Acoustic Fish Barriers for Grass Carp

by
Mike Curtin[1]

Sonalysts Corporate History

Sonalysts, Inc., is an employee-owned professional engineering services, research, and development organization. Sonalysts began in 1973 by offering extensive naval operational experience under contract to the U.S. Navy. Since that time, we have continually expanded and diversified our capabilities. Our extensive sonar system experience led to the development of our patented FishStartle System, which uses underwater sound to create barriers that fish avoid.

Sonalysts currently employs more than 400 people in offices throughout the United States. We have amassed an enviable record of completing over 6,000 contracts on time and within budget. For our commitment to excellence, we have been recognized by several agencies with many awards.

Successful Demonstrations

Sonalysts, Inc., is the first company to successfully deter fish with sound from both an operating nuclear power plant with 883 MW and 825 cfs of flow as well as a 30-MW hydroelectric project and 7,550 cfs of flow. Our system has also been used to keep fish away from a dredging and blasting site in Boston Harbor. In 1993-94, FishStartle was used on Staten Island at a thermal plant as well as at a hydroelectric plant on the Susquehanna River.

Nuclear power plant

In 1990, the James A. FitzPatrick (JAF) Nuclear Power Plant, located on Lake Ontario, was chosen by the Empire State Electric Energy Research Corporation (ESEERCO) to be the first operational site for a carefully conceived, scientifically performed, full-scale demonstration and feasibility study of an acoustic fish deterrence system. JAF had a documented impingement problem with alewives. The Nine Mile Point Nuclear Power Plant, also located on Lake Ontario, was chosen as the control facility. Nine Mile Point's intake is approximately 1 mile from the intake for JAF and provided an excellent comparison point for the purposes of the impingement study.

In 1991, Sonalysts patented FishStartle System was installed and operated at the JAF facility. During the test, independent contractors counted, not estimated, the number of alewives impinged at both facilities simultaneously. In addition, another independent contractor conducted hydroacoustic monitoring at the JAF intake to determine the density of alewives in front of the intake. Density measurements were based on established methods using state-of-the-art equipment. During the time when the FishStartle System was operated, JAF experienced an 87-percent reduction in alewife impingement as compared with the Nine Mile Point plant. A 96-percent reduction in fish density at the JAF intake was achieved as compared with the periods when the FishStartle System was not operating.

The success of the JAF demonstration clearly showed that Sonalysts FishStartle System is a very effective deterrent for alewives. The *North American Journal of Fisheries Management* article, dated Spring 1993, entitled "Response of Alewives to High Frequency Sound at a Power Plant Intake on Lake Ontario" documents this study.

[1] Sonalysts, Inc., Waterford, CT.

In 1993, our FishStartle System was installed and operated continuously from April 20 through July 19, which corresponds to the historical abundance period at JAF. The system achieved results similar to those reported in 1991. No evidence of acclimation was observed. A research paper, the third in a series describing this test, has been submitted for publication to the *North American Journal of Fisheries Management.*

Since the 1991 JAF experiment, Sonalysts has conducted and documented several other successful deterrence projects using FishStartle involving alewives, American shad, and blueback herring.

Hydroelectric generating station

In 1991 and 1992, Sonalysts conducted a demonstration of the FishStartle System at a hydroelectric generating station. The species of interest was the juvenile American shad. The initial purpose of the demonstration was to show that the FishStartle System would deter juvenile American shad from entering an area ensonified by the system. Underwater video cameras documented that the FishStartle System elicited the desired reactions from the shad. The FishStartle System was used to provide increased opportunities for shad to go downstream safely by keeping them away from turbine intakes and thus closer to the fish bypass pipe.

The demonstration made it clear that the overwhelming majority of American shad responded consistently and immediately every time the system was energized and sound transmitted into the water. The shad displayed no evidence of becoming acclimated to the sound source. Additionally, many more shad travelled down the fish bypass pipe when the system was transmitting than were noted at the fish bypass discharge when the system was off.

Marine construction and demolition project

In 1992, the annual spring migration of shad, blueback herring, and alewives coincided with underwater blasting of rock ledges in preparation to excavate a 3,850-ft trench for the immersed Third Harbor Tunnel between the city of Boston and Logan International Airport. Instead of halting marine work, Sonalysts deployed a mobile version of the FishStartle System and deterred fish from entering the blasting area, precluding a 3-month delay in the $5 billion project.

Current projects

Sonalysts is currently undertaking two large-scale demonstration projects with the FishStartle System. On Staten Island in New York, we will be demonstrating our unique capability at the Arthur Kill Generating Station. The species of interest are bay anchovy and blueback herring. This project began in August of 1993 and will continue through April of 1994.

In addition, Sonalysts deployed the FishStartle System at Metropolitan Edison's York Haven Station on the Susquehanna River in Pennsylvania. We used FishStartle to divert juvenile American shad away from the hydro plant's intake and toward a bypass gate. This project is now in the final report phase and is expected to conclude in early May 1994.

Sonalysts success

We believe the success Sonalysts has achieved in the application of acoustic fish deterrence is attributable to the following factors:

- Sonalysts, Inc., has more than two decades of experience in the field of underwater acoustics. Since 1973, Sonalysts has provided extensive technical, operational, and analytical support to the U.S. Navy for both submarine and surface ship sonar systems as a Department of Defense contractor. No other firm currently marketing acoustic fish deterrent systems or services can point to such extensive experience in the field of underwater sound.

- An integral part of our work with the Navy is developing underwater acoustic propagation models to determine not only how sound travels through the water column, but also what happens as it reflects from the surface and bottom. Using site-unique parameters, sound frequency, pressure levels, and target ensonification volumes, Sonalysts can use the models it has developed to design an optimum system for each site. Without this type of analysis, a costly trial and error approach can ensue, and the most effective system may never be implemented. No other firm currently marketing acoustic fish deterrent systems or services provides this measure of technical detail.

- Sonalysts, Inc., has assembled a team of experts including project managers, design engineers, field engineers, and physicists to successfully carry out this work.

Based on FishStartle's documented success with alewives, American shad, blueback herring, and coho salmon, Sonalysts is confident that we can successfully elicit an avoidance response from grass carp.

Publications

The success of Sonalysts FishStartle System has been documented in a number of professional journals and reports.

- Proceedings of the 1992 American Power Conference, "The Electronic Fish Startle System."

- Dunning, D. J., Ross, Q. E., Geoghegan, P., Reichle, J. J., Menezes, J. K., Watson, J. K. (1992). Alewives Avoid High Frequency Sound., *North American Journal of Fisheries Management*, 12:407-416.

- Ross, Q. E., Dunning, D. J., Thorne, R., Menezes, J. K., Tiller, G. W., Watson, J. K. (1993). Response of Alewives to High Frequency Sound at a Power Plant Intake on Lake Ontario, *North American Journal of Fisheries Management*, 13:291-303.

- Nestler, J. M., Ploskey, G. R., Pickens, J., Menezes, J., Schilt, C. (1992). Response of Blueback Herring to High Frequency Sound and Implications for Reducing Entrainment at Hydropower Dams., *North American Journal of Fisheries Management*, 12:667-683.

- Accepted for publication Dunning, D. J., Ross, Q. E., Menezes, J. K., Kenna, M. J., Dolan, P. J., Koeneke, M. A. Reducing Impingement of Alewives with High-Frequency Sound at a Power Plant Intake on Lake Ontario., *North American Journal of Fisheries Management.*

- Empire State Electric Energy Research Corporation Research Reports

  * "Acoustic Fish Deterrence: A Feasibility Study (May 91)."

  * "Response of Alewives to High Frequency Sound at a Power Plant Intake on Lake Ontario." (September 1992).

  * "Reducing Impingement of Alewives with High Frequency Sound at a Power Plant Intake on Lake Ontario." (December 1993).

Potential Applications for Grass Carp

Potential applications

There are many potential applications of FishStartle technology with grass carp. The most important application is probably to prevent grass carp from migrating into adjacent bodies of water. Other applications might be to keep grass carp in a specific area within a lake to reduce the required stocking density or to keep carp away from cooling water intakes. Regardless of the application, the initial phases of research are identical.

Confined area test

A confined area test is necessary to identify the optimum sound that grass carp avoid. This type of test is carried out in an area with deep, clear water. Fifty to one hundred carp

are placed within a cage and exposed to various underwater sound signals while underwater video is used to document their response. Once a sound signal is found that elicits the desired response, the test is repeated with various groups and ages of carp to ensure the results are repeatable.

Small-scale test

After identifying the optimum signal during the confined area test, a small-scale test is carried out to demonstrate that the system can be effective under operational conditions. A small site is selected to minimize costs. Therefore, the site selected for this test should be readily accessible for installing transducers and associated electronic equipment, allow for a method to easily quantify system effectiveness, and be acceptable to all interested parties. A variety of methods have been used for quantifying system effectiveness. For example, radio tags could be inserted in a number of fishes prior to releasing them near the barrier. A radio receiver is used to monitor the radio tags and determines if any fishes pass through the barrier. Alternatively, it is sometimes possible to deploy a net on the other side of the barrier to capture any carp that pass through the barrier. The method that is chosen is based on a trade-off of keeping costs down while still gathering useful data.

Full-scale demonstration

If the small-scale test is successful, a full-scale demonstration is often conducted on a larger site to for a longer term. The full-scale demonstration provides conclusive evidence that the system is effective for sites of all sizes under various environmental conditions.