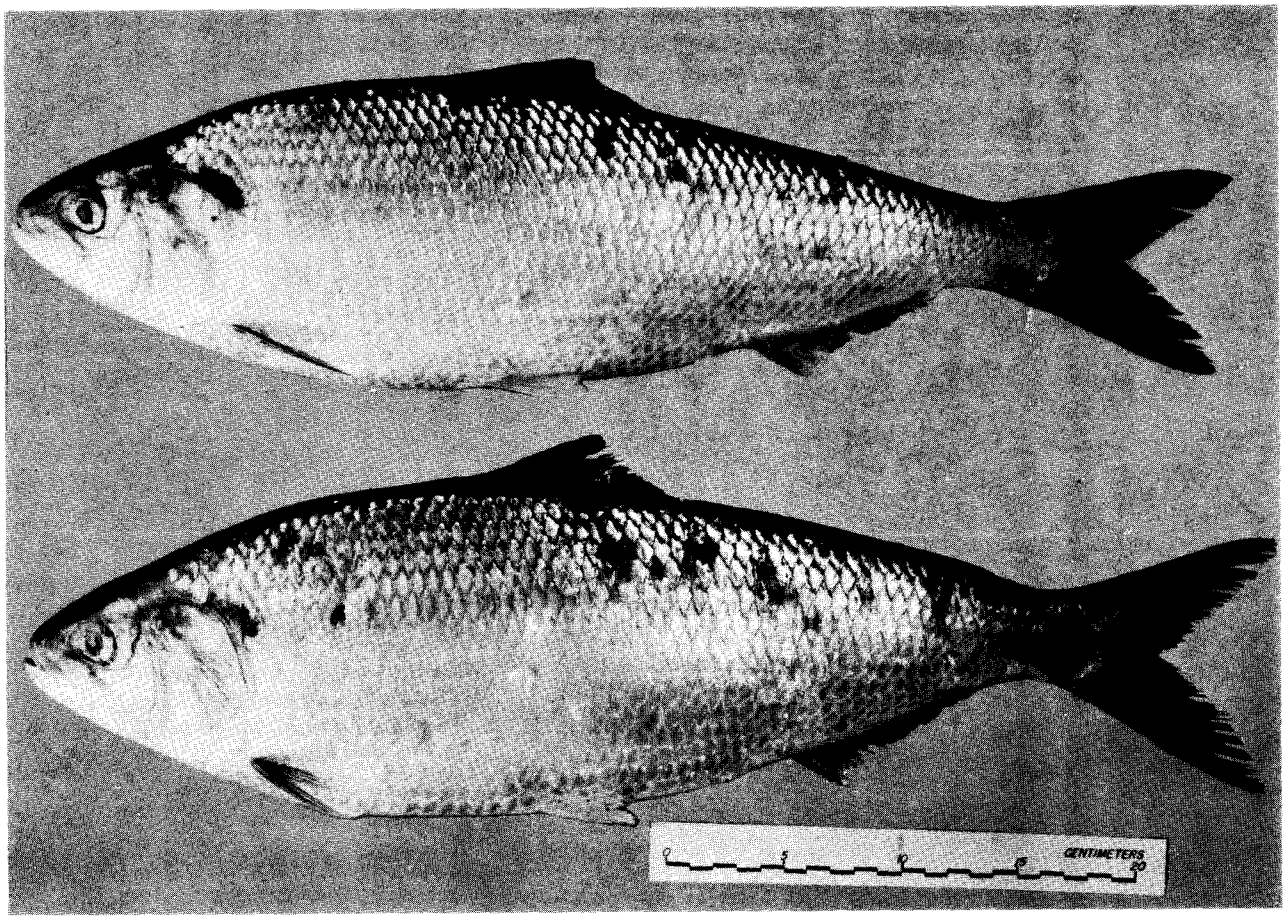
# THE AMERICAN SHAD




UNITED STATES DEPARTMENT OF THE INTERIOR

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BUREAU OF COMMERCIAL FISHERIES

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By

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# THE AMERICAN SHAD

By

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## ABSTRACT

The life history of the American shad (Alosa sapidissima) is described. The economic importance of the commercial and sport fisheries are reviewed, and the status of research and management of this species are summarized.

## INTRODUCTION

The American shad, Alosa sapidissima (Wilson), is the largest member of the herring family (Clupeidae) in North America. The shad is also known by other common names such as "white shad," "roe shad," and just plain "shad" and is one of the best known fishes of the Atlantic Coast. Although the species is distributed along the east coast from the St. Lawrence River, Canada, to the St. Johns River, Fla., it is most abundant from North Carolina to Connecticut. In 1871, about 12,000 young fish were taken across the continent by train and planted in Sacramento River, Calif. More were planted in succeeding years in Sacramento and Columbia Rivers, where they prospered. Now they occur on the Pacific Coast from the Mexican border to Cook Inlet, Alaska. Unsuccessful attempts have been made to introduce this fish into streams of the Mississippi River drainage, peninsular Florida, Colorado, the Great Lakes, and Great Salt Lake. The shad is found throughout its range in sufficient quantities to support fisheries of great commercial and recreational values. Because little information is available on Pacific Coast stocks, this leaflet is primarily about stocks on the Atlantic Coast.

## DESCRIPTION

The American shad is similar in appearance to many other herringlike fishes. It has a compressed fusiform shape, single soft-rayed back and anal fins, deeply forked tail fin, strongly serrated midline of belly, and large scales that are easily lost. The color is silvery with a bluish green metallic luster on the back. The shoulder has a large dark spot followed by several smaller spots. A longer-than-deep cheek bone and the outline of the lower jaw distinguish from other clupeids such as the alewife, blueback herring, and hickory shad. Mature males average between 2 and 3 pounds, and mature females between 3 and 4 pounds. Shad weighing up to 15 pounds were recorded in the early years of shad fishing, but today few shad weigh over 9 pounds.

## LIFE HISTORY

### Spawning

American shad are anadromous fish; that is, they spend most of their life in the ocean but return to fresh-water streams to spawn. The first summer of their life is spent in the stream where they were hatched (fig. 1). In the fall, when the young shad are about 3 to 6 inches long, they migrate to the ocean where they remain until mature. Males mature when 3, 4, or 5 years old, and females when 4, 5, or 6 years old. Most spawning shad are 3 or 4 years old. Mature shad return to their natal streams to spawn in early spring. The time the shad enter the rivers varies with latitude. In the St. Johns River, Fla., shad enter the river as early as November; in North Carolina, as early as February; but in eastern Canada, as late as July.

Figure 1.--Young shad collected with surface trawl to determine distribution and growth.

When seeking spawning grounds, shad ascend some streams for great distances. In the 19th century shad could ascend most streams to the headwaters--distances as great as 200 or 300 miles. Today dams on many streams restrict shad to the stream area below these barriers.

Spawning habits of American shad are very similar from river to river. Male shad usually enter the stream first and swim to the spawning grounds where the females later join them. They begin to spawn after the water temperature has warmed to at least 53° F., and spawning is usually over by the time the water temperature reaches 75° F. They start to spawn in the evening after sunset and continue to about midnight. One female is accompanied by several males during the spawning act. Eggs are released in open water where they are fertilized by the males. The spawning fish swim close together near the surface with their back fins projecting from the water. During spawning, the fish splash vigorously; fishermen call this action "washing" because of the sound.

The eggs of shad are very easily recognized. They are about one-sixteenth inch in diameter when spawned but soon absorb water and increase to about one-eighth inch. Their color is transparent, pale pink, or amber, and they are slightly heavier than water. The eggs sink and are carried along near the bottom by the current. If the eggs settled on the bottom, many would be smothered in the silt and mud. Eggs hatch in 3 to 8 days, depending on water temperature (6 days at 63° F.). Each female lays from 100,000 to 600,000 eggs, depending on her size and the stream from which she originates.

For unknown reasons shad that spawn in coastal streams of the South Atlantic States die after spawning. North of North Carolina, the number of shad that survives the initial spawning and returns to sea progressively increases northward. The fish that return again to fresh water to spawn the next year are called "repeaters."

## Food and Feeding

The food of American shad varies with size and age. The young possess small teeth and feed primarily on insects and crustaceans during their first summer in fresh water. Schools of young shad can be observed in the evening feeding on insects at the surface; many jump out of the water to catch flying insects. During the day, the young apparently feed below the surface on small crustaceans. After they leave the rivers in the fall, young shad lose their teeth. Then they feed on plankton (small organisms) in the same manner as adults, by straining water through comblike structures known as gill rakers. Adult shad do not feed during the spawning migration. They will, however, strike artificial lures when they are on their spawning grounds, but biologists believe the fish are acting instinctively to protect their spawning grounds.

## Age Determination

The age of shad is determined from their scales, which have rings somewhat similar to those on a tree. A scale from a 5-year-old shad is shown in figure 2. The markings or lines that lie close together and run laterally across the scale are called striae. The distinct marks that cross the scale laterally on the same general contour as the striae but are spaced farther apart are called transverse grooves. The annual growth rings (annuli) follow the contour of the outer edge of the scale.

Formation of an annulus is caused by slowing down or cessation of growth in late winter or early spring. The first ring on the scale does not represent the first year and is termed a false annulus. The area inside this ring is called the fresh-water zone because it is formed when the young shad move from fresh to salt water.

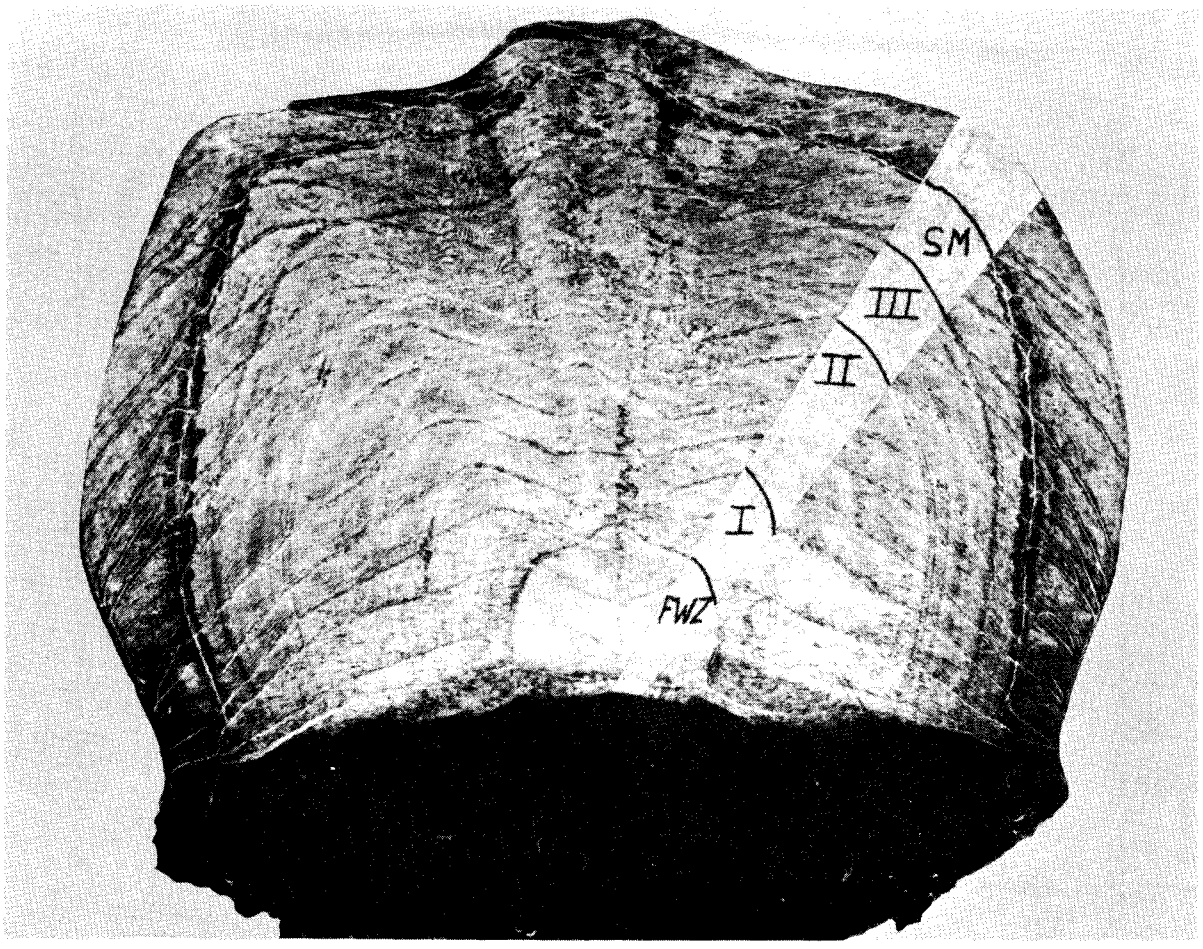


Figure 2.--Scale from 5-year-old American shad. FWZ marks the fresh-water zone. I, II, and III represent annular rings. SM represents a "spawning mark" which also is an annular ring.

Scales can also be used to tell how many times a shad has spawned. A shad does not feed during the spawning run, so the edge of the scale becomes resorbed by the fish. This resorption causes a scar or "spawning mark" on the edge of the scale and occurs about the same time a new annulus forms; thus the "spawning mark" is also counted as an annulus or year mark.

## Rate of Growth

American shad grow fast during their first 3 years of life. Average lengths are 5 to 6 inches at 1 year, 9 to 10 inches at 2 years, and 10 to 14 inches at 3 years. After the first 3 years, the growth rate decreases. The average length is 15 to 16 inches at 4 years of age and 18 to 19 inches at 5 years.

## Migrations

American shad, like salmon, migrate thousands of miles in the ocean and then return to spawn in the stream in which they were hatched--how they are guided is still a mystery. On the Atlantic Coast, adult shad that survive after spawning migrate back to sea and northward to the Gulf of Maine, where they spend the summer and fall feeding on abundant plankton. Scientists believe they winter in deep water off the Middle and South Atlantic States. As spawning season approaches, mature fish migrate inshore and move either southward or northward to their natal streams to spawn (fig. 3). They repeat this cycle each spring. Young shad leave the rivers in fall and probably overwinter in the ocean off the Atlantic States. In summer they presumably migrate with the adults to the Gulf of Maine.

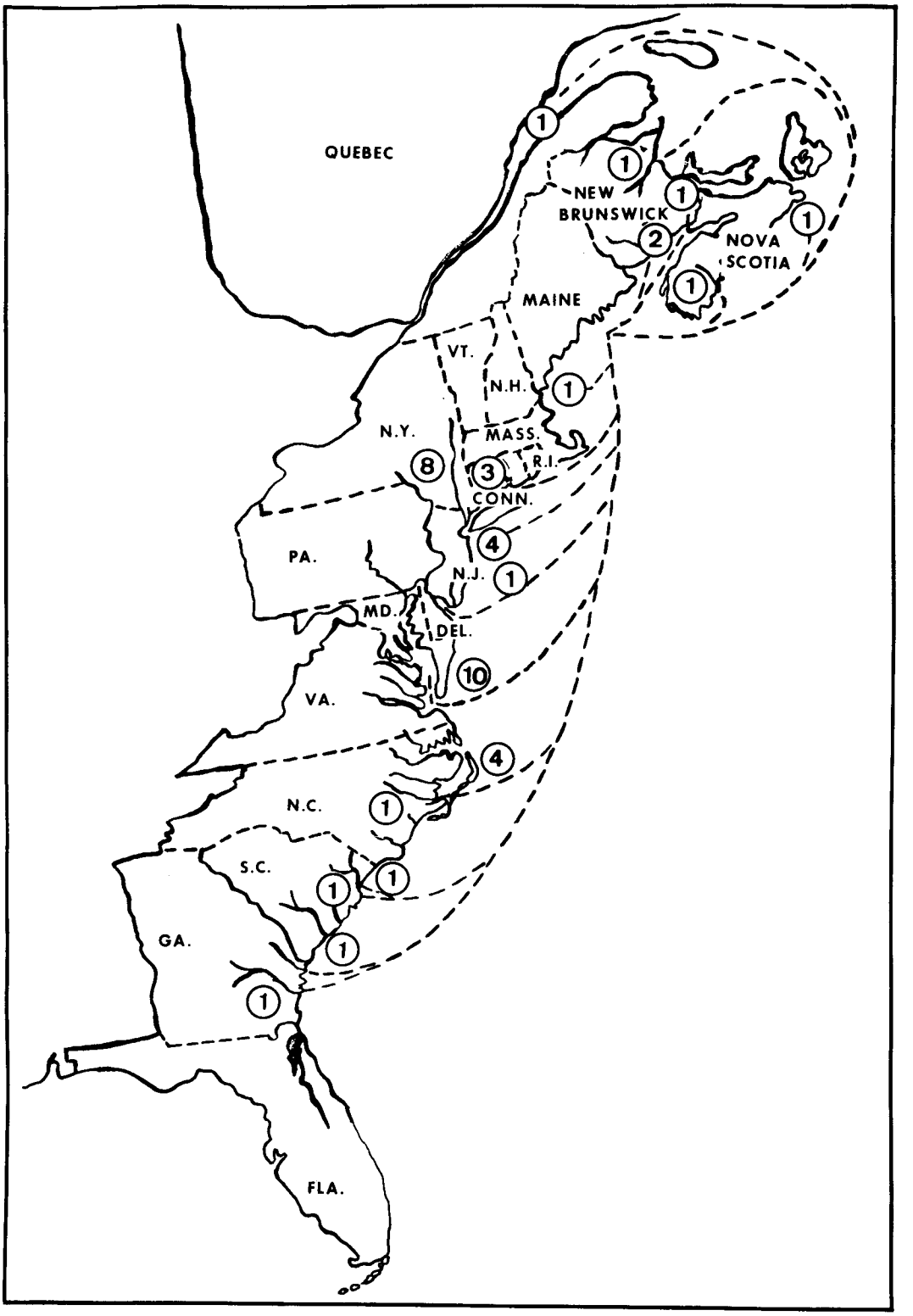


Figure 3.--Localities of recovery of American shad tagged in the Gulf of Maine extend from Georgia to Quebec. Numbers in circles indicate number of tags recovered at each location.

## ECONOMIC IMPORTANCE

In colonial times, the American shad was very abundant on the Atlantic Coast. As the human population increased, so did the harvest of shad. The peak was in 1896, when more than 50 million pounds were landed. Production declined to about 25 million pounds by 1908, when shad still ranked third in value among U.S. fishery products. Since 1908, the yield has decreased even more, and today the shad ranks 40th in weight and 28th in value among the species in the total U.S. catch. The annual catch of shad along the Atlantic Coast now is about 10 million pounds (fig. 4).

On the Pacific Coast, the commercial fishery began in 1890, and its catch increased to 7 million pounds in 1915, but today it has declined to about 1.5 million pounds annually. This decline in catch is probably due to the lack of market for shad and does not necessarily represent a decrease in abundance.

During the last 20 years, shad have become an important sport fish during their spawning runs in the rivers. The St. Johns, Ogeechee, Edisto, Pamlico-Tar, Susquehanna, Delaware, and Connecticut Rivers on the Atlantic Coast and Sacramento and American Rivers on the Pacific Coast are the main rivers with sport fisheries (fig. 5). Of these, the St. Johns and Connecticut Rivers are the most important. The sport catch is substantial but unrecorded in several other rivers. The annual catch by sport fishermen is estimated to be about one-half million shad (1.5 million pounds).

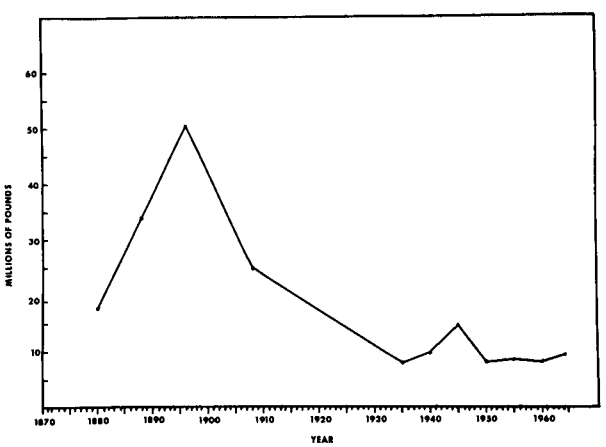


Figure 4.--Commercial catch of American shad on the Atlantic Coast of the United States, 1880-1965.

## Commercial Fishery

American Indians used shad for food before the white man arrived. The Indians took the shad with bush nets (seines), weirs, spears, and bows and arrows. Early in the fishery of the white man, haul seines, weirs, drift gill nets, and dip nets were used for shad, but the haul seine was the most efficient and most often used (fig. 6 and 7). Over the years, the gear has remained essentially the same but fishing techniques and net materials have changed. Principal gears are pound nets (fig. 8) and stake gill nets (fig. 9) in broad estuaries and bays; drift gill nets (figs. 10 and 11) in lower reaches of rivers; and seines, traps, gill nets, and bow nets (fig. 12) in narrow headwater streams. "Fishing machines" (fig. 13) are still being used to a limited extent in some North Carolina streams.

Some of the shad caught commercially on the Atlantic Coast are sold locally, but most are shipped to markets in Baltimore, Philadelphia, and New York each spring during the annual spawning runs. The female shad is more important commercially because of the demand for roe (eggs).

The appearance on the market of frozen fish and fish products that can easily and quickly be prepared by the housewife has caused a decrease in the demand for shad, which are usually marketed whole and fresh. The roe is sold separately, and a limited amount of shad is being marketed as fillets. These products have been popular, but account for only a small part of the catch; therefore, future use of the shad as a food fish is dependent on the development of still other products in a form more acceptable to the modern housewife.

## Sport Fishery

During the last 20 years the American shad has become a highly prized game fish. Shad are taken by trolling or casting various types of small spinners, spoons, and weighted jigs (fig. 14). Many fishermen use two of the lures in an arrangement called a "shad-rig." Shad strike hard and put up a game fight, jumping out of the water frequently. Their mouths are tender, and the hooks will tear out if pulled too hard, so light tackle is best.

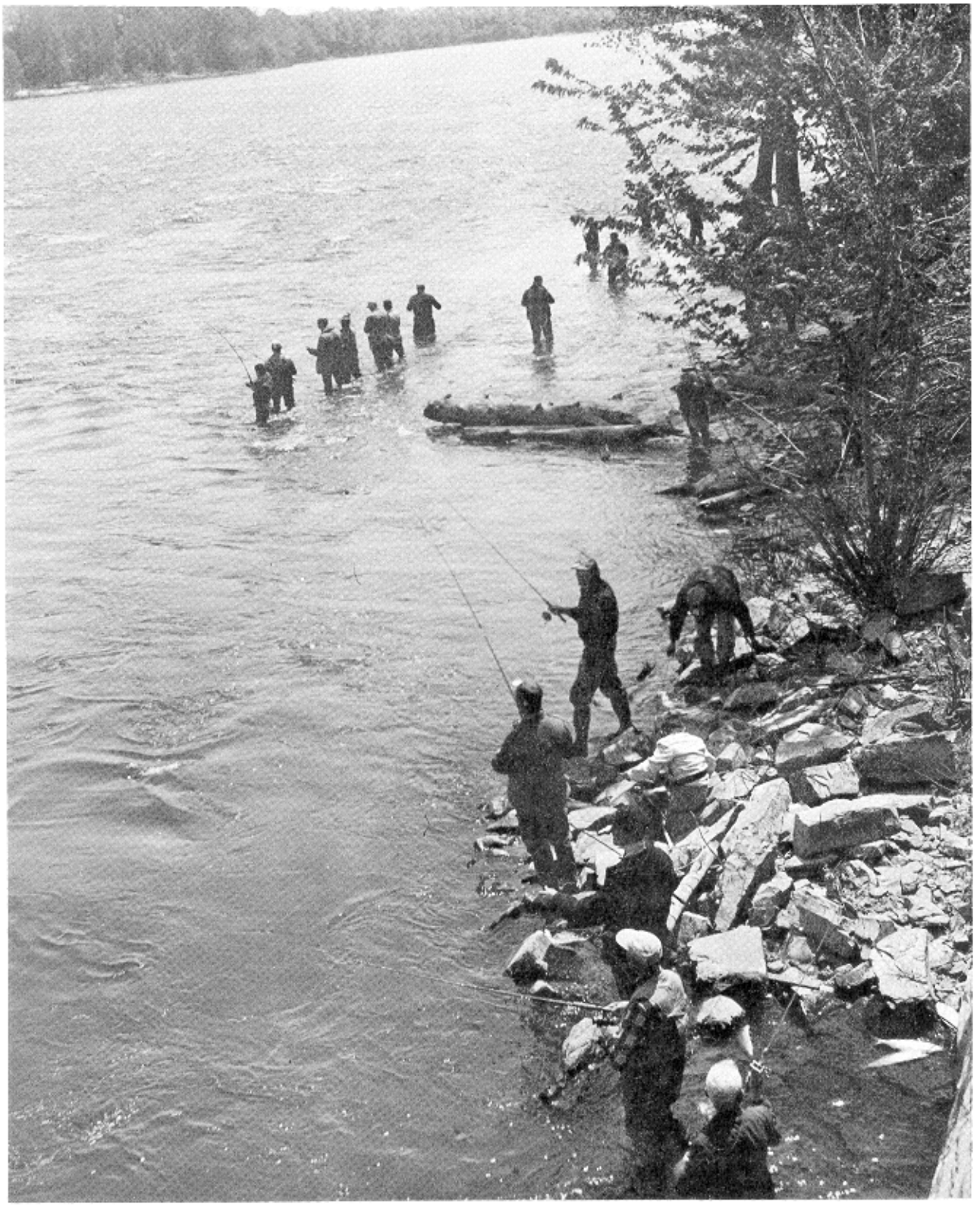

Figure 5.--Sport fishing for shad in the Connecticut River.

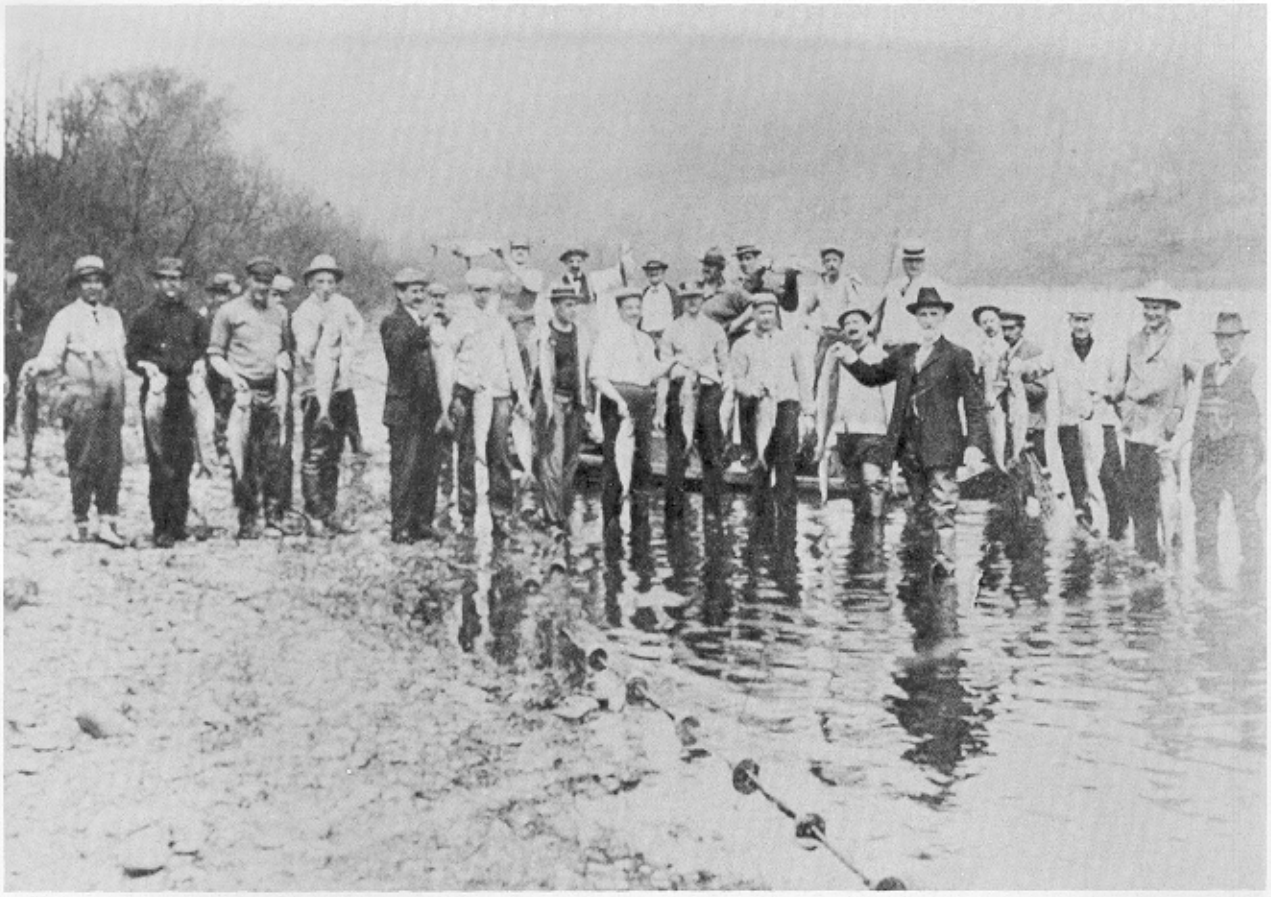

Figure 6.--A Delaware River shad club with haul seine in early 1900's (Photo courtesy of Frank Bowen, Hancock, N.Y.)

Figure 7.--Fishing a haul seine for American shad, St. Johns River, Fla.

Figure 8.--Fishing a pound net for American shad, Chesapeake Bay, Md.

Figure 9.--Setting or "riding down" a stake for stake gill nets, York River, Va. (Photo courtesy of Virginia Institute of Marine Science, Gloucester Point, Va.)

Figure 10.--Drift gill net fishing for American shad, Pamlico-Tar River, N.C.

Figure 11.--Removing American shad from drift gill net, Potomac River, Md.

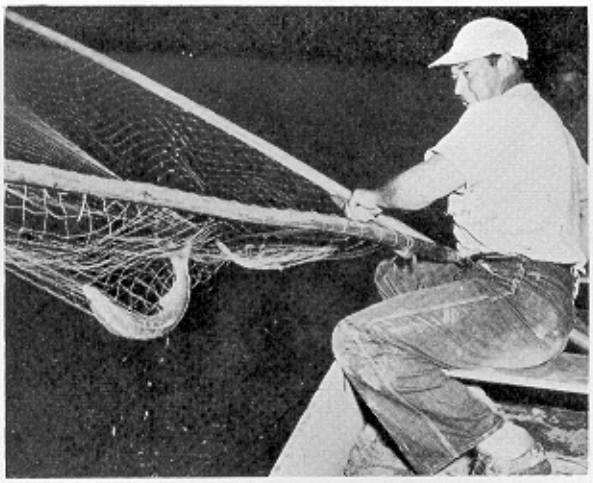

Figure 12.--Taking American shad with bow net, Neuse River, N.C. (Photo courtesy of North Carolina Wildlife Resources Commission)

Figure 13.--"Fishing machine" or "fish wheel" for taking shad and other anadromous fish, Roanoke River, N.C. Wheel is turned by the current and fish slide into boats on each side as scoop is raised.

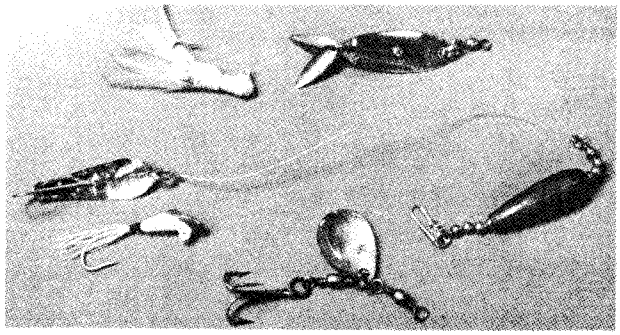

Figure 14--Lures used to take American shad in the sport fishery. Lead weight is added to make spoon fish deep.

## RESEARCH AND MANAGEMENT

In the late 1800's shad hatcheries were built along the Atlantic Coast with the hope of maintaining and increasing production (fig. 15). The hatching and stocking of young shad, as practiced from 1880 until 1950, did not, however, significantly increase shad abundance.

Over the last 2 decades the Bureau of Commerical Fisheries and several States have jointly and independently investigated the shad resource along the Atlantic Coast. These studies were made to acquire basic knowledge of the species and its fisheries and, through scientific management, to increase the size of the shad runs and the annual yield. Through the knowledge gained from these studies, the shad populations in several rivers are being effectively managed.

Primary problems of the shad resource are pollution, dams, and overfishing; thus, the most effective management procedures have been abatement of pollution (fig. 18), construction of fish-passage facilities (figs. 16 and 17), and regulation of fishing. Fishing regulations are set by each State and vary from State to State.

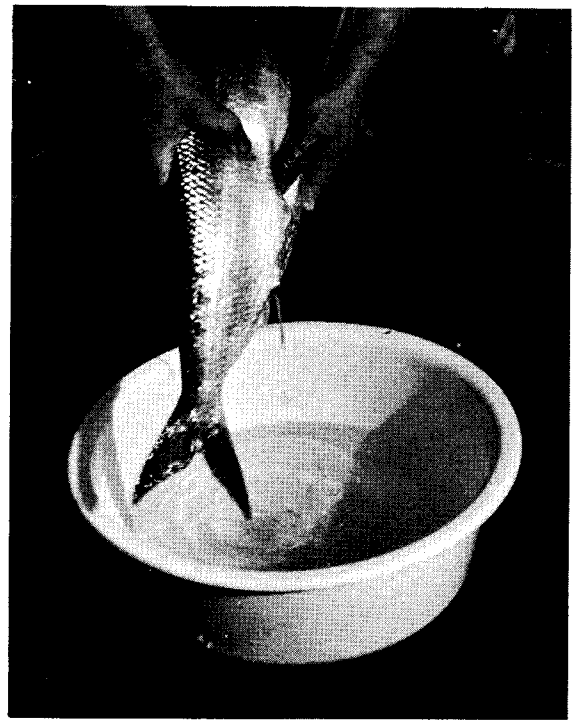

Figure 15.--Taking eggs from an American shad for incubation in a hatchery.

If annual production of shad could be restored to 19th century levels, the commercial catch would be worth more than $6.5 million and the sport fishery would provide many additional man-days of fishing.

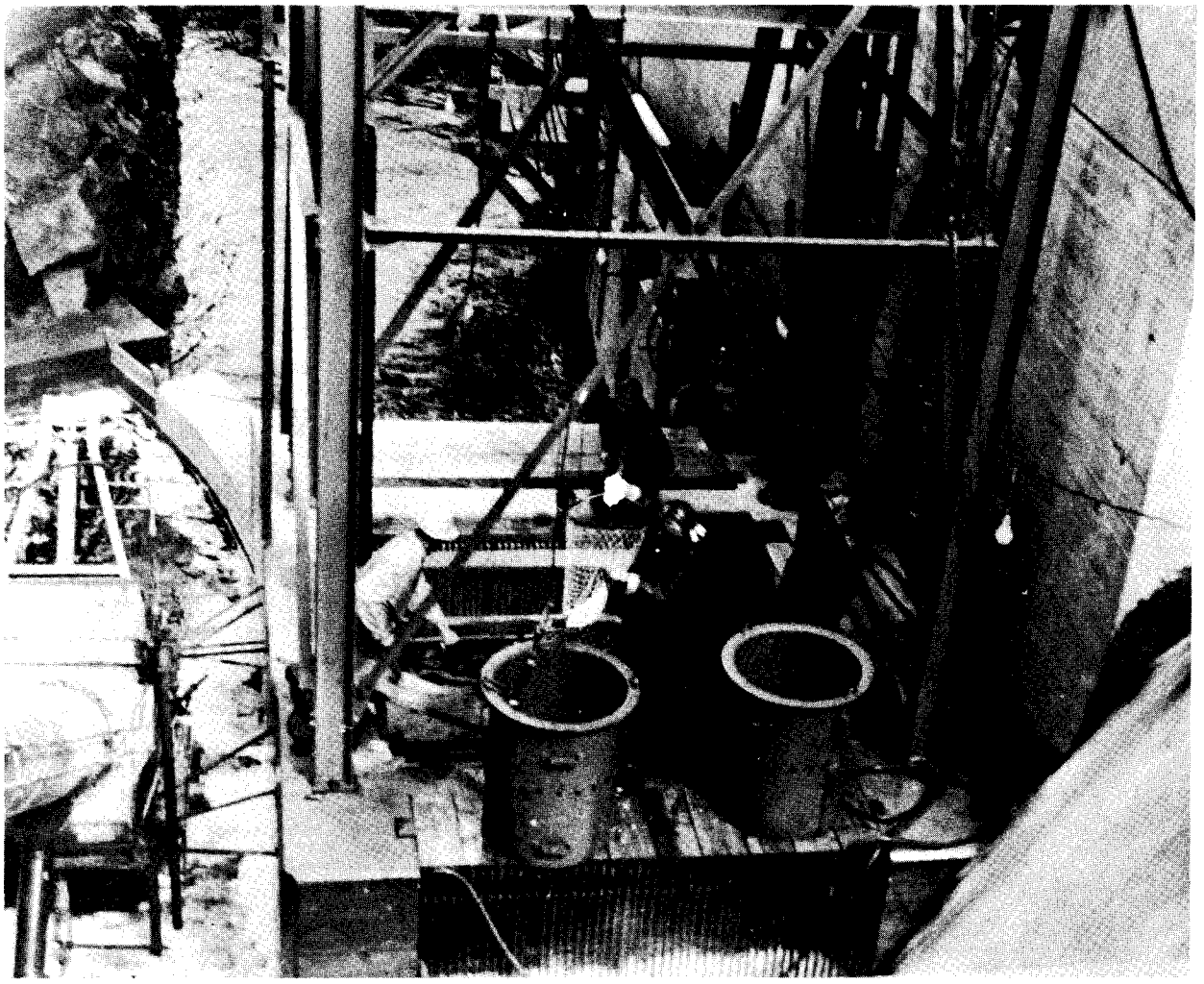

Figure 16.--Passing shad at the Connecticut River fish lift, Holyoke Mass.

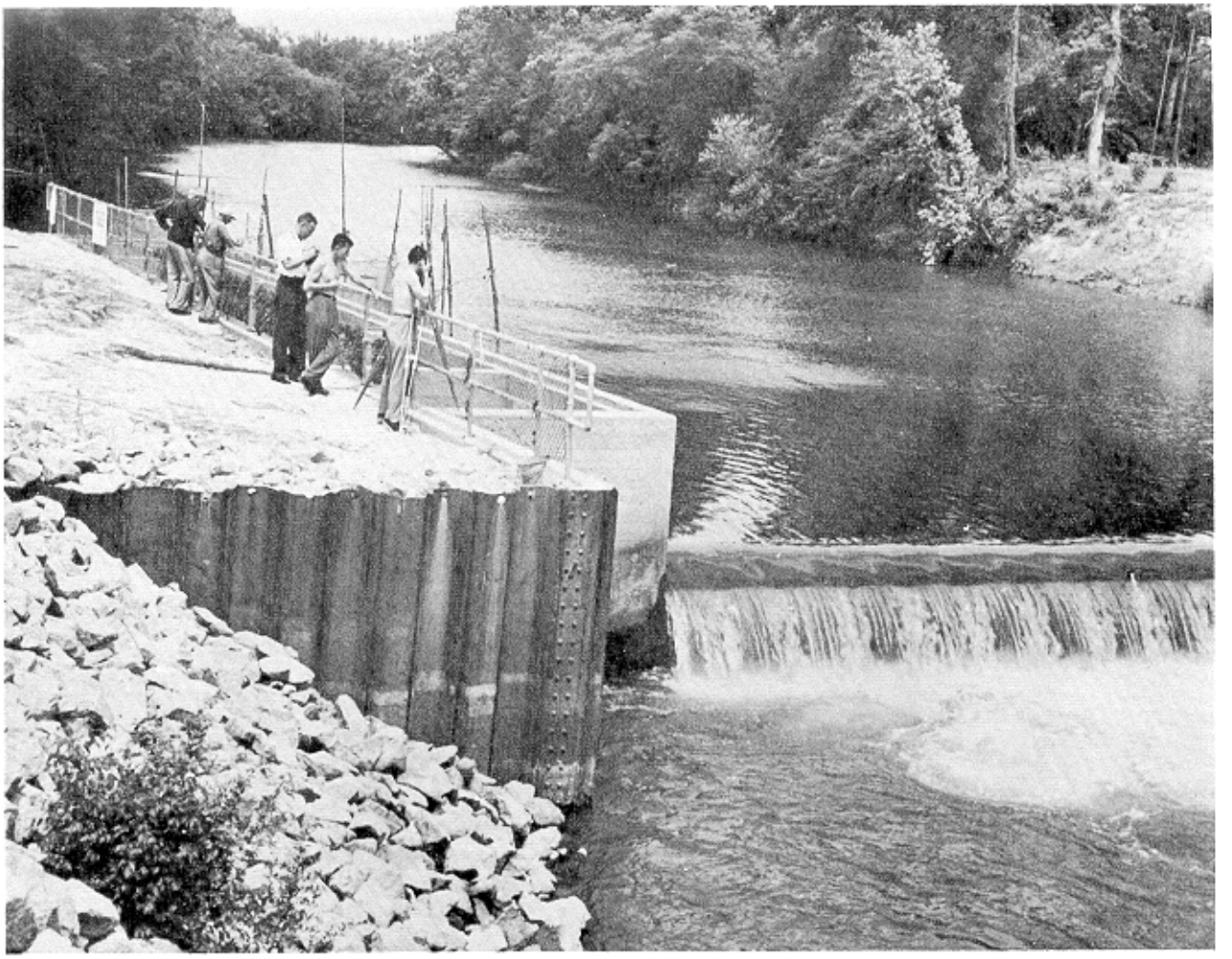

Figure 17.--Fishway and dam on Neuse River, Goldsboro, N. C.

Figure 18.--Young American shad killed by pollution in the Anacostia River, Washington, D.C. (Photo courtesy of Charles Del Vecchio, Washington Post-Times Herald)

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