

The Silver Hake Stocks and Fishery off the Northeastern United States

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Introduction

The silver hake or whiting, *Merluccius bilinearis*, stocks inhabiting the Continental Shelf waters off the northeastern coast of the United States have supported active commercial fishing since the 1930's. Fishing was conducted exclusively by the United States until distant water fleets from the U.S.S.R. began catching silver hake on Georges Bank in 1962.

Total international landings (commercial and estimated recreational) of silver hake from the Gulf of Maine to the Middle Atlantic increased from about 55,000 tons (100 percent U.S.) in 1960 to a peak of over 350,000 tons (15 percent U.S.) in 1965 and then declined sharply to again about 55,000 tons (40 percent U.S.) in 1970. Landings during 1971-75 averaged about 121,000 tons (15 percent U.S.), decreased to about 82,000 tons (31 percent U.S.) in 1976-77, and dropped further to 43,000 tons (67 percent U.S.) in 1978.

Distant water fleet catches have diminished steadily since 1973 due in part to quota limitations implemented beginning that year by the Interna-

tional Commission for the Northwest Atlantic Fisheries (ICNAF) and to further restrictions imposed by the United States beginning 1 March 1977 as a result of the Fishery Conservation and Management Act (FCMA). United States landings have improved slowly since 1974.

Edwards (1968) estimated that silver hake comprised the largest standing crop of any species in the offshore area between the Nova Scotian shelf and the New York Bight in 1963-65. Based on current assessments of the status of the stocks in this area (Resource Assessment Division¹), it still maintains that supremacy at the present time. By virtue of the available biomass and the current level of landings, silver hake must be classified as an underutilized species.

This paper describes the distribution and stock definition of silver hake off the northeastern United States, reviews the historical development and current status of the fishery, describes the past and present stock size estimates, and discusses some of the possible implications of an expanded U.S. silver hake fishery.

¹Resource Assessment Division. 1978. Summary of stock assessments August 1978. Woods Hole Lab. Ref. 78-40, 26 p., on file at Northeast Fisheries Center Woods Hole Laboratory, Woods Hole, Mass.

Distribution

The silver hake occurs in Atlantic continental shelf waters between Newfoundland and South Carolina and is most abundant between Cape Sable, Nova Scotia, and New York (Bigelow and Schroeder, 1953). In U.S. waters, it is abundant from Maine to New Jersey. Silver hake is also abundant on the Nova Scotian shelf in Canadian waters and supports a large, primarily U.S.S.R. fishery. The pattern of distribution varies with season and area. Throughout the winter off New England, it is found primarily in deeper waters near the outer edge of the continental shelf and in deep basins in the Gulf of Maine where the water is warmer than inshore. In the spring and summer as the coastal waters warm, there is a general, though incomplete, shoreward movement with the main concentrations of fish being found in waters of about 20-80 m. Some silver hake move into shallow beach areas. Farther south in the New York Bight, the seasonal pattern is somewhat different. Fish are present in inshore waters from late autumn to spring and then move more into southern New England waters during the spring and summer.

Stock Definition

The silver hake inhabiting waters off the northeast coast of the U.S. are pres-

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ABSTRACT—Three stocks of silver hake, *Merluccius bilinearis*, are presently defined for management purposes off the northeastern coast of the United States. The historical development and current status of the fishery is reviewed. Total international landings from the three stocks increased

from 55,000 tons in 1960 to over 350,000 tons in 1965, but have fluctuated at lower levels since and were only 43,000 tons in 1978. Landings, fishing patterns, and management regulations are reviewed for each stock since 1955. Estimates of stock biomass from virtual population analysis

indicate a general rebuilding of the resource since 1970. Current levels of harvest in relation to available surplus stock indicate the potential for major expansion of the U.S. silver hake fishery. Some of the implications associated with such an expansion are discussed.

ently grouped into three stocks according to divisions and subdivisions of ICNAF Subarea 5 and Statistical Area 6. These are: 1) The Gulf of Maine (Div. 5Y) stock, 2) the Georges Bank (Subdiv. 5Ze) stock, and 3) the southern New England-Middle Atlantic (Subdiv. 5Zw and Statistical Area 6) stock (Fig. 1). These delineations reflect, to some extent, scientific information concerning stock identification, but resulted primarily within ICNAF from a need to assess and manage based on the areas by which catch statistics were reported.

There is some evidence that silver hake in the area between the Gulf of Maine and Cape Hatteras consist of several discrete stocks. Conover et al. (1961) examined morphometric measurements and found no significant differences between fish from the inshore Gulf of Maine and the northern part of Georges Bank nor between fish from the southern New England and the Middle Atlantic areas, but did find highly significant differences between fish from the Gulf of Maine-northern Georges Bank area and the southern New England-Middle Atlantic area. Tagging studies were conducted in 1957-58 in the Gulf of Maine-Georges Bank area and off New Jersey (Fritz, 1959), resulting in only a 4.3 percent recapture rate (Fritz, 1963). The recaptures occurred fairly close to the tagging sites (the greatest distance traveled was 65 km), indicating the lack of any significant movement of silver hake from one area to another.

Nichy (1969) examined first-year growth patterns on otoliths from young silver hake and found a difference in otolith zonal formation and length at age between fish north and south of lat. 41°30'N. Recent calculation of growth parameters using age-length data from the Gulf of Maine, Georges Bank, and southern New England-Middle Atlantic areas (Almeida²) indicated that fish in

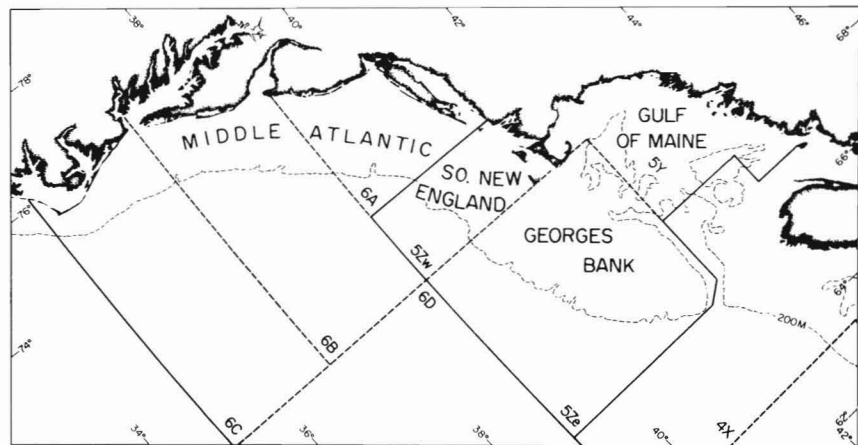


Figure 1.—Fishing grounds off northeastern U.S. and the divisions and subdivisions of ICNAF Subarea 5 and Statistical Area 6.

the Gulf of Maine grow faster and attain greater lengths than those to the south.

Konstantinov and Noskov (1969) reported that serological analysis had distinguished one silver hake stock in the Georges Bank area and another in the Cape Cod-Cape Hatteras area, with an approximate division in the Nantucket Shoals area (Subdiv. 5Ze and 5Zw boundary area) and some mixing of the two groups during autumn and winter.

Examination of the seasonal distribution of silver hake catches during U.S. research vessel bottom trawl surveys (Anderson, 1974) suggests that fish which summer in the inshore portions of the Gulf of Maine and along the northern part of Georges Bank appear to overwinter in the deep areas of the Gulf of Maine, and fish which occupy the southern part of Georges Bank in the warm months overwinter in deep water along the southern edge of the Bank. Fish in the southern New England-Middle Atlantic area undergo a seasonal inshore-offshore migration. Survey catches indicate a generally continuous distribution of fish from the southeastern part of Georges Bank to the Middle Atlantic area and show no apparent division between a Georges Bank stock and a southern New England-Middle Atlantic stock.

Examination and consideration of all available information suggests the possibility of a Gulf of Maine-northern

Georges Bank stock and another stock (maybe two) extending from southern Georges Bank to the Middle Atlantic area. However, scientific evidence is presently not sufficient to define separate spawning stocks which are genetically distinct. Results from additional studies planned or in progress, such as morphometric-meristic analysis, biochemical analysis, and tagging, must be examined before further conclusions can be drawn. In the meantime, providing that traditional fishing areas and patterns do not change substantially, the present stock delineations are satisfactory for management of the resource.

Fishery

Historical Development

The U.S. silver hake fishery apparently began in the early 1840's (Fritz, 1960). Prior to the early 1920's, landings were less than 7 million pounds (3,175 t) annually, and the species was considered a nuisance. However, in the early 1920's, a market was developed in St. Louis, Mo., for fried fish shops (Johnson, 1932), which purchased a quarter of the Atlantic coast yearly landings. Technological advances in handling, freezing, processing, and transportation further aided in creating markets and developing the fishery.

During the early days of the fishery, when it was an inshore operation, the

²Almeida, F. P. 1978. Determination of the von Bertalanffy growth equation for the southern New England-Middle Atlantic, Georges Bank, and Gulf of Maine stocks of silver hake. Woods Hole Lab. Ref. No. 78-13, 15 p., on file at Northeast Fisheries Center Woods Hole Laboratory, Woods Hole, Mass.

pound net was the principal gear (Fritz, 1960). After an active U.S. fishery began in the 1930's and operations extended offshore, the otter trawl became the primary gear. Floating traps, gill nets, purse seines, line trawls, and other gear have also been employed. Virtually all of the U.S. commercial catch is now taken by otter trawlers, with vessels less than 50 gross registered tons accounting for the greatest share.

The principal silver hake port since the end of World War II has been Gloucester, Mass., whereas Boston was formerly the leading one (Fritz, 1960; O'Brien, 1962). Catches from the Gulf of Maine-Georges Bank area have been landed at Gloucester and numerous other ports including Portland, Maine; and Provincetown, Mass. Catches from southern New England waters have been landed mainly at Point Judith, R. I., and those from the Middle Atlantic at Freeport, Long Island; and Point Pleasant and Belford, N.J.

Silver hake have been utilized commercially in many ways (Fritz, 1960; O'Brien, 1962). They have been processed largely for human consumption and sold as a frozen product in the headed and gutted form and to a lesser extent as fillets and fresh fish. They have also been marketed frozen as mink food and processed as canned pet food. Additional quantities of silver hake, generally those too small or otherwise undesirable for processing as a food product, have been processed into fish meal for use as poultry and cattle feed supplements. The latter use developed as a result of a specialized trawl fishery which began in 1949 in New England waters to supply fish, which were otherwise not marketable, for reduction or industrial purposes (Snow, 1950; Sayles, 1951; Edwards, 1958a; Edwards and Lux, 1958). A large part of the industrial catch, 15-40 percent depending on area and season, consisted of silver hake (Edwards, 1958a). New England silver hake landings for reduction were estimated to be about 18,000 tons in 1957 (Edwards, 1958b), 10,000 tons in 1958 (Edwards and Lawday, 1960), and peaked at close to 20,000

tons in 1964 (E. D. Anderson, unpubl. data). The reduction fishery declined after the early 1960's as a result of imports of fish meal from South America and is no longer of importance. Estimated silver hake landings for reduction have averaged less than 1,000 tons annually since 1970.

There is also a recreational hook-and-line fishery for silver hake from southern Massachusetts to New Jersey. Fish are caught from subtidal waters out to depths of approximately 45 m. The catch is greatest in New York-New Jersey, with the bulk taken during late autumn-early spring by both shore-based anglers and from boats (charter, party, and private). During this season, silver hake is very important to the recreational fishery due to its availability at a time when very few other species are present inshore. Marine angler surveys in 1960, 1965, 1970, and 1974 (Clark, 1962; Deuel and Clark, 1968; Deuel, 1973; Deuel³) estimated the recreational silver hake catch to be 1,801, 2,717, 950, and 1,075 tons, respectively, in those years. Results from National Marine Fisheries Service (NMFS), Northeast Fisheries Center creel surveys in the New York Bight area in 1975-77 gave estimates of 197, 1,706, and 3,948 tons, respectively, for those years.

Current Trends by State

Commercial landings of silver hake in the principal states during 1968-77 are given in Table 1. Maine landings fell sharply from over 13,000 tons in 1968 to only 116 tons in 1977. This

³D. G. Deuel, Resource Statistics Division, National Marine Fisheries Service, NOAA, Washington, DC 20235, pers. commun.

Table 1.—Landings of silver hake by state off northeastern U.S. in 1968-77, in metric tons.

Year	Maine	Mass.	Rhode Isl.	New York	New Jersey	Total
1968	13,114	18,365	985	1,501	1,834	35,799
1969	8,113	8,326	1,286	967	1,736	20,428
1970	6,729	9,792	1,631	462	1,497	20,111
1971	4,490	6,838	1,320	480	1,790	14,918
1972	1,857	5,092	1,248	1,193	2,467	11,857
1973	2,593	11,553	1,403	875	2,925	19,349
1974	1,301	5,609	2,367	887	3,184	13,348
1975	543	12,077	2,425	1,179	2,933	19,157
1976	185	13,351	3,303	1,155	3,590	21,584
1977	116	12,326	2,492	955	4,560	20,449

condition apparently was brought about by a shortage of fish and rather poor markets in the early 1970's. These factors led to the closing of the silver hake processing plants in Portland. Increased supplies and a better market environment are needed to revive this Maine fishery, which has been directed for silver hake.

Massachusetts is the leading State in silver hake landings (Table 1). Landings have varied between 5,100 and 18,400 tons during 1968-77 with improved landings in 1975-77. The fishery for silver hake, primarily out of Gloucester, is largely directed.

Silver hake landings in Rhode Island rose from 985 tons in 1968 to about 3,000 tons in 1976-77 (Table 1). The fishery is for a mixed catch of trawl-caught species which includes silver hake, although there sometimes are directed silver hake trips as well, depending upon market conditions.

Landings of silver hake in New York have averaged around 1,000 tons during 1968-77 (Table 1). In New Jersey, landings in 1968-77 ranged from 1,500 tons in 1970 to 4,600 tons in 1977. Landings in both New York and New Jersey result from directed silver hake effort. The principal grounds fished are in the New York Bight, mostly in depths inside of 45 m.

Average landings by month in 1975-76 for each of the above States are given in Table 2 to illustrate the seasonal character of the silver hake fisheries. Maine landings, although low in these 2 years, indicate a primarily summer fishery conducted mainly from June to October. In Massachusetts, the bulk of the landings in these years was data). The reduction fishery declined

Table 2.—Average monthly landings of silver hake in 1975-76 by state, in metric tons.

Month	Maine	Mass.	R.I.	N.Y.	N.J.
January	1	70	305	203	597
February	3	364	137	210	679
March	3	555	124	201	795
April	5	170	275	123	616
May	14	881	359	103	207
June	79	728	338	59	7
July	42	3,011	192	16	1
August	102	2,274	168	14	—
September	55	1,923	212	17	1
October	45	1,567	117	56	15
November	10	928	245	58	102
December	5	242	389	107	240
Total	364	12,713	2,861	1,167	3,260

during May-November. The situation in Rhode Island is somewhat different in that there are two principal seasons, although some silver hake are landed in each month. The first season is during April-June when fishermen say the silver hake are migrating eastward past the Rhode Island shore; the second is during November-January when fish are migrating westward toward their wintering grounds in the New York Bight. Almost all of the silver hake landings in New York and New Jersey are during November-May, when this species is most plentiful in the New York Bight.

Current Trends by Stock

Gulf of Maine

Total landings during 1955-64 varied between 21,500 and 37,000 tons and averaged 29,700 tons (Fig. 2). Landings dropped from 31,700 tons in 1964 to 22,600 tons in 1965, and ranged from 24,700 to 11,400 tons during 1965-70 while averaging 18,300 tons. Landings continued to drop and averaged only 7,900 tons during 1971-78 while ranging between 5,200 (1974) and 9,800 (1976) tons; 1978 landings were 6,200 tons.

This fishery has been conducted almost exclusively by the United States (Fig. 3). In 1963 and 1971-75, small landings were reported by the U.S.S.R., Poland, Federal Republic of Germany, German Democratic Republic, and Bulgaria, which averaged about 10 percent of the total annual landings in those years (Fig. 3).

The total allowable catch (TAC) for this stock was set by ICNAF at 10,000

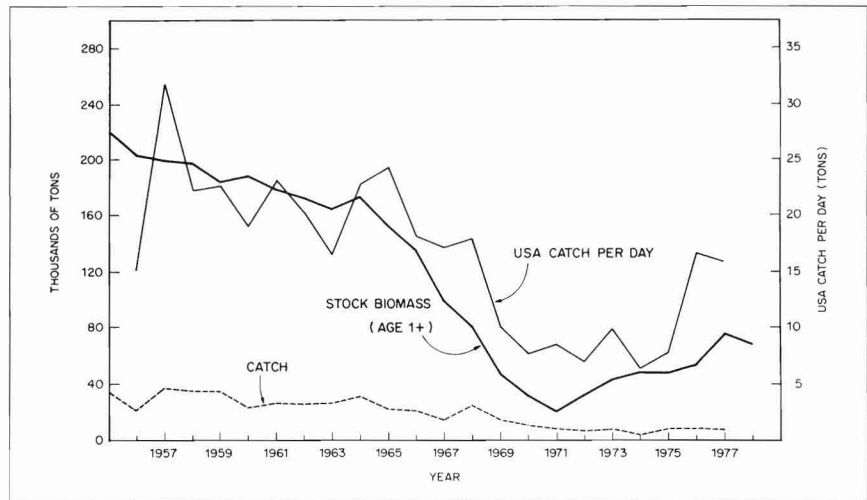
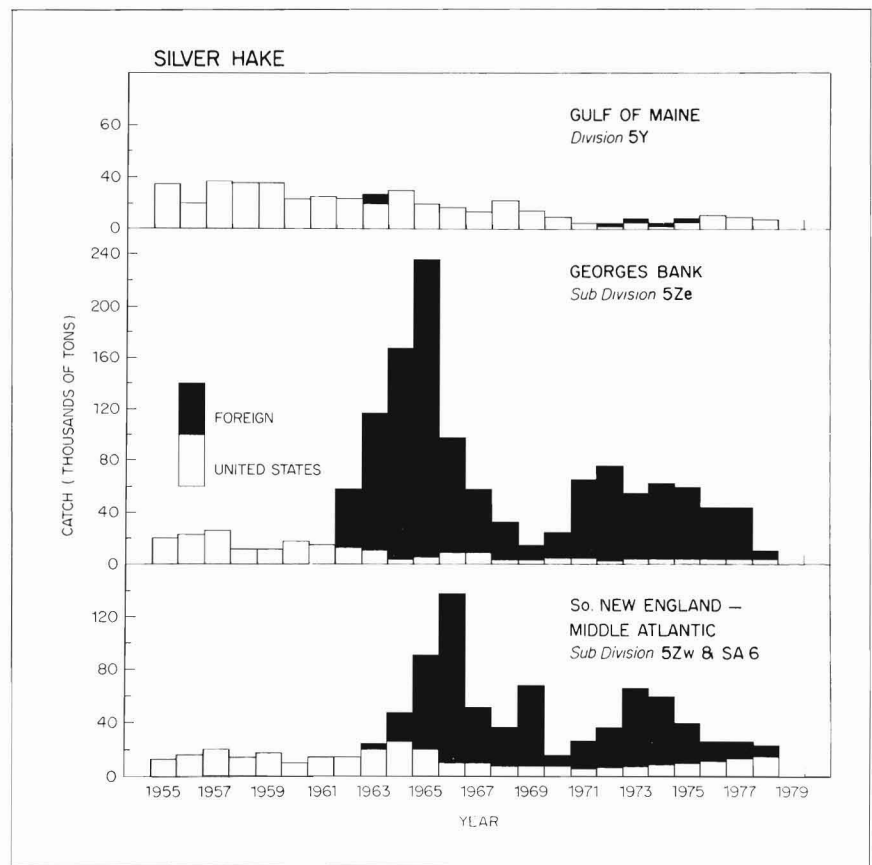


Figure 2.—International catch, stock biomass (ages 1 and older) from virtual population analysis, and U.S. commercial catch per day from the Gulf of Maine silver hake stock (Almeida and Anderson, 1979c).

Figure 3.—Total U.S. and foreign landings of silver hake from ICNAF Subarea 5 and Statistical Area 6 in 1955-78.



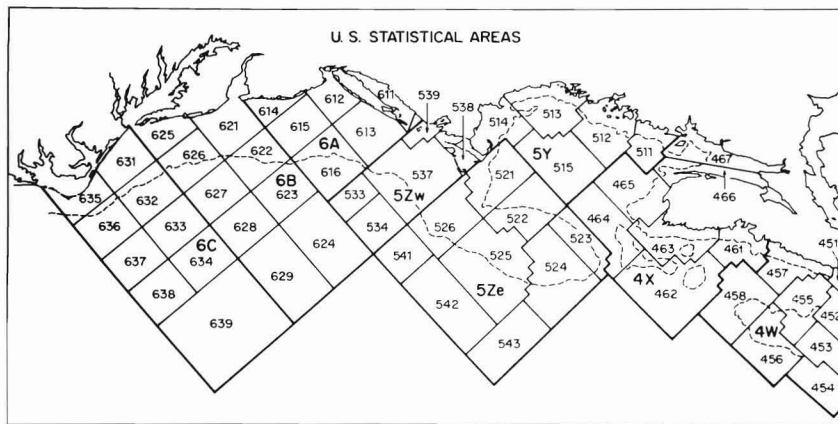


Figure 4.—U.S. statistical areas for the reporting of commercial fishery statistics.

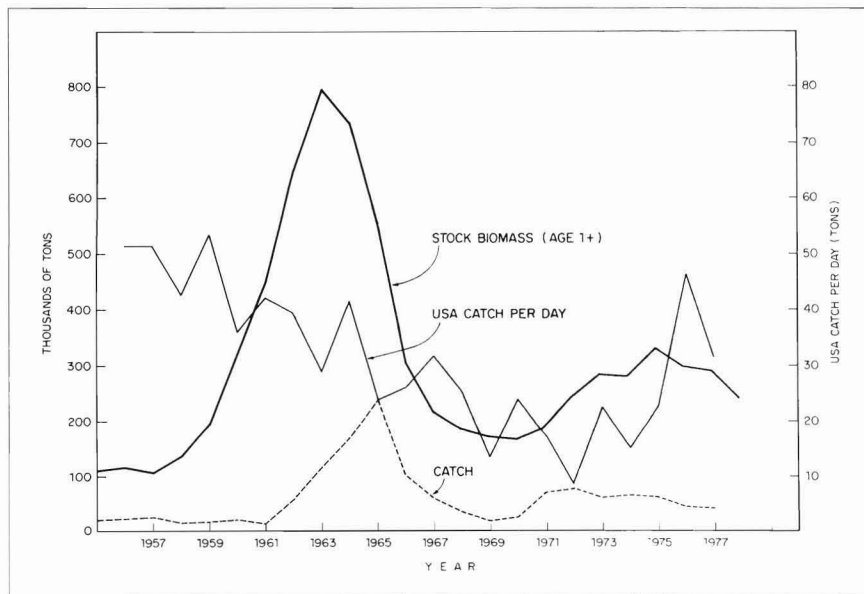


Figure 5.—International catch, stock biomass (ages 1 and older) from virtual population analysis, and U.S. commercial catch per day from the Georges Bank silver hake stock (Almeida and Anderson, 1979a).

tons for 1973-74, 15,000 tons for 1975, 10,000 tons for 1976, and 9,000 tons for 1977. This stock has not been under management regulation following implementation of the FCMA, and has been fished solely by domestic vessels.

The bulk of U.S. landings have traditionally been during May-December by small vessels fishing single-day trips in inshore areas, although there have been landings in all months since 1970.

Prior to 1964, the most productive grounds were located in U.S. statistical area 514 (Fig. 4) which includes Stellwagen Bank, local grounds adjacent to Gloucester, and Cape Cod Bay. During 1964-73, statistical area 513 (Jeffreys Ledge to Casco Bay) provided the greatest catches. During 1974-77, area 514 again was the most productive area. In 1977, 80 percent of the Div. 5Y silver hake landings came from area

514, and 10 percent each from areas 513 and 515. In earlier years landings were reported from area 512, as high as 750 tons in 1969, but have decreased to only a few tons per year in the last 5 years. In the last several years, the inshore fishery has essentially begun in April instead of May, and during 1976-78 significant catches were taken from area 515 (deep over-wintering area) during the January-April period.

Georges Bank

Total landings increased from an average of 19,000 tons during 1955-61 to nearly 239,000 tons in 1965 and declined rapidly to 18,400 tons in 1969 (Fig. 5). Landings increased and stabilized at an average of about 68,000 tons during 1971-75, but declined to 45,800 tons in 1976, 44,300 tons in 1977, and only 10,000 tons in 1978.

United States landings averaged 18,200 tons during 1955-63, but declined to average only 3,900 tons during 1968-78 (Fig. 3). Landings increased, however, from 3,700 tons in 1977 to 6,400 tons in 1978, the highest level since 1968.

During 1973-75, the ICNAF TAC was 80,000 tons each year. The 1976 and 1977 TAC's were 50,000 and 70,000 tons, respectively. As a result of FCMA, this stock was managed exclusively by the United States after 1 March 1977. The optimum yield (OY) established by the NMFS Preliminary Fishery Management Plan (PMP) for the Hake Fisheries of the Northwestern Atlantic was 58,800 tons in both 1978 and 1979. U. S. allocations of the 1973-77 TAC's were 17,000, 11,056, 11,100, 8,500, and 15,000 tons, respectively, whereas actual U.S. landings during this period averaged only about one-third of each year's allocation. The amount designated as U.S. capacity and reserved for U.S. fishermen in 1978 and 1979 was 26,000 tons.

Until 1969, statistical area 521 (Fig. 4), which lies immediately east of Cape Cod, produced the bulk of U.S. landings from Subdiv. 5Ze, with most of the fishery conducted during June-October. During 5 of the 8 years since 1969, area 522 on Georges Bank, which includes Cultivator Shoal, has

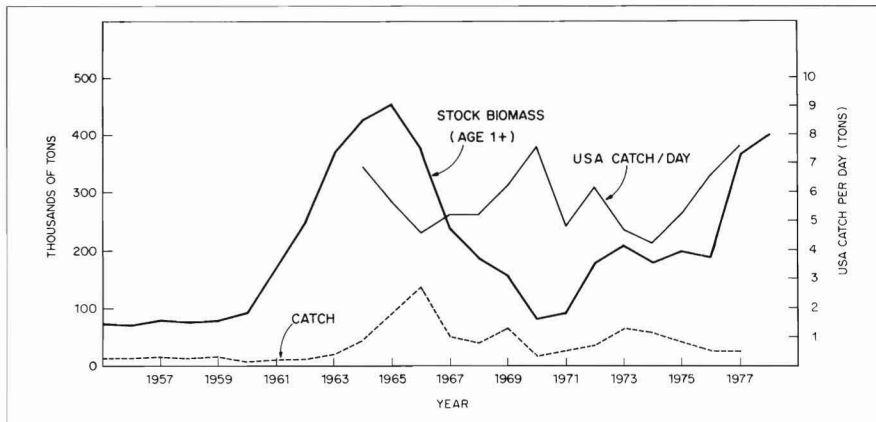


Figure 6.—International catch, stock biomass (ages 1 and older) from virtual population analysis, and U.S. commercial catch per day from the Southern New England - Middle Atlantic silver hake stock (Almeida and Anderson, 1979b).

outproduced area 521. U. S. fishermen have been catching silver hake from area 522 since 1955, primarily during June-September.

The distant water fleet (DWF) fishery for silver hake has been conducted primarily by the U.S.S.R. They have fished virtually all of Georges Bank for silver hake beginning in 1962 but have focused mainly along the southern part of the Bank in statistical areas 525, 526, and 524 (Fig. 4). The U.S.S.R. has also fished area 522 during the same months as the U.S. The seasonal pattern of the U.S.S.R. fishery has varied from year to year but has primarily been conducted during March-August. During 1962-77, about 77 percent of the landings occurred during those months. During 1973-76, March was the predominant month, averaging 30 percent per year of the total. In 1977, 84 percent of the U.S.S.R. landings were during April-June, with June having the largest share (37 percent).

Beginning in 1970, various conservation areas were established by ICNAF which closed parts of the area to the DWF hake fishery, in some cases for certain months and in other cases totally. In 1976, the U.S.S.R. stern trawler fleet for silver hake was excluded from most of Georges Bank by virtue of an ICNAF regulation banning the use of bottom trawls by vessels over 47 m (155 feet) in waters less than 73 m (40 fathoms). Consequently,

the U.S.S.R. fishery was confined to the southern slopes of the Bank. From 1 March to 30 June 1977, the DWF hake fishery in Subdiv. 5Ze was limited to a relatively narrow "window" extending between long. 67°W and 70°W along the edge of the continental shelf. The 1978 "window" was the same as in 1977, but with fishing allowed during April-June with bottom trawls and during March and October-December with pelagic gear only. In 1979, the "window" was reduced to extend only between long. 67°W and 68°45'W, and DWF fishing was permitted only during January-March with bottom trawls and August-December with off-bottom trawls.

Southern New England-Middle Atlantic

Total landings averaged about 16,800 tons during 1955-59, declined to 10,000 tons in 1960, and then improved steadily to 137,400 tons in 1966 (Fig. 6). Landings dropped sharply to 50,900 tons in 1967 and have since fluctuated between 19,200 and 67,000 tons. Landings increased steadily from 19,200 tons in 1970 to 66,000 tons in 1973 and then declined to an estimated 26,900 tons in 1978.

U.S. commercial landings during 1955-65 ranged between 8,200 and 25,000 tons (Fig. 3) and averaged about 14,800 tons per year, during which

time the industrial fishery and market were strong. Landings during 1966-78 were much lower following the closing of a major reduction plant, ranging between 5,000 and 11,400 tons and averaging about 7,900 tons or about 21 percent of the total per year. The 1978 landings of 11,400 tons were the highest since 1965. Estimated U.S. recreational catches during 1955-77 ranged between 692 and 3,948 tons and averaged about 1,000 tons per year. Assuming the same ratio between U.S. commercial landings and recreational catches in 1978 as in 1977 implies a 1978 recreational catch of about 4,800 tons.

The ICNAF TAC for this stock was 80,000 tons per year during 1973-75, 43,000 tons in 1976, and 45,000 tons in 1977. The 1978 OY established by the NMFS PMP was 33,200 tons and was increased by 5,000 tons in mid-year (this increase was added to the DWF allocation). The 1979 OY was increased to 40,000 tons. U.S. allocations during 1973-77 were 25,000, 18,864, 18,900, 9,000, and 12,500 (plus 2,000 for the U.S. recreational fishery) tons, respectively. During 1973-75, U.S. landings averaged only 35 percent of the allocated amounts, whereas in 1976 the United States exceeded its allocation by 6 percent, and in 1977 U.S. landings were about 75 percent of the allocation. The amount designated as U.S. capacity in 1978 and 1979 was 20,600 tons.

The U.S. silver hake fishery in Subdiv. 5Zw is conducted throughout the entire year, although in most years peak landings have been during May-July. Statistical area 539 (Fig. 4) has, in most years, contributed the largest share from southern New England waters. The U.S. fishery in Statistical Area 6 (SA 6) is primarily in Div. 6A and is conducted mainly from November through May.

The DWF fishery on this stock, as with the Georges Bank stock, has been conducted primarily by the U.S.S.R. The U.S.S.R. has fished in all areas of Subdiv. 5Zw and SA 6, with the largest share in most years (11 of 15) coming from 5Zw. Landings have occurred in all months; however, the bulk (average

of 56 percent during 1963-77) has generally come during February-April, although during 1969-72 the largest amounts came during June-August. ICNAF conservation areas have restricted the DWF fishery both seasonally and areally. Additional restrictions were placed on the DWF fishery in SA 6 as a result of bilateral fisheries agreements. The 1977 DWF hake fishery in Subdiv. 5Zw + SA 6 was restricted to a "window" extending from the 5Ze-5Zw boundary west into Div. 6A along the edge of the shelf which was open only through March. The 1978 and 1979 DWF fisheries were confined to essentially the same area with fishing with bottom gear (which is needed to catch silver hake although some may be caught with pelagic gear) limited to January-March.

Status of the Stocks

Gulf of Maine

Total estimated stock biomass (ages 1 and older) decreased from about 220,000 tons in 1955 to a low of only about 20,000 tons in 1971 (Fig. 2) and then increased to slightly over 75,000 tons in 1977 (Almeida and Anderson, 1979c). Recruitment to this stock was very poor during the mid- and late 1960's (Fig. 7), but improved in the 1970's. The 1973 and 1976 year-classes were estimated to be the strongest observed since 1964 although they were still smaller than the 1954-72 mean size. Projections indicate that the total stock biomass available at the beginning of 1978 was slightly less than in 1977, but spawning stock biomass (ages 2 and older) increased approximately 10 percent from 1977 to 1978 (Fig. 7). The catch of about 6,200 tons in 1978 was estimated to result in an increase of 5-10 percent in spawning stock biomass from 1978 to 1979. These estimates, as well as those for the other two stocks, are based on virtual population analysis (Almeida and Anderson (1979a,b,c) provide greater detail of the assessment analyses). The changes in biomass, as indicated, are more valid in a relative rather than absolute sense due to the imprecision of the data and parameters utilized in the analyses.

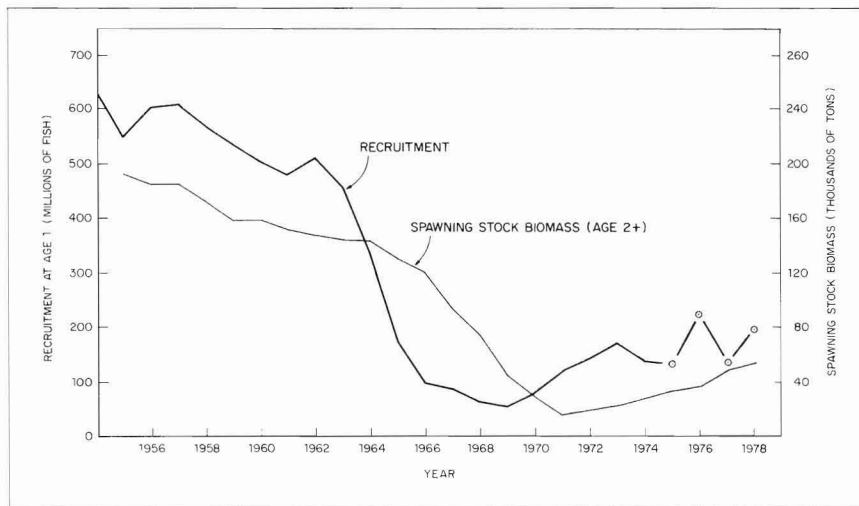


Figure 7.—Gulf of Maine silver hake spawning stock biomass (ages 2 and older) in 1955-78 and abundance at age 1 of the 1954-77 year classes. Open circles indicate estimated year-class sizes (Almeida and Anderson, 1979c).

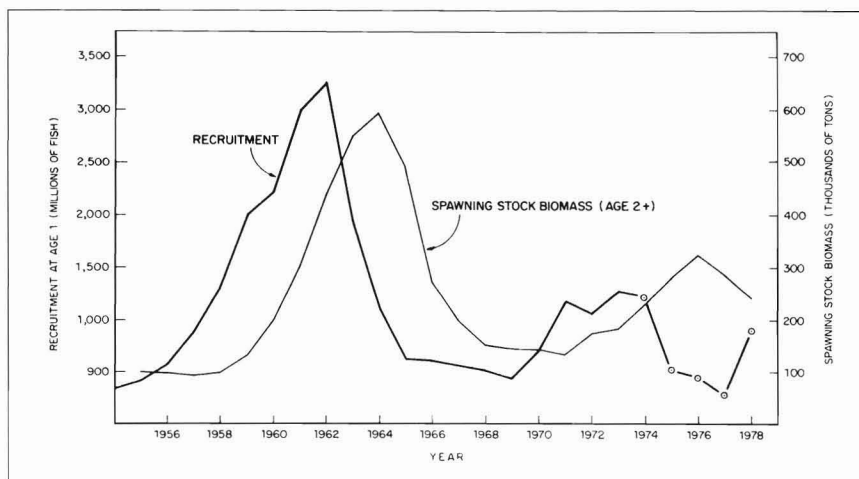


Figure 8.—Georges Bank silver hake spawning stock biomass (ages 2 and older) in 1955-78 and abundance at age 1 of the 1954-77 year classes. Open circles indicate estimated year-class sizes (Almeida and Anderson, 1979a).

Georges Bank

Total estimated stock biomass (ages 1 and older) increased from about 110,000 tons in 1955 (Fig. 5) to a high of nearly 800,000 tons in 1963 and then declined to about 168,000 tons in 1970 (Almeida and Anderson, 1979a). Total biomass increased to approximately 332,000 tons in 1975 but then declined

to an estimated 254,000 tons at the beginning of 1978. As with the Gulf of Maine stock, recruitment was very poor during the mid- and late 1960's (Fig. 8), but improved in the early 1970's. The 1975, 1976, and 1977 year classes were estimated to be poor. Projections indicate that the spawning stock biomass underwent a 10 percent de-

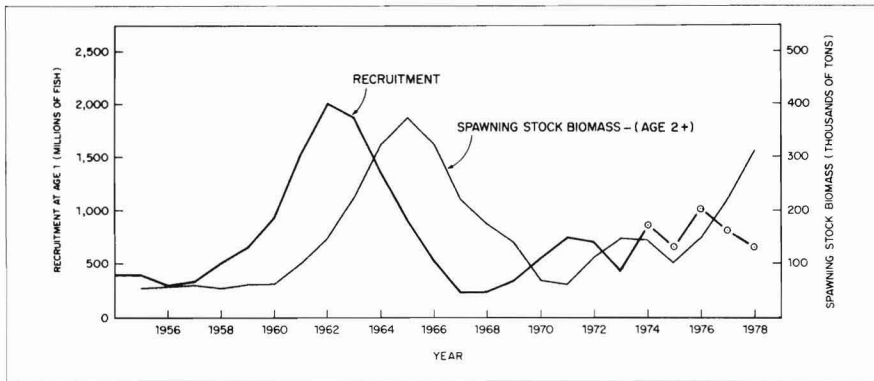


Figure 9. — Southern New England - Middle Atlantic silver hake spawning stock biomass (ages 2 and older) in 1955-78 and abundance at age 1 of the 1954-77 year classes. Open circles indicate estimated year-class sizes (Almeida and Anderson, 1979b).

crease from around 242,000 tons in 1977 to 218,000 tons in 1978. Given a 1978 catch of 10,000 tons, the resultant spawning stock biomass in 1979 will decline by about 5 percent from 1978 if the 1978 year class is assumed to be of median strength.

Southern New England-Middle Atlantic

Total estimated stock biomass (ages 1 and older) increased from an average of about 76,000 tons during 1955-59 to a high of close to 455,000 tons in 1965 (Fig. 6) and decreased to around 83,000 tons in 1970 (Almeida and Anderson, 1979b). Biomass increased to about 213,000 tons in 1973, decreased to an average of 189,000 tons during 1974-76, and then increased to an estimated 390,000 tons at the beginning of 1978. The 1974, 1976, and 1977 year classes were estimated to be above average (Fig. 9) with the 1976 year class estimated to be the strongest since 1964. Projections indicate that spawning stock biomass increased about 40 percent from around 201,000 tons in 1977 to approximately 286,000 tons in 1978, with the 1978 level being the highest since 1966. The 1978 catch of 26,900 tons was estimated to result in about a 20 percent increase in spawning biomass from 1978 to 1979.

Implications of an Expanded U.S. Fishery

In an effort to promote maximum utilization of the resource and relieve some of the excessive fishing pressure presently being exerted on Atlantic cod, *Gadus morhua*; haddock, *Melanogrammus aeglefinus*; and yellowtail flounder, *Limanda ferruginea*, in New England waters, the U.S. fishing industry has been encouraged to catch and market alternate species. At the present time, the silver hake stocks constitute one of the largest and most available alternative resources. The Georges Bank stock, and particularly the southern New England-Middle Atlantic stock, are high in abundance, and current U.S. landings are considerably below the amounts reserved for U.S. fishermen. The estimated surplus stock allocated to U.S. fishermen in 1978 was about six times greater than the 1977 landings. U.S. landings of silver hake were much higher 10-15 years ago than presently due to greater market demand (e.g., reduction, mink food, and human food).

Although the Gulf of Maine stock has been slowly rebuilding since 1971, further growth is needed before the biomass reaches the level it held in the 1950's and early 1960's. Consequently, there is not the potential for

increased landings from that stock beyond the 1975-77 level (about 9,000 tons) if the management strategy is to continue rebuilding the stock. The Georges Bank and southern New England-Middle Atlantic stocks, however, both offer substantial potential. Fish are not only available in inshore waters and on shoal portions of Georges Bank during the warm months, but are also available farther offshore along the edge of the continental shelf during the cold months.

There are various factors which must be considered in promoting an expansion of the U.S. silver hake fishery. Expanded effort in the offshore fishery may result in conflict with lobster pots fished throughout portions of the offshore area. Conflict with lobster pots has also existed with the DWF trawl fishery. An offshore fishery for silver hake may involve by-catch of species such as mackerel, *Scomber scombrus*; herring, *Clupea harengus harengus*; squids *Loligo pealei* and *Illex illecebrosus*; scup, *Stenotomus chrysops*; assorted flounder species, and others. The current inshore fishery also entails by-catch of species such as cod, haddock, flounder, and others, which may be greater than in the offshore fishery. The by-catch problem will require consideration in the future management of the silver hake fishery and may ultimately be solved through a multi-species approach to management.

An intensive winter-spring fishery for silver hake in offshore waters where fish concentrate during overwintering may affect availability of fish later for the inshore fishery. This may be particularly the case in the southern New England-Middle Atlantic stock. U.S. fishermen argued successfully in the late 1960's that the U.S.S.R. fishery in fact caused such a problem, and as a result a hake management area was established by ICNAF in southern New England waters during 1970-74, which prohibited fishing for hake during January-March in 1970-72 and during April in 1973-74. There is an important recreational fishery for silver hake in the New York Bight between October and June, and it is important to this fishery that fish be highly available. An

expansion in the commercial fishery in that area may reduce availability to the recreational fishery.

The U.S. silver hake trawl fishery does not have a minimum codend mesh size regulation although the DWF hake fishery has a 60-mm stretched mesh regulation. Significant expansion of the U.S. fishery in the absence of a minimum mesh size regulation may increase mortality on undersized silver hake, particularly in areas where pre-recruits are highly abundant.

An expanded silver hake fishery may not necessarily relieve pressure on the Atlantic cod, haddock, and yellowtail flounder stocks in all areas. The greatest potential for expansion is in the southern New England-Middle Atlantic stock. However, this area represents the southern extent of the range for cod and haddock, and catches of these two species are less there than in the Georges Bank and Gulf of Maine areas. In the Gulf of Maine, where there is perhaps the greatest need for alternate species to cod and haddock, the silver hake stock has not yet recovered to levels capable of supporting an expanded fishery.

It was suggested earlier that silver hake in the Gulf of Maine and on the northern part of Georges Bank may belong to the same stock but that scientific evidence is presently not sufficient to either verify or disprove this theory. If these areas were combined for management, it could be harmful to the inshore Gulf of Maine resource if the allowable harvest for the combined areas were taken solely or predominantly

from inshore waters. Until conclusive evidence becomes available to define the stock structure, traditional fishing areas and patterns should be maintained, which implies that any immediate expansion of the silver hake fishery in the Gulf of Maine-northern Georges Bank area should be confined to the latter area.

In conclusion, assessment analyses indicate that the silver hake resource off the northeastern coast of the United States has been rebuilding since 1970. The current low level of landings compared with the estimated available surplus stock indicates the potential for a major expansion of the U.S. silver hake fishery. Such an expansion, however, would probably impact on other species and fisheries but could be accomplished through a rational multi-species management regime.

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