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The Canadian Fishery for Northern Shrimp (*Pandalus borealis*) on Flemish Cap (NAFO Division 3M) in 1993 and 1994

by

D. G. Parsons and P. J. Veitch

Science Branch, Department of Fisheries and Oceans
P. O. Box 5667, St. John's, Newfoundland, Canada A1C 5X1

INTRODUCTION

Canada's northern shrimp fleet was granted access to Division 3M in spring, 1993, shortly after an exploratory shrimp fishery demonstrated the potential of the resource. That year, thirteen vessels participated in the fishery from late April to early August, taking 3724 tons of shrimp. Canadian vessels did not return to the Flemish Cap until March, 1994, when access to shrimp resources in more northern areas was restricted by ice and/or quotas. Eight vessels have participated to date in 1994 (March - June) and have caught 1030 tons.

On July 27, 1993, Canadian licence holders were instructed to use sorting grates when fishing for shrimp on Flemish Cap to reduce the amount of by-catch, especially small redfish. Vessels departed the area shortly thereafter as catch rates of shrimp declined and receding ice in the north provided access to the traditional fishing grounds. In 1994, however, grates were used by all Canadian vessels throughout the fishing season in Div. 3M.

Data from the Canadian fishery for both 1993 and 1994 were available from fishing log books and observer reports. Distribution of catch and effort, catch per unit effort (CPUE) and size/age composition of the catches are presented along with information on by-catches and shrimp discards.

MATERIALS AND METHODS

Catch (kilograms) and effort (hours fished) from individual fishing sets, as reported in vessel logs, were compiled by month for both years. The distribution of effort over the grounds was examined by month and year and unstandardized CPUE's (kg/hr) were calculated by day, month and year.

Size composition of shrimp catches sampled by observers before processing were summarized by month and a single length frequency distribution representing the total Canadian catch at carapace length (CL) was constructed for each year. Observers sorted the samples by sex (Rasmussen, 1953) and separated females into primiparous, multiparous (McCrary, 1971) and ovigerous groups. Oblique carapace lengths then were measured to the nearest 0.5 mm using Vernier calipers.

Age composition of the catches in 1993 and 1994 was estimated by modal analysis (Macdonald and Pitcher, 1979) of male length distributions and the primiparous - multiparous separation of females by sternal spines (McCrary, 1971). Ovigerous females occurred in very low numbers each year and were separated by age assuming the same ratios as determined by sternal spines for the non-ovigerous females. The age interpretation is based on the preliminary findings of Parsons and Veitch (1993).

Data on by-catches were compiled as percentages of the total observed catch and, for redfish, as kg per hour. The data available on the size composition of the redfish by-catches were summarized by month and year. Estimates of the proportions of discarded shrimp also were obtained from the observer data.

RESULTS

Catch, effort and CPUE

Logbook records showed that, in 1993, most of the catch and effort occurred in June when an estimated 2100 tons were caught. Significant catch and effort were also reported in May and July but only a few days were fished at the end of April and beginning of August. In 1994, about 80% of the catch and 75% of the effort occurred in May and June with considerably less amounts in March and April. A summary of catch (tons) and effort (hours fished) by month and year is given below.

Year	Month	March	April	May	June	July	August	Total
1993	Tons	-	<1	696	2091	922	14	3724
	Hours	-	5	1081	5488	4436	28	11038
1994	Tons	91	99	493	347	-	-	1030
	Hours	532	460	1780	1157	-	-	3929

Fishing positions recorded by Canadian vessels for the May - July period in 1993 indicated a concentration of activity north of 47°N in an arc extending from approximately 46°30'W to 44°W, in close association with the 400 m contour (Fig. 1). During May, fishing was limited to an area on the northwest slope of the Cap whereas, in June, effort was more widely distributed, north of 47°N. The activity reported for July occurred primarily in the northern and northwestern areas. In March, 1994, the area fished was similar to that of July, 1993. However, from April to June, most fishing was reported west of 45°W and substantial effort was located in western and southwestern regions, in contrast to the previous year. Mean depth of tow was similar in both years (about 370 m) but coefficients of variation were 20% in 1994 compared to 10% in 1993, indicating an increase in the range of depths fished.

In 1993, daily catch rates showed a steady decline from about 800 kg/hr in May to 250 kg/hr in late July (Fig. 2) followed by a brief increase at the end of the season. The variation in catch rates between days also decreased over time as CPUE fluctuated greatly during May and early June but much less during July. Catch rates in 1994 showed a different trend, starting low (about 200 kg/hr) and declining further in March, then increasing in April and varying around 300 kg/hr through May and June. Comparing over broader time scales, catch rates for May, June and the year were lower in 1994 than in 1993.

Year	Month	March	April	May	June	July	August	Total
1993	kg/hr	-	63	644	381	208	506	337
1994	kg/hr	171	215	277	300	-	-	262

Length distributions

The estimated size compositions of the 1993 Canadian catches in May, June and July showed that large, female shrimp with a modal length of 26.5 mm CL dominated both by number and weight (Fig. 3) in all three months. Three size groups of males also were consistently represented at approximately 17, 21 and 24 mm. Growth over time was evident in each male group but not for females and an additional male component at 10 mm emerged in July. When combined to provide an estimate of catch at length for the year, the modal structure was maintained and these data were used subsequently for ageing (see below).

The occurrence of modes was similar in the 1994 sampling data (Fig. 3) with males at roughly 16, 20 and 23 mm and females at 27 mm. The male group at 20 mm dominated the catches in March and May but was outnumbered by females in June. Although the largest

male component was poorly represented, especially in May, males were much more prevalent in the catches of 1994 compared to 1993. Growth can be inferred for both male and female size groups over the March - June period. Again, the combined catch-at-length data for the year maintained the modal structure evident in the monthly distributions and were used for ageing.

Age composition

Modal analysis of the composite male length distribution for 1993 readily separated the four size groups (Chi-square = 5.33, P = 1.00) which were interpreted to represent ages 1 through 4. The component at 10 mm (age 1), evident only in July, comprised less than 1% of the total sample. Females, which dominated the catch in numbers (63%), were split more or less evenly into primiparous (49%) and multiparous (51%) groups using the sternal spine characteristics and were assigned ages 5 and 6+, respectively. Less than 1% of all animals caught were ovigerous females which were allocated to ages 5 and 6+ in the same proportions as non-ovigerous females.

1993

Age	1	2	3	4	5	6+
Sex	Male	Male	Male	Male	Primi. Fe.	Multi. Fe.
CL(mm)	9.9	17.0	20.7	24.0	25.9	26.9
Per cent	0.44	8.20	17.95	10.39	31.04	31.97

Only three size groups of male shrimp (ages 2, 3 and 4) were evident in samples taken from the catches in 1994. Also, the component at roughly 23 mm (age 4) appeared weak and was partially overlapped by the dominant male group at 20.5 mm (age 3). Modal analysis was less precise for this distribution due to the lack of definition for the age 4 group and this was reflected in the goodness-of-fit (Chi-square = 13.22, P = 0. 72). Females comprised 42% of the catch in numbers and most of those (68%) were multiparous (age 6+). About 3% of all animals were ovigerous and, as for 1993, these were assigned to ages 5 and 6+ using the primiparous/multiparous ratio.

1994

Age	2	3	4	5	6+
Sex	Male	Male	Male	Primi. Fe.	Multi. Fe.
CL(mm)	16.6	20.5	22.7	25.4	27.6
Per cent	16.17	33.12	8.74	13.49	28.52

Using total catch and data on size distribution, it was estimated that approximately 400 million and 130 million shrimp were caught by Canadian vessels in 1993 and 1994, respectively. The results of the age analyses (above) were applied to these estimates, providing a breakdown of catch at age. These were further divided by the hours fished (unstandardized) in each year, producing age-specific catch rates which can be used to make inferences on year-class strength and some preliminary calculations of total mortality (Z) between the two years.

Year	Age	1	2	3	4	5	6+
1993	$Nx10^{-6}$	1.77	32.94	72.11	41.74	124.69	128.43
1994	$Nx10^{-6}$	-	21.21	43.43	11.46	17.69	37.40
1993	No./hr.	160	2985	6535	3782	11300	11638
1994	No./hr.	-	5397	11055	2917	4503	9519
1993/94	Z		-3.52	-1.31	0.81	-0.17	0.88

In this case, Z is calculated for individual cohorts except for 6+ which could include several ages. For ages 3+ in 1993 to 4+ in 1994, Z = 0.67 and for ages 4+ to 5+, Z = 0.64.

By-catches

Catch composition data by species, month and year from observer records showed that redfish (Sebastes spp.) occurred most frequently as by-catch. Other commercially valuable species, such as cod and Greenland halibut, were taken only in small quantities. The proportion of redfish in the total catch (weight) of all species in 1993 increased from 9% in May to 13% and 44% in June and July, respectively. Limited data for 1994 indicate 16% redfish in March, 32% in April, 24% in May and 14% in June.

Catch rates of redfish were estimated at 64, 62 and 186 kg/hr for May, June and July, 1993 and 37, 105, 88 and 56 kg/hr from March through June, 1994. Using monthly effort values derived above and assuming the data on redfish catch rates are representative, it is possible that over 1200 tons of redfish were taken as by-catch in the Canadian fishery in 1993 and about 290 tons up to the end of June, 1994.

Measurements of redfish obtained by observers (Fig. 4) showed a single mode of small fish at 14 cm in May, 1993. This group (year class) was clearly evident in June and July but was accompanied by larger fish forming modes at 23 cm in June and 19 cm in July. Redfish caught from April to June, 1994, despite the mandatory sorting grate (28 mm bar spacings), were unimodal at 17 - 18 cm and were presumed to be the same year class that was taken in 1993 at 14 cm. There were very few redfish taken in 1994 which were larger than 21 cm.

Shrimp discards

Shrimp discards in 1993 were estimated by observers at 1.3% of the total shrimp catch in May, 1.7% in June and 6.3% in July. For 1994, the estimates also were low at 2.1, 2.4, 2.0 and 2.2% from March to June, respectively. No length measurements of discarded shrimp are currently available to infer whether discarding is due to size or quality.

DISCUSSION

Although the fishery for northern shrimp on Flemish Cap is new, the data available from the Canadian component reveal some interesting and important findings within the first two years.

1. Catch, effort and catch per unit effort were all lower in 1994. The very low catch rates experienced in March of 1994 deterred some Canadian operators from participating significantly in the fishery. In 1993, vessels remained up to early August whereas, in 1994, they had departed by the third week of June.

2. Catch rates did not decline substantially over the season from initial high levels, as had been observed in 1993. Rather, they remained relatively low, only approaching 1993 levels in late June. Further, the low catch rates in March of 1994 occurred over grounds which were productive the previous year.

3. Effort shifted to more western and southwestern areas of the Cap in an attempt to maintain catch rates at acceptable levels.

4. Size and age composition of the shrimp catches sampled in 1994 were markedly different from those of 1993. Males accounted for almost 60% of the estimated catch numbers in 1994 compared to less than 40% in the previous year. Females, split evenly between primiparous and multiparous in 1993, were 68% multiparous in 1994. The gap in the length distributions between the most prominent male and female size/age components was considerably wider in 1994. The fishery was apparently maintained by the remains of the 1988 year class and recruitment of the 1991 year class whereas the 1993 fishery thrived on large female shrimp produced in the late 1980's.

5. The preliminary ageing exercise appears to be fairly accurate, at least for the younger male ages. However, for older males and the timing of sex inversion, events become somewhat complicated. The 1988 year class was believed to be strong, having dominated the length

distributions at age 2 in the 1990 Spanish research survey. It can be followed to age 3 in 1991 but, in 1992, the year class appeared to have split into male and female components. The 1993 fishery was dominated by females and at least half of these were estimated to be five years old. Finally, by 1994, virtually all of the remaining 1988 year class would be multiparous females, regardless of events of the previous two years. Regarding the interpretation of age and growth for the species in this area, it is encouraging to see in the Canadian data that multiparous females clearly dominated the female component in 1994 and was the main contribution to the catch in terms of weight.

6. Redfish by-catch remains a problem. Because of the small sizes encountered in both years, sorting grates with 28 mm bar spacings have not been effective in eliminating them from the catch. They will, however, become increasingly effective with time as these animals (assumed to be a single year class) grow and are very efficient at eliminating the larger fish. Of course, the problem will recur when new strong year classes of redfish are produced.

CONCLUSION

The Canadian data available from the shrimp fishery on Flemish Cap appear to be reflecting the effects of the high exploitation of 1993. Lower catch rates coupled with changes in the fishing pattern (new grounds, smaller shrimp) and uncertainty about the effects of the 1994 fishery do not present an optimistic outlook for 1995. Despite the obvious signs from the fishery data, calculations of total mortality (Z) were not excessive (less than 1.0), given that natural mortality M is considered by some to be in the range of 0.5 to 0.7. However, these estimates are likely unreliable if, in fact, the fishing pattern has changed dramatically between years. The catch-at-age data suggest that both the 1991 and 1992 year classes are strong but, if the recruitment of these sizes/ages has changed between years, they might have already been subjected to high fishing mortality in 1994.

Attempts at minimizing the redfish by-catch have only been partially successful. The negative effects on the redfish resource have not been quantified.

Canada accounted for only 13% of the catch in 1993 and about 5% so far in 1994. Firm conclusions about the status of the shrimp resource on Flemish Cap cannot be made until a more extensive data base has been scrutinized.

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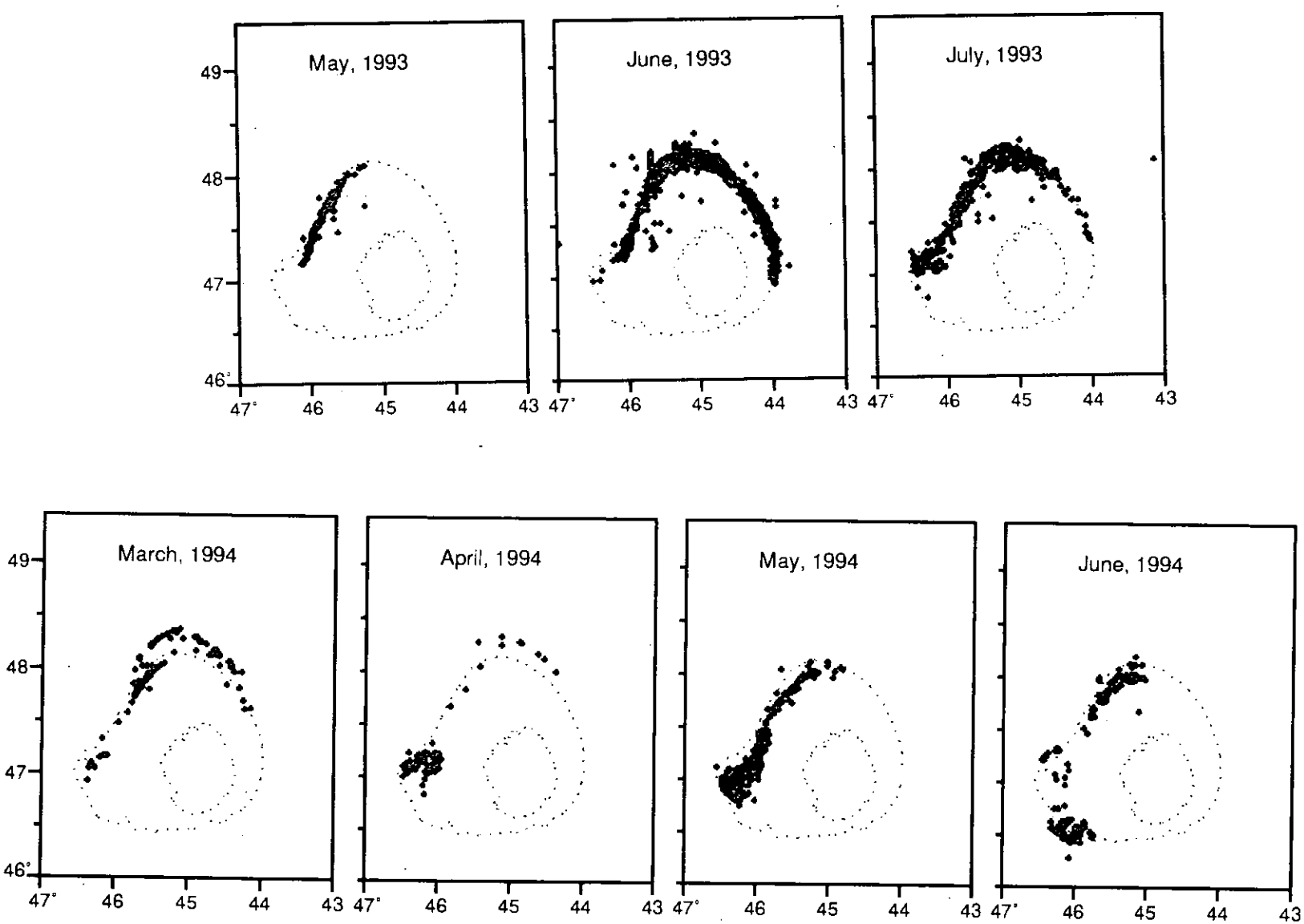

Fig. 1. Fishing positions on the Flemish Cap by month, 1993-1994.

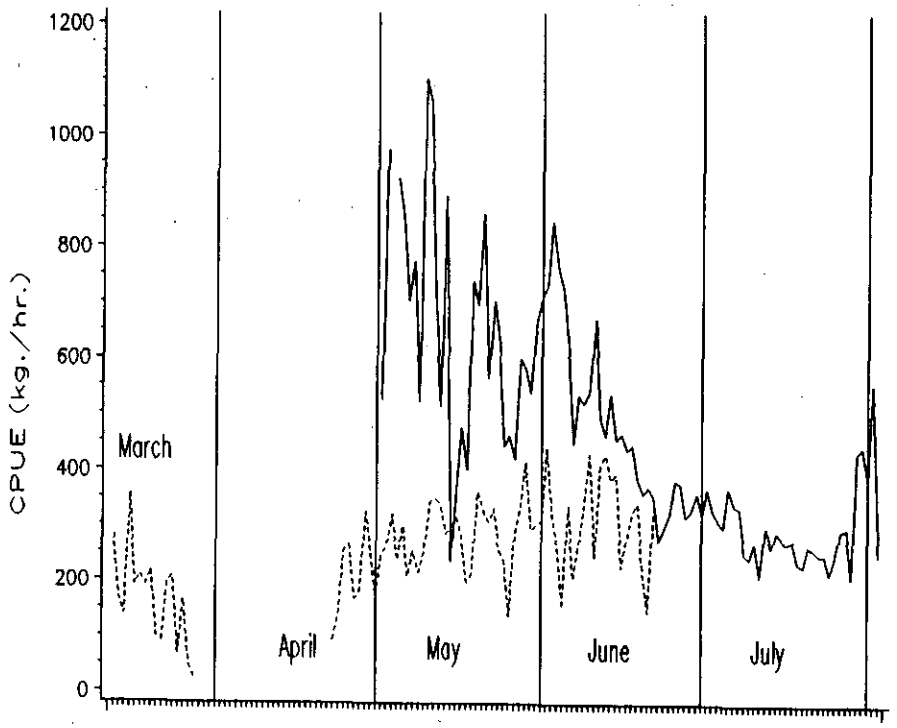

Fig. 2 Catch per unit effort (kg./hr.) by day for Canadian shrimp vessels, NAFO Div. 3M, 1993-94 (solid line = 1993).

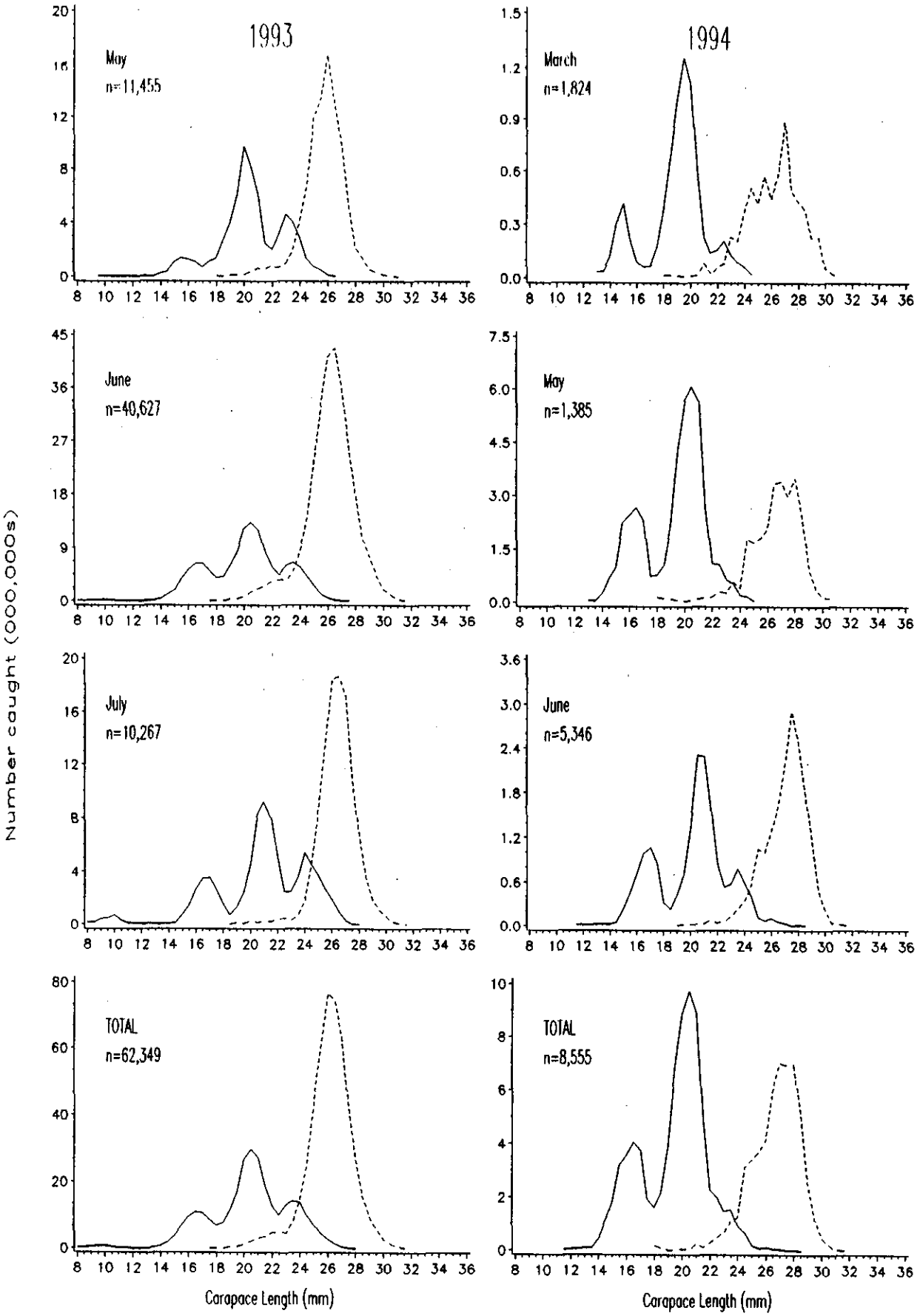

Fig. 3. Commercial length distributions by sex (Canada), from observers, NAFO Div. 3M, 1993–1994 (solid line = male, broken line = female, n = number measured).

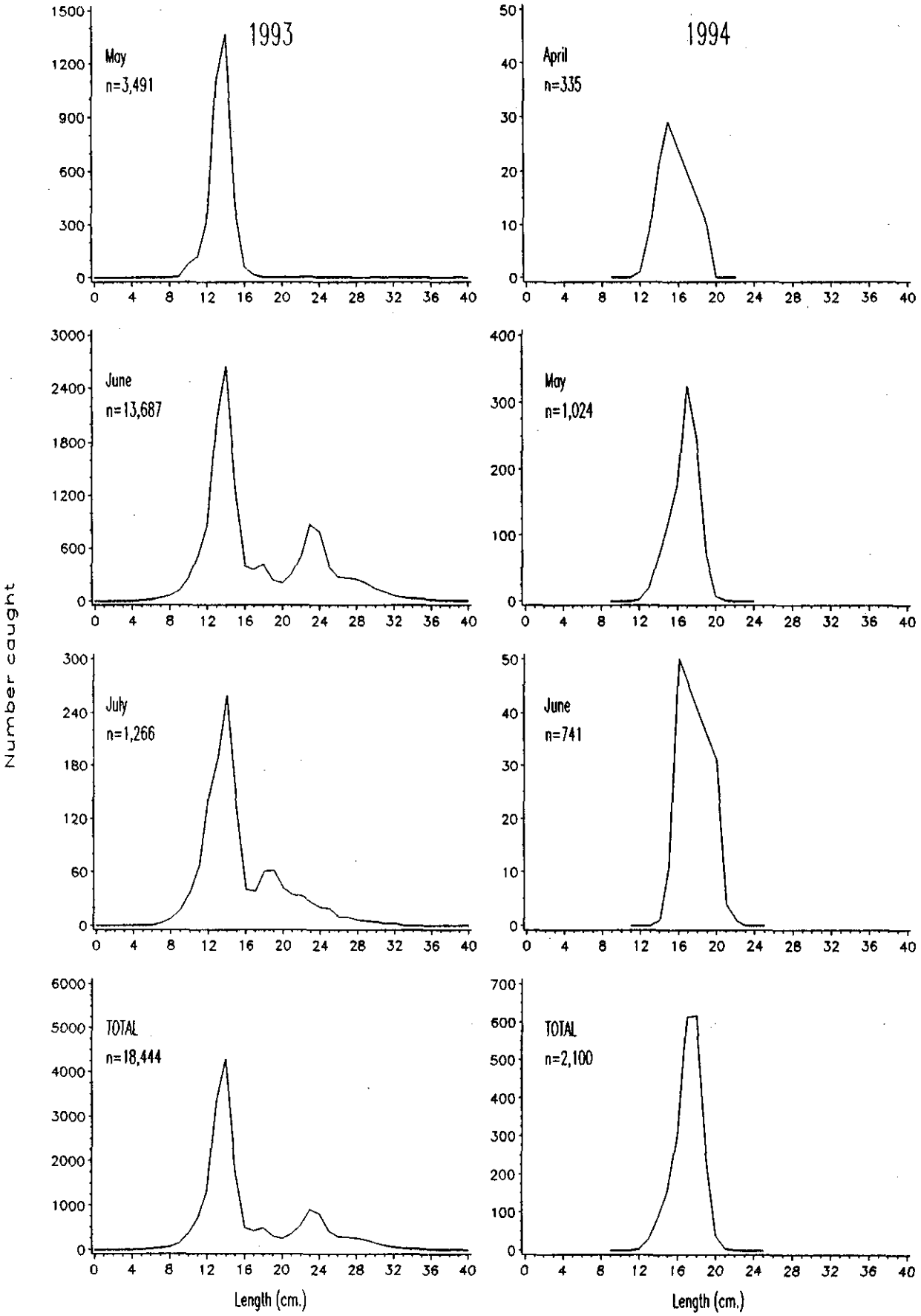

Fig. 4. Redfish length distributions (Canada), from observers, NAFO Div. 3M, 1993–1994 (n = number measured).