33

FOOD FROM THE SEA

FISH AND SHELLFISH OF NEW ENGLAND

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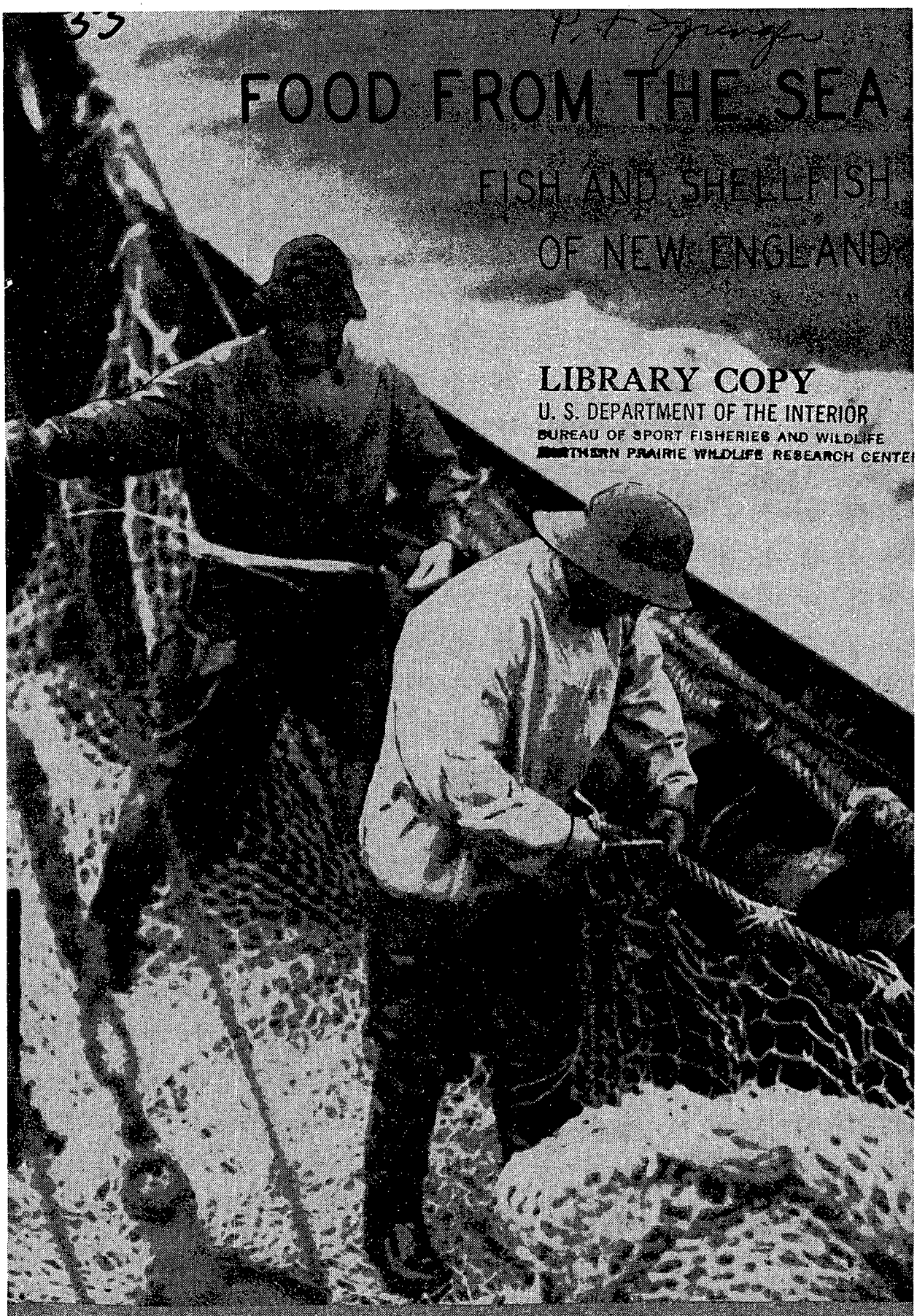

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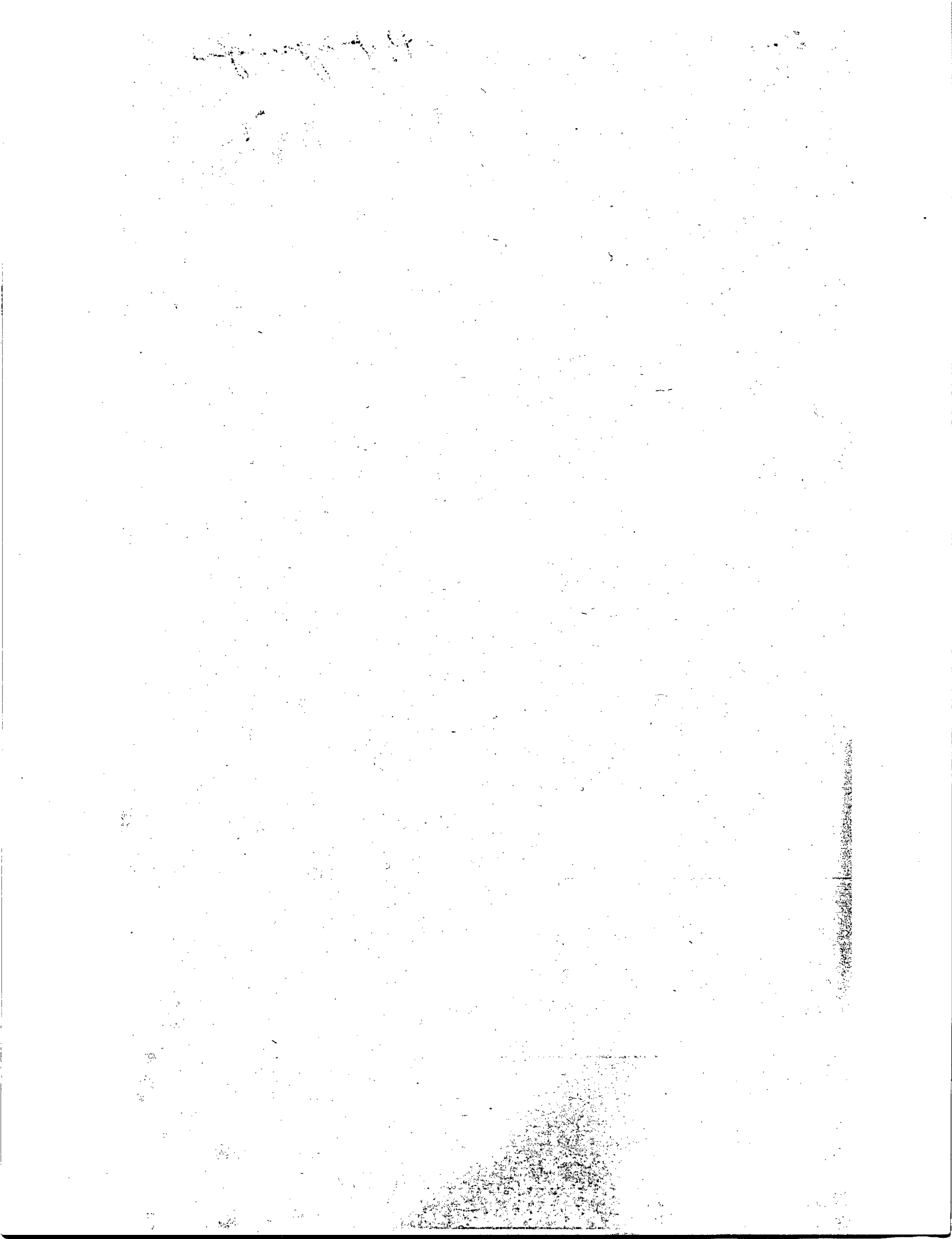

UNITED STATES DEPARTMENT OF THE INTERIOR
Harold L. Ickes, Secretary

FISH AND WILDLIFE SERVICE
Ira N. Gabrielson, Director

Conservation Bulletin 33

FOOD FROM THE SEA

Fish and Shellfish of New England

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Millions of Americans are developing new wartime food habits, trying foods they once neglected, turning to alternates for long familiar products. For every one of the ten fish or shellfish that make up more than four-fifths of New England's catch there are seven species little known or utilized, many of which could provide tasty and nutritious foods. Turning to these under-utilized species will conserve food resources by lifting the burden of over-exploitation from such fishes as cod and haddock and will augment dwindling supplies of protein foods. Exploring the seafood markets for unfamiliar species rewards the housewife and her family with delightful taste surprises, for scarcely any other class of food offers so great a variety, so rich an opportunity for mealtime adventures.

Before we can try new foods, we must know what they are—something of their nutritive value, where they come from, how market supplies vary with the season. Our enjoyment of these foods is heightened if we also know something of the creatures from which they are derived, how and where they live, how they are caught, their habits and migrations. This publication provides such an introduction to the more important fish and shellfish of New England.

FISH AND SHELLFISH OF NEW ENGLAND

CONTENTS

Conservation of the rich natural resources of the sea is a job for the consuming public as well as for State and Federal governments. Each of the millions of people who buy and eat fish can play an active part in conservation by utilizing a greater variety of seafoods. In New England, the specific job is to spread consumption more uniformly over the nearly 80 species of fish and shellfish that are brought into local ports each year. Production records of the fishing industry show a serious lack of balance—overexploitation of a few species on one hand, wasteful underexploitation of many species on the other. Although 600,000,000 pounds of seafood are caught by New England fishermen each year, 85 percent of this poundage consists of only 10 species, while the remaining 70 species are landed in quantities so limited that they make up only 15 percent of the total catch.

There are two reasons for this state of affairs. First, of course, is the obvious fact that some species are more abundant or more easily

caught than others. Second, and more important because remediable, is the lack of demand for the neglected seventy, caused by the fact that the public is unfamiliar with them and hesitates to try new species it knows nothing about. The 10 seafoods the New Englander eats so extensively are, for the most part, the best-known species—fishes by tradition as characteristic of New England as baked beans or boiled dinners. Haddock and cod, mackerel and herring, lobsters and clams—these are the natural choices of the New Englander when he goes to his seafood market to buy fish for dinner. The only newcomers that have, in recent years, given strong competition to these aristocrats of the fish world are rosefish (also called "redfish"), and flounders. Still little utilized are fishes like cusk, some of the flounders, skates, hakes, anglers, and dozens of others. From the standpoint of human welfare, thousands upon thousands of pounds of these less known fishes go to waste in the sea each year.

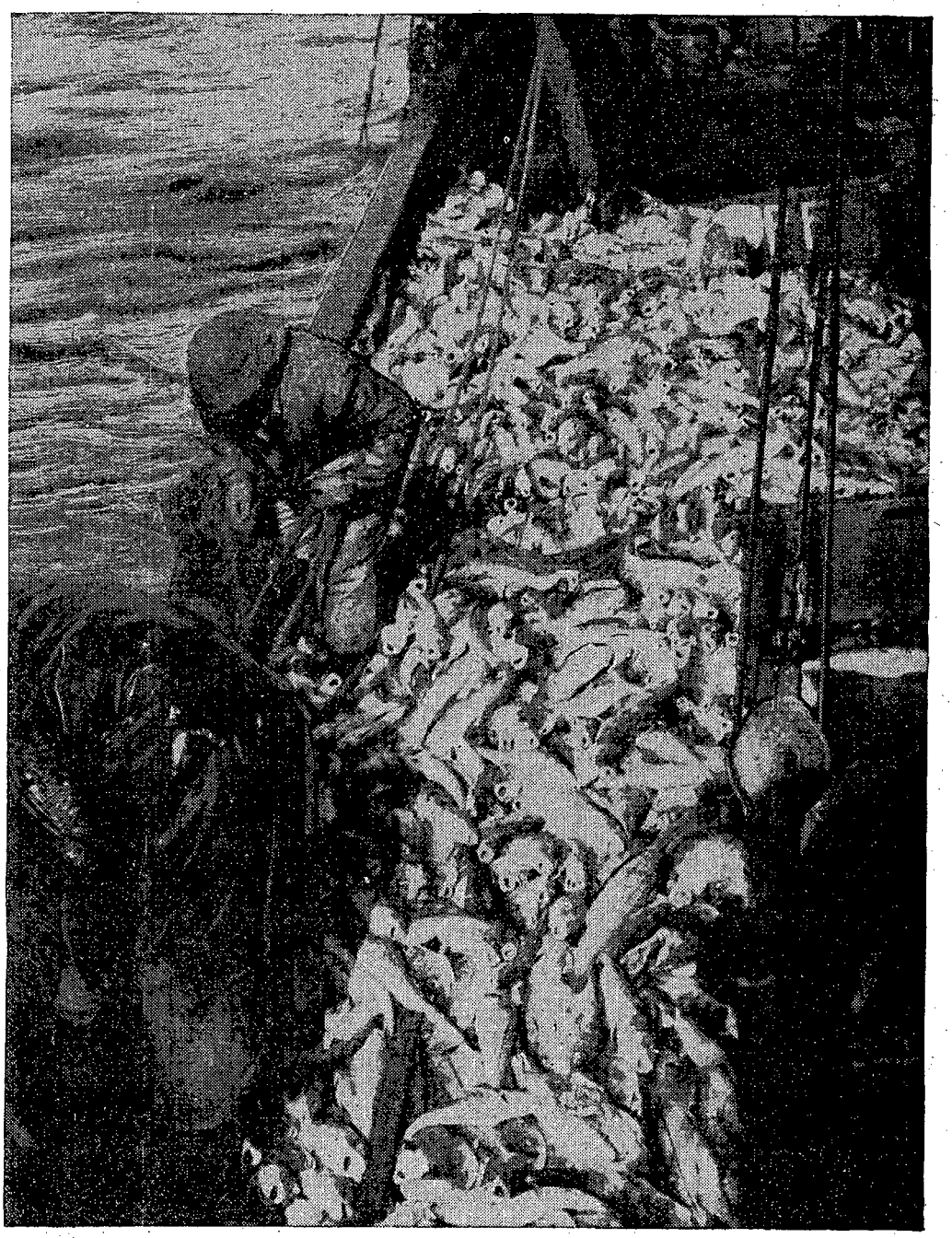
If New England fisheries are to yield their full quota of food, now and in future years, the burden of overexploitation must be lifted from the few species that now make up more than four-fifths of the catch; the slack of wasted pounds must be taken up from the fishes that now are underutilized. To this end, the major purpose of this publication is to acquaint the consumer with the fishes available in good quantity in New England markets, and to introduce those fishes as individual creatures—individual in flavor, food values, and gustatory appeal, in their habits, migrations, and relations to a varied sea environment, each with its own seasons of abundance and scarcity which, in turn, affect its availability and market quality.

NEW ENGLAND'S FISH SUPPLY

Leading Species

At the present time the largest item in New England's catch is haddock, with landings in 1940 amounting to 141,000,000 pounds valued at $4,600,000 (returns to fishermen). In the same year rosefish ranked second, producing 85,000,000 pounds worth one and a quarter millions. Third in poundage but second in value was cod, with a yield of 82,000,000 pounds worth two and a half millions.[1] Flounders, herring, whiting, pollock, and mackerel were the only other species taken in quantities exceeding 35,000,000 pounds. Sixteen others were caught in quantities exceeding a million pounds, and catches of less than a million pounds each were made of about 50 minor species.

[1] Members of the cod family (haddock, cusk, hake, whiting, and pollock, as well as the cod itself) ordinarily make up three-fifths of the total New England catch.



12,617

Figure 1.—Mass production is the keynote of New England's high seas fisheries.

TABLE 1.—*Fish and shellfish landed in New England in 1940 in quantities exceeding 100,000 pounds*

Fish	Pounds	Value to fishermen	Fish	Pounds	Value to fishermen
Alewives	3,193,400	$19,141	Skates	176,300	$2,331
Bonito	124,300	5,494	Smelt	562,300	45,617
Butterfish	2,475,700	94,694	Squeteagues or "sea trout"	153,700	11,158
Cod	82,288,900	2,502,745	Striped bass	147,400	18,881
Cusk	7,966,500	204,445	Swordfish	1,337,300	230,088
Eels:			Tautog	156,800	6,860
Common	273,900	24,480	Tuna	1,120,900	39,229
Conger	105,300	1,143	Whiting	40,868,900	335,855
Flounders:			Wolffish	1,233,000	33,721
Graysole	6,714,900	279,489			
Lemon sole	2,768,400	218,993	SHELLFISH		
Yellowtail and dab	33,590,200	728,230	Crabs	2,419,400	54,276
Blackback	10,692,900	468,234	Lobsters	11,165,300	2,000,566
Fluke	3,254,400	214,402	Clams:		
Other	550,800	18,598	Hard	4,453,100	583,721
Grayfish	575,500	19,426	Razor	342,400	11,085
Haddock	141,193,700	4,600,513	Soft	15,388,000	1,160,114
Hake	14,321,500	295,551	Oysters	5,990,200	1,051,224
Halibut	1,129,000	147,386	Scallops:		
Herring, sea	44,051,700	408,120	Bay	1,131,400	382,376
Launce	162,400	7,305	Sea	5,390,900	799,850
Mackerel	35,969,600	767,334	Conchs	424,500	8,116
Pollock	37,333,500	691,055	Sea urchins	102,500	785
Rosefish	85,141,700	1,271,303	Seaweeds:		
Scup or porgy	10,842,700	264,156	Irish moss	596,200	59,182
Sea bass	3,302,400	144,950	Other	137,000	685
Sea robin	142,200	1,582	Sand worms and bloodworms	559,000	156,794
Shad	573,300	22,214			
Sharks	226,400	4,375			

Fish as Food

New England's marine bill of fare includes so many items that it would be possible to make a different selection from it every day for two and a half months. Seafoods brought into New England ports range from staples like cod and haddock to delicacies like swordfish, lobsters, and scallops. They include fat fish and lean fish, fish of delicate flavor and fish of rich flavor, fish for baking, broiling, or pan-frying, for delicious and satisfying main dishes or for salads, appetizers, or chowders.[2]

Scarcely any other class of food offers so great a variety—so rich an opportunity for gustatory adventure. The housewife who experiments with new fish species and new methods of preparation banishes mealtime monotony and provides delightful taste surprises for her family. For example, instead of haddock fillets for dinner tonight, why not put new interest in your menu by serving the little known cusk, considered one of the choicest New England table fish? For a salad surprise try New England shrimp or flaked mackerel in gelatine. Instead of expensive fresh salmon, substitute fillets of wolffish, an excellent table fish that has only begun to achieve deserved importance. Any new species that is available is worth trying, if a tested recipe for its preparation is at hand.

[2] The Fish and Wildlife Service, as well as many commercial fishery organizations and other private agencies, issues cookbooks in which hundreds of recipes for the preparation of tempting seafood dishes are provided.

Besides their taste appeal, fish have solid claims to inclusion in the family diet on the basis of actual food values. Outstanding among the facts worthy of attention is the high quality of fish protein, the substance that replaces worn-out body tissues and promotes growth. Fish, on the average, are equal to beef round in the nutritive value of their protein, and many kinds of fish and shellfish rank higher than beef. Among these producers of superior quality protein are oysters, pilchard, and silver salmon from the Pacific coast, red snapper and shrimp from the south, Boston mackerel, shad, cod, and croakers. In general terms, an average serving of fish or shellfish may be counted upon to supply from a quarter to a half of the necessary daily allowance of protein.

Another reason for the high rating given fish by nutritionists is their mineral content. Iron, copper, magnesium, iodine, calcium, and phosphorus, all essential to human well being, are a few of the minerals that have been accumulating in the sea for thousands of years, washed down from the land by rivers. Through complex food chains these minerals enter into the bodies of small sea animals which, in turn, are eaten by fish. To cite three outstanding examples of why these facts are important from the nutritional standpoint: Iodine, which keeps the thyroid gland functioning properly, is found in marine food animals in quantities 50 to 200 times as high as in any other foods. Calcium and phosphorus (without which proper development of bones and teeth is impossible) occur in fish fillets in about the same quantities as in beef round. Oysters, shrimp, and crab meat, compared with milk, provide half as much calcium, five times as much magnesium, and slightly more phosphorus. Iron and copper, which build up the hemoglobin content of the blood and prevent or remedy nutritional anemia, are easily obtained by eating most fish. Oysters and shrimp are the best known sources of these two minerals.

As for vitamins, fish-liver oils have long been recognized as first-class sources of Vitamins A and D. Less widely understood is the fact that the flesh of fish also is a source of several vitamins. On the average, daily vitamin requirements could be obtained from ordinary portions of fish to the following extent: Vitamin A, 10 percent; Vitamin D, more than adequate amounts; thiamin (Vitamin B_1) 15 percent; riboflavin (Vitamin B_2) and nicotinic acid (another element of the Vitamin B complex), 70 percent.

When To Buy

Every month of the year in the fresh-fish markets, certain fish are better buys than others. Although the retail prices of most fish vary surprisingly little from season to season, it pays the housewife in better quality to buy a particular species of fish when the supply is

greatest. When whiting or pollock, for example, are most abundant in local waters, boats are making their catches in minimum time and the fish are arriving in the markets in the best possible condition.

These comments, of course, do not apply to frozen fish, which, because of the excellence of modern refrigeration, are usually equal to fresh in taste, appearance, and food value. Just as quick freezing makes a great variety of fruits and vegetables available in attractive packages every month of the year, it also makes possible the serving of many kinds of fish out of season.

Seasonal Supplies of Fresh Fish

JANUARY

This is one of the best months to try gray sole and yellowtails—white-meated flounders that are now being brought in abundantly by ice-encrusted trawlers from the fishing banks. Another fish to get acquainted with in January is the cusk, whose delicate flavor is well known to connoisseurs of good food and deserves to be better known to all American housewives. There may be a last chance to buy fresh mackerel this month, for a few of these fish sometimes linger about southern New England after the first of the year.

FEBRUARY

To gray sole, yellowtails, and cusk, still very abundant, February adds the large cod and haddock which the trawlers are picking up on nearby Georges. This is also a good month to buy fresh halibut from local waters.

MARCH

Supplies of cod, haddock, cusk, halibut, and gray sole continue good and the catches of wolffish, which slow down around the turn of the year, begin to pick up. The wolffish is one of New England's underexploited fishes, a condition that will be corrected when housewives discover its excellence.

APRIL

This is the best month to try out recipes for fresh cod, for with the largest landings of the year pouring into the markets, quality should be at its peak and prices moderate. Halibut also is at the peak of its abundance, and haddock, gray sole, and wolffish continue plentiful. Rosefish landings begin to go up after a slow midwinter fishery and now a real delicacy may be added to the menu as the scallop season is ushered in. Sea robins, scup, and striped bass are being caught in the traps of southern New England, and the first mackerel of the year are being taken in Middle Atlantic waters, to come by truck or rail to New England markets.

MAY

In May almost any fish is a good buy, with many species coming in so abundantly that their freshness and good quality are virtually assured. New species of flounders to try this month are the sweet-meated dab, the lemon sole, a large flounder caught only on Georges Bank, and the smaller winter flounder or blackback taken closer inshore. Mackerel have now arrived in New England waters and prices drop accordingly; butterfish, squeteague, sea bass, and whiting return to the southern New England coast and alewives to the rivers. Members of the cod family—cod, haddock, and cusk—continue abundant, as do wolffish and scallops. This is the biggest month for rosefish.

JUNE

With few exceptions, May's seafood advice holds good for June. The so-called "market cod" are now more abundant than the larger sizes and the dab fishery is at its peak.

JULY

Added to the list of seafoods abundant in May and June are swordfish, now being caught about Block Island. Two members of the cod family—the white and squirrel hakes—appear more abundantly in the markets, usually in the form of fillets. Haddock landings continue large. This is the peak month for the whiting fishery, and in southern New England the largest catches of lobsters are being made.

AUGUST

This is the best month of the year for swordfishing, hence the best month to enjoy the tender, richly flavored swordfish steaks. Mackerel are extremely abundant and lobster fishermen in Massachusetts are making their biggest catches. Haddock, hake, cusk, and whiting continue good buys, as do yellowtails, dabs, and blackbacks. Rosefish, whiting, and scallops are also abundant.

SEPTEMBER

September is the biggest month of the hake and yellowtail fisheries. Cod catches are relatively low; haddock landings are falling off but still good, especially from South Channel. Rosefish and whiting are coming in almost as fast as they did at the peak of their seasons and whiting are still abundant. In Maine this is the best month for lobsters.

OCTOBER

In October, try pollock, a handsome member of the cod family caught throughout the year but in special abundance during October, Novem-

ber, and December. Pollock usually appears in the markets in convenient fillets, white and fine-flavored. Haddock and hake continue in the markets in good quantity; among flounders, blackbacks and dabs are good buys; rosefish and scallops are abundant. Mackerel begin to move south but large catches of these fish, fat after their summer's feeding, are still being made.

NOVEMBER

November is the banner month for pollock as great numbers of these fish are taken by gill-net fishermen off the tip of Cape Cod. Haddock catches are at a low ebb and the mackerel are definitely moving off. Blackbacks have returned from their summer grounds offshore and good catches are being made. Landings of yellowtails are picking up after a temporary lull. Scallop catches are good and the oyster season is in full swing.

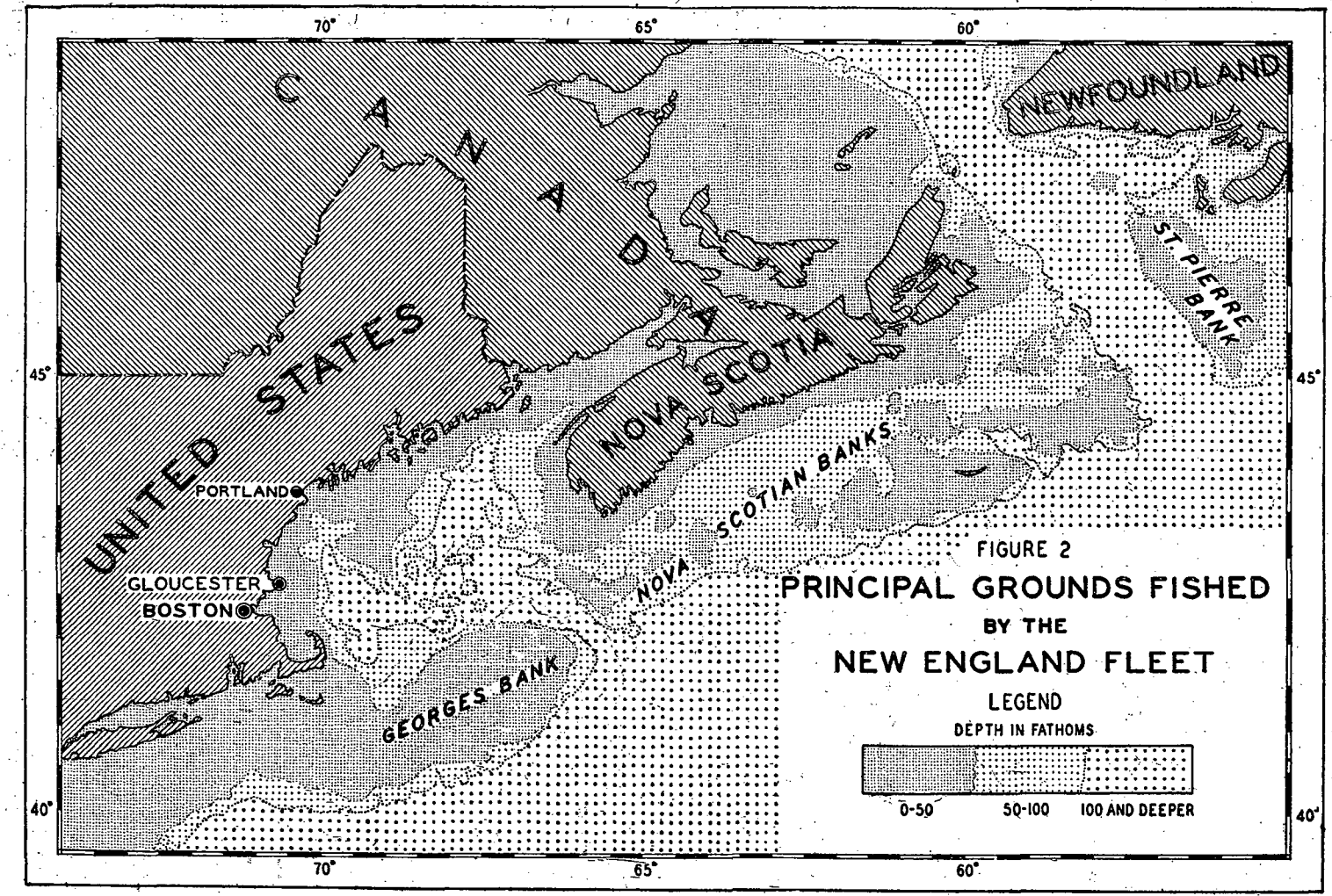
DECEMBER

Pollock catches are still very large and yellowtail and dab are plentiful. Most of the fisheries this month are yielding only average or lower-than-average catches, but an excellent variety is still available, with only the "summer fishes" like swordfish, whiting, and squeteague missing from local waters.

SOURCES OF SUPPLY

As we have seen, from six to seven hundred million pounds of fish and shellfish are brought into the ports of New England each year. Half of the catch comes in the holds of seagoing vessels into the great fishing centers of Boston, Gloucester, and Portland; the remainder comes in smaller vessels and boats into the many smaller coastal cities and towns that offer anchorage for fishing boats and means of transporting fish to market. Where do the fish come from—the haddock and cod by the hundred million pounds, the gleaming, iridescent mackerel, the giant swordfish that weigh several hundred pounds apiece, the colorful rosefish, the flounders and pollock and herring and lobsters? They come from an undersea terrain as varied and as clearly defined as the continent that borders it, a vast expanse of water including the whole coastline from rocky Maine to the quieter and more protected shores of Rhode Island and Connecticut, stretching out into the semi-enclosed sea known as the Gulf of Maine, extending into the ocean 200 miles to New England's famous fishing banks, and on 500 to 800 miles to the waters off Nova Scotia and the Banks of Newfoundland.

East of Maine, New Hampshire, and Massachusetts lies the great basin of water known as the Gulf of Maine—its northern, western, and southwestern rim formed by the curving shoreline from Cape Sable to Provincetown. To the south and east, the rim of the Gulf lies


70°
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CANADA
UNITED STATES
NEWFOUNDLAND
ST. PIERRE BANK
NOVA SCOTIA
NOVA SCOTIAN BANKS
PORTLAND
GLOUCESTER
BOSTON
GEORGES BANK
FIGURE 2
PRINCIPAL GROUNDS FISHED
BY THE
NEW ENGLAND FLEET
LEGEND
DEPTH IN FATHOMS
0-50
50-100
100 AND DEEPER

from 12 to 600 feet under water and consists of a 250-mile ridge (a sort of submarine mountain chain) that forms a barrier between the mile-deep waters of the open Atlantic and the shallower basin of the Gulf. Scattered along this curving ridge are the offshore fishing grounds of New England, known as Georges, Browns, and Seal Island Banks.

From Georges Bank, with its area of 22,000 square miles, about 100 million pounds of fish are taken each year.[3] The fishing grounds included in the Georges area lie from 80 to 220 miles from Boston, which means that fish taken there usually arrive in port in first-class condition. Browns Bank, next to the eastward, is only a fraction of the size of Georges. Haddock, rosefish, cod, pollock, cusk, and flounders are the principal species making up its 35-million-pound annual yield. Seal Island, the shoal which completes the seaward rim of the Gulf of Maine, is visited only by line trawlers and is a relatively unimportant fishing ground.

More than a third of all New England's fish come from the underwater domain just described—the basin of the Gulf of Maine plus the offshore banks that form its seaward boundary. Another one-fourth comes from a more distant chain of banks that lie off the southeastern coasts of Nova Scotia and Newfoundland from 38 to 62 hours' trawler run from Boston—La Have, Emerald, Sable Island, and Banquereau; while southeast of Newfoundland lies the famous Grand Bank. In a recent year, 141 United States vessels fished the Nova Scotian banks and brought back 100 million pounds of fish. The catch by United States vessels on the Newfoundland banks and the Gulf of St. Lawrence banks is negligible.

The fishing grounds of southern New England contrast markedly with those described above, consisting for the most part of gently sloping sea bottoms where shore fish, such as flounders, squeteague, and sea bass are found. These grounds lie comparatively close inshore, and so most of the fishing is done by smaller boats.

FISHERMEN AND FISHING BOATS

How the Fisheries Began

The fisheries of New England were the first commercial enterprise in our country. Years before permanent colonies were established the taking of fish from offshore waters had been under way. We know that in 1497 John Cabot reported the abundance of codfish at Newfoundland to his patron, Henry VII. Vessels began to sail out of

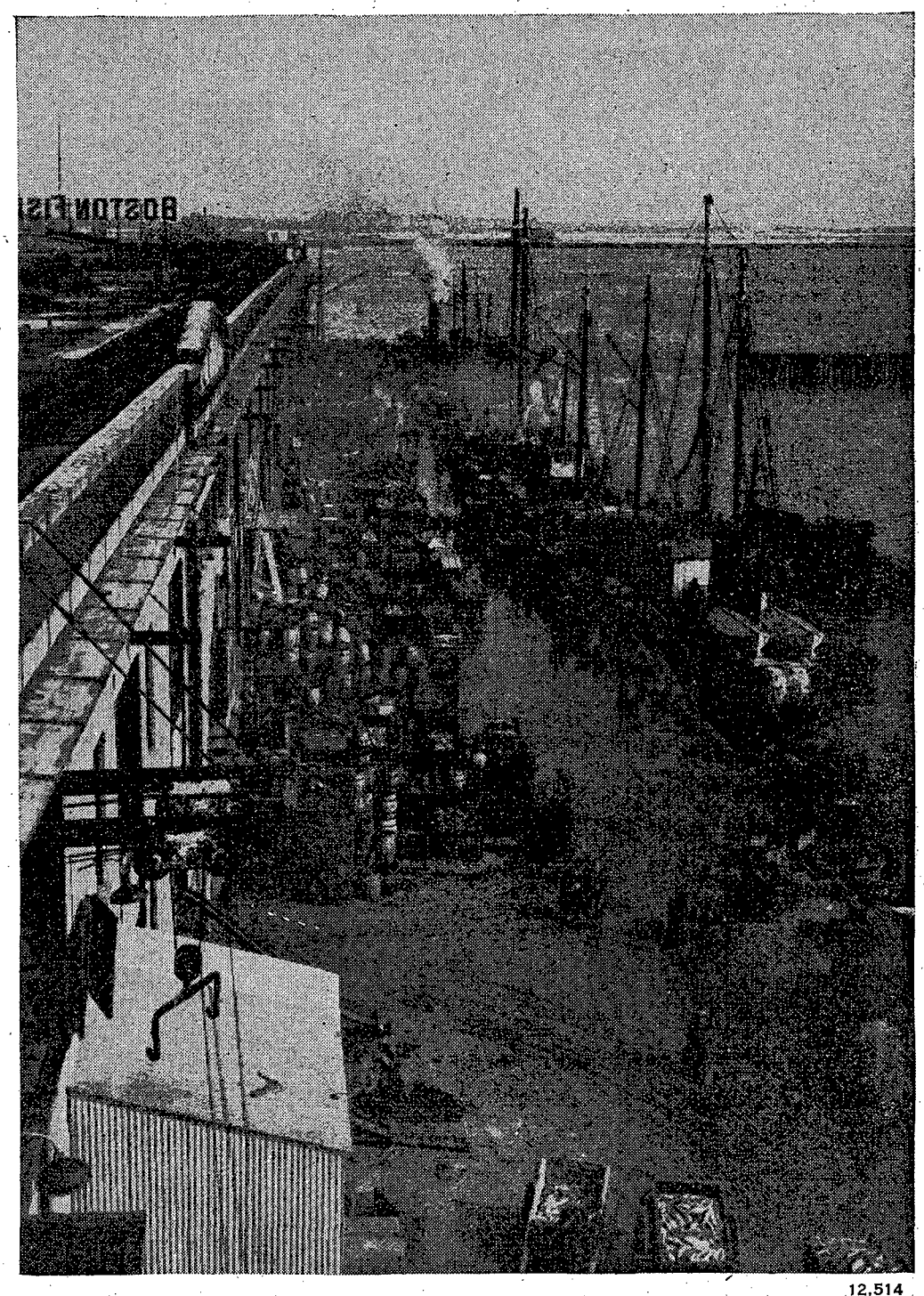
[3] In 1940, Georges Bank proper yielded 73,000,000 pounds; South Channel, separating the Bank from Nantucket Shoals, 75,000,000 pounds; and Nantucket Shoals, 6,000,000 pounds.

European ports to fish for cod on the Grand Bank, and by the middle 1500's this fleet numbered about 300 sail, and included boats from Spain, Portugal, France, and England. Need for land stations from which to operate played a part in the establishment of colonies; and competition for fishing advantages on the Grand Bank and the Nova Scotian and New England coasts was an important cause of the wars between France and England, as well as of later disputes between England and the American colonies. Even before the Revolution, their large export trade in fish had gained the colonies an important place in world trade, and attempts by England to place restrictions on this trade were among the major grievances that led to the war for independence.

The war itself was a disaster to the fisheries, for most of the vessels were taken over for naval service, while fishing wharves and shore equipment rotted away. After the Revolution, however, the fisheries returned to a place of importanee, only to suffer a fresh setback in the War of 1812. The subsequent period of expansion brought the increased development of the deep-sea fisheries, the rise of the mackerel fishery, and the beginning of important herring, oyster, and menhaden fisheries. During the past half century the yield of the New England fisheries has varied from 400,000,000 pounds to nearly 700,000,000 pounds.

New England's Place Among United States Fisheries

The five New England States that support marine fisheries provide 15 percent of the Nation's supply of fish. By tradition the fishery capital of the Nation, New England now sees its supremacy in this field challenged by the younger fisheries of other sections. In total production and value of fishery products it is far outstripped by the Pacific coast, whose production of one and three-quarter billion pounds exceeds that of all the States from Maine to Texas combined. However, the Pacific coast fisheries are built largely around pilchard, salmon, and tuna and their principal products are canned fish and fish oil and meal. By contrast, New England's fish with few exceptions go directly from the sea to the consumer as they are caught, or as parchment-jacketed fillets. Therefore, while the west coast leads in the canned-fish and the fish-oil and meal trade, New England remains the center of the fresh-fish industry of the country. On the Atlantic coast, moreover, the waters bordering the New England States still rank first as fish producers, providing a third of the fish taken from Maine to Texas. Fishermen who go to sea from New England's historic ports receive a larger total income from their aquatic harvest than fishermen of any other geographic section of the Atlantic coast, and their fish are a little more valuable, pound for pound, than any other fish in the United States. (Table 2.)



12,514

Figure 3.—Into the Boston Fish Pier come two-fifths of all the fish caught in New England, one-eighth of the total Atlantic coast catch.

TABLE 2.—*The fisheries of New England in 1940 compared with those of other sections of the coast*

Section	Number of fishermen	Catch			Value manufactured products	
		Pounds	Value to fishermen	Average price received per pound	By mfg. establishments	By fishermen
New England	18,546	626,054,000	$20,494,000	$0.032	$23,324,155	$1,356,815
Middle Atlantic	7,737	355,553,000	7,651,000	.021	15,815,684	513,165
Chesapeake Bay	14,269	320,736,000	7,457,000	.023	11,000,398	13,306
South Atlantic and Gulf	27,941	575,533,000	14,645,000	.025	13,838,590	109,845
Pacific coast	25,183	1,453,281,000	29,256,000	.020	62,631,235	192,948

The Fleet

New England's first-line fishing fleet—the large vessels that bring in the bulk of the catch—consisted in 1940 of 642 vessels, motor-powered with the exception of about half a dozen powered with steam. Smaller boats (about half with motor power and half without) totaled 9,137, making the number of craft of all types and sizes fishing in New England waters or landing fish at New England ports 9,779.

12,634

Figure 4.—New England fishermen harvest the biggest aquatic crop taken on the Atlantic coast.

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Fishermen, either on boats or ashore, used 22 different kinds of gear in New England waters in 1940.[4] Out of this assortment of fishing devices the otter trawl was by far the most important, catching 400,000,000 pounds or about two-thirds of all the fish landed. No other type of gear even approached the otter trawl in production, but the relative importance of other principal types of gear in 1940 is shown by the fact that lines were used for taking 9 percent of the total yield; purse seines and pound nets for 4 percent each; weirs, stop seines, hoes, and gill nets for 3 percent each; pots and dredges for 2 percent each; and dip nets for 1 percent.

Markets

New England's fish are shipped in quantities at least as far as Texas and Minnesota. A survey of retail sales made in representative United States cities (Johnson, 1936) [5] showed such New England species as haddock to be among the most popular fish in such distant cities as Chicago, Cedar Rapids, Dallas, and Minneapolis. Rosefish enjoys popularity in Milwaukee and Chicago and wolffish in Columbus, while about a fourth of the total catch of whiting is eaten in the St. Louis area.

A considerable portion of the catch, however, is served on New England tables. The New England housewife, loyal to local varieties, purchases relatively small quantities of non-native species. Citizens of Fall River, Mass., for example, (according to the survey cited above) showed a year-round preference for mackerel, followed by flounders and swordfish in season, while Bostonians favored haddock, halibut, mackerel, and cod. Manchester, N. H., eats more haddock and mackerel than any other fish, but Providence, R. I., votes for haddock, halibut, and cod in the order named. Save for shrimp from the south, salmon from Canada and the West Coast, and Pacific halibut, in the great volume of their seafood purchasing New Englanders buy New England fish.

BIOGRAPHIES OF NEW ENGLAND FISH AND SHELLFISH

People who suppose that fish are all alike—that they taste alike, look alike, behave alike—are much mistaken. Fish are as individual and as interesting in their habits as any other creatures, but (because they live in a watery world where people can seldom observe them in the way they can observe birds or big game animals) they are

[4] Information on most of these methods of fishing will be found in the biographical sections on the various fishes and shellfish, and more detailed accounts are given in some of the publications cited in the bibliography.

[5] Publications referred to parenthetically by date are listed in the bibliography.

commonly thought to have no more individuality than so many lumps of coal. To dispel this impression, these biographical sketches have been prepared to give some account of the way fishes live and of how the changing conditions of the sea bring them famine or plenty, cause them to migrate from one area to another hundreds of miles distant, affect their spawning and the survival of their young, and ultimately control the numbers and kinds of fishes available as human food. It is hoped that these thumb-nail sketches of New England's most important fish and shellfish will prove useful, not only to those who wish to become acquainted with a wider variety of seafoods, but to all who have an interest in the natural history of the sea.

Alewives (*Pomolobus pseudoharengus* and *Pomolobus aestivalis*)

Salted alewives in exchange for West Indian molasses, sugar, and rum founded a colonial trade that has persisted with modifications of volume and circumstance to the present day. More than a third of New England's annual catch of some 4,000,000 pounds (taken largely in Maine and Massachusetts) is salted in barrels, in part for home consumption, in part for export. Lesser quantities are smoked, and some alewives and alewife roe are canned, but only local markets have been developed for the fresh product. Compared with such fish as haddock or flounders, the alewife is small and rather bony (average weight is half a pound) but the meat is agreeably flavored and somewhat less oily than shad. Threatened shortages of other, better known fishes—especially those taken on distant grounds—focus attention on the alewife as a virtually neglected potential source of millions of pounds of protein food.

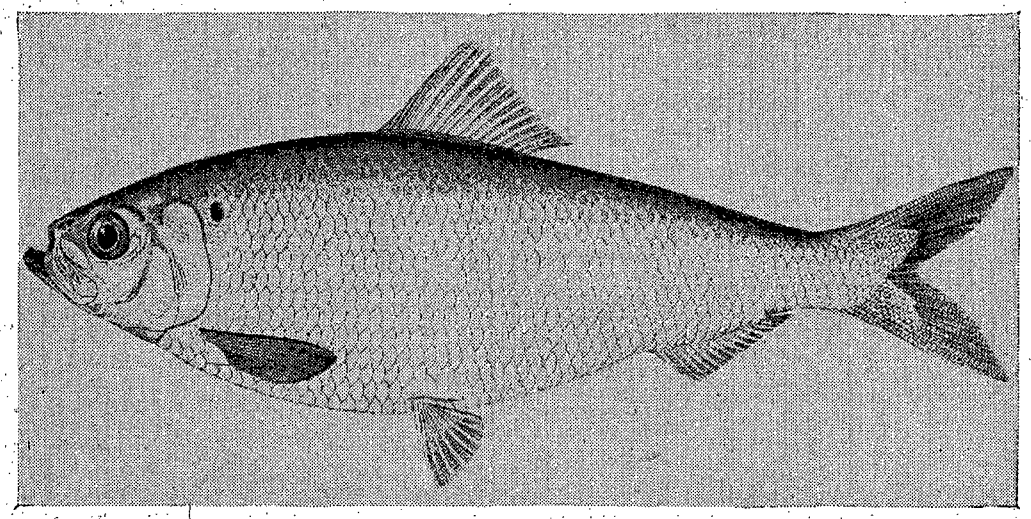

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Figure 5.—The alewife or branch herring.

But what of the supply? Although alewives still hold a place among the 14 fishes caught in largest volume in New England, present catches are insignificant compared with those of early years. Probably no other fish (with the possible exception of the cod) is mentioned more frequently in colonial literature, and eyewitness stories of the throngs of alewives that entered New England streams every spring remind us of the tales of the passenger pigeons. Today a remnant of those runs remains. Compare Connecticut's 34,000 pounds in 1940 with her million pounds in 1896; Rhode Island's 20,000 pounds with 2,000,000 pounds in 1896; Massachusetts' 900,000 pounds with 5,000,000 pounds in 1896. In Maine alone has the size of the alewife catch changed little during the past 50 years. Throughout most of New England, overfishing, obstruction of streams by dams, and water pollution have contributed to the decline. A brief account of the life of the alewife will show how easily human carelessness can deplete or destroy such resources, and, by the same token, how the runs could be restored by planning and attention.

Every spring the alewives come in from feeding grounds in the open Atlantic to spawn. They enter rivers and small streams, pressing up even into shallow creeks where there is scarcely enough flow for a fish to swim without breaking water. The first runs of alewives reach the streams of the Massachusetts Bay area in early April and the Maine streams later in the month or about the first of May. These are the true alewives (*Pomolobus pseudoharengus*), called also "branch herrings." Most of these early-run fish spawn in the numerous ponds that dot the New England countryside, rather than in streams. Two weeks to a month later they are followed by other runs composed of their close relatives, the bluebacks or glut herrings (*Pomolobus aestivalis*), although the name "alewife" sometimes is applied to these fish as well. The bluebacks seldom run far above tide water, often spawning in brackish-water ponds or in the larger rivers. The branch herring occurs from Nova Scotia and the Gulf of St. Lawrence south to the Carolinas, but is more abundant north of Cape Cod, while the blueback, a more southern species, is found all the way from the Bay of Fundy to Florida. In the more southern parts of their range both alewives are known as "river herrings."

In ascending the streams the alewives are said to move chiefly by day, dropping back a little with the current at nightfall. They prefer warm, sunny days for traveling and especially for ascending falls. They make their way up rapids of considerable velocity, and according to Atkins of the old U. S. Fish Commission, "will turn on their sides and push themselves up a steep, inclined plane against a sheet of water not half as thick as their bodies."

Years ago when small dams crowding into the coastal rivers began to obstruct the passage of migratory fishes, citizens here and there took

enough thought for the alewives to help them over the dams with dip-nets, and in some places fish ladders were built. Any tolerably efficient ladder served for the alewives. At Damariscotta, Maine, a series of 25 or 30 artificial pools were built of loose stones to allow the alewives to ascend a 50-foot ledge of rock over which Damariscotta Pond spilled its waters to a tidal stream below. The pond was stocked about 1816, and in a few years a large run of fish had been built up at this point. In most places, however, fishways were not provided, or were allowed to fall into disrepair.

Probably the longest alewife migration on record is their ascent of the east branch of the Penobscot River, where they once reached a point 200 miles from the sea. Ordinarily, however, they spawn much nearer to the ocean.

After depositing their eggs in masses which cling to the submerged roots and stones of the stream bed, the fish return to the sea in an emaciated condition, for they have taken no food during the spawning migration. As soon as they reach the brackish tidal estuaries on their return journey they begin to feed.

Meanwhile the young, resembling small, transparent eels more than alewives, are beginning to appear in numbers in the rivers. They grow rapidly and by the time they are an inch long have assumed the typical body form of their race. During the summer and fall, when about finger length, most of the young drop downstream to the sea.

The movements of young and adult alewives in the ocean are little known. Like the sea herring, mackerel, and menhaden, they apparently keep together in large schools, fish of a size congregating together. Sometimes they are taken in large numbers in seines and pound nets along the coast, and during the winter months a few have been caught in otter trawls (which are fished along the bottom) on such offshore grounds as Georges Bank and South Channel.

It is believed that the alewives, like the Pacific salmons, return at maturity to their native streams. Probably they live three years in the ocean before returning for the first time to spawn.

Building up the alewife fisheries to much higher levels of abundance is considered entirely feasible. Many established facts support this belief. For example, small runs have been maintained in streams blocked by dams merely by releasing a few barrels of alewives above the dams each year. Stocking of barren ponds has established runs within the three to four years necessary for the fish to complete the first prolonged period of residence in the ocean. The alewives of New England are not a doomed resource, but a neglected one. In great numbers of ponds and streams, all that is needed is stocking to restore exterminated runs; in others, the removal of screens at the mouth of ponds and the building of fishways over dams will bring back the alewives.

Sea Herring (*Clupea harengus*)

Probably no other fish in the Atlantic is so abundant as the sea herring, and probably no other is so continually and extensively preyed upon by so large a variety of natural enemies. Although fishermen have taken herring in their nets for untold centuries, it is probable that the total supply in the sea is little diminished from the days when whales and fishes and sea birds were the only predators. This does not mean, however, that the supply in any particular part of the sea remains the same from year to year. Like most of the so-called pelagic fishes that are taken as they school near the surface, the herring come and go with marked and often disastrous fluctuations in the numbers available locally to fishermen.

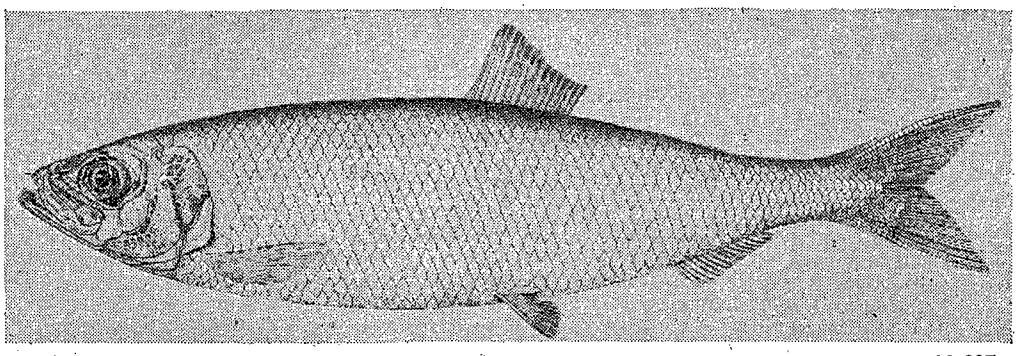

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Figure 6.—The sea herring.

The most important use made of the herring is the canning as sardines. From half a million to 2 or 3 million standard cases (each containing approximately 20 pounds) are packed each year in Maine sardine canneries. According to long-established practice, every year the canneries import almost as many young herring from Canada as they receive from local waters. Even with this additional source of supply the pack of sardines varies greatly from year to year. Canned sardines are by far the most valuable product of this fishery, bringing 3¾ million dollars in 1940, when 1,117,748 standard cases were packed.

While the young herrings are canned as sardines, the larger sizes—the "fat herring" approximately 3 years old and the large mature herring in their fourth summer or older—are utilized chiefly for smoking. Most are either soft- or hard-smoked in the round and thus prepared are known as bloaters. In New England, most of the smoked herring marketed in retail stores are sea herring; but from New York southward, the product called by the same name usually is prepared from the alewife or river herring. Lesser quantities are salted or spiced. Some of the smaller sizes—young just past the "sardine" size—are processed as smoked boneless herring. Even the waste prod-

ucts of the herring-processing plants are used, fish meal for poultry and fox food and oil for use in paints being prepared from these scraps.

In New England, only rosefish, haddock, cod, and flounders were taken in larger quantities than the herring in 1940. In that year a 44,000,000-pound catch, worth $408,000 to the fishermen, was landed. The value of the various products manufactured from herring in New England was 7½ million dollars in 1939, and 4 million dollars in 1940, a comparatively poor herring year.

The sea herring has so many natural enemies that man is, in a sense, an incidental predator. Almost every large fish of the sea, and some of the medium-sized ones as well, feed at some time on herring or on their spawn, which is deposited on the sea bottom. Fish like the haddock, cunner, and cod find the eggs that cluster on rocks and sea weeds a convenient source of food. Even winds and tides may be a cause of destruction, as when whole schools of young herring are washed ashore by storms to silver the beaches with their scales. In European waters quantities of spawn are tossed up on the shore, and this happens also in the Gulf of St. Lawrence, but not, apparently, in New England.

It is in the surface waters of the open sea, however, that the greatest slaughter of the herring takes place. The whole fraternity of piscine sea hunters—the bluefish, pollock, mackerel, salmon, cod, thresher shark, mackerel shark, swordfish and tuna—feed in part on herring to satisfy appetites born of the strenuous life of the open sea. Finbacks, the commonest whales in the Gulf of Maine, devour enormous numbers; packs of dogfish tear through the closely massed schools; whiting drive the luckless herring before them in so frenzied a chase that pursued and pursuers often rush heedlessly into shallow water where death by stranding puts an end to the hunt.

From such a listing of enemies (an incomplete one, at that) it would appear that the herring are born but to be eaten, but they themselves stand in the relation of dangerous predators to the lesser creatures that populate the waters of the open sea. Among the favorite foods of herring are small shrimps of surface-dwelling habit, which they actively pursue through the water. If the preferred shrimps are not to be had they strain the smaller copepods from the water, their gill rakers serving as sieves for the purpose. Although fish are not important in the diet of herring under ordinary conditions, they occasionally take small launce or sand eels, silversides, or even young of their own kind.

Well known though the herring is, at various stages of its life it is called by other names that are less familiar. The so-called "sardines" that are canned on the coast of Maine are in reality young herring, which are caught in great numbers when they come inshore during

the spring and summer. These young fish, 3 to 4 inches long, appear in enormous numbers off the coast of New England in the spring, usually arriving in Massachusetts Bay about the middle of April, and along the coast of Maine, the Bay of Fundy, and the west coast of Nova Scotia progressively later. Schools of young herring, ranging in size from 3 to 8 inches and including both one- and two-year-olds, usually may be found east of Penobscot Bay all summer. In July and August the sardine herrings of Massachusetts Bay are joined by schools of "sperling," the herring in their second summer that have grown to a length of 5 to 7 inches.

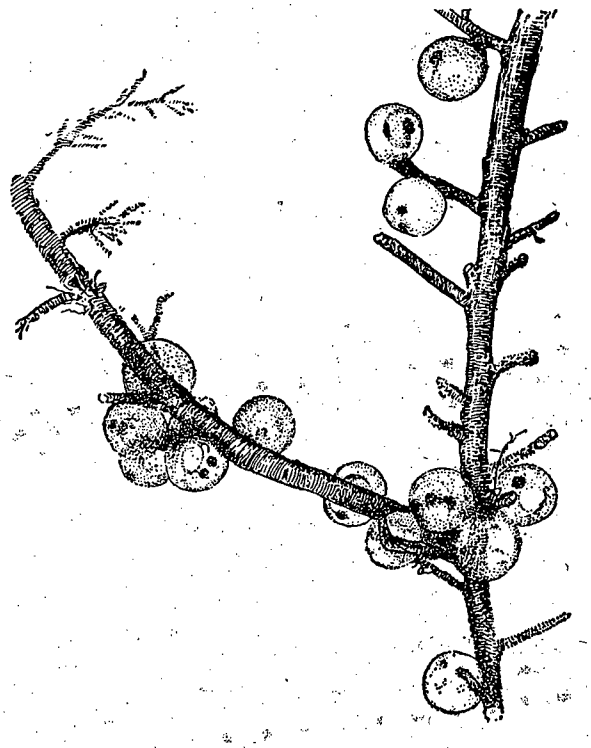

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Figure 7.—Herring eggs adhere to weeds, stones, or shells. The dark eyes of the developing young are easily seen.

Although the one- and two-year-old herring, as well as the large spawning adults, are still numerous along the New England coast line during the early autumn, they move out into deep water soon after the middle of October, probably to winter on the bottom. During their third summer the young herring, still immature, grow rapidly and accumulate large amounts of fat among the body tissues. In Europe, large fisheries are based on these "fat" herring, but on our side of the Atlantic the herring in this stage of development lie offshore more than do the younger fish, and so are less accessible to the fishermen. A few are taken by mackerel seiners, and stragglers come in along the Maine coast.

During the winter following this third summer the herring become leaner and attain maturity. During most of the year they live some

distance offshore, probably near the bottom, but come inshore to spawn from midsummer to early winter. The chief spawning grounds of the herring along the coasts of Maine and Massachusetts and in the Bay of Fundy lie at depths ranging from 12 down to 180 feet. Herring spawn not only close inshore but on the various banks and shoals as far out as 25 miles from shore. When boats are engaged in cod and haddock fishing on such banks the anchors often come up with herring eggs attached. The herring deposits from 20,000 to 40,000 eggs, in contrast to about 400,000 produced by the mackerel and upwards of 3,000,000 by the cod.

Primarily a North Atlantic fish found from northern Labrador to Block Island, the sea herring is taken occasionally as far south as Cape Hatteras. It occurs also in great numbers in the eastern Atlantic.

Mackerel (*Scomber scombrus*)

Every spring the mackerel rise from the deeper waters off the Atlantic coast, where they have spent the winter, and strike in toward the shore. Traveling in vast schools or associations of schools that may be miles in length, the mackerel approach the coast in two great divisions, one that arrives in the offing of the Chesapeake and Delaware Bays in April, and a more northerly group that comes inshore in the vicinity of southern New England in late May. Both of these groups work up the coast in a northeasterly direction.

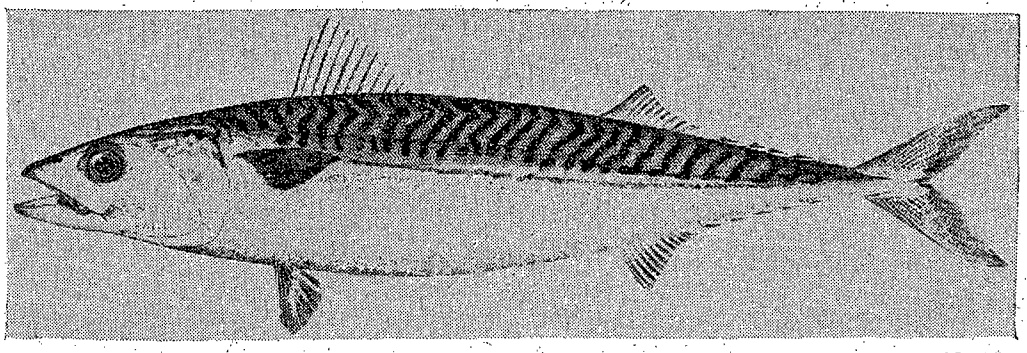

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Figure 8.—The mackerel.

This annual visit of the mackerel brings them to the principal spawning grounds—an area that lies from 10 to 30 or even 50 miles offshore, and extends from the vicinity of the Chesapeake Capes to the offing of Cape Cod. The eggs are shed in the surface waters of this area. After spawning, the mackerel spend the summer feeding on the rich surface life which abounds in the waters over the continental shelf. Wherever swarms of small crustaceans (especially the red copepod, *Calanus*) are most abundant, schools of mackerel are likely to be concentrated. The southern group of mackerel spends the summer in the

Gulf of Maine, while the northern division summers in the Gulf of St. Lawrence.

The first appearance of mackerel in the spring is awaited by fishermen operating usually out of Wildwood and Cape May, N. J., and often there is keen rivalry to be the first to land mackerel and reap the profits of early-season prices for this seafood delicacy. These vessels work up the coast with the fish, and for a period of 2 to 3 weeks land their catches chiefly at New York. As the mackerel approach New England waters, more boats from that area enter the fishery and landings are made at more northerly ports—especially at Boston, New Bedford, and Gloucester. During recent years mackerel fishing has been carried on through so great a portion of the year that the fresh fish are available, in varying quantities, from April through December. The heaviest landings come in midsummer.

Mackerel in the fresh state is considered by many to be one of the choicest of all food fishes. It is rich in fat and when properly prepared is a fine-flavored fish. Some cookery experts consider it too fat to fry, and prefer to split and broil it. Large mackerel may be stuffed and baked. Fresh mackerel should reach the fish markets already dressed, for they do not keep so well "in the round." They are often sold as fresh or frozen fillets—the latter available throughout the year. Some are salted either as fillets or split fish, and some are smoked. Although the early mackerel fishery was built on the salt product, little of the catch is consumed in this form in New England today. The usual size of mackerel seen in the markets is about 10 to 16 inches.

Most mackerel fishing is done from purse-seine vessels, but there is also a small gill-net fishery. Seiners fish during the dark of the moon; netters on moonlight nights. This is because seiners must see the fish in order to surround the moving schools with their nets; while the gillnetters cannot catch fish if their nets are visible. Mackerel feed near the surface in the midst of innumerable small creatures that give off a phosphorescent light when disturbed. The effect produced by a large school of mackerel is a diffuse glow that can be seen by lookouts on the cruising seiners for a long distance on a dark night, although it is practically invisible when there is a sheen of moonlight on the water. Netters, however, set mile-long, perpendicular strings of webbing in the water at dusk and fish them at dawn. For these fishermen, darkness has a different effect, for the luminescent food-animals gather on the strands of the net and gleam as it sways in the water. For this reason the mackerel see the nets best on dark nights and so escape "gilling" in the twine. At certain seasons and in certain localities mackerel are taken in pound nets and floating traps close inshore.

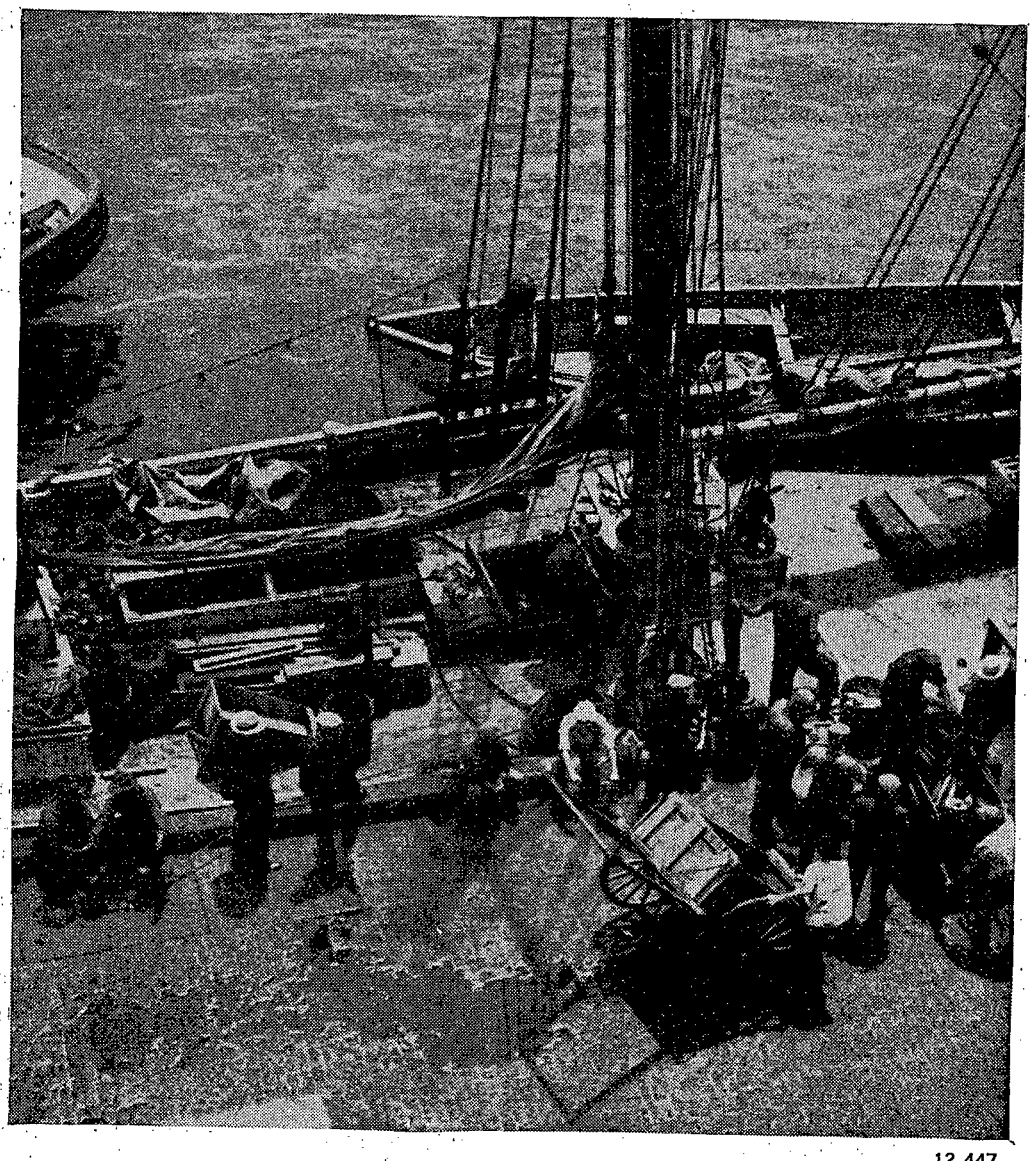

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Figure 9.—Mackerel from the open Atlantic arrive at a New England wharfside, completing the first lap of their journey to America's dinner tables.

The most interesting chapter in the life story of the mackerel is the period spent in the teeming nursery of the sea, first as a transparent egg about the size of a pinhead, later as a tadpole-like larva that drifts in the currents so helplessly that it is unable to keep right side uppermost. During these stages the young mackerel is a member of the plankton, the name given to the drifting community of oddly assorted creatures and microscopic plants in the upper layers of the sea. During a part of each year the plankton includes the eggs of many fishes and of a great number of invertebrates, such as barnacles, starfish, mollusks, and worms. Later, the eggs are replaced by the recently

hatched larvae of all of these forms. In addition, there are hordes of the small crustaceans which form an important source of food for adult fishes. Enemies of the young fishes are everywhere to be found in these surface waters. Among the more important of these foes are the small glassworms that prowl through the drifting plankton, or the destructive comb jellies which sweep the water practically clear of fish eggs and larvae wherever they swarm in large numbers.

The mackerel egg is about one-twentieth of an inch in diameter and is buoyed up by an oil globule so that it floats near the surface. When water temperatures on the spawning grounds are normal, the larval mackerel—about an eighth of an inch long—hatches in about a week. About 4 weeks after hatching, the young mackerel develops fins like those of the adult fish and for the first time is able to swim against the currents. This so-called "post-larval" period lasts for 6 weeks, making the total period of infancy some 11 weeks from the time of spawning.

Recent studies by the former Bureau of Fisheries showed that the mortality during this early period of the mackerel's life may be extremely high. In years when conditions on the spawning grounds are particularly unfavorable, as happened in 1932, as few as four young for every million eggs produced may survive the larval period. The unfavorable direction of the prevailing winds and currents, which carried the young mackerel away from their usual nursery grounds, combined with a scarcity of suitable food for the young were probable causes of the disaster. (Sette, unpublished manuscript.)

Studies of this sort have thrown light on the hitherto puzzling question of why the supply of adult mackerel fluctuates greatly from year to year. Records show that the catch may fall as low as about 6,000,000 pounds or rise as high as 179,000,000 pounds. These fluctuations are due to actual changes in the number of fish in the sea; and these changes, in turn, are due to the varying survival of the young in various years. A succession of poor spawning years may result in a scarcity of mackerel for a number of years. On the other hand, with proper conditions for the production and survival of young, a brood of such enormous size may result that the fishery will be at a high level of production for several years.

Records of the Fish and Wildlife Service that trace the commercial mackerel fishery back to its beginnings in 1804 show the extent of these ups and downs in production. From 1804 to 1831 the catch gradually increased to a level of about 70,000,000 pounds. During the next 9 years there was a gradual falling off to 23,000,000 pounds in 1840. Again the pendulum swung, and for a long period the catch ranged from 80,000,000 to 100,000,000 pounds a year. In 1884, the record year for mackerel landings, the catch was 179,000,000 pounds. Compared

with these early years, 1886 ushered in a period of low catches that persisted to 1926. Variations in the size of the landings are still evident, with the catch sometimes doubling from one year to the next, but the general average for the modern period of the fishery is near 40,000,000 pounds annually.

Swordfish (*Xiphias gladius*)

From 30 to 70 vessels outfit each summer for the most picturesque of the New England fisheries—swordfishing. Cruising offshore waters from the offing of Block Island to the Nova Scotian banks, swordfishermen capture their prey individually with harpoons—200 to 600 pounds of fighting fish armed with a weapon that is capable of splintering the sides of a dory. The fleet lands about 3,000,000 pounds a year in New England ports, but so far does this amount fall short of satisfying the growing demand that in recent years more than 4,000,000 pounds of frozen swordfish have been imported annually from Canada and Japan.

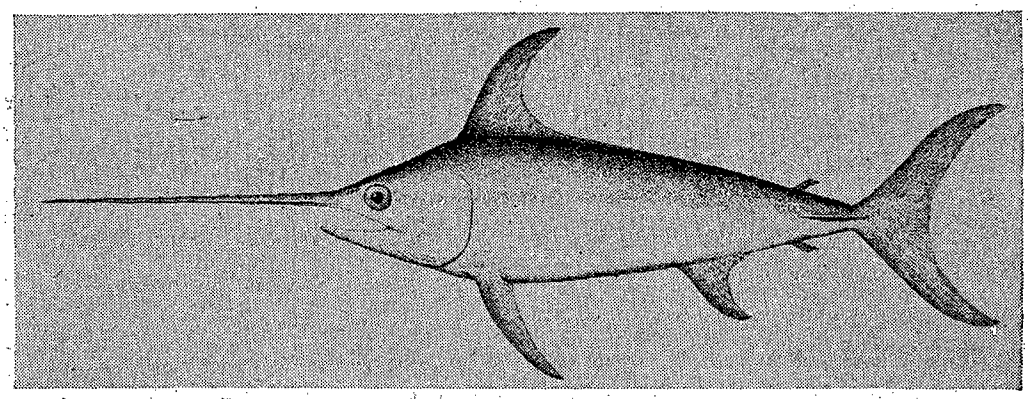

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Figure 10.—The swordfish.

The swordfish ranks high among the "quality fish" of New England. Thick steaks entirely free from small bones are cut from this large fish. They are excellent when broiled, and planked swordfish is a special delicacy. The flesh is somewhat like that of halibut in consistency, but is more oily and has a rich, indescribable flavor that is different from that of any other product of the sea.

The vitamin content of swordfish-liver oil is exceptionally high. This oil has been found by chemists of the Fish and Wildlife Service to be "100 times more potent in Vitamin A than the U. S. P. reference sample of cod-liver oil of 3,000 U. S. P. units per gram, and 500 times more potent than the minimum U. S. P. requirement for cod-liver oil." It is interesting to compare this product and certain foods that we ordinarily regard as good sources of Vitamins A and D. For

example, the Vitamin A content of swordfish-liver oil is 25,000 times as high as that of butter or eggs.

The swordfish is so widely distributed that it is well known throughout much of the world. On the western side of the Atlantic it ranges as far as the Newfoundland Banks and Cape Breton (unconfirmed reports of fishermen also place them off Labrador), and in the eastern Atlantic as far north as Norway. Southward, their range extends to the Cape of Good Hope. They are found also in the Mediterranean and Red Seas and in the Indian and Pacific Oceans.

Swordfish appear off Block Island late in May or early in June, and are seen at successively later dates on Nantucket Shoals, Georges Bank, and on the Nova Scotian Banks, where they usually arrive in July. They keep mostly to the offshore banks, and are most numerous in July and August. With the approach of cold weather they vanish. On rare occasions stragglers have been seen during the winter months, as when 13 were found entangled in line trawls set for tile fish in 95 to 125 fathoms of water off Long Island in midwinter.

Although no one knows precisely where the spawning grounds of the swordfish may be, it is certain that they lie at a considerable distance from our coast, for fish with ripe ovaries have never been taken in American waters. The smallest specimen ever caught in New England weighed 7⅜ pounds. In the Mediterranean, however, small swordfish weighing half a pound are commonly taken, and about the year 1890 Lütken found fry in the North Atlantic that must have been recently hatched (for they were only about three-eighths of an inch long) in several localities scattered between the latitudes of 20° and 39° N. Therefore, although the birthplace of the swordfish that appear seasonally in American waters remains one of the mysteries of the sea, it is assumed that it may lie somewhere in the eastern Atlantic, possibly in the Canaries Current off the western coast of Africa.

Along with the tunas and the sharks, swordfish rank as the largest known fish of the seas. It is generally supposed that the very large specimens taken from time to time are of considerable age, although little is known about the rate of growth or the greatest age attained. The largest swordfish definitely recorded from the Gulf of Maine is described by Bigelow and Schroeder as having been caught in the summer of 1921 and landed at the Boston Fish Pier. The fish weighed 915 pounds dressed; hence upward of 1,000 pounds alive. The sword alone was more than 5 feet long. Another large swordfish was caught in 1931, a 13-foot specimen weighing 644 pounds dressed. The usual weight of the fish taken commercially in the vicinity of Cape Breton is stated by Nichols and LaMonte (1937) to average 265 pounds dressed, while Bigelow and Welsh (1924) say that the larger run of swordfish on

Georges Bank and in the Gulf of Maine average 300 pounds, although Block Island fish run smaller.

The annual visit of swordfish to our shores is probably a feeding migration, with abundant schools of herring, mackerel, and other schooling fish serving as the bait that lures them to American waters. These smaller fish, in turn, are feeding upon the minute crustacea and other planktonic animals which swarm abundantly in the surface waters over the continental shelf during the spring and summer.

Closely schooling fish form an ideal food for the swordfish, which, with its toothless mouth and weak jaws, is poorly equipped to capture individual prey. According to common belief, it rises up in the midst of a school, swinging sharply to right and left with its sword and either wounding or stunning the smaller fish. The fact that fish with broken backs have been found in swordfish stomachs seems to support this belief, although the exact method of underwater feeding is, of course, hard to observe.

Judging by the stomach contents of several specimens, the swordfish may sometimes descend to considerable depths in search of food, ranging down a thousand feet or more to capture small black fish (stomiatids) with phosphorescent organs that live below the zone of light penetration.

The swordfish is a relatively accessible target for the fisherman's harpoon because of its habit of drifting lazily at the surface of the water on calm, sunny days, with the dorsal fin and the upper lobe of the tail fin protruding. Since virtually all of the specimens so taken have their stomachs filled with food (several bucketfuls of small fish have been taken from a single stomach) it is thought they may seek warm surface waters after feeding to digest their meal. Apparently fish so occupied are more or less oblivious to their surroundings, for boats are often able to approach within harpoon range without difficulty.

Fresh swordfish ordinarily is available only during the months of June, July, August, and September. Wholesale prices are highest in June, when the fish are just coming into season, and lowest during the August peak of abundance. Frozen swordfish is to be had throughout the year.

Cod (*Gadus callarias*)

During every month of the year, while the seasons for other fish come and go, vessels come into Boston, Portland, and other New England ports with fares of codfish. Cod from the Grand Banks of Newfoundland, from Sable Island and La Have, from Browns Bank and Quereau, from almost every bank and ledge of the inshore and offshore grounds from Cape Sable to Nantucket pass through the fishing ports of New England to the tables of people all over the United States.

Shredded codfish, codfish flakes, salt cod, pickled cod, green or smoked cod, cod liver oil for medicine or stock feed are some of the familiar ways in which this fish has long been marketed. To these staples are now added the attractive packaged fillets in which form the cod, along with other "groundfish," probably is best known to the modern housewife.

The cod provides the raw materials for the most truly international fishery in North America. It is found all the way from Greenland to New Jersey and irregularly to Hatteras, and from shallow coastal waters out to depths of 900 feet. In the northern part of its range it has been exploited for many years by fishermen of five nations: Newfoundland, Canada, France, the United States, and Portugal, listed in order of the size of their catch. Over the 40-year period from 1896 to 1935, the combined annual catch of these 5 nations averaged more than a billion pounds, of which United States vessels took a yearly average of 130 million pounds. Although the United States catch is considerably smaller than in 1896, the productivity of the western Atlantic fishery as a whole neither increased nor declined markedly during this period.

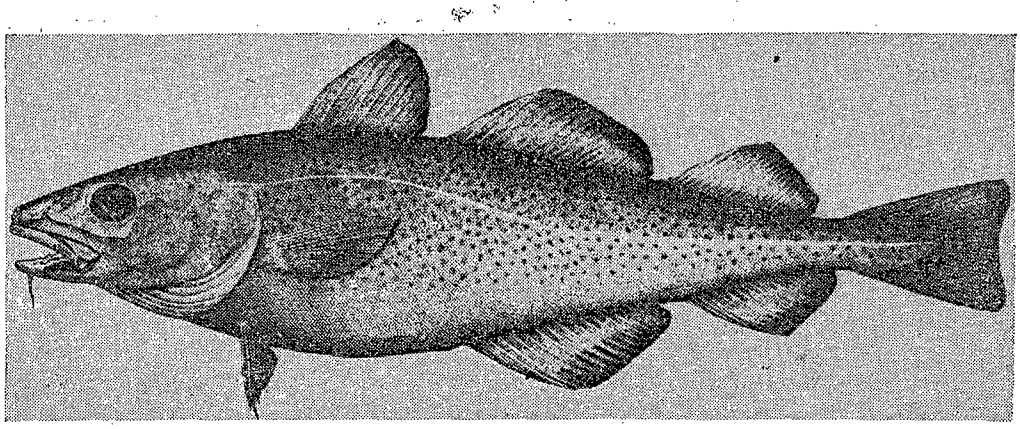

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Figure 11.—The cod.

The name "cod" is applied to an entire family of fishes, most of which are important sources of food. The cod itself, the haddock, the pollock, the white and squirrel hakes, the cusk and the whiting all have been caught and marketed in increasing quantities since the development of fish filleting in the early 1920's. All the members of the family are soft-finned fishes and may be separated from herring, salmon, and other fishes also having soft fins by the fact that the large ventral fins lie under or in front of the pectorals, not behind them. The cod has 3 separate dorsal and two anal fins, a heavy body, large head, blunt nose, and wide mouth. It may be distinguished from the haddock by

the pale lateral line, and from the pollock by the square, broom-shaped tail, projecting upper jaw, and mottled color pattern. None of its other relatives are sufficiently like it to prove confusing.

Most of the members of the cod family are popularly designated as "groundfish." However, the cod itself is not always exclusively a groundfish, for, unlike the strictly bottom-living haddock and cusk, it often roams freely above the banks and ledges which are its home, ascending even to the surface. These roving habits of the cod have been discovered in several ways. The most direct way is, of course, by observations of fishermen and other people at sea, who have often seen codfish chasing squid, herring, or capelin in the upper waters, sometimes coming so close to the surface as to permit their observers to gaff them. It is reported, also, that they sometimes strand on the beaches of Labrador while pursuing capelin. The cod that support the famous Lofoten Island fishery off the northern coast of Norway often are taken some distance above the bottom, where they congregate presumably in search of the most agreeable water temperatures. Their presence in these intermediate water layers has been demonstrated by European scientists by the use of an echo-sounding apparatus. On this side of the Atlantic, a few hundred pounds are taken each year as incidental catches of purse seines, which are fished at the surface.

Even more telling evidence of the movements of cod comes from our knowledge of their diet. The stomachs of the very smallest cod that are caught at the surface in tow nets contain the minute plants and animals that drift in the upper layers of the sea. Cod a little larger have eaten, in addition to the small crustaceans that are to be found at practically all depths, such typical bottom forms as amphipods and small worms. Examining adult cods, we find that the bulk of their diet is made up of animals that live only on the bottom.

Mollusks predominate over all other items in the cod's diet, and if both large and small shellfish are available, the cod appears to choose the larger varieties. Sea clams, cockles, and sea mussels are eaten in quantity. They are swallowed whole, the meats digested out, and the empty shells stacked in the stomach like a nest of ash trays, probably to be expelled later. Remains of various kinds of crabs, lobsters, and prawns are often found in cod stomachs, showing that they also capture the more active residents of the bottom. The spiny-skinned tribe, including starfish, sea urchins, brittle stars, and sea cucumbers are eaten, as are the sand worm, *Nereis*, and the sac-like animals known as sea squirts. Apparently no fish that lives on the bottom or hunts close above it is immune to the attacks of the cod, which picks up flounders and skates off the sea floor and hunts out cunners, blennies, rock eels, sculpins, and sea ravens from the tangles of sea weeds and

the shelter of overhanging rocks and ledges. In finding its prey, the cod probably uses its sense of smell more than sight, and so hunts with equal success by night or day.

From such a diet list it is evident that the cod is the enemy of practically every smaller animal of the sea. Since even an average-size cod weighs about 10 pounds and 50- to 60-pound cod are sometimes taken (the record size is 211¼ pounds) the number of animals that must count it a foe is large indeed. On the other hand, the cod in New England waters has comparatively few enemies. Among fish, only the dogfish and sharks can attack it successfully, and of other aquatic animals, only the seals, which are not abundant in this region, are potentially important enemies. Very young cod are, of course, at the mercy of the usual predators of the plankton, and the slightly larger sizes that frequent harbors and inshore locations are devoured in numbers by such active fish as their relative, the pollock.

12,642

Figure 12.—Found in the bottom of the net, these inhabitants of the sea floor are all listed on the cod's bill of fare.

The longest cod migration on record is that of an individual tagged in Iceland that crossed the Atlantic and was recaptured in Newfoundland 2,000 miles from the point of tagging. On this side of the Atlantic, tagging has demonstrated a regular mass migration of the cod that live in summer about Nantucket Shoals to the coasts of New York and New Jersey and even farther south in winter. During this southward migration the cod spawn, and in the spring they return to Nan-

tucket Shoals. Whether the larvae produced in these more southern waters manage to return to New England waters is unknown, but fry 1½ to 2½ inches long have been taken on the bottom as far south as the area off southern Virginia. Few, if any, cod from within the Gulf of Maine join the Nantucket cod on their southerly migration.

The most important spawning grounds are on Georges Bank, the Nova Scotian Banks, and the Newfoundland Banks. Many cod congregate for spawning in Massachusetts Bay, but their eggs and the resulting fry are all swept out of the bay by the water currents that move steadily around it in a counter-clockwise direction. There is some evidence that fry produced on these Massachusetts Bay grounds may be carried away, some northward to Nova Scotia, some south around the outer arm of Cape Cod to the region of Nantucket. At any rate, it is certain that cod spawned in Massachusetts Bay do not grow up there, and that local stocks must be kept up by immigration of young from other spawning areas.

Cod are marketed in three distinct size categories. The well-known "scrod" is not a distinct species of fish, but a young cod weighing 1½ to 2½ pounds. So-called "market cod" weigh from 2½ to 10 pounds; "large" cod may be any weight over 10 pounds. In general, the spring and early summer months are the periods of largest cod catches.

Haddock (*Melanogrammus aeglifinus*)

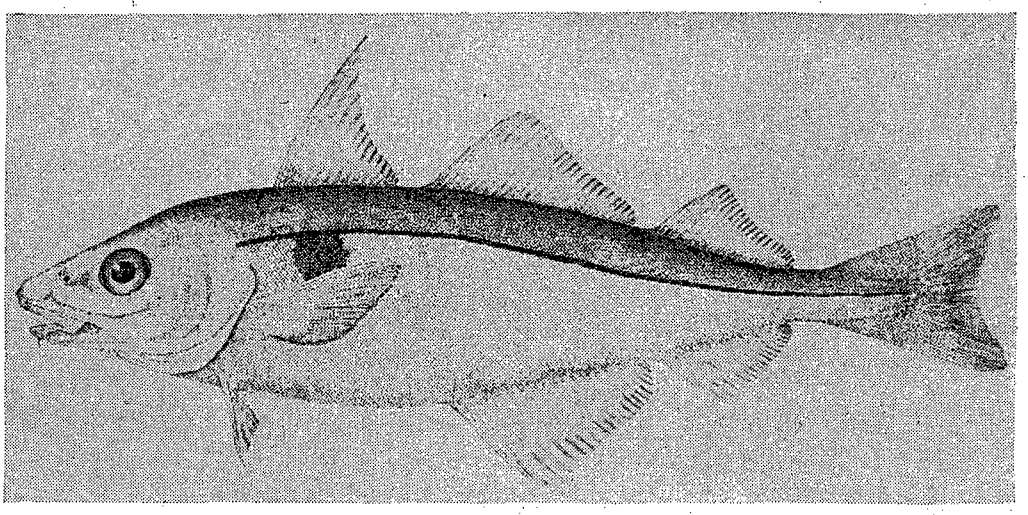
The haddock is now the first-ranking New England fish both in quantity produced and in value, with the annual catch amounting to about 140,000,000 pounds, which fishermen sell for approximately $4,000,000.[6] The sudden increase in the catch of haddock from the 40- to 60-million-pound level of earlier years came about 1925, with the development of a rapidly expanding market for filleted and quick-frozen fish. The haddock proved to be perfectly adapted to the demands of this new market, being available in large quantities from nearby grounds. It is a very white-meated, firm-fleshed fish, of mild and pleasant flavor. Besides being suitable for filleting, it may be smoked or salted, made into fish flakes, or used in the preparation of fish chowders. Lightly smoked haddock is known as "finnan haddie."

The future trend of the haddock fishery is in doubt. The recent tendency to bring in larger and larger catches of young, immature fish is eating into future reserves at an alarming rate. If continued, this practice will undoubtedly bring about a serious decline in the catch, which is already well below the 1925–28 level. On the other hand, if the young are given proper protection and allowed to pass the period

[6] In 1942 the catch of rosefish exceeded that of haddock by about six million pounds. See page 46 for the story of the rapid development of this fishery.

of most rapid growth before they are caught, biologists believe that much larger catches—possibly amounting to a hundred-million-pound increase—may be made with safety in the future.

Most haddock of the western Atlantic live east of Marthas Vineyard and to the north along the coast of Massachusetts, Maine, and Nova Scotia. In winter, however, some are taken southward to New York and New Jersey. A few have been trawled in deep water as far from their center of abundance as Cape Hatteras, although their southward migration apparently is not nearly so extensive as that of the Nantucket Shoals cod. Neither does the haddock range as far north as the cod, for few are taken even in the southern part of the Gulf of St. Lawrence, and none along the coast of Labrador where cod are abundant in summer.



12.643

Figure 13.—The haddock.

As far as the United States fishery is concerned, the principal haddock grounds lie on Georges Bank, in South Channel, and on the Nova Scotian banks farther east along this same southward rim of the Gulf of Maine. On Georges Bank haddock are much more numerous than cod. This is true also of the inshore grounds all around the Gulf of Maine, for although the catch of cod in coastal waters amounts to a greater poundage than the catch of haddock, it is composed of fewer individuals.

It is easy to distinguish the haddock from the cod, in spite of their close relationship. The haddock has a considerably higher and more triangular first dorsal fin, and is conspicuously marked by its black (rather than pale) lateral line and the black patch on the side, below the lateral line and above the pectoral fin. In size, haddock average considerably smaller than cod. The largest on record is an Iceland specimen that measured 44 inches and weighed 37 pounds. In New

England waters the average size is about 20 inches weighing 2½ to 3 pounds. The largest haddock recorded from the northwestern Atlantic (caught on the northeast peak of Georges in 1935) was 37 inches long and weighed 15 pounds.

Haddock, on the average, live deeper than cod and remain more closely on the bottom, probably never rising far above it in their pursuit of prey. They never school at the surface like pollock and do not drive their prey in to strand on the beach as the whiting and pollock often do. While cod may be caught over almost any kind of bottom, haddock prefer smooth, hard sand, gravel, pebbles, or broken shells. Although they move from one feeding ground to another, they wander less than cod. However, recent tagging of haddock along the Maine coast shows that they may migrate from these coastal waters to the Nova Scotian banks, the South Channel, and Georges Bank.

12,754

Figure 14.—Biologists go to sea on the haddock trawlers, measure fish, and determine the trend of the fishery—up or down.

In March or early April—sometimes as early as the end of January—haddock eggs are to be found adrift in the sea. Most of the known spawning grounds in the Gulf of Maine lie at depths less than 450 feet, and it is believed that the haddock never descend into the deepest parts of the basin to shed their spawn. On the other hand, they rarely come into inshore shallows for the purpose, but rather choose shoals of moderate depth, often where the bottom is smooth sand and gravel.

The newly spawned eggs cannot be distinguished from those of cod, but shortly before hatching the granules of pigment become arranged in a pattern that is characteristic of the haddock. When the little fish completes its development it hatches as a larva less than a quarter of an inch long—a fragile, thread-like creature with nothing but its color pattern to mark it as a haddock. For about 10 days it carries the larval yolk sac; then this is absorbed and the fins begin to develop. A baby haddock only an inch long can be distinguished at a glance from a young cod or pollock because it has the same high first dorsal fin that is a striking field mark of the adult haddock.

When they are about three months old young haddock are ready to leave the surface waters and take up the bottom life of their kind. By this time they are usually far from the spawning place. Biologists who have studied the migrations of baby haddock by making systematic collections of planktonic life in fine-meshed nets have found that eggs from eastern Georges Bank (which is one of the most important spawning grounds) under normal ocean conditions drift to the southwestern part of the bank, where they hatch. Part of the larvae are then picked up by the currents that swirl around the banks. When they are ready to descend to the bottom they are over Georges Shoals, where favorable conditions await them. Some of the haddock fry are less fortunate, for they are picked up by another current that carries them westward toward Long Island. Evidently they do not find the surroundings they need in order to survive, for no young haddock have been found on the bottom in that region. Still others, it is believed, may sometimes be carried out beyond the banks over the deep Atlantic basin. These are doomed to death, for when they seek bottom in obedience to their racial instinct there is none within reach.

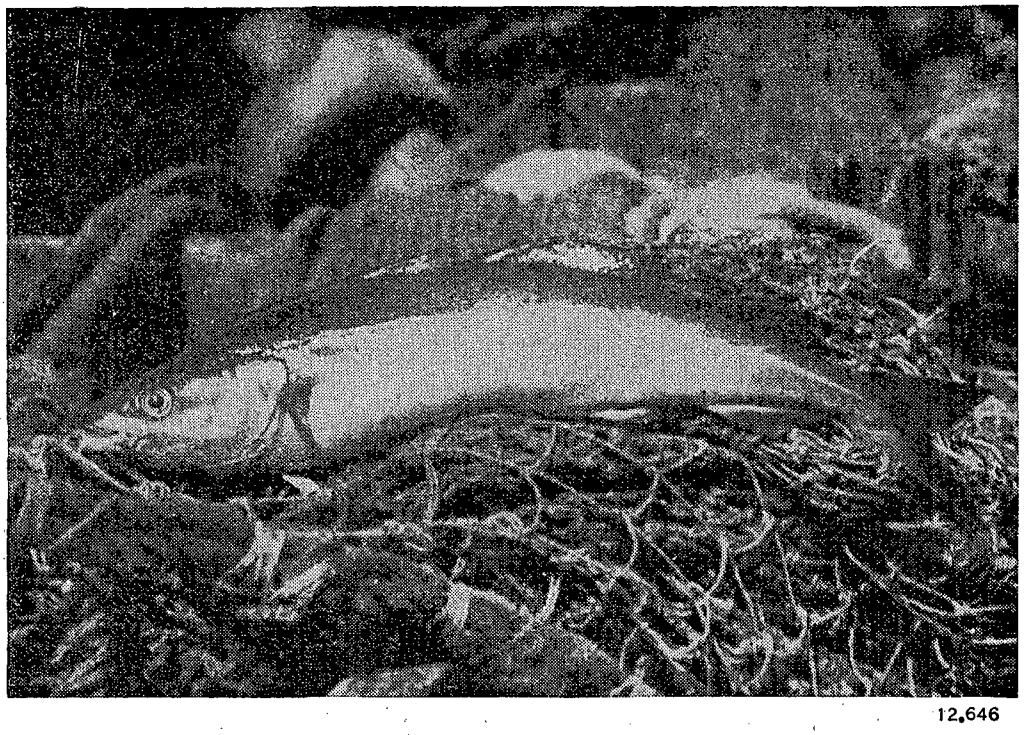
Although young haddock cannot descend safely into very deep water, on the other hand they almost never go to the bottom in water less than 60 feet deep. Unlike young cod and pollock, they are never seen about harbors.

Pollock (*Pollachius virens*)

The largest pollock catches of the year are landed at the Boston Fish Pier during November and December. Most of the fish in these late autumn and early winter landings are caught by gill-net fishermen in coastal waters of Maine and Massachusetts, for this is the season of a great inshore movement of fish. Migrating in toward Massachusetts Bay, the large pollock congregate for spawning on the broken ground southeast of Gloucester and on a long, gravelly ridge that runs north from the outer headlands of the bay, like an underwater extension of Cape Cod. The gill-netters make large catches—sometimes several thousand pounds per man per day—while the fish are within easy reach, but netting comes to an abrupt halt toward the end of January

when the pollock again swing offshore. On the fishing banks the otter trawlers make catches of considerable size, and late spring again sees a stream of pollock landings flowing into Boston and other ports.

Fishing for pollock brings New England commercial fishermen some half million dollars a year for a 35- to 40-million pound catch, and also affords some of the best sport of the season to anglers off the eastern tip of Long Island. Pollock are often caught at the surface by trolling, and because of their strength and active habits are almost as gamy as salmon when taken on a light rod.



12,646

Figure 15.—White, tasty fillets are cut from the pollock, a shapely fish of handsome green color.

The pollock is one of several New England fishes that has become much better known during recent years, as an indirect result of the great expansion of the haddock fishery. When methods of filleting and packaging fish were developed about 1925, the haddock was the first to be prepared for market in this form to an important extent. Later, when haddock became relatively scarce, the fishing industry turned to other species, notably pollock, whiting, rosefish, and flounders. Being a white-meated, firm-textured fish of agreeable flavor, pollock is well adapted to filleting. The fillets, however, are not always marketed by name, some such term as "deep-sea fillets" being widely used to designate all groundfish prepared in this manner. When served in the vicinity of Boston, the pollock is often called "bluefish" or "Boston bluefish."

The pollock is a member of the cod family, and as such is closely related to both haddock and cod. Unlike these relatives, however, pollock range all levels of the coastal waters. They school at the surface like mackerel; they break water like porpoises, diving and rolling as they pursue the shrimp that swarm in surface waters; they gather to play and feed in tide rips and strong currents; they are taken in gill nets as they rove the water at mid-depths or in otter-trawl nets on the bottom. They prefer the shallow coastal waters and shun the deep gorges and basins that are scattered over the continental shelf. They are seldom found farther at sea than the 75-fathom contour, and only the large fish range this far from shore. While small they often linger about harbors and pursue the smelt runs into river estuaries.

Pollock are plentiful from the southwestern tip of Cape Cod to Cape Breton, and they may occasionally be found considerably beyond this center of abundance, ranging as strays as far north as Hudson and Davis Straits and as far south as Chesapeake Bay.

The pollock is a shapely fish with a deep, plump body tapering toward both nose and tail. The projecting lower jaw, forked, sharp-cornered tail, small ventral fins, and handsome green color serve to distinguish it from cod and haddock.

Some interesting pollock statistics are the following: The specimen of average size is 2 to 3 feet long, weighs 4 to 12 pounds. The largest of the species on record measured 3½ feet and tipped the scales at 35 pounds. A large female is capable of producing 4,000,000 eggs per season (average is 225,000), each egg about a sixteenth of an inch in diameter. A 9-inch pollock's appetite and capacity are such that it can eat 77 young herring at one gigantic meal.

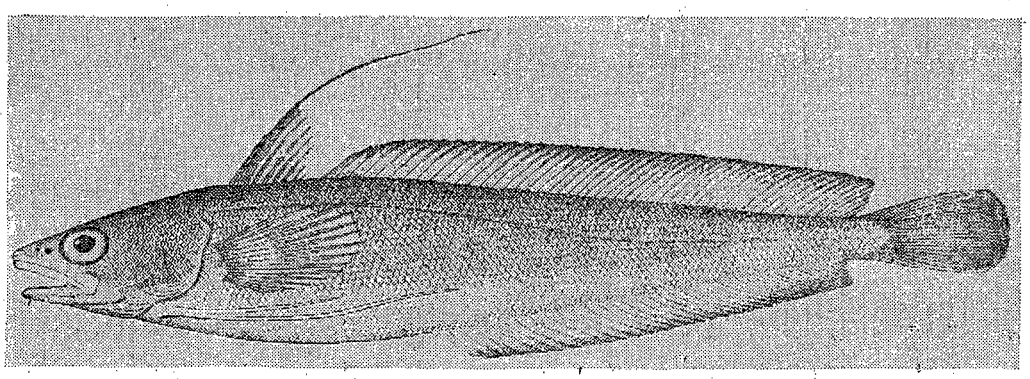
The habits of the pollock are better known than those of cusk, hake, rosefish, and other species that never come to the surface where they may be observed. From earliest life it is fierce and aggressive. Bigelow (1924) said that the young pollock that "infest" harbors are the worst enemies of young cod, and that a single young pollock 7 or 8 inches long is so fierce that it will scatter a school comprised of hundreds of cod fry, causing the little fish to hide among weeds and between stones and sheltering rocks.

Although salmon smolts, adult launce, and the young of such fishes as herring, cod, haddock, hake, and whiting have been taken from the stomachs of pollock, these fish often prefer the small, glassy-clear shrimps that in certain localities and seasons abound in the surface waters. Even a large pollock will eat such small crustaceans as copepods. Those that feed near the bottom eat crabs and shrimps, but probably never take shelled mollusks, differing markedly in this respect from cod and haddock.

Pollock eggs are buoyant and drift near the surface. In about a week to ten days the young hatch as slender larvae with such large yolk sacs that they drift on their backs until the yolk is absorbed. By the time the young pollock is from 2 to 3 months old it strongly resembles its parents, having all the typical fins of the adult fish. Young pollock hatched in mid-winter are between 1 and 2 inches long by their second spring. During the first months of life they live at or near the surface, and in this stage of their existence the sea probably sweeps them far from their birthplace. Pollock fry hatched during the preceding winter appear in spring at Woods Hole at the mouth of Buzzards Bay, although it is believed they must have been spawned east or north of Cape Cod. In the same way, it is thought that the many small pollock that appear on the coast of Maine have been produced in some distant, but unknown place.

Hakes (*Urophycis tenuis* and *Urophycis chuss*)

The hakes—white hake and squirrel hake combined—rank among the ten species of fish taken in largest quantities in New England, with the annual catch amounting to 19 or 20 million pounds and bringing fishermen $300,000 to $350,000. Despite this considerable catch, hakes are not well known by name to the average housewife. The two or two and a half million that reach the market as ready-for-the kitchen fillets are not always sold by name, so that many a housewife who buys "filleted fish" or "deep-sea fillets" may serve hake. However, hake bulks very small in the total output of New England groundfish fillets—only about two percent. Besides sending about five millions pounds to the filleting plants, New England salts some two millions pounds of its hake catch. The greater part of the landings, however, are placed on the market as whole fresh fish. Although soft-meated, the hake is considered an excellent table fish.



12.793

Figure 16.—The squirrel hake.

Stepping up hake production to as much as 50 million pounds a year is considered a distinct possibility by biologists, who class the hakes as under-utilized fish. Fishermen discard quantities of them for want of brisk market demand. This is no reflection on the quality of the hake, for in earlier years the haddock—considered a "nuisance" on the lines of halibut fishermen—met the same fate. Large populations of squirrel hake inhabit parts of Georges Bank and can be brought in when the fisherman finds a paying market for larger catches.

Although the hakes are closely related to cod and haddock, they are very different from them in appearance. They are much more slender and softer-bodied fish, tapering back from the shoulders to a small tail. Moreover, there are only two dorsal or back fins (the second many times as long as the first) whereas in the cod and haddock there are three. The large eyes and the long, feeler-like ventral fin are easily recognized hake features. Both hakes are reddish or olive-brown fish, darker above and paler on the sides, with the underparts and the sides of the head white or yellowish. It is usually impossible for fishermen or purchasers to tell whether a fish is a white hake or a squirrel hake, for the physical differences are rather obscure. Probably most of the commercial catch consists of white hake.

A peculiar habit of the hakes is their use of the ventral fins in feeding. Presumably they swim close to the bottom, dragging the tips of the fins on the ground until these sensitive organs can detect a clam, amphipod, or other small animal lying on the mud or moving over it. Probably such active animals as squid or shrimp attempt to escape by darting ahead, only to be seized. Many years ago, in the laboratory of the former Bureau of Fisheries at Woods Hole, Herrick found that the squirrel hake depends for its livelihood far more on this delicate sense of touch than on sight. This is not surprising, for it lives in regions where the light is extremely dim at best, and does most of its hunting in the complete darkness of night.

The squirrel hake is exclusively an American fish, living only on the western side of the Atlantic from the Gulf of St. Lawrence on the north to the Virginia Capes and North Carolina on the south. In the proper season it may be found anywhere from the tide line down to depths of some 300 fathoms. It is a cold-water fish, however. As such it remains offshore during the summer and comes into the shallows only during the fall and winter. It enters the harbors along the northeastern coast of the Gulf of Maine at this season of the year, and may even run up into some of the rivers.

Offshore, hakes prefer the soft, muddy bottoms, which usually are to be found in the deeper sinks or valleys between the banks, as well as the sloping sides of the banks themselves. The few hakes that are

caught on Georges Bank are taken well down on the slopes, and line trawls that are set over the deeper valleys are likely to bring up hakes. Line trawls are the most important kind of gear in the hake fishery, because of the difficulty of operating otter trawls on typical "hake bottoms."

Although primarily bottom fish, hakes occasionally wander up far enough to capture the shrimps that live in the upper water layers, although they seldom chase prey to the surface as cod and pollock do. Squid, shrimps, amphipods, and various other small crustaceans are the chief items in their diet, plus a great variety of small fish in certain localities.

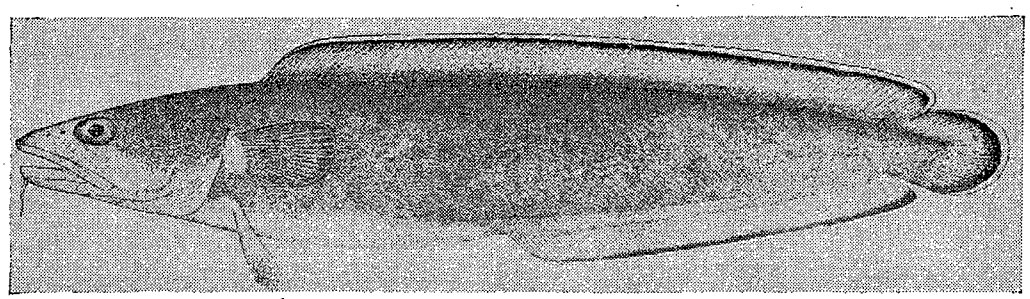
The hake begins life at the surface of the sea, where it lives for a considerable period. Hake fry from half an inch to several inches long have been seen darting about at the surface, probably capturing minute crustaceans. While living at the surface they may shelter under floating eelgrass or rockweed. Some young only 2 inches long obey the inherited instinct to seek bottom, for hakes of this size have been found living close below tidemark in submerged meadows of eelgrass. Those that go down in deeper water have a curious habit of taking shelter within the shells of living scallops, a custom that has been described by fishermen as well as biologists.

How much a young hake grows in a year is not definitely known, but it is believed that small fish two to three inches long, seen along shore in summer, were spawned early in the same season. Fish six to seven inches long are probably in their second summer. This length may be doubled by the third summer, but thereafter growth is slower, so that a 3-year-old hake (in its fourth summer) is about 16 to 18 inches long. The white hakes average 5 to 8 pounds, but attain a maximum weight of 30 pounds. Squirrel hakes are smaller, averaging 2 to 5 pounds, with the maximum about 8 pounds.

Cusk (*Brosme brosme*)

The cusk is one of New England's fish that deserves to be better known. Its meat, white and delicately flavored, is esteemed for the table by those who know a wide variety of fishes and are good judges of food qualities. At the present time about half of the seven-million-pound catch is prepared for market in the form of fresh fillets, while a smaller amount is salted or smoked. Biologists are of the opinion that supplies of cusk would permit an increase in the catch to as much as 12 million pounds. Increased consumer demand is necessary, however, to induce fishermen to set more lines for cusk instead of concentrating on the heavily fished haddock.

A member of the cod family, the cusk is easily distinguished from its relatives by the single back fin, which extends in a thick flange from just behind the head to the rounded tail. The anal fin is like the dorsal, but only half as long. This is a more slender fish than the hakes, round of body toward the forward half, and tapering evenly back to the base of the tail fin. The cusk lacks the long ventral feelers that are characteristic of hakes. It is a drab fish, with the upper parts slate-gray to reddish-brown or yellow, depending on the bottoms where it lives. The dorsal, anal, and tail fins are black at the margins and narrowly edged with white.



12,647

Figure 17.—The cusk.

In almost every particular the habits of cusk are different from those of hake. They rarely if ever come into harbors or river mouths, but remain well offshore, and they never frequent the surface waters except during the early months of life. On the European side they live in water as much as half a mile deep; if they live in shallower water in the Gulf of Maine it is probably because the deep bottoms are soft and sticky, whereas cusk prefer boulder-strewn bottoms or rocky ledges and canyons. Off the New England coast a few may stray down the sides of the continental slope to depths of 300 fathoms, but here, too, the soft character of the bottom repels them. Cusk are found from Greenland, Labrador, and the Gulf of St. Lawrence southward to Cape Cod and South Channel, but rarely as far south as New Jersey.

The cusk is a solitary fish, never grazing on the sea bottom in herds like the haddock or hunting in packs like the pollock. For this reason practically the entire catch is taken by line trawlers. What food the cusk finds and devours among the rocks and ledges of its undersea home is unknown, but it takes the hook readily when line trawls are baited with clams, cockles, or herring. In spite of its sluggishness it has a strong, lithe body. Fishermen complain that when the cusk is hooked it frequently grips a rock so firmly with its tail that the line cannot be hauled and the gear is damaged or destroyed.

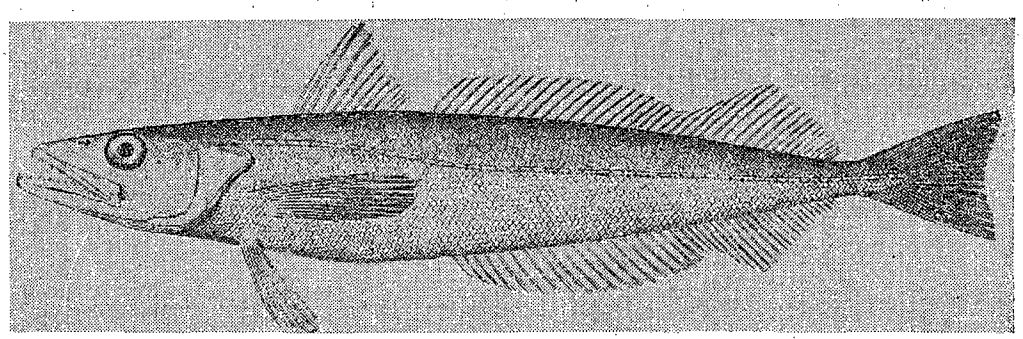
Our knowledge of the spawning habits and the early life of the cusk is scanty. Fish in spawning condition have been taken near the Isles

of Shoals in April and May, and a nearly ripe female was caught on Platts Bank on July 23. This suggests that the spawning season lasts throughout the greater part of the summer. Larvae not more than a quarter of an inch long have been seen in various places, some of them close inshore, in the Gulf of Maine. The eggs have not been taken in tows on this side of the Atlantic. Newly hatched cusk are about an eighth of an inch long, and live in the surface waters until they have grown to a length of approximately two inches.

The cusk is very prolific, for a medium-size female may contain more than 2,000,000 eggs. Most Gulf of Maine cusk are from 1½ to 2½ feet long, and weigh from 5 to 10 pounds. The largest on record measured 3 feet and weighed 30 pounds.

Whiting (*Merluccius bilinearis*)

Although it is little utilized in the States bordering its native waters, the whiting or silver hake is one of the best known and most widely used of New England fishes in sections of the middle west. This surprising condition is due largely to its great popularity in the fried-fish shops of the interior of the country. Properly prepared and served with appropriate sauces, whiting is well adapted to such use. In St. Louis, for example, it is used exclusively for this trade, and so great is the demand that retail sales of whiting outranked those of all other kinds of fish in this city during 1936. Only about a seventh of the 1938 catch went to filleting establishments, although 10 million pounds were prepared as pan-dressed fresh fish.



12,648

Figure 18.—The whiting.

The recent generally increased demand for whiting caused New England landings of this species to jump from about 2 million pounds a year to some 41 million pounds in 1940. This increase does not mean that whiting have suddenly become more abundant, but indicates that fishermen who formerly threw away most of the whiting they caught now find it profitable to fish for them. Probably there are enough whiting in New England waters to support a yearly catch of 60 million pounds, when the demand justifies such further increase.

The whiting is a slender, dark gray fish with silvery under parts. The two distinct and well-developed dorsal fins—the second much longer than the first—distinguish it from most other New England fishes except the true hakes (white, squirrel, and others). The whiting, however, lacks the chin barbels characteristic of the hakes and its ventral fins are of ordinary form instead of being altered into long feelers.

The home of the great body of whiting on which the fishermen draw lies off the New England coast between Cape Cod and Cape Sable. However, this fish is found all the way from the Bahamas to the Grand Banks, and from the water's edge down to depths of nearly 2,000 feet. Closely related to the large and well known family of cods, the whiting differs from these relatives in several important respects. While the cods are chiefly bottom dwellers, the whiting is a fish that ranges freely through the water, probably moving most often at mid-depths or closer to the surface in pursuit of prey.

North of Cape Cod whiting appear in May or sometimes as early as March. They arrive on Georges Bank, as a rule, late in April. In late autumn they disappear from the coastal waters and by December are gone from the offshore banks. Like the majority of the fishes that are seasonal migrants to our coast, they probably sink into deep water along the edge of the continental shelf, and may even travel some little distance down the steeper descents of the continental slope.

The whiting belongs to the group of fishes that live as roving sea predators. For such an existence it is exceptionally well equipped—a strong and vigorous swimmer with a wide mouth armed with two or more rows of sharp, recurved teeth. It is one of the principal enemies of a great variety of young fishes, including its own kind. On the New England coast, it is not uncommon to see bands of whiting pursuing schools of small fishes into such shallow water that both pursued and pursuers strand on the beach.

Fishes that swim in schools are the chief game of the whiting, which themselves hunt in packs more often than singly. Thus, they harry the densely massed herring shoals, feed on squids, crabs, and various crustaceans, and often descend to the underlying sea bottom to prey on the growing young of haddock and other bottom fishes.

Protected by its active habits and its defensive equipment, the whiting counts as enemies only certain of the larger and stronger fishes of the high seas. The bluefish undoubtedly is an active enemy of the whiting close inshore, although it does not occur in the central part of the Gulf of Maine, or on Georges Bank.

Because of their roving habits, the whiting apparently do not concentrate on any particular banks at spawning time, but shed their

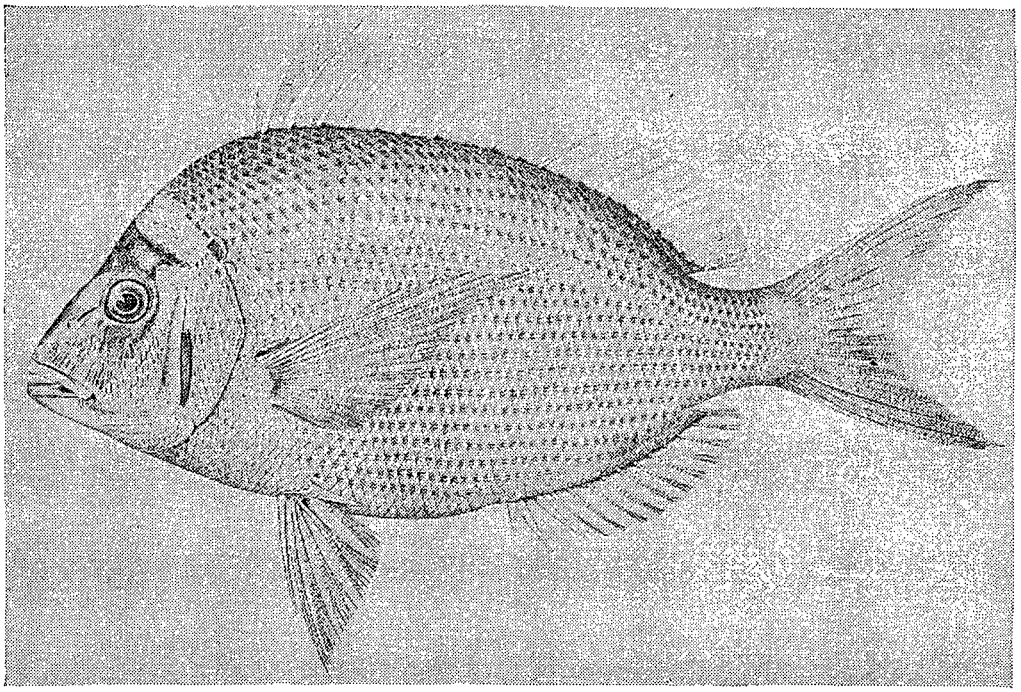
eggs during the summer here and there along the entire coast from Cape Cod to Grand Manan. Most of the eggs discovered in the Gulf of Maine have been floating over water less than 300 feet deep, although off Nova Scotia and southern New England they have been taken over much deeper water. Successful spawning is unknown in the cold waters of the New Brunswick shore of the Bay of Fundy, probably because the eggs need water as warm as 55° to 60° for their development.

The prevailing counter-clockwise drift of water in the Gulf of Maine carries the eggs and newly hatched larvae from north-east to south-west around the shores of the Gulf. After this stage of passive drifting the young whiting take to the bottom, presumably during their first autumn when they are from an inch to an inch-and-a-half long. It is not known how rapidly the young fish grows, but it is believed that the whiting matures at the age of two years. Adults average about 14 inches long, but may reach a length of 2 feet and a weight of 8 pounds.

Scup (*Stenotomus chrysops*)

The scup is one of the common shore fishes of eastern United States, found from Cape Cod to South Carolina. In 1940, New England's catch of 4¼ million pounds amounted to about a fourth of the total United States catch. (Statistical records credit New England with 10,842,700 pounds of scup in 1940, but 6,571,600 pounds of this total, although caught by Massachusetts vessels, was taken off the Virginia Capes and landed at Middle Atlantic ports.) In contrast to the whiting—little honored in its home territory but eagerly sought for interior markets—the scup is best known in coastal communities and almost unheard of by inland consumers. This is because it is not filleted in any quantities but is marketed chiefly as fresh, pan-dressed fish; hence it is less adapted to long-distance shipping than whiting, cod, haddock, and others. It is an excellent pan fish. The flesh is tender, flaky, and of good flavor, and frys well if rolled in flour, cracker or bread crumbs, or corn meal. The retail price generally is low enough to make it an inexpensive dish.

The scup is not likely to be confused with other New England fishes, for the deep and much compressed body and the crescent-like indentation of the tail fin are easily recognized features. The single dorsal fin contains a series of tall spines at the forward end but is lower and soft-rayed posteriorly. This fish is brown tinged with red or pink above, paling on the sides to silvery underparts. It reaches a length of 18 inches and a weight of 3 to 4 pounds, but 12-inch fish weighing 1½ to 2 pounds are average size.



12,649

Figure 19.—The scup.

Although commercially the scup is one of the most important shore fishes of southern New England, it is a New England fish during only part of the year. In spring, the scup appear in the vicinity of the bays of Rhode Island and southern Massachusetts, apparently coming in from the southwest between Block Island and Marthas Vineyard. They enter the shallow coastal waters late in April, heavy with spawn and traveling slowly—according to some accounts drifting in and out with the tides. After spawning they move offshore, to wander in schools through the rich feeding grounds of the continental shelf. They are typically bottom feeders, and find on the rocky floor of the southern New England coast a great variety of the small invertebrate animals which they eat. Often during the summer they rise to the surface, swimming there in schools as mackerel or herring do and probably feeding on the small animals that drift abundantly in the upper layers at that season. When the water begins to chill in the fall, many of the scup leave the New England area, and by mid-October most of them have migrated south to winter quarters off the mouth of the Chesapeake Bay.

As recently as a decade ago, no one knew where the scup went when they left New England waters every fall. About 1929, trawlers began to fish during the winter on the deeper offshore bottoms off the mouth of the Chesapeake Bay and southward toward Cape Hatteras. Among their catches of sea bass, flounders, croakers, and weakfish they found many scup. A few years later, Bureau of Fisheries biologists marked

large numbers of scup with numbered tags. Recoveries of these tagged fish proved that many of the scup wintering off Virginia had been in southern New England in the spring.

Almost the entire New England catch is taken in the waters of Rhode Island and southern Massachusetts. Although occasionally a few scup wander into Massachusetts Bay (Eastport, Maine, is the northern record for the species), this happens so seldom that these strays are regarded as curiosities when they happen to be caught.

In Rhode Island and Massachusetts the scup season extends from the last of April to the end of June. The spawning season over, the fish no longer enter the traps readily and soon move outside the waters where traps and pound nets operate. The floating traps used in this spring scup fishery are much like pound nets, but are buoyed by large floats and anchored in deep water instead of being attached to stakes or posts driven into the bottom. Floating traps can be used where deep water, rocky bottoms, or strong tides would prevent the use of fixed gear. When the scup season ends, these traps usually are dismantled until the following spring. To counteract to some extent the disadvantages of the short season, the fishermen hold their excess catches in pounds anchored in protected coves and ship the fish to market throughout the summer.

Such inshore waters as Narragansett Bay and Vineyard Sound are the places where scup deposit their eggs, of pinhead size and buoyant. When the water is as warm as 72°, the egg passes quickly through the period of development, producing a larval fish in only 40 hours. When first hatched, a young scup is about a sixteenth of an inch long.

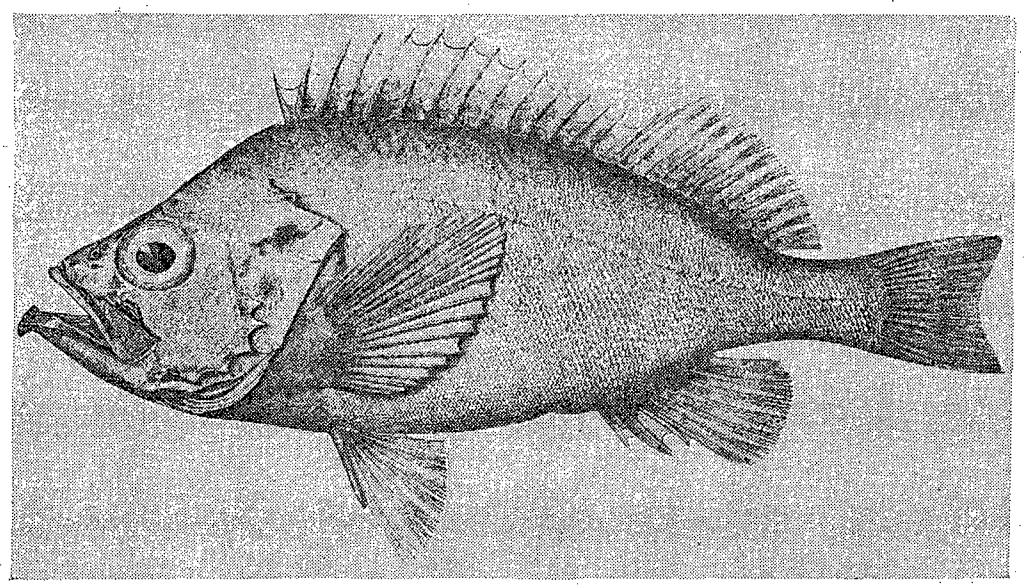
Like mackerel, scup experience many years when unfavorable conditions of one kind or another kill almost all the young produced. In other years the reverse is true, and enormous numbers of young survive. As a result, scup of commercial size are very abundant in some years and comparatively scarce in others. However, such fluctuations are much less extreme than those that occur in the mackerel populations.

Scup have the usual enemies of moderate-size fish. It has sometimes been maintained—but without good evidence—that their spiny fins protect them from bluefish, which attack most smaller surface swimmers with great ferocity. While living on the bottom, scup are preyed upon by sharks, halibut, cod, and other ground fish.

An increasing number of small boats from such places as Woods Hole, Mass., Montauk, N. Y., and Wildwood, N. J., carry sportsmen to fishing grounds for scup, now well established on the list of popular salt-water game fish that includes sea bass, bluefish, and weakfish. The catch by anglers has increased so greatly that it is believed to amount to a large part of the total New England catch of this species.

Rosefish (*Sebastes marinus*)

Although long familiar to fishermen, the rosefish (called also "redfish") was practically unknown to the fish-eating public until about 1935. Before that time, the small catches made incidentally as fishermen sought other species were thrown overboard. Early in the 1930's this picture was completely changed. Catches of haddock were falling off, and in 1934 reached the lowest level of any year during the period from 1918 to 1938. Otter trawlers made trips to Georges Bank and even beyond to Browns and the Nova Scotian banks, only to return with too few haddock to pay the expense of operation. Skippers began to bring in their catches of the smaller and brightly colored rosefish. In 1934—the year of the poorest haddock catches—they marketed one and a third million pounds of rosefish, whereas the year before they had brought in less than 300,000 pounds.



12,621

Figure 20.—The rosefish.

About this time the industry began to experiment with filleting rosefish and found it adapted to this method of preparation, hence suitable for shipping to inland markets in the middle west and south. The next year (1935) 17,000,000 pounds of rosefish were landed at New England ports, and in 1936 the catch rose to nearly 67,000,000 pounds, which was almost more than the market could absorb. Nevertheless, the catch has never fallen below 58,000,000 pounds since that year, and in 1940 it reached a peak of 85,000,000 pounds. (Recent figures indicate that the 1941 catch may have been as much as 139,350,000 pounds.) In the few years since 1933, therefore, rosefish has risen from a place

of relative insignificance to rank with haddock and cod among the leading species of the New England fisheries.

The rosefish is an excellent food fish, with flesh that is firm and of a rich and agreeable flavor. Probably only the fact that it had not been introduced to a wide enough market prevented its fuller utilization in earlier years. It is a well known food fish in Europe, and has long been used in the more northern parts of its range along the western Atlantic coast. It is found from Greenland and Davis Strait as far south as New Jersey in deep water, also in the eastern North Atlantic and the Arctic Sea.

In general appearance the rosefish suggests the basses or perches, but it is not related to either. The brilliant color makes it easy to identify in life, for it is a vivid orange or red, with paler underparts and large black eyes contrasting sharply. The head, large in proportion to the body, is armed with prominent spines. Average market-size rosefish are about 11 inches; the average weight is three-fourths of a pound. The maximum size reported from American waters is about 2 feet and 12 to 14 pounds. In the eastern Atlantic and in Arctic Seas this fish reaches a length of 3 feet or more.

Typically a bottom fish in the western Atlantic, the rosefish is taken in otter trawls. Comparatively insignificant quantities are taken on lines, especially in South Channel. Beginning in the 1939 season the deep channel known as the Gully, off eastern Nova Scotia, became important as a source of rosefish, furnishing more than half the total catch of the large otter trawlers, which, with their long cruising radius, are the only vessels able to reach these grounds.

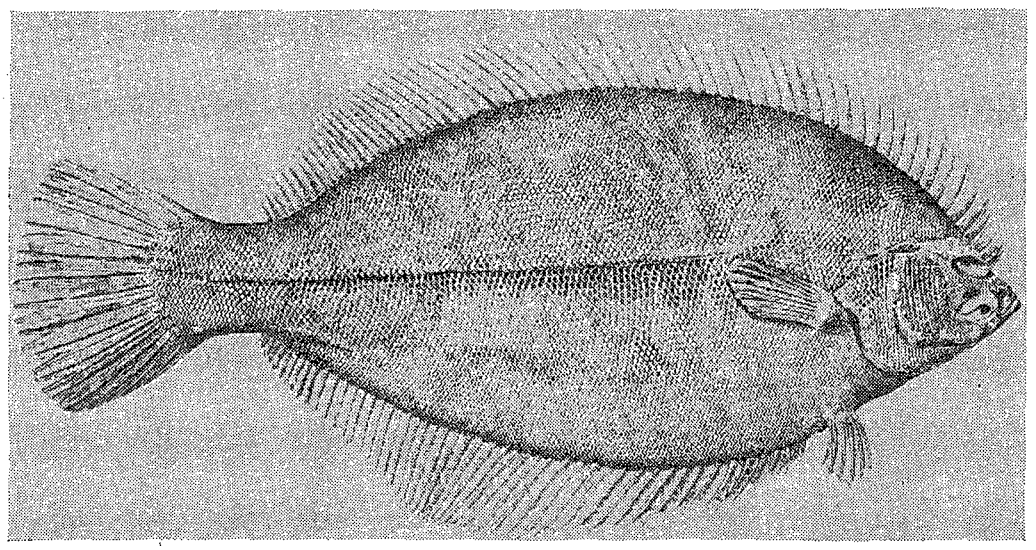
Unlike any of the other fishes described in these pages, the rosefish brings forth its young alive; that is, the eggs develop and hatch within the body of the mother instead of free in the water. The birth of the young takes place during the months of June, July, and August. Just before and during this period it is possible to detect the presence of young in many of the fish brought to market, because their black eyes show through the body wall of the mother. Just-hatched rosefish (which are about ¼ inch long) have been taken at many places scattered over the northern part of the Gulf of Maine.

When first hatched, the young retain part of the yolk sac, and none of the fins are formed. Soon they develop many recognizable characters of the species—large, spiny heads, large eyes, and relatively short tapering bodies. The characteristic fins are fairly well developed by the time the little fish are an inch long, and about this stage the red coloration appears. During the early weeks of life the larvae and fry live near the surface, and about the three-quarter inch stage they descend to the bottom and take up the normal life of adults.

The food of rosefish, as might be expected, consists of a great variety of bottom forms, including crustaceans, the smaller mollusks, shrimps, and small fish. Its enemies include most of the larger predaceous fish that inhabit the same areas.

Flounders

In New England at least five different species of flatfish or flounders are brought to market from nearby coastal waters as well as from offshore banks. These are commonly known as the dab (*Hippoglossoides platessoides*), *gray sole* (*Glyptocephalus cynoglossus*), yellowtail (*Limanda ferruginea*), winter flounder (*Pseudopleuronectes americanus*), and lemon sole (*Pseudopleuronectes dignabilis*), although other names may be applied to them as well. Of the five, the winter flounder or "blackback" is perhaps the best known, being found in almost every bay, cove, and harbor along the entire coastline of New England. Several of these five flounders were virtually unknown until large-scale otter trawling brought them to light, because their small mouths prevented them from taking the large hooks commonly used in the older methods of fishing. At the same time the development of the filleting trade has led to more widespread appreciation of the excellent food qualities of the various flounders. The gray sole or witch flounder formerly was caught only in limited quantities, but during the past 5 years the expansion of the fishery and the discovery of new grounds has brought more of them into the markets. This species now has the largest total value of any of the flounders landed at the three large ports of Boston, Gloucester, and Portland (six million pounds worth $255,000 in 1940).



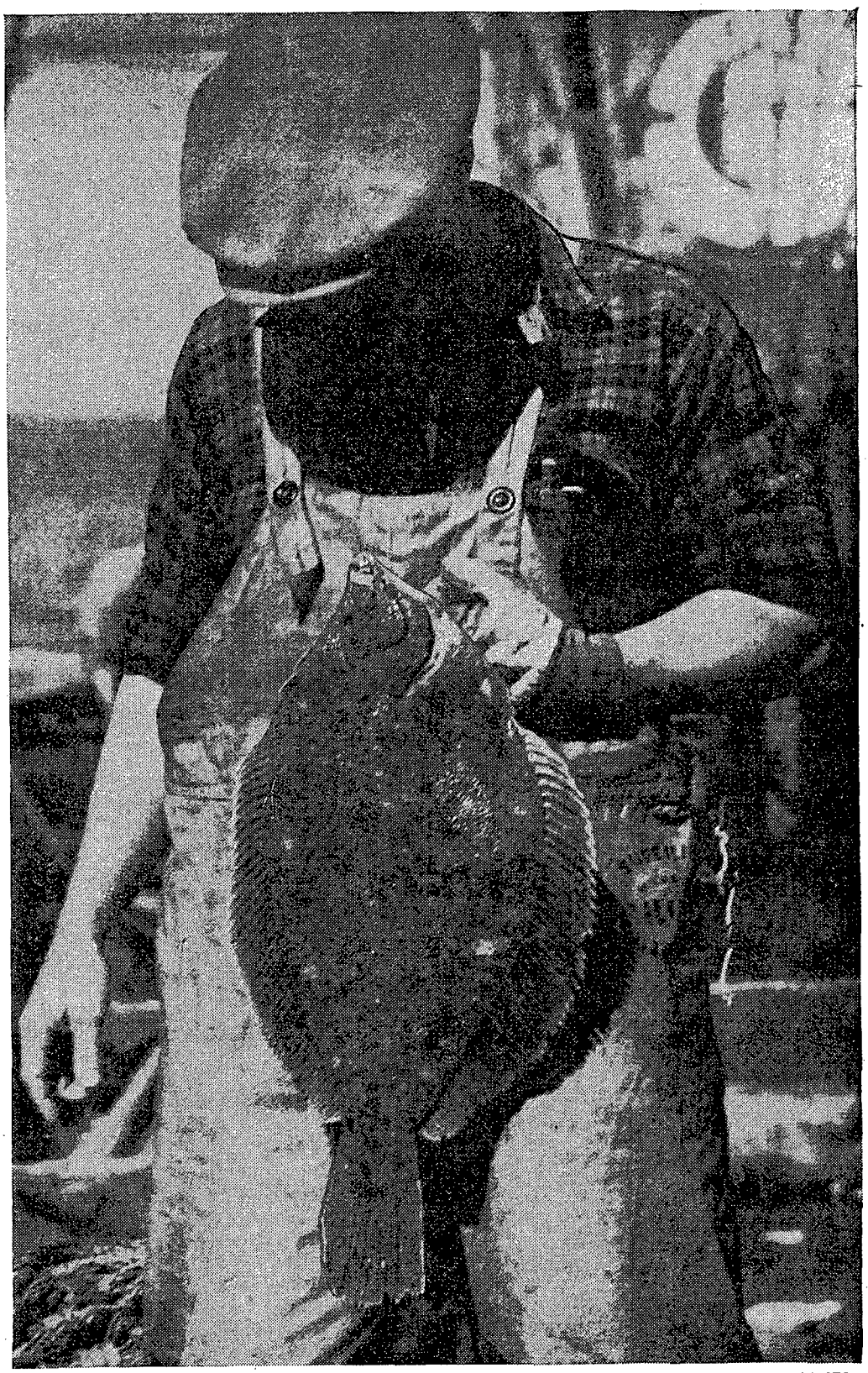
12,651

Figure 21.—The winter flounder.

These five flounders differ slightly in food quality. The gray sole is considered one of the best of all flatfishes in flavor, and the bases of the fins have large amounts of gelatinous fat of the sort for which the European turbot is noted. Of the smaller flatfishes, the winter flounder is regarded by many as the best flavored, the thickest, and the meatiest. This is the predominant species taken in southern New England and the Long Island Sound region. The lemon sole, taken only on Georges Bank, is very similar to the winter flounder. The yellowtail is a thinner-bodied fish than the winter flounder, and in this respect is a less desirable food fish, but it has a good flavor and is now marketed in large quantities. The dab is another flatfish that has only recently come into its rightful place, for in 1924 Bigelow reported "so little market for it that few are brought in," although he described it as an excellent pan fish. Now, however, about 2½ million pounds a year are landed at Boston, Portsmouth, and Gloucester. The dab has a thick layer of flesh, free from bones, on both upper and lower sides. The meat is sweet and not oily, with a distinctive flavor and texture.

Although the item "fillet of sole" appears often on the menu cards of restaurants, none of the flounders taken commercially in American waters is related to the renowned English sole (*Solea vulgaris*). The only representative of the family Soleidae in New England is the small hog choker (*Achirus fasciatus*). Although the flesh is said to be delicious, its small size (6 to 7 inches long) bars it from commercial markets.

The flounders are a particularly interesting group of fishes because of their habit of lying on their sides. Usually associated with this mode of life are the loss of all pigment on one side of the body (either right or left according to the habit of the species) and the migration of one of the eyes across the forehead, so that both eyes are on the same side of the head (the upper side as the fish lies). Most surprising of all is the fact that young flounders begin life swimming upright like any other fish. At the age of 5 to 7 weeks (in the winter flounder) the left eye begins to move upward until it may be seen above the dorsal profile of the head. From this point the transformation proceeds swiftly, with the left eye moving across the forehead to lie beside the right eye. The pigment on the now eyeless side fades, while the eyed or uppermost side becomes uniformly pigmented. The little fish has by this time abandoned its former swimming habits and swims and lies on its side. The transformation is completed by the time it is not much more than three-eighths of an inch long. With the transformation of structure goes a change of feeding habits, for the little flounder, instead of swimming actively in the open water and feeding on minute



12,652

Figure 22.—Lemon soles resemble large winter flounders but are caught only on Georges Bank.

plankton organisms, now lies on the bottom much of the time, like the older fish.

Besides the longer migrations undertaken for the sake of finding suitable temperatures, or at spawning time, some flounders probably wander in groups from place to place as food becomes scarce. A roving habit is, however, more characteristic of the flounders' large relative, the halibut, and of the summer flounder or fluke than of any of the 5 species discussed here. Both the halibut and the fluke are exceedingly active as flatfishes go, pursuing small fishes like capelin and launce to the surface, or roaming over the bottom in bands as they hunt fish, crustaceans, mollusks, and other food. A typical flounder habit, displayed by both winter and summer flounders, is to bury in the mud immediately upon settling to the bottom, leaving only the eyes uncovered. On sighting a shrimp or other prey the flounder may dart up with surprising speed to seize its victim. On the flood tides, when the water is bringing new food into the shoals from farther at sea, these flounders are more active, and roam about through the eel grass in search of food. The occasional capture of dabs and yellowtails in gill nets shows that these species also may roam actively at times.

A female flounder of average size produces about 500,000 eggs annually, a large fish well over a million. Spawning occurs during the winter months, at which time the fish congregate in shallow inshore waters. The eggs hatch in 15 to 18 days.

While flounders grow more rapidly in some areas than in others, in general the young winter flounder reaches a length of about 4⅜ inches at the end of the first year. Fish 7½ inches long are 2 years old; 9⅞ inches, 3 years old; 11½ inches, 4 years old; 13 inches, 5 years old; and 13¾ inches, 6 years old.

Because it lives in coastal waters, sportsmen find the winter flounder the most accessible of the New England flatfish. In some localities anglers take as many winter flounders as commercial fishermen do, and during the entire summer season virtually every southern New England port, large or small, sends out from its docks numerous small boats carrying anglers to fish for winter flounders. In spite of its small mouth this flounder takes the hook readily. Clams are apparently one of the best baits.

During the winter, from October to April, the winter flounder is intensively fished by small trawlers or flounder draggers that operate out of the bays, coves, and inlets of southern New England. At this time of the year the fish are somewhat more concentrated in bays and inlets as a result of a seasonal moving in from more offshore grounds to spawn. Some 12,000,000 pounds of winter flounders are caught by commercial fishermen each year, with more than 10,000,000 pounds of this total coming from the States of Massachusetts and Connecticut.

Halibut (*Hippoglossus hippoglossus*)

The largest landings of halibut arrive in New England ports during the months from March to September, although catches are made and landed every month of the year. Because of the good keeping qualities of halibut and the excellence of the frozen product, the steaks of this large fish, white and flaky and of delicious flavor, may be enjoyed at any time of year. Much of the halibut consumed in New England comes from the Pacific coast, but North Atlantic waters still yield an annual catch of one to two million pounds of this excellent food fish. Close inshore, the halibut was virtually fished out more than half a century ago and now all the coastal grounds combined furnish barely a quarter of a million pounds. The outlying banks, being less accessible, have held up better. Browns, St. Pierre, Banquereau, and the distant Grand Bank of Newfoundland each yield approximately a quarter of a million pounds of halibut. Because they are very large fish and also because they often frequent the deeper gullies, halibut are for the most part caught individually on line trawls (only a quarter of the catch is taken by otter trawls).

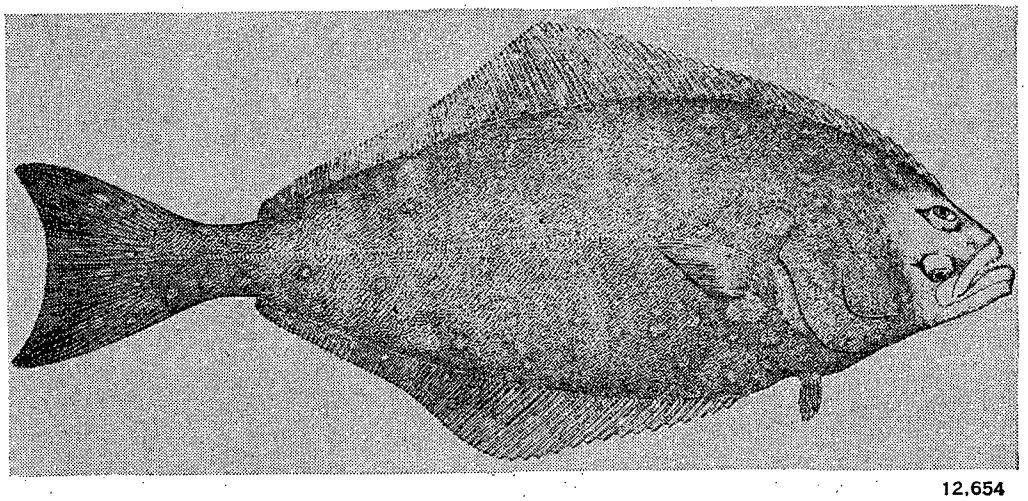


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Figure 23.—The halibut.

The halibut is the largest of the flatfish—in appearance an enormously overgrown flounder. It sometimes weighs as much as 500 or 600 pounds, but usually a large halibut now means one weighing about 200 pounds, while average sizes are probably 50 to 100 pounds. Halibut are such slow growers that they do not reach sexual maturity for 9 or 10 years. As fishes go, they are exceedingly long lived. The 7-foot fish that are occasionally caught may, it is believed, be as much as 50 years old.

The halibut's slow growth and relatively high age at maturity makes it possible for a stock to be depleted very rapidly where a fishery is

intensive enough to remove a large proportion of the fish before they have spawned. Regulation of the Pacific coast halibut fishery by an international commission has proved very successful, however. Biologists believe that controlled development of the more distant east coast halibut grounds—such as Davis Strait and the Grand Bank—might result in increased Atlantic coast catches, perhaps as much as a 12-million-pound total.

12,656

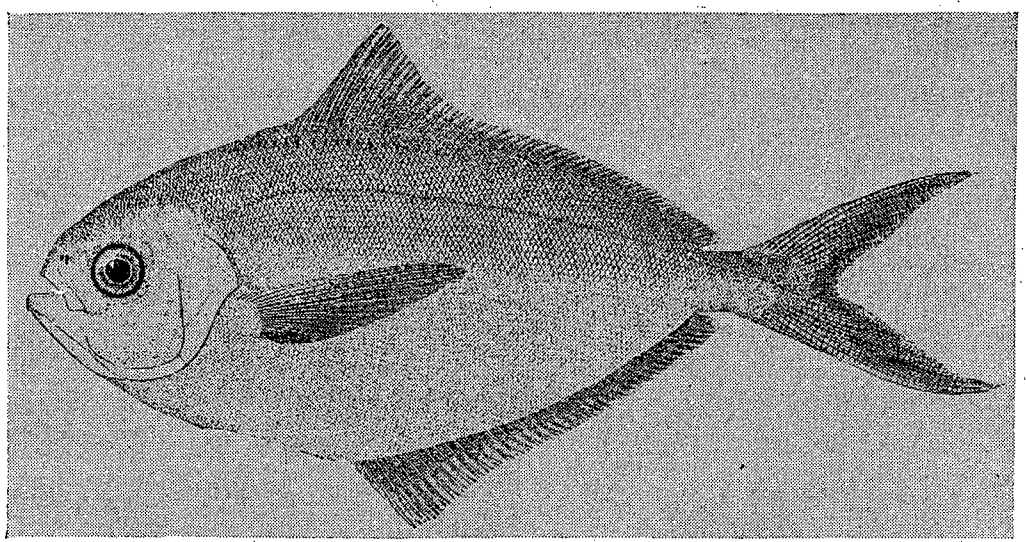
Figure 24.—The wolffish will furnish many thousand pounds of excellent food when the American public becomes better acquainted with it.

Wolffish (*Anarhichas lupus*)

The wolffish is an excellent table fish that deserves to be better known. It is somewhat similar to the haddock (to which, however, it is no relation) in the texture and flavor of its meat, and is often marketed in the filleted form. Biologists believe that the present catches of approximately three million pounds could be doubled without danger to the future productiveness of the fishery.

The wolffish is solitary, never schooling up in great droves as most of the cods do, which may account, in part, for the fact that it has never been marketed in quantities great enough to allow the public to become well acquainted with its good qualities. Belying its fierce and aggressive appearance (dory fishermen have to kill it immediately it is taken aboard to prevent being bitten) it is thought to be a weak swimmer that spends most of its time hunting among seaweeds and over rocky ground for the shellfish, crustacea, and starfish-like animals which it eats. The wolffish has never been known to turn cannibal and eat its own kind, in spite of legends to the contrary.

Although wolffish probably are not abundant in any one place, they are widely distributed from Davis Strait on the north to Cape Cod (and rarely to southern New England) on the south, and from near the tidelines outward to depths of 500 feet or more.



12,657

Figure 25.—The butterfish.

Butterfish (*Poronotus triacanthus*)

The butterfish is one of the best of table fishes. Fat and delicately flavored, it is an ideal pan-fish that fries to a crisp golden brown and melts in the mouth. Most butterfish are only 6 to 8 inches long; the largest run to about 10 inches. Schools of butterfish appear in the shallow coastal waters of New England in summer, arriving in the

vicinity of Rhode Island in late April, but seldom are plentiful north of Cape Cod before July. Although typically inshore fish, the butterfish nevertheless are not wholly confined to coastal waters but are taken in some abundance on Georges Bank. In winter no butterfish are to be found in New England waters, but where the fish go when they disappear in October or November is unknown.

Present catches of butterfish amount to about two million pounds—a considerable number of individual fish, in view of their small size.

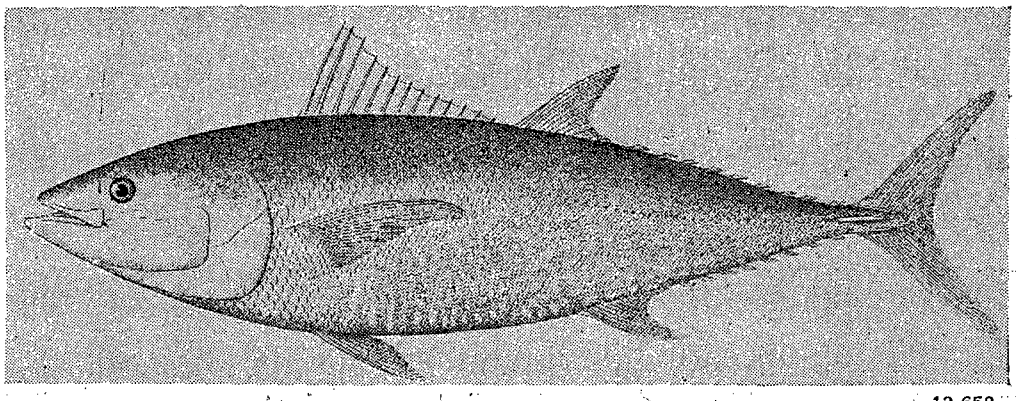


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Figure 26.—The bluefin tuna.

Tuna (*Thunnus thynnus*)

The bluefin tuna has only recently been considered a commercial fish on the east coast. Present catches now approach a million pounds a year (1940 catch was 1,121,000 pounds) and probably could be increased to four or five million pounds. Lack of facilities for large-scale canning in New England and competition with the Pacific coast product have not encouraged fishermen to develop an important tuna fishery, but recent activities in the canning of tuna at Gloucester and other places may change the situation.

The flesh of the tuna is rich and oily, better adapted for canning than for consumption in the fresh form. East coast tuna are light-meated, as are most of the Pacific coast tunas (only the albacore has true "white" meat).

The bluefin tuna is found on the eastern coast of North America as far north as Newfoundland, also on the Pacific coast and in the Mediterranean. Being an inhabitant of comparatively warm water, it visits our shores only during the summer and disappears in autumn. No one knows where the tuna spends the winter months, or where it spawns.

The tunas are among the strongest and most active fishes, roving the open sea in packs like the predatory animals which, in fact, they are. They feed on a great variety of smaller schooling fishes. Fishermen (who call them "horse mackerel") often locate feeding tuna by the

flocks of sea birds that gather where the small fish are being driven to the surface.

On the Atlantic coast bluefin tuna are said to grow to a maximum size of 14 feet and a weight of 1,600 pounds. These large fish (as well as the smaller "school tuna") provide sport for numerous big game anglers from Maryland to Nova Scotia. Most fish now caught commercially fall into two size categories: school tuna weighing from 8 to 65 pounds, and large tuna ranging from 65 to about 600 pounds.

Summer Flounder (*Paralichthys dentatus*)

In addition to the five flounders caught in abundance in New England waters (see pages 48 to 51), the summer flounder or fluke is locally important. A commercial catch of a little over a million pounds in 1940 was made chiefly in southern New England, for this fish occurs only in small numbers north of Cape Cod, and the center of its abundance is south of New England. Massachusetts boats fishing off Virginia took another 2½ million pounds, credited to New England in the statistical records.

The fluke is considered one of the best of table fishes—white-meated and of excellent flavor. Average size flukes run from a pound to 5 pounds; the largest on record measured 3 feet and weighed 25 pounds.

Because of their seasonal migrations, flukes are taken in greatest abundance in the summer months. Then they are found in shallow inshore waters, lurking about docks and over sandy or grassy bottoms. In the winter they move out into deeper water. Flukes range at least as far offshore as Georges Bank.

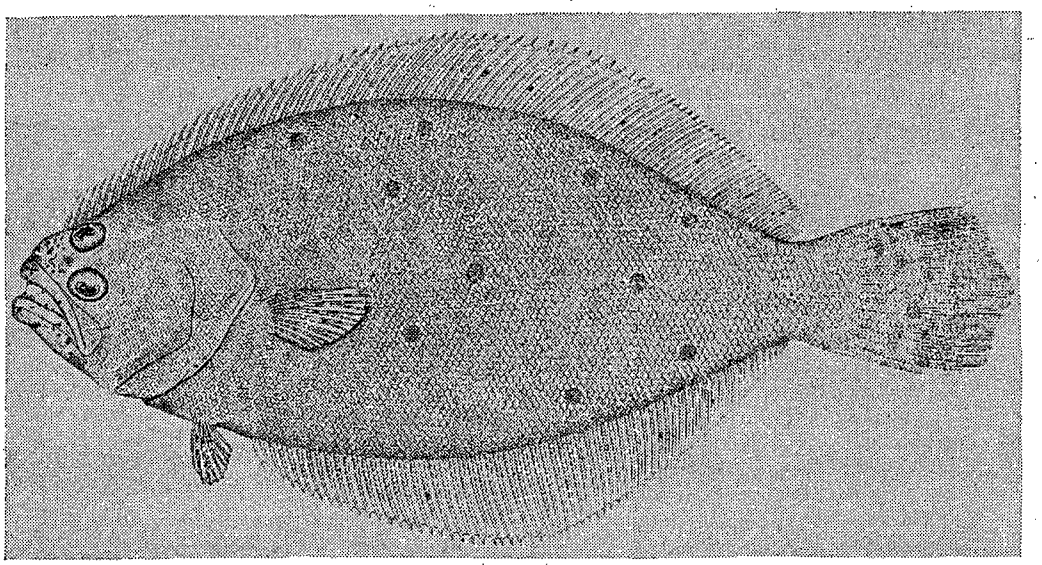

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Figure 27.—The summer flounder.

Its size and active habits make the fluke an excellent game fish. Unlike most of its sluggish relatives, the fluke pursues its prey (small fishes, shrimps, crabs, and the like) swiftly, driving shoals of small fry to the surface and sometimes leaping clear of the water.

Anglerfish (*Lophius piscatorius*)

Among the virtually untouched seafood resources of New England is the anglerfish. In reality an excellent food fish, white-meated, free of small bones, and with a pleasant flavor, until recently the angler was considered unmarketable by the trawler crews and was pitched overboard when it came up in the net. In 1940, however, 21,000 pounds were marketed (chiefly in Massachusetts and Connecticut) and during the past year or so several of the larger trawlers have experimented with bringing in their catches of this fish. Undoubtedly it could furnish many thousands of pounds of excellent food.

The angler has a variety of other names (such as goosefish, bellowsfish, all-mouth, monkfish, and fishing frog) which relate to its interesting habits or peculiar appearance. It is a much flattened fish with a very large head, from the top of which grows a supple wandlike "fishing rod." It is thought that fish are attracted to investigate the "lure" which dangles from this rod and are seized in the capacious mouth of the angler before they can escape. The name "goosefish" was given because of the supposed ability of this fish to capture water fowl resting on the surface of the water.

On the east coast of America anglerfish are found from the Newfoundland Banks and the Gulf of St. Lawrence to North Carolina in shoal water and as far south as the Barbadoes in deep water. They live also in the eastern Atlantic.

Skates (*Raja species*)

Other species commonly discarded by trawler crews are several kinds of skates, although these fish are esteemed in Great Britain. Skates are much flattened fishes (flattened from above downward, unlike flounders which are flattened from side to side) with enormous pectoral fins or "wings." The mouth and gill openings are on the under side and cannot be seen from above. Like the sharks to which they are related, they have a skeleton that is largely cartilage, instead of bone as in higher fishes.

Several species of skates are common in New England waters, but fishermen do not, as a rule, distinguish one from another. Three main groups may be recognized easily: the true skates with comparatively short tails and without spines; the sting rays with long whip-like tails

bearing stiff spines; and the torpedo, rounded and with a large tail fin, which is capable of giving a strong electric shock. Only the skates are common in New England.

When searching for food, skates glide along over the bottom with an undulating movement of their wings, and it is said that they can uncover shellfish buried in the bottom by vigorous flapping of the fins.

The common New England skates lay large eggs with leathery black or green shells, attaching them to seaweeds or other objects by means of long tendrils. On almost every beach the empty egg cases ("mermaid's purses") may be seen among the debris that litters the tide lines.

A considerable catch of skates could undoubtedly be made if demand justified it. Probably most of the species are equally good eating. Sections of the wings are marketed fresh or frozen, and are considered an excellent casserole and salad dish.

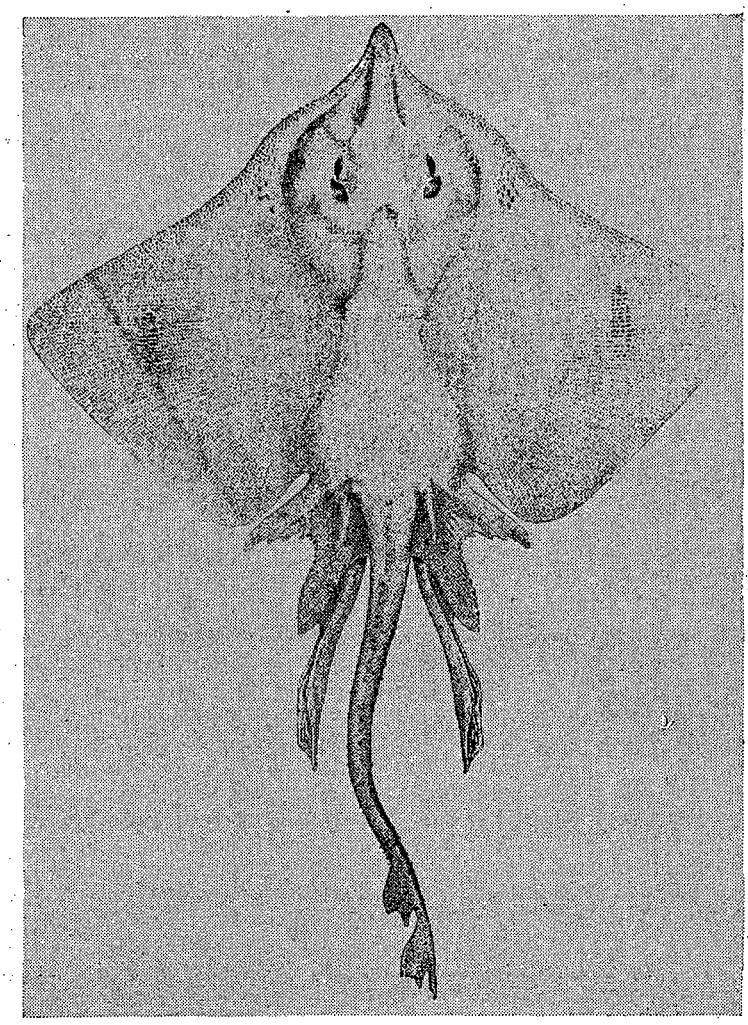

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Figure 28.—The barndoor skate.

The Oyster (*Ostrea virginica*)

New England's oysters are the product of underwater farming, cultivated and harvested with all the care that the professional truck gardener gives to his vegetable crops. While haddock, cod, lobster, and most of the region's other leading fishery products are caught by fishermen wherever they can be found, most oysters are taken from definitely circumscribed beds in coastal waters by growers who have leased extensive underwater tracts for the purpose of planting and cultivating their shellfish crop. This system of private oyster farming in New England includes virtually the entire fishery; only about one percent of the total oyster crop comes from natural or uncultivated beds.

At first glance, a comparison of New England's oyster output with that of other coastal sections makes the industry appear an insignificant one. In total pounds produced, New England ranks below any of the other commonly recognized geographic units of the coast (table 3). An examination of the value of the crop tells a different story. Despite the low poundage, the total value of New England's oysters was greater in 1939 than that of any other New England fishery product except haddock, cod, lobsters, and clams—traditional headliners of the region. Furthermore, in terms of price per pound, the New England oyster far outranks the product of any other section.

TABLE 3.—*Production of oysters by various coastal sections of the United States in 1939 and 1940*

Section	Pounds		Total value		Average price per pound	
	1939	1940	1939	1940	1939	1940
New England	7,805,000	5,991,000	$1,564,000	$1,051,000	$0.19	$0.18
Middle Atlantic	11,653,000	13,984,000	1,788,000	2,182,000	.14	.16
Chesapeake Bay	36,847,000	37,457,000	2,726,000	3,217,000	.07	.09
South Atlantic and Gulf	27,713,000	20,950,000	1,441,000	1,263,000	.05	.06
Pacific	8,978,000	11,001,000	681,000	754,000	.07	.07
Total	93,006,000	89,383,000	8,190,000	8,467,000	.09	.09

The reasons for the limited oyster production by New England States are several. All are related to the fact that New England represents nearly the northern limit of the waters within which oysters will grow rapidly enough to establish themselves. (Northern Nova Scotia, New Brunswick, and Prince Edward Island support small oyster fisheries.) During most of the year the water is too cold to permit oysters to spawn. Such larvae as are produced, moreover, seldom find favorable conditions awaiting them, so that the abundant "set" of young oysters common to southern waters is a rarity in New England. Oysters do not feed during severe winter

weather; hence their feeding and growing season is shorter in New England than toward the south. All these facts combined mean that the rate of natural replacement is low, and that heavy fishing could quickly deplete the natural beds. This is, in fact, exactly what has happened in New England during the past century, and is the reason that the industry is wholly dependent on systematic cultivation. The course of depletion was quickly run in Maine and New Hampshire, which now have no oyster industry, although there is definite evidence that these mollusks grew along our northern coast in colonial and precolonial times. Natural beds south of Cape Cod were virtually exhausted during the past century, and as a matter of necessity methods of cultivation were resorted to.

Oysters are found only in enclosed bays, coves, and river estuaries where the saltiness of the water is reduced by the inflow of fresh water. Coming southward along the New England coast, we find beds at such places as Wellfleet on the sheltered or bay side of the outer arm of Cape Cod, although the ocean side with its exposed beaches is barren of oysters as far as Chatham at the bend of the cape. Some are taken from Buzzards Bay and from the mouths of the Taunton and Wareham Rivers. In Rhode Island the most important beds are found in Narragansett Bay, while oysters line practically the entire Connecticut and inner Long Island coasts, including the many harbors, coves, and river mouths of the shore line and the waters of Long Island Sound.

To cultivate the oyster successfully, growers must understand many phases of its life history, the most important of which are the following. Spawning usually begins early in July in New England, when the water temperature is from 66° to 70° Fahrenheit. The oyster is highly prolific. A female may produce from 15 million to 114 million eggs at one spawning, and since she may spawn repeatedly throughout a season the total number of eggs produced in a summer may amount to several hundred million. The fertilized egg develops into a small, free-swimming larva in only 5 to 10 hours, depending upon the temperature. The oyster larvae live free in the water for about 2 weeks, and may be widely scattered by tides and currents. Larval development is completed when the young oyster is approximately 2 weeks old and one seventy-fifth of an inch in diameter. It is then ready to "set" or "strike," as the act of attachment is called. For successful attachment a clean, hard surface is required. After setting, the larva (now called a "spat") quickly develops organs like those of the adult oyster and grows so rapidly that in 2 weeks' time the shell is a quarter of an inch long. Oysters from this size to 2 inches in length are known as "seed oysters." Once an oyster has set it remains attached for life, unless dislodged by man or violent storms.

Since the oyster feeds by opening the shells and drawing in water, it is able to thrive and grow without moving about in active search of food. As the seawater is strained through the gills the food organisms become entangled in the layer of adhesive slime that covers all the soft parts of the body. Once entangled, they are driven along to the mouth by the beating of hair-like cilia. As long as the oyster's shells are open, this process of drawing in water with its contained food and oxygen is going on. Oysters growing between the tide lines close their shells when the tide is out and so do not grow as rapidly, as a rule, as those living in deeper water. Changes in temperature also affect feeding, and during months of cold weather the shells remain closed. At a temperature of about 78° F., however, large volumes of water are filtered by the oyster, as much as 27 quarts of water passing through the gills of an adult in an hour.

The best locations for oyster farming are protected areas with hard or semihard bottoms, moderately deep, with the tidal ebb and flow changing the water regularly. Sandy, shifting bottoms are not suitable for oyster culture. Soft mud bottoms may be reinforced with shells, gravel, slag, or other hard material so that the oysters will not sink and be smothered.

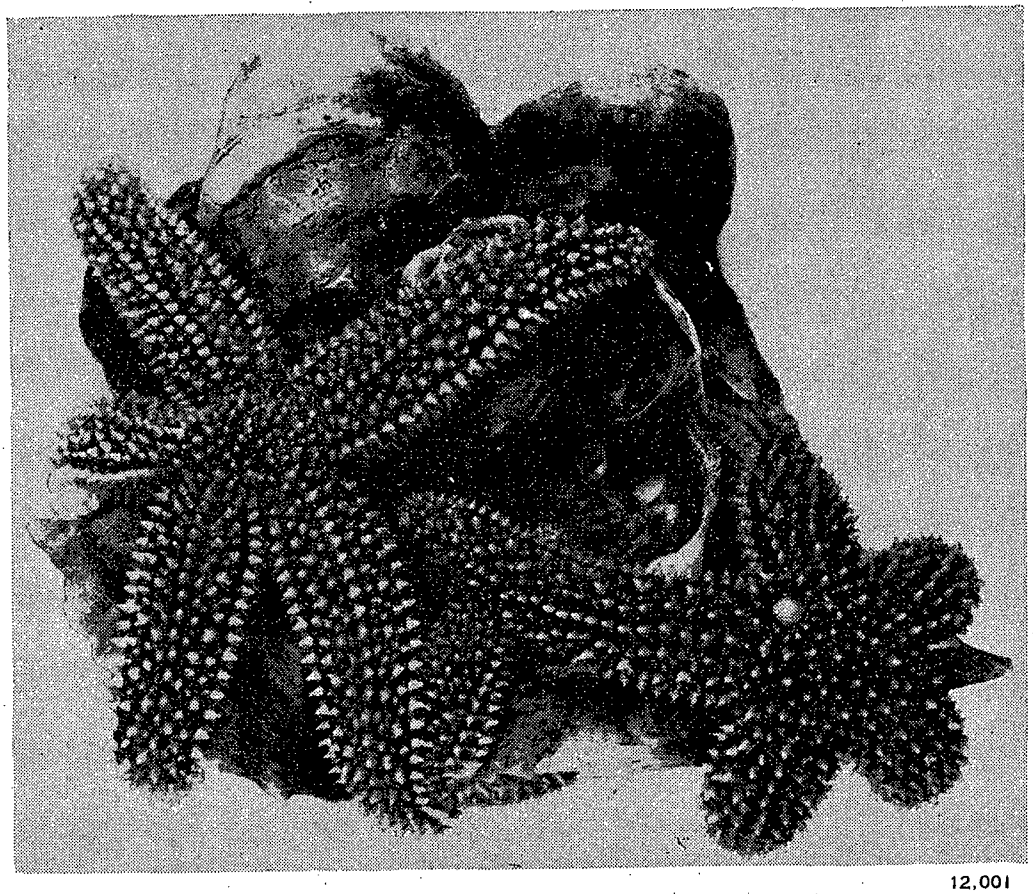
The oyster farmer prepares his ground by dredging and clearing away old shells and removing as many starfish, drills, and other natural enemies of the oyster as possible. He then puts down material on which to catch the "set," often using for this purpose the shells of oysters, clams, and scallops. Sometimes the shells are planted in wire bags, which simplifies the task of later taking up and replanting the seed. The shells or other collectors should not be placed in the water too early, for they quickly become fouled with a slimy accumulation of marine algae and sometimes silt, and are then unsuitable places for the attachment of young oysters.

Set obtained on the collectors may be left until the following fall or spring, but often is transplanted soon to growing grounds in deeper water, where food is more abundant. In Long Island Sound oysters are usually transplanted as many as five times before they are ready for market. Instead of becoming stunted and misshapen from overcrowding, transplanted oysters are able to obtain plenty of food and to grow to the natural shape and maximum size.

Besides transplanting repeatedly, the oyster grower must protect his beds from starfish and drills and other natural enemies. In New England the most important enemy of the oyster is the starfish, which, in spite of long-continued and costly efforts by oystermen to reduce its numbers, takes a half-million-dollar toll each year in Long Island Sound alone. Recently biologists of the Fish and Wildlife Service have developed a chemical method of control which promises to give

better results than the older mechanical methods. (Loosanoff and Engle, 1942.)

Oysters from the Atlantic coast are shipped into the interior of the country, and many New England oysters go to Canada, where there is no important commercial production. Ordinarily, oysters are shucked before shipping, because the shells contribute greatly to transportation costs without providing food. Many Cape Cod oysters, however, are shipped in the shell to Boston, where tradition demands the eating of oysters on the half shell.



12,001

Figure 29.—Starfish attack young and old oysters, gripping them with their five rays or arms and forcing the shells open.

Widely appreciated as an article of food, the oyster is one of the most valuable fishery products taken from United States waters. The total crop ranks second only to the salmons and tunas in the income it returns to fishermen. The oyster is better balanced from the point of view of nutrition than almost any other food. Its copper, iron, and manganese aid in combating anemia; its calcium and phosphorus are needed for bone growth; and its iodine regulates the thyroid gland and helps prevent goiter. It contains most of the essential vitamins. Its protein is especially high in nutritive value, and starch is present in

the form of glycogen which is readily digestible whether eaten raw or cooked.

The Lobster (*Homarus americanus*)

Lobsters were once so plentiful that they could be bought for a penny apiece; now they are so scarce that lobster meat has become a luxury. In spite of the present small catches, New England fishermen receive a larger income from lobsters than from any other shellfish, the figure amounting to a tenth of the total value of the approximately 80 fishery products of New England. Canned lobster seen in the markets comes from Canada, the world's largest producer of lobsters. The United States catch is marketed live, or as packaged, freshly boiled meat. Restaurants commonly receive shipments of live lobsters and keep them alive until they are to be prepared for serving; and some markets boil lobsters for their customers at the time of purchase. The meat comes from the claws and the many-jointed "tail," for the body proper contains the vital organs and very little muscle. The claw meat is considered the choicest, hence is priced higher than the tail meat.

The American lobster lives only on the eastern coast of North America, although several unsuccessful attempts have been made to introduce it into Pacific coast waters. The most northern point at which this crustacean has been captured is Henley Harbor, Labrador; the most southern is 1,300 miles distant, off the coast of North Carolina. Generally speaking, the lobster's range is a narrow, ribbonlike strip of coastline extending from the tide lines out to depths of as much as 600 feet and generally from 30 to 50 miles wide, although broadening to 200 miles on Georges Bank. Probably lobsters have always been most abundant north of Cape Cod, although, surprisingly, some of the largest specimens ever captured are now being taken from the southern trawl fisheries operating during the winter months off North Carolina, and a half-million-pound fishery now exists in the Middle Atlantic States. Two-thirds of New England's 11-million-pound annual catch comes from the State of Maine.

Although they are able to swim rapidly by flexing their powerful, muscular tails, lobsters seldom leave the sea bottom, where they prowl about in search of food. Heavy, awkward, and well-nigh helpless though they are on land. they move about nimbly on the sea floor, for the water supports their bulk and they walk lightly on the tips of their legs. They usually carry the large claws directly forward, ready to ward off an enemy or to seize any small and not too active fish that pass within range. They spend much time digging up the bottom in search of clams and other mollusks, and their long, sensitive "feelers" or antennae are continually sweeping back and forth to detect the

presence of food. Sometimes they capture their prey by stealth, and lie hidden among weeds, in rock crevices, or in their burrows to watch for passing victims. A keen sense of smell and their usually active habits lead them to discover the cratelike lobster pots set by fishermen and to enter the single narrow opening to find the bait within. Usually they are unable to retrace their path and so the fisherman makes his catch.

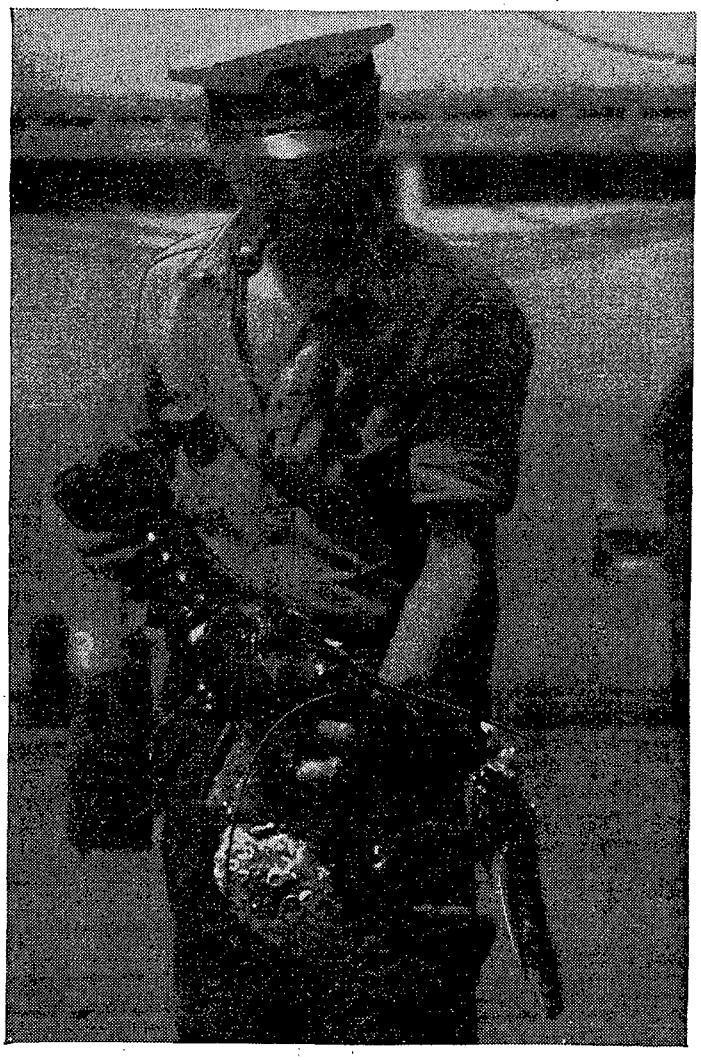


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Figure 30.—Not many lobsters the size of this barnacle-encrusted giant remain in New England waters.

Although lobsters are not long-distance migrants, they move out from the shoreline into deeper and warmer water with the approach of cold weather. To some extent, they also wander up and down along the coast, but none of those tagged and later recovered has made a journey longer than 10 miles.

During its infancy, the lobster receives more careful maternal attention than almost any other sea creature. The eggs, instead of being shed broadcast in the water like those of most fishes and shellfish, are carried by the female on her abdominal appendages or swimmerets, to which they adhere by a gluey substance that coats them. Here they remain throughout the whole period of incubation, which requires 10 months on the coast of Maine. The mother regularly aerates and cleans the eggs by moving her swimmerets back and forth, and protects them from enemies by flexing her tail, enclosing them in a sort of pocket. Because of this care, very few are lost.

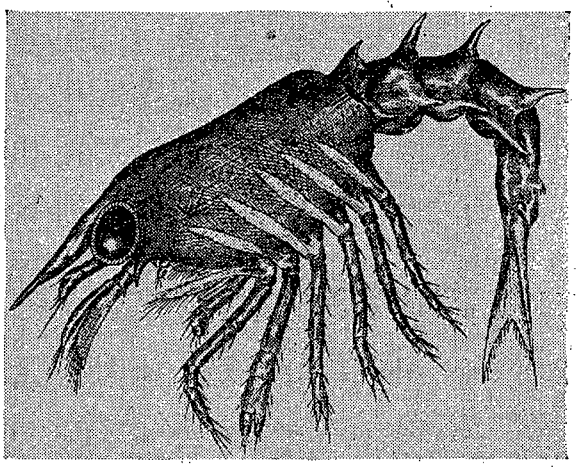

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Figure 31.—A young lobster in the first stage of development.

Hatching usually takes place at night or on cloudy days. As the young emerge from the eggs they are dispersed in clouds by the violent agitation of the mother's swimmerets. Immediately they ascend to the surface, where they remain for some weeks, sinking into deeper water during the day as a rule, but rising again at night. At first they bear little resemblance to the adults. The cuticle is wholly transparent, so that the internal organs show clearly through it: the yellowish-brown liver which looks much like a cluster of grapes, the heart and blood vessels, the digestive tract, and the feathery gills. Altogether the young lobster is a colorful creature, for within the skin are numerous red and yellow pigment cells or chromatophores. When these are expanded the larva is distinctly red; when they are contracted the pigment of the blood gives it a predominantly pale-blue tone. The large eyes are a bright emerald green.

Larval lobsters are exceedingly active and are incessantly on the move, snapping up particles of almost any sort of food that happens to be drifting in the water. They prey without hesitation on smaller or weaker lobster larvae and sometimes swim about dragging their victims with them and feeding as they go.

The cuticle of a lobster is firm and inelastic, and when the animal grows it is compelled to shed its covering at intervals. The larval lobster undergoes a series of molts, each of which brings it a little closer to a lobsterlike appearance. The 4th-stage larva looks much like a miniature adult, and often during this stage the young leaves the surface waters and begins to live on the bottom. On taking up the new mode of life, the instincts of fear and caution appear to be developed for the first time, and the larva digs holes where it conceals itself like an adult. Sometimes the descent is delayed until the 5th or 6th stage. At first they seem to spend a great deal of time hiding under stones or in burrows, and by the time they are from 3½ to 5 inches long they come out of concealment more frequently and explore the bottom boldly.

During its first year of life a lobster molts from 14 to 17 times. Small lobsters increase in bulk as much as 20 percent at each molt, although large ones average less than a 9-percent increase. A 10½-inch lobster has molted 25 to 26 times and is about 5 years old. The size at which lobsters come to maturity varies in different parts of the coast. For example, a female as small as 7 inches may spawn in some sections, although in Maine few lobsters mature when less than 10½ inches long.

Mating takes place in the summer, immediately after the female has molted, but the actual spawning is delayed until the following spring. Lobsters spawn only once in every two years, and the number of eggs laid increases greatly with age. For example, an 8-inch lobster produces 5,000 eggs; a 10-inch lobster 10,000 eggs; and a 12-inch lobster 20,000 eggs.

The New England lobster fishery has declined steadily since the earliest years for which we have records. In 1889, 30,500,000 pounds were marketed; in 1940 the total catch was approximately 11,000,000 pounds, although about twice as many pots were fished as in the earlier year. Moreover, present-day catches contain a larger percentage of small lobsters, which in itself is a dangerous sign. A recent study by Fish and Wildlife Service biologists showed that on the Maine coast, for example, probably only about 8 out of every 100 lobsters that reach market size survive to spawn. Although each of the 5 maritime New England States prescribes size limits for the purpose of protecting small lobsters, in 3 of the States, at this writing, the laws are such that a lobster is subject to capture by fishermen for 3 years before it reaches maturity. In Maine and Massachusetts (also in New York) the size limit has been increased so that this time interval has been reduced by almost a year, thus allowing more lobsters to reach spawning size. Such protection of under-size lobsters appears to be essential if the decline in productiveness of this important fishery resource is to be halted.

Clams (*Mya arenaria* and *Venus mercenaria*)

Fresh clams, clam chowder, canned clams, and clam broth have made the clam justly famous far beyond the narrow limits of its native coastal waters. Locally, the clam is probably known and used by a larger number of people than any other shellfish because it may be gathered, at least in small quantities, by amateur as well as professional fishermen. A clam fork, a little muscular exertion, and considerable patience are the only requirements. Among shore communities a permanent social institution is the New England clam bake, in which the clams (along with corn, potatoes, fish, and sometimes other food) are roasted in a hole lined with hot stones and packed with freshly gathered seaweed.

Two kinds of clams make up the bulk of New England's production: the soft or long-necked clam (*Mya arenaria*), and the hard or little-necked clam (*Venus mercenaria*). To the New Englander, however, only *Mya* is a "true" clam, and the hard clam is called by the old Indian name, "quahaug." Soft clams are found chiefly north of Cape Cod, and their range extends all the way to the Arctic Ocean, where man as a predator is largely replaced by polar bears, seals, and walruses. This species constitutes three-fourths of the 20-million-pound New England clam production and is the only kind taken in appreciable quantities north of Boston. The hard clam, on the other hand, is much more abundant south of the Cape, and occurs all the way to Texas. This clam is used in chowders more than the soft clam because of its stronger flavor. Small quahaugs, suitable for eating raw on the half shell, are known as "cherrystone clams."

Even where their range overlaps, the two species prefer, for the most part, slightly different habitats. *Mya* is the clam of the tide flats, living buried in the sand or mud of the vast intertidal zone that is alternately exposed and submerged by the tides. When the water is over the flats the clams push their long, tubelike siphons up to the surface of the sand. Water laden with food and oxygen is drawn in, and water containing carbon dioxide, nitrogenous waste products, and undigested food is expelled. Through the siphons, too, the eggs and sperms are liberated into the water during the spawning season. When the tide ebbs, the siphons are withdrawn, and the pitting of the wet sand may show the location of each clam hole below. Some soft clams live also in shallow water below the low-tide mark, but this, as well as considerably deeper water, is predominantly the home of the hard clam in New England. In the southern part of its range, *Venus* lives only in shallow water. Like *Mya*, *Venus* may burrow into the bottom, even though constantly submerged, but usually only deep enough to cover the shell. Having only very short siphons, this clam is not adapted to the deeper burrowing habits of its relative.

Commercially, soft clams are taken by digging—dry digging when the tide is out, or wet digging when the flats are covered with water. Usually clams are dry-dug, and for this an instrument somewhat like a potato digger is used. According to the abundance of clams and the skill and industry of the digger, from 1 to 4 bushels can be dug during the few hours when the tide is out. Wet digging requires two persons. The clams are unearthed by an instrument called a seahorse. This is a stout, short-handled clam hoe with long prongs, which is worked deep into the sand and dragged by a man who wades over the submerged bottoms. His partner follows and gathers the dislodged clams. Hard clams, because they live in deep water, are taken by long-handled rakes or tongs and by dredges.

How the clam spends the early weeks of life is an interesting story, and since the two species are very similar in this respect, only the story of the soft clam need be told. During the summer months the water over the flats is often teeming with the minute, swimming forms that are embryo clams. These tiny creatures are swept in and out by the changing tides, and are carried up and down the coast by prevailing currents and eddies. Each of the embryos is about $\frac{1}{300}$ of an inch long and swims through the water by a spinning motion. At this stage they are very sensitive to temperature changes, and a long, cold rain may kill them by the thousand. Probably many are eaten by small jellyfish, comb jellies, and larval fishes. Those that survive develop a muscular "foot" (the digging tool of the adult clam), a siphon or breathing tube, and gills. Meanwhile the swimming organ, a small pad covered with rapidly beating hairs, gradually shrivels away, and sometimes between the third and sixth days of life the young clam is no longer able to swim, but sinks to the bottom.

Since some spawning of clams continues throughout the entire period from about the first of June to the end of August, there is also during this time a light but more or less constant rain of young clams descending from the overlying water onto the bottom, for some of the young are reaching the end of the swimming stage almost every day. Sometimes large numbers settle on eel grass and sea weeds, and thick colonies of them may populate certain shore areas, leaving other areas practically barren. Probably these thickly settled areas are places where eddying currents have concentrated large numbers of swimming young.

When it descends to the underlying bottom the young clam is only about as large as a sand grain. Instead of burrowing at once into the bottom it spins a tough thread (known as a byssus) and anchors itself to a bit of seaweed, a stone, or a shell, and so keeps its position during the tidal ebb and flow. At slack water it may cast off the anchor line and creep about on its muscular foot; but soon it secretes another thread, although it may continue to crawl about in various

directions at the end of its tether. At this stage the young clams have no protection against enemies that creep about over the bottom or swim above it, for the shell is thin and brittle. Crabs and small fishes may eat them, but probably the greatest damage is done by young starfish, which are spawned about the same time as the clams and settle to the bottom with them. The infant starfish are able to attack young clams and force open their shells in the same way that the adults attack grown shellfish.

Sometime before the shell has become ¼-inch long, the young clam begins to dig among the sand grains with its sharp foot, gradually working the shell down into the bottom. Usually this first descent is only a trial venture, and the young clam may come out of its shallow burrow and wander about for a time, only to reimbed itself once more. Within the burrow it anchors itself by byssus threads, which may be secreted until the shell is at least ½-inch long. About this stage the clam makes its final descent, when it loses its power to secrete threads through the disappearance of the byssus gland. It never again leaves its subterranean chamber of its own accord.

The total take of clams in New England in 1940 brought diggers, rakers, and other fishermen $1,754,920. Maine fishermen got $266,996 for their share of the clam harvest, and the manufacturing establishments of that State produced chowder, juice, canned clams, and fresh shucked clams worth $773,998. Fresh shucked clams from Massachusetts (where no canning is done) were worth approximately another half million dollars.

Although in many respects a neglected resource, denied the benefit of the intensive cultivation given oysters, harvested largely by individual enterprise with negligible outlay of capital, the clam fishery nevertheless ranks among the half dozen most valuable fisheries in New England.

Scallops (*Pecten irradians* and *Pecten magellanicus*)

No account of New England's shellfish resources is complete without mention of the highly prized scallop. Scallops are of two kinds—bay scallops and sea scallops—and come from two wholly different localities. The bay scallop (*Pecten irradians*), considered the greater delicacy of the two, is taken from inshore waters as the name indicates. Subjected to intensive fishing because easily accessible, it is now so scarce that only a million pounds were placed on the market in 1940. The large sea scallop (*Pecten magellanicus*), inhabitant of the offshore banks and other deep waters, is now brought in by scallop draggers to the amount of some 5 to 7 million pounds a year, worth from three-fourths of a million to a million dollars to fishermen.

Scallops are mollusks with two shells like oysters and clams, but differ from these in that they are active swimmers, moving freely through the water or over the bottom. Scallop beds may shift considerably, therefore, and during heavy storms a New England community may lose virtually its entire population of bay scallops. The recent disappearance of eel grass from vast Atlantic coastal areas adversely affected the scallops, which are sheltered by the grass during the earlier stages of life.

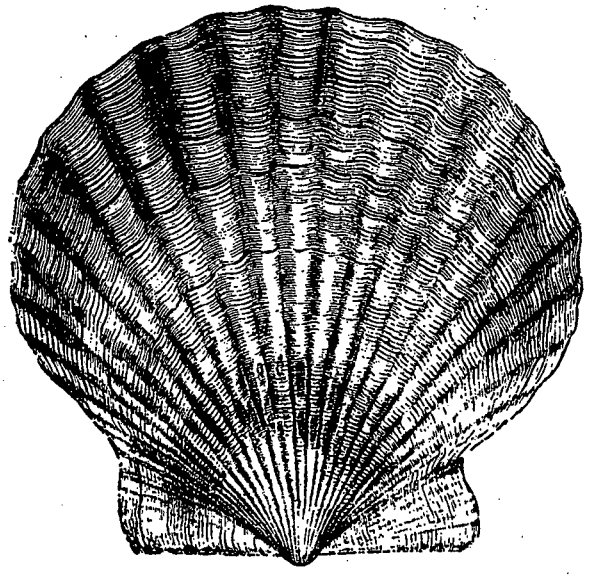

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Figure 32.—The bay scallop.

Only the large muscle that controls the shell movements is eaten. This muscle (called the "eye") comprises only a small proportion of the total weight of the meat. The remainder is discarded or used as bait or fertilizer, although it is good, edible meat. In Europe the entire scallop is eaten, and there seems to be no good reason why it should be wasted here.

Crabs

Crabs support another New England shellfishery of limited extent. The 1940 catch was 2,419,400 pounds, worth $54,276. Several species, not separated in the statistical reports, make up the catch. Most important is the rock crab, *Cancer irroratus*, found from South Carolina to Labrador but most abundant in New England. It is said to contain more meat than the blue crab of the south and to be its equal in flavor, but it is not fished extensively enough, and may not be abundant enough, to offer serious competition to the blue crab in the markets. The Jonah crab, *Cancer borealis*, of more limited distribution, is found in certain localities scattered from Long Island to Nova Scotia. An

unknown, but small, amount of blue crabs (*Callinectes sapidus*) is included in the catch, because this predominantly southern species reaches the limit of its range in Massachusetts. Probably most of the crab eaten in New England is brought in from the great crab-producing waters of Chesapeake Bay and the South Atlantic and Gulf Coasts.

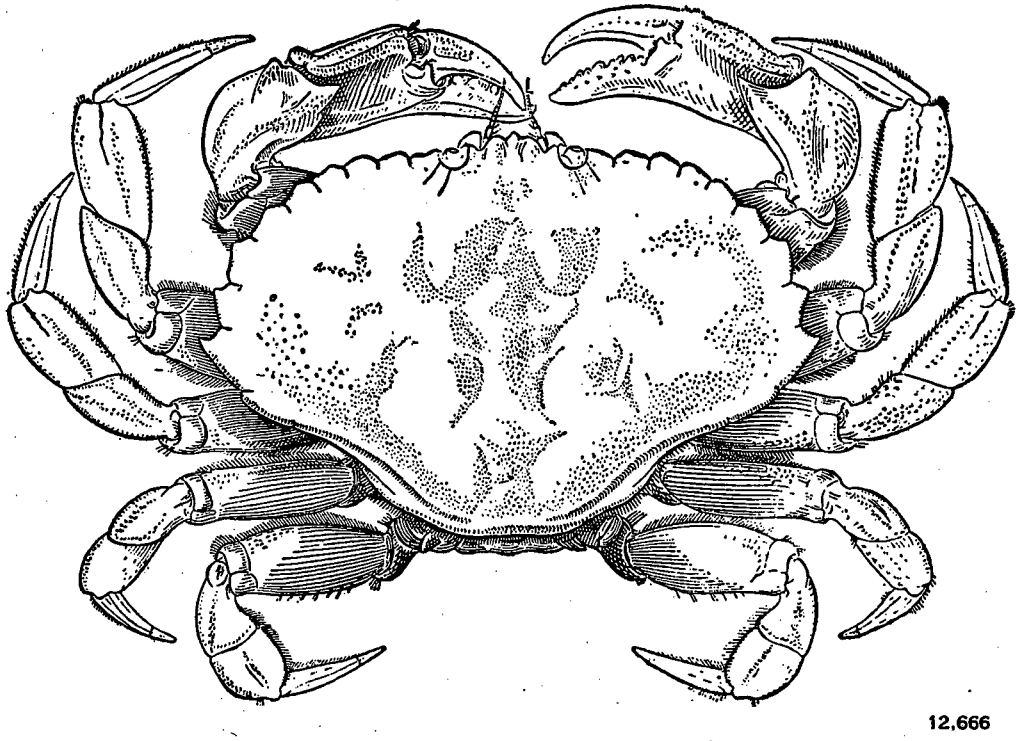

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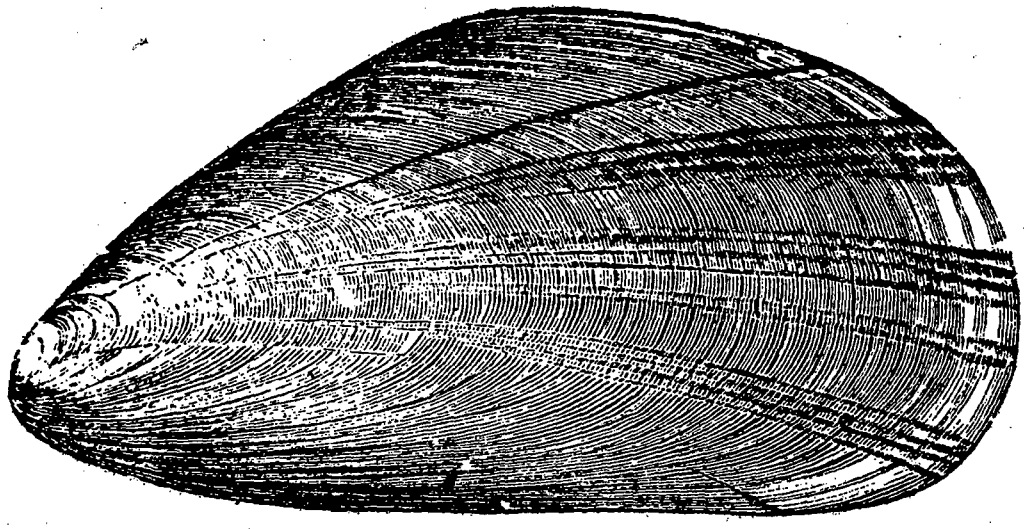
Figure 33.—The rock crab.

Shrimp (*Pandalus borealis*)

In 1938 some exploratory fishing was carried on cooperatively by the Federal Government and the State of Maine to determine whether the offshore populations of shrimp were large enough to warrant the development of a fishery. Considerable quantities of shrimp were found, especially on the deeper muddy bottoms, but the relatively low cost of production of the southern shrimp (shipped north from the Carolinas, Florida, Louisiana, and other southern States) prevented serious attempts to develop the northern resource. Changing economic conditions, however, might well make it worth while to bring in more than the present insignificant poundage.

Sea Mussels (*Mytilus edulis*)

Another virtually untapped shellfish resource is the common sea mussel which lines hundreds of miles of the Atlantic coast with its small black shells. Except for the few gathered locally by people who appreciate its delicate flavor, the mussel beds are almost wholly neg-



12,792

Figure 34.—The sea mussel.

lected. In 1940 about 17,500 pounds were taken commercially in Massachusetts, Connecticut and Rhode Island; none in Maine or New Hampshire. In Europe, by contrast, the demand for mussels is so great that for many years propagation has been practiced extensively to augment the natural supply. Like most other shellfish, sea mussels are rich in minerals, vitamins, and proteins. They are among the most digestible of foods, for the human body is able to use practically all of the nutriment contained in their meats and liquor. Because their shells are thinner, a bushel of mussels contains considerably more food than a bushel of oysters. Undoubtedly the thousands of acres of untouched mussel beds represent a seafood resource of great potential value.

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