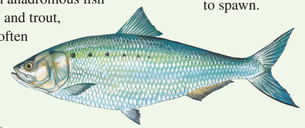
ANADROMOUS FISH

Anadromous fish are fish that spend most of their lives in the saltwater environment of oceans and bays, but return to the freshwater environment of rivers and streams to spawn. Some of the best known anadromous fish are salmon and trout, which are often shown jumping over rapids as they migrate up streams to their spawning areas.



AMERICAN SHAD

Several species of anadromous fish use the Santee-Cooper system. Some of these are blueback herring, American shad, striped bass, hickory shad, shortnose sturgeon and Atlantic sturgeon. Of these, the blueback herring and American shad are quite abundant, while the shortnose sturgeon is so rare that it is considered an endangered species. Each spring these fish make their migration runs up our rivers in search of suitable spawning habitat.

Between spawning runs, some species of anadromous fish make extensive ocean migrations. Biologists have found that blueback herring and American shad spawned in the Santee-Cooper system may migrate over 1,000 miles to the Bay of Fundy in Canada's Atlantic Provinces. Here shad and herring from stocks along the Atlantic Seaboard congregate to spend autumns feeding on the Bay's abundant plankton. As a result, Santee-Cooper anadromous fish contribute to recreational and commercial fisheries in other states and Canada while at the same time returning fish have grown by consuming food from those distant estuaries and coasts.

The fish continue to make annual migrations along the East Coast until they reach maturity around the age of four. At this time, each stock seeks out the river in which they were spawned. The mechanism that anadromous fish use to guide them on these homecoming journeys is not fully understood. It is believed that the young fish actually memorize a particular "smell" or taste of the river and they use this smell to guide them to their natal river as they get closer to it's mouth when they return to spawn.

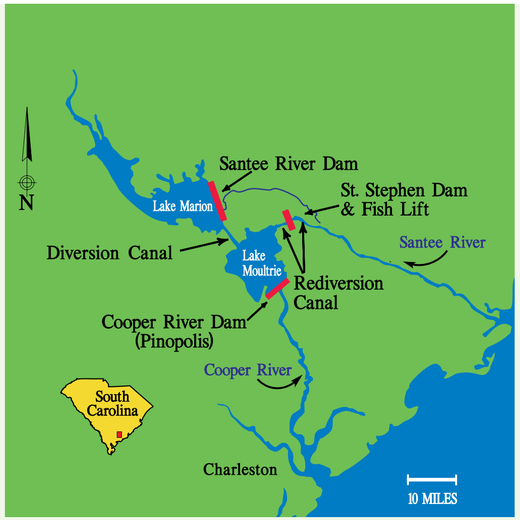
As the fish leave saltwater and ascend to freshwater streams, various physiological processes take place. These adaptations are unique to anadromous fish, as changes from saltwater to freshwater would be lethal to most other species of fish. The fish may travel over 100 miles up freshwater rivers to reach their spawning grounds, and have evolved the ability to navigate rapids and many other natural obstructions. Man-made obstructions such as dams, however, can completely block access to the spawning grounds. In these cases a man-made passageway, called a fishway, is needed so fish may pass around the obstruction.

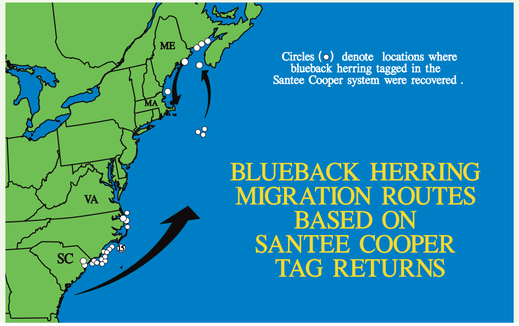
BLUEBACK HERRING

FISHWAYS

Fishways have been constructed for hundreds of years to allow migrating fish to pass dams on rivers and streams. Many of the earlier fishways did not function well because the designers did not understand the particular attraction flow requirements or swimming ability of the fish, or the flow characteristics of the site. While much progress has been made in this area through research and experimentation, biologists and engineers are still working on resolving various problems to allow fish to freely migrate to and from their spawning areas. The St. Stephen fishlift is a good example of a fishway where data collected at the site is used to implement improvements.

There are many types of facilities designed to pass fish around dams such as fish ladders, fish lifts, and navigation locks. In the Santee-Cooper system a fish lift and a navigation (boat) lock are used by migrating fish to pass from the Santee and Cooper rivers into the lakes and rivers beyond.





CHANGES TO THE SANTEE AND COOPER RIVERS

The Santee Canal

The water of the Santee and Cooper rivers has been manipulated by man for several uses. When Europeans first settled this region, low marshy areas along the rivers were diked and flooded to produce rice fields. The success of this crop gave rise to many of the plantations that were so prevalent in the Lowcountry. In 1800 a newly constructed 22-mile long, 10-lock canal first connected the Santee and Cooper rivers. This canal allowed goods from the plantations to be delivered from the central Carolinas to Charleston on barges drawn by horses or mules. By using the canal, the boats avoided a perilous journey down the Santee River and along the coast to Charleston Harbor. The canal closed in the 1850's and is now overgrown or flooded by the Santee-Cooper Lakes. For more information on the canal a visit to The Old Santee Canal Park in Moncks Corner is recommended.

Diversion

The most significant change to the Santee and Cooper rivers occurred in 1941 when Santee River was dammed, and Lakes Moultrie and Marion were created. The water from Santee River, one of the largest drainages on the East Coast, was diverted to the small tidal Cooper River. The project was constructed by the South Carolina Public Service Authority, now known as Santee Cooper.

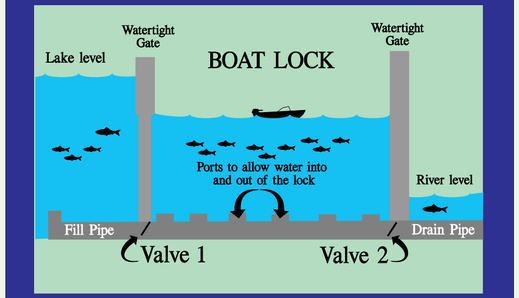
The goals of the Diversion project were to provide hydroelectric power to rural Lowcountry residents, provide flood control for the Santee River basin, and to provide a navigation route from Charleston to Columbia. Following the commerce principles behind construction of the Old Santee Canal, a lock was installed at the dam on the Cooper River. It was designed to allow boat traffic to pass from the river to Lake Moultrie and back, and at the time of its construction this was the world's highest single lift lock.

An unanticipated result of this project was to create the country's first landlocked striped bass fishery in the newly formed lakes. Unfortunately, the damming of the river also blocked hundreds of miles of migration routes for anadromous fish returning to the system. However, while commercial use of the lock never developed, operation of the lock in conjunction with high springtime discharges of water from the Cooper River dam allowed fish to pass into the lake system.

Each spring anadromous fish concentrated at the base of the dam as their upstream migrations were blocked by it, and the lock was operated several times a day to allow fish to be passed into the lakes. This provided the fish with access to their spawning and nursery grounds in the lakes and rivers above the dam. Fish that live in the lakes year-round, called resident fish, such as striped bass also benefited from a supply of food fish as they fed on the adult blueback herring which migrated into the lakes and the young anadromous fish that were hatched in the Santee-Cooper system. This was important to the ecology of the lake because other species of forage fish are resident species and must compete for food even with young game fish. On the other hand, anadromous fish, since they have grown in the ocean for most of their lives provide the lake with a nutritional supplement. Not only do resident fish benefit by directly consuming anadromous fish, but the decaying bodies of dead anadromous fish also enrich the entire food web in the lake ecosystem. This nutritional enrichment is analogous to a farmer fertilizing his fields with manure trucked in from another farm.

While the lock worked well in passing fish above the new dam and the ecosystem created by the new lakes seemed to be stabilizing, a problem arose as a result of diversion. The Cooper River, previously a small tidal creek terminating at Charleston Harbor, was now carrying the combined flows and sediments of the Cooper and the much larger Santee rivers. The increased flow created shoaling problems in the harbor that interfered with Navy and commercial shipping traffic. Dredging costs dramatically increased and sites to deposit the removed sediments began filling up quickly. To address this problem without losing the fish passage and the hydroelectric power generation provided by Diversion, the U.S. Army Corps of Engineers proposed the Cooper River Rediversion Project.

A Shortnose Sturgeon *photo by Jarrett Gibbons*

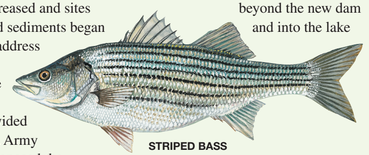


To bring a boat from the river to the lake, the boat enters the lock and the gates are closed. Valve 1 is then opened while valve 2 is closed, allowing the boat lock to fill with water to the level of the lake. The lake side gate is then opened and the boat can enter the lake.

To bring a boat from the lake to the river, the opposite occurs. Valve 1 is closed while valve 2 is opened. When the water drains to the river level, the river side gate can then be opened. The fish lift operates on a similar principle, with the addition of various devices for attracting fish into and through the facility.

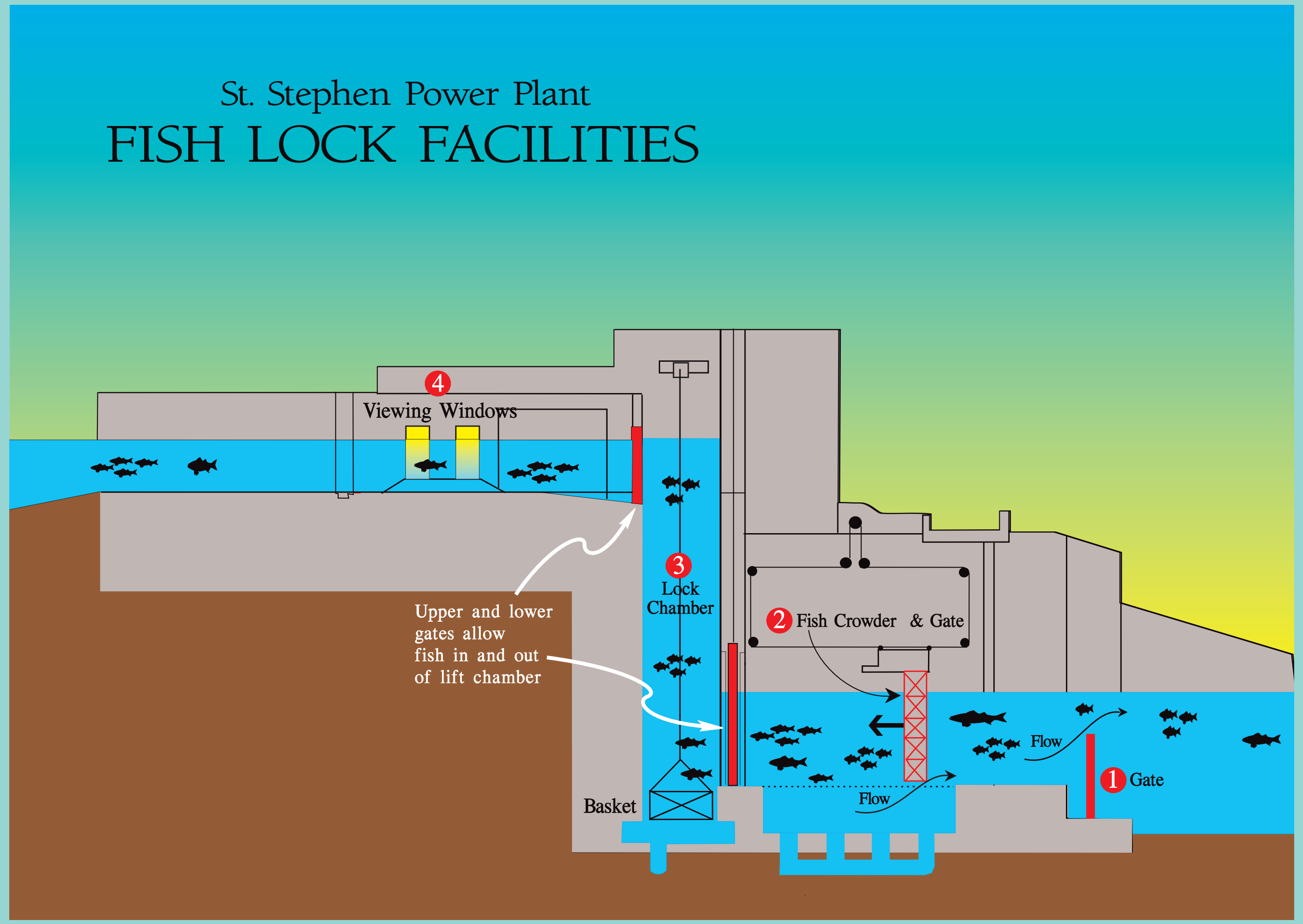
Rediversion

Beginning in 1985, Rediversion allowed Santee River water to continue to be diverted to Lake Moultrie, but instead of discharging all of the water into Cooper River through Pinopolis Dam, the majority of the water was now re-diverted back to the Santee River via a new canal, the Rediversion Canal. A dam was constructed on the Rediversion Canal near St. Stephen, South Carolina to maintain discharge control and hydroelectric power generation. To allow upstream migrating fish to pass beyond the new dam and into the lake system, a lock was specifically designed and built into the dam. This lock came to be known as the St. Stephen fish lift.



STRIPED BASS

The new fish lock, or fish lift, was much smaller than the original navigation lock on Cooper River, which was constructed for boat passage. Special gates were designed to create and adjust flows that would attract fish into a long entrance channel on the downstream side of the dam. Once in this channel, a gate closes behind the fish and drives them into the lock



1. As the fish are migrating upstream, they are attracted to a downstream flow at the entrance gates of the lift.
2. The migrating fish pass through another gate on a wall, known as a fish crowder. Once a lift cycle is started, this gate closes and the crowder moves forward, forcing the fish into the lock chamber.
3. The lock then floods, just as a boat lock does, and a basket forces the fish up to the lake level.
4. As the fish exit into the lake system, they pass by viewing windows where they can be identified and counted.

US Army Corps of Engineers

Santee Cooper

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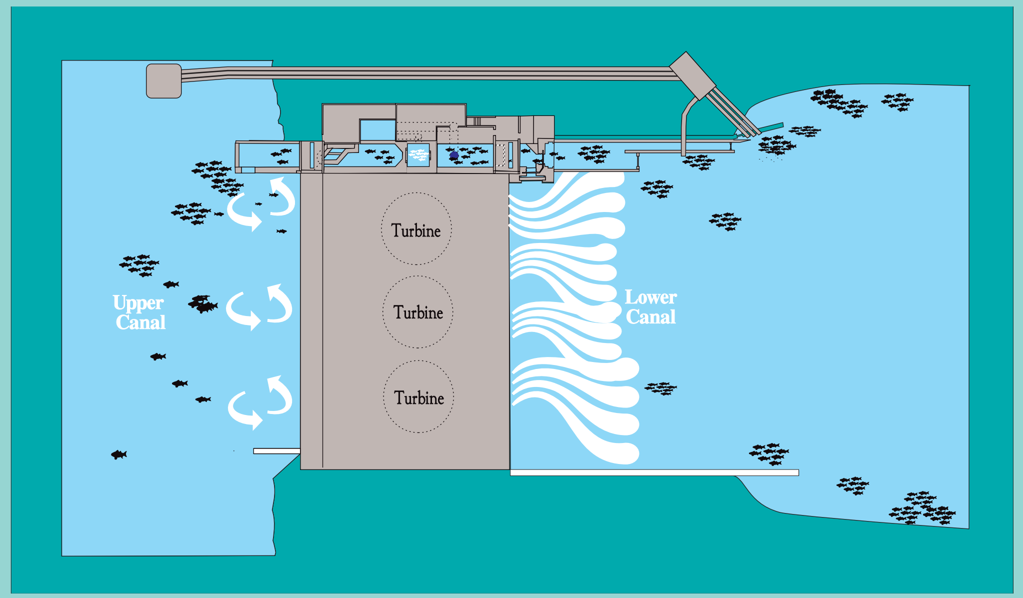
Aerial view of St. Stephen Power Plant and Fish Lock Facilities



chamber. The lock then floods to lake level just as a boat lock does. The fish are then prompted to swim up and out of the lift chamber by a slowly lifted basket known as a brail basket. As the fish exit toward the lake system they pass by viewing windows where they can be identified and counted. This allows biologists to collect data on the various species of migrating fish entering the lake. This information is important to the proper management of the fisheries. The viewing windows also provide an underwater parade for visitors to watch as hundreds of thousands of fish pass each spring.

WORKING TOGETHER

After Rediversion the numbers of fish passed into the lakes drastically declined. The U.S. Army Corps of Engineers and Santee Cooper have been working closely with Department of Natural Resources personnel over the past several years to restore fish passage numbers to pre-Rediversion levels. The Corps of Engineers, who constructed and maintain the fish lift, has been funding ongoing fishery studies to provide the best possible access to the lakes for the migrating fish. Numerous modifications to the fish lift have taken place since its original construction. In 2000, the most recent modification to the lift was completed. This modification allowed for a larger volume of attraction flow, which is vital to guide fish into the entrance channels. The modification also provided a downstream bypass structure, an alternative to passing through the hydroelectric turbines of the dam for juvenile anadromous fish migrating to saltwater and continuing their life cycle. More structural changes are currently being studied. These changes will increase the lift's efficiency in terms of the number of fish passed and the reliability of its operations.

Santee Cooper, who constructed and maintains the boat lock on the Cooper River, has operated that lock for fish passage for the past several decades. They have also provided favorable water discharges to allow the fish access to both facilities. Modifications to the lock designed to enhance fish passage are currently being explored.

It is hoped that through these cooperative efforts, anadromous fish populations will return to their previous abundance. As more adult fish are allowed access to the thousands of acres of spawning and nursery grounds in the lake system and beyond, more young fish will be spawned, which in turn will come back in four to five years to spawn themselves. The resident fish, such as striped bass and largemouth bass, benefit from the increased forage in the lake, while fishermen benefit both directly as they fish for anadromous fish and indirectly as they harvest fish that eat the anadromous fish.

An American Shad *photo by Bill Post*