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Status of Atlantic Salmon (*Salmo salar* L.) in Indian Bay Brook, Middle Brook, and Terra Nova River (SFA 5), Northeast Brook, Trepassey (SFA 9), and Northeast River, Placentia (SFA 10), Newfoundland, in 1997

by

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Abstract

The status of Atlantic salmon stocks was determined for Indian Bay Brook, Middle Brook, and Terra Nova River in Salmon Fishing Area (SFA) 5, Northeast Brook, Trepassey in SFA 9, and Northeast River, Placentia in SFA 10. Total returns of small salmon to Indian Bay Brook and Middle Brook in 1997 decreased by 54% and 39% from 1996 and were the lowest since the commercial salmon fishery moratorium was implemented in 1992. Total returns of small salmon to Terra Nova River decreased by 44% and were the second lowest of the moratorium years. Declines in returns of small salmon were also recorded for Northeast Brook, Trepassey (32%) and Northeast River, Placentia (49%); returns for the former were the lowest of the moratorium years and second lowest for the latter. Record high returns of large salmon occurred in Middle Brook and Northeast River, Placentia in 1997 while for Terra Nova River returns were the second highest recorded. Returns of large salmon to Northeast Brook, Trepassey in 1997 were among the lowest of the moratorium years. Conservation egg requirement was achieved in all rivers except Terra Nova River. However, it should be noted that accessible rearing habitat above the lower Terra Nova River fishway more than doubled with the opening of the area above Mollyguajeck Falls in 1985. Smolt-to-adult survival for Northeast Brook, Trepassey in 1997 (adult year) was 2.9%; a record high of 9.2% occurred in 1996. The survival value for 1997 was the lowest of the moratorium years and the second lowest of the entire time series.

Résumé

L'état des stocks de saumon de l'Atlantique a été déterminé pour les ruisseaux Indian Bay et Middle et la rivière Terra Nova, de la zone de pêche du saumon (ZPS) 5, le ruisseau Northeast, Trepassey dans la ZPS 9, et la rivière Northeast, Placentia dans la ZPS 10. Les remontées totales de petits saumons des ruisseaux Indian Bay et Middle en 1997 ont diminué de 54 % et de 39 % par rapport à 1996 et sont les plus faibles notées depuis l'imposition du moratoire sur la pêche commerciale du saumon en 1992. Les remontées totales de petits saumons de la Terra Nova ont diminué de 44 % et sont les deuxièmes plus faibles notées pendant le moratoire. Des diminutions des remontées de petits saumons ont aussi été notées pour le ruisseau Northeast, Trepassey (32 %) et la rivière Northeast, Placentia (49 %). Les remontées du ruisseau ont été les plus faibles du moratoire et celles de la rivière les deuxièmes plus faibles. Des remontées record de grands saumons ont été signalées en 1997 pour le ruisseau Middle et la rivière Northeast, Placentia, tandis que celles de la Terra Nova ont été les deuxièmes plus élevées. Les remontées de grands saumons du ruisseau Northeast, Trepassey, en 1997 comptent parmi les plus faibles du moratoire. À l'exception de la Terra Nova, les objectifs de ponte nécessaires à la conservation ont été atteints partout. Il faut cependant noter que l'habitat de croissance accessible en amont de la passe à poissons du cours inférieur de la Terra Nova a plus que doublé de par l'accès à la zone située en amont de Mollyguajeck Falls, en 1985. Le taux de survie saumoneau-adulte dans le ruisseau Northeast, Trepassey, en 1997 (adultes) a été de 2,9 %; le record maximal de 9,2 % a été noté en 1996. Le taux de survie de 1997 a été le plus faible de la période du moratoire et le deuxième plus faible de la série chronologique.

Introduction

In this paper, we examine the status of Atlantic salmon in Indian Bay Brook, Middle Brook, and Terra Nova River, Bonavista Bay (Salmon Fishing Area (SFA)) 5, Northeast Brook, Trepassey, St. Mary's Bay (SFA 9), and Northeast River, Placentia Bay (SFA 10) in 1997, the sixth year of the commercial salmon fishery moratorium. The location of each river is shown in Fig. 1. In this report, detailed assessments are provided for Indian Bay Brook and Northeast Brook, Trepassey for the first time. While Indian Bay Brook is renowned for trophy size brook trout, *Salvelinus fontinalis* (Mitchill), it also supports a population of Atlantic salmon. Northeast Brook, Trepassey has been the focus of a study of optimum spawning requirements for Atlantic salmon since 1984, with smolts and adults being counted annually.

Counts of small and large salmon are used in conjunction with recreational fishery data and biological characteristics data to calculate total river returns and egg depositions. Stock status is evaluated relative to conservation egg requirements for all rivers.

Management Measures, Past and Present

The introduction of the commercial Atlantic salmon fishery moratorium in insular Newfoundland in 1992 followed a major management plan introduced in 1984 (O'Connell *et al.* 1992a; May 1993), which was modified in 1990 and 1991 to include a commercial fishery quota in each SFA (O'Connell *et al.* MS 1992b). Elements of this management regime continued into the moratorium years. In addition to the closure of the commercial Atlantic salmon fishery in 1992, a moratorium was placed on the Northern Cod Fishery, which should have eliminated by-catch in cod fishing gear in SFAs 1-9. This moratorium remained in effect in 1997. In August 1993, a moratorium was placed cod fishing in SFAs 10-14A which also remained in effect in 1997, with the exception of a limited fishery in SFA 11.

A quota on the number of fish that could be retained in the recreational fishery was introduced in each SFA in 1992 and 1993. The quota was assigned for each SFA as a whole as opposed to individual river quotas. Only hook-and-release fishing was permitted after the quota was caught. Recreational fishery quotas were eliminated in 1994. In place of quotas, for insular Newfoundland, the season bag limit for retained small salmon was lowered from eight to six fish, three to be caught prior to July 31 and three after that date. Hook-and-release fishing only was permitted after the bag limit of three was reached in each time period. These measures remained in effect in 1995-97. As in previous years, retention of large salmon was not permitted in insular Newfoundland. Rivers in SFAs 9 and 10 were opened for hook-and-release fishing two weeks earlier than usual in 1997, after which time retention of catch was permitted until the end of the season, scheduled to end one week early. Rivers in SFAs 5, 9, and 10 were closed to retention of small salmon on July 28 when an in-season review projected that overall returns would be substantially lower than expected. Hook-and-release fishing only was permitted (only in the AM for rivers in SFA 5) at that point; however, on August 2, low water levels and high water temperatures forced the complete closure of most rivers

in SFA 5 and all rivers in SFAs 9 and 10 until the end of the season. Northeast Brook, Trepassey has been closed to angling since 1984 in conjunction with ongoing research activity.

Atlantic Salmon Enhancement - Terra Nova River

Terra Nova River has undergone Atlantic salmon enhancement programs since the early 1950s. A fishway was built around impassable falls located approximately 22 km from the mouth of the river in 1952 (Porter *et al.* 1974). This structure (upper fishway) provided access for anadromous Atlantic salmon upstream as far as the complete obstruction at Mollyguajeck Falls. Colonization of the newly accessible area depended on adults straying from below the fishway. A fishway (lower) was built around falls located approximately 8 km from the mouth of the river in 1954 in order to facilitate the upstream movement of adults. Anadromous Atlantic salmon were introduced into the area above Mollyguajeck Falls in 1985-89. Adults were collected from the upper fishway and transferred above the falls by helicopter. In order to allow the progeny of these transferred fish to access their natal areas, passage through Mollyguajeck Falls was made possible by blasting pools in the river bed in 1985. A swim-up fry stocking program utilizing broodstock from the upper fishway was initiated above Mollyguajeck Falls in 1994 and continued in 1997.

The falls in Middle Brook and Northeast River, Placentia, were not complete obstructions and only impeded adult migration during low water conditions. The fishways for these rivers were installed to ease passage during low flows, similar to the situation for the lower Terra Nova River fishway.

Methods

Recreational fishery data and counts of adult salmon in 1997 were compared to two pre-salmon moratorium means (1984-89 and 1986-91) and to the 1992-96 mean during the moratorium. The 1984-89 mean corresponds to years under the major management changes in the commercial fishery in the Newfoundland Region, cited above. The 1986-91 mean incorporates the commercial fishery quota years of 1990 and 1991. The mix of management measures in effect during 1984-89 on the one hand and the imposition of commercial quotas in 1990 and 1991 on the other, should be kept in mind when making evaluations based on the 1986-91 mean.

Adult salmon counting equipment

Adult salmon were counted in traps installed in the fishways located in Middle Brook, lower Terra Nova River, and Northeast River, Placentia. Adult counts in Indian Bay Brook were obtained with the semi-automatic (video tape recording) salmonid Silhouette Imaging and Counting System (Pippy *et al.* 1997) installed in a counting fence. The tunnel for this system was installed in the stream bed immediately outside of and continuous with the upstream fish release gate of a conventional wooden adult trap. Smolt and adult counts were obtained in Northeast Brook, Trepassey with a counting fence and a convertible steel smolt-adult trap (Whelan *et al.* 1989).

Recreational fishery data

Prior to 1997, catch and effort data for each river were collected by Department of Fisheries and Oceans (DFO) River Guardians and processed by DFO Science Branch staff, according to procedures outlined in Ash and O'Connell (1987). Rivers with counting facilities had information separated above and below the counting facilities. No data were available from River Guardians for these rivers in 1997. Angling data for Middle Brook in 1997 (collected above and below the fishway) were obtained through a creel survey (O'Connell *et al.* MS 1998a). For the remaining rivers, data for 1997, which at this stage have to be regarded as preliminary, were derived from the License Stub Return System (O'Connell *et al.* MS 1998a). It was not possible to apportion information above and below counting facilities with the License Stub Return. For Terra Nova River and Northeast River, Placentia, this was accomplished by applying the mean values for above and below for the period 1993-96 to the License Stub Return estimate for the entire river. Since 1997 was the first year for the counting fence in Indian Bay Brook, there was no previous information for above and below the fence. Personnel operating the counting fence estimated that approximately 30% of the number of small salmon retained came from below, which was applied to the 1997 License Stub Return estimate for the entire system.

The License Stub Return System for collecting recreational fishery data represents a complete departure from the previous DFO River Guardian method. Details on the methodology employed in the Stub Return System and a comparison of stub data with DFO River Guardian data for 1994-97 are provided in O'Connell *et al.* (MS 1998a). Overall, estimates of released small and large salmon from the stub were substantially higher than estimates from River Guardians while the two methods were closer with respect to estimates of small salmon retained. This has to be kept in mind when comparing catches in 1997 with previous years. There is evidence that effort expenditure was under-reported by the stub method and hence this information will not be used in the present document. Analyses are currently being carried out to adjust for under-reporting. Effort data were available for Middle Brook from the creel survey.

Data for Maccles Brook were included in the totals for Terra Nova River. Angling data for 1987 were not included in the means because in that year the rivers were closed to angling for nearly the entire season due to drought conditions.

Biological characteristics

Biological characteristics information (obtained by sampling recreational catches) used to calculate egg depositions for small salmon (< 63 cm in length) is shown in Tables 1-4. Since there was no recreational fishery in Northeast Brook, Trepassey, there was no information available on bright (upstream migrating) adult salmon, in year (i). Bright adults were not sampled at the trap because of the small run size involved and the risk of mortality, which might have compromised ongoing research on egg-to-smolt survival. Therefore, kelts were sampled in year (i + 1), and mean fork length (cm) was used in the calculation of egg deposition in year (i) instead of mean weight (kg). These kelts were also sexed using external characteristics. In instances where sample sizes were small

(N < 20), the means of the various parameters for either the mortatorium period (1992-97) or the pre-moratorium period (1984-91) were used. Biological characteristics information was not available for Indian Bay Brook; in default, data for nearby Middle Brook were used.

A mean weight of 3.13 kg and a proportion of female value of 0.77 (O'Connell *et al.* MS 1997a) was used for fish ≥ 63 cm in length (large salmon) for all years and for all rivers except Northeast Brook, Trepassey. Mean length and proportion of female from a blended sample of small and large kelts were used for this system.

Fecundity was determined from ovaries collected in the recreational fishery. Ovaries were stored in Gilson's fluid until ovarian tissue had broken down, after which time eggs were transferred to 10% formalin. Eggs, which for the most part were in early stages of development, were counted directly. Relative fecundity values used for all rivers except Indian Bay Brook and Northeast Brook, Trepassey are shown in Table 5. The value used for Indian Bay Brook was that presented in Table 5 for years combined for Middle Brook (1980 eggs/kg). For Northeast Brook, Trepassey, the relative fecundity value (65.6 eggs/cm) used was that for all years combined for nearby Biscay Bay River, from O'Connell *et al.* (MS 1997b). In years when the sample size was small (N < 20), the mean fecundity for all years combined for a given river was used. The same relative fecundity was used for both small and large salmon.

Total river returns, spawning escapement, and egg deposition

Calculations were performed for small and large salmon separately, except in the case of Northeast Brook, Trepassey, where small and large salmon were combined. Total egg deposition was obtained by summing depositions for small and large salmon for rivers other than Northeast Brook, Trepassey.

Total River Returns

Total river returns (TRR) were calculated as follows:

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

where,

RC_b = recreational catch below counting facility
C = count of fish at counting facility
HRM_b = hook-and-release mortalities (10% of hook-and-release fish) below counting facility in 1993-96 (see O'Connell and Reddin MS 1997)

For Terra Nova River, recreational catch below the fishway did not include that of Maccles Brook.

For the period 1984-96, i.e., prior to the counting fence, TRR for small salmon for Indian Bay Brook was estimated as the ratio of total retained recreational catch (RC_t) and an annual exploitation rate (μ_t) derived by Porter *et al.* (1996)

$$TRR = RC_t/\mu t \quad (2)$$

Spawning Escapement

Spawning escapement (SE) was calculated according to the formula:

$$SE = FR - RC_a - BR - HRM_a \quad (3)$$

where,

FR = fish released at counting facility
RC_a = recreational catch above counting facility
BR = broodstock removal (Terra Nova River in 1994-97)
HRM_a = hook-and-release mortalities (10% of hook-and-release fish) above counting facility in 1993-96 (see O'Connell and Reddin MS 1997)

Spawning escapement for Indian Bay Brook in 1984-96 was estimated as follows:

$$SE = TRR - RC_t - HRM_t \quad (4)$$

where,

HRM_t = hook-and-release mortalities (10% of total hook-and-release small salmon in 1993-96)

A number of mortalities of small salmon occurred in Northeast River (49) and Middle Brook (16) subsequent to being counted in 1996 which were deducted from FR in equation 3. These mortalities resulted from unusually high flood conditions in Northeast River and from modifications to the trap configuration in Middle Brook.

Egg Deposition

Egg deposition (ED) was calculated as follows:

$$ED = SE \times PF \times RF \times MW \quad (5)$$

where,

SE = number of spawners
PF = proportion of females
RF = relative fecundity (no. of eggs/kg)
MW = mean weight of females

For Northeast Brook, Trepassey, as pointed out above, RF was in terms of number of eggs per cm and mean length females was used instead of mean weight (MW). For Terra Nova River, spawning escapements and egg depositions were calculated for the area above the lower fishway, including the area above Mollyguajeck Falls.

The phenomenon of atresia occurs in Atlantic salmon in insular Newfoundland (O'Connell and Dempson MS 1997). Since egg deposition calculations above were based on eggs in early stages of development, they should be regarded as potential egg depositions.

Conservation egg deposition and spawner requirements

The conservation egg deposition and spawner requirements for each river were developed by O'Connell and Dempson (MS 1991a,b) (Table 6). Requirements for Northeast Brook, Trepassey were modified from those presented in O'Connell and Dempson (MS 1991b) based on a more recent survey of available parr rearing habitat. The egg requirement for fluvial parr rearing habitat (Elson 1957) for all rivers was 240 eggs/100 m^2 (Elson 1975); the requirement for lacustrine habitat was 368 eggs/ha (O'Connell and Dempson 1995). The adult conservation requirement for each river was calculated in terms of small salmon only. Egg deposition from large salmon was considered as a buffer.

Results

Recreational fishery

Catch and effort data for each river are presented in Appendices 1-4. Catches for all years prior to 1992 represent retained catch for the entire angling season. Total catch for 1997 (retained plus released fish) is compared to years prior to 1992 and 1992-96; comparison of effort and catch per unit of effort (CPUE) in 1997 with previous years was only possible for Middle Brook, for reasons already discussed. There was no estimate of released fish during the period of retention of catch in 1992 which could impact on comparisons. The total number of fish retained in 1997 is also shown. Calculation of CPUE in terms of retained fish only was not possible since effort figures apply to both retained and released fish collectively. Numbers of small salmon retained in 1997 in Indian Bay Brook, Middle Brook, and Terra Nova River were the lowest or second lowest since 1974 and below the 1984-89, 1986-91, and 1992-96 means. The number of small salmon retained in Northeast River Placentia in 1997 decreased substantially from the record catch in 1996 and was below the

means. The numbers of small salmon released in Indian Bay Brook and Northeast River, Placentia in 1997 increased over 1996 but was below the 1992-96 mean. Decreases from 1996 and the mean were noted for Middle Brook and Terra Nova River. Numbers of large salmon released in 1997 increased markedly over 1996 and the 1992-96 mean in Indian Bay Brook and Northeast River, Placentia. The reverse was true for Terra Nova River; only one large salmon was released in Middle Brook compared to none in 1996.

Counts at counting facilities

Counts of small and large salmon for the Indian Bay Brook counting fence in 1997 are shown in Table 7 and Fig. 2. The run of small salmon was characterized by several distinct peaks throughout the summer (Fig. 3). Highest daily numbers of large salmon were encountered in late july to early August with the peak occurring at the end of July. The median date of return of small salmon was around 10 days earlier than for large salmon (Fig. 4).

Counts of small and large salmon for the Middle Brook fishway are shown in Table 7 and Fig. 2. The count of small salmon in 1997 decreased from 1996 (30%) and the 1992-96 mean (19%) but remained above the 1984-89 (33%) and 1986-91 (62%) means. The count of large salmon was the highest on record, increasing substantially over 1996 (63%) and the 1984-89 (941%), 1986-91 (1572%), and 1992-96 (139%) means. The daily count of small salmon peaked in late July in 1997 compared to mid-July in 1996 (Fig. 5). The peak for large salmon in 1997 occurred in early August while in 1996 it was mid-July, coincident with the peak for small salmon. The median date of return of small salmon in 1997 was approximately 9 days later than the mid-July occurrence in 1996 (Fig. 6). Run timing similar to 1997 for small salmon also occurred in 1992 and 1993. The median for large salmon in 1997 was also later than in 1996; similar median dates to 1997 occurred in 1992, 1993, and 1995. The highest number of days that the median for large salmon occurred later than for small salmon was in 1995 while in 1992, the two medians were virtually coincident.

Counts of small and large salmon for the lower Terra Nova River fishway are presented in Table 7 and Fig. 2. The number of small salmon counted in 1997 decreased from 1996 (21%) and the 1992-96 mean (21%) but increased over the 1984-89 (23%) and 1992-96 (37%) means. The count of large salmon increased over 1996 and the means (14, 314, 294, and 27%, respectively) and was the second highest on record. The highest daily number of large salmon counted occurred in early September (Fig. 7). This was due mainly to an accumulation of fish below the fishway as a result of low water levels and their ascension *en masse* when water levels improved. Aside from this peak, the highest daily numbers were encountered in early August compared to late July in 1996. A similar pattern was noted for large salmon in 1997 and for the 1996 comparison with the exception that the September peak was lower that of August in 1997. The median count for small salmon in 1997 was approximately 10 days later than in 1996, and with the possible exception of 1993, was the latest of the 1992-97 period (Fig. 8). The median for large salmon in 1997 was the latest recorded for the 1992-97 period; the median for large salmon was only a few days later than for small salmon in 1996 and 1997. Widest separation between the medians for small and large salmon occurred in 1995 while in 1993 they coincided.

Counts of small and large salmon for the Northeast Brook, Trepassey counting fence are shown in Table 8 and Fig. 9. The count of small salmon in 1997 was the second lowest on record, decreasing by 32, 52, 48, and 34%, respectively, from 1996 and the means. The count of large salmon also decreased from 1996 and the means (40, 68, 55, and 35%, respectively). Daily counts of small and large salmon and dates of median counts are shown in Figs. 10 and 11. The median count of small salmon in 1997 occurred approximately one week later than in 1996 while that of large salmon was around two weeks later than in 1996. The number of days between medians for small and large salmon in 1997 was the second highest during 1992-97; in 1992 and 1995 they were coincident.

Counts of small and large salmon for the Northeast River, Placentia fishway are shown in Table 8 and Fig. 9. The count of small salmon in 1997 decreased from 1996 (48%) and the 1992-96 mean (26%) but increased over the 1984-89 (24%) and 1986-91 (20%) means. The count of large salmon in 1997 was the highest on record, increasing by 50, 788, 874, and 145% over 1996 and the means, respectively. There was no distinct peak in daily counts of small salmon in 1997 (Fig. 12) while in 1996 the maximum count occurred in early July. Most large salmon ascended the fishway in late July-early August in 1997. There was an accumulation of small and large salmon below the fishway in mid-late August, similar to the situation described above for Terra Nova River; these fish moved quickly when water conditions improved in late August-early September. The median count of small salmon in 1997 occurred approximately 9 days later than in 1996 (Fig. 13). The median count for large salmon occurred a week later than that of small salmon; the number of days between medians for small and large salmon in 1997 was the highest of the 1992-97 period.

Total river returns, spawning escapement, and percentage of conservation requirement achieved

Total river returns, spawning escapement, potential egg deposition, and percentage of conservation requirement achieved for Indian Bay Brook, Middle Brook, and Terra Nova River are shown in Table 9. Small salmon total river returns, spawning escapement, and percentage of conservation requirement achieved for Indian Bay Brook for years prior to 1997 derived using exploitation rates are shown in Table 10. The percentage of conservation egg requirements achieved for Middle Brook and Terra Nova River is also shown in Fig. 14. The number of small salmon returning to Indian Bay Brook in 1997 decreased by 54% from 1996 and was the lowest of the moratorium years. Indian Bay Brook achieved conservation egg requirement in 1997 but did not meet the requirement for small salmon. The proportionate contribution of the large salmon spawning component was instrumental in meeting the egg requirement. During the moratorium, conservation requirement for small salmon was met in all years except 1994 and 1997; prior to the moratorium, the requirement was met (or nearly so) in all years except 1986, 1989, and 1991. Total returns of small salmon to Middle Brook in 1997 decreased by 39% from 1996, the lowest of the moratorium years. Total returns of large salmon in 1997 were the highest on record. Conservation requirements in terms of both eggs and small salmon were achieved in all moratorium years in Middle Brook but in only one year (1984) prior to the moratorium. The highest proportionate contribution by large salmon to total egg deposition in Middle Brook occurred in 1997. The number of small salmon returning to Terra Nova River in 1997 decreased by 44% from 1996, the second lowest of the

moratorium years. Total returns of large salmon in 1997 were the second highest on record. The percentages of conservation egg requirement met during the moratorium years for Terra Nova River were generally higher than during pre-moratorium years, with record highs being recorded during the moratorium. The percentage of small salmon conservation requirement met in 1997 was the lowest of the moratorium years while the proportionate contribution by large salmon to total egg deposition was the highest.

Total river returns, spawning escapement, potential egg deposition, and percentage of conservation egg requirement achieved for Northeast Brook, Trepassey and Northeast River, Placentia are shown in Table 11. The percentage of conservation egg requirement achieved for these systems is also shown in Fig. 14. Returns of small salmon in 1997 decreased from 1996 for both systems (32% for Northeast Brook, Trepassey; 49% for Northeast River, Placentia. Record high returns of large salmon occurred in Northeast River, Placentia while in Northeast Brook, Trepassey returns were among the lowest of the moratorium years. Conservation egg requirements were achieved in all years for both systems. The lowest percentage of small salmon requirement achieved for Northeast River, Placentia during the moratorium occurred in 1997; the percentage for Northeast Brook, Trepassey in 1997 was the second lowest of the moratorium. The proportionate contribution of the large salmon component to total egg deposition in 1997 was the highest recorded for Northeast River, Placentia, but this was not the case for Northeast Brook, Trepassey,

Egg-to-smolt survival, Northeast Brook, Trepassey

Over the period 1986-92, egg deposition in Northeast Brook, Trepassey showed an overall decline (Table 12 and Fig. 15). Egg-to-smolt survivals corresponding to these egg depositions were more or less stable between 1984 and 1991 but the 1992 year class showed a marked increase.

Smolt-to-adult survival, Northeast Brook, Trepassey

The smolt-to-adult survival (which includes repeat spawners) of 2.9% observed in 1997 (adult year) was the second lowest on record, only slightly better than the low observed in 1992 and well below the record high of 9.2% in 1996 (Table 13 and Fig. 16). Survivals during the moratorium years were either comparable to or only slightly higher than those observed prior to the moratorium.

Discussion

O'Connell and Reddin (MS 1997) used an analysis of trends in numbers of small salmon recruits and spawners to provide an estimate of anticipated total returns to Middle Brook in 1997. Approximately 2690 small salmon (with estimated upper and lower values of 1770 and 3240) were expected to return in 1997. However, actual returns of 1287 small salmon fell below the estimated lower value. The lower than expected returns for Middle Brook in 1997 was consistent with observations for other rivers with counting facilities in insular Newfoundland, particularly on the Northern Peninsula and northeast and east coasts. For detailed analyses examining possible reasons

for the overall low returns of small salmon in insular Newfoundland in 1997, which includes information and discussion for the rivers in this report, see Dempson *et al.* (MS 1998) and O'Connell *et al.* (MS 1998b).

Conservation requirement has never been reached in Terra Nova River. It should be noted that accessible rearing habitat above the lower Terra Nova River fishway more than doubled with the opening of the area above Mollyguajeck Falls. The first returns resulting from the adult transfers in 1985-89 were expected beginning in 1990. In the absence of counts of the numbers of adults ascending Mollyguajeck Falls since 1990, it is not possible to assess the results of the adult stocking. Broodstock used for swim-up fry stocking in the area above Mollyguajeck Falls since 1994 were simply deducted from spawning escapement, i.e., no attempt was made at this stage to back-calculate fry into egg equivalents.

Cautions associated with the parameter values used to calculate the conservation egg requirement have been discussed previously by O'Connell and Dempson (1995) and will not be dealt with here.

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References

Ash, E.G.M., and M. F. O'Connell. 1987. Atlantic salmon fishery in Newfoundland and Labrador, commercial and recreational, 1985. Can. Data Rep. Fish. Aquat. Sci. 672: v + 284 p.

Dempson, J. B., D. G. Reddin, M. F. O'Connell, J. Helbig, C. E. Bourgeois, C. Mullins, T. R. Porter, G. Lilly, J. Carscadden, G. B. Stenson, and D. Kulka. MS 1998. Spatial and temporal variation in Atlantic salmon abundance in the Newfoundland-Labrador region with emphasis on factors that may have contributed to low returns in 1997. DFO, CSAS Res. Doc. 98/114. 161 p.

Elson, P. F. 1957. Using hatchery reared Atlantic salmon to best advantage. Can. Fish. Cult. 21: 7-17.

Elson, P. F. 1975. Atlantic salmon rivers smolt production and optimal spawning. An overview of natural production. Int. Atl. Salmon Found. Spec. Publ. Ser. 6: 96-119.

May, A. W. 1993. A review of management and allocation of the Atlantic salmon resource in Atlantic Canada. p. 220-232. *In* Mills, D. [ed.] Salmon in the sea and new enhancement strategies. Fishing News Books. 423 p.

O'Connell, M. F., N. M. Cochrane, and C. C. Mullins. MS 1998a. An analysis of the license stub return system in the Newfoundland Region, 1994-97. DFO, CSAS Res. Doc. 98/111. 67 p.

O'Connell, M. F., and J. B. Dempson. MS 1991a. Atlantic salmon (*Salmo salar* L.) target spawning requirements for selected rivers in salmon fishing area 5 (Bonavista Bay), Newfoundland. CAFSAC Res. Doc. 91/17. 10 p.

O'Connell, M. F., and J. B. Dempson. MS 1991b. Atlantic salmon (*Salmo salar* L.) target spawning requirements for rivers in Notre Dame Bay (SFA 4), St. Mary's Bay (SFA 9), and Placentia Bay (SFA 10), Newfoundland. CAFSAC Res. Doc. 91/18. 14 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., and J. B. Dempson. 1997. Follicular atresia in Atlantic salmon (*Salmo salar* L.) in Newfoundland rivers. DFO, CSAS Res. Doc. 97/93. 21 p.

O'Connell, M. F., J. B. Dempson, C. C. Mullins, D. G. Reddin, N. M. Cochrane, and D. Caines. MS 1998b. Status of Atlantic salmon (*Salmo salar* L.) Stocks of insular Newfoundland (SFAs 3-14a), 1997. DFO, CSAS Res. Doc. 98/107. 71 p.

O'Connell, M. F., J. B. Dempson, T. R. Porter, D. G. Reddin, E.G.M. Ash, and N. M. Cochrane. MS 1992b. Status of Atlantic salmon (*Salmo salar* L.) stocks of the Newfoundland Region, 1991. CAFSAC Res. Doc. 92/22. 56 p.

O'Connell, M. F., J. B. Dempson, and D. G. Reddin. 1992a. Evaluation of the impacts of major management changes in the Atlantic salmon (*Salmo salar* L.) fisheries of Newfoundland and Labrador, Canada, 1984-1988. ICES J. mar. Sci.: 49-69.

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

O'Connell, M. F., and D. G. Reddin. MS 1997. Status of Atlantic salmon (*Salmo salar* L) in Middle Brook and Terra Nova River (SFA 5), Biscay Bay River (SFA 9), and Northeast River, Placentia (SFA 10), Newfoundland, in 1996. DFO, CSAS Res. Doc. 97/40. 51 p.

O'Connell. M. F., D. G. Reddin, P. G. Amiro, F. Caron, T. L. Marshall, G. Chaput, C. C. Mullins, A. Locke, S. F. O'Neil, and D. K. Cairns. MS 1997a. Estimates of conservation spawner requirements for Atlantic salmon (*Salmo salar* L.) for Canada. DFO, CSAS Res. Doc. 97/100. 58 p.

Pippy, J.H.C., W. G. Whelan, and M. F. O'Connell. 1997. A field guide to counting and measuring salmonids using the silhouette imaging and counting system (SIACS). Can. MS Rep. Fish. Aquat. Sci. 2386: xi + 88 p.

Porter, T. R., D. G. Reddin, M. F. O'Connell, and J. B. Dempson. 1996. Scientific requirements for watershed management, p. 109-116. *In* L. F. Felt and C. L. Dominy [eds.] The challenge of community watershed management for recreational fisheries. Proceedings of Symposium, Corner Brook, Newfoundland, April 1995.

Porter, T. R., L. G. Riche, and G. R. Traverse. 1974. Catalogue of rivers in insular Newfoundland. Volume D. Resource Development Branch, Newfoundland Region, Department of Environment, Fisheries and Marine Service Data Record Series No. NEW/D-74-9, 316 p.

Whelan, W. G., M. F. O'Connell, and R. N. Hefford. 1989. Improved trap design for counting migrating fish in rivers. N. Am. J. Fish. Manage. 9: 245-248.

Table 1. Biological characteristics data for female small salmon and with sexes combined plus unsexed fish by year and for pre-moratorium (1984-91) and moratorium (1992-97) periods for Middle Brook, Bonavista Bay (SFA 5), Newfoundland. WW = whole weight (kg); FL = fork length (cm); RS = repeat spawning grilse.

	Sexes combined plus unsexed								Females						%	
Year	$\bar{X}$ WW	SD	N	$\bar{X}$ FL	SD	N	% RS	N	$\bar{X}$ WW	SD	N	$\bar{X}$ FL	SD	N	Female	N
1984	1.48	0.39	155	49.9	4.31	155	7.7	12	1.48	0.40	121	49.8	4.43	121	79	121
1985	1.48	0.35	115	49.5	4.46	115	4.4	5	1.51	0.34	89	50.2	4.20	89	82	89
1986	1.63	0.47	54	52.2	4.56	55	18.2	10	1.58	0.47	41	52.0	4.75	42	86	42
1987	1.33	0.34	19	49.9	3.14	19	15.8	3	1.30	0.33	7	49.5	3.36	7	41	7
1988	1.32	0.41	46	49.3	3.47	47	0.0	0	1.37	0.51	22	49.7	3.82	22	71	22
1989	1.48	0.30	9	51.5	4.37	15	26.7	4	1.80		1	53.3	0.35	2	100	2
1990	1.67	0.24	16	52.3	2.39	16	25.0	4	1.69	0.27	11	52.7	2.67	11	85	11
1991	1.50	0.45	11	53.4	4.82	11	9.1	1	1.40	0.50	4	51.5	5.34	4	50	4
1992	1.64	0.43	78	53.6	3.96	93	8.2	6	1.74	0.40	37	54.1	3.27	48	83	48
1993	1.72	0.44	120	53.7	4.38	137	0.8	1	1.65	0.42	71	53.2	4.40	79	76	79
1994	1.78	0.40	72	53.2	3.61	73	1.6	1	1.75	0.33	33	53.0	3.42	34	74	34
1995	1.55	0.45	83	51.3	4.11	83	2.5	2	1.47	0.34	33	51.5	4.31	33	62	33
1996	1.96	0.42	73	54.2	3.74	73	15.7	11	1.95	0.38	41	54.2	3.58	41	82	41
1997	1.73	0.42	51	54.1	4.67	51	3.9	2	1.72	0.43	40	53.8	4.67	40	81	42
Pre-moratorium																
1984-91	1.48	0.40	425	50.2	4.34	433	9.1	39	1.50	0.40	296	50.4	4.34	298	78	298
Moratorium																
1992-97	1.72	0.44	477	53.3	4.19	510	5.0	23	1.72	0.41	255	53.3	4.07	275	76	277

Table 2. Biological characteristics data for female small salmon and with sexes combined plus unsexed fish by year and for pre-moratorium (1984-91) and moratorium (1992-97) periods for Terra Nova River, Bonavista Bay (SFA 5), Newfoundland. WW = whole weight (kg); FL = fork length (cm); RS = repeat spawning grilse.

	Sexes combined plus unsexed								Females						%	
Year	$\bar{X}$ WW	SD	N	$\bar{X}$ FL	SD	N	% RS	N	$\bar{X}$ WW	SD	N	$\bar{X}$ FL	SD	N	Female	N
1984	1.59	0.40	118	50.2	4.43	118	12.7	15	1.57	0.36	73	50.2	3.74	73	74	73
1985	1.49	0.33	119	51.0	3.98	132	11.4	16	1.53	0.37	13	51.8	4.30	24	76	25
1986	1.70	0.37	93	53.4	3.66	93	29.6	29	1.63	0.32	31	52.7	3.45	31	65	31
1987	1.56	0.34	59	51.9	3.60	58	18.6	11	1.52	0.32	36	51.5	3.48	35	72	36
1988	1.81	0.40	47	52.8	3.67	46	31.9	15	1.70	0.65	4	50.0	5.72	4	57	4
1989	1.67	0.33	32	51.3	3.78	32	22.6	7							0	0
1990	1.65	0.36	50	52.0	3.86	50	10.6	5	1.70	0.39	5	51.0	4.47	5	100	5
1991	1.43	0.39	29	51.3	3.07	29	6.9	2	1.00	0.00	2	49.5	4.95	2	100	2
1992	1.76	0.37	84	53.0	3.65	95	1.1	1	1.30	0.30	6	49.3	2.64	6	75	6
1993	1.70	0.36	47	53.9	3.62	47	4.2	2	1.60	0.40	11	52.6	4.58	11	79	11
1994	1.80	0.42	82	54.8	3.72	83	10.4	8	1.75	0.50	15	55.0	5.33	16	84	16
1995	1.69	0.40	53	53.4	3.93	53	15.4	10	1.47	0.30	11	51.7	3.49	11	65	11
1996	1.71	0.42	63	53.7	4.27	63	13.1	8	1.57	0.39	19	52.4	4.53	19	76	19
1997	1.55	0.27	23	53.2	4.00	23	13.0	3	1.43	0.14	4	52.7	5.12	4	100	4
Pre-moratorium																
1984-91	1.61	0.38	547	51.6	4.03	558	17.5	100	1.56	0.35	164	51.1	3.85	174	72	176
Moratorium																
1992-97	1.72	0.39	368	53.7	3.92	380	8.8	32	1.59	0.42	77	52.9	4.86	78	76	78

Table 3. Biological characteristics data for female small salmon kelts and with sexes combined plus unsexed fish by year and for pre-moratorium (1985-91) and moratorium (1992-97) periods for Northeast Brook, Trepassey (SFA 9), Newfoundland. FL = fork length (cm); RS = repeat spawning grilse.

	Sexes combined plus unsexed					Females			%	
Year	$\bar{X}$ FL	SD	N	% RS	N	$\bar{X}$ FL	SD	N	Female	N
1985	55.0	4.88	16	6.7	1	57.6	5.94	4	25	4
1986	53.7	4.35	86	7.2	6	52.6	3.59	68	79	68
1987	54.3	3.63	104	13.7	13	53.7	3.57	83	80	83
1988	53.1	4.70	23	0.0	0	53.4	1.95	13	57	13
1989	52.4	4.05	63	8.6	5	52.3	4.16	48	77	49
1990	52.4	5.66	21	0.0	0	52.3	5.94	19	90	19
1991	55.6	3.69	55	5.9	3	54.9	3.64	43	78	43
1992	55.6	3.85	41	7.7	3	55.3	3.98	36	88	36
1993	57.6	2.79	33	14.8	4	57.4	2.83	27	82	27
1994	56.0	3.80	42	5.7	2	55.3	3.72	31	79	31
1995	54.5	3.97	44	9.3	4	54.8	3.41	37	84	37
1996	56.4	4.82	65	7.5	4	55.8	4.52	54	83	54
1997	56.7	6.39	39	17.6	6	56.8	6.80	34	88	35
*Pre-moratorium										
1984-91	54.1	4.24	409	8.2	31	53.6	4.02	314	77	315
*Moratorium										
1992-97	56.2	4.63	223	10.4	20	55.9	4.57	183	83	184

*These time periods reflect the year of adult return, e.g., kelts sampled in 1997 returned as adults in 1996.

Table 4. Biological characteristics data for female small salmon and with sexes combined plus unsexed fish by year and for pre-moratorium (1984-91) and moratorium (1992-97) periods for Northeast River, Placentia Bay (SFA 10), Newfoundland. WW = whole weight (kg); FL = fork length (cm); RS = repeat spawning grilse.

	Sexes combined plus unsexed								Females						%	
Year	$\bar{X}$ WW	SD	N	$\bar{X}$ FL	SD	N	% RS	N	$\bar{X}$ WW	SD	N	$\bar{X}$ FL	SD	N	Female	N
1984	1.50	0.18	25	52.1	2.40	27	3.7	1	1.51	0.19	22	52.2	2.32	24	89	24
1985	1.55	0.24	51	51.6	3.26	51	7.8	4	1.56	0.24	47	51.8	3.25	47	92	47
1986	1.67	0.25	68	53.1	2.39	69	2.9	2	1.69	0.25	63	53.3	2.36	63	93	63
1987	1.40		1	52.6	5.09	2	0.0	0	1.40		1	49.0		1	100	1
1988	1.61	0.27	44	52.6	3.38	43	6.8	3	1.63	0.27	33	52.8	3.56	33	94	33
1989	1.71	0.22	24	53.7	2.85	25	8.0	2	1.72	0.24	19	53.9	2.64	19	95	19
1990	1.60	0.31	49	54.6	2.32	49	4.1	2	1.56	0.29	40	54.4	2.33	40	87	40
1991	1.00		1	47.5		1	0.0	0	1.00		1	47.5		1	100	1
1992			0	53.5	2.95	10	0.0	0			0	53.6	3.13	9	100	9
1993	1.83	0.31	23	54.2	3.08	24	4.8	1	1.76	0.33	10	52.9	1.97	10	83	10
1994	1.62	0.44	30	55.2	3.14	30	40.9	9	1.73	0.24	5	55.0	2.69	5	100	5
1995	1.77	0.47	48	55.4	3.76	48	31.1	14	1.72	0.37	25	54.7	3.21	25	100	25
1996	1.83	0.44	71	55.5	3.71	70	30.0	21	1.81	0.42	45	55.3	3.45	44	98	45
1997	1.87	0.30	44	54.3	2.81	44	4.9	2	1.88	0.27	31	54.2	2.48	31	94	31
Pre-moratorium 1984-91	1.61	0.26	263	52.9	2.96	267	5.2	14	1.61	0.26	226	53.0	2.91	228	92	228
Moratorium 1992-97	1.8	0.41	216	55	3.41	226	22.5	47	1.80	0.36	116	54.6	3.07	124	96	125

Table 5. Relative fecundity values used to calculate egg depositions for each river in SFAs 5 and 10.

River	Year	Relative fecundity (No. eggs/Kg)	N
SFA 5			
Middle Brook	1984	1896	102
	1985	1993	84
	1986	1955	36
	1987	2160	5
	1988	2259	10
	1990	1896	10
	1993	2150	31
	Years combined	1980	278
Terra Nova River	1984	1709	46
	1985	2163	7
	1986	1410	15
	1987	2323	3
	1990	2281	5
	1993	1794	8
	Years combined	1761	84
SFA 10			
Northeast River, Placentia	1984	2332	21
	1985	2205	39
	1986	2282	45
	1988	2472	34
	1990	2500	41
	1993	2144	5
	Years combined	2352	186

Table 6. Atlantic salmon conservation requirement for each river in terms of eggs and small salmon.

River	Conservation requirement	
	Eggs (Millions)	Small salmon (No.)
SFA 5		
Middle Brook	2.342	1012
Terra Nova River	14.303	7094
SFA 9		
Northeast Brook, Trepasssey	0.144	51
SFA 10		
Northeast River, Placentia	0.719	224

Table 7. Counts of Atlantic salmon at Indian Bay Brook counting fence 1997, Middle Brook fishway 1974-97, and lower Terra Nova River fishway 1978-97, Bonavista Bay (SFA 5). Partial counts are in parentheses and are not included in means.

	Indian Bay Brook		Middle Brook		Terra Nova River	
Year	Small	Large	Small	Large	Small	Large
1974			(770)	(77)		
1975			(1119)	(9)		
1976						
1977						
1978			1403	16	810	20
1979			(1350)	(54)	569	170
1980			1712	91	843	39
1981			2414	39	1115	90
1982			1281	20	963	19
1983			1195	75	1210	57
1984			1379	57	1233	107
1985			904	27	1557	112
1986			1036	15	1051	140
1987			914	19	974	56
1988			772	14	1737	206
1989			496	19	1138	142
1990			745	13	1149	144
1991			562	14	873	114
1992			1182	43	1443	270
1993			1959	87	(2713)	(470)
1994			1513	90	1571	242
1995			1139	168	2258	634
1996			1751	161	2005	464
1997	1375	352	1221	262	1577	527
$\bar{X}$ 84-89			917	25	1282	127
95% LCL			610	8	965	75
95% UCL			1223	42	1598	179
N			6	6	6	6
$\bar{X}$ 86-91			754	16	1154	134
95% LCL			540	13	835	83
95% UCL			969	18	1473	185
N			6	6	6	6
$\bar{X}$ 92-96			1509	110	1998	416
95% LCL			1068	44	1356	215
95% UCL			1950	176	2640	617
N			5	5	5	5

Table 8. Counts of Atlantic salmon at the Northeast Brook, Trepassey counting fence, St. Mary's Bay (SFA 9), 1984-97, and the Northeast River fishway, Placentia Bay (SFA 10), 1974-97. Partial counts are in parentheses and are not included in means.

	Northeast Brook, Trepassey		Northeast River, Placentia	
Year	Small salmon	Large salmon	Small salmon	Large salmon
1974			223	9
1975			(186)	(36)
1976			294	56
1977				
1978			390	32
1979			454	37
1980			433	34
1981			334	62
1982			86	36
1983			233	22
1984	89	33	419	44
1985	124	41	384	0
1986	158	30	725	39
1987	91	30	325	16
1988	97	19	543	11
1989	62	18	706	15
1990	71	9	551	25
1991	99	13	353	8
1992	49	10	921	46
1993	79	17	847	65
1994	99	15	677	70
1995	80	12	663	74
1996	73	15	1225	123
1997	50	9	641	185
$\bar{X}$ 84-89	104	29	517	21
95% LCL	69	19	339	3
95% UCL	138	38	695	39
N	6	6	6	6
$\bar{X}$ 86-91	96	20	534	19
95% LCL	61	11	356	7
95% UCL	132	29	711	31
N	6	6	6	6
$\bar{X}$ 92-96	76	14	867	76
95% LCL	54	10	583	40
95% UCL	98	17	1151	111
N	5	5	5	5

Table 9. Total river returns, spawning escapement, and percentage of conservation requirement achieved in terms of small salmon and eggs for Indian Bay Brook 1997, Middle Brook and Terra Nova River 1984-97, Bonavista Bay (SFA 5).

	Total returns		Prop.	Spawning escapement		Egg deposition (Millions)		% cons. req. achieved		Eggs per
Year	Small	Large	Large	Small	Large	Small	Large	Small	Eggs	100 sq. m
				Indian Bay Brook						
1997	1439	352	0.197	1227	351	3.176	1.673	60	106	1256
				Middle Brook						
1984	1675	57	0.033	1265	57	2.804	0.260	125	131	1161
1985	1283	27	0.021	745	27	1.838	0.130	74	84	745
1986	1547	15	0.010	758	15	2.014	0.071	75	89	789
1987	1053	19	0.018	866	19	2.006	0.091	86	90	794
1988	1337	14	0.010	629	14	1.211	0.067	62	55	484
1989	626	19	0.029	461	19	1.068	0.091	46	49	439
1990	1070	13	0.012	721	13	1.670	0.062	71	74	656
1991	763	14	0.018	485	14	1.124	0.067	48	51	451
1992	1563	43	0.027	1140	43	3.260	0.205	113	148	1312
1993	2247	88	0.038	1909	84	5.148	0.436	189	238	2115
1994	1844	90	0.047	1423	90	3.648	0.429	141	174	1544
1995	1448	168	0.104	1037	168	1.872	0.801	102	114	1012
1996	2112	161	0.071	1605	161	5.081	0.767	159	250	2215
1997	1287	262	0.169	1209	262	3.335	1.249	119	196	1736
				Terra Nova River						
1984	1534	107	0.065	1100	107	2.184	0.440	16	18	80
1985	2012	112	0.053	1431	112	2.830	0.475	20	23	101
1986	1459	140	0.088	974	140	1.817	0.593	14	17	74
1987	1404	56	0.038	940	56	1.812	0.237	13	14	63
1988	2114	206	0.089	1617	206	3.198	0.873	23	28	125
1989	1377	142	0.093	1085	142	2.146	0.602	15	19	84
1990	1518	144	0.087	1052	144	2.081	0.610	15	19	82
1991	1127	114	0.092	815	114	1.612	0.483	11	15	64
1992	1780	270	0.132	1371	270	2.899	1.144	19	28	124
1993	3050	472	0.134	2620	467	5.540	1.977	37	53	230
1994	2035	246	0.108	1305	232	2.759	0.985	18	26	115
1995	2638	638	0.195	1835	587	3.881	2.486	26	45	195
1996	2575	472	0.155	1577	429	3.334	1.818	22	36	158
1997	1786	527	0.228	1142	498	2.430	2.110	16	32	139

Table 10. Total river returns, spawning escapement, and percentage of conservation requirement achieved in terms of small salmon for Indian Bay Brook, 1984-1997. Information for 1984-96 was derived using an estimated angler exploitation rate (see text). A hook-and- release mortality of 10% was used in the calculation of spawning escapement, 1993-97.

Year	Total returns	Spawning escapement	% cons. req. achieved
		Indian Bay Brook	
1984	4192	3647	177
1985	3086	2407	117
1986	1685	1230	60
1987	2267	2063	100
1988	2764	1990	97
1989	1879	1616	79
1990	3176	2636	128
1991	1411	1143	56
1992	2500	2150	105
1993	7286	6753	329
1994	2445	1839	89
1995	4553	3842	187
1996	3241	2687	131
1997	1439	1227	60

Table 11. Total river returns, spawning escapement, and percentage of conservation requirement achieved in terms of small salmon and eggs for Northeast Brook Trepassey, St. Mary's Bay (SFA 9), and Northeast River, Placentia Bay (SFA 10), 1984-97.

	Total returns		Prop.	Spawning escapement		Egg deposition (Millions)	% cons. req. achieved		Eggs per
Year	Small	Large	Large	Small	Large	Sm.+ Lg.	Small	Eggs	100 sq. m
				Northeast Brook, Trepassey					
1984	89	33	0.270	89	33	0.330	175	229	594
1985	124	41	0.248	124	41	0.450	243	312	809
1986	158	30	0.160	158	30	0.530	310	368	953
1987	91	30	0.248	91	30	0.368	178	256	662
1988	97	19	0.164	97	19	0.306	190	213	551
1989	62	18	0.225	62	18	0.250	122	173	449
1990	71	9	0.113	71	9	0.225	139	156	404
1991	99	13	0.116	99	13	0.358	194	249	644
1992	49	10	0.169	49	10	0.182	96	126	328
1993	79	17	0.177	79	17	0.279	155	193	501
1994	99	15	0.132	99	15	0.344	194	239	619
1995	80	12	0.130	80	12	0.280	157	194	503
1996	73	15	0.170	73	15	0.282	143	196	507
1997	50	9	0.153	50	9	0.166	98	115	299

	Total returns		Prop.	Spawning escapement		Egg deposition (Millions)		% cons. req. achieved		Eggs per
Year	Small	Large	Large	Small	Large	Small	Large	Small	Eggs	100 sq. m
					Northeast River, Placentia					
1984	459	44	0.087	389	44	1.219	0.247	174	204	1084
1985	519	0	0.000	346	0	1.095	0.000	154	152	810
1986	879	39	0.042	645	39	2.313	0.214	288	352	1870
1987	350	16	0.044	317	16	1.104	0.091	142	166	884
1988	637	11	0.017	451	11	1.708	0.065	201	247	1312
1989	809	15	0.018	599	15	2.087	0.085	267	302	1606
1990	699	25	0.035	526	25	1.785	0.150	235	269	1431
1991	368	8	0.021	349	8	1.216	0.045	156	175	933
1992	956	46	0.046	919	46	3.732	0.260	410	555	2953
1993	980	65	0.062	842	65	3.419	0.368	376	527	2801
1994	710	70	0.090	670	70	2.721	0.396	299	434	2306
1995	774	74	0.087	646	74	2.613	0.419	288	422	2243
1996	1420	123	0.080	1102	123	4.598	0.696	492	736	3916
1997	722	185	0.204	593	182	2.463	1.028	265	486	2582

Table 12. Estimates of egg deposition, smolt production by year class, and egg-to-smolt survival for Northeast Brook, Trepassey.

Year-class (eggs)	Estimated egg deposition (no.)	Smolt production (no.)	Survival (%)	Eggs/100 m^2
1984	330308	1604	0.49	594
1985	449780	1611	0.36	809
1986	529817	2442	0.46	953
1987	368281	1476	0.40	662
1988	306446	1787	0.58	551
1989	249768	1232	0.49	449
1990	224730	816	0.36	404
1991	358191	1221	0.34	644
1992	182172	(1893)[1]	1.04	328

[1]To age 4 smolts in 1997

Table 13. Atlantic salmon smolt-to-adult survival (back to the river) for Northeast Brook, Trepassey (SFA 9).

	Northeast Brook (Trepassey)		
Year (i)	Smolts year i	Small Salmon year i + 1	% Survival
1986	1117	91	8.1
1987	1404	97	6.9
1988	1692	62	3.7
1989	1708	71	4.2
1990	1902	99	5.2
1991	1911	49	2.6
1992	1674	79	4.7
1993	1849	99	5.4
1994	944	80	8.5
1995	792	73	9.2
1996	1749	50	2.9
1997	1832		

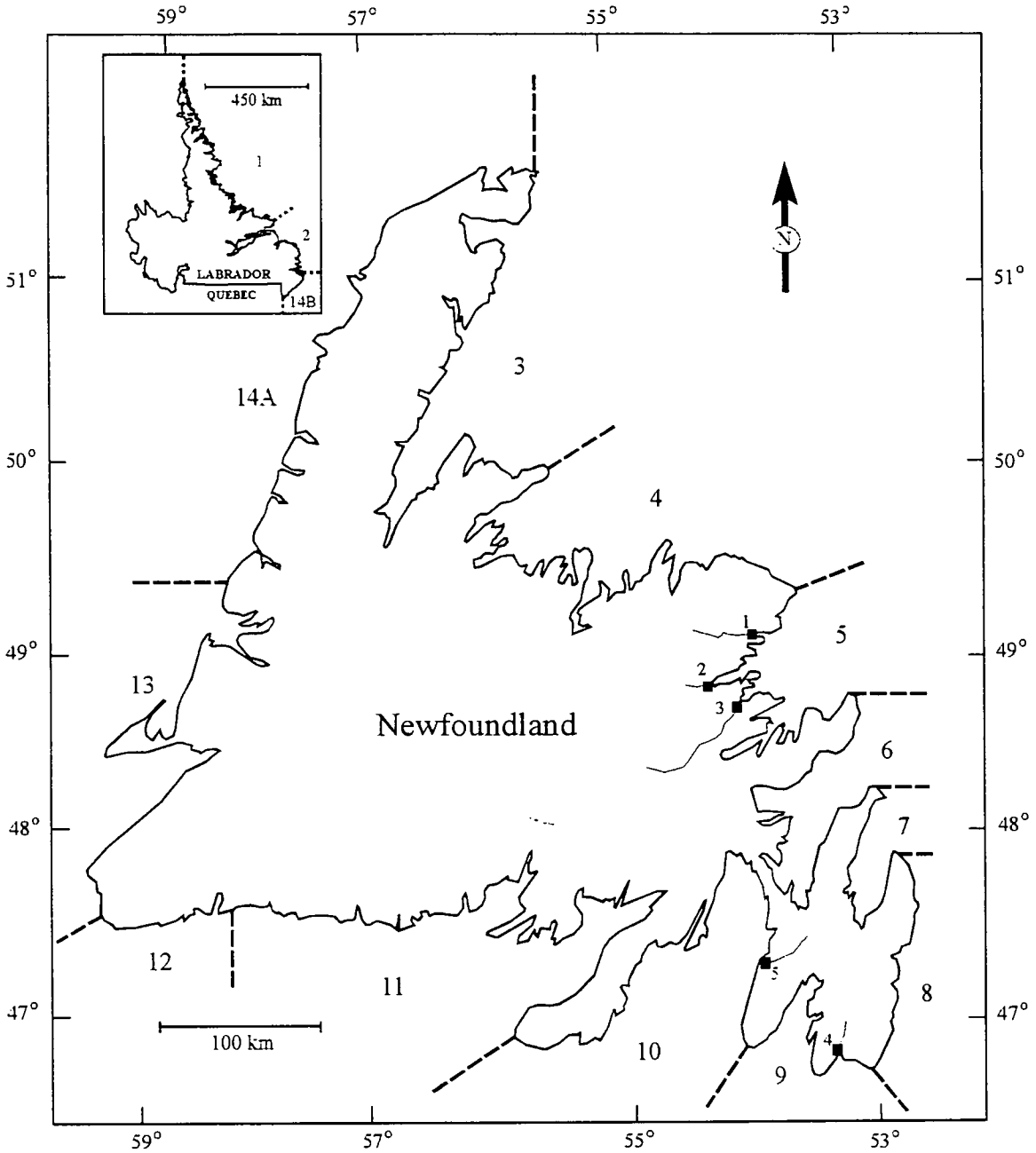

Fig. 1. Map showing Salmon Fishing Areas of Newfoundland and Labrador and the locations of the five rivers mentioned in the text (1) Indian Bay Brook; (2) Middle Brook; (3) Terra Nova River; (4) Northeast Brook, Trepassey; (5) Northeast River, Placentia.

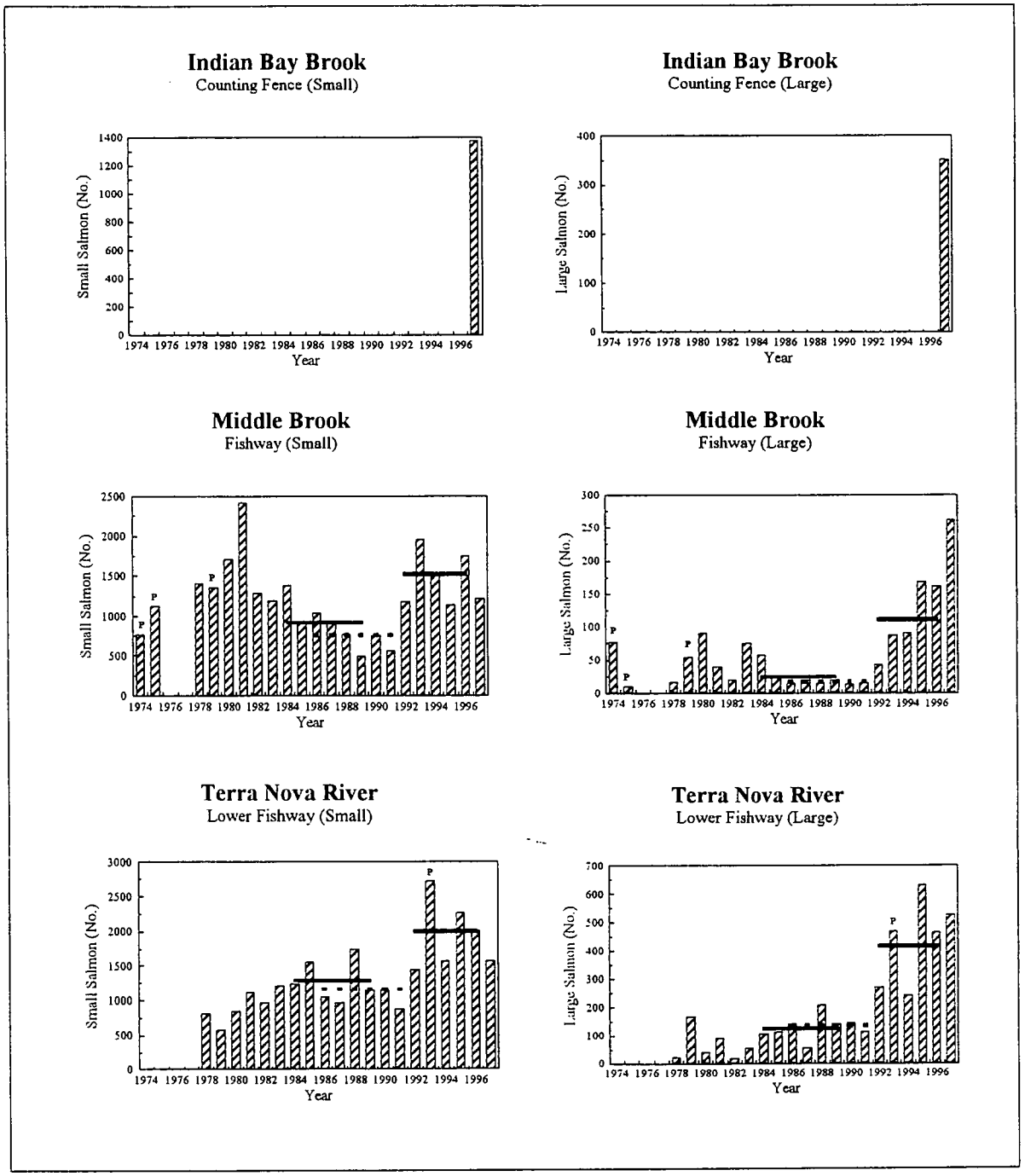

Fig. 2. Counts of small and large salmon at the Indian Bay Brook counting fence, lower Terra Nova River fishway and Middle Brook fishway, 1974-97. The thin solid horizontal line represents the 1984-89 mean, the broken line the 1986-91 mean and the thick solid line the 1992-96 mean. P=partial count not included in means.

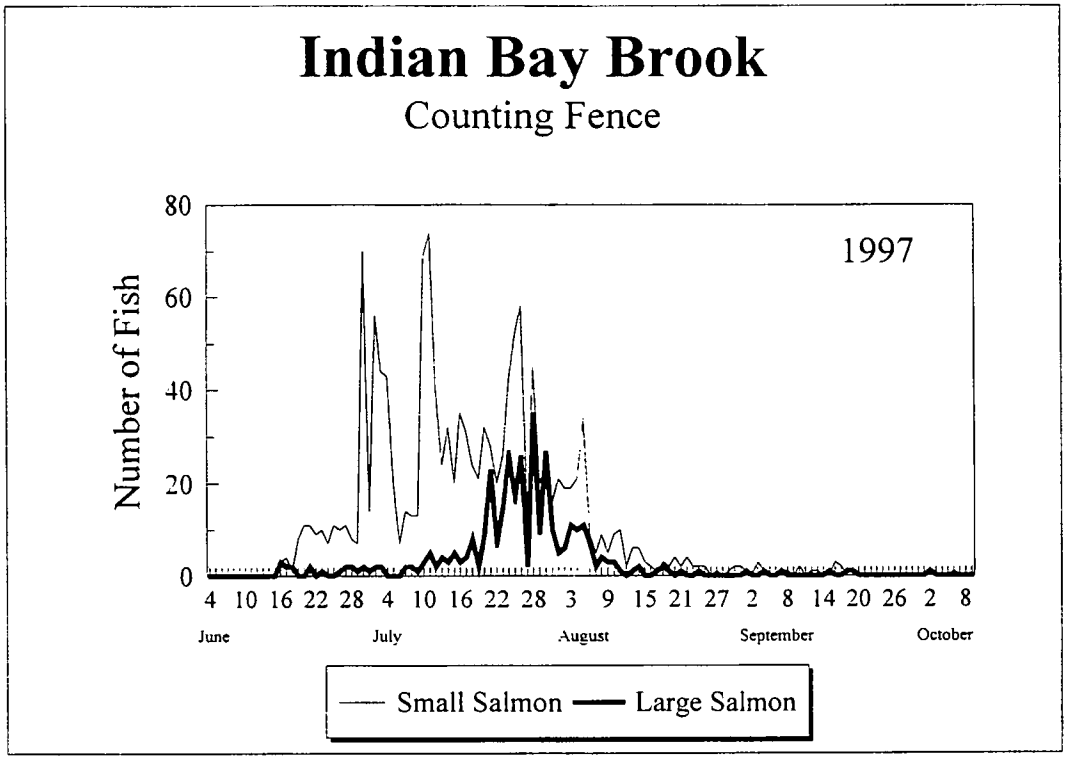

Fig. 3. Daily counts of small and large salmon from the counting fence in Indian Bay Brook, 1997.

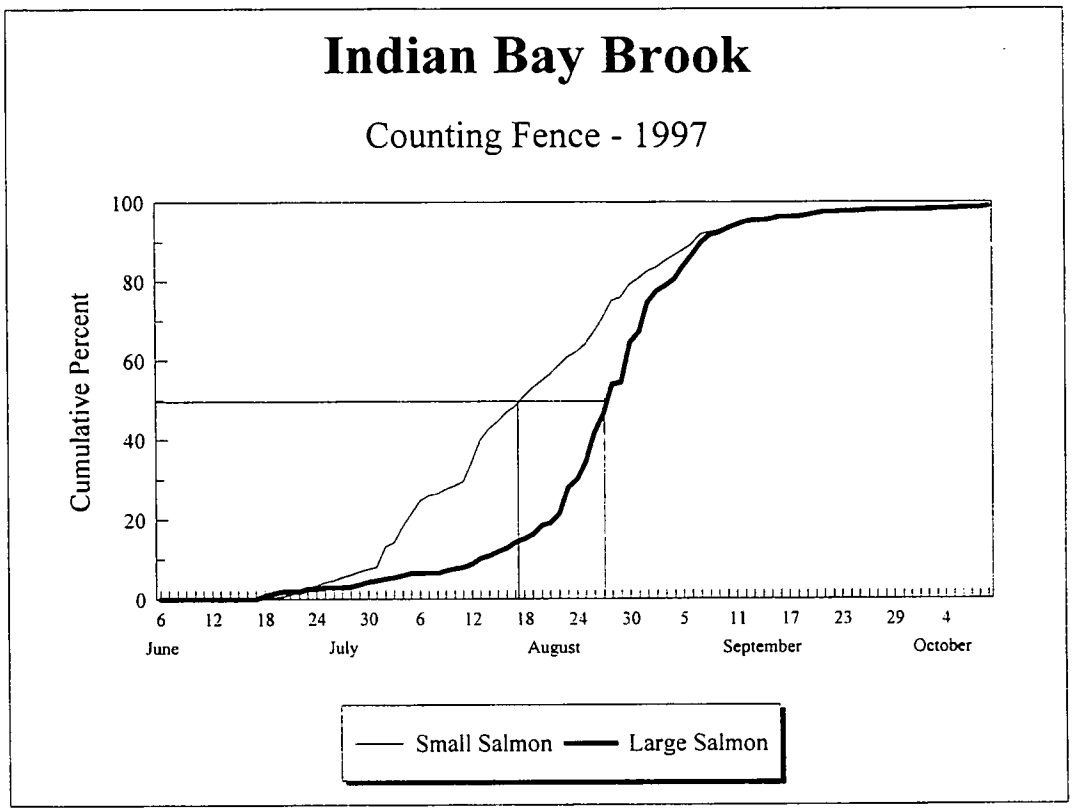

Fig. 4. Daily cumulative percent of small and large salmon from the counting fence in Indian Bay Brook, 1997. Dates of median counts are also shown.

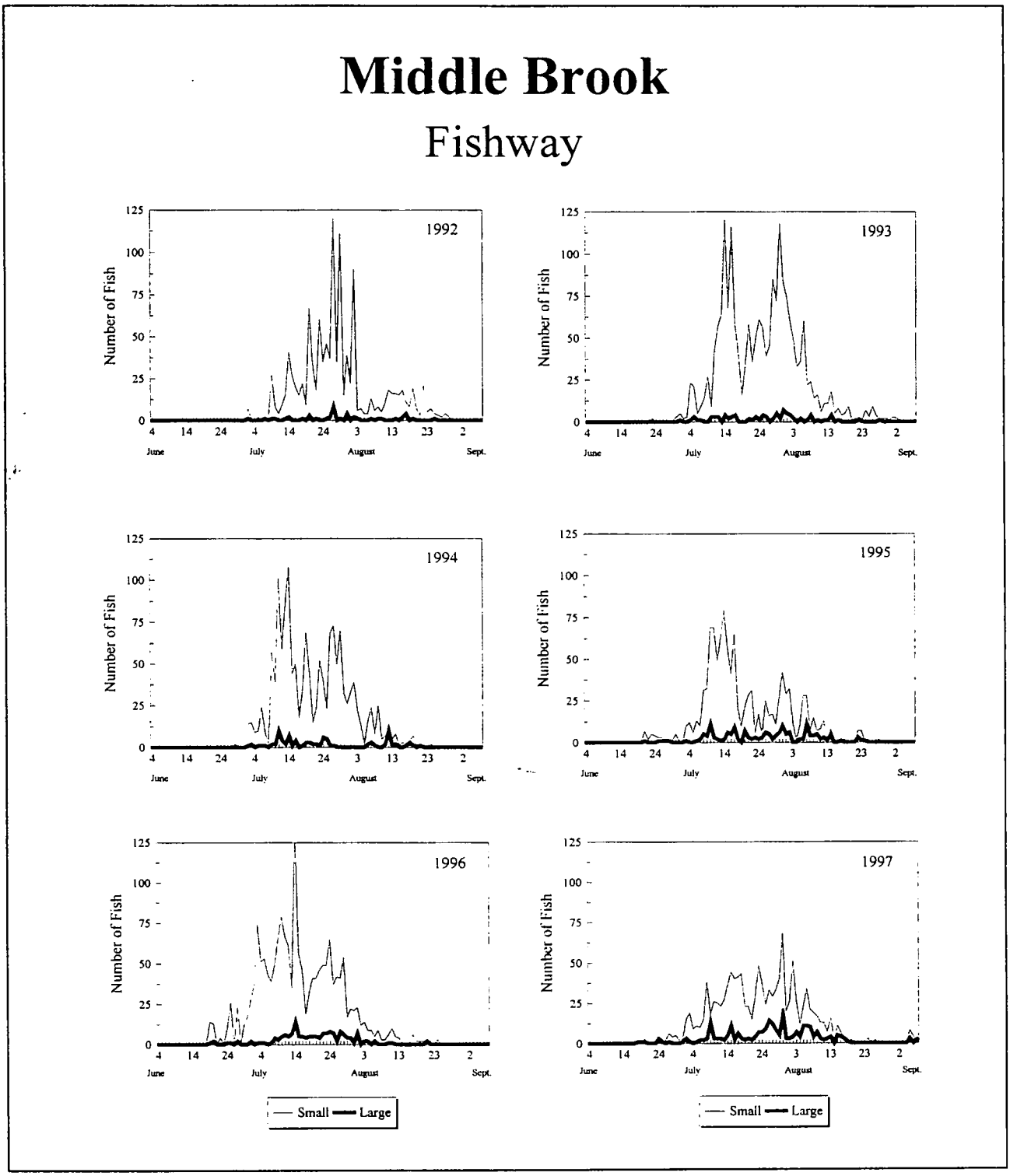

Fig. 5. Daily counts of small and large salmon at the Middle Brook fishway, during the moratorium years, 1992-97.

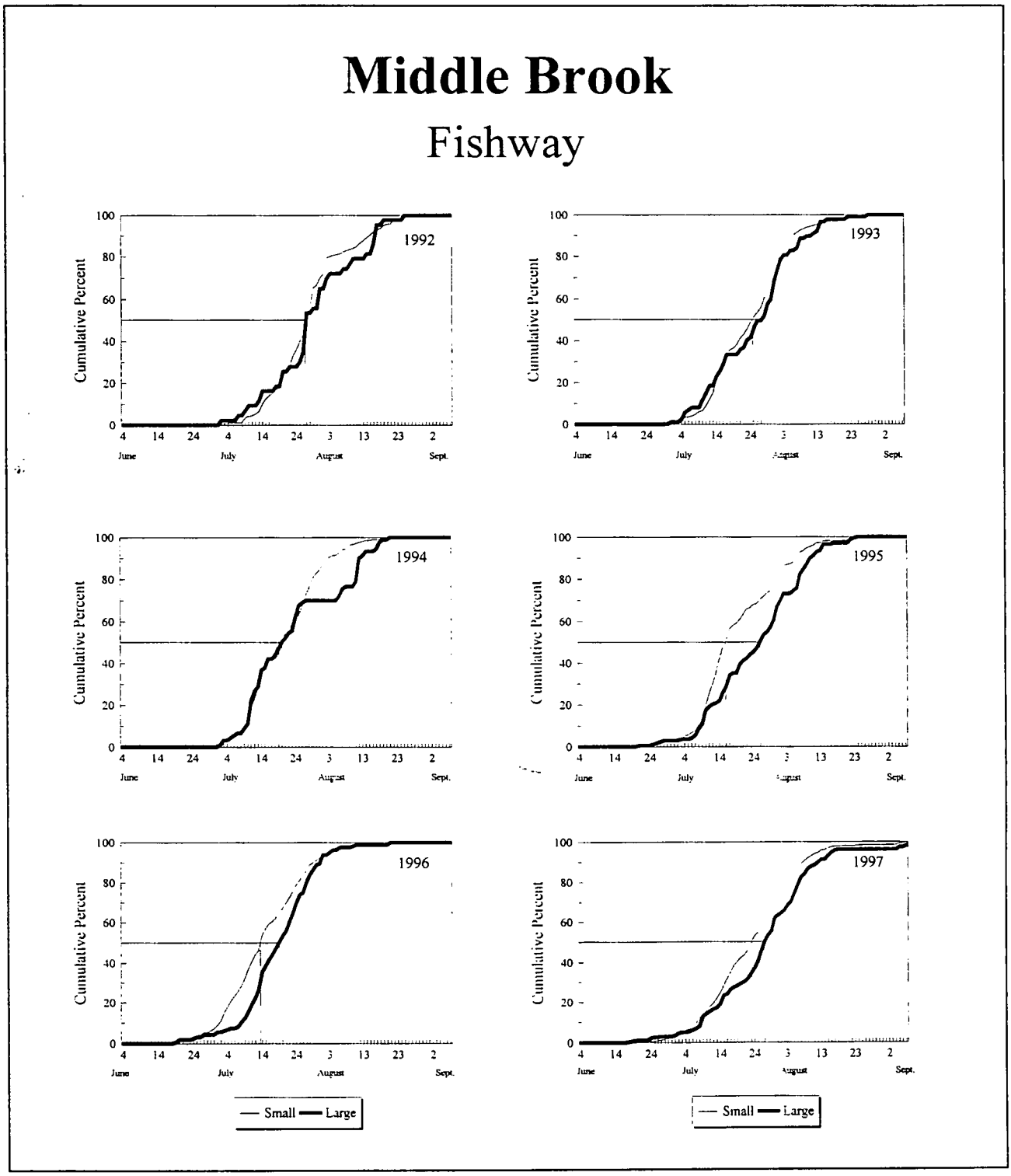

Fig. 6. Daily cumulative percent of small and large salmon at the Middle Brook fishway, during the moratorium years, 1992-97. Dates of median counts are also shown.

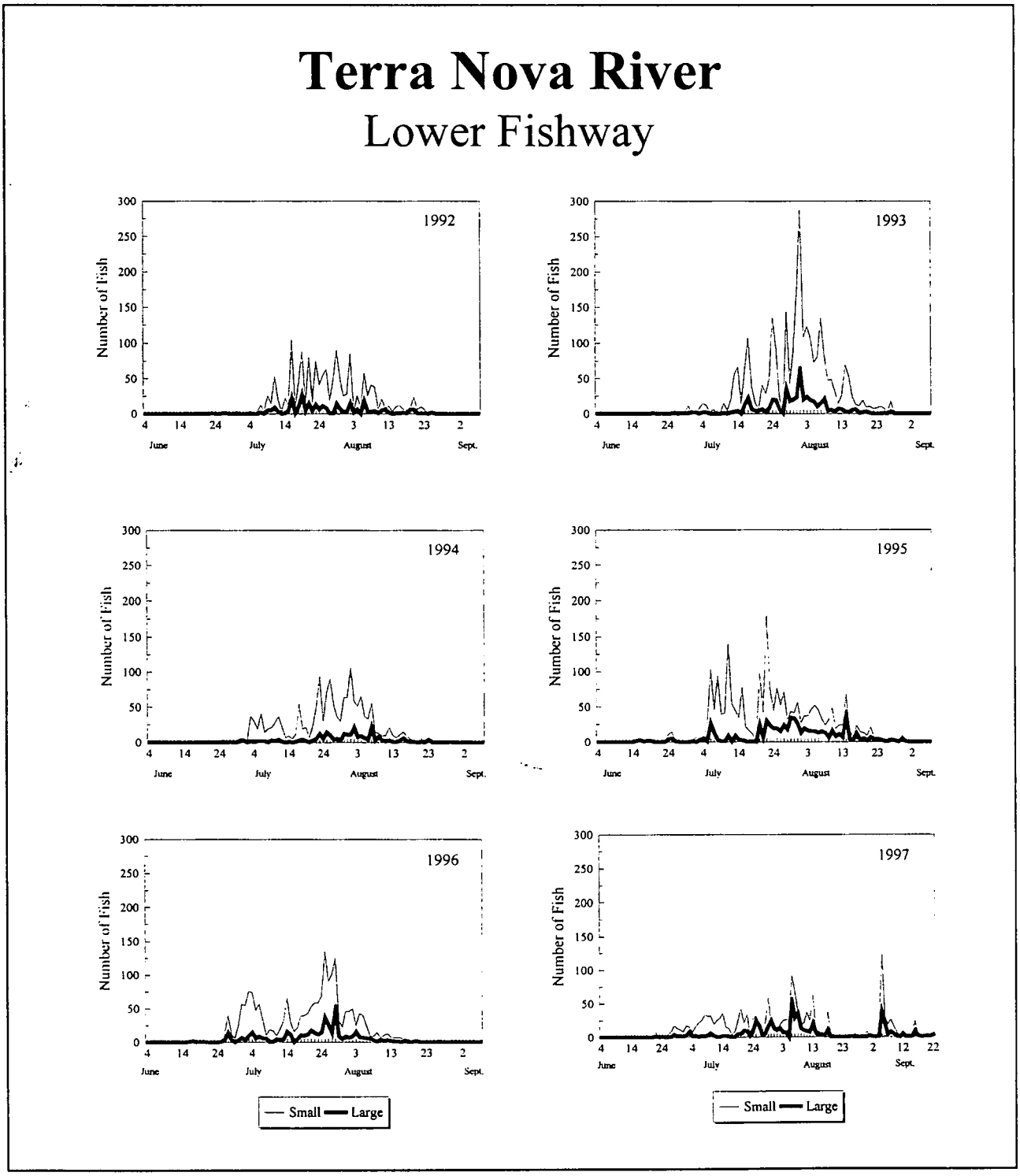

Fig. 7. Daily counts of small and large salmon at the lower fishway in Terra Nova River, during the moratorium years, 1992-97.

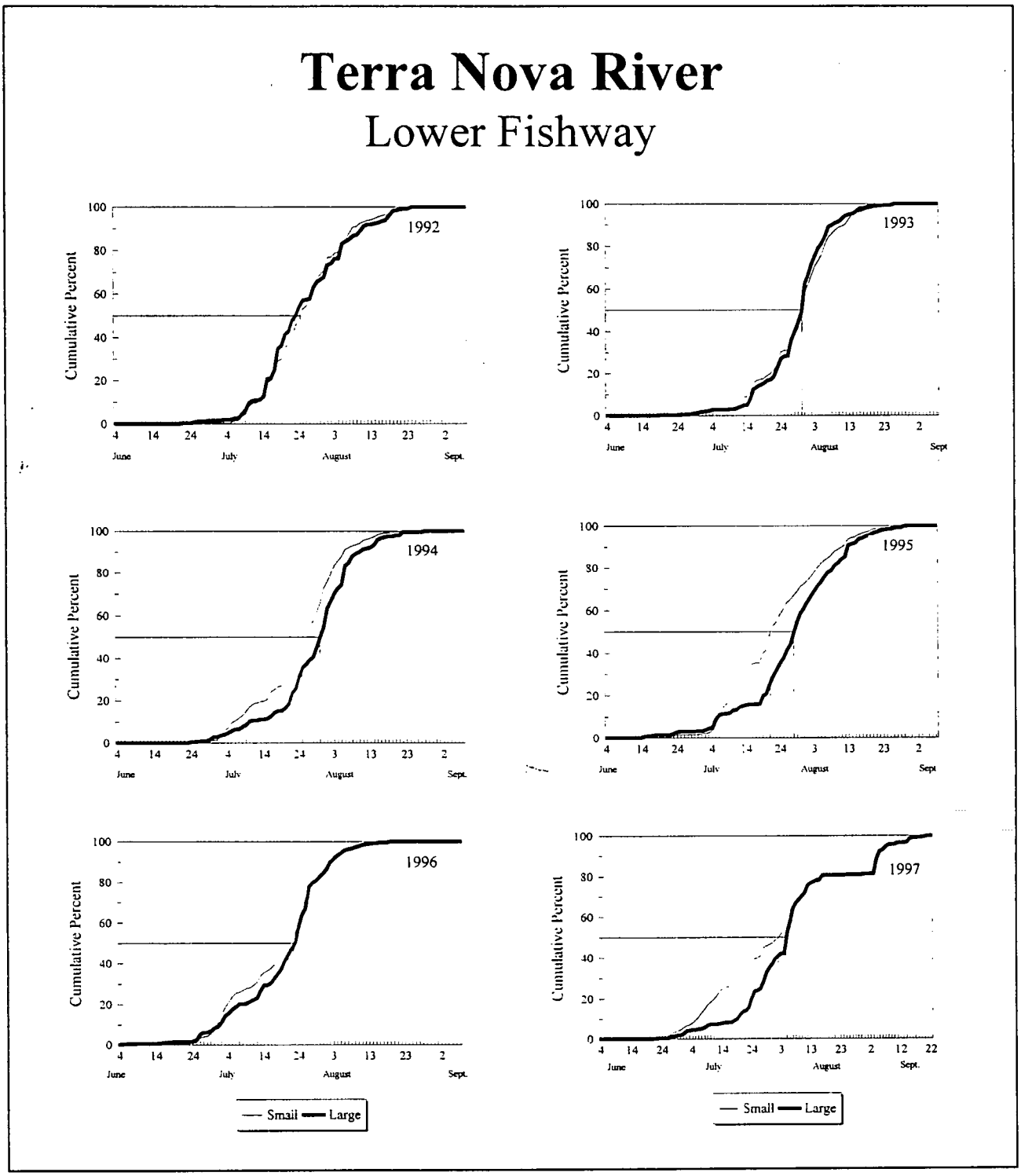

Fig. 8. Daily cumulative percent of small and large salmon at the lower fishway in Terra Nova River, during the moratorium years, 1992-97. Dates of median counts are also shown.

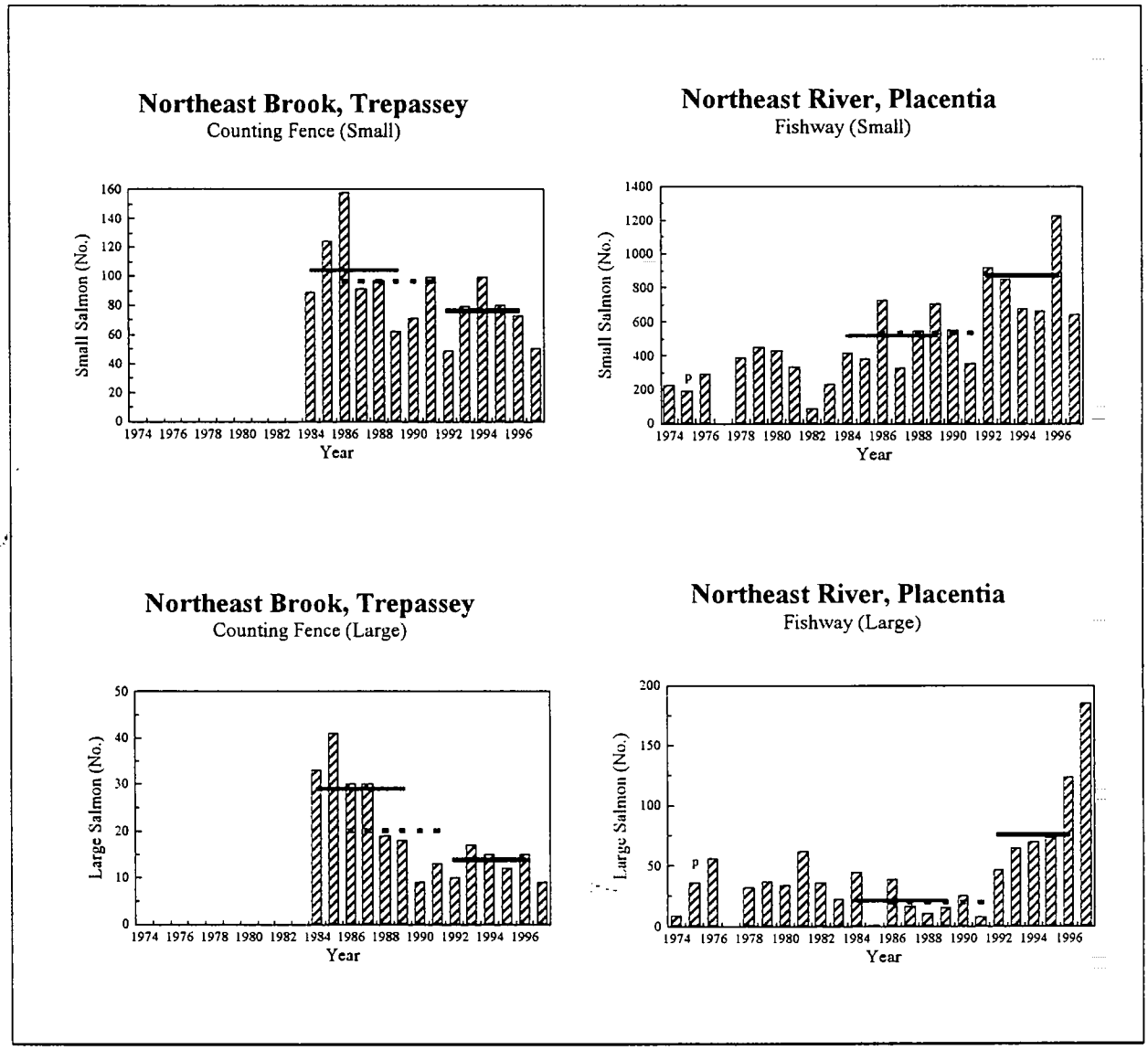

Fig. 9. Counts of small and large salmon at the Northeast Brook Trepassey counting fence, 1984-97 and the Northeast River Placentia fishway, 1974-97. The thin solid horizontal line represents the 1984-89 mean, the broken line the 1986-91 mean and the thick solid line the 1992-96 mean. P=partial count not included in means.

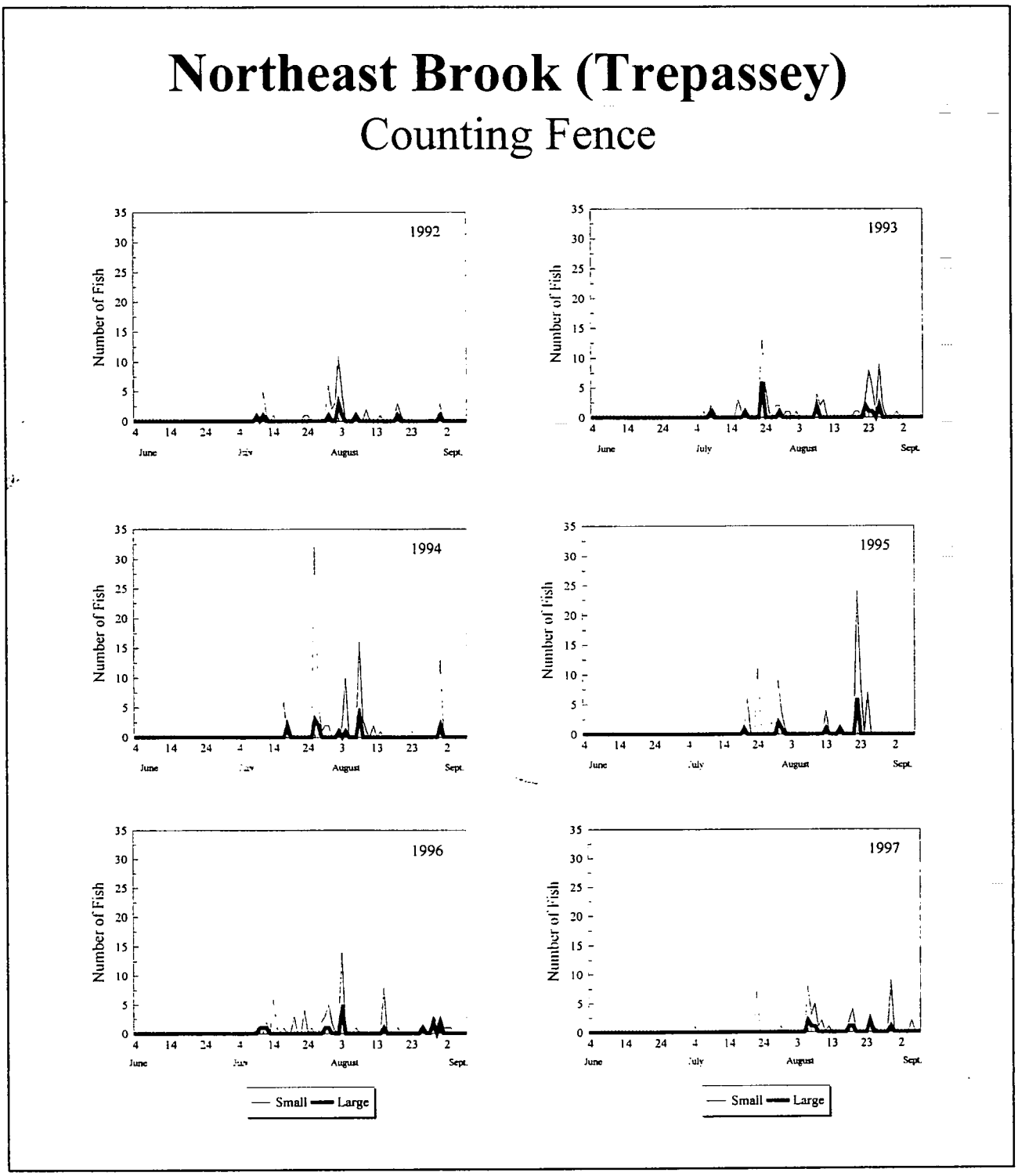

Fig. 10. Daily counts of small and large salmon at the Northeast Brook (Trepassey) counting fence, during the moratorium years, 1992-97.

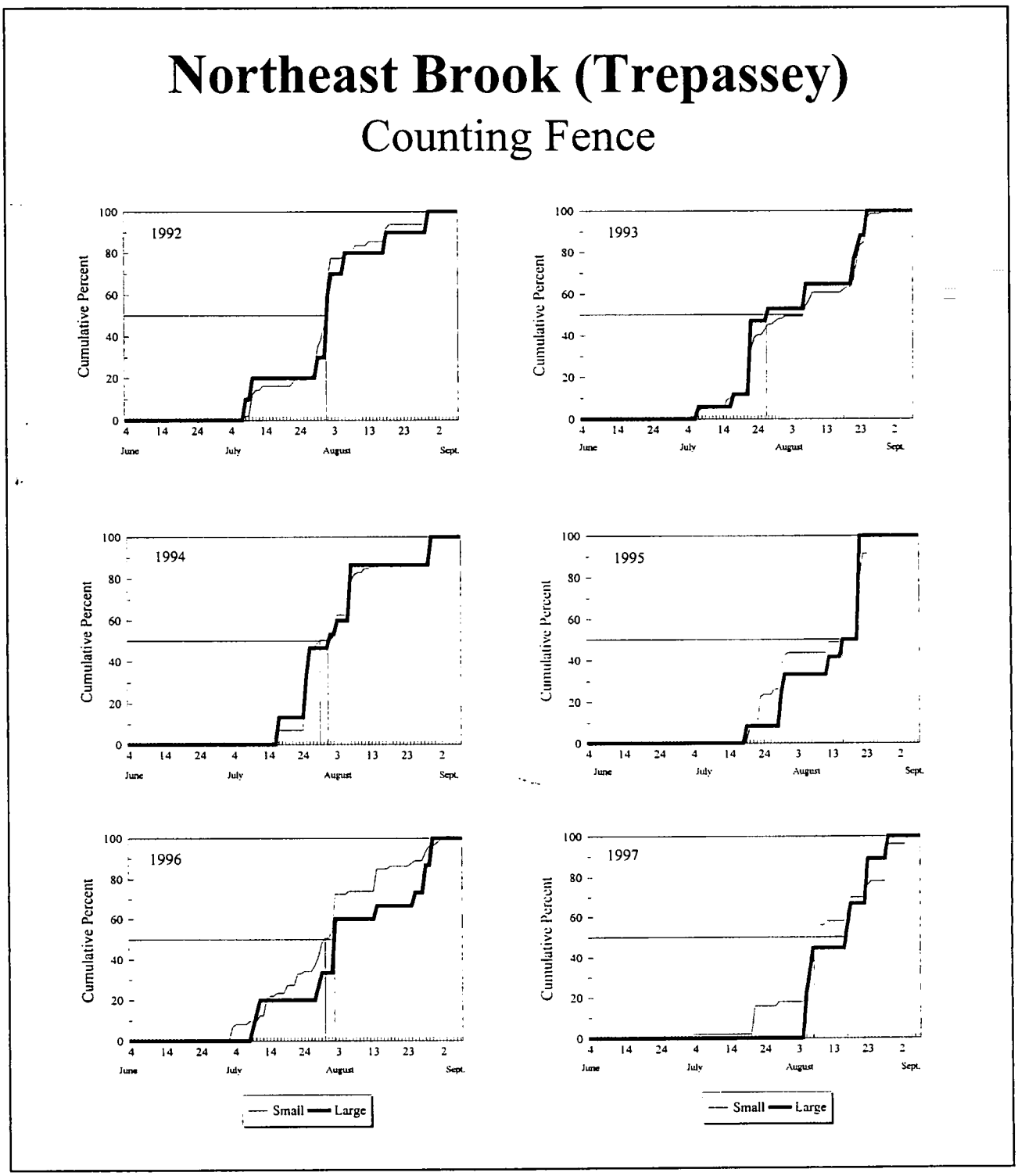

Fig. 11. Daily cumulative percent of small and large salmon at the Northeast Brook (Trepassey) counting fence, during the moratorium years,1992-97. Dates of median counts are also shown.

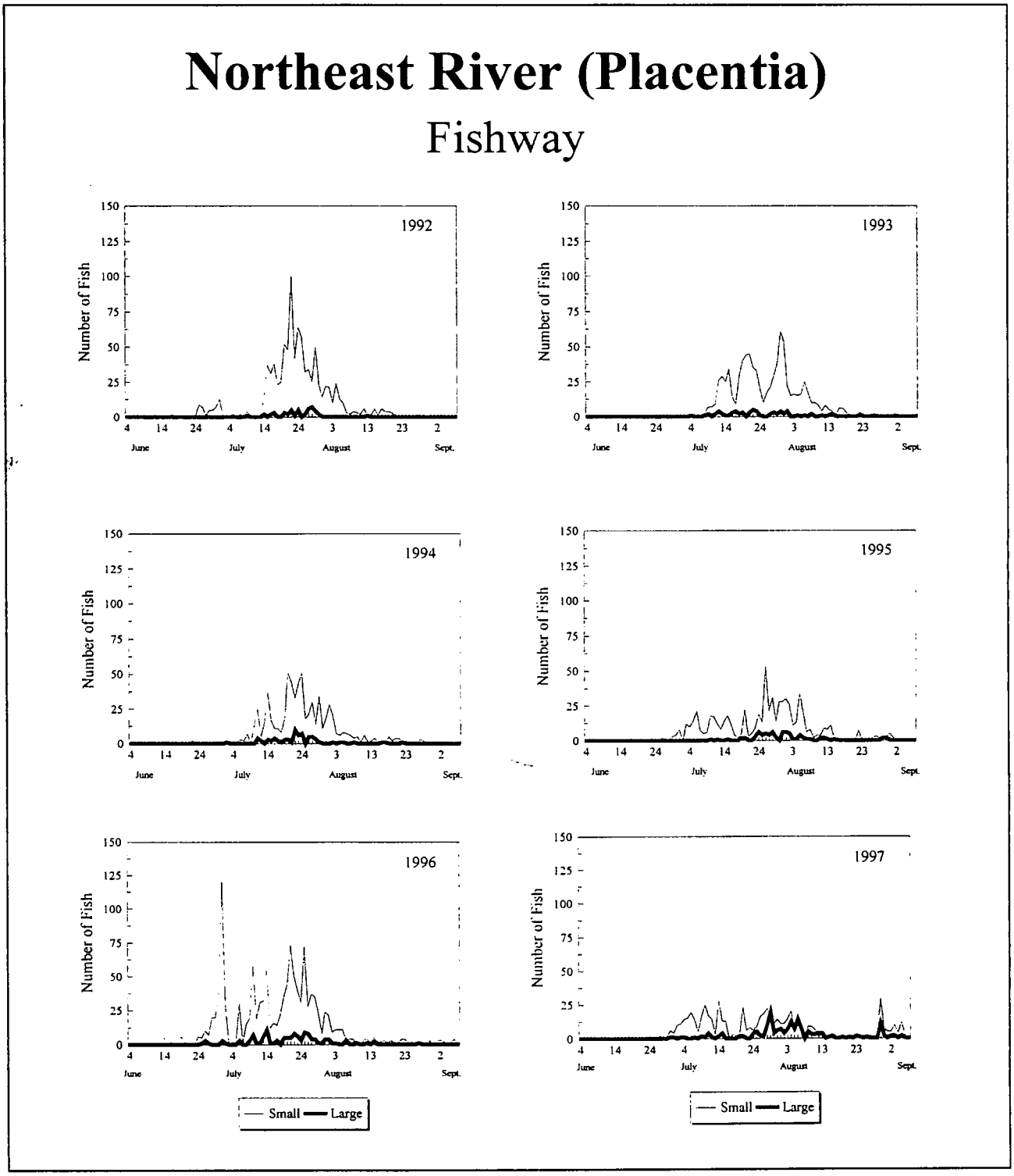

Fig. 12. Daily counts of small and large salmon at the fishway in Northeast River (Placentia), during the moratorium years, 1992-97.

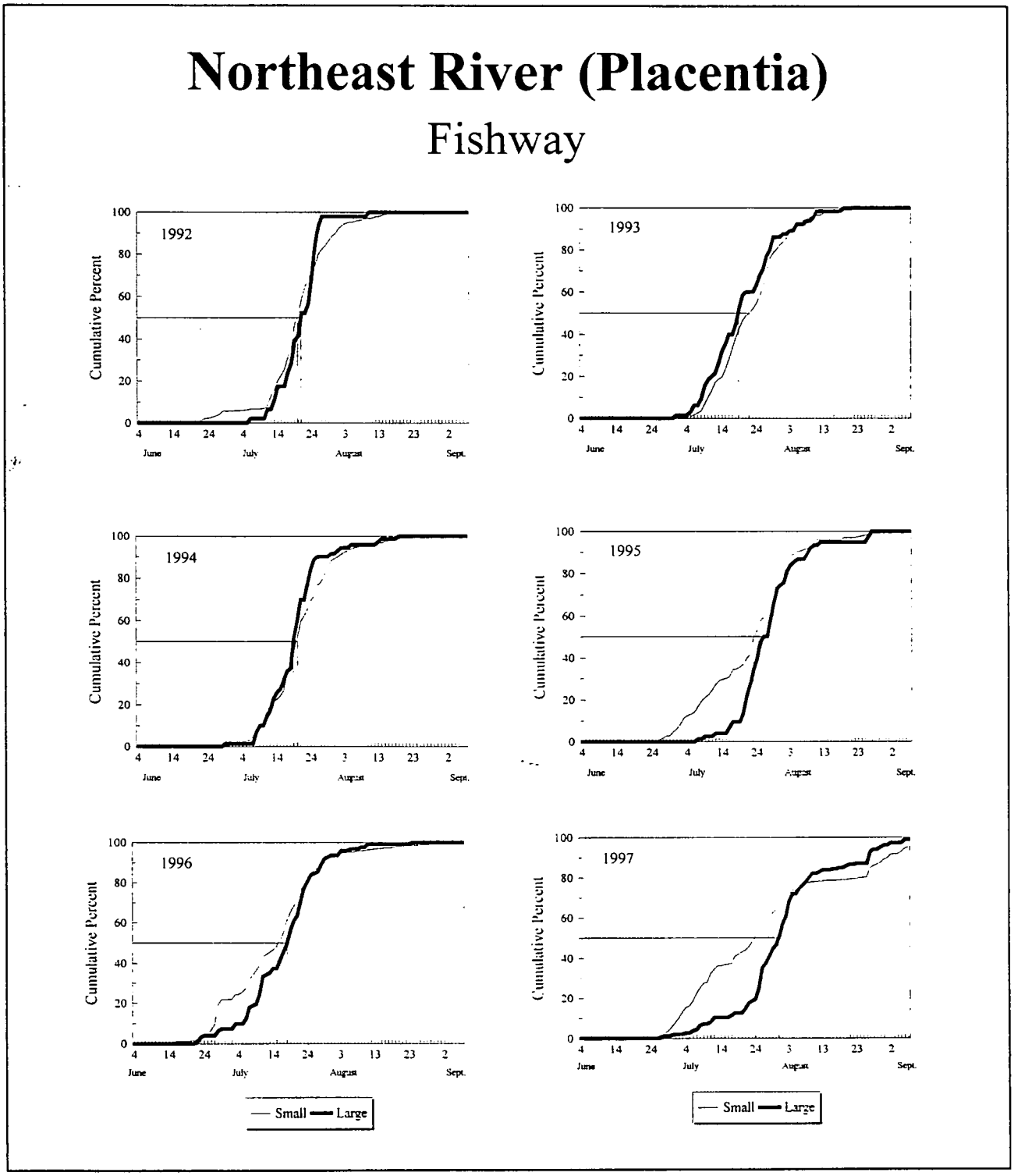

Fig. 13. Daily cumulative percent of small and large salmon at the fishway in Northeast River (Placentia), during the moratorium years, 1992-97. Dates of median counts are also shown.

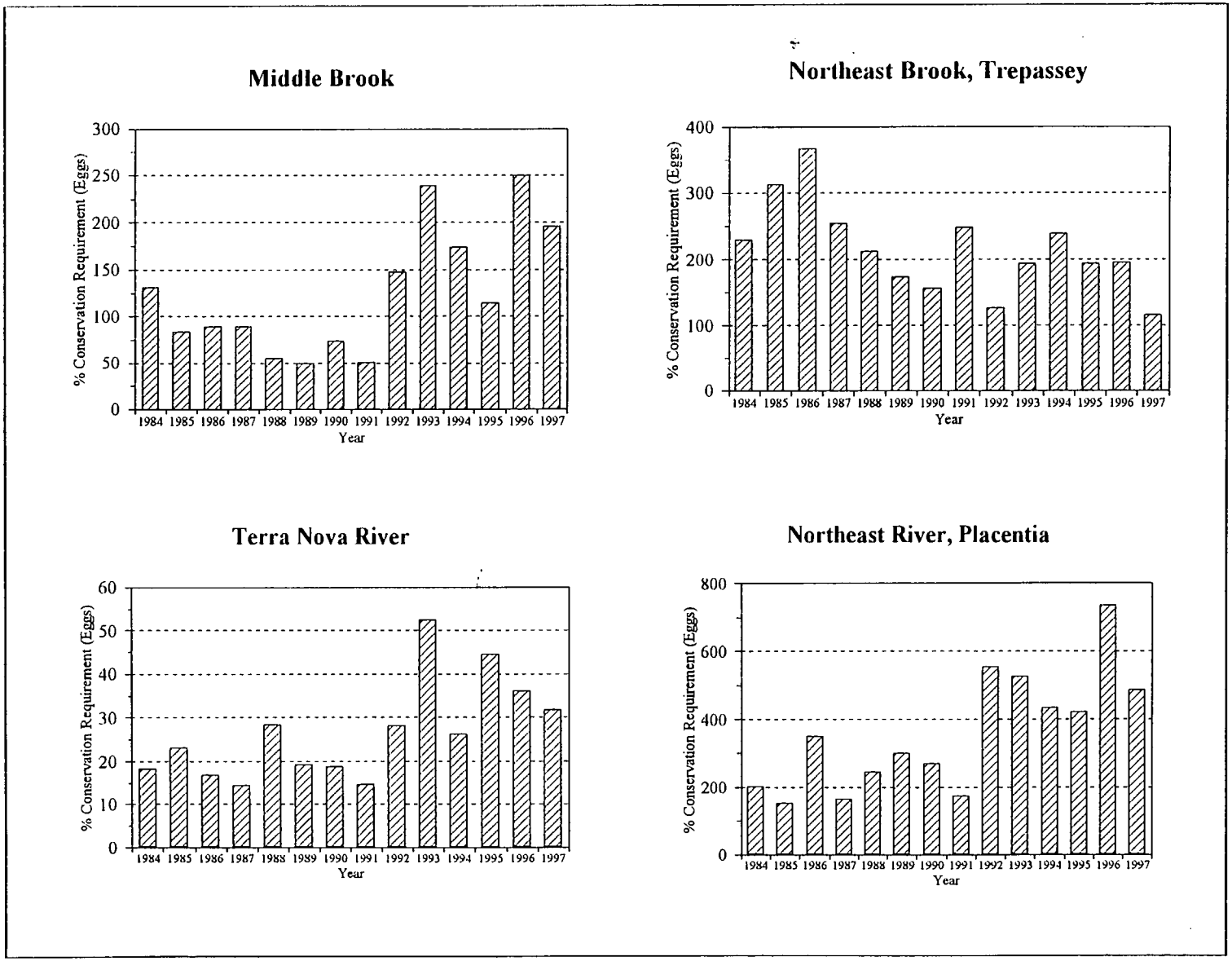

Fig. 14. Percentage conservation egg requirement achieved for Middle Brook and Terra Nova River (SFA 5), Northeast Brook, Trepassey (SFA 9) and Northeast River, Placentia (SFA 10), 1984-97.

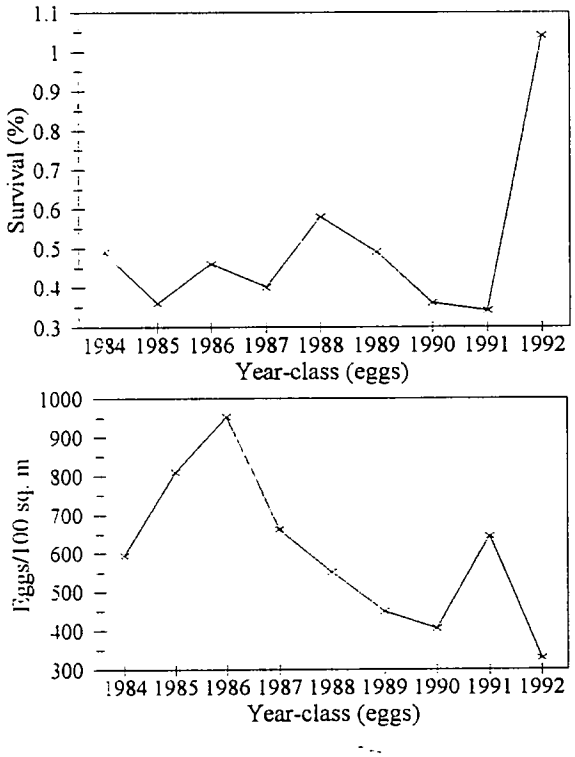

Fig. 15. Egg-to-smolt survival and egg deposition rate for Northeast Brook, Trepassey.

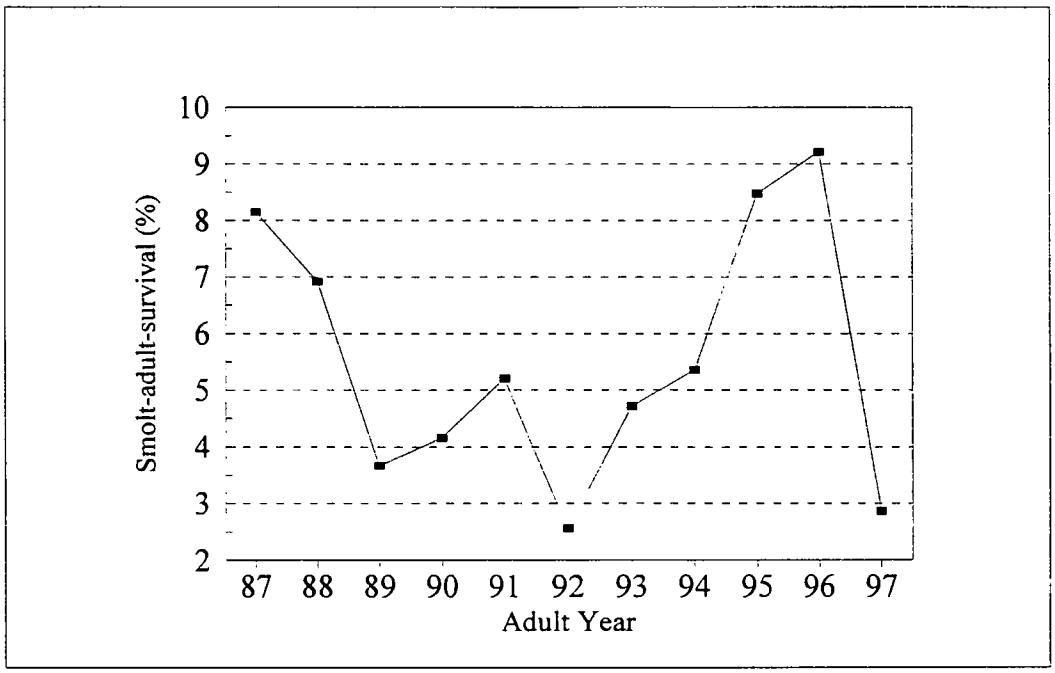

Fig. 16. Atlantic salmon smolt-to-adult survival (back to the river) for Northeast Brook, Trepassey (SFA 9).

Appendix 1. Atlantic salmon recreational fishery catch and effort data for Indian Bay Brook, Bonavista Bay (SFA 5), 1974-97. Ret. = retained fish; Rel. = released fish. The 1997 data, obtained from the licence stub return, are preliminary.

	Effort	Small (<63 cm)			Large (>=63 cm)			Total (Small + Large)			
Year	Rod Days	Ret.	Rel.	Tot.	Ret.	Rel.	Tot.	Ret.	Rel.	Tot.	CPUE
1974	1259	614	.	614	0	.	0	614	.	614	0.49
1975	1013	527	.	527	4	.	4	531	.	531	0.52
1976	917	469	.	469	4	.	4	473	.	473	0.52
1977	1636	893	.	893	6	.	6	899	.	899	0.55
1978	1285	586	.	586	1	.	1	587	.	587	0.46
1979	878	339	.	339	0	.	0	339	.	339	0.39
1980	1196	477	.	477	0	.	0	477	.	477	0.40
1981	1354	820	.	820	0	.	0	820	.	820	0.61
1982	1825	623	.	623	0	.	0	623	.	623	0.34
1983	1759	538	.	538	2	.	2	540	.	540	0.31
1984	1532	545	.	545	0	.	0	545	.	545	0.36
1985	1774	679	.	679	*	.	0	679	.	679	0.38
1986	1303	455	.	455	*	.	0	455	.	455	0.35
1987	772	204	.	204	*	.	0	204	.	204	0.26
1988	1690	774	.	774	*	.	0	774	.	774	0.46
1989	1010	263	.	263	*	.	0	263	.	263	0.26
1990	1298	540	.	540	*	.	0	540	.	540	0.42
1991	1000	268	.	268	*	.	0	268	.	268	0.27
1992	1026	350	110	460	*	1	1	350	111	461	0.45
1993	1663	510	225	735	*	0	0	510	225	735	0.44
1994	2080	589	171	760	*	1	1	589	172	761	0.37
1995	1937	683	288	971	*	0	0	683	288	971	0.50
1996	1580	551	36	587	*	0	0	551	36	587	0.37
1997**		206	58	264	*	14	14	206	72	278	
84-89 $\bar{X}$	1461.8	543.2	.	543.2	.	.	.	543.2	.	543.2	0.37
95% CL	384.6	246.7	.	246.7	.	.	.	246.7	.	246.7	0.08
N	5	5	0	5	0	0	0	5	0	5	5
86-91 $\bar{X}$	1260.2	460.0	.	460.0	.	.	.	460.0	.	460.0	0.37
95% CL	350.2	263.9	.	263.9	.	.	.	263.9	.	263.9	0.11
N	5	5	0	5	0	0	0	5	0	5	5
92-96 $\bar{X}$	1657.2	536.6	166.0	702.6	.	0.4	0.4	536.6	166.4	703.0	0.42
95% CL	504.8	151.9	121.7	239.3	.	0.7	0.7	151.9	121.5	239.0	0.08
N	5	5	5	5	0	5	5	5	5	5	5

1987 DATA NOT INCLUDED IN MEAN.

IN THE ABOVE TABLE A PERIOD INDICATES NO DATA FOR THAT YEAR.

CPUE IS BASED ON RETAINED + RELEASED FISH FOR 1992 - 1997 AND ON RETAINED FISH ONLY PRIOR TO 1992.

* NOT ALLOWED TO RETAIN LARGE SALMON IN INSULAR NEWFOUNDLAND.

**DATA OBTAINED FROM THE LICENSE STUB RETURN AND ARE PRELIMINARY

Appendix 2. Atlantic salmon recreational fishery catch and effort data for Middle Brook, Bonavista Bay (SFA 5), 1974-97. Ret. = retained fish; Rel. = released fish. The 1997 data were obtained from a creel survey.

	Effort	Small (<63 cm)			Large (>=63 cm)			Total (Small + Large)			
Year	Rod Days	Ret.	Rel.	Tot.	Ret.	Rel.	Tot.	Ret.	Rel.	Tot.	CPUE
1974	1823	277	.	277	11	.	11	288	.	288	0.16
1975	1635	415	.	415	8	.	8	423	.	423	0.26
1976	1339	280	.	280	2	.	2	282	.	282	0.21
1977	1511	767	.	767	3	.	3	770	.	770	0.51
1978	1322	391	.	391	1	.	1	392	.	392	0.30
1979	211	28	.	28	0	.	0	28	.	28	0.13
1980	1358	542	.	542	2	.	2	544	.	544	0.40
1981	1574	587	.	587	0	.	0	587	.	587	0.37
1982	2481	504	.	504	8	.	8	512	.	512	0.21
1983	1505	372	.	372	20	.	20	392	.	392	0.26
1984	2712	410	.	410	0	.	0	410	.	410	0.15
1985	2319	538	.	538	*	.	0	538	.	538	0.23
1986	2307	789	.	789	*	.	0	789	.	789	0.34
1987	840	187	.	187	*	.	0	187	.	187	0.22
1988	1545	708	.	708	*	.	0	708	.	708	0.46
1989	712	165	.	165	*	.	0	165	.	165	0.23
1990	949	349	.	349	*	.	0	349	.	349	0.37
1991	903	278	.	278	*	.	0	278	.	278	0.31
1992	1584	423	17	440	*	0	0	423	17	440	0.28
1993	1327	299	387	686	*	37	37	299	424	723	0.54
1994	2049	409	122	531	*	0	0	409	122	531	0.26
1995	2657	402	82	484	*	0	0	402	82	484	0.18
1996	2481	476	153	629	*	0	0	476	153	629	0.25
1997**	1821	77	10	87	*	1	1	77	11	88	0.05
84-89 $\bar{X}$	1919.0	522.0	.	522.0	.	.	.	522.0	.	522.0	0.27
95% CL	988.5	308.0	.	308.0	.	.	.	308.0	.	308.0	0.15
N	5	5	0	5	0	0	0	5	0	5	5
86-91 $\bar{X}$	1283.2	457.8	.	457.8	.	.	.	457.8	.	457.8	0.36
95% CL	809.1	341.2	.	341.2	.	.	.	341.2	.	341.2	0.09
N	5	5	0	5	0	0	0	5	0	5	5
92-96 $\bar{X}$	2019.6	401.8	152.2	554.0	.	7.4	7.4	401.8	159.6	561.4	0.28
95% CL	704.9	79.9	174.7	126.4	.	20.5	20.5	79.9	194.0	142.0	0.14
N	5	5	5	5	0	5	5	5	5	5	5

1987 DATA NOT INCLUDED IN MEAN.

IN THE ABOVE TABLE A PERIOD INDICATES NO DATA FOR THAT YEAR.

CPUE IS BASED ON RETAINED + RELEASED FISH FOR 1992 - 1997 AND ON RETAINED FISH ONLY PRIOR TO 1992.

* NOT ALLOWED TO RETAIN LARGE SALMON IN INSULAR NEWFOUNDLAND.

**DATA WERE OBTAINED FROM A CREEL SURVEY

Appendix 3. Atlantic salmon recreational fishery catch and effort data for Terra Nova River, Bonavista Bay (SFA 5), 1974-97. Ret. = retained fish; Rel. = released fish. The 1997 data, obtained from the licence stub return, are preliminary.

	Effort	Small (<63 cm)			Large (>=63 cm)			Total (Small + Large)			
Year	Rod Days	Ret.	Rel.	Tot.	Ret.	Rel.	Tot.	Ret.	Rel.	Tot.	CPUE
1974	2098	243	.	243	5	.	5	248	.	248	0.12
1975	1723	506	.	506	2	.	2	508	.	508	0.29
1976	1236	424	.	424	7	.	7	431	.	431	0.35
1977	1956	850	.	850	13	.	13	863	.	863	0.44
1978	1608	628	.	628	6	.	6	634	.	634	0.39
1979	910	537	.	537	15	.	15	552	.	552	0.61
1980	872	512	.	512	22	.	22	534	.	534	0.61
1981	1303	739	.	739	33	.	33	772	.	772	0.59
1982	1174	465	.	465	24	.	24	489	.	489	0.42
1983	2157	486	.	486	43	.	43	529	.	529	0.25
1984	2042	636	.	636	0	.	0	636	.	636	0.31
1985	1810	751	.	751	*	.	0	751	.	751	0.41
1986	1485	620	.	620	*	.	0	620	.	620	0.42
1987	1764	546	.	546	*	.	0	546	.	546	0.31
1988	1613	682	.	682	*	.	0	682	.	682	0.42
1989	1946	357	.	357	*	.	0	357	.	357	0.18
1990	2165	624	.	624	*	.	0	624	.	624	0.29
1991	1701	448	.	448	*	.	0	448	.	448	0.26
1992	2488	409	141	550	*	0	0	409	141	550	0.22
1993	3925	484	569	1053	*	62	62	484	631	1115	0.28
1994	5853	822	178	1000	*	44	44	822	222	1044	0.18
1995	6042	696	132	828	*	72	72	696	204	900	0.15
1996	5933	896	260	1156	*	113	113	896	373	1269	0.21
1997**		279	127	406	*	5	5	279	132	411	
84-89 $\bar{X}$	1779.2	609.2	.	609.2	.	.	.	609.2	.	609.2	0.34
95% CL	285.8	186.1	.	186.1	.	.	.	186.1	.	186.1	0.13
N	5	5	0	5	0	0	0	5	0	5	5
86-91 $\bar{X}$	1782.0	546.2	.	546.2	.	.	.	546.2	.	546.2	0.31
95% CL	338.2	170.4	.	170.4	.	.	.	170.4	.	170.4	0.12
N	5	5	0	5	0	0	0	5	0	5	5
92-96 $\bar{X}$	4848.2	661.4	256.0	917.4	.	58.2	58.2	661.4	314.2	975.6	0.20
95% CL	1966.3	261.3	226.1	294.5	.	51.2	51.2	261.3	244.0	338.3	0.06
N	5	5	5	5	0	5	5	5	5	5	5

1987 DATA NOT INCLUDED IN MEAN.

IN THE ABOVE TABLE A PERIOD INDICATES NO DATA FOR THAT YEAR.

CPUE IS BASED ON RETAINED + RELEASED FISH FOR 1992 - 1997 AND ON RETAINED FISH ONLY PRIOR TO 1992.

* NOT ALLOWED TO RETAIN LARGE SALMON IN INSULAR NEWFOUNDLAND.

**DATA OBTAINED FROM THE LICENSE STUB RETURN AND ARE PRELIMINARY

Appendix 4. Atlantic salmon recreational fishery catch and effort data for Northeast River, Placentia Bay (SFA 10), 1974-97. Ret. = retained fish; Rel. = released fish. The 1997 data, obtained from the licence stub return, are preliminary.

	Effort	Small (<63 cm)			Large (>=63 cm)			Total (Small + Large)			
Year	Rod Days	Ret.	Rel.	Tot.	Ret.	Rel.	Tot.	Ret.	Rel.	Tot.	CPUE
1974	1721	142	.	142	0	.	0	142	.	142	0.08
1975	877	121	.	121	4	.	4	125	.	125	0.14
1976	1164	147	.	147	1	.	1	148	.	148	0.13
1977	1465	180	.	180	1	.	1	181	.	181	0.12
1978	1237	161	.	161	0	.	0	161	.	161	0.13
1979	969	138	.	138	0	.	0	138	.	138	0.14
1980	1612	246	.	246	6	.	6	252	.	252	0.16
1981	2339	349	.	349	0	.	0	349	.	349	0.15
1982	1303	150	.	150	0	.	0	150	.	150	0.12
1983	2037	165	.	165	0	.	0	165	.	165	0.08
1984	988	70	.	70	0	.	0	70	.	70	0.07
1985	1276	173	.	173	*	.	0	173	.	173	0.14
1986	862	234	.	234	*	.	0	234	.	234	0.27
1987	349	36	.	36	*	.	0	36	.	36	0.10
1988	772	186	.	186	*	.	0	186	.	186	0.24
1989	852	210	.	210	*	.	0	210	.	210	0.25
1990	786	173	.	173	*	.	0	173	.	173	0.22
1991	153	19	.	19	*	.	0	19	.	19	0.12
1992	485	37	189	226	*	0	0	37	189	226	0.47
1993	592	132	61	193	*	0	0	132	61	193	0.33
1994	313	39	5	44	*	0	0	39	5	44	0.14
1995	544	127	8	135	*	0	0	127	8	135	0.25
1996	2883	268	7	275	*	0	0	268	7	275	0.10
1997**		94	44	138	*	34	34	94	78	172	
84-89 $\bar{X}$	950.0	174.6	.	174.6	.	.	.	174.6	.	174.6	0.18
95% CL	245.8	78.2	.	78.2	.	.	.	78.2	.	78.2	0.11
N	5	5	0	5	0	0	0	5	0	5	5
86-91 $\bar{X}$	685.0	164.4	.	164.4	.	.	.	164.4	.	164.4	0.24
95% CL	372.4	105.0	.	105.0	.	.	.	105.0	.	105.0	0.03
N	5	5	0	5	0	0	0	5	0	5	5
92-96 $\bar{X}$	963.4	120.6	54.0	174.6	.	0.0	0.0	120.6	54.0	174.6	0.18
95% CL	1338.6	117.0	98.1	110.5	.	0.0	0.0	117.0	98.1	110.5	0.19
N	5	5	5	5	0	5	5	5	5	5	5

1987 DATA NOT INCLUDED IN MEAN.

IN THE ABOVE TABLE A PERIOD INDICATES NO DATA FOR THAT YEAR.

CPUE IS BASED ON RETAINED + RELEASED FISH FOR 1992 - 1997 AND ON RETAINED FISH ONLY PRIOR TO 1992.

* NOT ALLOWED TO RETAIN LARGE SALMON IN INSULAR NEWFOUNDLAND.

**DATA OBTAINED FROM THE LICENSE STUB RETURN AND ARE PRELIMINARY