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Status of the Miramichi River gaspereau fishery (1985)

by

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ABSTRACT

The 1985 Miramichi River gaspereau fishery remained at 36 nets fishing seven days per week. Harvest was estimated at 1,857 tonnes which is a substantial increase from 1984 and approaches the 36 year mean of 1,987 tonnes. Much of the improved catch was attributable to the strong 1981 year-class of bluebacks and the fishery continues to depend on only a small number of age groups. Average fishing mortality for alewives over the five years studied was estimated at 1.77 compared to an $F_{0.1}$ value of 0.45. For bluebacks, $F_{0.1}$ was estimated at 0.42 and, although fishing mortality fell below that level in 1984, the average for five years was 0.80. Consequently, it is recommended that exploitation be reduced. Fishing at the $F_{0.1}$ level could be expected to harvest a total of 1,173 tonnes of gaspereau in 1986. To facilitate this, estimates of weekly closed times suggested that one-, two- and three-day closures could reduce harvest by 11%, 21% and 36%, respectively. A delayed season opening of fourteen days could reduce harvest on the more heavily exploited alewives by 28% while reducing harvest on the later run of bluebacks by only 7%.

RESUME

En 1985, avec des moyens inchangés, soit 36 filets exploités sept jours sur sept, les prises approximatives de gaspareau dans la rivière Miramichi se sont élevées à 1 857 tonnes. Ce chiffre est proche de la moyenne de 1 987 tonnes établie sur 36 ans et notablement supérieur à celui des prises de 1984, à cause principalement de l'abondance des aloses d'été de la classe d'âge 1981. La pêche continue d'être alimentée par un nombre restreint de classes d'âge. Pour les cinq années considérées, la mortalité moyenne due à la pêche du gaspareau a été évaluée à 1.77, comparativement à une valeur $F_{0.1}$ de 0.45. Dans le cas de l'alose d'été, on a évalué le $F_{0.1}$ à 0.42, la moyenne pour cinq ans étant de 0.80, quoique l'on ait enregistré une mortalité inférieure à ce chiffre en 1984. Il est donc suggéré que le niveau d'exploitation soit réduit. Au taux d'exploitation $F_{0.1}$, les prises totales pourraient s'établir à 1 173 tonnes en 1986. On estime que des fermetures hebdomadaires de un, deux et trois jours permettraient de réduire les prises de 11, 21 et 36 % respectivement. Par ailleurs, en reportant de quatorze jours la date d'ouverture de la pêche, on pourrait réduire de 28 % les prises dans les stocks de gaspareau les plus exploités et de 7 % seulement les prises d'alose d'été pendant la remontée ultérieure.

INTRODUCTION

Assessment of the 1982 and 1983 Miramichi River gaspereau fishery (Alexander and Vromans 1983, 1984) concluded that mixed stocks of alewife (Alosa pseudoharengus) and blueback herring (Alosa aestivalis) were being exploited at levels above optimum. In spite of recommendations that exploitation be reduced, the 1985 fishery remained steady at 36 nets fishing seven days per week. The 1984 assessment (Alexander and Vromans 1985) indicated that rate of exploitation was high at the beginning of the season, but was reduced as a consequence of poor market conditions near the end of the season. It was again recommended that exploitation be reduced. However, there was speculation that reduced harvest in 1984 could contribute to improved harvest in 1985 and the fishery was allowed to continue without further restriction. The present report provides an assessment of the 1985 fishery and is the first assessment in which sequential population analysis has been applied.

METHODS

Samples of gaspereau, ranging from 20 to 50 fish daily, were collected from the Millbank trap to represent the commercial catch, as in previous years. Determination of species, sex, state of maturity, age, length, and weight was similar to that for 1984 (Alexander and Vromans 1985). These biological data were weighted using catch-effort data collected through voluntary logbooks in order to accurately reflect the characteristics of the catch. Statistics were generated from programs written inhouse and run on a Zenith 100 microcomputer.

Catch-at-age figures, required for sequential population analysis, were determined using the age distribution of the daily samples and the estimated total daily catch. Weight at age (APPENDIX I) was determined by converting mean length of all fish in the age sample to weight, from the log length-log weight regression equation calculated for the year. In all cases, samples were separated by species. Age at full recruitment was taken as the age prior to the age when the number of virgin spawners, as determined from scales, was reduced to negligible levels. Total mortality between years was estimated by comparing the catch rate for fully-recruited age groups in one year to the catch rate of those same year-classes in the next year. This total mortality estimate was reduced by an assumed natural mortality rate of 0.2. Partial recruitment was estimated from the catch matrix and the proportion of virgins at each age by comparing the cumulative catch of virgins from a cohort, adjusted for mortality and escapement, to the initial catch of virgins from the cohort, also adjusted for fishing mortality. For sequential population analysis, mortality of the oldest age groups in all years and for all age groups in the most recent year was taken as the mean annual Paloheimo fishing mortality rate (Ricker 1975) for fully-recruited fish. For age groups not fully recruited, this value was multiplied by the estimated partial recruitment value. Sequential population analysis (SPA) was run using APL programs described by Rivard (1982).

RESULTS

Although the fishing season opened May 15 and some fishing effort was recorded at that time (Table 1), no catch was recorded before May 26. This is consistant with observations of late gaspereau runs on other rivers of the Region in 1985.

Statistical Services Branch was unable to provide an estimate of gaspereau catch on the Miramichi River in time for the 1985 assessment. Consequently, Research Branch personnel manually sorted sales slips and estimated total harvest at 1,857,386 kg. This is the highest landing in the past five years (Table 2) and approaches the 36 year mean of 1,987 tonnes. Since the 1985 catch recorded in logbooks was 1,492,829 kg, a factor of 1.2442 was used to convert logbook data to represent the fishery as a whole (Table 3). This is similar to conversion factors for the other four years. Total fishing effort was estimated at 19,090 hours, an increase from 1984, but lower than in 1982 or 1983. The catch rate of 97.3 kg/hr is approximately equal to the catch rate in 1981 and nearly twice that recorded for 1982-84.

Alewives were caught more than a week earlier than bluebacks (Table 4, Fig. 1), as expected. Total catch by numbers consisted of 1,868,400 (24%) alewives and 6,001,800 bluebacks (76%). This is a reversal of the 1984 species composition but is nearly identical to that of 1981 (Table 5). Alewives averaged only 248 g and bluebacks 232 g. This is the smallest mean weight for either species in the five years studied and continues the declining trend (Table 5).

The 1985 age structure of the catch shows that alewife contributed to the fishery only at age 3, 4, and 5 with almost 90% of the catch age 3 and 4 (Table 6, Fig. 2). Bluebacks were harvested mostly at age 4 and 5 (83%). The age structure of the catch is similar to that of 1984 but is in sharp contrast to that of 1981 when 42% of the harvest consisted of age 6 blueback as well as significant proportions of age groups of both species older than age 5. A catch-at-age matrix has been developed for alewife (Table 7) and for blueback (Table 8) for use in sequential population analysis. The scarcity of fish at older ages is apparent in these tables.

Partial recruitment of alewives was estimated to be 0.0 at age 2, 0.5 at age 3 and 1.0 at age 4 and older. For bluebacks, recruitment was estimated to be 0.0 at age 2, 0.04 at age 3, 0.6 at age 4 and 1.0 at age 5 and older.

Estimates of cumulative catch per hour for selected age groups (Table 9) suggested that between year instantaneous mortality for alewives ranged from 1.35 to 1.87. Average between year fishing mortality was calculated to be 1.37. In the blueback calculations, catch per hour increased for fully recruited age groups between 1984 and those same year-classes in 1985. This produced a negative value for mortality. The negative value could result from an overestimate of fishing effort in 1984. Fishing effort would be overestimated if fishermen were not checking their nets on a regular daily

basis. Maximum between year mortality was estimated to be 1.50. The average fishing mortality of these age groups was estimated at 0.74 for use in sequential population analysis.

Yield per recruit analysis for alewife produced an $F_{0.1}$ value of 0.4498 at a yield per recruit of 0.176 kg. Using the Paloheimo mortality rate of 1.37, weighted fishing mortality rates converged in three runs of the SPA (Table 10). These fishing mortality rates averaged 1.76 and greatly exceed the $F_{0.1}$ value. Consequently, a reduction in rate of exploitation is recommended.

Projections of alewife harvest were made using an average population at age 3 of 1,975,000 fish and fishing mortality at the $F_{0.1}$ value of 0.45. This projection (Table 11) suggests that catch will fall to 186 tonnes in 1986, but will increase to 348 tonnes by 1992. Average size will also increase and catch per unit effort will increase substantially. If 1985 had been fished at $F_{0.1}$, catch would have been 223 tonnes, a reduction of 52%.

Yield per recruit analysis for bluebacks produced an $F_{0.1}$ value of 0.4152 at a yield per recruit of 0.132 kg. When fishing mortality was input to the SPA at the Paloheimo value of 0.74 and iterated with generated mortality rates, weighted fishing mortality estimates converged within three iterations (Table 12). These values averaged 0.8 and exceed $F_{0.1}$ except in 1984. A reduced rate of exploitation is recommended.

Blueback catch projections were made using population numbers generated by cohort analysis, average population at age 3 equal to the five-year average of 7,570,000, and fishing at the $F_{0.1}$ level of 0.42. This projection (Table 13) indicates that 1986 harvest would fall to 987 tonnes, rising to 1,138 tonnes in 1987 and declining slightly in subsequent years. This value might be considered as a quota for management purposes. If 1985 had been fished at the $F_{0.1}$ level, catch would have been 773 tonnes, a reduction of 45%.

Examination of catch on Saturdays, Sundays and Mondays over the years of fishing (Table 14) suggests that approximately 11%, 21% and 36% could be reduced from the harvest by imposing one-, two- or three-day closures each week. Similarly, a one- or two-week postponement of season would cause a reduction in catch although the consequences are highly variable between years. In 1984 for example, 47% of the alewife harvest would have been reduced by a two-week delay, but that delay would have had almost no impact on blueback. A 14-day delay in season opening shows an average harvest reduction of 28.4% for alewife and 6.8% for blueback. This option may be desirable because alewives are more heavily over-exploited. A combination of delayed season and weekly closure is likely needed to achieve $F_{0.1}$.

SUMMARY

Although harvest improved in the 1985 fishery, most of the improvement was directly attributable to the 1981 year-class of bluebacks which are expected to make a substantial contribution to the fishery again next year. Both alewives and bluebacks are caught over a small number of ages and it appears that the numbers in older age groups have declined substantially over a period of just five years. Scale analysis for the 1985 harvest shows that about 70% of alewives (Table 15) and 55% of bluebacks (Table 16) are on the spawning migration for the first time. Paloheimo estimates of average fishing mortality over the five years of study are much higher than the mortality rates at $F_{0.1}$ estimated from yield per recruit analysis. Clearly the Miramichi gaspereau stocks are being over-harvested and action should be taken to reduce exploitation.

Catch projections suggest that 1986 harvest should be reduced to 186 tonnes of alewife and 987 tonnes of blueback in order to reduce fishing mortality to the $F_{0.1}$ level. A harvest reduction might be achieved through a weekly closed time. Because alewife are harvested over a longer portion of the fishery, they are more heavily exploited and it therefore appears prudent to delay opening of the season in order to increase escapement of that stock. Unfortunately, the heavy dependence on only a few young year-classes of fish means that the success of the fishery is highly dependent on the strength of the new year-classes and forecasting is therefore very imprecise.

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Table 1. Daily catch (kg), effort (hours) and catch per unit effort (kg/hr.) in the 1985 Miramichi River gaspereau fishery, as reported through gaspereau catch and effort logbooks.

		Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday	Week total
May 13-19	Catch	0	0	0	0	0	0	0	0
	Effort	0	0	80	162	162	162	164	730
	CPUE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
May 20-26	Catch	0	0	0	0	0	0	340	340
	Effort	302	304	302	302	316	327	359	2,212
	CPUE	0.00	0.00	0.00	0.00	0.00	0.00	0.95	0.15
May 27-02	Catch	7,266	2,711	16,103	15,366	18,025	16,244	5,131	80,845
	Effort	375	380	376	401	446	444	452	2,874
	CPUE	19.38	7.13	42.83	38.32	40.42	36.59	11.35	28.13
June 03-09	Catch	36,340	84,463	78,435	56,726	93,123	97,904	44,906	491,896
	Effort	564	560	564	590	590	588	590	4,046
	CPUE	64.43	150.83	139.07	96.15	157.84	166.50	76.11	121.58
June 10-16	Catch	77,813	72,638	126,406	152,302	150,894	122,195	103,533	805,780
	Effort	634	637	638	635	634	634	586	4,398
	CPUE	122.73	114.03	198.13	239.85	238.00	192.74	176.68	183.22
June 17-23	Catch	53,354	56,812	2,892	907	0	0	0	113,965
	Effort	517	496	46	24	0	0	0	1,083
	CPUE	103.20	114.54	62.86	37.80	0.00	0.00	0.00	105.23
Total	Catch	174,773	216,623	223,836	225,301	262,042	236,342	153,910	1,492,826
	Effort	2,392	2,377	2,006	2,114	2,148	2,155	2,151	15,343
	CPUE	73.07	91.13	111.58	106.58	121.99	109.67	71.55	97.30

Table 2. Annual catch statistics and number of fishing licences for the Miramichi River, New Brunswick, gaspereau fishery (Districts 71 and 72).

Year	Catch (mt)	Number of licences	Catch/licence
1950	4,952	220	22.51
1951	8,014	163	49.17
1952	11,381	180	63.23
1953	8,026	178	45.09
1954	4,649	231	20.13
1955	3,413	181	18.86
1956	3,009	166	18.13
1957	884	135	6.55
1958	816	120	6.80
1959	1,596	108	14.78
1960	716	120	5.97
1961	161	109	1.48
1962	733	67	10.94
1963	543	66	8.23
1964	119	37	3.22
1965	425	36	11.81
1966	746	41	18.20
1967	532	34	15.65
1968	436	27	16.15
1969	175	23	7.61
1970	874	28	31.21
1971	469	37	12.68
1972	468	26	18.00
1973	967	35	27.63
1974	271	35[1]	7.74
1975	141	34[1]	4.15
1976	406	34[1]	11.94
1977	2,240	34[1]	65.88
1978	1,434	34[1]	42.18
1979	3,343 (694)[2]	34[1]	98.32
1980	3,767 (398)[2]	34[1]	110.79
1981	1,410	34[1]	41.47
1982	1,278	36	35.50
1983	1,088	36	30.22
1984	665	36	18.47
1985	1,857	36	51.58

1 The number of traps may have been as high as 36 beginning in 1974.
2 "Over-the-side-sales" for all gaspereau in New Brunswick.

Table 3. Miramichi River gaspereau catches reported through voluntary logbooks, total estimated catch for the river and resultant conversion factors used to convert logbook data to represent the whole fishery each year.

	Year				
	1981	1982	1983	1984	1985
Total catch (kg) A	1,410,241	1,277,639	1,087,899	664,774	1,857,386
Logbook catch (kg) B	1,320,172	1,106,124	848,869	610,906	1,492,829
Conversion factor A/B	1.0682	1.1551	1.2816	1.0882	1.2442
Total effort (hrs.)	14,800	25,500	22,049	13,207	19,090
CPUE (kg/hr.)	95.3	50.1	49.3	50.3	97.3
Blueback effort (hrs.)*	14,774	24,918	19,011	8,251	12,416
Alewife effort (hrs.)*	14,800	25,056	22,018	12,452	15,846

* This adjusted effort was calculated by summing effort only for days on which the species was caught.

Table 4. Estimated daily catch of gaspereau, in Districts 71 and 72 combined, Miramichi River, 1985.

	Alewife		Blueback		Catch (kg)			Number		
Date	Mean wt.	%	Mean wt.	%	Alewife	Blueback	Combined	Alewife	Blueback	Combined
Ma 26	.2660	100.0	.0000	0.0	423	0	423	1,590	0	1,590
Ma 27	.2660	100.0	.0000	0.0	9,040	0	9,040	33,986	0	33,986
Ma 28	.2660	100.0	.0000	0.0	3,373	0	3,373	12,681	0	12,681
Ma 29	.2660	100.0	.0000	0.0	20,035	0	20,035	75,321	0	75,321
Ma 30	.2660	100.0	.0000	0.0	19,118	0	19,118	71,874	0	71,874
Ma 31	.2618	100.0	.0000	0.0	22,427	0	22,427	85,664	0	85,664
Jn 1	.2380	100.0	.0000	0.0	20,211	0	20,211	84,920	0	84,920
Jn 2	.2750	93.8	.2110	6.3	6,073	311	6,384	22,085	1,472	23,557
Jn 3	.2559	84.0	.2175	16.0	38,914	6,300	45,214	152,069	28,965	181,034
Jn 4	.2543	84.2	.2507	15.8	88,695	16,395	105,089	348,779	65,396	414,175
Jn 5	.2787	71.4	.3321	28.6	66,089	31,501	97,589	237,132	94,853	331,985
Jn 6	.2754	47.3	.3035	52.7	31,661	38,918	70,579	114,964	128,230	243,194
Jn 7	.1920	5.0	.2885	95.0	3,921	111,943	115,864	20,422	388,018	408,440
Jn 8	.2291	14.0	.2333	86.0	16,789	105,023	121,813	73,283	450,165	523,448
Jn 9	.2345	12.5	.2402	87.5	6,838	49,034	55,872	29,162	204,137	233,299
Jn 10	.2470	10.0	.2513	90.0	9,532	87,283	96,815	38,592	347,326	385,918
Jn 11	.2370	8.0	.2382	92.0	7,197	83,180	90,377	30,365	349,203	379,568
Jn 12	.2285	8.0	.2347	92.0	12,275	145,000	157,275	53,722	617,808	671,530
Jn 13	.2115	8.0	.2277	92.0	14,162	175,333	189,495	66,958	770,019	836,977
Jn 14	.2070	5.0	.2221	95.0	8,779	178,964	187,743	42,410	805,782	848,192
Jn 15	.2157	12.0	.2128	88.0	18,463	133,573	152,036	85,594	627,693	713,287
Jn 16	.2055	22.0	.2083	78.0	28,042	100,775	128,816	136,455	483,797	620,252
Jn 17	.2375	8.0	.2079	92.0	5,999	60,385	66,383	25,257	290,451	315,708
Jn 18	.1765	6.7	.2038	93.3	4,118	66,568	70,686	23,331	326,633	349,964
Jn 19	.1934	10.0	.1996	90.0	350	3,248	3,598	1,808	16,275	18,083
Jn 20	.1989	0.0	.2013	100.0	0	1,128	1,128	0	5,606	5,606
	.2475		.2324		462,524	1,394,862	1,857,386	1,868,424	6,001,829	7,870,253
% of Dist. Total					25.32	74.68		23.74	76.26	

Table 5. Relative contribution by alewives and blueback herring to the Miramichi River gaspereau fishery, 1981-1985.

Year	Species	Number X 1,000	Percentage of total	Weight kg (X 1,000)	Percentage of total	Mean weight (g)
1981	Alewife	1,067.7	24.5	316.0	22.4	296
	Blueback	3,289.7	75.5	1,094.3	77.6	333
1982	Alewife	1,590.1	39.6	493.1	38.6	310
	Blueback	2,425.5	60.4	784.5	61.4	323
1983	Alewife	1,832.7	44.9	493.8	45.5	269
	Blueback	2,251.4	55.1	594.1	54.6	264
1984	Alewife	1,899.2	73.7	487.9	72.6	257
	Blueback	677.5	26.3	176.9	27.4	261
1985	Alewife	1,868.4	23.7	462.5	25.3	248
	Blueback	6,001.8	76.3	1,394.9	74.7	232

Table 6. Percentage contribution by each age of alewife and blueback herring to the Miramichi River gaspereau fishery, 1981-1985. Contribution is shown as a percentage of the species catch (S) and as a percentage of the total catch (T).

Year	Species	Group	Age 2	3	4	5	6	7	8	9
1981	Alewife	S	0.0	3.5	31.6	14.5	28.9	19.0	1.4	1.1
		T	0.0	0.9	7.7	3.5	7.1	4.7	0.3	0.3
	Blueback	S	0.0	0.3	6.0	14.3	55.8	10.5	8.7	4.2
		T	0.0	0.3	4.5	10.8	42.2	7.9	6.6	3.2
	Both	T	0.0	1.2	12.2	14.3	49.3	12.6	6.9	3.5
1982	Alewife	S	0.0	33.9	47.7	7.5	5.7	2.2	2.8	0.0
		T	0.0	12.3	17.3	2.7	2.1	0.8	1.0	0.0
	Blueback	S	0.0	1.5	20.3	29.9	12.1	30.0	2.7	3.5
		T	0.0	0.8	11.2	16.5	6.7	16.5	1.5	2.0
	Both	T	0.0	13.1	28.5	19.2	8.8	17.3	2.5	2.0
1983	Alewife	S	0.2	34.0	52.6	6.1	2.9	1.4	1.8	0.6
		T	0.1	15.2	23.6	2.7	1.3	0.6	0.8	0.3
	Blueback	S	0.0	2.5	46.6	27.8	11.0	3.0	7.0	1.3
		T	0.0	1.4	25.7	15.3	6.1	1.7	3.9	0.4
	Both	T	0.1	16.6	49.3	18.0	7.4	2.3	4.7	0.7
1984	Alewife	S	0.0	55.6	35.8	6.4	2.0	0.0	0.0	0.2
		T	0.0	41.0	26.4	4.7	1.5	0.0	0.0	0.1
	Blueback	S	0.0	7.6	48.0	21.7	11.3	5.0	3.8	1.9
		T	0.0	2.0	12.6	5.7	3.0	1.3	1.0	0.5
	Both	T	0.0	43.0	39.0	10.4	4.5	1.3	1.0	0.7
1985	Alewife	S	0.0	38.4	51.1	10.4	0.0	0.0	0.0	0.0
		T	0.0	9.1	12.1	2.5	0.0	0.0	0.0	0.0
	Blueback*	S	0.0	6.1	62.8	20.1	6.7	1.8	0.1	1.9
		T	0.0	4.7	47.9	15.3	5.1	1.4	0.1	1.5
	Both**	T	0.0	13.8	60.0	17.8	5.1	1.4	0.1	1.5

* Age 12 S = 0.4%, T = 0.3%
** Age 12 T = 0.3%

Table 7. Catch at age (numbers of fish) of alewife in the Miramichi River gaspereau fisheries, 1981 to 1985.

Age	1981	1982	1983	1984	1985
2	0	363	3,719	411	0
3	38,619	502,137	622,237	1,055,839	717,910
4	317,258	773,959	964,566	679,906	955,514
5	147,714	115,197	111,979	120,792	195,001
6	304,056	98,261	52,594	38,564	0
7	217,214	36,003	25,603	0	0
8	14,696	50,399	33,023	0	0
9	12,494	0	11,726	3,730	0
10	0	0	753	0	0
11	0	610	6,486	0	0
12	0	0	0	0	0

Table 8. Catch at age (numbers of fish) of blueback herring in the Miramichi River gaspereau fisheries, 1981 to 1985.

Age	1981	1982	1983	1984	1985
2	0	0	163	0	0
3	10,586	40,283	55,462	51,341	368,098
4	194,411	506,240	1,049,216	324,828	3,766,743
5	476,165	746,833	625,558	146,937	1,205,880
6	1,830,828	302,795	247,459	76,348	403,914
7	344,686	686,484	68,468	33,907	110,187
8	289,803	69,135	159,626	25,476	8,423
9	136,676	86,227	15,283	12,932	113,740
10	0	1,547	29,906	3,629	0
11	19,287	0	291	0	0
12	0	0	0	2,074	24,844

Table 9. Estimates of cumulative catch-per-hour for fully-recruited age groups of alewife and blueback in each year and in those same age classes in the next year on the Miramichi River, and the resultant estimates of instantaneous mortality (Z) between years.

Species	Age groups	Catch/hr. 1981	Z	1982	Z	1983	Z	1984	Z	1985
Alewife	4+	55.61	1.58	41.26	1.35	54.41	1.48	66.03	1.87	
	5+			11.41		10.69		12.37		10.22
Blueback herring	5+	206.8	1.50	74.40	1.15	51.97	1.50	22.43	-0.40	
	6+			46.00		23.61		11.58		33.33

Table 10. Estimated instantaneous fishing mortality for alewives at each age in each of five years of commercial fishing on the Miramichi River.

	Fishing mortality (F)				
Age	1981	1982	1983	1984	1985
3	0.032	0.315	0.415	0.525	0.685
4	0.895	1.606	2.020	1.157	1.370
5	0.659	1.027	1.217	11.232	1.370
6	1.397	1.421	9.715	10.091	1.370
7	1.324	0.580	9.132	0.486	1.370
8	9.367	1.523	2.131	0.582	1.370
9	1.141	1.454	2.354	2.514	1.370
4+	1.141	1.454	2.354	2.514	1.370

Table 11. Projection of alewife population numbers, population biomass and catch biomass in the Miramichi River gaspereau assuming the available number of fish at age three to be constant at 1,975,000 and fishing at the $F_{0.1}$ level of 0.45.

Year	1984	1985	1986	1987
Population numbers	4,131,881	3,272,431	3,072,904	3,839,351
Population biomass (kg)	632,584	491,527	589,065	753,651
Catch (kg)	473,005	462,524	185,798	259,862
F or quota	473,005	462,524	0.45	0.45

Year	1988	1989	1990	1991
Population numbers	4,239,370	4,448,134	4,552,099	4,598,748
Population biomass (kg)	848,599	902,421	930,050	942,554
Catch (kg)	302,589	326,809	339,242	344,868
F or quota	0.45	0.45	0.45	0.45

Year	1992
Population numbers	4,621,821
Population biomass (kg)	949,510
Catch (kg)	347,998
F or quota	0.45

Table 12. Estimated instantaneous fishing mortality for blueback at each age in each of five years of commercial fishing on the Miramichi River.

	Fishing mortality				
Age	1981	1982	1983	1984	1985
3	0.005	0.014	0.014	0.004	0.030
4	0.132	0.339	0.586	0.116	0.440
5	0.391	1.084	0.937	0.147	0.740
6	0.980	0.464	1.569	0.263	0.740
7	1.387	1.436	0.178	1.011	0.740
8	1.060	1.258	2.407	0.093	0.740
9	4.219	1.156	1.139	9.128	0.740
10	0.943	1.031	1.009	0.252	0.740
5+	0.943	1.031	1.009	0.252	0.740

Table 13. Projection of blueback population numbers, population biomass and catch biomass in the Miramichi River gaspereau fishery assuming the available number of fish at age three to be constant at 7,570,000 and fishing at the $F_{0.1}$ level of 0.42.

Year	1981	1982	1983
Population numbers	10,150,526	8,626,542	8,717,968
Population biomass (kg)	1,747,389	1,340,486	1,274,353
Catch (kg)	989,315	784,456	594,107
F or quota	989,315	784,456	594,107
	1984	1985	1986
Population numbers	19,140,762	28,674,816	25,218,835
Population biomass (kg)	3,025,976	4,207,795	4,150,302
Catch (kg)	176,908	1,394,862	987,284
F or quota	176,908	1,394,862	0.42
	1987	1988	1989
Population numbers	24,259,096	23,277,006	22,744,298
Population biomass (kg)	4,209,061	4,178,029	4,093,401
Catch (kg)	1,137,927	1,125,049	1,089,928
F or quota	0.42	0.42	0.42
	1990		
Population numbers	22,444,056		
Population biomass (kg)	4,014,504		
Catch (kg)	1,057,186		
F or quota	0.42		

Table 14. Estimated reduction in catch (in percent of total catch) of alewives and blueback herring due to one-day (Saturday), two-day (Saturday and Sunday) and three-day (Saturday, Sunday and Monday) per week closures of the Miramichi River gaspereau fishery, by year and all year averages. Effect of a seven-day and fourteen-day fishing season opening delay is also shown.

Closure period	1981	1982	1983	1984	1985	Years combined
Alewife						
One-day	13	5	6	13	13	10.4
Two-day	27	9	24	23	18	20.4
Three-day	50	25	45	32	31	35.5
Seven-day	8	4	7	1	0	3.6
Fourteen-day	42	9	44	47	3	28.4
Blueback herring						
One-day	15	9	18	9	11	12.5
Two-day	27	13	30	16	22	22.8
Three-day	46	29	40	36	34	36.8
Seven-day	0	0	6	0	0	1.0
Fourteen-day	3	0	39	1	0	6.8
Combined species						
One-day	14	7	14	12	12	11.8
Two-day	27	11	27	22	21	21.7
Three-day	47	27	42	33	33	36.3
Seven-day	2	2	6	1	0	1.9
Fourteen-day	12	4	41	35	1	14.5

Table 15. Proportions of virgin spawning alewives at each age in samples collected at Millbank, NB, and estimates of the number of virgin spawners at each age in respective years of Miramichi River gaspereau fisheries.

Year	Age	% of virgin spawners in selected age groups	Estimated number of virgin spawners at age in the gaspereau fishery	% of catch
1981	3	100.0	38,619	3.7
	4	100.0	317,258	30.2
	5	80.8	119,353	11.3
	6	14.9	45,304	4.3
	Total		520,534	49.5
1982	2	100.0	363	
	3	100.0	502,137	31.6
	4	62.6	484,498	30.5
	5	5.0	5,760	0.4
	Total		992,758	62.4
1983	2	100.0	3,719	0.2
	3	99.6	619,748	33.8
	4	76.6	738,858	40.3
	5	11.7	13,102	0.7
	6	5.6	2,945	0.2
	Total		1,378,372	75.2
1984	2	100.0	411	> 0.1
	3	100.0	1,055,839	55.6
	4	76.8	522,168	27.5
	5	0.0	0	0.0
	Total		1,578,418	83.1
1985	2	100.0	0	0.0
	3	98.5	707,141	37.8
	4	62.0	592,419	31.7
	5	0.0	0	0.0
	Total		1,299,560	69.6

Table 16. Proportions of virgin spawning blueback herring at each age in samples collected at Millbank, NB, and estimates of the number of virgin spawners at each age in respective years of Miramichi River gaspereau fisheries.

Year	Age	% of virgin spawners in selected age groups	Estimated number of virgin spawners at age in the gaspereau fishery	% of catch
1981	3	85.7	9,072	0.3
	4	95.2	185,079	5.6
	5	60.3	287,128	8.7
	6	12.2	223,361	6.8
	Total		704,640	21.3
1982	3	100.0	40,283	1.7
	4	90.2	456,629	18.8
	5	37.2	277,822	11.5
	Total		774,734	31.9
1983	2	100.0	163	> 0.1
	3	100.0	55,462	2.5
	4	95.9	1,006,198	44.7
	5	44.0	275,246	12.2
	6	4.2	10,393	0.5
	Total		1,347,462	59.8
1984	3	95.3	48,928	7.2
	4	87.6	284,549	42.0
	5	31.4	46,138	6.8
	Total		379,615	56.0
1985	2	100.0	0	0.0
	3	77.6	285,644	4.8
	4	73.5	2,768,556	46.1
	5	18.0	217,058	3.6
	Total		3,271,258	54.5

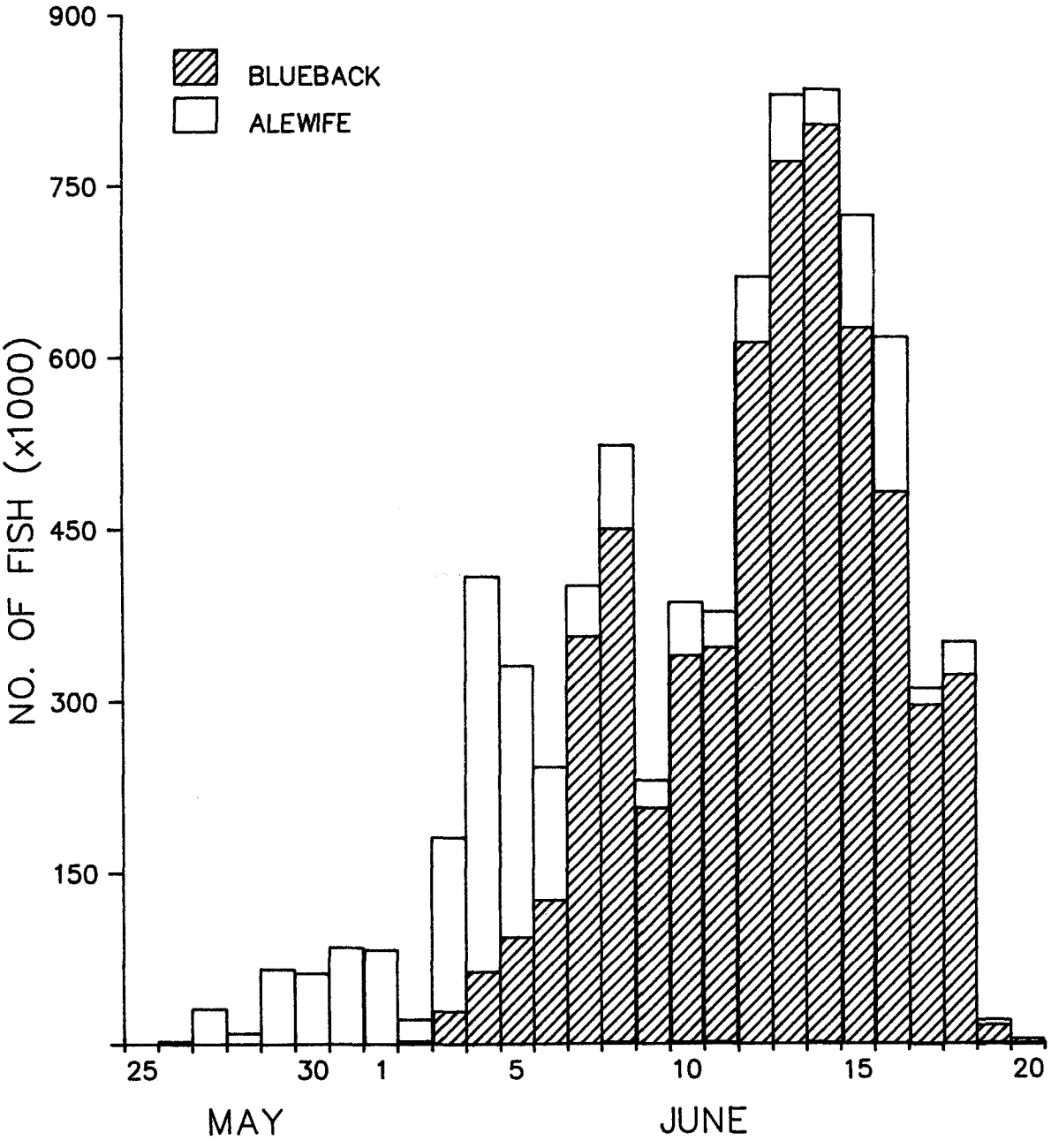

Fig. 1. Estimated number of alewives and blueback herring caught per day in the Miramichi River estuary gaspereau fishery, 1985.

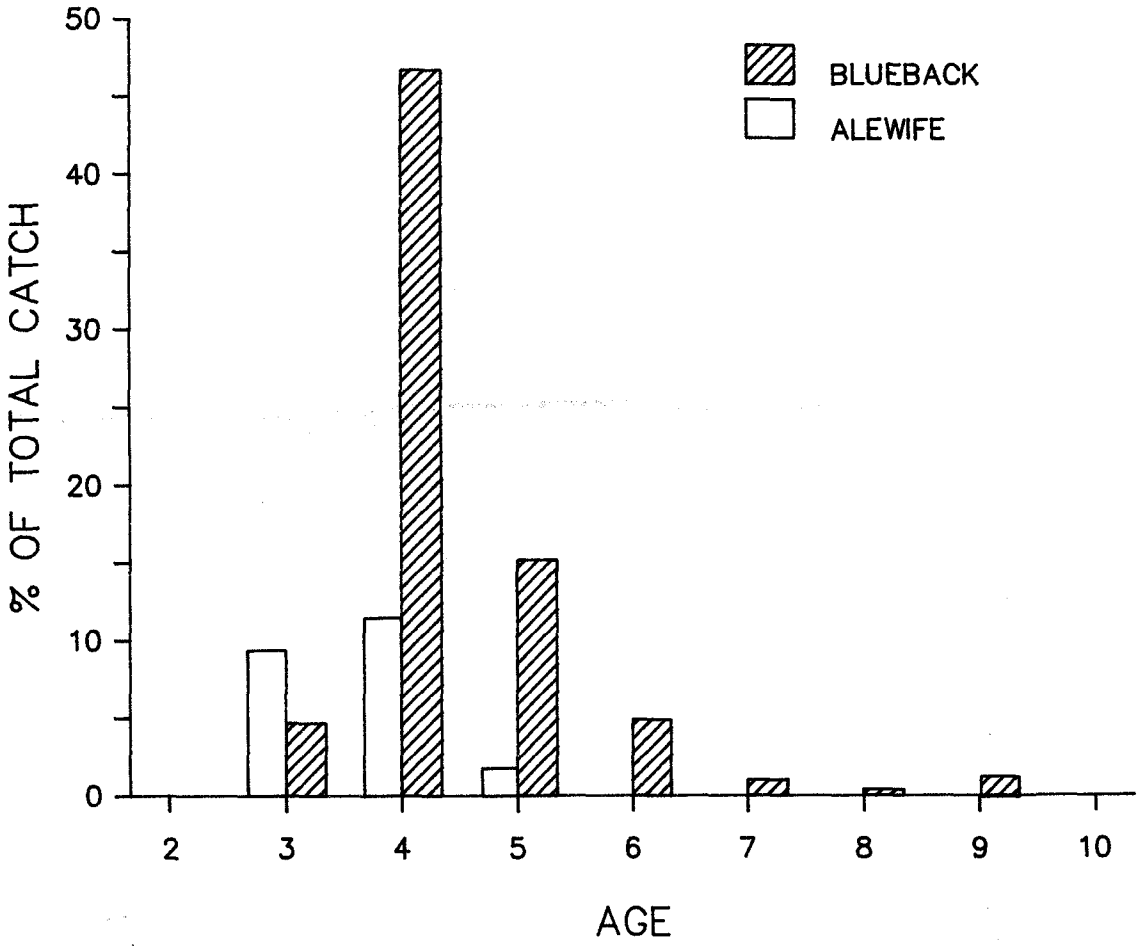

Fig. 2. Catch of alewife and blueback herring, in each age group, in the Miramichi River estuary gaspereau fishery 1985.

APPENDIX I. Mean weight-at-age matrix, determined from log length-log weight regression equations for alewives and blueback herring in the Miramichi River.

Age	1981	1982	1983	1984	1985	Mean
Alewife						
2		135	114	137	122	
3	240	244	223	210	210	219
4	278	317	275	271	254	278
5	299	347	328	324	290	314
6	334	393	317	352	349*	345
7	340	398	404	381*	381*	353
8	392	460	374	409*	409*	362
9	401	536	404	460	450*	410
Blueback herring						
2			100		117	
3	169	169	171	154	165	165
4	220	213	208	192	193	198
5	257	238	256	228	233	242
6	313	333	297	275	275	307
7	341	367	359	311	307	353
8	349	341	359	347	389	351
9	345	325	374	320	389	354
10	355*	362	370	333	355*	366
11						
12						

* Values determined by averaging across years for which data are present.