



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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BIRMINGHAM, ALABAMA**

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STUDY PLAN 4 - FISH ENTRAINMENT AND TURBINE MORTALITY

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 (APC, 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 (APC, 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 make attempts to verify the entrainment estimates at some level through field verification. One method that APC proposes to address this concern is the use of hydroacoustics to provide verification. Hydroacoustics (either split beam or DIDSON) may be used to sample the penstock area, trash rack area, or forebay area to gather information on fish targets moving into the turbine intakes. The specific location of hydroacoustic collections will be based on additional investigation of the penstock configuration and the ability to sample that area.

Hydroacoustic sampling would be performed on a seasonal basis (quarterly basis) and collect data over a 3-day period encompassing both day and night periods. Estimates of entrainment would be determined through analysis of the collected data and compared to the results of the desktop analysis.

APC 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 striped bass and largemouth bass. APC 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 is draft and APC intends to develop a formal schedule with MIG 1 members upon Final FERC approval of the study.

APC files Final Study Plan	November 2008
Anticipated FERC Approval.....	May 2009
MIG 1 Consultation	May 2009 – December 2010
Develop Entrainment and Turbine Mortality Databases	May – June 2009
Draft Report	July 2009
Field Verification Hydroacoustic.....	October & December 2009 March & June 2010
Final Report	December 2010

10.0 LEVEL OF EFFORT AND COST

APC estimates the cost of performing Phase 1 (Desktop Analysis) will be approximately \$45,000. Performing Phase 2 (Field Verification) would include collecting fisheries data, analyses, and reporting, which could be approximately \$150,000.

11.0 REFERENCES

- Alabama Power Company. 2003. Coosa and Warrior River Projects- E11 - Impingement, Entrainment, and Turbine Mortality Study. Alabama Power Company, Birmingham, AL.
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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.