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ASSESSMENT OF THE MARGAREE RIVER GASPEREAU FISHERIES 1991 AND 1992

BY

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ABSTRACT

Fisheries regulations in 1991 and 1992 were identical to those imposed in 1984 and included one day per week closures staggered over the two geographic zones of the river below Lake Ainslie. About 41 traps were fished in both years resulting in a harvest of 450 t in 1991 and 550 t in 1992. These landings are about 50% of the mean landing for the 1986-1990 period. In both 1991 and 1992, the migration of gaspereau into the Margaree River was delayed by almost two weeks relative to the migrations during the 1980's. New recruitment dominated the catch composition in both years comprising 87% and 90% of the catch. The 1986 and 1988 year classes have been weakly represented in the catches. The abundance index, calculated from logbook reports, was the lowest ever in 1991 but increased in 1992 to a level which was about the catch rates of the 1987 to 1989 fisheries. Recruitment of the 1989 year class was strong in 1992. The current level of exploitation remains high with about 60% of the spawning population removed every year. Staggered weekend closures introduced in 1984, are important in ensuring that a component of the spawning migration escapes into Lake Ainslie.

RESUME

Les règlements de pêches en 1991 et 1992 étaient semblables à ceux en vigueur depuis 1984 et imposaient une fermeture obligatoire d'une journée par semaine décalée suivant les deux zones de la rivière. En 1990, 41 de 62 détenteurs de permis ont éxercé leur droit de pêche. Les prises se sont situées à 450 tonnes en 1991 et 550 tonnes en 1992, une baisse de 50% par rapport à la moyenne des cinq années précédentes. La montaison de gaspareau durant les deux années était retardée de près de 2 semaines par rapport aux remontées des années 80. Les nouvelles recrues représentaient 87% et 90% des captures totales. Les cohortes de 1986 et 1988 étaient faibles. L'abondance de gaspareau, calculé en utilisant les prises et l'effort quotidiennes enrégistrés dans des carnets de pêche, était la plus basse en 1991 mais a augmenté en 1992 à un niveau d'environ la moitié celui des années 1987 à 1989. Le recrutement de la cohorte de 1989 était fort en 1992. Le taux d'exploitation est demeuré élevé et près de 60% de la remontée annuelle est prise par la pêche. Les fermetures de fin de semaine, en vigueur depuis 1984, sont importantes afin d'assurer le passage jusqu'au Lac Ainslie et ainsi le frai d'une partie de la remontée.

INTRODUCTION

Annual assessments of the gaspereau fishery in the Margaree River have been presented since 1983 (Alexander MS1984; Alexander and Vromans MS1985, MS1986, MS1987, MS1988; Chaput and LeBlanc MS1989, MS1990; Chaput et al. MS1991). The river has been partitioned into two management zones: a lower zone encompassing all waters downstream of NS provincial highway #19 bridge and an upper zone encompassing all waters upstream of the bridge (Fig. 1). Fishery regulations in 1991 and 1992 were similar to those imposed in 1984: a one day staggered closure per week with the fishery closed from Friday 18:00 to Sunday 8:00 for the lower river zone and Saturday 18:00 to Monday 8:00 for the upper zone. The fishing season closed on June 30, as in previous years.

This document provides descriptions of the 1991 and 1992 gaspereau fisheries and presents the input parameters used for a cohort analysis under Type I fishery assumptions. The pre-fishery population numbers at age for a given year and the associated estimates of the fishing mortality on the spawning stock are derived by tuning the fishing mortality in the recent year with an abundance index based on catch and effort logbook reports.

MATERIALS AND METHODS

Sampling of the commercial catch was undertaken on a daily basis in both management zones of the river, stratified randomly into AM & PM periods (Chaput and LeBlanc MS1990). Fishing locations sampled in each zone were randomly selected for each day constrained by the traps actually fishing on a particular day and site accessibility. Length stratified sampling was undertaken and a subsample of 3 fish per half cm fork length for fish less than 28.0 cm and 5 fish per half cm length for fish >= 28.0 cm was retained for detailed analysis. The actual sites sampled, dates, time periods and numbers measured for length in 1991 and 1992 are summarized in Table 1.

Detailed Processing of Samples

Biological characteristics collected include fork length (+0.25 cm), whole weight (+1 g), species (alewife, *Alosa pseudoharengus*; or blueback herring, *Alosa aestivalis*) and sex. Scales were removed from the left side of the fish, in the region midway between the dorsal fin and the ventral scutes. Species were distinguished on the basis of the external appearance and peritoneum colour (Scott and Crossman 1973). Total age and age of first spawning were determined from scales according to criteria described by Cating (1953).

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

$$\text{adjusted length (mm)} = 4.557 + 1.1043 \times \text{frozen length (mm)}$$

$$R^2 = 0.96 \qquad N = 49.$$

The catch-at-age of alewife and blueback herring was obtained using the program AGELEN (Wright 1990). The catch-at-age from each of the two zones was calculated separately. A total of 4 keys were used in 1991 and 3 keys were used in 1992. The keys were constructed using combined samples from the lower and upper zones. The estimate of the catch-at-age was obtained as follows:

1) individual length samples were weighted by the respective logbook catch for the day,
2) the appropriate age/length key was applied to the weighted length sample,
3) catch by age for each sampled day was summed for each age-length key period,
4) catch-at-age for each key period was calculated by projecting to logbook catch within the key period,
5) catch-at-age for all logbook catch was estimated by summing across all age-length key periods,
6) catch-at-age was expanded to total catch by multiplying by the ratio of total catch to logbook catch.

Catch and Effort Logbooks

Voluntary catch and effort logbooks, collected from individual fishing locations, were processed for catch and effort (hours and days) for each individual report.

Landings

Landings for 1991 and 1992 were calculated from the sum of the bait sales and from total pail counts of cured, packed gaspereau (50 lb pail was estimated to represent 32 kg of fresh fish).

Abundance Indices

An abundance index for all ages combined was estimated directly from the daily catch per unit of effort on the river. The index, for lower and upper zones separately, represents the sum of the average daily catch (kg/trap-day equivalents) over the entire fishing season. This index was used to account for differences in the duration and ultimately the timing of the upriver migration (see Appendix 1).

A second catch rate index using catch and effort logbook data was estimated using the multiplicative model approach of previous assessments (Gavaris 1980). Catch and effort data were treated in the following manner:

1. In contrast to previous assessments where the lower 10% and the upper 10% of the catch was ignored, all the catch from the logbook reports was included although days with effort but no catch were eliminated from the analysis.
2. Catch-per-unit-effort (CPUE) was calculated as the ratio of the total catch (kg) to total effort (days) for each trap report. The natural log of the CPUE was the dependent variable with year and management zone as predictor variables.

The multiplicative model was fitted using SAS GLM procedures and model diagnostics were obtained using SAS REG procedures (SAS 1989). Diagnostics included the DFFITS calculation which estimates the change in the predicted value of an observation when it is included in the model relative to when it is not included in the model. Cumulative probability plots of the residuals were used to assess the normality of the residual term as described by Neter et al. (1983) and Freund and Littell (1986). The backtransformed values were estimated from the model solutions to the year factor using the transformation equation described by Gavaris (MS1988a).

Natural Mortality

As in the previous assessments, a composite non-inriver instantaneous fishing mortality component, calculated as M_c= 0.44 for alewife during the first spawning migration and M_c = 1.05 for subsequent spawning years was used (Chaput and Alexander MS1989).

Cohort Analysis

Cohort analysis was performed under Type I fishery assumptions: 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 fishery commences (May 1) and natural mortality occurs after the fishing ends (Ricker 1975:p10-11). The cohort model used in this analysis assumed that the population numbers of the last age group were equal to the catch with fishing complete. The population numbers refer to the numbers just prior to the beginning of the fishery and were estimated separately for the catch matrices for 3 and 4 year old recruitment groups. This analysis eliminates the requirement for a partial recruitment vector since in each simulation, all the fish included are fully recruited to the fishery. Alewife aged as 2 and 5 year old recruits have constituted a minor component of the population and are not considered further.

The ADAPT formulation (Gavaris MS1988b), modified for Type I fishery assumptions was tried but population numbers at age which were significantly different from the mean number at age could not be obtained using either of the abundance indices. A simple cohort analysis was attempted instead: age aggregated index by fishing zone, the sum of the population numbers for both age matrices combined, and F's which were identical for all ages in 1992. The F in the most recent year was determined using a linear regression (with intercept) of the index of abundance on population number.

RESULTS

The number of licenses has been frozen at the 1990 value of 62. The number of trap sites actually fished in 1991 and 1992 was about 40. The enforcement of new fisheries inspection regulations in 1992, particularly the requirement that all gaspereau destined for human consumption must be cured in a certified building, secure from the elements, prevented some individuals from actively participating to the same extent as in previous years.

The landings of gaspereau in 1991 and 1992 were estimated to have been 450 and 550 metric tons respectively, less than 50% of the 1986 to 1990 mean (Table 2). Relative to the gaspereau fisheries within Gulf Region, the Margaree River remains the dominant stock exploited in Nova Scotia and has represented about 15 to 40% of the total landings of gaspereau from Gulf Region (Table 3).

1991 and 1992 Fisheries

The 1991 and 1992 fisheries were unusual compared to the previous years' fisheries in terms of the low landings and the delayed in-river migration and the relatively short duration (Table 4; Fig. 2). The delayed migration of the gaspereau in the river was similar to those of 1985 and 1990 (Table 4). Ice conditions off the western shore of Cape Breton, which persisted into early May in 1991 and mid-May in 1992, would have contributed to the late arrival of the gaspereau to the Margaree River.

The gaspereau catch was estimated to have consisted of 95% and 96% alewife by weight in 1991 and 1992, respectively. This is slightly less than previous years and may reflect some of the additional fishing effort expended in early June when blueback herring normally enter. Most individuals had stopped fishing in late May in previous years. The estimated total catches of blueback herring in 1991 and 1992 were the highest since 1983 (Table 5).

The alewife catch in 1991 and 1992 was about 2 million fish. New recruitment dominated the catch composition in both years (87% and 90%) and was the highest in the time series (Table 6). The 1987 cohort was dominant in 1990 and 1991 while the 1989 cohort was dominant in 1992 (Table 6). The 1986 and the 1988 cohorts have been weakly represented in the catches.

Abundance Index

The reference categories for the full multiplicative model were the same as those in the 1990 assessment; year 1989, lower zone in the river. The interaction term, yearXzone, was not significant (P=0.81). Both the year and zone treatments were significant and explained 23% of the total variance in catch rates for the period 1984 to 1992. The 1983 data were omitted because of the small number (4) of logbook reports. The abundance of gaspereau in 1992 was not significantly different from that of 1989 but the abundance in 1991 was significantly lower (Table 8). The 1991 catch rate was the lowest in the 1984-1992 series. The same results were evident when the two management zones were considered separately although there was no significant difference between years in the catch rates from the upper zone (Table 8; Fig. 3). Catch rates in the upper zone were in most years about half those of the lower zone (Table 7).

The abundance index based on the sum of the daily CPUE for each zone separately provides a slightly different picture of the trends in abundance. Again, the upper zone catch rate was about half the lower zone value but the abundance of the 1989 migration is greater than the estimated value obtained with the multiplicative model (Fig. 3). The cumulative daily CPUE is the appropriate index to use to reflect total population numbers (see Appendix 1) and it was used to tune the fishing mortality in the recent year, 1992.

The best fits of abundance index and population numbers were obtained for both indices at an F value in 1992 between 0.5 and 0.6 (Table 9). These F values also provided the smallest residuals for the 1991 and 1992 data points, the only two points which were impacted by the tuning process (Table 9). The population of gaspereau ascending the Margaree River in 1992 was estimated at 5 million individuals, while about 3.1 million ascended in 1991 (Table 10). The exploitation rate on this stock remains high, with over 60%, on average, of the spawning population being removed by the fishery. Tuning the F values for 1991 as the year for the terminal fishery provided an estimated F of 1.0 for the 1991 fishery (Table 10). The current year F values for 1990 and 1991 were overestimated when only the 1991 fishery is considered relative to when the 1992 data are included (Table 10). The results, however, confirm the high fishing mortality on the 1990 spawning run when almost 80% of the spawners were harvested (Table 10).

Other indicators of the spawning population size were obtained by considering the estimates of larval abundance in Lake Ainslie obtained in 1983-85 and in 1989-91 (Crawford MS1992) (Fig. 4). The values of escapement and larval density were log-transformed and the correlation was highest (0.62), though not significant (P=0.19), when the 1992 fishing mortality was 0.4.

DISCUSSION

Assuming that the ageing errors are not large, we can obtain a preliminary view of the type of stock-recruit function that the Margaree River alewife stock may follow. Jessop (1990) indicated that, for the St. John gaspereau stock, the year-class abundance was established by the level of escapement, but that the recruitment per spawner was inversely related to spawning escapement. The early indications from the Margaree River data are that a similar relationship holds and escapements in excess of 3 million fish have resulted in poor recruitment to date (Fig. 4). Larval densities reflect the estimates of escapement but high escapement levels do not necessarily translate into strong recruitment (Fig. 4). The inriver environmental conditions observed in 1990 to 1992 have been relatively cold with river and lake temperatures not exceeding 15 C on a regular basis until well towards the end of May. The impact of such cold temperatures on subsequent survival of post-larvae and juveniles is unknown. Variable conditions at sea would also expectedly impact on the recruitment strength of individual cohorts.

The low catches obtained in the last two years have prompted many suggestions by the users that the fishery is exploiting too many fish and not allowing sufficient escapement into the lake to spawn. The fishery is indeed harvesting the stock at high levels, with 60% of the spawning population removed every year. Yield-per-recruit analysis of the Margaree River alewife stock estimated the sustainable fishing mortality ($F_{0.1}$) at 1.3, which represents about 75% of the spawning population (Chaput and LeBlanc MS1989). The fishing mortality in most years has approached this value and in 1990, the level was exceeded. On that basis, the restrictions on effort should be maintained to ensure at least some free, though limited, movement of gaspereau to Lake Ainslie. Staggered weekend closures are the most important component of this management strategy.

Larval abundance estimates for the 1989 and 1990 cohorts indicate that the 1990 larval abundance was almost half that of 1989 (Fig. 4), consequently the 1990 cohort is expected to be weak. However, the 1983 and 1985 cohort estimates of larval abundance and recruiting year class strength are reversed suggesting that the 1990 cohort could be stronger than the 1989 cohort. On the basis of such preliminary and contradictory relationships, no forecast is possible.

Although the current level of exploitation is high, there is no indication that the present levels of harvest are endangering the sustainability of the fishery. Initiatives which could estimate the escapement into Lake Ainslie should be considered in order to validate the abundance indices and the cohort analysis of the size of the spawning stock.

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Table 1. Locations, dates and periods sampled during the 1991 and 1992 Margaree River gaspereau fisheries. Vertical bars indicate sample aggregations for the age/length keys constructed in 1991 and 1992.

		1991						1992					
		Lower			Upper			Lower			Upper		
		Site #	Period	No. Meas.	Site #	Period	No. Meas.	Site #	Period	No. Meas.	Site #	Period	No. Meas.
May	4												
	5												
	6												
	7												
	8												
	9												
	10												
	11												
	12	12	AM	2									
	13	12	AM	13									
	14												
	15												
	16	12	PM	16									
	17	7	AM		49	PM	174						
		9	AM	420	33	AM	188						
	18												
	19	12	AM	190									
	20				49	AM	138	26	AM	143			
	21	12	AM	239				1.1	PM	142			
	22	9	AM	238				1	AM	118			
	23										38	PM	135
	24							12	AM	151			
	25				49	PM	186	5	PM	228	35	PM	249
	26	1.2	PM	173				12	PM	199	49	PM	125
	27							1	AM	110	35	AM	261
	28	7	AM										
		8	PM	335									
	29				35	AM	205						
	30	9	AM	238	35	AM	240						
	31	5	AM	207	60	AM	221	4	AM	174			
June	1				30	AM	223	7	PM	219	49	AM	169
	2	26	PM	135				17	PM	192	35	AM	196
	3							12	AM	171	37	PM	205
	4												
	5							12	AM	217	60	AM	252
	6												
	7												
	8												
	9	26	AM	157									
	10	1	AM										
		26	AM	296									
				2659			1575			2064			1592

Table 2. Gaspereau landings from District 2 and Margaree River, 1950 to 1992. 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	1,506	1,123 *
1990	1,005	1,016 *
1991	450 *	450 *
1992	550 *	550 *
Means (95% C.I.)		
Historical	857 (718-996)	
10-Year	991 (732-1,389)	
5-Year	1,085 (340-1,725)	961 (467-1,553)

* = Science Branch estimates

Table 3. Landings of gaspereau for the Gulf Region, 1978 to 1990. 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
1989	1506.0	-	244.8	148.3	129.9	74.7	11.8	2115.5	3681.4	132.5	5929.4
1990	1005.0	-	226.0	1.0	202.0	33.0	26.0	1493.0	3196.0	84.0	4773.0
Mean	1,252.7	0.5	263.3	178.2	107.2	57.9	19.6	1,879.3	3,179.2	215.0	5,273.4

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

Table 4. Catch, effort and dates of maximum and cumulative landings for the gaspereau fishery of the Southwest Margaree River, 1983 to 1992.

		1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
Logbook catch (mt)		112.65	637.07	506.37	212.69	882.27	1375.08	972.70	780.13	208.13	300.1
Estimated Landings (mt)		579.8	883.4	1,222.7	545.2	1,258.8	1,665.7	1,123.0	1,016.2	449.7	550.0
Expansion Factor		5.15	1.39	2.41	2.56	1.43	1.21	1.15	1.30	2.16	1.83
Landings											
Date of:	Maximum catch	May 17	May 17	May 30	May 17	May 13	May 22	May 18	June 4	May 31	June 2
	Cumulative 10%	10	16	21	9	12	17	14	13	18	24
	50%	17	21	28	17	16	23	19	29	28	June 1
	90%	24	28	June 2	26	26	29	23	June 4	31	June 4
Total days for 10% to 90%		15	12	12	17	15	13	10	22	13	12

Table 5. Catch at age (numbers) of blueback herring in the Southwest Margaree River gaspereau fishery, 1983 to 1992. AGE.FSP refers to total age followed by age of recruitment.

AGE.FSP	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
1.1	0	42	0	0	0	0	0	0	0	0
2.2	0	0	0	0	0	0	0	0	0	0
3.2	0	1,093	1,419	0	0	0	0	0	0	0
4.2	0	716	2,943	0	0	0	0	0	0	0
5.2	0	666	72	0	0	0	0	0	0	0
3.3	0	51	138	169	675	2,152	0	13264	49289	93562
4.3	0	4,229	10,919	87	0	5,475	341	0	10148	0
5.3	0	3,012	3,619	237	0	0	597	1099	0	2310
6.3	6,290	1,501	0	614	52	0	0	0	0	0
7.3	0	0	0	105	597	0	0	0	0	0
8.3	0	0	1,353	0	0	0	0	0	0	0
9.3	0	0	0	0	0	0	0	0	0	0
4.4	0	0	7,115	668	1,946	24,956	5,176	0	39447	11641
5.4	0	16	1,775	1,499	77	1,765	35,141	45520	416	1073
6.4	6,290	28	7,165	699	1,814	0	1,244	3786	5678	0
7.4	0	0	0	248	103	0	114	535	1605	0
8.4	0	0	0	0	597	0	0	0	0	0
9.4	164	446	0	0	0	0	0	0	0	0
10.4	164	0	0	0	0	0	0	0	0	0
5.5	0	0	0	0	0	0	14201	793	9939	0
6.5	0	0	0	0	0	0	654	1673	416	0
7.5	0	0	0	0	0	0	28	0	1050	0
Total Catch	12,908	11,800	36,518	4,326	5,861	34,348	57,496	66,670	117,988	108,586

Table 6. Estimated numbers of alewife by total age and age of recruitment in the gaspereau fishery, Southwest Margaree River, 1983 to 1992. %FSP refers to percent new recruitment.

Numbers of alewife

	Year										C.V. %	
Total Age	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1991	1992
Recruited at age 2												
2	0	0	24,806	2,104	0	0	657	0	5,986	4,642	46.2	91.1
3	1,759	0	106,971	15,683	0	0	0	0	0	2,532		0.0
4	0	0	0	0	9,936	0	0	0	0	0		
5	0	0	0	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	2,806,413	422,393	1,773,675	5.7	1.3
4	397,393	258,404	920,280	158,545	429,356	2,354,640	1,235,744	54,329	41,206	133,262	20.2	7.9
5	334,105	185,480	40,614	129,007	18,600	160,274	181,065	243,656	54,907	96,684	18.2	10.0
6	52,414	4,211	27,024	5,818	4,607	6,993	6,235	55,072	20,053	1,816	27.4	75.0
7	17,976	1,090	2,937	0	0	0	0	2,713	770	144	81.6	40.0
8	2,733	644	0	0	0	0	0	0	0	0		
9	5,248	0	0	0	0	0	0	0	0	0		
10	0	0	0	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	281,029	1,282,864	187,884	2.1	6.3
5	156,504	35,124	204,850	371,931	130,546	267,326	185,607	628,352	55,863	47,302	14.5	5.1
6	45,417	20,213	6,467	10,649	181,210	69	11,078	22,619	18,548	920	15.5	39.8
7	0	4,112	0	3,888	0	0	38	3,938	726	0	82.6	
8	2,733	4,409	1,343	0	0	0	0	0	0	0		
9	0	43,447	0	0	0	0	0	0	0	0		
10	0	248	0	0	0	0	0	0	0	0		
11	0	0	0	0	0	0	0	0	0	0		
Recruited at age 5												
5	0	0	0	0	0	0	1,434	35,611	35,160	0	25.4	
6	5,248	1,239	875	6,529	0	0	0	1,230	0	0		
7	0	0	0	0	0	0	0	250	1,080	0	68.7	
Total	2,105,400	3,587,536	4,852,865	2,201,700	5,608,169	6,699,762	4,186,037	4,135,212	1,939,556	2,248,861		
% FSP	51.5	84.4	73.0	68.1	86.2	58.4	61.3	75.5	90.0	87.4		
Dominant Year-class	1979	1981	1981	1983	1984	1984	1985	1987	1987	1989		
% of total	36.5	72.5	82.2	58.0	78.5	56.5	87.9	67.9	68.3	79.0		

Table 7. Multiplicative model analysis of the catch rates of gaspereau from the Margaree River, 1984 to 1992 for lower and upper zones. Reference categories are year = 1989, zone = LOWER.

General Linear Models Procedure
Class Level Information

Class	Levels	Values
YY	9	84 85 86 87 88 90 91 92 89
LOCAT	2	UPPER LOWER

Number of observations in data set = 225

General Linear Models Procedure

Dependent Variable: LOGCPUE

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	9	80.24249664	8.91583296	6.99	0.0001
Error	215	274.23621307	1.27551727		
Corrected Total	224	354.47870971			

R-Square	C.V.	Root MSE	LOGCPUE Mean
0.226368	15.47766	1.12938801	7.29689238

Source	DF	Type III SS	Mean Square	F Value	Pr > F
YY	8	43.31089216	5.41386152	4.24	0.0001
LOCAT	1	38.38951807	38.38951807	30.10	0.0001

Parameter		Estimate	T for H0: Parameter=0	Pr > |T|	Std Error of Estimate
INTERCEPT		8.085415791 B	39.31	0.0001	0.20568890
YY	84	-0.693752435 B	-2.62	0.0095	0.26513390
	85	0.001976348 B	0.01	0.9954	0.34574041
	86	-0.835914036 B	-2.29	0.0229	0.36464858
	87	0.043263658 B	0.14	0.8870	0.30408017
	88	0.098639980 B	0.38	0.7039	0.25921221
	90	-0.484903851 B	-1.75	0.0822	0.27767196
	91	-1.267238613 B	-4.01	0.0001	0.31621271
	92	-0.032522857 B	-0.09	0.9293	0.36637774
	89	0.000000000 B	.	.	.
LOCAT	UPPER	-0.855560627 B	-5.49	0.0001	0.15595081
	LOWER	0.000000000 B	.	.	.

Table 8. Multiplicative model analysis of the catch rates of gaspereau from the Margaree River, 1984 to 1992, by zone.

Class	Levels	Values
YY	9	84 85 86 87 88 90 91 92 89

Zone = **LOWER**
Number of observations in data set = 101
Dependent Variable: LOGCPUE

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	8	33.47171765	4.18396471	5.03	0.0001
Error	92	76.51080798	0.83163922		
Corrected Total	100	109.98252562			

R-Square	C.V.	Root MSE	LOGCPUE Mean
0.304337	11.77338	0.91194255	7.74580104

Source	DF	Type III SS	Mean Square	F Value	Pr > F
YY	8	33.47171765	4.18396471	5.03	0.0001

Parameter		Estimate	T for H0: Parameter=0	Pr > |T|	Std Error of Estimate
INTERCEPT		8.144721796 B	35.72	0.0001	0.22798564
YY	84	-0.726059655 B	-2.03	0.0450	0.35718485
	85	-0.363966565 B	-0.88	0.3808	0.41325906
	86	-1.233000669 B	-2.42	0.0175	0.50979138
	87	-0.135121107 B	-0.36	0.7230	0.37997606
	88	0.347154737 B	1.08	0.2844	0.32242038
	90	-0.553949864 B	-1.69	0.0944	0.32775000
	91	-1.464539602 B	-4.39	0.0001	0.33373680
	92	-0.038906119 B	-0.10	0.9187	0.37997606
	89	0.000000000 B	.	.	.

Zone = **UPPER**
Number of observations in data set = 124
Dependent Variable: LOGCPUE

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	8	15.60328691	1.95041086	1.17	0.3242
Error	115	191.96129270	1.66922863		
Corrected Total	123	207.56457960			

R-Square	C.V.	Root MSE	LOGCPUE Mean
0.075173	18.64002	1.29198631	6.93124903

Source	DF	Type III SS	Mean Square	F Value	Pr > F
YY	8	15.60328691	1.95041086	1.17	0.3242

Parameter		Estimate	T for H0: Parameter=0	Pr > |T|	Std Error of Estimate
INTERCEPT		7.184669636 B	25.48	0.0001	0.28193453
YY	84	-0.660446372 B	-1.73	0.0869	0.38243460
	85	0.315469169 B	0.59	0.5579	0.53678735
	86	-0.640603784 B	-1.24	0.2158	0.51473967
	87	0.170888327 B	0.37	0.7085	0.45594877
	88	-0.070310675 B	-0.18	0.8572	0.38995158
	90	-0.429978316 B	-0.98	0.3270	0.43677109
	91	-0.900064791 B	-1.50	0.1351	0.59807345
	92	-0.106413501 B	-0.15	0.8803	0.70483632
	89	0.000000000 B	.	.	.

Table 9. Tuning diagnostics for 1992 F using the linear regression of observed abundance index for lower and upper zone on total population, ages 3 to 7. NS means parameter estimate is not significantly different from 0 (P>0.05).

	Residuals			
	Lower Index		Upper Index	
F	1991	1992	1991	1992
0.3	-38498	-63970	-8644	-35616
0.4	-30120	-29443	-3789	-11516
0.5	-27957	-7789	-2858	3150
0.6	-27693	5836	-3022	12219
0.7	-28007	14871	-3465	18162
0.8	-28476	21178	-3946	22275
1	-29405	29235	-4785	27481
1.1	-29805	31920	-5127	29202
1.2	-30156	34047	-5421	30561
1.4	-30731	37174	-5893	32550

	R-square		Slopes		Intercept at Origin	
F	Lower	Upper	Lower	Upper	Lower	Upper
0.3	0.680	0.879	0.022	0.016	NS	NS
0.4	0.769	0.956	0.023	0.016	NS	NS
0.5	0.792	0.964	0.023	0.016	NS	NS
0.6	0.795	0.955	0.023	0.015	NS	NS
0.7	0.793	0.943	0.022	0.015	NS	NS
0.8	0.788	0.932	0.022	0.014	NS	NS
1	0.779	0.912	0.021	0.014	NS	NS
1.1	0.775	0.905	0.021	0.014	NS	NS
1.2	0.771	0.898	0.021	0.014	NS	NS
1.4	0.765	0.888	0.020	0.013	NS	NS

Table 10. Prefishery population numbers estimated F for alewife from the Margaree River for a fishing mortality of F=0.6 in 1992.

Population at Age	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
Recruited at age 3										
3	1,368,411	4,660,340	864,162	2,719,127	9,592,401	5,743,329	472,928	3,821,208	880,997	3,931,119
4	1,172,094	421,973	1,326,556	268,806	938,280	3,343,943	2,102,072	227,240	653,565	295,358
5	351,093	271,097	57,239	142,171	38,585	178,092	346,194	303,161	60,508	214,287
6	78,370	5,945	29,961	5,818	4,607	6,993	6,235	57,785	20,823	1,960
Recruited at age 4										
4	503,195	793,652	4,451,460	438,782	947,844	1,828,794	3,502,034	376,815	1,445,648	416,420
5	225,235	85,356	235,282	889,767	131,054	331,142	256,173	681,356	61,690	104,839
6	194,631	24,052	17,578	10,649	181,210	178	22,331	24,694	18,548	2,039
7	2,733	52,216	1,343	3,888	0	0	38	3,938	726	0
Total										
3	1,368,411	4,660,340	864,162	2,719,127	9,592,401	5,743,329	472,928	3,821,208	880,997	3,931,119
4	1,675,289	1,215,625	5,778,016	707,589	1,886,124	5,172,737	5,604,106	604,055	2,099,213	711,778
5	576,328	356,453	292,521	1,031,938	169,639	509,233	602,367	984,517	122,198	319,126
6	273,002	29,996	47,539	16,467	185,817	7,171	28,566	82,479	39,371	3,999
7	2,733	52,216	1,343	3,888	0	0	38	3,938	726	0
Using 1992 Catches										
Prefishery Population	3,895,763	6,314,631	6,983,581	4,479,008	11,833,981	11,432,470	6,708,005	5,496,196	3,142,505	4,966,022
Escapement	1,797,369	2,728,333	2,263,367	2,301,624	6,235,747	4,732,708	2,524,059	1,398,075	1,245,175	2,724,335
Using 1991 Catches										
Prefishery Population	3,895,763	6,314,631	6,983,581	4,479,008	11,833,981	11,432,470	6,872,000	4,730,000	2,989,000	
Escapement	1,797,369	2,728,333	2,263,367	2,301,624	6,235,747	4,732,708	2,689,000	632,000	1,092,000	
F-values										
3	0.7	0.8	0.7	0.6	0.6	0.6	0.3	1.3	0.7	0.6
4	0.6	0.8	1.2	0.8	0.6	1.3	1.1	0.8	1.0	0.6
5	1.9	1.0	1.8	0.7	2.1	1.8	0.9	2.2	2.4	0.6
6	0.6	2.1	1.5	-	-	4.2	0.9	3.7	-	1.3
7	-	-	-	-	-	-	-	-	-	-
Total (using 1992)	0.8	0.8	1.1	0.7	0.6	0.9	1.0	1.4	0.9	0.6
Total (using 1991)	0.8	0.8	1.1	0.7	0.6	0.9	0.9	2.0	1.0	
Spawning Population Removed by Fishery										
Using 1992	53.9%	56.8%	67.6%	48.6%	47.3%	58.6%	62.4%	74.6%	60.4%	45.1%
Using 1991	53.9%	56.8%	67.6%	48.6%	47.3%	58.6%	62.4%	86.0%	63.0%	

Appendix 1. Simulation of the catch-per-unit-effort obtained from logbooks relative to annual variation in migration intensity.

Simulated Population: 1000 gaspereau enter every year

Fisher population:
each trap catches 10% of the daily migration of gaspereau.
not all fishers fish every day - fisher 1 fishes on average 95% of the time, fisher 2 fishes on average 25% of the time, and fisher 3 fishes on average 50% of the time.

Logbook reports contain estimates of the catch for a given day.
Effort is in trap-day units.
Only days when catch is reported are considered as valid effort.
The duration of the run is estimated from the catches as the time period between the first day fish are reported caught and the last day fish are reported caught.

Simulated migration of gasperau into the river.

	Year				
Day	1	2	3	4	5
1	66.7	0	0	10	0
2	66.7	0	10	10	0
3	66.7	0	50	10	0
4	66.7	100	100	20	0
5	66.7	200	200	50	0
6	66.7	400	100	100	0
7	66.7	200	30	150	0
8	66.7	100	20	300	1000
9	66.7	0	30	150	0
10	66.7	0	100	100	0
11	66.7	0	200	50	0
12	66.7	0	100	20	0
13	66.7	0	50	10	0
14	66.7	0	10	10	0
15	66.7	0	0	10	0
Total Run	1000	1000	1000	1000	1000

The Ideal Fisherman, fishes every day over the entire migration and catches 10% of the daily run.

	Year				
Day	1	2	3	4	5
	Catch per Day				
1	6.7	0.0	0.0	1.0	0.0
2	6.7	0.0	1.0	1.0	0.0
3	6.7	0.0	5.0	1.0	0.0
4	6.7	10.0	10.0	2.0	0.0
5	6.7	20.0	20.0	5.0	0.0
6	6.7	40.0	10.0	10.0	0.0
7	6.7	20.0	3.0	15.0	0.0
8	6.7	10.0	2.0	30.0	100.0
9	6.7	0.0	3.0	15.0	0.0
10	6.7	0.0	10.0	10.0	0.0
11	6.7	0.0	20.0	5.0	0.0
12	6.7	0.0	10.0	2.0	0.0
13	6.7	0.0	5.0	1.0	0.0
14	6.7	0.0	1.0	1.0	0.0
15	6.7	0.0	0.0	1.0	0.0
Total Catch	100	100	100	100	100
Total Effort	15	5	13	15	1
CPUE	6.666666	20	7.692307	6.666666	100 Avg. Duration
Duration of Run	15	5	13	15	1 9.8
Adjusted CPUE	10.20408	10.20408	10.20408	10.20408	10.20408

Adjusted CPUE is calculated by multiplying CPUE by ratio of annual duration relative to average duration over the time series.

Appendix 1 (cont'd).

Fisher #1	Year					Fishing Activity: Fish (1) or Don't Fish (0)				
Day	1	2	3	4	5	1	2	3	4	5
1	6.7	0.0	0.0	1.0	0.0	1	1	1	1	1
2	6.7	0.0	1.0	1.0	0.0	1	1	1	1	1
3	6.7	0.0	5.0	0.0	0.0	1	1	1	0	1
4	6.7	10.0	10.0	2.0	0.0	1	1	1	1	1
5	6.7	20.0	20.0	5.0	0.0	1	1	1	1	1
6	6.7	40.0	10.0	10.0	0.0	1	1	1	1	1
7	6.7	20.0	3.0	15.0	0.0	1	1	1	1	1
8	6.7	10.0	2.0	30.0	100.0	1	1	1	1	1
9	6.7	0.0	3.0	15.0	0.0	1	1	1	1	1
10	6.7	0.0	10.0	10.0	0.0	1	1	1	1	1
11	0.0	0.0	20.0	5.0	0.0	0	1	1	1	1
12	6.7	0.0	10.0	2.0	0.0	1	1	1	1	1
13	6.7	0.0	5.0	1.0	0.0	1	1	1	1	1
14	6.7	0.0	1.0	1.0	0.0	1	1	1	1	1
15	6.7	0.0	0.0	1.0	0.0	1	1	1	1	1
Total Catch	93.3	100	100	99	100					
Total Effort	14	4	9	15	1					
CPUE	6.67	25	11.11	6.60	100	Avg. Duration				
Duration of Run	15	5	13	15	1	9.8				
Adjusted CPUE	10.20	12.75	14.74	10.10	10.20					

Fisher #2	Year									
Day	1	2	3	4	5					
1	0.0	0.0	0.0	1.0	0.0	0	0	0	1	0
2	6.7	0.0	0.0	0.0	0.0	1	1	0	0	0
3	6.7	0.0	5.0	0.0	0.0	1	0	1	0	0
4	0.0	0.0	0.0	0.0	0.0	0	0	0	0	0
5	6.7	0.0	0.0	0.0	0.0	1	0	0	0	1
6	6.7	40.0	0.0	0.0	0.0	1	1	0	0	1
7	6.7	0.0	0.0	0.0	0.0	1	0	0	0	0
8	6.7	0.0	0.0	30.0	0.0	1	0	0	1	0
9	0.0	0.0	0.0	15.0	0.0	0	0	0	1	1
10	6.7	0.0	10.0	0.0	0.0	1	0	1	0	0
11	0.0	0.0	0.0	0.0	0.0	0	1	0	0	0
12	0.0	0.0	10.0	2.0	0.0	0	0	1	1	1
13	0.0	0.0	5.0	0.0	0.0	0	0	1	0	1
14	6.7	0.0	1.0	0.0	0.0	1	0	1	0	0
15	0.0	0.0	0.0	0.0	0.0	0	0	1	0	1
Total Catch	53.33	40.00	31.00	48.00	0.0					
Total Effort	8	1	5	4	0					
CPUE	6.67	40.00	6.20	12.00	0.0	Avg. Duration				
Duration of Run	13	1	12	12	0	7.6				
Adjusted CPUE	11.40	5.26	9.79	18.95	0.0					

Fisher #3	Year									
Day	1	2	3	4	5					
1	0.0	0.0	0.0	1.0	0.0	0	0	1	1	0
2	0.0	0.0	1.0	1.0	0.0	0	0	1	1	1
3	6.7	0.0	5.0	0.0	0.0	1	0	1	0	1
4	6.7	0.0	0.0	0.0	0.0	1	0	0	0	1
5	0.0	0.0	0.0	5.0	0.0	0	0	0	1	1
6	0.0	0.0	0.0	0.0	0.0	0	0	0	0	1
7	6.7	20.0	3.0	15.0	0.0	1	1	1	1	1
8	6.7	10.0	0.0	0.0	100.0	1	1	0	0	1
9	0.0	0.0	0.0	15.0	0.0	0	0	0	1	0
10	0.0	0.0	0.0	0.0	0.0	0	1	0	0	1
11	6.7	0.0	20.0	0.0	0.0	1	0	1	0	0
12	6.7	0.0	0.0	2.0	0.0	1	0	0	1	1
13	0.0	0.0	5.0	0.0	0.0	0	1	1	0	0
14	6.7	0.0	0.0	0.0	0.0	1	1	0	0	0
15	6.7	0.0	0.0	1.0	0.0	1	1	1	1	0
Total Catch	53.3	30.0	34.0	40.0	100.0					
Total Effort	8	2	5	7	1					
CPUE	6.7	15.0	6.8	5.7	100.0	Avg. Duration				
Duration of Run	13	2	12	15	1	8.6				
Adjusted CPUE	10.1	3.5	9.5	10.0	11.6					

Appendix 1 (cont'd).

For combining all the logbook reports for a given year

All Fishers Combined

Day	1	2	3	4	5	CPUE PER DAY 1	2	3	4	5
	Sum of Reported Catches					Daily CPUE (all reports combined)				
1	6.7	0.0	0.0	3.0	0.0	6.7	0.0	0.0	1.0	0.0
2	13.3	0.0	2.0	2.0	0.0	6.7	0.0	1.0	1.0	0.0
3	20.0	0.0	15.0	0.0	0.0	6.7	0.0	5.0	0.0	0.0
4	13.3	10.0	10.0	2.0	0.0	6.7	10.0	10.0	2.0	0.0
5	13.3	20.0	20.0	10.0	0.0	6.7	20.0	20.0	5.0	0.0
6	13.3	80.0	10.0	10.0	0.0	6.7	40.0	10.0	10.0	0.0
7	20.0	40.0	6.0	30.0	0.0	6.7	20.0	3.0	15.0	0.0
8	20.0	20.0	2.0	60.0	200.0	6.7	10.0	2.0	30.0	100.0
9	6.7	0.0	3.0	45.0	0.0	6.7	0.0	3.0	15.0	0.0
10	13.3	0.0	20.0	10.0	0.0	6.7	0.0	10.0	10.0	0.0
11	6.7	0.0	40.0	5.0	0.0	6.7	0.0	20.0	5.0	0.0
12	13.3	0.0	20.0	6.0	0.0	6.7	0.0	10.0	2.0	0.0
13	6.7	0.0	15.0	1.0	0.0	6.7	0.0	5.0	1.0	0.0
14	20.0	0.0	2.0	1.0	0.0	6.7	0.0	1.0	1.0	0.0
15	13.3	0.0	0.0	2.0	0.0	6.7	0.0	0.0	1.0	0.0
Total Catch	200.0	170.0	165.0	187.0	200.0					
Total Effort	30.0	7.0	19.0	26.0	2.0	Sum of the Average Daily CPUE for all Logbook Reports				
CPUE	6.7	24.3	8.7	7.2	100.0	100.0	100.0	100.0	99.0	100.0
Average CPUE for 3 Reports	6.67	26.67	8.04	8.10	66.67					
						Avg. Duration				
Duration of Run	15	5	13	15	1	9.8				
Adjusted CPUE	10.20	13.61	10.66	12.41	6.80					

Summary of the annual abundance indices for each estimation method using all the logbook reports:

	Year 1	2	3	4	5	CV%
Actual Run Size	1000	1000	1000	1000	1000	0.0%
Average CPUE	6.67	26.67	8.04	8.10	66.67	110%
Average CPUE adjusted for the duration of the run	10.20	13.61	10.66	12.41	6.80	24%
Sum of the daily average CPUE	100.00	100.00	100.00	99.00	100.00	0.4%

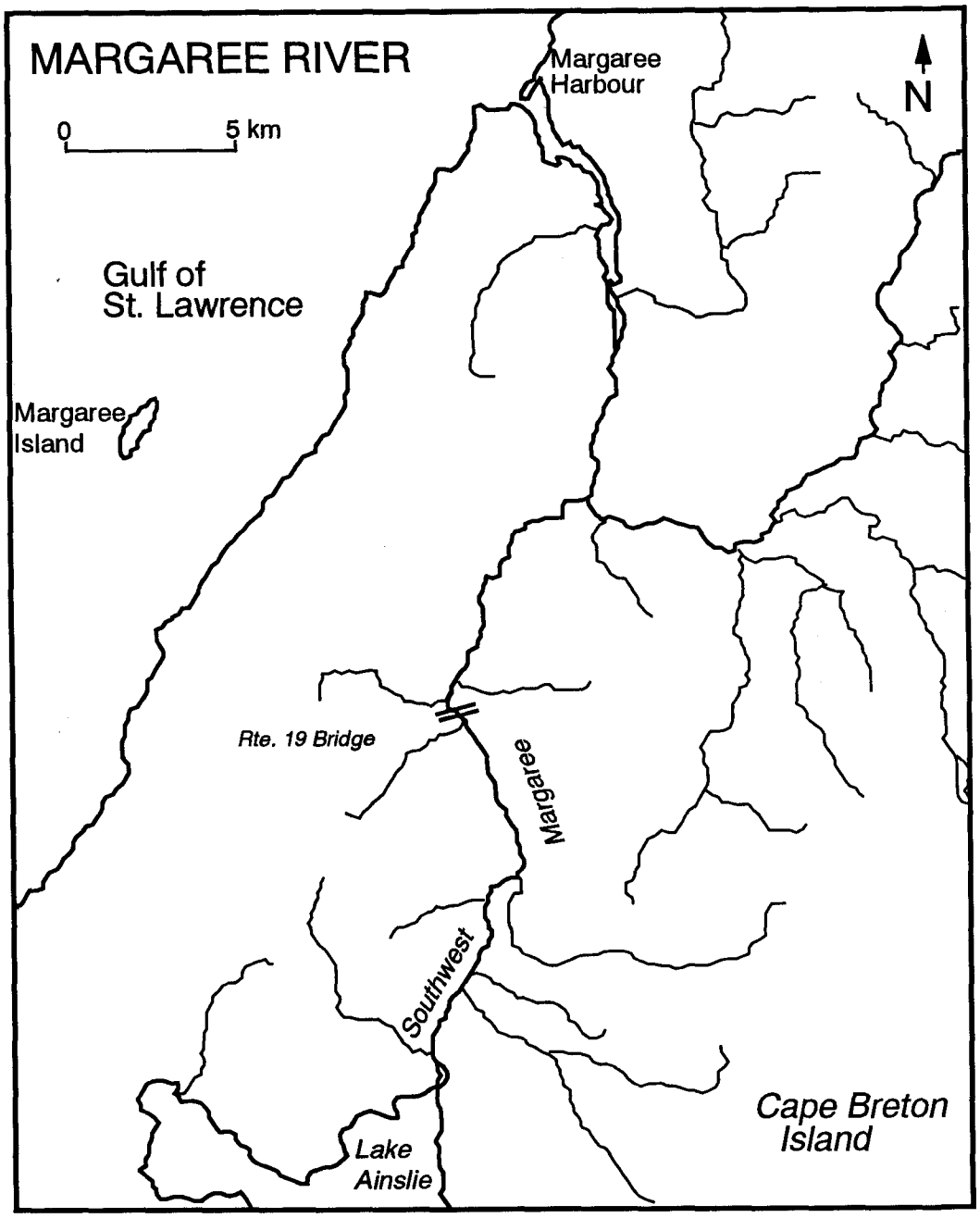


Figure 1. Margaree River, NS showing highway 19 bridge.

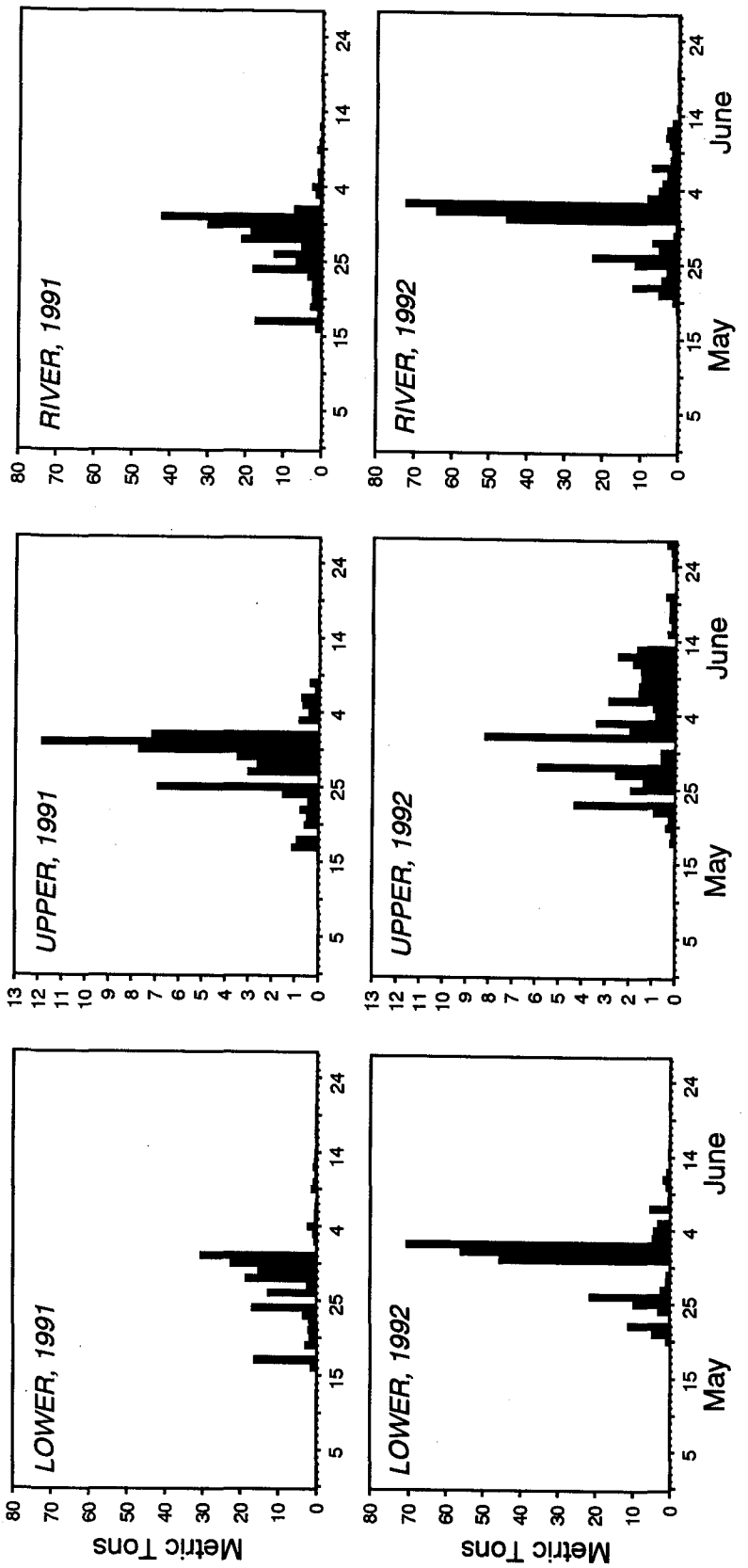


Figure 2. Timing of the catch of gaspereau based on logbook catch and effort reports from the Margaree River, 1991 and 1992.

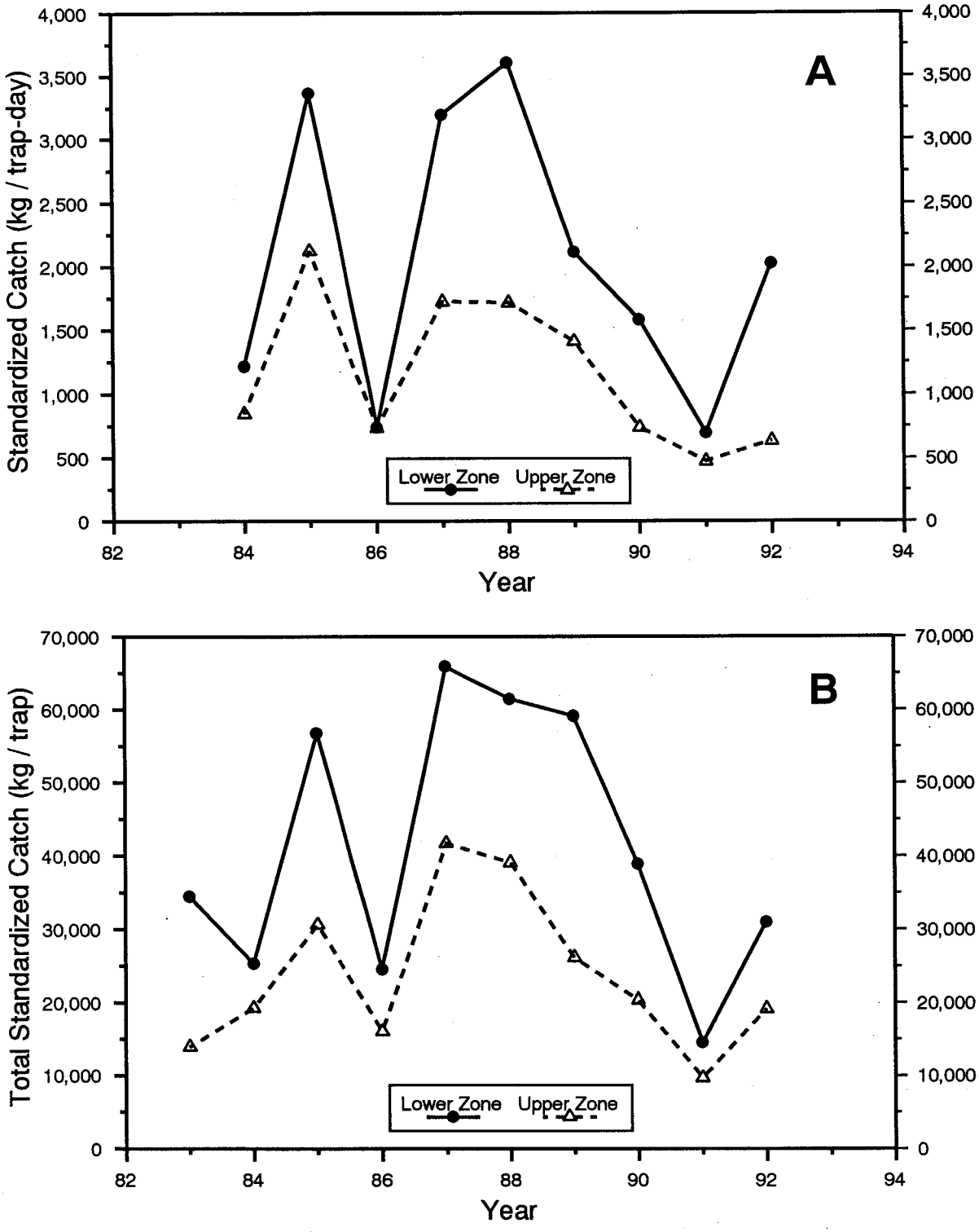
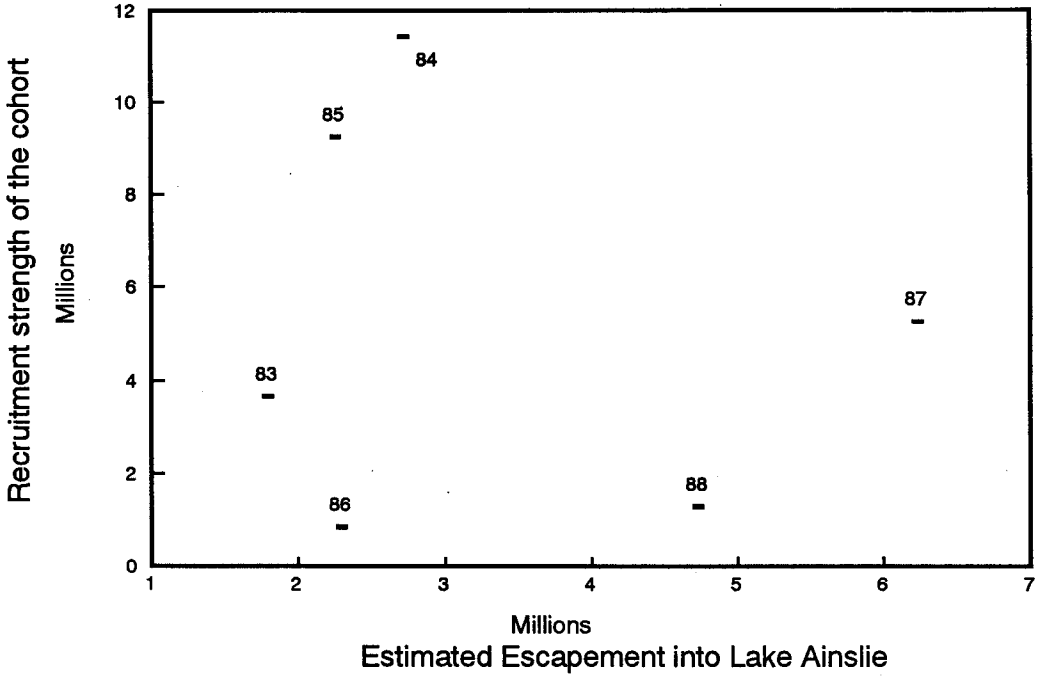


Figure 3. Catch rates for the Margaree River gaspereau fishery for 1983 to 1992. Catch rates in A are those using the average catch per individual logbook whereas catch rates in B are those using the average catch per day, summed over the duration of the fishery.



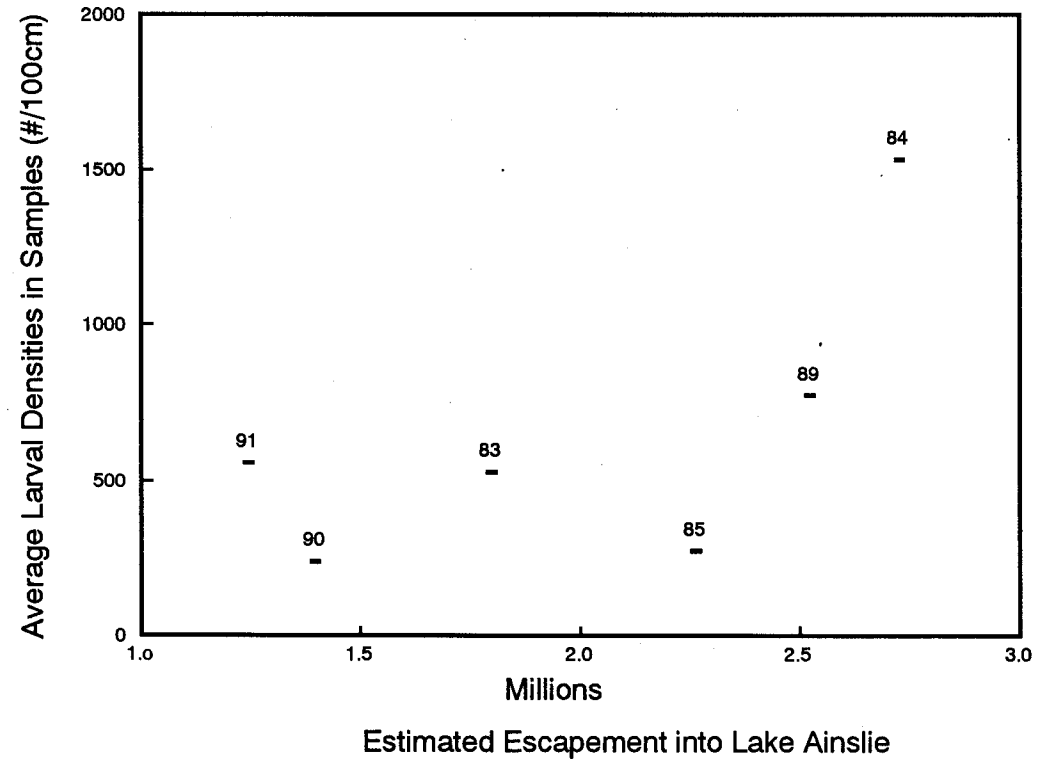


Figure 4. Estimated larval abundance and estimated recruitment from the escapements into Lake Ainslie.