Fisheries and Oceans Canada | Pêches et Océans Canada

Canadian Stock Assessment Secretariat
Research Document 99/92

Not to be cited without
permission of the authors[1]

Secrétariat canadien pour l'évaluation des stocks
Document de recherche 99/92

Ne pas citer sans
autorisation des auteurs[1]

Status of Atlantic salmon in Conne River, SFA 11, Newfoundland, 1998

J. B. Dempson, G. Furey and M. Bloom

Science Branch
Department of Fisheries and Oceans
P.O. Box 5667
St. John's, Newfoundland
A1C 5X1

[1] This series documents the scientific basis for the evaluation of fisheries resources in Canada. As such, it addresses the issues of the day in the time frames required and the documents it contains are not intended as definitive statements on the subjects addressed but rather as progress reports on ongoing investigations.

Research documents are produced in the official language in which they are provided to the Secretariat.

[1] La présente série documente les bases scientifiques des évaluations des ressources halieutiques du Canada. Elle traite des problèmes courants selon les échéanciers dictés. Les documents qu'elle contient ne doivent pas être considérés comme des énoncés définitifs sur les sujets traités, mais plutôt comme des rapports d'étape sur les études en cours.

Les documents de recherche sont publiés dans la langue officielle utilisée dans le manuscrit envoyé au secrétariat.

ISSN 1480-4883
Ottawa, 1999
Canada

Contents

Abstract 3

Introduction 4

Methods 5

1. Landings 5
2. Environmental conditions 5
3. Biological characteristics 6
4. Estimated returns and spawning escapement 7
5. Net-marked and escaped farmed salmon 9
6. Smolt production 9
7. In-season and pre-season forecasts of salmon abundance 9

Results and Discussion 10

1. Landings 10
2. Environmental conditions 10
3. Biological characteristics 11
4. Estimated returns, sea survival and spawning escapement 14
5. Net-marked salmon 17
6. Smolt production 17
7. In-season and pre-season forecasts of salmon abundance 18
8. Review of the current Management Target for Conne River 18

Acknowledgements 19

References 19

Tables 21

Figures 39

Summary Sheet 51

Abstract

Results obtained from a fish counting fence provided the basis for the assessment of the Conne River Atlantic salmon stock in 1998. Returns to home waters (river and estuary) were 2931 salmon < 63 cm in length and 295 salmon ≥ 63 cm in size. This represented a decrease of 8% for small salmon in comparison with 1997 while large salmon returns increased by 59% to the highest level since 1990. Sea survival to 1SW salmon fell to the lowest level recorded (2.46%). Only 83% of the **Management Target** was met but 150% of the **conservation egg requirement** was attained. A mark-recapture study estimated a smolt run in 1998 of approximately 70,000, which was 31% lower than 1997 but 6% higher than the average from 1987 - 1995. Based upon an increase in egg-to-smolt survival coincident with decreasing egg deposition rates per unit of fluvial habitat, a review of the current Management Target of 7.8 million eggs may be warranted. Information on the occurrence of escaped farmed rainbow (steelhead) trout in Conne River, and results of angling activity for escaped rainbow trout during the winter of 1999 are also provided.

Résumé

Les données obtenues à une barrière de dénombrement ont servi à l'évaluation du stock de saumon de l'Atlantique de la rivière Conne en 1998. Les remontées dans les eaux natales (rivière et estuaire) ont été 2 931 saumons < 63 cm et de 295 saumons ≥ 63 cm de longueur. Cela représente une diminution de 8 % pour les petits saumons par rapport à 1997, mais les remontées de grands saumons ont augmenté de 59 % pour atteindre la valeur la plus élevée depuis 1990. La survie en mer des UBM a chuté au niveau le plus faible jamais enregistré (2,46%). La **cible de gestion** n'a été atteinte qu'à 83 %, mais **l'objectif de ponte de conservation** l'a été à 150 %. Une étude par marquage-recapture a permis d'estimer à 70 000 environ la descente des saumoneaux en 1998 ; cette valeur est inférieure de 31 % à celle de 1997, mais de 6 % supérieure à la moyenne de la période 1987-1995. L'augmentation de la survie œuf-saumoneau, qui coïncide avec une baisse de la ponte par unité d'habitat fluvial, pourrait justifier un examen de la cible de gestion actuelle de 7,8 millions d'œufs. Des renseignements sur la présence de truites arc-en-ciel d'élevage échappées dans la rivière Conne et les résultats de la capture par les pêcheurs à la ligne de ces truites pendant l'hiver de 1999, sont aussi présentés.

Introduction

Conne River, SFA 11 (Fig. 1) flows into Bay d'Espoir on the south coast of Newfoundland. It is a sixth-order river with a drainage area of 602 km^2 and a total length of 193 km. Since 1986, a fish counting fence has been operated to enumerate the upstream migrating population of Atlantic salmon (*Salmo salar*). Previous estimates of total returns of small salmon have ranged from a low of 1533 in 1994 to a high of 10155 in 1987. Mark-recapture studies were initiated in 1987 to survey the number of migrating smolts and continued in 1998. Smolt production has varied from about 56 thousand in 1993 to 101 thousand in 1997.

Conne River is currently managed against a Management Target (MT) which differs and is higher than the conservation requirement. 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. The returns were adjusted to account for the total population prior to any sea fisheries by using an assumed commercial exploitation rate.

The Management Target was met or exceeded from 1986-90, but declined to 40% in 1994 (Dempson et al. MS 1998). Stocking of reared fry in 1995, from brood fish maintained in 1994, increased the 'equivalent' egg deposition in 1994 to 58% of the Management Target. Increased sea survival over the 1994-95 period resulted in 81% of the Target being met in 1995 followed by 112% in 1996 and 70% in 1997 (Dempson et al. MS 1998).

A major change in the management of the Conne River Atlantic salmon stock for 1993 was the complete closure of the recreational fishery. In light of the forecast of low salmon returns in 1994 and 1995, this closure was continued and extended to the Indian Band Council's food fishery. Both fisheries remained closed in 1996 and again in 1998 but limited food and recreational fisheries were allocated for 1997.

Expectations for 1998

In past years, marine survival of Conne River smolts to one-sea-winter (1SW) salmon was linearly associated with: a) an index of marine thermal habitat ($r^2 = 0.68$; N = 9; 1987-95 smolt years); and b) median smolt run timing where an early smolt run generally coincided with better marine survival ($r^2 = 0.73$; N = 9; 1987-95 smolt years) (Dempson and Furey MS 1996). These associations weakened substantially with the inclusion of returns from the 1996 smolt class (Dempson et al. MS 1998). Consequently, quantitative forecasts were not provided for 1998. It was noted, however, that although: i) thermal habitat values for the January - March 1998 period were among the highest recorded; and ii) that the 1997 smolt run at Conne River was the highest to date, timing of the 1997 smolt run was also the latest observed and condition of smolts in 1997 was not among the higher values obtained. Thus the Stock Status report for the Conne River area (SFAs 9-11; DFO Science Stock Status Report D2-04 (1998)) cautioned that ***"these characteristics have tended to coincide with below average survival in past years"***. The Stock Status Report also cautioned that some south coast stocks, including Conne River, had not shown

any consistent improvement in returns during the moratorium years and thus there was still concern about the health of these stocks.

This paper summarizes smolt production and returns of adult Atlantic salmon to Conne River in 1998. Information on environmental characteristics during the 1998 season is also provided, and biological characteristic data for Atlantic salmon are updated. Results from the 1998 season are addressed relative to the Management Target as well as the conservation egg deposition requirement. Owing to resumed interest in the occurrence of escaped steelhead (rainbow) trout at Conne River, information for the period 1990 to 1998 is updated and provided for reference. In addition, we have also included biological characteristic data obtained from sampling escaped farmed salmonids that were captured in Conne River March 24 - 25, 1999. We have also provided a summary of numbers of people observed fishing and corresponding numbers of rainbow trout caught in the upper Bay d'Espoir area during the period February 1 to April 2, 1999. These data were collected during patrols carried out by the Conne River Aboriginal Guardians.

1998 Highlights

The following summarizes highlights to fishery regulations and other observations/events occurring in 1998:

- recreational and native food fisheries were closed again in 1998;
- sea survival from smolts to 1SW salmon was the lowest value recorded (2.46%) in eleven years;
- 83% of the Management Target was achieved in 1998; however, 150% of the conservation egg requirement was attained;
- smolt production in 1998 declined by 31% from the peak production recorded in 1997;
- egg-to-smolt survival has increased coincident with a decline in the egg deposition rate per unit of fluvial habitat.

Methods

1. Landings

Information on recreational catch statistics from past years were collected by Department of Fisheries and Oceans (DFO) guardians. Similarly, previous landings from the native food fishery were obtained from the Conne River Native Band Council.

2. Environmental conditions

Water temperature information was obtained from a continuous recording Hugrun thermograph located in the lower Conne River (April 20 - September 22, 1998) (Fig. 2).

Information on air temperature, precipitation, and discharge was obtained from the Provincial Water Resources Management Division monitoring facility located on the main stem of Conne River, below Conne Pond.

3. Biological characteristics

Biological characteristic data on adult salmon returns in 1998, including fork length, whole weight, and age, were derived from sampling salmon captured at the fish counting fence. Biological data on Atlantic salmon smolts were obtained from specimens sampled at the downstream fish counting fence trap.

Estimates of the numbers of salmon of different life stages (1SW, 2SW, consecutive and alternate spawners) that have returned to Conne River were obtained in a manner consistent with the approach used in previous years (Dempson et al. MS 1998). Salmon returning to the river were initially categorized as either small (< 63 cm) or large (≥ 63 cm) salmon. Biological characteristic data were similarly partitioned into these respective size classes and applied to numbers of returning fish. Data were available for 2184 small salmon, but only 112 large salmon.

For small salmon, year specific information was applied from 1986 to 1990, and 1995-1998. For years 1991-1994, the average contribution for the years 1986-94 was used. With respect to large salmon, numbers in each year were recalculated using the average values for the 1986-1998 period. Survival of repeat spawning salmon was determined separately for consecutive spawning small salmon, and also by adding the subsequent numbers of consecutive and alternate spawners for both small and large salmon in each case relating the numbers back to the corresponding number of fish that originally spawned as virgin 1SW fish. As in the past, consecutive or alternate spawners were all assumed to be associated with the previous 1SW component by a time span of either one (consecutive) or two (alternate) years. This assumption is essentially correct for the small salmon category, but about 24% of the large salmon category is associated with the original 1SW component by 3 or 4 years. However, given the relatively minor contribution large salmon represent at Conne River, the overall impact is small. Within the small size category, 93.6% of all samples were virgin 1SW fish, 6.3% were consecutive spawners, and 0.1% were alternate spawners. In contrast, within the large salmon component, 76.8% were alternate spawners, 14.3% were consecutive spawners and 8.9% were 2SW fish. Owing to the dependence on using average values over all years for large salmon, it is probably more appropriate to use year-specific information for small salmon only to examine changes in the survival of previous spawners.

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

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

where, W = whole weight in grams; C = a constant, 100,000; and F = fork length in mm.

4. Estimated returns and spawning escapement

Adult Atlantic salmon migrants were enumerated at a fish counting fence, located about 1 km upstream from the mouth of the Conne River (Fig. 1), which operated from May 19 to September 20, 1998 (Table 1). The counting fence was monitored as a co-operative project between DFO and the Conne River Indian Band.

During 1998, adult salmon were again counted either as they: 1) passed through monitored openings in the fish counting fence; 2) entered the trap directly; or 3) passed through openings in the fish counting fence but were recorded on the video camera system. The video camera system utilized a positive image horizontally directed camera (Panasonic model WV-BD400) positioned on the substrate and angled to view an opening in the fish counting fence. A Panasonic Time Lapse Video Recorder (Model AG 6040) was used to record the video signal from the camera and could also superimpose the time and date thus providing a summary of actual fish passage times. The video system was operated each day from June 8 until July 27 and generally from early evening until about 0900 hours the following morning.

Total river returns

Total river return (TRR) of adult salmon in have been estimated from:

$$TRR = C + Mb + Cn$$

where,
- C = the count of salmon at the counting fence
- Mb = the known mortalities (including angled salmon) below the counting fence, and
- Cn = the estimated catch of Conne River origin salmon in the native food fishery (0 fish in 1998).

Spawning escapement

Spawning escapement (SE) has been estimated as:

$$SE = FR - Ma - Br$$

where,
- FR = the number of fish released at the counting fence
- Ma = the number of known mortalities (including angled salmon) above the fence
- Br = the number of salmon removed for brood stock use (0 in 1998).

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 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 past years, egg deposition (ED) was calculated separately for salmon < 63 cm and salmon ≥ 63 cm and then totaled.

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

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. MS 1987):

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

where fork length was the mean length of female salmon < 63 cm. For 1998, the mean length and proportion of females from all years were used ($\bar{x}$ = 50.8 cm; N = 1232, and includes repeat spawning females < 63 cm; percentage female was 78%).

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 data for mean length (67.8 cm) and percent females (71%) as used in past years (Dempson et al. MS 1998).

The **Management Target** has been maintained as in past years at **7.8 million eggs**. This was equivalent to about 4000 salmon < 63 cm in size.

In order to compare correctly and evaluate Conne River against other Newfoundland salmon rivers for which stock assessments are done, a corresponding **conservation egg requirement (ER)** was been calculated. The calculation follows methods 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 egg requirement** then, equals **4,337,358** eggs versus 7.8 million as a **Management Target.**

The equivalent total number of spawners (TNS) associated with the **conservation 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.

5. Net-marked and escaped farmed Atlantic salmon

Surveys of net-marked salmon returning to Conne River were carried out from June 7 - July 20, 1998, but only on those fish clearly observed in the fish counting fence trap. Similarly, salmon observed in the counting fence trap showing characteristic 'farmed fish' appearance (fin size, shape and form, body shape and pigmentation) are noted and removed from the river. Identity of these 'suspect' fish are subsequently confirmed by examination of scale circuli characteristics. **Note, given that salmon can pass freely through an opening in the fish counting fence used in conjunction with operation of the video camera system, not all escaped farmed salmon (or rainbow trout) are removed from the Conne River system.** In addition, examination of scales obtained from sampling salmon throughout the run are used in a retrospective manner to infer the presence of escaped farmed salmon in Conne River.

6. Smolt production

A mark-recapture study was carried out to estimate the smolt production in 1998. The study was similar to those carried out in 1987-97, the design of which is summarized in Dempson and Stansbury (1991) and uses the estimator described in Schwarz and Dempson (1994). Since 1995, the downstream smolt trap has been monitored 24 hours of the day.

During 1998, 2952 smolts were tagged and released at the upstream partial counting fence site (Fig. 1). At the downstream recapture site, 8636 smolts were caught including 367 tagged smolts.

7. In-season and pre-season forecasts of salmon abundance

In-season forecasts

In recent years, in-season forecasts of small salmon abundance were generated from regressions of counts to date versus total count for the year to infer whether the Management Target would likely be attained. Data from 1986-1997 were available for inferences relative to the 1998 season. Various in-season dates were chosen starting from June 18 until July 5. A retrospective analysis of this approach (Dempson and Furey MS 1997) indicated that incorrect 'advice' would have been produced in about 7.6% of the cases going back to 1986. However, in

all of these cases, the incorrect 'advice' would have erred on the side of conservation. Thus, the utility of this approach for Conne River, at least, was believed to still have some merit for use again in 1998.

Pre-season forecasts

A stated earlier, two relationships from which pre-season forecasts of subsequent salmon abundance had been attempted for Conne River were no longer appropriate and quantitative information was not provided for the 1998 season. The first had been derived from a relationship between the median date of smolt run timing and subsequent survival to 1SW salmon. The second forecast had been based on a relationship between an index of marine thermal habitat (Reddin and Friedland 1993; Dempson and Reddin MS 1995) and subsequent survival to 1SW salmon. For consistency with past years, plots of updated information are provided and illustrate possible changes in the shape of the past relationships. Again, pre-season forecasts of abundance for 1999 are not given.

Results and Discussion

1. Landings

Landings in the recreational fishery are summarized in Table 2. Harvest of over 2000 small salmon have been reported in some past years. As indicated earlier, there was no recreational fishery at Conne River in 1998. We note that in past years, angling exploitation rates have varied from 0.181 to 0.285 (Dempson et al. MS 1994).

Native food fishery catches are also summarized in Table 2. The highest catch occurred in 1990. There was no food fishery in 1998.

2. Environmental conditions

In contrast with 1997 when the mean air temperature for the month of April was the coldest during the period of operation at Conne River (1986 - 1997), the average April 1998 air temperature was the second warmest since 1990. Similarly, the average May air temperature was the warmest since 1989, whereas an air temperature index for the period April 1 to May 15, was the warmest since 1988 (Fig. 3b). The first day with a mean daily temperature of over 10° C in 1998 was May 2; in 1997, it was June 9. Water temperatures (Fig. 2) similarly warmed up earlier than in 1997 and contributed to an earlier smolt run. While May 16 was the first day when the average daily water temperature was over 10°C in 1997 (lower fish counting fence - Hugrun thermograph), this occurred on May 3 in 1998. Note that mean April temperature explained 59% of the variation ($P = 0.0034$) in smolt run timing (median) at Conne River while the mean April 16 - 30 air temperature explained 70% ($P = 0.0008$) of the variation.

Year	Mean air temperature °C				Median day of smolt run Timing
	April	May	April 1 - May 15	April 16 - 30	
1986	5.11	7.70	5.60	8.51	-
1987	4.11	8.15	5.48	4.37	131
1988	3.18	10.08	4.77	3.55	136
1989	2.69	8.90	4.08	3.01	138
1990	2.28	6.36	3.46	2.72	138
1991	1.16	5.95	2.87	3.25	141
1992	0.36	7.77	2.36	0.67	145
1993	1.49	6.87	2.34	3.35	143
1994	1.17	6.21	2.69	2.28	142
1995	0.49	5.56	1.80	2.54	139
1996	3.09	5.82	3.69	5.02	124
1997	-0.36	5.87	1.59	0.43	146
1998	2.08	8.23	4.31	3.34	130
1999	2.56	10.46	4.86	3.39	

Water temperatures increased over the summer with the warmest temperatures occurring in the latter part of July and in early August (Fig. 2). During the period May 2 - September 11, mean daily temperatures exceeded 20 °C on 29 occasions (Fig. 2), including each day from July 25 through to August 12. In contrast, average daily temperatures exceeding 20°C occurred only 10 times in 1997. The maximum water temperature was recorded in 1998 was on August 9 (27.0 °C), while maximum temperatures ≥ 25°C were recorded on 12 separate days (mostly in early August).

Water levels were moderately high in late April and early May with generally low conditions persisting throughout much of June, July and August (Fig. 2). Higher levels occurred again in early September (Sept. 7-11), with a substantial increase in flow occurring on September 24 just after the fish counting fence operation had terminated for the year.

3. Biological characteristics

Adult samples

Table 3a summarizes annual biological characteristic data of Atlantic salmon from Conne River, 1986-1998. Mean weight of 1SW salmon in 1994 and 1995 is lower by comparison with earlier years. This may have been because measurements were taken from salmon maintained in cages for brood stock and were recorded in September rather than in June or July as in past years.

Repeat spawning salmon are separated into consecutive and alternate categories. Consecutive spawners are typically less than 63 cm in fork length ($\bar{x}$ = 577 mm, Table 3) while alternate spawners average 693 mm in length (Table 3a) (Fig. 4). As acknowledged in past reports, not all size classes of fish can be sampled representatively. However, with respect to salmon less than 63

cm in length, only 139 (6.36%) out of 2184 samples at Conne River were either consecutive (N = 137) or alternate (N = 2) spawning fish. Length-frequency distributions of 1SW, 2SW, consecutive, and alternate spawners sampled at Conne River are illustrated in Figure 4. Biological characteristics of fish separated by life-history groups for small and large salmon is shown in Table 3b. Large salmon are primarily alternate spawners.

Biological characteristics of Atlantic salmon captured in the aboriginal food fishery are presented in Table 4.

Survival of repeat spawning salmon (small and large fish) was less than 10% until 1994 (Table 5). Since then, the contribution of repeat spawners has increased dramatically (Table 5). The most accurate information is derived from using consecutive spawning salmon from the small size category only. With these data, average survival has increased from 2.38% from 1986-94, to 20.93% for the past three years (1995-97).

O'Connell et al. (1997) recently examined inter-annual variation in fecundity for a variety of Newfoundland salmon rivers, including Conne River. Data (N = 459) from small salmon at Conne River were available from six years (1986 - 1988, 1990 - 1992) and were expressed in terms of number of eggs per female, as well as relative fecundity in terms of weight and length (Table 6). It was noted that there was a substantial decline in fecundity from 1988 to 1992 at Conne River. Information obtained in 1997 has now been added to the time series. As indicated in Table 6, following the low fecundity values during the early 1990's, fecundity in 1997 was the highest recorded. No additional information was obtained in 1998.

Smolt samples

Smolt condition (Fulton's condition factor) has ranged from a high of 0.98 in 1987 to a low of 0.89 in 1992 (Fig. 3a). Smolt condition in 1998 was similar to the long term mean condition over all year (1986-98). Previously, it was noted that years in which smolts had a higher condition were often those that were associated with warmer spring temperatures (Fig. 3c). There was also an indication that smolt condition was associated with subsequent sea survival, as higher survival of smolts often occurred in years where condition was greater (Fig. 3d). The lower condition of smolts in 1997 was consistent with reduced survival that occurred with returning salmon in 1998.

Farmed (hatchery) salmon and presence of enhanced fish in 1998

There were two (2) salmon identified as escaped farmed fish from a post-season analysis of scale characteristics out of 191 adult salmon sampled in 1998. No salmon of farmed origin were identified in 282 smolts sampled in 1998.

In 1995, approximately 40,000 fall fed fingerlings were stocked into Twillick Brook. These fish were all adipose fin clipped. Ten (10) (3.55%) fin clipped smolts were observed in the 1998 sample of smolts (N = 283 smolts sampled; ages obtained from 282, with 1 additional smolt

for which the river age was undetermined). If this can be assumed to be a representative sample (i.e. 3.55% of the entire 1998 smolt run), then an estimate of the survival of these fish from stocking to age 3 smolts ranged from 5.4 to 7.0% (using the lower and upper confidence intervals for the estimated number of smolts in 1998).

Run timing

Figure 5 illustrates the run timing of smolts and adult small 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 1998 was the second earliest recorded to date (Fig. 5). Recall that 70% of the variation in timing of the smolt run can be explained by the mean April 16-30 air temperature (Section 2 - Environmental conditions). The distributions of each of the annual smolt runs are shown in Figure 6. As discussed in previous years, smolt run timing has been linearly associated with subsequent survival to 1SW salmon. While this pattern was not consistent with results of adult returns in 1997 from the early smolt migration in 1996, the adult salmon returns in 1998 were consistent with past results in that a low survival once again coincided with a late smolt run in 1997. Adult run timing was also the second earliest recorded since 1986 (Fig. 5).

Rainbow (steelhead) trout

Updated records on the numbers of rainbow (steelhead) trout encountered at Conne River from all years (1990 - 1998) are provided in Table 7a. Note that it is not possible to provide an absolute number of rainbow that have been observed in Conne River. This is because observations from snorkelling surveys, which occur at periodic intervals over the summer, are included and thus some trout are likely counted on more than one occasion (i.e. double counted) during successive surveys. Rainbow trout that are captured in the fish counting fence trap are removed from the river and sampled. As noted earlier, rainbow trout can pass freely through the opening in the fish counting fence where the video camera system is installed.

Figure 7 illustrates the length frequency distributions of those escaped farmed rainbow that have been sampled at Conne River along with the corresponding length distributions obtained from the gill netting survey carried out in Bay d'Espoir in 1995 (see Dempson and Furey MS 1996 for further details). Escaped rainbow sampled at Conne River show at least two distinct modal sizes: one at 16 cm and another around 38-40 cm. While fish up to 60 cm have been sampled, relatively few fish greater than 50 cm have been observed (Fig. 7). Size distributions of rainbow trout caught in Bay d'Espoir (May sample N = 33; September sample N = 164) displayed a strong mode at 34 cm (September) while the May sample, with fewer fish caught, had a small mode at around 38 cm (Fig. 7).

Survey of lower Conne River - March 1999

On March 24 - 25, 1999, brief surveys were carried out by angling in selective pools in the lower section of Conne River below Goodyears and Dashwoods Steady. Surveys were not intended to be quantitative but rather provide additional information on the spatial distribution of these escaped fish in Conne River at that time of the year. Thus, when a rainbow trout was angled in a particular pool, sampling then moved downstream to the next location. Escaped farmed rainbow trout were caught in virtually every pool angling was attempted. In total 13 rainbow were caught (320 - 550 mm fork length; 0.5 - 2.3 kg whole weight), along with two (2) escaped farmed brook trout, and one (1) farmed Atlantic salmon. Data from individual specimens are summarized in Table 7b.

Aboriginal Guardian patrols: February - April 1999

In addition to the survey of the lower section of Conne River, regular patrols were carried out in the upper Bay d'Espoir area by the Conne River Aboriginal Guardians. Data obtained from weekly reports provide **minimum** accounts of numbers of people observed fishing and corresponding numbers of fish captured. Data are considered **minimum** as surveys were not carried out at each location during an entire day, but rather represent 'instantaneous' observations during the particular period that Guardians happened to visit any specific site. Also, few weekend patrols were conducted when recreational angling activity might be expected to be higher than during week days.

A summary of the patrol reports stratified by standard weeks is provided in Table 7c. Most recreational fishing activity (43.5% of total numbers of people observed) was reported during standard weeks 6 and 7, corresponding to calendar dates February 5th through 18th. In contrast, only 21% of the total numbers of people observed fishing occurred from March 12 onward. Most fishing activity was reported at the Causeway-Tailrace and Vyse Cove areas although rainbow trout were also reported being captured at St. Alban's, Little River, Swanger's Cove, and lower Conne River (Table 7c). Overall, more than 900 escaped farmed rainbow trout were reported caught. There is no doubt that these minimum data reflect the reality that escaped rainbow trout were very abundant in the Bay d'Espoir area during the winter of 1999.

4. Estimated returns, sea survival and spawning escapement

There were 2931 salmon $<$ 63 cm and 294 salmon $\geq$ 63 cm counted at the fish counting fence on Conne River in 1997 (Tables 8 and 9). This represents an increase of 10% in the number of small salmon by comparison with 1997 while the number of large salmon increased by 60% and were the highest number obtained since 1990. The single largest daily run occurred on June 26 (285 small salmon) (Fig. 8) and about 95% of the run of small salmon in 1998 was complete by July 8. The distributions of past annual small salmon counts are also shown in Figure 8.

Partitioning the count of salmon among the various ways fish were enumerated in 1998 is as follows:

	Small Salmon		Large Salmon	
	N	%	N	%
Fence opening	0	0	0	0
Counting fence trap	1287	44	210	71
Video camera chamber	1644	56	84	29
Total	2931	100	294	100

With respect to the video camera system, salmon again generally migrated all night long. During 1998, the period from 2230 to 0229 hours accounted for 35% of the total, somewhat less than in past years. A total of 1359 fish were associated with time of fish passage during the evening or throughout the night as follows:

Time (hours)	Number of fish	%
2030 - 2229	309	23
2230 - 0029	240	18
0030 - 0229	238	17
0230 - 0429	250	18
0430 - 0900	322	24
Total	1359	100

Total returns (Fig. 9) of adult salmon to Conne River in 1998 are summarized in Tables 8 and 9 for small and large salmon, respectively.

Total returns of small salmon (2931) were 8% lower than in 1997, and have fallen 34% since 1996. In contrast, total returns of large salmon (295) improved by 59% over 1997 and can be attributed to the increased survival of repeat spawning salmon at Conne River in recent years (Table 5).

Sea survival

Sea survival from smolts to small salmon has varied from 2.7 to 10.2% (Table 10). Survival had increased from 2.7% (2.6-3.0%) in 1994 (return year) to 7.2% (6.4-8.3%) in 1996 but subsequently decreased dramatically to 3.4% (3.0-4.0%) and now to 2.9% (2.7-3.2%) with the 1997 and 1998 returns, respectively (Fig. 9, Table 10). Corresponding sea survival to 1SW

salmon once again fell to the new lowest value recorded (2.46%). At these low survivals, it is clearly the high smolt production in 1996 and 1997 that has sustained the numbers of salmon that are returning to Conne River. Otherwise, adult returns could have been more than 40% less than that which has occurred.

Spawning escapement

Potential spawning escapement in 1998 was estimated to be 2926 small salmon and 294 large salmon (Tables 8 and 9). Although the total return of small salmon was actually lower in 1998 than in 1997, spawning escapement increased. This was because there were no Aboriginal food or recreational fisheries harvesting salmon in 1998. Mean number of eggs per female for the wild salmon was 2413 using average size data of females for all years.

small salmon = 5.50714 million eggs
large salmon = 1.00550 million eggs

for a total egg deposition of 6.51 million, representing 83% of the current **Management Target** or 150% of the **conservation egg requirement** (Table 9).

Estimates of egg-to-smolt survival are now available for eight year-classes (1986 to 1992; the 1993 year-class complete only to age 4 smolts in 1998). These values, by year-class, are:

Year-class (eggs)	Estimated egg deposition	Smolt Production	Survival (%)	Number of eggs per 100 m²
1986	11340000	56873	0.50	860
1987	16730000	76655	0.46	1269
1988	12420000	65038	0.52	942
1989	8040000	55335	0.68	610
1990	8730000	68720	0.79	662
1991	3980000	57793	1.45	302
1992	3970000	95781	2.41	301
1993	4760000	(98664)[1]	(2.07)	361
1994	3120000			237
1995	6320000			480
1996	8730000			662
1997	5430000			412
1998	6510000			494
1999				

[1] to age 4 smolts in 1998

Egg-to-smolt survival, has increased three-fold from the average of the 1986 to 1990 values (mean = 0.59%) to those obtained since 1991. The dramatic increase in the egg-to-smolt survival coincided with the first of several successive years in which the egg depositions were below the conservation requirement of 7.8 million eggs and has maintained this pattern. Smolts produced to date from the 1994 year class are now complete to age 3; egg-to-smolt survival is already 1.71%

and should again exceed 2% survival from an egg deposition rate well less than the Management Target.

5. Net-marked salmon

The following summarizes observations of net marked fish at Conne River during 1998.

Date	Number of fish observed	Number scarred	Percent Scarred
June 7-16	128	6	4.7
June 17-21	221	9	4.1
June 22-26	341	10	2.9
June 27-July 1	166	5	3.0
July 2-6	43	3	7.0
July 7-11	19	1	5.3
July 13-20	38	1	2.6
Total	956	35	3.7

Numbers of net marked salmon varied on each occasion with no apparent increasing or decreasing trend. Results from 1998 are the lowest recorded (1994 = 18.6%; 1995 = 7.1%; 1996 = 6.2%; 1997 = 7.2%).

6. Smolt production

The estimated number of smolts in 1998 was 69,841 (95% confidence limit = 60617-79064) (Table 10). Smolt production declined by 31% from the peak run in 1997, but was still 6% greater than the average production estimated from 1987 to 1995 (65,897 smolts). Seventy-five (75) percent of the smolt migrants in 1998 were age 3+, and thus were derived from the 1994 spawning escapement which was the lowest recorded to day and was estimated to have produced about 3.12 million eggs. The number of smolts in each age group is summarized in Table 11. As stated above, there were no farmed smolts identified in the sample of Conne River salmon smolts removed for biological characteristic information in 1998.

7. In-season and pre-season forecasts of salmon abundance

In-season forecasts

Based upon an in-season review using data up to June 28, 1998, returns were expected to be from 2720 - 5332 small salmon suggesting that the conservation requirement would be met and returns would exceed those of 1997. However, the early season strong run of salmon to Conne River, which was the second highest return to June 28 since 1989, ended rapidly. A revised review carried out using information to July 5, then indicated that returns of small salmon would likely be closer to the lower confidence interval bound perhaps approaching 3000 fish (actual return = 2931 small salmon) and could actually be lower than returns in 1997. The revised conclusion indicated that the conservation requirement would still be attained while returns would fall short of the Management Target. The above illustrates that even with 12 years of prior information, and a retrospective analysis suggesting that any in-season predictions would likely be quite good, salmon runs can still be highly variable.

Figure 10 illustrates the updated sequential regressions of in-season counts to various dates with the corresponding total run for the year beginning with June 18. At Conne River, the cumulative count to June 18 has now ranged from a high of 34.2% of the total run in 1998 (33.8% in 1987) to a low of 2.0% in 1990. With the inclusion of 1998 data, the relationships for all in-season dates are still highly significant ($r^2 \geq 0.78$) (Fig. 10). As expected, the r^2 value increases as the season progresses as more and more of the final total is being accounted for.

Pre-season forecasts

Figure 11 updates plots of sea survival to 1SW salmon related to: (a) median timing of the smolt run from the previous year; and (b) an index of marine thermal habitat (January-March). As seen on the first graph, results incorporating the 1996 smolt class are suggestive of a non-linear association in that smolts in 1996 may have migrated too early, but we caution that there is only a single point from which to establish this relationship. Recall, however, that timing of the 1998 smolt run was day 130. Interestingly, we note that Ritter (1989, Figs. 2-3, p.132-133) has shown similar parabolic relationships in recapture rates of tagged salmon from the Miramichi and LaHave rivers with lower rates often occurring with either early or late tag release dates. With respect to the thermal habitat data, 1998 had the highest index for the series of years considered here (1987 - 1997 smolt class). As stated last year, problems that develop with the inclusion on an additional year are typically a sign of model instability when models are based on relatively little data. Again, given the spurious nature of the above relationships, pre-season forecasts are not provided for 1999.

8. Review of the current Management Target for Conne River

The current Management Target for Conne River is 7.8 million eggs, equivalent to about 4000 small salmon. This translates into an egg deposition rate of approximately 592 eggs per unit

of fluvial spawning/rearing habitat. As summarized in Section 4, above, there has been an increase in egg-to-smolt survival coincident with a decrease in the egg deposition rate per unit of fluvial habitat. This relationship is illustrated in Figure 12. While reasons other than the rate of egg deposition may have contributed to this pattern (e.g. environmental conditions), the data show that with egg deposition rates greater than 500 per unit, egg-to-smolt survival has been less than 1%. Indeed, the egg deposition rate from the 1994 year class of 237 eggs per unit will similarly yield a survival that will approach or exceed 2%. It will not be until results from the 1995 spawning year class when the egg deposition rate will again approach 500 will it be possible to see if the pattern for reduced freshwater survival at higher spawning rates will follow the earlier trend. Thus, by the end of year 2000, when age 4+ smolts resulting from the 1995 year class migrate, a clearer picture may emerge.

Until then, it is worthy to note that the 1.9% value for egg-to-smolt survival for the target spawning requirement model for lacustrine habitat (O'Connell and Dempson 1995) is obtained from the Conne River data at an egg deposition rate of 307 eggs per unit. The latter value is also consistent with the current conservation requirement derived for Conne River of 4.34 million eggs or, expressed in terms of egg deposition per unit fluvial habitat, a rate of 329 per unit. These data could suggest that there is little merit in maintaining a Management Target of 7.8 million eggs.

Acknowledgements

We again wish to acknowledge the support and co-operation of the Conne River Indian Band during all aspects of the 1998 project. Ken Durdle, Fisheries Management Branch, kindly provided Aboriginal Guardian weekly patrol reports. As in past years, Milton Shears and Roger Johnson provided valuable assistance during the smolt phase of the project.

References

Dempson, J. B., and G. Furey. MS 1996. Stock status of Atlantic salmon from Conne River, SFA 11, Newfoundland, 1995. DFO Atlantic Fisheries Res. Doc. 96/48. 31 p.

Dempson, J. B., and G. Furey. MS 1997. Stock status of Atlantic salmon from Conne River, SFA 11, Newfoundland, 1996. DFO Canadian Stock Assessment Secretariat Res. Doc. 97/34. 44 p.

Dempson, J. B., G. Furey, and C. Pennell. MS 1994. Status of the Atlantic salmon population of Conne River, SFA 11, Newfoundland, in 1993. DFO Atlantic Fisheries Res. Doc. 94/12. 35 p.

Dempson, J. B., G. Furey, and M. Bloom. MS 1998. Status of the Atlantic salmon population of Conne River, SFA 11, Newfoundland, 1997. DFO Canadian Stock Assessment Secretariat Res. Doc. 98/28. 43 p.

Dempson, J. B., T. R. Porter, and G. Furey. MS 1987. Assessment of the Atlantic salmon population of Conne River, Newfoundland, 1987. CAFSAC Res. Doc. 87/104. 14 p.

Dempson, J. B., and D. G. Reddin. MS 1995. Factors affecting the returns of adult Atlantic salmon, Salmo salar, with emphasis on Conne River. DFO Atlantic Fisheries Res. Doc. 95/78. 27 p.

Dempson, J. B., and D. E. Stansbury. 1991. Using partial counting fences and a two-sample stratified design for mark-recapture estimation of an Atlantic salmon smolt population. N. Amer. J. Fish. Manag. 11: 27-37.

DFO Science. 1998. Atlantic salmon: 1997 Atlantic Salmon: Insular Newfoundland, south Newfoundland, Salmon Fishing Areas 9-11. DFO Science Stock Status Report D2 - 04. 11 p.

O'Connell, M. F., and J. B. Dempson. 1995. Target spawning requirements for Atlantic salmon Salmo salar L., in Newfoundland rivers. Fisheries Management and Ecology, 2: 161-170.

O'Connell, M. F., J. B. Dempson, and D. G. Reddin. 1997. Inter-annual and inter-river variability in fecundity in Atlantic salmon (*Salmo salar* L.) in Newfoundland Region rivers. DFO Canadian Stock Assessment Secretariat Res. Doc. 97/94. 33 p.

Reddin, D. G., and K. D. Friedland. 1993. Marine environmental factors influencing the movement and survival of Atlantic salmon, p. 107-113. In, D. Mills [ed.], Salmon in the sea and new enhancement strategies. Fishing News Books, London: Blackwell-Scientific.

Ritter, J. A. 1989. Marine migration and natural mortality of North American Atlantic salmon (*Salmo salar* L.). Can. Manuscript Rept. Fish. Aquat. Sci. No. 2041, 136 p.

Schwarz, C., and J. B. Dempson. 1994. Mark-recapture estimation of a salmon smolt population. Biometrics 50: 98-108.

Table 1. Summary of dates of operation for downstream smolt mark-recapture studies, and upstream adult salmon counts at Conne River, Newfoundland, 1986 - 1998.

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

Table 2. Atlantic salmon landings (in numbers of fish) in the recreational fishery, 1974-1998, and in the native food fishery, 1986-1998, at Conne River, Newfoundland. Note that the recreational fishery was closed from 1993 - 1996 and again in 1998, while the food fishery was closed from 1994 - 1996, and in 1998.

	Recreational Fishery				Native Food Fishery			
	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	11
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

* 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 3a. Summary of biological characteristics for Atlantic salmon samples from Conne River, Newfoundland (SFA 11), 1986-1998.

		Fork length (mm)					Whole weight (g)					River age (y)					Sex Ratio	
Lifestage	Year	N	Mean	SD	Min	Max	N	Mean	SD	Min	Max	N	Mean	SD	Min	Max	N	% female
Smolt	1986	145	153	12.0	125	210	0					145	3.25	0.48	2	5	0	
	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
	1988	328	147	15.7	102	201	328	32.3	10.4	12.4	78.8	328	3.41	0.51	3	5	327	73
	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
	1990	271	148	21.2	100	253	271	30.5	13.1	10.3	122.8	271	3.29	0.49	2	5	271	74
	1991	246	153	19.9	104	244	246	33.5	13.6	12.6	112.5	246	3.19	0.44	2	5	245	66
	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
	1993	246	149	16.5	114	198	246	31.6	10.3	15.7	71.7	246	3.26	0.45	3	5	246	67
	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
	1995	249	143	15.2	103	179	249	28.6	8.3	10.3	50.6	249	3.31	0.51	2	5	249	73
	1996	243	151	16.0	102	224	243	32.9	10.2	16.3	93.8	243	3.16	0.47	2	5	243	73
	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
	1998	282	147	14.8	110	233	282	30.8	9.4	12.4	106	282	3.23	0.48	2	5	282	71
TOTAL		3326	148	17.1	98	253	3181	31.3	11.0	9.8	123.2	3326	3.26	0.49	2	5	3178	73
1 SW	1986	357	506	23.0	440	570	357	1451	220.4	900	2900	357	3.38	0.57	2	5	356	76
	1987	373	509	23.3	430	580	373	1492	247.5	600	2600	373	3.18	0.46	2	5	352	79
	1988	267	506	26.1	440	600	267	1352	226.5	1000	2200	267	3.14	0.42	2	4	261	80
	1989	140	512	23.3	460	580	140	1411	201.7	1000	2000	140	3.18	0.50	2	5	135	79
	1990	174	508	23.4	449	575	142	1454	184.4	1100	2000	174	3.27	0.52	2	5	141	81
	1991	39	514	22.8	455	552	34	1362	172.4	1000	1700	39	3.18	0.39	3	4	33	70
	1992	77	505	22.4	453	580	36	1363	276.1	900	2000	77	3.18	0.53	2	5	43	79
	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	75
	1995 *	111	498	24.8	433	573	107	1144	184.4	800	1700	111	3.14	0.42	2	5	105	77
	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
	1998	135	502	22.3	420	560	0					135	3.08	0.42	2	4	0	
TOTAL		2045	508	24.0	405	620	1608	1407	241.1	600	2900	2045	3.22	0.49	1	5	1538	78

* 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 3a. (Continued) Summary of biological characteristics for Atlantic salmon samples from Conne River, Newfoundland (SFA 11), 1986-1998.

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
2 SW	1986	1	630				1	2600				1	3.00				1	100
	1989	2	665	21.2	650	680	1	2700				2	3.50	0.71	3	4	1	100
	1992	1	650				1	2700				1	4.00				0	
	1994	1	700				0					1	3.00				0	
	1995	2	735	49.5	700	770	0					2	3.00	0.00	3	3	0	
	1996	2	665	14.1	655	675	0					2	2.50	0.71	2	3	0	
	1997	1	740				0					1	3.00				0	
TOTAL		10	685	43.7	630	770	3	2667	57.5	2600	2700	10	3.10	0.57	2	4	2	100
Consecutive Spawning Grilse																		
	1986	1	560				1	1800				1	3.00				1	100
	1987	6	528	29.4	485	576	6	1578	351.6	1070	2100	6	3.17	0.75	2	4	5	100
	1988	5	556	24.1	530	590	5	1640	260.8	1500	2100	5	2.80	0.84	2	4	5	40
	1989	6	575	23.5	550	610	6	1767	233.8	1500	2000	6	3.00	0.00	3	3	6	50
	1990	3	564	51.4	505	601	0					3	3.33	0.58	3	4	0	
	1991	4	586	49.9	548	659	1	1400				4	3.50	0.58	3	4	1	100
	1992	8	581	43.6	530	660	0					8	3.50	0.53	3	4	0	
	1993	3	617	56.9	570	680	0					3	2.67	1.15	2	4	0	
	1994	15	564	36.1	510	640	14	1714	455.5	1200	2900	15	3.20	0.56	2	4	15	73
	1995	2	547	3.5	544	549	2	1500	141.4	1400	1600	2	3.00	0.00	3	3	2	100
	1996	19	572	60.8	505	795	0					19	3.16	0.37	3	4	2	50
	1997	52	582	37.0	510	665	0					52	3.21	0.50	2	4	0	
	1998	29	591	45.8	490	700	0					29	3.28	0.45	3	4	0	
TOTAL		153	577	43.7	485	795	35	1671	350.1	1070	2900	153	3.20	0.52	2	4	37	70
Alternate Spawning Grilse																		
	1986	1	600				1	2400				1	3.00				1	100
	1989	13	683	18.9	660	710	2	3350	212.1	3200	3500	13	3.08	0.28	3	4	2	100
	1991	2	700	29.0	679	720	0					2	3.50	0.71	3	4	0	
	1992	8	682	44.4	630	770	0					8	2.88	0.35	2	3	1	100
	1993	6	675	35.1	640	710	0					6	3.33	0.52	3	4	0	
	1994	3	703	45.1	660	750	0					3	3.00	0.00	3	3	0	
	1995	5	730	29.2	710	780	0					5	3.00	0.00	3	3	0	
	1996	4	710	21.2	695	740	0					4	3.25	0.50	3	4	0	
	1997	19	702	30.9	655	780	0					19	3.21	0.42	3	4	0	
	1998	27	691	32.1	625	760	0					27	3.07	0.27	3	4	0	
TOTAL		88	693	34.0	600	780	3	3033	568.6	2400	3500	88	3.11	0.35	2	4	4	100

Table 3b. Summary of biological characteristic information by life-history groups for small and large fish with corresponding notation for Conne River Atlantic salmon, 1986 - 1998.

Life-history group	Notation		Notation N	Notation 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
Small salmon (< 630 mm for length)														
Virgin grilse	1.1		1	0.05	1	531				1	1300			
	2.1		57	2.61	57	502	23.8	440	540	41	1337	242.6	600	1900
	3.1		1499	68.64	1499	507	23.9	405	610	1164	1401	237.8	700	2600
	4.1		473	21.66	473	510	24.1	420	620	389	1434	249.2	800	2900
	5.1		15	0.69	15	522	26.8	490	590	13	1460	229.8	1000	1800
Consecutive spawning grilse	2.1.SM		5	0.23	5	552	20.5	520	570	3	1633	152.8	1500	1800
	3.1.SM		82	3.75	82	564	31.4	490	625	22	1636	259.2	1300	2100
	3.1.SM.SM		14	0.64	14	598	22.7	560	625	2	1900	141.4	1800	2000
	4.1.SM		30	1.37	30	560	28.7	485	610	6	1428	242.5	1070	1700
	4.1.SM.SM		6	0.27	6	583	28.1	550	625	1	2300			
Alternate spawning grilse	3.1.SM.1		2	0.09	2	613	17.7	600	625	1	2400			
Large salmon (>= 630 mm for length)														
Virgin 2SW	2.2		1	0.89	1	675								
	3.2		7	6.25	7	685	53.0	630	770	3	2667	57.7	2600	2700
	4.2		2	1.79	2	690	14.1	680	700					
Consecutive spawning large	2.1.SM.SM		2	1.79	2	670	14.1	660	680					
	2.1.SM.SM.SM.SM		1	0.89	1	640								
	3.1.SM.SM		7	6.25	7	668	57.7	630	795					
	3.1.SM.SM.SM		3	2.68	3	668	30.1	640	700					
	4.1.SM.SM		3	2.68	3	650	10.0	640	660					
Alternate spawning large	2.1.SM.1		1	0.89	1	630								
	3.1.SM.1		71	63.39	71	696	30.8	640	780	2	3350	212.1	3200	3500
	3.1.SM.SM.1	*	2	1.79	2	730	42.4	700	760					
	3.1.SM.SM.SM.1	*	1	0.89	1	680								
	4.1.SM.1		11	9.82	11	691	34.1	640	755					

* 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 4. Summary of biological characteristics for Atlantic salmon samples from the Conne River aboriginal food fishery, 1988, 1992-93, and 1997.

		Fork length (mm)					Whole weight (g)					River age (y)					Sex Ratio	
Lifestage	Year	N	Mean	SD	Min	Max	N	Mean	SD	Min	Max	N	Mean	SD	Min	Max	N	% female
1 SW	1988	527	503	25.0	406	585	489	1397	219.0	600	2100	527	3.17	0.40	2	5	516	78
	1992	208	516	20.3	470	580	205	1389	176.6	1000	2000	208	3.07	0.44	2	5	206	67
	1993	253	504	24.3	430	640	253	1347	214.1	900	2400	253	3.08	0.39	1	4	253	67
	1997	472	529	23.6	460	610	472	1774	279.8	1000	2900	472	3.21	0.49	2	5	472	71
TOTAL		1460	513	26.5	406	640	1419	1512	299.2	600	2900	1460	3.15	0.44	1	5	1447	72
2 SW	1988	1	670				1	3300				1	4.00				1	100
	1992	1	690				1	2200				1	3.00				1	100
TOTAL		2	680	14.1	670	690	2	2750	777.8	2200	3300	2	3.50	0.71	3	4	2	100
Consecutive Spawning Grilse																		
	1988	11	591	58.6	518	733	9	2278	767.8	1300	3900	11	3.45	0.52	3	4	11	91
	1997	3	527	41.6	480	560	3	1367	152.8	1200	1500	3	4.00	0.00	4	4	3	100
TOTAL		14	578	60.6	480	733	12	2050	776.4	1200	3900	14	3.57	0.51	3	4	14	93
Alternate Spawning Grilse																		
	1992	2	665	7.1	660	670	2	3650	353.6	3400	3900	2	3.50	0.71	3	4	2	100
	1993	2	685	7.1	680	690	2	3550	212.1	3400	3700	2	3.00	0.00	3	3	2	100
	1997	1	690				1	4400				1	3.00				1	100
TOTAL		5	678	13	660	690	5	3760	415.9	3400	4400	5	3.20	0.45	3	4	5	100

Table 5. Estimated numbers of small and large Conne River Atlantic salmon partitioned by life stage, and the percentage of 1SW small salmon that survive to spawn in year i+1 as a small consecutive spawner. The last column includes the contribution of large salmon in deriving the estimated survival of repeat spawners. Bracketed value for 1997 is preliminary pending alternate salmon spawners in 1999.

	Small salmon				Large salmon			
		Previous spawners		Survival of 1SW fish to consecutive spawners (%)		Previous spawners		% Survival of 1SW fish to consecutive or alternate spawners
Year	1SW	Consecutive	Alternate	in year i+1	2SW	Consecutive	Alternate	(small and large salmon)
1986	8256	23	23	1.83	37	56	319	6.61
1987	10004	151	0	1.40	46	70	400	4.45
1988	7487	140	0	2.72	38	57	325	7.15
1989	4764	204	0	1.91	29	43	248	4.41
1990	5277	91	0	1.33	34	50	288	3.88
1991	2341	70	0	3.16	8	12	69	7.35
1992	2449	74	0	3.23	14	21	123	6.94
1993	2624	79	0	1.71	9	14	77	5.49
1994	1488	45	0	4.17	9	14	77	14.52
1995	3440	62	0	24.16	10	15	85	29.01
1996	3323	831	0	21.55	16	24	139	29.19
1997	2484	716	0	17.07	17	25	143	(18.01)
1998	2489	424	18		27	40	229	

* example of survival calculation from 8256 1SW salmon in 1986 that would include large salmon:

151 consecutive spawners from 1987 + 70 (large) consecutive spawners from 1987 + 325 (large) alternate spawners

from 1988: = 546/8256 * 100 = 6.61%

1SW data for 1996 have been adjusted for the wild-aquacultured salmon that returned that year

For large salmon, the average breakdown over all years (1986-1998) has been used to apportion fish into respective life history classes.

Table 6. 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	46.0	56.0	1.28	0.17	1.02	1.74	47.8	1907
1986		102	3494	682	1450	5590	50.9	2.37	45.0	56.0	1.48	0.23	1.00	2.90	68.7	2367
1987		136	3424	635	1287	5476	51.1	2.36	42.0	57.6	1.45	0.25	1.00	2.60	67.0	2364
1988		85	3196	568	2111	5054	50.2	2.50	46.0	60.0	1.35	0.24	1.00	2.20	63.7	2366
1990		93	2245	575	703	3544	51.1	2.09	46.0	57.0	1.45	0.18	1.10	2.00	44.0	1545
1991		22	2772	1241	595	5010	51.7	2.01	47.0	55.2	1.35	0.15	1.00	1.60	53.6	2046
1992		21	1768	498	1009	2545	50.6	2.15	45.3	55.2	1.38	0.25	0.90	1.90	35.0	1278
1997		33	3627	459	2929	5158	51.6	2.29	46.0	57.5	1.45	0.33	0.70	2.00	70.3	2504
Years Combined	**	492	3090	845	595	5590	50.9	2.33	42.0	60.0	1.43	0.24	0.70	2.90	60.7	2159

* 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 7a. Summary of rainbow trout occurrences and captures at Conne River, 1990 - 1998, with corresponding size data where available. Information from past years has been summarized in previous research assessment documents, but is included here for completeness.

Year	Date	Location/gear	Length (mm)	Whole weight (g)
1990	May 25	Downstream trap	345	400
	June 12	Upstream trap	370	700
	July 22	Beach mortality	216	100
1991	June 5	Upstream trap	470	1400
	June 10	Pool above fence	532	2200
	June 15	8 fish caught at Dashwoods		4 - (18 - 20 cm) 2 - (1.5 - 2 kg) 2 - (0.5 - 0.7 kg)
	June 15	Angled above fence		~ 700
	June 16	3 angled above fence	494	1600
			540	2600
			538	2200
	June 17	Angled at Dashwoods		> 2000
	June 25	2 caught below fence		
	June 25	Upstream trap	395	710
	June 26	1 caught below fence		
	June 27	5 observed passing downstream through fence		
	June 27	Angled above fence	354	300
	June 27	Angled above fence	547	2000
	June 27	1 observed passing upstream through fence		
	July 13	11 observed above fence while snorkling		
	Aug 18	9 observed above fence while snorkling		
1992	May 21	Downstream fence	~170	
	May 28	Downstream fence	~300	
	May 28	Upstream trap	600	
1993	May 11	Downstream trap	162	63
	May 16	Downstream trap	169	60
	May 30	Downstream trap	171	68
	May 31	Downstream trap	157	56
	June 1	Downstream trap	185	96
	June 2	Downstream trap	200	99
	June 7	Downstream trap	175	73
	June 16	Downstream trap	165	60
	July 4	Upstream camera system		
	July 5	Upstream camera system		
	July 18	Upstream trap	195	92
1994	May 22	Downstream trap	170	47
	May 24	Downstream trap	168	45
	June 7	Downstream trap	138	30
	June 7	Downstream trap	158	41
	June 15	Downstream trap	132	25
	July 4	Upstream trap	160	44
	July 5	Electrofished	147	30
	July 7	Electrofished	166	40
	July 20	Upstream trap	185	55
	July 20	Upstream trap	170	45
	Sept 19	Upstream trap	350	
	Sept 26	Upstream trap	450	1850

Table 7a. Continued. Summary of rainbow trout occurrences and captures at Conne River, 1990 - 1998, with corresponding size data where available. Information from past years has been summarized in previous research assessment documents, but is included here for completeness.

Year	Date	Location/gear	Length (mm)	Whole weight (g)
1995	May 17	Downstream trap	405	
	May 17	Downstream trap	365	
	May 22	Downstream trap	337	
	May 22	Downstream trap	430	
	May 26	Downstream trap	336	
	June 21	Snorkling observation (N = 4)	~300 - 400	
	July 8	Video camera system		
	July 9	Video camera system		
	July 9	Fence mortality	414	
	July 9	Upstream trap	410	
	July 9	Upstream trap	454	
	July 10	Video camera system (N = 2)		
	July 14	Snorkling observation (N = 12)	~200 - 500	
	July 17	Video camera system (N = 2)		
	Aug 26	Upstream trap	330	
	Aug 30	Fence mortality	~350 - 400	
	Sept 1	Upstream trap	~350 - 400	
	Sept 5	Upstream trap	~350 - 400	
	Sept 6	Upstream trap	~350 - 400	
	Sept 6	Upstream trap	~350 - 400	
	Sept 14	Upstream trap	~350 - 400	
	Sept 14	Upstream trap	~350 - 400	
	Sept 17	Upstream trap	~350 - 400	
1996	May 22	Upstream trap	380	
	May 29	Downstream trap	325	
	May 30	Downstream trap	300 - 350	
	June 17	Snorkling observation (N = 11)	300 - 400	
	June 20	Snorkling observation (N = 3)	300 - 400	
	June 29	Snorkling observation (N = 8)	300 - 400	
	July 1	Video camera system (N = 2)	300 - 400	
	July 9	Upstream trap	400	
	July 27	Upstream trap	185	
	July 27	Upstream trap	435	
	July 31	Fence mortality	300 - 400	
	Aug 5	Upstream trap (N = 3)	300 - 400	
	Aug 7	Upstream trap	390	
	Aug 8	Upstream trap	337	
	Aug 8	Upstream trap	385	
	Aug 9	Upstream trap	352	
	Aug 9	Upstream trap	309	
	Sept 2	Upstream trap	300 - 400	
	Sept 16	Upstream trap	300 - 400	

Table 7a. Continued. Summary of rainbow trout occurrences and captures at Conne River, 1990 - 1998, with corresponding size data where available. Information from past years has been summarized in previous research assessment documents, but is included here for completeness.

Year	Date	Location/gear	Length (mm)	Whole weight (g)
1997	May 18	Downstream trap	546	
	May 23	Downstream trap		
	June 1	Downstream trap	170	
	June 3	Downstream trap	195	
	June 4	Downstream trap	405	
	June 17	Snorkling observation (N = 25)	150 - 500	
	June 26	Snorkling observation (N = 8)	200 - 400	
	July 1	Fence mortality	475	
	July 2	Snorkling observation (N = 15)	200 - 400	
	July 3	Upstream trap	540	
	July 9	Upstream trap	300	
	July 13	Snorkling observation (N = 3)	150 - 200	
	July 26	Snorkling observation (N = 10)	200 - 500	
	August 2	Fence mortality	520	
	August 7	Upstream trap	395	
1998	May 11	Downstream trap	385	
	May 20	Upstream trap	300 - 400	
	June 5	Upstream trap	435	
	June 25	Snorkling observation (N = 3)	250 - 350	
	July 5	Snorkling observation (N = 3)	150 - 200	
	July 7	Snorkling observation (N = 3)	150 - 400	
	July 9	Snorkling observation (N = 3)	150 - 200	
	July 9	Upstream trap	405	
	July 14	Snorkling observation (N = 2)	200 - 400	
	July 18	Snorkling observation (N = 7)	200 - 400	

Table 7b. Summary of escaped farmed salmonids captured in Conne River, March 24 - 25, 1999. All fish were caught by angling in the lower section of the river below Goodyears and Dashwood Steady. Gross examination of stomach contents are provided.

Species	Length (mm)	Whole weight (kg)	Sex	Stomach Contents
Rainbow	460	1.2	-	detritus
Rainbow	420	1.0	-	detritus
Rainbow	440	1.3	-	35 Caddis larvae
Rainbow	360	0.6	-	detritus
Rainbow	400	0.8	-	detritus
Rainbow	410	1.0	-	3 Caddis larvae and detritus
Rainbow	360	0.6	-	detritus
Rainbow	510	1.9	-	14 Caddis larvae
Rainbow	360	0.5	-	detritus
Salmon	480	1.3	Female *	detritus
Brook trout	410	1.0	Male *	detritus
Brook trout	430	0.9	Male *	detritus
Rainbow	320	0.5	-	detritus
Rainbow	370	0.6	-	detritus
Rainbow	550	2.0	-	small pebbles
Rainbow	550	2.3	-	pebbles and detritus

* The escaped farmed salmon and brook trout showed early indications of maturation

Table 7c. Summary of numbers of people observed fishing and corresponding numbers of rainbow trout and brook trout caught in the upper Bay d'Espoir and surrounding area by standard week, from February 1 - April 2, 1999. Data were collected during patrols carried out by the Conne River Aboriginal Guardians. Areas left blank indicate no observed catch.

Date	Standard Week	Number of people fishing	Area patrolled	Number of fish caught		
				Rainbow trout	Brook trout	Sea Trout
Jan 29 - Feb 4	5	188	Causeway, Vyse Cove & Little R.			
		56	Ice fishing			
Feb 5 - 11	6	388	Causeway & Vyse Cove	260		
		21	Little River		148	
		25	Ice fishing			
Feb 12 - 18	7	163	Causeway & Vyse Cove	78		
		21	Causeway - Tailrace	4		
		33	Vyse Cove	26		
		23	St. Alban's	15		
		62	Conne	54		
		8	Ice fishing			
Feb 19 - 25	8	11	Causeway - Tailrace	3		
		57	Vyse Cove	30		
		20	Conne	24		
Feb 26 - Mar 4	9	113	Causeway - Tailrace	52	16	
		26	Vyse Cove	7	3	
		2	Conne	4	6	
		12	St. Alban's	9		
		0	Harbour Breton highway			
Mar 5 - 11	10	108	Causeway - Tailrace	68	15	
		5	Vyse Cove	4		
		4	Little River	4		25
		2	St. Alban's			
Mar 12 - 18	11	94	Causeway - Tailrace	56	1	
		2	Vyse Cove			
		10	Swanger's Cove (Bridge)	12	2	
		2	Conne River shoreline	1		
		16	Conne River (lower)	35	7	
Mar 19 - 25	12	83	Causeway - Tailrace	45	5	
		6	Vyse Cove	4		
		6	Conne	1		
Mar 26 - Apr 1	13	55	Causeway - Tailrace	14	1	
		25	Vyse Cove	40		2
		1	Swanger's Cove (Bridge)			
		8	St. Alban's			
		3	Head of Bay d'Espoir (along shore)			
		2	Southeast Bk			
		2	Morrisville area			
		21	Conne River (lower)	70		
Apr 2 - 8	14	22	Causeway - Tailrace	5		
		4	Conne River (lower)	12	1	
Total		1710		937	205	27

Table 8. Total estimated returns of small salmon to Conne River, Newfoundland, with a summary of mortalities and removals and estimated spawning escapement, 1986-98.

	Year												
	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Returns													
* Food Fishery (estuary)	766	451	506	317	831	234	403	347	0	0	0	428	0
Angling below fence				180	213	70	137	0	0	0	0	95	0
Mortalities below fence	21	17	3	2	3	2	0	1	0	2	4	1	0
Count at fence	7515	9287	7118	4469	4321	2086	1973	2355	1533	3500	4436	2676	2931
Estimated count		400				19	10						
Total Returns	8302	10155	7627	4968	5368	2411	2523	2703	1533	3502	4440	3200	2931
1 - Released at fence	7515	9687	7118	4469	4321	2105	1983	2355	1533	3500	4436	2676	2931
Removals and mortalities													
Mortalities above fence/or in trap	27	21	7	4	2	5	8	2	5	7	9	5	5
Angling above fence	2060	1598	1544	856	554	38	192	0	0	0	0	102	0
Brood stock removal	0	245	0	0	0	0	0	0	93	117	25	0	0
Farmed salmon removed	0	0	0	0	0	0	0	0	0	0	0	3	0
Hook and release mortalities												8	
2 - Total	2087	1864	1551	860	556	43	200	2	98	124	34	118	5
Spawning escapement													
(1) - (2)	5428	7823	5567	3609	3765	2062	1783	2353	1435	3376	4402	2558	2926
Egg deposition													
in millions of eggs	9.86	14.66	10.65	6.95	7.50	3.68	3.45	4.43	2.78	5.95	8.12	4.81	5.51
% of Management Target met	126	188	137	89	96	47	44	57	36	76	104	62	71
% of Conservation egg requirement met	227	338	246	160	173	85	80	102	64	137	187	111	127

* 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 9. Total estimated returns of large salmon to Conne River, Newfoundland, with a summary of mortalities and removals and estimated spawning escapement, 1986-98. Total estimated egg deposition from small and large salmon are also indicated along with the combined estimate of the percentage of the Management Target or Conservation egg requirement met.

	Year												
	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Returns													
* Food Fishery (estuary)	14	18	2	1	11	2	4	2	0	0	0	1	0
Angling below fence	0	0	0	0	0	0	0	0	0	0	0	0	0
Mortalities below fence	1	0	0	0	0	0	1	0	0	0	0	0	1
Count at fence	397	498	418	319	361	87	154	98	100	110	179	184	294
Estimated count													
Total Returns	412	516	420	320	372	89	159	100	100	110	179	185	295
1 - Released at fence	397	498	418	319	361	87	154	98	100	110	179	184	294
Removals and mortalities													
Mortalities above fence/or in trap	1	0	0	0	0	0	1	1	0	2	0	0	0
Angling above fence	0	0	0	0	0	0	0	0	0	0	0	0	0
Brood stock removal		10							1	0	0	0	0
Farmed salmon removed												2	0
Hook and release mortalities													
2 - Total	1	10	0	0	0	0	1	1	1	2	0	2	0
Spawning escapement													
(1) - (2)	396	488	418	319	361	87	153	97	99	108	179	182	294
Egg deposition													
in millions of eggs	1.48	2.07	1.77	1.09	1.23	0.30	0.52	0.33	0.34	0.37	0.61	0.62	1.01
% of Management Target met	19	27	23	14	16	4	7	4	4	5	8	8	13
% of Conservation egg requirement met	34	48	41	25	28	7	12	8	8	9	14	14	23
Total egg deposition - small and large salmon	11.34	16.73	12.42	8.04	8.73	3.98	3.97	4.76	3.12	6.32	8.73	5.43	6.51
Egg deposition per unit fluvial habitat	860	1269	942	610	662	302	301	361	237	480	662	412	494
Total % Management Target met	145	214	159	103	112	51	51	61	40	81	112	70	83
Total % Conservation requirement met	261	386	286	185	201	92	92	110	72	146	201	125	150

* 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 10. Estimates of Atlantic salmon smolts from Conne River, 1987 - 1998, along with subsequent survival to both small salmon in year i + 1, and to 1SW salmon (repeat spawning fish omitted).

	Number of smolts			Population estimate			Survival		
	Upper site	Lower site							
Year (i)	Tagged & released	Total number Captured	Tag Recoveries	N	Confidence interval	Coeffiicient of variation %	% survival to small salmon year i + 1	Survival range	% survival to 1SW salmon year i + 1
1987	4975	14314	990	74585	67597 - 81573	5.1	10.2	9.3 - 11.3	10.04
1988	3235	19515	1054	65692	59862 - 71522	4.8	7.6	6.9 - 8.3	7.25
1989	2699	16928	604	73724	66598 - 80850	5.1	7.3	6.7 - 8.1	7.16
1990	3719	13881	945	56943	52315 - 61571	4.4	4.2	3.9 - 4.6	4.11
1991	3753	9581	398	74645	62033 - 87527	9.0	3.4	2.9 - 4.1	3.28
1992	3758	10229	529	68208	61334 - 75052	5.4	4.0	3.6 - 4.4	3.85
1993	2456	15992	735	55765	51666 - 59864	3.9	2.7	2.6 - 3.0	2.67
1994	2366	11875	479	60762	53759 - 67765	6.2	5.8	5.2 - 6.5	5.66
1995	2558	12260	545	62749*	55300 - 70197	6.3	7.2	6.4 - 8.3	5.76
1996	3373	14575	499	94088	79867 - 108309	8.0	3.4	3.0 - 4.0	2.74
1997	3715	18290	662	100983	92812 - 109154	8.4	2.9	2.7 - 3.2	2.46
1998	2952	8636	367	69841	60617 - 79064	13.8			

* Of these fish, 5016 smolt were transferred to sea cage holding facilities at Roti Bay.

Table 11. Estimated total number of smolts in each age group, Conne River, Newfoundland, 1987-97. Lower chart indicates the percentage of smolts at each river age.

	River age (y)				
Year	2	3	4	5	Total
1987	1492	49226	22375	1492	74585
1988	0	40072	24963	657	65692
1989	2212	52344	17694	1474	73724
1990	569	39861	15944	569	56943
1991	747	59716	13436	746	74645
1992	682	49792	16370	1364	68208
1993	0	41266	14499	0	55765
1994	0	48002	12760	0	60762
1995	627	42670	18825	627	62749
1996	2823	75270	14113	1882	94088
1997	1010	79777	19186	1010	100983
1998	698	52381	16064	698	69841

	Percent in each age group				Number of
Year	2	3	4	5	samples
1987	2	66	30	2	271
1988	0	61	38	1	328
1989	3	71	24	2	288
1990	1	70	28	1	271
1991	1	80	18	1	246
1992	1	73	24	2	169
1993	0	74	26	0	246
1994	0	79	21	0	208
1995	1	68	30	1	249
1996	3	80	15	2	243
1997	1	79	19	1	380
1998	1	75	23	1	282

Table 12. Marine thermal habitat units along with estimates of sea survival to small salmon or 1SW salmon at Conne River.

Year	Thermal habitat units								Sea survival	
	Jan	Feb	March	April	May	June	Jan-March	Jan-Feb	Small	1SW
1986	1832	1688	1547	1674	1880	2366	5067	3520		
1987	1711	1627	1471	1658	1655	1754	4809	3338		
1988	1747	1698	1622	1676	1864	2022	5067	3445	10.2	10.04
1989	1807	1642	1552	1552	1665	1985	5001	3449	7.6	7.25
1990	1526	1503	1491	1318	1543	1747	4520	3029	7.3	7.16
1991	1403	1357	1519	1529	1592	2050	4279	2760	4.2	4.11
1992	1474	1381	1378	1395	1582	1891	4233	2855	3.4	3.28
1993	1441	1252	1242	1353	1517	1923	3935	2693	4.0	3.85
1994	1487	1329	1373	1403	1711	1955	4189	2816	2.7	2.67
1995	1444	1311	1279	1378	1679	1941	4034	2755	5.8	5.66
1996	1647	1470	1419	1495	1859	2086	4536	3117	7.2	5.76
1997	1791	1594	1605	1714	1868	2071	4990	3385	3.4	2.74
1998	2018	1849	1795	1851	1789	1899	5662	3867	2.9	2.46
1999	1769	1741	1664				5174	3510		

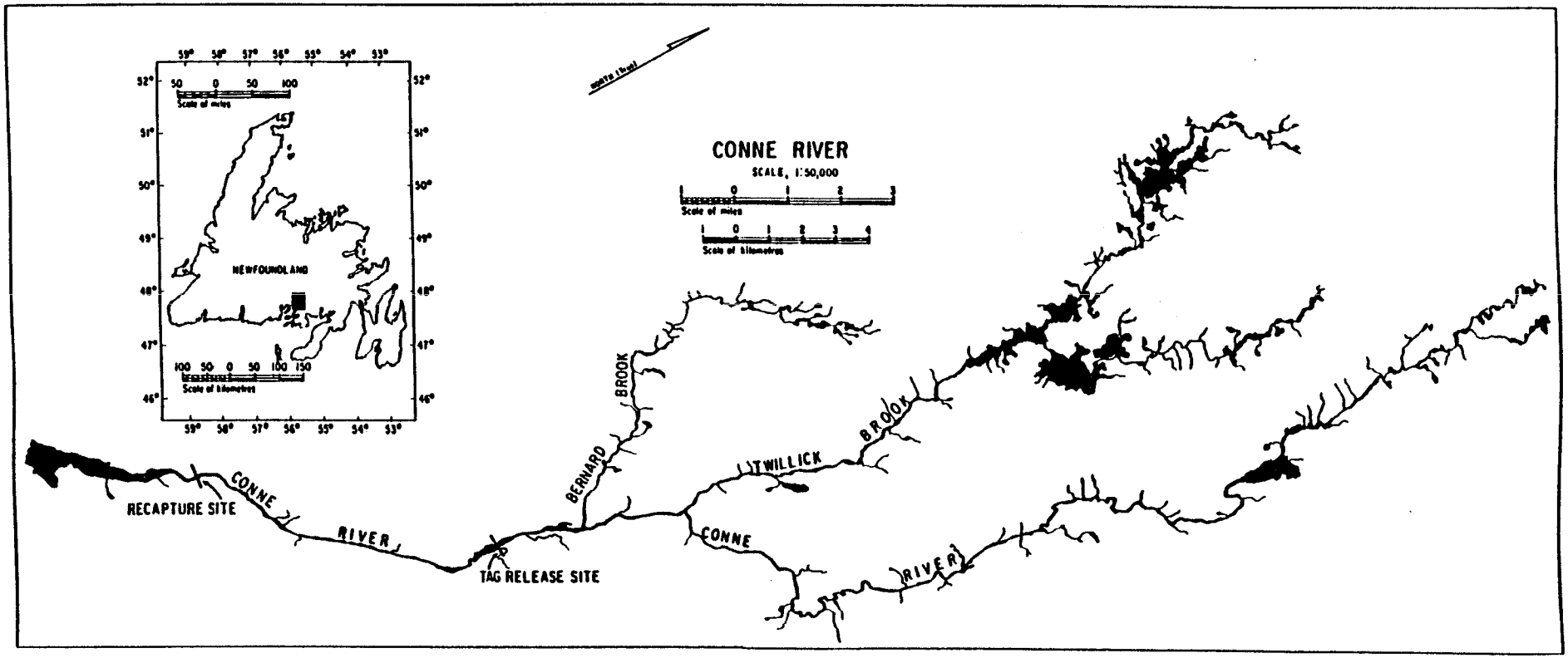

Fig. 1. Conne River, Newfoundland, SFA 11, illustrating the location of the fish counting fences used for the smolt mark-recapture survey. The recapture site is also the location of the upstream adult fish counting facility.

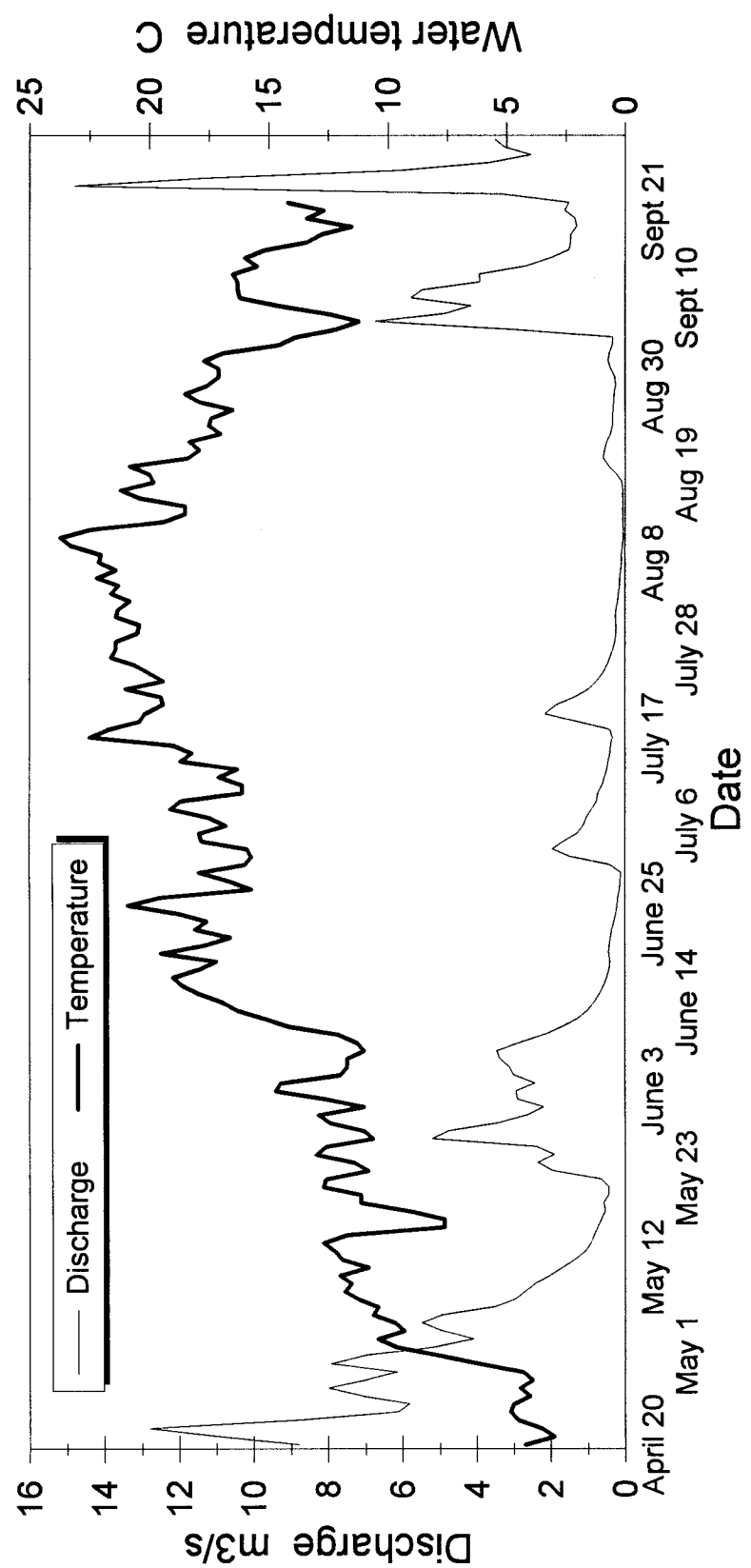

Figure 2. Discharge (April 20 - Sept. 30) and temperature (April 20 - Sept. 22) profile at Conne River, Newfoundland, 1998. Discharge data from the Environment Canada monitoring station located below Conne Pond. Temperature data from a Hugrun thermograph located at the lower (adult) fish counting fence site.

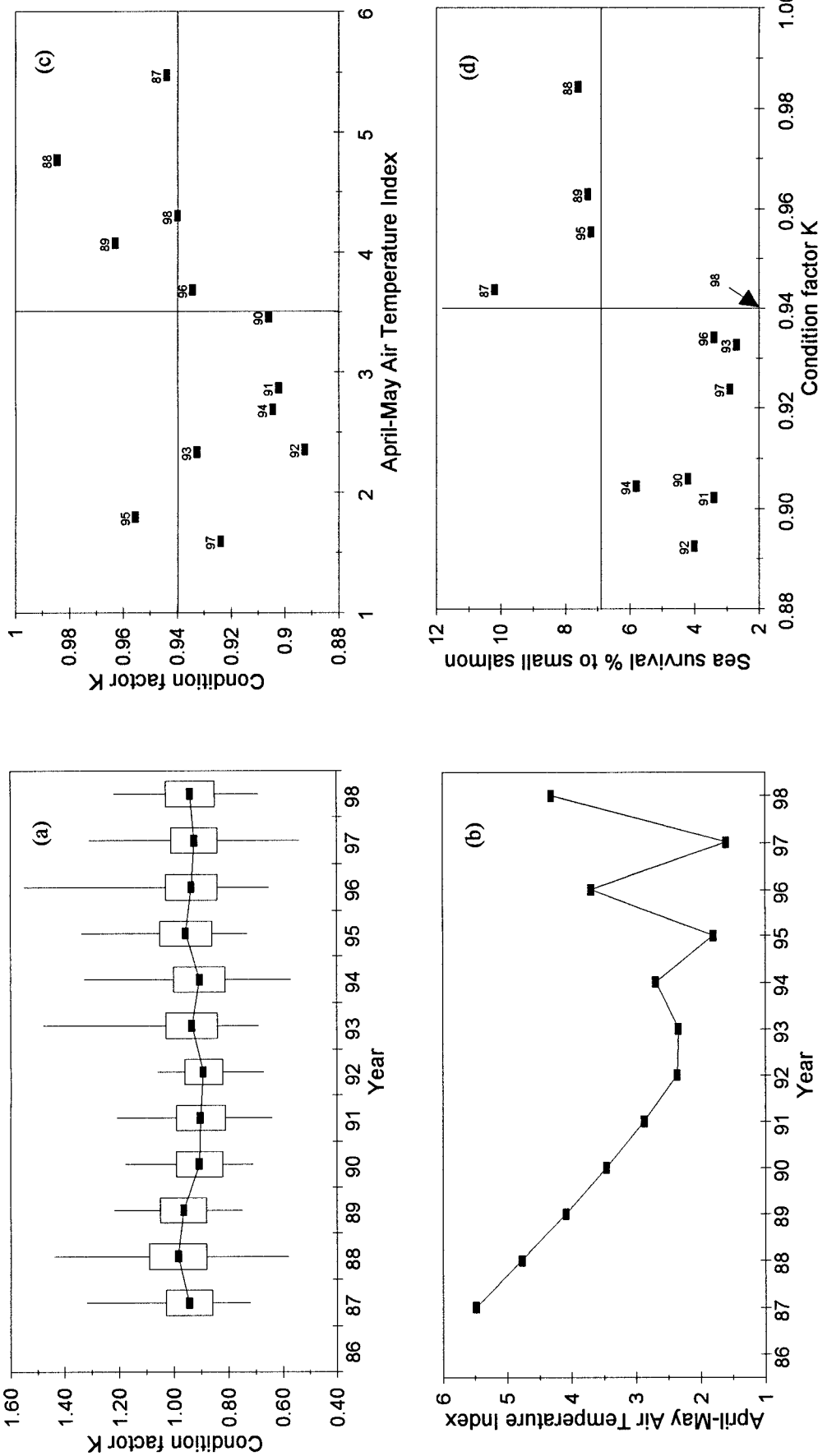

Figure 3. Trends in (a) Conne River smolt condition and (b) the April-May air temperature index over years; (c) smolt condition versus the air temperature index, and (d) sea survival (%) of small salmon versus smolt condition. Years shown refer to the year of smolt migration. In panel (d), the arrow indicates the 1998 smolt condition. In plot (a), vertical lines represent the minimum and maximum condition, the rectangle denotes one standard deviation about the mean which is the point within the rectangle.

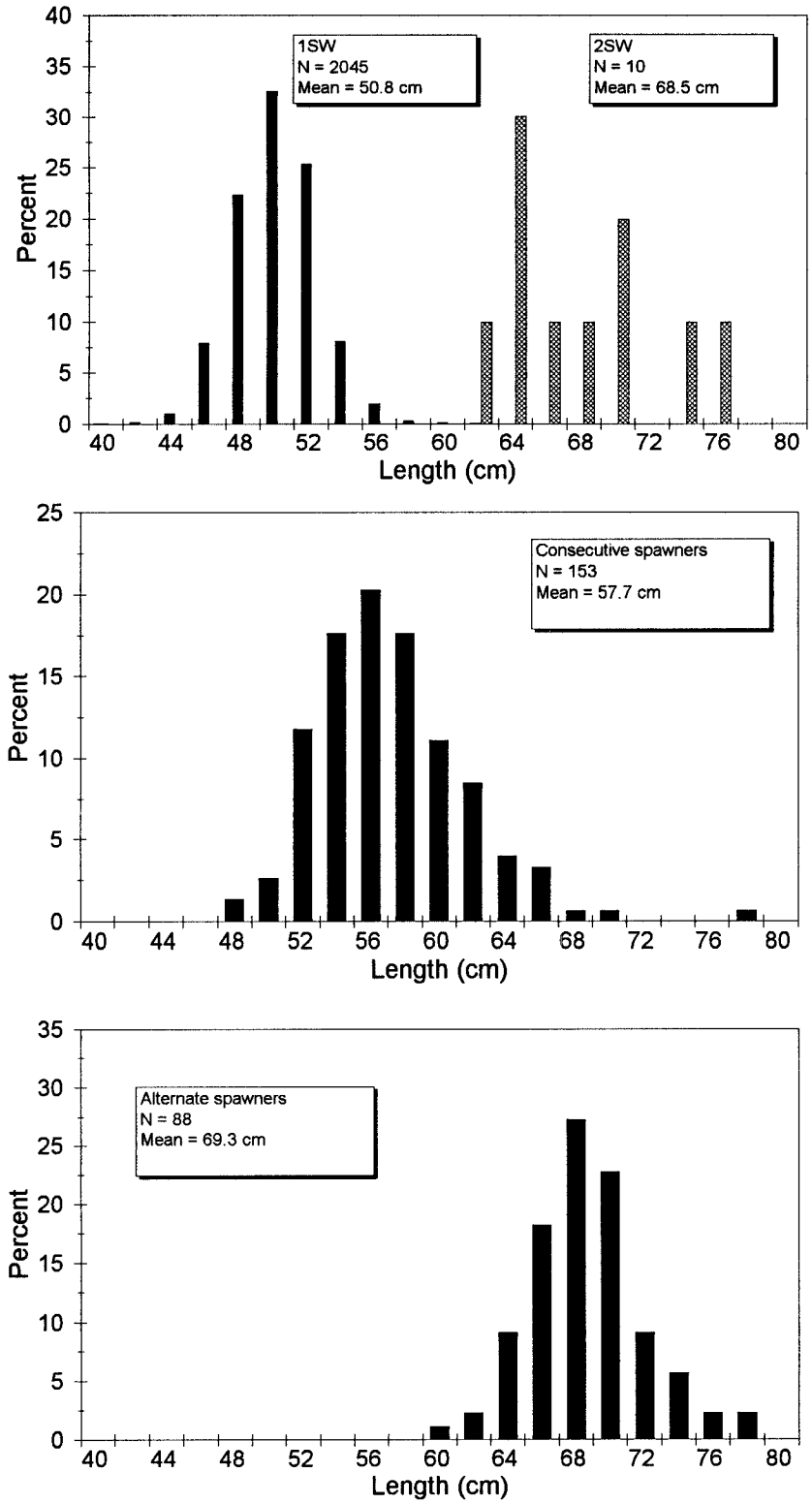

Figure 4. Length-frequency distribution of 1SW, 2SW, consecutive and alternate spawners, all years (1986-1998) combined, at Conne River, Newfoundland.

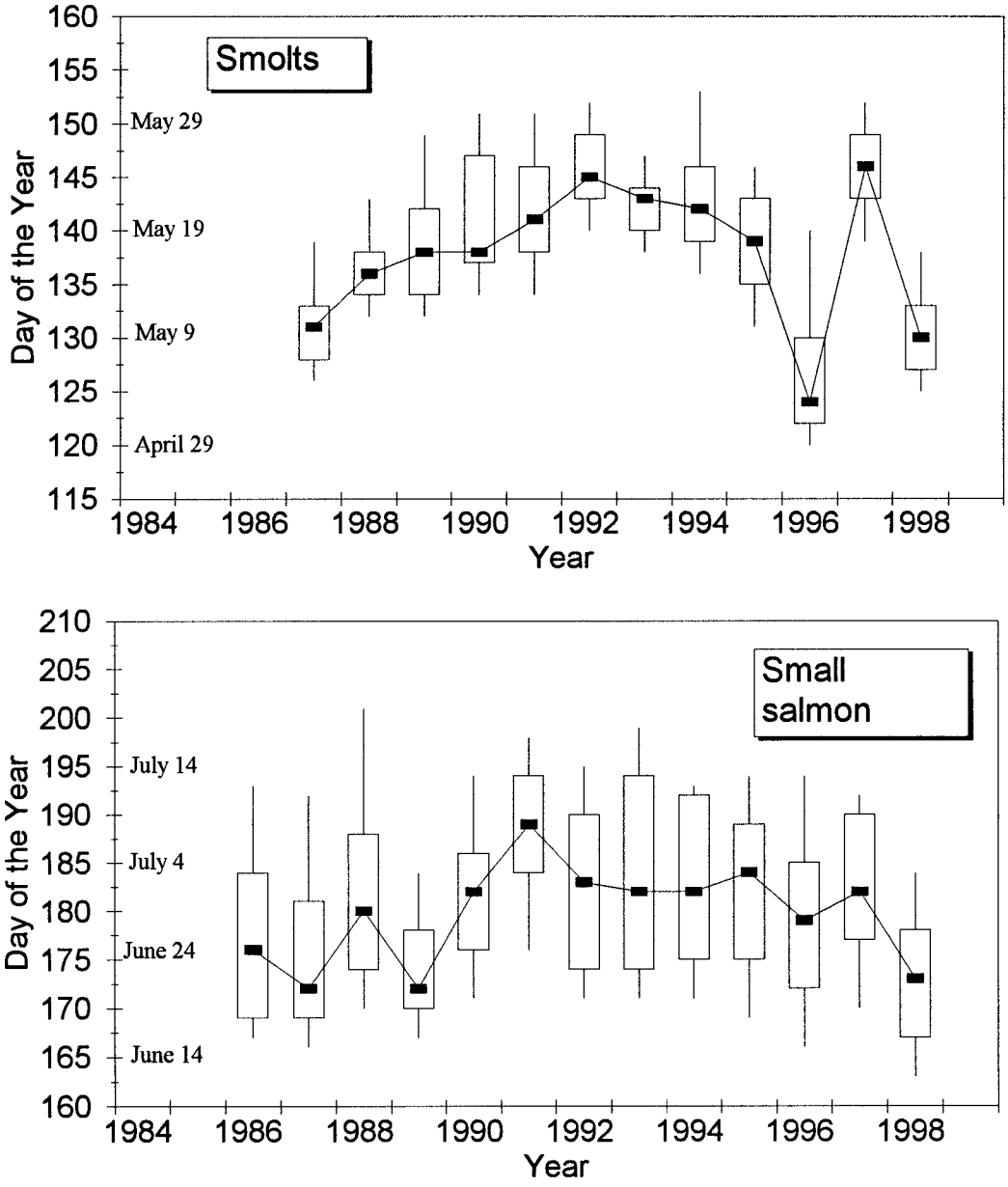

Figure 5. Annual variation in run timing at Conne River, Newfoundland, for Atlantic salmon smolts and returning small salmon. Vertical lines represent the 10th and 90th percentiles of the day of the year of migration, the rectangle is the 25th and 75th percentiles, and the marker within the rectangle is the median run timing value.

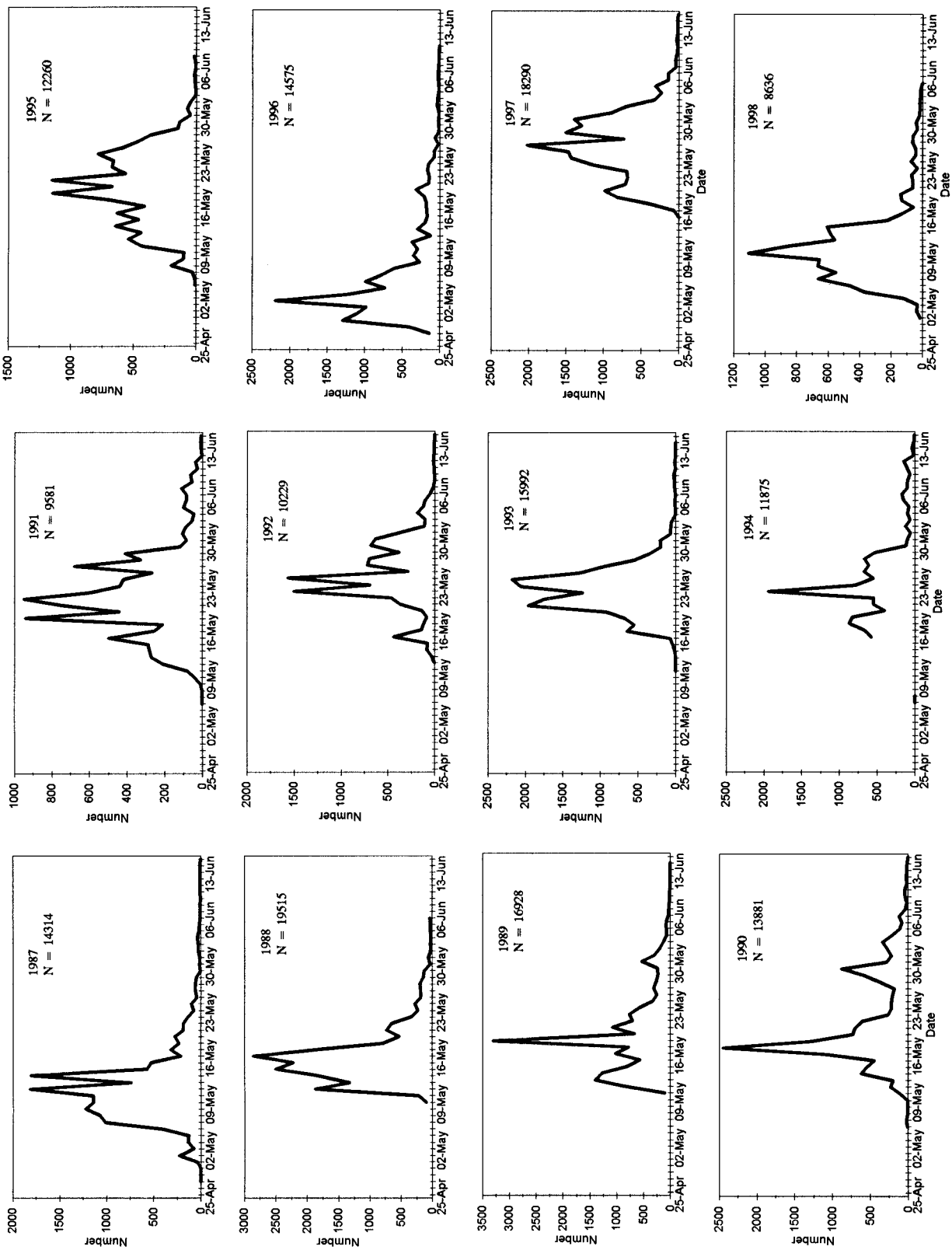

Figure 6. Numbers of Atlantic salmon smolts counted by day up to June 15 each year at the downstream fish counting fence trap at Conne River, Newfoundland, 1987 - 1998. N = total fence count of smolt for the season. Note that the total smolt population is estimated by mark-recapture.

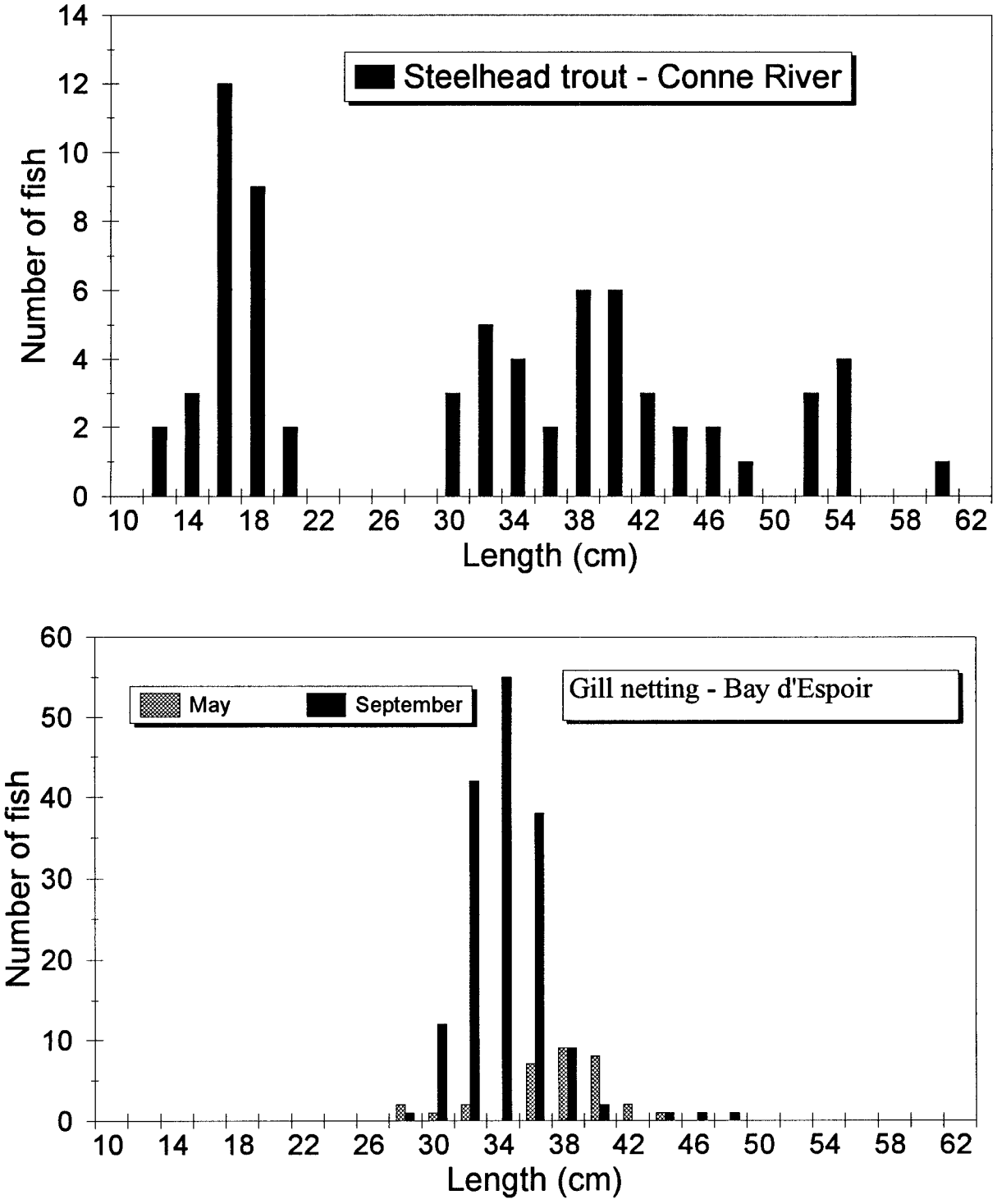

Fig. 7. Length-frequency distribution of steelhead trout caught at Conne River, Newfoundland, 1990 - 1998 (upper panel). Lower panel illustrates length distributions of steelhead trout caught in gill nets set in Bay d'Espoir in May and September, 1995.

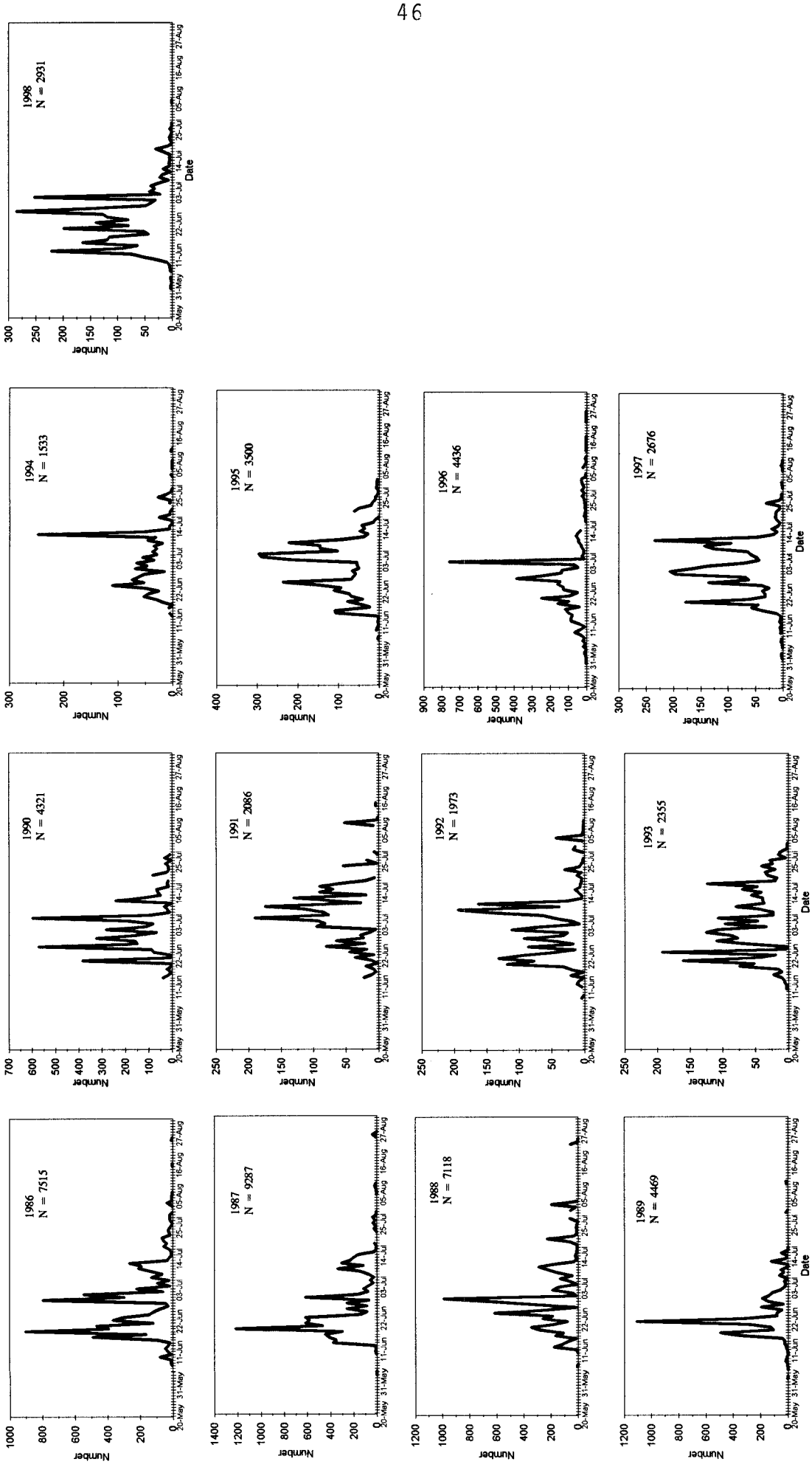

Figure 8. Numbers of small Atlantic salmon counted by day up to August 31 each year at the upstream fish counting fence at Conne River, Newfoundland, 1986 - 1998. N = total fence count of small salmon for the entire season.

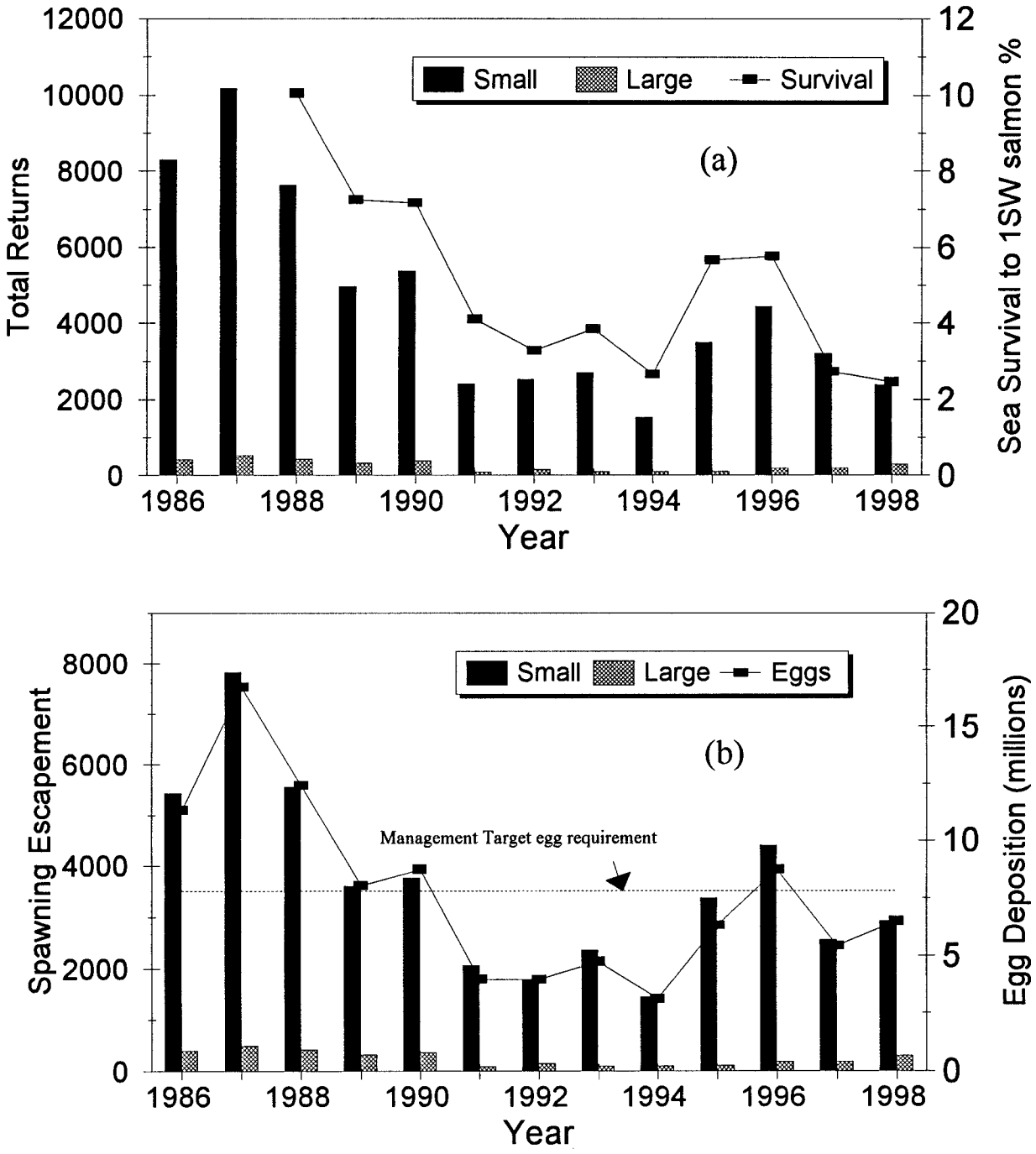

Figure 9. Total returns of small and large Atlantic salmon to Conne River, Newfoundland along with estimated sea survival from smolts to 1SW salmon (a). Survival estimates correspond to the year of adult return. Lower panel (b) illustrates the trend in spawning escapments and estimated egg deposition. The dashed horizontal line represents the current Management Target egg requirement.

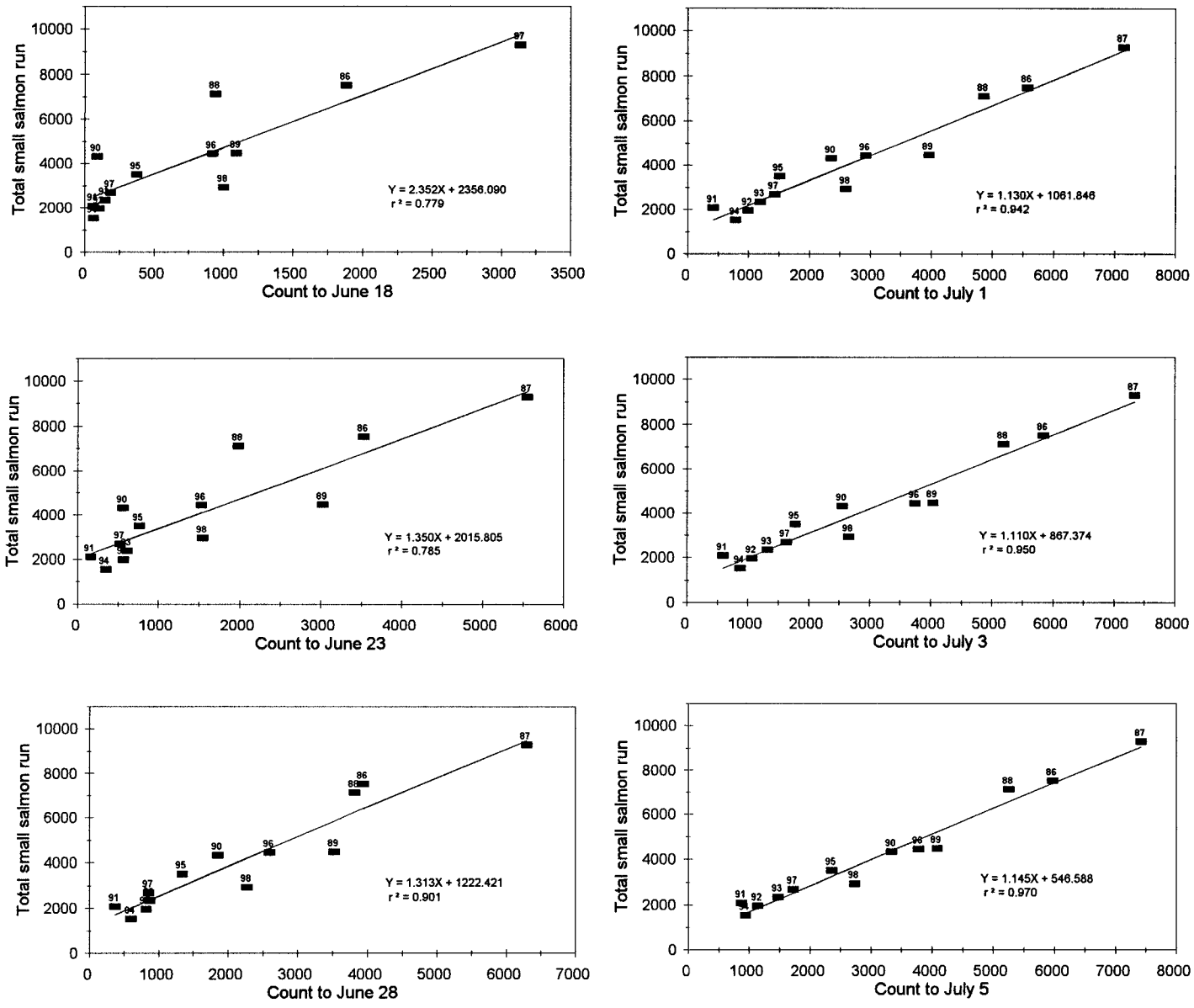

Figure 10. Regressions of cumulative counts of small salmon at various dates with the corresponding total counts of small salmon for the year, at Conne River, Newfoundland, 1986 - 1998.

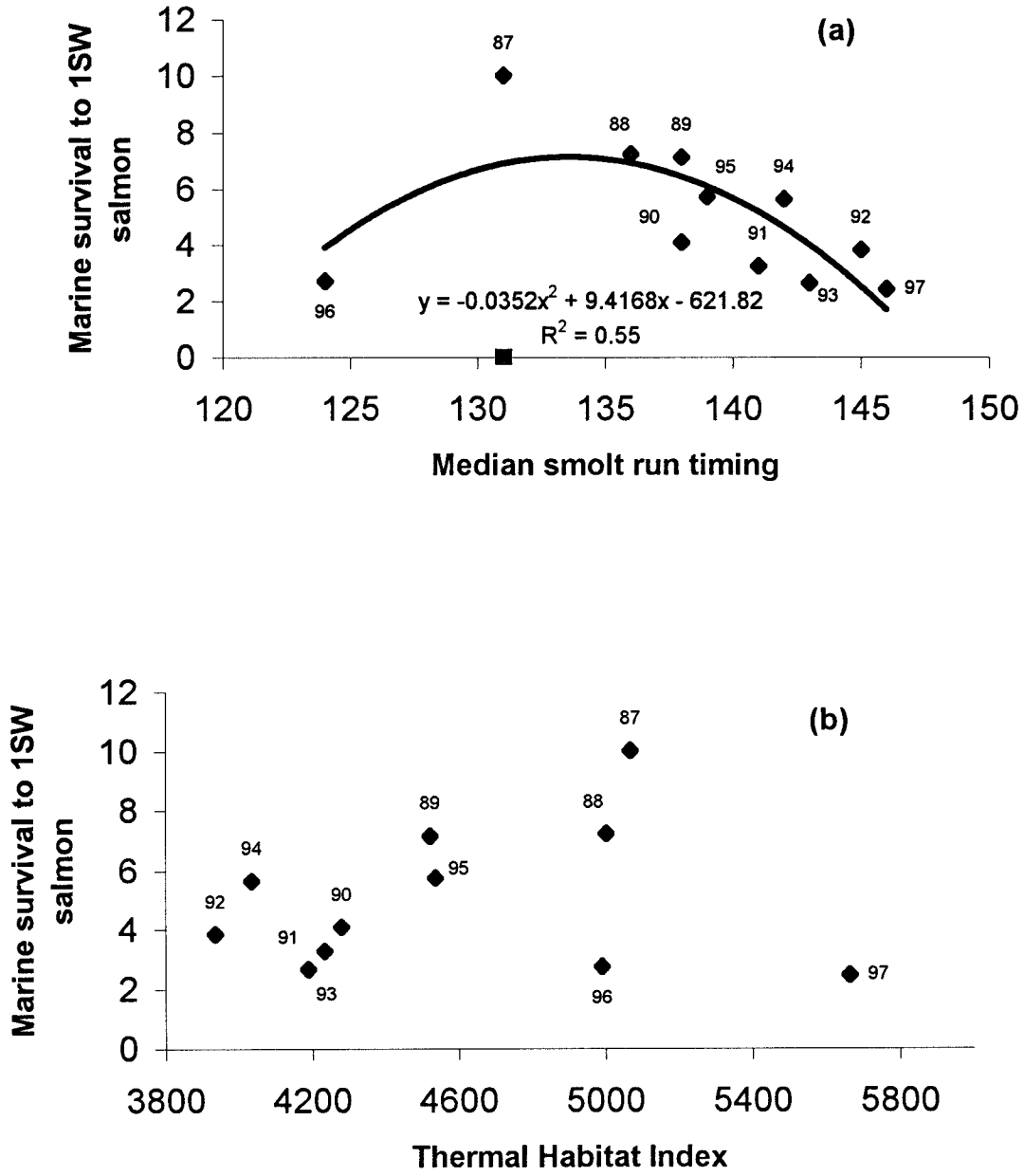

Fig. 11. Relationships between: a) marine survival and smolt run timing (upper panel); and b) index of marine thermal habitat in year i (Jan - March) with sea survival to 1SW salmon returning in the same year. Years shown represent the smolt class year.

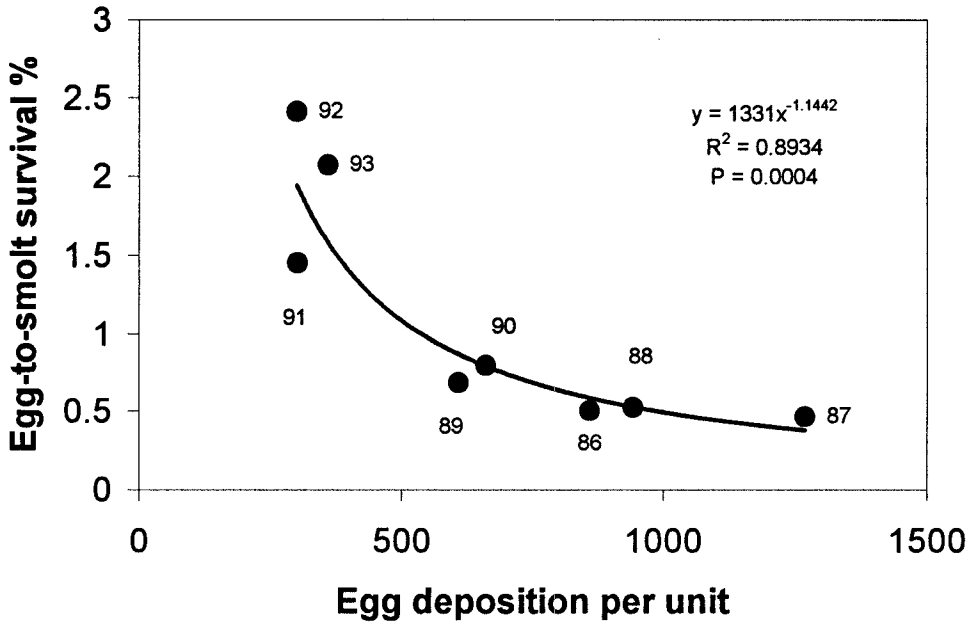

Fig. 12. Relationship between egg-to-smolt survival and the egg deposition rate per unit of fluvial habitat for Conne River, Newfoundland.

STOCK: Conne River (SFA 11) **Drainage area:** 602 km^2

MANAGEMENT TARGET: 7.8 million eggs (~4000 small salmon) calculated as fluvial area x 2.4 eggs/m^2 and egg/recruit applied to total population as derived from assumed commercial exploitation rates.

	1993	1994	1995	1996	1997	1998	MIN[1]	MAX[1]
Total returns to home waters								
Small	2703	1533	3502	4440	3200	2931	1533	10155
Large	100	100	110	179	185	295	89	516
First Peoples' harvest								
Small	417	0	0	0	514	0	0	948
Large	3	0	0	0	1	0	0	11
Recreational harvest (small salmon)								
Retained	-	-	-	-	197	-	0	3302
Released	-	-	-	-	80	-	0	80
Recreational harvest (large salmon)								
Retained	-	-	-	-	0	-	0	27
Released	-	-	-	-	0	-	0	0
Other mortalities								
Small salmon	3	5	9	13	6	5	3	48
Large salmon	1	1	2	0	0	1	0	2
Broodstock removal								
Small salmon	0	93	117	25	0	0	25	245
Large salmon	0	1	0	0	0	0	0	1
Spawners								
Small	2353	1435	3376	4402	2558	2926	1435	7823
Large	97	99	108	179	182	294	87	488
Management target								
% eggs met	61	40	81	112	70	83	40	214
Smolt estimate	55765	60762	62749	94088	100983	69841	55765	100983
% Sea survival[2]	4.0	2.7	5.8	7.2	3.4	2.9	2.7	10.2

[1] Min and max are for the period of record since 1974. First Peoples harvest in salt water includes some salmon from other rivers. First Peoples fishery quota of 1200 fish has been in effect since 1986, but was reduced to 500 fish for 1993. First Peoples fishery was closed from 1994-96, while 600 small salmon were allocated in 1997. This fishery was closed again in 1998 as was the recreational fishery at Conne River.

[2] Sea survival is from smolt to small salmon returns in year of adult return.

Data and methodology: Smolts estimates are derived from mark-recapture surveys. Returning adult salmon are enumerated at a fish counting fence. Angling harvests for Conne River are from DFO statistics. A video camera system was introduced in 1993.

State of the stock: The Management Target, which is higher than the conservation egg requirement, was met from 1986 to 1990 and again in 1996. Only 40-61% of the target was achieved from 1991-1994, rose to 81% in 1995 and was 83% in 1998. Sea survival to small salmon fell to the second lowest value (2.9%) recorded while survival to 1SW salmon was the lowest (2.5%). In contrast with the Management Target, the Conservation egg requirement was met or exceeded from 1986-1990, in 1993, and again from 1995-1998.

Forecast: Estimated smolt output in 1998 was: 69,841 (60,617-79,064). A sea survival of 5.73% would result in 4,000 1SW adult salmon returns in 1999. While survivals in the 7 - 10% range have occurred in the past, in recent years 1SW survival has remained low varying from 2.5 to 5.8%. Given the high variability in marine survival in recent years, a preseason forecast for 1999 is not provided.