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A preliminary assessment of the pollock fishery inICNAF Divisions 4VWX and Subarea 5

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Abstract

Pollock landings for Divs. 4VWX and SA5 have fluctuated considerably since 1960, apparently in response to changes in abundance and to shifts in directed effort. Landings have increased substantially since 1970. Current evidence indicates that pollock in Divs. 4VWX and SA5 should be considered as a discrete stock for assessment purposes. Application of the Von Bertalanffy growth equation to length-at-age data obtained on USA spring and autumn bottom trawl surveys yielded the following parameter estimates: L_∞, 101.6 cm; K, 0.2159, and t_0, 0.3782. Commercial and research vessel survey abundance indices indicate declines in abundance since the mid-1960s, followed by an apparent increase; since 1973, abundance again appears to have declined. Research vessel survey data also indicates substantial increases in F levels in recent years (to over 0.5 since 1973). Yield per recruit studies indicate F_{max} and $F_{0.1}$ values of 0.4 and 0.24, respectively, for a mean selection age of 3.5 years. Catches corresponding to F at the level of F_{max} and $F_{0.1}$ in 1977 would be 30,000 and 19,000 MT, respectively.

INTRODUCTION

The pollock (*Pollachius virens*) is currently increasing in commercial importance in Subareas 4 and 5 of the ICNAF Convention Area. Historically, this has not been a prime species; amounts landed appear to have been determined chiefly by demand rather than supply although local variations have occurred. Until 1973, pollock catches were totally unregulated, but at the Special Commission Meeting in January of that year a 50,000 MT TAC was approved for Div. 4X and Subarea 5 (ICNAF, 1973a) based on commercial and research vessel survey data. This TAC level was subsequently revised to 55,000 MT for 1974 for Divs. 4VWX and SA 5 inclusive (ICNAF, 1973b). The 55,000 MT TAC has remained in effect for 1975 and 1976, as continued monitoring of commercial and research vessel survey data has shown no conclusive evidence for declining catch levels.

At the April 1975 meeting of the Assessments Subcommittee, attention was drawn to the need for a more detailed assessment of this stock. In addition, the Commission's expressed desire to establish separate TAC's for pollock in Subareas 4 and 5 has also been noted (ICNAF, 1975a). The present paper represents an attempt to assess the status of the Divs. 4VWX - SA 5 pollock stock in greater detail and examines available evidence relative to stock boundaries.

BIOLOGY

Distribution and Life History

Pollock occurs on both sides of the North Atlantic in cool temperate and boreal waters. In the Northwest Atlantic, it ranges from Cape Hatteras to Labrador and West Greenland (Bigelow and Schroeder, 1953); commercial landings data (ICNAF, 1962-72; 1974; 1975b; 1976) indicate the center of its distribution to lie in ICNAF Div. 4X, although it is also common in Divs. 5Y and 5Ze and in Div. 4W. Pronounced declines in abundance occur to the west and east of these areas, and to the east of Division 4W landings are of little significance commercially (Fleming, 1969). Templeman (1966) noted that stocks in the Newfoundland area were not adequate to sustain a large commercial operation and that in any event supply was subject to fluctuate due to temperature influences on year-class strength.

Excellent reviews of pollock life history are given by Bigelow and Schroeder (1953) and Steele (1963) and the subject will be considered only briefly here. In late fall and winter, ripe adults congregate in Div. 5Y in the area extending from Massachusetts Bay to the Isles of Shoals (Steele, 1963). This is the only known spawning concentration in the Divs. 4VWX - SA 5 area, although there is some evidence to suggest that spawning also occurs on the Scotian Shelf and off Cape Breton Island. Spawning occurs from November through February and reaches a climax before the winter minimum temperature is reached. Females produce an average of 225,000 pelagic eggs; incubation requires nine days at a temperature of 6^{0} C (Bigelow and Schroeder, 1953).

Larvae are approximately 4 mm long at hatching. After absorption of the yolk sac, juveniles apparently live near the surface for a period of time, moving inshore into sublittoral areas in their first summer of life. After wintering offshore, one-year-old "harbor pollock" return inshore in large numbers, where they remain until late summer or early autumn (Steele, 1963). Older pollock tend to frequent deeper waters and more definite localities. Steele (1963) has observed a tendency for segregation by size in the Bay of Fundy and in areas to the east and noted that segregation by size into schools is an important feature of pollock behavior. Sexual maturity occurs at 4-7 years of age (50-65 cm) in males; females mature at 5-7 years of age (55-70 cm).

Stock Structure

Primarily from tagging returns, Steele (1963) identified three separate groups of pollock in the Div. 4X - SA 5 area during summertime (a Bay of Fundy group, a western Nova Scotia group, and a southern Gulf of Maine group) but noted that the distinctness of these groups could not be determined. On the basis of distributional studies and tag returns, Kohler (1968) reported three groups of pollock in the region encompassing the Bay of Fundy and the western Nova Scotia banks and considered the Bay of Fundy group to be discrete from the remaining units. Lack of further definitive information prompted the Commission to establish Div. 4X and SA 5 as a stock area in January 1973 (ICNAF, 1973a); in June, this area was extended to include Divs. 4V and 4W as it was considered likely that pollock in these areas comprised part of the Div. 4X - SA 5 stock (Halliday, 1973; ICNAF, 1973b).

In the following sections, trends in seasonal catches, tagging studies, and the distribution of ripe adults and larvae are reviewed in an attempt to delineate stock boundaries for this species with greater accuracy.

Seasonal Catch Data

Distributions of landings by month in Divs. 4X and 5Y provide information on seasonal movements. Monthly landings data for the 1972-1974 period for the Canadian fishery in Div. 4X (ICNAF, 1974; 1975b; 1976) increased to a peak the summer months, followed by a precipitous decline during autumn and winter (Figure 1A). At the same time, monthly landings for the United States (USA) Div. 5Y fishery (Figure 1B) show a reversal of this trend, with peak catches being taken in late autumn and winter. This pattern appears to reflect a southward spawning migration in fall and winter, and certainly the data of Figure 1 indicate that the movement may be quite substantial.

Tagging Studies

Bigelow and Schroeder (1953) mention tagging studies by the former (USA) Bureau of Fisheries in the Gulf of Maine which were inconclusive; many recaptures were taken in the vicinity of the tagging area after relatively long periods of time, although some marked fish were recaptured at considerable distances to the eastward (one as far east as Sable Island, Figure 2). Steele (1963) tagged 1,000 pollock (60-85 cm) in the Bay of Fundy in July 1960; during 1960-1962, tags were recovered from the Bay of Fundy and off southwestern Nova Scotia in summer and early autumn, but in November, December, and January, returns also came from the mouth of Massachusetts Bay in Div. 5Y. A limited number of recoveries were also made off southwestern Nova Scotia in spring.

On the basis of the above information, Steele concluded that some of the Bay of Fundy population migrate south to spawn in Div. 5Y in fall and winter and that a similar movement might well occur to the south of western Nova Scotia. There appeared to be little mixing between pollock in the Bay of Fundy, the southern Gulf of Maine, and the Scotian Shelf during summertime.

Distribution of Ripe Adults, Eggs, and Larvae

In autumn and winter, ripe adults congregate in large numbers off the mouth of Massachusetts Bay and between Cape Ann and the Isles of Shoals (Bigelow and Schroeder, 1953, Figure 2). Ripe fish have also been reported in limited numbers along the Maine coast and to the south of Massachusetts Bay, but no evidence was found to indicate that spawning occurs to the west of Cape Cod or within the Bay of Fundy, and accordingly Bigelow and Schroeder concluded that "no production of any importance takes place anywhere in the Gulf of Maine east of Cape Elizabeth." East of the Gulf of Maine, however, Steele (1963) noted the presence of large, mature pollock off Nova Scotia in winter during his study, while nine ripe and ripening pollock were taken off Cape Breton Island in winter of 1961. These observations indicate that at least some spawning occurs east of the Gulf of Maine, although recent attempts to locate ripe fish on the Scotian Shelf by interviewing Canadian fishermen have been unsuccessful. Consequently, it does not appear that major spawning concentrations occur east of the Gulf of Maine.

Distributions of pollock eggs and larvae substantiate the importance of the western Gulf of Maine spawning concentration and also give some indication of spawning on the Scotian Shelf. Bigelow and Schroeder (1953) found no pollock eggs anywhere north of the Isles of Shbals, nor have larvae been found in the Passamaquoddy region (Bigelow and Schroeder, 1953; Legaré and Maclellan, 1960,

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In Steele, 1963). In January and February, pollock larvae are concentrated in the southern Gulf of Maine and to the south of Cape Cod; in March-May, larvae become more scattered throughout the Gulf of Maine, with some appearing on the Scotian Shelf (Colton, *In* Steele, 1963). Colton and St. Onge (1974) also reported larvae on the Scotian Shelf as early as January, and Steele (1963) reported larvae at the Lurcher Lightship in January, 1960 (Figure 2); thus, spawning on the Scotian Shelf would appear probable. Our knowledge of water circulation patterns in the Gulf of Maine in winter and early spring is incomplete at present, although a counterclockwise eddy appears to exist within the Gulf proper, supplemented by a strong movement southward along Cape Cod (Colton and Temple, 1961; Figure 2). This configuration, and the presence of an opposing countercurrent along the eastern Nova Scotia coast (Steele, 1963) explain the observed winter and spring distribution of larvae within the Gulf of Maine nicely yet do not provide a mechanism for transport of larvae to the eastern Nova Scotia area. As small harbor pollock are found along the length of the Nova Scotia coast northward to southern Newfoundland (Steele, 1963), it again would appear that at least some spawning occurs to the east of the Gulf of Maine.

To summarize, evidence currently suggests that one major spawning area exists in the 4VWX-5 region, this being the area in the western Gulf of Maine. We also have evidence of additional spawning to the eastward, although information is scanty at present and in any event is not adequate to provide a basis for stock delineation. Accordingly, it is proposed to retain the present boundaries as suggested by Halliday (1973) recognizing that this area may be further subdivided when more information becomes available.

Growth

Pollock growth is rapid in the first years of life, declining with the onset of sexual maturity (Steele, 1963). Bigelow and Schroeder (1953) report the following length data for the ages indicated: I, 13-18 cm; II, 30-33 cm; III, 43-46 cm; IV, 53-56 cm; V, 61 cm; and VI, 66 cm. These data indicate a slightly higher size at age than that reported by Hoberman and Jensen (1962) for the Gulf of Maine and by Steele (1963) for the Bay of Fundy and the Scotian Shelf.

A sample of 2,227 otoliths collected on ALBATROSS IV spring and autumn bottom trawl survey cruises in the Div. 4X - SA 5 area from 1970 to 1975 was used to evaluate the growth rate of Div. 4VWX - SA 5 pollock. The relation $y = -0.2909 + 1.0441x$ determined from ALBATROSS IV survey data (where x = fork length in cm) was used to convert fork length to total length, and ages were coded at half-year intervals assuming a January birth date (e.g.,a pollock hatched in January was assumed to be 0.75 years old in autumn of that year and 1.25 years old during the following spring). The Von Bertalanffy growth equation was then fitted to the length at age data using the method of Tomlinson and Abramson (1961). The results (Table 1, Figure 3) agree closely with data reported by Bigelow and Schroeder but again indicate a higher average size at age than observed by Hoberman and Jensen (1962) and Steele (1963).

COMMERCIAL LANDINGS

Coastal States

Historical landings data for the USA and Canadian pollock fisheries in Divs. 4VWX and SA 5 are given in Figure 4; summaries by nation and area for 1960-1975 are given in Tables 2-5. These data reveal that up until the present time the fishery has been dominated by Canada and the USA, although other nations, notably the German Democratic Republic (GDR) and the Union of Soviet Scoialist Republics (USSR) have on occasion made significant catches. With the exception of the Jeffreys Ledge winter fishery in Div. 5Y, the USA fishery has been chiefly incidental in nature; in Canada, however, more effort appears to have been directed towards this species, particularly since 1950 (Figure 4). The data of Figure 4 reveal a sharp increase in USA landings between 1930 and 1935, followed by a period of fluctuation between 10 and 20 x 10^3 MT from 1935 to 1960. This pattern probably reflects expansion and technological improvement in the USA trawl fleet in the early 1930's, followed by relatively stabilized fishing (Hennemuth, 1969). In contrast, Canadian landings show a more gradual increase up until the mid-1940's and a brief period of relative stability between 1945 and 1952, followed by a continued increase until 1962. Declines and subsequent upswings which have occurred in both fisheries since the early 1960's (Figure 4, Tables 3 and 4) are thought to relate to changes in abundance (Halliday, 1973) although changing availability of primary species such as cod and haddock and consequent transfer of fishing effort may also have been involved. Historically, the bulk of the USA catch has been taken in SA 5 and 6 (Tables 4 and 5) and landed in Maine and Massachusetts ports;

small quantities have also been landed in the remaining New England coastal states and in New York and New Jersey. Most of the Canadian catch, however, has been taken in Divs. 4VWX (Tables 4 and 5) and landed at New Brunswick and Nova Scotia ports.

Distant Water Fleets

Pollock catches by distant-water fleets appear to have been of relatively minor significance, although landings by other nations did range from 20% to 39% of the total from 1969-1971. The relative percentage of the total catch landed by foreign vessels increased continually from less than 1% in the early 1960's to approximately 39% in 1971, when GDR landings reached a maximum level; since that time relative percentages have declined sharply (to 11% in 1974). Spain appears to have caught minor quantities of pollock from Divs. 4VWX prior to 1960 although exact data are not available. The Federal Republic of Germany (FRG), the United Kingdom (UK), and the USSR began fishing for pollock in this area in 1963, while the GDR and Japan began taking pollock in 1967 and 1970, respectively. With the possible exception of the GDR and the USSR, all of these fisheries appear to have been incidental in nature, and in any event, GDR and USSR landings both dropped sharply following periods of relatively intense exploitation. Denmark, France, Italy, Iceland, and Poland have also taken minor quantities on occasion. The data of Tables 4 and 5 reveal that Spanish and Japanese effort was concentrated primarily in Divs. 4VWX, while FRG and GDR effort was concentrated primarily in SA 5 and 6. USSR effort appears to have been divided rather equally between these areas.

Age Composition

Length-frequency sampling of the Divs. 4VWX - SA 5 pollock catch has been very limited. Samples have been collected since 1961, but during 1961-1973 seasonal coverage has been incomplete. Canadian and USA sampling during 1973-1975 approximated one sample per 1000 MT landed. There has been no sampling of pollock catches by other nations since 1972.

The age composition of the USA commercial catch since mid-1972 was determined by applying Canadian age-length keys for 1973-1975 (obtained from commercial sampling in the 4X - 5 area) to USA commercial length-frequency samples on a quarterly basis. Resulting sample numbers at age were divided by the total number sampled to provide percentage distributions at age. Mean length at age was calculated and converted to mean weight at age using the relation $w = .000022379\ l^{3.028}$ where l = fork length in cm as determined from sample data collected in ALBATROSS IV groundfish surveys. The resulting values were multiplied by the corresponding sample percent-at-age distributions and divided by the cumulative sum over all ages to provide quarterly percentage distributions in weight by age, which were applied to commercial landings by quarter to provide the weight distribution at age of the total catch. These values were then divided by the corresponding mean weight at age figures to obtain actual numbers landed. Similar figures were computed for the Canadian fishery. Percentage age compositions of Canadian and USA commercial catches (numbers) are given in Table 6.

To obtain estimated total numbers landed for the entire stock by year, estimates of numbers landed at age were required for other nations. As length-frequency data for catches by distant-water fleets were unavailable, this information was obtained by prorating total landings for other nations (MT) according to summarized distributions of weight at age for the Canadian and USA fisheries and dividing the resulting values by mean weight at age in Canadian landings to give estimates of numbers landed at age. These values were combined with Canadian and USA figures to provide estimates of total numbers landed at age for Divs. 4VWX and SA 5 (Table 7). It is recognized that this method is based on the assumption that the age distribution of the catch by foreign vessels is similar to that of the coastal states, a premise which may be violated in that coastal states take higher proportions of their total catch inshore.

Data given in Table 6 are generally consistent in revealing the presence of three relatively strong year-classes. In Canadian landings, the 1968 year-class was a relatively strong one throughout 1973 and the first two quarters of 1974, while the 1969 year-class was consistently strong during both years (Table 6). Together, these year-classes dominated Canadian landings in 1973 (67%) and were again a strong element (31%) in 1974 (Table 7). In addition, the 1971 year-class shows up very strongly in the last two quarters of 1974 and throughout 1975 (Table 6). USA landings show a similar pattern although relative percentages are less consistent (Table 6). The 1968 and 1969 year-classes are again relatively strong ones and together comprise an important element of the 1973 total (35%, Table 7). In 1974, however, the corresponding figure dropped to 15%. The 1971 year-class dominated USA landings in 1974 (52%, Table 7). It will be noted, however, that in comparison to the relative percentages computed for Canadian data values are considerably more variable between quarters for these year-classes (Table 6).

In addition to the differences in year-class strength referred to above, the Canadian and USA age composition data in Table 6 differ in one additional respect. For the most part, Canadian age distributions appear to be relatively stable between quarters, while for USA data striking seasonal differences are apparent; landings for quarters 1 and 2 are exclusively composed of younger age groups, while older fish show pronounced increases in abundance during the latter part of the year. This trend is evidently a consequence of autumn and winter spawning movements into Div. 5Y.

INDICES OF RELATIVE ABUNDANCE

Research Vessel Survey Catches

Due to the relatively large stock area involved, trends for separate divisions were examined in addition to trends for the area as a unit. Stratified mean catch per tow values in numbers and weight (kg) were calculated for ALBATROSS IV spring (1968-1975) and fall (1963-1975) bottom trawl surveys for areas corresponding approximately to Subdiv. 5Ze (Georges Bank, strata 13-23 and 25), Div. 5Y (Gulf of Maine, strata 24, 26-30 and 36-40) and Div. 4X (Gulf of Maine-Scotian Shelf, strata 31-35, 41, and 42). Values were also calculated for strata 13-42 as a unit (see Figure 5). Strata to the west of Subdiv. 5Ze were not considered as ALBATROSS IV survey catches have been negligible in that area during 1963-1975. Results are given in Table 8 and Figure 6.

The autumn survey data of Table 8 and Figure 6 are remarkably consistent for Divs. 5Y and 4X and further indicate a close relationship between these areas; data for Subdiv. 5Ze do not agree as well with the combined average although they would appear to exhibit the same general trends. The combined average for all areas declined from 5.79 kg/tow in 1963 to 1.63 kg/tow in 1967, after which values increased to 4.76 kg/tow in 1972 (Table 8, Figure 6). The peak values observed in 1969 appear to reflect an unusual influx of large individuals into the survey area rather than recruitment during that year

(Table 8). However, the gradual increase observed during 1971-1972 does appear to reflect recruitment of the relatively strong 1968 and 1969 year-classes (which also appear in commercial catches, Table 6) as individual weight in the survey data appears to have declined sharply (Table 8). The continued decline observed since 1972 (to 1.94 kg/tow in 1975) is a possible indication of declining stock abundance and would also suggest that the 1971 year-class may not be as strong as anticipated from commercial data (Table 6).

The data from spring surveys exhibit the same general trends (Table 8) although trends since 1972 are less clear in that a high-opening trawl (i.e., the 41 Yankee) was used. As a satisfactory conversion factor has not been obtained for pollock from previous gear-comparison studies, a 1.5-1 conversion factor was assumed on the basis of differences in surface area alone and indices were recalculated (Table 8). Again, values decline as for the fall survey. It is probable that the actual conversion ratio is much higher and that consequently declines are more pronounced.

Commercial Indices

Commercial abundance indices for Divs. 4V-4X (kg/hr fished) have been calculated for Canadian otter trawlers of 151-500 GRT for the period 1965-1975. Similar abundance indices have been calculated for USA otter trawlers for 1964-1975 using catch-effort data for all trips in which pollock constituted 10% or more of the total catch. Both sets of data are plotted in Figure 7.

Canadian indices drop very sharply from 153.3 kg/hr fished in 1965 to 66.6 kg/hr fished in 1967, followed by a more gradual decline to 45.5 kg/hr fished in 1971; since that year, values have risen to a high of 258.8 kg/hr fished in 1974. As noted by Halliday (1973) substantial changes have occurred in relative abundance of primary species such as cod and haddock in this area in recent years, which could have affected observed trends considerably; in particular, it would appear that shifts in directed effort associated with declining abundance of haddock in the Div. 4X-SA 5 area in the mid-1960's and subsequent quota management since 1971 could have had a very direct influence. However, the consistency of the observed trends, and the general agreement with USA research vessel survey abundance indices observed prior to 1972 (Figure 6) do suggest declining stock abundance since the mid-1960's followed by a subsequent improvement as noted by Halliday (1973) in spite of possible bias associated with shifts in directed effort.

In contrast to Canadian data, USA abundance indices are relatively stable up to 1970, increasing to a high of 115.6 kg/hr fished in 1973. Since 1973, values have declined (Figure 7). Again, the USA indices are subject to bias associated with shifts in directed effort as are the Canadian figures, although this factor is probably not as significant due to the more incidental nature of the USA fishery. Consequently, the decline observed in recent years is again a possible indication of declining stock abundance.

YIELD PER RECRUIT

Hylen (1969) estimated a selection factor of 3.79 for the species, which provides a 50% selection length (lc) of approximately 49 cm for a mesh size of 130 mm. Thus, from the data of Table 1, the mean selection age (t_c) is seen to approximate 3.5 years. In addition, Canadian and USA commercial data indicate recruitment to be essentially completed at age IV. Recent European assessments (ICES, 1975) have considered M=0.2 for pollock in the North Sea.

Using the Beverton-Holt (1957) model, yield per recruit values were calculated for Divs. 4VWX-SA5 pollock assuming $t_r = 2.0$, $t_\lambda = 16.0$, and $M = 0.2$ and using the parameter estimates for L_∞, K, and t_0 calculated above (L_∞ = 102 cm, providing a W_∞ of 10.9 kg; K = 0.216, and $t_0 = 0.378$). The resulting yield isopleth diagram (assuming t_c varying between 2 and 8 years, and F varying between 0.1 and 1.8) is given in Figure 8; yield per recruit curves for t_c values of 3.0, 3.5, and 4.0 are given in Figure 9. Values of F giving maximum yield per recruit (F_{max}) are 0.33, 0.40, and 0.48, respectively, while the corresponding values of $F_{.01}$ are 0.21, 0.24, and 0.28. Maximum yield per recruit increases 14 percent by increasing t_c from 3.0 to 4.0 years and increasing F from 0.30 to 0.50.

MORTALITY

Stratified mean catch per tow at age for ALBATROSS IV autumn bottom trawl survey cruises in Divs. 4X and 5Y (Gulf of Maine - Scotian Shelf, strata 24 and 26-42) for the period 1970-1975 are given in Table 9; total mortality coefficients computed from these data are given in Table 10. Computed values in Table 10 fluctuate considerably but do indicate a substantial increase in mortality in recent years; weighted estimates of Z (Table 10) are negative between 1971 and 1973 but increase to 0.73 and 0.83 between 1973-1974 and 1974-1975, respectively (Table 10). Similarly, available data from ALBATROSS IV spring bottom trawl surveys (1973-1975) also indicate increased mortality (the weighted estimate of Z was negative for 1973-1974 but increased to 0.73 for 1974-1975). Assuming M=0.2 for pollock (ICES, 1975), the USA surveys indicate that F has increased to approximately 0.5 since 1973. However, Canadian research vessel survey data indicate a somewhat lower value for 1973-1975 (Z=0.47) although the 1970-1975 figure was higher (Z = 0.62).

It is recognized that a variety of interpretations of the above data are possible. In particular, the data of Tables 9 and 10 indicate considerable variability in catch rates of certain year-classes, which may be associated with shifts in distribution associated with environmental factors; this could be a source of error for this species in the present situation as neither survey covered the Divs. 4VWX-SA 5 area as a unit. In addition, the pollock tends to frequent higher levels of the water column than other groundfish species and is therefore less available to the survey gear. Either of these factors could have biased the computed mortality estimates to some degree. In view of evidence given in preceding sections indicating actual declines in abundance since 1972, however, it would appear logical to assume that F is in fact increasing and to accept the values indicated by the USA survey data (i.e., F = 0.5).

Discussion

Mortality estimates obtained from USA surveys in recent years indicate that F values are currently exceeding F_{max} for this stock. This trend is corroborated by USA commercial and research vessel abundance indices, both of which indicate declines in stock abundance during the same period. Catch at age data from USA research vessel surveys also suggest that the 1972-1974 year-classes are weaker than those of 1968, 1969 and 1971 and that recruitment prospects are less favorable than during 1968-1973. Accordingly, the evidence available indicates that harvesting the existing TAC of 55,000 MT for Divs. 4VWX-SA5 would result in an F considerably above F_{max}.

Assuming an F value of 0.5 for 1975, and assuming an average weight of 2.5 kg per fish in commercial landings, a stock size of 48.4×10^6 fish (121.2×10^3 MT) is obtained for Divs. 4VWX-SA5 pollock at the beginning of 1975. At present, recruitment indices are not available for this stock and thus estimates for 1976 and 1977 are uncertain, but it appears that in view of recent declines in abundance a reduction from the 1975 figure appears likely. Assuming a modest decline in stock size to 100,000 MT for 1977, a catch of 30,000 MT would result from fishing at F_{max}, whereas a catch of 19,000 MT would result from fishing at $F_{.01}$.

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Table 1. Length at age data for pollock caught in ALBATROSS IV spring and autumn bottom trawl surveys, 1970-1975, and fitted lengths and parameter estimates obtained by fitting the von Bertalanffy growth equation.

Age	Sample size	Sample mean length (cm)	Standard error of sample mean	Fitted length (cm)
0.75	-	-	-	12.77
1.25	79	20.34	0.234	17.44
1.75	126	30.68	0.272	26.06
2.25	274	31.58	0.265	33.79
2.75	220	40.45	0.272	40.73
3.25	210	43.69	0.374	46.96
3.75	153	51.10	0.374	52.56
4.25	149	57.10	0.490	57.58
4.75	118	63.14	0.403	62.09
5.25	80	68.63	0.531	66.13
5.75	69	73.71	0.434	69.76
6.25	73	76.18	0.493	73.02
6.75	70	78.69	0.437	75.95
7.25	46	80.26	0.679	78.58
7.75	52	83.17	0.713	80.94
8.25	60	83.02	0.374	83.05
8.75	37	85.70	0.693	84.95
9.25	34	85.76	0.753	86.66
9.75	18	89.50	1.235	88.19
10.25	48	87.35	0.520	89.56
10.75	27	89.81	0.818	90.80
11.25	50	90.36	0.666	91.90
11.75	15	91.27	1.462	92.90
12.25	24	91.58	1.023	93.79
12.75	10	93.80	1.604	94.59
13.25	30	93.87	0.940	95.31
13.75	14	94.14	1.321	95.96
14.25	44	95.02	0.785	96.54
14.75	12	98.92	1.505	97.06
15.25+	85	97.68	0.870	97.52

Estimated parameters and standard errors

	L_∞	K	t_0
Estimates	101.62	0.2159	0.3782
Standard errors	0.49	0.0033	0.0262

Table 2. Pollock landings (MT, round fresh) by division, 4VWX, Subarea 5, and Statistical Area 6.

Year	4Vn	4Vs	4W	4X	Total 4VWX	5Y	5Ze	5Zw	Total 5Z	5NK	Total SA5	SA6	Total
1960	692	811	8,354	20,132	29,989	6,545	-	-	3,834	18	10,397	-	40,386
1961	811	1,053	13,167	14,321	29,352	5,017	-	-	3,177	25	8,219	-	37,571
1962	554	738	12,045	19,624	32,961	2,560	-	-	3,576	15	6,151	-	39,112
1963	400	274	9,152	20,645	30,471	2,168	-	-	3,947	10	6,125	116	36,712
1964	337	137	12,488	19,283	32,245	1,754	-	-	7,250	-	9,004	4	41,253
1965	147	1,058	13,134	13,390	27,729	1,933	-	-	7,065	-	8,998	2	36,729
1966	226	562	11,040	12,648	24,476	953	-	-	8,846	-	9,799	48	34,323
1967	147	510	5,836	8,290	14,787	1,728	-	-	6,790	-	8,523	2	23,312
1968	256	757	5,954	10,656	17,623	1,416	3,724	82	3,806	-	5,222	4	22,849
1969	91	209	3,938	10,983	15,221	4,635	5,025	162	5,187	-	9,822	-	25,043
1970	130	519	2,952	8,194	11,795	6,281	5,157	123	5,280	-	11,561	-	23,356
1971	214	317	1,802	9,739	12,072	7,016	7,096	142	7,238	-	14,312	891	27,275
1972	102	495	3,419	16,190	20,206	6,419	6,519	51	6,570	-	12,989	24	33,219
1973	170	834	5,871	23,225	30,100	5,202	6,235	1,618	7,853	-	13,055	21	43,176
1974	68	239	4,740	20,362	25,409	6,106	6,233	5	6,238	-	12,370	44	37,802

Table 3. Pollock landings for divisions 4VWX, Subarea 5, and Statistical Area 6, by country (MT, round fresh).

Year	Canada	Fed. Rep. Germany	German Dem. Rep.	Japan	Spain	USSR	United Kingdom	U.S.A.	Other[1]	Total
1960	29,470	-	-	-	783	-	-	10,132	1	40,386
1961	26,323	-	-	-	982	-	-	10,265	1	37,571
1962	31,721	-	-	-	-	-	-	7,391	-	39,112
1963	28,999	126	-	-	-	906	28	6,653	-	36,712
1964	30,007	208	-	-	-	4,603	374	6,006	55	41,253
1965	27,316	71	-	-	1,361	2,667	11	5,303	-	36,729
1966	18,271	-	-	-	2,384	9,865	12	3,791	-	34,323
1967	17,567	-	9	-	1,779	644	1	3,312	-	23,312
1968	18,062	-	-	-	1,128	372	-	3,280	7	22,849
1969	15,968	1,188	2,195	-	1,515	227	-	3,943	7	25,043
1970	10,753	3,233	4,295	40	532	527	-	3,976	-	23,356
1971	11,757	633	6,849	15	912	2,216	-	4,890	3	27,275
1972	18,022	475	4,816	8	616	3,495	4	5,729	54	33,219
1973	26,990	1,124	948	1,570	3,113	3,092	-	6,303	36	43,176
1974	24,975	149	2	40	1,500	2,348	48	8,726	14	37,802
1975[2]	26,512	300	96	1	575	2,050	-	8,934	17	38,485

[1]Includes Denmark, France, Italy, Iceland, and Poland.
[2]From ICNAF provisional statistics for 1975.

Table 4. Pollock landings (MT, round fresh) for divisions 4VWX by country.

Year	Canada	Fed. Rep. Germany	German Dem. Rep.	Japan	Spain	USSR	United Kingdom	U.S.A.	Other[1]	Total
1960	27,259	-	-	-	783	-	-	1,946	1	29,989
1961	25,965	-	-	-	982	-	-	2,404	1	29,352
1962	31,120	-	-	-	-	-	-	1,841	-	32,961
1963	28,046	126	-	-	-	291	28	1,980	-	30,471
1964	28,065	208	-	-	-	2,631	48	1,238	55	32,245
1965	25,272	71	-	-	1,361	627	11	387	-	27,729
1966	14,259	-	-	-	2,339	7,254	4	620	-	24,476
1967	12,280	-	4	-	1,675	299	1	528	-	14,787
1968	16,322	-	-	-	770	231	-	295	5	17,623
1969	13,525	16	-	-	1,175	62	-	436	7	15,221
1970	9,900	77	393	39	526	476	-	384	-	11,795
1971	10,121	-	-	10	728	1,053	-	158	2	12,072
1972	16,656	8	14	4	536	2,452	4	486	46	20,206
1973	25,263	39	-	1,556	2,314	340	-	572	16	30,100
1974	21,436	118	-	40	836	2,301	1	676	1	25,409
1975[2]	21,820	-	-	-	-	1,762	-	742	-	24,324

[1]Includes Denmark, France, Poland, Italy, Iceland.
[2]From ICNAF provisional statistics for 1975.

Table 5. Pollock landings (MT, round fresh) for Subarea 5 and Statistical Area 6 by country.

Year	Canada	Fed. Rep. Germany	German Dem. Rep.	Japan	Spain	USSR	United Kingdom	U.S.A.	Other[1]	Total
1960	2,211	-	-	-	-	-	-	8,186	-	10,397
1961	358	-	-	-	-	-	-	7,861	-	8,219
1962	601	-	-	-	-	-	-	5,550	-	6,151
1963	953	-	-	-	-	615	-	4,673	-	6,241
1964	1,942	-	-	-	-	1,972	326	4,768	-	9,008
1965	2,044	-	-	-	-	2,040	-	4,916	-	9,000
1966	4,012	-	-	-	45	2,611	8	3,171	-	9,847
1967	5,287	-	5	-	104	345	-	2,784	-	8,525
1968	1,740	-	-	-	358	141	-	2,985	2	5,226
1969	2,443	1,172	2,195	-	340	165	-	3,507	-	9,822
1970	853	3,156	3,902	1	6	51	-	3,592	-	11,561
1971	1,636	633	6,849	5	184	1,163	-	4,732	1	15,203
1972	1,366	467	4,802	4	80	1,043	-	5,243	8	13,013
1973	1,727	1,085	948	14	799	2,752	-	5,731	20	13,076
1974	3,539	31	2	-	664	47	47	8,050	13	12,393
1975[2]	4,692	-	96	1	-	288	-	8,192	17	13,286

[1]Includes Denmark, France, Poland, Italy, Iceland.
[2]From ICNAF provisional statistics for 1975.

Table 6. Percentage age composition of Canadian and USA pollock landings for Divs. 4VWX and SA 5 by quarter, 1972-1975.

Year and quarter	Age 2	3	4	5	6	7	8	9	10	11	12+
						Canada					
1972-2	-	1.5	17.6	31.8	24.0	13.6	3.6	2.9	4.2	-	-
4	9.8	27.6	36.6	17.0	7.0	1.6	-	0.2	0.3	-	-
1973-1	-	-	35.1	43.1	8.8	3.2	3.7	2.7	2.0	0.7	0.7
2	-	5.8	29.8	34.6	6.4	6.9	2.2	5.7	7.2	1.4	-
3	1.4	9.0	31.9	30.0	9.8	8.7	1.7	4.1	2.6	0.5	0.4
4	3.5	15.4	47.6	23.3	4.7	2.2	1.7	1.0	0.6	-	-
1974-1	-	-	4.8	56.1	22.6	4.9	6.4	-	3.1	1.1	1.1
2	-	10.7	20.3	36.7	19.7	5.8	3.0	1.5	1.6	0.7	0.1
3	4.1	48.5	22.9	16.8	4.3	1.5	1.0	0.4	0.1	0.3	0.1
4	1.9	57.7	13.4	14.9	8.0	2.4	0.9	0.2	0.3	-	0.1
1975-1	-	2.9	52.2	27.1	15.6	1.8	-	0.2	0.2	-	0.2
2	0.5	12.8	40.8	16.8	19.4	7.4	1.2	0.4	0.3	0.3	0.2
3	0.6	23.5	60.0	8.8	5.0	1.7	-	-	0.4	-	0.1
4	4.5	22.5	42.5	11.9	12.0	3.4	1.5	0.5	0.4	0.5	0.4
						USA					
1972-3	7.5	61.5	7.0	3.0	2.0	2.5	5.5	3.5	0.5	2.5	4.5
4	4.5	25.4	11.3	12.5	13.4	7.2	7.0	6.3	8.4	2.0	2.0
1973-1	2.6	78.2	19.0	0.3							
2	-	19.0	49.5	31.6							
3	8.0	25.4	52.1	9.9	2.4	2.4					
4	47.8	5.9	7.3	12.2	11.7	5.9	4.4	4.4	0.5		
1974-1	10.9	7.6	37.2	41.4	2.9						
2		78.6	20.8	0.6							
3	17.8	75.3	6.9								
4		4.7	11.0	21.4	18.7	8.9	13.3	14.4	6.1	0.5	1.2
1975-1	19.6	75.8	4.6								
2		34.2	63.8	2.0							
3	4.9	21.7	32.8	3.3	7.2	13.4	2.2	2.8	8.3	3.3	

Table 7. Pollock landings by age (nos. X10^{-3}) for Divs. 4VWX and SA 5, 1973-1975.

Year	Age 2	3	4	5	6	7	8	9	10	11	12+
					Canada						
1973	116	771	3180	2800	648	523	185	330	321	63	22
1974	240	4210	1903	2227	975	284	166	61	61	35	14
1975	213	2119	5218	1342	1208	388	87	31	38	26	26
					USA						
1973	645	1072	745	345	153	82	54	54	6	-	-
1974	401	2304	778	528	146	57	85	92	39	3	8
1975	564	2595	1280	69	103	190	32	40	119	47	-
					Other						
1973	173	411	1114	919	237	176	69	110	93	18	6
1974	56	745	319	339	138	42	30	19	12	5	3
1975	27	227	402	87	82	37	7	4	9	4	2
					Total						
1973	934	2254	5039	4064	1038	781	308	494	420	81	28
1974	697	7259	3000	3094	1259	383	281	172	112	43	17
1975	804	4941	6900	1498	1393	615	126	75	166	77	28

Table 8. Stratified mean catch per tow (kg) of pollock from the Georges Bank, the Gulf of Maine, and the Scotian Shelf, *ALBATROSS IV* autumn and spring bottom trawl surveys, 1963-1975.

Year	Subdiv. 5Ze (Strata 13-23 and 25) Nos.	Wt(kg)	Div.5Y (Strata 24,26-30,36-40) Nos.	Wt(kg)	Div. 4X (Strata 31-35, 41 & 42) Nos.	Wt (kg)	All areas combined (Strata 13-42) Nos.	Wt(kg)
				Autumn				
1963	0.3	1.08	2.1	8.61	1.9	6.23	1.5	5.79
1964	0.7	2.15	2.7	7.07	0.2	0.24	1.6	4.40
1965	0.3	1.13	1.1	3.70	0.5	1.69	0.8	2.46
1966	1.8	3.02	0.7	2.31	0.2	0.93	0.9	2.18
1967	0.3	0.92	0.7	2.76	0.3	0.33	0.5	1.63
1968	0.1	0.47	1.1	5.22	0.5	1.43	0.7	2.92
1969	0.2	0.35	2.3	12.27	3.7	22.11	2.0	11.22
1970	0.2	0.20	0.8	3.37	0.7	3.27	0.6	2.43
1971	1.0	1.34	0.9	5.63	1.1	2.47	1.0	3.62
1972	0.7	0.55	2.1	7.67	4.3	4.21	2.2	4.76
1973	0.3	0.45	1.4	6.05	3.4	6.27	1.6	4.48
1974	0.1	0.21	1.6	5.52	0.6	2.56	0.9	3.26
1975	0.1	0.14	1.1	3.34	0.5	1.41	0.7	1.94
				Spring[1]				
1968	0.3	1.70	1.7	6.59	0.6	2.66	1.0	4.21
1969	0.4	1.28	1.3	3.25	4.2	14.57	1.7	5.44
1970	0.6	1.22	1.7	7.22	3.8	3.40	1.9	4.55
1971	0.5	1.16	1.1	4.36	3.0	7.10	1.4	4.11
1972	5.7	3.41	2.3	5.65	5.7	6.52	4.1	5.22
1973	7.9	(3.85)	2.5	(2.97)	6.3	(4.36)	5.0	(3.56)
1974	1.9	(2.15)	1.0	(2.81)	4.6	(10.58)	2.1	(4.51)
1975	1.7	(3.06)	1.2	(3.87)	3.5	(6.79)	1.7	(3.93)

[1]Values in parentheses obtained by applying a 1.5-1 conversion ratio for the 41 Yankee trawl.

C 5

Table 9. Stratified mean catch per tow at age (nos) for pollock in ALBATROSS IV autumn bottom trawl survey cruises in Divs. 4X and 5Y (strata 24 and 26-42).

	AGE														
Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14+
1970	0.01	.14	.06	.03	.10	.10	.10	.05	.04	.01	.03	.01	.00	.04	.05
1971	0.03	.14	.24	.07	.01	.08	.12	.05	.10	.03	.01	.01	.02	.02	.08
1972	0.00	.58	1.02	.56	.08	.09	.11	.07	.07	.06	.03	.03	.03	.02	.07
1973	0.00	.04	.88	.13	.22	.15	.16	.11	.07	.00	.18	.02	.01	.05	.07
1974	0.00	.00	.10	.34	.28	.16	.12	.11	.02	.03	.00	.04	.00	.00	.02
1975	0.01	.28	.06	.04	.13	.06	.06	.08	.06	.02	.01	.01	.00	.01	.03

Table 10. Total mortality coefficients (Z) for pollock computed from catch at age data in ALBATROSS IV autumn bottom trawl surveys (strata 24 and 26-42).

Age group	70-71	71-72	72-73	73-74	74-75	Pooled avg.[1] 70-75
1	-0.539	-1.986	-0.417	-0.916	-1.792	-0.938
2	-0.154	-0.847	2.060	0.951	0.916	0.702
3	1.099	-0.133	0.934	-0.767	0.961	0.451
4	0.223	-2.197	-0.629	0.318	1.540	0.245
5	-0.182	-0.318	-0.575	0.223	0.981	0.017
6	0.693	0.539	0.000	0.375	0.405	0.373
7	-0.693	-0.336	0.000	1.705	0.606	0.198
8	0.288	0.511	1.946	0.847	0.000	0.762
9	0.000	0.000	-1.099	0.000	1.099	-0.571
10	1.099	-1.099	0.405	1.504	0.000	0.821
11	-0.693	-1.099	1.099	0.693	1.386	0.606
12	-0.693	0.000	-0.511	0.000	0.000	-0.510
13	-0.693	-1.253	-1.253	0.916	-1.099	-0.731
Pooled Avg. Z_{4+}[2]	0.02	-0.09	-0.22	0.73	0.83	

[1]Computed as $\ln \left(\frac{\Sigma \text{ at age 70-74}}{\Sigma \text{ at age 71-75}}\right)$

[2]Computed as $\ln \left(\frac{\Sigma \text{ ages 4 and older}}{\Sigma \text{ ages 5 and older}}\right)$

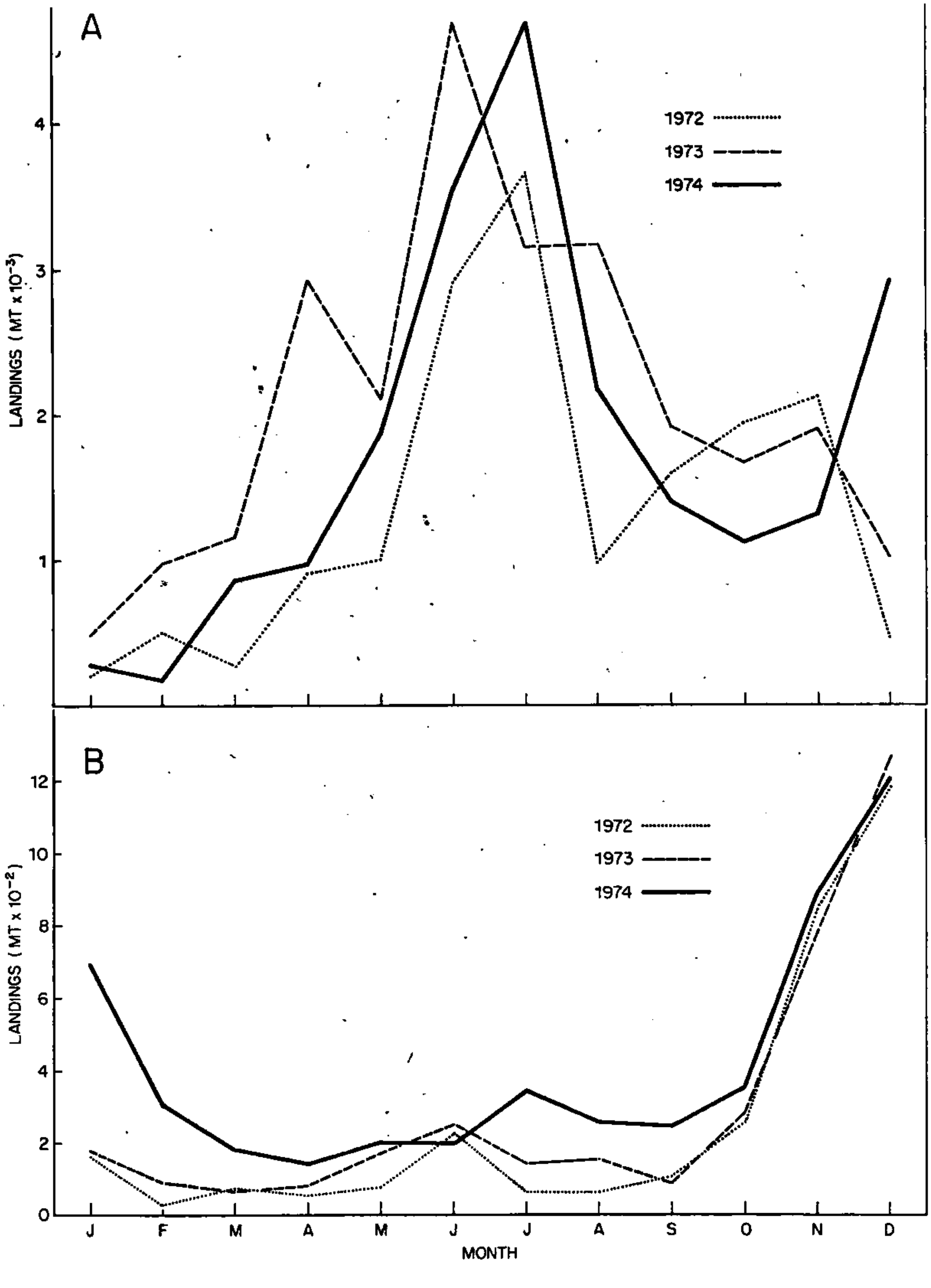

Figure 1. (A) Canadian landings by month in Divs. 4VWX, and (B) USA landings in Div. 5Y, 1972-1974. (Data taken from Table 4 of ICNAF statistical bulletins 22-24).

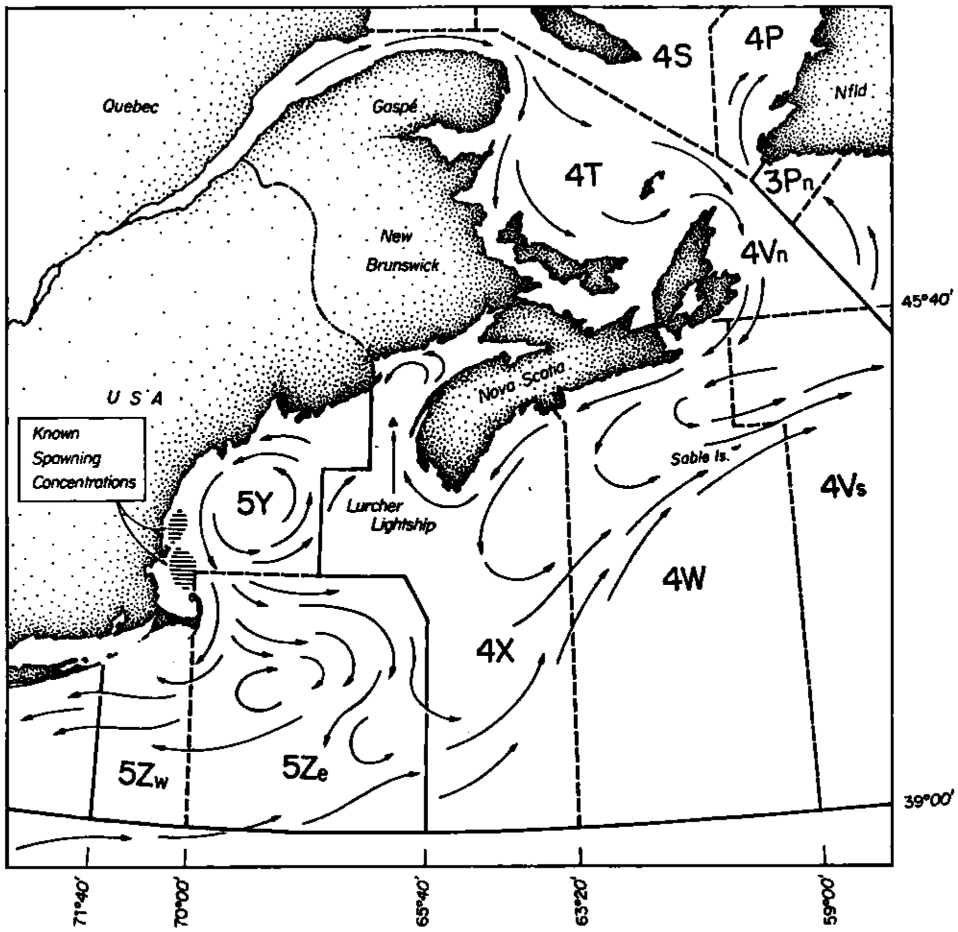

Figure 2. Pollock spawning concentrations and non-tidal summer surface currents of western Atlantic coastal waters in summertime (after Colton and Temple, 1961; Steele, 1963).

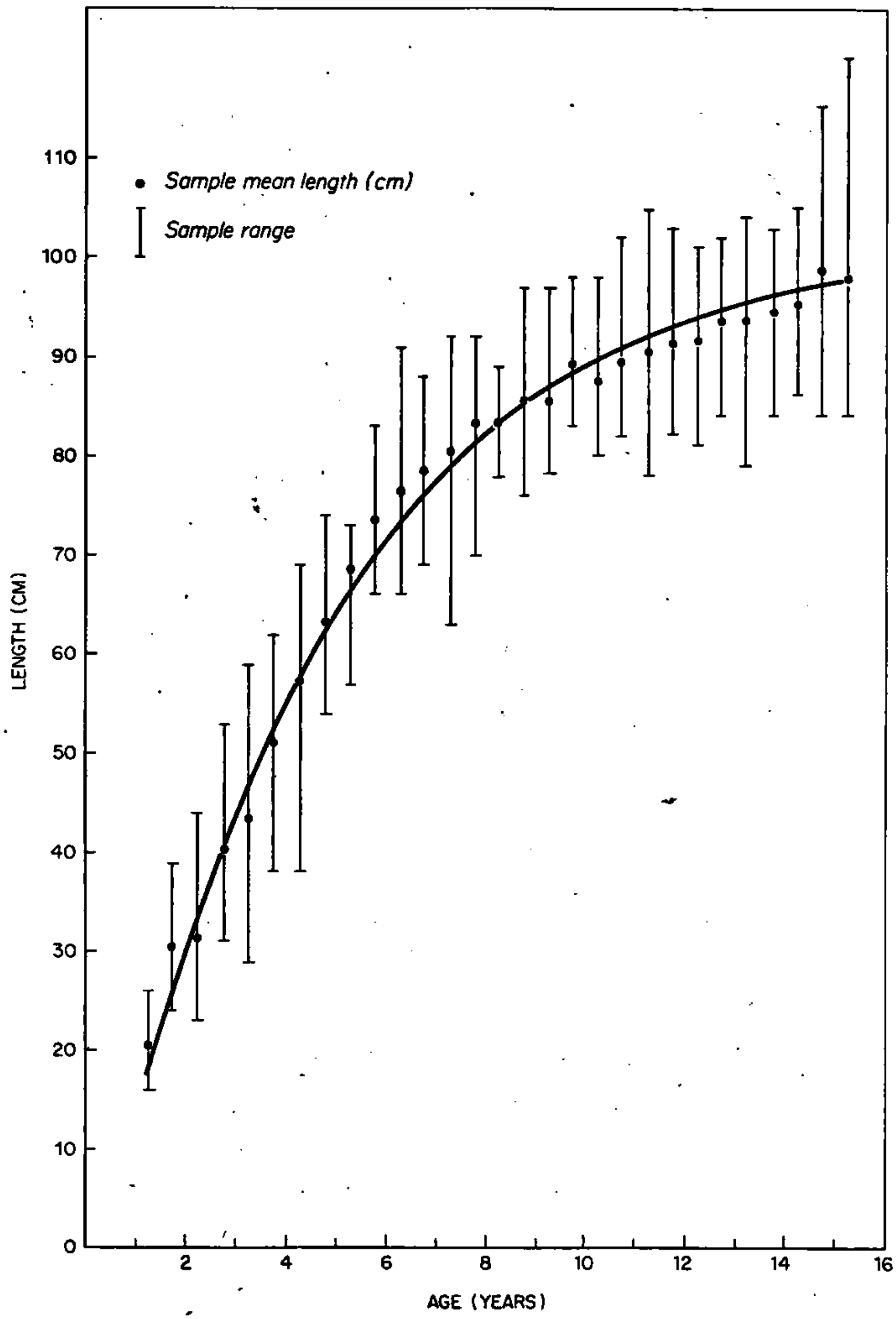

Figure 3. Van Bertalanffy growth curve for pollock from Divs. 4X and Subarea 5, fitted to length at age data collected on ALBATROSS IV bottom trawl surveys, spring and autumn 1970-1975.

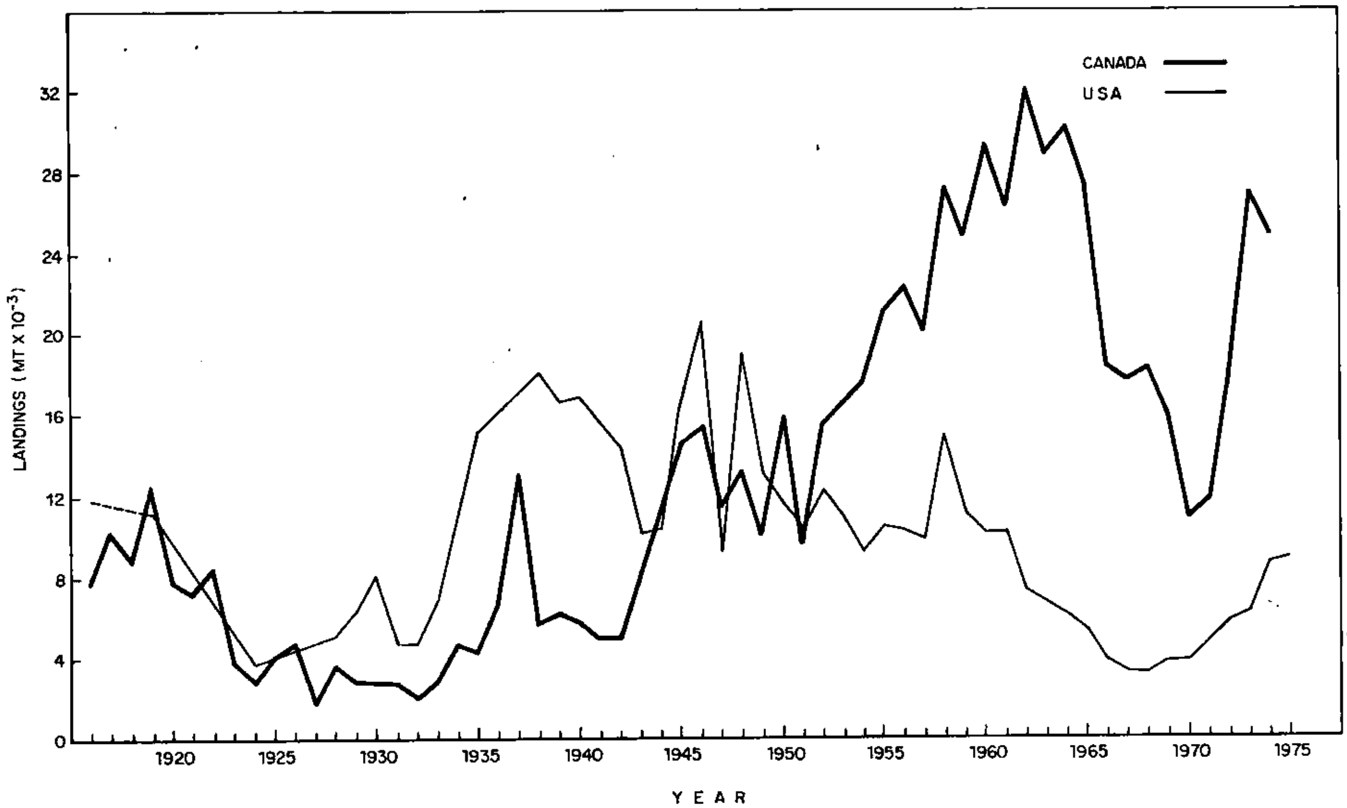

Figure 4. Canadian and US landings from Divs. 4VWX and SA5, 1920-1975. Canadian landings prior to 1960 were approximated by using New Brunswick and Nova Scotia landings, converted to round fresh weight, as given in Fisheries Statistics of Canada, U.S. figures were obtained from the Statistical Digest for 1965.

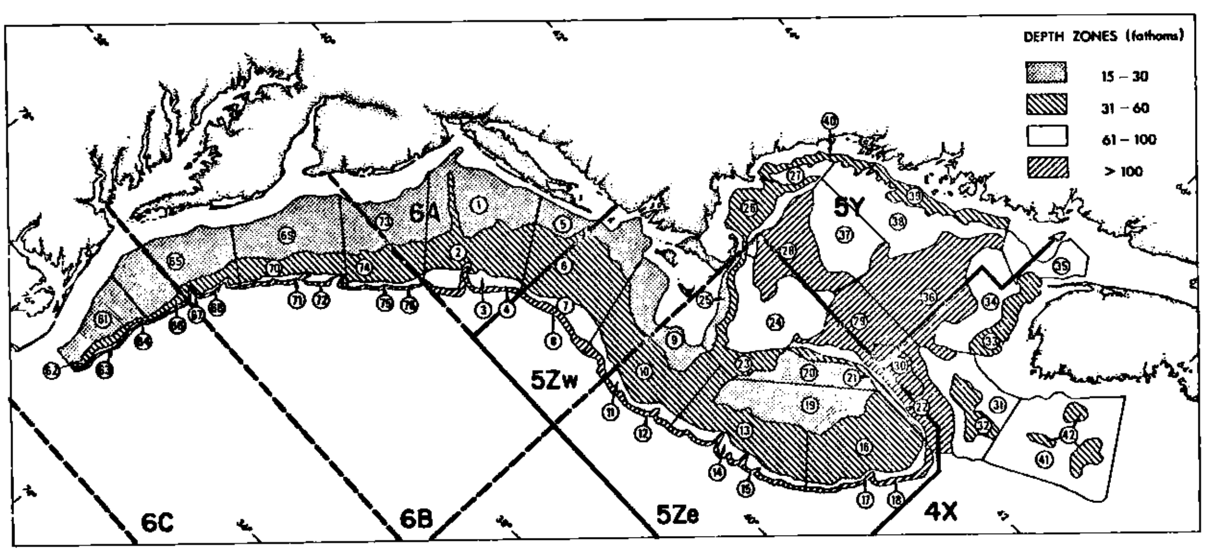

Figure 5. Strata used in ALBATROSS IV spring and autumn bottom trawl surveys with ICNAF division boundaries superimposed.

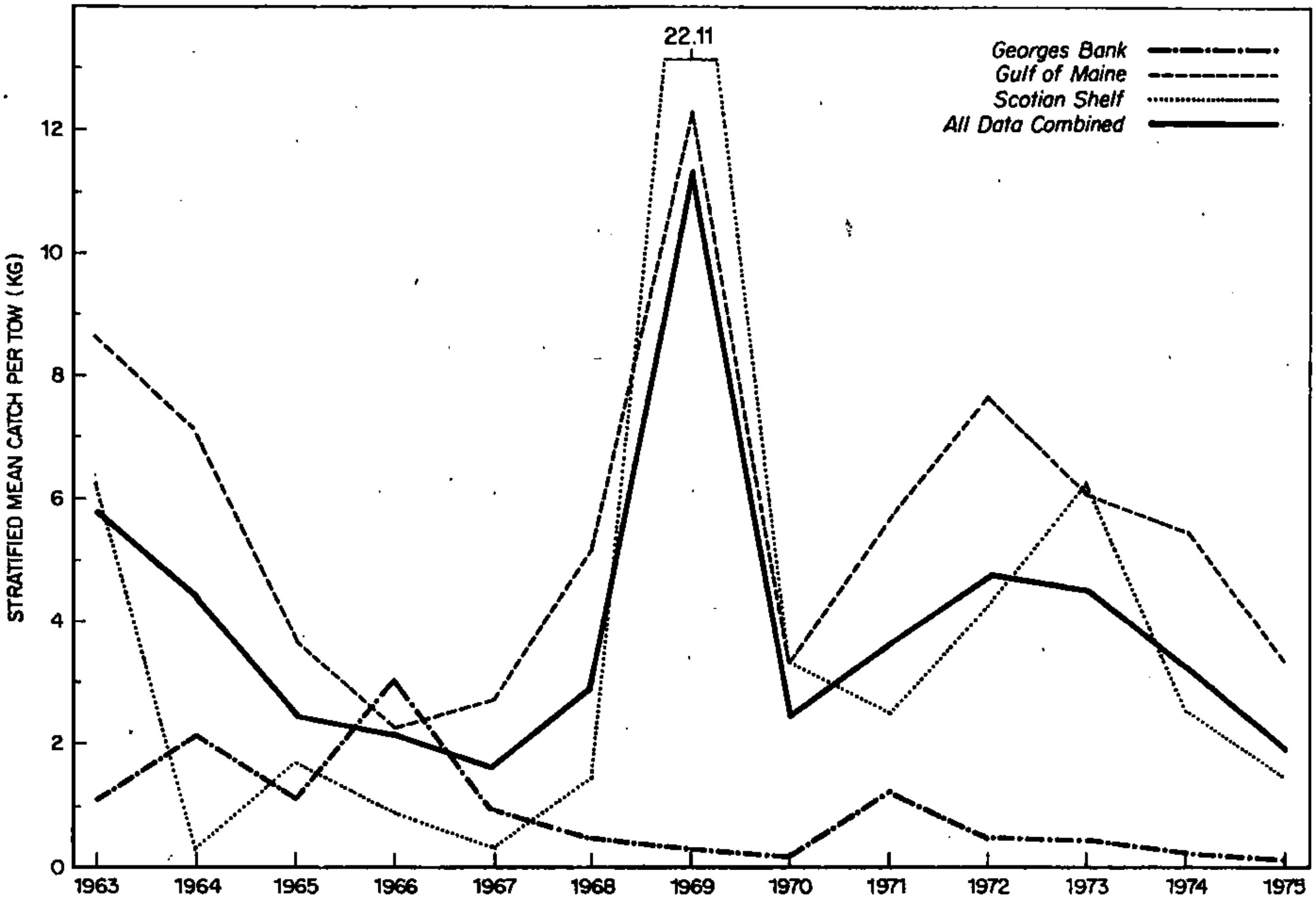

Figure 6. ALBATROSS IV autumn bottom trawl survey abundance indices for Georges Bank (Subdiv. 5Ze), the Gulf of Maine (Div. 5Y) and the Scotian Shelf (Div. 4X), plotted individually and combined.

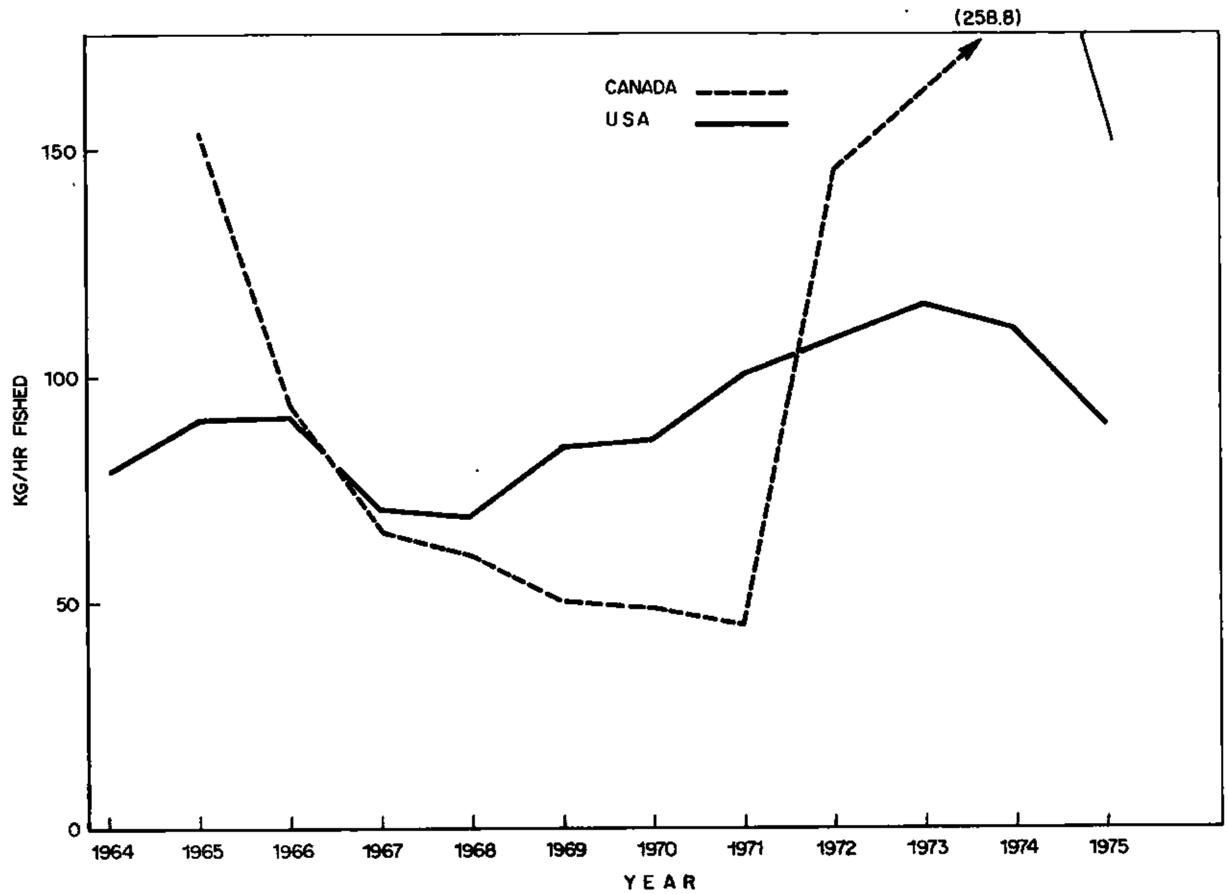

Figure 7. Commercial abundance indices for pollock in Divs. 4VWX-SA5 for Canada and the USA, 1964-1975. Canadian data computed from catches of otter trawlers of 151-500 GRT; US data computed from catches of all otter trawlers landing pollock in amounts equal to or greater than 10% of the total per trip.

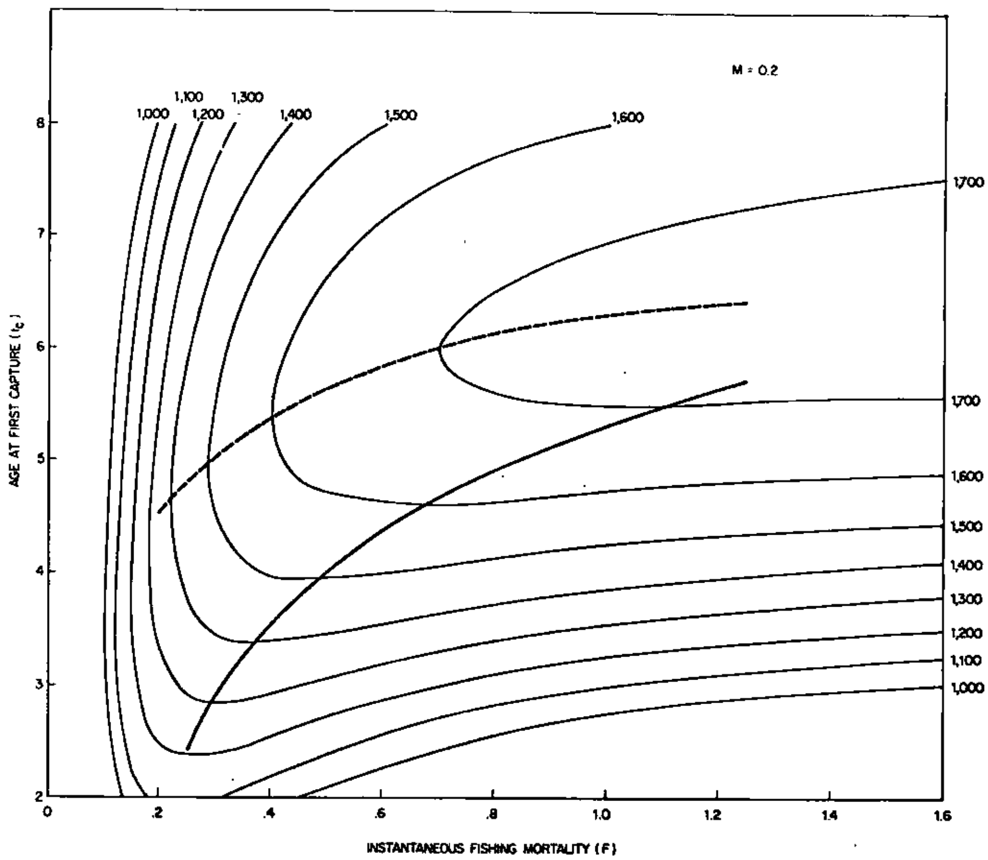

Figure 8. Yield isopleth diagram for Divs. 4VWX - SA5 pollock assuming W_∞ = 10.9 kg, K = 0.216, t_0 = 0.378, t_r = 2.0, t_λ = 16.0, and M = 0.2. The heavy solid line indicates F_{max} at t_c, while the dashed line indicates the t_c giving the greatest yield per recruit at a given F.

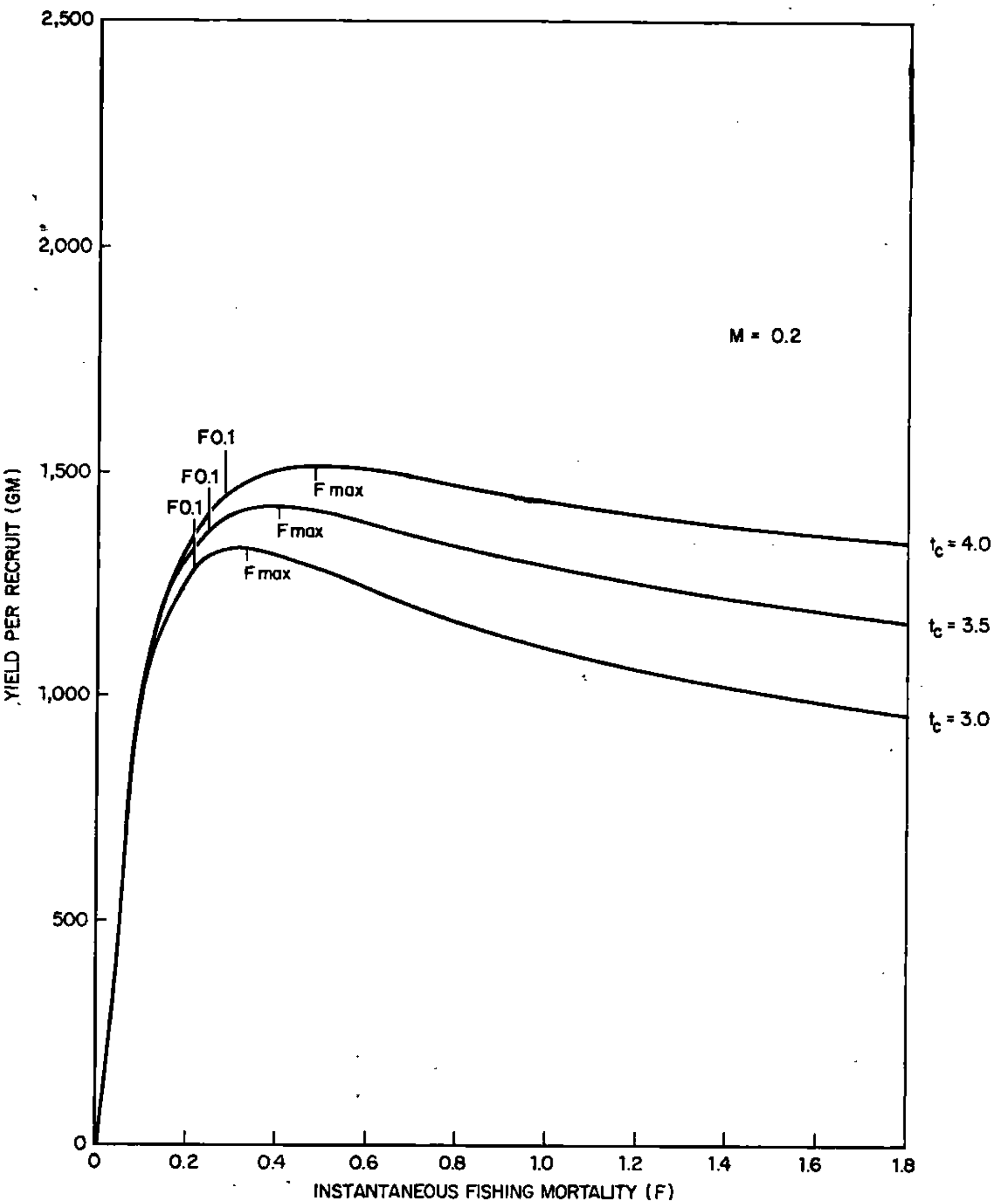

Figure 9. Yield per recruit curves for Divs. 4VWX-SA5 pollock assuming t_c values of 3.0, 3.5, and 4.0 years, W_∞ = 10.9 kg, K = 0.216, t_0 = 0.378, t_r =2.0, t_λ = 16.0, and M = 0.2.

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Addendum

ANNUAL MEETING - JUNE 1976

A preliminary assessment of the pollock fishery in ICNAF Divisions 4VWX and Subarea 5

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Age composition of Canadian 1975 landings

In 1975, Canadian landings of 26,512 mt are estimated to have contained 10.7 x 10^6 fish with average weight of 2.5 kg (Table 1). The 1971 year class as 4-yr.-olds predominated in the catch, supporting the conclusion that it is a year class of above average size.

Canadian research vessel survey results

The 1975 Canadian groundfish survey results suggest that pollock abundance in Div. 4VWX was lower than in 1974. The 1969 and 1971 year classes predominated in the catch, and catches of age 2 and age 3 fish (the 1972 and 1973 year classes) were the lowest for these age groups in the data series (Table 2).

Mortality estimates (Z) from surveys averaged for the 1970-75 period are $Z = 0.65$ which, assuming $M = 0.20$, gives an estimate of $F = 0.45$. Average commercial catches during this period was 34,000 mt.

Cohort analysis

Given three years of commercial removals at age data, meaningful results can be expected for the first of these years from cohort analysis if the assumed F in the last year is reasonably accurate. A starting $F = 0.45$ ($M = 0.20$) was applied to the 1973-75 removals at age (Table 3). This gave weighted average F's for ages 4-10 in 1973 and 1974 of $F = 0.56$ and $F = 0.48$ respectively. This supports the conclusion that F has been in the order of 0.50 in most recent years.

Canadian commercial catch rates

Canadian catch rates increased from a low of 45.5 kg/hr in 1971 to 258.8 kg/hr in 1974, but declined to 153.2 kg/hr in 1975 (Table 4). The rapid increase in the 1970's was at least in past due to an increase in directed fishing for pollock. However, the increased Canadian catch of pollock in 1975 at a lower catch rate suggests that the lower catch rate is not a reflection of changes in the direction of fishing, but reflects a decline in pollock abundance.

Conclusions

Recent catches which averaged 34,000 net have generated mortalities above F_{max} and with indications of declining abundance due to poorer recruitment in the immediate future, the conclusion that removals from this stock be reduced is supported.

Table 1 . Div. 4VWX + SA5 Pollock - 1975 commercial catch age compositions for Canada ($x10^{-3}$).

Age	Jan.-Mar.	Apr.	May	June	July-Sept.	Oct.	Nov.	Dec.	Total
2	-	9	-	3	21	1	109	71	213
3	13	140	94	74	902	84	142	670	2119
4	238	432	292	261	2298	295	330	1071	5218
5	124	126	107	173	336	184	152	140	1342
6	71	135	113	219	190	174	215	91	1208
7	8	41	19	118	66	53	43	39	388
8	-	3	2	23	-	26	32	-	87
9	1	1	1	8	-	11	8	-	31
10	1	-	2	6	16	7	7	-	38
11	-	-	3	3	-	9	-	11	26
12	1	-	-	-	4	11	-	-	16
13+	-	-	1	4	-	1	3	-	10
Totals	456	887	634	892	3833	857	1043	2092	10,694
Mean wt. (kg)	2.28	2.28	2.38	3.27	2.28	3.30	2.86	2.14	2.48
Mean length (cm)	56.9	55.9	56.8	64.1	56.7	64.5	60.4	55.15	58.0
No. of samples	3	7	4	6	6	5	2	3	36

Table 2 . Div. 4VWX Pollock - Survey estimates of population biomass (mt) and numbers at age ($x10^{-3}$).

Age	1970	1971	1972	1973	1974	1975
1	35	-	51	-	35	-
2	8,867	3,631	465	1,998	209	29
3	2,136	3,023	986	1,859	4,679	89
4	1,326	837	6,146	5,649	1,162	1,624
5	967	194	1,905	2,075	1,421	1,383
6	953	89	551	330	923	1,838
7	766	158	157	76	1,047	307
8	494	54	272	191	464	460
9	106	36	227	290	421	147
10	-	111	177	11	261	20
11	266	-	61	128	641	37
12	66	-	29	56	230	-
13+	-	-	125	-	-	-
Unk.	135	-	51	69	-	-
Total nos.	16,117	8,133	11,203	12,732	11,493	5,934
Biomass (mt)	29,830	9,500	28,080	28,770	36,500	21,490

	1970–1971	1971–1972	1972–1973	1973–1974	1974–1975	Mean
$Z_{4+/5+}$	2.07	-0.88	1.10	0.50	0.45	0.65
$Z_{5+/6+}$	2.13	-0.94	1.13	0.21	0.66	0.64

$Z_{4+/5+}$	$Z_{5+/6+}$
1970-75 = 0.62	1970-75 = 0.50
1973-75 = 0.47	1973-75 = 0.24
1974-75 = 0.45	1974-75 = 0.65

Table 3 . Div. 4VWX + Subarea 5 Pollock - cohort analysis.

	AGE 2	3	4	5	6	7	8	9	10	11	12
A. Catch at age ($x10^{-3}$)											
1973	934	2254	5039	4064	1038	781	309	494	420	81	28
1974	697	7259	3000	3094	1259	383	281	172	112	43	17
1975	842	5110	7044	1530	1421	627	129	77	170	79	17
B. Popn. nos. ($x10^{-3}$)											
1973	42587	13439	16152	9018	2246	1590	1339	1053	559	120	40
1974	(31773)	34022	8963	8665	3706	899	595	818	415	78	25
1975	(31418)	(25383)	21288	4624	4294	1895	390	233	514	239	25
C. Fishing mortality (F)											
1973	0.03	0.21	0.42	0.69	0.72	0.78	0.29	0.73	1.78	1.38	0.45
1974	(0.03)	0.27	0.46	0.50	0.47	0.64	0.74	0.27	0.35	0.95	0.45
1975	(0.03)	(0.25)	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45

F weighted by popn. nos. at age for ages 4 - 10.

1973 = 0.56

1974 = 0.48

Table 4. Division 4VWX Pollock - catch rates of Canadian side otter trawlers of 151-500g.t. (kg./hr. fished).

Year	4Vn	4Vs	4W	4X	4VWX
1965	1.6	17.6	260.7	160.1	153.3
66	0.6	5.3	174.2	86.3	93.3
67	1.9	7.8	119.6	63.2	66.6
68	0.1	8.8	93.6	70.8	60.5
69	0.5	3.2	65.2	73.3	50.4
70	0.4	2.0	45.8	88.6	49.1
71	5.2	5.2	22.9	97.3	45.5
72	0.3	94.0	111.3	233.3	145.3
73	1.2	20.4	138.6	298.1	162.9
74	0.6	51.5	309.2	379.9	258.8
75	2.4	39.7	173.6	228.0	153.2