AQUATIC PLANT CONTROL

The long-term objective of the District's aquatic plant control program has been the eradication of noxious plants (Eurasian water milfoil and coontail) to facilitate public access, improve water quality and enhance fish habitat. The District understood that if the abundance of noxious weeds and algae present in the Lake were not controlled, excessive amounts of nutrients (mainly phosphorous) would continue to be released into the food chain following plant die-off, providing a food source for even more abundant vegetation. Extensive growth of aquatic vegetation has always developed in Big Bear Lake during the summer months, particularly in the upper fifteen to twenty feet, with the plants covering approximately 800 acres of the Lake's 3,000 acre surface. District records indicate that of the weeds harvested, 73% was milfoil, 20% was coontail and the remaining 7% was a combination of other types. These statistics confirmed that the two main invasive species, Eurasian water milfoil and coontail, became so predominant that the native species were unable to survive. During 2002 and 2003, the District's herbicide applications almost completely eliminated these two noxious plants allowing a variety of native species to return.

Eurasian water milfoil was described as a "harmful non-indigenous species" in a 1993 report to the U.S. Congress, and the Federal Invasive Species Council has classified this weed as a threat to the water resources of the United States. It is an extremely aggressive plant, and is a threat to most water uses. The excessive growth of this plant in Big Bear Lake was one of the main reasons the Lake was placed on the State of California's 303d list of impaired water bodies. Along with plant infestation, high nutrient levels were also identified as an impairment. As a result of this listing, the TMDL (Total Maximum Daily Load) process was initiated by the Santa Ana Regional Water Quality Control Board in 2000. It was quickly determined in that process that much of the Lake's high phosphorous levels are caused by in-lake sources (sediment and aquatic plants). As a result, the TMDL Work Group developed pilot projects and secured grant funding to address various methods of removing the invasive plants and the nutrient-laden sediment.

The District realizes that even though aquatic plant removal is essential to remove nutrients and to provide adequate recreational areas on the Lake, certain types of vascular rooted plants are an important environmental attribute in Big Bear Lake. These plants provide essential habitat for fish life and they produce an abundance of food organisms for all species of fish present. Aquatic plants are also utilized to a significant extent as food by migratory waterfowl and often serve as some control of shoreline erosion. As the invasive species are removed, a return of the native plant species will ensure this essential food source remains in Big Bear Lake.

The District has adopted a program that includes the following three types of aquatic plant control:

- **Mechanical harvesting** The harvesting program has traditionally been implemented every boating season to provide boating access to private dock systems, commercial marinas and public launch facilities. It was always considered a short-term solution, as an aquatic weed harvester is much like a giant lawnmower, and can actually spread the growth of weeds to other areas of the Lake. The recent success with herbicide applications has practically eliminated the need for the mechanical harvesting program.
- **Herbicide applications** Herbicide treatments can give many seasons of relief in selected areas of the Lake and can eventually lead to the elimination of specifically targeted noxious aquatic plants.
- **Dredging** Removal of the plant roots and creating deeper water where plants are deprived of sunlight and cannot grow, is the best long-term solution to controlling aquatic weed growth.

AQUATIC PLANT OVERVIEW

A wide range of aquatic plants can be found growing in, on, and around a body of water. Based on their various adaptations, some will be found rooted in flowing waters while others can only survive in placid, stagnant areas. Within a natural, well-balanced system, these plants provide food and cover for fish, waterfowl and aquatic vertebrates. They produce oxygen and help stabilize bottom sediments. Like terrestrial plants, aquatic vegetation requires a carbon source, sunlight and nutrients. Dissolved carbon dioxide, bicarbonates and carbonates, typically quite abundant in water, provide a source of carbon for the growth and food production process known as photosynthesis. The energy driving this process is derived from sunlight. Therefore, the depth of the sunlight penetration will limit the depth to which aquatic plants can grow. At the same time, the amount of nutrients available (mainly nitrogen and phosphorous) will limit the quantity of vegetation, which will grow.

Aquatic plants derive their nutrients from the sediments and/or the water column. These nutrients are cycled between the sediments and the water on an annual basis. Adding to this nutrient enrichment of a lake, a process known as eutrophication, are inputs from external sources. Nutrients and sediments are contributed by man's agricultural, domestic and industrial activities through sources such as domestic waste discharges, construction site erosion, lawn and garden fertilizer runoff, and septic tanks. The most noticeable symptom resulting from eutrophication is the development of prolific aquatic plant growth. Eight types of aquatic plants have been identified in Big Bear Lake, of which coontail and milfoil have historically been the most abundant and the most troublesome to navigation, fishing and aesthetics.

HARVESTING PROGRAM

Harvester off-Loading to the Conveyer Belt

Historically, the Big Bear Municipal Water District operated up to four aquatic weed harvesters and one Aquamog on the Lake for the purpose of removing weeds, primarily from around docks and major boating areas. Approximately 86% of the weed cutting occurred around private docks, with the remaining 14% occurring in areas where improved public access was needed or navigational hazards must be removed. From 1964 to 2002, the harvesting program removed about one thousand tons of weeds from the Lake annually. In 2002 and 2003, the District began using Sonar herbicide in place of harvesting to control and eventually eradicate Eurasian Watermilfoil. This program was so successful that the need for harvesting was substantially reduced. Harvesting is now used minimally to address weed growth in areas of the Lake where the herbicide has not yet been used. Over the next few years, the District will evaluate the harvesting needs and determine how much equipment should be retained. If the goal of eradicating Eurasian Watermilfoil is ultimately achieved, harvesting may eventually become a seldom used practice.

Harvester off-loading to the transporter

The harvesting program was developed because aquatic plants covered about 800 acres around the perimeter of Big Bear Lake and it was the safest and most environmentally acceptable control. Approximately 240 acres of the aquatic plant growth was controlled with the use of aquatic weed harvesters. These harvesters held three tons of harvested weeds, which

were transferred to a shore conveyor and into a dump truck. The harvester effort was concentrated around the lakefront property docks and private dock owners pay an annual fee to cover the cost of this service or other methods of aquatic plant control. Harvesting was also completed in other areas of the Lake as needed to improve recreational access, navigation and safety. Each area on the Lake has been identified for its use and the harvesting program was is formulated around those needs, as is the current plant control program.

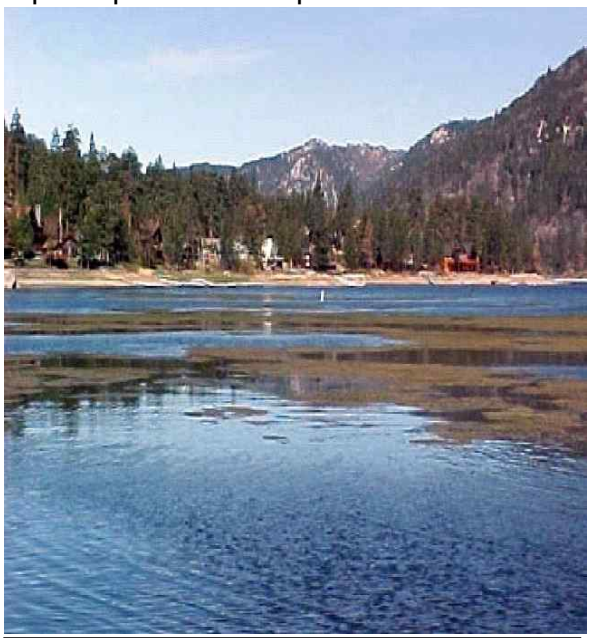
HERBICIDE/ALUM TREATMENTS

In the summer of 1996, the District completed an experimental application in Grout Bay of a product called Sonar. Sonar is an aquatic herbicide developed specifically for the control of aquatic plants. It has been used for a number of years in other states, but was not approved for use in California until 1996. Sonar has no restrictions on use of the water after application and has been shown to be especially successful in controlling or even eradicating unwanted plants such as coontail and milfoil. These two noxious plants are the targets of the District's current weed harvesting program and are the most annoying to boaters.

Sonar's active ingredient is Fluridone, which is not a chronic poison or a carcinogen. It works by restricting the plants' ability to make food, causing them to die. This involves inhibiting development of the yellow pigments that protect a plant's chlorophyll from decomposition by sunlight. As the plant's chlorophyll decreases, so does its capacity to produce food. The visual symptom of Sonar's action is bleaching on the terminal bud or growing points of the plant. Sonar is selective and controls target weeds slowly. The dilution factor of the product directs which plants will be destroyed.

After many weeks of studying case histories regarding the use of Sonar and actually visiting sites where Sonar had been used, the District determined that a test in Big Bear Lake was the appropriate first step in analyzing Sonar's potential. Grout Bay, on the north shore of the Lake, was selected as the test area as it is very protected from the wind and also from weed harvesting operations. This 35 acre area was initially treated during the first week of August 1996, with additional applications approximately every three weeks throughout the remainder of the summer. District Staff monitored the test area following the applications and concluded that the product results were unsatisfactory. Upon further evaluation, it was determined that the applications occurred too late in the growing season to achieve maximum results. A second series of applications took place in 1998 in the same area of the Lake. The cost for these treatments was approximately $1,000 per acre\and the result was nearly three years of weed-free access in Grout Bay. Based on these results, the District developed a plan to treat specific areas of the Lake again in 2000. However, a federal court of appeals decision on the use of herbicides, chemicals, pesticides and algaecides resulted in new permitting requirements. This made it impossible for the District to proceed as planned.

In January 2001, in order to obtain updated information on weed distribution throughout the Lake, along with an evaluation of current and proposed methods of control, the District retained ReMetrix Inc. to complete a Vegetation Assessment and Management Plan for Big Bear Lake. The report was accompanied by a computer software program designed to help the District coordinate its harvesting program and evaluate the results. This plan will not only be helpful in improving the District's plant control program, but it will also be an important reference tool when seeking future grant funding for Lake improvement projects.



Weed growth before Sonar herbicide application

In December of 2001, the District decided to move forward in the spring of 2002 with an aggressive program for herbicide treatments. Following three dry years with less than normal inflow to the Lake, and a Lake that was 9'6" below full, it was determined that applications in the east end of the Lake, in Boulder Bay and in the Mallard Lagoon/Canvasback Cove areas could achieve many years of relief from the infestation of Eurasian water milfoil. A consultant was retained to coordinate the permit process work with the Santa Ana Regional Water Quality Control Board. As a part of the TMDL (Total Maximum Daily Load) process, Proposition 13 funding was available in 2003 for additional Sonar applications in Papoose Bay and along the south shore of the Lake from Big Bear Marina to Eagle Point. The Sonar applications have been a total success, eradicating Eurasian milfoil in the target areas, and the District is confident that in the near future, milfoil will no longer be present in Big Bear Lake. There was some return of milfoil in 2004 along the north shore and other small areas not targeted in 2003. These areas were treated with a product called Renovate, which is preferred for small outbreaks of the nuisance plant. Since 2005 has produced a significant increase in lake level, it is anticipated there will be little need for aquatic plant control during the 2005 boating season. The District will monitor the return of native vegetation.

Same area after Sonar herbicide application

In 2003, Proposition 13 funds were also used to conduct a pilot-scale aluminum sulfate (alum) treatment in Papoose Bay. The bay was curtained off from the rest of the Lake before the alum was applied. The results provided empirical evidence that Big Bear Lake has enough buffering capacity/alkalinity to withstand an alum application without resulting in adverse impacts to water column PH. This, in turn, justified using other Proposition 13 funds to expand the project to treat additional lake bottom. In July 2004, a large scale alum treatment was performed at a cost of approximately $570 per acre, for a total treatment cost of $753,170 ($400,000 was from Prop 13). Water quality monitoring conducted as part of the project showed that the environment benefits of an alum application are immediate in achieving long-term improvements in water column phosphorous concentrations, chlorophyll a concentrations and water clarity. Alum application directly inhibits sediment release of phosphorous as aluminum irreversibly binds up available phosphorous. Alum application indirectly controls algae and algal blooms by reducing the amount of nutrient phosphorous available for biological growth. The reduction in water column phosphorous reduces the number of algae blooms through control of the limiting nutrient.