

## REDUCTION OF NUISANCE AQUATIC PLANTS IN BIG BEAR LAKE

Big Bear Lake has always been populated with aquatic plants, but until recently, these plants were controlled by aquatic plant harvesters. Harvesters, however, could no longer keep up with the expanding plant area, and after much research, the Big Bear Municipal Water District (BBMWD) decided that the application of an aquatic herbicide directly targeted at two nuisance plants, Eurasian Water Milfoil (*Myriophyllum spicatum*) and Coontail (*Ceratophyllum demersum*), was the most cost effective solution to manage the plants. The two targeted species of plants comprised the majority of the plant species found in Big Bear Lake prior to the herbicide applications. After the herbicide treatments in 2002 and 2003, the biomass of these two species decreased by at least 85% within all herbicide treatment areas and these two species became the least dominant. Increases in other plant species were observed in 2004, the final year of aquatic plant monitoring efforts for the herbicide treatments.

Big Bear Lake is a man-made reservoir created by the construction of the current Bear Valley Dam in 1912, and is located in the San Bernardino Mountains in San Bernardino County, approximately 100 miles northeast of Los Angeles. In 1994, the Santa Ana Regional Water Quality Control Board (SARWQCB), placed Big Bear Lake on the state's Section 303(d) list of impaired water bodies for noxious aquatic plants and nutrients, among other constituents. By the year 2000, an estimated 781 acres of the 2971 acre lake were dominated with two species of plants, the non-native Eurasian Water Milfoil, and the native Coontail. These plants not only interfered with several of the lake's beneficial uses (e.g., recreation), but also contributed to nonpoint source pollution via nutrient loading within the lake (i.e., internal nutrient loading). Internal nutrient loads from plants alone were calculated at 17,943 lbs/yr of total phosphorus and 116,942 lbs/year of total nitrogen.

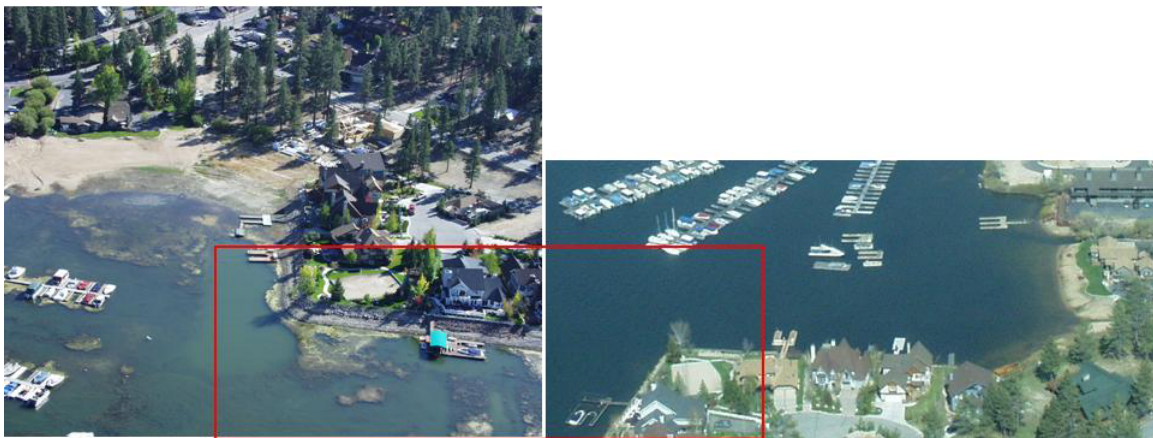
The Nutrient Total Maximum Daily Load (TMDL) for dry hydrological conditions for Big Bear Lake approved by the SARWQCB on April 21, 2006, specifies that total phosphorus loads from plants will be reduced to 15,700 lbs/year in order to meet the total phosphorus numeric target of 35 µg/L. In addition, there is an aquatic plant coverage target (i.e., 30-40% on a total lake area basis) and a percentage of nuisance aquatic vascular plant species target (i.e., 95% eradication of Eurasian watermilfoil and any other invasive aquatic plant species).

In the past, the BBMWD utilized aquatic harvesters to control problems resulting from excessive aquatic plants. The harvesters, however, could only maintain approximately 250 acres of the aquatic plants each growing season. Harvesting alone, therefore, was no longer sufficient to protect the lake's beneficial uses directly affected by the nuisance aquatic plants. Harvesting could also have led to the spread of Eurasian Water Milfoil throughout the lake. The application of an aquatic herbicide directly targeted at the nuisance plants would allow the BBMWD to more effectively manage the lake, and restore impacted beneficial uses.

In May 2002, the BBMWD initiated a campaign to address the aggressive growth of the invasive Eurasian Water Milfoil and the nuisance Coontail. For two consecutive years (i.e., 2002 and 2003), an aquatic herbicide was applied in selected areas of Big Bear Lake. These applications required a National Pollutant Discharge Elimination System (NPDES) permit from the SARWQCB. The permit required extensive water quality monitoring. Respective pre-treatment and post-treatment aquatic plant surveys were performed in designated control and treatment areas. A total of 76 biomass sample point locations and 31 hydroacoustic transect line locations were surveyed and re-surveyed between May 2002 and July 2004.

The 2002 herbicide application was funded by the BBMWD from their lake improvement account and treated a total of 270 acres of plants for a total cost of \$327,000. The pre-treatment and post-treatment surveys were conducted in May 2002 and June 2003. The 2003 herbicide application was funded by a Section 319(h) grant (Contract # 02-151-258-0; \$120,000) awarded to the BBMWD, and treated an additional 144 acres of plants. Respective pre-and post-treatment aquatic plant surveys were conducted in June 2003 and September 2003. An additional plant survey was performed in July 2004 to evaluate the success of the 2003 grant using a portion of funds (approximately \$30,000) from a Proposition 13 grant (Contract # 03-160-558) awarded to the BBMWD. The BBMWD also provided \$25,000 in matching funds. In addition, a preliminary index system for aquatic plants was created. In 2006, building on this preliminary index system, an Emergent and Aquatic Plant Management Plan was developed and aquatic plant monitoring was conducted using a portion of funds (approximately \$45,000) from a separate Proposition 13 grant (Contract # 04-204-558-0) also awarded to the BBMWD. The aquatic plant monitoring determined the presence or absence of aquatic plants, aquatic plant species, aquatic plant relative densities and relative percent abundance of aquatic plant species throughout the entire lake. Results from this and future aquatic plant monitoring will determine compliance with the aquatic plant-related TMDL numeric targets. Furthermore, in August 2006, the BBMWD and the U.S. Forest Service (USFS) surveyed the entire Big Bear Lake shoreline and Stanfield Marsh for the presence of Tamarisk (i.e., saltcedar). This plant is invasive and competes with other plants for water.

The aquatic herbicide treatments conducted in 2002 and 2003 were beneficial in decreasing the biomass of Eurasian watermilfoil and Coontail. The July 2004 vegetation assessment efforts sampled neither of these plants within the herbicide treated areas of the lake. The overall biomass of these two species of plants decreased by at least 85% within all treatment areas and in 2004, these species were no longer the dominant plant species. Figures 1 and 2 show pre- and post-treated Big Bear Lake. Figure 3 shows how the data from the 2002, 2003 and 2004 surveys were summarized for each transect.



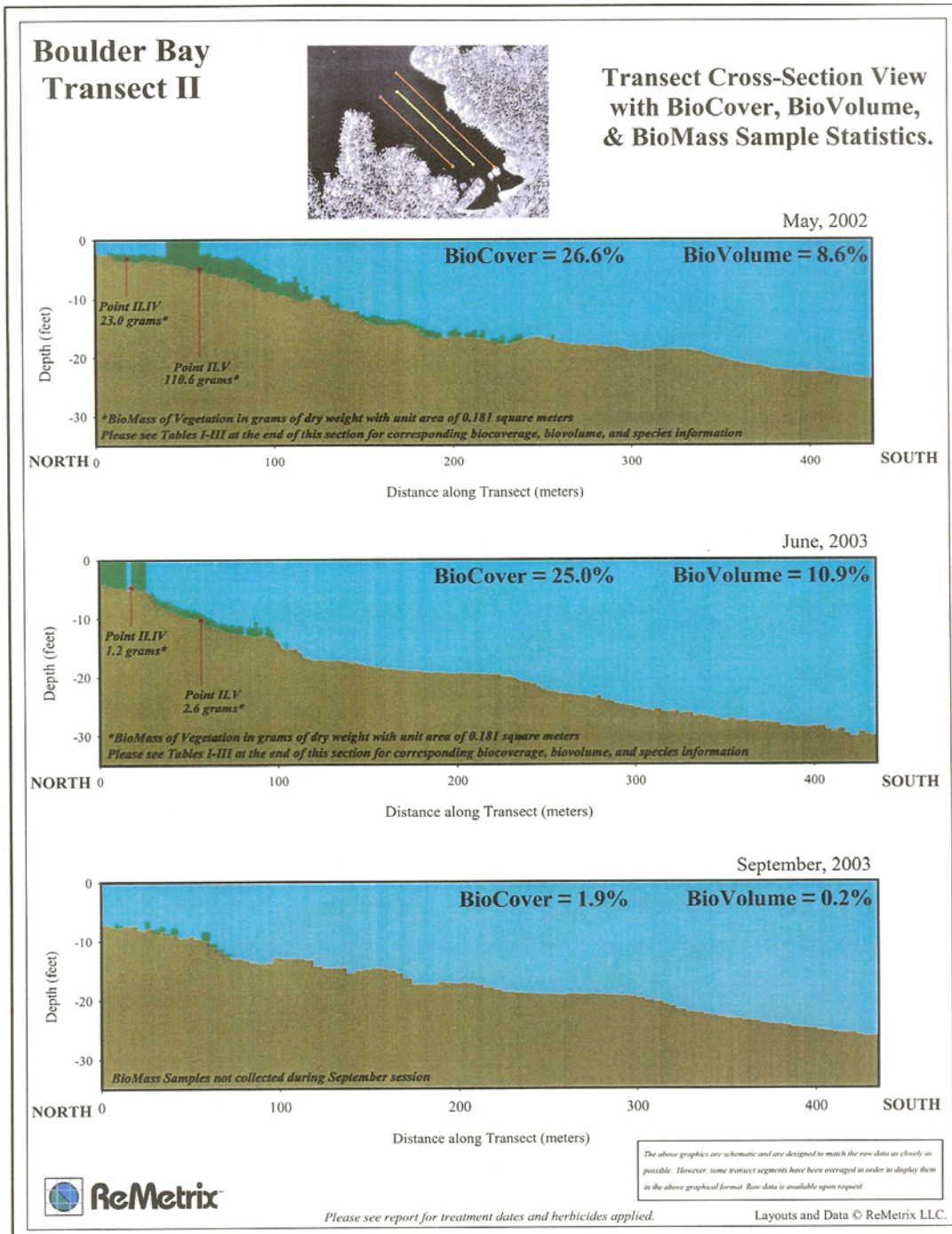
**Figure 1. Big Bear Lake pre-treatment.      Figure 2. Big Bear Lake post-treatment.**  
**Areas outlined in red correspond with each other, but views are different.**

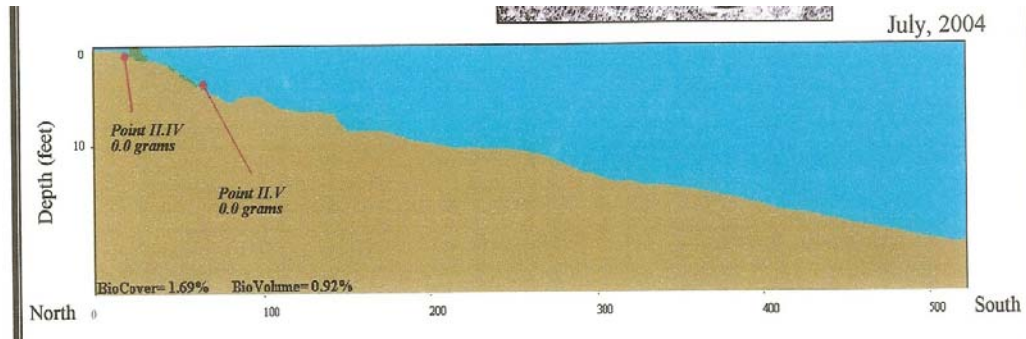
All of this data, including the data collected from 2006 and future years, will be used by the BBMWD in a geographical information system (GIS) to track aquatic plants in Big Bear Lake. The GIS will be used to track the regrowth of Eurasian watermilfoil, so that it can be removed before it grows to excessive levels as occurred prior to 2002. The GIS will also target areas of the

lake for plant restoration and areas that need to be controlled so that all the beneficial uses of the lake can be attained and maintained.

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**Figure 3. For each transect, data were presented in graphical (shown) and text format (not shown), summarizing the biocover, biovolume and biomass sample statistics. Biocover measures the percentage of bottom covered in vegetation, biovolume estimates the percentage of the water column occupied by submersed vegetation and biomass measures the weight of the plants.**