DFO Atlantic Fisheries
Research Document 93/ 51

MPO Document de recherche sur les pêches dans l'Atlantique 93/51

ASSESSMENT OF THE MIRAMICHI RIVER GASPEREAU FISHERY, 1991 AND 1992

by

F. Mowbray, G.Chaput and S.Courtenay
Science Branch
Department of Fisheries and Oceans
P.O. Box 5030
Moncton, New Brunswick E1C 9B6

ABSTRACT

The 1991 gaspereau landings from districts 71 and 72 at Loggieville, Millbank, Chatham and Newcastle were 2021 mt, of which 68% were alewife (*Alosa pseudoharengus*) and 32% were blueback (*Alosa aestivalis*). In 1992 the same areas had landings of 1315 mt consisting of 64% alewife and 36% blueback. In 1991, both the alewife and blueback herring catch was dominated by the 1987 class. First-time spawners composed 87% of alewife catch and 71% of the blueback catch. In 1992 both alewife and blueback herring captures were dominated by the 1988 cohort. First-time spawners accounted for 50% of the alewife catch and 38% of the blueback herring catch. An abundance index calculated from logbook effort showed alewife catch rates in 1991 and 1992 to be the highest since 1982 whereas catch rates for blueback herring were lower than those of 1987-1990 while still higher than years prior to 1987. With average recruitment, catches in 1993 could reach average or above average levels.

RESUME

En 1991, les débarquements de gaspareau des districts 71 et 72 à Loggieville, Millbank, Chatham et Newcastle se chiffraient à 2 021 tonnes métriques, dont 68 % étaient constitués de gaspareau (Alosa pseudoharengus) et 32 % d'alose d'été (Alosa aestivalis). En 1992, ils étaient de 1 315 tonnes métriques, dont 64 % de gaspareau et 36 % d'alose d'été. En 1991, la classe d'âge de 1987 dominait parmi les prises tant de gaspareau que d'alose d'été; les poissons frayant pour la première fois composaient 87 % des prises de gaspareau et 71 % de celles d'alose d'été. En 1992, les captures (gaspareau et alose d'été) étaient dominées par la cohorte de 1988, tandis que les nouveaux reproducteurs représentaient 50 % des prises de gaspareau et 38 % des prises d'alose d'été. Selon un indice d'abondance établi d'après l'effort consigné dans les journaux de pêche, les taux de prises du gaspareau de 1991 et de 1992 étaient les plus élevés depuis 1982, tandis que les taux de prises d'alose d'été se situaient en-dessous de ceux de 1987-1990, mais étaient supérieurs à ceux d'avant 1987. Avec un recrutement moyen, les prises de 1993 pourraient atteindre ou dépasser les niveaux moyens.

INTRODUCTION

The Miramichi River gaspereau fishery has been assessed annually from 1983-1990 (Alexander and Vromans, 1983,1984,1985,1986,1987,1988; Chaput and LeBlanc, 1989; LeBlanc *et al.*, 1990). In 1990, it was decided that bi-annual assessments were adequate, thus this document presents analyses for 1991 and 1992. The regulated fishing season for Miramichi gaspereau is from May 15 to June 15. In some years in-season extensions are given to compensate for poor catches due to retarded spawning runs in the early part of the season. In 1992, the fishery was extended by five days (to June 20) for this reason. During both years, one day a week closures (1200 hours Saturday till 1800 hours Sunday) were in effect during the month of May but not in June. From 1987-1990 one day a week closures were enforced throughout the entire season, and prior to 1987 the fishery was executed 7 days a week.

As in the assessments of 1987-1990, this document presents a description of the fisheries with reference to species and age. Due to time limitations cohort analysis was not performed. Stock abundance was derived from abundance indices and catch-at-age.

METHODS

Two-stage stratified sampling

A two-stage stratified sampling program of the Miramichi River commercial fishery was conducted in 1991 and 1992 from landing sites at Chatham, Loggieville, Millbank and Newcastle (Fig. 1). First, randomly selected samples of 118-270 fish were measured for length, and species was identified based external appearance and peritoneal colour. Second, for each species, a detailed sample of 2-4 fish per 0.5 cm length group was selected. These detailed samples were usually frozen for later processing.

During 1991 and 1992, samples were taken 1-2 times weekly from commercial traps at Millbank and Loggieville, and 2-3 times weekly from commercial traps at Chatham and Newcastle. Samples were collected from May 28 to June 14 in 1991 and from May 26 to June 15 in 1992 (Table 1). Samples were taken less frequently from Loggieville and Millbank due to the smaller number of fishermen and lower landings at these locations.

Detailed processing of samples

Biological characteristics recorded included fork length (nearest 0.25 cm), weight (nearest g), species (alewife: *Alosa pseudoharengus* or blueback herring: *Alosa aestivalis*), and sex. Species were distinguished on the basis of external appearance and peritoneum colour (Scott and Crossman, 1973). Scales were removed from the left side of the fish, in the region midway between the dorsal fin and the ventral scutes. Total age and age of first spawning were interpreted according to criteria described by Cating (1953) (Table 2).

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

adjusted length (mm) = 4.557 + 1.0143 x frozen length (mm)

Catch-at-age

Catches-at-age for the two-stage commercial sampling were obtained using the program AGELEN (Wright 1990), which calculates catches-at-age based on the equations of Gavaris and Gavaris (1983). Catch-at-age matrices were calculated for each species, by age of first spawning. Catches were first projected for each location and then the resultant matrices were summed. For each location, species specific age-length keys were used and catches were weighted by the location's total logbook catch. A conversion factor calculated as the ratio of total purchase slip landings divided by total logbook catches was then applied to the summed matrix in order to correct for discrepancies between logbook and purchase slip landings. Calculation of the catch-at-age for 1991 and 1992 differs only slightly from 1989-90 assessments in that catch-at-age was not originally projected within weekly intervals due to inadequate age-length information in some weeks.

Abundance Indices

The logbook data were prepared by partitioning the catches for a given day and location (Chatham, Loggieville or Newcastle) into catches of alewife and blueback herring using the species proportions, by weight, from the two-phase sampling. Catch from days without samples was estimated as the mean of the proportions in samples from the day before and after. Catches at the beginning of the season, without sampling information, were partitioned using the first sampled day's proportions. Because only one logbook was returned from Millbank each year, Millbank effort and landings were eliminated from abundance index calculations.

An abundance index for combined ages was estimated directly from the daily catch-per-unit effort on the river. The index, for separate fishing locations: Loggieville, Chatham and Newcastle, represents the sum of the average daily catch standardized to one hour of trapnet effort (kg/hour) over the entire fishing season. This index was used to account for differences in the duration and timing of the upriver migration between years (Chaput 1993).

A second catch rate index using catch and effort logbook data was estimated using the multiplicative model approach of previous assessments (LeBlanc et al. 1991; Gavaris 1980). Observations in a given year represent individual logbook reports for which the CPUE was calculated as the sum of the logbook catch divided by the sum of the effort to obtain that catch for each individual logbook report for alewife and blueback separately. The natural log of the CPUE (kg/hour) was the dependent variable with year and location as explanatory 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 back-transformed values were estimated from the model solutions to the year factor using the transformation equation described by Gavaris (1988).

RESULTS

Catch description

The catch of gaspereau from Districts 71 and 72 landings at Newcastle, Chatham, Millbank and Loggieville was estimated as 2022 mt and 1315 mt in 1991 and 1992, respectively. The 1991 landings exceeded the historic (1950-1992) 5 year and 10 year means, as well as the 5 and 10 year 95% confidence intervals. In contrast, the low 1992 landings were within the confidence intervals of the 10 year and historic means, but fell below the 5 year mean (Table 3). Landings from Napan Bay were not included in the estimates.

Purchase slip landings in 1991 and 1992 exceeded logbook landings necessitating the use of a conversion factor in order to estimate total effort for the river. Conversion factors for 1991 and 1992 were 2.005 and 1.589, respectively (Table 4). Maximum daily landings of gaspereau for Districts 71 (Millbank, Loggieville and Chatham) and 72 (Newcastle) occurred on June 8 in 1991 and on June 6 in 1992. The partitioning of total purchase-slip landings into districts 71 and 72 was 87% and 13% respectively in both 1991 and 1992.

Species composition

Gaspereau catches in 1991 and 1992 were composed of both alewife and blueback herring. In 1991, alewife contributed 65.9% of catches and blueback herring 34.1%. In 1992, alewife were responsible for 64.3% and blueback herring 35.7%.

Species composition (by weight) was compared among sites for both years (Fig.2). In 1991, up to June 5, the proportion of alewife was greater than 90% in all locations. After June 8 the proportion of alewife began to decline, first at Millbank, then Newcastle, Chatham and Loggieville. With the exception of Chatham, alewife proportions declined gradually throughout the season, ending near 50%. At Chatham quantities of alewife also declined during the season, but showed a marked decrease on June 14 and 15 from 78% to 30% followed by an increase to 48% on June 16 and 17. Species composition for 1992 followed a similar pattern with less than 90% alewife at all sites before June 5, and blueback herring appearing first at Millbank and then Chatham. As in 1991 the 1992 proportion of alewife at Chatham dipped between June 8 and June 12 rather than declining gradually.

Age composition and catch-at-age matrices

The total gaspereau catch (alewife and blueback combined) was estimated as 8.1 and 5.1 million fish for 1991 and 1992 respectively. In both years, alewife ages ranged from 3 to 8 years. Blueback herring ages differed between years, with ages 3-9 present in 1991, but only 3-8 found in 1992 (Tables 2a and 2b). Four year-old fish (combined first-time and repeat spawners) dominated catches of alewife and blue-back herring in both years.

Catches-at-age (numbers) of alewife and blueback herring are presented in Tables 5a and 5b. Matrices are divided according to the age of first spawning.

In 1991, alewife catches were dominated by the 1987 year class (49.7%). A large number of 4 year-old first-time spawners (FSP) were present, and the number of FSP (87.4%; all ages combined) was the highest recorded since 1982 (Table 5a). Blueback herring catches were also dominated by the 1987 year class (49.5%) and the percent of FSP blueback herring was the highest recorded at 71% (Table 5b).

In 1992, alewife catches were dominated by the 1988 year class (49.7%) with an average number of FSP (49.9%). The 1988 year class was also dominate in 1992 blueback herring catches (46.9% by number), mainly due to 4 year-old FSP. The percent of FSP blueback herring in 1992 was 37.6% (all ages combined).

Weight-at-age matrices

The weight at age matrix for alewife and blueback herring (1982-1992) is presented in Table 6. In all years, mean weights-at-age were calculated using the measured weights of individual fish.

Weights-at-age for most ages of alewives were above the 11 year mean in 1991 and below the mean in 1992, however in neither year did the values exceed those previously seen. During both 1991 and 1992 blueback herring weights were above the 11 year mean, and the weights at ages 3-6 were the highest in the time series.

Abundance Index

Alewife

The reference categories for the full multiplicative model were the same as those in the 1990 assessment: year=1990, Newcastle for location. The interaction term, year*location, was significant (P=0.002). Both the year and location treatments were significant factors (Table 7). When the catch rates were calculated for each location separately, the year factor was significant for all three locations. The year factor explained from 63% of the variation in catch rate for the Chatham location to 75% at Newcastle (Table 7). The catch rates at all three locations have increased since 1990 and have exceeded the rates observed for the 1982 to 1988 series (Fig. 4, Table 8). The increased average catch has been accompanied by increased variation between individual trap catches at all three locations (Table 9). The trends in abundance among sites were not consistent in recent years, (Fig. 4). The catch rates of alewife

in 1992 at Loggieville and Chatham were the highest of the time series but only the Loggieville value in 1992 was significantly higher than the 1990 catch rate (P=0.01; Table 8). The 1991 catch rate was significantly higher than the 1990 rate at Newcastle but not for the other two locations (P=0.01; Fig. 4, Table 8).

Catch rates of alewife at Chatham and Newcastle were quite similar at about 150 kg per hour of trap fishing. These rates were about double the rates observed for the Loggieville traps, except for 1992 when the average catch rate at these down river traps was equal to the Newcastle trap rates (Table 8).

The trends in the abundance indices based on the sum of the daily CPUE for each location illustrate a similar trend of increased catch rates since 1990, rates which are the highest in the time series (Fig. 4). In contrast to the other abundance index, the catch rate at Newcastle in 1992 was estimated to have been as high as in 1991 (Fig. 4).

Blueback Herring

The interaction term year*location was also significant in the blueback herring catch rate model (Table 10). When the catch rates were analyzed for each location separately, year was a significant predictor of catch rate variation at the Newcastle and Chatham locations but not at the Loggieville site. Although the model for Loggieville using year as the predictor could account for 51% of the total variance in catch rates, the overall model was not significant (Table 10). The Chatham and Newcastle catch rates have fluctuated at about 100 kg/hour of trap effort since 1988, twice the catch rate levels noted for the Loggieville trapnets (Fig. 4). Similarly to the alewife catch rates, the average abundance appears to have increased in the recent 5 years compared to the years 1982 to 1986 (Fig. 4). The coefficient of variation has not increased in the 1988 to 1992 period as was noted for the alewife abundances (Table 9).

The trends in the abundance indices based on the sum of the daily CPUE of blueback herring for each location also support the trends noted with the multiplicative model: generally stable catch rates at Loggieville and fluctuating catches at Newcastle and Chatham (Fig 4). The highest catch rates were, however, noted for the 1988 and 1989 fishing years while the 1990 to 1992 values decreased to an average catch rate roughly half to two-thirds of the higher values (Table 8).

DISCUSSION

The lifting of the one-day-a-week June closures for 1991-92 as well as the 5 day season extension given in 1992 appeared to have had little affect on total catches. The 1991 gaspereau landings in the Miramichi River were significantly higher than the 5 year mean and the 1992 landings were significantly lower. The 1992 five day extension was only realised at one location and the proportion of total catch taken was small (Fig. 3).

Gaspereau landings continued to be dominated by alewife which composed 68% and 64% of the catch in 1991 and 1992, respectively. The 1987 cohort, which had dominated 1990 and 1991 alewife captures, was replaced in 1992 by the 1988

cohort. The 1992 captures of 3 year-old FSP alewives is one of the lowest in the time series. Blueback captures in 1992 were dominated by the 1988 cohort, which were also strong as 3 year-old recruits in 1991. Because the numbers of the 1989 cohort caught in 1992 are below those associated with dominate cohorts in the past, it is likely that the 1988 cohort will be a main component of blueback catches in 1993.

Analysis of abundance indices showed high catch rates for alewife in recent years. Present catch rates are thought to correspond to a moderate (0.6) to low (0.4) fishing mortality like those of the 1986,1987 and 1990 fisheries (Alexander and Vromans 1987, 1988; LeBlanc *et al.* 1991). As in previous assessments, catch rates were higher for alewife than for blueback herring. Alewife captures also include a higher proportion of first time spawners than blueback herring. Together the catch rates and FSP conponents of these populations support the assumption of a higher alewife fishing mortality.

Blueback herring catch rates inferior to alewife catch rates may be a function of run timing in relation to fishing season. Inter-annual changes in blueback run timing may cause fluctuations in annual catch rates as its coincidence with the commercial fishery changes. As demonstrated in Fig. 3, the proportion of blueback herring in 1991 and 1992 catches seldom peaked before the end of the fishing season and was not a major component until the first week of June. During the years 1986-1989 blueback herring ran approximately one week earlier than in 1991-92, increasing the period of exploitation. Assuming that some biological characteristics may be a factor in run timing, the change of exploitation period relative to run timing may also contribute to the weight-at-age changes noted in blueback herring in 1991-92. Due to the changes in blueback run timing and the continued high catch rates for alewives, no major change in stock size is anticipated, and no change in management measures are suggested for 1993.

ACKNOWLEDGEMENTS

We would like to acknowledge the efforts of Kimberly Robichaud and Christine Daigle who collected and processed all the biological samples for this assessment. Our gratitude also goes to the many fisherman who supplied samples and all those fisherman who faithfully filled in logbooks. Technical support supplied by Colin MacDougall in aging samples is also most appreciated.

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Table 1. Dates, locations and species composition of gaspereau length samples taken from the Miramichi River in 1991 and 1992.

Date	Loggieville		Chatham		Newcastle		Millbank		Total
	Alewife	Blueback	Alewife	Blueback	Alewife	Blueback	Alewife	Blueback	
1991									
May 28	154	2	193	0	0	0	0	0	349
May 29	0	0	0	0	0	0	195	1	196
May 30	0	0	200	2	0	0	0	0	202
June 3	0	0	159	14	177	5	0	0	355
June 4	217	19	131	29	0	0	0	0	396
June 5	0	0	0	0	157	41	190	25	413
June 7	128	66	131	39	170	64	0	0	598
June 10	0	0	67	151	150	79	0	0	447
June 11	104	130	0	0	0	0	120	115	469
June 12	0	0	104	112	142	127	0	0	485
June 13	108	93	0	0	0	0	0	0	201
June 14	0	0	78	116	67	157	0	0	418
1992									
May 26	170	0	0	0	270	0	0	0	440
May 27	0	0	183	0	0	0	0	0	183
May 28	0	0	0	0	196	0	161	0	357
June 1	0	0	0	0	201	0	0	0	201
June 2	167	1	0	0	0	0	226	0	394
June 3	0	0	0	0	173	0	0	0	173
June 4	214	1	186	8	0	0	0	0	409
June 5	0	0	118	0	133	7	0	0	258
June 8	0	0	109	32	173	30	0	0	344
June 9	101	59	0	0	179	10	0	0	349
June 10	0	0	84	97	0	0	90	83	354
June 11	0	0	32	146	91	122	0	0	391
June 12	41	126	0	0	0	0	0	0	167
June 15	100	57	123	111	124	107	0	0	622

Table 2a. Numbers of gaspereau aged, by species, from the stratified sampling of the Miramichi commercial fishery , 1991.

Species	Age		Commercial fishery stratified samples				Total
	Total	Recruit	Chatham	Loggieville	Millbank	Newcastle	
Alewives	unknown	unknown	19	6	7	7	39
	3	3	81	66	26	66	239
	4	3	21	14	11	8	54
		4	109	62	49	86	306
	5	3	8	4	1	1	14
		4	15	9	11	3	38
		5	7	6	2	4	19
	6	3	11	5	1	1	18
		4	12	13	9	2	36
		5	1	2	0	0	3
		6	0	0	1	0	1
	7	3	0	0	1	0	1
		4	3	1	3	1	8
		5	0	1	0	1	2
	8	5	0	1	0	0	1
total			287	190	122	180	779
Blueback	unknown	unknown	49	47	24	53	173
	3	3	14	10	9	19	52
		5	0	0	0	1	1
		6	0	0	0	1	1
	4	3	1	0	1	0	2
		4	47	37	18	54	156
	5	3	2	5	1	3	11
		5	9	4	0	3	16
	6	3	4	1	2	4	11
		4	25	12	6	29	72
		6	1	0	0	1	2
	7	3	3	0	0	1	4
		4	23	14	3	13	53
		5	3	0	0	1	4
	8	4	9	1	0	5	15
		5	3	1	0	3	7
	9	4	2	0	0	0	2
total			199	135	67	200	601

Table 2b. Numbers of gaspereau aged, by species, from stratified sampling of the Miramichi River commercial fishery, 1992.

Species	Age		Commercial fishery stratified samples				Total
	total	recruit	Chatham	Loggieville	Millbank	Newcastle	
Alewife	unknown	unknown	43	52	24	40	159
	3	3	23	32	9	26	90
	4	3	43	27	22	66	158
		4	52	37	24	59	172
	5	3	18	12	12	24	66
		4	20	15	11	15	61
		5	1	0	0	3	4
	6	3	1	2	4	2	9
		4	4	2	2	1	9
	7	3	1	1	0	1	3
		4	0	1	0	1	2
	8	4	1	0	0	0	1
total			207	181	108	238	734
Blueback herring	unknown	unknown	34	38	9	30	111
	3	3	5	4	0	3	12
	4	2	0	0	0	1	1
		3	14	10	5	13	42
		4	28	19	2	22	71
	5	3	9	7	3	8	27
	6	3	9	3	5	6	23
		4	6	3	1	3	13
		5	1	0	0	0	1
	7	3	2	4	0	3	9
		4	8	2	2	0	12
	8	4	1	2	0	1	4
		5	2	0	0	0	2
total			143	102	34	108	387

Table 3. Annual landings for the Miramichi River gaspereau fishery 1950-1992 (Districts 71 and 72).

Year	Landings (metric tons)
1950	4,952
1951	8,014
1952	11,381
1953	8,026
1954	4,649
1955	3,413
1956	3,009
1957	884
1958	816
1959	1,596
1960	716
1961	161
1962	733
1963	543
1964	119
1965	425
1966	746
1967	532
1968	436
1969	175
1970	874
1971	469
1972	468
1973	967
1974	271
1975	141
1976	406
1977	2,240
1978	1,434
1979	3,343
1980	3,767
1981	1,410
1982	1,278
1983	1,088
1984	665
1985	1,857
1986	1,154
1987	2,145
1988	1,888
1989	1,682
1990	1,789
1991	2,022
1992	1,315 *
Means (95% C.I.)	
Historical	1,953 (1,241 - 2,690)
10 Year	1,561 (1,279 - 1,843)
5 Year	1,739 (1,529 - 1,949)

* 1992 preliminary estimate based on purchase slip total and does not include the Napan area.

Table 4. Miramichi River catches reported through data from purchase slips and Supp 'B' slips collated by Statistics Branch DFO and through voluntary logbooks, 1981 to 1992, with resultant conversion factor and CPUE estimates.

(mt)	1981	1982	1983	1984	1985[1]	1986	1987	1988	1989	1990	1991	1992[2]
Total landings (mt) A	1410.9	1277.6	1087.9	666.1	1857.4	1171.4	2208.7	1888.3	1681.7	1788.5	2021.7	1315.2
Logbook catches (mt) B	1322.9	1108.4	829.2	612.2	1496	609.6	1077.3	691.3	1174.5	1148.1	1008.6	827.4
Logbook effort (hrs)	12308	13148	14894	8857	10507	7450	7572	6166	6348	6378	3299	2580
Conversion factor A/B	1.067	1.153	1.312	1.088	1.242	1.922	2.050	2.732	1.432	1.558	2.005	1.589
Total effort (hrs)	13127	15155	19541	9637	13045	14316	15524	12105	9089	9936	6615	4100
CPUE (kg/hr)	107.5	84.3	55.7	69.1	142.4	81.8	142.3	112.1	185.0	180.0	305.6	320.8

[1] 1985 landings total used was one by Science Branch since Statistics Branch estimate was lower than logbook catches reported for that year.

[2] Preliminary landings estimate based on purchase slips and voluntary logbooks only.

Table 5a. Miramichi River alewife catch-at-age (numbers of fish), 1982-1992. FSP=First Time Spawners

Numbers of alewife

Total Age	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	CV(%) 1992
Recruited at age 2												
2	88	3372	442	0	0	0	0	510	2501	0	0	.
3	0	2998	0	0	0	0	0	0	0	0	0	.
4	0	0	2914	0	0	0	0	0	0	0	0	.
5	0	0	0	0	0	0	2205	0	0	0	0	.
6	0	0	0	0	0	0	0	0	0	0	0	.
7	0	0	0	0	0	0	0	0	0	0	0	.
8	0	0	0	0	0	0	0	0	0	0	0	.
Recruited at age 3												
3	476996	648450	1070590	767926	2345873	644357	635441	213827	3832752	2335342	537857	5.4
4	512276	234132	146091	386590	286470	1440508	446532	372259	26354	370865	911814	3.9
5	609	32675	68132	56831	151799	242523	404010	389031	150938	41253	316923	6.9
6	6892	0	16625	0	0	66394	30355	145617	57965	42711	23314	24.4
7	3522	0	0	0	0	0	0	906	16386	652	5968	50.1
8	0	8203	0	0	0	0	0	159	2451	0	0	.
9	0	1156	4141	0	0	0	0	0	0	0	0	.
10	0	191	0	0	0	0	0	0	0	0	0	.
11	631	0	0	0	0	0	0	0	0	0	0	.
Recruited at age 4												
4	487639	782317	553192	687357	299466	1408619	620082	776520	254267	2242033	1013676	3.5
5	130479	62669	63102	113236	118662	391723	308847	553205	295240	106109	294777	7.2
6	143367	39749	24958	0	16014	122139	21373	217380	113121	79278	21664	22.1
7	43161	16464	0	0	0	24679	2869	1534	25688	14326	8185	49.1
8	81564	22757	0	0	0	0	0	113	1326	0	1071	59.9
9	0	11090	0	0	0	0	0	0	0	0	0	.
10	0	289	0	0	0	0	0	0	0	0	0	.
11	0	6281	0	0	0	0	0	0	0	0	0	.
Recruited at age 5												
5	0	21180	0	0	1046	11426	88472	28501	25115	64413	26404	27.2
6	0	15941	65	0	0	5598	7410	31756	8856	7813	0	.
7	7661	5730	0	0	0	0	0	3512	12479	5774	0	.
8	2282	2971	0	0	0	0	0	0	0	0	0	.
9	0	31	0	0	0	0	0	0	0	0	0	.
10	0	264	0	0	0	0	0	0	0	0	0	.
Recruited at age 6												
6	0	0	0	0	0	0	0	0	0	0	0	.
7	0	5314	0	0	0	0	0	0	0	0	0	.
8	0	27	0	0	0	0	0	0	0	0	0	.
Total	1897166	1924250	1950252	2011940	3219329	4357965	2567596	2734829	4825441	5310567	3161654	0.3
Dominant Cohort	1978	1979	1981	1981	1983	1983	1984	1985	1987	1987	1988	
%	52.7	52.8	54.9	53.4	72.9	65.4	41.5	42.0	79.4	49.2	60.9	
% FSP	50.9	75.6	83.3	72.3	82.2	47.4	52.3	37.3	85.3	87.4	49.9	

Table 5b. Miramichi River blueback herring catch-at-age (numbers of fish), 1982-1992. FSP=First Time Spawners.

Numbers of blueback

Total Age	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	CV(%) 1992
Recruited at age 2												
2	0	152	0	0	8896	0	0	0	0	0	0	.
3	0	0	0	45286	4041	441	0	0	0	0	0	.
4	156	3348	8928	458701	10745	0	0	0	0	0	0	.
5	38979	0	65	61651	0	0	0	0	0	0	0	.
6	38530	0	0	0	0	0	0	0	0	0	0	.
7	38530	0	0	0	0	0	0	0	0	0	0	.
8	0	2971	0	0	0	0	0	0	0	0	0	.
Recruited at age 3												
3	24844	56029	51449	344541	540890	191386	1737	4072	415669	520061	130055	17.5
4	331	56345	46033	651074	115960	827750	300134	1950	0	35075	307425	9.8
5	104330	24476	19005	238591	112724	30711	478031	98445	22591	47932	178218	12.1
6	57735	22581	132	83989	7486	26879	0	132846	84888	50508	102303	20.1
7	245140	0	5692	6269	635	0	15398	0	6518	11651	47905	26.3
8	295	9110	6437	0	4890	0	0	0	0	0	0	.
9	156	0	3573	53698	910	0	0	0	0	0	0	.
10	295	0	0	0	5502	0	0	0	0	0	0	.
11	0	0	0	0	0	0	0	0	0	0	0	.
12	0	0	0	22048	0	0	0	0	0	0	0	.
Recruited at age 4												
4	410476	985907	316563	2939955	218307	3185102	1363433	610630	397837	1323294	591241	6.4
5	269938	320701	115687	791462	680984	146913	2502843	1423871	583445	93172	403882	0.8
6	113298	96567	85019	284856	149370	495935	114810	1849546	788698	285626	76717	26.1
7	346806	20837	9861	57964	15240	173138	90714	40462	218700	212227	67377	22.4
8	25609	115083	25692	11866	10227	0	7410	0	14712	45939	7290	39.9
9	59235	14860	10110	48540	0	0	0	278	1533	0	0	.
10	0	23796	3835	0	0	0	0	0	0	0	0	.
11	0	264	0	0	0	0	0	0	0	0	0	.
12	0	0	4235	0	0	0	0	0	0	0	0	.
Recruited at age 5												
5	178851	280301	42162	176825	30342	52881	405389	135906	163315	106047	0	.
6	44219	113850	4412	46808	24821	13989	36777	83890	98825	798	4808	65.3
7	129543	35305	24077	46514	0	32355	0	6676	43963	13421	0	.
8	19490	34208	6377	0	0	42683	0	163	0	0	0	.
9	19490	111	2040	22048	0	0	0	0	0	0	0	.
10	609	6368	0	0	0	0	0	0	0	0	0	.
Recruited at age 6												
6	0	11430	0	0	0	0	0	0	0	0	0	.
7	7313	13054	0	0	0	0	0	0	0	0	0	.
8	0	98	0	0	0	0	0	0	0	0	0	.
Total	2174197	2247751	791382	6392686	1941971	5220163	5316677	4388735	2840700	2745751	1917222	0.6
Dominant Cohort	1975	1979	1980	1981	1981	1983	1983	1983	1984	1987	1988	
%	35.3	46.5	46.9	63.3	42.4	76.9	63.7	47.1	34.2	49.5	46.9	
% FSP	28.2	59.3	51.8	54.1	41.1	65.7	33.3	17.1	34.4	71.0	37.6	

Table 6. Mean weight (g) at age of alewife and blueback herring from the Miramichi River, 1982-1992.

AGE	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	MEAN
ALEWIFE												
1	-	53	-	-	-	-	-	-	-	-	-	53
2	132	112	134	122	119	-	-	122	139	-	-	126
3	249	225	213	210	208	218	231	185	197	223	244	218
4	321	279	276	262	273	245	267	281	257	267	265	272
5	343	339	329	286	307	296	286	298	328	350	278	313
6	398	314	340	-	291	296	321	325	337	397	325	334
7	406	402	-	-	-	312	542	401	362	448	347	403
8	494	391	-	-	-	-	-	383	402	-	374	409
9	554	420	525	-	-	-	-	-	-	-	-	500
10	-	348	-	-	-	-	-	-	-	-	-	348
11	634	383	-	-	-	-	-	-	-	-	-	509
BLUEBACK												
2	-	107	-	124	130	-	-	-	-	-	-	120
3	176	172	157	166	166	164	166	142	162	206	212	172
4	213	209	193	194	204	189	202	192	178	245	230	204
5	242	260	233	237	235	228	234	232	237	267	254	242
6	333	299	287	290	265	247	274	270	277	303	292	285
7	369	383	330	305	305	275	293	324	303	325	281	318
8	382	375	384	344	364	334	-	377	332	333	376	360
9	351	379	390	393	327	390	-	397	346	-	-	372
10	353	392	353	-	356	-	-	-	-	-	-	364
11	-	335	-	-	-	-	-	-	-	-	-	335
12	-	-	485	381	-	-	-	-	-	-	-	433

Table 7. Analysis of variance results and parameter estimates of catch rates of alewife (Ln kg/hour) for locations as treatment and by location on the river. Sites are Chatham (CHA), Loggieville (LOG) and Newcastle (NEW). Reference categories are 1990 and Newcastle.

General Linear Models Procedure
Class Level Information

Class	Levels	Values
YEAR	11	82 83 84 85 86 87 88 89 91 92 909
SITE	3	CHA LOG NEW

Number of observations in data set = 140

Dependent Variable: CPUEHRS

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	32	51.02899983	1.59465624	8.11	0.0001
Error	107	21.03674664	0.19660511		
Corrected Total	139	72.06574647			

R-Square	C.V.	Root MSE	CPUEHRS Mean
0.708090	11.44519	0.44340175	3.87413168

Source	DF	Type III SS	Mean Square	F Value	Pr > F
YEAR	10	33.26962053	3.32696205	16.92	0.0001
SITE	2	5.63958607	2.81979304	14.34	0.0001
YEAR*SITE	20	9.66537782	0.48326889	2.46	0.0017

Newcastle logbooks
Dependent Variable: CPUEHRS

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	10	25.69690	2.56969	13.358	0.0001
Error	44	8.46417	0.19237		
C Total	54	34.16107			

Root MSE	0.43860	R-square	0.7522
Dep Mean	3.83701	Adj R-sq	0.6959
C.V.	11.43070		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	4.426325	0.21929859	20.184	0.0001
YY82	1	-1.301884	0.26858482	-4.847	0.0001
YY83	1	-1.387913	0.27490533	-5.049	0.0001
YY84	1	-1.106640	0.27490533	-4.026	0.0002
YY85	1	-0.751161	0.26858482	-2.797	0.0076
YY86	1	0.089989	0.33498413	0.269	0.7895
YY87	1	0.294169	0.29421993	1.000	0.3229
YY88	1	-0.351187	0.31013504	-1.132	0.2636
YY89	1	-0.530867	0.31013504	-1.712	0.0940
YY91	1	0.900780	0.33498413	2.689	0.0101
YY92	1	0.279518	0.37983630	0.736	0.4657

Table 7. (cont'd).

Chatham logbooks - alewife
3
Dependent Variable: CPUEHRS

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	10	14.80391	1.48039	7.027	0.0001
Error	42	8.84851	0.21068		
C Total	52	23.65242			

Root MSE	0.45900	R-square	0.6259
Dep Mean	4.03403	Adj R-sq	0.5368
C.V.	11.37814		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	4.775757	0.20527002	23.266	0.0001
YY82	1	-0.936561	0.25601670	-3.658	0.0007
YY83	1	-1.488835	0.26876155	-5.540	0.0001
YY84	1	-0.825281	0.27793693	-2.969	0.0049
YY85	1	-1.118828	0.27793693	-4.025	0.0002
YY86	1	-0.669281	0.29029565	-2.306	0.0261
YY87	1	-0.474427	0.33520455	-1.415	0.1643
YY88	1	-0.895510	0.33520455	-2.672	0.0107
YY89	1	-0.834863	0.30790504	-2.711	0.0097
YY91	1	0.321888	0.33520455	0.960	0.3424
YY92	1	0.517061	0.38402505	1.346	0.1854

Loggieville logbooks - alewife
Dependent Variable: CPUEHRS

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	10	7.80403	0.78040	4.401	0.0021
Error	21	3.72406	0.17734		
C Total	31	11.52810			

Root MSE	0.42111	R-square	0.6770
Dep Mean	3.67310	Adj R-sq	0.5231
C.V.	11.46480		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	3.750313	0.24312982	15.425	0.0001
YY82	1	-0.038566	0.32163052	-0.120	0.9057
YY83	1	-0.822658	0.32163052	-2.558	0.0183
YY84	1	0.174050	0.30753760	0.566	0.5774
YY85	1	-0.464951	0.38442200	-1.209	0.2399
YY86	1	-0.240178	0.34383749	-0.699	0.4925
YY87	1	-0.350660	0.48625965	-0.721	0.4788
YY88	1	-0.490805	0.38442200	-1.277	0.2156
YY89	1	-0.532529	0.38442200	-1.385	0.1805
YY91	1	0.408946	0.34383749	1.189	0.2476
YY92	1	0.974901	0.34383749	2.835	0.0099

Table 8. Catch rates (kg/hr) of alewife and blueback, by location, using the sum of the average catch per unit effort on a given day of the fishing season.

	Chatham		Loggieville		Newcastle	
Year	Alewife	Blueback	Alewife	Blueback	Alewife	Blueback
82	1146	958	936	926	407	527
83	846	828	674	728	685	934
84	1198	636	1117	421	661	284
85	804	1909	610	861	823	1675
86	1915	1134	964	615	1986	1576
87	1721	1095	714	350	2341	2296
88	1074	2704	560	979	1032	2056
89	1303	2196	682	926	1030	2475
90	2409	1022	1053	624	1767	1405
91	2717	1221	1402	394	2669	1517
92	2789	2168	2138	824	2585	1285

Table 9. Back-transformed catch rates of alewife and blueback from the multiplicative model analysis by location using the sum of the catch divided by the sum of the effort of individual logbook reports for a given year as data points.

ALEWIFE

	Newcastle			Chatham			Loggieville		
Year	Mean	StdErr	Variance	Mean	StdErr	Variance	Mean	StdErr	Variance
82	25	3.9	15	51	7.9	62	44	9.3	87
83	23	3.8	14	29	5.1	26	20	4.3	18
84	30	5.0	25	57	10.7	114	55	10.4	108
85	43	6.7	45	42	8.0	63	28	8.3	69
86	98	24.6	606	66	13.6	185	36	8.7	76
87	121	23.8	569	79	20.9	436	30	12.3	152
88	63	13.9	193	52	13.7	188	27	8.1	66
89	53	11.6	135	56	12.8	163	26	7.8	61
90	90	19.7	389	129	26.6	706	45	11.1	123
91	220	55.4	3066	176	46.3	2145	68	16.7	279
92	116	35.6	1264	210	67.1	4505	120	29.4	864

BLUEBACK

	Newcastle			Chatham			Loggieville		
Year	Mean	StdErr	Variance	Mean	StdErr	Variance	Mean	StdErr	Variance
82	35	7.4	54	50	9.3	86	47	12.0	143
83	41	10.1	101	36	7.5	56	22	5.5	30
84	11	2.5	6	23	5.1	26	20	4.5	20
85	120	25.3	638	115	26.0	675	53	18.6	345
86	22	8.8	78	42	10.3	106	19	5.6	31
87	131	34.7	1201	45	14.1	199	14	6.6	44
88	71	21.0	441	155	48.8	2382	47	16.6	275
89	154	45.5	2074	109	30.0	902	39	13.5	183
90	76	22.5	507	58	14.2	202	36	10.4	109
91	130	44.1	1944	83	26.2	686	24	6.9	48
92	68	27.6	764	168	64.0	4093	48	13.9	192

Table 10. Analysis of variance results and parameter estimates of catch rates of blueback (Ln kg/hour) for locations as treatment and by location on the river. Sites are Chatham (CHA), Loggieville (LOG) and Newcastle (NEW). Reference categories are 1990 and Newcastle.

General Linear Models Procedure
Class Level Information

Class	Levels	Values
YEAR	11	82 83 84 85 86 87 88 89 91 92 909
SITE	3	CHA LOG NEW

Number of observations in data set = 138
Dependent Variable: CPUEHRS

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	32	70.76555518	2.21142360	7.01	0.0001
Error	105	33.12019811	0.31543046		
Corrected Total	137	103.88575329			

R-Square	C.V.	Root MSE	CPUEHRS Mean
0.681186	14.87492	0.56163196	3.77569766

Source	DF	Type III SS	Mean Square	F Value	Pr > F
YEAR	10	38.53239482	3.85323948	12.22	0.0001
SITE	2	9.78294935	4.89147467	15.51	0.0001
YEAR*SITE	20	15.18326001	0.75916300	2.41	0.0021

Newcastle logbooks
Dependent Variable: CPUEHRS

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	10	38.32476	3.83248	10.751	0.0001
Error	42	14.97224	0.35648		
C Total	52	53.29701			

Root MSE	0.59706	R-square	0.7191
Dep Mean	3.89014	Adj R-sq	0.6522
C.V.	15.34808		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	4.197440	0.29853057	14.060	0.0001
YY82	1	-0.804909	0.36562379	-2.201	0.0332
YY83	1	-0.624711	0.38540131	-1.621	0.1125
YY84	1	-1.966266	0.37422788	-5.254	0.0001
YY85	1	0.426929	0.36562379	1.168	0.2495
YY86	1	-1.216990	0.51707012	-2.354	0.0233
YY87	1	0.528832	0.40052079	1.320	0.1939
YY88	1	-0.070494	0.42218598	-0.167	0.8682
YY89	1	0.704142	0.42218598	1.668	0.1028
YY91	1	0.550525	0.45601298	1.207	0.2341
YY92	1	-0.073751	0.51707012	-0.143	0.8873

Table 10. (cont'd).

Chatham logbooks
Dependent Variable: CPUEHRS

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	10	18.36807	1.83681	5.980	0.0001
Error	42	12.90035	0.30715		
C Total	52	31.26842			

Root MSE	0.55421	R-square	0.5874
Dep Mean	3.93499	Adj R-sq	0.4892
C.V.	14.08419		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	3.927648	0.24785125	15.847	0.0001
YY82	1	-0.151923	0.30912481	-0.491	0.6257
YY83	1	-0.487732	0.32451346	-1.503	0.1403
YY84	1	-0.941652	0.33559217	-2.806	0.0076
YY85	1	0.686010	0.33559217	2.044	0.0472
YY86	1	-0.321840	0.35051459	-0.918	0.3638
YY87	1	-0.232503	0.40473939	-0.574	0.5687
YY88	1	1.009057	0.40473939	2.493	0.0167
YY89	1	0.648097	0.37177687	1.743	0.0886
YY91	1	0.386589	0.40473939	0.955	0.3450
YY92	1	1.116012	0.46368722	2.407	0.0206

Loggieville logbooks
Dependent Variable: CPUEHRS

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	10	5.45623	0.54562	2.183	0.0633
Error	21	5.24760	0.24989		
C Total	31	10.70383			

Root MSE	0.49989	R-square	0.5097
Dep Mean	3.32232	Adj R-sq	0.2763
C.V.	15.04627		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	3.497770	0.28860924	12.119	0.0001
YY82	1	0.264355	0.38179414	0.692	0.4963
YY83	1	-0.508493	0.38179414	-1.332	0.1972
YY84	1	-0.620871	0.36506502	-1.701	0.1038
YY85	1	0.408305	0.45633128	0.895	0.3811
YY86	1	-0.622975	0.40815510	-1.526	0.1419
YY87	1	-0.871338	0.57721848	-1.510	0.1461
YY88	1	0.295071	0.45633128	0.647	0.5249
YY89	1	0.091571	0.45633128	0.201	0.8429
YY91	1	-0.412091	0.40815510	-1.010	0.3242
YY92	1	0.284436	0.40815510	0.697	0.4935

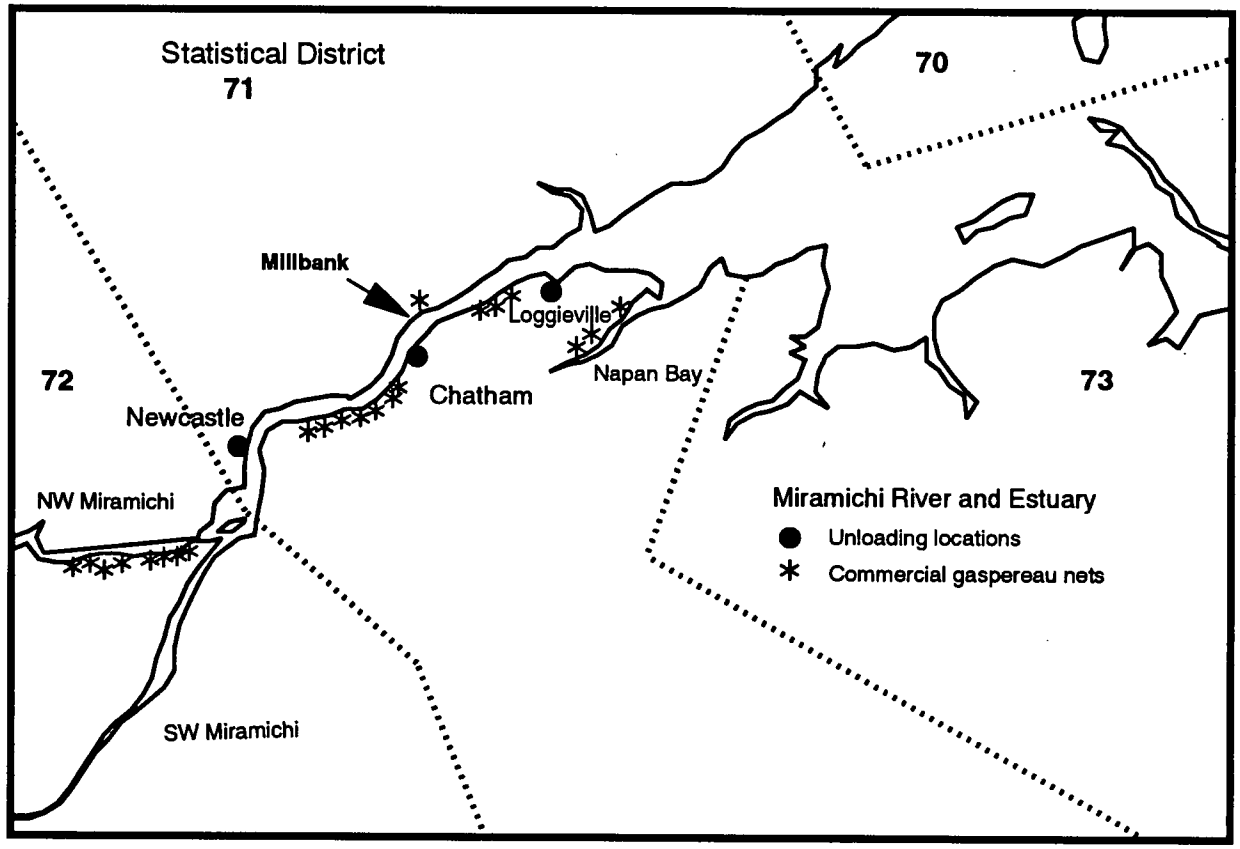
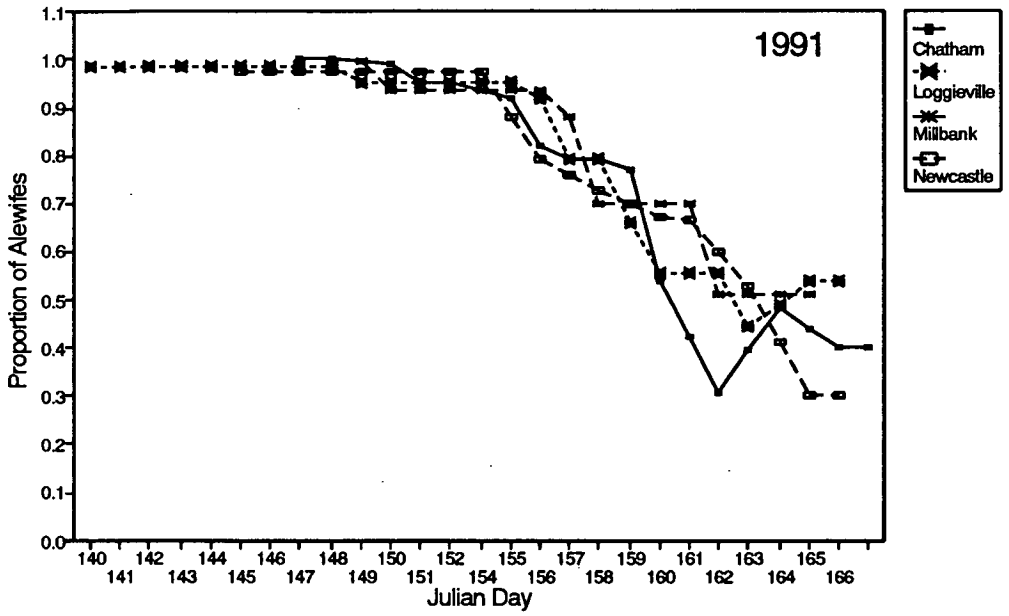


Figure 1. Miramichi River and estuary showing gaspereau fishing locations and distribution of nets.

Fig. 2 Daily proportions of alewifes in logbook landings for 1991 and 1992, by fishing site. For days on which no samples were taken proportion of alewifes was estimated as the mean of the proportion for the day previous and the day following.



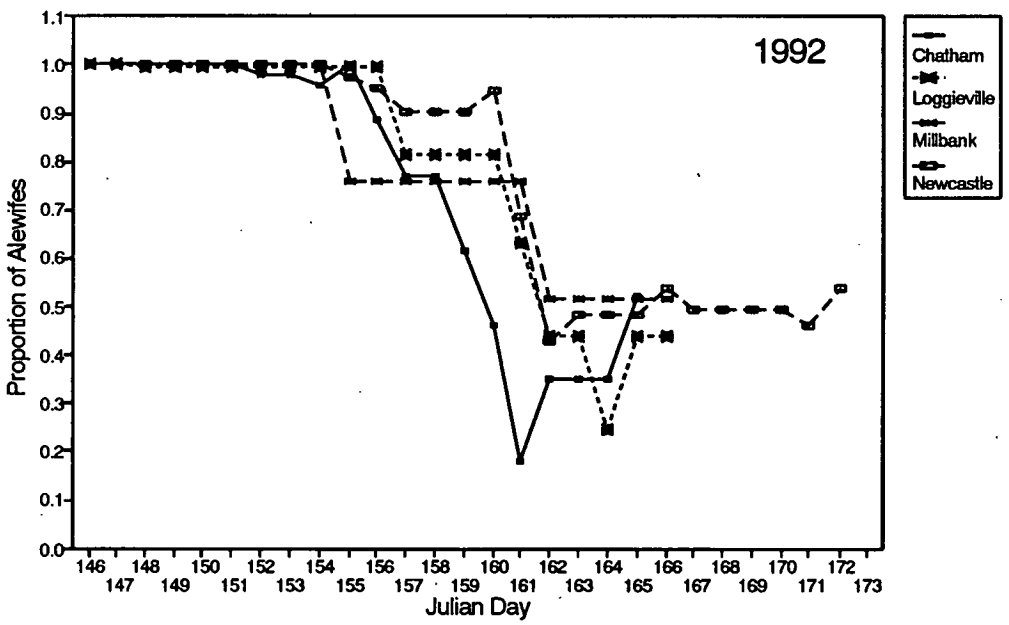


Fig. 3a Timing of alewife and blueback landings by fishing location on Miramichi River 1991 as derived from logbooks and sampling.

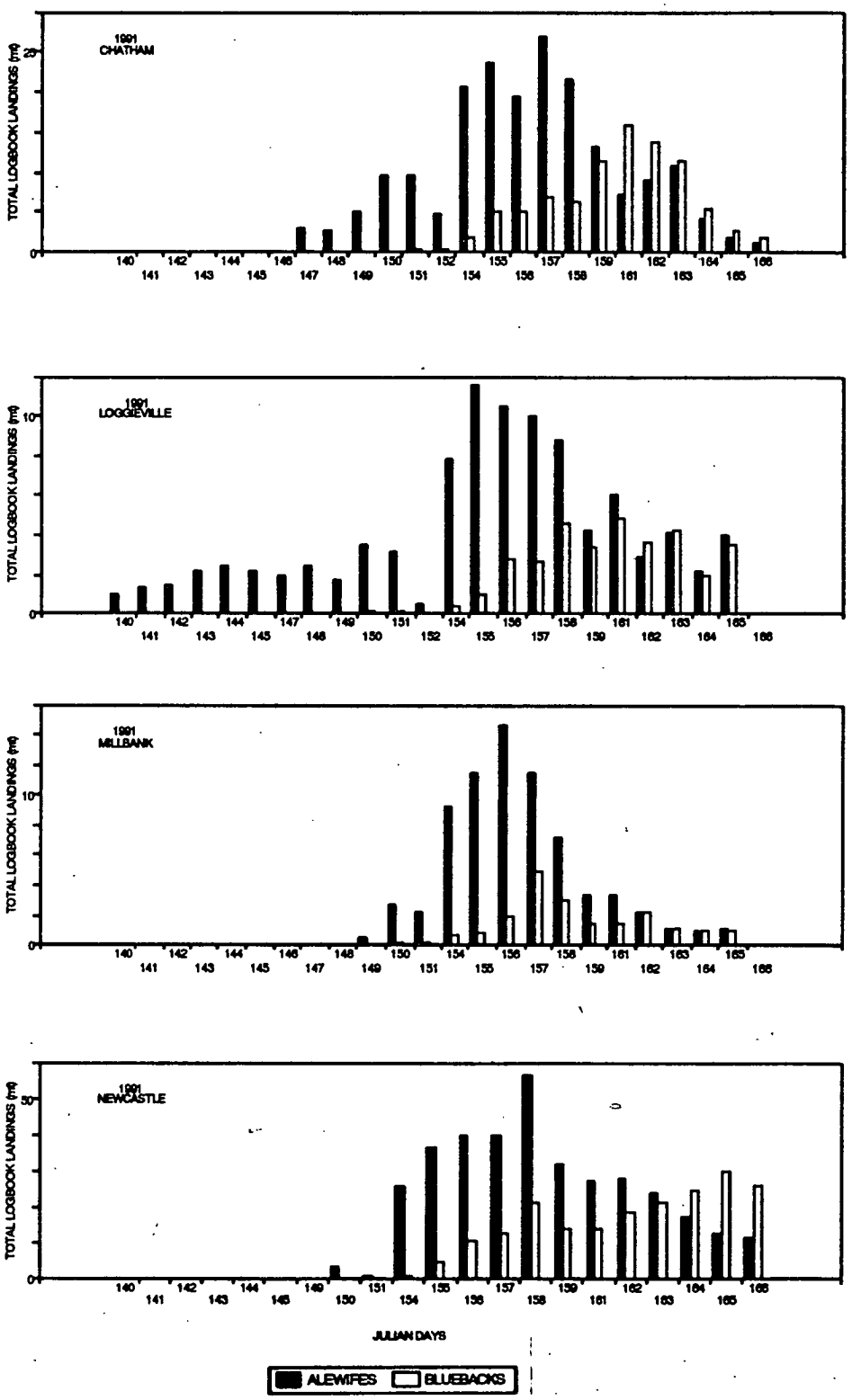
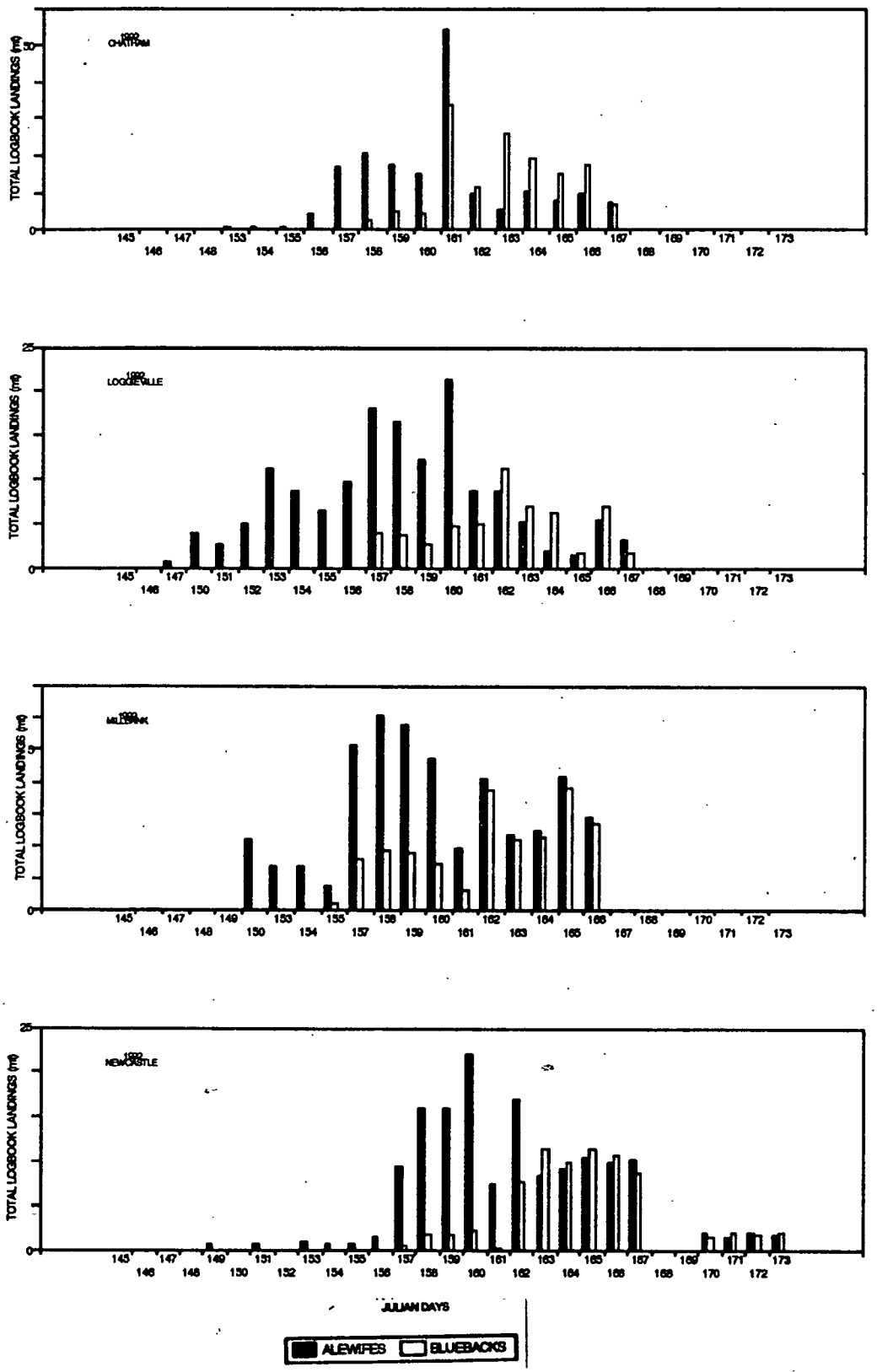


Fig. 3b Timing of alewife and blueback landings by fishing location on Miramichi River 1992, as derived from logbooks and sampling.



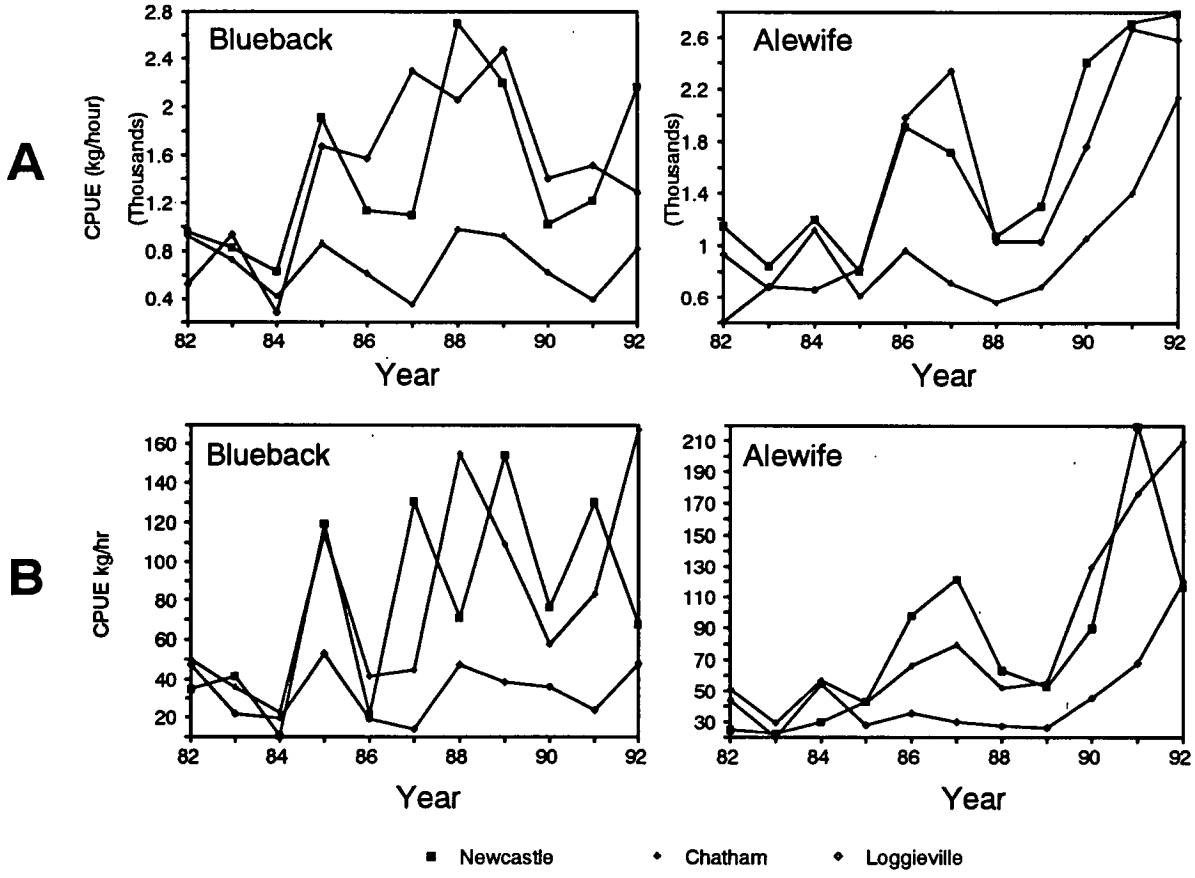


Figure 4. Catch-per-unit of effort for alewife and blueback from the Miramichi River. Catch rates in A are those using the average catch per day summed over the duration of the fishery whereas catch rates in B are those using the average catch per individual logbook based on the multiplicative model.