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Juvenile Flatfish Fisheries on the Grand Bank: a Discussion of Conservation Techniques

by

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INTRODUCTION

On the Grand Bank, NAFO Divisions 3L, 3N and 3O there are two major areas of concentrations of juvenile American plaice, *Hippoglossoides platessoides*,: one located on the north and northeast slope of Div. 3L and the other located on the southern Grand Bank, in an area known as the "Tail of the Bank", in Div. 3NO. This latter concentration is found mainly outside the Canadian 200 mile boundary, in the NAFO Regulatory Area. A smaller concentration of juveniles is also found in a deepwater basin known as Whale Deep, on the western side of the Bank, in Div. 3O (Walsh 1991a, 1991b).

Juvenile yellowtail flounder, *Limanda ferruginea*, are concentrated in an area in and around the Southeast Shoal, Div. 3N, being found mainly in the area outside the Canadian 200 mile boundary. It has been hypothesized that these areas of concentrations are the oceanic nursery sites for both species (Walsh 1991a, 1991b; Walsh 1992). There is no distinct separation of the juvenile and adult components of the stock typically reported in coastal nurseries of other flatfish species (de Veen, 1978). Consequently, any directed commercial fishery for Grand Bank adult plaice and yellowtail flounders using towed bottom fishing gears will be conducted mainly on the nursery grounds.

CODEND SELECTIVITY

In 1974 ICNAF set the minimum codend mesh size of bottom trawls used in the Grand Bank based on the type of material: 120 mm in cotton, hemp, polyamide and polyester fibres nets and 130 mm for nets made of manila or any other material. If seines were used the mesh size was 110 mm and if the fishery was directing for short-finned squid, *Illex illecebrosus*, a mesh size of 60 mm could be used, regardless of material. The NAFO Fisheries Commission adopted the same measures in 1983 (NAFO 1991). In September of 1981 the Canadian Government eliminated the differentials in netting material and standardized all trawls and seines, used by the Canadian fleet, to a mesh size of 130 mm. Currently, many fleets of the European Community and Russia commonly use polyamide material in their codends, hence 120 mm is a typical standard mesh size in use in the Regulatory Area.

Holden (1971) calculated selection parameters for 123 mm mesh size codends for plaice. Using his selection factor (50% retention length/mesh size) of 2.2 and the same selection range of 5.2, I calculated the following selection parameters for 120 mm mesh codends: L25% = 23 cm; L50% = 26 cm; and L75% = 29 cm.

Figure 1 shows the selectivity curve for 130 mm mesh size codends derived from trouser trawl experiments on the Grand Bank in 1990 (Walsh et al. 1992). Table 1 gives the selection parameters for a 130 mm diamond mesh codend derived for plaice. A L50% of 31 cm and a selection factor of 2.4 were derived for the 130 mm mesh codend giving a L25% of 28 cm and a L75% of 35 cm (Walsh et al. 1992). These estimates agree with those derived by Smolowitz (1983).

Smolowitz (1983) estimated a L50% of 30 cm for yellowtail flounder in 133 mm mesh size codends. Applying his selection factor of 2.3 and 6 cm selection range, the calculated selection parameters for 130 mm mesh size are: L50% = 30 cm; L25% = 27 cm; and, L75% = 33 cm. For 120 mm mesh size the estimated selection parameters are: L25% = 25 cm; L50% = 28 cm; and, L75% = 31 cm. Since there is no reason to expect the derived selection values for plaice in 130 mm mesh codends should be different from yellowtail flounder, given similar morphology and selection factors, the selection values in Table 1 are taken to represent both species.

THE PROBLEM

PLAICE FISHERY

One-half to two thirds of the entire Grand Bank population of plaice is located on the northern slope of the Grand Bank, with approximately 9% of the population located outside the 200 mile boundary on the northeast slope (Brodie et al 1990). The 1989-91 juvenile surveys have shown that concentrations of age 1 to 4 plaice were located inside the 200 mile boundary on the north and northeast slopes of Div. 3L, consequently only the Canadian fleet fishes this nursery area (Fig.2). Canadian fleets land their catches at Newfoundland ports where fish plants have a minimum landing size of 32 cm for both species. Fish under this size are usually culled and discarded at sea (Stevenson 1980,1983).

Table 2 shows a summary of discards of plaice by the Canadian fleet for the years 1986-88 for which data are available. The discard rate was highest in 1986 at 14%, by weight, (6.6 million fish) decreasing to 4% (0.3 to 0.4 million fish) in 1987 and 1988 (Walsh 1991b). Discarded plaice generally ranged in size from 12 to 50 cm with a mean size of 32 cm being observed (ca. age 4) (Stevenson 1980, 1983; Kulka 1986). The majority of the discarding took place in the northern section of Div. 3L (Fig. 3).

On the southern Grand Bank 70 to 90% of the 1985-91 survey catches of 1 to 6 year old juvenile plaice were found in the Tail of the Bank region, the Regulatory Area of Div. 3NO (Walsh 1991a, 1992b). Detail length and age composition of trawler catches are made available to NAFO by Spain, USA and Canada. Figure 4 shows a comparison of the landed catch composition of plaice by the Canadian offshore trawlers inside the 200 mile boundary with the trawl catches of the United States and Spain outside the boundary for the period of 1987 to 1989. Both the Canadian and the US fleets show similar age composition, with older plaice dominating the catches, for equivalent years. This suggests that either the same mesh size or discarding practices (or both) were used by both countries. In the 1989 Spanish catches, there was a noticeable shift in the age composition to younger ages when compared to 1987 and 1988. Juveniles were first recruited to the fleet at age 4 in 1987, age 3 in 1988 and age 2 in 1989 . Juveniles also dominated the Spanish catch at age in the Regulatory Area in 1990 and 1991 (Brodie and Baird 1991; Brodie et al. 1992).

YELLOWTAIL FLOUNDER FISHERY

The Canadian fishery for yellowtail flounder is carried out mainly on the southern Grand Bank, in and around an area known as the Southeast Shoals in NAFO Div. 3NO. Table 2 shows a summary of discards for yellowtail flounder for 1986-88, for which data is available. Discards ranged from 1 to 4% in weight (Walsh 1991b). A mean discard size of 31 cm (ca. age 5) was calculated for discards with individuals sizes ranging from 16 to 40 cm (Stevenson 1980, 1983; Kulka 1986). The majority of the discarding took place in the area around the Southeast Shoal (Fig. 4).

Seventy (70%) to 90% of the 1985-89 juvenile survey catches of 1 to 5 year old yellowtail flounder were located outside the 200 mile boundary with older fish being more abundant inside the boundary (Walsh 1991b, 1992).This trend is also evident in the 1990-91 juvenile surveys (Brodie et al. 1991; Brodie and Walsh 1992). Figure 7 shows that the age composition of the landed catches of the Canadian and United States fleet were dominated by older individuals, again, either a reflection of similar mesh sizes or discarding practices by both countries. The 1988-89 age composition of the Spanish fleet was dominated by juveniles recruiting to the fleet at age 2 in 1988 and age 1 in 1989. Juvenile yellowtail flounder also dominated the catch at age in the 1990-91 in the Regulatory Area (Brodie et al 1991; Brodie and Walsh 1992).

PROGNOSIS

Data obtained by fisheries surveillance officers aboard Canadian vessels during the period of 1985-89 revealed that 29% of the non-Canadian vessels boarded in the Regulatory Area were using small mesh codends, ca. 60 mm mesh size. The vessels boarded were either NAFO members or non-members (Dept. Fisheries and Oceans, Newfoundland Region; unpubl. data). Since 1982, the increased fishing effort in the Regulatory Area has resulted in a reduction of approximately one-half the percentage of biomass of both species during the period 1986-90 compared to 1979-85 (Brodie et al. 1990).

There appears to be dual conflicting fisheries taking place on the southern Grand Bank on the same stocks of plaice and yellowtail flounder but of different age groups. In this situation, the fishery on the younger fish (outside the boundary) may reduce recruitment to the second fishery (inside) by the numbers caught minus losses due to natural mortality during the period between the two fisheries. This consequence may be more critical for yellowtail flounder because of the single nursery area. If discarding is a larger problem then it appears in the Canadian fishery and if the level of removals of juveniles and discarding (if any) by non-Canadian fleets in the Regulatory Area are not accurately reported then major impacts on the directed fishery yield in both species are expected.

SOLUTIONS

The proportion of the population at length caught by otter trawls is a function of the mesh size used and the size (age) composition of the population. From an industry perspective it is the size composition of fish in the catch which is of greater concern. The Canadian industry's minimum accepted port landing size is 32 cm for both species of flounders and this corresponds to the calculated 50% retention length of 130 mm diamond mesh codends used. This means that only 50% of 32 cm flounders which are caught by the gear are retained and discarding is expected to be highly variable as a consequence of fluctuating strengths of year classes.

It is important to remember that a selection ogive for a given mesh size and the resulting calculated selection parameters will vary because of many factors. Behaviour of the fishing vessels and captains, areal, seasonal and yearly differences could result in variability in size composition of trawl catches with the same mesh size. In the Regulatory Area of the southern Grand Bank, Div. 3NO, vessels fishing on grounds containing high proportions of small plaice and yellowtail flounder may have lower calculated 50% retention lengths than vessels fishing in areas where fish are larger.

The question becomes: " *How to effectively reduce the large catches of juvenile flounders on the Grand Bank, knowing the magnitude of the problem can fluctuate with the strength of incoming year classes?* "

TECHNICAL MEASURES TO INCREASE SIZE SELECTION OF THE GEAR

CLOSED AREAS

Information on the distribution of juvenile and adult plaice and yellowtail flounders shows that both size groups overlap considerably in their respective habitats. Also, on the southern Grand Bank, in the Regulatory Area, juvenile plaice and yellowtail flounders also overlap their distribution in the area immediately below the Southest Shoals. Closing juvenile nursery areas on the northern and southern Grand Bank and the Whale Deep area in Div. 3O would effectively close the majority of the fishery for flounders and cod, *Gadus morhua*, Closing the yellowtail flounder nursery grounds in the Southeast Shoal area of Div. 3N would close a large part of the fishery area for large yellowtail flounder. However, area closer would not be as severe as for plaice since the distribution of larger yellowtail flounder is away from the Shoals to the west and the northern sections of the Bank, into Divs. 3O and 3L (Walsh 1992).

A fishery for both species would entail a large increase in effort to maintain the expected catch levels in a no closure fishery. On the positive side the landed mean weight of fish in the catch would be greater, returning a higher dollar value. Area closures for both species based on nursery areas would virtually eliminate the fishery outside the 200 mile boundary on the southern Grand Bank leaving only a small area on the "Nose of the Bank",in Div. 3L's Regulatory Area.

MESH SIZE AND MINIMUM LANDING SIZE INCREASE

Halliday and White (1989) look at the problem of conservation of juvenile fish resources in the groundfish fisheries in the Scotia-Fundy Region by considering an increase in mesh size and the introduction of minimum landing size regulations. These authors concluded that the importance of appropriate mesh size regulations is not reduced by the introduction of a minimum landing size since the minimum size provides a guide to the suitability of particular mesh sizes. The authors suggested that mesh size be set which results in the 25% retention length being at or above the minimum landed fish size. For 130 mm diamond mesh codends this would be ca. 28 cm (Table 1).

With the Canadian industry minimum landing size of 32 cm this would suggest a shift to a mesh size of at least 152-155 mm diamond mesh (Halliday and White 1989; Walsh et al 1992). Of course such an increase would result in a drop in landings per unit effort but mean weight of fish landed would increase and generally would result in fewer juvenile fish being discarded at sea.

In the Regulatory Area, an adoption of a minimum of 130 mm mesh size, regardless of material used in the codend, would reduce some of the catches of juveniles. However, it must be kept in mind that in the Regulatory Area on the southern Grand Bank there is, at present, a preponderance of juveniles of both species. If selectivity experiments were carried out in that area, lower selectivity parameters are expected than that derived for experiments which were conducted with the full range of size distribution of the population. Consequently, a larger mesh size may be needed to produce the same selection as seen in 130 mm mesh size codends in use inside of the 200 mile boundary.

SIZE SELECTION BEFORE CAPTURE

Plaice and yellowtail flounders spend a considerable amount of their daily activity close to or resting on the seabed. Their herding behaviour in relation to various components (cables and groundgear) of the trawl gear is usually in a perpendicular direction when that component comes close to contact with the fish. Often the fish will burst away from a resting position only to settle to the bottom a few meters away,and repeat the behaviour again as the trawl component comes closer (Beamish 1966; Walsh and Hickey 1992). At night, this visually coordinated behaviour is absent and escapement is reduced, hence catches are generally higher at night for both species, especially juveniles, because the trawl is more efficient for flounders at night (Walsh 1988, 1991c). Day only fishing would reduce the catches of both juvenile species, but it would necessitate an increase in effort to maintain catch levels equivalent 24 hour fishing.

The use of large bobbin roller gear in conjunction with higher towing speeds (4 knots and above) and smaller bridle angles will affect size selectivity of trawls for both species. Faster towing speeds and smaller bridle angles, created by using short ground wires, will decrease the size selection by promoting escapement of smaller fish under the various components of the groundgear. Large steel bobbins generally have poorer bottom contact than heavier rubber discs, and the effective escape area underneath the footgear is thus greater and contributes to the escapement of small plaice and yellowtail flounders, as well as cod (Engas and Godo 1989; Walsh 1989, 1991c; Godo and Walsh 1992).

However, the use of rockhopper footgear could reduce escapement, thus having the opposite effect (Godo and Walsh 1992)

CONCLUSION

The introduction of a joint increase in mesh size and minimum landing size regulations may be the best option for consideration. It is suggested that the L25% retention length, derived for the new mesh size, serve as the basis for setting a minimum landing size. An increase in mesh size by itself could increase the mis-reporting due to reduce catch rates. As well, the incentive to illegally rig the gear to be more selective would be stronger because, with a minimum landing size in place, marketable fish will be lost with any increase in mesh size. This would result in discarding at sea of unwanted sizes. An increase in enforcement will be required to maintain the same level of compliance with a larger mesh size than a smaller one, both in the transitional phase and in the long term (Halliday and White 1989). Strict enforcement of minimum landing sizes at various ports will also be required.

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Table 1. Percent retained of plaice and yellowtail flounders in a 130 mm diamond mesh codend. (Walsh et al. 1992).

PERCENT RETAINED	LENGTH (CM)
5	19
10	24
15	26
20	27
25	28
50	31
75	35

Table 2. A summary of discards by weight (metric tons) of American plaice and yellowtail flounders observed in the Canadian otter trawl fleet during the period 1986-1989. (Walsh 1991)

	1986			1987			1988		
SPECIES	Wt.	%	No.	Wt.	%	No.	Wt.	%	No.
PLAICE	1790	15	6.6	93.3	4	0.3	104	4	0.4
YELLOWTAIL	403	4	1.5	19.9	3	0.1	6.1	1	0

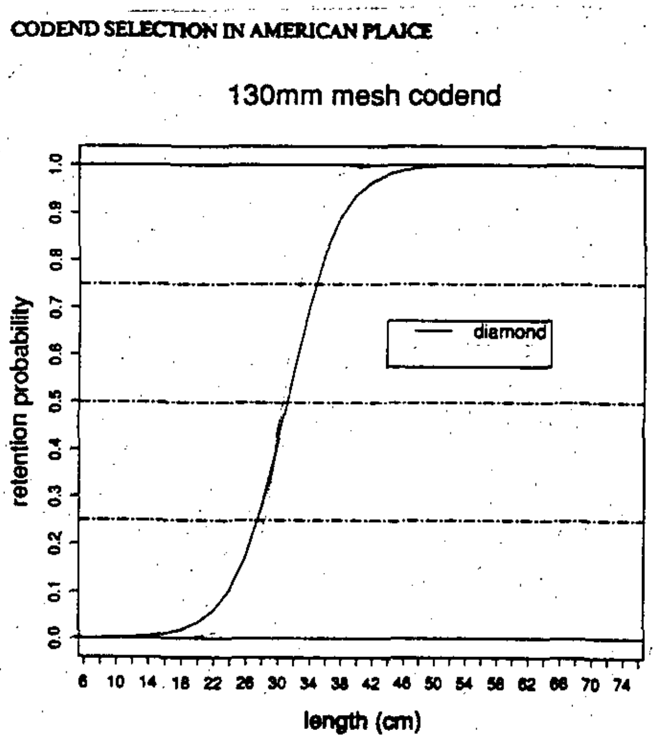

Figure 1. Selection curve for plaice from the 130 mm diamond mesh codend

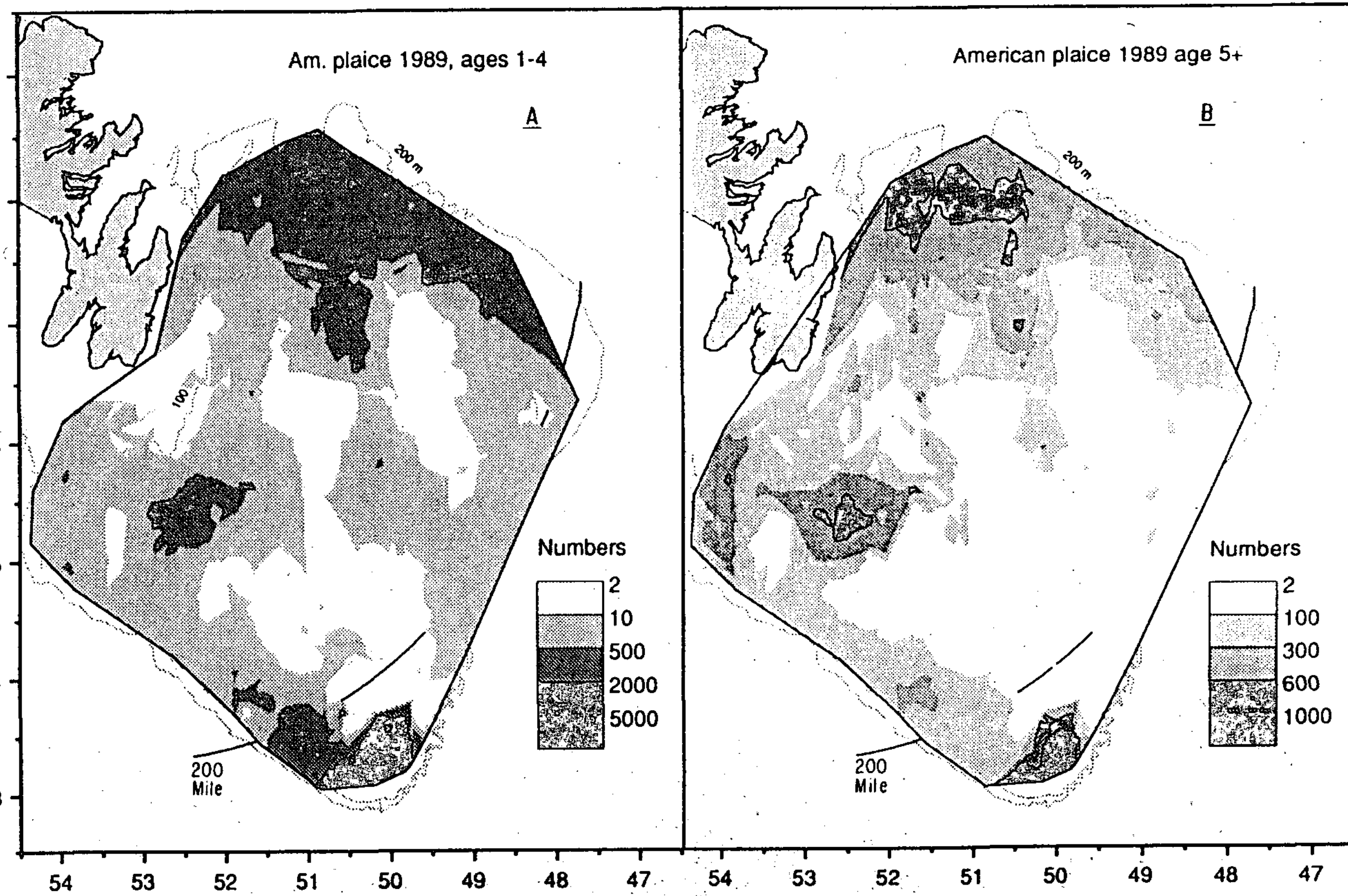

Figure 2. Distribution of abundance of A) juvenile and B) adult American plaice on the Grand Bank in the 1989 survey.

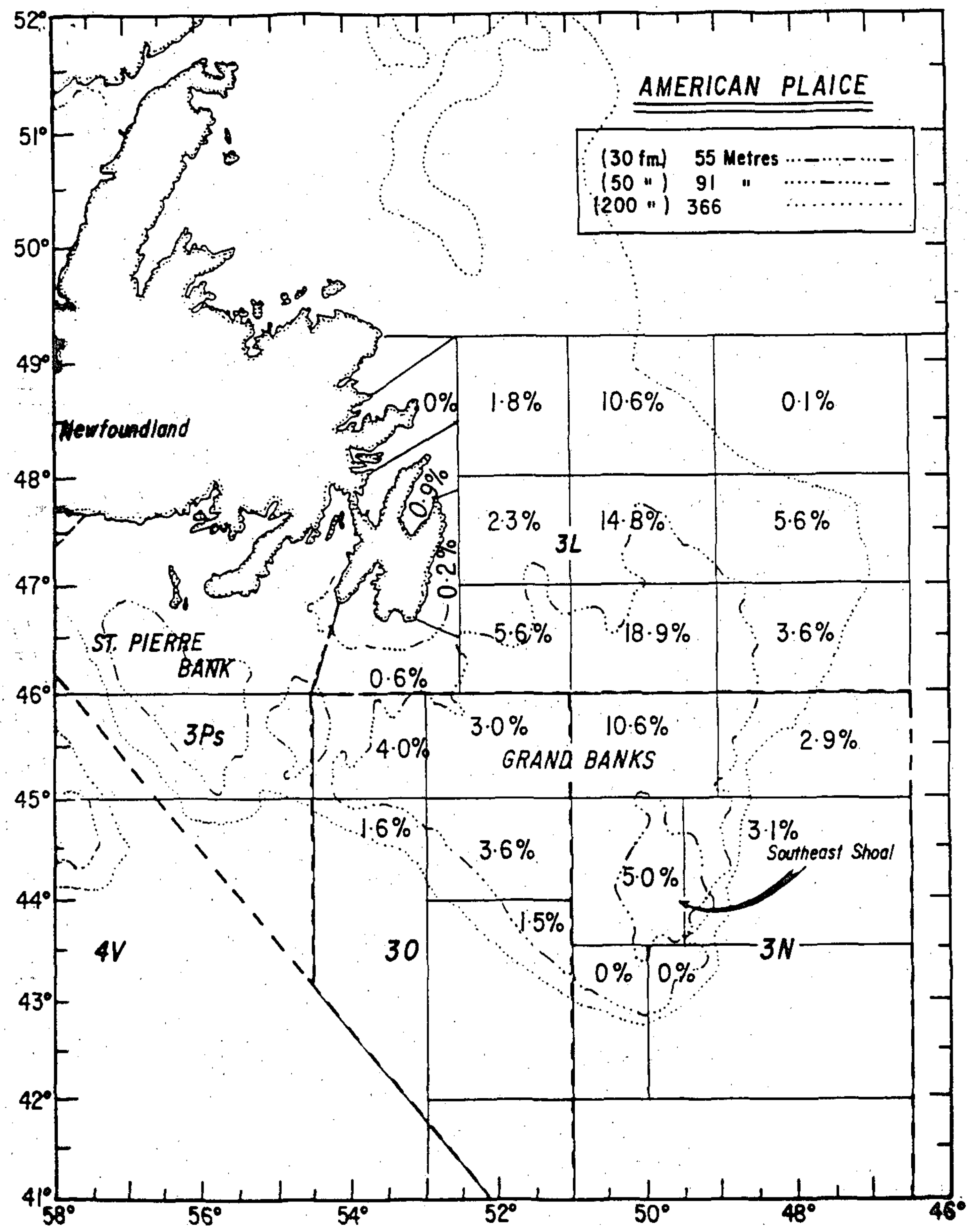

Figure 3. Distribution of discards (percentage) by weight of American plaice by the Canadian offshore trawler fleet, 1986-88 combined.

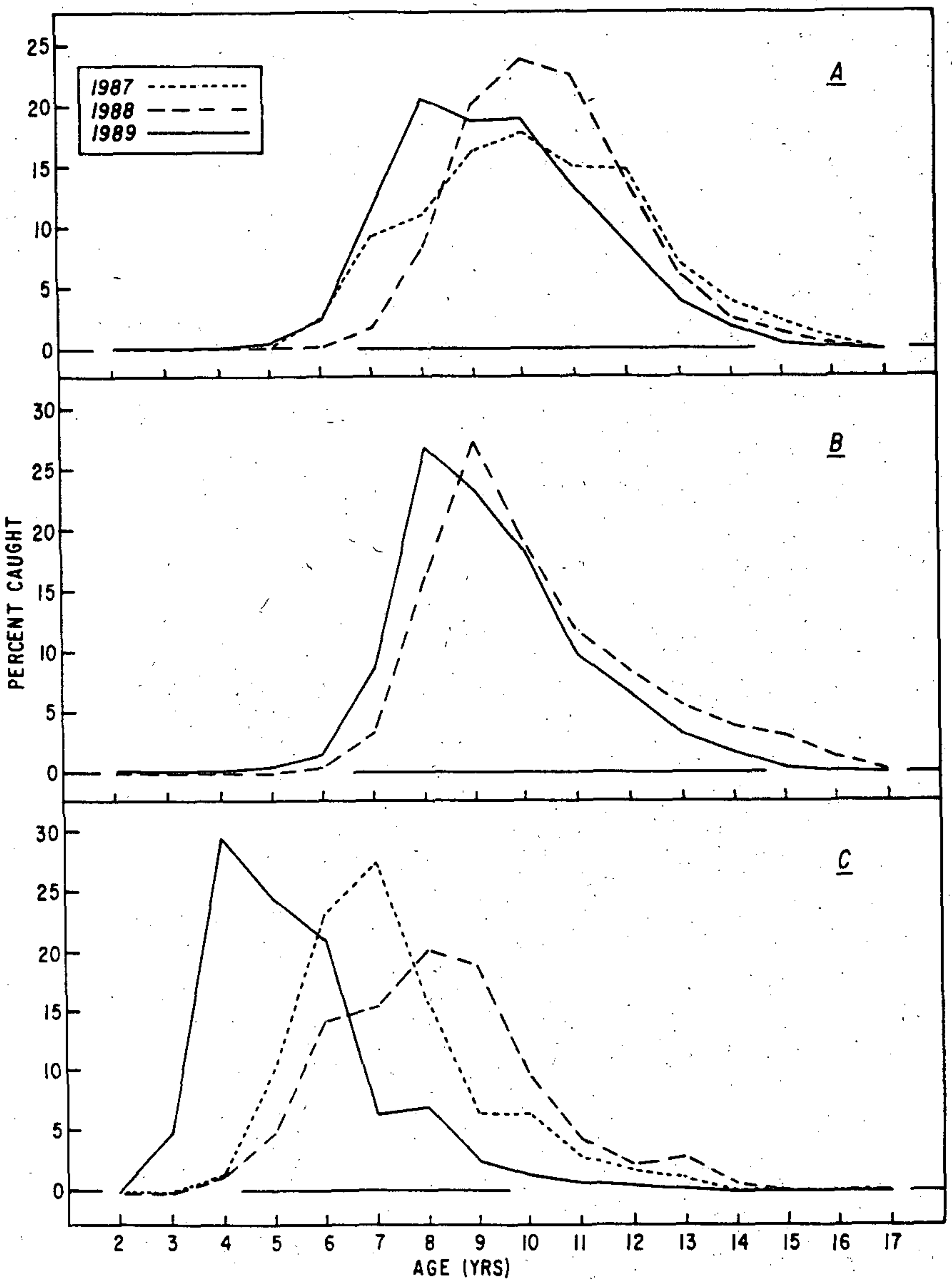

Figure 4. Comparison of age composition of American plaice in the trawl catches by the (A) Canadian fleet inside the 200 mile boundary with the catches by (B) United States and (C) Spanish fleets outside the boundary,1987-89.

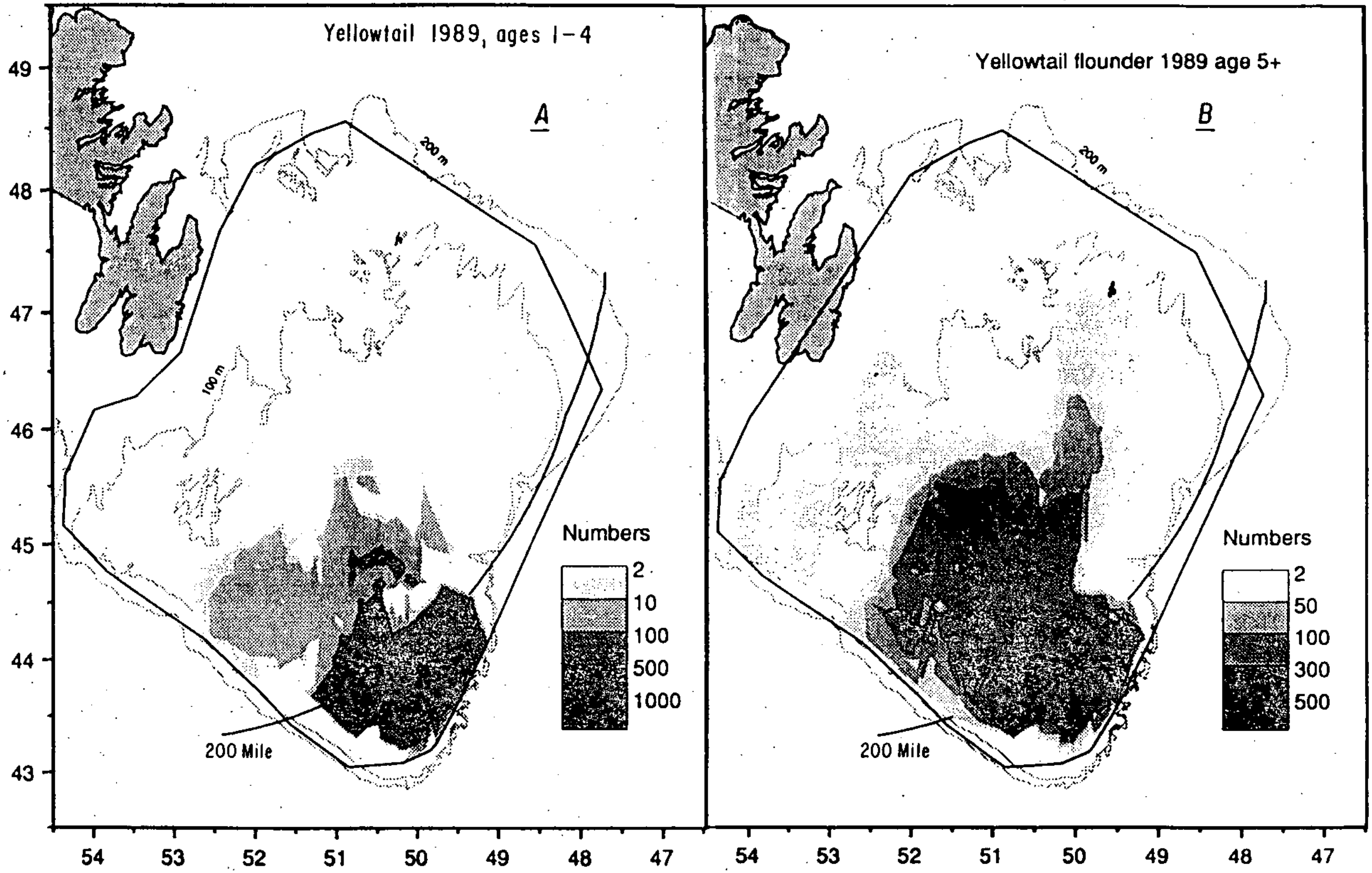

Figure 5. Distribution of abundance of A) juvenile and B)adult yellowtail flounder on the Grand Bank in the 1989 survey.

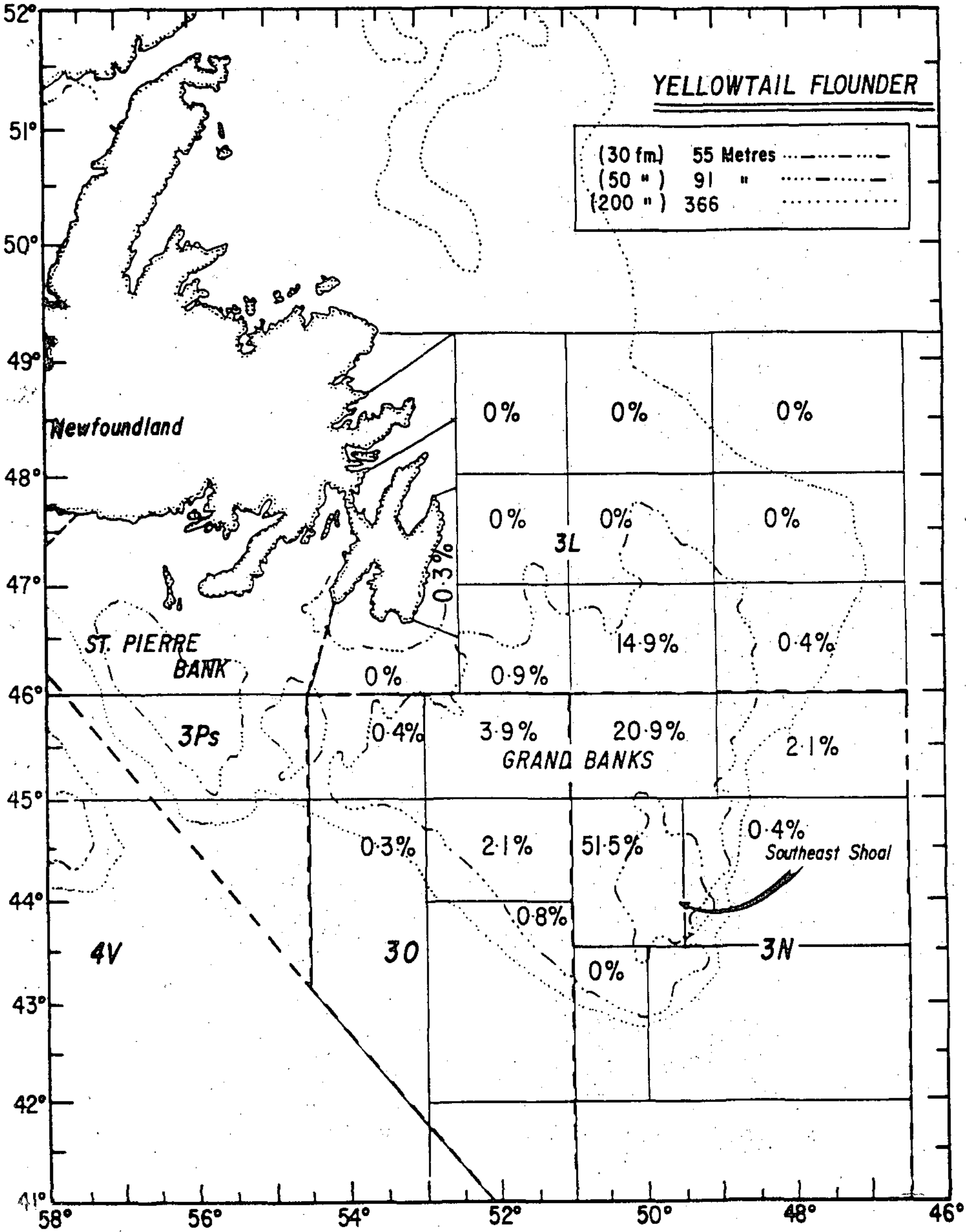

Figure 6. Distribution of discards (percentage) by weight of yellowtail flounder by the Canadian offshore trawker fleet,1986-89 combined.

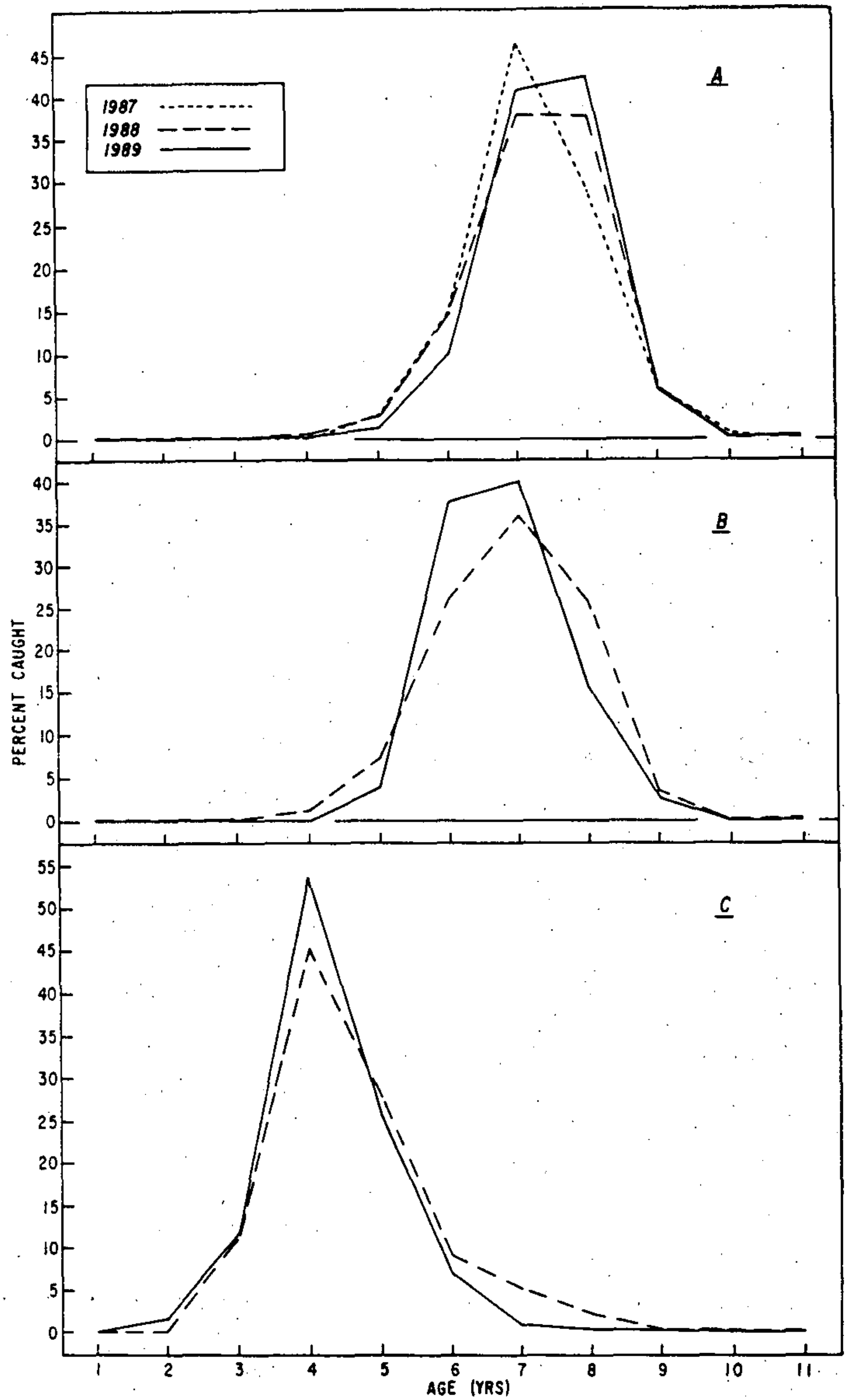

Figure 7. Comparison of age composition of yellowtail flounder in the trawl catches by the (A) Canadian fleet inside the 200 mile boundary with the catches by the (B) United States and (C) Spanish fleets outside the boundary,1987-89.