SMUD
SACRAMENTO MUNICIPAL UTILITY DISTRICT
The Power To Do More.®

Energy Efficiency & Customer Research & Development
Technology Brief…The SolarBee™

Contents

Background

Just ask any of the residents of Laguna West Lakes and they will tell you how much they enjoy their lake. Whether fishing, boating or simply just taking an evening stroll along the shoreline, the lake has been a source of enjoyment for all ages. However, a few years ago the lake began to experience problems with fish-kills, blue algae blooms and foul-smelling, stagnant water. After trying several different and moderately successful approaches to control the problems, the Association decided to test a SolarBee pond circulator, thus adding another tool to the lake management plan.

Blue-Green Algae: a Most Unwelcome Guest

You have probably seen blue-green algae blooms before: they look like someone dumped iridescent green paint or chopped grass into the water. Blue-green algae, also known as cyanobacteria, typically favor warm, stagnant waters rich with soluble nitrogen and phosphorus. Unfortunately, blue-green algae produce some very nasty toxins that make them unpalatable to aquatic animals and fish while eliminating competing types of algae. To make matters even worse, microbial decomposition of blue-green algae blooms degrades surface waters with smelly pond scum, and depletes waters of life-supporting dissolved oxygen. When dissolved oxygen concentrations go down to 0-1 mg/L (milligrams per liter) in bottom waters, fish, crayfish, and other aquatic animals die. Furthermore, those toxins released with blue-green decomposition can be highly detrimental to aquatic life. Finally, if all of this is not discouraging enough, try to wade through the thick mats of invasive aquatic vegetation that often accompanies blue-green algae!


Blue-green algae

Traditional Lake Management Approaches

If blue-green algae and invasive aquatic weeds are the problem, then eliminating them should be the solution. For the past several decades, the main ways to improve lakes have been to 1) reduce or eliminate algal nutrient inputs to the lake, 2) apply herbicides to kill the blue-green algae and invasive aquatic weeds, and 3) use mechanical weed harvesters to physically remove unwanted plants. While none of these approaches are independently successful and sustainable for the control of the blue-green algae and aquatic plants, each plays an important part of an overall lake management plan.

A New Approach

One of the characteristics that allows blue-green algae to dominate is their ability to regulate buoyancy - they move upward during the day for light and downward into nutrient-rich waters at night. During the past few years there has been growing evidence that both blue-green algae blooms and several species of invasive aquatic weeds can be controlled by modifying their respective habitats through water circulation. However, this knowledge had not yet been successfully applied to larger bodies of water until the SolarBee was introduced.

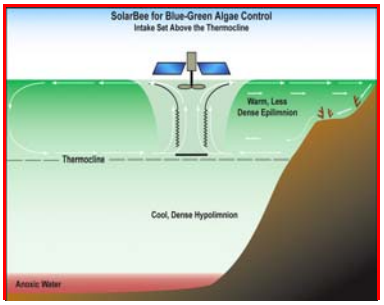
The SolarBee: a Solar-Powered Water Circulator

While the SolarBee is not the most aesthetically pleasing piece of equipment (it looks a lot like a fallen satellite floating in a lake) it appears to offer an effective strategy for controlling blue-green algae and addressing other water quality issues. Pump Systems Inc., the manufacturer, has assembled an impressive list of clients and case studies for the 700 plus systems currently deployed in the United States. These case studies are available via the manufacturer's website at: www.solarbee.com.

How SolarBee Works

The basic strategy behind the SolarBee is very simple: to use water circulation to disrupt the growth of blue-green algae, circulate oxygen and reduce water stagnation. The device itself consists of a floating assembly that uses solar panels, a ½ hp direct current motor, a large diameter impeller (up to three feet) and an intake tube (see photo) to gently circulate large volumes of water. The intake tube is adjustable and can be set for depths of 3 to 100 feet.

The water is drawn upward through the intake tube and is then gently spread radially outward from the machine in a near-laminar (smooth) flow that enables long distance movement of the water. In fact, as incredible as it may seem, independent tests have proven that the SolarBee is capable of moving water up to 1,000 feet – using only a ½ hp D.C. motor driven by 30-watts of solar power!



As the water spreads across the surface of the lake, it acquires dissolved oxygen from the air and through algal photosynthesis. When the moving water reaches the shores, it moves downward along the lake's sediments until it reaches the depth of the intake hose where it is drawn back towards the machine. According to Pump Systems Inc., this type of water circulation provides numerous ecological benefits:

1. **Control of blue-green algae blooms and reduction of invasive aquatic weeds:** Blue-green algae are negatively impacted by the continuous circulation of deeper waters (e.g., from 8-10 feet) up to the surface, while oxygen-rich surface waters are transported downward to the level of the machine's intake hose. This movement disrupts the ability of bloom-forming blue-greens to out-compete the more beneficial, edible algae.

2. **Enhanced biodiversity:** Nutrients that would otherwise be consumed by blue-greens become available to other forms of algae that can be eaten by aquatic animals, enhancing the food chain and biodiversity while improving water clarity. As for aquatic weeds, the return flow of oxygen-rich water along the sediments and back to the machine helps deplete the sediments of ammonia-nitrogen (the form of nitrogen strongly preferred by many invasive aquatic weeds), thus limiting the plants' growth by limiting the availability of a primary plant food (i.e., ammonia-N). This circulation of oxygen-rich water also benefits the health and survival of fish.

Laguna West Lakes: Preliminary Results

Laguna West Lakes in Elk Grove, California is a four-lake chain covering a total of 73 acres. Typical of many highly urbanized lakes, these waters experience blue-green algae blooms, fish kills due to low dissolved oxygen levels, invasive aquatic weeds, poor circulation and stagnation, and unpleasant odors. In June 2004, one SolarBee machine was installed in a three-acre dead-end cove (average and maximum depth of about 10 feet) experiencing dangerously low dissolved oxygen concentrations and surface scum. In addition to increasing dissolved oxygen levels in the water column to prevent fish kills, other objectives included controlling blue-green algae blooms and reducing invasive aquatic weeds.

Reports from homeowners and routine lake monitoring indicate that the water circulation induced by the SolarBee has been effective. The SolarBee was able to maintain dissolved oxygen levels of 5+ mg/L (a level good for fish) throughout the water column, prevent a build up of surface scum, and reduce the presence of blue-green algae. In contrast, the other lakes in the chain suffered from chronic blue-green algae blooms.

Vice President of the Association, David Riddell is excited by the positive and visible results from the SolarBee. He stated, "The lake is the only commonly owned property in the Association and therefore the most important obligation the Board of Directors has is to protect and enhance the lake. The SolarBee was an experiment at the time of installation, but we felt it added another weapon to our arsenal of tactics that add up to a comprehensive lake management plan. The Board of Directors is thinking of adding additional SolarBees to help with water clarity of the lakes along with the other benefits."

Acknowledgements

We gratefully acknowledge the SolarBee Division of Pump Systems, Inc. for their significant contributions to this report.

The Customer Advanced Technologies Program

SMUD's Customer Advanced Technologies (C.A.T.) program works with customers to encourage the use and evaluation of new or underutilized technologies. The program provides research grants to customers for eligible technologies in exchange for monitoring rights. For more program information, please visit: http://www.smud.org/education/cat/index.html