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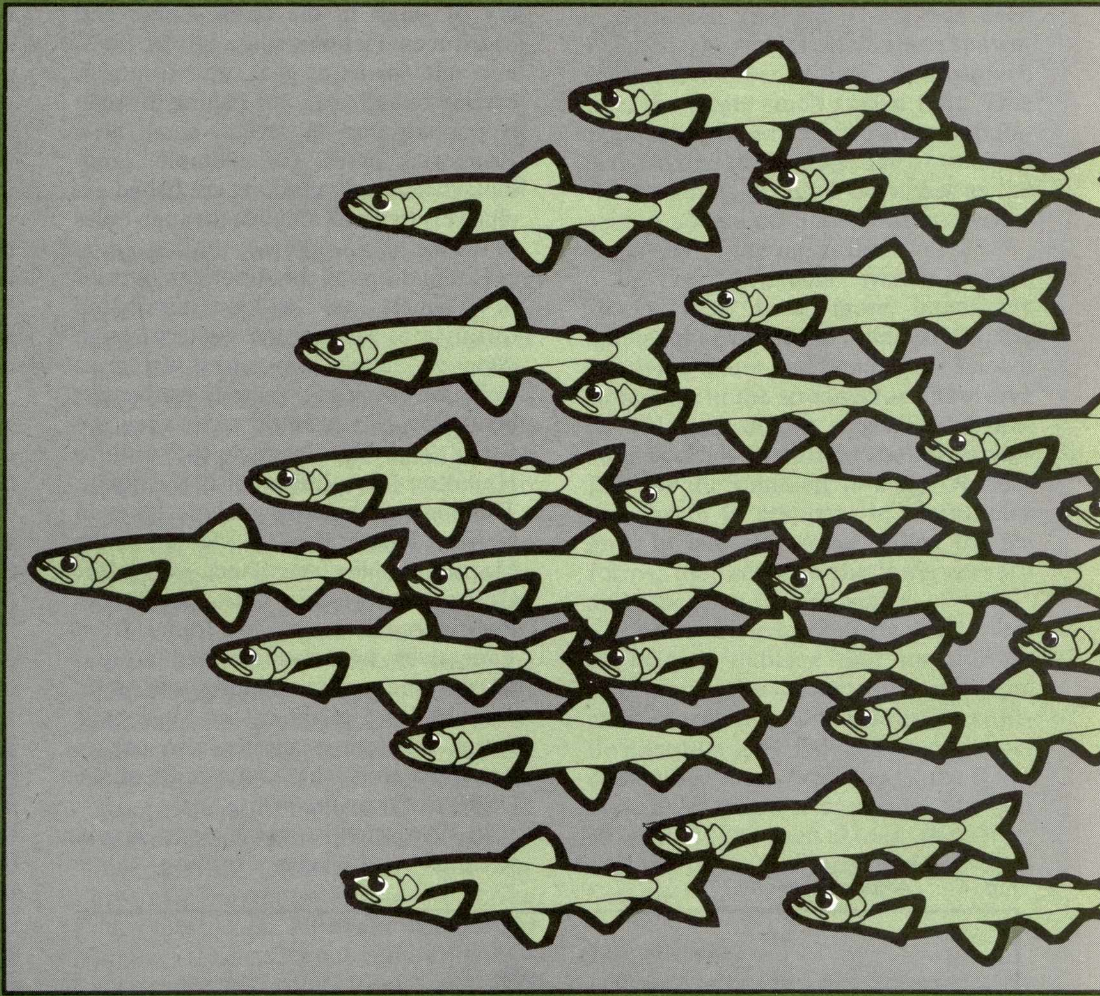


The American Smelt

Fisheries and Oceans
Pêches et Océans

Canada

The American Smelt

There are few fisheries where catches have shifted so dramatically from one part of the country to another as that of the American smelt.

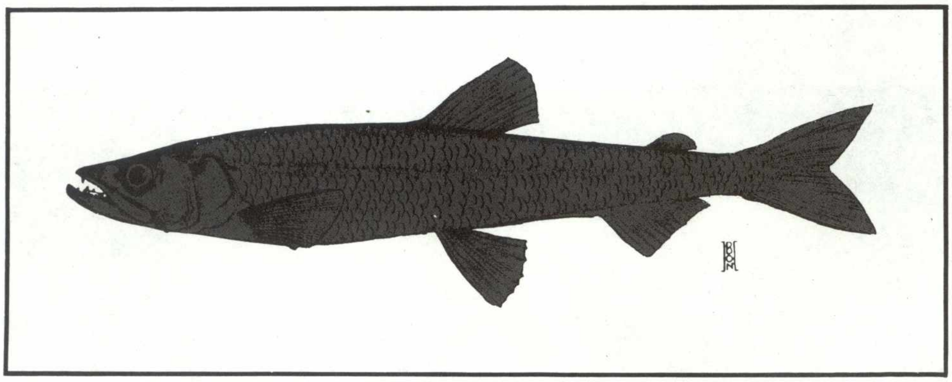
Prior to 1948 the commercial smelt fishery was centered on the Atlantic coast. In that year an experimental gill-net fishery was established in the Great Lakes, and became increasingly successful. Gradually, the Great Lakes fishery exceeded the Atlantic coast ventures both in terms of the weight of total landings and their market value.

There is also an extensive sport fishery of smelt in the Great Lakes and Maritimes. Fishermen use hooks, lines, nets and spears as gear, and fishing is carried out all year. Ice fishing of smelt is popular and in several small New Brunswick lakes, for example, landlocked smelt populations are fished exclusively by hook and line through holes in the ice.

Populations of the American or rainbow smelt are widely distributed throughout eastern and western North America, inhabiting coastal waters as well as countless inland freshwater lakes. On the Atlantic coast they are found from New Jersey in the south to Hamilton Inlet, Labrador in the north. Their inland habitats include lakes in New Hampshire, Maine, the Maritimes, Newfoundland, Labrador, Quebec and eastern Ontario. On the Pacific coast, smelt are found from Vancouver Island northward around Alaska and eastward along the Arctic coast at least as far as the Mackenzie River. The same species also ranges westward along the Arctic coast of the USSR as far as the White Sea.

In 1906, smelt stocking was begun in streams and lakes feeding Lake Michigan in order to provide forage for salmonids. Eventually large smelt populations were found in all the Great Lakes, especially Lake Erie. There is some evidence that the smelt inhabiting Lake Ontario were not a result of these stockings but of an independent movement from Lake Champlain stocks. Smelt have also been introduced into smaller lakes in central Ontario.

Fig. 1 American smelt



Description

The scientific name of the American or rainbow smelt is *Osmerus mordax*. It belongs to the family *Osmeridae,* which also includes the longfin smelt and the eulachon of the west coast, the pond smelt of the western Arctic, and the capelin which inhabits east coast waters. Relatives of the American smelt include the Atlantic argentine, the salmonids, and, although dissimilar in appearance, the European smelt. While the Atlantic silverside, found along the Maritimes coast, is similar in appearance to both the American smelt and capelin, it is altogether unrelated.

The American smelt is a pelagic schooling species, inhabiting inshore coastal regions and the midwaters of lakes. Since it is sensitive to both light and warmer temperatures, schools of smelt tend to concentrate near the bottom of lakes and coastal waters during daylight hours.

In appearance, the American smelt is a slender, silver fish, with a pale green or olive-green back. Fresh from the water, the sides of the fish take on a purple, blue or pink iridescent hue. Most specimens are less than 20 cm long, although some measuring 35 cm have been found. The scales on the smelt are large and easily detached, and at spawning time those on the males develop small tubercles, resembling tiny buttons which serve as a mark of their sex. The lower jaw of the fish projects beyond the upper one and the entire mouth extends beyond the middle of the eye. On the tip of the tongue are large teeth. One large dorsal fin is located about halfway along the back and, behind that, a small adipose fin.

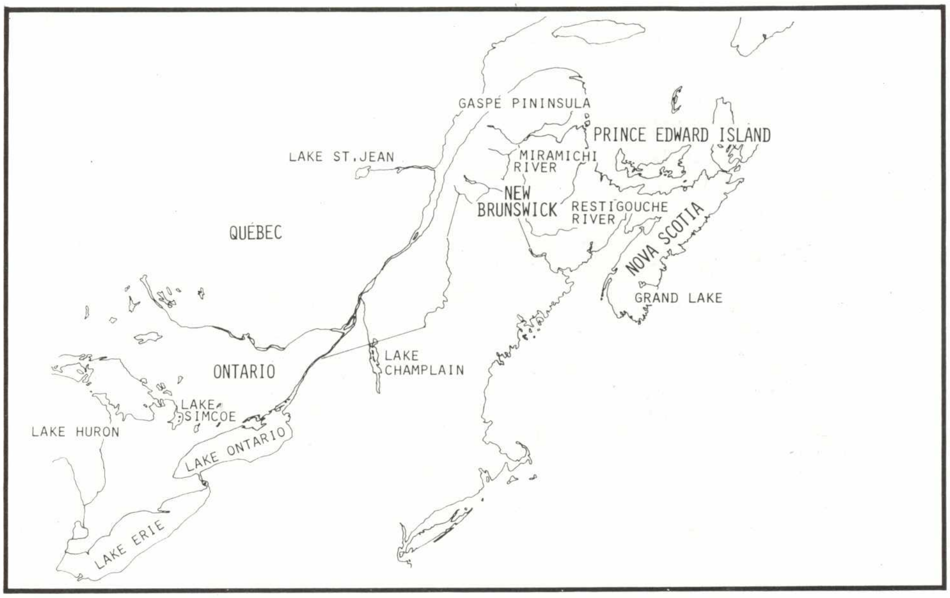


Fig. 2 Areas with resident smelt populations

Fig. 3 Fishing through the ice in New Brunswick

Distribution and Migration

The *Osmeridae* family, as well as the related *Salmonidae* family, include a number of "anadromous" species which pass part of the year in salt water, migrating to fresh or brackish water to spawn. Both the American smelt and the Atlantic salmon are among those species which are often able to adapt to a strictly freshwater environment.

In the spring, both anadromous and landlocked adult smelt migrate upstream to freshwater spawning grounds. During bad weather, however, or where obstructions along the migratory route inhibit movement, some spawning may occur before freshwater sites are reached. Stormy weather may also cause spawning to take place along beaches or on gravelly-bottomed offshore banks. Smelt in the Miramichi River system, for example, begin their upstream migration before the spring thaw has begun. When the ice breakup begins, freshets can temporarily halt upstream migration, and, in some instances, force the smelt to move back downstream. If the migration is sufficiently delayed spawning may take place below the head of the tide.

Spawners reach the tide head in the main tributaries when the water temperature is only 4°C to 5°C. In the Great Lakes, however, migration begins shortly after the ice breaks up, when the water temperature is at least 8°C. Smaller streams are entered when the temperature is 6°C to 7°C. Anadromous smelt in the Gaspé Peninsula spawn in similar temperatures, although some landlocked populations in Lake Champlain and lakes in New Hampshire may spawn in temperatures as low as 2°C.

Once the freshwater site has been reached, the smelt remain there spawning for a number of days. At any given age, the larger smelt spawn first. This applies to the entire migrating population, so that the average size of smelt on the spawning grounds decreases as the season advances. Shortly after spawning many of the males die.

In the Miramichi system, where stocks have been more intensively studied than other Canadian stocks, the surviving males and females are known to remain in the streams for about five to 10 days before migrating downstream. They remain in the Miramichi Bay for the summer; in early October they begin to reappear in the estuary and, in late November, when the ice forms, they settle in the lower estuary and inner bay for the winter.

Studies carried out through a system of tagging indicate that most smelt spawning in the Miramichi return to the same stream or to one nearby. Very little intermixing of fish has been observed between main branches of the River system or between early and late-run streams. It has been shown, therefore, that the smelt demonstrate a degree of homing.

Life History

Observations in Lake Superior show that some smelt are mature at two years of age, and therefore able to spawn, and all are mature at three years of age. In the Miramichi River system, studies have shown that 66 per cent of spawners were two years old, 30 per cent were three years old, and four per cent were four, five or six years old.

Fecundity, or the number of eggs produced per female, varies from one area to another. Anadromous populations are more fecund than landlocked populations. For example, a fully-grown (about 21 cm long) female smelt from the Miramichi River will produce about 70,000 eggs, while a female of a similar length from Lake Superior will produce about 31,000 eggs. The smallest mature female observed in the Miramichi (about 10 cm long) produced an average of about 7,000 eggs.

Observations of smelt in the Miramichi indicate that spawning occurs mainly at night, typically over a gravelly bottom. Females, in fact, sometimes leave the spawning site during the daylight hours. During spawning, two or more males place themselves alongside a female and release their milt at the same time the female releases a cluster of eggs.

On contact with water the outer envelope of the egg becomes sticky and adheres to the gravel or other bottom objects. This outer coat is soon broken and torn away by the current except for that portion of the egg adhering to the bottom surface. Where the density of egg deposits is not too high, this little "stem" permits the egg to sway freely in the current, thus assuring good aeration. In some streams, however, where smelt are obliged to spawn below impassable obstructions, repeated spawnings will result in egg deposits of up to 10 cm thick. Water circulation and aeration of the lower layers is very poor, due to the buildup of sediment, and mortalities are extremely high.

Fig. 4 A dragger on the Great Lakes

Experiments carried out on a Miramichi tributary indicate that at low egg densities about four per cent of the eggs hatched, while at very high densities only 0.03 per cent of the eggs survived.

Egg mortality is also high when freshets occur, causing streams to overflow their banks. Under these conditions many smelt spawn beyond the normal limits of the streambed. These eggs die when the streams return to their original size.

The time required for the eggs to hatch depends upon the water temperature. At 4°C, eggs take at least 50 days to develop; at 6°C hatching occurs after about 30 days, and at 10°C, less than 20 days is required.

Larvae are about 5 mm long at the time of hatching. They drift downstream with the current to the estuary where they drift back and forth with the tide. There is evidence that they are able to exercise some control over their movements, since daylight finds them close to the river bottom.

During the summer months, larvae and juveniles are found throughout the Miramichi River, Bay, and Estuary, then leave the river in mid-August.

Female smelt grow more quickly than males, attain a larger size, and live longer. In the Miramichi River, two-year-old females were observed to be 13.9 cm long on the average; two year-old males were 13.5 cm long. By five years of age, females were 20.6 cm long and males were 18.3 cm long. Lake Superior smelt are apparently larger throughout their adult life than Miramichi smelt. Two-year-old males and females averaged about 15 cm in length, whereas five-year-old males averaged 21.8 cm and females averaged 23.9 cm. Smelt restricted to small inland lakes are usually much smaller and often do not exceed 10 cm in length. Individuals 36 cm long have been captured in the coastal waters of the Maritimes and in Lake Ontario.

In the Great Lakes, a shrimp-like crustacean, *Mysis relicta,* is the smelt's

Fig. 5 Inspection at dockside

principal food. Smelt also consume other zooplankton, insect larvae, and aquatic worms and may eat small quantities of fish, including smaller smelts, sculpins, burbots, white bass, whitefish, and emerald shiners. Studies of Miramichi River populations show that smelt larvae consume small zooplankton, while adults consume larger zooplankton, including shrimps and shrimplike organisms, aquatic worms, and small fish, such as juvenile herring, mummichog and silversides.

Conversely, Miramichi smelt are prey for cod, salmon, seals, comorant, and mergansers, while Great Lakes smelt fall prey to lake trout, salmon, brook trout, burbots, walleye, yellow perch, and birds such as gulls and crows.

Smelt are also afflicted by parasites, one of which forms white cysts in the viscera and body cavity of smelt inhabiting both North American and European waters. Fortunately, it does not appear to be harmful to humans who consume the fish. Smelt may also fall victim to contagious diseases. Between 1942 and 1946, an estimated 50 million pounds of smelt in Lake Michigan were lost because of what may have been a viral infection.

The Fishery

On the Atlantic coast, anadromous smelt stocks are fished during the fall and winter before the onset of the migration to spawning sites. Commercial-sized smelt are caught in gillnets of about 3.25 cm mesh size. Bag nets of a smaller mesh size are also used to avoid gilling and to ensure that smelt are trapped in the net "bag". The opening of a bag net may be up to 10.5 m wide and 7.5 m long, and the bag is oriented so that the large "mouth" faces the tidal currents. The whole structure is held in place by poles driven into the bottom of the estuary or bay. As smelt move with the current, they enter the large opening, continue through the smaller opening of the internal trap, and finally arrive at the "bunt", the tapered end of the bag net. At slack tide, the fisherman hauls up the foot line to shut off the mouth of the net, shakes all the smelt back towards the bunt, and hauls it out of the water, emptying the catch into his boat.

The bulk of Atlantic coast smelt are caught during the winter through holes made in the ice. The most popular gear is the "double-ender" box net. A mesh leader about 6.5 m wide and 30 m long is placed across the current. At the end nearest the centre of the channel, the leader passes through the entrance into a long rectangular, small-mesh "box". At both ebb and flow tides, smelt, arriving at the leader, pass along it until they end up in the trap inside the box. The design is such that, even if the tide changes, escape is impossible. The centre of the box net is directly under the rectangular hole made in the ice, so that the fisherman may easily haul the bunts at either end of the box onto the ice.

In the Great Lakes, smelt are fished commercially by trawls which are towed through the schools of fish. This mobile gear permits much higher catch rates than can be obtained with the fixed gear used in the Atlantic coast smelt fishery, and also makes possible a year-round fishery.

The smelt is also a popular sport fish. In Lake Erie, thousands of fishermen use dip nets and seines to capture smelt. In the Maritimes, smelts are fished with hook and line from docks during the summer months. Dip nets are limited by regulation to use during the spring. In the winter, thousands of small shacks are erected throughout the Maritimes and Quebec for purposes of ice fishing. Sports fishermen use a hook and line or spears.

Before 1948, about 99 per cent of Canadian commercial landings came from the Atlantic coast; the remainder came from British Columbia. Total east coast landings numbered about 3,700 metric tons (t) per year, with New Brunswick accounting for about 70 per cent of the total. About half of New Brunswick landings came from the Miramichi River system. In 1948, an experimental gillnet fishery for smelts was undertaken in the Great Lakes which, following the conversion to trap nets, saw landings increase rapidly to 2,086 t by 1958. The conversion to mobile gear in the following year led to new increases, and Great Lakes landings reached 8,662 t in 1962. A record of 12,399 t was attained in 1978. In 1979, Great Lakes landings totalling 10,979 t were valued at $2,035,000. Atlantic coast (reported) landings were 2,542 t and valued at $1,065,767. It is highly likely, however, that total landings were much higher. Landings in both major fisheries seem to be determined more by market demand than by the availability of the smelt resource.

During the 1950s, the abundant new supply of smelt from the Great Lakes caused a general decline in prices paid to fishermen. With the introduction of trawls which permitted larger catches per vessel per day, prices again fell drastically in the early 1960s. On the Miramichi River, for example, prices often exceeded 90 cents per kg in the late 1940s and early 1950s; by the early 1960s, they were below 45 cents per kg. Not surprisingly, the number of Miramichi smelt fishermen decreased steadily throughout the 1950s, and then dropped drastically in 1960. Atlantic coast landings reached a low of 1,169 t in 1962.

A considerably higher price is paid for anadromous smelt, however, and reflects the opinion that they are of superior quality than the landlocked variety. In 1962, for example, the average price paid for smelt on the Atlantic coast was almost 42 cents per kg, whereas only 15.3 cents per kg was paid for those landed in the Great Lakes. In 1979, when Atlantic coast fishermen received an average of 85.5 cents per kg, Great Lakes fishermen received 37.8 cents per kg.

For many east coast fishermen, the smelt fishery is an "off-season" activity and year-to-year variations in participation will therefore be influenced by their economic success in other fisheries.

Fig. 6 Keeping quality high

Utilization

Most of Canada's smelt production is exported frozen to Japan or the United States. Some Great Lakes smelt is sold fresh to the United States. In 1982, Canada exported an estimated 13,500 t of smelt products, valued at close to $17 million.

Fig. 7 Packaging lake smelt

Research and Management

Management regulations for the smelt fishery vary from province to province and include restrictions on the location and type of gear used, mesh size and the establishment of seasons. However, comprehensive management plans for the smelt fisheries do not exist and considerable research is necessary before a scientific management plan could be instituted. In general, estimates of population size and exploitation rates are difficult to calculate accurately; growth rate and natural mortality rate for given populations are unknown. Until estimates of these parameters become available, it is impossible to recommend a scientifically acceptable catch level. A management plan might be concerned with measures which would exert more control over the level of fishing effort and the setting of a maximum annual catch limit. One objective of a management plan might be to assure the highest possible yield from the stocks without endangering the existing smelt populations. Others might be to produce the optimum economic benefits to fishermen or to achieve an equitable distribution of benefits.

Market research is also necessary, involving both the industry and the consumer. Answers to questions such as the price that can be expected for finished products, and whether processors and fishermen on the Atlantic coast are interested in investing in an expanded smelt fishery would provide important data. The industry could then investigate the possibilities of developing fishing efforts and the processing industry, and the feasibility of expanding markets.

Further Reading:

Leim, A.H. and Scott, W.B. 1966. *Fishes of the Atlantic coast of Canada,* Bull No. 155, Fisheries Research Board Can. (American smelt p. 119).

MacCrimmon, H.R. and Pugsley, R.W. 1979. "Food and feeding of the rainbow smelt (Osmerus mordax) in Lake Simcoe, Ontario". *Canadian Field Naturalist 93(3);* p. 266-271.

Loch, J.S.; Derksen, A.J.; Hora, M.E.; Oetting, R.B. 1979. *Potential effects of exotic fish species on Manitoba: an impact assessment of the Garrison Diversion Unit.* Tech. Rep. Fish Mar. Serv. (Can.), (no. 838).

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