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SOME ASPECTS OF GROWTH AND EXPLOITATION OF YELLOWTAIL FLOUNDER (*Limanda ferruginea*) IN THE CANADIAN MARITIMES AREA OF THE NORTHWEST ATLANTIC OCEAN

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ABSTRACT

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Variability in growth rates of yellowtail flounder (Limanda ferruginea), as well as yellowtail size and age compositions, was investigated in the southern Gulf of St. Lawrence (Div. 4T) and the Scotian Shelf (Divs. 4VWX) fisheries. Mean lengths-at-age for yellowtail flounder derived from Canadian groundfish surveys indicated that linear regressions adequately described yellowtail flounder growth up to age 10 for females and age 8 for males. They also indicated that females grew faster than did males, and yellowtail flounder in warmer waters grew faster than those in cooler waters. Instantaneous grow rates of female yellowtail were generally above 0.20 for ages 6 and under and for males above 0.15 for ages 6 and under. These ages constituted at times up to 70% of the females and 60% of the males landed by Canadian otter trawlers in Subdiv. 4Vs. In Div. 4W, up to 40% of the females and 70% of the males landed by otter trawlers could be age 6 or less.

Key words: exploitation, growth, Limanda ferruginea, population dynamics, Scotian Shelf.

RESUME

Beacham, Terry D. 1982. Some aspects of growth and exploitation of yellowtail flounder (Limanda ferruginea) in the Canadian Maritimes area of the Northwest Atlantic Ocean. Can. Tech. Rep. Fish. Aquat. Sci. 1092: iv + 27 p.

L'auteur a étudié la variabilité du taux de croissance de la limande à queue jaune (Limanda ferruginea) ainsi que la composition par taille et par âge de la population exploitée au sud du golfe St-Laurent (div. 4T) et sur la plate-forme Scotian (Div. 4VWX). Les moyennes longueur âge obtenues à partir des relevés de la pêche canadienne du poisson de fond indiquent que des régressions linéaires décrivent correctement la croissance de la limande à queue jaune jusqu'à l'âge de 10 ans chez les femelles et 8 ans chez mâles; d'autre part, les femelles grandissent plus vite que les mâles, et les spécimens d'eau chaude plus vite que ceux d'eau froide. Le taux instantané de croissance chez les femelles est généralement au-dessus de 0.20 pour les spécimens de 6 ans et moins et, chez les mâles, au-dessus de 0.15 pour la même tranche d'âge. Cette tranche constitue parfois jusqu'à 70 % des femelles et 60 % des mâles débarqués au chalut à panneaux par les pêcheurs canadiens dans la subdivision 4Vs. Dans la division 4W, une proportion de 40 % des femelles et 70 % des mâles ainsi capturés peut appartenir à la tranche d'âge de 6 ans et moins.

Mots-clés: exploitation, croissance, Limanda ferruginea, dynamique des populations, plate-forme Scotian.

INTRODUCTION

The yellowtail flounder (*Limanda ferruginea*) is most abundant in Northwest Atlantic Fisheries Organization Subarea 4 on the northern Scotian Shelf, particularly on the Banquereau (Subdiv. 4Vs) and Sable Island (Div. 4W) Banks (Scott 1976) (Fig. 1). Yellowtail is much less abundant on Browns Bank (Div. 4X). Pitt (1970) has indicated the distribution and abundance of yellowtail adjacent to Newfoundland in Subarea 3. However, little is known about stock structure or seasonal movements of yellowtail on the Scotian Shelf.

The fishery for yellowtail is conducted largely by otter trawlers. In the 1960s and early 1970s, Canadian landings originated mainly from Subdiv. 4Vs, whereas Soviet Union landings originated from Div. 4W (Halliday 1973). By 1977, the fishery was almost entirely Canadian.

Growth of yellowtail flounder in the Northwest Atlantic has been investigated by Scott (1954), Royce et al. (1959), Lux and Nichy (1969), and Pitt (1974). However, if natural mortality rates are known, age-specific instantaneous growth rates may be analyzed to determine the age at which a year-class reaches maximum biomass in order to optimize yield from a fishery. Yield could be increased if exploitation of ages in which the instantaneous growth rate is greater than the instantaneous mortality rate is reduced. Regional variability in growth rates may be of value in defining stocks. The major purpose of this paper is to present some aspects of growth and size and age compositions of yellowtail flounder in the landings of the commercial fishery in relation to these problems.

MATERIALS AND METHODS

The stratified random design Canadian groundfish surveys upon which part of the analysis was based began in 1970 (Halliday and Kohler, MS 1971). A #36 Yankee otter trawl with 3/4-inch (19 mm) mesh was used in the July surveys of the A.T. CAMERON on the Scotian Shelf and the September surveys of the E.E. PRINCE in the southern Gulf of St. Lawrence. Otoliths in the commercial and research samples were collected in a sampling design stratified by length, the design based on a method described by Gulland (1955). The age of yellowtail was determined from otoliths according to the method used for cod (*Gadus morhua*) by Kohler (1964). Total length of yellowtail flounder was measured to the nearest cm in both the groundfish surveys and commercial samples.

Length and age compositions of yellowtail were determined for 5-yr periods. The estimation of age composition first required increasing the number sampled at each 1-cm length interval to the total catch of the sampled boat. Values from each sample were weighted by the ratio of catch weight of sampled boat to weight of sampled fish. Age-length keys were applied to the total length frequency to give age compositions. Over 75% of the samples of the landings from the commercial fishery were collected from May through August. Monthly distributions of the available samples were outlined by Cleary (MS 1979). For the research surveys, only data from the July surveys on the Scotian Shelf and September surveys in the southern Gulf of St. Lawrence were grouped in 5-yr periods. Grouping of the data increased the number of fish in the youngest and oldest ages, thereby allowing more reliable estimation of mean lengths and weights at these ages. However, grouping of the data in this way will allow only regional and long-term fluctuations in growth to be detected.

RESULTS

AGE AND LENGTH FREQUENCIES

Canadian groundfish surveys indicated that the 1964 and 1965 year-classes of yellowtail in Subdiv. 4Vs were relatively abundant, and yellowtail from these year-classes comprised about 60% of the research catch of females and 70% of the catch of males in 1971 and 1972. The 1973 year-class was also relatively abundant, comprising 35% of the research catch in 1977. The 1964 and 1965 year-classes of yellowtail in Div. 4W were abundant, comprising 50% of the research catch of females and 35% of the catch of males in 1971-72. These same year-classes also comprised 50% of the research catch in Div. 4T in 1972.

When the data from the groundfish surveys were compared in 5-yr intervals, length frequencies of female yellowtail flounder caught in the July surveys indicated that larger fish were more abundant in Div. 4X than in other more northerly areas (Fig. 2), but that older females were less abundant in the catch than in other areas (Fig. 3). Length frequencies and age compositions of male yellowtail showed trends similar to those of females, and are omitted for simplicity.

Yellowtail in Div. 4T tended to have the oldest age distributions, but age distributions in Subdiv. 4Vs were similar to those in Div. 4T. All yellowtail were caught with the same type of net, thus eliminating changes in selectivity accounting for different length and age frequencies. Age distributions of yellowtail in Divs. 4W and 4X indicated a higher proportion of younger fish in the research catch than in more northerly areas (Fig. 3), but not more smaller fish (Fig. 2), which suggests that younger yellowtail were larger in the southern areas than those in the northern areas. About 50% of the females caught during the groundfish surveys on the Scotian Shelf were age 5 or younger.

The landings of otter trawlers have been the most extensively sampled for all gears that have conducted the Canadian fishery for yellowtail flounder on the Scotian Shelf. Age compositions and length frequencies are presented in detail only for females in Div. 4W, as males had trends similar to those of females.

In Div. 4W, mean length and age of the landed catch decreased past 1960 as compared with the 1950s (Table 1). Older yellowtail were less abundant in the landings during this same interval (Fig. 4). Yellowtail age 6 or less comprised about 15% of the female landings during 1970-74 and about 40% during 1975-78 (Fig. 4). During 1975-78, yellowtail age 6 or less comprised about 70% of the landings of males. Yellowtail in the landings were smaller and younger during 1975-78 as compared with 1970-74. There has been a general decline in modal length of the landings of females. Length and age compositions of females in the landings were more similar to those in the groundfish surveys than were those of males. Males were proportionately less abundant below 30 cm in length in the commercial landings than were females.

In Subdiv. 4Vs, the mean length of landed yellowtail has decreased during 1948-78, and with the mean age of the landed catch lower during 1965-78 than during 1948-64 (Table 1). Larger, older yellowtail disappeared from the landings past 1964. In the 1970s, females 33-39 cm in length were most abundant in the landings, while males 30-36 cm in length were most abundant. Modal age and length frequencies in the research catch were similar to those in the commercial landings, but a main difference was the virtual absence of females less than 30 cm in length in the commercial landings.

GROWTH

The data covering the available age ranges for females indicates that growth was essentially linear after age 2 (Fig. 5). However, even with the data grouped in 5-yr intervals, less than 20 fish per age-class were sampled for males older than 9 yr and females older than 10 yr. The data for males suggests a more curvilinear relationship (Fig. 6), but this relationship was difficult to determine empirically because the data in the older age groups were variable. For females, because there was little evidence of asymptotic growth over the range of ages in this analysis, linear regressions were used to describe variability in growth rates. Bowering (1978) followed a similar procedure in describing growth of Greenland halibut (Reinhardtius hippoglossoides). Linear regressions were also fitted to the male mean length-at-age data to allow for a comparison with females. Linear regressions were fitted to the mean length-at-age data between ages 3 and 10 for females, and ages 3-8 for males.

Linear regressions generally accounted for the variability in mean length-at-age quite well (most $r2>0.90$) (Table 2). Females generally grew faster than males, with average rates of 2.6 cm/yr and 2.5 cm/yr, respectively, over the range of ages investigated. However, growth rates of yellowtail before age 3 were considerably faster than these values. Age 3 yellowtail caught by the research gear were about 22 cm, but because yellowtail were only partially recruited to the research gear at age 3, with only the larger ones susceptible to capture, then the mean length of age-3 yellowtail in the population will be less than 22, and thus growth rates of age-3+ yellowtail would be larger than calculated. There was some tendency for the intercept to increase with decreasing latitude, which suggests that yellowtail in the more southerly areas initially grew faster than those in the more northerly areas, as indicated in Fig. 5 and 6.

Regional variability in growth rates was investigated by comparing mean length-at-age of same-age yellowtail between 1970-78 over all areas and among years on an annual basis by sign test analysis (Mendenhall 1971). When the mean length of yellowtail in a southerly area was greater than in a northerly one, the comparison was scored "+"; when it was lower, it was scored "-". This sign test analysis indicated that yellowtail of the same age were generally larger in more southerly areas than those in more northerly ones (Table 3). This same trend is apparent in Fig. 5 and 6, although yellowtail in Subdiv. 4Vs were smaller than those in Div. 4W until age 6, after which they were larger, and this accounts for the nonsignificance of the sign test (Table 3). A similar sign test analysis based on all areas and on age-3+ yellowtail indicated that females were larger than same-age males (163+, 33-, $P<0.01$).

The effect of bottom water temperatures on growth rates was investigated by comparing mean length-at-age for age 4 and mean bottom temperatures as derived from the July groundfish surveys in Divs. 4VWX and the September survey in Div. 4T. Mean length at age 4 was correlated with water temperature for males ($r=0.90$, $n=8$, $P<0.01$) and females ($r=0.74$, $n=8$, $P<0.05$) (Table 4). An increasing rate of growth of yellowtail flounder from northerly to southerly areas was coincident with increasing bottom water temperatures.

Table 5 illustrates that the mean age of the catch by the research vessels was lower in the southerly areas compared with the northerly ones. Mean age of males in the catch was less than that of females in all areas. Yellowtail in Divs. 4T and 4W had the smallest mean weights compared with other areas. The exponent in the length-weight relationship for yellowtail in each area was generally larger for females than for males, which indicates that the rate of increase in weight with respect to length was generally greater in females than in males.

Mean weights-at-age for Div. 4T yellowtail (September) and Divs. 4VWX yellowtail (July) based on the groundfish survey cruises are indicated in Table 6. In the more southerly areas (Divs. 4WX), males and females had similar weights until about age 3 or 4, while in the northerly areas, weights between the sexes were similar until about age 5 (Table 6). After age 8, there was a greater difference between male and female weights in the more southerly areas as compared with the more northerly ones. Yellowtail in Div. 4X were heavier during 1975-78 than during 1970-74, but the same trend was not apparent in yellowtail in the other areas.

Instantaneous growth rates derived from the weights-at-age in Table 6 are indicated in Table 7. Instantaneous growth rates of Div. 4X yellowtail were variable, due to the low frequency of sampling in this area (Table 6). Instantaneous growth rates of females were generally above 0.20 up to age 6, and above 0.15 up to age 7 or 8. Instantaneous growth rates of males were generally above 0.15 until age 6.

DISCUSSION

Studies on variability in growth of yellowtail flounder have indicated that there is regional variability in growth rates (Scott 1954; Lux and Nichy 1969; Pitt 1974). Water temperatures and subsequent growth rates have been linked in some stocks (Scott 1954; Pitt 1974), with higher growth rates generally found at higher water temperatures. The influence of stock biomass on growth rates has not been investigated because the stock structure of yellowtail on the Scotian Shelf was uncertain. However in flatfish, stock density has been suggested to have an impact on growth rates (Pitt 1975; Bannister 1977), and this avenue could be explored further when long-term information on yellowtail stock size is available on the Scotian Shelf.

Mean lengths-at-age for yellowtail in the research surveys in Divs. 4TVW in the 1970s were lower than reported for Div. 4W yellowtail in 1946 by Scott (1954) and for Grand Bank of Newfoundland (Subarea 3) yellowtail by Pitt (1974). For example, age-6 females were about 31 cm in length in the present study (Fig. 5), but were about 36 cm in the two previous studies. However, mean lengths-at-age of age-6 yellowtail in the commercial samples were about 36 cm (unpublished data), so that differences between the results of the present study and those of Scott (1954) and Pitt (1974) may be partly different gear selectivities, although Pitt used both commercial and research vessel data in his analysis. Mean lengths-at-age for Scotian Shelf (Divs. 4VWX) yellowtail were less than those recorded by Lux and Nichy (1969) for yellowtail off New England, with the differences most likely attributable to variations in water temperature. The present study indicated that yellowtail flounder inhabiting warmer waters have higher initial rates of growth than those in cooler waters, but that there was no practical way of defining stocks of yellowtail based upon variability in growth rates presently available.

The major difference between length frequencies in the commercial and research data was the virtual absence of yellowtail below 30 cm in length in the commercial samples. Some of this difference is due to the different selectivities of the gears, but most is undoubtedly due to discarding of yellowtail below 30 cm in the commercial fishery. Belzile (MS 1978) reported that substantial quantities of American plaice below 30 cm in length in Div. 4T were discarded because they were not acceptable to processing plants.

The mean age of the landed catch was lower in the 1960s and 1970s than in the 1950s. Scott (1954) found that for yellowtail in Div. 4W in 1946, at least 80% were age 7 or older. This age composition was similar to that between 1948-59, when over 80% of the landings of females were age 7 or older (Fig. 4). Lux (1969) found that for the yellowtail fishery off New England, the landings were composed mainly of ages 3-5, possibly indicative of higher growth rates of yellowtail in warmer waters.

The analysis of the landings of Canadian otter trawlers indicate that in the 1970s yellowtail age 6 or less could constitute up to 70% of the landings. Instantaneous growth rates of female yellowtail derived from the groundfish surveys were generally above 0.20 until about age 6, while male instantaneous growth rates were generally below 0.15 after age 6 (Table 7). There is no estimate of natural mortality for Scotian Shelf yellowtail, but Lux (1969) suggested a rate of 0.22 for New England yellowtail. If there is a link between growth rate and natural mortality (Gerking 1957; Ware 1975), then presumably the slower-growing Scotian Shelf yellowtail should have lower rates of natural mortality. If natural mortality is about 0.20, then yield is lost from a year-class when yellowtail less than age 5 or 6 comprise a substantial portion of the catch (Table 7). At these ages, the instantaneous growth rate is greater than the instantaneous mortality rate, resulting in a net increase in biomass of the year-class. However, further work is necessary to evaluate rates of natural mortality for Scotian Shelf yellowtail. Future research should also identify stock boundaries and investigate variability in annual growth rates in relation to stock biomass when the stocks are well defined.

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Table 1. Mean length (cm), mean age (yr), and sample sizes of yellowtail flounder from sampling landings of Canadian otter trawlers, 1948-78.

	Area	Sex	Period 1948-59	1960-64	1965-69	1970-74	1975-78
Mean length	4T	Male	-	-	-	-	28.2
		Female	-	-	-	-	30.5
	4Vs	Male	42.2	36.2	35.1	34.9	33.9
		Female	43.8	43.1	39.4	37.3	36.4
	4W	Male	41.9	39.1	32.8	34.8	32.9
		Female	43.9	42.2	37.9	39.4	34.8
Mean age	4T	Male	-	-	-	-	5.3
		Female	-	-	-	-	5.2
	4Vs	Male	8.3	6.6	6.1	7.0	6.1
		Female	8.5	8.3	6.5	7.2	6.4
	4W	Male	8.4	-	6.0	7.2	5.9
		Female	8.7	-	6.6	8.2	7.3
Number of samples	4T		0	1	0	0	1
	4Vs		10	3	11	2	11
	4W		14	4	2	1	1
Number measured	4T		0	14	0	0	200
	4Vs		1091	614	2143	319	2135
	4W		1209	713	301	200	182
Number aged	4T		0	0	0	0	40
	4Vs		60	69	258	61	337
	4W		139	0	60	40	31

Table 2. Growth rates (cm/yr) of yellowtail flounder caught in Canadian groundfish surveys in the southern Gulf of St. Lawrence (Div. 4T) in September and on the Scotian Shelf (Divs. 4VWX) in July, 1970-78. Linear regressions of mean length-at-age on age were fitted for males from ages 3-8 and for females from ages 3-10.

	Males				Females			
	4T	4Vs	4W	4X	4T	4Vs	4W	4X
				1970-74				
Rate	2.40	2.87	2.05	2.04	2.09	2.65	2.35	3.39
S.E.	0.06	0.20	0.18	0.63	0.15	0.20	0.19	0.54
Intercept	11.92	12.71	16.69	16.04	14.77	13.66	15.91	11.52
r^2	0.99	0.99	0.98	0.78	0.97	0.97	0.97	0.87
				1975-78				
Rate	1.85	3.25	2.07	3.21	1.92	2.94	2.14	3.20
S.E.	0.13	0.33	0.07	0.34	0.19	0.37	0.16	0.29
Intercept	15.61	11.65	7.69	17.15	16.04	12.99	18.43	18.80
r^2	0.98	0.97	0.99	0.97	0.95	0.93	0.97	0.96

Table 3. Results of sign test analysis on mean lengths-at-age of yellowtail flounder as derived from Canadian groundfish surveys, 1970-78. When mean length of yellowtail in a southern area was greater than that of northern area, the comparison was scored "+"; when it was lower, it was scored "-".

	Area		
	4T	4Vs	4W
		Males	
4X	28+, 2-*	27+, 6-*	35+, 4-*
4W	43+, 4-*	24+, 33-	
4Vs	37+, 2-*		
		Females	
4X	39+, 0-*	35+, 4-*	39+, 8-*
4W	55+, 4-*	34+, 33-	
4Vs	46+, 6-*		

*P<0.01.

Table 4. Mean length (cm) at age 4 for yellowtail caught during Canadian groundfish surveys in Divs. 4VWX (July) and Div. 4T (September) and associated bottom water temperatures at time of surveys.

Area	Age 4		Bottom water temperature (°C)
	Male	Female	
		1970-74	
4T	21.3	21.8	2.22
4Vs	24.6	24.8	3.51
4W	25.3	25.1	5.63
4X	26.2	25.3	6.90
		1975-78	
4T	22.8	23.8	2.33
4Vs	24.4	24.3	3.99
4W	26.2	27.0	6.48
4X	29.6	33.4	7.19

Table 5. Length, weight, and age parameters for yellowtail flounder caught during survey Canadian groundfish surveys, 1970-79. Surveys in Division 4T were in September and surveys in the other areas were in July.

		Males				Females			
		4T	4Vs	4W	4X	4T	4Vs	4W	4X
					1970-74				
Mean length (cm)		26.4	30.7	26.6	26.7	29.0	31.6	29.0	34.0
Mean weight (kg)		0.18	0.27	0.16	0.20	0.25	0.31	0.22	0.43
Mean age (yr)		6.1	6.5	4.9	4.5	6.8	6.7	5.5	6.2
Length (cm)-	a	0.0157	0.0128	0.0080	0.0013	0.0119	0.0097	0.0070	0.0019
Weight (g)	b	2.847	2.883	3.002	3.527	2.940	2.972	3.045	3.404
Relation	n	385	928	1955	94	619	1041	2400	116
$W=aL^b$	r^2	0.89	0.95	0.94	0.92	0.90	0.95	0.96	0.98
					1975-78				
Mean length (cm)		25.6	29.1	27.4	30.0	28.0	30.3	30.4	35.4
Mean weight (kg)		0.14	0.23	0.18	0.27	0.20	0.27	0.25	0.46
Mean age (yr)		5.4	5.6	4.8	4.1	6.1	5.9	5.5	5.2
Length (cm)-	a	0.0051	0.0105	0.0174	0.0033	0.0050	0.0097	0.0128	0.0045
Weight (g)	b	3.149	2.933	2.768	3.270	3.164	2.964	2.869	3.183
Relation	n	541	629	1412	177	833	797	1809	160
$W=aL^b$	r^2	0.82	0.93	0.88	0.95	0.87	0.94	0.91	0.96

able 6. Mean weights-at-age (kg) for yellowtail flounder caught during Canadian groundfish urveys in the southern Gulf of St. Lawrence (Div. 4T) in September and on the Scotian Shelf Divs. 4VWX) in July. The number of otoliths read for each age is in parentheses.

	Males				Females			
ge	4T	4Vs	4W	4X	4T	4Vs	4W	4X
				1970-74				
2	- (0)	0.04 (12)	0.05 (82)	0.04 (1)	0.07 (2)	0.04 (13)	0.06 (64)	0.06 (2)
3	0.08 (14)	0.08 (43)	0.09(157)	0.10(18)	0.11 (20)	0.08 (37)	0.09(141)	0.06 (6)
4	0.10 (40)	0.14 (48)	0.13(238)	0.11(16)	0.11 (34)	0.14 (45)	0.14(208)	0.13 (9)
5	0.14 (48)	0.18 (78)	0.17(368)	0.12(19)	0.15 (54)	0.18 (93)	0.19(345)	0.25(13)
6	0.18 (50)	0.25(160)	0.21(304)	0.16 (9)	0.21 (56)	0.26(148)	0.25(385)	0.32(14)
7	0.22 (48)	0.29(236)	0.24(312)	0.27 (7)	0.25 (87)	0.33(199)	0.30(314)	0.30(15)
8	0.26 (35)	0.33(135)	0.27 (71)	0.33 (1)	0.31 (84)	0.37(210)	0.38(187)	0.67 (4)
9	0.31 (7)	0.36 (48)	0.34 (13)	0.39 (1)	0.36 (37)	0.44(103)	0.39 (70)	0.98 (4)
0	0.46 (1)	0.45 (18)	0.43 (3)	0.93 (1)	0.40 (14)	0.61 (38)	0.48 (21)	0.55 (1)
1	- (0)	0.61 (4)	0.36 (3)	1.00 (1)	0.38 (3)	0.71 (12)	0.78 (6)	1.21 (2)
2	- (0)	0.53 (1)	- (0)	- (0)	0.52 (1)	0.78 (3)	- (0)	0.89 (1)
				1975-78				
2	0.04 (5)	0.03 (1)	0.06 (44)	0.08(11)	0.06 (7)	0.07 (3)	0.05 (24)	0.08 (5)
3	0.08 (36)	0.08 (33)	0.11(160)	0.17(18)	0.07 (31)	0.12 (26)	0.12(137)	0.14 (3)
4	0.10 (89)	0.13 (71)	0.15(246)	0.23(28)	0.12 (86)	0.13 (77)	0.17(242)	0.33(16)
5	0.14(102)	0.21 (87)	0.18(263)	0.30(29)	0.16(106)	0.23(106)	0.23(284)	0.42(24)
6	0.16 (84)	0.28 (88)	0.22(241)	0.49(13)	0.21(116)	0.30 (74)	0.28(328)	0.50(22)
7	0.19 (57)	0.31(160)	0.26(149)	0.53 (5)	0.24(117)	0.38(132)	0.32(285)	0.67(19)
8	0.20 (20)	0.33(106)	0.28 (50)	- (0)	0.27 (84)	0.42(183)	0.37(138)	0.79 (9)
9	0.24 (4)	0.37 (20)	0.32 (5)	0.65 (2)	0.30 (37)	0.44 (79)	0.41 (35)	0.95 (3)
0	0.25 (1)	0.34 (2)	- (0)	- (0)	0.33 (21)	0.53 (23)	0.48 (16)	0.99 (3)
1	- (0)	- (0)	- (0)	- (0)	0.38 (6)	0.59 (3)	- (0)	1.20 (1)
2	- (0)	- (0)	- (0)	- (0)	0.38 (1)	0.95 (3)	- (0)	- (0)

Table 7. Mean instantaneous growth rates as measured by changes in weight for yellowtail flounder caught during Canadian groundfish surveys, 1970-78. Weights-at-age are listed in Table 6.

	Males				Females			
Age	4T	4Vs	4W	4X	4T	4Vs	4W	4X
				1970-74				
3-4	0.254	0.511	0.346	0.095	0.000	0.547	0.453	0.807
4-5	0.357	0.251	0.268	0.087	0.310	0.251	0.305	0.654
5-6	0.251	0.329	0.211	0.288	0.337	0.368	0.274	0.247
6-7	0.201	0.148	0.134	0.523	0.174	0.238	0.182	-0.065
7-8	0.167	0.129	0.118	0.201	0.215	0.114	0.236	0.804
8-9	0.176	0.087	0.231	0.167	0.150	0.173	0.026	0.380
9-10	0.395	0.223	0.235	0.869	0.105	0.327	0.208	-0.578
				1975-78				
3-4	0.251	0.473	0.310	0.302	0.483	0.080	0.348	0.856
4-5	0.347	0.480	0.182	0.266	0.288	0.571	0.302	0.241
5-6	0.134	0.288	0.201	0.491	0.272	0.266	0.197	0.174
6-7	0.172	0.102	0.167	0.078	0.134	0.236	0.134	0.292
7-8	0.051	0.063	0.074	-	0.118	0.100	0.145	0.165
8-9	0.182	0.114	0.134	-	0.105	0.047	0.103	0.184
9-10	0.041	0.085	-	-	0.095	0.186	0.158	0.041

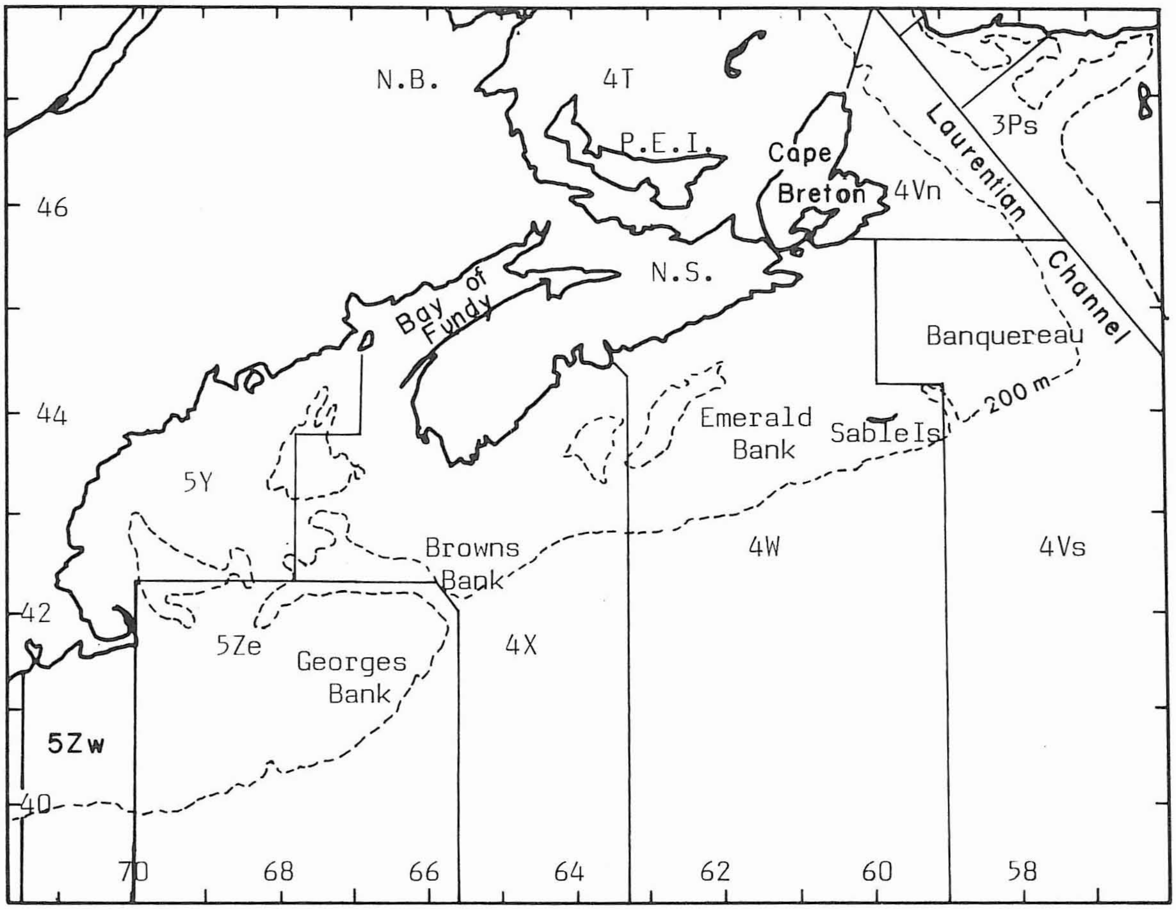

Fig. 1. Northwest Atlantic Fisheries Organization Divisions in Subarea 4.

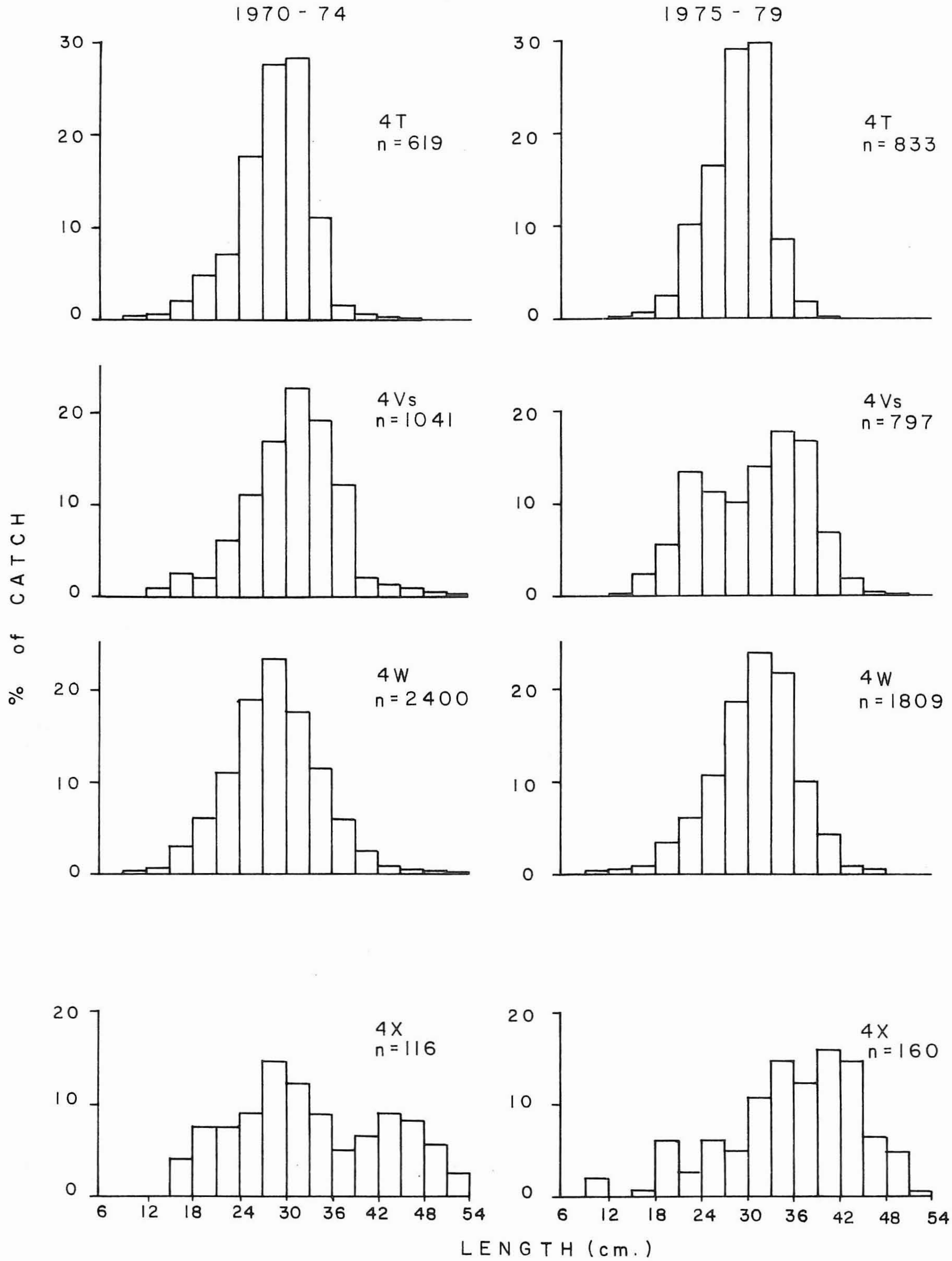

Fig. 2. Length frequencies of female yellowtail flounder caught during Canadian groundfish surveys in Div. 4T (September) and Divs. 4VWX (July), 1970-78.

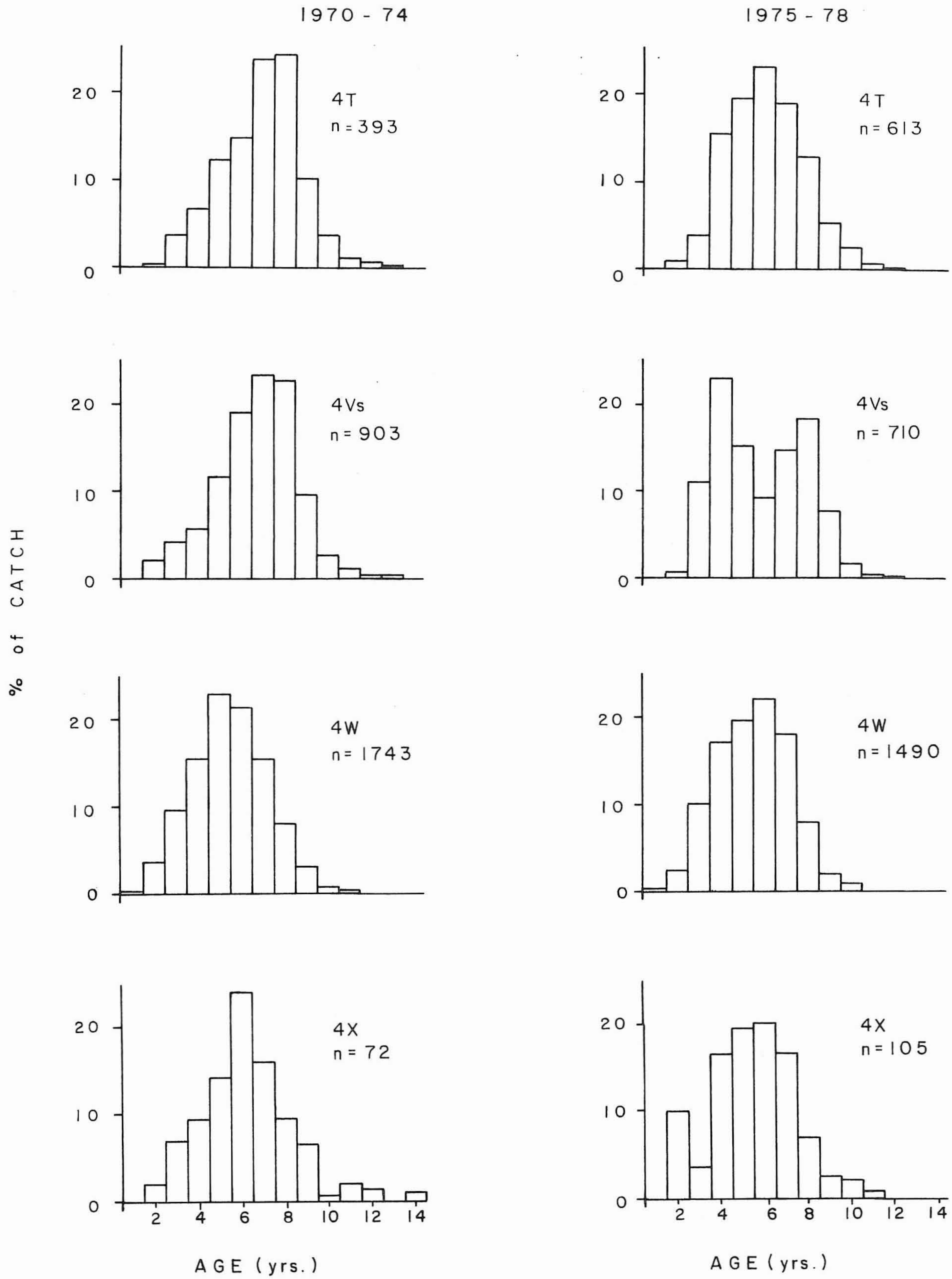

Fig. 3. Age compositions of female yellowtail flounder caught during Canadian groundfish surveys from 1970-78.

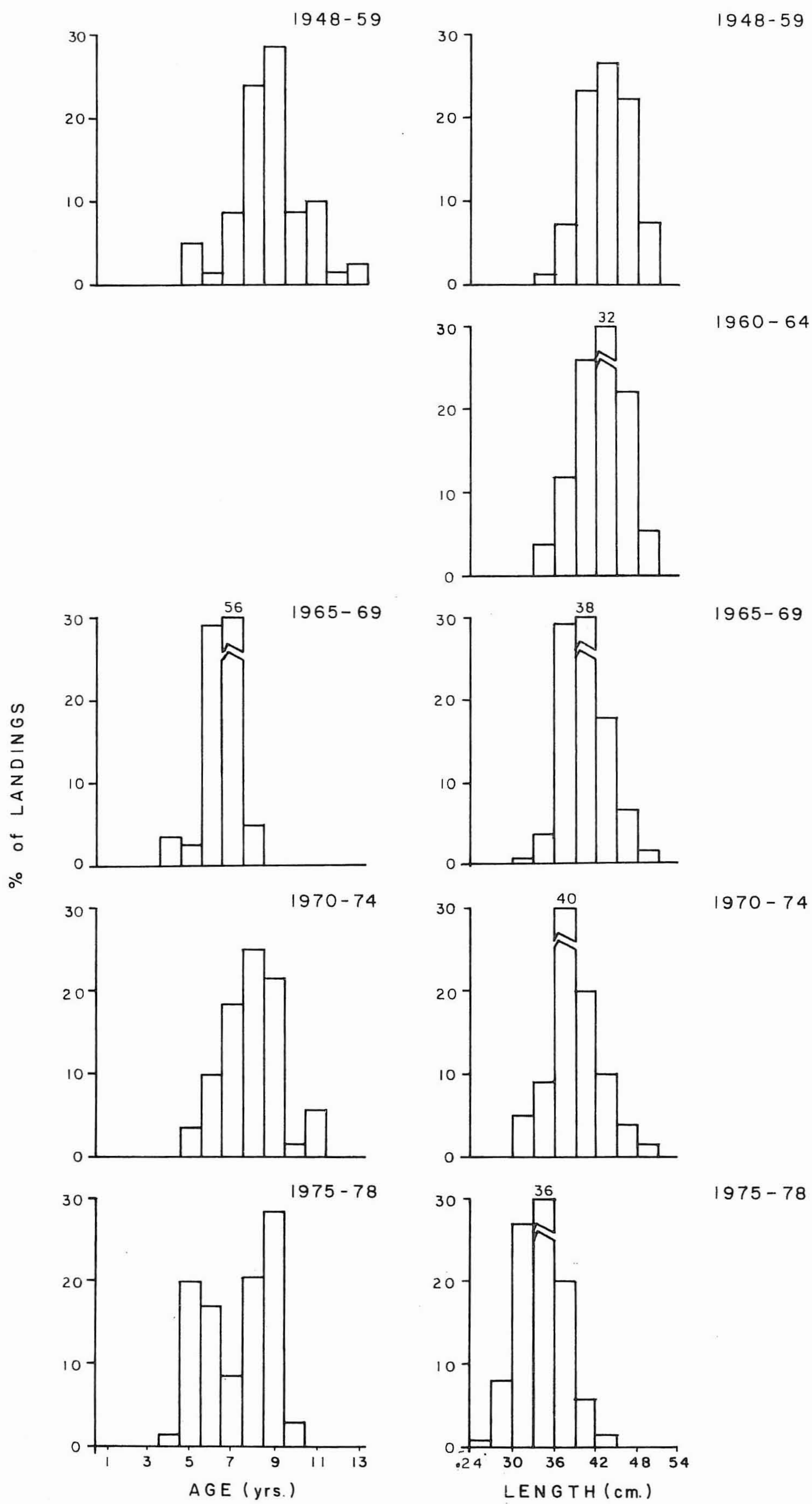

Fig. 4. Age compositions and length frequencies for female yellowtail flounder landed by Canadian otter trawlers in

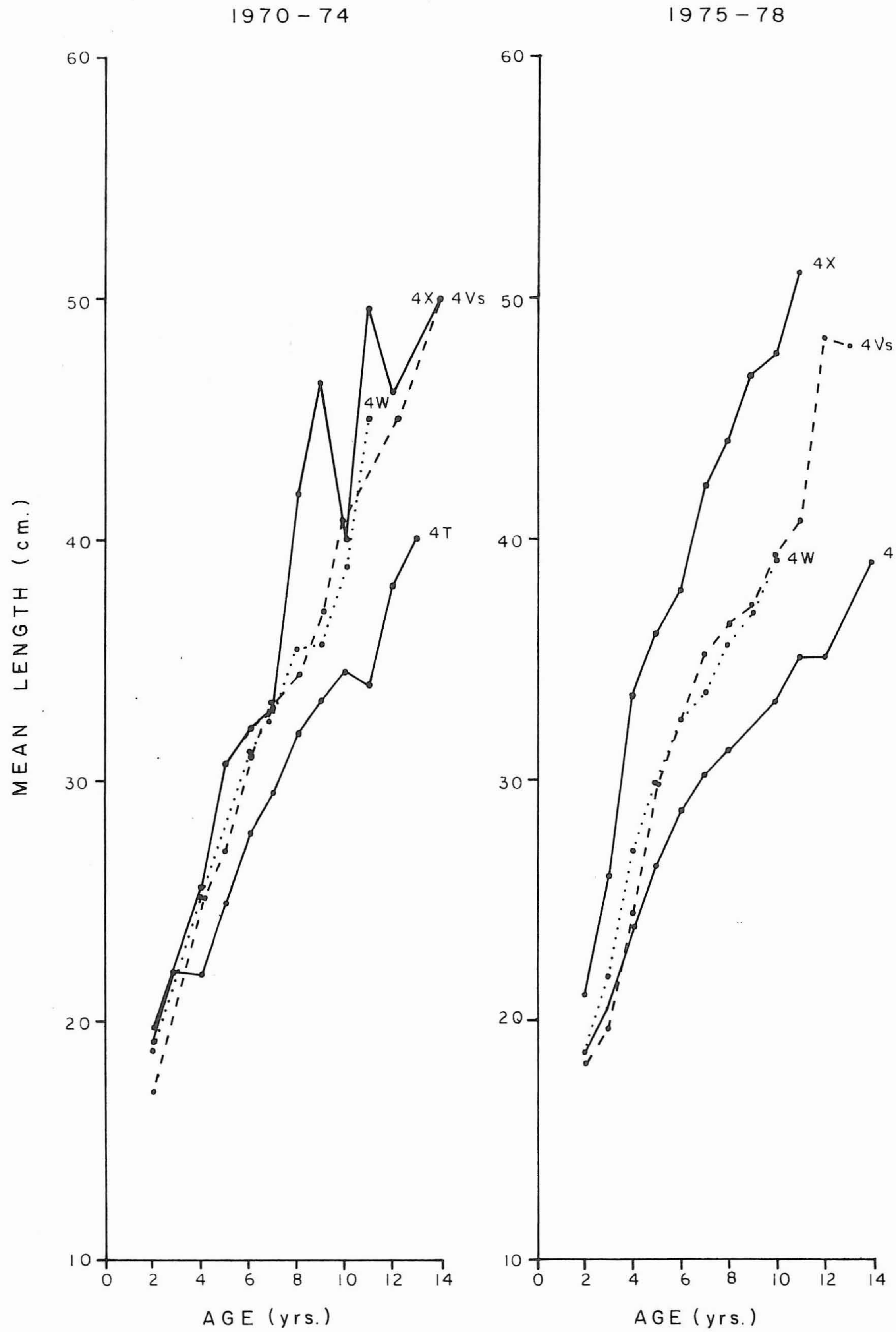

Fig. 5. Observed mean lengths-at-age for female yellowtail caught during Canadian groundfish surveys, 1970-78.

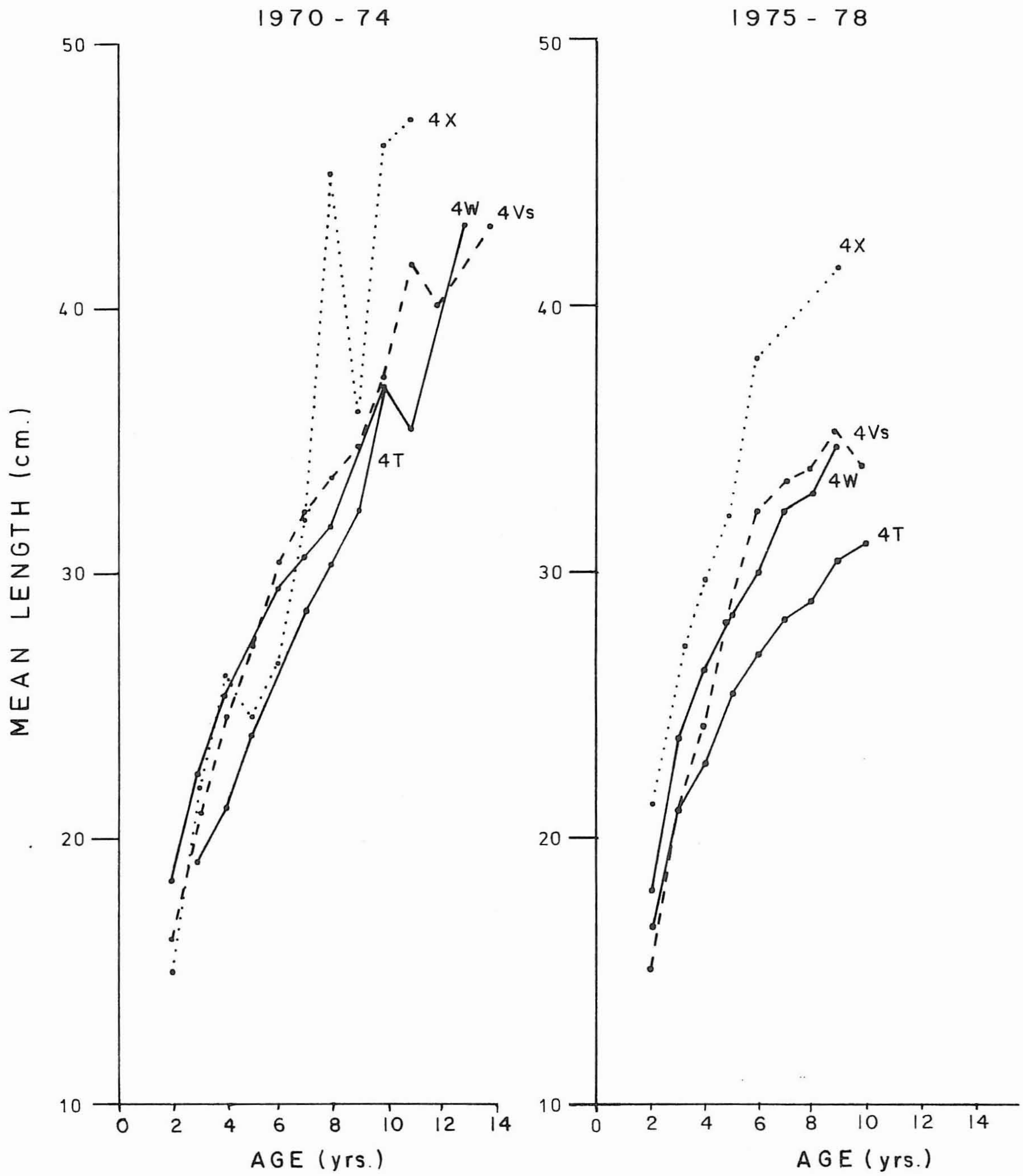

Fig. 6. Observed mean lengths-at-age for male yellowtail caught during Canadian groundfish surveys, 1970-78.