Fisheries Fact Sheet

Department of Fisheries and Forestry
Ottawa

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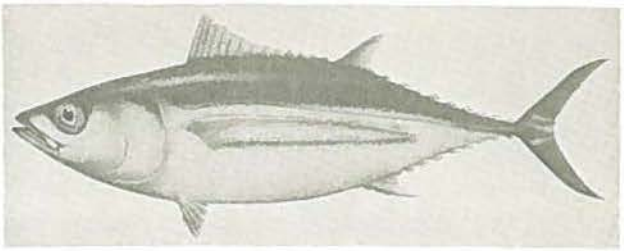
The Albacore

THE ALBACORE *(Thunnus alalunga)* is one of the tunas and belongs to the mackerel family, a group of fishes which by virtue of their streamlined bodies are very rapid swimmers. Albacore are readily distinguished from other members of the family by their long sabre-like pectoral fins, a feature which has earned the species an alternative common name - longfin tuna. In color, its back and sides are metallic steely-blue and its under surface is silvery.

Albacore are pelagic, that is, they live freely in open waters, and occur throughout all warm and temperate seas. Those in the North Pacific are now considered to belong to a single population which is believed to spawn in subtropical waters west of the Hawaiian Islands. Commercial catches indicate that the largest individuals are most abundant in these waters, medium sized individuals are found in coastal waters off Japan and adjacent offshore waters, while the smallest individuals occur in the eastern Pacific. Those occurring off British Columbia, usually in July, August and September, range from 21 to 33 inches in length and from 7. 5 to 23. 6 pounds in weight.

The food of albacore in the eastern Pacific varies with locality, but in general consists of small fish which swim in schools such as anchovies, pilchards, herring, sauries, lanternfishes, as well as squid and zoo-plankton.

The first commercial catch of albacore in the eastern Pacific Ocean by Canadian fishermen was made in 1939. In that year and until 1960 fishing was done entirely by trolling. The fleet operated off British Columbia in some years but more often southward to the Columbia River and on occasion to northern California. During this period the



Albacore *(Thunnus alalunga)*

catch averaged 0. 5 million pounds per year, with a high of 2. 2 million pounds in 1949. In 1960, as a result of the successful use of purse-seines by United States fishermen, a small number of Canadian purse-seine vessels entered the tuna fishery. By 1962, with the arrival of improved shipboard methods of freezing fish, which increased the range and time over which vessels could operate, Canadian seiners ventured as far south as Mexico, and were responsible for catching the bulk of the albacore landed in British Columbia.

The catch upon landing is customarily frozen for later processing. Upon removal from cold storage the fish are thawed, dressed and washed. They are then graded according to size, and pre-cooked in retorts under steam pressure. The cooked fish are then skinned and boned, and the dark meat is removed. The white meat is packed as solid or flaked tuna and the dark meat is used in the preparation of pet food.

(Prepared by the Nanaimo Biological Station of the Fisheries Research Board of Canada).

April, 1967

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Ottawa

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The American Lobster

By D.G. Wilder

Fisheries Research Board of Canada

THE AMERICAN LOBSTER, or Homarus americanus as it is known to biologists, belongs to a group of animals known as decapod crustacea, so called because they have 10 jointed legs and a crust-like, jointed shell. This group includes the crabs, shrimps, prawns and crayfish. Our lobster's closest relative is the almost identical European lobster (Homarus vulgaris). Another close relative is the smaller, more delicate Norway lobster (Nephrops norvegicus) also called the Dublin Bay prawn or scampi.

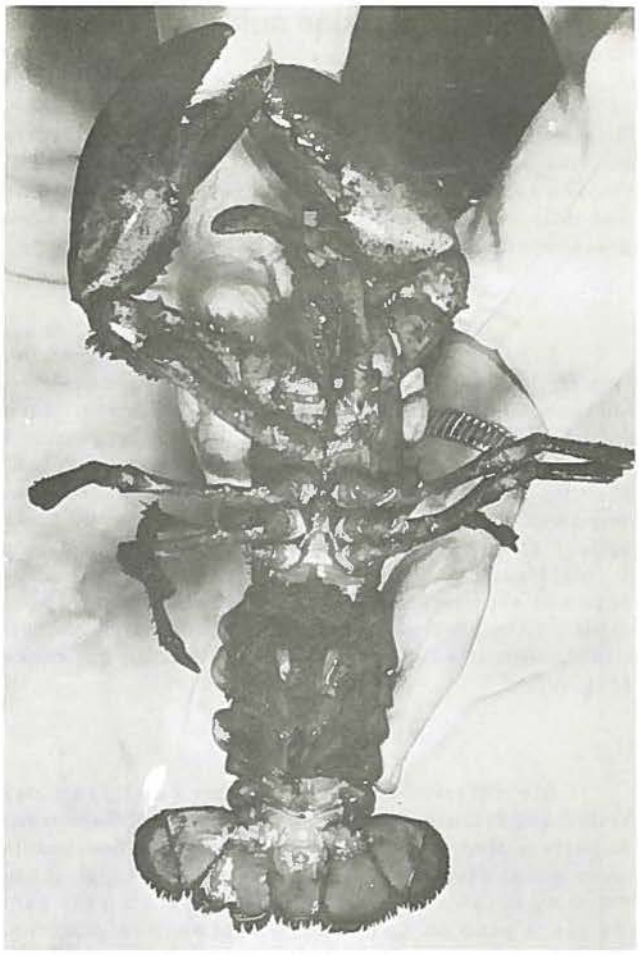

FIG. 1. -- Egg-bearing or "berried" female.

DESCRIPTION

The body of the lobster is divided into two main parts, the combined head and thorax often referred to simply as the "body", and the 6-jointed abdomen or tail. The shell which covers much of the body is made of chitin, a horn-like substance hardened with lime salts. The black eyes on short, movable stalks are on either side of a stout, spiny horn. There are two pairs of antennae and a complicated set of mouth parts. The first pair of legs are large and well armed with strong claws that are generously provided with teeth and sharp spines. One of these claws known as the "crusher" is considerably heavier than the more slender "pincer" claw. The 8 walking legs are considerably shorter and quite slender. There is a series of small paddles or swimmerets on the underside of the abdomen which ends in a wide flattened tail fan (Fig. 1). Lobsters vary greatly in colour but are usually dark greenish or reddish on the back and often liberally speckled with dark spots. The under surface of the claws is usually red. The world's record lobster caught in deep water south of Boston was well over 3 feet long with its claws extended and weighed 42½ pounds. Those caught in inshore waters are much smaller, averaging about 9 inches in length and 1 pound in weight; lobsters over 10 pounds are rare inshore (Fig. 2).

FIG. 2. -- 27-pound lobster, 39 1/2 inches long with claws extended, compared with 1-pound lobster.

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DISTRIBUTION

The American lobster lives on the east coast of North America from North Carolina to Labrador. It is most abundant in Maine, southern Nova Scotia and the southern Gulf of St. Lawrence where it thrives in shallow coastal waters on rocky bottom. Recently, extensive stocks of lobsters have been discovered well offshore along the continental slope.

FEEDING

Lobsters in search of food walk nimbly on the tips of their walking legs, with their long sensitive antennae continuously sweeping back and forth. Live food is often caught and held by the large claws which are also effective weapons against enemies. If suddenly disturbed, lobsters often swim backward with amazing speed by vigorously flapping their tails. They feed on a great variety of bottom-living animals such as worms, crabs, fish, clams, mussels and sea urchins. During the daytime, particularly in shallow water, they spend much of their time hidden in burrows or crevices among the rocks (Fig. 3).

MOVEMENTS

Big differences in the lobster catch from day to day and from season to season have led fishermen to believe that lobsters undergo mass movements over great distances. However, the tagging and marking of over 200,000 lobsters during the past 25 years gave no indication of such migrations. Over half of the tagged lobsters were recaptured and most of these were caught within a mile or so of the points where they were released. A few moved along shore as far as 35 miles and four apparently travelled from southern Nova Scotia to Maine, 65 to 170 miles across the Bay of Fundy in 5 to 8 months. Changes in the lobster catch are caused partly by the intense fishery which quickly reduces the stock and by changes in the bottom water temperature which greatly affect the lobsters' activity, feeding and trapping.

MOULTING, GROWTH AND AGE

When a lobster has outgrown its hard, inelastic shell it casts it off in one piece. This process known as moulting or shedding usually takes place in summer. The moulting lobster bends in a V and the membrane joining the body and tail splits across its upper surface. Within 5 to 20 minutes the lobster draws itself through this gaping split, emerging with a clean, bright but extremely soft shell. The newly-moulted lobster absorbs sea water through its membranes and swells in an amazing fashion to reach its new size in 4 to 5 hours. The soft shell gradually hardens and the watery meat becomes firmer in a few weeks to several months depending on the size of the lobster, the water temperature and the food supply. Young lobsters moult 5 to 7 times in their first growing season but less frequently each succeeding year. Commercial-sized lobsters usually moult once a year and grow about 15% in length and nearly 50% in weight. Very large lobsters often fail to moult for several years. The growth rate varies a great deal and age is difficult to estimate. In the southern Gulf of St. Lawrence lobsters $7\frac{1}{2}$ inches long weighing half a pound are thought to be about 5 years old, those $9\frac{1}{2}$ inches long weighing a pound, about 7 years old.

FIG. 3. -- Lobster burrow photographed at depth of 40 feet. Lobster's claws showing.

MATURITY, MATING AND EGG LAYING

Lobsters mature when they are 7 to 12 inches long weighing from $\frac{1}{2}$ to 2 pounds. Mating takes place mainly in summer between hard-shelled males and newly-moulted, soft-shelled females. During mating which takes about 5 minutes the male deposits sperm in the female's sperm sac located between the bases of the last 2 pairs of legs. Egg laying occurs from early June to September, a month or more after mating. When the eggs are laid they are fertilized by sperm (released from the female's sperm sac) and then become fastened to the swimmerets by a glue-like cement. A 7-inch female lays about 3,000 eggs, an 18-inch female about 75,000. The newly-laid eggs are dark green, round, and about 1/16 inch in diameter. The female carries the eggs on her swimmerets until they are ready to hatch about a year later (Fig. 1). Hatching starts about mid-June, reaches a peak in July and continues to the end of September.

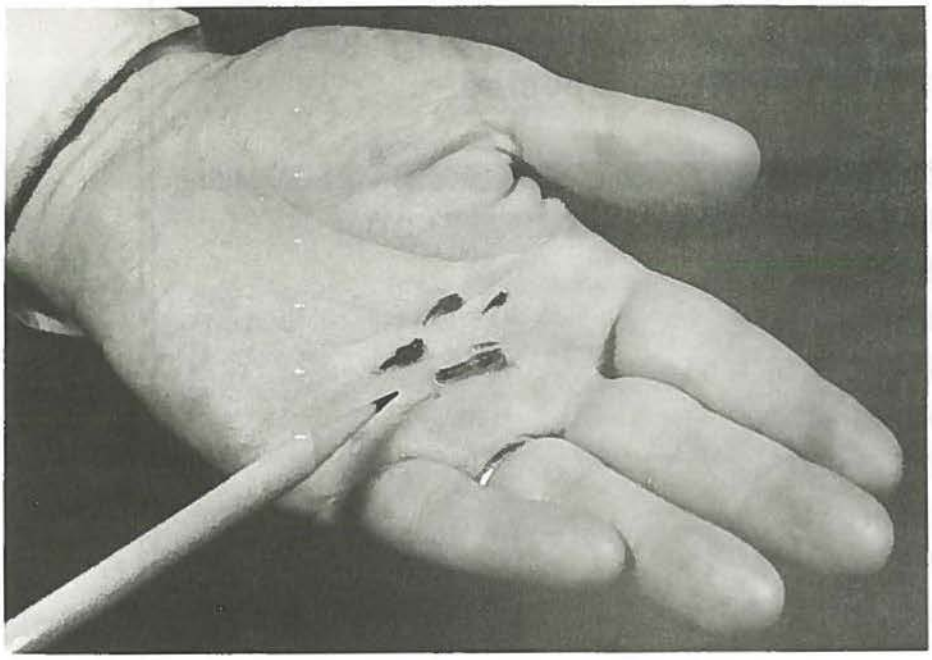


FIG. 4. -- The four free-swimming larval stages.

Newly-hatched lobsters, called larvae, are about one-third of an inch long. They rise to the surface of the water and spend much of their time over the next 1 to 2 months swimming freely at or near the surface. During this period they moult three times changing form and growing appreciably at each moult. When they reach the 4th larval stage, they are slightly over $\frac{1}{2}$ inch long and resemble the adults in form and colour (Fig. 4). Although lobster larvae can swim, they are easily carried by surface currents. When they settle to bottom during the 4th stage they may be many miles from where they were hatched. The free-swimming larvae suffer extremely heavy mortalities, being preyed upon by countless fish and other marine creatures. Newly-settled lobsters are also subject tc attack by bottom-feeding fish, crabs and even other lobsters. These small lobsters behave much like adults, living for the most part in rocky burrows.

DISEASES AND PARASITES

Lobsters suffer from two known diseases, both of which may be fatal. One is a bacterial infection of the blood that at times spreads quite rapidly among stored lobsters. The other is a bacterial infection that attacks the chitin of the shell, pitting and weakening it but seldom causing serious commercial

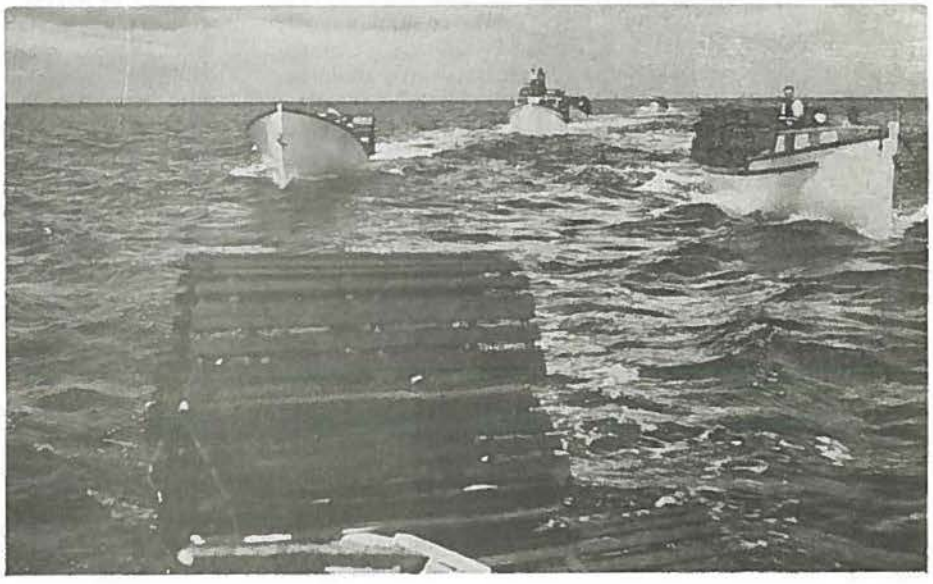


FIG. 5. -- Lobster boats loaded with traps on opening day of season.

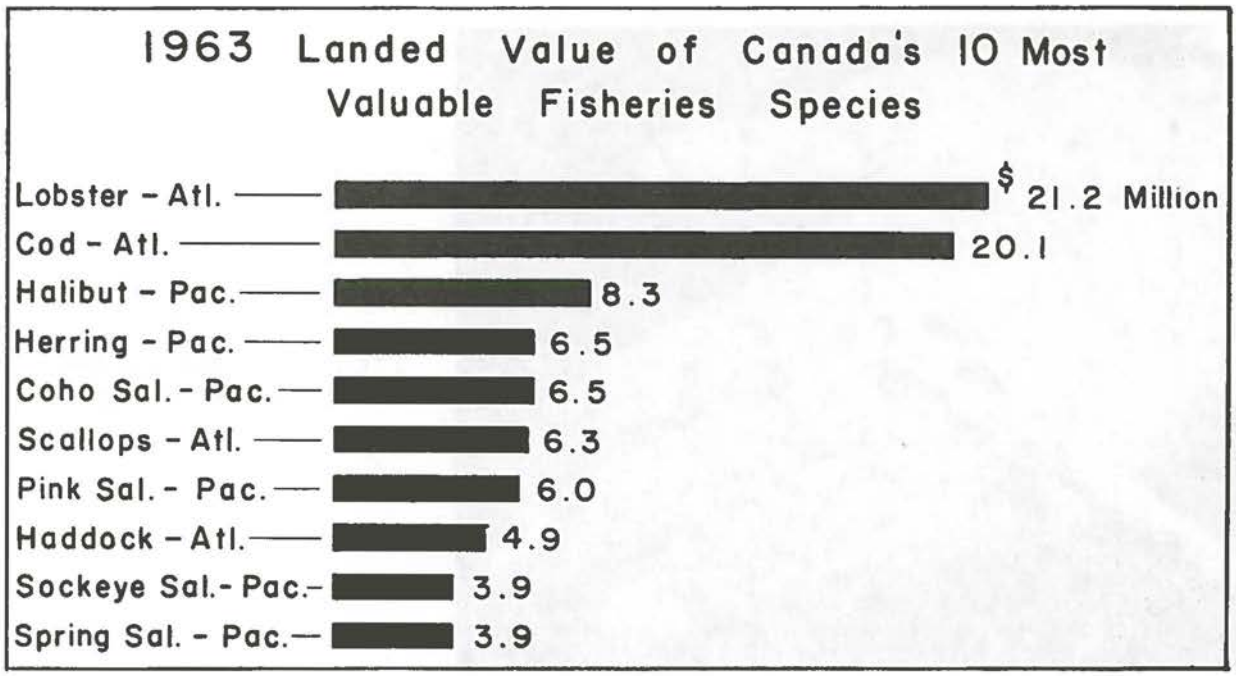


FIG. 6. -- Canada's 10 most valuable fisheries species.

losses. Neither disease is harmful to man. Lobsters also harbour three kinds of parasites in their digestive tract and a great variety of plants and animals such as kelp, sea lettuce, small crustacea, barnacles, limpets and blue mussels may grow on their shells. These cause little if any injury to the lobsters and are harmless to man.

FISHING GEAR AND LANDINGS

The Canadian lobster fishery started on a very small scale over 100 years ago but now employs over 32,000 licensed lobster fishermen who operate more than 15,000 small boats. There are usually one or two fishermen in each 25- to 45-foot motor boat and they generally fish inshore within 10 miles of their home port and land their catches daily (Fig. 5). In Canada the only legal lobster fishing gear is the conventional trap. Traps are usually in the form of a half cylinder, $2\frac{1}{2}$ to 4 feet long, with wooden frames covered with wooden laths and netting and are weighted with flat stones or concrete. Most traps are divided into two compartments, the "kitchen" where fresh or salt bait is placed, and the "parlour" from which escape is difficult. From one to three funnel-like entrances lead into the kitchen and a similar funnel leads from the kitchen to the parlour. Up to 500 traps or more are fished from each boat.

The Canadian catch in recent years averaged about 47 million pounds or 62% of the North American total. The average catch by provinces was as follows: Nova Scotia 19.8 million pounds, New Brunswick 10.6, Prince Edward Island 9.3, Newfoundland 4.4 and Quebec 3.2 million. Recent landings in the United States averaged 28.8 million pounds, over three-quarters of which were caught in Maine. In 1963, the lobster was Canada's most valuable fisheries species in terms of landed value which exceeded $21 million (Fig. 6). The geographic distribution of North American landings is shown in Fig. 7.

SEASONS

In Canada, lobster fishing seasons are prescribed by law. Seasons ensure that lobsters are landed in better condition, aid marketing and allow fishermen to fish for other species or turn to other occupations when their area is closed to lobster fishing. West of Halifax the seasons are open for 6 to 7 months during the late fall, winter, and early spring. East of Halifax the seasons are open for about 2 months usually in the spring. Because of the interplay of seasons, weather conditions, water temperatures and growth, over two-thirds of our lobsters are landed in May, June, and December when they are hard-shelled, full-meated and withstand storage and shipment better during these cooler months.

MINIMUM SIZE LIMITS

To allow more young lobsters to grow to more valuable sizes and to maturity, the fishery regulations specify the smallest sizes that may be landed. Since growth rate, size at maturity and the sizes of lobsters caught vary considerably along the coast, four minimum size limits have been adapted. These are based on the length of the body shell

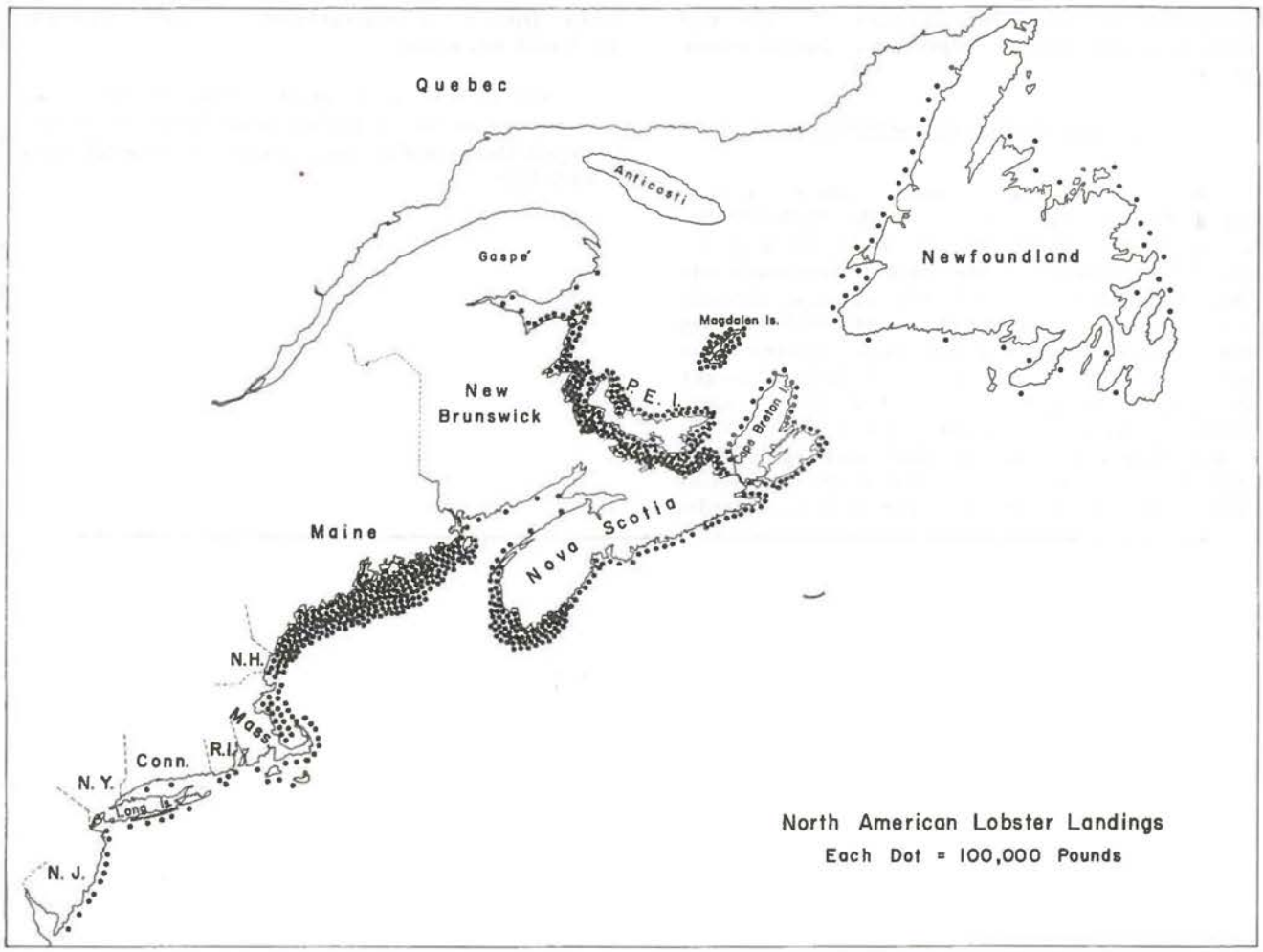


FIG. 7. -- North American average lobster landings, 1956-60.

or carapace and correspond to total lengths of $7\frac{1}{4}$ to $9\frac{1}{4}$ inches and weights of 7 to 15 ounces.

PROTECTION OF EGG-BEARING FEMALES

To permit as large a hatch of lobster larvae as possible, the lobster fishery regulations prohibit the sale of females carrying external eggs. Most fishermen handle these "berried" females with great care and promptly release them.

THE OFFSHORE FISHERY

During the past 10 years or so an offshore lobster fishery has developed along the continental slope south of Georges Bank in a large area centred roughly 175 miles southeast of Boston. Here, lobsters are caught by medium-sized trawlers 65 to 115 feet long that tow nets 70 to 90 feet wide along the bottom at depths of 50 to 300 fathoms. Offshore lobsters vary in size from place to place averaging about 5 pounds in weight, considerably larger than inshore lobsters. Well over 2,000,000 pounds have

FIG. 8. -- One of largest tidal lobster "pounds" in the world, located on Deer Island, New Brunswick.

been landed annually in recent years. To date this fishery is prosecuted principally by United States fishermen.

STORAGE AND MARKETING

Almost two-thirds of Canada's lobster catch is shipped alive to markets across the United States and Canada and recently to several European countries. The remainder of the catch is processed into lobster meat that is sold fresh, frozen or canned. Lobsters for live shipment are stored in floating wooden crates, larger floating "cars", wooden tanks supplied with running sea water, or in much larger tidal "pounds" (Fig. 8). They are shipped quite successfully by boat, truck, train or aircraft, provided they are handled carefully and kept cool and moist. Retail outlets in many inland cities now store lobsters for several weeks in attractive display tanks filled with refrigerated, aerated, filtered, artificial sea water.

For further information on lobsters the reader is referred to the following publications available from the Queen's Printer, Ottawa, or through your bookseller:

FISHERIES FACT SHEET

The American Smelt

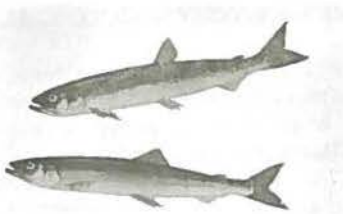
By J.L. Hart

(Fisheries Research Board of Canada)

and R.G. Ferguson

(Ontario Department of Lands and Forests)

THE NAME smelt designates the American smelt, a fragile fish with the scientific name Osmerus mordax. Originally this was stricly an anadromous species growing in the sea around the Atlantic shores and entering coastal streams to spawn. Now it has become landlocked also and has developed special populations in a number of lakes in the Maritime Provinces and the New England States, including Lake Champlain. Early in the twentieth century the species was introduced into the Great Lakes. It has thrived there, becoming first a nuisance and, later, a useful commercial species and an eagerly sought sports fish. In Lake Superior it is an important food of lake trout and siscowet.



The American Smelt *(Osmerus mordax)*

The American smelt has several close relatives in Canada and some of them have economic importance. The capelin occurs on both coasts and is abundant in Newfoundland-Labrador where it spawns in spectacular abundance on the beaches. It is widely used locally in a variety of ways. The anadromous eulachon of British Columbia played an important part in the primitive Indian economy and is now the source of a restricted fishery. Also in British Columbia, the surf smelt or silver smelt supplies a small fishery. On the Atlantic coast the smelt is sometimes confused with the similar but unrelated silverside.

COMMERCIAL IMPORTANCE

The range of the smelt is from Labrador to New Jersey with the centre of abundance in the southern Gulf of St. Lawrence. There, especially along the New Brunswick shore, smelt provide an important minor fishery. The average annual catch in New Brunswick from 1918 to 1957 was 4.6 million pounds of which more than a third came from the Miramichi. The annual smelt catch on the Canadian Atlantic coast in 1962 declined to 2.6 million pounds valued at $240,500.

The Canadian Great Lakes landings of smelt are almost entirely from Lake Erie. They have increased steadily since 1950 and now greatly exceed those of the total Atlantic coast. Lake Erie landings may level off at 10 to 12 million pounds annually but the peak catch in 1962 was 19 million pounds valued at $650,000.

DESCRIPTION

The smelt is a slender, silvery fish, olive green along the back. It rarely exceeds 9 inches in length, although 12-inch specimens are encountered. About 10 per cent of the commercial catch in the Miramichi area exceeds 7 inches. The fins are arranged generally as in the salmon to which the smelt is distantly related. The angle of the large mouth is behind the middle of the eye. The mouth is directed upward as well as forward. The lower jaw projects beyond the upper. The tip of the tongue has large fang-like teeth. These teeth and the large mouth distinguish the smelt from the capelin and silverside. Scales of the smelt are fairly large and come off readily. At spawning time tubercles develop on the scales of male smelt only. This gives the fish a texture like sandpaper, and a rough appearance. At other seasons both sexes are smooth.

LIFE HISTORY - MIRAMICHI RIVER

Smelt have been carefully studied in the Miramichi River. Adult fish accumulate in the estuary in the autumn. In March they begin to move upstream arriving at the head of tide in the various streams late in April. The run extends through May. Spawning takes place chiefly after the spring freshets slacken. Most spawning is at night but the males tend to remain on the spawning grounds continuously. They arrive on the spawning grounds ahead of the females and stay longer. Many smelt, mostly male, die during the spawning period.

A smelt egg fertilized early in March hatches in about 3 weeks. Those deposited toward the end of the season in warming water take about 10 days to hatch. The young from early spawnings retain a size advantage throughout life. All newly hatched fry are quickly carried into the tidal estuary where

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they remain close to bottom in the daytime but spread out at night. These juveniles remain in the estuary during the summer and even the adults seldom wander far.

A large female smelt produces over 60,000 eggs. A fish of average size produces in the neighbourhood of 30,000 eggs. Eggs have an outer coat which becomes sticky, tears open, and acts as a stickfast. When fish are excessively abundant or if they are confined by stream obstructions, eggs become very crowded and may form a mat up to 4 inches thick. When this happens, large numbers of eggs are smothered. When spawning takes place during the period of dropping water levels, eggs die from being left stranded.

LIFE HISTORY - LAKE ERIE

In Lake Erie during the summer, adult smelt frequent depths of 50 feet or more where they find cool water. Most of the population is in water 45°F or cooler, although they may be found in water approximately 60°F for brief periods. The food consists of small shrimp-like invertebrates or molluscs that live close to the bottom or at mid-depths. Smelt show a marked response to light with the result that they are found close to the bottom by day but more generally dispersed at night.

In the fall and winter when the water is of uniform cold temperature some smelt return to the shallow water. By April just prior to spawning, most adults are in 40 feet of water or shallower. Spawning takes place on the beaches of Lake Erie to a greater extent than it does in streams. Suitable streams are scarce on Lake Erie. All beaches along the north shore appear to be utilized, but headlands such as Point Pelee and Pte. aux Pins are apparently favoured. South shore streams and beaches have smaller runs or none at all in some years.

For reasons which are not yet clear success in reproduction in Lake Erie has been good only in alternate years. As a result, age 2 fish predominate in the catch in one year and age 3 fish in the next.

Young and juveniles have been observed inshore and in surface waters during the summer. Larger yearlings start to move into deeper water by July and by early October all are in mid-water. By late October yearlings have moved into deep water along with older smelt. By this time the larger yearlings are as large as some of the older fish.

Smelt spawn first when they are 2 years old and many spawn at age 3.

A one-celled organism is found infesting Lake Erie smelt. This organism has caused great mortalities among European smelt but has not yet been observed to kill smelt in Lake Erie.

THE FISHERY

In the Maritimes, fishing is carried out in the estuaries. There is some open-water gillnetting in the fall. However most of the fishing is by trapping the smelt in box nets set either in open water or through the ice of the estuary. When nets are lifted, fish are frozen quickly and graded for sale according to size. The product is highly regarded and is readily sold on local and continental markets.

On Lake Erie smelt were first taken experimentally with gillnets. The more efficient pound nets and trap nets soon replaced gillnets and were very successful in late spring and fall fisheries. Beginning in 1959 fixed gear gave way to trawls. Trawls provided a year-round fishery and the opportunity to make effective use of shore installations and established markets. Most of the smelt are processed (dressed and headed) before they are individually frozen and packaged for sale throughout Canada and the United States.

In the Maritimes the fishery declined over the last 30 years. To some extent this may have been a result of declining abundance of stocks of fish that habitually appeared early on the fishing grounds. Recently there has been the additional factor of competition for markets with the Great Lakes fishery which can be carried on at lower cost.

The Great Lakes fishery in Lake Erie has grown rapidly from 30,000 pounds in 1948 to 4.6 million pounds in 1958. From 1959, when trawls were introduced, to 1962 landings increased to 19.1 million pounds. During 1963 they decreased to 10.5 million pounds, and there were 12.7 million pounds in 1964. The present level of landings appears to be determined by market demand rather than smelt availability.

REFERENCES

The smelt has been dealt with in more detail in two publications of the Fisheries Research Board. These can be obtained by writing to the Queen's Printer, Ottawa, and asking for:

Bulletin of the Fisheries Research Board of Canada, No. 70. The smelt fishery of northeastern New Brunswick, by R.A. McKenzie, 20 pages, 10 illustrations, published in 1946, cost 20¢; and

Bulletin of the Fisheries Research Board of Canada, No. 144. Smelt life history and fishery in the Miramichi River, New Brunswick, by R.A. McKenzie, 77 pages, 27 illustrations, published in 1964, cost $2.00.

Those interested especially in landlocked races of smelt may read, The smelts of Lake Champlain by Williard C. Greene in pages 105-129 of State of New York Conservation Department, Part IV, of "A Biological Survey of the Champlain Watershed", supplemented to the Nineteenth Annual Report for 1929 and published in 1930. This will be available only in technical libraries. ✔

March, 1966

FISHERIES FACT SHEET

The Arctic Char

By J.G.Hunter

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St. Anne de Bellevue, Que.

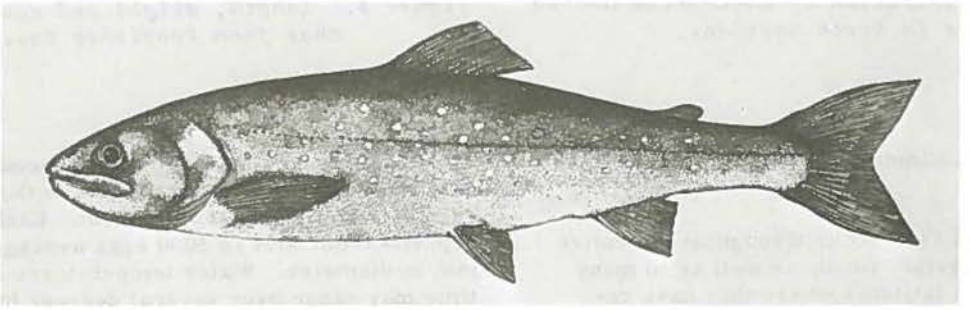

Figure 1. Arctic char *(Salvelinus alpinus)*.
Courtesy of W.B. Scott.

THE ARCTIC CHAR *(Salvelinus alpinus)* is known by a number of vernacular names depending upon its geographic location, habitat, size, colouration and body proportions. The Eskimo people, who are at home throughout a large part of the char's range in North America generally refer to the species as irkalukpik, but they also use a number of other names which convey information about size, colouration and breeding condition. The chars as a group are represented by three other species: the dollyvarden *S. malma*, which occurs in both eastern Asian and western North American waters: the lake, grey or bull trout *S. namaycush*, and the eastern brook or speckled trout *S. fontinalis*, both of which are endemic to North America.

The arctic char occurs in two principal forms. One migrates into the sea in the summer to feed but returns to fresh water to pass the winter. This is the anadromous form. The other remains in fresh water throughout its entire life and is often, though not necessarily, prevented from migrating by physical barriers. This is the so-called landlocked form.

DESCRIPTION

The arctic char has an elongate body typical of salmon and trout and in the sea-run condition is silvery with a deep blue or greenish-blue on the back and upper sides. Sometimes a series of small pink spots is noticeable along and below the lateral line.

As char approach spawning condition body colouration changes from a silvery sheen, through orange, to a range of reddish hues from bright red to deep vermilion. The leading edges of the pectoral, pelvic and anal fins, and the fold of skin lying under the maxillary bones of the upper jaw become conspicuously white. Jaws are equal in size except at spawning time, when males frequently develop a kype or hook on the lower jaw, the point of which fits into a notch in the upper jaw.

In the spawning condition landlocked char normally show the same colouration as the sea-run form, and at other times continue to exhibit a pink to red colouration of the belly. When sexually immature, both landlocked and anadromous char are silvery. The flesh is usually red, but occasionally may be pink or white.

DISTRIBUTION AND ECONOMIC IMPORTANCE

The arctic char has a circumpolar range, the southern limits of the anadromous form roughly

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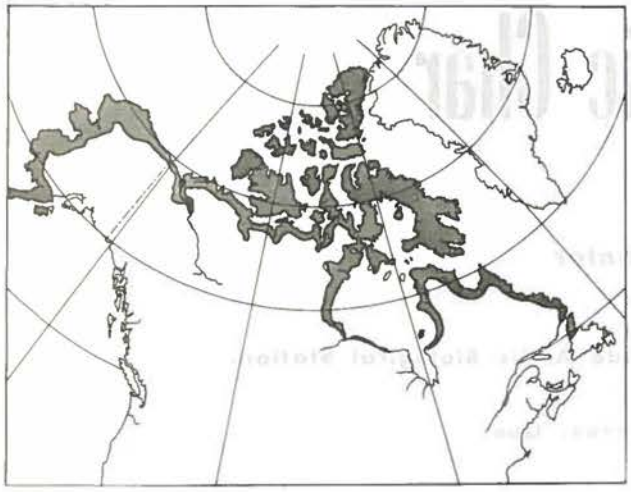


Figure 2. Distribution of anadromous arctic char in North America.

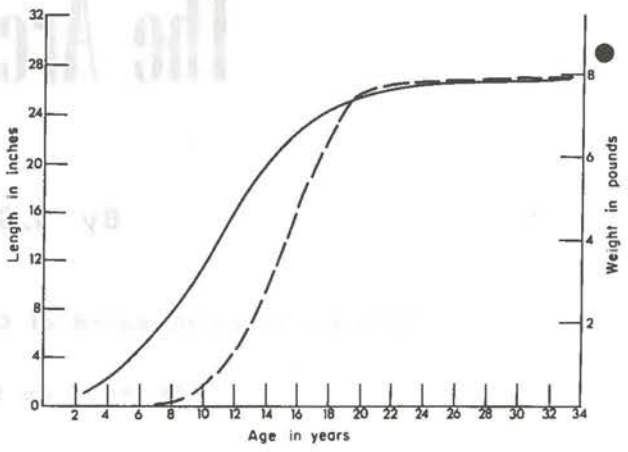


Figure 3. Length, weight and age of arctic char from Frobisher Bay.

following a mean summer sea temperature of 50°F.

Landlocked char occur throughout the entire range of the migratory form, as well as in many lakes in southern latitudes where they have remained as glacial relicts.

The importance of the species in North America has been confined, in the past, to its use as food for local use. In the past 10 years it has achieved status on the market as a luxury food item and renown as an excellent sports fish.

Commercial exploitation began on the Labrador coast in the early 1940's and has reached a peak annual production of 200,000 pounds. Smaller commercial catches, totalling approximately 100,000 pounds annually, now also originate from Ungava, Frobisher and Cambridge Bays and the rivers to the west of the Mackenzie. These catches are shipped frozen to southern markets and are primarily sea-run fish. Landlocked char are of minor importance in North America.

The sports fishery for arctic char has been expanding rapidly and at present total catches are estimated to exceed 50,000 pounds annually.

LIFE HISTORY AND HABITS

SPAWNING

In the Arctic, char spawn during the months of September and October on areas of lake bottom or river bed where suitable gravel and small rocks occur and where winter ice does not become a problem. The female provides a nest or redd by scooping out a shallow depression in the loose bottom. Eggs and milt are released simultaneously into the nest, then the female lightly covers the fertilized eggs by fanning gravel over them. Each female deposits from 3000 to 5000 eggs averaging about 5.0 mm in diameter. Water temperatures at spawning time may range over several degrees but are generally less than 39°F.

Mortality of the eggs occurs when water temperatures exceed about 46°F. However this is not usually a problem within the distributional area of anadromous char where winter temperatures are usually between 32° and 36°F. Observations on hatching time are not available, but samples of alevins, which are the young char with yolk sac attached, have been collected as early as mid April, giving the char a probably birth date of April 1. Emergence of the young free-swimming fish, known as "fry" at this stage, probably coincides with ice disappearance in mid July when food in the form of plankton becomes available. Fry collected around the shore at this time are about one inch in length.

Little is known about the factors affecting survival of eggs. Since anadromous char are frequently the only species of fish to occur in a lake or river system (although nine-spined sticklebacks are common), predatory action on the eggs is probably nil. It is known that spawning char will eat any eggs improperly covered in the nest, but no deliberate excavation of nests has ever been observed. Apart from egg losses resulting from multiple nest building in the same area, and poor physical conditions of oxygen and temperature, no factors contributing to egg mortality have been discovered. The greatest mortality of char probably occurs after emergence as fry, through competition for available food supplies and cannibalism.

MATURATION AND MIGRATION

Young char start feeding on minute plants and animals. As they increase in size, larger food items such as insects and their larvae, small bivalve molluscs, gastropods, crustaceans and fish are eaten. When anadromous char reach a length of six to eight inches they migrate to sea for the first time, usually in early spring as soon as the frozen rivers open. Return to fresh water occurs from mid August to late September. Overwintering in the sea is unknown. While in the sea char feed voraciously on the abundant small crustaceans, and on small fish if they are available.

Sexual maturity generally occurs at a length of 18 inches, after which spawning occurs every second or third year. In these reproductive years the char remains in fresh water and does not emigrate to sea.

The mechanisms controlling migratory behaviour are not well known, but are presumably initiated by changing light intensities and controlled by hormonal balance. Once char have migrated to sea, movement may be controlled by food availability, since they frequently remain close to the mouths of their rivers of origin when food is abundant but disappear into offshore waters when food is scarce. Tagged specimens have been recovered as far as 80 miles from their river of origin. While in the sea, char from distant rivers mingle, but later segregate and return to their parent stream. In some instances they even return to the exact spawning sites of previous spawning years.

GROWTH

The general productivity of cold northern waters is low but the arctic char is adapted to low temperatures and can take advantage of a wide range of feeding circumstances. Despite this adaptability growth is slow and the length of one-year-old char is often under two inches, the size at which scale development begins. Growth rates vary between individual fish in a given habitat and between fish in different habitat areas, but on the average, full size is reached at an age of 20 years. Some char may live as long as 40 years but may not be appreciably larger than fish 20 years of age. Large or trophy-sized char have been caught ranging a few ounces in excess of 27 pounds in North America and 34 pounds in Novaya Zemlya, USSR. Such char need not be of great age but may simply have an inherent ability to respond to particularly good growing conditions.

Apart from the expected increase of weight with increase in length, differences as great as 15% in weight may occur between spring- and fall-caught fish of equal lengths. During the winter, char feed little or not at all but use large fat reserves stored during the previous summer to take care of their metabolic needs.

PREDATION AND COMPETITION

The char has relatively few predators. In many systems it may be the only fish-eating species present. Birds such as gulls and loons may take numbers of the small fish but their depredations seem to be low. In the sea a few char are taken by seals and possibly white whales but again the concentration of these predators is usually so light as to be only a minor factor. Cannibalism may account for large numbers of the younger and smaller fish but such predation is virtually complete by the time char have reached a length of six inches.

Competition probably plays a much greater role in the regulation of numbers of char in a system. Food availability restricts all sizes of fish within a lake and may be particularly damaging to survival of the early age groups. These young fish may, in fact, act as a potential food supply for larger char in times of adversity and thus constitute a method of conserving energy for the surviving population in the lake.

Observations on char in aquaria show that some fish maintain territories and dominate other fish. This may result in lower survival and slower growth in the less dominant fish. Such territorial behaviour might well restrict both the number and total weight of fish that a lake is able to support. Where char live in rivers instead of lakes, the productive capacity per unit surface area of the river is greater than in the lake. This may result from territorial requirements of individual fish being reduced by some function of the speed of the current or discharge rate of the river. Also, feeding conditions may be better in the river, thus reducing the space requirements for adequate searching.

PRODUCTION

The size of char populations is controlled by the availability of suitable fresh water. The slow rate of growth coupled with limited population size results in low production of the species. Where an anadromous population is exploited and the stock density is reduced, no recognizable increase in productive capacity has been observed. This is because most feeding is done in the sea, once migratory size has been reached, and no increase in rate of growth results from a lower population density of large fish. In all probability no decrease in the pre-migratory stock occurs through removal of larger individuals, and competition within the lake remains high.

Present studies indicate a lake production of about one pound of char per acre per annum, which is about 10% of the standing stock of fishable-sized fish. River populations, though maintaining the same percentage yield, are capable of producing char at rates as high as 60 pounds per acre per annum.

September 1966

FISHERIES FACT SHEET

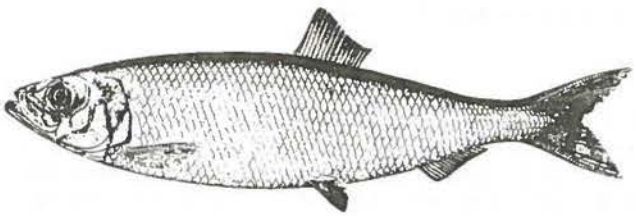
The Atlantic Herring

by S.N. Tibbo and R.D. Humphreys

Fisheries Research Board of Canada

THE FISH we call Atlantic herring or sea herring, is known to zoologists as Clupea harengus. It is a member of the family Clupeidae (true herrings). Members of this family are found in almost every part of the world, arctic, temperate and tropical waters, and even inland lakes and seas. Their closest relatives are the tarpons (Elopidae), the round herrings (Dussumieriidae), and the anchovies (Engraulidae).

There are seven true herrings on the North Atlantic coast of North America - Atlantic herring, hickory shad, alewife, blueback, shad, thread herring, and menhaden. But the Atlantic herring is by far the most important species in terms of sheer numbers and economic value.



Atlantic or sea herring (Clupea harengus L.)

DESCRIPTION

The Atlantic herring has an elongate body which is deep steel-blue or greenish-blue on the back with green reflections. The sides and belly are silvery. The body is much deeper than thick. The mouth is large with the lower jaw projecting a little beyond the upper. The tail is deeply forked and the single dorsal fin stands over the small ventral fin. The scales are large and loosely attached.

DISTRIBUTION AND IMPORTANCE

The Atlantic herring is found on both sides of the Atlantic Ocean from latitude 30°N to the arctic regions. On the European side, it inhabits the open seas around Iceland, between Iceland and Norway, and northward off Spitzbergen and Nova Zembla. It also inhabits coastal waters from the White Sea to the Naze of Norway, around the British Isles and on the coast of Brittany as far south as latitude 47° N. On the North American side, it extends from Block Island (near the entrance to Long Island Sound, New York State), northwards to Labrador and Greenland.

From 1960 to 1964 the average annual catch of herring from eastern Canadian waters was about 122,000 metric tons. Mature herring normally constitute about two-thirds of the catch and immature herring ("sardines") the remainder. The average annual marketed values are more than $15,000,000.

LIFE HISTORY AND HABITS

Spawning: The herring is the only member of the family Clupeidae that deliberately lays its eggs on the sea-bed, and for this purpose the fish selects certain areas where the bottom is firm. The eggs stick in layers or clumps to sand or clay, seaweeds, stones or other objects on which they chance to settle. Eggs are 1.0 to 1.4 millimetres in diameter and each female deposits from 20,000 to 80,000 eggs. The process of fertilization is not fully known, and it cannot be stated definitely if the milt is scattered among the eggs before they have reached the sea-bed or after they have been deposited.

In eastern Canadian waters spawning takes place in the spring, summer and fall depending on the locality and the herring stocks occupying it. In the Gulf of St. Lawrence, there are both spring- and fall-spawning stocks whereas most of the outer coast of Nova Scotia stocks spawn in late August or early September.

In the Georges Bank-Bay of Fundy area, eggs hatch in 10 to 15 days. In colder waters the incubation time is longer (up to 40 days). Newly hatched fry are called "larvae". They are about one-quarter of an inch long and they depend on the egg yolk for their first nourishment. But when this is absorbed they must begin feeding and fend for themselves. They can swim only in small jerky movements. Because they can't go far, their food must be close

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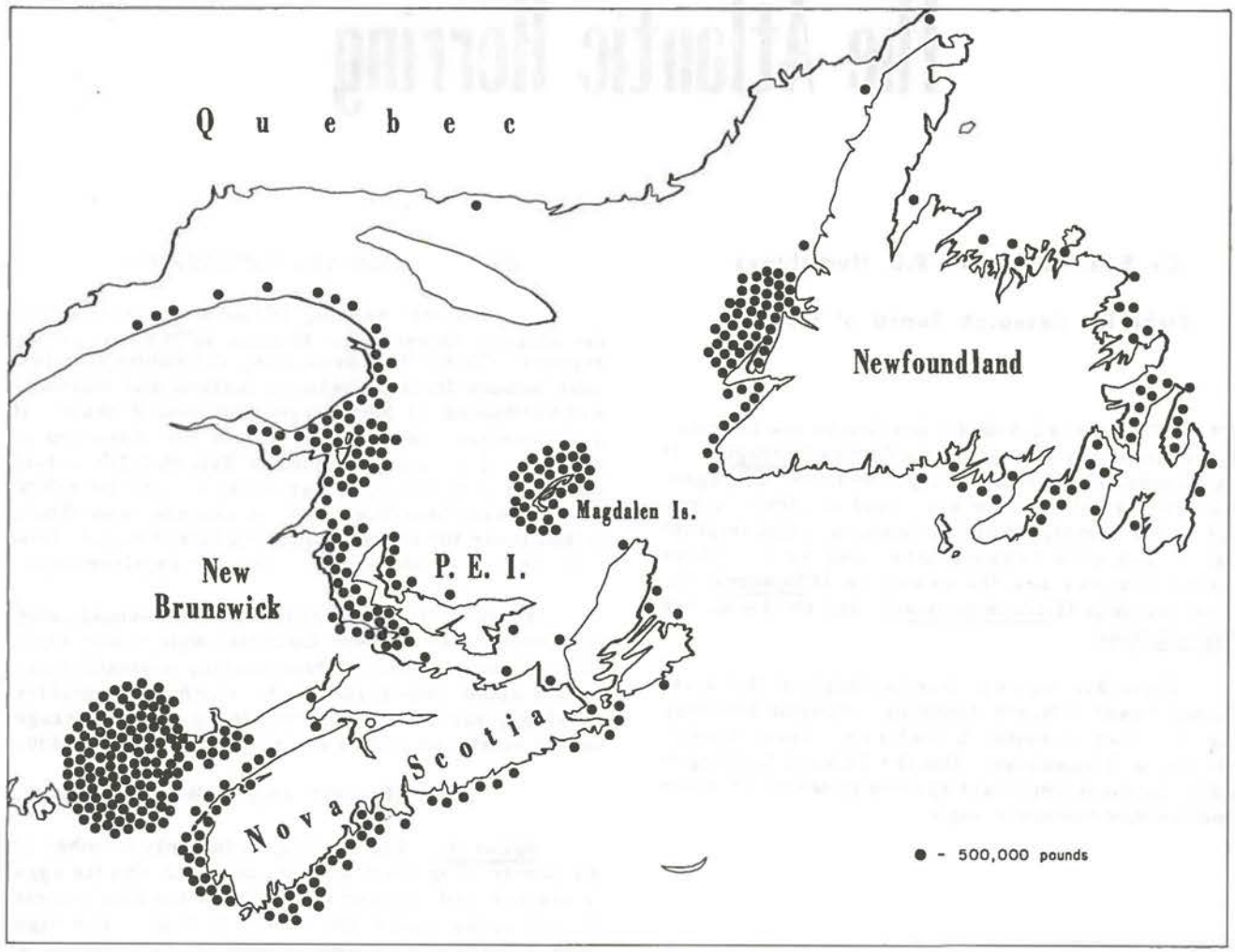


Distribution of herring catches in the Canadian Atlantic.

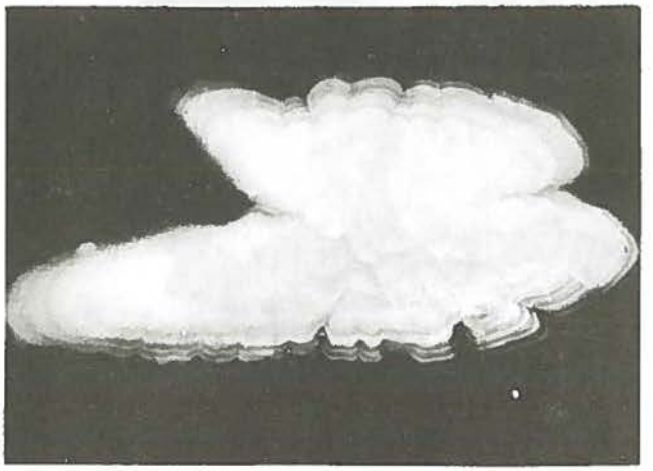
at hand if they are to survive. At this stage, they feed on minute plants, and on eggs and small invertebrate animals that are close to the sea surface. As they grow older, they feed chiefly on larger animals of the shrimp family.

Factors controlling abundance: The tiny mouth of post-larval herring can only accommodate small food so the food organisms present in the herring's environment must be small enough to ensure the herring's survival. Weather, too, probably plays a big part in the success of broods. Wind certainly affects the drift of larvae away from spawning grounds. It may drive them on to a lee shore and to destruction.

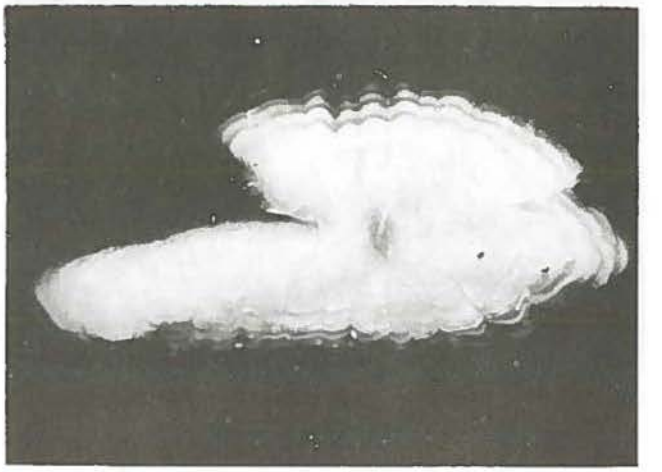
Herring eggs are eaten in large quantities by cod, haddock and flounders. The larvae and post-larvae are eaten in large quantities by various kinds of fish, and the herring itself is a cannibal at times. Immature and adult herring are preyed upon by cod, pollock, haddock, silver hake, striped bass, mackerel, tuna, salmon, dogfish, mackerel sharks, finback whales, and squid. Man himself is one of the chief predators. Disease organisms also take their toll. A fungus disease, which reached epidemic proportions during the mid 1950's, drastically reduced the abundance of herring in the Chaleur Bay area of the Gulf of St. Lawrence. Herring landings in the area declined from 25 million pounds in 1947 to 12 million pounds in 1959.

Growth and Maturation: Herring hatched in late summer and early autumn grow to about three-quarters of an inch by December. They grow slowly during winter when food is scarce and the cold water lowers their activity. Herring reach a length of about 4 inches by the end of their first full year, 7 inches at the end of 2 years, and 10 inches at the end of the third year. A few herring spawn at 3 years of age, but most spawn for the first time at age 4, at which time they are 12 to 13 inches long. Thereafter they spawn each year and may live 20 years or more and reach a length of 17 inches.

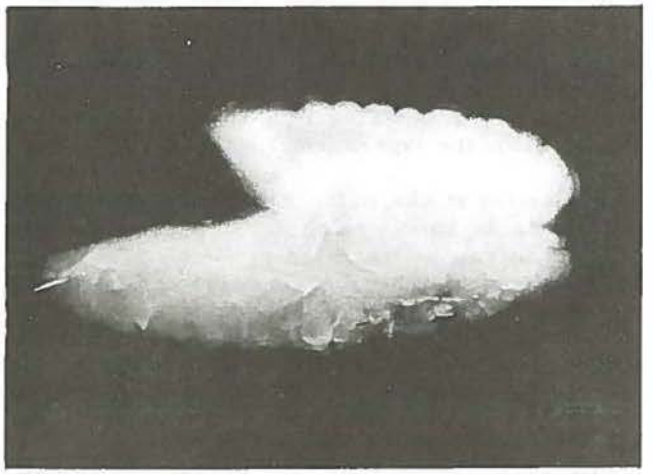
HERRING AGES AND SPAWNING SEASONS ARE "READ" FROM OTOLITHS



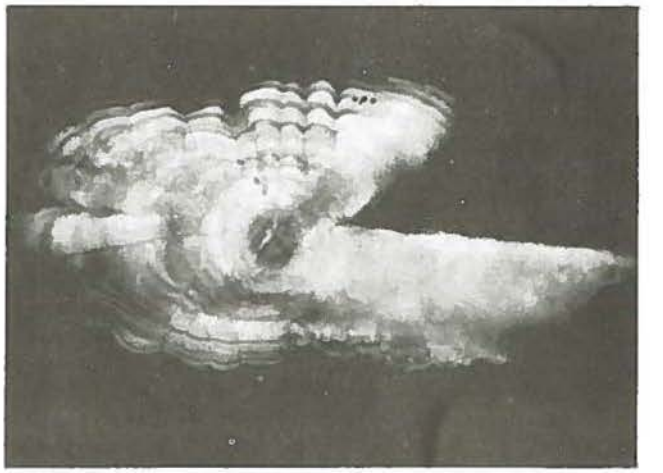
Spring spawned (opaque centre)



Autumn spawned (clear centre)



Young herring (2+years)



Old herring (7+years)

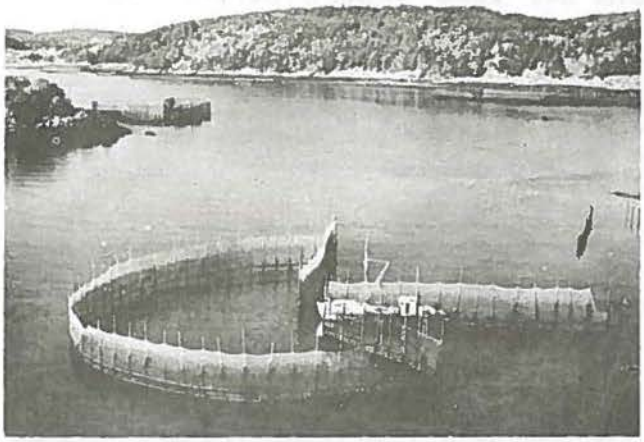
Migrations: Little is known about movements of herring during their first year, but presumably they are carried by ocean currents. Yearling and two-year old herring, 4 to 8 inches long, are found in abundance throughout most of the year in the inshore waters on both sides of the Bay of Fundy where they support the sardine fishery.

Two-year old herring, having reached the "fat" stage, are found scattered over rich offshore feeding grounds in areas such as the Gulf of St. Lawrence, the Gulf of Maine and the offshore banks. Most three- to four-year old herring that are sexually mature join adult schools and move in vast schools into the shoal-water coastal spawning grounds. After spawning, the "spent" herring disappear and presumably return to deep offshore waters where they feed and recover their fatness. Some spawnings occur in deep water on the offshore banks. These seem to be separate stocks and little is known of their movements.

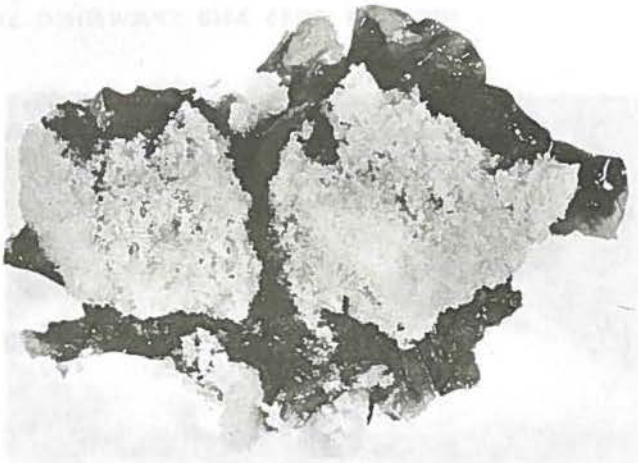
FISHERY

The average annual herring catch in the Northwest Atlantic has amounted to approximately 275,000 metric tons in recent years (1961-64). About 42% of this comes from the coastal areas of the Bay of Fundy and Gulf of Maine, and a similar quantity from offshore areas - chiefly Georges Bank. Other Canadian areas - outer coast of Nova Scotia, western part of the Gulf of St. Lawrence and Newfoundland account for most of the remainder (16%).

The Bay of Fundy-Gulf of Maine herring fishery is mainly for immature fish which are used in the 'sardine' canning industry. The offshore catches are for large herring which are used for food as are the catches in other Canadian localities where pickled, salted, smoked and vinegar-cured are the most important products. An unknown but undoubtedly substantial quantity of herring is used for



Typical herring (sardine) weirs. (Photo by J.B. Hinson.)



Herring eggs are deposited on seaweeds.

bait in the lobster fishery and small quantities are converted to meal and oil.

Weirs and purse seines are the principal methods of fishing in the Bay of Fundy 'sardine' fishery. Weirs operate during the spring and summer months and purse seines account for a considerable portion of the catch in all seasons.

The gill net is the major gear used in the spring spawning herring fishery of the Chaleur Bay, Northumberland Strait and Magdalen Island areas. Traps are also operated on the Magdalen Islands and purse seines have come into increased use during recent years.

The purse seine has largely replaced the gill net as the major fishing gear in the late summer-spawning herring fishery of southern Nova Scotia, although gill nets and traps are still set along the shore.

On the south and west coasts of Newfoundland, extensive winter and spring fisheries for spring-spawning herring have been in existence for many years. Most are anchored gill nets although shore and beach seines have been used to some extent. Purse seining in this area is a recent development and is still in the experimental stage.

Herring stocks on the Atlantic coast are not fully used. In most years far more herring are caught than can be marketed profitably. Substantial development of herring fisheries can be anticipated as the demand for food increases. Much of the present herring catch is of poor quality and suitable only for low grades of pickled products, for bait and for reduction to meal and oil. High quality herring are available offshore in many areas during the summer and early autumn and an extension of the fishery to exploit these resources should provide for herring that are suitable for high grade food products. ✔

FISHERIES FACT SHEET

The Atlantic Mackerel

By R.D. Humphreys and S.N. Tibbo, Fisheries Research Board of Canada

THE ATLANTIC MACKEREL (Scomber scombrus) (Fig. 1) is often called Northern or Boston mackerel to distinguish it from its close relative to the south, the Spanish mackerel. Both are members of the family Scombridae which also includes the tunas, bonitos, chub mackerel, and king mackerel. All members of the family are alike in having two fins on their backs - a spiny one and a soft one - followed by several small finlets. Finlets are also present on the under surface of the body near the tail. They are slender, streamlined fish, tapering both to snout and to tail. The skin is velvety with small scales. Mackerel are swift, active plankton feeders that migrate extensively over the open sea.

The Atlantic mackerel's head is long and its mouth large. The jaws are of equal length and armed with small, sharp, slender teeth. The eye is large and is protected by the "adipose eyelid", two gelatinous plates which cover the eye except for a perpendicular slit over the pupil.

The upper surface of the body is dark steely to greenish blue, often almost blue-black on the head, and is barred with 23 to 33 dark, transverse, wavy bands to the midline of the body. The lower sides are white with silvery, coppery or brassy iridescence. The belly is silvery white. Atlantic mackerel have been recorded up to 22 inches in length, weighing as much as 3 1/2 pounds.

DISTRIBUTION AND IMPORTANCE

Scomber scombrus is found on both sides of the Atlantic Ocean between the 30th and 50th parallels of north latitude. Although American and European representatives are very much alike in appearance, life history, and habits, their ranges are discontinuous and hence the two populations may be regarded as being separate with no intermigration.

On the American side, the mackerel is found from North Carolina to the Straits of Belle Isle and is sufficiently abundant for commercial fishing from Chesapeake Bay in the south to the Magdalen Islands and the Gaspé Peninsula in the north. During the fishing season, it is most abundant in the open waters of the inner third or half of the Continental Shelf.

On the American coast, the mackerel has been caught and marketed in large amounts from colonial times. In the nineteenth century, annual yields occasionally reached 200,000,000 pounds. The United States fishery takes about three-quarters of the annual catch and the Canadian fishery the remainder. Canadian landings in 1964 were about 24,000,000 pounds with a marketed value of $2 million. Based on a 20-year average, the coastal waters of Newfoundland contribute about 5% of the Canadian landings, the coast of Nova Scotia 60%, and the Gulf of St. Lawrence 35%.

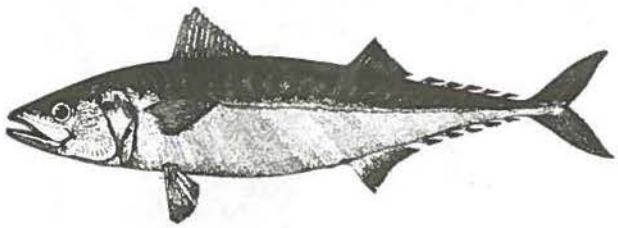


Fig. 1. The Atlantic mackerel (Scomber scumbrus).

LIFE HISTORY AND HABITS

Spawning: In their decreasing order of importance, mackerel spawning grounds have been found along the Continental Shelf between Cape Cod and Cape Hatteras, in the Gulf of St. Lawrence, Gulf of Maine, and along the outer coast of Nova Scotia (Fig. 2).

Spawning begins in mid April south of Cape Cod, in May off the New Jersey and New York coasts and in May and June off southern Massachusetts. Spawning occurs along the Nova Scotian coast in late May to mid June and in late May to mid August in the Gulf of St. Lawrence.

A few males, and a very few females, spawn as yearlings. Four-fifths of the males and two-thirds of the females spawn for the first time when 2 years old. By the time they are three years old, all the fish of both sexes are spawners.

It is difficult to determine the number of eggs spawned by an individual mackerel as there are

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successive batches of eggs ripened during the course of the season. A probable maximum of 50,000 eggs are expelled at one time, but the total number matured in a spawning season in one female of average size is several hundred thousand. Mackerel eggs are 0.05 inches in diameter and contain an oil globule 0.01 inches in diameter. Although mackerel spawning has never been observed, it is generally supposed that eggs and sperm are discharged together into the water, where fertilization takes place. Thereafter, during the period of early development, the eggs are suspended in the sea water near the surface.

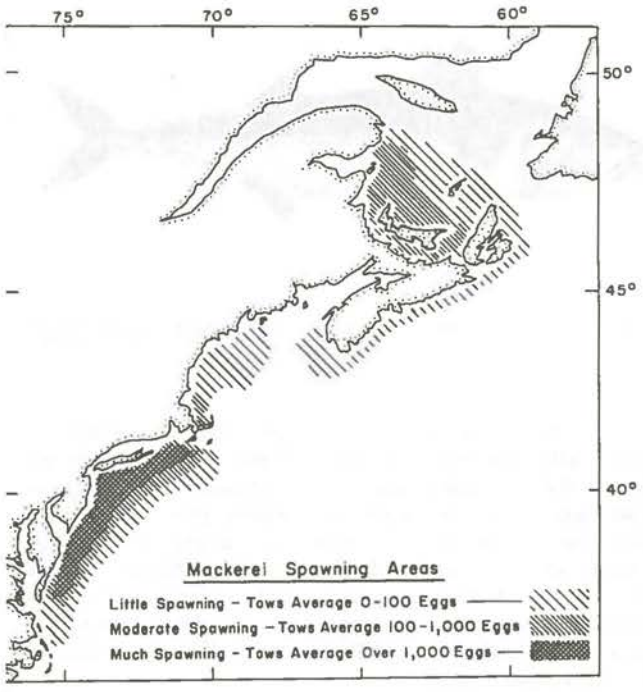


Fig. 2. Known spawning areas of the Atlantic mackerel along the North American coast (after Sette, O.E. 1943).

As in most cold-blooded organisms, the rate of development depends on temperature, being slower at low temperatures and faster at high temperatures. Eggs hatch after four to six days under best conditions of temperature and salinity.

Growth: The newly hatched larvae are slightly less than one-eighth of an inch in length and swim very feebly. Their movements are short, spasmodic, random and topsy-turvy - sometimes upside down, right side up, and at various angles. They are totally at the mercy of water movements. By the time they are 3/16 of an inch long, the yolk is absorbed and the mouth formed, the teeth are visible, and the first traces of the caudal fin rays have formed. Gulf of Maine mackerel grow to a length of about 2 inches during the first 1 to 2 months after they are hatched.

In spring and early summer of their second year of growth, mackerel are 10 to 11 inches long and are known as tinkers. They usually measure 12 to 13 inches by that autumn, or 14 inches in years of especially rapid growth. Mackerel grow very slowly after their third summer, although they are long-lived. In their eighth year, mackerel average about 17 inches.

Food: Mackerel feed chiefly on plankton, with small crustaceans a dominant item. They feed more heavily in spring after they move into coastal waters than in winter when they stay along the edge of the Continental Shelf. In late summer larger individuals may subsist mainly on young fishes such as the "sardine" herring.

Factors concerning abundance: The mackerel falls easy prey to all the larger predaceous sea animals. Whales, porpoises, mackerel and thresher sharks, dogfish, tuna, bonito, bluefish, and striped bass take a heavy toll. Cod often eat small mackerel, squid destroy great numbers of young fish up to 4 or 5 inches long, and sea birds of various kinds follow and prey upon the schools when these are at the surface. Man is a major predator.

Migrations: Mackerel appear in coastal waters in April near the southerly end of their range, but not until July in the region from southern New England to the Gaspé. In September they begin to disappear from coastal waters in the most northerly regions and by December they have vanished from all coastal waters. During summer the smaller, younger fish usually come closer to shore than the adults.

When mackerel disappear in the fall they go southward and offshore to the zone of warm water which flanks the outer edge of the Continental Shelf. During winter they occupy a relatively narrow strip of water parallel to shore, but some 20 to 100 miles offshore. This strip extends from Cape Hatteras northward to the southern edge of Georges Bank and possibly as far north as Sable Island. While there, they are believed to occupy mid depths because they are seldom seen or caught.

The pronounced schooling habit of the mackerel depends on vision, and hence schools may disband and reform according to diurnal variations in light. Luminescence probably is important in keeping schools together at night. Schooling tends to be according to sizes, perhaps owing to a connection between size and swimming ability.

There are at least two subdivisions in the western Atlantic mackerel population - a southern and a northern group. The southern group migrates from its offshore winter habitat toward the Virginia, Maryland, and New Jersey coasts in April, and thence northeastward to occupy the western part of the Gulf of Maine in summer. The northern group migrates toward the southern New England coast in May and thence northeastward to occupy the Gulf of

St. Lawrence in summer. During these spring migrations both groups are joined by vague schools which apparently move in from directly offshore. For a short while in May, all groups are together in the area off southern New England, otherwise, their courses are fairly independent. In the fall migration, both groups approximately retrace their spring courses in returning to their winter habitat.

FISHERY

Formerly, most of the mackerel were caught with hook and line from boats that threw ground-up bait into the water to lure the schools. But starting about 1870, this way of fishing was gradually given up when the use of the purse seine became general. Now practically the entire catch is made with purse seines. Pound nets, weirs and floating traps come second, and gill nets are a poor third.

Atlantic mackerel are fished commercially in Canadian waters from the Bay of Fundy to Labrador. However, best catches are landed in southwestern Nova Scotia and in the Gulf of St. Lawrence around Magdalen Islands, Prince Edward Island and Cape Breton Island.

The migratory patterns of these fish vary somewhat from year to year and their abundance fluctuates widely due to good and bad years for production of the young. For this reason, Canadian landings of Atlantic mackerel have varied widely from year to year and from place to place. The

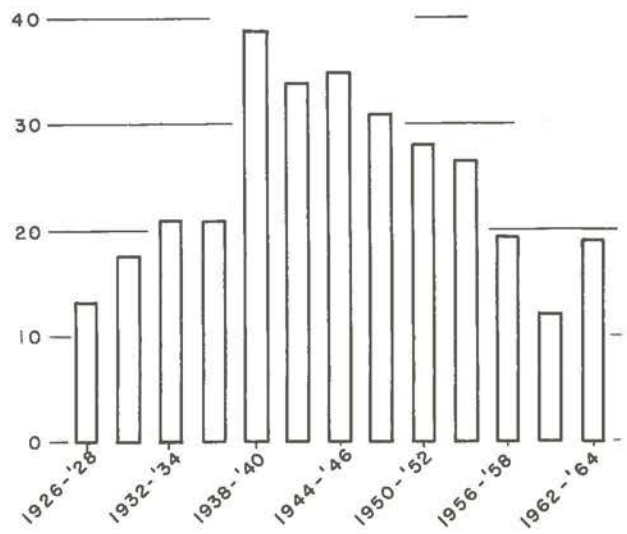


Fig. 3. Canadian Atlantic mackerel landings, 1926-1964.

trend in Canadian Atlantic mackerel landings is shown in Figure 3.

The mackerel is a delicious fish, but it does not keep as well as some other fishes that have less oil in their tissues. Salted, smoked and fresh mackerel are consumed in large quantities while salt or pickled mackerel are widely exported. Smaller quantities are canned or used as bait for swordfish and lobsters. ✔

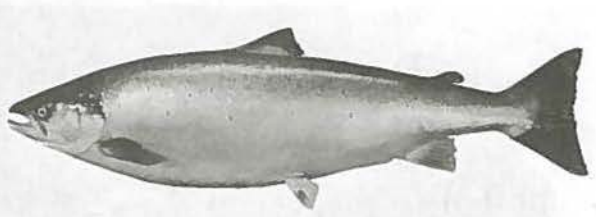
FISHERIES FACT SHEET

ATLANTIC SALMON

By

M.W. Smith, Fisheries Research Board of Canada

THE scientific name of the Atlantic salmon, given to the species by Linnaeus in 1758, is Salmo salar - salmon, the leaper. Not only its spectacular ability to leap falls (a vertical height of 11 feet has been recorded), but its migration between stream and sea, its challenge to anglers, and, certainly not least, its superior quality as a food fish have long made the Atlantic salmon famed and prized.



The Atlantic Salmon (Salmo salar)

Distribution

The Atlantic salmon spawns in rivers and streams tributary to the North Atlantic area. Its range in the west is from Massachusetts, United States, northward through the Atlantic provinces of Canada as far as Ungava Bay, Greenland, Iceland, and then in the east, Scandanavia, Kola Peninsula in Russia, the Baltic area, British Isles, southward to north Spain and Portugal. Damming of rivers, pollution, and alteration of rivers by settlement have caused salmon to disappear, or to become markedly reduced in numbers, in many rivers where they were formerly abundant.

Description

Like other members of the salmon family, the Atlantic salmon has an elongate, yet stout, moderately compressed body, large mouth, small scales, and a fleshy fin (adipose) on the back just in front of the tail fin. Peculiar to the adult Atlantic salmon are the deep blue colour of the back, the silvery sides, and white belly. The head and body have large, often x-shaped black spots.

The young salmon (parr) in the streams have 9 to 11 (usually 11) dark bars or blotches--parr marks--along each side, alternate with a single row of red spots along the lateral line. The pectoral and pelvic fins are usually grey, and the tail fin is deeply forked.

LIFE HISTORY

Spawning

Spawning occurs in the autumn, commonly in October and November, in shallow areas of gravel with rapidly-flowing water. Aided by the flow of water (1 to 2 feet per second), the female salmon excavates a depression--the nest or redd--by vigorous action of her body and tail fin. Eggs are extruded into the pit of the redd, being fertilized by milt of an accompanying male as they drop. The female then covers them to a depth from 3 or 4 inches to as much as a foot. Female salmon produce 500 to 900 eggs per pound of fish depending upon age and size. Eggs are about a quarter of an inch in diameter when spawned.

Hatching of eggs

The eggs hatch in late winter or early spring into alevins or sac fry with the yolk-sac attached. The sac fry remain in the redd until the nourishment in the yolk-sac has been absorbed. The young salmon are about an inch in length when they finally emerge from the gravel sometime in May or June.

Life in fresh water

Young salmon tend to establish small territories of less than one to several square yards in extent which they defend against intruders. The general term for young salmon is parr, although in their first year they are often called underyearlings, and in their second, yearlings. Freshwater or parr life is 1 to 7 years, depending upon food supply and temperature of water. It is usually 2 to 4 years in streams of the Canadian Atlantic provinces. In spring of their final year in fresh water, the parr, then 5 to 6 inches in length, become silvery in appearance and are called smolts. Smolts usually migrate downstream into salt water during May and June.

Life in salt water

Growth of salmon in the sea is rapid. Where the Atlantic salmon spend their lives in the sea has

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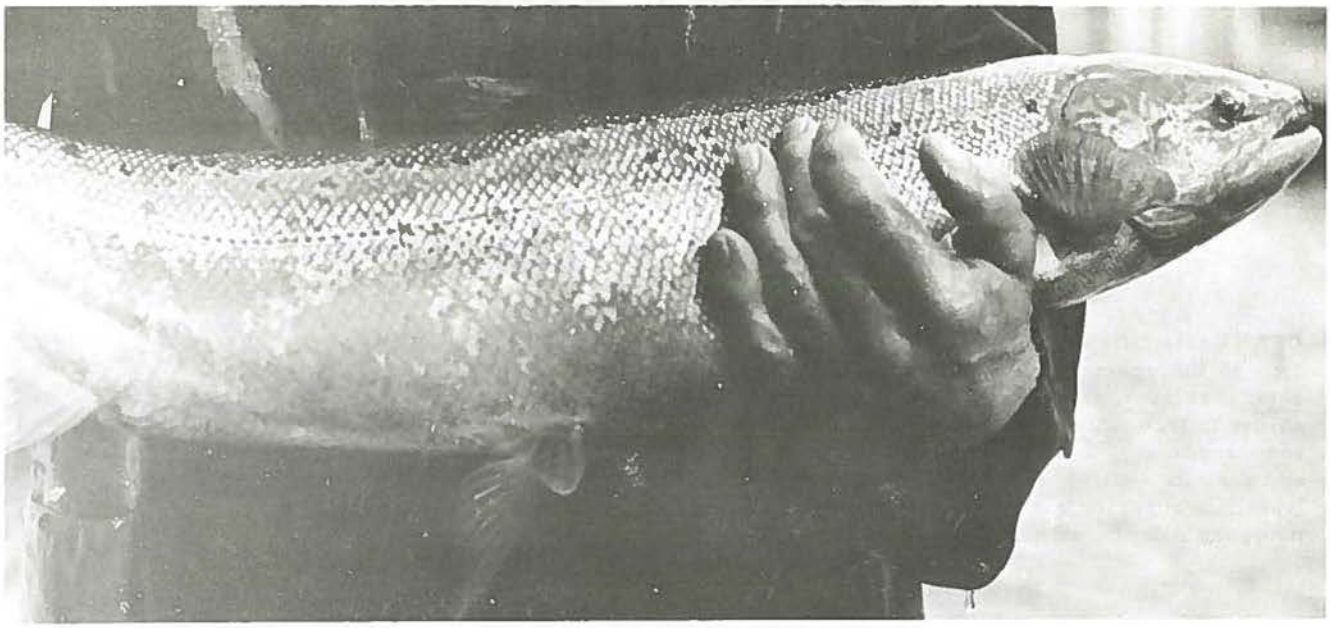


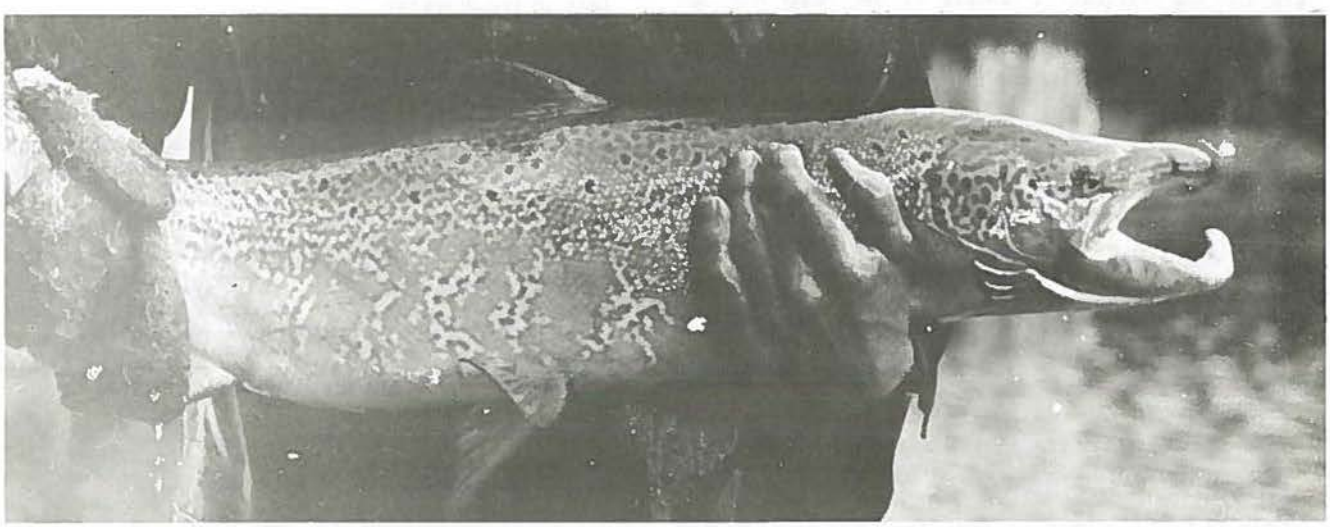
Female Atlantic salmon just prior to spawning.

long been a debated question. Tagging of smolts and older salmon has shown that they may move long distances. For instances, smolts from the Miramichi River, New Brunswick, are taken in the Newfoundland area, and tagged smolts and salmon from Europe and Atlantic provinces of Canada have been captured in the rapidly expanding fishery for salmon along the west coast of Greenland. In contrast, the salmon of the Baltic apparently do not leave that sea, and there is some evidence that many of the salmon of the Saint John River, New Brunswick, do not leave the Bay of Fundy.

Atlantic salmon return to the river of origin, but not invariably since, as shown by marking, they are occasionally taken in other rivers. They usually enter fresh water from May to late autumn. Some, both male and female, return and spawn after having spent only a year in the sea. These fish are commonly called grilse and most weigh 2 to 6 pounds. Others that remain in the sea 2 or 3 years before returning for the first time are known as maiden salmon, weighing from 8 to 30 or more pounds. Two-sea-year salmon in Canadian waters average about 10 pounds.

Re-spawners

Atlantic salmon may spawn more than once. After spawning they are thin, have become dark in colour, and are called kelts. Kelts move to sea soon after spawning or remain in pools of rivers over



Male Atlantic salmon. Note hooked jaw of near-spawning fish.

winter until April and May. Tagging of kelts in Canadian waters indicates that less than 10% of kelts survive to re-spawn. Kelts usually spend a year in the sea, where they recover condition and grow larger before entering rivers to spawn again.

Landlocked Atlantic salmon

Atlantic salmon occur as so-called landlocked races in lakes of North America, notably in Newfoundland, and off Scandanavia. The ouananiche of Lake St. John, Quebec, and sebago of Lake Sebago, Maine, are populations of landlocked salmon of long recognition in America. The life cycle appears to be between lakes and their tributaries, but studies are needed to learn more fully what movements occur where the lakes are not physically landlocked, and access to and from the sea is possible. Landlocked salmon attain a smaller size than the sea-run, up to 10 pounds or possibly larger, but usually smaller.

Table I. Commercial landings of Atlantic salmon in the Atlantic provinces of Canada in recent years. Weight in thousands of pounds. No landings reported for Prince Edward Island.

	1961	1962	1963	1964
Newfoundland	2,093	2,239	2,677	2,462
Nova Scotia	279	312	301	266
New Brunswick	584	723	640	1,039
Quebec	509	501	432	590
Total for Canada	3,465	3,775	4,050	4,357

Variability in life history

Male parr, but seldom female parr, may become sexually mature without leaving their native streams. These precocious male parr are capable of fertilizing the eggs of sea-run female salmon. In a few places it has been noted that parr that are less silvery than the typical smolts may run from small streams into salt water estuaries in autumn. Such departures from the above generalized account of the life history of the salmon are frequently encountered, and point to the adaptability of the species to differences in environment encountered over its wide geographical range.

Food

In fresh water the young salmon feed to a large extent on larval and mature aquatic insects, as well as terrestrial insects that fall on the surface of the water. A variety of other aquatic invertebrates are also eaten. More needs to be learned about the food habits of the salmon in the sea but an abundance of food, including crustaceans and small fishes, is available. These and other forms are apparently readily eaten as shown by the rapid growth of the salmon after their migration to salt water.

Economic value

The Atlantic salmon supports both commercial and sport fisheries. Angling for grilse and salmon is carried on in freshwater streams. The commercial fishery in Canada is carried out in salt water, largely with trap-nets on shore and drift gill-nets farther off. Nearly all of Canada's commercial catch of Atlantic salmon is marketed in the fresh and frozen forms in Canada, United States, and Europe.

In 1962 the world commercial catch of Atlantic salmon was about 19 million pounds. The Canadian commercial catch in the same year was about 3 3/4 million pounds with a landed value of about 1 3/4 million dollars (Table I). The most significant recent change in Atlantic salmon commercial fisheries has taken place in Greenland where the catch (exported) has increased sharply from about 120,000 pounds in 1960 to about 3,000,000 pounds in 1964.

Wherever they occur, anglers have long looked upon the Atlantic salmon as a king among sport fish. The economic value of the world sport fishery for Atlantic salmon is not easily assessed but every year large sums of money are spent for the purchase and maintenance of fishing privileges, for operation of fishing lodges, and for licences, gear, and travel.

Atlantic salmon is a luxury product, for which demand exceeds the supply, when taken either commercially or by sportsmen.

Culture

The Atlantic salmon can be spawned under artificial conditions, the eggs hatched, and the young successfully reared in artificial rearing establishments. The belief that hatching, rearing, and planting young salmon would increase stocks over those naturally produced led in the last century to extensive development of salmon fish culture, particularly in North America. This belief has been seriously challenged but the planting of hatchery-reared young salmon, increasingly as smolts, remains a practiced method of supplementing or replacing natural production, especially in polluted or dammed streams. The Baltic Sea fishery is largely maintained by the release of artificially-reared smolts in Sweden, the production of which became extensive after the principal salmon-rearing rivers of that country were dammed by hydroelectric developments. Recently, the farming of salmon to marketable size entirely under artificial conditions is receiving serious attention. ✔

FISHERIES FACT SHEET

BLUEFIN TUNA

By S.N. Tibbo, Fisheries Research Board of Canada, St. Andrews, N.B.

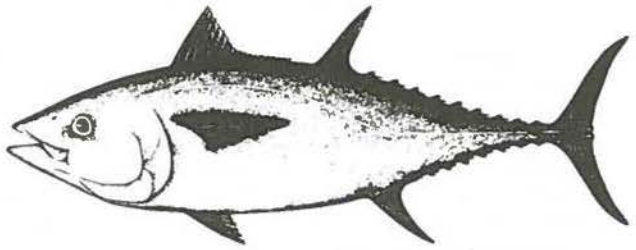
THE BLUEFIN TUNA *(Thunnus thynnus L.)* is also called horse-mackerel, great albacore or tunny. It is the largest member of the mackerel family and among the largest of all fishes. It is almost world-wide in occurrence being found on both sides of the Atlantic and Pacific Oceans. In the eastern Atlantic, it ranges from Norway to the Mediterranean Sea and southward off the African coast to the Cape of Good Hope. In the western Atlantic, it is found from Newfoundland southward at least as far as the West Indies and probably to Brazil. Very few small bluefin have been taken south of Cape Hatteras, although large fish are abundant throughout the Caribbean Sea and Gulf of Mexico.

DESCRIPTION

The bluefin is a beautifully streamlined fish with a bluntly pointed nose and a robust body that tapers evenly from the shoulder region to a long, slim tail region. The head has tightly closing jaws, flat gill-covers and eyes set flush with the surrounding surfaces. The body is completely covered with scales, including a corselet of large scales in the shoulder region. The fins fold into grooves or depressions thus giving a smooth contour to the body. With such a shape, it is not surprising that the bluefin is one of the swiftest (and widest ranging) fish in the sea.

Like all tunas, the two dorsal (back) fins of the bluefin are set close together. The trailing edge of the first dorsal is almost straight whereas that of the second dorsal is deeply concave. The pectoral (shoulder) fins are short and extend backward only as far as the rear of the first dorsal fin. In all other tunas this fin extends to the region of the second dorsal. The tail is deeply forked, much broader than long and both lobes are sharply pointed. As with all the mackerel tribe, there are small fins (finlets) between the second dorsal fin and the tail and between the anal fin and the tail. In the bluefin these finlets are yellow with black edges and there are 8 to 10 in each row.

The adult bluefin is a dark metallic blue with a greenish sheen on the back shading through silver on the sides to white on the belly. There are no dark bars, stripes or streaks like those on the skipjack, common bonito and false albacore. In contrast with adults, young bluefin have conspicuous white vertical bars and spots along the sides, but these disappear gradually as the fish grows.



Bluefin Tuna *(Thunnus thynnus L.)*

DISTRIBUTION AND IMPORTANCE

During the warm months of the year, the Atlantic bluefin are found over the continental shelf at depths of 15 to 100 fathoms from Cape Hatteras to Newfoundland. The smaller individuals are found towards the south, the larger ones towards the north. In winter they leave the continental shelf and are widely dispersed in the Atlantic.

Bluefin are gregarious fish and usually travel in schools. The number in a school rarely exceeds 10 for large bluefin (over 300 lb), but may reach 1000 or more for medium-size fish (80-300 lb) and several thousand for small fish (to 80 lb).

In Canadian waters there seem to be two distinct sizes of fish: the giants (over 300 lb) which appear in June and the jumpers (50-150 lb) which usually do not arrive until late August or early September.

Each year in April and May schools of large bluefin are seen swimming northward past Bimini Islands off the coast of Florida. It is presumed that these are the same fish which appear off the Canadian coast in late June and early July. The areas where bluefin schools appear may change considerably from year to year. Because of erratic and so far unpredictable occurrence, there has been no well organized and continuous commercial fishery. For the same reason sport fishing is also sporadic and may not occur in the same places in succeeding years.

BEHAVIOUR

When schools of bluefin are swimming at the surface they have three typical behaviour patterns: "pushing", "milling" (breezing) and "smashing".

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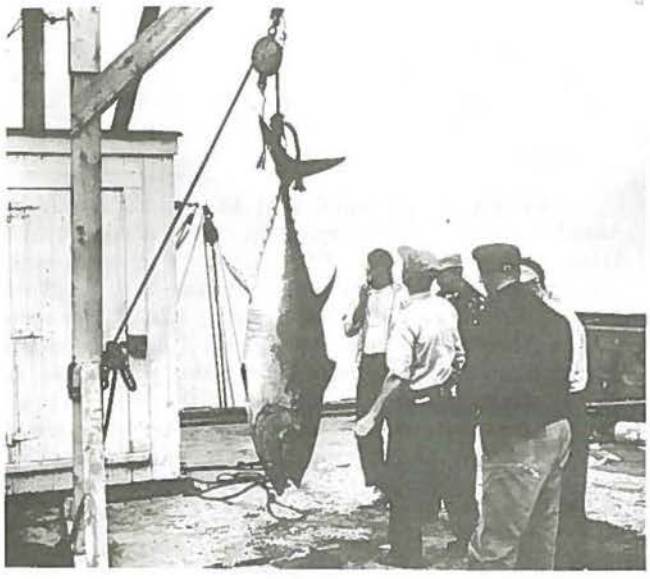
When "pushing" the fish all swim in the same direction at 3 to 8 knots and push a wave before them like a small motor boat. When "milling" the school is more or less stationary, but the individual fish move in circles or at random and cause a rippling at the surface. When "smashing" the school is also more or less stationary, but individuals are feeding voraciously, driving schools of forage fish to the surface, splashing and whirling and often leaping clear of the water altogether.

LIFE HISTORY AND HABITS

Spawning: The life history of bluefin is still incompletely known. It is known, however, that large fish spawn between Cuba and the Bahamas, near the edge of the Florida current, during April and May. At this time, schools of bluefin are frequently seen swimming northward at nearly 3 knots in the shallow water near the islands. This migration is frequently interrupted as the fish mill around for short periods. Available evidence indicates that during these "milling" sessions, the eggs are released and fertilized. The eggs are about 1/25 inch in diameter and contain a small oil globule. They float at the surface and hatch in a few days.

Growth: Young bluefin grow so rapidly that fish hatched in June weigh more than a pound by September and 8 pounds at the end of their first full year of life. A two-year old bluefin weighs about 15 pounds and a ten-year old about 350 pounds. A 700-pound fish is 14 or 15 years old. Bluefin may grow to over 1200 pounds, but fish over 900 pounds are seldom landed, probably because of their immense power. The world record for bluefin taken on rod and reel is 977 pounds. This fish was taken in St. Ann's Bay, Nova Scotia.



Weighing a sportsman's catch at Wedgeport, Nova Scotia.

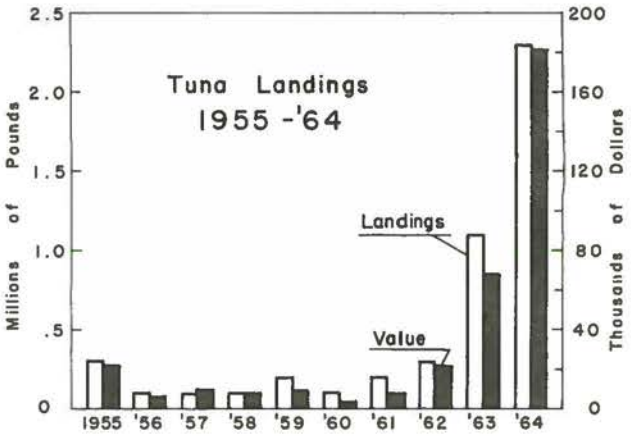
Purse seine caught tuna are discharged from the M.V. Blue Waters at Campobello, N.B.

Food: Bluefin are very active predators, hunting squid and a wide variety of fishes. They eat both surface-dwelling forms, such as herring, mackerel and younger tuna, and deep-living fishes such as the lanternfishes and barracudinas which occur in waters down to about 100 fathoms.

Factors controlling abundance: Fish which eat the same food as bluefin are competitors. However, competition has little effect on abundance since, if one feeding area should become exhausted, the bluefin can search for another more quickly than most of its competitors. Eggs and the very young stages of bluefin are an easy prey for predators, including larger bluefin and other tunas. Intermediate sizes are eaten by large fish and marine mammals. The toothed whales and some large sharks are the only predators that are big enough to deal with the giants. Parasites can cause considerable damage, especially to gill tissues, but it is unlikely that they have any serious effect on the abundance of bluefin. Man is taking an increasing toll of bluefin, and fishing mortality in some areas may be as high as 20-25 per cent of the available stock.

Migrations: The bluefin is a fish of the open sea wandering far and wide in search of food. Its migrations have been a subject of interest and speculation for centuries and although much work has been done these migrations cannot yet be described in detail.

In April, May and June, eastern Atlantic bluefin congregate for spawning in the Mediterranean Sea



Canadian tuna landings and values 1955-64.

and in the Atlantic just outside the Strait of Gibraltar. Immediately after spawning they embark on a northward feeding migration and from July to October are found in the North Sea and off the Norwegian coast. The approach of winter brings about a reverse migration.

The migrations in the western Atlantic are undoubtedly similar, but are less completely understood. In April and May bluefin congregate for spawning in the West Indies area and then set out on a northward migration as far as Newfoundland. There are, however, a number of contingents that have their own patterns for time and place of occurrence. The largest fish lead the way, to be followed some weeks later by small fish and finally by intermediate sizes. The smallest commercial sizes are seldom found north of Cape Cod whereas intermediate sizes occur regularly along the Nova Scotia coast and giants as far north as Newfoundland. There are several records of trans-Atlantic migrants and it has been suggested that such migrations are part of a regular pattern.

THE FISHERY

The Canadian bluefin fishery is small with landings in the 1953-62 period varying from 40 to 100 tons annually. In 1963 and 1964 landings increased to 570 and 1160 tons respectively, mainly as a result of the introduction of two purse seiners that exploited the stocks of small bluefin and skipjack in the Cape Cod to Cape Hatteras region.

Trapping, harpooning, and longlining with baited hooks are the main methods of the commercial inshore bluefin fishery. Baited hooks are also used in sport fishing. Commercial fishing with purse seines became profitable about 1958 with the adoption of synthetic materials for making nets and the use of "power blocks" for hauling them. Longlining for swordfish on the high seas, particularly during June and July, accounts for substantial incidental catches of bluefin.

It is difficult to predict what the future holds for the bluefin fishery. Landings throughout the world are small by comparison with landings of other tunas such as yellowfin and albacore. However, in many countries bluefin are the most highly regarded of the tunas and hence command the best prices. Commercial fisheries interests in the tunas are expanding rapidly in the western Atlantic and increasing fishing pressure on the stocks of bluefin is inevitable.

Extensive studies of the biology of bluefin are needed to determine the size of the stock and the amount of fishing it can withstand in perpetuity.

FISHERIES FACT SHEET

CANADA'S FISHERIES

The waters off Canada's coasts comprise some of the most important fishing grounds of the globe. Those off the Atlantic coast have been continuously exploited by many nations for more than 400 years. Fishing is Canada's oldest industry and is carried on in inland waters as well as on both the Pacific and Atlantic coasts. The industry is of the greatest importance to many of the communities along Canada's many thousands of miles of coastline. It provides 95,000 people with full or seasonal employment either in fishing (80,000) or in fish processing industries (15,000). The industry ranks among the first ten fishing industries of the world, and Canada, with over two-thirds of her catch being sold in foreign markets, is one of the world's largest fish exporters. Nearly 2 1/4 billion pounds of fish are caught annually, having a total marketed value of about $255 million.

Canada's fishing grounds fall naturally into three main divisions: Atlantic, Pacific and Inland, each with its own special characteristics.

ATLANTIC FISHERIES

The fisheries of Newfoundland, Nova Scotia, New Brunswick, Prince Edward Island and Quebec together account for more than one-half the marketed value of all Canadian fish.

The most valuable Atlantic catch is that of lobsters, which are mainly caught in the three Maritime Provinces, but are also found in the waters of Quebec and Newfoundland. Second in value among Atlantic fishery products is cod, taken by fishermen in all the five provinces, with Newfoundland and Nova Scotia predominating. Other "groundfish", so called because they feed at the sea bottom, are often taken with the cod. They include haddock, pollock, hake, cusk, rosefish and catfish. Other inhabitants of deep waters caught by Atlantic fishermen are the flatfish: halibut, plaice, yellowtail, witch and flounder. In addition to lobster, other types of shellfish caught are clams and quahaugs, of which New Brunswick and Nova Scotia both produce considerable quantities, oysters (chiefly from New Brunswick and Prince Edward Island) and scallops from Nova Scotia. Mussels, winkles and crabs are marketed on a smaller scale. Of the fish species occurring in schools ("pelagic" fish) and those entering the river estuaries ("estuarial fish"), the herring are the most important. Immature herring landed in southwestern New Brunswick are the basis of an important sardine canning industry. Other pelagic and estuarial fish are mackerel, smelts (which are caught in large numbers off New Brunswick and elsewhere), Atlantic salmon and swordfish.

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Canada's Fisheries (Cont'd.)

Altogether, more than 30 different kinds of fish, shellfish and marine mammals such as seals and whales, are commercially taken by Canada's Atlantic fishermen. In addition, other marine products such as Irish moss and other sea-grasses are harvested.

There is a fairly clear distinction to be made between two branches of the Atlantic fisheries. The shore fishery, which is more important, is carried on in waters within 12 or 15 miles of land, while the deep-sea fishery is worked on the "banks" farther away. Individual fishermen fishing near their homes from small row-boats, sailboats, or motor-boats, produce the bulk of the landings of the shore fisheries. The Labrador Coast fishing is of a special type, being conducted mainly by Newfoundland fishermen who voyage there for the summer. Handlines, and trawl lines with individually baited hooks, are the gear chiefly used in the shore fisheries to catch such fish as cod, haddock and halibut, but in Newfoundland the greater portion of the inshore cod catch is accounted for by cod-traps. Mackerel and herring are captured with seines, trap-nets and gill-nets; lobsters are trapped in "pots"; and smelts are mostly caught in winter in box-nets and bag-nets through holes in the ice. Oysters are gathered from their beds by special rakes or tongs; scallops are landed by drags or dredges.

Years ago the offshore fishery was carried on by dory schooners which were wind-propelled and ranged in size from 75 to 125 tons or larger. The typical dory schooners carried 12 to 24 fishermen who fished in pairs from small open boats (dories), using trawl lines. These vessels have been replaced almost entirely by modern types such as the trawler, dragger and long-liner. The former two are propelled by powerful engines and catch fish by dragging an otter-trawl or similar device. This is a large baglike arrangement of nets which captures fish as the vessel tows it through the water. The nets with the captured fish are winched aboard by mechanical power. New interest in schooners has been aroused by experiments with powered dories which are carried to the fishing grounds by the schooners. These dories are fished by two-men crews but utilize engines for propulsion and haul in the long lines with a power gurdy. The number of trawlers and draggers is increasing each year, especially the small and medium sizes. They are employed in all of the Atlantic provinces although only recently in Prince Edward Island and Quebec. At the same time long-lining is also gaining in importance. This type of vessel is also used in each province and the name is derived from the long trawl lines which are used to catch the fish. These lines carry thousands of baited hooks and are hauled with their catch by means of power gurdies.

A considerable proportion of the groundfish landed in the Atlantic provinces continues to be salted and dried for export to Carribbean, Mediterranean and South American markets. In North America, however, these species are marketed mainly in the chilled or frozen state. This has been made possible by the development in the past 25 years of refrigerated distribution facilities, which now bring sea fish to all of the important interior markets. The long distances involved in

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this distribution process make the question of weight important and there has been a steady trend towards filleting at the coast and shipping only the edible portion of the fish to market. This not only reduces transportation costs but also makes cooking easier in the home.

Canning continues to be an important method of preserving and distributing other species, especially immature herring (sardines) and lobsters. Oily fish, mackerel, herring and mature herring -- are still preserved in the pickled state for certain export markets, as well as in the frozen and canned forms.

The by-products from the filleting operations, livers and viscera are the raw products for fertilizer, fishmeal, vitamin and industrial oils. To some extent whole fish are used for one or other of these purposes, as is the case with herring used by fishermen for bait.

PACIFIC FISHERIES

The fisheries of British Columbia, Canada's Pacific Coast province, are dominated by salmon, which account for over two-thirds of the total value. Herring contributed about one-tenth, and halibut with other flatfish (soles and flounders) also about one-tenth of the marketed value of the British Columbia catch. Grayfish, soup-fin and other sharks are rich sources of vitamin oil and as such are commercially important, Ling and black cod (not related to the true cod), albacore tuna and clams, crabs and oysters also provide a source of income to fishermen. A variety of other aquatic species, ranging from shrimps to whales, are among the catches of the British Columbia fishermen.

Almost all fishing in British Columbia waters is carried on within sight of land and there are no very large vessels, but even small boats, usually highly powered and equipped with modern mechanical gear, navigational aids and radio, travel long distances up and down the coast following the seasonal movements of the fish and taking advantage of open seasons in widely scattered areas.

Among the typical craft and gear used are the purse-seine boats which are important in the salmon fishery and account for the bulk of the herring catch.

Mobility, modern equipment and efficiency characterize the Pacific fisheries which show a high degree of organization both among the fishermen and among the processing companies.

The greater part of the Pacific salmon catch is canned. The product enjoys a world-wide reputation for quality and is exported to many countries.

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Fresh and frozen salmon, halibut and many other species, including shellfish, are supplied to Canadian and United States markets. Herring is turned largely into fish meal and oil, as are the waste materials produced in the canning and filleting of other types of fish. The extraction of vitamin oils from livers and viscera is another important and growing branch of the industry.

INLAND FISHERIES

Apart from being a great sport-fishing area, the inland waters of Canada, which comprise over one-half the fresh water of the globe, also support important commercial fisheries, particularly in Ontario, the Prairie Provinces and as far north as Great Slave Lake in the Northwest Territories. Quebec, New Brunswick and Yukon have commercial inland fisheries on a smaller scale.

A great variety of fish is taken in these inland waters; whitefish, which occur in all the provinces, head the list, followed by pickerel (or dore) and lake trout. Other species are sometimes of considerable local importance, e.g., saugers in Manitoba and eels in Quebec.

The Great Lakes, and the larger bodies of water in the Prairie Provinces and Great Slave Lake in the Northwest Territories are fished extensively in the summer, the fishermen using boats up to 46 feet in length (e.g., the whitefish boats on Lake Winnipeg) as well as skiffs and canoes. Gill-nets and pound-nets are the chief gear. Production is channelled through permanent shore stations with docking, icing, cooling, grading and warehousing facilities.

Winter fishing on large and small lakes with gill-nets set through holes in the ice is carried on by teams of men, many of whom are only part-time fishermen whose chief occupations are farming, lumbering or in the fur industries. Accommodation for the fishermen as well as handling facilities are available at hut camps or in the form of mobile cabooses. Dog teams, horses, cars and snowmobiles are used to haul fish and equipment.

Most of the catch is marketed fresh or frozen, with a large proportion going south across the border.

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FISHERIES FACT SHEET

CAPELIN

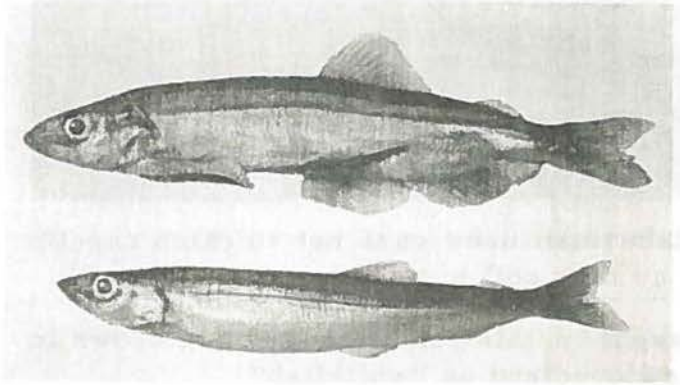
Distribution and Importance

The capelin, Mallotus villosus, is a close relative of the smelt and indeed belongs to the same family of fish. Capelin are found in arctic and subarctic regions and southward along the Atlantic coast sometimes to the Gulf of Maine. Capelin are also found on the Grand Bank and are especially abundant around the coast of Newfoundland during June and early July. They are also common around Gaspé.

Many forms of larger fish and sea mammals feed to a large extent on capelin during a good part of the year. It is the main food of Newfoundland east and south coast cod during June and July and of the north and northeast Grand Bank cod from early spring to late July. In addition to its importance as a food for other fish probably 25,000,000 pounds or more are caught in cast nets and beach seines during the spawning season and used as bait for cod, as fertilizer, eaten locally and exported in comparatively small quantities in either the fresh, frozen, salted or smoked condition. Capelin are also used as food for dogs and mink and in the preparation of pet food. Comparatively small quantities have been used in the past to produce fish meal.

Description

The capelin has small teeth as compared to those of the smelt and it is somewhat more slender than the latter. The mouth extends back below the fairly large eye, and the lower jaw protrudes. The adults range in size mainly from five to eight inches in length with the male averaging about seven inches and the female about six inches. The back of the fish is



Male (top) and female (bottom) during spawning period.

olive green and the lower parts of the sides are silvery. There are two fins on the back, a fairly large one at about the middle of the back and a small, soft fleshy fin just in front of the tail. The scales are small and soft. The spawning male has a distinctly different appearance from the female. All the fins of the spawning male are large and firmer than those of the female. This is especially noticeable in the fin on the lower side just in front of the tail. In the male this fin is large and its base is keel-like. Also along the sides of the male are two conspicuous ridges (upper and lower) of enlarged scales known as "spawning ridges". These are absent from the female. The immature or non-spawning male capelin has no "spawning ridges" or other distinguishing characteristics and is similar to the female in appearance. When they are

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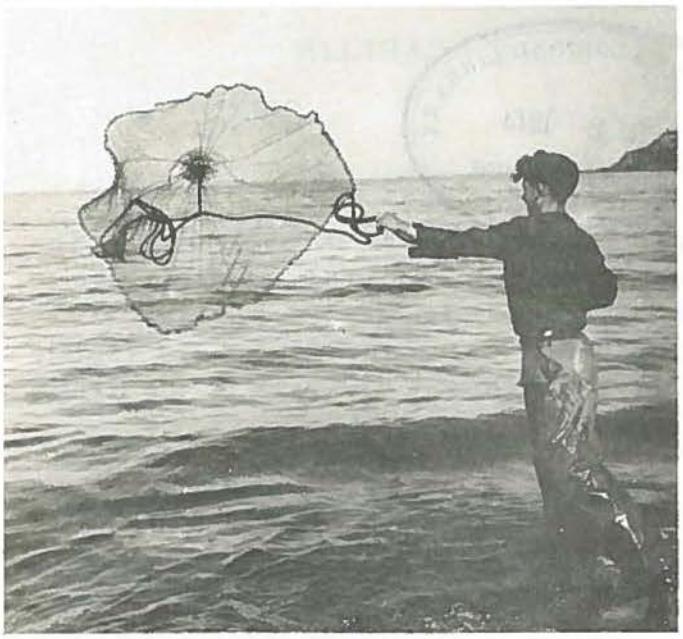

Fisherman uses cast net to catch capelin as they roll in to spawn on the beach.

This young fisherman uses a dip net to scoop up the capelin swarming ashore.

caught in this condition they are known in Newfoundland as "whitefish"

Spawning

In June and early July capelin approach the coast in very large schools, and when suitable conditions prevail mass spawning takes place on or near the beaches. At the height of the spawning activity a beach becomes "alive" with squirming fish as each wave brings them in, and then recedes leaving thousands stranded on the beach. It has now been definitely established that capelin also spawn in great numbers on the Grand Bank, especially on the Southeast Shoal.

Most of the spawning capelin are three years old with smaller numbers two and four years and very occasionally five years of age.

Fisherfolk gather at the water's edge to dip capelin and throw them ashore.

Tons of capelin stockpiled near the beach for use as bait, food or fertilizer.

FISHERIES FACT SHEET

Chinook (Spring) Salmon

THE CHINOOK, or spring, salmon is the giant of the five species found in British Columbia waters (the others are the sockeye, chum, coho and pink). Its scientific name is *Oncorhynchus tshawytscha*. The chinook forms an important part of the British Columbia salmon catch, being found along the entire coast. In many areas it provides excellent sport fishing, and in some of these localities, such as Rivers Inlet, and off Comox and the Campbell and Oyster Rivers on Vancouver Island, it is known as the "tyee" when its weight exceeds 30 pounds. In some parts of the United States it also goes by the names of "quinnat" and "king" salmon.

In North America the chinook salmon is common over a wide range, from southern California to northwestern Alaska, and, in smaller numbers, it also occurs in northeast Asia.

DESCRIPTION

The chinook has the typical body shape and fins of all the Pacific salmon. The back, down to the lateral or mid-body line, is usually heavily marked with irregular black spots, and similar spots are found on the dorsal fin and on both lobes of the caudal or tail fin. The young have strongly developed parr marks that extend almost completely across the side of the body. The adult chinook salmon can generally be distinguished from the adult coho salmon by the presence in the mouth of black pigment along the bases of the lower teeth. In the coho the lower gums are usually pale, whereas in the chinook salmon they are usually dark or even quite black. The appearance of the adipose fin in the chinook and coho is a very useful means of telling the young of the two species apart - in the chinook salmon this fin is usually not completely mottled, but has a clear forward area, whereas the mottling is complete in the coho, giving it an overall dark-grey appearance.

The average weight of commercially-caught chinook salmon is about 15-20 pounds, but fish of up to more than 100 pounds are taken quite commonly. The small, maturing, male "jack" chinooks weigh about four pounds on the average. Chinook "grilse" are the small immature fish of both sexes which are frequently caught by ocean sport fishermen. These fish usually weigh up to three pounds.

The chief food of the chinook salmon is herring and sandlance, augmented by other small fish, crustaceans and squid. The flesh of the chinook salmon may be red, pink or white, and its commercial value is in that same order.

Chinook Salmon *(Oncorhynchus tshawytscha)*

MIGRATION AND REPRODUCTION

The main spawning runs of chinook salmon in British Columbia take place from late spring to early fall. In the Columbia River there are distinct spring, summer and autumn or "fall" runs, while in the Fraser River there is an early run of mainly red-fleshed fish and a late run of mainly white-fleshed fish.

The young chinook salmon may migrate to sea during their first year or not until 12 months or more later. They mature in their third or fourth year of life, or as 2-year-old "jack" males, or as older fish, possibly as much as eight years of age.

Tagging operations have shown that they make long ocean migrations, probably mainly in coastal or near-coastal waters, but individuals have also been found far out in the Gulf of Alaska and even farther west. Northern California chinook salmon have been taken as far north as off southeast Alaska. Much of the life history of the chinook salmon is similar to that of the other species of Pacific salmon.

METHODS OF CATCHING

The principal commercial method of taking chinook salmon is by trolling, but gill-netters and purse-seiners also take important numbers.

The chinook salmon is sold mainly as fresh fish either whole or in fillets, and it is also the chief species of salmon utilized for mild-curing. Part of the catch is canned, and some is also smoked or dry salted. The principal markets are in the United States and Canada.

(Prepared by the Nanaimo Biological Station of the Fisheries Research Board of Canada).

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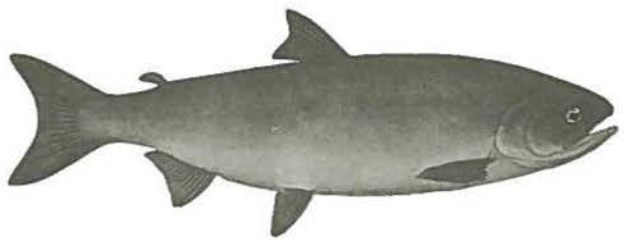
FISHERIES FACT SHEET

Chum Salmon

FORMERLY KNOWN as dog salmon, the chum, with the scientific name *Oncorhynchus keta*, has also been called the qualla, keta and calico salmon. Its geographic range in North America extends from northern California into the Arctic as far east as the Mackenzie River. In British Columbia it is caught all along the coast and ascends practically all streams. The catch in British Columbia which during 1951 an 1963 averaged 2. 8 million fish per year and had an average landed value of 2 million dollars is widely marketed in several forms.



Chum Salmon
(Oncorhynchus keta)

DESCRIPTION

Like other Pacific salmon (sockeye, pink, spring and coho), the body of the chum is elongate and the head is conical. The teeth are strongly developed, and in the mature male resemble fangs. The parr marks on the young are slender bars, and the back has a green iridescence. The back of the adult fish is a metallic blue with occasional black specklings. There are black tinges at the tips of the pectoral, anal and caudal fins, especially marked in the male.

When the adult chum returns to fresh water to spawn and die, it changes color, becoming almost black with irregular reddish, dusky streaks across the sides of its body, and the tips of the pelvic and anal fins turn white. Chums grow to about three feet in length and an average weight of about eight pounds, although some frequently weigh as much as 18 pounds and in rare instances as much as 30 pounds.

The life span is four years, sometimes three or five. During the spawning season chums develop a characteristic hook over the upper jaw. The flesh of the chum is white, with a creamy tinge. It lives on small crustaceans, and its own food value is similar to that of others of the species. Of the five the chum is fourth in protein content and fifth in fat content.

MIGRATION AND REPRODUCTION

In British Columbia each spring in many different kinds of streams, chums, as fry measuring about 1 1/2 inches in length, emerge from the gravel and immediately migrate seaward. Some are still present in coastal waters as late as November but others are considerably farther offshore. At sea, chums grow rapidly and conduct seasonal movements, moving northward in the spring and summer and southward in the fall and winter. Stocks originating in British Columbia spend most if not all of their life in the Gulf of Alaska and in their final year as 3, 4 or 5-year-olds return, mainly in the fall, to streams where they were born. Many stocks enter streams emptying directly into open coastal waters but others are bound for mainland areas of southern British Columbia and the east coast of Vancouver Island, and reach these areas by migrating through Johnstone Strait as well as the Strait of Juan de Fuca.

METHODS OF CATCHING

Chums are caught by purse-seines, gill-nets and, to a limited extent, by trolling.

A variety of methods is employed to prepare the chum for market. A large quantity is sold fresh, other portions of the catch are frozen, canned, or dry-salted. Indians produce smoked chum, but for their own use. As is the case with all British Columbia salmon, the markets are world-wide but largest in the United States.

(Prepared by the Nanaimo Biological Station of the Fisheries Research Board of Canada).

June, 1967

Department of Fisheries and Forestry

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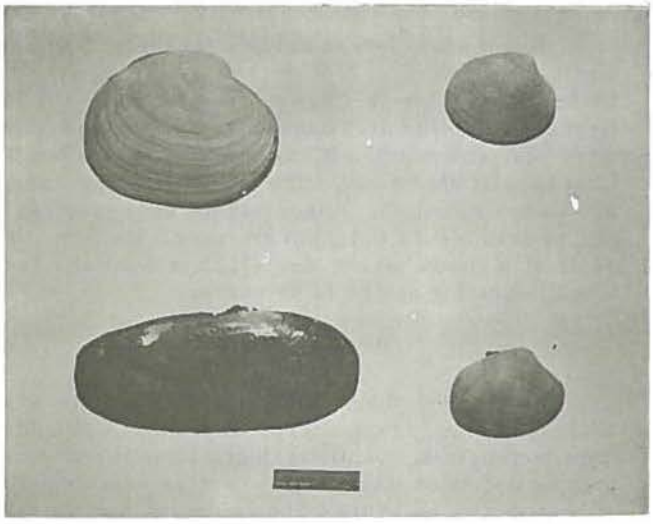
FISHERIES FACT SHEET

Clams of British Columbia

OF THE various species of clams found along the coast of British Columbia, only four are used commercially to any great extent. These are the butter clam *(Saxidomus giganteus)*, little-neck clam *(Protothaca staminea)*, Manila or Japanese little-neck *(Venerupis japonica)*, and razor clam *(Siliqua patula)*. The first two species are generally found on the same beaches and are widely distributed in British Columbia; the third species occurs in the southern part of the province; while the fourth species is restricted in its distribution to sandy, surf-swept beaches. Other species of clams, including the geoduck *(Panope generosa)* and the cockle *(Clinocardium nuttali)*, may be used locally but do not enter the commercial catch.



Four most important commercial species of British Columbia clams: (upper left) butter clam: (upper right) little-neck clam; (lower left) razor clam; and (lower right) Manila clam.

The butter clam, the most abundant of the commercially important British Columbia clams, is used almost exclusively for canning. It is widely distributed throughout the province and although it may live in many types of soil it occurs most frequently on beaches composed of a mixture of sand and gravel, at a depth of not more than a foot below the surface of the beach. In vertical distribution it occurs in approximately the lower third of the intertidal zone. It is known to occur in deeper water but these sub-tidal populations are not abundant enough to permit commercial exploitation.

The native little-neck clam is usually marketed fresh and eaten steamed. It also is widely distributed in the province and is found on most types of beaches. The typical habitat of the little-neck, however, is a mixture of pebbles and fine sand and it is most often found in the lower half of the intertidal zone.

The Manila clam or Japanese little neck, was accidentally introduced into British Columbia from Japan and was first recorded in the province in 1936. It is now common in Georgia Strait to Seymour Narrows and occurs on the west coast of Vancouver Island as far north as Esperanza Inlet. It is found on muddy-gravel beaches above the half-tide level of the beach. Like the native little-neck it is usually marketed fresh and eaten steamed.

The razor clam occurs in situations quite different from those of the other three species. A very fine sand, free of gravel and clay, seems to be most desirable. Apparently this clam will not stand as great a variety of physical conditions, because it is not found in the inner waters where salinity is low and the surface water temperatures high at certain times of the year. It occurs on beaches exposed to the open ocean and pounding surf. The only beach in British Columbia that is dug commercially for razor clams is on Graham Island, largest of the Queen Charlotte group.

DESCRIPTION

Externally the shell of the butter clam is quite smooth, with numerous fine concentric lines of growth interspersed between a number of more prominent grooves which represent winter-checks in growth. The muscle-scars on the inside of the shell are quite large and deeply impressed. There are several hinge-teeth and the external hinge-ligament is large and prominent. All of the meat of this species may be eaten, although the black tips of the siphons are usually removed. The butter clam may reach a length of five inches. The average size in the commercial catch is about three inches.

The shells of little-neck clams are pure white or cream colored, with angular brown markings, have numerous fine radiating lines as well as many concentric ones. The muscle-scars are clearly outlined and the hinge-teeth are quite prominent. The average size is about two inches but a length of nearly three inches may be attained.

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The shells of the Manilla clam are quite oblong, much longer than high and have concentric and radial striations on the external surface. The outer surfaces are dull grey-brown in color with black and white geometric patterns, particularly in young specimens on sandy beaches. The tip of the sipon is split. Clams in the commercial catch average about two inches but they may grow to two and a half inches.

The long, narrow, thin shells of the razor clam are covered with a distinctive shiny brown periostracum. They may reach a length of six inches and a height of two and one half inches. This species must not be confused with the small "jack-knife" clam which it resembles and which is found on protected sandy beaches.

FOOD AND FEEDING

Most clams feed on minute plant and animal organisms that swim and float about in the water, and are collectively known as plankton. The minute organisms are carried by water currents between the shells where they are caught by the gills and then passed along to small flaps or palps situated at each side of the mouth. They pass through the mouth into the digestive tract. Clams can excercise some selection of their food but little is known about which organisms are preferred or which organisms produce best growth.

Razor clams obtain food in the same way as the other three species. They are much more active in their movements but that has little effect on their ability to obtain food.

REPRODUCTION

Butter, little-neck, Manila and razor clams are divided into distinct sexes, but there is no apparent difference between males and females. The size and number of males and females is approximately equal. Eggs and sperm are shed into the water and soon after fertilization, tiny free-swimming larvae develop. In the southern part of the Strait of Georgia, the butter clam spawns in summer, but the specific breeding time is not known. Little-neck and Manila clams also spawn in the summer, the latter species usually a little later than the former.

In the main, spawning of the razor clam takes place during July, but it is probable that in some summers it may be earlier, depending upon the time when the water temperature reaches the necessary minimum for spawning.

GROWTH

When the larvae are still free-swimming, they develop a pair of shells and in time the small animals settle to the sand or gravel to begin their sedentary existence and gradual growth. Butter clams begin to spawn when they are three years old, but most do not spawn until they are four years old.

The minimum length of the first spawners of butter clams is about one and one-half inches. After the first spawning, under normal conditions, annual spawning takes place. Most clams taken commercially are less than 12 years old, but occasional specimens as old as 20 years have been found.

Little-neck clam larvae settle when they are about one-hundredth of an inch long. About half of them spawn in their second year, when the shell is about one inch long, and the remainder for the first time in their third year. Few little-neck clams more than eight years old are obtained but occasional ones are found as old as 14 years. Manila clams have a slightly slower growth rate than little-neck clams.

Razor clam larvae settle when their shells are about one-tenth of an inch in length. Apparently there is little growth during the remainder of the first season. Earliest spawning is at the end of the third year and nearly all razor clams spawn for the first time at that time. The shells are then about 3.6 inches in length. Razor clams over nine years old, and six inches in length are rare. However, the shell of a much larger one (7.25 inches) has been found indicating an age of 15 years.

PRODUCTION

Since 1950 there has been a general trend of decreased clam production in British Columbia. This decline is due partly to fluctuations in economic prosperity; clam digging is not as economically attractive now as in previous years and also the decline is due partly to recent closure of some clam beds because of shellfish poisoning and pollution.

Total clam landings have fluctuated from a high of 6.7 million pounds (round weight) in 1952 to a low of 1.6 million pounds in 1964. The value of this catch has varied from $222,000 to $59,000. During this period the bulk of the landings have been butter clams, (76-93% of the annual catch). The remaining three species have comprised: little-neck clams 0.5-11.6%, Manila clams 1.5-11.8%, and razor clams 2-10% of the annual catch.

(The preceding was prepared by the Nanaimo Biological Station of the Fisheries Research Board of Canada.)

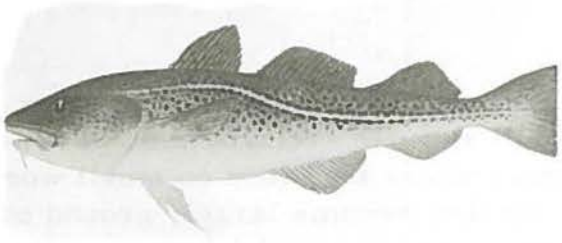
June 1966

FISHERIES FACT SHEET

COD (Atlantic)

Distribution and Importance

The Common, Atlantic, or Rock Cod, with the scientific name Gadus callarias is well-known on both sides of the North Atlantic. On the American coast it is found as far north as Greenland, Davis Strait and Hudson Strait and south nearly to Cape Hatteras. It is particularly abundant in the waters around and off the Canadian Atlantic Coast. The cod of the Grand Banks of Newfoundland was one of the principal inducements which led England to establish colonies in America. So important was this fish in the early history of this country that its picture was placed on a Nova Scotian banknote with the legend "Success to the Fisheries". From the early days to the present it has retained great economic importance to Canadian East Coast fishermen and it has contributed a large share of the fisheries income of all the Maritime Provinces. Salted codfish is the "backbone" of the fisheries industry of Newfoundland. The flesh is highly palatable, easily digestible and nutritious.



Atlantic Cod
(Gadus callarias)

Description

The most noticeable external characteristics are its three dorsal and two anal fins, its protruding upper jaw, its almost square tail and a pale line running along each side of the body from the head to the tail. There is a fleshy barbel under the lower jaw. In most fish the upper part of the body is thickly speckled with small, round, vague-edged spots, somewhat darker than the body color which may range from a reddish hue to brown, gray or greenish.

Cod sometimes grow to a tremendous size. A monster of 211 1/4 pounds, more than six feet long, was caught off the Massachusetts coast in 1895. However, a "large" fish is considered one of from 25 to 50 pounds in weight.

Habits and Movements

Although it stays close to the bottom of the sea and therefore is typically a "groundfish", it may be found anywhere from surface to 250 fathoms. Its usual habitat is within a few fathoms of the bottom but it comes to the top of the water in pursuit of small fish or squid. Cod live chiefly over rocky, pebbly ground, on sand or gravel and seldom on soft mud. Their movements are not well understood. They go in schools, but not in such dense bodies as mackerel and herring. The movements

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on and offshore and from bank to bank are due chiefly to temperature influence, the presence or absence of food and the search for proper spawning conditions. Sometimes they make long journeys as has been shown from tagging operations carried out by the Fisheries Research Board of Canada. Migrations into the Gulf of St. Lawrence in spring and back to the offshore banks in the fall have been indicated. These fish prefer a rather definite range of temperature which varies with the locality and season. Best catches are made at bottom temperatures ranging from 32°F. to 40°F. while smaller catches are made in waters of up to 50°F.

Food

Cod feed voraciously on almost all types of sea life. During its early floating life, the young feed upon some of the small animals around them. When older and about an inch long they take to the bottom where they feed on small worms and tiny shrimp-like animals. As they grow older they become largely ground or bottom feeders, consuming such things as mussels, crabs, small lobsters, brittle stars and sea urchins in quantity. More important foods are the capelin, herring and sand launce. The cod depends largely upon smell to locate food since its range of vision is limited to a few feet.

Spawning

The majority spawn during the early spring months, each fish producing from 3,000,000 to 9,000,000 eggs depending on its size. The minute transparent eggs rise and drift in the water at the mercy of the wind and tide and the animals which feed on them. The eggs hatch in from 10 to 40 days depending on the temperature of the water, and the young fish about three-sixteenths of an inch long begin to feed for themselves.

Growth

Growth varies from area to area and from season to season depending largely on the food available and the temperature of water in which they live. The cod of the Bay of Fundy grow much faster than those of the Grand Banks of Newfoundland. Cod of 30 to 32 inches in length have an average weight of approximately 10 pounds and in the Bay of Fundy area would be about six years of age. However, fish of the same length and weight would be about nine years of age on the Grand Banks. Cod from fishing banks off Nova Scotia enter the commercial fishery at about four years of age.

Fishing Areas and the Fishery

Areas fished extend from Labrador along the whole Canadian coastline. However, the most productive areas are our offshore banks such as the Grand Banks of Newfoundland, the fishing banks off Nova Scotia and the banks of the Gulf of St.

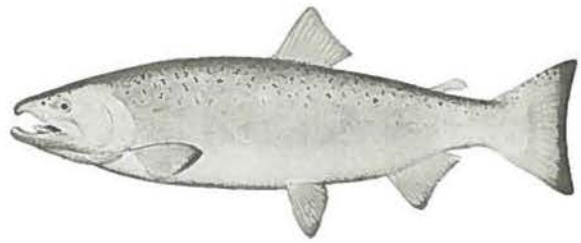
Lawrence. Great quantities are also caught within five miles of the shoreline along the entire Canadian Atlantic coast.

They are caught mainly by means of hook and line and by means of otter trawl. Large quantities are also taken by trap-nets and gill-nets. Millions of pounds of herring and mackerel are stored in cold storage units along the Canadian Atlantic coastline to provide year round bait for the cod fishermen.

A large part of the commercial catch is split, salted and dried. The progress in refrigeration and transportation has increased the production of fresh and frozen fillets. Waste after filleting forms the basis for fish meal valued for its high protein content and used as cattle feed. Livers are used for the extraction of cod-liver oil.

FISHERIES FACT SHEET

Coho Salmon



COHO SALMON *(Oncorhynchus kisutch)*

THE COHO SALMON, whose scientific name is *Oncorhynchus kisutch*, is abundant in British Columbia, and is produced in numerous small coastal streams and in tributaries of the larger rivers. It supports an important and valuable commercial fishery, and is also eagerly sought by sport fishermen. Because of its coloring, it is commonly known as the "blueback" in British Columbia, when it is late in its first year of ocean life and weighs from four to eight pounds. In parts of the United States coho salmon are known as "silvers". In North America this species occurs from Monterey Bay, California, to northwestern Alaska, and it is also fairly abundant in northeast Asia.

DESCRIPTION

The coho salmon has the typical body shape and fins of all the Pacific salmon. Irregular black spots are usually apparent over most of the back of the coho, and on the upper lobe of the caudal fin. The young have strongly developed parr marks that extend almost completely across the side of the body. The adult coho salmon can generally be distinguished from the adult chinook by the absence of black pigment along the bases of the lower teeth. In the coho salmon the lower gums are usually pale, whereas in the chinook salmon they are usually dark or even quite black. The appearance of the adipose fin in the young of the chinook and coho salmon is a very useful means of telling them apart - in the coho salmon this fin is almost always completely mottled, giving it an overall dark-grey appearance, whereas in the chinook salmon the mottling is not complete and the fin has a clear forward area.

The average weight of commercially caught coho salmon is about eight pounds, but fish up to 31 pounds have been taken. Coho "grilse" are the small, immature fish of both sexes which are frequently caught by ocean sport fishermen. These fish weight up to 3 pounds.

The food of the coho salmon is quite varied. It is a very active predator, even as a juvenile in fresh water. In the sea, herring, sandlance and other small fishes make up its principal diet, but squid and crustaceans are also important.

MIGRATION AND REPRODUCTION

Most coho salmon in British Columbia spend a year in fresh water before they migrate to sea, and most mature and return to the rivers to spawn after a further year and some months in the ocean. Their growth in the ocean is very rapid, comparable to that of pink salmon which spend a similar time at sea before they mature. Further north on this continent proportionately more coho salmon mature in their fourth year of life, having spent two years rather than one in fresh water before going to sea, and a similar situation occurs among Russian coho.

The principal commercial fisheries for coho salmon occur at the time and places where they intercept the returning spawning runs, but important catches of still immature fish are also made in inside waters such as Georgia Strait. Appreciable catches in our British Columbia fisheries are made from July to September, with the peaks usually occurring around mid-August.

The tagging of coho salmon has shown that fish from many, and often widely separated, rivers intermingle at sea during the course of their feeding migrations. Washington, British Columbia and southeast Alaska coho have been taken at widely scattered points in the Gulf of Alaska, but as yet none of these areas has been identified westward of the Gulf.

Much of the life history of the coho salmon is similar to that of the other species of Pacific salmon.

METHODS OF CATCHING

Trolling is the principal means of taking coho salmon in British Columbia, but gill-netting and purse-seining are also important, both when fishing specifically for this species, and when fishing primarily for sockeye, pinks or chums. In the sea the feeding coho are frequently taken by sportsmen casting a "buck-tail" fly, although the more common method is by trolling with rod and line, with lures similar to, but usually smaller, than those used by commercial fishermen.

In recent years the great bulk of our coho salmon catch has been sold as canned and fresh frozen (mainly dressed), and a small proportion as mild-cured fish. These products are choice items in many world markets, but particularly in the United States and Canada. (Prepared by the Nanaimo Biological Station of the Fisheries Research Board of Canada).

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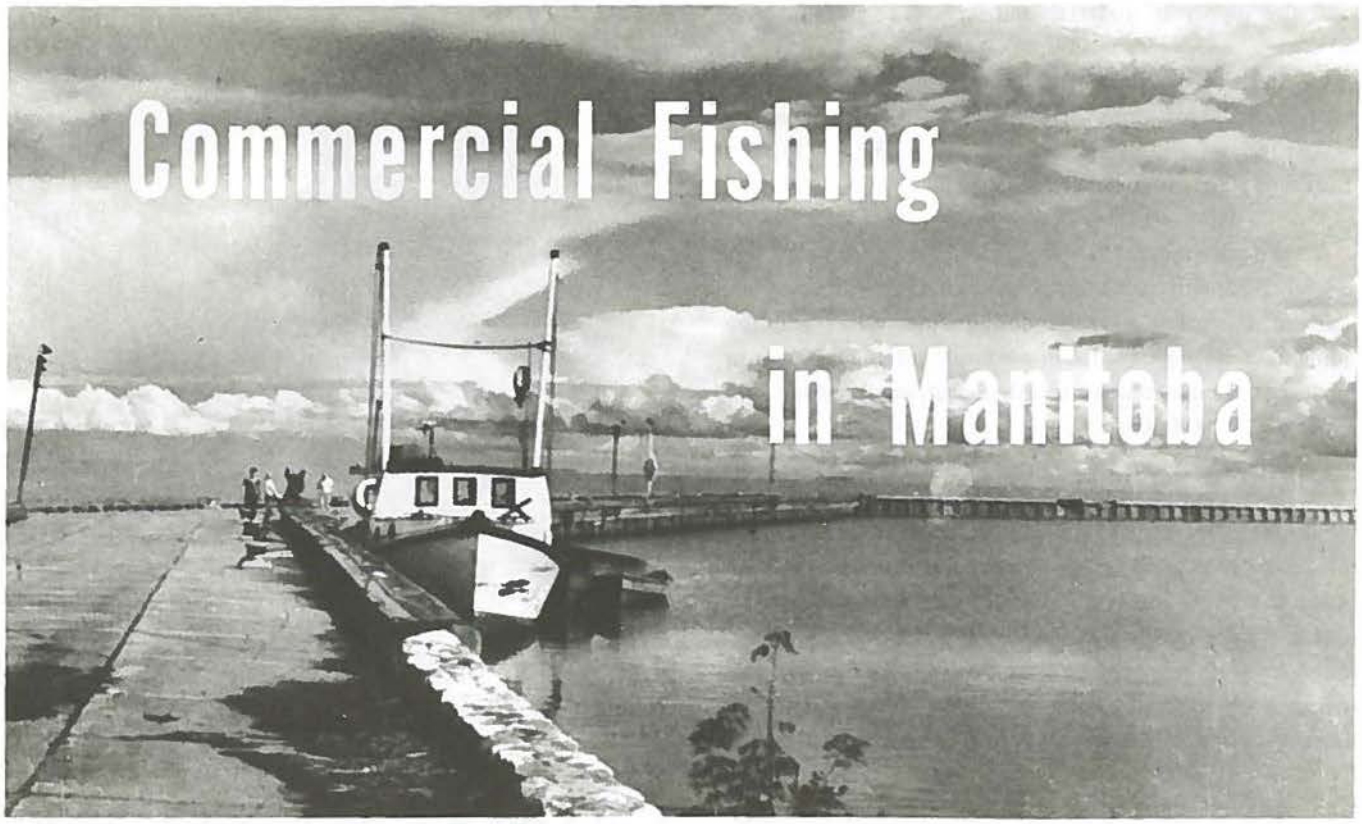
FISHERIES FACT SHEET

Commercial Fishing in Manitoba



Manitoba Department of Mines and Natural Resources photo.

BY J.G.K. BARRIE

ALMOST 30 per cent of the total fresh water in the world lies in a crescent-shaped area of Central Canada, bounded by the Northwest Territories to the north and Lakes Ontario and Erie to the south. Situated in the geographical centre of this area is the Province of Manitoba, and it is not surprising that the province ranks as one of the most important locations of freshwater fishing interests in the North American continent.

The federal Department of Fisheries and Forestry has its Regional Headquarters in Winnipeg, Manitoba, to serve the fishing interests in the Northwest Territories, Alberta, Saskatchewan, Manitoba and Ontario. Also in that city, the Fisheries Research Board of Canada has set up a research and development station, known as the Freshwater Institute.

There are approximately 39,000 square miles of freshwater in Manitoba. Of this, only 22,000 square miles are presently being fished commercially. As more roads and airports are being extended into the north, lakes are being made accessible for commercial fishing. At the present time two-thirds of the total fish harvested in the province comes from the abundant waters of Lakes Winnipeg, Winnipegosis and Manitoba.

80 DIFFERENT SPECIES

There are 80 different species of fish known to inhabit the province's lakes and rivers. However, only 15 species, or groups of species, are of any significant commercial value. Whitefish accounts for the greatest volume, followed by pike, pickerel, suckers and sauger. Other stocks fished commercially are carp, goldeye, bass (i.e. freshwater drum), bullheads, catfish, tullibee, perch, lake trout, burbot and sturgeon. Not all species are found in all lakes but scientists are carrying out investigations exploring the possibility of introducing new uses for underutilized species and for selected introductions in particular situations.

Some 3,400 persons are employed in the primary commercial fishing industry, with approximately an equal number deriving part of their living from fish processing

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and the supply of materials and services to the industry.

In 1966-67, Lake Winnipeg produced 8,063,600 lb. of fish, Lake Manitoba 6,510,200 lb., Lake Winnipegosis 4,330,100 lb. and other southern lakes 659,100 lb. The northern lakes produced 10,367,300 lb.

Total value to fishermen in 1966-67 was $4,787,502, with a marketed value of $7,544,700. About half of the catch is taken during open water and the remainder through the ice in winter. Capital investment in boats, gear, warehouses and other equipment amounts to close to $4,000,000.

It is ironic that one species of fish bearing the name Winnipeg goldeye, which was once abundant in the waters of Lake Winnipeg, has declined to the extent that the main source locally comes from Lakes Winnipegosis and Cedar and the Saskatchewan and Churchill Rivers. Smoked Winnipeg goldeye is still a gourmet's delight but where it once was available in volume, today it must be imported to meet the market demand.

There is some difficulty in tracing the history of the freshwater fishing industry in Manitoba as few records were kept until late in the 19th century. Archives provide some reference to the importance of fish as food to the early settlers who came to Fort Garry (now Winnipeg)

Hauling in nets at Horse Island, Manitoba.

Manitoba conservation inspector checks size of nets used by freshwater fishermen.

around 1822. They settled along the banks of the Red River and Lake Winnipeg and fished these waters for their own needs. Of course to the many Indians who lived in the forest area, Manitoba waters were a natural and abundant source of food to be stored or smoked and dried for winter.

The first known record of a commercial fishing operation in the province dates back to 1872. A report on file from the Manitoba Fisheries Commission of 1910-11 related an unprofitable venture of several far-sighted Winnipeg businessmen who backed the outfitting of a sailing vessel to fish in Lake Winnipeg and thereby establishing a supply for local fish markets.

The real breakthrough as a new industry came ten years later in 1882, when a small sailing boat set out on the same lake with the same purpose in mind. It is reported that in a relatively short time the fishermen landed 127,000 pounds of whitefish that realized a return of $4,000 to these enterprising pioneer operators. It was not long before other fishermen were attracted to the area to reap the rich resource of fish that Lake Winnipeg offered. By 1889, returns were reported to have grown from the modest $4,000 to $167,000.

In 1892 the fishing industry of Manitoba came of age. Two hundred and fifty commercial fishermen landed

approximately 4,000,000 lbs. of fish with a value, in that era, of an estimated $250,000. In a short time fishermen also found Lake Manitoba and Lake Winnipegosis to be valuable fish-producing lakes. From 1895 to the present day, Manitoba's fishing industry has grown steadily to become known as a prime producer of quality fish for markets in Canada, United States, and Europe. The United States, as a major fish market, was introduced to Manitoba's fish when the railway between St. Paul, Minnesota, and Winnipeg was opened in 1878. Then, as now, shipments by both rail and truck move the short distance between Winnipeg and American cities, to be distributed to waiting markets.

TECHNICAL ADVANCES

Most of the fishing in the province is carried on during regular seasonal periods when the waters are open to commercial fishing. Like all other industries of the present day, techniques, boats and equipment are being constantly improved to make today's fisherman a competitive producer of a quality product. In recognition of this, the Manitoba Department of Mines and Natural Resources has recently established a residential school for fishermen. It is located at Hnausa, Manitoba, on the west side of Lake Winnipeg and is the only one of its kind in Canada. Here, fishermen who have already obtained the basic knowledge of the industry are given modern advanced classroom and practical on-the-lake fishing instruction. Through continuing co-operation, federal and provincial fisheries officers will assist in making the school's graduates conscious of the need to keep the quality of marketable fish high and their operation methods profitable.

The transporting of fish to market has undergone changes as well. Where once teams of horses were used to haul fish, now modern refrigerated trucks speed over the network of smooth highways. In winter, snow vehicles have replaced horses and dog sleds. Aircraft are often used to bring fish from remote lakes to central shipping points for packaging and re-shipment to Winnipeg.

As a valuable renewable resource, fishing is a heritage handed down from generation to generation. To guard against its depletion, the Provincial Department of Mines and Natural Resources has a staff of Conservation Officers patrolling the lakes, streams and adjacent areas constantly watchful of both commercial and sports fishing. Licences are issued and catches inspected to make sure there is no abuse or misuse of the lakes and fish.

Under the terms of the British North America Act, the control and regulation of all fishing within Canadian boundaries is the responsibility of the Government of Canada. However, by agreement some provinces, including Manitoba, administer fishery regulations formulated and enacted by the Government of Canada.

The Provincial department of fisheries, in addition

Fishermen arrive by air to set up camp for winter fishing operations at West Rat Lake, Manitoba.

to the enforcement of fishing regulations, is also interested in the scientific development and research. Stocks of fish from hatcheries located in Whiteshell Park and other parts of the province are planted in many of the lakes. In addition to this, fish tagging to trace movements and monitoring of the size and composition of commercial stocks as well as biological surveys are carried out in a planned program.

FRESHWATER INSTITUTE

Co-operating in the scientific research of fishing, and related interests, is the Freshwater Institute, a biological, technological and environmental organization of the Fisheries Research Board of Canada. The Freshwater Institute, located on the campus of the University of Manitoba, was established in September, 1966, under the authority of the Minister of Fisheries of Canada. It is unique in Canada and deals entirely with the freshwater fishing and resources.

Three main sections co-operate in scientific research: the Population Dynamics Section carrying out studies of fish growth, fish population and the establishment of the fish capacity of a lake or stream; the Technological Section, interested in new uses for more species of fish, better production methods and the scientific research of each species of freshwater fish; and the Eutrophication or Pollution Section where scientists carry on a ceaseless fight against the growing problem of water pollution by probing lake bottoms, analysing streams emptying into lakes, searching to ascertain how present pollution may be counteracted and what effect pollutants and nutrient enrichments have on species of fish and their food.

Apart from the commercial fishing aspect, sports fishermen play an important role in Manitoba's economy. Although the total annual catch is, of course, below the commercial counterpart, nevertheless this yield accounts for several tons each year. Attractive fishing areas in Manitoba like Riding Mountain Park, Flin Fon, Grand Rapids and the beautiful Whiteshell Provincial Park, all attract thousands of tourists each year from Canada and United States. At one time, visiting and resident anglers only fished in the lakes and streams from spring until freeze-up. Today, with the growing popularity and number of snow vehicles, many of the favorite places once referred to as "summer resorts" in the province remain open all year and cater to the sport of ice fishing during the winter.

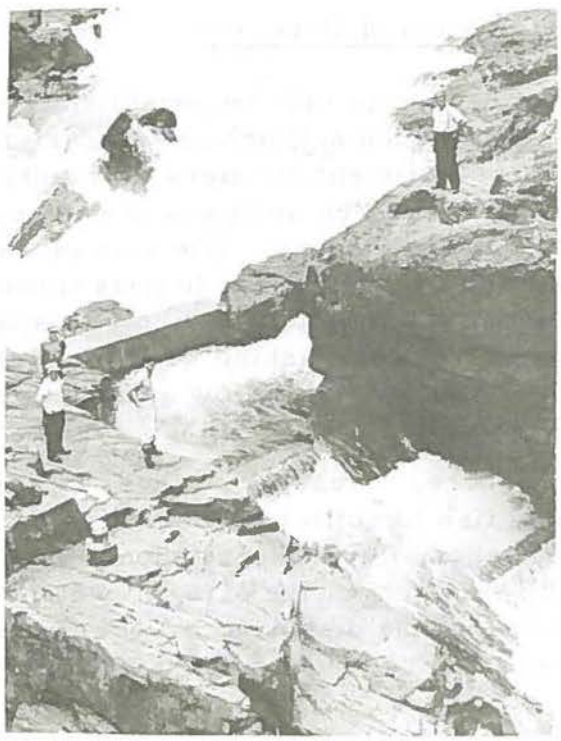
With proper conservation of the fish and the lakes, improved fishing methods and marketing, there is no reason to doubt that future generations of Manitoba fishermen will continue to produce fish and fish products that have gained an enviable reputation in Canada and indeed the whole continent.

Fisherman setting out from camp to place nets under the ice at West Rat Lake, Manitoba. Snow vehicles have now replaced horses in freshwater fishing.

FISHERIES FACT SHEET

CONSERVATION MEASURES

The fisheries should be regarded as annual crops and developed and reaped in much the same way as land crops to give the greatest continuous return to the largest number without jeopardizing future production. Therefore conservation in respect to the fisheries, a renewable natural resource, means the kind of control and management that will permit man to make the maximum exploitation in perpetuity.



Salmon Ladder
(Stamp Falls, B.C.)

Protective measures are embodied in the Fisheries Act and Fishery Regulations and are enforced by a protective service which includes wardens, inspectors and supervisors who carry on patrols on land, on water, and to some extent from the air, to prevent undue exploitation and illegal fishing.

Minimum size limits are enforced to prevent young fish from being caught until they have reached an age or a size where the majority may reproduce their kind at least once. Bag limits enable the fishermen to take a reasonable number of fish per day but require them to leave some for the next fisherman. Seasonal catch limits or quotas restrict the total quantity of fish that may be taken lawfully from a body of water during the year on the assumption that the catch should not exceed the natural increase for the same period.

Closed Seasons, Annual or Extended

Annual closed seasons are the periods during each year, when no individuals of a species designated may be taken legally. They usually cover the period when fish are congregating on their spawning beds, as well as their spawning season. Protection during this period is of the utmost importance, because not only are the fish more readily taken than at other seasons but all the eggs (which are potentially young fish) that they might have laid, would be lost after the fish had passed all the hazards, both natural and artificial. The fishery would thus be so much the poorer.

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Conservation Measures (Cont'd)

Extended close seasons may cover a period of one or more years and are employed to build up a limited or partially depleted fishery or to permit non-native or introduced species to reach a size where most of them will have spawned at least once.

Protection of Escapement by Regulation of Nets, etc.

Boundaries within which fishing is not permitted may be established or extended, or fishing may be prohibited, should such action be necessary to permit fish to reach the spawning grounds in sufficient numbers to maintain the fishery. The regulation of escapement is based on analyses of catches of previous years and the general condition of the fishery. The size of the mesh of nets is regulated to permit small and immature fish to pass through until they reach legal size or the age at which the majority is likely to spawn at least once. Where conditions call for such action, fishing gear is placed so as to leave open a portion of the channel that the fish follow and thus permit a fair proportion to reach their spawning grounds.

The discharge or drainage from any source, - vessels, mines, factories, sawmills, etc., - into water frequented by fish in sufficient quantities to be injurious to fish life is prohibited by the Fishery Regulations. Some of these discharges are directly poisonous to fish, some cover the stream bed and destroy natural fish foods, some decompose and use up the dissolved oxygen in the water that is necessary to support fish life, while others cause mechanical injury to the fishes' gills.

Regulation of Screens, Obstructions, Fishways

The screening of inlets to irrigation ditches is required under the Regulations. Without such screens extremely heavy losses may sometimes be caused by fish following the ditches and being carried on to the irrigated lands. The screening of inlets leading to power plants is also required to prevent fish from being drawn into and destroyed in the turbines.

Many species of fish spend the greater portion of their life and attain their growth in lakes, the deeper portions of rivers or in the sea, while their most suitable spawning grounds or their only spawning grounds and the nurseries for their young are much further upstream, in streams tributary to lakes or in small headwater brooks. Log jams or accumulations of debris, waterfalls or power dams may prevent fish from reaching excellent spawning grounds and nurseries. Such conditions are remedied by removing or opening the jams, modifying or lessening the ascent at the falls to ease the passage, or by means of fishways that enable the fish to surmount falls or dams, thus increasing the productive area of the system to the extent to which suitable spawning grounds or nurseries are made accessible.

Conservation Measures (Cont'd)

The use of explosives for killing fish is also prohibited. Dynamite and other explosives, besides being most "unsportsmanlike", destroy old and young alike and may cause great damage to the fisheries.

Fish Culture

"Fish culture" is the term applied to the collection of fish eggs, the hatching of the eggs and the rearing of the young fish (fry and fingerlings) in hatcheries, rearing tanks and ponds, and the stocking and management of lakes and streams so that they may produce the largest annual crops of the best species of fish that the different kinds of water are capable of producing. Fish culture in its relation to water areas is, therefore, analogous to agriculture in its relation to land crops. Agricultural problems have been for many years or are the subject of intensive research, while in comparison fish cultural research relating to the management and development of water areas is only in its beginning. On the other hand, fish culture as it relates to the collection, fertilization, and hatching of eggs, the rearing of the young fish and the development of high class brood stocks of some species has reached a high state of efficiency.

Fish culture, however, supplements but does not replace natural reproduction, except in instances where natural reproduction is non-existent. Natural reproduction may be absent in lakes or streams that are quite suitable for young and adult fish because there are no suitable spawning grounds or because the quality of the water kills the eggs yet young fish may be able to live and grow well therein.

In natural reproduction, there are a number of factors both controllable and uncontrollable, which may affect the resultant hatch. Predators such as bears and eagles may kill the adults before or during spawning. Other fish may eat the eggs. Late running fish may in the course of their spawning, disturb eggs previously deposited. Fish may spawn during freshets on high bars from which the water will drop later. For species which spawn in the autumn, there is the danger of low water levels in the winter and freezing of the beds if the snow cover is limited. Severe freshets may scour the eggs out of the redds.

Artificial propagation is designed to give protection from these difficulties through regulated flow. The young fry are protected in tanks and the product is finally carefully distributed. In such a procedure, however, only relatively small numbers may be handled.

In Canada, fish cultural services, including hatcheries, rearing ponds for fish of different ages from the newly hatched fry to adults, are maintained and operated by the Department of Fisheries, the National Parks Bureau of the Department of Resources and Development and the Provinces of Quebec, Ontario, Manitoba, Saskatchewan, Alberta and British Columbia.

Remedial Measures, Stream and Lake Improvement

Some waters are deficient in spawning grounds, suitable shelter for the young fish, suitable habitat for the adults at some seasons of the year, or suitable natural food for the fish at certain stages of their growth. In some cases,

Conservation Measures (Cont'd)

these deficiencies may be improved or remedied by building spawning beds of gravel. Shelter for the young may be improved or provided by the introduction of aquatic vegetation or by rock and brush piles, logs or piles of stone. Some waters are not congenial or suitable for adult fish at certain seasons of the year on account of shallow water or lack of pools. Pools may be provided by logs placed across a stream, by deflecting, straight or V-shaped dams, thus providing suitable habitat during the warm weather low water periods of the summer, or during the low water period of the winter months. Natural food conditions in some instances may also be improved by the establishment of aquatic vegetation, which usually carries considerable insect life. Sometimes, food conditions for the newly-hatched fry are excellent, but there is a deficiency of suitable food in the shape of minnows for the larger fish. This deficiency may be remedied to some extent by the introduction of minnows to fill this break in the food chain.

Most bodies of water are capable of producing a certain poundage of fish each year. This crop may be in the form of a small number of large fish or a larger number of small fish. A large number of small fish may be due to an insufficiency of natural food to produce normal growth and might possibly be remedied to some extent by more intensive fishing.

Competitors for the available food supply or predatory fish may tend to keep the annual crop of desirable fish at a low level. In some instances this condition may be improved or remedied by reducing or removing the competitors and predators. Reduction of competitor and predator fish is a difficult matter and should only be undertaken with the advice of a competent fish cultural officer.

In some instances, much damage has been caused to streams and portions of lakes by the methods followed in lumbering operations which tend to cause: a quick run-off and lower water levels below the needs of the fish, severe freshets with destructive soil erosion, flooding, silting of spawning beds and scouring of stream bottoms, which lessens and may even prevent or destroy natural reproduction of the fish as well as the production of natural fish food organisms. Where conservative methods have been followed these damaging conditions have not been severe and in most instances conditions may be improved by reforestation involving the control of soil erosion and eventually the moderation of freshets of a serious nature.

Fish and Game Protective Associations and local organizations can be of the greatest assistance in maintaining the fisheries by good example, by discouraging illegalities and by co-operating closely with the Protective Service. In a few instances such organizations have engaged actively and successfully in fish cultural work, particularly in building, maintaining and operating ponds in which small fish or "fry" are retained and fed for several months before they are distributed in suitable waters.

FISHERIES FACT SHEET

DOGFISH (Pacific)

Distribution and Importance

The Pacific dogfish (Squalus suckleyi) is found from southern California to northwestern Alaska. Of all the shark species caught in British Columbia waters the dogfish is by far the most important. It is important not as a food fish but as a source of vitamin A which is obtained from its liver. Once the livers have been removed, the carcasses are usually discarded at sea by the fishermen. Attempts to market the flesh of the dogfish as fresh or canned fish have proved unsuccessful. Some industrial companies have used the carcasses for reduction into oil, meal, and fertilizer but this operation has been practiced only where fishing occurs within a convenient distance from a reduction plant. Difficulties involving handling and processing techniques as well as the problem of maintaining a continuous supply of raw material has limited the success and profit in reducing carcasses.

Increased requirements for vitamin A during World War II brought about a very rapid growth of the dogfish liver industry and fishery. Landings of dogfish livers increased from 178,000 pounds valued at $10,702 in 1937 to a peak of 7,769,564 pounds valued at $2,661,573 in 1944. In 1944 a marketed value of $3,751,567 for the livers, liver oil, meal, and fertilizer placed the fishery third in importance in British Columbia and fifth in importance in all of Canada. It was exceeded only by the salmon, cod, herring and lobster fisheries.

The introduction of synthetic vitamin A and the importation of considerable quantities of vitamin liver products from Japan since 1949 has caused a decline in demand for British Columbia dogfish livers. The future of this branch of the industry is now somewhat uncertain.

Description

The dogfish is a small shark and like other sharks, it is characterized by a cartilaginous skeleton rather than a bony skeleton. Its

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mouth is situated on the under side of the head well behind the snout and its jaws are covered with many sharp teeth in several rows. Five pairs of gill openings (instead of one as in the so-called bony fishes), a spiracle close behind the eye, the absence of an anal fin, and the presence of two dorsal fins, each of which is preceded by a sharp stout spine, readily distinguish the dogfish from other sharks found in this area. In colour the dogfish is slate gray on the dorsal surface and dirty white on the ventral surface. White or yellowish spots are present on the sides of young dogfish.

Reproduction and Maturity of Dogfish

Dogfish give birth to living young. Mating time occurs during the months of November and December, usually after the female has given birth to her young. In the male, parts of the pelvic fins are modified to form claspers which make possible the fertilization of the eggs within the body of the female. The fertilized eggs, with much yolk (larger than the yolk in a chicken's egg), descend to the uterus and are found enclosed in a thin, light amber-coloured gelatinous or membranous capsule called a "candle". After a period of a few months this capsule or "candle" breaks down or is shed, leaving the young unattached within the uterus of the mother. While the embryos are growing, new ovarian eggs are developing to take their place. It is known that the gestation period, or the period of development of the young dogfish inside the mother, has a duration of two years. At birth the young are between 10 and 11 inches long. The number of young in a single litter may range from 2 to 17, but the most usual number is seven or eight.

Maturity in the males is attained at a length of 27 to 30 inches, and 31 to 36 inches in the female.

Age and Growth

The alternate dark and light rings on the second dorsal spine have been used in the age determination of the dogfish. Annulations on the spines of the dogfish are the result of periods of fast growth during the summer months (light rings), and periods of retarded growth during the winter months (dark rings). These annulations indicate that some dogfish may live to reach an age of about 30 years.

Male dogfish attain a length of 39 inches and a weight of about eight pounds. The females may reach a length of five feet but seldom

Pacific Dogfish (cont'd.)

exceed a length of four feet and a weight of 20 pounds. The rate of growth of both sexes is between one and 1-1/2 inches each year.

Food

Dogfish are voracious in their food habits. They feed predominantly upon small fishes such as the pilchard, herring, anchovy, smelt, and flatfishes. Other items in their diet include small crabs, squid and brill or euphausiids (small shrimp-like crustaceans).

The predacious food habits of the dogfish have caused great concern in other fisheries in the past. At times bounties for its destruction have been recommended because of the damage to fishing gear and netted fish. This interference is especially noticeable in the salmon and herring fisheries.

Schooling Habits and Migration

Schools of immature dogfish usually contain about equal numbers of males and females. However, segregation of the sexes into separate schools seems to become a common occurrence once maturity is reached. Fishermen often find large schools travelling in the offshore waters. Their movements northward in summer and southward in winter in the waters off the coasts of California, Oregon, Washington, and British Columbia have been demonstrated by tagging experiments. The tagged fish are easily detected by fishermen recovering the marked dogfish in their catches at a later date. A distance of over 1200 miles has been recorded for one dogfish, which travelled from the eastern coast of the Queen Charlotte Islands southward to the waters off Santa Cruz, California, during the period from September, 1945 to March, 1946.

Fishing Methods

Three different types of fishing gear are utilized in catching dogfish in British Columbia. Otter trawls are used extensively in all inshore and offshore waters, but are limited to grounds where the type of bottom is suitable for trawling.

Dogfish are caught by long-line or hook and line gear operated by boats rigged specially for fishing dogfish. However, considerable

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Pacific Dogfish (cont'd.)

quantities are caught incidentaly by halibut and blackcod vessels. This type of gear is particularly effective over reefs, in swift tidal waters, in depths of 100 fathoms or more, close to shore, and in areas where other types of fishing gear cannot be employed.

Sunken gill nets have been employed successfully in Hecate Strait and off the west coast of Vancouver Island. The mesh size of the sunken gill nets is such that only the largest dogfish, those with highest vitamin A concentration in their livers, are caught, whereas the smaller individuals of no commercial value pass through the webbing.

No. 64

FISHERIES FACT SHEET

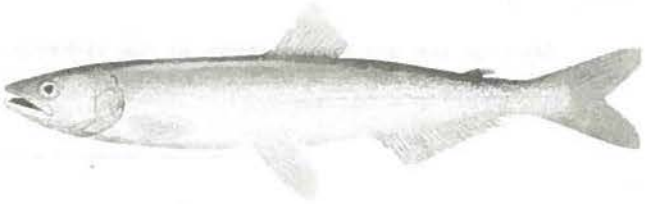
Eulachon, Anchovy and Pilchard

Eulachon

THE EULACHON *(Thaleichthys pacificus)* is a small delicate fish of the smelt family and supports one of the oldest fisheries in British Columbia. Eulachons are rich in oil and have been used by Indians for centuries either as food, or when dried and fitted with a wick of the inner bark of the cedar tree, as candles. The eulachon also forms an important source of food for birds, mammals and other fish.

Eulachons are bluish-brown in color, about 8 inches long and weigh only a few ounces. They have an adipose fin and fine parallel lines on the gill cover. The mouth is relatively large and during their marine existence it contains pointed teeth. These teeth are lost later during spawning runs into fresh water. The males do not attain as great a size as the females.

Although the eulachon is essentally a marine species it reproduces in fresh water, ascending the larger rivers (particularly the Nass and Fraser) during March-May to spawn. The male fish exhibit special breeding characteristics: lengthening of the fins, thickening of the bodywall muscles and growth of small, round swellings on the head and some scales. Most eulachons spawn towards the end of their second year, usually spawning but once and dying soon after. An average-sized female spawns about 25,000 eggs. The adhesive eggs are anchored to sand grains on the river bottom. The eggs hatch in 2-3 weeks and the infant fish drift down to the sea where they develop to maturity.



Eulachon *(Thaleichthys pacificus)*

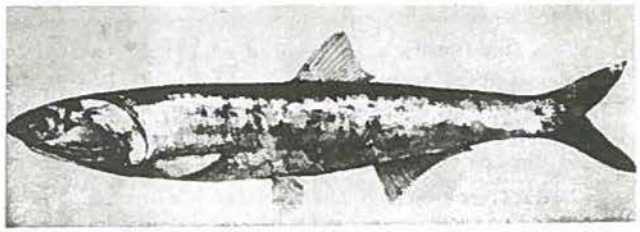
The present-day commercial fishery is of only minor importance and is limited to the Fraser River where eulachons are taken with drifting gill nets. The catch is used fresh or smoked and as food for fur-bearing animals. From 1958-62 the annual catch averaged 150 tons, worth about $26,000. The largest annual catch was in 1906 when 603 tons were taken. The coastal Indians have always placed a high value on eulachons as food, a source of light, medicine and for barter.

The name "eulachon" comes from the Chinook language of British Columbia's coastal Indians. Spellings that have appeared in print over the years include: hoolakan, hooligan, hoolikan, olachan, ollachan, oolachon, ollichan, oulachan, oulachon, oulacon, ulchen, ulichan, uthlecan and yshuh. Such variety is believed due to the difficulty the white settlers of different nationalities had in pronouncing the name. Eulachon are also known as candlefish.

Anchovy

The northern anchovy *(Engraulis mordax)* ranges from California to British Columbia. It is found in southern British Columbia inlets in limited numbers only and is of no great importance commercially. It is a pelagic fish, typically moving in schools and feeding largely on plankton.

The anchovy belongs to the *Engraulidae* family and is characterized by a very large mouth and large eyes near the tip of the snout. The 5-6 inch long body is spindle-shaped with metallic blue color-



Northern Anchovy *(Engraulis mordax)*

Department of Fisheries and Forestry

Ottawa

ing on the back shading into silvery sides. The anchovy was first recorded in British Columbia waters in 1866.

During the 1940's anchovies were quite abundant in the Strait of Georgia. Five million pounds of anchovies were taken annually from this region during World War II. The marketed value of anchovy products (mainly canned) in 1946 reached $600,000. After the war the inshore stocks of this species dwindled and no anchovies have been landed in British Columbia since 1954. Today, anchovy stocks are present in offshore waters but they are not particularly large. Reduction of anchovies to meal and oil is not profitable because of the low oil content.

Most of the anchovies taken in the fisheries during the 1940's were 3 to 4 years of age. Very few were older than 7 years or larger than 7 inches. The inshore stocks exploited in the 1940's appear to be distinct from offshore spawning populations. The latter stocks spawn many miles out to sea. Young anchovies have been found in the stomachs of tuna 200 miles offshore.

Anchovies mature in their third year and by June the females have ripened three batches of eggs. Multiple spawnings occur and about 150,000 eggs are liberated in 3 or more batches each year. The eggs are colorless and hatch near the surface about 62 hours after fertilization.

Little information exists on the size and distribution of present anchovy stocks in British Columbia, but it would appear very unlikely that catches as large as those made during the 1940's would be possible today.

Pilchard

The pilchard or Pacific sardine *(Sardinops sagax)* formerly supported a fishery averaging 62,000 tons annually on the west coast of Vancouver Island. Since 1947, however, there have been only scattered reports of the presence of this species off the British Columbia coast.

The pilchard is a moderate-sized fish 9 to 10 inches long, of the herring family. The body is round in cross-section with black spots on the back and sides of a steel-blue upper body. The young of the pilchard is regarded in some countries as the true sardine, as the latter name was first applied to the young of the Mediterranean pilchard caught off the Island of Sardinia.

Pilchards are highly migratory. Tagging experiments along the west coast of the United States showed a definite north-south migration pattern with older fish reaching British Columbia waters. The centre of pilchard abundance lay off southern California, but in the 1920's and 1930's, when stocks were plentiful, adult pilchards migrated northward each year in sufficient numbers to provide a summer, purse-seine fishery off the British Columbia coast.

In the 1940's a southward shift in the centre of the spawning population to off Baja California, apparently occurred. This shift coupled with heavy exploitation and poor spawning seasons reduced the pilchard stocks to the point where by 1947 few fish reached the British Columbia coast, and the pilchard eventually disappeared from Canadian waters. Between 1927 and 1947 the Canadian

Pilchard *(Sardinops sagax)*

pilchard landings exceeded 80,000 tons three times and three times they were less than 5,000 tons. Nearly all of the catch was reduced to fishmeal and oil.

Spawning takes place in a large area within 100 miles of the coast off southern California and off Baja California, from March to May. The eggs float freely near the surface. Each female spawns several times in one season liberating 50,000 eggs per season.

The pilchards may return to Canadian waters if the centre of spawning shifts northward and if the stocks regain some of their former abundance.

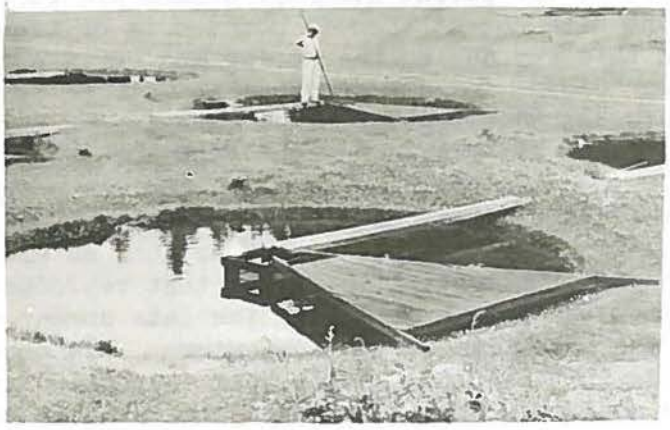
(Prepared by the Nanaimo Biological Station of the Fisheries Research Board of Canada).

April, 1967

FISHERIES FACT SHEET

FISH HATCHERIES

Fish hatcheries are establishments where fish eggs are hatched and where the young fish or "fry" are retained and fed for varying periods, sometimes for several seasons until they have been stripped of their eggs and milt for fish cultural purposes, or, until it is no longer economical to continue to do so because of lessened production.



Federal trout rearing ponds
Cardigan, P.E.I.

The term "Fish Hatchery" describes the buildings, ponds and equipment used in hatching fish eggs and rearing fish.

Fish culture in Canada is carried on in the interest of the more important freshwater and anadromous fishes such as Atlantic salmon and speckled trout in the East; whitefish, lake herring, salmon trout or lake trout, speckled trout, pickerel, bass and maskinonge in the Interior; and rainbow, Kamloops and cutthroat trout in the West.

Object of Fish Culture

Fish Culture interpreted in the broad sense in its relation to water crops is analogous to agriculture in its relation to land crops. The object of fish culture is to help conserve and maintain the fisheries against depletion, and, at the same time, enable them to be utilized to the fullest possible extent. It includes the stocking of suitable barren waters with desirable species of fish to make them productive, the replenishing of depleted streams and lakes and the encouraging and maintaining of fish life generally. It also includes stream management, building and maintaining fishways, removal of obstructions, fry salvage, control of depredations by birds, control of pollution, and fish predators, fertilization of waters, removal of undesirable fish through poisoning and testing and applying results of fishery research.

The adults or parent fish from which the eggs are obtained are captured in various ways depending upon the species, the topography of the country and the nature of the streams and lakes in which the fish are caught.

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Obtaining the Eggs

Whitefish, pickerel and salmon trout are usually taken in pound-nets. A considerable portion of the parent Atlantic salmon are purchased from commercial fishermen who have caught them in pound-nets or trap-nets. Salmon which are secured in this way during the spring and early summer are held in ponds until they "ripen" and are stripped in October or November following. In some instances advantage is taken of existing barriers or dams and in other cases rivers are fenced and the fish are trapped by intercepting them on their way to the spawning grounds. Salmon caught in this way are usually near the spawning period and consequently they are not held in pens or ponds, until they "ripen", nearly as long as are salmon caught in the spring of the year. All Atlantic salmon that reproduce, whether they are caught during the spring or during the late summer or autumn months, spawn about the same time during the autumn. Kamloops, rainbow and cutthroat trout spawn in the spring of the year. Speckled trout spawn in the autumn and are sometimes caught in traps set in lakes or in streams, but most speckled trout eggs hatched by the federal Department of Fisheries, are obtained from adult fish that have been reared in ponds and maintained at the various hatcheries.

The eggs of all fish propagated by the Department are hatched in running water. Salmon and trout eggs are hatched in trays or baskets in troughs. The water is almost invariably obtained by gravity from running streams. It is piped into head troughs in the hatcheries. From there it flows by gravity into the individual hatching troughs. The quantity in all instances is controlled by valves and may be lessened or increased as may be required.

The eggs of whitefish, lake herring and pickerel are semi-buoyant as compared with salmon and trout eggs. Semi-buoyant, or lighter eggs, are hatched in jars. The water used is usually pumped from a lake into a large overhead tank in the hatchery. From the tank it is distributed by gravity and is carried in a regulated flow through a tube to the bottom of each jar. The water, in its upward flow from the bottom of the jar keeps up a gently boiling motion amongst the eggs. This motion carries the dead and infertile eggs, which are lighter than the good ones, to the tops of the jars from which they are readily removed.

Bass have not as yet been stripped successfully as have many other species. It is therefore the practice to place the proper number of pairs of adult bass in prepared ponds that are under control at all times and in which the proper number of prepared spawning beds or nests have been provided. The bass spawn on these prepared beds or nests. The adult bass keep the eggs clean and free from sediment and guard both the eggs and the fry from their enemies until the fry rise from the spawning beds and begin to disperse. The adult bass are then removed from the ponds and the young bass survive on natural or artificial food.

The stripping of fish and the fertilizing and handling of their eggs are comparatively simple operations but require the greatest care at all

Fish Hatcheries (Cont'd.)

stages. Stripping, or taking the eggs artificially, is done by exerting a gentle pressure of the hand on the abdomen of the female fish, which, if the fish is "ripe", causes the eggs to flow into a stripping pan that has been rinsed in clean unadulterated cold water. The male fish is stripped in the same way. The eggs from the female and the milt from the male fish are gently but thoroughly mixed as they are extruded. When the stripping pan contains a sufficient quantity of eggs and milt, thoroughly mixed, a little water is added, the contents of the pan gently but thoroughly stirred and allowed to stand a few minutes. More water is then added, the eggs gently stirred and the water poured off. This is repeated until all surplus milt is removed and the water comes away clear. The eggs in pans or in trays are then placed in running water in hardening tanks or in hatching troughs if they have been obtained near a hatchery. If running water is not available the eggs are kept in the pans or in the pails or tubs in a cool shaded place and the eggs which are covered with water are stirred gently at half hour intervals until they are packed in trays in cases for shipment or are transferred to a hatchery.

When fish eggs are first extruded or stripped they are soft to the touch. Fertilization takes place as soon as the milt comes in contact with them. On addition of water, absorption takes place until the eggs become quite firm to touch and are "water hardened".

Development of the Eggs

Fish eggs that are stripped or spawned during the autumn hatch during the following spring. From seven to twelve weeks after the eggs are stripped, depending upon the temperature of the water, the eyes of the fish appear as two black spots, followed by the outline of the back-bone. When the eyes are visible the eggs are in what is called the "eyed" stage. Fish eggs in the eyed stage are much less susceptible to injury from handling than they are during an earlier stage, and it is while they are eyed that long distance shipments of fish eggs are made between hatcheries.

For a short time after the egg hatches the young fish or "fry" obtains nourishment from the contents of the food sac that is attached to its abdomen. As the contents of this sac are absorbed the young fish begins to swim and takes other natural food present in the water or artificial food that is provided.

It is the practice of the Department to begin to feed fry when the food sac is slightly more than half absorbed. Up to the present, fresh beef liver ground or pulped to suit the size of the fish has been found to give the best general results with regard to growth, health and mortality. Experimental feeding of other foods and combinations of foods is carried on with a view to finding a ration that is more efficient and less expensive than

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Fish Hatcheries (Cont'd.)

liver. Some of these rations have given encouraging results but a certain amount of liver is essential.

Egg Distribution

A small portion of the annual output from the hatcheries operated by the Department is distributed as fry. A large portion is retained and fed to the advanced fry, fingerling, yearling and older stages before being distributed.

When the fish are ready to plant out they are carefully transferred from the hatching troughs, tanks or ponds to distributing cans, barrels or tanks and conveyed to the lake or stream which is to be stocked, or in which the fish are to be distributed. When the point of distribution is reached the water in the container is gradually brought to the same temperature as the water of the lake or stream by adding water from the latter to the former, pouring off, and repeating the process until the water in the container is of the proper temperature. The fish are then distributed, a few only at each place and as widely as may be feasible, over all suitable areas of the lake or stream that is being stocked.

Fish Marking

For the purpose of gaining information regarding their growth, migrations and results that are being obtained some of the fish produced in hatcheries, or handled in connection with hatcheries, may be marked before being liberated. Fingerlings and small fish are marked by clipping or removing one or more of their fins. Such fish are bathed in a salt solution and retained at the hatchery for at least ten days before they are distributed.

Thirteen hatcheries, six rearing stations and six salmon retaining ponds are operated by the Department in New Brunswick, Nova Scotia and Prince Edward Island. Their locations and the species propagated in each are indicated in the annual reports of the federal Department of Fisheries. Hatcheries are operated also by the provinces of Quebec, Ontario, Manitoba, Saskatchewan, Alberta and British Columbia and by the National Parks Bureau of the Federal Department of Northern Affairs and National Resources.

The Fisheries of Saskatchewan

BY J.G.K. BARRIE

IT MAY come as a surprise to those who tend to think of the province of Saskatchewan as "bald prairie", to learn that about one-eighth of its surface area of 251,700 square miles is water.

The water bodies that make up this 31,500 square miles, range from tiny pothole lakes in the Great Sand Hills of the southwest, to the tremendous lakes of the Precambrian Shield.....and from the tiny trout streams of the Missouri watershed, to the mighty clear cold rivers of the north such as the Churchill and Fond du Lac.

These gigantic watersheds and the tens of thousands of lakes and ponds that drain into them comprise a vast number of environments that provide a basis for one of Canada's major inland fisheries.

Fish invaded the water areas of what is now the Province of Saskatchewan sometime after the disappearance of the last glacial age. During the post-glacial period, American Indians probably occupied this region and undoubtedly caught the same species of fish as are present in that area today. The fisheries played a vital role in the province's early history by providing a readily available supply of fresh food for the explorers and fur traders, and then later, the hardy pioneer settlers. Fur traders brought the first gill nets into the province.

As Saskatchewan became more settled and the economy of the province developed, the fisheries began to play a less vital role. In areas near lakes and rivers, the fish stocks were utilized for domestic purposes and even today this source of food has great significance in the diet of northern residents. There are at least 61 species of fish, comprising 17 families, to be found in these northern Saskatchewan waters. Some of the more common are whitefish, lake trout, walleye (pickerel), and northern pike. Whitefish is the province's most important commercial

Commercial fishermen pull nets from under the ice at Lac La Ronge, Saskatchewan.

Department of Fisheries and Forestry

Ottawa

stock, as it represents over 50% of the total catch. Other fish of commercial significance include lake trout, pickerel, pike, sucker, ling, tullibee, sturgeon, goldeye, buffalo fish and perch. Whitefish, pickerel and pike are the most plentiful and widely-spread species, as they are found in nearly all lakes in Saskatchewan.

MARKET VALUE

The waters in northern Saskatchewan yield annually in excess of 15,000,000 pounds of fish, of which about half is whitefish. The total market value each year means several millions of dollars to the industry. The province, which has the third largest freshwater fishery in Canada, issues about 3,000 commercial fishing licences annually.

All fish that are commercially exported out of the province to the United States, Europe or to other provinces in Canada, are inspected by the federal Department of Fisheries, who maintain permanent offices in Prince Albert as well as inspection stations at Meadow Lake and Big River. There are at present eleven fish plants in Saskatchewan that are registered and inspected by the federal Department of Fisheries. They produce about two million pounds of fillets annually.

A recent development is the harvesting of brine shrimp and brine shrimp eggs on Little Manitou Lake, a natural salt water lake near Watrous, Saskatchewan. Brine shrimp products are used as food for aquaria fish by pet fish hobbyists. Two companies harvested 500,000 lbs in 1966. The expansion of this industry to other saline lakes in the province is now being undertaken.

Ambrose Vouvier sets net for commercial fishing operation at Canoe Lake, Saskatchewan.

Approximately 250 lakes in the province are fished commercially, the vast majority of them being

Winter fishing at Last Mountain Lake, Saskatchewan. Nets are pulled off a tractor-drawn sled and "fed" into the water through holes in the ice.

Pulling nets on Peter Pond Lake near Dillon, Saskatchewan.

in the northern half of the province. The most prolific fishing grounds are Lakes Athabaska, Reindeer, Big Peter Pond and Wollaston.

Saskatchewan is one of the top Canadian producers of whitefish and lake trout. About seven million pounds of whitefish and two million pounds of lake trout are harvested annually. The industry also takes approximately six million pounds of other species such as pickerel, northern pike, sucker and cisco for a total annual harvest of fifteen million pounds. About 75% of the total is exported to United States markets. In addition to the commercial production, the mink ranch industry utilizes the "coarse" species of fish that have little other commercial value. This accounts for a harvest of five million pounds. An additional two million pounds are taken by domestic and free Indian permit fishermen.

The introduction of refrigeration, use of aircraft and the extension of roads into the north, has completely changed the complexion of Saskatchewan's fishing industry from the early days when settlers farmed in the summer and fished commercially in the winter. Until a few years ago, commercial fishing was predominantly a winter operation. However there is now a definite trend toward summer production. In 1954, 46% of the total harvest was taken in the summer season. This increased to 65% in 1965. The summer commercial fishery has become more attractive to fishermen and dealers due to the construction of modern handling and freezing facilities, the use of larger and more seaworthy fishing craft, improved transportation equipment and the building of access roads into the northern areas of the province.

Transportation is still the main difficulty in marketing fish caught in both winter and summer. It is a long way from northern lakes to cities in the southern part of the province and U.S. centres. The advent of snow vehicles has replaced the general use of dogs and the old horse and sleighs of another era, although dogs are still used in some of the remote northern areas.

Aircraft and the establishment of new plants to process and freeze the fish are chiefly responsible for the predominance of summer fishing. From northern lakes, aircraft fly the catch to be iced and packed at Beaver Lake, near the Manitoba border, close to Flin Flon. Fish are also flown from Wollaston Lake and trucked from Reindeer Lake to Lynn Lake, Manitoba. A unique situation for Saskatchewan is that fish from Athabaska Lake are transported to the railhead by barge.

SPEEDY TRANSIT

From Beaver and Lynn Lakes, this perishable food product is assured speedy transit to distant cities. Small skiffs and canoes, between 15 and 18 feet in length, are the most commonly used vessels in this fishery. A few two- or three-man boats, 38 to

40 feet in length, are also used primarily on Reindeer, Wollaston and Athabaska lakes.

The province's fisheries are administered by the Fisheries Branch of the Saskatchewan Department of Natural Resources. On the recommendations of the Royal Commission on Fisheries of the Province in 1947, a fisheries research program was inaugurated to secure information on the province's fishery resource. The first major biological and fisheries investigation was undertaken on Lac la Ronge. Since the initiation of the research program, fisheries surveys have been carried out on all major waters. Many other small lakes have been examined also.

A major step was taken in 1964 in the development of the freshwater fisheries with the establishment of the Federal-Provincial Prairie Fisheries Committee. This committee, composed of Deputy Ministers of the federal Department of Fisheries and the appropriate Departments of Manitoba, Saskatchewan and Alberta, was set up as a result of the first Federal-Provincial Fisheries Conference held in Ottawa.

Few people in the province depend on fishing exclusively for their livelihood. However, 2,000 residents derive income from this primary industry, as well as three to four hundred involved in the secondary phases of the industry. At the present time, the Co-operative Fisheries Limited operate eight of the eleven registered fish plants and a large group of the primary producers in the province utilize the service of Co-operative Fisheries Limited.

Workers at a processing plant at Lac La Ronge unload trays of fresh fish from Otter aircraft bringing a catch from Pinehouse (Snake Lake).

Fishermen remove tullibee (ciscoes) from nylon net on Last Mountain Lake. Note plywood windbreak in background.

In the last few years provincial fish culture officials have been placing great emphasis on extending the range of the Arctic grayling species from the far north into the Churchill River area, and on the introduction of eastern brook and rainbow trout and certain warm water species into areas where preliminary studies seem to indicate suitable environment.

May, 1968

FISHERIES FACT SHEET

Fishing Gear and Methods on the Pacific Coast

FISHING methods and types of gear vary between fishing areas in Canada, and between species of fish. In the past, this was largely because fishermen found, through trial-and-error, that one type of gear or operation was more efficient in taking certain species than another.

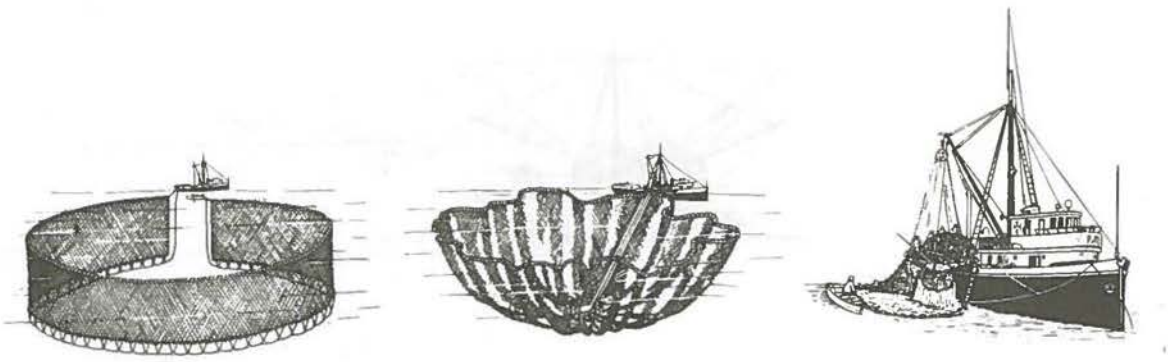
In recent years, however, scientific studies have been instituted by such agencies as the Department of Fisheries and the Fisheries Research Board of Canada to find more effective and economic methods and gear where the resource is capable of supporting larger fisheries. Usually, the type of gear, when, where and how it may be used, is regulated by the Government in the interests of conservation.

On Canada's Pacific Coast a wide variety of fishing gear is used to harvest the rich marine resources.

SALMON

The salmon are taken by three different types of vessel: the purse seiner, gillnetter and troller.

Salmon purse seiners are vessels 60' to 110' long, carrying crews of four to eight men. The purse seine is a large, small-meshed net that is carried on the stern of the vessel either on a "table" or a drum. The seine is normally over 200-fathoms in length (it cannot exceed 220 fathoms), is at least 250 meshes deep, and has floats along the top and a lead line at the bottom. The purse line passes through rings along the lead line. The seine is set over the stern of the vessel with one end secured to a skiff. The seiner then runs in a large circle around a school of fish returning to the skiff where the two ends of the seine are joined. The purse line is tightened, drawing the bottom together to form a huge purse or bag in which salmon are trapped. The seine is then hauled aboard over a power block or drum until the fish are massed in a small area close to the surface and at the side of the vessel. A dip-net or "brailer" scoops the fish from the seine and by means of a power winch, transfers them to the hold. Seiners catch all species of salmon, but their major landings are pinks, sockeye and chum.



PURSE SEINING

Purse seiners ranging in length from 60 to 110 feet catch salmon and herring. The huge net, or purse seine, is set out from a platform or table at the stern and is maneuvered to encircle a school of fish. The seine is then drawn together and the fish are dipped into the boat with a brailer, a large dip net on a long pole.

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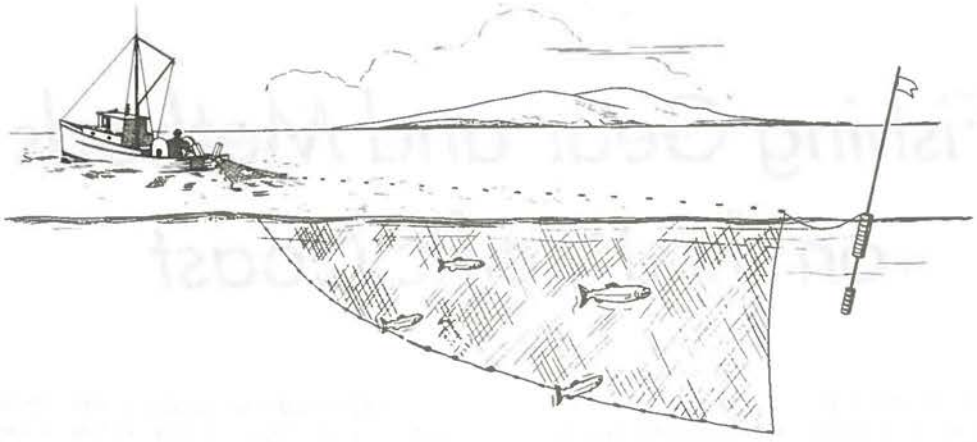
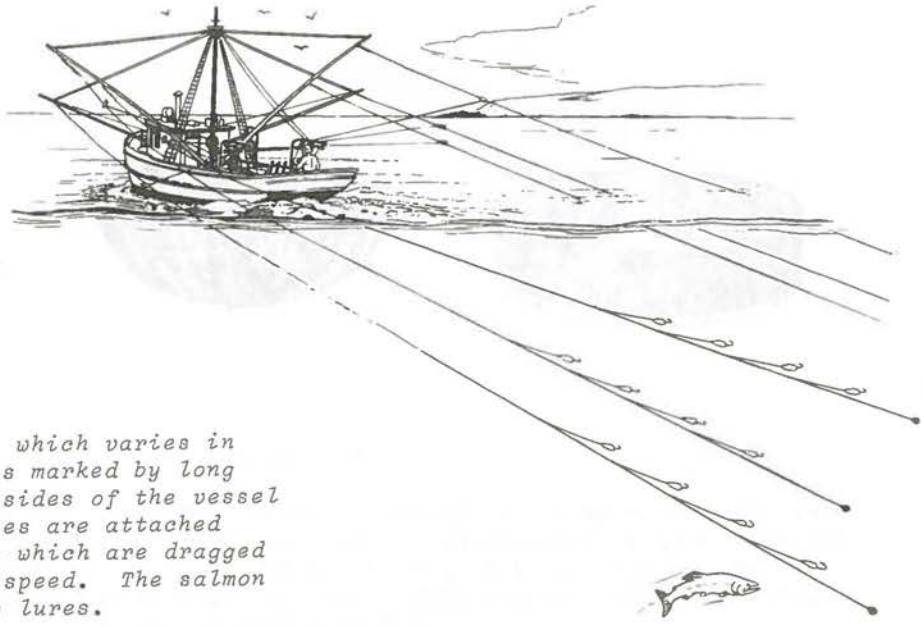


GILL NETTING

The gill netters, usually operated by one man, range upward from 30 feet in length, with large multi-purpose gill netters reaching 38 feet. These are the most popular craft for salmon fishing. From a drum at the stern the net is set out and hangs like a curtain in the water. The fish are caught by becoming entangled when they swim into the net.

Gillnetters are usually 30' to 38' boats with wooden, fibreglass or aluminum hulls. Almost without exception they are operated by one man. The gill nets, mostly of nylon mesh, are wound around a drum in the stern of the boat. The drum is operated by a power take-off from the main engine and is controlled by a clutch operated by the fisherman as he stands in the cockpit at the stern. A flag attached to a float (at night a light is used) marks the end of the gill nets to warn off other vessels. The gill net, having floats along the upper edge and a lead line at the bottom, hangs like a curtain from the surface. When the net is set, the boat and net drift for one to four hours depending upon the tides, distance from the shoreline, etc. The net is taken in by being rewound on the drum. As the net comes in over and between rollers, the fisherman pulls out the salmon. Gill nets must not be less than 75 fathoms and not greater than 200 fathoms in length, with a maximum depth of 60 meshes of uniform size. Other size limits may be demanded by the British Columbia Fishery Regulations. The mesh size may vary between seasons and the type of salmon being fished. Gillnetters' major landings are sockeye, pinks and chum.



TROLLING

The salmon catching troller, which varies in length from 30 to 48 feet, is marked by long poles which extend over the sides of the vessel while fishing. To these poles are attached weighted lines bearing lures which are dragged through the water at a slow speed. The salmon are caught on the lures.

The troller fishes salmon with hooks and lures that are dragged on four or six lines behind and at the sides of the boat. The typical troller has two long poles fastened to the deck or rail aft of the cabin. These poles, which extend out from the sides of the boat when fishing, carry pulleys or blocks through which the lines run. Two additional lines go through pulleys over the stern of the boat. The lines are controlled by powered gurdies equipped with a clutch similar to that used for the gill net drum. The troller moves slowly through the water and, when a fish strikes, the line is drawn in, the salmon taken from the hook and the line returned to fishing order. The depth at which gear is trolled can be varied by the speed of the boat, or by the weight of a sinker called a "cannonball" at the end of the line. Spring and coho salmon are the main species taken by the trollers.

HALIBUT AND BLACK COD

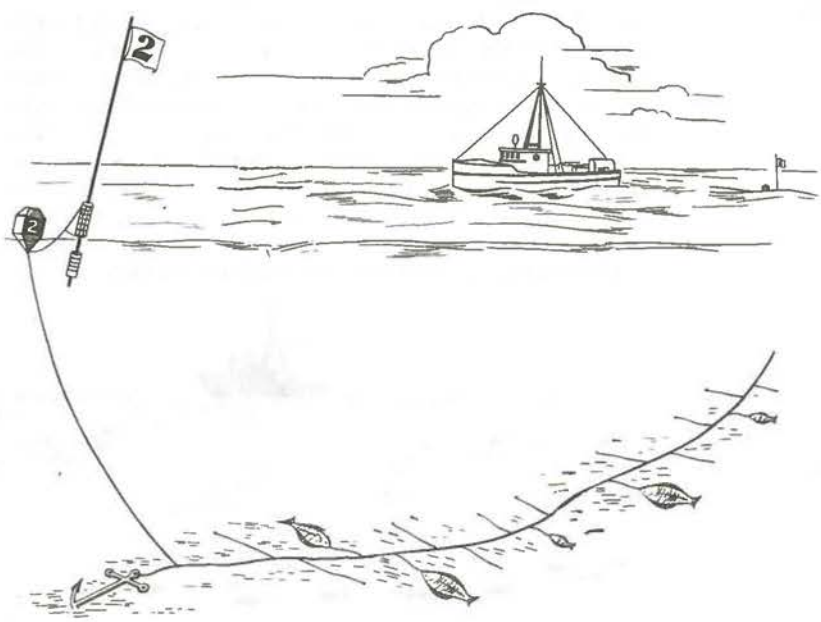
Halibut and black cod are taken in a longline operation. The British Columbia longliners carry crews of four to eight men and may operate as far north as the Bering Sea in search of halibut. The longliner uses set ground lines with hooks baited with chunks of herring, octopus or salmon. When the longliner's gear is made up it is known as a "skate" and several skates may be linked to make up a "string of gear". The string of gear is paid out over the stern of the longliner through a metal trough or chute as the vessel runs over the fishing grounds. At both ends of the longline are buoy lines which carry anchors to secure the gear at the bottom of the ocean. The buoy lines are fastened to brightly coloured floats and flags which mark the location of the gear. The longline is hauled by a power-driven gurdy which draws the line in over a roller. The fish are removed from the hooks as they come over the side and the gear may then be rebaited and set out again.

HERRING

Herring are taken chiefly by purse seiners which operate in the same manner as in the salmon fishery but the herring seine is longer and deeper. Herring schools are located by electronic equipment which can define the size of the school and its position in relation to the ocean bottom. Single sets producing 300 to 400 tons of herring are not uncommon and larger sets up to 1200 tons have been made.

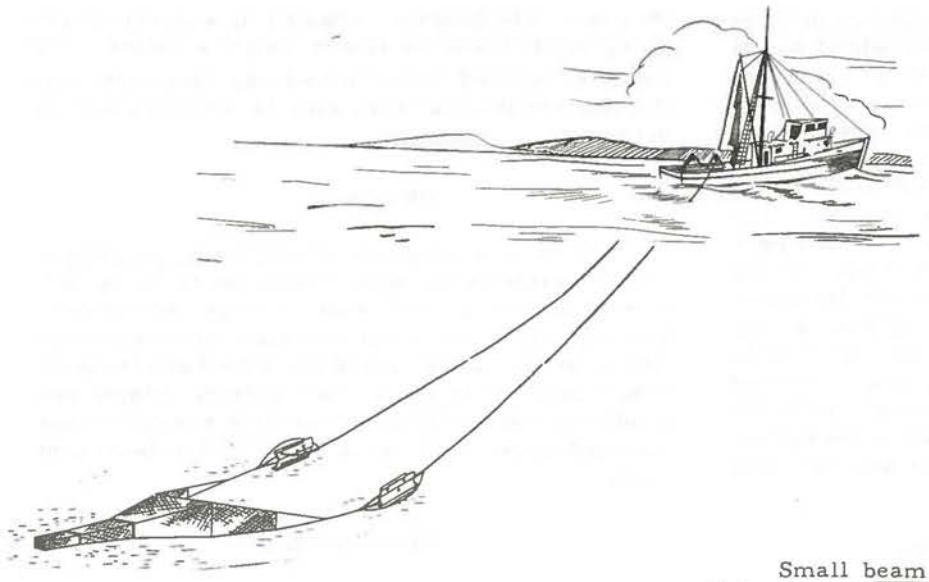
GROUNDFISH

Groundfish, such as sole, flounder and ling cod, are taken by small trawlers or "draggers". The Pacific Coast draggers carry crews of four to six and are generally smaller than their Atlantic counterparts. The draggers mainly use the otter trawl, a long wedge-shaped net that narrows into a funnel-shaped bag known as the cod-end. Two iron-clad wooden "doors" keep the mouth of the net open as it is towed along the ocean floor, scooping up the fish in its path. As the trawl is taken back the fish are forced into the cod-end which is hoisted over the ship's side and emptied on the deck. The dragger may then resume fishing while the fish of the previous catch is sorted or graded and iced down in the hold.



LONGLINING

The long-line is used to catch halibut and Pacific Coast cod. This fishing gear consists of a strong rope made up in lengths or skates to which are attached shorter lines with baited hooks. The long-line is set out on the bottom of the sea and is later hauled in with its catch by the aid of a powered winch.



OTTER TRAWLING

Among the Pacific groundfish are the ling, gray and black cods, ocean perch, soles and flounders. They are all caught by otter trawls. The otter trawl is a large bag-shaped net which is dragged along the ocean floor. The net is held open by planing boards called "doors".

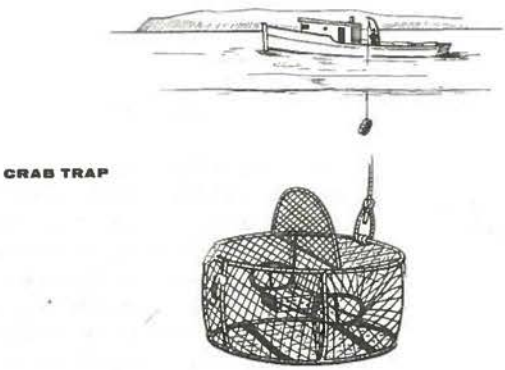
Small beam trawls are used in the shrimp fishery on the Pacific Coast to take the larger shrimps or prawns. The beam trawl fishes in much the same way as the otter trawl but its mouth is held open by a long horizontal pole or beam. The shrimp boats may be converted trollers or gillnetters which fish for salmon during part of the year.

SHELLFISH

Crabs are taken in traps that are either rectangular or circular in shape. The heavy circular traps are used mainly on the exposed Queen Charlotte Island grounds. Crab traps have metal frames covered with stainless steel netting. They may be fished singly or in strings that are set and hauled in much the same manner as are longlines. The traps are baited, usually with clams, either canned or fresh.

Clams and oysters are taken from the beaches by diggers at low tide. The commercial oyster fishery is mainly carried on by firms that lease stretches of shoreline where oyster seed or "spat" is planted and permitted to grow to maturity.

SHELLFISH OPERATIONS

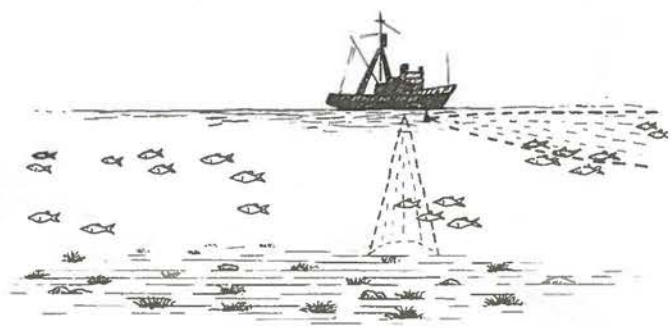


CRAB TRAP

Pacific Coast fishermen land commercially important catches of crabs, shrimp, clams and oysters. The latter two are harvested in shoal water along the beaches. Crabs are caught by trap and trawl. Shrimp are taken by beam trawl and, to a lesser extent, by trap. Crab trap is shown here.

FISH FINDING

Fishermen today have the task of seeking out schools of fish made much easier for them by the use of fish-finding echosounders. These echosounders work on sound waves, as opposed to radar which works on electric waves. Vessels fitted with this equipment are able not only to locate fish schools but can also locate and avoid wrecks and rocks which might tear their nets. Most seiners and trawlers on Canada's Pacific Coast are now fitted with this equipment which operates either horizontally or vertically beneath the vessel.



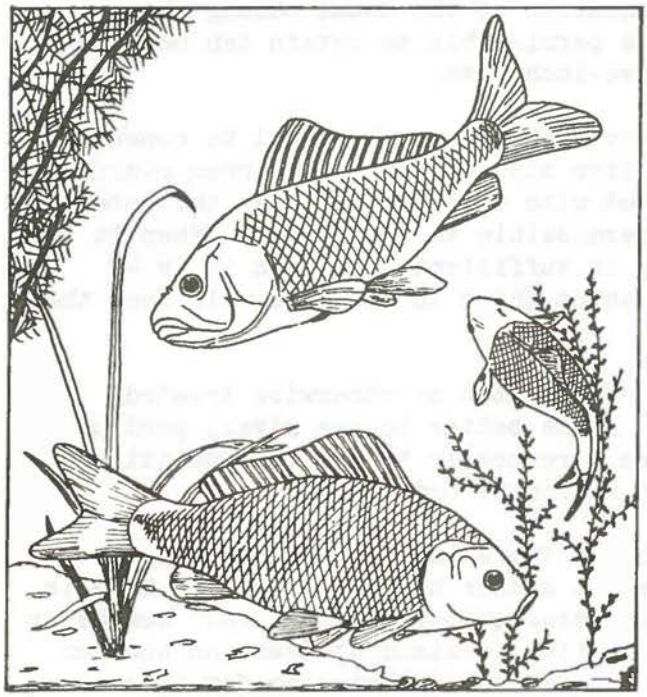
FISHERIES FACT SHEET

GOLDFISH

The federal Department of Fisheries does not propagate goldfish, but as many requests are received for information in regard to the species, the following may be of interest to the beginner. Most of the data have been compiled from the following sources:

"Goldfish Varieties and Tropical Aquarium Fishes" by W.T. Innes; "Goldfish, Their Care in Small Aquaria and Ponds" by E.C. Fearnow.

Goldfish are members of the carp family. There are two root-stocks, the European goldfish, Carassius carassius, and the Asiatic, Carassius auratus. The Orientals, principally those of Korea, China and Japan must be given credit for first establishing by selective breeding, the goldfish as an ornamental pet, and for fixing fancy breeds.



Cleanliness, good light, plants well distributed over the bottom, proper food in moderate quantity, scavengers, prompt removal of sick fish, and avoidance of overstocking, are essential factors for the maintenance of a successful aquarium.

The common goldfish is a very hardy pet, and should live when properly taken care of from 10 to 20 years. In ponds their span of life is even longer, and if not subjected to severe winter conditions, should survive for 30 years or more. Fancy goldfish, however, seldom exceed twelve years of age.

Fancy Types

By careful selective breeding many fancy types have been developed. Some of these are known as - the Comet, the Shubunkin, the Fantail, the Japanese Fringetail, the Japanese Barnacled Goldfish, the Japanese Nymph, the Chinese Telescope, the Scaleless Veiltail Telescope, the Chinese Moor Telescope, the Chinese Celestial Telescope, the Lionhead or Buffalohead, the Oranda, the Chinese Eggfish and others. These fancy types are more delicate than the common goldfish, and require more care

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and attention, but their added beauty fully recompenses for any extra effort required to raise them.

Their Care in Small Aquaria

The common goldfish is quite hardy and will live under conditions that would kill most other fishes. The main causes of failure in order of their importance are, - overcrowding, overfeeding, sudden temperature changes, lack of proper plant life and insufficient lighting.

Some fish fanciers give the rule - one inch of fish to one gallon of water. That is, in a 10-gallon aquarium of the usual oblong shape, well planted and in good light, it is permissible to retain ten one-inch fish or five two-inch fish or two five-inch fish.

Unless raising young stock, never feed more than will be consumed at once. If any food is left after five minutes, they have been overfed, and the surplus food should be removed with a dip-tube. When the water is at 60 degrees, or higher, it is permissible to feed daily. When it is 55 to 60 degrees, every other day is sufficient, and when it is 40 to 55 degrees, feeding separated by about three to six days will keep the fish in good condition.

Water from the city mains if chlorinated or otherwise treated should be used sparingly if at all. It is better to use river, pond or cistern water as these waters conform more nearly to natural conditions. Excessively hard water from whatever source is undesirable.

If it becomes necessary to change the water, do not subject the fish to any sudden change of temperature either higher or lower. This is one of the most frequent causes of sickness and eventual death. New water should be "ripened" before using by letting it stand at least an hour or two, but do not use galvanized iron or new wood receptacles for this purpose.

For the prevention of acid condition in the aquarium which is usually brought about by the decomposition of plants, a small piece of Plaster-of-Paris is recommended. Pieces of gypsum will perform the same function but more slowly. When snails are kept in the aquarium the Plaster-of-Paris or gypsum is necessary for their shell formation.

Water Temperature

The larger the water surface the higher the temperature the fish can stand. A general standard for summer would be 65 to 75 degrees and for winter 50 to 65. Temperatures slightly in excess of 85 degrees should not prove harmful if the water is well aerated. Newly hatched goldfish-fry under six weeks in age do well in temperatures of 75 to 85 degrees.

Because of its narrow neck the so-called fish globe is not well adapted to keeping goldfish in a comfortable and healthy state. Its small

amount of water surface does not permit sufficient oxygen to be absorbed. It is also objectionable because it reflects and refracts the light rays and tends to make the fish nervous and uneasy. An aquarium with straight sides is the most suitable for goldfish. It should be of rectangular shape and of equal width at top and bottom. The bottom should be covered with clean sand and gravel to a depth of about one ane one-half inches. If a globe 'must' be used, select one of the larger sizes; do not fill it over two thirds full of water, and do not overcrowd or overfeed. Be sure to establish growing plants.

When relations of plant life and animal life in an aquarium are properly proportioned the aquarium is said to be self-sustaining or 'balanced' and the water need seldom be changed - filling it to make up for what has evaporated is all that is necessary. Fish live by absorbing oxygen and they give off carbon dioxide as a waste product. Plants under the influence of daylight do the exact opposite so that what is poison to one is life to the other. It is therefore desirable to have suitable plants in your aquarium. The plants are benefited by the presence of the fish and the fish are helped by the presence of the plants.

Oxygen-Producing Plants

Different plants have varying powers of producing oxygen, and purely ornamental plants are desirable only after a sufficient quantity of oxygen-producers have been provided. In order of their oxygenating powers the following are named - Anacharis, Vallisneria, Sagittaria, Nitella, Herpestis, Fontinalis, Potamogeton and Ludwigia. Cabomba or Fanwort is a leading aquatic plant but does not live so well in the aquarium. It is brittle, and fish if active soon pick it to shreds. Myriophyllum at first looks well in an aquarium, but it deteriorates. Its finely divided leaves however are ideal for receiving the spawn of goldfish. Ceratophyllum or Hornwort is a poor aquarium plant as it is very brittle and liable to decompose.

Plants require daylight to do their work. Select for the aquarium a place close to a window with a good strong light, preferably one where it will get about two hours of direct sun a day. In hot weather be careful not to overheat a small aquarium in the sun. Too much light will overstimulate the growth of algae causing the water to turn green.

Food

Aquarium fish naturally desire a variety of foods and the nearer nature is approximated in this regard the better will be the results. Always keep in mind the necessary balance of vegetable, animal, and mineral content required. Most of the better foods are granular in form, usually of a dark color, and composed of dried insects, meat, fish roe, flour, codfish and other ingredients. Puppy biscuit when broken up and ground in a coffee mill to small sizes is said to be a good fish food.

A food used with considerable success is oatmeal prepared exactly as it comes to the breakfast table. For fish under 10 weeks old the oatmeal should be squeezed through cheesecloth to take out the kernels. Let the young fish have as much as they can eat all day, but let none remain over night. This does not apply to fish in their second year or over, although oatmeal in much smaller quantity is good for them also. Practically all fishes enjoy scrambled egg. Finely chopped lettuce leaves and boiled spinach chopped fine, may be used. In feeding dried granular food, use small sizes as water may cause the grains to swell considerably. Dried mussel flesh in powdered form is said to be good. Chopped earthworms, meal worms or daphnia may be fed; also infusoria, mosquito larvae, cyclops, cypris, blood worms, tubifex worms, gammarus, enchytrae and flies. Fish as a rule do better on living foods than on an artificially prepared diet.

Breeding and Spawning

The chief indications of a male fish in the breeding season (January to August) are the small tubercles appearing on the gill plates and sometimes on the first ray of the pectoral fins. The female is usually shorter and fuller of body, particularly when carrying spawn. Early in the year the male may be distinguished from the female by the fact that he chases her around the aquarium. This, however, is not an infallible sign of sex as males sometimes chase each other.

Goldfish begin breeding in their second year, and while they may continue to reproduce for six or seven years, they yield the maximum number of eggs in their third and fourth years. As spawning time approaches, fish should be well fed on nourishing food, such as finely chopped earthworms or live daphnia. Scrambled egg alternating every other day with regular fish food, is a fair substitute for live food at this time. When the breeders have been selected they should be placed together by themselves. Two or three males to one female will insure a higher percentage of fertilized eggs than if only one male is used. Papier mache or seasoned wood tubs may be used for the spawners. Goldfish deposit their eggs preferably on floating aquatic plants, and these should be provided (first making sure they contain no snails or other enemies of fish eggs). The best plants for spawners are water hyacinths and bunches of myriophyllum. The eggs are of a mucilaginous character and adhere where they touch. They are about 1-16th of an inch in diameter and are at first of a pale amber hue, becoming still paler and more difficult to see on the second and third days. The infertile eggs turn white on the second day, and soon become the centre of a ball of fungus. A complete spawning of a medium sized female runs from 500 to 1,000 eggs. As the plants become covered with eggs they should be removed from time to time, allowing a few minutes for the last deposit to become fertilized. These plants may be transferred to large enamel receptacles containing clean water of the same temperature as the breeding tank or tub. If more convenient the fish may be removed after spawning to allow the eggs to hatch as they have fallen. Some females eat their own spawn, so eggs and fish must be separated. Snails should not be present as they will

eat the eggs. However, after the eggs have hatched, snails should be used to eat the infertile ones. Eggs will hatch in from four to 14 days depending on the temperature of the water. The yolk sac will be absorbed in about three days, and the little fish will need some food. The first natural food is a large variety of microscopic animals known under the gneral head of infusoria. These are present in all exposed water which has stood a few days. Dried and powdered lettuce, duckweed leaves or pea flour sprinkled thickly on water will produce them in a few days if kept in a warm place and a subdued light; also a quantity of hay over which boiling water is poured will soon produce the creatures. After the culture is apparent and the fish swimming freely, occasional dips of culture water should be put in with the young fry. This sort of food should be used for about 10 days or two weeks. After the fry have noticeably increased in size they should be fed young daphnia which have been screened through a fine wire tea strainer. As size increases, feed full sized daphnia. If it is not possible to secure living food, the young fry may be started on rice flour, yellow of eggs forced through bolting cloth or fish food reduced to a powder, and sifted through cheesecloth. As they increase in size an excellent food is the paste from boiled oatmeal after straining through muslin or cheesecloth. Scrambled eggs with a little cream of wheat or cream of barley cooked in it makes one of the best substitutes for live food after the fry are six weeks old. Young fish should be fed liberally. It is better to feed several times daily than to put in a whole day's supply at one time. As the fish grow they should be sorted into sizes and kept separate. Do not overcrowd your fish - a growing fish requires plenty of water. Small fry should be dipped out with a spoon and never poured as rough handling will kill them.

Treatment of Diseases

Fish are subject to diseases. If a fish is out of condition it is usually shown by listless movements, loss of appetite, dropping dorsal fin (when the fish is in the habit of holding it erect) congested or frayed fins, white slime on body, and bubbles in the excrement. Affected fish should be immediately removed from the rest, as the disease may be contagious. The most common treatment of diseased fish is the salt bath. The best medicine is real sea water properly diluted. The next best is Turk's Island salt. When the fish show a tendency to constipation one-quarter of the salt content may be Epsom salts. If neither sea water nor Turk's Island salt are available, then ordinary table salt may be used in the proportion of two heaping teaspoonfuls to each gallon of water. In placing the patient in the medicated water see that there is no considerable change in temperature. Aquarium fishes can live indefinitely in the solution described but it is well to give them a new solution daily. If the sick fish does not show signs of improvement in four days, gradually increase the strength of salt solution for two or three days until four heaping teaspoonfuls are used to each gallon of water. After remaining in this for two days the salt proportion is slowly weakened down again to the first formula. This salt treatment is the

simplest and is the one usually used for goldfish diseases. Some of the common ailments of goldfish are fin congestion, white fungus, black fungus, itch, gill congestion, constipation, consumption, dropsy, swimming bladder trouble and eye inflammation. Parasites may also infect them. The most common are leeches, lice, flukes and ichthyophthirius.

Enemies

The following are enemies of aquarium fishes and should be guarded against - water tiger, which is the larva of the predaceous diving beetle; the spearmouth, which is the larva of the large water scavenger beetle; dragon fly larvae; giant water bug; water scorpion; whirligig beetle and larva; water strider; mites; hydra.

Scavengers are desirable in an aquarium as they remove harmful offal and decomposition. The following snails are excellent - the large Japanese snail (Viviparus malleatus), the so-called African paper-shelled snail (Lymnaea auricularia), the Ramshorn snail (Planorbis) and the Pond snail (Physa). These are all active in eating vegetable growth from the glass or particles of food which the fish have not taken. Another scavenger is the freshwater mussel. It helps to keep down the vegetable growth which causes aquarium water to turn green.

Two fishes that are scavengers are the weatherfish and the Saccobranchus fossilis. Both of these are harmless to other fish, but should not be used when over five inches long as they stir up the water too much.

Cleaning the Aquarium

The glass in an aquarium may be quickly cleaned by scraping with a safety razor blade. Water absorbs most gases and fumes readily. This applies to coal gas and heavy tobacco smoke, neither of which is good for the fish. If fish persist in coming to the top and gasping air it is usually a sign that they are overcrowded or that the water has become bad from some kind of decomposition. The trouble should be quickly found and remedied. A partial change of water or the removal of some of the fish will usually improve matters. Sometimes the condition is produced by a dead snail or mussel or from the decomposition of uneaten food.

Goldfish must be handled gently and as little as possible to avoid injury to their scales, fins and tails. In lifting fish a dip net should be used. If it can be avoided fish should not be grasped with the hands, but if the hands 'must' be used they should be wet before touching the fish.

If the family cat develops the habit of "fishing" for your goldfish or if the fish jump out of the aquarium, a fine mesh screen may be fitted over the top of the receptacle to discourage these habits - a tight air proof cover however should not be used, as a free circulation of air is quite necessary for the fish.

March, 1950.

FISHERIES FACT SHEET

HALIBUT (Atlantic)

By P.M. Powles, Fisheries Research Board of Canada

St. Andrews, N.B.

THERE ARE two types of halibut: the Atlantic halibut which is taken from Northwest Atlantic waters, and the Pacific halibut of our west coast. The former is found from Labrador to the Gulf of Maine off the American coast, also in the waters off west Greenland, Iceland, and in the northern seas of Europe. The Atlantic halibut *Hippoglossus hippoglossus* (Linnaeus), is caught chiefly on the Nova Scotian Banks, in the Gulf of St. Lawrence and on the Grand Bank, and is one of Canada's most prized table fish.

COMMERCIAL IMPORTANCE

The halibut commands the highest market price per pound of any flatfish, though total landings are well below other smaller but more numerous flatfishes (commonly called flounders). Average annual Canadian Atlantic landings of halibut amount to about 7 or 8 million lb, representing a landed value of about 1.5 million dollars. From 1920 to 1940 landings averaged about 4 million lb; from 1940 to 1948 landings decreased to 2 million lb; 1950 was a peak year when landings rose to 13 million lb; since 1952 landings have declined and remained near the long-term average of 7 or 8 million lb.

DESCRIPTION

Halibut is readily distinguished from other flatfish by its large mouth, forked tail, and a lateral line along its side which arches above the pectoral fin. Large specimens reach weights of 600 to 700 lb, a weight exceeded only by some of the tunas, sharks and swordfish. The only flatfish with which halibut may be confused is the Greenland halibut or turbot which is a more northerly species, darker in colour, with a straight lateral line.

LIFE-HISTORY AND HABITS

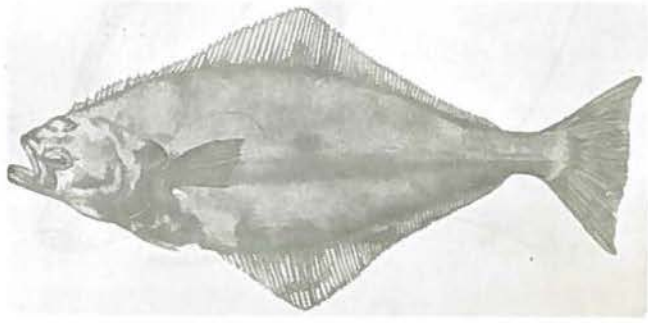
Young halibut grow quickly, the exact rate of growth depending on the area in which they live. On the average, a weight of 10 lb is reached by 7 years. However, after 8 years of age males grow more slowly than females. Males rarely exceed a weight of 80 lb (age 20), while female fish generally reach a weight of 100 lb and a length of over 5 ft in about 15 years.

FOOD

Although the halibut spends most of its time on or near the sea bottom and is thus considered a groundfish, it is occasionally seen near the surface. It is an exceedingly voracious feeder. The food consists mainly of fishes, crabs, clams, squid and worms.

REPRODUCTION AND DEVELOPMENT

Usually halibut become sexually mature in 9 to 11 years. They spawn in late winter and early spring and, since the eggs are heavier than the surface sea water and lighter than the deep water, they float at intermediate levels in the ocean. As development proceeds, the eggs tend to sink closer and closer to the bottom. Like all flatfishes, the young halibut is symmetrical when hatched, and like an ordinary fish has one eye on each side. Soon it starts to rest and swim on its left side. Gradually, as the very young halibut grows, the left eye moves over towards the right side of the head, and the skull twists over at the top. The right side (now the top) becomes a brownish shade and the left, "blind" side remains grayish-white.



Atlantic halibut, Hippoglossus hippoglossus (Linnaeus)

Department of Fisheries and Forestry

Ottawa

STOCKS AND MIGRATION

Tagging studies suggest that there are two "stocks" or main groups of halibut of importance to the Canadian fishery: One lives in the Gulf of St. Lawrence and the other in the Nova Scotian-Grand Bank region. Halibut, unlike most of the smaller flatfishes, may migrate considerable distances. For instance, one halibut tagged in the Gulf of St. Lawrence was recaptured in Icelandic waters some years later.

FISHERY

Canadian hook-and-line fishermen who fish in deep offshore waters using large hooks catch about 6-7 million lb of halibut, comprising the bulk of landings. However, large numbers of smaller halibut are taken during groundfishing operations for other species. This catch of small, fast-growing fish may exceed a million lb. a year.

Halibut which are blotched with gray on the blind side are known as "grays" in the trade, and are not as valuable as normal fish. In many cases too, the blind side is suffused with red and then the fish are called "cherries" or "cherry bellies". Commercial grading is also carried out according to weight, as follows:

Snapper: 5 - 8 lb	Medium: 45-80 lb
Chicken: 8 - 15	Large medium: 80 - 125
Small medium: 15 - 45	Whale: over 125

The diversity of fishing practices and the fact that large and small fish occur on different grounds make it difficult to predict the effects of fishing. However, judging by long-term patterns of landings and fishing effort, there is a suggestion that the stocks could be reduced fairly rapidly if fishing is greatly intensified over its present level.

Further suggested reading

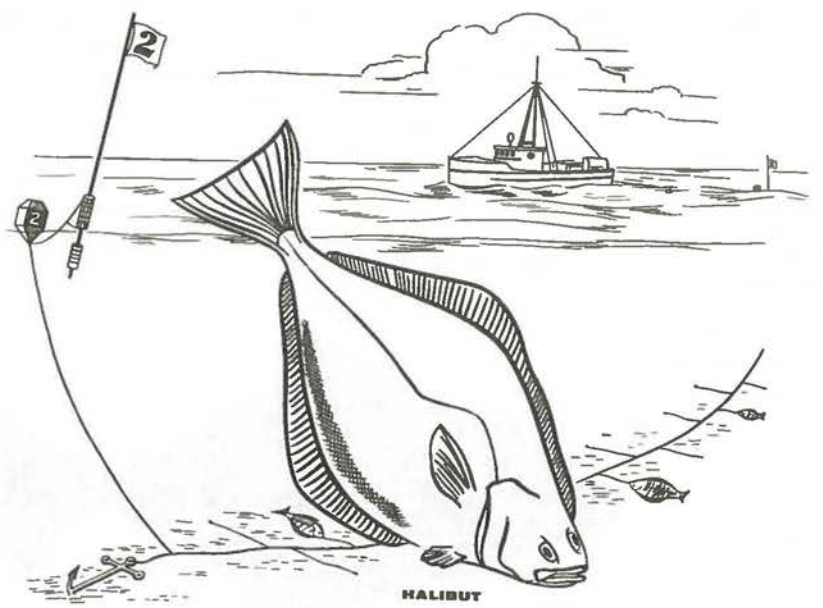
Kohler, A.C. 1964. Movements of halibut on the Nova Scotian and Grand Banks. J. Fish. Res. Bd. Canada, 21 (4): 837-840. [1)]

McCracken, F.D., and W.R. Martin. 1955. Recent recoveries of tagged halibut. Fish. Res. Bd. Canada, Atlantic Prog. Rept., No. 61, pp. 3-4. [2)]

McCracken, F.D. 1958. On the biology and fishery of the Canadian Atlantic halibut, *Hippoglossus hippoglossus* (L.) J. Fish. Res. Bd. Canada, 15(6): 1269-1311. [1)]

1) Copies available from Queen's Printer, Ottawa, and limited supply from Biological Station, St. Andrews, N.B.

2) Limited copies available from Biological Station, St. Andrews, N.B.



Sketch at left shows the long-line method which is used to catch halibut and Pacific Coast cod. The fishing gear consists of a strong rope made up in lengths or skates to which are attached shorter lines with baited hooks. The long-line is set out on the bottom of the sea and is later hauled in with its catch with the aid of a powered winch.

May, 1966

FISHERIES FACT SHEET

HERRING AND SARDINE CANNING

The canning of sardines, herring, pilchards and anchovies may be grouped together because they are tender-meated oily fish of small size. They demand very careful handling and call for more hand-labour in the canning process than in salmon canning, for instance.

In weight and numbers, landings of sea herring exceed those of any other variety of fish taken by Canadian fishermen. These fish are found in abundance on the Atlantic and Pacific coasts, and besides being canned on both coasts they are marketed in a variety of smoked, pickled and salted forms.

Canadian sardines are the young of herring and the sardine canning industry in Canada is confined to the Bay of Fundy and Passamaquoddy Bay districts in New Brunswick, where the largest sardine canning plant in the British Commonwealth is located. The canning of pilchards and anchovies is confined to British Columbia and packs are small.

While the general principle of cooking and sealing in a tin container applies to all these species of fish, there are variations in methods and equipment in the processing.

Sardine Canning

Sardines are usually caught in weirs which are fence-like structures erected close to shore. The weir diverts the fish into an enclosure, then fishermen run a seine net around the inside of the enclosure and gather the catch within it. Each cannery has its own fleet of collecting boats, "buyers" as they are called by the fishermen. These boats arrange with the weir owner for the purchase of his supply of sardines while the tasty little fish are still alive and swimming in the weir.

The collecting boats are fitted with water-tight holds kept scrupulously clean. Into these, the sardines are dumped alive with a considerable amount of water and a quantity of salt. The fish are practically afloat in brine by the time the boat is loaded. This prevents any chance of deterioration setting in before the canning process is begun. They must remain in this strong pickle for at least three hours and if the carrying boat reaches

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the cannery before that time, unloading does not begin until the three hours have elapsed.

At the cannery wharf the young herring are dumped into a bin and washed down a chute to washing tanks on the lower floor of the cannery. In the washing tanks the scales are rubbed off by stirring and rotation in streams of water against wire screens. Many of the scales have already rubbed off in the holds of the collecting boats. The scales are collected both from the boats and from the washing tanks and sold to pearl essence factories.

The fish are then conveyed automatically to a machine which spreads them out on wire mesh trays called flakes. The machine which does this operation is called a flaking machine. One man constantly feeds the wire mesh trays on to a conveyer leading to the machine and another man takes the filled trays and places them in "racks".

The rack is simply an upright framework which holds tiers of flakes for the cooking process. As fast as a rack is filled, it is wheeled into the steam cooker, or steam box as it is commonly called, and subjected to a preliminary cooking from seven to eleven minutes.

The cooker is simply a compartment built in the cannery with iron walls and ceiling and a cement floor. A drainage pipe carries off the escaping moisture. Cooking is by direct application of steam. From the cooker the racks are wheeled to the dryer which extracts much of the excess moisture from the fish.

All the packing is done by women. At the packing tables, women grade the fish as to size, snip off the heads and tails with scissors and pack them precisely and carefully into flat cans. These cans may be brought to the room on an endless belt from the can-making machine and dropped into bins near the packing tables.

Filled cans are placed on trays which are conveyed to an automatic oil-filling machine. A regulated quantity of oil -- just enough to fill each can brim-full -- is added. Olive oil or other salad oils, rich tomato sauce or fragrant mustard sauce may be used to cater to varying tastes.

The sealing of the covers on the cans is done mechanically. The cover, fitted with a rubber gasket, is rolled on to ensure absolute tightness. Some modern can-closing machines seal as many as thirty-four cans a minute.

From the closing machines, the cans drop on to a conveyer which carries them to retorts for sterilization. Each retort holds about fifty cases and is filled about half full of water so the cans will not be damaged when they drop from the conveyer. From the retorts, the racks of canned sardines are withdrawn, washed and cooled, labelled, wrapped and packed in cases containing 100 cans each, ready for shipment to any part of the globe. Some are fitted with key-openers.

Herring Canning

As soon as the herring are landed at the cannery wharf, they are "dry-salted" in bins, using coarse ground salt. The purpose of this salting is to allow some salt to penetrate into the fish, making them more tasty, firming the flesh slightly and toughening the skin so that it will not be so easily broken in the packing and steaming procedures. They are left in the bins until the salt has produced the desired results -- usually from six to ten hours.

Then they are washed and scaled in revolving metal mesh cylinders using large volumes of clear pure water. In some plants "scaling" is done before "salting". Regardless of this, all the herring are again washed before being dressed and cut for the cans.

The scaled and washed fish then go to automatic machines that cut off the heads and pull out the entrails, leaving the cleaned fish ready for the can. In some plants, the heads, entrails and tails are removed by hand.

The dressed herring are then packed carefully by hand into cans which are then placed bottom up on wire mesh screens. Still unsealed, they are passed into steam retorts to be partially cooked. In this cooking process the excess moisture and oil is drained from the inverted cans of fish through the wire screens. Upon being taken out from the retorts and while still steaming hot, the cans are turned right side up and passed under a machine which injects boiling tomato sauce and a sprinkle of salt into them. Sealing is the next operation and then the canned herring is given the final cooking. After coming from the retorts, the cans are washed, cooled and boxed for storage and ultimate shipment.

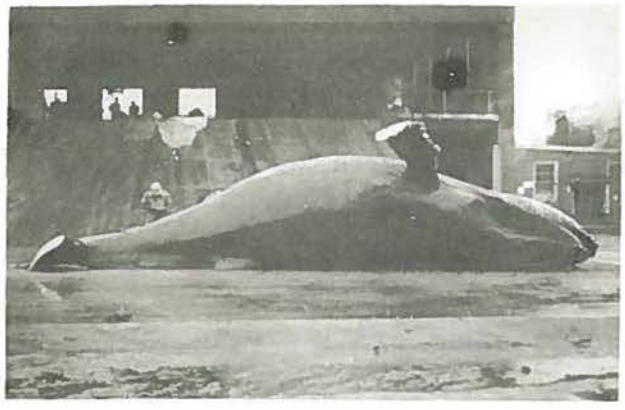
Herring are usually packed in flat oval cans, although some canneries pack them in "talls". Canned herring are an inexpensive canned product furnishing high quality protein, fat and other essential food factors. They are suitable for eating cold or hot or for use in salads or cooked dishes.

FISHERIES FACT SHEET

HUMPBACK WHALE

Distribution and Importance

The humpback whale, Megaptera nodosa is found along the coastlines and in the bays of the world's ocean areas including the Pacific Ocean off the British Columbia coast and the Atlantic off Newfoundland and Labrador. It reaches a length of from 45 to 50 feet when fully grown. It is clumsy in appearance with a thick-set body, but nevertheless is a very graceful swimmer. It has a pair of flippers just back of the head, which in adults are up to 14 feet in length. The throat has a number of longitudinal folds like those of the related finbacks. The blow or spout is vertical, being broad and relatively short. Its flukes are large with a serrated hind margin and are often white or mottled white on the under surface. On the last blow before submerging the back is humped and the animal dives almost vertically, throwing its flukes in the air. The dive usually lasts from five to 20 minutes although the humpback has been known to stay under for periods lasting as long as 40 minutes.



Humpback Whale

The humpback is one of the few good-sized whales which can jump clear out of the water. It is very playful and at times will swim along-side a ship for miles, until it tires of the fun and swims away. Like most whalebone whales it feeds on small shrimps but eats a few fish as well. Because of its tremendous size and its almost constant food requirements it can be found only where a plentiful supply of food is available. (In winter, in the low latitudes, the stomachs of whales are usually empty). In feeding it fills its mouth with food and water as it swims through thick masses of small shrimp-like crustacea. It pushes out the water with its huge tongue, using the whalebone, or baleen, as a sieve to retain the food. This baleen consists of long, flat plates hanging from the sides of the upper jaws. They are of a fibrous, hornlike substance, very strong and flexible, and their function is to strain from the water the small organisms called "krill" upon which the humpback and other members of the whalebone family feed. At one time the whales of this family were hunted entirely for whalebone and oil, and the remainder of the whale was discarded.

Reproduction and Growth

Humpback whales, like other whales and most of the big mammals, bear only one offspring at a time, altough occasionally they have twins. The gestation period for a humpback is slightly less than a year, and there is usually a two-year interval between calves, as the young whales are called. Sometimes a humpback will calve twice in three years. The young are fed on the mother's milk, which

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Humpback (Cont'd.)

has a very high fat content. On an average, whales weigh one ton for every foot of length. The calf's rate of growth is tremendous in its first year of life and it may gain up to a ton in weight in the first 16 days. The humpback matures sexually when only 22 months old.

Method of Fishing

In Canada the humpback is taken by harpooning off both the Atlantic and Pacific coasts. When a whale suitable for killing is located, the lookout on the masthead gives the word and the harpooner fires his missile from the bow of the vessel.

After the whale has been killed it is pulled alongside the vessel and inflated with air which is pumped into the body cavity. Then it is towed to the shore processing plant.

Processing Methods

When the whale has been made ready the flensers take over. They are so called because of the sharp flensing knives they use to remove the blubber. The blubber is a three to six inch layer of fat immediately below the skin. Incisions are made along the entire body and a piece of blubber is undercut to release it from the body. Then a rope or cable is tied around the blubber and a power winch peels off the entire strip. This is continued until all of the blubber has been removed. These strips are cut up in small squares and are ready to place in the boiling vats to extract the oil. After all the oil has been taken from them the bones are manufactured into fertilizer. The meat is high in food value but it is not at present being handled commercially on the Canadian market.

The oil yield is from 50 to 80 per cent of the blubber's weight. However, there is a considerable oil yield from the meat and bones. The oil is a very good raw material for shortening, being superior in some respects to the vegetable oils which are the chief competitors. A good margarine also can be made using whale oil although only a negligible amount has yet been used for this purpose in Canada. A competitive price to vegetable oils is the main requirement.

Research is also being carried out by federal scientists in order to investigate the possibilities of obtaining commercial quantities of insulin from whales.

FISHERIES FACT SHEET

INCONNU
(Stenodus leucichthys mackenzii)

Distribution and Importance

The inconnu is an edible fish, found in some parts of the Northwest and Yukon Territories where it is of some local importance both as a food for humans and for sled dogs. It was given its vernacular name by the early French-speaking voyageurs. As they travelled the north they caught some of the fish, the first of the kind they had ever seen. "Poissons inconnus", unknown fish, they said, and as time went by "inconnu" passed into usage as the name of the species. Very often, fishermen shorten the name to "connie" or "coney". In Alaska it is called the "Sheefish".

Scientific records generally list the fish as Stenodus mackenzii. The "mackenzii" derives from the fact that in North America the inconnu is found mainly in the Mackenzie River basin, though it is present also in the Yukon Territory and in Alaska. A similar species occurs in Siberia and is known as Stenodus leucichthys. Some scientists regard the Canadian inconnu as the same species as the Siberian one, hence the commonly accepted name is Stenodus leucichthys mackenzii. Although the inconnus of the Mackenzie basin all belong to the same species, there appear to be two groups among them or two "forms" to use the scientific term. One of the two is a "landlocked" or freshwater form found in Great Slave Lake and the second is a migratory form found in the lower Mackenzie River. Fish in the first group are believed to spawn in the Big Buffalo River and other tributaries of Great Slave Lake, the other in the Mackenzie and some of its tributaries.

Description

Inconnus of quite large size are sometimes taken in the Mackenzie area and individuals weighing 25 or 30 pounds are not uncommon, though they are well above the average. There is record, however, of at least one inconnu caught in the Mackenzie area which weighed 63 pounds and was a little over 59 inches in length. Others have been reported weighing from 45 pounds to something over 56 pounds. Inconnus found in the Yukon are said to be of smaller size, on the average, than those taken in the

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Inconnu (Cont'd.)

Mackenzie district. Inconnus are light in exterior colouring with the dorsal fins dusky at the tip, the caudal fin shading to dark at the edge. The lower jaw is longer than the upper and usually somewhat hooked. There are bristle-like teeth on the upper jaw and weaker ones below. The flesh is white but rather soft and oily.

Methods of Fishing

Although Inconnus will take the hook, under certain conditions at least, white fishermen make their catches by means of gill-nets. Eskimos in the Mackenzie delta, on the other hand, sometimes catch them with barbless hooks, fishing through the ice, sometimes by means of a fishing spoon or bait, or perhaps by a hook baited with a thin piece of bone. On the Yukon River, the fish are said to offer good sport when fished with troll or minnow, in contrast to the Mackenzie inconnus, which seem to show little spirit.

Handling the Catch

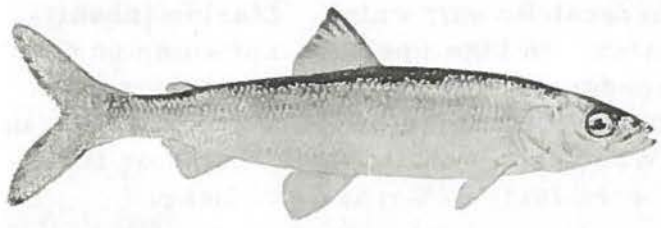
Until 1945 there was no fishing for inconnus on a commercial scale. Catches were made only to meet local needs. Since 1945, however, some of the fish have been handled commercially by fishermen operating on Great Slave Lake. These inconnus are taken in nets set primarily for whitefish and lake trout. Drying and smoking are the methods used when the fresh fish are being preserved for future use locally.

FISHERIES FACT SHEET

LAKE HERRING, CISCO
OR TULLIBEE

Fifteen Species in Group

The common names "lake herring", "cisco", or "tullibee" do not refer to one single species of fish but to a very complex group belonging to the genus Leucichthys comprising, in North America, some fifteen species. Certain species do possess a particular common name such as Leucichthys alpenae, long-jaw cisco, L. nigripinnis, black-fin cisco and L. artedi, the lake herring. More often several associating together in a lake are grouped under one name. In this sense "chubs" and "bloaters" are used on the Great Lakes. The term "tullibee", first used by fur traders for lake herring of northern distribution, has persisted in the Prairie Provinces. It may be used either as a synonym for lake herring or as the large and deep-bodied form of one species, Leucichthys artedi. This confusion between common names is the result of extreme similarity between species. Specific identification is a task better left to the specialist.



Lake Herring, Cisco or Tullibee
(Leucichthys Spp.)

Distribution and Description

Lake herring, like other members of the family Coregonidae, are of northern distribution, occurring in Siberia, Alaska, Northwestern Canada and Northern Europe. In America their most southern limit is in the Great Lakes region. Individual species are more restricted. Two Siberian species, L. autumnalis and L. sardinella reach their eastern limit in Alaska and the Mackenzie delta. Confined to the Great Lakes region are L. alpenae, L. johnannae, and L. kiyi. L. zenithicus, L. nigripinnis and L. artedi have been recorded from the Northwest Territories, Manitoba and the Great Lakes region.

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Lake Herring, Cisco or Tullibee (Cont'd.)

Lake herring possess cucloid scales, an adipose fin and lack sharp spines in the fins. Shiny scales give a silvery appearance, while the underlying surface is green on the back shading to white on the sides and belly. Fins may be clear or dusky. Form of body and size attained vary according to the species. The larger species attain fourteen inches in standard length and one and one-half pounds in weight. However, ciscoes in the Prairie Provinces weighing seven pounds are not uncommon.

Life History and Commercial Value

Lake herring may live in fresh or salt water. Marine inhabitants, however, spawn in fresh water. In lake species, spawning generally occurs in shallow water on muddy or stony bottom during the fall months. Lake herring mature during their third or fourth year of life in the Great Lakes and Lake of the Woods regions, in their fourth or fifth year in the Hudson Bay area and even later in Great Bear Lake.

These fish are mainly plankton feeders. In turn, they serve as food for lake trout, Cristivomer namaycush; pike, Esox lucius; inconnu, Stenodus leucichthys, and ling, Lota lota.

When caught commercially, they are taken in gill-nets either floated up or set on the bottom. Pound nets have been used in the Lake of the Woods.

FISHERIES FACT SHEET

LAKE TROUT

(Cristivomer namaycush)

Description and Importance

Lake trout go by more than half a dozen names. Lake trout and salmon trout are the two most generally used but in New Brunswick people call the fish the "togue"; in parts of Quebec the "touladi", and in some other Quebec areas and sometimes in Ontario the "grey trout". Occasionally the fish is called the "namaycush" or "Great Lakes trout". In northern British Columbia some of the Indians have a name for it which, in rough conversion into the white man's tongue, seems to be "so-pi."

Scientifically, the fish belongs to the *Salmonidae* family. That means that it has a good many relatives, in one degree of relationship or another, among Canadian fish. Most trout, of course, are game fish but lake trout enter mainly into the commercial fishery. They will take the hook, both in fly fishing and when some baits are used. They run, in general, to bigger sizes than any of the other species of trout. Those living in large lakes usually grow to a larger size than those in smaller bodies of water. Occasional specimens weighing as much as 75 pounds or more have been taken, and 20- to 30-pounders are not uncommon though, on the average, the weight of the fish entering into commercial catches is probably about 10 pounds and the length two feet or so.

Description

In exterior colouring lake trout vary from almost black to grayish or very light green. Similarly, there are variations in the colour of the flesh. Sometimes the tissues are deep pink or blood red, sometimes pale ivory, sometimes any one of the several shades between the two. These differences are probably determined in part by heredity and in part by environment. Some of the fish are probably by nature lighter in flesh colour than others. On the other hand, it is probable that the kind and amount of food eaten also influences flesh colour. The main food is fish although smaller aquatic organisms are also eaten.

Fishing Areas and the Fishery

Lake trout are North American fish, with wide distribution over the continent. They occur in Labrador, in one or two sections of the Maritime Provinces, on through Quebec and Ontario, and thence westward and northward. In the western provinces their distribution is in northerly waters rather than those in the southern areas. They are present, too, in the Northwest Territories and the Yukon. In the United States the fish are found in Maine and in some of the western states and Alaska. Incidentally, the statement that lake trout occur in the Maritime Provinces should be qualified by the explanation that they are found in western Nova Scotia and in the Chamcook Lakes region of southwestern New Brunswick.

Chief producers of lake trout are the Great Lakes, the northern lakes of Saskatchewan, and Great Slave Lake in the Northwest Territories. In fact, Great Slave Lake yields more trout than any other single lake in Canada. In Nova Scotia and New Brunswick, fishing for trout is restricted entirely to angling.

Commercial fishing for lake trout in Canada is done mainly by means of gill-nets and pound-nets, although trolls and set hooks are used in some places. The greater part of the catch is taken in the summer months but in the Prairie Provinces, as a whole, most of the fish are caught in winter when the nets are set through the ice. The fish are marketed in the fresh and frozen forms. Much of each year's catch is exported to the United States.

In Great Slave Lake the lake trout mature when about eight years old, when they weigh about 2 1/2 pounds and are about 18 inches long. There is a tremendous difference in growth rate; some fish are four times as heavy as others at the same age.

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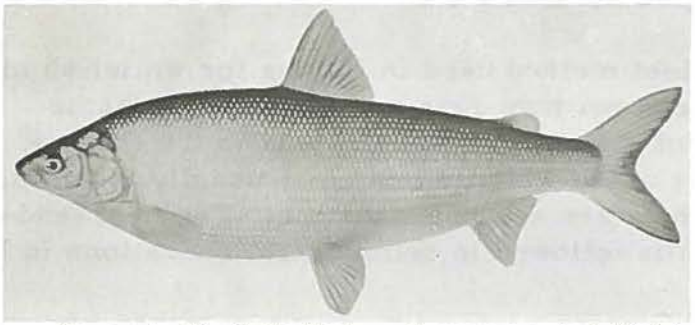
FISHERIES FACT SHEET

LAKE WHITEFISH
(Coregonus clupeaformis)

Distribution and Importance

Of the varieties of whitefish recorded in Canadian inland waters the common whitefish or lake whitefish is of greatest importance in Canada's commercial fisheries. The whitefish, along with Ciscoes, lake herring and bloaters, belongs to the family Coregonidae. The common whitefish occurs in all larger lakes from the Maritimes to the Yukon Territory. Lakes in the Northwest Territories, Manitoba, Ontario and Saskatchewan are the main producers of whitefish. Commercial fishing for whitefish at Great Slave Lake in the Northwest Territories was undertaken for the first time in 1945.



Description

In colouring the whitefish is olivaceous on the upper part of the body, with whitish sides and under portions. The lower fins may be dusky. The tail fin is deeply forked. Head and mouth are comparatively small, the scales large. The mouth is sub-terminal, distinguishing it from certain other members of the family. Some adult whitefish have a fleshy bump at the shoulders. So far as weight and body measurements are concerned, it is not possible to give exact averages for any species of fish but the mature whitefish average 18 inches in length and weigh about $2\frac{1}{2}$ pounds. This size makes up 75 per cent or more of the catch.

Feeding and Breeding Habits

The whitefish lives upon minute molluscs, crustaceans and other small aquatic creatures. Its summer habitat is in the deeper, colder parts of the lakes, from which it moves into more shallow water at spawning time. The spawning time varies somewhat in different years depending on weather conditions and locality. Spawning begins in the latter part of October and continues into the first week of December. In Great Slave Lake it may continue into January in some areas.

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Lake Whitefish (Cont'd.)

Whitefish generally reach maturity in the third and fourth year, but may not mature until the eighth year in lakes where the average water temperature is low. A full grown individual deposits from 10,000 to 75,000 eggs, depending on the fish's size.

Gill-netting is the chief method used in fishing for whitefish although stationary pound-nets and trap-nets are also used in some areas. In areas where winter fishing is done -- and in the Prairie Provinces, the bigger part of the whitefish catch is usually taken in the winter season -- the gill-nets are set under the ice. The hook-and-line method of fishing for them is followed in commercial operations in Lake Simcoe.

Virtually all of the whitefish marketed by Canadian fishermen is sold in the fresh and frozen forms, though small quantities are smoked. The catch finds sale in Canada and the United States, most of it in the latter country.

No. 21

FISHERIES FACT SHEET

Life History, Migration and Reproduction of Pacific Salmon

THERE are five kinds, or species, of Pacific salmon in British Columbia. Their common and scientific names are:

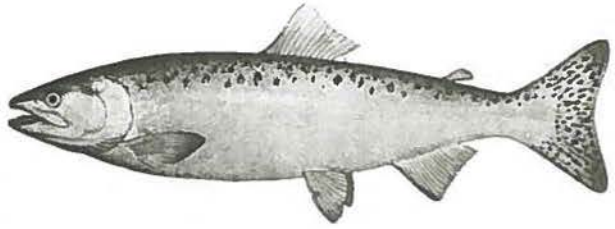
Sockeye *(Oncorhynchus nerka)*
Pink *(Oncorhynchus gorbuscha)*
Chum *(Oncorhynchus keta)*
Coho *(Oncorhynchus kisutch)*
Chinook or
spring *(Oncorhynchus tschawytscha)*

Except for some races of sockeye which remain throughout their life in lakes (known by many names but most commonly as "Kokanees") all salmon are anadromous. That is, they begin their life in fresh water, grow and mature in the ocean and return to fresh water to spawn. More detailed accounts of the life-history of individual species are given in other Fact Sheets forming part of this series.

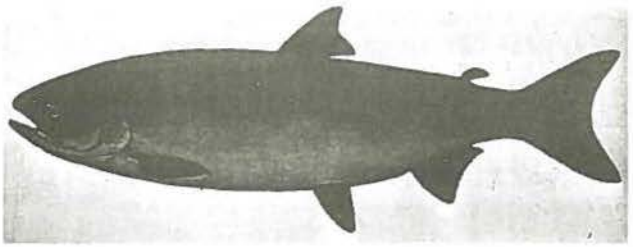
SPAWNING AND DEVELOPMENT

Adult salmon enter rivers and streams from late summer to early winter, the exact time differing between stocks and species. The female, upon choosing a suitable spawning site, digs a nest or "redd" in the streambed. The male, meanwhile, remains in close attendance, courting the female and fending off competing males. When the redd is completed, the female drops into it and releases some of her thousands of eggs, the numbers varying between species and size of individual. At this moment the male moves alongside his mate and releases milt, thus fertilizing the eggs. The female, then with snout, fin and tail covers the eggs while the male returns to his post to resume vigilance. This sequence of redd-building, courting and spawning is repeated until the sex products of both male and female are exhausted, and having spawned once each depart and shortly die.

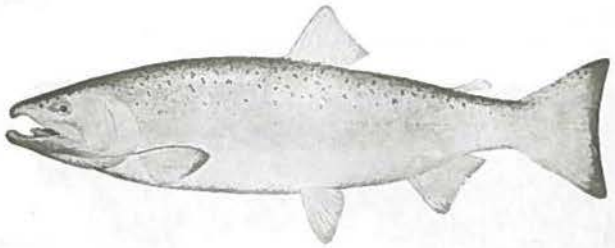
SOCKEYE SALMON



PINK SALMON



CHUM SALMON



COHO SALMON

CHINOOK or SPRING SALMON

Of the eggs spawned, some hatch while others

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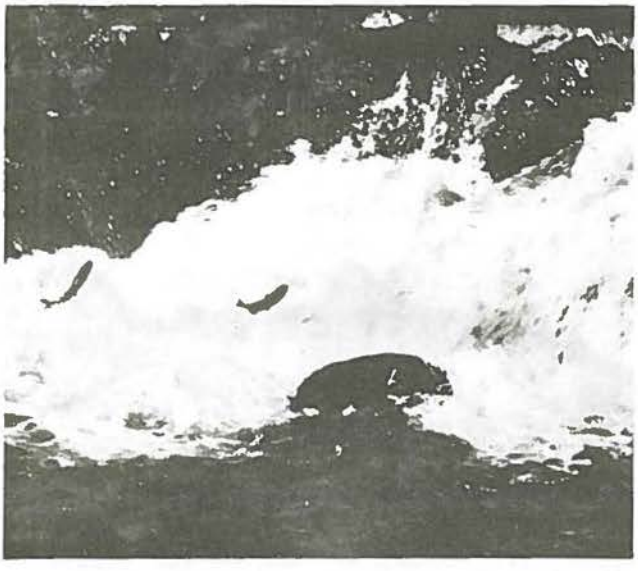
are lost as a result of poor stream conditions or predation by trout and other stream fishes. The time required for hatching is influenced by the temperature of the stream. The newborn salmon, or alevin, remains hidden until spring in the gravels forming the streambed. Receiving nourishment from a yolk-sac attached to the underside of its body, the alevin gradually transforms into a miniature salmon, and in the spring emerges from the gravel as a fry. Depending on the species, the fry migrates either immediately to sea, or remains in the stream or river for a few months, or takes up lake-residence for a year, usually, or two, before going to sea. Those living in lakes for a year or more are known as smolts when they leave for the sea.

In the ocean, as in fresh water, the different species as well as stocks of the same species spend varying amounts of time, ranging from about 14 months for pinks to 4 or 5 years for chums and chinooks.

DISTRIBUTION AND MIGRATION

Along the Pacific coast of North America salmon occur from central California northward into the Arctic Ocean as far east as the Mackenzie



Salmon fighting their way upstream to the spawning grounds.

River, but are most abundant between southern British Columbia and western Alaska. Within this length of coastline the geographic range of each species overlaps considerably so that some species at the same time occupy not only the same geographic territory but frequently the same stream.

During their ocean life, salmon range widely throughout the northern North Pacific Ocean and the

Fish ladders such as this one at Stamp Falls, B.C., help salmon move upstream.

Bering Sea, occurring farther south in the winter than in summer. In the spring and summer maturing fish depart the high seas for coastal spawning grounds, travelling at rates which increase as the fish matures. Salmon originating in British Columbia inhabit the eastern North Pacific Ocean where they become intermixed with salmon from Alaska, and to a much lesser extent, with some from Asia.

SIZE AND GROWTH

The size of salmon varies between species, as well as between individuals of the same and different stocks. On the average, chinooks are the largest of the salmons, followed in order of size by chums, coho, sockeye and pinks. While smallest in ultimate size, pinks grow more rapidly than the other species, reaching an average length of 24 inches and an average weight of 4 pounds from the time they leave the streams as fry and return as adults, a period of about 14 months. Chinooks frequently reach a weight of 50 pounds and on occasion 100 pounds.

Maturing salmon, silver and corpulent and belonging to many runs, enter coastal waters during the summer and fall where they are caught by purse-seine, gill net and trolling gear. The average annual catch of salmon in British Columbia amounts to about 180,000,000 pounds and has a landed value of about $25,000,000. *(Prepared by the Fisheries Research Board of Canada Biological Station, Nanaimo, B.C.)*

FISHERIES FACT SHEET

The Lingcod

THE lingcod is one of the larger commercial fish of British Columbia. It is notable for its large mouth, large pectoral fins, smooth body, and long continuous dorsal fin divided by a notch into spiny and soft parts. Young individuals are slender throughout, but larger specimens are moderately robust forward with large heads and fearsome jaws. The colour is very variable, usually darkly mottled, on backgrounds ranging from dark gray to fawn. Fish taken from the same reef are frequently coloured alike with the result that some experienced fishermen claim the ability to tell the origin of fish by their appearance. The sexes can be distinguished externally by the presence in the males of an anal papilla.

LINGCOD *(Ophiodon elongatus)*

Lingcod are found in the coastwise waters of North America from California to Alaska. In British Columbia they occur at a considerable range of depths- from very shallow to more than 70 fathoms. The lingcod has no very close relatives among other fish species. The closest are the so-called greenlings and sculpins, which are familiar but have no commercial value.

Lingcod spawn in the winter from December to February. The eggs are deposited in porous pearly masses stuck to the rocks, usually, in crevices or beneath overhanging boulders. Egg masses may be two feet in length, weigh as much as thirty pounds, and contain more than half a million eggs. A considerable number of egg masses are found in the intertidal zone. Some evidently occur below low tide mark but what proportion, or how deep, is not known. The egg masses are tended by the males, who drive away potential predators.

The eggs hatch in one or two months to produce larvae about half-an-inch long. At this stage they have small yolk sacs on the abdomen with a ten-day supply of food and noticeably blue eyes. The young apparently move around near the surface until they are three or four months old, when they are found near the bottom in shallow water. Many of them gradually work down to take up more or less permanent positions in deep water. In general, the larger lingcod are found on "hard bottom" or rock or gravel.

Lingcod reach large size. The largest specimen recorded is 105-pounds and 50-60 pounders are frequently caught by commercial gear. Maximum length is between 4 and 4-1/2 feet. Males are much smaller than females and it is doubtful that they exceed three feet in length or a weight of 25 pounds. As might be expected from their larger size, female lingcod grow about 1-1/2 times as fast as males. On the average, female lingcod grow about 2-3/4 pounds per year, and males 1-3/4 pounds. The rate of growth is not constant throughout life, so that at eight years of age a male lingcod will weigh about 9-3/4 pounds and a female 14-3/4 pounds. The age of the 60-pound monsters can be only a guess but it seems likely that they are not only old but have grown faster than average too.

The data obtained by tagging nearly 2,000 lingcod in the Strait of Georgia with strap tags on the gills, or celluloid spirals rolled on the upper jaws, have shown that many of them are very sedentary, as they are recaptured years later in the same place as tagged. Others show considerable movement and the evidence of the fishery on the west coast of Vancouver Island is that lingcod appear on fishing grounds as though they were taking part in a mass migration.

Lingcod are caught commercially on several types of gear. These are, in order of importance, trawls, hand lines, trolls, and long lines.

Hand lining or jigging with live bait is carried out from small or medium-sized vessels fitted with live wells in which the water is continually changing. The live wells hold living herring for bait and also keep the catches so that they can be brought into harbour alive and retained in floating, slat boxes for sale as the market requires. Lingcod handled in this

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way are regarded as a superior product and usually command better prices than when handled in other ways. The gear is designed to bring the hooks baited with live herring close to the lingcod on the bottom without disturbing the lingcod or damaging the precious bait. On the ends of the main lines are heavy weights (2 to 5 pounds) and spreader bars of heavy wire or light rod. The live herring on hooks are attached to short lines on the ends of the spreader bars which keep them from damage or fouling when the weights touch the bottom in the fishermen's constant efforts to follow the contour. Usually the bait is fished a few feet (3 to 6) off the bottom. There are different methods of rigging the gear. By some fishermen the main line and weight is attached to one end of the spreader bar and by others to the centre. Lingcod occur in quantity only in very limited areas which are known and thoroughly studied by the fisherman. In some of these areas dead bait is found to be reasonably effective so live wells are dispensed with and the fishing methods are modified accordingly.

OTHER FISHING METHODS

Additional lingcod landings are made by gears used chiefly for other species although fishing methods with them are occasionally modified to concentrate on lingcod. For example, modern trolling gear, in which the lures are streamed on short leads from an almost vertical wire held down by a 20- to 35-pound cast iron or lead "cannon ball", is sometimes used as an effective method of fishing near known lingcod reefs by working large lures or dead herring bait close to the bottom. The main wires pass over sheaves supported by large springs so that fisherman has warning of when his gear hits bottom by the action of the springs. Trolling and hand-lining methods grade into one another and are frequently carried on by the same boats so they are not always distinguishable.

Otter trawls, in which open cones of net are dragged along the bottom, take travelling lingcod in some areas and seasons. When fished with special precautions to avoid catching the net on rocks, more sedentary lingcod are occasionally taken on the reefs in great quantities.

Where lingcod are abundant so that competition for food is keen, they are often taken on long-line gear set for halibut or dogfish. Long lines are made by attaching hooks on short (5 feet) side lines from heavier main lines held in place on the fishing banks by anchors at either end.

Fishing methods differ with season and locality. Trollers and hand liners provide practically all of the highly productive fishery during the spring and early summer in the sheltered waters between Victoria and Discovery Passage. Trawlers contribute about 90 per cent of the most important fishery, which is off the west coast of Vancouver Island during the summer, and trawlers also take the greater part of the catch in the northern part of British Columbia.

The primitive method of fishing by Indians was ingenious. A wooden shuttlecock-like lure or hee-hee made of wood and fibres was pushed down toward the reef with a long 3-tined spear. When the spear was sharply withdrawn, the hee-hee spun slowly toward the surface followed by the curious or hungry lingcod. When the fish came close to the surface it was deftly speared and landed.

Lingcod is marketed either fresh or frozen, and may be whole or filleted. In 1965, 60% of the total catch was taken by trawlers. The earlier markets for oil and Vitamin A derived from lingcod livers and viscera has now almost completely vanished. In 1966, landings of about five million pounds were worth $602, 000. ✔

FISHERIES FACT SHEET

OTTER-TRAWLING
(Dragging)

Evolution of the Method

Otter-trawling is a method of fishing by which a bag-shaped net is dragged along the ocean floor by a powered vessel called a trawler. The origin of the method is vague, but in England at least there is a record as early as 1376 which mentions an instrument having the description of a beam trawl. Beam trawls were commonly used by sailing vessels and later by steam trawlers up to the beginning of the 20th century. The first commercial otter trawls were used near the end of the last century. These were originally beam trawls with the beams removed and otter-boards or door-shaped structures substituted where the ends of the beams were formerly located. This method was first adapted to Canadian fishing in 1899 when an east coast vessel was fitted with an otter trawl made in the Maritimes from specifications sent out from England. Although the first experiment was unsuccessful, the potential advantage of the otter trawl was recognized. In 1908 an English steam trawler was the first vessel to pursue this type of fishery in Canadian waters on a full-time basis. The early vessels had many difficulties to overcome, but as captains became more familiar with the fishing grounds and as numerous improvements were made to the gear and the vessels, particularly the introduction of the bridle between the door and the trawl wing in the 1920's, the change to diesel power in vessels, and the introduction of echo-sounders and Loran and Decca navigation, trawling has evolved into the very efficient method for catching fish that it is at present.

Trawler on the Grand Banks.

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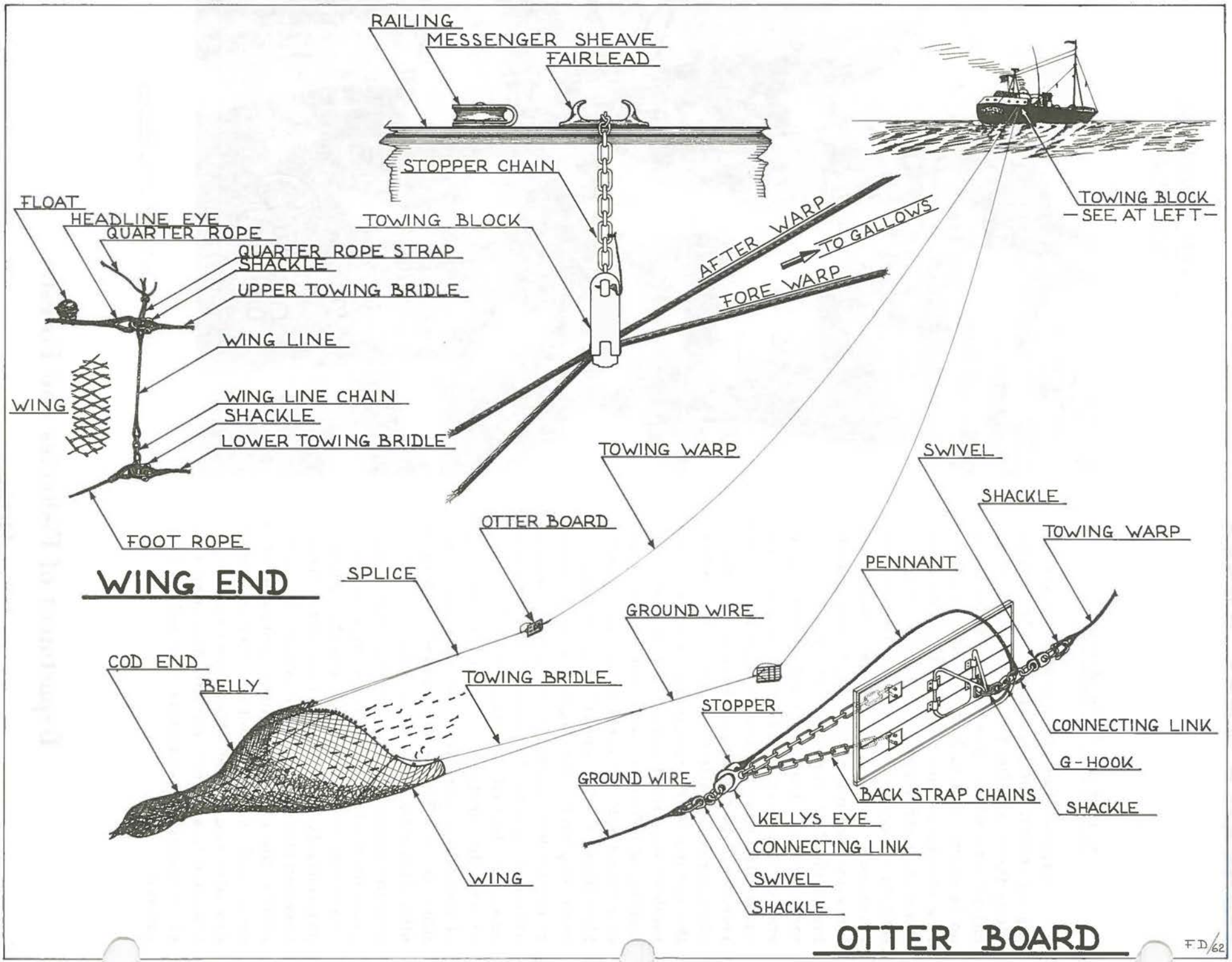
RAILING
MESSENGER SHEAVE
FAIRLEAD
STOPPER CHAIN
TOWING BLOCK
— SEE AT LEFT —
FLOAT
HEADLINE EYE
QUARTER ROPE
QUARTER ROPE STRAP
SHACKLE
UPPER TOWING BRIDLE
TOWING BLOCK
AFTER WARP
TO GALLOWS
FORE WARP
WING LINE
WING
WING LINE CHAIN
SHACKLE
LOWER TOWING BRIDLE
FOOT ROPE
WING END
TOWING WARP
SWIVEL
SHACKLE
TOWING WARP
OTTER BOARD
PENNANT
SPLICE
GROUND WIRE
COD END
BELLY
TOWING BRIDLE
STOPPER
CONNECTING LINK
G-HOOK
GROUND WIRE
BACK STRAP CHAINS
SHACKLE
KELLYS EYE
CONNECTING LINK
SWIVEL
SHACKLE
WING
OTTER BOARD
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Description and Method of Operation

The net is cone-shaped and that part towards the apex forms a trap called the "codend". The large opening of the forward part of the trawl is kept open horizontally by iron-shod wooden doors or "otter-boards" attached at each side by a bridle to the wings. Wire ropes or "warps" from the trawler to the otter-boards are used to tow the trawl astern of the ship. The otter-boards stand on edge and have a kite-like action. As the net is pulled forward by the vessel the otter-boards deflect outwards keeping the mouth of the net spread wide horizontally. Floats are attached to the "headrope" along the upper edge of the forward opening to keep the trawl open vertically. Heavy rollers are placed along the bottom edge or "footrope" to keep the footrope on the bottom and to aid the net in passing over obstructions as it is dragged along the bottom. On the bottom side of the codend cowsides are usually attached to prevent chafing and tearing of the net as a result of contact with the ocean floor.

As the trawl is pulled forward, many of the fish in its path enter the net and eventually become massed in the codend. If the meshes of the codend are large enough, most of the fish that are too small for the market will be able to pass out unhurt through the meshes and escape capture. Fish too big to pass through the meshes will be captured. Usually the trawler tows the trawl at a speed of 3 to 4 knots with the duration of the tow depending on the skipper's knowledge of the fishing ground and the degree of concentration of fish on or near the bottom. When the skipper thinks that the net contains a good catch, the warps are hauled in by winches until the otter-boards or doors are brought to the two "gallows" frames, one forward and one aft of the working space on the main deck. The doors are then hooked to the gallows and the trawl is pulled alongside the ship between them. The forward parts of the trawl are pulled on board until only the codend containing the catch is in the water. This is then hoisted onboard and the draw-rope or codline, which keeps the codend closed during the fishing operation, is released. The catch is thus spilled into pens on the deck to be sorted and cleaned for icing in the hold. Before this commences, however, the net is put out again to start another tow.

Vessels and Equipment

The method described above is that of a conventional side trawler used by Canadian fishermen on the offshore fishing grounds. Canadian trawlers may range from 50 feet or less in length, for use on fishing grounds in coastal waters or on fishing grounds not too distant from the coast, to about 150 feet long for use on the distant offshore banks. They carry crews ranging from 5 men or less for the small vessels to about 20 for the larger ones. In terms of gross tonnage they range up to about 500 tons and are classed as small and medium size trawlers. All are equipped with radio-telephones and depth sounders, while the larger ones carry the latest in navigational and fish-finding equipment, such as radar, direction-finders, Loran, Decca navigators and echo-sounders for detecting fish concentrations.

Other countries with fishing fleets in the Northwest Atlantic also use conventional side trawlers, but these are generally much larger than those used in Canada and their size may range up to 2000 gross tons. For a number of years Spain has operated a fleet of pair trawlers. This method involves the operation of two vessels as a fishing unit using a trawl several times as big as that used by Canadian trawlers. Instead of using otter-boards to keep the mouth of the net spread

Model of Canadian otter trawler used in the Northwest Atlantic.

apart, the trawl is towed by two vessels. They alternate in taking the catch on board.

A number of European countries with fleets in the Northwest Atlantic now use stern trawlers, which are usually large factory ships, generally over 2000 gross tons. The large trawl when being pulled back is taken completely on board over the sloping ramp at the stern of the ship. When the codend is opened the catch is dumped through a hatch onto the deck below, where it is sorted, cleaned, filleted, packaged and stored in the refrigerated compartments, and is all ready for the market when the ship returns to its home port.

A trawler crew member tugs at the cod end rope of a trawl to spill a load of flounder into the overflowing checkers.

FISHERIES FACT SHEET

The Pacific Blackcod

(Prepared by the Nanaimo Biological Station of the
Fisheries Research Board of Canada.)

THE blackcod *(Anoplopoma fimbria)* like several other species of Pacific coast fish is misnamed in that it is not a true cod. Active fisheries for this species occur from California to Alaska. The total annual production for the Pacific coast has been maintained at a level of 14 to 18 million pounds in recent years, with Alaska taking between 40 and 50 percent. The Canadian catch, which has averaged over two million pounds per year, has had an average landed value of over a quarter of a million dollars. Over 60 percent of this catch comes from the waters off the Queen Charlotte Islands and off the coast of Alaska during the summer months.

DESCRIPTION

The blackcod or sablefish is a member of the skilfish family. It is distinguished by its green to bluish black colour, two widely separated dorsal fins, a slender caudal peduncle and a smooth, streamlined body.

HABITS

The adults of this species inhabit much greater depths than most other groundfish species, being commonly taken in waters of 70 to 250 fathoms. Spawning takes place in the late winter months and is believed to occur in deep water off the west coast of Vancouver Island and off the Queen Charlotte Islands. The eggs are pelagic. Very young stages have been captured near the surface several hundred miles off the continental shelf. Large schools of immature fish between one and two feet in length are frequently seen in the surface waters close to land in the straits and inlets. On the fishing banks the smaller fish are encountered at shallower depths than the larger fish.

The food of the blackcod consists mainly of herring, sand lance and crustaceans.

BLACKCOD *(Anoplopoma fimbria)*

AGE AND GROWTH

From a study of the rings on the scales of the blackcod it has been found that commercial size is reached at an age of approximately five years and maturity is reached at about six to eight years. At that age the fish are about 28 inches in length. Very old fish may reach a length of three and a half feet and a weight of forty pounds.

FISHING METHODS

Almost all of the Canadian catch of blackcod is landed by longline vessels. The main landings usually occur after the halibut season has closed. Since otter-trawlers usually do not fish as deep as the longliners they seldom encounter fish which are much over the legal size.

HANDLING

The major part of the catch is put through the smoking process, the finished product often appearing on the market as "smoked Alaska cod". Small quantities are dry-salted. Because of the high oil content in the flesh, blackcod is seldom marketed fresh.

The liver oil, like that of the lingcod, halibut and dogfish, is high in vitamins A and D. The heavy demand for this product during the war years contributed greatly to the expansion of the fishery.

February 1967

Department of Fisheries and Forestry

Ottawa

FISHERIES FACT SHEET

Pacific Edible Crab

THE PACIFIC edible crab, or Dungeness crab *(Cancer magister)* is one of the larger crustaceans found on the Pacific coast of North America, exceeded in size only by the king crabs of the Gulf of Alaska and the Bering Sea. The distribution of the edible crab on the Pacific coast is from Unalaska to Monterey, California. It lives from the low tide mark to as deep as 100 fathoms, but is not often fished in British Columbia waters deeper than 20 fathoms. The crab fishery is one of the minor fisheries of British Columbia, with an annual total landed value of about $627,000 in 1966.

The mature crabs usually mate during the summer months in the inshore waters. The male pairs with a soft-shelled, i.e. recently moulted female. In late fall or early winter, eggs are spawned by the female and retained on the lower surface of the abdomen.

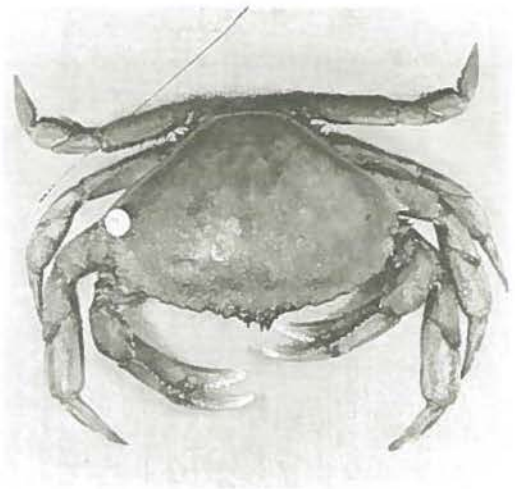
The eggs, as many as a million, are carried by the female until hatching in the spring, after which the young crabs (larvae) swim freely for three months or longer before settling to the bottom.

Growth is accomplished by frequent moulting of the juvenile crab. After the attainment of maturity (believed to be three years in British Columbia), moulting takes place annually or sometimes less frequently. The legal minimum size of 6 1/2 inches, measured across the back and including the longest spines, is reached at about 4 years. The maximum size for the edible crab is about 10 inches. Females rarely reach the minimum size, so in actual practice do not appear in commercial catches.

The crab is generally found on a firm sandy bottom. Specimens taken from a muddy habitat are small in size and often quite discoloured. Its diet consists of clams, marine worms, and even small fish.

FISHING AREAS AND METHODS

Up to three quarters of the total British Columbia catch is taken off the northern part of the Queen Charlotte Islands. Other areas are in Boundary Bay, at the mouth of the Fraser River, Chatham Sound, Burrard Inlet, Sooke Harbour, and near Tofino on the west coast of Vancouver Island.



Pacific Edible Crab *(Cancer magister)*

Traps are largely used in the capture of the edible crab. In all areas today, the main trap is a heavy circular, stainless steel-meshed type, having a diameter of about 40 inches and depth of 14 inches, with two tunnel mouths. Each trap has a separate line and floating buoy. Formerly light, rectangular traps, attached at intervals along a long groundline, were the regular crab gear in sheltered bays and inlets. Clams, squid or frozen herring are used for bait. A limited quantity of crabs is caught by bottom trawling.

Crab canneries are situated at Masset in Queen Charlotte Islands, at Prince Rupert and at nearby Port Edward. Other products include: whole cooked crabs, fresh and frozen; frozen unshelled but gutted crabs; and fresh crab meat.

(Prepared by the Nanaimo Biological Station of the Fisheries Research Board of Canada.)

Department of Fisheries and Forestry

Ottawa

FISHERIES FACT SHEET

The Pacific Gray Cod

THE gray cod *(Gadus macrocephalus)* is the true cod of the Pacific Ocean and is closely related to the famous cod of the north Atlantic. It is an inhabitant of the colder waters of the coast and seldom ventures south of Oregon. The species is abundant off the west coast of Vancouver Island and in Hecate Strait. Extensive fisheries have occurred as far north as Alaska and the Bering Sea. Over the past few years the gray cod has been increasing in importance to the Canadian fishermen. The total catch by Canadian and American vessels of the British Columbia coast exceeded 30 million pounds in 1965.

GRAY COD *(Gadus macrocephalus)*

DESCRIPTION

The presence of three soft-rayed dorsal fins and two anal fins are characteristics which distinguish the members of the cod family. The gray cod is readily distinguishable from its relatives, the tomcod and whiting, by the long barbel on the lower jaw (the tomcod has a very short barbel and the whiting has none).

HABITS

Little is known of the life history of the gray cod. Spawning is known to take place during the winter months, but the actual location of the spawning grounds is known only for a few small inshore populations. The eggs of the cod, unlike those of some flatfish species, do not float after they have been liberated.

Small gray cod are encountered in shallow water during the summer months and the adults occur at depths of 30 to 60 fathoms.

Food consists mainly of herring, sand lance and flatfish. Other items in the diet include crabs, shrimps and euphausiids.

The gray cod grows very rapidly, reaching a length of 24 inches by the end of its third year. The average age in the commercial catches is three or four years but some fish may reach an age of eight years and a length of close to three feet. Maturity is reached in two or three years.

FISHING METHODS

Otter-trawlers, particularly those equipped with high opening nets of light web, account for the major part of the gray cod landings. Small quantities are caught incidentally in the line fisheries. Several decades ago there existed an active line fishery for gray cod off the Alaska coast and in the Bering Sea, but this petered out, probably because of marketing problems.

In the years following World War II there has been an increasing demand for gray cod. Some of the catch is landed dressed. It is then filleted and packaged for freezing. A fair percentage of the catch is used as halibut bait by longliners.

(Prepared by the Nanaimo Biological Station of the Fisheries Research Board of Canada).

Department of Fisheries and Forestry

Ottawa

FISHERIES FACT SHEET

The Pacific Halibut

THE HALIBUT ranks as Canada's eighth most important food fish (in terms of value of products) and is found on both coasts of the Dominion. The Pacific halibut is distinguished from the Atlantic species by certain scale characteristics which have given it the specific name, *Hippoglossus stenolepis* Halibut are found both in shallow waters and in depths of at least 600 fathoms, but for the most part range from 30 to 225 fathoms. British Columbia fishermen take halibut from within the whole area of the continental shelf extending from the Strait of Juan de Fuca to the eastern Bering Sea. The principal fishery, however, is centered in the waters off northern British Columbia and in the Gulf of Alaska. Of the 35 to 40 million pounds caught annually by Canadians in Atlantic and Pacific waters, the British Columbia catch makes up 85 to 90 per cent of Canada's total. The marketed value of West Coast halibut amounts to more than $10 million annually.

DESCRIPTION

The halibut, a member of the flatfish family, is dark brown on the upper side, with lighter irregular blotches. The lower side is white, and rarely blotched. It has a mouth extending to a point below the eye. The eyes are large, with the upper eye slightly behind the lower. The scales are very small and smooth and the lateral line is arched.

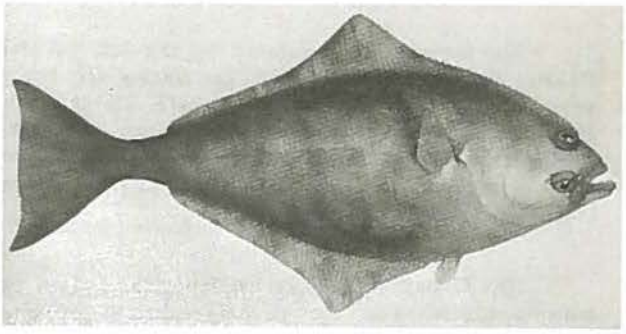
HABITS AND MOVEMENTS

The eggs and larvae are heavier than surface sea water and lighter than the deep water. For this reason, they drift passively with the currents at depths down to 375 fathoms. They gradually rise to the surface as development proceeds, and drift into shallow water with the inshore surface currents.

When six or seven months old, the young fish settle to the bottom in the shallow waters of sandy bays and inshore banks. With advancing size and age they move into deeper waters. Tagging operations have shown that the immature halibut move within very restricted areas. Mature fish, however, migrate extensively to and from the spawning grounds. A few West Coast halibut have travelled as much as 2,000 miles.

FOOD

The halibut are ground feeders, but occasionally will swim near the surface in quest of food, which consists of fishes, crabs, clams, squid, worms, etc.



THE PACIFIC HALIBUT (HIPPOGLOSSUS STENOLEPIS)

SPAWNING

Spawning takes place from November to January in well defined areas of depths from 150 to 225 fathoms. Halibut do not spawn until they are 10 to 12 years old. At that time, a large female of 140 pounds may have as many as 2,700,000 eggs.

GROWTH

The larvae like those of other members of the flatfish family, begin life in an upright position with eyes on each side of the head, and both sides of the body the same colour. However, after the young halibut is about an inch long, an extraordinary transformation takes place. It proceeds to the bottom, from the near-surface depths of the ocean in which it has lived since birth, and acquires the habit of resting and swimming on its left side. Gradually, as the young halibut grows, the left eye migrates or twists over towards the right side of the head. Simultaneously the left or underside of the fish changes colour and becomes white or grayish, while the right or upper side is a varying slate brown, often mottled and sometimes almost black. By early spring the transformation is complete and the young fish settles to the bottom in the shallow waters near shore. The female halibut is faster growing than the male. However, she does not reach maturity until she is from eight to 16 years old, averaging around 12 years, while males mature considerably earlier. Males have been known to attain an age of 25 years and a weight of 40 pounds. They have been known to reach 4 feet, 7 inches in length. Female halibut may weigh as much as 470 pounds, and reach a length of over eight feet. They are known to live for 35 years or more.

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FISHING AREAS AND THE FISHERY

British Columbia is close to the world's greatest halibut fishing grounds. Some of the principal ones are off the north coast of Vancouver Island, off the Queen Charlotte Islands, in Hecate Strait and in Dixon Entrance. Others, farther away, but commercially accessible to British Columbia vessels, lie off Alaska. All told, these areas yield more than 60 per cent of the world's annual halibut catch.

The fishery is regulated by the International Pacific Halibut Commission, consisting of representatives of Canada and the United States, which operates under a treaty between the two countries. The work of the Commission is one of the world's outstanding examples of successful international action in fisheries conservation.

The Canadian Pacific halibut fishery is a primary industry, and as such a specialized fleet is engaged in its prosecution. The halibut is caught on set-lines, the unit of line being the "skate". These are run out on relatively shallow bank areas, ranging in depth from 10 to 150 fathoms. Frozen herring, cod or octopus is usually used for bait, and the bait, and the baited long lines are paid out directly from the power-boats. In early days of the fishery, however, the gear was set from dories.

Among the West Coast companies, the following categories are used to ensure uniformity in the commercial handling of halibut.

Chicken	5 - 10 lbs.
Small Medium	10 - 40 lbs.
Large Medium	40 - 60 lbs.
Large	60 - 125 lbs.
Whales 125 and over.	

Practically all the five million pounds landed on the Atlantic Coast are marketed as fresh, of which about half is exported to the United States. On the Pacific Coast, about 25 per cent of the catch is landed directly by fishermen at U.S. ports and most of what is landed in Canada is sold as frozen dressed. About two-thirds of B.C. production of frozen dressed halibut is sold to foreign markets, mainly to the United States and United Kingdom.

(Prepared by the Fisheries Research Board of Canada Biological Station, Nanaimo, B.C.)

September 1966

FISHERIES FACT SHEET

The Pacific Herring

HERRING were one of the first coastal fishes to be utilized by man. In northern Europe, particularly, they have been a source of food since before written history. In British Columbia herring and herring roe have been an article of food or barter of the coastal Indian tribes for many centuries. They were not fished, however, on a commercial basis until 1877 when 75 tons were caught.

From 1959-1963 the annual catch has averaged about 210,000 tons.

While this fishery is first in landed weight and second to salmon in landed value, it is only worth about one-quarter as much as British Columbia's salmon catch.

Fluctuations in the world price of fish meal and oil cause the market value of about eight million dollars to vary from year to year.

THE FISHERY

The British Columbia herring fishery is a highly organized operation utilizing modern shore plants and efficient fishing vessels. The seventy- to eighty-foot long seine boats are equipped with the very latest electronic fish-detecting equipment, enabling the fishermen to "see" the shoals before setting the net. In some areas the eighty vessel fishing fleet may use powerful blue-tinted lights to attract fish schools.

Purse seining has been the dominant method of harvesting the herring crop since 1910. The 275-fathom long net encircles a school of herring and a purse line closes off the bottom like a draw string to prevent herring from escaping.

Sets average about 70 tons but catches up to 300 tons or about three million herring are not uncommon. The largest catches by a single net ever recorded were 1260 tons from Ogden Channel near Prince Rupert in 1950 and 1150 tons off Comox in 1949. The former was made by the seiner "Maple Leaf C", the latter by the seiner "Western Ranger". The captured herring are scooped two tons at a time with a giant dipnet or brailer into the hold of the fishing vessel and conveyed rapidly to the shore plants. Some herring are also caught by mid-water trawls and a few, to supply the fresh fish market, by gill nets.

The Pacific Herring *(Clupea palasii)*

In southern British Columbia the most prolific fishing grounds are along the Vancouver Island shoreline. On the east coast the best localities are off Campbell River, off Comox and amongst the "Gulf Islands" between Nanaimo and Victoria and on the west coast in Barkley Sound, in Nootka Sound and in Esperanza Inlet. In central British Columbia herring are caught in the channels near Bella Bella and in northern British Columbia around the islands south of Prince Rupert. Considerable catches are sometimes made along the lower east coast of the Queen Charlotte Islands.

Fish caught in southern British Columbia are generally processed at Steveston near Vancouver while those captured in central and northern British Columbia are delivered to shore plants in Prince Rupert and Namu, south of Bella Bella.

At the shore plants herring are unloaded by a giant suction hose into storage bins to await processing into fish meal and oil. The herring harvest of British Columbia is not utilized directly for human consumption but rather forms a protein and mineral rich supplement in the diet of poultry, pigs and mink. The edible fish oil is shipped by rail and truck to markets in Canada and the United States for use in the manufacture of soaps, paints and cooking compounds. Only five per cent of the total herring catch is used for human sustenance either canned, salted, pickled or fresh.

DESCRIPTION

Pacific coast herring are bony fish about nine inches long with blue-green backs shading away to silvery white on the sides. The mouth is large with a slightly projecting lower jaw; the tail is deeply forked. They are graceful but somewhat nervous swimmers, characteristically travelling in large shoals. They are grouped scientifically in the family Clupeidae, to which also belong such other closely related Pacific coast species as the pilchard (Pacific sardine) and the shad.

Iridescent, loosely attached scales, about

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one-quarter of an inch broad, are imprinted with annual rings that can be used to tell the age of a herring. In British Columbia the herring catches are composed mainly of fish that are three and four years of age. If there were no fishery some herring would grow to be quite old. The oldest herring on record, caught several years ago near Prince Rupert, was more than fifteen years old.

REPRODUCTION AND GROWTH

To fulfill the instinct to reproduce their species the herring legions undertake long spawning pilgrimages each year. In the fall, they leave the rich offshore feeding grounds above the continental shelf and migrate to inshore waters. Here, they form in dense schools awaiting the ripening of their reproductive organs. It is during this winter resting phase that the fishermen intervene to make their catches. Spawning takes place along the shore in early spring.

Each spring herring leave the ocean depths and crowd onto the beaches in vast numbers to perpetuate their race. Although male and female are present in equal numbers on the spawning ground there is no "pairing off" during the spawning act. Females discharge sticky eggs on green eel grass and brown rockweed, japweed and kelp. The males shed milt into the surrounding water turning it milky and opaque for miles. During the 1964 spawning season, over 220 miles of spawn were deposited along the 17,000 miles of British Columbia shoreline. After spawning, the spent fish return offshore to feed in scattered schools.

An average-sized herring deposits about 20,000 eggs each year. The transparent eggs are less than one-sixteenth of an inch in diameter and one square inch of seaweed may be covered with as many as one thousand eggs. After a sixteen-day incubation period the embryonic fish finally break out of the confining egg membranes and drift away.

During the brief period that they are fastened to moist seaweed many thousands of eggs are destroyed. Storms frequently annihilate whole spawnings. Seagulls and diving ducks are attracted in large flocks to the spawning beaches, first to feed on the spawners and then on the spawn left exposed at low tide. Mortality during the egg stage may amount to as much as 70-80 per cent.

By late April the sea lanes are populated with tremendous numbers of newly hatched, almost invisible herring larvae. These fragile, thread-like one-quarter-inch long infant herring bear little resemblance to the adult fish. They lack scales, the head and black eyes are greatly enlarged and they can barely swim. Two months later when about one and one-half inches long they will have undergone a gradual metamorphosis that changed their outward appearance into that of a miniature adult herring.

After schooling up, the infant herring now known as juveniles can be found frequenting kelp beds for protection during the summer months. These sardine-sized fish are raked by sports fishermen for use as live bait when trolling for salmon. Occasionally, a small fishery for these juveniles takes place but the schools of young herring have never been exploited to the extent of those along the Atlantic seaboard and in the Gulf of Maine.

In October, when about 4 inches long, juvenile herring normally forsake their shallow-water haunts and move seawards into deeper waters. Their survivors will return in the fishable stocks mostly as mature, three-year-old herring. They will continue to return each year in the spawning runs for the remainder of their life span. Little information exists with respect to the distribution and abundance of immature herring between the time they leave shallow water and the time they return as adult fish.

Herring research has shown that two types of herring stocks exist in the coastal waters of British Columbia; major migratory stocks and minor resident stocks, the latter present in local waters all year round. A twenty-year herring tagging program carried out by the Nanaimo Biological Station of the Fisheries Research Board of Canada has indicated that there are at least nine relatively separate migratory herring populations along the coast.

MANAGEMENT PROGRAM

Present day efforts are designed to provide a scientific basis for a management program that will allow the greatest possible catch from all populations. In the continuing program emphasis is placed on compilation of catch statistics, sampling for age, length and maturity, estimating spawn abundance and echo-sounding surveys. The analysis of these data provides information on the level of abundance of each population and on the relationship between the size of the spawning stock (measured by the amount of spawn deposited) and the resulting number of recruits to the fishable schools (year-class strength).

The British Columbia herring fishery is regulated through the Federal Department of Fisheries by a combination of closed areas, closed seasons and catch quotas. The closed season extending from February 5 to May 1 in southern British Columbia is designed to protect the fish at spawning time when they are massed close to shore. By mutual agreement, a 48-hour closure period occurs each weekend as well as a 3-week shut-down over Christmas. However, control of the fishery is provided principally by a system of catch quotas applied to most of the major herring populations. Thus, 40,000 tons of herring may be taken each year from the herring population off the lower east coast of Vancouver Island. If surveys by patrol vessels of the Department of Fisheries and biological evidence indicate