ALABAMA POWER COMPANY

BIRMINGHAM, ALABAMA

MARTIN HYDROELECTRIC PROJECT

FERC NO. 349

STUDY PLAN 4 – FISH ENTRAINMENT AND TURBINE MORTALITY

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Prepared by:

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1.0 GOALS AND OBJECTIVES OF STUDY

Operation of hydroelectric projects can result in the sporadic entrainment of fish into the project turbines. Passage through the turbines can result in some degree of mortality as well as removal of fish from the project reservoir. The Alabama Department of Conservation and Natural Resources (ADCNR) and U.S. Fish and Wildlife Service (USFWS) would like to understand the relationship of project operation and the potential impacts of entrainment and turbine mortality on fish in Lake Martin.

In particular, the ADCNR is concerned about the impacts of fish entrainment on the populations of striped bass (*Morone saxatilis)* and largemouth bass (*Micropterus salmoides)* in Lake Martin, in part, because the stocking rates of these two species can be adjusted to offset entrainment impacts.

2.0 RELEVANT RESOURCE MANAGEMENT GOALS

The ADCNR maintains a population of Gulf-strain striped bass in Lake Martin through an active stocking program. They also regulate the recreational fishing of game species such as largemouth bass. Knowledge of impacts to the Lake Martin fishery due to entrainment can allow them to adjust their management strategies for managing these two fisheries and potentially other recreational fisheries.

3.0 BACKGROUND AND EXISTING INFORMATION

Over fifty site-specific studies of resident fish entrainment and mortality at hydroelectric sites in the United States have been performed and reported on to date. These studies provide order-of-magnitude estimates of annual fish entrainment (FERC, 1995). Descriptive information has been gathered from each entrainment study and includes:

- Location: geographical proximity, river basin;
- Project size: discharge capacity and power production;
- Project operation: *e.g.*, peaking run-of-river, etc.;
- Biological factors: fish species composition;
- Impoundment characteristics: general water quality, impoundment size, flow regime; and
- Physical project characteristics: trash rack spacing, intake velocity, etc.

Extensive turbine mortality study data exists for a range of turbine types and physical characteristics, which can be compared to the Martin project turbines. These characteristics are commonly attributed to turbine passage mortality (Cramer and Oligher, 1963; Bell, 1991; Eicher, 1987; EPRI, 1992). Descriptive data includes:

- turbine design type;
- operating head;
- runner speed;
- diameter; and
- peripheral runner velocity.

Current information for Lake Martin's fish populations is available through the ADCNR Reservoir Management Reports. Similar study information performed on the recent Coosa and Warrior relicense is also available for use (Alabama Power, 2003).

4.0 PROJECT NEXUS

The study will estimate the magnitude of impacts related to fish entrainment and turbine mortality related to existing operation of the Lake Martin project.

5.0 STUDY AREA AND STUDY SITES

The study area for this issue would include the forebay and intake area of the Martin Project.

6.0 PROPOSED METHODOLOGY

The methodology for this study will involve two Phases:

- Phase 1 will estimate the magnitude of entrainment and turbine mortality through the performance of a Desktop analysis.
- Phase 2 will include field verification of the estimated entrainment impact. Field verification may include the use of hydroacoustic technology to verify entrainment estimates and sizes of fish entrained.

The methods for each Phase are described herein. The methodology for both Phases follows standard methods previously accepted by FERC or standard methodologies used by the Fisheries Management community.

Phase 1 – Desktop Entrainment Study Methods

Define the Entrainment Database

For this study, fish entrainment information from other hydroelectric projects will be assembled into a database for analyzing the magnitude of potential entrainment. After review of the database, the most similar projects will be selected and used to develop a Martin entrainment estimate.

Calculate An Estimated Fish Entrainment Rate

The entrainment rate information from the selected entrainment studies will be consolidated to develop fish entrainment rates for the Martin Project. The entrainment rates will be presented both in fish entrained per hour and fish entrained by volume of water passed through the project turbines (fish/million cubic feet). The data will be grouped by season where appropriate to determine an entrainment rate for each season of the year. The seasonal data will be used to develop an estimated seasonal mean entrainment rate for the Martin Project.

Estimate Species Composition and Length Frequency Distribution

The species composition data from the Coosa Entrainment Study (Alabama Power, 2003), in conjunction with ADCNR data for Lake Martin, will be used to develop species composition for entrainment. Length frequency of fish entrained will be based on information from the entrainment database.

Estimate of 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 projects will be compared to the characteristics of the Martin Project and suitable studies will be selected for the transfer of turbine mortality data for each development. Selected turbine survival rate data will be obtained from the literature and used to estimate the number of fish killed due to turbine mortality. The following turbine characteristics will be used as criteria for use in this analysis:

- design type;
- operating head;
- runner speed;
- diameter; and
- peripheral runner velocity.

To the extent possible, turbine mortality rate data available from source studies will be related to the species-family group and size class of fish estimated to be entrained at the Martin Project. Where multiple tests are available for a given species-family group/size class, a mean survival rate will be computed. For species-family groups/size classes where no applicable data can be found or accepted, the survival rate reported for a similar group/size class will be substituted.

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

Filters

Due to certain site-specific characteristics of the Martin Project, it may be necessary to adjust entrainment estimates. Factors affecting entrainment rates that may warrant investigation for adjustment of estimates include:

- stratification at the intakes (dissolved oxygen);
- intake velocities;
- fish habitat available at the intakes; and/or
- other factors.

Phase 2 – Field Verification

ADCNR and USFWS have expressed a desire to verify the entrainment estimates through field verification, with specific emphasis on striped bass and largemouth bass. Alabama Power proposes to address this concern both quantitatively and qualitatively, through the use of two separate types of hydroacoustic equipment. Many studies have used hydroacoustics to estimate fish abundance or density, fish length distribution and to evaluate entrainment rates at hydropower dams. In addition, hydroacoustics can provide a high degree of sampling power encompassing seasonal and diel variations. This study will focus monitoring on the Unit 1 intake bays. Unit 1, located closest to the west bank, was chosen based on historical usage and consistent availability.

The first type of hydroacoustics, used to provide a quantitative entrainment estimate, is a 201 kHz DT-X series (Biosonics Inc, Seattle, Washington) split-beam system with 6° beam width transducers. Using two transducers, each will be placed in a separate intake bay for the Unit 1 Turbine. Transducers will be positioned below the water surface to maximize sampling volumes of the area between the trash rack and the penstock. The second type of hydroacoustics, used for qualitative purposes, is the multi-beam sonar unit called the Dual-frequency Identification Sonar (DIDSON) (Soundmetrics Corp., Lake Forest Park, WA). The DIDSON will be deployed in front of the forebay trash rack and operated using the identification mode (1.8 MHz) for the highest image resolution to identify estimated sizes and shapes as well as fish behavior.

Hydroacoustic sampling from the split-beam (Biosonics) and the multi-beam (DIDSON) systems will be collect 15 days of data per season (quarterly). The Biosonics system will collect and record continuously alternating between the two transducers. The DIDSON will collect and record data sufficient to possibly observe fish presence including size and shape. Hydroacoustic data files from the Biosonics unit will be processed with Echoview post-processing software (version 4.6, Myriax Software Pty. Ltd, Tasmania, Australia) to determine fish densities and size distribution. Seasonal fish density estimates will be extrapolated to total entrainment based on unit flow rates. Data files from the DIDSON unit will be used to identify fish size and shape near the intake during each season.

A mobile survey using hydroacoustics will be performed seasonally in conjunction with the fixed surveys performed at or near the intake. These surveys will target the areas upstream of the dam including the forebay. The sampling will use the same Biosonics system used for the fixed deployment study and will be processed with the same software. Each mobile survey will be used to obtain fish density, including vertical and longitudinal distributions in the forebay and upstream areas.

Based on the desktop analysis and entrainment estimates, Alabama Power would develop a report that includes a recommendation regarding the level of impact that entrainment and turbine mortality potentially has on the lake fishery, with specific emphasis on the striped bass and largemouth bass fishery. Alabama Power will then review their results with stakeholders to develop potential protection and enhancement measures commensurate with the level of impact.

7.0 CONSISTENCY WITH GENERALLY ACCEPTED SCIENTIFIC PRACTICE

This study employs generally accepted practices for evaluating fish entrainment and turbine mortality at hydroelectric projects. The study methodology is consistent with generally accepted fishery sampling principles and practices.

8.0 PRODUCTS

Data and analyses from this study will be included in periodic reports to the ADCNR, USFWS, Alabama Department of Environmental Management (ADEM), and the MIG 1. A draft report will be distributed to the MIG 1 for review and comment within 6 to 8 months of completion of the analysis. A final report will be provided as part of the draft license application that will include raw data in tabular form, analysis performed, and results and discussion.

9.0 SCHEDULE

This schedule corresponds to Alabama Power's Process Plan and Schedule filed with FERC on February 16, 2009. Actual consultation meeting dates will be determined with MIG 1 members upon FERC approval of the study plan.

Alabama Power files Final Study Plan .....March 2009
FERC Approval .....April 2009
MIG 1 Consultation .....May 2009 – December 2010
Desktop Entrainment and Turbine Mortality.....May – June 2009
Desktop Entrainment Report.....July 2009
Field Verification - Hydroacoustics.....April 2009 – February 2010
Draft Field Verification Report.....March 2010
Study Report Meeting .....August 2009
.....January 2010
.....March & June 2010
Final Entrainment Report & Recommendations.....July 2010
FERC Updated Study Report..... September 2010
Updated Study Report Meeting ..... September 2010

10.0 LEVEL OF EFFORT AND COST

Alabama Power estimates the cost of performing Phase 1 (Desktop Analysis) will be approximately $35,000. Performing Phase 2 (Field Verification) would include collecting fisheries data, analyses, and reporting, which could be approximately $150,000.

11.0 REFERENCES

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Eicher Associates, Inc. 1987. Turbine-related fish mortality: Review and evaluation of studies. Research Project 2694-4. Prepared for Electric Power Research Institute, Palo Alto, CA.

Electric Power Research Institute (EPRI). September 1992. Fish Entrainment and Turbine Mortality Review and Guidelines. TR-101231 Research Project 2694-01. Prepared by Stone & Webster Environmental Services.

Federal Energy Regulatory Commission (FERC). 1995. Preliminary assessment of fish entrainment at hydropower projects – volume 1 (Paper No. DPR-10). Office of Hydropower Licensing, FERC, Washington, DC.