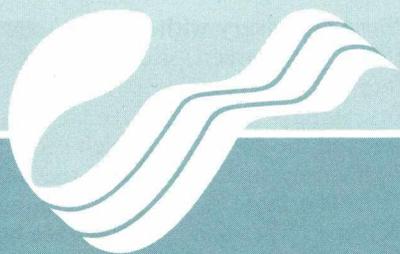
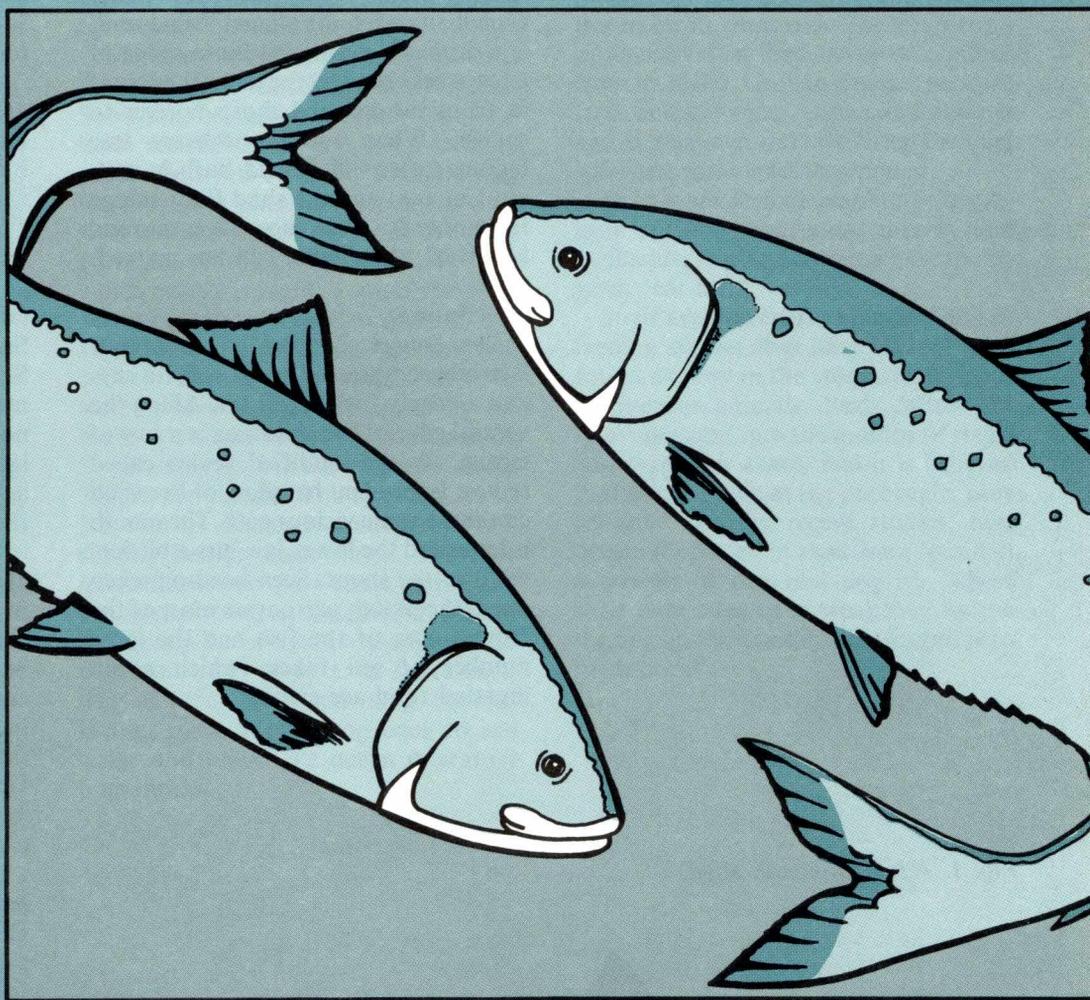


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UNDERWATER WORLD



The American Shad



Fisheries
and Oceans

Pêches
et Océans

Canada

THE AMERICAN SHAD

The appearance of shad in fresh food markets of Maritime Canada is a sure sign of spring. The traditional spring meal in New Brunswick is shad and fiddleheads (young fern shoots). Although shad are bony and considered difficult to eat, those who have the patience or know-how to properly prepare it realize it is a tasty fish. In fact, its scientific name *sapidissima* means "most delicious".

The American shad (*Alosa sapidissima*) is the largest member of the herring family Clupeidae. In many Canadian rivers, the annual "shad run" is a dramatic event. Within a space of a few weeks shad by the thousands come in from the sea and move upriver to spawn. When the serviceberry tree blooms (often called shad bush in eastern Canada) and the shad flies emerge from the St. Lawrence River around Montreal, the annual run has arrived.

Description

The American shad has a broad, laterally compressed body, soft fin rays and a deeply forked tail fin. Along the ventral edge of the abdomen is a row of strong, sharp, modified scales called scutes. Imprudent handling of live shad can cause some vicious cuts. The mouth is large and the lower jaw juts a bit forward of the snout. Seen head-on when open, the mouth gap covers most of the frontal area of the fish and the large number of gill rakers which retain ingested food are evident.

Shad are silvery with a brown-black through blue-green iridescent back. There are one to three rows of dark spots along the side between the gill cover and the dorsal fin, which become progressively smaller towards the posterior. The large scales are deciduous (easily lost) when shad are in the sea but become firmly embedded when the fish are in freshwater. After a short period in freshwater for spawning, shad take on a bronze or coppery hue and the head and ventral portions of the body become red, especially among males. Young shad in freshwater are silvery with a blue-green back.

Mature shad are 40 to 60 cm in length and weigh 1 to 3 kg. Females are usually larger than males. The largest shad seen by Canadian biologists in recent years was 75 cm long and weighed 4.2 kg.

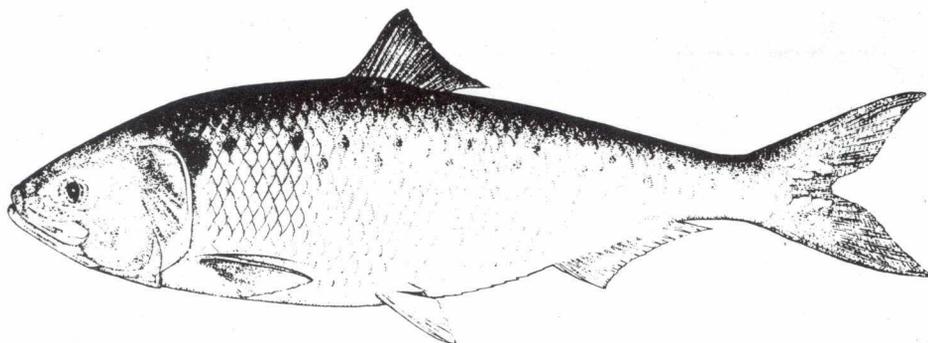
Distribution and Migration

The natural range of spawning populations of American shad is from the St. Lawrence River, Quebec to the St. John's River, Florida. During summer, shad are found in the sea as far north as central Labrador. Large populations occur in the Annapolis, Shubenacadie, Miramichi and St. Lawrence rivers.

Shad were introduced to the Pacific coast in 1871 in the Sacramento River in California and have become established from California to Alaska. They were first seen off the British Columbia coast in the 1800s but are rarely caught in the Fraser River or any other river on the Canadian west coast. Migrants from U.S.A. rivers to the south are caught occasionally in the sea along the British Columbia coast.

A closely-related shad, *Alosa alabamiae*, occurs on the northern coast of the Gulf of Mexico and two other closely-related species, *Alosa alosa* and *Alosa fallax*, occur in Europe, from the Baltic to Spain.

Fig. 1. Adult American shad.



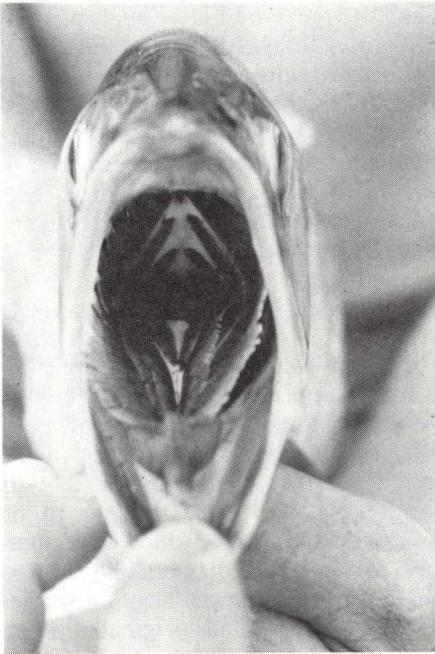


Fig. 2. Head on view of shad showing gillrakers.

Life History

American shad, like the salmon, is a classic anadromous fish — that is, one which is born in freshwater, goes to sea to grow to maturity and returns to freshwater to spawn. In eastern Canada spawning runs enter rivers between late April and late June, depending on spring weather and geographic location. Water temperature at the time is usually 8 to 12°C. Little is known of shad behavior in British Columbia, but in the Columbia River the shad run usually passes the Bonneville Dam when temperatures are around 16°C.

Males arrive on the spawning grounds first, followed closely by the females. Spawning begins when water temperatures exceed 12°C and peak activity occurs between 16 to 20°C. Spawning usually takes place in deep areas of a river where there are moderate to strong currents. During the spawning act, which occurs at night, a single female is accompanied by several males and they swim close to the surface, splashing and rolling. The eggs are released in open water where they are fertilized by the males. A single female may release up to 400,000 eggs, but the average is about 130,000 per female. The eggs are 2.5 to 3.5 mm in diameter, transparent and slightly heavier than water. They are non-adhesive so they settle singly and are carried along by the current. Hatching takes place in eight to 12 days at temperatures of 11 to 15°C or six to eight days at 17°C. After spawning, the surviving, spent adults drop back to salt water and rejoin the ocean migratory population.

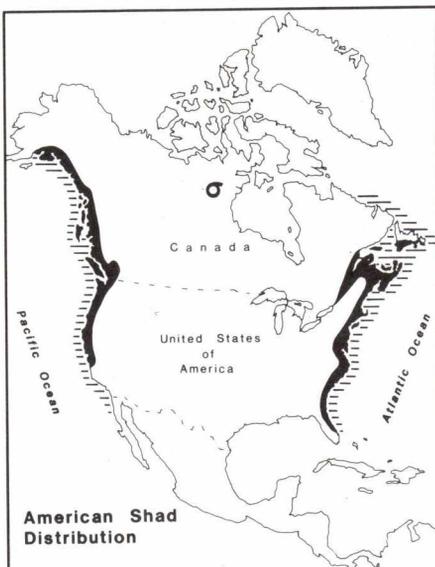
Larvae are about 10 mm long when they hatch, transparent and very slender. They spend their first summer in the river feeding on insects and planktonic crustacea. By autumn they are between 7 to 10 cm long, and when water temperatures drop to 15°C they move downstream and out to sea.

Shad remain at sea until they mature at age four or five years and attain a length of 40 to 50 cm. Most males mature at age four, most females by age five. Among Canadian populations, adults may spawn up to seven times and live to be 13 years old. The life history of an individual shad can be determined from its scales. Growth changes between fresh and salt water, winter and summer and at what age and how often the shad spawned can all be interpreted.

Shad at sea feed on planktonic organisms such as copepods, mysids and euphasids. During spawning migrations, adults eat little.

Shad are powerful swimmers and in feeding studies they have seldom been found as prey in the stomachs of large piscivorous animals. Seals follow the spawning runs into the mouths of rivers and take their share, and it is believed that sharks, such as the porbeagle, prey on shad. During recent studies, tags originally placed in shad were found in stomachs of cod and dogfish. These shad may have been weakened by the tagging and become more susceptible to predation.

Fig. 3. Range of American shad.



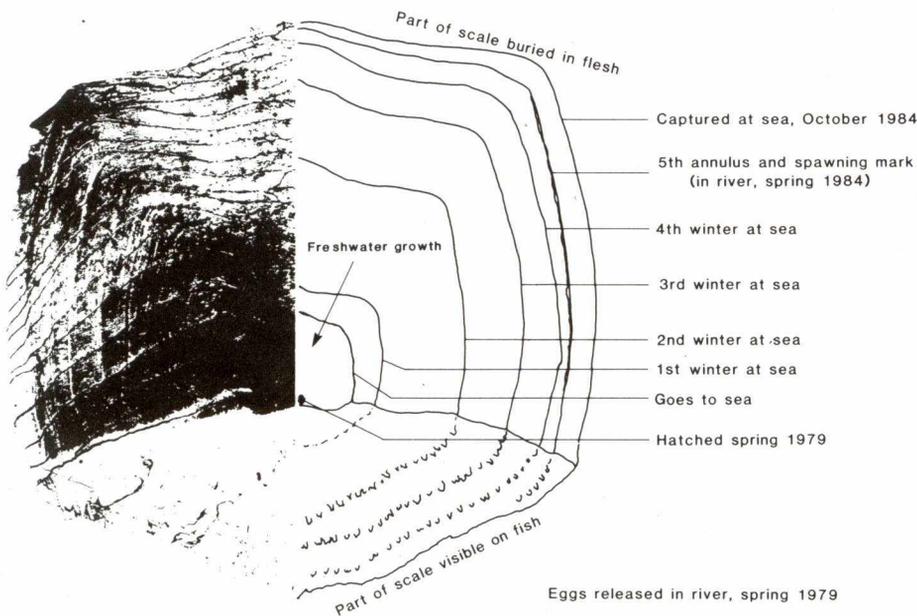


Fig. 4. American shad scale and interpreted life history.

Ocean Migration

Some of the most interesting facts about American shad have come to light during the last 30 years. Tagging studies in the early 1950s revealed that shad have an extensive northward migration in summer, then return to the southern part of their oceanic range in winter. The majority of shad were found to migrate between North Carolina and the

Fig. 5. Annual migration of American shad on the east coast of North America.

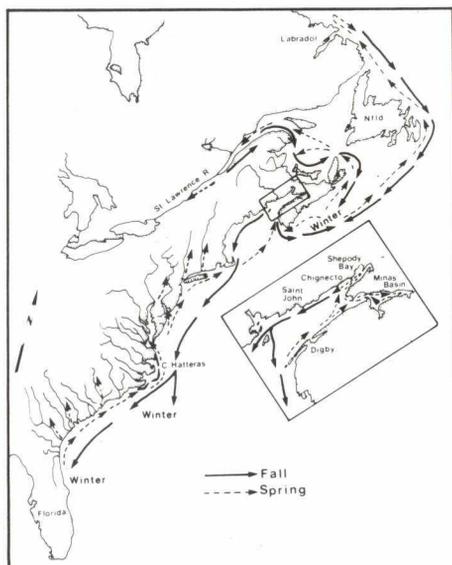


Fig. 6. Tag returns from 12,000 tags applied to American shad in the upper Bay of Fundy.



Gulf of Maine and later analysis indicated they followed or selected particular ocean temperatures during migration. By swimming north in spring and summer and south in fall and winter, shad are able to maintain themselves in the 13 to 18°C ocean isotherm. This appears to be their preferred temperature. During the course of this migration a shad from the St. John's River, Florida would travel 4,500 km in a single year.

Perhaps even more exciting developments have occurred during the last six years. Scientists from the Department of Fisheries and Oceans, working in the muddy waters of the upper Bay of Fundy, an area once thought to be almost devoid of fish, found large numbers of ocean-feeding shad occurred there during summer. Tagging studies revealed these shad originated from rivers along the entire east coast of North America, and for two or three months every summer a good portion of all east coast shad at sea were concentrated in this one small area. Rather than stopping in the Gulf of Maine as was originally thought, the main body of ocean-migrating shad move either into the upper Bay of Fundy or along the eastern coast of Canada into the mouth of the St. Lawrence River, and as far north as Nain, Labrador. Of the three regions where shad occur in summer (all in Canadian waters) the upper Bay of Fundy is apparently most important. Just as salmon born in eastern Canadian rivers go north to Greenland for the summer, American shad from eastern United States rivers come north to the Bay of Fundy. One reason they are obvious in this region is the turbidity of the water. In clear ocean water, shad usually remain at depths of 100 to 200 m, where they find their preferred level of light intensity. Since they are in deep water they are seldom encountered. In the upper Bay of Fundy the extreme turbidity of the water moves the preferred light intensity zone in to shallow depths (less than 10 m). This makes the shad accessible to fishermen and their presence obvious.

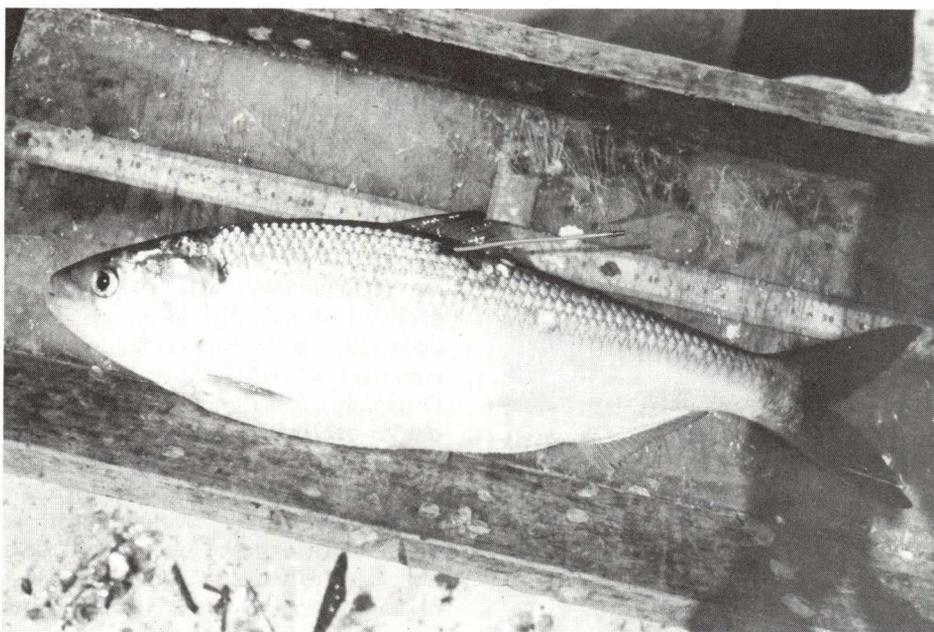


Fig. 7. American shad with plastic experimental dart tag under the dorsal fin.

The migration of American shad in the Bay of Fundy is complex. Shad destined to spawn in the local rivers (Annapolis, Shubenacadie, Saint John) arrive first in late April. During late May and early June immature, mature and spent ocean-feeding shad arrive in large numbers. The shad migrate around the Bay of Fundy in a counterclockwise direction, occurring off Nova Scotia in spring, at the head of the bay during

Fig. 8. Commercial drift gillnet fishermen.



summer, and off New Brunswick in the fall. Duration of the shad run in Minas Basin is from June to August, in Cumberland Basin, June to October.

Tag returns indicate these shad represent all the river populations of eastern North America. Shad have an acute sense of homing, similar to salmon returning to the river where they were born. Of 12,000 shad tagged and released in the upper Bay of Fundy, there were 55 (8.3 per cent) tag returns from Canadian marine locations, 175 (26.4 per cent) from coastal United States, 69 (10.3 per cent) from Canadian rivers and 365 (55 per cent) from United States rivers. As many as one million shad may occur in an embayment like Cobequid Bay at high tide during the height of the summer run. It is estimated that five to 10 million shad may migrate through the upper Bay of Fundy during a summer.

Commercial Fishery

The major commercial fisheries for shad are found in the large spawning rivers on the east coast (Saint John, Miramichi, St. Lawrence) and in the embayments of the upper Bay of Fundy. No substantial commercial fishery developed on the Canadian Pacific coast after the shad introduction, but large landings are now made to the south in the United States.

Riverine commercial fisheries are usually concentrated in or near the estuary to exploit mature shad returning to spawn. The fishing season is only for a short period in spring. Shad are captured using drift or fixed gillnets, trap nets or scoop nets (Annapolis River, Nova Scotia). These are valuable fisheries since female shad "roe" or "eggs" are the most sought-after item. During the spawning season, landed value of female shad is often over \$2.50 per kg.

The marine fisheries in the upper Bay of Fundy and the St. Lawrence estuary exploit non-spawning, ocean-feeding shad during the summer. These summer fisheries for shad are unique and occur only in Canada because of the combination of ocean habitat (turbid water) and the northward migration of all east coast shad. Shad are captured here using drift or fixed gillnets or large intertidal fish weirs.

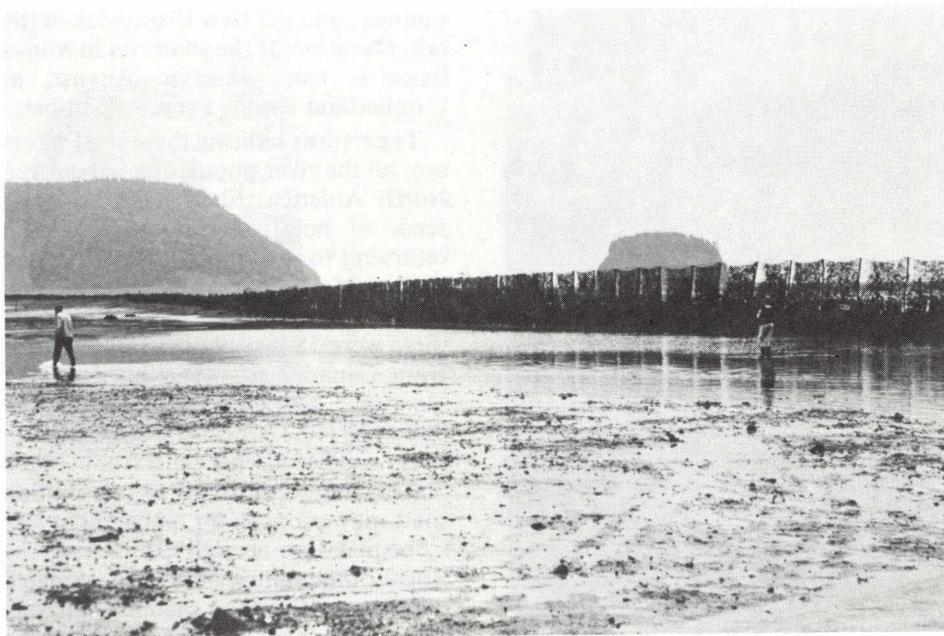
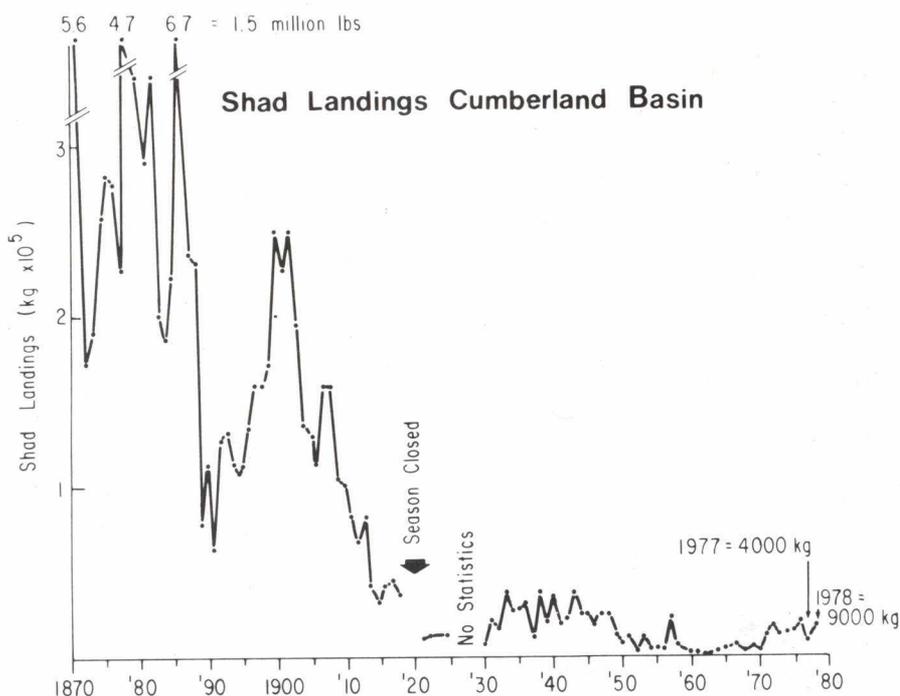


Fig. 9. An intertidal weir in Minas Basin for commercial fishing.

The shad fishery has existed in Atlantic Canada since the earliest arrival of Europeans. The weir fishery on the tide flats of the upper Bay of Fundy started before 1750. Many writers have described the abundance of shad in this region and the relative ease with which primitive or simple capture methods could take up to 100,000 shad on a single tide. During the late 1800s a large export trade in salt shad

Fig. 10. Commercial landings of American shad from an ocean fishery (lower left) and a river fishery (upper right).

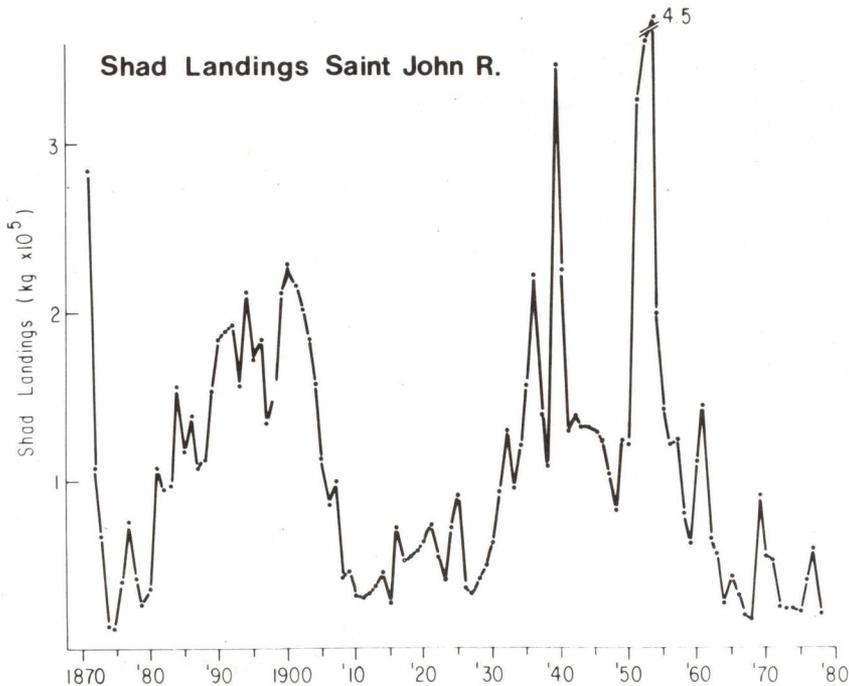


existed between the upper Bay of Fundy and the Eastern United States. At the time it was one of the most valuable fisheries in the Maritimes.

Between 1870 and 1900, annual shad landings for the upper Bay of Fundy were 200 to 400 metric tons (t). Landings in peak years were as large as 1300 t. This was about two-thirds of the total Canadian shad landings. After 1900, landings declined drastically as a result of decreased shad abundance and have remained at low levels to the present. Originally it was thought the decline was due to overfishing and the fishery was closed between 1919 and 1923. This action did not result in regeneration of the fishery and the recent work linking these ocean shad to eastern United States stocks indicates the decline was due to the loss of habitat in the major United States rivers. Pollution and damage of major rivers like the Delaware and Susquehanna caused their shad populations to decline to negligible numbers.

Landings from Canadian rivers have fluctuated widely during the last 100 years. The majority of landings have been from the Saint John and the St. Lawrence rivers. In some years, landings have exceeded 300 t, but the average is usually about 100 t.

Since the 1960s, however, landings have been uniformly low in all shad fisheries, marine and freshwater. Unfortunately, a large part of the perceived decline is due to a lack of demand for shad in the marketplace rather than a lack of abundance. The bony nature of the flesh and increased availability of other fish has led to decreased acceptance by consumers. Demand for the roe, however, is increasing and fishing effort probably will increase to meet this demand.



Sport Fishery

Angling for shad is of recent origin in Canada but growing in popularity. Most sport fishing is confined to rivers in Nova Scotia but recently it has become popular in the St. Lawrence around the island of Montreal. In the United States angling for shad is a popular pastime. The estimated annual value of the sport fishery for shad on the Connecticut and Delaware rivers is \$10 million. Up to 20,000 anglers fish the Delaware each spring for shad.

The popular method for shad angling is fly fishing. A weighted "jig" is the preferred lure. Shad do not feed while migrating upstream to spawn, but like salmon they will strike at a lure.

Research and Resource Management

In Canada the responsibility for research and management of American shad lies with the federal Department of Fisheries and Oceans (DFO). Provincial government departments engage in certain related activities including licensing of sport fishermen, assisting law enforcement and conducting surveys.

Most research is done by the DFO but some is also carried out independently or under government contract by universities. Research activity includes studies on population origin, aging methods, feeding and the potential impact of tidal hydroelectric power development.

Shad, like other fish which require streams for spawning, can be eradicated from rivers by dam construction without proper fishways at sites downstream from the traditional spawning areas. This occurred in the St. Croix River on the Canada-United States border and in numerous other United States rivers. Rehabilitation efforts are now in progress on many rivers to restore the shad populations. Construction of planned, large-scale tidal hydroelectric projects in marine feeding sites of shad could disrupt migration patterns or local marine food webs. It is difficult to predict the potential impact of such developments.

Shad management regulations exist to maintain and enhance existing populations. Regulations include closed seasons, control of fishing locations and gear specifications.

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