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Canadian Atlantic Fisheries
Scientific Advisory Committee

Comité scientifique consultatif des
pêches canadiennes dans d'Atlantique

CAFSAC Research Document 88/25

CSCPCA Document de recherche 88/25

Status of the Margaree River alewife (Alosa pseudoharengus) fishery 1987

by

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ABSTRACT

The 1987 harvest of gaspereau on the Southwest Margaree River increased to 1,259 tonnes compared to a 38 year mean of 827 tonnes. This improved catch is largely attributable to the strong 1984 year-class produced in the first year of the current weekly closed time regulation. Sequential population analysis indicates that fishing mortality in 1987 (0.7) was lower than in previous years but continued to exceed the $F_{0.1}$ value of 0.42. In 1988, the fishery should be able to harvest 760 tonnes even with no recruitment and reduced exploitation. With moderate recruitment and recent levels of exploitation, harvest may reach 1,400 tonnes. An alternate harvest forecast method based on water temperatures in Lake Ainslie indicates that 1988 catch will be only 700 tonnes. Results from a pilot tagging study provide independent estimates of fishing exploitation, including a value (53%) nearly identical to that (50.3%) from sequential population analysis. It was estimated that 76% of the tags recovered were not reported. The average length of time between tagging and recovery was 129 hours. Tagging data show a strong homing migration to the Southwest branch of the river and suggest reduced rate of migration when traps are encountered.

RESUME

La récolte 1987 de Gaspareau dans la rivière Southwest Margaree a augmenté jusqu'à 1259 tonnes, à comparer à la moyenne de 38 ans de 827 tonnes. Cette prise améliorée est largement attribuable à la forte classe d'âge de 1984 produite pendant la première année d'application du règlement en vigueur d'une période hebdomadaire de fermeture. L'analyse séquentielle des populations indique que la mortalité par la pêche en 1987 (0,7) est inférieure à ce qu'elle était les années passées, mais elle continue de dépasser la valeur $F_{0,1}$ de 0,42. En 1988, la pêcherie devrait pouvoir récolter 760 tonnes même sans recrutement et exploitation réduite. Avec un recrutement modéré et les niveaux récents d'exploitation, la récolte peut atteindre 1400 tonnes. Une autre méthode de prévision de la récolte qui est fondée sur la température de l'eau du lac Ainslie, indique que la prise en 1988 sera de seulement 700 tonnes. Les résultats obtenus à partir d'une étude pilote de marquage conduisent à des évaluations indépendantes de l'exploitation par la pêche, mais permet d'obtenir notamment une valuer (53 %) presque identique à celle obtenue par l'analyse séquentielle des populations (50.3 %). On estime à 76 % le total des bagues récupérées et non rendues. La durée moyenne entre le marquage et la recapture a été de 129 heures. Le résultat du marquage a établi qu'il y a une forte remonte dans la branche sud-ouest de la rivière; cela suggère que le taux de migration est réduit lorsqu'il y a des pièges.

INTRODUCTION

Annual assessments indicate that the Margaree River gaspereau fishery has exploited alewives (Alosa pseudoharengus) at excessive levels every year since at least 1983 (Alexander 1984, Alexander and Vromans 1985, 1986, 1987). This occurred despite a 1984 regulation which closed the fishery each week on Saturday downstream from the #19 highway bridge and on Sunday upstream from that point (Fig. 1). The 1986 harvest fell below the long-term average because persistent overharvest placed too much dependence on the weak 1982 year-class. Following the 1986 fishery, a reduction in rate of exploitation was again recommended by CAFSAC. However, fishermen were optimistic that the partial closure in 1984 provided increased spawning escapement that would produce a strong year-class capable of producing high short term yield beginning in 1987. The 1987 fishery was prosecuted without further restriction. Results of the 1987 assessment using sequential population analysis are provided in this report.

Although sequential population analysis (SPA) has been used in the Margaree gaspereau assessment for several years, the time series data are not adequate to draw convincing conclusions. The method is not easily accepted by fishermen in any case. Additional information on the fishery has therefore been considered desirable to substantiate or refute the conclusions. Fishermen specifically requested information on rate of fish migration in the river in order to assess the effectiveness of the weekly closed time. To address these issues, the 1987 program included tagging of fish upon entry to the fishing area with tag recovery information provided by the fishermen. Results of that tagging project are included in this assessment.

METHODS

Gaspereau samples were collected daily from the commercial trap operated by Martin Cameron, processed as in previous years (Alexander and Vromans 1985) to provide biological data and weighted using logbook statistics to represent the fishery as a whole. Comparable data are available for each year since 1983 and were used for sequential population analysis. This analysis was performed using APL programs described by Rivard (1982) with revisions to provide rapid tuning (G. Nielsen, pers. comm., DFO, Gulf Region).

An estimate of the total gaspereau landings for the year was provided by DFO Conservation and Protection personnel. This estimate includes the total weight sold fresh as bait plus the number of 50-pound pails of salted fish multiplied by 70 to provide a fresh weight equivalent.

In the previous assessment (Alexander and Vromans 1987) partial recruitment was estimated, using the proportion of virgin fish caught and a form of historical averaging, to be 0.0 at age 2, 0.57 at age 3 and 1.0 at age 4 and older. These same values were used in the current assessment. Weight was input to the initial SPA as the weight-at-age matrix and to projections as the mean weight-at-age vector. Between-year total mortality (Z) for fully-recruited year-classes was calculated using the Paloheimo method (Ricker 1975). A natural mortality rate of 0.2 was assumed. Average consecutive year Paloheimo estimates of fishing mortality for fully recruited year-classes were then used as the initial mortality rates for sequential population analysis. Yield per recruit was calculated using the method of Thompson and Bell (Ricker 1975).

Projections of catch were made using the geometric mean of the estimated population numbers at age 3 from 1983 to 1987 as future recruitment. Projections include hypothetical fishing at $F_{0.1}$, "F" derived from Tune programs, and at the mean annual Paloheimo value of fishing mortality.

Gaspereau required for tagging were collected from the first commercial trap above Margaree Forks, operated by Richard Gillis. Fish were individually marked with sequentially numbered international orange Floy T-bar tags inserted at the base of the dorsal fin, without anesthetic. No measurements or scale samples were taken. During most of the tagging procedure fish were held in portable splash tanks containing 400 litres of water, usually at a density not exceeding 50 fish per container. Tagged fish in paired groups were released above the Forks trap (f) and at the East Margaree Bridge (b) located 5.0 km downstream (Fig.1). Transportation to the Bridge required approximately 15 minutes in splash tanks or a hatchery distribution tank. Total time from capture to release for any fish seldom exceeded 60 minutes. Gaspereau were tagged and released on several days during the fishery including one Saturday on which all downriver traps are not permitted to fish. Fishermen were requested to provide information on location, date and time of tag recovery on a voluntary basis.

One group of 100 gaspereau was tagged in the usual manner, transported to Margaree hatchery and held in a 7.6 metre circular pond to provide information on tag loss and tagging mortality. A group of 100 untagged fish was held in the same pond as a control group. The pond was checked daily to record mortalities. At the end of the holding period all fish were removed and all remaining tags were recovered for inventory purposes.

RESULTS AND DISCUSSION

Gaspereau landings in 1987 were recorded at 1,259 tonnes. This harvest is a substantial increase over 1986 and is well above the long-term average of 827 tonnes (Table 1) despite persistent overharvest.

Harvest reported in logbooks submitted for 23 traps was 880,427 kg compared to the total estimated harvest of 1,258,800 kg. An expansion factor of 1.4298 (Table 2) was therefore used to convert logbook data to represent the fishery as a whole. Total fishing effort was recorded as 6,394 hours which is the lowest level observed since 1983. This reduced effort reflects cessation of fishing by some fishermen when they reached personal objectives or when their storage facilities were filled. All estimates of annual fishing effort have been reduced slightly from values reported in previous assessments by excluding effort for days on which there was no catch. This is considered to be more realistic because on those days some traps were in the water and recorded as fishing even though there was no real effort to catch fish since they were not being tipped. Fishermen use this technique to visually assess the numbers of fish accumulating at the trap and available for capture. The catch per hour was calculated at 196.9 kg/hr and is the highest recorded during assessments. This is concluded to be an indication of a relative increase in abundance.

The fishery took place almost exclusively during May, as expected, and run timing was similar to 1986 with more than 75% of the total catch taken during the two weeks of May 11 to 24 (Table 3). Catch peaked at 207,075 kg on May 13 (Table 4, Fig. 2). Total catch consisted of 99.9% alewife (Alosa pseudoharengus) and bluebacks (Alosa aestivalis) were not considered further in the assessment.

Mean weight of gaspereau was 231 g. This is the lowest value recorded since 1983 (Table 5). The small size is consistent with low mean age which was calculated to be 3.3. Mean age is also the lowest observed in five years (Table 6). The catch-at-age matrix (Table 6, Fig. 3) shows that the 1984 year-class at age 3 dominated the catch. Those virgin fish accounted for 75.3% of the total weight. The 1987 recruitment is well above average and is the highest observed since 1983. If this strong year-class is the result of increased escapement in 1984, then the limited closure imposed on the fishery in that year has had a desirable impact. However, there are not sufficient data to show that such a spawner to recruit relationship is established.

Estimates of cumulative catch per hour used in the Paloheimo calculation indicate that between-year instantaneous total mortality for fully recruited age groups ranged from 2.17 in 1985-86, down to 0.80 in 1986-87 (Table 7). Although these are between-year rates, they suggest that fishing mortality in 1987 was much below average. Consecutive year values were averaged and reduced by the annual natural mortality rate (0.2) to provide estimates of annual fishing mortality. The average fishing mortality (1.2) was used for the first and last year. These values were used as the estimates of F for the initial cohort analysis and an automatic iterative procedure then generated best estimates of fishing mortality each year for subsequent calculations (Table 7). Automatic Tune programs produced useable results only for regressions of age 4+ population numbers on age 4+ catch per hour. This regression provided the highest r^2 (0.998), the lowest 1987 residual and the lowest standardized residual value at a 1987 fully recruited fishing mortality of 0.7. The SPA was then re-run at this value to produce new estimates of population numbers at each age (Table 8).

Yield-per-recruit analysis produced an $F_{0.1}$ fishing mortality of 0.415 at a yield per recruit of 172 g and an average weight of 279 g. Although the Paloheimo estimate of F (0.6) and the best estimate of F from SPA calibration (0.7) are much closer to $F_{0.1}$ than in previous assessments, fishing mortality continues to be excessive. To reach the general management objective, ($F_{0.1}$) exploitation should be reduced, but continued fishing at current levels may provide more useable data for development of the assessment model.

The previous assessment (Alexander and Vromans 1987) using SPA had forecast a poor 1987 harvest, if the 1984 year-class was of average size. Since that year-class has been shown to be much stronger than average, the catch projection was understandably too low. Re-examination of the forecast however, indicates a better agreement for older ages. At average fishing mortality, the forecast 1987 catch of fish age 4 and older was 270 tonnes compared to an actual catch of 311 tonnes. Because of uncertainty in estimating strength of the youngest age groups it appears useful to examine the forecast catch of older fish separately.

Projections of harvest were made using the 1987 population numbers (Table 8) derived from cohort analysis with a terminal fishing mortality of 0.7. Projections include cases in which 1988 recruitment at age 3 equals the low value observed for 1985; the high value observed for 1987; and the geometric mean of annual recruitment since 1983. In each case, recruitment for 1989 and 1990 was input as the geometric mean of the number at age 3. For each of the three levels of recruitment a projection was made for future exploitation at a fishing mortality of 0.42 ($F_{0.1}$); at the probable 1987 level of 0.7; and at a continued high level of 1.2. Future harvest of currently recruited fish has been calculated and represents the harvest that would be available in the total absence of new recruits.

Results of the forecasts provide a bright outlook for the future of this fishery (Table 9). Survivors from the 1987 fishery should be able to provide for a harvest of no less than 761 tonnes in 1988. If the 1985 year-class equals the strength of the 1984 year-class, then a high level of exploitation could produce a harvest of up to 2,960 tonnes. That would be above any harvest achieved since 1950 (Table 1) and is probably too much to expect. The recommended level would be that achieved at $F_{0.1}$ and mean annual recruitment. That estimate of catch is 944 tonnes but in the absence of any new restrictions, catch would be expected to reach 1,406 tonnes. Given this same level of annual recruitment and rate of exploitation, harvest would fall back to 1,136 tonnes by 1989 and 968 tonnes by 1990 (Table 9).

Despite the apparent improvement for 1988, persistent exploitation far in excess of $F_{0.1}$ has caused the Margaree gaspereau fishery to be highly dependent on the numbers of newly recruited fish. Projections therefore include much uncertainty because sequential population analysis provides no direct information on the numbers of those fish to be expected and mean recruitment is therefore used. Although this situation would improve if appropriate management could bring the population to equilibrium at $F_{0.1}$, dependence on these young fish will likely continue to be substantial (Mahon 1987).

The projected improvements in catch of older fish resulting from exploitation at $F_{0.1}$ are disappointing (Table 9). That harvest would modestly exceed the harvest at high exploitation by 1989 but would still be less than at moderate exploitation. By 1990, harvest of these older fish at $F_{0.1}$ would exceed that for both other levels but the total is not great. The cumulative future catch from these year-classes is estimated for F = 0.42; F = 0.70 and F = 1.20 to be: 1,542 tonnes; 1,895 tonnes and 2,145 tonnes, respectively. Since fishing at $F_{0.1}$ provides only a slight increase in contribution of older fish with a lower total yield, it appears that this management strategy may not be the most appropriate. There is concern, however, that the assumed natural mortality rate of 0.2 used in these SPA calculations is too low for gaspereau on the spawning migration. An increase in the value of natural mortality would produce a higher estimate of fishing mortality at $F_{0.1}$.

Regardless of the management strategy selected, a reliable method of estimating the abundance of fish in the recruiting age-classes is necessary (Mahon 1987) if accurate predictions of harvest are to be produced. Investigations of stock recruitment relationships and environmental influences on recruitment are routinely examined in stock assessments for other anadromous species such as Atlantic salmon (Salmo salar), and may provide a predictive method for gaspereau recruitment. However, the data required to examine the relationship between abundance of gaspereau spawners and recruits is lacking and the effects of environmental factors and of stock size on recruitment are almost certainly inter-related, thus requiring a consideration of both to develop a suitable model. Nevertheless, in a previous assessment (Crawford 1983), a negative relationship was shown between lake outlet temperature in June and July (T) and catch (C) four years later. Although the biological significance has been questioned, this relationship ($C=5939.5 - 255.6T$) remains significant ($p=0.0172$, $n=13$) and indicates a 1988 catch of only 701 tonnes without further restrictions (Crawford 1988). The relationship assumes a constant rate of exploitation and could lose predictive capability with reduced exploitation calculated for 1987. Even so, it should be noted that the existing correlation is negative, suggesting that the extremely high temperature in 1987 will contribute to reduced catch in 1991. A relationship between temperature and either catch or population numbers at age 3 would have more biological significance and would be useful in SPA but the available data (n=4) are not adequate. These possible relationships can continue to be examined as a routine step in the tuning procedure for sequential population analysis.

Tag loss and tagging mortality of gaspereau held at Margaree hatchery for 14 days (May 28-June 11) was considered typical for fish tagged and released to the river even though conditions are not identical. These tagged fish experienced mortality (27 of 100) not significantly different from mortality of untagged fish (28 of 100). The total mortality rate (27.5%) is high and may be an artifact of stress imposed by the holding facility and the additional transportation, or it may be a reflection of handling stress including that from tagging. At the end of the holding period one tag was recovered from the bottom of the pond and three were not accounted for except by the presence of three surplus "untagged" fish. It appears that tag loss was therefore 4%. The 4% tag loss and the 27.5% mortality may be factors to consider in comparing absolute tag return rates but can be ignored for comparison of relative returns between similar groups.

Science personnel tagged and released 3,020 gaspereau. From those, 380 were returned by 30 Margaree River fishermen for a recovery rate of 12.6%. That recovery represents 17.1% of the number of tags available for capture (2,217) after adjustment for simultaneous tag loss and handling mortality. Both of these rates are much lower than the fishing exploitation rate of 50.3% which corresponds to the instantaneous rate of 0.7 estimated from sequential population analysis. However, these calculations make no allowance for failure to observe tags captured or failure to report tags recovered. Casual conversation with some fishermen suggests that failure to report may be common. On average, gaspereau fishermen returned one tag for every 3,934 kg harvested. However, one individual who appeared most conscientious in returning tags with complete data recovered 99 tags at the rate of one tag for every 786 kg of harvest. There is no indication that any of these tags came from harvest other than his own. If this rate applied to all fishermen, then tag recovery would be 1,602 or 53.0% of the number released and 72.3% of the adjusted number of tags available. These harvest rates are much closer to the levels determined from SPA or from Paloheimo estimates and provide greater confidence in those calculations. If tag recoveries were fully reported they could provide an independent estimate of fishing mortality. Unfortunately, these estimates show that 76.3% of the tags were not returned. A substantial amount of information has been lost.

Tagged fish were released on six different fishing days. With division by release site and time of day, a total of 36 separate tag groups, ranging from 25 to 200 tagged fish each, were identified (Table 10). Using the information from the 380 tag recoveries, the relative harvest rates can be compared for these various groups. Information on time and location of recovery was considered to be reliable for only 255 of the tags. Those data were used for comparing time at large and rate of movement between release and recapture sites for various groups.

A comparison of recoveries between tag groups indicates that not all were similar (Table 10). Recoveries from Bridge groups No. 4 and No. 6 were much lower than expected (mean return rate) while those from Bridge groups No. 11 and No. 26 were much higher than expected. Recoveries from Forks groups No. 23 and No. 29 were both higher than expected. Only the recovery from group No. 29 was significantly different than expected at the 1% level. No explanation is offered for this difference in recovery.

When tag recoveries were compared according to day of release (Table 11), the differences were highly significant overall. Tags from the first groups released on Thursday May 14 were recovered at a rate of only 7.8%. This is significantly lower than average. By contrast, recoveries from fish released on May 20 were higher than average. Recoveries from fish tagged and released on Saturday May 23 were once again less than average. It is tempting to conclude that the partial closure on Saturdays and Sundays contributed to this reduced exploitation. An alternative explanation is that the rate of exploitation begins low, increases with increasing fishing intensity near the mid-point of the fishing interval and declines toward the end of the run as some fishermen stop fishing. The near normal distribution of the percentage recovery by day of tagging suggests that some change does occur. Expected tag recoveries from fish released on May 14 and 23 should therefore be lower than average while those for May 20 should be higher. Reduced rate of expected recovery for Saturday May 23 would result in a non-significant chi-square value. Consequently, the closure may have provided no increased escapement for fish near the Forks on Saturday. Nevertheless, escapement of fish further upstream at time of closure may have improved.

The comparison of tags recovered from all groups released at the Bridge and all groups released at the Forks (Table 12) shows that there was no difference in the rate of recovery. This indicates that: 1) gaspereau are not deterred from their spawning migration by the downstream displacement imposed upon them, 2) natural mortality involved in the additional transportation and repeat migration between Bridge and Forks is not significant and, 3) gaspereau collected from the Southwest Margaree demonstrated no significant tendency to stray to the Northeast Margaree when given a second chance to choose between those river branches.

Time at large after tagging ranged from 16.5 hours to 501 hours with a mean of 129 hours. The long and variable migration time may be responsible for the failure to reduce harvest of fish at the Forks through a one-day closure. The average time for Bridge fish (122 hrs.) was less than for fish released at the Forks (136 hrs.) (Table 13) although this difference was not statistically significant ($P = 0.2175$). These values may be biased by the higher rate of return from more distant traps, although the available data show no significant correlation between time and distance for either group (Table 14). The bias in return by trap is reflected in the average distance travelled which was calculated at 13.0 km from the Forks and 18.6 km from the Bridge even though distance to the furthest trap was 19.8 km and 24.8 km for the two sites, respectively.

The average rate of migration from Bridge to recapture site was 0.182 km/hr compared to 0.134 km/hr from the Forks (Table 13). This difference is significant ($P = 0.0001$). The higher rate for fish released at the Bridge suggests that they travelled the 5 km from Bridge to Forks at greater speed than that achieved above the Forks. This difference is presumed to be caused by the presence of fish traps acting as a partial barrier to migration. If the rate of migration by captured fish is typical of fish escaping to the lake, then rate of migration from the Forks indicates that gaspereau require 148 hours to pass through the 19.8 km fishing zone.

The correlation between rate of migration and distance to recapture site was positive for both sites but not significant for tags released at either site (Table 14). It appears that the effect of the traps is not compounded by the presence of more than one trap but there is little or no beneficial learning experience either. Fish that migrated at faster rates were harvested in less time for both sites but this too was not significant. An improved rate of tag return from all traps would provide more conclusive results.

SUMMARY

Cohort analysis indicates that fishing mortality in 1987 was much lower than in previous years but continued to exceed $F_{0.1}$ and should be reduced. The improved catch was largely attributable to the very strong 1984 year-class. That year-class was produced during the first year of the partial closure recently imposed. Survivors from older year-classes should be able to provide a catch of up to 1,123 tonnes in 1988 although the recommended level is 760 tonnes. If recruitment from the 1985 year-class is average, catch in 1988 should reach 944 tonnes at $F_{0.1}$ or 1,406 tonnes at current rates. In contrast, a negative correlation between water temperature in Lake Ainslie and catch 4 years later suggests that 1988 harvest will be only 700 tonnes.

Results from the tagging project provided some support to the calculation of fishing mortality from cohort analysis. Those results also show that gaspereau remain in the fishing zone for an extended period and that current closures do not allow the fish to move swiftly to the lake without any opportunity to harvest them.

ACKNOWLEDGEMENTS

Martin Cameron, gaspereau fisherman, provided fish specimens for biological sampling and Richard Gillis provided fish for tagging. Leonard Forsyth, Manager, Margaree Fish Culture Station, provided fish holding tanks and collected data on tag loss and gaspereau mortality in the pond. Summer students Shannon Komadina, Mary McKay and Raman Joshi processed many of these specimens with assistance from Perry Swan, technician. We are grateful to those fishermen who provided voluntary logbook data. Dr. M. Chadwick and D. Clay provided a review of the manuscript.

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Table 1. Annual gaspereau (alewife and blueback herring) landings on the Margaree River.

Year	Catch (tonnes)
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
1985	1,223
1986	545
1987	1,259
mean	827

Table 2. Logbook catch and effort, total reported catch, estimated total effort and conversion factors used in assessment of the Southwest Margaree gaspereau fishery (1983-87).

	Year				
	1983	1984	1985	1986	1987
Logbook effort (hrs)	2,010	7,498	3,306	3,271	4,472
Logbook catch (kg)	112,319	643,770	505,311	212,243	880,427
Total reported catch (kg)	579,816	883,409	1,222,698	545,202	1,258,800
Expansion factor	5.1622	1.3722	2.4197	2.5688	1.4298
Expanded effort (hrs)	10,376	10,289	8,000	8,402	6,394
Catch per hour (kg/hr)	55.88	85.9	152.8	64.9	196.9

Table 3. Daily catch (kg), effort (hours) and catch per unit effort (kg/hr) in the 1987 Southwest Margaree River gaspereau fishery as reported through gaspereau catch-and-effort logbooks.

	Mon	Tue	Wed	Thur	Fri	Sat	Sun	Total
Apr 27-May 3								
Catch (kg)	0	0	0	0	0	0	0	0
Effort (hr)	0	0	0	0	0	0	0	0
CPUE (kg/hr)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
May 4-May 10								
Catch (kg)	0	0	0	1,882	4,627	454	35,063	42,025
Effort (hr)	0	0	0	27	55	10	108	200
CPUE (kg/hr)	0.00	0.00	0.00	69.72	84.12	45.36	324.65	210.13
May 11-May 17								
Catch (kg)	23,224	77,746	144,832	91,875	50,394	12,610	7,167	407,847
Effort (hr)	159	242	295	311	264	131	86	1,488
CPUE (kg/hr)	146.06	321.26	490.96	295.42	190.89	96.26	83.33	274.09
May 18-May 24								
Catch (kg)	15,150	19,663	28,055	51,619	72,484	38,329	36,242	261,541
Effort (hr)	246	251	249	249	244	123	73	1,435
CPUE (kg/hr)	61.59	78.34	112.67	207.30	297.07	311.61	496.47	182.26
May 25-May 31								
Catch (kg)	50,031	33,588	33,929	14,447	13,029	15,740	91	160,855
Effort (hr)	186	201	193	156	142	95	13	986
CPUE (kg/hr)	268.98	167.11	175.80	92.61	91.76	165.68	6.98	163.14
June 1-June 7								
Catch (kg)	2,495	3,810	408	288	91	91	0	7,183
Effort (hr)	61	63	59	43	8	8	0	242
CPUE (kg/hr)	40.90	60.48	6.92	6.70	11.34	11.34	0.00	29.68
June 8-June 14								
Catch (kg)	100	408	91	91	64	0	64	816
Effort (hr)	11	25	15	15	12	0	13	91
CPUE (kg/hr)	9.07	16.33	6.05	6.05	5.29	0.00	4.88	8.97
June 15-June 21								
Catch (kg)	91	64	0	0	0	0	0	154
Effort (hr)	15	15	0	0	0	0	0	30
CPUE (kg/hr)	6.05	4.23	0.00	0.00	0.00	0.00	0.00	5.14
June 22-June 28								
Catch (kg)	0	0	0	0	0	0	0	0
Effort (hr)	0	0	0	0	0	0	0	0
CPUE (kg/hr)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
June 29-July 5								
Catch (kg)	0	0	0	0	0	0	0	0
Effort (hr)	0	0	0	0	0	0	0	0
CPUE (kg/hr)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TOTALS								
Catch (kg)	91,090	135,279	207,314	160,202	140,688	67,222	78,626	880,422
Effort (hr)	678	797	811	801	725	367	293	4,472
CPUE (kg/hr)	134.35	169.74	255.63	200.00	194.05	183.17	268.35	196.87

Table 4. Estimated daily catch in weight (kg) and numbers of gaspereau for the SW Margaree River gaspereau fishery, 1987.

Date	Alewife Mean wt.(kg)	Alewife %	Blueback Mean wt.(kg)	Blueback %	Catch (kg) Alewife	Catch (kg) Blueback	Catch (kg) Combined	Number Alewife	Number Blueback	Number Combined
Ma 7	.2654	100.0	.0000	0.0	2,691	0	2,691	10,139	0	10,139
Ma 8	.2740	100.0	.0000	0.0	6,616	0	6,616	24,144	0	24,144
Ma 9	.2652	100.0	.0000	0.0	649	0	649	2,448	0	2,448
Ma 10	.2585	100.0	.0000	0.0	50,132	0	50,132	193,933	0	193,933
Ma 11	.2739	100.0	.0000	0.0	33,205	0	33,205	121,230	0	121,230
Ma 12	.2410	100.0	.0000	0.0	111,158	0	111,158	461,237	0	461,237
Ma 13	.2279	100.0	.0000	0.0	207,075	0	207,075	908,623	0	908,623
Ma 14	.2394	100.0	.0000	0.0	131,359	0	131,359	548,702	0	548,702
Ma 15	.2334	100.0	.0000	0.0	72,051	0	72,051	308,703	0	308,703
Ma 16	.2363	100.0	.0000	0.0	18,029	0	18,029	76,298	0	76,298
Ma 17	.2394	100.0	.0000	0.0	10,247	0	10,247	42,803	0	42,803
Ma 18	.2440	100.0	.0000	0.0	21,661	0	21,661	88,774	0	88,774
Ma 19	.2305	100.0	.0000	0.0	28,113	0	28,113	121,967	0	121,967
Ma 20	.2319	100.0	.0000	0.0	40,112	0	40,112	172,971	0	172,971
Ma 21	.2236	100.0	.0000	0.0	73,803	0	73,803	330,066	0	330,066
Ma 22	.2290	100.0	.0000	0.0	103,635	0	103,635	452,554	0	452,554
Ma 23	.2268	100.0	.0000	0.0	54,801	0	54,801	241,628	0	241,628
Ma 24	.2246	100.0	.0000	0.0	51,817	0	51,817	230,710	0	230,710
Ma 25	.2267	100.0	.0000	0.0	71,532	0	71,532	315,538	0	315,538
Ma 26	.2230	100.0	.0000	0.0	48,023	0	48,023	215,349	0	215,349
Ma 27	.2110	100.0	.0000	0.0	48,510	0	48,510	229,907	0	229,907
Ma 28	.2169	100.0	.0000	0.0	20,656	0	20,656	95,232	0	95,232
Ma 29	.2095	100.0	.0000	0.0	18,628	0	18,628	88,918	0	88,918
Ma 30	.2039	100.0	.0000	0.0	22,504	0	22,504	110,370	0	110,370
Ma 31	.1982	100.0	.0000	0.0	130	0	130	656	0	656
Jn 1	.2103	100.0	.0000	0.0	3,567	0	3,567	16,963	0	16,963
Jn 2	.2093	96.0	.2630	4.0	5,176	271	5,447	24,732	1,030	25,762
Jn 3	.2099	97.1	.2630	2.9	563	21	583	2,680	79	2,759
Jn 4	.2115	100.0	.0000	0.0	412	0	412	1,947	0	1,947
Jn 5	.2107	100.0	.0000	0.0	130	0	130	618	0	618
Jn 6	.2105	95.9	.2290	4.1	124	6	130	591	25	616
Jn 7	.2102	91.7	.2290	8.3	0	0	0	0	0	0
Jn 8	.1925	8.0	.2312	92.0	10	133	143	50	577	627
Jn 9	.2117	30.0	.2026	70.0	180	403	583	852	1,989	2,841
Jn 10	.2117	30.0	.2026	70.0	40	90	130	190	444	634
Jn 11	.2117	30.0	.2026	70.0	40	90	130	190	444	634
Jn 12	.2117	30.0	.2026	70.0	28	63	92	134	312	446
Jn 13	.2117	30.0	.2026	70.0	0	0	0	0	0	0
Jn 14	.2117	30.0	.2026	70.0	28	63	92	134	312	446
Jn 15	.2117	30.0	.2026	70.0	40	90	130	190	444	634
Jn 16	.2117	30.0	.2026	70.0	28	63	92	134	312	446
	.2311		.2167		1,257,508	1,293	1,258,800	5,442,305	5,968	5,448,273
% of total					99.9	.1		99.9	.1	

Table 5. Mean weight-at-age matrix determined from length-weight regression equations for alewives in the Southwest Margaree River gaspereau fishery.

	Weight (g)					
	Year					
Age	1983	1984	1985	1986	1987	Mean
2	---	---	161	151	---	156
3	222	205	213	215	212	213
4	283	289	247	265	250	267
5	308	356	310	298	290	312
6	325	382	374	341	333	351
7	356	428	408	397	381	394
8	382	443	421	---	---	415
9	378	478	466	---	---	441
10	---	500	---	---	---	500
Mean	277	245	256	243	231	

Table 6. Number of fish caught and percentage of catch (by weight) at each age, each year (1983-86) in the Southwest Margaree River gaspereau fishery.

	Year				
	1983	1984	1985	1986	1987
Age	Number (% by weight)				
2	---	---	16,280	1,403	---
3	502,731 (19.3)	2,450,383 (58.4)	564,476 (10.3)	1,386,148 (55.1)	4,311,464 (75.3)
4	898,317 (44.0)	787,409 (26.5)	3,752,712 (79.2)	357,579 (17.5)	839,238 (17.3)
5	515,812 (27.5)	262,518 (10.9)	296,677 (7.9)	473,924 (26.1)	165,009 (3.9)
6	89,514 (5.0)	32,906 (1.5)	30,837 (1.0)	15,256 (1.0)	126,584 (3.5)
7	52,185 (3.2)	19,863 (1.0)	21,145 (0.7)	4,494 (0.3)	13 (0.0)
8	9,821 (0.6)	13,208 (0.7)	2,724 (0.1)	---	---
9	4,465 (0.3)	20,241 (1.0)	22,297 (0.9)	---	---
10	---	43	---	---	---
Mean	4.2	3.5	4.0	3.6	3.3

Table 7. Estimates of cumulative catch-per-hour for fully recruited age groups of alewife in each year, and those same year-classes in the next year, on the Southwest Margaree River and the resultant (Paloheimo) estimates of instantaneous mortality (Z) between years. Annual fishing mortality (F) and best estimates (SPA) of F from cohort analysis are shown.

Age Groups	Catch/hr. 1983	Z	1984	Z	1985	Z	1986	Z	1987
4+	151.33		110.42		515.79		101.33		176.86
		1.50		0.86		2.17		0.80	
5+	64.75		33.89		46.70		58.77		45.61
F (4+)	1.20		0.98		1.32		1.29		1.20
SPA F (4+)	1.43		1.25		1.71		0.85		0.70

Table 8. Summary of population numbers at each age each year, estimated for cohort analysis run at 1987 fishing mortality of F = 0.7.

Age I	Population Numbers 1983	1984	1985	1986	1987
3	2,138,417	9,054,816	1,639,859	3,752,778	14,363,148
4	1,407,052	1,295,898	5,196,258	831,844	1,818,276
5	649,348	339,166	348,514	858,742	357,505
6	130,235	64,915	40,150	16,895	274,254
7	119,734	25,632	23,373	4,969	28
8	49,398	50,811	3,013	4	2
9	6,566	31,557	29,650	2	2
3+	4,500,750	10,862,795	7,280,817	5,465,234	16,813,217
4+	2,362,333	1,807,979	5,640,958	1,712,456	2,450,068
5+	955,281	512,082	444,700	880,612	631,792
6+	305,933	172,915	96,186	21,870	274,287

Table 9. Summary of projected catch of gaspereau from Margaree River assuming 1988 recruitment at high, medium and low levels followed by recruitment at medium levels and with future exploitation at three different levels. The future harvest of currently recruited year-classes is independent of future recruitment and is shown in parenthesis.

1988 Recruitment	Exploitation	CATCH (tonnes) 1988		1989		1990	
low	0.42	829	(761)	747	(476)	764	(287)
low	0.70	1,228	(1,123)	925	(530)	878	(242)
low	1.20	1,729	(1,571)	995	(450)	903	(124)
mean	0.42	944	(761)	897	(476)	859	(287)
mean	0.70	1,406	(1,123)	1,136	(530)	968	(242)
mean	1.20	2,000	(1,571)	1,194	(450)	960	(124)
high	0.42	1,354	(761)	1,432	(476)	1,195	(287)
high	0.70	2,041	(1,123)	1,786	(530)	1,287	(242)
high	1.20	2,960	(1,571)	1,902	(450)	1,164	(124)

Note: low recruitment is the estimated number of fish at age three in 1985 (1.64×10^6).

mean recruitment is the geometric mean of the number of fish at age three from 1983 to 1987 (4.43×10^6).

high recruitment is the estimated number of fish at age three in 1987 (14.36×10^6).

Table 10. Information on gaspereau in 36 tag groups released at the Bridge (b) or Forks (f) site in May and recovered in commercial traps on the Margaree River, 1987. The calculated chi-square value is shown for each group. Expected recovery was the average value.

Tag Group	N	Release location	Release Time day	Release Time hour	Number Recovered Observed	Number Recovered Expected	X^2
1	25	f	14	13:30	1	3	1.333
2	25	b	14	13:45	4	3	0.333
3	50	f	14	14:35	7	6	0.167
4	50	b	14	15:55	1	6	4.167 *
5	100	f	14	16:25	11	13	0.308
6	100	b	14	17:25	5	13	4.923 *
7	75	f	14	18:20	4	9	2.778
8	75	b	14	19:15	6	9	1.000
9	75	b	15	11:15	12	9	1.000
10	75	f	15	12:00	14	9	2.778
11	75	b	15	14:30	16	9	5.444 *
13	75	f	15	15:35	5	9	1.778
14	50	b	15	17:50	6	6	0.000
15	50	f	15	18:05	8	6	0.667
18	50	f	20	13:40	8	6	0.667
19	50	b	20	14:40	7	6	0.167
20	100	f	20	15:45	19	13	2.769
21	50	b	20	16:45	9	6	1.500
22	50	b	20	17:40	8	6	0.667
23	75	f	21	12:35	15	9	4.000 *
24	75	b	21	13:20	11	9	0.444
25	75	f	21	14:15	11	9	0.444
26	75	b	21	15:10	15	9	4.000 *
27	71	f	21	16:25	9	9	0.000
28	75	b	21	17:15	12	9	1.000
29	100	f	21	18:20	23	13	7.692 **
30	100	b	21	19:15	14	13	0.077
31	75	b	21	20:00	4	9	2.778
32	75	f	21	20:45	4	9	2.778
33	99	b	22	16:00	11	13	0.308
34	100	b	22	17:35	14	13	0.077
35	200	f	22	18:50	25	25	0.000
36	150	b	23	14:00	14	19	1.316
37	200	f	23	15:45	22	25	0.360
38	150	b	23	17:45	15	19	0.842
39	125	f	23	18:30	10	16	2.250
							58.557 **

Table 11. Information on gaspereau in 36 tag groups, regrouped by day of release and recovered in commercial traps on the Margaree River, 1987. The calculated chi-square value for recovery is shown for each group. Expected rate of recovery was the average value for all days.

Tag Groups	N	Day and Date of release	Number Recovered Observed	Number Recovered Expected	Percent recovery	X^2
1,2,3, 4,5,6, 7,8	500	Thursday May 14	39	63	7.8	9.143 *
9,10,11, 13,14, 15	400	Friday May 15	61	50	15.3	2.420
18,19, 20,21, 22	300	Wednesday May 20	51	38	17.0	4.447 *
23,24, 25,26, 27,28, 29,30, 31,32	796	Thursday May 21	118	100	14.8	3.240
33,34, 35	399	Friday May 22	50	50	12.5	0.000
37,38, 39	625	Saturday May 23	61	79	9.8	4.101 *
TOTAL	3,020		380	380	12.6	23.351 **

Table 12. Information on gaspereau in 36 tag groups, regrouped by Bridge (b) and Forks (f) release sites and recovered in commercial traps on the Margaree River, 1987. The calculated chi-square value for recovery is shown for each group on the assumption that exploitation would be equal for each.

Tag Groups	N	Release location	Number Recovered Observed	Number Recovered Expected	X^2
1,3,5,7,10, 13,15,18,20, 23,25,27,29, 32,35,37,39	1,521	f	196	191	0.131
2,4,6,8,9, 11,14,19,21, 22,24,26,28, 30,31,33,34, 36,38	1,499	b	184	189	0.132
				TOTAL	0.263

Table 13. Summary of rate of migration, distance and time-at-large information for gaspereau released at the Margaree Forks or Bridge and recaptured in commercial traps, 1987.

	Release Location	
	Forks	Bridge
N	131	124
Time-at-large (hrs)	136	122
Rate (km/hr)	0.134	0.182
Distance (km)	13.001	18.594

Table 14. Relationships (R^2) between time-at-large (TLARG) rate of travel (RATE) and distance travelled (DIST) for gaspereau released at the Forks or Bridge and recaptured in commercial traps on the Margaree River, 1987.

	Forks			Bridge		
	TLARG	RATE	DIST	TLARG	RATE	DIST
TLARG		-0.537	0.385		-0.650	0.394
RATE	-0.537		0.255	-0.650		0.161
DIST	0.385	0.255		0.394	0.161	

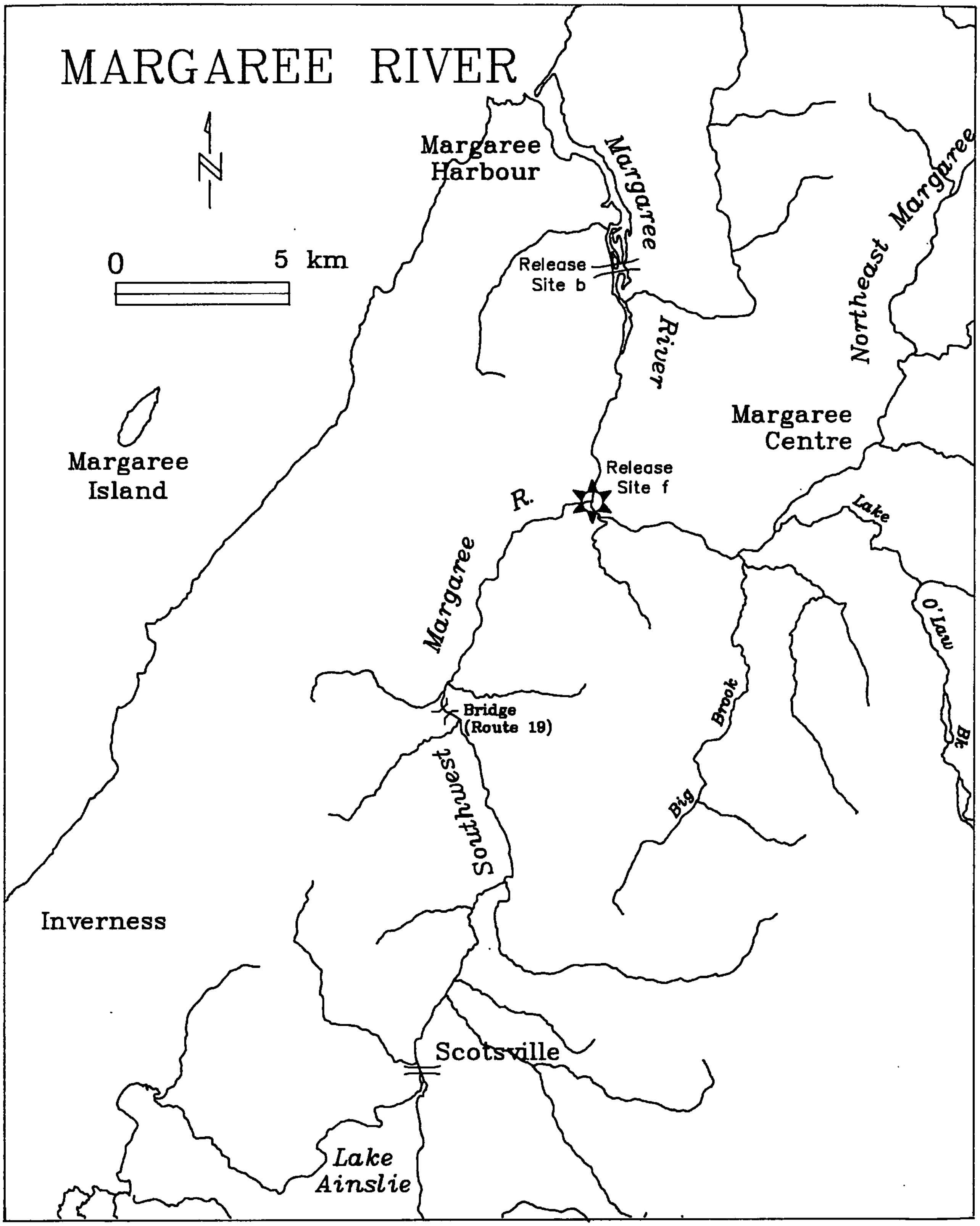

Fig. 1. Map of Margaree River showing location of the Forks (f) and Bridge (b) release sites for tagged gaspereau.

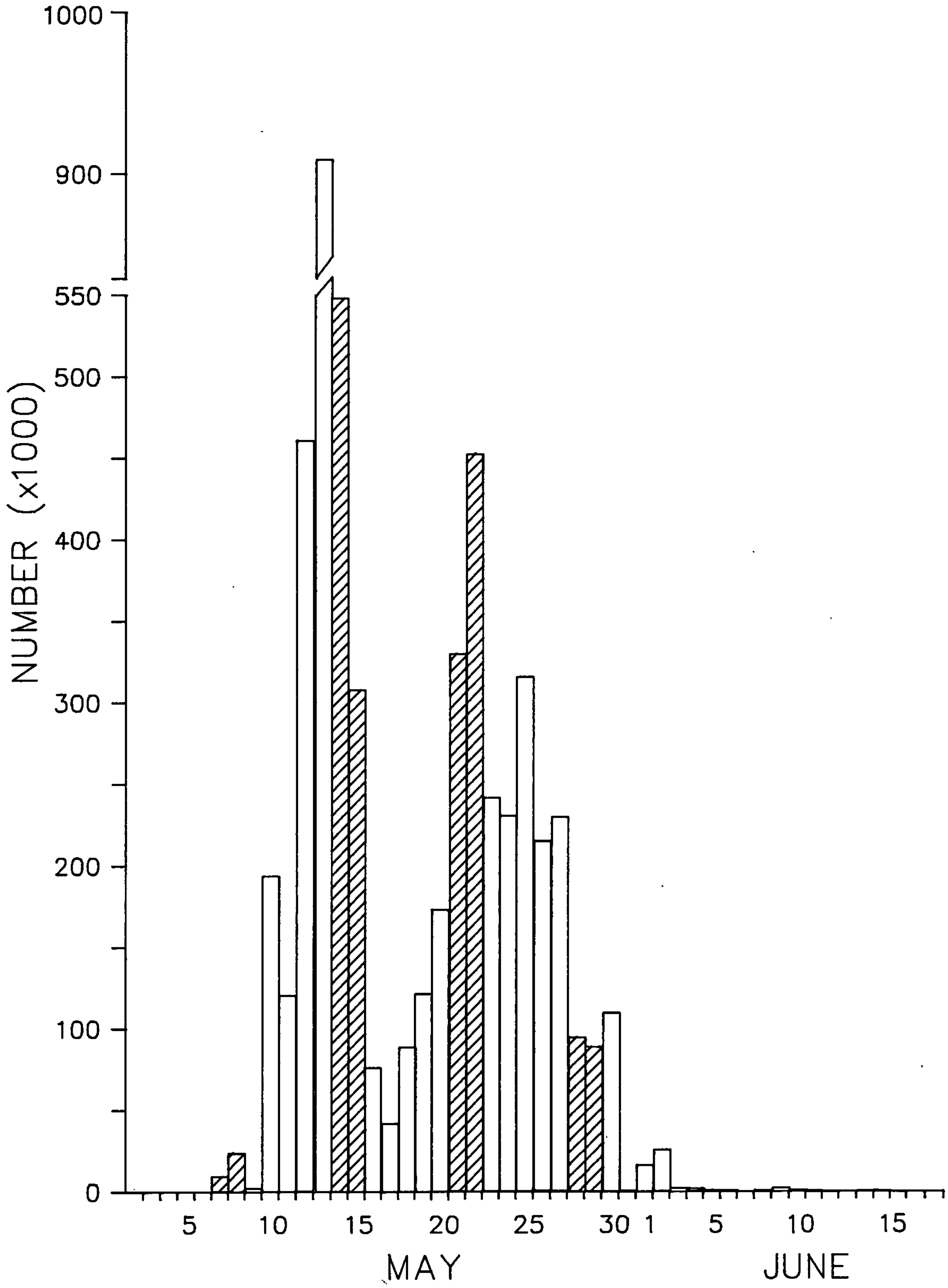

Fig. 2. Daily gaspereau catch in the Southwest Margaree River, 1987. (Saturdays and Sundays are shaded for contrast.)

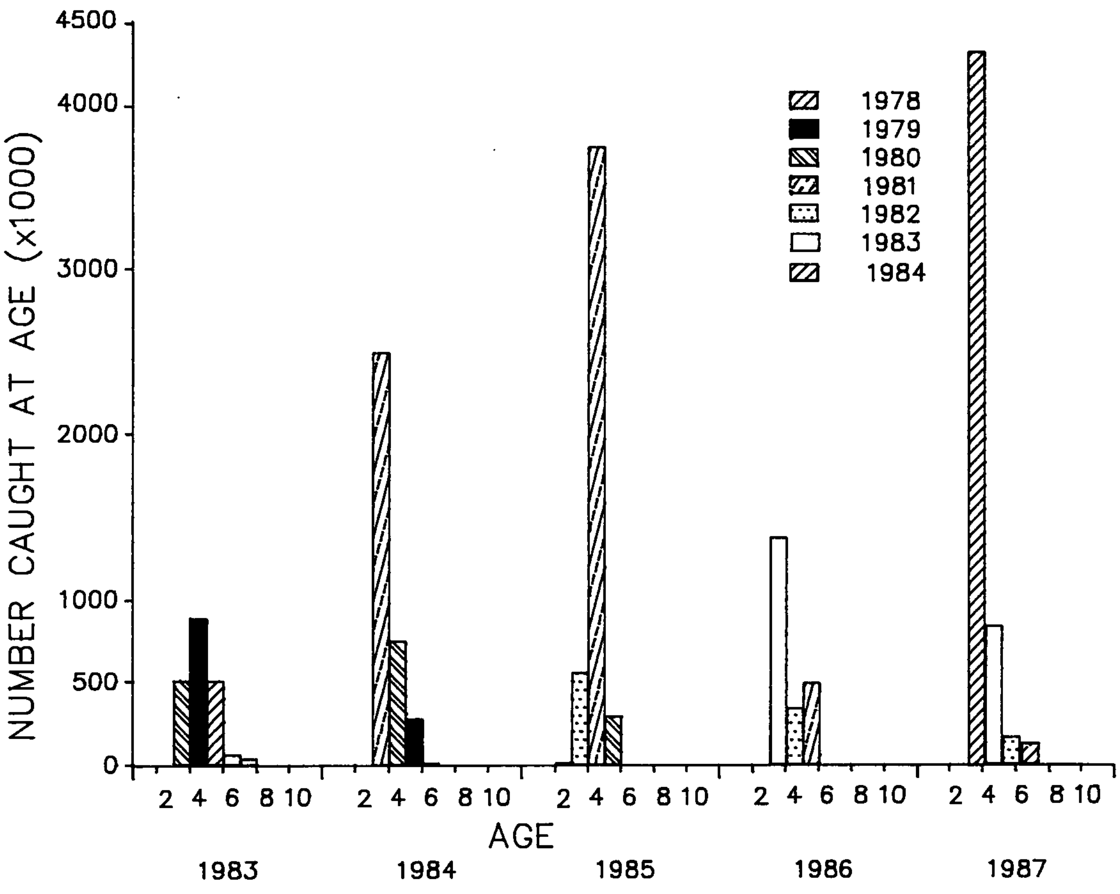

Fig. 3. Number of fish (X 1000) at each age in each year, 1983 to 1987, in the Southwest Margaree River gaspereau fishery.