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Preliminary Assessmen
of White Hake

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A PRELIMINARY ASSESSMENT OF WHITE HAKE IN THE GULF OF MAINE - GEORGES BANK AREA

1984

by

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SUMMARY

This report reviews biological and fishery-related information for white hake [*Urophycis tenuis* (M.)] off the northeast coast of the USA. White hake are most abundant in deeper muddy basin areas within the Gulf of Maine, although seasonal movements between inshore and offshore areas have been documented for both juveniles and adults. Maturity data suggest protracted spawning from November to April; however, only 7% of the males and 2% of the females examined were classified as ripe fish. Total length at 50% maturity (L_{50}) was found to be about 42 cm (17 inches) for both sexes. A preliminary analysis of length-at-age data collected during NEFC surveys suggests growth rates similar to those reported for white hake in the Gulf of St. Lawrence.

Commercial landings from the Gulf of Maine - Georges Bank region averaged 4,700 mt during 1975-1980 and have since increased to about 7,000 mt in 1983; the projected USA total for 1984 is about 6,500 mt. Since 1960, USA vessels have accounted for 92% of the total, with most of the remainder being taken by Canada. Most of the USA catch has been taken by bottom trawling in the western Gulf of Maine during summer. There is little information relative to size/age composition of the commercial catch. Commercial catch per unit effort (CPUE) has been relatively high since 1980; research vessel survey indices fluctuated without a definite trend during 1969-1979, increased somewhat during 1980-1981, and have since declined. The initial increase in these indices about 1980 was associated with improved recruitment, although subsequent CPUE values have likely been biased upwards by changing fishing practices and increases in fishing power. Consequently, greater reliance has been placed on trends evidenced by research vessel survey data, and accordingly it is herein concluded that abundance and biomass have declined since 1981. The concomitant increase in landings since that year indicates that fishing mortality has also increased. Recent harvest levels (in the order of 6-7,000 mt) may not be sustainable, although additional information is needed to properly evaluate the long-term impacts of recent increases in exploitation.

INTRODUCTION

The white hake [*Urophycis tenuis* (Mitchill)] is a demersal gadoid species commonly taken in deeper areas of the Gulf of Maine. Commercial interest in white hake is limited; poor keeping qualities and low ex-vessel prices have inhibited the development of a directed fishery, and thus, most landings are taken as by-catch. Nevertheless, harvests have increased in recent years and are currently the highest observed since the late 1940's.

From 1973-1976, white hake were managed under a collective total allowable catch (TAC) for "other finfish" established by the International Commission for the Northwest Atlantic Fisheries (ICNAF). Since withdrawal of the United States from ICNAF in December 1976, domestic landings of white hake have been essentially unregulated. This species was included in the "Preliminary Fishery Management Plan for Finfish Caught Incidental to the Trawl Fisheries of the Northwest Atlantic" implemented by the United States Department of Commerce (USDC) in February 1977. Beginning in that year, total allowable levels of foreign fishing (TALFFs) were established for this complex, but allocations for white hake were never specified. White hake are also included in the species complex to be managed by the Atlantic Demersal Finfish (ADF) Plan now under development by the New England Fishery Management Council (NEFMC) and originally scheduled for implementation in April 1985.

Musick (1969) reported that white hake from the Scotian Shelf exhibited identical meristic and morphometric characteristics as observed for Gulf of Maine fish, although Northeast Fisheries Center (NEFC) survey data indicate a discontinuous distribution. For the purposes of this

assessment, white hake of the Gulf of Maine - Georges Bank region are herein considered as a unit stock. Other arrangements may be more appropriate; but final determinations cannot be made without additional analyses which are beyond the scope of the present document.

This report summarizes biological and fisheries-related information for white hake in the Gulf of Maine - Georges Bank region (Northwest Atlantic Fisheries Organization or NAFO Subarea 5), and provides a preliminary stock assessment based on analyses of commercial and research vessel survey data. The data bases used include USA commercial landings and effort data for Statistical Areas 511-515 and 521-539 (Figure 1) and NEFC research vessel survey data for Strata 21-30 and 33-40 (Figure 2).

DISTRIBUTION

White hake inhabit deep, cold regions of the western North Atlantic. The range of this boreal species extends along the continental shelf from Labrador and the Grand Banks of Newfoundland to Georges Bank, and in deeper slope waters southward to Florida (Bigelow and Schroeder 1953; Musick 1974). Off the northeastern United States, white hake are most abundant in the Gulf of Maine and in deeper areas along the fringes of Georges Bank (Figure 3). White hake are most common over mud bottom (Bigelow and Welsh 1925; Musick 1974) and coexist with red hake (*Urophycis chuss*), silver hake (*Merluccius bilinearis*), witch flounder (*Glyptocephalus cynoglossus*), American plaice (*Hippoglossoides platessoides*), redfish (*Sebastes* spp.), and other species common to deep water mud basins (Bigelow and Schroeder 1939).

The depth distribution of white hake varies by season and life stage. Typically, adults move inshore to depths as shallow as 30 m in summer,

perhaps after spawning, and disperse to offshore areas and/or basins at depths of up to 400 m in late fall and winter (Musick 1974). This pattern is somewhat variable within the Gulf of Maine, probably due to irregular topography (i.e., deep basins interspersed with swells and ledges) obscuring an inshore-offshore delineation. Juveniles are pelagic in habit and generally occur in shallower waters; they reportedly move inshore into harbors and estuaries in the spring, especially in the northern Gulf of Maine region, returning to deeper offshore areas in autumn. Juveniles appear to be slightly more temperature-tolerant (2°-15°C) than adults (2°-13°C) (Musick 1974). Juveniles have been noted to use floating patches of eelgrass (*Zostera*) and rockweed (*Fucus*) for cover, a behavior observed by Nichols and Breder (1927) for another species of hake, *Urophycis floridana*. By the time they have attained lengths of about 32 cm (13 inches), most juveniles have settled to the bottom in deep areas to assume the adult pattern of existence (Musick 1969). Most trawl catches of white hake are taken at depths greater than 120 m, although they are also taken in summertime as shallow as 30 m during gillnetting operations.

BIOLOGY

A recurring difficulty in the study of white hake is its close resemblance to the red hake. Although white hake grow much larger and can be identified by meristic and/or morphometric criteria (Bigelow and Schroeder 1953, Musick 1973), the latter differences are not immediately obvious and thus the two hakes are often misidentified. Battle (MS 1951), Bigelow and Schroeder (1953), and Leim and Scott (1966) have all acknowledged this confusion and treat the two species as one. However,

Musick (1960) conducted an extensive meristic and morphometric analysis of the two species and established conclusive distinguishing characters, namely, the number of scales along the lateral line (*U. tenuis*, 119 to 148; *U. chuss*, 95 to 117) and the number of gill rakers on the epibranchial of the first gill arch (*U. tenuis*, 2; *U. chuss*, 3). Musick also dispelled the common misconception that juvenile white hake are inquiline (living in the mantle cavity) with sea scallops (*Placopecten magellanicus*), a behavior documented for red hake. Musick (1969) reviewed geographic distribution patterns of the two hakes and reported them to be "complementary rather than coincidental", i.e., white hake tend to be more common on the Scotian Shelf and further north, while red hake are more common off the USA Mid-Atlantic coast. These species are commonly taken together during NEFC bottom trawl surveys within the Gulf of Maine, however, especially during summer and autumn. Information collected during dockside interviews and aboard commercial fishing vessels also suggests a more extensive degree of overlap for the two species.

White hake attain total lengths of 135 cm (53 inches) and weights of 21 kg or 46 pounds (Leim and Scott 1966). The weight-length relationship derived from NEFC survey data is:

$$W = 0.0000034L^{3.2196}$$

where W = weight (kg) and L = total length (cm). A similar relationship has been derived by Beacham and Nepszy (1980) for white hake in the Gulf of St. Lawrence (NAFO Division 4T), viz.

$$W = 0.0000043L^{3.153}$$

Length at 50% maturity (L_{50}), based on data from NEFC surveys for 1977-1982, is about 42 cm for both sexes (Figure 4). Morse (MS 1979) reported L_{50} values of 43 cm and 48 cm for males and females, respectively, while Beacham (1983) reported a range of 45-59 cm for females in Canadian waters. Given a 50% selection factor of 4.0 for this species (Mayo et al. MS 1981), this implies that L_{50} for white hake in the Georges Bank - Gulf of Maine region is below the mean retention length of 5.5 inch mesh trawls (56 cm).

Age data for white hake are limited although some preliminary aging has been performed (Beacham and Nepszy 1980, Hunt MS 1982). The latter author obtained the following von Bertalanffy growth equations for the Gulf of St. Lawrence region (NAFO Div. 4T):

$$L_t = 110.6\ [1-e^{-0.11(t+1.17)}]\ \text{(males); and}$$

$$L_t = 135.3\ [1-e^{-0.09(t+0.89)}]\ \text{(females)}$$

where L_t = total length (cm) at age t in years. Preliminary analyses of age-length data for the Gulf of Maine provided generally similar parameter estimates, although data were not adequate for definitive analyses. Ages of up to 21 years have been documented in the Gulf of Maine.

Information relative to white hake spawning is both limited and conflicting. Bigelow and Schroeder (1953) suggest that white hake spawn from late winter through late summer, and Colton and St. Onge (1974) found larvae in May and June from Southern New England to the Scotian Shelf. However, Colton et al. (1979) observed ripe fish in the Middle Atlantic Bight (Continental Slope region) between October and April, with peak activity from December through February. Leim and Scott (1966) indicate that spawning occurs in early autumn on the Scotian Shelf and during late winter and early spring in the Bay of Fundy. Petrov (MS 1973) concluded

that spawning in Subarea 3 took place during the summer. NEFC maturity data for the Gulf of Maine suggest protracted spawning from November to April; however, only 7% of the males and less than 2% of the females examined were classified as ripe fish. This scarcity of ripe fish, combined with the lack of a clearly defined spawning season, led Musick (1969) to conclude that white hake do not spawn successfully in the Gulf of Maine, and accordingly he proposed that this population is sustained by larval recruitment from the Scotian Shelf. Musick observed identical morphometric characters between Gulf of Maine and Scotian Shelf white hake, lending some support to this hypothesis. Much additional information is needed relative to white hake reproduction in the Gulf of Maine region. No fecundity estimates exist for white hake in the Gulf of Maine, but Beacham and Nepszy (1980) calculated the following relationship from a sample of 41 fish from the Gulf of St. Lawrence (NAFO Division 4T):

$$F = 0.000257L^{5.53}$$

where F = number of eggs and L = total length in centimeters.

Juvenile white hake feed primarily upon crustaceans, especially decapod shrimp and euphausiids; 93% of the diet (stomach contents by weight) of fish 21-30 cm in length is crustaceans (Bowman and Michaels MS 1982). Fish are the preferred food of individuals $\geq$40 cm, and white hake larger than 60 cm are almost exclusively piscivorous. Adults prey heavily on juveniles as well as silver hake, argentines (*Argentine silus*), winter flounder (*Pseudopleuronectes americanus*), and clupeids (Bowman and Michaels MS 1982). Bigelow and Schroeder (1953) suggest that hakes are nocturnal foragers, and a preliminary analysis of NEFC food habits data indicates a diel aspect to white hake activity, with feeding initiated at

dusk and peaking at midnight[1]. While juvenile hake appear to be preyed upon heavily by adults and other large gadoids, this would not appear to be true for adults because of their size.

COMMERCIAL FISHERY

Although an excellent table fish when fresh, white hake possess soft flesh and do not keep as well as other gadoids. There is some demand for fresh white hake both locally and in New York and other northeastern U.S. cities. Freezing leads to the buildup of dimethylamine and formaldehyde in hake meat (Castell et al. 1971), a problem which is more severe for white hake and red hake than for other gadoid species[2]. Current efforts to address this problem (Racicot et al. 1984) may result in expanded use of white hake for frozen products.

Accordingly, there has been no continuous directed fishery for white hake, and landings have resulted primarily from by-catch in trips directed towards more valuable species. There is similarly little or no directed recreational fishery for this species, although white hake are occasionally taken from recreational party and charter boats. Recreational catch records do not exist for this species prior to 1979, and estimated catches during 1979-1983 were negligible[3].

Nominal Catch and Discard

Nominal catches (live weight equivalent of landings exclusive of discard, hereafter referred to as "landings") of white hake from NAFO Subarea 5 averaged 3,900 metric tons (mt) during 1960-1983, ranging from a low of 400 mt in 1968 to a high of about 7,000 mt in 1983 (Table 1).

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[1]Bowman, Ray, NEFC, Woods Hole Laboratory, personal communication.

[2]Licciardello, Joseph, NEFC, Gloucester Laboratory, personal communication.

[3]Holliday, Mark, Resource Statistics Division, NMFS, Washington, DC, personal communication.

Annual landings averaged 3,400 mt during 1960-1965 and then declined sharply to only 400 mt in 1968. Landings subsequently increased steadily to 5,100 mt in 1974, averaged 4,700 mt during 1975-1980, and have since increased to 7,000 mt (provisional) for 1983. This increase appears to be primarily associated with a general increase in USA effort in the western Gulf of Maine in recent years. USA landings for NAFO Subarea 5 approximated 6,200 mt in 1983; the projected USA total for 1984 is 6,500 mt.

Since 1960, USA vessels have accounted for 92% of Subarea 5 landings, with Canadian vessels accounting for most of the remainder; most of the Canadian catch has been taken on eastern Georges Bank. Landings by other countries have been minor (and negligible since 1978). This would be expected based on distribution data from NEFC surveys (Figure 3) and restriction of demersal trawl effort by distant water fleets to offshore areas along the outer continental shelf from southern Georges Bank to Cape Hatteras[4]. Since 1969, 57% of the USA white hake catch has been landed in Maine (Table 2), especially in the ports of Portland and Rockland. The relative proportion has increased since 1980, however, reflecting the rise of a gill net fishery operating from Vinalhaven and Stonington.

Discard information for white hake is limited. Culling practices tend to be highly variable; if market prices are relatively high, fish as small as 40 cm may be kept, otherwise the average cull length will generally fluctuate between 55 and 60 cm. Discard information from a sea sampling trip made in the Gulf of Maine during July 1984 (Figure 5) appears generally representative of the latter situation, although smaller

[4]Federal Register, 50 CFR Part 611, January 13, 1983.

fish (40-55 cm) were retained if the catch of other species on any individual tow was light[5]. Significant discard of white hake appears to occur during trips directed towards redfish in the Gulf of Maine due to depths and locations fished and mesh size used.

Vessels and Gear

White hake are caught primarily by bottom trawls (Table 3). Since the mid-1970's, the line trawl (longline) fishery has been almost completely replaced by gillnetting, which presently accounts for most of the remainder. Small amounts (<1%) of white hake are also taken by other types of gear.

Since 1969, tonnage class (TC) 2 vessels of 5-50 gross registered tons (GRT) have accounted for 56% of USA white hake landings (Table 4). Increased landings by TC 3 (51-150 GRT) and 4 (151-500 GRT) vessels since 1980 reflect increases in fleet size and apparent shifts in directed effort in recent years. The number of TC 4 vessels in the New England otter trawl fleet has, in fact, almost tripled between 1978 and 1983[6].

Area and Season

Since 1969, 79% of USA white hake landings have been taken in the western Gulf of Maine (Statistical Areas 511-515, Figure 1), and most of this catch has been from Statistical Areas 512 and 513 (Table 5). Increased gillnet activity in recent years has been centered in the latter two areas. Approximately 65% of the Gulf of Maine landings occur during July-October (Table 6, Figure 6), reflecting seasonal changes in fishing effort and

[5] Crew members reported high levels of white hake discard (>25% by weight) during 1981-1983, but it is likely that at least some of this catch was, in fact, red hake.

[6] Kirkley, James, NEFC, Woods Hole Laboratory, personal communication.

availability. The remainder of the white hake landings in the Gulf of Maine are taken primarily as by-catch from year-round trawling operations directed towards species such as witch flounder, American plaice, and redfish which inhabit deeper offshore areas, e.g., in Statistical Area 515 (Figure 1), although white hake may also be an intended component in such mixed fishery situations when ex-vessel prices are high.

The Georges Bank catch is primarily incidental in fisheries directed towards other gadoids (haddock, *Melanogrammus aeglefinus*, Atlantic cod, *Gadus morhua*, and pollock, *Pollachius virens*). These catches occur year-round, primarily in Statistical Areas 521 (Great South Channel) and 522-523 (Northern Edge) at depths greater than 120 m.

The recent World Court decision transferring jurisdiction over the Northern Edge - Northeast Peak region of Georges Bank and the eastern Gulf of Maine to Canada is expected to result in a comparatively minor reduction in availability of white hake to the U.S. fishery. During 1981-1983, only 3% of the total harvest by USA vessels came from the Georges Bank area now under Canadian jurisdiction, and the proportion of the total taken in areas of NAFO Division 5Y now under Canadian jurisdiction appears to be even less. Redistribution of USA effort, however, could result in increased fishing mortality on white hake on western Georges Bank and in the western Gulf of Maine.

Size Composition of Commercial Landings

Although nine market categories currently exist for white hake, virtually all landings are reported as "unclassified" due to the practice of removing heads. (Since eyes cannot be used as an indicator of product

quality, heads have traditionally been removed at sea). As a result, NEFC port sampling for white hake length frequencies is now virtually nonexistent, although samples are taken whenever possible during sea sampling work. At present, landings for market categories other than unclassified (large round, large dressed, and small dressed) are reported only for Portland, Maine, and Point Judith, Rhode Island, but such landings represent less than 1% of the total.

INDICES OF ABUNDANCE

Catch Per Unit Effort (CPUE)

Commercial catch and effort data are often useful for evaluating trends in relative abundance, although derivation of appropriate indices is difficult for by-catch species such as white hake. Nominal catch, effort (days fished), and catch per unit effort (CPUE) were examined by vessel tonnage class for 1975-1983 (Table 7) to develop such an index, using trips by Portland, Rockland, and Gloucester vessels employing otter trawl gear. Indices were calculated by tonnage class for all trips and for trips in which at least 40% of the total catch by weight consisted of white hake in an attempt to identify "directed" effort. The latter criterion was arbitrary and does not insure that such trips were, in fact, directed towards this species.

For all tonnage classes, CPUE has generally fluctuated without a discernible trend, although values increased sharply in 1981 and have since remained relatively high. There is some evidence from NEFC surveys and industry reports of improved recruitment during this period, suggesting

that the initial rise in CPUE did, in fact, reflect an actual increase in white hake abundance. The continued utility of such indices, however, is dependent on the assumption that fleet composition, market conditions, and fishing practices have not changed; and since abundance of several other commercially important species in this region has, in fact, declined in recent years concomitant with increases in fleet size and effort, this is quite likely not the case. Declines in abundance have been noted since 1981 for cod, haddock, plaice, witch flounder, and cusk, *Brosme brosme* (Resource Assessment Division 1984). This trend, coupled with continued increases in fleet size and fishing power (particularly for TC 4 vessels), may have biased recent trends in CPUE. A sharp increase in landings and effort did occur in the 40% category in 1983, indicating that shifts in directed effort have occurred.

Research Vessel Survey Indices

The NEFC initiated stratified random bottom trawl surveys in the Gulf of Maine - Georges Bank region in the autumn of 1963; a spring survey was initiated in 1968. The autumn surveys have employed a standard "36 Yankee" trawl; this trawl was also used for spring surveys during 1968-1972 and during 1982-1984. Spring surveys during 1973-1981 utilized a modified high-opening "41 Yankee" trawl. Both trawls have been equipped with 1.25 cm mesh codend liners and roller gear to make them suitable for use on rough bottom. Further details on NEFC survey methodology and application of resulting data to assessments are provided by Grosslein (1969), Azarovitz (1981), and Clark (1981).

Indices of relative abundance and biomass (stratified mean catch per tow in numbers and weight in kilograms, kg) for white hake were derived from data for Strata 21-30 and 33-40 (Figure 2) and are presented in Table 8 and Figures 7 and 8. Spring indices have generally been consistent with autumn, although since 1981 the spring index has declined more sharply. This may have resulted, at least in part, from the 1982 gear conversion noted above. No conversion factors are available to adjust for increases in fishing power.

The autumn survey (weight) index correlates reasonably well with commercial landings for 1963-1981 ($r = 0.59$, $p<0.01$; see Figure 9). In view of the incidental nature of the fishery during this period, such a correlation provides some evidence that the survey does, in fact, accurately reflect resource trends. No significant relationship was observed for spring, although index trends generally agree with those for autumn. Indices for autumn, after averaging 4.4 fish or 5.5 kg per tow during 1963-1968, rose sharply in 1969 and fluctuated around 8.1 fish or 11.8 kg during 1969-1979 without any consistent trends (landings averaging 4,100 mt during this period, with a range of 2,000-5,600 mt; See Table 8). Indices increased to 10.9 fish or 16.7 kg in 1980, and have since declined steadily (1982 values are considered anomalous). Recent trends for spring survey index values have been similar as noted above. Thus, NEFC survey results are consistent in indicating declines in both abundance and biomass in recent years as fishing effort has increased.

Length-frequency distributions for white hake sampled in NEFC surveys (Figure 10) suggest limited availability prior to autumn at age 1 (<20 cm) and recruitment to the survey gear may not be complete for another year or so. There was evidence for recruitment of a relatively strong year class at age 2 in 1981 (Figure 10) which appears to have supported high catch levels since that year. This is substantiated by fishermen's reports of high discard of smaller fish during this period. There is no evidence for continued above-average recruitment to support the fishery in the near future.

Misidentification problems (red vs. white hake) do not appear to have affected these results appreciably. An attempt to quantify the magnitude of this problem, based on differences in otolith (earbone) shape between the two species, suggests that, with the exception of two cruises, misidentifications were minimal. Survey indices for the two years in question were recalculated; however, this correction did not significantly alter the index values obtained.

CONCLUSIONS

Commercial landings of white hake in the Gulf of Maine - Georges Bank region have increased steadily since 1968, and are currently at the highest level observed since the late 1940's. Effort in the New England otter trawl fishery has risen substantially in recent years and appears to have been a primary factor in this increase, since most white hake are caught incidentally in fisheries directed toward other species or as an intended component of the catch in mixed fishery situations. There are also indications of an increase in directed effort, e.g., a directed gillnet fishery for white hake appears to be emerging in Statistical Areas 512

and 513 during summer and autumn. Continued declines in abundance of traditional species, i.e., cod, haddock, and flounders, coupled with technological advances in preservation and "surimi" processing, could lead to further increases in directed effort.

Information relative to white hake abundance is limited. Historically, NEFC spring and autumn survey indices appear to have been representative, and commercial and survey indices are consistent in suggesting a modest increase in biomass since the late 1970's. Since 1981, both spring and autumn survey indices have declined, although commercial CPUE has remained relatively high. Since there has been a substantial increase in fleet size through capital construction in recent years, and abundance of many "traditional" species in the Gulf of Maine has declined since 1981, it is felt that commercial CPUE may have been biased by shifts in directed effort and increased fishing power (within tonnage classes) during this period. Accordingly, evaluations of recent trends in abundance are herein based on research vessel survey results, and it is concluded that abundance has declined in recent years. Since this decline has been accompanied by an increase in landings, it is inferred that fishing mortality has also increased, perhaps substantially. Survey catch-per-tow-at-length data suggest above-average recruitment during the early 1980's which has apparently contributed to recent increases in landings and commercial CPUE but there is no evidence for continuation of this trend.

The general lack of biological data for this species, coupled with a lack of key fishery-related information, e.g., directed effort and catch-at-age data, make evaluation of recent levels of exploitation difficult. Nevertheless, reductions in abundance evidenced by NEFC surveys

since 1981 suggest that current harvest levels (>6,000 mt) will probably not be sustainable. The uncertainty regarding white hake spawning and recruitment processes in the Gulf of Maine is an added complication in such evaluations and underscores the need for further biological research.

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Table 1. Nominal catch[1] of white hake (metric tons, live) by country from the Gulf of Maine to Cape Hatteras (NAFO Subareas 5 and 6), 1960-1983.

	NAFO Subarea/Division													
	5Y[2]			5Z			6[3]			Totals			Total Subarea 5	Grand Total
Year	Canada	USA	Other	Canada	USA	Other[4]	Canada	USA	Other[4]	Canada	USA	Other		
1960	-	2,421	-	-	906	-	-	-	-	-	3,327	-	3,327	3,327
1961	-	2,143	-	-	872	-	-	-	-	-	3,015	-	3,015	3,015
1962	1	2,596	-	8	551	-	-	-	-	9	3,147	-	3,156	3,156
1963	-	2,747	-	11	665	-	-	75	-	11	3,487	-	3,423	3,498
1964	3	2,888	-	26	1,327	-	-	36	-	29	4,251	-	4,244	4,280
1965	-	2,688	-	-	811	-	-	29	-	-	3,528	-	3,499	3,528
1966	-	926	-	-	334	-	-	43	-	-	1,303	-	1,260	1,303
1967	-	419	-	16	21	-	-	21	-	16	461	-	456	477
1968	5	334	-	80	24	-	-	24	-	85	382	-	443	467
1969	-	1,095	-	-	892	6	-	28	-	-	2,015	6	1,993	2,021
1970	12	1,564	-	34	909	222	-	20	58	46	2,493	280	2,741	2,819
1971	18	2,137	-	82	1,432	109	-	68	105	100	3,637	214	3,778	3,951
1972	8	2,839	-	32	1,026	159	-	54	-	40	3,919	159	4,064	4,118
1973	17	3,057	-	100	1,063	1	-	40	4	117	4,160	5	4,238	4,282
1974	36	3,839	-	196	1,001	-	-	60	-	232	4,900	-	5,072	5,132
1975	17	3,039	-	129	556	-	-	40	-	146	3,635	-	3,741	3,781
1976	-	3,542	-	195	548	-	-	25	-	195	4,115	-	4,285	4,310
1977	-	4,391	-	170	880	189	-	12	149	170	5,283	338	5,630	5,791
1978	20	4,151	-	135	923	1	-	15	28	155	5,089	29	5,230	5,273
1979	102	3,235	-	149	859	3	-	1	1	251	4,095	4	4,348	4,350
1980	14	3,835	-	291	980	1	-	4	1	305	4,819	2	5,121	5,126
1981	21	4,480	-	433	1,221	-	-	5	-	454	5,706	-	6,155	6,160
1982	352	4,906	-	412	1,074	1	-	4	1	764	5,984	2	6,745	6,750
1983[5]	441	5,055	-	369	1,113	1	-	2	-	810	6,168	1	6,979	6,981

[1] As reported to ICNAF/NAFO for 1960-1983. All USA data prior to 1981 multiplied by a factor of 1.34 to adjust from gutted, heads-off weight as reported to NAFO to live weight.

[2] NK landings for SA5 assigned to Division 5Y.

[3] Statistics not available prior to 1963.

[4] Includes Japan, Spain, and the USSR.

[5] Provisional (incomplete).

Table 2. U.S. nominal catch[1] of white hake (metric tons, live) by state, 1970-1983.

Year	State			Total
	Maine	Mass.	Others	
1970	856	1,516	91	2,463
1971	1,183	2,165	138	3,487
1972	1,792	2,141	76	4,009
1973	1,700	2,295	86	4,082
1974	2,297	2,589	40	4,926
1975	2,069	1,423	16	3,508
1976	2,506	1,423	16	3,945
1977	2,968	1,766	35	4,769
1978	3,046	1,621	19	4,685
1979	2,404	1,364	11	3,779
1980	2,727	1,591	43	4,360
1981	3,621	2,004	93	5,718
1982	4,253	1,800	128	6,181
1983	4,291	1,871	245	6,407
Mean	2,551	1,826	74	4,451
% Total	57.3	41.0	1.7	100.0
% Since 1980	66.5	31.0	2.5	100.0

[1]Source: NEFC Weighout Files. All data prior to 1981 multiplied by a factor of 1.34 to adjust from gutted, heads-off weight to live weight.

Table 3. U.S. nominal catch[1] of white hake (metric tons, live) by gear, 1970-1983.

Year	Gear: Line Trawl	Gear: Bottom Otter Trawl	Gear: Sinking Gill Net	Other[2]	Total
1970	268	2,017	173	5	2,463
1971	713	2,604	158	12	3,487
1972	1,116	2,365	513	15	4,009
1973	1,093	2,416	564	7	4,080
1974	836	2,472	1,605	13	4,927
1975	972	1,333	1,201	1	3,507
1976	527	1,595	1,818	7	3,946
1977	350	2,318	2,092	9	4,769
1978	297	2,157	2,212	19	4,686
1979	192	2,014	1,556	19	3,780
1980	71	2,584	1,679	27	4,360
1981	104	3,342	2,262	11	5,719
1982	95	3,867	2,201	18	6,181
1983	59	4,870	1,394	85	6,408
Mean	478	2,568	1,388	18	4,452
% Total	10.7	57.7	31.2	0.4	100.0
% Since 1980	1.4	66.0	32.0	0.6	100.0

[1]Source: NEFC Weighout Files. All data prior to 1981 multiplied by a factor of 1.34 to adjust from gutted, heads-off weight to live weight.

[2]Includes handline, Scottish seine, drifting gill net, scallop dredge, Danish seine, pound net, hand seine, floating trap net, longline, and midwater trawl.

Table 4. U.S. nominal catch[1] of white hake (metric tons, live) by vessel tonnage class[2], 1970-1983.

Year	Tonnage Class (TC) 2	3	4	Others[3]	Total
1970	1,030	1,000	433	-	2,463
1971	1,501	1,493	492	-	3,485
1972	2,195	1,343	458	-	3,996
1973	2,447	1,235	399	-	4,082
1974	3,247	1,215	465	-	4,927
1975	2,629	607	271	-	3,507
1976	2,802	843	299	-	3,944
1977	3,272	1,020	504	1	4,770
1978	3,063	1,087	535	-	4,685
1979	2,200	1,055	469	55	3,779
1980	2,490	1,142	729	-	4,360
1981	2,911	1,467	1,327	-	5,705
1982	3,037	1,832	1,311	-	6,180
1983	2,150	2,407	1,792	1	6,350
Mean	2,498	1,268	677	4	4,445
% Total	56.2	28.5	15.2	0.1	100.0
% Since 1980	44.4	31.3	24.3	0.0	100.0

[1]Source: NEFC Weighout Files. All data prior to 1981 multiplied by a factor of 1.34 to adjust from gutted, heads-off weight to live weight.

[2]TC2 = 5-50 GRT, TC3 = 51-150 GRT, TC4 = 151-500 GRT.

[3]Undertonnage vessels.

Table 5. U.S. nominal catch[1] of white hake (metric tons, live) by Statistical Area for Georges Bank and Gulf of Maine region, 1970-1983.

Year	Statistical Areas[2]															Total
	511	512	513	514	515	521	522	523	524	525	526	537	538	539	6+	
1970	27	370	768	255	153	367	240	62	8	9	43	56	-	4	7	2,368
1971	72	769	788	371	141	657	374	60	16	12	32	58	1	4	39	3,394
1972	80	1,111	1,110	421	133	523	297	67	59	28	23	24	-	3	19	3,897
1973	51	783	1,351	632	255	602	220	27	15	8	20	59	-	3	4	4,028
1974	84	661	2,100	737	244	704	239	24	28	4	17	9	-	4	4	4,859
1975	50	997	2,163	351	340	496	165	29	24	7	8	5	-	4	1	4,640
1976	20	829	1,821	272	393	403	95	9	15	5	5	4	-	-	3	3,875
1977	28	537	2,428	531	385	350	303	35	20	11	5	5	-	-	-	4,638
1978	35	1,345	1,743	351	334	366	359	70	13	4	4	19	1	-	5	4,650
1979	342	957	1,036	276	295	409	348	82	8	3	5	4	-	3	-	3,767
1980	86	821	1,776	253	397	465	373	98	9	8	9	15	-	5	3	4,317
1981	59	1,358	2,252	148	662	303	478	354	52	10	7	13	-	1	4	5,701
1982	299	2,056	1,423	286	843	411	346	240	17	21	11	20	4	3	4	5,984
1983	427	1,601	1,464	264	1,296	352	387	297	35	9	7	16	-	10	2	6,167
Mean	119	1,014	1,587	368	419	458	302	104	23	10	14	22	0.4	3	7	4,449
% Total	2.7	22.8	35.7	8.3	9.4	10.3	6.8	2.3	0.5	0.2	0.3	0.5	0.0	0.1	0.2	100.0

[1]Source: NEFC Weighout Files. All data prior to 1981 multiplied by a factor of 1.34 to adjust from gutted, heads-off weight to live weight.

[2]Statistical Areas given in Figure 1.

Table 6. U.S. nominal catch[1] of white hake by month from the Gulf of Maine (NAFO Division 5Y) and Georges Bank (NAFO Division 5Z), 1970-1983.

	NAFO Div 5Y (Gulf of Maine)												
Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
1970	32	19	27	28	94	163	190	255	253	256	147	106	1,570
1971	38	21	24	32	79	208	173	512	359	292	257	147	2,143
1972	46	21	20	27	143	196	418	704	493	474	166	147	2,856
1973	59	28	42	55	122	197	348	728	504	497	253	239	3,071
1974	176	42	39	121	189	174	401	631	651	685	419	297	3,824
1975	98	66	51	94	267	326	555	922	607	303	410	202	3,899
1976	76	123	134	99	113	244	708	516	598	299	265	163	3,338
1977	91	56	114	110	141	236	557	760	592	560	490	201	3,909
1978	88	119	60	101	118	162	328	978	762	595	338	158	3,808
1979	71	25	42	62	151	260	544	831	369	247	178	127	2,906
1980	76	62	60	71	67	330	590	722	513	464	248	130	3,333
1981	54	39	76	45	69	331	751	1,188	638	510	551	227	4,479
1982	85	51	109	77	123	416	984	1,133	656	582	447	243	4,906
1983	292	171	222	152	252	458	642	886	593	615	450	322	5,055
Mean	92	60	73	77	138	264	514	769	542	456	330	194	3,507
% Total	2.6	1.7	2.1	2.2	3.9	7.5	14.7	21.9	15.5	13.0	9.4	5.5	100.0

	NAFO Div 5Z (Georges Bank)												
Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
1970	44	52	36	21	58	51	54	67	92	186	71	55	788
1971	64	27	21	25	40	25	68	94	181	295	272	98	1,211
1972	114	62	46	31	48	51	87	138	71	186	118	72	1,024
1973	95	42	46	48	74	58	68	48	52	146	178	111	966
1974	54	25	71	76	31	84	74	78	88	172	137	138	1,028
1975	40	28	31	38	44	70	67	50	54	115	146	56	738
1976	17	23	16	19	20	71	39	31	64	66	113	54	532
1977	25	35	84	35	47	42	63	86	48	74	119	71	729
1978	13	27	51	27	43	102	40	101	96	166	142	32	840
1979	16	8	29	44	79	62	95	131	66	133	129	54	858
1980	29	43	39	24	62	110	129	135	123	90	147	54	985
1981	135	41	33	39	58	105	132	173	155	136	112	101	1,220
1982	86	70	56	46	57	45	153	124	140	100	113	85	1,075
1983	94	54	41	47	71	144	152	115	106	96	116	77	1,113
Mean	59	38	43	37	52	73	87	98	95	140	137	76	936
% Total	6.3	4.1	4.6	4.0	5.6	7.8	9.5	10.5	10.1	15.0	14.6	8.1	100.0

[1]Source: NEFC Weighout Files. All data prior to 1981 multiplied by a factor of 1.34 to adjust from gutted, heads-off weight to live weight.

Table 7. Nominal catch[1] (C), days fished (DF) and catch per day fished (C/DF) by vessel tonnage class for trips[2] in which white hake were landed, and trips for which 40% or more of the total catch consisted of white hake, 1975-1983.

	Tonnage Class								
	2			3			4		
Year	C	DF	C/DF	C	DF	C/DF	C	DF	C/DF
				All Trips					
1975	287	354.0	0.81	847	1,386.2	0.61	319	682.6	0.47
1976	279	360.4	0.77	1,336	1,340.0	1.00	390	817.3	0.48
1977	752	1,370.0	0.55	1,643	1,969.7	0.83	726	897.1	0.81
1978	401	1,289.1	0.31	1,676	2,275.3	0.74	816	1,179.1	0.69
1979	430	1,412.4	0.30	1,423	2,695.4	0.53	508	1,069.5	0.47
1980	437	1,342.5	0.33	1,486	3,071.4	0.48	966	1,583.6	0.61
1981	555	999.1	0.56	2,379	3,343.3	0.71	2,133	2,077.7	1.03
1982	877	1,861.2	0.47	3,251	4,541.5	0.72	2,535	3,078.1	0.82
1983	917	1,686.3	0.54	3,430	3,958.3	0.87	2,823	3,009.6	0.94
				40% Trips					
1975	51	7.7	6.62	21	5.7	3.68	3	0.4	7.50
1976	59	13.3	4.44	110	8.5	12.94	0	0.0	0.00
1977	8	1.9	4.21	12	1.6	7.50	135	4.7	28.72
1978	1	1.0	1.18	13	1.2	10.83	0	0.0	0.00
1979	9	2.3	3.91	66	6.4	10.31	0	0.0	0.00
1980	9	2.8	3.21	11	1.0	11.00	0	0.0	0.00
1981	34	13.8	2.49	123	15.0	8.20	54	6.5	8.31
1982	11	1.9	5.78	85	12.8	6.62	6	0.5	11.26
1983	187	38.4	4.87	289	49.5	5.83	235	32.7	7.18

[1]Source: NEFC Weighout and interview files. Nominal catch and catch per day fished given in thousands of pounds. All data prior to 1981 multiplied by a factor of 1.34 to adjust from gutted, heads-off weight to live weight.

[2]Trips landed in Portland, Maine, Rockland, Maine, and Gloucester, Massachusetts, only, and using otter trawl as only gear.

Table 8. Stratified mean catch per tow in numbers and weight (kg) of white hake from NEFC offshore spring and autumn bottom trawl surveys[1] in the Gulf of Maine and on Georges Bank, 1963-1984.

Year	Spring[2] Nos.	Spring[2] Wt.	Autumn Nos.	Autumn Wt.
1963	--	--	5.00	6.31
1964	--	--	1.76	4.14
1965	--	--	4.39	6.85
1966	--	--	6.79	7.66
1967	--	--	3.90	3.64
1968	1.60	1.74	4.24	4.54
1969	3.76	5.09	9.24	13.10
1970	5.84	11.86	8.05	12.83
1971	3.31	5.13	10.38	12.10
1972	10.18	12.66	12.52	13.10
1973	9.24	12.21	9.05	13.46
1974	8.08	13.99	5.35	11.00
1975	9.31	11.22	5.28	7.23
1976	9.98	17.00	6.04	10.56
1977	6.12	11.01	9.78	13.74
1978	3.22	6.14	7.87	12.54
1979	5.26	4.97	5.62	10.31
1980	10.37	13.96	10.86	16.66
1981	17.09	19.92	8.70	12.16
1982	6.06	8.91	1.59	1.87
1983	3.21	3.12	7.96	10.60
1984	2.65	4.09	5.14	8.16

[1]Strata 21-30 and 33-40 (see Figure 3).

[2]Spring surveys used a modified high-opening "41 Yankee" trawl from 1973-1981. Indices presented are not converted to reflect differences from "36 Yankee" trawl used in the remainder of the survey time series.

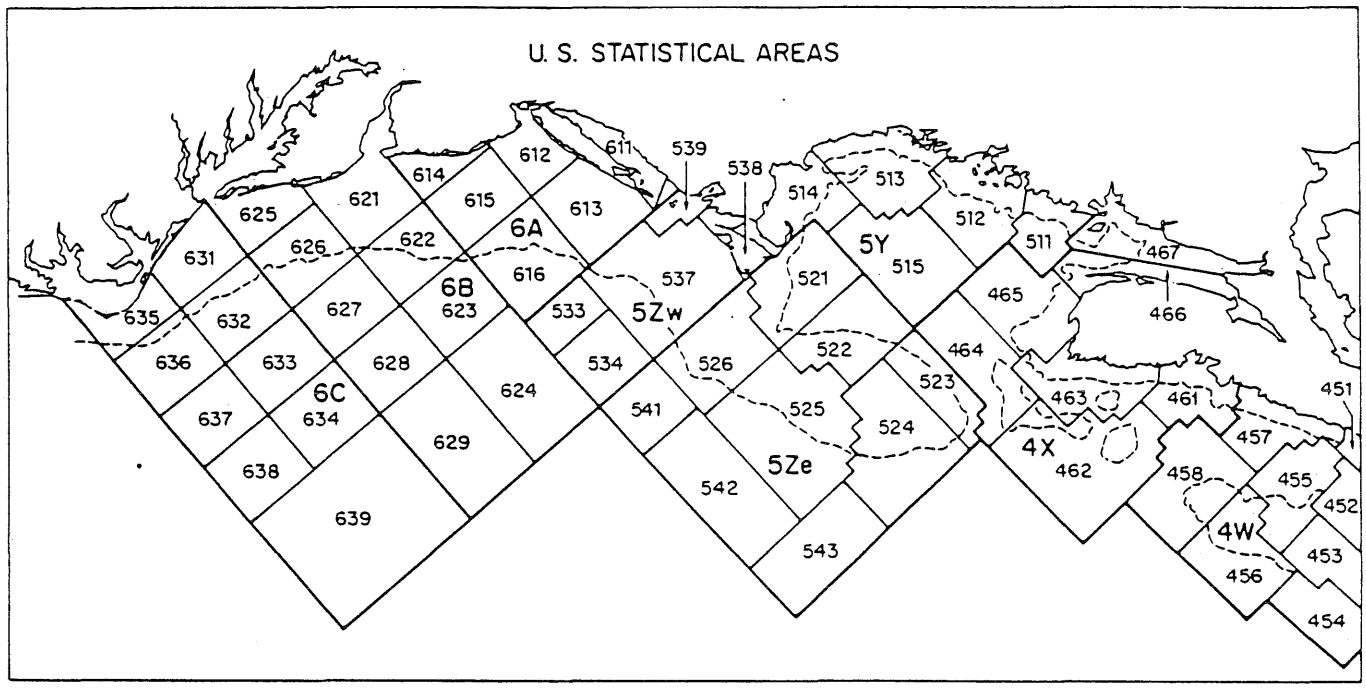


Figure 1. Statistical areas used for reporting USA commercial fishery statistics.

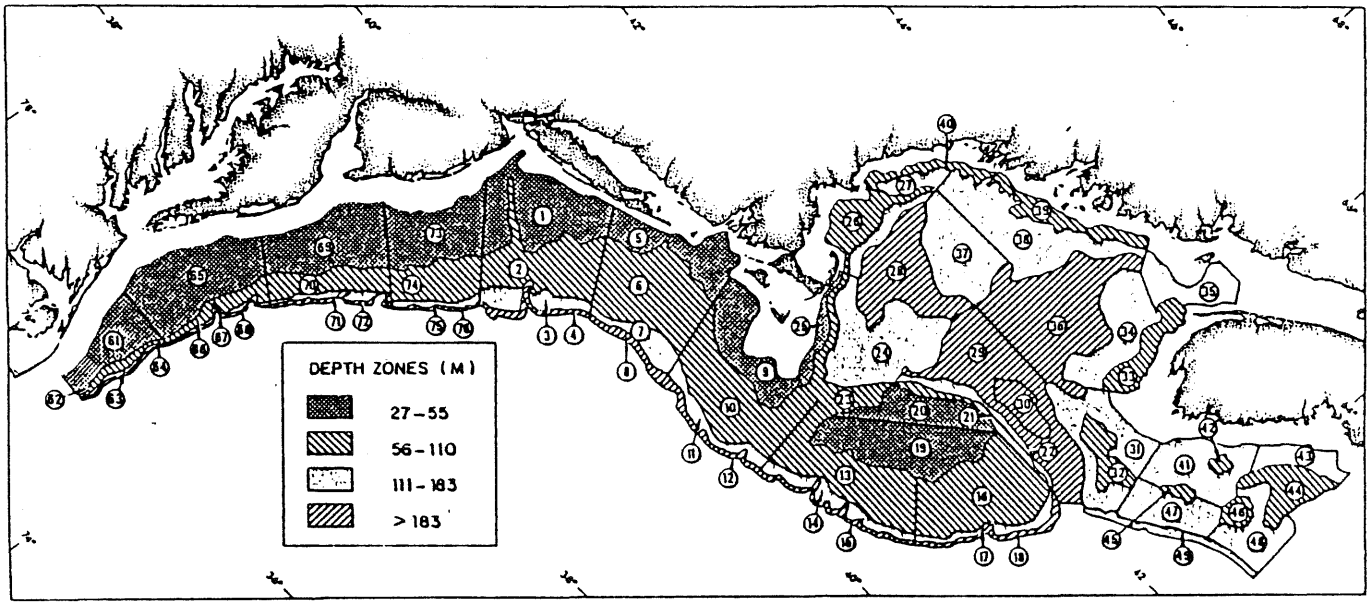


Figure 2. Sampling strata used in NEFC offshore bottom trawl surveys.

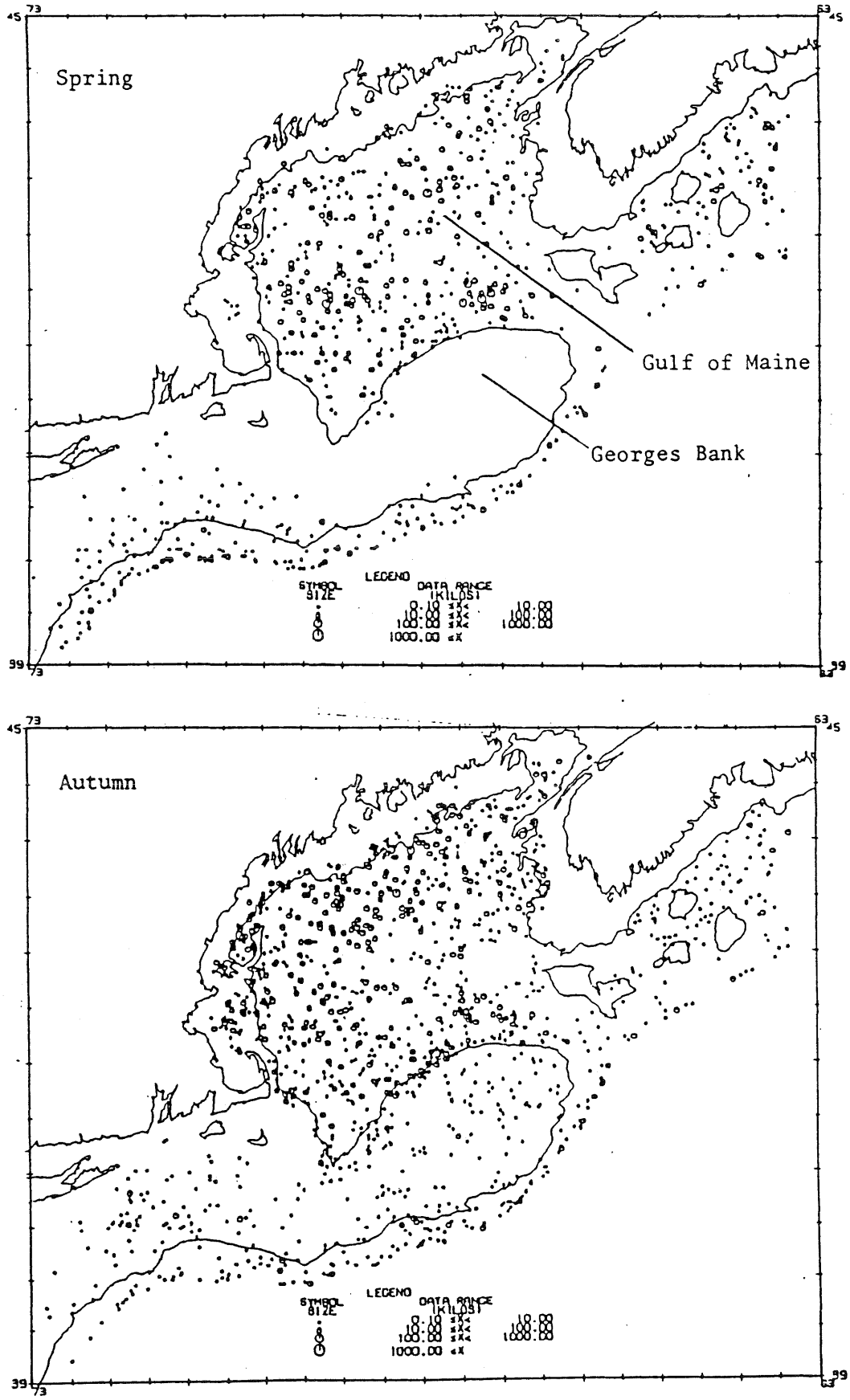
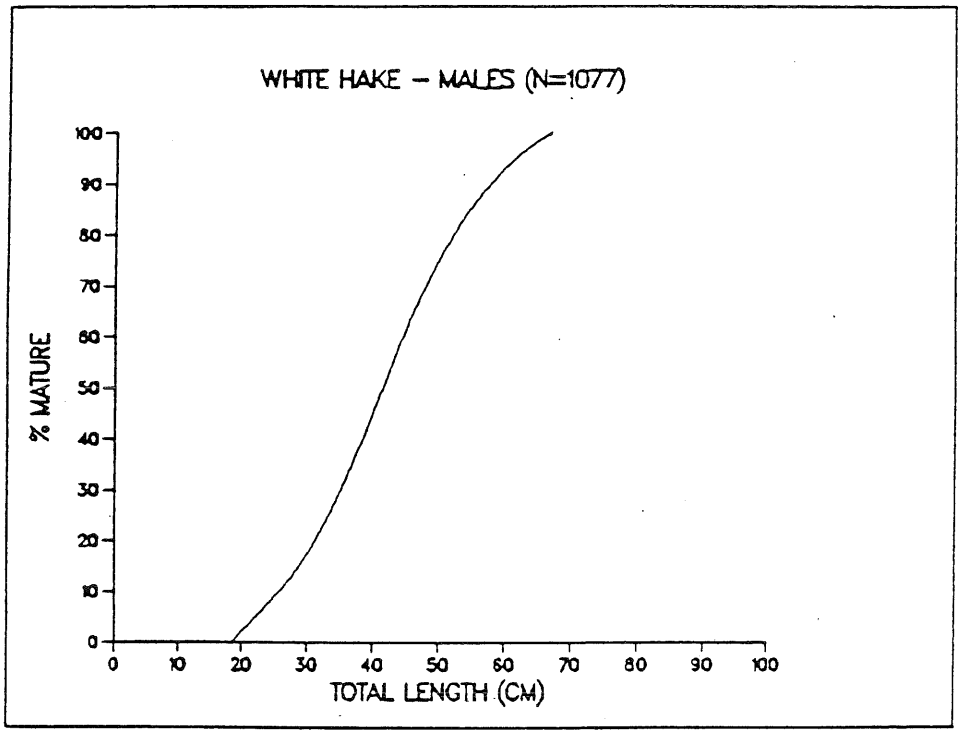


Figure 3. Distributions of white hake observed in Northeast Fisheries Center (NEFC) offshore spring and autumn bottom trawl surveys.



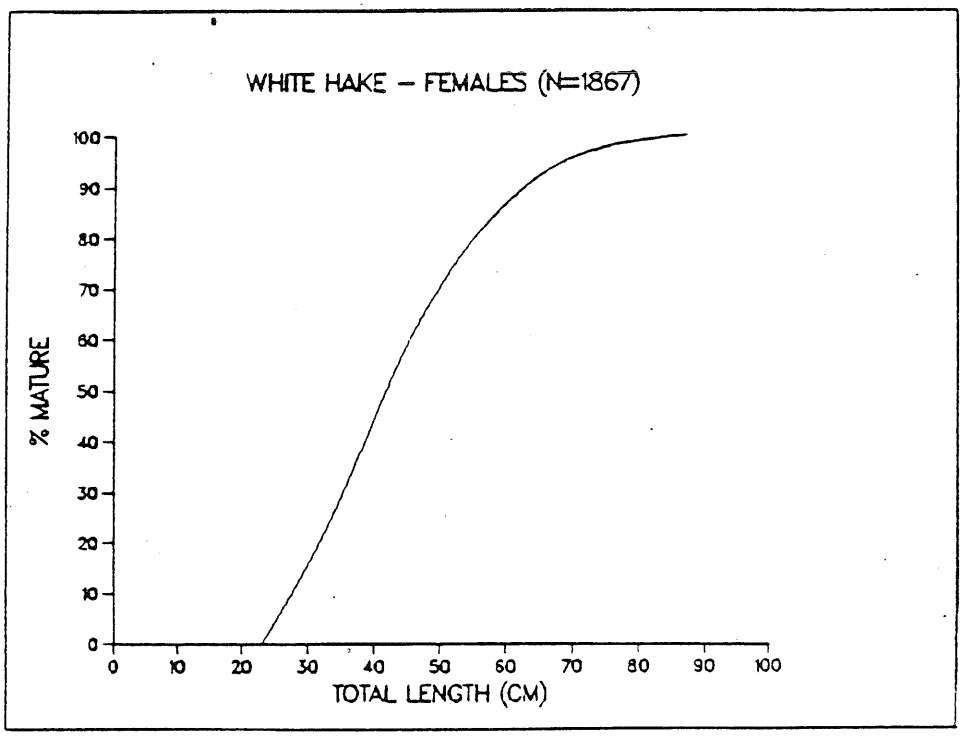


Figure 4. Maturity ogives for white hake as determined from NEFC spring and autumn bottom trawl survey samples collected during 1977-1982.

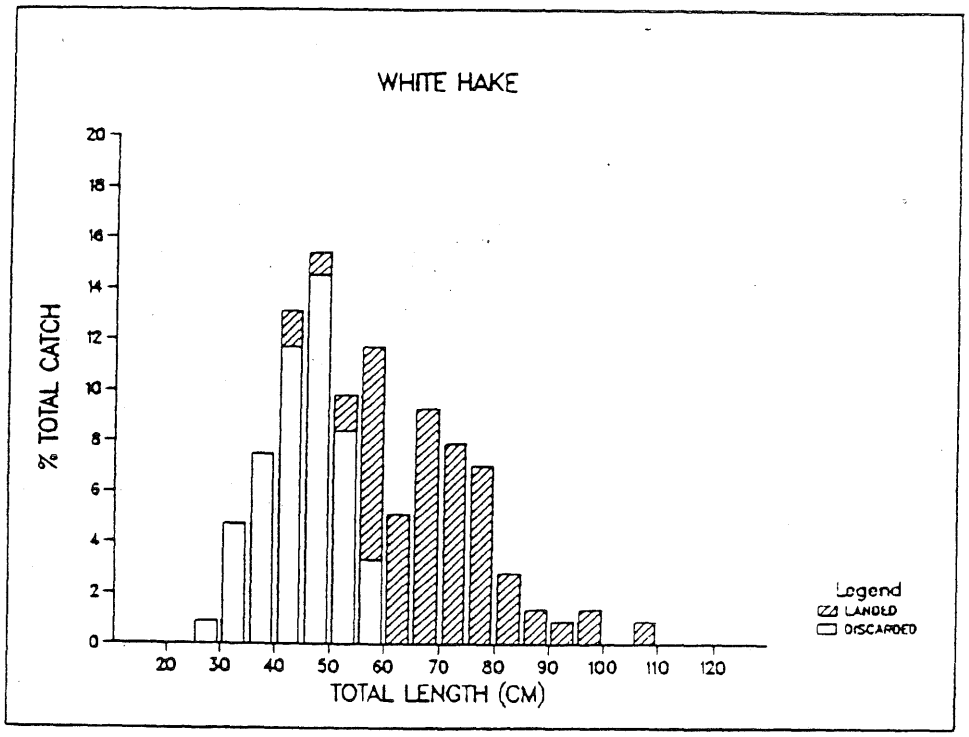


Figure 5. Length-frequency data for landings and discard of white hake obtained aboard F/V IRENE'S WAY, July 8-18, 1984.

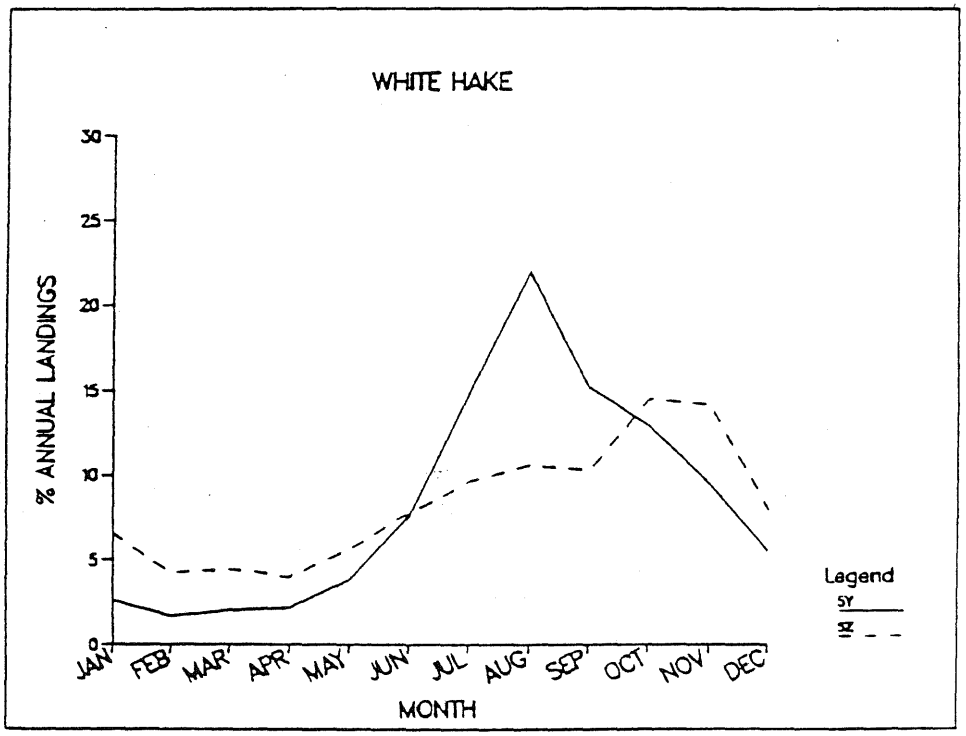


Figure 6. Distribution of white hake landings by month for the Gulf of Maine (NAFO Division 5Y) and Georges Bank (NAFO Division 5Z), 1970-1983.

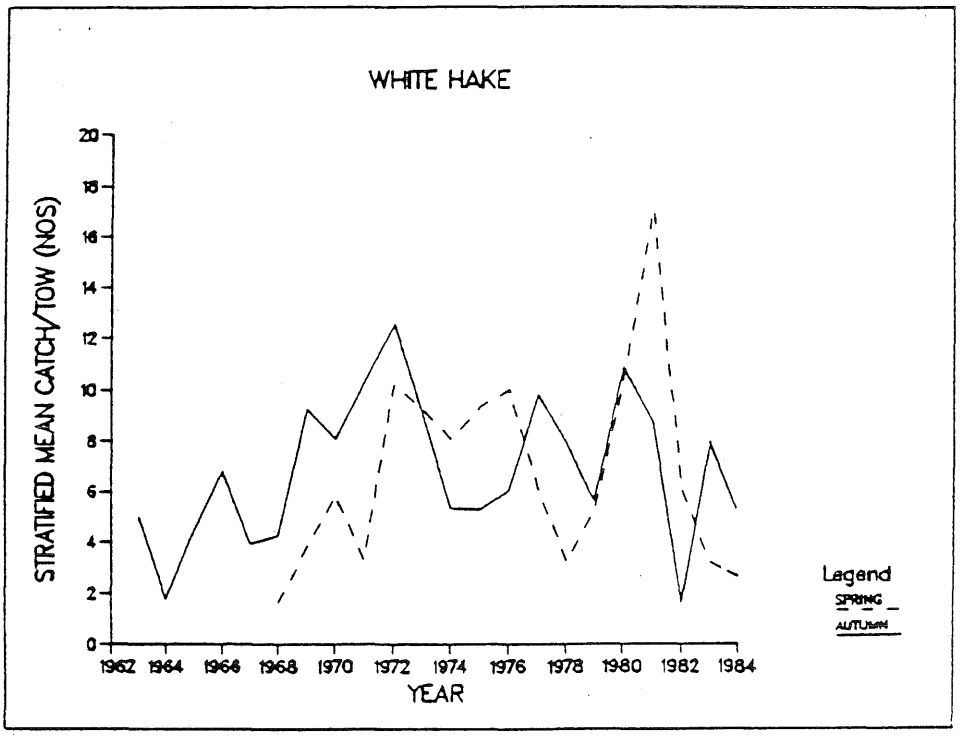


Figure 7. Stratified mean catch per tow (numbers) of white hake in NEFC offshore spring and autumn bottom trawl surveys in the Georges Bank - Gulf of Maine region (Strata 21-30 and 33-40), 1963-1984.

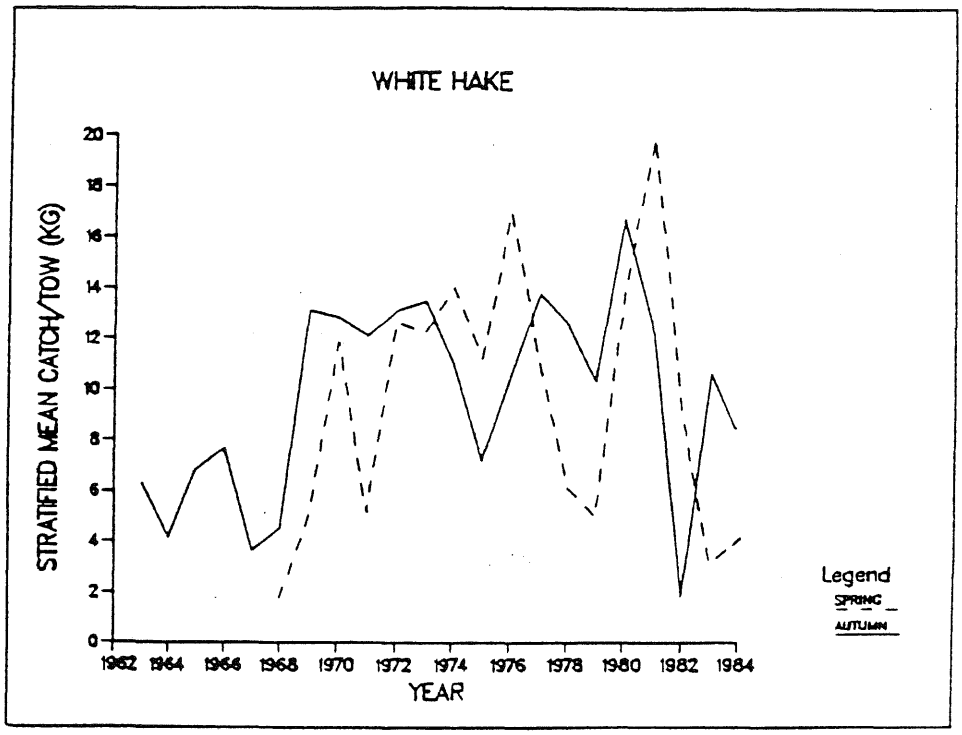


Figure 8. Stratified mean catch per tow (weight) of white hake in NEFC offshore spring and autumn bottom trawl surveys in the Georges Bank - Gulf of Maine region (Strata 21-30 and 33-40), 1963-1984.

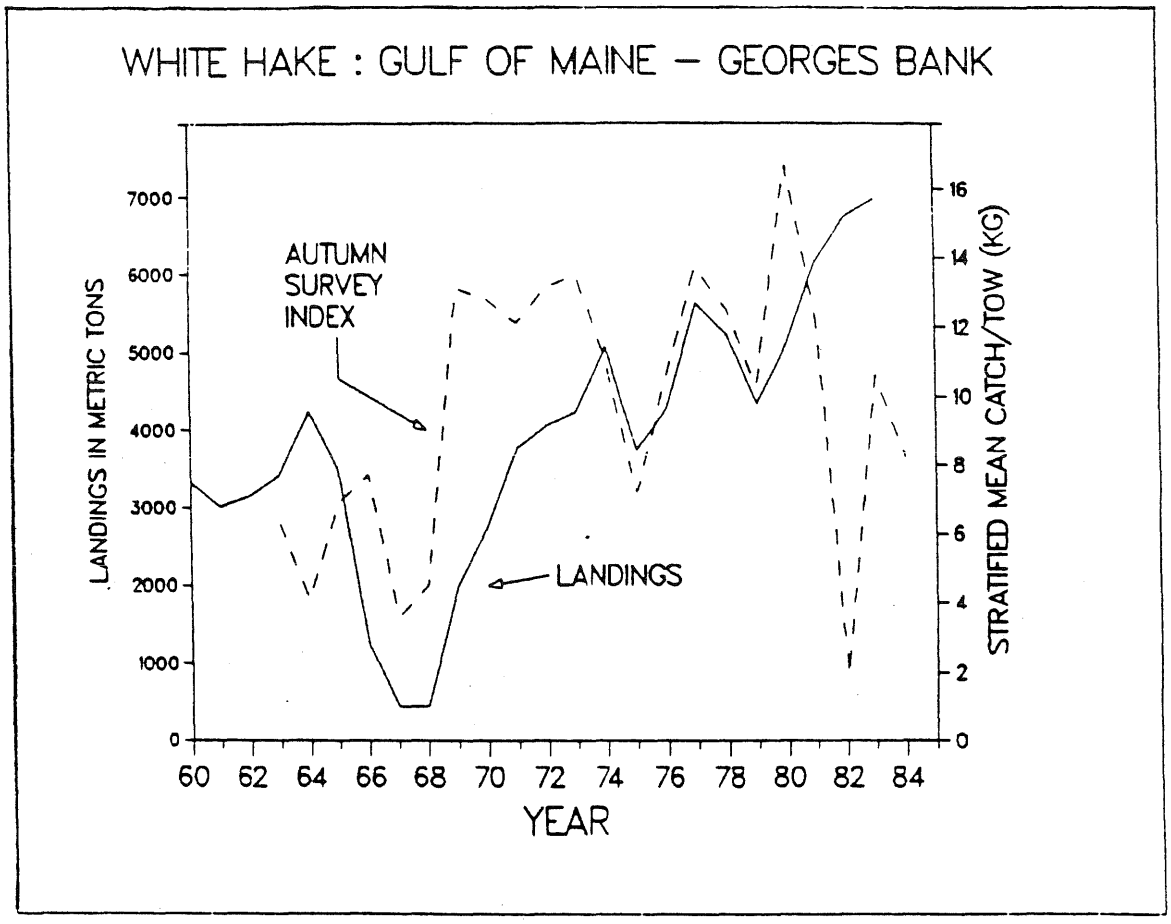


Figure 9. Commercial landings plotted against the NEFC autumn surveys (weight) index for white hake in the Gulf of Maine - Georges Bank area.

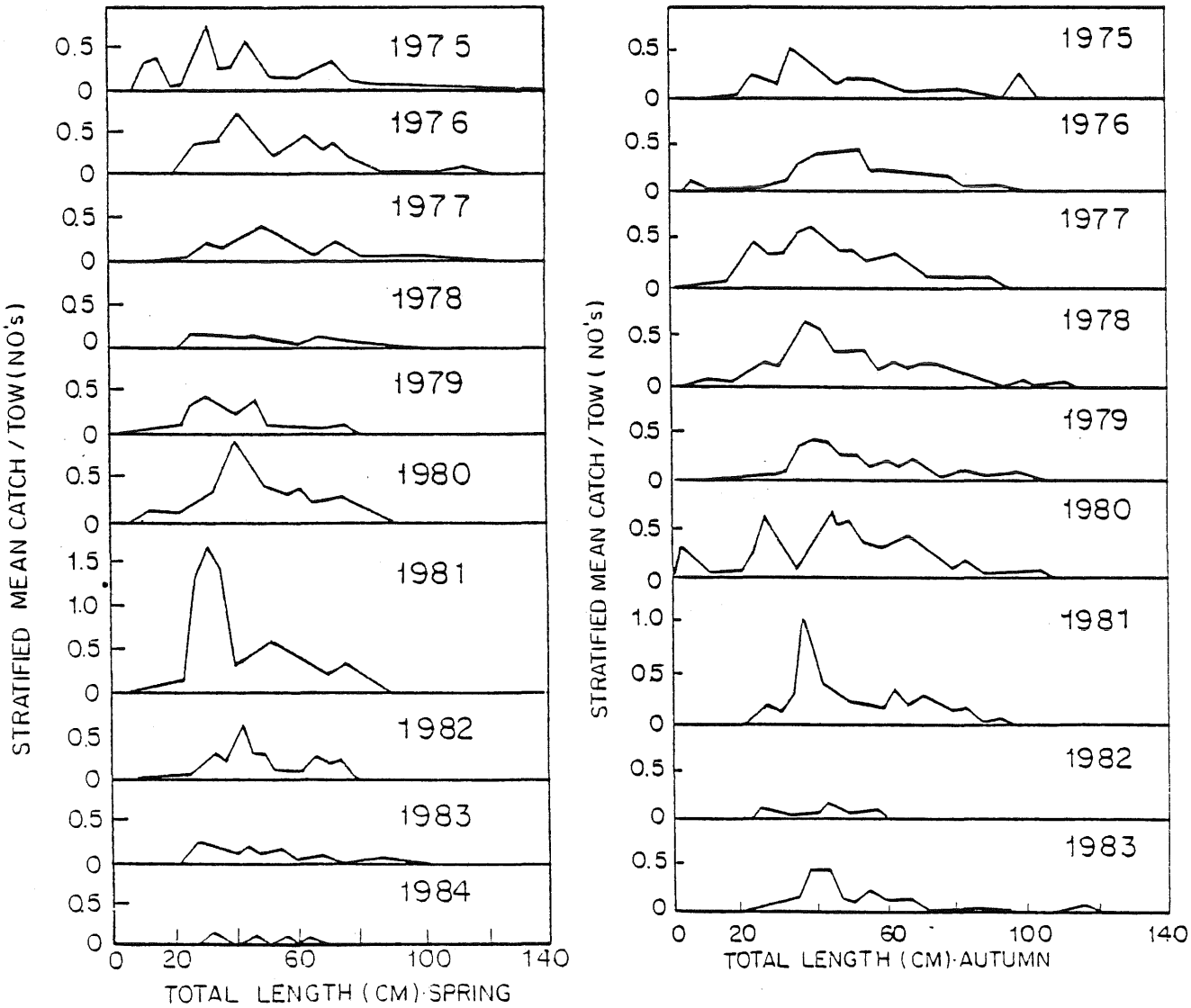


Figure 10. White hake length frequency distributions from NEFC spring (1975-1984) and autumn (1975-1983) offshore bottom trawl surveys.