2017 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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December 2017

Project Overview

This was Northwest Aquatic Eco-Systems (NWAE) sixth 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 2017 report. The basis for providing this past history is to present a brief historical timeline to interested parties in an effort to fully understand the past efforts and results. 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 are currently limited to a few small infestations located along the southwest shoreline of the lake. These same locations have supported sporadic milfoil growth for a number of years. There has been no other milfoil sightings lake wide. As noxious weed species declined throughout the lake, 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 based on the established fish timing window at that time. The shallow nature of the immediate shoreline area historically produced weed growth that typically reached the waters' 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 does provide for a more seasonal friendly treatment schedule resulting in reduced weed associated problems during the early summer months. Depending on weather conditions and late summer favorable temperatures, regrowth within earlier targeted sites is possible.

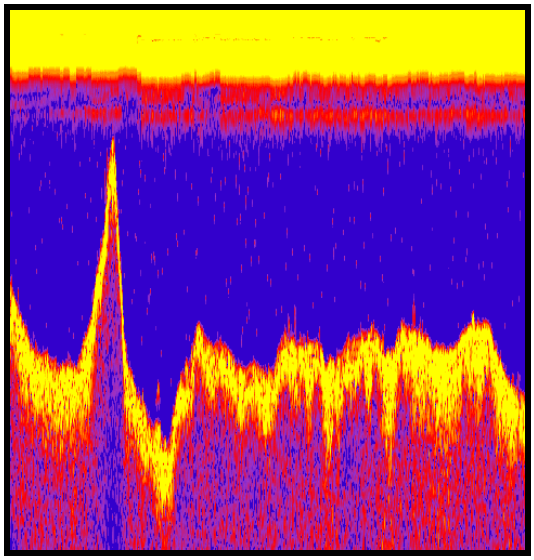
The above average rainfall experienced during the early spring of 2017 produced cooler early season water temperatures that resulted in delayed weed growth statewide. Many lakes, because of this late seed germination phase, were susceptible to late seasonal weed growth that occurred following initial weed treatments. Late season growth is dependent on numerous environmental conditions that favor growth some years and not others.

Survey Protocol

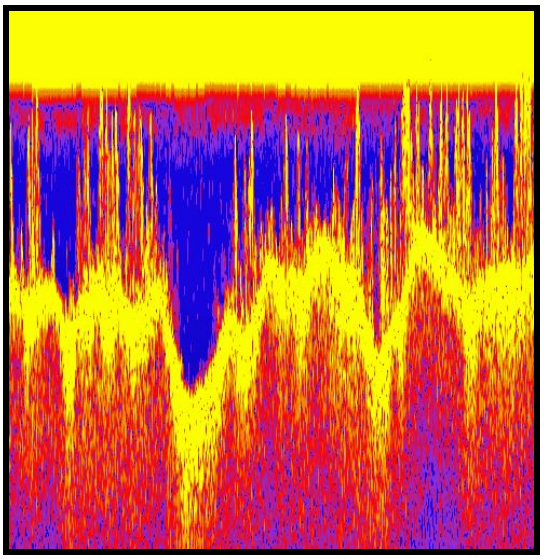
Survey techniques for 2017 once again utilized the new sonar mapping technology initiated during the 2013 treatment season. Our mapping technology incorporates sonar technology with on board chart recording. Sonar data is collected on board and processed to produce an on-screen map of the lake bottom 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

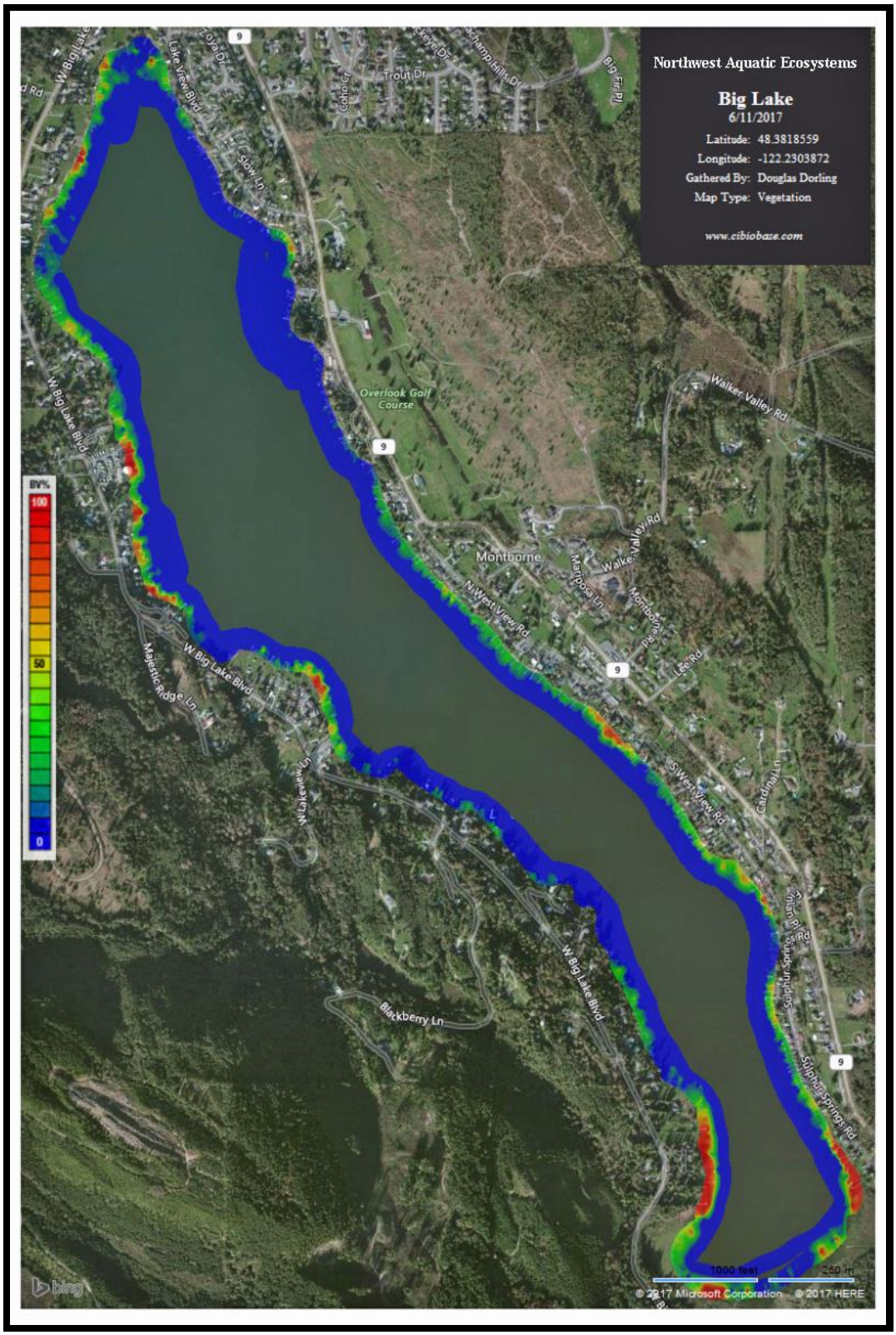
Big Lake was surveyed on June 11, 2017. Weed growth was not as dense as experienced in prior years probably due to the heavy spring rains that reduced water temperatures. During 2016, above normal spring temperatures resulted in abnormal heavy early season growth opposite of what transpired during 2017.

Once water temperatures achieved seasonal averages, a normal in lake temperature pattern developed for the remainder of the season.

Water temperature fluctuations have an impact as to when seed germination will occur, and the rate of weed growth. Cooler early seasonal water temperatures impede timely lake wide seed germination often producing inconsistent weed growth lake-wide.

Although weed growth sites remained relatively the same, density within those growth areas were inconsistent.

There have virtually been no changes in the weed species noted during the 2017 survey as have been identified in prior surveys. In general, Vallisineria americana, a ribbon like native species appears to be increasing in range throughout the lake proper. Vallisineria is a difficult expensive species to control. Species noted during the survey 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.


Northwest Aquatic Ecosystems
Big Lake
6/11/2017
Latitude: 48.3818559
Longitude: -122.2303872
Gathered By: Douglas Dorling
Map Type: Vegetation
www.cibiobase.com
BV%
100
50
0
Overlook Golf Course
Montborne
W Big Lake Blvd
Walker Valley Rd
Lake View Blvd
Trout Dr
Stony Ln
Mariposa Ln
N West View Rd
S West View Rd
Life Rd
Cardinal Ln
Majestic Ridge Ln
W Lakeview Ln
Blackberry Ln
Sulphur Springs Rd
9
1000 feet
250 m
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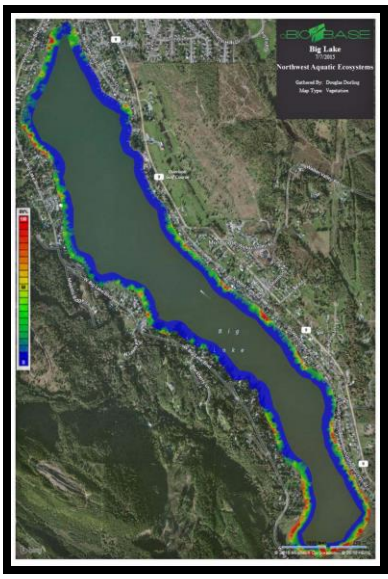
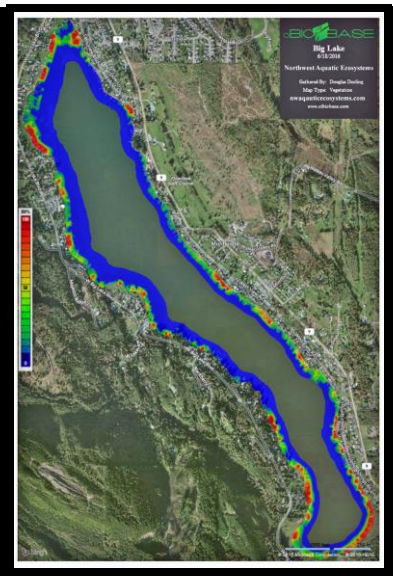
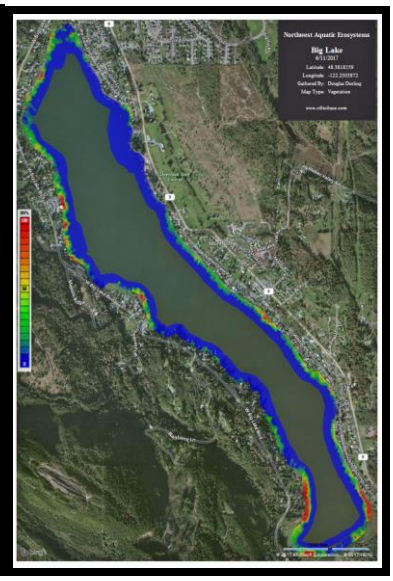


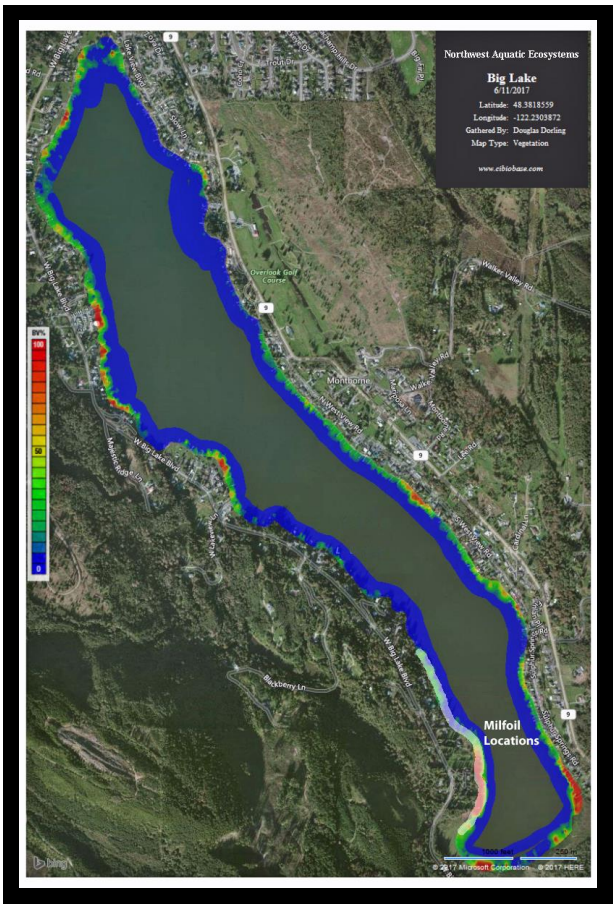
2015 Spring Survey



2016 Spring Survey



2017 Spring Survey



Milfoil Locations 2017

July 10, 2017 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.

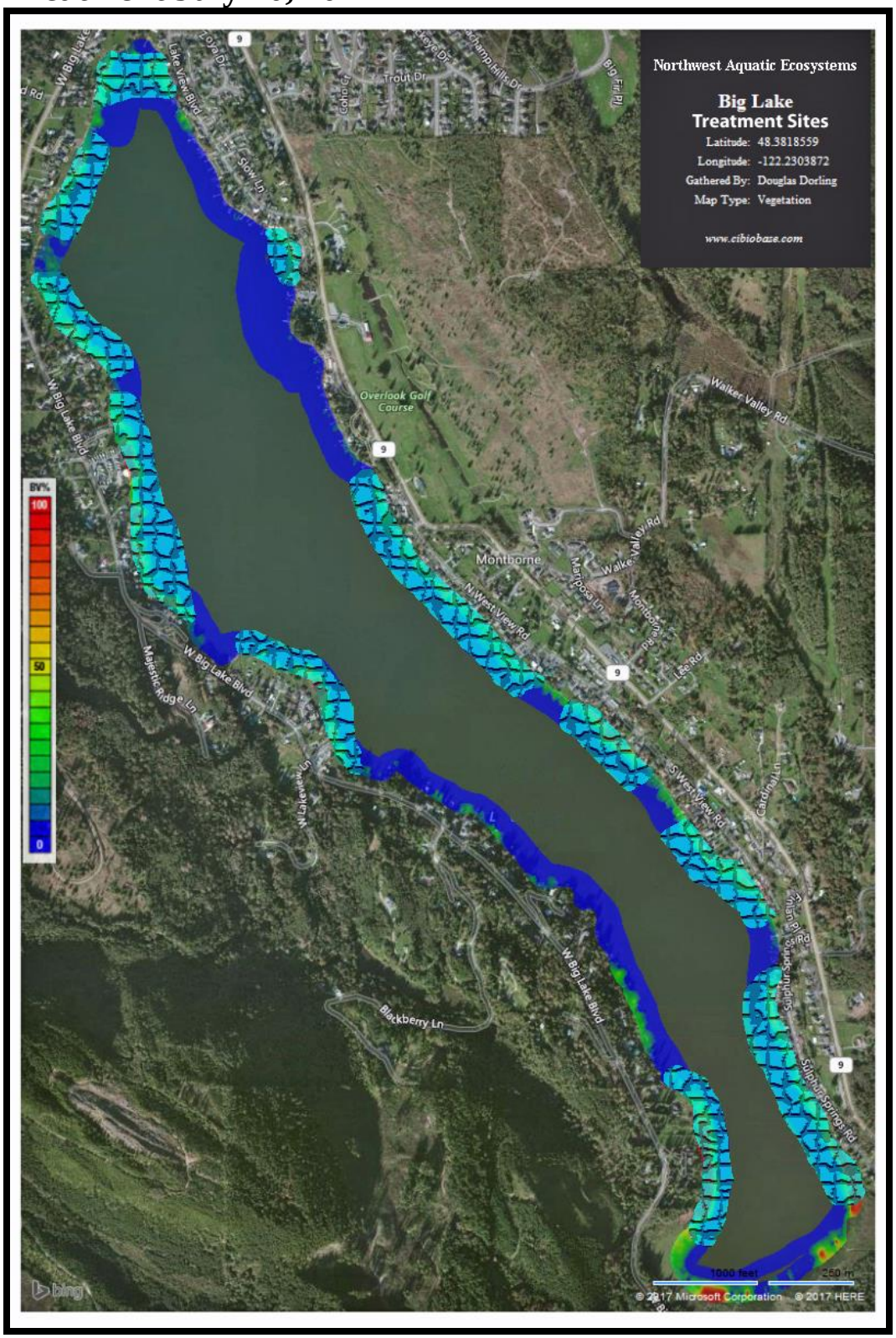
Our approach during 2017 was to continue to provide maximum coverage under the current NPDES guidelines. The 2017 treatment model was designed similar to the prior models expanding treatment outward from the shoreline. Continued use of Glyphosate, Aquathol K, Aquathol K granular, Diquat and Aquathol K/Diquat tank mixes. Recent studies indicate that once only recognized as a contact herbicide, Aquathol K has been found to exhibit systemic herbicide properties related to the ability of the active ingredient to be translocated to the root systems of targeted species. Past use of Aquathol K 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. The use of a Diquat/Aquathol K mix is now an industry standard supported by the recent production of this same mixture under the trade name Strike.

Shoreline posting was conducted on July 10. A three person crew comprised of two watercrafts completed the posting task within a 12 hour timeframe. 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. The 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 new signage was posted at the boat launch displaying the areas of the lake that were targeted for treatment and the water restrictions associated with the 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 July 10. 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 July 10, 2017

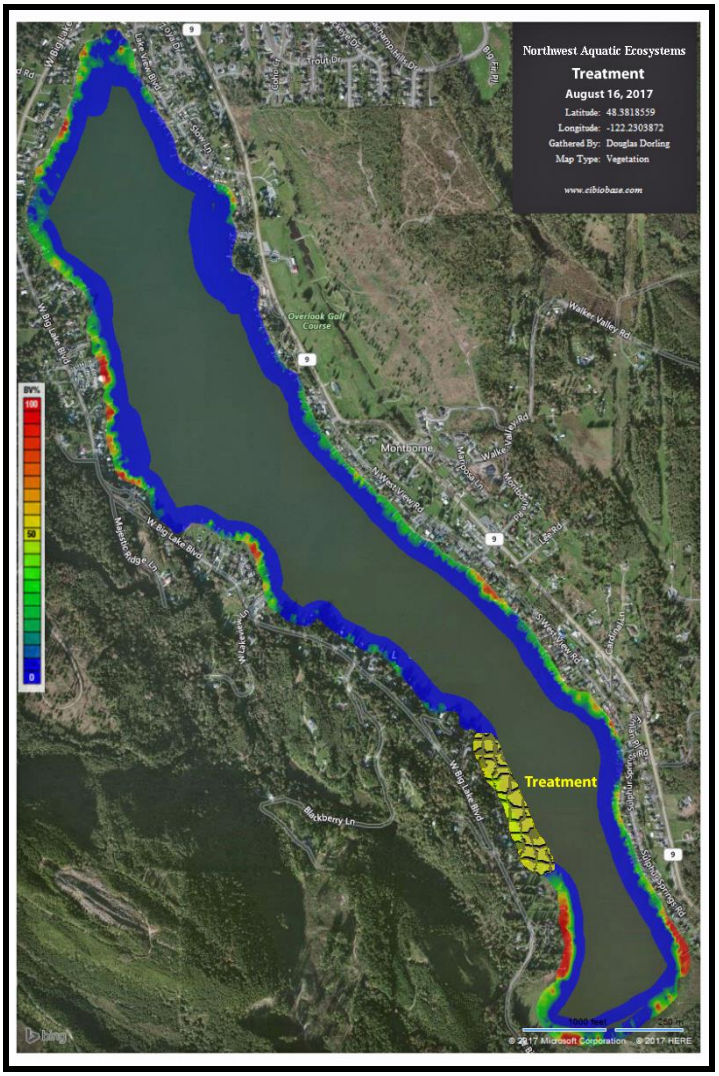


As the boat targeting the submersed weeds treated the designated sites, a second boat was then utilized to apply herbicide to the lily pad infestations. Weather conditions posed no problems throughout the day and permitted the entire basin to receive treatment for both lily pads and submersed weeds. For lily pad control an 18 foot aluminum boat equipped with one 25 gallon spray tank was utilized during this spray event. Use of this smaller maneuverable boat permitted access to the entire lake shoreline. The 25 gallon tank was filled with lake water, herbicide and surfactant. Once mixed, the application boat drove along the shoreline identifying targeted floating plants. The spray mixture was then discharged using a spray gun. When emptied, the tank was refilled and the process was repeated until the entire lake shoreline was covered. Lily pads received a 1.0% solution of glyphosate sprayed directly onto the floating leaves. Similar areas treated during 2014, 2015 & 2016 received treatment again during 2017. Plant densities were reduced considerably with many of the original patches now supporting only a few floating leaves.

August 16, 2017 Treatment

Approximately 10 acres of the shoreline located adjacent to West Big Lake Blvd was retreated. A small portion of this area had been originally targeted during the July application. Results were minimal at best. At the time of the August treatment the problematic species was noted as elodea. This particular plant had reached the surface along some of the individual shoreline parcels creating poor access to the main lake body. A much lower water level than observed earlier in the year may also have contributed to the weed hindrance related issue.

The area was retreated with diquat and a return to the area approximately two weeks post application identified that the weed issue had been successfully addressed and that all of the targeted parcels were responding nicely to the treatment. Plants were already void of leaves and stems were decaying along the bottom.



Fall Survey

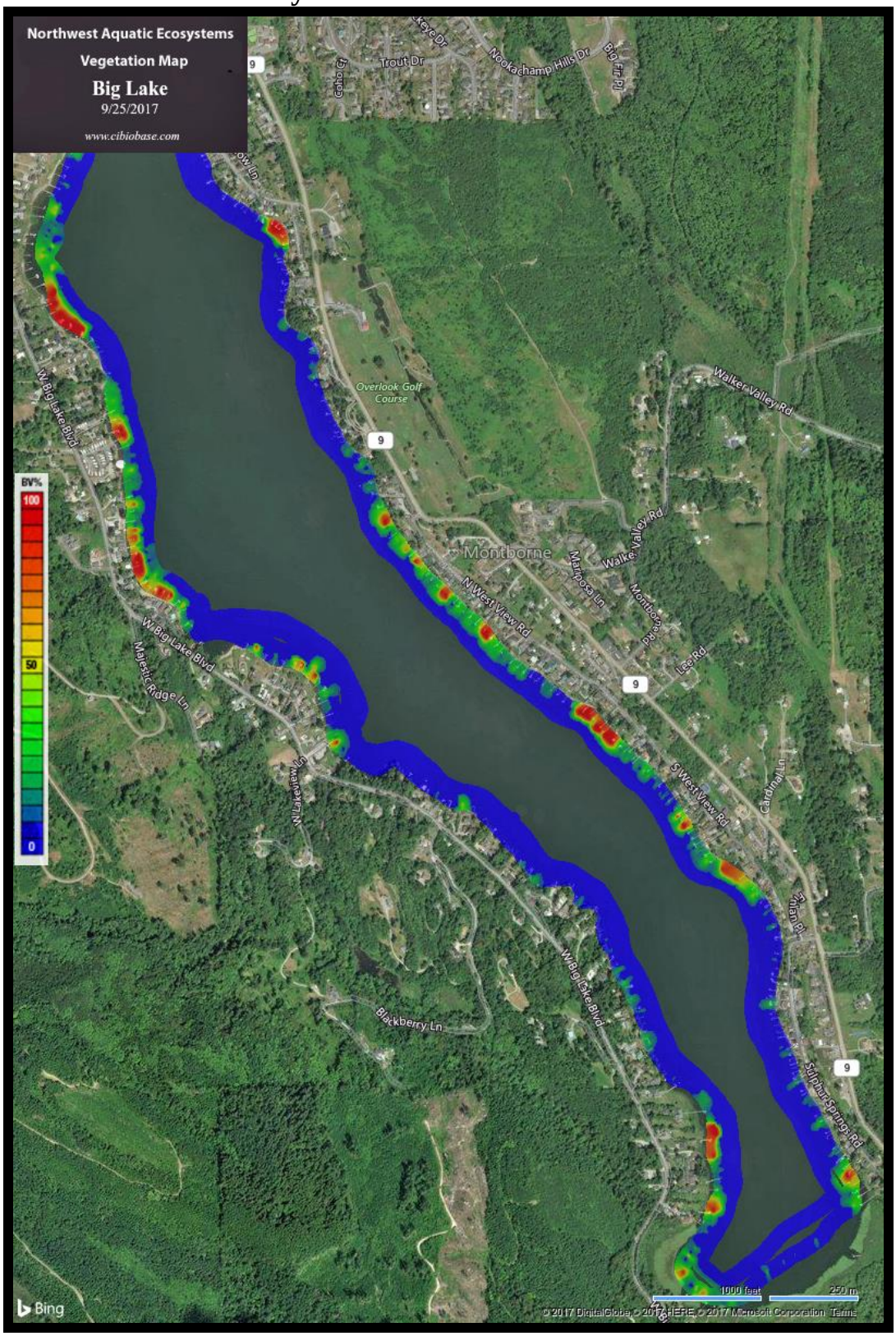
Our fall survey was performed on September 25, 2017. Results were sporadic with some shorelines showing good control while others supported mixed results. These types of results are typical of what we observed lakeside throughout Washington State for the 2017 season. The unusually late start to the weed growth season cultivated a late season resurgence of growth. Some of the areas experiencing such growth were also noted to support dense populations of filamentous algae (nitella) and ell grass. Nitella is a non-targeted plant while ell grass is a very difficult species to control.

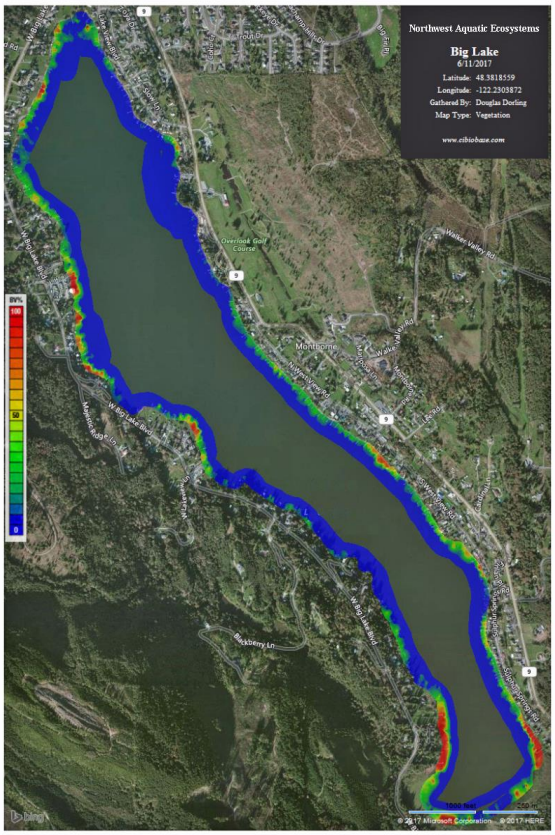
As noted during the 2016 report, the earlier start time may influence the timing of seed germination. That aspect of plant germination in conjunction with the above normal 2017 spring rains added an additional component to macrophyte growth equation that proved to be inconsistent and unpredictable. The late season treatment proved to be an effective treatment and perhaps needed to be expanded to other areas of the lake. NWAE will expand on the knowledge obtained during 2016 & 2017 as related to weed growth patterns and implement positive changes for the 2018 season.

Lake water level had decreased considerably since the pre-treatment survey. Later in the season as water levels decline, macrophyte growth that normally would not prove to be problematic may produce recreational concerns. Survey results from these now shallower growth zones would exhibit different density characteristics from similar deeper water environments experienced earlier in the season.

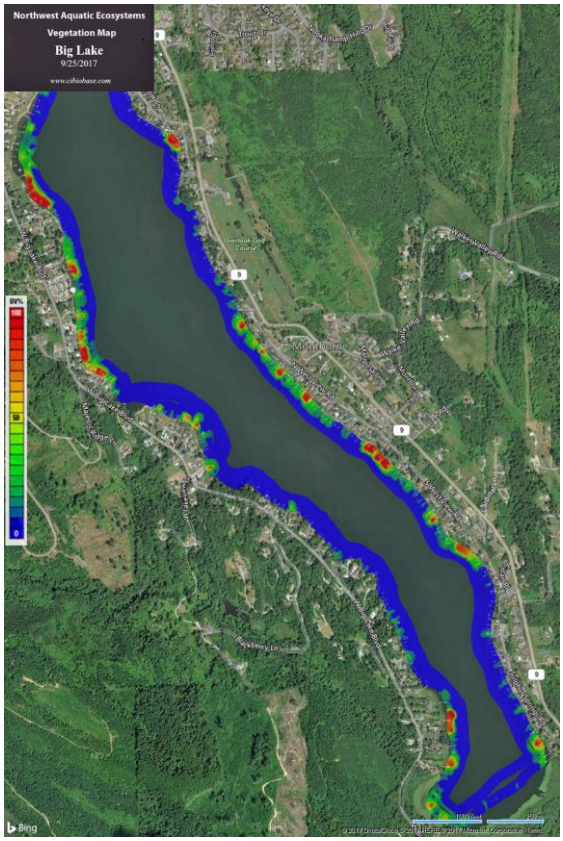
Lily pad response to treatment during 2017 was once again noted lake-wide. As these patches diminish in size, the observable change is less pronounced. Pad density and size of these smaller infestations decrease as spray activities continue. The ability of these smaller areas to adequately maintain material on the pads surface immediately following treatment becomes a difficult task.

Post Treatment Survey Results





Pre-Treatment 2017



Post Treatment 2017

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. Actions that 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. This mid season brief survey was not conducted during 2017 because of the July 10 initial treatment date.

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

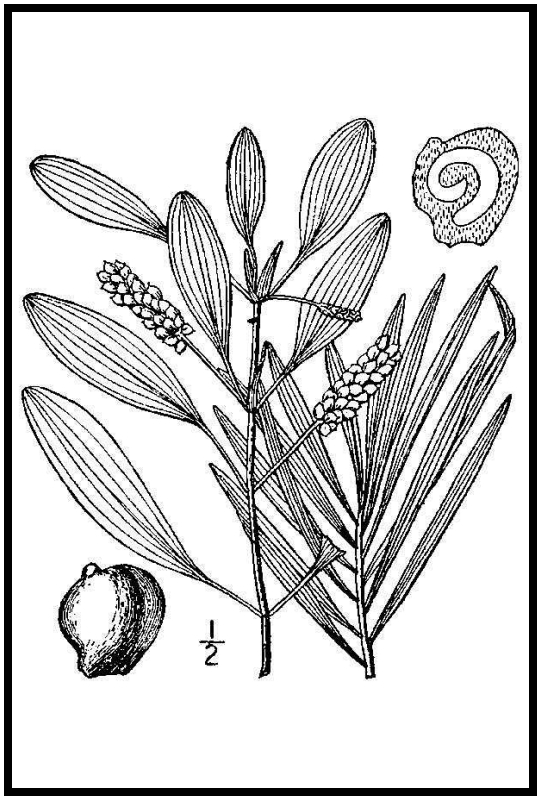
6. Continue use of the contact herbicide Aquathol K. Use of the material has proved to be successful in controlling some pondweeds not susceptible to diquat. Use should also include tank mixes of both diquat and Aquathol K.

7. Continue use of the granular formulation of Aquathol K within the problematic shoreline area of the lake in conjunction with a late season spraying event within these immediate targeted zones.

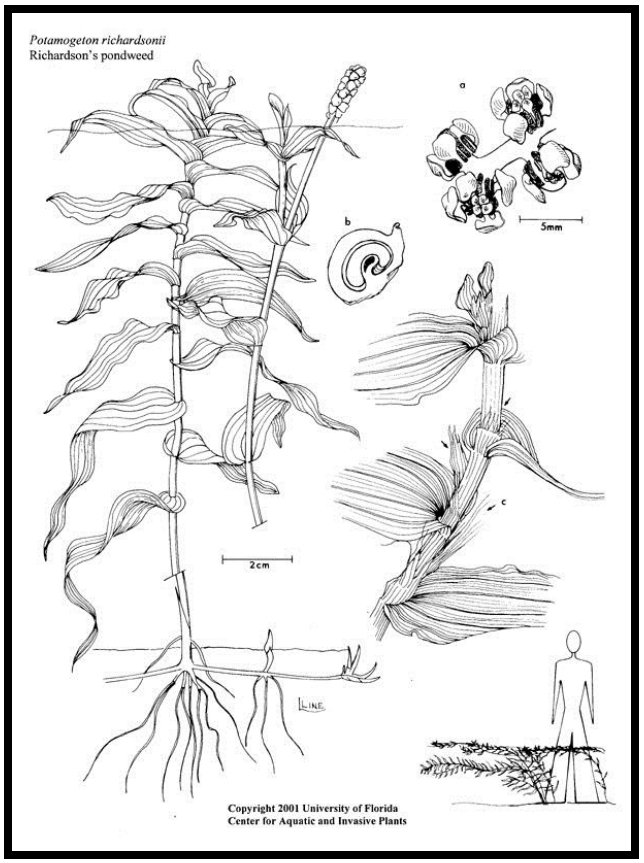
8. Continued use of the new mapping technology. This technology provides an excellent visual evaluation of weed conditions lake-wide. The resulting map can be understood by all users of the lake and requires no in-depth technical background for review. The technology also provides an excellent reference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

9. Use knowledge and experience obtained during 2016 & 2017 related to early and late seasonal weed growth patterns to fine tune future treatments using Aquathol K and diquat mixtures.

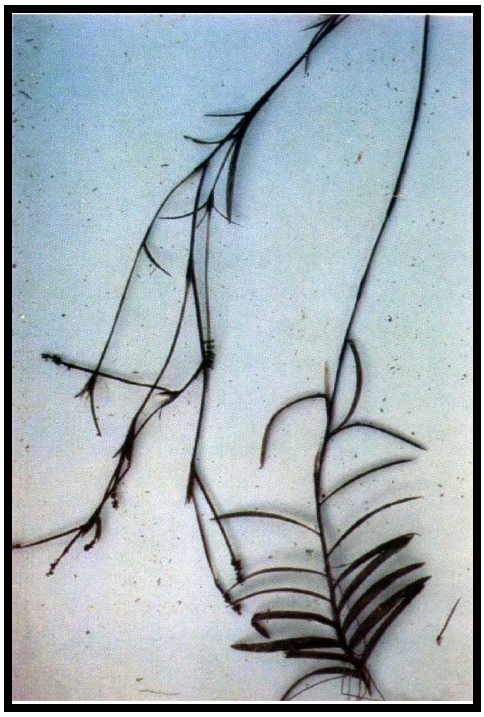
Dominant Submersed Macrophyte Species
Potamogeton epihydrus

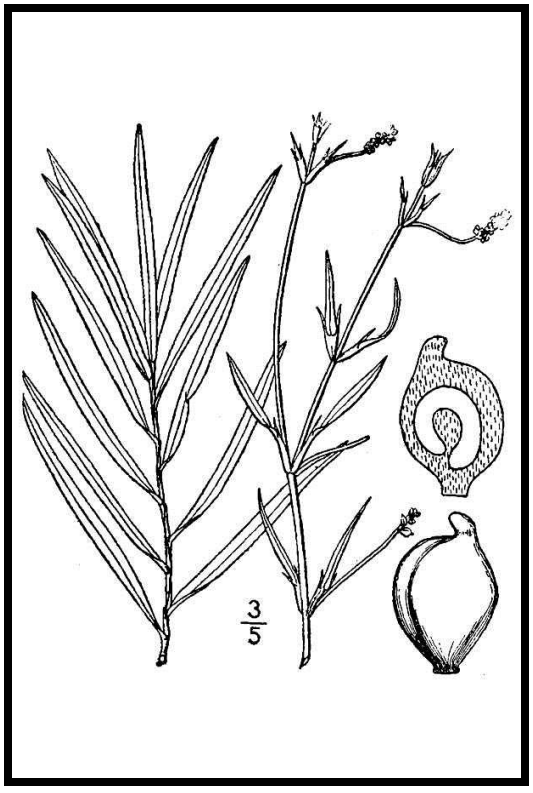


Potamogeton richardonsii

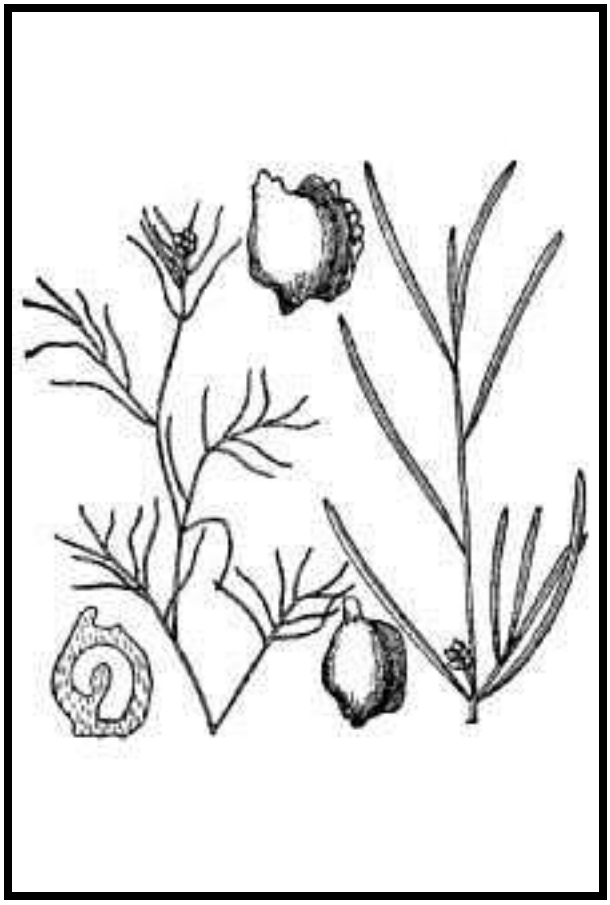


Potamogeton robbinsii

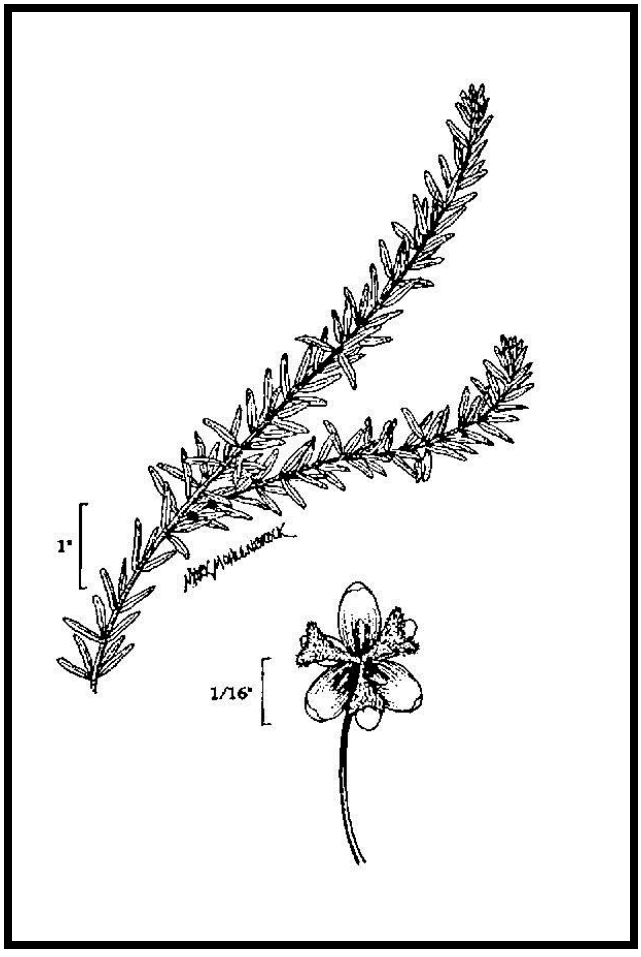




Potamogeton foliosus



Elodea canadensis



Vallisneria americana