RECONNAISSANCE PLANNING AID REPORT
ON
SAVANNAH RIVER BASIN STUDY

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EXECUTIVE SUMMARY

This planning aid report evaluates existing fish and wildlife resources within the Savannah River Basin study area and identifies problems, opportunities, and planning objectives for these resources.

The extensive forested wetlands of the Savannah River below Augusta are important habitat to many significant commercial and recreational fish and wildlife species, as well as to endangered and threatened plants and animals. These wetlands are also important for flood control and purification, soil enrichment, erosion control, and support for downstream fishing. By modifying the natural flow regime, reservoir construction in the Piedmont has caused loss and degradation of forested wetlands and aquatic habitat along the lower Savannah River. The Corps' actions in the lower river, dredging and placement of pile dikes associated with construction and maintenance of the navigation channel to Augusta, have also affected the hydrological conditions in the forested wetlands and aquatic habitat. Reservoir construction also has blocked passage of anadromous fish to historic spawning grounds.

The Service recommends the following studies and actions to address the problems identified in the Savannah River Basin project. In conjunction with fish and wildlife agencies and other stakeholders, determine and implement a Savannah River flow regime that provides for diverse and productive fish and wildlife habitat. The flow regime evaluation should include determination of the quantity, duration and periodicity of flows needed to support aquatic and wetland functions. The flow regime study should include an evaluation of the potential to reduce salinity intrusion in Savannah Harbor, and restore tidal freshwater marsh and striped bass habitat, by modifying management and operation of J. Strom Thurmond Reservoir. The study should also evaluate the extent and impact of development in the Savannah River flood plain subsequent to construction of Corps flood control projects.

With regard to the navigation project to Augusta, we recommend that the Corps seek deauthorization of this navigation project and determine the need for further restoration action on cutoff bends. We also recommend that you continue to ensure anadromous fish passage at New Savannah Bluff Lock and Dam using lock operations or upstream flow releases and evaluate removal of this obstruction to anadromous fish.

In addition, we recommend that efforts to improve water quality, particularly dissolved oxygen level, below J. Strom Thurmond Dam, continue. Instream flow impacts of surface water withdrawal in the Piedmont region of the basin also need to be evaluated.

SAVANNAH RIVER BASIN STUDY

INTRODUCTION

AUTHORITY

Section 414 of the Water Resources Development Act of 1996 authorized the Savannah River Basin Comprehensive Water Resources Study. The Fish and Wildlife Coordination Act (48 Stat. 40l, as amended; 16 U.S.C. 661 et seq.) (FWCA) authorized the U.S. Fish and Wildlife Service's (Service) involvement in this study. The Service prepared this report with funds transferred from the Corps under the National Letter of Agreement between our agencies for funding of FWCA activities.

PURPOSE AND SCOPE

The purpose of this study is to conduct a comprehensive study to address the current and future needs for flood damage prevention and reduction, water supply, navigation and environmental restoration. This planning aid report evaluates existing fish and wildlife resources within the lower Savannah River study area and identifies problems, opportunities, and planning objectives for these resources.

PRIOR STUDIES AND REPORTS

The Service provided a reconnaissance level Planning Aid Report (PAR) in August 1985 which provided fish and wildlife resource information on the Savannah River Basin and identified problems opportunities and planning objectives relative to these resources. In December 1989 the Service provided another reconnaissance level PAR addressing water allocation and new water supply requests in the Savannah River Basin. In November 1991, the Service provided a reconnaissance Planning Aid Report that surveyed fish and wildlife conditions in the river from Augusta to Savannah and discussed potential restoration measures. In May 1995, the Service provided a draft Fish and Wildlife Coordination Act Report on restoration of cut off bends from Savannah to Augusta. In February 1996 the Service provided a final Fish and Wildlife Coordination Act Report on restoration measures in the lower Savannah River Basin.

The Service has completed several reports on Savannah Harbor. The Service provided Savannah Harbor Comprehensive Study (SHCS) planning aid letters to the Corps dated March 21, 1981, July 23, 1981, and September 18, 1981, expressing concerns related to dredged material disposal, Savannah NWR, harbor deepening, and harbor extension. The Service submitted a SHCS Planning Aid Report (PAR) on September 16, 1982, which provided: (1) an analysis of wetland resources in the study area; (2) an evaluation of the impacts of tide gate operation on Savannah NWR and striped bass habitat; and (3) a habitat evaluation procedures study of potential spoil areas. On December 1, 1983, the Service completed a second SHCS PAR which provided: (1) an evaluation of fish and wildlife resources on two new potential dredged material disposal areas; (2) resource categories and general mitigation goals and measures for all potential spoil areas; and (3) further analysis of freshwater supply problems on Savannah NWR.

The Service provided a reconnaissance level PAR on September 27, 1984, which analyzed impacts of harbor extension on fish, wildlife, and wetlands of Savannah NWR and adjacent areas. The PAR also identified information and studies needed to adequately assess impacts of harbor extension.

In November 1986, the Service provided a Draft FWCA Report on the SHCS. This report evaluated existing and future fish and wildlife resources in the study area and identified problems, opportunities, and planning objectives for these resources. In addition, using information available at that time, the report evaluated fish and wildlife impacts of tide gate operation and harbor deepening. The report also questioned the reliability of the Corps' hydrodynamic model and recommended adequate verification before using the model for evaluation of harbor deepening.

The Service provided a revised SHCS Draft FWCA Report in November 1990. This report concluded that deepening of Savannah Harbor in conjunction with continued operation of the tide gate project would exacerbate currently unacceptable fish and wildlife impacts. The Service opposed channel deepening until such time as the impacts of the tide gate project were completely offset and strongly recommended that the Corps remove the tide gate and fill New Cut.

The Service provided a Fish and Wildlife Coordination Act Report on Savannah Harbor - Closure of New Cut in June 1991. The Service supported the plan to close New Cut and take the tide gate out of operation.

The Service provided a Reconnaissance Planning Aid Report on Port Wentworth Deepening Project in December 1993. The purpose of the Corps' study was to evaluate deepening of Savannah Harbor in the vicinity of Port Wentworth from Station 102 + 000 to Station 112 + 500.

In August 1996 the Service provided a Reconnaissance Planning Aid Report on Savannah Harbor Expansion. The Service recommended that a reliable Savannah Harbor hydrodynamic model be developed to estimate impacts of the alternative plans on river system salinity patterns. The Service expressed concern that the project could increase salinity levels in the lower Savannah River system. An increased salinity level would adversely impact managed wetlands, tidal freshwater wetlands, and striped bass habitat on and near Savannah National Wildlife Refuge. The service also expressed concern that moderate incremental increases in the salinity level may become cumulatively significant if depth of the harbor is repetitively increased over time.

DESCRIPTION OF THE STUDY AREA

The Savannah River basin, with a surface area of about 10,577 square miles, of which 5,821 square miles are in Georgia, 4,581 square miles are in South Carolina and 175 square miles are in North Carolina. The basin includes portions of 27 counties in Georgia, 13 counties in South Carolina and four counties in North Carolina (Figure 1). Although the basin is predominantly rural, metropolitan areas are experiencing significant growth and development pressures. The growth is occurring primarily in the cities of Augusta and Savannah, Georgia, although many smaller cities and towns are also growing. The study area drains portions of three physiographic provinces: the Blue Ridge mountains, the Piedmont and the Coastal Plain. In its middle and upper reaches the river flow is regulated by several reservoirs, including three large multipurpose Corp projects (Hartwell Lake, Richard B. Russell Lake and Thurmond Reservoir) and two large private power reservoirs (Lakes Keowee and Jocassee) (Figure 2).

The Blue Ridge Mountain province is characterized as a region of dissected rugged mountains with narrow valleys underlain by acid, crystalline, metamorphic rock of pre-Cambrian origin. Elevations range from about 1,000 to 5,000 feet M.S.L. Streams have narrow to moderately wide flood plains that are nearly level and are frequently flooded in the winter and spring. Moderately deep to deep soils formed mainly from schist, gneiss, and granite occur on the ridges and side slopes. Original topsoil on the slopes has a gray sandy surface. The more productive soils on the terraces and river bottoms are loams and clays. Most of the Blue Ridge province in the basin is forested but a few small farms are located in the valleys and coves. About 30 percent of the basin in the Blue Ridge province is owned and managed by the U.S. Forest Service in the Nantahala National Forest and Chattahoochee National Forest.

Located southeast of the mountains, the Piedmont province consists of gently rolling to hilly slopes with narrow stream valleys in the northern part and broad inter-stream areas in the southern part. This area is underlain by acid crystalline and metamorphic rock of Pre-Cambrian origin. Elevations range from about 600 to 1,000 feet M.S.L. In the upper Piedmont, the level to nearly level flood plains adjacent to creeks and rivers are flooded frequently for short periods. The predominant soils on these flood plains are mostly well drained to somewhat poorly drained and loamy. In the southern Piedmont flood plains are moderately wide and the bottom lands along the major streams and their tributaries are subject to frequent overflow in winter and early spring. These river bottoms drain slowly and remain wet for long periods. The red upland soils of the Piedmont are generally well drained. These soils are acid and low in nitrogen and phosphorus in their native state with gray, loamy to sandy surface layers. Subsoils are red to dark red with sandy clay to clay textures. Much of the original topsoil has been eroded due to poor cultivation practices leaving the clay subsoil exposed.

The Coastal Plain is a region of gently to moderate slopes underlain by marine sands, loam, and clays. Elevation ranges from approximately 10 to 500 feet M.S.L. Although sandy and infertile in the native state, most Coastal Plain soils are productive when fertilized and limed. Except for

the lowland areas, Coastal Plain soils are well drained and consist of light gray, sandy surface zones underlain by friable yellow, sandy clay loam to clay subsoils. Agriculture is important in the Coastal Plain, comprising about one third of the land use and most of the remaining area is forested. Throughout the study area Coastal Plain there is little development on the Savannah River and the flood plain ranges up to more than two miles in width. Palustrine forested wetlands (swamps) cover most of the flood plain.

Water discharge in the Savannah River varies considerably both seasonally and annually, even though it is largely controlled by releases from the Corps' J. Strom Thurmond Dam located about 20 miles northwest of Augusta, Georgia. Discharge is typically high in winter and early spring and low in summer and fall, but regulation by upstream reservoirs has reduced natural flow variations. At the New Savannah Bluff Lock and Dam 12 miles downstream of Augusta average discharge is about 10,000 cubic feet per second (cfs). The range in water year 1998 was about 4,300 cfs to 42,700 cfs. Average discharge at Clyo (Effingham County, Georgia) is 12,040 cfs with a range for water year 1998 of 6,280 cfs to 52,600 cfs (Cooney et al. 1999). Tidal effects extend upstream to approximately river mile 45.

The Corps maintains and operates three large multipurpose projects in the basin. Hartwell Dam and Lake (55,950 acre summer pool) is located 89 miles upstream of Augusta and was filled in 1962. Richard B. Russell Dam and Lake (26,650 acre summer pool) is located 59 miles upstream of Augusta and was filled in 1984. The Corps is seeking to operate Russell as a pumped storage project. J. Strom Thurmond Dam and Lake (70,000 acre summer pool) is located 22 miles upstream of Augusta and was filled in 1954.

The authorized project for the Savannah River between Augusta and Savannah, Georgia, provides for a navigation channel 9 feet deep and 90 feet wide from the upper end of Savannah Harbor (mile 21.3) to the head of navigation just below the 13th Street bridge (mile 202.2), a distance of 180.9 miles. The project also includes the lock and dam at New Savannah Bluff, located about 12 miles downstream from Augusta. Channel modifications, including deepening, widening, snagging, construction of bend cutoffs, and construction of pile dikes, have been made on the river to provide the 9-foot depth. However, by 1980, shipping on the river had virtually ceased, and channel maintenance was discontinued. Also, due to the lack of commercial traffic, a study is currently underway on the disposition of the New Savannah Bluff Lock and Dam

The existing authorized Savannah Harbor navigation project provides for a channel 44 feet deep and 600 feet wide across the ocean bar; 42 feet deep and 500 to 600 feet wide to the vicinity of Kings Island Turning Basin; and 30 feet deep and 200 feet wide to a point l,500 feet below the Houlihan Bridge (Highway 17). The terminus of the existing channel for Savannah Harbor is at approximately river mile 21. The project provides turning basins for vessels at various locations in the harbor.

FISH AND WILDLIFE RESOURCES

FISH

A comprehensive five year fishery survey concluded that the lower Savannah River supports an abundant, diversified fish community, but has a low to moderately utilized fishery (Schmitt and Hornsby 1985). Based on number and weight collected the most abundant game fish were largemouth bass, chain pickerel, black crappie, yellow perch, redbreast sunfish, bluegill, redear sunfish, warmouth, flier, and pumpkinseed. Important non-game fish include longnose gar, bowfin, white catfish, channel catfish, common carp, spotted sucker, silver redhorse, striped mullet, and brown bullhead. The most important forage fish are gizzard shad and a number of minnow species. Anadromous fish found in the lower Savannah River are striped bass, American shad, hickory shad, blueback herring, shortnose sturgeon, and Atlantic sturgeon. In southern waters (south of Cape Hatteras, NC) striped bass occupy riverine and estuarine waters and don't frequent the open ocean.

During the early part of the 19th century, anadromous fish (with the exception of sturgeon) annually migrated as far as the headwaters of the Savannah River, through the Tugaloo River and up the Tallulah River to Tallulah Falls, Georgia, approximately 384 river miles from the ocean. After 1846 the Augusta Diversion Dam acted as a barrier to inland migration of anadromous species. Completion of the New Savannah Bluff Lock and Dam (NSBLD) in 1937 further restricted spawning migrations to below river mile 265. During the late 1950's through the early 1960's, the Corps' Savannah River navigation project constructed 38 cuts across meander bends and as a result shortened the river by 78 miles. Therefore, New Savannah Bluff Lock and Dam is now located at river mile 187.3. The Stevens Creek Dam, a South Carolina Electric and Gas hydroelectric project, was constructed upstream of the Augusta Diversion Dam in 1914.

Anadromous fish are still an important component of the River's sport and commercial fisheries. Large numbers of American shad and blueback herring, and lesser numbers of striped bass and sturgeon migrate to the NSBLD facility which is the first major obstruction to passage on the river. However, some fish have continued to migrate to historical spawning grounds above the facility. The fish pass upstream by swimming through fully opened dam gates at flows of 16,000 cfs or higher, and by swimming through the navigation lock when it is operated in a manner suitable for fish passage.

Because of the national importance of anadromous fishery resources and the historical significance of the Savannah River in supporting these resources, in 1986 the Service initiated studies aimed at restoring full anadromous fish passage to historical spawning grounds above NSBLD. This cooperative effort among the Service, Corps of Engineers, Georgia Wildlife Resources Division, and South Carolina Department of Natural Resources (SCDNR) has continued to the present. Various combinations of lock operation and flow releases from J. Strom Thurmond reservoir have been used to facilitate fish passage at NSBLD. On-going studies led by the SCDNR are attempting to assess the effectiveness of fish passage efforts. Results to date indicate that both methods are effective for upstream passage of American Shad.

In 1992, the Service, the South Carolina Department of Natural Resources and the Georgia Department of Natural Resources approved an "Elements on consensus on American shad management in the stretch of Savannah River between Strom Thurmond (Clarks Hill) Dam and Augusta. Goals identified for this reach of the Savannah River included (1) the continued lockage of American Shad at NSBLD, (2) the design and implementation of an upstream fish passage mechanism at the Augusta Diversion Dam and (3) similarly at the Stevens Creek Dam, (4) improvement of poor dissolved oxygen, and (5) safe downstream passage mechanisms for out migrant anadromous fish, if deemed necessary (Appendix A).

The lower Savannah River provides extremely important striped bass habitat. Prior to initiation of tide gate operation in 1977, the primary spawning area for striped bass in the Savannah River system was the tidal fresh water zone approximately 18-25 miles from the river mouth, specifically the Little Back River (McBay 1968; Rees 1974). Salinity changes due to the tide gate operation (1977-1992) reduced the extent of this tidal freshwater zone. Studies indicated significant declines in numbers of striped bass eggs and larvae in the lower Savannah River system during this period. These declines were related to increased salinity and modified transport patterns caused by the tide gate and associated hydrologic modifications (Van Den Avyle et al. 1990, Winger and Lasier 1990).

The Little Back River, due to its unique physical characteristics, is the only suitable area within the Savannah River System for efficient collection of brood fish for Georgia statewide propagation and stocking program of striped bass and hybrid bass (white bass x striped bass). In the early 1980's, an average of 4,291 kilograms of striped bass were harvested annually by sport fishermen in the Savannah River downstream of the NSBLD (Scmitt and Hornsby 1985.) Since 1989, because of the documented reproduction decline, there has been a striped bass harvest moratorium on the Savannah River downstream of NSBLD.

WETLANDS

Palustrine forested wetlands dominate the extensive alluvial plain of the Savannah River. The wettest parts of the flood plain, such as swales, sloughs, and back swamps are dominated by bald cypress, water tupelo, and swamp tupelo. Slightly higher areas, which are usually flooded for much of the growing season are often dominated by overcup oak and water hickory. Most of the Savannah River floodplain consists of low relief flats or terraces. These areas are flooded during most of the winter and early spring and one or two months during the growing season. Laurel oak is the dominant species on these flats and green ash, American elm, sweetgum, spruce pine, sugarberry, and swamp palm are often present. Swamp chestnut oak, cherrybark oak, spruce pine, and loblolly pine are found on the highest elevations of the flood plain, which are only flooded infrequently during the growing season.

On the Savannah River downstream of Interstate Highway 95 tidal palustrine emergent wetlands, also known as tidal freshwater marsh, becomes prevalent. Tidal palustrine emergent wetlands are flooded twice daily by tidal action in the study area. These marshes are vegetated with a

diverse mixture of plants including giant cutgrass, spikerushes, and up to 58 other plant species (Pearlstine et al. 1990, Applied Technology and Management 1998).

In palustrine emergent wetland, primary productivity is high, falling in the range of 500 to 2000 grams/square meter/year (Odum et al. 1984). The quality of primary production of the fresh marsh community is also high. Major primary producers in the salt marsh community are grasses that have little immediate nutritional value to fish and wildlife but support an important detritus based food web (Teal 1962). In contrast, the fleshy broad-leaf plants characteristic of fresh marshes generally are high in nitrogen and low in fiber content and there is a high incidence of direct grazing or feeding on these plants (Odum et al. 1984).

Fresh marsh vegetation also contributes to the food web base that supports the study area's freshwater fishery. The leaves of the larger macrophytes in this community are used as attachment places by mollusks, insect nymphs, rotifers, hydra, and midge larvae, all important fish foods. The submerged littoral zone is vital to the development of freshwater fish, as well as some marine and estuarine species, as these areas are the principal spawning sites and provide nursery and juvenile habitats.

WILDLIFE

Wildlife associated with forested wetlands is numerous and diverse. The furbearers are an important component of these wetlands and include beaver, muskrat, mink, otter, bobcat, gray fox, raccoon, and opossum Deer, turkey, and even black bear in the more isolated areas, use the bottomlands. Palustrine emergent wetlands also provide excellent habitat for furbearers including the mink, beaver, and river otter. Terrestrial species from surrounding areas often utilize the fresh marsh edge for shelter, food, and water; these include raccoon, opossum, rabbit, and bobcat.

The study area is part of the Atlantic Flyway and forested wetlands provide important wintering habitat for many waterfowl species and nesting habitat for wood ducks. Many species of woodpeckers, hawks, and owls use the bottomlands and swamps.

Neotropical migratory birds, many of which are decreasing in abundance, depend upon contiguous tracts of forested swamps for breeding and as corridors during migration. Robbins et al. (1989) found that the most area-sensitive bird species required at least 2,800 acres of contiguous forest to be present. The extensive forested wetlands of the Savannah River flood plain provide very valuable habitat for these birds. The American swallow-tailed kite, a state (SC) listed endangered species, can be observed on the study area. Swallow-tailed kites nest in and are closely associated with palustrine wetlands.

Palustrine emergent wetlands also provide habitat for many bird species. Resident, transient, and migrating birds of both terrestrial and aquatic origin utilize food and shelter found in this community; some species use freshwater marshes for nesting and breeding. Waterfowl feed upon fresh marsh vegetation, mollusks, insects, small crustaceans, and fish found in the fresh

marsh community. Wading birds such as the wood stork, great blue heron, little blue heron, green heron, snowy egret, and great egret also heavily utilize the tidal freshwater marsh.

The study area provides excellent habitat for a large number of reptiles and amphibians. Wetland habitats support many kinds of frogs including bullfrog, bronze frog, southern leopard frog, and several species of tree frogs, cricket frogs, and chorus frogs. Turtles found in the wetlands include river cooter, Florida cooter, pond slider, eastern chicken turtle, snapping turtle, mud turtle, and stinkpot. Snakes found in the wetlands include red-bellied water snake, banded water snake, brown water snake, eastern mud snake, rainbow snake, and eastern cottonmouth. The American alligator can be observed on streams and ponds of the Coastal Plain study area.

ENDANGERED SPECIES

Federal Endangered (E), Threatened (T), and Candidate (C) species that are likely to occur in the Savannah Basin Study Area include:

Mammals:
Indiana Bat (*Myotis sodalis*) - E
West Indian manatee (*Trichechus manatus*) - E

Birds:
American peregrine falcon (*Falco peregrinus anatum*) - E
Bald eagle (*Haliaeetus leucocephalus*) - T
Red-cockaded woodpecker (*Picoides borealis*) - E
Piping plover (*Charadrius melodus*) - T
Wood stork (*Mycteria americana*) - E
Kirtland's warbler (*Dendroica kirtlandii*) - E

Reptiles:
Eastern indigo snake (*Drymarchon corais couperi*) - T

Amphibians:
Flatwoods salamander (*Ambystoma cingulatum*) - T

Fishes:
Shortnose sturgeon (*Acipenser brevirostrum*) - E

Plants:
Canby's dropwort (*Oxypolis canbyi*) - E
Chaff-seed (*Schwalbea americana*) - E
Schweinitz's sunflower (*Helianthus schweinitzii*) - E
Small whorled pogonia (*Isotria medeoloides*) - T

Pondberry (*Lindera melissifolia*) - E
Rough-leaved loosestrife (*Lysimachia asperulaefolia*) - E

Bunched arrowhead (*Sagittaria fasciculata*) - E
White irisette (*Sisyrinchium dichotomum*) - E
Dwarf-flowered heartleaf (*Hexastylis naniflora*) - T
Mountain sweet pitcher plant (*Sarracenia rubra ssp. jonesii*) - E
Harperella (*Ptilimnium nodosum*) - E
Swamp-pink (*Helonias bullata*) - T
Smooth coneflower (*Echinacea laevigata*) - E
Seabeach amaranth (*Amaranthus pumilus*) - T
Persistent trillium (*Trillium persistens*) - E
Relict trillium (*Trillium reliquum*) - E
Little amphianthus (*Amphianthus pusillus*) - T
Miccosukee gooseberry (*Ribes echinellum*) - T
Bog asphodel (*Narthecium americanum*) - C

Maintenance and enhancement of habitat for endangered and threatened species is an important Service goal. The species listed above should be taken into consideration in any future federal projects.

PROBLEMS, OPPORTUNITIES, AND PLANNING OBJECTIVES

Representative of Georgia Department of Natural Resources have expressed concern with maintaining adequate instream flows and habitat in piedmont tributary streams that flow into the Corps reservoirs. Population growth and development are increasing demands for surface water withdrawals. Modification of instream flows can lead to loss of aquatic habitat quality and quantity and reduced biodiversity and productivity. Stream sediment input and non-point source pollution also are frequently associated with development. These stream modifications need to be evaluated and identified problems need to be addressed.

Upstream of Augusta, the Stevens Creek pool experiences low dissolved oxygen for two to three months each year due to unaltered hypolimnetic releases from J. Strom Thurmond Dam. Through the Federal Energy Regulatory Commission licensing process the Service, SCDNR and GADNR are seeking to restore passage of anadromous fish at the Augusta Diversion Dam and Stevens Creek Dam to the base of Thurmond Dam. Cooperative efforts underway in conjunction with turbine renovation at Thurmond Dam should improve dissolved oxygen below the dam. Design of the new system is underway and the system could be installed by the year 2001. This improvement would help ensure survival of spawned American shad fry and improve the resident aquatic community.

The extensive forested wetlands of the Savannah River below Augusta are important habitat to many significant commercial and recreational fish and wildlife species, as well as to endangered and threatened plants and animals. These wetlands are also important for flood control and purification, soil enrichment, erosion control, and support for downstream fishing.

By modifying the natural flow regime, reservoir construction and operation in the Piedmont has caused loss and degradation of forested wetlands along the lower Savannah River. The character of southeastern forested wetlands is determined by many factors including: (1) duration and periodicity of flooding; (2) depth of flooding; (3) intensity of stream flow; (4) quantity, nature and deposition rates of sediment carried by the stream, and (5) chemical aspects of the water (Bozeman and Darrell 1975). Regulation of river flow at the reservoirs has significantly modified all these factors.

One result has been the succession of many of the remaining forested wetland communities to drier habitat types. This has reduced the richness and diversity of the river swamp and eliminated and degraded wetland habitats and associated values and functions that are important for fish and wildlife. Reduced river flow to the seasonally flooded wetland have also made it possible for landowners to convert hundreds of acres of this habitat type to agriculture and pine plantations and residential development which are less productive for wildlife.

Riverine fish communities benefit from natural spring floods. Overbank flooding allows for inundation of extensive spawning habitat. Flood water slowly recedes allowing the larval and juvenile fish to contribute to the river's population. Temporary connection of the natural oxbow lakes on the flood plain to the river, which allowed for the movement of adult fish into the frequently isolated oxbows, and the emigration of younger fish to the river, is especially important. The carbon cycle of Coastal Plain rivers also is closely tied to overbank flooding. Productivity (primary and advanced) suffers with the loss of flood episodes. Due to reduced flooding resulting from upstream dams and the construction of cutoffs, these natural mechanisms to recharge the riverine fish populations have been reduced. There is little question that fish populations in the river and floodplain downstream of Augusta have been reduced.

In addition, water quality in the Coastal Plain tributary system has been degraded. Under unregulated conditions, tributaries were subject to pulses of high flow, which helped flush the system and thereby reduced the organic content and nutrient levels and increased dissolved oxygen. Therefore, under unregulated conditions, these blackwater tributaries were oligotrophic systems that exhibited good water quality. The lower portion of Ebeneezer Creek, designated a Georgia Scenic River and a National Natural Landmark at river mile 45 is a prime example. This area contains a backwater swamp with old-growth bald cypress-water tupelo. Ebeneezer Creek has become plagued with nuisance aquatic vegetation, declining water quality, and fish kills. Reduced flushing due to river flow modification is thought to be a contributing factor to these problems. More study is needed to assess the extent and magnitude of all of these flow regime impacts.

The Corps' actions in the lower river, dredging and placement of pile dikes associated with maintenance of the navigation channel to Augusta, are also affecting the hydrological conditions in the forested wetlands. Shortening of the river by 30 percent has steepened the gradient of the river and undoubtedly led to channel degradation. Sediment buildup at the entrance to waterways since

the channel modifications, in combination with the lower flows resulting from the reservoirs has reduced water flow into swamps, creeks, and lakes. Changes in vegetative communities and lower population levels of wildlife may result from these reduced flows.

In addition, the channel cuts have increased current velocity in the new channel and degraded the quality and quantity (78 miles) of high value fish habitat in the cutoff meander bends. Some of the meander bends have filled so that flow has been essentially eliminated under all except flood conditions. Some of the meander bends contain flow during high river discharge but do not support flows during low flow periods. The cutoff bends have accumulated organic matter that reduces dissolved oxygen in the water during low flow/warm water conditions. Fish and macroinvertebrate habitats have been adversely affected under these conditions and fish recruitment may be reduced. Site specific data is needed to assess the magnitude of this water quality problem at specific cutoff bends and to develop appropriate remedies.

The following example illustrates the flow regime and stream modification problems. The City of Savannah has experienced declining water quality (pH) at its pump station on Little Abercorn Creek. City officials believe that this problem is caused by reduced flow and wetland flushing from tributaries of the Savannah River. The tributaries that flow into Little Abercorn Creek include Bear Creek and Mill Creek. The entrance to Bear Creek is located on Savannah River Cutoff Bend Number 3. Reduced flow in the cutoff bend resulting from construction of the cutoff has reduced flows into Bear Creek. Mill Creek is partially fed water by channels off of the Savannah River at Flat Ditch Point. Reduced flow in this cutoff bend resulting from construction of cutoff number 4 has reduced flows into Mill Creek. In addition to affecting the city water supply these flow conditions reduce the duration and depth of flooding in adjacent Savannah National Wildlife Refuge and privately owned wetlands. Flushing of detritus and nutrients from the wetlands is reduced as is access to the flood plain for larval and juvenile fish. Wetland vegetation species composition may change over time due to the reduced flooding.

The tidal fresh marsh on Savannah NWR supports an extremely diverse plant community providing food, cover and nesting habitat for a wide variety of wildlife species. Tidal freshwater marsh is relatively scarce in comparison to coastal brackish and salt marshes. Because of tidal freshwater marsh scarcity and its high fish and wildlife value, a primary Service goal is to restore and maintain tidal freshwater marsh in the lower Savannah River. Past harbor modifications, including harbor deepening, have greatly increased salinity levels throughout much of Savannah NWR and reduced the quantity of tidal freshwater marsh. According to our preliminary evaluation, Savannah NWR contained about 6,000 acres of tidal freshwater marsh when it was established in 1927. By 1997, due to the cumulative impacts of harbor deepening, tidal freshwater marsh had declined to 2,800 acres, a reduction of 53 percent. Measures to reverse this habitat degradation need to be evaluated and implemented.

Prior to 1977, the Savannah River supported the most important naturally reproducing striped bass population in the State of Georgia but production of striped bass eggs in the Savannah River estuary has declined by about 95 percent since that time. Tide gate operation, in conjunction with the cumulative impacts of harbor deepening, caused a number of impacts, including increased

salinity and loss of suitable spawning habitat throughout most of Little Back River and the lower Savannah River. Striped bass eggs and larvae were also transported through New Cut and then rapidly downstream to areas with toxic salinity levels. It was hoped that the tide gate restoration

project would improve most of these conditions. Unfortunately, in spite of supplemental stocking and an increase in adult numbers, the striped bass population has not recovered as anticipated. The failure of recovery may be due, in part, to the cumulative impacts of harbor deepening. An interagency Section 1135 environmental restoration project, led by the Corps' and GADNR, is currently underway to identify and implement striped bass restoration measures in Back River.

The following planning objectives were developed considering the above problems.

1. Implement a Savannah River flow regime that will provide diverse and productive fish and wildlife habitat in the lower Savannah River. The flow regime should be established by evaluating the quantity, duration and periodicity of flows needed to support aquatic and wetland functions.

2. Evaluate the potential to reduce salinity intrusion in Savannah Harbor, and restore tidal freshwater marsh and striped bass habitat, by modifying management and operation of J. Strom Thurmond Reservoir.

3. Evaluate the extent and impact of development in the Savannah River flood plain subsequent to construction of Corps flood control projects.

4. Allow the Savannah River to establish a new hydraulic equilibrium by no longer maintaining the Augusta to Savannah navigation channel and associated structures.

5. Restore Savannah River cutoff bends to natural conditions where fish and wildlife and/or other benefits can be demonstrated.

6. Maintain small (fishing) boat access to those cutoff bends providing significant fishing opportunities.

7. Gather water quality and morphometry survey information on selected cutoff bends to help determine the need for restoration or other actions at additional cutoff bends.

8. Maintain and enhance fish passage at the New Savannah Bluff Lock and Dam or remove this impediment to fish passage.

9. Improve water quality, particularly dissolved oxygen level, below J. Strom Thurmond Dam.

10. Evaluate instream flow impacts of surface water withdrawal in the Piedmont region of the basin.

FUTURE FWCA ACTIVITIES AND FUNDING NEEDS

Projecting the specific FWCA activities that would be necessary to adequately describe existing

fish and wildlife resources, assess impacts and evaluate alternative plans, and develop necessary conservation measures is difficult because the scope of the potential study has not been well defined. Required activities will be directly related to problems evaluated and potential solutions and their likely impacts upon fish and wildlife resources. For planning purposes, we have assumed that future studies would focus on the flow regime. The Service would anticipate providing assistance in scoping, designing and analyzing the results of studies needed to evaluate flow problems. In addition, study results would be used to prepare Fish and Wildlife Coordination Act Reports evaluating fish and wildlife habitat with and without the project and providing recommendations on management measures. Our funding estimate for these activities is $60,000. Should the study continue, detailed scopes of work and associated funding needs will be developed under our transfer funding agreement.

RECOMMENDATIONS

The Service recommends that the Corps perform the following actions to address the problems associated with the Savannah River Basin project.

1. In conjunction with fish and wildlife agencies and other stakeholders, determine and implement a Savannah River flow regime that provides for diverse and productive fish and wildlife habitat. The flow regime evaluation should include determination of the quantity, duration and periodicity of flows needed to support aquatic and wetland functions.

2. Evaluate the potential to reduce salinity intrusion in Savannah Harbor, and restore tidal freshwater marsh and striped bass habitat, by modifying management and operation of J. Strom Thurmond Reservoir.

3. Evaluate the extent and impact of development in the Savannah River flood plain subsequent to construction of Corps flood control projects.

4. Do not conduct any dredging maintenance activities on the Savannah to Augusta navigation project and seek deauthorization of this navigation project.

5. In conjunction with fish and wildlife agencies, determine need for further restoration action on cutoff bends.

6. Continue to ensure anadromous fish passage at New Savannah Bluff Lock and Dam using lock operations or upstream flow releases. Evaluate removal of this obstruction to anadromous fish. Ensure that fish passage is continued if the disposition study leads to a new lock and dam manager.

7. Improve water quality, particularly dissolved oxygen level, below J. Strom Thurmond Dam.

8. Evaluate instream flow impacts of surface water withdrawal in the piedmont region of the basin.

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APPENDIX A