

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 determine the magnitude of impacts related to fish entrainment and turbine mortality related to 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 methods for this study will follow those used to determine potential entrainment impacts for hydroelectric projects on the Coosa River as part of the Coosa relicensing process (APC, 2003).

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 (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.

Field Verification

ADCNR and USFWS have expressed a desire to verify the entrainment estimates at some level through field verification. APC proposes to use hydroacoustics to provide this verification. Hydroacoustics (either split beam or DIDSON) will be used to sample the penstock area, trash rack area, or forebay area to gather information on fish targets moving into the turbine intakes. Specific location of collections will be based on additional investigation of the penstock configuration and the ability to sample that area.

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

APC files Final Study Plan	November 2008
Anticipated FERC Approval	April 2009
Develop Entrainment and Turbine Mortality databases	May 2009
Draft Report	December 2009
Final Report	April 201

10.0 LEVEL OF EFFORT AND COST

APC estimates the cost of collecting the existing fisheries data, analyses and reporting is approximately \$115,000. This is based on development and analysis of a database of existing data and does not include additional field studies.

11.0 REFERENCES

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

Bell, M. C. 1991. Fisheries Handbook of Engineering Requirements and Biological Criteria. United States Army Corps of Engineers, Fish Passage Development and Evaluation Program, Portland, OR.

Cramer, F. K., and R. C. Oligher. 1963. Passing fish through hydraulic turbines. Transactions of the American Fisheries Society 93:243-259.

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.