2014 Aquatic Macrophyte Survey

LAKE WACCABUC
LEWISBORO, NY
July 22, 2014

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2014 Aquatic Macrophyte Survey Report

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Introduction

On July 22, 2014, Allied Biological was pleased to conduct a detailed aquatic macrophyte survey at Lake Waccabuc, The Three Lakes, in South Salem, NY. The survey was conducted utilizing the Point Intercept Method (PIM). Three biologists were on site for the duration of the survey which was conducted in approximately nine hours of on-the-water time. The weather was fair with a high of 85 F and light variable winds, gusting up to 10 MPH in the afternoon. The survey was conducted to determine the aquatic macrophyte community at Lake Waccabuc and identify and changes to this structure based on the previous data collected in 2008 and from 2010 through 2013.

Lake Waccabuc is a 138 surface acre lake with a maximum depth of 44 feet. The littoral zone (defined as less than 15 feet deep) is restricted to the shoreline, the East and West ends of the lake, plus three coves. These are the North Cove (the largest), the Northeast Cove, and the South Outlet Cove. A canal connects Lake Waccabuc to Lake Oscaleta, and it too was surveyed, up to Oscaleta Road. Sediment type varies throughout the basin, but generally with softer organic-rich mud at the East end of the lake, and to an extent in the other coves to sandy sediment with medium to large rocks scattered about the remaining littoral zone.

Surveying the aquatic macrophyte community at Lake Waccabuc continues to be an important part of the lake management plan. The quantity and quality of data that has been collected since 2008 allows for a direct comparison and gives a detailed picture of the changes to the plant community within the basin. Watching these changes over time allows good management strategies to be put into place and quick responses to any invasive plant species that are identified. In 2008, Brazilian elodea was identified in the North Cove during the survey. Aggressive control efforts were employed in 2009, including suction harvesting and hand pulling. The 2010 survey identified one patch of the invasive outside the North Cove adjacent to the island. The area was hand pulled to continue efforts to eradicate the Brazilian elodea from the basin. With the evidence from the 2010 survey that the plant had spread outside the North Cove area the survey parameters were altered to three weed anchor tosses per site (two had been done previously). In addition, the access area was visually inspected, as well as the shallow coves and around the island (via walking in the shallows) as an added precaution. All other parameters and sampling procedures, including site locations, remained the same. Surveys were then preformed in 2011 – 2013 to determine the presence of Brazillian elodea or any other invasive species or RTE species.

Table #1, below, summarizes the aquatic macrophytes collected or observed during the 2008, 2010- 2014 surveys at Lake Waccabuc. An "X" in the column indicates the

Aquatic Macrophyte	Scientific Name	2008	2010	2011	2012	2013	2014	Change
Arrowhead (rosette)	*Sagittaria sp.*	X	X	X	X	X	X	+1%
Bass Weed	*Potamogeton amplifolius*	X	X	X	X	X	X	-2%
Benthic filamentous Algae		X	X	X	X	X	X	+2%
Brazilian Elodea	*Egeria densa*	X	X					0%
Brittle Naiad	*Najas minor*		X	X		X	X	-1%
Common Watermeal	*Wolffia columbiana*				X	X	X	0%
Common Waterweed	*Elodea canadensis*	X	X	X	X	X	X	+4%
Coontail	*Ceratophyllum demersum*	X	X	X	X	X	X	+2%
Creeping Bladderwort	*Utricularia gibba*	X	X	X	X	X	X	-3%
Curly-leaf Pondweed	*Potamogeton crispus*	X		X		X	X	-3%
Dwarf Water Milfoil	*Myriophyllum tenellum*	X	X	X	X	X	X	0%
Eurasian Water Milfoil	*Myriophyllum spicatum*	X	X	X	X	X	X	+1%
Flat-stem Pondweed	*Potamogeton zosteriformis*	X						0%
Floating Filamentous Algae		X	X	X	X	X	X	0%
Great Duckweed	*Spirodela polyrhiza*				X	X	X	+1%
Leafy Pondweed	*Potamogeton foliosus*	X	X	X	X	X	X	0%
Pondweed sp.							X	+12%
Ribbon-leaf Pondweed	*Potamogeton epihydrus*		X	X	X	X	X	+1%
Robbin's Pondweed	*Potamogeton robbinsii*	X	X	X	X	X	X	+7%
Slender Naiad	*Najas flexilis*			X				0%
Small Duckweed	*Lemna minor*		X		X	X	X	+4%
Spatterdock	*Nuphar variegata*	X	X	X	X	X	X	-1%
Spiral-fruited Pondweed	*Potamogeton spirillus*	X	X	X	X	X		-11%
Water Chestnut	*Trapa natans*						X	+1%
Water Stargrass	*Zosterella dubia*		X	X	X	X	X	+3%
Watermoss	*Fontinalis* sp.				X	X		-2%
Watershield	*Brasenia schreberi*	X	X	X	X	X	X	+4%
White Water Lily	*Nymphaea odorata*	X	X	X	X	X	X	+3%

macrophyte was collected/observed in that year. A red "X" indicates an invasive species. The last column (labeled "change") indicates whether the macrophyte in question increased (+), or decreased (-) in abundance from 2013 to 2014. If plant abundance was similar both years, it is indicated by 0%.

The Appendix of this report contains bar graphs depicting the percent abundance data for each macrophyte for all five sampling years. The overall bar represents the total frequency of the macrophytes occurrence for each respective sample year. The total bar is then divided by different colors, indicating a breakdown of the four measured densities (trace, sparse, medium and dense). If a color is not present, that macrophyte did not occur at that density. By examining these graphs, the change in macrophyte percent occurrence and abundance can be discerned between the all sample years. Keep in mind; nuisance density growth of macrophytes for management purposes is typically considered medium and dense density.

Procedures

In 2014, the sample locations utilized in previous surveys at Waccabuc Lake, were used again for continuity and comparison. The primary goal of the survey continues to be the identification of any sites containing Brazilian elodea. To that end the additional sites added in 2010 were again included. It should be noted that deeper water areas (total depth greater than 15 feet) are generally not surveyed due to the lack of macrophyte growth caused by poor light penetration. The sample locations are depicted on a map in the Appendix of this report.

The survey boat is piloted to the first sample location, using the 2010-logged GPS coordinates, loaded on a Trimble GeoXH 2008 series handheld GPS unit (sub-meter accuracy). The water depth was also measured, using a boat-mounted depth finder, a handheld depth gun (HawkEye digital sonar system, or equivalent), or a calibrated metal pole, as appropriate to the conditions. The water depth is recorded on a field log (and confirmed with 2010 data), and is depicted on a map. Any other pertinent field notes regarding the sample location (or habitat) are also recorded on a field log, such as additional macrophyte species observed but not collected on weed anchor tosses, or nuisance macrophytes at the surface.

Next, a weed anchor attached to a 10 meter-long piece of rope is tossed from a random side of the boat. It is important to toss the weed anchor the full 10 meters (a loop at the end of the rope is attached to the boat to prevent losing the anchor). The weed anchor is slowly retrieved along the bottom, and carefully hoisted into the boat. To determine the overall submersed vegetation amount, the weed mass is assigned one of five densities, based on semi-quantitative metrics developed by Cornell University (Lord, et al, 2005). These densities are: **No Plants** (empty anchor), **Trace** (one or two stems per anchor, or the amount that can be held between two fingers), **Sparse** (three to 10 stems, but lightly covering the anchor, or about a handful), **Medium** (more than 10 stems, and covering all the tines of the anchor), or **Dense** (entire anchor full of stems, and one has trouble getting the mass into the boat). See the Appendix of this report for pictures of these representative densities. These densities are abbreviated in the field notes as 0, T, S, M, and D. Next the submersed weed mass is sorted by Genus (or species if possible) and one of the five densities (as described above) is assigned to each Genus. Finally, overall floating macrophyte density within a 10 meter diameter of the survey boat is assigned a density, as well as an estimated density for each separate Genus (or species) observed. This data is recorded in the field notes. This procedure is then repeated for the remaining sample points.

The survey conducted at Lake Waccabuc in 2014 continued to utilize three anchor tosses per site. The tosses were conducted from opposite sides of the boat and labeled Toss A, Toss B, and Toss C, respectively. The data for all three tosses are included on Table #2, in the Appendix. Each density was assigned a numeric value: 0 for no plants, 1 for trace, 2 for sparse, 3 for medium, and 4 for dense plants. The mean of these three values for all tosses (rounded up) are also displayed on Table #2. These mean values were used to assign overall densities, as depicted on the distribution maps in the Appendix. For example, if toss A was medium density (3), toss B was sparse (2), and toss C was trace density (1) for the same macrophyte, the mean density would be sparse (3+2+1=6/3=2). Although using three tosses is ideal for detecting the presence of many different aquatic macrophytes, these procedures and associated calculations tend to decrease the overall abundance per site. Therefore, very few sites will be classified as dense. The 2008 through 2012 percent abundance bar graphs depict this trend. However, as stated above, the primary goal of the survey was to locate patches of Brazilian elodea (or other invasive macrophytes), even at the cost of generating a data set that might not be ideally comparable to the 2008 and 2010 data.

A sample of each different macrophyte was collected and placed in a bottle with a letter or number code (A, B, 1, 2, etc.). If possible, these samples included both submersed and floating leaves (if any), seeds, and flowers (if present), to facilitate identification. These bottles were placed in a cooler stocked with blue-ice packs or ice, and returned to Allied Biological's lab for positive identification and photographing. Regionally appropriate taxonomic keys (see references in the Appendix of this report) were used to identify the aquatic macrophytes.

The weed anchor used for aquatic macrophyte surveys has a specific design. It is constructed with two 13.5 inch wide metal garden rakes attached back to back with several hose clamps. The wooden handles are removed and a 10 meter-long nylon rope is attached to the rake heads.

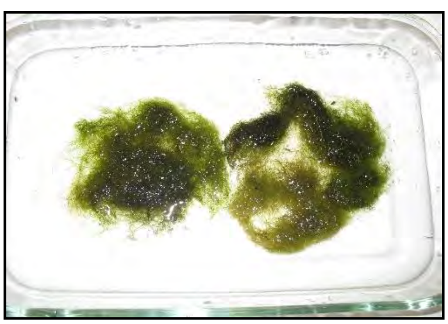
Macrophyte Summary

The following aquatic macrophyte species were observed at Lake Waccabuc during the 2014 survey performed on July 24th, 2014. A few additional macrophytes were observed during the survey (but not collected via anchor toss), as discussed at the end of this section. The data and maps are located in the Appendix of this report. The macrophyte percent abundance for each species is summarized in Table 2 and the abundance for each species on each individual rake toss is summarized in Table 3 (both located in the Appendix of this report).

Below is a short description and picture of each macrophyte collected or observed during the 2014 survey. Unless otherwise noted, all pictures of macrophytes represent the actual plant collected or observe at Lake Waccabuc either taken in the field, of from samples returned to Allied Biological's laboratory. These descriptions are presented in alphabetical order by common name.

Arrowhead (Submersed Rosette) (*Sagittaria* sp. Common Name: Arrowhead. **Native**.): This plant is the submersed rosette of a species of arrowhead. The submersed rosette lacks both flowers and seeds, so further identification is usually not possible. However, when the submersed rosette form is found, lake edges are usually inhabited by emergent arrowhead plants of similar species. Arrowhead has emergent leaves, and usually inhabits shallow waters at pond or lake edges, or along sluggish streams. It can tolerate a wide variety of sediment types and pH ranges. Arrowhead is very suitable for constructed wetland development due to its tolerance of habitats, and ability to act as a nutrient sink for phosphorous. Typical arrowhead reproduction is via rhizomes and tubers although seed production is possible if conditions are ideal. Arrowhead has high wildlife value, providing high-energy food sources for waterfowl, muskrats and beavers. Arrowhead beds provide suitable shelter and forage opportunities for juvenile fish as well.

Bass Weed (*Potamogeton amplifolius*. Common Names: Large-leaf Pondweed, Bass Weed, Musky Weed. **Native.**): Bass weed has robust stems that originate from black-scaled rhizomes. The submersed leaves of bass weed are among the broadest in the region. The submersed leaves are arched and slightly folded, attached to stems via stalks, and possess many (25-37) veins. Oval floating leaves, also with numerous veins, are produced on long stalks (ranging from 8-30 cm in length). Stipules are large (up to 12 cm long), free and taper to a sharp point. Flowers are produced by midsummer, (and fruit, later in the season) densely packed onto a spike. The fruit have three low ridges on its surface. Bass weed prefers soft sediments in water one to four meters deep. This plant is sensitive to increased turbidity and also has difficulty recovering from top-cutting, from such devices as boat propellers and aquatic plant harvesters. As its name implies, the broad leaves of this submersed plant provides abundant shade, shelter and foraging opportunities for fish. The high numbers of nutlets produced per plant make it an excellent waterfowl food source. Studies have demonstrated that bass weed can be established in littoral areas via stem clippings if growing conditions are ideal.

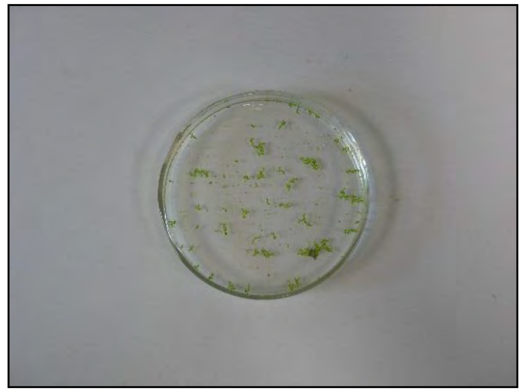


Benthic or Floating Filamentous Algae: Filamentous algae is a chain or series of similar algae cells arranged in an end to end manner. Benthic filamentous algae is attached to a hard substrate, such as logs, rocks, a lake bottom, or even other aquatic plants. When growing in heavy densities, benthic filamentous algae can appear as brown or green mats of vegetation that can reach the surface. When large pieces break off the bottom substrate, they become floating filamentous algae patches. Benthic and floating filamentous algae can comprise an entire range of morphologies, but flagellated taxa are far less common. Typically, green algae and blue-green algae groups are represented by macroscopic filamentous algae.

Brazilian Elodea – NOT OBSERVED IN 2014 - (*Egeria densa*. Common Names: Egeria, Anacharis, Brazilian waterweed. **Exotic, Aggressive, Invasive.**): Brazilian elodea is an aggressive exotic invasive submersed plant that originated from South America. It was introduced via the aquarium hobby trade, and is a top selling plant used as an oxygenator. The stems can be several meters long, and the strap-like leaves are situated in whorls of three to six, but usually four. The leaves are finely serrated, and are tightly packed together near the end of the stem. Brazilian elodea can be rooted or free floating, and due to its highly branching and buoyant nature, most of its biomass occurs at or near the surface. Submersed plants can quickly reach nuisance densities, crowding out native vegetation and floating mats can block light penetration needed for lower growing native submersed plants. Although it can be confused with *Hydrilla*, another invasive submersed plant, its lack of tuber production and leaf structure differentiates it. Although it can produce white flowers, it reproduces vegetatively in the United States. Two adventitious roots can be seen in the picture to the left. Waterfowl consume Brazilian elodea, and fish and invertebrates uses the stems for refuge and habitat.

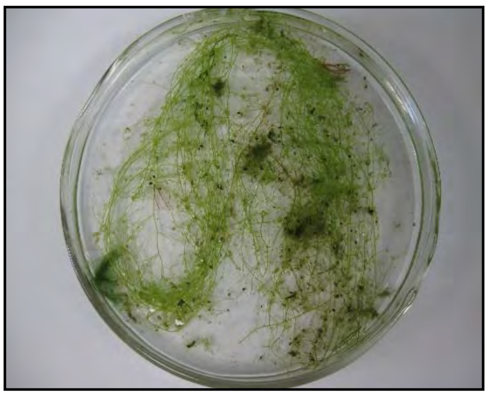
Brittle Naiad (*Najas minor*. Common Names: brittle water nymph, European naiad. **Exotic, Invasive**): Brittle naiad is a submersed annual that flowers in August to October. It resembles other naiads, except its leaves (usually less than 3.5 cm long) are highly toothed with 6-15 spinules on each side of the leaf, visible without the aid of magnification. The leaves are opposite, simple, thread-like, and usually lime-green in color, often with a "brittle" feel to them. Brittle naiad fruit are narrow, slightly curved, and marked with 10-18 longitudinal ribs, resembling a ladder. Often the fruits are purplish in color. Although it can reproduce via fragmentation, its primary mode of reproduction is seed production. Brittle naiad has been introduced from Europe in the early 1900's, and can be found in most of the northeastern states. Brittle naiad can occur in water as deep as five meters, and although it prefers sandy and gravel substrates, it can tolerate a wide range of bottom types. It's tolerant of turbid and eutrophic conditions. Waterfowl graze on the fruit.

Common Watermeal (*Wolffia columbiana*. Common Names: common watermeal, watermeal. **Native.**): Common watermeal appears as pale green globes of vegetative matter without roots, stems or true leaves. It's one of the world's smallest flowering plants, but flowers are rarely found and require magnification to see. Common watermeal usually reproduces by budding. Common watermeal is typically found on the surface, intermingled with duckweeds. It drifts with the water's current or wind, and therefore it grows independent of water depth, clarity or sediment type. In the fall it produces winter buds that sink to the bottom. In the spring, the buds become buoyant and float to the surface. Waterfowl, fish, and muskrats all include common watermeal in their diets.



Common Waterweed (*Elodea canadensis*: Common Names: Elodea, common waterweed. **Native.**): Common waterweed has slender stems that can reach a meter or more in length, and a shallow root system. The stem is adorned with lance-like leaves that are attached directly to the stalk that tend to congregate near the stem tip. The leaves occur in whorls of three (or occasionally two). The leaves are populated by a variety of aquatic invertebrates. Male and female flowers occur on separate plants, but it can also reproduce via stem fragmentation. Common waterweed overwinters as an evergreen plant, and primarily reproduces via fragmentation. Its resistance to disease and tolerance of low-light conditions grant it a competitive advantage. Although common waterweed is considered a desirable native plant, it can reach nuisance levels, creating dense mats that can obstruct fish movement, and the operation of boat motors.

Coontail (*Ceratophyllum demersum*. Common Names: coontail, hornwort. **Native.**): Coontail has long trailing stems that lack true roots, although it can become loosely anchored to sediment by modified stems. The lack of a true root system can have an affect its distribution in a lake basin, due to prevailing winds, water currents, and boat movement. The leaves are stiff, and arranged in whorls of five to 12 at each node. Each leaf is forked once or twice, and has teeth along the margins. The whorls of leaves are spaced closer at the end of the stem, creating a raccoon tail appearance. Coontail is tolerant of low light conditions, and since it is not rooted, it can drift into different depth zones. Coontail can also tolerate cool water and can overwinter as an evergreen plant under the ice. Typically, it reproduces via fragmentation. Bushy stems of coontail provide valuable habitat for invertebrates and fish (especially during winter), and the leaves are grazed on by waterfowl. Although considered a desirable native plant, it can reach nuisance density at the surface of a lake.



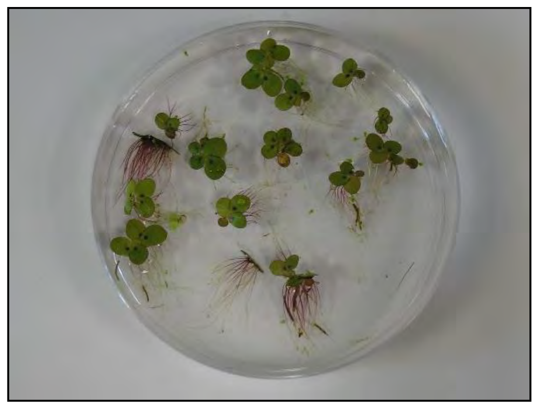
Creeping Bladderwort (*Utricularia gibba*. Common Names: creeping bladderwort, humped bladderwort, cone-spur bladderwort. **Native**.). Creeping bladderwort is a small (usually less than 10 cm long), delicate, free-floating stem. It often forms tangled mats in quiet shallow waters, often associated with bogs, or stranded on soil. It is sometimes mistaken for algae. It has short side braches that fork once or twice, a defining characteristic. Small bladders, used to capture live prey, are situated on these side branches, but they are few in number when compared to other bladderworts. Small yellow snap-dragon-like flowers are produced on a short stalk, typically developing in early summer, yet persisting for several weeks. Mats of creeping bladderwort offer limited cover and foraging opportunities for fish.

Curly-leaf Pondweed (*Potamogeton crispus*. Common Name: curly-leaf pondweed. **Aggressive, Invasive, Exotic.**): Curly-leaf pondweed is native to Europe, but was introduced to North America in the mid-1800's. This invader is very common in the northeast, and its range now includes most of the USA. Curly-leaf pondweed has spaghetti-like stems that often reach the surface by mid-June (up to four meters long). Its submersed leaves are oblong, and attached directly to the stem in an

alternate pattern. The margins of the leaves are wavy and finely serrated, hence its name. No floating leaves are produced. Stipules are fused to the base of the stem, but disintegrate early in the season. Curly-leaf pondweed can tolerate turbid water conditions better than most other macrophytes, giving it a competitive advantage over most desirable native plants. In late summer, curly-leaf pondweed enters its summer dormancy stage. It naturally dies off (often creating a sudden loss of habitat and releasing nutrients into the water to fuel algae growth) and produces vegetative buds called turions. These turions germinate when the water gets cooler in the autumn and give way to a winter growth form that allows it to thrive under ice and snow cover, providing habitat for fish and invertebrates.

Dwarf Water Milfoil (*Myriophyllum tenellum*. Common Name: Dwarf water milfoil. **Native**.): Dwarf milfoil, which does not look anything like other milfoil species, has slender unbranched stems ranging from 2 cm to 15 cm in height. The leaves are reduced to scales or "bumps". If the tips rise out of the water, they are capable of producing pale flowers and nut-like fruits (produced in late summer). These flowers are then wind pollinated. The toothpick-like stems arise from rhizomes in a chain. Dwarf milfoil is small and delicate, often overlooked even when visible in the shallows. It prefers sandy bottoms in water up to four meters deep, but typically only a few inches deep. Dwarf water milfoil provides suitable spawning habitat for panfish and adequate shelter for small invertebrates. The dense tufts of rhizome networks are ideal to stabilize bottom sediments.

Eurasian Water Milfoil (*Myriophyllum spicatum*. Common Names: Asian water milfoil. **Aggressive, Exotic, Invasive**.): Eurasian water milfoil has long (two to four meters long) spaghetti-like stems that grow from submerged rhizomes. The stems often branch repeatedly at the water's surface creating a canopy that can shade out other vegetation, and obstruct recreation and boat navigation. Low light conditions and high surface water temperatures promote canopy formation. The leaves are arranged in whorls of four to five, often spread out along the stem one to three centimeters apart. The leaves are divided like a feather, resembling the bones on a fish spine, typically with 14 to 20 pairs. Eurasian water milfoil is an exotic, originating in Europe and Asia, but its range now includes most of the United States. It's ability to grow in cool water and at low light conditions gives it an early season advantage over other native submersed plants. It can grow in water up to 15 feet deep, and prefers fine-textured inorganic sediments. In addition to reproducing via fruit production, it can also reproduce via fragmentation. It does not produce winter buds, and can persist under the ice as an evergreen plant. Waterfowl graze on Eurasian water milfoil, and its vegetation provides substandard habitat for invertebrates. However, studies have determined mixed beds of native pondweeds and wild celery can support more abundant and diverse invertebrate populations.

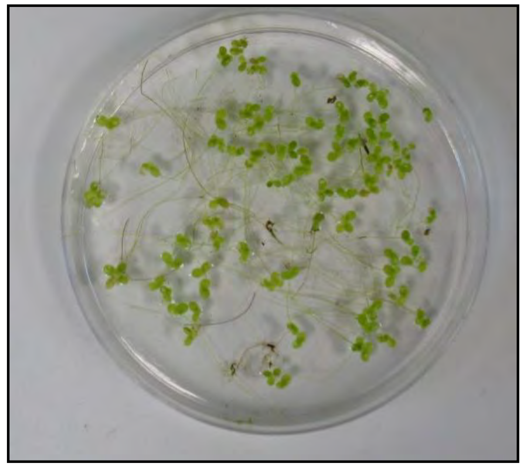


Great Duckweed (*Spirodela polyrhiza*. Common Names: Great duckweed, large duckweed. **Native.**). Great duckweed is the largest of the duckweeds, but it is still very small compared to other aquatic macrophytes. It has simple flattened fronds with irregular oval shapes, often up to 1 cm in length and 2.5 to 8.0 mm long. The frond surface is usually green with a conspicuous purple dot. The underside of the frond is magenta with a cluster of 5-12 roots that dangle into the water. Indeed, peering at great duckweed from under the water grants it the appearance a tiny jellyfish. Although great duckweed produces flowers, it usually reproduces via budding, and like other duckweeds, it is capable of rapid growth. It often occurs with other duckweeds, and since it is free floating, it can be moved via the wind or water currents. It derives its nutrients from the water column and often occurs in eutrophic systems. It's an excellent food source for waterfowl, and is also used by muskrat and fish. The dense mats offer shade and cover for fish.

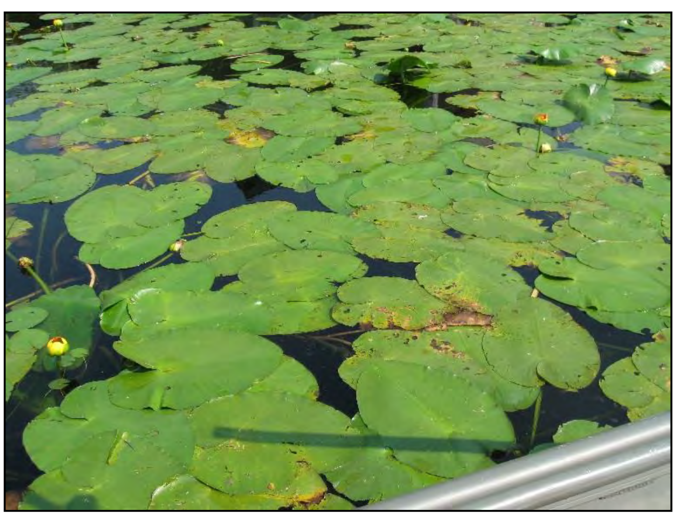
Leafy Pondweed (*Potamogeton foliosus*: Common Name: leafy pondweed. **Native**.): Leafy pondweed has freely branched stems that hold slender submersed leaves that become slightly narrower as they approach the stem. The leaf contains three to five veins, typically flanked by one to two rows of hollow (lacunae) cells. The leaves often taper to a point. Stipules are membranous and free from the stems in mature plants, but wrap around the stem in developing plants. No floating leaves are produced. It produces early season abundant fruits in tight clusters on short stalks in the leaf axils. The seeds are flattened with a dorsal wavy ridge and a short beak. These early season fruits are often the first grazed upon by waterfowl during the season. Muskrat, beaver, deer and even moose also graze on the fruit. It inhabits a wide range of habitats, but usually prefers shallow water and softer sediments. In ideal habitats, it can reach nuisance densities. It has a high tolerance for eutrophic conditions, allowing it to even colonize secondary water treatment ponds.

Ribbon-leaf Pondweed (*Potamogeton epihydrus*: Common Name: ribbon-leaf pondweed. **Native**.): Ribbon-leaf pondweed has flattened stems and two types of leaves. The submersed leaves are alternate on the stem, lack a leaf stalk, and are long tape-like in shape. Each leaf, which can reach lengths up to 20 cm long, has a prominent stripe of pale green hollow cells flanking the midvein, and 5 to 13 other veins. Stipules are not fused to the leaf. Floating leaves are egg or ellipse-shaped and supported by a leaf stalk about as long as the leaf itself. Fruiting stalks are located at the top of the stem and packed with flattened disk-shaped fruits. It is typically found growing in low alkalinity environments, and in a variety of substrates. Seeds are highly sought after by all manner of waterfowl, and the plant is grazed on by muskrat, deer, beaver and moose. The ribbon-like leaves are often colonized by invertebrates, and offer foraging opportunities for fish and frogs.

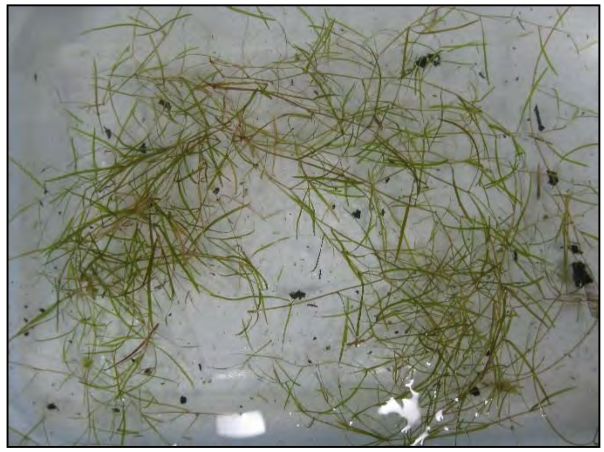
Robbin's Pondweed (*Potamogeton robbinsii*. Common Name: Fern Pondweed. **Native**.). Robbin's pondweed has robust stems that emerge from spreading rhizomes. The rhizomes can be tightly spaced, creating a carpet of Robbin's pondweed that possibly could inhibit other submersed plants from becoming established. The leaves are strongly ranked creating a fern-like appearance most clearly seen while still submerged, yet still evident when out of the water. Its distinct closely-spaced fern-like leaves give it a unique appearance among the pondweeds of our region. Each leaf is firm and linear, with a base that wraps around the stem with ear-like lobes fused with a fibrous stipule. No floating leaves are produced. Whorls of flowers can be produced, but fruit rarely is produced. Robbin's pondweed thrives in deeper water, often inhabiting a thin margin at the edge of the littoral zone, beyond most other submersed plants. Under some circumstances, portions of Robbin's pondweed can over winter green. Robbins pondweed creates suitable invertebrate habitat, and cover for lie-in-wait predaceous fish, such as pickerel and pike.



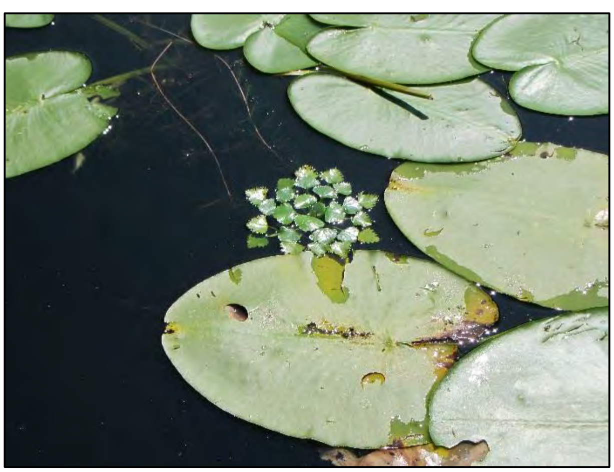
Small Duckweed (*Lemna minor.* Common Names: Small duckweed, water lentil, lesser duckweed. **Native.**). Small duckweed is a free floating plant, with round to oval-shaped leaf bodies typically referred to as fronds. The fronds are small (typically less than 0.5 cm in diameter), and it can occur in large densities that can create a dense mat on the water's surface. Each frond contains three faint nerves, a single root (a characteristic used to distinguish it from other duckweeds), and no stem. Although it can produce flowers, it usually reproduces via budding at a tremendous rate. Its population can double in three to five days. Since it is free floating, it drifts with the wind or water current, and is often found intermixed with other duckweeds. Since it's not attached to the sediment, it derives nutrients directly from the water, and is often associated with eutrophic conditions. It over-winters by producing turions late in the season. Small duckweed is extremely nutritious and can provide up to 90% of the dietary needs for waterfowl. It's also consumed by muskrat, beaver and fish, and dense mats of duckweed can actually inhibit mosquito breeding.



Spatterdock (*Nuphar vareigata*. Common Name: Yellow pond lily, bullhead pond lily, spatterdock. **Native.**): Spatterdock leaf stalks emerge directly from a robust submerged fleshy rhizome often adorned with scars from previous flower stalks. Spatterdock has large (up to 25 cm) heart-shaped leaves with a prominent notch and two lower lobes. The leaf stalk sports a winged margin, setting it apart from another yellow pond lily, *N. advena*. Flowering occurs in the summer and, the flowers open during the day and close at night. Flowers are bulbous in shape with yellow sepals often tinted red at the base. Spatterdock typically inhabits quiet water less than two meters deep, such as ponds, shallow lakes and slow-moving streams. Occasionally, the leaves are held erect, above the surface of the water. The leaves offer shade and protection for fish, and the leaves, stems, and flowers are grazed upon by muskrats, beaver, and sometimes even deer.

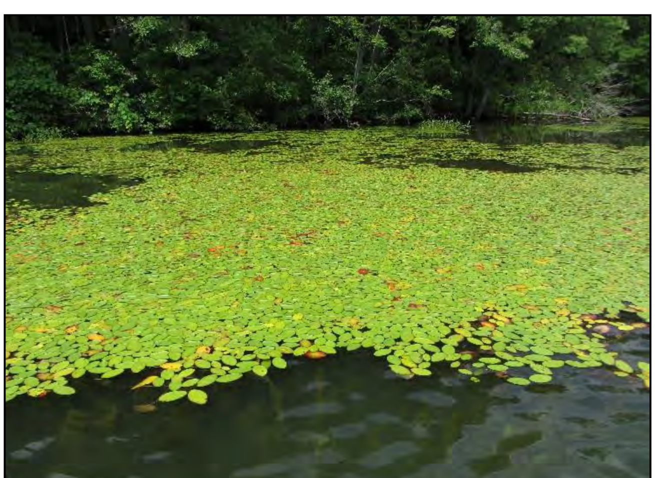


Spiral-fruited Pondweed – NOT POSITIVELY IDENTIFIED IN 2014 - (*Potamogeton spirillus*. Common Name: Spiral-fruited pondweed. **Native.**): Spiral-fruited pondweed has slender stems that originate from a delicate, spreading rhizome. The stems tend to be compact and have numerous branches. Submersed leaves are linear with a curved appearance. Floating leaves are delicate, ellipse-shaped and range from seven to 35 mm long and two to 13 mm wide. Stipules are fused to the leaf blade for more than half of their length. Flowering occurs early in the season, with fruit production by mid-season. Nut-like fruits are produced on stalks of varies lengths. Shorter stalks tend to be on lower axils with fruit arranged in a compact head, while longer stalks tend to appear on upper axils, with fruit arranged in a cylindrical head. The fruit itself is a flatten disc with a sharply-toothed margin. Its smooth sides appear like a tightly coiled embryo, a distinguishing characteristic. Spiral-fruited pondweed prefers shallow water with sandy substrate, but can inhabit a wide range of bottom substrates. It serves as an important sediment stabilizer and cover for fish fry and invertebrates.



Water Chestnut – 1st APPEARANCE IN 2014 (*Trapa natans*. Common Names: Water nut, water chestnut. **Aggressive, Exotic, Invasive**.): Water chestnut is native to Europe and Asia, and was first observed in the United States in the late 1800's in Massachusetts. Water chestnut has two types of leaves, submerged and floating rosettes. The submersed leaves are delicate, opposite and contain numerous adventitious roots. Floating leaves are strongly toothed triangular leaves displayed in a rosette fashion, supported by long petioles with spongy inflated bladders for buoyancy. These petioles can reach lengths of up to 16 feet. Water chestnut prefers to inhabit nutrient-rich slow moving waters in lakes, ponds or streams. Although water chestnut can reproduce via fragmented rosettes, the plant produces numerous single-seeded horned nuts armed with sharp ½" barbs. After maturation, these nuts fall off the plant and over winter, producing 10-15 new rosettes the following season. These nuts can inflict painful wounds to swimmers if stepped on. Studies have shown a water chestnut can lie dormant on a lake bottom for up to 12 years, and still germinate. Water chestnut is a poor source of food for waterfowl. High densities of water chestnut can inhibit boating and fishing.

Water Stargrass (*Zosterella dubia* (*=Heteranthera dubia*): Common Name: Water stargrass, eelgrass. **Native.**): Water stargrass has slender free-branched slightly flattened stems that originate from rhizomes. The leaves are narrow and alternate, attaching directly to the stem. Leaves can be up to 15 cm long, and lack a prominent midvein, a distinguishing characteristic. Although water stargrass appears to be a pondweed, it's actually not related to that diverse genus, being in the pickerelweed family. Water stargrass can inhabit a wide range of water depths and sediment types, and can tolerate reduced clarity environments. Yellow star-shaped flowers are produced by midsummer, but reproduction is usually via over wintering rhizomes. Flowers are typically only produced in shallow water or stranded-on-shore plants. Water stargrass is a locally important waterfowl food source, and provides suitable cover and foraging opportunities for fish.



Watershield (*Brasenia schreberi*. Common Names: common water shield, water target. **Native**.): Watershield is a floating-leaf aquatic plant similar to water lilies. Its stem and leaves are elastic, and are attached to a rooted rhizome that acts as an anchor and source of stored nutrients. The leaf stalks are attached to the middle of the leaf, creating a bull's eye effect, hence its name water target. The leaves, which are typically much smaller than other water lilies, are green on the upper surface, and purple underneath. Maroon to purple small flowers (less than 3 cm in diameter) peak above the water's surface on short, stout stalks. Watershield is usually coated with a clear gelatinous slime on the stem and underside of the leaves. Watershield prefers soft-water lakes and ponds in sediments containing decomposing organic matter. Under ideal conditions, watershield can become aggressive, and reach nearly 100% coverage on the surface. The whole plant is consumed by waterfowl, and the floating leaves provide shade and cover for fish.

White Water Lily (*Nymphaea odorata.* Common Name: white water lily, fragrant water lily. **Native.**): White water lily leaf stalks emerge directly from a submerged fleshy rhizome. White water lilies have round floating leaves that can reach 30 cm in diameter. The floating leaves have a narrow notch (or sinus), and a green to purple underside. The white flowers are prominent and showy (seven to 20 cm) and arise from stalks from the rhizome. Flowering occurs during the summer, and the flowers open during the day, and close during the night. White water lilies are very common and typically inhabit quiet water less than two meters deep, such as ponds, shallow lakes and slow-moving streams. They inhabit a variety of sediment types, and can reach nuisance density under ideal circumstances. Nuisance density white lilies shade other macrophyte growth, compound sediment accumulations, and obstruct boat movement. The leaves offer shade and protection for fish, and the leaves, stems, and flowers are grazed upon by muskrats, beaver, and sometimes even deer. There is quite a bit of debate among aquatic macrophyte taxonomists regarding the placement of fragrant white water lily and tuberous white lily (*N. tuberosa*).

Water Moss (*Fontinalis* sp. Common Name: water moss. **Native.**): Water mosses are submerged mosses that are attached to rocks, trees, logs, and other hard substrates by false rootlets located at the base of their stems. The stems are dark-green to brown, and about one foot long. The leaves share a similar color as the stems, and are usually ovate with fine-toothed margins. Water moss is utilized by aquatic invertebrates, and as a breeding site for small fish. Water moss rarely reaches nuisance levels.

Discussion

During the 2014 survey at Lake Waccabuc, 22 aquatic macrophytes were positively identified using regionally appropriate taxonomic keys. One specimen, a pondweed, was not able to be identified to species (referred to as Pondweed sp. in Table 1). The specimens of Pondweed sp. obtained during the survey did not contain either seeds or floating leaves which could be used to positively identify them. The specimen most closely resembled water thread pondweed or spiral fruited pondweed. Maps depicting the distribution of all aquatic macrophytes (including the unidentified pondweed sp. and both floating and benthic filamentous algae) according to species and density at each sampling site are included in the Appendix of this report. A total of 27 maps are included, with separate maps depicting sample location, water depth and total floating and submersed aquatic vegetation. A map depicting Richness (number of individual species) per sample location is also included. A total of 120 sample locations were surveyed for aquatic macrophytes at Lake Waccabuc in 2014. This includes four sites surveyed in the channel leading from Lake Waccabuc to the Oscaleta Road overpass. At the channel sites, only one rake toss was performed per site, due to the canal width; this has been a standard practice since the beginning of these surveys.

Fifteen submersed aquatic macrophytes, including benthic filamentous algae, were collected during the July 2014 survey at Lake Waccabuc. As in 2013, three invasive species were observed: Eurasian water milfoil, curly-leaf pondweed, and brittle naiad. Brazilian elodea was not collected during the 2014 survey, this is the fourth consecutive year that the plant was not noted in the basin. The remaining 12 aquatic macrophytes consisted of a mix of native species, although some of these species, such as coontail or common waterweed, can reach nuisance densities and negatively impact lake uses. Nuisance density is considered medium or dense level plant growth.

Submersed macrophytes were collected at 103 (or 86%) of the survey sites in 2014, down from 107 sites in 2013. Nuisance level vegetation was observed at 18 of the sites (or 18%) surveyed, 15 sites supported medium abundance and 3 sites

Figure 1: Dense abundance plant growth - East Inlet cove - Lake Waccabuc - 2014

supported dense abundance (Fig 1). At 51 sites (50%) trace abundance of vegetative growth was supported and 34 sites (33%) supported sparse abundance. The 2014 data show that the general distribution of aquatic plant growth was similar to what was collected in 2013. A slight decrease in dense level abundance, 6% in 2013 to 3% in 2014, was offset by a slight increase in medium level abundance, 11% in 2013 to 15% in 2014. Trace and sparse abundance stayed essentially the same from 2013 to 2014.

Due to the basin morphology, submersed macrophytes at Lake Waccabuc are limited to the shorelines, including around the island, in the North Cove, in the Outlet Cove, and the East Inlet end of the lake. The highest abundance locations continue to be the East Inlet end (with eight medium sites and two dense sites), and the North Cove (two medium sites and one dense site). The North Cove abundance continues to rebound since the suction harvested project conducted in 2009, with at least sparse growth along much of the southern shoreline sites and increased abundance at the interior of the cove. Sample site richness continues to increase in this cove, especially along the eastern shoreline (richness seven to ten species per site). Seven of the sites in this cove contained at least six different species and five had eight or more. A stretch of the North shore (sites 80, 81, and 88 to 91) was devoid of submersed plants due to the rocky bottom and steep slopes of the littoral zone. That said, submersed macrophytes typically occur at between 80% and 90% of the sampling sites since data collection began in 2008.

Numerous factors can influence the submersed macrophyte abundance and distribution in a lake community. The presence of aggressive invasive species, such as Eurasian water milfoil which continues to dominate the population at Lake Waccabuc, can cause a decrease in the number and abundance of native species. Aquatic macrophyte control projects, such as hand pulling by local residents or the suction harvesting (which occurred in 2009) can impact the submersed aquatic community as well. Basin morphology plays a defining role in determining the suitability for submersed macrophytes to inhabit certain locations throughout the basin. Shallow coves with nutrient rich bottom sediments are choked with vegetation, whereas stretches of steep littoral zone shorelines and the presence of large boulders, rocks and cobble limit submersed macrophyte establishment. Not only do these large rocks create unsuitable bottom substrate for all but the hardiest species, they make traditional weed anchor sampling difficult as the anchors become “hung up” often, preventing a full 10 meter drag. Water clarity also defines the littoral zone of a basin. If sunlight can’t reach the bottom of the lake (due to turbidity possibly influenced by unicellular phytoplankton blooms), submersed macrophytes have a difficult time becoming established. The water clarity on the date of the survey was measured at 8.5 feet, a significant increase from the clarity observed during the 2013 survey (4.5 feet). Increased water clarity, while helping to extend the littoral zone and expand the available suitable submersed aquatic macrophyte habitat, also allows better visual observations to be noted during the survey. This helps to give a better overall picture of the plant community within the basin as observations can be made between official sampling points. Finally, seasonal weather patterns (rainfall, ambient regional air temperatures, prevailing winds, storm events, winter ice cover) all play a role in the complex ecological function of a lake system. Temperatures in the South Salem area in the 2013/2014 winter were cooler than average causing extended periods of ice cover and accounting for increased snow pack. Low temperatures and high snow precipitation and accumulation on iced areas can impact early season growth of algae and some aquatic plant species. A decrease in precipitation quantities in early spring and through most of the summer likely resulted in a decrease of runoff and nutrient inputs into the lake system.

Richness data, included on a map in the Appendix of this report, ranged from zero to 12 different macrophyte species per site at Lake Waccabuc this year. The average richness for the 2014 season was calculated at 4.18. This was an increase of 0.21 species per site compared to the 2013 data set. The highest richness values continue to occur in the East Inlet area and the North cove, 6 to 12 and 5 to 12 respectively.

The dominant submersed macrophyte at Lake Waccabuc continues to be the invasive Eurasian water milfoil. Eurasian water milfoil has been the dominant species in the basin on all six sampling dates. In 2014 it was collected at 97 sites (81%), one more than in 2013. The overall density of plants has decreased slightly even though it continues to expand its range within the basin. Trace abundance was supported at 71 sites surveyed (73%) in 2014 compared to 57 (59%) in 2013, a significant increase. Sparse sites decreased from 2013 to 2014 with only 22 sites (23%) supporting sparse abundance in 2014 compared to 33 (34%) in 2013. Finally, 4 sites (4%) supported medium growth in 2014, a decrease compared to 6 sites in 2013. The decreased plant growth density in 2014 could be a result of the cool early season conditions and extended ice cover over the winter months. Though the growth density was overall lower, this invasive continues to spread its range and should be closely monitored. Observational notations during the survey indicate growth of Eurasian water milfoil between many of the sampling locations including a medium patch between sample points W30 and W31 and trace patches between W47 and W48 and W74 and W75.

Benthic filamentous algae was observed at 67 sites (56%) during the 2014 survey. This is a slight increase, two percent, compared to 2013. Trace abundance was observed at 47 sites (70%), while 13 sites (19%) supported sparse abundance. Nuisance level abundance was observed at 7 sites (10%), all of which supported medium abundance. The distribution of benthic algae remained similar to past years with the nuisance growth being concentrated in the East Inlet area (6 sites). The remaining medium density site was located in the north cove. No benthic algae were observed in the four canal sites.

Coontail was observed at a total of 46 sites (38%) which is a slight increase when compared to the 2013 data (43 sites/36%). Six sites, all located in the East Inlet area, contained nuisance level abundance, 4 sites (9%) supported medium abundance and 2 sites (4%) supported dense abundance. Trace abundance was supported at 36 sties (78%) while 4 sites (9%) supported sparse abundance. No coontail was observed around the island or along the central northern shoreline in 2014. However, three new sites were noted, one along the western portion of the south shoreline and two in the western end of the basin. Also, abundance increased overall in the southern cove area with three sites in the cove and one to either side, all supporting trace abundance.

Bassweed abundance decreased overall by 2% from 2013 to 2014. Bassweed was observed at a total of 41 sites (34%) in 2014. Trace abundance was supported at 29 sites (71%) while sparse abundance was noted at 8 sites (20%). Medium abundance was observed at 3 sites (7%) and one site supported dense abundance. Bassweed continues to be concentrated in the East Inlet cove and the North cove with scattered patches throughout the rest of the basin. The dense level growth was observed centrally in the east Inlet with medium level growth in the immediate surrounding area. Sites in the North cove supported trace and sparse abundance growth.

Robbin's pondweed, a desirable native macrophyte, had a significant increase in overall, 7%, compared to the 2013 season. According to our data, this native has been decreasing since its peak in 2011 of 20% total abundance. In 2014 total abundance for Robbin's pondweed was 17% or 20 of the surveyed sites, though this is still slightly lower than the 2011 abundance, the increase is encouraging. All sites supported trace abundance growth levels and the highest concentration continues to be in the East Inlet area. However, two new sites of note were observed, one adjacent to the swimming area and one in the North cove.

Water stargrass was observed at 19 sites (16%) during the 2014 survey. This is an increase of 3% compared to the 2013 data. All sites supported trace density growth. Water startgrass continues to be scattered throughout the basin with the highest concentrations in the North and South coves. Water stargrass was also observed near site W119.

Common waterweed was observed at 18 sites (15%) of the surveyed sites in 2014. This is an increase of 4% from 2013. Of the 18 sites where it was observed, 17 sites supported trace density and the remaining site, located in the North cove, supported medium growth. The distribution of common waterweed continues to be concentrated in the North cove and the East Inlet, but the density is increasing in both areas. In New York State, there continues to be concerns distinguishing common waterweed and slender waterweed (*E. nuttallii*) to the point that some scientists prefer to lump them all as *Elodea* sp. (personal communication, Robert Johnson, Cornell University, 2010). The samples collected in 2014 did not possess characteristics to differentiate these two species, so for the purposes of this report, the common waterweed collected at Lake Waccabuc shall continue to be considered *E. canadensis*. However, all common waterweed samples were closely examined in the field to confirm they were not Hydrilla (*Hydrilla verticillata*), which has recently been confirmed in upstate New York, or Brazilian elodea (Egeria densa) which was previously observed at Lake Waccabuc in 2008 and 2010. *Neither Hydrilla nor Brazillian elodea were observed in 2014.*

Arrowhead is a common native emergent macrophyte that occurs along the shoreline or shallow water of most lakes that also produces a submersed rosette form (leaves arranged in a radiating pattern at the base of a plant). The rosette is sometimes collected during weed anchor toss surveys, but due to its morphology and ability to hold fast into the sediment, it's often underestimated during Point Intercept surveys. Often it is merely observed during sampling, due to these characteristics. Arrowhead rosettes were collected at 16 sites (13%) in 2014, and increase of 1% over 2013. Of the sites observed 15 supported trace density while the remaining site, located in the mid-northeast cove, supported sparse density. The distribution was similar to the 2013 survey results with one additional site located in the North cove area.

As in 2013, in 2014 a thin-leaved pondweed was collected that was unable to be identified due to a lack of seed or reproductive structures. For the purposes of this report, this thin-leaved pondweed (henceforth referred to as pondweed sp.) will be compared to the spiral fruited pondweed observations of 2013. Since spiral-fruited pondweed has been confirmed in the past in this basin, this is the likely species but it is possible that some of these samples are actually leafy pondweed, or perhaps even another native thin-leaved pondweed (such as small pondweed, *P. pusillus*, or thread-leaf pondweed, *P. diversifolius*). In the future, if seeds and/or other distinguishing characteristics can be confirmed in the field (possibly through volunteer-collected samples), we can get a better understanding on the classification of thin-leaved pondweeds in this basin. Pondweed sp. was observed at 14 sites (12%) during the 2014 survey. Trace density was observed at 13 sites and the remaining site supported sparse density. The distribution of this pondweed is similar to the distribution seen in 2013 (under spiral-fruited pondweed).

Creeping bladderwort abundance decreased in 2014 when compared with the data from 2013, 6 sites (5%) and 9 sites (8%) respectively. Five sites were considered trace density with the remaining site supporting sparse density. All six sites were located in the East inlet area. No observations were made in the North cove area, as were in 2013, it is possible that creeping bladderwort was still present in this area but not retrieved on a rake toss or that it is being outcompeted but the more robust broad leafed macrophytes such as common waterweed.

Ribbon-leaf pondweed was observed at 5 sample sites (4%) in 2014, a slight increase over the 2013 data, 3 sites (3%). The distribution remains limited to the Inlet canal and East inlet area. No observations were made in the North cove this year. Of the five sites four supported trace abundance and one, at the mouth of the canal, supported sparse abundance.

Dwarf water milfoil was collected at 4 sites (3%) during the 2014 survey. Dwarf water milfoil continues to be concentrated in two areas within the basin. Trace density was observed at three sites, in the mid-Northeast cove and sparse density was observed along the northern shoreline near the west end of the basin. In 2013 the west end area seemed less vigorous than that in previous seasons, but has rebounded in 2014.

Leafy-pondweed, also collected at 4 sites (3%) in 2014 was concentrated along the southern shore of the eastern end of the basin and in one spot in the North cove. All occurrences supported trace density. This is a shift in population compared to 2013 when leafy pondweed, though still observed at four sites, had scattered distribution with no observances in the east end of the basin.

Brittle naiad was again observed at Lake Waccabuc in 2014, this is the second consecutive year (the fourth year in total) that this invasive species was observed. In 2014 brittle naiad was observed at only two sample locations (2%) compared to three in 2013. Both sites supported only trace density growth. One site was located in the mid-northeast cove and the other site was located in the southern cove. The distribution remains similar to that observed in 2013.

The final submersed macrophyte observed at Lake Waccabuc in 2014 was curly-leaf pondweed. This pondweed was observed at only one site, located near the mouth of the canal at trace density. However, it should be noted that this species has an early season growth pattern and commonly dies back as warmer water temperatures accompanied by summer weather set in. Due to these conditions, and the timing of our survey, it is unlikely that this is a true representation of the curly leaf pondweed population at Lake Waccabuc.

In 2014, five macrophytes made up the floating macrophyte community, including floating filamentous algae and one new species, the invasive water chestnut. Floating macrophytes were observed at 72 (60%) of the 120 sites surveyed at Lake Waccabuc. This was an increase of 12% over the data from 2013 and is the highest distribution of floating macrophytes recorded during a survey by Allied Biological. However, though floating macrophytes were observed at more sites in 2014, the overall density at those sites was lower than in 2013, more closely resembling the densities seen during the 2011 survey. Trace and sparse abundance was supported at a total of 61 sites (85%), with 34 sites (47%) supporting trace abundance and 27 sites (38%) supporting sparse abundance. A total of 11 sites (15%) were considered to support nuisance level density, 10 sites supported medium abundance and one site supported dense abundance. This is a decrease compared to 2013 when 14 sites supported nuisance level abundance, eight medium and 6 dense. The highest floating densities continued to be observed in the East Inlet area, with 6 medium sites and one dense site. The North cove supported three of the remaining four medium sites and the final medium site was located in the Southern cove. The West end of the lake supported only trace and sparse density floating macrophytes.

The dominant floating macrophyte at Lake Waccabuc in 2014 continues to be white water lily. White water lilies have been slowly increasing in the basin since the initial survey in 2008. In 2012 it became the dominant floating macrophyte in the basin and has continued to slowly increase in abundance. White water lilies were observed at 52 sites (43%) in 2014 up 3% from the 2013 data. The majority of the sites supported trace to sparse abundance, 39 sites (75%) and 9 sites (17%) respectively. Four sites (8%) were considered to support nuisance level abundance, three sites (6%) at medium abundance and one site (1%) at dense abundance. While white water lilies were distributed throughout the littoral zone of the basin, the highest concentrations were located in the North cove, with two sites supporting medium density, three supporting sparse density and two supporting trace density, and the East Inlet are with the remaining medium site and the single dense site, as well as 8 sites supporting trace density and three supporting sparse density.

In 2014, watershield abundance increased by 4% from the 2013 level. Watersheild was observed at 38 sites (32%) in 2014. More than half (22 sites/58%) of the sites observed supported trace density, while sparse density was supported at 14 sites (37%). The remaining two sites supported medium abundance and no sample sites supported dense abundance of watershield. Distribution was similar to that in 2013, with the most occurrences in the southern half of the East Inlet area, in the Southern cove and along the shoreline at the western and of the basin.

Floating filamentous algae was again observed at 25 sites (21%) in 2014, as in 2013. Abundance shifted slightly, with more sites supporting trace abundance, 17 sites (68%) in 2014 compared to 14 sites (56%) in 2013. Only 6 sites (24%) supported sparse abundance in 2014 compared to 10 sites in 2013. Medium density was observed at 2 sites in 2014 (no medium sites were observed in 2013) and no dense sites were observed. The distribution was similar to that seen in 2013 with most observances being mixed with surface level submersed macrophytes or floating macrophytes. In the North cove, the filamentous algae was observed in mats close to the shoreline.

Spatterdock was observed at 20 sample sites (17%) in 2014, a slight decrease (1%) from 2013. Trace abundance was observed at 13 sites (65%) while sparse abundance was observed at four sites (20%). This is a slight increase in density from the 2013 data which saw 16 trace sites and only 2 sparse sites. However, the nuisance level abundance shifted towards medium abundance, with 3 sites supporting medium abundance and no dense abundance observed in 2014 compared to 1 medium sites and three dense sites in 2013. Spatterdock distribution was similar to that seen in 2013 with the highest concentrations occurring in the East Inlet and the Southern cove. One new site was noted in the West end of the basin.

Great and small duckweeds were both observed again in 2014. Great duckweed was observed in the same to locations in the North cove. Small duckweed was observed at 7 sample points (6%). It was observed in the two North cove locations, in the canal at two sample points, and on either shoreline of the east end of the basin. The last location was in the western end of the basin along the northern shoreline. Duckweeds are free floating plants and are easily distributed by both wind and water current. It should also be noted that both duckweeds and watermeal were observed at the launch site in the eastern end of the basin on the northern side.

The last floating macrophyte observed was water chestnut. This was the first observation of this macrophyte in Lake Waccabuc though it is known to be in other waterbodies in the region. Water chestnut was found at one site (four rosettes), W19 in the East Inlet area, and was hand pulled (with roots) by Allied Biological biologists. Possible modes of introduction could include waterfowl, boating or flow from an upstream source. This aggressive invasive can be overlooked in the early stages of infestation if it is mixed with other, native, floating leaf macrophytes as seen to the right. The best strategy for controlling early infestations is hand pulling. Hand pulling should be done early in the season prior to the formation of the nut/fruit that forms under the leaf cluster. These nuts fall into the sediment and can produce 10-15 new rosettes each and they have been known to stay viable in the sediment for as long as 12 years. Educating the residents to monitor the area for this invasive species can help to identify and remove rosettes as early as possible helping to contain the spread and control the invasion.

We again accessed the lake at the East Inlet end of the basin, adjacent to sampling point W26. The cove continues to support a dense growth of macrophytes including both duckweed species and watermeal as mentioned above. Filamentous algae was also noted in this area.

Emergent species were also observed during the 2014 survey throughout the basin. Pickerelweed (*Pontedaria cordata*) was the most common, emergent observed with eight locations noted: W4, W9, W66, W68 – W71, W103, and W109. A moderate stand of cattails (*Typha sp.*) were again noted between sites W41 and W42.

Summary of Findings and 2015 Recommendations

On July 22, 2014, a Point Intercept aquatic macrophyte survey was performed at Lake Waccabuc. A total of 120 GPS referenced sites were surveyed, covering the littoral zone of the main basin and canal. For ease of comparison the procedures established in 2011, three rake tosses per survey site, were used to complete the 2014 survey. The following is a summary of the finding of the 2014 survey.

- The primary goal of the 2014 survey was to identify any established patches of the invasive macrophyte, Brazillain elodea. For the fourth consecutive year, no observations were made of this macrophyte.
- Water clarity improved again this year and was estimated at 8.5 feet during the survey. This likely aided in visual observations of submersed macrophytes in the shallow water areas.
- Eurasian water milfoil continues to be the dominant submersed macrophyte in the basin. It increased slightly in range diversity (1%) though the overall density of plant growth decreased form 2013.
- Macrophyte abundance remains within the normal seasonal variance range with most macrophytes +/- 4% compared with 2013. The exceptions were Spiral-fruited pondweed (-11%/no confirmed sites) unless pondweed sp. is used for this data, then it is a +1% increase, which falls within the normal range, and Robbin's pondweed (+7%).
- Three invasive submersed macrophytes were again collected in 2014: Eurasian water milfoil, Brittle naiad, and Curly-leaf pondweed.
- White water lily continues to be the dominant floating macrophyte throughout the basin. Both white water lily and watersheild (the second most abundant) increased in abundance in 2014.
- The invasive Water chestnut was observed for the first time at Lake Waccabuc. Four small specimens were observed and it was hand pulled at the time of the survey.

The continued absence of Brazillian elodea at Lake Waccabuc strengthens the position that this aggressive species has been eradicated from the basin. The efforts and continued vigilance of the 3LC volunteers and their program to monitor the situation should be applauded. Continued monitoring for the presence of Brazillian elodea in Lake Waccabuc and the connecting basins, Lake Oscaleta and Lake Rippowam, should be encouraged in 2015. The latter two basins have not been surveyed in several years.

A new invasive species, water chestnut, was discovered in the East Inlet area of Lake Wacabucc in 2014. Though the four rosettes were hand pulled by Allied Biological biologists at the time of discovery, the area should be closely monitored during the 2015 season. The 3LC should consider posting educational signs at all launces and distributing educational material to residents so that any sightings of water chestnut can be reported and Rapid Response control methods (hand pulling as early as possible) can be put into place to help spread the control of this aggressive growing species. The west end of Lake Osceleta is prime habitat for water chestnut and should be the area of focus for 2015 survey efforts.

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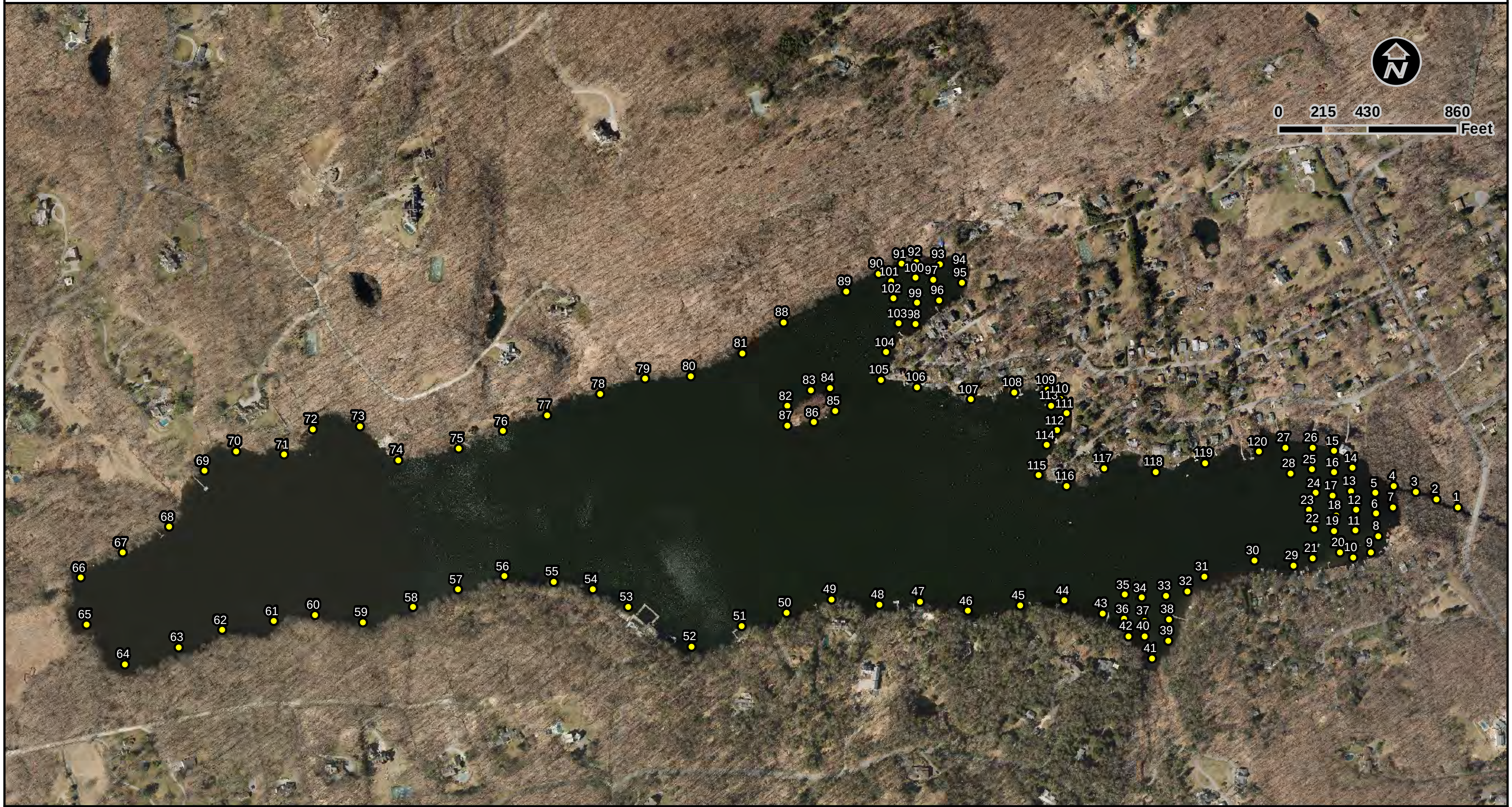
Young, S. M. (editor). 2010. New York Rare Plant Status Lists. New York Natural Heritage Program, Albany, NY. June 2010. 111 pages.

Sample Point Location



Lake Waccabuc and Canal
Aquatic Vegetation Survey
July 22, 2014

Total Sample Sites: 120

Sample Point

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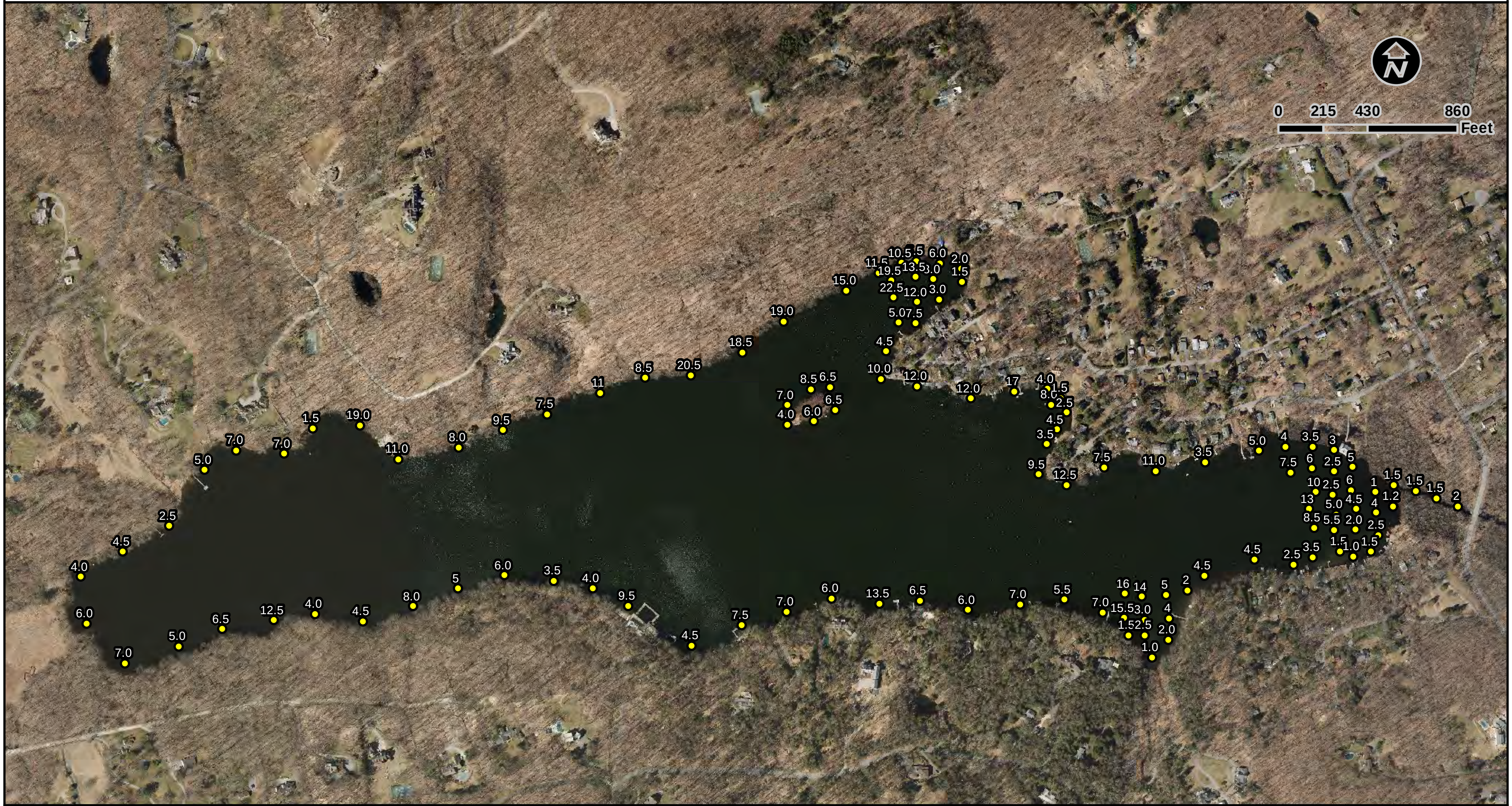
Water Depth Distribution



Lake Waccabuc and Canal
Aquatic Vegetation Survey
July 22, 2014

Total Sample Sites: 120

Water Depth in Feet

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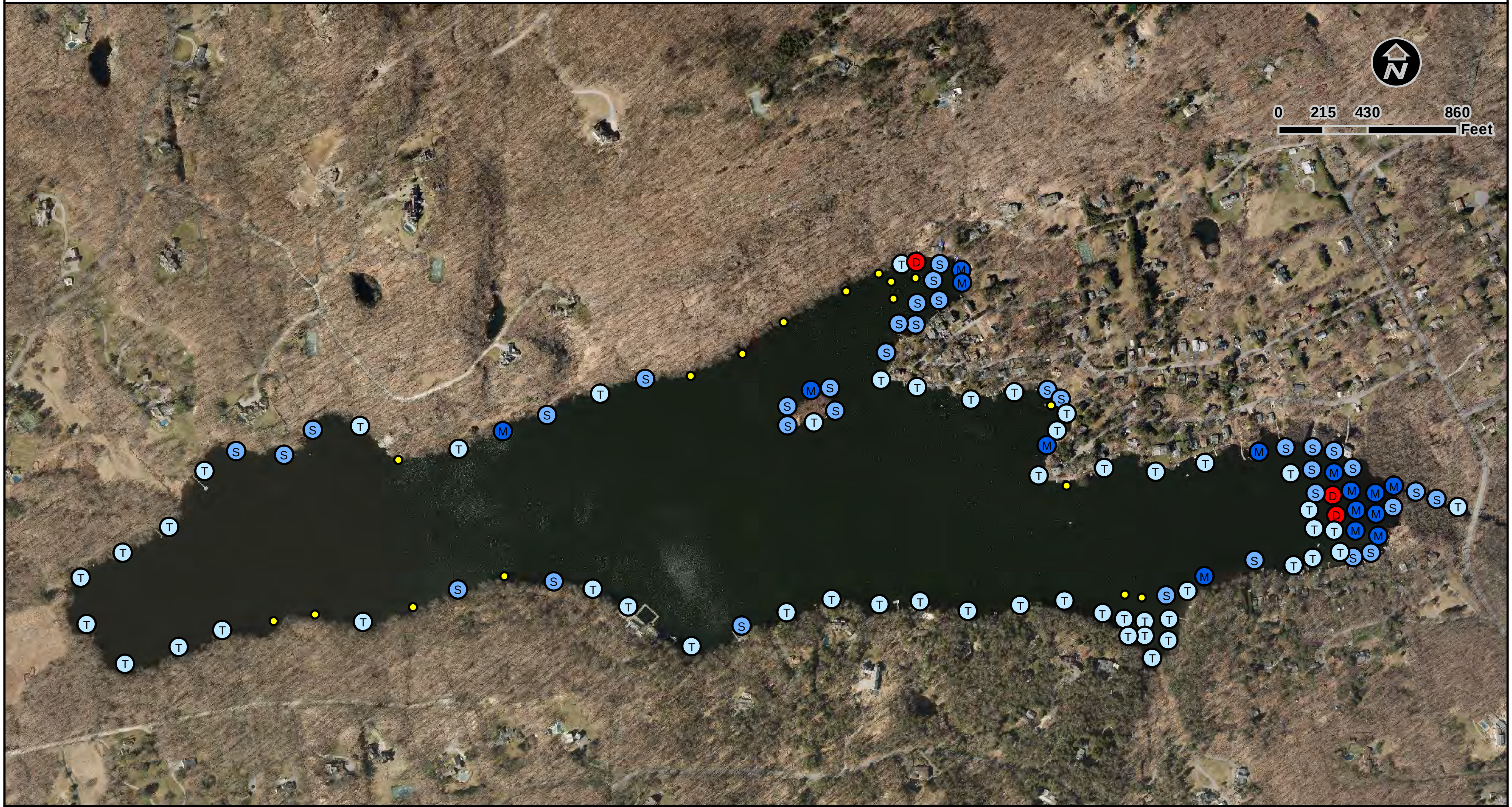
Total Submersed Vegetation Distribution



Lake Waccabuc and Canal
Aquatic Vegetation Survey
July 22, 2014

Total Sample Sites: 120

Plant Density Legend

- = No Plants
- T = Trace Plants
- S = Sparse Plants
- M = Medium Plants
- D = Dense Plants

Percent Distribution

Abundance	Sites	Percentage
Total	103	86%
Trace	51	50%
Sparse	34	33%
Medium	15	15%
Dense	3	3%

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Eurasian Water Milfoil (*Myriophyllum spicatum*) Distribution

Lake Waccabuc and Canal
Aquatic Vegetation Survey
July 22, 2014

Total Sample Sites: 120

Plant Density Legend

- = No Plants
- T = Trace Plants
- S = Sparse Plants
- M = Medium Plants
- D = Dense Plants

Percent Distribution

Abundance	Sites	Percentage
Total	97	81%
Trace	71	73%
Sparse	22	23%
Medium	4	4%
Dense	0	0%

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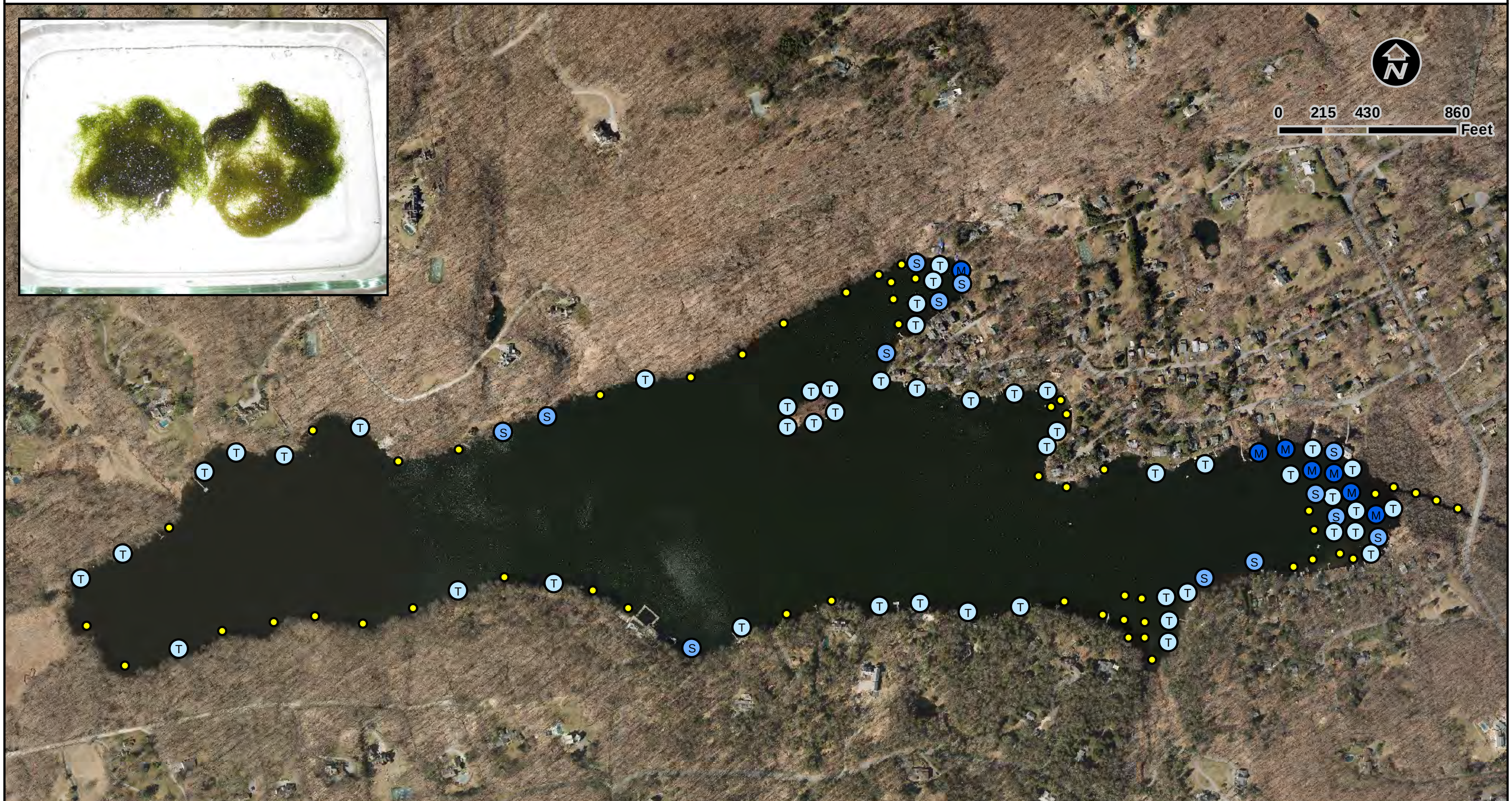
Benthic Filamentous Algae Distribution



Lake Waccabuc and Canal
Aquatic Vegetation Survey
July 22, 2014

Total Sample Sites: 120

Plant Density Legend

- = No Plants
- T = Trace Plants
- S = Sparse Plants
- M = Medium Plants
- D = Dense Plants

Percent Distribution

Abundance	Sites	Percentage
Total	67	56%
Trace	47	70%
Sparse	13	19%
Medium	7	10%
Dense	0	0%

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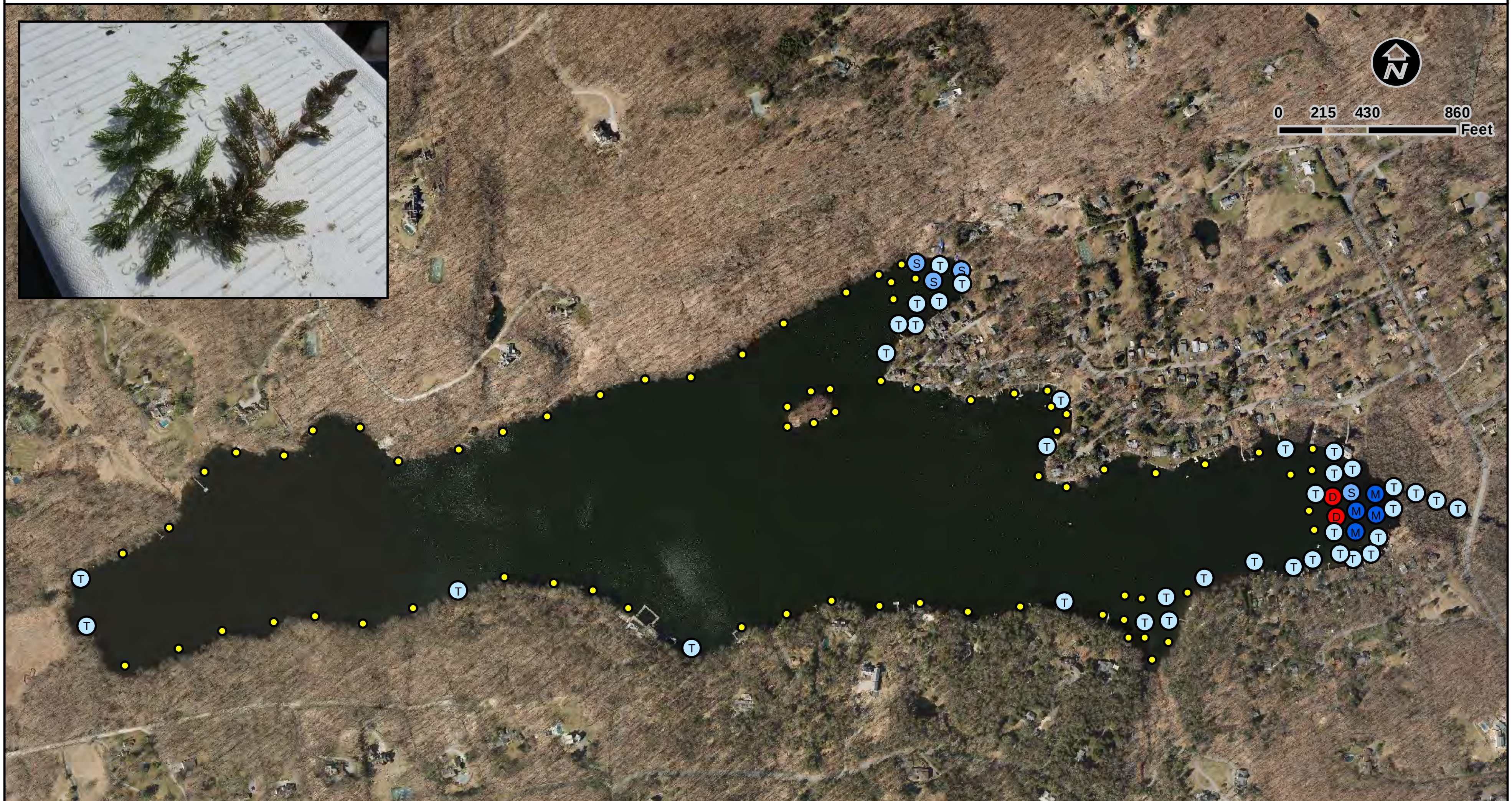
Coontail (*Ceratophyllum demersum*) Distribution



Lake Waccabuc and Canal Aquatic Vegetation Survey July 22, 2014

Total Sample Sites: 120

Plant Density Legend

- = No Plants
- T = Trace Plants
- S = Sparse Plants
- M = Medium Plants
- D = Dense Plants

Percent Distribution

Abundance	Sites	Percentage
Total	46	38%
Trace	36	78%
Sparse	4	9%
Medium	4	9%
Dense	2	4%

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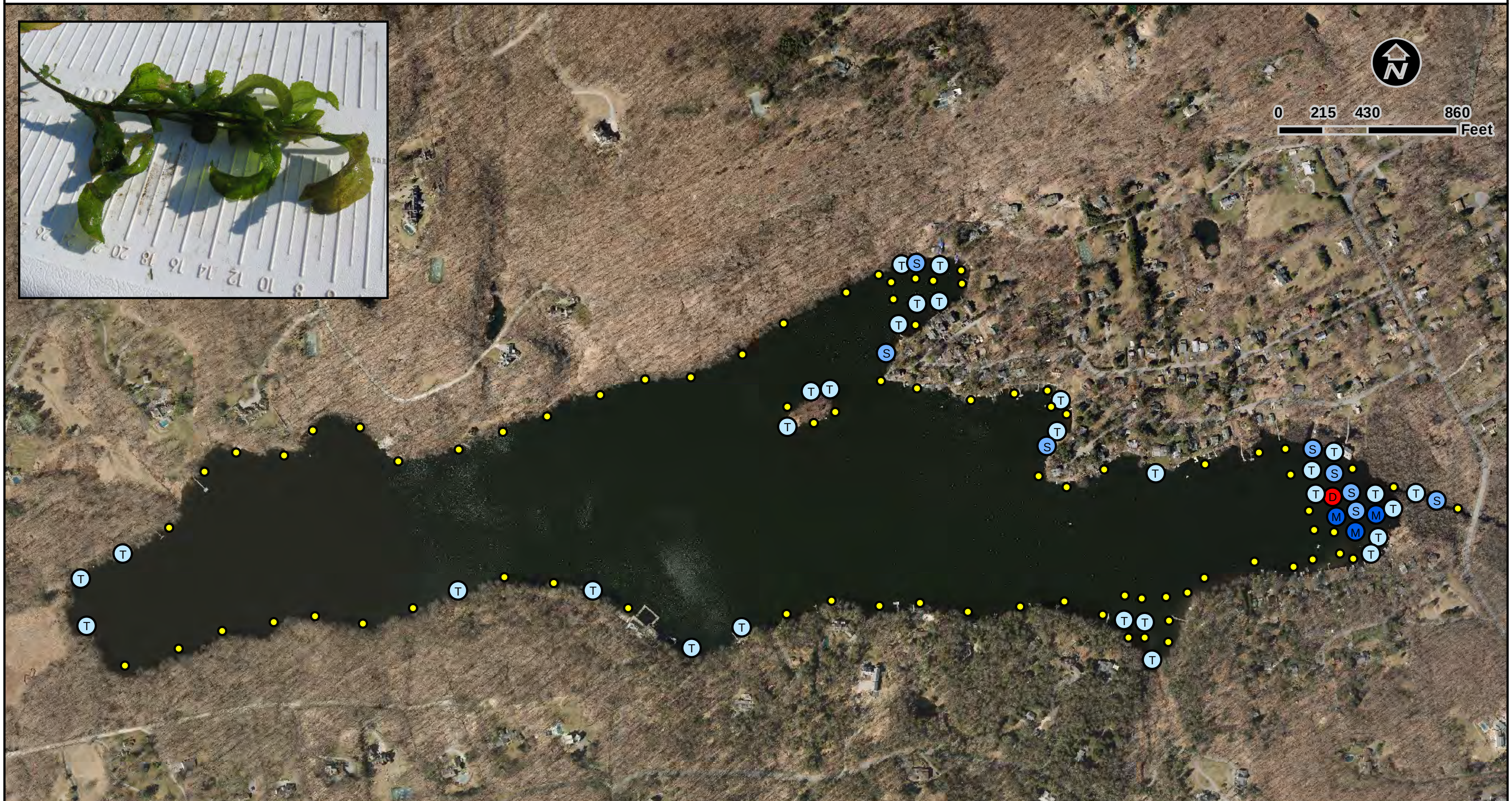
Bass Weed (*Potamogeton amplifolius*) Distribution



Lake Waccabuc and Canal
Aquatic Vegetation Survey
July 22, 2014

Total Sample Sites: 120

Plant Density Legend

- = No Plants
- T = Trace Plants
- S = Sparse Plants
- M = Medium Plants
- D = Dense Plants

Percent Distribution

Abundance	Sites	Percentage
Total	41	34%
Trace	29	71%
Sparse	8	20%
Medium	3	7%
Dense	1	2%

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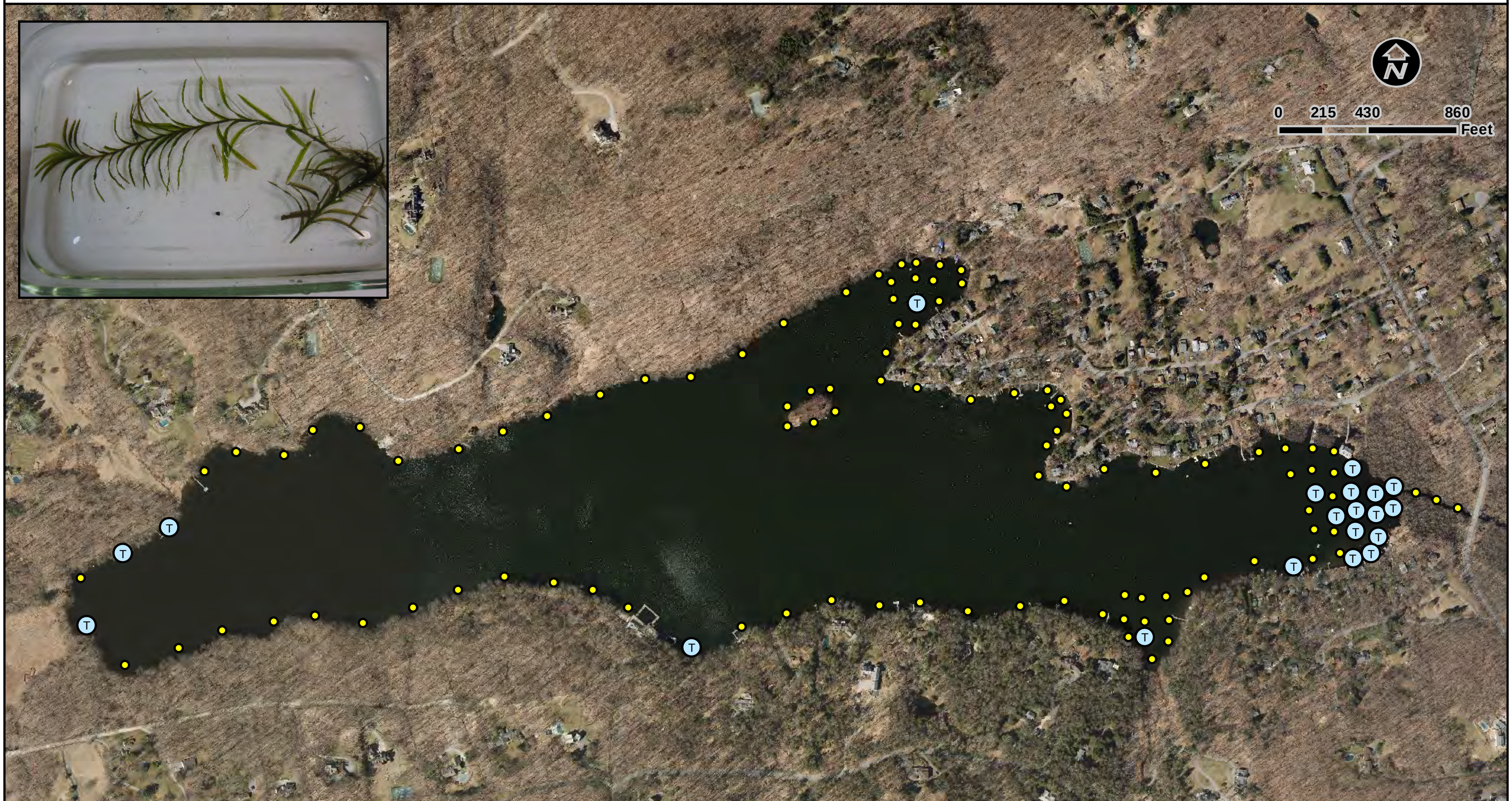
Robbin's Pondweed (*Potamogeton robbinsii*) Distribution



Lake Waccabuc and Canal
Aquatic Vegetation Survey
July 22, 2014

Total Sample Sites: 120

Plant Density Legend

- = No Plants
- T = Trace Plants
- S = Sparse Plants
- M = Medium Plants
- D = Dense Plants

Percent Distribution

Abundance	Sites	Percentage
Total	20	17%
Trace	20	100%
Sparse	0	0%
Medium	0	0%
Dense	0	0%

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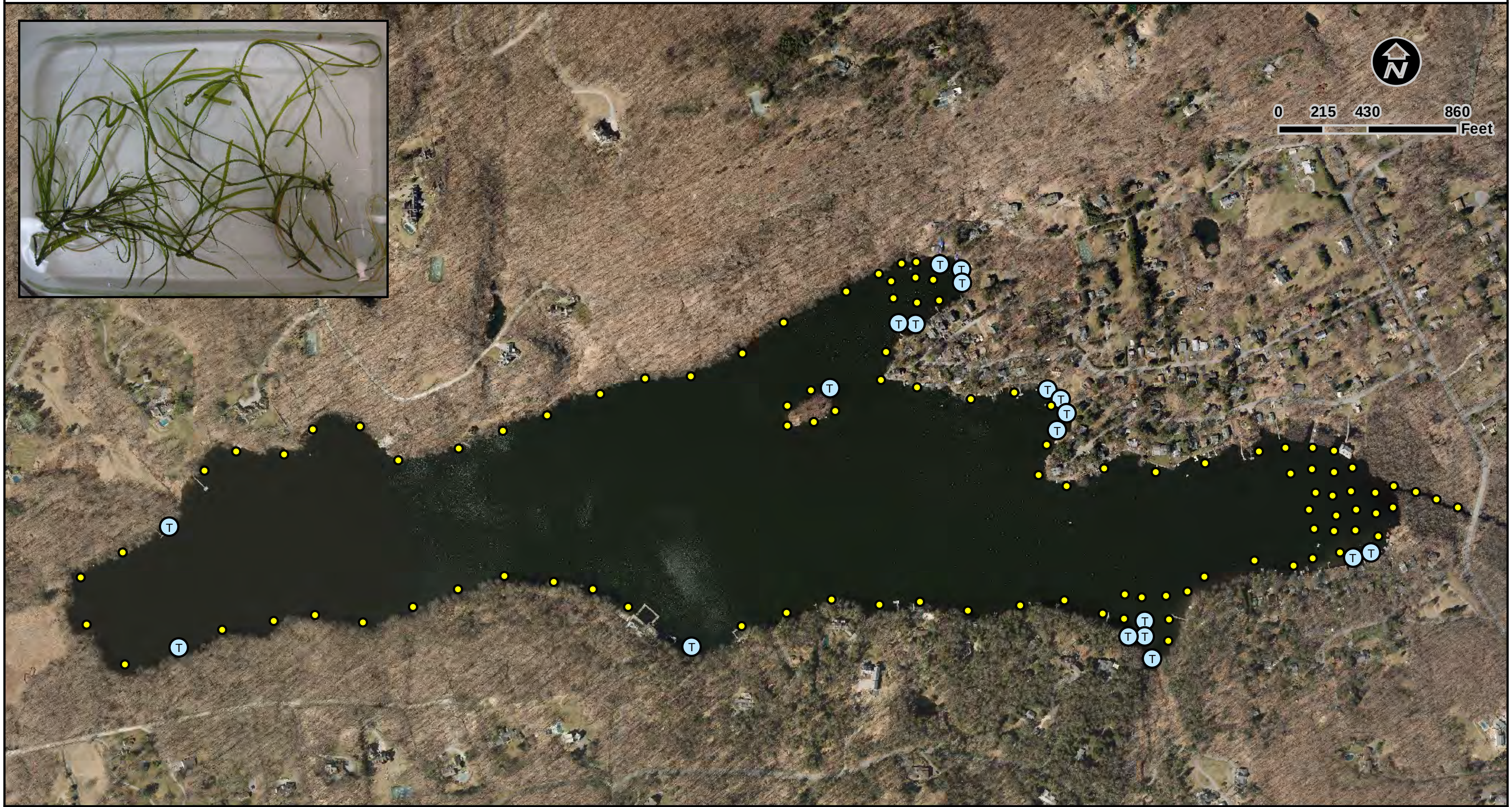
Water Stargrass (*Zosterella dubia*) Distribution



Lake Waccabuc and Canal
Aquatic Vegetation Survey
July 22, 2014

Total Sample Sites: 120

Plant Density Legend

- = No Plants
- T = Trace Plants
- S = Sparse Plants
- M = Medium Plants
- D = Dense Plants

Percent Distribution

Abundance	Sites	Percentage
Total	19	16%
Trace	19	100%
Sparse	0	0%
Medium	0	0%
Dense	0	0%

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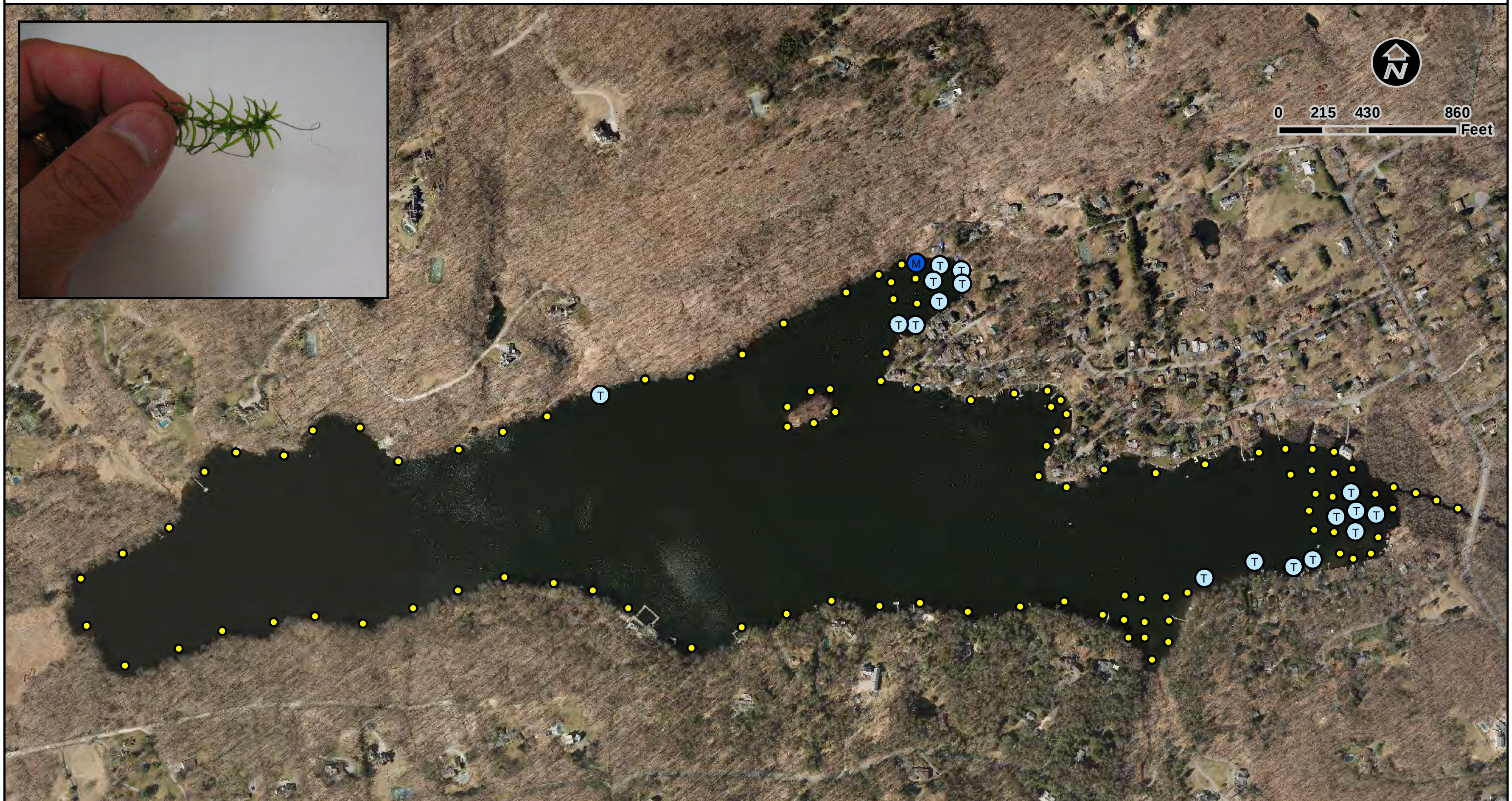
Common Waterweed (*Elodea canadensis*) Distribution



Lake Waccabuc and Canal
Aquatic Vegetation Survey
July 22, 2014

Total Sample Sites: 120

Plant Density Legend

- = No Plants
- T = Trace Plants
- S = Sparse Plants
- M = Medium Plants
- D = Dense Plants

Percent Distribution

Abundance	Sites	Percentage
Total	18	15%
Trace	17	94%
Sparse	0	0%
Medium	1	6%
Dense	0	0%

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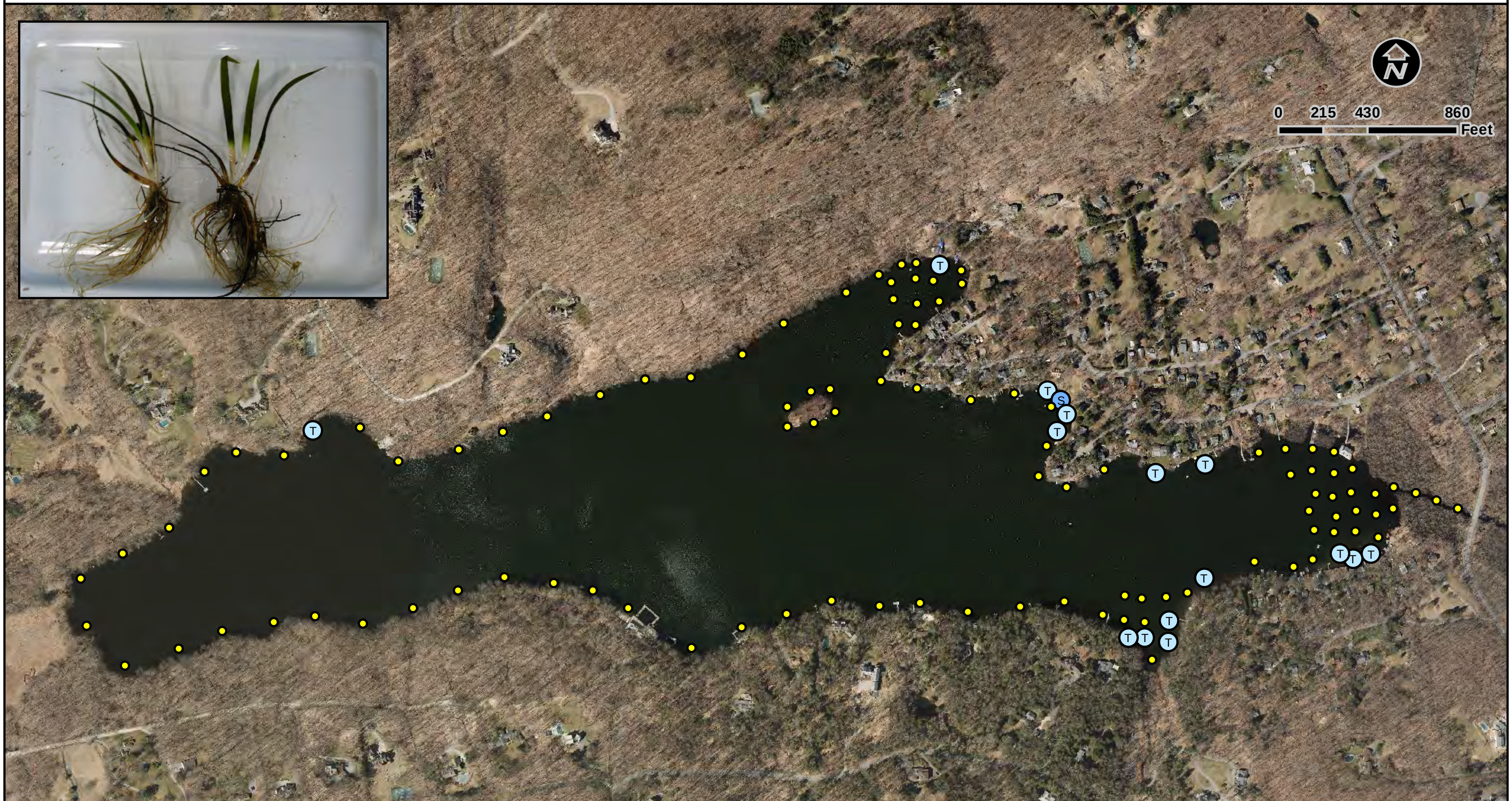
Arrowhead (rosette) (*Sagittaria* sp.) Distribution



Lake Waccabuc and Canal
Aquatic Vegetation Survey
July 22, 2014

Total Sample Sites: 120

Plant Density Legend

- = No Plants
- T = Trace Plants
- S = Sparse Plants
- M = Medium Plants
- D = Dense Plants

Percent Distribution

Abundance	Sites	Percentage
Total	16	13%
Trace	15	94%
Sparse	1	6%
Medium	0	0%
Dense	0	0%

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Pondweed sp. (*Potamogeton* sp.) Distribution

Lake Waccabuc and Canal
Aquatic Vegetation Survey
July 22, 2014

Total Sample Sites: 120

Plant Density Legend

- = No Plants
- T = Trace Plants
- S = Sparse Plants
- M = Medium Plants
- D = Dense Plants

Percent Distribution

Abundance	Sites	Percentage
Total	14	12%
Trace	13	93%
Sparse	1	7%
Medium	0	0%
Dense	0	0%

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Creeping Bladderwort (*Utricularia gibba*) Distribution

Lake Waccabuc and Canal
Aquatic Vegetation Survey
July 22, 2014

Total Sample Sites: 120

Plant Density Legend

- = No Plants
- T = Trace Plants
- S = Sparse Plants
- M = Medium Plants
- D = Dense Plants

Percent Distribution

Abundance	Sites	Percentage
Total	6	5%
Trace	5	83%
Sparse	1	17%
Medium	0	0%
Dense	0	0%

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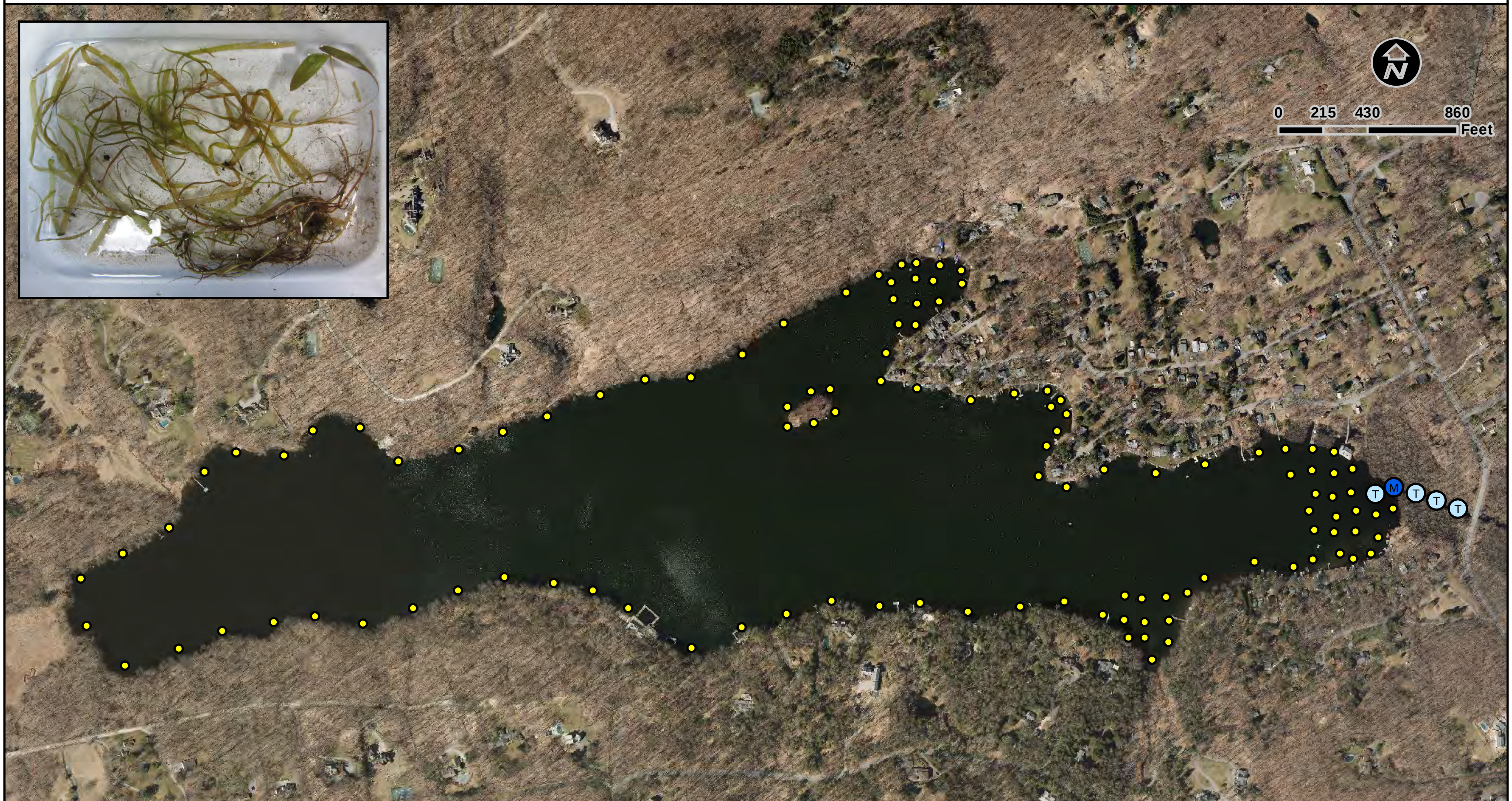
Ribbon-leaf Pondweed (*Potamogeton epihydrus*) Distribution



Lake Waccabuc and Canal
Aquatic Vegetation Survey
July 22, 2014

Total Sample Sites: 120

Plant Density Legend

- = No Plants
- T = Trace Plants
- S = Sparse Plants
- M = Medium Plants
- D = Dense Plants

Percent Distribution

Abundance	Sites	Percentage
Total	5	4%
Trace	4	80%
Sparse	0	0%
Medium	1	20%
Dense	0	0%

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Dwarf Water Milfoil (*Myriophyllum tenellum*) Distribution

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Total Sample Sites: 120

Plant Density Legend

- = No Plants
- T = Trace Plants
- S = Sparse Plants
- M = Medium Plants
- D = Dense Plants

Percent Distribution

Abundance	Sites	Percentage
Total	4	3%
Trace	3	75%
Sparse	1	25%
Medium	0	0%
Dense	0	0%

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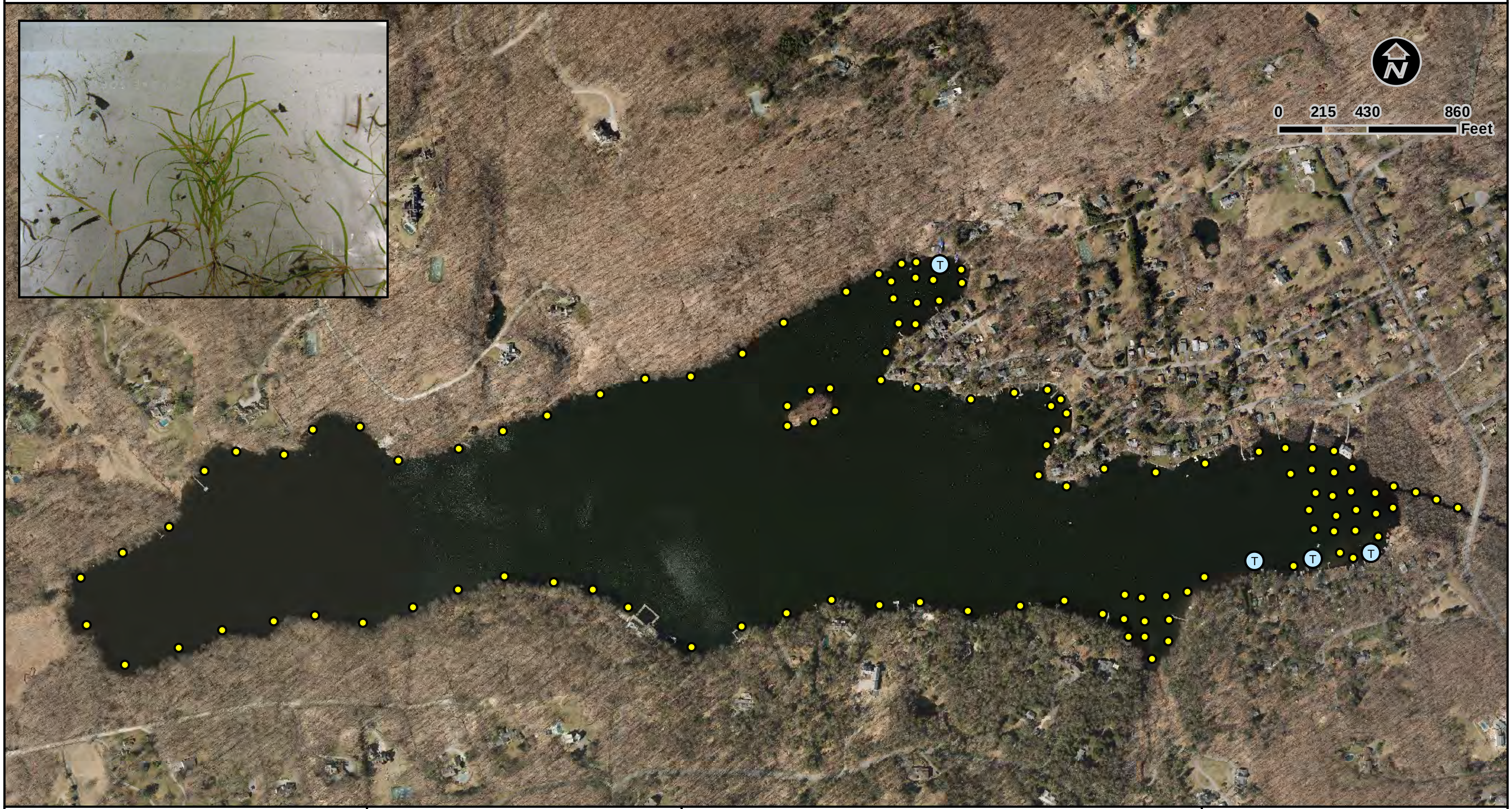
Leafy Pondweed (*Potamogeton foliosus*) Distribution



Lake Waccabuc and Canal
Aquatic Vegetation Survey
July 22, 2014

Total Sample Sites: 120

Plant Density Legend

- = No Plants
- T = Trace Plants
- S = Sparse Plants
- M = Medium Plants
- D = Dense Plants

Percent Distribution

Abundance	Sites	Percentage
Total	4	3%
Trace	4	100%
Sparse	0	0%
Medium	0	0%
Dense	0	0%

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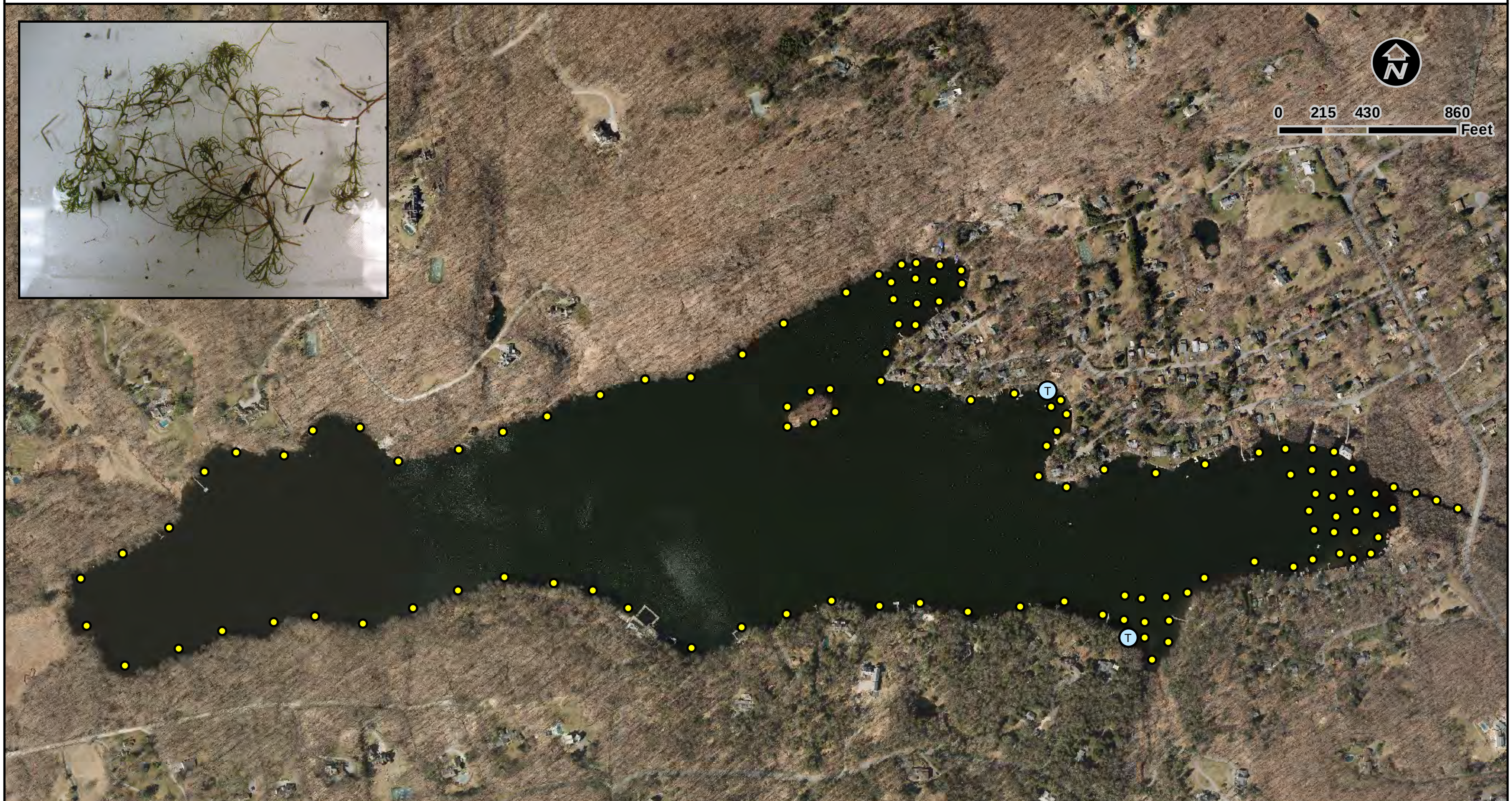
Brittle Naiad (*Najas minor*) Distribution



Lake Waccabuc and Canal
Aquatic Vegetation Survey
July 22, 2014

Total Sample Sites: 120

Plant Density Legend

- = No Plants
- T = Trace Plants
- S = Sparse Plants
- M = Medium Plants
- D = Dense Plants

Percent Distribution

Abundance	Sites	Percentage
Total	2	2%
Trace	2	100%
Sparse	0	0%
Medium	0	0%
Dense	0	0%

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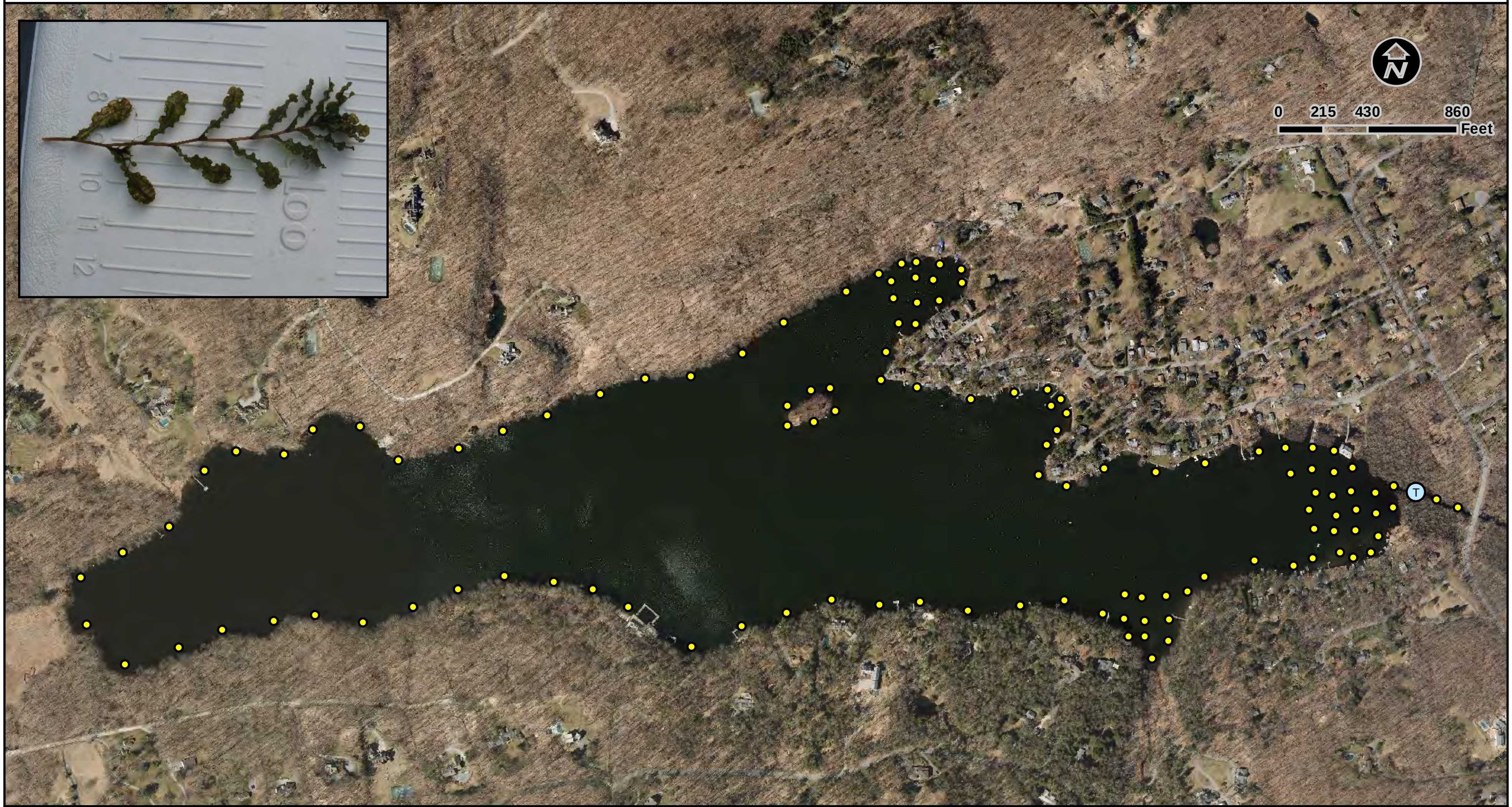
Curly-leaf Pondweed (*Potamogeton crispus*) Distribution



Lake Waccabuc and Canal
Aquatic Vegetation Survey
July 22, 2014

Total Sample Sites: 120

Plant Density Legend

- = No Plants
- T = Trace Plants
- S = Sparse Plants
- M = Medium Plants
- D = Dense Plants

Percent Distribution

Abundance	Sites	Percentage
Total	1	1%
Trace	1	100%
Sparse	0	0%
Medium	0	0%
Dense	0	0%

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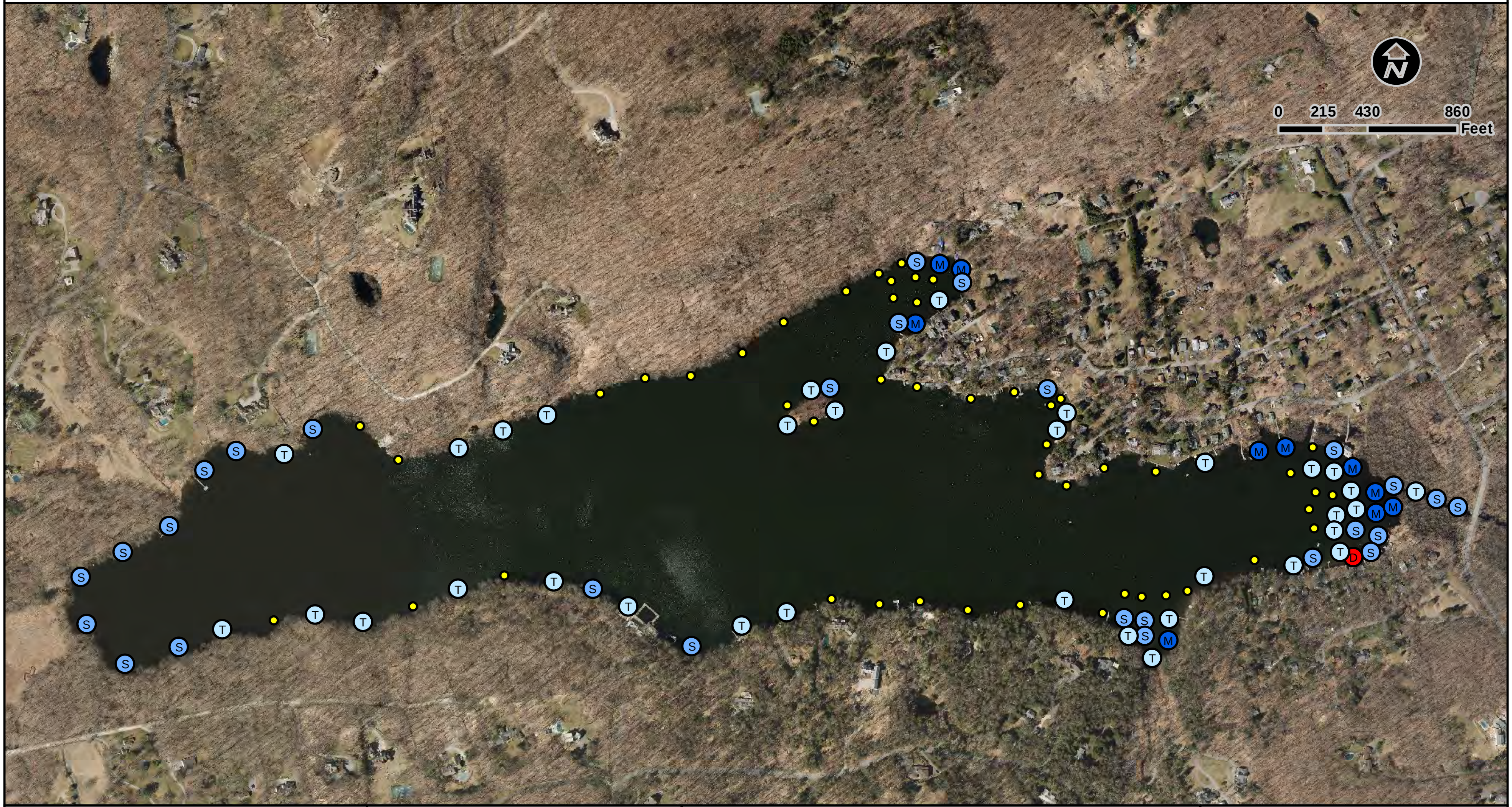
Total Floating Vegetation Distribution



Lake Waccabuc and Canal Aquatic Vegetation Survey July 22, 2014

Total Sample Sites: 120

Plant Density Legend

- = No Plants
- T = Trace Plants
- S = Sparse Plants
- M = Medium Plants
- D = Dense Plants

Percent Distribution

Abundance	Sites	Percentage
Total	72	60%
Trace	34	47%
Sparse	27	38%
Medium	10	14%
Dense	1	1%

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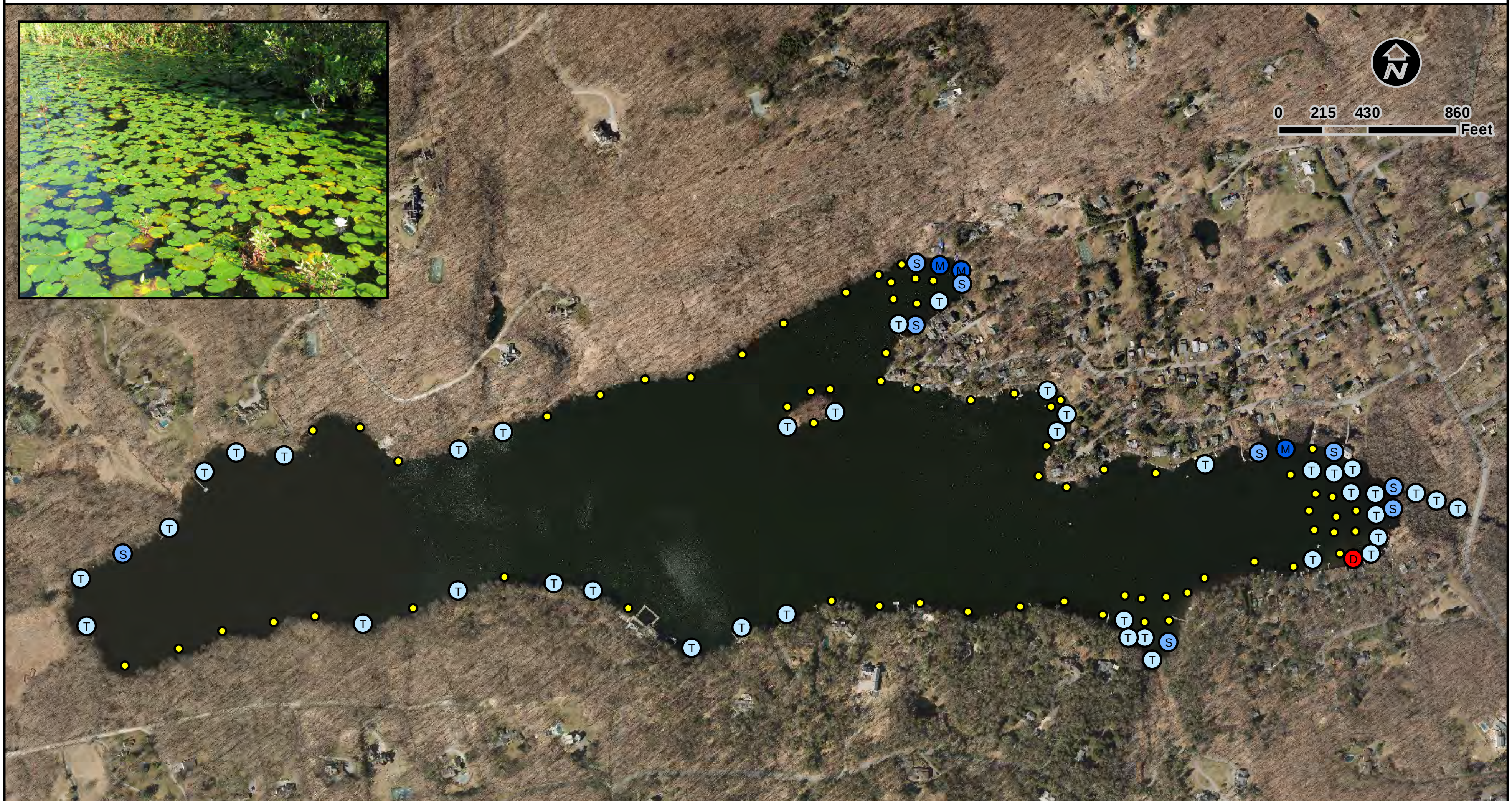
White Water Lily (*Nymphaea odorata*) Distribution



Lake Waccabuc and Canal
Aquatic Vegetation Survey
July 22, 2014

Total Sample Sites: 120

Plant Density Legend

- = No Plants
- T = Trace Plants
- S = Sparse Plants
- M = Medium Plants
- D = Dense Plants

Percent Distribution

Abundance	Sites	Percentage
Total	52	43%
Trace	39	75%
Sparse	9	17%
Medium	3	6%
Dense	1	2%

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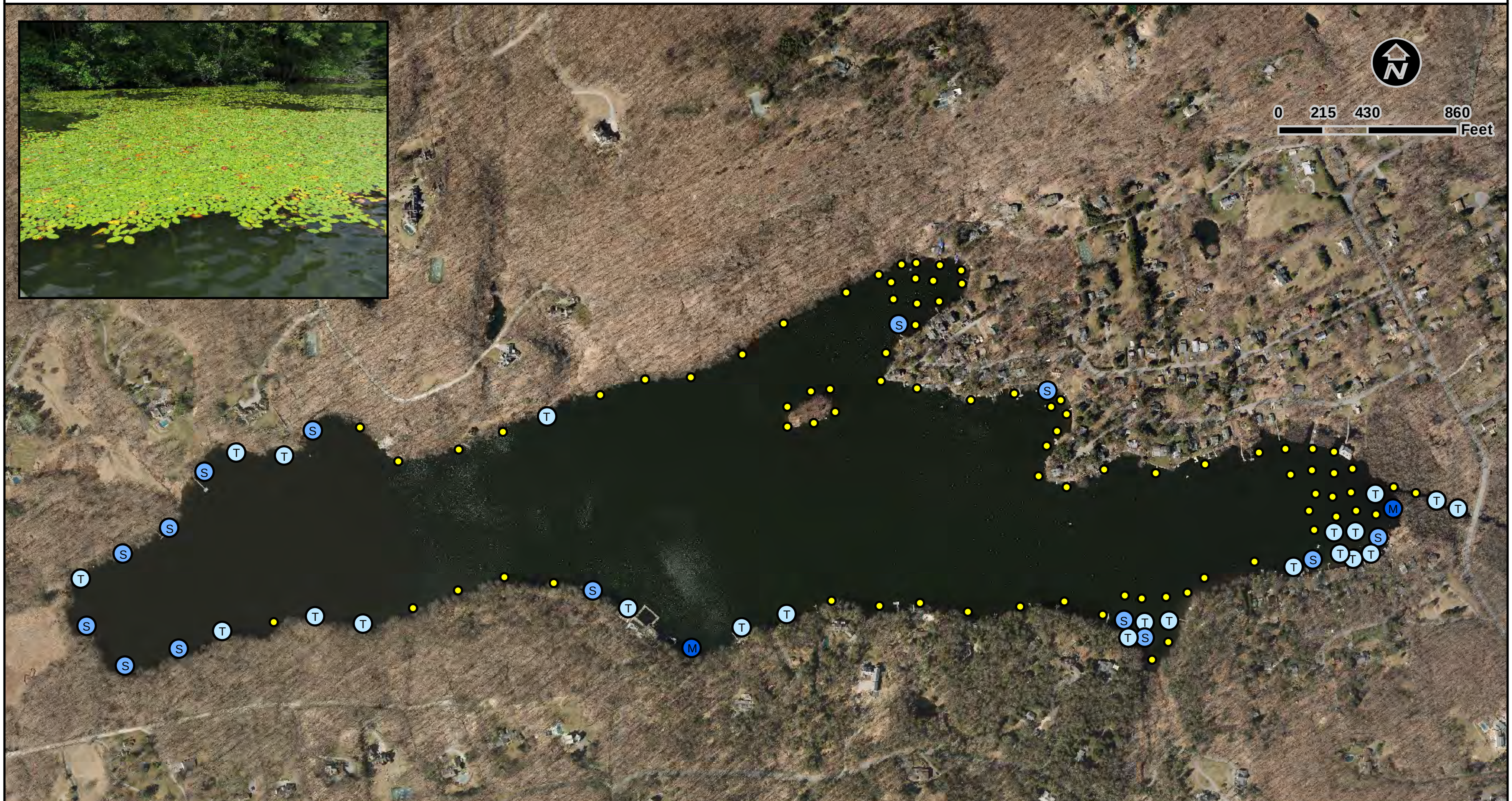
Watershield (*Brasenia schreberi*) Distribution



Lake Waccabuc and Canal
Aquatic Vegetation Survey
July 22, 2014

Total Sample Sites: 120

Plant Density Legend

- = No Plants
- T = Trace Plants
- S = Sparse Plants
- M = Medium Plants
- D = Dense Plants

Percent Distribution

Abundance	Sites	Percentage
Total	38	32%
Trace	22	58%
Sparse	14	37%
Medium	2	5%
Dense	0	0%

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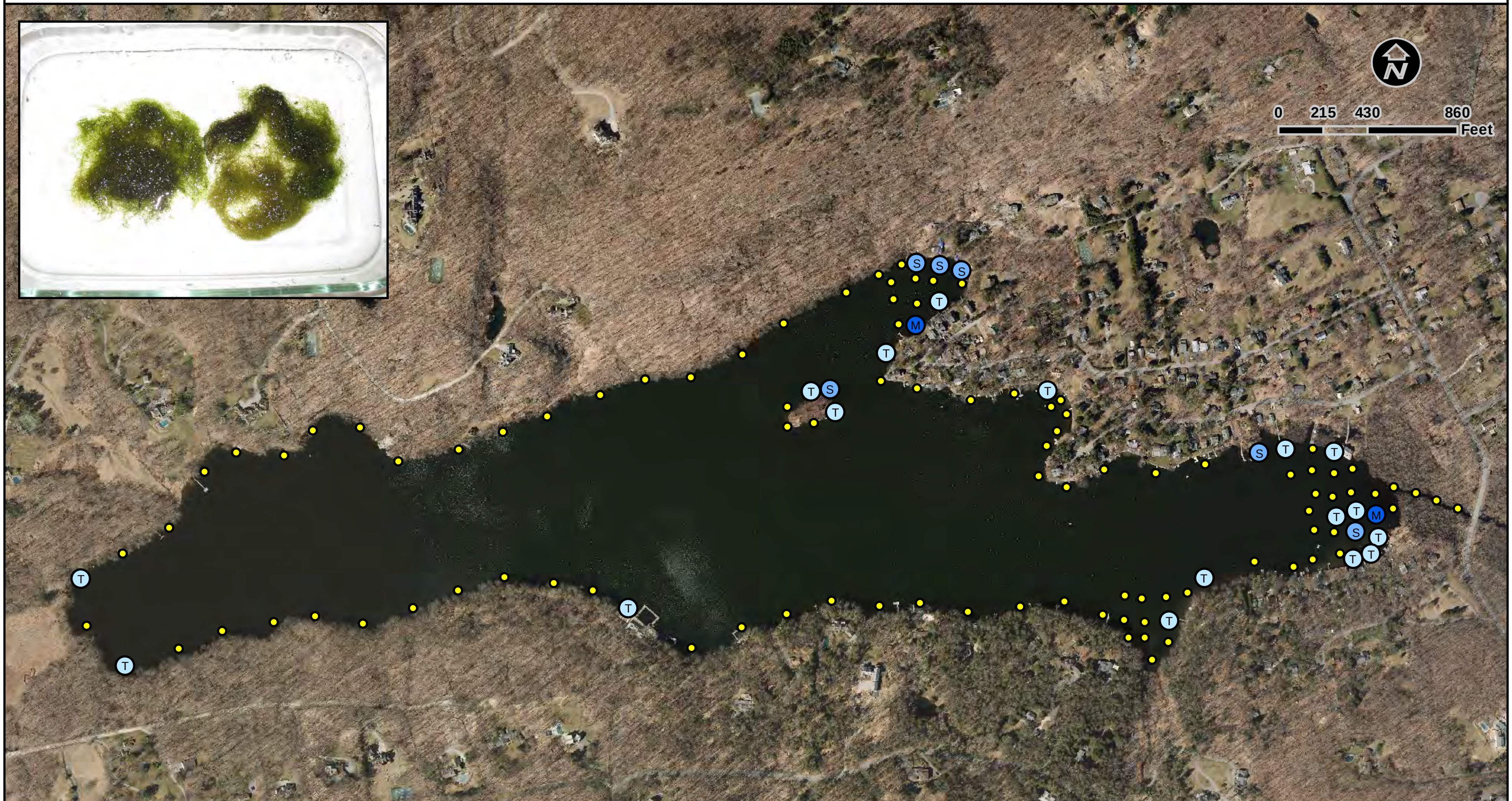
Floating Filamentous Algae Distribution



Lake Waccabuc and Canal
Aquatic Vegetation Survey
July 22, 2014

Total Sample Sites: 120

Plant Density Legend

- ● = No Plants
- T = Trace Plants
- S = Sparse Plants
- M = Medium Plants
- D = Dense Plants

Percent Distribution

Abundance	Sites	Percentage
Total	25	21%
Trace	17	68%
Sparse	6	24%
Medium	2	8%
Dense	0	0%

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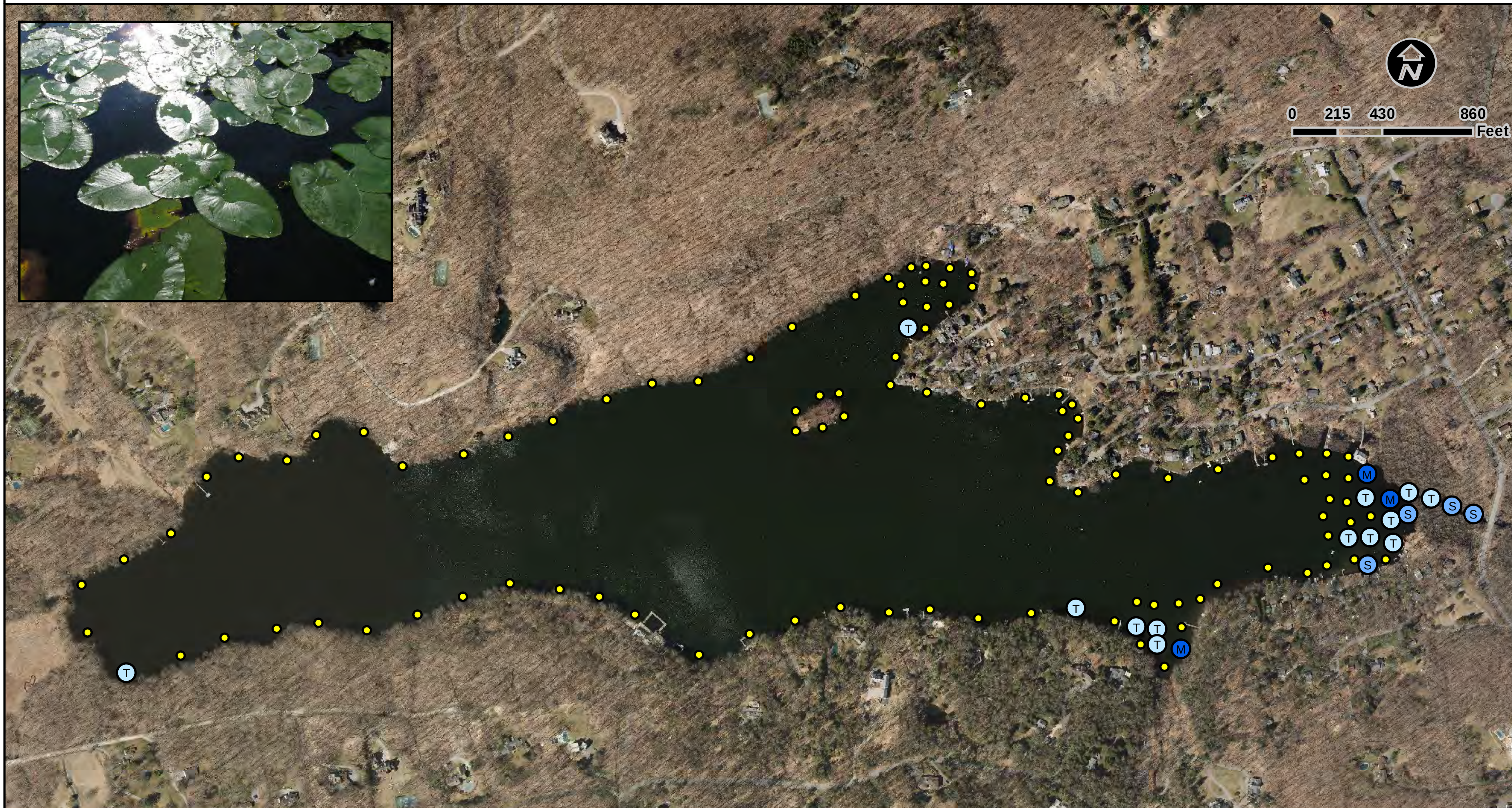
Spatterdock (*Nuphar variegata*) Distribution



Lake Waccabuc and Canal
Aquatic Vegetation Survey
July 22, 2014

Total Sample Sites: 120

Plant Density Legend

- = No Plants
- T = Trace Plants
- S = Sparse Plants
- M = Medium Plants
- D = Dense Plants

Percent Distribution

Abundance	Sites	Percentage
Total	20	17%
Trace	13	65%
Sparse	4	20%
Medium	3	15%
Dense	0	0%

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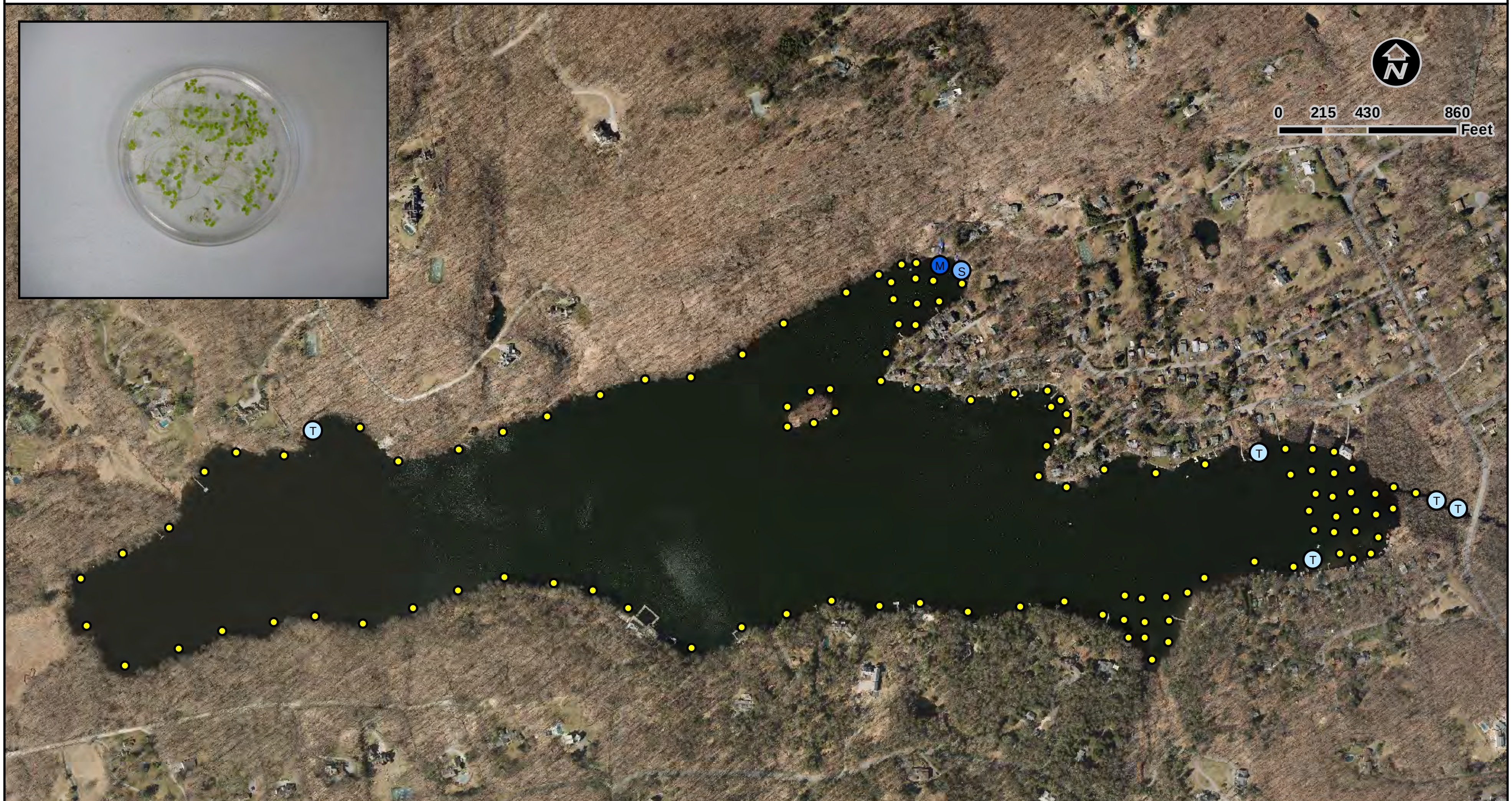
Small Duckweed (*Lemna minor*) Distribution



Lake Waccabuc and Canal
Aquatic Vegetation Survey
July 22, 2014

Total Sample Sites: 120

Plant Density Legend

- = No Plants
- T = Trace Plants
- S = Sparse Plants
- M = Medium Plants
- D = Dense Plants

Percent Distribution

Abundance	Sites	Percentage
Total	7	6%
Trace	5	71%
Sparse	1	14%
Medium	1	14%
Dense	0	0%

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Great Duckweed (*Spirodela polyrhiza*) Distribution

Lake Waccabuc and Canal Aquatic Vegetation Survey July 22, 2014

Total Sample Sites: 120

Plant Density Legend

- = No Plants
- T = Trace Plants
- S = Sparse Plants
- M = Medium Plants
- D = Dense Plants

Percent Distribution

Abundance	Sites	Percentage
Total	3	3%
Trace	3	100%
Sparse	0	0%
Medium	0	0%
Dense	0	0%

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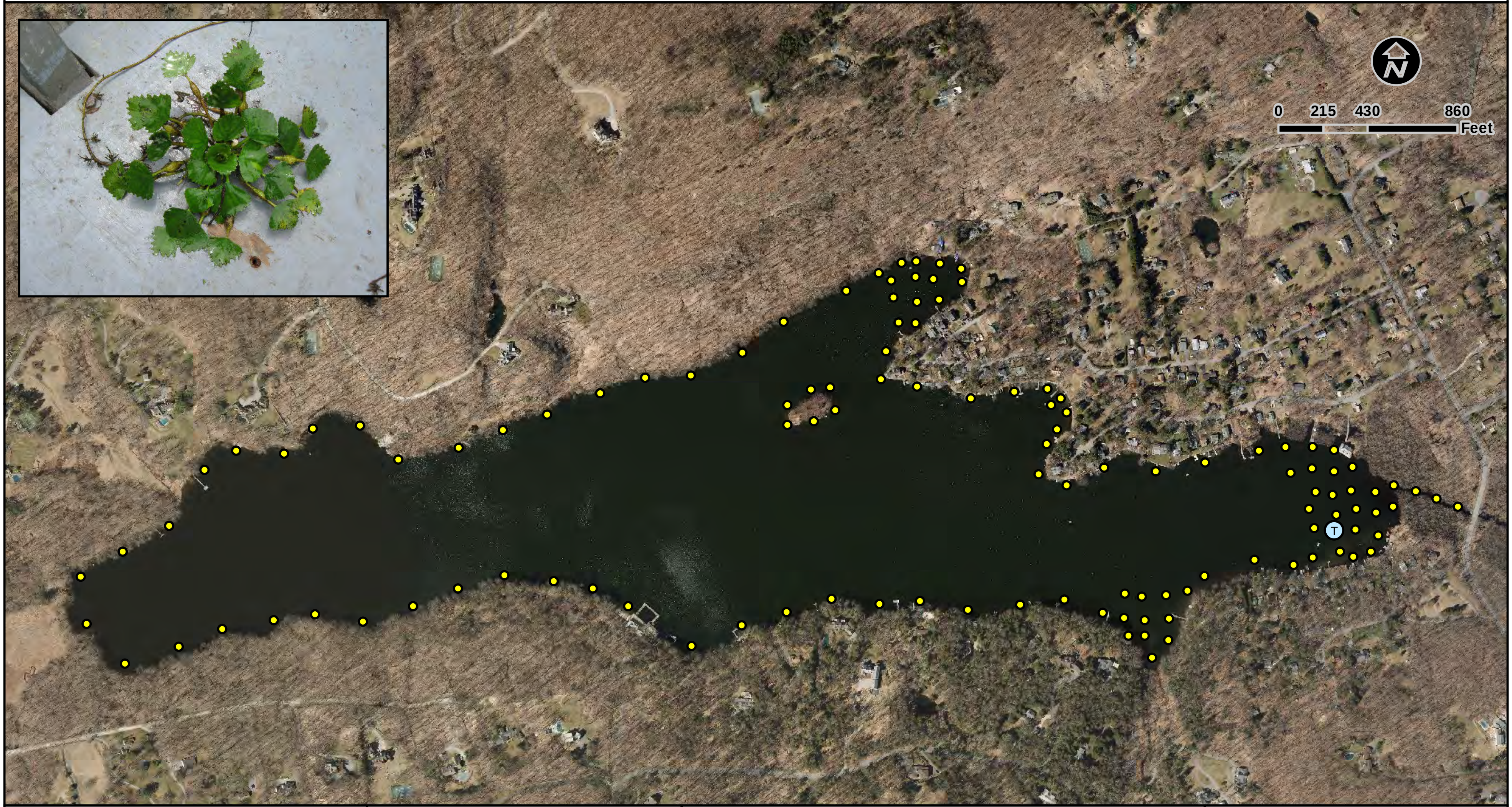
Water Chestnut (*Trapa natans*) Distribution



Lake Waccabuc and Canal
Aquatic Vegetation Survey
July 22, 2014

Total Sample Sites: 120

Plant Density Legend

- = No Plants
- T = Trace Plants
- S = Sparse Plants
- M = Medium Plants
- D = Dense Plants

Percent Distribution

Abundance	Sites	Percentage
Total	1	1%
Trace	1	100%
Sparse	0	0%
Medium	0	0%
Dense	0	0%

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Aquatic Vegetation Sample Site Richness

Lake Waccabuc and Canal Aquatic Vegetation Survey July 22, 2014

Total Sample Sites: 120

Richness: Number of Species/Sample Site

0 1 2 3 4 5 6 7 8 9 10 11 12

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