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Status of the Margaree River gaspereau fishery (1986)

by

D.R. Alexander and A.H. Vromans
Science Branch, Gulf Region
Department of Fisheries and Oceans
P.O. Box 5030
Moncton, New Brunswick
E1C 9B6

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ABSTRACT

The 1986 gaspereau catch on the Southwest Margaree River fell to 545 tonnes compared to a 37 year average of 815 tonnes. This poor catch is attributed to a weak 1982 year-class. Sequential population analysis indicates that this heavy dependence on a single year-class has been caused by persistent over-exploitation despite a staggered closure imposed on the fishery in 1984. Average Paloheimo estimates of fishing mortality in four years studied was 1.3 compared to $F_{0.1}$ of 0.42 determined from yield-per-recruit analysis. Continued high exploitation in 1987 can likely harvest 567 tonnes, but catch at $F_{0.1}$ would be only 245 tonnes. More years of data are required to develop a method of forecasting year-class strength.

RESUME

En 1986, les prises de gaspereau dans la rivière Southwest Margaree ont baissé à 545 tonnes comparativement à une moyenne de 815 tonnes établie sur une période de 37 ans. Cette pêche médiocre est attribuable à une classe d'âge 1982 faible. L'analyse séquentielle de population indique que cette forte dépendance à l'égard d'une seule classe d'âge est attribuable à une surexploitation persistante, malgré une fermeture échelonnée imposée en 1984. Les estimations moyennes de Paloheimo de la mortalité par pêche au cours des 4 années étudiées a été de 1,3 comparativement à une $F_{0,1}$ de 0,42 déterminée à partir de l'analyse du rendement par recrue. Une exploitation élevée qui se poursuivra en 1987 pourrait vraisemblablement permettre une récolte de 567 tonnes, mais les prises à $F_{0,1}$ ne seraient que de 245 tonnes. Des données sur un plus grand nombre d'années seront nécessaires pour mettre au point une méthode permettant de faire des prévisions sur l'importance de la classe d'âge.

INTRODUCTION

Assessments of the gaspereau fishery on the Southwest Margaree River (Alexander 1984, Alexander and Vromans 1985, 1986) have concluded that exploitation is excessive. Reduced exploitation would stabilize the fishery by increasing the number of year-classes being harvested. Although the fishery was closed on Saturdays in the lower river and on Sundays in the upper river beginning in 1984, the exploitation in both 1984 and 1985 continued to be excessive (Alexander and Vromans 1985, 1986). No additional closed times were imposed on the 1986 fishery. Results of the 1986 assessment, using sequential population analysis, are provided in this paper.

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 (SPA). This analysis was performed using APL programs described by Rivard (1982) with revisions to provide rapid tuning (G. Nielsen, pers. comm., DFO, Gulf Region).

In any fishing year, not all fish are exploitable (recruited) by the fishery. The number of fish that are recruited (not necessarily caught) in a year-class, divided by the total number of fish in that year-class, at that age, is the rate of partial recruitment. An estimate of this recruitment rate at each age is essential to carry out sequential population analysis. For this, it was assumed that all fish on the spawning migration are recruited to the fishery. Consequently, any fish with a spawning mark on its scales was considered to be recruited in the year represented by the mark as well as in the year of capture. Using the catch matrix and the proportion of virgin and repeat spawners in the catch, it was, therefore, possible to estimate the rate of partial recruitment as follows:

> The total number of fish recruited to the fishery in the first year of exploitation of a year-class is equal to the number of virgins caught in that year plus the number that escaped and died of natural causes or returned as repeat spawners the next year. The number of virgin fish caught is available from the catch matrix. The number of first year repeat spawners caught in the next year, expanded to allow for between-year fishing and natural mortality represents the number of virgins that were recruited but which escaped the first year of fishing. The sum of the two values represents the number of fish recruited to the fishery in the first year of exploitation. This value is the numerator of the partial recruitment ratio.
>
> The total number of fish in the year-class at the age under consideration is the denominator of the recruitment ratio. This

number includes all of the recruited fish, as estimated above, plus those fish that were not yet on the first spawning run. The latter are represented by virgin spawners of that year-class in the next or subsequent years of the fishery expanded to allow for between-year mortality. If the fish are virgins in the next year, the number is expanded by the between-year fishing and natural mortality. If the fish were caught as virgins two or more years after the first catch from the year-class, then the catch is expanded by the between-year fishing and natural mortality for the last year, and then by a factor representing only natural mortality for each additional year removed from first recruitment. The sum of all of these values represents the total number of fish in the year-class at the first year of recruitment. Using similar calculations, the rate of partial recruitment can be estimated for the second or subsequent years of exploitation for a year-class.

In this 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. Mortality of the oldest age groups in all years and of all fully-recruited age groups in the most recent year was initially input as the mean annual Paloheimo value. Yield per recruit was calculated using the method of Thompson and Bell (Ricker 1975).

In addition to commercial catch-and-effort figures used for potential tuning of the SPA, the relationships between water temperatures in Lake Ainslie and SPA parameters were examined.

Projections of catch were made using the geometric mean of the estimated population numbers at age 3 between 1983 and 1986 as future recruitment. Projections include hypothetical fishing at $F_{0.1}$ and at the mean annual Paloheimo value of fishing mortality.

RESULTS AND DISCUSSION

Gaspereau landings in 1986 fell to 545 tonnes. This is the lowest catch since 1976 (Table 1) and is below the long-term average (815 tonnes). Although some of this reduction may be attributed to the weekly closed time, it has been estimated (Alexander and Vromans 1986) that a one-day-per-week closure would reduce harvest by about only 10%. The reduction may be more appropriately attributed to persistent over-exploitation and to a weak year-class.

Harvest reported by 13 fishermen submitting logbooks was 212,243 kg compared to a total estimated harvest of 545,000 kg. An expansion factor of 2.5688 (Table 2) was, therefore, required to convert logbook data to represent the fishery as a whole. Emphasis should be placed on greater use of logbooks in 1987. Total fishing effort was estimated at 10,090 hours with an overall success rate of 53.3 kg/hr. This rate is similar to that in the

1983 fishery which had a similar harvest at 580 tonnes. The fishery took place almost exclusively during the month of May (Table 3) although 80% of the harvest was taken in the shorter interval of May 12 to 25. Catch peaked at 103,771 kg on May 17 (Table 4; Fig. 1). Total catch consisted of 99.8% alewives (Alosa pseudoharengus). Bluebacks (Alosa aestivalis) were not considered further in the assessment. Mean weight of fish was 243 g compared to 277, 245 and 256 in 1983 to 1985, respectively (Table 5). The catch-at-age matrix (Table 6; Fig. 2) developed for use in SPA shows that the 1984 and 1985 fisheries were largely supported by the strong 1981 year-class. The 1982 year-class appears to be very weak and the 1986 fishery remained heavily dependent on fish at age 5 (26.1%), plus virgin fish at age 3 (55.1%).

Partial recruitment was estimated to be 0.0 at age 2, 0.57 at age 3 and 1.0 at age 4 based on the proportion of virgins at each age (Table 7). Estimates of cumulative catch per hour for fully-recruited age groups (Table 8) indicate that between-year instantaneous mortality ranged from 0.86 to 2.32 with an average of 1.50. Average between-year mortality as a result of fishing was, therefore, estimated at 1.30 for use in the first SPA. Fishing mortality for recruited alewives converged in three runs of SPA at 1.50. Tune programs gave the highest correlation between fishing mortality and fishing effort ($r^2 = 0.533$) at a 1986 fishing mortality of 1.75. Although this is higher than either mean F or Paloheimo F, only a few years of data are available and the fishing mortality in the most recent year was therefore left unchanged. Population numbers from that SPA were used for catch projections.

Yield-per-recruit analysis produced an $F_{0.1}$ fishing mortality of 0.416 at a yield per recruit of 0.174 kg and an average weight of 283 g. Since fishing mortality in all of our calculations exceeds $F_{0.1}$, it is recommended that rate of exploitation be reduced.

Projections of harvest were made using an estimated average population at age 3 of 2,889,000 fish and annual fishing mortality at the $F_{0.1}$ value of 0.42 as well as at the Paloheimo value of 1.3. Results (Table 9) indicate that to reach $F_{0.1}$, harvest should be reduced to only 245 tonnes in 1987, and reaching a long-term average of 505 tonnes. Average fish size would be expected to increase from 247 g at present to 283 g in future. In contrast, if exploitation continues at high levels, catch in 1987 could reach 567 tonnes, with a long-term average of 574 tonnes. However, average fish size would fall to 243 g in 1987 and remain there. These projections, even at high rates of exploitation, are below the long-term average catch observed. This would suggest that the average number of fish at age 3 (2.9×10^6) is too low for use in projections based on only four years of estimated numbers at that age (range: $1.3 \times 10^6 - 8.8 \times 10^6$). It may be that an historical stock recruitment relationship has been destroyed by persistent over-exploitation. At a higher number of fish age 3 annually, yield at $F_{0.1}$ or $F_{1.3}$ would be higher. Because the fishery is highly dependent on the the strength of the youngest age group, a method of predicting the strength of the new year-class is desirable and could provide more accurate projections of catch.

Crawford (1983) has related fish harvest to water temperature in Lake Ainslie during June and July, four years prior to harvest, with good results. Using that relationship, the harvest in 1986 was predicted at 509 tonnes and in 1987 harvest is predicted at 1,017 tonnes. The relationship appears to be biologically justified if the catch at age 4 is largely responsible for the total catch. Under the observed high rates of exploitation, this is frequently true. The small catch of fish at age 4 in 1986 (Table 6) indicates a weak year-class which may be related to temperature at the time of juvenile rearing. Catch of fish from other year-classes was not adequate to maintain a good total catch. Similarily, the high catch at age 4 in 1985 is largely responsible for the success of the fishery and may be related to water temperature although the required temperature data are not available for that year. However, it is difficult to see how the 1984 catch could be related to water temperature which would influence survival to age 4 since fish at age 3 were largely responsible for the success of the fishery.

The 1986 catch at age 3 suggests that the 1983 year-class is stronger than the 1982 year-class and that harvest of fish at age 4 should increase in 1987 if high rates of exploitation are maintained. This has been considered in the projections. However, the strength of the new year-class at age 3 is unknown. Harvest could be much better than predicted if this 1984 year-class, produced during the first year of the staggered closure, is stronger than average.

A relationship between environmental variables and year-class strength at first recruitment (age 3) independent of rate of exploitation would be useful since rate of exploitation could then be manipulated to optimize the fishery. Unfortunately, population numbers have been estimated for only four years and temperature data which might be related to those numbers are available for only three years. A regression between estimated population numbers and water temperatures does indicate a relationship, but this is based on only three points. The current relationship based on age 4 is likely to be maintained only if exploitation remains excessive. Additional years of age-specific catch and abundance data are required to examine potential environmental influences on recruitment.

SUMMARY

Sequential population analysis indicates that the Margaree gaspereau fishery continues to exploit alewives at excessive levels despite the staggered closure imposed in 1984. The lower than average 1986 catch is attributed to this continued high exploitation which placed too much dependence on the weak 1982 year-class. Successive weak year-classes would be even more damaging. Assuming average recruitment and continued high exploitation, the 1987 catch can be expected to reach only 567 tonnes, although this will be increased if the 1984 year-class is strong. If the fishery is to be managed to eventually achieve $F_{0.1}$, harvest in 1987 should be held below 567 tonnes.

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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

Table 2. Logbook catch and effort, total reported catch, estimated total effort and conversion factors used in assessment of the Southwest Margaree gaspereau fishery (1983-86).

	Year			
	1983	1984	1985	1986
Logbook effort (hrs)	2,457	7,749	3,423	3,982
Logbook catch (kg)	112,319	643,770	505,311	212,243
Total reported catch (kg)	579,816	883,409	1,222,698	545,202
Expansion factor	5.1622	1.3722	2.4197	2.5688
Expanded effort (hrs)	12,684	10,634	8,283	10,090
Catch per hour (kg/hr)	45.7	83.0	147.6	53.3

Table 3. Daily catch (kg), effort (hours) and catch per unit effort (kg/hr) in the 1986 Southwest Margaree River gaspereau fishery as reported through gaspereau catch-and-effort logbooks.

	Mon	Tue	Wed	Thur	Fri	Sat	Sun	Total
Apr 21-Apr 27								
Catch (kg)	0	0	0	0	0	0	5	5
Effort (hr)	0	0	0	0	14	0	12	26
CPUE (kg/hr)	0.00	0.00	0.00	0.00	0.00	0.00	0.45	0.21
Apr 28-May 4								
Catch (kg)	23	79	635	1,229	1,551	735	1,474	5,727
Effort (hr)	36	36	63	78	73	24	44	354
CPUE (kg/hr)	0.63	2.20	10.08	15.76	21.25	30.62	33.50	16.18
May 5-May 11								
Catch (kg)	2,472	1,905	1,724	1,837	6,055	11,612	2,767	28,372
Effort (hr)	103	104	121	117	114	76	48	681
CPUE (kg/hr)	24.12	18.41	14.30	15.77	53.12	152.79	57.64	41.66
May 12-May 18								
Catch (kg)	12,134	7,031	3,651	8,403	14,501	40,311	2,676	88,707
Effort (hr)	148	153	163	163	167	110	47	950
CPUE (kg/hr)	82.26	46.10	22.47	51.55	86.83	366.46	56.94	93.42
May 19-May 25								
Catch (kg)	3,751	5,792	3,853	11,576	17,872	14,243	2,835	59,922
Effort (hr)	161	176	178	179	174	109	45	1,022
CPUE (kg/hr)	23.37	32.91	21.65	64.67	102.71	130.67	63.00	58.66
May 26-June 1								
Catch (kg)	13,063	7,416	4,604	2,121	878	249	68	28,399
Effort (hr)	132	142	120	127	98	60	24	703
CPUE (kg/hr)	98.97	52.23	38.37	16.70	8.96	4.16	2.83	40.40
June 2-June 8								
Catch (kg)	91	45	34	181	9	41	91	493
Effort (hr)	32	32	32	18	15	6	16	151
CPUE (kg/hr)	2.83	1.42	1.08	10.08	0.60	6.80	5.67	3.26
June 9-June 15								
Catch (kg)	340	249	23	5	0	0	0	618
Effort (hr)	18	26	26	18	4	0	4	96
CPUE (kg/hr)	18.90	9.60	0.87	0.30	0.00	0.00	0.00	6.44
TOTALS								
Catch (kg)	31,874	22,519	14,524	25,352	40,866	67,191	9,916	212,243
Effort (hr)	629	668	702	700	659	385	240	3,982
CPUE (kg/hr)	50.71	33.71	20.69	36.24	62.01	174.52	41.32	53.30

Table 4. Estimated daily catch in weight (kg) and numbers of gaspereau for the SW Margaree River gaspereau fishery, 1986.

	Alewife		Blueback		Catch (kg)			Number		
Date	Mean wt.(kg)	%	Mean wt.(kg)	%	Alewife	Blueback	Combined	Alewife	Blueback	Combined
Ap 27	.2393	100.0	.0000	0.0	13	0	13	54	0	54
Ap 28	.2830	100.0	.0000	0.0	59	0	59	209	0	209
Ap 29	.2750	100.0	.0000	0.0	204	0	203	740	0	740
Ap 30	.2618	100.0	.0000	0.0	1,635	0	1,635	6,244	0	6,244
Ma 1	.2762	100.0	.0000	0.0	3,164	0	3,164	11,455	0	11,455
Ma 2	.2698	100.0	.0000	0.0	3,993	0	3,993	14,799	0	14,799
Ma 3	.2504	100.0	.0000	0.0	1,892	0	1,892	7,556	0	7,556
Ma 4	.2620	100.0	.0000	0.0	3,795	0	3,794	14,483	0	14,483
Ma 5	.2736	100.0	.0000	0.0	6,364	0	6,364	23,259	0	23,259
Ma 6	.2872	100.0	.0000	0.0	4,904	0	4,904	17,075	0	17,075
Ma 7	.2734	100.0	.0000	0.0	4,438	0	4,438	16,233	0	16,233
Ma 8	.2746	100.0	.0000	0.0	4,729	0	4,729	17,221	0	17,221
Ma 9	.2764	100.0	.0000	0.0	15,587	0	15,587	56,393	0	56,393
Ma 10	.2671	100.0	.0000	0.0	29,892	0	29,892	111,914	0	111,914
Ma 11	.2578	100.0	.0000	0.0	7,123	0	7,123	27,630	0	27,630
Ma 12	.2820	100.0	.0000	0.0	31,236	0	31,236	110,766	0	110,766
Ma 13	.2777	100.0	.0000	0.0	18,100	0	18,100	65,177	0	65,177
Ma 14	.2788	100.0	.0000	0.0	9,399	0	9,399	35,711	0	33,711
Ma 15	.2811	100.0	.0000	0.0	21,631	0	21,631	76,953	0	76,953
Ma 16	.2754	100.0	.0000	0.0	36,171	0	36,171	131,339	0	131,339
Ma 17	.2243	100.0	.0000	0.0	103,771	0	103,771	462,643	0	462,643
Ma 18	.2374	100.0	.0000	0.0	6,889	0	6,889	29,017	0	29,017
Ma 19	.2285	100.0	.0000	0.0	9,656	0	9,656	42,258	0	42,258
Ma 20	.2193	100.0	.0000	0.0	14,910	0	14,910	67,990	0	67,990
Ma 21	.2278	100.0	.0000	0.0	9,919	0	9,919	43,541	0	43,541
Ma 22	.2318	100.0	.0000	0.0	29,800	0	29,800	128,557	0	128,557
Ma 23	.2359	100.0	.0000	0.0	46,007	0	46,007	195,028	0	195,028
Ma 24	.2314	100.0	.0000	0.0	36,665	0	36,665	158,449	0	158,449
Ma 25	.2270	100.0	.0000	0.0	7,298	0	7,298	32,150	0	32,150
Ma 26	.2201	100.0	.0000	0.0	33,628	0	33,628	152,783	0	152,783
Ma 27	.2304	100.0	.0000	0.0	19,091	0	19,091	82,859	0	82,859
Ma 28	.2276	100.0	.0000	0.0	11,852	0	11,852	52,073	0	52,073
Ma 29	.2125	100.0	.0000	0.0	5,460	0	5,460	25,694	0	25,694
Ma 30	.2094	88.0	.2530	12.0	1,941	320	2,260	9,267	1,264	10,531
Ma 31	.2070	94.0	.2438	6.0	596	45	641	2,880	184	3,064
Jn 1	.2048	100.0	.2438	0.0	175	0	175	855	0	855
Jn 2	.2074	80.0	.2382	20.0	182	52	234	878	219	1,097
Jn 3	.2051	86.0	.2680	14.0	96	20	116	466	76	542
Jn 4	.2022	84.0	.2547	16.0	71	17	88	349	67	416
Jn 5	.1961	80.0	.2360	20.0	358	108	466	1,826	457	2,283
Jn 6	.2042	56.0	.2410	44.0	12	11	23	59	46	105
Jn 7	.2033	72.0	.2491	28.0	71	34	106	351	137	488
Jn 8	.2033	72.0	.2491	28.0	159	76	234	780	304	1,084
Jn 9	.2027	88.0	.2787	12.0	737	138	875	3,636	496	4,132
Jn 10	.2141	36.0	.2478	64.0	210	431	641	979	1,741	2,720
Jn 11	.2116	68.0	.2461	32.0	38	21	59	181	85	266
Jn 12	.2116	68.0	.2461	32.0	8	5	13	39	19	58
	.2430		.2509		543,924	1,278	545,202	2,238,799	5,095	2,243,894
% of total					99.8	0.2		99.8	0.2	

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

Age	Weight (g) Year 1983	1984	1985	1986	Mean
2	---	---	161	151	156
3	222	205	213	215	214
4	283	289	247	265	271
5	308	356	310	298	318
6	325	382	374	341	356
7	356	428	408	397	397
8	382	443	421	---	415
9	378	478	466	---	441
10		500		---	500
Mean	277	245	256	243	

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.

Age	Year 1983	1984	1985	1986
	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	898,317 (44.0)	787,409 (26.5)	3,752,712 (79.2)	357,579 (17.5)
5	515,812 (27.5)	262,518 (10.9)	296,677 (7.9)	473,924 (26.1)
6	89,514 (5.0)	32,906 (1.5)	30,837 (1.0)	15,256 (1.0)
7	52,185 (3.2)	19,863 (1.0)	21,145 (0.7)	4,494 (0.3)
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

Table 7. Percentage of virgin fish at each age in each year of the Margaree River gaspereau fishery (1983-86).

Age	Year 1983	1984	1985	1986
3	100	100	93	99
4	56	52	68	58
5	1	1	8	1
6	0	0	0	0

Table 8. Estimates of cumulative catch-per-hour for fully-recruited age groups of alewife in each year and those same age-classes in the next year on the Southwest Margaree River, and the resultant estimates of instantaneous mortality (Z) between years.

Age groups	Catch/hr 1983	Z	1984	Z	1985	Z	1986
4+	123.78		106.85		498.17		
		1.328		0.86		2.32	
5+			32.80		45.11		48.95

$\bar{Z}$ = 1.50

Table 9. Summary of projected annual catch of alewife from the Southwest Margaree River at $F_{0.1}$ (0.42) and at Paloheimo F (1.3) with mean annual recruitment (2,889,000 fish age 3).

Fishing rate		Year 1986	1987	1988	1989	1990	1991	1992	1993
0.42	Catch (T)	551	245	356	424	465	487	501	505
	Wt (g)	247	245	258	268	275	279	281	283
1.30	Catch (T)	551	567	572	574	574	574	574	574
	Wt (g)	247	243	243	243	243	243	243	243

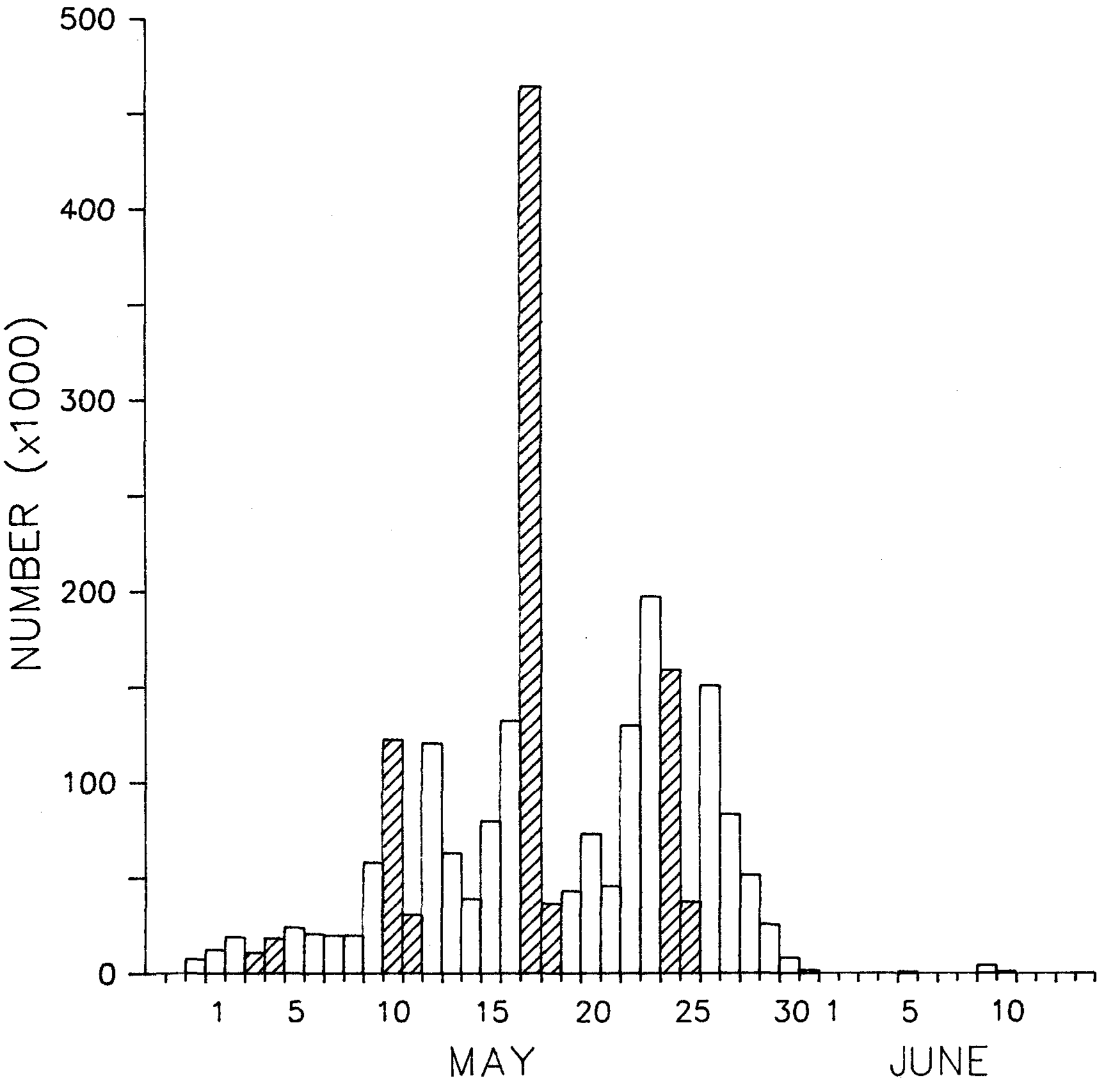

Fig. 1 Daily gaspereau catch in Southwest Margaree River, 1986. (Saturdays & Sundays are shaded for contrast).

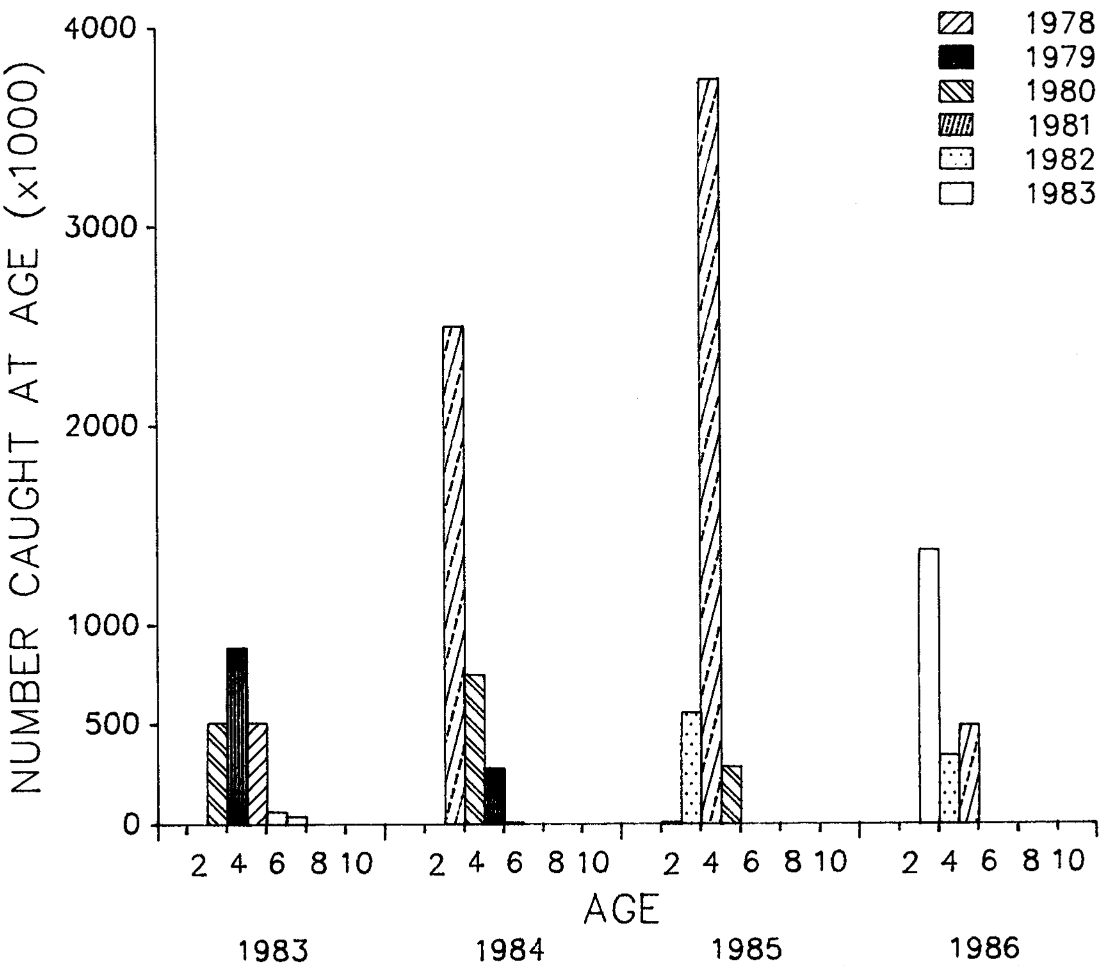

Fig. 2 Number of fish (X 1000) at each age in each year (1983-86) in the Southwest Margaree River gaspereau fishery.