2016 Big Lake
Aquatic Weed Control Program

Prepared for

Big Lake LMD #1
Skagit County Public Works
Mount Vernon, Washington

Prepared by

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Project Overview

This was Northwest Aquatic Eco-Systems (NWAE) fifth year of providing aquatic weed control services for the Big Lake LMD #1 district. Much of the past historical data included in the previous reports has been incorporated into the 2016 report. Big Lake has been actively involved for at least ten years with an intense program to eradicate noxious aquatic macrophytes from the system. Targeted species include Eurasian watermilfoil, Egeria densa (Brazilian elodea), Nymphaea odorata and yellow flag iris. Densities of Eurasian watermilfoil is limited now to a few small infestations located along the southwest shoreline of the lake. This shoreline area has consistently supported milfoil growth and has maintained very light densities of single plant populations for a number of years. There has been no other milfoil sightings lake wide except for this section of the lake. As noxious weed species declined lake wide, native species have increased their range throughout the lake's littoral zone.

Prior to the 2016 treatment season, weed control activities had been limited to commence after July 15th as a result of the past established fish timing window. The shallow nature of the immediate shoreline area historically produced weed growth that typically reached the water's surface prior to July 15th. This growth rendered some of those shoreline areas unacceptable during the early summer months of recreational lake use. In an effort to treat earlier, NWAE, in conjunction with the LMD petitioned the state to approve weed control activities to commence prior to July 15th. As a result of this effort the Department of Ecology granted a treatment window modification authorizing treatment after June 15th. This earlier treatment window did result in favorable lake conditions throughout most of the summer. However, late season weed growth did surface at various locations lake wide. Late season growth is dependent on numerous environmental conditions that favor growth some years and not others.

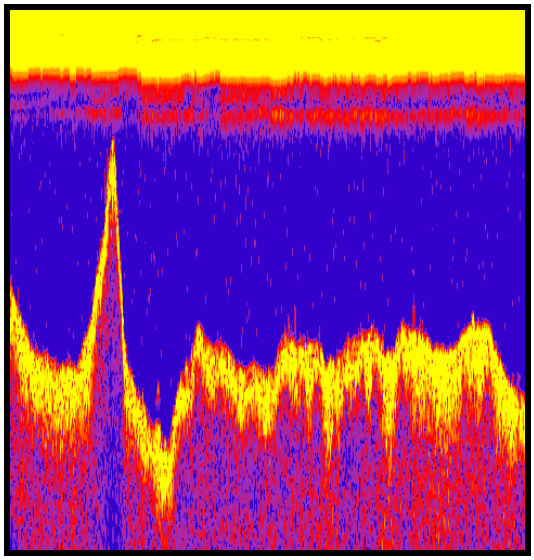
Under the current Big Lake NPDES permit, treatment of native species is limited to no more than 30% of the lake's shoreline.

Survey Protocol

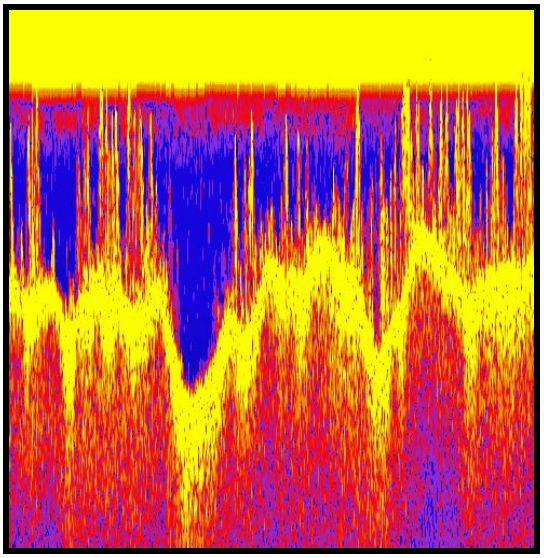
Survey techniques for 2016 once again utilized the new sonar mapping technology initiated during the 2013 treatment season. This new mapping technology incorporates sonar technology with on board chart recording. Sonar data is collected on board and processed to produce an on screen map of the lake bottom surface. When weeds are no longer observed along the lake bottom the collection of sonar data is terminated. Once collected, the SD card is uploaded via cloud based technology and the processing of the data is finalized. The resulting product is a color coded map of the lake bottom identifying weed growth areas and plant densities. Not only is a well-defined map produced, but a sonar log of the survey is saved allowing a complete review and evaluation of the survey to occur in house.

This updated protocol encompasses a surface vehicle transecting the lake along the littoral zone. Boat tracks are designed to be approximately 100 feet apart. To ensure the efficacy of the survey, a bottom sampling rake is thrown from the boat at various locations lake wide. The rake is then drawn across the lake bottom, brought to the surface and into the boat. Plants attached to the rake are identified and confirmed as being the same species as noted through the structure scan or visually through the water column. The system automatically calculates and stores the position of every transect data point enabling the mapping of thousands of data points on a daily basis.

When individual milfoil plants were identified from the surface, waypoints were added to the transect line.



Weed Free Lake Bottom

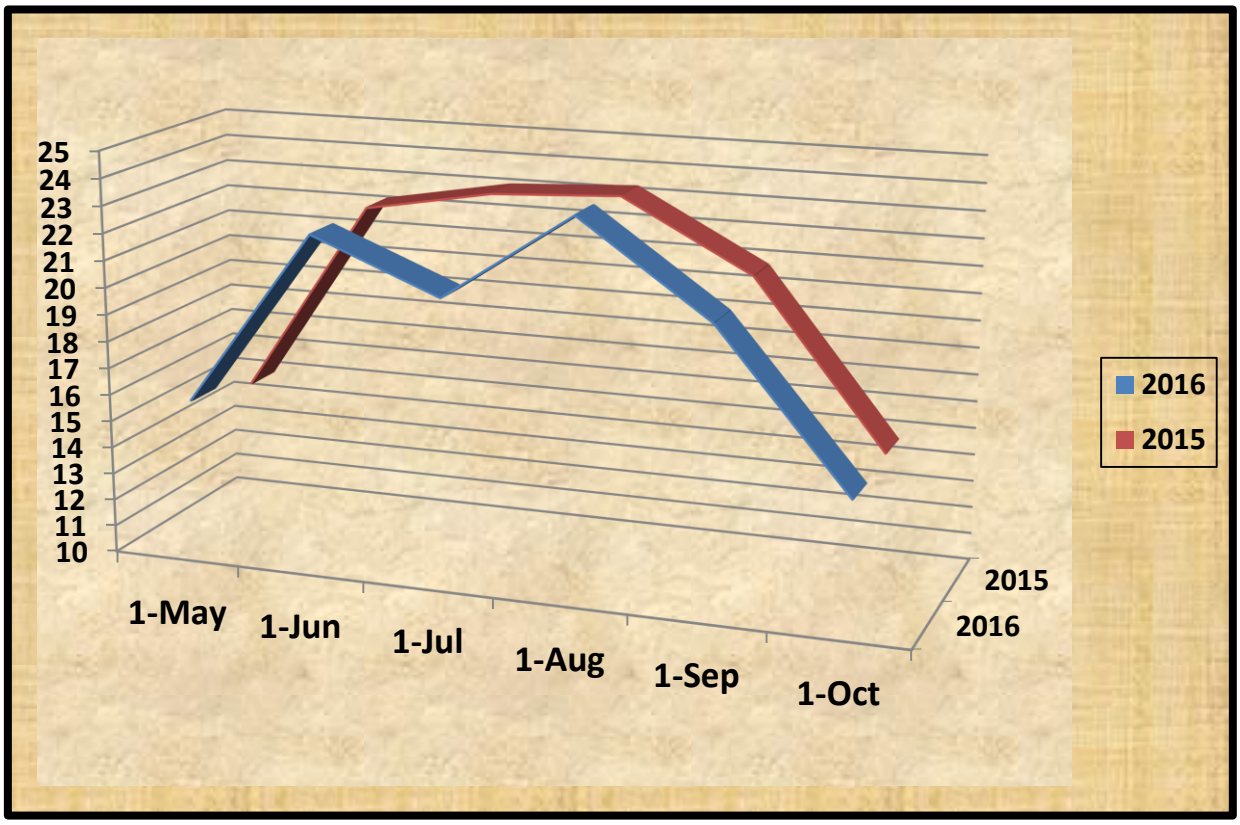


Dense Weed Growth Lake Bottom

Big Lake Pre Treatment Survey Results

Big Lake was surveyed on June 18, 2016. Above normal spring temperatures resulted in abnormal heavy early season growth. Some lake shoreline areas already were experiencing surface weed mats. Once again early season water temperatures were elevated state wide, similar to conditions noted during 2015.

Unlike 2015 when water temperatures increased throughout most of the summer months, the year 2016 identified an increase through mid-May then a three degree centigrade decrease over the next 30 days until water temperatures began to rise again. The same surface temperatures noted during mid-May were not again obtained until mid-July.

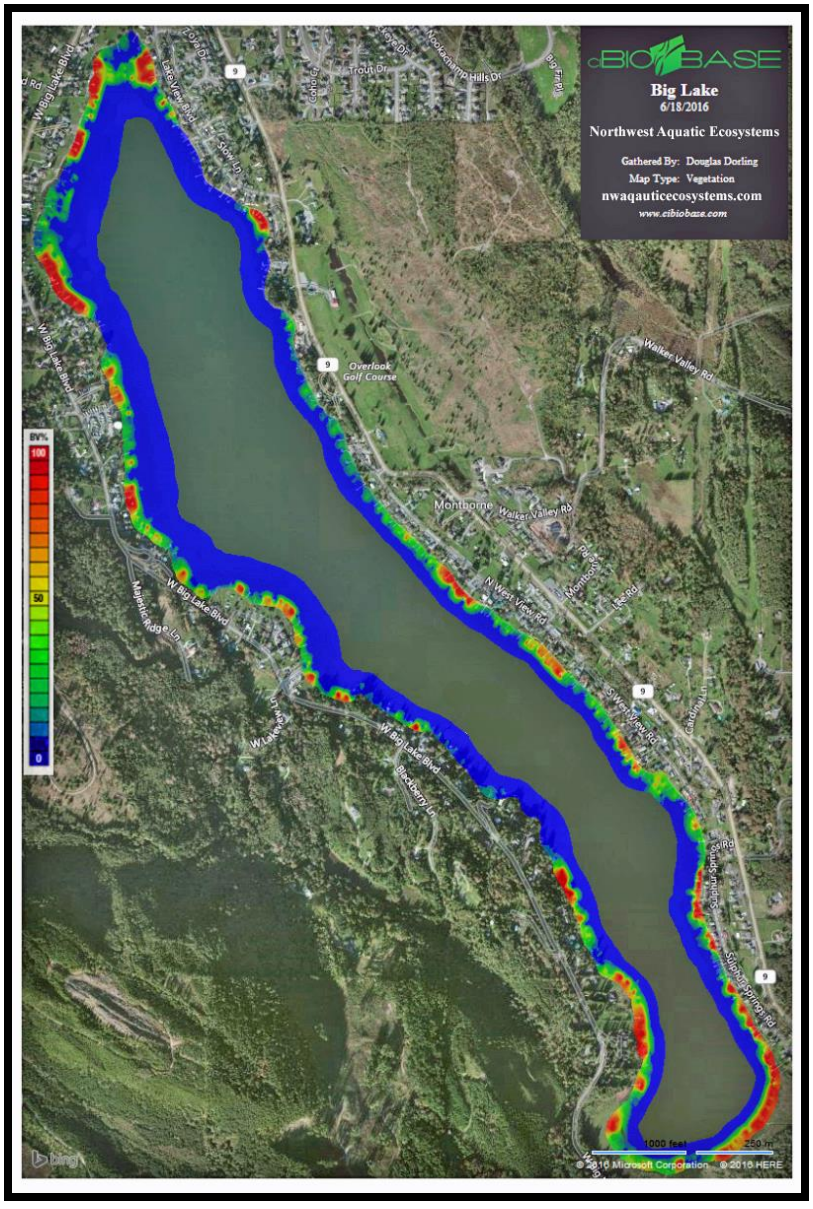


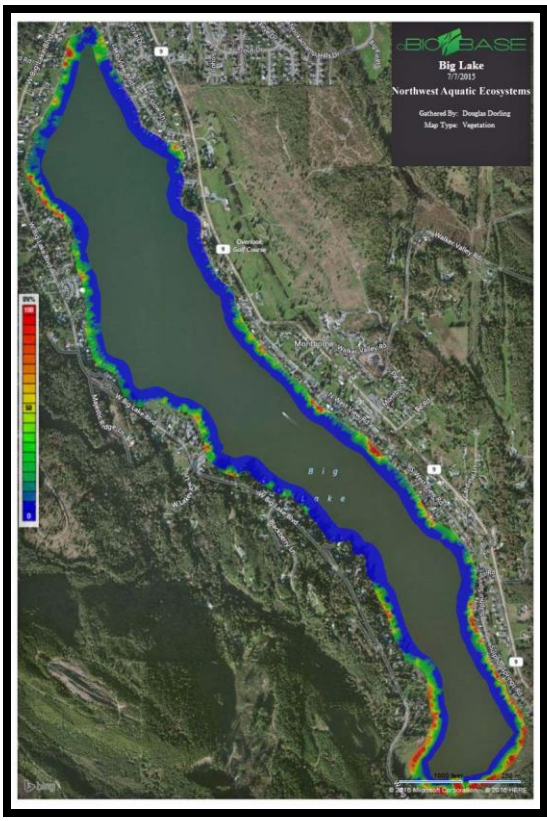
Note : Taken from Steilacoom Lake data set

Water temperature fluctuations have an impact as to when seed germination will occur, and the rate of weed growth. Warm, early, seasonal water temperatures encouraged timely seed germination and rapid weed growth resulting in problematic shoreline infestations. Although weed growth sites remained relatively the same, density within those growth areas were elevated from 2015 levels. These increased densities are noted on the 2016 survey map as red. It is important to note that the 2015 survey was performed approximately one month later than the 2016 survey so it is rational to assume that if the 2016 survey was performed in conjunction with the 2015 survey timeline weed densities would have been greater than noted on the 2016 map.

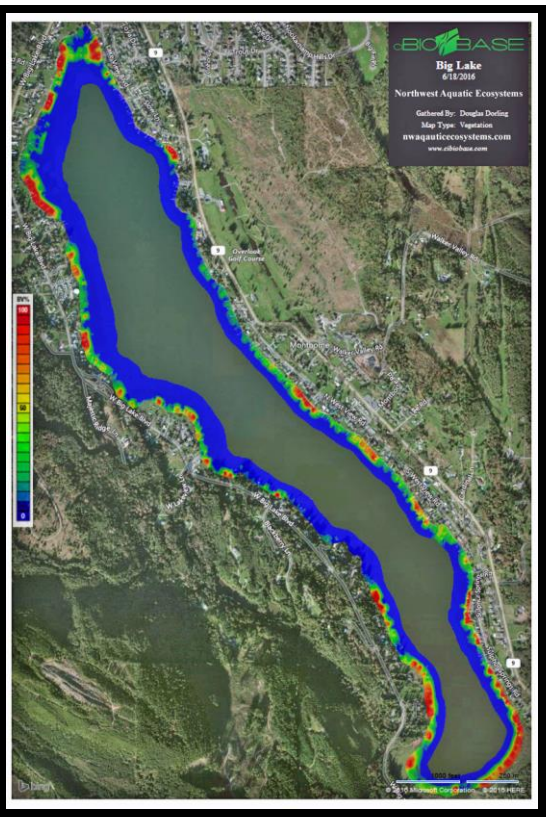
At the conclusion of the 2015 season we were hopeful that current weed densities would continue to decline as existing seed beds declined. NWAE may have underestimated the densities of the preexisting viable seeds contained within the Big Lake bottom sediments. Typically, seeds deposited from past years growth may stay viable for a number of years and germinate when conditions are favorable. The length of time as to how long

deposited seeds may remain viable is difficult to determine. We are hopeful that such declines as noted during 2015 will once again prevail during 2017. The late season growth noted during 2016 and the production of late season seed heads may once again produce heavier than normal early season 2017 growth. There have virtually been no changes in the weed species noted during the 2017 survey as have been identified in prior surveys. Species include: minor occurrences of P. amplifolius, while most of the native growth included P. richardsonii, P. robbinsii, P. praelongus, P. foliosus and P. epihydrus. Problematic non-pondweed species included Elodea canadensis and Vallisineria americana. Different shoreline sections of the lake were dominated by dissimilar pondweed species.



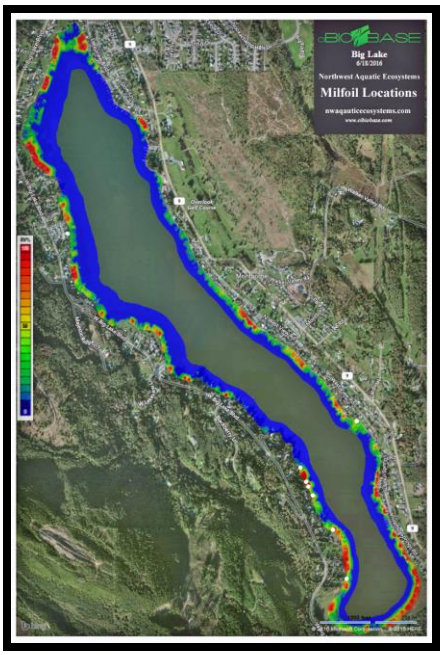


2015 Spring Macrophyte Survey



2016 Spring Macrophyte Survey

June 2016 Milfoil Locations



June 22, 2016 Treatment

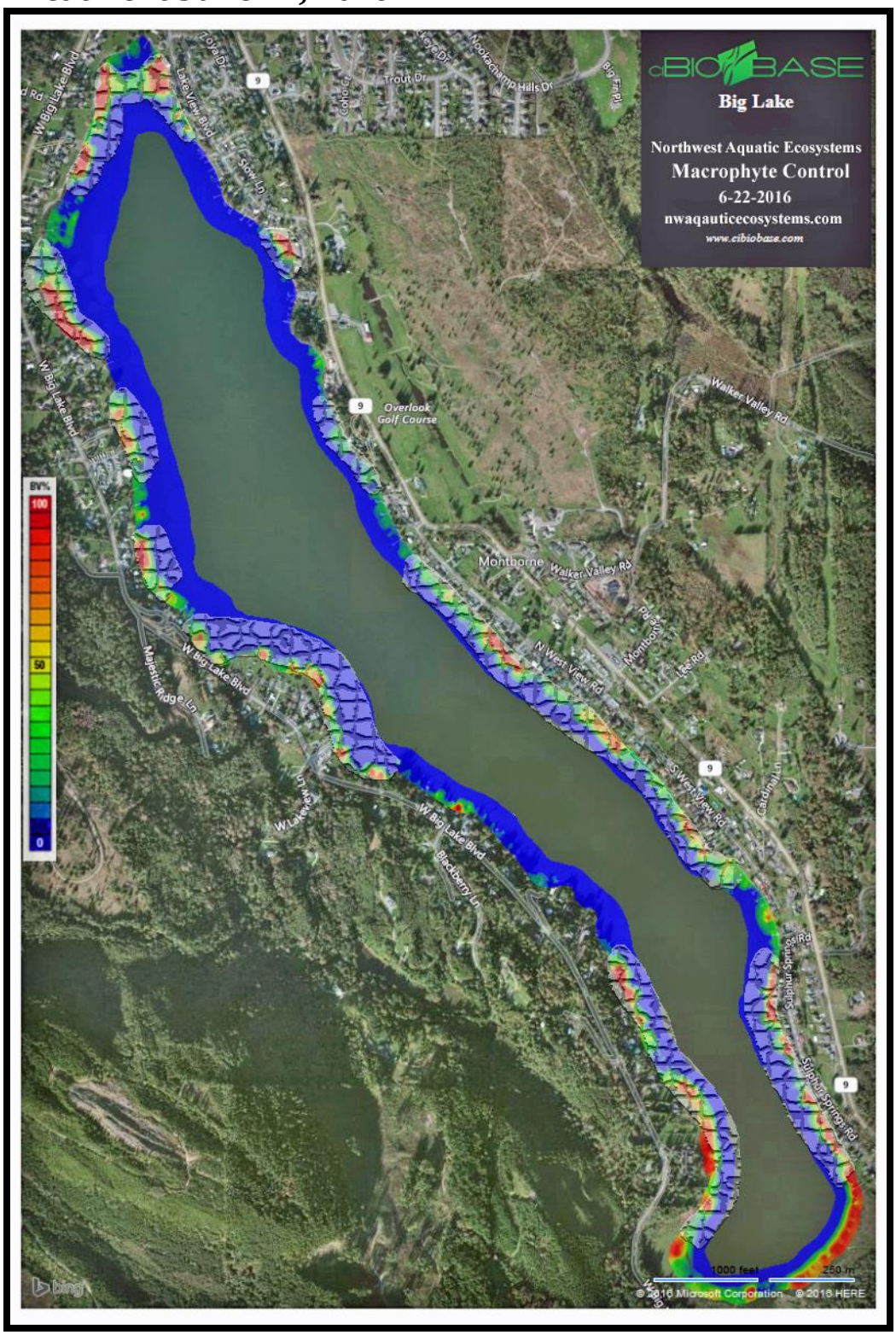
Under current NPDES guidelines, native macrophyte control is limited to no more than approximately 10,000 feet of the lake shoreline. Noxious weeds can be controlled lake wide having no impact on the 10,000 feet designated for native plant control.

Our approach during 2016 was to continue to provide maximum coverage under the current NPDES guidelines. The 2016 treatment model was designed similar to the prior models expanding treatment outward from the shoreline. Continued use of past Aquathol K, diquat and Aquathol K/diquat tank mixtures was encouraged into the 2016 season. Past use of these mixtures has increased the efficacy of treatments in those lake areas plagued with shallow rich organic muck bottoms. Although the use of Aquathol K increases material costs considerably, results justify product use. Diquat-Aquathol K mixtures increase the efficacy of treatment enhancing control within those targeted sites.

Shoreline posting was conducted on June 21 & June 22. A two person crew completed that particular component of the treatment. Similar to past treatments the local newspaper was contacted addressing the upcoming treatment. Information about the treatment was also forwarded to the local radio station. One public boat launch was posted with a large sign requesting that no boating occur during the treatment. The boat launch signage was in place 24 hours prior to treatment. On the day of treatment, material was offloaded from a locked container truck and transferred into two 25 gallon spray tanks mounted on the application boat. Containers were triple rinsed on site and returned empty, back into the truck. Herbicides, diquat and Aquathol K, were applied utilizing an 18 foot Airgator airboat. Lake water was drawn into the boat through intake ports located in the hull of the boat. Herbicide was then metered into the lake water via an injection manifold. Once the herbicide was injected into the on board lake water, the lake water/herbicide mixture was then discharged back into the lake. Weighted hoses were used to place the material at the appropriate depth in the water column.

Prior to treatment, a lake treatment map, identifying treatment plots was downloaded into the onboard GPS system. The treatment boat utilized the onboard GPS to identify treatment site boundaries. All of the targeted submersed sites were treated on June 22nd. Submersed weeds were treated with Diquat at a rate of one to two gallons per surface acre. Aquathol K was applied at a five gallon per acre rate in a tank mix consisting of five gallons of Aquathol K and one-two gallons of diquat.

Treatment June 22, 2016



Once the submersed weed portion of the application was underway, a second boat was then utilized to apply herbicide to the lily pad infestations. Weather conditions posed no problems throughout the day and permitted the entire basin to receive treatment for lily pads. An 18 foot aluminum boat equipped with one 25 gallon spray tank was utilized during this spray event. Use of a smaller maneuverable boat permitted access to the entire lake shoreline. The 25 gallon tank was filled with lake water and herbicide and surfactant was then added directly into the tank. Once mixed, the application boat drove along the shoreline identifying targeted floating plants and the spray mixture was then discharged using a spray gun. When emptied, the tank was refilled and dispensed as needed. Lily pads received a 1.0% solution of glyphosate sprayed directly onto the floating leaves. Similar areas treated during 2014 & 2015 received treatment again during 2016.

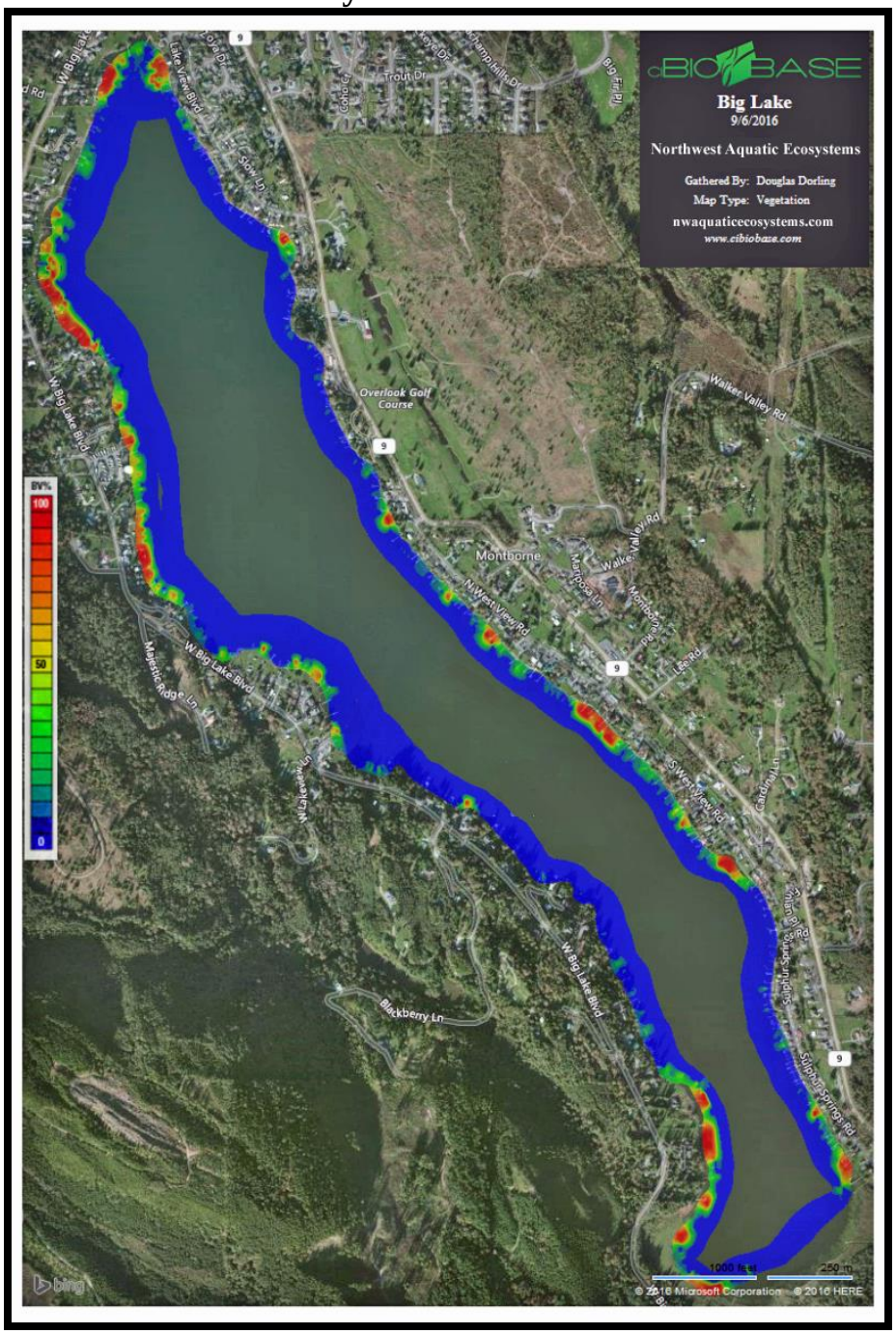
As noted in past years the increased effort to inform residents of the treatment and problems associated with high speed recreational boat use during treatment resulted in a favorable treatment environment.

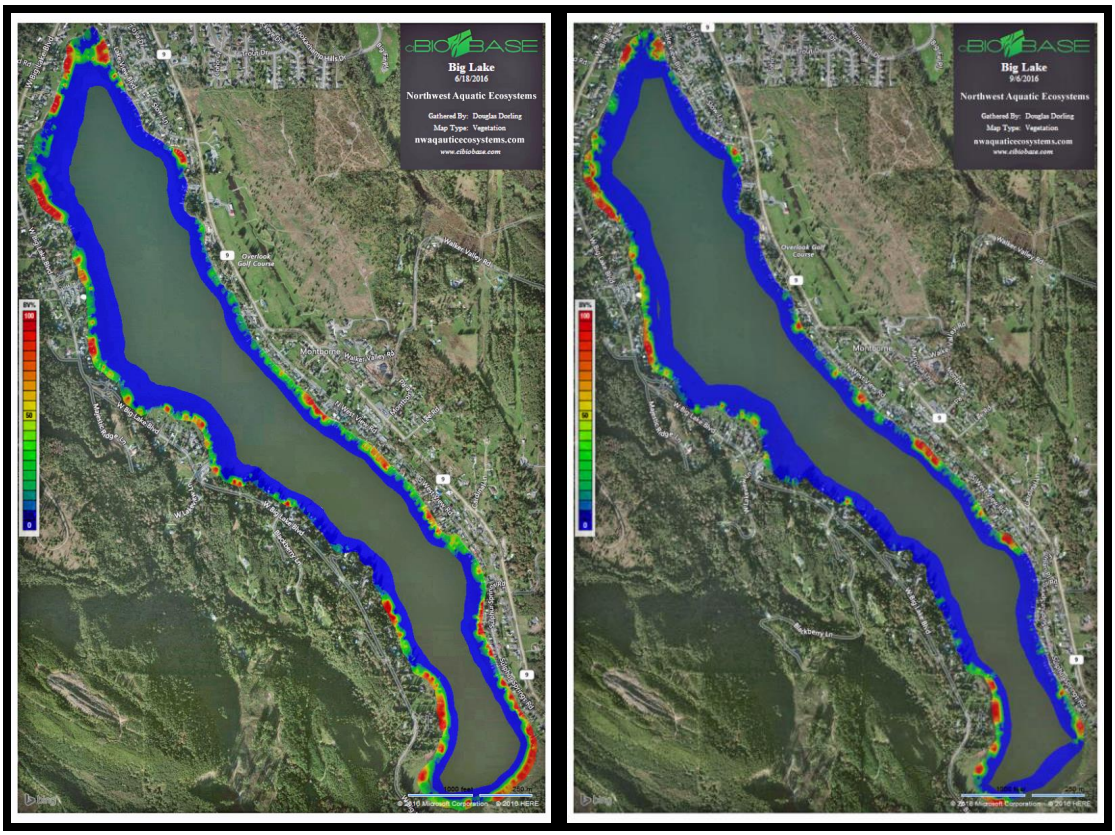
September 6, 2016 Fall Survey

Our fall survey was performed on September 6, 2016. Prior to the survey there were reports that weed growth may have reached the surface at a number of locations lake-wide. There was discussion over the possibility of spot treatments being performed to alleviate this late season growth. This survey did confirm concerns that problematic shoreline areas were experiencing late season growth. In general lake wide weed growth and densities had been reduced considerably from pre treatment levels. Normally this noted secondary regrowth would have occurred similar to growth observed in prior years, later in the season or none at all. The earlier treatment window did however result in the weed regrowth cycle being advanced forward by approximately 30 days. The earlier start time may have also not allowed all of the potential seeds to germinate prior to treatment. June 15th treatment windows may at times require a secondary treatment later in the season. These secondary spot treatments are seasonal in nature and may be required one year and not the next. Secondary treatments can be controversial since timing is critical in relation to the cost/benefit received. Late season applications are often performed when lake use begins to subside later in the season. Benefits from such treatments are often realized by a smaller percentage of active recreational lake users. In the case of Big Lake, secondary treatments, if required, should be accomplished prior to mid-August so that a larger percentage of lakeside residents benefit from the expense. There were no milfoil plants identified during the survey.

Positive lily pad response to treatment during 2016 was once again noted lake wide. The approach of only applying materials when limited wave and wind action are present has resulted in continued improved control. Some areas of the lake shoreline once emendated with lily growth now support only a few plants. As the density and size of these smaller infestations decrease, the ability of these areas to adequately maintain material on the pads surface immediately following treatment becomes a more difficult task.

Post Treatment Survey Results





Pre Treatment 2016 Post Treatment 2016

Recommendations

1. Continue the expanded notification to the property owners and local residents through newspaper articles, radio and LMD notifications. Emphasis again needs to be directed at no lake use during the treatment.

2. Lily pad control operations should only be conducted during those hours when wind conditions are minimal.

3. Noxious species appear to no longer represent the problematic species lake wide. The range and location of milfoil plants have stabilized, not much expansion has been detected. Plants currently coexist in mixed stands of native species. Milfoil can now seasonally be controlled with either contact herbicides or specifically targeted with systemic materials. How these plants are controlled and what materials should be applied requires evaluation preceding the spring survey. What actions may or may not be implemented will probably change on a year to year basis.

4. The spring survey should be considered the more important of the two scheduled surveys. This survey will determine what plants are targeted and what materials will

be used during any treatment year. With the now established earlier treatment window, an early August brief electronic inspection should be conducted to determine the need for a smaller late season secondary treatment. In the past, the late summer survey is performed too late in the season to direct any necessary further native weed control operations.

5. Late season comprehensive electronic summer survey as performed in the past should be performed 30-45 days post any required secondary treatment.

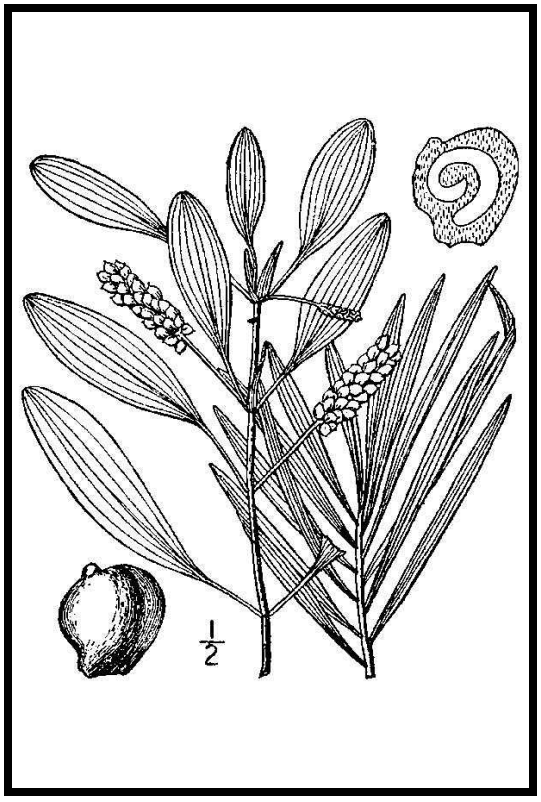
6. Continued use of the contact herbicide Aquathol K. Use of the material has proved to be successful in controlling some pondweeds not susceptible to diquat. Use should also include tank mixes of both diquat and Aquathol K.

7. Initiate use of the granular formulation of Aquathol K within the problematic southwest shoreline area of the lake in conjunction with a late season spraying event within this immediate area. Approach will need board approval. Although NWAE was under budget for 2016 the increased expense of the granular material in conjunction with a late season application may result in exceeding the current budget by approximately $8,000.00.

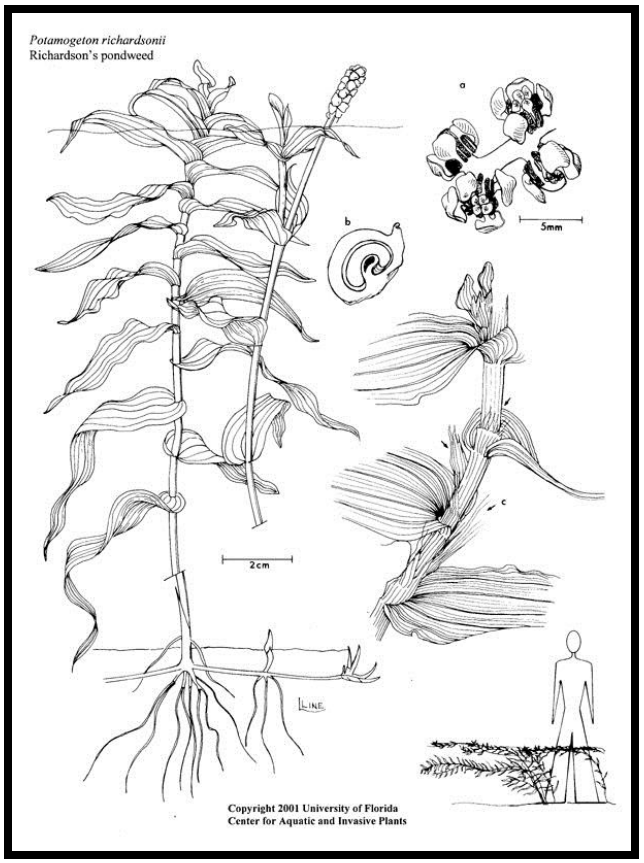
8. Continued use of the new mapping technology. This technology provides an excellent visual evaluation of weed conditions lake-wide. The resulting map can be understood by all users of the lake and requires no in-depth technical background for review. The technology also provides an excellent reference to visually show a property owner if problematic weeds are present at their parcel.

9. Use knowledge and experience obtained over the last five years to fine tune future treatments using Aquathol K and diquat mixtures and explore the need for late season weed control as a result of the earlier fish timing window.

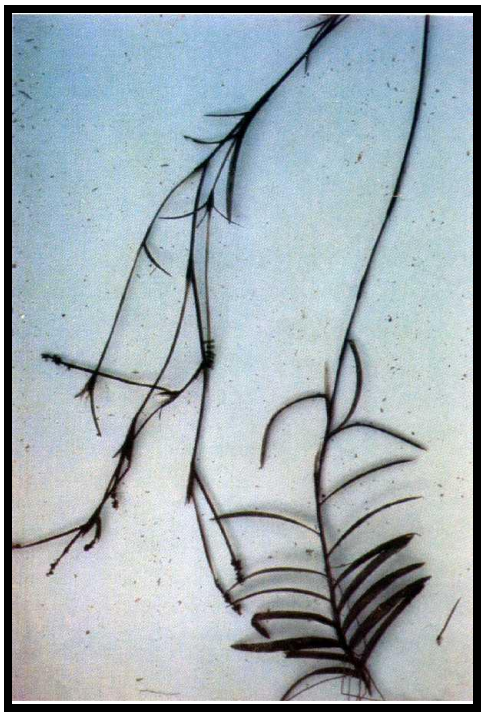
Dominant Submersed Macrophyte Species
Potamogeton epihydrus

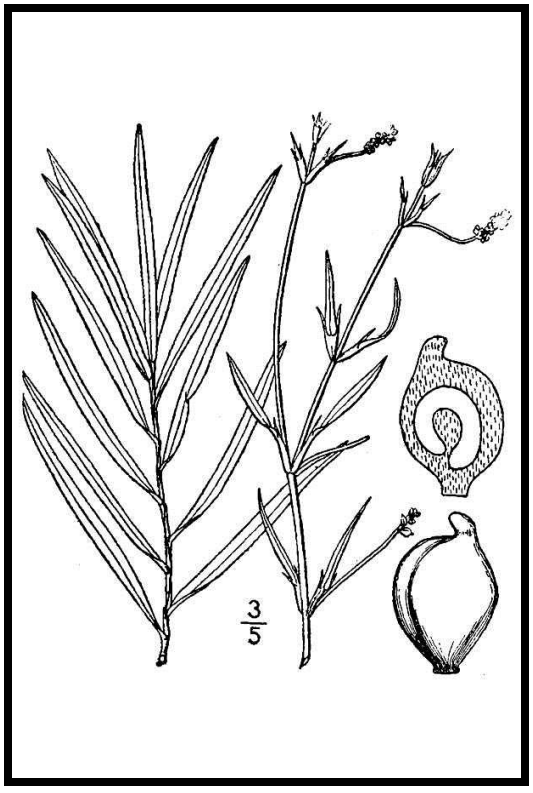


Potamogeton richardonsii

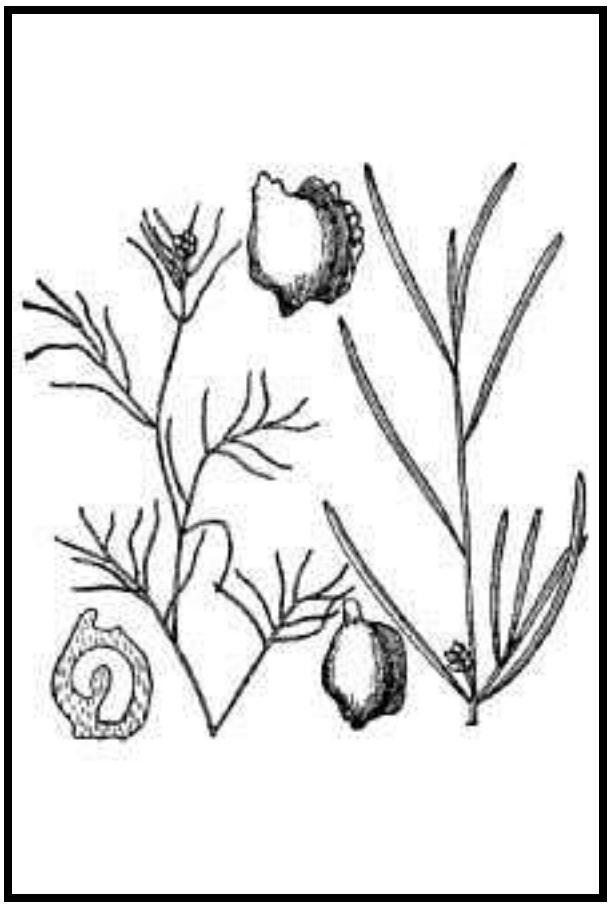


Potamogeton robbinsii

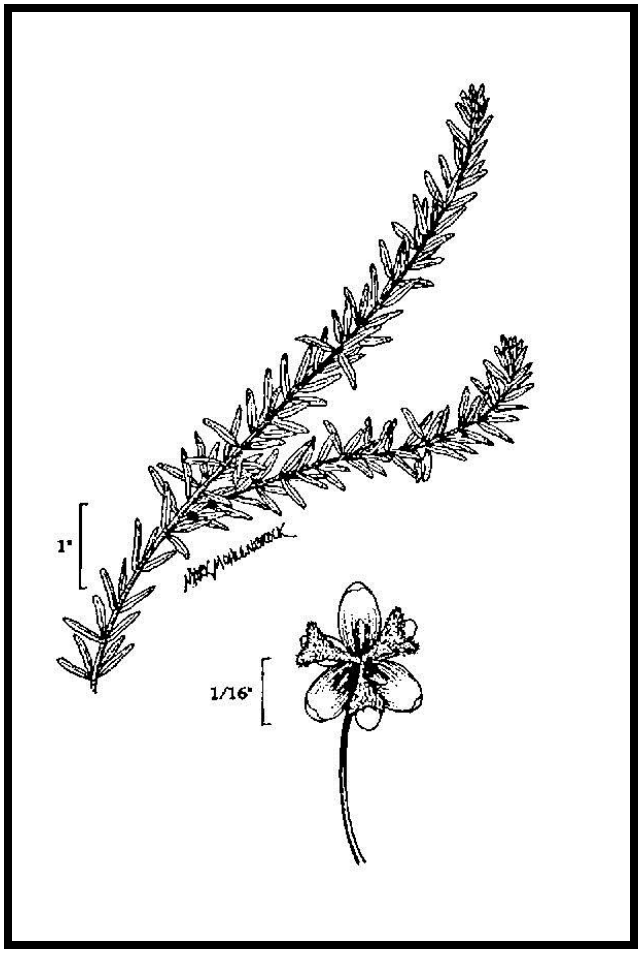




Potamogeton foliosus



Elodea canadensis



Vallisneria americana