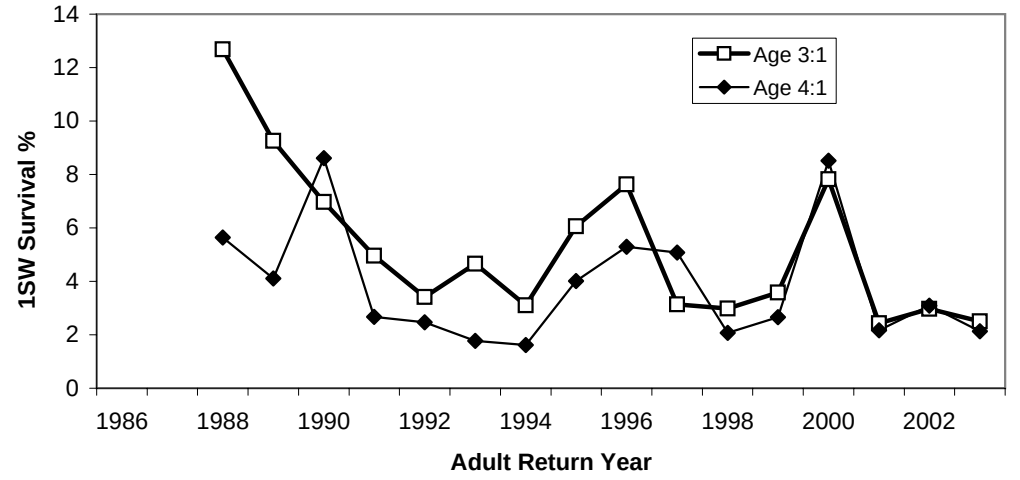


Figure 2. Trend in mean length and condition of river age 3 and 4 Conne River smolt, 1987 - 2003.





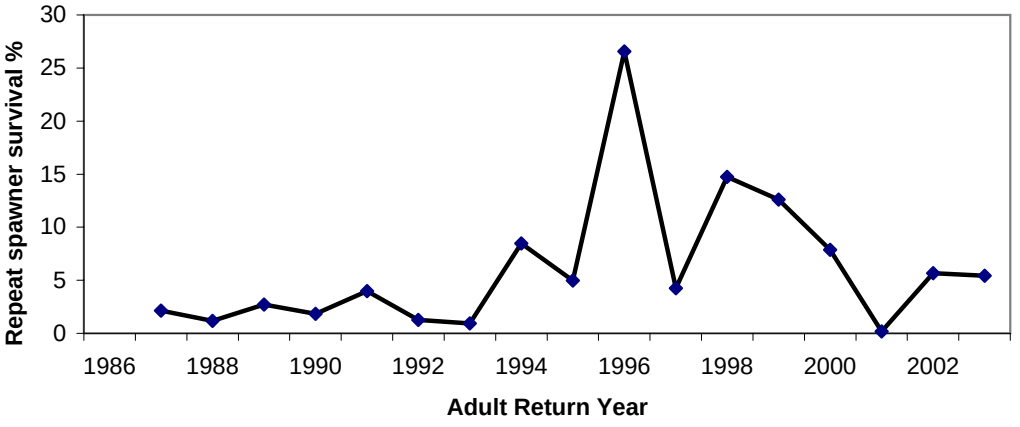


Figure 3. Trends in survival to various life-history stages of Conne River salmon: a) egg-to-smolt survival; b) survival of 1SW salmon by respective river age groups; and c) survival of first time consecutive spawners.

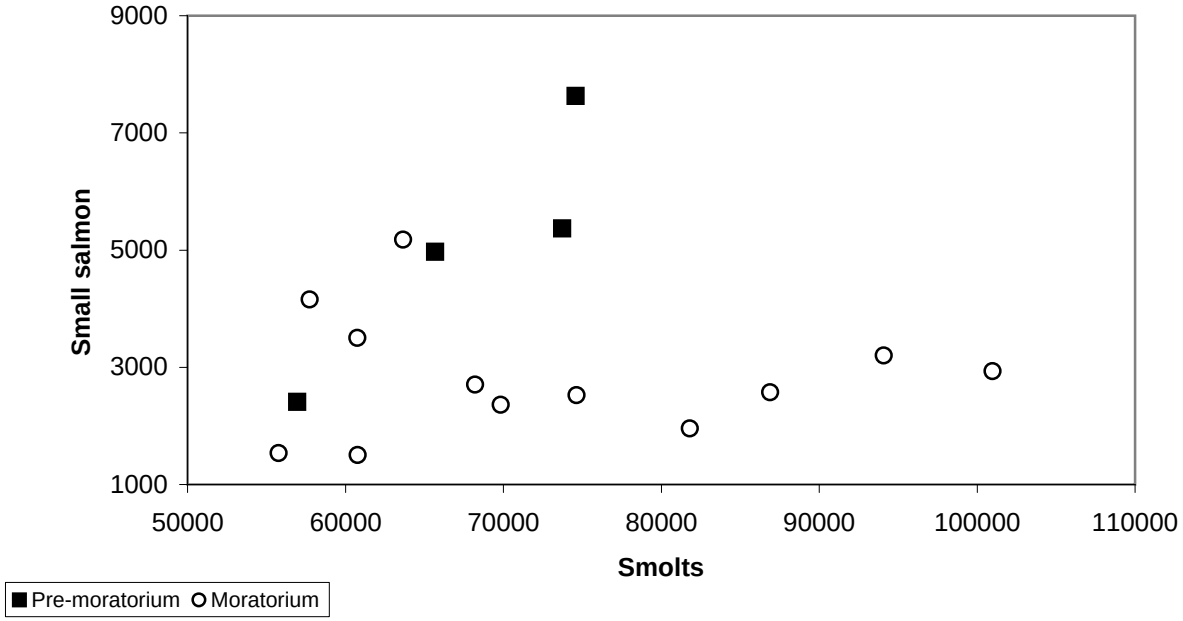
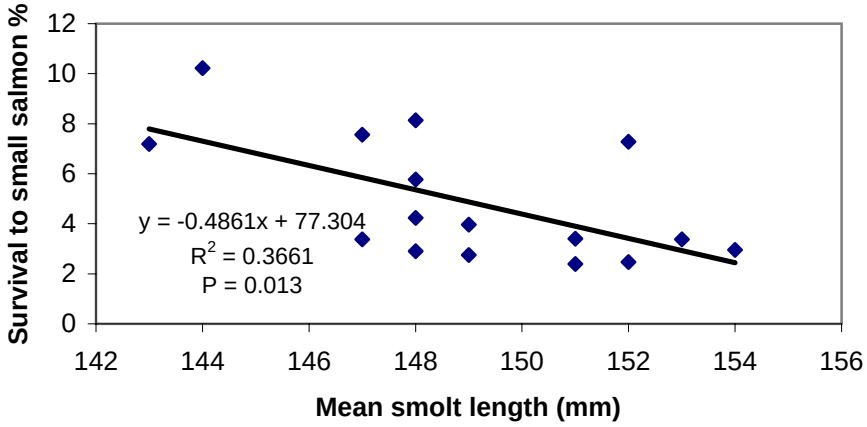
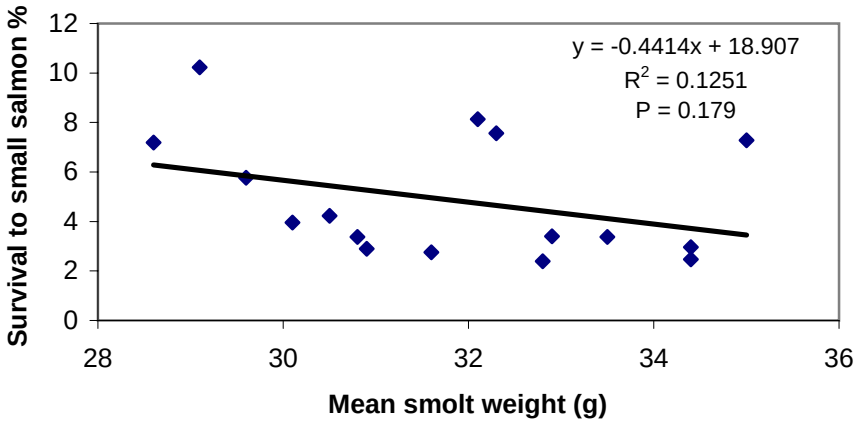


Figure 4. Relationship between number of outmigrating smolts and subsequent number of adult small salmon returning in the following year for smolt run years 1987 to 2002, Conne River, Newfoundland. Moratorium versus pre-moratorium years are illustrated with different symbols.





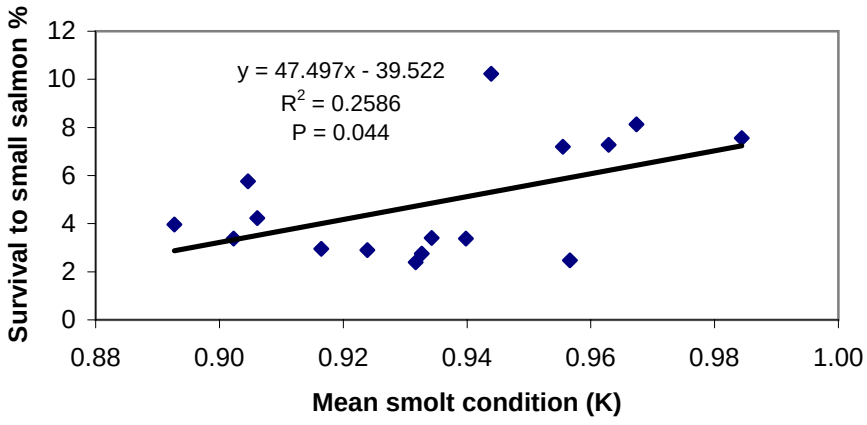


Figure 5. Relationships between smolt length, weight, and condition with marine survival (%) of Conne River Atlantic salmon smolts, for adult salmon returns from 1988 to 2003.

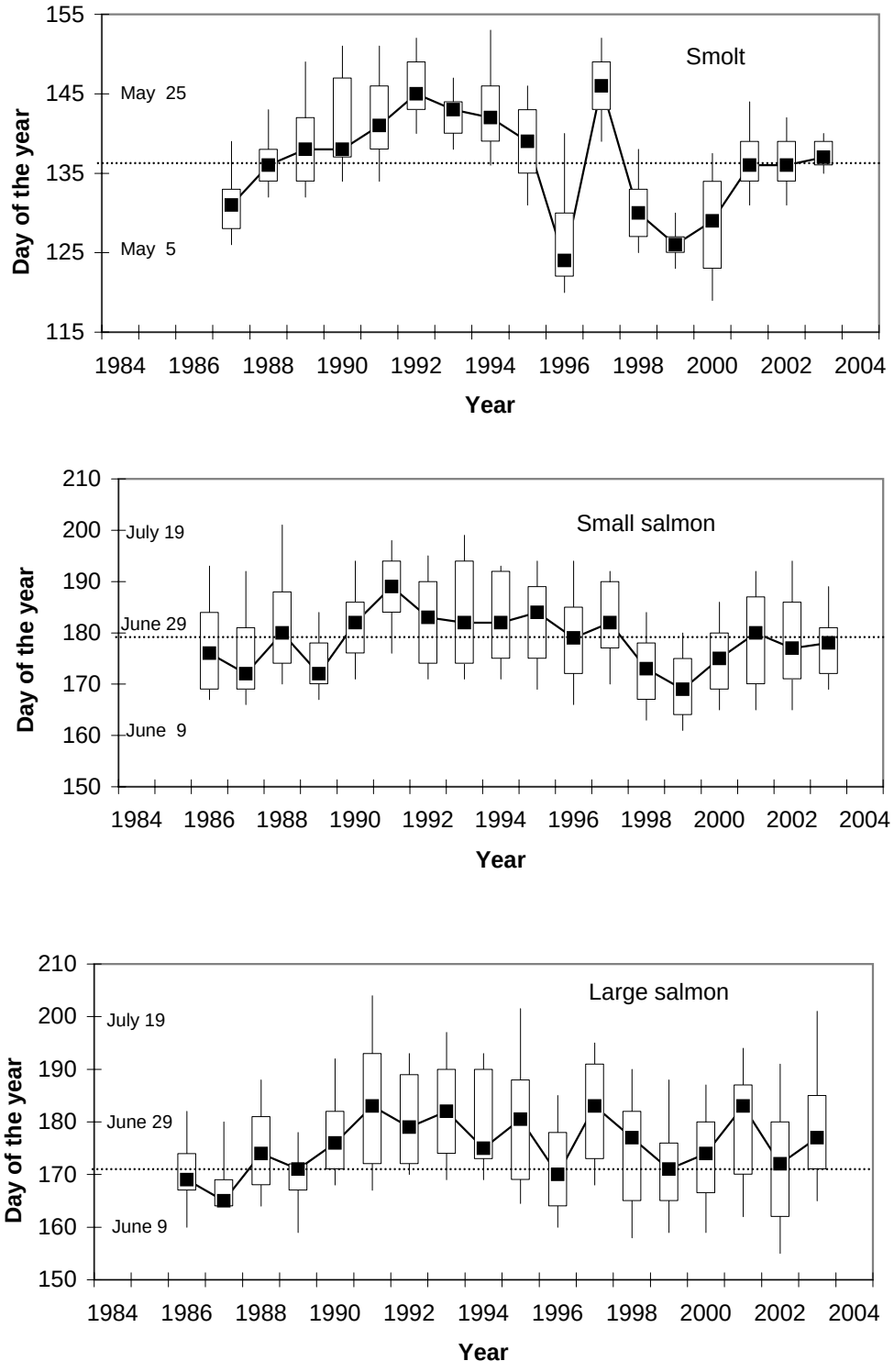
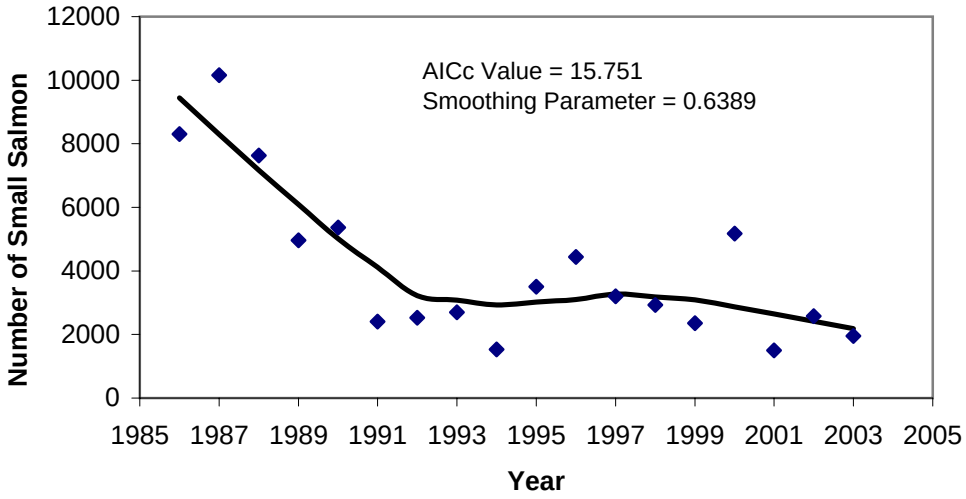


Figure 6. Annual variation in Atlantic salmon run timing at Conne River, Newfoundland, for smolt and adult small and large size components. Vertical lines represent the 10th and 90th percentiles of the day of the year of migration, the rectangle encompasses the 25th and 75th percentiles, while the solid marker within the box is the median (50th) run timing value. The thin horizontal line in each panel is the overall mean of the median values.



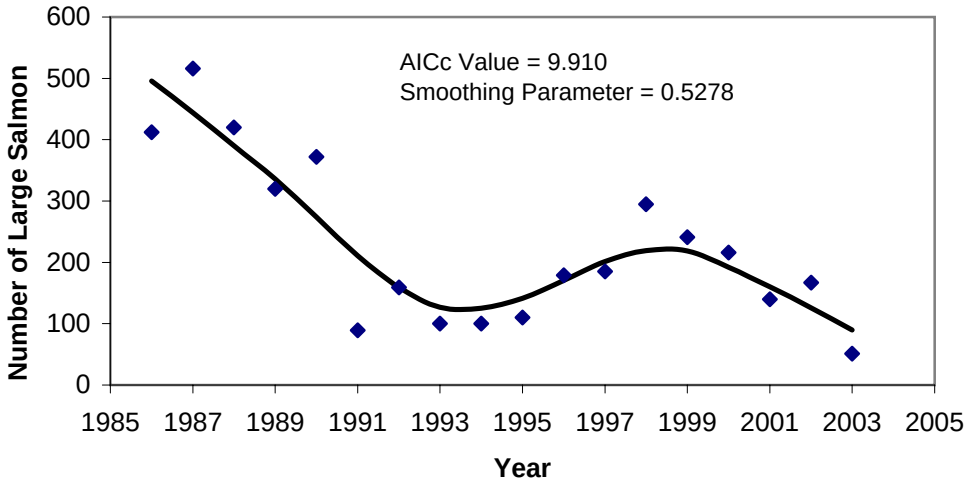


Figure 7. Scatter plots of total returns of small and large Atlantic salmon to Conne River, 1986 - 2003. Solid lines represent the non-linear LOWESS regression lines. Akaike information criterion (AICc) and smoothing parameter values are indicated for each plot.