2019 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) eighth year of providing aquatic weed control services for the Big Lake LMD #1 district. Lower water levels than noted during 2018 produced state wide issues related to decreased water depths and increased exposed shorelines. These two factors impacted recreational use lake-wide during the late summer months. Much of the past historical data included in the previous reports has been incorporated into the 2018 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. One Brazilian elodea data point was documented by the Department of Ecology during their late summer survey. Ecology also noted one small purple loosestrife infestation. The lakes littoral zone is experiencing native plant growth adjacent to nearly 100% of the shoreline.

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.

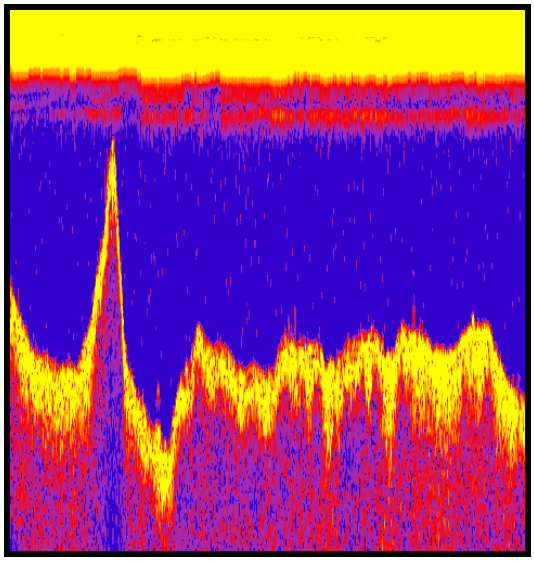
Algae related problems occur seasonally. Some years the blooms produce thick surface scums that are windblown lake-wide. Other years the blooms are short and barely noticeable. Water clarity during our spring survey was very clear while our late season survey revealed a bloom that appeared to be on the decline. Big Lake also experienced a late May early June 2-3 inch perch die off. The Game Department determined this was normal.

Survey Protocol

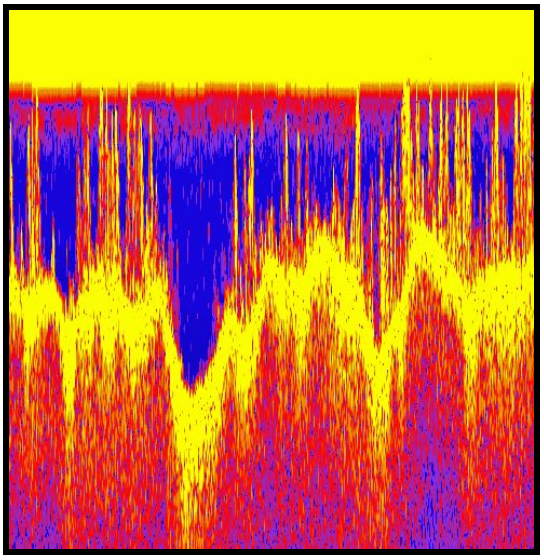
Survey techniques for 2018 once again utilized the sonar mapping technology initiated during the 2013 treatment season. The current mapping protocol is now an industry standard utilized worldwide. Current mapping technology incorporates sonar technology with on board chart recording. Sonar data is collected on board and processed to produce an on-screen map of the lake bottom as the boat transects the lake. 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

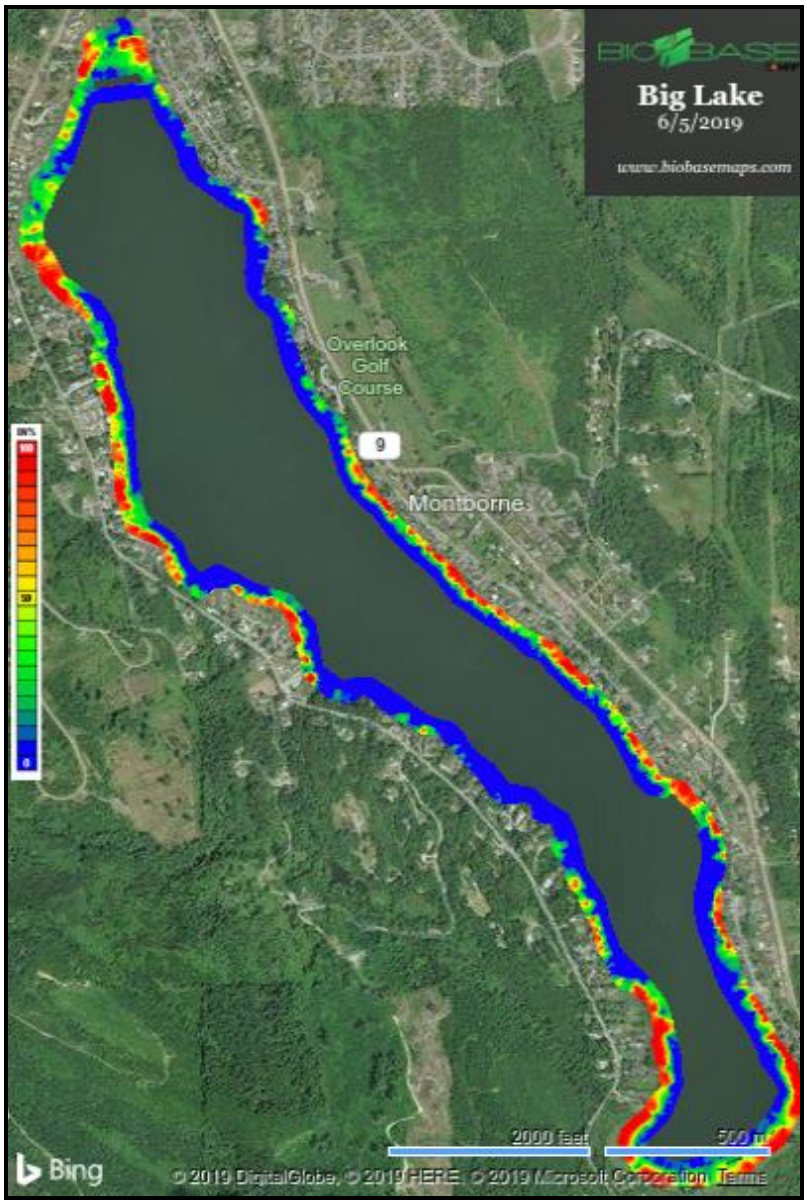
Weed Growth

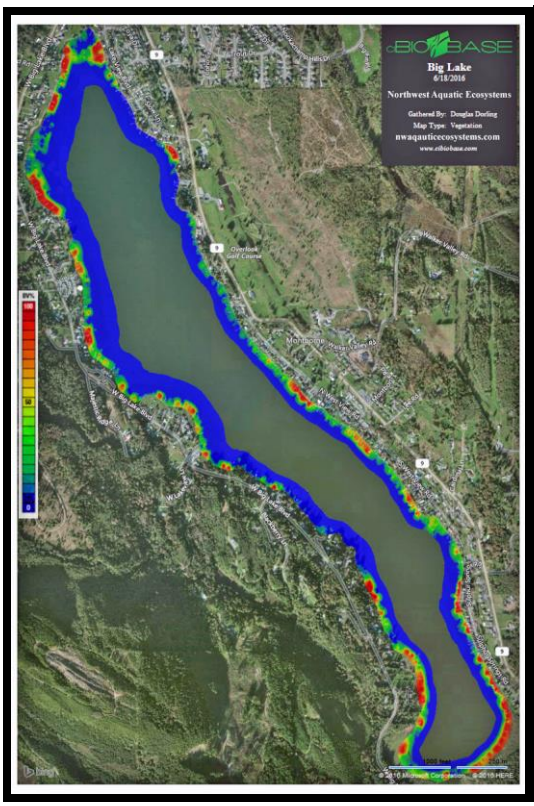
Big Lake Pre-Treatment Survey Results

Big Lake was surveyed on June 05, 2019, approximately within the same timeline as the 2018 & 2017 surveys. Macrophyte growth was heavy along most of the shoreline as noted by the increased red thermal imaging noted within the map file for 2019. These results are in contrast with previous surveys assessed since 2015. Perhaps the advantageous early seasonal good water clarity noted at the time of the survey contributed to the elevated growth.

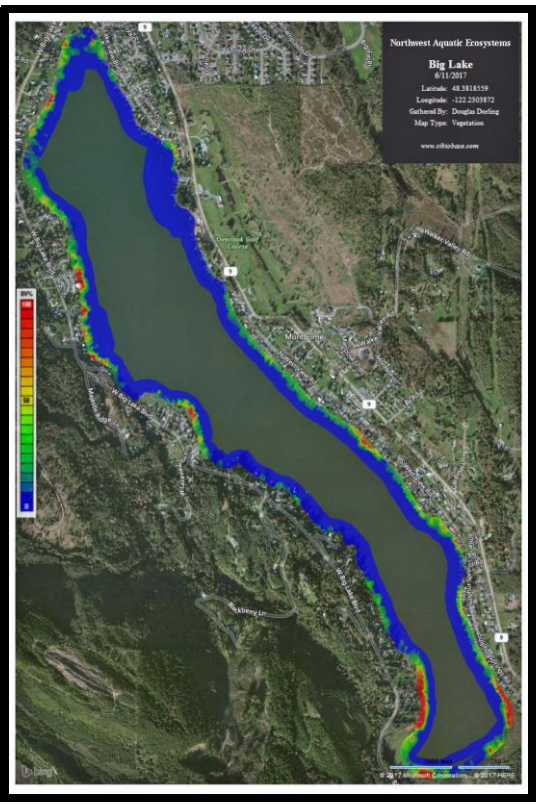
Water temperature fluctuations, lake levels and water clarity all have an impact as to when seed germination occurs and the rate of weed growth. Cooler early seasonal water temperatures impede timely lake-wide seed germination often producing inconsistent weed growth. Reduced water clarity impacts the depth to which seeds will germinate. Favorable water clarity increases the depth in which seeds have the ability to germinate.

Weed species noted during the 2019 survey were similar to those identified in prior surveys. No new species were recognized. Lake's littoral zone is dominated by P. robbinsii, P. zosteriformis, P. epihydrus, P. richardsoni, vallisaneri and elodea. Different weed species were dominant depending on the shoreline area sampled. In general P. robbinsii is dominant lake-wide.

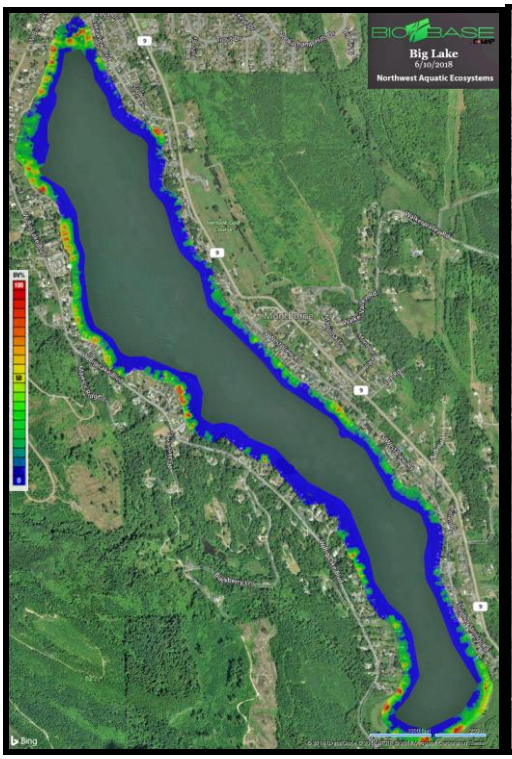




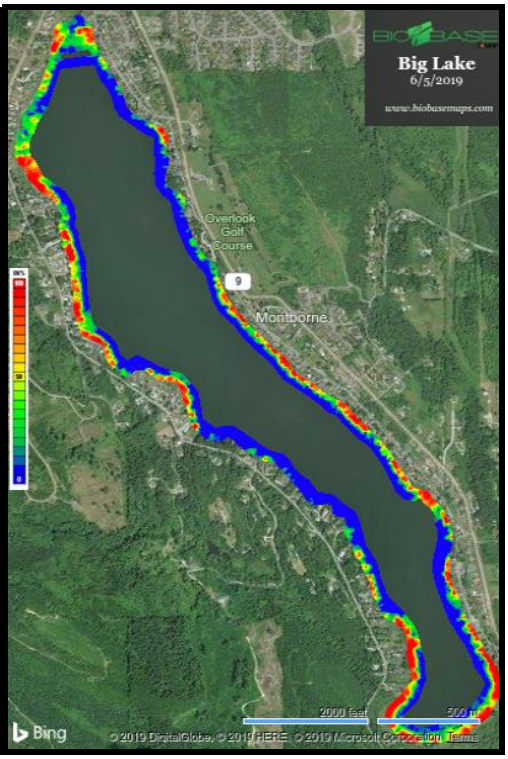
Spring 2016



Spring 2017



Spring 2018



Spring 2019

Milfoil Locations 2019

June 26, 2019 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 2019 was to continue to provide maximum coverage under the current NPDES guidelines. The 2019 treatment model was designed similar to the prior models expanding treatment outward from the shoreline with continued use of Aquathol K liquid , Aquathol K granular, Diquat and Aquathol K/Diquat tank mixes. Glyphosate will be replaced with imazapyr for lily pad and iris control. 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 June 2. A two person crew comprised of one watercraft completed the posting task within a 10 hour timeframe. One crew member was off loaded along the shoreline. The other crew member drove up the shoreline and secured the boat to a dock, exited the boat and began posting. Once the first crew member reached the moored boat, the boat was then repositioned again a distance from

the initial crew member. When a crew member could no longer transverse the shoreline due to fences or other obstructions the member was picked up and transported beyond the obstruction. Similar to past treatments, the local newspaper was contacted addressing the upcoming treatment and notice was published in the newspaper. 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 no less than 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 back into the truck empty. 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 26th. 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.

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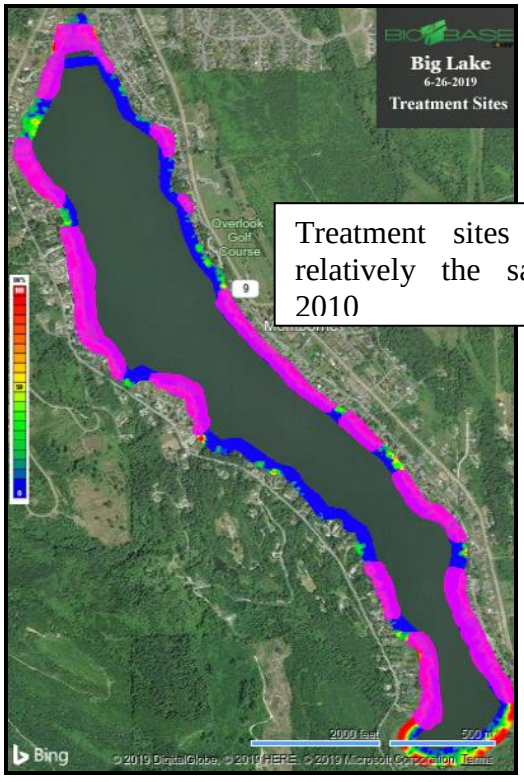
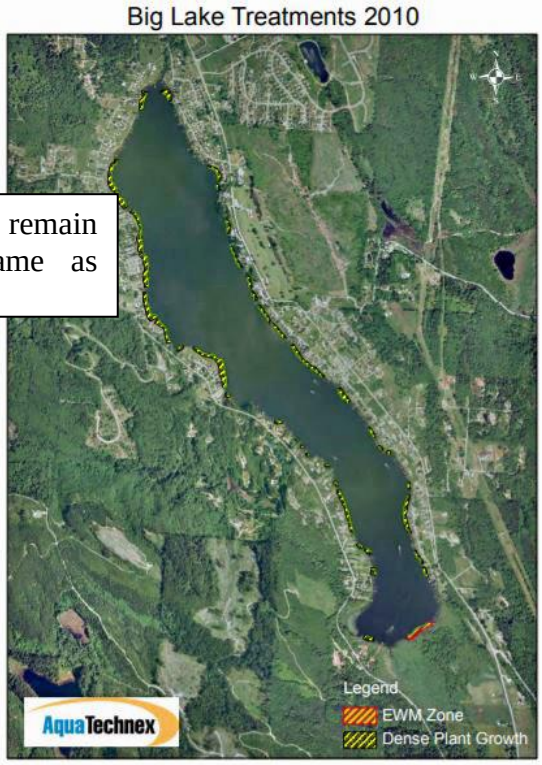


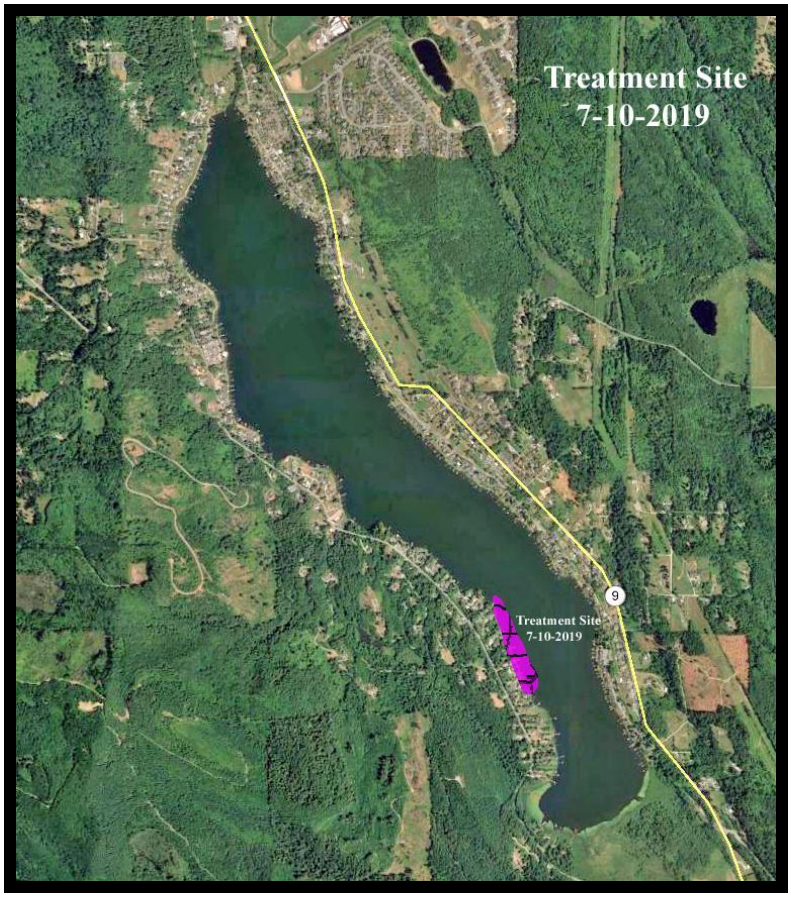
Treatment sites remain relatively the same as 2010



Weather conditions posed a problem during the late afternoon. Lily pad treatment was cancelled shortly after the process began. 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 imazapyr sprayed directly onto the floating leaves. Plant densities in most of the prior treatment sites have now been eliminated or reduced to considerably smaller patches consisting of only a few floating leaves. Three residents historically have requested no treatment. These same sites continued to receive no treatment.

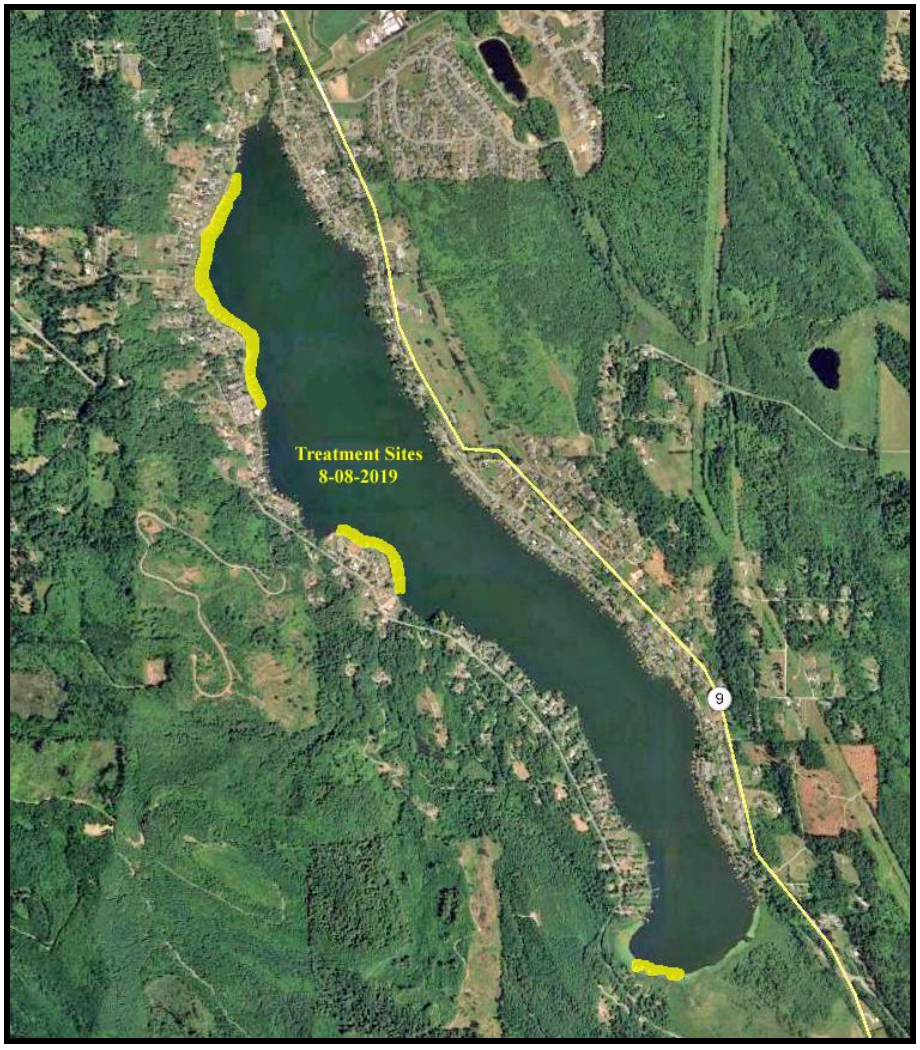
July 10, 2019 Treatment

NWAE responded to a citizens concern that weeds in their area had not responded to the earlier treatment. An inspection of the site was made and it was determined to treat the immediate area consisting of approximately 7.5 acres. Upon further evaluation it was noted that this particular area of the lake was not treated earlier and that the projected drift from the adjacent treatment area did not develop as anticipated.



August 09, 2019 Treatment

Approximately 30 acres of the northwestern shoreline of the lake was treated to control pondweed growth that had surfaced as a result of regrowth and lower than expected water level. Low water levels were common throughout Washington State during 2019 creating problematic shoreline recreational access issues, boat launching problems and exposure of stumps that historically posed no problems. At the close of the summer some Washington State lakes were at their historically lowest levels. Some had dried up while others lost up to 5 feet in depth. Posting of the shoreline was completed prior to treatment on the day of application.



Lily Pad Imazapyr Applications

Glyphosate was not utilized on Big Lake during 2019. Because of the controversy surrounding glyphosate, imazapyr was substituted for lily pad control. Herbicide was mixed into a 25 gallon tank and then sprayed directly onto the pads utilizing a 1% solution of herbicide and water. Windy conditions during site visits resulted in our inability to treat all the lake-wide pads during any one visit. What resulted was that spraying occurred until conditions prohibited further application.

Note: Yellow brown areas are sites responding to an application

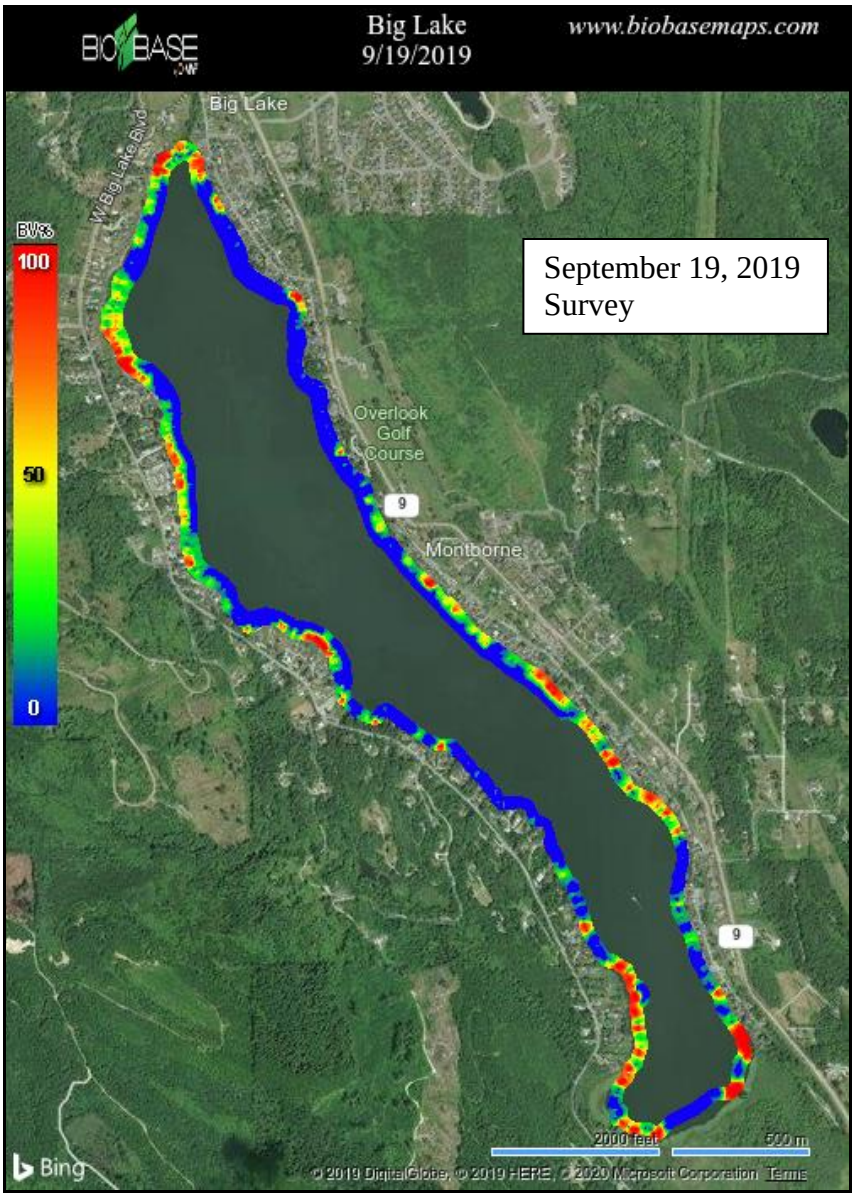
Fall Survey 9-19-2019

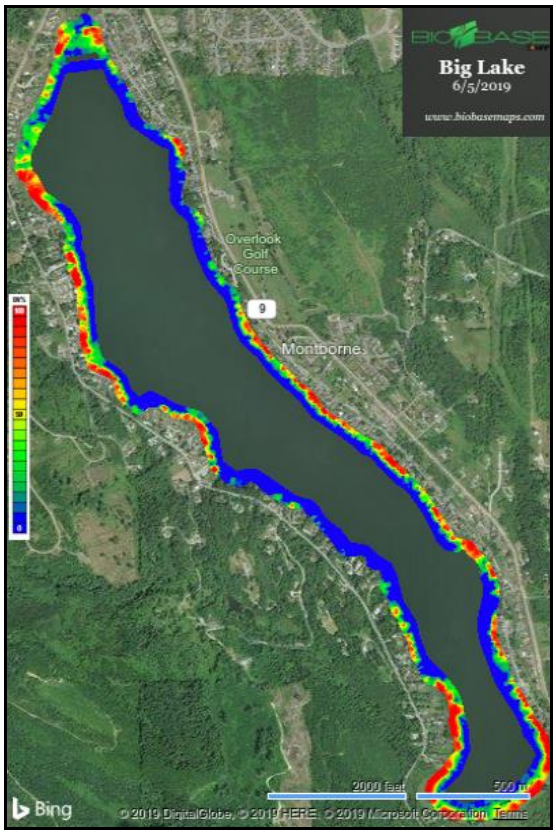
Our fall survey was performed on September 19, 2019. Our visual results were very encouraging as the late seasonal weed growth noted during 2018 was reduced considerably. Areas receiving a secondary treatment similarly exhibited minor regrowth. Many of the shoreline areas were experiencing elevated nitella (filamentous algae) growth. This algae exhibits the same type of visual survey mapping results as aquatic plants.

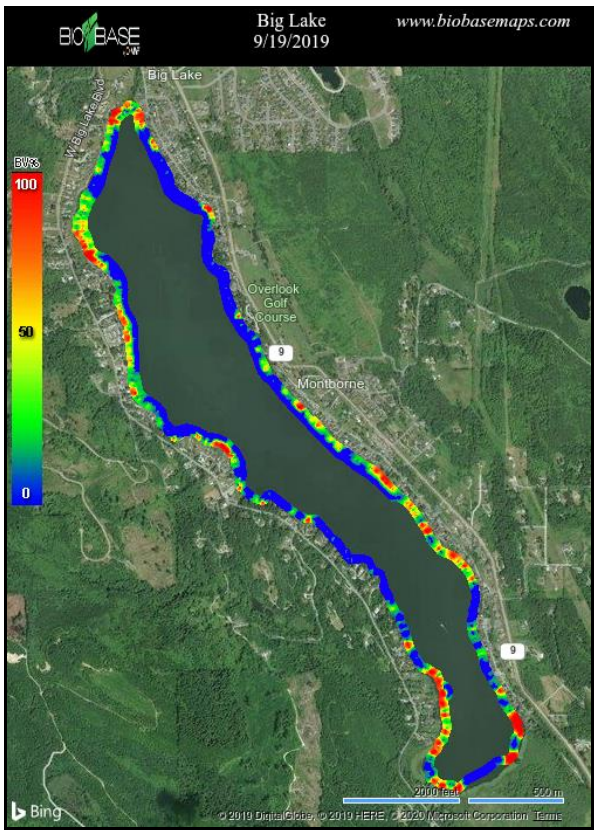
The BioBase mapping protocol utilizes water depth and the heat transmitted off the plant surfaces in calculating plant densities. As water depth declines, plants that earlier in the

season were below the water's surface are now floating on or near the surface. Lake shoreline areas that were supporting spring depths of four feet were now exhibiting depths of approximately two feet. Lake shorelines and dock areas that once supported a 25% - 50% weed density grid now exhibit densities of 100%. Although the September survey provides an accurate representation of the growth densities at the time of the survey, it is difficult to compare early seasonal weed growth with late growth when water depths have declined above normal seasonal levels.

As noted during 2018 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.







Spring 2019 Survey **Fall 2019 Survey**

2019 Department of Ecology Late Summer Survey

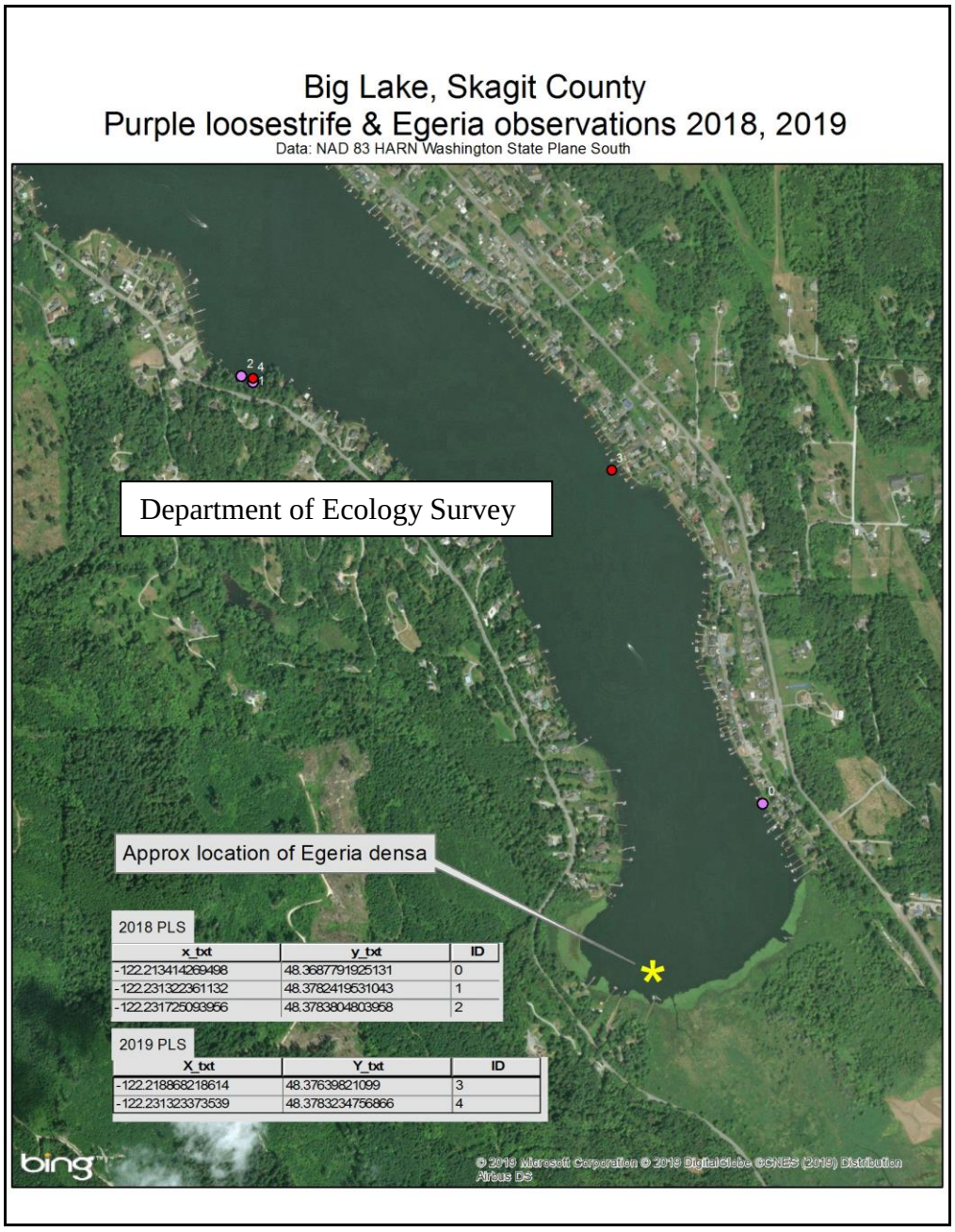
One Egeria densa and three purple loosestrife locations were identified by the Washington State Department of Ecology to be present within Big Lake. The Egeria densa location was identified to be in the extreme southern portion of the lake a wetland conservation zone.

Wetland Conservancy zone

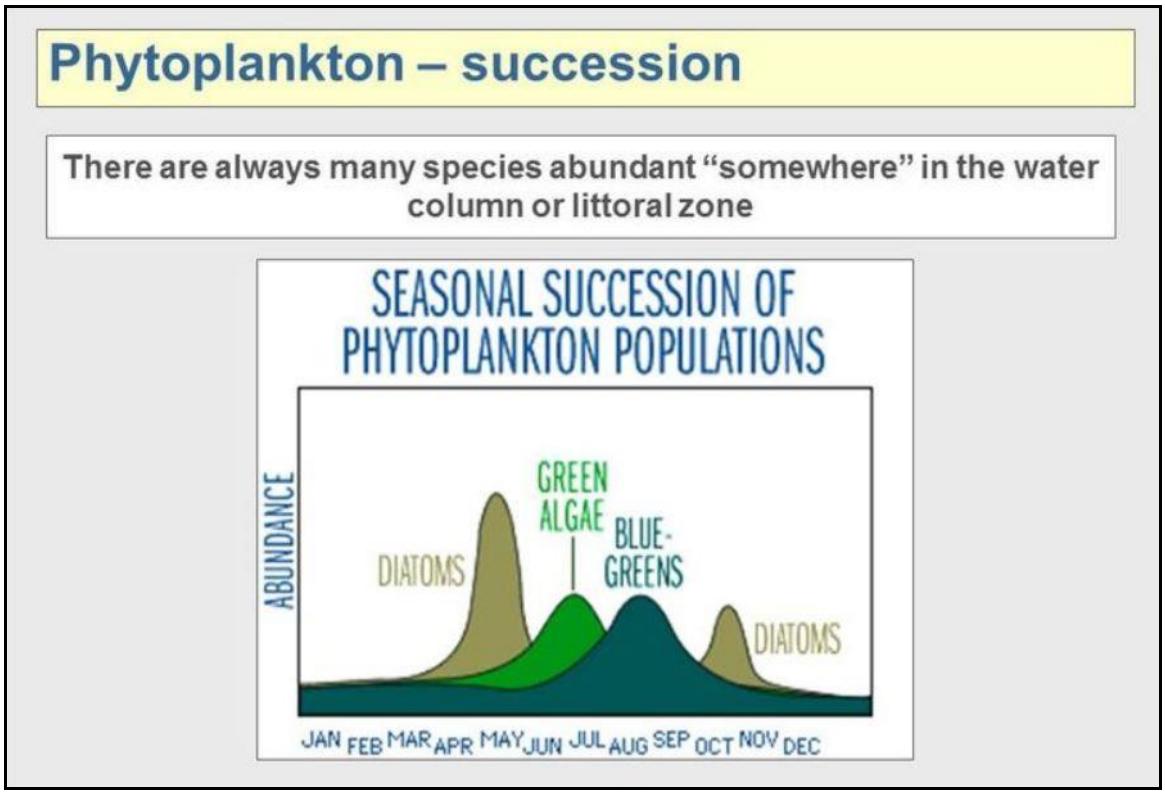
The area is designated as a lake area that typically receives no native plant control except for three or four private docks. Noxious floating plants and submersed nonnative species are targeted when identified. Since our presence on the lake in 2011, no Egeria densa had been recognized to be present. This particular area of the lake is heavily infested with

native plant growth. At times during recent surveys boat passage through the area proved to be problematic. Boat prop entanglement within weed beds in conjunction with associated clogged water intakes rendered some areas within this designated portion of the lake inaccessible.

Purple loosestrife was noted at two locations; one is a developed private residential lot the other site is an undeveloped wooded shoreline area on the lake.



Big Lake is a shallow sediment nutrient rich water body with a majority of the lake bottom void of aquatic plants. Nearly 100% of the shoreline supports residential development. This popular utilized recreational shoreline supports most of the lakes entire macrophyte population. In conjunction with dense littoral macrophyte growth the lake also supports typical seasonal algal populations that change as the water temperature and light intensity increases and diminishes throughout the year. All lakes cycle through this progression.



When excessive nutrients reside within a system that cannot be adequately controlled through native plant growth, these uncontrolled nutrients provide the required nutrient source to encourage algae populations to create unstable populations dominated by only one species. Once this occurs, the species typically exhibits accelerated growth eventually dominating the water column producing what is communally referred to as an "algae bloom". Without sufficient macrophyte growth to utilize these excess nutrients, poor water clarity and potentially unhealthy lake waters may result.

Residents at Big Lake are confronted with an unpleasant scenario of allowing untreated shoreline macrophyte growth to exist that may render lakefront use unsafe or result in poor water clarity if not controlled. There is no guarantee that reducing weed growth will curtail algae related issues if nutrient levels within the system already exceed threshold limits or if nutrient release through the bottom sediments later in the season occurs. With limited inflow during the summer months resulting in poor water exchange, any nutrients released through the decomposition of treated aquatic plants or bottom sediments will likely remain in the system until the winter.

Alum

One technique often utilized in the control of nutrients within a lake system is the application of alum. Phosphorous released from bottom sediment under anaerobic conditions becomes soluble within the water column. Once released into the water column the nutrients are then mixed throughout the water column and become available for uptake by algae. Alum when applied to the lakes surface water reacts to form a white, milky floc which settles to the bottom and permanently binds sediment so that it is no longer available as a phosphorous source for algae. If inflowing nutrient levels are elevated, alum applications typically are short lived. If nutrient inflow is slow, treatments can last in excess of five years.

Prior to applying alum, data needs to be collected in order to determine the dosing rate and the likely longevity of the treatment. NWAE has extrapolated a cost estimate from similar projects that have recently (2018) been treated with alum. It is estimated that at the same alum application rate of 10.9 mg AL/L applying alum to Big Lake would be in the range of 1.25 million dollars.

2020 BUDGET

Surveys (pre)	1	@	$1,800.00	$ 1,800.00
Surveys (post)	2	@	$1,500.00	$ 3,000.00
NPDES Permit	1	@	$ 675.00	$ 675.00
Noxious Weed Control	15	@	$ 250.00	$ 3,750.00
Native Weed Control (Diquat)	80	@	$ 300.00	$ 24,000.00
Eel Grass Control	12	@	$ 700.00	$ 8,400.00
Native Weed Control Aquathol K	30	@	$ 700.00	$ 21,000.00
Purple Loosestrife Lily Pad Control	4	@	$ 400.00	$ 1,600.00
Communication				$ 450.00
Mailings				$ 600.00
Newspaper Notice Signs Boat Launch				$ 525.00

Total	$ 65,800.00
2020 Budget	$ 66,500.00
Unused Budget 2019	$ 9,500.00

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 treatment.

2. Locate the B. elodea data point identified by the Department of Ecology and perform an in depth survey of the immediate area targeting B. elodea. Treat when appropriate.

3. Locate the purple loosestrife data points and treat accordingly.

4. Lily pad control operations should only be conducted during those hours when wind conditions are minimal. Patches consisting of only a few plants should be cut and removed by the property owners.

5. 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. Only a few plants were detected in our spring survey while our fall survey in conjunction with the Department of Ecology survey detected none. 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. Actions that may or may not be implemented will probably change on a year to year basis.

6. 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. A mid-season brief survey should be conducted to determine lake areas that may require a secondary treatment.

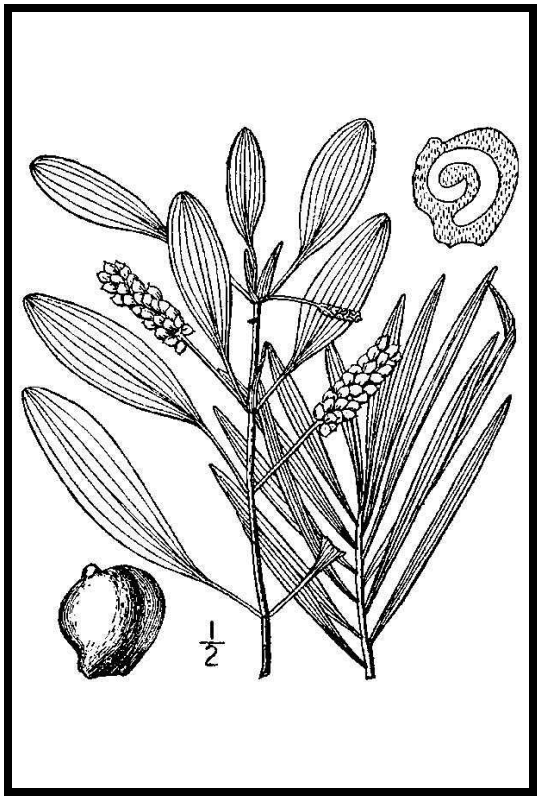
7. Discussions with the Big Lake Board should be initiated to determine if a reduction in shoreline macrophyte control should be implemented for 2020. If such a decision is made, what areas of the lake should no longer be targeted?

8. Expanded control of eel grass.

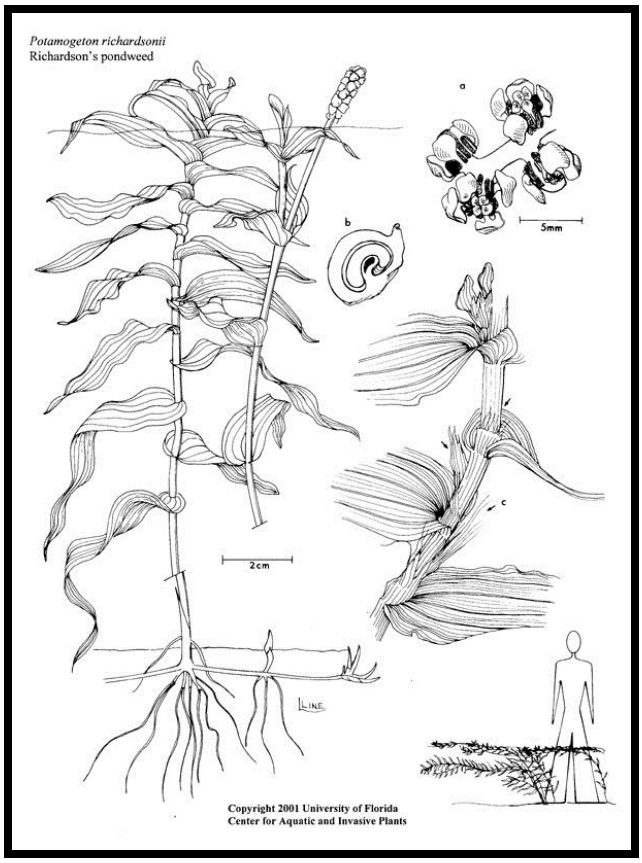
9. Continue use of the contact herbicide Aquathol K utilizing both the liquid and granular formulations. Use of the material has proved to be successful in controlling some pondweeds not susceptible to diquat. Use should also include tank mixes of both diquat and Aquathol K.

10. 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.

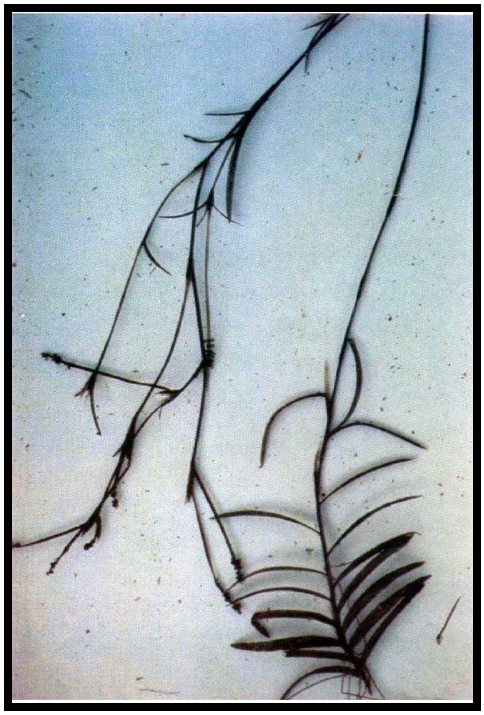
Dominant Submersed Macrophyte Species
Potamogeton epihydrus

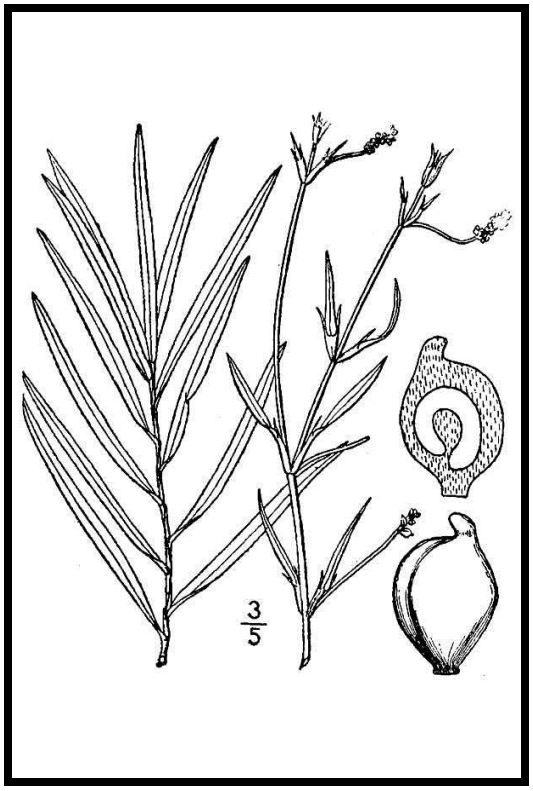


Potamogeton richardonsii

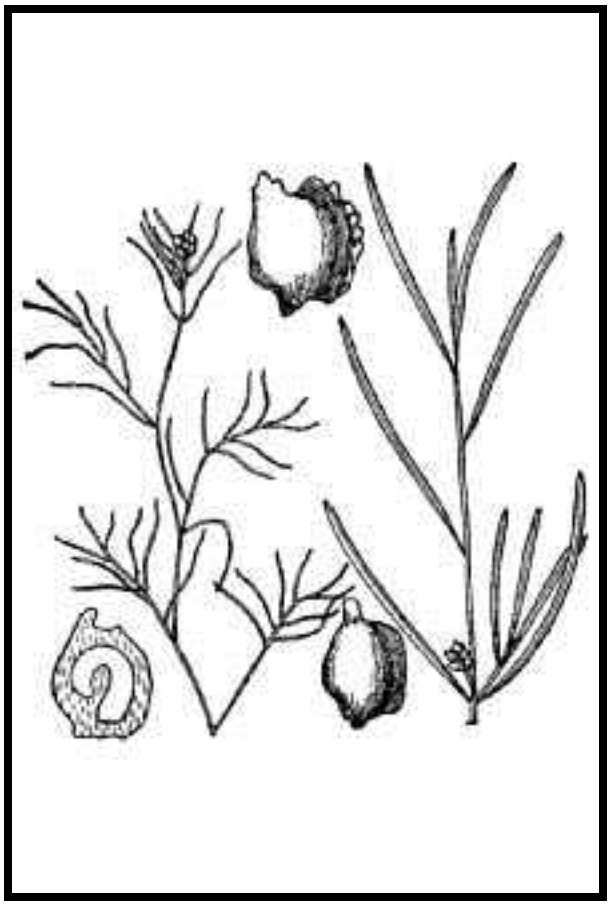


Potamogeton robbinsii

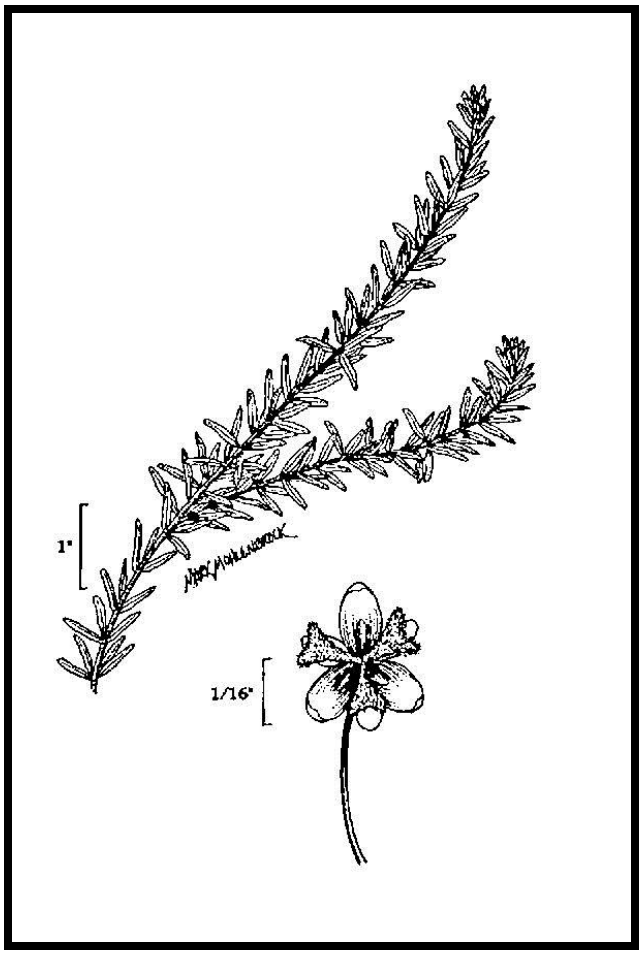




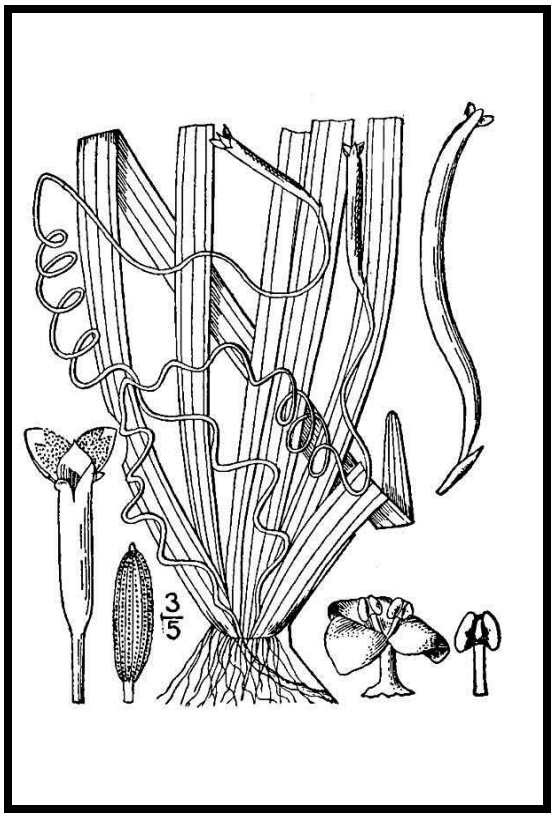
Potamogeton foliosus



Elodea canadensis



Vallisneria americana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