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# ASSESSMENT OF THE MARGAREE GASPEREAU FISHERY, 1989

by

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**ABSTRACT**

The Margaree River gaspereau catch in 1989, estimated at 1,123 tons, was similar to the previous 5 year mean and was composed of greater than 99% alewife (Alosa pseudoharengus) by weight. The 1989 catch was dominated by the 1985 cohort (87% by number) and percent new recruits was similar to the average of the previous 6 years (61%). The contribution of 3 year old new recruits (1986 cohort) was 3%, the lowest ever. An abundance index based upon catch rates from logbook reports indicated that in 1989, alewife were less abundant than in the previous two years. Sequential population analysis, under Type I fishery assumptions, generated a 1989 fishing mortality of 0.80. Predicted alewife landing for 1990 at F=1.0 is 864 tons within a 90% confidence interval of 583 to 1463 t. In spite of increased sampling intensity, alewife or blueback herring older than 7 years of age were not sampled. The historical random samples weighted by lower river zone logbook catch were most similar to two-phase length stratified sampling from both zones of the river. However, differences in numbers at age of recruitment of 5 year old alewife and in proportion of new recruits were noted. Assuming sampling conditions in previous years suffered from similar bias to 1989, the catch matrix for 1983 to 1988 would be acceptable.

**RÉSUMÉ**

Les prises de gaspereau de la rivière Margaree en 1989, estimées à 1,123 tonnes, étaient semblable à la moyenne des cinq dernières années. Ces prises, composées de plus de 99% Alosa pseudoharengus dont 61% était de nouvelles recrues, étaient dominées par le cohorte de 1985 (87% en nombre). Les nouvelles recrues de 3 ans, cohorte de 1986, ont constitué la plus faible proportion pour ce groupe dans les prises jusqu'à date. Un indice d'abondance fut calculé en utilisant les journaux de prises et de l'effort et indiquait une abondance réduite en 1989 relative à 1987 et 1988. Une analyse séquentielle de population, effectuée selon les hypothèses d'un modèle de pêche de type I, a estimé le taux de mortalité dû à la pêche en 1989 à 0,80. La prévision pour 1990, à un taux de mortalité dû à la pêche de 1,0 s'élève à 864 tonnes dans un intervalle de confiance (90%) de 583 à 1463 t. Malgré un programme d'échantillonnage plus intensif en 1989, des gaspereaux âgés de plus de 7 années n'ont pas été retrouvés. Les échantillons aléatoires pondérés par les prises quotidiennes des pêcheurs du bas de la rivière ont générés un estimé des prises à l'âge semblable à des échantillons stratifiés par longueur. Cependant, des différences dans les proportions de nouvelles recrues ainsi que dans la quantité de poissons âgés de cinq ans ont été retrouvées. Si le biais d'échantillonnage des années précédentes était semblable ou moins que celui de 1989, la matrice de captures à l'âge de 1983 à 1988 serait acceptable.

## INTRODUCTION

Annual assessments of the gaspereau fishery in the Margaree River have been presented since 1983 (Alexander 1984, Alexander and Vromans 1985, 1986, 1987, 1988, Chaput and LeBlanc 1989). Assessments of the 1987 and 1988 fisheries have estimated the fishing mortality on the spawning stock using Sequential Population Analysis (SPA or Cohort). A one day staggered closure per week, imposed in 1984, was maintained in 1989 with the river divided into two regulatory zones; a lower river zone, consisting of all waters downstream of NS Provincial Highway # 19 was closed to fishing on Friday 6:00 p.m. and all day Saturday and an upper river zone, consisting of waters above the Highway 19 bridge to the outlet of Lake Ainslie, was closed 6:00 p.m. Saturday and all day Sunday (Fig. 1). The fishery closed on June 30 as in previous years.

The absence of older gaspereau (aged 7+) in the fishery in recent years was highlighted as a concern by the Canadian Atlantic Fisheries Scientific Advisory Committee (CAFSAC) since it implied that fishing exploitation must have become excessive on that stock or the sampling was inappropriate. A sampling program in 1989 was undertaken to address the concerns expressed by CAFSAC. 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 at various locations along the river to determine if the historical sampling procedure represented the fishery.

Part B describes the 1989 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 using mean recruitment values for the last 7 years, estimated from cohort results.

## METHODS

### Historical sampling

Random samples of 25 fish per day were collected by the fisherman from the index trap sampled since 1984 (Fig. 1). Samples were frozen prior to analysis. Dates and samples collected are summarized in Table 1.

**Two phase length stratified sampling**

A two-phase length stratified sampling program was simultaneously undertaken in 1989. Length samples, consisting of approximately 250-300 measurements and a detailed sample of 5 fish per one-half centimetre length group, were obtained from various fishing locations in both management zones. Detailed samples were generally frozen for later processing. Daily sampling, in both zones, was stratified into AM & PM periods, and choice of period was randomly allocated, independently to each zone. Fishing locations sampled in each zone were randomly selected for each day within the constraints of the traps fishing on any particular day. Within trap variation was assessed by obtaining samples during both time periods from the same trap on the same day. Intertrap variation within a zone was assessed by obtaining samples from other traps within a zone on the same day. Locations sampled, dates and time periods are summarized in Table 1.

**Detailed processing of samples**

Biological characteristics collected include fork length (nearest quarter cm), whole weight (nearest gram), species (Alosa pseudoharengus; alewife or Alosa aestivalis; blueback herring), sex and scales which 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). Total age and age of first spawning were interpreted from scales 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-phase sampling were obtained using the program AGELEN (Wright 1990) which calculates catches at age based on the equations of Gavaris and Gavaris (1983). Because 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 fishing locations were processed for catch and effort (hours) by location. Reports of 0 effort or 0 catch were deleted from further analysis.

**Total landings**

Total catch for 1989 was calculated from the sum of the bait sales and from total pail counts of cured, packed gaspereau (a 50 lb pail of gaspereau was estimated to represent 32 kg of fresh fish).

**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 from the random sampling program at the index trap was calculated, for comparative purposes, using three weighting schemes.

1) daily samples were weighted by the logbook report from the index trap only (as per Chaput and LeBlanc 1989). Unsampled days prior to the first collected sample were allocated to the first sampled day. Landings from unsampled days after the last sampling date were allocated backward to the last sample. Unsampled days during the fishing season were analyzed using a mean value of the before and after sample days.

2) Daily samples were weighted by the logbook catch from the lower river zone for that day. Unsampled day analyses were identical to that of Method 1 above.

3) Daily samples were weighted by the logbook catch from the entire river for that day. Unsampled day allocations are similar to Methods 1 and 2 except unsampled days during the fishing season which were allocated backwards to the previous sampling day as per Chaput and LeBlanc (1989).

Catch at age from the two-phase sampling program was estimated using 3 age-length key strategies. In all estimates, the method of projecting within catch interval by zone followed by summing across intervals was used (project and add Method).

1) Catch period keys by fishing zone which correspond to the relative abundance of gaspereau in the river as indicated in the logbook reports. Length samples were weighted by the daily logbook catch for the day, projected onto catch for the period and summed for all periods (5 in all) and two zones (Table 1).

2) Weekly age-length keys by fishing zone. Length samples were weighted by daily logbook catch, projected within week catch and summed across weeks.

3) Twice weekly age-length keys by fishing zone. Length samples were weighted similarly to Method 2.

Total catch at age was calculated using the ratio of logbook catch from the age-length calculations to total catch for the year. Catch at age proportions were compared using the procedure outlined by Smith and Maguire (1983) for determining if samples originated from a common multinominal distribution.

**Verification of the absence of older age groups (7+ years of age).**

In spite of the increased sampling intensity, alewife or blueback older than 7 years of age were not found during the fishery period in 1989 (Table 2). Random samples collected from the index trap included alewife ranging in age from 2 to 7 years. Only 1 alewife out of 664 fish aged from the random samples (0.19%) was aged 7 years and it occurred on May 1 when the catch from the river was null. Stratified sampling generated alewife ranging in age from 2 to 7 years. A total of 3 out of 1922 alewife aged were designated as 7 year olds (0.16% of aged fish). Gaspereau were noted ascending the river during the first week in May, the first gaspereau to succumb to a partially installed trap was captured on April 29. If indeed, older age groups ascend the river first, then some older fish may have escaped to Lake Ainslie. Blueback aged 7 years were relatively more abundant than alewife, 0.92% of aged fish (Table 2).

**Assessment of the historical sampling procedure.**

In order to assess the representativeness of a sampling program, the true population structure must be determined. Under the assumptions of constant catchability, independent of trap location on the river, and equal fishing effort distribution, then the age composition of the catch in the lower zone should be similar to that in the upper zone, both representing the true age structure of the migrating population. An unbiased weighting method should result in similar catch-at-age proportions between zones.

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

1) variation in age composition of the catch dependent upon time of day sampled,

2) variation among trap catches for the same day within a zone, and

3) overall variation among the two zones.

Replicate samples obtained from the same trap during AM & PM time periods were significantly different relative to age composition (Chi-square; $P < 0.001$) (Table 3). Time periods were randomly selected a priori for both zones independently to reduce any bias resulting from heterogeneous distribution of ages in the catch during the day.

Samples were obtained from several traps within a zone on the same day. Significant differences in proportion at age were also noted (Chi-square; $P < 0.001$) (Table 4). Sites were randomly selected daily within a zone within the constraints of the traps actually fishing that day thus among trap variation was accounted for.

The catch at age from the stratified sampling was estimated using three age-length key structures to account for differences in timing of catch and age composition (Chaput and LeBlanc 1989). The twice weekly age keys, by zone, were used to account for changes in age composition over time (Chaput and LeBlanc 1989). Weekly keys were based on management time periods by zone. Catch period keys were structured by zone on the basis of the logbook catch rates such that samples collected on the high catch rate days were aggregated together rather than being divided among two keys (Table 5, Fig. 2). In 1989, the peak of the daily catch occurred two days earlier in the lower zone relative to the upper zone (Fig. 2).

The catch period weighting strategy was most appropriate for constructing the catch at age in the 1989 fishery. There was no significant difference in the lower and upper zone proportions using the catch period weighting strategy, whereas significant differences were noted in the weekly and twice weekly key estimates (Table 5). When zones were combined, the proportions at age using the three weighting schemes were not significantly different (Chi-square, $P > 0.05$; Table 6). The coefficients of variation (CV) for the dominant age groups using the catch period weighting were equal to or less than the CV's from the weekly and twice weekly weighings for the age groups comprising over 90% of the catch (Table 6).

**Random samples catch at age composition**

In a previous assessment (Chaput and LeBlanc 1989), random samples were weighted daily by the logbook catch of the index trap only, because samples were only obtained from the index trap. During the 1989 fishery, catch from the index trap was not representative of the catch from either the lower zone or the entire river because of trap malfunctions during the peak of the run (Fig. 2). Consequently, alternate weighting schemes were used. The proportions at age and species using index trap weighting were significantly different from either lower zone weighting and entire river weighting (Table 6); the pairwise significant difference being noted for blueback herring age 5 years recruited as 4 year olds. Considering the lag in catches of gaspereu from lower to upper zones, the lower zone weighting method was considered the most appropriate for the 1989 historical sampling for comparison with the two-phase sampling results.

Having established an appropriate representation of the age and species composition of the 1989 fishery, the representativeness of the historical sampling program can be evaluated. Three aspects were evaluated:

1) differences in age composition,

2) changes in length of gaspereau during the spawning migration, and

3) changes in estimated species composition over time.

**Catch at age composition**

The proportions at age estimated using the catch period weighted stratified samples and the lower zone weighted random samples were significantly different (Chi-square = 34.0, df = 9, $P < 0.01$) as a result of differences in the proportions of 5 year old alewife recruited at ages 3 and 4 (Table 6). The species proportions were similar although the stratified sampling indicated a higher proportion of new recruits (first time spawners = FSP) in the 1989 catch than did the random samples (Table 6). Coefficients of variation were much lower in the stratified sampling compared to the random sampling, 6 of 18 CV's were less than 10% compared to 2 of 14 for the random samples. The lower CV's in the stratified sampling are in large part attributable to the larger number of samples aged.

The change in fork length of gaspereau over the spawning migration in upper zone, lower zone and random samples was examined with a dummy regression, homogeneity of slopes model accompanied by a lack of fit test (Neter et al. 1983). The fork length of gaspereau decreased over the season in the stratified samples from the upper and lower zones as well as random samples, however, the slopes and intercepts of the upper and lower zone regressions were not significantly different from each other but were significantly different from the random sample slope and intercept.

| Zone | Parameter | P-value Parameter = 0 | P-value Upper = Lower | P-value Upper = Lower = 0 |
|---|---|---|---|---|
| | Slope | | | |
| Upper | -0.435 | 0.0001 | 0.409 | 0.0001 |
| Lower | -0.417 | 0.0001 | | |
| Random | -0.258 | 0.0001 | | |
| | Intercept | | | |
| Upper | 329.4 | 0.0001 | 0.274 | 0.0001 |
| Lower | 326.1 | | | |
| Random | 304.7 | | | |

The low overall R-square (0.11) for the homogeneity of slopes model reflects the large variance in length associated with each date. The lengths did not decrease monotonically over time which explains the significant lack of fit test for the above regressions. In spite of this, we can conclude that the distribution of lengths from the random sampling was quite different from that of the stratified samples (Fig. 3).

**Species composition**

There was no clear indication that the species composition of the stratified samples, by zone, was different from that of the random samples. Blueback were first identified from the random samples on May 23 and on May 29 from upper zone samples. Species composition was greater than 50% blueback after June 1 in all samples (Fig. 4).

**Summary**

Random samples collected from a single trap and weighted by the daily lower zone logbook catch were closest in age composition to that obtained from the stratified sampling but differed in the quantity and proportion by recruited age of 5 year old alewife, as well as in proportion of new recruits. The historical random sampling does not take into account variations in catch dependent upon time of day (do not know when samples are kept on any given day by the fisherman) as well as variations among traps. There were no gross differences in proportions at age between random sampling and stratified sampling in 1989, but the higher coefficients of variation from the random sampling make these estimates less reliable than the stratified sampling values. Assuming sampling conditions in previous years suffered from similar or less bias than in 1989, the catch matrix for 1983 to 1988 should be acceptable.

Variations in age composition between traps and within traps can be accounted for by sampling different traps during different time periods within a day. Stratification by zone is also an appropriate sampling strategy and when samples are weighted by catch periods rather than structured weekly periods, unbiased age compositions are obtained.

**PART B**

In 1989, 56 licenses were issued (as of October 31, 1989) although only 41 tip trap sites were actually fished. Landings of gaspereau from the Margaree River fishery for 1950 to 1989 are presented in Table 7. The 1989 catch for Margaree, estimated at 1,123 metric tons, is similar to the 5 year average but exceeded the upper 95% confidence interval of the historical (40 years), mean for District 2 (Table 7). Relative to gaspereau fisheries within Gulf Region, the Margaree fishery remains the dominant stock exploited in Nova Scotia and represents approximately 15 to 38% of the total landings from the Gulf (Table 8).

**1989 Fishery**

Based upon logbook reports, the largest daily catch occurred on May 18, when 172 tons of gaspereau were landed (18% of total logbook catch). The date of 50% catch was May 19 which is very similar to previous years and provides further evidence of the predictable migration timing (within one week) of alewife into Margaree River (Table 9). The fishery was conducted over a very short period of time, 80% of the catch was landed over a period of 10 days, the shortest interval ever (Table 9).

The 1989 gaspereau catch was estimated to consist of **99.5%** alewife by weight. This is similar to previous year fisheries and consequently a blueback herring assessment has not been provided. Catch at age matrix of blueback herring is presented in Table 10.

### Catch at Age Matrices

The catches at age for alewife are presented, by age of recruitment, for the years 1983 to 1989 (Table 11). The catch vector for 1989 was calculated from the stratified samples by zone, using catch period interval keys.

The 1985 year class was the dominant component of the alewife catch in 1989 (87% by number). Percent new recruits was about average to the previous 6 years but would have been substantially higher had the 1986 year class (3 year old new recruits) not been such a minor component of the overall catch (Table 11). The contribution by the 3 year old fish (2.9% by number) was the lowest in the past 7 years, previous low was in 1985 (9.2%) while the highest contribution by that age group was recorded in 1987 (79% of total) (Table 11). The previously dominant 1984 year class continued to contribute significantly to the catch, accounting for almost 9% by number (Table 11).

### Weight at Age Matrix

The weight at age matrix for alewife for 1983 to 1989 is presented in Table 12. In all years, mean weights at age were calculated using the measured weights of individual fish. The weight at age vector used in yield per recruit analysis was the weighted mean of all years, 1983 to 1989.

## ABUNDANCE INDEX

In the previous assessment, an abundance index was calculated from the index trap catch based on effort for the 5% to 95% cumulative catch interval. In 1989, the index trap was not representative of the daily catch trend of the river. This index was therefore considered inappropriate for 1989. A new index based upon catch rates from logbook reports from the entire river was constructed using a multiplicative model approach (Gavaris 1980). The catch and effort data from the logbooks were treated in the following manner.

1) The 10 to 90% catch interval for the entire river was identified and catches outside the interval were eliminated. This was done to remove the effect of scouting and opportunistic fishing towards the end of the season. As well, bluebacks which enter the river in the latter part of the season would not be considered in the analysis.

2) Catch per unit effort was calculated as the quotient of total catch (kg) to total effort (days) for each trap during the catch interval estimated in Step 1. Natural log of catch per unit effort was the dependent variable.

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 influential 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 zone on the river (lower vs upper) and total effort expended during the year by individual traps (i.e. opportunists fishing < 10 days in any year, moderates fishing between 10 and 17 days per year and extremists fishing > 17 days per year).

The year variable, by itself, explained less than 11% of the total variance of the catch rates. The fishing effort category added to the model containing year increased the R-square to 0.12. Addition of the zone variable to the model containing year increased the R-square to 0.26 and it was kept. Influence diagnostics of the model containing the year and zone parameters after several steps resulted in the deletion of 10 of the original 164 from the model and a final R-square of 0.34 (Table 13). Normal probability plot of the residuals confirmed the normality assumption (Fig. 5). Influence diagnostics of this final model did not reveal any observations with high DFFITS values (Fig. 6). The 1983 observations did have high leverage values but individually had low influence as seen from the plot of Cook's D statistic (Fig. 6). Transformed catch rates (tons/day) were:

| | |
|---|---|
| 1983 | 2.50 |
| 1984 | 2.36 |
| 1985 | 5.03 |
| 1986 | 2.57 |
| 1987 | 4.47 |
| 1988 | 5.33 |
| 1989 | 4.18 |

The abundance indices from the catch rate model and from the previous assessment are summarized in Fig. 7. The abundance indices give a different pattern of abundance of gaspereau during 1983 to 1989.

## NATURAL MORTALITY

A composite non-inriver fishing mortality component, calculated as Mc = 0.44 for alewife during the first spawning migration and Mc = 1.05 for subsequent spawning years (Chaput and Alexander 1989) was used.

## 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 with fishing complete. The population numbers refer to numbers just prior to the beginning of the fishery. Cohort analysis of the alewife population was performed on two groups separately based upon the age of recruitment. 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. Two groups were analyzed for Margaree, age 3 recruits and age 4 recruits. Alewife, aged as 2 and 5 year old recruits, constitute a minor component of the population and are not considered.

Because population of the oldest age equals catch of the oldest age, this cohort analysis ignores oldest age group F's encountered in other SPA models. The terminal F values were determined iteratively by regressing population biomass at F against the index of abundance (intercept model) and selecting the F from a combination of high R-square value and intercept term close to the origin. A final cohort analysis was performed using the selected terminal F to generate estimated population numbers at the beginning of the fishery. A summary of the calibration sequence is presented in Fig. 8. Population numbers and estimated F values are presented in Table 14.

Total river returns in 1989 were estimated at 7.593 million fish, the third highest estimated number since 1983 (Table 14). Returns were dominated by 4 year old new recruitment, second highest since 1983 whereas 3 year old recruitment was the lowest estimate to date. The 1984 year class continued to provide significant quantities of fish, 0.67 million, to the river returns and should be present in detectable quantities next year. Retrospective analysis of predicted year class size from the 1988 assessment (Chaput and LeBlanc 1989) relative to current year estimates, indicated that the size of the 1984 year class was previously overestimated by almost 10% (Fig. 9). The 1985 year class has been estimated this year as approximately one-third larger than previously estimated. Converged year classes (1980, 1981, and 1982) showed little change in numbers from the previous year, in spite of having used different abundance indices in the two years.

Predictions of new recruitment for the 1989 fishery, based on mean recruitment values of the previous years were wrong. The estimated strength of the 3 year new recruitment (1986 cohort) was 7% of predicted whereas the 4 year old new recruitment (1985 cohort) was almost 4 times larger. Total recruitment numbers were closer, 4,656,000 estimated versus 4,130,000 predicted. The prefishery population numbers of previous spawners was 2,900,000 versus 1,983,000 predicted. Estimated catch in 1989 was within the 90% confidence interval (693 to 1533 t) of the predicted catch at F = 1.0.

## YIELD PER RECRUIT - $F_{0.1}$

A yield per recruit analysis by the method of Thompson and Bell (Rivard 1982) was performed for alewife 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 |
|---|---|---|---|---|
| Mc = 0.44, 1.05 | | | | |
| 3 | 1.01 | 0.182 | 0.225 | 3 to 9 |
| 4 | 1.03 | 0.223 | 0.275 | 4 to 10 |

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

| | | | | |
|---|---|---|---|---|
| 3 | 1.32 | 0.158 | 0.220 | 3 to 9 |
| 4 | 1.35 | 0.195 | 0.270 | 4 to 10 |

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. Fishing mortalities for 3 and 4 year old recruited alewife are close to or higher than the $F_{0.1}$ estimate. Fishing mortalities generally exceed the $F_{0.1}$ value for 4 year old recruits. Previous F's of 0.95 and 1.0 for the 1988 fishery were underestimated which explains the reduction in estimated numbers in the population for most cohorts.

## PROGNOSIS

An analysis of the population numbers generated with the cohort analysis and estimates of harvest at F = 1.0 ($F_{0.1}$ value) are presented in Table 15. The estimated landing for 1990 of 864 metric tons is based in large part upon a seven year mean of 3 and 4 year old recruitment, which would account for 58% of the anticipated landing. The Margaree alewife stock has provided large landings in the past three years, exploiting a strong 1984 year class and a 1985 year class which appears to be stronger than average. The 1985 year class will be a significant component of the 1990 landings. The ratio of 3 year old recruits to 4 year old recruits for a cohort has always been greater than 1 (Table 14). If this pattern is consistent for the 1986 year class, then 4 year old fish in the 1990 fishery should be rare indeed and the landing for 1990 could be substantially lower than predicted based upon the 7 year mean of 4 year old recruits. The fishery continues to exploit the resource at and occasionally higher than $F_{0.1}$ value. Given the high exploitation rate on this resource and the predicted weakness of the 1986 year class, fishing effort on the river should not be increased from present levels and staggered weekly closures should be maintained.

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Table 1. Locations, dates and periods sampled during the 1989 Margaree River gaspereau fishery. Site numbers are indicated in Figure 1.

| | | Lower | | | Upper | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Site # | Period | No. Meas. | Site # | Period | No. Meas. | Site 12 Random | Julian Date |
| May | 1 | | | | | | | | 121 |
| | 2 | | | | | | | | 122 |
| | 3 | | | | | | | | 123 |
| | 4 | | | | | | | 25 | 124 |
| | 5 | | | | | | | | 125 |
| Saturday | 6 | | | | | | | | 126 |
| Sunday | 7 | | | | | | | 24 | 127 |
| | 8 | 8 | AM | 300 | | | | 25 | 128 |
| | 9 | 5 | PM | 299 | 49 | AM | 160 | 25 | 129 |
| | 10 | 9 | AM | 302 | 46 | PM | 129 | 23 | 130 |
| | 11 | 25 | AM | 283 | 33 | AM | 327 | | 131 |
| | 12 | 2 | AM | 288 | 49 | AM | 313 | 25 | 132 |
| Saturday | 13 | | | | 35 | AM | 309 | | 133 |
| | | | | | 35 | PM | 263 | | |
| Sunday | 14 | 12 | AM | 346 | | | | 25 | 134 |
| | | 12 | PM | 216 | | | | | |
| | 15 | 17 | PM | 258 | 39 | PM | 307 | 24 | 135 |
| | 16 | 5 | PM | 300 | 38 | PM | 305 | 24 | 136 |
| | 17 | 8 | AM | 301 | 33 | AM | 301 | | 137 |
| | 18 | 9 | PM | 305 | 49 | PM | 300 | 25 | 138 |
| | 19 | 7 | AM | 310 | 37 | PM | 303 | | 139 |
| Saturday | 20 | | | | 38 | AM | 301 | | 140 |
| | | | | | 51 | AM | 300 | | |
| Sunday | 21 | 2 | AM | 226 | | | | 25 | 141 |
| | | 8 | PM | 314 | | | | | |
| | | 11 | AM | 300 | | | | | |
| | 22 | 25 | PM | 300 | 64 | PM | 308 | 25 | 142 |
| | 23 | 9 | PM | 300 | 35 | PM | 300 | 25 | 143 |
| | 24 | 12 | AM | 306 | 33 | AM | 306 | 25 | 144 |
| | 25 | | | | 64 | AM | 303 | 25 | 145 |
| | 26 | | | | | | | 24 | 146 |
| Saturday | 27 | | | | 33 | AM | 340 | | 147 |
| Sunday | 28 | | | | | | | 25 | 148 |
| | 29 | | | | | | | 25 | 149 |
| | 30 | 12 | PM | 375 | | | | 25 | 150 |
| | 31 | 5 | AM | 130 | 56 | PM | 135 | 25 | 151 |
| June | 1 | | | | 64 | PM | 287 | 25 | 152 |
| | 2 | 12 | AM | 64 | 33 | AM | 108 | 24 | 153 |
| Saturday | 3 | | | | | | | | 154 |
| Sunday | 4 | | | | | | | 25 | 155 |
| | 5 | | | | | | | 25 | 156 |
| | 6 | 15 | AM | 270 | | | | 25 | 157 |
| | 7 | 17 | PM | 205 | 64 | PM | 195 | 24 | 158 |
| | 8 | | | | 64 | PM | 83 | 23 | 159 |
| | 9 | 15 | AM | 250 | | | | | 160 |
| Saturday | 10 | | | | | | | | 161 |
| Sunday | 11 | | | | | | | | 162 |
| Number of gaspereau measured | | | | 6548 | | | 5983 | 665 | |

Table 2. Number of gaspereau aged by species from the stratified samples and the random samples, Margaree River, 1989. Age.fsp refers to total age followed by age of first recruitment to the river.

| Species | Stratified Sampling | | | Historical |
| --- | --- | --- | --- | --- |
| age.fsp | Lower | Upper | Combined | Random |
| Alewife | | | | |
| 2.2 | 8 | 15 | 23 | 3 |
| 3.3 | 77 | 96 | 173 | 18 |
| 4.3 | 254 | 240 | 494 | 128 |
| 4.4 | 443 | 468 | 911 | 302 |
| 5.3 | 71 | 77 | 148 | 24 |
| 5.4 | 70 | 65 | 135 | 44 |
| 5.5 | 2 | | 2 | |
| 6.3 | 3 | 9 | 12 | 2 |
| 6.4 | 9 | 12 | 21 | 4 |
| 7.4 | 3 | | 3 | 1 |
| Blueback | | | | |
| 4.3 | 2 | 1 | 3 | 1 |
| 4.4 | 22 | 17 | 39 | 18 |
| 5.3 | 2 | 2 | 4 | 3 |
| 5.4 | 97 | 94 | 191 | 91 |
| 5.5 | 37 | 34 | 71 | 22 |
| 6.3 | | 1 | 1 | |
| 6.4 | 6 | 4 | 10 | 2 |
| 6.5 | 2 | 2 | 4 | 1 |
| 7.4 | 1 | 1 | 2 | |
| 7.5 | | 1 | 1 | |
| Total | 1109 | 1139 | 2248 | 664 |

Table 3. Intratrap variation of estimated percent at age of alewife, Margaree River, 1989. Age.fsp refers to total age and age of first spawning. AM & PM refer to morning and afternoon sampling periods, combined refers to samples from AM & PM combined. Site 12 is a lower zone trap, site 35 is from the upper zone. Asterisk (*) indicates differences in proportion at age between AM, PM samples and combined samples.

| | Site 12 | | Site 35 | |
|---|---|---|---|---|
| Age.fsp | AM | PM | AM | PM |
| Alewife | | | | |
| 3.3 | 0.29 | - | 5.18 | 5.70 |
| 4.3 | 40.58 | 18.98 * | 22.65 | 23.19 |
| 5.3 | 8.41 | 17.97 * | 33.01 | 17.11 * |
| 6.3 | 1.74 | - | - | 6.46 * |
| 4.4 | 39.71 | 56.89 * | 28.80 | 31.18 |
| 5.4 | 6.09 | 5.99 | 5.83 | 12.55 * |
| 6.4 | 3.19 | 0.46 | 4.53 | 3.80 |
| 7.4 | - | - | - | - |
| 5.5 | - | - | - | - |
| Chi-square | | 47.3 | | 42.4 |
| df | | 6 | | 6 |
| P-value | | <0.001 | | <0.001 |
| Sample size | 346 | 216 | 309 | 263 |

Table 4. Intertrap variation of estimated percent at age of alewife, Margaree River, 1989. Age.fsp refers to total age and age of first spawning. AM & PM refer to morning and afternoon sampling periods, combined refers to samples from all sites combined. Asterisk (*) indicates differences in proportion at age between site samples and combined site samples.

| | Lower Zone | | | Upper Zone | |
|---|---|---|---|---|---|
| Age.fsp | 2 | 8 | 11 | 38 | 51 |
| Alewife | | | | | |
| 3.3 | 1.33 | 1.28 | 0.33 | 1.66 | 0.00 |
| 4.3 | 40.71 | 11.50 | 19.40 * | 42.19 | 38.33 |
| 5.3 | 2.21 | 1.28 | 0.00 | 4.32 | 4.33 |
| 6.3 | - | - | - | - | - |
| 4.4 | 54.42 | 85.94 | 77.93 * | 50.17 | 29.00 * |
| 5.4 | 1.33 | 0.00 | 2.34 * | 1.66 | 28.33 * |
| 6.4 | - | - | - | - | - |
| 7.4 | - | - | - | - | - |
| 5.5 | - | - | - | - | - |
| Chi-square | | 85.47 | | | 94.46 |
| df | | 8 | | | 4 |
| P-value | | <0.001 | | | <0.001 |
| Sample size | 226 | 314 | 300 | 301 | 300 |

Table 5. Percent by number at age of alewife and blueback by management zone in the 1989 Margaree River gaspereau fishery estimated using different age-length key sample combinations. Asterisk (*) indicates significant differences (P<0.05) between lower and upper zone proportions.

| | Percent at age | | | | | |
|---|---|---|---|---|---|---|
| | Catch Period | | Weekly | | Twice Weekly | |
| AGE.FSP | Lower | Upper | Lower | Upper | Lower | Upper |
| Alewife | | | | | | |
| 2.2 | 0.01 | 0.02 | 0.02 | 0.02 | 0.01 | 0.03 |
| 3.3 | 2.81 | 2.86 | 3.00 | 3.70 | 2.79 | 2.42 |
| 4.3 | 27.32 | 31.82 | 27.82 | 30.60 | 27.77 | 31.90 |
| 5.3 | 4.89 | 3.33 | 6.89 | 2.85 * | 6.74 | 3.03 * |
| 6.3 | 0.09 | 0.23 | 0.17 | 0.31 | 0.08 | 0.18 |
| 4.4 | 58.45 | 56.31 | 53.48 | 57.27 | 54.37 | 57.78 |
| 5.4 | 4.76 | 3.80 | 5.85 | 3.67 | 6.29 | 3.32 * |
| 6.4 | 0.27 | 0.25 | 0.48 | 0.43 | 0.31 | 0.42 |
| 7.4 | 0.01 | 0.00 | <.01 | 0.00 | 0.01 | 0.00 |
| 5.5 | 0.06 | 0.00 | 0.05 | 0.00 | 0.04 | 0.00 |
| Blueback | | | | | | |
| 4.3 | 0.01 | 0.01 | 0.01 | 0.02 | 0.01 | 0.02 |
| 5.3 | <.01 | 0.02 | 0.01 | 0.01 | 0.01 | 0.01 |
| 4.4 | 0.11 | 0.15 | 0.19 | 0.14 | 0.14 | 0.12 |
| 5.4 | 0.83 | 0.83 | 1.33 | 0.65 | 0.78 | 0.51 |
| 6.4 | 0.00 | 0.03 | 0.04 | 0.02 | 0.02 | 0.03 |
| 7.4 | 0.01 | <.01 | <.01 | <.01 | <.01 | <.01 |
| 5.5 | 0.35 | 0.31 | 0.64 | 0.29 | 0.63 | 0.21 |
| 6.5 | 0.03 | 0.02 | 0.02 | 0.01 | 0.01 | 0.01 |
| 7.5 | <.01 | <.01 | 0.00 | <.01 | 0.00 | <.01 |
| Sample size | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 |
| Chi-square | | 9.66 | | 30.09 | | 31.40 |
| df | | 10 | | 9 | | 9 |
| P-value | | >0.05 | | <0.01 | | <0.01 |
| Percent by number | | | | | | |
| Alewife | 98.7 | 98.6 | 97.8 | 98.9 | 98.4 | 99.1 |
| Blueback | 1.3 | 1.4 | 2.2 | 1.1 | 1.6 | 0.9 |
| Dates (Julian) corresponding to periods used in age-length key aggregations | | | | | | |
| Period 1 | <134 | <135 | <133 | <134 | <130 | <131 |
| | | | | | 130-132 | 131-133 |
| 2 | 134-137 | 135-137 | 134-139 | 135-140 | 134-136 | 135-137 |
| | | | | | 137-139 | 138-140 |
| 3 | 138-142 | 138-143 | 141-146 | 142-147 | 141-143 | 142-144 |
| | | | | | 144-146 | 145-147 |
| 4 | 143-148 | 144-147 | 148-153 | 149-154 | 148-150 | 149-151 |
| | | | | | 151-153 | 152-154 |
| 5 | >148 | >147 | >154 | >155 | 155-157 | 156-158 |
| | | | | | >157 | >158 |

Table 6. Percent at age and coefficient of variation of alewife and blueback in the 1989 Margaree River gaspereau fishery estimated using different age-length key sample combinations for two-stage stratified sampling and historical random sampling strategies.

| | Two-Stage Stratified Sampling | | | | | | Historical Random Sampling | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Percent at Age | | | Coefficient of Variation | | | Percent at Age | | | Coefficient of Variation | | |
| Age.fsp | Catch Period | Weekly | Twice Weekly | Catch Period | Weekly | Twice Weekly | Index Trap | Lower Zone | River | Index Trap | Lower Zone | River |
| Alewife | | | | | | | | | | | | |
| 2.2 | <.01 | 0.02 | 0.02 | 93.8 | >100 | >100 | 0.15 | 0.02 | 0.03 | - | - | - |
| 3.3 | 2.83 | 3.28 | 2.64 | 14.2 | 11.7 | 16.9 | 1.04 | 2.24 | 2.56 | 23.7 | 81.3 | 81.6 |
| 4.3 | 29.12 | 28.94 | 29.43 | 2.6 | 2.6 | 3.4 | 27.32 | 32.30 | 31.56 | 12.4 | 13.9 | 15.5 |
| 5.3 @ | 4.27 | 5.25 | 5.25 | 9.3 | 8.7 | 11.9 | 2.40 | 1.96 | 1.64 | 45.3 | 43.9 | 39.3 |
| 6.3 | 0.15 | 0.23 | 0.12 | 71.5 | 72.6 | >100 | 0.10 | 0.03 | 0.05 | 76.1 | 77.4 | 22.9 |
| 4.4 | 57.60 | 55.01 | 55.75 | 1.5 | 1.6 | 2.1 | 55.54 | 51.78 | 52.94 | 6.5 | 7.5 | 7.8 |
| 5.4 @ | 4.37 | 4.97 | 5.09 | 8.5 | 9.3 | 11.9 | 7.40 | 8.95 | 8.90 | 29.2 | 30.2 | 32.7 |
| 6.4 | 0.26 | 0.46 | 0.35 | 49.4 | 46.7 | 51.3 | 0.83 | 0.69 | 0.74 | 25.5 | 64.0 | 62.9 |
| 7.4 | <.01 | <.01 | <.01 | >100 | >100 | >100 | 0.00 | 0.00 | 0.00 | - | - | - |
| 5.5 | 0.03 | 0.03 | 0.02 | 41.4 | 41.5 | 66.0 | 0.00 | 0.00 | 0.00 | - | - | - |
| Blueback | | | | | | | | | | | | |
| 4.3 | 0.01 | 0.01 | 0.01 | 42.2 | 50.0 | 72.0 | 0.04 | 0.05 | 0.02 | >100 | >100 | >100 |
| 5.3 | 0.01 | 0.01 | 0.01 | 27.2 | 65.7 | >100 | 0.11 | 0.03 | 0.02 | 59.6 | 67.1 | 64.9 |
| 4.4 | 0.12 | 0.17 | 0.13 | 10.5 | 13.1 | 16.9 | 0.90 | 0.31 | 0.45 | 30.1 | 32.6 | 54.7 |
| 5.4 | 0.83 | 1.05 | 0.67 | 2.9 | 4.5 | 5.6 | 3.33 | 1.20 | 0.84 * | 9.4 | 10.3 | 10.7 |
| 6.4 | 0.03 | 0.03 | 0.03 | 24.6 | 42.2 | 55.4 | 0.07 | 0.03 | 0.01 | 55.9 | 36.5 | 23.6 |
| 7.4 | <.01 | <.01 | <.01 | 89.4 | >100 | >100 | 0.00 | 0.00 | 0.00 | - | - | - |
| 5.5 | 0.33 | 0.50 | 0.46 | 5.0 | 6.9 | 8.7 | 0.72 | 0.40 | 0.21 | 24.1 | 23.2 | 25.4 |
| 6.5 | 0.02 | 0.02 | 0.01 | 24.4 | 56.7 | 91.3 | 0.04 | 0.02 | 0.02 | >100 | >100 | >100 |
| 7.5 | <.01 | <.01 | <.01 | - | >100 | >100 | 0.00 | 0.00 | 0.00 | - | - | - |
| Sample size | 1000 | 1000 | 1000 | | | | 1000 | 1000 | 1000 | | | |
| Chi-square | | 5.39 | | | | | | 46.29 | | | | |
| d.f. | | 36 | | | | | | 24 | | | | |
| P-value | | >0.05 | | | | | | <0.01 | | | | |
| Percent by number | | | | | | | | | | | | |
| Alewife | 98.63 | 98.19 | 98.67 | | | | 94.78 | 97.96 | 98.42 | | | |
| FSP | 60.5 | 58.3 | 58.4 | | | | 56.7 | 54.0 | 55.5 | | | |
| PREV | 38.2 | 39.9 | 40.2 | | | | 38.1 | 43.9 | 42.9 | | | |
| Blueback | 1.35 | 1.79 | 1.32 | | | | 5.22 | 2.04 | 1.58 | | | |
| FSP | 0.45 | 0.67 | 0.59 | | | | 1.6 | 0.7 | 0.7 | | | |
| PREV | 0.89 | 1.12 | 0.73 | | | | 3.6 | 1.3 | 0.9 | | | |

* significant difference (P<0.05) in proportions at age estimated with the three weighting schemes for the random samples.

@ significant difference (P<0.05) in proportions at age estimated from the stratified samples (catch period weighting) and the random sampling (lower zone weighting).

Table 7. Gaspereau landings from District 2 and Margaree River, 1950 to 1989. Historical, recent 10 year and 5 year means (95% confidence intervals) are also presented.

| | Landings (mt) | | |
|---|---|---|---|
| Year | District 2 | | Margaree River only |
| 1950 | 713 | | |
| 1951 | 755 | | |
| 1952 | 964 | | |
| 1953 | 638 | | |
| 1954 | 1,275 | | |
| 1955 | 1,163 | | |
| 1956 | 859 | | |
| 1957 | 58 | | |
| 1958 | 395 | | |
| 1959 | 496 | | |
| 1960 | 531 | | |
| 1961 | 423 | | |
| 1962 | 558 | | |
| 1963 | 551 | | |
| 1964 | 640 | | |
| 1965 | 875 | | |
| 1966 | 320 | | |
| 1967 | 185 | | |
| 1968 | 188 | | |
| 1969 | 251 | | |
| 1970 | 408 | | |
| 1971 | 620 | | |
| 1972 | 965 | | |
| 1973 | 1,113 | | |
| 1974 | 1,681 | | |
| 1975 | 1,238 | | |
| 1976 | 497 | | |
| 1977 | 1,202 | | |
| 1978 | 1,713 | | |
| 1979 | 1,776 | | |
| 1980 | 1,069 | | |
| 1981 | 1,369 | | |
| 1982 | 1,445 | | |
| 1983 | 580 | | |
| 1984 | 883 * | | 883 * |
| 1985 | 1,223 * | | 1,223 * |
| 1986 | 545 * | | 545 * |
| 1987 | 1,259 * | | 1,259 * |
| 1988 | 1,912 | | 1,666 * |
| 1989 | 1,123 * | | 1,123 * |
| Means (95% C.I.) | | | |
| Historical | 855 | (702-1,007) | |
| 10 Year | 1,206 | (902-1,510) | |
| 5 Year | 1,164 | (600-1,729) | 1,115 (645-1,761) |

* Science Branch estimates. All other values are from Statistics Branch.

Table 8. Landings of gaspereau for the Gulf Region, 1978 to 1988. Data summarized from purchase slip and Supp. "B" slips collated by Statistics Branch, DFO.

| | Nova Scotia Statistical District | | | | | | | Total Landings (metric tons) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | 2 | 3 | 11 | 12 | 13 | 45 | 46 | NS | NB | PEI | Gulf |
| 1978 | 1,712.7 | 4.9 | 36.3 | 6.8 | 32.4 | 117.9 | 0.0 | 1,911.0 | 3,084.1 | 104.2 | 5,099.3 |
| 1979 | 1,776.1 | 0.2 | 114.4 | 9.1 | 49.4 | 74.3 | 0.0 | 2,023.4 | 4,408.7 | 405.3 | 6,837.4 |
| 1980 | 1,069.3 | 0.0 | 909.7 | 21.2 | 79.8 | 75.5 | 11.8 | 2,167.4 | 4,676.0 | 253.2 | 7,096.5 |
| 1981 | 1,368.6 | 0.7 | 61.2 | 12.7 | 77.6 | 103.1 | 29.5 | 1,653.5 | 2,708.0 | 258.8 | 4,620.3 |
| 1982 | 1,445.5 | 0.0 | 29.4 | 18.2 | 34.4 | 115.4 | 20.6 | 1,663.6 | 1,993.7 | 132.9 | 3,790.2 |
| 1983 | 579.8 | 0.0 | 144.1 | 27.2 | 16.0 | 10.2 | 2.5 | 779.8 | 1,900.6 | 36.4 | 2,716.9 |
| 1984 | 883.0 * | 0.0 | 77.5 | 6.8 | 84.7 | 0.2 | 0.1 | 1,052.4 | 1,716.9 | 87.9 | 2,857.2 |
| 1985 | 1,223.0 * | 0.0 | 0.0 | 1,854.2 | 99.6 | 26.4 | 0.0 | 3,203.3 | 3,569.2 | 238.4 | 7,010.9 |
| 1986 | 545.0 * | 0.0 | 161.4 | 31.8 | 236.2 | 0.0 | 0.0 | 974.3 | 2,261.3 | 463.6 | 3,699.3 |
| 1987 | 1,259.0 * | 0.0 | 847.5 | 59.1 | 127.6 | 121.6 | 143.7 | 2,558.6 | 4,419.2 | 364.2 | 7,342.0 |
| 1988 | 1,911.8 | - | 570.2 | 120.0 | 224.5 | - | 8.4 | 2,835.0 | 3,713.7 | 233.2 | 6,782.1 |
| Mean | 1,252.2 | 0.5 | 268.3 | 197.0 | 96.6 | 58.6 | 19.7 | 1,892.9 | 3,132.0 | 234.4 | 5,259.3 |

* District 2 1984-1987 landings as per DFO Science Branch estimate (see Table 7).

Table 9. Catch, effort and dates of maximum and cumulative landings for the gaspereau fishery of the Southwest Margaree River, 1983 to 1989.

| | | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 |
|---|---|---|---|---|---|---|---|---|
| Logbook: | effort (hrs) | 2,010 | 7,498 | 3,306 | 3,283 | 4,374 | 8,046 | |
| | catch (mt) | 112.65 | 637.07 | 506.37 | 212.69 | 882.27 | 1375.08 | 972.70 |
| Estimated Landings (mt) | | 579.82 | 883.41 | 1222.70 | 545.20 | 1258.80 | 1665.70 | 1123.00 |
| Expansion Factor | | 5.1471 | 1.3867 | 2.4146 | 2.5634 | 1.4268 | 1.2113 | 1.1545 |
| Estimated Effort (hrs) | | 10,346 | 10,397 | 7,983 | 8,416 | 6,241 | 9,747 | |
| Landings | | | | | | | | |
| Date of: | Maximum catch | May 17 | May 17 | May 30 | May 17 | May 13 | May 22 | May 18 |
| | Cumulative 10% | 10 | 16 | 21 | 9 | 12 | 17 | 14 |
| | 50% | 17 | 21 | 28 | 17 | 16 | 23 | 19 |
| | 90% | 24 | 28 | June 2 | 26 | 26 | 29 | 23 |
| Total days for 10% to 90% | | 15 | 12 | 12 | 17 | 15 | 13 | 10 |

Catch timing values for 1983 to 1988 were corrected from those presented by Chaput and LeBlanc (1989) who reported the 5% to 95% cumulative catch period.

Table 10. Catch at age (numbers) of blueback herring in the Southwest Margaree River gaspereau fishery, 1983 to 1989. AGE.FSP refers to total age followed by age of recruitment.

| AGE.FSP | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 |
|---|---|---|---|---|---|---|---|
| 1.1 | 0 | 42 | 0 | 0 | 0 | 0 | 0 |
| 2.2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 3.2 | 0 | 1,093 | 1,419 | 0 | 0 | 0 | 0 |
| 4.2 | 0 | 716 | 2,943 | 0 | 0 | 0 | 0 |
| 5.2 | 0 | 666 | 72 | 0 | 0 | 0 | 0 |
| 3.3 | 0 | 51 | 138 | 169 | 675 | 2,152 | 0 |
| 4.3 | 0 | 4,229 | 10,919 | 87 | 0 | 5,475 | 341 |
| 5.3 | 0 | 3,012 | 3,619 | 237 | 0 | 0 | 597 |
| 6.3 | 6,290 | 1,501 | 0 | 614 | 52 | 0 | 0 |
| 7.3 | 0 | 0 | 0 | 105 | 597 | 0 | 0 |
| 8.3 | 0 | 0 | 1,353 | 0 | 0 | 0 | 0 |
| 9.3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 4.4 | 0 | 0 | 7,115 | 668 | 1,946 | 24,956 | 5,176 |
| 5.4 | 0 | 16 | 1,775 | 1,499 | 77 | 1,765 | 35,141 |
| 6.4 | 6,290 | 28 | 7,165 | 699 | 1,814 | 0 | 1,244 |
| 7.4 | 0 | 0 | 0 | 248 | 103 | 0 | 114 |
| 8.4 | 0 | 0 | 0 | 0 | 597 | 0 | 0 |
| 9.4 | 164 | 446 | 0 | 0 | 0 | 0 | 0 |
| 10.4 | 164 | 0 | 0 | 0 | 0 | 0 | 0 |
| 5.5 | 0 | 0 | 0 | 0 | 0 | 0 | 14201 |
| 6.5 | 0 | 0 | 0 | 0 | 0 | 0 | 654 |
| 7.5 | 0 | 0 | 0 | 0 | 0 | 0 | 28 |
| Total Catch | 12,908 | 11,800 | 36,518 | 4,326 | 5,861 | 34,348 | 57,496 |

Table 11. Estimated numbers of alewife by total age and age of recruitment in the gaspereau fishery, Southwest Margaree River, 1983 to 1989. %FSP refers to percent new recruitment.

| Numbers of alewife | Year | | | | | | |
|---|---|---|---|---|---|---|---|
| Total Age | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 |
| Recruited at age 2 | | | | | | | |
| 2 | 0 | 0 | 24,806 | 2,104 | 0 | 0 | 657 |
| 3 | 1,759 | 0 | 106,971 | 15,683 | 0 | 0 | 0 |
| 4 | 0 | 0 | 0 | 0 | 9,936 | 0 | 0 |
| 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Recruited at age 3 | | | | | | | |
| 3 | 713,210 | 2,600,587 | 446,784 | 1,262,253 | 4,400,237 | 2,479,427 | 120,091 |
| 4 | 397,393 | 258,404 | 920,280 | 158,545 | 429,356 | 2,354,640 | 1,235,744 |
| 5 | 334,105 | 185,480 | 40,614 | 129,007 | 18,600 | 160,274 | 181,065 |
| 6 | 52,414 | 4,211 | 27,024 | 5,818 | 4,607 | 6,993 | 6,235 |
| 7 | 17,976 | 1,090 | 2,937 | 0 | 0 | 0 | 0 |
| 8 | 2,733 | 644 | 0 | 0 | 0 | 0 | 0 |
| 9 | 5,248 | 0 | 0 | 0 | 0 | 0 | 0 |
| 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Recruited at age 4 | | | | | | | |
| 4 | 370,661 | 428,329 | 3,069,913 | 235,293 | 433,678 | 1,431,033 | 2,444,088 |
| 5 | 156,504 | 35,124 | 204,850 | 371,931 | 130,546 | 267,326 | 185,607 |
| 6 | 45,417 | 20,213 | 6,467 | 10,649 | 181,210 | 69 | 11,078 |
| 7 | 0 | 4,112 | 0 | 3,888 | 0 | 0 | 38 |
| 8 | 2,733 | 4,409 | 1,343 | 0 | 0 | 0 | 0 |
| 9 | 0 | 43,447 | 0 | 0 | 0 | 0 | 0 |
| 10 | 0 | 248 | 0 | 0 | 0 | 0 | 0 |
| 11 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Recruited at age 5 | | | | | | | |
| 5 | 0 | 0 | 0 | 0 | 0 | 0 | 1,434 |
| 6 | 5,248 | 1,239 | 875 | 6,529 | 0 | 0 | 0 |
| 7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total | 2,105,400 | 3,587,536 | 4,852,865 | 2,201,700 | 5,608,169 | 6,699,762 | 4,186,037 |
| % FSP | 51.5 | 84.4 | 73.0 | 68.1 | 86.2 | 58.4 | 61.3 |
| Dominant Year-class | 1979 | 1981 | 1981 | 1983 | 1984 | 1984 | 1985 |
| % of total | 36.5 | 72.5 | 82.2 | 58.0 | 78.5 | 56.5 | 87.9 |

Table 12. Mean weight (g) at age for alewife in the Southwest Margaree gaspereau fishery.

| | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 |
|---|---|---|---|---|---|---|---|
| 2 | - | - | 164 | 152 | - | - | 137 |
| 3 | 220 | 210 | 210 | 215 | 211 | 214 | 188 |
| 4 | 289 | 288 | 250 | 264 | 252 | 261 | 265 |
| 5 | 308 | 349 | 321 | 303 | 294 | 303 | 310 |
| 6 | 322 | 376 | 348 | 358 | 347 | 339 | 357 |
| 7 | 352 | 407 | 405 | 412 | - | 411 | 406 |
| 8 | 375 | 403 | 397 | - | - | - | - |
| 9 | 356 | 446 | 455 | - | - | - | - |
| 10 | - | 478 | - | - | - | - | - |
| 6+ | 340 | 381 | 381 | 363 | 346 | 353 | 362 |
| 7+ | 357 | 389 | 415 | 412 | - | 411 | 406 |

Table 13. Results of multiplicative model using natural log of kg per days fished per trap in lower and upper zones, 1983 to 1989. This model uses all logbook reports during the 10 - 90 % catch interval for each season.

GENERAL LINEAR MODELS PROCEDURE

CLASS LEVEL INFORMATION

| CLASS | LEVELS | VALUES |
|---|---|---|
| YY | 7 | 83 84 85 86 87 88 89 |
| ZONE | 2 | 0 1 |

NUMBER OF OBSERVATIONS IN DATA SET = 154

DEPENDENT VARIABLE: LOGKG

| SOURCE | DF | SUM OF SQUARES | MEAN SQUARE | F VALUE | PR > F |
|---|---|---|---|---|---|
| MODEL | 7 | 36.65099902 | 5.23585700 | 10.71 | 0.0001 |
| ERROR | 146 | 71.39191919 | 0.48898575 | | |
| CORRECTED TOTAL | 153 | 108.04291821 | | | |

| | |
|---|---|
| R-SQUARE | 0.339226 |
| ROOT MSE | 0.69927516 |
| MEAN LOGKG | 0.56313378 |
| C.V. | 9.2458 |

| SOURCE | DF | TYPE III SS | F VALUE | PR > F |
|---|---|---|---|---|
| YY | 6 | 16.12853968 | 5.50 | 0.0001 |
| ZONE | 1 | 16.97917546 | 34.72 | 0.0001 |

| PARAMETER | | ESTIMATE | T FOR H0: PARAMETER=0 | PR > \|T\| | STD ERROR OF ESTIMATE |
|---|---|---|---|---|---|
| INTERCEPT | | 7.40128473 B | 56.74 | 0.0 | 0.13043195 |
| YY | 83 | -0.46773373 B | -1.39 | 0.1655 | 0.33558221 |
| | 84 | -0.56905134 B | -3.35 | 0.0010 | 0.16993676 |
| | 85 | 0.20500082 B | 0.84 | 0.4013 | 0.24356302 |
| | 86 | -0.46290286 B | -1.83 | 0.0699 | 0.25347240 |
| | 87 | 0.07477703 B | 0.39 | 0.6990 | 0.19300819 |
| | 88 | 0.24650106 B | 1.48 | 0.1407 | 0.16642173 |
| | 89 | 0.00000000 B | . | . | . |
| ZONE | LOWER | 0.70076553 B | 5.89 | 0.0001 | 0.11892209 |
| | UPPER | 0.00000000 B | . | . | . |

| | |
|---|---|
| SUM OF RESIDUALS | -1.42109E-13 |
| SUM OF SQUARED RESIDUALS | 71.39192 |
| PREDICTED RESID SS (PRESS) | 77.79121 |

Table 14. Prefishery population numbers of alewife and values of F by recruitment age, estimated from Type I cohort analysis.

| Age | Year 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 |
|---|---|---|---|---|---|---|---|
| Total River Returns | 3,895,766 | 6,314,647 | 6,983,599 | 4,479,014 | 11,747,012 | 11,722,541 | 7,592,794 |
| Recruited at age 3 | | | | | | | |
| 3 | 1,368,414 | 4,660,344 | 864,157 | 2,719,126 | 9,515,256 | 5,963,824 | 218,081 |
| 4 | 1,172,097 | 421,975 | 1,326,559 | 268,803 | 938,279 | 3,294,258 | 2,244,078 |
| 5 | 351,094 | 271,098 | 57,240 | 142,172 | 38,584 | 178,091 | 328,808 |
| 6+ | 78,371 | 5,945 | 29,961 | 5,818 | 4,607 | 6,993 | 6,235 |
| 3+ | 2,969,976 | 5,359,362 | 2,277,917 | 3,135,919 | 10,496,726 | 9,443,166 | 2,797,202 |
| Fishing Mortality | | | | | | | |
| 3 | 0.74 | 0.82 | 0.73 | 0.62 | 0.62 | 0.54 | 0.80 |
| 4 | 0.41 | 0.95 | 1.18 | 0.89 | 0.61 | 1.25 | 0.80 |
| 5 | 3.03 | 1.15 | 1.24 | 2.38 | 0.66 | 2.30 | 0.80 |
| 6+ | - | - | - | - | - | - | - |
| 3+ | 0.89 | 0.84 | 1.01 | 0.73 | 0.62 | 0.82 | 0.80 |
| Population number recruited at age 4 | | | | | | | |
| 4 | 503,192 | 793,664 | 4,451,472 | 438,781 | 938,019 | 1,954,382 | 4,438,381 |
| 5 | 225,233 | 85,354 | 235,289 | 889,774 | 131,053 | 324,814 | 337,056 |
| 6 | 194,632 | 24,051 | 17,578 | 10,652 | 181,213 | 178 | 20,117 |
| 7+ | 2,733 | 52,216 | 1,343 | 3,888 | 1 | 1 | 38 |
| 4+ | 925,790 | 955,285 | 4,705,682 | 1,343,095 | 1,250,286 | 2,279,375 | 4,795,592 |
| Fishing Mortality | | | | | | | |
| 4 | 1.33 | 0.78 | 1.17 | 0.77 | 0.62 | 1.32 | 0.8 |
| 5 | 1.19 | 0.53 | 2.05 | 0.54 | 5.55 | 1.73 | 0.8 |
| 6 | 0.27 | 1.84 | 0.46 | 8.22 | 11.06 | 0.49 | 0.8 |
| 7+ | - | - | - | - | - | - | - |
| 4+ | 1.07 | 0.79 | 1.21 | 0.68 | 2.65 | 1.38 | 0.80 |

Table 15. Predicted potential landing of alewife in the Margaree River fishery in 1990 at sustained F = 1.0. Prediction inferred from population numbers generated from Type I cohort analysis.

| Year Class | Prefishery Population 1989 | Catch 1989 | Composite Mortality Removals | (Mc=) | Prefishery Population 1990 | Catch (F=1.0) | Landed Weight (Tons) |
|---|---|---|---|---|---|---|---|
| Recruited at age 3 | | | | | | | |
| 1986 | 218081 | 120091 | 34881 | (0.44) | 63109 | 39893 | 10.5 |
| 1985 | 2244078 | 1235744 | 655480 | (1.05) | 352854 | 223046 | 70.9 |
| 1984 | 328808 | 181065 | 96042 | (1.05) | 51701 | 32681 | 11.7 |
| 1983 | 6235 | 6235 | 0 | (1.05) | | | |
| Recruited at age 4 | | | | | | | |
| 1985 | 4438381 | 2444088 | 709896 | (0.44) | 1284397 | 811894 | 258.2 |
| 1984 | 337056 | 185607 | 98451 | (1.05) | 52998 | 33501 | 12.0 |
| 1983 | 20117 | 11078 | 5876 | (1.05) | 3163 | 1999 | 0.7 |
| 1982 | 38 | 38 | 0 | (1.05) | | | |
| | Without new recruitment | | | | | Metric Tons | 363.9 |
| | With new recruitment - mean | | | age 3 | 2108781 | 1333004 | 283.9 |
| | | | | age 4 | 1302124 | 823099 | 215.7 |
| | | | | | Expected Landing | | 863.5 |
| | | | | | (90% C.I.) | | (583 to 1463) |

Age 3 and 4 new recruitment based upon 7 year geometric mean of 1983 to 1988 population recruited as per cohort analysis.

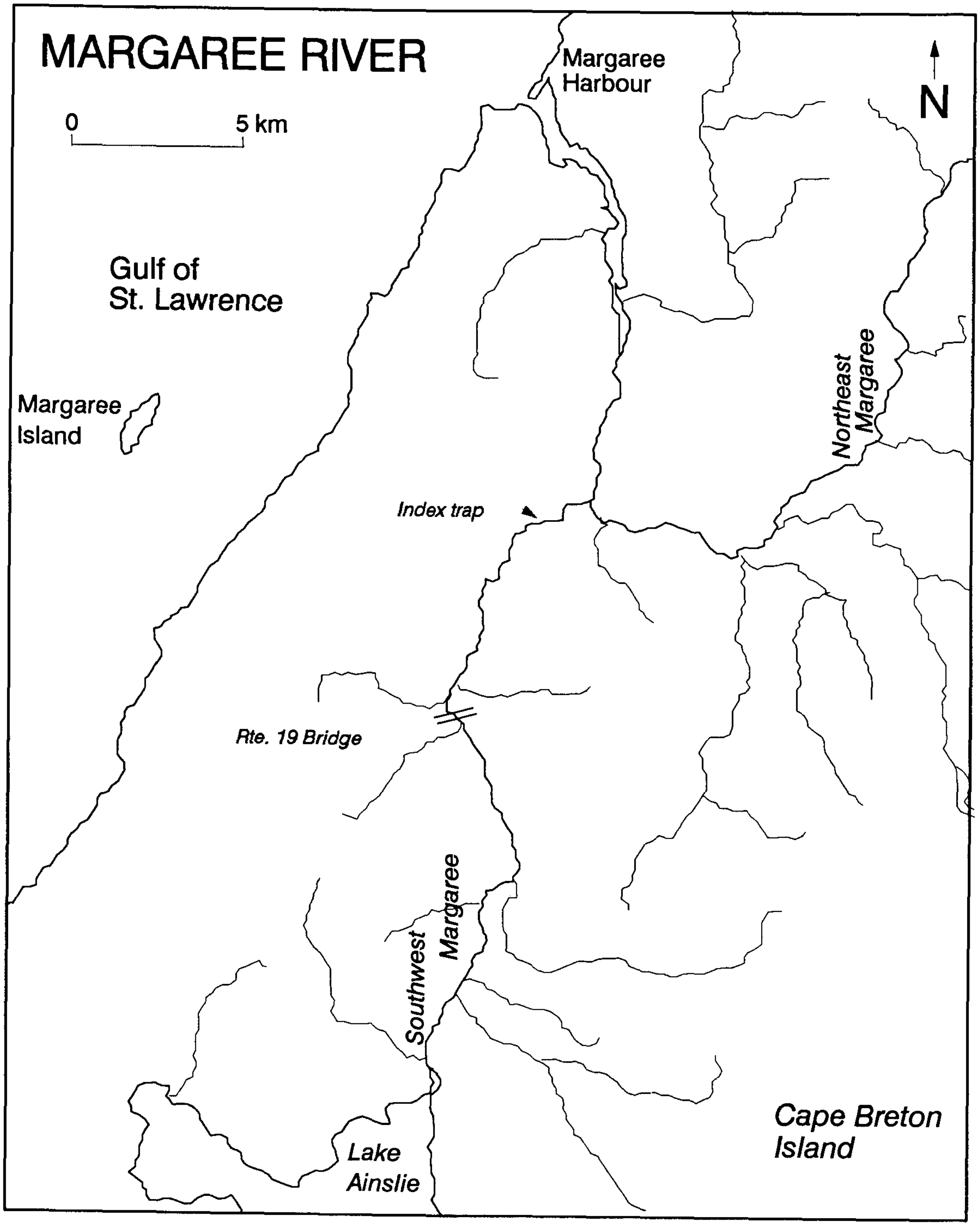


Fig. 1 Margaree River, showing management zones and location of historical index trap.

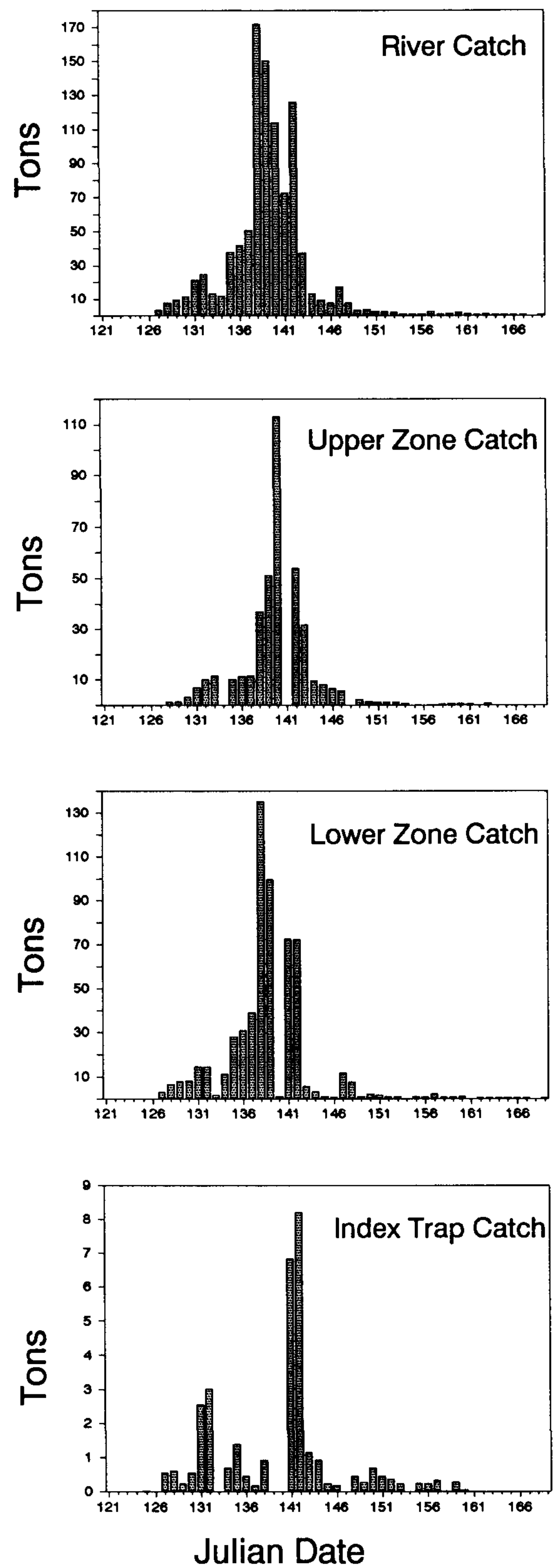


Fig. 2 Timing of gaspereau fishery of the Southwest Margaree River, 1989.

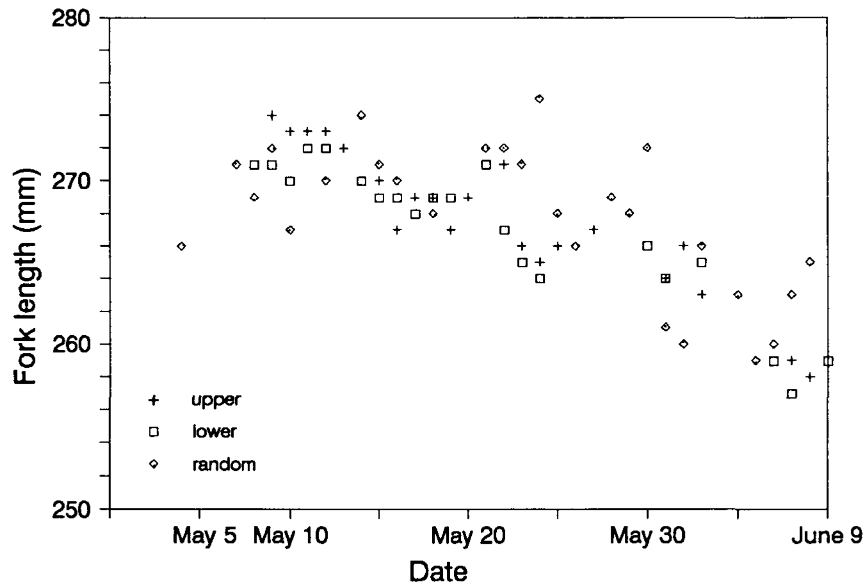


Fig. 3 Mean length (mm) of gaspereau by date from upper and lower zone stratified samples and random samples from historical index trap.

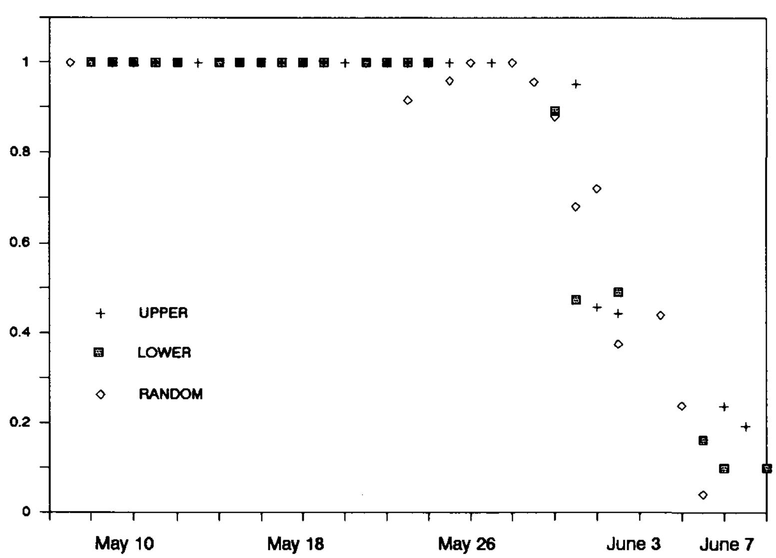


Fig 4. Proportion alewife (by number) by date in upper and lower zone stratified samples and random samples from historical index trap.

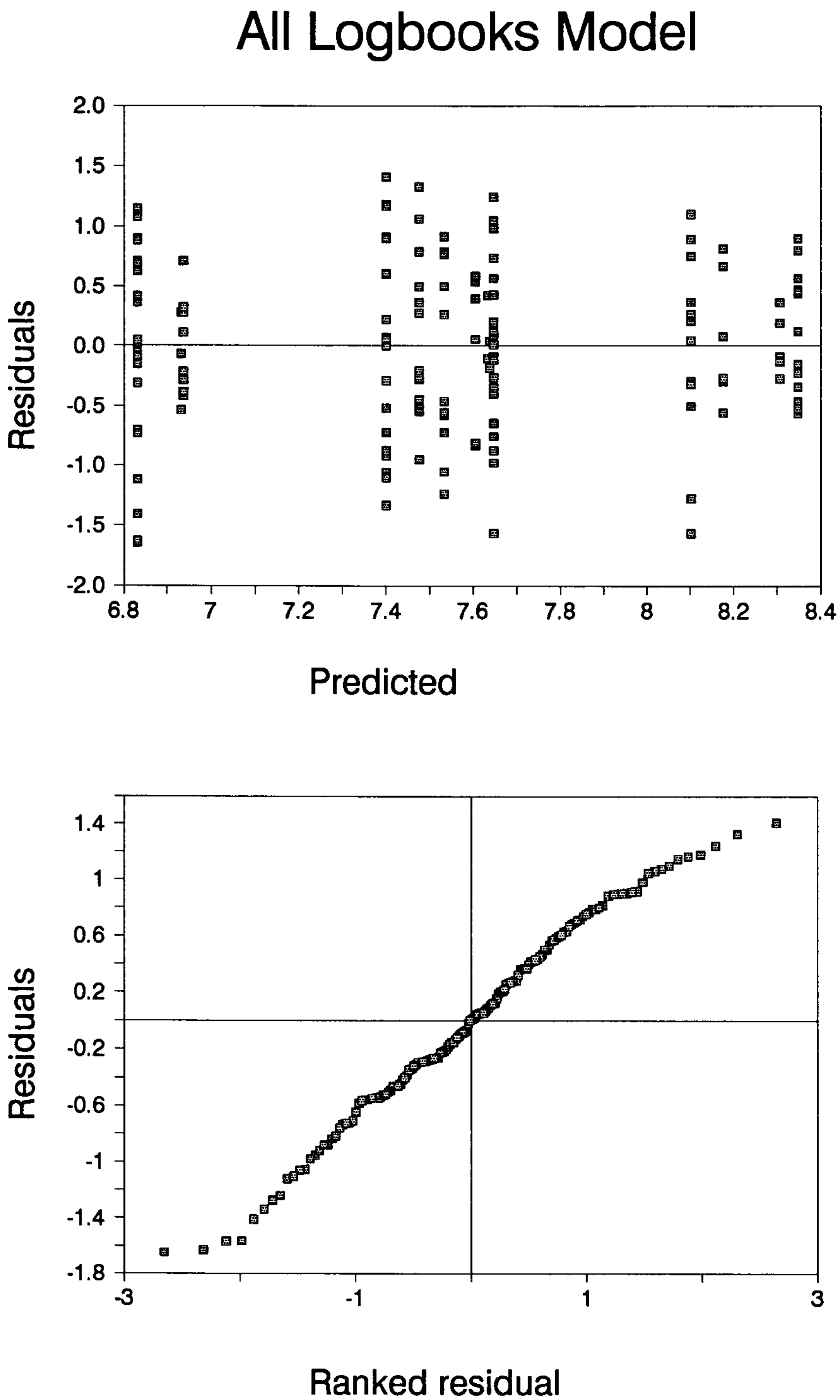


Fig. 5. Residual plots of the fall logbook catch rate multiplicative model.

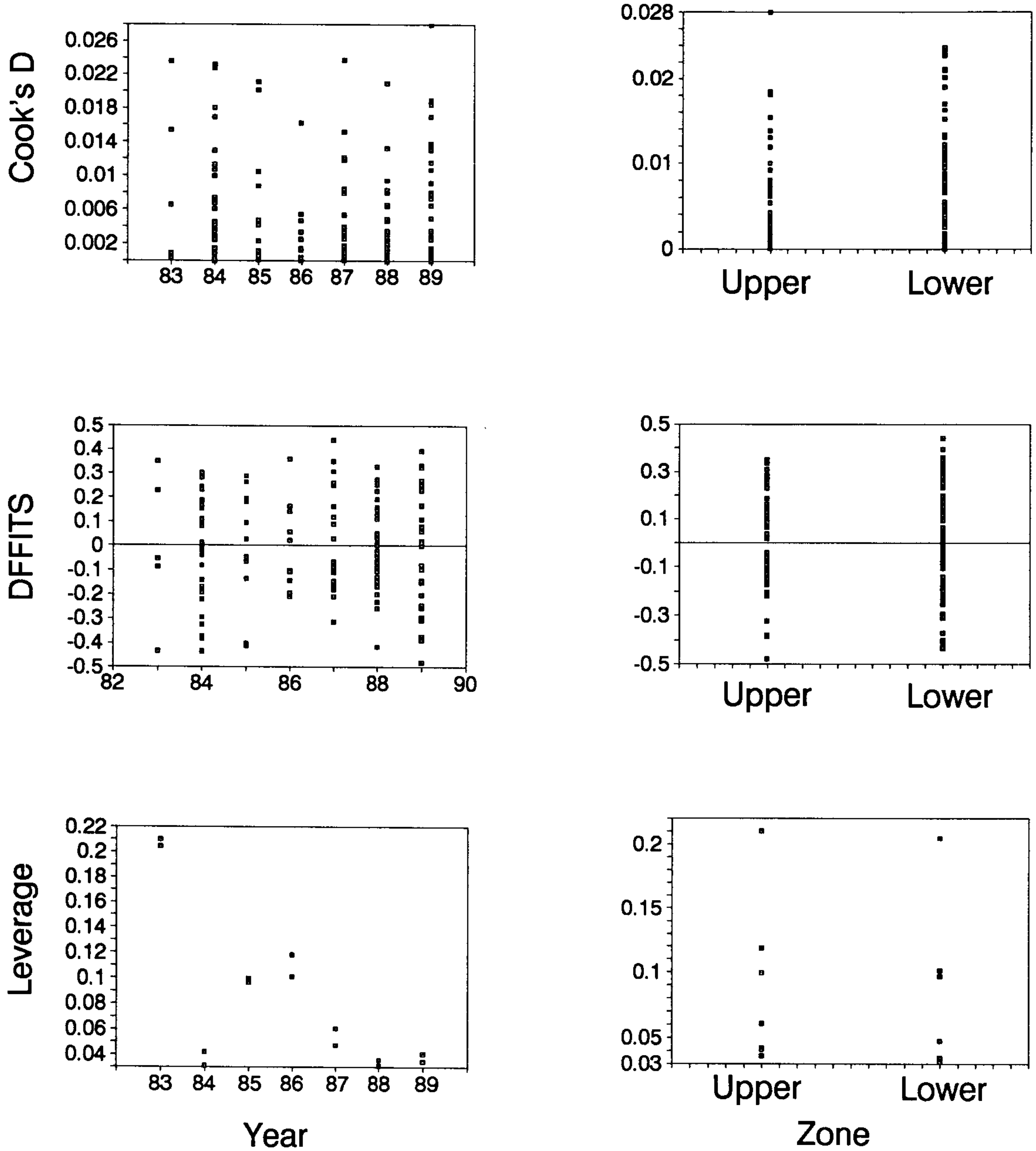


Fig. 6. Influence diagnostics of the fall logbook catch rate multiplicative model.

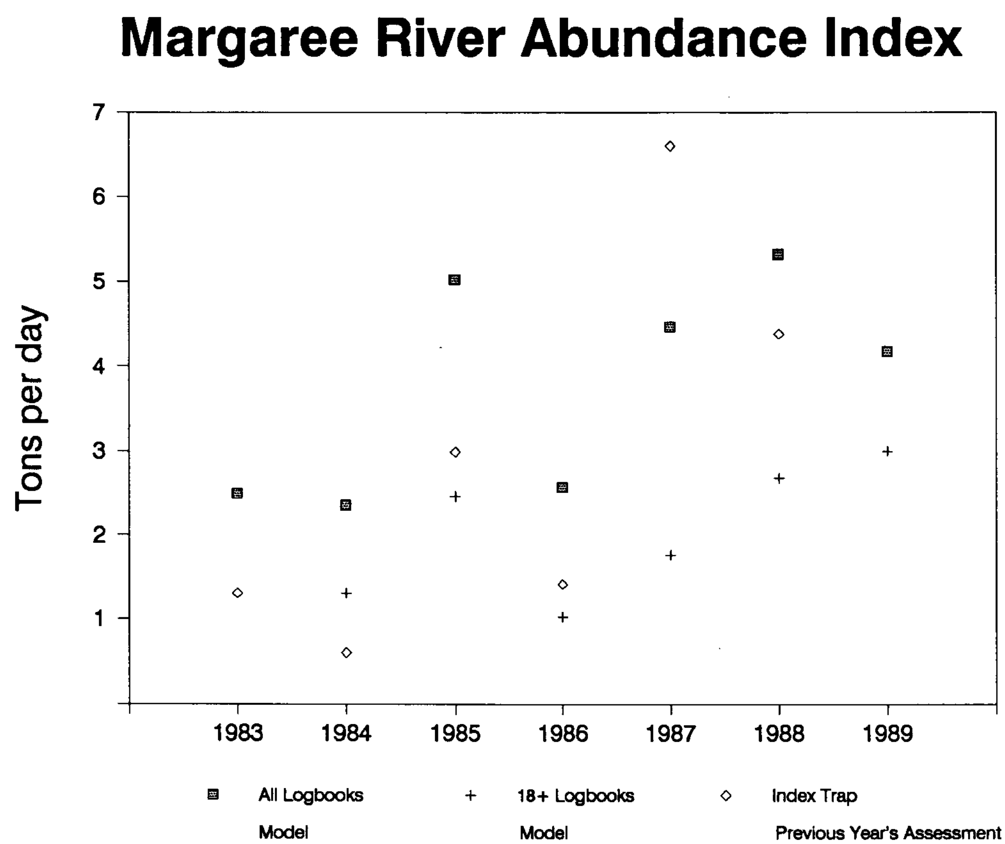


Fig. 7. Abundance indices of alewife in the Southwest Margaree River, 1983 to 1989.

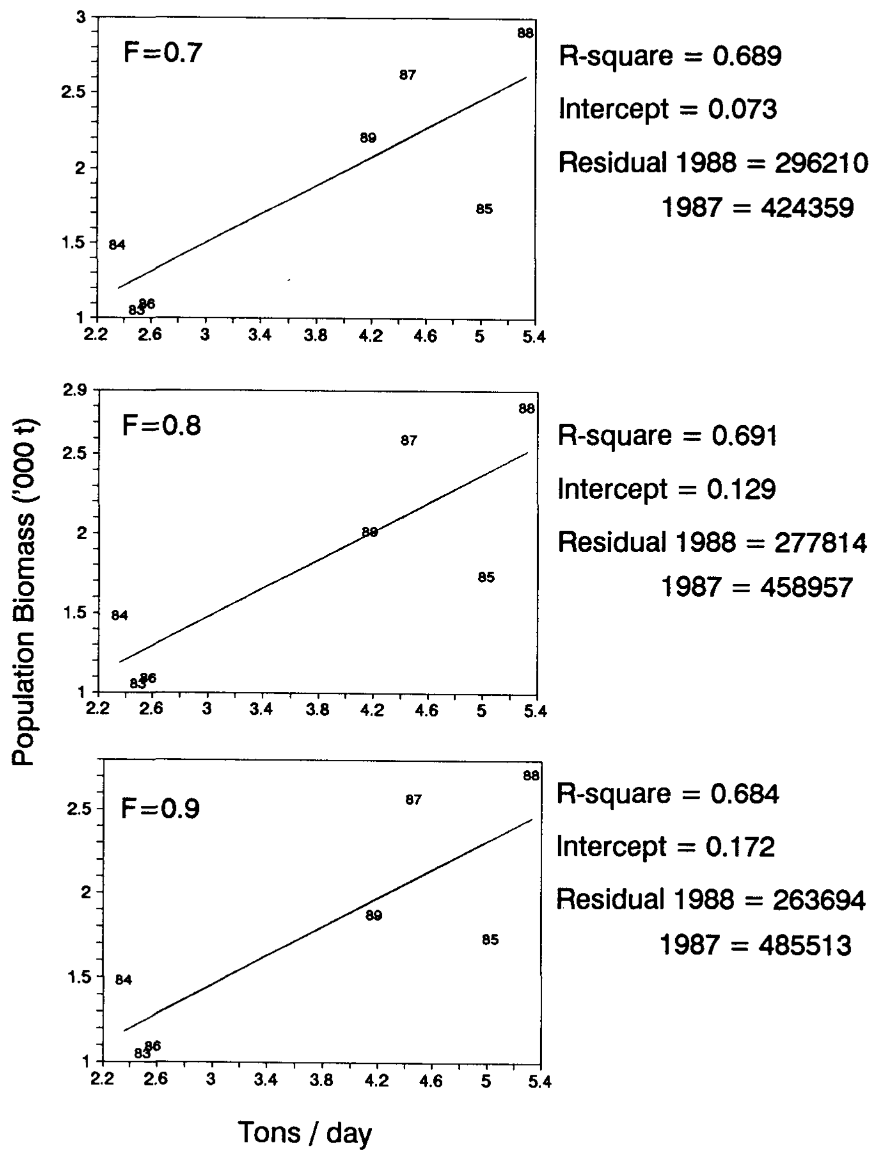


Fig. 8. Tuning plots of 1989 fishing mortality on alewife, Southwest Margaree River.

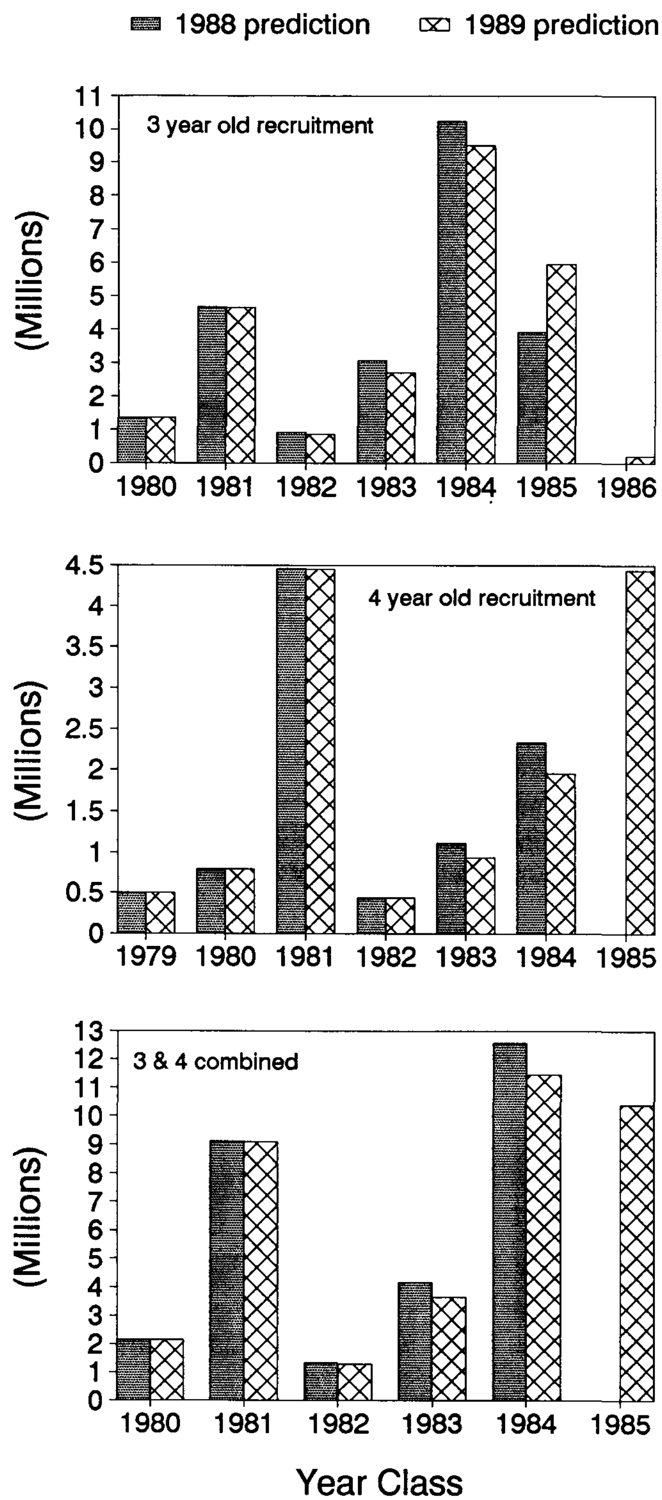


Fig. 9. Retrospective analysis of predicted year class size (number) from the 1988 and 1989 assessments.