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EVALUATION OF THE 1990 GASPEREAU FISHERY (Alosa pseudoharengus) AND (A. aestivalis) FROM THE MIRAMICHI RIVER, NEW BRUNSWICK

by

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ABSTRACT

Landings of gaspereau from districts 71 and 72 at Newcastle, Chatham and Loggieville in 1990 were 1,789 tons, of which 61% were alewife (Alosa pseudoharengus) and 39% were blueback herring (Alosa aestivalis). Of the alewife catch, the 1987 year-class was the dominant component and first time spawners comprised 85% of the catch. Blueback catch was dominated by the 1984 year-class and new recruits were 34% of the catch. An abundance index based upon catch rates from logbook reports indicated that alewife abundance was the highest since 1982 whereas blueback herring abundance was at midrange of the last nine years. With average recruitment, alewife and blueback catches in 1991 should reach average or better than average levels. As was recommended in 1989, sampling was directed at the fishery, stratified across location and time. A description of the 1989 and 1990 gaspereau fisheries for three other New Brunswick rivers, Richibucto, Tracadie and Pokemouche, is added.

RESUME

Les débarquements de gaspareau en 1990 pour les districts 71 et 72 provenant de Newcastle, Chatham et Loggieville ont atteint un niveau de 1,789 t dont 61% A. pseudoharengus et 39% Alosa aestivalis . Les prises de A. pseudoharengus se composaient principalement du cohorte de 1987 et les nouvelles recrues ont contribué à 85% des prises. Le cohorte de 1984 a dominé les prises de A. aestivalis mais les nouvelles recrues n'ont constitué que 34% des prises pour cette espèce. Un indice d'abondance calculé par l'entremise de journaux de prises et de l'effort a indiqué que l'abondance de A. pseudoharengus en 1990 était la plus élevée depuis 1982. Par contre, l'abondance de A. aestivalis est située au milieu des neuf dernières années. Les prises en 1991 devraient atteindre un niveau moyen ou supérieur à la moyenne si le recrutement est semblable à la moyenne des 7 dernières années. Tel que recommandé en 1989, les échantillons ont été recueillis directement des captures de la pêche, straitifiés par lieu de pêche et période. Une description des pêcheries de gaspareau (1989 et 1990) de trois autres rivières du Nouveau-Brunswick, les rivères Richibucto, Tracadie et Pokemouche, est incluse.

INTRODUCTION

Annual assessments of the gaspereau fishery in the Miramichi River (Statistical Districts 71 and 72) have been presented since 1983 (Alexander and Vromans 1983, 1984, 1985, 1986, 1987, 1988, Chaput and LeBlanc 1989, 1990). The fishing season extends from May 15 to June 15. In 1990, a 3 day extension to the season was granted and the fishery closed on June 18. During 1980 through 1986, fishing was conducted seven days a week in spite of provisions in the regulations for a closed time of Saturday morning to Monday morning in the 1984, 1985 and 1986 seasons. Since 1987 , a one day per week closure has been enforced during the period from 12:00 hours on Saturday till 18:00 hours on Sunday (i.e. nets had to be tied up, out of the water for those time periods).

This document contains two parts. Part A describes the 1990 Miramichi River gaspereau fishery and presents the input parameters of the cohort analysis, under Type I assumptions described below, used to estimate the fishing mortality on the spawning stock. An abundance index, estimated from catch and effort logbook reports was used to calibrate the cohort analysis. Prognosis for 1991 is provided based upon the results of cohort analysis. Part B describes other New Brunswick rivers sampled in 1989 and 1990.

PART A: MIRAMICHI RIVER

METHODS

Two-stage stratified sampling

A two-stage stratified sampling program of the commercial fishery was conducted in 1990. First, length measurements, with species identification done on the basis of external appeareance and peritonial colour, were taken on a random sample of 170-250 fish. Secondly, a detailed sample of 2-4 fish per species and per one-half centimeter length group was selected from the length frequency sample. The detailed samples were generally frozen for later processing. Sampling was carried out at three landing locations on the Miramichi River; namely Newcastle, Chatham, and Loggieville (Fig. 1).

Detailed processing of samples

Biological characteristics recorded included fork length (nearest quarter cm), weight (nearest gram), species (*Alosa pseudoharengus*; alewife or *Alosa aestivalis*; blueback herring) and sex. Scales were removed from the left side of the fish, in the region midway between the dorsal fin and the ventral scutes. Species were distinguished on the basis of external appearance and peritoneum colour (Scott and Crossman 1973) and verified by scale markings (as described by MacLellan *et al.* 1981). Total age and age of first spawning were interpreted according to criteria described by Cating (1953).

Fish lengths of frozen fish were adjusted to fresh lengths using the linear equation :

adjusted lgth (mm) = 4.557 + 1.0143 X frozen length (mm)
r-square = 0.96

Catches-at-age for the two-stage commercial sampling were obtained using the program AGELEN (Wright 1990) which calculates catches-at-age based on the equations of Gavaris and Gavaris (1983).

Logbook catch and effort and total landings

Logbooks collected from individual fishermen were processed for catch and effort (hours) by location. Reports of 0 effort or 0 catch were deleted from further analysis.

Total catch for 1990 was calculated from purchase slip, by location, as collated by Statistics Branch, Gulf Region.

Catch-at-age

As in the 1989 fishery assessment, catch-at-age matrices were calculated by age of recruitment for each species. Catch-at-age from the two-stage sampling of the commercial fishery was estimated using the method of projecting within weekly intervals by location, followed by summing across weeks (project and add method). This method used daily logbook catch from a location to weight the sample for the particular day.

Species segregated length samples, weighted by the logbook catch by species for that day, were processed for age composition using weekly age-length keys (Monday to Saturday samples) by location and projected to catch for the week using the total logbook catch for that week. Weeks were aggregated first, the resultant catch matrix by location was multiplied by a conversion factor (ratio of total purchase slip catch to total logbook catch for that location) and catches summed across locations to arrive at the final catch-at-age matrix. The catch-at-age matrix was adjusted such that the crossproducts of the numbers at age and weight at age summed to landings for the year.

Abundance index

An abundance index was calculated using catch and effort information from logbooks which was analysed using the multiplicative model approach of Gavaris (1980). The catch on a given day was partitioned by species in the following manner:

1. For the years 1982 to 1988, the species proportions by weight were estimated from the sampled catch at the Millbank trapnet and applied to all logbooks from all areas.

2. In 1989, the proportion by weight of species in the logbook catch from Chatham and Newcastle was partitioned using the species proportions from the two-phase stratified sampling at each location. Catch from days without samples was partitioned from the mean proportion in the sampled days before and after. Catches at the beginning of the season, without sampling information, were partitioned using the first sampled day proportions. Sampling of the Loggieville fishery was not as intense as at Chatham and Newcastle and proportions by weight from the Millbank trapnet were used to partition the catch from this zone.

3. In 1990, proportion by weight of species in the logbook catch from Chatham, Loggieville and Newcastle was partitioned using the species segregated proportions from the two-phase stratified sampling at each location. Catch from days without samples was partitioned from the mean proportion in the sampled days before and after. Catches at the beginning of the season, without sampling information, were partitioned using the first sampled day proportions.

The catch rate model was fitted using SAS GLM procedures and model diagnostics were obtained using SAS REG procedures (SAS 1985). These diagnostics included influence statistics using the DFFITS calculation which estimates the change in the parameter coefficients when an observation is left out relative to when the observation is included in the model. Cumulative probability plots of residuals were used to assess the normality of the residuals. These procedures are described by Neter et al. (1983) and Freund and Littell (1986). The annual abundance index was estimated from the multiplicative model solutions, using the transformation equation described by Gavaris (1988) which corrects for the standard errors.

Parameters which were considered potentially important in explaining the variance in catch rates over time were year and location on the river (Loggieville, Chatham and Newcastle).

Natural mortality

A non-inriver fishing mortality component, calculated as Mc = 0.44 during the first spawning migration and Mc = 1.05 for subsequent spawning years (Chaput and Alexander 1989), was assumed for both alewife and blueback herring, as in previous assessments.

Cohort analysis

Cohort analysis was performed under Type I fishery assumptions, i.e., the natural mortality occurs at a time of year other than the fishing season and the population decreases during the fishing season as a result of catch removals only. For convenience, the biological year begins when the fishing commences and natural mortality occurs after fishing ends (Ricker 1975: p.10-11). The cohort model utilized in this document uses a modification of the catch equations documented by Rivard (1982). Specifically, population numbers of the last age group are considered equal to the catch and fishing is complete. The population numbers refer to numbers just prior to the beginning of the fishery. Cohort analysis of the alewife population was performed for 3 and 4 year-old recruits whereas three recruited age groups 3, 4 and 5 were estimated for blueback herring. This type of analysis eliminates the requirement of a partial recruitment vector since in each simulation, all the fish included are fully recruited to the fishery. Alewife, 2 and 5 year-old recruits, and blueback herring aged as 2 and 6 year-old recruits, constituted a minor component of the population and are not considered further.

Cohort analysis and tuning using 'ADAPT' was also done, together with a brief comparison of the results.

Yield-per-recruit

A yield per recruit analysis, by the method of Thompson and Bell (Rivard 1982) has been performed in the 1989 assessment for alewife and blueback by age of recruitment, under the assumptions of Type I fisheries and using the Mc values previously mentioned (Chaput and LeBlanc 1990). $F_{0.1}$ values for alewife were approximately 1.05 and for blueback herring approximately 1.01.

RESULTS

Species composition

Species segregated length samples were taken by location every 2 to 3 days from May 29 to June 18 (Table 1). The Loggieville site was sampled less often due to its fewer number of fishermen and lower landings. In the stratified samples of the commercial fishery, alewife ranging in age from 2 to 8 years were found. Blueback ranged in age from 3 to 9 years (Table 2).

Species composition (by weight) was compared by location; prior to May 29, gaspereau in the Miramichi were exclusively alewife followed by a gradual movement of blueback into the system, with the alewife proportion remaining over 74% until June 7 (Table 3). As of June 8, the proportions varied among locations with Loggieville remaining stable at 47 to 51% alewife, while Newcastle proportions stayed over 60% alewife until June 12. Chatham species composition stayed over 50% alewife except for June 11.

Catch description

The catch of gaspereau from Districts 71 and 72 landings from Newcastle, Chatham and Loggieville in 1990 was estimated at 1,789 tons. This is similar to the 5 and 10 year arithmetic means, lower than the historical mean and within the 95% confidence intervals of all period estimates (Table 4). Landings from the Napan Bay region were not estimated. The districts 71 and 72 fisheries remain the dominant gaspereau fishery in Gulf New Brunswick and have constituted almost 60% of the total gaspereau landings of the Gulf Region since 1978 (Table 5).

Logbooks were returned by 12 of 17 fishermen in 1990, 7 from district 71 and 5 from district 72, which necessitated the use of a conversion factor of 1.558 for estimating total effort for the river (Table 6). Catch per unit effort (CPUE, kg of gaspereau per hour of fishing) was the second highest recorded in the past 9 years. The maximum daily landing of gaspereau for district 71 (Chatham and Loggieville) and district 72 (Newcastle) was recorded on June 9. The 1990 gaspereau catch was estimated to consist of 61% alewife by weight based upon the commercial fishery sampling.

Catch-at-Age matrices

The catches-at-age (number) for alewife and blueback herring are presented, by age of recruitment, for the years 1982 to 1990 (Table 7a,b). The total gaspereau catch in 1990 was estimated at 7.67 million fish.

In 1990, 62.9% of the total number of gaspereau caught were alewives (Table 7a). The 1987 year-class was the dominant component of the alewife catch (79.4% by number). Percent new recruits (FSP) was the highest of the previous 9 years (85.3%) mainly because of the 1987 year-class (3 year-old new recruits). The contribution by the 3 year-old fish to the total number was the highest ever; the lowest was in 1989 (7.8%) while the second highest contribution by that age group was recorded in 1986 (72.9% of total) (Table 7a).

Blueback accounted for 37.1% of the total number. The 1984 year class was the dominant component of the blueback catch in 1990 (34.2% by number) replacing the 1983 year-class which had been dominant for the last three years (Table 7b). Percent new recruits was low (34.4%), mainly because the 1986 year-class (4 year old) was weak. The combined contribution by the 3 year-old and 4 year-old fish to the total number was 28.6%; the lowest value was in 1982 (20%) while the highest contribution by those age groups was recorded in 1987 (80.5% of total) (Table 7b).

Weight at age matrix

The weight at age matrix for alewife and blueback from 1982 to 1990 is presented in Table 8. In all years, mean weights at age were calculated using the measured weights of individual fish.

Catch rates

Catch and effort data for the period encompassing the 5 to 100% catch by species in any given year were used; the first 5% of catch requires more effort at the beginning of the season when the fish are gradually starting to migrate. CPUE was calculated as the quotient of total catch (kg) to total effort (hours of trapnet effort) for each logbook fisherman. Natural log of CPUE, by species, was used as the dependent variable in the model.

Alewife catch rate

The first model run using all available logbook reports (N=121) and only year as the independent variable explained 40% of the total variance. From the first run, 3 observations were estimated as having unaccepatble influence and were removed. Second and third runs with removal of 6 more observations resulted in an explained variance of 52%. The inclusion of the location variable in the model increased the R-square value to 0.55. The final model (Table 9), estimated with 112 observations, generated the following progression of catch rates for alewife:

1983 < 1985 < 1982 < 1989 < 1984 < 1988 < 1986 < 1987 < 1990 (Fig. 3).

Normal probabilty plot of the residuals confirmed the normality assumption (Fig. 4). Influence diagnostics of this final model did not reveal an unbalanced distribution of observations with high DFFITS values (Fig. 4). The backtransformed values are summarized as follows:

Year	N	mean kg/hr	Std error	C.V.
1982	21	46.47	4.57	10%
1983	16	35.04	3.84	11%
1984	17	55.67	6.14	11%
1985	16	45.10	5.05	11%
1986	9	84.35	11.85	14%
1987	7	126.15	20.54	16%
1988	8	55.92	8.56	15%
1989	8	54.10	8.10	15%
1990	10	131.46	17.76	14%

Blueback herring catch rate

The first run using all available logbook reports (N=119) and only year as the independent variable explained 54% of the total variance. From the first and subsequent runs, a total of 8 observations were omitted because of unacceptable influence, resulting in an explained variance of 65%. The inclusion of the location variable in the model increased the R-square value minimally to 0.67. Another 4 observations were omitted, resulting in an explained variance of 71%. The final model (Table 10), estimated with 107 observations, generated the following progression of catch rates for blueback herring:

1984 < 1983 < 1982 < 1986 < 1990 < 1988 < 1987 < 1989 < 1985 (Fig. 3)

Normal probabilty plot of the residuals confirmed the normality assumption (Fig. 5). Influence diagnostics of this final model did not reveal an unbalanced distribution of observations with high DFFITS values (Fig. 5). The backtransformed values are summarized as follows:

Year	N	mean kg/hr	Std error	C.V.
1982	21	57.22	5.72	10%
1983	16	55.52	5.60	11%
1984	17	45.41	4.93	11%
1985	16	189.25	21.38	11%
1986	9	80.53	12.34	15%
1987	7	172.71	29.40	17%
1988	8	153.36	25.93	17%
1989	8	187.32	25.93	14%
1990	10	119.51	15.09	13%

Cohort analysis

Tuning

The multiplicative model used for tuning the 1990 fishing mortality (F) values incorporated catch rates from logbook reports as the abundance index. The best models were obtained by using a log-log relationship. Such a model makes intuitive sense for the Miramichi fishery. The model has a zero intercept term, thus 0 population corresponds to 0 abundance. Secondly, this model describes a trend where catch rates tend towards an asymtotic value in spite of increasing population size. The gaspereau nets are of finite size and are fished at most twice per day at tide changes. Gear saturation would, therefore, be a factor limiting the catch rates during periods of high population numbers.

Combinations of population biomass values were regressed on abundance index to find the best fit value of F giving minimal sum of squared resisuals with all years included as well as for 1988 to 1990 residuals only.

Alewife

The best fits were obtained with the log-log relationships of 3 year-old recruited biomass on 3 year-old recruited catch rate and combined 3 and 4 year-old recruited biomass on 3 and 4 year-old recruited catch rate. The sum of squared residuals for all years included, and with the last three years only, gave an F of 0.5 with 3 year-old recruits and 0.6 to 0.65 with combined 3 and 4 year-old recruits (Table 11). The F of 0.6 with the combined 3 and 4 year-old recruits was chosen as more representative of the population. The selection of 0.6 over 0.65 as an F was done because we had no reason to weight some catch rates more than others. C.V.'s of the catch rates were similar for all years, thus, the minimum sum of squared residuals for all years included was chosen. The regression plot for the combined 3 and 4 year-old recruited relationship with F=0.6 and R-square of 0.63 is shown in figure 6. The 1990 value was at the upper extreme of the catch rate values and its population biomass value situated within the upper cluster.

Approximately 10.6 million alewife entered the Miramichi River between May 15 and June 18, 1990 (Table 12) which is the third highest number for the last nine years. Alewife from the 3 year-old recruitment constitued 86% of the numbers in 1990, the highest proportion, equal with 1986, of the last nine years. The 1987 year-class , 3 year-old recruits, represents 80% of the total number (8.5 million) and is the highest proportion of 3 year-old recruits for the years analysed. Estimated fishing mortality on alewife is higher for the 4 year-old recruitment (Table 12).

Blueback

The best fits were obtained with the log-log relationships of 4 year-old recruited biomass on 4 year-old recruited catch rate, 5 year-old recruited biomass on 5 year-old recruited catch rate and combined 4 and 5 year-old recruited biomass on 4 and 5 year-old recruited catch rate. With all years included, all combinations generated a minimum sum of squared residuals at F=0.35, while the minimum sum of squared residuals with the last 3 years included varied in F value. The regression plot for the combined 4 and 5 year-old recruited relationship with F=0.35 and R-square of 0.62 is shown in figure 6. The 1990 value was at midrange of the catch rate values, its population biomass value was situated within the lower cluster (Fig. 6).

Approximately 9.6 million blueback entered the Miramichi River between May 29 and June 18, 1990 (Table 13) which is less than all other years except 1983. Blueback from the 4 year-old recruitment constitued 71% of the numbers in 1990. The 3 year-old recruitment in the previous two years has been low; such low population values have not been estimated during the previous seven years (Table 13). The 1986 year-class, recruited as 3 and 4 year-olds, is the weakest (1.3 million blueback), while the strongest year-class currently in the fishery is 1984 with 3.3 million. Estimated fishing mortality on blueback herring is very low, except for 5 year-old recruited blueback (Table 13). Blueback population numbers are, at best, estimates of the numbers up to and including June 15 to 18, depending on the year. Total blueback herring population entering the system would be larger.

Cohort analysis and tuning using 'ADAPT' was completed and provided results which were similar to the linear regression calibrations. Alewife 3 year-old recruit and 4 year-old recruit matrices converged after 11 and 17 iterations respectively. The similarity of the results lends some confidence to the population numbers and estimated F's obtained from linear regression tuning (Table 12).

Blueback 3, 4 and 5 year-old recruit matrices converged after 23, 43 and 12 iterations respectively. Terminal F values were not different from the regression tuning results, but indicated that fishing mortality on blueback was approximately half to two-thirds than alewife mortality (Table 13).

PROGNOSIS

The alewife catch rate in 1990 (131.5 kg/hour of trap effort) was the highest catch rate since 1982 and was higher than the blueback catch rate (119.5 kg/hour of trap effort). The catch of 3 year-old alewife new recruits was the highest estimated number of the past nine years and the main component of this high catch rate (79% of total). Alewife catch in 1991 will be sustained mainly by this 1987 year-class, as the 1986 year-class is weak. If new recruitment is average, then catches of alewife would probably be equal or higher than average.

Estimated fishing mortalities on alewife are below estimated $F_{0.1}$. The strong year-class (1987) entering the fishery will result in normal total escapement in 1991. Of the two species exploited, the alewife is exposed to the highest level of fishing effort; nets are deployed during their entire spawning migration. Fishing effort on alewife should not be increased above present levels and weekend closures during May should be kept to maintain spawning escapement, especially of previous spawners.

Blueback herring catches in the last three years had been sustained by the 1983 year-class which was not a major component of the 1990 catch. Rather, the 1984 year-class dominated, followed closely by the 1985 year-class. The 1986 year-class is weak while the 1987 year-class (3 year-old recruits) appears to be average. The catch of blueback herring in 1991 will depend on the timing of migration and proportion of new recruits.

Blueback herring are usually more abundant than alewife, and because of the later spawning migration, are exposed to a lower level of fishing mortality. This species could sustain a higher level of exploitation. Rather than issuing new licenses, the elimination of weekend closures during June to allow a higher exploitation on the blueback component could be considered. Alternatively, a one week delay in the opening of the season with the addition of an extra week in June would reduce the exploitation rate on alewife and increase it on blueback herring.

PART B: OTHER NEW BRUNSWICK RIVERS

In order to obtain data on population structure, species composition, catch rates and timing of spawning migration, sampling of three other New Brunswick gaspereau commercial fisheries was conducted in 1989 and 1990. They were the Richibucto, Tracadie and Pokemouche rivers. Richibucto River is the second most important gaspereau fishery river in New Brunswick, followed by the Pokemouche and Tracadie rivers. The fishing season extends from May 15 to June 30. A one day per week closure has been enforced during the period from 12:00 hours on Saturday till 18:00 hours on Sunday (i.e. nets had to be tied up, out of the water for those time periods).

METHODS

A two-stage stratified sampling program similar to the Miramichi River sampling was carried out. Length samples, consisting of approximately 170-250 measurements, with species identification done (1990 only) on the basis of external appeareance and peritonial colour, plus a detailed sample of 2-4 fish per species per one-half centimeter length group were obtained from the three river's landing locations. Detailed samples were generally frozen for later processing which was done in the same manner as described for the Miramichi samples.

Logbooks collected from individual fishermen were processed for catch and effort (hours) by river. Reports of 0 effort or 0 catch were deleted from further analysis. Total catch for 1989 and 1990 was calculated from purchase slip, by river, collated by Statistics Branch, Gulf Region.

Catch-at-age matrices were calculated by age of recruitment for each river and year. Catch-at-age from the two-stage sampling of the commercial fishery was estimated using the method of projecting within determined intervals followed by summing across intervals (project and add method). This method used daily logbook catch to weight the sample for the particular day for all rivers except for the 1990 Richibucto catch-at-age which was projected directly on purchase slip totals because of poor logbook returns.

RESULTS

Annual landing statistics from 1968 to 1990 for the three rivers (Table 14) show that 1990 landings were within the 95% confidence interval of the mean for all sites, while that 1989 had higher values.

Richibucto River

Catch of gaspereau from District 76 was estimated at 408 tons in 1990 and 803 tons in 1989 (Table 14). Species composition, by number, was 75% alewife in 1989 and 89% alewife in 1990 (Table 15). In the stratified sampling of the fishery, alewife ranging from 2 to 7 years-old were found both years. In 1989, blueback herring ranged in age from 2 to 8, but without any 7 year-old, and from 3 to 6 years-old in 1990. These differences could be due to the less intensive sampling in 1990. Timing of mean gaspereau catch per fisherman based on purchase slip estimates is summarized in figure 7. The maximum daily landing of gaspereau was recorded on June 24 in 1989 and June 19 in 1990.

The catches-at-age (number) for alewife and blueback herring are presented, by age of recruitment, for the years 1989 and 1990 (Table 15). Total gaspereau catch in 1990 was estimated at 1.9 million individuals and 2.2 million in 1989.

The 1987 year-class was the dominant component of the alewife catch in 1990 (94.4% by number), while the 1985 year-class was dominant in 1989 (45.4%). Percent new recruits (FSP) was very high (97.8%) in 1990 mainly because of the 1987 year-class (3 year-old new recruits) (Table 15).

Blueback accounted for 25% by number in 1989 and only 11% in 1990. The 1986 year class was the dominant component of the blueback catch in 1990 (42.9% by number), while the 1985 year-class dominated in 1989 (73.7%). Percent new recruits was 75.1% in 1989 mainly because of the 1985 year-class (4 year-old), while the percentage dropped to 57.7% in 1990 because of the weaker 1986 year-class (Table 15).

Tracadie River

The catch of gaspereau from District 68 was estimated at 88.2 tons in 1990 and 187.4 tons in 1989 (Table 14). Species composition by number was 95% alewife in 1989 and 96% alewife in 1990 (Table 16). Thus, only alewife was considered for the catch-at-age analysis. In the stratified samples of the fishery, alewife ranging in age from 2 to 7 were found in 1989 and from ages 3 to 6 in 1990. These differences could be due to the less intensive sampling in 1990. The maximum daily landing of gaspereau was recorded on June 17 in 1989 and June 18 in 1990 (Figure 8), based on catch and effort logbook estimates.

The catches at age (number) for alewife are presented, by age of recruitment, for the years 1989 and 1990 (Table 16). Total gaspereau catch in 1990 was estimated at 372 thousand individuals and 738 thousand in 1989.

The 1987 year-class was the dominant component of the alewife catch in 1990 (70.7% by number), while the 1985 year-class was dominant in 1989 (63.6%). Percent new recruits (FSP) was high (77.8%) in 1990 mainly because of the 1987 year-class (3 year-old new recruits) (Table 16).

Pokemouche River

Catch of gaspereau from District 67 was estimated at 280 tons in 1990 and 442 tons in 1989 (Table 14). Species composition by number was 94% alewife in 1989 and 95% alewife in 1990 (Table 17). Thus, only alewife was considered for the catch-at-age analysis. In the stratified samples of the fishery, alewife ranging in age from 3 to 7 were found in 1989 and from ages 3 to 8 in 1990. The maximum daily landing of gaspereau was recorded on June 5 in 1989 and June 11 in 1990 (Figure 8).

The catches-at-age (number) for alewife are presented, by age of recruitment, for the years 1989 and 1990 (Table 17). Total gaspereau catch in 1990 was estimated at 1.2 million individuals and 1.7 million in 1989.

The 1987 year-class was the dominant component of the alewife catch in 1990 (77.7% by number), while the 1985 year-class was dominant in 1989 (76.9%). Percent new recruits (FSP) was high (85.4%) in 1990 mainly because of the 1987 year-class (3 year-old new recruits) (Table 17).

Discussion

Species composition in the Pokemouche and Tracadie rivers is approximately 95% alewife, while the Richibucto River had 75% alewife in 1989 and 89% in 1990. These differ substantially from the Miramichi River, which has an important blueback herring population. Timing of the spawning migrations is different between rivers. The Pokemouche River has peak runs at about the same time as the Miramichi River (5-10 June), while the Tracadie River peaks around the 18th or later and the Richibucto River around the 20th of June or later.

The catch of 3 year-old alewife new recruits was very high for all three rivers in 1990, ranging from 70 to 94% of total estimated numbers. The alewife catch in 1991 will be sustained mainly by this 1987 year-class, as the 1986 year-class is weak. If new recruitment is average, then catches of alewife would probably be equal to or higher than average.

The 1990 alewife catch-at-age of all three rivers were similar to the Miramichi River catch-at-age composition. All these river's catches were heavely dependent on the 1987 year-class (3 year-old new recruits) and consequently, the percentage of first time spawners was high. They also had a very weak 1986 year-class (4 year-olds) which made the 1990 fishery almost entirely dependent on one year-class. Fortunately, this 1987 year-class was a strong one and upheld a fair level of catches.

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Table 1. Dates, locations and size (numbers) of length samples of alewife and blueback from the Miramichi River, 1990.

Date		Loggieville		Chatham		Newcastle		Total
		Alewife	Blueback	Alewife	Blueback	Alewife	Blueback	
MAY	18	0	0	53	0	0	0	53
	29	0	0	146	0	152	0	298
JUNE	1	144	1	156	6	167	2	476
	4	0	0	192	6	192	8	398
	6	0	0	199	12	229	8	448
	8	109	90	139	44	122	54	558
	11	0	0	120	98	193	72	483
	13	128	119	150	81	98	129	705
	15	0	0	210	68	156	96	530
	18	130	122	145	118	93	149	757
Total		511	332	1510	433	1402	518	4706

Table 2. Numbers of gaspereau aged, by species, from the stratified sampling of the Miramichi River commercial fishery, 1990.

	Total age	Recruit age	Commercial fishery stratified sampling			Total
			Loggieville	Chatham	Newcastle	
ALEWIFE						
	2	2	.	1	.	1
	3	3	75	173	181	429
	4	3	1	8	1	10
		4	12	29	35	76
	5	3	13	53	36	102
		4	30	91	71	192
		5	.	8	1	9
	6	3	5	17	12	34
		4	12	33	25	70
		5	.	2	1	3
	7	3	3	1	5	9
		4	3	6	9	18
		5	.	1	5	6
	8	3	.	.	1	1
		4	.	1	.	1
Total alewife			163	424	387	974
BLUEBACK						
	3	3	9	21	14	44
	4	4	2	18	20	40
	5	3	.	2	1	3
		4	16	24	22	62
		5	3	2	7	12
	6	3	4	4	8	16
		4	25	62	62	149
		5	2	6	6	14
	7	3	.	.	2	2
		4	12	27	45	84
		5	.	1	5	6
	8	4	.	1	7	8
	9	4	.	.	2	2
Total blueback			130	217	221	568
Total			293	641	608	1542

Table 3. Percentage (by weight) of alewife in the daily logbook catch from the Miramichi River, 1990. For days on which no fishing occured or no samples were collected, percentage was estimated using mean proportions of previous and following days.

		Commercial fishery		
		Loggieville	Chatham	Newcastle
May	16	100.0	.	.
	17	100.0	.	100.0
	18	100.0	100.0	100.0
	19	100.0	100.0	100.0
	21	100.0	100.0	100.0
	23	100.0	100.0	100.0
	24	100.0	100.0	100.0
	25	100.0	100.0	100.0
	26	100.0	100.0	100.0
	28	100.0	100.0	100.0
	29	100.0	100.0	100.0
	30	100.0	97.2	98.9
	31	100.0	97.2	98.9
June	1	99.1	94.3	97.7
	2	74.4	94.8	95.6
	4	74.4	95.3	93.5
	5	82.6	93.6	94.6
	6	74.4	91.8	95.8
	7	74.4	82.1	81.0
	8	49.6	72.4	66.1
	9	48.7	60.8	64.3
	11	48.7	49.2	62.5
	12	48.7	54.9	49.2
	13	47.7	60.5	35.9
	14	49.5	66.4	46.4
	15	49.5	72.3	56.9
	16	49.5	64.5	45.6
	17	49.5	64.5	45.6
	18	51.3	56.6	34.4

Table 4. Annual landings for the Miramichi River gaspereau fishery 1950-1990 (districts 71 and 72).

Year	Landings (metric tons)	
1950	4,952	
1951	8,014	
1952	11,381	
1953	8,026	
1954	4,649	
1955	3,413	
1956	3,009	
1957	884	
1958	816	
1959	1,596	
1960	716	
1961	161	
1962	733	
1963	543	
1964	119	
1965	425	
1966	746	
1967	532	
1968	436	
1969	175	
1970	874	
1971	469	
1972	468	
1973	967	
1974	271	
1975	141	
1976	406	
1977	2,240	
1978	1,434	
1979	3,343	
1980	3,767	
1981	1,410	
1982	1,278	
1983	1,088	
1984	665	
1985	1,857	
1986	1,154	
1987	2,145	
1988	1,888	
1989	1,682	
1990	1,789 *	
Means (95% C.I.)		
Historical	1,978	(1,308 - 2,627)
10 Year	1,718	(1,188 - 1,804)
5 Year	1,794	(1,326 - 2,138)

* 1990 preliminary estimate based on purchase slip total and does not include the Napan area.

Table 5. Landings of gaspereau for the Gulf Region, 1978 to 1989. Data summarized from purchase slip and Supplementary 'B' slips collated by Statistics Branch, DFO.

	New Brunswick Statistical Districts						Total Landings (metric tons)			
Year	63-65	66-70	71-72	73-75	76	77-80	NB	NS	PEI	Gulf
1978	0.9	781.0	1,433.7	200.0	566.4	102.1	3,084.1	1,911.0	104.2	5,099.4
1979	33.2	413.4	3,343.1	343.4	212.8	62.9	4,408.7	2,023.4	405.3	6,837.4
1980	105.0	237.3	3,767.2	218.5	237.0	111.0	4,676.0	2,167.4	253.2	7,096.5
1981	320.3	128.4	1,410.9	143.2	564.3	140.9	2,708.0	1,653.5	258.8	4,620.3
1982	45.2	149.6	1,277.6	193.4	314.1	13.8	1,993.7	1,663.6	132.9	3,790.2
1983	9.3	226.2	1,087.9	123.2	392.3	61.8	1,900.6	779.8	36.4	2,716.9
1984	.	205.2	666.1	196.5	506.5	142.5	1,716.9	1,052.4	87.9	2,857.2
1985*	5.0	465.4	1,341.9	136.5	1,427.4	193.0	3,569.2	3,203.3	238.4	7,010.9
1986	.	293.6	1,171.4	45.5	398.1	352.7	2,261.3	974.3	463.6	3,699.2
1987	.	620.4	2,208.7	141.0	1,152.2	296.8	4,419.2	2,558.6	364.2	7,342.0
1988	.	480.9	1,888.3	268.5	902.5	173.5	3,713.7	2,835.0	233.2	6,782.1
1989	7.6	629.6	1,681.7	431.8	803.3	127.4	3,681.4	2,115.5	132.5	5,929.4
Mean	43.9	385.9	1,773.2	203.5	623.1	148.2	3,177.8	1,910.5	225.9	5,314.1

* 1985 landings for districts 71-72 as per Statistics Branch data are lower than the Science Branch estimate for that year (see Table 8).

. no landings recorded

Table 6. Miramichi River catches reported through data from purchase slips and Supp 'B' slips collated by Statistics Branch DFO and through voluntary logbooks, 1981 to 1990, with resultant conversion factor and CPUE estimates.

	1981	1982	1983	1984	*1985	1986	1987	1988	1989	**1990
Total landings (mt) A	1410.9	1277.6	1087.9	666.1	1857.4	1171.4	2208.7	1888.3	1681.7	1788.5
Logbook catches (mt) B	1322.9	1108.4	829.2	612.2	1496	609.6	1077.3	691.3	1174.5	1148.1
Logbook effort (hrs)	12308	13148	14894	8857	10507	7450	7572	6166	6348	6378
Conversion factor A/B	1.067	1.153	1.312	1.088	1.242	1.922	2.050	2.732	1.432	1.558
Total effort (hrs)	13127	15155	19541	9637	13045	14316	15524	12105	9089	9936
CPUE (kg/hr)	107.5	84.3	55.7	69.1	142.4	81.8	142.3	112.1	185.0	180.0

* 1985 landings total used was one by Science Branch since Statistics Branch estimate was lower than logbook catches reported for that year.

**1990 preliminary landings estimate based on purchase slips and voluntary logbooks only.

Table 7a. Miramichi River alewife catch at age matrix (numbers of fish), 1982-1990. FSP = first time spawners.

Total Age	1982	1983	1984	1985	1986	1987	1988	1989	1990	CV (%) 1990
	Numbers of alewife									
Recruited at age 2										
2	88	3,372	442	0	0	0	0	510	2,501	.
3	0	2,998	0	0	0	0	0	0	0	.
4	0	0	2,914	0	0	0	0	0	0	.
5	0	0	0	0	0	0	2,205	0	0	.
6	0	0	0	0	0	0	0	0	0	.
7	0	0	0	0	0	0	0	0	0	.
8	0	0	0	0	0	0	0	0	0	.
Recruited at age 3										
3	476,996	648,450	1,070,590	767,926	2,345,873	644,357	635,441	213,827	3,832,752	1.0
4	512,276	234,132	146,091	386,590	286,470	1,440,508	446,532	372,259	26,354	33.9
5	609	32,675	68,132	56,831	151,799	242,523	404,010	389,031	150,938	12.3
6	6,892	0	16,625	0	0	66,394	30,355	145,617	57,965	21.1
7	3,522	0	0	0	0	0	0	906	16,386	39.9
8	0	8,203	0	0	0	0	0	159	2,451	.
9	0	1,156	4,141	0	0	0	0	0	0	.
10	0	191	0	0	0	0	0	0	0	.
11	631	0	0	0	0	0	0	0	0	.
Recruited at age 4										
4	487,639	782,317	553,192	687,357	299,466	1,408,619	620,082	776,520	254,267	10.4
5	130,479	62,669	63,102	113,236	118,662	391,723	308,847	553,205	295,240	8.8
6	143,367	39,749	24,958	0	16,014	122,139	21,373	217,380	113,121	14.8
7	43,161	16,464	0	0	0	24,679	2,869	1,534	25,688	30.4
8	81,564	22,757	0	0	0	0	0	113	1,326	.
9	0	11,090	0	0	0	0	0	0	0	.
10	0	289	0	0	0	0	0	0	0	.
11	0	6,281	0	0	0	0	0	0	0	.
Recruited at age 5										
5	0	21,180	0	0	1,046	11,426	88,472	28,501	25,115	32.7
6	0	15,941	65	0	0	5,598	7,410	31,756	8,856	52.7
7	7,661	5,730	0	0	0	0	0	3,512	12,479	40.9
8	2,282	2,971	0	0	0	0	0	0	0	.
9	0	31	0	0	0	0	0	0	0	.
10	0	264	0	0	0	0	0	0	0	.
Recruited at age 6										
6	0	0	0	0	0	0	0	0	0	.
7	0	5,314	0	0	0	0	0	0	0	.
8	0	27	0	0	0	0	0	0	0	.
Total	1,897,166	1,924,250	1,950,252	2,011,940	3,219,329	4,357,965	2,567,596	2,734,829	4,825,441	
Dominant Cohort	1978	1979	1981	1981	1983	1983	1984	1985	1987	
%	52.7	52.8	54.9	53.4	72.9	65.4	41.5	42.0	79.4	
% FSP	50.9	75.6	83.3	72.3	82.2	47.4	52.3	37.3	85.3	

Table 7b. Miramichi River blueback herring catch at age matrix (numbers of fish), 1982-1990. FSP = first time spawners.

	Numbers of blueback									CV (%)
Total Age	1982	1983	1984	1985	1986	1987	1988	1989	1990	1990
Recruited at age 2										
2	0	152	0	0	8,896	0	0	0	0	.
3	0	0	0	45,286	4,041	441	0	0	0	.
4	156	3,348	8,928	458,701	10,745	0	0	0	0	.
5	38,979	0	65	61,651	0	0	0	0	0	.
6	38,530	0	0	0	0	0	0	0	0	.
7	38,530	0	0	0	0	0	0	0	0	.
8	0	2,971	0	0	0	0	0	0	0	.
Recruited at age 3										
3	24,844	56,029	51,449	344,541	540,890	191,386	1,737	4,072	415,669	8.2
4	331	56,345	46,033	651,074	115,960	827,750	300,134	1,950	0	.
5	104,330	24,476	19,005	238,591	112,724	30,711	478,031	98,445	22,591	48.6
6	57,735	22,581	132	83,989	7,486	26,879	0	132,846	84,888	27.1
7	245,140	0	5,692	6,269	635	0	15,398	0	6,518	43.7
8	295	9,110	6,437	0	4,890	0	0	0	0	.
9	156	0	3,573	53,698	910	0	0	0	0	.
10	295	0	0	0	5,502	0	0	0	0	.
11	0	0	0	0	0	0	0	0	0	.
12	0	0	0	22,048	0	0	0	0	0	.
Recruited at age 4										
4	410,476	985,907	316,563	2,939,955	218,307	3,185,102	1,363,433	610,630	397,837	9.2
5	269,938	320,701	115,687	791,462	680,984	146,913	2,502,843	1,423,871	583,445	8.1
6	113,298	96,567	85,019	284,856	149,370	495,935	114,810	1,849,546	788,698	6.2
7	346,806	20,837	9,861	57,964	15,240	173,138	90,714	40,462	218,700	12.3
8	25,609	115,083	25,692	11,866	10,227	0	7,410	0	14,712	25.6
9	59,235	14,860	10,110	48,540	0	0	0	278	1,533	.
10	0	23,796	3,835	0	0	0	0	0	0	.
11	0	264	0	0	0	0	0	0	0	.
12	0	0	4,235	0	0	0	0	0	0	.
Recruited at age 5										
5	178,851	280,301	42,162	176,825	30,342	52,881	405,389	135,906	163,315	18.4
6	44,219	113,850	4,412	46,808	24,821	13,989	36,777	83,890	98,825	24.8
7	129,543	35,305	24,077	46,514	0	32,355	0	6,676	43,963	30.2
8	19,490	34,208	6,377	0	0	42,683	0	163	0	.
9	19,490	111	2,040	22,048	0	0	0	0	0	.
10	609	6,368	0	0	0	0	0	0	0	.
Recruited at age 6										
6	0	11,430	0	0	0	0	0	0	0	.
7	7,313	13,054	0	0	0	0	0	0	0	.
8	0	98	0	0	0	0	0	0	0	.
Total	2,174,197	2,247,751	791,382	6,392,686	1,941,971	5,220,163	5,316,677	4,388,735	2,840,700	0.6
Dominant Cohort	1975	1979	1980	1981	1981	1983	1983	1983	1984	
(%)	35.3	46.5	46.9	63.3	42.4	76.9	63.7	47.1	34.2	
% FSP	28.2	59.3	51.8	54.1	41.1	65.7	33.3	17.1	34.4	

Table 8. Mean weight (g) at age of alewife and blueback from the Miramichi River, 1982 to 1990.

Age	1982	1983	1984	1985	1986	1987	1988	1989	1990	Mean
Alewife										
1	-	53	-	-	-	-	-	-	-	53
2	132	112	134	122	119	-	-	122	139	126
3	249	225	213	210	208	218	231	185	197	215
4	321	279	276	262	273	245	267	281	257	273
5	343	339	329	286	307	296	286	298	328	312
6	398	314	340	-	291	296	321	325	337	328
7	406	402	-	-	-	312	542	401	362	404
8	494	391	-	-	-	-	-	383	402	418
9	554	420	525	-	-	-	-	-	-	500
10	-	348	-	-	-	-	-	-	-	348
11	634	383	-	-	-	-	-	-	-	509
Blueback										
2	-	107	-	124	130	-	-	-	-	120
3	176	172	157	166	166	164	166	142	162	163
4	213	209	193	194	204	189	202	192	178	197
5	242	260	233	237	235	228	234	232	237	238
6	333	299	287	290	265	247	274	270	277	282
7	369	383	330	305	305	275	293	324	303	321
8	382	375	384	344	364	334	-	377	332	362
9	351	379	390	393	327	390	-	397	346	372
10	353	392	353	-	356	-	-	-	-	364
11	-	335	-	-	-	-	-	-	-	335
12	-	-	485	381	-	-	-	-	-	433

Table 9. Multiplicative model of catch rate (kg/hr) of alewife from the Miramichi gaspereau fisheries, 1982 to 1990. Catch rates are calculated as quotient of total catch to total effort by logbook report by year for the 5 to 100% catch interval of alewife in a given year.

General Linear Models Procedure
Class Level Information

Class	Levels	Values
YY	9	82 83 84 85 86 87 88 89 90
LIEU	3	CHA LOG NEW

Number of observations in data set = 112

Dependent Variable: KGHR

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	10	19.50596945	1.95059695	12.17	0.0001
Error	101	16.19398907	0.16033653		
Corrected Total	111	35.69995852			

R-Square	C.V.	Root MSE	KGHR Mean
0.546386	10.34174	0.40042044	3.87188753

Source	DF	Type I SS	Mean Square	F Value	Pr > F
YY	8	18.51299253	2.31412407	14.43	0.0001
LIEU	2	0.99297693	0.49648846	3.10	0.0495

Source	DF	Type III SS	Mean Square	F Value	Pr > F
YY	8	18.45118812	2.30639851	14.38	0.0001
LIEU	2	0.99297693	0.49648846	3.10	0.0495

Parameter		Estimate	T for H0: Parameter=0	Pr > |T|
INTERCEPT		4.679289954	34.67	0.0001
YY	82	-1.044286976	-6.79	0.0001
	83	-1.325547154	-8.21	0.0001
	84	-0.862436477	-5.40	0.0001
	85	-1.072827229	-6.64	0.0001
	86	-0.443029224	-2.41	0.0179
	87	-0.037085007	-0.19	0.8526
	88	-0.852148633	-4.48	0.0001
	89	-0.887258934	-4.67	0.0001
LIEU	CHA	0.127695840	1.50	0.1365
	LOG	-0.132973229	-1.24	0.2174

Table 10. Multiplicative model of catch rates of blueback herring in the Miramichi gaspereau fishery, 1982 to 1990. Catch rates (kg/hr) are calculated from the quotient of total catch of blueback herring to total hours fished by logbook report for the 5 to 100% catch interval of blueback in any year.

General Linear Models Procedure
Class Level Information

Class	Levels	Values
YY	9	82 83 84 85 86 87 88 89 90
LIEU	3	CHA LOG NEW

Number of observations in data set = 107

Dependent Variable: KGHR

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	10	36.39346172	3.63934617	23.48	0.0001
Error	96	14.88251299	0.15502618		
Corrected Total	106	51.27597472			

R-Square	C.V.	Root MSE	KGHR Mean
0.709757	9.125627	0.39373364	4.31459249

Source	DF	Type I SS	Mean Square	F Value	Pr > F
YY	8	35.36504039	4.42063005	28.52	0.0001
LIEU	2	1.02842133	0.51421066	3.32	0.0405

Source	DF	Type III SS	Mean Square	F Value	Pr > F
YY	8	33.42328659	4.17791082	26.95	0.0001
LIEU	2	1.02842133	0.51421066	3.32	0.0405

Parameter		Estimate	T for H0: Parameter=0	Pr > |T|
INTERCEPT		4.581110333	35.49	0.0001
YY	82	-0.739436461	-5.00	0.0001
	83	-0.768777557	-4.98	0.0001
	84	-0.969784265	-6.35	0.0001
	85	0.458113533	2.92	0.0044
	86	-0.390773309	-2.04	0.0437
	87	0.374932483	1.86	0.0659
	88	0.255910354	1.28	0.2048
	89	0.451083104	2.55	0.0125
LIEU	CHA	0.131968099	1.54	0.1266
	LOG	-0.136479876	-1.24	0.2192

Table 11. Tuning diagnostics for Miramichi alewife and blueback herring fishing mortality, 1990.

Species	Recruit Group	F	Sum of Sq. Res. All Years	Sum of Sq. Res. 88-90	Slope Signif.	R-sqare
Alewife	3	0.35	0.7189	0.4358	**	0.817
		0.40	0.6697	0.4018	**	0.819
		0.45	0.6477	0.3855	**	0.816
		0.50	0.6432 @	0.3806 @	**	0.811
		0.55	0.6503	0.3834	**	0.802
		0.60	0.6648	0.3910	**	0.793
		0.65	0.6842	0.4020	**	0.782
		0.70	0.7068	0.4151	**	0.771
	4	no slopes were significantly different from 0				
	3 & 4	0.35	0.9593	0.6116	**	0.671
		0.40	0.8867	0.5569	**	0.669
		0.45	0.8435	0.5224	**	0.663
		0.50	0.8199	0.5014	**	0.654
		0.55	0.8095	0.4896	**	0.642
		0.60	0.8082 @	0.4842	*	0.629
		0.65	0.8133	0.4834 @	*	0.615
		0.70	0.8229	0.4858	*	0.601
Blueback Herring	3	no slopes significantly different from 0				
	4	0.10	2.5072	0.8432	**	0.694
		0.15	1.7682	0.6521	**	0.705
		0.20	1.4305	0.5953 @	**	0.704
		0.25	1.2686	0.5969	**	0.693
		0.30	1.1967	0.6274	**	0.675
		0.35	1.1751 @	0.6727	**	0.653
		0.40	1.1830	0.7257	*	0.628
		0.45	1.2088	0.7822	*	0.602
		0.50	1.2454	0.8399	*	0.576
	5	0.15	2.3965	0.5198	*	0.563
		0.20	1.9833	0.2750	*	0.569
		0.25	1.7879	0.1561	*	0.562
		0.30	1.7007	0.1010	*	0.547
		0.35	1.6726 @	0.0813 @	*	0.528
		0.40	1.6784	0.0824	*	0.507
		0.45	1.7043	0.0962	*	0.486
		0.50	1.7421	0.1176	*	0.465
	4 & 5	0.15	1.6390	0.5651	**	0.688
		0.20	1.3133	0.5122 @	**	0.684
		0.25	1.1570	0.5141	**	0.669
		0.30	1.0876	0.5432	**	0.647
		0.35	1.0666 @	0.5865	*	0.620
		0.40	1.0743	0.6370	*	0.590
		0.45	1.0992	0.6910	*	0.559
		0.50	1.1345	0.7461	*	0.529
	3 & 4 & 5	0.10	2.4116	0.7530	*	0.563
		0.15	1.6236	0.5490	*	0.567
		0.20	1.2724	0.4911 @	*	0.556
		0.25	1.1101	0.4959	*	0.531
		0.30	1.0431	0.5310	*	0.497
		0.35	1.0285 @	0.5816	*	0.458
		0.40	1.0444	0.6398	NS	0.417
		0.45	1.0783	0.7015	NS	0.377
		0.50	1.1228	0.7641	NS	0.340

@ Minimum value ** P<0.01 * P<0.05 NS=not significant

Table 12. Prefishery population numbers of alewife and values of F by recruitment age, estimated from Type I cohort analysis, 1990.

Age	1982	1983	1984	1985	1986	1987	1988	1989	1990	from ADAPT
Population number recruited at age 3										
3	1,142,892	1,127,500	3,186,288	2,712,308	8,904,108	4,692,839	2,697,811	304,521	8,494,794	
4	741,436	428,861	308,526	1,362,589	1,252,253	4,223,742	2,607,370	1,328,241	58,410	
5	34,428	80,192	68,143	56,842	341,538	337,964	973,959	756,159	334,534	
6	34,183	11,835	16,628	4	4	66,397	33,398	199,447	128,472	
7+	4,153	9,550	4,141	1	1	1	1	1,065	18,837	
3+	1,957,092	1,657,938	3,583,726	4,131,744	10,497,904	9,320,943	6,312,539	2,589,433	9,035,047	
from ADAPT	1,957,092	1,657,938	3,583,726	4,131,744	10,497,904	10,055,083	6,775,128	2,825,469	9,463,057	
Fishing Mortality (F)										
3	0.54	0.86	0.41	0.33	0.31	0.15	0.27	1.21	0.60	0.57
4	1.17	0.79	0.64	0.33	0.26	0.42	0.19	0.33	0.60	0.28
5	0.02	0.52	8.73	8.55	0.59	1.27	0.54	0.72	0.60	0.61
6	0.23	8.45	8.67	0.30	0.30	10.05	2.40	1.31	0.60	0.37
3+	0.76	0.87	0.63	0.44	0.31	0.38	0.29	0.62	0.60	
from ADAPT	0.77	0.82	0.63	0.45	0.31	0.35	0.27	0.54	0.56	
Population number recruited at age 4										
4	695,736	880,349	1,113,028	1,454,019	1,070,028	3,574,609	2,591,507	1,792,551	563,550	
5	244,099	134,022	63,136	360,555	493,758	496,270	1,394,977	1,269,669	654,361	
6	190,424	39,760	24,969	12	86,546	131,260	36,585	380,078	250,718	
7	108,193	16,467	4	4	4	24,682	3,192	5,323	56,934	
8+	81,564	22,757	1	1	1	1	1	113	1,326	
4+	1,320,016	1,093,355	1,201,138	1,814,591	1,650,337	4,226,822	4,026,262	3,447,734	1,526,889	
from ADAPT	1,320,016	1,093,355	1,201,138	1,814,591	1,650,337	4,176,956	3,831,145	3,497,523	1,851,274	
Fishing Mortality (F)										
4	1.21	2.20	0.69	0.64	0.33	0.50	0.27	0.57	0.60	0.37
5	0.77	0.63	7.52	0.38	0.27	1.56	0.25	0.57	0.60	0.49
6	1.40	8.19	7.73	0.09	0.20	2.67	0.88	0.85	0.60	0.75
7	0.51	8.66	0.30	0.30	0.30	9.06	2.29	0.34	0.60	0.66
4+	1.02	2.28	1.20	0.59	0.31	0.74	0.27	0.60	0.60	
from ADAPT	1.09	2.32	1.19	0.59	0.31	0.75	0.28	0.59	0.47	
Population number, ages combined										
	3,277,108	2,751,293	4,784,864	5,946,335	12,148,241	13,547,765	10,338,801	6,037,167	10,561,936	

Table 13. Prefishery population numbers of blueback herring and values of F by recruitment age, estimated from Type I cohort analysis, 1990.

	Year									
Age	1982	1983	1984	1985	1986	1987	1988	1989	1990	from ADAPT
Recruited at age 3										
3	1,694,137	1,281,112	2,461,293	660,909	5,867,830	4,739,013	344,197	4,077	1,407,559	
4	1,985,260	1,075,086	788,998	1,552,027	203,753	3,430,743	2,928,837	220,557	3	
5	297,084	694,602	356,496	259,992	315,277	30,722	910,886	919,883	76,499	
6	83,768	67,452	234,502	118,101	7,489	70,881	4	151,472	287,452	
7+	245,886	9,110	15,702	82,015	11,937	1	15,398	1	6,518	
3+	4,306,135	3,127,362	3,856,991	2,673,044	6,406,286	8,271,360	4,199,322	1,295,990	1,778,031	
from ADAPT	4,306,135	3,127,362	3,856,991	2,673,044	6,406,286	7,166,169	3,248,383	892,888	1,570,605	
Fishing Mortality										
3	0.02	0.05	0.02	0.74	0.10	0.04	0.01	6.65	0.35	0.37
4	0.00	0.05	0.06	0.54	0.84	0.28	0.11	0.01	0.35	0.21
5	0.43	0.04	0.06	2.50	0.44	7.93	0.74	0.11	0.35	7.88
6	1.17	0.41	0.00	1.24	7.87	0.48	0.30	2.10	0.35	0.55
3+	0.12	0.06	0.04	0.83	0.15	0.17	0.24	0.35	0.35	
from ADAPT	0.06	0.05	0.03	0.82	0.15	0.20	0.31	0.51	0.50	
Population number recruited at age 4										
4	2,391,199	2,622,743	4,672,068	7,358,131	2,057,510	24,668,177	15,424,566	3,678,299	1,347,176	
5	2,036,058	1,275,657	1,054,182	2,805,104	2,845,467	1,184,514	13,835,844	9,055,882	1,975,691	
6	531,109	618,032	334,175	328,415	704,649	757,434	363,096	3,965,845	2,670,729	
7	786,893	146,208	182,480	87,189	15,243	194,313	91,508	86,885	740,573	
8+	84,844	154,003	43,872	60,406	10,227	1	7,410	278	16,245	
4+	5,830,103	4,816,643	6,286,777	10,639,245	5,633,096	26,804,439	29,722,424	16,787,189	6,750,414	
from ADAPT	5,830,103	4,816,643	6,286,777	10,639,245	5,633,096	26,697,832	27,291,109	17,167,406	9,203,857	
Fishing Mortality										
4	0.19	0.47	0.07	0.51	0.11	0.14	0.09	0.18	0.35	0.14
5	0.14	0.29	0.12	0.33	0.27	0.13	0.20	0.17	0.35	0.2
6	0.24	0.17	0.29	2.02	0.24	1.06	0.38	0.63	0.35	0.46
7	0.58	0.15	0.06	1.09	8.58	2.22	4.75	0.63	0.35	0.36
4+	0.24	0.39	0.10	0.52	0.23	0.18	0.16	0.28	0.35	
from ADAPT	0.23	0.37	0.09	0.51	0.23	0.18	0.18	0.28	0.25	
Population number recruited at age 5										
5	462,508	493,588	656,088	358,976	54,170	139,650	1,196,195	655,514	553,025	
6	711,698	182,685	137,364	395,391	117,312	15,346	55,882	509,308	334,646	
7	243,957	233,576	24,088	46,525	121,982	32,366	475	6,686	148,870	
8	38,005	40,038	69,382	4	4	42,686	4	166	4	
9+	20,099	6,479	2,040	22,048	1	1	1	1	1	
5+	1,476,267	956,366	888,962	822,944	293,469	230,049	1,252,557	1,171,675	1,036,546	
from ADAPT	1,476,267	956,366	888,962	822,944	293,469	230,049	1,745,970	1,592,234	1,284,470	
Fishing Mortality										
5	0.49	0.84	0.07	0.68	0.82	0.48	0.41	0.23	0.35	0.3
6	0.06	0.98	0.03	0.13	0.24	2.43	1.07	0.18	0.35	0.28
7	0.76	0.16	7.69	8.35	0.00	7.99	0.00	6.54	0.35	0.19
8	0.72	1.93	0.10	0.30	0.30	9.61	0.30	4.06	0.35	0.41
5+	0.34	0.75	0.27	0.86	0.25	3.36	0.44	0.25	0.35	
from ADAPT	0.33	0.75	0.27	0.85	0.25	3.36	0.3	0.18	0.27	
Population number, ages combined										
	11,612,505	8,900,371	11,032,730	14,135,233	12,332,851	35,305,848	35,174,303	19,254,854	9,564,991	

Table 14. Annual gaspereau landings by statistical district, location of the Pokemouche, Tracadie and Richibucto Rivers, as compiled by Statistics Branch, DFO, 1968 to 1990.

YEAR	LANDINGS (METRIC TONS) BY RIVER AND DISTRICT		
	POKEMOUCHE (67)	TRACADIE (68)	RICHIBUCTO (76)
1968	82.49	293.92	118.04
1969	218.92	14.07	14.36
1970	171.49	45.37	232.38
1971	655.12	26.31	360.04
1972	256.96	17.69	234.44
1973	650.84	29.55	263.32
1974	294.05	35.40	170.56
1975	80.99	94.37	151.39
1976	178.87	35.06	318.96
1977	258.39	21.08	253.56
1978	564.94	34.70	566.42
1979	226.80	18.92	212.17
1980	130.04	34.75	237.03
1981	42.91	46.97	564.28
1982	73.97	29.44	314.08
1983	34.75	72.18	392.27
1984	127.25	77.92	506.51
1985	386.58	78.86	1427.40
1986	272.62	20.68	396.33
1987	518.83	73.55	1148.60
1988	392.66	84.94	902.47
1989	442.24	187.41	803.30 **
* 1990	280.48	88.19	408.15
Mean	275.75	63.54	434.61
95% C.I.	(196.13-355.36)	(36.66-90.41)	(289.62-579.60)

* 1990 preliminary estimate based on purchase slips total compiled by Science Branch, and may be underestimated.

** 1989 Statistics Branch total is higher than Science Branch estimate presented in table 15.

Table 15. Richibucto River alewife and blueback herring catch-at-age matrix (numbers of fish), 1989 and 1990.
FSP = first time spawners

	ALEWIFE		BLUEBACK HERRING	
Total Age	1989	1990	1989	1990
Recruited at age 2				
2	190,785	51,286	6,362	0
Recruited at age 3				
3	484,958	1,624,866	3,388	32,083
4	323,013	865	2,198	0
5	118,044	10,780	3,998	0
6	5,321	561	0	0
7	1,647	52	0	0
Recruited at age 4				
4	419,623	8,648	399,410	92,850
5	85,586	16,348	83,851	66,071
6	6,575	5,821	40,634	11,929
8	0	0	3,333	0
Recruited at age 5				
5	0	2,897	1,512	13,224
6	0	0	0	380
TOTAL NUMBER	1,635,551	1,722,131	544,685	216,543
Dominant cohort	1985	1987	1985	1986
Percentage	45.4	94.4	73.7	42.9
% FSP	67.0	97.8	75.1	57.7
PROPORTION	0.75	0.89	0.25	0.11

*		
YY	1989	1990
ALEWIFE+BLUEBACK		
TOTAL NUMBER	2,180,241	1,938,674
LOGBOOK WT (KG)	110691	
PSLIP WT (KG)	497995	408153
PSLIP/LOG FACTOR	4.50	--

* Corresponding yearly total numbers, logbook and purchase slip weights, and resulting multiplicative factor used (1990 projection used weekly purchase slip landings as only one logbook was returned).

Table 16. Tracadie River alewife catch-at-age matrix (numbers of fish), 1989 and 1990.
FSP = first time spawners

	Numbers	
Total Age	1989	1990
Recruited at age 2		
2	1,859	0
Recruited at age 3		
3	24,046	253,138
4	72,738	0
5	70,958	24,534
6	2,671	3,791
7	446	0
Recruited at age 4		
4	372,497	21,406
5	134,486	49,384
6	6,031	1,695
7	1,103	0
Recruited at age 5		
5	12,943	3,859
6	0	246
TOT ALEWIFE	699,776	358,031
Dominant cohort	1985	1987
Percentage	63.6	70.7
% FSP	58.8	77.8
ALEWIFE PROP.	0.95	0.96
*		
BLUEBACK NUMBERS	38,666	13,754
ALEWIFE+BLUEBACK		
TOTAL NUMBER	738,442	371,785
LOGBOOK WT (KG)	143933	49134
PSLIP WT (KG)	195849	88182
PSLIP/LOG FACTOR	1.36	1.79

* Corresponding blueback hering numbers, total number, logbook and purchase slip weights, and resulting multiplicative factor used.

Table 17. Pokemouche River alewife catch-at-age matrix (numbers of fish), 1989 and 1990.
FSP = first time spawners

	Numbers	
Total Age	1989	1990
Recruited at age 2		
2	0	0
4	16,887	0
Recruited at age 3		
3	92,850	881,842
4	243,609	10,547
5	51,782	12,305
6	3,648	5,096
7	128	0
Recruited at age 4		
4	992,299	92,392
5	204,662	114,139
6	645	24,014
7	0	225
8	0	210
Recruited at age 5		
5	633	1,561
6	0	0
TOT ALEWIFE	1,607,144	1,142,331
Dominant cohort	1985	1987
Percentage	76.9	77.2
% FSP	67.6	85.4
ALEWIFE PROP.	0.94	0.95
*		
BLUEBACK NUMBERS	96,422	54,472
ALEWIFE+BLUEBACK		
TOTAL NUMBER	1,703,566	1,196,804
LOGBOOK WT (KG)	139261	153807
PSLIP WT (KG)	436069	280483
PSLIP/LOG FACTOR	3.13	1.82

* Corresponding blueback hering numbers, total number, logbook and purchase slip weights, and resulting multiplicative factor used.

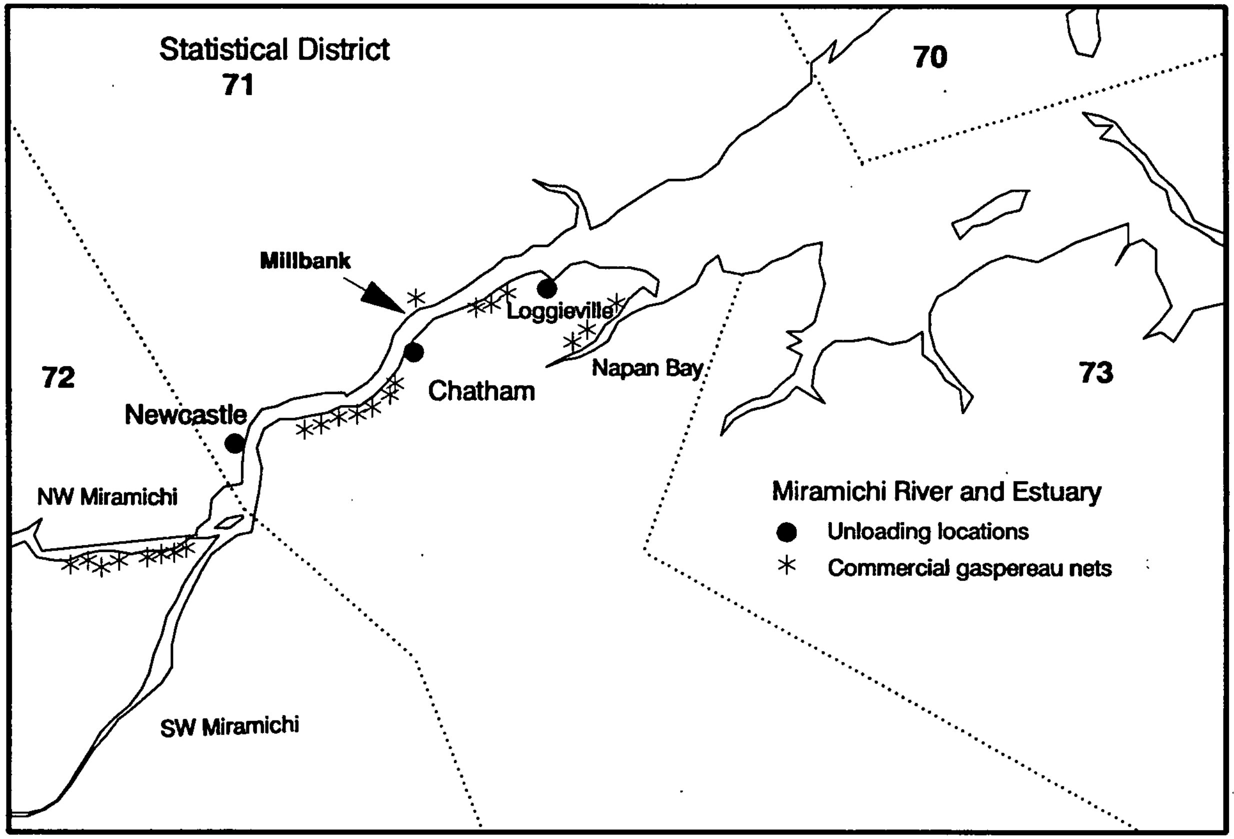

Fig. 1 Miramichi River and estuary showing gaspereau fishing locations and distribution of nets.

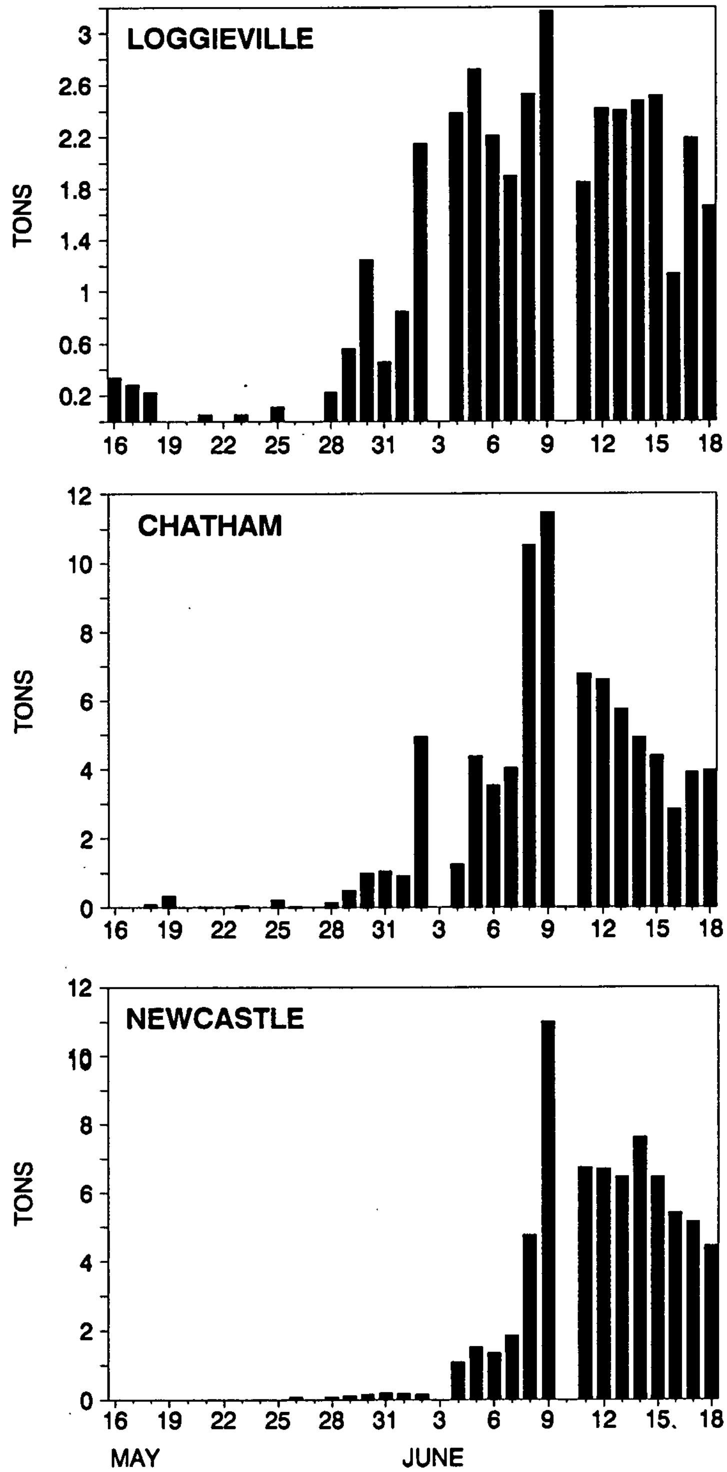

Fig. 2 Timing of gaspereau landings (mean catch per trap, species combined) by fishing location, Miramichi River, as derived from catch and effort logbooks 1990.

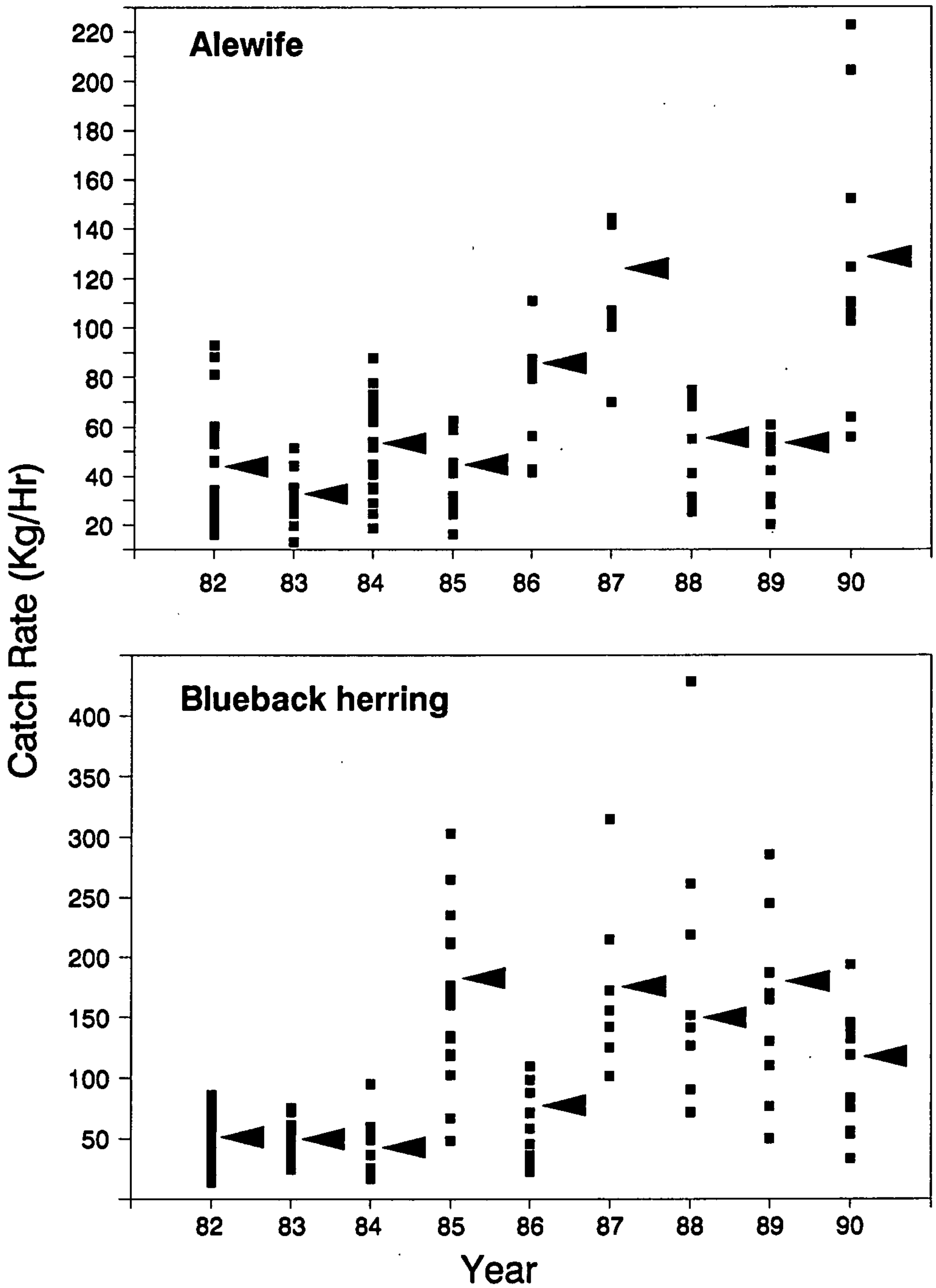

Fig. 3 Abundance indices of alewife and blueback herring in the Miramichi River derived from logbook catch rate per trap, 1982 to 1990.

- ▪ mean catch rate per fisherman
- ◀ multiplicative model solution annual catch rate

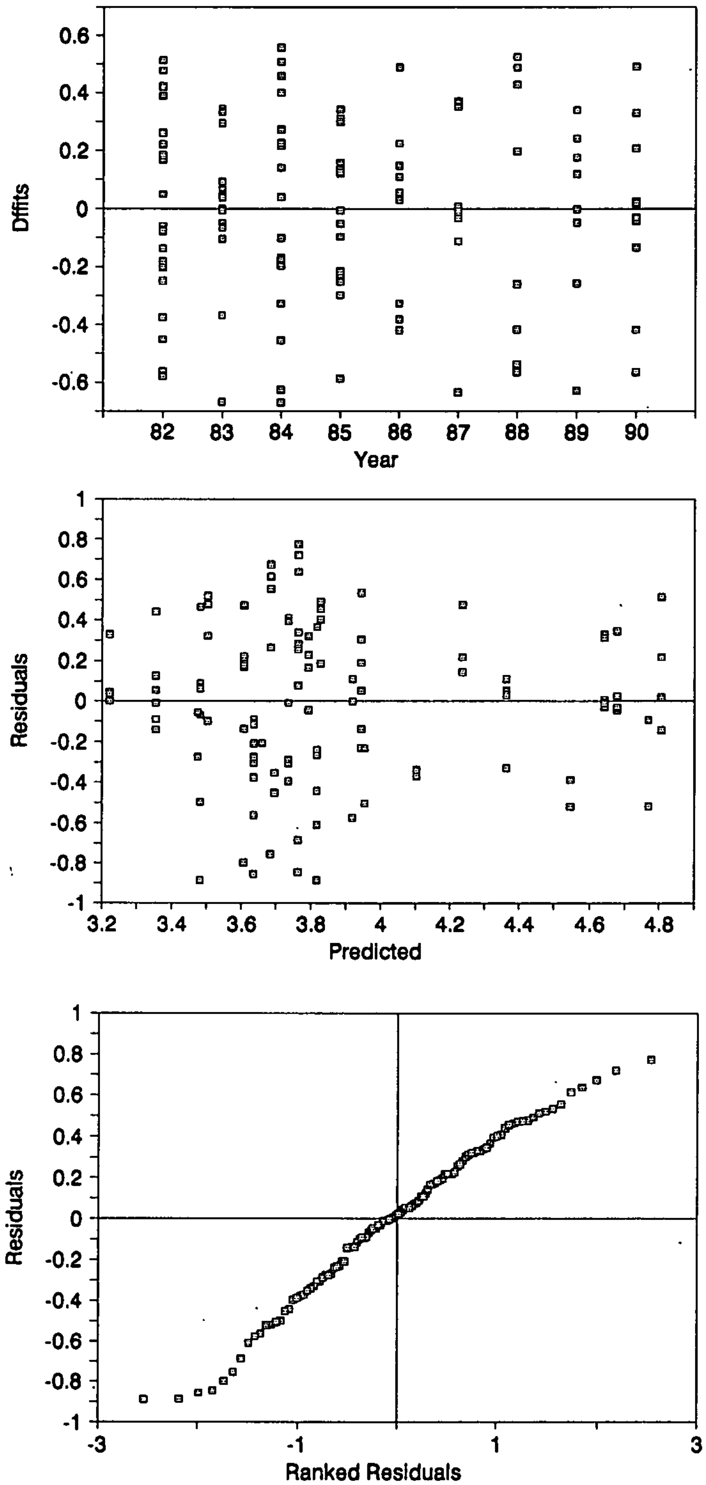

Fig. 4 Residual plots and influence diagnostic of logbook catch rate multiplicative model for alewife, Miramichi River, 1982 to 1990.

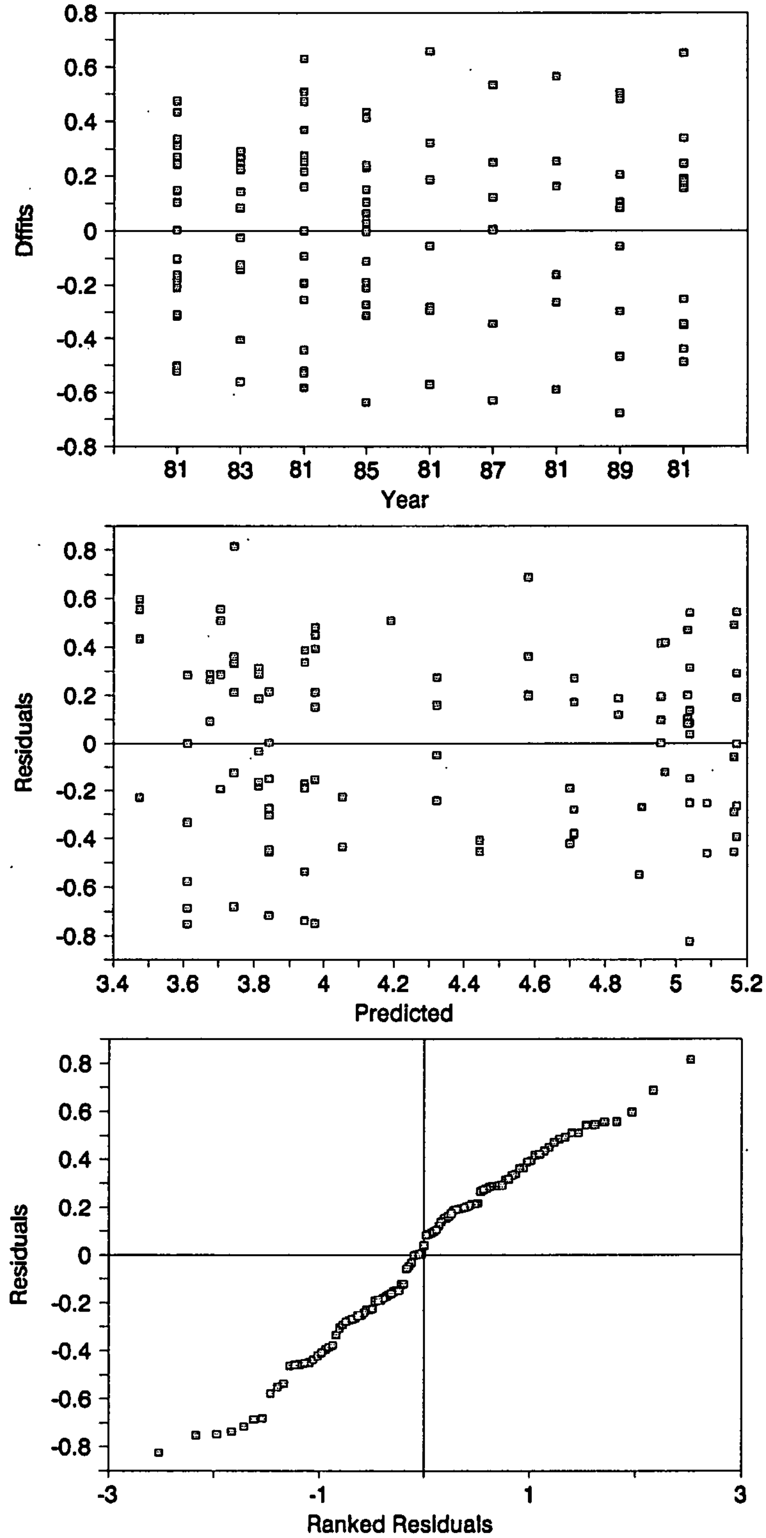

Fig. 5 Residual plots and influence diagnostic of logbook catch multiplicative model for blueback herring, Miramichi River, 1982 to 1990.

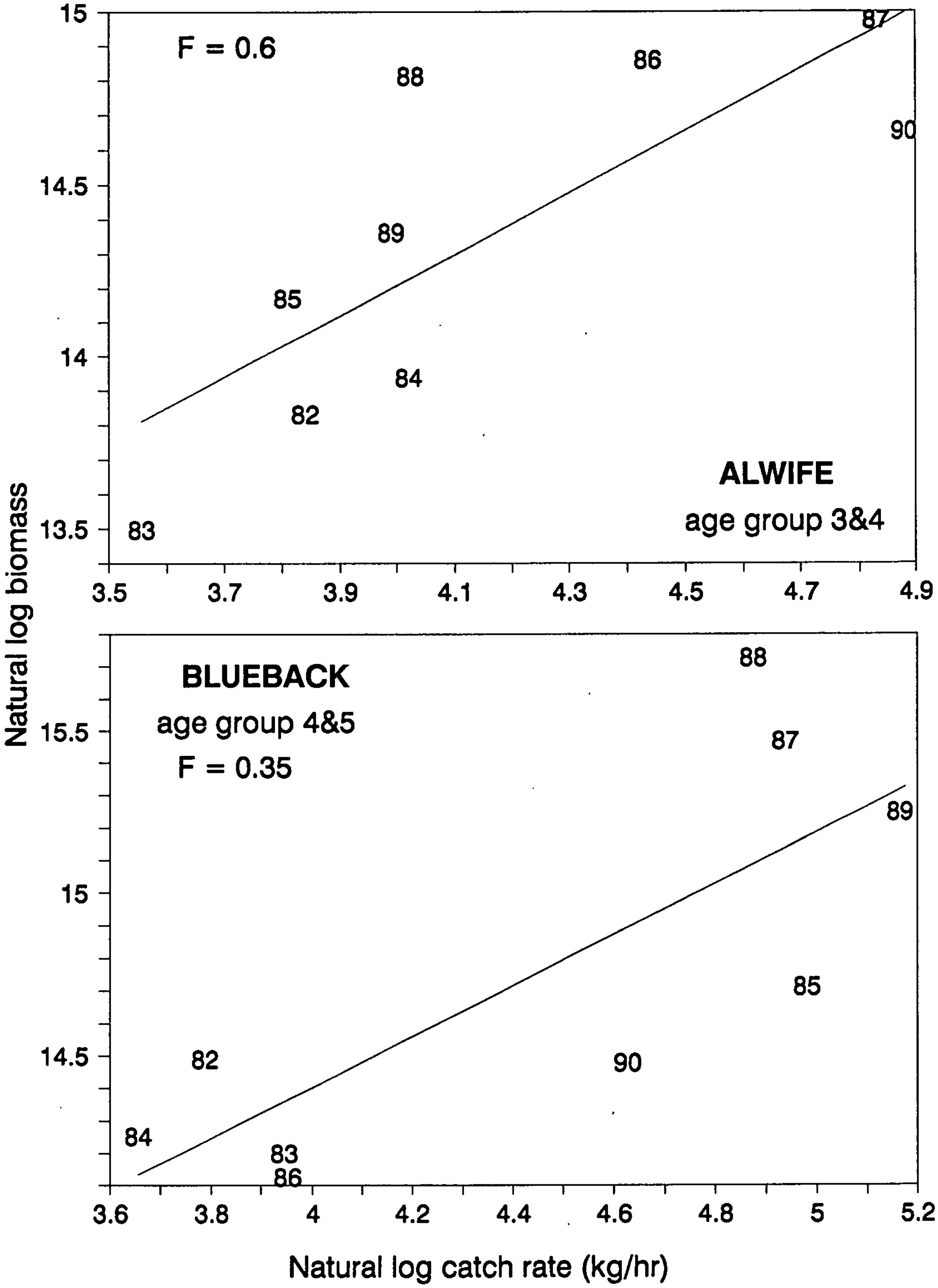

Fig. 6 Tuning plots of fishing mortality on alewife and blueback herring in the Miramichi River gaspereau fishery, 1990. (line represents best fit regression at the stated value of F)

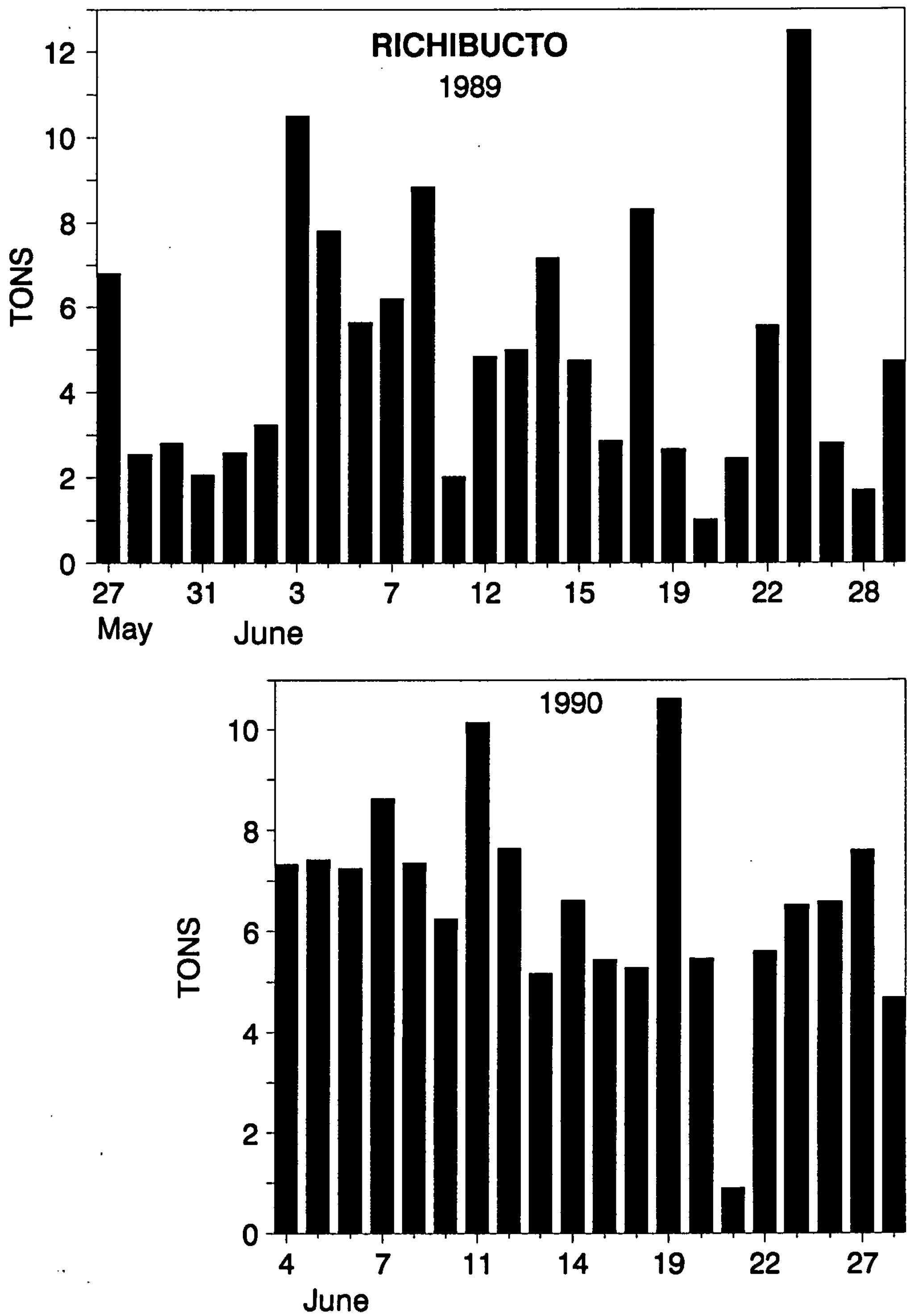

Fig. 7 Timing of mean gaspereau catch (species combined) per fisherman on the Richibucto River as summarized from purchase slips, 1989 and 1990

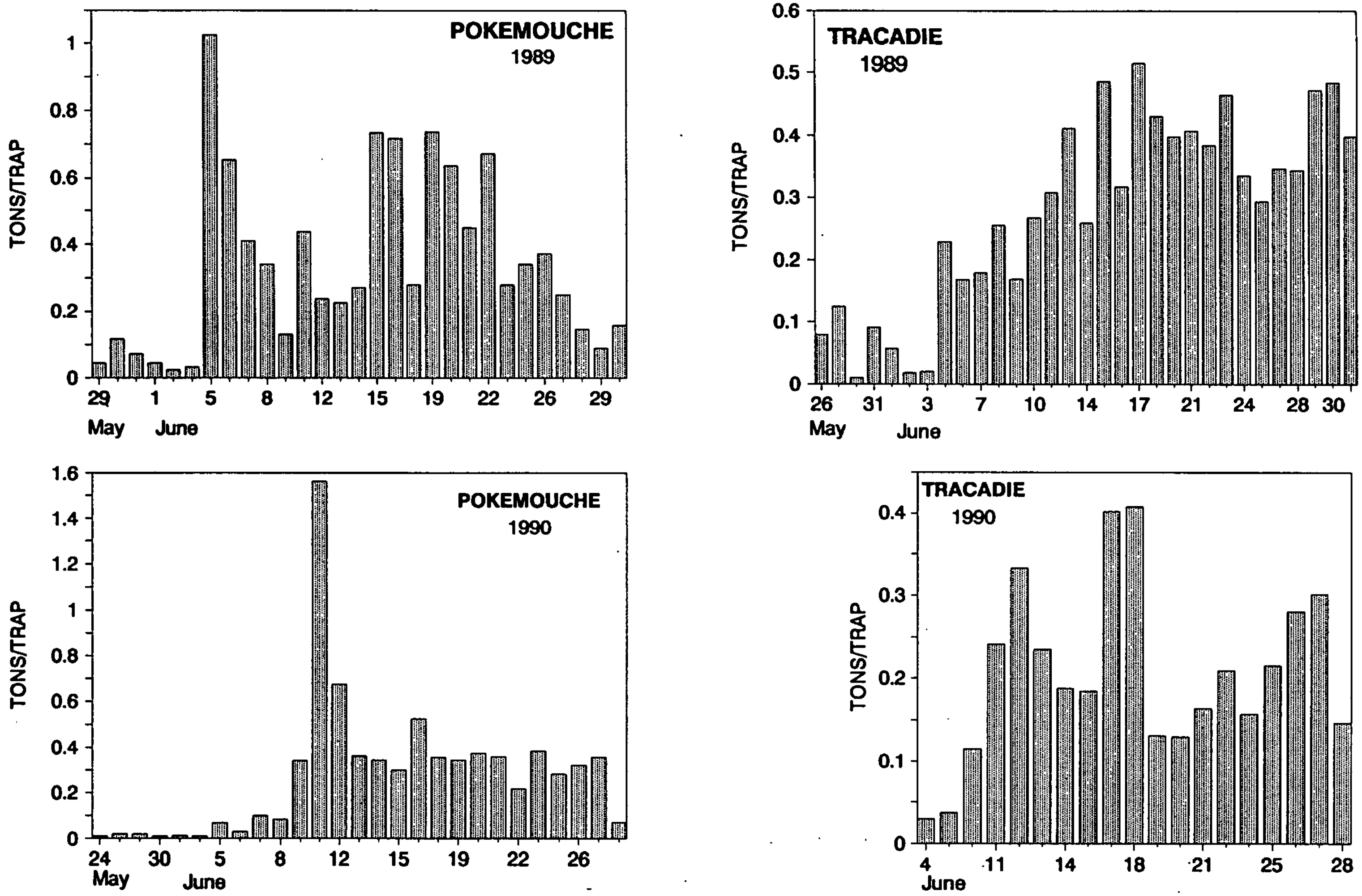

Fig. 8 Timing of gaspereau mean catch (species combined) for the Pokemouche and Tracadie Rivers as derived from catch and effort logbooks, 1989 and 1990