

# DESKTOP FISH ENTRAINMENT STUDY PLAN

**PARR HYDROELECTRIC PROJECT  
(FERC No. 1894)**

*Prepared for:*

**South Carolina Electric & Gas Company  
Cayce, South Carolina**

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February 2014

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## DESKTOP FISH ENTRAINMENT STUDY PLAN

### PARR HYDROELECTRIC PROJECT (FERC No. 1894)

#### SOUTH CAROLINA ELECTRIC & GAS COMPANY

## 1.0 INTRODUCTION

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South Carolina Electric & Gas Company (SCE&G) is the Licensee of the Parr Hydroelectric Project (FERC No. 1894) (Project). The Project consists of the Parr Hydro Development and the Fairfield Pumped Storage Development. Both developments are located along the Broad River in Fairfield and Newberry Counties, South Carolina.

The Project is currently involved in a relicensing process which involves cooperation and collaboration between SCE&G, as licensee, and a variety of stakeholders including state and federal resource agencies, state and local government, non-governmental organizations (NGO), and interested individuals. Collaboration and cooperation is essential in the identification of and treatment of operational, economic, and environmental issues associated with a new operating license for the Project. SCE&G has established several Technical Working Committees (TWC's) comprised of interested stakeholders with the objective of achieving consensus regarding the identification and proper treatment of these issues in the context of a new license.

The TWC determined that a desktop fish entrainment and mortality study should be conducted to determine the likely effects of Project-induced entrainment and impingement based on the physical characteristics of the Project. This study plan outlines the process for a desktop analysis.

## 2.0 BACKGROUND AND EXISTING INFORMATION

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As noted, the Project is comprised of two developments. The Parr Hydro Development forms Parr Reservoir along the Broad River. The Development consists of a 37-foot-high, 200-foot-long concrete gravity spillway dam with a powerhouse housing generating units with a combined licensed capacity of 14.9 MW. Parr Hydro operates in a modified run-of-river mode and normally operates continuously to pass Broad River flow. Current minimum flow license articles require that 1,000 cubic feet-per-second (cfs), or average daily natural inflow to Parr Reservoir<sup>1</sup>, whichever is less, be provided downstream of Parr Dam from March through May. During the remainder of the year, 800 cfs daily average flow and 150 cfs minimum flow, or natural inflow, whichever is less, are required downstream of the Parr Dam. The 13-mile-long Parr Reservoir has a surface area of 4,400 acres at full pool and serves as the lower reservoir for pumped-storage operations at the Fairfield Pumped Storage Development.

The Fairfield Pumped Storage Development is located directly off of the Broad River. Four earthen dams form the 6,800-acre upper reservoir, Monticello Reservoir. As noted, Parr Reservoir serves as the lower reservoir for pumped storage operations. The Fairfield Development has a licensed capacity of 511.2 MW and is primarily used for peaking operations, reserve generation, and power usage.

The Project area supports warmwater fish communities typical of impounded river reaches in the Piedmont of South Carolina. Recent survey work within the Project area has documented 30 species of fish occurring in Parr Reservoir and 24 species in Monticello Reservoir (Table 1). Although some seasonal variations in community structure have been documented, the fish communities are generally similar between the two reservoirs, with gizzard shad, blue catfish, bluegill, channel catfish and white perch being the dominant species (Normandeau 2007, 2008, 2009; SCANA 2013). No state or federally listed threatened or endangered species have been documented in Monticello or Parr reservoirs, although robust redhorse, which is considered a

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<sup>1</sup> Evaporative loss from Parr and Monticello Reservoirs is subtracted from average daily natural inflow to determine flows downstream of Parr Dam.

species of highest conservation concern by the SCDNR (2005), has been documented in limited<sup>2</sup> numbers in both reservoirs.

**TABLE 1 FISH SPECIES DOCUMENTED AT PARR AND MONTICELLO RESERVOIRS**  
(SOURCE: NORMANDEAU 2007, 2008, 2009; SCANA 2013)

COMMON NAME	SCIENTIFIC NAME	PARR	MONTICELLO
black crappie	<i>Pomoxis nigromaculatus</i>	x	x
blue catfish	<i>Ictalurus furcatus</i>	x	x
bluegill	<i>Lepomis macrochirus</i>	x	x
channel catfish	<i>Ictalurus punctatus</i>	x	x
flat bullhead	<i>Ameiurus platycephalus</i>	x	x
flathead catfish	<i>Pylodictis olivaris</i>	x	
gizzard shad	<i>Dorosoma cepedianum</i>	x	x
golden shiner	<i>Notemigonus chrysoleucas</i>	x	x
highfin carpsucker	<i>Carpionodes velifer</i>	x	
largemouth bass	<i>Micropterus salmoides</i>	x	x
longnose gar	<i>Lepisosteus osseus</i>	x	
northern hogsucker	<i>Hypentelium nigricans</i>	x	x
notchlip redhorse	<i>Moxostoma collapsum</i>	x	x
pumpkinseed	<i>Lepomis gibbosus</i>	x	x
quillback	<i>Carpionodes cyprinus</i>	x	x
redbreast sunfish	<i>Lepomis auritus</i>	x	x
redeer sunfish	<i>Lepomis microlophus</i>	x	x
robust redhorse	<i>Moxostoma robustum</i>	x	x
sandbar shiner	<i>Notropis scepcticus</i>	x	
shorthead redhorse	<i>Moxostoma macrolepidotum</i>	x	x
smallmouth bass	<i>Micropterus dolomieu</i>	x	x
snail bullhead	<i>Ameiurus brunneus</i>		x
spottail shiner	<i>Notropis hudsonius</i>	x	x
threadfin shad	<i>Dorosoma petenense</i>	x	x
warmouth	<i>Lepomis gulosus</i>	x	
white bass	<i>Morone chrysops</i>	x	
white catfish	<i>Ameiurus catus</i>	x	x
white perch	<i>Morone americana</i>	x	x
whitefin shiner	<i>Cyprinella nivea</i>	x	x
yellow bullhead	<i>Amierus natalis</i>	x	x
yellow perch	<i>Perca flavescens</i>	x	x

<sup>2</sup> To date, 2 robust redhorse have been documented in Monticello Reservoir and 3 robust redhorse have been documented in Parr Reservoir.

### **3.0 STUDY GOALS AND OBJECTIVES**

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The goal of the desktop fish entrainment and mortality study is to develop additional information necessary to estimate potential fish entrainment and impingement at the Project. This will provide a basis for understanding the effects of entrainment, impingement and turbine mortality on fisheries resources in the Project area. The study objective is to characterize and provide an order-of-magnitude estimate of entrainment at both developments using existing literature and site-specific information.

### **4.0 PROJECT NEXUS**

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Fish that reside in the Project area could be susceptible to impingement on the Project trashracks or entrainment through the Project turbines. Evaluation of the physical characteristics of each Project development along with an evaluation of expected fish behavior at the intake structures utilizing existing information will help in the understanding of the potential for continued Project operations to affect the fishery.

### **5.0 GEOGRAPHIC SCOPE**

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As this analysis is a desktop exercise, no field reconnaissance will be implemented. Fish species present within the Project vicinity that are determined to be potentially susceptible to impingement and/or entrainment through the Project will be analyzed in this study.

### **6.0 METHODOLOGY**

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Fish impingement and entrainment at the Project may occur when fish that elect to enter into the project intake flow field during periods of operation may become impinged on the trashracks or entrained through the turbines. Fish that are small enough to pass through the projects trashracks will be considered susceptible to entrainment while those physically excluded due to size (i.e. length, width, and/or depth) will be considered as potential candidates for impingement. Not all fish species occurring in the Project reservoirs may be equally susceptible to entrainment or impingement because of their habitat use, behavior and swimming abilities relative to the project intake velocity. As noted, fish entrainment at the Project developments will be assessed through a desktop study. The primary inputs for this analysis will be as follows:

1. Develop an entrainment and turbine mortality database that can be applied to the Parr and Monticello developments.
2. Calculate and estimate fish entrainment rates, seasonally if possible, at each Project development. Entrainment rates are defined as: number of Fish/volume of water entrained.
3. Characterize the species composition of potential fish entrainment.
4. Apply any physical or biological filters that may influence entrainment.
5. Estimate the total annual entrainment for the Project based on normal operation.
6. Estimate potential turbine mortality for fish entrainment based on turbine mortality estimates from similar project studies.
7. Estimate impingement mortality for fish eliminated from entrainment estimates.

These inputs are described in more detail below.

#### Development of an Entrainment Database

Over seventy site-specific studies of resident fish entrainment at hydroelectric sites in the United States have been reported to date, which provide order-of-magnitude estimates of annual fish entrainment (FERC, 1995). Descriptive information will be gathered from available entrainment studies and will include:

- Location: geographic proximity (preference given to same river basin).
- Project size: discharge capacity and power production.
- Mode of operation - e.g., peaking, run-of-river, etc.
- Biological factors: fish species composition.
- Impoundment characteristics: general water quality, impoundment size, flow regime.
- Physical project characteristics: trash rack spacing, intake velocity, etc.

This information will be assembled into a “matrix” of data to be used as a database for the desktop study. After review of the “matrix”, specific studies that are most applicable to the Project developments will be selected for use in the entrainment database. Key criteria to be used in acceptance of candidate studies may include:

- Similar geographic location, with preference given to projects located in the same river basin.
- Similar station hydraulic capacity.
- Similar station operation (peaking, run-of-river, etc.).



- Biological similarities: fish species, assemblage and water quality.
- Availability and type of entrainment data (netting vs hydroacoustic).

### Estimation of Fish Entrainment

Fish entrainment by species for the proposed Project will be estimated on a monthly basis (if possible) to provide an order-of-magnitude fish entrainment estimate. As noted, the entrainment rates will be presented in fish entrained per hour of operation and fish per volume of water passed through project turbines (fish/million cubic feet). The data will be grouped by season, where appropriate, to determine an entrainment density for each season of the year. The seasonal data from each entrainment study will be averaged to develop a seasonal mean entrainment estimate at each Project development.

### Species Composition Analysis

Species composition data from the accepted entrainment studies will be analyzed and compiled to determine the fish species typically entrained at other hydroelectric projects. This information will be grouped to yield predicted seasonal estimates of species-specific data for entrained fish to determine:

- Likelihood of entrainment by species.
- Expected relative abundance of each species identified as potentially entrained.
- Prediction of seasonal entrainment by species and size, if applicable.

### Application of Physical or Biological Filters

Adjustment of fish entrainment rates based on site-specific characteristics of the Project may be appropriate. Factors potentially affecting entrainment rates that may warrant adjustment of estimates include:

- Trashrack spacing.
- Fish habitat available at the intakes.
- Other site specific factors as determined during the study.

Some limited boat electrofishing will also be conducted in the Fairfield development forebay in Monticello Reservoir and in the Fairfield development tailrace canal in Parr Reservoir for purposes of characterizing the fish communities occurring in the intake vicinities. Sampling will be conducted in the spring and fall of the 2014 and 2015, concurrent with fish tissue

sampling required as part of environmental compliance activities for the VC Summer Nuclear Station. All fish encountered will be identified to species, measured for total length, and either returned alive to the river or retained for fish tissue sampling. While ancillary to the entrainment and impingement estimates described above, the sampling will provide qualitative data describing spatial and temporal patterns of fish occurring in the intake zone. Existing fish community data for Parr Reservoir (summarized in the Parr and Fairfield Baseline Fisheries Report) will also be used to better understand spatial and temporal fish distribution trends as part of developing entrainment estimates for both developments.

#### Total Annual Entrainment Estimate

Total fish entrainment for each Project development will be estimated on an annual basis to provide an order-of-magnitude entrainment estimate. The total fish entrainment estimate will be produced for a typical water and operating year.

#### Turbine Mortality

As fish move through hydroelectric turbines, a percentage are killed due to turbine mortality (i.e. blade strikes, shear forces, and pressure changes, etc.). Turbine passage survival studies have been performed at numerous hydroelectric projects throughout the country. Characteristics of these known project studies will be compared to the characteristics of the Parr and Monticello development turbines and appropriate studies will be selected for the transfer of turbine mortality data. Selected turbine survival rate data will also be obtained from the literature and used to estimate the number of fish lost due to turbine mortality. Important turbine characteristics viewed as general criteria for accepting turbine mortality studies will include but are not limited to:

- Turbine design type.
- Operating head.
- Turbine runner speed.
- Turbine diameter, and peripheral runner velocity.

Species specific turbine mortality rate data available from source studies will also be reviewed and consolidated. Where multiple tests are available for a given fish genus or family, a mean survival rate will be computed. For genus or families where no acceptable data can be identified, the survival rate data from surrogate genus and/or family groups will be utilized.

Once turbine mortality rates are developed from the study database, the rates will be applied to the fish entrainment estimates for the Project. This will be accomplished by multiplying fish entrainment estimates by the composite mortality rates for each family/genus group (where applicable).

### Impingement Estimates

Fish eliminated from entrainment estimates due to their size in relation to the trashrack spacing will be considered susceptible to impingement. Swim speed information for these species and size groups will be compared to intake velocities to estimate the potential for impingement. Those species or size groups lacking the ability to avoid impingement will be considered impinged and subsequently killed due to impingement mortality.

## **7.0 SCHEDULE AND PRODUCTS**

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Our goal is to complete this study by the end of 2015. Based on review of an earlier draft of the study plan, the TWC identified several “hold points,” associated with the 7 primary study inputs identified in Section 6.0. Specifically, “hold points” were requested following completion of Step 1 (entrainment and turbine mortality database development), Step 3 (characterization of species composition), and Step 5 (estimate of total annual entrainment). At each of these hold points, the TWC will be convened to review the study progress to date prior to proceeding with the next phase of the analysis.

Comments from the TWC will be addressed during each phase of the analysis. Upon completion of the study, a draft report will be prepared and distributed to the TWC for review and comment. The draft report will summarize the results obtained in the study; will contain appropriate tables and figures depicting estimated fish entrainment; and will contain all supporting correspondence among the TWC members. After receipt of all comments, the draft report will be revised to address final comments by TWC members and will be resubmitted as the Final Report.

## **8.0 USE OF STUDY RESULTS**

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Study results will be used as an information resource during discussion of relicensing issues and developing potential Protection, Mitigation and Enhancement measures with the South Carolina Department of Natural Resources, USFWS, Fisheries TWC, and other relicensing stakeholders.

## 9.0 REFERENCES

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