

## Ultrasonic Algal Control Literature Review

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*Ultrasonic algae control has been proposed as a nonintrusive non-chemical environmentally safe method of destroying nuisance algae growth in ponds, pools, and other small bodies of water. In the recent Barton Springs Pool Masterplan, it was listed as a potential project requiring pilot data to be generated before proceeding. These units operate by resonating at a frequency that will burst algae cell walls. They produce sound in the frequency range of 20 kHz depending on type of algae targeted. In the algae control business the specifications for these units are largely proprietary information. However, several non industry studies have found them to be effective in algae control. No studies of toxicity, avoidance, feeding inhibition, or other ecological effects on aquatic life for ultrasonic algae control could be found. Industry representatives stated that such data may be forthcoming, but has not been published in peer reviewed journals. Since laboratory or field data with ecological monitoring are not currently available, this technology was determined to be unripe for full scale pursuit at the is time. Trials in noncritical habitat and an outline for future testing of the units necessary for regulatory approval are recommended.*

### Introduction

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The Barton Springs Pool Masterplan (Limbaucher & Godfrey, 2008) listed several short term projects which required additional investigation to determine their potential for full scale implementation. One of these projects was the use of ultrasonic algae control to reduce nuisance algae in the pool (Master Plan, p. 67). Readily available studies and vendor information indicated that this method may have application in both Barton Springs Pool and possibly other waterbodies with seasonal algae blooms which negatively affect recreation and aquatic ecosystems. However, little information was available about the safety and environmental effects of ultrasonic algae control. A review of relevant literature was undertaken to remedy this lack of information. Information on specific aquatic life impacts would be necessary to obtain USFWS permission to test ultrasonic algae control in Barton Springs Pool. Focus was particularly on the industry standard LG Sonics ultrasonic algae control devices as they appeared to be the most well developed and researched line of control units.

### Methods

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Literature available online through the University of Texas Library system was used to research this potential application of ultrasonic technology. Searches of relevant scholarly journals in the areas of limnology, phycology, and applied ecology were made based on a variety of keywords designed to elucidate impacts of ultrasound used for algae control. This search was broadened to look for anthropogenic sound impacts to aquatic life with a focus on laboratory and field studies quantifying effects levels. Impacts to humans were also investigated through medical literature.

In addition, several vendor contacts were made and industry research studies into aquatic life impacts of ultrasonic algae control were investigated.

## **Results**

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### Vendor Information and Industry Testing

LG Sonic Products are a line of ultrasonic devices for deployment in water bodies to control nuisance algae developed by South Santee Aquaculture, Inc. The company claims that their products “do not harm life forms other than algae” (Hutchinson, unknown date) based on the theory that all life forms have specific resonance frequencies. Laureen Earnest from AlgaeControl.US, a division of South Santee Aquaculture, Inc., provided a detailed list of research projects involving their ultrasonic devices and other aquatic fauna. As of March 2008, none of the studies listed had data accessible to the public.

Dr. Jonathan Newman of Waterland Management Ltd, a British company providing ultrasonic algae control devices similar to LG Sonic Products, provided a list of published papers supporting the use of low power ultrasonic techniques to control various water nuisances. None of the published studies listed investigate the effects of ultrasonic techniques on fauna, but Dr. Newman states that their devices are not loud enough for fish to hear and no fishing clubs that have purchased the ultrasonic devices have reported adverse effects on fly life or fish behaviors (personal communication, 2008). Dr. Newman also states that they were requested to investigate ultrasonic effects on sediment dwelling organisms, but results were not readily available due to proprietary restrictions (personal communication, 2008 and 2009). Dr. Newman subsequently reported that they are conducting tests of effects of their unit on amphibians and major invertebrate groups along with the Wessex Water, a major regional water provider across southwestern England (personal communication, 10/20/2010).

### Published Research Results

While comparing methods for controlling cyanobacteria in lakes, Michaela Drabkova stated that there is a “lack of information about the effects of ultrasound in aquatic ecosystems” (2007). Although no adverse reports are known to have been submitted by residential or commercial users of ultrasonic devices, there is a void of scientific research regarding ecosystem responses to ultrasonic techniques.

Numerous published papers support the effective control of algae by ultrasound in a laboratory setting (Francko *et al.*, 1990; Ahn *et al.*, 2003; Hao *et al.*, 2004; Zhang *et al.*, 2006a; Zhang *et al.*, 2006b) while only a single in situ algal bloom control study was found (Nakano *et al.*, 2001). While the laboratory studies supported the effectiveness of ultrasound on algal control, Nakano *et al.* (2001) only found the ultrasonic treatment to be moderately effective, although numerous other factors were in play (shallow water body, simulated currents, draining of lake). The release of microcystins, a hepatotoxin released from certain algae, due to ultrasonic treatment was investigated to determine if stress levels in the aquatic environment would increase by increasing toxins into the water (Ma *et al.*, 2005; Ross *et al.*, 2006). Ross *et al.* (2006) found that the microcystins released from *Microcystis aeruginosa* after ultrasonication could increase 90%, although the density of *Microcystis* is not correlated with microcystins concentrations in the water column due to variable toxicity of *Microcystis*. Ma *et al.* (2005) found that ultrasonic irradiation would not increase the microcystins concentration from *Microcystis* in the water column.

A broader scope of ultrasound effects on aquatic ecosystems in published literature was taken, only to find a complete lack of evidence. Fish acoustics are frequently discussed in the literature and two informative reports were found; Hastings and Popper (2004) and Gisiner (1998). Hastings and Popper (2004) review the known effects of anthropogenic noise, specifically pile driving, on fish and identify research that needs to be conducted. Due to acoustic threshold variability and hearing specialist/generalist distinctions in fish species, it is difficult to extrapolate data from one species to another. Past research looking at responses of fish to anthropogenic acoustics were conducted at frequencies lower than 20 kHz, the frequency of the LG Sonic products. Amoser and Ladich (2005) found that the frequency threshold for fish was parabolic over the 0.1 – 4.0 kHz range.

Data on the effects of sound on eggs and larval fish is sparse. Banner and Hyatt (1973) found slowed larval development and species specific egg mortality when exposed to frequencies between 100-1000 Hz. The gas bladder is also of concern, but sounds amplified by the swim bladder are usually less than 1000 Hz. Gisiner (1998) reviews literature regarding underwater sound and its effect on gas voids, bowel, lungs, swim bladder, eye, heart, and reproduction. All publications reviewed utilize frequencies significantly less than 20 kHz and cannot be extrapolated for higher frequencies.

## Human Impacts

Effects on humans are of concern since Barton Springs Pool is a recreational swimming pool. The range of human hearing is about 250 Hz to 20,000 Hz. Stelmachowicz *et al.* examined normative thresholds from 8000 to 20,000 Hz as a function of age. They found that the sensitivities of the youngest group, 10 – 19 years old, were the most sensitive and that sensitivity decreased with age. Trehub *et al.* (1989) found that sensitivity to 20 kHz increased until age 8, and then began to deteriorate on a group of subjects from 1.5 – 16 years old. Fausti *et al.* compared the hearing sensitivities of 20-29 year old veterans who were exposed to steady state or impulsive noise exposure. They found that subjects exposed to steady state or impulsive noise had decreased sensitivity from the control subjects (unexposed 20-29 year olds). The intensity (in dB) of the LG Sonic is proprietary information and cannot be disclosed (ref).

## **Recommendations**

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Barton Springs Pool is not the appropriate test location for ultrasonic algae control at this time. The scientific literature is inadequate to base a decision that the technology could be implemented safely for salamanders and the public. The technology simply is not ripe for full scale testing in a critical habitat. However, the few studies that have evaluated quantitatively the efficacy of ultrasonic algae control indicate that we should continue to look at this technology for the future. Testing in ponds with problematic algae blooms and overgrowths is recommended. In addition, an outline of necessary laboratory and field testing necessary for USFWS to consider installation near salamander habitat should be developed.

## References

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- Ahn, Chi-Yong, Myung-Hwan Park, Seung-Hyun Joung, Hee-Sik Kim, Kan-Yong Jang, and Hee-Mock Oh. (2003) Growth inhibition of cyanobacteria by ultrasonic radiation: Laboratory and enclosure studies. *Environmental Science and Technology*. 37(13), 3031-3037.
- Amoser, Sonja and Friedrich Ladich. (2005) Are hearing sensitivities of freshwater fish adapted to the ambient noise in their habitats? *The Journal of Experimental Biology*. 208, 3533-3542.
- Banner, Arnold, and Martin Hyatt. (1973) Effects of noise on eggs and larvae of two estuarine fishes. *Transactions of the American Fisheries Society*. 102(1), 134-136.
- Fausti, Stephen A., Deborah A. Erickson, Richard H. Frey, B. Z. Rappaport, and M. A. Schechter. (1981) The effects of noise upon human hearing sensitivity from 8000 to 20,000 Hz. *Journal of the Acoustical Society of America*. 69(5), 1343-1349.
- Francko, D. A., S. R. Taylor, B. J. Thomas, and D. McIntosh. (1990) Effect of Low Dose Ultrasonic Treatment on Physiological Variables in *Anabaena flos-aque* and *Selenastrum capricornutum*. *Biotechnology Letters*. 12(3), 219-224.
- Gisiner, Robert C. (1998) Proceedings – workshop on the effects of anthropogenic noise in the marine environment. Marine Mammal Science Program, Office of Naval Research.
- Hao, Hongwei, Minsheng Wu, Yifang Chen, Jiaowen Tang, and Qingyu Wu. (2004) Cyanobacterial bloom control by ultrasonic irradiation at 20 kHz and 1.7 Mhz. *Journal of Environmental Science and Health, Part A: Toxic/Hazardous Substances and Environmental Engineering*. 36(6), 1435-1446.
- Hastings, Mardi C. and Arthur N. Popper. (2005) Effects of sound on fish. Final Technical Report. California Department of Transportation Contract No. 43A0139, Task Order 1.
- Hutchinson, George. Why the LG Sonic Products do not harm life forms other than algae. Technical White Paper. AlgaeControl.US Division, South Santee Aquaculture, Inc.
- Limbaucher & Godfrey Architects. (2008) Barton Springs Pool Master Plan Prepared for City of Austin, Parks and Recreation Department, February 19, 2008., Austin, Texas.
- Ma, Bozhi, Yifang Chen, Hongwei Hao, Minsheng Wu, Bo Wang, Honggang Lv, Guangming Zhang. (2005) Influence of ultrasonic field on microcystins produced by bloom-forming algae. *Colloids and Surfaces B: Biointerfaces*. 41, 197-201.

Nakano, Kazunori, Tae Jong Lee, and Masatoshi Matsumura. (2001) In situ algal bloom control by the integration of ultrasonic radiation and jet circulation to flushing. *Environmental Science and Technology*. 35(24), 4941-4946.

Newman, Jonathan. (2008) Personal communication.

Newman, Jonathan. (2009) Personal communication.

Newman, Jonathan. (2010) Personal communication with Ed Peacock, City of Austin, WPD. October 20, 2010.

Ross, Cliff, Lory Santiago-Vazquez, and Valerie Paul. (2006) Toxin release in response to oxidative stress and programmed cell death in cyanobacterium *Microcystis aeruginosa*. *Aquatic Toxicology*. 78, 66-73.

Stelmachowicz, Patricia G., Kathryn A. Beauchaine, Ann Kalberer, and Walt Jesteadt. (1989) Normative thresholds in the 8- to 20-kHz range as a function of age. *Journal of the Acoustical Society of America*. 86(4), 1384-1391.

Trehub, S. E., B. A. Schneider, B. A. Morrongiello, and L. A. Thorpe. (1989) Developmental changes in high-frequency sensitivity. *Audiology*. 28(5), 241-249.

Zhang, Guangming, Panyue Zhang, Hong Liu, and Bo Wang. (2006a) Ultrasonic damages on cyanobacterial photosynthesis. *Ultrasonics Sonochemistry*. 13, 501-505.

Zhang, Guangming, Panyue Zhang, Bo Wang, and Hong Liu. (2006b) Ultrasonic frequency effects on the removal of *Microcystis aeruginosa*. *Ultrasonics Sonochemistry*. 13, 446-450.