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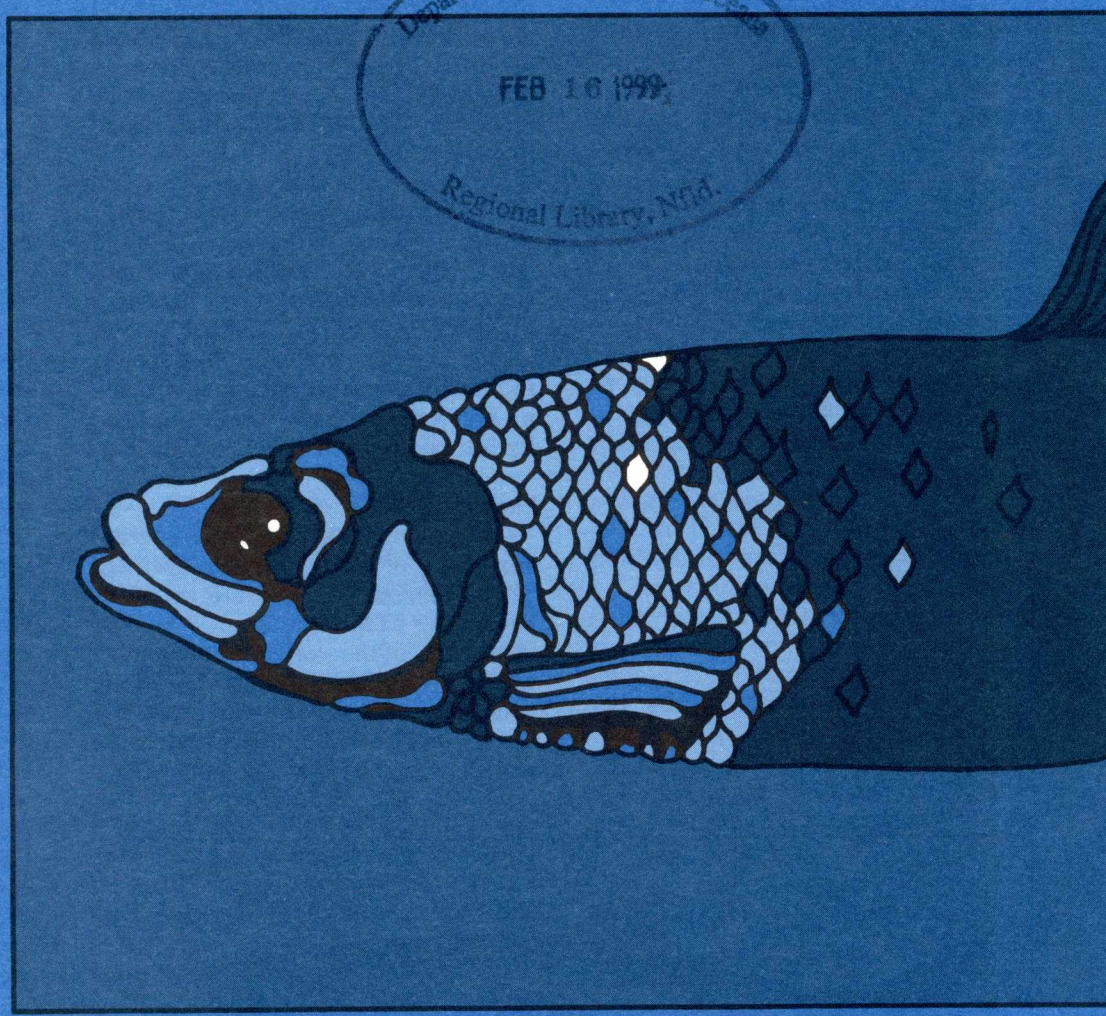


## Atlantic Herring

Fisheries and Oceans | Pêches et Océans

Canada

# Atlantic Herring

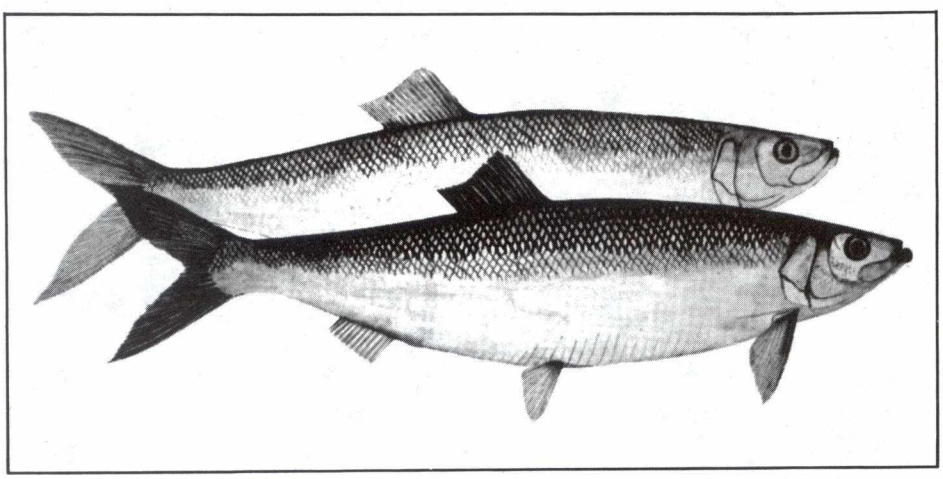
Although Canadians have been eating Atlantic herring canned as sardines since the 1870s, many are not aware that they are not the true sardines of the genus *Sardinops*, which are not found in Canada.

In 1953, a reduction plant for transforming herring into fishmeal and oil was opened in the Magdalen Islands, and other plants followed in New Brunswick, Newfoundland and Nova Scotia. By 1968, most Canadian herring catches were being reduced to low-priced fish meal or oil. However, with the failure of several major herring fisheries around the world in the early 1970s, the demand for food herring increased. Prices to fishermen rose from an average of one cent a pound in 1969 to 12 cents a pound in 1979.

Now herring is seldom used for fish meal production. Most of it is exported as frozen fillets, sardines, pickled and cured fillets, and pickled and cured whole-dressed herring. Whole herring is also sold fresh or frozen and is used as lobster bait. The preparation of roe for the Japanese market is a lucrative activity which has probably not yet attained its full potential in Atlantic Canada.

**Description**

The Atlantic herring (*Clupea harengus*) is one of the best known open sea fish on Canada's east coast. It is a member of the Clupeidae family found in many parts of the world, including some species living in inland lakes. Among Clupeidae on Canada's east coast are the blueback herring, the gaspareau or alweife, the shad and the menhaden.



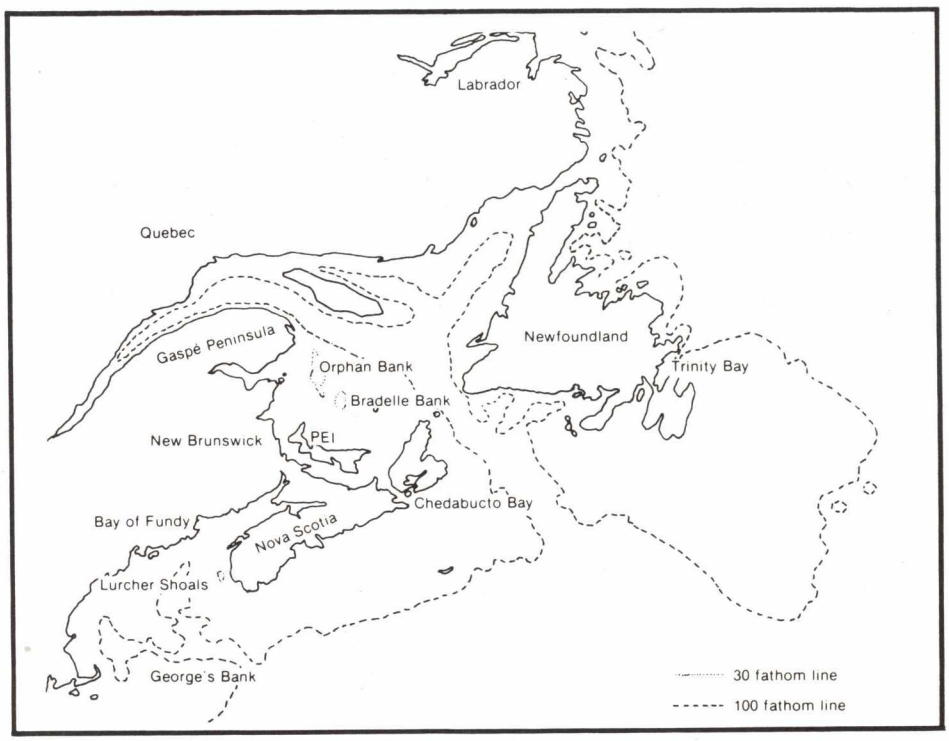
The Atlantic herring has a streamlined, elongated body, much deeper than it is thick, with an iridescent steel-blue or greenish-blue back and silvery sides and belly that provide excellent camouflage in the open sea. It has a deeply-forked tail, large loosely-attached scales and a single dorsal fin on the back.

**Life History**

In the northeast Atlantic, the Atlantic herring ranges from northern Labrador and Greenland to North Carolina. On the other side of the Atlantic, herring is found from Spitzbergen, north of Norway, to Gibraltar, at the entrance to the Mediterranean.

Along the Canadian Atlantic coast, spawning may occur in any month between April and October, but it is concentrated in May and September. Most evidence shows that spring and fall spawners are biologically independent stock groups.

It is not clear what factors control the timing and locality of spawning. However, herring eggs adhere to objects on the seabed, such as rocks, gravel and algae. Less stable surfaces do not provide the necessary conditions for the maintenance of a spawning bed. Some fishermen claim that the timing of spawning is precisely related to the lunar cycle. This idea has never been fully evaluated by scientists and the existing evidence is contradictory. In the southwest Gulf of St. Lawrence, the peak of spring spawning is apparently related to the water temperature. However, there is also evidence of a fixed number of waves of spring spawners regulated by factors other than water temperature. Fall spawners reproduce at very different temperatures than spring spawners in the same area.




During spawning, eggs and milt (sperm cells of male fish with their milky fluid) are released into the water by herring in schools. Eggs remain attached to the seabed until hatching, which takes about 30 days at 5°C, a typical spring spawning temperature, and only 10 days at 15°C, typical of Gulf of St. Lawrence fall spawning temperatures. Fall-spawned eggs off southwest Nova Scotia develop at about 10°C.

Before 1970, when most populations were more abundant than they are now, the water would turn white over inshore spawning beds due to the release of milt from male spawners. Storms would carry waves of eggs onto the beaches, where in some localities they were shovelled into wagons and used to fertilize the fields. Eggs are also eaten by groundfish like cod and haddock, and various flounders.

Improving knowledge of the subsequent survival and growth of larvae and juveniles is a frontier of biological research. After they have absorbed the yolk sac retained from the egg stage, young larvae risk starvation if their hatching is not followed by a period of adequate food production. They also may be dispersed if currents are not suitable. Predation by pelagic fish such as mackerel and herring may be a major cause of larval mortality.

The larvae of some stocks have been shown to stay very close to the spawning bed where they were hatched. This is a result of the formation of tidally-induced retention areas, which prevent larvae from being dispersed by water currents. When these larvae metamorphose into juvenile herring, the resulting schools are composed of fish from the same spawning site. Since the members of a school stay together, this results in the maintenance of separate stocks, even though mixing with other stocks may occur during feeding or overwintering.

The length of time it takes for larvae to metamorphose into juvenile herring is related to the water temperature and the availability of food. Larvae hatched in the early summer will become juveniles that same year, whereas fall hatched larvae will not metamorphose until the following spring or summer.

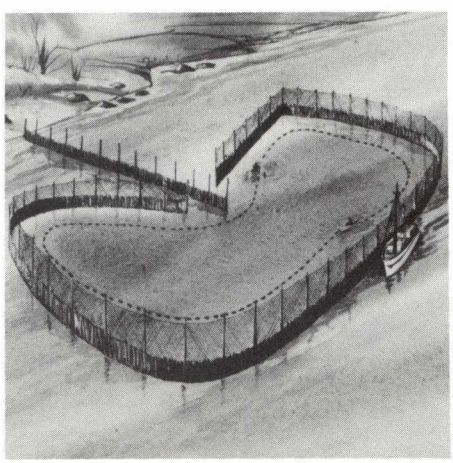
The length and age at sexual maturity have varied in Canadian populations of the Atlantic herring. As a rule, the youngest mature herring are three years old, and almost all are mature by age five. But it appears that to a certain extent they will become sexually mature at a younger age as populations diminish under intensive fishing. In 1978 in the

Gulf of St. Lawrence, three-year-olds were about 25 cm long, while five-year-olds were 30 cm in length. Growth rates vary between and within stocks over time. These variations are not fully understood, but are certainly influenced by the water temperature and population size. Higher water temperatures may be accompanied by faster growth rates, while competition for food in a dense population may restrain growth.

Fecundity (the production of eggs per female) increases as fish grow. For example, 25 cm spring-spawning herring in Chaleur Bay produce about 30,000 eggs. At 30 cm they produce 60,000 eggs, and at 35 cm, 130,000. The total weight of eggs produced increases faster than the total weight of the fish. For spring spawners in Newfoundland, internal eggs are about 28 per cent of the total weight of herring weighing 200 gm, but 40 per cent of the weight of 400 gm herring.

Fall spawners produce about 50 per cent more eggs than spring spawners of the same length. Fall spawners measuring 35 cm in Chaleur Bay produce more than 200,000 eggs per female. The high productivity of fall spawners is probably due to warmer water and greater availability of food during the summer months before spawning, compared to the conditions in March and April before spring spawning.

*fig. 1. Herring weir*



Herring are the prey of a number of open-sea predators, such as cod, tuna, sharks, dogfish, squid, sea birds, seals and whales. Herring may also fall victim to disease. Between 1954 and 1956, many herring in the Gulf of St. Lawrence died from a fungus infection. It is now estimated that about 18 per cent of adult herring die each year from causes other than fishing. But for most herring populations, fishing is the most important cause of mortality. Depending upon the stock, between 10 and 50 per cent of adult herring are captured every year.

The herring's principal food is tiny planktonic (drifting) crustaceans, such as copepods and euphausids. They also consume eggs, larvae and any other organisms which are small enough to enter their mouths. Herring are primarily particulate feeders ("bite" feeders), but they may also filter feed with their gills when food is suitable.

**Major Stocks**

A large stock of herring spawns off Southwest Nova Scotia in the fall. Spawning activity is concentrated on the Trinity Ledge and Lurcher Shoals near Yarmouth. Much of the adult stock then migrates up the Nova Scotia coast to winter in the area around Chedabucto Bay. In the spring, they migrate to the Bay of Fundy where they feed during the summer off the south and southwest coasts of Nova Scotia before moving to the spawning grounds. Juvenile herring from this stock mix with Gulf of Maine juveniles to form large concentrations of "sardines" along the New Brunswick coast of the Bay of Fundy during summer, where they support a traditional weir fishery.

Both spring and fall spawning herring are found in the southern Gulf of St. Lawrence. Spring spawning occurs mainly in Chaleur Bay, on the eastern shore of New Brunswick, and at the Magdalen Islands. The most important fall spawning sites are in Chaleur Bay, and along the eastern shore of New Brunswick and Nova Scotia. The biologically-separate spring and fall spawners mingle together during summer feeding in the shallow waters along

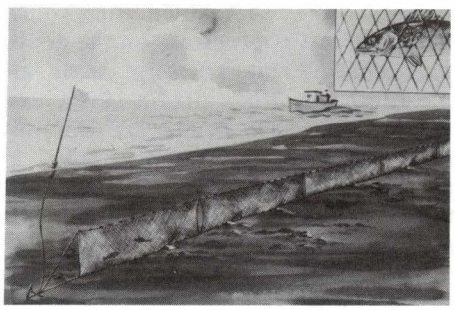


*fig. 2. Gillnet*

these same coasts. They again mix in the fall, mainly in Chaleur Bay, in preparation for the migration to overwintering areas. In the late 1960s, when these stocks were much more abundant than they now are, most adults would migrate to the deep fjords of southwest Newfoundland, where they were heavily fished during the winter. Fishing would again occur in the spring when these same fish would migrate back into the Gulf along the edge of the Laurentian Channel. Herring is no longer found in abundance in either of these areas. However, part of the southern Gulf adult herring group is known to overwinter in the Sydney Bight off Cape Breton Island. Here they mix with fish from the southwest Nova Scotia stocks as well as local spawning populations. Juveniles do not undertake such extensive migrations.

Each of the larger bays around Newfoundland supports a local herring population. These fish do not migrate as far as the larger Bay of Fundy and Gulf of St. Lawrence groups.

Georges Bank was formerly the spawning ground for a large herring population. However, a large international fishery developed there in the 1960s with the USSR as the most active participant. Overfishing eventually led to the collapse of this fishery, and surveys in the area have found very few larvae since 1977.

Our knowledge of the stock structure of herring is based upon several sources of information. Tagging studies are a traditional method. Meristic studies compare the counts of some body parts, especially vertebrae, gill rakers and fin rays. These counts are different between fish from some stocks. Biochemical studies have recently shown that there are clear genetic differences between fall-spawning and spring-spawning herring.

**Fishery and Stock Trends**

Prior to the mid 1960s, in most areas of Atlantic Canada, herring were caught by small inshore boats using gillnets or traps, or in weirs. Catches — made almost exclusively during spawning runs — were limited more by markets than by abundance of fish. However, Bay of Fundy weirs have always caught juvenile fish during their summer feeding. Purse seines used to be limited to a fleet of small boats in the Bay of Fundy. And in the Magdalen Islands, herring were traditionally caught in floating trap nets.

Between 1965 and 1972, catches increased rapidly due to the introduction of a fleet of large purse seiners. But total landings have declined considerably from the record levels attained in the early 1970s, and today's herring fleets are underutilized due to a lack of sufficient fish to catch.

The most dramatic fluctuations in landings and stock size have occurred in the southern Gulf of St. Lawrence fisheries. In 1965, purse seiners began fishing there and in southwest Newfoundland, where the adult stock used to overwinter. The subsequent high landings were made possible by the abundant 1958, 1959, 1962 and 1963 year classes; the catch increased from 39,000 tonnes (t) in 1964 to nearly 300,000 t in 1970. But the winter fishery collapsed in the early '70s, and landings reached a low of 37,000 t in 1974.

Most of the herring caught in the southern Gulf fishery was caught by purse seiners from the late '60s until 1980. As stocks declined, some formerly important spawning sites in Chaleur Bay and Northumberland Strait became much less productive for the gillnet fisheries concentrated there. The Magdalen Islands trap fishery has virtually disappeared. Since 1980, overall Total Allowable Catches (TAC) have been reduced by fishery managers and only 20 per cent of the total is now allocated to seiners.

In Newfoundland the traditional fisheries took place in Fortune Bay and in the area of the Port-au-Port Peninsula. Gillnets were the traditional gear, but purse seines were introduced as early as the 1930s. The first major purse seine fishery on local Newfoundland stocks began in 1966 north of Cape St. Gregory on the west coast, and activity spread to

St. George's Bay in 1975. In recent years, catches in western Newfoundland have been shared between seiners and gillnetters. The total catch reached a record 19,000 t in 1980, but poor recruitment of young fish had forced a decline to half this level by 1982.

The 1968 year class of herring was abundant around the Newfoundland coast, permitting the development of a mobile purse seine and ringnet fleet during the early 1970s. On the east coast, landings reached a record 26,000 t in 1979, when the inshore fishery caught 70 per cent of the herring. Recruitment was very poor however, and the stocks had dwindled to such a low level that fishing was curtailed in 1983. Smaller fisheries in Placentia Bay, St. Mary's Bay and Fortune Bay were closed for the same reason in 1982.

In Nova Scotia, inshore fishermen in Sidney Bight and Chedabucto Bay fish local spawning runs of herring. Purse seiners in these areas fish overwintering herring. The winter seine fishery in Sydney Bight began in 1968 and reached a peak of 17,547 t in 1973, only to decline to less than 4,000 t per year by the early 1980s. Catches are a mixture of overwintering herring from southwest Nova Scotia, the Gulf of St. Lawrence, and local Cape Breton stocks. The peak catch from the winter fishery off Chedabucto Bay was in the order of 50,000 t in the early 1970s. More recently catches have varied between 10,000 and 20,000 t per year. The Chedabucto Bay fishery has been shown, by tagging studies, to be closely associated with the Southwest Nova Scotia stock and has been managed in conjunction with the southwest Nova Scotia fishery since 1974. The TAC for the fishery off Chedabucto Bay is determined according to the management plan for the southwest Nova Scotia fishery.

A purse seine fishery for juvenile and adult herring is carried out off southwest Nova Scotia in the early summer and early fall. A weir fishery catches juveniles during the summer and fall, while the gillnetters concentrate on the adult fall spawning run. The total catch for the southwest Nova Scotia stock, excluding the New Brunswick Bay of Fundy fishery for juveniles, reached a peak of nearly 190,000 t in 1970. About 85,000 t per year were caught in 1981 and 1982.

The New Brunswick Bay of Fundy fishery, which exploits herring schools from several neighboring stocks, is the home of Canada's oldest purse seine fishery and the sardine canning industry. Weirs are the main fishing gear, supplemented by shut-off seines and purse seines. Landings reached 75,000 t in 1968 and have varied considerably since then. The 1982 catch was about 25,000 t.

George's Bank was formerly the spawning ground for a large herring population, and an international fishery developed in the 1960s with the U.S.S.R. as the most active participant. In 1968, Canadian vessels caught 13,674 t out of a total catch of 373,344 t. Overfishing eventually led to the collapse of this fishery, and surveys in the area have found very few larvae since then.

Canada's participation in the herring fishery in the Gulf of Maine has decreased considerably in recent years due to the poor state of the adult stock. Since 1977, when both Canada and the United States extended their jurisdiction over fisheries to 200 miles, Canada has not had a fishery in the Gulf of Maine.

**Research and Management**

Modern herring fisheries are very difficult to manage. Purse seiners are capable of capturing entire schools of fish in a few hours. Gillnets may become so heavily concentrated over spawning beds that most of the herring in a run are captured before having a chance to reproduce. Overfishing has in fact combined with poor recruitment of young fish to reduce several Canadian Atlantic herring stocks to very low levels.

Overfishing results in the loss of production due to growth and in the loss of production of young. Most individuals may spawn only once or twice before being caught. Yet if they were allowed to reproduce more often, they would contribute much more to the production

*fig. 3. A purse seiner*

*fig. 4. Gill netting for herring*

of future generations of new recruits. The capture of most herring when they are young also prevents fishermen from taking full advantage of the potential growth in weight of each fish. However, the maximum possible yield does not occur when all the fish are old and very large, since growth rates slow down after a few years, and more fish die every year from causes other than fishing. It is important to balance off the advantages of growth and reproduction against this continuing mortality when deciding what portion of a population should be harvested.

Some of the largest Canadian herring fisheries are carried out when fish from several spawning populations are mixed together for feeding or migration. Under these circumstances, it is impossible to predict exactly what portion of the TAC will be caught from any one population. There is a real danger that small populations contributing to a large fishery might accidentally bear much more than their share. The result can be the virtual elimination of these spawning populations. It may take many years before new stocks repopulate the abandoned spawning sites.

To help solve management problems, scientists must estimate quite accurately the abundance of fish in a population at a given time. One very useful guide for some species of fish is the catch rate of commercial fishing vessels. If they catch more per day this year than they did last year, this suggests fish are more abundant. But the schooling behaviour of herring complicates this situation. If a stock is decreasing in size, high catch rates may still be maintained as long as the schools can be located. A smaller stock may be distributed over a smaller territory, and experienced fishermen using sophisticated electronic equipment can usually find the fish. Awareness of the complexity of the problem has led scientists to exercise caution in recent years in their recommendations for TACs.

New techniques are being developed to estimate the abundance of herring stocks. Catch rates on spawning fisheries are being used to estimate the numbers of reproducers. Acoustic surveys are particularly useful to determine the abundance of overwintering herring, since stocks are more concentrated then. Surveys of the numbers of eggs deposited on spawning beds permit back calculation of the number of parent fish.

The most challenging area of research concerns the understanding of recruitment variability. Acoustic surveys are being tried to estimate the abundance of juveniles. But in order to predict accurately future variations in recruitment, much more information about the relationships between herring and other species and with the environment is necessary. Ecological research about these relationships continues.

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**Published By:**

Communications Directorate
Department of Fisheries and Oceans
Ottawa, Ontario
K1A 0E6

**DFO/4834 UW/16**


Catalogue Number Fs 41-33/16-1993E
ISBN 0-662-2051-0

**Disponible en français**

Printed on recycled paper