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Status of the Miramichi River gaspereau fishery (1986)

by

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ABSTRACT

Thirty-six licensed gaspereau nets on the Miramichi River continued to fish without weekly closed times in 1986. However, maximum potential harvest under the prevailing conditions was not achieved because of poor markets. Over-the-side sales of 566 tonnes provided some market improvement and accounted for nearly half the total catch (1,154 T). Despite this reduced harvest, Paloheimo estimates of average fishing mortality on both alewives and bluebacks for six years studied was 1.4 compared to $F_{0.1}$ of 0.4. This persistent over-harvest has caused heavy dependence by the fishery on a small number of year-classes. The 1981 year-class of alewives at age 3 contributed 46% of the 1986 catch, and bluebacks at age 3 provided an additional 11%. The 1983 year-class of bluebacks, which supported much of the 1985 fishery, contributed 16% of the total in 1986. Forecasts of future harvest, using sequential population analysis, suggest that a stable fishery with average recruitment should yield 782 tonnes per year. Because of expectations of an improved market for gaspereau, the 1987 fishery is likely to exceed both the recommended harvest level and the final market demand if not regulated.

RESUME

En 1986, 36 filets pour la pêche au gaspereau installés dans la rivière Miramichi sont restés en activité sans période de fermeture hebdomadaire. Cependant, la récolte potentielle maximale n'a pas été réalisée dans les conditions qui régnaient, parce que les marchés étaient médiocres. Les ventes de bateau à bateau, qui s'élèvent à 566 tonnes, ont apporté une certaine amélioration du marché et représentent près de la moitié de la prise totale (1154 tonnes). Malgré cette récolte réduite, les estimations de Paloheimo de la mortalité moyenne par pêche, autant pour le gaspereau que pour l'alose d'été, pour les 6 années étudiées, étaient de 1,4 comparativement à une $F_{0,1}$ de 0,4. Cette surexploitation persistante a été à l'origine d'une forte dépendance de la pêche sur un petit nombre de classes d'âge. La classe d'âge 1981 de gaspereau d'âge 3 a fourni 46 % de la prise de 1986, et l'alose d'été d'âge 3 a fourni une autre tranche de 11 %. La classe d'âge de 1983 d'alose d'été, qui a alimenté pour une grande part la pêche de 1985, a fourni 16 % des prises totales en 1986. Les prévisions relatives aux récoltes futures, à l'aide de l'analyse séquentielle de population, indiquent qu'une pêche stable combinée à un recrutement moyen devrait donner 782 tonnes par année. Comme on s'attend à une amélioration du marché du gaspereau, il est probable que la pêche de 1987 excédera le niveau des prises recommandées et la demande du marché si elle ne fait pas l'objet d'une forme quelconque de réglementation.

INTRODUCTION

The Miramichi River gaspereau fishery harvests mixed stocks of alewife (Alosa pseudoharengus) and blueback herring (Alosa aestivalis). Although the number of licensed nets has been greatly reduced from historical levels (Table 1) and has been limited to 36 since the 1970's, the fishery is largely opportunistic. Landings vary in response to market conditions and availability of fish.

Annual stock assessments conducted since 1982 (Alexander and Vromans 1983, 1984, 1985, 1986) have concluded that observed rates of exploitation are excessive to produce optimum yield, but no management action has been imposed to alter the fishery. Results of the 1986 assessment, using sequential population analysis, are provided in this paper.

METHODS

Gaspereau samples were collected from the Millbank trap site. These were processed to provide biological data (Alexander and Vromans 1985) which were weighted using logbook statistics (Alexander and Vromans 1986) to represent the commercial catch of each species. Comparable data are available for each year since 1981 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 the 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 to tune the SPA, we examined the relationship between annual catches of gaspereau at Millbank and the SPA parameters, as well as between water temperatures at Millbank and the estimated subsequent catch of fish from that brood-year.

Projections of catch were made using the geometric mean of the estimated population numbers at age 3 between 1981 and 1986. These projections included hypothetical fishing at $F_{0.1}$ and at the mean annual Paloheimo estimate of fishing mortality.

RESULTS

Surplus gaspereau harvest from 1985 remained unsold in January 1986. Buyers were threatened with substantial financial losses and were not expecting to purchase fish in 1986 unless they had firm commitments for resale. This influenced some fishermen to fish their nets at less than their maximum potential. However, about half of the surplus stocks from 1985 had been sold by the beginning of the 1986 season. In addition, an agreement had been signed to allow an over-the-side sale of up to 1,000 tonnes of gaspereau to a Soviet vessel stationed at Chatham. This market improvement influenced some fishermen to be more active although the final harvest was barely adequate to meet demands. The 1986 catch, as well as remaining surplus from 1985, had been cleared by January 1987.

Science Branch personnel estimated total gaspereau landings on the Miramichi at 1,153,542 kg, based on sales slips. This includes over-the-side sales of 566 tonnes. Although the 1986 harvest was reduced, relative to 1985 (Table 1), it was higher than might have been forecast from early market conditions and near the average of 1,242 tonnes observed since 1981. Since the catch recorded in voluntary logbooks was only 608,365 kg, a factor of 1.8961 was used to convert logbook data to represent the fishery as a whole (Table 2). This is the highest conversion factor required in six years of study, and although the result is still more than adequate to represent the fishery, an effort should be made to improve logbook reporting in 1987. Total fishing effort was estimated at 18,472 hours (logbook effort= 9,724 hours), extending from mid-May to late June (Table 3) with an overall success rate of 62.5 kg/hr.

Only alewives were harvested during the first two weeks of the season (Table 4; Fig. 1). Total catch by numbers consisted of 3,146,700 (62%) alewives and 1,931,500 (38%) bluebacks. This most closely resembles the species composition of 1984 (Table 5) when market was poor near the end of the season. Alewives averaged only 228 g, and bluebacks, 225 g. These weights are slightly less than for 1985 and are the lowest values recorded in six years of study (Table 5).

The 1986 age structure of the combined catch shows that age 3 alewives and bluebacks contributed 57% (Table 6) of the total catch. This is the highest contribution by that first age group in six years of study. Age 3 alewives (Table 6; Fig. 2) provided 46% of the total. Bluebacks were harvested in substantial numbers over ages 3 to 5 with age 5 fish contributing 16% of the total gaspereau harvest. This same year-class showed strength in the 1985 fishery (Table 6). A catch-at-age matrix developed for alewife (Table 7) shows the strength of the 1983 year-class while the matrix for blueback (Table 8) shows the strong 1981 year-class. For both species, the mean age of fish caught has declined dramatically over six years studied.

The contribution of the catch by virgin spawners in each year suggests that bluebacks are recruited to the fishery at older average age than alewives (Table 9). Estimated partial recruitment for alewives was 0.00 at age 2, 0.53 at age 3 and 1.00 at age 4. These are similar to the values used in the previous assessment (Alexander and Vromans 1986). Partial recruitment for bluebacks was estimated at 0.11 at age 3, 0.88 for age 4 and 1.00 for age 5. These values are somewhat higher at age 3 and 4 than for the previous assessment.

Estimates of cumulative catch per hour for fully-recruited age groups (Table 10) suggested that between-year instantaneous mortality for alewives ranged from 1.35 to 1.87 with an average of 1.56. Average between year fishing mortality was, therefore, estimated to be 1.36 for use in the SPA. In the blueback calculations, between-year mortality reached 2.09 in 1985-86, but had been calculated as negative in 1984-1985, probably because effort was over-estimated in 1984 (Alexander and Vromans 1986). Since only a starting value is required for SPA, it was decided to ignore the negative value and to

use the average, 1.56, as calculated for other years. The fishing mortality was, therefore, input as 1.36, which is the same as for alewives.

Fishing mortality estimates for recruited alewives converged in three runs of SPA (average 1.792). Tune programs were run to see if revised estimates of fishing mortality in 1986 would improve regressions of: average F on effort, SPA population numbers-at-age on catch per-unit-effort at age, SPA population numbers-at-age on Millbank catch, and SPA numbers-at-age on Millbank water temperature. Only the age 5+ SPA numbers on catch per hour gave a significant correlation (r^2 = 0.9). This suggested that the F for 1986 should be between 1.25 and 1.50, and required no revision. Population numbers generated were used for projections.

Yield per recruit analysis for alewives produced an $F_{0.1}$ fishing mortality of 0.43 at a yield per recruit of 177 g and an average weight of 285 g. Since the average fishing mortality in all of our calculations exceeds $F_{0.1}$, it is recommended that rate of exploitation be reduced.

Projections of alewife harvest were made using estimated average population at age 3 of 2,288,000 fish and annual fishing mortality at the $F_{0.1}$ value of 0.43 and at the Paloheimo value of 1.4. Results (Table 11) indicate that to reach $F_{0.1}$, harvest should be reduced to 295 tonnes in 1987, rising to a long-term average of 405 tonnes. Average size of fish would be expected to increase from 240 g at present to 285 g in the future. By contrast, if fishing continues at high levels, harvest in 1987 could reach 683 tonnes (Table 11), falling to a long-term average of 468 tonnes. Because of strong year-classes, fish size in 1987 should increase to about 258 g, but will not achieve the long-term average attainable at $F_{0.1}$. These projections are made on the assumption of average recruitment. Estimated recruitment fell below that level in four of six years studied.

Terminal fishing mortality for bluebacks converged in four runs of SPA (average 1.13). Tune programs suggested a relationship between population estimates and water temperature, but it was not considered necessary to revise estimates of 1986 fishing mortality. Population numbers for 1986, generated from SPA, were used for projections.

Yield per recruit analysis for bluebacks produced an $F_{0.1}$ fishing mortality of 0.40 at a yield per recruit of 133 g and an average weight of 244 g. Since average fishing mortality exceeds $F_{0.1}$, it is recommended that rate of exploitation be reduced.

Projections of blueback harvest were made using an estimated average population at age 3 of 2,843,000 fish and annual fishing mortality at the $F_{0.1}$ value of 0.40 and at the Paloheimo value of 1.4. Results of these projections (Table 11) indicate that harvest in 1987 should be reduced to 229 tonnes, increasing to a long-term average of about 377 tonnes. Size will

increase from 220 g at present and stabilize at 244 g. If fishing continues at high levels, harvest in 1987 could reach 566 tonnes, but would subsequently fall to 434 tonnes and average fish size would be near 208 g. Again, it should be stressed that these projections assume average recruitment. This recruitment level (2.8×10^6) was greatly exceeded in 1986 (4.4×10^6), as well as in 1984 (6.9×10^6), but was lower in the other four years studied. Also, historical stock-recruitment may have been disrupted by over-exploitation, and recruitment could improve with increased spawning escapement.

CONCLUSION

Using sequential population analysis, it is recommended that the 1987 harvest of gaspereau from the Miramichi River should be reduced to 524 tonnes if the $F_{0.1}$ level is sought. This harvest would later rise to 782 tonnes and average size of fish would increase. This level of harvest is lower than levels observed in recent years. Continued harvest at higher rates can be achieved, possibly reaching 1,249 tonnes in 1987, but fish size will remain small and future harvest will be determined largely by the strength of a single year-class. The 1987 market is expected to be strong initially and fishermen will likely exceed both the recommended harvest level and the final market demand if not regulated. Fisheries managers have many options, including a return to a weekly closed time, in order to reduce exploitation.

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Table 1. Annual catch statistics and number of fishing licences for the Miramichi River, New Brunswick, gaspereau fishery (Districts 71 and 72).

Year	Catch (t)	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
1986	1,154 (566)[2]	36	32.04

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 2. 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	1986
Total catch (kg) A	1,410,241	1,277,639	1,087,899	664,774	1,857,386	1,153,542
Logbook catch (kg) B	1,320,172	1,106,124	848,869	610,906	1,492,829	608,365
Conversion factor A/B	1.0682	1.1551	1.2816	1.0882	1.2442	1.8961
Total effort (hrs.)	14,800	25,500	22,049	13,207	19,090	18,472
CPUE (kg/hr.)	95.3	50.1	49.3	50.3	97.3	62.5
Blueback effort (hrs.)*	14,774	24,918	19,011	8,251	12,416	10,886
Alewife effort (hrs.)*	14,800	25,056	22,018	12,452	15,846	18,472

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

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

		Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday	Week total
May 12-18	Catch	0	0	0	737	2,495	3,856	0	7,088
	Effort	0	0	0	78	156	192	192	618
	CPUE	0.00	0.00	0.00	9.45	15.99	20.08	0.00	11.47
May 19-25	Catch	8,875	5,532	13,976	26,307	14,375	6,752	1,211	77,028
	Effort	240	262	335	329	332	335	330	2,163
	CPUE	36.98	21.11	41.72	79.96	43.30	20.16	3.67	35.61
May 26-01	Catch	2,644	3,004	27,738	40,893	47,854	42,874	34,840	199,847
	Effort	286	294	311	311	311	307	311	2,131
	CPUE	9.24	10.22	89.19	131.49	153.87	139.65	112.03	93.78
June 02-08	Catch	34,273	28,545	21,813	27,836	40,691	28,519	18,554	200,231
	Effort	311	309	309	309	308	308	311	2,165
	CPUE	110.20	92.38	70.59	90.08	132.11	92.59	59.66	92.49
June 09-15	Catch	14,822	13,480	26,813	12,439	14,534	21,377	3,596	107,061
	Effort	285	285	280	280	285	263	178	1,856
	CPUE	52.01	47.30	95.76	44.43	51.00	81.28	20.20	57.68
June 16-22	Catch	4,583	3,429	1,973	1,461	1,080	1,929	113	14,568
	Effort	96	96	96	90	87	96	68	629
	CPUE	47.74	35.72	20.55	16.23	12.41	20.09	1.66	23.16
June 23-29	Catch	1,633	501	408	0	0	0	0	2,542
	Effort	66	48	48	0	0	0	0	162
	CPUE	24.74	10.44	8.50	0.00	0.00	0.00	0.00	15.69
Total	Catch	66,830	54,491	92,721	109,673	121,029	105,307	58,314	608,365
	Effort	1,284	1,294	1,379	1,397	1,479	1,501	1,390	9,724
	CPUE	52.05	42.11	67.24	78.51	81.83	70.16	41.95	62.56

Table 4. Estimated daily catch (Districts 71 and 72) in the 1986 Miramichi River gaspereau fishery.

	Alewife		Blueback		Catch (kg)			Number		
Date	Mean wt.	%	Mean wt.	%	Alewife	Blueback	Combined	Alewife	Blueback	Combined
Ma 15	.2929	100.0	.0000	0.0	1,397	0	1,397	4,771	0	4,771
Ma 16	.2791	100.0	.0000	0.0	4,731	0	4,731	16,950	0	16,950
Ma 17	.2810	100.0	.0000	0.0	7,312	0	7,311	26,020	0	26,020
Ma 18	.2863	100.0	.0000	0.0	0	0	0	0	0	0
Ma 19	.2915	100.0	.0000	0.0	16,828	0	16,828	57,730	0	57,730
Ma 20	.2934	100.0	.0000	0.0	10,489	0	10,489	35,751	0	35,751
Ma 21	.2777	100.0	.0000	0.0	26,500	0	26,500	95,428	0	95,428
Ma 22	.2533	100.0	.0000	0.0	49,882	0	49,882	196,927	0	196,927
Ma 23	.2528	100.0	.0000	0.0	27,257	0	27,257	107,820	0	107,820
Ma 24	.2601	100.0	.0000	0.0	12,803	0	12,803	49,222	0	49,222
Ma 25	.2601	100.0	.0000	0.0	2,296	0	2,296	8,828	0	8,828
Ma 26	.2733	100.0	.0000	0.0	5,013	0	5,013	18,344	0	18,344
Ma 27	.2827	100.0	.0000	0.0	5,696	0	5,696	20,149	0	20,149
Ma 28	.2595	100.0	.0000	0.0	52,595	0	52,595	202,678	0	202,678
Ma 29	.2358	100.0	.0000	0.0	77,539	0	77,539	328,832	0	328,832
Ma 30	.2250	92.0	.2553	8.0	82,589	8,149	90,738	367,062	31,918	398,980
Ma 31	.2243	94.0	.2650	6.0	75,594	5,701	81,295	337,023	21,512	358,535
Jn 1	.2088	96.0	.2510	4.0	62,910	3,151	66,061	301,294	12,554	313,848
Jn 2	.2173	82.9	.2328	17.1	53,195	11,791	64,986	244,801	50,648	295,449
Jn 3	.2089	67.6	.2319	32.4	35,355	18,770	54,125	169,242	80,942	250,184
Jn 4	.2108	45.0	.2801	55.0	15,762	25,598	41,360	74,773	91,390	166,163
Jn 5	.1883	68.6	.2395	31.4	33,343	19,438	52,781	177,075	81,159	258,234
Jn 6	.2007	18.0	.2407	82.0	11,937	65,218	77,156	59,478	270,953	330,431
Jn 7	.1914	16.0	.2327	84.0	7,324	46,751	54,076	38,268	200,908	239,176
Jn 8	.1966	16.1	.2151	83.9	5,259	29,922	35,181	26,751	139,106	165,857
Jn 9	.1924	19.5	.2140	80.5	5,029	23,075	28,105	26,140	107,828	133,968
Jn 10	.1924	19.5	.2140	80.5	4,574	20,986	25,560	23,773	98,065	121,838
Jn 11	.1906	21.6	.2133	78.4	10,029	40,812	50,841	52,618	191,336	243,954
Jn 12	.1962	18.0	.2338	82.0	3,669	19,917	23,586	18,700	85,189	103,889
Jn 13	.1838	11.4	.2219	88.6	2,661	24,897	27,558	14,478	112,201	126,679
Jn 14	.2100	11.4	.2161	88.6	4,516	36,017	40,534	21,506	166,670	188,176
Jn 15	.1702	6.3	.1896	93.7	389	6,429	6,819	2,286	33,910	36,196
Jn 16	.1768	9.7	.1895	90.3	788	7,902	8,690	4,456	41,700	46,156
Jn 17	.1818	16.0	.1894	84.0	1,005	5,497	6,502	5,528	29,022	34,550
Jn 18	.2123	11.4	.1951	88.6	461	3,280	3,741	2,170	16,814	18,984
Jn 19	.1839	28.0	.1691	72.0	823	1,947	2,770	4,477	11,513	15,990
Jn 20	.1920	10.0	.1850	90.0	212	1,836	2,048	1,103	9,925	11,028
Jn 21	.1856	12.9	.1839	87.1	474	3,184	3,658	2,554	17,312	19,866
Jn 22	.1775	20.0	.1807	80.0	42	172	214	238	952	1,190
Jn 23	.2030	5.0	.1632	95.0	190	2,906	3,096	937	17,807	18,744
Jn 24	.1880	5.0	.1607	95.0	55	895	950	293	5,569	5,862
Jn 25	.1730	5.0	.1581	95.0	42	731	774	244	4,626	4,870
	.2284		.2252		718,568	434,974	1,153,542	3,146,718	1,931,529	5,078,247
% of Dist. Total					62.21	37.79		61.96	38.04	

Table 5. Relative contribution by alewives and blueback herring to the Miramichi River gaspereau fishery, 1981-1986.

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
1986	Alewife	3,146.7	62.0	718.6	62.2	228
	Blueback	1,931.5	38.0	435.0	37.8	225

Table 6. Percentage contribution by each age of alewife and blueback herring to the Miramichi River gaspereau fishery, 1981-1986. 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
1986	Alewife	S	0.0	74.2	18.0	7.5	0.3	0.0	0.0	0.0
		T	0.4	46.0	11.2	4.7	0.2	0.0	0.0	0.0
	Blueback	S	0.4	28.9	16.7	42.4	9.5	0.8	0.9	0.0
		T	0.2	11.0	6.4	16.1	3.6	0.3	0.4	0.0
	Both	T	0.2	56.9	17.5	20.8	3.8	0.3	0.4	0.0

Table 7. Catch-at-age (numbers of fish) of alewife in the Miramichi River gaspereau fisheries, 1981 to 1986.

Age	1981	1982	1983	1984	1985	1986
2	0	363	3,719	411	0	0
3	38,619	502,137	622,237	1,055,839	717,910	2,333,664
4	317,258	773,959	964,566	679,906	955,514	566,640
5	147,714	115,197	111,979	120,792	195,001	235,992
6	304,056	98,261	52,594	38,564	0	10,424
7	217,214	36,003	25,603	0	0	0
8	14,696	50,399	33,023	0	0	0
9	12,494	0	11,726	3,730	0	0
10	0	0	753	0	0	0
11	0	610	6,486	0	0	0
12	0	0	0	0	0	0
Mean age	5.42	4.08	3.92	3.56	3.72	3.34

Table 8. Catch-at-age (numbers of fish) of blueback herring in the Miramichi River gaspereau fisheries, 1981 to 1986.

Age	1981	1982	1983	1984	1985	1986
2	0	0	163	0	0	8,304
3	10,586	40,283	55,462	51,341	368,098	557,669
4	194,411	506,240	1,049,216	324,828	3,766,743	322,453
5	476,165	746,833	625,558	146,937	1,205,880	819,141
6	1,830,828	302,795	247,459	76,348	403,914	183,970
7	344,686	686,484	68,468	33,907	110,187	15,956
8	289,803	69,135	159,626	25,476	8,423	17,923
9	136,676	86,227	15,283	12,932	113,740	743
10	0	1,547	29,906	3,629	0	5,376
11	19,287	0	291	0	0	0
12	0	0	0	2,074	24,844	0
Mean age	6.13	5.88	4.96	4.80	4.43	4.41

Table 9. Proportions of virgin spawning alewives and blueback herring at each age in the Miramichi River gaspereau fishery (1981-86).

Year	Age	Percentage of virgin spawners	
		Alewife	Blueback
1981	3	100	86
	4	100	95
	5	81	60
	6	15	12
1982	3	100	100
	4	63	90
	5	5	37
	6	0	
1983	3	100	100
	4	77	96
	5	12	44
	6	6	4
1984	3	100	95
	4	77	88
	5	0	31
	6	0	0
1985	3	99	78
	4	62	74
	5	0	18
	6	0	0
1986	3	100	96
	4	43	64
	5	4	4
	6	0	0

Table 10. 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	Z	1986
Alewife	4+	55.61	1.58	41.26	1.35	54.41	1.48	66.03	1.87	60.27	1.51	
	5+			11.41		10.69		12.37		10.22		13.34
Blueback herring	5+	206.8	1.50	74.40	1.15	51.97	1.50	22.43	-0.40	97.80	2.09	
	6+			46.00		23.61		11.58		33.33		12.12

Table 11. Summary of projected annual catch of alewife and blueback herring from the Miramichi River at $F_{0.1}$ and at Paloheimo F with mean annual recruitment (alewife: 2,288,000 age 3; blueback: 2,843,000 age 3).

Fishing rate		Year							
		1986	1987	1988	1989	1990	1991	1992	1993
Alewife									
0.43	Catch (T)	754	295	347	377	394	403	408	405
	Wt (g)	240	260	272	278	283	285	285	285
1.40	Catch (T)	754	683	517	479	471	469	468	468
	Wt (g)	240	258	254	251	250	249	249	249
Blueback									
0.40	Catch (T)	423	229	295	335	358	371	376	377
	Wt (g)	220	211	223	233	239	243	244	244
1.40	Catch (T)	423	566	474	444	436	435	434	434
	Wt (g)	220	209	210	209	208	208	208	208

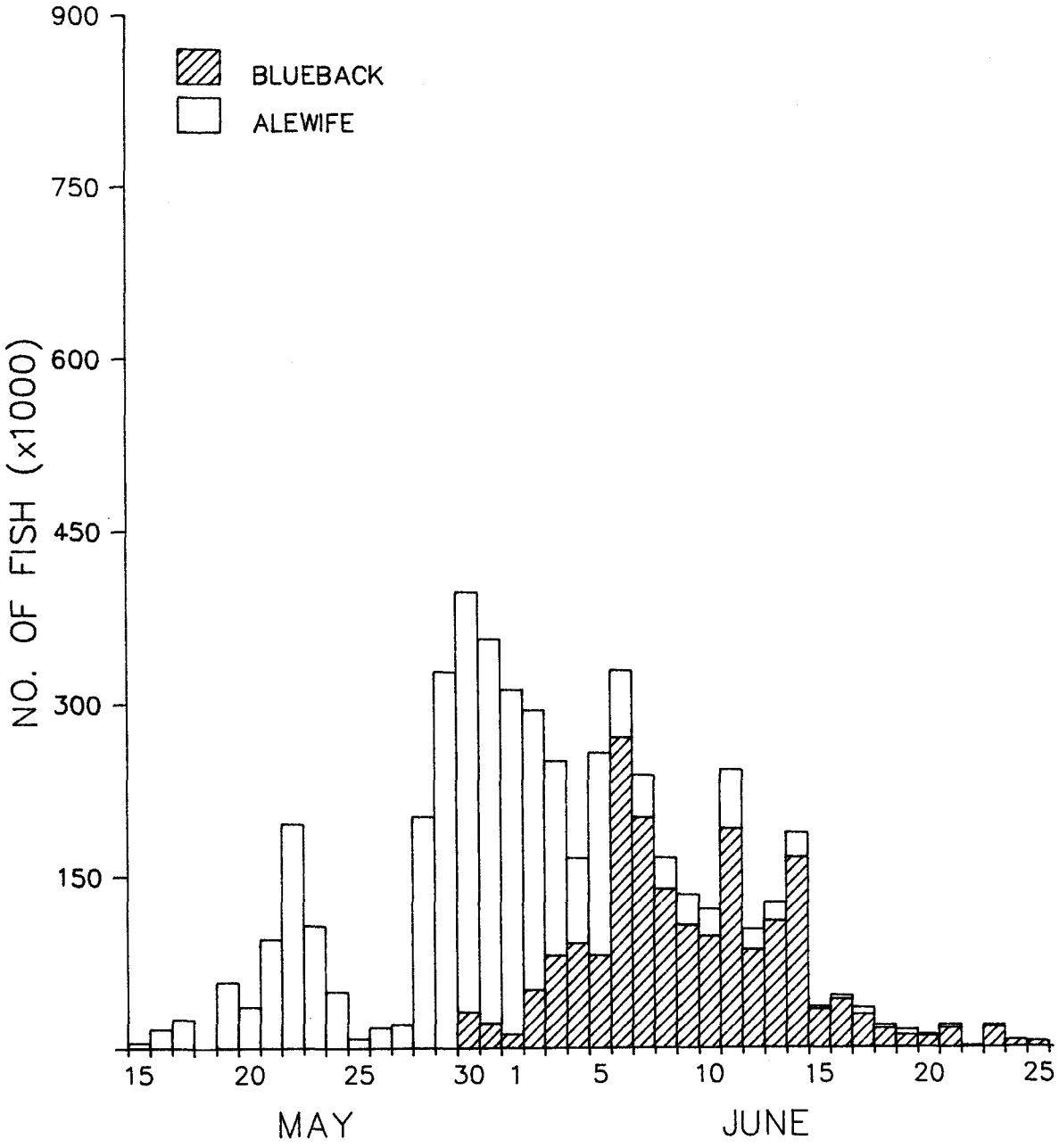

Fig. 1 Estimated number of alewives and blueback herring caught per day in the Miramichi River estuary gaspereau fishery, 1986.

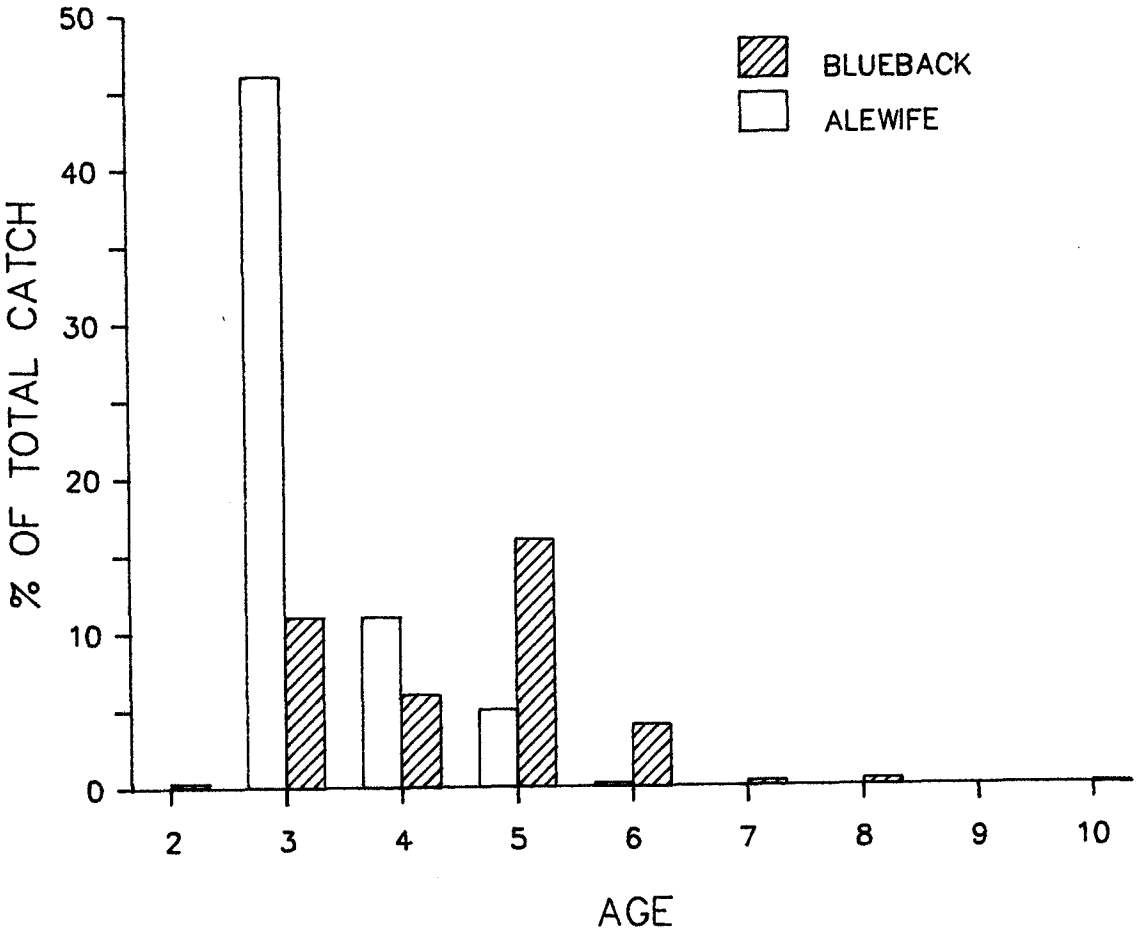

Fig. 2 Catch of alewife and blueback herring, in each age group, in the Miramichi River estuary gaspereau fishery, 1986.

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	1986	Mean*
Alewife							
2		135	114	137	122	127	127
3	240	244	223	210	210	206	222
4	278	317	275	271	254	270	278
5	299	347	328	324	290	302	315
6	334	393	317	352	349*	334	346
7	340	398	404	381*	381*	381*	381
8	392	460	374	409*	409*	409*	409
9	401	536	404	460	450*	450*	450
Blueback herring							
2			100		117	120	112
3	169	169	171	154	165	166	166
4	220	213	208	192	193	202	205
5	257	238	256	228	233	230	240
6	313	333	297	275	275	255	291
7	341	367	359	311	307	308	332
8	349	341	359	347	389	385	362
9	345	325	374	320	389	373	354
10	355*	362	370	333	355*	373	360

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