# EVALUATION OF THE 1989 GASPEREAU FISHERY (*Alosa aestivalis* AND *A. pseudoharengus*) FROM THE MIRAMICHI RIVER, NEW BRUNSWICK

by

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**ABSTRACT**

Landings of gaspereau from districts 71 and 72 in 1989 were 1,924 tons, of which 58% were blueback herring (Alosa aestivalis) and 42% were alewife (Alosa pseudoharengus). Of the alewife catch, the 1985 year class was the dominant component and first time spawners comprised 37% of the catch. Blueback catch was dominated by the 1983 year class and new recruits were 17% of the catch. An abundance index based upon catch rates from logbook reports indicated that alewife abundance was the second lowest since 1982 whereas blueback herring abundance was highest in 1989. Overall, blueback catch rates were three times that of alewife. With average recruitment, alewife and blueback catches in 1990 should be similar to 1982-1985 levels (approx. 1200 t). In spite of increased sampling at Millbank and from the fishery, very few alewife and blueback older than 7 years old were found. Proportions at age in the catch estimated from samples collected exclusively at Millbank trapnet versus samples from the fishery were different as were proportions of each species. Catch rates at Millbank differed in terms of timing and level from the commercial gear. Differences in proportions at age were also noted between different locations on the river. In the future, sampling should be directed at the fishery, stratified across location and time. Millbank sampling provides an independent estimate of migration timing and species abundance.

**RÉSUMÉ**

Les débarquements de gaspareau pour les districts 71 et 72 en 1989 ont atteint un niveau de 1,924 t dont 58% Alosa aestivalis et 42% A. pseudoharengus. Les prises de A. pseudoharengus se composaient principalement de la cohorte de 1985 et les nouvelles recrues ont contribué à 37% des prises. La cohorte de 1983 a dominé les prises de A. aestivalis mais les nouvelles recrues n'ont constitué que 17% des prises pour cette espèce. Un indice d'abondance calculé par l'entremise de journaux de prises et de l'effort a révélé que l'abondance de A. pseudoharengus en 1989 était la deuxième plus faible depuis 1982. Par contre, A. aestivalis était plus abondant en 1989 que auparavant et était 3 fois plus abondant que A. pseudoharengus en 1989. Les prises en 1990 devraient atteindre un niveau semblable à 1982-1985 si le recrutement est semblable à la moyenne des 7 dernières années. Malgré un programme d'échantillonnage plus intensif que les années précédentes, très peu de gaspareau âgés de plus de 7 ans ont été retrouvés. Les proportions des prises à l'age estimées à partir des échantillons de Millbank étaient différentes de celles calculées à partir des échantillons recueillis de la pêche commerciale. Les proportions estimées des deux espèces étaient aussi différentes. Les proportions des prises à l'age étaient différentes selon le lieu de pêche de la rivière Miramichi. Le taux et la périodicité des captures du filet de Millbank étaient différents de ceux des filets commerciales. À l'avenir, les échantillons devraient être recueillis directement des captures et devraient être stratifiés par lieu de pêche et période. L'échantillonnage au filet de Millbank permet d'estimer l'abondance et la migration du gaspareau dans la rivière Miramichi indépendamment de la pêche commerciale.

## 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). The fishing season extends from May 15 to June 15 except for fishermen in the Napan Bay area whose season closes June 30. From 1980 to 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).

The absence of older age groups (aged 7+) in the fishery in recent years and concerns regarding the representativeness of the Millbank catches relative to the fishery were highlighted by the Canadian Atlantic Fisheries Scientific Advisory Committee (CAFSAC). A sampling program was undertaken in 1989 to address these concerns. This document is structured into two parts.

Part A addresses the following points:

1 - verification of the absence of older age groups by more intensive sampling of the fishery

2 - sampling of the fishery directly to assess the representativeness of the historical sampling procedure.

Part B describes the 1989 gaspereau fishery and presents the input parameters of the cohort analysis, under Type I assumptions, 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. Yield per recruit analysis, estimated under Type I assumptions, generated $F_{0.1}$ values. Prognosis for 1990 is provided based upon the results of cohort analysis and the abundance of age groups estimated from the Millbank index trapnet.

## METHODS

### Historical Sampling

Daily counts of gaspereau captured at the index trapnet at Millbank, operated by DFO, have been obtained since 1982 (Fig. 1). Samples (19-264) were collected daily and all fish were measured, species identified and a subsample of 4 fish per half cm length group per species was kept for age determination (Table 1). Most samples were processed for detailed analysis the same day.

**Two-Stage Stratified Sampling**

A two-stage stratified sampling program of the commercial fishery was also undertaken in 1989. Length samples, consisting of approximately 200-250 measurements and a detailed sample of 8 fish per one-half centimetre length group, were obtained from three landing locations on the Miramichi River; namely Newcastle, Chatham, and Loggieville (Fig. 1). Detailed samples were generally frozen for later processing. Samples were obtained daily from two locations (Table 1); boat sampled varied between days dependent upon which boat was present at the wharf or was first to arrive for unloading. On two occasions, a second sample was obtained from a different catch at the same location to assess variation among traps.

**Detailed Processing**

Biological characteristics measured included fork length (nearest quarter cm), weight (nearest gram), species (Alosa pseudoharengus; alewife or Alosa aestivalis; blueback herring), sex and 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 against 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

Catch at age for the historical sampling and 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). Since species were not distinguished during the length sampling, a coded value of age representing species and age was used to determine catch by species and age with associated variances.

**Logbook Catch and Effort Analysis**

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.

**Landings**

Total catch for 1989 was calculated from purchase slip, by location, collated by Statistics Branch, Gulf Region.

## PART A

As in the 1988 fishery assessment, catch at age matrices were calculated by age of recruitment for each species.

The catch at age of the 1989 fishery, based on samples collected at Millbank, was calculated using a similar method to that of the previous assessments. Daily age by species composition of the samples from Millbank trapnet was weighted by the daily logbook catch from districts 71 & 72 and summed for the season. Final catch at age numbers were estimated by factoring with total landings (purchase slips) / total logbook catch.

Catch at age from the two-stage sampling of the commercial fishery was estimated using 2 age-length key weighting strategies. In all estimates, the method of projecting within weekly intervals by location followed by summing across weeks was used (project and add). Both methods used daily logbook catch from a location to weight the sample for the particular day. The methods differ in the values used to project catch for the week.

1) Length samples, weighted by the logbook catch for that day, were segregated into species and age composition using weekly age-length keys (Monday to Saturday samples) for the location and projected to catch for the week using the total logbook catch for the week. Weeks were aggregated first, catches summed across locations and the resultant catch matrix was multiplied by a conversion factor (ratio of total purchase slip catch to total logbook catch) 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 landing for the year.

2) Length samples were weighted similarly to Method 1 however projection onto catch for the week was made using purchase slip landing for that week, that location. Weeks were summed followed by location to arrive at the final catch matrix. The catch matrix was adjusted such that the crossproducts of numbers at age and weight at age summed to landing for the year. Since logbook catch represents only a portion of the total catch on a given day, (not all fishermen returned logbooks and logbook information has not been verified for accuracy), this weighting strategy may provide a truer picture of the age and species structure of the landings.

Catch at age proportions were compared using the procedure outlined by Smith and Maguire (1983) for determining if samples had a common multinominal distribution.

### Verification of the Absence of Older Age Groups.

Alewife older than 7 years of age have been absent from samples obtained at Millbank since 1985 whereas blueback herring older than 8 years of age were last sampled in 1986 (Chaput and LeBlanc 1989). In spite of increased sampling intensity at Millbank in 1989, no alewife older than 7 years were found

(Table 2). Only 5 alewife out of 1055 fish aged from the Millbank samples (0.47%) were aged 7 years. Blueback herring from the Millbank trapnet ranged from 3 to 8 years of age; 13 were aged as 7 years old (1.2%) and 3 as 8 years (0.27%).

In the stratified samples of the commercial fishery, alewife ranging in age from 2 to 8 years were found; the 8 year olds were represented by 2 individuals (0.27% of aged alewife). Blueback ranged in age from 3 to 9 years; one aged 8 years and one aged 9 years old were found (Table 2).

In previous years, the age structure in the Millbank samples had rarely included alewife as old as 7 years of age. Except for 1982 and 1983, older age groups were represented by very few individuals; often single specimens. Age classes were more varied for blueback herring although age 8+ blueback have been rare since 1986.

**Assessment of the Historical Sampling Procedure.**

Several aspects of the two-stage stratified sampling program as they relate to the estimation of the age composition of the catch from the fishery are considered:

1) variation in age composition of the catch between traps from the same location on the same day,

2) variation in species composition over time by location, and

3) variation among fishing locations on the river.

1. On two occasions, a second sample was obtained from a different fisherman from the same fishing location on the same day. Analysis of the species and age proportions of these samples indicated significant differences for the two dates sampled (Chi-square; $P < 0.001$) (Table 3). For the May 25 samples from Chatham, differences in proportion of 4 and 5 year old alewife between traps were noted whereas at Newcastle on June 2, differences at age of blueback and differences in species proportions were found (Table 3). Rather than attempting to obtain a sample from each boat's catch, attempts were made to sample the catches from different fishermen during the fishing season.

2. We used the reductionist approach regarding the number of age-length keys used to restructure the age and species composition of the landings. Age-length keys were constructed by aggregating detailed sample information by location (Loggieville, Chatham and Newcastle) and week, Monday to Saturday. The usefulness of such a stratification was assessed by examining the species composition over time and the catch at age by location.

Species composition (by weight) was similar between locations; prior to May 25, gaspereau in the Miramichi were exclusively alewife followed by a rapid movement of blueback into the system between May 27 and May 31 (Table 4). Proportions stabilised at approximately 75% blueback after May 31, May 30 at

Millbank trapnet. The detailed samples were aggregated by fishing week and location which meant that the second week of the fishery consisted of a transition period with percentage of catch decreasing to approximately 80% alewife at Chatham and Newcastle during the second half of the week from 100% at the beginning of the week (Table 4). This would introduce a small bias towards blueback since some of the early week landings would be allocated to the blueback component when this species was not present in the catch. If species had been identified during the length sampling stage, this bias could have been avoided.

Patterns of logbook catch indicated, however, that weekly keys were appropriate since landings at Chatham and Newcastle were generally peaked in the middle of the week, weekend closure seemingly affecting the catches in the initial few days (Figure 2).

Having stratified the age-length keys by location and week, two projection methods were used to estimate the unsampled portion of the catch. The first weighting scheme involved using only the logbook data for the week. The second method used weekly purchase slip landings for the projection because these data are representative of the catch of all fishermen, not just those which returned logbooks. These two methods, summed over weeks and locations generated different species and age proportions in the catch, however, the goodness of fit test did not reject the null hypothesis of a common multinominal distribution origin (Table 5). The species composition was different enough, however, that we examined the catch trends by week from the logbook and purchase slips for a possible explanation.

Logbook reports to purchase slip reports from Loggieville and Chatham were similar in distribution whereas the Newcastle reports were biased; total catch for the season had been distributed evenly across weeks (Fig. 3). Our on-location sampling had verified the fact that an insignificant amount of gaspereau had been landed during the first week of the season, in contrast to the large landing from Newcastle recorded on purchase slips. This large reported catch in the first week was, according to samples from the first and second week almost exclusively alewife which explains the higher proportion of alewife in the purchase slip projection method over the logbook projection (Table 5). Individual logbook totals were similar to individual purchase slip totals from all three locations which indicated that logbook reports were accurate in terms of timing of the catches. Consequently, we considered the weighting method using logbook catch to project onto week more appropriate.

3. Analysis of the restructured catch at age, using logbook weighting by location, indicated that there were differences in age composition between Loggieville, Chatham and Newcastle (Table 6). Newcastle age and species proportions were most different from Loggieville and Chatham whereas the latter two had only one age group different. Total fishery catch at age using Millbank samples weighted by daily logbook catch from the entire river were most significant from all other locations (Table 6). Stratification by location was thus a valid strategy to use.

Having established an appropriate representation of the age and species composition of the 1989 fishery, validation of the historical sampling program can be undertaken. Comparisons consist of two parts:

3.1) differences in catch at age composition, and

3.2) differences in catch rate between Millbank trapnet and the commercial trapnets.

3.1 The proportions at age estimated using the logbook weighted stratified samples, summed across locations, and the logbook weighted Millbank samples were significantly different (Chi-square = 124.5, df = 29, $P < 0.001$). Pairwise differences in proportion of 3 year old alewife and 3 age groups of blueback herring were noted (Table 7). Overall species proportions were different, blueback composing approximately 62% of the catch in the stratified commercial sampling in contrast to 71% when only Millbank age and species composition is used. Coefficients of variation were all substantially higher when Millbank samples were used, due in part to the smaller number of samples aged and to the large catch proportions attributed to few samples.

3.2 The 1989 catch rate over time of the Millbank index trapnet (number per day) compared to those of commercial traps (kg per trap) at the three fishing locations on the river showed marked differences both in terms of timing and efficiency (Fig. 2). The Millbank catch rate was distinctly lower than the catch rates at the other locations during the week of May 22 to 27 and from June 7 to 9 (Fig. 2). Chatham and Loggieville show similar catch rates whereas Newcastle had a lower relative catch rate during May 22 to 27 compared to the other two locations. In terms of catch, Millbank is extremely inefficient in capturing gaspereau, the leader at the trap is of large enough mesh that gaspereau are able to swim through in contrast to the smaller mesh of the commercial traps on the Miramichi.

**Summary**

The use of samples from Millbank trap to estimate the species and age composition in the 1989 fishery catch was not appropriate; it was probably not appropriate in previous years either. The problem arises not from the location or fishing performance of the trap itself but rather from assuming that species and age composition on any day is homogeneous throughout the fishing zone. The sampling of the commercial fishery in 1989 at various locations and restructuring of the catch according to location and week indicated that catches at Chatham and Newcastle were different; these differences could not have been accounted for by sampling exclusively at one trap or several traps at one location.

Species proportions in the landings from previous years may be slightly different than estimated, however, it is unlikely that the true proportions in the catch were reversed from that estimated. Small daily sample sizes (< 50) of the historical sampling at Millbank have undoubtedly contributed to the impression that gaspereau beyond age 7 were absent. The 1989 sampling at

Millbank was substantially more intensive than in previous years and confirmed the hypothesis that Millbank age structure was not different from the commercial fishery age structure. The problem was the method of extrapolation of the Millbank information onto the catch from the fishery.

Catch rates at Millbank were also different from those of the commercial fishery in 1989. Sampling should not have been concentrated exclusively at Millbank. Future assessments should be based upon samples collected from the fishery directly, stratified across locations and time. Millbank sampling remains important in that it provides an independent estimate of migration timing and species abundance.

## PART B

### Landings 1989

Catch of gaspereau from Districts 71 and 72 in 1989 was estimated at 1,924 tons which is higher than the 5 and 10 year means, similar to the historical mean and within the 95% confidence intervals of all period estimates (Table 8). Landings from the Napan Bay region were estimated at 65.3 tons (3.4% of Districts 71 and 72 catch). The districts 71 and 72 fisheries remain the dominant gaspereau fishery in Gulf New Brunswick which have constituted almost 60% of the total gaspereau landings of the Gulf Region since 1978 (Table 9).

Logbooks were returned by 12 of 23 fishermen in 1989, 8 from district 71 and 4 from district 72, which necessitated the use of a conversion factor of 1.638 for estimating total effort for the river (Table 10). Catch per unit effort (kg of gaspereau per hour of fishing) was the highest recorded in the past 8 years (Table 10). The maximum daily landing of gaspereau for district 71 (Chatham and Loggieville) was recorded on June 2, whereas district 72 (Newcastle) maximum was recorded on June 8. Combined district maximum catch was recorded on June 7 (9.04% of total logbook catch).

The 1989 gaspereau catch was estimated to consist of 57.9% blueback 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 1989 (Table 11 a,b). The catch vector for 1989 was calculated from the commercial fishery samples, using weekly interval keys by location, projected onto logbook catch for the interval and added across intervals. The resulting logbook catch at age was then multiplied by the total catch over logbook catch ratio and adjusted for equality of sum of crossproducts of numbers at age and weight at age.

Total gaspereau catch in 1989 was estimated at 7.12 million individuals. The percentage of alewife in the 1989 fishery was 38.4% by number. The 1985

year class was the dominant component of the alewife catch in 1989 (42% by number). Percent new recruits (FSP) was the lowest of the previous 8 years (37.3%) mainly because the 1986 year class (3 year old new recruits) contributed substantially less to the catch than in previous years (Table 11a). The contribution by the 3 year old fish (7.8% by number) was the lowest ever; previous low was in 1987 (14.8%) while the highest contribution by that age group was recorded in 1986 (72.9% of total) (Table 11a).

Blueback accounted for 61.6% by number. The 1983 year class was again the dominant component of the blueback catch in 1989 (47.1% by number) as it was in 1987 (76.9%) and 1988 (63.7%) (Table 11b). Percent new recruits was the lowest of the previous 7 years (17.1%), because the 1986 year class (3 year old new recruits) and the 1985 year class (4 year old) were weak. The combined contribution by the 3 year old fish (.09% by number) and 4 year old (14%) was the lowest ever; previous low was in 1982 (20%) while the highest contribution by those age groups was recorded in 1987 (80.5% of total) (Table 11b).

**Weight at Age Matrix**

The weight at age matrix for alewife and blueback from 1982 to 1989 is presented in Table 12. In all years, mean weights at age were calculated using the measured weights of individual fish. The weighted mean of all years, 1982 to 1989, was used in yield per recruit analysis.

**Abundance Index**

Two abundance indices were estimated. The first abundance index is based on catch (number per day) of alewife and blueback separately for the 5 to 95% catch interval at Millbank trapnet up to and including June 15 in any year (Table 13a,b). In the previous assessment, the catch interval was calculated on catches to June 30 because of Napan Bay fishing which extended to June 30. However, Napan Bay catches constituted such a minor component of the Miramichi River catch (3%) that it was not considered further. The following progression of abundances of alewife and blueback herring since 1982 were:

**Alewife**

1989 < 1982 < 1988 < 1986 < 1984 < 1985 < 1987 < 1983 (Fig. 4)

**Blueback herring**

1989 < 1987 < 1986 < 1982 < 1983 < 1984 < 1988 < 1985 (Fig. 4).

The total count of gaspereau at Millbank trap, 17,646 up to June 30, was the lowest number recorded since 1982 and half the previous low value (Chaput and LeBlanc 1989).

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

a) 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.

b) In 1989, 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 Chatham and Newcastle and proportions by weight from the Millbank trapnet were used to partition the catch from this zone.

Catch and effort data for the period encompassing the 10 to 90% catch by species in any given year were used. Catch per unit effort was calculated as the quotient of total catch (kg) to total effort (hours of trapnet effort) for each logbook fisherman. Natural log of catch per unit effort by species was used as the dependent variable in the model.

The catch rate model was fitted using SAS GLM procedures and model diagnostics were obtained using SAS REG procedures (SAS 1985). These diagnostics included leverage estimates (diagonal of the Hat matrix) and influence statistics using Cook's D and 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 abundance index was estimated from the model solutions to the year variable using the transformation equation described by Gavaris (1988) which corrects for the standard errors of the coefficients.

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).

**Alewife Catch Rates**

The first model run using all available logbook reports (N = 110) and only year as the independent variable explained 40% of the total variance. From the first run, 4 observations were estimated as having unacceptable influence and were removed. Second and third runs with removal of 3 more observations resulted in an explained variance of 54%. The inclusion of the location variable in the model increased the R-square value to 0.57 from 0.54 however the catch rates by location were not significantly different and the location

variable was subsequently dropped. The final model (Table 14), estimated with 103 observations, generated the following progression of catch rates for alewife:

1983 < 1989 < 1985 < 1984 < 1988 < 1982 < 1986 < 1987 (Fig. 4).

Normal probability 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 1987 observations did have high leverage values but individually had low influence as seen from the plot of Cook's D and the DFFITS statistics (Fig. 5).

**Blueback Herring Catch Rates**

The first run using all available logbook reports (N = 107) and only year as the independent variable explained 58% of the total variance. From the first and subsequent runs, a total of 15 observations were omitted because of unacceptable influence resulting in an explained variance of 71%. The inclusion of the location variable in the model increased the R-square value to 0.72 however the catch rates by zone were not significantly different and the zone variable was subsequently dropped. The final model (Table 15), estimated with 92 observations, generated the following progression of catch rates for blueback herring:

1984 < 1983 < 1986 < 1982 < 1987 < 1988 < 1985 < 1989 (Fig. 4)

Normal probability plot of the residuals confirmed the normality assumption (Fig. 6). Influence diagnostics of this final model did not reveal an unbalanced distribution of observations with high DFFITS values (Fig. 6). The 1986 observations did have high leverage values but individually had low influence as seen from the plot of Cook's D and the DFFITS statistics (Fig. 6).

**Natural Mortality**

A composite 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 used for both alewife and blueback herring.

**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 and recruited age groups 3, 4 and 5 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.

**Tuning**

Of the models assessed for tuning the 1989 fishing mortality (F) values, only those incorporating catch rates from logbook reports as the abundance index showed promise. Millbank abundance of alewife and blueback, whether ages grouped or recruitment ages segregated regressed on estimated population numbers failed to generate any linear models with a slope significantly different from zero. In contrast, multiplicative model catch rates did generate relationships with slopes significantly different from zero. The most significant 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 asymptotic 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. The natural log transformed values of population biomass and abundance index were used in the following analyses.

**Alewife**

Combinations of population biomass values were regressed on abundance index of alewife and no good fits were obtained; R-square was very small or increased with increasing F for both log-log regressions and raw value regressions whether using intercept or no-intercept models. Consequently terminal F for alewife in 1989 could not be determined and prefishery population numbers were not estimated.

**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 3, 4 and 5 year old recruited biomass on 3, 4 and 5 year old recruited catch rate. All combinations generated the highest R-square value at $F = 0.15$ and the regression plots for the combined 3, 4 and 5 year old recruited relationship are shown in Fig. 7. The 1989 value was at the upper extreme of the catch rate values which is the least favourable position, however, its population biomass value was situated

within the upper cluster which reduces substantially its influence on the fit of the model for F values between 0.10 and 0.20 (Fig. 7).

Approximately 32 million blueback entered the Miramichi River between May 15 and June 15, 1989 (Table 16) which is more than twice the number for 1982 to 1985 but half to a third of 1988 and 1987 numbers. Blueback from the 4 year old recruitment constituted 90% of the numbers in 1989. The 3 year old recruitment in the last two years has been a failure; such low population values have not been estimated during the last seven years (Table 16). The 1985 year class, recruited as 3 and 4 year olds, is the weakest estimated to date (4.4 million blueback) and is 5.4% of the high 1983 year class. Estimated fishing mortality on blueback herring is very low except for 5 year old recruited blueback (Table 16). Blueback population numbers are, at best, estimates of the numbers up to and including June 15. Total blueback herring population entering the system would be larger.

**Yield per Recruit - $F_{0.1}$**

A yield per recruit analysis by the method of Thompson and Bell (Rivard 1982) was performed for alewife and blueback by age of recruitment, under the assumptions of Type I fisheries and using the Mc values mentioned previously. The results are summarized below:

| Recruited age | $F_{0.1}$ | Yield per Recruit | Avg. Weight | Interval of Estimate |
|---|---|---|---|---|
| Alewife | | | | |
| 3 | 1.01 | 0.185 | 0.230 | 3 to 9 |
| 4 | 1.08 | 0.230 | 0.279 | 4 to 10 |
| Blueback | | | | |
| 3 | 1.01 | 0.140 | 0.173 | 3 to 9 |
| 4 | 1.01 | 0.168 | 0.208 | 4 to 10 |
| 5 | 1.03 | 0.203 | 0.250 | 5 to 10 |

Under Type II assumptions, yield per recruit analysis generated the following results:

| | | | | |
|---|---|---|---|---|
| Alewife | | | | |
| 3 | 1.32 | 0.161 | 0.225 | 3 to 9 |
| 4 | 1.41 | 0.202 | 0.276 | 4 to 10 |
| Blueback | | | | |
| 3 | 1.33 | 0.122 | 0.170 | 3 to 9 |
| 4 | 1.33 | 0.147 | 0.204 | 4 to 10 |
| 5 | 1.34 | 0.178 | 0.246 | 5 to 9 |

The $F_{0.1}$ value of F calculated using the variable composite mortality under Type I assumptions is substantially smaller than that estimated under Type II assumptions. Although fishing mortality on alewife was not estimated, it can be inferred, from a combination of a low abundance index for 1989 which was one third that of blueback but which generated landings of alewife which were almost equal to those of blueback (by weight), that the exploitation rate on alewife was higher than on blueback.

**Prognosis**

Alewife catch rate in 1989 (50.5 kg/hour of trap effort) was the second lowest catch rate since 1982 and was one-third that of blueback catch rate in 1989 (153.8 kg/hour of trap effort). In a simplistic sense, since landings of blueback and alewife in 1989 were almost equal, this would imply that exploitation rate on alewife in 1989 was three times that on blueback, which would result in an estimated F of at least 0.5. The catch of 3 year old alewife new recruits was the lowest estimated number of the past eight years. Millbank abundance values substantiate the relative absence of this year class in the river in 1989. Alewife catch in 1990 will be sustained at a lower level than in previous years by the 1985 and 1984 year classes. If new recruitment is average, then catches of alewife would probably rise to levels attained during 1982 to 1985.

If fishing mortalities on alewife from the simplistic relationship above are accepted, then it would still appear that fishing mortality is below estimated $F_{0.1}$. The weak year class (1986) entering the fishery will result in reduced total escapement in 1990. Of the two species exploited, the alewife is least abundant and 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 maintained to improve spawning escapement, especially of previous spawners.

Blueback herring catches in the last three years have been sustained by the 1983 year class which should not be a major component of the 1990 catch. Rather, the 1984 year class will dominate based on estimates of cohort size which indicate weak 1985 and 1986 year classes. Estimates of new recruitment from Millbank up to June 30 are also indicative of weak 1985 and 1986 year classes. The catch of blueback herring in 1990 is anticipated to be less than the catches of 1989 and 1988.

Blueback herring are 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.

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Table 1. Dates, locations and size of length samples of gaspereau from the Miramichi River, 1989. Asterisks indicate dates when 2 samples were obtained.

| | | Historic sampling | Commercial fishery stratified sampling | | | |
|---|---|---|---|---|---|---|
| | | Index trapnet | | | | |
| | | Millbank | Loggieville | Chatham | Newcastle | Total |
| May | 17 | 45 | . | 272 | . | 272 |
| | 18 | 19 | . | 290 | . | 290 |
| | 19 | 20 | . | . | . | 0 |
| | 20 | 19 | . | 274 | . | 274 |
| | 21 | 27 | . | . | . | 0 |
| | 22 | 49 | 235 | . | . | 235 |
| | 23 | 154 | 257 | 178 | . | 435 |
| | 24 | 103 | . | 170 | 202 | 372 |
| | 25 | 21 | . | 349* | . | 349 |
| | 26 | 132 | . | 191 | 158 | 349 |
| | 27 | 19 | . | 156 | . | 156 |
| | 28 | 20 | . | . | . | 0 |
| | 29 | 20 | . | 160 | 185 | 345 |
| | 30 | 19 | . | 152 | 241 | 393 |
| | 31 | 161 | 160 | . | . | 160 |
| June | 1 | 131 | . | 195 | 241 | 436 |
| | 2 | 123 | 165 | . | 453* | 618 |
| | 3 | 33 | . | 204 | . | 204 |
| | 4 | 117 | . | . | . | 0 |
| | 5 | 124 | 207 | . | 267 | 474 |
| | 6 | 131 | . | 207 | 224 | 431 |
| | 7 | 20 | . | 224 | 224 | 448 |
| | 8 | 20 | 198 | 187 | . | 385 |
| | 9 | 20 | . | 209 | 232 | 441 |
| | 10 | 131 | . | . | . | 0 |
| | 11 | 20 | . | . | . | 0 |
| | 12 | 20 | . | 250 | 247 | 497 |
| | 13 | 20 | . | 189 | . | 189 |
| | 14 | 244 | 212 | . | 226 | 438 |
| | 15 | 264 | . | 249 | 231 | 480 |
| Total | | 2246 | 1434 | 4106 | 3131 | 8671 |

Table 2. Numbers of gaspereau aged by species from the stratified sampling of the Miramichi River commercial fishery and the Millbank index trapnet sampling, 1989.

| Total age | Recruit age | Commercial fishery stratified sampling | | | | Index trapnet |
|---|---|---|---|---|---|---|
| | | Loggieville | Chatham | Newcastle | Total | Millbank |
| ALEWIFE | | | | | | |
| 2 | 2 | - | 1 | - | 1 | 2 |
| 3 | 3 | 12 | 18 | 32 | 62 | 18 |
| 4 | 3 | 55 | 123 | 27 | 205 | 113 |
| | 4 | 46 | 121 | 57 | 224 | 145 |
| 5 | 3 | 38 | 67 | 32 | 137 | 44 |
| | 4 | 41 | 94 | 57 | 192 | 103 |
| | 5 | 1 | 4 | 1 | 6 | 5 |
| 6 | 3 | 11 | 25 | 25 | 61 | 24 |
| | 4 | 11 | 36 | 41 | 88 | 29 |
| | 5 | 1 | 3 | 3 | 7 | 0 |
| 7 | 3 | - | 4 | 1 | 5 | 2 |
| | 4 | 2 | - | 3 | 5 | 3 |
| | 5 | - | - | 3 | 3 | 0 |
| 8 | 3 | - | 1 | - | 1 | 0 |
| | 4 | - | 1 | - | 1 | 0 |
| Total alewife | | 218 | 498 | 282 | 998 | 488 |
| BLUEBACK | | | | | | |
| 3 | 3 | - | - | 1 | 1 | 1 |
| 4 | 3 | 1 | - | - | 1 | 0 |
| | 4 | 24 | 48 | 50 | 122 | 58 |
| 5 | 3 | 3 | 10 | 7 | 20 | 15 |
| | 4 | 36 | 118 | 89 | 243 | 135 |
| | 5 | 5 | 11 | 9 | 25 | 64 |
| 6 | 3 | 3 | 16 | 13 | 32 | 24 |
| | 4 | 66 | 162 | 221 | 449 | 222 |
| | 5 | 6 | 10 | 10 | 26 | 32 |
| 7 | 3 | - | - | - | 0 | 2 |
| | 4 | 6 | 8 | 13 | 27 | 9 |
| | 5 | 1 | - | 3 | 4 | 2 |
| 8 | 4 | - | - | - | 0 | 1 |
| | 5 | 1 | - | - | 1 | 2 |
| 9 | 4 | - | 1 | - | 1 | 0 |
| Total blueback | | 152 | 384 | 416 | 952 | 567 |
| Total | | 370 | 882 | 698 | 1950 | 1055 |

Table 3. Comparison of species and age proportions (percent) in samples from two different trapnets on the same day. Asterisks indicate ages at which significant differences (P<0.05) in proportions between samples were noted.

| Total age | Recruit age | Chatham-May 25 sample 1 | Chatham-May 25 sample 2 | Newcastle-June 2 sample 1 | Newcastle-June 2 sample 2 |
|---|---|---|---|---|---|
| Alewife | | | | | |
| 3 | 3 | - | - | 3.05 | 1.56 |
| 4 | 3 | 34.65 | 20.54 * | 5.83 | 0.78 * |
| | 4 | 34.59 | 36.47 | 9.31 | 7.77 |
| 5 | 3 | 14.61 | 15.51 | 1.36 | - |
| | 4 | 6.42 | 23.63 * | 6.83 | 11.68 |
| | 5 | 1.04 | - | - | - |
| 6 | 3 | 5.41 | 2.32 | 4.11 | 4.74 |
| | 4 | 1.90 | 0.80 | 9.85 | 6.19 |
| | 5 | - | - | - | 3.00 |
| 7 | 3 | 1.38 | - | - | - |
| | 5 | - | - | - | 1.17 |
| 8 | 4 | - | 0.38 | - | - |
| Blueback | | | | | |
| 4 | 4 | - | - | 1.72 | 3.88 |
| 5 | 4 | - | 0.35 | 15.18 | 9.76 |
| | 5 | - | - | 5.40 | - * |
| 6 | 3 | - | - | - | 0.69 |
| | 4 | - | - | 35.60 | 40.97 |
| | 5 | - | - | - | 7.59 * |
| 7 | 4 | - | - | - | 0.20 |
| | 5 | - | - | 1.76 | - |
| % Blueback | | 0.00 | 0.35 | 59.67 | 63.10 |
| Chi-sqare | | | 31.93 | | 68.44 |
| df | | | 9 | | 15 |
| P-value | | | <0.001 | | <0.001 |
| Sample size | | 170 | 179 | 234 | 219 |

Table 4. Percentage by weight of alewife in the daily logbook catch from the Miramichi River, 1989. For Chatham and Newcastle, days for which no fishing occurred or no samples collected were estimated using mean proportions of before and after days.

| | | Index trapnet | Commercial fishery | | |
|---|---|---|---|---|---|
| | | Millbank | Loggieville | Chatham | Newcastle |
| May | 17 | 100.0 | . | 100.0 | . |
| | 18 | 100.0 | . | 100.0 | . |
| | 19 | 100.0 | . | 100.0 | . |
| | 20 | 100.0 | . | 100.0 | . |
| | 21 | 100.0 | . | 100.0 | . |
| | 22 | 100.0 | 100.0 | 100.0 | . |
| | 23 | 100.0 | 100.0 | 100.0 | . |
| | 24 | 100.0 | . | 100.0 | 100.0 |
| | 25 | 100.0 | . | 99.8 | 95.8 |
| | 26 | 92.8 | . | 92.5 | 93.4 |
| | 27 | 84.7 | . | 86.5 | 79.1 |
| | 28 | 84.2 | . | 68.2 | 67.0 |
| | 29 | 30.0 | . | 55.6 | 56.7 |
| | 30 | 10.6 | . | 65.1 | 72.0 |
| | 31 | 27.7 | 28.5 | 24.9 | 26.0 |
| June | 1 | 40.0 | . | 13.3 | 0.0 |
| | 2 | 14.4 | 32.2 | 18.7 | 37.8 |
| | 3 | 24.0 | . | 23.1 | 31.6 |
| | 4 | 23.0 | . | 25.7 | 25.3 |
| | 5 | 37.4 | 23.0 | 29.2 | 19.1 |
| | 6 | 25.6 | . | 33.7 | 25.7 |
| | 7 | 24.5 | . | 9.0 | 18.0 |
| | 8 | 15.7 | 4.8 | 13.4 | 14.9 |
| | 9 | 4.8 | . | 17.4 | 11.4 |
| | 10 | 1.6 | . | 16.2 | 15.0 |
| | 11 | 0.0 | . | 14.2 | 20.0 |
| | 12 | 0.0 | . | 11.3 | 26.3 |
| | 13 | 4.8 | . | 9.0 | 15.8 |
| | 14 | 21.7 | 18.8 | 7.2 | 6.9 |
| | 15 | 24.0 | . | 5.5 | 43.5 |
| | 16 | 9.2 | . | . | . |
| | 17 | 21.3 | . | . | . |
| | 18 | 24.8 | . | . | . |
| | 19 | 17.1 | . | . | . |
| | 20 | 7.8 | . | . | . |
| | 21 | 5.4 | . | . | . |
| | 22 | 17.3 | . | . | . |
| | 23 | 7.1 | . | . | . |
| | 24 | 5.6 | . | . | . |
| | 25 | 5.3 | . | . | . |
| | 26 | 40.9 | . | . | . |
| | 27 | 28.3 | . | . | . |
| | 28 | 21.7 | . | . | . |
| | 29 | 50.0 | . | . | . |
| | 30 | 42.9 | . | . | . |

Table 5. 1989 Miramichi River commercial fishery percentage of numbers at age using weekly age-length keys based on a) weekly purchase slip totals and b) weekly logbook totals.

| Total age | Recruit age | Purchase slip age-length keys percentage | Logbook age-length keys percentage |
|---|---|---|---|
| Alewife | | | |
| 2 | 2 | 0.01 | 0.01 |
| 3 | 3 | 2.68 | 3.00 |
| 4 | 3 | 7.23 | 5.23 |
| | 4 | 12.79 | 10.90 |
| 5 | 3 | 6.48 | 5.46 |
| | 4 | 10.10 | 7.77 |
| | 5 | 0.40 | 0.40 |
| 6 | 3 | 3.03 | 2.04 |
| | 4 | 3.63 | 3.05 |
| | 5 | 0.30 | 0.45 |
| 7 | 3 | 0.03 | 0.01 |
| | 4 | 0.09 | 0.02 |
| | 5 | 0.04 | 0.05 |
| 8 | 3 | <.01 | <.01 |
| | 4 | <.01 | <.01 |
| % Alewife | | 46.82 | 38.39 |
| Blueback | | | |
| 3 | 3 | 0.06 | 0.06 |
| 4 | 3 | 0.02 | 0.03 |
| | 4 | 8.63 | 8.57 |
| 5 | 3 | 1.11 | 1.38 |
| | 4 | 17.15 | 19.99 |
| | 5 | 1.65 | 1.91 |
| 6 | 3 | 1.73 | 1.86 |
| | 4 | 21.25 | 25.96 |
| | 5 | 1.01 | 1.18 |
| 7 | 4 | 0.49 | 0.57 |
| | 5 | 0.07 | 0.09 |
| 8 | 5 | <.01 | <.01 |
| 9 | 4 | <.01 | <.01 |
| % Blueback | | 53.18 | 61.61 |
| Chi-sqare | | | 19.89 |
| df | | | 27 |
| P-value | | | >0.05 |
| Sample size | | 1000 | 1000 |

Table 6. Comparison of the age composition (%) of the commercial fishery at three landing locations and at the Millbank index trapnet location.

| Total age | Recruit age | Historic sampling Index trapnet | Stratified two-stage sampling Commercial fishery | | |
|---|---|---|---|---|---|
| | | Millbank | Loggieville | Chatham | Newcastle |
| Alewife | | | | | |
| 2 | 2 | 0.04 | - | 0.02 | - |
| 3 | 3 | 0.66 | 2.71 | 2.23 | 3.52 |
| 4 | 3 | 4.77 | 10.02 | 7.79 | 3.01 |
| | 4 | 9.61 | 12.23 | 14.36 | 8.58 |
| 5 | 3 | 3.16 | 8.36 | 6.37 | 4.52 |
| | 4 | 6.39 | 7.77 | 8.42 | 7.36 |
| | 5 | 0.43 | 0.18 | 0.90 | 0.12 |
| 6 | 3 | 2.80 | 1.31 | 1.24 | 2.64 |
| | 4 | 1.35 | 1.24 | 3.23 | 3.18 |
| | 5 | - | 0.09 | 0.27 | 0.60 |
| 7 | 3 | 0.02 | - | 0.02 | 0.01 |
| | 4 | 0.13 | 0.10 | - | 0.02 |
| | 5 | - | - | - | 0.09 |
| 8 | 3 | - | - | 0.01 | - |
| | 4 | - | - | <.01 | - |
| % Alewife | | 29.36 | 44.01 | 44.87 | 33.64 |
| Blueback | | | | | |
| 3 | 3 | 0.02 | - | - | 0.10 |
| 4 | 3 | - | 0.37 | - | - |
| | 4 | 3.76 | 9.73 | 7.54 | 9.06 |
| 5 | 3 | 2.10 | 1.73 | 1.31 | 1.38 |
| | 4 | 19.82 | 15.03 | 21.83 | 19.49 |
| | 5 | 7.71 | 1.90 | 1.79 | 1.99 |
| 6 | 3 | 2.53 | 0.93 | 2.06 | 1.87 |
| | 4 | 27.84 | 24.17 | 18.64 | 30.74 |
| | 5 | 4.39 | 1.57 | 1.50 | 0.93 |
| 7 | 3 | 0.15 | - | - | - |
| | 4 | 1.87 | 0.43 | 0.46 | 0.65 |
| | 5 | 0.23 | 0.12 | - | 0.15 |
| 8 | 4 | 0.07 | - | - | - |
| | 5 | 0.16 | 0.03 | - | - |
| 9 | 4 | - | - | 0.01 | - |
| % Blueback | | 70.64 | 56.00 | 55.13 | 66.36 |
| | Chi-sqare | | | 400.2 | |
| | df | | | 84 | |
| | P-value | | | <0.001 | |
| Sample size | | 1000 | 1000 | 1000 | 1000 |

Number of age classes with significant differences (P<0.05) in percentages between locations:

| | Loggieville | Chatham | Newcastle |
|---|---|---|---|
| Millbank | 6 | 6 | 4 |
| Loggieville | - | - | 5 |
| Chatham | 1 | - | 5 |

Table 7. Percent at age and coeficent of variation comparison between historic sampling at Millbank and two-stage stratified sampling of the Miramichi River commercial fishery, 1989. Asterisks indicate significant differences (P<0.05) between percentages.

| Total age | Recruit age | Percent at age: Historical sampling Millbank index trap | Percent at age: Two-stage stratified sampling Commercial fishery | Coeficient of variation: Historical sampling Millbank index trap | Coeficient of variation: Two-stage stratified sampling Commercial fishery |
|---|---|---|---|---|---|
| Alewife | | | | | |
| 2 | 2 | 0.04 | 0.01 | 0.57 | - |
| 3 | 3 | 0.66 | 3.00 * | 0.27 | 0.10 |
| 4 | 3 | 4.77 | 5.23 | 0.15 | 0.05 |
| | 4 | 9.61 | 10.90 | 0.11 | 0.04 |
| 5 | 3 | 3.16 | 5.46 | 0.27 | 0.06 |
| | 4 | 6.39 | 7.77 | 0.12 | 0.05 |
| | 5 | 0.43 | 0.40 | 0.71 | 0.17 |
| 6 | 3 | 2.80 | 2.04 | 0.33 | 0.11 |
| | 4 | 1.35 | 3.05 | 0.26 | 0.10 |
| | 5 | - | 0.45 | - | 0.28 |
| 7 | 3 | 0.02 | 0.01 | - | 2.35 |
| | 4 | 0.13 | 0.02 | 0.86 | 4.04 |
| | 5 | - | 0.05 | - | 1.22 |
| 8 | 3 | - | <.01 | - | 8.69 |
| | 4 | - | <.01 | - | 8.60 |
| % Alewife | | 29.36 | 38.39 | | |
| Blueback | | | | | |
| 3 | 3 | <.01 | 0.06 | - | 0.83 |
| 4 | 3 | - | 0.03 | - | 0.61 |
| | 4 | 3.76 | 8.57 * | 0.20 | 0.04 |
| 5 | 3 | 2.10 | 1.38 | 0.31 | 0.13 |
| | 4 | 19.82 | 19.99 | 0.10 | 0.03 |
| | 5 | 7.71 | 1.91 * | 0.17 | 0.11 |
| 6 | 3 | 2.53 | 1.86 | 0.23 | 0.12 |
| | 4 | 27.84 | 25.96 | 0.07 | 0.03 |
| | 5 | 4.39 | 1.18 * | 0.23 | 0.17 |
| 7 | 3 | 0.15 | - | 0.84 | - |
| | 4 | 1.87 | 0.57 | 0.38 | 0.36 |
| | 5 | 0.23 | 0.09 | 0.76 | 1.11 |
| 8 | 4 | 0.07 | - | 0.01 | - |
| | 5 | 0.16 | <.01 | 0.79 | 12.19 |
| 9 | 4 | - | <.01 | - | - |
| % Blueback | | 70.64 | 61.61 | | |
| Chi-sqare | | | 124.5 | | |
| df | | | 29 | | |
| P-value | | | <0.001 | | |
| Sample size | | 1000 | 1000 | | |

Table 8. Annual landings for the Miramichi River gaspereau fishery 1950-1989 (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 | 1,924 * |

| Means (95% C.I.) | | |
|---|---|---|
| Historical | 1,978 | (1,336 - 2,619) |
| 10 Year | 1,718 | (1,137 - 2,298) |
| 5 Year | 1,794 | (1,377 - 2,210) |

* 1989 preliminary estimate based on purchase slip total

Table 9. Landings of gaspereau for the Gulf Region, 1978 to 1988. 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 | 0.0 | 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 | 0.0 | 293.6 | 1,171.4 | 45.5 | 398.1 | 352.7 | 2,261.3 | 974.3 | 463.6 | 3,699.2 |
| 1987 | 0.0 | 620.4 | 2,208.7 | 141.0 | 1,152.2 | 296.8 | 4,419.2 | 2,558.6 | 364.2 | 7,342.0 |
| 1988 | 0.0 | 480.9 | 1,888.3 | 268.5 | 902.5 | 173.5 | 3,713.7 | 2,835.0 | 233.2 | 6,782.1 |
| Mean | 47.2 | 363.8 | 1,781.6 | 182.7 | 606.7 | 150.1 | 3,132.0 | 1,892.9 | 234.4 | 5,259.3 |

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

Table 10. Miramichi River catches reported through data from purchase slips and Supp 'B' slips collated by Statistics Branch DFO and through voluntary logbooks, 1981 to 1989, with resultant conversion factor and CPUE estimates.

| | 1981 | 1982 | 1983 | 1984 | *1985 | 1986 | 1987 | 1988 | **1989 |
|---|---|---|---|---|---|---|---|---|---|
| Total landings (mt) A | 1410.9 | 1277.6 | 1087.9 | 666.1 | 1857.4 | 1171.4 | 2208.7 | 1888.3 | 1923.6 |
| Logbook catches (mt) B | 1322.9 | 1108.4 | 829.2 | 612.2 | 1496 | 609.6 | 1077.3 | 691.3 | 1174.5 |
| Logbook effort (hrs) | 12308 | 13148 | 14894 | 8857 | 10507 | 7450 | 7572 | 6166 | 6348 |
| Conversion factor A/B | 1.067 | 1.153 | 1.312 | 1.088 | 1.242 | 1.922 | 2.050 | 2.732 | 1.638 |
| Total effort (hrs) | 13127 | 15155 | 19541 | 9637 | 13045 | 14316 | 15524 | 12105 | 10397 |
| CPUE (kg/hr) | 107.5 | 84.3 | 55.7 | 69.1 | 142.4 | 81.8 | 142.3 | 112.1 | 185.0 |

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

**1989 preliminary landings estimate based on purchase slips and voluntary logbooks only.

Table 11a. Miramichi River alewife catch at age matrix (numbers of fish), 1982-1989.
FSP = first time spawners.

| | Numbers of alewife | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Total Age | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 |
| Recruited at age 2 | | | | | | | | |
| 2 | 88 | 3,372 | 442 | 0 | 0 | 0 | 0 | 510 |
| 3 | 0 | 2,998 | 0 | 0 | 0 | 0 | 0 | 0 |
| 4 | 0 | 0 | 2,914 | 0 | 0 | 0 | 0 | 0 |
| 5 | 0 | 0 | 0 | 0 | 0 | 0 | 2,205 | 0 |
| 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 8 | 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 |
| 4 | 512,276 | 234,132 | 146,091 | 386,590 | 286,470 | 1,440,508 | 446,532 | 372,259 |
| 5 | 609 | 32,675 | 68,132 | 56,831 | 151,799 | 242,523 | 404,010 | 389,031 |
| 6 | 6,892 | 0 | 16,625 | 0 | 0 | 66,394 | 30,355 | 145,617 |
| 7 | 3,522 | 0 | 0 | 0 | 0 | 0 | 0 | 906 |
| 8 | 0 | 8,203 | 0 | 0 | 0 | 0 | 0 | 159 |
| 9 | 0 | 1,156 | 4,141 | 0 | 0 | 0 | 0 | 0 |
| 10 | 0 | 191 | 0 | 0 | 0 | 0 | 0 | 0 |
| 11 | 631 | 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 |
| 5 | 130,479 | 62,669 | 63,102 | 113,236 | 118,662 | 391,723 | 308,847 | 553,205 |
| 6 | 143,367 | 39,749 | 24,958 | 0 | 16,014 | 122,139 | 21,373 | 217,380 |
| 7 | 43,161 | 16,464 | 0 | 0 | 0 | 24,679 | 2,869 | 1,534 |
| 8 | 81,564 | 22,757 | 0 | 0 | 0 | 0 | 0 | 113 |
| 9 | 0 | 11,090 | 0 | 0 | 0 | 0 | 0 | 0 |
| 10 | 0 | 289 | 0 | 0 | 0 | 0 | 0 | 0 |
| 11 | 0 | 6,281 | 0 | 0 | 0 | 0 | 0 | 0 |
| Recruited at age 5 | | | | | | | | |
| 5 | 0 | 21,180 | 0 | 0 | 1,046 | 11,426 | 88,472 | 28,501 |
| 6 | 0 | 15,941 | 65 | 0 | 0 | 5,598 | 7,410 | 31,756 |
| 7 | 7,661 | 5,730 | 0 | 0 | 0 | 0 | 0 | 3,512 |
| 8 | 2,282 | 2,971 | 0 | 0 | 0 | 0 | 0 | 0 |
| 9 | 0 | 31 | 0 | 0 | 0 | 0 | 0 | 0 |
| 10 | 0 | 264 | 0 | 0 | 0 | 0 | 0 | 0 |
| Recruited at age 6 | | | | | | | | |
| 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7 | 0 | 5,314 | 0 | 0 | 0 | 0 | 0 | 0 |
| 8 | 0 | 27 | 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 |
| Dominant Cohort | 1978 | 1979 | 1981 | 1981 | 1983 | 1983 | 1984 | 1985 |
| % | 52.7 | 52.8 | 54.9 | 53.4 | 72.9 | 65.4 | 41.5 | 42.0 |
| % FSP | 50.9 | 75.6 | 83.3 | 72.3 | 82.2 | 47.4 | 52.3 | 37.3 |

Table 11b. Miramichi River blueback herring catch at age matrix (numbers of fish), 1982-1989.
FSP = first time spawners.

| | Numbers of blueback | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Total Age | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 |
| Recruited at age 2 | | | | | | | | |
| 2 | 0 | 152 | 0 | 0 | 8,896 | 0 | 0 | 0 |
| 3 | 0 | 0 | 0 | 45,286 | 4,041 | 441 | 0 | 0 |
| 4 | 156 | 3,348 | 8,928 | 458,701 | 10,745 | 0 | 0 | 0 |
| 5 | 38,979 | 0 | 65 | 61,651 | 0 | 0 | 0 | 0 |
| 6 | 38,530 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7 | 38,530 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 8 | 0 | 2,971 | 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 |
| 4 | 331 | 56,345 | 46,033 | 651,074 | 115,960 | 827,750 | 300,134 | 1,950 |
| 5 | 104,330 | 24,476 | 19,005 | 238,591 | 112,724 | 30,711 | 478,031 | 98,445 |
| 6 | 57,735 | 22,581 | 132 | 83,989 | 7,486 | 26,879 | 0 | 132,846 |
| 7 | 245,140 | 0 | 5,692 | 6,269 | 635 | 0 | 15,398 | 0 |
| 8 | 295 | 9,110 | 6,437 | 0 | 4,890 | 0 | 0 | 0 |
| 9 | 156 | 0 | 3,573 | 53,698 | 910 | 0 | 0 | 0 |
| 10 | 295 | 0 | 0 | 0 | 5,502 | 0 | 0 | 0 |
| 11 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 12 | 0 | 0 | 0 | 22,048 | 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 |
| 5 | 269,938 | 320,701 | 115,687 | 791,462 | 680,984 | 146,913 | 2,502,843 | 1,423,871 |
| 6 | 113,298 | 96,567 | 85,019 | 284,856 | 149,370 | 495,935 | 114,810 | 1,849,546 |
| 7 | 346,806 | 20,837 | 9,861 | 57,964 | 15,240 | 173,138 | 90,714 | 40,462 |
| 8 | 25,609 | 115,083 | 25,692 | 11,866 | 10,227 | 0 | 7,410 | 0 |
| 9 | 59,235 | 14,860 | 10,110 | 48,540 | 0 | 0 | 0 | 278 |
| 10 | 0 | 23,796 | 3,835 | 0 | 0 | 0 | 0 | 0 |
| 11 | 0 | 264 | 0 | 0 | 0 | 0 | 0 | 0 |
| 12 | 0 | 0 | 4,235 | 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 |
| 6 | 44,219 | 113,850 | 4,412 | 46,808 | 24,821 | 13,989 | 36,777 | 83,890 |
| 7 | 129,543 | 35,305 | 24,077 | 46,514 | 0 | 32,355 | 0 | 6,676 |
| 8 | 19,490 | 34,208 | 6,377 | 0 | 0 | 42,683 | 0 | 163 |
| 9 | 19,490 | 111 | 2,040 | 22,048 | 0 | 0 | 0 | 0 |
| 10 | 609 | 6,368 | 0 | 0 | 0 | 0 | 0 | 0 |
| Recruited at age 6 | | | | | | | | |
| 6 | 0 | 11,430 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7 | 7,313 | 13,054 | 0 | 0 | 0 | 0 | 0 | 0 |
| 8 | 0 | 98 | 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 |
| Dominant Cohort | 1975 | 1979 | 1980 | 1981 | 1981 | 1983 | 1983 | 1983 |
| (%) | 35.3 | 46.5 | 46.9 | 63.3 | 42.4 | 76.9 | 63.7 | 47.1 |
| % FSP | 28.2 | 59.3 | 51.8 | 54.1 | 41.1 | 65.7 | 33.3 | 17.1 |

Table 12. Mean weight (g) at age of alewife and blueback from the Miramichi River, 1982 to 1989.

| Age | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | Mean |
|---|---|---|---|---|---|---|---|---|---|
| Alewife | | | | | | | | | |
| 1 | - | 53 | - | - | - | - | - | - | 53 |
| 2 | 132 | 112 | 134 | 122 | 119 | - | - | 122 | 124 |
| 3 | 249 | 225 | 213 | 210 | 208 | 218 | 231 | 185 | 217 |
| 4 | 321 | 279 | 276 | 262 | 273 | 245 | 267 | 281 | 276 |
| 5 | 343 | 339 | 329 | 286 | 307 | 296 | 286 | 298 | 311 |
| 6 | 398 | 314 | 340 | - | 291 | 296 | 321 | 325 | 326 |
| 7 | 406 | 402 | - | - | - | 312 | 542 | 401 | 413 |
| 8 | 494 | 391 | - | - | - | - | - | 383 | 423 |
| 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 | 164 |
| 4 | 213 | 209 | 193 | 194 | 204 | 189 | 202 | 192 | 200 |
| 5 | 242 | 260 | 233 | 237 | 235 | 228 | 234 | 232 | 238 |
| 6 | 333 | 299 | 287 | 290 | 265 | 247 | 274 | 270 | 283 |
| 7 | 369 | 383 | 330 | 305 | 305 | 275 | 293 | 324 | 323 |
| 8 | 382 | 375 | 384 | 344 | 364 | 334 | - | 377 | 366 |
| 9 | 351 | 379 | 390 | 393 | 327 | 390 | - | 397 | 375 |
| 10 | 353 | 392 | 353 | - | 356 | - | - | - | 364 |
| 11 | - | 335 | - | - | - | - | - | - | 335 |
| 12 | - | - | 485 | 381 | - | - | - | - | 433 |

Table 13a. Abundance index (number per day) of alewife using counts at Millbank trap (5% to 95% catch interval) up to June 15, 1982 to 1989.

| | Year | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Age | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 |
| Recruited at age 2 | | | | | | | | |
| 2 | 0 | 0 | 37.7 | 0 | 0 | 0 | 0 | 0.2 |
| 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 5 | 0 | 0 | 0 | 0 | 0 | 0 | 1.0 | 0 |
| Recruited at age 3 | | | | | | | | |
| 3 | 132.1 | 245.5 | 256.3 | 182.0 | 332.6 | 94.3 | 106.5 | 3.5 |
| 4 | 81.2 | 86.1 | 33.7 | 100.4 | 35.2 | 198.5 | 77.4 | 20.3 |
| 5 | 0.1 | 9.2 | 16.0 | 20.2 | 16.1 | 32.7 | 76.0 | 9.0 |
| 6 | 1.4 | 0 | 1.6 | 0 | 0 | 13.0 | 5.6 | 8.4 |
| 7 | 0.7 | 0 | 0 | 0 | 0 | 0 | 0 | 0.1 |
| 8 | 0 | 3.1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 9 | 0 | 0.6 | 0.4 | 0 | 0 | 0 | 0 | 0 |
| 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 11 | 0.4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Recruited at age 4 | | | | | | | | |
| 4 | 106.8 | 243.2 | 135.5 | 200.9 | 37.1 | 144.0 | 101.6 | 38.0 |
| 5 | 24.0 | 29.7 | 11.4 | 32.6 | 17.7 | 40.1 | 54.3 | 27.9 |
| 6 | 28.7 | 14.9 | 9.1 | 0 | 5.2 | 13.7 | 2.6 | 9.1 |
| 7 | 7.2 | 9.6 | 0 | 0 | 0 | 1.5 | 0 | 0.4 |
| 8 | 12.6 | 10.0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 9 | 0 | 3.9 | 0 | 0 | 0 | 0 | 0 | 0 |
| 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 11 | 0 | 2.6 | 0 | 0 | 0 | 0 | 0 | 0 |
| Recruited at age 5 | | | | | | | | |
| 5 | 0 | 3.9 | 0 | 0 | 0.6 | 2.8 | 13.7 | 2.5 |
| 6 | 0 | 3.7 | 3.7 | 0 | 0 | 0.4 | 0.6 | 0 |
| 7 | 3.6 | 0.5 | 0 | 0 | 0 | 0 | 0 | 0 |
| 8 | 0.3 | 1.0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Recruited at age 6 | | | | | | | | |
| 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7 | 0 | 1.2 | 0 | 0 | 0 | 0 | 0 | 0 |
| 8 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Ages Combined | 399.1 | 668.6 | 505.4 | 536.1 | 444.5 | 541.0 | 439.2 | 144.5 |
| Days 5% to 95% | 23 | 22 | 22 | 14 | 26 | 23 | 20 | 28 |

Table 13b. Abundance index (number per day) of blueback using counts at Millbank trap (5% to 95% catch interval) up to June 15, 1982 to 1989.

| | Year | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Age | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 |
| Recruited at age 2 | | | | | | | | |
| 2 | 0 | 0 | 0 | 0 | 22.6 | 0 | 0 | 0 |
| 3 | 0 | 0 | 0 | 11.4 | 9.0 | 0 | 0 | 0 |
| 4 | 0 | 3.6 | 5.1 | 145.7 | 10.0 | 0 | 0 | 0 |
| 5 | 15.7 | 0 | 8.1 | 8.4 | 0 | 0 | 0 | 0 |
| 6 | 9.5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7 | 9.5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Recruited at age 3 | | | | | | | | |
| 3 | 7.9 | 22.8 | 140.7 | 110.0 | 473.0 | 47.8 | 0 | 0.1 |
| 4 | 0 | 36.8 | 153.5 | 282.1 | 62.5 | 161.3 | 131.7 | 0 |
| 5 | 10.6 | 10.7 | 77.8 | 129.6 | 71.7 | 8.8 | 183.3 | 18.7 |
| 6 | 55.5 | 18.0 | 19.8 | 33.7 | 7.0 | 7.1 | 0 | 13.1 |
| 7 | 75.0 | 0 | 10.7 | 0 | 0 | 0 | 1.8 | 1.0 |
| 8 | 0 | 1.3 | 26.7 | 0 | 1.2 | 0 | 0 | 0 |
| 9 | 0 | 0 | 0 | 14.6 | 4.5 | 0 | 0 | 0 |
| 10 | 0 | 0 | 0 | 0 | 7.5 | 0 | 0 | 0 |
| 11 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 12 | 0 | 0 | 0 | 7.8 | 0 | 0 | 0 | 0 |
| Recruited at age 4 | | | | | | | | |
| 4 | 373.8 | 641.3 | 816.4 | 1133.7 | 117.8 | 740.9 | 809.6 | 34.5 |
| 5 | 192.4 | 212.0 | 265.6 | 371.4 | 405.1 | 17.4 | 1088.8 | 132.5 |
| 6 | 94.4 | 58.9 | 110.3 | 150.3 | 81.3 | 86.2 | 64.1 | 200.6 |
| 7 | 123.8 | 4.8 | 22.6 | 18.0 | 5.3 | 23.5 | 48.1 | 4.4 |
| 8 | 7.9 | 52.6 | 23.2 | 10.1 | 1.1 | 0 | 0 | 0.8 |
| 9 | 17.3 | 8.1 | 0 | 12.8 | 0 | 2.6 | 0 | 0 |
| 10 | 0 | 5.2 | 0 | 0 | 0 | 0 | 0 | 0 |
| 11 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Recruited at age 5 | | | | | | | | |
| 5 | 154.1 | 205.4 | 207.6 | 81.2 | 11.5 | 13.4 | 222.7 | 57.2 |
| 6 | 59.7 | 67.2 | 23.8 | 27.5 | 11.0 | 5.9 | 8.4 | 35.2 |
| 7 | 68.2 | 13.4 | 10.9 | 14.2 | 0 | 3.9 | 1.7 | 1.2 |
| 8 | 7.9 | 30.3 | 2.5 | 0 | 0 | 8.5 | 0 | 0.8 |
| 9 | 7.9 | 0 | 0 | 7.8 | 0 | 0 | 0 | 0 |
| 10 | 0 | 7.4 | 0 | 0 | 0 | 0 | 0 | 0 |
| Recruited at age 6 | | | | | | | | |
| 6 | 0 | 6.3 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7 | 12.0 | 3.7 | 0 | 0 | 0 | 0 | 0 | 0 |
| 8 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Ages Combined | 1398.4 | 1409.9 | 1925.3 | 2570.5 | 1302.2 | 1127.3 | 2560.1 | 509.2 |
| Days of 5% to 95% | 14 | 13 | 10 | 10 | 12 | 12 | 12 | 17 |

Table 14. Multiplicative model of catch rate (kg/hr) of alewife from the Miramichi gaspereau fisheries, 1982 to 1989. Catch rates are calculated as quotient of total catch to total effort by logbook report by year for the 10 to 90% catch interval of alewife in a given year.

GENERAL LINEAR MODELS PROCEDURE

CLASS LEVEL INFORMATION

| CLASS | LEVELS | VALUES |
|---|---|---|
| YY | 8 | 82 83 84 85 86 87 88 89 |

NUMBER OF OBSERVATIONS IN DATA SET = 103

DEP VARIABLE: KGHR

| SOURCE | DF | SUM OF SQUARES | MEAN SQUARE | F VALUE | PROB>F |
|---|---|---|---|---|---|
| MODEL | 7 | 18.97374501 | 2.71053500 | 16.232 | 0.0001 |
| ERROR | 95 | 15.86340717 | 0.16698323 | | |
| C TOTAL | 102 | 34.83715217 | | | |

| | | | |
|---|---|---|---|
| ROOT MSE | 0.4086358 | R-SQUARE | 0.5446 |
| DEP MEAN | 4.067963 | ADJ R-SQ | 0.5111 |
| C.V. | 10.04522 | | |

| SOURCE | DF | TYPE III SS | F VALUE | PR > F |
|---|---|---|---|---|
| YY | 7 | 18.97374501 | 16.23 | 0.0001 |

| VARIABLE | DF | PARAMETER ESTIMATE | STANDARD ERROR | T FOR HO: PARAMETER=0 | PROB > \|T\| |
|---|---|---|---|---|---|
| INTERCEP | 1 | 3.73536819 | 0.13621194 | 27.423 | 0.0001 |
| YY82 | 1 | 0.75979329 | 0.16402090 | 4.632 | 0.0001 |
| YY83 | 1 | -0.291572 | 0.16845247 | -1.731 | 0.0867 |
| YY84 | 1 | 0.30623799 | 0.17026492 | 1.799 | 0.0753 |
| YY85 | 1 | 0.02250985 | 0.17026492 | 0.132 | 0.8951 |
| YY86 | 1 | 0.79514563 | 0.19263277 | 4.128 | 0.0001 |
| YY87 | 1 | 1.10171626 | 0.20593310 | 5.350 | 0.0001 |
| YY88 | 1 | 0.43220356 | 0.19263277 | 2.244 | 0.0272 |

| | |
|---|---|
| SUM OF RESIDUALS | -1.38778E-14 |
| SUM OF SQUARED RESIDUALS | 15.86341 |
| PREDICTED RESID SS (PRESS) | 18.38863 |

Table 15. Multiplicative model of catch rates of blueback herring in the Miramichi gaspereau fishery, 1982 to 1989. Catch rates (kg/hr) are calculated from the quotient of total catch of blueback herring to total hours fished by logbook report for the 10 to 90% catch interval of blueback in any year.

GENERAL LINEAR MODELS PROCEDURE

CLASS LEVEL INFORMATION

| CLASS | LEVELS | VALUES |
|---|---|---|
| YY | 8 | 82 83 84 85 86 87 88 89 |

NUMBER OF OBSERVATIONS IN DATA SET = 92

| SOURCE | DF | SUM OF SQUARES | MEAN SQUARE | F VALUE | PROB>F |
|---|---|---|---|---|---|
| MODEL | 7 | 26.73719169 | 3.81959881 | 29.921 | 0.0001 |
| ERROR | 84 | 10.72306096 | 0.12765549 | | |
| C TOTAL | 91 | 37.46025266 | | | |

| | | | |
|---|---|---|---|
| ROOT MSE | 0.3572891 | R-SQUARE | 0.7137 |
| DEP MEAN | 4.171848 | ADJ R-SQ | 0.6899 |
| C.V. | 8.564289 | | |

| SOURCE | DF | TYPE III SS | F VALUE | PR > F |
|---|---|---|---|---|
| YY | 7 | 26.73719169 | 29.92 | 0.0001 |

PARAMETER ESTIMATES

| VARIABLE | DF | PARAMETER ESTIMATE | STANDARD ERROR | T FOR HO: PARAMETER=0 | PROB > \|T\| |
|---|---|---|---|---|---|
| INTERCEP | 1 | 4.97935600 | 0.12632077 | 39.418 | 0.0001 |
| YY82 | 1 | -0.944289 | 0.14844450 | -6.361 | 0.0001 |
| YY83 | 1 | -1.27368 | 0.15471071 | -8.233 | 0.0001 |
| YY84 | 1 | -1.54534 | 0.15642027 | -9.879 | 0.0001 |
| YY85 | 1 | -0.172931 | 0.15471071 | -1.118 | 0.2669 |
| YY86 | 1 | -1.1544 | 0.24188585 | -4.772 | 0.0001 |
| YY87 | 1 | -0.427265 | 0.18491467 | -2.311 | 0.0233 |
| YY88 | 1 | -0.280137 | 0.19295816 | -1.452 | 0.1503 |

| | |
|---|---|
| SUM OF RESIDUALS | -5.77316E-15 |
| SUM OF SQUARED RESIDUALS | 10.72306 |
| PREDICTED RESID SS (PRESS) | 12.56183 |

Table 16. Prefishery population numbers of blueback herring and values of F by recruitment age, estimated from Type I cohort analysis, 1989.

| | Year | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Age | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 |
| Recruited at age 3 | | | | | | | | |
| 3 | 1,694,137 | 1,281,112 | 2,461,293 | 660,909 | 16,040,106 | 3,793,335 | 23,474 | 29,234 |
| 4 | 1,985,260 | 1,075,086 | 788,998 | 1,552,027 | 203,753 | 9,982,060 | 2,319,786 | 13,999 |
| 5 | 297,084 | 694,602 | 356,496 | 259,992 | 315,277 | 30,722 | 3,203,438 | 706,753 |
| 6 | 83,768 | 67,452 | 234,502 | 118,101 | 7,489 | 70,881 | 4 | 953,723 |
| 7+ | 245,886 | 9,110 | 15,702 | 82,015 | 11,937 | 1 | 15,398 | 1 |
| 3+ | 4,306,135 | 3,127,362 | 3,856,991 | 2,673,044 | 16,578,562 | 13,876,999 | 5,562,100 | 1,703,710 |
| Fishing Mortality | | | | | | | | |
| 3 | 0.02 | 0.05 | 0.02 | 0.74 | 0.03 | 0.05 | 0.08 | 0.15 |
| 4 | 0.00 | 0.05 | 0.06 | 0.54 | 0.84 | 0.09 | 0.14 | 0.15 |
| 5 | 0.43 | 0.04 | 0.06 | 2.50 | 0.44 | 7.93 | 0.16 | 0.15 |
| 6 | 1.17 | 0.41 | 0.00 | 1.24 | 7.87 | 0.48 | 0.30 | 0.15 |
| 3+ | 0.12 | 0.06 | 0.04 | 0.83 | 0.06 | 0.10 | 0.15 | 0.15 |
| Population number recruited at age 4 | | | | | | | | |
| 4 | 2,391,199 | 2,622,743 | 4,672,068 | 7,358,131 | 4,639,075 | 65,987,883 | 17,235,518 | 4,383,812 |
| 5 | 2,036,058 | 1,275,657 | 1,054,182 | 2,805,104 | 2,845,467 | 2,847,136 | 40,447,278 | 10,222,201 |
| 6 | 531,109 | 618,032 | 334,175 | 328,415 | 704,649 | 757,434 | 944,910 | 13,278,190 |
| 7 | 786,893 | 146,208 | 182,480 | 87,189 | 15,243 | 194,313 | 91,508 | 290,483 |
| 8+ | 84,844 | 154,003 | 43,872 | 60,406 | 10,227 | 1 | 7,410 | 278 |
| 4+ | 5,830,103 | 4,816,643 | 6,286,777 | 10,639,245 | 8,214,661 | 69,786,767 | 58,726,624 | 28,174,964 |
| Fishing Mortality | | | | | | | | |
| 4 | 0.19 | 0.47 | 0.07 | 0.51 | 0.05 | 0.05 | 0.08 | 0.15 |
| 5 | 0.14 | 0.29 | 0.12 | 0.33 | 0.27 | 0.05 | 0.06 | 0.15 |
| 6 | 0.24 | 0.17 | 0.29 | 2.02 | 0.24 | 1.06 | 0.13 | 0.15 |
| 7 | 0.58 | 0.15 | 0.06 | 1.09 | 8.58 | 2.22 | 4.75 | 0.15 |
| 4+ | 0.24 | 0.39 | 0.10 | 0.52 | 0.16 | 0.07 | 0.08 | 0.15 |
| Population number recruited at age 5 | | | | | | | | |
| 5 | 462,508 | 493,588 | 656,088 | 358,976 | 66,905 | 322,646 | 1,340,522 | 975,691 |
| 6 | 711,698 | 182,685 | 137,364 | 395,391 | 117,312 | 23,548 | 173,739 | 602,260 |
| 7 | 243,957 | 233,576 | 24,088 | 46,525 | 121,982 | 32,366 | 3,345 | 47,928 |
| 8 | 38,005 | 40,038 | 69,382 | 4 | 4 | 42,686 | 4 | 1,170 |
| 9+ | 20,099 | 6,479 | 2,040 | 22,048 | 1 | 1 | 1 | 1 |
| 5+ | 1,476,267 | 956,366 | 888,962 | 822,944 | 306,204 | 421,247 | 1,517,611 | 1,627,050 |
| Fishing Mortality | | | | | | | | |
| 5 | 0.49 | 0.84 | 0.07 | 0.68 | 0.60 | 0.18 | 0.36 | 0.15 |
| 6 | 0.06 | 0.98 | 0.03 | 0.13 | 0.24 | 0.90 | 0.24 | 0.15 |
| 7 | 0.76 | 0.16 | 7.69 | 8.35 | 0.00 | 7.99 | 0.00 | 0.15 |
| 8 | 0.72 | 1.93 | 0.10 | 0.30 | 0.30 | 9.61 | 0.30 | 0.15 |
| 5+ | 0.34 | 0.75 | 0.27 | 0.86 | 0.22 | 1.78 | 0.35 | 0.15 |
| Population number, ages combined | | | | | | | | |
| | 11,612,505 | 8,900,371 | 11,032,730 | 14,135,233 | 25,099,427 | 84,085,013 | 65,806,335 | 31,505,724 |

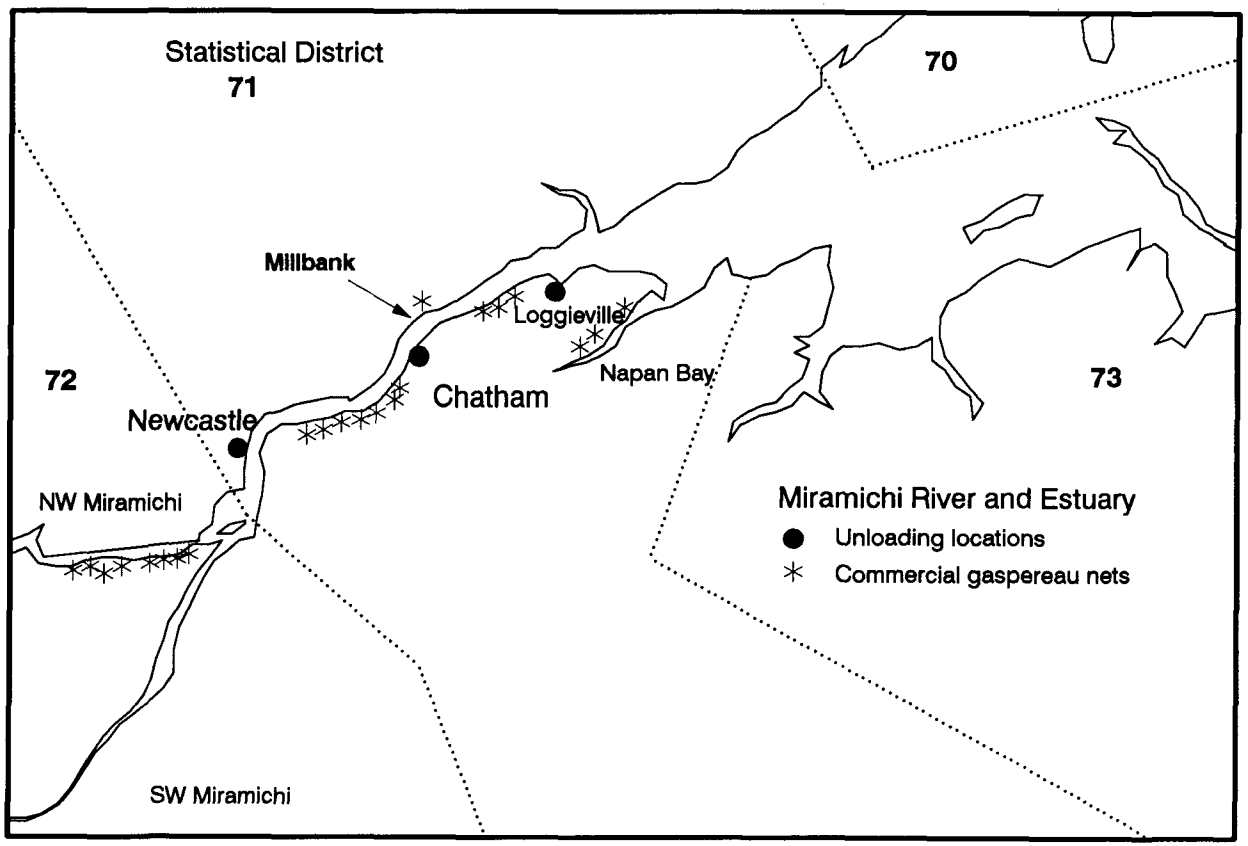


Fig. 1. Miramichi River and estuary showing gaspereau fishery sampling locations, distribution of nets and Millbank index trapnet location.

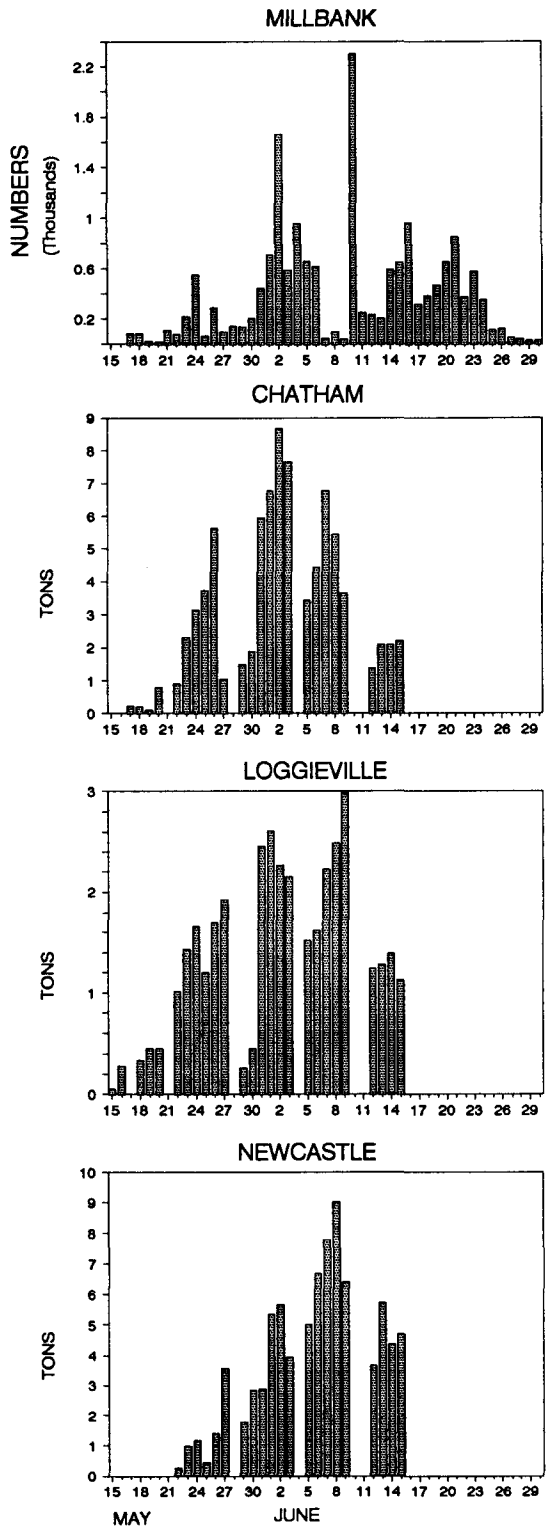


Fig. 2. Timing of catch of gaspereau (species combined) by fishing location on the Miramichi River as reported in catch and effort logbooks and at Millbank trapnet, 1989.

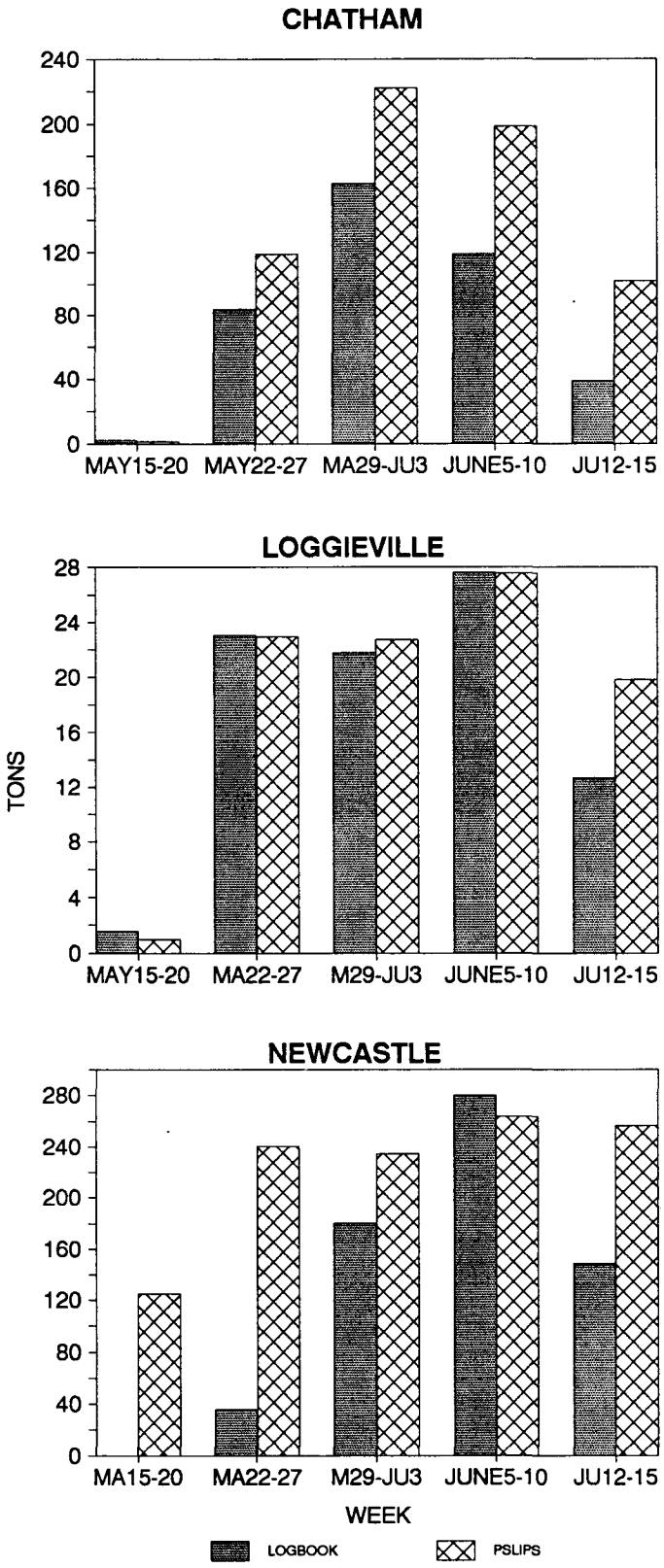


Fig. 3. Total catch of gaspereau from logbook reports and from purchase slip statistics by week and fishing location on the Miramichi River, 1989.

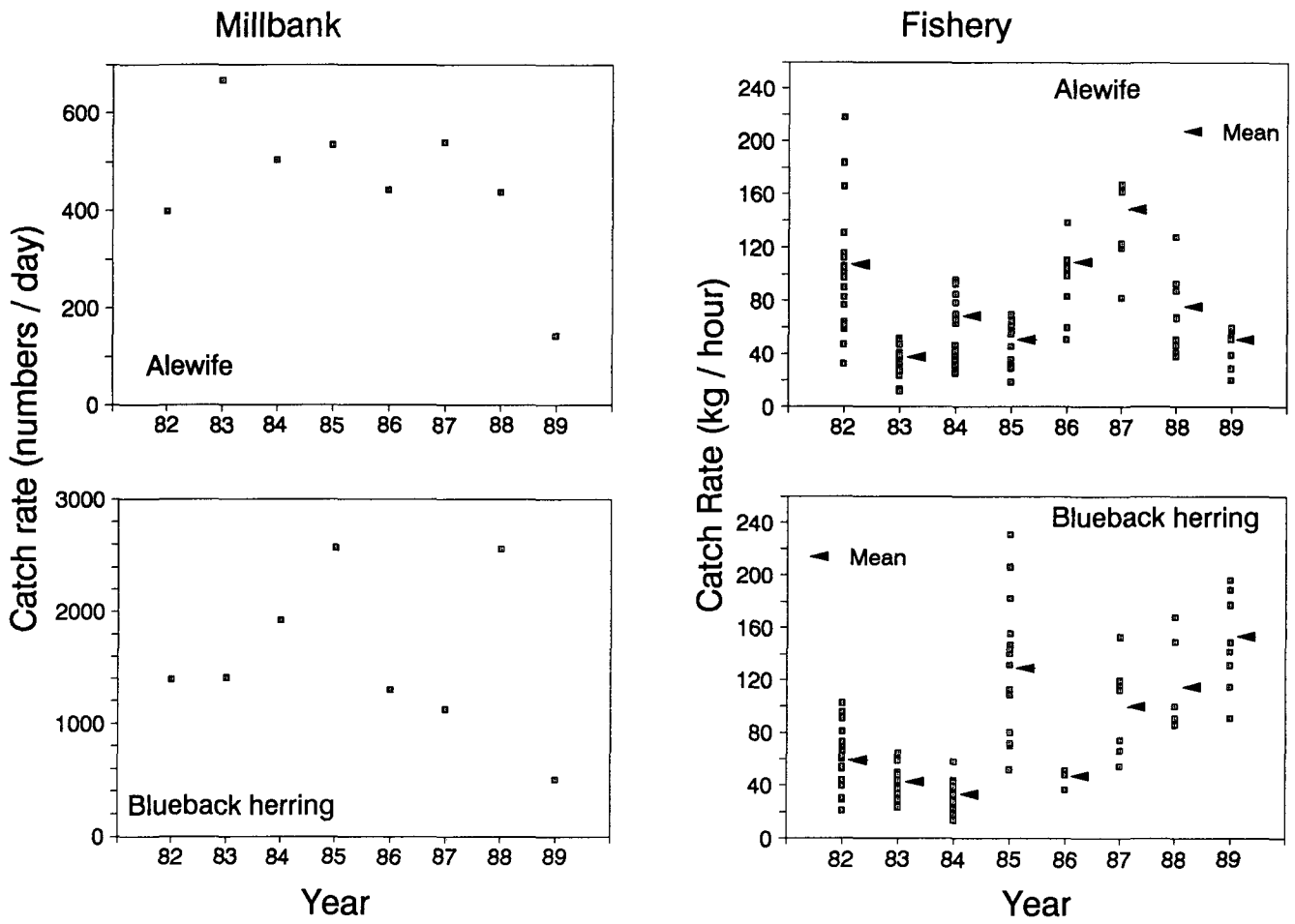


Fig. 4. Abundance indices of alewife and blueback herring in the Miramichi River, 1982 to 1989.

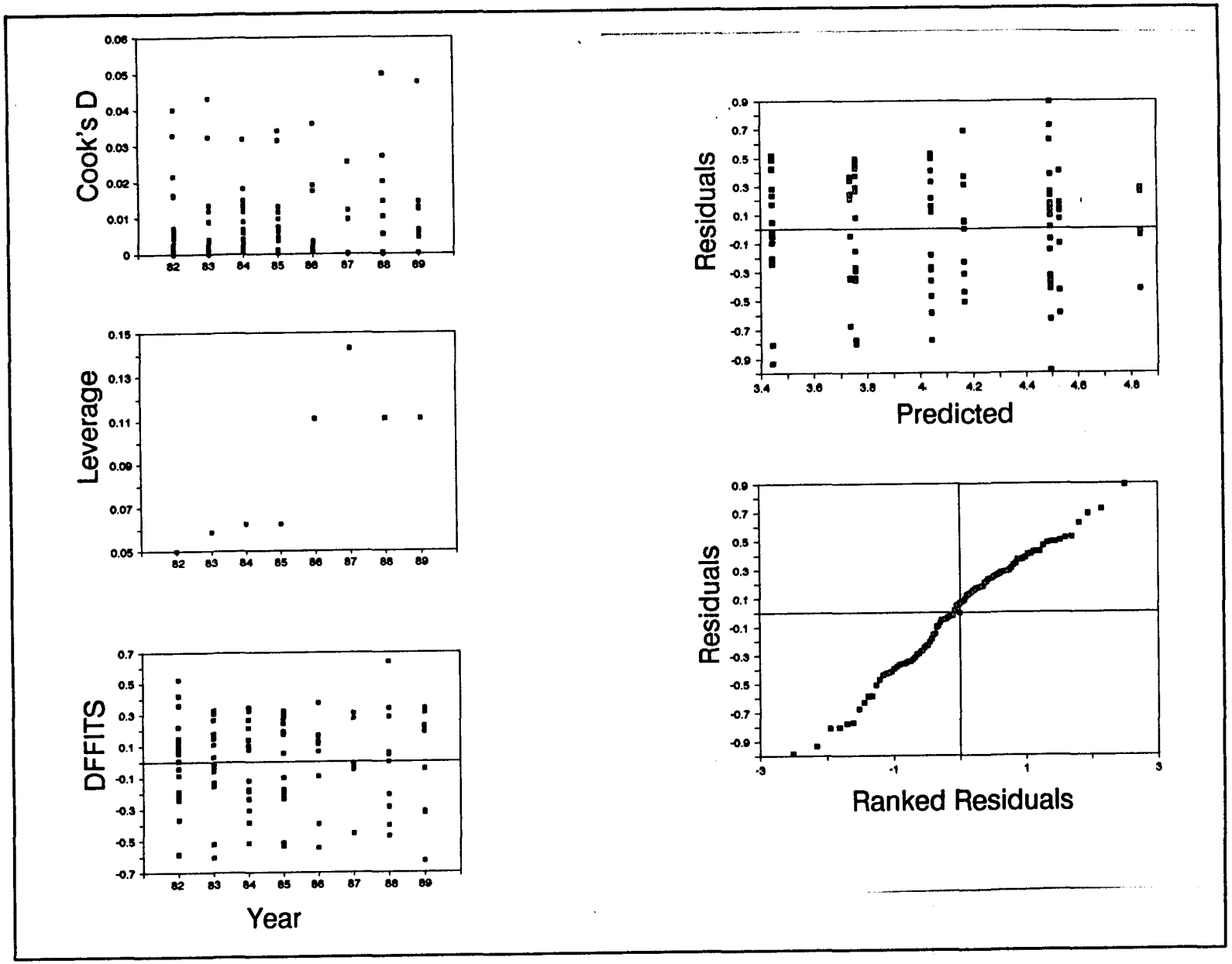


Fig. 5. Residual plots and influence diagnostics of the logbook catch rate multiplicative model for alewife, Miramichi River, 1982 to 1989.

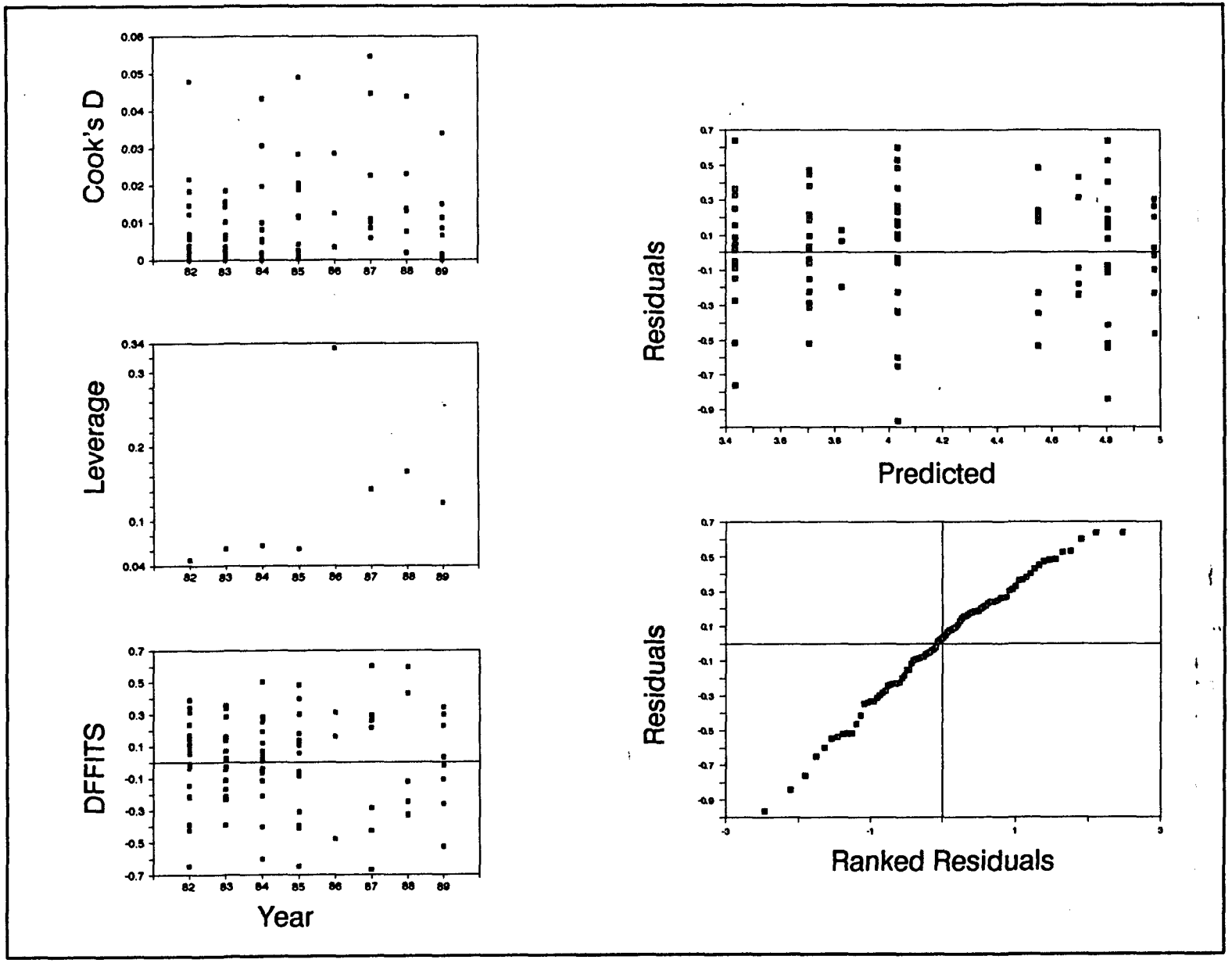


Fig. 6. Residual plots and influence diagnostics of the logbook catch rate multiplicative model for blueback herring, Miramichi River, 1982 to 1989.

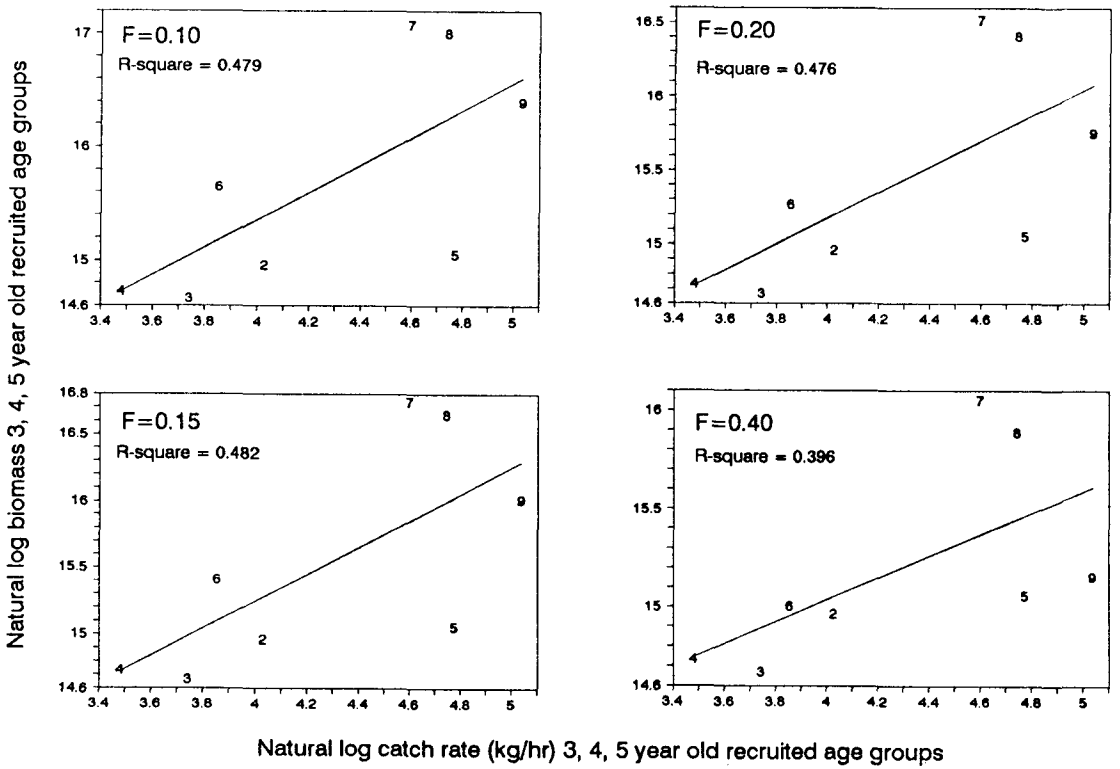


Fig. 7. Tuning plots of fishing mortality on blueback herring in the Miramichi River gaspereau fishery, 1989.