ATTACHMENT 4b

FINAL SCHEDULE B RESPONSE INCLUDING ADDRESSING OF CONSULTING AGENCIES AND TRIBES COMMENTS AND RECOMMENDATIONS –

Appendices 1 through 18

Appendix 1

Whitepaper Regarding Increasing the Winter Minimum Pool Level for Normal Operations of Lake Murray

Whitepaper Regarding Increasing the Winter Minimum Pool Level for Normal Operations of Lake Murray

Drafted June 20, 2008

Introduction

SCE&G is considering whether to change the present pool level operating policy regarding the minimum pool elevation during the months December through March. Over the past 28 years the normal winter minimum pool elevation varied between 348 and 355, and in general it was near 350± about half the years and near 354± the other years.

This whitepaper addresses the probable effects of increasing the minimum pool elevation to 354 ft amsl or higher each year on inflow sediment deposition and water quality in the lake, especially originating in the upper areas of the lake that would likely be significantly impacted.

There are three main impacts that are addressed:

1. Effects of increased future sediment deposition and reduced current sediment scouring near the inflow areas of the lake on greater and more frequent inundation of property upstream from the lake
2. Effects of reduced current sediment scouring on water quality in the lake and anoxic products (including greenhouse gases) in the releases from Saluda Hydro
3. Effects of raised minimum pool elevation on increased aquatic plants around the shoreline

In the way of background, a comprehensive study on the effects of pool levels on issues like the one SCE&G is facing is not available. However, there are five pertinent observations that can be gleaned from actual, notable experiences:

1. In the TVA system there are two main types of reservoirs: those where winter pool elevations are lowered more than 20 feet and those where they are lowered about 5 feet. Those lowered 20 or more do not experience the kinds of issues that are a concern for Lake Murray. Those that are lowered about 5 feet do experience problems that are a concern for Lake Murray.
2. The most advanced study known to the author of sediment deposition problems was conducted at Smith Mountain Reservoir recently. Smith Mountain experiences significant problems expressed by stakeholders and it is lowered only 5 feet each year. One observation stated in their report was that the winter minimum pool elevation had a significant effect on the sediment deposition problems noted by stakeholders.
3. The pool level of Brownlee Reservoir (Snake River, ID and OR state line) is dropped about 90 feet about every five years. Sediment deposition that occurs for four years is partly scoured every fifth year when the pool level drops, but some remains causing constricted flow to the scoured channel. A similar phenomena occurs at the upper end of Parksville Lake (TN) that has experienced large

amounts of exposed sediment deposition over the past 100 years from erosion of the Copperhill basin but is only partly scoured by large inflows each year. These experiences show that once deposition occurs and it stays in place for a period of time like years, there is a limit to how much of it will be scoured and redeposited to deeper areas. Where sediment deposits in such areas, the original channel is constricted and hydraulic backwater curves increase in elevation.

4. Larger lakes in the southeast like Lake Murray experience similar levels of drawdowns: Hartwell, JST, Lanier. The large lakes on the TVA system experience drawdowns or 20-100 feet.
5. Other reservoirs in the southeast, i.e., Rhodhiss on the Catawba River and Claytor on the New River (VA), with low annual pool fluctuations like that proposed by LMA and sizeable uncontrolled drainage areas like Lake Murray experience notable sediment issues. Backwater effects are significant upstream from Rhodhiss, and water quality issues regarding eutrophication and sediment accumulation in the top few feet of Claytor have been reported.

These actual experiences are worthy of consideration for the decision SCE&G is facing regarding Lake Murray.

Deposition and Scour of Sediments at the Inflow Region of Reservoirs

Two distinctly different processes affect sediment deposition at the inflow regions to Lake Murray, especially the main inflow from the Saluda River.

The most obvious process is that of scour when the pool level is lowered each year starting in October. As the pool level drops the settled sediment in the inflow regions is scoured and redeposited to deeper regions of the inflow area. This process continues as long as the pool level is less than the summer pool elevation, and it is proportional to the amount of flow entering the lake as well as by the amount that the pool level is decreased in terms of elevation and duration of drawdown. This scouring process works best on newly deposited sediment, and older sediment from previous years is usually more resistant to scour and erosion (see Golterman, 1975).

The other major process is not so apparent, but has great significance based on available data: most new sediment entering Lake Murray enters the lake during January through April. When the lake level is at 350' amsl compared to a higher level, the inflowing sediment is carried down further into the reservoir before it settles. During relicensing studies in 1974-5, it was determined that 97% (adjusted for estimated bedload sediment in the Saluda River per Rosgen and Silvey, 1996) of the sediment entering Lake Murray from the Saluda River occurred over the months of January through April. Also, it should be noted that 86% of the sediment entering Lake Murray came from the Saluda River. The Saluda River sediment load to Lake Murray for January through April was estimated to be 161,000 tons while the sediment load in the remaining months was estimated to be 5100 tons. Sediment loads vary from year to year depending on the amount of runoff each year and the timing of the runoff; however, the sediment load estimated from the 1974-1975 study is consistent with the observed seven foot difference in sediment elevation between 1975 and 2007 as shown in Figure 1.

It is important to note that no measurable deposition of sediments was observed by ERC (1976) downstream from the Rocky Creek area of Lake Murray, i.e., all deposition that occurred in Lake Murray over the ~ 50-year period prior to 1975 occurred upstream from the Rocky Creek area. This is consistent with the experience of Ruane, i.e., sediment deposits in reservoirs occur in the upper end of reservoir and progress towards the dam as the delta forms and moves toward the dam as more sediment continues to extend the length of the delta, and this process is significantly affected by the winter minimum pool elevation.

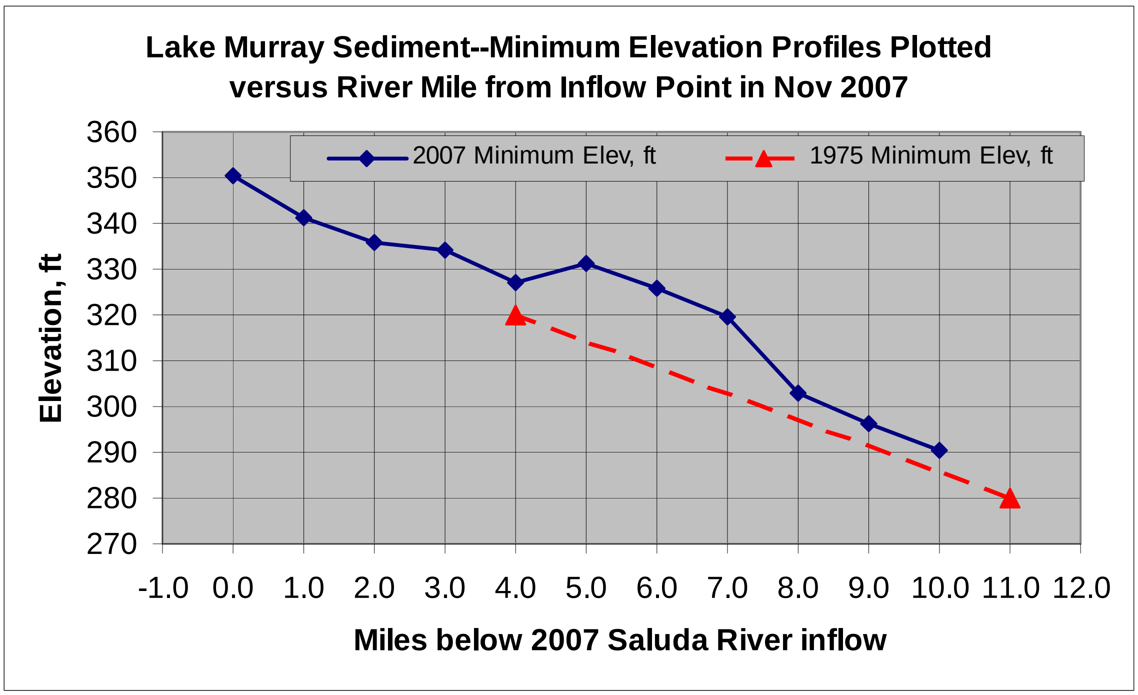

Figure 1. Elevation measurements in 1975 and 2007 in the upper 11-12 miles of the main channel of Lake Murray showing the amount of sediment accumulation over the 32 year period at a location four miles below the 2007 inflow point (this location is about one mile upstream from the confluence with LSR.) It appears that a delta of sediment has formed over the four mile reach between locations four and eight miles below the 2007 inflow point.

What about the region 350' to 354'amsl? What might happen in this region if the minimum pool elevation is raised to 354' amsl or higher? If minimum pool elevation is raised, more sediment will deposit in the first one-two miles at the upper end of the lake (and even some distance upstream from the lake) and the inflow region will be shallower than present conditions. The following fundamental processes would occur:

1. If the target operating policy for minimum winter lake pool level is increased from current levels, water velocities would decrease significantly in the upper 1-2 miles of the lake, especially near the inflow where currently water is shallowest and velocities are highest. This is best illustrated by viewing the 2007 sediment profile in Figure 1 where the profile intersects with elevation 350. In November 2007 the water depth at this inflow location was 1.6 ft deep. If the pool elevation had been 354 instead of 352.2 , the water velocity would have been about half the speed. If the pool elevation had been at 350 amsl, the sediment bottom at the start of the flat pool would have been at elevation 348 or 349 and water depth would have been 1 to 2 feet. Raising the pool level to 354 or 356 at the same location would cause a drop in water velocity to 14-33 % of that velocity that had occurred with the pool elevation at 350 amsl.
2. Key principles of sedimentation at the inflows to reservoirs: 1) when water velocity changes from river flow to pooled reservoir conditions, suspended sediment starts settling and inflowing bedload (sediment that moves along the riverbed) starts depositing at the first opportunity of lower water velocities; 2) when the minimum pool level is increased, settling starts closer to the reservoir inflow point when the lake is full; 3) scouring velocities in the inflow region of a reservoir decrease as the minimum pool level increases; 4) these principles add up to one coherent end-result: higher minimum pool levels result in more sediment accumulation at the inflow regions of the lake. Finally, this process causes constriction/restriction to flow entering the lake and this causes the backwater areas upstream from the reservoir to experience higher surface water elevations that in turn causes more flooding upstream from the reservoir, both in terms of water elevation and the frequency of inundation. This same process would occur at the inflow points of all the major tributaries to Lake Murray, except that the degree of sediment deposition would be proportional to the size of the watershed draining to Lake Murray.
3. Suspended solids in inflowing waters and associated bedload from watershed erosion would settle and accumulate as they enter the lake, with larger, heavier particles settling/accumulating first closer to the inflow area of the lake (within minutes, hours); and finer, smaller particles settling last further into the reservoir (within days and weeks). It should be noted that bedload is usually about the same as the suspended sediment load when inflows are high and when upstream Saluda River weeds "die back" over the winter. Also, bedload would be the first sediment to accumulate within the inflow areas, i.e., it would be the main cause for creating shallower water in the inflow regions of the lake.
4. At the lower water velocities associated with higher pool levels near the inflows to the lake, more settling and accumulation of solids would occur upstream of where it currently occurs. The sediment deposits/accumulation near the inflow would be noticeable. Tommy Boozer said he has observed some mounds of sediment already occurring in the inflow region of the lake—if minimum pool levels are raised, these would occur with more frequency and over larger areas of the inflows (including a reach of the Saluda River upstream from Lake Murray) due to the lower velocities that would occur with a raised minimum pool elevation.

5. Drainage area and therefore sediment sources are primarily from upstream of the main waterbodies feeding the reservoir, i.e., the Saluda River, Bush River, Little Saluda River, and Clouds Creek. SCE&G observations in 2007 at the creek inflow to Camping Creek embayment indicated that sediment accumulation and aquatic plants were present. This sediment deposition would increase if the winter minimum pool level was increased from 350 to 354 or higher. As for the main inflow from the Saluda River, backwater elevation would increase in Camping Creek when high flow events occur if the minimum pool level is increased.
6. The slopes of the reservoir channel (i.e., the thalweg) are lower in the upper part of the reservoir, mainly due to the nature of topography/bathymetry of reservoirs like Lake Murray and because more sediment has settled in this region of the lake than in deeper waters (for more information, see discussion in the ERC, 1975, report for gradation of sediment particle sizes).
7. When summer pool levels drop during drought conditions like those that occurred in 2007, the pool level in the September-November time frame would drop to about 353 feet above mean sea level. Unfortunately, the low river inflows would do little to scour the added sediment deposits that had accumulated in previous years, and these added sediment deposits would interfere with boating that otherwise occurs currently.

Considering that these two major processes (scour and deposition at different times depending on river flows and lake pool elevations) affect sediment deposition in the first one-two miles of the inflow region of Lake Murray and that they would be adversely affected (i.e., result in sediment deposition up-reservoir from where current deposition occurs) by raising the minimum winter pool elevation, it is evident that there is strong likelihood for sediment-related problems to occur if the minimum pool level is increased to 354 or 356. These problems could include the following:

1. Increased elevations for backwater curves upstream from Lake Murray as flood flows were restricted (compared to current conditions) as they passed through the entrance area to Lake Murray. The restricted flow would be caused by increased constrictions in the channel that would be caused by increased sediment deposition.
2. Considering that water would be shallower than current conditions and sediment would be more stable compared to the current "shifting sediment" conditions due to the current scouring conditions, aquatic plants could grow under these habitat conditions. If this were to occur, even more sediment deposition would occur in this same area since aquatic plants trap more sediment as sediment laden water passes through them. If aquatic plants develop in this area, additional pollutant loads of organic and nutrient levels would be added to the reservoir.
3. Boating in the inflow region would become more difficult due to the sediment build-up, especially in years like 2007 when the inflow is low and evaporation causes the pool to drop to 353 or even 352. In these cases, the later summer pool elevation would be lower than the winter minimum pool elevation and sediment deposition would be worse than current conditions at the inflow to the lake.

4. As will be discussed in the next section, water quality in the lake would be adversely affected due to the accumulation of organic matter in the sediments in the upper 1-2 miles of the inflow region.

Finally, the concerns expressed above would be even worse if the Greenwood pool is filled in February and the pool in Lake Murray is filled by March 1 instead of April 1. The combination of these two operational changes would postpone high inflows to Lake Murray from Lake Greenwood to later than currently occur and these postponed inflows would enter Lake Murray when pool levels would be higher than under current operations when the pool is filled by April 1. Hence, if the combination of these two lake operational changes were to be combined with the proposed minimum pool of Lake Murray being at elevation 354 or 356, the effects on sediment deposition in the first 1-2 miles of Lake Murray compounded significantly.

Bottom Line: raising minimum pool elevation (especially if combined with the proposed earlier full pool targets at Greenwood and Lake Murray) will result in shallower water in the upper 1-2 miles of the lake and its associated consequences—the only question is how much shallower, and addressing this question would take further study. Such studies can be expensive: upwards of $500,000. Unfortunately, testing an increased minimum pool level for a certain time period is not advisable since it would take a number of years to test just one scenario; and, within this time period adverse impacts would not likely be reversible unless dredging is considered. Also, it would be difficult for SCE&G to revert to current operating policy as SCE&G might deem needed based on the results of the proposed trial period because LMA pressure as well as concerns by Lexington County regarding potential (even if perceived) impacts property values would raise a steep barrier to overcome. If SCE&G were to proceed with raising the minimum pool level, even on a trial basis, they would experience costs due to damages upstream from the lake and possibly increased costs for aeration for the releases from Saluda Hydro (to be discussed in the next section.) In addition, water quality in the upper reaches of the lake would be adversely affected (to be discussed in the next section.)

It is also worthy to note that this issue is common to all man-made lakes, i.e., reservoirs, especially hydropower reservoirs since they typically have higher inflows and larger watersheds. There are two main variables that affect the sediment problems in reservoirs: the watershed characteristics and how the pool level is drawn down during the winter. SCE&G has control of only one of these variables.

Effects of Reduced Sediment Scouring on Water Quality in the Lake

Lake water quality is significantly affected by sediment transport—especially less than 30-40 feet deep, and these sediments are significantly affected by winter minimum pool levels.

The inflow regions of Lake Murray already experience poor water quality and SC DHEC has taken some action to start to improve water quality in the upper reaches of Lake

Murray. They have required TP reductions in the Bush River watershed and have considered establishing a TMDL on the LSR embayment. But much more is needed, especially for TP reductions in the Saluda River, LSR, and Clouds Creek. The LMA has strongly encouraged these efforts. However, raising the minimum pool level would adversely affect these efforts, i.e., they are at odds. Some members of LMA have expressed to me that they are not concerned about water quality and weeds and other sediment-related issues that would occur in the upper regions of Lake Murray.

The following summarizes the water quality conditions at the inflow region of Lake Murray.

Summary of Water Quality Issues Identified by SCDHEC and USGS

- The stations at Rocky Creek and in the Bush River arm of Lake Murray have been reported to be among the most eutrophic sites on large lakes in South Carolina, and both of these locations were designated as non-supporting for aquatic life uses. All the locations between Rocky Creek and the dam, including the embayment locations, were reported to be among the least eutrophic in South Carolina.
- Low pH in the tailrace was the cause for non-supporting and partially supporting ratings in the tailrace in the 303(d) listings in 2004 and 2006. *[note: low pH in the tailrace is caused by eutrophication in the inflow regions of the lake]*
- USGS monitors at Black's Bridge and the bridge over the LSR near its mouth have recorded DO levels less than DHEC standards…this is attributable to eutrophic conditions at these two locations.
- Watershed management has been recommended to reduce phosphorus loading to two areas of the lake: Bush River embayment and the Rocky Creek area of Lake Murray.
- Total phosphorus loads to Lake Murray still remain high due to nutrient loads from Ninety-Six Creek, Bush River, Little Saluda, and Clouds Creek. These tributaries to the upper end of Lake Murray contribute an estimated 71% of the TP load to Lake Murray while their streamflow contributions only total about 18%. DHEC has stated that they will not pursue TP reductions at Greenwood which is the largest source of known phosphorus loads to Lake Murray.
- Considerations for internal nutrient cycling—eutrophication at Rocky Creek and low DO in the metalimnion (and subsequently in the turbine releases) could be partly attributed to internal nutrient cycling. Also, the nutrients released from the sediments in the upper region of the lake could be subject to upwelling induced by power pulse inflows from Lake Greenwood being cooler than the surface water. This upwelling could contribute additional P and N (i.e., NH_3) into the surface layer.
- Water quality problems (algae, anoxics, low DO) in the Little Saluda River embayment are partly caused by internal nutrient cycling due to the small watershed feeding this embayment (i.e., it is a sizeable body of water with relatively low potential for sediments to be flushed out.) Nutrients accumulate

in a system like this and cycle over and over as they are taken up by algae, the algae die and settle, and then the nutrients are cycled up into the water column again. DHEC is considering designating the LSR embayment as a TMDL site. *[note: LSR water quality modeling indicates that internal nutrient cycling is occurring and raising the minimum pool elevation would increase this internal nutrient cycling.]*

- The Bush River arm of Lake Murray was reported in both the 1995 and 1998 reports to be among the most eutrophic sites on large lakes in South Carolina. The median TP was about 0.10 mg/L, indicative of eutrophic-hypereutrophic conditions.

SCE&G can't control sediment and pollutant loads from the watershed, but they can affect water quality by how they operate Lake Murray. Raising the winter minimum pool level would aggravate the current water quality problems making it more difficult to improve water quality.

<u>What is the likely impact to sediments if the minimum pool elevation is increased to 354 or 356?</u> Greater levels of nutrient and organic matter in shallower reaches of the lake; greater levels of SOD in these shallower reaches; greater levels of releases of nutrients (i.e., internal nutrient cycling) and anoxic products; lower DO in the inflow region and higher frequency of low DO in this region; higher levels of algae and possibly aquatic weeds. These near-field effects could result in far-field effects on striped bass habitat and water quality issues for the releases from Saluda Hydro. *[Note: internal nutrient cycling can be a significant source of phosphorus. Tufford and McKellar reported that internal "sediment flux accounted for … 50% … of the annual load" of phosphorus in Lake Marion.]*

<u>What did the study conducted by SCE&G in November 2007 show?</u> Sediment ooze is very sensitive to water velocity: none was found in shallow inflow water less than about 1 m deep; ooze contains dead organic matter like algae, bacteria are very active in this layer, and ooze releases ammonia, phosphorus, and methane to the overlying water. Ooze also causes sediment oxygen demand, i.e., SOD. The shallower the water, the more impact it has on the water above it. If minimum pool elevation is raised, more sediment area in the upper reaches of the reservoir will be covered with ooze. Ooze causes internal nutrient cycling, resulting in more algae growths and organic matter. With more sediment deposition in the upper 1-2 miles, the water depth will be less than current depths and organic matter is likely to be higher than current considering less scour in this reach than before (resulting in sediment with higher organic content, i.e., ooze) and weeds may take hold. The effects of sediment DO demands and releases of nutrients from the sediments would reduce DO in the water that enters the interflow through Lake Murray and impact striped bass habitat and water quality in the releases from Saluda Hydro.

The following table (developed using the results of the November 2007 sediment study) shows that lake sediments contained much higher levels of organic matter, nutrients, and SOD (as indicated by the ammonia levels) than the sediment samples at the five inflow points. This simply means that if the minimum pool elevation is raised and full pool is targeted earlier, the resulting inflow points will be further upstream and the sediments will contain about 50% greater organic matter, 100% greater phosphorus releases, and almost 100% greater SOD. The increased length of reservoir containing such sediments would be about half of a mile, but the water depth over these sediments would be shallow resulting in a much greater effect on water above the sediments. Considering these two factors, the increase in nutrient contributions to the upper layer of Lake Murray would be about 15-20%.

Results of sediment sampling by SCE&G in November 2007	**Volatile Solids (~organic matter)**	**Total Organic Carbon**	**Organic Nitrogen**	**Phosphorus**	**Ammonia**
Percent increase between inflow sites and in-lake sites	**51**	**77**	**46**	**103**	**84**

Could algae blooms occur in the upper parts of Lake Murray? Algae blooms are usually caused by cyanobacteria (blue-green algae), i.e., nitrogen fixers like Anabaena and Aphanizomenon. As far as what triggers such blooms it is likely that inorganic nitrogen concentrations are low (if not zero) and phosphorus is relatively high. Nitrogen is already low in the inflows to Lake Murray, so that leads to better conditions for blue-green algae to thrive. ERC (1976) reported that blue-green algae reached bloom proportions in the upper reaches of Lake Murray in August 1975. Therefore their occurrence is likely dependent on phosphorus levels, and these would tend to increase if minimum pool elevations are increased.

How could striped bass habitat and releases from Saluda Hydro be impacted? Organic matter in the upper reaches of Lake Murray is a significant contributor to the low DO and production of anoxic products that is seen at the dam. Therefore, this organic matter impacts the striped bass habitat and the anoxic products that occur in the releases from Saluda Hydro. The anoxic products are not regulated at this time, but likely will be in the future especially considering the current concerns about greenhouse gases (i.e., methane and carbon dioxide are greenhouse gases.) Although these gases are directly affected by pollutants from the watershed, even more so than low DO, SCE&G may likely be responsible for "treating" these anoxic products. Reducing anoxic products would cost more than aerating the releases from Saluda Hydro—it would likely require in-lake aeration several miles upstream from the dam, costing $millions. About 20-50% of the cost of such a system could be attributed to increased organic matter caused by increasing the minimum winter pool level.

What is my response to the whitepaper prepared by LMA? Following is their whitepaper with my responses:

"There are a number of reasons The Lake Murray Association is opposed to any proposed operational policy for Lake Murray that calls for a periodic draw down to the 350 msl level for the purpose of sediment scouring.

- *Coves that have no stream inflows would not benefit from scouring, especially where the inflow terrain is fairly flat and the velocity of water movement would be insufficient for sediment scouring*. I agree with this. I informed them of this in my Nov 2007 and Jan 2008 presentations. But this applies primarily to the lower end of the lake where impounded tributaries are steep due to their location, i.e., they are closer to the dam
- *Unless there is torrential, high volume rainfall, any scouring will be confined to narrow stream beds and will be of insignificant benefit.* This would be true for tributaries to the lower end of the lake. But, it is not true for main inflows like the Saluda River, LSR, Bush R, and Clouds Creek. Also, their point would apply to cohesive sediments that have been settled for sometime, like occurs when the pool level is <u>not</u> dropped "frequently." However, as described above there can be significant impact to the lake if the minimum winter pool level is raised.
- *Scouring benefits occur at the interface of stream entry to the lake. This dynamic occurs whether the lake level is at 350 msl or at 354 msl. There is no available data that supports a greater benefit of scouring when lake levels are 350 msl versus when lake levels are at 354 msl.* No data are actually needed on Lake Murray to address the issue as to whether "a greater benefit of scouring (occurs) when lake levels are 350 msl versus when lake levels are at 354 msl" Fundamental principles of sediment settling and scouring would lead to rejection of this point. However, available data are presented in this whitepaper and the results of my analysis show that significant impact will occur.
- *There has been no data presented that show that the recent multi-year draw down associated with dam remediation provided any benefit that reduced the chances for fish kills. In fact, despite the recent extended drawdown, there was a fish kill in 2007.* Fish kills occurred before and after the drawdown, but this does not provide <u>any</u> evidence that raising the minimum pool to higher than current levels would not cause fish kills. All available data is based on the current operations policy. These data cannot be used to prove that fish kills will not occur if pool elevations are raised. To me, their thoughts along this line are nonsensical.

Effects of Increasing the Minimum Winter Pool Elevation on Aquatic Plants in the Lake

Aquatic weeds periodically occur around the shoreline of Lake Murray. Figures 2-4 provide illustrations of the water primrose problem that occurred in 2005. Although the weed condition in 2005 followed an extended drawdown period to 345' amsl, the same situation could occur when the lake is naturally at 352-353' amsl due to drought conditions. Considering that summer pool elevation can drop to < 358 ft even when May-June elevation starts at 358 ft due to low inflows, evaporation, and minimum flow provision, aquatic plants could take root at elevation ~ 352-353 when summer pools are low. Therefore, the minimum winter pool should be dropped to about elevation 350 periodically to freeze these plants.

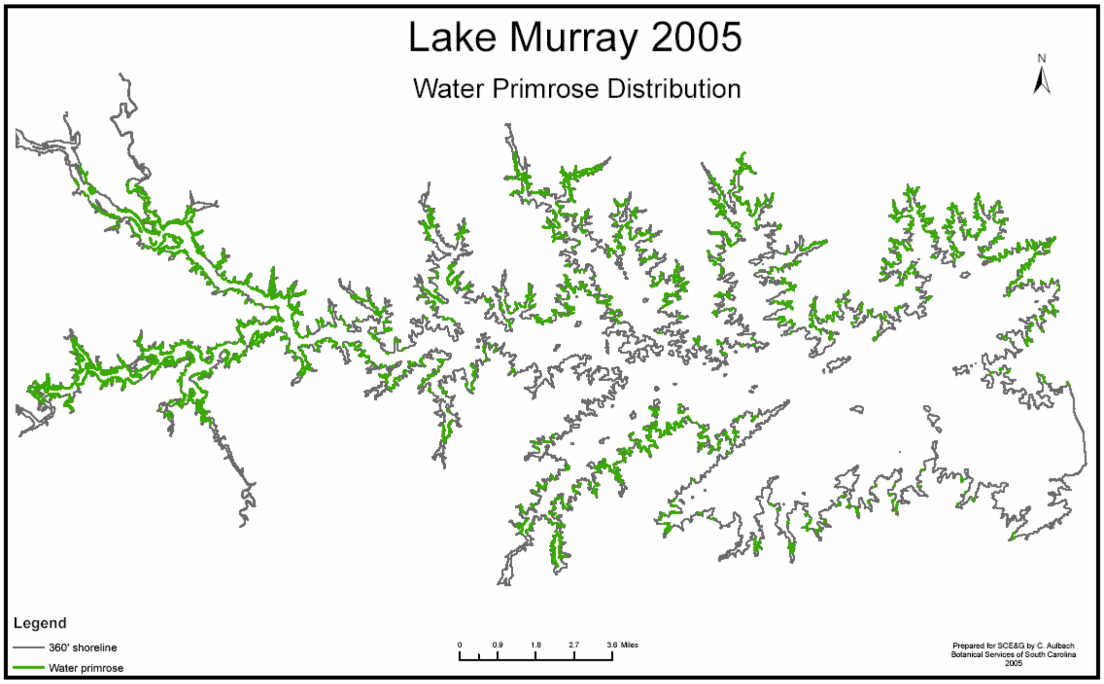

Figure 2. Water Primrose distribution in Lake Murray in 2005

Figure 3. Water Primrose reaching the surface of the lake in 2005. The roots were at elevation 346 and had started growing during the drawdown of 2003-2004. When the pool increased over the winter of 2004-2005, the weeds were not killed during freezing conditions because they were submerged.

Figure 4. Water Primrose in a cove of LSR embayment in 2005. The roots had started growing during the drawdown of 2003-2004. When the pool level increased the winter of 2005, the weeds were not killed during freezing conditions because they were submerged (the winter pool elevation was greater than 354' amsl).

Tommy Boozer has expressed concern about aquatic plants not being controlled if the minimum winter pool elevation is not dropped to 350 amsl periodically.

Closing Comments

There is considerable risk in changing the current operating policy for Lake Murray to raise the winter minimum pool elevation, especially in combination with changing the full pool level target to March 1 and considering that Lake Greenwood apparently will be filled in February instead of the current filling period. Although this whitepaper has relied generally on qualitative analyses instead of a thorough quantitative study, the risk analysis is based on sound, fundamental principles and information that solidly point to the conclusions derived.

The impacts that would occur are as follows:

1. Backwater problems will occur at the inflows to Lake Murray, especially the larger inflows to the upper parts of the lake. These are likely to be irreversible unless dredging is considered.

2. Water quality in the lake at the upper end of the reservoir would be adversely affected, and water quality in the lower part of the lake and in the releases from Saluda Hydro would likely be adversely affected.
3. Aquatic plants would cost more to manage

Regarding considerations for developing a policy for winter minimum pool levels, based on data for 1980 through 2007, the winter pool level was down to about 350 ± 2' about half the time. It would be best to maintain this frequency of drawing the lake down to this level each year or risk poorer water quality compared to current conditions.

A key point: sediment and water quality in Lake Murray is affected by the watershed as well as minimum winter pool levels, and SCE&G can control only the pool levels.

Appendix 2

Shortnose Sturgeon Monitoring and Adaptive Recovery Program- NMFS Proposal

Diadromous Fish Protection, Mitigation and Enhancement Measures
Saluda Hydroelectric Project

Shortnose Sturgeon Monitoring and Adaptive Recovery Program

- NMFS Proposal-
November 17, 2008

Background
This draft proposal was prepared by National Marine Fisheries Service (NMFS) in coordination with South Carolina Department of Natural Resources (DNR) for South Carolina Electric & Gas Company and the Saluda Relicensing Team. This proposal is intended to be included in development of a relicensing settlement agreement for the Saluda Project's aquatic resource protection, mitigation and enhancement measures (PM&E). Revisions may be considered during the settlement discussions to better integrate proposed studies into an overall plan for aquatic resource PM&E measures. NMFS intends to include the proposed measures in development of recommendations to FERC pursuant to Section 10(j), and in resolution of consultation pursuant to the Endangered Species Act.

The Saluda Project relicensing proceeding includes fishery and aquatic resource studies designed by S.C. Electric & Gas Company in consultation with state and federal fishery management and water quality agencies including National Marine Fisheries Service, U.S. Fish and Wildlife Service, South Carolina DNR, and South Carolina Department of Health and Environmental Control. Other stakeholders including American Rivers, South Carolina Coastal Conservation League, Trout Unlimited also participated in developing the relicensing study plans. The purpose of the relicensing studies is to identify continuing project effects on the environment, and to aid in development of protection, mitigation and enhancement measures for inclusion in the new hydropower license.

Project Effects on Sturgeon
Construction and operation of the Saluda Project since its construction in the 1930's has resulted in blockage of access to many river miles of former spawning and maturation habitats above the Lake Murray Dam, permanent loss of riverine habitat by reservoir inundation, and alteration of natural flows, temperature, and dissolved oxygen in the lower Saluda and Congaree Rivers (Columbia Shoals). Hypolimnetic flows from the Lake Murray Dam depressed seasonal ambient dissolved oxygen levels and temperatures in the lower Saluda River for decades, potentially playing a role in the observed absence of diadromous species including sturgeon, striped bass, American shad and other alosines, and American eel. In recent years dissolved oxygen levels in the Saluda have been substantially improved through installation of turbine runner hub baffles and other design features. Because of the lower ambient temperatures in the lake Murray Dam flow releases, trout were introduced in the 1960's to provide a "put and take" fishery which has become popular and of economic importance to the public and state fishery management objectives for the Saluda River. Active management of the Saluda River as a cold water fishery for trout reduces habitat suitability for potential restoration of natural resident aquatic species

and migratory diadromous fishes including sturgeon, striped bass, American shad and other alosines, and American eel.

Development of practical actions for mitigation of continuing project effects on availability of suitable habitat is limited by the size and depth of the Lake Murray Dam and reservoir, limited options for effective fish passage, hydropower generation operations, and established management of the lower Saluda River for a cold water trout fishery.

Recommended Sturgeon Monitoring and Recovery Program
To promote protection and recovery of sturgeon in remaining accessible habitats in the Broad, Saluda and Congaree Rivers, the following integrated studies and an adaptive management program are recommended:

I. Sturgeon behavior and movements.

Purpose: Monitor sturgeon behavior and movements to improve understanding of habitat use patterns in response to river flow regulation, short term and seasonal temperature and dissolved oxygen variations, and availability of suitable habitat in the Saluda, lower Broad, and Congaree Rivers. Improved understanding of factors limiting recovery of sturgeon and other diadromous species is expected to support practical adaptive management actions.

Methods: Conduct a long term telemetry study to monitor movements of sturgeon in the Congaree, lower Broad, and Saluda Rivers, in concert with other telemetry studies in the Santee River Basin. This objective will be achieved by using a receiver array system already in place and in use (figure 1). Study budget should include funding for the Biologist and Technician and supply monies to purchase transmitters (table 1). Recommendations would be for a 10-year study with annual review of study findings and assessment of factors affecting sturgeon recovery.

Figure 1. Receiver array system currently in use.

II. Temperature and Water Quality Monitoring Study.

Purpose: Establish a temperature and water quality monitoring program to help develop a better understanding of physical habitat factors potentially affecting movements, migrations, spawning, and recovery of sturgeon and other diadromous and resident species of special management interest. Study area should include the Saluda River, lower Broad River, and the Congaree River.

Methods: Establish an array of temperature and water chemistry monitoring stations located throughout the study area to allow for automated data collection and analysis. Data analysis should help identify annual and seasonal variations in temperature throughout the study area using GIS spatial analysis tools. Funding should include purchasing dataloggers and project personnel (table 1). An initial 10-year study should be planned for with annual review of study findings and assessment of environmental factors actually or potentially affecting sturgeon recovery.

III. Habitat Characterization Study.

Purpose: Integrate the findings of Studies I and II with a detailed physical habitat study to identify characterize, and map habitats in the Saluda, lower Broad, and Congaree Rivers to provide support for a long term sturgeon recovery program in the Santee River Basin. Identify potential critical habitats and limiting factors.

Approach/Methods: Conduct a field study to characterize, classify, and map important habitat components in the study area including substrate type, depth/velocity characteristics, location of point source discharges, seasonal temperature and dissolved oxygen distribution, etc. Plan for a one-year initial physical habitat characterization study, with provisions to adapt the habitat characterization based on findings of studies I and II.

IV. Adaptive Management Study for Sturgeon Recovery.

Purpose: Integrate the findings of studies I-III to identify Saluda Project-specific effects and limiting factors, and other limiting factors affecting sturgeon recovery in the study area. Identify practical beneficial actions that can be undertaken to contribute positively to recovery of sturgeon in the Santee River Basin.

Approach: Establish a sturgeon technical advisory team to collaboratively participate in design and conduct of the proposed sturgeon study program, and to develop practical management and recovery actions. The technical advisory team would seek to integrate studies conducted and/or funded by S.C. Electric & Gas Company with other studies in order to develop sound and practical actions.

Table 1. Estimated costs for 2010

Sturgeon Studies	
Personnel	
Biologist II-6 months	17,250
Technician II - 12.0 months	21,000
Fringe	11,475
Indirect	11,253
Travel	5,000
Supplies	38,000
Misc.	5,000

Total	**108,978**

Budget Justification, 2010:

Personnel – Biologist II and Tech. II employees including fringe and indirect for field sampling.

Travel -Vehicle mileage for field work.

Supplies -30 Vemco transmitters and shipping charges; 100 dataloggers plus associated software.

Misc -Equipment maintenance, long distance calls, and supplies.

Appendix 3

RT&E Educational Brochure

Rare Plant and Animal Species of Interest Around Lake Murray and the lower Saluda River

Bald Eagle

The bald eagle (*Haliaeetus leucocephalus*) is best known as the national bird of the United States of America. The bald eagle was listed as federally-endangered on March 11, 1967, due to population declines attributed to exposure to pesticides, loss of suitable habitat and illegal shooting. Today, the species has recovered to the degree that it was recently removed from the Federal Endangered Species List in July of 2007. The bald eagle continues to receive protection under the South Carolina Nongame and Endangered Species Conservation Act as a state endangered species, as well as through the Bald and Golden Eagle Protection Act and Migratory Bird Treaty Act.

The bald eagle is a bird of prey that may be found throughout North America, typically around water bodies, including Lake Murray and the lower Saluda River, where they feed and nest. Eagles forage on

Lake Murray year round, with peak usage likely occurring during the winter months. Nesting of bald eagles on Lake Murray was first documented in 1996, and since that time, the nesting population has increased significantly. The South Carolina Department of Natural Resources (SCDNR) has recently documented seven active bald eagle nests on Lake Murray as well as one active nest on the lower Saluda River. Active bald eagle nests occurring within Lake Murray and lower Saluda River are managed by South Carolina Electric & Gas (SCE&G) in accordance with the National Bald Eagle Management Guidelines. These guidelines generally prohibit potential "disturbance" within 660 ft of an active nest during the nesting season (September through May) and 330 ft during the non-nesting season.

Photo by Jennifer S. Hand

What You Can Do: Avoid disturbing eagles at nesting and feeding areas and provide habitat for eagles by maintaining mature trees on your property. If you find an injured eagle call the South Carolina Center for Birds of Prey at (843) 971-7474.

Wood Stork

The wood stork (*Mycteria americana*) is a large wading bird native to coastal areas of South Carolina, Georgia, Florida and is the only stork species native to North America. The wood stork was federally listed as endangered in 1984, with population declines attributed primarily to loss of wetlands suitable for nesting and foraging. Like most other wading birds, wood storks feed primarily on small fish in habitats such as narrow tidal creeks, flooded tidal pools, freshwater marshes and freshwater wetlands. Wood storks typically use tall cypresses or other trees near wetlands or marshes for colonial nest sites. Nests are usually located in the upper branches of large trees and there are typically several nests in each tree. Currently, nesting of the species in the U.S. is thought to be limited to the coastal plain of South Carolina, Georgia and Florida.

Wood storks were observed feeding at various locations in the upper portions of Lake Murray between the years of 2001 and 2004. A study conducted by SCE&G during 2005 and 2006, in cooperation with the SCDNR, found that a small number of wood storks periodically forage in the upper reaches of Lake Murray, the Saluda River upstream of the reservoir and nearby wetlands during the late-summer and early-fall of some years. Timing of these observations suggest that these wood storks are likely what is known by biologists as "post-dispersal migrations," meaning that they likely nested or were hatched in coastal areas during the summer months, dispersed from the

nest, and then migrating through the Lake Murray area to exploit temporary food sources (fish trapped in shallow pools) before returning to coastal areas for the winter. Although, there have been no wood stork observations recently, SCE&G and SCDNR will continue to monitor for wood storks on Lake Murray during routine bald eagle and waterfowl surveys on the reservoir.

Photos by Jennifer S. Hand

What You Can Do: If you happen to see a wood stork soaring above Lake Murray or wading along the shorelines call SCE&G's Environmental Services at (XXX) XXX-XXXX. Adult wood storks appear all white with long blackish-grey legs and pink feet. They have an unfeathered head and neck with a long, thick black bill. In flight, the wings underneath are edged in black.

Rocky Shoals Spider Lily

The rocky shoals spider lily (RSSL) (*Hymenocallis coronaria*), also referred to as Cahaba lily, is a flowering aquatic plan that typically inhabits large streams and rivers in South Carolina, Georgia and Alabama. As the name would suggest, these areas usually consist of rocky shoals hence and bedrock outcrops, which provide anchor points for the RSSL's roots and bulbs. RSSL grows best in constantly flowing, shallow water. The decline of RSSL has historically been attributed to loss of shoal habitat due to construction of impoundments and other channel modifications. Threats to current populations include modification of river flows and fluctuating water levels resulting from dam operations, water pollution and collection for use in gardens. The RSSL is considered a species of concern by the State of South Carolina.

Photo by Jennifer S. Hand

A good vantage point from which to observe the RSSL is at the Columbia Riverfront Park. The lily's are in the island complex at the confluence of the Broad and Saluda rivers and just upstream of the confluence in the bypass reach of the Broad River downstream of the Columbia Diversion Dam. Each spring from mid-April to May in this section of the Broad River, one to three stalks will emerge from a RSSL bulb and each will produce a group of six to nine beautiful white flows. As many as xxxx RSSL plants have been estimated to occur in the area during some years.

What You Can Do: Do not pick the lilies or remove the bulbs for transplant, as they will not grow in a typical garden setting. Rocky shoals spider lilies are most beautiful in it's natural habitat.

Shortnose Sturgeon

The Shortnose sturgeon (*Acipenser brevirostrum*) is one of the oldest living fish species, predating dinosaurs. They range from three to four feet in length and have primitive characteristics such as an elongated, slightly flattened body covered with bony plates (scutes). They have a toothless mouth that is positioned under the snout, which allows them to feed on bottom dwelling organisms. Shortnose sturgeon are spawned in freshwater rivers and migrate out to the ocean where they spend most of their life. Sturgeon will return to their natal rivers to spawn several times throughout their life. Shortnose sturgeon are restricted to the east coast of North America. The National Marine Fisheries Service has recognized South Carolina as one of the 19 distinct population segments of shortnose sturgeon. Shortnose sturgeon have been documented downstream of the dams associated with the Santee-Cooper Lakes (Marion and Moultrie) and as far up as the Congaree River in the vicinity of the Gervais Street Bridge.

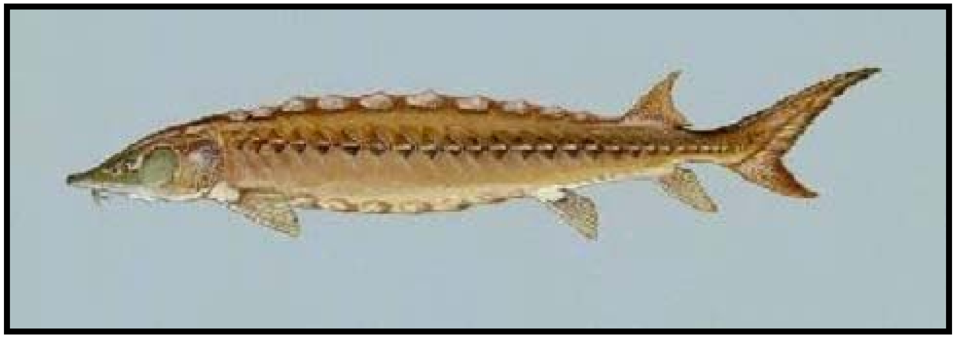

Photo by Duane Raver, USFWS

The shortnose sturgeon was federally listed as endangered on March 11, 1967, with population declines attributed to extensive overharvesting, loss of habitat, limited access to spawning grounds and polluted waters. Specific environmental conditions must be present for sturgeon to spawn such as specific water temperatures and available spawning habitat. Females will spawn every 3 to 5 years after reaching sexual maturity at age 8 to 12 years. With the combination of human threats along with the number of years it takes a female sturgeon to reach sexual maturity, it will take many years for the shortnose sturgeon populations to recover from its decline.

What You Can Do: Become familiar with the fish species native to your area before going fishing. If a live sturgeon is captured, return it safely to the water.

Appendix 4

Lower Saluda River Benthic Macroinvertebrate Monitoring and Enhancement Program

SOUTH CAROLINA ELECTRIC & GAS COMPANY

COLUMBIA, SOUTH CAROLINA

SALUDA HYDROELECTRIC PROJECT

(FERC NO. 516)

LOWER SALUDA RIVER BENTHIC MACROINVERTEBRATE MONITORING AND ENHANCEMENT PROGRAM

DECEMBER 2008

Prepared by:

Kleinschmidt
Energy & Water Resource Consultants

SOUTH CAROLINA ELECTRIC & GAS COMPANY
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COLUMBIA, SOUTH CAROLINA

SALUDA HYDROELECTRIC PROJECT
(FERC NO. 516)

LOWER SALUDA RIVER BENTHIC MACROINVERTEBRATE MONITORING AND ENHANCEMENT PROGRAM

1.0 INTRODUCTION

The Saluda Hydro Project (Project) is a 202.6 megawatt (MW) hydroelectric facility owned and operated by South Carolina Electric & Gas (SCE&G or Licensee) and located on the Saluda River in Lexington, Newberry, Richland, and Saluda counties of South Carolina (Figure 1-1). The Project is currently licensed by the Federal Energy Regulatory Commission (FERC No. 516), and the present license is due to expire in the year 2010. SCE&G has been engaged with state and federal agencies, non-governmental organizations (NGO's), and other stakeholders in a cooperative relicensing process for the Project since early 2005. The final application to relicense the Project was filed with the FERC on August 27, 2008.

During the relicensing process, a number of stakeholders, representing primarily state and federal resource agencies and non-governmental organizations, requested that SCE&G study the macroinvertebrate community of the lower Saluda River (LSR) to evaluate the effectiveness of recent dissolved oxygen (DO) enhancements at the Project (i.e. turbine venting). SCE&G subsequently formed a Freshwater Mussels and Benthic Macroinvertebrate Technical Working Committee (TWC) to address issues related to these species, which included representatives from the U.S. Fish and Wildlife Service (USFWS), NOAA – National Marine Fisheries Service (NMFS), South Carolina Department of Natural Resources (SCDNR), South Carolina Department of Health and Environmental Control (SCDHEC), and American Rivers. With oversight from the TWC, a two-year relicensing study of the LSR macroinvertebrate community was developed and implemented during 2006 and 2007. As is typical of hydropower projects, the study found generally impaired conditions close to the dam, with conditions improving with increased downstream distance from the dam (additional detail provided below in Background Information). In comments issued on the Draft License Application for Saluda Hydro, state and federal resource agency staff requested that SCE&G develop a plan for mitigation and/or continued monitoring of the LSR macroinvertebrate community under a new license term. The program described herein was prepared pursuant to their request.

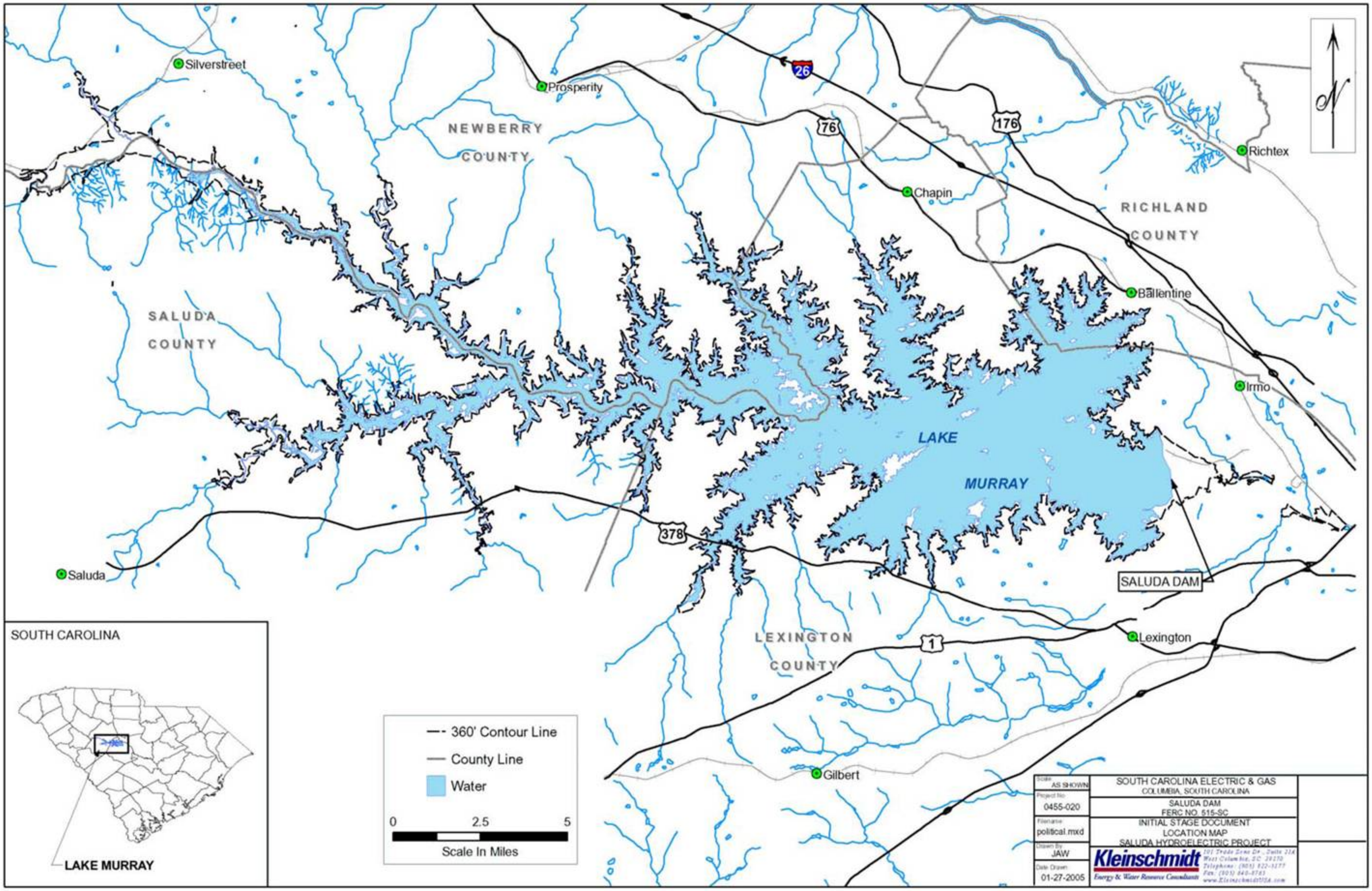

Figure 1-1: Location Map for the Saluda Hydroelectric Project (FERC No. 516)

2.0 BACKGROUND

The benthic macroinvertebrate community of the LSR downstream of Saluda Hydro has been assessed regularly by SCE&G over the past decade (Shealy, 1996a; 1996b; 2001; 2004; 2005; Carnagey Biological, 2006; 2007). Recent assessments have shown that biotic conditions (based on metrics such as taxa richness and abundance, EPT Index, EPT abundance, and dominant taxa) improved with increased distance from the Project dam (Shealy, 2004; 2005; Carnagey Biological, 2006; 2007). Similarly, North Carolina Biotic Index (NCBI) scores from these studies have generally ranged from "good" to "fair" for lower sites near the Riverbanks Zoo, to "poor" at sites directly below the dam (Shealy, 2004; 2005; Carnagey Biological, 2006).

The most recent assessment (Carnagey Biological, 2006; 2007), conducted in 2006 and 2007 as part of the current relicensing, sampled the LSR macroinvertebrate community at six locations downstream of Saluda Hydro (Figure 2-1). This study was conducted during the late-summer and early-fall months when DO levels were expected to be at their lowest levels and employed both the artificial substrate samplers used in previous assessments (Hester-Dendy multi-plate), as well as rapid bioassessment methods (Barbour et. al. 1999). As in previous studies, regression analysis of the Hester-Dendy data suggested improved biotic conditions as distance from the Saluda Hydro dam increased during both 2006 and 2007. NCBI scores during the study generally ranged from "poor" immediately downstream of Project dam (TR) to "fair" to "good-fair" at the Oh Brother Rapids (OB) downstream near the Interstate 26 crossing. These results were not surprising, as studies have shown that operation of hydroelectric dams often results in decreased benthic diversity immediately downstream due to habitat instability associated with water level fluctuations and scour associated with increased water velocity (Carnagey Biological, 2006; 2007).

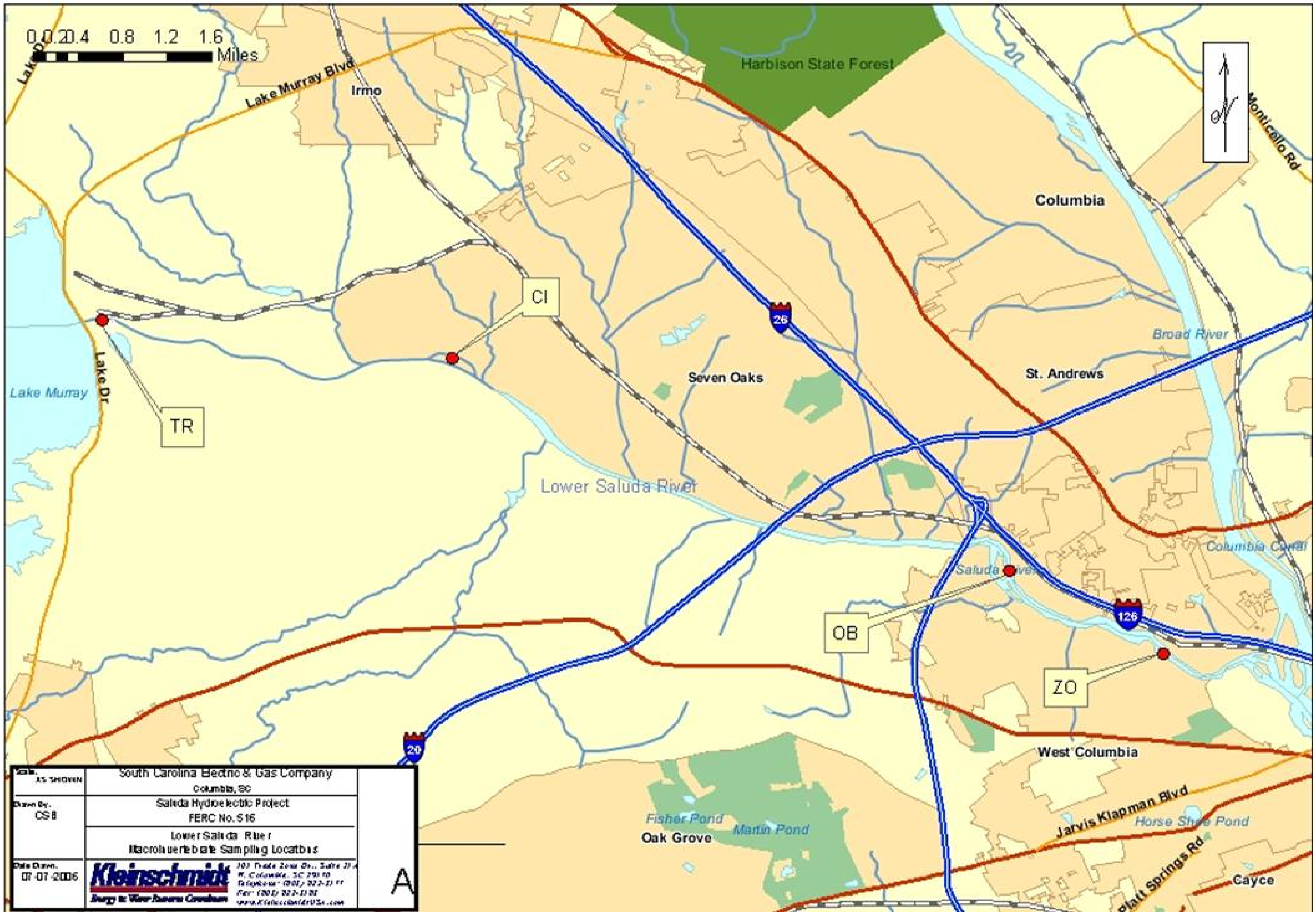

Figure 2-1: Proposed Macroinvertebrate Sampling Locations in the Lower Saluda River Downstream of the Saluda Hydroelectric Project Dam

3.0 ENHANCEMENT AND MONITORING

SCE&G proposed in its Final License Application for Saluda Hydro (filed with the FERC on August 27, 2008) to continue turbine aeration measures implemented since 1999 aimed at optimizing DO in Project releases. Specifically, these measures included installation of turbine venting and hub baffles on Project turbines (completed in 1999 and 2005, respectively), as well as implementation of operational modifications ("look-up tables") developed in recent years to provide guidance regarding unit and gate combinations that provide the greatest DO enhancement under various operating scenarios. These measures have resulted in significant DO improvements in the LSR, with median DO in Project releases increasing from 2.7 mg/L before 1999 to 7.2 mg/L after implementation (1999 to 2007). Likewise, this has resulted in less frequent occurrences of DO levels in the release below 5.0 mg/L, from 88% to about 12% of the time.

SCE&G has also proposed to implement minimum flow releases from Saluda Hydro to support target riverine species in the LSR, including benthic macroinvertebrates. In addition to improved DO conditions (through increased shoaling and turbulence), implementation of minimum flows will likely improve benthic macroinvertebrate habitat by ensuring more stable flows and maintenance of riverine wetted width. Physical Habitat Simulation (PHABSIM) modeling conducted in support of the current relicensing suggests that the 700 cfs minimum flow being proposed for the majority of months during a normal water year will provide between 71% and 97% of maximum Weighted Usable Area (an estimate of available habitat) for benthic macroinvertebrates, depending on the river reach being considered (Kleinschmidt 2008).

Because continuation of DO enhancement measures and implementation of minimum flows are likely to improve the aquatic habitats of the LSR, and because macroinvertebrates serve as an important bioindicator of aquatic health, SCE&G deems it necessary to implement a long-term aquatic macroinvertebrate monitoring program. Specifically, SCE&G will implement a monitoring program utilizing both the artificial substrate (Hester-Dendy) and USEPA Rapid Bioassessment sampling methods utilized in previous LSR studies. Details regarding timing, duration, methodology, and reporting/consultation requirements of the program are provided below.

3.1 Monitoring Program

The macroinvertebrate fauna of the LSR will be sampled for a period of six years following issuance of a new FERC license for the Project. Sampling will occur at four locations: the project tailrace (TR); Corley Island (CI); the Ocean Boulevard shoal area (OB); and in the vicinity of Riverbanks Zoo (ZO)[1] (Figure 2). Three of these sites (TR, OB & ZO) are consistent with previous investigations on the LSR[2]. Although not previously sampled, the Corley Island (CI) area represents a significant aquatic habitat in the LSR, with extensive gravel substrates and shoal/riffle habitats, and thus has been added to this monitoring program.

A multi-habitat assessment, following the USEPA *Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers* (Barbour et al. 1999), will be performed bi-annually at each of the sample sites during the six-year monitoring period. Bi-annual sampling will consist of a spring sample coinciding with the period when DO levels are typically highest downstream of Project (March - April), as well as a late-Summer and early-Fall months (August – October) when downstream DO conditions are typically at their most critical. Multihabitat sampling will involve timed, quantitative sampling of the various habitat types available within the identified reaches (i.e. cobble, sand, snags, woody debris, etc.), using kicknets and/or D-shaped dipnets, with each habitat type sampled in approximate proportion to its availability.

Artificial substrate sampling will also be conducted at each site on alternate years. During these years, three replicate Hester-Dendy multi-plate samplers will be deployed at each location and allowed to colonize for 45–60 days. Similar to the multi-habitat assessment, Hester-Dendy sampling will be conducted during the spring when DO levels downstream of the project are typically highest (March – April) and again during the low DO period during late-summer and early fall (August – October).

[1] Site is in close proximity to the “old police club” (OPC) sampled in previous investigations (see Shealy 2005); sites may be used interchangeably depending on field conditions and access.
[2] Habitat is described in previous investigations at these sites (Shealy 2001; 2003; 2004; 2005).

Intact Hester Dendy samplers, as well as raw samples from the multihabitat assessment, will be preserved in the field with 95% ethanol and transported to a South Carolina Department of Health and Environmental Control (SCDHEC) – approved laboratory for processing. In the laboratory, macroinvertebrates will be separated from debris with the aid of a stereo microscope, identified to the lowest possible taxonomic level, and enumerated using appropriate techniques and taxonomic keys. Specimens will be maintained in a voucher collection for five years or placed permanently in a reference collection.

Differences in taxonomic composition between sampling sites will be examined using appropriate bioassessment metrics, as described in Barbour et al. (1999). These metrics will likely included taxa richness (diversity); EPT (Ephemeroptera, Plecoptera, Trichoptera) Index; Chironomidae taxa and abundance; ratio of EPT and Chironomid abundance; ratio of scraper/scraper and filtering collectors; shredder/total number of specimens collected; percent contribution of dominant taxa; and North Carolina Biotic Index (NCBI)[3]. Regression analyses may also be used to detect trends in community composition as a function of distance from the dam. Water Quality data (dissolved oxygen and temperature) will also be reported for the sampling period. Water quality data will be obtained either from the two USGS gages on the LSR (#02168504, Saluda River below Lake Murray Dam or #02169000, Saluda River near Columbia) or from field measurements collected during macroinvertebrate sampling.

3.1.1 Reporting and Consultation

Results of macroinvertebrate monitoring will be summarized in an annual report, which will be issued to state and federal resource agencies on or before January 31 of the year following the sampling period. Finally, SCE&G will meet annually with state and federal resource agency staff to review the status of aquatic macroinvertebrate monitoring and enhancement efforts. Timing, duration, methodology or other aspects of the program may be modified based on such

[3] Bioassessment metrics are described in greater detail in Barbour et al. (1999) and in reports summarizing previous macroinvertebrate investigations at the LSR sites (Shealy 2001; 2003; 2004; 2005).

consultation. This meeting may be combined with other resource agency consultation relative to water quality; fisheries; freshwater mussels; rare, threatened and endangered species; or other Saluda Hydro enhancement/monitoring programs.

3.1.2 Follow-up Monitoring

Tens years following completion of the six-year sampling regime described above, SCE&G will initiate a two-year-long follow-up assessment of the LSR macroinvertebrate community in order to assess long-term impacts of the aquatic enhancements being proposed as part of the current relicensing process (i.e., continued DO enhancements, implementation of minimum flows, etc.). SCE&G will consult with the appropriate state and federal resource agencies prior to initiating this study. Unless otherwise agreed upon in consultation with the agencies, this assessment will be conducted during two consecutive years and utilize the methodology described in this plan (bi-annual rapid bioassessment during the spring and fall, with Hester-Dendy sampling during at least one year).

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Appendix 5

FRESHWATER MUSSEL ADAPTIVE MANAGEMENT PROGRAM

SOUTH CAROLINA ELECTRIC & GAS COMPANY

COLUMBIA, SOUTH CAROLINA

SALUDA HYDROELECTRIC PROJECT

(FERC NO. 516)

FRESHWATER MUSSEL ADAPTIVE MANAGEMENT PROGRAM

DECEMBER 2008

Prepared by:

Kleinschmidt

Energy & Water Resource Consultants

SOUTH CAROLINA ELECTRIC & GAS COMPANY
COLUMBIA, SOUTH CAROLINA

SALUDA HYDROELECTRIC PROJECT
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COLUMBIA, SOUTH CAROLINA

SALUDA HYDROELECTRIC PROJECT
(FERC NO. 516)

FRESHWATER MUSSEL ADAPTIVE MANAGEMENT PROGRAM

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(FERC NO. 516)

FRESHWATER MUSSEL ADAPTIVE MANAGEMENT PROGRAM

1.0 INTRODUCTION

The Saluda Hydro Project (Project) is a 202.6 megawatt (MW) licensed hydroelectric facility located on the Saluda River in Lexington, Newberry, Richland, and Saluda counties of South Carolina (Figure 1-1) that is owned and operated by South Carolina Electric & Gas Company (SCE&G or Licensee). The Project is currently licensed by the Federal Energy Regulatory Commission (FERC No. 516), and the present license is due to expire in the year 2010. To initiate relicensing of the project, SCE&G prepared and issued the Initial Consultation Document (ICD) on April 29, 2005. In response to the ICD, the United States Fish and Wildlife Service (USFWS), South Carolina Department of Natural Resources (SCDNR), and several Non-governmental Organizations (NGO's) requested that SCE&G conduct studies characterizing the mussel fauna occurring in the Project vicinity and identify potential Project impacts to these species. SCE&G subsequently formed a Freshwater Mussels and Macroinvertebrate Technical Working Committee (TWC) to address relicensing requests related to these organisms, and with oversight from this TWC, contracted with a regional expert (John M. Alderman) to conduct mussel surveys of the Project vicinity.

These surveys, conducted during the summer of 2006, documented 15 native freshwater mussel species as occurring in Lake Murray, its tributaries, and the upper Congaree River (Alderman, 2006). .Further, the study found no mussels directly downstream of the Project in the lower Saluda River (LSR) and concluded that mussel assemblages were more diverse and abundant on the Broad River side of the Congaree River than on the LSR side. These findings prompted USFWS, SCDNR and other stakeholders to request mitigation for the lack of mussel fauna in their comments on the Saluda Draft License Application and in subsequent consultation. The program outlined herein was prepared pursuant to this request and is intended to serve as a guiding document for adaptive management of mussels in the Project vicinity.

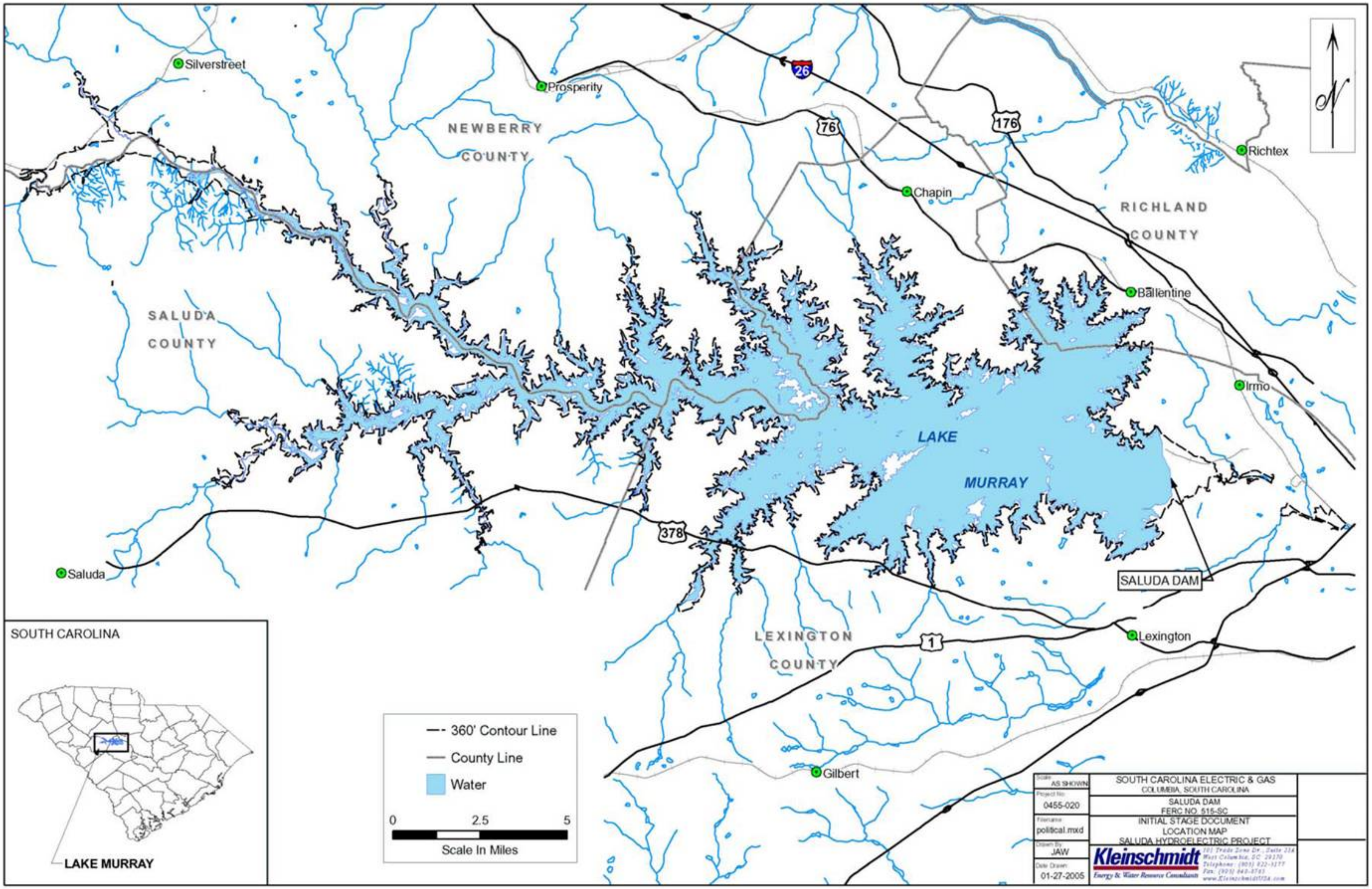

Figure 1-1: Location Map for the Saluda Hydroelectric Project (FERC No. 516)

2.0 BACKGROUND

The southeastern United States is considered the “epicenter” of North American freshwater mussel biodiversity, with approximately 90% of the 300 species known from the U.S. occurring in the region (USGS, 2000). However, the freshwater mussel fauna of most southeastern river systems has declined dramatically in the past 30 years. In the past, one of the largest impacts to mussels was the construction of large dams which converted large amounts of riverine habitat into impoundments. Subsequently, mussel populations that remained in unimpounded streams were impacted by habitat degradation caused by dredging, mining, point and non-point source pollution, and siltation. Presently, most remaining mussel populations are highly fragmented, occupying small reaches of their historic range where habitats have remained relatively unimpacted. It is estimated that 70% of our freshwater mussels are extinct, endangered, or in need of special protection (Williams, et. al. 1993).

Twenty-four species of native freshwater mussel are known to occur or are thought to have occurred historically in the Santee River Basin in South Carolina (Alderman and Bogan, 2004) (Table 2-1). However, prior to the current relicensing, little information was available regarding their distribution in Lake Murray, its tributaries, or the LSR. As previously noted, surveys conducted in support of relicensing found 15 native freshwater mussel species as occurring in Lake Murray, its tributaries, and the upper Congaree River (Alderman, 2006). While none of the species encountered are federally or state listed as threatened or endangered, a number are consider federal species of concern (Table 2-2). Alderman (2006) also noted differences in mussel assemblages between areas upstream and downstream of the Project dam. In Lake Murray and its tributaries, 11 native freshwater mussel species were identified, with the sample area dominated by backwater-adapted species such as Eastern floater and paper pondshell. No mussels were collected in the LSR downstream of the Saluda Dam. However, 9 native species were documented in the upper Congaree River and the confluence area of the Broad and Saluda rivers.

Riverine species such as Carolina slabshell and Roanoke slabshell were dominant in these two areas. Several of the species collected in the upper Congaree River and the confluence area were not collected upstream of the Saluda Dam, which could suggest the need for an anadromous host and or the lack of species specific habitat. Also noted was the greater abundance of mussels on the Broad River side of the confluence area than on the Saluda River side, suggesting temperature may be a limiting factor. A similar pattern was observed in the Congaree River downstream of the confluence (Alderman, 2006).

Table 2-1: Native Freshwater Mussels of the Santee River Basin in South Carolina (Source: Alderman and Bogan, 2004, except where otherwise noted)

COMMON NAME	SPECIES	G RANK[1]	FEDERAL STATUS[2]	STATE STATUS[3]	OCCURRENCE IN BASIN[4]
Roanoke Slabshell	*Elliptio roanokensis*	G2G3	SOC		X
yellow lampmussel	*Lampsilis cariosa*	G3G4	SOC	SOC	X
Carolina slabshell	*Elliptio congaraea*	G4	SOC	SOC	X
Carolina Lance	*Elliptio angustata*	G4	SOC		X
Common Elliptio	*Elliptio complanata*	G5			X
Variable Spike	*Elliptio icterina*	G4			X
Atlantic Spike	*Elliptio producta*	G4			X
Savannah Lilliput	*Toxolasma pullus*	G3	SOC	SOC	X
Eastern floater	*Pyganodon cataracta*	G5		SOC	X
paper pondshell	*Utterbackia imbecillis*	G5		SOC	X
Rayed Pink Fatmucket	*Lampsilis splendida*	G3	SOC	SOC	X
Eastern Creekshell	*Villosa delumbis*	G4		SOC	X
Creeper	*Strophitus undulatus*	G5			X
Florida pondhorn	*Uniomerus carolinianus*	G4			X
northern lance	*Elliptio fisheriana*	G4			X
barrel floater	*Anodonta couperiana*	G4		SOC	H?
brook floater	*Alasmidonta varicosa*	G3		SOC	H,N
Triangle floater	*Alasmidonta undulata*	G4			H
Carolina heelsplitter	*Lasmigona decorata*	G1	E	E	X
Pod lance	*Elliptio folliculata*	G2G3Q			X
Eastern pondmussel	*Ligumia nasuta*	G4			X
Southern rainbow	*Villosa vibex*	G5Q		SOC	H
Notched rainbow	*Villosa constricta*	G3		SOC	N
Carolina creekshell	*Villosa vaughaniana*	G2			X
Eastern lampmussel	*Lampsilis radiata*	G5			X

[1] G1 = Critically Imperiled; G2 = Imperiled; G3 = Vulnerable; G4 = Apparently Secure; G5 = Secure
[2] Endangered; SOC = Species of Concern
[3] E = Endangered; SOC = Species of Concern (Source: SCDNR, 2008)
[4] X = extant; H = historical; N = just into N. Carolina

Table 2-2: Occurrence and Status of Freshwater Mussel Species Documented in the Vicinity of the Saluda Hydroelectric Project, including the Lower Saluda and Upper Congaree Rivers and Lake Murray and Selected Tributaries (Source: Alderman, 2006)

COMMON NAME	SPECIES	G RANK	FEDERAL STATUS	OCCURANCE[2]
Roanoke Slabshell	*Elliptio roanokensis*	G2G3	SOC	BR, CO
yellow lampmussel	*Lampsilis cariosa*	G3G4	SOC	BR, CO
Carolina slabshell	*Elliptio congaraea*	G4	SOC	CO
Carolina Lance	*Elliptio angustata*	G4	SOC	LM, LMT, BR, CO
Common Elliptio	*Elliptio complanata*	G5		LM, LMT, BR, CO, S*
Variable Spike	*Elliptio icterina*	G4		LMT, CO
Atlantic Spike	*Elliptio producta*	G4		LM, LMT
Savannah Lilliput	*Toxolasma pullus*	G3	SOC	LM, LMT
Eastern floater	*Pyganodon cataracta*	G5		LM, LMT
paper pondshell	*Utterbackia imbecillis*	G5		LM, LMT
Rayed Pink Fatmucket	*Lampsilis splendida*	G3	SOC	LM, CO
Eastern Creekshell	*Villosa delumbis*	G4		LM, LMT, BR, CO, S*
Creeper	*Strophitus undulatus*	G5		S*, CO
Florida pondhorn	*Uniomerus carolinianus*	G4		LM, LMT
northern lance	*Elliptio fisheriana*	G4		LM

[1] G1 - Critically Imperiled; G2 - Imperiled; G3 - Vulnerable; G4 - Apparently Secure; G5 - Secure
[2] BR = Broad; CO = Congaree; S = Saluda; LM = Lake Murray; LMT = Lake Murray Tributaries
* Refers to Saluda River side of confluence area.

3.0 CONSULTATION HISTORY

An earlier draft of this Adaptive Management Program document, which focused on reintroduction of native freshwater mussels to habitat downstream of the Project in the LSR, was reviewed with state and federal resource agencies, NGO staff, and other local experts during the Fall of 2008. During this consultation, USFWS and University of South Carolina biologists with expertise in freshwater mussels expressed concern regarding the feasibility of re-establishing mussel populations in the LSR due to a number of factors including, prevailing cool year-round water temperatures resulting from hypolymentic releases from the Project, scour from periodic Project operations, and the relatively short length of the reach (10 miles). It was subsequently determined that reintroduction of mussels to the LSR was likely to meet with little success and that mussel restoration efforts should focus on areas upstream of the Project dam (See Fish and Wildlife Meeting Notes, 17 October 2008). This consultation also resulted in formation of a Freshwater Mussel Working Group to provide technical expertise and guidance for mussel monitoring, restoration, and management efforts in the Project vicinity (See Item 1 below for additional detail).

An initial meeting of the Freshwater Mussel Working Group identified the Savannah lilliput (*Toxolasma pullus*) as likely being the most imperiled species occurring in the Project Area upstream of the dam and identified further assessment of this population as an appropriate focus for the initial phase of this Program. Savannah lilliput is Federal Species of Concern that was detected at two locations in upper Lake Murray during the 2006 reconnaissance surveys (Alderman, 2006). The Working Group identified a greater understanding of the distribution, abundance, population ecology and reproductive status of this species as being an essential first step for restoration efforts in the basin.

4.0 PROGRAM ACTIVITIES

The mechanism governing mussel distributions in the Saluda Project vicinity remain unclear at this time. Potential factors influencing mussel distributions likely include biotic factors, such as presence and abundance of suitable host fish, and abiotic environmental factors such as water temperature and dissolved oxygen. Due to these uncertainties, SCE&G proposes to employ an adaptive management strategy for the Project Area. Specifically, SCE&G proposes implementation of the following after issuance of a new FERC license for the Saluda Project:

4.1 Freshwater Mussel Working Group

SCE&G will coordinate formation of a Freshwater Mussel Working Group to provide technical expertise and guidance for mussel restoration efforts in the Project Area. Potential participants will likely include SCE&G staff, representatives from state and federal resource agencies, such as USFWS and SCDNR, as well as academic and other regional mussel experts. The Working Group will meet at least annually to review relevant data, evaluate effectiveness of restoration efforts to date, and to establish goals and objectives for the coming year. Results of the monitoring program will be filed with the FERC as part of the annual report (See Section 5.0).

4.2 Phase I – Savannah Lilliput Distribution in Upper Lake Murray

An in-depth survey for Savannah lilliput (*Toxolasma pullus*) will be conducted in upper Lake Murray to further document distribution, abundance, and reproductive status of this species. This survey will focus on Lake Murray and its tributaries, beginning in the vicinity of the Buffalo Creek area of Lake Murray (near the easternmost junction of Saluda and Newberry counties) and extending upstream into the reservoir headwaters. Survey methodology will be consistent with the 2006 reconnaissance survey of the area (Alderman, 2006), and will consist of timed, qualitative searches utilizing tactile methods (probing into substrate) and visual methods (snorkeling and/or bathoscope inspections in shallow water and visual shoreline searches).

Specific sites within the survey area will be selected and prioritized based on appearance of best available habitat, with shallow shoreline areas preferred by this species given initial priority. As many sites as possible will be surveyed during a two week survey period (10 field days). The survey team will consist of at least three people, at least two of which will be biologists. All sites surveyed will be documented with a Global Positioning System (GPS). Approximately 1-2 person hours will be expended at each site to determine presence/absence and to maximize the number of sites examined. If presence of Savannah lilliput is confirmed at a site based on occurrence of live or dead specimens, an additional 6 – 12 person hours, or possibly more if needed, will be expended at each site in order to adequately assess the population. Specifically, the following parameters will be collected at each site where *T. pullus* is found.

- Abundance and Catch-Per-Unit-Effort, based on total number of live and dead individuals collected.
- Length measurements (cm) for all live and fresh-dead specimens to allow development of size-class estimates and aid in determining if reproduction is taking place.
- Determination of gravidity based on examination of a sub-set of female mussels from the site.
- Age of live specimens based on growth ring patterns.

- General habitat conditions, including dominant substrate, approximate slope of bank, extent of shoreline vegetative cover, depth range of population.

Microhabitat water quality data will be collected at each site surveyed and will include:

- Dissolved Oxygen (DO)
- Water Temperature
- pH
- Conductivity
- Water Hardness

4.2.1 Age Structure Determination

If available, fresh-dead shells (that have not eroded significantly) will be collected from sites where *T. pullus* presence is confirmed for age structure determination. Shells will be thin sectioned, polished and age estimated according to methods described in (Neves and Moyer, 1988). Thin section age data, combined with the field aging of live specimens and lengths measurements described above, will be used for development of age-length curves for the population.

4.3 Phase II - Host Fish Trials

Should the Phase I survey indicate sufficient availability of gravid *T. pullus* females in upper Lake Murray (12 or more gravid females at a given sample site), SCE&G will initiate laboratory trials aimed at identifying host fish species. Although specific details of the trials will need to be worked out in consultation with the Working Group, this effort will involve collection of subset of gravid female mussels during the reproductive season (likely May through June). Effort will be to made to avoid collecting more than 25-30% of gravid females from a site in order to preserve the viability of the local population (e.g., no more than 3-4 from a site with 12 confirmed gravid females). Glochidia will be extracted from collected females in a laboratory setting, after which females will be returned alive to the source population. Lepomid fish species will be collected by electrofishing or other accepted methods, transported to laboratory aquaria, and inoculated with glochidia from the source mussels.

Feasibility and additional details associated with this task will be determined based on results of the Phase I *T. pullus* survey and subsequent consultation with the Working Group.

5.0 ADDITIONAL STUDIES

Additional phases will be contingent upon the findings of the Phase I and Phase II of this program. Potential additional phases identified by the Working Group include additional water quality data analyses in the vicinity of *T. pullus* sites (i.e., phosphorous, nitrogen concentrations); laboratory testing of sediment toxicity; and diet studies of native mussels. Scope and objectives of any additional phases will be developed in consultation with the Working Group.

6.0 REPORTING

SCE&G will file the final Phase I and Phase II reports detailing status of freshwater mussel studies conducted in the Project Area. A draft report will be distributed to the Working Group for review and comment by the end of February of the year following completion of each phase. The final report will be filed with the FERC and distributed to the above noted parties by April 30 the same year. The final report will contain recommendations from the Working Group on any changes to the Adaptive Management Program

7.0 FUNDING

SCE&G will provide funding for Phases I and II of this Mussel Adaptive Management Program. Any additional studies or tasks determined by the Working Group will be funded by other sources. While SCE&G is supportive of the Working Group’s desire to find out as much about the Savannah lillput (*T. pullus*), it cannot guarantee that additional studies will be conducted. However, SCE&G will consider providing in-kind services (consisting of manpower, boat, and/or monitoring equipment) in support of future studies or surveys within the Lake Murray Project boundary if the Working Group is interested in future research.

8.0 IMPLEMENTATION SCHEDULE

Implementation of this Program's Phase I survey will commence within two years after issuance of the new license. This time frame is necessary to assure adequate time for mobilization and securing contracts between license issuance and the next monitoring season, which usually is in the May to June time frame. Phase II will be implemented within 2 years of commission approval of the Phase I Final Report.

9.0 LITERATURE CITED

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Appendix 6

TROUT MANAGEMENT PLAN FOR THE LOWER SALUDA RIVER

SOUTH CAROLINA ELECTRIC & GAS COMPANY

COLUMBIA, SOUTH CAROLINA

SALUDA HYDROELECTRIC PROJECT

(FERC NO. 516)

TROUT MANAGEMENT PLAN
FOR THE LOWER SALUDA RIVER

DRAFT

JANUARY 2009

Prepared by:

Kleinschmidt

Energy & Water Resource Consultants

SOUTH CAROLINA ELECTRIC & GAS COMPANY
COLUMBIA, SOUTH CAROLINA

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1.0 INTRODUCTION

The South Carolina Electric & Gas Company (SCE&G) filed an Application for New License on August 27, 2008, and as part, has developed a Comprehensive Settlement Agreement for Protection, Mitigation and Enhancement of environmental resources at the Saluda Hydro Project (FERC No. 516)(Project). The enhanced relicensing process implemented was a multi-year cooperative effort between SCE&G and interested stakeholders to address operational, recreational and ecological concerns associated with hydroelectric project operations.

As part of that relicensing process, SCE&G consulted with a wide variety of stakeholders including, state and federal resource agencies, non-governmental organizations and concerned citizens seeking their input on important relicensing issues. As a result of that consultation and subsequent stakeholder meetings, relicensing participants identified several issues that they believed needed to be addressed during the relicensing process. One of the identified issues included management of the Put, Grow and Take trout fishery located in the Saluda Hydro Tailrace.

The existing Put, Grow and Take fishery appears to be a thriving and successfully managed trout fishery that maintains healthy stocks of both brown and rainbow trout. Several efforts are currently underway by SCE&G to improve DO conditions in the lower Saluda River (LSR) that are likely to further improve habitat for trout. Enhancement measures consist of turbine venting, alternate operating scenarios, and implementation of IFIM flow recommendations.

During relicensing consultation, interest was expressed by stakeholder groups in the potential for a “self-sustaining” trout fishery in the LSR. Although existing habitat in the Saluda River may generally provide suitable growing conditions for much of the year for adults of both trout species, several conditional factors make establishment of a self-sustaining trout fishery a highly unlikely option. An evaluation on brown and rainbow trout populations in the LSR, which culminated in a white paper, further substantiated this. These factors, and the white paper, are summarized in Section 2.2 of this document. Although self-sustaining populations are not likely, it has been theorized that there is potential for some level of natural trout reproduction in the LSR.

The *Trout Management Program for the Lower Saluda River* (Program) was developed by the F&W TWC and initiated by SCE&G to monitor and assess the success of water quality enhancement measures on trout reproduction. It is a culmination of SCE&G’s work with stakeholders to define resource goals and objectives for the lower Saluda trout fishery. Furthermore, the Program will determine a process for evaluating changes and making decisions for management of the fishery based on the best available information. This document explains the goals, objectives, management, and methods of the Program, and was developed to serve as a guidance document for future management of the tailrace trout fishery during the new license term of the Saluda Project.

This document is organized to describe the Program in the following manner:

- Section 2 – Background of Saluda Project and Tailrace
- Section 3 – Goals and Objectives for the Saluda Tailrace Trout Fishery
- Section 4 – Management of the Program and Formation of the Advisory Committee
- Section 5 –Methods for Monitoring Enhancement Measures
- Section 6 – Implementation Schedule
- Section 7 – Compliance

2.0 BACKGROUND OF SALUDA PROJECT AND TAILRACE FISHERY

2.1 Saluda Project

The Saluda Hydroelectric Project (Saluda Hydro or Project) is an existing licensed hydroelectric project, owned and operated by South Carolina Electric & Gas Company (SCE&G). The Project is located on the Saluda River, in the counties of Lexington, Richland, Newberry and Saluda, South Carolina. The Project consists of an earth fill embankment Dam (Saluda Dam) impounding a 48,000-acre reservoir (at elevation 356.5’[1]), a gated emergency spillway, a back-up Dam, a powerhouse, five concrete intake towers and associated penstocks. Construction of the Project was completed in 1930, and construction of the back-up dam was completed in 2005.

The lower Saluda River (LSR) is approximately 10 miles in length and is characterized by bedrock-dominated riffles, with limited gravel and cobble substrates, and a high percentage of pool habitat. The river receives hypolimnetic (i.e coldwater) flows from Lake Murray via the Saluda Hydro Project. This cold water has created the opportunity for the South Carolina Department of Natural Resources (SCDNR) to establish a successful Put, Grow and Take trout fishery for brown trout (*Salmo trutta*) and rainbow trout (*Oncorhynchus mykiss*). The following sections summarize features of the fishery and water quality resources of the LSR, including results of applicable studies.

2.2 Fishery Resources

The LSR fishery community is unique in that it provides fishing opportunities for both resident warmwater species, as well as stocked coldwater species (trout). As mentioned previously, the LSR currently supports a tailrace trout fishery for rainbow and brown trout that is managed by the SCDNR as a Put, Grow and Take fishery. Trout are

[1] Unless otherwise noted, all elevation references in this document are given in North American Vertical Datum 1988 (NAVD 88); conversion to traditional plant datum (PD) requires the addition of 1.50 feet.

not native to the LSR, and the fishery is maintained through stocking of sub-adult rainbow and brown trout. Typically, the SCDNR stocking program runs from early December until mid-April. The total number of trout stocked annually typically averages around 35,000, but varies annually based primarily on availability of fish from the Walhalla State Fish Hatchery. This management approach, which has been employed since the 1960's, is appropriate where trout habitat is marginal but can provide the acceptable growth and survival of enough sub-adult trout to support a fishery (D. Christie, SCDNR, Pers. Comm.). Similarly, the LSR is classified by the SCDHEC for regulatory purposes as Put, Grow, and Take Trout Waters, which are defined as freshwaters suitable for supporting the growth of stocked trout populations and a balanced, indigenous aquatic community of fauna and flora (SCDHEC, 2004).

A trout growth study conducted in 2003 in support of establishment of a site-specific DO standard for the LSR found that growth of trout in the LSR exceeds many other southeastern tailwaters (0.7 percent weight gain per day, 0.67 inches per month) (Kleinschmidt et al., 2003). Further, the study found that 74 of 441 brown and rainbow trout collected during 2003 were greater than 16 inches in length, suggesting a significant number of carryovers from previous stocking years. The study concluded that the high growth rates and large number of carryovers observed in 2003 could potentially be attributed to higher DO levels since the inception of SCE&G's turbine venting program (Kleinschmidt et al. 2003). Conversely, a recent study begun by SCDNR to evaluate the annual mortality of the stocked trout in the LSR documented slightly less carryover of trout during the spring and summer of 2007 (H. Beard, SCDNR, Pers. Comm.). Disparity between study results suggests that there may be significant annual variability in carryover.

As described previously, an interest has been expressed by stakeholder groups in the potential for a self-sustaining trout fishery in the LSR. The issue was evaluated by the Instream Flow/Aquatic Habitat Technical Working Committee and the results were documented in a white paper [2]. Several factors were identified that suggest that

[2] Evaluation of the Potential for a Self-Sustaining Brown and Rainbow Trout Population in the Lower Saluda River Available on the Saluda Hydro Relicensing website at http://www.saludahydrorelicense.com/StudyReports.htm.

establishment of a self-sustaining populations of brown and rainbow trout is unlikely. They are summarized here but described more fully in the white paper produced on the subject.

Limited spawning recruitment. Available information suggests that adult survivorship is variable and likely limited during some years. Creel data and annual electrofishing by SCDNR generally indicates a significant decline in LSR adult trout abundance beginning in early summer and variability in yearly adult survival, for reasons not completely known (H. Beard, SCDNR, unpublished data). However, recruitment issues to age II and older likely arise through the cumulative effects of heavy fishing effort and liberal creel limits, as well as predation and physical habitat degradation.

Limited spawning and nursery potential. It is unlikely that spawning will be sufficient to support self sustaining populations of either species. Factors identified that support this conclusion include the small numbers of fish that survive to reach age II and older, marginal spawning and incubation water temperatures (brown trout), limited amount and quality of gravel spawning beds for both species, and discontinuous and limited fry and juvenile nursery habitat.

As mentioned, the fishery is supported by significant annual trout stocking. Although it is theoretically possible that some occasional natural reproduction may occur, at least for rainbow trout, the magnitude and frequency of the production would not likely support a recreational fishery, or measurably contribute to the existing fishery, given the natural vagaries of reproduction in trout populations, marginal water temperatures, abundance of warm water predators, proximity to an urban area, and the popularity of angling (where it is reasonable to expect pressure on this fishery to remain the same if not increase). Few if any urban salmonid fisheries located in native or at least more favorable cold water ecosystems are maintained by natural reproduction. Given the public expectations for this fishery, and the marginal potential for self-sustaining coldwater salmonid populations, it is not clear what material benefit would be derived by altering LSR trout fishery management to rely on natural reproduction rather than the existing stocking strategy.

2.3 Water Resources

SCE&G began monitoring DO and temperature in the Saluda Project turbine releases in 1989 and continues the effort to the present day. Most recently, SCE&G conducted a study from 2000 to 2006 to characterize water resources by collecting baseline water quality data in the Saluda Tailrace extending downstream to the confluence with the Broad River. Results of this study and other water quality data are summarized below.

2.3.1 Dissolved Oxygen

The LSR occasionally suffers from periods of low DO during high flow or when the pool level of Lake Murray is drawn down for special purposes. Characteristics of the project reservoir, namely the relatively high water retention time and considerable depth of Lake Murray, coupled with regional climate conditions, results in seasonal thermal stratification of the lake and an associated decrease in DO in the lower water column. The problem is further exacerbated by watershed factors such as high nutrient loading, particularly from point discharges of phosphorus. High nutrient inputs to Lake Murray leads to an increase in the biological oxygen demand, especially during periods of high runoff (high flow), and consequent depletion of DO from the water column.

In 1999, to address issues associated with low DO of Project discharges, SCE&G installed an aeration system. This aeration system, which along with modified operational patterns, has since improved water quality of discharges. Currently, Project discharges of low DO waters to the LSR are infrequent, and are above the minimum DO level protective for trout survival (3.0 mg/L) 97 percent of the time. Results of 2000 to 2006 water quality monitoring showed average monthly DO levels to be above 6.2 mg/L throughout the year with the lowest levels observed in September (average minimum of 4.2 mg/L), and highest levels in February (monthly average 11.0 mg/L).

2.3.2 Temperature

According to the 2000-2006 water quality study, average water temperature throughout the late winter, spring, and early summer months (February – July) in the LSR ranges from 9.5 to 15.4º C. Specifically, during the spring and early summer months (March – June) average water temperature typically remains between 10º C and 14º C. As the summer progresses, water temperatures rise and are at their highest, about 17º C, between mid-September and early November. During the study, water temperatures never exceeded the lethal limit for trout of 25°C at any of the monitored trout habitat sites.

2.4 Technical Work Committees Meeting Notes

Note to readers: to be added once the consultation process within the TWC has been completed

3.0 GOALS AND OBJECTIVES

The goals and objectives of the Trout Management Program for the LSR were developed using a consensus-based approach during stakeholder discussions by the Fish and Wildlife Technical Working Committee. Specially, the goals and objectives are focused in two areas that are fundamental to effective management of the lower Saluda Tailrace Trout Fishery, namely water quality and fishery resources. For each goal identified in these two areas, there are several qualitative and quantitative objectives for measuring the progress made towards meeting the goals. The F&W TWC determined field collection methods appropriate for gathering the relevant data, which are described in more detail in Section 5.0. The Program goals for fishery resources and water quality, and their associated objectives, are described below.

3.1 Fishery Resources

Goal #1 To manage the Put, Grow, and Take trout fishery to maximize fishing opportunities for the public.

Objectives

- Measure changes in the fishery community by summarizing data in standard community-level metrics, such as species diversity, richness, relative abundance, trophic levels, presence and distribution of key species, and other summarizations that the Fish Team deems appropriate.
- Document and assess qualitative changes in trout habitat, including food resources (BMI) and water quality factors, resulting from flow modifications and DO enhancements.

Success Criteria

- **Note to readers : to be developed within the TWC**

Goal #2 To investigate reproductive successes of trout to augment stocked fishery.

Objectives

- Document recruitment of young-of-year within the LSR
- Document eggs or larval life-stages in the LSR

Success Criteria

- **Note to readers: to be developed within the TWC**

Goal #3 Determine feasibility of a naturally reproducing trout population as a management goal for the LSR.

Objectives

- Advisory Committee to conduct annual review and assessment of water quality, IFIM, and biological data. Committee to issue a report of findings and assessment of progress towards goals.

Success Criteria

- **Note to readers: to be developed within the TWC**

Goal #4 Determine growth rates of adult trout after implementing new instream flow regimes developed by the TWC.

Objectives

- SCE&G will conduct a trout growth study in year 7 of this program. The study will document trout growth and be similar to the study conducted in 2003 during the development of the LSR site specific DO standard.

SCE&G will coordinate the study with the SCDNR and their trout production facilities.

Success Criteria

- **Note to readers: to be developed within the TWC**

3.2 Water Quality

Goal #5 To release water from the Saluda Project that meets, to the extent possible, applicable State Water Quality Standards.

Objective

- Collect water quality data in the Saluda Tailrace year-round for 6 consecutive years to capture conditions during all seasons and for wet and dry years.

Success Criteria

- **Note to readers: to be developed within the TWC**

4.0 MANAGEMENT OF THE PROGRAM

The Fish & Wildlife TWC has developed this Trout Management Program for the LSR during the relicensing process for inclusion in the FERC license application and eventual incorporation into the new Saluda Project License. SCE&G is ultimately responsible for collection and analysis of Program data; however, a Advisory Committee will be been convened, as described below, and it is anticipated and desired that Committee members will actively participate in all facets of the Program.

4.1 Formation of Advisory Committee

To help develop and oversee implementation of the Program, a Advisory Committee (Committee) will be created. Member organizations and their responsibilities, as well as the approved dispute resolution procedures, are described below.

4.1.1 Committee Members and Responsibilities

The Committee will be comprised of representatives from SCE&G, SCDNR, the United States Fish and Wildlife Service (USFWS), Trout Unlimited (TU), and other interested Stakeholders. Each entity will have the opportunity to select its own representation to the Committee. SCE&G (or their designee) will serve as chairperson of the Committee and be responsible for organizing meetings and distributing documents to committee members.

The Committee will ultimately be responsible for guiding the decision making processes specified in the Program. It is anticipated that the Committee will be comprised of many members of the TWC responsible for development of this Program. The Committee’s responsibilities may include, but are not limited to the following:

- Collection and evaluation of baseline information and evaluation of study plans;
- Providing overall guidance and decision making for the Program process;
- Evaluating other study (*i.e.,* existing) information or information which becomes available during the time period of evaluations;
- Establishing and documenting the goals and objectives of each modification and determine the appropriate metrics for evaluative purposes;
- Keeping other stakeholders aware of information relative to potential decisions and providing opportunities to comment prior to decisions on modifications and provide a notification system of Advisory Committee meetings;
- Determining and considering long term impacts of operational modifications on downstream projects and project economics when evaluating the feasibility of implementing flow modifications; and
- Reviewing the annual report that provides information on the prior year's activities which SCE&G will file with FERC.

The Committee acknowledges the importance of allowing interested stakeholders to review and comment on major documents, such as study results, that may impact the evaluation and potential modification to the Project. The Committee chairman (an SCE&G representative or designee) will distribute these study results and make annual reports available to interested stakeholders. Interested stakeholders can request documents in writing to the Committee chairman. The Committee chairman will ensure that interested stakeholders have adequate notice and review time prior to final decisions of the committee relative to modifications to test flows, etc. For all other documents on which stakeholders wish to comment, the Committee will review all timely comments and include these comments in the official record.

All information from the Committee relative to this Program, including notification of meetings, meeting summaries, study results and final study plans will be coordinated by SCE&G and shared with each committee member.

4.1.2 Advisory Committee Meetings

The Advisory Committee will establish a meeting schedule based on the activities and deliverables in any given year. To keep all committee members abreast of the schedule, the Advisory Committee will establish an annual calendar that will be distributed to members, along with any notes from previous meetings. The tentative Program schedule is provided in Section 6 of this plan. It should be noted that this schedule is based upon the issuance of a new license in 2010. A delayed issuance of the license will require that the schedule be revised accordingly.

4.2 Budget and Program Resources

Responsibility for implementing this Program will rest primarily with SCE&G, as licensee for the Saluda Project. Annual budgets will be developed by SCE&G relative to the monitoring and study costs as well as administrative costs and expenses. SCE&G will also rely on other resources outside of its establishment including, but not limited to, the following:

- federal, state and local grants
- donated services (federal and state agency involvement)
- equipment (purchases and loaners)
- expertise (governmental, non-governmental, private)

5.0 PROGRAM MONITORING METHODS

(Note to readers: Further refinement of Sampling Methodologies will be conducted within the TWC)

5.1 Sampling Techniques

5.1.1 Water Quality Monitoring

Water Quality monitoring in the Saluda Tailrace is necessary to establish an accurate baseline and to evaluate changes in water quality resulting from DO enhancements and changes to project operations. Further, it will be the basis from which to determine whether the Project is in compliance with applicable State Water Quality Standards (Goal #4).

Continuous water temperature and DO data will be sampled annually using installed USGS gages located below Saluda Hydro and near Riverbanks Zoo. Data will be collected at 15 minute intervals.

5.1.2 Flow Monitoring

Flow monitoring in the LSR is necessary to establish an accurate baseline and to evaluate changes in instream flows as they relate to TWC recommended flows, recreational flow releases and changes in project operations.

Continuous flow data will be collected annually using installed USGS gages located below Saluda Hydro and near Riverbanks Zoo. Data will be collected at 15 minute intervals.

5.1.3 Fish Sampling

Monitoring of the fish community in the Saluda Tailrace is necessary to establish an accurate baseline and to evaluate changes resulting from DO enhancements and changes to project operations. Fish sampling will be conducted using standard collection techniques that gather information on both community structure and document carryover of adults . Fishery collections may also assist in documenting active spawning. Methodologies for each are described below.

Fish Community Sampling

During each year of the Program (years 1 through 6), fish community data will be collected using daytime boat electrofishing during the April/May and September-October time periods.

Boat electrofishing will be used to sample the fish community at the deeper locations within each reach (generally, greater than 2 feet deep). Boat sampling will include 2-ten minute samples (pedal down) in each reach (total of 20 minutes of sampling time). Sampling will commence at the beginning of each reach with a shoreline (10 min.) and a mid-channel (10 min.) sample, if feasible. Each 10 minute sample will be processed as a separate sample. If habitat and channel width does not permit both a shoreline and mid-channel sample, mid-channel efforts will be shifted to shoreline sampling to obtain the required 20 minutes in the sample reach. Within each sampling station, all microhabitats (pools, riffles, runs, brush piles, stumps, boulders, etc.) will be sampled in an attempt to clearly describe the fishery community present.

All stunned fish will be collected during sampling, placed in a live well or collection container and identified to species. Weight (to nearest gram) and total length of collected individuals will be determined. Any individuals not identified in the field will be preserved and returned The sample will be returned for lab identification, at which time the species will be added to the datasheet. All other fish will be returned downstream of the collection area.

Other pertinent information that will be collected during electrofishing efforts will include date, time, weather conditions, sample location, collection technique, sampling effort, water temperature, DO, and secchi disc, etc.

5.1.4 BMI Sampling

BMI Sampling will be conducted in accordance with the macroinvertebrate Program approved by the F&W TWC.

5.1.5 Ichthyoplankton Sampling

Sampling for fish at the egg and larval stages, or ichthyoplankton sampling, will be performed annually at Ocean Boulevard and Oh Brother Rapids 1 time a week during April and May. Duplicate samples will be collected at each location using standard drift net sampling techniques.

5.1.6 Trout Growth Study

SCE&G proposes to conduct an in-situ growth study in the LSR to determine growth rates of rainbow trout in the LSR. The trout growth study will be conducted during December – May and employ tag and recapture techniques utilized in the 2003 growth study conducted in LSR (Appendix A).

Annual Report Format and Summary Data Package

At the conclusion of the sampling season for each year of the Program, SCE&G will prepare reports for the various data collection components of the Program and consolidate them into a summary report that will be used by the Committee to track trends in the Saluda Tailrace.

The annual summary report package will include summaries of the following information:

- Water quality sampling data
- Saluda Tailrace flow data for the year
- Fish sampling data
- BMI sampling data
- Ichthyoplankton sampling data
- Trout stocking data
- Trout growth study results (following 7th year only)

Water quality data will be summarized and displayed graphically by daily average and instantaneous temperature and DO value. Each annual report will include a discussion of any occurrences when water quality did not meet State standards as well as an analysis of the influence of generation on water quality in the Tailrace. Also, as the Program progresses, each report should include a discussion comparing the current years data to previous years data to identify any trends or anomalies.

Baseline fishery data will be compared to the Program goals to determine the potential and observed changes (positive or detrimental) to the aquatic biota associated with changes in project operations. Analysis of data may include, but not be limited to, a comparison of the following metrics:

- species richness/diversity
- species distribution
- species density
- trophic shifts
- young-of-year recruitment
- distribution of migratory species
- catch rate (average number / 300 FT^2 or 10 minutes of boat shocking)

- percentage of individuals with disease, tumors, fin damage or other anomalies
- Other sources of available fishery data may also be incorporated into this analysis

Benthic macroinvertebrate sampling data will be summarized to determine the potential and observed changes (positive or detrimental) to the food sources with changes in project operations. Analysis of data may include, but not be limited to, a comparison of the following metrics:

- species richness/diversity
- species distribution
- species density

Ichthyoplankton sampling data will be summarized to reflect successful reproduction of trout at the Oh Brother/Ocean Boulevard complexes. These two areas were identified by the TWC as high quality trout habitat containing the highest potential for successful reproduction. This data will be used to determine the reproductive potential and success within the LSR.

5.2 Implementation Schedule

The Program is designed to be implemented for a total of seven years. Annual data collection for water quality, flow monitoring, and biological sampling (fish, BMI, ichthyoplankton) will be conducted for six years. At the end of each year, an annual evaluation will be conducted by the Committee to assess the data. As the Program progresses, the Committee will be tasked with considering previous years data, as well as the current years data, to determine trends and to assess overall progress towards Program goals. On the seventh year of the Program, the Trout Growth Study will be implemented to assess changes in growth patterns of rainbow trout since implementation of the TWC recommended instream flow regimes.

5.3 Decision Process for Program Modifications

The AdvisoryCommittee will evaluate the annual data and make recommendations to SCE&G for any changes in the Program.

APPENDIX A

LOWER SALUDA RIVER TROUT GROWTH STUDY

SOUTH CAROLINA ELECTRIC & GAS CO.
COLUMBIA, SOUTH CAROLINA

SALUDA DO STANDARD PROJECT
LOWER SALUDA RIVER TROUT GROWTH STUDY

1.0 DISSOLVED OXYGEN CRITERIA

In 1986 the U.S. Environmental Protection Agency (EPA) produced the Ambient Water Quality Criteria for Dissolved Oxygen (freshwater). This document replaced all previously published EPA aquatic life criteria for dissolved oxygen (DO). State water quality criteria may have the same numerical values as those in the EPA document or States may want to adjust their criteria to reflect local environmental conditions.

Site-specific criteria are allowed by regulation and are subject to EPA review and approval. Although no specific procedures are in place for establishing site-specific criteria for DO in freshwater, existing guidance and practice are that EPA will approve site-specific criteria developed using appropriate procedures. Site-specific criteria must be based upon a sound scientific rationale in order to protect the designated use. A site-specific criterion is intended to come closer than the national criterion to providing the intended level of protection to the aquatic life at the site, usually by taking into account the biological and/or chemical conditions at the site. The LSR trout growth study was the initial step in the use of the bioenergetic model to predict a DO standard that provides a level of protection of trout growth consistent with the EPA DO criteria.

The LSR growth study and the resultant growth model predictions are used to establish a long-term average concentration that will adequately protect trout growth in the LSR. In addition to the long-term average, the DO criteria also contain a short-term DO concentration that will prevent mortality as a result of acute hypoxia. Even short-term exposure to DO levels in the range of 1 to 2 mg/L can kill trout in a short period of time if they are not able to find local refugia where DOs are higher. In one case, mortality of trout has been reported after 3-4 day exposure to 2.4 mg/L at 20 C. In general, low DO is better tolerated at cooler temperatures than at warmer temperatures. In order to avoid direct mortality due to low DO, the EPA criteria document recommends a minimum DO of 3 mg/L, a DO concentration that is survived by salmonids, including trout, in long-term growth studies.

Although EPA cited, and agreed with, reviews that concluded that invertebrates are generally protected by DO levels that protect fish, there were potential exceptions that induced EPA to recommend a minimum DO of 4 mg/L to protect sensitive species of mayflies, caddisflies, and stoneflies that are present in some areas of the western U.S. There are no data available on the many insect species that inhabit other habitats and regions.

In order to protect trout growth, EPA concluded that the growth attained at a constant, or 30-day running mean, DO concentration of 6.5 mg/L was adequate. The assumed level of protection was estimated to be the threshold of effect of DO on growth. Lower mean concentrations are adequate to protect important fishery resources, but risk slight growth impairment (6 mg/L) or moderate growth impairment (5 mg/L). EPA concluded that reductions in growth rate sometimes seen above 6 mg/L are usually not significant and that DO concentrations below 4 mg/L can have severe effects on growth. Between 4 and 6 mg/L the effect on growth is moderate to slight if the exposure is sufficiently long. It must be noted that these findings are derived from laboratory studies in which food was surplus.

Because DO affects fish growth primarily by reducing appetite and food consumption, growth effects are greatest when food is not limited according to the EPA criteria document. For example, in tests with coho salmon and DOs of 3, 5 and 8 mg/L, growth effects were seen only at food availability greater than 70% of maximum consumption and a DO of 3 mg/L. No effects were seen at 5 mg/L. This 70% food availability is similar to that estimated from the LSR growth study.

The most "natural" DO study included in the EPA criteria document was a test conducted in laboratory streams in which coho salmon fed on insects produced in the streams (9.5-15.5 C). At high growth rates (0.04 to 0.05 g/g/d) dissolved oxygen levels below 5 mg/L reduced growth, but at lower growth rates (0 to 0.02 g/g/d) no effects were seen at concentrations down to 3 mg/L. These lower growth rates are similar to those observed in the LSR. Although these studies were not conducted with rainbow trout, there is a general similarity in growth response to

DO in all tested salmonid species and these results are probably representative of rainbow trout as well.

Perhaps the most critical issue identified in the EPA criteria document was the application of data from tests with constant DO exposure levels to natural situations in which DO may fluctuate significantly. They concluded that existing data allowed for a tentative theoretical dosing model for fluctuating DO as applied to fish growth if daily average DO was calculated using as a maximum value the threshold concentration below which growth effects are observed under constant exposure conditions.

The publication of several fish bioenergetic model papers occurred almost simultaneously with the publication of the EPA criteria document for DO (Cuenco et al., 1985 a, b, c). It was immediately evident that the fish growth analysis performed for the EPA DO criteria document (JRB Associates, 1984) provided the DO-food consumption link that would enable a similar modeling approach to be used for generating growth-effect predictions for natural conditions with cycling DO. Consequently, EPA and TVA entered into a cooperative agreement to develop and test a fish growth model using DO-growth effect data and the other bioenergetic parameters common to established fish growth models. The EPA-TVA model also utilized many physiological parameters from another bioenergetics model developed by the University of Wisconsin Sea Grant Program (Hewett and Johnson, 1991). The resultant model (Shiao et al., 1993) forms the basis for the LSR growth study and the LSR site-specific DO criteria proposal. The 1993 model has been updated with data of better precision for rainbow trout respiration and food consumption relationships with temperature (From and Rasmussen, 1984) and with additional analysis of the rainbow trout growth studies from the EPA criteria document (Spoor, 1981).

This modeling approach provides a tool to address what EPA termed a most critical and poorly documented aspect of the dissolved oxygen criterion which is the acceptable minimum DO under cycles of varying periodicity.

2.0 LOWER SALUDA RIVER TROUT GROWTH STUDY

Prediction of trout growth in the LSR requires adequate knowledge of three key parameters: temperature, DO concentration, and food availability to trout. In-stream monitoring of temperature and DO, coupled with turbine intake DO, a turbine aeration model, and a tailwater water quality model, provided very good data and estimates of the actual temperature and DO to which trout are exposed. Food availability can be estimated by measuring fish growth, determining the temperature and DO during the period that growth was measured, and using the FISH bioenergetics model to estimate food consumption (availability). During the period of this growth study DO was sufficiently high that there was no significant effect of DO. Therefore, food consumption and growth were determined almost exclusively by temperature and food availability.

The growth study was conducted to closely simulate the typical pattern of rainbow trout release into the put, grow, and take trout fishery in the LSR. This pattern is characterized by periodic releases of catchable trout (8-10 inches) at several locations along the LSR.

The growth study began with the tagging of approximately 15,000 rainbow trout obtained from the South Carolina Department of Natural Resources Walhalla Fish Hatchery. The tagging efforts were divided into four nearly equal monthly batches beginning in November and concluding in February. The November batch of rainbow trout contained 3000 individuals while the remaining 3 batches contained approximately 4000 individuals.

Each monthly batch of rainbow trout (201.4 ± 49.7 mm total length, 136 ± 36.7 g; mean ± SD) was tagged with sequentially numbered, large format, soft Alphanumeric Visible Implant Elastomer (VI-alpha) tags produced by Northwest Marine Technology Inc. To conduct the tagging exercise, fish were crowded in a raceway and 10 - 20 individuals were transferred to 50 – L aerated holding containers containing an anesthetic (~ 90 mg/L MS 222). Once fish were anesthetized, each rainbow trout received one visible implant tag, injected using a syringe-like tag applicator designed and supplied by the manufacturer just below the surface of the clear adipose postorbital eye tissue. The fish were then returned to a separate raceway and held for a minimum of 21 days as required by federal regulation for drug clearance as mandated by the

Food and Drug Administration. During the holding period, fish were maintained in a flow-through raceway system at 4 – 12 C.

After the 21 day waiting period, all fish tagged for that month were individually weighted and measured {Total length (mm) and wet weight (g)} and the tag code recorded for each fish. All fish were left unfed two days prior to weighing and measuring. Each monthly batch of tagged fish were divided up into 1000 fish sub-units, with each sub-group designated for release at one of the four release locations. The December plantings were divided into 4 lots, one 300 batch (Lake Murray Dam), one 700 fish grouping (Saluda Shoals) and 2 1000 fish batches (Allied Signal and Quail Hollow) All other monthly stockings contained relatively equal stockings of 1000 (less tag loss). Monthly tagging numbers and tag retention rates appear in Table B1.

Trout were planted in four discreet releases, one each in December 2002, and in January, February and March of 2003. Release sites were three that are routinely used for the fishery (Saluda Shoals Park, Allied Signal, and Quail Hollow) plus an additional upstream site just below Lake Murray dam (Figure B-1).

The tagged fish arrived in hatchery trucks each outfitted with multiple cells to keep fish separated. To accomplish this, fish were taken from numbered raceways at the hatchery with each raceway containing known tagged fish. Fish were then placed in each of the designated cells for transport and release to the LSR. For the helicopter stocking, the fish were placed in the helicopter bucket and the pilot was given specific directions where to place the fish in the LSR. The remaining stockings were conducted via truck with each driver having a designated stocking location to release fish based on a pre-arranged raceway numbered matrix. During the January stocking, the lock on the access gate to Quail Hollow had been changed which required the driver to stock the fish at Allied Signal. To compensate and provide an even distribution of fish at all stocking locations, two 1000 batches of fish were released in the Quail Hollow area during February stocking event.

To determine trout growth, recovery of tagged trout was carried out by obtaining trout from the LSR by electrofishing as well as by obtaining weight and length data of freshly caught trout in the LSR sports fishery. Fish were collected from the LSR from April thru June using primarily boat electrofishing means. The sampling area extended from the base of Lake Murray Dam to the I -26 bridge (Figure B-1). While no sampling was conducted below the I-26 Bridge, there were anecdotal reports of tagged fish being caught near Riverbanks Zoo, approximately 1 mile downstream. Boat electrofishing was conducted using a 16 foot aluminum boat outfitted with a generator, Smith-Root model VII-A Electrofisher, and anode and cathode umbrella droppers. Pulsed DC current was placed in the water and output amperage was adjusted to maximize electric current in the water. Voltage was regulated in attempts to maintain approximately 5 amps. During electrofishing sampling, electric current was directed to all microhabitats (shoals, ruffle run complexes and rock outcroppings) throughout the LSR. Electrofishing effort was typically expended over a two and three day period. All trout captured were placed in 100 L aerated containers. Fish were then evaluated to determine if they were tagged. Those fish that were tagged individual length and weight, data was collected, along with the corresponding tag color and number and recorded on field data sheets. Fish were then released back to the LSR in the general location of capture. Additionally untagged trout were collected and those individuals were enumerated and length data obtained.

2.1 Growth Results

A total of 111 tagged trout were collected, weighed and measured during April, May and June. The growth data were analyzed to determine if the data were sufficiently homogeneous to allow use of the entire data set for estimation of food availability in the LSR. There were several factors that might have caused growth (and food availability estimates) to be significantly different for one or more subsets of fish in the growth study. These factors included:

- Release site
- Release date
- Recapture site
- Size at release
- Condition at release
- Condition at recapture
- Direction of movement after release
- Distance of movement after release

- Time between release and recapture

Because growth was primarily influenced by temperature and food availability during the study period (DO was always high), any difference in these factors related to tailwater location or date could have caused differences in growth rate. In addition, size and condition of the fish might be related to fitness to the tailwater environment, including adaptability to feeding, as well as finding and competing for most-suitable habitat. Obviously, any factors that might tend to selectively crop fish through predation, movement out of the study area, or susceptibility to angler harvest could influence the study result. However, as these factors are always present, their exclusion, even if possible, would make the study less representative of the actual conditions for the trout remaining in the system.

2.2 Initial Data Analysis

A summary of the data collected for each recaptured fish from the growth study is provided in Table 2. The weight at release and recapture of the 111 fish used for the growth analysis is shown in Figure B-2. It is immediately evident that there was a large range in fish weight both at release and recapture. The range of trout weight at release is typical, as trout will feed and grow at different rates even in a hatchery environment where feeding is regular. The same phenomenon occurs in nature, as individual fish become more-or-less adapted to the natural habitat and more-or-less dominant in retaining better habitat niches.

2.3 Release Site and Date

The initial analysis of growth rate by release site and release date indicated that differences in median growth raters were relatively small (Table B-3). Because of periodic access problems, only 14 of the 16 potential release combinations (4 sites x 4 dates) were possible. The number of fish recaptures represented in these 14 combinations ranged from 1 to 14, with several releases being represented by fewer than a half-dozen individuals.

Comparing individual trout growth rates as a function of release site and release date indicated that only two of fourteen release groups had growth rates that appeared to be lower than the norm for the other release groups (Figures B-2a and 2b). The two groups with lower growth rates were the December group released at Quail Hollow and the March group released at Allied Signal. However, these two groups were represented by only four and one fish, respectively. With the large range of growth rates represented within each of the other groups and the fact that most groups in the March release had fish which lost weight following release, there was no reason to remove these two groups (five fish) from the overall data set of 111 trout.

2.4 Recapture Site

It is not possible to determine where an individual fish resided between the time of release and the time of recapture. For those fish that were recaptured near the release site it might be concluded that there was not a significant movement upstream or downstream from the point of release. Other fish that were recaptured farther from the release site may or may not have moved rapidly to the vicinity of the point of recapture. Given the pool-like nature of much of the study area, it is possible that many of the released trout moved freely up and down long stretches of the LSR and established no small-scale area of residency. On the assumption that recapture site might indicate the primary area of residency following release, the growth rate data were analyzed to see if there was a relationship between growth rate and recapture site (Figure B-3).

Growth rates were highly variable regardless of recapture site. Almost twice as many fish were recaptured between Allied Signal and Saluda Shoals than in the upstream or downstream sections. Median growth rates were slightly higher in this intermediate stretch (0.75 percent per day) as compared with upstream (0.68 percent per day) and downstream (0.65 percent per day). Given the highly variable growth rates, these relatively small differences were not seen as significant to the modeling effort. Fish from the Saluda Shoals releases were the most common at all recapture sites below RM 8 (and below the Saluda Shoals release site, ca. RM 8.3), and fish from the release immediately below the dam were most common above RM 8 (Figure B-4). The effect of movement from the site of release was analyzed separately from the site of recapture.

2.5 Growth and Movement

All four release times were characterized by fish moving both up- and downstream from the release sites. In general, more fish moved downstream than upstream, with median movement ranging from 0.3 to 1.2 miles downstream. Although the pattern of movement differed slightly among the four release dates (Figure B-5) only fish from the January releases appeared to differ in any noticeable way from the overall pattern. This exception is perhaps more noteworthy because no fish were released at Quail Hollow during January, and fish that moved downstream from Quail Hollow were outside of the recapture area. In fact, only trout that were released at the two intermediate sites, Saluda Shoals and Allied Signal, could be sampled both above and below the release site. The Quail Hollow released fish were not sampled below the site of release and the fish released just below the dam were obviously limited to the immediate area of the release or movement downstream.

Analysis of fish movement for the two intermediate release sites indicated that both the Saluda Shoals and Allied Signal fish from the December release tended to move downstream (Figure B-6). [Note that in this and other figures some data points are identical and are superimposed in the figures, thus, the number of points visible may not equal the number of data points represented (n).] Later releases at Saluda Shoals followed this pattern, but the indications are that the Allied Signal fish may have moved upstream more frequently following the January and March releases (there was no February release at that site). The release of fish immediately below the dam may have populated the upstream section to the extent that competitive pressure produced the net downstream movement of Saluda Shoals fish. Of course, this movement pattern may also be a direct response to physical habitat characteristics.

Although the movement of trout released at the dam was limited to essentially staying put or moving downstream, and the Quail Hollow releases were only sampled at and above the release site, the analysis of this data is of interest (Figure B-7). The Lake Murray dam releases routinely had a median movement of 0.8 miles downstream. Perhaps the most interesting aspect of all the movement data was the relatively rapid upstream migration of several fish from the March release at Quail Hollow. Although median movement was still less than one mile upstream, at least four fish moved 3-5 miles upstream in the period between release and sampling.

Given the wide range of dispersal seen among the fish (up to 5 miles up and downstream from the release site) the potential effect of this movement on growth was considered potentially important. As shown in Figure B-8, there was essentially no pattern seen in the growth data when distance and direction of post-release movement was included as a variable. A similar analysis broken down by release site and release date showed no appreciable pattern (Figures B-9-12). Figure B-13 shows the analysis of the relationship between time in the LSR after release and distance traveled between release and recapture. In general, there was no relationship between distance traveled and the time between release and recapture.

2.6 Size at Release and Growth Rate

The maximum growth rate of fish is in part dependent upon fish size, with smaller fish capable of higher food consumption rates and higher growth rates than larger fish. Hatchery feeding practices have routinely used size as a determinant of how much feed to provide trout (e.g., Leitritz, 1972: 2-inch fish 4x and 5-inch fish 2x the food fed 9-inch fish). The growth rate observed for fish in the LSR study indicated a weak relationship to size at release, with most growth rates >1 percent per day occurring in trout that were <150 grams at release (Figure B-14). Given the wide range of growth rates for fish of any particular size and the growth model expression of food availability as a percent of maximum consumption potential rather than absolute amounts of food consumed, there was no compelling need to consider size in determining food availability for the growth model.

2.7 Condition Factor and Growth Rate

Trout of any length may be judged as to their general condition by overall appearance and described as skinny, solid, plump, fat, etc. A quantitative term that describes the length and weight relationship is the "condition factor." The condition factor (c.f.) is expressed as:

$$c.f. = (W \times 100) / (L)^3$$

where: W = weight in grams and L = length in cm.

A condition factor of 1.0 may be used as a general guide with factors <1 representing less than optimal condition in trout and those >1 representing well-fed trout.

Trout with lower initial condition factors tended to grow at a faster rate than those with higher initial condition factors (Figure B-15). This is an expected finding under circumstances where hatchery conditions can cause a wide spread in condition factor and where field conditions allow dispersal of fish into areas of adequate food. The overall range in initial condition factors (ca. 0.8-1.8 in this study) is not unusual in crowded fish culture units without extensive and frequent grading and separation of fish sizes. Once released into the LSR the fish were able to disperse and feed more uniformly. This tends to allow the skinny fish to bulk up and the fatter fish to become more trim, resulting in the growth rate relationship seen in Figure B-15. This phenomenon is probably typical of the LSR put, grow, and take trout fishery and does not complicate the use of this growth study with the bioenergetic growth model.

The change in condition factor is illustrated in Figure B-16. In general, trout with initial condition factors >1.2 became more trim and those with initial condition factors <1.0 became more robust. The central tendency in the population was to develop a condition factor of about 1.1. This same trend was evident for trout recaptured from each of the release periods (Figures B-17a and b). This trend towards uniformity of condition factor is clearly evident in the decreasing variability in the length-weight relationships between release and recapture (Figure B-18) where r^2 values improved from 0.61 to 0.87 during residency in the LSR. The trend to greater uniformity in condition simplifies the application of the bioenergetic growth model.

Because growth was related to condition factor, the data were analyzed to see if there was any relationship between post-release movement in the LSR and the condition factor of the trout at time of release (Figure B-19). There was no effect of condition factor on the movement of trout following release.

A final analysis of the data was to determine if there was any relationship between growth rate and the time between release and recapture. Except for an apparently reduced growth rate for fish captured shortly after the March release, growth was essentially independent of residence time. The slightly reduced growth seen in the early recapture of the March release is probably attributable to a period of recovery from handling procedures inherent in capture, transport and release of fish in the planting process. Some period of time is also probably needed for the fish to adapt to feeding in nature as opposed to feeding under hatchery conditions. It is likely that all four release periods underwent the same handling stress and adaptation process, but the December-February releases experienced that pattern long before the initial recapture effort in April 2003.

2.8 LSR Trout Fishery Information

Additional information collected during the growth study revealed significant numbers of rainbow and brown trout that appear to be carryovers from previous stockings. A total of 441 tagged and untagged trout were collected from the LSR, with 253 rainbow and 188 brown trout comprising the total catch.

Of the 441 rainbow and brown trout collected, 74 exceeded 16 inches in length, or nearly one in every six fish. The largest rainbow and brown trout collected during these surveys were 22 and 24 inches, respectively, with all fish appearing robust and healthy. Further examination of the data indicates that trout do appear to carryover from annual stockings. Figure B-21 illustrates that at a minimum two distinct age classes of fish were collected in the LSR during the study. However, without otolith examination it is not readily possible to determine what year classes these individuals represent. One likely contributor to this observed carryover is likely is the higher DO levels maintained in the LSR since the inception of SCE&G's turbine venting program than those DO levels historically observed.

3.0 SUMMARY

A detailed analysis of growth patterns and relationships with potentially significant variables relating to the LSR sites, release dates, and fish size indicated that there were no factors requiring either data deletion or subdivision prior to the use of observed growth rates for calculating food availability. Consequently growth rate data from all 111 recaptured trout were used to calibrate the bioenergetics model for the LSR.

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SOUTH CAROLINA ELECTRIC & GAS CO.
COLUMBIA, SOUTH CAROLINA

SALUDA DO STANDARD PROJECT
LOWER SALUDA RIVER TROUT GROWTH STUDY

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SALUDA DO STANDARD PROJECT

LOWER SALUDA RIVER TROUT GROWTH STUDY

AUGUST 2003

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SOUTH CAROLINA ELECTRIC & GAS CO.

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Table B-1: Number tagged, number of survivors, survival (%), number retaining tags, and proportion (%) retaining tags of rainbow trout tagged with large format, soft VI-alpha tags and held for 25 days

TAG DATE	TAGGED (N)	SURVIVORS (N)	SURVIVAL (%)	NUMBER RELEASED (N)	RETENTION (%)
12/8/02	3000	2975	99.2	2405	80.8
1/6/03	4000	3780	94.5	2979	78.8
1/20/03	4400	4281	97.3	3331	77.8
2/13/03	4000	3251	81.3	3089	95.0
Total	15400	14287	92.8	11804	82.6

Table B-2: Data on rainbow trout recaptured and used in the Bioenergetics Model from the Lower Saluda River Growth Study April- June

	Tag Color	Tag Number	Stocked Total Length (mm)	Recaptured Total Length (mm)	Stock Weight (g)	Recaptured Weight (g)	Location Recaptured	Location on Figure B-1 (blue except where noted)	Location Stocked	Location on Figure B-1 (Red unless noted	Stock Date	Recaptured Date
1	yellow	C27	242	307	179	353	Sandy Beach, way point 106	3	Saluda Shoals Park	2	12/17/2002	4/2/2003
2	yellow	D55	217	230	157	171	Sandy Beach, way point 106	3	Saluda Shoals Park	2	12/17/2002	4/2/2003
3	yellow	22D	233	290	164	299	Corley Island shoal	7	Saluda Shoals Park	2	12/17/2002	4/3/2003
4	yellow	X26	253	298	216	302	downstream of I-20 at house	10	Quail Hollow	4	12/17/2002	4/3/2003
5	yellow	R73	261	324	221	438	tailrace, near spillway inflow	1	Lake Murray Dam	1	12/17/2002	4/28/2003
6	yellow	50E	245	315	197	347	above Sandy Beach (near shoal)	2	Saluda Shoals Park	2	12/17/2002	4/28/2003
7	yellow	D42	233	290	156	273	Sandy Beach	3	Saluda Shoals Park	2	12/17/2002	4/28/2003
8	yellow	L97	243	320	165	379	Upstream of Rawls Creek at shoal	5	Saluda Shoals Park	2	12/17/2002	4/28/2003
9	yellow	R72	245	325	156	350	downstream of I-20 bridge	11	Allied Signal	3	12/17/2002	5/1/2003
10	yellow	K20	244	315	143	328	downstream of I-20 bridge	11	unknown	n/a	12/17/2002	5/1/2003
11	yellow	J59	265	348	234	501	downstream of I-20 bridge	11	Allied Signal	3	12/17/2002	5/1/2003
12	yellow	L41	234	278	204	294	downstream of I-20 bridge	11	Saluda Shoals Park	2	12/17/2002	5/1/2003
13	yellow	G73	239	305	210	375	downstream of I-20 bridge	11	Quail Hollow	4	12/17/2002	5/1/2003
14	yellow	I38	208	275	117	211	downstream of I-20 bridge	11	Saluda Shoals Park	2	12/17/2002	5/1/2003

	Tag Color	Tag Number	Stocked Total Length (mm)	Recaptured Total Length (mm)	Stock Weight (g)	Recaptured Weight (g)	Location Recaptured	Location on Figure B-1 (blue except where noted)	Location Stocked	Location on Figure B-1 (Red unless noted	Stock Date	Recaptured Date
15	yellow	09D	239	302	168	309	downstream of I-20 bridge	11	Allied Signal	3	12/17/2002	5/1/2003
16	yellow	54E	250	335	194	461	Corley Island shoal	7	Allied Signal	3	12/17/2002	5/1/2003
17	yellow	35C	277	345	204	472	Corley Island shoal	7	Saluda Shoals Park	2	12/17/2002	5/1/2003
18	yellow	O7E	239	282	113	255	upstream of Quail Hollow, mile 4+	12	Saluda Shoals	2	12/17/2002	5/20/2003
19	yellow	X04	216	281	197	236.0	upstream of Quail Hollow, mile 4+	12	Quail Hollow	4	12/17/2002	5/20/2003
20	yellow	B97	245	311	209	283	upstream of Quail Hollow, mile 4+	12	Quail Hollow	4	12/17/2002	5/20/2003
21	yellow	56D	254	333	179	377	asphalt plant, mile 4+	11	Allied Signal	3	12/17/2002	5/20/2003
22	yellow	J22	245	336	166	361	tailrace boat ramp & upstream	1 (red)	Lake Murray Dam	1	12/17/2002	6/2/2003
23	yellow	L92	224	334	165	415	Corley Island shoal	7	Saluda Shoals	2	12/17/2002	6/2/2003
24	red	A96	240	295	185	307	Sandy Beach, way point 106	3	Lake Murray Dam	1	1/7/2003	4/2/2003
25	red	S22	220	266	145	222	Sandy Beach, way point 106	3	Lake Murray Dam	1	1/7/2003	4/2/2003
26	red	46B	212	271	102	223	Sandy Beach, way point 106	3	Saluda Shoals Park	2	1/8/2003	4/2/2003
27	red	B84	207	258	133	206	Sandy Beach, way point 106	3	Saluda Shoals Park	2	1/8/2003	4/2/2003
28	red	C59	260	308	238	313	downstream of Hope Ferry Landing	4	Saluda Shoals Park	2	1/8/2003	4/2/2003
29	red	64K	231	275	125	228	Corley Island shoal	7	Saluda Shoals Park	2	1/8/2003	4/3/2003
30	red	50G	226	290	162	227	Corley Island shoal	7	Saluda Shoals Park	2	1/8/2003	4/3/2003
31	red	P13	250	285	183	252	Corley Island shoal	7	Allied Signal	3	1/9/2003	4/3/2003
32	red	88L	185	279	70	243	Corley Island shoal	7	Allied Signal	3	1/9/2003	4/3/2003

	Tag Color	Tag Number	Stocked Total Length (mm)	Recaptured Total Length (mm)	Stock Weight (g)	Recaptured Weight (g)	Location Recaptured	Location on Figure B-1 (blue except where noted)	Location Stocked	Location on Figure B-1 (Red unless noted	Stock Date	Recaptured Date
33	red	77D	236	275	168	227	Corley Island shoal	7	Allied Signal	3	1/9/2003	4/3/2003
34	red	E36	237	280	166	227	above Sandy Beach (near shoal)	2	Allied Signal	3	1/9/2003	4/28/2003
35	red	E17	213	282	130	240	above Sandy Beach (near shoal)	2	Lake Murray Dam	1	1/7/2003	4/28/2003
36	red	85E	220	304	130	319	Upstream of Rawls Creek at shoal	5	Saluda Shoals Park	2	1/8/2003	4/28/2003
37	red	A44	228	305	171	333	Upstream of Rawls Creek at shoal	5	Saluda Shoals Park	2	1/8/2003	4/28/2003
38	red	80M	219	271	124	230	Corley Island shoal	7	Allied Signal	3	1/9/2003	4/28/2003
39	red	92I	264	315	223	339	downstream of I-20 bridge	11	Allied Signal	3	1/9/2003	5/1/2003
40	red	P97	230	283	146	232	downstream of I-20 bridge	11	Allied Signal	3	1/9/2003	5/1/2003
41	red	51D	217	280	125	242	Honeywell Intake	9	Saluda Shoals Park	2	1/8/2003	5/1/2003
42	red	P95	226	298	130	311	Honeywell Intake	9	Allied Signal	3	1/9/2003	5/1/2003
43	red	52M	240	296	157	282	Corley Island shoal	7	Allied Signal	3	1/9/2003	5/1/2003
44	red	V97	217	284	150	272	Corley Island shoal	7	Allied Signal	3	1/9/2003	5/1/2003
45	red	63C	228	301	155	282	Honeywell Intake	9	Saluda Shoals Park	2	1/7/2003	5/20/2003
46	red	K51	223	278	112	206	Honeywell Intake	9	Lake Murray Dam	1	1/8/2003	5/20/2003
47	red	P72	228	289	126	222	Honeywell Intake	9	Allied Signal	3	1/9/2003	5/20/2003
48	red	07I	255	317	235	326	Honeywell Intake	9	Allied Signal	3	1/9/2003	5/20/2003
49	red	F67	224	313	168	339	asphalt plant, mile 4+	11	Allied Signal	3	1/9/2003	5/20/2003
50	red	H29	205	280	91	231	Corley Island shoal, mile 7+	7	Allied Signal	3	1/9/2003	5/20/2003
51	red	82H	221	329	141	434	Corley Island shoal, mile 7+	7	Saluda Shoals	3	1/8/2003	5/20/2003
52	red	23K	245	311	180	298	tailrace boat ramp & upstream	1 (red)	Lake Murray Dam	1	1/7/2003	6/2/2003
53	red	19B	232	320	102	343	downstream of Saluda Shoals	4	Lake Murray Dam	1	1/7/2003	6/2/2003

	Tag Color	Tag Number	Stocked Total Length (mm)	Recaptured Total Length (mm)	Stock Weight (g)	Recaptured Weight (g)	Location Recaptured	Location on Figure B-1 (blue except where noted)	Location Stocked	Location on Figure B-1 (Red unless noted	Stock Date	Recaptured Date
54	red	50N	243	335	179	397	downstream of Saluda Shoals Park	4	Saluda Shoals	2	1/8/2003	6/2/2003
55	red	P41	203	289	149	264	downstream of Saluda Shoals Park, above "Logan's Point"	5	Saluda Shoals	2	1/8/2003	6/2/2003
56	orange	V09	224	258	119	194	Sandy Beach, way point 106	3	Lake Murray Dam	1	2/11/2003	4/2/2003
57	orange	I77	232	277	141	222	Sandy Beach, way point 106	3	Lake Murray Dam	1	2/11/2003	4/2/2003
58	orange	D20	247	273	165	244	downstream of Hope Ferry Landing	4	Lake Murray Dam	1	2/11/2003	4/2/2003
59	orange	Y10	233	244	153	161	Corley Island shoal	7	Saluda Shoals Park	2	2/12/2003	4/3/2003
60	orange	88J	217	247	112	168	Corley Island shoal	7	Quail Hollow	4	2/13/2003	4/3/2003
61	orange	N04	235	252	136	166	Corley Island shoal	7	Saluda Shoals Park	2	2/12/2003	4/3/2003
62	orange	47A	247	265	145	210	Corley Island shoal	7	Saluda Shoals Park	2	2/12/2003	4/3/2003
63	orange	46V	222	227	102	147	downstream of I-20 at house	10	Quail Hollow	4	2/13/2003	4/3/2003
64	orange	73V	218	254	113	185	tailrace, near spillway inflow	1	Lake Murray Dam	1	2/11/2003	4/28/2003
65	orange	G07	212	251	107	171	above Sandy Beach ("flat")	2	Lake Murray Dam	1	2/11/2003	4/28/2003
66	orange	U87	219	260	118	215	above Sandy Beach (near shoal)	2	Lake Murray Dam	1	2/11/2003	4/28/2003
67	orange	26V	220	252	154	179	above Sandy Beach (near shoal)	2	Lake Murray Dam	1	2/11/2003	4/28/2003
68	orange	90P	208	260	108	214	Upstream of Rawls Creek at shoal	5	Lake Murray Dam	1	2/11/2003	4/28/2003
69	orange	09Y	186	288	62	246	downstream of I-20 bridge	5	Lake Murray Dam	1	2/11/2003	5/1/2003
70	orange	Y79	249	295	146	266	downstream of I-20 bridge	10	Quail Hollow	4	2/13/2003	5/1/2003

	Tag Color	Tag Number	Stocked Total Length (mm)	Recaptured Total Length (mm)	Stock Weight (g)	Recaptured Weight (g)	Location Recaptured	Location on Figure B-1 (blue except where noted)	Location Stocked	Location on Figure B-1 (Red unless noted	Stock Date	Recaptured Date
71	orange	13B	225	265	126	218	downstream of I-20 bridge	10	Saluda Shoals Park	2	2/12/2003	5/1/2003
72	orange	74A	232	270	124	186	downstream of I-20 bridge	10	Quail Hollow	4	2/13/2003	5/1/2003
73	orange	M37	249	264	131	208	Honeywell intake area	9	Saluda Shoals Park	2	2/12/2003	5/1/2003
74	orange	18A	236	257	143	165	Honeywell intake area	9	Saluda Shoals Park	2	2/12/2003	5/1/2003
75	orange	73B	224	274	131	211	Corley Island shoal	7	Lake Murray Dam	1	2/11/2003	5/1/2003
76	orange	R44	261	306	183	360	asphalt plant, mile 4+	11	Quail Hollow	4	2/13/2003	5/20/2003
77	orange	62P	203	264	112	193	BC Components intake	8	Saluda Shoals	2	2/12/2003	5/20/2003
78	orange	J45	230	273	148	216	BC Components intake	8	Saluda Shoals	2	2/12/2003	5/20/2003
79	orange	D60	203	241	106	130	Corley Island shoal, mile 7+	7	Quail Hollow	4	2/13/2003	5/20/2003
80	orange	R77	216	280	100	250	Corley Island shoal, mile 7+	7	Saluda Shoals	2	2/12/2003	5/20/2003
81	orange	17C	223	282	142	239	downstream of Saluda Shoals Park	4	Lake Murray Dam	1	2/11/2003	6/2/2003
82	green	R76	267	278	234	243	Sandy Beach, way point 106	3	Lake Murray Dam	1	3/11/2003	4/2/2003
83	green	R79	260	258	173	165	SCE&G boat landing - tailrace, way point 108	1 (red)	Lake Murray Dam	1	3/11/2003	4/2/2003
84	green	Z71	237	279	215	243	downstream of Hope Ferry Landing	4	Quail Hollow	4	3/14/2003	4/2/2003
85	green	22R	215	226	134	126	Corley Island shoal	7	Allied Signal	3	3/13/2003	4/3/2003
86	green	98G	220	230	140	155	Corley Island shoal	7	Saluda Shoals Park	2	3/12/2003	4/3/2003
87	green	L34	245	245	192	177	Corley Island shoal	7	Saluda Shoals Park	2	3/12/2003	4/3/2003

	Tag Color	Tag Number	Stocked Total Length (mm)	Recaptured Total Length (mm)	Stock Weight (g)	Recaptured Weight (g)	Location Recaptured	Location on Figure B-1 (blue except where noted)	Location Stocked	Location on Figure B-1 (Red unless noted	Stock Date	Recaptured Date
88	green	O00	215	270	108	220	above Sandy Beach (near shoal)	2	Saluda Shoals Park	2	3/12/2003	4/28/2003
89	green	N24	242	266	176	225	Sandy Beach	3	Lake Murray Dam	1	3/11/2003	4/28/2003
90	green	47G	238	265	173	203	Sandy Beach	3	Lake Murray Dam	1	3/11/2003	4/28/2003
91	green	81L	236	265	148	191	Upstream of Rawls Creek at shoal	5	Lake Murray Dam	1	3/11/2003	4/28/2003
92	green	O57	244	280	154	219	downstream of I-20 bridge	11	Quail Hollow	4	3/14/2003	5/1/2003
95	green	S64	280	300	255	327	downstream of I-20 bridge	11	Quail Hollow	4	3/14/2003	5/1/2003
93	green	91Y	246	278	177	222	downstream of I-20 bridge	11	Quail Hollow	4	3/14/2003	5/1/2003
94	green	37G	235	269	152	238	Honeywell Intake	9	Lake Murray Dam	1	3/11/2003	5/1/2003
95	green	Z21	237	285	215	301	Corley Island shoal	7	Saluda Shoals Park	2	3/12/2003	5/1/2003
96	green	30T	238	280	138	204	Quail Hollow, mile 3 to mile 4	12	Quail Hollow	4	3/14/2003	5/20/2003
97	green	H42	252	305	178	213.0	Honeywell Intake	9	Quail Hollow	4	3/14/2003	5/20/2003
98	green	11C	230	272	178	204.0	Honeywell Intake	9	Saluda Shoals	2	3/12/2003	5/20/2003
100	green	P34	281	326	252	366	BC Components intake	8	Quail Hollow	4	3/14/2003	5/20/2003
101	green	82R	230	272	186	189	asphalt plant, mile 4+	11	Quail Hollow	4	3/14/2003	5/20/2003
102	green	T65	216	284	167	216	upstream of I-20, ~mile 4.5	13	Quail Hollow	4	3/14/2003	5/20/2003
103	green	G41	300	334	360	372	BC Components intake	8	Lake Murray Dam	1	3/11/2003	5/20/2003
104	green	P89	235	285	145	286	Corley Island shoal, mile 7+	7	Saluda Shoals	2	3/12/2003	5/20/2003
105	green	09Y	225	272	155	186	Corley Island shoal, mile 7+	7	Lake Murray Dam	1	3/11/2003	5/20/2003
106	green	08R	210	262	134	209	Corley Island shoal, mile 7+	7	Lake Murray Dam	1	3/11/2003	5/20/2003

	Tag Color	Tag Number	Stocked Total Length (mm)	Recaptured Total Length (mm)	Stock Weight (g)	Recaptured Weight (g)	Location Recaptured	Location on Figure B-1 (blue except where noted)	Location Stocked	Location on Figure B-1 (Red unless noted	Stock Date	Recaptured Date
107	green	28B	193	213	88	74	tailrace boat ramp & upstream	1 (red)	Lake Murray Dam	1	3/11/2003	6/2/2003
108	green	G67	230	271	126	211.5	tailrace boat ramp & upstream	1 (red)	Lake Murray Dam	1	3/11/2003	6/2/2003
109	green	72Y	259	291	159	259.0	Sandy Beach (upstream of Saluda Shoals Park landing)	3	Lake Murray Dam	1	3/11/2003	6/2/2003
110	green	E35	250	284	157	213.0	Sandy Beach (upstream of Saluda Shoals Park landing)	3	Quail Hollow	4	3/14/2003	6/2/2003
111	green	N25	233	272	146	204.0	downstream of Saluda Shoals Park, above "Logan's Point"	5	Lake Murray Dam	1	3/11/2003	6/2/2003

Table B-3: Median growth rate (n) for each of the fourteen combinations of release site and release date. Overall median (n) growth rates are shown for each site, each date, and for all 111 recaptured trout. Growth rates are g/g/day and the overall rate of 0.0071 g/g/day is 0.71 percent weight gain per day.

	DEC.	**JAN.**	**FEB.**	**MAR.**	**ALL MONTHS**
Below Dam	0.0072 (2)	0.0070 (6)	0.0095 (11)	0.0048 (13)	**0.0075 (32)**
Saluda Shoals	0.0077 (11)	0.0083 (12)	0.0075 (9)	0.0063 (6)	**0.0076 (38)**
Allied Signal	0.0078 (6)	0.0065 (14)	No release	-0.0030 (1)	**0.0071 (21)**
Quail Hollow	0.0030 (4)	No release	0.0095 (6)	0.0055 (10)	**0.0056 (20)**
All Sites	**0.0071 (23)**	**0.0072 (32)**	**0.0083 (26)**	**0.0056 (30)**	**0.0071 (111)**

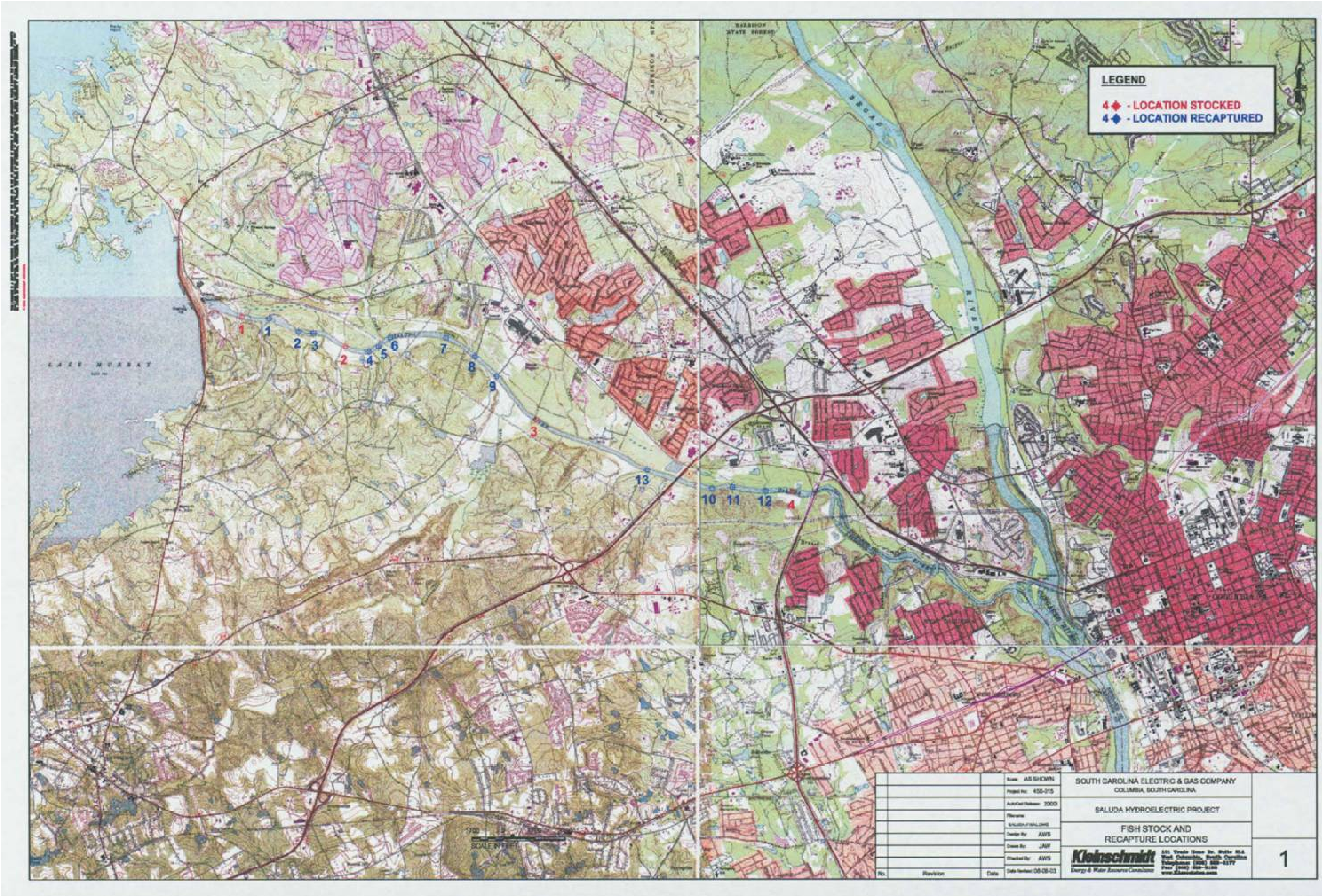


Figure B-1: **Fish Stock and Recapture Locations**

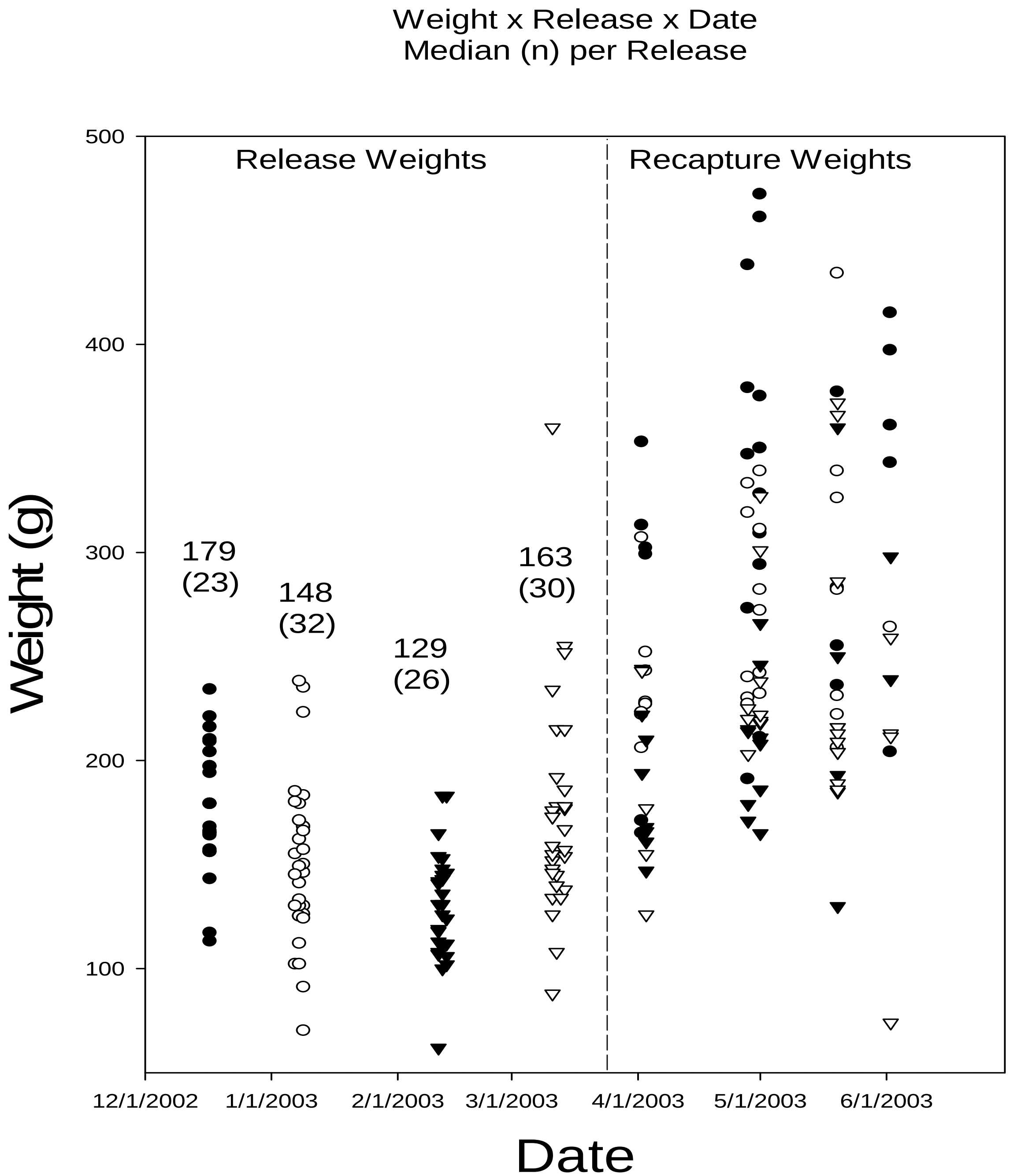
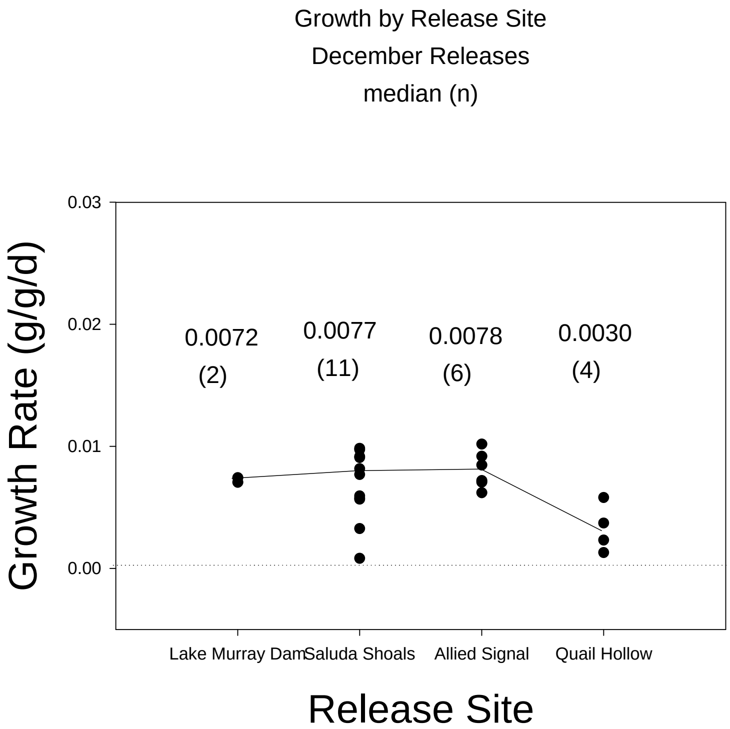


Figure B-2: Weight (g) of Recaptured Trout at Time of Release and Time of Recapture



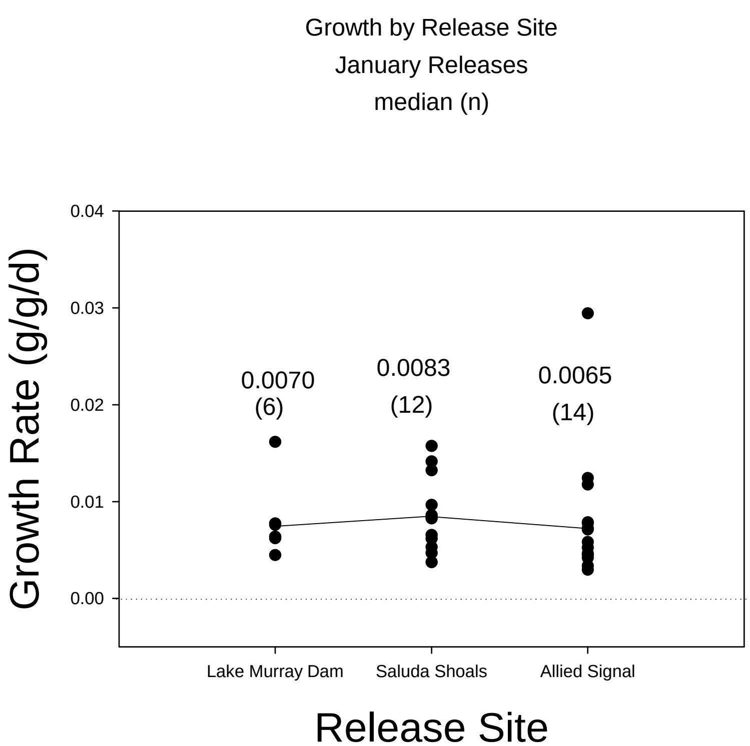
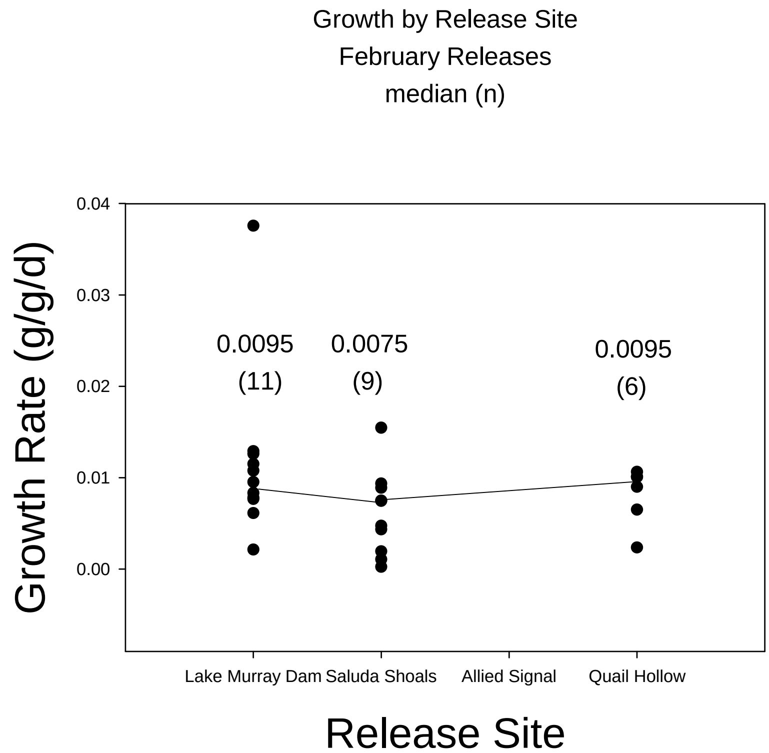


Figure B-2a: Growth Rate by Release Site for December and January Releases



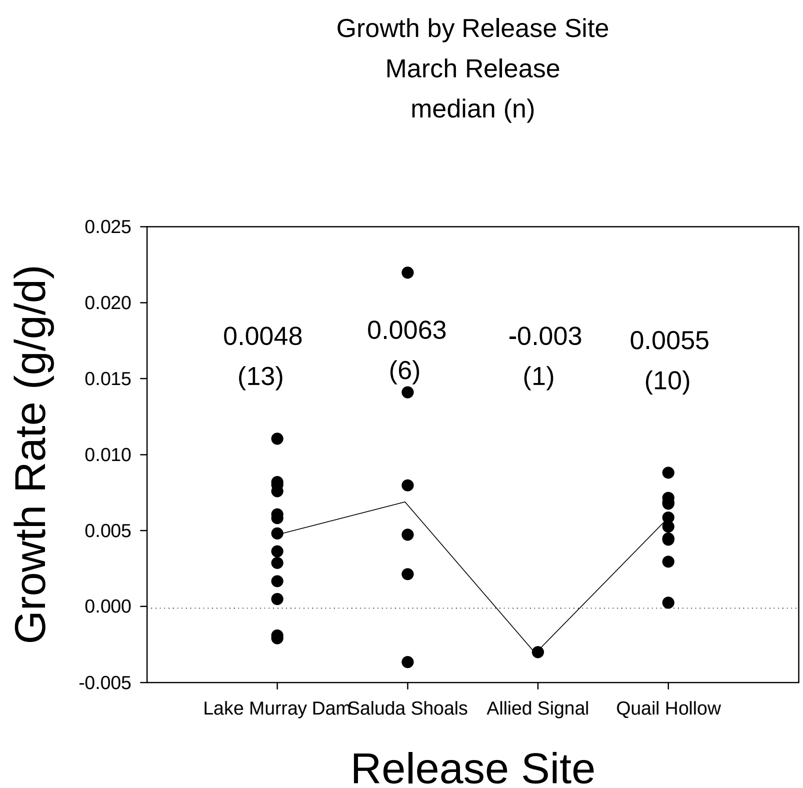


Figure B-2b: Growth Rate of Trout by Release Site for the February and March Releases

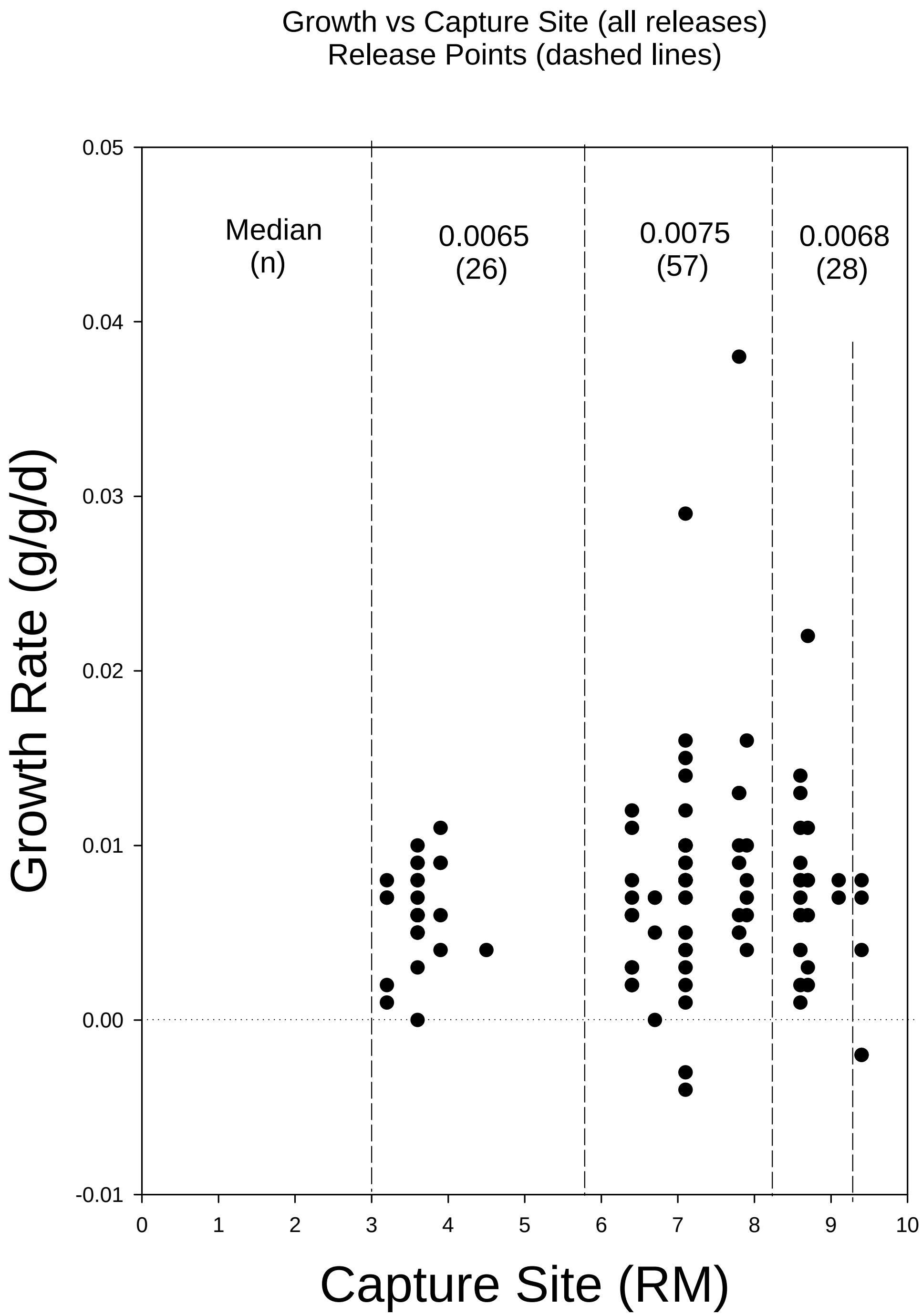


Figure B-3: Growth Rate is Shown as a Function of Recapture Location by River Mile. Release points are indicted by vertical dashed lines. From downstream to upstream these are Quail Hollow, Allied Signal, Saluda Shoals Park, and the immediate vicinity of the Lake Murray dam. No recapture efforts were made below the Quail Hollow release point (RM 3).

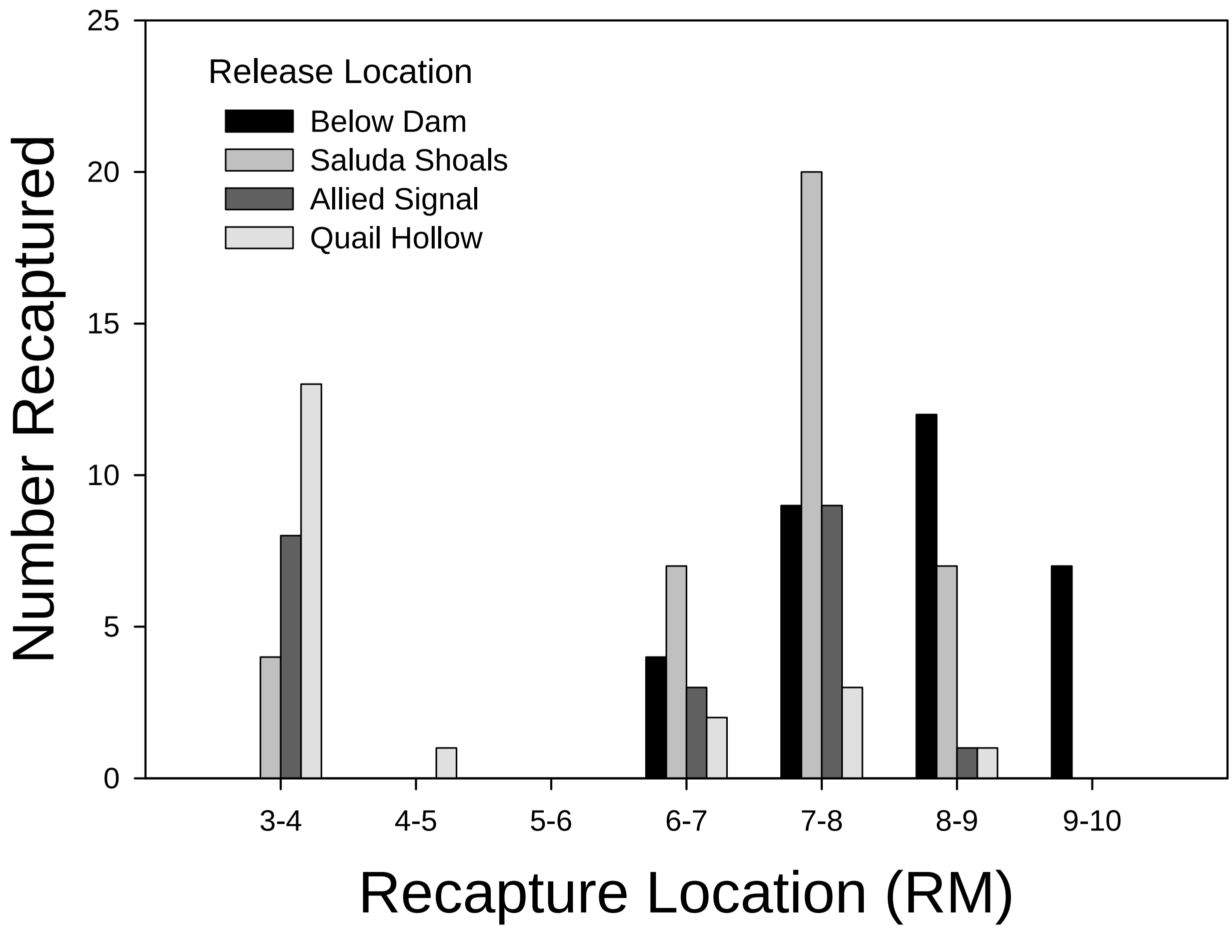


Figure B-4: Recapture Location (RM) and Site of Release. There was Limited Recapture Effort Between RM 4 and 6.

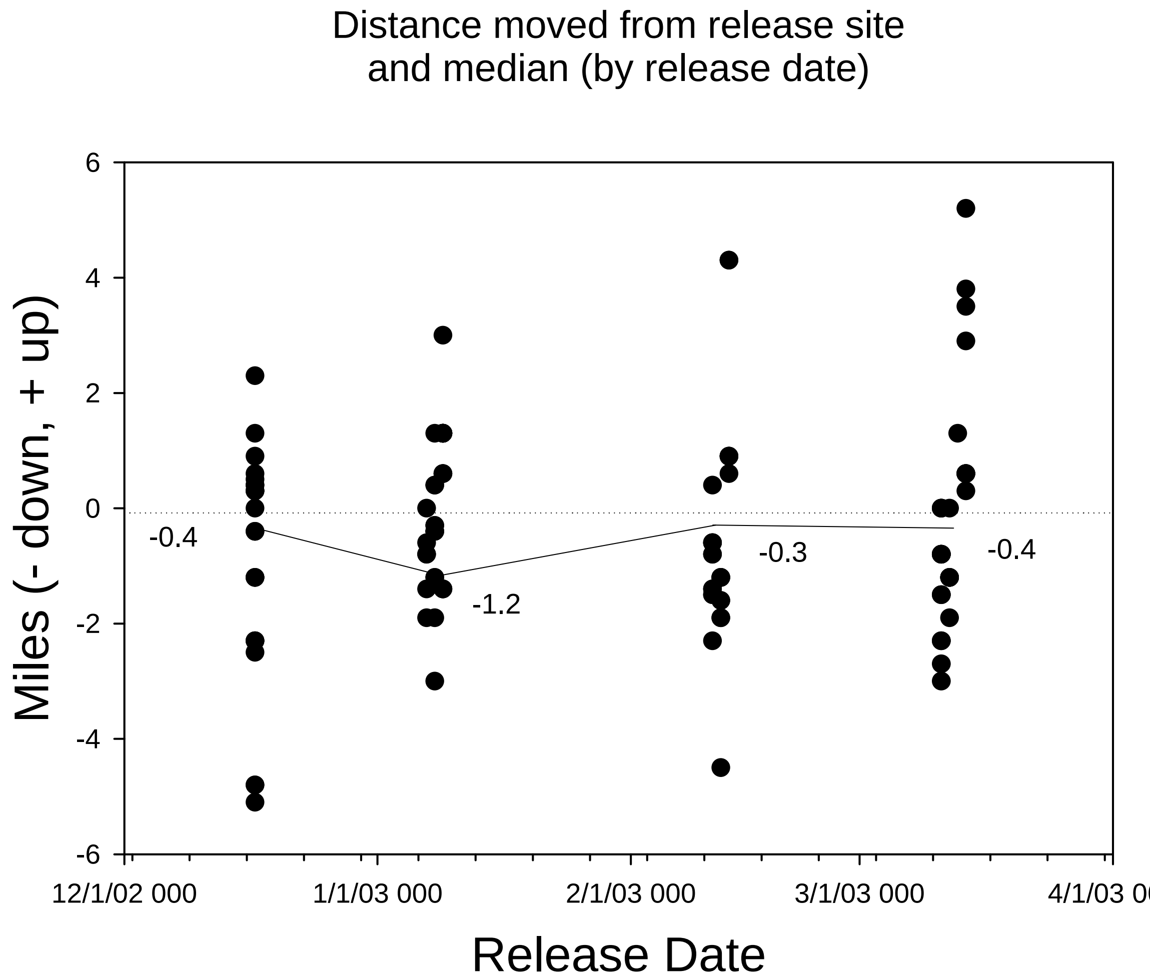


Figure B-5: Distance Moved from Release Site for Each Release Date. Median Distances are Shown on the Graph for each Release Date

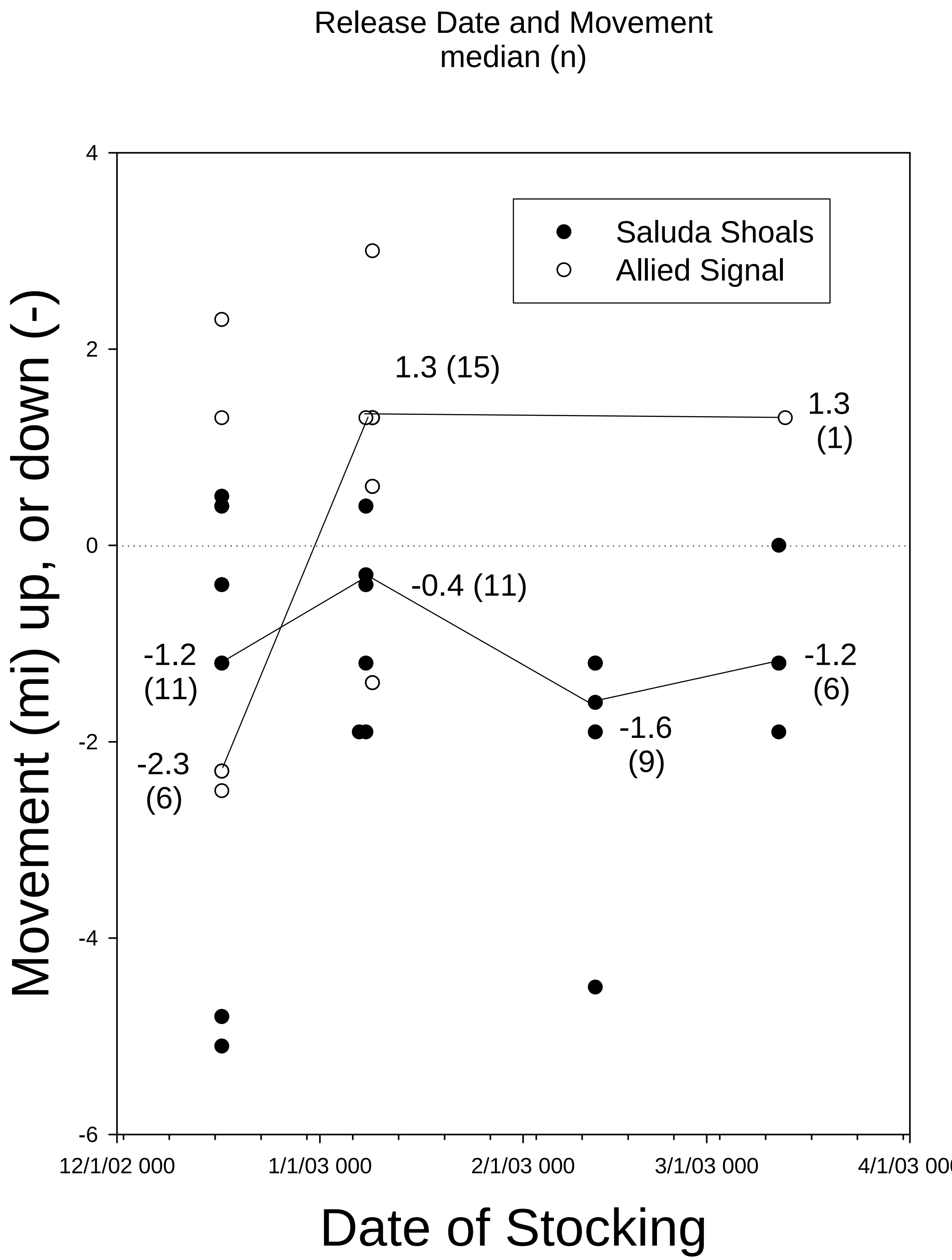


Figure B-6: Movement of Trout by Stocking Date from the Two Intermediate Release Sites where Upstream and Downstream Movement were not Limited by the Dam or by Sampling Site Limitations

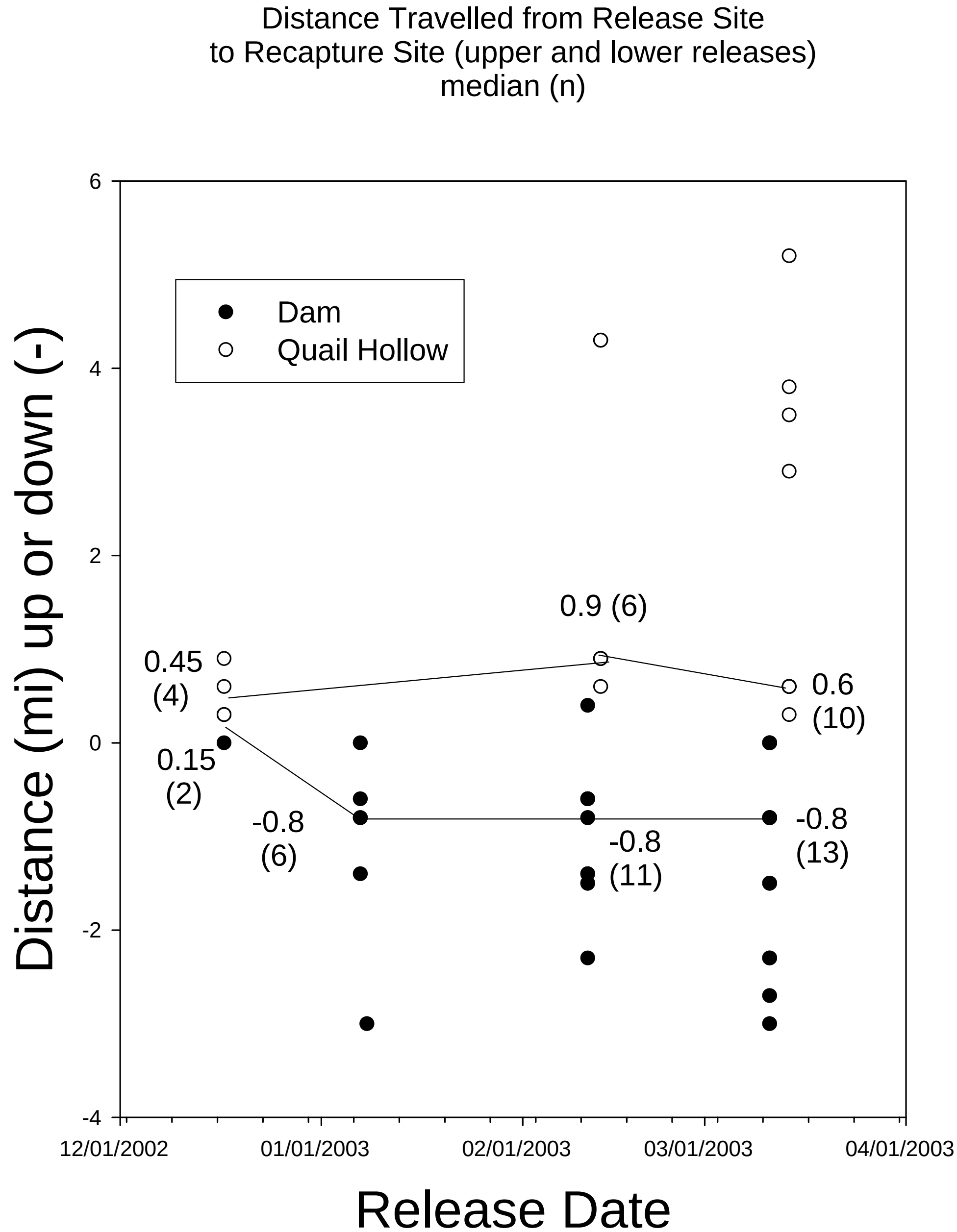


Figure B-7: Movement of Fish Following Release at Various Times at the Upstream Site Near Lake Murray Dam and at Quail Hollow

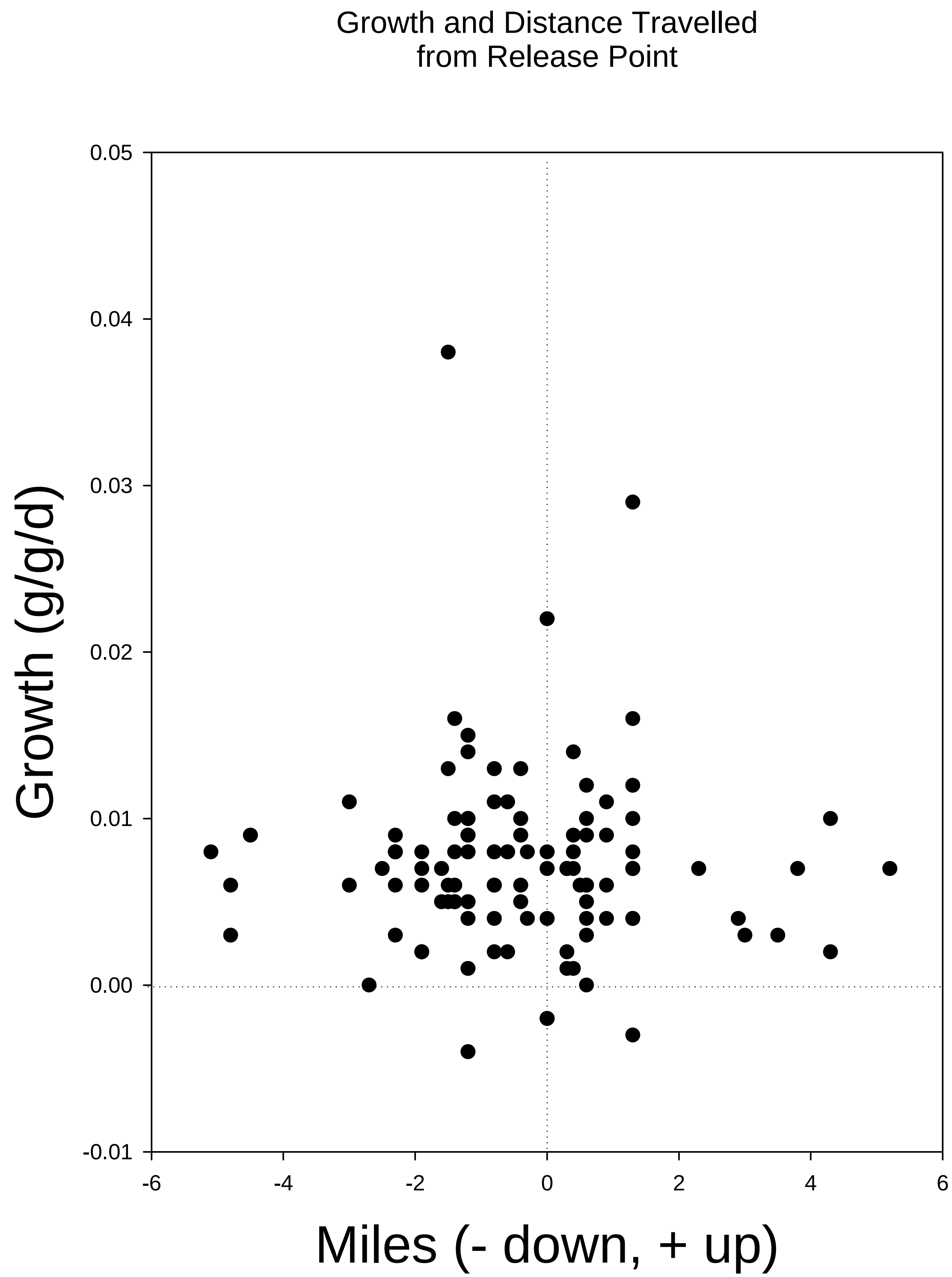


Figure B-8: This Figure Shows the Growth Rates for All 111 Fish as a Function of Their Movement Up or Downstream Following Release

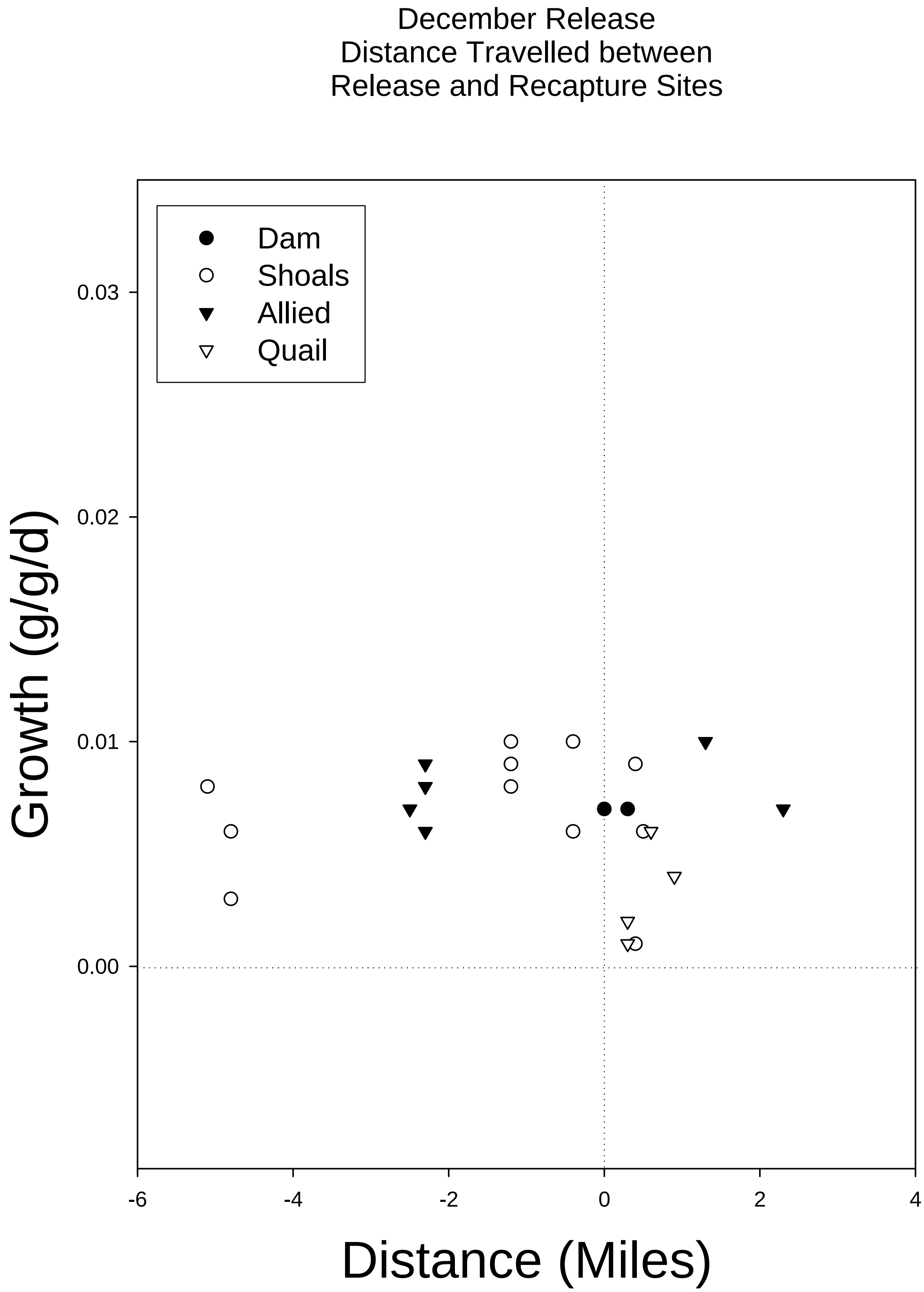


Figure B-9: Analysis of Growth Rate as a Function of Post-Release Movement for Fish Released in December at the Four Release Sites

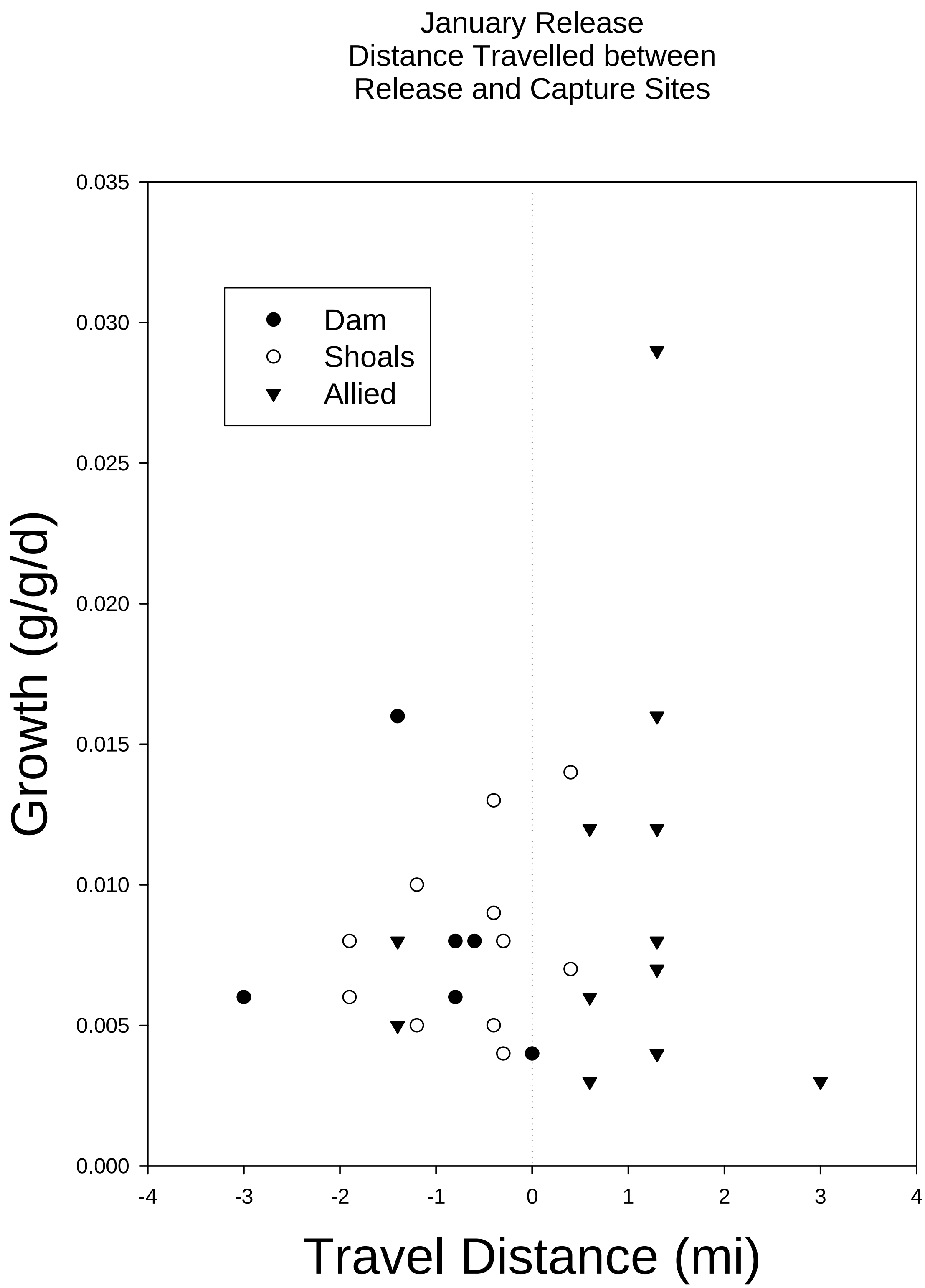


Figure B-10: Analysis of Growth Rate as a Function of Post-Release Movement for Fish Released in January at the Three Release Sites

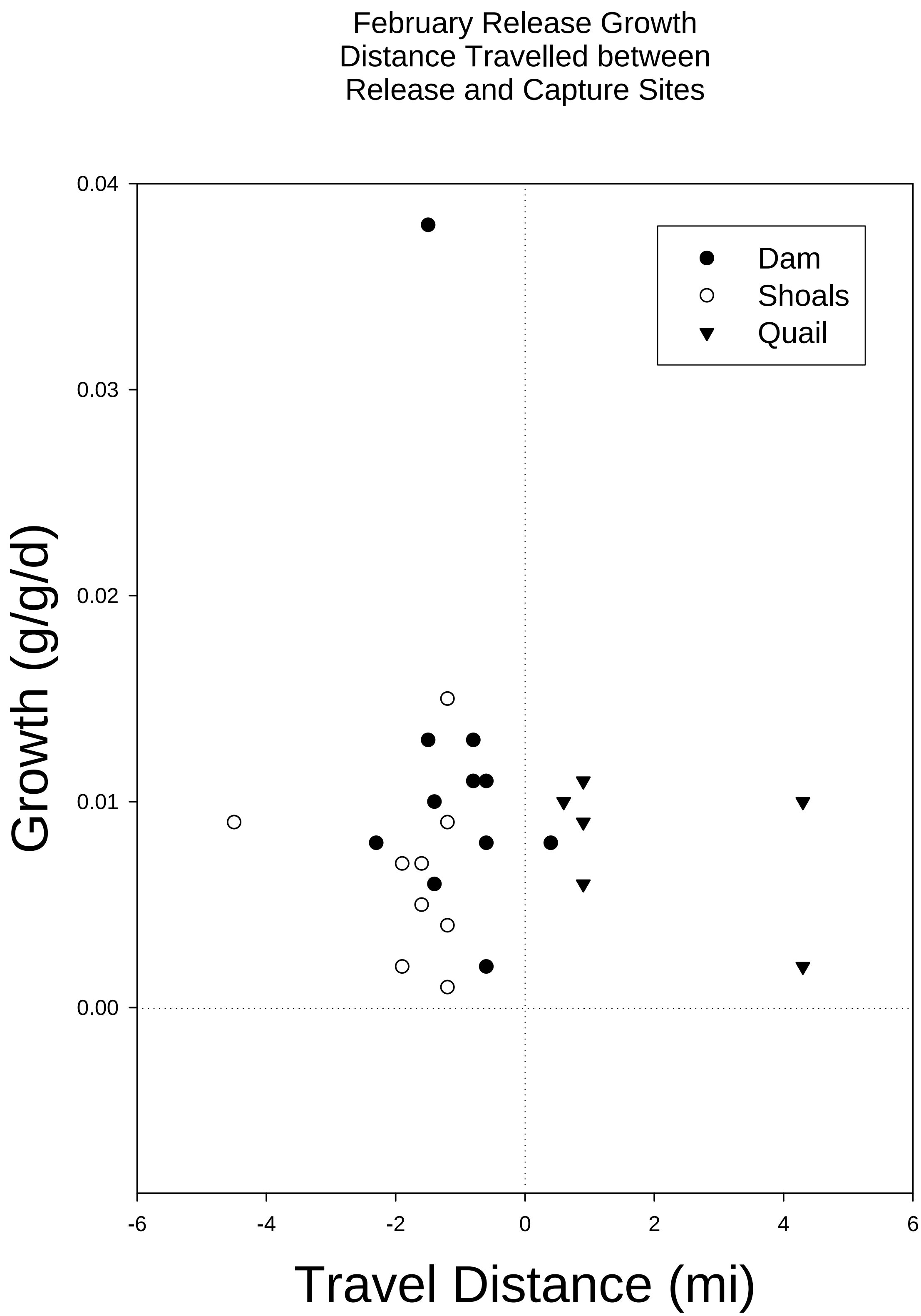


Figure B-11: Analysis of Growth Rate as a Function of Post-Release Movement for Fish Released in February at the Three Release Sites

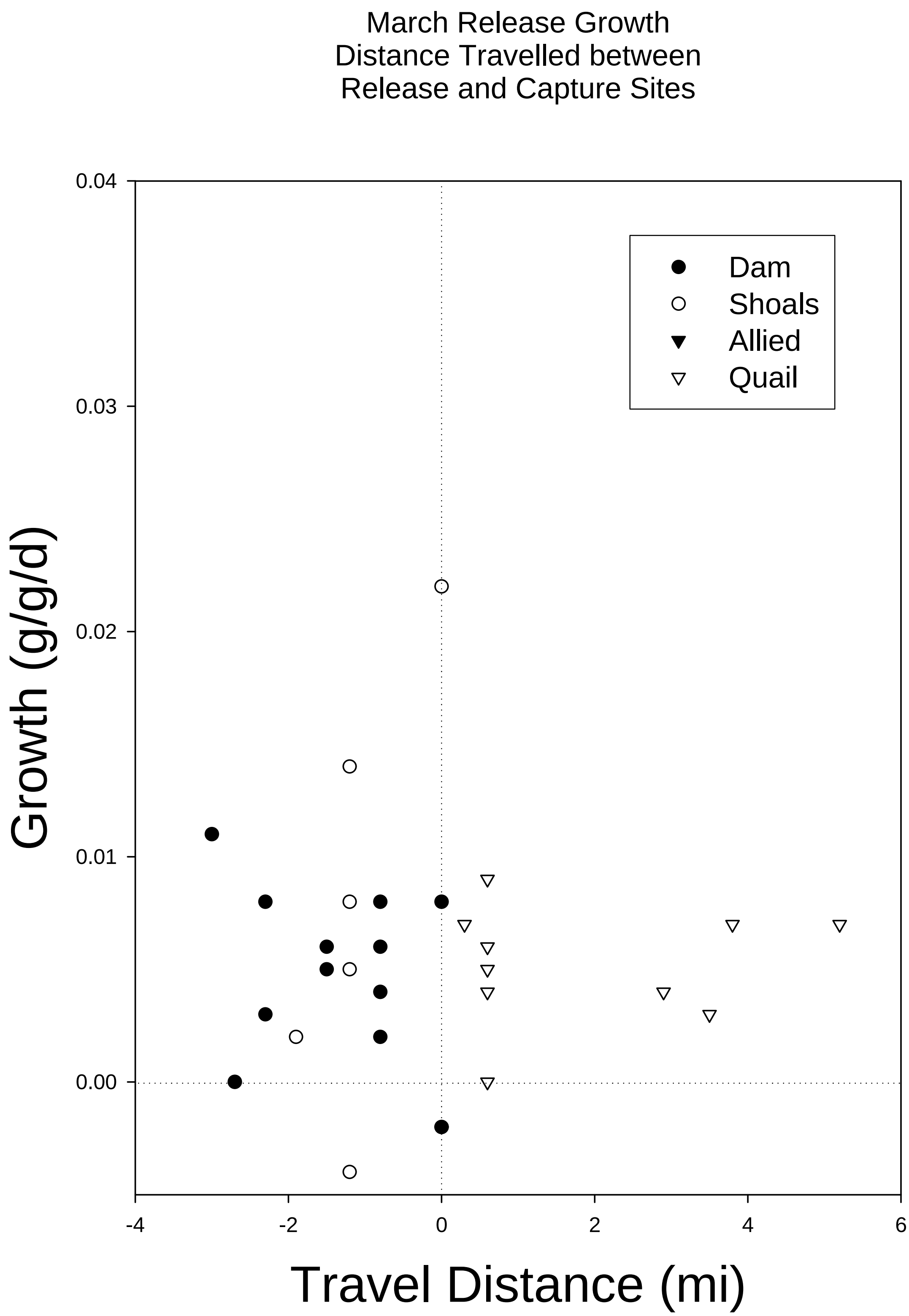


Figure B-12: Analysis of Growth Rate as a Function of Post-Release Movement for Fish Released in March at the Four Release Sites

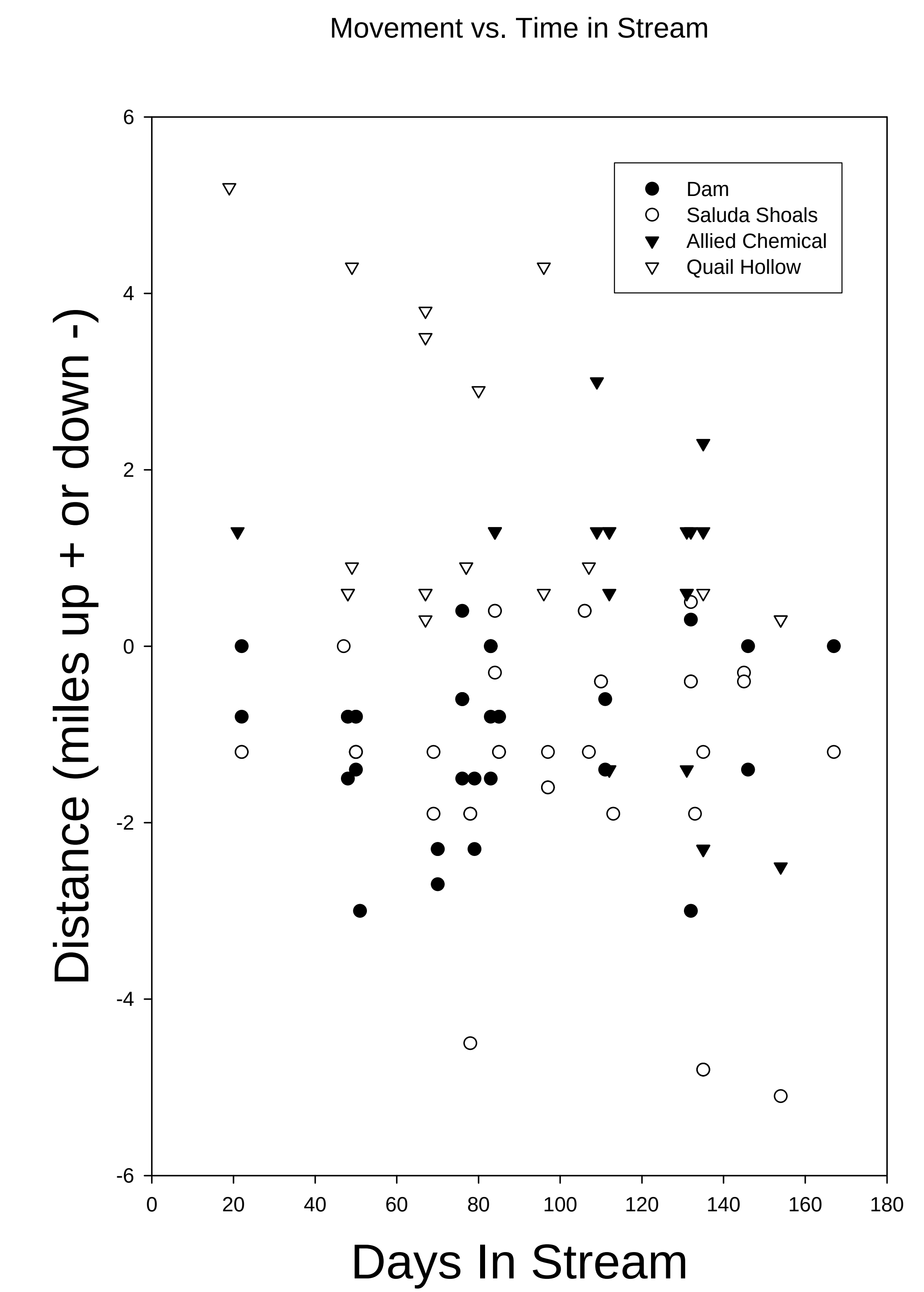


Figure B-13: Relationship Between Days in the Stream Between Release and Capture and the Distance Traveled from the Point of Release

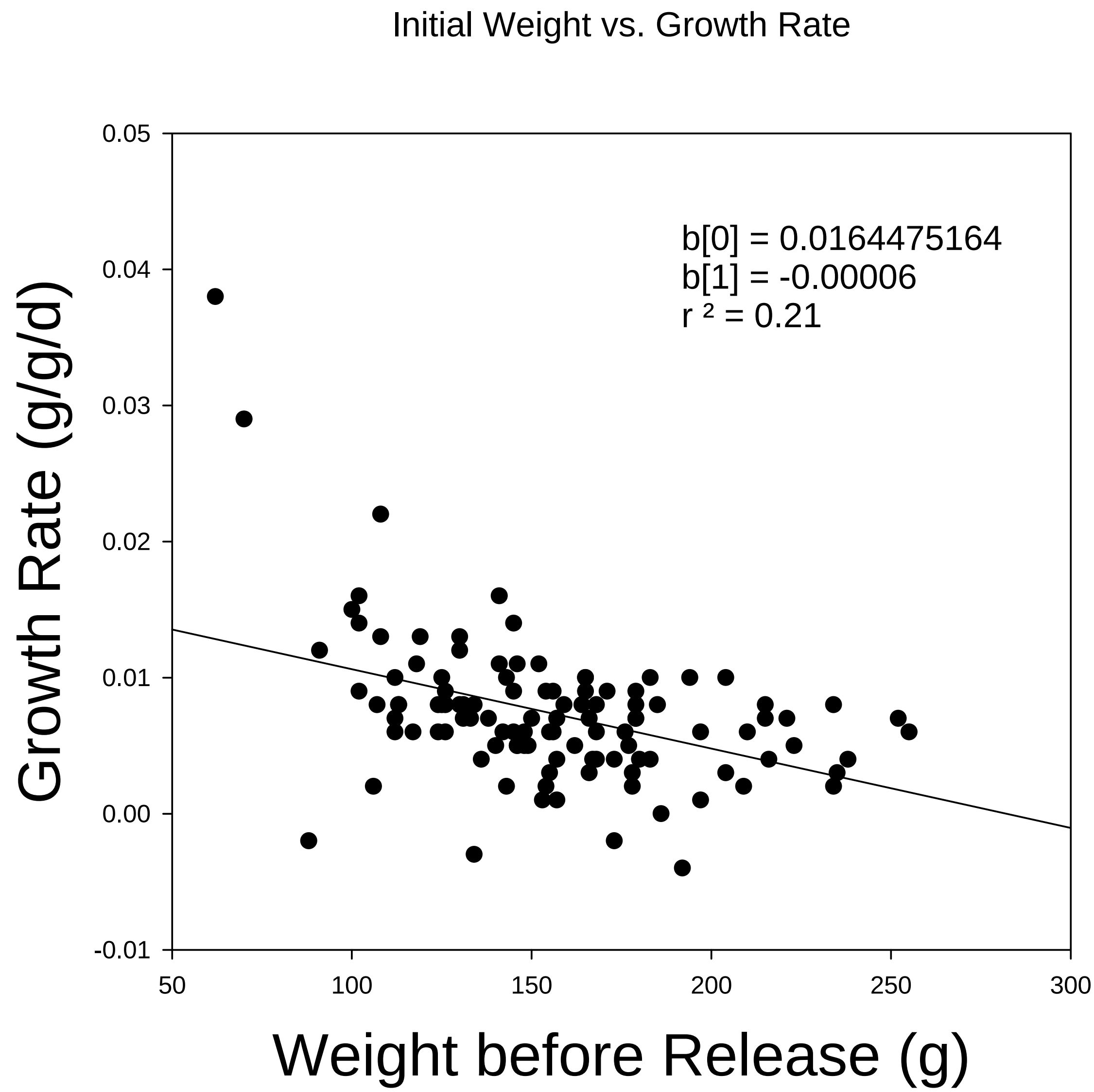


Figure B-14: The growth Rate of Trout in the LSR Showed a Slight Relationship with Size at Release

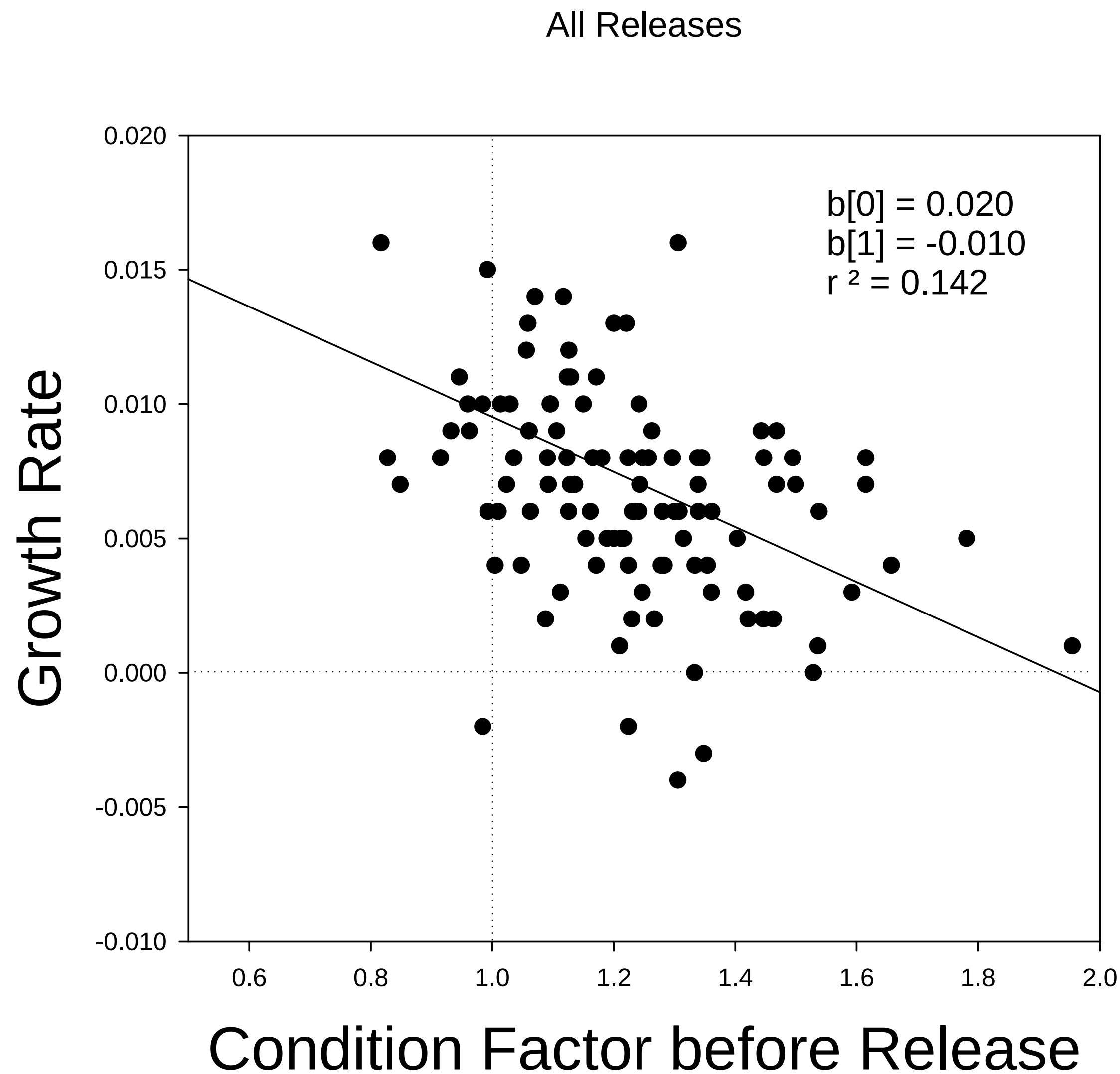


Figure B-15: Growth Rate was Greater in Fish with Lower Initial Condition Factors Following Release into the LSR

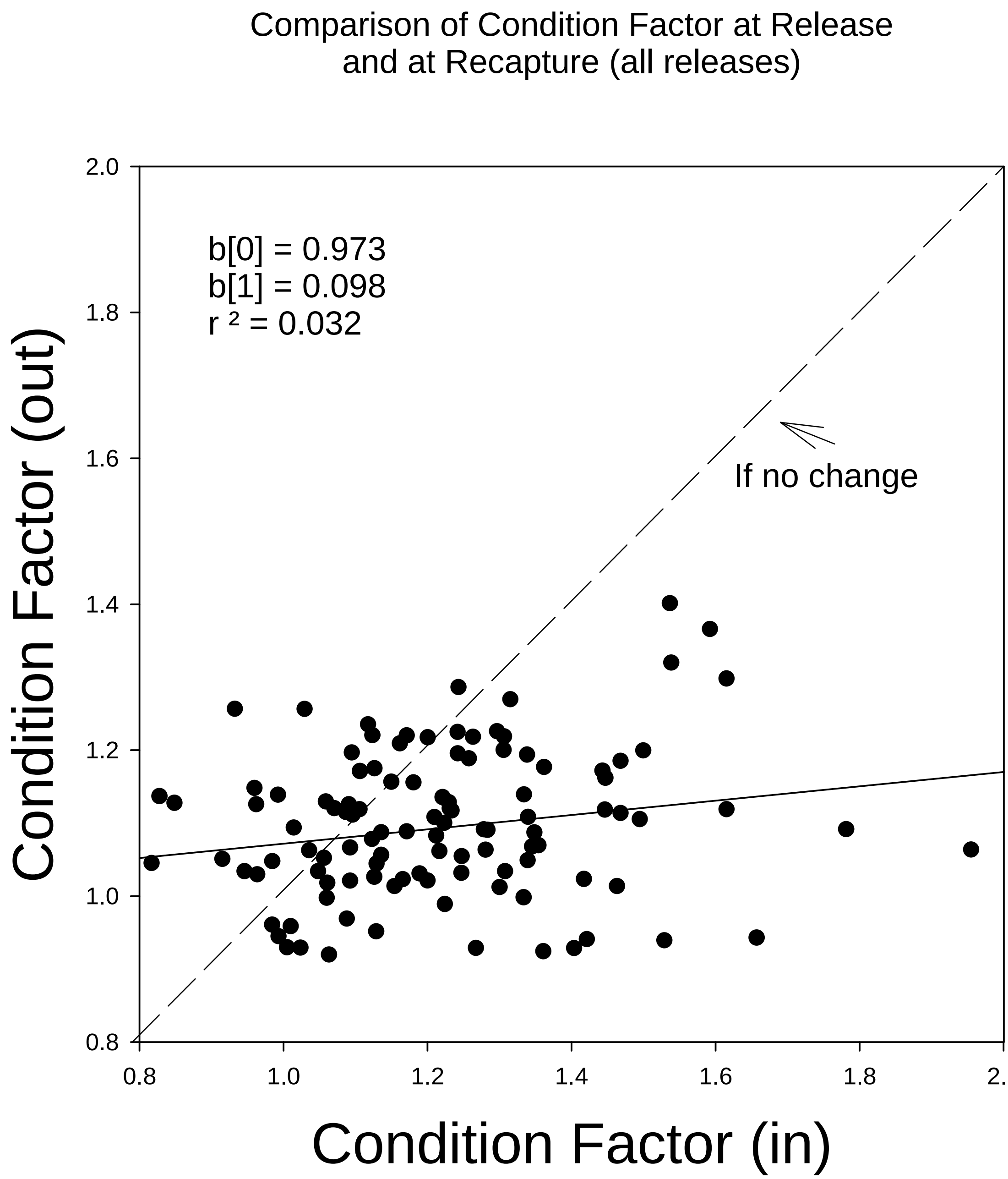
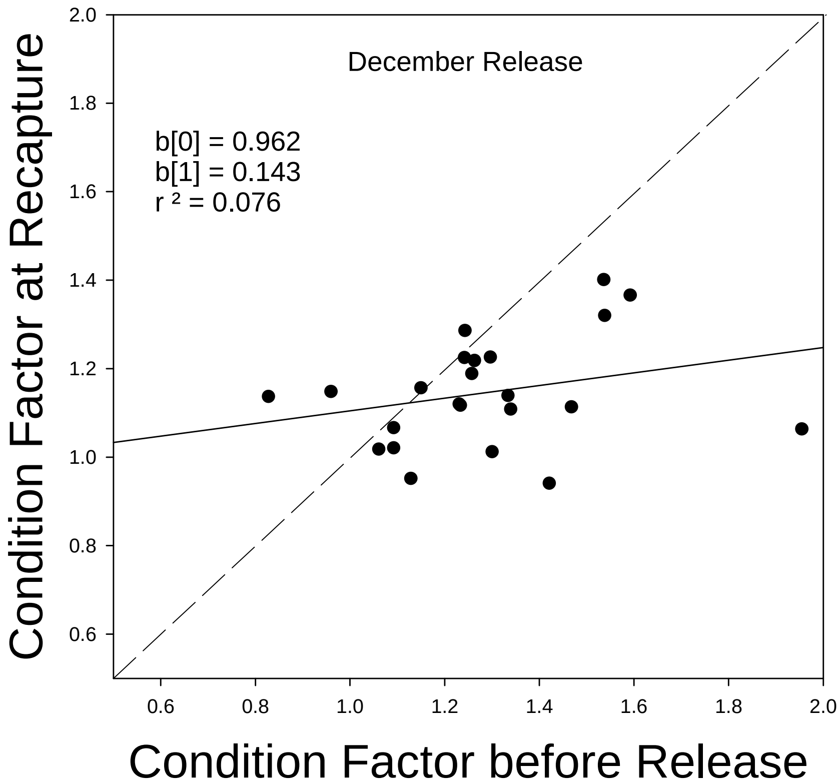


Figure B-16: The Condition of Trout in the LSR Became Much More Uniform Than That Seen at the Time of Release



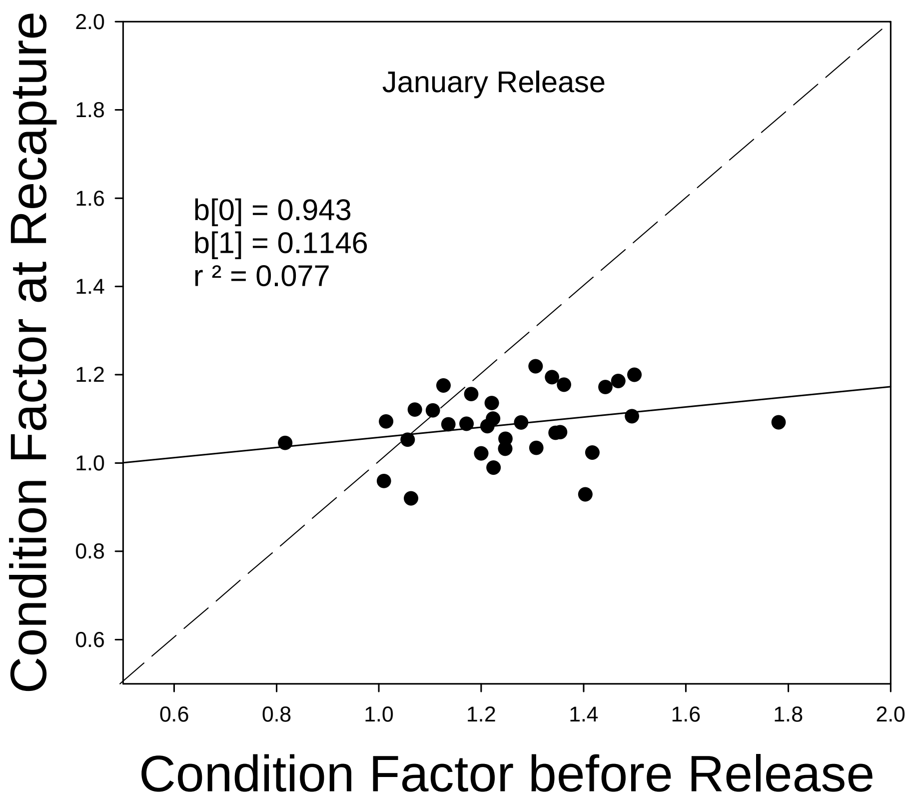


Figure B-17a: Condition Factor Change for December and January Releases

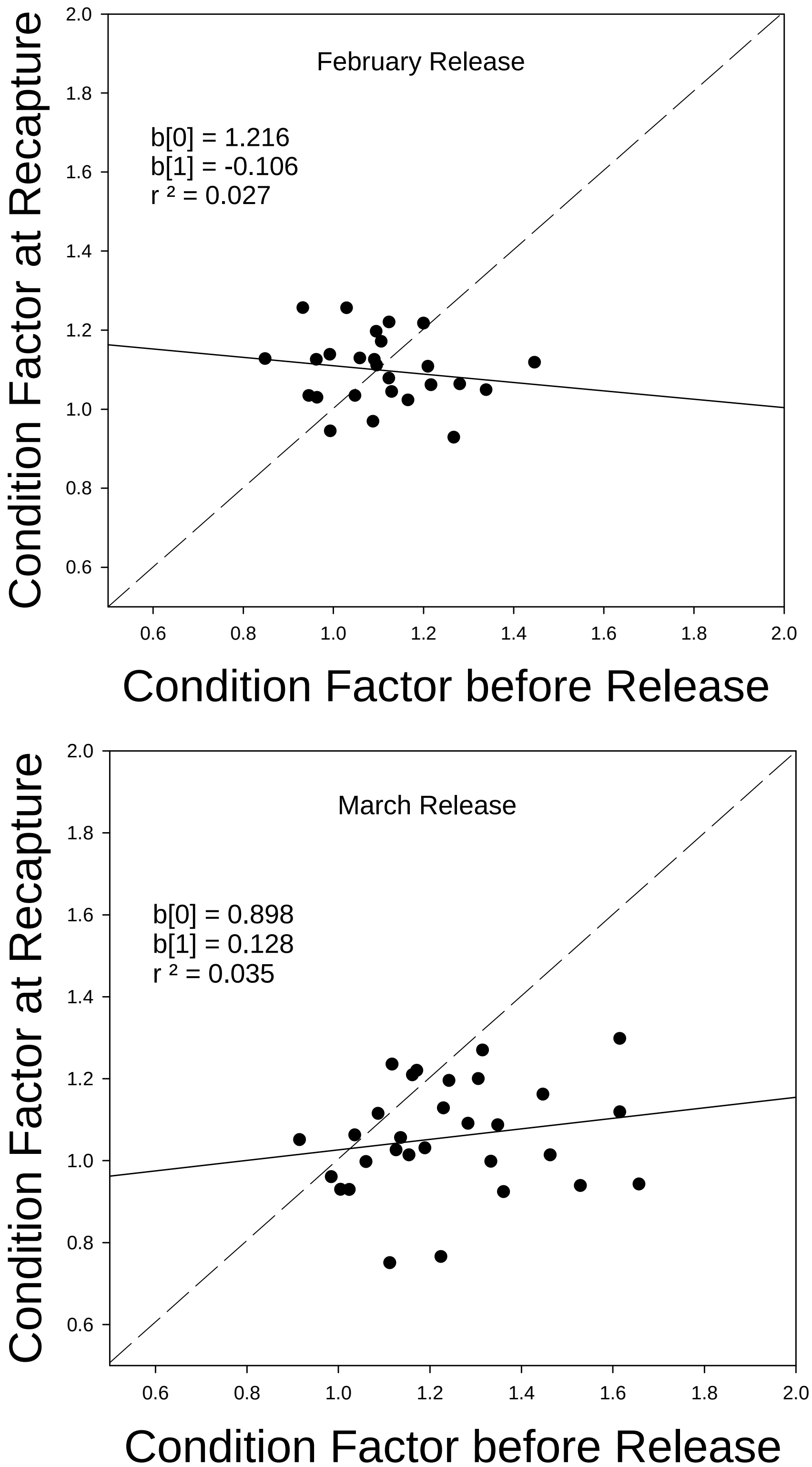


Figure B-17b:Condition Factor Change for January and March Releases

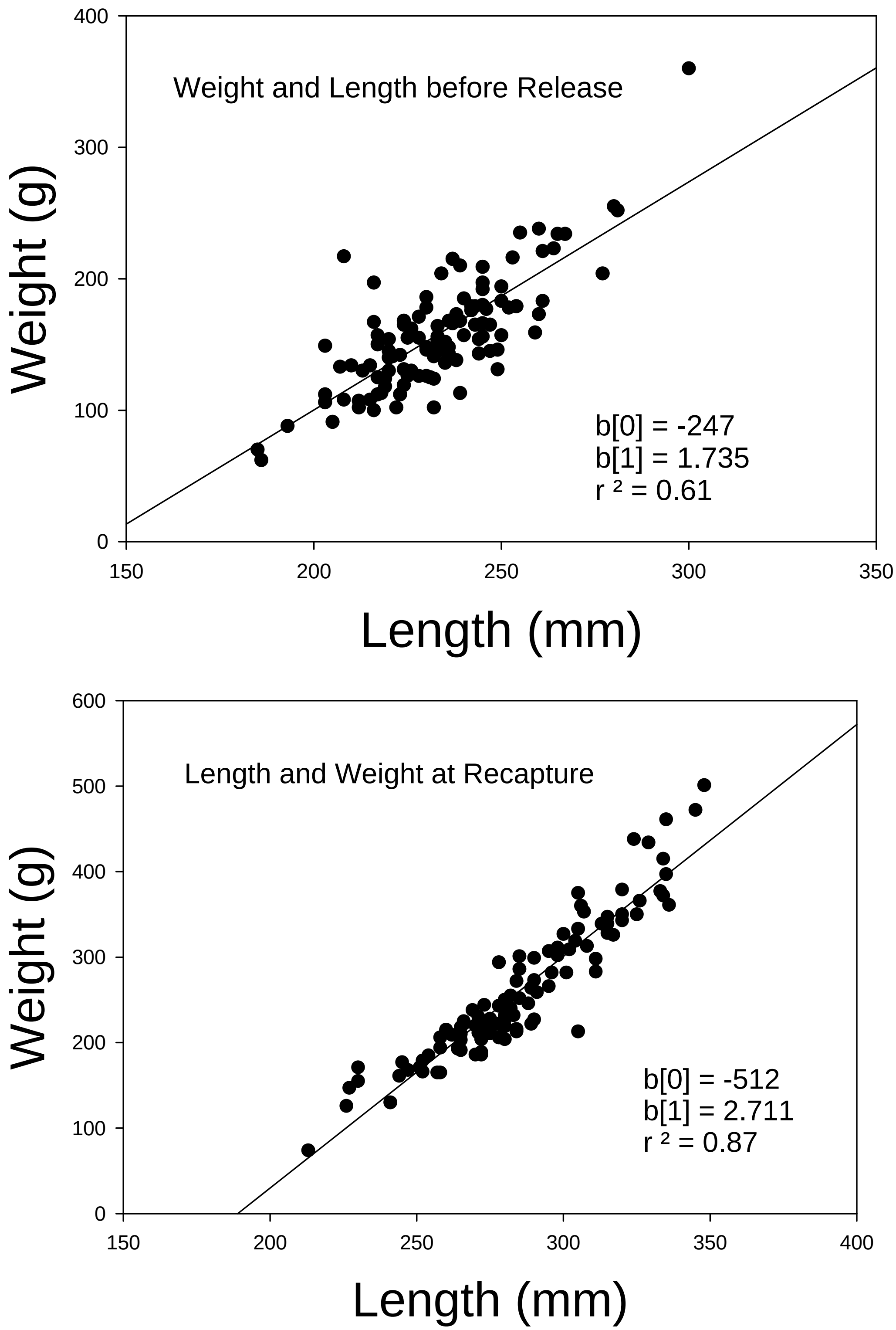


Figure B-18: Illustrating the Increased Uniformity of Trout Condition Following Release into the LSR

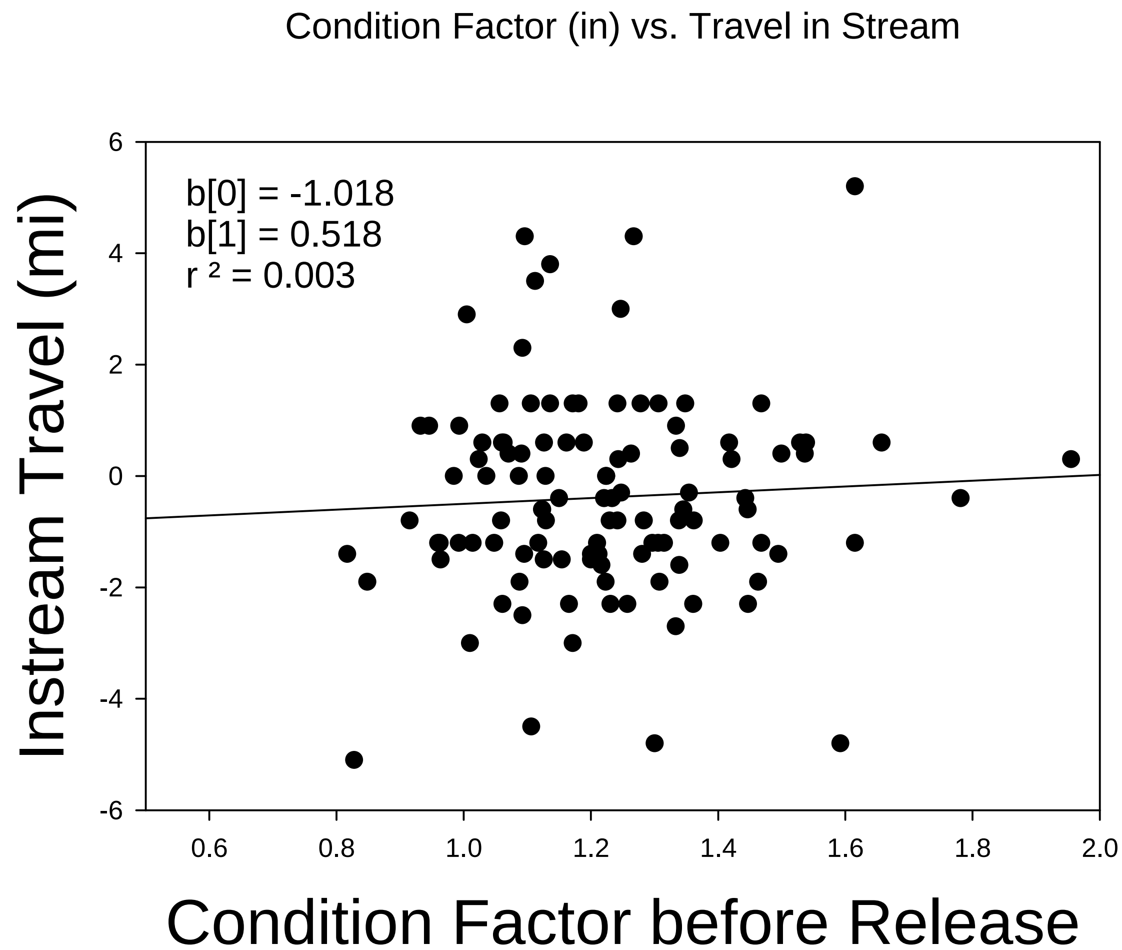


Figure B-19: There was No Significant Effect of Initial Condition Factor on the Tendency of Fish to Move Up or Downstream Following Release

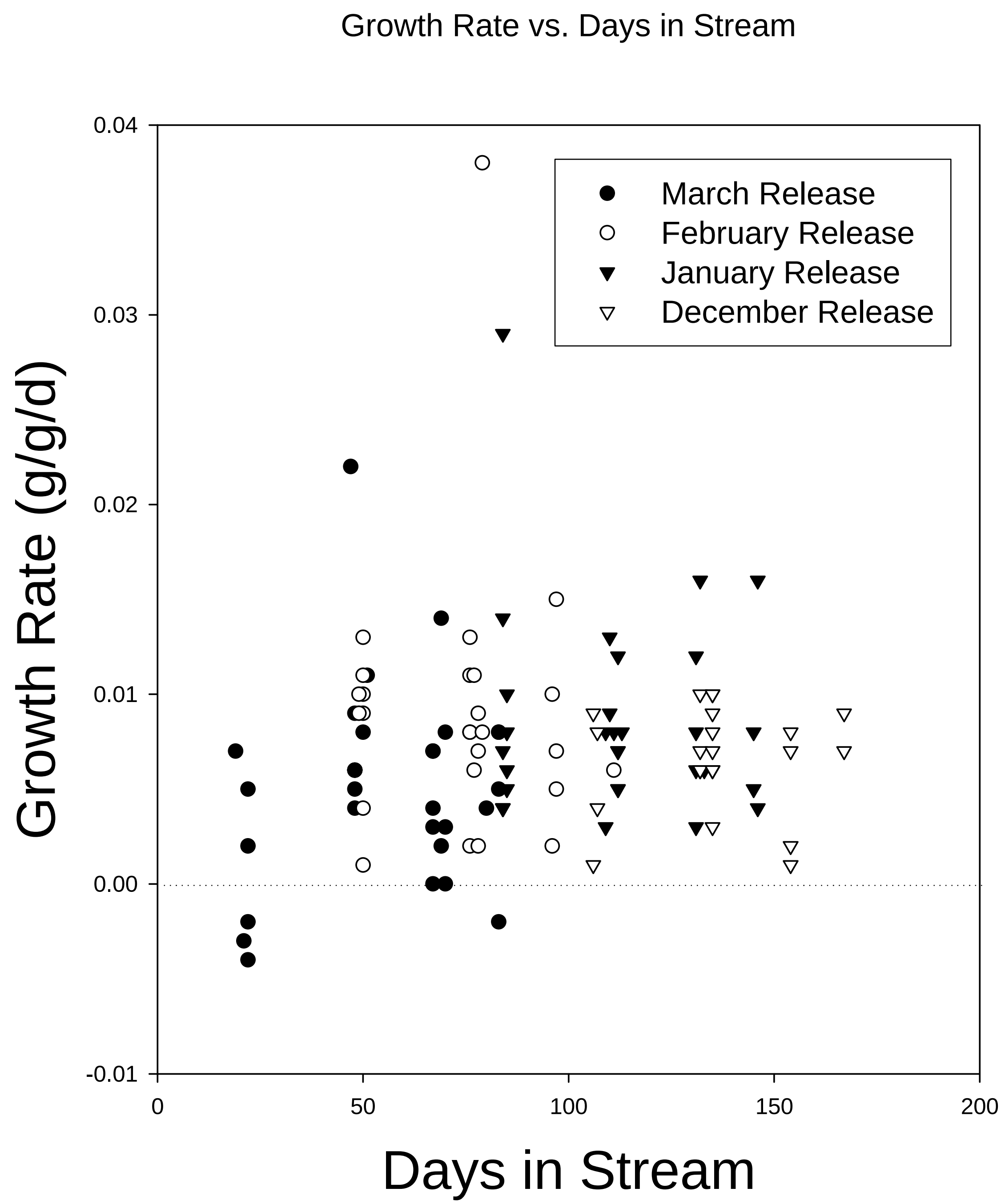


Figure B-20: There was No Appreciable Effect of Residency Duration on the Growth of Fish in the LSR

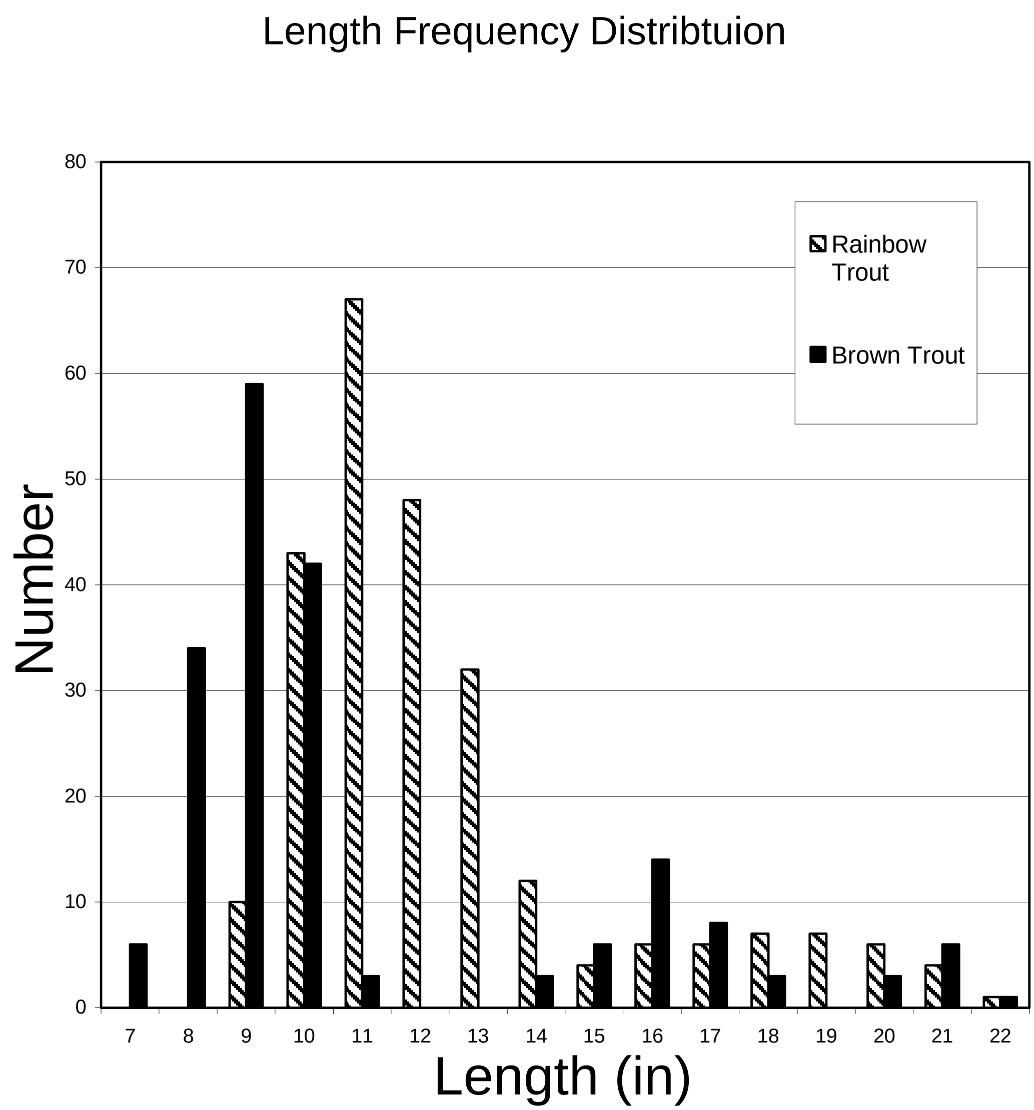


Figure B-21: Length Frequency Distribution of All Brown and Rainbow Trout Collected from the Lower Saluda River, April – June 2003

SOUTH CAROLINA ELECTRIC & GAS CO.
COLUMBIA, SOUTH CAROLINA

SALUDA DO STANDARD PROJECT
LOWER SALUDA RIVER TROUT GROWTH STUDY

1.0 DISSOLVED OXYGEN CRITERIA

In 1986 the U.S. Environmental Protection Agency (EPA) produced the Ambient Water Quality Criteria for Dissolved Oxygen (freshwater). This document replaced all previously published EPA aquatic life criteria for dissolved oxygen (DO). State water quality criteria may have the same numerical values as those in the EPA document or States may want to adjust their criteria to reflect local environmental conditions.

Site-specific criteria are allowed by regulation and are subject to EPA review and approval. Although no specific procedures are in place for establishing site-specific criteria for DO in freshwater, existing guidance and practice are that EPA will approve site-specific criteria developed using appropriate procedures. Site-specific criteria must be based upon a sound scientific rationale in order to protect the designated use. A site-specific criterion is intended to come closer than the national criterion to providing the intended level of protection to the aquatic life at the site, usually by taking into account the biological and/or chemical conditions at the site. The LSR trout growth study was the initial step in the use of the bioenergetic model to predict a DO standard that provides a level of protection of trout growth consistent with the EPA DO criteria.

The LSR growth study and the resultant growth model predictions are used to establish a long-term average concentration that will adequately protect trout growth in the LSR. In addition to the long-term average, the DO criteria also contain a short-term DO concentration that will prevent mortality as a result of acute hypoxia. Even short-term exposure to DO levels in the range of 1 to 2 mg/L can kill trout in a short period of time if they are not able to find local refugia where DOs are higher. In one case, mortality of trout has been reported after 3-4 day exposure to 2.4 mg/L at 20 C. In general, low DO is better tolerated at cooler temperatures than at warmer temperatures. In order to avoid direct mortality due to low DO, the EPA criteria document recommends a minimum DO of 3 mg/L, a DO concentration that is survived by salmonids, including trout, in long-term growth studies.

Although EPA cited, and agreed with, reviews that concluded that invertebrates are generally protected by DO levels that protect fish, there were potential exceptions that induced EPA to recommend a minimum DO of 4 mg/L to protect sensitive species of mayflies, caddisflies, and stoneflies that are present in some areas of the western U.S. There are no data available on the many insect species that inhabit other habitats and regions.

In order to protect trout growth, EPA concluded that the growth attained at a constant, or 30-day running mean, DO concentration of 6.5 mg/L was adequate. The assumed level of protection was estimated to be the threshold of effect of DO on growth. Lower mean concentrations are adequate to protect important fishery resources, but risk slight growth impairment (6 mg/L) or moderate growth impairment (5 mg/L). EPA concluded that reductions in growth rate sometimes seen above 6 mg/L are usually not significant and that DO concentrations below 4 mg/L can have severe effects on growth. Between 4 and 6 mg/L the effect on growth is moderate to slight if the exposure is sufficiently long. It must be noted that these findings are derived from laboratory studies in which food was surplus.

Because DO affects fish growth primarily by reducing appetite and food consumption, growth effects are greatest when food is not limited according to the EPA criteria document. For example, in tests with coho salmon and DOs of 3, 5 and 8 mg/L, growth effects were seen only at food availability greater than 70% of maximum consumption and a DO of 3 mg/L. No effects were seen at 5 mg/L. This 70% food availability is similar to that estimated from the LSR growth study.

The most "natural" DO study included in the EPA criteria document was a test conducted in laboratory streams in which coho salmon fed on insects produced in the streams (9.5-15.5 C). At high growth rates (0.04 to 0.05 g/g/d) dissolved oxygen levels below 5 mg/L reduced growth, but at lower growth rates (0 to 0.02 g/g/d) no effects were seen at concentrations down to 3 mg/L. These lower growth rates are similar to those observed in the LSR. Although these studies were not conducted with rainbow trout, there is a general similarity in growth response to

DO in all tested salmonid species and these results are probably representative of rainbow trout as well.

Perhaps the most critical issue identified in the EPA criteria document was the application of data from tests with constant DO exposure levels to natural situations in which DO may fluctuate significantly. They concluded that existing data allowed for a tentative theoretical dosing model for fluctuating DO as applied to fish growth if daily average DO was calculated using as a maximum value the threshold concentration below which growth effects are observed under constant exposure conditions.

The publication of several fish bioenergetic model papers occurred almost simultaneously with the publication of the EPA criteria document for DO (Cuenco et al., 1985 a, b, c). It was immediately evident that the fish growth analysis performed for the EPA DO criteria document (JRB Associates, 1984) provided the DO-food consumption link that would enable a similar modeling approach to be used for generating growth-effect predictions for natural conditions with cycling DO. Consequently, EPA and TVA entered into a cooperative agreement to develop and test a fish growth model using DO-growth effect data and the other bioenergetic parameters common to established fish growth models. The EPA-TVA model also utilized many physiological parameters from another bioenergetics model developed by the University of Wisconsin Sea Grant Program (Hewett and Johnson, 1991). The resultant model (Shiao et al., 1993) forms the basis for the LSR growth study and the LSR site-specific DO criteria proposal. The 1993 model has been updated with data of better precision for rainbow trout respiration and food consumption relationships with temperature (From and Rasmussen, 1984) and with additional analysis of the rainbow trout growth studies from the EPA criteria document (Spoor, 1981).

This modeling approach provides a tool to address what EPA termed a most critical and poorly documented aspect of the dissolved oxygen criterion which is the acceptable minimum DO under cycles of varying periodicity.

2.0 LOWER SALUDA RIVER TROUT GROWTH STUDY

Prediction of trout growth in the LSR requires adequate knowledge of three key parameters: temperature, DO concentration, and food availability to trout. In-stream monitoring of temperature and DO, coupled with turbine intake DO, a turbine aeration model, and a tailwater water quality model, provided very good data and estimates of the actual temperature and DO to which trout are exposed. Food availability can be estimated by measuring fish growth, determining the temperature and DO during the period that growth was measured, and using the FISH bioenergetics model to estimate food consumption (availability). During the period of this growth study DO was sufficiently high that there was no significant effect of DO. Therefore, food consumption and growth were determined almost exclusively by temperature and food availability.

The growth study was conducted to closely simulate the typical pattern of rainbow trout release into the put, grow, and take trout fishery in the LSR. This pattern is characterized by periodic releases of catchable trout (8-10 inches) at several locations along the LSR.

The growth study began with the tagging of approximately 15,000 rainbow trout obtained from the South Carolina Department of Natural Resources Walhalla Fish Hatchery. The tagging efforts were divided into four nearly equal monthly batches beginning in November and concluding in February. The November batch of rainbow trout contained 3000 individuals while the remaining 3 batches contained approximately 4000 individuals.

Each monthly batch of rainbow trout (201.4 ± 49.7 mm total length, 136 ± 36.7 g; mean ± SD) was tagged with sequentially numbered, large format, soft Alphanumeric Visible Implant Elastomer (VI-alpha) tags produced by Northwest Marine Technology Inc. To conduct the tagging exercise, fish were crowded in a raceway and 10 - 20 individuals were transferred to 50 – L aerated holding containers containing an anesthetic (~ 90 mg/L MS 222). Once fish were anesthetized, each rainbow trout received one visible implant tag, injected using a syringe-like tag applicator designed and supplied by the manufacturer just below the surface of the clear adipose postorbital eye tissue. The fish were then returned to a separate raceway and held for a minimum of 21 days as required by federal regulation for drug clearance as mandated by the

Food and Drug Administration. During the holding period, fish were maintained in a flow-through raceway system at 4 – 12 C.

After the 21 day waiting period, all fish tagged for that month were individually weighted and measured {Total length (mm) and wet weight (g)} and the tag code recorded for each fish. All fish were left unfed two days prior to weighing and measuring. Each monthly batch of tagged fish were divided up into 1000 fish sub-units, with each sub-group designated for release at one of the four release locations. The December plantings were divided into 4 lots, one 300 batch (Lake Murray Dam), one 700 fish grouping (Saluda Shoals) and 2 1000 fish batches (Allied Signal and Quail Hollow) All other monthly stockings contained relatively equal stockings of 1000 (less tag loss). Monthly tagging numbers and tag retention rates appear in Table B1.

Trout were planted in four discreet releases, one each in December 2002, and in January, February and March of 2003. Release sites were three that are routinely used for the fishery (Saluda Shoals Park, Allied Signal, and Quail Hollow) plus an additional upstream site just below Lake Murray dam (Figure B-1).

The tagged fish arrived in hatchery trucks each outfitted with multiple cells to keep fish separated. To accomplish this, fish were taken from numbered raceways at the hatchery with each raceway containing known tagged fish. Fish were then placed in each of the designated cells for transport and release to the LSR. For the helicopter stocking, the fish were placed in the helicopter bucket and the pilot was given specific directions where to place the fish in the LSR. The remaining stockings were conducted via truck with each driver having a designated stocking location to release fish based on a pre-arranged raceway numbered matrix. During the January stocking, the lock on the access gate to Quail Hollow had been changed which required the driver to stock the fish at Allied Signal. To compensate and provide an even distribution of fish at all stocking locations, two 1000 batches of fish were released in the Quail Hollow area during February stocking event.

To determine trout growth, recovery of tagged trout was carried out by obtaining trout from the LSR by electrofishing as well as by obtaining weight and length data of freshly caught trout in the LSR sports fishery. Fish were collected from the LSR from April thru June using primarily boat electrofishing means. The sampling area extended from the base of Lake Murray Dam to the I -26 bridge (Figure B-1). While no sampling was conducted below the I-26 Bridge, there were anecdotal reports of tagged fish being caught near Riverbanks Zoo, approximately 1 mile downstream. Boat electrofishing was conducted using a 16 foot aluminum boat outfitted with a generator, Smith-Root model VII-A Electrofisher, and anode and cathode umbrella droppers. Pulsed DC current was placed in the water and output amperage was adjusted to maximize electric current in the water. Voltage was regulated in attempts to maintain approximately 5 amps. During electrofishing sampling, electric current was directed to all microhabitats (shoals, ruffle run complexes and rock outcroppings) throughout the LSR. Electrofishing effort was typically expended over a two and three day period. All trout captured were placed in 100 L aerated containers. Fish were then evaluated to determine if they were tagged. Those fish that were tagged individual length and weight, data was collected, along with the corresponding tag color and number and recorded on field data sheets. Fish were then released back to the LSR in the general location of capture. Additionally untagged trout were collected and those individuals were enumerated and length data obtained.

2.1 Growth Results

A total of 111 tagged trout were collected, weighed and measured during April, May and June. The growth data were analyzed to determine if the data were sufficiently homogeneous to allow use of the entire data set for estimation of food availability in the LSR. There were several factors that might have caused growth (and food availability estimates) to be significantly different for one or more subsets of fish in the growth study. These factors included:

- Release site
- Release date
- Recapture site
- Size at release
- Condition at release
- Condition at recapture
- Direction of movement after release
- Distance of movement after release

- Time between release and recapture

Because growth was primarily influenced by temperature and food availability during the study period (DO was always high), any difference in these factors related to tailwater location or date could have caused differences in growth rate. In addition, size and condition of the fish might be related to fitness to the tailwater environment, including adaptability to feeding, as well as finding and competing for most-suitable habitat. Obviously, any factors that might tend to selectively crop fish through predation, movement out of the study area, or susceptibility to angler harvest could influence the study result. However, as these factors are always present, their exclusion, even if possible, would make the study less representative of the actual conditions for the trout remaining in the system.

2.2 Initial Data Analysis

A summary of the data collected for each recaptured fish from the growth study is provided in Table 2. The weight at release and recapture of the 111 fish used for the growth analysis is shown in Figure B-2. It is immediately evident that there was a large range in fish weight both at release and recapture. The range of trout weight at release is typical, as trout will feed and grow at different rates even in a hatchery environment where feeding is regular. The same phenomenon occurs in nature, as individual fish become more-or-less adapted to the natural habitat and more-or-less dominant in retaining better habitat niches.

2.3 Release Site and Date

The initial analysis of growth rate by release site and release date indicated that differences in median growth raters were relatively small (Table B-3). Because of periodic access problems, only 14 of the 16 potential release combinations (4 sites x 4 dates) were possible. The number of fish recaptures represented in these 14 combinations ranged from 1 to 14, with several releases being represented by fewer than a half-dozen individuals.

Comparing individual trout growth rates as a function of release site and release date indicated that only two of fourteen release groups had growth rates that appeared to be lower than the norm for the other release groups (Figures B-2a and 2b). The two groups with lower growth rates were the December group released at Quail Hollow and the March group released at Allied Signal. However, these two groups were represented by only four and one fish, respectively. With the large range of growth rates represented within each of the other groups and the fact that most groups in the March release had fish which lost weight following release, there was no reason to remove these two groups (five fish) from the overall data set of 111 trout.

2.4 Recapture Site

It is not possible to determine where an individual fish resided between the time of release and the time of recapture. For those fish that were recaptured near the release site it might be concluded that there was not a significant movement upstream or downstream from the point of release. Other fish that were recaptured farther from the release site may or may not have moved rapidly to the vicinity of the point of recapture. Given the pool-like nature of much of the study area, it is possible that many of the released trout moved freely up and down long stretches of the LSR and established no small-scale area of residency. On the assumption that recapture site might indicate the primary area of residency following release, the growth rate data were analyzed to see if there was a relationship between growth rate and recapture site (Figure B-3).

Growth rates were highly variable regardless of recapture site. Almost twice as many fish were recaptured between Allied Signal and Saluda Shoals than in the upstream or downstream sections. Median growth rates were slightly higher in this intermediate stretch (0.75 percent per day) as compared with upstream (0.68 percent per day) and downstream (0.65 percent per day). Given the highly variable growth rates, these relatively small differences were not seen as significant to the modeling effort. Fish from the Saluda Shoals releases were the most common at all recapture sites below RM 8 (and below the Saluda Shoals release site, ca. RM 8.3), and fish from the release immediately below the dam were most common above RM 8 (Figure B-4). The effect of movement from the site of release was analyzed separately from the site of recapture.

2.5 Growth and Movement

All four release times were characterized by fish moving both up- and down-stream from the release sites. In general, more fish moved downstream than upstream, with median movement ranging from 0.3 to 1.2 miles downstream. Although the pattern of movement differed slightly among the four release dates (Figure B-5) only fish from the January releases appeared to differ in any noticeable way from the overall pattern. This exception is perhaps more noteworthy because no fish were released at Quail Hollow during January, and fish that moved downstream from Quail Hollow were outside of the recapture area. In fact, only trout that were released at the two intermediate sites, Saluda Shoals and Allied Signal, could be sampled both above and below the release site. The Quail Hollow released fish were not sampled below the site of release and the fish released just below the dam were obviously limited to the immediate area of the release or movement downstream.

Analysis of fish movement for the two intermediate release sites indicated that both the Saluda Shoals and Allied Signal fish from the December release tended to move downstream (Figure B-6). [Note that in this and other figures some data points are identical and are superimposed in the figures, thus, the number of points visible may not equal the number of data points represented (n).] Later releases at Saluda Shoals followed this pattern, but the indications are that the Allied Signal fish may have moved upstream more frequently following the January and March releases (there was no February release at that site). The release of fish immediately below the dam may have populated the upstream section to the extent that competitive pressure produced the net downstream movement of Saluda Shoals fish. Of course, this movement pattern may also be a direct response to physical habitat characteristics.

Although the movement of trout released at the dam was limited to essentially staying put or moving downstream, and the Quail Hollow releases were only sampled at and above the release site, the analysis of this data is of interest (Figure B-7). The Lake Murray dam releases routinely had a median movement of 0.8 miles downstream. Perhaps the most interesting aspect of all the movement data was the relatively rapid upstream migration of several fish from the March release at Quail Hollow. Although median movement was still less than one mile upstream, at least four fish moved 3-5 miles upstream in the period between release and sampling.

Given the wide range of dispersal seen among the fish (up to 5 miles up and downstream from the release site) the potential effect of this movement on growth was considered potentially important. As shown in Figure B-8, there was essentially no pattern seen in the growth data when distance and direction of post-release movement was included as a variable. A similar analysis broken down by release site and release date showed no appreciable pattern (Figures B-9-12). Figure B-13 shows the analysis of the relationship between time in the LSR after release and distance traveled between release and recapture. In general, there was no relationship between distance traveled and the time between release and recapture.

2.6 Size at Release and Growth Rate

The maximum growth rate of fish is in part dependent upon fish size, with smaller fish capable of higher food consumption rates and higher growth rates than larger fish. Hatchery feeding practices have routinely used size as a determinant of how much feed to provide trout (e.g., Leitritz, 1972: 2-inch fish 4x and 5-inch fish 2x the food fed 9-inch fish). The growth rate observed for fish in the LSR study indicated a weak relationship to size at release, with most growth rates >1 percent per day occurring in trout that were <150 grams at release (Figure B-14). Given the wide range of growth rates for fish of any particular size and the growth model expression of food availability as a percent of maximum consumption potential rather than absolute amounts of food consumed, there was no compelling need to consider size in determining food availability for the growth model.

2.7 Condition Factor and Growth Rate

Trout of any length may be judged as to their general condition by overall appearance and described as skinny, solid, plump, fat, etc. A quantitative term that describes the length and weight relationship is the “condition factor.” The condition factor (c.f.) is expressed as:

$$c.f. = (W \times 100) / (L)^3$$

where: W = weight in grams and L = length in cm.

A condition factor of 1.0 may be used as a general guide with factors <1 representing less than optimal condition in trout and those >1 representing well-fed trout.

Trout with lower initial condition factors tended to grow at a faster rate than those with higher initial condition factors (Figure B-15). This is an expected finding under circumstances where hatchery conditions can cause a wide spread in condition factor and where field conditions allow dispersal of fish into areas of adequate food. The overall range in initial condition factors (ca. 0.8-1.8 in this study) is not unusual in crowded fish culture units without extensive and frequent grading and separation of fish sizes. Once released into the LSR the fish were able to disperse and feed more uniformly. This tends to allow the skinny fish to bulk up and the fatter fish to become more trim, resulting in the growth rate relationship seen in Figure B-15. This phenomenon is probably typical of the LSR put, grow, and take trout fishery and does not complicate the use of this growth study with the bioenergetic growth model.

The change in condition factor is illustrated in Figure B-16. In general, trout with initial condition factors >1.2 became more trim and those with initial condition factors <1.0 became more robust. The central tendency in the population was to develop a condition factor of about 1.1. This same trend was evident for trout recaptured from each of the release periods (Figures B-17a and b). This trend towards uniformity of condition factor is clearly evident in the decreasing variability in the length-weight relationships between release and recapture (Figure B-18) where r^2 values improved from 0.61 to 0.87 during residency in the LSR. The trend to greater uniformity in condition simplifies the application of the bioenergetic growth model.

Because growth was related to condition factor, the data were analyzed to see if there was any relationship between post-release movement in the LSR and the condition factor of the trout at time of release (Figure B-19). There was no effect of condition factor on the movement of trout following release.

A final analysis of the data was to determine if there was any relationship between growth rate and the time between release and recapture. Except for an apparently reduced growth rate for fish captured shortly after the March release, growth was essentially independent of residence time. The slightly reduced growth seen in the early recapture of the March release is probably attributable to a period of recovery from handling procedures inherent in capture, transport and release of fish in the planting process. Some period of time is also probably needed for the fish to adapt to feeding in nature as opposed to feeding under hatchery conditions. It is likely that all four release periods underwent the same handling stress and adaptation process, but the December-February releases experienced that pattern long before the initial recapture effort in April 2003.

2.8 LSR Trout Fishery Information

Additional information collected during the growth study revealed significant numbers of rainbow and brown trout that appear to be carryovers from previous stockings. A total of 441 tagged and untagged trout were collected from the LSR, with 253 rainbow and 188 brown trout comprising the total catch.

Of the 441 rainbow and brown trout collected, 74 exceeded 16 inches in length, or nearly one in every six fish. The largest rainbow and brown trout collected during these surveys were 22 and 24 inches, respectively, with all fish appearing robust and healthy. Further examination of the data indicates that trout do appear to carryover from annual stockings. Figure B-21 illustrates that at a minimum two distinct age classes of fish were collected in the LSR during the study. However, without otolith examination it is not readily possible to determine what year classes these individuals represent. One likely contributor to this observed carryover is likely is the higher DO levels maintained in the LSR since the inception of SCE&G’s turbine venting program than those DO levels historically observed.

3.0 SUMMARY

A detailed analysis of growth patterns and relationships with potentially significant variables relating to the LSR sites, release dates, and fish size indicated that there were no factors requiring either data deletion or subdivision prior to the use of observed growth rates for calculating food availability. Consequently growth rate data from all 111 recaptured trout were used to calibrate the bioenergetics model for the LSR.

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SOUTH CAROLINA ELECTRIC & GAS CO.
COLUMBIA, SOUTH CAROLINA

SALUDA DO STANDARD PROJECT
LOWER SALUDA RIVER TROUT GROWTH STUDY

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SALUDA DO STANDARD PROJECT

LOWER SALUDA RIVER TROUT GROWTH STUDY

AUGUST 2003

Prepared by:

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SOUTH CAROLINA ELECTRIC & GAS CO.

SALUDA DO STANDARD PROJECT

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Table B-1: Number tagged, number of survivors, survival (%), number retaining tags, and proportion (%) retaining tags of rainbow trout tagged with large format, soft VI-alpha tags and held for 25 days

TAG DATE	TAGGED (N)	SURVIVORS (N)	SURVIVAL (%)	NUMBER RELEASED (N)	RETENTION (%)
12/8/02	3000	2975	99.2	2405	80.8
1/6/03	4000	3780	94.5	2979	78.8
1/20/03	4400	4281	97.3	3331	77.8
2/13/03	4000	3251	81.3	3089	95.0
Total	15400	14287	92.8	11804	82.6

Table B-2: Data on rainbow trout recaptured and used in the Bioenergetics Model from the Lower Saluda River Growth Study April- June

	Tag Color	Tag Number	Stocked Total Length (mm)	Recaptured Total Length (mm)	Stock Weight (g)	Recaptured Weight (g)	Location Recaptured	Location on Figure B-1 (blue except where noted)	Location Stocked	Location on Figure B-1 (Red unless noted	Stock Date	Recaptured Date
1	yellow	C27	242	307	179	353	Sandy Beach, way point 106	3	Saulda Shoals Park	2	12/17/2002	4/2/2003
2	yellow	D55	217	230	157	171	Sandy Beach, way point 106	3	Saulda Shoals Park	2	12/17/2002	4/2/2003
3	yellow	22D	233	290	164	299	Corley Island shoal	7	Saulda Shoals Park	2	12/17/2002	4/3/2003
4	yellow	X26	253	298	216	302	downstream of I-20 at house	10	Quail Hollow	4	12/17/2002	4/3/2003
5	yellow	R73	261	324	221	438	tailrace, near spillway inflow	1	Lake Murray Dam	1	12/17/2002	4/28/2003
6	yellow	50E	245	315	197	347	above Sandy Beach (near shoal)	2	Saulda Shoals Park	2	12/17/2002	4/28/2003
7	yellow	D42	233	290	156	273	Sandy Beach	3	Saulda Shoals Park	2	12/17/2002	4/28/2003
8	yellow	L97	243	320	165	379	Upstream of Rawls Creek at shoal	5	Saulda Shoals Park	2	12/17/2002	4/28/2003
9	yellow	R72	245	325	156	350	downstream of I-20 bridge	11	Allied Signal	3	12/17/2002	5/1/2003
10	yellow	K20	244	315	143	328	downstream of I-20 bridge	11	unknown	n/a	12/17/2002	5/1/2003
11	yellow	J59	265	348	234	501	downstream of I-20 bridge	11	Allied Signal	3	12/17/2002	5/1/2003
12	yellow	L41	234	278	204	294	downstream of I-20 bridge	11	Saulda Shoals Park	2	12/17/2002	5/1/2003
13	yellow	G73	239	305	210	375	downstream of I-20 bridge	11	Quail Hollow	4	12/17/2002	5/1/2003
14	yellow	I38	208	275	117	211	downstream of I-20 bridge	11	Saulda Shoals Park	2	12/17/2002	5/1/2003

	Tag Color	Tag Number	Stocked Total Length (mm)	Recaptured Total Length (mm)	Stock Weight (g)	Recaptured Weight (g)	Location Recaptured	Location on Figure B-1 (blue except where noted)	Location Stocked	Location on Figure B-1 (Red unless noted	Stock Date	Recaptured Date
15	yellow	09D	239	302	168	309	downstream of I-20 bridge	11	Allied Signal	3	12/17/2002	5/1/2003
16	yellow	54E	250	335	194	461	Corley Island shoal	7	Allied Signal	3	12/17/2002	5/1/2003
17	yellow	35C	277	345	204	472	Corley Island shoal	7	Saulda Shoals Park	2	12/17/2002	5/1/2003
18	yellow	O7E	239	282	113	255	upstream of Quail Hollow, mile 4+	12	Saluda Shoals	2	12/17/2002	5/20/2003
19	yellow	X04	216	281	197	236.0	upstream of Quail Hollow, mile 4+	12	Quail Hollow	4	12/17/2002	5/20/2003
20	yellow	B97	245	311	209	283	upstream of Quail Hollow, mile 4+	12	Quail Hollow	4	12/17/2002	5/20/2003
21	yellow	56D	254	333	179	377	asphalt plant, mile 4+	11	Allied Signal	3	12/17/2002	5/20/2003
22	yellow	J22	245	336	166	361	tailrace boat ramp & upstream	1 (red)	Lake Murray Dam	1	12/17/2002	6/2/2003
23	yellow	L92	224	334	165	415	Corley Island shoal	7	Saluda Shoals	2	12/17/2002	6/2/2003
24	red	A96	240	295	185	307	Sandy Beach, way point 106	3	Lake Murray Dam	1	1/7/2003	4/2/2003
25	red	S22	220	266	145	222	Sandy Beach, way point 106	3	Lake Murray Dam	1	1/7/2003	4/2/2003
26	red	46B	212	271	102	223	Sandy Beach, way point 106	3	Saulda Shoals Park	2	1/8/2003	4/2/2003
27	red	B84	207	258	133	206	Sandy Beach, way point 106	3	Saulda Shoals Park	2	1/8/2003	4/2/2003
28	red	C59	260	308	238	313	downstream of Hope Ferry Landing	4	Saulda Shoals Park	2	1/8/2003	4/2/2003
29	red	64K	231	275	125	228	Corley Island shoal	7	Saulda Shoals Park	2	1/8/2003	4/3/2003
30	red	50G	226	290	162	227	Corley Island shoal	7	Saulda Shoals Park	2	1/8/2003	4/3/2003
31	red	P13	250	285	183	252	Corley Island shoal	7	Allied Signal	3	1/9/2003	4/3/2003
32	red	88L	185	279	70	243	Corley Island shoal	7	Allied Signal	3	1/9/2003	4/3/2003

	Tag Color	Tag Number	Stocked Total Length (mm)	Recaptured Total Length (mm)	Stock Weight (g)	Recaptured Weight (g)	Location Recaptured	Location on Figure B-1 (blue except where noted)	Location Stocked	Location on Figure B-1 (Red unless noted	Stock Date	Recaptured Date
33	red	77D	236	275	168	227	Corley Island shoal	7	Allied Signal	3	1/9/2003	4/3/2003
34	red	E36	237	280	166	227	above Sandy Beach (near shoal)	2	Allied Signal	3	1/9/2003	4/28/2003
35	red	E17	213	282	130	240	above Sandy Beach (near shoal)	2	Lake Murray Dam	1	1/7/2003	4/28/2003
36	red	85E	220	304	130	319	Upstream of Rawls Creek at shoal	5	Saulda Shoals Park	2	1/8/2003	4/28/2003
37	red	A44	228	305	171	333	Upstream of Rawls Creek at shoal	5	Saulda Shoals Park	2	1/8/2003	4/28/2003
38	red	80M	219	271	124	230	Corley Island shoal	7	Allied Signal	3	1/9/2003	4/28/2003
39	red	92I	264	315	223	339	downstream of I-20 bridge	11	Allied Signal	3	1/9/2003	5/1/2003
40	red	P97	230	283	146	232	downstream of I-20 bridge	11	Allied Signal	3	1/9/2003	5/1/2003
41	red	51D	217	280	125	242	Honeywell Intake	9	Saulda Shoals Park	2	1/8/2003	5/1/2003
42	red	P95	226	298	130	311	Honeywell Intake	9	Allied Signal	3	1/9/2003	5/1/2003
43	red	52M	240	296	157	282	Corley Island shoal	7	Allied Signal	3	1/9/2003	5/1/2003
44	red	V97	217	284	150	272	Corley Island shoal	7	Allied Signal	3	1/9/2003	5/1/2003
45	red	63C	228	301	155	282	Honeywell Intake	9	Saulda Shoals Park	2	1/7/2003	5/20/2003
46	red	K51	223	278	112	206	Honeywell Intake	9	Lake Murray Dam	1	1/8/2003	5/20/2003
47	red	P72	228	289	126	222	Honeywell Intake	9	Allied Signal	3	1/9/2003	5/20/2003
48	red	07I	255	317	235	326	Honeywell Intake	9	Allied Signal	3	1/9/2003	5/20/2003
49	red	F67	224	313	168	339	asphalt plant, mile 4+	11	Allied Signal	3	1/9/2003	5/20/2003
50	red	H29	205	280	91	231	Corley Island shoal, mile 7+	7	Allied Signal	3	1/9/2003	5/20/2003
51	red	82H	221	329	141	434	Corley Island shoal, mile 7+	7	Saluda Shoals	3	1/8/2003	5/20/2003
52	red	23K	245	311	180	298	tailrace boat ramp & upstream	1 (red)	Lake Murray Dam	1	1/7/2003	6/2/2003
53	red	19B	232	320	102	343	downstream of Saluda Shoals	4	Lake Murray Dam	1	1/7/2003	6/2/2003

	Tag Color	Tag Number	Stocked Total Length (mm)	Recaptured Total Length (mm)	Stock Weight (g)	Recaptured Weight (g)	Location Recaptured	Location on Figure B-1 (blue except where noted)	Location Stocked	Location on Figure B-1 (Red unless noted	Stock Date	Recaptured Date
54	red	50N	243	335	179	397	downstram of Saluda Shoals Park	4	Saluda Shoals	2	1/8/2003	6/2/2003
55	red	P41	203	289	149	264	downstram of Saluda Shoals Park, above "Logan's Point"	5	Saluda Shoals	2	1/8/2003	6/2/2003
56	orange	V09	224	258	119	194	Sandy Beach, way point 106	3	Lake Murray Dam	1	2/11/2003	4/2/2003
57	orange	I77	232	277	141	222	Sandy Beach, way point 106	3	Lake Murray Dam	1	2/11/2003	4/2/2003
58	orange	D20	247	273	165	244	downstream of Hope Ferry Landing	4	Lake Murray Dam	1	2/11/2003	4/2/2003
59	orange	Y10	233	244	153	161	Corley Island shoal	7	Saulda Shoals Park	2	2/12/2003	4/3/2003
60	orange	88J	217	247	112	168	Corley Island shoal	7	Quail Hollow	4	2/13/2003	4/3/2003
61	orange	N04	235	252	136	166	Corley Island shoal	7	Saulda Shoals Park	2	2/12/2003	4/3/2003
62	orange	47A	247	265	145	210	Corley Island shoal	7	Saulda Shoals Park	2	2/12/2003	4/3/2003
63	orange	46V	222	227	102	147	downstream of I-20 at house	10	Quail Hollow	4	2/13/2003	4/3/2003
64	orange	73V	218	254	113	185	tailrace, near spillway inflow	1	Lake Murray Dam	1	2/11/2003	4/28/2003
65	orange	G07	212	251	107	171	above Sandy Beach ("flat")	2	Lake Murray Dam	1	2/11/2003	4/28/2003
66	orange	U87	219	260	118	215	above Sandy Beach (near shoal)	2	Lake Murray Dam	1	2/11/2003	4/28/2003
67	orange	26V	220	252	154	179	above Sandy Beach (near shoal)	2	Lake Murray Dam	1	2/11/2003	4/28/2003
68	orange	90P	208	260	108	214	Upstream of Rawls Creek at shoal	5	Lake Murray Dam	1	2/11/2003	4/28/2003

	Tag Color	Tag Number	Stocked Total Length (mm)	Recaptured Total Length (mm)	Stock Weight (g)	Recaptured Weight (g)	Location Recaptured	Location on Figure B-1 (blue except where noted)	Location Stocked	Location on Figure B-1 (Red unless noted	Stock Date	Recaptured Date
69	orange	09Y	186	288	62	246	downstream of I-20 bridge	5	Lake Murray Dam	1	2/11/2003	5/1/2003
70	orange	Y79	249	295	146	266	downstream of I-20 bridge	10	Quail Hollow	4	2/13/2003	5/1/2003
71	orange	13B	225	265	126	218	downstream of I-20 bridge	10	Saulda Shoals Park	2	2/12/2003	5/1/2003
72	orange	74A	232	270	124	186	downstream of I-20 bridge	10	Quail Hollow	4	2/13/2003	5/1/2003
73	orange	M37	249	264	131	208	Honeywell intake area	9	Saulda Shoals Park	2	2/12/2003	5/1/2003
74	orange	18A	236	257	143	165	Honeywell intake area	9	Saulda Shoals Park	2	2/12/2003	5/1/2003
75	orange	73B	224	274	131	211	Corley Island shoal	7	Lake Murray Dam	1	2/11/2003	5/1/2003
76	orange	R44	261	306	183	360	asphalt plant, mile 4+	11	Quail Hollow	4	2/13/2003	5/20/2003
77	orange	62P	203	264	112	193	BC Components intake	8	Saluda Shoals	2	2/12/2003	5/20/2003
78	orange	J45	230	273	148	216	BC Components intake	8	Saluda Shoals	2	2/12/2003	5/20/2003
79	orange	D60	203	241	106	130	Corley Island shoal, mile 7+	7	Quail Hollow	4	2/13/2003	5/20/2003
80	orange	R77	216	280	100	250	Corley Island shoal, mile 7+	7	Saluda Shoals	2	2/12/2003	5/20/2003
81	orange	17C	223	282	142	239	downstram of Saluda Shoals Park	4	Lake Murray Dam	1	2/11/2003	6/2/2003
82	green	R76	267	278	234	243	Sandy Beach, way point 106	3	Lake Murray Dam	1	3/11/2003	4/2/2003
83	green	R79	260	258	173	165	SCE&G boat landing - tailrace, way point 108	1 (red)	Lake Murray Dam	1	3/11/2003	4/2/2003

	Tag Color	Tag Number	Stocked Total Length (mm)	Recaptured Total Length (mm)	Stock Weight (g)	Recaptured Weight (g)	Location Recaptured	Location on Figure B-1 (blue except where noted)	Location Stocked	Location on Figure B-1 (Red unless noted	Stock Date	Recaptured Date
84	green	Z71	237	279	215	243	downstream of Hope Ferry Landing	4	Quail Hollow	4	3/14/2003	4/2/2003
85	green	22R	215	226	134	126	Corley Island shoal	7	Allied Signal	3	3/13/2003	4/3/2003
86	green	98G	220	230	140	155	Corley Island shoal	7	Saulda Shoals Park	2	3/12/2003	4/3/2003
87	green	L34	245	245	192	177	Corley Island shoal	7	Saulda Shoals Park	2	3/12/2003	4/3/2003
88	green	O00	215	270	108	220	above Sandy Beach (near shoal)	2	Saulda Shoals Park	2	3/12/2003	4/28/2003
89	green	N24	242	266	176	225	Sandy Beach	3	Lake Murray Dam	1	3/11/2003	4/28/2003
90	green	47G	238	265	173	203	Sandy Beach	3	Lake Murray Dam	1	3/11/2003	4/28/2003
91	green	81L	236	265	148	191	Upstream of Rawls Creek at shoal	5	Lake Murray Dam	1	3/11/2003	4/28/2003
92	green	O57	244	280	154	219	downstream of I-20 bridge	11	Quail Hollow	4	3/14/2003	5/1/2003
95	green	S64	280	300	255	327	downstream of I-20 bridge	11	Quail Hollow	4	3/14/2003	5/1/2003
93	green	91Y	246	278	177	222	downstream of I-20 bridge	11	Quail Hollow	4	3/14/2003	5/1/2003
94	green	37G	235	269	152	238	Honeywell Intake	9	Lake Murray Dam	1	3/11/2003	5/1/2003
95	green	Z21	237	285	215	301	Corley Island shoal	7	Saulda Shoals Park	2	3/12/2003	5/1/2003
96	green	30T	238	280	138	204	Quail Hollow, mile 3 to mile 4	12	Quail Hollow	4	3/14/2003	5/20/2003
97	green	H42	252	305	178	213.0	Honeywell Intake	9	Quail Hollow	4	3/14/2003	5/20/2003
98	green	11C	230	272	178	204.0	Honeywell Intake	9	Saluda Shoals	2	3/12/2003	5/20/2003
100	green	P34	281	326	252	366	BC Components intake	8	Quail Hollow	4	3/14/2003	5/20/2003
101	green	82R	230	272	186	189	asphalt plant, mile 4+	11	Quail Hollow	4	3/14/2003	5/20/2003
102	green	T65	216	284	167	216	upstream of I-20, ~mile 4.5	13	Quail Hollow	4	3/14/2003	5/20/2003
103	green	G41	300	334	360	372	BC Components intake	8	Lake Murray Dam	1	3/11/2003	5/20/2003

	Tag Color	Tag Number	Stocked Total Length (mm)	Recaptured Total Length (mm)	Stock Weight (g)	Recaptured Weight (g)	Location Recaptured	Location on Figure B-1 (blue except where noted)	Location Stocked	Location on Figure B-1 (Red unless noted	Stock Date	Recaptured Date
104	green	P89	235	285	145	286	Corley Island shoal, mile 7+	7	Saluda Shoals	2	3/12/2003	5/20/2003
105	green	09Y	225	272	155	186	Corley Island shoal, mile 7+	7	Lake Murray Dam	1	3/11/2003	5/20/2003
106	green	08R	210	262	134	209	Corley Island shoal, mile 7+	7	Lake Murray Dam	1	3/11/2003	5/20/2003
107	green	28B	193	213	88	74	tailrace boat ramp & upstream	1 (red)	Lake Murray Dam	1	3/11/2003	6/2/2003
108	green	G67	230	271	126	211.5	tailrace boat ramp & upstream	1 (red)	Lake Murray Dam	1	3/11/2003	6/2/2003
109	green	72Y	259	291	159	259.0	Sandy Beach (upstream of Saluda Shoals Park landing)	3	Lake Murray Dam	1	3/11/2003	6/2/2003
110	green	E35	250	284	157	213.0	Sandy Beach (upstream of Saluda Shoals Park landing)	3	Quail Hollow	4	3/14/2003	6/2/2003
111	green	N25	233	272	146	204.0	downstram of Saluda Shoals Park, above "Logan's Point"	5	Lake Murray Dam	1	3/11/2003	6/2/2003

Table B-3: Median growth rate (n) for each of the fourteen combinations of release site and release date. Overall median (n) growth rates are shown for each site, each date, and for all 111 recaptured trout. Growth rates are g/g/day and the overall rate of 0.0071 g/g/day is 0.71 percent weight gain per day.

	DEC.	**JAN.**	**FEB.**	**MAR.**	**ALL MONTHS**
Below Dam	0.0072 (2)	0.0070 (6)	0.0095 (11)	0.0048 (13)	**0.0075 (32)**
Saluda Shoals	0.0077 (11)	0.0083 (12)	0.0075 (9)	0.0063 (6)	**0.0076 (38)**
Allied Signal	0.0078 (6)	0.0065 (14)	No release	-0.0030 (1)	**0.0071 (21)**
Quail Hollow	0.0030 (4)	No release	0.0095 (6)	0.0055 (10)	**0.0056 (20)**
All Sites	**0.0071 (23)**	**0.0072 (32)**	**0.0083 (26)**	**0.0056 (30)**	**0.0071 (111)**

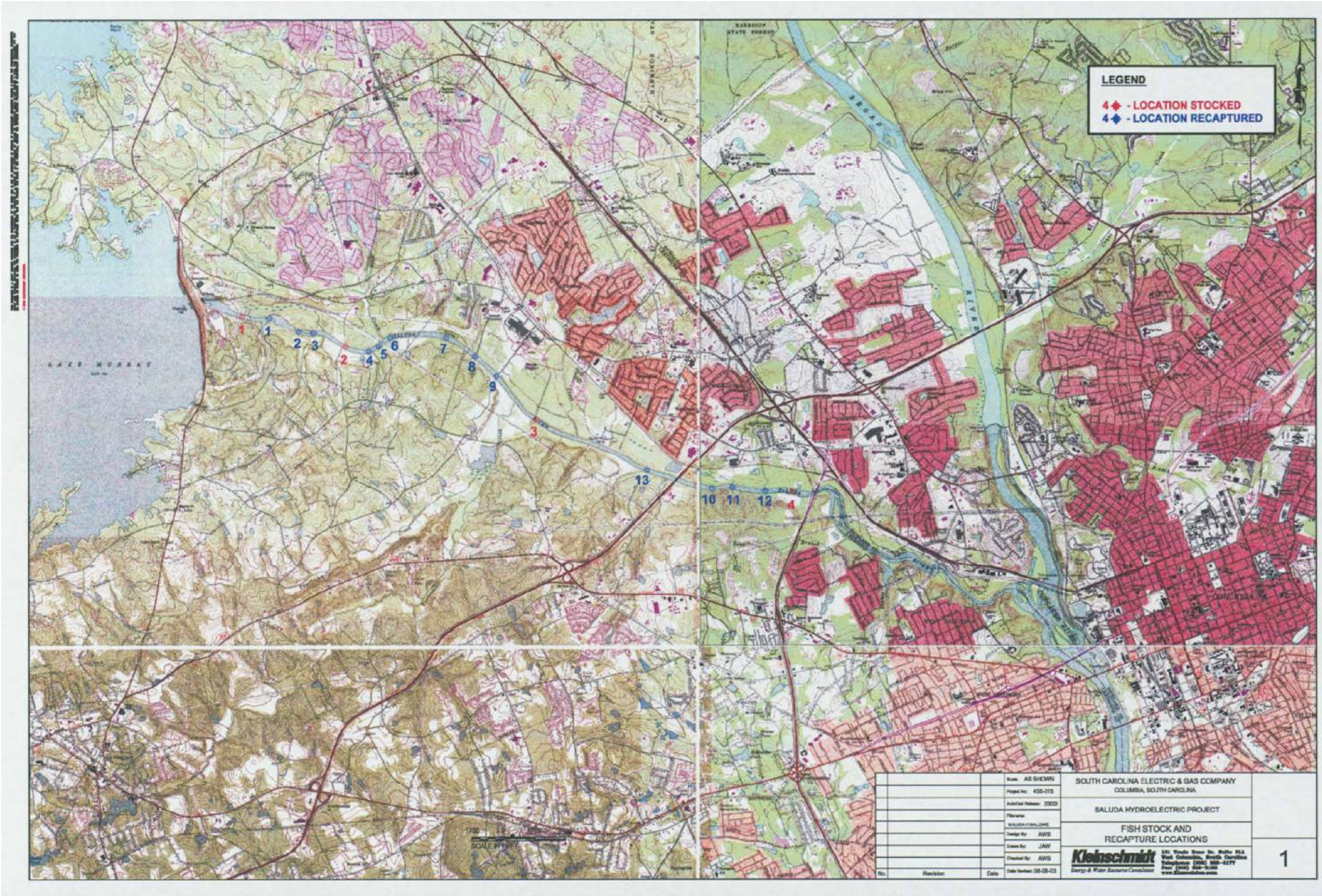


Figure B-1: Fish Stock and Recapture Locations

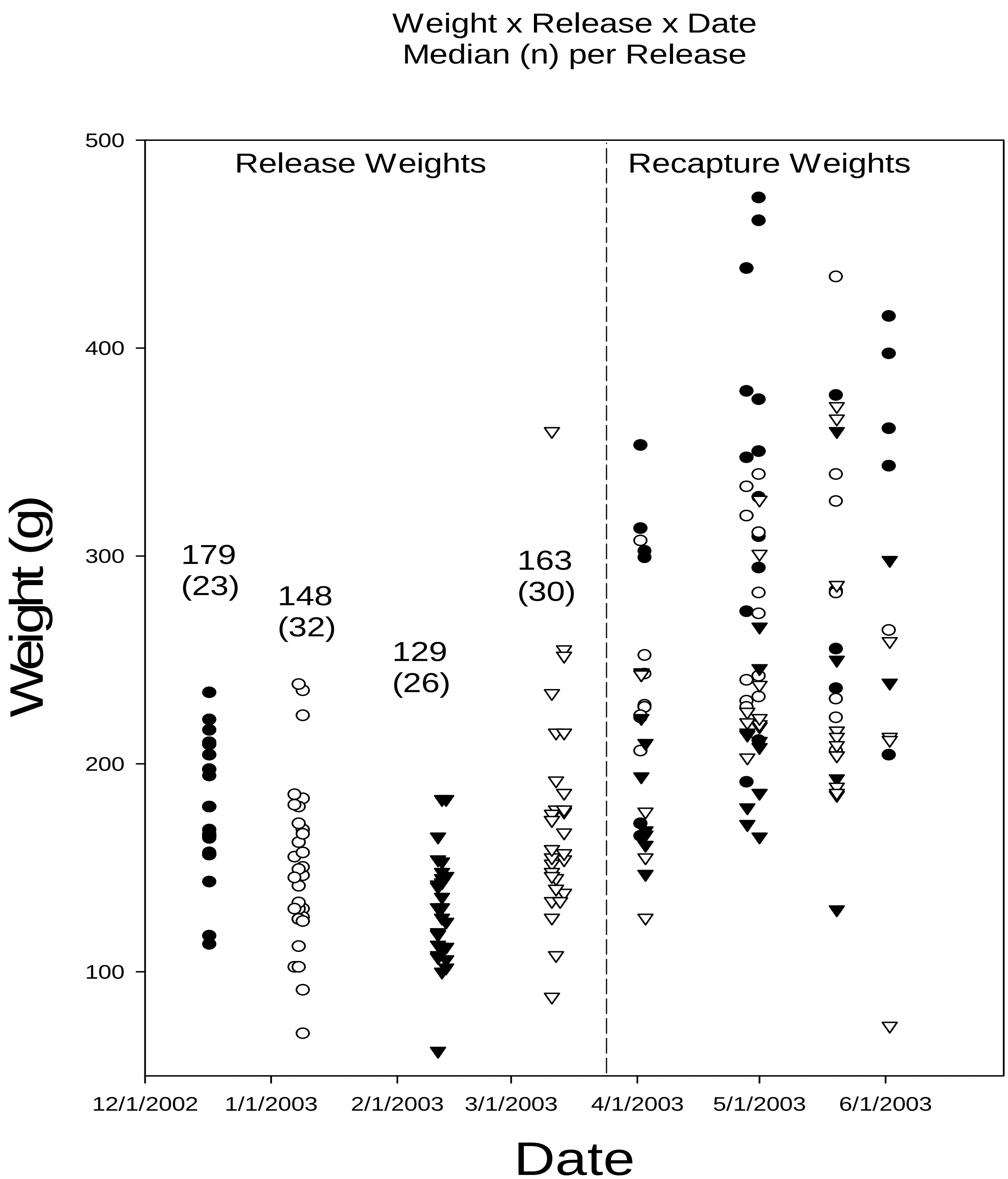
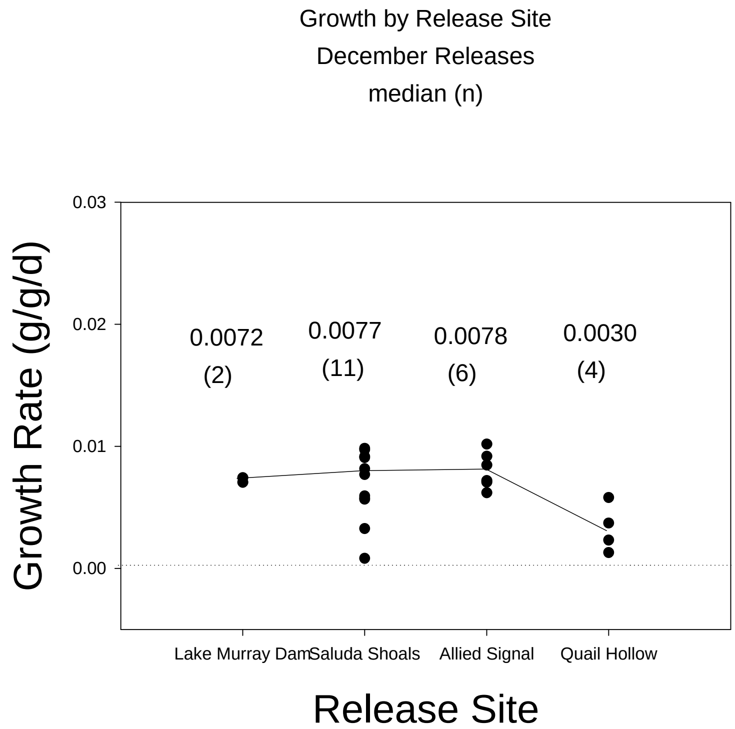


Figure B-2: Weight (g) of Recaptured Trout at Time of Release and Time of Recapture



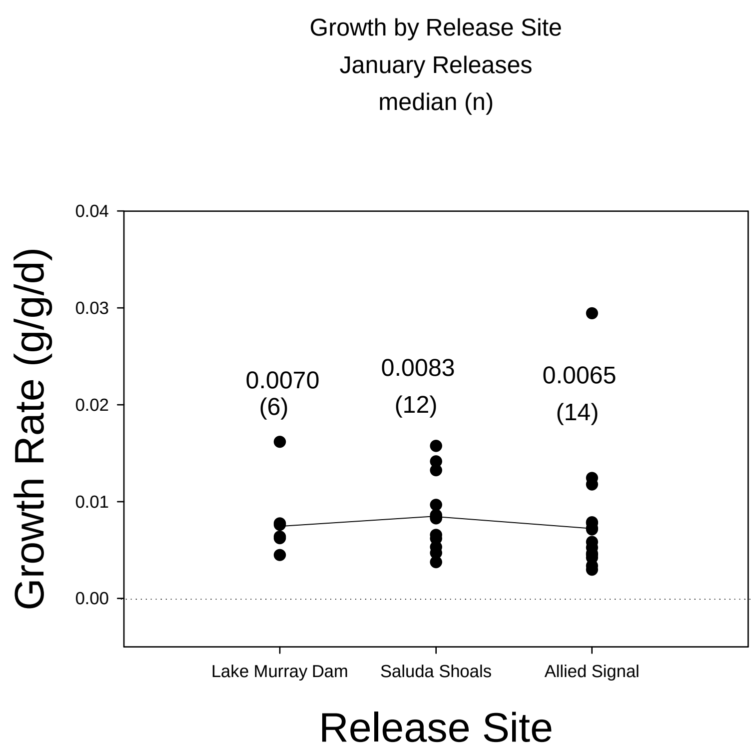
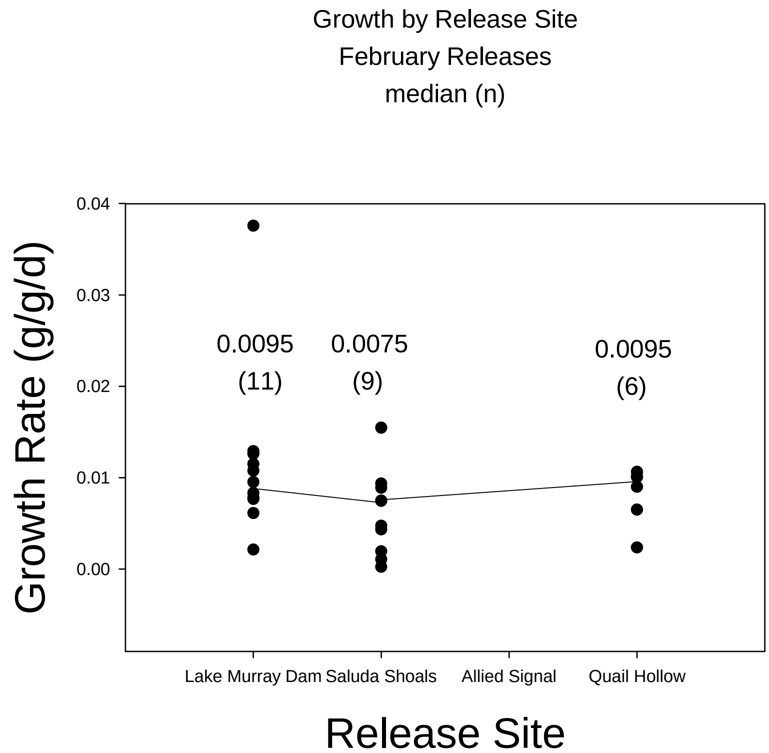


Figure B-2a: Growth Rate by Release Site for December and January Releases



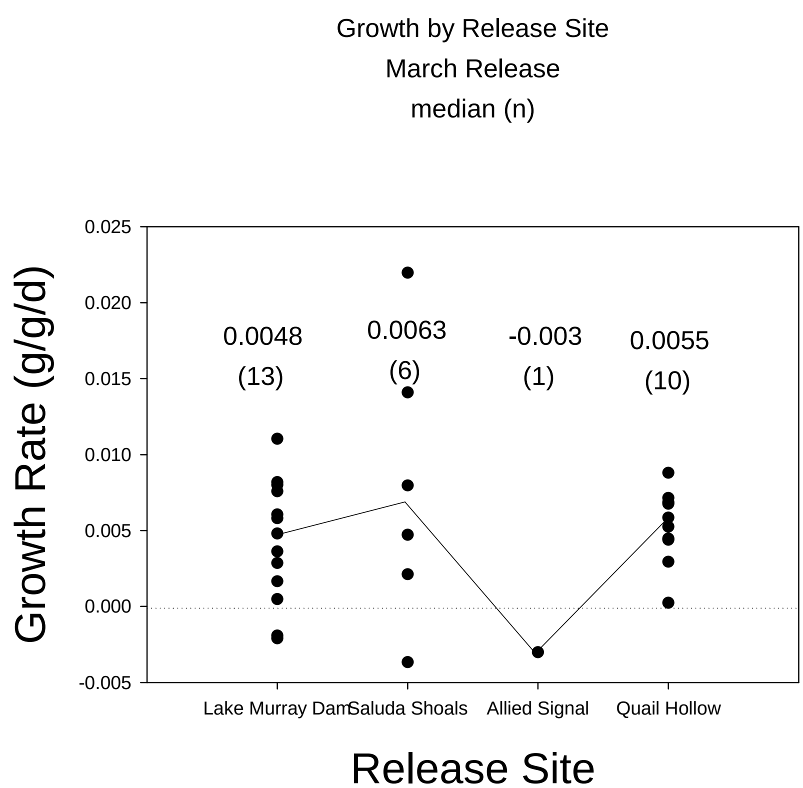


Figure B-2b: Growth Rate of Trout by Release Site for the February and March Releases

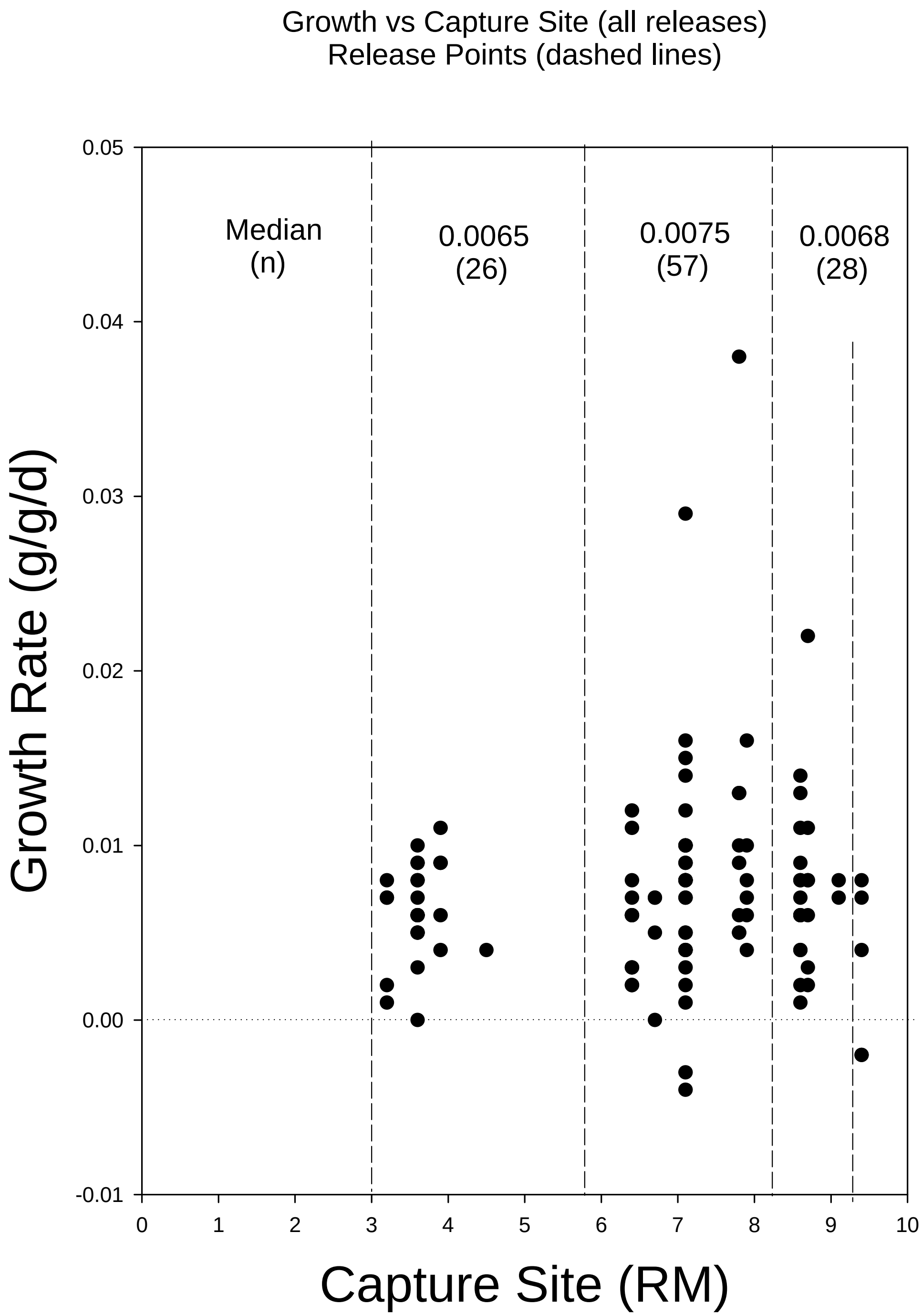


Figure B-3: **Growth Rate is Shown as a Function of Recapture Location by River Mile. Release points are indicted by vertical dashed lines. From downstream to upstream these are Quail Hollow, Allied Signal, Saluda Shoals Park, and the immediate vicinity of the Lake Murray dam. No recapture efforts were made below the Quail Hollow release point (RM 3).**

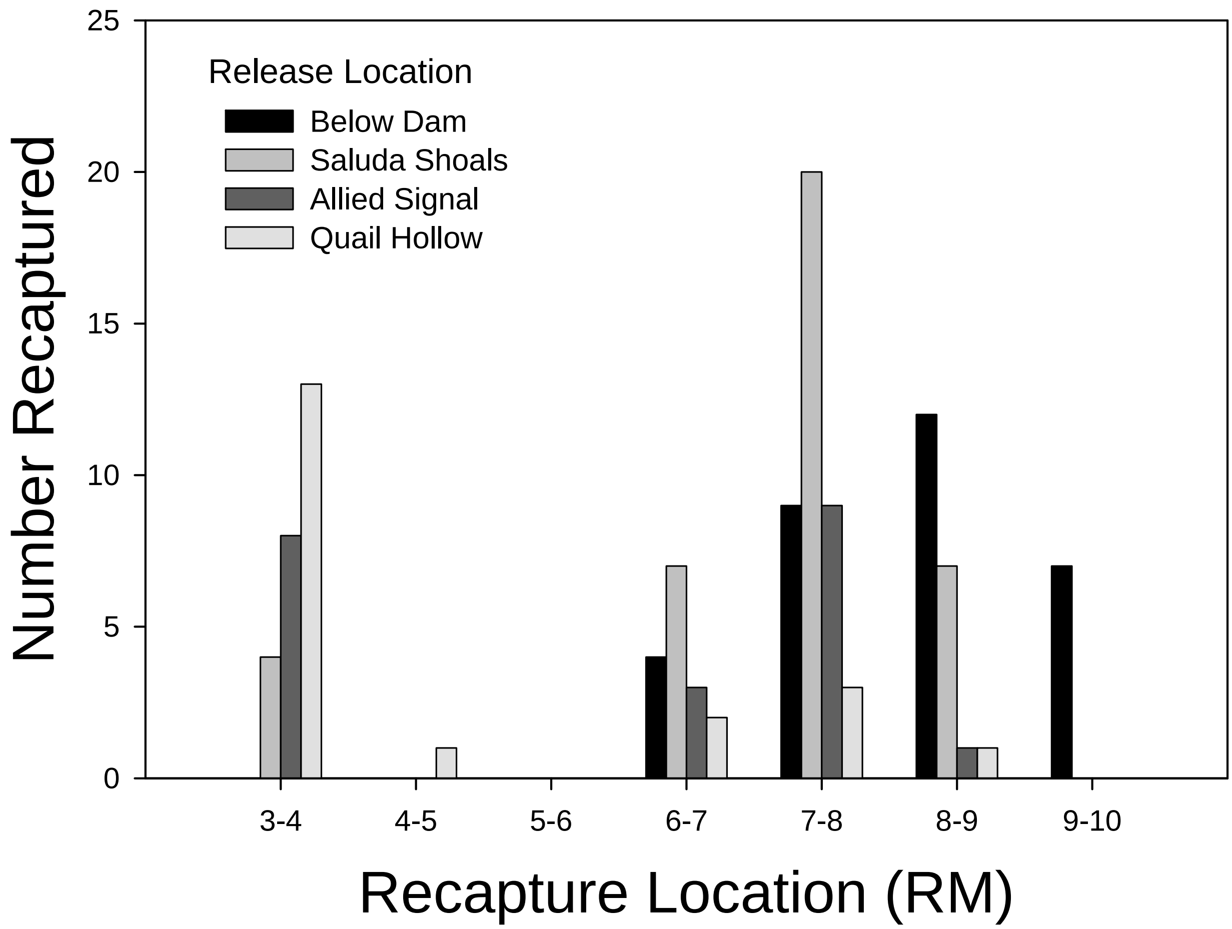


Figure B-4: Recapture Location (RM) and Site of Release. There was Limited Recapture Effort Between RM 4 and 6.

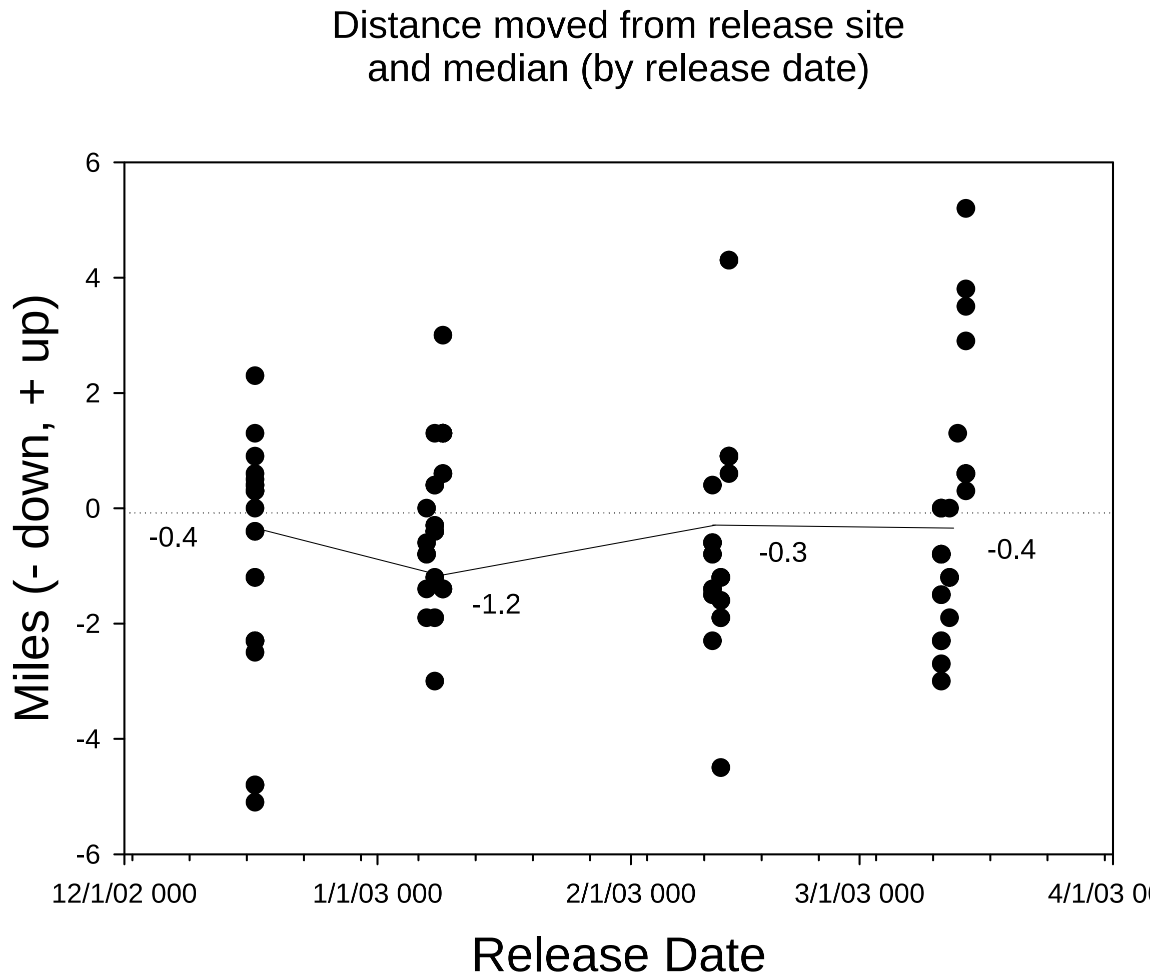


Figure B-5: Distance Moved from Release Site for Each Release Date. Median Distances are Shown on the Graph for each Release Date

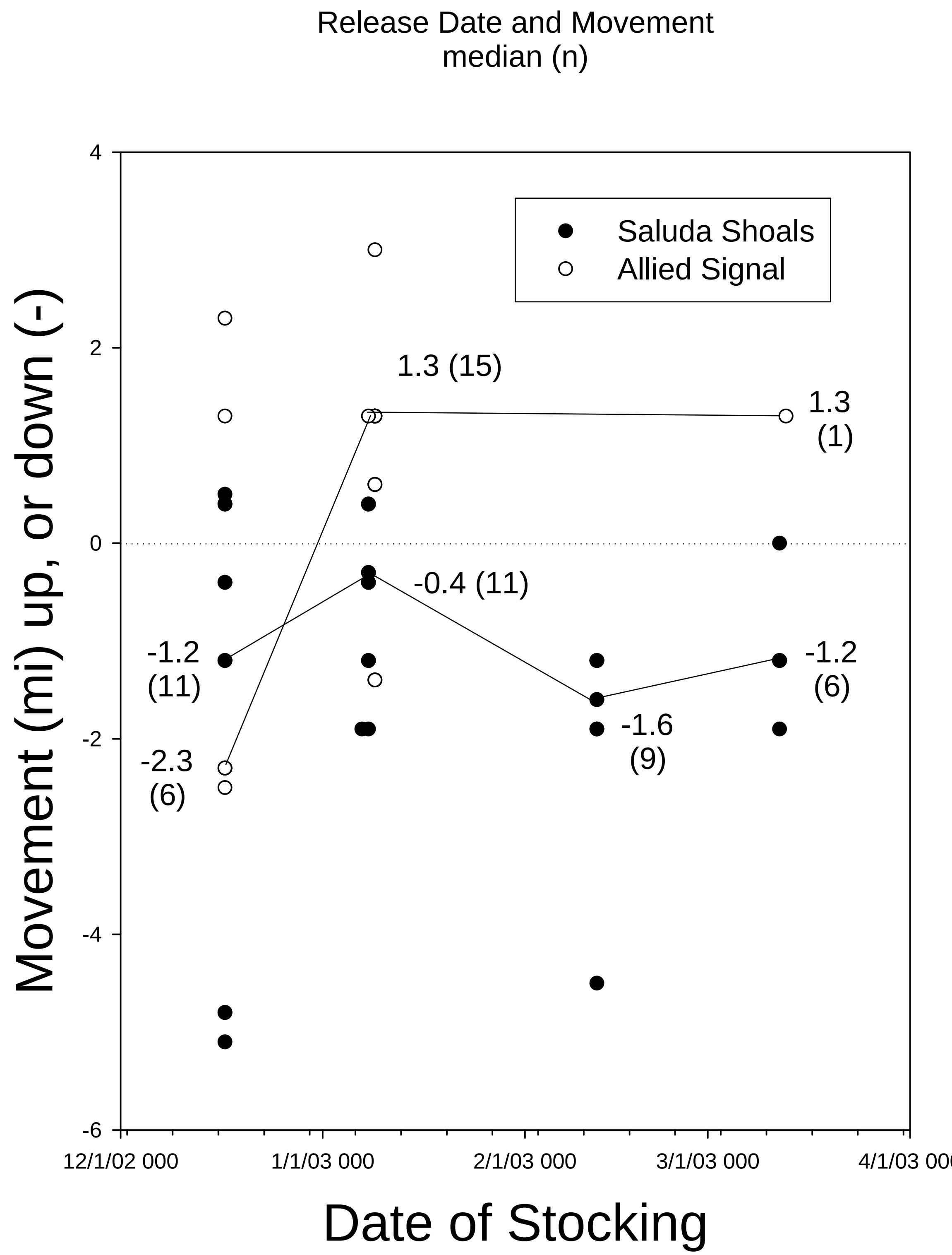


Figure B-6: Movement of Trout by Stocking Date from the Two Intermediate Release Sites where Upstream and Downstream Movement were not Limited by the Dam or by Sampling Site Limitations

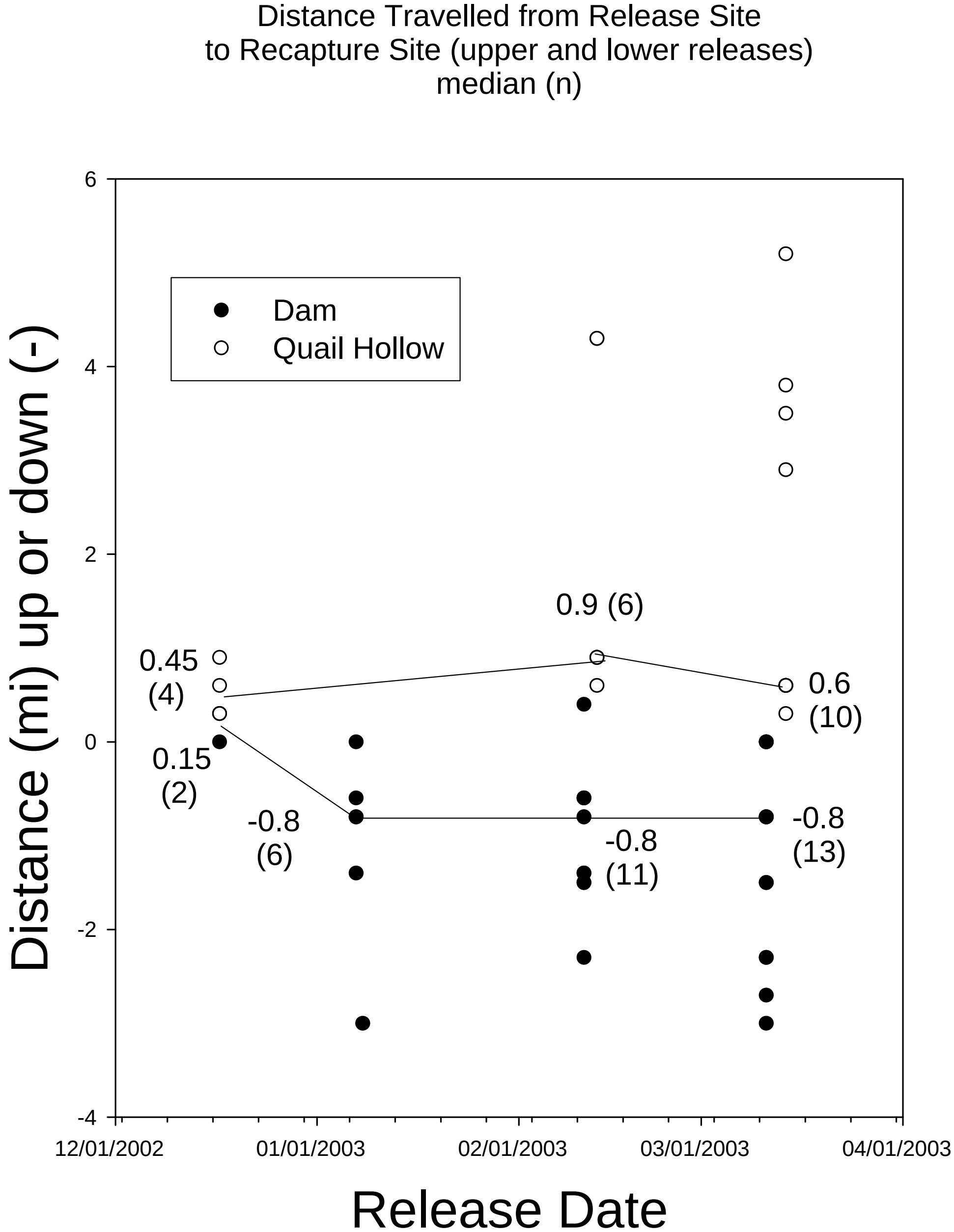


Figure B-7: Movement of Fish Following Release at Various Times at the Upstream Site Near Lake Murray Dam and at Quail Hollow

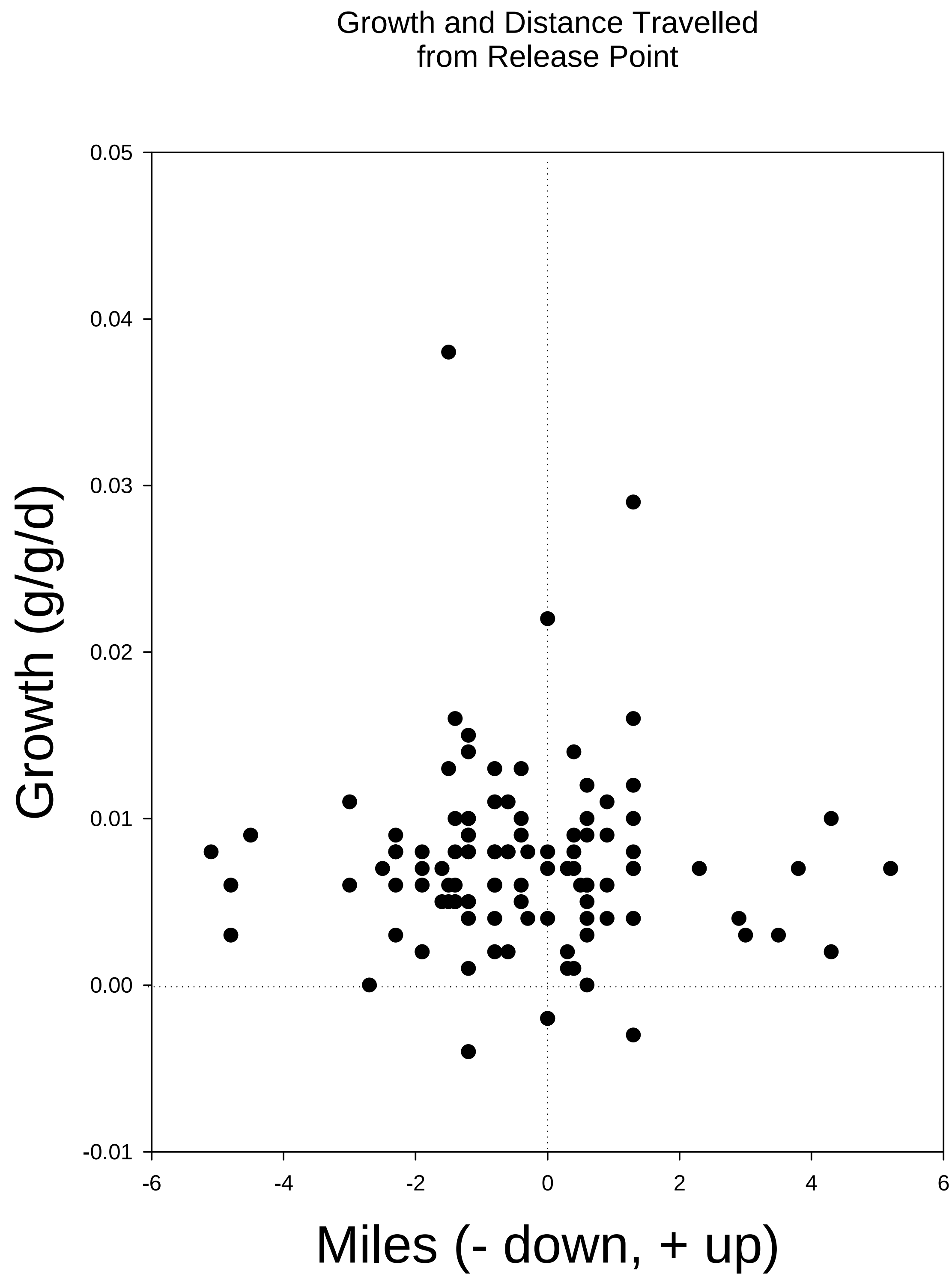


Figure B-8: This Figure Shows the Growth Rates for All 111 Fish as a Function of Their Movement Up or Downstream Following Release

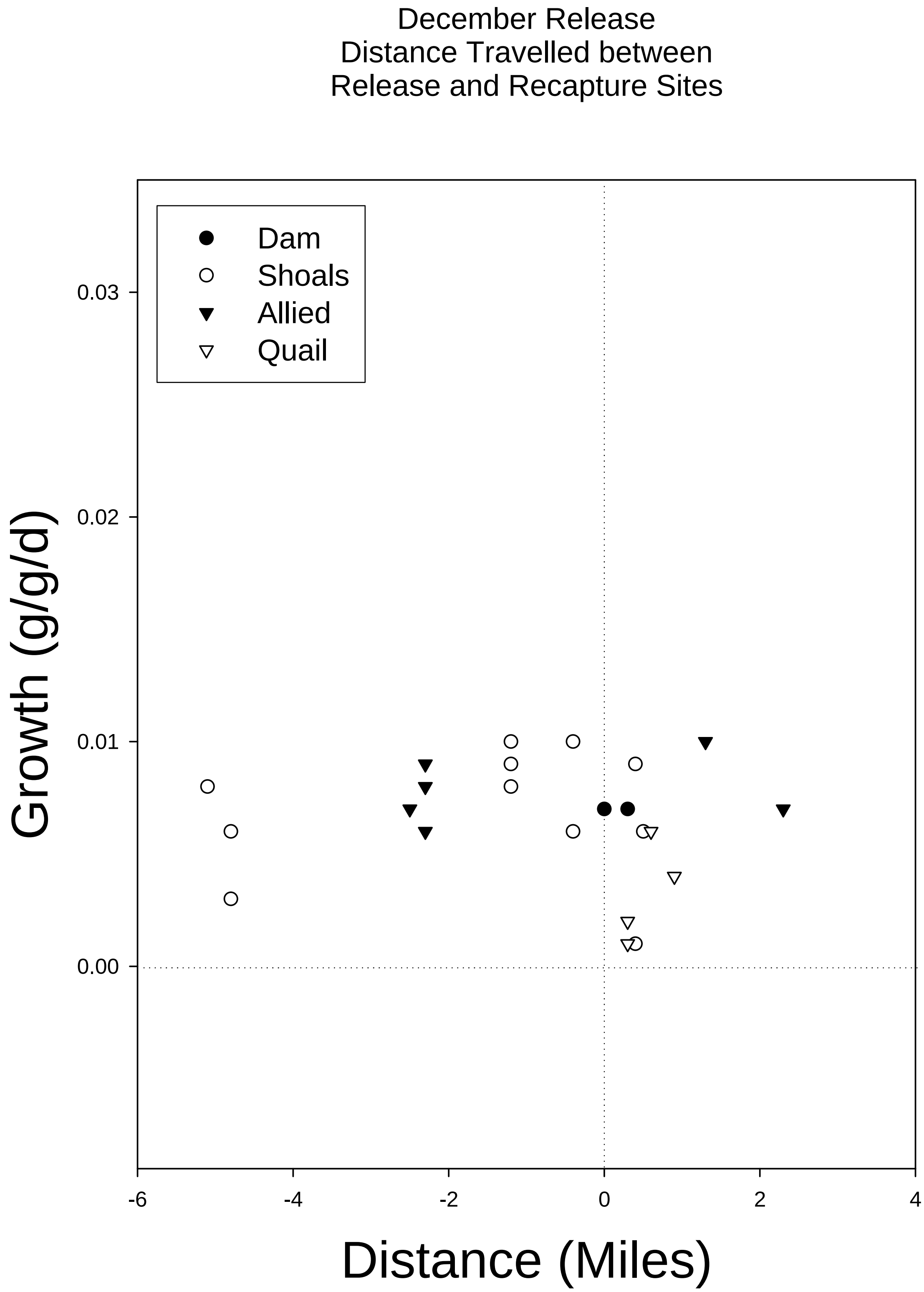


Figure B-9: **Analysis of Growth Rate as a Function of Post-Release Movement for Fish Released in December at the Four Release Sites**

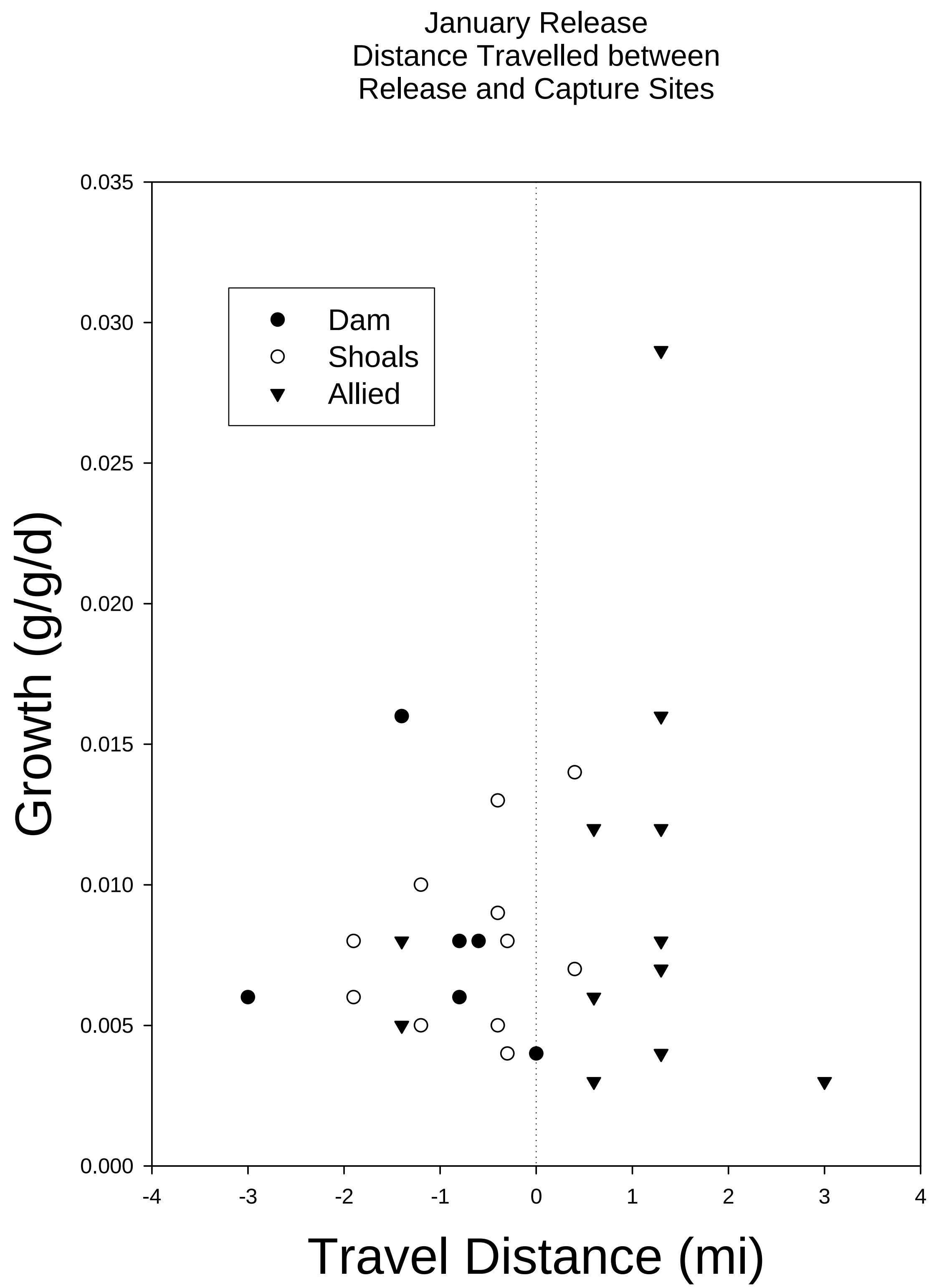


Figure B-10: Analysis of Growth Rate as a Function of Post-Release Movement for Fish Released in January at the Three Release Sites

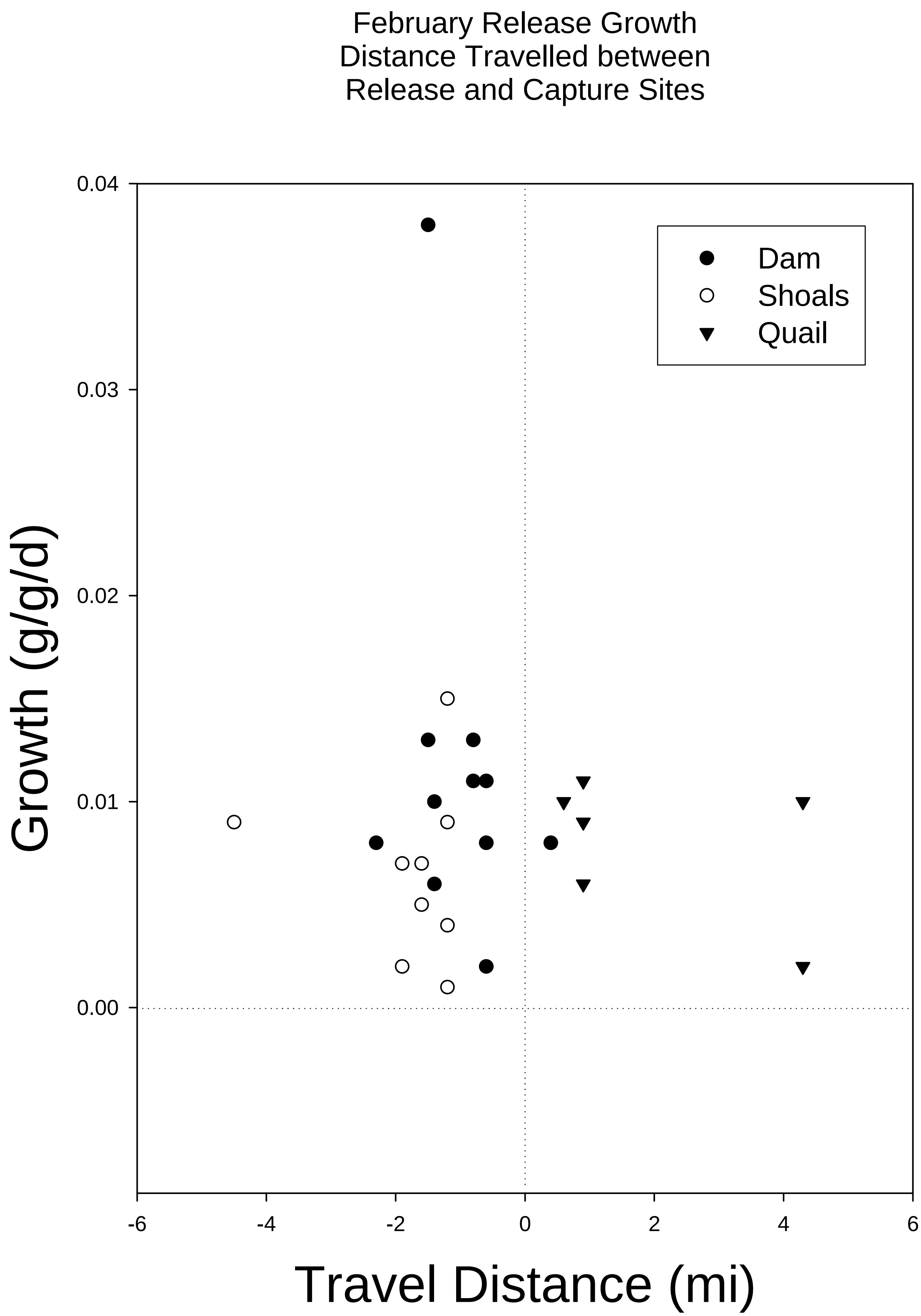


Figure B-11: Analysis of Growth Rate as a Function of Post-Release Movement for Fish Released in February at the Three Release Sites

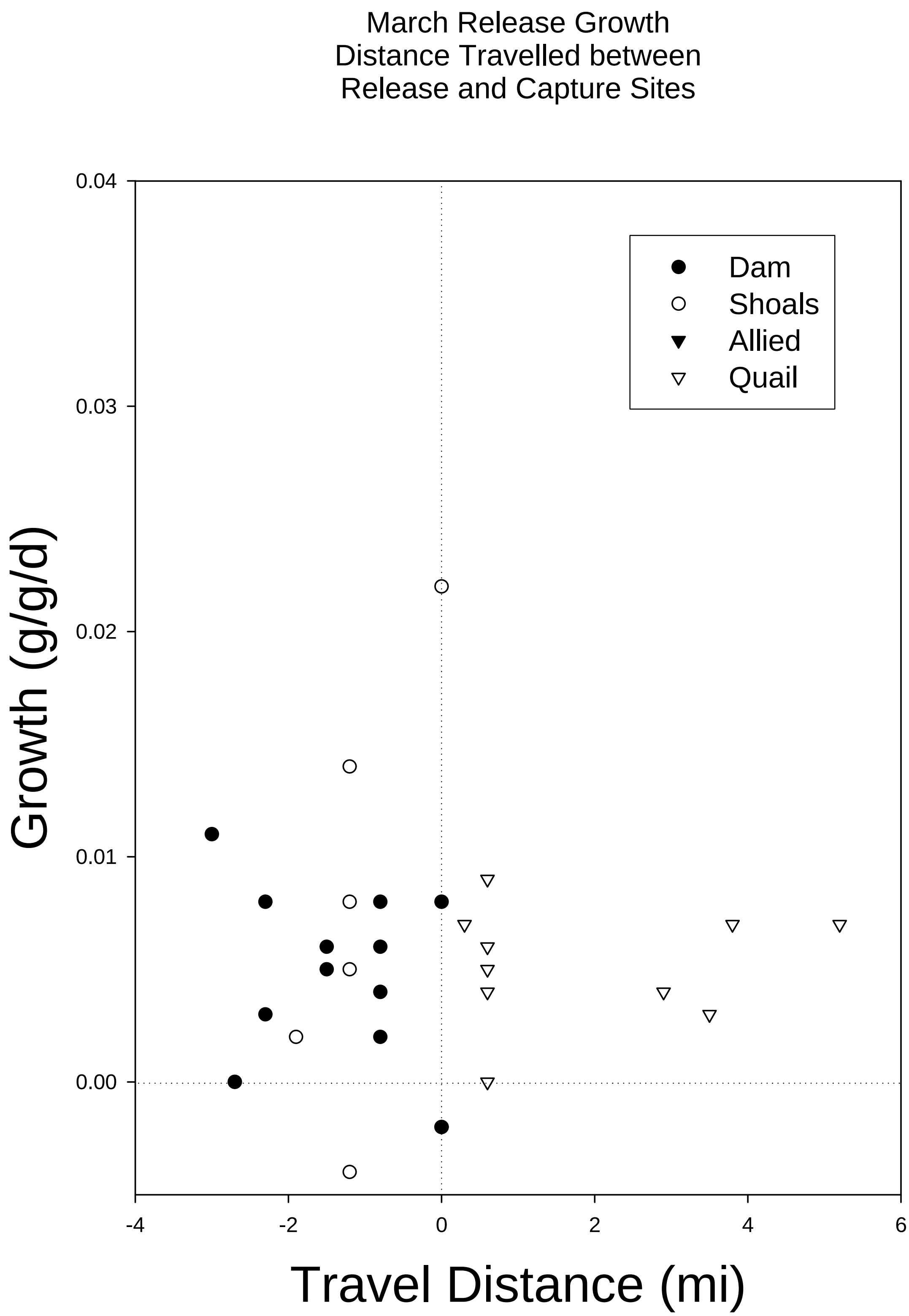


Figure B-12: Analysis of Growth Rate as a Function of Post-Release Movement for Fish Released in March at the Four Release Sites

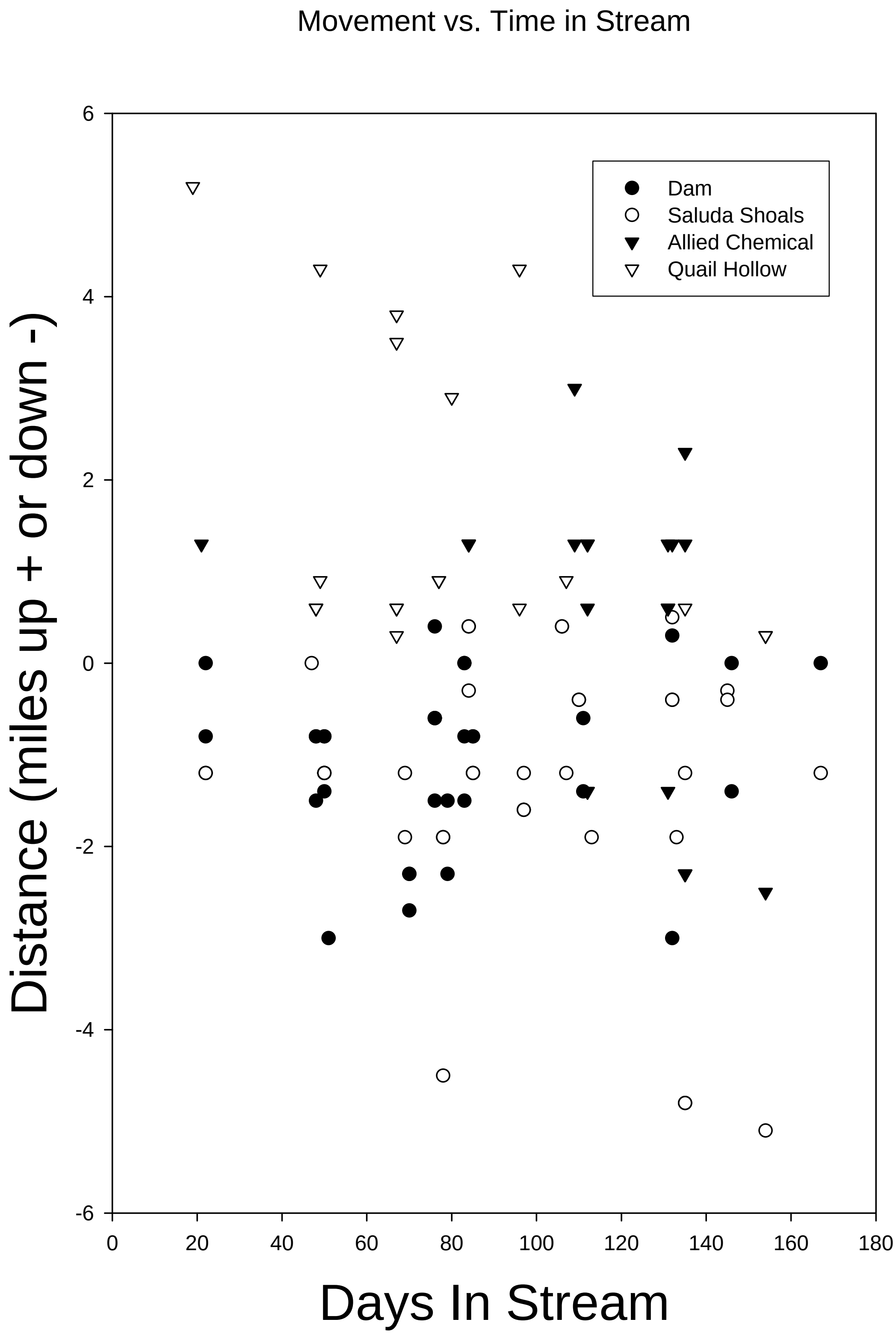


Figure B-13: Relationship Between Days in the Stream Between Release and Capture and the Distance Traveled from the Point of Release

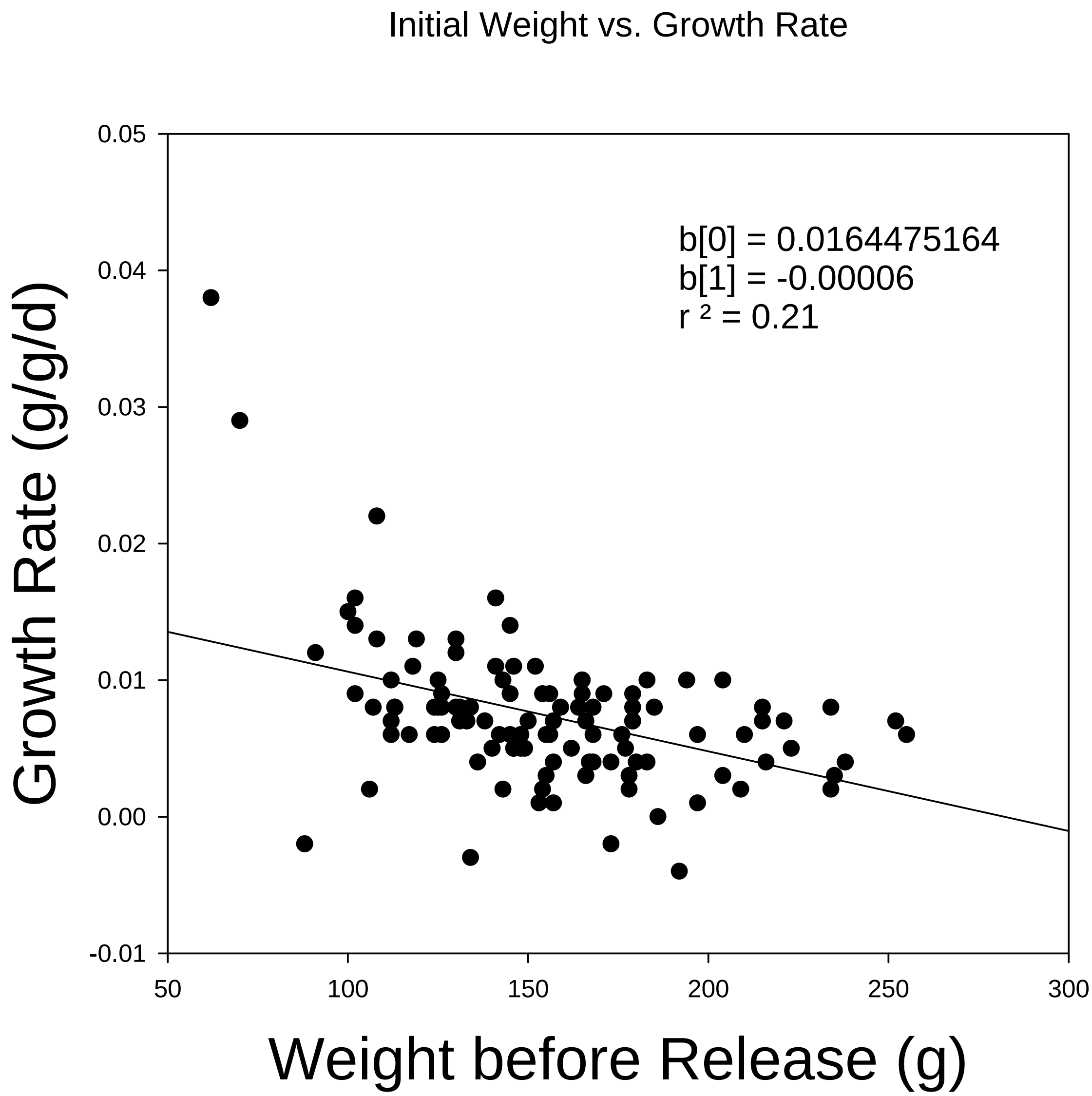


Figure B-14: The growth Rate of Trout in the LSR Showed a Slight Relationship with Size at Release

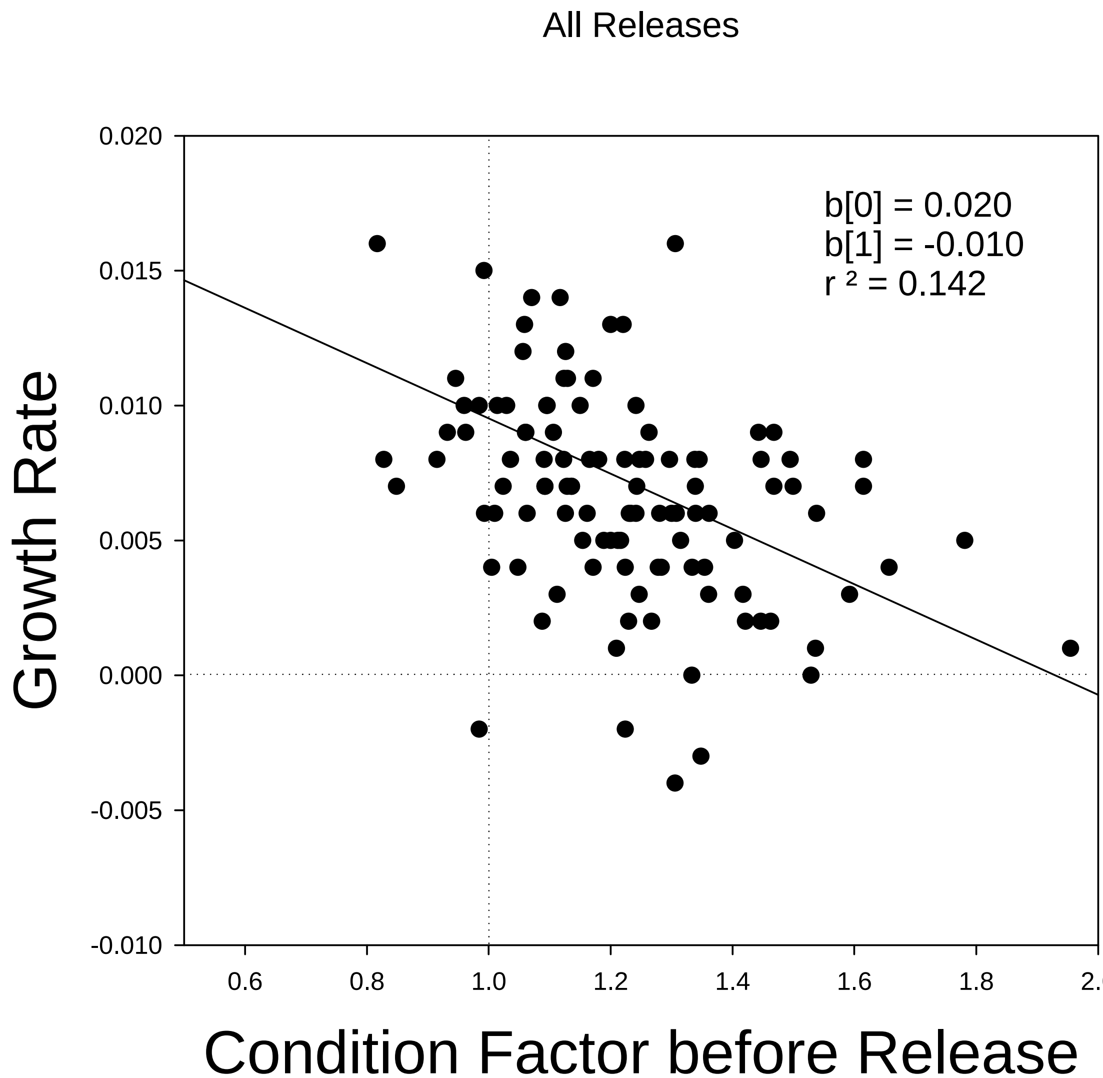


Figure B-15: Growth Rate was Greater in Fish with Lower Initial Condition Factors Following Release into the LSR

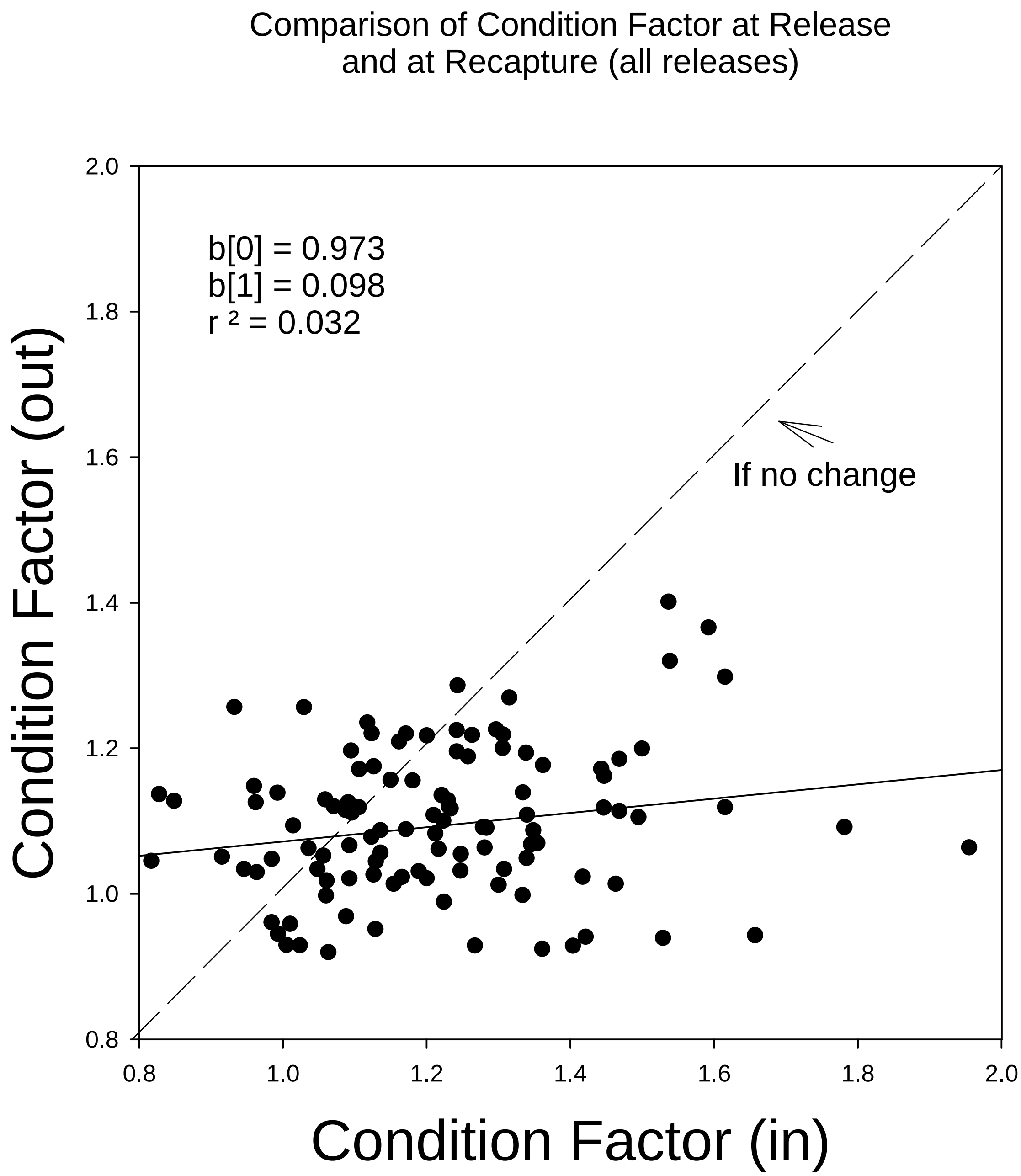
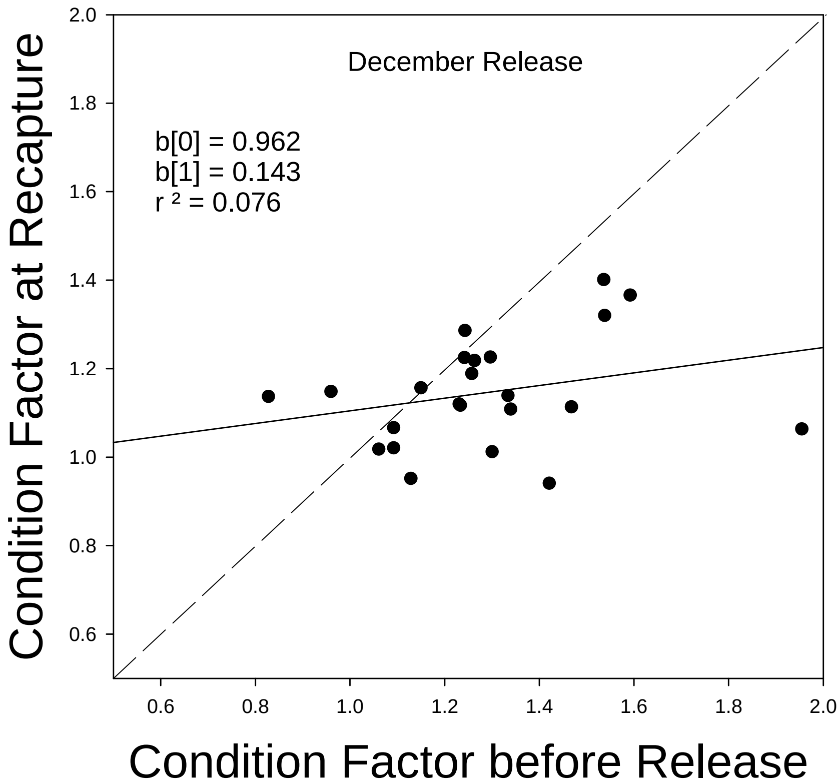


Figure B-16: The Condition of Trout in the LSR Became Much More Uniform Than That Seen at the Time of Release



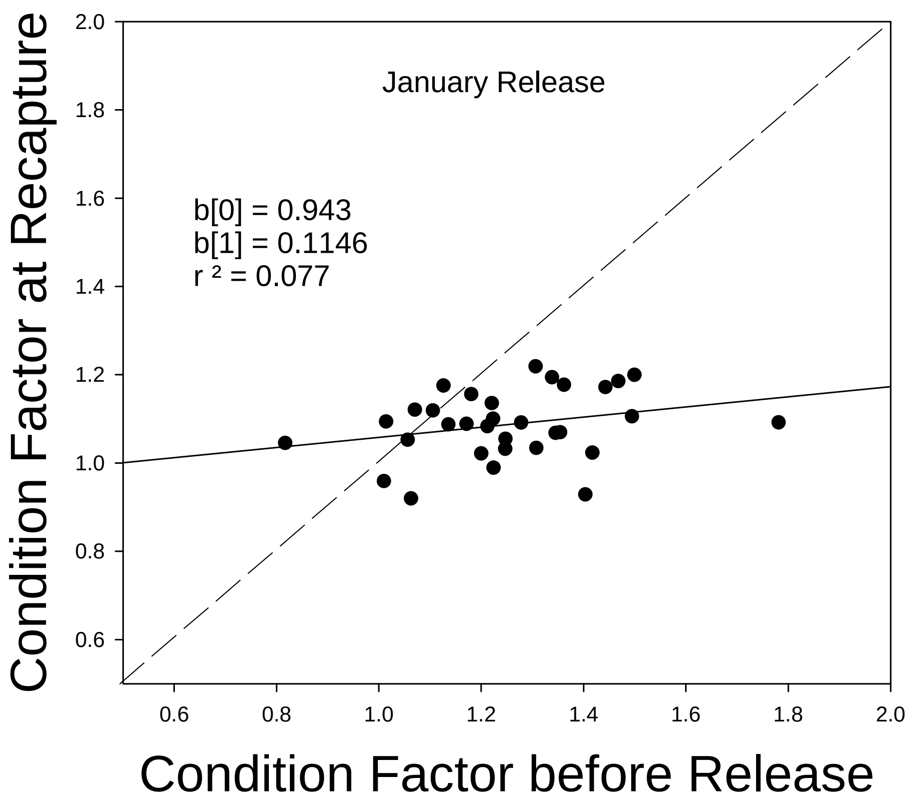
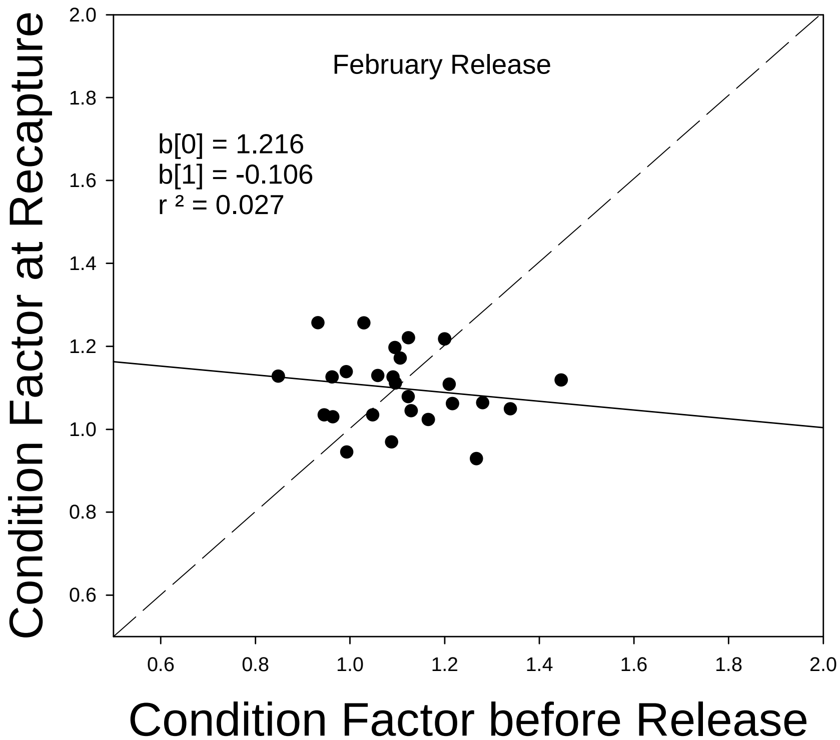


Figure B-17a: Condition Factor Change for December and January Releases



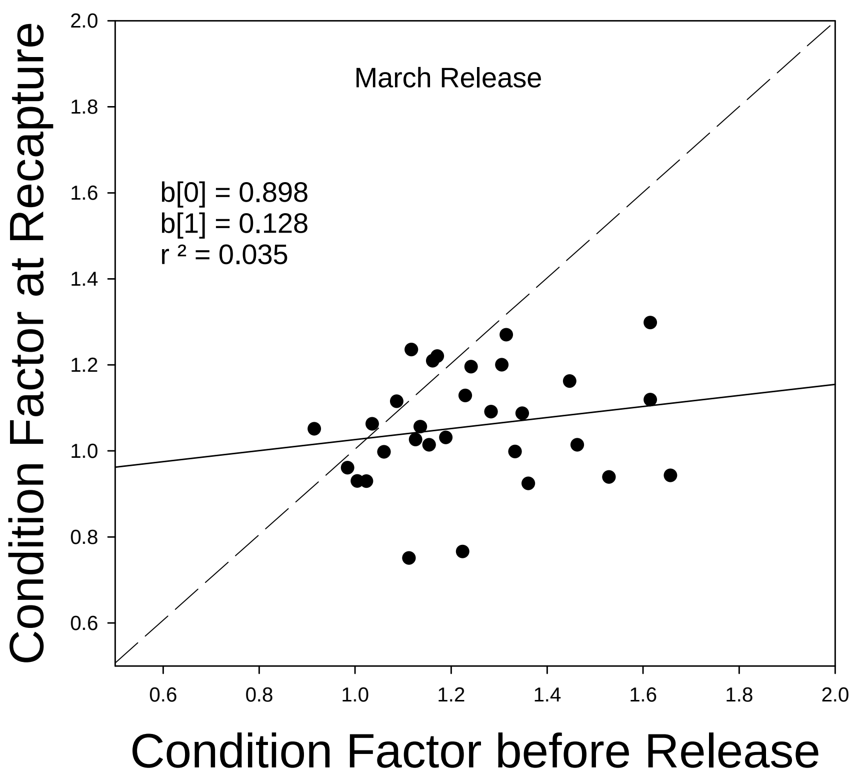


Figure B-17b:Condition Factor Change for January and March Releases

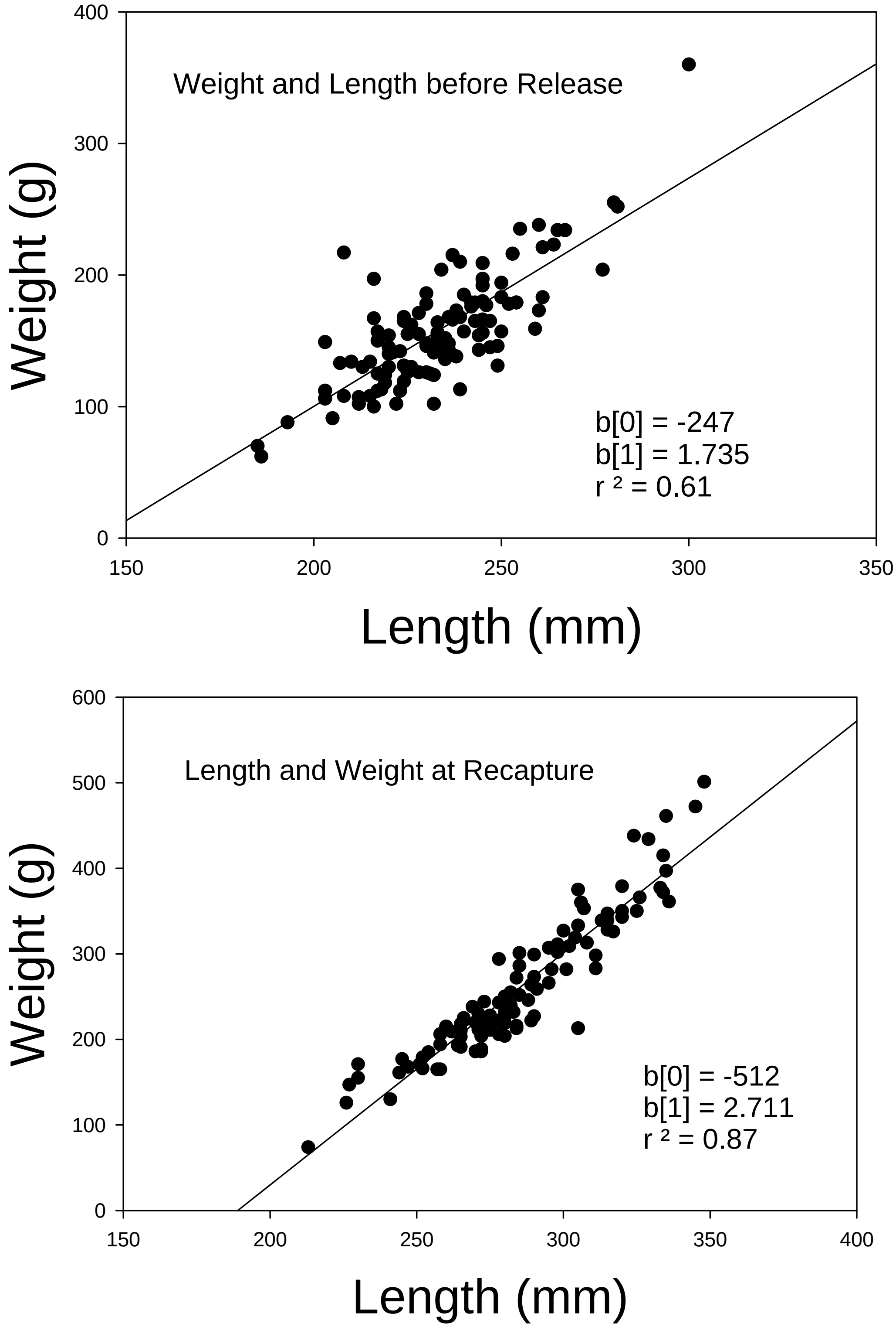


Figure B-18: Illustrating the Increased Uniformity of Trout Condition Following Release into the LSR

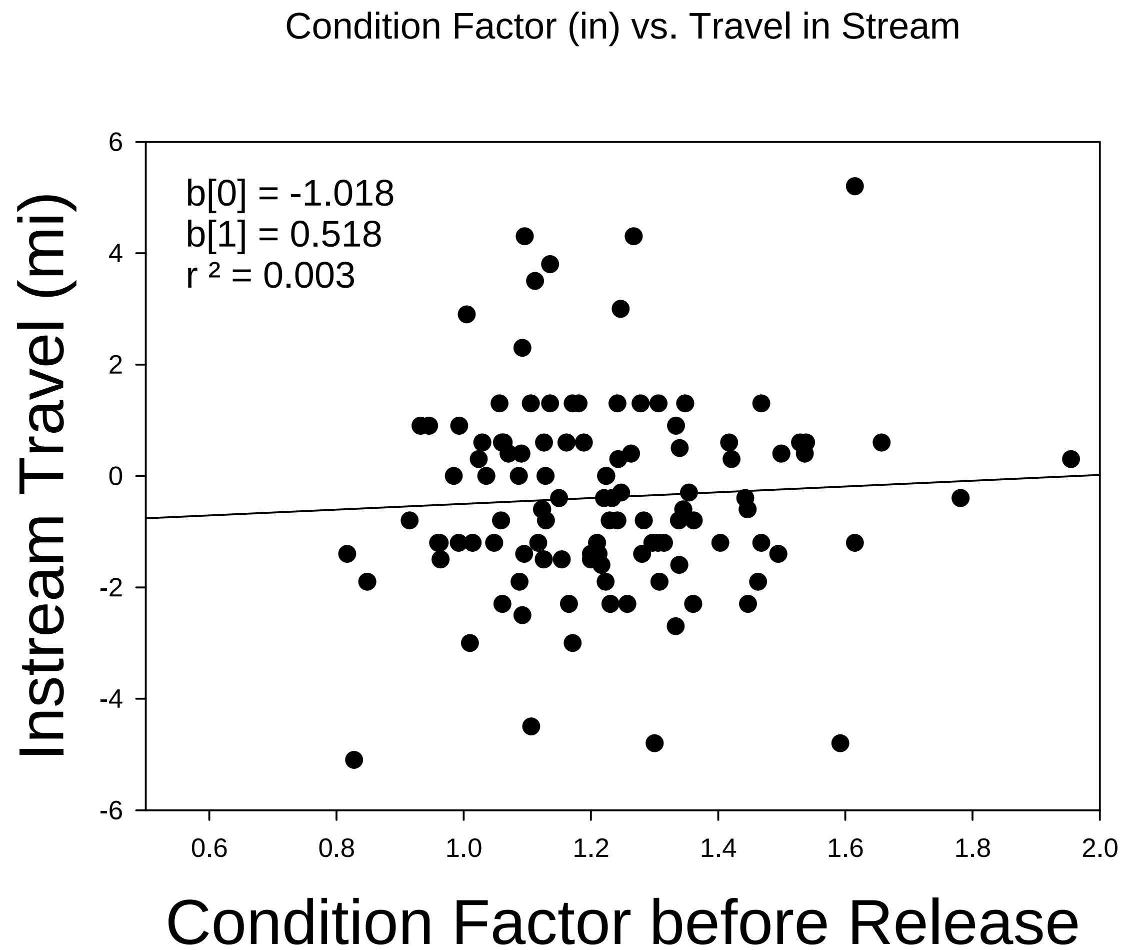


Figure B-19: There was No Significant Effect of Initial Condition Factor on the Tendency of Fish to Move Up or Downstream Following Release

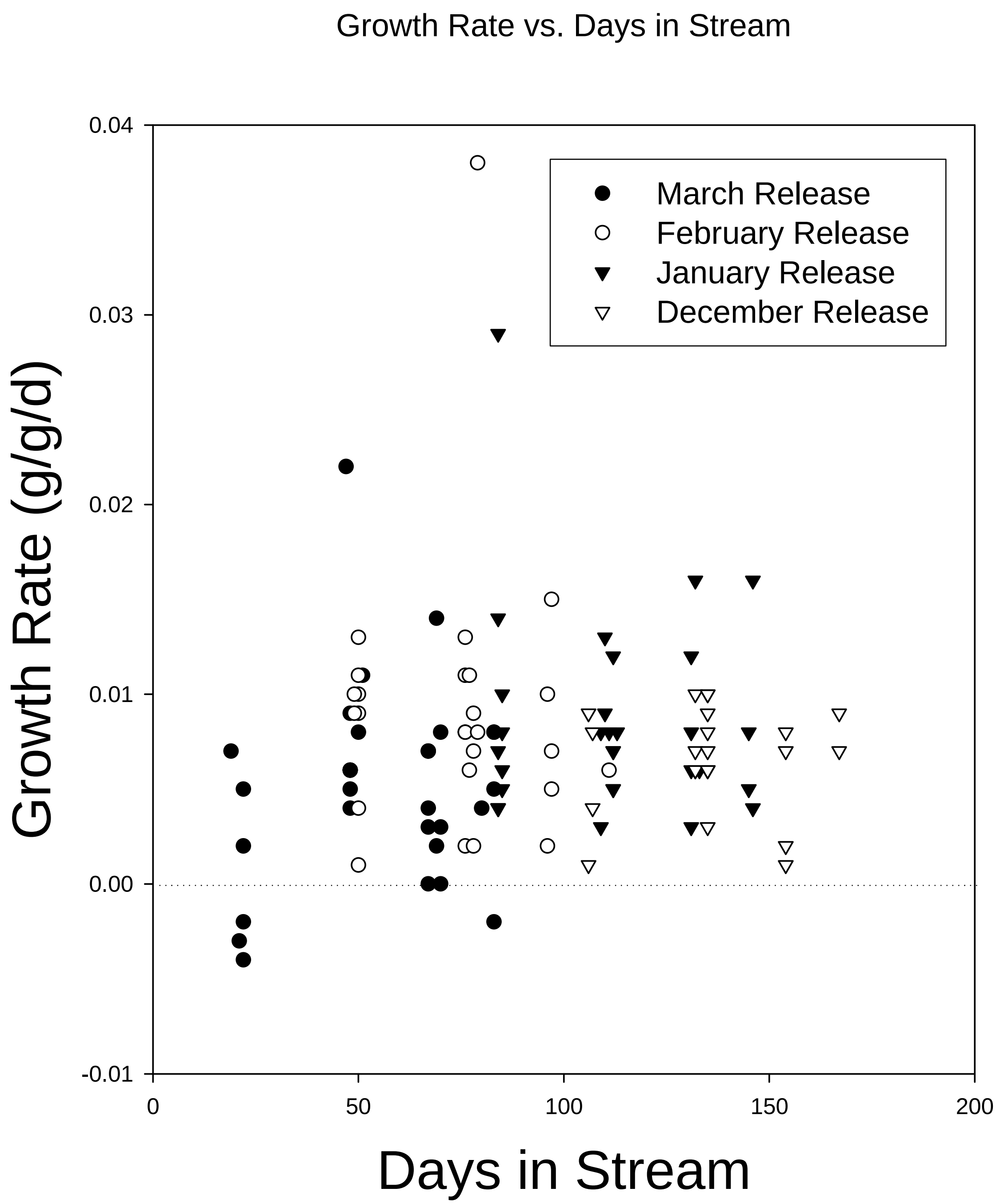


Figure B-20: There was No Appreciable Effect of Residency Duration on the Growth of Fish in the LSR

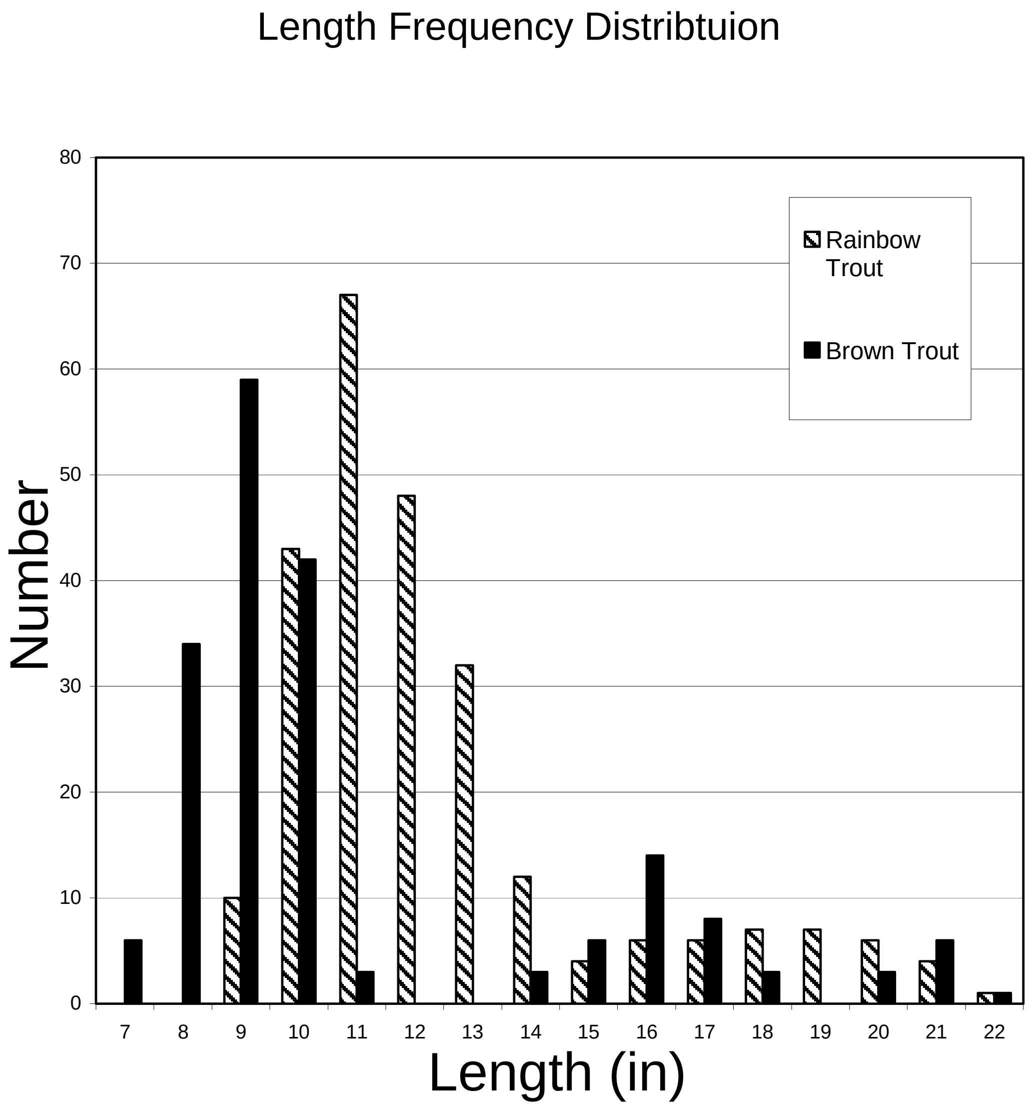


Figure B-21: Length Frequency Distribution of All Brown and Rainbow Trout Collected from the Lower Saluda River, April – June 2003

Appendix 7

Meeting Notes from the October 17th 2008 Fish and Wildlife TWC's

MEETING NOTES

SOUTH CAROLINA ELECTRIC & GAS COMPANY
SALUDA HYDRO PROJECT RELICENSING
Joint Meeting of Fish and Wildlife Technical Working Committees
October 17, 2008

final CSB 12082008

ATTENDEES:

Vivian Vejdani, SCDNR
Alan Stuart, Kleinschmidt Associates
Shane Boring, Kleinschmidt Associates
Jeni Hand, Kleinschmidt Associates
Will Dillman, SCDHEC
David Eargle, SCDHEC
Milton Quattlebaum, SCANA Services
Bob Siebels, Riverbanks Zoo (retired)
Prescott Brownell, NOAA Nat. Marine Fisheries Serv.
Robert Newton, NOAA Nat. Marine Fisheries Serv.
Jennifer Price, Univ. of SC
Randy Mahan, SCANA Services
Amanda Hill, USFWS
Bill Argentieri, SCE&G
Steve Summer, SCANA Services

ACTION ITEMS:

- Finalize draft Trout Feasibility Program document and distribute to TWC for review
  Alan Stuart
- Update Benthic Macroinvertebrate Program document and distribute for TWC review
  Shane Boring
- Coordinate kick-off of technical group to guide upstream mussel restoration efforts
  Shane Boring
- Draft components of RT&E Species Awareness Program; distribute text to agencies for review
  Kleinschmidt/SCE&G
- Develop list of priority NMFS diadromous fish studies for submission to Santee Fish Accord Board; provide list to B. Argentieri
  Prescott Brownell
- Finalize next meeting date
  Shane Boring

NEXT MEETING:

Proposed for Mid-December, 2008

MEETING NOTES:

These notes serve as a summary of the major points presented during the meeting and are not intended to be a transcript or analysis of the meeting.

Shane Boring opened the meeting at approximately 9:00 AM. Following introductions, Shane noted that the purpose of the days' meeting was to review the three draft plans recently distributed to TWC members via e-mail: the Lower Saluda River Freshwater Mussel Restoration Program; the Lower Saluda River Benthic Macroinvertebrate Monitoring and Enhancement Program; and the Saluda Hydro Rare, Threatened and Endangered Species Management Program. It was noted that, if consensus could be reached on the programs, it was SCE&G's intent to propose these as PM&E measures under a new license for Saluda Hydro and that they would hopefully be included in the settlement agreement for project relicensing. Alan Stuart noted that, in addition to reviewing the documents associated with the above proposed programs, he would like to present a draft framework for trout monitoring in the lower Saluda River (LSR) under a new project license. He noted that the purpose of this trout monitoring program would be to address previous request for an adaptive management strategy to evaluate long-term potential for a self-reproducing trout population downstream of the project. It was noted that Prescott Brownell would also be leading a discussion to gather ideas on appropriate long-term monitoring/enhancement efforts for shortnose sturgeon and other diadromous species under a new license.

Freshwater Mussel Restoration Program

Shane opened the discussion by reviewing the results of the freshwater mussel survey conducted by John Alderman in 2006. Specifically, it was noted that significant mussel fauna had been documented in Lake Murray and its tributaries, downstream of the project in the Congaree River and in the adjacent Broad River, but that no mussels were found directly downstream of the project in the LSR. Shane added that resource agencies, in their comments on the Draft License Application, had requested mitigation for the lack of mussels and that the draft Program had been developed pursuant to that request. Shane added that the draft program was not set in stone and that it was mostly intended as a starting point to facilitate a dialogue.

Jennifer Price then gave a brief review of her research on mussel in the Congaree and Broad Rivers. As it pertains to the Saluda Hydro vicinity, Jennifer noted patterns similar to those observed by Alderman in 2006, with mussels being much more abundant on the Broad River side of the Congaree than the Saluda side. She also noted that preliminary investigations of gravidity this past summer found abundant gravid mussels in the Broad River upstream of the confluence of the LSR (and thus upstream of the influence of Saluda Hydro) and very few gravid mussels below the confluence with the LSR (at Blossom St Bridge). She noted that it is unclear why there are not mussels in the LSR, but that potential influencing factors might include: historic low DO issues, shear forces associated with high flow release event (particularly for easily-displaced juveniles), low water temperatures below the dam, and low flow events during non-generation that might result in stranding. Jennifer added that, considering the recent improvements in DO levels in Project releases she did not think that DO is currently a limiting factor. She added she felt that temperature was likely a much more limiting factor, with several recent studies demonstrating significant impacts of coldwater dam releases on downstream mussel fauna.

Amanda Hill noted that she had discussed the temperature issue with Lora Zimmerman, the USFWS mussel expert in their office, and that Lora had serious concerns about whether reintroduction of mussels in the LSR would be successful due to low water temperatures, shear forces associated with project generation, and other issues. Following a brief discussion of the temperature regime in the LSR, the group agreed that reintroduction of mussels to the LSR would likely meet with little success and suggested scrapping the current plan. Amanda suggested that focusing efforts on upstream areas (above Lake Murray) might be more fruitful. After some additional discussion, it was agreed that a small technical working group should be formed to develop a strategy for freshwater mussels upstream of the Project dam, specifically in Lake Murray and its tributaries. It was agreed that a conference call would be the best method for a kick-off meeting. Group members identified a preliminary list of potential participants including: John Alderman, Jennifer Price, Shane Boring, Lora Zimmerman, David Eargle, and Milton Quattlebaum. Alan and Bill noted it would be best to have a Program for upstream areas finalized in time for inclusion in the relicensing Settlement Agreement, and as such, requested that the group be mobilized as soon as possible. Shane Boring was tasked with coordinating the group.

<u>Rare, Threatened and Endangered (RTE) Species Management Program</u>

Shane noted that this plan deals with three of the species that agency staff and other participating in the RTE TWC had identified as being in need of a management plan under a new FERC license for Saluda Hydro: bald eagle, wood stork, and rocky shoals spider lily. The group then addressed each of the species.

Bald Eagle
Shane noted that the proposed measures merely codify those items already required under the USFWS (1997) Bald Eagle Guidelines, which ensure compliance with the Bald and Golden Eagle Protection Act and Migratory Bird Treaty Act. In general, the guidelines require that a buffer of 660 ft be maintained around nest trees during the nesting season and 330 ft during non-nesting. Shane noted these requirements were implemented in 1997 following de-listing of the bald eagle. He added that, according to Tommy Boozer, SCE&G was notified of the change by letter several months ago, and that they were already following the new measures as part of shoreline permitting activities. Steve Summer noted that SCANA has a Raptor Protection Policy and enquired whether it had been integrated with the plan being discussed. Shane indicated that adherence to the Raptor Protection Plan is referenced in the Program and that Laura Blake-Orr had reviewed and approved the bald eagle section of the RTE Program. The group agreed that the bald eagle management measures were acceptable.

Wood Stork

Shane briefly reviewed the measured proposed in the Program for Wood Stork, including:

- Documentation of any wood storks observed during fall/winter waterfowl surveys on Lake Murray
- Inclusion of wood stork in an RTE Species Public Awareness Program, including a mechanism to report stork sightings.
- Coordination with SCDNR Endangered Species staff to ensure that SCE&G has most current information on whether storks have been observed recently on Lake Murray.
- Report any new sightings of wood storks to SCDNR and USFWS staff.

The group agreed that the measures proposed for wood stork appeared acceptable.

Rocky Shoals Spider Lily
Shane explained that there are no RSSL plants in the LSR directly downstream of the project, and that the RSSL population referred to in the Program is located in the Saluda/Broad confluence area. He added that this population is currently managed under the Columbia Hydro Project RSSL Enhancement Plan, which SCE&G, the City of Columbia, Riverbanks Botanical Gardens and other partners began implementing in 2007. He added that the measures included in the RTE Management Program are intended to mirror those already implemented in the existing Columbia Hydro RSSL Enhancement Plan. The group generally agreed that using the RTE Management Program as a means to tie Saluda Hydro to the existing restoration efforts in the confluence was acceptable. Amanda indicated that she would like to have Lora Zimmerman have a look at the draft RSSL measures, but that she did not anticipate there being issues.

RTE Awareness Program
Several attendees enquired as to whether all of the RTE species occurring in the Saluda Project vicinity would be a part of the RTE Species Public Awareness Program (RSSL, Bald Eagle, Wood Stork, Shortnose Sturgeon). Alan and Bill indicated that these four species would be included. Amanda and Vivian requested that their agencies be allowed to review the program materials prior to implementation. Alan and Bill agreed. Shane enquired as to whether it would be acceptable to send the raw information (in MS Word format) for review and then allow SCE&G to handle the graphic design without further review. The group was agreeable to this approach.

<u>LSR Benthic Macroinvertebrate Monitoring and Enhancement Program</u>

Steve Summer noted that SCE&G has been conducting some type of macroinvertebrate monitoring on the LSR on an almost yearly basis since approximately the late 1990's. Shane noted that the proposed program would be a continuation and expansion of this monitoring effort under a new license for the project. Specifically, it was noted that the proposed program would include a bi-annual (twice yearly) Rapid Bioassessment for a period of 6 years following issuance of the new license, as well as bi-annual Hester-Dendy sampling during alternate years. It was noted that sampling would be conducted at 4 locations: the project tailrace, Oh Brother/Ocean Blvd rapids, Corley Island and adjacent to Riverbanks Zoo. Amanda asked whether there was anything special about the 6 year sampling period and enquired if any follow up sampling was planned. Noting that

SCE&G would likely continue sampling beyond the 6 years anyway, Bill proposed a commitment in the plan to consult with the agencies and if there is a need for additional information, initiate a 2-year follow-up survey cycle (2 years of Rapid Bioassessment and 1 year of Hester-Dendy sampling) 10 years following completion of the initial 6 years. The group concluded that this was acceptable. Shane Boring was tasked with updating the draft program document and distributing it to the TWC for review.

Proposed LSR Trout Monitoring Framework

Alan Stuart noted that, at the request of Trout Unlimited, a Trout White Paper had been prepared as part of relicensing to determine potential for a self-reproducing and/or self-sustaining trout fishery. He added that, while this early assessment determined that trout reproduction was unlikely in the LSR under current conditions, SCE&G committed to establishing an adaptive management strategy for trout to allow for reproductive potential to be re-examined once aquatic enhancements, such as minimum flows and DO enhancements, have been implemented under a new license. Alan then presented a proposed Trout Monitoring Framework.

Alan noted the proposed trout program would likely include formation of a technical committee to meet periodically to review pertinent data and guide management recommendations. Pertinent data to be considered for decision making will likely include a number of existing programs, including: water quality (DO and temp), flow (USGS gages), macroinvertebrate (from the SCE&G macroinvertebrate program described above), and electrofishing data (SCDNR, SCE&G). In addition to existing data, the program will likely include icthyoplankton sampling in the Ocean Blvd./Oh Brother Rapids area during the potential window for rainbow trout spawning (May), as well as visual searches for redds during the preceding weeks. It was noted that ichthyoplankton sampling and redd searches will likely be conducted for a period of 6 years (concurrent with the macroinvertebrate sampling). Alan noted the program will likely include a replication of the trout growth study (originally performed in 2003) following completion of the initial 6 years of macroinvertebrate, ichthyoplankton and redd monitoring (see macroinvertebrate program described above). Finally, the program will likely include an annual report summarizing the data collected during each year of the program.

Alan indicated that the program had not been fully developed, but that he wanted to present an outline today to get a feel of whether the TWC felt it was heading in the right direction. The group concluded that the program seemed generally acceptable. Alan noted that the plan would be further refined and distributed to the TWC for review in the near future.

Diadromous Fish Needs Under a New Saluda Hydro License

Shane noted that, in the comments on the Draft License Application, NMFS alluded to some long-term monitoring that might be appropriate for shortnose sturgeon under a new license term for Saluda. Prescott clarified the NMFS position, noting that some additional measures to promote sturgeon conservation would likely be needed considering the length of the license, the importance of the Santee Basin to the recovery of shortnose sturgeon and other diadromous species, and the pending implementation of minimum flows and other enhancements. Prescott urged the group to not just focus on sturgeon, but on all diadromous species.

Bill A. asked if Prescott had specific monitoring in mind. Prescott mentioned a number of potential long-term monitoring efforts with potential to contribute to diadromous fish recovery, including: water quality/chemistry studies, fish population dynamics studies, and telemetry studies to better document fish movement and habitat use. Prescott noted that these are just a few potential studies and that, as with several other relicensing issues, some sort of adaptive management approach would likely be best. Prescott noted specifically the need for telemetry work in the confluence area to understand movement at the Broad/Saluda interface and that potential influence of newly-established fish passage on the Broad. He also noted a need for telemetry work in the upper Santee-Cooper Lakes to determine basin preferences (use of Wateree versus Congaree, etc.).

Amanda noted that much of what Prescott mentioned is already planned as part of the Santee Basin Diadromous Fish Accord. Bill enquired as to whether those measures being proposed under the Accord would satisfy the NMFS request for additional monitoring. Prescott noted that they might, but not being a signatory to the Accord, they would need to have a closer look at exactly what is being proposed. Bill noted that he would send Prescott the 10 year plan for the Accord and suggested that Prescott review the actions being proposed and pass along any additional requests he might have. Prescott agreed with this general approach. He added that an ideal approach would be to develop a mechanism to ensure they are kept abreast of developments in the Accord process and occasionally meet to discuss any items not addressed by the Accord. Bill suggested that SCE&G take the lead in letting NMFS know when Accord technical meetings are taking place and that NMFS could potentially attend as observers. Prescott noted that being kept informed of meetings would be very helpful, as attendance at these meetings would help them develop ideas regarding monitoring needs/studies. Bill indicated that he would notify the Accord Board that NMFS will likely be attending as an observer.

Amanda noted that sturgeon studies under the Accord are slated to start in 2010, but that specific studies have not been identified. She advised that NMFS should let SCE&G know of what studies they would like to see performed as soon as possible. Prescott then expanded a bit on a few of the studies NMFS feels might be most worthwhile, including: sturgeon telemetry studies, population dynamics, and characterization of spawning habitat. Bill proposed that SCE&G could present these ideas to the Accord group to ensure that they are addressed as part of the process. Prescott noted that he would like to get together with other agency staff from his agency, as well as possibly USFWS and SCDNR, to further refine the list of requested studies. Prescott indicated that he would try to have the list of studies to SCE&G by Friday, October 31. Bill noted that SCE&G and Kleinschmidt would incorporate the study recommendations into a draft PM&E Program once they are received from NMFS. Bill reiterated that SCE&G would work with NMFS to address any of the study requests not addressed under the Accord. Amanda noted that they would assist SCE&G in recommending the NMF requested studies to the Accord group.

The meeting adjourned at approximately 2:45 PM.

Appendix 8

1-7-09 SUBMITTAL DRAFT PROPOSED MAINTENANCE, EMERGENCY, AND HIGH/LOW INFLOW PROTOCOL

(SUPERSEDED BY APPENDIX 36)

SALUDA HYDROELECTRIC PROJECT P-516
PROPOSED MAINTENANCE, EMERGENCY, AND HIGH/LOW INFLOW PROTOCOL
- DRAFT -

PURPOSE

The proposed Maintenance, Emergency, and Low Inflow Protocol (MELIP) for the Saluda Hydroelectric Project (FERC Project No. 516) is intended to provide operational guidance for abnormal operating situations caused by maintenance activities, emergency situations (including high inflow or flood events), and periods of sustained low inflow or drought conditions.

There are several types of maintenance activities which may require temporary modifications to normal reservoir levels and/or seasonal minimum flow and scheduled recreation flow releases. Certain emergency situations involving the interconnected electric system ("grid"), project structures, equipment, or waterways may also require temporary modifications to normal reservoir levels and/or seasonal minimum flow and scheduled recreation flow releases.

During periods of high inflow or flood events, the project must be operated to safely pass and/or store the high inflow without compromising the safety of the dam and other project structures. This may require temporary modifications to normal reservoir levels and/or seasonal minimum flow and scheduled recreation flow releases, either to pass higher than normal inflow, or to draw down the reservoir in advance of forecast high inflow.

During periods of low inflow, the Licensee's goal is to conserve the remaining water stored in Lake Murray, in order to delay or prevent depletion of the usable storage in the reservoir. This will allow the project to continue to fulfill three primary critical functions for as long as possible during drought periods: Reserve electric generation, municipal water supply, and critical downstream flow releases. This will also act to preserve the recreational and environmental values of the reservoir.

PROPOSED TARGET RESERVOIR ELEVATIONS

Normal target reservoir elevations are defined by the proposed Reservoir Guide Curve (Appendix 1). These are reservoir elevations which the Licensee will endeavor in good faith to achieve, unless operating under one of the conditions listed in this Maintenance, Emergency, and Low Inflow Protocol.

PROPOSED MINIMUM FLOW SCHEDULE

The seasonal minimum flow regime for the project under normal inflow conditions is currently being evaluated by the Licensee in consultation with the stakeholders. Currently proposed values for the normal seasonal flow regime are:

January 1 – March 31: 700 CFS
April 1 – April 14: 1,000 CFS
April 15 – May 14: 1,300 CFS
May 15 – May 31: 1,000 CFS
June 1 – December 31: 700 CFS

At this time, the consensus of the stakeholders is that a low flow of 400 CFS is a reasonable value to provide minimal navigability and preserve suitable conditions for most fish and other aquatic species in the lower Saluda River during periods of low inflow.

OPERATION DURING MAINTENANCE ACTIVITIES

Under some maintenance conditions, it may be necessary to operate the project such that reservoir elevations and/or seasonal minimum or scheduled recreation flows cannot be maintained in the normal ranges, even during periods of normal inflow and hydrologic conditions. Examples of such conditions are:

- Scheduled or unscheduled project structure or hydro unit maintenance;
- Scheduled reservoir drawdown below normal minimum elevation due to required inspection or maintenance of project structures, or improvements to lakeside facilities.

To the extent practical, the Licensee will avoid scheduling project structure or hydro unit maintenance that would impact the ability of the Licensee to release the required seasonal minimum flow or scheduled recreation flows, unless it is likely that further damage or unscheduled maintenance would ensue if the work is delayed. If it is determined that the seasonal minimum flows cannot be maintained due to the scheduled maintenance activities, the Licensee will consult with the appropriate resource agencies to monitor and minimize impacts to water quality and aquatic habitat. To the extent practical, the licensee will also endeavor to replace any scheduled recreation flows which are impacted by the scheduled maintenance activities within the same calendar year as originally scheduled.

The reservoir may periodically be drawn down to its minimum level of el. 343.5' (el. 345.0' PD)[1] for repairs to the upstream riprap armor on the original earth dam, inspection or repairs to the intake towers or spillway structure, or to accomplish improvements to boat landings or other recreational sites. Scheduled drawdowns such as this would normally occur during October through February; however the time period may vary depending on the required scope of maintenance work. The Licensee will make public notification of scheduled drawdowns via media releases and announcements on the corporate web site as far in advance as practical.

An unscheduled reservoir drawdown due to unforeseen equipment damage or other reason is very unlikely; however it is possible that this would occur at some time. To the extent practical, the Licensee will take steps to limit the magnitude and duration of any unscheduled reservoir drawdown.

[1] All elevation references in this MELIP are given in North American Vertical Datum 1988 (NAVD 88); conversion to traditional plant datum (PD, used in numerous supporting studies for this license application and often erroneously referred to as MSL) requires the addition of 1.5 ft.

OPERATION DURING EMERGENCIES

During emergency conditions, it may be necessary to operate the project such that reservoir elevations and/or seasonal minimum or scheduled recreation flows cannot be maintained in the normal ranges, even during periods of normal inflow and hydrologic conditions. Examples of such emergencies are:

- Grid voltage or capacity emergency declared by the Licensee's System Operations Center or Transmission Operations Center;
- Dam safety emergency;
- Emergency plant shutdown due to equipment failure, fire, or other situations which endanger human health and safety or the environment;
- River access special circumstances (e.g., emergency rescue or recovery operations).

During a declared grid voltage or capacity emergency, the Licensee will operate the project as required to maintain or restore the reliability of the electrical system, with due regard to the safety of both the public and the project structures. This may result in deviation from scheduled recreation flows and/or normal reservoir operation levels.

During a dam safety emergency, the safety of the downstream population is paramount, and the Licensee will take actions as required to maintain or restore the integrity of all project water retaining structures. This may result in deviation from seasonal minimum flow, scheduled recreation flows and/or normal reservoir operation levels.

In the event of serious equipment failure, fire, releases or spills, or other conditions which endanger plant personnel, the public, or the environment, it may be necessary to completely shut down the Saluda Hydro plant and limit discharge from the facility to the minimum possible. This may result is deviation from seasonal minimum flow and/or scheduled recreation flows.

Upon request from local emergency response agencies, it may be necessary to decrease or increase the discharge from the Saluda Hydro plant in order to facilitate access to the lower Saluda River for rescue or recovery operations. This may result in deviation from seasonal minimum flow and/or scheduled recreation flows.

If it is determined that the seasonal minimum flows cannot be maintained due to an emergency condition, the Licensee will consult with the appropriate resource agencies as soon as is practical to monitor and minimize impacts to water quality and aquatic habitat. To the extent practical, the licensee will also endeavor to replace any scheduled recreation flows which are impacted by the emergency situation within the same calendar year as originally scheduled.

OPERATION DURING HIGH INFLOW PERIODS OR FLOODS

The Licensee has developed a Flow Forecast Model (FFM) for the purpose of anticipating high inflow events due to large amounts of rainfall in the Saluda River basin draining to Lake Murray. The FFM uses precipitation forecasts from the National Weather Service (NWS) and near real time data from the U.S. Geological Survey (USGS) to estimate inflow to Lake Murray up to 5 days in advance. The Licensee's System Operators also monitor the National Weather Service on a routine basis. In the event a weather system capable of producing heavy precipitation is forecast to impact the Saluda Project, the Licensee's engineering staff runs the FFM using the latest precipitation forecast and current streamflow data from the USGS gauge network. Based on the magnitude and duration of the inflow hydrograph computed by the FFM, the System Operators are advised as to what action to take in order to safely pass and/or store the projected inflow. Such actions may include:

- Reduction of reservoir level below the existing target elevation in advance of or during the weather system to provide storage volume for the forecast inflow;
- Operation of one or more spillway gates to pass inflow in excess of that which can be passed by generation and prevent the reservoir from rising above el. 358.5' (360.0' PD);
- Allowing the reservoir to rise above the existing target elevation in order to store all or a portion of the inflow and limit excessive downstream releases.

Any of these actions may result in deviation from scheduled recreation flows and/or normal reservoir operation levels. To the extent practical, the licensee will endeavor to replace any scheduled recreation flows which are impacted by the high inflow conditions within the same calendar year as originally scheduled.

OPERATION DURING LOW INFLOW PERIODS

For operation during periods of sustained low inflow or drought, the MELIP defines trigger points and procedures for incremental reductions in seasonal minimum flow and downstream recreation flows based on gauged inflow to the project. During periods of normal inflow, the Licensee will operate the Saluda Project to maintain the reservoir level at or near the current target elevation within the proposed normal operating range of el. 352.5' (354.0' PD) to el. 356.5.0' (358.0' PD), while providing the normal seasonal minimum downstream flow and normal scheduled recreation and safety training flows. The project will be available for reserve generation as required by the Licensee's system and obligations under the Virginia-Carolinas Electric Reliability Council (VACAR, or its successor) Reserve Sharing Agreement (VRSA). During times when inflow to the project exceeds the seasonal minimum flow and scheduled recreation flows, the project will generate on an as-needed basis to maintain the reservoir at or near the current target elevation.

If hydrologic conditions in the Saluda River basin draining to Lake Murray worsen and the 14 day average gauged inflow less estimated municipal usage ("net inflow")[2] falls below the scheduled minimum flow, water stored in Lake Murray will be used to augment project inflow to provide the normal seasonal minimum flow until the reservoir level falls to more than 1.0 ft. below the current target elevation. At that time, the Licensee will discharge target flow as follows:

14 Day Average Net Inflow	**Target Flow (except April 15 – May 14)**
< 1,000 CFS	700 CFS
< 700 CFS	500 CFS (400 CFS minimum)

If 14 day average net inflow falls below the scheduled minimum flow during the April 15 through May 14 period when the scheduled minimum flow is 1,300 CFS, a reduced continuous minimum flow with daily or twice daily pulses to facilitate fish passage over shoals in the lower Saluda River will be implemented as follows, once the reservoir falls to more than 1.0 ft. below the current target elevation:

14 Day Average Net Inflow	**Target Flow Provided April 15 – May 14**
≥ 1,000 CFS	1,300 CFS continuous
< 1,000 CFS	700 CFS continuous with (2) pulses per day of 3,000 CFS for 1.5 hours each. (Yields 988 CFS daily average flow.)
< 700 CFS	500 CFS continuous with (1) pulse per day of 3,000 CFS for 1.5 hours. (Yields 656 CFS daily average flow.)
≤ 500 CFS	500 CFS target (400 CFS minimum) continuous, no pulses.

[2] Gauged inflow will be computed each day as the sum of three scaled USGS gauge values for the Saluda River, Little River, and Bush River, less estimated municipal usage from the reservoir. The 14 day average of these daily values will be computed each day. See Appendix 2 for details of inflow scaling and computing net inflow.

If 14 day average net inflow should fall below the scheduled minimum flow between December 16th and January 17th, when the target reservoir elevation is within 1.0 ft. of el. 352.5' (354.0' PD), the reservoir will not be required to drop 1.0 ft. below the current target elevation before reducing the minimum flow. Additionally, at any time during a low inflow period (when 14 day average net inflow is less than the scheduled minimum flow), should the reservoir level fall below el. 352.5' (354.0' PD), the minimum flow from the project will be reduced to a target flow of 500 CFS (400 CFS minimum), and will remain at that value regardless of any increase of inflow until the reservoir level has risen above el. 352.5' (354.0' PD).

During low inflow periods, scheduled recreation flows will be reduced in stages. [This is to be determined in consultation with the Recreational Flow TWC.] Once the reservoir level falls to below el. 352.5' (354.0' PD), all scheduled recreation flows will be suspended until the reservoir level has risen above el. 352.5' (354.0' PD).

Scheduled spring and fall safety training flows for the Columbia Fire Department (CFD) Swift Water Rescue Team will be provided in full if the following criteria are met:

Spring: Reservoir level at least 354.5' (356.0' PD) on February 1 for early March safety training.

Fall: Reservoir level at least 354.5' (356.0' PD) on November 1 for early December safety training.

These criteria may be modified in a given year if circumstances warrant or permit. If the criteria for providing full safety training flows are not met, a prearranged reduced schedule of flows will be provided by mutual agreement between the Licensee and the Columbia Fire Department. [This is to be determined in consultation with the CFD.]

During extended periods of low inflow, when depletion of the reservoir below el. 348.5' (350.0' PD) is imminent, the Licensee will consult with the South Carolina Department of Natural Resources (SCDNR), the South Carolina Department of Health and Environmental Control (SCDHEC), and other applicable resource agencies to determine if further reductions in minimum flow below 400 CFS should be considered. At that time, the Licensee will also coordinate a joint meeting with consulting agencies and the managers of the municipal water systems which withdraw water from Lake Murray, to determine a drought management plan that could include voluntary or mandatory water conservation measures, as determined by the agencies.

COORDINATION OF LOW INFLOW PROTOCOL WITH MAINTENANCE ACTIVITIES OR EMERGENCY CONDITIONS

If maintenance or emergency conditions require modifications to the normal reservoir target elevations and/or the normal minimum flow schedule during low inflow periods, the requirements of the maintenance activity or emergency condition may supersede the Low Inflow Protocol operation if necessary.

Drawdown of the reservoir due to maintenance or emergency conditions will not automatically trigger reductions in minimum flow, unless 14 day average inflow falls below the scheduled minimum flow. During refilling of the reservoir after a drawdown, if 14 day average inflow falls below the scheduled minimum flow while the reservoir is below el. 352.5' (el. 354.0' PD), the target flow will be reduced to 500 CFS (400 CFS minimum) until the reservoir exceeds el. 352.5' (el. 354.0' PD).

It should also be noted that the South Carolina Department of Natural Resources (SCDNR) has certain statutory authority under the South Carolina Drought Response Act and Regulations, and nothing in this LIP is intended to abrogate that authority.

PERIODIC REVIEW OF PROTOCOL

Upon request, the Licensee will consult with the South Carolina Department of Natural Resources (SCDNR), the South Carolina Department of Health and Environmental Control (SCDHEC), and other applicable resource agencies every 5 years during the license term to evaluate the effectiveness of the MELIP during the previous 5 years, and to determine if any modifications to the MELIP are required.

APPENDIX 1

RESERVOIR GUIDE CURVE AND TABLES

- DRAFT -

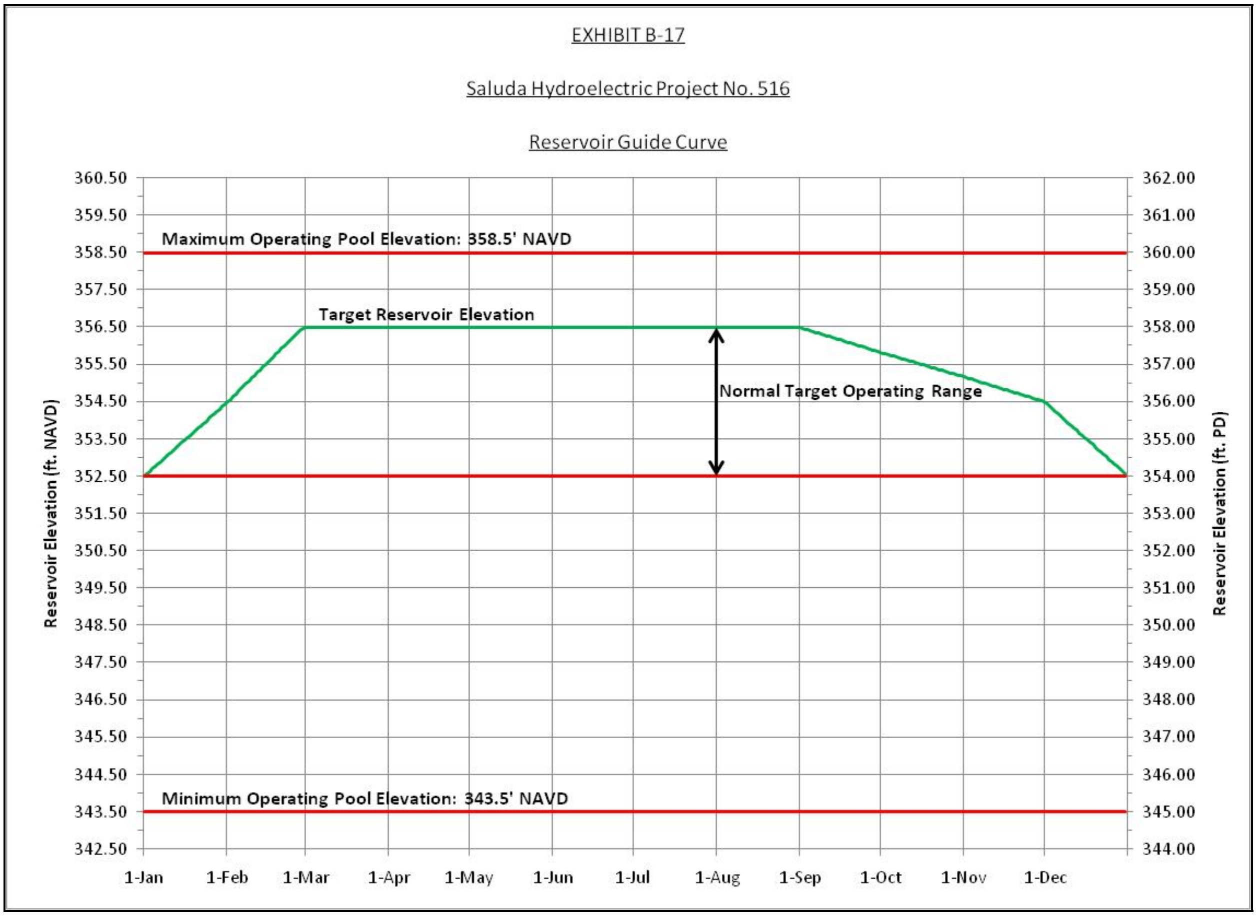


EXHIBIT B-17
Saluda Hydroelectric Project No. 516
Reservoir Guide Curve
Maximum Operating Pool Elevation: 358.5' NAVD
Target Reservoir Elevation
Normal Target Operating Range
Minimum Operating Pool Elevation: 343.5' NAVD
Reservoir Elevation (ft. NAVD)
Reservoir Elevation (ft. PD)
360.50
359.50
358.50
357.50
356.50
355.50
354.50
353.50
352.50
351.50
350.50
349.50
348.50
347.50
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1-Jan
1-Feb
1-Mar
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1-May
1-Jun
1-Jul
1-Aug
1-Sep
1-Oct
1-Nov
1-Dec

Reservoir Guide Curve Table – Elevations in Feet NAVD

	January	February	March	April	May	June	July	August	September	October	November	December
1	352.50	354.50	356.50	356.50	356.50	356.50	356.50	356.50	356.50	355.83	355.17	354.50
2	352.56	354.57	356.50	356.50	356.50	356.50	356.50	356.50	356.48	355.81	355.15	354.44
3	352.63	354.64	356.50	356.50	356.50	356.50	356.50	356.50	356.46	355.79	355.13	354.37
4	352.69	354.71	356.50	356.50	356.50	356.50	356.50	356.50	356.43	355.77	355.10	354.31
5	352.76	354.79	356.50	356.50	356.50	356.50	356.50	356.50	356.41	355.74	355.08	354.24
6	352.82	354.86	356.50	356.50	356.50	356.50	356.50	356.50	356.39	355.72	355.06	354.18
7	352.89	354.93	356.50	356.50	356.50	356.50	356.50	356.50	356.37	355.70	355.04	354.11
8	352.95	355.00	356.50	356.50	356.50	356.50	356.50	356.50	356.34	355.68	355.01	354.05
9	353.02	355.07	356.50	356.50	356.50	356.50	356.50	356.50	356.32	355.66	354.99	353.98
10	353.08	355.14	356.50	356.50	356.50	356.50	356.50	356.50	356.30	355.64	354.97	353.92
11	353.15	355.21	356.50	356.50	356.50	356.50	356.50	356.50	356.28	355.62	354.95	353.85
12	353.21	355.29	356.50	356.50	356.50	356.50	356.50	356.50	356.25	355.60	354.92	353.79
13	353.27	355.36	356.50	356.50	356.50	356.50	356.50	356.50	356.23	355.57	354.90	353.73
14	353.34	355.43	356.50	356.50	356.50	356.50	356.50	356.50	356.21	355.55	354.88	353.66
15	353.40	355.50	356.50	356.50	356.50	356.50	356.50	356.50	356.19	355.53	354.86	353.60
16	353.47	355.57	356.50	356.50	356.50	356.50	356.50	356.50	356.17	355.51	354.84	353.53
17	353.53	355.64	356.50	356.50	356.50	356.50	356.50	356.50	356.14	355.49	354.81	353.47
18	353.60	355.71	356.50	356.50	356.50	356.50	356.50	356.50	356.12	355.47	354.79	353.40
19	353.66	355.79	356.50	356.50	356.50	356.50	356.50	356.50	356.10	355.45	354.77	353.34
20	353.73	355.86	356.50	356.50	356.50	356.50	356.50	356.50	356.08	355.43	354.75	353.27
21	353.79	355.93	356.50	356.50	356.50	356.50	356.50	356.50	356.05	355.40	354.72	353.21
22	353.85	356.00	356.50	356.50	356.50	356.50	356.50	356.50	356.03	355.38	354.70	353.15
23	353.92	356.07	356.50	356.50	356.50	356.50	356.50	356.50	356.01	355.36	354.68	353.08
24	353.98	356.14	356.50	356.50	356.50	356.50	356.50	356.50	355.99	355.34	354.66	353.02
25	354.05	356.21	356.50	356.50	356.50	356.50	356.50	356.50	355.96	355.32	354.63	352.95
26	354.11	356.29	356.50	356.50	356.50	356.50	356.50	356.50	355.94	355.30	354.61	352.89
27	354.18	356.36	356.50	356.50	356.50	356.50	356.50	356.50	355.92	355.28	354.59	352.82
28	354.24	356.43	356.50	356.50	356.50	356.50	356.50	356.50	355.90	355.26	354.57	352.76
29	354.31	356.43	356.50	356.50	356.50	356.50	356.50	356.50	355.87	355.23	354.54	352.69
30	354.37		356.50	356.50	356.50	356.50	356.50	356.50	355.85	355.21	354.52	352.63
31	354.44		356.50		356.50		356.50	356.50		355.19		352.56

- DRAFT -

Reservoir Guide Curve Table – Elevations in Feet Plant Datum (PD)

	January	February	March	April	May	June	July	August	September	October	November	December
1	354.00	356.00	358.00	358.00	358.00	358.00	358.00	358.00	358.00	357.33	356.67	356.00
2	354.06	356.07	358.00	358.00	358.00	358.00	358.00	358.00	357.98	357.31	356.65	355.94
3	354.13	356.14	358.00	358.00	358.00	358.00	358.00	358.00	357.96	357.29	356.63	355.87
4	354.19	356.21	358.00	358.00	358.00	358.00	358.00	358.00	357.93	357.27	356.60	355.81
5	354.26	356.29	358.00	358.00	358.00	358.00	358.00	358.00	357.91	357.24	356.58	355.74
6	354.32	356.36	358.00	358.00	358.00	358.00	358.00	358.00	357.89	357.22	356.56	355.68
7	354.39	356.43	358.00	358.00	358.00	358.00	358.00	358.00	357.87	357.20	356.54	355.61
8	354.45	356.50	358.00	358.00	358.00	358.00	358.00	358.00	357.84	357.18	356.51	355.55
9	354.52	356.57	358.00	358.00	358.00	358.00	358.00	358.00	357.82	357.16	356.49	355.48
10	354.58	356.64	358.00	358.00	358.00	358.00	358.00	358.00	357.80	357.14	356.47	355.42
11	354.65	356.71	358.00	358.00	358.00	358.00	358.00	358.00	357.78	357.12	356.45	355.35
12	354.71	356.79	358.00	358.00	358.00	358.00	358.00	358.00	357.75	357.10	356.42	355.29
13	354.77	356.86	358.00	358.00	358.00	358.00	358.00	358.00	357.73	357.07	356.40	355.23
14	354.84	356.93	358.00	358.00	358.00	358.00	358.00	358.00	357.71	357.05	356.38	355.16
15	354.90	357.00	358.00	358.00	358.00	358.00	358.00	358.00	357.69	357.03	356.36	355.10
16	354.97	357.07	358.00	358.00	358.00	358.00	358.00	358.00	357.67	357.01	356.34	355.03
17	355.03	357.14	358.00	358.00	358.00	358.00	358.00	358.00	357.64	356.99	356.31	354.97
18	355.10	357.21	358.00	358.00	358.00	358.00	358.00	358.00	357.62	356.97	356.29	354.90
19	355.16	357.29	358.00	358.00	358.00	358.00	358.00	358.00	357.60	356.95	356.27	354.84
20	355.23	357.36	358.00	358.00	358.00	358.00	358.00	358.00	357.58	356.93	356.25	354.77
21	355.29	357.43	358.00	358.00	358.00	358.00	358.00	358.00	357.55	356.90	356.22	354.71
22	355.35	357.50	358.00	358.00	358.00	358.00	358.00	358.00	357.53	356.88	356.20	354.65
23	355.42	357.57	358.00	358.00	358.00	358.00	358.00	358.00	357.51	356.86	356.18	354.58
24	355.48	357.64	358.00	358.00	358.00	358.00	358.00	358.00	357.49	356.84	356.16	354.52
25	355.55	357.71	358.00	358.00	358.00	358.00	358.00	358.00	357.46	356.82	356.13	354.45
26	355.61	357.79	358.00	358.00	358.00	358.00	358.00	358.00	357.44	356.80	356.11	354.39
27	355.68	357.86	358.00	358.00	358.00	358.00	358.00	358.00	357.42	356.78	356.09	354.32
28	355.74	357.93	358.00	358.00	358.00	358.00	358.00	358.00	357.40	356.76	356.07	354.26
29	355.81	357.93	358.00	358.00	358.00	358.00	358.00	358.00	357.37	356.73	356.04	354.19
30	355.87		358.00	358.00	358.00	358.00	358.00	358.00	357.35	356.71	356.02	354.13
31	355.94		358.00		358.00		358.00	358.00		356.69		354.06

APPENDIX 2 – NET INFLOW COMPUTATION

INFLOW SCALING

The three USGS gauge stations used to compute inflow to Lake Murray are:

02167000 Saluda River at Chappells (gauged drainage area = 1,360 mi^2)
02167450 Little River near Silverstreet (gauged drainage area = 230 mi^2)
02167582 Bush River near Prosperity (gauged drainage area = 115 mi^2)

Since the total drainage area of the Saluda River basin at the Saluda Dam is 2,420 mi^2, the discharge values recorded at the gauge sites must be scaled to provide an estimate of the total inflow to Lake Murray. The project drainage basin has been divided into seven sub-basins, five of which are downstream of Lake Greenwood and represent inflow to Lake Murray. Two sub-basins (nos. 6 & 7) are un-gauged, and inflow from these areas is estimated based on the Bush River gauge using the scale factors in the table below. [Note: a streamflow gauge was installed in 2008 on the Little Saluda River near Saluda (No. 02167705), however there has been insufficient flow for the USGS to calibrate (rate) the gauge since it was installed. When this gauge has been rated, it will replace the Bush River gauge for estimating flow from sub-basins 6 & 7.]

Basin No.	Name	Area (SM)	Cum. Area (SM)	Gage No.	DA at Gage	Scale Factor	
1	Upper Saluda R.	1,034.0	1,034.0				
2	Lake Greenwood	126.0	1,160.0				
3	Chappells	227.3	1,387.3	02167000	1,360.0	**1.020**	
4	Little River	283.5	1,670.8	02167450	230.0	**1.233**	
5	Bush River	140.1	1,810.9	02167582	115.0	1.218	
6	Little Saluda River	331.0	2,141.9	Scaled from 7582	115.0	2.878	**6.515**
7	Lake Murray Direct	278.1	2,420.0	Scaled from 7582	115.0	2.418	

Using these scale factors, the total inflow (Q_{total}) to Lake Murray is computed as:

$Q_{total} = (1.02)(Q_{Chappells}) + (1.233)(Q_{Little\ R.}) + (6.515)(Q_{Bush\ R.})$

ESTIMATED MUNICIPAL WITHDRAWALS

Five municipal water intakes are permitted to withdraw water from Lake Murray. The total maximum withdrawal rate for these intakes is estimated to be approximately 120 CFS as of 2008[3]. The actual withdrawal rate varies throughout the year, as estimated in the following table.

Month	Estimated Withdrawal Rate (CFS)	Month	Estimated Withdrawal Rate (CFS)
January	60	July	120
February	60	August	120
March	60	September	120
April	90	October	100
May	100	November	60
June	120	December	60

[3] The existing municipal water intakes are approved for higher withdrawal rates than those shown in the table, which represent estimates of actual withdrawals as of 2008. If water withdrawal rates change or new intakes are approved, the Licensee may modify the estimated withdrawal rates used to compute net inflow.

The above withdrawal rates are subtracted from the total inflow to Lake Murray to compute the net inflow to the project. The 14 day running average of net inflow is used to determine minimum flow during low inflow periods.

Appendix 9

MEETING NOTES FROM THE LOW INFLOW PROTOCOL TWC:

AUGUST 5, 2008
AUGUST 19, 2008
SEPTEMBER 19, 2008
NOVEMBER 12, 2008

MEETING NOTES

SOUTH CAROLINA ELECTRIC & GAS COMPANY
SALUDA HYDRO PROJECT RELICENSING
LOW INFLOW PROTOCOL (LIP) FOCUS GROUP

SCE&G's Lake Murray Training Center
August 5, 2008

Final-CSB

ATTENDEES:

Bill Argentieri, SCE&G
Bud Badr, SCDNR
Shane Boring, Kleinschmidt Associates
Gerrit Jobsis, Am. Rivers
Dick Christie, SCDNR
Tom Gitto, Midlands Striper Club
Steve Summer, SCANA Services
Alan Stuart, Kleinschmidt Associates
Steve Bell, Lake Watch
Ray Ammarell, SCE&G
Milton Quattlebaum, SCANA Services
Dave Landis, Lake Murray Association
Bill Marshall, SCDNR

ACTION ITEMS:

- Provide Steve Bell with copy of documents supporting zone-of-passage flow needs for striped bass at Millrace Rapids
  Alan Stuart

- Provide meeting attendees with copy of presentation summarizing alternative LIP and comparison of alternative and original LIP results
  Ray Ammarell

NEXT MEETING

August 19, 2008
Lake Murray Training Center

MEETING NOTES:

These notes serve as a summary of the major points presented during the meeting and are not intended to be a transcript or analysis of the meeting.

Alan Stuart opened the meeting at approximately 9:30 am and thanked the group for attending the first meeting of the LIP Focus Group. Alan noted that it was obvious from previous meetings that there are a number of competing interests to be considering in establishing an effective LIP for the Saluda Project, and as such, a smaller "focus group" was deemed necessary. He noted that, due to the varying backgrounds of attendees, this initial meeting would focus on a number of presentations to familiarize the group with water management in the basin, Instream flow and lake level interests, and the LIP models and associated triggers that have been developed to date.

Dick Christie gave the opening presentation, a review of the South Carolina State water plan. He noted that the purpose of the plan was to establish a comprehensive policy for management of the state's water. It was noted that the plan, originally issued in 1998, was updated in 2004 following the drought of 1999-2003. Following a review of the general hydrology of South Carolina, Dick noted that one of the primary recommendations of the plan is establishment of regulations to govern withdrawals of surface and groundwater. Dick note that the plan also recommends a water sharing strategy that relates stream inflows and lake levels to downstream releases and other lake withdrawals in an effort to balance and mitigate the negative impacts that water shortages have on all water users. It was noted that a full version of the plan is available online at http://www.dnr.sc.gov/water/admin/pubs/pdfs/SCWaterPlan2.pdf.

Gerrit Jobsis then briefly discussed American Rivers' position on the LIP process. Specifically, Gerrit noted that he felt an LIP was needed to help preserve lake levels during low inflow periods, but added that any process must ensure that downstream needs, such the Congaree National Park and instream flow in the Congaree and Saluda rivers must be taken into consideration.

Steve Bell then presented Lake Watch's concerns regarding the current LIP. Specifically, Steve noted that their primary concern is that implementation of the LIP as proposed will not preserve enough water in the lake during low inflow periods, resulting in impacts to dock access, recreation, boating safety and shoreline environments. He added that, based on his group's observations, the lake is generally safe at levels at or above 354'. From an aquatic/shoreline habitat perspective, it was noted that the button bushes and other shoreline vegetation become wetted at around 356.' Steve noted that he generally did not have a problem with the instream flows being proposed, with the exception of the spring flows of 1000-1300 cfs for spring spawning/passage. Steve then asked for an explanation for why these flows are needed. It was noted that the 1300 cfs spring passage flow is based on a zone-of-passage study conducted by SCDNR and represents the minimum flow needed to provide adequate upstream passage at Millrace Rapids for inmigrating striped bass. Steve asked if he could have copies of these supporting documents. Alan Stuart agreed to provide copies of the SCDNR Instream Flow Policy supporting document, which contains this information.

Ray Ammarell then presented a recap of the original LIP proposal that was presented at the All RCG's Meeting on May 22, 2008 (available online at) http://www.saludahydrorelicense.com/documents/SaludaHydroGuideCurveandLIP.pdf . Dave Landis noted that he felt that the lake level trigger points were not aggressive enough on the existing LIP and that as proposed the lake would be at an unacceptable level before conservation measures are triggered. Dave added that he did not like the use of the 70 yr period of record, as in his view it does not reflect the current low flow conditions. Steve Bell requested LIP model runs for the flowing guide curve scenarios: 1) lake level of 358' feet year-round and 2) a lake level that fluctuates annually between 354-356' (winter) and 358' (summer) (see written request for additional detail).

Bud Badr, SC State Hydrologist, then shared his views on the original LIP proposal. He noted that the he didn't see the two user groups (upstream and downstream) as being that far apart in terms of what they would like to see. He urged the group to remember that the state water plan requires that a number of factors be considered including: water quality (both upstream and downstream), sufficient water (both upstream and downstream) for municipal water users, and sufficient downstram flow to ensure ecosystem function in the LSR, the Congaree, and to aid in providing sufficient water to the Santee Basin to downstream issues such as saltwater intrusion below the Santee Cooper Lakes.

Ray Ammarell then presented results of an alternative LIP model that focuses on inflow as a trigger and does not consider lake levels, as well as a comparison of the results to the originally proposed LIP. Ray noted that, while the triggers are quite different from the original, the results (frequency of guide curve violation) were quite similar. Bud Badr noted that the state water plan states that minimum flows and any associated LIP should be a function of not only inflows, but also lake levels. Bud added that the two methods appear closer than anticipated. Ray enquired as to whether the group preferred one method over the other. SCNDR staff noted that the two were very close, but that they would like to have additional time to review the two proposals. Gerrit noted that he would be willing to support reductions in minimum flow during period when inflows to Lake Murray are less than corresponding minimum flow for that time of year; however, he would like to see evaoparation not be subtracted from the inflow calculation since it is a Project-related impact. He added that he didn't want the river to be penalized for reservoir-related effect of evaporation. Ray noted that this seemed like a reasonable request and that he would integrate it into the next model runs. Several attendees requested a copy of the presentation. Ray agreed to provide the presentation via e-mail.

MEETING NOTES

SOUTH CAROLINA ELECTRIC & GAS COMPANY
SALUDA HYDRO PROJECT RELICENSING
Low Inflow Protocol Focus Group

Lake Murray Training Center
August 19, 2008

final ACG 10-31-08

ATTENDEES:

Alan Stuart, Kleinschmidt Associates
Alison Guth, Kleinschmidt Associates
Scott Harder, SCDNR
Bill Marshall, LSSRAC, SCDNR
Ray Ammarell, SCE&G
Jim Cumberland, SCCCL
Steve Bell, LW
Bill Argentieri, SCE&G
Dave Landis, LMA
Tom Gitto, Midlands Striper Club
Bret Hoffman, Kleinschmidt Associates

DATE: September 19, 2008

INTRODUCTIONS AND DISCUSSION

These notes serve to be a summary of the major points presented during the meeting and are not intended to be a transcript or analysis of the meeting.

The meeting was opened by Ray Ammarell, and it was noted that they would be reviewing comments from the August 5, 2008 LIP meeting. Ray also continued to note that he would like the group to provide input on the best LIP method to move forward with and how to evaluate the approach. When the floor was opened for discussions, Alan noted that the group needed to develop triggers for the LIP.

The group discussed when to implement the LIP and Ray explained that for a certain period of time the group may want to look at implementing a reduction in outflow adjusted based on an averaging period. Ray continued to explain that, in simulating project operation using actual net inflow from past years, the criteria that he used to identify potential LIP years was: if the reservoir dropped below 90 percent of its target lake level for more than 30 days, then that year became a candidate for the LIP.

The group discussed Gerrit Jobsis's suggestion of not subtracting evaporation in the determination of net inflows. It continued to be explained that Gerrit was concerned that the outflows were being penalized due to the large reservoir's evaporation potential. Dave Landis commented that creating the reservoir also creates the opportunity to control the outflows, of which there are benefits to the downstream concerns. Ray noted that that was valid because the reservoir does bank water that provides for the opportunity to regulate or maintain the flow downstream. Ray continued to explain that the USGS performed a study on reservoirs in South Carolina and found that overall reservoirs boosted the low flow. The group discussed inflows, and conferred upon whether they should be calculated as gross inflow minus evaporation, gross inflow minus municipal withdrawals, or a combination of these. Bill Argentieri noted that if evaporation was not taken out of the equation, then they needed to set some sort of low lake level limit so that enough water was maintained in the reservoir to provide downstream flows. This is termed a "stop loss". Steve Bell noted that when the lake drops one foot below the guide curve then the downstream flows should be reduced in order to let the lake return to the guide curve. Alan explained that Dick Christie had noted in one of the meetings that there was plenty of water in the lake, and there was no reason why the downstream flows should be compromised until a significant drop in lake level occurred.

Dave explained that people were going to ask if the river is healthy at a 180 cfs outflow for a low flow, and the higher downstream flows can be provided for most of the time. Furthermore, Dave noted that as in nature, the dynamics of the river are such that they adapt. Alan gave the example that there was recently a mussel survey in the LSR, and no mussels were found. Alan continued to note that they were unsure as to whether this was due to flow, water temperature, or low DO, but there were mussels in the Broad/Congaree. Bill Marshall added that the goal of setting minimum flow was to enhance and improve the aquatic habitat. Steve replied that he believes that the 700 cfs would meet all of the downstream needs, however if the outflows exceeded the inflows, then the lake habitat is being affected. Ray noted that based on what he has looked at, the 1,300 cfs flow request is during the high flow period of the year. Ray also explained that during normal years, one will find very few times where there are problems in the April/May timeframe.

Steve Bell questioned the group as to what was wrong with the 400 cfs level at all times during a LIP. He continued to note that if the Lake was dropping off of the guide curve than 700 cfs should not be provided. Jim Cumberland noted that the CCL and American Rivers believed that the 400 cfs level was the "floor", however they would like to not have to reach the 400 cfs level.

The group discussed the inflow splitting method of the LIP. It was noted that at the last meeting the group discussed whether or not to subtract evaporation from inflows in order to determine whether or not an LIP should be implemented. It was reiterated that at the previous meeting, American Rivers had noted that they would like for evaporation not to be subtracted from inflows. Dave noted that there may be the need for a study to determine the economic impacts to the lake due to the balance of water. Alan noted that DNR typically does annual surveys in the reservoir in order to determine the general health of the reservoir. Furthermore, from a biological perspective, there are most likely not negative impacts of existing operations, relatively stable lake levels are typically what the reservoir needs.

Bret Hoffman presented information on the alternatives requested by Gerrit, which included the number of days spent in the LIP zones, based on the previous LIP proposal. Bret explained that they were trending towards the inflow splitting proposal, however, due to the fact that the initial LIP proposal is very cumbersome. The group noticed some items to be corrected in the information and moved on to discuss the Zone of Passage.

Bret presented information on the alternatives presented by Gerrit, the number of days spent in the zones, based on previous LIP proposal. Bill Argentieri explained that they are trying to move away from this first LIP proposal because it is very cumbersome, and move towards inflow splitting. The group noticed some items for questions, and moved to the LIP Pulse Flows for Zone of Passage (ZOP).

Alan discussed the ZOP with the group and explained that there was an IFIM study back in the early 80's and it was determined that Millrace Rapids was the most restrictive area for the passage of fish. Alan continued to explain that based on the criteria that was developed when DNR developed an instream flow policy, there was a certain depth and width that the striped bass needed in order to move upstream. It was further explained that the most recent IFIM confirmed this criteria. The group continued to discuss this issue, and it was noted that the driver for the 1,300 cfs was the criteria for fish passage through this area. It was shown that a higher pulse of water would provide good results due to less attenuation and use less water because it would be for a shorter period of time. Alan also pointed out that the interest was in more species than striped bass; the needs of striped bass were simply what the criteria was developed from.

The group discussed that as weather patterns change there may be a need to amend the LIP. Alan noted that it was important to have a set procedure, however to also have the flexibility to alter it if conditions change in the future. The group discussed 5 or 10 year increment review periods for this purpose.

Steve Bell began discussions on the LMHOC/LW proposal. He noted that he believed that SCE&G should have some flexibility in the 700 and 1300 cfs increments. Steve explained that the LMHOC proposal notes that when the lake level drops one foot below 358' then the downstream flows are cut back to 400 cfs, then as the lake rises more water is released downstream in the April/May time period.

The group continued to discuss the inflow splitting LIP proposal. Ray explained that the averaging period was a good method because it has the effect of smoothing out fluctuations in inflow. After lunch, Ray explained the inflow scaling and pointed out that scaled inflow accounts for the whole drainage area as it takes the sum of the three gages and adjusts it for the whole watershed. Ray also presented the group with evaporation values and municipal use values from Lake Murray. Ray showed that many times when evaporation and municipal withdrawals are subtracted from inflows, negative inflows are produced.

Ray then asked the group which approach to pursue: a reservoir driven LIP, or the inflow driven with "stop loss" reservoir limit. It was noted that an inflow driven LIP is what the group was leaning towards. Jim noted that he would check with Gerrit on the inflow driven LIP, and Scott Harder noted that he would check with Bud. The group also discussed a "stop loss" reservoir limit. Bill explained that the "stop loss" would be implemented when the LIP was in effect and the reservoir drops below 354'. Dave agreed that there was a point when lake level needed to be considered, however, he believed the 354 was too low.

The group discussed whether or not it was meaningful to look at upstream and downstream impacts for a certain number of days. Jim noted it was a good illustration, but it may not be meaningful. The group tabled the evaluation of upstream vs. downstream impacts. The group then discussed pulsing of flows in an LIP. Ray noted that during the 30 day period of April 15 to May 14 then:

- If inflows were > or equal to 1,300 than outflows would be > or equal to 1,300
- If inflows were < or equal to 1,000 than outflows would = 700 with 2, 3,000 cfs pulses for 1.5 hours a day

- If inflows were < or equal to 700 than outflows would be 500 with 1, 3,000 cfs for 1.5 hours a day
- If inflows were < or equal to 400 than Outflows would equal 400 with no pulsing.

Bill A. asked what happened when inflows were between 1,300 and 1,000. Ray replied that 1,300 is still released, that way it is not affected by the little dips in inflow. Bill M. asked that if SCE&G was going to generate 10,000 cfs one evening for reserve, if they would get into averaging for the minimum flows, as that was not desirable. Ray responded that they wouldn't, but asked if a reserve call could count for a pulse of water in the LIP. Bill A. noted that the pulses were at dawn and/or dusk. Alan noted that if it overlaps a dawn or dusk pulse then SCE&G should receive credit for it.

Jim Cumberland asked Ray to run a 45 day average for comparison. The group decided that a 14 day, 20 day, and 45 day should be looked at. Scott noted he would like to see the plots of the lake level with that. Dave also suggested adding in a stop loss trigger for 1 foot below 358' for the 30 and 60 day periods. The group also noted that they would like to view the plots that showed what the outflow was versus the inflow.

The group adjourned and scheduled the next meeting date for September 19th.

MEETING NOTES

SOUTH CAROLINA ELECTRIC & GAS COMPANY
SALUDA HYDRO PROJECT RELICENSING
Low Inflow Protocol Focus Group

Lake Murray Training Center
September 19, 2008

Final ACG 10-31-08

ATTENDEES:

Alan Stuart, Kleinschmidt Associates
Alison Guth, Kleinschmidt Associates
Dick Christie, SCDNR
Bill Marshall, LSSRAC, SCDNR
Ray Ammarell, SCE&G
Steve Bell, LW
Bill Argentieri, SCE&G
Dave Landis, LMA

DATE: September 19, 2008

INTRODUCTIONS AND DISCUSSION

These notes serve to be a summary of the major points presented during the meeting and are not intended to be a transcript or analysis of the meeting.

Ray opened the meeting and noted that the first discussion item would be to review the LIP runs that were recently distributed. Ray noted that he would like to come to a consensus on as many of the parameters as they could, so that he could start moving forward in putting an actual procedure together for review.

Ray briefly reviewed the LIP graphs with the group. It was shown that the reservoir fared a lot better with the LIP implemented than without. However, during the graphed scenarios the reservoir was not able to stay on the guide curve at all times during the low inflow years. The group discussed the current year and it was shown that there were good inflows up through April, therefore there would be no reason not to provide the higher minimum flows at that point. Ray pointed out that the lake was a little above 356' currently, and asked if that was actually a bad situation and if there was a burden on recreation. Furthermore, Ray added that for being in a drought, the lake was not faring too badly. Steve Bell explained that the reason the lake is at 356' this time of year is because SCE&G restricted releases during late winter and spring- below 400 cfs at times. Dick Christie explained that the water was available to drive the spring flows, and if it was a normal flow year, then the water would return. Dick continued to note that what the group seemed to be struggling with, was over the next 50 years, how often would this situation be expected to happen. Dick explained that he had spent a good amount of time reviewing the graphed years, and there are a number of years that were pretty close to equally sharing the water between upstream and downstream in the inflow tracking LIP. He further noted that the graphs show in some years that safety flows (City of Columbia Swift Water Rescue Training) do have an impact on the lake, and in some years it is just a blip. Dick continued to add, however, that the safety flow was a very important flow. Bill pointed out that the graphs being shown by Ray include the full flows for the safety, however, after the LIP is developed we will approach the CFD to determine how to decrease the duration of the safety flows. The group discussed the fact that when the previous guide curve was established the forecasting was not as good, and that they may be able to keep levels higher in the spring. Although, there are dam safety implications with doing this, in the event of a large spring flood event.

Dave Landis noted that as the group was discussing “sharing the pain”, the LMA believes that the provision of the 400 cfs flow during a drought situation was “sharing the pain”. Ray shifted all of the outflow inputs to 400 cfs in the spreadsheet model, and the group viewed that although the graphed lines shifted up about one foot, the steepness of the line did not drastically change. Dick pointed out the graphs and noted that it was being suggested that the flows were benefiting more than the reservoir; however, the 2007 graph showed that the reservoir was reaching 87.5 percent of its storage, while the downstream flows are only receiving 80.7 percent of the targeted flow. If this combination was chosen, then the reservoir was going to receive a higher percentage of the available inflow then the outflows would. It was also shown that in 2006 the situation was reversed.

Dave Landis noted that the 700 cfs flow was the optimum flow for the river, and the minimum was 400 cfs flow; moreover, the guide curve was the optimum lake level. Dave continued to note that one option would be to reduce outflows to 400 cfs once there is a departure from the guide curve. In this way the lake level would not drop as drastically, and once the guide curve was reached then outflows could be increased. Ray commented that this would be an example of an LIP that would be very conservative for the reservoir, and more restrictive on downstream flow.

Dick noted that this method partitioned a larger share of the inflow to the reservoir. Dick suggested that the inflows be split 50-50. Steve noted that he believed that this took away from the littoral fishery. Dick replied that it could actually be positive to the fishery, it occurs infrequently, and allows things to break down and oxidize. He further noted that the fish are going to move a little deeper, and when there is water 8 years out of 10 in those areas, it has been proven that it is not a problem. Alan noted that fish spawn in a range of depths and Dick added that 2 to 4 feet is more important and minor fluctuations are not a big deal. Steve noted that they felt very strongly about having the lake up from April to June. Steve noted that it is important that the emergent vegetation which typically grows near the 357’ contour be inundated with water during April 1 through early fall. Ray added that there was nothing special about the guide curve, but it is necessary to have target elevations to operate the reservoir and for the model to work.

Dave Landis asked the group if the river has survived sufficiently with the current flows. He noted that the 400 cfs minimum was something that they were trying to understand and explain to their group. Since there were no downstream representatives available, Dick noted that he was trying to balance the discussions even though both sides of the issue were important to DNR.

Bill A. noted that he would like to keep as much water in the lake as he could for generation purposes, however, he realizes the need for a balance. He continued to note that the reservoir was currently around 356’ and he has not heard any complaints about the lake level. Bill A. explained that there is currently a minimum flow proposed by the Instream Flow TWC, and under the new license, when the spring comes SCE&G will be obligated to provide the required minimum flows. The goal is to figure out how inflows are going to be partitioned during low inflow years.

Furthermore, Bill A. noted there is an impression that this focus group was trying to change the minimum flows. He explained that the minimum flows are going to be provided if the inflows are available. Dick noted that he was not able to share DNR's thoughts on this issue before discussion with Bud Badr and Scott Harder, however, he noted that typically DNR's focus in other relicensing is to protect the downstream flows because there are a number of users on the reservoir side that typically try to hold-back the water. He continued to note that the scenarios were very helpful, and he would be interested in viewing the modeling of a six inch reservoir trigger and a 14 day averaging period. Steve noted that a six inch trigger would allow outflows of 700 cfs for 30 to 40 days before restrictions would occur, allowing adequate time for rain events to bring the lake back up to guide curve. Regarding downstream flow request, Steve noted that the Instream Flow TWC had not presented its findings specifically to the Fish and Wildlife RCG, therefore the lake groups have asked to meet with DNR to review the study and discuss the recommendations. Steve also indicated that the lake groups were completing a presentation on lake level impacts which would be discussed at the meeting. Steve indicated that justification for certain releases will be the key factor in getting buy in from lake leaders including the business community.

Moving along, the group discussed looking at a shorter averaging period and a smaller reservoir drop. Bill Marshall noted that after the last meeting, he thought that the shorter averaging looked suitable, and he was comfortable with the 1 foot lake level trigger. Ray reviewed the discussion points with the group as follows:

A. Net inflow – Ray noted that he believed that everyone at the meeting was agreeable to taking inflows, subtracting municipals, and leaving in evaporation. (Lake Watch noted that they do not support leaving in evaporation since reservoir storage significantly benefits downstream recreation and other flows).

B. Inflow averaging period – Ray reviewed that the group was leaning towards a shorter averaging period.

C. Reservoir level triggers - Ray reviewed that the individuals in this meeting are trending towards a smaller reservoir trigger, 6 inches to 1 foot or so.

D . Stop loss -

The group discussed the stop loss and Bill A. asked how it would be possible to have a stop loss elevation higher than 354'. Ray explained that it would be complicated and cumbersome. Bill A. asked if it would be possible to have a stop loss curve. Ray replied that the idea behind it is to at some point, even though inflows may become greater, keep the outflows depressed in order for the reservoir elevation to become higher. Several members of the group expressed that 354' was an acceptable stop loss, and Dick noted that he would discuss this with Bud and Scott.

E. April-May Pulsing –

Ray explained that they have carried this information forward with the only changes being the brackets for the inflow. Steve asked if pulsing was something that provides acceptable flows for downstream. Dick replied that it was not acceptable for use all the time. He explained that there are other issues. Dick noted that the pulses would meet the needs for the fish passage criteria, however it did not address other ecological aspects, such as the habitat in the edges, and the sediment and water quality issues. Steve Bell suggested having pulsing instead of a constant minimum flow and a guaranteed 400 cfs flow. Alan noted that he believed that the IFIM TWC looked at that scenario and they were willing to take the risk in order to have the 1300, as opposed to a guaranteed 400 flow.

Ray reviewed the homework items with the group and noted that he would synthesize all of the discussion into a draft document to be distributed to the group. Dick noted that he would review discussion points with Bud Badr and Scott Harder and provide their thoughts back to the group.

Inflow Information from Whiteboard:

4-15 through 5-14 (30 day)

- If inflows were > or equal to 1,300 than outflows would be > or equal to 1,300
- If inflows were < or equal to 1,000 than outflows would = 700 with 2, 3,000 cfs pulses for 1.5 hours a day – 988 CFS daily average flow.
- If inflows were < or equal to 700 than outflows would be 500 with 1, 3,000 cfs for 1.5 hours a day – 656 CFS daily average flow.
- If inflows were < or equal to 400 than Outflows would equal 400 with no pulsing.

MEETING NOTES

SOUTH CAROLINA ELECTRIC & GAS COMPANY
SALUDA HYDRO PROJECT RELICENSING
Low Inflow Protocol Focus Group

Lake Murray Training Center
November 12, 2008

final ACG 1-6-09

ATTENDEES:

Alan Stuart, Kleinschmidt Associates
Alison Guth, Kleinschmidt Associates
Scott Harder, SCDNR
Bill Marshall, LSSRAC, SCDNR
Ray Ammarell, SCE&G
Jim Cumberland, SCCCL
Steve Bell, LW
Bill Argentieri, SCE&G
Dave Landis, LMA
Reed Bull, Midlands Striper Club
Dick Christie, SCDNR

DATE: November 12, 2008

INTRODUCTIONS AND DISCUSSION

These notes serve to be a summary of the major points presented during the meeting and are not intended to be a transcript or analysis of the meeting.

Alan Stuart opened the LIP Focus Group meeting and noted that purpose of this meeting was to review concerns that DNR had on the LIP, as well as review additional information that Ray had put together. Alan also explained that at this point, he did not see the group achieving agreement on an LIP as they were still very far apart. However, it was noted that they would reevaluate at the close of the meeting.

Scott Harder began the meeting discussions with a presentation from DNR on their concerns with the LIP as it was currently being discussed. Scott began his presentation with the management guidelines for lakes from the State Water Plan. He pointed out that an important goal in the plan was the balance of water. Scott further noted that DNR must consider resources from a state perspective and when water shortages arise, the negative impacts should be balanced among the users and other lakes in the state.

Scott explained that using SCE&G's spreadsheet model, he has analyzed the outcomes of various LIP scenarios. He discussed both the fixed inputs to the scenarios as well as the varied inputs. SCE&G explained that the 400 cfs minimum outflow scenario was not applicable because the units could not reach a level that low efficiently; therefore 500 was more realistic. The group continued to review the graphs that Scott developed depicting different inputs and scenarios. Scott noted that the main question to be answered was how much to allow the lake level to drop before flows are reduced in the LSR.

Scott reviewed lake level graphs during low flow years under several proposed scenarios. An example of 2001 was shown and it was illustrated that the 0 foot drop scenario and the 1 foot drop scenario was very similar while the 2 foot drop and 4 foot drop was very similar. It was shown that in 2004 there were no differences between the triggers. In 2007 the group viewed that none of the LIP scenarios returned back to the guide curve.

Ray pointed out to Scott that whatever trigger is used for the LIP implementation (0,1,2 or 4), when the lake level drops off of the guide curve, the objective of the State Water Plan is being accomplished to some degree. The group then compared the different stages with 14, 30, and 45 day inflow averages. Bill Argentieri observed that the 30 and 45 inflow averages could cause the lake to drop 1.5 to 2 feet while waiting for the inflow average to taper off. Reed Bull asked the group if Jim Ruane had studied what happens to the water quality of the lake with the new minimum flows, as the Striper Club was interested in this information. Reed continued to note that from a striped bass standpoint, Jim had shown that the higher flow years were the worst for the striped bass. Reed expressed concern that the bad conditions could increase with the increased minimum flows. Alan noted that he would contact Jim Ruane to get his take on this question.

Scott went on to discuss the conclusions in the presentation, he noted that one key question was how long to maintain the recommended minimum flows in the spring and summer at the expense of the lake. Scott noted that the two foot trigger provides prolonged flows without much additional impacts on the lake. He further pointed out that in the worst drought situation that they had information on (2007 to 2008), there were minor differences between the 0,1, and 2 foot triggers. Scott concluded by noting that DNR believed using the 2 foot lake level trigger and the 14 day inflow averaging period is a reasonable balance between upstream and downstream users.

After the presentation, the group discussed DNR’s proposal. Steve Bell noted that they were concerned about whether or not these same scenarios would be seen in the next 50 years. Dick Christie explained that the best science now was to establish a hydrologic period of record, such as 50 years, as one could not predict what would happen in the future. Dick continued to note that at some point in the future it would be wise to reconvene and discuss the LIP, as the period of record will have changed at that point.

Dave Landis explained that they had questions regarding how the current flows have actually affected the river over the past 70 years, as they have not observed the records where it has been detrimental. He further pointed out that if the river was in its optimal range, they would like the lake to be optimal as well. Dave continued to note that it originally seemed like individuals wanted a run of river scenario, where there were high flows and low flows and both sides shared the pain. However, he noted, now it seems that certain entities desire it to be more flow controlled.

Noting the discussions, Bill A asked if LMA and Lake Watch had a proposal that they would like to present to the group as DNR has done. Bill A. further pointed out that this proposal should be specific and not a generalization. Dave replied that as far as the averaging period goes, they believe the 14 day is reasonable. Dave continued to noted that they want to make sure there are procedures in place that slow the lake level drop as much as possible when providing flows downstream. Steve added that he would like further review on the proposed minimum flows. He also noted that if there was no rainfall coming in, that SCE&G would not drop it down to 354’ immediately in the fall knowing that there will be fall safety flows. At this time, Steve and Dave reiterated their request to meet with DNR about the minimum flows before making any decision on the LIP. Dick noted that he has been trying to coordinate with Bob Perry on a date and time for this meeting and that he would try to set something up before the end of this meeting. Reed added that if the lake goes below 354', recreation on the lake does not completely come to a halt. He continued to note that he believes the group has done a good job of putting stop losses in the model and he pointed out that at some point they are going to have to agree that that is the best they can achieve. Alan pointed out that he believed the common ground was to have a program in place that does not deplete the reservoir so far during one year that there is no water left the next year. The group discussed the need for an adaptive management scenario for the LIP. Dick explained that during the Catawba relicensing an annual meeting with a five year review process was put in place for the LIP, and the group agreed that this would be also appropriate for Saluda.

The group noted that they were close, the question was how to achieve agreement between the 1 foot and 2 foot lake level drops. Steve noted that they would put something together to present to DNR and the group. Dick noted that DNR was willing to make a presentation to homeowner groups if that is needed. Dick also noted that they would be happy to explain minimum flow needs. However the instream flow recommendation is from the instream flow group therefore, Dick noted that he does not believe DNR can speak to that recommendation.

The group discussed any questions on Ray's report that was issued to the group. There was a question on North American Vertical Datum '88 versus Plant Datum. Ray explained that Plant Datum was an arbitrary datum established prior to the construction of the dam and there is a 1.5 foot difference between that and NAVD. The group continued to make a few changes interactively to the wording of the document.

The group concluded that Lake Watch, LMA and DNR would meet on or around December 2 to discuss their opinions on an LIP. There will potentially be another LIP Focus Group meeting during the first part of January.

Group adjourned.

Appendix 10

Santee River Basin Accord For Diadromous Fish Protection, Restoration, and Enhancement

SANTEE RIVER BASIN ACCORD FOR DIADROMOUS FISH PROTECTION, RESTORATION, AND ENHANCEMENT

General

The Santee River Basin Accord ("Accord") is a collaborative approach among utilities with licensed hydroelectric projects, and federal and state resource agencies to address diadromous fish protection, restoration, and enhancement in the Santee River Basin ("Basin"). This Accord supports the *Santee-Cooper Basin Diadromous Fish Passage Restoration Plan* (2001) which was developed by the South Carolina Department of Natural Resources ("SCDNR"), the National Oceanic and Atmospheric Administration's National Marine Fisheries Service ("NMFS"), and the United States Fish and Wildlife Service ("USFWS"), and was accepted as a Comprehensive Plan by the Federal Energy Regulatory Commission ("FERC") as noted in the FERC's letter to the USFWS dated October 3, 2001.

Accord participants and hydroelectric projects (referred to herein singularly as "Project" and together as "Projects") that are the subject of this Accord include South Carolina Electric & Gas Company ("SCE&G"), licensee of the Saluda Hydroelectric Project No. 516, the Parr Hydroelectric Project No. 1894, and the Neal Shoals Hydroelectric Project No. 2315, and Duke Energy Carolinas, LLC ("Duke"), licensee of the Catawba-Wateree Hydroelectric Project No. 2232, the Ninety-Nine Islands Hydroelectric Project No. 2331, and the Gaston Shoals Hydroelectric Project No. 2332 (SCE&G and Duke referred to herein singularly as "Utility" and together as "Utilities") and their successors; and the SCDNR, the North Carolina Wildlife Resources Commission ("NCWRC"), and the USFWS (referred to herein singularly as "Agency" and together as "Agencies") and their successors. Singularly, any Utility or Agency that signs this Accord may be referred to herein as "Party". Collectively, the Utilities and Agencies that sign this Accord constitute the Cooperative Accord Partnership ("CAP" or "Parties"). The NMFS and the South Carolina Department of Health and Environmental Control ("SCDHEC") were also involved in the development of this Accord, but neither are currently signatories to the Accord and are therefore not CAP members. Future CAP members, if any, will be limited to federal and state resource agencies with authority for any diadromous fish species and their habitats in the Basin, and to owners of other FERC-licensed hydroelectric projects in the Basin. Non-governmental organizations and the general public will not be members of the CAP, but may participate via consultation with CAP members and may attend CAP meetings in a non-decision-making role. However, all discussions by non-CAP members in CAP meetings will be limited to a short public comment period (to include submission of written comments, if desired) at the start of a meeting, unless the CAP agrees by consensus on a case-by-case basis to do otherwise.

This Accord constitutes an agreement among the CAP members for the protection, restoration, and enhancement of diadromous fish in the Basin through implementation of a 10-year Action Plan ("Plan") that was initially developed by the USFWS (*Cooperative Accord 10-Year Action Plan For The Restoration and Enhancement of Diadromous Fish In The Santee Basin*—original draft dated January 24, 2007), and that includes no-sooner-than dates and biological triggers for fish passage as specified in this document. Tasks and cost estimates for each activity in the Plan are shown in Appendix A, and no-sooner-than dates, biological triggers, and other agreed-upon actions are noted in Appendix B. The agreements, activities, and biological studies identified in the Accord, and in Appendices A, B, and C which are hereby incorporated by reference, will be used to support the development of fish passage prescriptions that will protect, restore, and enhance diadromous fish species in the Basin and will be filed with the FERC for inclusion in the new licenses for some of the above-referenced Projects. The CAP members have worked to create this Accord to meet the interests of CAP members while still allowing all Agencies and Jurisdictional Bodies to meet their respective statutory obligations for diadromous fish under §7 of the Endangered Species Act ("ESA") and under §4(e), §10(a), §10(j), and §18 of the Federal Power Act ("FPA"), and under §401 of the Clean Water Act ("CWA"), for the above-referenced Projects. The CAP has agreed to implement phased, deliberate, and effective activities that will initiate diadromous fish population enhancements in the near-term while collecting data and monitoring diadromous fisheries over a longer period for optimizing further restoration efforts.

Definitions

Consensus—a vote with no dissenting votes; abstention by a member is not a dissenting vote.

Jurisdictional Body—any governmental body, except Agencies, which has the authority to bind the Utilities by imposing requirements affecting the operation of the Projects that are the subject of the Accord.

Existing Project License—the hydropower license that as of the effective date of this Accord has been issued by the FERC for Projects No. 1894, No. 2315, No. 2331, and No. 2332 but does not include subsequent or renewed licenses, or their terms, even if some or all of the terms of a subsequent or renewed license are identical to terms in an Existing Project License.

Inconsistent Act—(A) any requirement, condition, prescription, or recommendation imposed by a Jurisdictional Body pursuant to §§4(e), 10(a), 10(j), or 18 of the FPA, §7 of the ESA, or §401 of the CWA for operation of a Project that materially varies any obligation concerning the restoration of diadromous fish, reservoir elevation limitations, required flow releases, and low inflow protocols or high inflow protocols from those set forth in the Catawba-Wateree Comprehensive Relicensing Agreement (CRA), as amended on December 29, 2006, or in an Existing Project License; or (B) any requirement, condition, prescription, or recommendation imposed by a Jurisdictional Body pursuant to §§4(e), 10(a), 10(j), or 18 of the FPA, §7 of the ESA, or §401 of the CWA that materially varies any obligation from those set forth in this Accord.

Breach—a failure of a Party to comply with the terms of the Accord in a significant and non-trivial manner and includes, but is not limited to: (A) a requirement, condition, prescription, or recommendation for a Project that is imposed by an Agency pursuant to §§4(e), 10(a), 10(j), or 18 of the FPA, or §7 of the ESA that materially varies any obligation set forth in this Accord; or (B) any CAP member's requesting, promoting, or supporting an Inconsistent Act or other requirements that materially varies any obligation set forth in this Accord.

Materially Vary or Varies—a requirement, condition, prescription, or recommendation materially varies if it imposes additional obligations that in the discretion of the affected Utility are significant and includes, but is not limited to: (A) reservoir elevation limitations; required flow releases; low inflow protocols or high inflow protocols that are significantly different from those in the CRA or in an Existing Project License (whether by changing the actual obligation or by changing the method of implementing the obligation); (B) upstream or downstream passage of diadromous fish at a Project dam on a schedule different from that identified in the Accord; (C) installation of fishway equipment on a Project dam that is in addition to or different from what is required by the Accord; or (D) fish studies, monitoring, or analyses that are in addition to or different from what is required by the Accord.

Fish Passage Facilities, Fishways, and Prescriptions— defined in *Notice of Proposed Interagency Policy on the Prescription of Fishways Under Section 18 of the Federal Power Act,* (Federal Register/Volume 65, No. 247/Friday, December 22, 2000) for existing hydroelectric projects on the Saluda, Broad, and Catawba-Wateree rivers. These terms are used interchangeably throughout this document.

Key Agreements

The CAP members agree as follows:

General Agreements

1. The Utilities will not pursue Trial Type Hearings ("TTH") before an Administrative Law Judge pursuant to FPA §§4(e) or 18 to contest the USFWS's FPA §§4(e) or 18 diadromous fish requirements so long as the USFWS's ESA §7 requirements, FPA §§4(e) conditions, 10(a) and 10(j) recommendations, and 18 prescriptions do not materially vary reservoir elevation limitations, required flow releases, low inflow protocols or the high inflow protocols as set forth in: (A) the CRA; (B) Existing Project Licenses at the Ninety-Nine Islands and Gaston Shoals Projects; (C) a settlement agreement among the SCDNR, the USFWS, and SCE&G for the Saluda Hydroelectric Project; and (D) this Accord.

2. The Plan, which emphasizes research on fish movement (both upstream and downstream), distribution, and habitat use; fish population enhancement and restoration activities; and related funding responsibilities for American eels, American shad, Atlantic sturgeon, blueback herring, and shortnose sturgeon, will be implemented.

3. The Accord's no-sooner-than dates and biological triggers (in Appendix B) will be used to initiate conceptual design and subsequent construction of fish passage facilities for existing hydroelectric Projects on the Broad River and the Catawba-Wateree River.

4. The restoration target numbers for adult anadromous American shad and adult anadromous blueback herring restoration in the Broad River are set in Appendix C.

5. Subject to limitations regarding confidential and proprietary information, the CAP will establish and maintain a publicly accessible electronic archive for all data and documents created as a result of the Accord. When requested by a Utility, the Agencies will treat specific data provided by the Utility as confidential and proprietary, to the extent permitted by law. This may include pre-decisional work products, proprietary information, and sensitive resource data. In the event that any confidential or proprietary information is required by law to be released by an Agency, that Agency shall provide

CAP members affected by such a release with at least a 30-day written notice in advance of such release, unless a shorter notice period is required by law. Nothing herein shall be interpreted to prevent any Agency from complying with the Freedom of Information Act and 43 CFR Part 2, Subpart A and B.

6. If any Utility considers an action or omission to be an Inconsistent Act or a Breach, then that Utility may withdraw from this Accord by giving written notice of its intent to withdraw, pursuant to Paragraph 7; provided, however, that in the case of an Inconsistent Act, such notice of withdrawal may not take place until the time period to initiate administrative appeal of the Inconsistent Act has expired.

7. A withdrawing Utility initiates withdrawal by providing written notice of an Inconsistent Act or Breach and its intent to withdraw to all CAP members. This notice must include a brief statement setting forth: (A) the date and nature of the Inconsistent Act or Breach giving rise to the right to withdraw and (B) how the alleged Inconsistent Act or Breach meets the definition of "Inconsistent Act" or "Breach," as defined herein.

8. In the event of an alleged Accord Breach by any CAP member, the CAP member that is alleged to have breached the Accord shall have thirty (30) days after receipt of the notice of Breach within which to cure the Breach. If it is not reasonably possible to cure such Breach within thirty (30) days, the breaching CAP member shall notify the CAP Board ("Board," see Paragraph 26) of the time reasonably necessary to cure such Breach. If the Board can agree on the time reasonably necessary to cure the Breach, the breaching CAP member shall proceed to cure such Breach within such time as the Board shall agree. If the Board is unable to agree on the time reasonably necessary to cure the Breach, the breaching CAP member shall proceed to cure such Breach as soon as reasonably possible. The breaching CAP member(s) shall keep the Board informed of the progress in curing the Breach. Failure of the breaching CAP member to cure a Breach in accordance with this paragraph shall allow the CAP member that is harmed by the Breach to withdraw from the Accord.

9. In the event of a withdrawal by a Utility or the failure of a Utility to cure a Breach of the Accord, the Agencies have the option to reconsider any prior fish passage prescriptions submitted pursuant to FPA §18 for Projects owned by the withdrawing or breaching Utility. Withdrawal relieves the Utility of its performance obligations under this Accord, but will not result in the return of any funds previously contributed pursuant to Paragraph 37.

10. If the Accord Utility membership changes, the Plan will be adjusted by the remaining CAP members to be compatible with funding being provided by the remaining member Utilities.

11. The Agencies and Utilities agree that extension of the Plan beyond 2017 is optional, and the obligation and agreement to comply with the Accord is not conditioned upon a continuation of the Plan beyond the initial 10-year term.

12. The Agencies and the Utilities agree to use their best efforts to make this Accord a success and to participate in all Accord administrative activities at their own expense.

SCE&G Specific Agreements

13. The reservoir elevation limitations, required flow releases, low inflow protocols or high inflow protocols to be developed in a relicensing agreement for the Saluda Hydroelectric Project among the USFWS, SCDNR, and SCE&G along with the reservation by the USFWS of any fishway prescriptions for this Project will be filed with the FERC for the term of the new Saluda Hydroelectric Project license which is anticipated to be issued in 2010.

14. It is the understanding of the CAP that the diadromous fish study needs below the Parr Shoals Development Dam will be addressed through the Accord. Additional diadromous fish studies downstream of Parr Shoals Development Dam will not be required during the relicensing of the Parr Hydroelectric Project. A Fish Passage Feasibility Assessment (an evaluation of the upstream and downstream passage alternatives and their conceptual designs) will be conducted pursuant to the Accord, by SCE&G, and will commence upon attainment of the biological triggers as set out in Appendix B.

15. The Fish Passage Feasibility Assessment will commence at the Parr Shoals Development Dam within one year following passage of 50% of the adult anadromous American shad or adult anadromous blueback herring target restoration numbers as set out in Appendix B, upstream for any three years in a five-year period at the Columbia Diversion Dam Fish Passage Facility. Construction of a fishway at the Parr Shoals Development Dam will be initiated within one year and completed within three years following passage of 75% of the adult anadromous American shad or adult anadromous blueback herring target restoration numbers as described in Appendix B, upstream for any three years in a five-year period at the Columbia Diversion Dam Fish Passage Facility. In no event shall fish passage feasibility assessment or construction of the fishway commence before 2012. No changes will be required in the Parr Hydroelectric Project's current operations until issuance of the new FERC license for this Project. Any fish passage at this Project will not impact generation and pumping operations at the Fairfield Pumped Storage Facility until relicensing studies support the need for such a change and then only with the issuance of the new license for the Parr Hydroelectric Project (anticipated to be issued by FERC in 2020).

16. The USFWS agrees to reserve its FPA §18 authority to prescribe any type of fish passage facilities for sturgeon species at the Parr Shoals Development Dam until the new FERC license is issued for the Parr Hydroelectric Project, anticipated to be in 2020.

17. In the event that SCE&G applies for an amendment to the Parr Hydroelectric Project's current license for construction of a future power plant, the USFWS will reserve its authority under FPA §4(e) and §18 for this license amendment at that Project.

18. The Fish Passage Feasibility Assessment, including conceptual designs, will begin at the Neal Shoals Hydroelectric Project within one year following 50% of target restoration

numbers for adult anadromous American shad or adult anadromous blueback herring, as described in Appendix B, being passed upstream for any three years out of a five-year period at the Parr Shoals Dam. The construction of fish passage facilities at the Neal Shoals Hydroelectric Project will commence within one year and be completed within three years following passage of 75% of target restoration numbers of adult anadromous American shad or adult anadromous blueback herring being passed upstream three years out of a five-year period at the Parr Shoals Development Dam, but in no event shall the fish passage feasibility assessment or construction commence before 2016.

Duke Specific Agreements

19. For the Catawba-Wateree Hydroelectric Project, the obligation to operate a fishway and associated facilities as set out in the Accord will continue for the term of the new license, and the USFWS agrees that the prescription to be filed with the FERC for the new license will include such a provision. A trap and truck fish passage facility ("T&T facility") for adult anadromous American shad and adult anadromous blueback herring will be designed by Duke, in consultation with the Agencies and with input from the Accord Technical Committee ("TC;" see Paragraph 33), by December 31, 2015, and will commence operation by January 1, 2018, at the Wateree Development of the Catawba-Wateree Hydroelectric Project (see Appendix B). Fish trapped at this T&T facility will be placed in Lake Wateree. The year after the combined annual total catches of adult anadromous American shad and adult anadromous blueback herring equal or exceed 10,000, and in all subsequent years of the term of this Accord, all trapped adult anadromous American shad and adult anadromous blueback herring shall be trucked to upstream areas in the SC portion of the Catawba-Wateree River Basin designated by the TC. If the Accord is not functional, then the USFWS and the SCDNR will designate these upstream reaches in the SC portion of the Catawba-Wateree River Basin by consensus. Effectiveness studies (e.g., usefulness of attraction flows to increase capture of target fish and determination of target fish mortality associated with handling and transportation) for this T&T facility will be conducted by Duke during the first three years of operations, provided sufficient numbers of fish, as determined by the consensus of the Agencies with input from the TC, are available to do so. Information from the effectiveness studies will be used to improve effectiveness of the T&T facility.

20. The Agencies agree that operation of the T&T facility at the Wateree Development, as specified above and as incorporated in the prescription to be filed with the FERC for inclusion in the new license, will fulfill FPA §18 prescriptions and ESA §7 requirements for upstream passage for all adult anadromous fish (including but not limited to American shad, blueback herring, Atlantic sturgeon, and shortnose sturgeon) for all Catawba-Wateree Hydroelectric Project developments for the term of the new license.

21. The SCDNR will issue a scientific collection permit to operate the T&T facility at the Wateree Development pursuant to SC Code §50-11-1180 to ensure that Duke will not be held civilly or criminally responsible for any bycatch mortality, provided Duke is in compliance with its collection permit.

22. The Agencies agree that existing upstream fish passage facilities at the Wateree Development (i.e., partial ramp(s) and manual trap(s) in good repair and similar to that described in David Solomon's 2004 Fish Passage Design for Eels and Elvers) that use manual transport and release of captured American eels into Lake Wateree are sufficient to fulfill FPA §18 upstream prescriptions for catadromous fish (e.g., American eels) at the Wateree Development, when supplemented with additional partial ramp(s)/manual trap(s) determined by the results of partial ramp/manual trapping conducted in all seasons in 2009-2011 in areas adjacent to the spillway (data collected via the Catawba-Wateree River Elver Study in Appendix A). So long as American eels are passed upstream at the Wateree Development in an efficient, safe, and timely manner, Duke, at its sole discretion, may decide to continue operation of the ramp/trap fishway or construct a new passage facility. If Duke chooses to construct a new American eel passage facility at the Wateree Development, Duke will consult with the Agencies and the TC regarding facility design and construction.

23. The Agencies and Duke agree that a series of portable ramp/trap devices will be sufficient for the three-year monitoring studies, and that the studies will be conducted at each development in an orderly upstream sequence of the Catawba-Wateree Hydroelectric Project developments upstream of the Wateree Development. A template for the initial and subsequent studies to ascertain American eel abundance at each tailrace site is set out in the 10-Year Action Plan and is budgeted in Appendix A (location of such studies will occur in an orderly upstream sequence beginning at the Rocky Creek-Cedar Creek Development and ending at the Bridgewater Development at a time to be determined in consultation with the Agencies and with input from the TC). These data will allow effective design and placement of permanent or semi-permanent passage devices for best upstream passage at each development for American eels. Duke will develop a study plan for review and approval by the Agencies with input from the TC prior to commencing any studies at these upstream developments. Information collected from these studies shall include size, seasonality, and location of juvenile American eels in the tailrace areas where these fish may congregate. Captured American eels will be passed into the immediate upstream reservoir. The Agencies and the TC may approve a request for extension of the term of the initial monitoring study in the event few American eels are captured during the study phase.

24. Following the above monitoring for American eels described in Paragraph 23, Duke agrees to design, construct, and operate at each development (in consultation with the Agencies and with input from the TC after a review of the data collected during each three-year study) permanent or semi-permanent upstream passage facilities at each development within two years of completion of the monitoring study at a particular development. So long as American eels are passed upstream at each development in an efficient, safe, and timely manner, Duke, at its sole discretion, may decide to continue operation of the ramp/trap type fishways or construct a new passage facility at each Catawba-Wateree Project development.

25. Duke in cooperation with Agencies and with input from the TC will commence studies in 2024 to address the safe, timely, and effective downstream passage of American eels in the Catawba-Wateree system.

Management and Direction

CAP Board

26. The Accord will be directed by a Board composed of one representative appointed by each CAP member. Each CAP member may designate an alternate who may function as its Board representative in the absence of the appointed Board member. It shall be the responsibility of each CAP member to notify other members in writing within 14 calendar days following any change of the name or contact information for its Board member and/or alternate. On an annual basis, the Board shall elect a chairperson ("Chair") and may elect other officers as deemed necessary. Initial terms for Board members will be staggered so that there is continuity in the operation of the Accord over the long term, with Duke and USFWS Board members serving three-year initial terms and SCE&G and state agency members serving two-year terms. Successive Board members will serve two-year terms. Meetings by the Board will be held in compliance with the Freedom of Information Act in the jurisdiction where the meeting is held.

27. The initial Board shall establish and schedule at least one meeting of the Board per calendar year (Annual Meeting) for the duration of the Accord. The Chair will select the meeting location and will develop an agenda and provide draft minutes of the previous meeting within two weeks following each meeting and require all members to return their comments within two weeks following receipt of the draft minutes. Additional meetings (Called Meetings) of the Board may be called by the Chair or upon the agreement of at least 25 percent of the Board members, but no Called Meeting that is not called by consensus vote by the Board may be held with less than four weeks prior written notice.

28. A quorum is required for the transaction of business (e.g., official votes) at any Board meeting. A quorum is defined as the presence of a representative or alternate of each CAP member participating in the Accord on the date of the meeting. Once a quorum is established, it may not be broken by departure of one or more members' representatives or alternates, and voting may occur once a quorum is established.

29. Failure to comply with terms of the Accord, including the prompt payment of a Utility's annual contributions, will result in the revocation of that member's right to vote until the failure to comply is remedied.

30. The representatives of the members, or their alternates, may participate, which participation includes voting, in meetings by any means of communication by which all participants may simultaneously hear each other during the meeting. A member's representative or its alternate participating in a meeting by this means is deemed to be present in person at the meeting. No proxy voting shall be permitted. A member's alternate shall not vote if that member's regular representative is present.

31. In addition to conducting its affairs at meetings, the Board may also validly exercise its authority in writing. A proposal may be presented, whether in written or electronic format, to each member's representative. Upon the approval, whether in written or electronic format, of each member's representative to that written proposal, the action of

the Board concerning the proposal will constitute a valid exercise of the Board's authority. A complete record of all action taken by the Board without meeting shall be filed with the minutes of the proceedings of the members, whether done before or after the action so taken.

32. Final decisions must be made by consensus of Board members or their alternates.

Technical Committee (TC)

33. A TC comprised of fishery biologists and/or other qualified professionals representing each CAP member will be established by the Board and will advise the Board on technical issues associated with the Accord. The TC will exist for the duration of the Accord.

34. The TC will develop consensus recommendations to the Board and will guide the design and implementation of all Plan tasks for the duration of the Plan. Following the expiration of the term of the Plan, the TC will function as a scientific advisor to the Board regarding all matters related to the restoration of diadromous fish in the Santee Basin.

35. Failure to allocate and disburse funds according to direction of the Board will result in the revocation of that member's right to participate or to vote on matters brought to the TC, until the failure to comply is remedied.

36. For the duration of the Accord, the TC will provide a brief written annual progress report to the Board by February 15 of the following year.

Communications Protocol

The Board will develop a protocol to communicate clearly on all Accord-related resource study, protection, restoration, and enhancement activities occurring in the Basin. All CAP members shall adhere to the Communications Protocol. It is the intent of the Accord to publicly disseminate all technical and scientific findings of its monitoring and study efforts.

Term of the Accord and the 10-year Action Plan

The effective date of this Accord shall be April 15, 2008. The Accord shall terminate for SCE&G at the end of the term of the new FERC license for the Saluda Hydroelectric Project (expected to be issued by the FERC in 2010) and for Duke at the end of the term of the new FERC license for the Catawba-Wateree Hydroelectric Project (expected to be issued in 2009). Each annual extension, if any, of the applicable new licenses by the FERC (commonly referred to as an "annual license") will also extend the term of the Accord for the applicable Utility by one year. Since diadromous fish restoration can be a long-term endeavor, the Board may desire to extend the term of the Plan, or to increase funding during its term. Through a consensus vote of its members, the Board may alter or modify Plan tasks and expenditures within those amounts currently established by the Plan and such Plan modifications do not require new signatures on the Accord from the authorized representative of each CAP member's organization.

The term of the Plan shall be April 15, 2008, through December 31, 2017, unless extended as noted above. The Board shall consider revision or renewal of the Plan in 2015 and shall decide by consensus of its membership if the Plan shall be revised or renewed. A decision not to extend or renew the Plan does not affect the obligations of and agreements among the CAP members contained in the Accord.

Dispute Resolution

Major disputes regarding the Accord, if at all possible, will be resolved by the Board through good-faith negotiations which may be assisted by selecting the services of a neutral mediator (cost of the mediator to be shared as determined by the Board).

Roles and Responsibilities for Implementing the 10-year Action Plan

Utilities

37. Utilities will fund the Plan with SCE&G providing $200,000 per year (unadjusted annual contribution) and Duke providing $500,000 per year (contributions expressed in 2008 dollars and to be adjusted annually using the Consumer Price Index). Additional funding secured through grants or other sources by the CAP may be incorporated into the budget and is encouraged. Funding levels provided by the original Utilities are set at that described above. If the costs of proposed activities and studies under the Plan exceed the funding provided by the Utilities, then later activities and studies under the Plan will be abandoned or reduced appropriately as determined by the Board to accommodate the funding level agreed to in this document, unless the necessary additional funding can be obtained by new utility participants, non-CAP member entities, grants and/or existing Fisheries Enhancement Plans from within the Basin. However, funding by non-CAP members will not render otherwise ineligible entities eligible to guide Accord activities or become members of the CAP.

38. In addition to the funding set forth in Paragraph 37, Utilities will provide technical/scientific input to program development, personnel and in-kind services (as appropriate), while conducting some studies, and will provide assistance in the scheduling and conduct of studies.

State and Federal Agencies

39. Agencies will provide technical/scientific input to program development, assistance in the scheduling of studies, personnel and in-kind services (as appropriate) while conducting some studies, and assistance in reporting study results.

40. Agencies will investigate and solicit any sources of supplemental or matching funds.

41. Agencies will assist, to the extent practicable, with the issuance of all applicable permits.

Fund Management

Funds to be contributed by the Utilities shall be maintained by each Utility and accounted for in a separate CAP Fund Account. The CAP Board will develop and adopt procedures concerning when the Utilities will deposit their contributions to this account and how disbursements from this account are approved. Each Utility shall provide annually, no later than March 31, a report of all fund deposits, disbursements, and balances for the previous calendar year. Any funds obtained by a Utility from other sources that are to be used solely in the execution of the Plan shall be included in that Utility's CAP Fund Account and shall be identified in the annual report as a contribution by others. The annual reports provided by the Utilities to the CAP Board will be provided to all CAP members. All such funds, whether contributed by Utilities or others shall be the exclusive property of the CAP to be disbursed and spent according to the Board.

Disbursements from a Utility's CAP Fund Account shall be made only at the consensus direction of the CAP Board. Each Utility owes a fiduciary duty to manage and account for the funds for the benefit of the CAP and to follow the CAP Board's direction for disbursements.

It is the desire of the Utilities that all monies contributed to the Plan be spent during the term of the Plan. In the event that the Plan is not extended and unspent funds are available at the conclusion of the Plan term, the Board will decide by consensus and direct the Utilities to allocate these monies to other ongoing programs of a similar nature and the Utility CAP Fund Accounts will be closed, after which each Utility shall submit to the CAP Board a final accounting report within 60 days following closing its account.

Reserved Authority

The Utilities recognize that the USFWS will reserve authority to alter its FPA §4(e) conditions and FPA §18 prescriptions for diadromous fish. The Agencies and Utilities agree that the Accord provisions are appropriately based on current knowledge of diadromous fisheries in the Santee River Basin. The USFWS believes it will be able to meet its FPA §§ 4(e) and 18 and ESA §7 obligations consistent with its Accord commitments.

State Commitments

The SCDNR agrees to use its best efforts to make this Accord a success. In the event that the USFWS exercises its reserved authority and issues a FPA §18 prescription or a FPA §4(e) condition, or an ESA §7 requirement, or the SCDHEC issues a CWA §401 certification that is inconsistent with, or would impose obligations in addition to those set forth in the Accord or Project settlement agreement with the SCDNR, the SCDNR may exercise any procedural and substantive rights it may have to contest such a prescription, condition, or requirement.

The NCWRC agrees to use its best efforts to make this Accord a success. In the event that the USFWS exercises its reserved authority and issues a FPA §18 prescription or a FPA §4(e) condition, or an ESA §7 requirement, or the North Carolina Division of Water Quality issues a CWA §401 certification that is inconsistent with, or would impose obligations in addition to those set forth in the Accord or Project settlement agreements with the NCWRC, the NCWRC may exercise any procedural and substantive rights it may have to contest such a prescription, condition, or requirement.

Modification of the Accord

This Accord may be modified; however, except for modifications of the Plan as described above, no modification of the Accord will be effective or valid unless it is signed by the authorized representative of each CAP member's organization.

Miscellaneous Agreements

No Admission of Liability – The Accord is a compromise, balancing many interests. The actions taken hereunder are not intended nor shall be construed as an admission on the part of any CAP member, or its agents, representatives, attorneys or employees that such CAP member was so obligated in any manner independent of this Accord. Except as provided herein, no CAP member shall be prejudiced, prevented, or estopped from advocating in any manner or before any entity, including the FERC or any state agency, any position inconsistent with those contained in this Accord regarding the licensing, permitting and license compliance of these or any other hydropower projects other than those addressed in this Accord.

Accord Terms Contractual/Merger – The terms of the Accord are contractual and not mere recitals. This Accord, which includes and fully incorporates any and all Appendices and the Plan, constitutes the entire agreement among the CAP members with respect to the subject matter hereof. All prior contemporaneous or other oral or written statements, representations or agreements by, between or among any of the CAP members, with respect solely to fish passage and fishway prescriptions of the subject Projects are superseded hereby. Nothing herein shall be construed to affect, negate, or supersede obligations and benefits arising from Duke's Comprehensive Relicensing Agreement and SCE&G's potential settlement agreement for the Saluda Hydroelectric Project regarding reservoir elevation limitations, required flow releases, low inflow protocols or high inflow protocols.

Enforceability – All terms of the Accord not incorporated as FERC License Articles shall be enforced through remedies available under applicable state or federal law.

Compliance with Laws – It is the responsibility of the CAP members to comply with all applicable federal, state and local laws, codes, rules, regulations, and orders of any governmental authority, and, except as otherwise provided herein, each CAP member will obtain, at its own expense all permits and licenses pertaining to its obligations under the Accord. The Accord is not intended and shall not be construed as a defense to or a limitation on civil or criminal liability in any action brought by any governmental entity to enforce any law and shall not limit the assessment or award of any fees, fines, penalties, remediation costs or similar liabilities in any such enforcement action.

Force Majeure – The Parties agree that a CAP member shall not be in breach of the Accord to the extent that any delay or default in performance is due to causes beyond the reasonable control of the delayed or defaulting CAP member; provided, that the delayed or defaulting CAP member notifies the other CAP members as soon as possible of: (A) the event; (B) the expected duration of the event; and (C) the delayed or defaulting CAP member's plan to mitigate the effects of the delay or default. Such causes may include, but are not limited to, natural disasters, labor or civil disruption, acts of terrorism, the inability to secure any legal authorization from another entity (e.g., a permit or license) where such legal authorization is a prerequisite or requirement for complying with the Accord, or breakdown or failure of the affected Project's works, so long as such causes are beyond the reasonable control of the delayed or defaulting CAP member.

Applicable Law and Venue – This Accord shall be governed by the law of the state wherein the subject hydroelectric development is located. Execution of the Accord does not constitute a consent to jurisdiction of any court unless such jurisdiction otherwise exists. Execution of the Accord also does not constitute a waiver of any immunity or privilege except as provided by law.

Waiver Independence – No consent to or waiver of any provision of the Accord shall be deemed either a consent to or waiver of any other provision hereof, whether or not similar, or a continuing consent or waiver unless otherwise specifically provided.

Water Rights Unaffected – Except as between the Parties hereto and as specifically set forth in this Accord, the Accord does not release, deny, grant or affirm any property right, license or privilege in any waters or any right of use in any waters. The Accord does not authorize any person to interfere with the riparian rights, littoral rights or water use rights of any other person. No person shall interpose the Accord as a defense in an action respecting the determination of riparian or littoral rights or other water use rights.

Parties' Own Costs – Except as expressly provided for in the Accord, all CAP members are to bear their own costs of participating in the Accord.

Existing Laws – Unless otherwise noted, any reference to any statute, regulation or other document refers to the statute, regulation or document as it exists on the date of the first signature on the Accord.

No Third-Party Beneficiary – The Accord shall not create any right in any individual or entity that is not a signatory hereto or in the public as a third-party beneficiary. This Accord shall not be construed to authorize any such third party to initiate or to maintain a suit in law or equity or other administrative proceeding.

No Commitment of Funds – Nothing in the Accord shall be construed as obligating any federal, tribal, state, or local agency to expend in any fiscal year any sum in excess of appropriations made by Congress, tribal councils, or state or local legislatures or administratively allocated for the purpose of this Accord for the fiscal year or to involve any federal, tribal, state, or local agency in any contract or obligations for the future expenditure of money in excess of such appropriations or allocations.

No Government Agency Delegation – Nothing in the Accord shall be construed as requiring or involving the delegation by any government agency to any other body of any authority entrusted to it by Congress, tribal council, or by the legislature of any state.

Successors and Assigns – The Accord shall apply to, and be binding on, the CAP members, their successors, transferees and assigns. No change of ownership in a Project or transfer of a license shall in any way modify or otherwise affect any other CAP member's interests, rights, responsibilities, or obligations under the Accord. (See the General section of the Accord for a list of Projects and current licensees.) Unless prohibited by applicable law, the licensee of the affected Project shall provide in any transfer of the existing or new license for the Project, that such new owner shall be bound by, and shall assume the rights and obligations of the Accord upon completion of the change of ownership. In the event applicable law prohibits the new owner from assuming the rights and obligations of the Accord, any CAP member may withdraw from the Accord. The licensee of the affected Project shall provide written notice to the other CAP members at least 90 days prior to completing such transfer of the license.

Caption Headings – The paragraph titles and caption headings in the Accord are for convenience of reference and organization, are not part of the Accord, and shall not be used to modify, explain, interpret, or define any provisions of the Accord or the intention of the CAP members.

Limitation of Applicability – The CAP members have entered into the negotiations and discussions leading to the Accord with the explicit understanding that all discussions relating thereto are to be considered as settlement negotiations, shall not prejudice the position of any CAP member or entity that took part in such discussions and negotiations, and are not to be otherwise used in any manner in connection with these or any other proceedings. The CAP members understand and agree that execution of the Accord establishes no precedents, does not admit or consent to any fact, opinion, approach, methodology, or principle except as expressly provided herein.

Execution in Counterparts – This Accord may be signed in counterparts to expedite signatures, and shall become binding between the Utilities and the Agencies upon the last signature below by an authorized representative of each.

Full Legal Authority – Each signatory Party to the Accord represents that it has the full legal authority to execute this Accord and to bind the principal who it represents, and that by such representative's signature, such principal shall be bound upon full execution of the Accord.

Notices – Notices in connection with matters under the Accord shall be provided in writing and addressed to:

Hugh Barwick
Senior Environmental Resource Manager
Duke Energy Carolinas, LLC
526 South Church Street, P. O. Box 1006 (EC12Y)
Charlotte, NC 28201-1006
704/382-8614 FAX

William Argentieri, PE
Manager—Civil Engineering F/H Technical Services
South Carolina Electric & Gas Company
111 Research Drive
Columbia, SC 29203
803/933-7849 FAX

Bennett Wynne
Anadromous Fish Coordinator
NC Wildlife Resources Commission
901 Laroque Avenue
Kinston, NC 28501
252/522-9736 FAX

Richard Christie
FERC Coordinator
SC Department of Natural Resources
1771-C Highway 521 By-Pass South
Lancaster, SC 29720
803/286-5598 FAX

Tim Hall
USFWS Field Supervisor
176 Croghan Spur Rd., Suite 200
Charleston, SC 29407
843/727-4218 FAX

Brian Cole
USFWS Field Supervisor
160 Zillicoa Street
Asheville, NC 28801
828/258-5330 FAX

AGREED TO BY THE AUTHORIZED REPRESENTATIVES OF THE PARTIES NAMED BELOW ON THE DATES SHOWN BY THEIR SIGNATURES:

SOUTH CAROLINA ELECTRIC & GAS COMPANY

By: ____________________ Date: 4/18/08
James M. Landreth
Vice President, Fossil Hydro Operations
111 Research Drive
Columbia, SC 29203

DUKE ENERGY CAROLINAS, LLC

By: ____________________ Date: 4/10/08
Steven D. Jester
Vice President, Hydro Licensing and Lake Services
526 South Church Street
Charlotte, NC 28202

U.S. FISH & WILDLIFE SERVICE

By: ____________________ Date: 4/25/08
Sam Hamilton
Regional Director, Southeast Region
1875 Century Blvd., Suite 400
Atlanta, GA 30345

S.C. DEPARTMENT OF NATURAL RESOURCES

By: ____________________ Date: 5/14/08
John Frampton
Director
1000 Assembly Street
Columbia, SC 29202

N.C. WILDLIFE RESOURCES COMMISSION

By: ____________________ Date: 4/21/08
Fred Harris
Interim Executive Director
1701 Mail Service Center
Raleigh, NC 27699-1701

Appendix A. Projected annual costs for tasks in the Santee River Basin Cooperative Fish Passage Accord 10-Year Action Plan[1].

Task	Years										Total for all years
	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	
Hatchery Operations	$ 340,000	$ 138,000	$ 142,000	$ 146,000	$ 151,000	$ 155,000	$ 160,000	$ 165,000	$ 170,000	$ 175,000	$ 1,742,000
Adult Shad Transport	$ 77,000	$ 80,000	$ 82,000	$ 84,000	$ 87,000	$ 90,000	$ 92,000	$ 95,000	$ 98,000	$ 101,000	$ 886,000
Elver Studies/Catawba-Wateree River	$ 43,000	$ 64,000	$ 46,000	$ 47,000	$ 75,000	$ 50,000	$ 52,000	$ 82,000	$ 55,000	$ 56,000	$ 570,000
Juvenile Shad Monitoring		$ 106,000	$ 109,000	$ 113,000	$ 116,000	$ 119,000	$ 123,000	$ 127,000	$ 130,000	$ 134,000	$ 1,077,000
Adult Shad Migration		$ 159,000						$ 190,000			$ 349,000
Sturgeon Studies			$ 109,000	$ 113,000	$ 116,000	$ 119,000	$ 123,000				$ 580,000
Elver Studies/Parr									$ 65,000	$ 34,000	$ 99,000
Estimated Annual Costs	$ 460,000	$ 547,000	$ 488,000	$ 503,000	$ 545,000	$ 533,000	$ 550,000	$ 659,000	$ 518,000	$ 500,000	$ 5,303,000
Available Funds	$ 700,000	$ 715,000	$ 730,450	$ 746,364	$ 762,755	$ 779,638	$ 797,027	$ 814,938	$ 833,386	$ 852,388	$ 7,731,946
Fund Balance[2]	$ 240,000	$ 408,000	$ 650,450	$ 893,814	$ 1,111,569	$ 1,358,207	$ 1,605,234	$ 1,761,172	$ 2,076,558	$ 2,428,946	

[1] Assumes an annual 3% inflation rate for all items except contributions by South Carolina Electric and Gas Company.

[2] Fund balance or contengency is the difference between the estimated task costs and available funds for that year, and includes the balance from the previous year.

Appendix B. No-sooner-than dates, total restorational numbers, and biological triggers for construction of fish passage facilities at selected Santee River Basin hydroelectric dams.

Utility	Dam	Date	Total number[1]	50% Trigger[2]	75% Trigger[3]
SCE&G	Saluda	Deferred	NA[4]	NA	NA
	Columbia[5]	2007	92,800 (464,000)	46,400 (185,600)	69,600 (348,000)
	Parr	2012	128,150 (640,750)	64,075 (320,325)	96,112 (480,562)
	Neal Shoals	2016	37,400 (187,000)	18,700 (93,500)	28,050 (140,250)
Duke	Wateree[6]	2018	NA	NA	NA

[1] **Total restoration numbers for adult andaromous American shad (blueback herring) developed by the USFWS from surface acreage** calculations of the river (including available tributaries) from that dam to the next dam upstream.

[2] **50% trigger or when 50% of the total restoration numbers for adult anadromous American shad (blueback herring) for the unblocked** reach upstream of the dam are being passed at that dam. This would initiate a Fish Passage Feasibility Assessment at the upstream dam.

[3] **75% trigger or when 75% of the total restoration numbers for adult anadromous American shad (blueback herring) for the unblocked reach upstream of the dam are being passed at that dam. This would initiate construction of a Fish Passage Facility at the upstream dan**

[4] NA = Not applicable

[5] Volitional Fish Passage Facility is operational and passage is currently being evaluated.

[6] Trap and Truck Fish Passage Facility operational by January 1, 2018.

Appendix C. River miles, surface acreages of the mainstem river and associated tributaries, and restoration numbers (fish/acre) calculated for adult anadromous American shad and blueback herring from selected reaches of the Broad River.

Restoration phase and Reach	River miles	Mainstem acres	Tributary acres	Total acres	Shad[1]	Herring[2]
Phase 1						
Columbia Dam to Parr Shoals Development Dam	24	1,758	98	1,856	92,800	464,000
Phase 2						
Parr Shoals Development Dam to Neal Shoals Dam	31	2,106	457	2,563	128,150	640,750

[1] American shad restoration numbers are the product of total acres and 50 fish/acre.

[2] Blueback herring restoration numbers are the product of total acres and 250 fish/acre.

Appendix 11

RARE, THREATENED AND ENDANGERED SPECIES MANAGEMENT PROGRAM

SOUTH CAROLINA ELECTRIC & GAS COMPANY

COLUMBIA, SOUTH CAROLINA

SALUDA HYDROELECTRIC PROJECT

(FERC NO. 516)

RARE, THREATENED AND ENDANGERED SPECIES MANAGEMENT PROGRAM

SEPTEMBER 2008

Prepared by:

Kleinschmidt

Energy & Water Resource Consultants

SOUTH CAROLINA ELECTRIC & GAS COMPANY
COLUMBIA, SOUTH CAROLINA

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RT&E SPECIES MANAGEMENT PROGRAM

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RT&E SPECIES MANAGEMENT PROGRAM

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COLUMBIA, SOUTH CAROLINA

SALUDA HYDROELECTRIC PROJECT
(FERC NO. 516)

RARE, THREATENED & ENDANGERED SPECIES MANAGEMENT PROGRAM

1.0 INTRODUCTION

The Saluda Hydro Project (Project) is a 202.6 megawatt (MW) licensed hydroelectric facility located on the Saluda River in Lexington, Newberry, Richland, and Saluda counties of South Carolina (Figure 1-1) that is owned and operated by South Carolina Electric & Gas (SCE&G or Licensee). The Project is currently licensed by the Federal Energy Regulatory Commission (FERC No. 516), and the present license is due to expire in the year 2010. To initiate relicensing of the project, SCE&G prepared and issued the Initial Consultation Document (ICD) on April 29, 2005. In response to the ICD, the United States Fish and Wildlife Service (USFWS), South Carolina Department of Natural Resources (SCDNR), National Marine Fisheries Service (NMFS), and several Non-governmental Organizations (NGO's) requested information regarding the status of a rare, threatened and endangered (RT&E) species in the Project Area and requested an assessment of potential impacts to theses species from Project operations.

To address RT&E species-related relicensing requests, SCE&G formed a RT&E Species Technical Working Committee (TWC), which included representatives from the USFWS, NMFS, SCDNR, NGOs, and other stakeholders. With oversight from the RT&E TWC, the Saluda Hydro Project Rare, Threatened and Endangered Species Assessment (Kleinschmidt, 2008) was developed to provide the requested information regarding status of RT&E species in the Project vicinity, as well as potential project-related impacts. The assessment identified three species of conservation concern as having been document within or in close proximity to the Project: rocky shoals spider lily (*Hymenocallis coronaria*), bald eagle (*Haliaeetus leucocephalus*), and wood stork (*Mycteria americana*). State and federal resource agency staff, as well as other RT&E TWC participants, subsequently requested that management plans be prepared for these species. This program was prepared pursuant to their request.

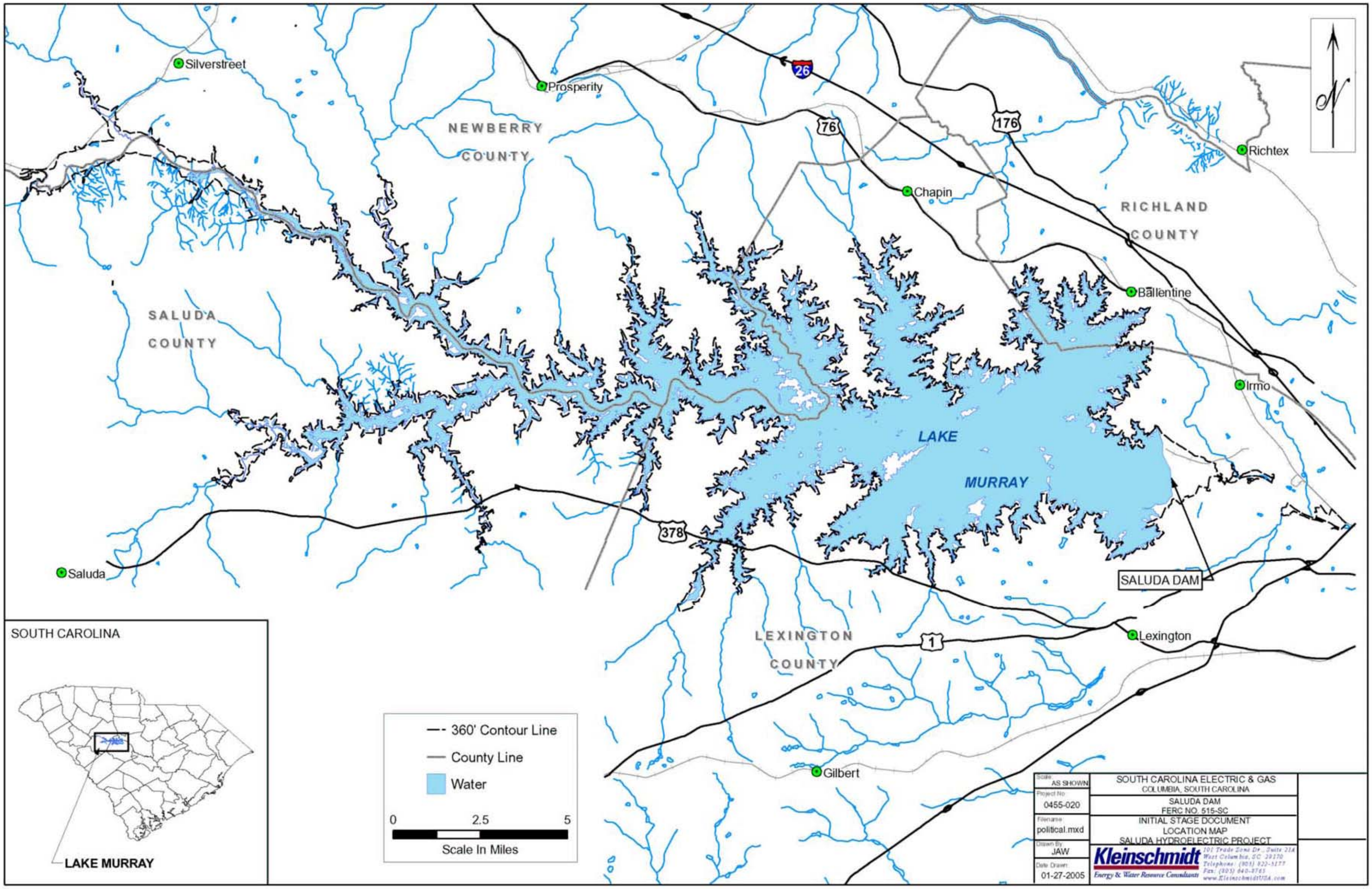

Figure 1-1: Location Map for the Saluda Hydroelectric Project (FERC No. 516)

2.0 BALD EAGLE

The bald eagle was listed as federally-endangered on March 11, 1967, partially due to significant population declines attributed to exposure to the pesticide Dichloro-Diphenyl-Trichloroethane (DDT). Subsequent to the banning of DDT, populations began to increase and the eagle's status was lowered from endangered to threatened on July 12, 1995 (USFWS 1995). Today, the species has recovered to the degree that it was recently removed from the Federal Endangered Species List, effective July 2007 (72 FR 37345 37372)(USFWS 2007). In South Carolina, the number of estimated nesting pairs has increased from 13 in 1977 to 181 in 2003 (Wilde et al. 2003). The bald eagle continues to receive protection under the South Carolina Nongame and Endangered Species Conservation Act as a state endangered species, as well as through the Bald and Golden Eagle Protection Act and Migratory Bird Treaty Act (16 U.S.C.668-668d) (72 FR 37345-37372).

Bald eagles may be found throughout North America, typically around water bodies where they feed primarily on fish and scavenge carrion. Studies suggest reservoirs, especially those associated with hydroelectric facilities, are particularly attractive to foraging bald eagles (Brown 1996). Eagles nest in large trees near water and typically use the same nest for several years, making repairs to it annually (USFWS 1989). In South Carolina, the distribution of eagle nesting has shifted, from historically being located primarily along the coast, to encompass more inland areas; this expansion has been attributed to the construction of approximately 491,000 acres of large reservoirs in the state since the early 1900's (Wilde et al. 2003).

2.1 Status in the Project Area

Bald eagles have likely used Lake Murray for foraging and nesting since its construction in 1930. Eagles utilizing the lake for foraging are thought to be a mix of native nesting adults and juveniles from South Carolina and adult and juveniles from outside the state (Wilde et al. 2003). Eagles forage on Lake Murray year round, with peak usage likely occurring during the winter months. Nesting of bald eagles on Lake Murray was first documented in 1996, and since that time, the nesting population has increased significantly (Wilde et al., 1996). The most recent survey, performed by

SCDNR biologists as part of state-wide monitoring, documented seven active bald eagle nests on Lake Murray as well as one active nest on the lower Saluda River (LSR) (T. Murphy, SCDNR, unpublished data, 2007). Productivity (young produced) has also increased substantially around the lake from two chicks in 1996 to 10 chicks in the 2002/2003 nesting season (Wilde et al. 2003).

Lake Murray was one of four South Carolina reservoirs affected by an outbreak of Avian Vacuolar Myelinopathy (AVM), which was first documented at DeGray Lake, Arkansas in the winter of 1994-1995 (Jeffers 2000). AVM has been confirmed in birds from 11 reservoirs in five southern states (SC, NC, GA, AR, TX) and has resulted in the death of at least 93 bald eagles, thousands of American coots, and smaller numbers of waterfowl and other species (Wilde et al. 2003, Birrenkott et al. 2004). AVM is thought to be linked to an unknown neurotoxin that causes lesions in the white matter of the brain and the spinal cord. Affected animals demonstrate difficulty flying, swimming and walking (Jeffers 2000). Evidence suggests that bald eagles contract AVM by preying on afflicted coots and other waterfowl that are unable to evade predators (Wilde et al. 2003).

Researchers suspect that the neurotoxin thought to cause AVM may be the product of a cyanobacteria (blue-green algae) often found growing in association with aquatic vegetation (i.e., *Hydrilla*) (Wilde et al. 2003). Sampling conducted at AVM-affected reservoirs by SDCNR and the University of South Carolina (USC) during 2001 and 2002 found that one particular species of blue-green algae, which is known to produce toxic compounds, had the greatest incidence of colonization at the location with the highest eagle mortality from AVM (Strom Thurmond Lake on the South Carolina/Georgia border). In addition, a recently-published feeding study involving mallards found a cause-effect relationship between ingestion of *Hydrilla* from these sites and AVM infection (Birrenkott et al. 2004).

As part of the Saluda Dam Remediation Project, from 2002 to 2005 SCE&G funded monthly surveys on Lake Murray to monitor for the presence of AVM-affected birds, as well as periodic collections of American coots to screen for the disease. To date, there have been no known occurrences of AVM in the Lake Murray bald eagle population; however, a low percentage of the coots collected during the winters of 1999

(2 out of 17 collected), 2000 (5 out of 27 collected), and 2003 (1 out of 30 collected) did test positive for the disease, as well as one Canada goose collected during December 2000 (Wilde et al. 2003). Despite the presence of some affected prey species, SCDNR and USC scientists have concluded that, to date, the presence of AVM at Lake Murray does not appear to have resulted in extensive losses of breeding adult bald eagles as both the number and productivity of eagles nesting on Lake Murray have increased from 1996 level (Wilde et al. 2003). It should be noted that the presence of AVM in the lone coot from the 2003 collection was determined only through clinical testing, with no birds displaying obvious neurological impairment, suggesting that AVM was not severe at Lake Murray during the 2002/2003 season (Wilde et al. 2003).

2.2 Management Regime

Active bald eagle nests occurring within the Project Area will be managed in accordance with the National Bald Eagle Management Guidelines (USFWS, 2007), which were published following de-listing of the species to ensure adherence to the Bald and Golden Eagle Protection Act. While restrictions vary according to the type of disturbance, the guidelines generally prohibit potential “disturbance” within 660 ft of an active nest during the nesting season (September through May) and 330 ft during the non-nesting season. Additional details regarding the various disturbance categories, as well as restrictions associated with each category, are summarized in Table 2-1 and Table 2-2.

SCE&G will ensure adherence to the National Bald Eagle Management Guidelines by implementing the following:

1) As part of he shoreline permitting process, SCE&G Lake Management staff will consult the disturbance matrices (Table 2-1 and Table 2-2 below) to ensure that permitted shoreline activities do not violate the buffer requirements outlined in National Bald Eagle Management Guidelines (USFWS, 2007);
2) SCANA Corporate Environmental, SCE&G Lake Management, and/or their consultants will continue to coordinate with SCDNR endangered species biologists on an annual basis to acquire the most up-to-date data

information regarding the location and status of active eagle nests in the Project vicinity;

3) SCE&G Lake Management and/or SCANA Corporate Environmental will consult with SCNDR and/or USFWS Ecological Services staff in the event that a yet undocumented nest is discovered in an area of proposed shoreline disturbance, or if there is difficulty in determining the disturbance category of a proposed activity; and

4) SCE&G will implement a Rare, Threatened, and Endangered Species Public Awareness Program, which will include the bald eagle. The Program will likely include information on bald eagle identification, habitat requirements and natural history, recent rangewide recovery successes, and the importance of Lake Murray and the LSR in providing nesting and foraging habitat for South Carolina's resident bald eagles.

5) SCE&G will also adhere to its Avian Protection Plan (APP) that requires incident reporting and tracking of avian interactions (collisions and electrocutions) with SCE&G power lines and electrical equipment located in its substations. Repeat occurrences may result in retrofitting problem poles or spans of lines with raptor protection devices. The APP also includes a discreet subsection on Eagle Protection and addresses annual reporting requirements.

Table 2-1: Summary of Bald Eagle Disturbance Categories, Representative Disturbance Activates, and Minimum Setback Requirements
Source: National Bald Eagle Management Guidelines (USFWS, 2007)

CATEGORY	REPRESENTATIVE DISTURBANCE ACTIVITIES	DISTANCE FROM A BALD EAGLE NEST
A	Building construction, 1or 2 story, with project footprint of <0.5 acre Construction of roads, trails, canals, power lines, and other linear utilities Agriculture and aquaculture- new or expanded operations Alteration of shorelines or wetlands Installation of docks or moorings Water impoundments	See Table 2
B	Building construction, 3 or more stories or 1 to 2 stories but with a footprint of >0.5 acre Installation or expansion of marinas with a capacity of 6 or more boats Mining and associated activities Oil and natural gas drilling and refining and associated activities	See Table 2
C	Timber operations and forestry practices	No clear cutting or removal of trees within 330 feet of a nest No logging activities within 660 feet of a nest during the nesting season
D	Off-road vehicle use	330 - 660 ft (depending on visibility from the nest) during the nesting season*
E	Motorized watercraft use	330 ft during the nesting season
F	Non-motorized recreation and human entry	330 ft during the nesting season
G	Helicopters and fixed-wing aircraft	1,000 ft during the nesting season
H	Blasting and other loud, intermittent noises	0.5 miles (2,640 ft) during the nesting season

Table 2-2: Minimum Distances for Category A and B Disturbances for Bald Eagle Nests Source: National Bald Eagle Management Guidelines (USFWS, 2007)

	NO SIMILAR ACTIVITY WITHIN 1 MILE OF NEST	SIMILAR ACTIVITY WITHIN OF NEST
Activity will be visible from nest	660 feet	660 feet
Activity will not be visible from nest	Category A: 330 feet* Category B: 660 feet	330 feet*

*Activities that would involve cutting trees and changing the landscape should be done outside the breeding season or at distances >660 feet from a bald eagle nest.

3.0 WOOD STORK

The wood stork is a large wading bird endemic to coastal areas of South Carolina, Georgia, Florida and is the only stork species native to North America (USFWS, 1997). Like most other wading birds, wood storks feed primarily on small fish. However, because wood storks feed by tactilocation, depressions where fish become concentrated during periods of falling water levels are particularly attractive (USFWS, 1997). Typical foraging habitats include narrow tidal creeks, flooded tidal pools, freshwater marshes, and freshwater wetlands. Wood storks typically use tall cypresses or other trees near wetlands or marshes for colonial nest sites. Nests are usually located in the upper branches of large trees and there are typically several nests in each tree. Trees utilized for nesting and roosting typically provide easy access from the air and an abundance of lateral limbs (USFWS, 1997). Currently, nesting of the species in the U.S. is thought to be limited to the coastal plain of South Carolina, Georgia, and Florida (USFWS, 1997). The wood stork was federally listed as endangered in 1984, with population declines attributed primarily to general habitat loss (USFWS, 1997).

3.1 Status in the Project Area

A local resident reported observing foraging and roosting wood storks at a number of locations in Lake Murray between approximately 2001 and 2004. Presumably based on these reports, The FERC ordered SCE&G to designate two areas near Bush River and Big Bay Creek in Lake Murray as wood stork “conservation areas” (FERC Order 107 FERC ¶ 62,273 dated June 23, 2004). Further, the order required that these areas, as well as all other wood stork roosting and foraging habitat identified within the Project boundary, remain protected and undeveloped until evidence could be submitted to indicate that protection of these areas was not warranted.

In response to the wood stork sightings on Lake Murray and the subsequent FERC Order, SCE&G initiated consultation with the SCDNR and USFWS during Summer 2004. Biologists from SCDNR and Kleinschmidt Associates subsequently performed two wood stork reconnaissance surveys on Lake Murray in August 2004, during which approximately 60 storks were observed feeding at various locations in the middle Saluda River and the upper portion of Lake Murray (Kleinschmidt 2004a). The surveys also documented two wetlands areas along the floodplain of the Saluda River upstream of the reservoir that contained nests similar to those of wood storks. Based on these initial findings, SCE&G, SCNDR, and USFWS cooperatively developed a five-year study plan aimed at documenting where and under what conditions wood storks were utilizing habitats within the Project boundary and in the Project vicinity (Kleinschmidt, 2004b).

In accordance with the Lake Murray Wood Stork Study Plan (Kleinschmidt 2004b), aerial surveys were performed monthly during February through November of 2005 and 2006. No wood storks were observed during 2005 surveys, and a limited number (approximately 12-13) were observed during August and September of 2006 (Kleinschmidt, 2005; 2007). The storks observed in 2006 consisted of scattered individuals soaring above and foraging in wetlands off the Saluda's main channel upstream of the reservoir. No nesting of wood storks was observed during 2005 and 2006. The suspected wood stork nest was found to be occupied by great blue heron during both 2005 and 2006.

Timing of wood stork observations during 2006 (August and September), suggested that these were likely post-dispersal migrants from coastal nesting sites. During the late-summer/early-fall period, when chicks have fledged and adults are no longer tied to the nest site by chick rearing, adult and juvenile wood stork dispersing from nesting colonies often undertake extensive migrations to exploit ephemeral food resources prior to returning to coastal areas for the winter months. In South Carolina and Georgia, young-of-year storks typically fledge during July and August, but return to the nest for an additional 3 to 4 weeks to be fed before finally dispersing from the colony site in August and September (USFWS, 1997). Storks dispersing post-breeding from southern US colonies (Florida, Georgia, and South Carolina) have been documented as far north as North Carolina and as far west as Mississippi and Alabama (USFWS, 1997).

Following completion of the 2005 and 2006 surveys, SCE&G met with representatives from the USFWS and SCDNR to discuss the status of wood stork monitoring on Lake Murray (see February 7, 2007 meeting notes). Both SCDNR and

USFWS concurred with the findings of the 2006 Wood Stork Monitoring Report (Kleinschmidt, 2007), agreeing that no nesting of wood stork in the Project area was evident based on study results and that timing of the observations during 2006 was consistent with post-dispersal migration. Due to the limited nature of stork activities observed in the Project vicinity, the agencies concurred with recommendations to discontinue further wood stork surveys on Lake Murray and that continued protection of the areas identified in the FERC Order as wood stork "conservation areas" was no longer warranted or necessary. Agency staff recommended, however, that an education program be developed to assist lake users in identifying and reporting wood stork occurrence in the future.

3.2 Management Regime

In accordance with the agency recommendations, SCE&G will implement the following:

1) SCE&G will document any wood storks observed during ongoing winter waterfowl surveys;
2) SCE&G will implement a Rare, Threatened, and Endangered Species Public Awareness Program, which will include information on wood stork identification, habitat requirements, and natural history, as well as a mechanism to report any storks observed in the Project vicinity;
3) SCANA Corporate Environmental, SCE&G Lake Management, and/or their consultants will coordinate annually with SCDNR endangered species biologists to determine whether wood storks were observed on the Lake Murray vicinity during routine bald eagle surveys on the reservoir; and
4) SCE&G will notify the USFWS and SCDNR in the event that additional wood storks are sighted on Lake Murray.

4.0 ROCKY SHOALS SPIDER LILY

Rocky shoals spider lily (RSSL), also referred to as Cahaba lily, is a flowering perennial that typically inhabits large streams and rivers at or above the fall line. These areas usually consist of rocky shoals and bedrock outcrops, substrates which provide anchor points for the RSSL's roots and bulbs (Patrick et al., 1995). RSSL grows best in constantly flowing water with relatively low sediment loads and water depths (to bulb) of 4 to 12 inches (Aulbach-Smith, 1998). The decline of RSSL has historically been attributed to loss of shoals habitat due to construction of impoundments and other channel modifications. Threats to current populations include flow modifications and fluctuating water levels resulting from dam operations, water pollution, and collection for use in gardens. The RSSL is considered a species of concern by the State of South Carolina (SCDNR, 2007).

4.1 Status in the Project Area

A survey conducted in May 2006 in support of relicensing revealed no viable populations of RSSL downstream of the Project in the lower Saluda River (LSR) proper (See Kleinschmidt memorandum dates July 20, 2006). However, a large RSSL population occurs in the island complex at the confluence of the Broad and Saluda rivers and just upstream of the confluence in the bypassed reach of the Broad River downstream of the Columbia Hydroelectric Project (FERC Project No. 1895). The confluence population of RSSL was first documented during SCE&G's relicensing of the Columbia Project in the late-1990's, and at that time, was estimated to consist of 7,921 plants in 48 colonies (Kleinschmidt, 1998). Although not located within the Saluda Project Area, agency staff suggested during consultation that the portion of the population on the Saluda side of the confluence could potentially be "under Project influence" and requested that a management plan be prepared.

The RSSL population located in the confluence and lower Broad River area is managed under an existing RSSL Management and Enhancement Plan (Plan) (Appendix A). The existing Plan was developed by SCE&G in accordance with Article 409 of the current FERC license for the Columbia Hydroelectric Project and filed on behalf of the

City of Columbia (City), the current owner of the Columbia Project, on April 24, 2006. The Columbia Plan was implemented in 2007 and is a collaborative effort between the City, SCE&G, South Carolina Native Plant Society, Riverbanks Botanical Gardens, and SCDNR. Implementation of the Plan has resulted in hiring of a regional RSSL expert to guide monitoring and restoration efforts, development of a RSSL propagation facility at Riverbanks Botanical Garden, updated surveys of the existing RSSL colonies, and transplantation of approximately 94 RSSL seedlings into suitable habitat in the LSR. SCE&G, the City, and other collaborators have also conducted numerous educational and outreach programs in accordance with the Plan, including the First Annual Rocky Shoals Spider Lily Festival, which was sponsored by SCE&G at the Columbia Riverfront Park in May, 2008.

In accordance with Article 409 of the Columbia Hydroelectric Project license, the existing RSSL Plan, and the FERC Order approving the plan (116 FERC ¶ 62,046 dated July 19, 2006), SCE&G filed the two RSSL monitoring reports with the FERC on behalf of the City on November 30, 2006 and November 30, 2007 (Appendix B). The reports include two progress report from Ms. Cindy Aulbach, a botanist and regional RSSL expert hired to serve as technical lead for the RSSL monitoring and restoration efforts. According to the reports, a total of 1,443 RSSL plants in 183 colonies were found during surveys conducted during 2007, significantly fewer than indicated in the 1998 survey (7,921 plants in 48 colonies) (Kleinschmidt, 1998). Aulbach noted that, while differing personnel and survey methods between 1998 and 2007 likely contributed to the differences in population estimates, the magnitude of the disparity likely indicates a significant reduction in the RSSL population from 1998 to 2007. Ms. Aulbach speculated that the reduction in population could potentially be attributed to deeper water associated with recent implementation of license required minimum flow releases from the Columbia Project. Finally, the report found 12 of the 94 bulbs transplanted in the LSR during Fall of 2006 to be surviving (13%). Additional details regarding the 2007 surveys and other restoration and monitoring efforts to date are provided in the 2006 and 2007 RSSL reports, which are included as Appendix B.

4.2 Management Regime

Under a new license term for the Saluda Project, SCE&G will continue to assist and support the City and other partners with the RSSL monitoring and restoration efforts implemented under Columbia RSSL Enhancement Plan. Activities that will continue to be supported include:

1. RSSL Propagation – SCE&G will continue to support and assist the Riverbanks Botanical Gardens in their efforts to propagate RSSL bulbs for transplantation to the confluence area and LSR.
2. Technical Expertise – SCE&G and its partners will continue to employ the service of a regional RSSL expert to guide restoration, enhancement and monitoring efforts.
3. Monitoring – As outlined in the Columbia Plan, monitoring of RSSL colonies in the confluence area will be conducted on a minimum five year interval. Monitoring will consist of ground surveys of the entire confluence area, during which the number of live plants will be counted and colony locations documented using Global Positioning System (GPS) technology. Any diseased or distressed plants will be noted and documented.
4. Pilot Planting Phase – SCE&G will continue to support and assist the City and its partners in experimental planting of RSSL bulbs until such time that approximately 300 RSSL have been successfully transplanted. Only bulbs grown from seeds collected from the Broad River Basin will be transplanted, per request of the USFWS.
5. Phase I Planting – This phase will involve large scale propagation and transplantation of seedlings into the confluence and Broad River Bypass reach. Phase I will last for two years or more if necessary until such point that 3000 new RSSL plants have been established. Specific goals and schedule for this phase will be determined in consultation with the technical expert and agency staff and will be outlined in the annual report prior to implementation.

6. Phase II Planting – This phase will commence upon completion of Phase I and will involve commercial scale production of RSSL seedling utilizing the propagation facilities established at Riverbanks Botanical Gardens. This phase will aim at establishing up to 1,000,000 new RSSL plants. The Columbia Hydro RSSL Plan states that funding for this phase is to be provided by the River Alliance and that if funding is not available, the City will assist SCDNR and Riverbanks Botanical Gardens to obtain funding through public or business options. Specific goals and schedule for this phase will be determined in consultation with the technical expert and agency staff and will be outlined in the annual report prior to implementation.
7. Reporting – In accordance with Article 409 of the Columbia Hydroelectric Project license, the existing RSSL Plan, and the order approving the plan, a report will be filed annually to update the status of RSSL enhancement and restoration efforts. The annual report will be filed with the FERC, USFWS, SCDNR, River Alliance, and Riverbanks Botanical Gardens by November 30 or each year. A draft of the report will be circulated to the above noted parties for their review prior to filing of the annual report.
8. Public Awareness – As with the wood stork and bald eagle, the RSSL will be included as a component of the Rare, Threatened and Endangered Species Public Awareness Program. The program will likely include information on RSSL life history, tips for RSSL viewing during the blooming season, and information on the RSSL restoration and enhancement efforts that have been undertaken by SCE&G, The City and its partners in recent years.

This management plan is intended to serve as a regulatory link between the Saluda Hydroelectric Project and the restoration and enhancement efforts currently being conducted relative to the RSSL population located at the confluence of the LSR and Broad River.

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Appendix 12

Bald Eagle Nest Location Map

Due to the sensitive nature of the contents of this document, it is considered Privileged, and has been removed from the public version of this document

Appendix 13

USFWS RT&E Consultation - September 25, 2007

Shane Boring

From: Amanda_Hill@fws.gov
Sent: Tuesday, September 25, 2007 8:18 AM
To: Shane Boring
Subject: Re: Saluda Hydro Project Relicense: Draft Rare, Threatened and Endangered Species Assessment

Saluda RTE Assessment - Fig 1... Saluda RTE Assessment Draft 20... Saluda RTE Assessment - Append...

Hey Shane,

The report seems adequate for federal T&E species, however, you should review the state listed threatened and endangered species for the four counties and include these in the report also.

Amanda Hill
Fisheries Biologist
U.S. Fish and Wildlife Service
176 Croghan Spur Rd., Suite 200
Charleston, SC 29407
843-727-4707 ext. 303
843-727-4218 fax
amanda_hill@fws.gov

"For all at last returns to the sea -
to Oceanus, the ocean river,
like the everflowing stream of time,
the beginning and the end." -Rachel Carson

"Shane Boring"
<Shane.Boring@KleinschmidtUSA.com>

09/20/2007 04:20 PM

To
"Shane Boring" <shane.boring@kleinschmidtusa.com>, "Alan Stuart" <alan.stuart@kleinschmidtusa.com>, "Amanda Hill" <amanda_hill@fws.gov>, "Bill Argentieri" <bargentieri@scana.com>, <bseibels@yahoo.com>, "Gerrit Jobsis \(American Rivers\)" <gjobsis@americanrivers.org>, "J. Hamilton Hagood" <jhamilton@scana.com>, "Jennifer Summerlin" <Jennifer.Hand@KleinschmidtUSA.com>, "Jim Glover" <GloverJB@dhec.sc.gov>, "Randy Mahan" <rmahan@scana.com>, "Ron Ahle" <ahler@dnr.sc.gov>

cc

Subject

Saluda Hydro Project Relicense:
Draft Rare, Threatened and
Endangered Species Assessment

Attached for your review is the draft Rare, Threatened and Endangered Species Assessment for the Saluda Hydro Project Relicensing. Please note that Figure 1 and Appendix A are included as separate files. If possible, please have your comments on the assessment to me by Thursday October 4th 20007. Thanks for your continued participation in the Saluda relicensing process.

Shane

C. Shane Boring
Environmental Scientist
Kleinschmidt Associates
204 Caughman Farm Lane; Suite 301
Lexington, SC 29072
Phone: (803)951-2077
Fax: (803)951-2124

<<Saluda RTE Assessment - Fig 1.pdf>> <<Saluda RTE Assessment Draft 2007-09-20.doc>>
<<Saluda RTE Assessment - Appendix A.pdf>>

(See attached file: Saluda RTE Assessment - Fig 1.pdf)(See attached file: Saluda RTE Assessment Draft 2007-09-20.doc)(See attached file: Saluda RTE Assessment - Appendix A.pdf)

Appendix 14

Designate New Waterfowl Hunting Areas - Request for Time Extension – December 29, 2006

ORIGINAL

SCE&G®
A SCANA COMPANY

December 29, 2006

2007 JAN -3 P 3:02
2007 Jan 3

Magalie R. Salas, Secretary
Federal Energy Regulatory Commission
ATTN: OEP/Division of Hydropower Administration and Compliance
888 First Street, N. E.
Washington, D. C. 20426

P-516-441
P-516-442

Subject: South Carolina Electric & Gas Company
Saluda Hydroelectric Project, FERC Project No. 516 - 442
Shoreline Management Plan – June 23, 2004 FERC Order
Paragraph I – Compliance with as-built drawings of two additional recreation sites proposed by SCE&G as future recreation areas;
Paragraph I – Designate New Waterfowl Hunting Areas – Request for Time Extension

Dear Secretary Salas:

South Carolina Electric & Gas Company (SCE&G), Licensee for Saluda Hydroelectric Project, FERC Project No. 516, hereby files an original and eight copies of its notice of compliance for one section and a request for an extension of time until August 31, 2008 to comply with another section of Paragraph I of the ORDER APPROVING LAND USE AND SHORELINE MANAGEMENT PLAN WITH MODIFICATIONS AND AMENDING EXHIBIT R issued by the Federal Energy Regulatory Commission (FERC) on June 23, 2004 and ORDER CLARIFYING AND MODIFYING ORDER AND DENYING REHEARING issued on October 28, 2004. By letter dated May 31, 2005 the Licensee requested an extension of time until August 31, 2008 to comply with Paragraph I of the original Order (two additional recreation sites proposed by SCE&G as future recreation areas and waterfowl hunting areas). The FERC issued ORDER GRANTING EXTENSION OF TIME TO FILE SUPPLIMENTS TO LAND USE AND SHORELINE MANAGEMENT PLAN dated December 15, 2005, concluding that the Licensee did not provide enough justification for the requested time extension for Paragraph I, and required compliance of this paragraph by December 31, 2006. The Licensee filed an interim report on June 1, 2006 describing the progress it is making to meet the new deadline and FERC acknowledged our progress by letter dated July 27, 2006. Paragraph I is repeated below followed by a description of our compliance with this paragraph of the FERC Order.

"(I) The licensee's proposed changes to its recreation facilities are approved and made a part of the project's Exhibit R-Recreation Plan. The proposed recreation changes shall include designation of Two Bird Cove and Hurricane Hole Cove as special recreation areas and a full description of the two additional recreation sites proposed by SCE&G as future recreation areas. The licensee shall also consult with the U.S Fish and Wildlife Service and South Carolina Department of Natural Resources and designate new waterfowl hunting areas for those lost to land sales and development, and indicate these areas in the Recreation Plan. The licensee's proposed changes shall be implemented within 1 year of issuance of this order. The licensee shall file, for Commission approval, as-built drawings of the implemented recreation facilities within 60 days of completing construction. These changes shall be indicated in the next Land Use and Shoreline Management Plan update."

Compliance: Two Bird Cove and Hurricane Cove - as-built drawings of these two coves were filed with the Commission on September 1, 2006 in compliance with the June 23, 2004 FERC Order and subsequent correspondence. Upon approval of the as-built drawings this section of Paragraph I will be complete.

Two additional recreation sites (Saluda Shoals Regional Park and Lake Murray Estates Park) – Saluda Shoals Park is an expansion and improvement of an existing park identified as Site #9 on Exhibit R-1, located on Sheet K-5 drawing. An original and eight copies of the as-built drawings for these two recreation sites are enclosed in compliance with the June 23, 2004 FERC Order and subsequent correspondence. Upon approval of the as-built drawings this section of Paragraph I will be complete.

Designation of new waterfowl hunting areas - On February 9, 2006 SCE&G met with USFWS and SCDNR to discuss the appropriate action for waterfowl hunting areas within the project. Minutes of the February 9, 2006 meeting were filed with the June 1, 2006 interim report. The Licensee wishes to reiterate that currently all waters of Lake Murray that are physically accessible to hunters, excepting only those areas which by virtue of county ordinances addressing discharge of firearm set-backs near residences, are open to waterfowl hunting. Additionally, all SCE&G owned islands, except those that are leased, are available for public waterfowl hunting opportunities. The SCDNR is specifically interested in creating a hydraulically manipulated impoundment in the upper area of Lake Murray. The resource agencies indicated that while designating specific areas within Lake Murray may protect waterfowl hunting opportunities for hunters it would not provide an overall benefit to waterfowl numbers and species, as they would prefer. SCDNR suggested that creating an agency managed waterfowl impoundment area would better serve their overall management strategies by simultaneously providing hunting opportunities and enhancing waterfowl and other wildlife habitats.

SCE&G understands SCDNR interest in this unique opportunity to potentially partner to explore the creation of such a unique habitat enhancement program that may provide a greater benefit to the overall resource. SCDNR has expressed to SCE&G their understanding that such a project would require more data, planning, and consultation beyond what is typically considered for designating waterfowl hunting areas at existing water bodies. On June 6, 2006 and July 28, 2006 SCE&G and representatives from SCDNR, USFWS, and State department waterfowl biologists met to review hydrologic data and perform on-site visits to evaluate potential areas for the waterfowl enhancement program in the upper reaches of Lake Murray. On October 2, 2006 and October 19, 2006 SCE&G and SCDNR met to discuss a scope of work necessary to evaluate the feasibility of creating an impoundment for waterfowl hunting opportunities at a proposed site within Lake Murray's project boundary. SCE&G in consultation with SCDNR conducted soil studies, surveys, and a flood analysis of this proposed site. The results of these analyses are still being evaluated, but do not appear to provide a good foundation for a waterfowl hunting area. Due to the preliminary results of the initial studies, survey, and analysis of the first site, two other sites are being evaluated for potential compatibility as a waterfowl hunting area. These other sites will be visited in 2007 and studies, surveys, and engineering analyses will be conducted at that time.

Attached is a letter and Interagency Field Review report provided by SCDNR dated December 14, 2006 that describes their involvement and concurrence with the current investigation associated with the waterfowl hunting area mitigation required in the FERC Order. The SCDNR letter requests that the portion of the lake and Saluda River channel, project boundary, fringe lands and adjacent Wildlife Management Area (WMA) lands between SC 121 and SC 395 (Higgin's and Kempson's bridges) be designated as *special waterfowl and waterbird management area*. This will include the area of the original proposed sub-impoundment, a substantial acreage of disjoint beaver ponds on both sides of the river, several undeveloped or relatively undeveloped creeks, tributaries and Bush River all having headwaters providing potential waterfowl and waterbird habitat. SCE&G will evaluate their request as part of the land reclassification evaluation associated with the Saluda Relicensing process. The Licensee needs to first determine what the implications might be to making such a designation. Designating a body of water or portion of land without the appropriate input from the general public that uses this area could cause additional problems. Obviously, there can be a lot of ramifications, at least in the public perceptions and resulting fallout as the Commission will recall happened with deciding to designate Two Bird Cove and Hurricane Cove as "special recreation areas." This issue will best be evaluated during the relicensing process in which the public will be represented through our Resource Conservation Groups.

Prior to the final designation of a site as a waterfowl hunting area, SCE&G in consultation with SCDNR will need to identify soil conditions, perform the appropriate engineering analysis, design the berm, pump, and weir configuration to provide for planting and flooding at the appropriate times of the year, investigate acquisition of the appropriate land necessary to provide hunting buffers to this designated area, determine appropriate land ingress and egress to the site, investigate the potential impact of archaeological sites within the designated area, and obtain the appropriate federal, State and local permits necessary to construct an appropriate facility. If one of the proposed designated areas is suitable for a waterfowl impoundment based on an evaluation of the above listed activities, SCE&G will file the appropriate documentation and design details for a designated waterfowl hunting area. However, if these sites are not suitable for a waterfowl hunting area, SCE&G will continue to consult with SCDNR and USFWS to determine the best way to comply with this section of Paragraph I of the June 23, 2004 FERC Order.

In an effort to comply with the June 23, 2004 FERC Order by working in consultation with SCDNR and USFWS and hopefully, providing clarification of the scope of work and enough justification to the Commission, SCE&G respectfully requests that the Commission grant an extension of time until August 31, 2008 to comply with the designation of a waterfowl hunting area section of Paragraph I of the June 23, 2004 Order.

The above referenced documents are submitted to the Commission for approval and close-out of the two additional recreation sites proposed by SCE&G as future recreation areas section of Paragraph I and requesting of an extension of time for the waterfowl hunting area designation section of Paragraph I associated with the ORDER APPROVING LAND USE AND SHORELINE MANAGEMENT PLAN WITH MODIFICATIONS AND AMENDING EXHIBIT R issued by the Commission on June 23, 2004.

If you have any questions about this filing, please call Mr. William Argentieri at (803) 217-9162 or Mr. Tommy Boozer at (803) 217-9007.

Very truly yours,

William R Argentieri for

Michael C. Summer, General Manager
Fossil/Hydro Technical Services

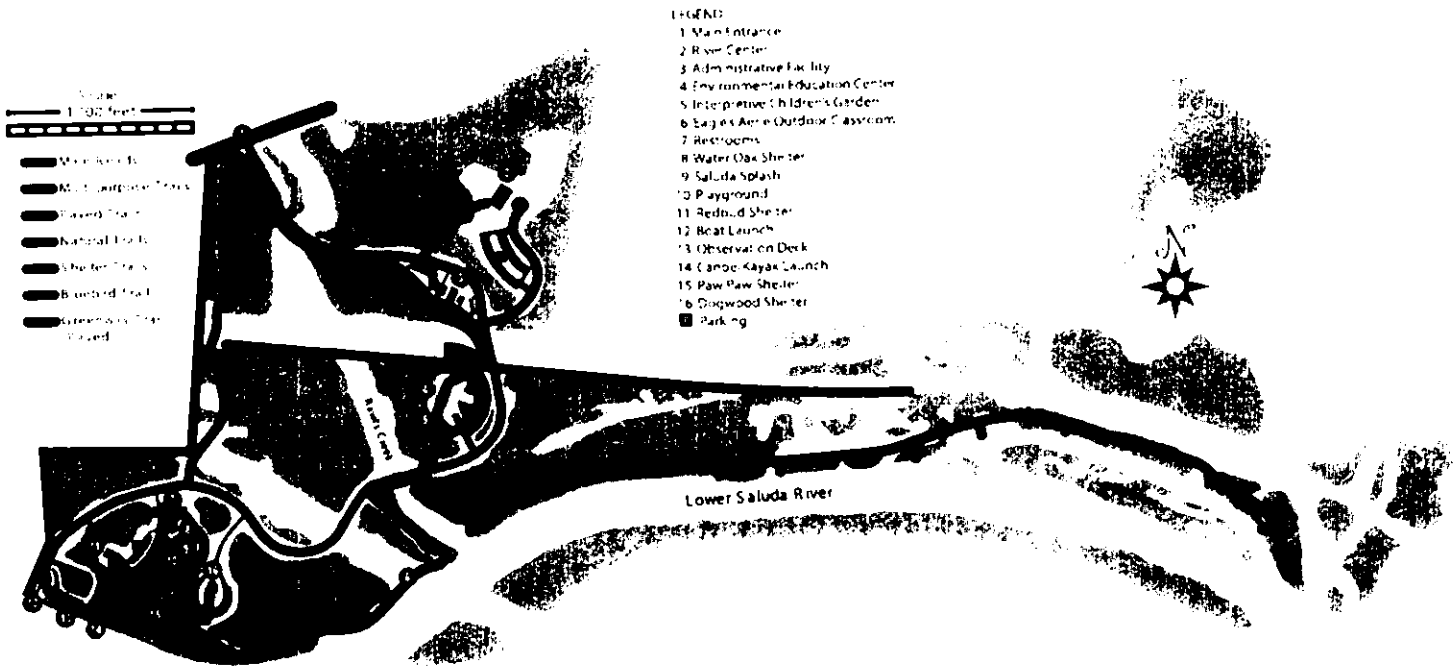
WRA/wa

Enclosures

c: M. C. Summer/W. R. Argentieri/SHFile
A. I. Spell/M. C. Clonts/J. R. Stockman
T. C. Boozer
R. R. Mahan
T. G. Eppink
Corporate Records
B. J. McManus - Jones Day
R. W. Christie – SCDNR
A. K. Hill – USFWS
D. M. Murray – FERC Washington (MC PJ 12.2)

Saluda Shoals Park

5605 Bush River Road
Columbia, SC 29212
803-731-5208



Saluda Shoals Park
A 270 acre riverfront park with and observation deck, walking trails, canoe launch, boat ramp, picnic tables, fish cleaning station, playground and administrative building.

The Environmental Education Center
A 12,000 square foot facility that features a 100-seat auditorium, two classrooms and an exhibit hall.

Picnic Shelters
Four various sized picnic shelters equipped with ceiling fans, grills, and running water that accommodate groups as small as 15 and as large as 140.

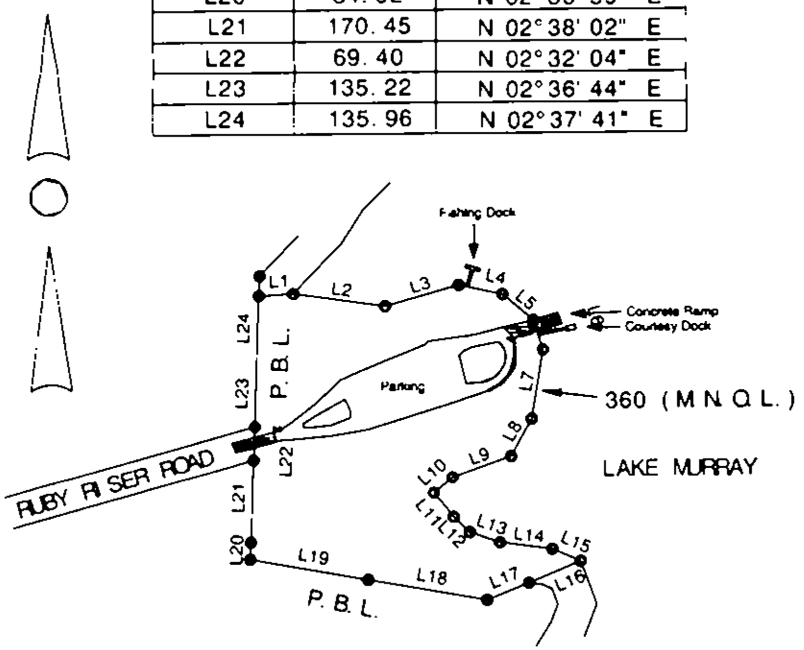
The River Center
A 11,000 square foot conference center with over 5,000 square feet of meeting space. The River Center is a versatile, full-service conference center that can accommodate small and large business meetings and social functions. A beautiful wedding gazebo is also available for outdoor weddings.

Saluda Splash
A zero-depth touch activated water playground.

Barking Lot Dog Park
A one-acre permanent fenced dog park facility for unleashed pets.

Saluda Shoals
PARK

SITE-22		
7.15 ACRES		
LINE	LENGTH	BEARING
L1	70.66	N 86°47' 01" E
L2	188.21	S 81°43' 37" E
L3	155.02	N 74°08' 04" E
L4	91.74	S 77°20' 51" E
L5	82.34	S 49°09' 45" E
L6	65.20	S 17°17' 48" E
L7	144.79	S 09°55' 29" W
L8	88.60	S 29°19' 37" W
L9	127.25	S 70°24' 17" W
L10	49.71	S 49°21' 37" W
L11	63.67	S 38°28' 38" E
L12	45.14	S 45°16' 40" E
L13	65.17	S 70°27' 44" E
L14	108.54	S 82°18' 11" E
L15	63.43	S 66°12' 20" E
L16	115.09	S 67°49' 48" W
L17	91.93	S 68°25' 44" W
L18	245.59	N 79°46' 55" W
L19	244.91	N 79°43' 51" W
L20	34.92	N 02°36' 59" E
L21	170.45	N 02°38' 02" E
L22	69.40	N 02°32' 04" E
L23	135.22	N 02°36' 44" E
L24	135.96	N 02°37' 41" E



LAKE MURRAY ESTATES
SEE SHT. K-12
EXH. R-1, INDEX 8

SITE 22

South Carolina Department of
Natural Resources

Bob Perry
Certified Wildlife Biologist
Office of Environmental Programs
1000 Assembly Street Room 310A
PO Box 167
Columbia, SC 29202
803-734-3766
perryb@dnr.sc.gov

John E. Frampton
Director
Robert E. Duncan
Director, Office of
Environmental Programs

14 December 2006

Mr. William R. Argentieri
South Carolina Electric & Gas Company
111 Research Drive
Columbia, SC 29203

Dear Mr. Argentieri,

Reference is made to the proposed sub-impoundment off the Saluda River, a project staff of South Carolina Department of Natural Resources (DNR) have been discussing with you and other South Carolina Electric & Gas (SCE&G) personnel and staff of Kleinschmidt Associates in an effort to pursue mitigation for lost waterfowl habitat and waterfowl hunting opportunity on and around Lake Murray as a result of decades of development.

Pursuant to all investigations undertaken thus far, we are in agreement that extraordinary measures and costs would be required in order to develop the proposed sub-impoundment, and it cannot be determine there is reasonable assurance of successful water level control, a critical need. Accordingly, we agree it prudent to pursue other options and abandon this proposal at this time. We submit all parties have agreed that the concept to develop the sub-impoundment would be an appropriate step substantially mitigating for both lost habitat and opportunity. However, development and management of the sub-impoundment cannot be supported based on current examination of soil types, hydrology and other findings. DNR does request SCE&G agree that we be able to return to this project for further discussion if future data is presented or new technology or innovative design be made available making it worthwhile to develop the sub-impoundment in the future.

Personnel of DNR and SCE&G have invested considerable effort attempting to locate areas within the project boundary of Lake Murray to pursue the stated and desired mitigation. We submit the area of the upper end of the lake associated with the Saluda River is the most suitable area and arguably the only area with desired waterfowl habitat characteristics and lack of development. We specifically request future designation as a *special waterfowl and waterbird management area* all that portion of the lake and Saluda River channel, project boundary, fringe lands and adjacent Wildlife Management Area (WMA) lands between (Higgin's and Kempson's bridges) SC 121 and SC 395. This will include the area of the proposed sub-impoundment, a substantial acreage of disjoint beaver ponds on both sides of the river, several undeveloped or relatively undeveloped creeks, tributaries and Bush River all having headwaters providing potential waterfowl and waterbird habitat. We pledge to work with SCE&G to continue to evaluate these habitats to determine beneficial and cost effective habitat management options to enhance the area for waterfowl and other waterbirds. We submit there may be substantial potential for habitat enhancement in beaver wetlands, as yet not fully inventoried. Early in this process we discussed potential development of certain beaver wetland habitats by impounding them and installing water control devices. We submit it may be necessary to return to this discussion and evaluate these possibilities. Finally, we have pledged to SCE&G staff to examine, early in January, additional sites above Higgin's Bridge in order to determine if there are any other suitable sites potentially meeting the stated mitigation needs.

I have attached a copy of the whitepaper developed several months ago when we began an examination of the proposed sub-impoundment. Please feel free to use this document, as you deem necessary in your response to the Federal Energy Regulatory Commission. We believe this document appropriately describes the area we request be designated for waterfowl and waterbird management in addition to providing the rationale for pursuing the sub-impoundment proposal. Any further development of water management capability for the purpose of enhancing beaver wetlands for waterfowl habitat would follow a similar water management scenario as described in the whitepaper.

We have been pleased with the cooperative and enthusiastic response demonstrated by SCE&G staff in pursuit of the stated mitigation need, and we look forward to working with you and your staff in the coming weeks to finalize a project meeting resource requirements and providing replacement public use opportunities. Please do not hesitate to contact me if you have any questions regarding this transmittal.

Very truly yours,

Bob Perry

Bob Perry

Opportunities to Mitigate for Lost Waterfowl Habitat on Lake Murray
Prepared for Interagency Field Review
Prepared by Bob Perry, SCDNR
28 July 2006

Statement of Need

In the context of FERC re-licensing there is a need to mitigate for loss of waterfowl habitat and loss of public waterfowl hunting opportunity on Lake Murray pursuant to shoreline development occurring over the past several decades and loss of submerged aquatic vegetation occurring within the past several years.

Discussion

Limited data and anecdotal evidence indicate Lake Murray historically provided considerable waterfowl habitat and public hunting opportunity. Examination of the estimated statewide waterfowl harvest during the period 1971-80 indicates 8% of the total South Carolina (SC) annual mallard (*Anas platyrhincos*) harvest was reported from Lexington, Newberry, Richland and Saluda counties (Carney et al. 1983). During that same period these counties accounted for 5% of the total estimated annual SC waterfowl harvest (Carney et al. 1983). The preponderance of waterfowl habitat in these counties available during that time period was on or directly associated with Lake Murray.

Shallow water margins of the lake provide a substantial amount of potential waterfowl foraging, resting and loafing habitat for dabbling ducks. Deeper waters *provide potential rafting/loafing and some foraging habitat for a wide range of diving* duck species wintering in SC. Although shallow waters of other wetland types may be of more importance to waterfowl, interior lakes such as Lake Murray, provide important migrating and wintering habitat for ducks and geese (Chamberlain 1960, Addy 1964, Bellrose 1976).

Johnson and Montalbano (1989) described waterfowl habitat, waterfowl winter utilization, habitat management practices and limiting factors affecting SC reservoirs and lakes including Lake Murray. Through the Fish and Wildlife Coordination Act of 1934 (FWCA) the US Fish and Wildlife Service (FWS) has the opportunity to use reservoir projects constructed or licensed through the Federal Energy Regulatory Commission (FERC) for migratory bird habitat development (White and Malaher 1964). FWS is required to protect, develop and manage migratory bird habitat in accordance with FWCA amendments added in 1946 and 1958 (Shaw and Fredine 1956, White and Malaher 1964). An example of a major waterfowl habitat project developed in SC under the FWCA is Santee NWR. The South Carolina Department of Natural Resources (DNR) also is obligated to protect, manage and develop migratory bird habitat to the benefit of the citizens of SC and for the quality of life in SC.

Despite successes under the FWCA reservoirs such as Lake Murray do not always provide optimum wintering and migrating waterfowl habitat due to inadequate forage resources (Neely and Davidson 1971, Chabreck 1979) because water level fluctuations restrict establishment and utilization of desirable aquatic plant communities (Taylor and Taylor 1976), and because of direct and cumulative impacts associated with shoreline development (Johnson and Montalbano 1989).

Reservoirs constructed for flood control and hydroelectric generation often apply a rule or operational curve to pool levels such that drawdown occurs during winter months when inflow does not equal or exceed outflow due to hydro generation and maintenance of storage capacity prior to spring/summer wet periods (Chabreck 1979, Johnson and Montalbano 1989). Reservoir operational curves also dictate that full pools likely occur during spring and summer. Reservoir levels therefore often are not in accordance with needs of wintering and migratory waterfowl such that full pools would occur in winter to flood shallow, productive margins and backwaters, and such that draw-downs would occur in late summer to expose mudflats and shallows stimulating desirable emergent aquatics and make available a diverse invertebrate forage. Shoreline development of southern reservoirs increases human disturbance and degrades shallow, shoreline habitat causing wintering waterfowl to seek more reclusive foraging and loafing habitat (Baldassarre and Bolen 1994). Since the early 1980s wintering dabbling duck utilization of Lake Murray has declined so as to be virtually non-existent (DNR, unpublished data)..

Submerged and emergent aquatic vegetation is recognized as a valuable component of the surface water environment providing many life cycle needs to numerous species of wildlife including waterfowl (Baldassarre and Bolen 1994). The presence of limited quantities of submerged aquatics may improve water quality and enhance wetland aesthetics. Wildlife foraging, plant senescence, and competition usually maintain a desirable balance of submerged aquatics, however submerged aquatics can become a nuisance taking over entire water columns to the point of blocking navigation, stopping water flow and reducing water quality. Establishment of an invasive submerged aquatic in Lake Murray occurred 1995 – 2003 to the point of proliferation of hydrilla (*Hydrilla verticillata*). Wintering waterfowl, particularly ring-necked ducks (*Aythya collaris*) exploited rafts of submerged hydrilla and associated invertebrates during this period. These wintering diving ducks provided significant public hunting opportunities. Subsequently submerged aquatic vegetation on Lake Murray effectively has been eliminated using a combination of herbivorous sterile grass carp (*Cteno pharyngodon*) and selective herbicides. As a result of the loss of submerged aquatics, waterfowl utilization of Lake Murray and associated public hunting opportunities again have plummeted (B. Baker, DNR, person. comm.).

<u>The FERC Process</u>

Re-licensing of Lake Murray under the FERC process presents a unique opportunity to examine opportunities to mitigate for lost waterfowl habitat and public waterfowl hunting opportunities. Staff from DNR and SCE&G has conducted a comprehensive examination of areas within the Lake Murray project boundary potentially available for development of a meaningful, successful waterfowl management area. The upper Lake Murray project boundary associated with the Saluda River presents the most likely, and arguably the only, site available to develop waterfowl habitat. The area identified is that portion of the Saluda River channel between SC 121 and SC 395.

Current Habitat Conditions

Some of the former river bottomlands in this area were converted to pine plantations by SCE&G in the late 1970s and early 1980s, and much of this type habitat has been invaded by and is impounded by beavers (*Castor canadensis*). Beavers can create considerable, productive shallow wetlands (Jenkins and Busher 1979) of high value to wintering waterfowl and resident wood ducks (*Aix sponsa*) (Arner and Hepp 1989).

Arner and Hepp (1989) described the habitat types, successional stages of beaver ponds and their value as waterfowl habitat. Hepp (1977) described a classification system for beaver ponds in the piedmont region of SC. Hepp's (1977) classification follows a successional pattern, and several of the classifications or successional stages have high value as waterfowl habitat. New beaver ponds contain open water and dying or dead trees as a result of beaver activity and continuous flooding. As ponds trap sediments water depth decreases with pond age (Naiman et al. 1986), and emergent plants transition from desirable to undesirable (Arner and Hepp 1989). Beaver pond age and vegetation are key factors determining the suitability of beaver ponds to waterfowl.

Beaver ponds offer significant potential to manage water levels and thereby emergent vegetation or planting of cereal grains to the benefit of the waterfowl resource (Arner 1963, Landers et al. 1977, Fredrickson and Taylor 1982). Landers et al. (1977), Mayer et al. (1986) and Arner and Hepp (1989) indicated beaver ponds to be of particular importance to wintering wood ducks, mallards, green-winged teal and hooded mergansers (*Mergus cucullatus*) as well as of significant importance as wood duck nesting and production habitat. Yarrow and Yarrow (1999) described effective techniques for seasonally draining beaver ponds in order to manage naturally occurring vegetation and/or plant cereal grains for winter flooding including the most efficient technique yet devised, the Clemson Beaver Pond Leveler (Clemson Univ. 1991).

Beaver habitat in the Saluda River corridor selected for investigation is considered to be mature and thus of limited value to wintering waterfowl. The area is providing foraging and nesting habitat for a variety of shorebirds and non-migratory wood ducks. A documented great blue heron (*Ardea herodias*) rookery exists in the area, and wood storks (*Mycteria americana*) are known to use the area for foraging habitat. There may be as much as 300 acres of mature beaver habitat occurring on a combination of both sides of the Saluda River in the Lake Murray project boundary between SC 121 and SC 395. Most of the beaver habitat is currently in the Wildlife Management Area system under cooperative agreement between DNR and SCE&G.

Adjacent to and downstream of the majority of the beaver habitat is an area forming a shallow embayment of Lake Murray. This embayment is flooded only when the lake is at full or nearly full pool. A stream system flows through the edge of this embayment and thence into the Saluda River. DNR has recognized the importance of this area to waterfowl, and wood duck nest boxes were erected and are maintained in the area in coordination with SCE&G. Under the historic rule curve for Lake Murray the embayment is flooded during early spring through early summer, and begins to dry out as the lake level drops by mid- to late summer. During the period when migratory waterfowl are wintering in SC the embayment is typically dry and unavailable to this resource. The embayment is a nursery for fish production although it is considered to be of limited importance to overall Lake Murray fisheries production (pers. comm. Val Nash, DNR). When the embayment is flooded, it is used by fishermen. At times when the embayment is flooded, and during de-watering, it is exploited by foraging wading and shore birds.

A Habitat Development Opportunity

Conceptually the embayment could be developed as waterfowl and wading bird habitat by creating a system providing water control. A natural river levee occurs on the Saluda River side of most of the embayment. This natural river levee would require linkage entailing wetland fill and stream alteration at strategic points. At least 2 water control structures of strategic design would be required to be engineered and installed as well as a low head, reversible pump. Regulatory approval for wetland fill will be required through the US Army Corps of Engineers (Section 404 of the Clean Water Act) and through SC Department of Health and Environmental Control (Section 401 of the Clean Water Act and SC Navigable Waters Act).

The engineering required to develop this habitat is accomplishable using a proven successful model of embankment design and construction as well as water control structure design and placement (Perry 1987, Perry 1995, Williams et al. 1991). The design would not be unlike those typically employed in coastal, tidal systems where wetlands have been successfully developed and managed for these birds and human recreational use. Raising the natural river levee to a required height and spanning the stream channel before it merges with the Saluda River would construct an outer embankment. A gravity flow water control structure would be installed in the embankment in order to pass water in either direction as necessary to fulfill water management and water level objectives. The water control structure also would allow natural flow of the stream at stream level when the lake is low and the management unit is dewatered. A low head, reversible pump would be required to be installed in conjunction with the water control structure in order to fulfill water management and water level objectives when gravity flow is not possible, e.g., at times when the level of the lake and the Saluda River are opposite of what is desired.

A key regulatory issue needing to be addressed is public access and navigability once embankments are constructed. This would be achieved through design and installation of a second water control structure in the form of a weir of sufficient depth and width to pass fishing boats when the lake is full, e.g., when boats historically have accessed the embayment. The bottom of the weir would be equal to the elevation of the bed of the embayment.

A Conceptual Waterfowl and Wading Bird Habitat Management Scenario

March – May: When the lake is normally a high level, the level of the embayment would be equal to the lake with the water control structure doors open on both ends and the weir open to boat traffic. Water flow, navigability, fish movement, bird foraging opportunities, etc., would be as per normal lake conditions.

March – May: When the lake is abnormally low, the water control structure would be set to keep water in the embayment and spill excess, and/or the pump would be used to keep the embayment at full pool level. The weir would be closed to hold water. The closed weir during this scenario does not prohibit navigability that historically could not occur at a low lake level. Stream flow is otherwise normal although spilling rather than occurring at stream bed level. Fishing opportunity is preserved, but would be restricted to bank fishing, wading or by use of small boats hauled over the dike. Habitat for fish and wildlife is maintained when it otherwise would be unavailable.

June – August: When the lake normally is falling, the water control structure would be set to dewater providing moist-soil wetland management conditions. Water flow, navigability, and fish movement are as per normal lake conditions. Under heavy rainfall and low flow conditions the water control structure should maintain drawdown. Under unusual surge events the water control structures would be set to keep water out of the embayment and the pump would remove water as necessary preserving habitat management opportunities and shorebird utilization. Water flow, navigability, fish movement, bird foraging opportunities, etc., would be as per normal lake conditions.

August – October: When the lake is low due to low flow and hydro generation, the water control structure would be set to dewater providing moist-soil wetland management conditions. Under extreme drought the pump would be used to moisten the embayment to maintain moist-soil management. Water flow, navigability, and fish movement are as per normal lake conditions. Under heavy rainfall and low flow conditions the water control structure should maintain drawdown. Under unusual surge events the water control structures would be set to keep water out of the embayment and the pump would remove water as necessary preserving habitat management opportunities and shorebird utilization. Water flow, navigability, fish movement, bird foraging opportunities, etc., would be as per normal lake conditions.

October – February: When the lake is low and rising, the water control structure would be set to retain stream flow filling the embayment and spill excess maintaining optimum waterfowl and wading bird foraging opportunities. The pump would take in river water under drought conditions to maintain optimum waterfowl and wading bird foraging opportunities. Water flow would be as per normal lake conditions once the embayment is full. Fisheries habitat, waterfowl and wading bird foraging opportunities would be enhanced, as the habitat would normally be dry and unavailable. In-stream fish movement would be reduced. Navigability is not an issue under this scenario. Public fishing would be prohibited by regulation to allow waterfowl utilization. Public waterfowl hunting would be restricted to a limited number of hunters using the area once weekly during morning hours. Other regulations further restricting waterfowl hunting would apply.

October – February: When the lake is high, the water control structure would be set to remain open on each end maximizing stream flow and in-stream fish movement. The pump would be used only to maintain the embayment water level as necessary. Water flow would be as per normal lake conditions once the embayment is full. Fisheries habitat, waterfowl and wading bird foraging opportunities would be enhanced, as the habitat would normally be dry and unavailable. In-stream fish movement would be reduced. Navigability is not an issue under this scenario. Public fishing would be prohibited by regulation to allow waterfowl utilization. Public waterfowl hunting would be restricted to a limited number of hunters using the area once weekly during morning hours. Other regulations further restricting waterfowl hunting would apply.

Advantages

1. The embayment would become permanent manageable waterfowl and wading bird habitat.
2. The public benefit would be served by providing enhanced waterfowl opportunity where it has limited potential under the present conditions.
3. An opportunity to mitigate for lost habitat and public use will be realized.
4. Fisheries habitat would be maintained and fishing would be possible during spring at times when the lake is low.

Issues

1. Wetland fill and permitting will be required. The amount of fill necessary is to be determined.
2. Water control structures will be needed also requiring permitting.
3. Navigability will be restricted at certain times during the management cycle, e.g., during winter when the lake is unusually full and during summer when the lake is unusually full. Navigability, however, will be normal during spring when the lake is normally full.
4. Water flow would be seasonally restricted, e.g., when the embayment is full or filling at times when the lake is low.

Other Considerations

DNR would propose the larger area to be a specific waterfowl management area including beaver habitat complexes and the embayment. Certain portions of the larger area would be set aside as inviolate sanctuaries not to be hunted. Beaver habitat would be improved and managed by application of species specific herbicides in order set back plant succession and allow seed producing pioneering plants to return. Other habitat management options exist and can be used for the benefit of the waterfowl and wading bird resources.

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Appendix 15

Designate New Waterfowl Hunting Areas – 2007 Update – December 10, 2007

SCE&G®
A SCANA COMPANY

December 10, 2007

Kimberly D. Bose, Secretary
Federal Energy Regulatory Commission
ATTN: OEP/Division of Hydropower Administration and Compliance
888 First Street, N. E.
Washington, D. C. 20426

Subject: South Carolina Electric & Gas Company
Saluda Hydroelectric Project, FERC Project No. 516
Shoreline Management Plan – June 23, 2004 FERC Order
Paragraph I – Designate New Waterfowl Hunting Areas – 2007 Update

Dear Secretary Bose:

South Carolina Electric & Gas Company (SCE&G), Licensee for Saluda Hydroelectric Project, FERC Project No. 516, hereby files an original and eight copies of its 2007 update for the designation of a new waterfowl hunting area associated with Paragraph I of the ORDER APPROVING LAND USE AND SHORELINE MANAGEMENT PLAN WITH MODIFICATIONS AND AMENDING EXHIBIT R issued by the Federal Energy Regulatory Commission (FERC) on June 23, 2004 and ORDER CLARIFYING AND MODIFYING ORDER AND DENYING REHEARING issued on October 28, 2004. By letter dated December 29, 2006 the Licensee filed a report describing the progress we are making to meet this requirement and requested an extension of time until August 31, 2008 to comply with this section of Paragraph I of the original Order (waterfowl hunting areas). The FERC issued ORDER GRANTING EXTENSION OF TIME TO FILE DOCUMENTATION OF WATERFOWL HUNTING AREA DESIGNATION dated March 6, 2007 approving this extension of time request and ordered that a report be filed with the Commission on or before December 31, 2007 describing the progress the Licensee is making to meet the extended deadline. Paragraph I of the June 23, 2004 FERC Order is repeated below followed by a progress report of the waterfowl hunting areas designation section of this paragraph.

"**(I)** The licensee's proposed changes to its recreation facilities are approved and made a part of the project's Exhibit R-Recreation Plan. The proposed recreation changes shall include designation of Two Bird Cove and Hurricane Hole Cove as special recreation areas and a full description of the two additional recreation sites proposed by SCE&G as future recreation areas. The licensee shall also consult with the U.S Fish and Wildlife Service and South Carolina Department of Natural Resources and designate new waterfowl hunting areas for those lost to land sales and development, and indicate these areas in the Recreation Plan. The licensee's proposed changes shall be implemented within 1 year of issuance of this order. The licensee shall file, for Commission approval, as-built drawings of the implemented recreation facilities within 60 days of completing construction. These changes shall be indicated in the next Land Use and Shoreline Management Plan update."

Progress Report: Designation of new waterfowl hunting areas – On January 4 and January 22, 2007 SCDNR and SCE&G made site visits to a property that had been discussed earlier by these two parties and was determined to be a potential candidate for a waterfowl hunting area. At this time, SCDNR planned to contact the State and federal permitting agencies to coordinate a meeting with them at this site. In March SCE&G contracted with a mapping company to generate topographic maps for this site. On May 25, 2007 a third site visit was made by SCDNR and SCE&G to this property. At that time the topographic maps were distributed to SCDNR. In June 2007 designs for a pump/intake structure from another project were provided to a design engineer to assist in the design development of a similar structure for this property. In September 2007 SCDNR drops effort to coordinate with State and federal permitting agencies due to conflicting schedules. Licensee design engineer and SCDNR located a local chapter of Ducks Unlimited that can perform design of pumps and intake structure once a specific site is selected. In October the Licensee started working with the owner of the proposed property site to secure an option-to-buy contract until further issues resolution negotiations between SCE&G and SCDNR, associated with the new license application, are developed.

Prior to the final designation of a site as a waterfowl hunting area, SCE&G in consultation with SCDNR will need to identify soil conditions, perform the appropriate engineering analysis, design the berm, pump, and weir configuration to provide for planting and flooding at the appropriate times of the year, investigate acquisition of the appropriate land necessary to provide hunting buffers to this designated area, determine appropriate land ingress and egress to the site, investigate the potential impact of archaeological sites within the designated area, and obtain the appropriate federal, State and local permits necessary to construct an appropriate facility. If this proposed site can be acquired and negotiations with SCDNR can be resolved during the new license application process, SCE&G will file the appropriate documentation and design details for a designated waterfowl hunting area. However, if for any reason this property is not able to be procured and converted into a waterfowl hunting area, SCE&G will continue to consult with SCDNR and USFWS to determine the best way to comply with this section of Paragraph I of the June 23, 2004 FERC Order.

This report reflects the status of the waterfowl hunting areas designation requirement identified in Paragraph I of the ORDER APPROVING LAND USE AND SHORELINE MANAGEMENT PLAN WITH MODIFICATIONS AND AMENDING EXHIBIT R issued by the Commission on June 23, 2004 and subsequent orders as listed above.

If you have any questions about this filing, please call Mr. William Argentieri at (803) 217-9162 or Mr. Tommy Boozer at (803) 217-9007.

Very truly yours,

Michael Summer

Michael C. Summer, General Manager
Fossil/Hydro Technical Services

WRA/wa

c: M. C. Summer/W. R. Argentieri/SHFile
A. I. Spell/M. C. Clonts/J. R. Stockman
T. C. Boozer
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J. H. Hamilton
Corporate Records
B. J. McManus - Jones Day
R. W. Christie – SCDNR
A. K. Hill – USFWS
D. M. Murray – FERC Washington (MC PJ 12.2)

Submission Contents

Appendix 16

Designate New Waterfowl Hunting Areas – Update – August 28, 2008

SCE&G
A SCANA COMPANY

August 28, 2008

Kimberly D. Bose
Federal Energy Regulatory Commission
ATTN: OEP/Division of Hydropower Administration and Compliance
888 First Street, N. E.
Washington, D. C. 20426

Subject: South Carolina Electric & Gas Company
Saluda Hydroelectric Project, FERC Project No. 516
Shoreline Management Plan – June 23, 2004 FERC Order
Paragraph (F) – Future Development Land Re-classification and
Paragraph (I) Waterfowl Hunting Area

Dear Secretary Bose:

South Carolina Electric & Gas Company (SCE&G), Licensee for Saluda Hydroelectric Project, FERC Project No. 516, hereby files an original and eight copies of a request for an extension of time until June 30, 2009 to comply with Paragraph F and the waterfowl hunting area section of Paragraph I of the ORDER APPROVING LAND USE AND SHORELINE MANAGEMENT PLAN WITH MODIFICATIONS AND AMENDING EXHIBIT R issued by the Federal Energy Regulatory Commission (FERC) on June 23, 2004 and ORDER CLARIFYING AND MODIFYING ORDER AND DENYING REHEARING issued on October 28, 2004. The original FERC Orders requested that the land re-classification procedure and criteria (paragraph F) be addressed in the next Land Use and Shoreline Management Plan update that will be conducted as part of the current project relicensing process and resolution of this issue should be filed as part of the new license application which will be submitted to the FERC prior to or on August 31, 2008. By letter dated May 31, 2005 the Licensee requested an extension of time until August 31, 2008 to comply with Paragraph I of the original Order (waterfowl hunting areas). The FERC issued ORDER GRANTING EXTENSION OF TIME TO FILE SUPPLIMENTS TO LAND USE AND SHORELINE MANAGEMENT PLAN dated December 15, 2005, concluding that the Licensee did not provide enough justification for the requested time extension for Paragraph I, and required compliance of this paragraph by December 31, 2006. The Licensee filed an interim report on June 1, 2006 describing the progress it is making to meet the new deadline and FERC acknowledged our progress by letter dated July 27, 2006. By letter dated December 29, 2006 the Licensee filed a report describing the progress we are making to meet this requirement and requested an extension of time until August 31, 2008 to comply with this section of Paragraph I of the original Order (waterfowl hunting area). The FERC issued ORDER

GRANTING EXTENSION OF TIME TO FILE DOCUMENTATION OF WATERFOWL HUNTING AREA DESIGNATION dated March 6, 2007 approving this extension of time request and ordered that a report be filed with the Commission on or before December 31, 2007 describing the progress the Licensee is making to meet the extended deadline. By letter dated December 10, 2007 the Licensee filed a progress report of designating a new waterfowl hunting area for the Saluda Hydroelectric Project and FERC acknowledged our progress report by letter dated January 29, 2008. Paragraphs F and I are repeated below followed by a description of our request for an extension of time for these paragraphs.

"**(F)** The licensee, after consultation with the U. S. Fish and Wildlife Service, the South Carolina Department of Natural Resources and Department of Parks, Recreation and Tourism, shall establish a procedure and criteria for future land re-classifications. The land re-classification procedure and criteria shall be incorporated into the next. Land Use and Shoreline Management Plan update to be conducted with the next project relicensing."

Compliance: Land rebalancing of the shoreline is an integral part of the shoreline management plan and associated with the new license application settlement agreement. The new license application was filed by letter dated August 27, 2008; however the settlement agreement has not been completely resolved by the new license application filing date and will continue for several months as we attempt to reach agreements on all of the issues associated the new license application.

As part of its relicensing activities SCE&G assembled a diverse group of stakeholders in the Lake and Land Management Technical Working Committee (TWC) to revise and make more comprehensive the Shoreline Management Plan (SMP), as well as perform "land use rebalancing". Rebalancing discussions ensued in the TWC on October 31, 2006, with more formalized discussions occurring on November 21, 2006. At that time, the TWC decided to undertake a two-fold approach to rebalancing by reviewing both the economic and natural resource values of the individual parcels of current SCE&G future development lands. Subsequently, members of the TWC were placed on two separate committees, economics and natural resources, to consider and score the values of the future development lands without prejudice. Each parcel of the 299 future development properties was assigned an economic "value" as well as a natural resource "value" by the two separate committees on February 26 & 27, 2007(natural resources) and April 3 & 4, 2007 (economics). These "values" or "scores" were considered in future land classification and rebalancing discussions.

The process of land use rebalancing also included consolidating and renaming the original ten land use classifications down to four: Public Recreation, Natural Areas, Project Operations, and

Multi-Purpose. The Multi-purpose classification is further composed of four sub-classifications: easement, commercial, 75-ft buffer zone, and future development.

Subsequent to the land scoring exercise preformed by the TWC subcommittees in early 2007, there were several proposals made by both SCE&G and individual stakeholder groups on the rebalancing of future development lands. This culminated in the proposal presented by SCE&G on June 10, 2008, into which SCE&G incorporated many of the recommendations made by resource agencies and stakeholders. SCE&G's June 10, 2008 presentation proposes to protect from development 9,189 acres of land and 185 miles of currently undeveloped shoreline - lands identified as providing natural resource, recreation, and scenic values. The majority of the protected acreage came from reclassifying previously designated Future Development lands to forest management, which is now included under the Public Recreation Classification. Approximately 860 acreages and 40 shoreline miles were removed from the Future Development classification (now a sub-classification under the Multi-Purpose Classification) and placed in more protective classifications. The Natural Areas classification received almost half of this acreage, increasing in size from 42 to 506 acres.

Moreover, during rebalancing the TWC emphasized preservation of large, contiguous blocks of lands to minimize land use fragmentation. Such lands included shoreline acreage on the LSR and forested lands in the upper region of Lake Murray. In the June 10, 2008 proposal, SCE&G noted that in addition to the 45.04 acres already in the Scenic River easement on the LSR, they were proposing to classify 14 tracts totaling 275.14 acres as recreation. Thus increasing the Project lands preserved along the LSR to 320.18 acres. As the Commission can tell there was a large amount of effort that went into developing a land rebalancing program acceptable to all stakeholders, however, SCE&G still has a few items that need to be resolved before this activity is finalized. The rebalancing proposal will be included with the Comprehensive Settlement Agreement for consideration and inclusion in the new license. Our plan according to our post-filing schedule is to file the Comprehensive Settlement Agreement by June 2009.

"**(I)** The licensee's proposed changes to its recreation facilities are approved and made a part of the project's Exhibit R-Recreation Plan. The proposed recreation changes shall include designation of Two Bird Cove and Hurricane Hole Cove as special recreation areas and a full description of the two additional recreation sites proposed by SCE&G as future recreation areas. The licensee shall also consult with the U.S Fish and Wildlife Service and South Carolina Department of Natural Resources and designate new waterfowl hunting areas for those lost to land sales and development, and indicate these areas in the Recreation Plan. The licensee's proposed changes shall be implemented within 1 year of issuance of this order. The licensee shall file, for Commission approval, as-built drawings of the implemented recreation facilities within

60 days of completing construction. These changes shall be indicated in the next Land Use and Shoreline Management Plan update."

Compliance: The new license application was filed by letter dated August 27, 2008; however the settlement agreement, which will include details associated with designation of a waterfowl hunting area, has not been completely resolved by the new license application filing date and will continue for several months as we attempt to reach agreements on all of the issues associated the new license application.

As noted in our previous filings and annual status reports, the plan that is being developed in consultation with SCDNR and USFWS involves creating a hydraulically-manipulated impoundment with constructed berms and installed intake structures and pumps. The goal is to be able to manipulate the water level of the proposed impoundment on a seasonal basis so vegetation can be planted and flooded to optimize foraging conditions and maintenance of waterfowl habitat. Such a development would increase the quality of waterfowl habitat in the Project Area, and is expected to lead to increased waterfowl activity as well as recreation opportunities. This particular program is still in the developmental stages and requires procurement of property at the candidate site. On March 13, 2008, June 18, 2008, July 10, 2008, and again on August 5, 2008 SCE&G met with the property owners to discuss a contract for the option to purchase the land that appears to be suitable for this activity. At this filing, there are still several items that need to be negotiated with the property owners in order to provide the appropriate waterfowl hunting habitat land that SCDNR believes they need. SCE&G is also working with SCDNR to assure the appropriate funding can be secured and still needs to negotiate details for the design, construction, and annual maintenance of the waterfowl hunting area. SCE&G continues to work out the details of this proposal and will provide detailed information in conjunction with the Comprehensive Settlement Agreement for consideration and inclusion in the new license. Should acquisition of these non-project lands not occur due to factors beyond the control of the SCE&G, SCE&G will continue to consult with SCDNR and USFWS to determine the best way to comply with the June 23, 2004 FERC Order to designate waterfowl hunting areas. Any mitigation measure will be submitted to FERC for consideration. The plan according to our post-filing schedule is to file the Comprehensive Settlement Agreement by June 2009. Attached is a letter from SCDNR dated August 26, 2008 which expresses their concurrence with this request for a time extension in order to address the issues stated above.

The above descriptions are submitted to the Commission as documentation to respectfully request an extension of time until June 30, 2009 for Paragraph F (land re-balancing) and the waterfowl hunting area designation section of Paragraph I associated with the ORDER APPROVING LAND USE AND SHORELINE MANAGEMENT PLAN WITH MODIFICATIONS AND AMENDING EXHIBIT R issued by the Commission on June 23, 2004. Granting this extension of time will allow the Licensee the ability to resolve these issues through the settlement agreement associated with the new license application which was, we believe, the original intent for requesting completion of these activities as part of the new license application filing.

If you have any questions about this filing, please call Mr. William Argentieri at (803) 217-9162 or Mr. Tommy Boozer at (803) 217-9007.

Very truly yours,

Michael Summer

Michael C. Summer, General Manager
Fossil/Hydro Technical Services

WRA/wa

Enclosure

c: M. C. Summer/W. R. Argentieri/SHFile
A. I. Spell/M. C. Clonts/J. R. Stockman
T. C. Boozer
R. R. Mahan
Corporate Records
B. J. McManus - Jones Day
R. W. Christie – SCDNR
V. Vejdani - SCDNR
A. K. Hill – USFWS
D. M. Murray – FERC Washington (MC PJ 12.2)

South Carolina Department of
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John E. Frampton
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Chief-of-Staff

August 26, 2008

Mr. William R. Argentieri
South Carolina Electric & Gas Company
111 Research Drive
Columbia, SC 29203

Dear Mr. Argentieri,

Reference is made to numerous discussions and meetings including several site visits between Department of Natural Resources (DNR) staff and representatives of South Carolina Electric and Gas Company (SCE&G) to discuss opportunities to develop waterfowl habitat off the Saluda River. These meetings and discussions have been a product of the effort to pursue mitigation for lost waterfowl habitat and waterfowl hunting opportunity on and around Lake Murray as a result of decades of development.

This correspondence is submitted to indicate support of ongoing SCE&G efforts to secure the identified tract targeted to satisfy the mitigation need. DNR is aware SCE&G has met frequently with the landowner and continues to seek an option to purchase the tract. DNR acknowledges the negotiations have been time consuming, technical and difficult. Additionally SCE&G has consulted frequently with DNR regarding recommendations and needs for consideration in the prospective purchase of land. DNR recommends you notify the Federal Energy Regulatory Commission with a request for a time extension to complete the purchase and supply a development plan. DNR fully supports the need for additional time to complete work on this issue.

DNR continues to be pleased with the cooperative and enthusiastic response demonstrated by SCE&G staff in pursuit of the stated mitigation need, and DNR looks forward to working with you and your staff in the coming weeks to finalize a project meeting resource requirements and providing replacement public use opportunities. Please do not hesitate to contact me if you have any questions regarding this transmittal.

Very truly yours,

Bob Perry

Bob Perry

c: Dick Christie
Vivianne Vejdani

Document Content(s)

Appendix 17

Final Report and Recommendations of the Saluda/Congaree Ecologically Sustainable Water Management Process

Final Report and Recommendations of the Saluda/Congaree Ecologically Sustainable Water Management Process

October 2008

A cooperative effort led by the National Park Service, American Rivers, The Nature Conservancy, the U.S. Fish and Wildlife Service, and Carolina Coastal Conservation League. This project has been jointly funded by the National Park Service's Challenge Cost Share Program and American Rivers.

INTRODUCTION

South Carolina Electric and Gas (SCE&G), the National Park Service (NPS), the U.S. Fish and Wildlife Service (FWS), American Rivers (AR), The Nature Conservancy (TNC), and others have been working together to facilitate a science-based, stakeholder-inclusive process for balancing human and ecosystem needs for water in the Saluda and Congaree rivers. Modeled after the Ecologically Sustainable Water Management (ESWM) approach pioneered by TNC's Freshwater Initiative (Richter et al. 2006), the goal of this partnership is to improve knowledge, collaboration, and communication within the context of FERC relicensing concerning the allocation of water in Lake Murray, the lower Saluda River, and the Congaree River. What follows is a description of the ESWM methodology, a proposed flow recommendation, and an adaptive management framework to ensure ongoing collaboration toward the enhancement and sustainability of the Saluda, Broad and Congaree rivers.

ESWM is a multi-step process that incorporates scientific information, professional judgment, and diverse stakeholder interests to develop one or more flow recommendations that meet the needs of as many stakeholder interests as possible. As defined by Richter et al. (2006), ESWM is intended to be an "adaptive, inter-disciplinary, science-based process for developing flow recommendations." It requires an in depth investigation of the ecological and societal needs of the river and its hydrology. This is accomplished by convening a series of facilitated workshops that merge scientific tools and information, expert judgment from scientists, and stakeholder interests to enhance the dialogue about water allocation.

In most assessments of hydroelectric project operations, decision makers are faced with balancing competing demands and uses for finite water resources. In this regard, the relicensing of Saluda Dam presents a fairly typical water allocation puzzle; providing lake levels suitable for recreation and aesthetics, providing recreational and biological flows below the dam in the lower Saluda River, while maintaining optimal flexibility for producing hydropower to meet societal demands and regulatory obligations. What sets the Saluda Dam relicensing project apart from other relicensing projects is its relationship to Congaree National Park – an internationally significant floodplain ecosystem approximately 30 miles downstream from the Saluda Dam. Potential impacts to Congaree National Park as a result of altered hydrology associated with operations of the Saluda Dam have presented the need for stakeholders and decision-makers to balance societal needs with protection and enhancement of these natural, cultural and recreational public resources as part of the Saluda Dam relicensing process.

Originally designated in 1976 as Congaree Swamp National Monument (PL 94-545), Congress authorized the NPS to preserve and protect the largest remnant tract of old growth bottomland hardwood forest in the United States. In 2003, Congress upgraded the park to full national park status making it South Carolina's first and only national park. Located along the northeastern bank of the Congaree River and including a portion of the lower Wateree River, today Congaree National Park (CNP) protects a floodplain ecosystem consisting of nearly 26,000 acres. The long-term health of this unique floodplain ecosystem is directly linked to the flow regime of the Saluda, Broad, Congaree, and Wateree rivers.

Further compounding the complexity of the Saluda Dam Relicensing is the influence of the Broad River, a relatively unregulated and prominent contributor to flows in the Congaree. The Congaree River begins approximately 17 miles upstream of CNP at the confluence of the Saluda and Broad Rivers. On average, the Broad contributes approximately 2/3 of the flows within the Congaree; however, this relationship is complicated by a variety of factors leading to an apportionment that varies seasonally and annually from this average (Plewa and Graf 2005). A key challenge in understanding and improving the dynamic nature of flows in the Congaree is to agree on a means of managing Saluda Dam in light of unregulated flow contributions of the Broad in order to achieve needed flexibility in generation, stability in lake levels, and beneficial ecological and recreational flows in the lower Saluda.

Since 1930, flows in the Congaree River have been, in part, regulated by the operation of the Saluda Dam. Water releases from the Saluda Dam are typically inconsistent with the natural hydrograph and result in altered flow conditions both within and adjacent to CNP. These altered flow conditions and their associated effects on the complex ecological communities within the CNP floodplain remain a primary concern of the NPS and other stakeholders. While the ecological implications of this altered hydrologic regime on CNP resources have only recently become the focus of extensive study, several targeted scientific studies funded by the NPS have examined this relationship in order to provide useful information during the Saluda Dam relicensing process.

The United States Geological Survey (USGS) recently completed a flood frequency analysis on the peak flows within the Broad, Saluda and Congaree rivers for various periods of the historic record including pre- and post-impoundment of Lake Murray (Conrads et al. 2007). The analysis of daily gage heights on the Congaree River indicate that the operation of the Saluda Dam has decreased high gage heights that occur in the first six months of the year (December – May) and has increased the low gage heights that occur in the last half of the year (June – November). The operation of Saluda Dam has also increased the 1-, 3-, 7-, 30-, and 90-day minimum gage heights by up to 23.9% and decreased the 1-, 3-, 7-, 30-, and 90-day maximum gage heights by up to 7.2%. Overall, the operation of the Saluda Dam has affected monthly average gage heights by up to 18%.

These data support previous evidence and observations that the CNP floodplain may be undergoing a shift in community structure. Preliminary field evidence indicates that recruitment of bald cypress (*Taxodium distichum*), the co-dominant canopy species within the park, may be profoundly inhibited as a result of artificially prolonged flooding during the growing season (B. Sharitz, pers. comm.). In other words, by increasing water heights during low flow conditions, bald cypress seedlings experience prolonged inundation at a life stage that is highly intolerant to submersion. These changes in water level are further reflected in the surficial ground-water, which may have an effect on the root zone within the CNP floodplain and the associated vegetative community structure within the park. Together, these environmental changes occurring within the Congaree floodplain represent an ongoing suite of effects with a direct nexus to the operation of Saluda Dam.

Because of the influence of Saluda Dam operations in affecting flood frequency, timing, duration at CNP, the opportunity to enhance operations in a manner that benefits CNP while achieving other water allocation goals, plus the potential for increasing stakeholder awareness of the resource sensitivity at CNP, we chose to develop and implement an ESWM-based process in conjunction with the ongoing FERC relicensing of Saluda Dam.

METHODOLOGY

In 2006, after consulting with various partners, the NPS, FWS, AR, and others (henceforth, ESWM Leadership Committee or ESWM LC) approached SCE&G with the prospect of conducting an ESWM process for the Congaree and Saluda rivers. Since that time, and broadly following the approach laid out by TNC (Figure 1), the Saluda ESWM process has successfully completed a number of essential tasks associated with developing a science-based, stakeholder-inclusive consensus regarding future operations of Saluda Dam. Due to logistical and funding constraints associated with agency budget cycles and the existence of an ongoing FERC relicensing (ESWM was not developed with FERC relicensing in mind), we deviated somewhat from the original six-step process, chiefly by initiating the process with a literature review prior to the initial orientation meeting. In addition, we began developing a spatially-explicit floodplain inundation model prior to our first stakeholder workshop. This change in order likely had no effect on the desired outcomes of the ESWM process. All products developed prior to the initial stakeholder workshop were viewed as “draft” and participants were encouraged to provide constructive comments throughout the process.

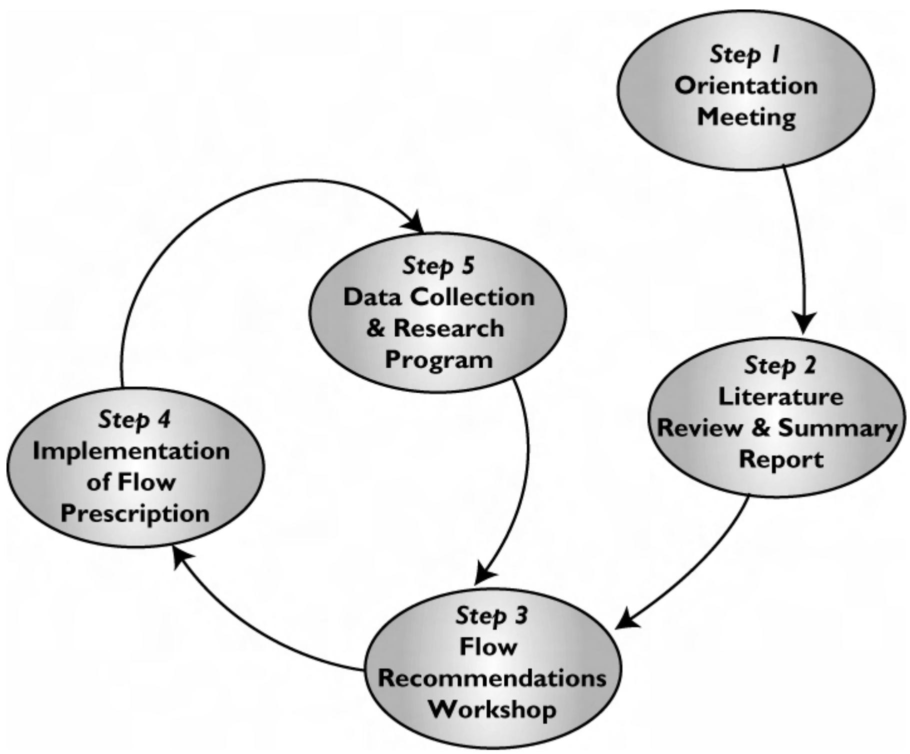

Figure 1. ESWM flow diagram from Richter et al. 2006. Steps 3–5 are repeated indefinitely to enable refinement of the flow recommendations over time.

Step 1: Basin-wide Literature Review and Floodplain Inundation Model
This step entailed the development of the basin-wide literature review and summary report that pulled together available relevant information concerning water allocation in the Saluda, Broad and Congaree rivers. Much of this information was contained in SCE&G's Initial Consultation Document (Kleinschmidt 2005). In addition, NPS contracted with the University of South Carolina to conduct an objective basin-wide literature review and develop an accompanying summary report (Graf and Stroup 2006 – see Appendix A). A floodplain inundation model was also developed as a GIS-based decision support system for modeling the effects of various river flows on floodplain inundation depths at Congaree National Park (Graf and Meitzen 2006 – see Appendix B). The flood inundation model used U.S. Army Corps of Engineers (USACE) Hydrologic Engineering Center's River Analysis System (HEC-RAS) software, a Geographic Information System (GIS), and HEC-Geo RAS GIS extension tools. Primary data sources included United States Geological Survey (USGS) stream flow data and high-resolution LiDAR data.

Step 2: Orientation Workshop
All stakeholders were invited to present their interests relating to water allocation associated with Saluda Dam, and to propose ESWM as a process for sharing information and developing a set of recommendations related to project operations. Nearly 50 participants attended the one-day orientation workshop which took place on June 26, 2007 at the University of South Carolina (USC). Participants acquired an in-depth understanding of the range of issues relating to the ESWM process, hydropower operations, river and floodplain ecology, and other stakeholder interests. There was a broad consensus that ESWM was an appropriate method for developing flow recommendations, and most participants agreed to attend future workshops in accordance with the ESWM framework. Several participants subsequently provided comments and input relating to the literature review and model development.

The group agreed on a vision for the Saluda, Broad and Congaree rivers:

"We envision an integrated river system, including Lake Murray, the Congaree National Park, the floodplain and riparian areas, that is managed with the inherent flexibility to take advantage of natural flow variation, provide ample electric power generation capacity, release flows that restore, improve and sustain ecological values, enhance aesthetic and economic values along the banks and shorelines, provide adequate clean water for withdrawals and assimilation, allow a variety of recreational opportunities such as swimming, boating, fishing, wildlife viewing and hiking, so that all these resource values will be enhanced and able to be continually improved as knowledge is gained and technologies are developed during our and future generations."

Step 3: Development of Indicator Species and Refinement of Model
Following the Orientation Workshop, with the assistance of USC, work was undertaken to refine the floodplain inundation model and develop a database of life history attributes for a suite of

flow sensitive indicator species (Appendix C). Flow sensitive indicator species were selected based on three main criteria:

(1) The species exists in the Congaree River corridor
(2) The species is affected by flow/floodplain inundation and/or temperature patterns
(3) Scientific information and/or reliable expert information exists for the species and the ecological relationship(s) of interest.

Step 4: Technical Workshop

The Technical Workshop took place on January 28-29, 2008 at USC. Based on consensus and additional information gained during steps 1, 2 and 3, a somewhat smaller group consisting of subject matter experts from various fields was assembled for this 2-day workshop to begin evaluating species life history information in the context of existing and potential future project operations. After an introduction to the status of existing information, workshop participants were divided into three facilitated groups based on expertise and interest. Group 1 focused on in-channel species; group 2 focused on aquatic species that inhabit or rely upon the floodplain; and group 3 focused on terrestrial species that inhabit or rely upon the floodplain. The groups were tasked to use existing information and expert judgment to identify important hydrological characteristics and/or develop flow recommendations for receptor species within their area of the river corridor.

The meeting outcomes included identification of key environmental constraints of particular indicator species with respect to Congaree flows. Examples of species information identified include the sensitivity of striped bass spawning behavior to slight changes in water temperature, and the sensitivity of bald cypress seedlings to floodplain inundation, the importance of inter- and intra-annual variability for overall community structure, and the relationship between river flows and habitat connectivity within the floodplain.

Following the initial Technical Workshop, the ESWM LC met to consolidate the information gained and the data gaps identified at the January meeting. The result of this meeting was the development of a conceptual diagram depicting critical flow and temperature thresholds for a variety of indicator species (Figure 2).

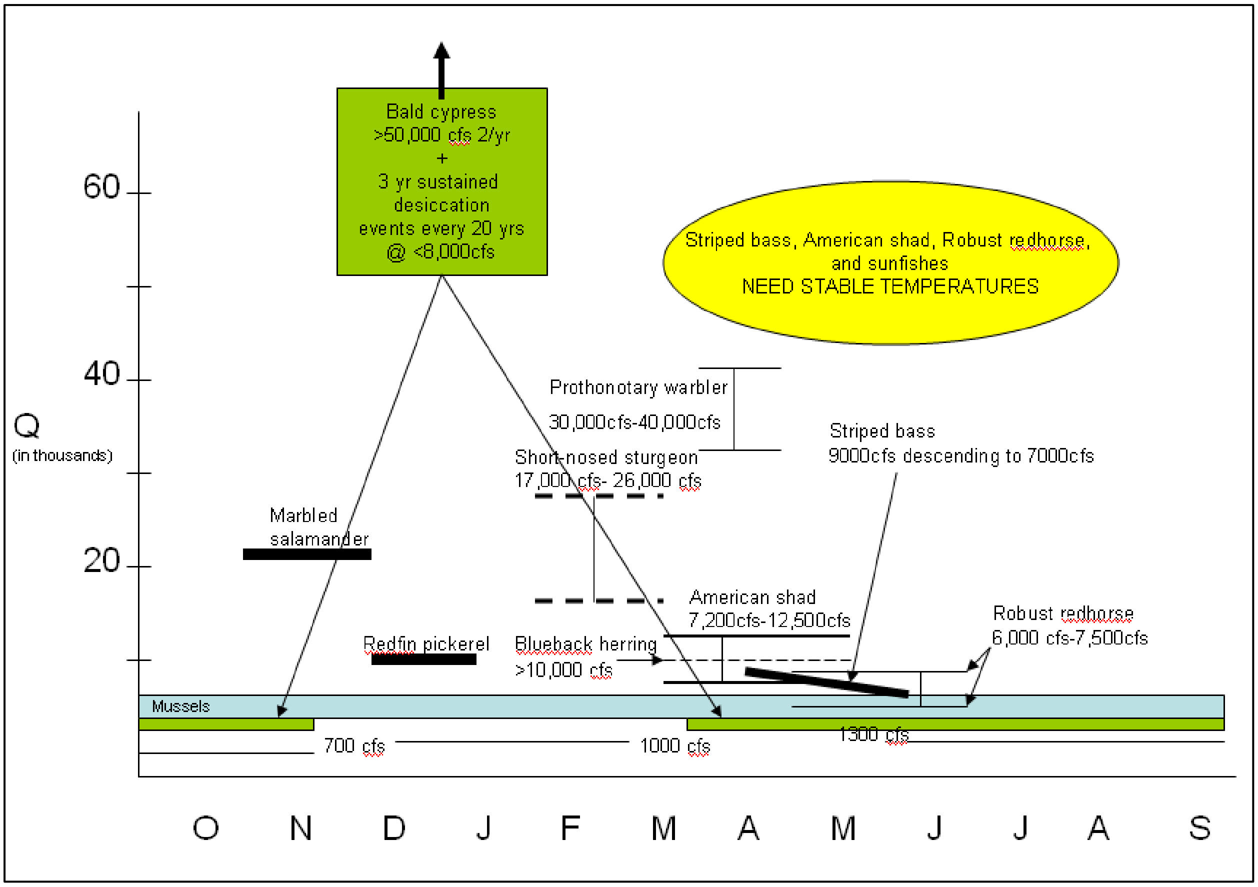

Figure 2. Conceptual diagram depicting flow and temperature thresholds for a variety of indicator species in the Congaree River basin.

Step 5: Flow Recommendation Workshops

The initial Flow Recommendation Workshop reconvened all stakeholders for a 1-day meeting at Saluda Shoals State Park on April 21, 2008. The focus of this meeting was to update stakeholders on progress made during the Technical Workshop with respect to key indicator species, and to begin a dialogue related to a Naturalized Flow Scenario (described below). While there was general consensus that a Naturalized Flow Scenario holds promise for sustaining and enhancing ecological resources, it was clear that further refinement of the scenario, analysis of its implications to lake levels, recreational flows, and reserve generating capacity is needed. Additional workshops will likely be needed as the group strives to agree on a flow scenario that meets the needs of all stakeholders. Integrating the ESWM Process with FERC relicensing is a key component of this step that will ultimately result in the development of a settlement agreement and, to the extent necessary and feasible, specific license articles.

Step 6: Monitoring, Research, and Feedback

Monitoring and additional research are key elements of the ESWM approach and in general will take place after a new license is issued. Despite the best research, expert judgment, and collaborative negotiations, ecological uncertainties will continue to exist with respect to ecological flows and the indicator species they target. In order to be effective, adaptive management must offer a balance between the flexibility that is necessary to achieve optimal ecological function within the river ecosystem and the certainty required by SCE&G and other stakeholders in ensuring ample water resources for human needs. An adaptive management framework is described the subsequent section.

GOALS RESULTING FROM THE ESWM PROCESS

The ESWM Process successfully produced a number of desirable and specific flow goals that meet or enhance the downstream needs of the Congaree River as it relates to the set of receptor species. These include operations to:

- Enhance high, medium and low levels of floodplain inundation and connectivity between the Congaree River and the creeks, guts, sloughs, and oxbows that provide habitat for many species;

- Stabilize water temperature in the Congaree River during spawning periods for striped bass and robust redhorse;

- Enhance Congaree River flows for spawning shortnose sturgeon, American shad, blueback herring, striped bass, sunfish and robust redhorse;

- Enhance breeding success for Prothonotary warbler and Marbled salamander;

- Enhance different levels of flooding in some years and refrain from inducing flooding in dry periods in some years to produce the variability needed for the bald cypress;

- Provide flows with inter- and intra-annual variability to mimic the inherent natural environmental variability that benefits different species in different years that sustains diverse biological assemblages.

We recognize that developing operational rules to meet all of these downstream flow needs, combined with goals associated with reservoir levels and recreational flows, would be extremely complex. Furthermore, trying to assure that Saluda operations coincide with specific flow events on the Broad River in real time would be difficult if not impossible. Therefore, to simplify, we suggest the following operation scenario to meet many of the downstream ecological needs while simultaneously creating a balance with other water allocation desires. We call this the ***naturalized flow scenario***.

FLOW RECOMMENDATIONS

The following describes our recommendations in the context of the naturalized flow scenario:

(1) Naturalized Flow Period: Provide 30 days of naturalized flows annually where SCE&G will operate Saluda Dam to release downstream flows continuously with limited variability based on average inflow into Lake Murray from the previous day. This period would generally be from

April 1 to April 30, but could start as early as March 21 and end as late as May 10 depending on climatic conditions and management goals.

Two of every 5 years provide an additional two-week flow naturalization period alternating between an early period (March 1 to March 15) and a late period (May 15 and May 31). The rationale is to produce naturalized flow conditions with intra- and inter-annual variability targeting spring spawning events for aquatic indicator species identified during the ESWM Process. The primary purpose of these periods is to increase flow variability for the full suite of ecological functions. Priorities for the early period are shortnose sturgeon and American shad spawning, and increased early season floodplain inundation. For the later period, priorities are temperature and flow stabilization for robust redhorse, sunfish and other late season spawners.

(2) Limitations to Naturalized Flows: The naturalized flow scenario would be in effect for Congaree River flows up to 30,000 cfs. The rationale for this upper limit is that higher discharge events (i.e., flood events in which the river banks CNP are over topped resulting in near complete flooding of the park's floodplain) are dominated by Broad River flows making Saluda flows of less importance during these events. This assumption corresponds to the conclusions of Conrads et al. (2007) and the ESWM floodplain inundation model (Graf and Meitzen 2006).

(3) Limitation on Temperature Fluctuations: During the naturalized flow period defined in Section 1, Saluda Dam would be operated so that temperatures in the Congaree River, in the vicinity of I-77, do not vary more than 1 degree Celsius from ambient temperatures (as represented by the Broad River). Temperature fluctuations greater than this can result in the failure of spawning events.

We recognize that an adaptive management process will be needed to understand the limits on Saluda Dam operations to meet this objective. A real time temperature gage would also need to be established and maintained in the I-77 vicinity.

We recognize that SCE&G values the use of Saluda Dam for reserve operations and agree that one reserve operation call resulting in greater than +\- 1 degree C change could be permitted during each 30-day naturalized flow period.

(4) Compatibility with Saluda River Flows: Releases from Saluda Dam during the naturalized flow period would never be less than the minimum flows recommended by the Saluda instream flow study (700 cfs March, 1000 cfs April 1-14, and 1,300 cfs April 15-May 15) unless under low inflow protocol (LIP) operations. (LIP operations are not yet agreed to but SCE&G has proposed reducing downstream flows in a step wise manner to as low as 400 cfs depending on the severity of the drought and lake levels.) Additionally, adjustments to operations during the flow naturalization period needed to support recreation flows for the Saluda River, as currently planned, is fully supported.

(5) Low Inflow Periods: Operate Saluda Dam during low inflow periods to maintain low flows in the Saluda River during the growing season – April 1 through October 15 – in order to perpetuate the positive effects of low flow periods for the Congaree ecosystem (e.g., bald cypress recruitment). We find the general concepts of the Low Inflow Protocol, as currently being discussed in the Instream Flow Technical Working Committee, to be consistent with our recommendations.

(6) **Lake Levels:** Limit Lake Murray drawdown to 354 ft and refill the reservoir to full pool (358 ft) by March 1 during normal operating conditions (non-LIP periods). More extreme drawdowns and later full pool targets would lessen the likelihood of meeting downstream flow targets and naturalized flow period goals.

(7) **Scheduling Naturalized Flow Periods:** The exact timing of the naturalized flow periods will be agreed to by an Adaptive Management Team (AMT) consisting of SCE&G, state and federal agencies and other relicensing stakeholders with relevant experience and interests. The AMT would meet twice annually, once in October to evaluate the effects of the previous year's naturalized flow period, and once in February to set the dates for the upcoming year. This would allow for real-time adaptation of flowing timing related to biological and climatic factors. In addition, the AMT may elect to meet as necessary to adjust to extreme, unforeseen weather events.

Adaptive Management Framework

The complexity and inherent uncertainty associated with our knowledge of nature means that any effort to actively "manage" natural systems is unlikely to result in outcomes that accomplish our preconceived notions of an optimized natural ecosystem. Further complicating this endeavor is the fact that most natural systems are already highly altered by the competing demands of society. This is indeed the case when it comes to decisions about the allocation of water within the Saluda, Broad, and Congaree rivers. The Naturalized Flow Scenario proposed within this document represents an initial attempt to optimize nature in the face of competing uses for water resources. Creating a balance between and among competing uses can best be accomplished through an iterative approach.

Adaptive management is an iterative approach to deal with complexity and uncertainty pertaining to the management of natural resources and other complex systems. To be successful, open dialogue, collaboration, long-term stakeholder engagement, monitoring, and maximum flexibility in decision-making are essential elements. The realities associated with the hydropower industry and FERC regulations require that constraints be placed on adaptive management such that legal and regulatory obligations of the power company and other stakeholders (e.g., the National Park Service) can be achieved. To accomplish this, an adaptive management framework needs to be developed that includes provisions identifying (1) metrics, (2) a monitoring plan, and (3) decision thresholds. In addition, adaptive management also requires a funding source and the establishment of a management body or council.

1. **Metrics.** Metrics are those parameters within the natural system (or developed system) that require measurement and serve as indicators of the effectiveness of management actions. Examples for the Saluda/Congaree system might include abundance of various age classes of striped bass within the Congaree River, recruitment of bald cypress saplings at CNP, etc.

2. **Monitoring Plan.** A monitoring plan identifies the timing, frequency, sampling methods, etc associated with various metrics. Continuing the example from above, a monitoring plan for the Saluda/Congaree system would identify precisely how and when striped bass populations and bald cypress stands would be measured.

3. **Decision Thresholds.** Decision thresholds are those pre-identified, generally quantitative, values for a particular metric that elicit a switch to a pre-identified alternative operational or monitoring approach. Examples for the Saluda/Congaree include a low level of reproductive success for striped bass over a three year period.

In order to be successful, all of these elements should be developed, implemented, and if necessary changed by an adaptive management council consisting of experts and interested stakeholders that meets on a regular and recurrent basis (e.g., twice annually). Adaptive management also requires ample funding to coordinate the council and implement the monitoring plan. Within the context of ESWM and the Saluda Relicensing Project, an adaptive management approach can be established via an Agreement In Principle, the details of which can be determined at later date after ample consideration and discussion among stakeholders.

SUMMARY

Thus far, the ESWM framework has proven to be an effective means of developing broad-based consensus relying on scientific analysis, expert judgment, and good-faith negotiations. ESWM has succeeded in focusing attention on the ecological needs of the Congaree River and Congaree National Park as they relate to the operations of Saluda Dam while generally diffusing much of the bureaucracy and adversarial nature that can accompany the FERC relicensing process. Through this process we have developed a set of flow recommendations for improving ecological processes and functions within the Congaree River while striving for balance among the various other uses associated with Saluda Dam operations. Specifically, our recommendations seek this balance by proposing a naturalized flow scenario allowing for continuous downstream flows for a set period each spring that approximate natural inflows. In addition, our recommendations are explicitly designed to stress the importance of intra- and inter-annual variability in order to meet broad-based ecological needs of the Congaree River ecosystem. We specifically propose the establishment of an Adaptive Management Team to continually monitor, evaluate, and recommend periodic adjustments to flow management procedures. The true test of whether the Saluda/Congaree ESWM Process will be effective in achieving its goals will require continued dialogue between and among all stakeholders as we move from the analysis of ecological indicators toward a testable set of consensus-based operational protocols.

LITERATURE CITED

Conrads, P.A., T.D. Feaster, and E.A. Roehl, Jr. 2007. Separating anthropogenic influences on hydrology using data mining techniques: A case study of the Congaree National Park, South

Carolina. Water Environment Federation Technical Exhibition Conference 2007, San Diego, California, October 2007

Graf, W.L. and K.M. Meitzen. 2006. Congaree Floodplain Decision Support Project: Assessing the extent of river regulation effects on resources with and around Congaree National Park – Part II: Floodplain Inundation Modeling Using HEC-RAS and GIS. A Report to NPS. 23 pp.

Graf, W.L. and L.J. Stroup. 2006. Congaree Floodplain Decision Support Project: Assessing the extent of river regulation effects on resources with and around Congaree National Park – Part 1: Literature Review. A Report for the National Park Service. June 2006. 47 pp.

Kleinschmidt. 2005. Initial Consultation Document. Saluda Hydroelectric Project Relicensing – FERC No. 516. April 2005. Prepared for South Carolina Electric & Gas. 364 pp.

Plewa T.T. and W.L. Graf. 2005. Hydrologic variation of the Congaree River near Congaree National Park, South Carolina. A report for the National Park Service. 25 pp.

Public Law 94-545. 1976. As enacted, the bill (H.R. 11891), approved October 18, 1976, is Public Law 94-545 (90 Stat. 2517) of the 94th Congress.

Ritcher, B.D., A.T. Warner, J.L. Meyer, and K. Lutz. 2006. A collaborative and adaptive process for developing environmental flow recommendations. *River Res. Applic*. 22:297-318.

APPENDIX A:

Literature Review for Saluda, Broad and Congaree Rivers

CONGAREE FLOODPLAIN DECISION SUPPORT PROJECT: ASSESSING THE EXTENT OF RIVER REGULATION EFFECTS ON RESOURCES WITHIN AND AROUND CONGAREE NATIONAL PARK
PART 1: LITERATURE REVIEW

Congaree River, South Carolina (W.L. Graf, 2005)

A Report for the National Park Service
Piedmont – South Atlantic Cooperative Ecosystems Studies Unit
Contract No. H5000030930, Order No. J5240050013
Requisition Reference No. R5240050013

by

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June 10, 2006

ABSTRACT

The content of this report, a literature review relevant to the resources of the Saluda, Broad and Congaree Rivers, was compiled from September 2005 to May 2006. This project was undertaken to better inform the National Park Service at Congaree National Park about natural and cultural features of the area for the Federal FERC relicensing of Saluda Dam. This report contains citations and accompanying annotations of sources related to the physical, chemical, biological, and socio-economic aspects of the three river basins. Congaree National Park Library resources compose the first section of this report. Materials cited include newspaper articles, reports, published papers, internet links, and books. The second section contains newspaper articles, reports, published papers, internet links, and books obtainable online, and resources from the University of South Carolina Libraries, SC DHEC, SC DNR, and USC Geography Department resources. The lack of literature on the Broad River is evident, and is an important finding, as Congaree National Park receives 2/3s of it water from the Broad River Basin. Additionally, more information and reports are likely to be created through the Federal relicensing process, and it is hoped this report will form the basis of future literature compilation regarding the three rivers and their relationship with Congaree National Park.

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INTRODUCTION

This report satisfies Object 1 of the Congaree Floodplain Decision Support Project: the compilation of an extensive and comprehensive annotated literature review which identifies the physical, biological, chemical and socio-economic characteristics of rivers influencing Congaree National Park. The comprehensive information enclosed includes the Broad, Saluda, and Congaree Rivers.

This project consists of the following sections: 1) citations and annotations regarding newspaper articles, reports, published papers, internet links, and books compiled and obtainable from the Congaree National Park Library; and 2) resources compiled from newspaper articles, reports, published papers, internet links, and books obtainable online, and resources from the University of South Carolina Libraries, SC DHEC, SC DNR, internet and USC Geography Department resources.

Congaree National Park Library Resources
Relevant to The Congaree Floodplain Decision Support Project
Compiled Dec. 7, 2005-January 23, 2005

General/Compilations

National Park Service, U.S. Department of the Interior. 1996. Water Resources Management Plan, Congaree Swamp National Monument. May 1996.

This plan provides information regarding impacts to water resources in the Monument and addresses the most pressing water resources issues. The report recommends improving the understanding of fluvial processes and hydrodynamics of the Congaree floodplain, assessing the degree of surface and groundwater contamination, detecting the effects of changing discharge on aquatic resources, participating in corridor planning, tracking land use within the watershed, and ensuring the safety and enjoyment of visitors while augmenting public awareness through education.

SC DHEC. 1998. Initial Unified Watershed Assessment Saluda Basin. Received November 1, 1999.

The Saluda River Basin was named a FY 1999-2000 SC watershed restoration priority. This report outlines the unified watershed assessment to sustain water quality and aquatic resources developed by representatives of SC DHEC and NRCS.

State of South Carolina, Water Resources Commission. n.d. South Carolina Drought. General Informational Brochure.

The Water Resources Commission has prepared a basic informational brochure relating to the climatic factors, drought management areas, and mitigation and conservation activities surrounding drought in the state of South Carolina.

State of South Carolina, Water Resources Commission, Amy Rudell. 1984. Congaree River: A Preliminary Management Survey. South Carolina State Scenic Rivers Program, SCWRC Admin. Report No. 143. September 1984.

As a cooperative effort between the National Park Service and the SCWRC in the summer of 1982, field investigations were conducted to document the environmental, historical, and geologic significance of the Congaree River to support a 1976 declaration that 37 miles of the river were eligible for protection under the State Scenic Rivers Program. This report contains general information regarding socio-economic, ecological, administrative, cultural, and hydrologic features of the area.

The Strom Thurmond Institute at Clemson University. 1985. The Situation and Outlook for Water Resource Use in South Carolina 1985-2000. South Carolina Water Resources Commission, First Year Executive Summary. November 1985.

This report was compiled in order to better anticipate water needs in the state, regarding water resources, approaching the next century. The report specifically focuses upon industrial water demand, the financial condition of water supply systems, rate structures, and several policy-related questions.

The U.S. Dept. of the Interior, USGS. 2001. Water Resources Data South Carolina Water Year 2001. Water Data Report SC-01-1, pp.113-336.

This report provides water-year information for 2001 regarding gage water quantity and/or quality characteristics. The Santee River watershed information is within the page numbers listed in the cite. A good general source for gage and water quality data for the Santee Basin for a recent water year.

FERC Relicensing

American Rivers. n.d. The Rivers and Streams of South Carolina. Meeting Handout(?)

This document outlines the importance of South Carolina's rivers in terms of the global diversity of freshwater aquatic life as well as mounting threats to their future survival. American River contends that the designation of South Carolina waterways as Wild and Scenic Rivers, as well as altering hydropower dam operations to balance environmental and economic interests, are two critical factors in their approach.

Day, J. 2003. Letter to M.R. Salas, Secretary of FERC, regarding SCE&G Project No. 516. June 19, 2003.

This letter is in regards to a letter filed with FERC on April 9, 2003 by the U.S. FWS citing concern over whether SCE&G was compliant with their FERC license during the time of drawdown of Lake Murray during construction activities on the Saluda Dam. The SCE&G believes they were in compliance, and attaches data in Appendix A of this letter from their lawyers to prove their case.

FERC, Office of Hydropower Licensing. 2002. Scoping Document 1: Saluda Dam Seismic Remediation Project South Carolina, FERC Project No. 516. May 2002.

FERC enlisted the input of the NPS regarding the appropriate level of environmental analysis needed for the Saluda Dam Remediation Project. The Scoping Document provides background information on the project to enlist agency expertise regarding environmental impacts of the dam retrofitting.

FERC. 2002. Draft Environmental Assessment: Saluda Dam Seismic Remediation, FERC Project No. 516. June 28, 2002.

The Environmental Assessment is intended to identify and quantify the effects of the construction of the backup Saluda Dam, and associated drawdown, will have on the environment, economy of the region, and local landowners. FERC asserts the construction of the backup dam must be completed without delay due to earthquake risk and that temporary adverse impacts of the project should not translate to long-term changes.

FERC. 2003. Order Extending Term of License, SCE&G. Project No. 516-374. November 18, 2003.

This order gives SCE&G permission to extend the license termination date for the Saluda Project No. 516 in order to give the company time to conduct studies after lake Murray has been filled and the environment is returned to baseline conditions. The termination date of the license was extended three years from August 31, 2007 to August 31, 2010, with August 31, 2008 the deadline for filing the relicensing application.

Fretwell, S. 2002. Dams up for license renewal: Public gets rare chance to improve conditions as part of relicensing process. *The State*. A1, A5. November 25, 2002.

This article highlights the issues, interests, and processes involved in the FERC relicensing of South Carolina's 21 eligible dams. Since FERC licenses are applicable for 30-50 years, the several-years-long relicensing process offers an opportunity for stakeholders to assert their views regarding the future operation and management of South Carolina's hydroelectric dams. The piece includes a map of the relevant dams up for relicensing.

Hydropower Reform Coalition. n.d. Ten Reasons Why Dams Damage Rivers. Meeting Handout(?)

The top ten reasons dams have negative effects on the environment are outlined, followed by short explanations.

The Hydropower Reform Coalition. n.d. FERC's Alternate Relicensing Process made Simple. PowerPoint Presentation from Workshop(?)

This printout of a PowerPoint presentation addresses comparisons of the traditional versus alternative relicensing process as well as the background needed to make informed decisions regarding the process.

Long, J.M. 2003. The Links among Hydropower, Flooding, and Aquatic Communities in Congaree Swamp National Monument, South Carolina. Division of Science and Natural Resource Management, Southeast Region, Natural Resource Challenge Newsletter. No. 3 (May 2003).

This short piece examines the effects of Saluda Dam operation on Congaree Swamp National Monument. The author notes the opportunities occurring to examine the linkages between river flow and aquatic communities in the Park due to the 2003 dam retrofitting and the 2007 expiration of the Saluda Dam FERC operating license.

National Park Service, 2005? Congaree National Park, South Carolina: New Hydro License could Enhance Congaree National Park Floodplan Ecosystem. Accessed: http://www.nps.gov/ncrc/programs/hydro/examples/sc.pdf

This online report provides background information about both the Park and the Saluda Dam-related FERC process. The report then explains the Hydropower Assistance Program, support provided through the NPS, available to the Park to help negotiate operating standards of the Dam consistent with Park conservation. To date, the Program has assisted the Park in obtaining $50,000 to research impacts of Dam operation on the Park and to help develop flow prescriptions which are science- and stakeholder-based.

Lake Murray and the Saluda Dam

Congaree National Monument. 1994. Lake Murray Dam Failure Emergency Response Plan. September 1994.

This packet of papers, in the administrative flies of the Park Library, recounts the plan to provide early warning and evacuation for employees and visitors to the Park in case of Saluda Dam failure. Funding requests for warning devices, and a map denoting their location, is included in the papers.

Flach, T. 2002. Deal to Alter Saluda's Flow: Water quality standards set for river during Lake Murray drawdown. *The State*. Metro Section, B1, B5. August 8, 2002.

Environmental groups, SCE&G representatives, and state officials agreed upon water quality standards during the drawdown of Lake Murray for the dam construction, starting September 15, 2002. River levels will fluctuate less and the river will operate closer to run-of-river conditions during the two-year planned drawdown. Congaree officials are uncertain the plan will be beneficial as it allows SCE&G to fall short of water quality of standards sometimes without a penalty and water flows affecting habitat will be altered.

Flach, T. 2003. Construction Begins on the New Lake Murray Dam: Past quakes spur new lake dam. *The State*. Metro Section, B1, B5. February 16, 2003.

Flach examines the seismic environment of Lake Murray and the Saluda Dam compared to a smaller but similar dam in California which failed due to an earthquake. FERC officials have mandated SCE&G construct a backup dam for the current Saluda Dam in order to protect downstream residents in the unlikely, but deadly, event of an earthquake. The article features a cross-section and schematic of the dam.

Flach, T. 2003. SCE&G may act to protect fish: Utility considers putting more oxygen in Saluda River. *The State*. Metro Section, B1. July 31, 2003.

SCE&G representatives may investigate a plan to inject more oxygen into the water through the installation of upgraded turbines in the Saluda Dam. State DHEC officials are uncertain as to how well this plan will protect fish by preventing fish kills, but SCE&G will have to comply with new state water quality standards when passed.

Flach, T. 2003. Environmentalists challenge Lake Murray Dam: Its way of handling hydropower called threat to Saluda River water, fish. The State. Metro Section, B1, B6. September 7, 2003.

Two environmental groups, American Rivers and the South Carolina Coastal Conservation League have filed a complaint with FERC. The groups, as well as an alliance of Midlands environmentalists, want more restrictions placed upon SCE&G's Saluda Dam operation to lessen the threat of decreased water quality to fish and wildlife downstream. Specifically DO and sediment are of concern. Lake Murray homeowners have watched the conflict with interest as they believe changes in operating procedures could also give them the benefit of better lake level conditions.

Flach, T. 2003. Backup dam slowed by rain, relics. The State. Metro Section, B1, B5. September 17, 2003.

A slowdown in construction due to weather and the discovery of items dating to the dam's construction has drawn criticism from Lake Murray residents. Crews are speeding up construction, but FERC officials will not allow lake levels to increase, due to the amount of pressure on the dam, until the new retrofit is attached to the existing dam and is no longer at risk of failure.

Flach, T. 2004. The New Lake Murray Dam: Project's first year full of surprises and 'scares.' *The State*. Metro Section, B1, B8. February 22, 2004.

Flach recounts the construction and structural problems encountered while retrofitting the Saluda Dam. The newspaper article includes a good summary of events occurring since construction began February 25, 2003 as well as useful schematics, pictures, and maps to better understand the project.

Holleman, J. 2002. 'The only whitewater we've got': Lake Murray drawdown stirs expectations for Saluda River recreation. *The State*. Get Out! And Stay Out! Section, E17. September 6, 2002.

The typical operation of the Lake Murray Dam causes the Saluda River below it to be suitable for calm-water canoeing. However, canoe and kayak trip guides as well as whitewater rafters had hoped the need to draw down the Lake Murray for the retrofitting would lead high releases initiating more exciting whitewater. However, the drawdown has proven unpredictable and not as exciting to whitewater interests as initially anticipated.

Robertson, P. 2004. Rising Hope. *South Carolina Wildlife*. May-June 2004, pp. 4-11.

Robertson relates that the drawdown of Lake Murray, though inconvenient for lakeside homeowners, dangerous for boaters, and bad for the local economy, has a positive impact in relation to fish and wildlife. Many fisherman and ecologists cited the drawdown as having a positive impact upon sport fisheries.

SCANA Corporation. 2001. SCANA in the Community - Lake Murray Backup Dam Project, About the Project and Frequently Asked Questions.

These two printouts from the internet provide pertinent background information regarding the construction of the backup dam provided by SCANA.

South Carolina Electric and Gas Company, Columbia, SC. 1997. Initial Stage Consultation Document. Columbia Hydroelectric Project FERC Project No. 1895. March 1997.

This document presents background information regarding the site and the project, and proposed future operation. The FERC relicensing process consists of three phases of which this document is the first. It was forwarded to interested agencies for review and comment to begin the relicensing process according to FERC regulations. SCE&G anticipated working closely with all interested agencies throughout each stage of the relicensing process. The most recent license expired June 30, 2000. A map of the project is enclosed.

Congaree River/Floodplain, National Park/Monument

Assessment of Flood Prediction Capabilities Workshop. 1999. Assessment of Flood Prediction Capabilities, Congaree Swamp National Monument. Workshop findings and papers. January 19, 1999.

These materials outline the outline of the meeting as well as the phases of the Flood Prediction Support System for Congaree Swamp National Monument. An abstract of a Master’s Thesis from Clemson University highlights the floodplain modeling methodology.

Federal Emergency Management Agency (FEMA). 2000. Appeal Resolution for Congaree River in Richland and Lexington Counties, South Carolina. September 26, 2000.

Due to the great amount of feedback regarding the revised flood study of the Congaree River, FEMA performed additional analyses and developed a new HEC-2 hydraulic model of the Congaree River to resolve appeals. Specifically, the appeals of Dr. John Grego, University if South Carolina, Dr. Paul Sandifer, SC DNR, and Ms. Deborah A. Hottel, McNair Law Firm, were listed as the appellants under Part 67 of the NFIP regulations. These three parties provided detailed technical analyses of the Congaree Floodplain, including alternative BFEs, floodway delineations, period of flood record used, and roughness coefficients of the HEC-2 model used by FERC.

Hayes, J.C, D.E. Linvill, H. Merdun, I. Strassman, and B. Morse. 2000. A Flood Prediction Decision Support System for Congaree Swamp National Monument, Final Project Report for the United States Department of Interior, National Park Service. January 31, 2000. (Disk in Library File).

The study utilized two routing models to examine the flood stage of the Congaree River based upon the USGS gage at Columbia. Further work examined flood levels at various interior points of the Monument based upon a statistical analysis of crest gage data.

Hurley, N.M. 1992. Inundation Characteristics of the Congaree Swamp National Monument, Near Gadsden, South Carolina. Project Proposal SC94e. U.S. Geological Survey, Water Resources Division, Columbia, SC. July 1992. (Disk in Library File).

This project's objectives were to predict the recurrence, severity, and duration of flooding inundation of the Monument and to assist the NPS in developing an early warning system for evacuation of visitors prior to flooding.

Maluk, T.L. and T. A. Abrahamsen. 1999. Results of water-quality sampling and ecological characterization of streams of Congaree Swamp, South Carolina, 1995-1998 prepared as part of the National Water-Quality Assessment Program. Columbia, S.C. : U.S. Dept. of the Interior, U.S. Geological Survey ; Denver, Colo. : Branch of Information Services [distributor], 1999. Available at the Congaree N.P. Library.

This report constitutes the NAWQA Program ecological assessment of streams and the Congaree River within Congaree Swamp between 1995-1998. Water quality samples were collected at one site for the Congaree River and on Myers Creek. Samples were selected at two sites on Cedar Creek and Toms Creek. Samples were analyzed for pesticides, ions, nutrients, and suspended sediments.

Morse, B.C., J.C. Hayes, D.E. Linvill. 1999. Simulation of Flows in the Congaree River. Interim Report Submitted to the National Park Service. Department of Agricultural and Biological Engineering, Clemson University. March 1999.

The goal of this project was to investigate the USGS Diffusion Analogy Model (DAFLOW) as a method for routing flows from the USGS gage at Columbia to the

USGS gage on the Congaree River west of Wise Lake near Gadsden. The accuracy and timing of flood peaks was of interest so that Park rangers can warn visitors of flooding events. Another goal of this project was to evaluate the sensitivity of the model to various input parameters.

Merdum, H., J.C. Hayes, and D.E. Linvill. 1996. Statistical Analysis of River Flows into Congaree Swamp National Monument. Department of Agricultural and Biological Engineering, Clemson University. October 1996.

The objectives for developing a floodplain decision support system for Congaree are to first study and document flood events and obtain swamp hydropatterns through utilizing streamflow data from upstream gages and to second determine lag times between upstream rivers and the Congaree River, and to third predict the recurrence, severity, and duration of flooding at the Congaree Swamp.

Patrick Center for Environmental Research, The Academy of Natural Sciences of Philadelphia. 1998. Aquatic Field Studies in the Congaree River near Columbia, South Carolina, 1997. Report No. 98-4F, Submitted to Carolina Eastman Division, Eastman Chemical Company. April 30, 1998.

No impacts of the expansion of the Eastman Chemical Company were found during two prior Academy of Natural Sciences biological studies of the Congaree River in 1974 and then in 1979. This biological study is meant to supplement and update the earlier surveys to assess the overall health of the river, determine if effluent from the Company is affecting the River, and to determine whether significant changes to the biota have occurred since the last 1979 study. This report found that the Company is not impacting the biota in the Congaree River, but that the main stressors affecting the study area are upstream and include nutrient enrichment, a high sediment load, and markedly-fluctuating river levels. The researchers did not note a deterioration of biological communities in the study area compared to 1979 levels.

Plewa, T.M. and W.L. Graf. 2005. Hydrologic Variation of the Congaree River near Congaree National Park, South Carolina. A Report for the National Park Service. Department of Geography, University of South Carolina. January 29, 2005.

This report explores the relationships between the flows of the Broad, Saluda, and Congaree Rivers near Congaree National Park and upstream dams by investigating stream gage data. The relative flow of the rivers in terms of volume contribution to the Congaree, and dam operation affecting streamflow, is discussed.

Strassmann, I. 1997. Modeling of Surface Flows into Congaree Swamp. Clemson University Diploma Paper, Department of Agricultural and Biological Engineering. February 1997.

This report is part of the larger Flood Prediction System Project for the Congaree Swamp National Monument. This particular study focuses upon the modeling of surface water flows, specifically how Cedar Creek reacts to flooding events. A second focus of this study is to understand flood waves travel from a stream gage upstream of the Monument, to the Park, and determine the cause of the variation in these lag times.

Fish Communities and Aquatic Species

Bulak, J.S., N.M. Hurley, Jr., and J.S. Crane. 1993. Production, Mortality, and Transport of Striped Bass Eggs in Congaree and Wateree Rivers, South Carolina. *American Fisheries Society Symposium* 14: 29-37.

From 1988 to 1990, the annual amount and mortality of striped bass eggs were investigated in the Congaree and Wateree Rivers. A striped bass egg transport model was developed in order to determine the link between biological events and physical processes.

Crawford, C.R., J.C. Davis, C.B. Hall, J. McCarthy, E. Robey, and E. Winn. 1990. Congaree Swamp: Larval Fish Study. Marine Science Program, University of South Carolina. December 6, 1990.

The purpose of this study was to assess the degree of utilization of the Congaree's floodplain by larval fish species. The unique hydrologic and intermittent, but frequent, flooding regime of the Park may be used by fish particularly adapted to this type of flooding event. Traps set throughout the floodplain were used to survey species diversity and abundance. Seasonal issues and fish trap difficulties impeded the conclusions of this study.

May, T., W. Brumbaugh, M. Walther, and B. Poulton. U.S. Department of the Interior, USGS and L. Rose, SC DHEC. 2005. Concentrations of Total Mercury in Sediment, Invertebrates, and Fish from the Congaree National Park, SC. Final Report CERC-8335-FY05-32-11. July 18, 2005.

In the summer of 2003, SCDNR employees collected sediment, fish, and invertebrate samples from Congaree National Park to test for Hg, specifically MeHg, in the park. GPS coordinates were collected for each of 29 collection sites. Sediment Hg concentrations were found to be low to moderate. The highest mean Hg concentration among invertebrates was found in Aeschidae dragonly larvae. Considerable Hg contamination was found in fish—10% of all fish sampled exceeded the USEPA guidelines for human consumption, especially for larger fish. This warrants additional investigation. The study authors recommend monitoring of Hg in sport fish of catchable size every three years. Map is included of sampling sites.

Pescador, M.L., B.A. Richard, and A.K. Rasmussen of Florida A&M University. 2004. An Aquatic Invertebrate Survey for the Congaree Swamp National Park, Richland County, South Carolina. March 2004.

The objectives of this study were to determine the health of the riparian ecosystems within Congaree National Park environment through sampling benthic macroinvertebrates. Specific tasks included investigating species richness, assembling permanent collections of insects for public viewing, and creating a spatial database to provide an overview of the diversity and a general water quality assessment for lake and streams in the Park.

Rose, L, for the South Carolina Department of Natural Resources and National Park Service. 2001. Annual Report: Species Diversity and Condition of the Fish Community of Congaree Swamp National Monument. CA No. H5240-00-0290. October 29, 2001.

A comprehensive survey of the fish community was conducted for Congaree National Monument to determine the relative health of the community. At each sampling location, physical and chemical samples were collected including, pH, DO, conductivity, temperature, and observations regarding fluvial geomorphology.

Smoak, L.A. and E. Gilinsky. 1982. Benthic Macroinvertebrate Communities of a Floodplain Creek in the Congaree Swamp Monument. Department of Biology, Virginia Commonwealth University. Contract No. CX5000-0-0946. February 1982.

This report addresses the importance of floodplain streams as a source of water for the Monument. The biological component of floodplain streams centers on the macroinvertebrate community. These organisms can be used as indicators of both short-term and long-term environmental disturbance in the Monument, specifically as it realtes to water quality.

South Carolina Department of Natural Resources, Jim Bulak. 1997. Job Progress Report: Fishery Survey of the Congaree Swamp National Monument. July 1, 1996 - June 30, 1997.

The purpose of this survey is to compare fish populations in a fished and an unfished oxbox lake and survey the fish community at Cedar Creek. Information on this survey can be used to determine the effects of fishing on the fish community and additionally provide an initial description of this community.

South Carolina Department of Natural Resources, L. Rose and J. Bulak. 2005. Species Diversity and Condition of the Fish Community During a Drought in Congaree National Park. Final Report. October 2005.

From 1999 to 2002, SCDNR, under agreement from the Park Service, conducted 59 fish surveys at 33 sites within the Park to establish baseline data to characterize the condition of the fish community. The two main objectives of the study were to inventory fish species and define the relative condition of the fish community within the Park. Drought conditions were experienced during the sampling period and enabled sampling in areas that would have normally been inaccessible and further provided insight regarding habitat naturally degraded by the drought.

Taylor, J.M. 1994. Invertebrate Survey of Congaree Swamp National Monument: Study plan for the Survey of the Aquatic Macroinvertebrate Communities of the Congaree River, Cedar Creek and Tom's Creek within the Congaree Swamp National Monument, Richland County, South Carolina. September 9, 1994.

The aquatic environment of Congaree can be used as a means to assessing impacts of human alteration of the environment in and around the Monument. Macroinvertebrates are an integral part of the tropic structure in the Monument and are excellent indicators of water quality. The study will provide baseline information on the macroinvertebrate communities in the Park, will provide continuous information regarding water quality, and will provide a complete list of taxa found at present in the Park.

Water Quality and Water Resources

Birch, J.B. n.d. Water Quality of the Congaree National Monument. Institute of Ecology, University of Georgia.

This report describes the physical characteristics of the Congaree river and floodplain which influence water quality. Suspended sediments, chemical concentrations, and ions are discussed. The report is divided into three sections: the first concerning water quality on Cedar Creek at low flow, the second, floodwater quality for the back floodplain, and the third the front floodplain.

Coyle, J., P. Anderson, and M. Nelson. 1997. Preliminary Report of Findings of the Contaminant Assessment Process for the Congaree Swamp National Monument. December 1997.

The Biological Resources Division of the USGS developed a systematic process for determining whether environmental contaminants threaten habitats and biota of DOI managed-lands. The contaminant assessment process (CAP) allows the Monument to assess potential threat from contaminants. The database is a compilation of GIS overlays and other EPA, SCDHEC, etc., databases that allow Monument threats to be analyzed spatially.

Foote, L. 199-?. Chapter Two: Sediment Dynamics of the Congaree River through Congaree Swamp National Monument, 1996-1998.

This report is one component of the larger study "Rizzo, W. and A.L. Foote. 1996. Processes and Profiles on Major Waterways in Congaree Swamp National Monument and Big Thicket National Preserve. National Wetlands Research Center, National Perk Service Research Report." Cited below. The study authors designed a series of field experiments to give preliminary indications of how bottomland forests like Congaree trap sediments and characterize the sediment transporting ability of normal versus flood flows.

Knowles, D.B., M.M. Brinson, R.A. Clark, and M.D. Flora. 1996. Water Resources Management Plan Congaree Swamp National Monument. May 1996.

This report consists of a compilation of water quality information in the Monument tracing two types of past studies: intensive short-term studies of chemicals and nutrients in surface water, and long-term analysis of surface water samples for physical and chemical characteristics. SCDHEC stores data from water quality sampling within the Monument in the EPA-STORET database. Maps and sample data from the database are included in the report.

National Park Service, Water Resources Division. 1996. Themes for Water-related Research and Resource Assessments.

This report presents and overview of the aquatic-research needs of national parks. Nine themes are outlined: protocols to assess impacts on wetlands, of backcountry recreation, boat and marina impacts, riparian resource/water quality relations, assess visitor impacts, assess land use changes, assess recreational fishing impacts, and generally assess baseline characteristics of water resources.

Rickard, M. 1991. A Water Quality Study at the Congaree Swamp National Monument of Myers Creek, Reeves Creek, and Toms Creek. National Park Service Cape Lookout National Seashore, Morehead City, NC. November 1991.

The purpose of this study was to develop a water quality monitoring program for Myers Creek, Reeves Creek, and Toms Creek. Basic water quality parameters were collected including dissolved metals. The data was analyzed in order to determine if upstream industrial development had affected water quality in the Monument.

Rizzo, W. and A.L. Foote. 1996. Processes and Profiles on Major Waterways in Congaree Swamp National Monument and Big Thicket National Preserve. National Wetlands Research Center, National Perk Service Research Report.

This report highlights major constituents of water quality for numerous points throughout the Park. Attached are annual profiles of water quality parameters for the various water quality sampling sites.

SC DHEC. 1995. Watershed Water Quality Management Strategy, Saluda-Edisto Basin. Technical Report No. 003-95.

DHEC, pursuant to EPA regulations, published basin planning reports for the four major basins in South Carolina. Area wide plans must then be established to provide a source of general information specific to water quality management in that basin. The report includes information relevant to pollutant TMDLs, BMPs, and NPDES permit issuances for the relevant basin.

SC DHEC. 1999. Congaree River Basin Description. Water Quality Assessment.

This report describes basin characteristics, water quality parameters for each station, and a list of supplemental literature. Maps and data tables regarding water quality trends and status by station are enclosed.

U.S. Department of the Interior, USGS. 2000? Surface Water Quality and Trophic Status of the Aquatic Ecosystems of Congaree Swamp National Monument (DRAFT). National Wetlands Research Center Final Report. December 20, 2000.

The USGS undertook this study in order to establish baseline water quality parameters essential to maintaining the natural ecosystem communities in the Park. A series of experiments were designed to understand how forested bottomlands trap sediments and to characterize the sediment-transporting ability of the river during normal and high flow regimes. Numerous ecological and hydrological baseline characteristics were discovered during the study.

Water Resources Division and Service-wide Inventory and Monitoring Program, National Park Service, Department of the Interior, Volumes 1 and 2. 1998. Baseline Water Quality Data Inventory and Analysis, Congaree Swamp National Monument. Technical Report NPS/NRWRD/NRTR-98/148. May 1998. (Disks in Library Files).

These documents present the results of a surface-water quality data retrieval and compilation from six of EPA's national databases: STORET, RF3, IFD, DRINKS, GAGES, and DAMS. The effort represents a compiled view of descriptive water quality information for Congaree National Monument.

Wetlands and Vegetation

Aerial Information Systems. 1998. Photo Interpretation Report USGS-NPS Vegetation and Inventory and Mapping Program Congaree Swamp National Monument. Aerial Information Systems Project Report. October 12, 1998.

This report provides a background to the park, information regarding flooding in Congaree Swamp, and divides the park into five vegetation mapping zones. The report contains a useful timeline-outline of the applicable vegetation mapping activities at Congaree Swamp.

Allen, B.P., E.F. Pauley, R.R. Sharitz of the Savannah River Ecology Laboratory. 1994. Vegetation Sampling and Effects of Hydrology on Forest Recruitment and Long-term Community Structure in the Congaree Swamp National Monument. Final Report, Cooperative Agreement No. CA-5000-9-8020. March 1, 1994.

In the Congaree National Monument, flood tolerance and shade tolerance act as filters to influence species composition and community structure of an area. The construction of the Saluda Dam may be influencing species distribution on the Congaree floodplain.

Specifically, sugarberry and water oak species migrated to wetter sites following the construction of the dam. The migration and increasing frequency of ironwood and sugarberry may be indicative of changes in flood frequencies that have led to species compositional changes in Congaree National Park.

Brinson, M.M. and R.D. Rheinhardt. 1998. Wetland Functions and Relations to Societal Values. In *Southern Forested Wetlands: Ecology and Management*. M.G. Messina and W.H. Conner (Eds.). New York: Lewis Publishers.

This book chapter overviews the past approaches to assessing the functions and values of wetlands, discusses the necessity of classification when assessing functions, and then concludes by addressing how a functional assessment can be used in a decision-making process to determine both market and non-market economic values.

Dawson, R.H. 1992. Vegetation Classification System for Congaree Swamp National Monument South Carolina. National Park Service Southeast Regional Office, Atlanta, Georgia. May 27, 1992.

Floodplain hardwood forests, like that of Congaree, are often vegetatively classified in various ways. The development of a vegetation and land-use cover classification system is essential for the processing of remotely sensed data like aerial photography and satellite imagery. Vegetation communities were delineated from NAPP 1:40,000, 1.5 m, resolution aerial photography.

Eargle, M.F. and J.M. Dean. 1989. A Functional Comparison of Two Bottomland Hardwood Sites in South Carolina using WET. Submitted for Publication to the Proceedings for the Association of State Wetland Managers. September 1989.

This report questions whether WET software is an adequate tool for extrapolating wetland function in wetland ecosystems in South Carolina in a diverse gradient of physical and biologic settings. A study area in Congaree NP was compared with a plot in Francis Biedler Forest.

Frost, C.C. and S. Wilds. 2001. Presettlement Vegetation and Natural Fire Regimes of the Congaree Swamp Uplands.

The goal of this project was to provide a new map of the original vegetation of the Congaree Swamp uplands in order to better inform management decisions. Utilizing maps, created by GIS through this project, can better enable foresters in the Park to establish management plans that conserve natural communities.

Gaddy, L.L., Kohlsaat, T.S., E.A. Laurent, and K.B. Stansell. 1975. A Vegetation Analysis of Preserve Alternatives Involving the Biedler Tract of the Congaree Swamp. Division of Natural Area Acquisition and Resources Planning, South Carolina Wildlife and Marine Resources Department. December 1975.

This report recounts the importance of the Biedler Tract as the last major remnant of bottomland hardwood ecosystem. Specifically, the authors note the unusual concentration of champion, record-breaking tree species, for South Carolina and nationally.

Gaddy, L.L. and G.A. Smathers. 1980. The Vegetation of the Congaree Swamp National Monument. Veroff: Geobot. Inst. ETH, Stiftung Rubel, Zurich 69. Heft, 171-182.

This article discusses and describes the physical and vegetation characteristics of the Congaree River floodplain. Further, current and future vegetation and ecological mapping efforts and studies are described.

Keefe, T.L. S.C. Dial, and W.T. Eatson. 1962. The Florisitcs of Cypress-Gum Stands in the Congaree Swamp. University of South Carolina.

This piece discusses the 13,000 acre tract once owned by Santee Cypress Company. The article recounts the physical attributes of the tract as well as a study of 24 10m x 10m quadrants of cypress-gum stands as well as stands of other species on higher ground that have not been cut over for at least several decades.

Lacy, R.B., T.P. Curley, B.C. Jones, and J.R. Wisdom. 1995. Wetland Resource Characterization of the Congaree Swamp National Monument, South Carolina: Database Preparation based on Remotely Sensed Data for Use in Geographic Information Systems. Final Project report prepared by South Carolina Department of Natural Resources, Land Resources and Conservation Districts Division for the National Park Service.

A comprehensive characterization of wetlands within the Monument is needed to provide a bottomland forest inventory to establish baseline conditions and to compare and combine data sources to assist in making vegetation community determinations. A remote sensing-based GIS database was produced from disparate information sources to be useful for ecological questions and management issues within the Monument. This baseline wetland inventory is useful to monitor and manage the Park's resources.

Patterson, G.G., G.K. Speiran and B.H. Whetstone. 1985. Hydrology and its effects on Distribution of Vegetation in Congaree Swamp National Monument, South Carolina. USGS, prepared in cooperation with the National Park Service. Water-Resources Investigations Report 85-4256.

This report describes the interaction of flooding vegetation and the physical characteristics of CSNM. The distribution of vegetation types within the Monument is influenced by the duration of saturated soils during the growing season, which is in turn influenced by inundation by the Congaree River. The frequency of large floods have decreased slightly since the completion of the Saluda Dam in 1929. The report contains many useful maps, figures, and charts to describe the hydrologic characteristics of the Monument.

Rheinhardt, R.D. M.M. Brinson, and F.M. Farley. 1997. Applying Wetland Reference Data to Functional Assessment, Mitigation, and Restoration. *Wetlands* 7(2): 195-215.

Rheinhardt, *et al*. outline the hydrogeomorphic (HGM) assessment procedure used to rapidly collect quantitative field data on wetland reference sites in order to assess ecological functions in wetlands. The authors also demonstrate how a HGM assessment can be utilized to determine a minimum area over which restoration should be applied in order to carry out a no-net-loss objective.

Rikard, M. 1989. Hydrologic and Vegetative Relationships of the Congaree Swamp National Monument. 1989. Cooperative Park Study Unit Clemson University. Technical Report Series, National Park Service. April 5, 1989.

This report aims to gain a better understanding of the relationships between vegetation and hydrologic conditions in order to better inform park management. Additionally, past changes in the hydrology of the Congaree River and how they affected the vegetation in the Monument, and how areas of unlogged land compare to recently logged land, are examined. Upstream changes in both water quality and quantity should be examined as to how they effect Monument vegetation.

Sharitz, R.R., R.L. Schneider, K.W. Dyer, and N.C. Martin. 1986. Wetland Forest Regeneration and Hydrologic Regime. In *Annual Report of Ecological Research at the Savannah River Ecology Laboratory*. W.D. McCort and R.B. Wolf (Eds.). Supported under Contract DE-AC09-76SR00-819 between the University of Georgia and the U.S. Department of Energy. July 31, 1986.

This report examines the effect of hydrologic regime on the regeneration of Savannah River floodplain forest. Southeastern floodplain forests, most notably Cypress-tupelo forests, are distributed along topographic and hydrologic gradients. Factors that impede reproduction include low seed production, viability, and dispersal, lack of suitable substrate for seed germination, and hydrologic conditions which impede seedling survival.

Smathers, G.A. 1980. Congaree Swamp National Monument Vegetation Type Map. U.S. Department of the Interior, National Park Service, NPS-SER Research/Resources Management Report No. 36. 11 pp.

The author describes a limited study of the vegetation types in Congaree National Monument needed for initial establishment, management, and preservation of the Park. Twenty-seven vegetation types were found. Quantitative data suggests the classification of these types into eleven plant community types. A useful map is enclosed in this report.

Story, M.H., J.R. Irons, A.L. Davis, and E.C. Brown de Colstoun. 199-?. Augmenting the NPS Vegetation Mapping Program using LANDSAT 7 Data. Type 1 application Proposal submitted in response to NASA Research Announcement NRA-00-OES-08, Carbon Cycle Science and Related Opportunities in Biology and Biogeochemistry of Ecosystems and Applications.

This report describes a Park Service-wide effort to map vegetation in the 250 units of the National Park System. The primary source-mapping material is from aerial photography. At the current rate, it will take 50 years for the Vegetation Mapping Program (VMP) to complete all the parks. The authors propose to utilize LANDSAT 7 Enhanced Thematic Mapper Plus (ETM+) data combined with digital elevation models (DEMs) to produce accurate maps to a scale of 1:48,000 that will contain less detail than the 1:24,000 VMP program maps.

Thompson, A.J. 1998. An Ecological Inventory and Classification of an Old-Growth Floodplain Forest in the Southeastern United States Coastal Plain. M.S. Thesis University of Georgia.

The author found that Congaree Swamp's floodplain system is characterized by greater structural and functional complexity than younger forests. The ecologically-complex system is strongly influenced by the fluvial processes of the Congaree River as well as natural disturbances such as wind storms. These characteristics directly impact species composition and the structures of plant communities. The two objectives of the study were to determine what vegetation associations exist and determine how this flooplain forested system fits within the accepted definition of old-growth forests.

Maps/Topography/ Remotely Sensed Data

Congaree Swamp National Monument. 1998. Map Files of Congaree Swamp National Monument. Excel Map Inventory File. July 17, 1998.

File contains information regarding maps applicable to the Monument, their respective dates, scale, author, material, location, etc.

Gaddy and Smathers. 1980. Vegetation Types.

A color map showing vegetation classification types within the Monument.

Karapatakis, D.J. 2001. Creation of a Digital One-Foot Contour Map of the Congaree Swamp National Monument. Report for the Congaree Swamp National Monument by the Savannah River Ecology Laboratory GIS and Remote Sensing Lab, October 8, 2001.

Using ESRI's ARC Info Software, the SREL created a one-foot contour map for Congaree Swamp National Monument. The map is based upon the 2-ft contour map from the USGS, interpolated to 1-ft using the ARC Info software, as well as LIDAR data acquired from Richland County, SC.

National Park Service, Congaree Swamp National Monument, Richland County, South Carolina. n.d. Stratification of Vegetation Types Using Park Drainages to Demark General Transtion Zones.

Black and white map of general vegetation zones (1-6).

National Park Service, Congaree Swamp National Monument. n.d. Flood Prediction Study—Crest Gauge Locations.

Black and white map of gage locations for flood prediction study. Gages 1, 2, 3, and 5 were continuously recording.

National Park Service, Congaree Swamp National Monument. n.d. Congaree Swamp National Monument Surface Hydrology.

Black and white map showing general area of frequent inundation?

Wiggins-Brown, H., T. Phillipi, D. Karapatakis. 2000. Review and Verification of the Congaree Swamp National Monument Topographic Database. Report for the Congaree Swamp National Monument by the Savannah River Ecology Laboratory GIS and Remote Sensing Lab, March 1, 2000.

The Savannah River Ecology Laboratory GIS and remote sensing lab reviewed the existing National Monument database including hard copy 2 ft contour maps and digital 4 ft contour data produced by SCDNR. More than 2 dozen sites were surveyed through the Monument using highly accurate GPS systems. The USGS data was found to be off by 1.4 feet and the SCDNR data was found to be geometrically inaccurate. The report recommends the collection of LIDAR-type data to collect the more accurate information.

Weblinks/Other Resources

USGS gages for Congaree National Park:

02169500 Congaree River at Columbia, SC

02169625 Congaree River at Congaree NP Near Gadsden, SC

02169672 Cedar Creek at Congaree NP Near Gadsden, SC

These gages have information regarding stream stage (ft), temperature (˚C), and discharge (cfs) every 15 minutes from 2/23/04 weekly to the present from the USGS National Water Information System (NWIS). See Theresa Yednock for this information.

Other Resources: The Saluda and Congaree Rivers

General/Compilations

Handel, S.N., W.T. Batson, D.J. Colquhoun, W.D. Dawson, P.J. DeCoursey, and R.L. Janiskee. 1979. *Research Bibliography of the Congaree Swamp National Monument Area*. Prepared under contract for the United States Department of the Interior National Park Service Southeast Regional Office, Atlanta, Georgia. Columbia, SC. May 1979, 383 pp.

This compilation is both a summary of biologic, ecologic, geologic and climatologic studies concerned with the Park's environs completed prior to 1979, as well as a guide for the NPS to determine what future studies were needed. The group was concerned with the future growth of Richland County and increased visitorship to the Monument adversely affecting Congaree Swamp. A multidisciplinary group of USC researchers compiled the study from the local resources of the Thomas Cooper Library, Richland County Public Library, computer searches, private collections, and the expertise of USC faculty members.

Hupp, C.R. 2000. Hydrology, geomorphology, and vegetation of coastal plain rivers in the south-eastern USA. *Hydrological Processes*. 14: 2991-3010.

This article compiles the current hydrological, geomorphological, and vegetational knowledge of southeastern coastal plain rivers. The author examines the physical distributions of these systems as well as their physical characteristics. The article contains a large number of diagrams, pictures, and charts illustrating the above characteristics. The author concludes by arguing that a large degree of multidisciplinary research is still needed to fully understand these complex, low gradient systems.

The Santee Basin

Abrahamsen, T.A. 2001. Ecological Data Collected in the Santee River Basin and Coastal Drainage, North and South Carolina, 1996-1998. U.S. Geological Survey Open File Report, 01-352.

As part of the NAWQA program, the ecological characteristics of 23 reaches of 16 streams in the Santee River Basin and some coastal drainages were evaluated using qualitative and quantitative techniques. The Broad, Saluda and Congaree, as well as the Catawba and Wateree Rivers, are included in this NAWQA study unit. Ecological factors examined include algal and benthic communities and habitat characteristics such as channel width and depth, bank and bed composition, and riparian vegetation characteristics. The goal of the project is to relate physical and chemical water quality characteristics to health of aquatic communities and human land use activities. This is a map, table, and hence data-rich report, comparing the ecological characteristics of the streams surveyed in this NAWQA unit.

Hughs, B., Abrahamsen, T., Maluk, T., Reuber, E., and L.J. Wilhelm. 2000. Water Quality in the Santee River Basin and Coastal Drainages, North and South Carolina, 1995-98. U.S. Dept. of the Interior, U.S. Geological Survey, Circular 1206. Accessed April 6, 2006: http://pubs.usgs.gov/circ/circ1206/pdf/circ1206.pdf

This report summarizes the major water quality findings for the Santee River Basin as part of the federal National Water-Quality Assessment (NAWQA) Program. In this effort, the quality of water resources for drinking water use as well as the status of ecological communities are assessed. The study found that surface water in the basin generally meets federal standards, however heavy agricultural and urban land uses have impacted water quality through elevated concentrations of pesticides, bacteria, and nutrients. Specific information is reported on particular heavy metals, pesticides, and nutrients in surface as well as groundwater. There is a good map of land use in the basin on page 3 of the report.

Hurley, N.M. 1991. Transport simulation of striped bass eggs in the Congaree, Wateree, and Santee rivers, South Carolina / by Noel M. Hurley, Jr. ; prepared in cooperation with the South Carolina Wildlife and Marine Resources Division [i.e. Department] Columbia, S.C.: U.S. Geological Survey. Available at Government Documents, University of SC, Thomas Cooper Library.

This USGS report recounts a 1988 study of the transport of striped bass eggs in the Congaree and other area rivers. The bass is an important game fish to dammed lakes in the Santee Basin, bringing many sport fishing dollars to the state each year. Egg survival depends upon four factors: spawning location, water temperature, streamflow and flow velocity. Results of model runs were used to predict the distance to the hatching point and distance to spawning point from sample sites. The model is site specific, but provides an easy method for estimating travel of the eggs. The report contains much information regarding the study area and flow characteristics of the Congaree River.

U.S. Geological Survey. 1995. The Santee River Basin, factors affecting a major resource. U.S.G.S Fact Sheet Number FS185-95. Available at the University of South Carolina Thomas Cooper Library and Congaree NP Library.

This short factsheet outlines the physical characteristics of the basin including Size, flow characteristics, climate, and land use. Major threats to the Basin are overviewed and the importance of the Basin to human water supply and electricity generation is noted. The piece also includes helpful Basin maps.

The Saluda River

Derrick, F. R. 1955. The distribution of the fishes of the Saluda River drainage basin, South Carolina. M.S. Thesis Department of Biology University of South Carolina. Available at the South Caroliniana Library.

The purpose of this survey was to provide insight into the distribution of fishes in the Saluda Basin, determine whether there are any undescribed species in the basin, add to the University of South Carolina fish collection, and serve as a baseline study for future research related to faunal changes in the basin. The effort was part of a statewide survey of flora and fauna. Like the Anderson study of the Congaree Basin listed below, this study is a descriptive cataloging of the fish species found in the basin at the time with maps of locations found and actual black and white photos of the relevant fish.

Koman, Tara M. 2003. The hydrologic effects of dams on the Saluda River, South Carolina. Department of Geography M.S. thesis available at the University of South Carolina Thomas Cooper Library and Congaree N.P. Library.

The author utilizes statistical methods and a software program, Indicators of Hydrologic Alteration (IHA), to determine the degree of hydrologic alteration cased by dams on the Saluda River. Specifically, concurrent changes, caused by dam installation, in the river's geomorphology and the riparian ecosystem, are explored.

Lower Saluda Scenic River Project.
http://www.dnr.state.sc.us/water/envaff/river/low_saluda_scenic.htm

In 1991, a ten-mile stretch of the Lower Saluda River below Lake Murray Dam was named a State Scenic River Corridor. This webpage overviews the opportunities available for recreation, conservation measures, and groups involved in the conservation of this stretch of the Saluda including a plan for a continuous greenway trail along the north side of the River.
See additionally:
South Carolina Water Resources Commission, SC Department of Parks, Recreation, and Tourism, Lower Saluda River Task Force, 1990. "The Lower Saluda River Corridor Plan." July, 1990. 463 pp. Accessed November 8, 2005: http://www.dnr.state.sc.us/water/envaff/river/LowerSaludaPlanComplete.pdf Also available at the University of South Carolina South Caroliniana Library.

Middle Saluda Scenic River. Accessed December 4, 2005:
http://www.dnr.state.sc.us/water/envaff/river/mid_sal_map.htm

This site is not as comprehensive as the website for the Lower Saluda Scenic River Project, but the website explains the Corridor's administration by SCDNR. The Middle Saluda River became the first river protected under the Scenic Rivers Program in South Carolina in 1978. Located in northern Greenville County and completely within Jones Gap State Park, about five miles of the Middle Saluda and its major tributary, Coldspring Branch, are protected by a 600-foot wide scenic corridor established through an agreement with the South Carolina Department of Parks, Recreation and Tourism.

USEPA, 2002. Endangered and threatened Wildlife and Plants; Reopening of public comment period and notice of availability of draft economic analysis for proposed critical habitat determination for the Carolina Heelsplitter. March 6, 2002. Accessed April 20, 2006:
http://www.epa.gov/fedrgstr/EPA-IMPACT/2002/March/Day-06/i5275.htm

The Saluda River Basin may contain habitat historically utilized by the Carolina Heelsplitter, a medium-sized freshwater mussel with a green-brown to dark brown shell. Recent collection records of the species indicate that it has been eliminated from all but a few regions of its historic range in the Carolinas. The four small remaining populations include: one each in the Pee Dee and Catawba River systems and two in the Savannah River system. There have been no successful collections of the heelsplitter in the Saluda River despite repeated attempts in recent years. Decline of the species is presumed due to changes in water and habitat quality including These factors include pollutants in wastewater discharges (sewage treatment plants and industrial discharges); habitat loss and alteration associated with impoundments and other stream alteration activities; and increased stormwater run-off and the run-off of silt, fertilizers, pesticides, and other non-point pollutant sources. Proposed critical habitat of the species, implemented under the ESA, includes tributary portions the Saluda River watershed, among others.

SCDHEC Watershed Strategy Coordinator. 2004. Watershed Water Quality Assessment: the Saluda River. October, 2004: 196 pp. Accessed April 5, 2006: http://www.scdhec.gov/water/pubs/saluda.pdf

SCDHEC watershed water quality assessment reports provide information to both internal and external parties to enable broader participation in the water quality management process. Water quality data from the Saluda River Basin was collected from 1997 to 2001 and assessed during this third five-year watershed management cycle. This updated atlas provides summary information on a watershed basis, as well as geographical presentations, of all permitted watershed activities. A waterbody index and facility indices allow the reader to locate information on specific waters and facilities of interest.

The Reedy River

Beasley, B.R. M. Criss, L. Quattro and R. Scharf. 2001. “The Reedy River Report: Managing a Watershed.” Department of Natural Resources. Land, Water and Conservation Division. Water Resource Publication Report: Number 22.

The purpose of this report was to conduct a comprehensive investigation of the Reedy River’s resources. The Friends of the Reedy River initiated the interest in this study which was overseen by SCDNR. SCDNR was interested in studying the human and natural resources of the watershed through a citizen-based planning effort that comprehensively examined the watershed’s resources so the community may make more informed management decisions. The Reedy River Task Force was established to examine critical issues in the watershed and create a long-term management plan. The report includes information on the basin’s physical geography including maps and images, historical information, biological, cultural, and recreational resources, and growth management opportunities. Appendices include useful tables and information regarding flow data, flood information, and relevant laws and the Reedy River Watershed Committee Proposal.

Frank, Barbara J. 1973. The effects of urbanization on the stream flow of the Reedy River, Greenville, South Carolina. Ph.D. Thesis available at University of South Carolina South Caroliniana Library.

This thesis utilizes the 1941-1971 gage record, aerial photo coverage, and present geomorphic character to document the changes in channel geomorphology due to urbanization through time. The objective of the study is to note the changes in the various hydraulic components of the Reedy River through time and if they manifest in stream characteristics. The author noted that channel manipulation and increased erosion from the urban area have been especially influential.

McKoy, Henry B. 1969. *The Story of the Reedy River*. Greenville, SC: Keys Printing Co, 74 pp. Available at the South Caroliniana Library.

This book provides some general information regarding the physical geography of the Reedy River through maps and physical descriptions, however it is mostly about the river's historical importance to South Carolina, namely, the founding of Greenville. Historical pictures, postcards, and maps are included. Information on floods and the U.S. Army Corps. of Engineers Plan's for the River are also recounted.

The Congaree River/National Park

Anderson, W.D. 1954. The distribution of the fishes of the Congaree river drainage area, South Carolina. M.S. Thesis Department of Biology, available at the University of South Carolina South Caroliniana Library.

This thesis provides a physical description of the basin, maps of where fish samples were collected, descriptions of fish collected, and actual black and white pictures of fish samples collected. The study is a very descriptive cataloging of the fish species found in the Congaree River basin at that time, including fifteen families, thirty-two genera, and forty-three species. The endeavor provides one part of what was envisioned as a cataloging of the general fauna of the state, starting with the Santee Basin.

Lee, J.K. and C. S. Bennett. 1981. A finite Model Study of the Impact of the proposed I-326 crossing on the flood stages of the Congaree River near Columbia, South Carolina. Prepared in cooperation with the South Carolina Department of Highways and Public Transportation. Columbia, S.C.: U.S. Dept. of the Interior, Geological Survey ; Denver, Colo.: Open-File Services Section. No. 81-1194. Available at the Congaree National Park Library.

A two-dimensional model finite-element surface water model developed by Norton and King was used to assess the hydraulic impact of the proposed Interstate 326 crossing on the Congaree River floodplain. An extensive dike system, the proposed highway crossing, and high roughness combine to cause significant lateral velocities and variations in stage during flooding events.

Plewa, T.M. and W.L. Graf, 2005. Hydrologic Variation of the Congaree River near Congaree National Park, South Carolina: A Report for the National Park Service. January 29, 2005.

This project examined a number of questions regarding how the flows of the Broad and Saluda Rivers affect the stage levels in Congaree National Park (CNP) and its creeks, most notably Cedar Creek. Streamflow data from USGS gages indicate that the Broad River contributes 2/3s of the Congaree River's water, while the Saluda River contributes 1/3. The Broad River therefore has a greater influence on conditions in CNP, with large flow volumes frequently obscuring the daily and hourly variations of the Saluda River. Waves of water from the operation of Parr Shoals Dam, upstream on the Broad River, reach the Park in about a day while pulses of water reach the Park from the Saluda Dam in about 15 hours. Operations of the Saluda dam can cause fluctuations of the gage in CNP of .25 to .5 ft. When stage levels at CNP reach about 8 feet, water in the Congaree River begin to influence Cedar Creek, the flow backing up into tributary flows.

United States. Congress. Senate. Committee on Energy and Natural Resources. Subcommittee on Public Lands, National Parks, and Forests. Mississippi River National Heritage Corridor Act, Congaree Swamp National Monument Expansion and Wilderness Act, and Charles Pinckney Historic Site : hearing before the Subcommittee on Public Lands, National Parks, and Forests of the Committee on Energy and Natural Resources, United States Senate, One Hundredth Congress, second session, on S. 1643 ... S. 2018 ... S. 2058 ... June 23, 1988. Washington: U.S. G.P.O. Available in Government Documents, USC Thomas Cooper Library.

The purpose of 2108, the focus of this government report in the Congressional Record, is to expand the boundaries of then the Congaree National Monument, to designate certain land contained within wilderness, and to increase the amount of money appropriated to Park development. The report notes the importance of the near-virgin southern hardwood floodplain forest of Congaree and as such Congress appropriates an additional $3 million for Park development.

Cooney, T.W. 1990. Concentrations of metals in bed material in the area of Congaree Swamp National Monument and in water in Cedar Creek, Richland County, South Carolina, prepared in cooperation with the National Park Service. Columbia, S.C.: U.S. Geological Survey ; Denver, Colo. Accessed April 25, 2006: http://library.usgs.gov/index.html

This report describes a study carried out by USGS and the National Park Service investigating the concentrations of selected metals in the surface waters of the Park including the bed of a major tributary to the Congaree River, Cedar Creek. Thirty-seven samples were taken at 28 sites in the study area between June 1985 and June 1986. Barium, iron, magnesium, and manganese occurred at various levels throughout the sample sites because they are naturally occurring in the basin. Concentrations of cadmium in Cedar Creek, a toxic metal, equaled or exceeded US EPA drinking water standards. Manganese also equaled or exceeded US EPA drinking water standards in

Cedar Creek in some samples. All other metals were below these US EPA concern levels. Metal concentrations were generally higher in Cedar Creek compared with Tom's Creek. There is some evidence that the floodplain acts as a sink for certain trace metals.

Hamel, P. B. 1989. Breeding bird populations on the Congaree Swamp National Monument, South Carolina. P. 617-628. In: R. R. Sharitz and J. W. Gibbons, eds. Freshwater wetlands and wildlife. DOE Symp. Series No. 61. US DOE Office of Sci. and Tech. Infor., Oak Ridge, TN.

The author notes that there is little data available regarding bird species in undisturbed bottomland hardwood forests. This study was designed to document the birds of Congaree Swamp, describe the breeding communities of species there, and compare species in undisturbed versus clearcut portions of the Swamp. Bird communities differed in old growth areas in quantity rather than by type. More species achieved the highest densities in the old growth areas, especially cavity nesting species. Bird species in the clearcut areas were more typical of open areas throughout the region and some species found in these areas were previously unrecorded in the Park.

Levey, R.A. 1977. Characterisitcs of coarse-grained point bars, Upper Congaree River, South Carolina. M.S. Thesis Department of Geology. Available at the University of South Carolina Thomas Cooper Library.

This Masters thesis describes the coarse-grained point-bar system of the upper Congaree River in Columbia, SC. The study objectives were to 1) develop a depositional model of a Coastal-Piedmont boundary river system, 2) relate the geomorphic structure of point bars and bed forms to their internal stratification, and 3) compare the results of this study to the known point bar sequence model. The author found that the facies type, morphologic features, and bedforms in the river depended upon local channel geometry, velocity distribution, sediment size and availability, and discharge pattern.

Maliszewski, Laura M. 2005. Assessment of contaminant sources and pathways affecting the Congaree National Park, South Carolina. M.S. Thesis Department of Civil and Environment Engineering available at the University of South Carolina Thomas Cooper Library.

The author asserts that hydrology is single most important factor influencing Congaree National Park due to the delivery of water, sediments, and nutrients that sustain the Park's unique ecosystem. This study compiled all previous studies and technical reports to identify deficiencies in water quality information, such as lack of groundwater quality and pesticide data as well as general water quality issues. The author compiled this information into a database. Suggestions were also made for further research in heavy metals entering the Park through surface water and sediment, the degree of fecal contamination entering the Park through Tom's Creek, and creating a water quality monitoring program at the Park.

Michie, J.L. 1980. An archeological survey of Congaree Swamp: cultural resources inventory assessment of a bottomland environment in central South Carolina. Columbia, S.C.: Institute of Archeology and Anthropology, University of South Carolina. Available at the South Caroliniana Library.

Before this study, the Congaree River Valley in Richland, Lexington and Calhoun Counties had never been subject to a large-scale archeological exploration and survey. The report contains background information regarding the founding of the Monument, hydrological, biological, historical, economic, and information on past human settlement in the area. The report contains numerous maps, profiles, and pictures of the study area. One major prehistoric site was found as well as several sights of more recent historical significance.

Rose, Leonard J. 2004. Species diversity and condition of the fish community during a drought in Congaree National Park. M.A. Thesis School of the Environment available at the University of South Carolina, Thomas Cooper Library.

This Masters thesis utilizes statistical clustering and ordination techniques to better understand how three distinctive fish communities within the Park related to habitat conditions during a drought. Dry conditions enabled sampling in areas that would otherwise not have been possible. The researcher was able to observe the fish community during a natural degradation of fish habitat brought on by drought in order to inventory the fish species within Congaree NP and define the relative condition of the fish community within the Park. This information was used to develop a model that predicts fish communities given habitat conditions.

Schuck-Kolben, R.E. 1992. Simulation of the effects of proposed construction of 12th Street extension and of flood-plain reforestation on flood elevations, Congaree River near Columbia, SC. Columbia, S.C.: U.S. Geological Survey. Available in Government Documents, USC Thomas Cooper Library.

The USGS and SC Department of Transportation sponsored this report to determine the effects of extending the Congaree-I-326 bridge as well as partial reforestation of the floodplain on subsequent flood elevations of the Congaree River. A model was used to simulate surface flows on a horizontal plane. Roughness associated with tree growth on the floodplain, and elevations to account for the embankment created for the bridge extension, were the only variables modified in the model runs. Water surface elevations and discharges were compared in different areas of the floodplain to evaluate the effects of floodplain conditions on the level of the 100-year flood. The authors found that the bridge extension had minimal impact on the flood discharge, while the increased roughness caused by mature pine trees had more of an impact. They also found that the construction of dams on the Saluda and Broad Rivers have impacted flood magnitude, especially the Saluda Dam due to its size and proximity to the study area. Lake Murray and the Saluda Dam provide limited flood protection for this stretch of the Congaree.

Wachob, A. 2002. “Impact of Removing the Granby Dam on Water Levels in the Congaree River.” Department of Natural Resources Land, Water and Conservation Division. Water Resource Publication Report Number 27. Accessed April 3, 2006: http://www.dnr.sc.gov/water/hydro/HydroPubs/Abs_dnr_R27.htm.

This report examines the impact of removing Granby Dam on water levels in the Congaree River. The author utilized a combination of surveyed water-surface and riverbed elevation data, flow rate data for the Congaree River, and computer model simulations to compare current water depths, flow velocities, and flow distributions to these features if the dam would be removed. The author found that without the dam, the lock system would be filled with sediment, water depth in the channel would decrease, and the level of water in the lock would decrease for all discharge levels.

Congaree National Park/Monument and Vegetation

Crewz, D.W. 1976. A floristic analysis of the Congaree River floodplain, South Carolina: succession and regeneration. M.S. Thesis Department of Biology available at the University of South Carolina Thomas Cooper Library and at the Congaree National Park Library.

This thesis study characterizes the effects of varied logging practices on the regeneration of mature bottomland forest and associated successional trends. The study includes an analysis of some harvested areas as well as relatively undisturbed forest in order to establish baseline conditions for future studies and argue for the protection of Congaree Swamp’s forest.

Jones, R. H. and R. R. Sharitz. 1998. Survival and growth of woody plant seedlings in the understorey of floodplain forests in South Carolina. *Journal of Ecology* 86:574-587.

Regression models were used to determine the likelihood of woody seedling survival in South Carolina floodplain forest due to species, location on the floodplain, time and seedling size and growth. Weak positive and negative relationships were noted regarding peak river discharge during the winter and during the summer, respectively. The authors contend that simulation models could be produced that include prediction of seedling age, species, intensity of winter floods, and degree of summer droughts.

Megonigal, J. P., W. H. Conner, S. Kroeger and R. R. Sharitz. 1997. Aboveground production in southeastern floodplain forests: A test of the subsidy-stress hypothesis. *Ecology* 78:370-384.

The authors concluded that the subsidy-stress hypothesis does not adequately explain net primary production in Southeastern floodplain forests. It was hypothesized that frequent flooding induced greater productivity compared to upland forests, however, this was not the case. Extensive flooding exacted a great degree of stress on floodplain forest productivity, and stress was exacerbated by impoundment or levee development.

FERC Relicensing

FERC Office of Hydropower Licensing, 2002. "Scoping Document 1, Saluda Dam Seismic Remediation Project South Carolina FERC Project No. 516. May 2002, 35 pp. Accessed April 20, 2006: http://www.ferc.gov/industries/hydropower/safety/saluda/saluda_sd1.pdf

As part of its oversight capacity, FERC implements a dam safety program, through its Division of Dam Safety and Inspections (D2SI), to ensure that Commission-licensed projects comply with Federal dam safety standards and are designed constructed, and operated safely. The D2SI Regional Engineer has the authority to, among other things, require a licensee to take an action to repair or modify project works for the purpose of achieving or protecting the safety, stability, and integrity of project works. It has been determined that the Saluda Dam near Columbia, SC would fail if subjected to a repeat of the Charleston Earthquake that occurred in 1886. The magnitude of the Charleston earthquake is estimated by seismologists, including the United States Geological Survey, to be about 7.3. The Saluda Dam must be strengthened to withstand earthquakes in the interest of public safety for the thousands of people living downstream. (copied, paraphrase).This document's purpose is to outline the scoping process involved in the retrofitting of the dam including NEPA requirements: such as inviting stakeholders to be involved in the process and determining alternatives.

South Carolina Electric & Gas Company. 2005. *Initial Consultation Document, Saluda Hydroelectric Relicensing, FERC No. 516.* prepared by Kleinschmidt Energy and Water Resource Consultants, Columbia, SC. April 2005, 286 pp. Accessed April 20, 2006: http://www.saludahydrorelicense.com/milestones.htm

This document is supplied by SCE&G, on their FERC Saluda Dam relicensing website. The Initial Consultation Document (ICD) provides information related to all project resources to interested state and federal resource agencies, nongovernmental organizations (NGOs), and the general public for review and comment. This comment period officially begins the Stage 1 Consultation efforts required under the FERC licensing process. This ICD for Saluda Hydro provides information relative to the site, the Project Works (structures, equipment, and facilities), and current and future operations. There are three distinct phases in the enhanced traditional licensing process, of which preparation of the ICD is the first. SCE&G anticipates working closely and cooperatively with all interested parties through each stage of the process in order to address and resolve collaboratively resource issues.

Bennett, Samantha. n.d. Developing a Water Quality model for FERC Re-licensing Stakeholder Presentations. Walden Associates, Inc. Wayne, PA Accessed November 8, 2005: http://www.walden-assoc.com/p0889/p0889.htm

While presenting water quality data for stakeholder meetings is often challenging, Section 603 of the Energy Act requires dam owners to hold stakeholder meetings on lake water quality issues during the FERC re-licensing process. Traditionally, maps, tables, and graphs have been distributed at stakeholder meetings to present water quality data.

This is often perceived as misleading and confusing. This paper presents the methodology for presenting complex water quality issues to a non-technical audience. The process used for data collection, data projection, modeling parameter selection, and modeling techniques to generate a water quality model in Lake Murray, South Carolina is reviewed.

Natural Heritage Institute. 2005. Santee River Basin Model (SRM). Accessed November 8, 2005: http://www.n-h-i.org/srm.html

SRM was developed to assist the South Carolina chapter of The Natural Conservancy, the Coastal Conservation League, American Rivers, and the Catawba-Wateree Relicensing Coalition in relicensing negotiations for Duke Power's (Duke) Catawba-Wateree Project (P-2232), South Carolina Energy and Gas's (SCE&G) Saluda Project (P-516), and the State of South Carolina's Santee-Cooper Project (P-199). The model is available to all stakeholders, and the site includes a downloadable users' manual as well as necessary additional files needed to run the model.

Lake Murray and the Saluda Dam

Environmental Research Center, Inc., 1975, "Environmental Inventory of Lake Murray, South Carolina—Volumes I and II," prepared for SCE&G, January 1976. Available in the USC School of Law Library.

Volume 1 of this two-volume series contains general information regarding the history, past and present socio-economic characteristics of the surrounding area, general specifications of the Lake and powerplant and the findings of the environmental inventory of the Lake, conducted by the EPA, from 1974-1975. The volume includes numerous fold-out maps including general area, bathymetric, weather and maps of the study sites supplemented with graphs of the accompanying data. The study found water quality was worse for samples at the sites in the upper section of Lake Murray than the lower lake, where variables remained stable. This was attributed to the upper Lake's proximity to tributaries with a large degree of urban and agricultural land use and the lower Lake being impounded for a longer time which allowed for associated biological and chemical stabilizing processes. Volume Two contains appendices of water quality data and notes regarding field sampling procedures, lab procedures, as well as a large number of data tables.

Bayne, C. 1999. Lake Murray: Legend and Leisure. Third Edition, Revised. Bayne Publishing Co. Sunset, S.C.

This largely pictorial work showcases the history and current state of Lake Murray. It is composed of one and two-page stories and anecdotes about current or historical aspects of the Lake. Maps of the area, historical pictures, and schematics of the Saluda River Hydro-electric Development are included.

Rohde, Kelly L. 2003. Immediate Impact of the Lake Murray Construction [2003 Dec.]. Seminar Paper written for History 816. Available at the University of South Carolina South Caroliniana Library, 17 pp.

This seminar paper describes the history of the Lake Murray Dam Project on the Saluda River. The paper first gives historical background of the region that became Lake Murray and the surrounding towns of Columbia, Lexington, Chapin, etc. In 1912, the site was passed over in favor of the Parr Shoals Hydro Project on the Broad River for a hydroelectric project. Then, Lexington Power Company received Federal Power Commission permission to begin construction on Saluda Dam February 27, 1927. The paper recounts much of the controversy surrounding the buyout of local landowners to obtain the 100,000 acres of land needed for the Saluda Dam Project as well as the economic boon to the area as a result of the construction of the dam and the creation of Lake Murray.

Lake Greenwood

Lake Greenwood Facts – Buzzard's Roost Hydro Project (circa 1940). 2005. http://www.co.greenwood.sc.us/_fileUploads/forms/112_Lake%20Greenwood%20Facts.pdf December 15, 2005. Accessed April 2, 2006.

This is a short report on the FERC relicensing of Buzzard's Roost Hydro Project by Duke Power on behalf of Greenwood County, the owner of the hydroelectric dam. The report contains the history and specifications of the project and describes its use to supply electricity to Greenwood. Greenwood County claims that as a result of the licensing process, additional public use facilities will be constructed. The County is concerned with the amount of development and growth of the Lake area due to people moving to the region to take advantage of lake amenities and how this will affect the quality of the Lake.

Saluda River Water Quality

Miller, A. SCDHEC Bureau of Water. 2004. Total Maximum Daily Load Development for Fecal Coliform Bacteria Lower Saluda River and Tributaries Stations: Lower Saluda S-149, Twelve Mile Creek S-294, Kinley Creek S-260. September 1, 2004: 33 pp.(HUC 03050109-210) Accessed April 24, 2006: http://www.scdhec.gov/water/html/tmdlsc.html

This website contains links to the lower Saluda TMDL report as well as for other rivers in the state. The TMDL process establishes the allowable loadings of pollutants. This TMDL is targeted at three stations in the Lower Saluda watershed: S-149 is located in the Lower Saluda main stem approximately 3 river miles downstream from the Lake Murray dam, S-294 is located on Twelve Mile Creek which is tributary to the Lower Saluda River, and Kinley Creek, which is monitored at station S-260. These three sites exceeded §303(b) regulations regarding fecal coliform. From 1994-1998, fecal coliform water quality standards were exceeded in 17% of samples at the downstream Lake Murray site, 21% of samples at the Twelve Mile Creek site, and 90% of samples at the Kinley Creek site. Management of this pollutant will involve limiting runoff from urban and agricultural lands, reducing inflow from possible failing septic systems, and decreasing uncontrolled access of livestock to streams.

SC DHEC, 1995, “Watershed Water Quality Management Strategy—Saluda-Edisto Basin,” Technical Report No. 003-95, prepared by South Carolina Department of Health and Environmental Control.

SC DHEC began watershed planning activities in 1972 as a result of a U.S. EPA grant. Subsequently, these plans have been updated on a 5-year basis. The watershed approach is useful in improving communication between relevant agencies and the public, allows for focus upon Congressional and Legislative mandates, and also to allow DHEC to act in a proactive manner in terms of watershed planning. The report contains useful information, including maps and summaries, of issues concerning water quality broken down by sub-basins of the Saluda-Edisto Basin. Tables included at the end of the report highlight water quality concerns in the constituent basins.

SC DHEC, 1998, “Watershed Water Quality Assessment—Saluda River Basin,” Technical Report No. 005-98, prepared by South Carolina Department of Health and Environmental Control, Bureau of Water, December, 1998.

SC DHEC began watershed planning activities in 1972 as a result of a U.S. EPA grant. Subsequently, these plans have been updated on a 5-year basis. The watershed approach is useful in improving communication between relevant agencies and the public, allows for focus upon Congressional and Legislative mandates, and also to allow DHEC to act in a proactive manner in terms of watershed planning. The report contains useful information, including maps and summaries, of issues concerning water quality broken down by sub-basins of the Saluda River.

SC DHEC, 2004, “Watershed Water Quality Assessment: Saluda Basin Technical Report No. 004-04, 3rd edition, prepared by the South Carolina Department of Health and Environmental Control, October 2004. Accessed February 20, 2006: http://www.scdhec.gov/eqc/water/pubs/saluda.pdf

SC DHEC began watershed planning activities in 1972 as a result of a U.S. EPA grant. Subsequently, these plans have been updated on a 5-year basis. The watershed approach is useful in improving communication between relevant agencies and the public, allows for focus upon Congressional and Legislative mandates, and also to allow DHEC to act in a proactive manner in terms of watershed planning. The report contains useful information, including maps and summaries, of issues concerning water quality broken down by sub-basins of the Saluda River.

SCDHEC Bureau of Water. 2004. Upper Saluda River Basin…Fecal Coliform Bacteria, EPA Finalized TMDL. September 29, 2004. 77 pp. Accessed April 20, 2006: http://www.epa.gov/waters/tmdldocs/Final%20Upper%20Saluda%20FC%20TMDL.pdf.

Levels of fecal coliform in the Upper Saluda are a serious concern. SC DHEC has named thirteen water quality stations on the Upper Saluda in violation of South Carolina §303(b) standards due to fecal coliform levels. There are 19 point sources for this pollutant in the watershed. A load-duration curve methodology was utilized to determine allowable total maximum daily load (TMDL) for the relevant stations. Some point sources will have to reduce their load to meet the water quality standard for this in this area of the Upper Saluda.

General Basin Water Management

American Rivers. n.d. River Restoration Case Study: Hydropower Dam Reform, Santee and Cooper Rivers: The Santee-Cooper Hydroelectric Project South Carolina. Accessed, November 16, 2005: http://www.americanrivers.org/site/DocServer/santee_cooper_case_study_04.pdf?docID=569

This is a short paper regarding a parallel FERC relicensing effort in the state. American Rivers, an environmental NGO concerned with river integrity, seeks to motivate the public to become involved in the FERC relicensing process of the Santee-Cooper Project, noting the critical window of influence regarding 40-50 year timeframe of a FERC license. The report contains background of the issue as well as conveys the group's discontent with public input and procedure in this FERC process.

Badr, A.W., A. Wachob, and J.A. Gellici, 2004. "South Carolina Water Plan, Second Edition." South Carolina Department of Natural Resources, Land, Water, and Conservation Division. January 2004. 132 pp. Accessed, January 14, 2006: http://www.dnr.state.sc.us/water/admin/pubs/pdfs/SCWaterPlan2.pdf

This document overviews the State of South Carolina's water management strategy. There is a good map on page 61 of DHEC's watershed water quality monitoring network and the Saulda River's annual watershed water quality management sites.

Trimble, Stanley and Weinrich, F. 1987. Reforestation and the Reduction of Water Yield on the Southern Piedmont Since Circa 1940. *Water Resources Research*: 23(3), 425-437.

This paper provides a general overview of the reforestation of the Southeastern piedmont from historical faming uses and the consequent effects on stream discharge. The authors found that the reversion from row crops to forest and pasture land covers decreased annual stream discharge from 4 to 21%. A portion of the study area was represented by the western part of the Saluda River Basin. The authors additionally note that small increases in forested land cover (10-28%) significantly reduced water yields causing a mixed bag of effects—decreased erosion concomitant with decreased runoff for water supply purposes.

Tufford, D.L. and H.N. McKellar. 1999. Spatial and temporal hydrodynamic and water quality modeling analysis of a large reservoir on the South Carolina (USA) coastal plain. *Ecological Modelling*. 114: 137-173.

Though mostly about the model to estimate water quality for Lake Marion, the article contains a detailed physical description of the Saluda River Basin to Lake Marion, and a map depicting the basin. The authors used phytoplankton kinetic rates in a hydrodynamic model to determine water quality in reference to DO, ammonia, and nutrients, as well as other indicators. The built WASP5 model was not able to effectively model all environmental conditions of Lake Marion, however portions of the model are useful for research and experimental purposes.

U.S. Army Corps. of Engineers. Charleston District. 1974. Special flood hazard information report : Congaree River, Broad River & Saluda River, Richland & Lexington Counties, South Carolina. Prepared for the Central Midlands Regional Planning Council by the U.S. Army Engineer District, Charleston Corps of Engineers, Charleston, S.C. Available in Government Documents, University of South Carolina Thomas Cooper Library.

The portions of Richland and Lexington County covered by the report are subject to flooding of the Broad, Saluda, and Congaree Rivers. The report included descriptions of past floods and identifies areas subject to future floods. Maps, aerial photos, and river profiles are provided. This report was prepared at the request of the Central Midlands Regional Planning Council and the SC Department of Water Resources. The report additionally provides gage information, basin background information, basin infrastructure descriptions, and flood damage reduction measures.

Historical Maps

Calhoun, Patrick B. 1770. Map of Cherokee Lands, 1770 Dec. 8 and 1993 Nov. 3. Available at the University of South Carolina South Carolinana Library.

Lexington Water Power Company. 1927. “Map showing location of Saluda River hydro-electric development near Columbia, SC.” Lexington Water Power Co., Murray & Flood Engineers. Available at the University of South Carolina South Caroliniana Library.

Maps

FISHUNT and E. H. Fetner. 197-?. A sportsman’s map of “Santee”: Lake Marion & Lake Moultrie. Columbia, S.C.

This map includes commercial & public landings, best fishing areas, a map of Cooper River, a map of upper Lake Marion, and a sketch map of the Congaree River.

U.S. National Park Service. 1995. Congaree Swamp National Monument, South Carolina. Washington, D.C. Available at the University of South Carolina Thomas Cooper Library.

U.S. National Park Service. 1988. Congaree Swamp National Monument, South Carolina: official map and guide. [Washington, D.C.] : National Park Service, U.S. Dept. of the Interior.

U.S. Geological Survey (U.S.G.S). Relevant topographic quad maps for the Saluda/Congaree Basins:

U.S.G.S. Congaree N.P. relevant 1:24,000 7.5 minute quads
Southwest Columbia
Fort Jackson South
Congaree
Eastover
Saylors Lake
Gadsden
Wateree
Staley Crossroads
Saint Mathews
Fort Motte

U.S.G.S. Saluda River relevant 1:24,000 7.5 minute quads
Eastatoe Gap
Table Rock
Cleveland
Dacusville
Paris Mountain
Greenville
Pelzer
Bolton East
Fork Shoals
Ware Shoals West
Ware Shoals East
Cokesbury
Waterloo
Ninety Six
Dyson
Chappells
Silverstreet
Prosperity
Denny
Delmar
Lake Murray West
Lake Murray East
Irmo
Columbia North
Southwest Columbia

U.S.G.S. Reedy River relevant 1:24,000 7.5 minute quads
Mauldin
Simpsonville
Fork Shoals
Hickory Tavern
Ware Shoals East
Cokesbury
Waterloo

Imagery
Richland County GIS 1-foot resolution aerial imagery (Congaree GIS Dataset stored at the park). Accessed November 4, 2005: http://www.richlandmaps.com/ .

USDA Aerial Photos available at the University of South Carolina Thomas Cooper Library.

Relevant Web Links
Lake Murray Association Website
Accessed December 2, 2005: http://www.lakemurrayassociation.com/whats_news.htm.

The Lake Murray Association (LMA) website provides updated information of the group's activities. According to their website, the organization, "provides representation for all lake users from the four counties around the lake on issues that pertain to the development, management and use of Lake Murray. The Association works to foster cooperation among the various users and organizations with an interest in the lake (i.e., stakeholders) to insure a clean, safe, and user friendly lake." Specifically, they are interested in relicensing issues, lake levels, safety, weed control, pollution monitoring, and shoreline management.

Saluda-Reedy Watershed Consortium.
Accessed December 2, 2006: http://www.saludareedy.org/.

Excellent site for general information regarding the Upper Saluda Watershed, from its headwaters until its confluence with the Reedy River in Lake Greenwood. The Consortium was formed to address the concerns of development and land use change in the region in order to preserve water quality and abundance. The Consortium has a two-year strategic plan for 2005-2006 which outlines protection of the watershed and sustainable future plans.

Friends of Congaree Swamp Website. Accessed March 15, 2006: http://www.friendsofcongaree.org/.

The Friends are a non-profit organization which advocates the park as a significant local, regional, state, and national resource and strives for associated conservation, enhancement, and educational outreach opportunities. Website information includes past

events held in the Park, membership information, and an archive of Organization Newsletters.

River Alliance Website. Accessed November 8, 2005:
http://www.riveralliance.org/

The River Alliance's mission is connecting people to Columbia's rivers, making them accessible while at the same time protecting their resources, and bringing the rivers back into the daily lives of area residents and visitors. The Alliance is responsible for and maintains the Three Rivers Greenway and the Riverwalk as well as organizing accompanying community educational programming and outreach.

Saluda Hydro Project Relicense Website. Accessed April 20, 2006:
http://www.saludahydrorelicense.com/.

This site provides up-to-date information on the progress of the multi-year FERC relicensing process including stakeholder and federal and state government input as well as soliciting online public comment. Numerous additional resources are continually added to this updated site including biological studies relevant to the Relicensing process.

SCDNR, 2005. Lake and Stream Data. Accessed November 9, 2005:
http://www.dnr.state.sc.us/water/hydro/gages.htm

Obtain information from this SC DNR site regarding real-time Lake Levels of Lake Murray as well as Stream Gages in the Saluda River Basin in real-time and compared to historical averages.

SCDNR, 2005. SCDNR GIS Clearinghouse County Selection map to download USGS. Topographic maps. Accessed October 7, 2005:
http://www.dnr.sc.gov/pls/gisdata/download_data.select_county_map.

From this site, one can download relevant topographic maps by county for GIS or viewing applications.

SCDHEC, 2005. Saluda River Basin. Accessed October 26, 2005:
http://www.scdhec.net/water/shed/saluda_main.html

Water quality information and general geographical information on both the Saluda and Congaree Basins.

Natural Resources Conservation Service. 2005. Accessed October 26, 2005:
http://www.sc.nrcs.usda.gov/programs/SaludaRiverWater.html

This site contains information regarding land use in the Saluda Basin, a map of the watershed, and information about encompassing counties.

Stream Gages in the Saluda and Congaree Basins are as follows:
02162290 SOUTH SALUDA RIVER NEAR CLEVELAND, SC
02162500 SALUDA RIVER NEAR GREENVILLE,S.C.
02163001 SALUDA RIVER NEAR WILLIAMSTON, SC
021630967 GROVE CREEK NEAR PIEDMONT, SC
02163500 SALUDA RIVER NEAR WARE SHOALS, SC
02164000 REEDY RIVER NEAR GREENVILLE, SC
02164110 REEDY RIVER ABOVE FORK SHOALS, S. C.
021650905 REEDY RIVER NEAR WATERLOO, SC
02165200 SOUTH RABON CREEK NEAR GRAY COURT,S.C.
02166500 LAKE GREENWOOD NEAR CHAPPELLS, SC
02166501 LAKE GREENWOOD TAILRACE NR CHAPPELLS, SC
02167000 SALUDA RIVER AT CHAPPELLS, SC
02167450 LITTLE RIVER NR SILVERSTREET, SC
02167563 BUSH RIVER AT NEWBERRY, SC
02167582 BUSH RIVER NR PROSPERITY, S C
02168500 LAKE MURRAY NEAR COLUMBIA, SC
02168501 LAKE MURRAY TAILRACE NEAR COLUMBIA, SC
02168504 SALUDA RIVER BELOW LK MURRAY DAM NR COLUMBIA,
02169000 SALUDA RIVER NEAR COLUMBIA, SC
02169500 CONGAREE RIVER AT COLUMBIA, SC
02169570 GILLS CREEK AT COLUMBIA, SC
02169625 CONGAREE RIVER AT CONGAREE NP NEAR GADSDEN, SC
02169672 CEDAR CREEK AT CONGAREE NP NEAR GADSDEN, SC
02169740 CONGAREE RIVER AT SOUTHERN RR NR FT MOTTE, SC

Broad River Resources

General Basin Water Management

Broad Scenic River Advisory Council. 2003. Broad Scenic River Management Plan. Report 32. Duke Power, A Division of Duke Energy, SC DNR, and SC DHEC, August 15, 2003.

In 1991, a 15.3 mile segment of the Broad River on the border of York and Cherokee Counties was designated a state scenic river. An advisory council was formed with members representing bordering landowners, river users, and community interests. The role of the Council is to advise SC DNR in protecting and managing this scenic river corridor. The plan's goals are to protect and enhance the natural, cultural, and scenic resources of the river for present as well as future generations. The first two sections of the plan provide an introduction to the Broad Scenic River Project. The remaining sections highlight the management plan by providing information regarding the resources, concerns, and uses of the Broad River Corridor. Recommendations and opportunities for the community outreach and education compose the final section of the plan.

Furman University. n.d. The River Basins Research Initiative at Furman University. http://ees.furman.edu/research/rbri/rbri.html. Accessed February 22, 2006.

The goal of this NASA, EPA, SC DHEC, and NSF-Research Experience for Undergraduates (REU)-sponsored research program is to determine the degree of human impact due to urbanization on the Lower Broad River Basin in both rural and urban areas. The effort is multi-disciplinary and includes the use of GIS and remote sensing, water quality and biological sampling, and geomorphic analysis. Research is completed in the summer by undergraduates under the guidance of Furman faculty and is available on the website.

Leigh, D.S. 1998. A >12,000-Year Record of Natural Levee Sedimentation Along the Broad River near Columbia, South Carolina. *Southeastern Geographer*. 38(2): 95-111.

This article described sedimentary analysis of an 8.1 m natural levee, north of Columbia, SC, along the Broad River. Seven meters depth of levee sediments span 12,000 years of deposition during late Pleistocene and Holocene time. The research indicates that incision of the river channel had concluded by end of the Pleistocene and aggradation of sediment on the floodplain characterizes the majority of the Holocene. The author asserts that paleoindian archeological sites could therefore be buried under several meters of deposits for Southern piedmont rivers. Paleosedimentation rates are about an order of magnitude lower then historical sedimentation rates, consistent with the findings in other river systems. This would indicate that sedimentation is increasing with increasing anthropogenic influence.

SC DNR. 2004. The Broad Scenic River Website. http://sercc.com/water/envaff/river/broad_scenic.htm Accessed February 22, 2006.

This site describes the Scenic Rivers Stewardship program and the Broad River Advisory Council's efforts to work with basin landowners to voluntarily protect river resources. The designated scenic river stretch is 15 miles from the 99 Islands dam to the confluence with the Pacolet River in South Carolina. The Advisory Council encourages landowners to consider memorandums of agreement, conservation easements, and land donation. The Advisory Council also recommends areas of special significance to be protected within the watershed for outstanding natural features, historic sites, etc.

Smith, K. 1993. Broad Scenic River Management Plan, South Carolina Water Resources Commission, Report No. 176, Columbia, South Carolina.

On May 17, 1989, Broad River Landowners Coalition requested the South Carolina Water Resources Commission investigate if a portion of the Broad river, extending from 99-Islands to its confluence with the Pacolet River, was eligible for induction as a state scenic river. A further reach was added, to the confluence with George Branch in Chester County, on May 25, 1990. Landowner opposition led this additional segment to be excluded from the scenic river designation. The goal of this management plan, created by the Saluda River Advisory Council, is to manage and enhance the aesthetics and recreational values of the Broad River Scenic Corridor through a local, community-based plan that is consistent with the state scenic rivers program. There are useful maps of the scenic river reach included in the report. Contact Mary Crockett at SC DNR for this report: crockettm@dnr.sc.gov

Broad River Water Quality

SC DHEC, Bureau of Water. 1998. Watershed Water Quality Management Strategy: Broad Basin, Bureau of Water Technical Report No. 001-98, Columbia, South Carolina.

SC DHEC began watershed planning activities in 1972 as a result of a U.S. EPA grant. Subsequently, these plans have been updated on a 5-year basis. The watershed approach is useful in improving communication between relevant agencies and the public, allows for focus upon Congressional and Legislative mandates, and also to allow DHEC to act in a proactive manner in terms of watershed planning. The report contains useful information, including maps and summaries, of issues concerning water quality broken down by sub-basins of the Broad River. Special concerns were noted for the lower Broad River in terms of water quality, specifically heavy metals. pH and DDT levels were so much a concern that aquatic life was not supported in some of the sites surveyed. Contact Mary Crockett at SC DNR for the report: crockettm@dnr.sc.gov or Richelle Tolton at SC DHEC Bureau of Water: TOLTONRD@dhec.sc.gov

SC DHEC, Bureau of Water. 2001. Watershed Water Quality Assessment Technical Report, Broad River Basin. 001-01. http://www.scdhec.net/eqc/water/shed/broaddoc.html Accessed Feb. 22, 2006.

This report describes and effort by DHEC to collect and compile water quality information for the Broad River watershed. Physical geographies of the Basin and components sub basins are included. Appendix C contains useful water quality summary tables and maps of the basin.

Fish Communities and Aquatic Species

Duke Engineering Services, 1999. Broad River Fish and Habitat Study, Conducted by Duke Power Laboratory Services.

The Ninety-nine Islands Hydroelectric Station powerhouse was built from 1905-1910, while the concrete dam was constructed in 1917. Both structures are eligible for inclusion in the National Register of Historic Places. The hydroelectric station is a modified peaking plant located on the main branch of the Broad River in Cherokee County, near Blackburg, SC. The Ninety-Nine Islands Dam impounds a 175 ha (433 ac) reservoir with free-flowing tailwater. The drainage basin totals 4020 km^2 (1550 mi^2). The heavy transport of silt by the channel has substantially reduced the area and volume of the reservoir since it was completed in 1910. The report contains information necessary for FERC relicensing , including information regarding water quality, fish, wildlife and botanical resources, existing and proposed measures for dam operation, hydrologic characteristics, archeological and historical resources, and recreation facilities as well as opportunities. Contact Mary Crockett at SC DNR for the report: crockettm@dnr.sc.gov

Foley, J.R. 1972. A Qualitative and Quantitative Study of the Annual Species Succession of the Phytoplankton in the Broad River near Parr, South Carolina. Masters of Science thesis for the Department of Biology, University of South Carolina. Available at the South Caroliniana Library.

The purpose of this thesis endeavor was to document basic qualitative and quantitative data regarding succession of phytoplankton species in conjunction with Broad River physical and water quality factors. The author was interested in comparing phytoplankton conditions before and after the construction of the nuclear and hydroelectric generation facilities on Frees Creek and Parr Shoals. Foley found that fluctuations in river statge, turbulence, turbidity and nutrient concentrations interrupted the progress of the phytoplankton community in reaching maturity.

SC DNR. 2005. Broad River Basin Aquatic Inventory. Accessed February 22, 2006: http://www.dnr.sc.gov/fish/fwfi/broadriver.html.

DNR purports that baseline data is needed for fish species in the Broad River Basin which have received relatively little attention. In response to federal dam relicencing activity in the basin, DNR has been conducting spot surveys of aquatic species. A more comprehensive survey of the River will characterize the composition and health of the biotic community. General physical basin parameters will also be collected. Mary Crockett at SC DNR related that the complete report of the Broad River's fish communities should be completed by the end of Summer 2006. Contact Mary Crockett at SC DNR for further information: crockettm@dnr.sc.gov

SC DNR. 2002? An inventory of the aquatic resources of the Broad River, with emphasis on fishes. Accessed April 5, 2006: www.dnr.sc.gov/fish/fwfi/broadriverresearch.pdf

The Broad River Mitigation Trust fund was established to oversee the protection and mitigation of threats to the fish community in the Broad River Basin. A representative from SC DNR, USFWS, Duke Power Company, and one from SCE&G serve as trustees overseeing Trust expenditures. The objective of this report is to obtain monies in order carry out the following tasks. The final goals of this study are to inventory the aquatic resources of the Broad River with emphasis on fish species, examine the major fish habitat types in the basin as determine the degree they are influenced by dams, compare the results of this study to existing studies in order to make correlations between the fish community and environmental variables, and use the data collected to protect and enhance the aquatic resources of the Broad River Basin.

Vegetation and Indigenous Species

Aulbach-Smith, C.A. 1999. Land Cover and Vegetation of the Broad River Scenic Corridor South Carolina, submitted to Duke Engineering and Services, Botanical Services of South Carolina.

Using 1989 and 1994 NAPP false color-infrared photos, soil survey maps, aerial surveys, and ground-truthing, the land cover of Broad River Scenic Corridor was determined. Mapping of the inundation zone additionally utilized USGS 7.5 minute quads. The report describes, in detail, the 11 land cover types determined, 6 of which are forest types, but also includes freshwater, agricultural fields, scrub, wildlife management areas, and "other." The report contains no map of the classifications in the corridor, which would have been extremely helpful in understanding their extent and distribution. However, it does describe the characteristics of a minimally impacted reach of the Broad River. Contact Mary Crockett at SC DNR for the report: crockettm@dnr.sc.gov

Gaddy, L.L. 1999. Inventory of Rare, Threatened, and Endangered Species and Significant Natural Areas of the Upper Broad River Corridor from Ninety-Nine Islands Lake to Lockhart, South Carolina, submitted to Duke Engineering and Services.

This report chronicles the species of concern in the Broad River Scenic Corridor. The lower reaches of the major tributaries, King's Creek, Thickety Creek, Bullock Creek, and the lower Pacolet River were also surveyed as part of this inventory. The purpose of the study was to inventory major habitats in the study area for the presence of rare and endangered species of plants and animals and also for significant natural areas. Field work was conducted Fall 1998 to June of 1999. Six state-listed species were found in the corridor and associated tributaries: rough sedge, shoals spider lily, single-flowered broomrape, sweet cicely, Canada moonseed, and drooping sedge. Additionally, several species not common to the area, but noteworthy, include the Carolina laurel, the Diana butterfly, and the piedmont heartleaf.

Historical Resources

Broad River Basin Historical Society. 1991-2002. The Broad River Notebook. Hickory Grove, SC. Available at the University of South Carolina, Caroliniana Library.

This serial publication recounts the importance of the Broad River to the history of northern South Carolina, namely western York County. The publication includes genealogical information and historical accounts of the region which often include the Broad River. Historical hydroclimatological information can be obtained from many of the accounts, such as in the December 2001 issue, which recounts bridge-building and flooding on the Broad River.

Broad River (and major tributaries) U.S.G.S relevant 1:24,000 7.5 minute quads

Fingerville East
Valley Falls
Chesnee

Cowpens
Boiling Springs South
Gaffney
Spartanburg
Pacolet
Pacolet Mills
Wilkinsville
Kelton
Moore
Glen Springs
Cross Anchor
Union West
Union East
Reidville
Woodruff
Enoree
Ora
Philson Crossroads
Sedalia
Whitmire North
Blacksburg North
Blacksburg South
Kings Creek
Hickory Grove
Lockhart
Leeds
Carlisle
Blair
Pomaria
Jenkinsville
Chapin
Richtex
Irmo
Columbia North

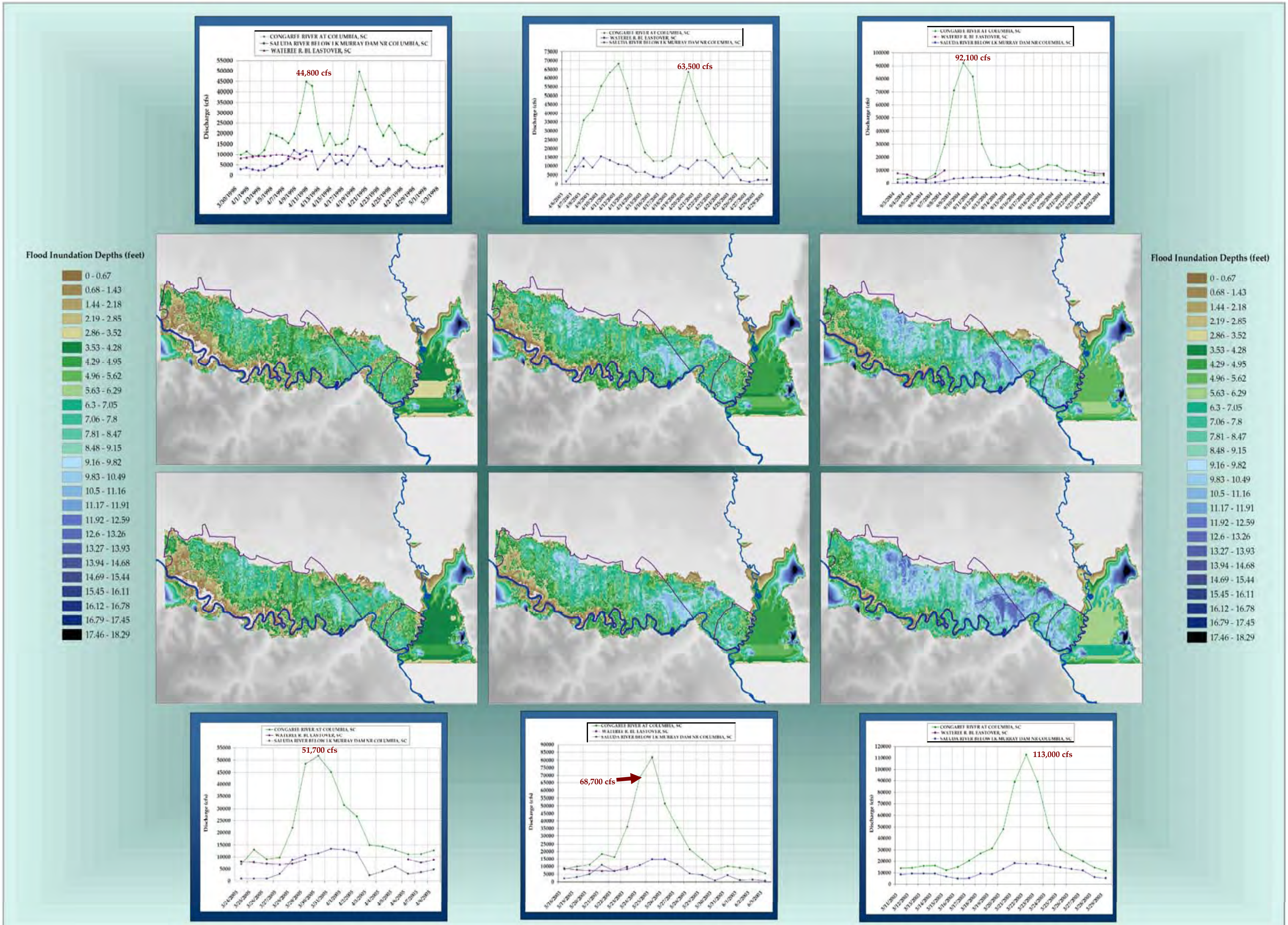
U.S.G.S. Gaging Stations for the Broad River Basin
02157490 BEAVERDAM CREEK ABOVE GREER, SC
02153680 BROAD R NR HICKORY GROVE S C
02161000 BROAD RIVER AT ALSTON, SC
02161500 BROAD RIVER AT RICHTEX, S. C.
02153551 BROAD RIVER BELOW CHEROKEE FALLS, SC
02153200 BROAD RIVER NEAR BLACKSBURG, SC
02156500 BROAD RIVER NEAR CARLISLE, S. C.
02153500 BROAD RIVER NEAR GAFFNEY, SC
021603257 BRUSHY CREEK NEAR PELHAM, SC
02155600 BUCK CREEK NEAR FINGERVILLE, SC

02153800 BULLOCK CREEK NR SHARON, SC
02167557 BUSH RIVER AT JOANNA, SC
02162010 CEDAR CREEK NEAR BLYTHEWOOD, SC
02153780 CLARKS FORK CREEK NR SMYRNA, SC
02160381 DURBIN CREEK ABOVE FOUNTAIN INN, SC
02159600 DUTCHMAN CREEK NEAR PAULINE, S.C.
02160326 ENOREE RIVER AT PELHAM, SC
02160200 ENOREE RIVER AT TAYLORS, SC
02160700 ENOREE RIVER AT WHITMIRE, SC
02160500 ENOREE RIVER NEAR ENOREE S.C.
02160390 ENOREE RIVER NEAR WOODRUFF, SC
02159800 FAIRFOREST CREEK AT SPARTANBURG, S. C.
02160000 FAIRFOREST CREEK NEAR UNION, S.C.
02160775 HELLERS CREEK NR POMARIA, SC
021607224 INDIAN CREEK ABOVE NEWBERRY, SC
02156301 LAWSON FORK CREEK @ TREATMENT PLANT @ SPARTANBURG
02156050 LAWSONS FORK CREEK AT DEWEY PLANT NR INMAN, SC
02156300 LAWSONS FORK CREEK AT SPARTANBURG SC
021584051 MAPLE CREEK NEAR DUNCAN, SC
02157500 MIDDLE TYGER RIVER AT LYMAN, S.C.
02157470 MIDDLE TYGER RIVER NEAR GRAMLING, SC
02157510 MIDDLE TYGER RIVER NEAR LYMAN, SC
02156450 NEALS CREEK NR CARLISLE, SC
02154500 NORTH PACOLET RIVER AT FINGERVILLE, S. C.
02157000 NORTH TYGER RIVER NEAR FAIRMONT, S. C.
02158000 NORTH TYGER RIVER NEAR MOORE, S. C.
021556525 PACOLET RIVER BELOW LAKE BLALOCK NEAR COWPENS, SC
02156000 PACOLET RIVER NEAR CLIFTON, S. C.
02155500 PACOLET RIVER NEAR FINGERVILLE, SC
02150495 SECOND BROAD RIVER NR LOGAN, NC
02162093 SMITH BRANCH AT NORTH MAIN ST AT COLUMBIA, SC
02154790 SOUTH PACOLET RIVER NR CAMPOBELLO, SC
02158408 SOUTH TYGER RIVER BELOW DUNCAN, SC
02158410 SOUTH TYGER RIVER BELOW LYMAN, SC
02158500 SOUTH TYGER RIVER NEAR REIDVILLE, S. C.
02159000 SOUTH TYGER RIVER NEAR WOODRUFF, S. C.
021563931 TURKEY CREEK NEAR LOWRYS, SC
02160105 TYGER RIVER NEAR DELTA, SC
02159500 TYGER RIVER NEAR WOODRUFF, S. C.
02161700 WEST FORK LITTLE RIVER NR SALEM CROSSROADS, S.C.

APPENDIX B:

Floodplain Inundation Modeling using HEC-RAS & GIS – EXAMPLES

HEC-RAS GIS Flood Inundation Depth Models and Flood Hydrographs



APPENDIX C:

Indicator Species and Associated Life History Attributes w/citations

ESWM Species List, Updated January 15, 2008

Group	Common Name	*Genus*	*Species*	Available Literature	Documented Response to Flow	Ecologically Significant	Threatened or Endangered	Category
Bird	Wood Duck	*Aix*	*sponsa*	many	yes (floodplain)	common/economic		Keep
Bird	Woodstork	*Mycteria*	*americana*	many	yes	foraging in floodplain, 100s in Wateree	State Species Concern, Federally Endangered	Keep
Bird	Prothonotary Warbler	*Protonotaria*	*citrea*	many	yes (floodplain)			Keep
Fish	Shortnose Sturgeon	*Acipenser*	*brevirostrum*	med.	yes/connectivity		Federally/State Endangered	Keep
Fish	American Shad	*Alosa*	*sapidissima*	many	connectivity of rivers			Keep
Fish	Redfin Pickerel	*Esox*	*americanus*	many	yes (floodplain)	floodplain spawner (fall)		Keep
Fish	Redbreast Sunfish	*Lepomis*	*auritus*	med.	yes	floodplain spawner		Keep
Fish	Striped Bass	*Morone*	*saxatilis*	many	yes	economic sig.		Keep
Fish	Robust redhorse	*Moxostoma*	*robustum*	med.	yes/connectivity			Keep
Fish	Blueback herring	*Alosa*	*aestivalis*	med.	yes/connectivity	floodplain spawner		Keep
Invertebrate	Roanoke Slabshell	*Elliptio*	*roanokensis*	med.	yes			Keep
Invertebrate	Yellow Lampmussel	*Lampsilis*	*cariosa*	med.	yes			Keep
Mammal	Otter	*Lontra/Lutra*	*canadensis*	many	some indication			Keep
Mammal	Wild Boar	*Sus*	*scrofa*	med.	negative relationship	direct management implications		Keep
Plant	Water Tupelo	*Nyssa*	*aquatica*	many	yes (floodplain)			Keep
Plant	Bald Cypress	*Taxodium*	*distichum*	many	yes (floodplain)			Keep

American Shad	J	F	M	A	M	J	J	A	S	O	N	D
Reproduction (spawning or nesting)			--Spawning occurs March-May in temperatures ranging from 12.5 to 25ºC, with a peak at 21-23ºC. [2,3] --Spawning occurs over flats or shallow water.[3]									
Growth (for juvenile stages)			--Larvae are generally found in the eddy and backwater areas of rivers. [1] --Feeding success is often low among first-feeding larvae. Abundant preferred food is an important consideration for survial.[1] --Larvae remain in tidal freshwater nursery until late fall, when they migrate out to sea or downstream to the mouth of the river to overwinter. [3]									
Maintenance (foraging, prey avoidance, competition with other sp.)			--Adult American shad feed little in freshwater while on a spawning run as prey zooplankton is much smaller than marine prey and is therefore unavailable.[3] --Larvae and juveniles prefer crustacean zooplankton and immature insects, but also feed on copepods, shrimp, worms, and some fishes.[1,3,5] --One of the largest threats with American shad is its inability to migrate due to fragmentation of river spawning habitat by hydroelectric dams.[4]									

1. Crecco, V.A. and Blake, M.M. Blake. 1983. Feeding Ecology of Coexisting Larvae of American Shad and Blueback Herring in the Connecticut River. *Transactions of the American Fisheries Society*.

2. DNR, South Carolina. 1983. "American Shad Eggs by Temperature" data. See Jim Bulak for more information.

3. Marcy, B.C., D.E. Fletcher, F.D. Martin, M.H. Paller, and M.J.M. Reichert. 2005. *Fishes of the Middle Savannah River Basin with Emphasis on the Savannah River Site*. Athens, GA: University of Georgia Press.

4. Patty, S.S., N. Roth, and D. Mountain. 1999. Maryland, the Power Plant Research Program, and Chesapeake Bay Watershed. *The Science of the Total Environment* 240: 171-188. [For context: Dams are a large impediment to spawning runs].

5. Rohde, F.C., R.G. Arndt, D.G. Lindquist, and J.F. Parnell. 1994. *Freshwater Fishes of the Carolinas, Virginia, Maryland, and Delaware*. Chapel Hill, N.C.: The University of North Carolina Press.

Jim Bulak: Only anecdotal information is available for SC populations of American shad.
Feeding and timing of growth information.—juvenile summer size from SCDNR monitoring collections. Rate of growth is dependent upon food supply. During current drought, growth rate is slower, all things being average. Any rains would increase nutrient availability.

Bald cypress	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Reproduction **Reproduction** (flowering, seed dispersal, germination)					--Floods May-Jul. have a negative affect on recruitment because they impede seed germination.[2]					--Floods occurring Oct.-Feb. are important to seed dispersal.[2]		
Growth (seedling/sapling stages)			Seedlings sensitive to flooding in low lying areas and drought in higher elevations (Almquist 2002).									
Maintenance (mature tree growing season, photosynthesis, root development and maintenance)	Mature trees tolerant of a winter floods during dormancy (Almquist 2002)											Mature trees tolerant of a winter floods during dormancy (Almquist 2002

1. McLeod, K.W. 2000. Species selection trials and silvicultural techniques for the restoration of bottomland hardwood forests. *Ecological Engineering* 15:S35-S46.

2. Meyer, J., et al. 2003. Summary Report Supporting the Development of Ecosystem Flow Recommendations for the Savannah River below Thurmond Dam. June 2003. pp. 150.

Patterson, G.G., G.K. Speiran and B.H. Whetstone. 1985. Hydrology and its effects on Distribution of Vegetation in Congaree Swamp National Monument, South Carolina. USGS, prepared in cooperation with the National Park Service. Water-Resources Investigations Report 85-4256. [I gave this one to you in digital format, it is in the hydrology folder].

Visser, J.M. and C.E. Sasser. 1995. Changes in tree species composition, structure and growth in a bald-cypress-water tupelo swamp forest, 1980-1990. *Forest Ecology and Management* 72: 119-129.

From Park Library, See LS summary of Minchin and Sharitz below:
Another possibility, although I doubt that this supports our argument for ecological flows due to the climatologic and insect effects ecosystem effect uncertainties:

Minchin, P.R. and R.R. Sharitz, 2007. Age Structure and Potential Long-term Dynamics of the Floodplain Forests of Congaree National Park. A report for the Park, Final Report submitted August 31, 2007.

The object of this research was to determine if alterations in the hydrograph of the Congaree River have known effects on the on the floodplain forests of Congaree. The study authors analyzed the size distribution of species and tested for evidence of long-term changes in forest composition due to changes in hydrologic regime. The authors also examined woody species recruitment during the 2004 season to compare with previous season's recruitment data. The study revealed that the community is trending toward a drier condition community, suggesting a long-term change in forest composition. Specifically, since 1930 (era of Saluda Dam establishment), the age cohorts of trees on study sites appeared to be increasingly indicative of species "typical of less frequently and less deeply flooded conditions." The majority of plots in sloughs with a significant trend (toward drier conditions) were on relatively higher elevation sites (located more than 3 km from the river channel) [this would indicate sites in the sloughs that used to get flooded by high floods no longer do], whereas most of the BLHW plots with significant trajectories were on lower elevation sites [used to having more water for a longer time than they now do?] within 2 km of the main channel. "Some BLHW plots may be undergoing a succession toward less flood-tolerant species that is primarily driven by sedimentation, rather than changes in the hydrologic regime."

The authors found that the modified run-of-river period for the retro-fit drawdown of Saluda Dam during the sample time [which was not true run-of-river in any case], encouraged no detectable pattern affecting woody seedling recruitment. They caution that at least ten years of observation would be needed to separate out effects of change in river flow patterns from variation in other environmental factors that would affect woody regeneration.

The frequency of large floods have decreased: 2 year floods now occur every 4.5 years and 5-year floods now occur every 25 years. Both high and low discharges have also been reduced, the typical winter flooding period has been extended into the early growing season, and the vertical movement of shallow groundwater has been reduced during low flows. The biota of floodplains is adapted to the timing and intensity of floods, conditions it uniquely adapted to. In the Savannah River, floods during the dormant season are important to seed dispersal by canopy-dominant species. Alternately, floods of several weeks duration in the growing season, due to Strom Thurmond Dam, are detrimental to woody seedlings and have been shown to limit recruitment of Bald cypress (*Taxodium distichum*) and Water tupelo (*Nyssa aquatica*) seedlings.

Blueback Herring	J	F	M	A	M	J	J	A	S	O	N	D
Reproduction (spawning or nesting)		--Spawn over vegetation in backwater tributary systems, including BLHFs and will use flooded areas to lay eggs—prefer shallow, flooded areas.[2,4,5] --Optimal spawning temperature is between 21-25°C.[2] --Fluctuations in flow affect habitat use: moderate to high flows increase use of spawning and nursery areas and hence recruitment.[4] --Eggs are initially demersal and adhesive in still water and may become pelagic after hardening and release from the substrate.[2]										
Growth (for juvenile stages)			--Larvae are generally found in the eddy and backwater areas of rivers.[1] --Feeding success is often low among first-feeding larvae. Abundant preferred food is an important consideration for survial.[1] --Smaller juveniles remain in the rivers where they hatched until fall.[2] --Flood-induced expansions of flooded forest habitat would be beneficial if flooded ample time to allow eggs to hatch, larvae to grow, and then to be slowly incorporated into the river.[4]									
Maintenance (foraging, prey avoidance, competition with other sp.)		--Adults feed primarily on zooplankton and some fishes, but do not eat extensively while on spawning run.[2,3] --Young feed especially on rotifers, and then on copepods, insects, shrimp, and worms.[1,2,3]										

1. Crecco, V.A. and Blake, M.M. Blake. 1983. Feeding Ecology of Coexisting Larvae of American Shad and Blueback Herring in the Connecticut River. *Transactions of the American Fisheries Society*.

2. Marcy, B.C., D.E. Fletcher, F.D. Martin, M.H. Paller, and M.J.M. Reichert. 2005. *Fishes of the Middle Savannah River Basin with Emphasis on the Savannah River Site*. Athens, GA: University of Georgia Press.

3. Rohde, F.C., R.G. Arndt, D.G. Lindquist, and J.F. Parnell. 1994. *Freshwater Fishes of the Carolinas, Virginia, Maryland, and Delaware*. Chapel Hill, N.C.: The University of North Carolina Press.

4. Walsh, H.J. 2005. Early life history of blueback herring and alewife in the lower Roanoke River, North Carolina. *Transactions of the American Fisheries Society* 134(4): 910 -926.

Jim Bulak information: competition with American Shad. There are 4 species of plankton grazers in the system— anadromous American shad, blueback herring, and resident gizzard shad and threadfin shad. In the last 20 years, the relative percentage of blueback herring has declined. New fish lifts favor American Shad over Blueback herring—style of fishlift? Stocks of herring are down along the Atlantic coast. This may be cyclic, indicating other things may be going on. Herring have lost ground to American shad in the last decade. Herring in Saluda River/Congaree River would use Congaree floodplain habitat. However, only a small percentage of herring would reach that high up in the system.

Feral hog	J	F	M	A	M	J	J	A	S	O	N	D
Reproduction (spawning or nesting)	--Births of piglets occur all year, but are less frequent August-November, with two peaks noted: December-January, and April-May.[2] -- Successful breeding is dependent upon food supply, however, the high reproductive level of this species allows for rapid recovery even after the end of a food shortage.[2]											
Growth (for juvenile stages)												
Maintenance (foraging, prey avoidance, competition with other sp.)	--Non-native feral hogs place the resources of Congaree National Park at risk: wetland communities, native vegetation, streams, aquatic habitats, rare or endangered species, historic structures, and trails can be damaged by hog rooting and other destructive behaviors.[3] --Lack of inundation of the floodplain, such as during drought conditions, may result in hogs concentrating their activity on the floodplain and remaining there for long periods or year-round due to water availability, lower temperatures, greater food availability, etc.[3] --Wild pigs are opportunistic foragers, although they have a decided preference for plant material most of the year, they can prey on mussel sp.[1,4] --The most depredated hardwood seedlings on the Savannah River Site by feral hog include cherrybark oak and swamp chestnut oak.[1]											

1. Mayer, J.J., E.A. Nelson, and L.D. Wike. 2000. Selective depredation of planted hardwood seedlings by wild pigs in a wetland restoration area. *Ecological Engineering* 15:S79-S85.

2. Tate, J. 1984. Techniques for Controlling Wild Hogs in Great Smokey Mountains National Park: Proceedings of a Workshop, November 29-30, 1983. National Park Service-Southeast Region, Research-Management Report SER-72. p.4

3. USGS, NPS, and Clemson University. 2005. Final Report: Feral Hog impact monitoring, management plan development, and initial management for Congaree National Park. NPS Agreement No. F 5240 00 0265, USGS No: 1434-HO-00RM-0062. May, 2005. 33 pp.

4. Williams, J.D. and A.J. Benson. 2004. Freshwater Mussels (Family Unionidae) of the Congaree Swamp National Park. Final Report to the Congaree Swamp National Park. U.S. Geological Survey, Gainesville, FL, December 30, 2004.

Prothonotary Warbler	J	F	M	A	M	J	J	A	S	O	N	D
Reproduction (spawning or nesting)		--Nesting highly specific to cavities over water. [1,5] --Nesting success dependent upon high water levels to reduce predation and hence improve reproductive success.[2, 4] --Comparatively larger clutches and more fledglings in swamp habitat than levee. [3]										
Growth (for juvenile stages)			Warblers in swamp habitat perceive and attack more prey per unit time. This could lead to more, healthy offspring. [3]			? Also a growth month?						
Maintenance (foraging, prey avoidance, competition with other sp.)		--Depend upon critical food resources associated with the presence of water. [2, 4] --To maintain the diversity of BLHF bird communities, an intact system is important, including all elevational and hence moisture varying zones. P.W. particularly like wetter habitats.[5]										

1. Bunn, A.G., D. L. Urban, and T.H. Keitt. 2000. Landscape connectivity: A conservation application of graph theory. *Journal of Environmental Management* 59: 265-278.
2. Hoover, J.P. 2006. Water Depth Influences Nest Predation for a Wetland-dependent bird in fragmented bottomland forests. *Biological Conservation* 127:37-45.
3. Lyons, J.E. 2005. Habitat-specific Foraging of Prothonotary Warblers: Deducing Habitat Quality. *The Condor* 107:41-49.
4. Petit, L.J. and Petit, D.R. 1996. Factors governing habitat selection by prothonotary warblers: field tests of the Fretwell-Lucas models. *Ecological Monographs* 66: 367-387.
5. Wakely, J.S. and T.H. Roberts. 1996. Bird Distributions and Forest Zonation in a Bottomland Hardwood Wetland. *Wetlands* 16(3):296-308.

Koman, T. M. 2003. The hydrologic effects of dams on the Saluda River, South Carolina. Masters Thesis in the Department of Geography, USC. [This paper used to establish pre-dam peak flood period]

Redbreast sunfish	J	F	M	A	M	J	J	A	S	O	N	D
Reproduction (spawning or nesting)				--Spawn April - June.[3] --Sunfish are at disadvantage for reproduction during peak flooding on floodplain.[4] --Nests are found in shallow areas on sand and gravel substrates.[1] --Impoundments may prevent redbreast sunfish from reaching suitable spawning areas,[1] and may delay spawning due to cold-water releases.[5]								
Growth (for juvenile stages)							Juvenile sunfishes utilize the floodplain.[1]					
Maintenance (foraging, prey avoidance, competition with other sp.)		--Numbers of sunfish decrease with peak flooding.[4] --Dusky Shiners prey on eggs of redbreast sunfish and trick them into raising their young. Whether an obligate or facultative nesting relationship for the shiner, is not known. [2] --Food items include aquatic insects, small clams, crustaceans (crayfish), and small fishes.[3,5]								Form wintering schools in deeper waters and disband in spring for nest sites.[1]		

1. Brim, J. 1991. Coastal Plain Fishes: Floodplain Utilization and the Effects of Impoundments. Master of Science in the Department of Biological Sciences, University of South Carolina.
2. Fletcher, D.E. 1993. Nest Association of Dusky Shiners (Notropis cummingsae) and Redbreast Sunfish (Lepomis auritus), a Potentially Parasitic Relationship. *Copeia* (1):159-167.
3. Rohde, F.C., R.G. Arndt, D.G. Lindquist, and J.F. Parnell. 1994. *Freshwater Fishes of the Carolinas, Virginia, Maryland, and Delaware*. Chapel Hill, N.C.: The University of North Carolina Press.
4. Rose, L. and J. Bulak. 2005. Flood Mediated Change of the Fish Community in Congaree National Park Streams. South Carolina Department of Natural Resources Freshwater Fisheries, 18 Pp.
5. Marcy, B.C., D.E. Fletcher, F.D. Martin, M.H. Paller, and M.J.M. Reichert. 2005. *Fishes of the Middle Savannah River Basin with Emphasis on the Savannah River Site*. Athens, GA: University of Georgia Press.

Jim Bulak information: Redbreast sunfish may like more constant conditions, counter to understanding that most fish like peak flooding conditions—drought tolerant. Life history species—spawn from May- June, so less likely during the natural hydrologic cycle to experience a flood event during their spawning period.

Redfin Pickerel	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Reproduction (spawning or nesting)	--Species take advantage of peak flooding for reproduction on floodplain.[1,5,6] --Evidence that redfin pickerel can spawn over a long time period, from fall to early spring.[1,2,5] --Temperature and rainfall prior to spawning date are the dominant factors in spurring reproduction.[1] Floodplain inundation may be the dominant factor.[2] --Eggs in three developmental stages indicate that redfin pickerel can take advantage of unpredicatable hydrologic events to spawn.[2]											
Growth (for juvenile stages)		Larval fish utilize floodplain.[1,2,3]										
Maintenance (foraging, prey avoidance, competition with other sp.)		--A voracious predator, larvae and smaller juveniles eat zooplankton and insects. Adults eat predominantly fishes, but may eat crayfish and other invertebrates. [5] --Numbers of Redfin Pickerel increase with peak flooding.[2,5,6] --Upstream in streams fragmented by impoundments, redfin pickerel were replaced by largemouth bass and white bass is terms of piscivore abundance and composition.[4]										

1. Ballek, M.S. 1994. Reproduction and Early Life History of the Redfin Pickerel, (Esox americanus americanus). Master of Science in the Department of Biological Sciences, University of South Carolina.
2. Brim, J. 1991. Coastal Plain Fishes: Floodplain Utilization and the Effects of Impoundments. Master of Science in the Department of Biological Sciences, University of South Carolina.
3. Crawford, C.R., J.C. Davis, C.B. Hall, J. McCarthy, E. Robey, and E. Winn. 1990. Congaree Swamp: Larval Fish Study. Marine Science Program, University of South Carolina. December 6, 1990.
4. Guenther, C.B. and A. Spacie. 2006. Changes in Fish Assemblage Structure Upstream of Impoundments within the Upper Wabash River Basin, Indiana. *Transactions of the American Fisheries Society* 135:570-583.
5. Marcy, B.C., D.E. Fletcher, F.D. Martin, M.H. Paller, and M.J.M. Reichert. 2005. *Fishes of the Middle Savannah River Basin with Emphasis on the Savannah River Site*. Athens, GA: University of Georgia Press.
6. Rose, L. and J. Bulak. 2005. Flood Mediated Change of the Fish Community in Congaree National Park Streams. South Carolina Department of Natural Resources Freshwater Fisheries, 18 Pp.

Jim Bulak information: Pickerel take advantage of beneficial environmental conditions – like a weed.

River Otter	J	F	M	A	M	J	J	A	S	O	N	D
Reproduction (spawning or nesting)		--Breeding of river otters occurs early spring in temperate regions.[2,5] --Timing of reproduction can alter due to environmental factors.[2]										
Growth (for juvenile stages)			--Young are helpless at birth—are born blind, lightly furred, toothless, and are dependent on the mother for 6-8 weeks.[4,5] --Natal dens are located in upland areas adjacent to river corridors, protected from rapid changes in water levels. Dens are horizontally or vertically distant from the nearest water body.[4]									
Maintenance (foraging, prey avoidance, competition with other sp.)		--Protecting instream flow, seasonal flow regimes, riparian vegetation, and the physical structure of banks and floodplains are key conservation considerations.[1,4,5,6] --Areas of shallow water and wetlands provide shallow water habitats for otter prey including slow-swimming fish, amphibians, reptiles, and invertebrates.[1,5,6] --Otters participate in cooperative foraging, especially clumped around fishing pools and other habitat structures.[3]										

1. Boyle, S. 2006. North American River Otter (*Lontra canadensis*): A Technical Conservation Assessment. Prepared for the USDA Forest Service, Rocky Mountain Region, Species Conservation Project. September 2, 2006. 56 pp.
2. Crait, J.R., G.M. Blundell, J.K. Herreman, and M. Ben-David. 2006. Notes and Discussion: Late Season Breeding of River Otters in Yellowstone National Park. *American Midland Naturalist* 156:189-192.
3. Gorman, T.A., J.D. Erb, B.R. McMillan, and D.J. Daniels. 2006. Space use and sociality of river otters (*Lontra canadensis*) in Minnesota. *Journal of Mammalogy* 87(4): 740-747.
4. Gorman, T.A., J.D. Erb, B.R. McMillan, D.J. Martin and J.A. Homyack. 2006. Site Characteristics of River Otter (*Lontra Canadensis*) Natal Dens in Minnesota. *American Midland Naturalist* 156:109-117.
5. Melquist, W.E. and A.E. Dronkert. 1999. Section IV: Species Biology, Management, and Conservation, Chapter 7 River Otter. In, *Wild Furbearer Management and Conservation in North America*: 626-641.
6. New Mexico Department of Game and Fish, Conservation Services Division. 2006. Feasibility Study: Potential for Restoration of River Otters in New Mexico. Review Draft; July 24, 2006. 59 pp.

Roanoke slabshell	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Reproduction (spawning or nesting)				--Blueback herring, gizzard shad, and white perch serve as hostfish.[4] --Gravid individuals found in the Broad and Congaree Rivers 5/15/-7/3/07.[4] --Gravid individuals are found in North Carolina in early spring.[1] --Ensuring flow of water in sand and gravel areas May-August may facilitate reproduction.[3] --Tailwater discharges from dams create low water temperatures that impede reproduction.[3] [Timeframe in summer months?].								
Growth (for juvenile stages)				--Hydropower peaking may prevent the settlement of juvenile mussels as well as cause reduced growth.[3] [Timeframe in summer months?]. --Increased juvenile recruitment is significantly correlated to the re-watering of channel margin habitats. [2]								
Maintenance (foraging, prey avoidance, competition with other sp.)				--Considered habitat generalists.[2] --Usually found associated with the deeper channels near shore in relatively fast flowing water. The substrate consists of coarse to medium sized sand and small gravel.[1] --Invasive bivalves, such as the Asian clam (*Corbicula fluminea*), may outcompete native mussels. [5] --*Sus scrofa* has a habitat degrading negative relationship with freshwater mussels and additionally uses them as a food source.[5]								

1. Bogan, A.E. and J.M. Alderman. 2004. Workbook and Key to the Freshwater Bivalves of South Carolina. 72 pp.
2. Krueger, E. and R. Heise. 200? Freshwater mussels of the Great Pee Dee River (Rev. 3): Habitat Preferences of Known Occurring Species; and Relationships to Flow, Emersion and Dissolved Oxygen.
3. Meyer, J., et al. 2003. Summary Report Supporting the Development of Ecosystem Flow Recommendations for the Savannah River below Thurmond Dam. June 2003. pp. 47.
4. Price, J. (DNR) and C. Eads (NC State U.). 2007. Personal communication. Email dated December 6, 2007.
5. Williams, J.D. and A.J. Benson. 2004. Freshwater Mussels (Family Unionidae) of the Congaree Swamp National Park. Final Report to the Congaree Swamp National. Park. U.S. Geological Survey, Gainesville, FL, December 30, 2004. [No Roanoke Slabshell were found during the sampling conducted for this study. The absence of migratory host-fish, blocked in their migration by downstream dams, may be a factor. The recent installation of fish ladders on downstream dams may restore some of the host fish and hence mussels to the Park region].

Robust Redhorse	J	F	M	A	M	J	J	A	S	O	N	D
Reproduction (spawning or nesting)			--Utilize shallow water gravel bars in the main channel during spring for spawning[1] in temperatures 21-23°C.[2] --Spawn from March to May, when they gather in large groups over shallow gravel riffles.[5]									
Growth (for juvenile stages)			--Laboratory studies demonstrated fine sediment particles that settle in gravel can entrap eggs and larvae and suffocate them.[4] --Predation on young by introduced flathead and blue catfish also poses a threat.[3,4] --May be tolerant of lentic habitat in juvenile stage.[4]									
Maintenance (foraging, prey avoidance, competition with other sp.)		--During flooding, robust redhorse accessed the floodplain and occupied flooded forest habitat.[3] --Foraging on the floodplain occurs prior to spawning.[3]			--Primary threats to the species are habitat loss due to impoundment, siltation, and other types of alteration.[4] --Food is primarily bivalve molluscs, which are crushed with their teeth.[4]	--Inhabit larger, deeper, and faster bodies of water, near outside river bends, and are therefore difficult to catch. Often found in association with fallen trees, and other woody debris.[3,4,5]						

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2. Georgia Power. 1999-2000. Robust Redhorse Conservation Strategy. [see Jim Bulak for information].

3. Grabowski, T.B. 2006. Seasonal and diel movements and habitat use of robust redhorses in the lower Savannah River, Georgia and South Carolina. *Transactions of the American Fisheries Society* 135 (5):1145 -1155.

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5. Rohde, F.C., R.G. Arndt, D.G. Lindquist, and J.F. Parnell. 1994. *Freshwater Fishes of the Carolinas, Virginia, Maryland, and Delaware*. Chapel Hill, N.C.: The University of North Carolina Press.

Jim Bulak: Robust redhorse have been stocked in the Broad River as of the last year to two years and have the potential to move into the adjoining Saluda-Congaree system.

Coughlan is a good contact. Lead biologist, Duke Power Huntersville, NC. DJCoughlan@duke-energy.com

Shortnose Sturgeon	J	F	M	A	M	J	J	A	S	O	N	D
Reproduction (spawning or nesting)		--Begin migration when temperatures are above 9˚C.[2] --Spawning takes place at temperatures between 10-15˚C.[2] --Spawning sites consists of coarse, hard substrate of gravel or cobble with fast flow.[3,5,6] --Eggs are demersal, and adhesive after fertilization, attaching to hard substrate and then drifting after 2 hours.[3] --Flow volume and water temperature in the fall preceding spawning were correlated with year-class strength.[7]										
Growth (for juvenile stages)		--Larvae and juveniles are poor swimmers. They stay near the bottom for two weeks, then migrate downstream.[3]										
Maintenance (foraging, prey avoidance, competition with other sp.)					--Non-spawning populations were associated with areas where rivers turn and velocity slows: creating levees and sandy shoals.[5] --These sandy or muddy bottom areas provide good foraging for adult food preference of mollusca, particularly Corbicula sp.[1,3,5] Other food preferences include worms, crustaceans, insect larvae, small clams, small fishes,[6] and isopods.[4] --Sturgeon seek deeper water during temperature extremes, especially the summer in SC. This is for temperature preference and may also allow them to conserve energy in slow moving water.[1,5]							

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Jim Bulak: Shortnose sturgeon have been documented spawning at the I-77 bridge vicinity.—timing-- April sometime?

Mark Collins—DNR Sturgeon expert and Bill Post. Extensive work on the sturgeon in SC rivers.

Striped Bass	J	F	M	A	M	J	J	A	S	O	N	D
Reproduction (spawning or nesting)		--Spawns in early spring after migrating up coastal or tributary rivers.[5] --Eggs are slightly heavier than water, so are suspended in the water column and bounce along bottom, drifting downstream. Therefore, good distance is needed for eggs to develop and hatch before reaching still water. [3,5] --Favorable condition of the floodplain frees up nutrients, leading to greater egg potential survival. This is water management dependent.[1]										
Growth (for juvenile stages)					--Juveniles depend upon open reservoir waters for nurseries.[2,5] --Larvae depend upon high concentrations of small zooplankton during the first few days after hatching.[4] --The upper portion of Lake Marion had higher zooplankton densities than the riverine habitat, meaning it is better nursery habitat.[2] --Management of upstream dams may increase recruitment in upper Lake Marion by optimizing temperature and flow. [2]							
Maintenance (foraging, prey avoidance, competition with other sp.)				--Voracious feeders on other fish—menhedan, herrings, shad sp., and eel.[5]								

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2. Bulak, J.S., J.S. Crane, D.H. Secor, and J.M. Dean. 1997. Recruitment Dynamics of Striped Bass in the Santee Cooper System, South Carolina. *Transactions of the American Fisheries Society* 126:133-143.

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Water Tupelo (*Nyssa aquatica*)	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Reproduction (flowering, seed dispersal, germination)					--Floods May-Jul. have a negative affect on recruitment because they impede seed germination.[2]					--Floods occurring Oct.-Feb. are important to seed dispersal.[2]		
Growth (seedling/sapling stages)												
Maintenance (mature tree growing season, photosynthesis, root development and maintenance)												

1. McLeod, K.W. 2000. Species selection trials and silvicultural techniques for the restoration of bottomland hardwood forests. *Ecological Engineering* 15:S35-S46.

2. Meyer, J., et al. 2003. Summary Report Supporting the Development of Ecosystem Flow Recommendations for the Savannah River below Thurmond Dam. June 2003. pp. 150.

Patterson, G.G., G.K. Speiran and B.H. Whetstone. 1985. Hydrology and its effects on Distribution of Vegetation in Congaree Swamp National Monument, South Carolina. USGS, prepared in cooperation with the National Park Service. Water-Resources Investigations Report 85-4256. [I gave this one to you in digital format, it is in the hydrology folder].

Visser, J.M. and C.E. Sasser. 1995. Changes in tree species composition, structure and growth in a bald-cypress-water tupelo swamp forest, 1980-1990. *Forest Ecology and Management* 72: 119-129.

Minchin, P.R. and R.R. Sharitz, 2007. Age Structure and Potential Long-term Dynamics of the Floodplain Forests of Congaree National Park. A report for the Park, Final Report submitted August 31, 2007.

The object of this research was to determine if alterations in the hydrograph of the Congaree River have known effects on the on the floodplain forests of Congaree. The study authors analyzed the size distribution of species and tested for evidence of long-term changes in forest composition due to changes in hydrologic regime. The authors also examined woody species recruitment during the 2004 season to compare with previous season's recruitment data. The study revealed that the community is trending toward a drier condition community, suggesting a long-term change in forest composition. Specifically, since 1930 (era of Saluda Dam establishment), the age cohorts of trees on study sites appeared to be increasingly indicative of species "typical of less frequently and less deeply flooded conditions." The majority of plots in sloughs with a significant trend (toward drier conditions) were on relatively higher elevation sites (located more than 3 km from the river channel) [this would indicate sites in the sloughs that used to get flooded by high floods no longer do], whereas most of the BLHW plots with significant trajectories were on lower elevation sites [used to having more water for a longer time than they now do] within 2 km of the main channel. "Some BLHW plots may be undergoing a succession toward less flood-tolerant species that is primarily driven by sedimentation, rather than changes in the hydrologic regime." The authors found that the modified run-of-river period for the retro-fit drawdown of Saluda Dam during the sample time [which was not true run-of-river in any case], encouraged no detectable pattern affecting woody seedling recruitment. They caution that at least ten years of observation would be needed to separate out effects of change in river flow patterns from variation in other environmental factors that would affect woody regeneration.

The frequency of large floods have decreased: 2 year floods now occur every 4.5 years and 5-year floods now occur every 25 years. Both high and low discharges have also been reduced, the typical winter flooding period has been extended into the early growing season, and the vertical movement of shallow groundwater has been reduced during low flows. The biota of floodplains is adapted to the timing and intensity of floods, conditions it uniquely adapted to. In the Savannah River, floods during the dormant season are important to seed dispersal by canopy-dominant species. Alternately, floods of several weeks duration in the growing season, due to Strom Thurmond Dam, are detrimental to woody seedlings and have been shown to limit recruitment of Bald cypress (*Taxodium distichum*) and Water tupelo (*Nyssa aquatica*) seedlings.

Wood Duck	J	F	M	A	M	J	J	A	S	O	N	D
Reproduction (spawning or nesting)	--Timing and success of reproduction/nesting depends on timing of flooding for nest establishment and to reduce predation.[1,3] --Laying females depend upon feeding on invertebrates in shallow water for egg formation.[3]											
Growth (for juvenile stages)		Fledging of offspring.[1]										
Maintenance (foraging, prey avoidance, competition with other sp.)		Peak flooding aides in reduced floodplain nest predation.[2, 3]										

1. Hepp, G.R., R.A. Kennamer, and W.F. Harvey. 1989. Recruitment and Natal Philopatry of Wood Ducks. *Ecology* 70:897-903.

2. Nielsen, C.L.R. and R.J. Gates. 2007. Reduced Nest Predation of Cavity-Nesting Wood Ducks During Flooding in a Bottomland Hardwood Forest. *The Condor* 109:210-215.

3. Ryan, D.C., R.J. Kawula, and R.J. Gates. 1998. Breeding Biology of Wood Ducks using Natural Cavities in Southern Illinois. *Journal of Wildlife Management* 62(1):112-123.

Koman, T. M. 2003. The hydrologic effects of dams on the Saluda River, South Carolina. Masters Thesis in the Department of Geography, USC. [This paper used to establish pre-dam peak flood period]

Wood stork	J	F	M	A	M	J	J	A	S	O	N	D
Reproduction (spawning or nesting)			--Nesting begins between mid-March to late April in northern populations.[1] --Nesting timing can be correlated with appropriate water level and/or evaporation rate. [3,5] --Production of eggs is partially dependent on the female's ability to collect and store nutrients which is dependent upon water levels.[5] --Nestlings eat food brought back by their parents. Clutch size ranges from 2-5 eggs. Incubation is 30 days. There is fierce competition for food among the nestlings, with the smallest usually unable to survive in times of food shortage.[5]									
Growth (for juvenile stages)					--Nestlings fledge in about 60 days after hatching.[5] --A successful fledgling leaves the nest but remains near the colony for an additional 25 days.[5]							
Maintenance (foraging, prey avoidance, competition with other sp.)		--Adult wood storks do not feed in water deeper than their legs are long, about 50 cm. Most of their food is obtained at a depth between 15 and 50 cm.[5] --Wood storks feed less successfully in deep water than shallow due to a "searcher" method of stirring and groping for foraging and feeding. [2,3,4,5] They depend heavily on receding water level to concentrate prey.[1,2] --Consumed fish prey (particularly *Gabusia affinis*) are small, averaging only 4.6 cm.[2,5] --Wading birds forage more successfully in groups than singly, and prefer to feed in sites with large flocks containing snowy egret. [3,5] --High water levels are a barrier around nests against predation.[5] --More non-breeding wood storks are found in the Everglades WCAs in dry years as this is better habitat than natural areas which are dried out during drought.[1]										

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2. Depkin, F.C., L.K. Estep, A. L. Bryan, C.S. Eldridge, and I.L. Brisbin. 2005. Comparison of Wood Stork Foraging Success and Behavior in Selected Tidal and Non-tidal Habitats. *Wilson Bulletin* 117(4):386-389.
3. Gawlik, D.E. and G.E. Crozier. 2007. A Test of Cues Affecting Habitat Selection by Wading Birds. *Auk* 124(3):1075-1082.
4. Kelly, J.F. D.E. Gawlik, and D.K. Kieckbusch. 2003. An Updated Account of Wading Bird Foraging Behavior. *Wilson Bulletin* 115(1):105-107.
5. Wolff, W.F. 1994. An Individual-oriented Model of a Wading Bird Nesting Colony. *Ecological Modelling* 72: 75-114.

Yellow Lampmussel	J	F	M	A	M	J	J	A	S	O	N	D
Reproduction (spawning or nesting)			--Smallmouth bass, largemouth bass, striped bass and black crappie all resulted in large numbers of glochidia to juvenile mussels (other species, marginal).[4] --Observed gravid in the Congaree River 5/16-5/30/07.[4] --Observed gravid in N. Carolina throughout the year, although peak is in the cooler months.[1] --Tailwater discharges from dams create low water temperatures that impede reproduction[3] [Timeframe in summer months?].				Also a critical month?					
Growth (for juvenile stages)				--Hydropower peaking may prevent the settlement of juvenile mussels as well as reduce growth[3] [Timeframe in summer months?]. -- Increased juvenile recruitment is significantly correlated to the re-watering of channel margin habitats. [2]								
Maintenance (foraging, prey avoidance, competition with other sp.)			--Habitat preference is for sand to gravel glides and pools, and moderate current.[2,5] --*Sus scrofa* has a habitat degrading negative relationship with freshwater mussels and additionally uses them as a food source.[5] -- Invasive bivalves, such as the Asian clam (*Corbicula fluminea*), may outcompete native mussels. [5] --Mussels in this subfamily may have more difficulty tolerating short dry spells than others.[2]									

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2. Krueger, E. and R. Heise. 200? Freshwater mussels of the Great Pee Dee River (Rev. 3): Habitat Preferences of Known Occurring Species; and Relationships to Flow, Emersion and Dissolved Oxygen.
3. Meyer, J., et al. 2003. Summary Report Supporting the Development of Ecosystem Flow Recommendations for the Savannah River below Thurmond Dam. June 2003. pp. 47. [No hostfish has yet been identified for the Yellow Lampmussel. [Anadromous host-fish suspected: reproduction could be limited of host is unable to reach mussel habitat and is extirpated such as from dam fragmentation of system].
4. Price, J. (DNR) and C. Eads (NC State U.). 2007. Personal communication. Email dated December 6, 2007.
5. Williams, J.D. and A.J. Benson. 2004. Freshwater Mussels (Family Unionidae) of the Congaree Swamp National Park. Final Report to the Congaree Swamp National. Park. U.S. Geological Survey, Gainesville, FL, December 30, 2004. [No Roanoke Slabshell were found during the sampling conducted for this study. The absence of migratory host-fish, blocked in their migration by downstream dams, may be a factor. The recent installation of fish ladders on downstream dams may restore some of the host fish and hence mussels to the Park region].

Appendix 18

SCE&G Response to October 2008 ESWM Proposal

SCE&G Response to October 2008 ESWM Proposal

Although the Ecological Sustainable Water Management (ESWM) program was not part of the Saluda Hydro Relicensing process, SCE&G did participate in a good faith effort to work with the organizations and governmental agencies participating in this program to develop a meaningful flow release scheme that would provide additional benefits, over and above those negotiated within the relicensing process, for river reaches beyond the lower Saluda River. Prior to receiving the ESWM Leadership Committee (LC) proposal, SCE&G received a proposal from SC Department of Natural Resources (SCDNR) requesting additional flows to enhance the striped bass population in the Congaree River. These flow releases would also enhance other species identified through the ESWM process. After reviewing the proposals from the ESWM LC and SCDNR, SCE&G would like to work on both of these proposals as one effort in order to provide a set of flow releases that could be achieved by Saluda Hydro operations. The following is the SCE&G response to the October 2008 proposal from the ESWM LC for additional flow releases from Saluda Hydro.

(1) Naturalized Flow Period: Provide 30 days of naturalized flows annually where SCE&G will operate Saluda Dam to release downstream flows continuously with limited variability based on average inflow into Lake Murray from the previous day. This period would generally be from April 1 to April 30, but could start as early as March 21 and end as late as May 10 depending on climatic conditions and management goals.

Two of every 5 years provide an additional two-week flow naturalization period alternating between an early period (March 1 to March 15) and a late period (May 15 and May 31). The rationale is to produce naturalized flow conditions with intra- and inter-annual variability targeting spring spawning events for aquatic indicator species identified during the ESWM Process. The primary purpose of these periods is to increase flow variability for the full suite of ecological functions. Priorities for the early period are shortnose sturgeon and American shad spawning, and increased early season floodplain inundation. For the later period, priorities are temperature and flow stabilization for robust redhorse, sunfish and other late season spawners.

SCE&G Response: In accordance with a request from the State General Assembly (House Bill H-4548) and the Governor of South Carolina, SCDNR has developed a proposal that addresses additional flow releases to enhance the Santee Cooper striped bass populations in the Congaree River and other species addressed in the ESWM process. These flow releases are being requested between April 1st and May 10th. Any additional flow releases associated with the ESWM process should be consistent with the flows requested by SCDNR so our system dispatch only has to provide one set of parameters. We appreciate your understanding of the complexity of trying to ask our system dispatchers to manage too many parameters at this one plant. Two other issues will need to be addressed once any additional flow release is proposed. These two issues have to do with the potential negative impact on recreational flows and fish habitat availability in the lower Saluda River that we are trying to enhance with our new minimum flow scheme.

It should be noted that the reservoir guide curve for Lake Murray, developed during relicensing, has a reservoir level target of el. 358.0 ft. Plant Datum (PD) beginning March 1 of each year and continuing until September 1. One implication of this is that once the reservoir has reached el. 358.0 ft. PD, most or all inflow will need to be discharged on a daily basis to keep the reservoir from exceeding its target level. This change in project operation from previous practice will provide increases in downstream flow in those years when there is sufficient inflow to allow the reservoir to reach the 358.0 ft. PD target elevation.

(2) Limitations to Naturalized Flows: The naturalized flow scenario would be in effect for Congaree River flows up to 30,000 cfs. The rationale for this upper limit is that higher discharge events (i.e., flood events in which the river banks CNP are over topped resulting in near complete flooding of the park's floodplain) are dominated by Broad River flows making Saluda flows of less importance during these events. This assumption corresponds to the conclusions of Conrads et al. (2007) and the ESWM floodplain inundation model (Graf and Meitzen 2006).

SCE&G Response: We would like to discuss this scenario in more detail and request that you provide clarification of what you are requesting for flows up to 30,000 CFS. Our understanding at this time is that the ESWM LC is in agreement with the new proposed guide curve. Since the new proposed guide curve reduces the annual drawdowns from eight feet to four feet, SCE&G has a greater concern with being able to manage the lake level safely during times of high inflow especially during the spring and fall seasons. Usually, if there are high flows in the Broad River, such as the 30,000 CFS recommended by your LC, it is more likely that there will be higher flows in the Saluda River basin. Therefore, SCE&G has a greater need to manage the releases for dam safety and not be as concerned with meeting a specified flow release over a specified period of time. It is imperative that dam safety comes first when managing water during a high inflow event to the point of even pre-planned flow releases as necessary to maintain the lake level in a safe manner. SCE&G needs to maintain operating flexibility of Saluda Hydro, especially during high inflow periods. Requesting designated flow releases when flows on the Broad River are up to 30,000 CFS will severely constrain our ability to manage the lake safely. And as you have already noted, flow releases from Saluda Hydro have less importance during times of high flows on the Broad River. Since this ESWM process is outside of the relicensing scope and addressing issues that are completely outside of the project boundary, SCE&G is less inclined to alter its operation for flows in excess of 8,000 CFS on the Broad River. At this time, the striped bass flow proposal by SCDNR appears to be more manageable.

(3) Limitation on Temperature Fluctuations: a) During the naturalized flow period defined in Section 1, Saluda Dam would be operated so that temperatures in the Congaree River, in the vicinity of I-77, do not vary more than 1 degree Celsius from ambient temperatures (as represented by the Broad River). Temperature fluctuations greater than this can result in the failure of spawning events.

b) We recognize that an adaptive management process will be needed to understand the limits on Saluda Dam operations to meet this objective. A real time temperature gage would also need to be established and maintained in the I-77 vicinity.

c) We recognize that SCE&G values the use of Saluda Dam for reserve operations and agree that one reserve operation call resulting in greater than +\- 1 degree C change could be permitted during each 30-day naturalized flow period.

SCE&G Response: a) SCE&G will not agree to any temperature limitations on flow releases during the year. During the spring time of the year diurnal temperature fluctuations greater than one degree Celsius have been observed to occur naturally on the lower Saluda River. The expectation of maintaining water temperatures is too constraining as the releases are subject to too many variables outside of SCE&G's control, such as ambient temperature, tributaries flows and temperature, and Broad River flows and temperature. Besides, the proposed constant flow release being requested by SCDNR should provide the more stable thermal environment that you are trying to achieve. Another issue is that during the spring time of the year there is a greater likelihood of a high inflow which would present the need to generate even outside of the reserve status. It is not in the best interest of the safety of the project to place this type of limitation on the flow releases during this time of the year. Besides, the new minimum flow scheme will help to provide more stable temperatures because the difference from minimum flow to higher flows will be less of a change.

b) Since temperature fluctuations are impracticable to be measured that far from the powerhouse, a new USGS gauge will not be required.

c) SCE&G appreciates your understanding of the importance of having Saluda Hydro available for reserve status as part of our total operating scenario. Since Saluda Hydro is such an important component of our planning and generating system, we cannot remove it from reserve status for an entire month. We have already agreed to remove Saluda from reserve status for 51 partial days associated with recreational flows and an additional 11 partial days for swift water rescue training throughout the year. You have noted below, that you support these recreational flows. Therefore, the only days that SCE&G will agree to remove Saluda Hydro from reserve status are those already identified as part of recreation and swift water rescue training.

(4) Compatibility with Saluda River Flows: Releases from Saluda Dam during the naturalized flow period would never be less than the minimum flows recommended by the Saluda instream flow study (700 cfs March, 1000 cfs April 1-14, and 1,300 cfs April 15-May 14) unless under low inflow protocol (LIP) operations. (LIP operations are not yet agreed to but SCE&G has proposed reducing downstream flows in a step wise manner to as low as 400 cfs depending on the severity of the drought and lake levels.)

Additionally, adjustments to operations during the flow naturalization period needed to support recreation flows for the Saluda River, as currently planned, is fully supported.

SCE&G Response: SCE&G will agree to the minimum flows and recreational flows as described in the final settlement agreement. Based on the proposed SCDNR striped bass flows, the originally agreed upon minimum flows were recently changed by the Instream Flow TWC and we are in the process of re-evaluating this new proposal. Members of your LC were in attendance at the Instream Flow TWC meeting and were supportive of changing the previously agreed to minimum flows.

(5) Low Inflow Periods: Operate Saluda Dam during low inflow periods to maintain low flows in the Saluda River during the growing season – April 1 through October 15 – in order to perpetuate the positive effects of low flow periods for the Congaree ecosystem (e.g., bald cypress recruitment). We find the general concepts of the Low Inflow Protocol, as currently being discussed in the Instream Flow Technical Working Committee, to be consistent with our recommendations.

SCE&G Response: As part of the Saluda Hydro Relicensing process we have organized a Low Inflow Protocol (LIP) focus group that is developing a LIP that will be presented to the other TWC and RCG members. Members of your LC are part of this focus group and as such we hope that you will be agreeable to the conditions presented by this group.

(6) Lake Levels: Limit Lake Murray drawdown to 354 ft and refill the reservoir to full pool (358 ft) by March 1 during normal operating conditions (non-LIP periods). More extreme drawdowns and later full pool targets would lessen the likelihood of meeting downstream flow targets and naturalized flow period goals.

SCE&G Response: At this time the proposed Saluda Hydro operating guide curve has an operating range of four feet, from a normal maximum operating lake level of 358' Plant Datum (PD) between March 1 and August 31, and a lower operating limit of 354' PD during normal inflow years. During periods of low inflow these elevations might not be met. As noted in your proposal and in accordance with our proposed guide curve, during the months of April and May the target normal operating lake level is proposed to be 358' PD.

(7) Scheduling Naturalized Flow Periods: The exact timing of the naturalized flow periods will be agreed to by an Adaptive Management Team (AMT) consisting of SCE&G, state and federal agencies and other relicensing stakeholders with relevant experience and interests. The AMT would meet twice annually, once in October to evaluate the effects of the previous year's naturalized flow period, and once in February to set the dates for the upcoming year. This would allow for real-time adaptation of flowing timing related to biological and climatic factors. In addition, the AMT may elect to meet as necessary to adjust to extreme, unforeseen weather events.

SCE&G Response: SCE&G agrees that it would be essential to determine if the flows provided during the spring are enhancing the striped bass population and other species identified in your study. Therefore, we agree that participation in meetings to evaluate the effectiveness of the program is beneficial.

Adaptive Management Framework:

1. Metrics. Metrics are those parameters within the natural system (or developed system) that require measurement and serve as indicators of the effectiveness of management actions. Examples for the Saluda/Congaree system might include abundance of various age classes of striped bass within the Congaree River, recruitment of bald cypress saplings at CNP, etc.

SCE&G Response: Since the latest SCDNR proposal is to incorporate these additional flows into the minimum flow regime and these flows are requested for improvements to an area outside of the Project boundary, SCE&G would expect representatives of the ESWM LC or other resource agencies to take the lead in developing the existing parameters and required measurements prior to implementation of a new flow scheme. We would be willing to participate in these meetings and assist with developing your study plans.

2. Monitoring Plan. A monitoring plan identifies the timing, frequency, sampling methods, etc associated with various metrics. Continuing the example from above, a monitoring plan for the Saluda/Congaree system would identify precisely how and when striped bass populations and bald cypress stands would be measured.

SCE&G Response: Since the latest SCDNR proposal is to incorporate these additional flows into the minimum flow scenario and these flows are requested for improvements to an area outside of the Project boundary, SCE&G would expect representatives of the ESWM LC or other resource agencies to take the lead in developing any study plans and provide the necessary resources for monitoring the effectiveness of the program. SCE&G would be interested in working with your LC representatives to develop the monitoring plans. Any monitoring plan should include evaluation of species in the lower Saluda River to determine if these flows are negatively impacting any of their habitats. If the monitoring plan results suggest that flow releases from Saluda Hydro are not the limiting factor for meeting the indicators set by the monitoring plan, then SCE&G would not be required to continue to release any additional flows, above the minimum flows, to enhance the species in the Congaree River.

3. Decision Thresholds. Decision thresholds are those pre-identified, generally quantitative, values for a particular metric that elicit a switch to a pre-identified alternative operational or monitoring approach. Examples for the Saluda/Congaree include a low level of reproductive success for striped bass over a three year period.

SCE&G Response: Any decision to change the agreed upon flow release scheme will need to be within the demonstrated operating parameters of the hydroelectric project and agreed to by SCE&G prior to implementation. Further, any decision to change operations must be consistent with conditions set forth in the new FERC license.

4. Funding source and the establishment of a management body or council.

SCE&G Response: Based on whatever flows are eventually agreed to, SCE&G would provide the engineering and system dispatch resources necessary to operate the Project, manage the requested flows, and meet the parameters of the proposed flows. SCE&G would participate in the management body or council as long as there is interest from representatives of the ESWM LC. SCE&G reserves the right to discontinue any additional flow release program if representatives of the ESWM LC do not perform the recommended studies and monitoring, or participate in the annual meetings during the years that flows are provided.