Aquatic Invasive Species Management Plan
For
Peshtigo Flowage

Chuck Druckrey
Marinette County Land Information Department
Land & Water Conservation Division
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Introduction & Purpose

Peshtigo Flowage is an impoundment of the Peshtigo River located approximately 7 miles upstream from the Bay of Green Bay in the City of Peshtigo, Wisconsin (figure 1). The purpose of this report is to develop a sustainable plan for the long-term management of aquatic plants in Peshtigo Flowage with an emphasis on the control of Eurasian watermilfoil (*Myriophyllum spicatum*), an invasive exotic species.

Physical & Chemical Characteristics of Peshtigo Flowage

Peshtigo flowage is formed by The Peshtigo Dam, built in 1920, and owned and operated by the Wisconsin Public Service Corporation (WPS). The dam is used for electricity generation and maintains a head of 13 feet. The dam is operated in run-of-the-river mode per Federal Energy Regulatory Commission (FERC) license. Run-of-the-river means that water is passed through the dam at the same rate it enters the flowage, limiting the amount of water level fluctuation to less than one foot. The FERC license requires WPS to maintain the water level in Peshtigo Flowage at 603 feet NGVD above sea level.

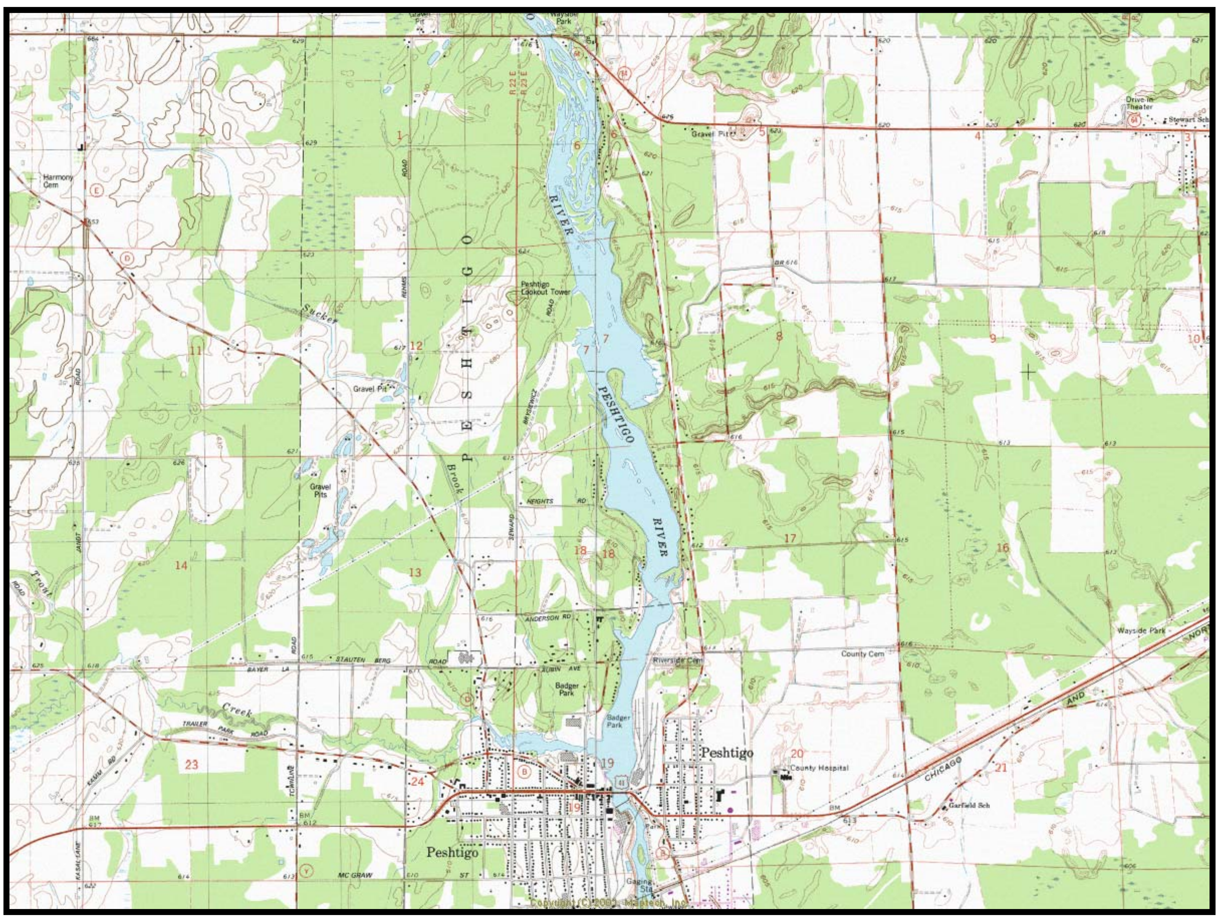


Figure 1. Peshtigo Flowage and vicinity.

According to the Wisconsin DNR the Peshtigo Flowage has a surface area of 232 acres. However it is often difficult to determine where the flowage stops and the river begins. The dam at Peshtigo effects water levels all the way to the Potato Rapids Dam located 5 miles upstream. However, this study only considers the lower 2.2 miles of the flowage, from the dam to where the power line crosses in section 7, T30N, R20E. The study area also includes Trout Creek Pond up to the North Lake Street Bridge. Within the study area the flowage has a surface area of 195 acres, including approximately 42 acres that supports persistent wetland vegetation.

The Peshtigo River has a watershed area of 1,080 square miles at the Peshtigo Dam. According to United States Geologic Survey monitoring the average flow for the river is 890.3 cubic feet per second (cfs) or 575.4 million gallons per day (mgd). The volume of water in Peshtigo Flowage is estimated to be 451.2 million gallons. Using this data the flushing rate of Peshtigo Flowage can be calculated. Flushing rate, or retention time, is amount of time it takes incoming water to replace the entire volume of a lake. Flushing rate is important because it impacts nutrient dynamics (how nutrients are stored, flushed, and recycled) within a lake or flowage. While most lakes have a flushing rate measured in years, the average flushing rate for Peshtigo Flowage varies from 8 hours in April during spring snowmelt to 30 hours in August. On average, it takes only 19 hours to replace the entire volume of Peshtigo Flowage with “new” water from the Peshtigo River.

The Peshtigo flowage has hard water. Hardness, or alkalinity, is a measure of the amount of calcium in the water. Lakes and flowages with high alkalinity are better able to resist acidification and typically support a greater variety and increased quantities of aquatic plants. Alkalinity is a function of the soil type in a lakes watershed and remains fairly constant over time.

Water clarity in the flowage is typically fair with moderately stained water. The light brown staining is due to dissolved organic chemicals in the water called tannins. Tannins are produced by decaying wetland vegetation and wash into the river with surface runoff. Water clarity in the flowage as measured by Secchi disk depth is typically less than 6 feet.

As part of a Lake Management Planning Grant water quality in Peshtigo Flowage and Trout Creek Pond was monitored in 1999 and 2000 (Druckrey 2002). Results indicated that water quality in Peshtigo Flowage was good. The average total phosphorus concentration during the monitoring period was 26.9 ug/l, which is well below the statewide average (65 ug/l) for impoundments. The phosphorus concentration in Trout Creek Pond was considerably higher at 52.2 ug/l. Limited runoff event monitoring found significantly elevated phosphorus levels in Trout creek and an unnamed tributary to Trout Creek Pond.

Shoreline Development and Public Access

The shoreline of Peshtigo Flowage is heavily developed with numerous permanent and seasonal dwellings. Development within the City of Peshtigo is a mix of single-family homes, multi-unit development, commercial, institutional, and public green space. The City of Peshtigo maintains a boat landing, swimming beach, and more than 2700 feet of park/green space on the flowage. Additional public access is available at a Wisconsin DNR boat landing located below the Potato Rapids dam.

Overview of the Peshtigo Flowage Fish Community

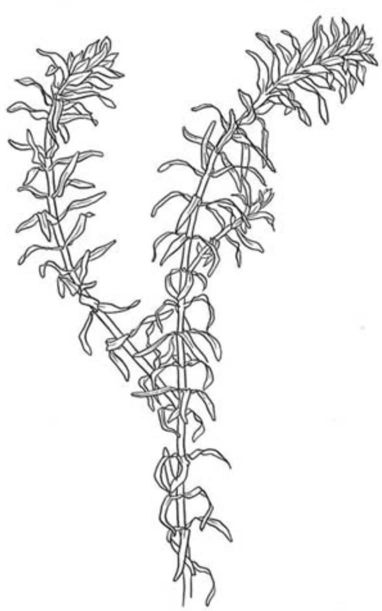
The Wisconsin DNR has conducted fish surveys on Peshtigo Flowage several times in the past 50 years most recently in 1999 and 2007. The surveys included both spring fyke netting and summer electrofishing during a two-year period. The 2007 report concludes, "Peshtigo Flowage supports a good quality and diverse fishery with natural reproduction of all major species present" (Hasz 2008). Notable in the report was the excellent numbers and size structure of bluegill and improvement in the numbers and size structure of the northern pike population since the 1999 fish survey.

Evidence of the excellent bluegill fishery was seen during the 2010 summer drawdown. While no official harvest estimate was made by the DNR, fishing for bluegill was exceptional during the drawdown period and it's likely that thousands were harvested as fish concentrated in the river channel in front of the dam. The City of Peshtigo and the DNR are currently working on a plan for stocking the flowage after another summer drawdown scheduled for 2012.

Aquatic Plant Community

An aquatic plant survey of Peshtigo Flowage was completed in July 2010 using the Wisconsin DNR recommended point intercept sampling protocol (Hauxwell 2010). Approximately 390 locations were sampled for plant species presence and density, water depth, and sediment type. Dense emergent and floating-leaf plant communities were also mapped and described. A detailed reporting of the aquatic plant survey can be found in Appendix A.

Common water-weed

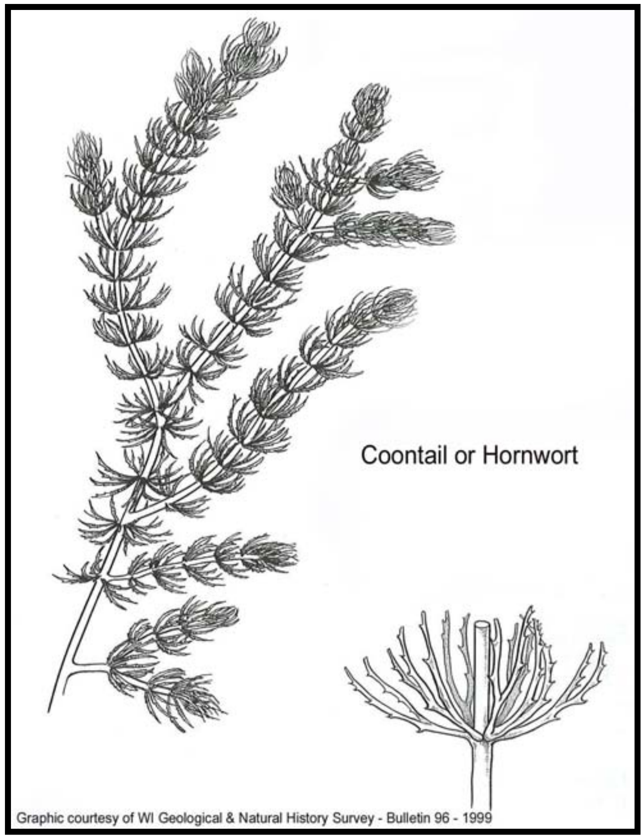


Graphic courtesy of Wisconsin and Natural History Survey Bulletin 96 1999

The 2010 survey identified twenty-six species of aquatic plants in Peshtigo Flowage including one aquatic invasive species (Eurasian watermilfoil) and one state endangered species (lake cress). Like many lakes and flowages however, the plant population in Peshtigo Flowage is dominated by a handful of abundant species. The following plants were found at 10% or more of the sample locations that were shallower than the maximum depth of plant growth (8 feet). Descriptions are taken from Through the Looking Glass A Field Guide to Aquatic Plants (Borman, 1997).

Common waterweed
Common waterweed (*Elodea canadensis*) was the most common plant in Peshtigo Flowage. It was found growing at 59% of sample points less than 8 feet deep. Common waterweed has slender branching stems with small lance shaped leaves attached in whorls of three. Leaves are typically spread out at the bottom of the plant and crowded together near the top. In

early summer it produces small white flowers at the surface but very few fruits are ever produced. Like many aquatic plants, common waterweed spreads primarily by stem fragments that settle to the bottom and take root.



Common waterweed prefers soft sediment with lots of organic matter. It is very tolerant of low light conditions and is often one of the most abundant plants in deep water. In the flowage common waterweed was found throughout the vegetated depth range (1–8 feet) and showed a slight preference for water between two and five feet deep with mucky sediment. It was most abundant in the upper half of the study area.

Common waterweed can overwinter green and begin growing again soon after ice out. It is used by waterfowl as a food source and provides general fish habitat. It typically does not grow to the surface in deep water so its nuisance potential is limited to shallow water areas.

Coontail
Coontail (*Ceratophyllum demersum*) is the most common aquatic plant in Wisconsin. It has long stems with leaves arranged in whorls around the stem. Unlike milfoil the leaves of coontail are very stiff and spiny, and tend to be dense near the ends of the stem, giving them the appearance of a bushy raccoon tail.

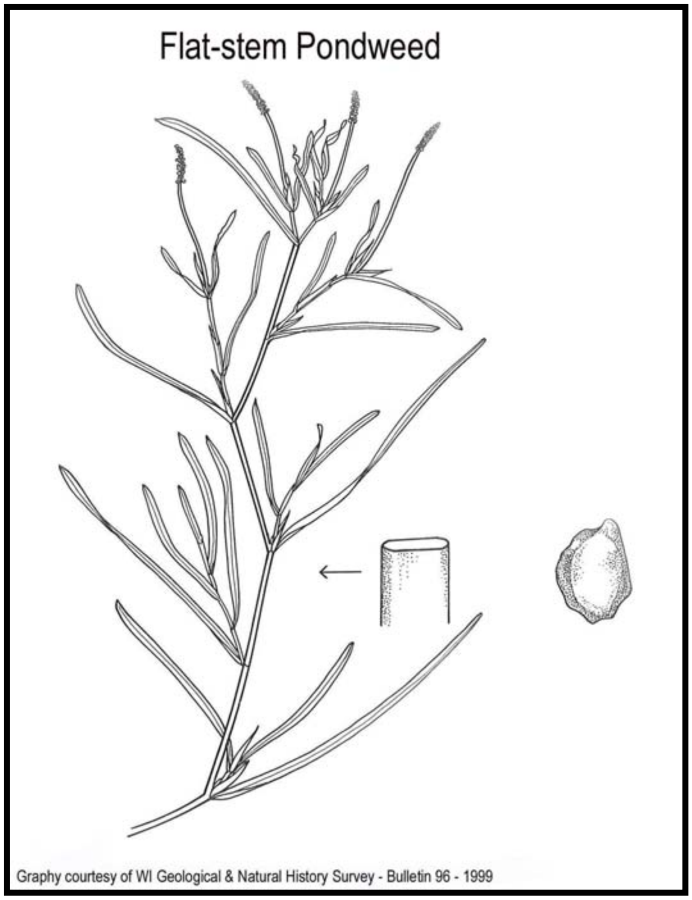
Coontail has no true roots but anchors to the sediment using modified stems that develop wherever it touches the bottom. Due to its poor “rooting” ability, coontail prefers soft organic sediment. It rarely produces seed but spreads by fragmentation.

In Peshtigo Flowage coontail was found at 58% of sites less than 8 feet deep. It shows a slight preference for muck sediment and is most abundant in water from 3 to 6 feet deep. Coontail was especially dense in shallow bays and calm backwater areas of the flowage where it often impeded navigation.

Coontail is important for fish habitat since it is slow to decompose and often stays alive under the ice. This habit makes it excellent winter habitat, attracting aquatic insects and the fish that feed on them.

Filamentous algae
Filamentous algae refers to several types of colonial algae that form strands or net-like structures. Filamentous algae can be attached to objects in the water, float on the surface, or suspend in the water column. Often algae that starts as attached or dispersed will float up and accumulate at the

surface. In Peshtigo Flowage filamentous algae was found at 47 percent of sample points less than 8 feet deep where it was attached to the bottom and covering many of the aquatic plants. It was especially abundant in areas with the greatest frequency of harvesting. At the time of the survey a thick layer of filamentous algae, combined with watermeal, and duckweed covered the surface in Trout Creek Pond and the protected bays on the west side of the flowage along River Bend Drive. Under microscopic inspection the dominant algae appeared to be *Anabena sp*. a common filamentous green algae



Graphy courtesy of WI Geological & Natural History Survey - Bulletin 96 - 1999

Flat-stem Pondweed
Flat-stem pondweed (*Potamogeton zosteriformis*) is identified, as the name implies, by its strongly flattened stems. The leaves are long (4-8 in), narrow (1/8-1/4 in) and stiff. The plant produces no floating leaves.

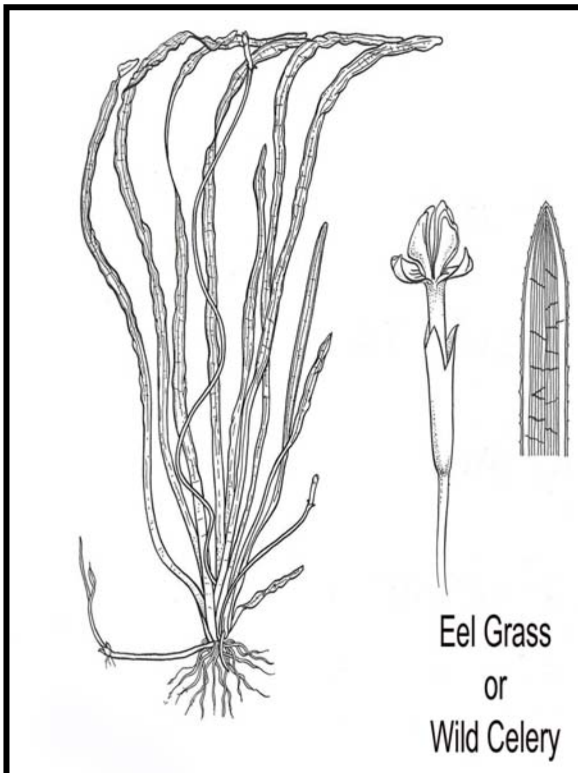
Flat-stem pondweed is a perennial that rarely reproduces by seed. Typically the entire plant dies back each year and re-grows from the root system. Like many of the pondweeds, flat-stem pondweed spreads by producing winter buds, specialized leaves packed in a tight cluster that form on side branches at the end of the season. When the plant dies back the winter buds detach and fall to the sediment where they take root.

Flat-stem pondweed was found at 31% of sample points less than 8 feet deep. It shows an affinity for firm muck or sand and can be found growing in water from 1 to 6 feet deep, but was most abundant in 4 to 5 feet of water. It was often found growing on the edge of dense plant beds where they meet open water.

Flat-stem pondweed is the most abundant large pondweed found in the flowage. As such, it provides important foraging habitat for panfish and edge cover for gamefish. It also serves as a food source for waterfowl that graze on its leaves and eat the seeds.

Wild Celery
Wild celery (*Vallisneria americana*) is a native plant common to lakes and flowages throughout the state. It has long ribbon shaped leaves ¼ to ½ inch wide and up to 7 feet long that emerge from a central rosette on the bottom. The leaves have a prominent central stripe and a cellophane-like consistency. The leaves are mostly submersed with just their tips trailing on the surface of the water. Late in the summer water celery produces tiny male flowers (1 mm wide) under water that break free and float up to the surface. The white female flowers are found at the end of a long

coiled stalk that extends to the waters surface. After pollination the female flower is withdrawn below the surface and a long narrow seed capsule develops.

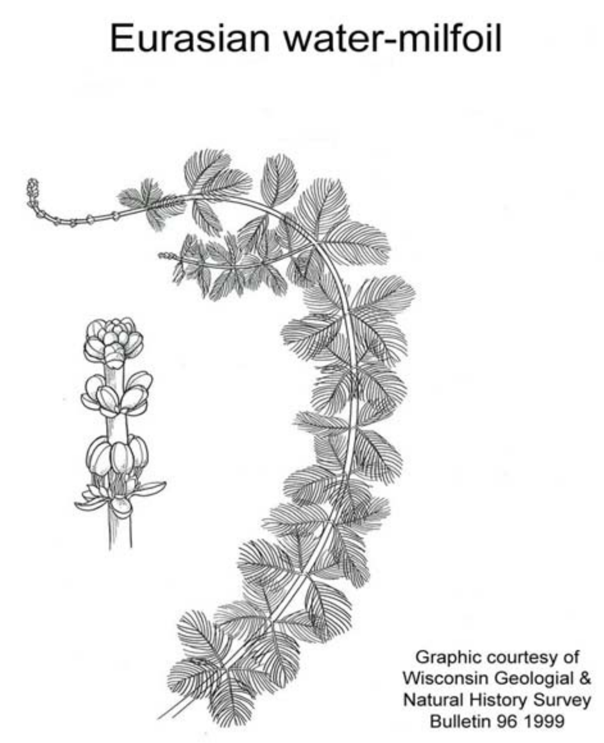


Graphic courtesy of WI Geological & Natural History Survey - Bulletin 96 - 1999

Wild celery prefers hard substrate (sand or firm muck) and is quite tolerant of turbid water. It's a common plant of large river systems and flowages. Wild celery is a perennial plant that spreads by seed and by vegetative means. Vegetative growth occurs primarily by underground rhizomes, which produce "offsets" along their length, some of which can detach and float to new locations. The plant also produces abundant tubers that overwinter in the sediment.

The State of Wisconsin lists wild celery as a "high value species" in NR 107. It is known as an important food source for ducks and geese, which eat the vegetation, rhizomes, tubers, and fruit. The starchy tubers are especially prized by canvasback ducks, which are almost completely dependent on them during their migration flights.

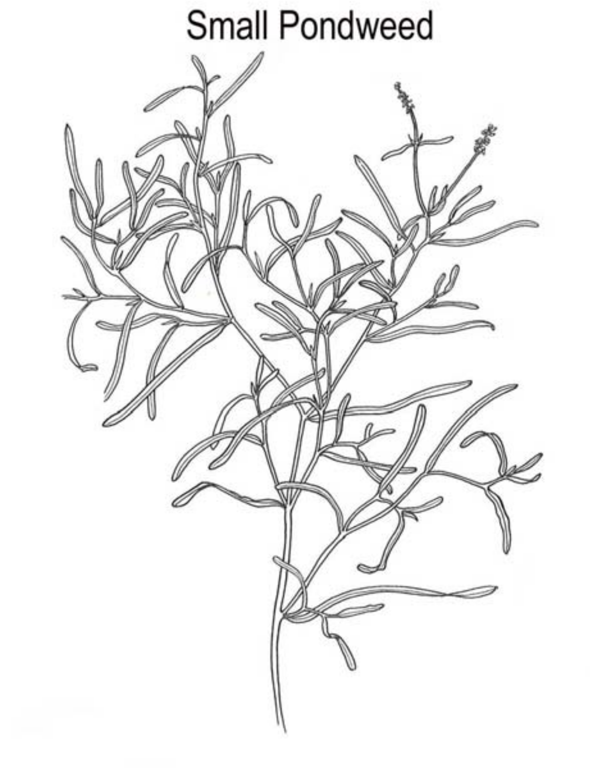
In Peshtigo Flowage wild celery was found growing at nearly 24% of the survey points less than 8 feet deep. It shows a distinct preference for sand and gravel and was most common at the edge of the old river channel and in areas with significant current.



Graphic courtesy of Wisconsin Geologial & Natural History Survey Bulletin 96 1999

Eurasian Water Milfoil (EWM)
Eurasian water milfoil (*Myriophyllum spicatum*) is an exotic aquatic invasive species (AIS) with soft feather-like leaves arranged in groups of four along a thin wiry stem. Each leaf has 14 to 20 pairs of thread-like leaflets. The stems are often reddish towards the tip and the plant tends to branch profusely when it reaches the surface, forming a canopy that shades the water beneath. EWM typically prefers muck and moderate water depths. It can reach the surface in water as deep as 10 feet.

EWM can overwinter green or survive as sprouts on the rootstock. The plant begins rapid growth at low water temperatures and quickly reaches the surface. EWM spreads primarily by



Graphic courtesy of WI Geological & Natural History Survey - Bulletin 96 - 1999

fragmentation, a process where even small fragments of the plant separated by boats or wave action drift to a new place and take root. The rapid growth, ease of spread, and its canopy forming habit, allows EWM to out compete many of the slower growing native plants.

While EWM provides some fish and wildlife habitat, studies show that native pondweeds support a higher diversity and greater numbers of beneficial aquatic insects (Engel 1990).

EWM was first identified in Peshtigo Flowage in 1992. At the time it was already well established and had likely been introduced years earlier. In 2010 EWM was found in 21% of the sample points shallower than 8 feet deep. It was most abundant in water from two to five feet in depth and was found exclusively in areas with muck sediment.

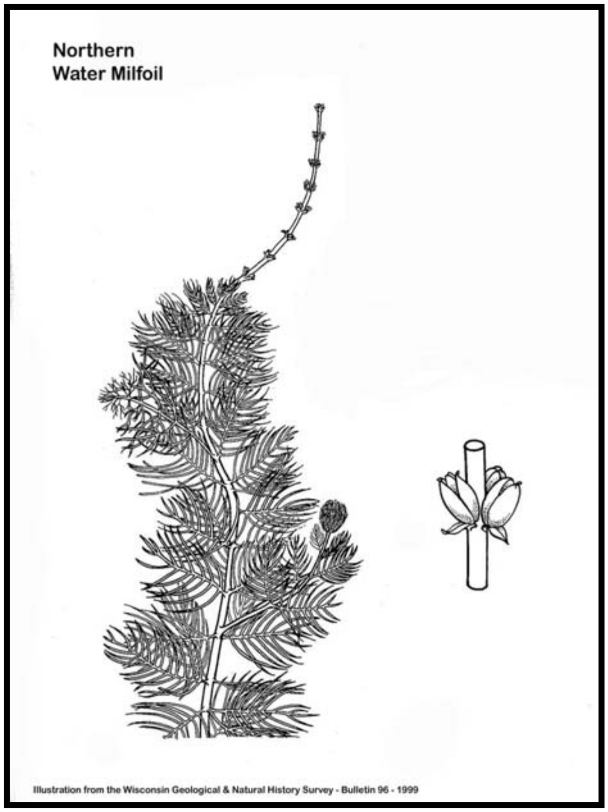
Small pondweed
Small pondweed (*Potamogeton pusillus*) is a common species in a large group of narrow-leaf pondweeds that are notoriously difficult to identify. They are differentiated based on floating leaves, winter buds, seed shape and other factors. Small pondweed has very fine stems that branch profusely as they rise towards the surface. The leaves are typically much longer (3/8 –2 1/2 in) than they are wide (1/16 -1/8 in).

Small pondweed was found at 20% of sites less than 8 feet deep. It was most abundant in 2 to 4 feet of water and showed a strong preference for muck sediment. Small pondweed provides important shallow water habitat for juvenile fish and the aquatic insects on which they feed. It is also grazed by many ducks and geese as well as muskrat. Many of the small pondweeds have similar sediment and depth preferences to EWM but cannot compete with the larger, more aggressive invader.

Northern watermilfoil
Northern watermilfoil (*Myriophyllum sibericum*) is a common native milfoil of northern lakes and flowages. Like EWM this plant has finely divided feather like leaves arranged in whorls of 4 around the stem. Northern watermilfoil has light green stems that are thicker and stiffer than those of EWM. The leaves have 5-12 pairs of leaflets in each leaf.

Northern watermilfoil overwinters by hardy rootstocks. It also produces winter buds, which are specialized leaves that grow in a tightly packed ball at the end of the stem. These winter buds survive the winter and sprout to form new plants in the spring.

In Peshtigo Flowage northern watermilfoil was found growing in 18% of the sites less than 8 feet deep. It was most frequently found in 4 to 5 feet of water in areas with a firm muck bottom. Northern watermilfoil was most often found growing at the edge of dense plant beds along the old diver channel.



Northern watermilfoil is not nearly as aggressive as EWM nor does it form a canopy at the water surface. It is a valuable member of the plant community and provides shade, shelter and foraging opportunities for fish. Its leaves and seeds are consumed by a wide variety of waterfowl.

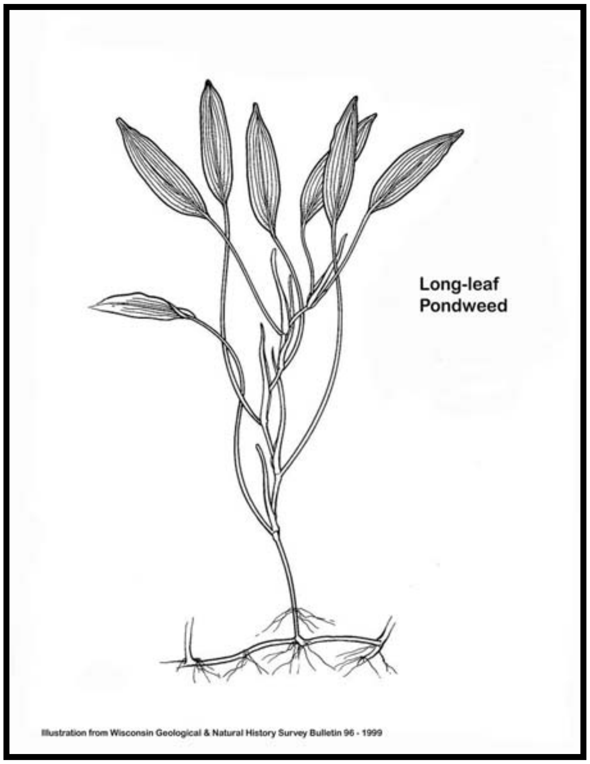
Wild rice

Wild rice (*Zizania aquatica*) is an emergent aquatic grass common in northern lakes and streams. Early in the year it develops long narrow (1/8 – 3/8 in) leaves that float on the surface. By mid-summer large wide (3/8 – 1 in) flat leaves and a 6 to 10 foot tall flower stalk emerge from the water. The flower stalk is topped with a plume of female flowers arranged in a tight cluster above the male flowers. Wild rice is an annual plant that prefers soft organic sediment and flowing water.

Wild rice was found at more than 12% of sample points less than 8 feet deep. It was most common in water less than 4 feet deep but was found growing in water as deep as 6 feet. Wild rice showed a strong preference for sand sediment with a thin layer of muck. Wild rice was most abundant in a narrow band along the old river channel in the upper half of the study area. Upstream from the study area wild rice is very abundant.

In Wisconsin wild rice is provided special protection due to its value in the aquatic community. In addition to providing valuable cover for fish, wild rice stabilizes soft sediment in the near shore area and provides food for many birds and migrating waterfowl. Wild rice is also harvested for human consumption. The harvesting of wild rice is regulated by the Wisconsin DNR and requires a permit.

Long-leaf pondweed



Long-leaf pondweed (*Potamogeton nodosus*) is identified by its long (6 – 12 in) narrow (1/2 – 1 in) leaves attached by a long tapering leaf stalk. The plant produces similarly shaped floating leaves and a fruiting stalk held above the water surface.

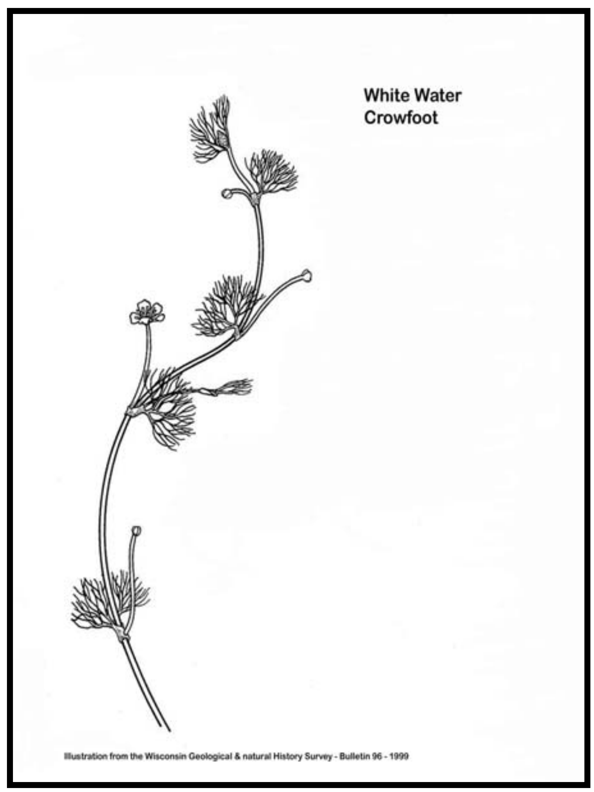
Long-leaf pondweed is a perennial plant that dies back each year and re-grows from the root system. Like many of the pondweeds, long-leaf pondweed spreads by rhizomes and by seed.

Long-leaf pondweed was found at 10% of sample points less than 8 feet deep. It shows an affinity for a firm sand bottom and water less than 4 feet deep. Long-leaf pondweed is a common plant of large rivers and prefers flowing water. It was rarely found in back bays where water exchange is poor.

Long-leaf pondweed offers exceptional habitat for invertebrates on which many fish species feed. It is also utilized by ducks, geese, and muskrats, which feed on its leaves and seeds. As one of the larger pondweed species, long-leaf also provides important ambush cover for large predator fish.

Stiff water crowfoot

Stiff water crowfoot (*Ranunculus longirostris*) has long branching stems that emerge from runners and buried rhizomes. The stiff leaves are finely cut into thread-like divisions attached to the stem with short leaf stalks. The plant produces numerous small white flowers with five petals that are held just above the waters surface. As the fruit matures the flower stalks curve back into the water.



Stiff water crowfoot is a perennial plant that reproduces from the rootstalk and seed. It's typically found in water with high alkalinity and prefers soft muck sediment. In Peshtigo Flowage stiff water crowfoot was found in protected areas in 2 to 4 feet of water.

Stiff water crowfoot provides important shallow water feeding habitat for fish. Its seeds are prized by waterfowl and even upland game birds when it grows in very shallow water. Ducks also graze on the leaves and stems.

Lake Cress

Lake cress (*Armoracia aquatica*), which is listed as a Wisconsin endangered species, was also found in Peshtigo Flowage. Lake cress has bright green stems that emerge from a fibrous root stalk. The leaves vary widely in shape and structure, even on the same plant. The first submersed leaves are often finely divided with many branching segments. As the stem nears the surface, leaves are often oblong or lance shaped with sharp lobes or deep cut teeth. Emergent leaves typically have toothed margins. Late in the summer small white flowers with four petals are produced on stems held above the water surface.

Illustration by Carol Watkins - from Through the Looking Glass

Lake cress is a perennial plant that over-winters by hardy rootstalks. It's reported that viable seeds are rarely produced within the fruit. Like many aquatic plants, lake cress reproduces primarily through fragmentation. As the plant matures the leaves fall off and float to new locations where they can take root. By the time the plant flowers it often has few, if any, submersed leaves.

In 2010 lake cress was found at 8 sites, or 3% of sample points less than 8 feet deep. However point intercept surveys, while good for describing the larger aquatic plant community, typically under-sample rare vegetation. A better method for conducting rare plant surveys is to focus on the specific habitat needs of the plant in question and thoroughly search those habitats that have a high probability of supporting the plant. In nearby Bagley Flowage, lake cress is typically found growing in stands of sparse emergent vegetation or in pockets within the emergent vegetation. It was most often found growing in association with common burreed (*Sparganium eurycarpum*) and wild rice in 1.5 to 5 feet of water (Druckrey 2010).

A systematic search of Peshtigo Flowage for lake cress was conducted in July of 2011. The search revealed that lake cress was much more common in Peshtigo Flowage than the 3% frequency would suggest (figure 2). While improved survey methodology can explain some of the change, much of the increase is likely due to a 13-foot water level drawdown conducted during August and September of 2010. Surveys indicated that a similar drawdown of Bagley Flowage in the summer of 2009 was followed by a significant increase in both the frequency of occurrence and density of lake cress in the following year (Druckrey 2010).

In Peshtigo Flowage Lake cress was most often found growing in sparse wild rice beds, or in pockets within the wild rice beds in 2 to 5 feet of water. Like wild rice, lake cress prefers a firm sand bottom covered with a thin layer of muck.

Duckweed and Watermeal
While their presence and abundance were not recorded during the plant survey, small duckweed (*Lemna minor*), forked duckweed (*Lemna trisulca*) and common watermeal (*Wolffia columbiana*) were found in abundance throughout the flowage in calm protected waters. All three are tiny free-floating plants that are often mistaken for algae. Watermeal consist of two pale green asymmetrical globes that, together, measure between 1/64 and 1/32 inches long. Small duckweed has round to oval leaf bodies that typically measure 1/16 – 3/16 inches long. A single root hangs below each frond. Forked duckweed is the giant of the group. It consists of a flattened frond and long stalk measuring 1/8 to 3/8 inches long. Each frond produces lateral fronds that often remain attached, giving the plant the appearance of a small rowboat complete with tiny oars.

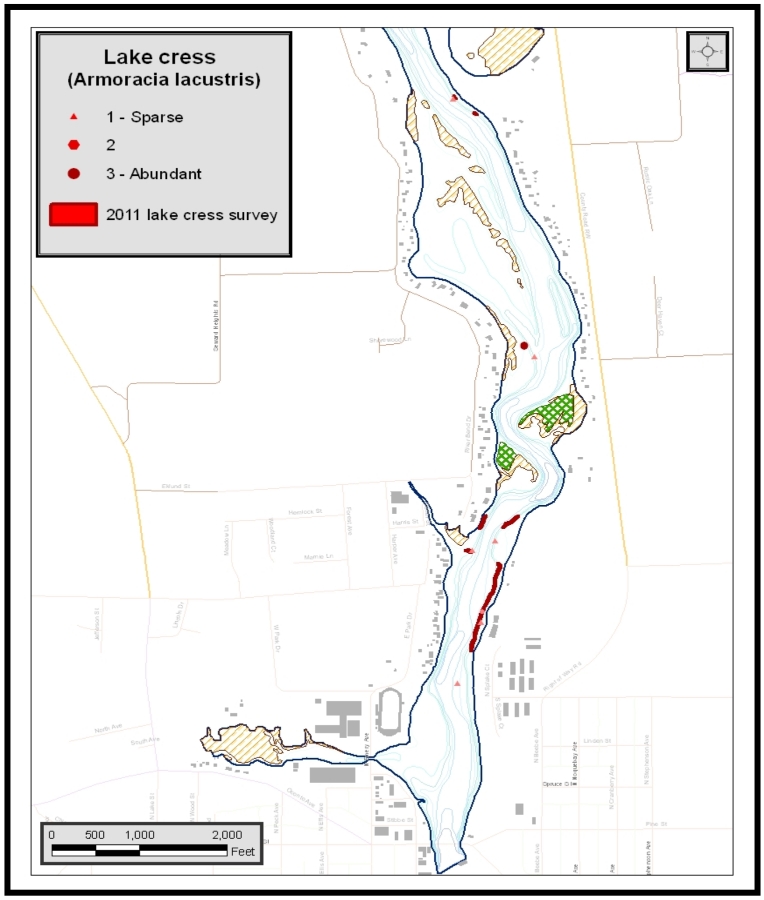
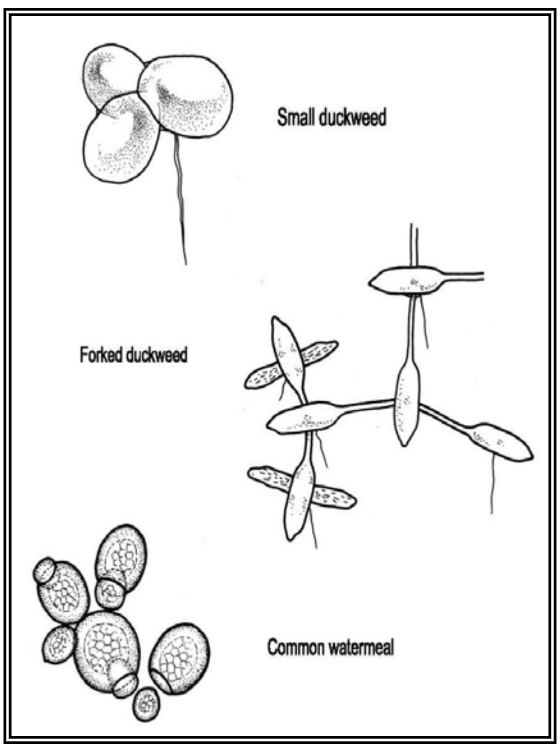


Figure 2. Distribution of lake cress (Armoracia lacustris) in Peshtigo Flowage.



These plants are often found together. They multiply primarily by budding and often remain joined together in groups. All produce winter buds that sink to the sediment in the fall and float up again when the water warms to continue growing. Because they are free floating they drift with the wind and accumulate in sheltered areas. Duckweed and watermeal absorb nutrients directly from the water column through their roots and/or leaf surfaces.

All three species are important food sources for surface feeding ducks. However, they can cause a nuisance when they accumulate in large quantities. Due to their small size they are often mistaken for a surface bloom of blue-green algae.

Infrequent Submersed Plants

The following aquatic plants were found at fewer than 10% of the Peshtigo Flowage survey points. This does not necessarily mean they are rare. The survey methodology tends to under sample some plants due to their location or their growth form. As before, descriptions are taken from *Through the Looking Glass, a Field Guide to Aquatic Plants* (Boreman 1997).

Other fine-leaved pondweeds
In addition to "small pondweed" (*Potamogeton pusillus*) there were three other fine-leaved pondweeds found in Peshtigo flowage. Bushy pondweed (*Najas flexilis*) is somewhat unusual in that it's an annual plant that does not overwinter but grows from seed each year. Sago pondweed (*Potamogeton pectinatus*) and an unknown small pondweed (*Potamogeton sp*.) were also found. Like small pondweed, these species have fine leaves and prefer moderate depths and muck sediment. The shape of the winter buds, glands, and leaf sheaths differentiate the species.

Large pondweeds
Several common large pondweeds were found in Peshtigo Flowage. Clasping-leaf pondweed (*Potamogeton richardsonni*) and large-leaf pondweed (*P. amplifolius*) are commonly referred to as "cabbage" by fishermen and provide excellent fish habitat. Floating-leaf pondweed (*P. natans*) was also found in the flowage. The latter is often viewed as a floating leaf plant since it had no obvious underwater leaves.

All of the larger pondweeds are at risk from EWM since they have the same depth and sediment preferences. All of the pondweeds die back to the sediment each winter and begin growth later in the spring than EWM.

Other milfoils
A third milfoil species, variable-leaf watermilfoil (*Myriophyllum heterophyllum*) was also found growing primarily in the area of Trout Creek Pond and the beach. Like most milfoils, variable-leaf watermilfoil has soft feather-like leaves arranged in whorls of four on a long thin stem. Variable-leaf milfoil can be identified by the very closely spaced whorls that give the plant the appearance of a thick rope both in and out of the water. Like Eurasian watermilfoil, it spreads primarily by fragmentation. In some area waters variable-leaf watermilfoil is a nuisance species due to its dense growth form.

Bladderwort
Common bladderwort (*Utricularia vulgaris*) is a carnivorous plant that traps and digests zooplankton, small aquatic insects and other organisms. They do this by sucking prey into specialized bladders where it is slowly digested. Common bladderwort is often mistaken for a milfoil but closer inspection reveals forked leaves (not feather shaped) and conspicuous bladders on the leaves. Bladderworts are most often found in calm shallow water with dense vegetation.

Macro algae
Outwardly, muskgrass (*Chara sp*.) and Stonewort (*Nitella sp*.) look like higher plants, but both are actually types of macro algae. Each "stem" and "leaf segment" are actually individual algae cells. Both have slender branching "stems" with whorls of "leaves" at each joint. Both are favorite foods of waterfowl.

Other submersed aquatic plants
Two other submersed aquatic plants were identified in Peshtigo Flowage. Water marigold (*Bidens beckii*) is often mistaken for a milfoil but can be distinguished by its branching instead of feather-like leaves. Water stargrass (*Zosterella dubia*) has long grass-like leaves and looks superficially like a young wild rice plant before it emerges from the water.

Floating-Leaf Plants

Floating-leaf plants include those with underwater stems and leaves that float on the surface. While many pondweeds also produce floating leaves when they flower, their primary leaves are under water. Floating leaf plants found in Peshtigo Flowage include spatterdock lily (*Nuphar variegata*) and white pond lily (*Nymphaea odorata*). Both were found at six to seven percent of the sample points. However, the survey methods do a poor job of sampling the floating leaf community. The point grids tend to under-sample very shallow areas where they grow best, and due to their growth form, the sampling gear often fails to collect the plants.

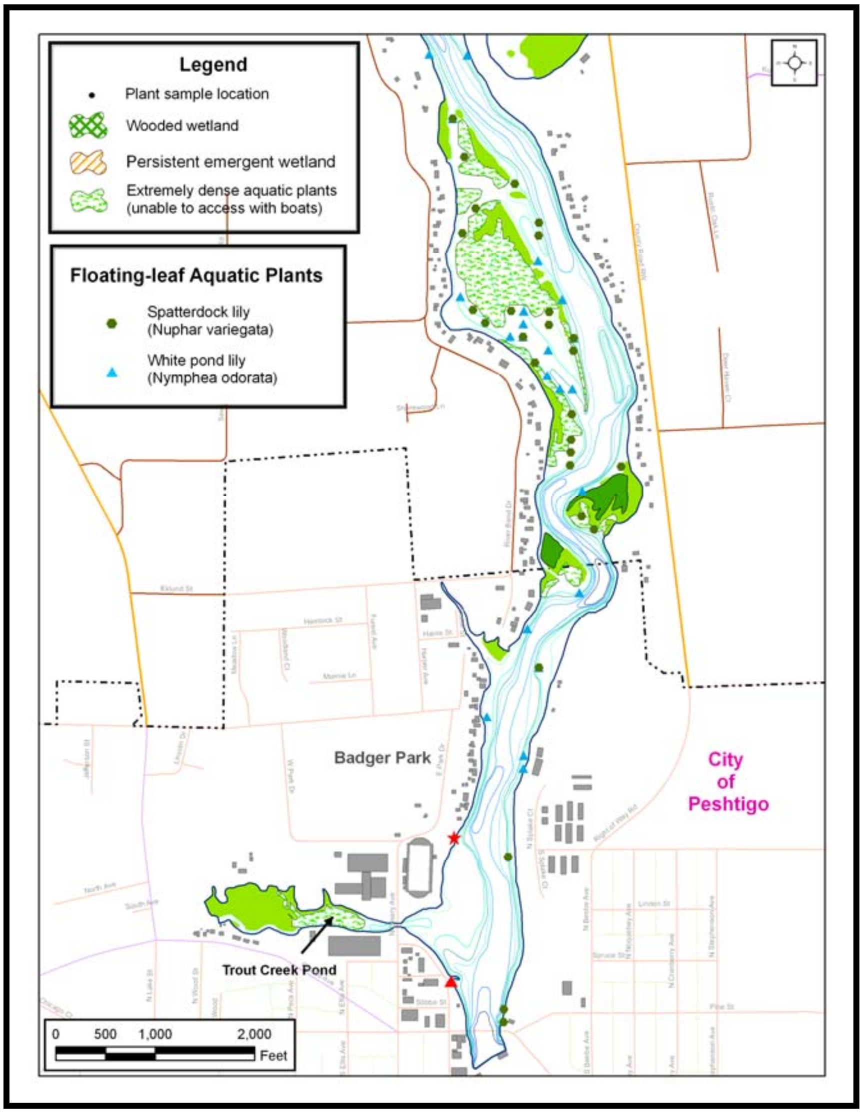


Figure 3. Floating leaf vegetation

In Peshtigo Flowage extremely dense water lilies cover more than 24 acres (figure 3). Plant growth in these areas was so dense that navigation by motorboat was nearly impossible. Dense water lily growth was most common in water less than 3 feet deep with a muck bottom. All lilies prefer protected water with little wave action.

All of the floating leaf plants have large fleshy rhizomes that anchor the plants and store nutrients. In areas with very flocculent muck these rhizomes, which are filled with air, can break loose and float to the surface where they decay and become rather unsightly.

Emergent Vegetation

Plants such as cattails, bulrushes, wild rice and others that reach above the surface of the lake are known as emergent vegetation. Many of these plants grow on the lakebed or in saturated soil on the shoreline. Most are adapted to fluctuating water levels and are unharmed, or actually stimulated, by low water periods.

Due to their location on the shoreline emergent plants are under-sampled in grid surveys. Those found in the flowage include wild rice (*Zizania aquatica*), broad-leaved cattail (*Typha lattifolia*), common bur-reed (*Sparganium eurycarpum*), and grass-leaved arrowhead (*Sagittaria graminea*). Others including three-way sedge (*Dulichium arundinaceum*) and rushes (*Juncus and Scirpus sp*.) were also noted. A more intensive survey of shoreline vegetation would certainly show even more species including many sedges and other wetland vegetation.

In general the emergent plant community on Peshtigo Flowage is healthy. In addition to the many areas dominated by wild rice, a review of aerial photography shows nearly 45 acres of persistent emergent wetland vegetation in the project area (figure 3). Persistent emergent plants are those that have above-water stems that persist through winter, including cattails, rushes, and many other wetland plants (wild rice is not persistent). Emergent plants are important in the lake ecosystem because of the habitat they provide for fish and amphibians that spawn on and amongst their underwater stems. Invertebrates (insects) and amphibians living in the shoreline fringe form the base of the aquatic food web and are vital for a healthy lake.

Floristic Quality Index

One measure of aquatic plant community "health" is the Floristic Quality Index (FQI). The FQI is based on the number of native species and their "coefficient of conservatism", a number assigned to every aquatic plant in the State representing how typical the plant is in pristine conditions. The FQI is based solely on the presence of a plant, not its abundance or dominance. The average FQI for northern flowages is 28.3. The FQI for Peshtigo Flowage was 31.0 indicating a high quality aquatic plant population. The high FQI also shows that despite the EWM infestation diversity remains high.

Aquatic Plant Distribution

Each species of aquatic plant has habitat preferences that determine where it grows or potentially can grow. These include such factors as depth, light exposure and sediment type.

Depth

The area of a lake or flowage where aquatic plants can grow is called the littoral zone and is determined by water transparency (clarity) and light penetration. In Peshtigo Flowage the maximum depth of plant colonization in approximately 8 feet. At water depths from 1 to 6 feet nearly 100% of sites contained at least some vegetation. Plant frequency dropped to 62% at 7 feet and fell sharply to only 7% at the 8-foot depth.

In Peshtigo Flowage color, not suspended sediment or algae is primarily responsible for limiting transparency and light penetration. The light brown staining is caused by tannins; naturally occurring dissolved organic compounds that drain from wetlands throughout the watershed area.

Most of the major aquatic plant species, including common waterweed, wild celery, and EWM are most abundant in 2 to 6 feet of water and have a fairly uniform depth distribution. Lake cress, stonewort, and northern watermilfoil show a preference for deeper water (more than 4 feet deep), while the water lilies, bushy pondweed, and small pondweed show a slight preference for water less than 4 feet deep. For all species there is a sharp decline in aquatic plant abundance beyond the 6-foot depth.

Sediment

Sediment type also plays a major role in aquatic plant distribution and abundance. Sediment preference can be related to physical properties of the sediment (coarseness, grain size, compaction) or in the chemical properties of the sediment such as pH, or nutrient availability.

In Peshtigo Flowage Eurasian watermilfoil, small pondweed, stiff water crowfoot, water stargrass, clasping-leaf pondweed, and stonewort were found almost exclusively at sites with muck sediment. Wild rice, long-leaf pondweed, and white water lily were most abundant at sites with a sand & gravel substrate. Lake cress also showed a strong preference for sand & gravel or rock substrate.

Water flow

Aquatic plants also differ in their response to flowing water. Some plants are intolerant of flowing water, some are resistant to its effects, and others prefer it. The effects of flow and sediment type can be hard to separate. Generally where there is considerable flow the sediment will consist of sand & gravel or rock. At high flows sediment scouring can be sufficient to prevent all plant growth.

In the upper reaches of the flowage the effects of water flow can be seen on the distribution of plants. The center of the channel where current is greatest is often free of plants even where the water is less than 8 feet deep. Long-leaf pondweed and wild rice are both adapted to growing in flowing water and were common at the edge of the channel where water flow is significant.

Aquatic Plant Density

In addition to describing patterns of aquatic plant distribution in Peshtigo Flowage, the survey was designed to determine plant density (figure 4). At each sample point a rake "fullness" measure of 1 (sparse) to 3(abundant) was used to estimate aquatic plant density. Density was recorded for each species independently and for all plants in aggregate at each sample point.

Overall plant density averaged 2.3 at sties shallower than the maximum rooting depth (8 ft). However, density varied considerably by depth. From 0 to 2 feet deep the average plant density was 1.6. Between 2 and 7 feet the density increased to 2.4. Beyond 7 feet the average density dropped to 1.0.

Approximately 45 acres of the study area supported persistent emergent wetlands. Persistent wetlands have vegetation that remains standing through the winter. In Peshtigo Flowage the wetlands were dominated by broad-leaved cattail (*Typha lattifolia*) and/or common burreed (*Sparganium eurycarpum*). An additional 25 acres supported an extremely dense mix of floating-leaf and submersed vegetation. Flooded stumps and timber were also abundant throughout these areas. The combination made navigation with a propeller driven boat extremely difficult.

In areas that could be accessed by boat, density varied considerably by sediment type. Plants were abundant at mucky sites (2.4) but sparse at sites with sand & gravel (1.1) or rock (1.0).

The submersed "plant" with the highest average density was filamentous algae (2.3), which has a sprawling growth form and is not dependent on bottom type. In fact, the density of filamentous algae was greatest at sites with sand & gravel or rock substrate. Wild rice was the only other common plant with an average density above 2.0. Most of the dominant plants had an average density between 1.0 and 1.5, indicating a relatively diverse plant community without a single dominant species. Eurasian watermilfoil had an average density of 1.4.

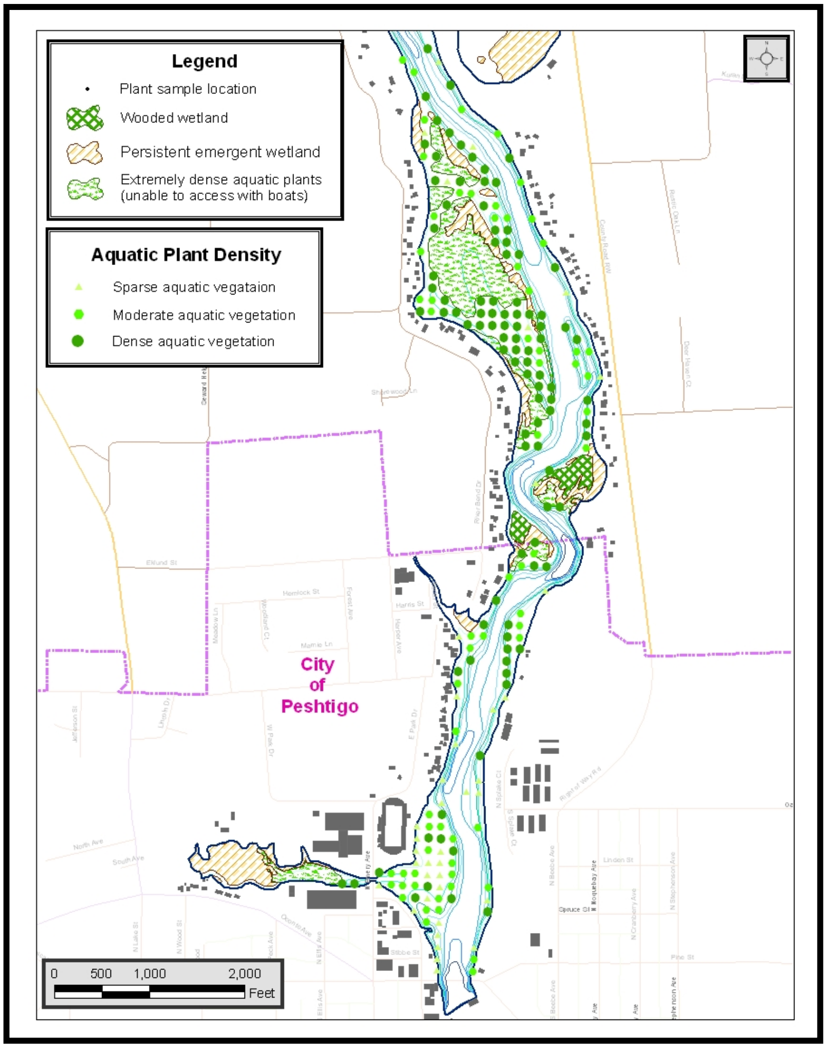


Figure 4. Aquatic Plant Density

Changes in the Aquatic Plant Community

One-time aquatic plant surveys are useful for describing the aquatic plant community but by themselves do not describe changes in the community. To identify changes the plant community needs to be tracked over time. The only other aquatic plant survey of Peshtigo Flowage was conducted in 1999 using a transect method. In the survey 15 transects were laid out along a line anchored to shore and extending perpendicular to shore beyond the maximum depth of plant growth, or to the opposite shoreline. Each sample plot, or "point", consisted of a rectangle one-meter long and 0.1 meters wide arranged along the line. A diver swam along the transect noting any plant species growing within each sample plot. In total, 307 individual "points" were surveyed using the transect method. While not directly comparable to the grid survey, the earlier transect survey does provide some basic information that can be used to make qualitative assessments of changes in the plant community over the last 12 years (figure 5).

Species richness was nearly identical in 1999 (30 species) and 2010 (29 species) and many of he same plants that dominated the flowage in 1999 are still dominant today including common waterweed, coontail, and Eurasian watermilfoil. Significant changes were seen in the frequency of several species. Eurasian watermilfoil was found at 63% of sample points in 1999 but only 21% in 2010. Variable-leaf milfoil also declined from 14% in 1999 to 3% in 2010. Most other plants increased in frequency, most notably flat-stem pondweed, which increased from 2% in 1999 to more than 31% in 2010.

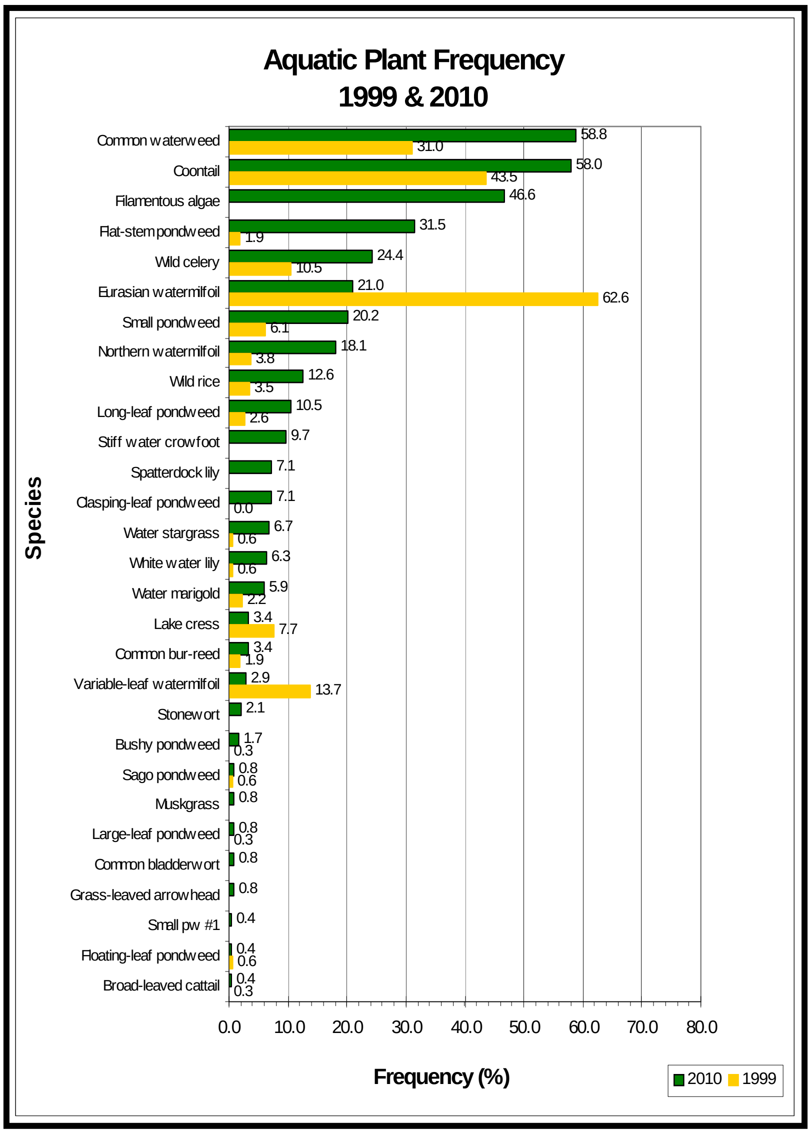


Figure 5. Comparison of plant frequency in 1999 and 2010.

History of APM Efforts & Review of Existing Harvesting Program

The City of Peshtigo has been managing aquatic plants in Peshtigo Flowage since the mid 1980's. Early efforts included aquatic herbicide use and mechanical cutting. Prior to 1990 the City treated the area between the boat landing and the beach several times using Aquathol and Diquat but were unhappy with the rapid reestablishment of plants and concerned about potential effects on the fish community. In 1989 the City purchased a Hockney weed cutter and invested a significant amount of time in cutting EWM and other aquatic plants in the vicinity of the public boat landing and beach. Weed cutting with the Hockney was abandoned in 1992 due in part to issues with cut plants clogging intakes at the Badger Paper Mill and the Peshtigo Dam (Sharpe, 1992).

In 1993 the City purchased a 5-foot Aquarius Systems weed harvester that is currently used to harvest aquatic plants within the Peshtigo City Limits. According to City Park and Recreation Director Dave Marquardt the City typically harvests plants two to three times per week as needed from late June to early September.

Records indicate that on an average year approximately 300 hours are spent harvesting aquatic plants. In 2010 the harvesting season was shortened by the late summer drawdown and harvesting was limited to 113 hours. A cool spring and lingering effects of the drawdown reduced nuisance aquatic plant growth in 2011 and harvesting fell to 84 hours.

According to Marquardt the harvesting effort has been concentrated on areas of dense EWM along the west side of the flowage within city limits (figure 6). These areas include most of the high use public areas and residential development. In the past harvesting was limited along the east side of the flowage due to a lack of residential development and the presence of lake cress, a State endangered species.

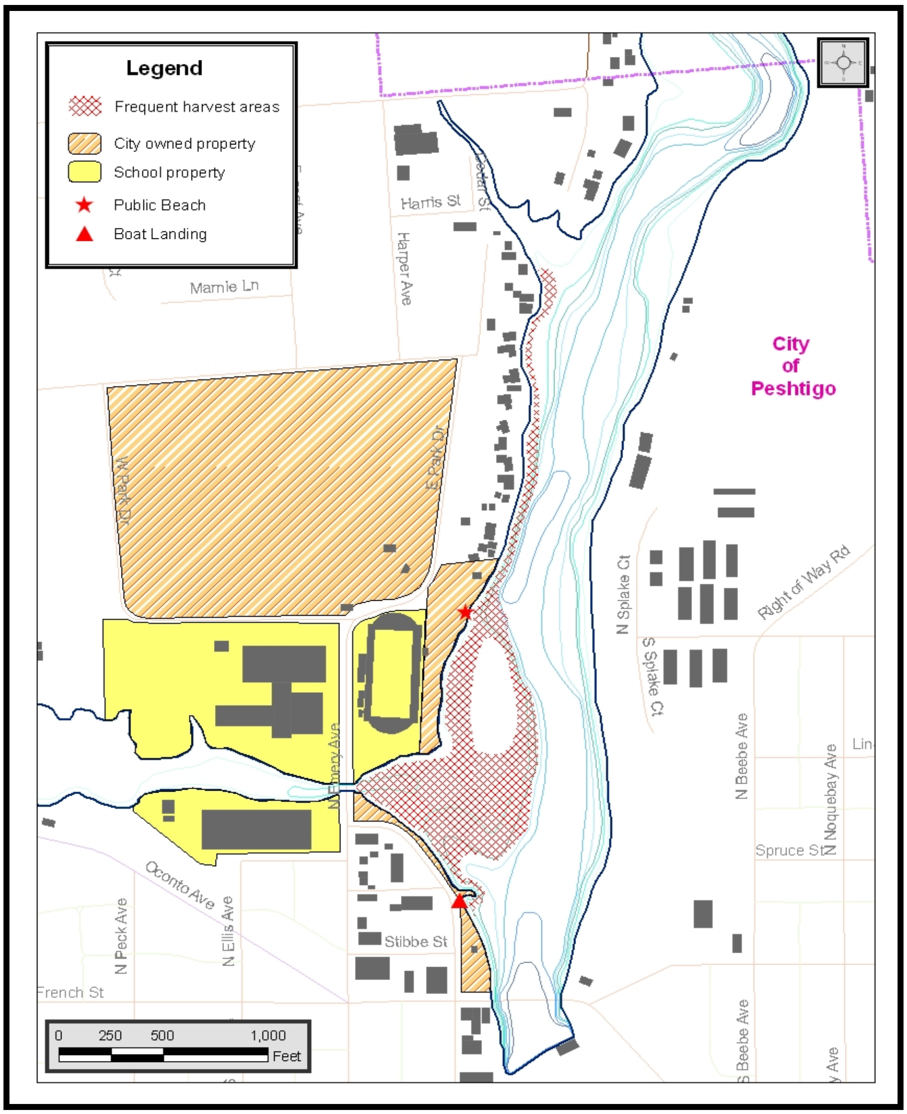


Figure 6. Primary harvest areas (1992 – 2011)

Identification of Problems and Threats to Peshtigo Flowage

Landowners and resource managers have clearly identified excessive aquatic plant growth as the most pressing concern on Peshtigo Flowage. Looking deeper, there are basically three separate but related problems, expansion of the EWM population, an overabundance of native aquatic plants, and nuisance algae growth. Other threats include new aquatic invasive species and nutrient enrichment.

Eurasian watermilfoil
The most pressing issue confronting Peshtigo Flowage is the continued expansion of EWM and the threat it poses to the native plant community, navigability, and recreational potential of the flowage. Without a long-term management effort EWM will continue to render much of the lower portion of the flowage impassable to boats and unsuitable for swimming and other recreational uses. Left to its own, EWM will also continue to expand into many areas of suitable habitat that still support native plant communities.

Dense native plants
Nuisance aquatic plant growth is a problem throughout much of the flowage, particularly in Trout Creek Pond and other areas off the main channel. While EWM is often responsible for nuisance conditions, native vegetation such as coontail, common waterweed, and water lilies are often the dominant plants. Nuisance conditions are exacerbated when the dense vegetation captures floating algae, watermeal and duckweed, creating a thick floating mat, often covering large expanses of the flowage (figure 7).

Figure 7. Thick mats of algae and duckweed cover large areas of Peshtigo Flowage.

Filamentous algae
In recent years filamentous algae has become a serious nuisance in Peshtigo Flowage. Most often the algae appear to start out as attached algae, which then float to the surface where they continue

to multiply and form a thick surface scum. Late in the season when the algae die the smell is awful, reminiscent of an open sewer.

Increasing reports of nuisance algae blooms from throughout the country indicate this problem is not unique to Peshtigo Flowage. Potential causes for the increase include more bright sunny days, warmer air and water temperatures, reduced flow, increasing nutrient inputs, and new species of algae. Of these, the only one that can be controlled is nutrient inputs.

Nutrient enrichment

The triple threat of increasing nutrient enrichment, reduced flows, and longer growing season is one shared by most area lakes and flowages. Although nutrient levels in Peshtigo Flowage are well below the statewide average for impounded waters, they are still considerably higher than would be expected in a natural lake. Within the main body of the flowage where the flushing rate is high algae flush out of the system before they can become a nuisance. In calm backwater areas where the flushing rate is low the system acts more like a nutrient rich lake with nuisance algae blooms.

The effect of high or increased phosphorus loading is compounded by long-term climate trends. The Wisconsin Initiative on Climate Change Impacts predicts slightly warmer summers, a continuing trend of less precipitation during the summer months and slightly warmer winters. Annual precipitation is not predicted to change greatly but the distribution is. The prediction is for a wetter spring and winter but a drier summer. Since phosphorus runoff is highest in the spring phosphorus loading may increase.

The net effect of these changes on lakes and flowages is a shorter period of ice cover, a longer and warmer growing season, and declining summer flow. All favoring increased aquatic plant and/or algae production.

Other aquatic invasive species

Future threats to Peshtigo Flowage include the introductions of new aquatic invasive species, many of which are found in nearby waters. The largest source for AIS is nearby Green Bay, home to dozens of harmful exotic species, all of which have the potential to impact Peshtigo Flowage. Peshtigo Flowage is also downstream from some of the most heavily used waters in Northeast Wisconsin where transient boaters are the rule. The following species are some of the most troublesome.

<u>Zebra mussels</u> (*Dreissena polymorpha*) can be found upstream in Lake Noquebay so they are probably already in the flowage. Zebra mussels are an attached bi-valve mollusk that feeds by filtering algae and zooplankton out of the water. In large numbers they can upset the food web by filtering out the beneficial algae and small zooplankton that form the base of the food web. Some studies have shown increases in blue-green algae after zebras mussel invasions because the blue-greens are larger and often float at the surface where they can avoid being eaten.

<u>Giant Reed</u> (*Phragmites australis*) has been a severe nuisance along Green Bay for many years. Declining water levels have left large areas of lakebed exposed. Phragmites is ideally suited to invading newly exposed lakebed where it has out competed virtually all native vegetation. Phragmites poses a serious threat to all wetlands in the region. Since phragmites is best at invading disturbed or degraded wetlands, maintaining a healthy undisturbed wetland is the best

defense against invasion. If phragmites does gain a foothold it should be controlled as soon as possible before it can spread. Chemical control is the most effective method.

Japanese Knotweed (*Polygonum cuspidatum*) is an invasive wetland species with large triangular leaves and 10-foot tall stems that look like bamboo. When established it forms impenetrable thickets along stream banks and lakeshores. It is an extremely aggressive plant with roots that reach 6 to 10 feet deep and rhizomes that can grow up to 60 feet in single season. Japanese knotweed was once planted as a landscape plant and has since escaped to the wild. During the aquatic plant survey Japanese knotweed was found growing along the shore of Trout Creek Pond adjacent to the practice field behind the elementary school.

Due to the extensive root system controlling Japanese knotweed is difficult. Best results have come with a combination of mowing or burning and multiple herbicide applications. Generally two to three seasons are required for eradication.

Curly-leaf pondweed (*Potamogeton crispus*) is a submersed aquatic plant that looks similar to some of the native pondweeds. It can be identified by its crispy “lasagna like” leaves with serrated edges. Curly-leaf pondweed has a unique growth pattern. In the fall it sprouts from turions in the sediment and continues to grow slowly throughout the winter. In the spring it begins rapidly growing, often becoming a nuisance by late May. In mid summer it forms new turions that detach and fall to the sediment when the plant dies back. By late July or August curly-leaf pondweed is in decline and can be difficult to find in late summer.

Curly-leaf pondweed is a serious nuisance in many southern Wisconsin lakes. To date, it is not widespread in the area but it has been seen in the Bay at Peshtigo Harbor.

Aquatic Plant Management Goals & Objectives

Develop and implement a sustainable aquatic plant management program for Peshtigo Flowage to prevent EWM dominance and control excessive aquatic plant growth where it restricts navigation and recreational use. To achieve these goals specific management objectives have been identified and targets have been set to gauge success and guide selection of management options.

Goal: Develop a sustainable aquatic plant management program.

A sustainable aquatic plant management program needs to be cost-effective and should, as much as possible, be relatively easy to repeat as needed. In determining cost effectiveness both management cost and duration of control should be considered. In the final analysis management efforts that cost more may be preferable if they provide multi-year control. Permitting requirements must also be considered and figured into the management cost.

Objective: <u>Place emphasis on aquatic plant management methods that provide multi-year control and reduce annual management costs.</u>

An aquatic plant management program that is sustainable over the long-term also needs to adapt as environmental conditions and the aquatic plant population changes. To make the required adjustments those responsible for making management decisions need current information upon which to base their decisions.

Objective: <u>Track changes in the aquatic plant population so past management efforts can be evaluated.</u>

The recommended frequency of plant surveys depends on the frequency of changes in management methods. When new management methods are adopted surveys should be completed to track changes and determine management effectiveness. Management activities funded through DNR grants typically require pre and post treatment aquatic plant monitoring.

Target *- Conduct pre and post management aquatic plant surveys to evaluate effectiveness of new management tools.*

When management is routine and no unexpected changes in the plant community are noticed, the amount of time between plant surveys can be lengthened considerably.

Target *- Conduct a full point/intercept survey of the flowage every 5 years unless conditions "on the ground" call for more frequent surveys*

In addition to formal point/intercept surveys the flowage should be routinely monitored for the early detection of new aquatic invasive species.

Target *- Conduct annual surveys of the flowage for new aquatic invasive species according to DNR aquatic invasive species monitoring protocol.*

For any management program to be sustainable waterfront property owners and those using the flowage need to understand and take ownership of the program. Good communication is essential so people are realistic about the expected outcomes and understand what they can do to help.

Objective: Communicate effectively with landowners, anglers and boaters.

Effective communication will require communicating information, goals and outcomes as well as providing educational materials to those using the flowage.

Target *–Inform the public about management practices and desired outcomes, and promote success stories.*

Target *- Provide educational materials promoting "lake friendly" living and aquatic invasive species prevention.*

Goal: Prevent EWM dominance in Peshtigo Flowage.

The impetus for the City of Peshtigo's existing aquatic plant management efforts was the introduction and rapid expansion of EWM. Currently EWM can be found in abundance throughout the flowage in water between 2 and 5 feet deep. Within the city limits EWM is primarily responsible for nuisance conditions.

There are no management tools currently available that will allow for the eradication of EWM in Peshtigo Flowage. Also, since EWM is very opportunistic and will quickly colonize suitable habitats, the most realistic objective is to reduce the abundance of EWM and minimize its nuisance potential.

Objective: Where possible, choose management practices that allow for selective control of EWM.

A plant can be "controlled" by reducing its frequency (where it is found) and/or by reducing its abundance (the amount or density at a location). Various management strategies differ in methods of control and in the potential to selectively control milfoil. The current harvesting program works primarily by reducing the abundance of milfoil and opening up the floating "canopy", allowing other native plants to grow. Some native plants have a lower growth form and seldom cause nuisance conditions. Promoting the growth of these good aquatic plants will alleviate nuisance conditions while preserving habitat.

Target *– Decrease EWM abundance in the flowage.*

Target *- Increase the frequency and abundance of low-growing species such as bushy pondweed, common waterweed, and other native species where experience shows them to be beneficial.*

Target *- Prevent the spread of EWM into areas that are currently dominated by pondweeds and other high quality native plants.*

Goal: Control excessive aquatic plant growth where it restricts navigation and recreational use.

Although EWM is the species primarily responsible for nuisance conditions in Peshtigo Flowage it's not the only species that restricts navigation and recreational uses. Coontail, common waterweed, and flat-stem pondweed were commonly found growing in such abundance that they would severely restrict boating and other recreational uses such as fishing or swimming. Floating algae, duckweed and watermeal also contribute to the problem. To improve habitat and maintain recreational uses of the flowage areas supporting dense vegetation at the surface should be managed even when dominated by native species.

Objective: <u>Manage excessive aquatic plant growth in high use areas such as the public beach, boat landing, and city owned water frontage.</u>

The public beach, boat landing, and city owned frontage all receive significant public use by swimmers, boaters, and shore anglers. All of these areas are located adjacent to shallow water areas that support dense aquatic plant growth. The area north of the boat landing at the mouth of Trout Creek sees heavy use by boaters and water skiers. Regular maintenance cutting or other control methods are required to prevent nuisance conditions.

Target *– Maintain navigational potential of the flowage within city limits.*

Target *–Eliminate vegetation from the public beach and reduce vegetation surrounding the beach to allow for better water exchange.*

Target *– Reduce excessive plant growth in near shore areas along city owned frontage to allow for improved shore fishing.*

Target *– Reduce nuisance vegetation in Trout Creek Pond to improve non-motorized boating and fishing access.*

Objective: <u>Manage excessive aquatic plant growth in navigation lanes and to provide access to docks.</u>

Dense aquatic plant growth severely restricts boat access to large areas of the flowage within the City of Peshtigo and in several upstream areas. This is particularly true along the west side of the flowage along River Bend Drive where, by late summer, it is difficult to navigate with any type of watercraft.

Target *– Maintain navigation lanes through dense vegetation along River Bend Drive.*

Target *– Maintain access to private docks.*

Target *– Reduce nuisance vegetation to improve fishing access.*

Aquatic Plant Management Alternatives

A successful aquatic plant management strategy must be tailored to the plants and water body in question and will typically utilize multiple control methods as appropriate. A comprehensive review of aquatic plant management alternatives follows. While each of the alternatives may be beneficial in certain situations, not all are currently applicable to managing aquatic plants in Peshtigo Flowage.

Do Nothing

Doing nothing is inexpensive, easy to do, and relatively uncontroversial. However, it rarely provides relief from the problem. Lakes and flowages are complicated ecosystems and aquatic plant populations fluctuate within them due to a variety of factors. Large-scale climactic conditions and local weather cycles can impact flow, temperature, and clarity, all of which effect aquatic plant growth. Plant populations also vary because of disease, species introduction, competition and other internal processes. Left to its own devices the plant community in Peshtigo Flowage will continue to change over time.

In the case of Eurasian watermilfoil, doing nothing typically leads to EWM domination of the aquatic plant community. While the EWM dominance is often thought to be permanent, the history of EWM in Wisconsin shows this is not always the case. Carpenter (1980) reported that the duration of peak abundance in some lakes is approximately 10 years after which EWM may experience a significant decline. While the reason for these “natural” declines in EWM abundance is poorly understood some attribute it to a native milfoil weevil (*Euhrychiopsis lecontei*), which feeds on milfoil species. Unfortunately this natural decline has not been seen everywhere and is often temporary. In some lakes EWM populations experience quite a bit of natural variability with periodic declines and subsequent increases without any active management.

The downside to doing nothing is that the result may be nothing. This option will result in a continuation of the problem in the short term. In the long term doing nothing will most likely result in expansion of EWM and a worsening of the situation.

Chemical Control

When properly planned and executed, chemical control of aquatic plants can be effective. However, if care is not taken in the selection timing, and application of aquatic herbicides the results can be less than desirable, or worse, have unintended negative consequences.

There are several herbicides approved for aquatic use in Wisconsin. Each differs in its mode of action and in the species it controls. Contact herbicides kill exposed plant material but can leave the root system intact, allowing for rapid recovery and plant growth. Systemic herbicides are transported to the roots and kill the entire plant. They provide longer-term control but may act more slowly than contact herbicides.

Herbicides can also be grouped into two general groups, “broad-spectrum” and “selective”. Broad-spectrum herbicides control a broad range of plants. Selective herbicides, as the name implies, are more-or-less selective and control fewer species while leaving many others unharmed. Often selectivity is a function of timing of application and/or concentration of the herbicide.

Eurasian watermilfoil (EWM) is susceptible to several common aquatic herbicides. Selective control can typically be achieved using 2,4-D, a systemic herbicide that many pondweeds are resistant to. The DNR typically requires 2,4-D applications be conducted prior to May 31 or before the water temperature at two feet reaches 65^{o} F. In Marinette County excellent control has been achieved by treating with 2,4-D as early as May 1 when EWM growth is just starting.

Chemical control of EWM is a popular and effective control measure where the goal is to shift the plant community to a more natural mix of native species. When used in a selective manner it is also possible to get multi-year control from herbicides. This is most likely to be achieved when the native community is relatively vigorous and can resist EWM reestablishment. Eventually EWM will return so even selective chemical control will have to be repeated on a regular basis.

Coontail (*Ceratophyllum demersum*) and filamentous algae are also responsible for nuisance conditions in the flowage. Chemical control of coontail can be achieved using several herbicides registered for use in Wisconsin. Hydrothol is one of the most effective but it has the potential to harm fish when applied at label rates for coontail control. Chemical control of filamentous algae is typically done using one of many herbicides containing copper compounds. Unfortunately, algae grows so rapidly that control measures often have to be repeated multiple times during the growing season.

Improper or excessive use of aquatic herbicides can have unintended consequences. Widespread use of broad-spectrum herbicides can leave large areas of suitable habitat exposed to colonization by nuisance species. Many of the more common nuisance plants, such as EWM, are aggressive pioneer species that can quickly invade disturbed areas. The decomposition of tons of aquatic plants also releases large amounts of nutrients to the water column. These nutrients can trigger algae blooms and fuel additional aquatic plant growth

Additional care must be taken when using aquatic herbicides in areas with a lot of water exchange (flowing water). For herbicides to work a minimum concentration of the active ingredient must be maintained in the treatment area for a sufficient period of time. If the water exchange rate is high the herbicide will be diluted before the contact time is achieved and control will be poor. Water flow can also carry the chemicals out of the treatment area and effect adjacent plants.

Chemical treatment cost depends on the chemical formulation and application rate, the distance a certified applicator has to travel, and the time and equipment involved. Currently (2012) EWM treatment with Navigate granular 2,4-D could be expected to cost between $700.00 and $1000.00 per acre depending on the water depth and size of the treatment area. In some instances the State of Wisconsin can provide funding for chemical treatment of Eurasian watermilfoil or other lake restoration activities recommended in a lake management plan approved by the DNR. Pre and post-treatment monitoring of the aquatic plant community is required when state cost-share dollars are used to support aquatic plant management efforts. Even without state funding it is a good idea to conduct pre and post-treatment monitoring to evaluate treatment effectiveness.

Chemical treatment of aquatic plants in Wisconsin always requires a permit from the Wisconsin DNR. This is to ensure that the proposed chemical treatment will use appropriate chemical(s), at the correct concentration and at the proper time of the year. In most situations the person applying the herbicide must be licensed by the Wisconsin Department of Agriculture Trade and Consumer Protection.

Benthic Barriers
Benthic, or sediment barriers cover the sediment and prevent the growth of aquatic plants. The barriers work by physically disrupting plant growth or eliminating light at the sediment surface. When installed properly benthic barriers are very effective at eliminating all plant growth. However the difficulty of installing and maintaining these barriers prevent their widespread use.

Benthic barriers can be made of naturally occurring materials (sand and gravel) or artificial (synthetic plastic sheeting). Sand or pea gravel is commonly used to create weed free swim areas. However, there are several common problems with sand and gravel benthic barriers. If deposited on soft sediment it can sink in and mix with the native sediment. Also, over time new sediment is deposited on top of the barrier. All of these factors will lead to failure of the barrier.

Artificial barriers typically consist of sheets of polypropylene, polyethylene, fiberglass or nylon (Wagner 2004). All must be weighted to hold them in place against water currents, waves, and boat wake. If constructed of non-porous material benthic barriers will be subject to billowing and may float free of the sediment as gasses from decomposition build up beneath them. Porous barriers are less subject to billowing but plant fragments that settle on top are better able to root through them. Both types of barriers require annual maintenance since sediment accumulation on top of the barriers will build up and support new aquatic plant growth.

Artificial benthic barriers are also relatively expensive and difficult to install and maintain. Maintenance consists primarily of annually removing accumulated sediment, which typically requires removal and replacement of the barrier. The use of any type of benthic barrier requires a DNR permit.

Automated Mechanical Bottom Disturbance
Several automated systems exist that control plants by physically disrupting them throughout the growing season. Modes of action include physically raking or rolling over the sediment, or spraying the sediment with jets of water. The Weed RollerTM is one of the more common devises. It has a central motor that attaches to a dock, boatlift or other fixed point. The motor slowly drives a series of cylindrical rollers back and forth across the bottom of the lake in an arc of up to 270 degrees. Fins on the rollers disturb the sediment and plants, removing existing plants and preventing the establishment of new ones.

In two studies weed rollers were found to cause a significant reduction in fine sediment and a nearly complete elimination of aquatic plants (James 2004, James 2006). Sediment displaced from the site was often deposited immediately outside of the impacted area.

These devices are only appropriate for small areas in shallow water to maintain swimming areas etc. Negative environmental impacts include sediment disturbance, which may lead to local increases in turbidity and suspended phosphorus. This may lead to major nutrient increases if the practice is widespread. While studies have not been conducted on the impact these devices have on aquatic organisms, the periodic bottom disturbance likely reduces or eliminates many aquatic insects and would surely prevent successful fish spawning in the impacted area.

Cost for the Weed RollerTM starts at approximately $3,000 for motor, mounting hardware, and a 21-foot roller (2009 pricing). Other comparable devises have similar price tags. This and other automated mechanical bottom disturbing devises require a Wisconsin DNR permit.

Dyes and Floating Covers

Dyes are liquid chemicals that are applied to change the color of the water. Covers physically cover the water surface. Both control aquatic plants by reducing the amount of light reaching the sediment.

Dyes typically color the water a deep blue or even black. For small ponds they are relatively inexpensive, long lasting, and effective. Effectiveness is limited in shallow water (2 feet or less) where the light reduction is seldom enough to prevent plant growth. Dyes must stay in the water throughout much of the growing season so they are not appropriate for use in flowing water.

Floating covers also disrupt plant growth by reducing light levels at the sediment surface. However, unlike dyes the floating covers prevent virtually all water use while they are in place. Floating covers can be difficult to install and effectively anchor.

Both dyes and floating covers require DNR permits. The main permitting issue with floating covers is the disruption of public water rights (fishing and navigation) that they cause while installed.

Harvesting

Aquatic plant harvesting is a widely accepted aquatic plant management alternative that can be effective on a large or small scale. Individual landowners often manually clear small areas around their dock or swim area. Typically this is accomplished by using one of several specially designed aquatic plant rakes and/or hand-held cutting implements. Under current Wisconsin Law landowners can manually harvest plants without a permit if the plant removal is not in a DNR designated sensitive area and is limited to a 30-foot wide area (measured parallel to shore). There is no limit on how far out into the lake a landowner can harvest by hand if they stay within the 30-foot wide corridor. The control area must be around existing piers, boat lifts, and swim rafts and the cut plants must be removed from the water.

In Peshtigo Flowage, large scale harvesting is done with a 1992 Aquarius Systems HM-220 Aquatic Plant Harvester. The HM-220 has a 5-foot wide cutter head and a maximum cutting depth of 5.5 feet. Approximately 6,500 lbs of vegetation can be cut and collected in one operation with the harvester.

Like most aquatic plant management alternatives harvesting seldom eliminates plants. Much like cutting your lawn, harvesting leaves the root system intact and plants will re-grow. In some cases repeated harvesting close to the sediment surface can stress plants enough to cause mortality. Species that depend on seed production for their spread may be partially controlled by harvesting if seeds are repeatedly removed. However, plants that spread by fragmentation such as EWM can actually be spread through harvesting when cut fragments escape the harvester and drift to other areas of the lake. Since EWM has been present in Peshtigo Flowage for more than 20 years and is already widespread, harvesting is unlikely to result in a significant worsening of the problem.

Plant re-growth depends on the species present, timing of harvest, and cutting depth. Studies have shown that very deep cutting (up to 10 feet) with specialized harvesters can even have multiple year effects on milfoil and other aquatic plants. In Peshtigo Flowage the maximum rooting depth is only 8 feet.

As a management tool harvesting is only minimally selective and most appropriate where nuisance species are dominant and widespread, such as in Peshtigo Flowage. Harvester operators can control where they cut but it is impossible to target individual species that grow in mixed assemblages. Repeated harvesting can have impacts on the aquatic plant community that go beyond the initial cutting. In Lake Noquebay repeated harvesting has led to measurable shifts in the aquatic plant community, shifting the population away from variable-leaf watermilfoil (*Myriophyllum heterophyllum*) in favor of the low-growing bushy pondweed (Druckrey 2009).

Large Scale mechanical harvesting is relatively expensive. Costs include operation and maintenance of equipment as well as capital equipment costs. A new harvester can range from $50,000 to $100,000 depending on the size of machine and options. Other necessary equipment includes a truck to transport plants to a disposal site and a shoreline conveyor to transfer cut plants from the harvester to the truck. Wisconsin does provide financial assistance for harvester and related equipment purchases through the Recreational Boating Facilities Grant Program. Grants are awarded on a competitive basis and cover 50% of equipment purchase price. The City of Peshtigo received grant funding in 1992 towards purchase of the existing harvester and shoreline conveyor.

Mechanical harvesting requires a Wisconsin DNR approved aquatic plant management plan and permit. The approved management plan is also a requirement for receiving a Recreational Boating Facilities Grant for equipment purchase.

Dredging

Typically a practice used for increasing depth to aid in navigation, dredging can also be an effective aquatic plant control technique. As a plant control measure dredging has two primary modes of action: changing sediment type, and increasing the depth to sediment.

Where a layer of nutrient rich organic sediment overlies a nutrient poor layer of mineral soil the organic layer can be removed to expose the sand or gravel layer that is less capable of supporting plant growth. Typically such removal will change the plant community structure, not eliminate all plant growth. Removing the upper layers of sediment also eliminates plant roots and most viable seeds. Unfortunately, the result of organic sediment removal is seldom long lived since many plants will colonize mineral soil where they quickly begin the process of building new organic matter. Very little organic matter is needed to support dense plant growth.

Eliminating all submersed aquatic plants requires dredging the lake to a depth where light availability limits plant growth. In Peshtigo Flowage the lower limit of aquatic plant growth is about 8 feet with sparse plant growth beyond the 7-foot depth.

There are two major types of dredging, hydraulic and mechanical. Hydraulic dredging is accomplished by pumping a slurry of sediment and water to a disposal/dewatering area where they are separated and the water is returned to the lake. Hydraulic dredging is best suited to loose organic sediment. Mechanical dredging employs heavy equipment deployed on barge or shore to dig out the sediment and transfer it to trucks for removal. Mechanical dredging can be simplified if done in conjunction with a drawdown since less water is moved. If a prolonged drawdown is possible conventional dry land excavating equipment can often be used.

It should come as no surprise that dredging is typically a very expensive alternative. Rough estimates for mechanical dredging range from $8.00 to $25.00 for each cubic yard (Wagner 2004).

Dredging in conjunction with a drawdown using conventional excavating equipment is much more cost effective than "wet" dredging using a barge mounted excavator or a dragline. The distance to an acceptable sediment disposal area is also an important factor in dredging cost.

Any type of dredging requires, at a minimum, a Wisconsin DNR and US Army Cops of Engineers permit. Permits must describe in detail the scope of the proposed dredging, dewatering and disposal of spoils, and the effects the project will have on fish, wildlife, and public water rights.

Drawdown

In impounded waters temporary drawdown can be a valuable aquatic plant management tool. Its effectiveness depends on the season and duration of the drawdown. Summer drawdown can kill some species of plants through desiccation of the root system but the duration of the drawdown has to be quite long to ensure adequate drying of the sediment. Organic sediment and untimely rains can make it nearly impossible to achieve sufficient sediment drying. Also, many plants are stimulated by changing water levels and actually increase with summer drawdown. A complete drawdown of the Peshtigo Flowage was conducted in August and September of 2010. Although a follow-up plant survey was not conducted, harvesting records indicate a reduction in overall aquatic plant growth during the summer of 2011.

Winter drawdown controls plants by exposing their root systems to freezing conditions. In winter the duration of the drawdown is less important than the timing. It is important that frost penetrates to the root zone before snow insulates the lakebed. The response of aquatic plants to drawdown is well known for some species but not for others. To complicate matters, accounts in the scientific literature do not always agree. Table 1 lists the species found in Peshtigo Flowage and their reported susceptibility to winter drawdown according to Cooke (2005), Konkel (2003) and local experience. As the table indicates, some aquatic plants are stimulated by winter drawdown.

The use of winter drawdown for EWM control in Wisconsin is very promising. The Wisconsin Public Service Corporation (WPS) conducted a drawdown of High Falls Flowage during the winter of 2001 for the purpose of Eurasian watermilfoil control. A 2001 plant survey found no EWM in 14 test plots that previously contained the plant. By 2005 the milfoil had re-colonized 5 of the plots but plant density was still much reduced (Shawn Puzen, pers. comm.). The duration of EWM control achieved by a single winter drawdown varies but has been reported as lasting for 3 - 5 years.

Typically Decrease	Variable/Unknown	Typically Increase
Eurasian watermilfoil	Common waterweed (V)	Wild celery
Variable-leaf watermilfoil	Small pondweed (V)	Bushy pondweed
Common bladderwort	Leafy pondweed (U)	Floating-leaf pondweed
Spatterdock lily	Stiff water crowfoot (V)	Water marigold
White water lily	Clasping-leaf pondweed (V)	Lake Cress
Coontail	Flat-leaf bladderwort (U)	
Flat-stem pondweed	Variable-leaf pondweed (V)	
Large-leaf pondweed	Muskgrass (V)	
	Sago pondweed (V)	
	Long-leaf pondweed (U)	
	Northern watermilfoil (V)	
	Wild Rice (U)	
	Water stargrass (U)	
	Common bur-reed (U)	

Table 1. Predicted effects of winter drawdown on aquatic plants found in Peshtigo Flowage.

The primary drawbacks to drawdown include loss of recreational use during the low water period (minimal with a winter drawdown) and potentially lowering water levels in shallow wells adjacent to the flowage. Other impacts may include unintended effects on fish and aquatic life. Starting the drawdown well before freeze up and gradually lowering the water level to allow aquatic organisms to seek refuge in deeper water can diminish fish and wildlife impacts.

Based on literature reviews and local experience it appears that a periodic winter drawdown of 6 to 8 feet would be an effective tool for EWM management on Peshtigo Flowage. This would expose most areas of EWM growth. Additional benefits could be seen in the reduction of floating-leaf vegetation and coontail, which are dominant in many bays and backwater areas upstream from the city limits.

While drawdowns are an effective aquatic plant management tool, they are typically only done for hydro dam maintenance and repair. To conduct a drawdown for EWM management the Peshtigo Flowage the City of Peshtigo and affected landowners need to work closely with the hydro dams owner, Wisconsin Public Service Corporation. The Federal Energy Regulatory Commission (FERC) licenses the Peshtigo Dam and would need to issue a permit for any proposed water level fluctuations. The Wisconsin DNR also needs to approve any changes in water level management.

Control/Reduce Nutrient Inputs
Aquatic plant response to nutrient input varies by species and source of nutrients. For the most part, rooted aquatic plants absorb their nutrients through the root system so nutrient additions to the sediment are more important than dissolved nutrients in the water column. Studies have shown that many aquatic plants are particularly stimulated by nitrogen and phosphorus additions to the sediment (Barko 1986). Rogers (1995) reported that nitrogen additions to sediment from groundwater significantly increased wild celery growth. Nitrogen is a water-soluble nutrient, which can become elevated due to intensive irrigation, excessive use of nitrogen fertilizer, and from septic systems. The use of fertilizers in an urban setting is also a major contributor of phosphorus and nitrogen to lakes.

Due to the high water exchange rate in Peshtigo Flowage the effects of nutrient runoff or groundwater additions from septic systems are most likely to show up away from the main channel in large bays and backwater areas where the water exchange rate is reduced. The excessive aquatic plant and algae growth in Trout Creek Pond and the bay along Rive Bend Drive may be exacerbated by excessive nutrient inputs.

Recently the State of Wisconsin severely restricted the use of phosphorus in lawn and garden fertilizer and recommended reductions in the use of nitrogen fertilizer to protect surface waters. Restricting fertilizer use is especially important near lakes since nutrient rich runoff from these areas is more likely to be delivered directly to the water.

Reducing runoff volume is also important in controlling nutrient inputs to the lake. Since most of the increase in nutrient load is a result of increased runoff volume, it stands to reason that decreasing the amount of impervious surface and taking steps to increase the amount of infiltration will protect water quality. Many of the practices designed to decrease runoff volume also remove nutrients from the runoff.

Biological Plant Control
Biological control (biocontrol) typically utilizes bacteria, fungi, or insects to control an unwanted plant. Biocontrol of exotic species often involves finding the natural control mechanism in the exotic plants country of origin and importing it to the US. Since there is always a risk that introducing a new organism may lead to unintended impacts to non-target species a lot of study is required to approve the use of new biocontrol agents.

In a rather unusual twist, one of the most promising biocontrol agents for Eurasian watermilfoil is a native insect. The milfoil weevil (*Euhrychiopsis lecontei*) is a native species that normally feeds on northern water milfoil. The adult weevil lays its eggs on the growing tips of milfoil where the larvae feed and weaken the plant. Older larvae also burrow into the stems, often causing enough damage to cause the plants to loose buoyancy and sink. The stout stems and shoots of northern water milfoil typically show little damage from this feeding activity. Eurasian water milfoil however has relatively weak stems that are readily damaged by the insect. Studies have shown that milfoil weevils actually prefer EWM and increase in population when EWM is the dominant food source (Lillie, 1997). It's believed that the natural decline in EWM infestations in some lakes may be due to the native milfoil weevil that is reportedly widespread in Wisconsin lakes (Jester, 1998).

Since its discovery as a control agent "stocking" milfoil weevils to control Eurasian watermilfoil has been used with mixed results. In Wisconsin it was found that in twelve lakes where weevils were stocked a few experienced large-scale milfoil declines while others saw little or no change (Jester 1999). Several factors seem to affect the success of EWM biocontrol. Jester found better results when EWM had already reached its maximum distribution. The study also found that weevil density was positively correlated with increasing water temperature, distance of plant beds from shore (closer was better), and the percent of natural shoreline. The amount of natural shoreline is important because the adult weevils overwinter in leaf litter on the forest floor along the waters edge. Other studies have found that sunfish species (bluegill, pumpkinseed etc.) are very efficient predators of milfoil weevils and play a major role in reducing their effectiveness (Newman 2004, Ward 2006). Environmental factors such as winter severity, disease, etc. can also affect weevil abundance and may play a role in the inconsistent biocontrol results.

Where successful, biocontrol can reduce the abundance of EWM and allow the native species to better compete. However, the expense ($1.00 per weevil) and highly variable results make it hard to recommend weevil stocking as a control measure. Also, even in lakes were biocontrol has been effective the declines in EWM biomass have often been temporary. This may be due to natural cycles in weevil abundance or other environmental factors.

Little is known about the prevalence of milfoil weevils in flowages. While there is probably no historical population, they may have found their way into the flowage over the years since northern watermilfoil is native to the water. However, milfoil weevils are also reportedly poor swimmers so they may not find flowing water hospitable.

Exotic Species Monitoring and Prevention
As is often the case, an ounce of prevention is worth a pound of cure. With aquatic invasive species this is doubly true. In most lakes, and for most exotic species, the primary mode of introduction is by boat, boat trailer, or bait bucket. While public access points are particularly susceptible, many exotic species have been introduced on lakes without public access.

Once established in a water body it is extremely difficult to eradicate an aquatic invasive species. In the few cases where eradication has been successful the introduction was detected early. For this reason routine monitoring to detect new invasive species is an important step in any aquatic plant management effort. The Wisconsin DNR and University of Wisconsin Extension have many good publications and websites to help the layperson identify exotic species. Periodically these agencies also offer exotic species identification and control workshops.

Aquatic Plant Management Recommendations

Since the City has already invested a great deal of time and money in a successful aquatic plant harvesting program the plan should focus on increasing the efficiency of aquatic plant harvesting. At the same time, the City should explore all available options to control Eurasian watermilfoil and improve navigation and the recreational potential of Peshtigo Flowage.

Many of the following recommendations refer to the aquatic plant harvesting plan map (figure 8), which divides the flowage into management zones. Table 2 describes management measures within each zone. Large scale harvesting plan maps can be found in Appendix B

Recommendation #1 – Continue harvesting to maintain the navigational potential of Peshtigo Flowage and to provide access to docks and high use areas.
The areas of Peshtigo Flowage that support heavy plant growth have been outlined in figure 6. The City should continue to implement the harvesting program described in table 2 to provide relief from excessive aquatic plant growth in high use areas.

Recommendation #2 – Where possible, selectively harvest areas dominated by EWM to benefit native vegetation and improve fishing.
Outside of high use areas and navigation lanes aquatic plant harvesting should be done to favor the growth of native aquatic plants. Where possible remove dense EWM and leave areas dominated by larger pondweeds and other beneficial native plants.

Recommendation #3 – Protect emergent vegetation.
Emergent vegetation provides important fish and wildlife habitat. Areas supporting emergent vegetation such as cattails, burreed, and wild rice should be avoided when harvesting.

Recommendation #4 – Protect lake cress.
Lake cress is a state endangered species that should be protected. Since lake cress is most often found growing in association with wild rice and other emergent vegetation it should be easy to protect if emergent vegetation is avoided.

Recommendation #5 –Explore alternate methods to control nuisance aquatic plant growth in Trout Creek Pond.
In most years, dense vegetation, algae, and duckweed combine to make Trout Creek Pond one of the most unappealing parts of the flowage. Since the harvester cannot fit under the bridge to access Trout Creek Pond (Figure 5) alternate methods should be pursued. Herbicide use will likely be limited to periods of minimal water flow. Although expensive, dredging would offer long-term control.

Recommendation #6 – Take advantage of state cost-share dollars to upgrade equipment and implement AIS management plans.
The Wisconsin Waterways Commission continues to provide 50% cost-share assistance for the purchase of aquatic plant harvesting equipment through the Recreational Boating Facilities Grant Program. The state retains an interest in the equipment for 10 years after which time the grant recipient has full ownership of the equipment. The City should consider replacing its 20-year old harvester with a new model. To take maximum advantage of the grant program the City should

apply for a new grant every 10 years then sell the used equipment while it still has excellent resale value.

Aquatic Invasive Species Control Grants are also available through the DNR to implement AIS control programs where established populations are found. The grants are competitive and require a DNR approved aquatic plant management plan.

Recommendation #7 – Explore winter drawdown as an aquatic plant management tool.
The use of periodic winter drawdown for the long-term control of EWM has worked well in nearby waters and should be explored as an option for Peshtigo Flowage. The City should work with closely with Wisconsin Public Service Corporation and the appropriate regulating agencies (FERC and Wisconsin DNR) to explore the possibility of a winter drawdown

Recommendation #8 – Apply for grant funding to dredge key areas of the flowage for long-term control of nuisance plants.
While expensive, dredging can provide long-term control of aquatic plants. The city should explore grant opportunities to dredge Trout Creek Pond and other high use areas such as the beach and the large shallow area at the mouth of Trout Creek.

Recommendation #9 – Explore alternative management options as they become available.
While harvesting is currently the most cost effective method of controlling aquatic plant growth in the flowage, changes in the plant community and new developments in aquatic plant management may call for new approaches. The City should keep and open mind and evaluate alternatives as conditions change and new management options become available.

Recommendation #10 – Explore cooperative agreements to provide aquatic plant management services outside of the City limits.
To better manage the whole flowage, the City should explore a cooperative agreement with the Town of Peshtigo or affected waterfront property owners upstream from the City to provide relief from nuisance plant growth outside of the City limits.

Recommendation #11 – Support measures to reduce runoff pollution to Peshtigo Flowage.
The City should support measures to reduce agricultural and urban runoff to reduce nutrient loading to Peshtigo Flowage. Within the City, stormwater controls should be installed to increase infiltration and reduce nutrient loading to the flowage. In the Peshtigo River watershed, and particularly in the Trout Creek subwatershed, the City should support state and federal programs to reduce runoff pollution.

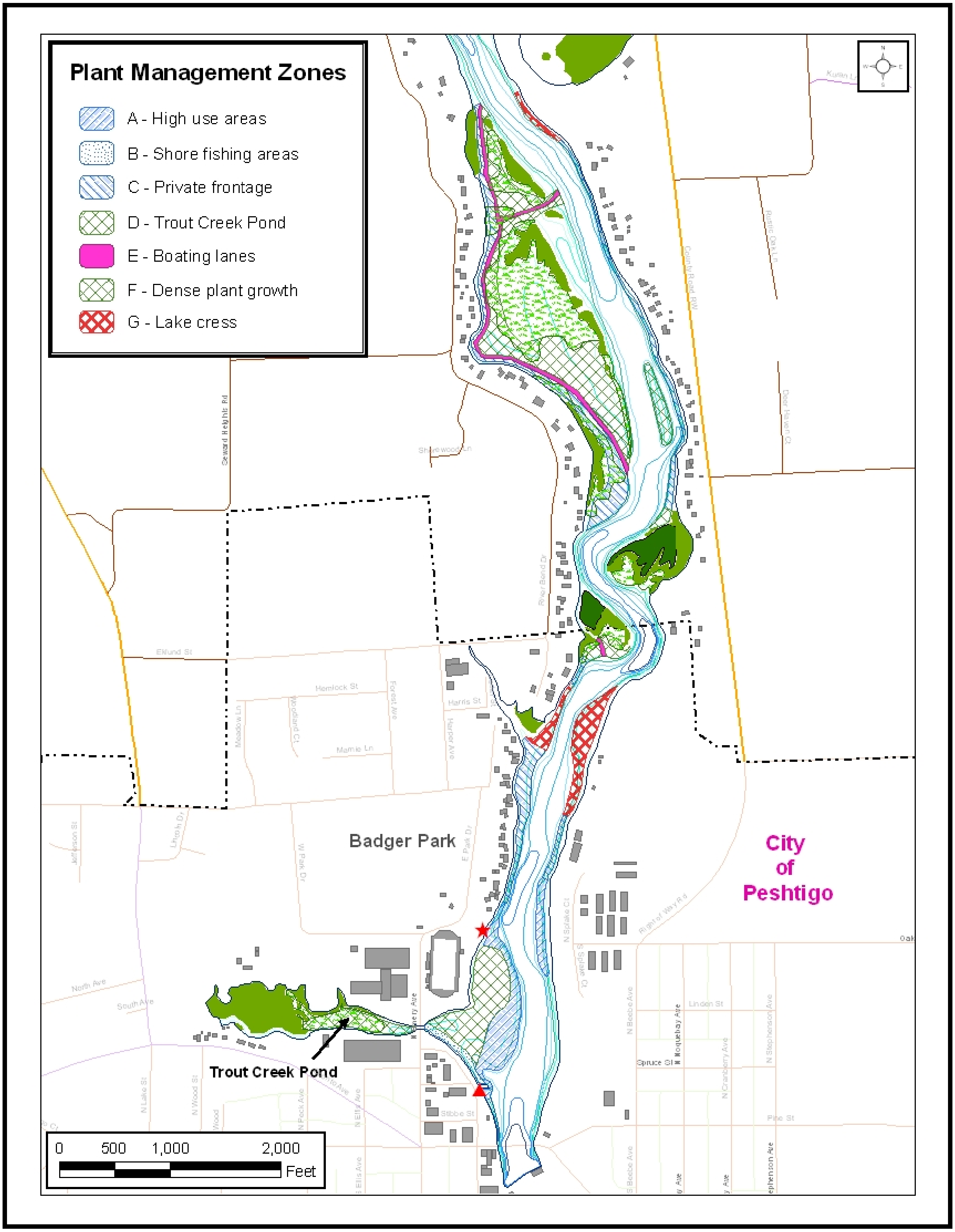


Figure 8. Aquatic plant harvesting plan map for Peshtigo Flowage.

Zone		Acres	Description & Management Measures
A	**Areas of high public use**	**7**	**Areas of the flowage that receive heavy boat traffic, the public boat landing, and public beach. Boat traffic is primarily from skiers and pleasure boaters. These areas support dense submersed aquatic vegetation including EWM.**
			Harvest aquatic plants as needed to prevent EWM and native vegetation from restricting use of these important areas.
B	**Public shore fishing areas**	**1.2**	**Areas popular with shore anglers.**
			Improve fishing opportunities by harvesting lanes perpendicular to shore through dense vegetation. Where possible, remove EWM and leave native plants.
C	**Private frontage**	**13.3**	**Private developed shoreline frontage. Aquatic plant density varies in this zone from minimal to extremely dense.**
			Harvest vegetation to allow for access to docks and swim areas.
D	**Trout Creek Pond**	**2.7**	**Extremely dense vegetation that gets stagnant and very unattractive in the summer. The area is inaccessible to the harvester.**
			Use chemical control when flow is minimal or explore other options such as dredging.
E	**Boating lanes**	**2.8**	**These areas support extremely dense submersed aquatic plant growth as well as scattered floating-leaf vegetation. A mix of EWM and native species is dominant in these areas.**
			Periodically harvest plants to provide a 20 to 30 foot wide lane for boat access.
F	**Heavy aquatic plant growth**	23.8	**"Other" areas of dense aquatic plant growth.**
			Harvest areas supporting dense EWM growth as time and budget allows. Harvest lanes for fishing access.
G	**Lake cress areas**	**4.9**	**Areas supporting lake cress (*Armoracia aquatica*), a State endangered species.**
			No harvesting except to provide a 30-foot wide access corridor to docks.

Table 2. Recommended aquatic plant management measures for Peshtigo Flowage.

Monitoring and Evaluation Plan

In order to evaluate and make changes to the management program the City needs to keep detailed management records and track changes in the aquatic plant community. The aquatic plant management program for Peshtigo Flowage needs to be evaluated on a regular basis and changed to meet shifting needs and address new challenges.

Recommendation #4 – Improve record keeping to better evaluate the harvesting program.
Improving record keeping is a quick and inexpensive way to collect important data that will allow the City to evaluate the harvesting program and make necessary changes. The harvester operator should collect the following information on a daily/weekly basis:

- Size and location of all areas harvested (a handheld GPS unit can assist with area calculations).
- Number of harvester loads taken from each area.
- Hours spent harvesting the area.

The previous information should also be collected for shoreline cleanup activities. A sample harvest record sheet is included in appendix B.

Recommendation #2 – Conduct periodic aquatic plant surveys to track changes in the flowages aquatic plant community and evaluate management practices.
Aquatic plant surveys are valuable tools, essential in evaluating new and ongoing aquatic plant management practices. Survey frequency should be dictated by changes in management practices and changes in the aquatic plant community. Assuming no new invasive aquatic species introductions or obvious changes to the aquatic plant community a complete survey of the flowage should be conducted in 2020 and every 8 to 10 years after that. If new aquatic invasive species are discovered, or if unexplained changes in the plant community are noticed a new survey should be conducted immediately. Likewise changes in management practices should be accompanied by aquatic plant surveys to evaluate practice effectiveness. Often these surveys can be conducted on a few representative areas where management changes are implemented.

Future aquatic plant surveys should be conducted according to Wisconsin DNR aquatic plant survey protocols. Lake-wide surveys should utilize the same sample locations used in 2010. Surveys designed to evaluate new management tools should be conducted before and after treatment and should be scaled appropriately to accurately describe the plant community. DNR or County Land & Water Conservation Department staff should be consulted when designing survey methods.

Recommendation #3 – Evaluate the harvesting program and new aquatic plant management practices on an annual basis.
The City of Peshtigo Parks and Recreation Committee evaluate the harvesting activities on a regular basis. The Committee should continue to review harvesting data and the plant community and recommend changes to the aquatic plant management program as needed.

Information & Education Plan

A strong information and education effort is an important part of any AIS prevention program. It is also important to effectively communicate with concerned stakeholders when trying to implement a flexible aquatic plant management plan.

Recommendation #1 – Maintain signage at the boat landing and provide educational materials to visitors to Peshtigo Flowage.
Maintain educational signage at the public boat landing to inform visitors to Peshtigo Flowage about the danger of AIS and how they can help prevent the spread. Signage should be clear and uncluttered. Handouts should be provided through the "Clean Boats, Clean Waters" program during busy periods. Signage and educational materials can be obtained from the Peshtigo DNR office or on line at Wisconsin Lakes Partnership website **http://www.uwsp.edu/cnr/uwexlakes/CBCW/pubs.asp** .

Recommendation #2 – Promote formation of a Peshtigo Flowage Association to assist in educational efforts and other AIS management efforts.
While the City may be the appropriate agency for operating the harvesting program, a separate Lake Association would be able to promote AIS prevention and lake friendly living, coordinate community events to promote the flowage, and bring property owners together. Lake Associations are eligible to receive state AIS education and lake management planning grants.

Aquatic Invasive Species Prevention, Monitoring and Rapid Response Plan

Locally, Marinette County is at the front lines of a rapid expansion of Eurasian watermilfoil (*Myriophyllum spicatum*) and curly-leaf pondweed (*Potamogeton crispus*). Even more concerning is the fact that Peshtigo Flowage is less than 10 miles from the Bay of Green Bay, which is home to almost every invasive aquatic species in the Midwest! The best way to deal with these invaders is to be proactive and prevent their introduction. The City should also adopt an aquatic invasive species monitoring plan to detect early invasions and a rapid response plan to deal with new invasive species if they are found.

Prevention

An effective AIS prevention plan should focus on the most common routes of AIS invasion, boats, and water gardens. Boats traveling between lakes can carry plant fragments or exotic mussels attached to the boat or trailer. Water in the boat or bait buckets can carry plants, snails, mussels, zooplankton, algae, and disease causing organisms. While the information and education program can provide valuable information regarding the spread of AIS a more effective case can be made when delivering the message face-to-face.

Recommendation #1 – Participate in the "Clean Boats, Clean Waters" watercraft inspection and information program.

Volunteers should be trained to conduct watercraft inspections at Peshtigo Flowage public landings and talk to boaters about the danger of spreading invasive species. State grant funding is available to conducting "CBCW" watercraft inspections. Many lake management organizations partner with local scout or other youth organization to conduct watercraft inspection and education programs.

Recommendation #2 – Promote/support watercraft inspection and AIS education at nearby source waters.

Studies show it is more efficient to target AIS efforts at the source waters than at the receiving water. In Marinette County the most likely source waters are Green Bay, High Falls Flowage, Cauldron Falls Flowage, Lake Noquebay, and the Menominee River Flowages. The City should promote and support AIS education and watercraft inspection efforts at these waters.

Recommendation #3 – Focus education efforts on the most common modes of AIS introduction.

The most important pathway for introduction of AIS is through the movement of watercraft between waterbodies. Increasingly, however, intentional and unintentional introductions have been traced to private water gardens. A recent investigation of the water garden industry found that plants known to be invasive are available and routinely shipped around the country. Contamination of orders with other species, including invasive species, is also rampant (Maki, 2004). AIS education efforts aimed at lake residents and visitors should focus on these modes of infestation.

Recommendation #4 – Keep current on AIS prevention and management strategies.

Work with the Marinette County AIS coordinator and the Peshtigo DNR office to maintain current knowledge of evolving AIS threats, prevention strategies, and management strategies. The Wisconsin DNR website **http://dnr.wi.gov/invasives/** contains up-to-date AIS information and regulations (Chapter NR 40).

Monitoring

Effective management of AIS is much easier when the invader is detected early. In some cases it may even be possible to eradicate an invasive species if it is discovered early enough.

Recommendation #1 – City weed harvesting staff should be trained to conduct aquatic invasive species monitoring.
All City harvesting staff should be trained to identify aquatic invasive species. The Marinette County LWCD in cooperation with the Citizen Lake Monitoring Network (CLMN) holds workshops to train volunteers in AIS monitoring protocols. The Citizen Lake Monitoring website contains valuable AIS monitoring tools and information (http://www4.uwsp.edu/cnr/uwexlakes/clmn/). AIS monitoring workshop participants receive instructions and materials needed to monitor for the presence of several aquatic invasive species including plants, snails, minnows, mollusks, and zooplankton.

Recommendation #2 – AIS monitors should conduct annual AIS surveys of the Flowage.
Aquatic plant surveys, although very beneficial, are not designed to find many types of aquatic invaders and may even miss pioneer plant invasions. A better method is to look specifically for different invasive species at the optimal time of year and in the most likely habitats. The ideal monitoring time varies by species but can typically be covered with one early season inspection and one late season inspection.

Trained volunteers should conduct annual invasive species surveys. Findings should be reported to the City and the Citizen Lake Monitoring Network. The harvesting crew should carry AIS identification material on the harvesters and marker buoys that can be quickly deployed to mark suspicious plants.

If possible, implement an adopt-a-shoreline strategy to watch for new aquatic invasive species and/or document EWM growth. Adopt-a-shoreline is a volunteer program where individuals adopt a section of shoreline and monitor it for AIS infestations etc. Information concerning adopt-a-shoreline programs is available through the Citizen Lake Monitoring Network.

Recommendation #3 – Report any suspected aquatic invasive species to local resource professionals. If any suspected exotic species are found report it immediately to the Peshtigo DNR office or the County LWCD. Collect a sample of the invasive species for positive identification (keep samples wet and refrigerated), and mark or record the location of suspect plants.

Rapid Response

When a new invasive species is positively identified the City needs to act quickly. Depending on the species found, length of time since invasion, and where the pioneer colony is found, there may be a possibility for eradication. The following steps should be followed:

Step #1 – Notify City officials and local resource agencies and explore grant funding opportunities.
The Mayor, City Council, or appropriate committee should arrange a meeting with the Wisconsin DNR as soon as possible to explore control measures and determine if obtaining an AIS Rapid Response grant is appropriate. These grants were designed to deal with pioneer AIS infestations. The typical grant application process is bypassed so grant funds can be made available within weeks in hopes of eradication.

Step #2 – Notify the public of the discovery and what the City plans to do about it. Notify the public about the discovery and advise them of any measures they can take to prevent its further spread within the flowage or to other waters. Let them know how the City plans on dealing with the invasion.

Step #3 – Conduct a thorough survey of the flowage to determine the extent of the AIS infestation. Working with County LWCD or DNR staff, conduct a thorough survey of the flowage. Map location of the invasive species and record its density as well as any other physical data that may be important such as water depth, sediment type etc.

Step #4 – Determine if eradication is a possibility or if management is the only option. Work with local resource agencies and outside experts where necessary to determine if eradication is possible. Where eradication is not feasible begin revising the AIS management plan to deal with the new species.

Step #5 – Develop an action plan based on species and extent of invasion. Work closely with the experts to develop a customized plan aimed at eradication or control. If outside consultants are needed for things like herbicide treatment or scuba diving bring them into the process. Many consultants can also help with things like mapping and planning.

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Appendix A

Peshtigo Flowage Aquatic Plant Community Data

STATS

Peshtigo Flowage
Marinette
515800
07/20/10

INDIVIDUAL SPECIES STATS:

	Total vegetation	Myriophyllum spicatum	Potamogeton crispus	Filamentous algae	Ceratophyllum demersum	Nuphar variagata	Valisinaria americana	x	Elodea canadensis	Potamogeton. zosteriformis	Bidens beckii	Potamogeton richardsonii	Armoracia lacustris	Potamogeton nodosus	Myriophyllum heterophyllum
Frequency of occurrence within vegetated areas (%)		23.47		52.11	64.79	7.98	27.23		65.73	35.21	6.57	7.98	3.76	11.74	3.29
Frequency of occurrence at sites shallower than maximum depth of plants		21.01		46.64	57.98	7.14	24.37		58.82	31.51	5.88	7.14	3.36	10.50	2.94
Relative Frequency (%)		5.8		12.8	16.0	2.0	6.7		16.2	8.7	1.6	2.0	0.9	2.9	0.8
Relative Frequency (squared)	0.09	0.00		0.02	0.03	0.00	0.00		0.03	0.01	0.00	0.00	0.00	0.00	0.00
Number of sites where species found		50		111	138	17	58		140	75	14	17	8	25	7
Average Rake Fullness	2.30	1.38		2.33	1.64	1.41	1.60		1.53	1.36	1.57	1.71	1.25	1.08	1.57
#visual sightings		7			1	10				5	2	3	1	8	3
present (visual or collected)		present		present	present	present	present		present	present	present	present	present	present	present

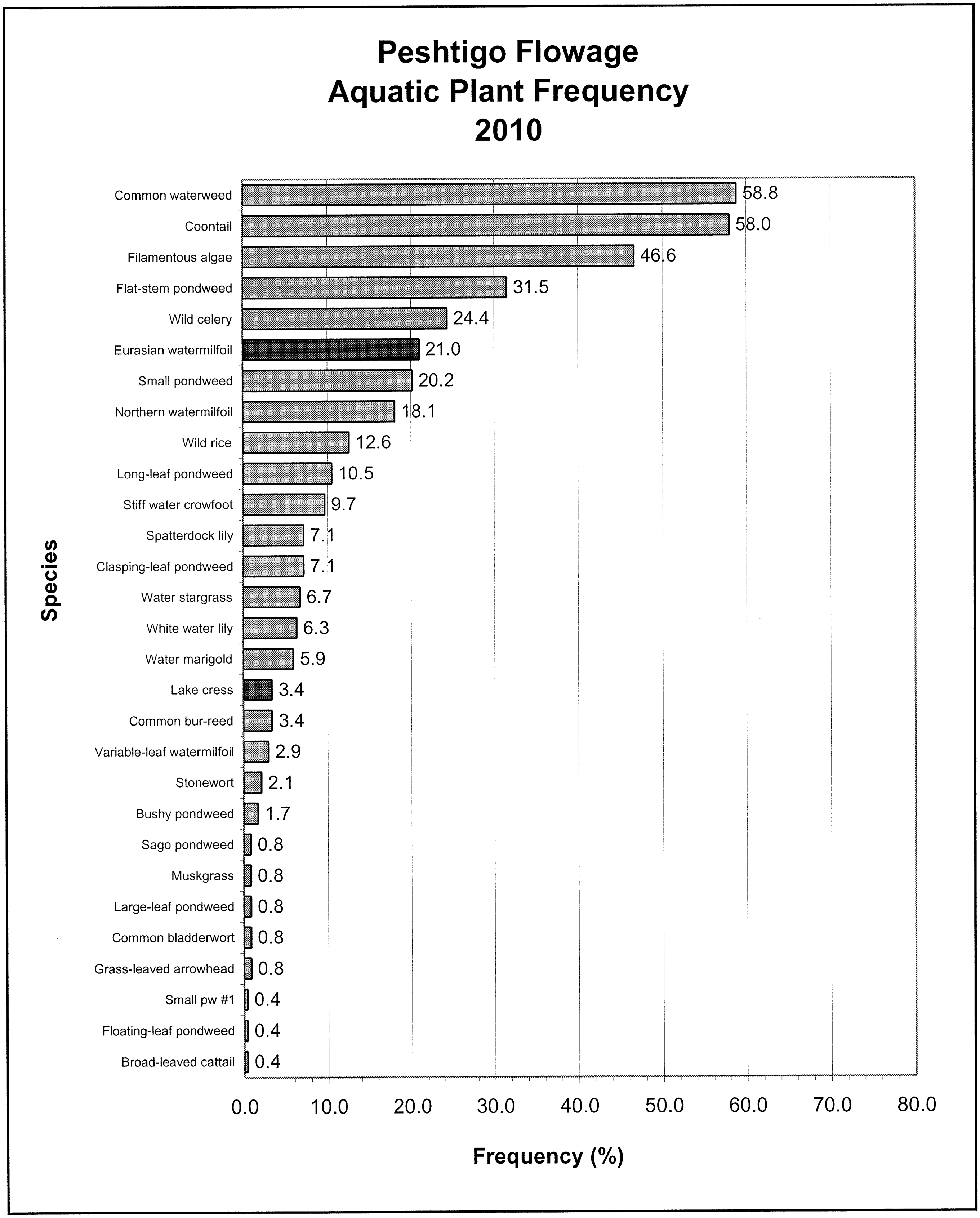
	Myriophyllum sibiricum	Potamogeton pectinatus	Zosterella dubia	Rannunculus longirostris	Chara spp.	Potamogeton amplifolius	Zizania	Nymphea odorata	Small PW 1	Potamogeton natans	Sparganium eurycarpum	Najas flexilis	Potamogeton pusillus	Equisitrum fluviatile	Typha latifolia	Nitella spp.	Utricularia vulgaris	Sagittaria graminea	X
Frequency of occurrence within vegetated areas (%)	20.19	0.94	7.51	10.80	0.94	0.94	14.08	7.04	0.47	0.47	3.76	1.88	22.54		0.47	2.35	0.94	0.94	
Frequency of occurrence at sites shallower than maximum depth of plants	18.07	0.84	6.72	9.66	0.84	0.84	12.61	6.30	0.42	0.42	3.36	1.68	20.17		0.42	2.10	0.84	0.84	
Relative Frequency (%)	5.0	0.2	1.8	2.7	0.2	0.2	3.5	1.7	0.1	0.1	0.9	0.5	5.5		0.1	0.6	0.2	0.2	
Relative Frequency (squared)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	
Number of sites where species found	43	2	16	23	2	2	30	15	1	1	8	4	48		1	5	2	2	
Average Rake Fullness	1.51	1.50	1.19	1.09	1.00	1.00	2.07	1.13	1.00	1.00	1.25	1.00	1.10		1.00	1.00	2.00	2.00	
#visual sightings		1	4			1	6	7			2	1	1	1			1	1	
present (visual or collected)	present	present	present	present	present	present	present	present	present	present	present	present	present	present	present	present	present	present	

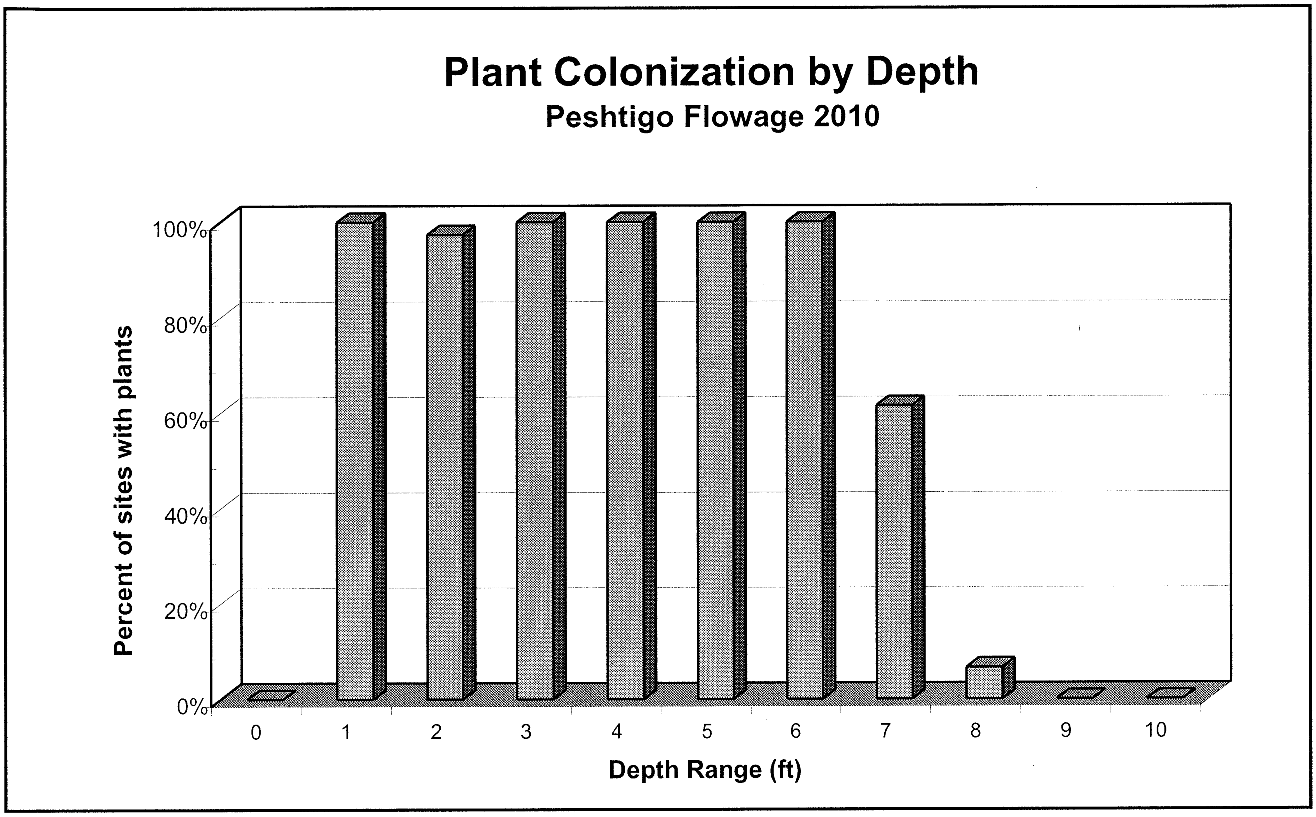
EXOTICS SPECIES STATS:

	Myriophyllum spicatum	Potamogeton crispus
# at surface	0	
# within 1 ft of surface	0	
# > 1 ft from surface	0	
# sparse	0	
# dense	0	
# unknown	0	

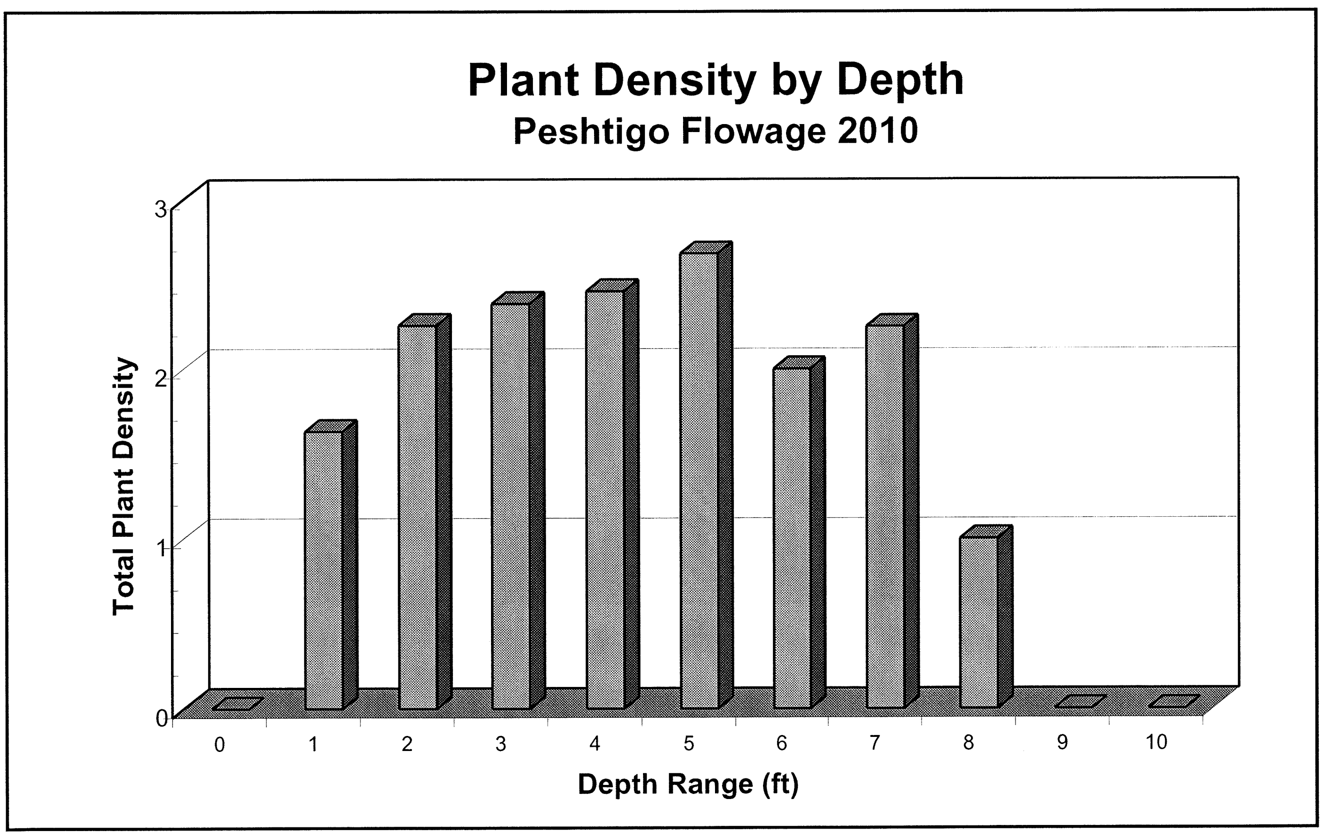
SUMMARY STATS:

Total number of points sampled	386
Total number of sites with vegetation	213
Total number of sites shallower than maximum depth of plants	238
Frequency of occurrence at sites shallower than maximum depth of plants	89.50
Simpson Diversity Index	0.91
Maximum depth of plants (ft)	8.00
Number of sites sampled using rake on Rope (R)	0
Number of sites sampled using rake on Pole (P)	392
Average number of all species per site (shallower than max depth)	3.63
Average number of all species per site (veg. sites only)	3.83
Average number of native species per site (shallower than max depth)	3.42
Average number of native species per site (veg. sites only)	3.83
Species Richness	29
Species Richness (including visuals)	30

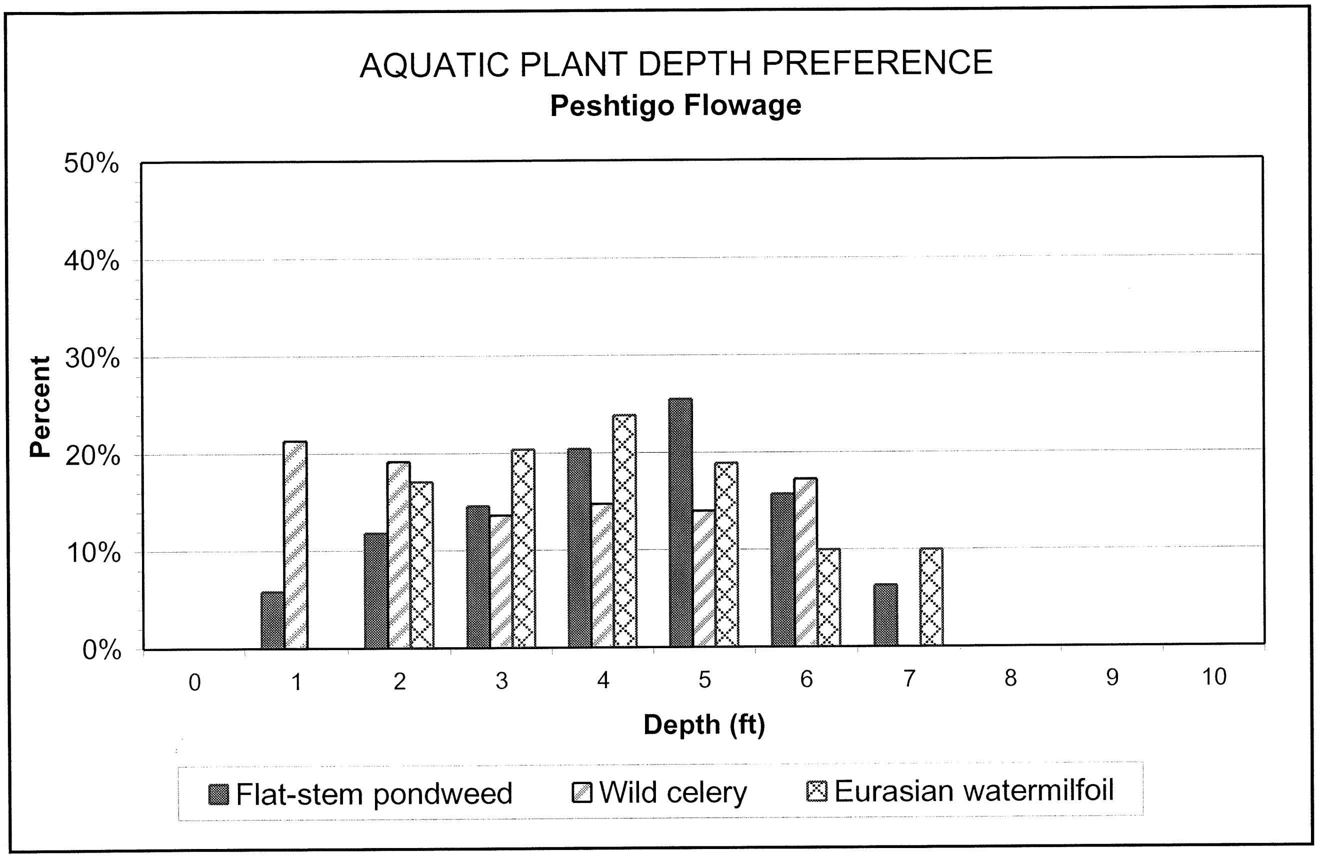

Peshtigo Flowage
Aquatic Plant Frequency
2010
Species
Common waterweed 58.8
Coontail 58.0
Filamentous algae 46.6
Flat-stem pondweed 31.5
Wild celery 24.4
Eurasian watermilfoil 21.0
Small pondweed 20.2
Northern watermilfoil 18.1
Wild rice 12.6
Long-leaf pondweed 10.5
Stiff water crowfoot 9.7
Spatterdock lily 7.1
Clasping-leaf pondweed 7.1
Water stargrass 6.7
White water lily 6.3
Water marigold 5.9
Lake cress 3.4
Common bur-reed 3.4
Variable-leaf watermilfoil 2.9
Stonewort 2.1
Bushy pondweed 1.7
Sago pondweed 0.8
Muskgrass 0.8
Large-leaf pondweed 0.8
Common bladderwort 0.8
Grass-leaved arrowhead 0.8
Small pw #1 0.4
Floating-leaf pondweed 0.4
Broad-leaved cattail 0.4
0.0
10.0
20.0
30.0
40.0
50.0
60.0
70.0
80.0
Frequency (%)

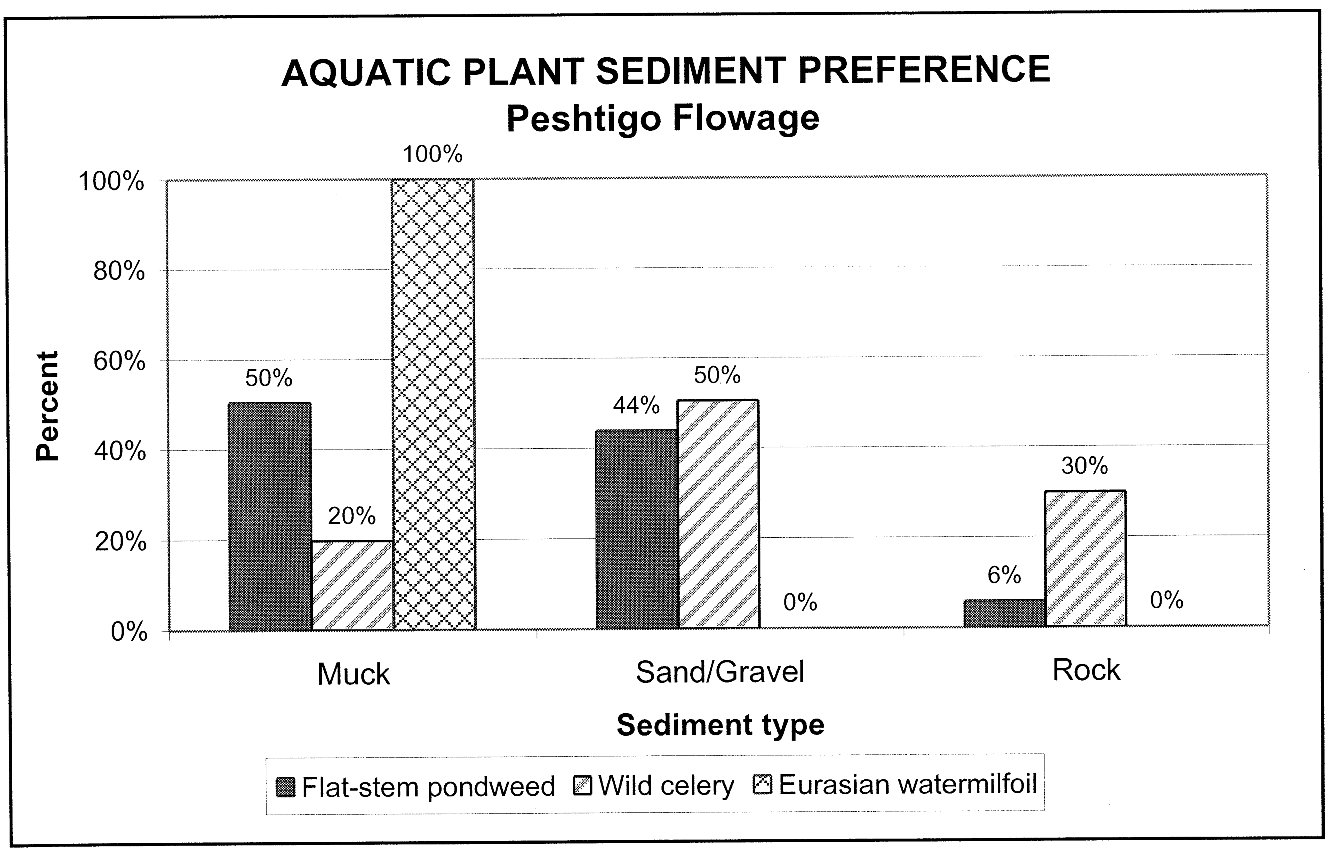


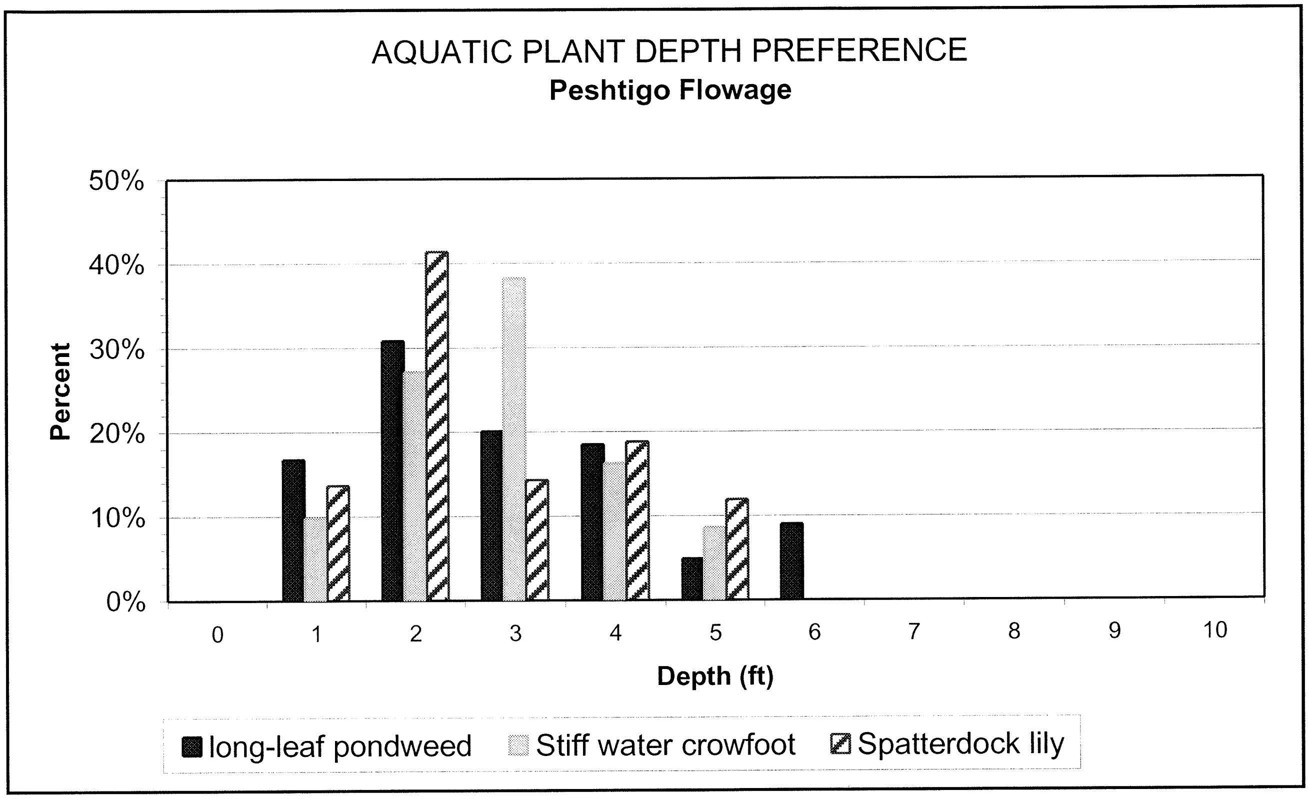
Plant Colonization by Depth
Peshtigo Flowage 2010
Percent of sites with plants
100%
80%
60%
40%
20%
0%
0
1
2
3
4
5
6
7
8
9
10
Depth Range (ft)

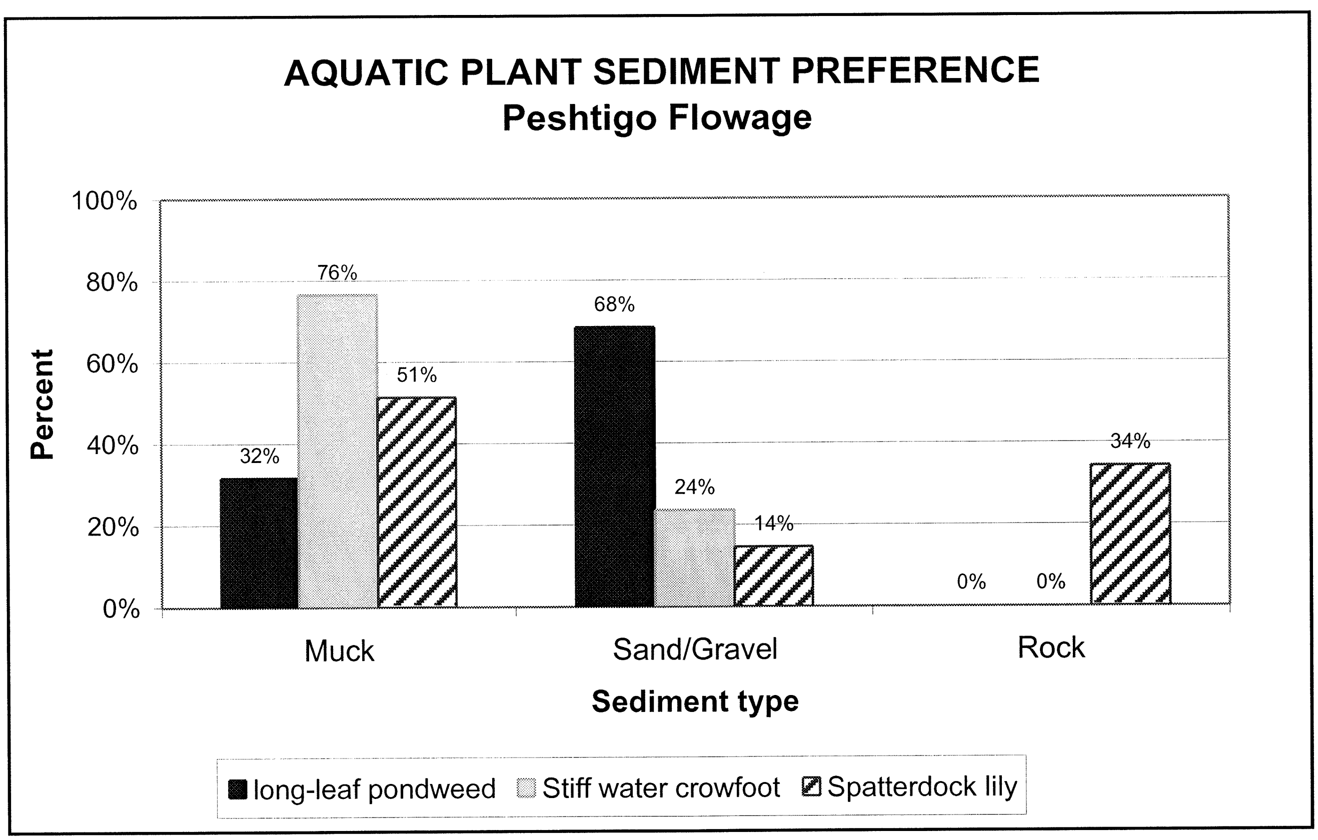


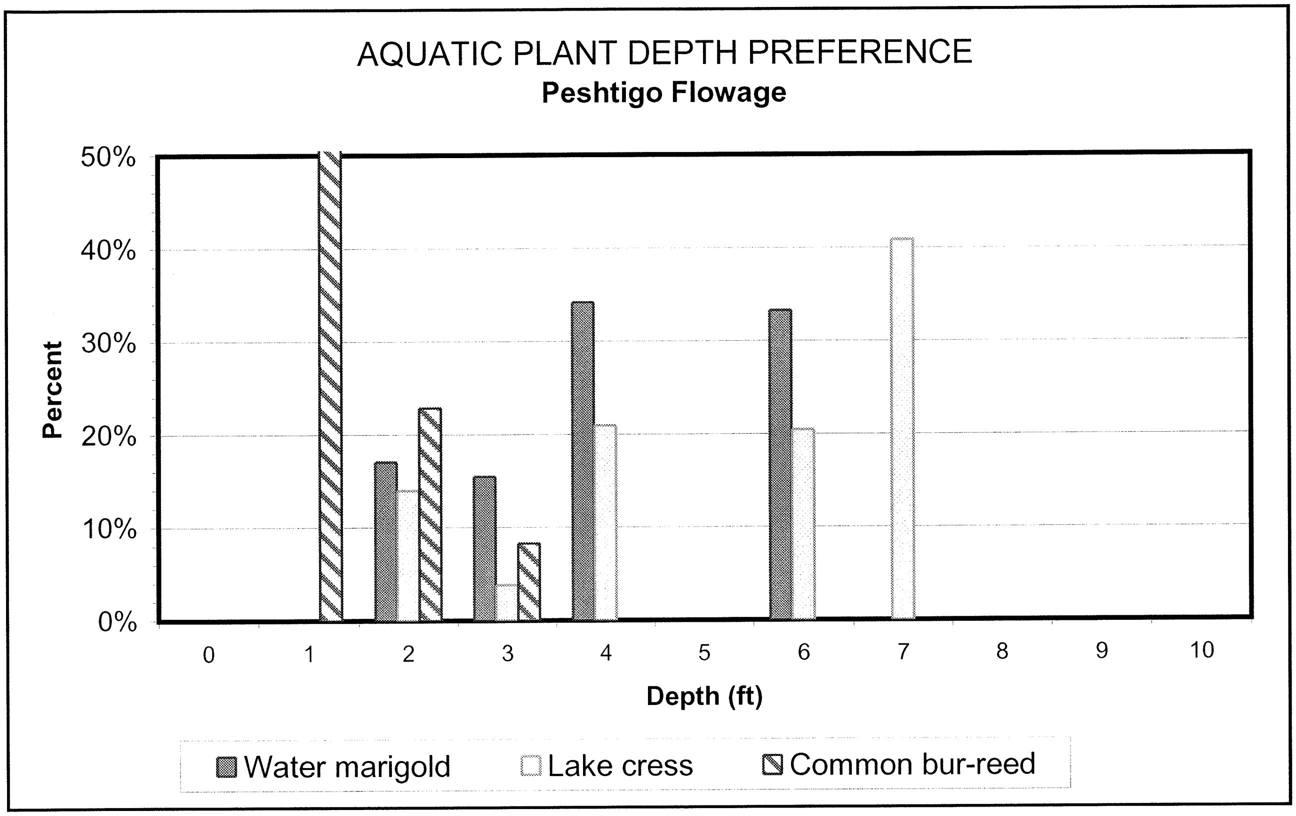
Plant Density by Depth
Peshtigo Flowage 2010
Total Plant Density
3
2
1
0
0
1
2
3
4
5
6
7
8
9
10
Depth Range (ft)

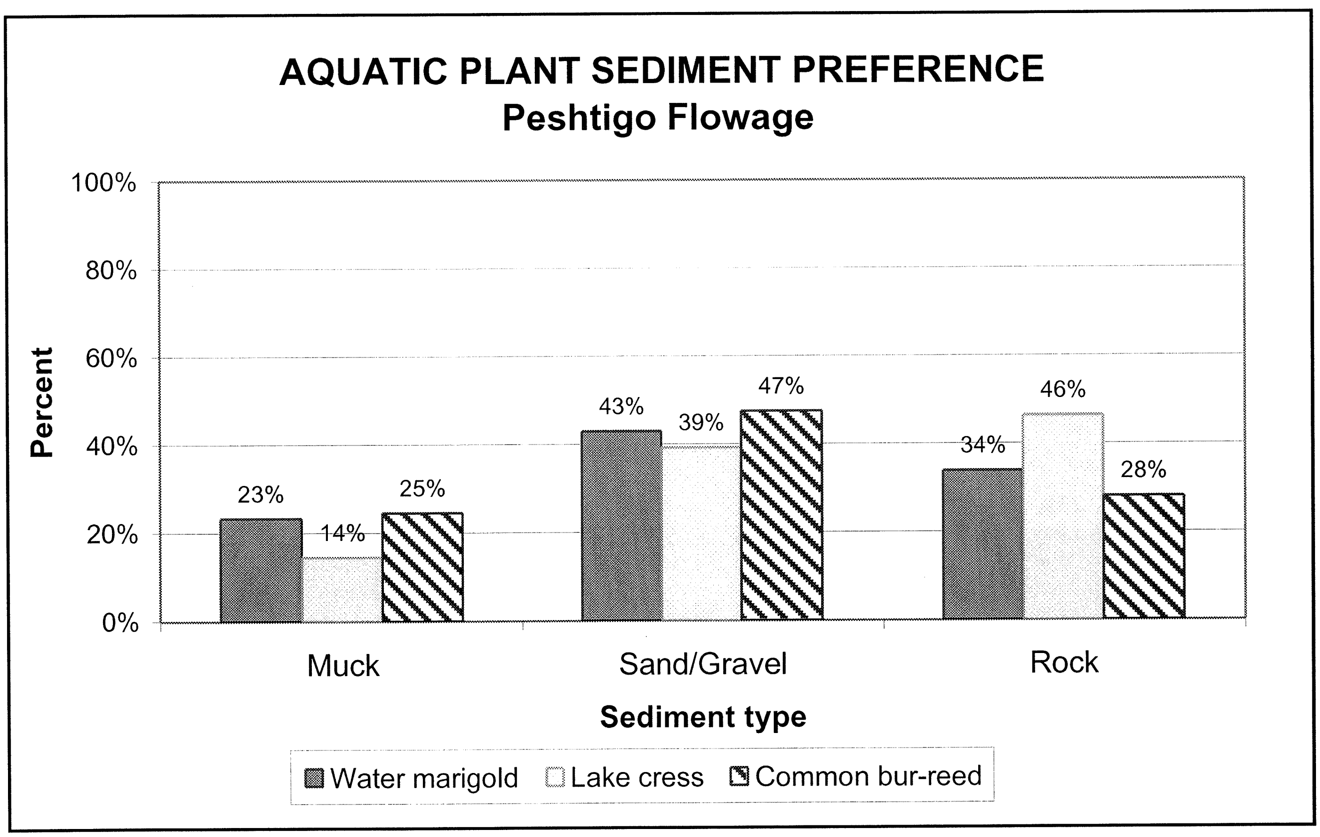

AQUATIC PLANT DEPTH PREFERENCE
Peshtigo Flowage
Percent
50%
40%
30%
20%
10%
0%
0
1
2
3
4
5
6
7
8
9
10
Depth (ft)
Flat-stem pondweed
Wild celery
Eurasian watermilfoil

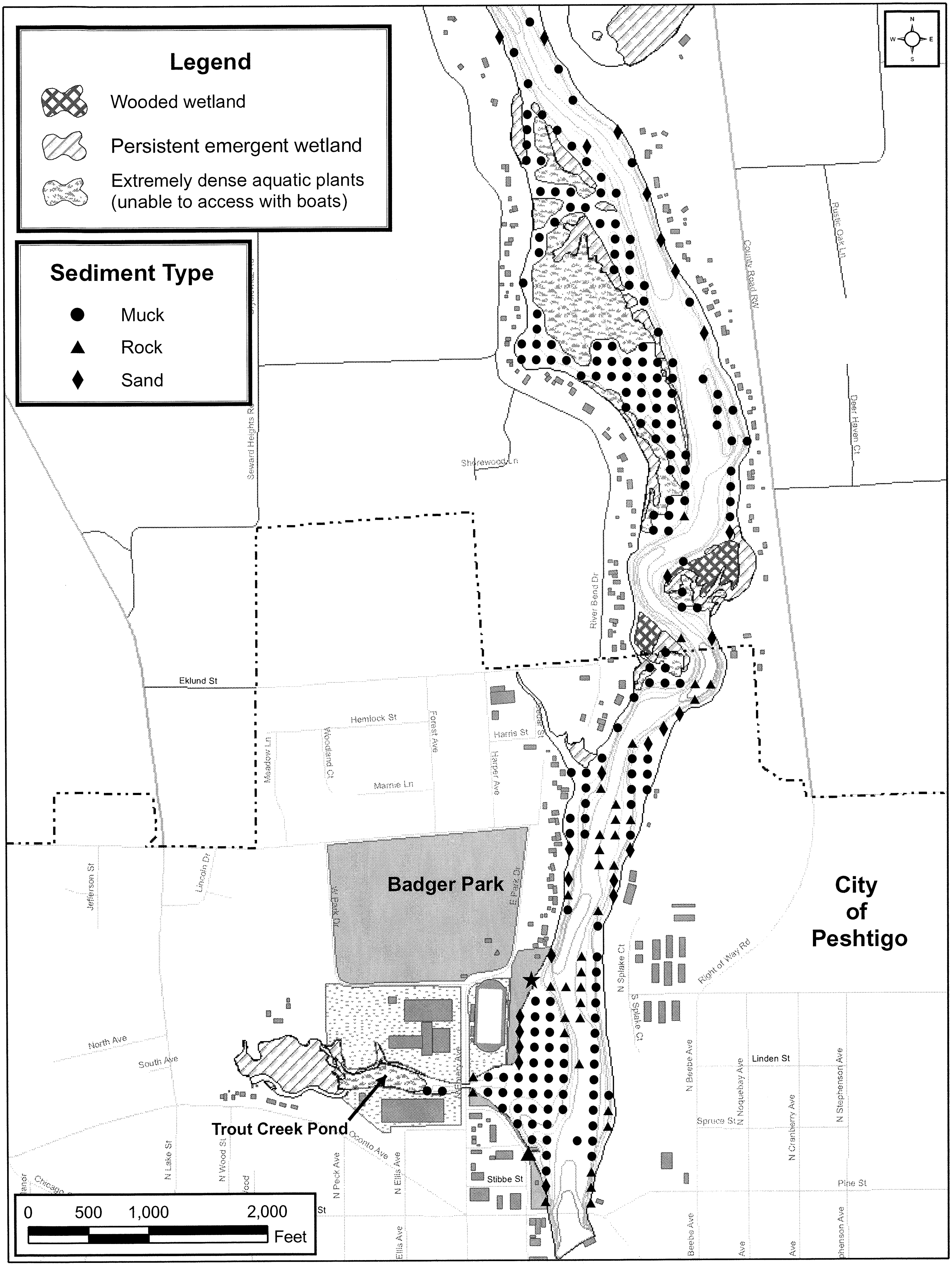

AQUATIC PLANT SEDIMENT PREFERENCE
Peshtigo Flowage
Percent
100%
80%
60%
40%
20%
0%
50%
20%
100%
44%
50%
0%
6%
30%
0%
Muck
Sand/Gravel
Rock
Sediment type
Flat-stem pondweed
Wild celery
Eurasian watermilfoil


AQUATIC PLANT DEPTH PREFERENCE
Peshtigo Flowage
50%
40%
30%
20%
10%
0%
Percent
0
1
2
3
4
5
6
7
8
9
10
Depth (ft)
long-leaf pondweed
Stiff water crowfoot
Spatterdock lily

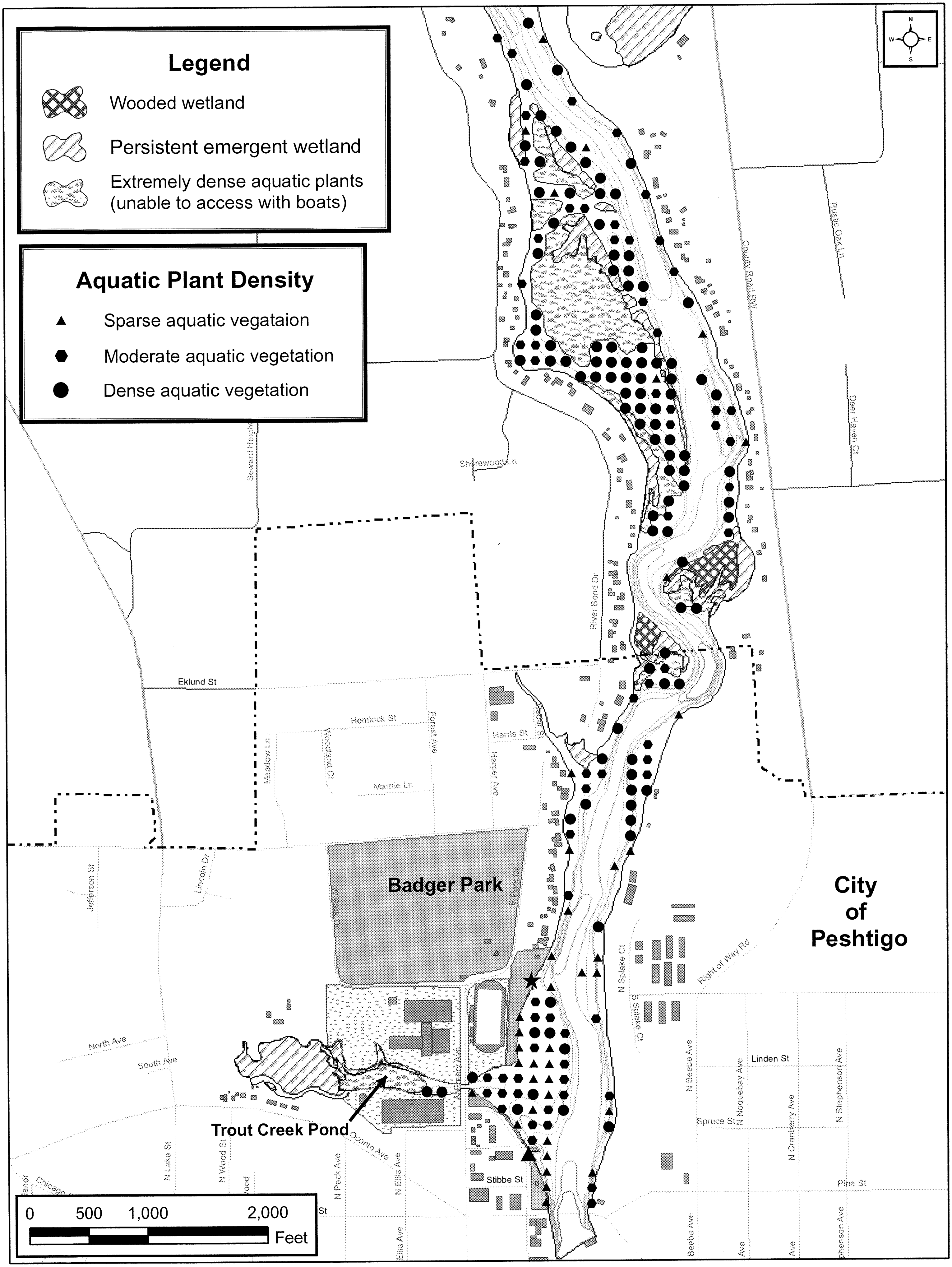

AQUATIC PLANT SEDIMENT PREFERENCE
Peshtigo Flowage
100%
80%
60%
40%
20%
0%
Percent
32%
76%
51%
68%
24%
14%
0%
0%
34%
Muck
Sand/Gravel
Rock
Sediment type
long-leaf pondweed
Stiff water crowfoot
Spatterdock lily

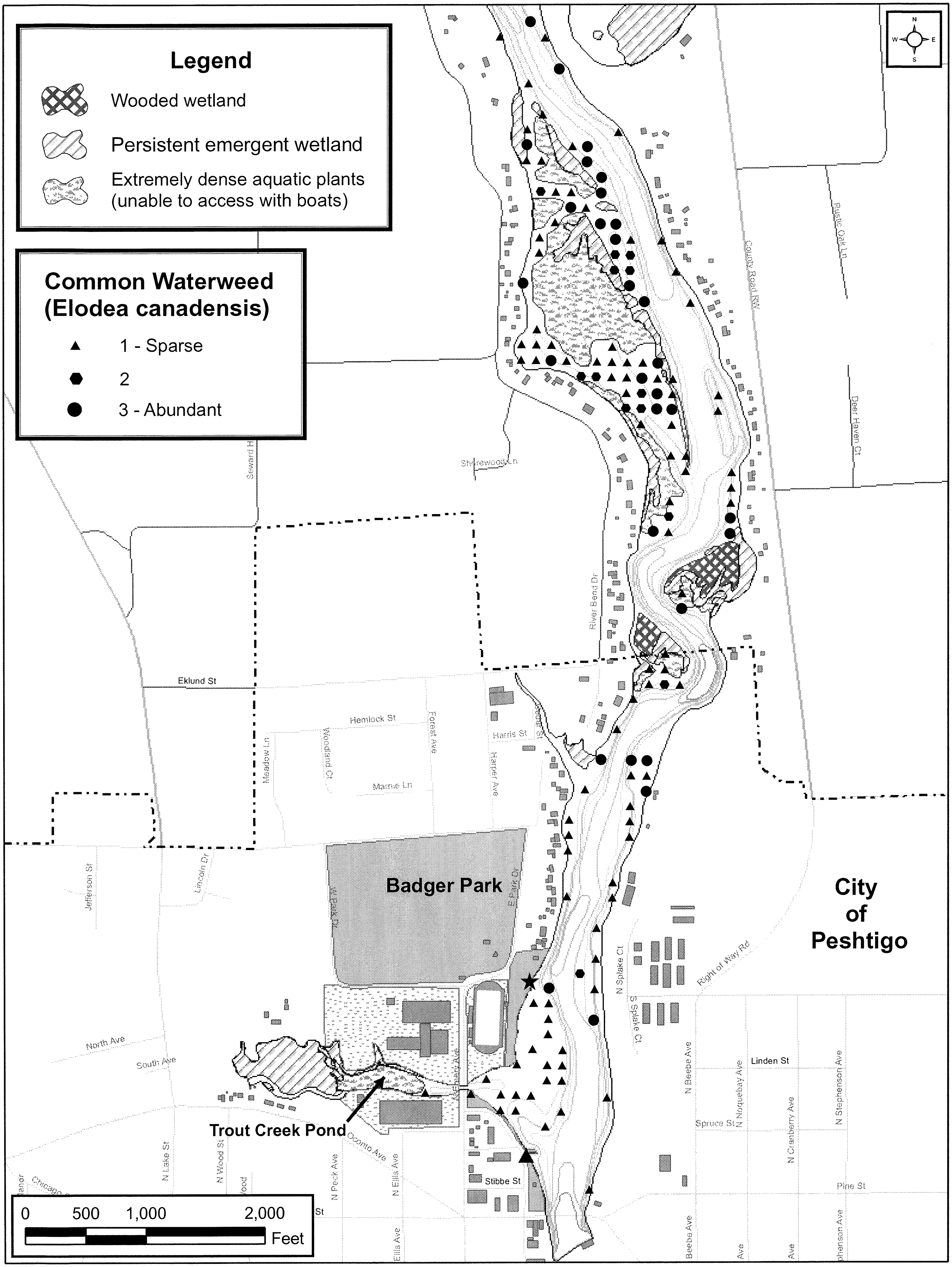

AQUATIC PLANT DEPTH PREFERENCE
Peshtigo Flowage
50%
40%
30%
20%
10%
0%
Percent
0
1
2
3
4
5
6
7
8
9
10
Depth (ft)
Water marigold
Lake cress
Common bur-reed


AQUATIC PLANT SEDIMENT PREFERENCE
Peshtigo Flowage
100%
80%
60%
40%
20%
0%
Percent
23%
14%
25%
43%
39%
47%
34%
46%
28%
Muck
Sand/Gravel
Rock
Sediment type
Water marigold
Lake cress
Common bur-reed

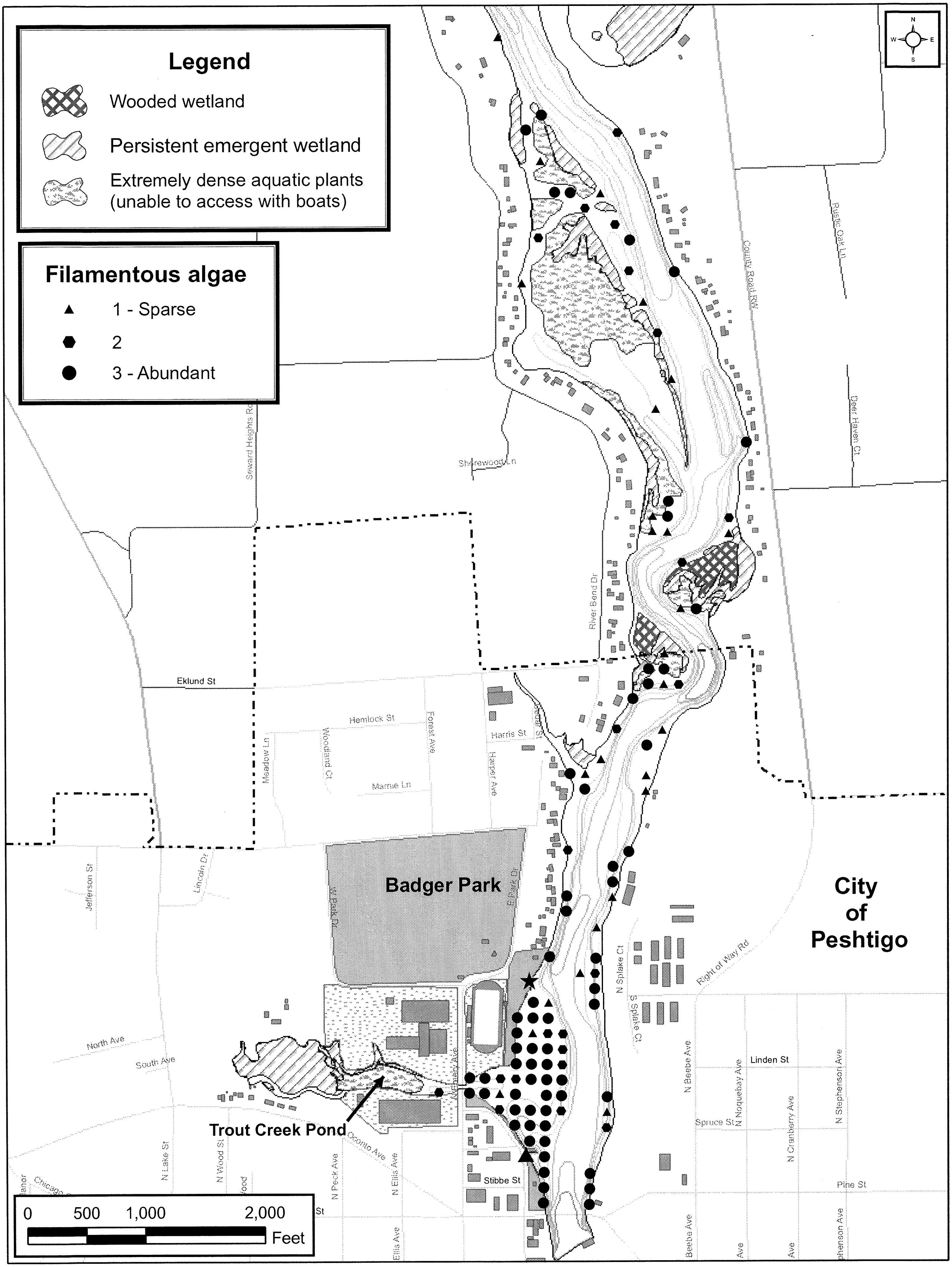


Legend
Wooded wetland
Persistent emergent wetland
Extremely dense aquatic plants
(unable to access with boats)
Sediment Type
Muck
Rock
Sand
Badger Park
City
of
Peshtigo
Trout Creek Pond
0
500
1,000
2,000
Feet
Eklund St
Hemlock St
Harris St
Marnie Ln
Shorewood Ln
River Bend Dr
County Road RW
Rustic Oak Ln
Deer Haven Ct
Seward Heights Rd
Meadow Ln
Woodland Ct
Forest Ave
Harper Ave
Jefferson St
Lincoln Dr
North Ave
South Ave
W Park Dr
E Park Dr
N Splake Ct
S Splake Ct
Right of Way Rd
Linden St
Spruce St
Stibbe St
Pine St
Oconto Ave
N Lake St
N Wood St
N Peck Ave
N Ellis Ave
N Beebe Ave
N Noquebay Ave
N Cranberry Ave
N Stephenson Ave

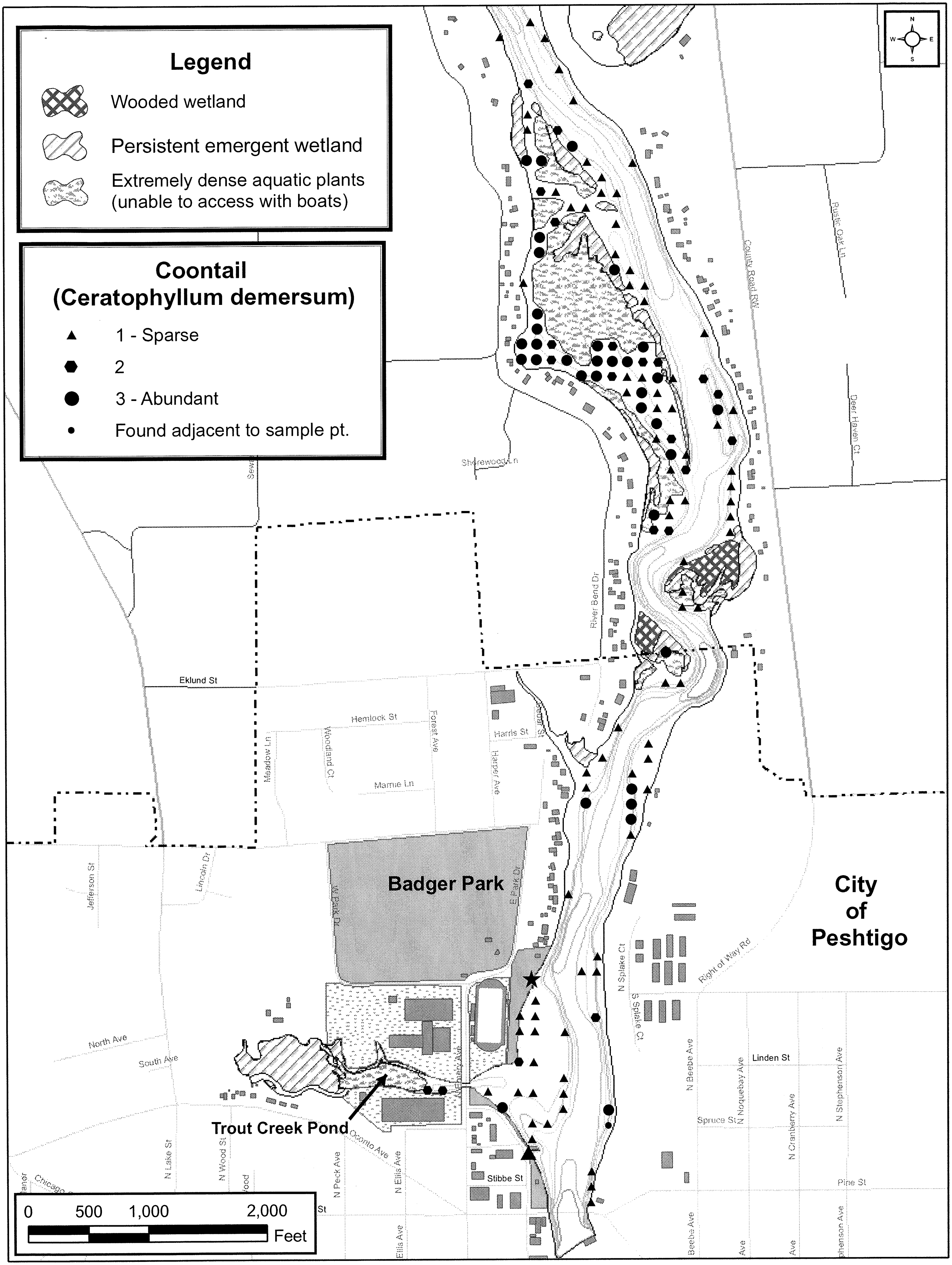

Legend
Wooded wetland
Persistent emergent wetland
Extremely dense aquatic plants
(unable to access with boats)
Aquatic Plant Density
Sparse aquatic vegetaion
Moderate aquatic vegetation
Dense aquatic vegetation
Badger Park
City of Peshtigo
Trout Creek Pond
Eklund St
Hemlock St
Harris St
Marnie Ln
Meadow Ln
Woodland Ct
Forest Ave
Harper Ave
River Bend Dr
County Road RW
Rustic Oak Ln
Deer Haven Ct
North Ave
South Ave
Jefferson St
Lincoln Dr
N Splake Ct
Right of Way Rd
Linden St
Spruce St
Pine St
Stibbe St
Oconto Ave
N Peck Ave
N Ellis Ave
N Lake St
N Wood St
N Beebe Ave
N Noquebay Ave
N Cranberry Ave
N Stephenson Ave
0 500 1,000 2,000
Feet



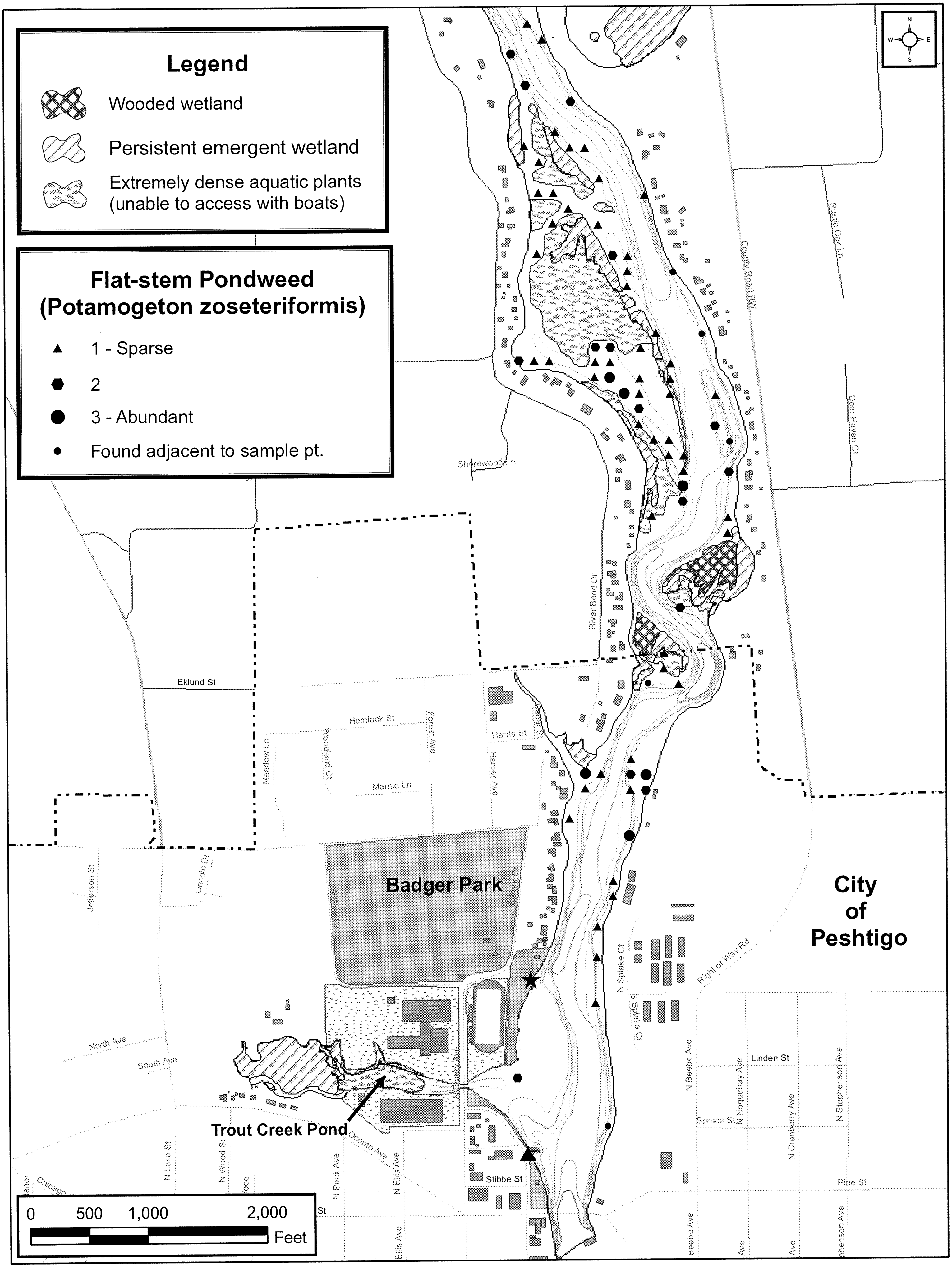
Legend
Wooded wetland
Persistent emergent wetland
Extremely dense aquatic plants
(unable to access with boats)
Common Waterweed
(Elodea canadensis)
1 - Sparse
2
3 - Abundant
Badger Park
City
of
Peshtigo
Trout Creek Pond
Eklund St
Hemlock St
Harris St
Marnie Ln
Meadow Ln
Woodland Ct
Forest Ave
Harper Ave
River Bend Dr
County Road RW
Rustic Oak Ln
Deer Haven Ct
Seward H
North Ave
South Ave
Jefferson St
Lincoln Dr
Right of Way Rd
N Splake Ct
S Splake Ct
Linden St
N Beebe Ave
N Noquebay Ave
N Cranberry Ave
N Stephenson Ave
Spruce St
Pine St
Stibbe St
Oconto Ave
N Peck Ave
N Ellis Ave
N Lake St
N Wood St
0 500 1,000 2,000
Feet

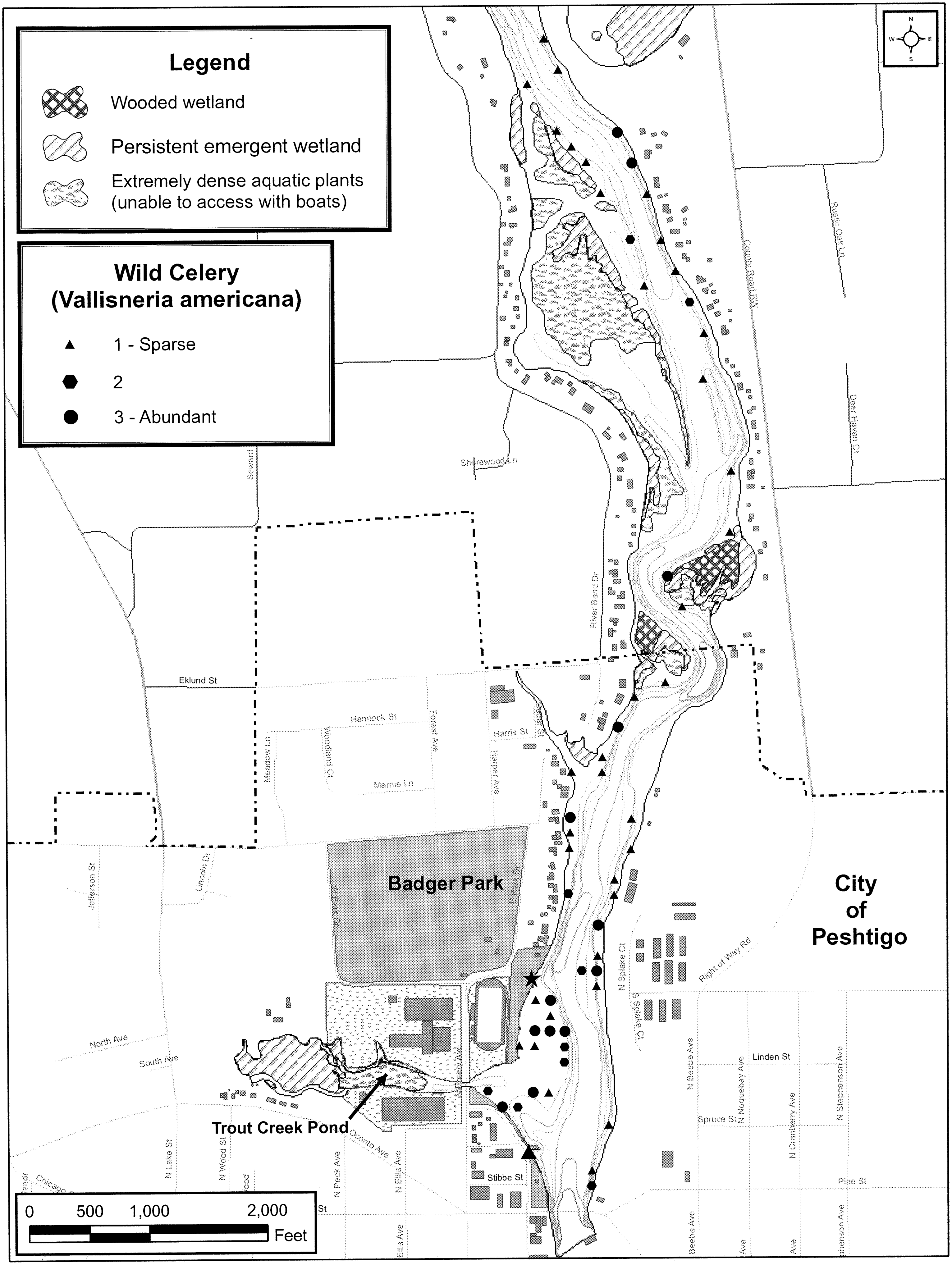


Legend
Wooded wetland
Persistent emergent wetland
Extremely dense aquatic plants (unable to access with boats)
Filamentous algae
1 - Sparse
2
3 - Abundant
Badger Park
City of Peshtigo
Trout Creek Pond
Eklund St
Hemlock St
Harris St
Marnie Ln
Meadow Ln
Woodland Ct
Forest Ave
Harper Ave
Seward Heights Rd
Shorewood Ln
River Bend Dr
County Road RW
Rustic Oak Ln
Deer Haven Ct
Jefferson St
Lincoln Dr
North Ave
South Ave
W Park Dr
E Park Dr
N Splake Ct
S Splake Ct
Right of Way Rd
N Beebe Ave
N Noquebay Ave
Linden St
N Stephenson Ave
Spruce St
N Cranberry Ave
Pine St
Stibbe St
Oconto Ave
N Peck Ave
N Ellis Ave
N Lake St
N Wood St
0 500 1,000 2,000
Feet

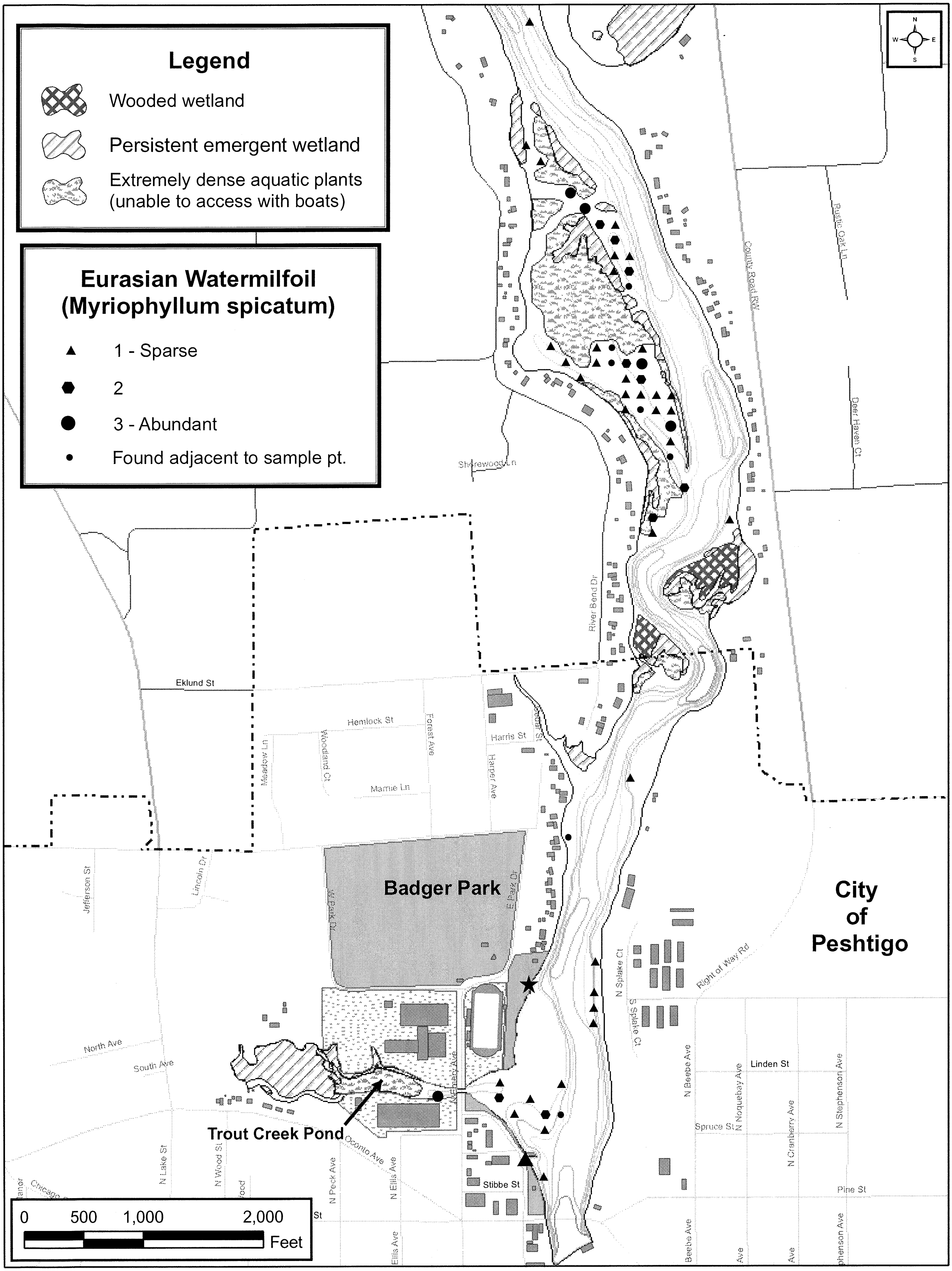


Legend
Wooded wetland
Persistent emergent wetland
Extremely dense aquatic plants (unable to access with boats)
Coontail
(Ceratophyllum demersum)
1 - Sparse
2
3 - Abundant
Found adjacent to sample pt.
Badger Park
Trout Creek Pond
City of Peshtigo
County Road RW
Rustic Oak Ln
Deer Haven Ct
Sherewood Ln
River Bend Dr
Eklund St
Hemlock St
Forest Ave
Harris St
Harper Ave
Meadow Ln
Woodland Ct
Marnie Ln
Jefferson St
Lincoln Dr
W Park Dr
E Park Dr
North Ave
South Ave
N Splake Ct
S Splake Ct
Right of Way Rd
Linden St
N Beebe Ave
N Noquebay Ave
N Cranberry Ave
N Stephenson Ave
Spruce St
Pine St
Stibbe St
Oconto Ave
N Ellis Ave
N Peck Ave
N Wood St
N Lake St
0 500 1,000 2,000
Feet

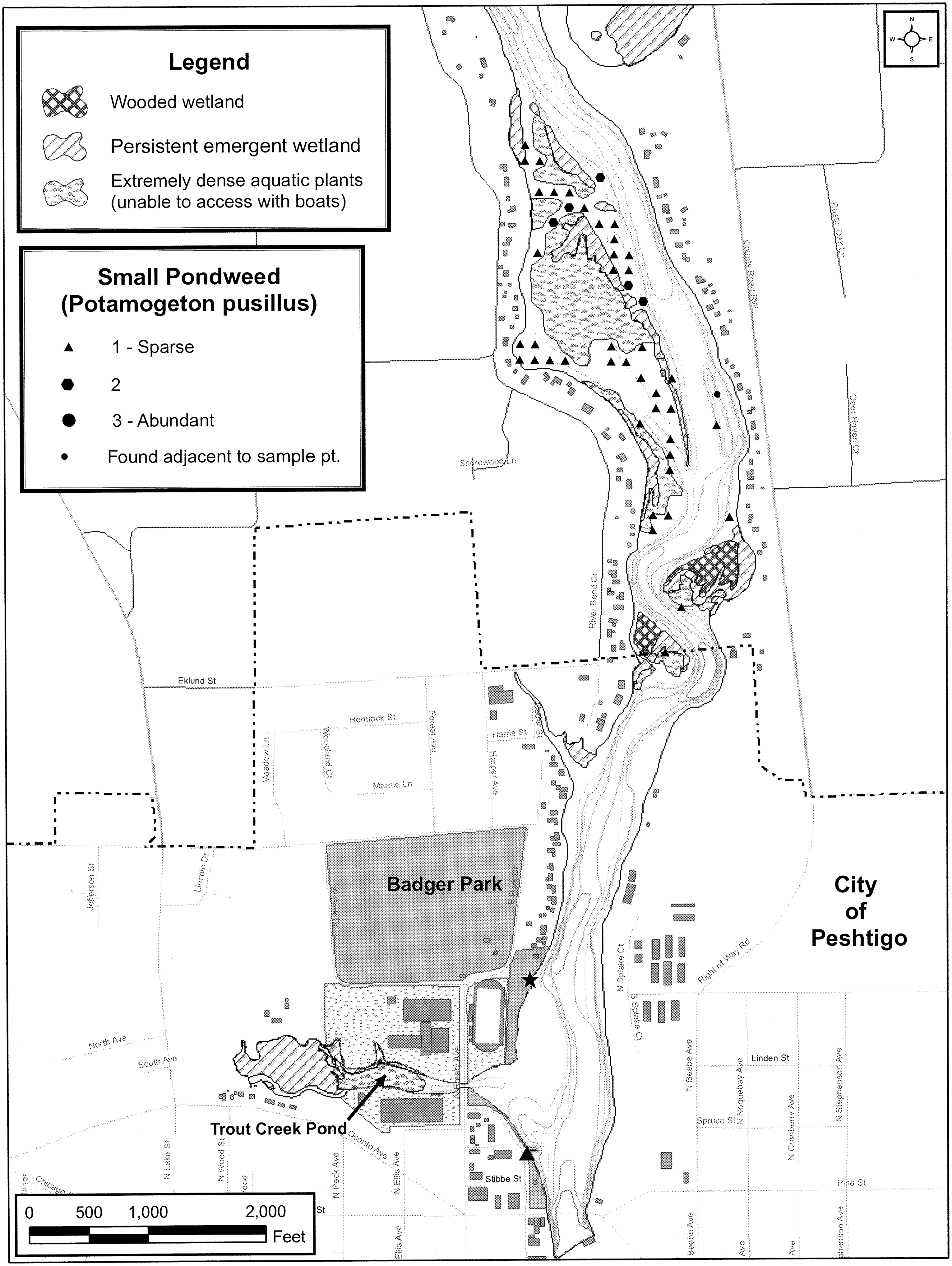

Legend
Wooded wetland
Persistent emergent wetland
Extremely dense aquatic plants
(unable to access with boats)
Flat-stem Pondweed
(Potamogeton zoseteriformis)
1 - Sparse
2
3 - Abundant
Found adjacent to sample pt.
County Road RW
Rustic Oak Ln
Deer Haven Ct
Shorewood Ln
River Bend Dr
Eklund St
Hemlock St
Forest Ave
Woodland Ct
Meadow Ln
Harris St
Harper Ave
Marnie Ln
Badger Park
City
of
Peshtigo
Jefferson St
Lincoln Dr
E Park Dr
W Park Dr
N Splake Ct
S Splake Ct
Right of Way Rd
North Ave
South Ave
Linden St
N Beebe Ave
N Noquebay Ave
N Cranberry Ave
N Stephenson Ave
Spruce St
Trout Creek Pond
Oconto Ave
N Peck Ave
N Ellis Ave
N Lake St
N Wood St
Stibbe St
Pine St
0
500
1,000
2,000
Feet



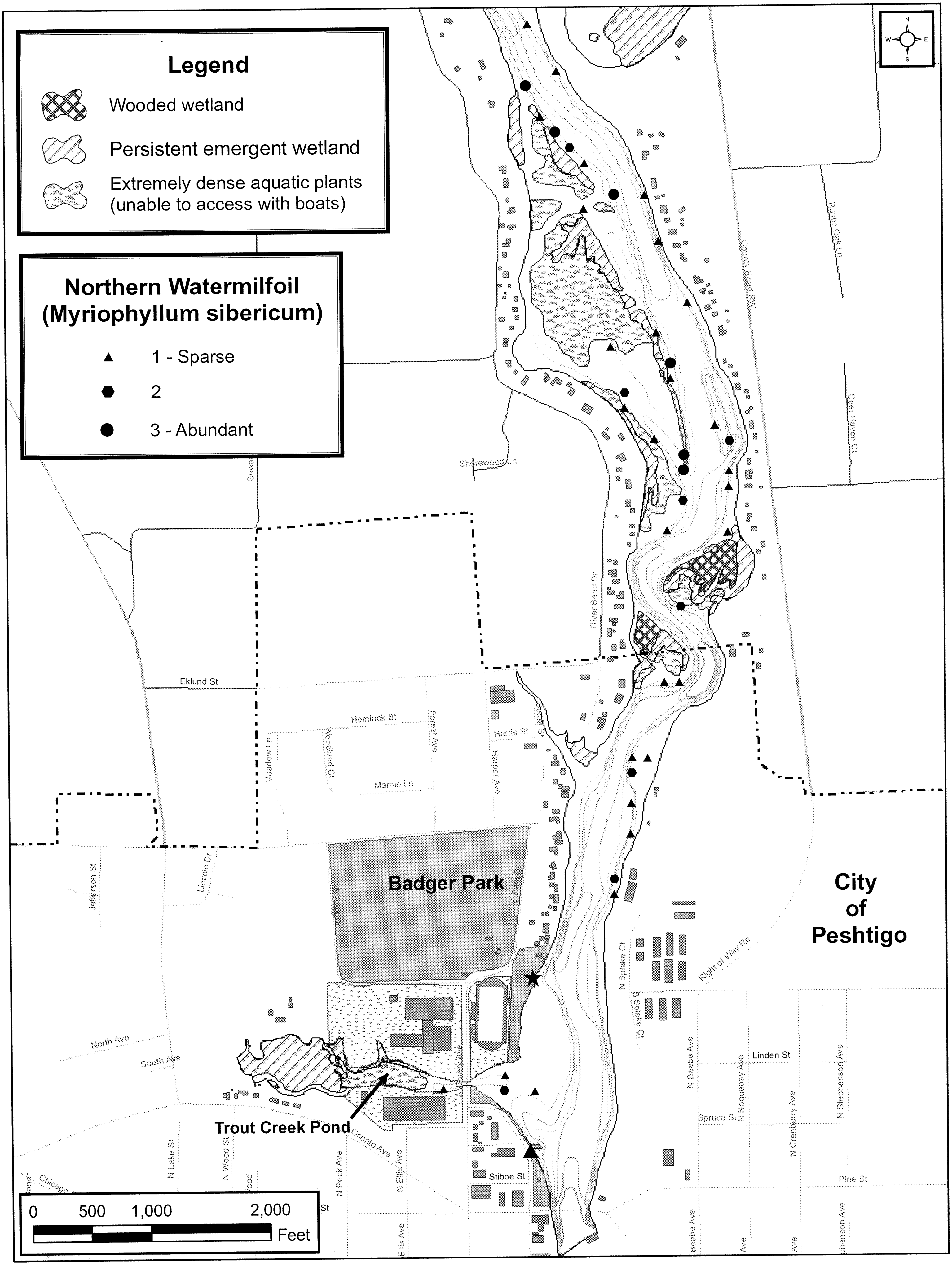
Legend
Wooded wetland
Persistent emergent wetland
Extremely dense aquatic plants (unable to access with boats)
Wild Celery (Vallisneria americana)
1 - Sparse
2
3 - Abundant
Badger Park
City of Peshtigo
Trout Creek Pond
Eklund St
Hemlock St
Harris St
Marnie Ln
North Ave
South Ave
Linden St
Spruce St
Stibbe St
Pine St
N Beebe Ave
N Splake Ct
Right of Way Rd
County Road RW
Rustic Oak Ln
Deer Haven Ct
River Bend Dr
Shorewood Ln
Meadow Ln
Woodland Ct
Forest Ave
Harper Ave
Jefferson St
Lincoln Dr
N Lake St
N Wood St
N Peck Ave
N Ellis Ave
Oconto Ave
N Noquebay Ave
N Cranberry Ave
N Stephenson Ave
0 500 1,000 2,000 Feet



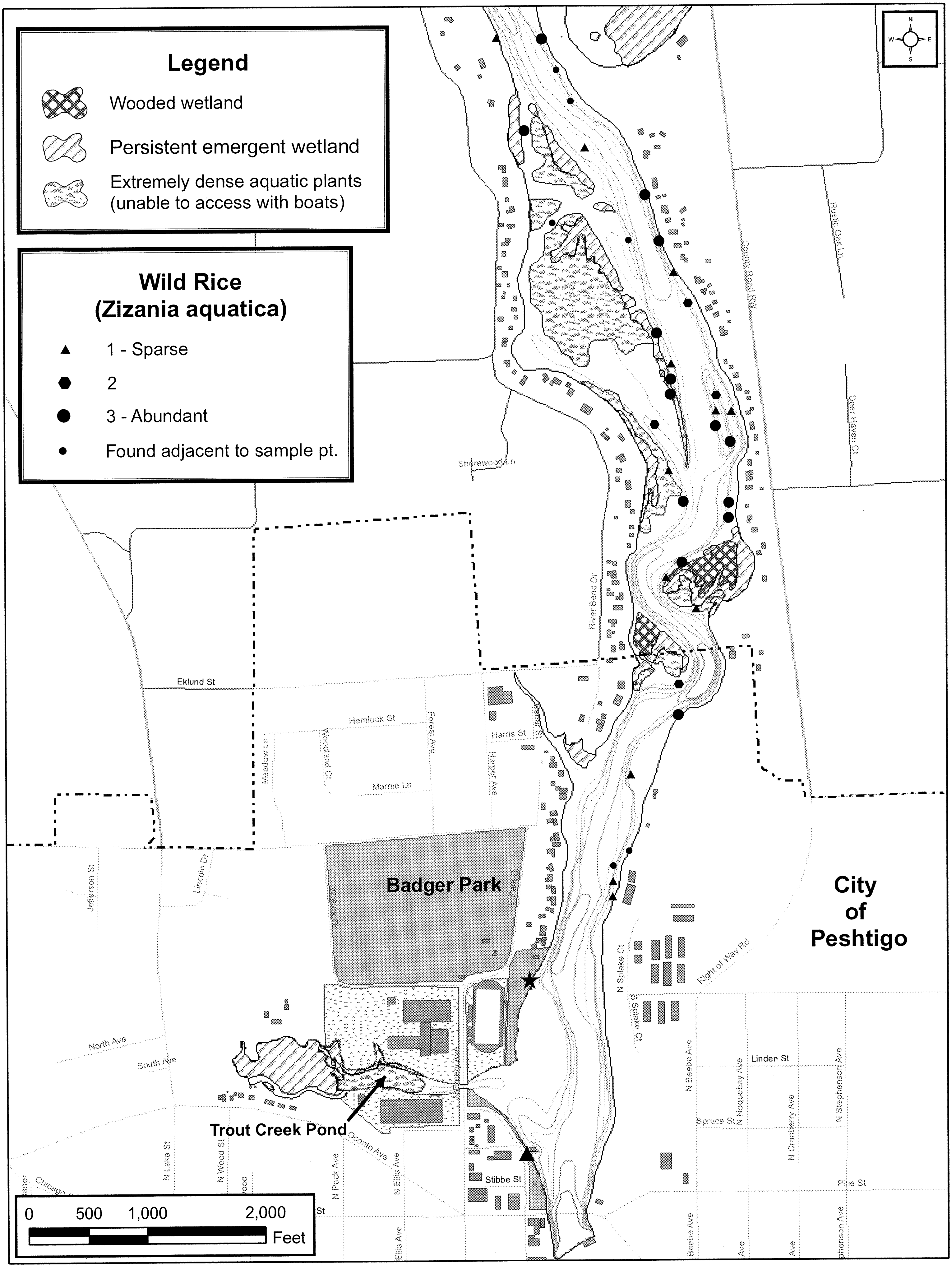
Legend
Wooded wetland
Persistent emergent wetland
Extremely dense aquatic plants (unable to access with boats)
Eurasian Watermilfoil (Myriophyllum spicatum)
1 - Sparse
2
3 - Abundant
Found adjacent to sample pt.
Badger Park
City of Peshtigo
Trout Creek Pond
Eklund St
Hemlock St
Harris St
Marnie Ln
Meadow Ln
Woodland Ct
Forest Ave
Harper Ave
Shorewood Ln
River Bend Dr
County Road RW
Rustic Oak Ln
Deer Haven Ct
Jefferson St
Lincoln Dr
North Ave
South Ave
Oconto Ave
N Lake St
N Wood St
N Peck Ave
N Ellis Ave
Stibbe St
N Splake Ct
S Splake Ct
Right of Way Rd
N Beebe Ave
Linden St
Spruce St
N Noquebay Ave
N Cranberry Ave
N Stephenson Ave
Pine St
0 500 1,000 2,000
Feet



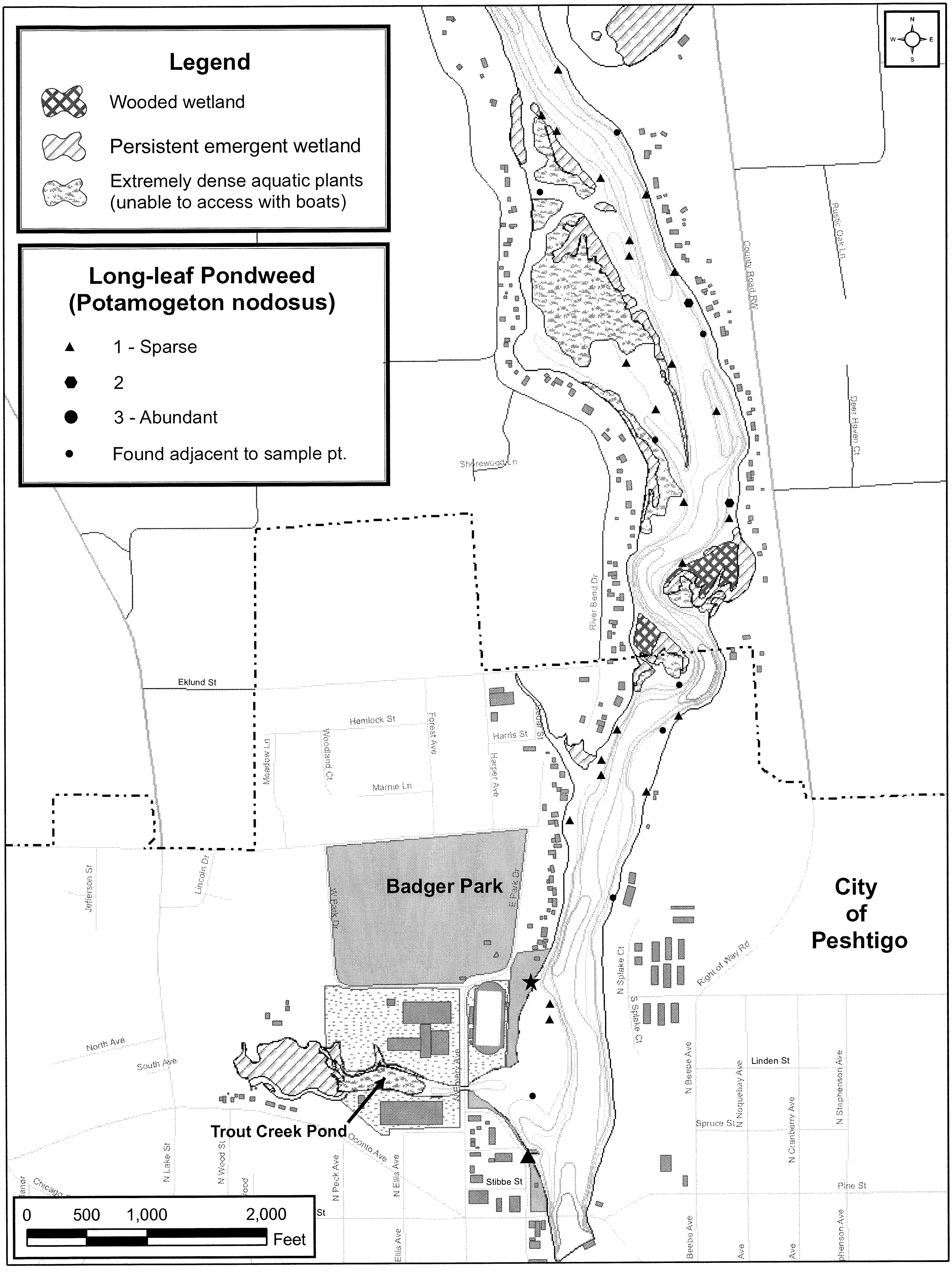
Legend
Wooded wetland
Persistent emergent wetland
Extremely dense aquatic plants
(unable to access with boats)
Small Pondweed
(Potamogeton pusillus)
1 - Sparse
2
3 - Abundant
Found adjacent to sample pt.
Badger Park
Trout Creek Pond
City
of
Peshtigo
County Road RW
Rustic Oak Ln
Deer Haven Ct
Sherewood Ln
River Bend Dr
Eklund St
Hemlock St
Woodland Ct
Forest Ave
Harris St
Harper Ave
Meadow Ln
Marnie Ln
Jefferson St
Lincoln Dr
W Park Dr
E Park Dr
North Ave
South Ave
N Splake Ct
S Splake Ct
Right of Way Rd
N Beebe Ave
N Noquebay Ave
Linden St
N Stephenson Ave
Spruce St
N Cranberry Ave
Oconto Ave
N Lake St
N Wood St
N Peck Ave
N Ellis Ave
Stibbe St
Pine St
Ellis Ave
Beebe Ave
0
500
1,000
2,000
Feet

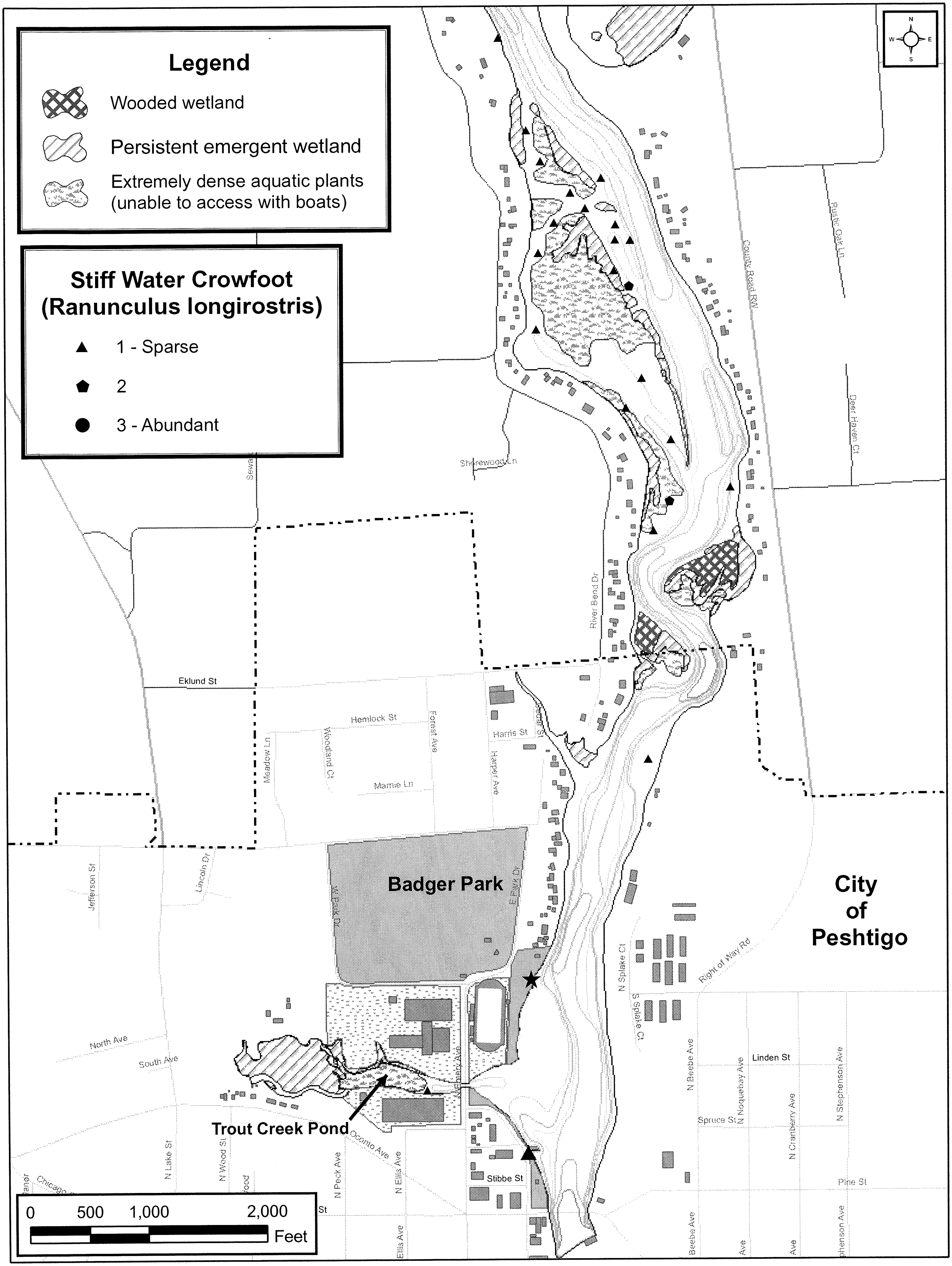


Legend
Wooded wetland
Persistent emergent wetland
Extremely dense aquatic plants (unable to access with boats)
Northern Watermilfoil (Myriophyllum sibericum)
1 - Sparse
2
3 - Abundant
Badger Park
City of Peshtigo
Trout Creek Pond
0 500 1,000 2,000 Feet
County Road RW
Rustic Oak Ln
Deer Haven Ct
Sherewood Ln
River Bend Dr
Eklund St
Hemlock St
Forest Ave
Woodland Ct
Meadow Ln
Marnie Ln
Harris St
Harper Ave
Jefferson St
Lincoln Dr
W Park Dr
E Park Ct
North Ave
South Ave
N Splake Ct
S Splake Ct
Right of Way Rd
Linden St
N Beebe Ave
N Noquebay Ave
N Cranberry Ave
N Stephenson Ave
Spruce St
Pine St
Stibbe St
Oconto Ave
N Peck Ave
N Ellis Ave
N Lake St
N Wood St
Ellis Ave
Beebe Ave

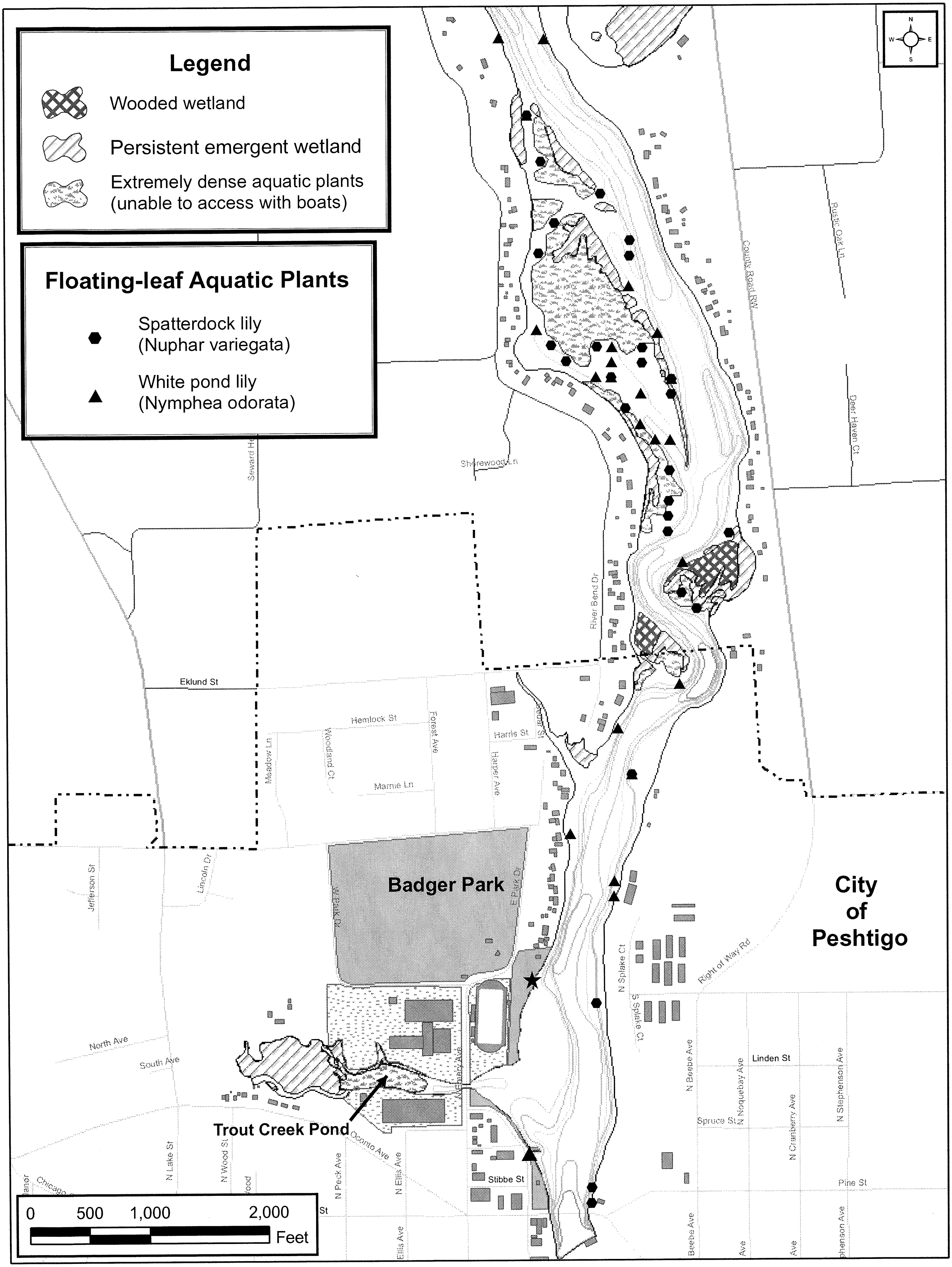


Legend
Wooded wetland
Persistent emergent wetland
Extremely dense aquatic plants
(unable to access with boats)
Wild Rice
(Zizania aquatica)
1 - Sparse
2
3 - Abundant
Found adjacent to sample pt.
Badger Park
City of Peshtigo
Trout Creek Pond
County Road RW
Rustic Oak Ln
Deer Haven Ct
Shorewood Ln
River Bend Dr
Eklund St
Hemlock St
Woodland Ct
Forest Ave
Harris St
Harper Ave
Meadow Ln
Marnie Ln
Jefferson St
Lincoln Dr
North Ave
South Ave
N Splake Ct
S Splake Ct
Right of Way Rd
Linden St
N Beebe Ave
N Noquebay Ave
Spruce St
N Cranberry Ave
N Stephenson Ave
Pine St
Stibbe St
Oconto Ave
N Ellis Ave
N Peck Ave
N Lake St
N Wood St
0 500 1,000 2,000
Feet

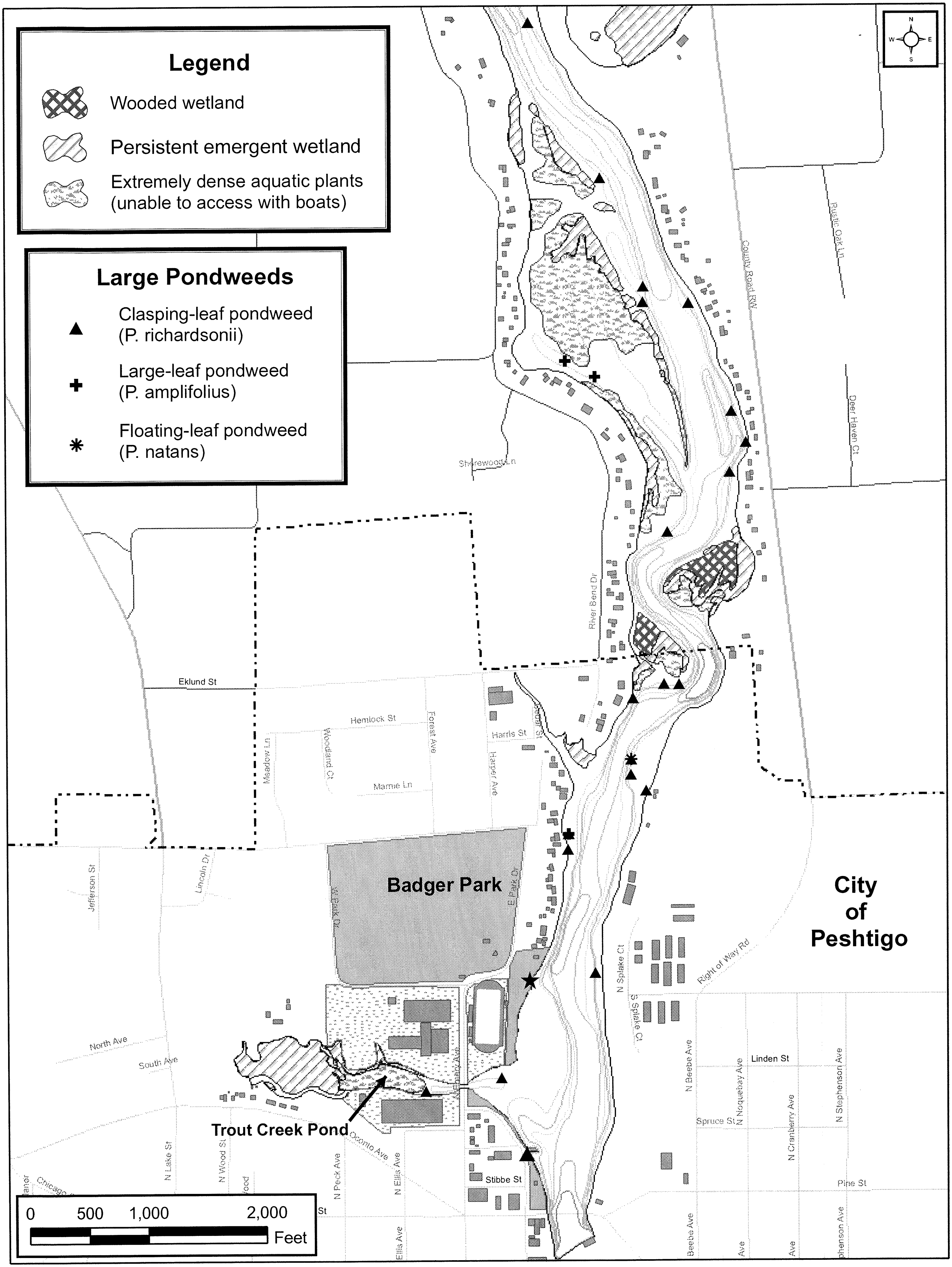

Legend
Wooded wetland
Persistent emergent wetland
Extremely dense aquatic plants
(unable to access with boats)
Long-leaf Pondweed
(Potamogeton nodosus)
1 - Sparse
2
3 - Abundant
Found adjacent to sample pt.
N
W
E
S
Rustic Oak Ln
County Road RW
Deer Haven Ct
Shorewood Ln
River Bend Dr
Eklund St
Hemlock St
Forest Ave
Woodland Ct
Meadow Ln
Harris St
Harper Ave
Marnie Ln
Jefferson St
Lincoln Dr
Badger Park
W Park Dr
E Park Dr
City
of
Peshtigo
Right of Way Rd
N Splake Ct
S Splake Ct
North Ave
South Ave
Trout Creek Pond
Oconto Ave
N Beebe Ave
N Noquebay Ave
Linden St
N Cranberry Ave
N Stephenson Ave
Spruce St
Pine St
N Lake St
N Wood St
N Peck Ave
N Ellis Ave
Stibbe St
Chicago
Ellis Ave
Beebe Ave
0
500
1,000
2,000
Feet



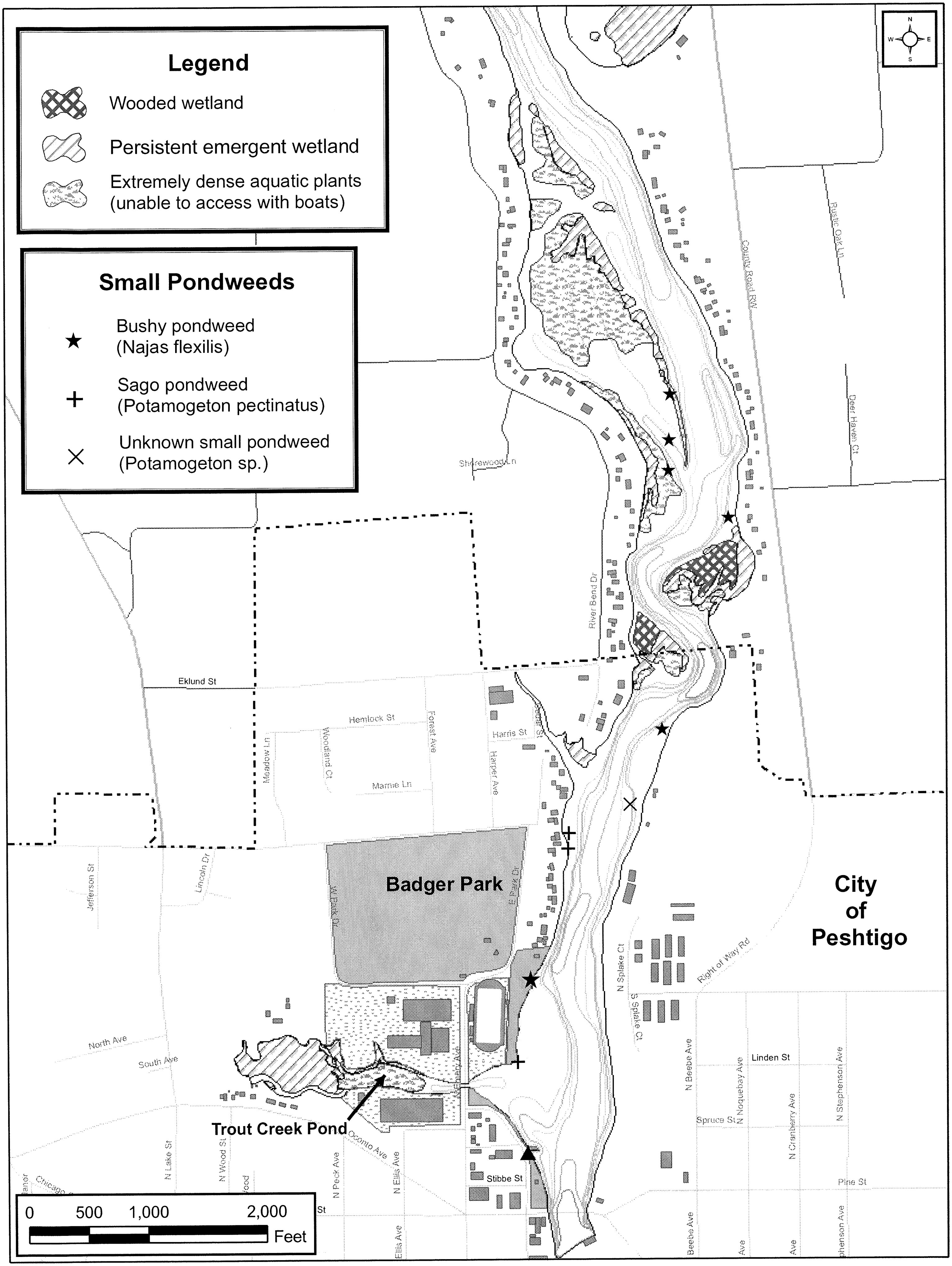
Legend
Wooded wetland
Persistent emergent wetland
Extremely dense aquatic plants (unable to access with boats)
Stiff Water Crowfoot (Ranunculus longirostris)
1 - Sparse
2
3 - Abundant
Badger Park
City of Peshtigo
Trout Creek Pond
0 500 1,000 2,000 Feet
Eklund St
Hemlock St
Harris St
Marnie Ln
Meadow Ln
Woodland Ct
Forest Ave
Harper Ave
Shorewood Ln
River Bend Dr
County Road RW
Rustic Oak Ln
Deer Haven Ct
Jefferson St
Lincoln Dr
North Ave
South Ave
N Splake Ct
S Splake Ct
Right of Way Rd
Linden St
Spruce St
N Beebe Ave
N Noquebay Ave
N Cranberry Ave
N Stephenson Ave
Pine St
Stibbe St
Oconto Ave
N Peck Ave
N Ellis Ave
Ellis Ave
N Lake St
N Wood St



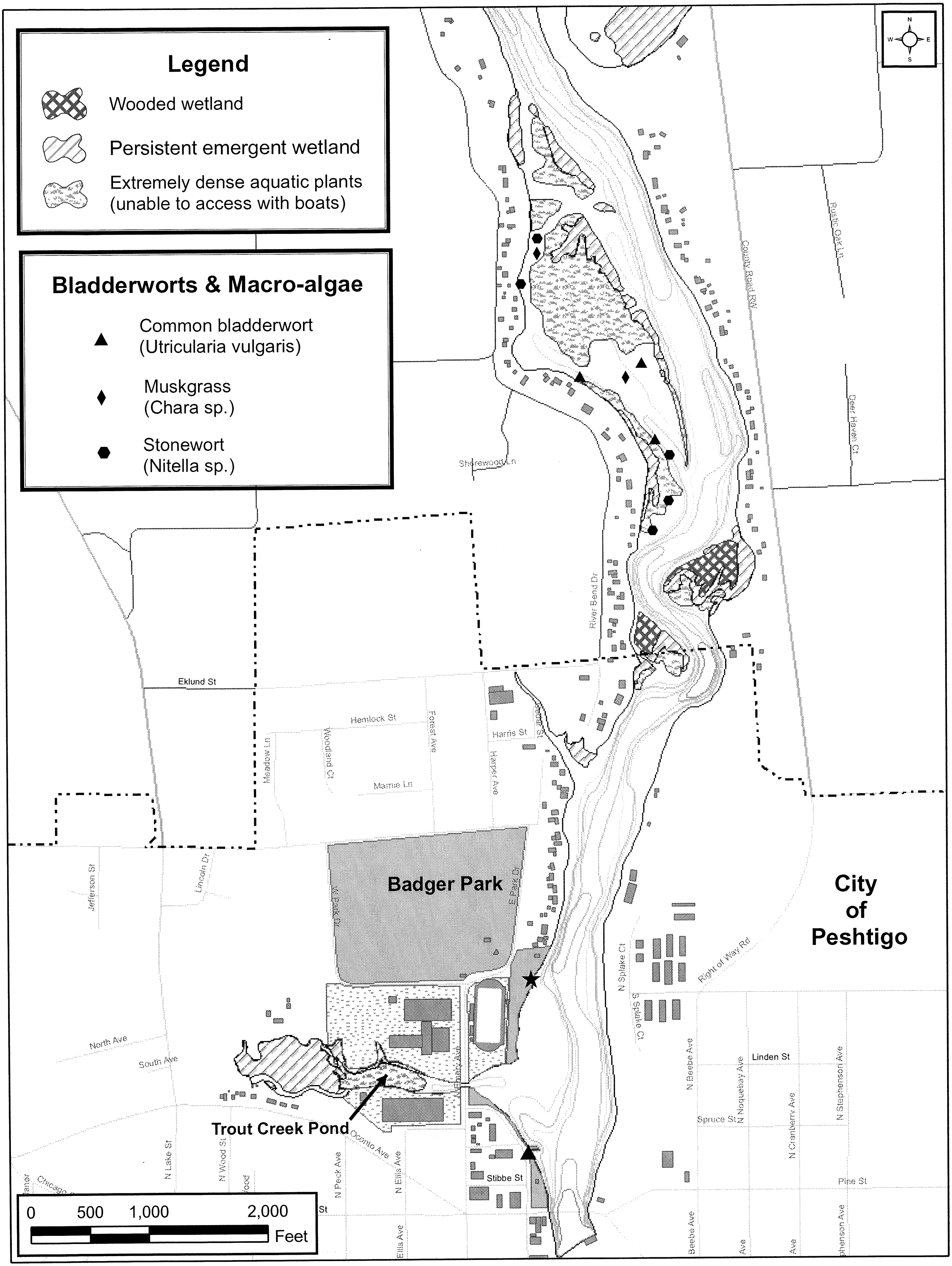
Legend
Wooded wetland
Persistent emergent wetland
Extremely dense aquatic plants (unable to access with boats)
Floating-leaf Aquatic Plants
Spatterdock lily (Nuphar variegata)
White pond lily (Nymphea odorata)
County Road RW
Rustic Oak Ln
Deer Haven Ct
Shorewood Ln
River Bend Dr
Eklund St
Hemlock St
Forest Ave
Harris St
Woodland Ct
Meadow Ln
Marnie Ln
Harper Ave
Badger Park
City of Peshtigo
Jefferson St
Lincoln Dr
N Splake Ct
S Splake Ct
Right of Way Rd
North Ave
South Ave
N Beebe Ave
Linden St
N Noquebay Ave
N Stephenson Ave
Spruce St
N Cranberry Ave
Trout Creek Pond
Oconto Ave
N Lake St
N Wood St
N Peck Ave
N Ellis Ave
Stibbe St
Pine St
0 500 1,000 2,000
Feet



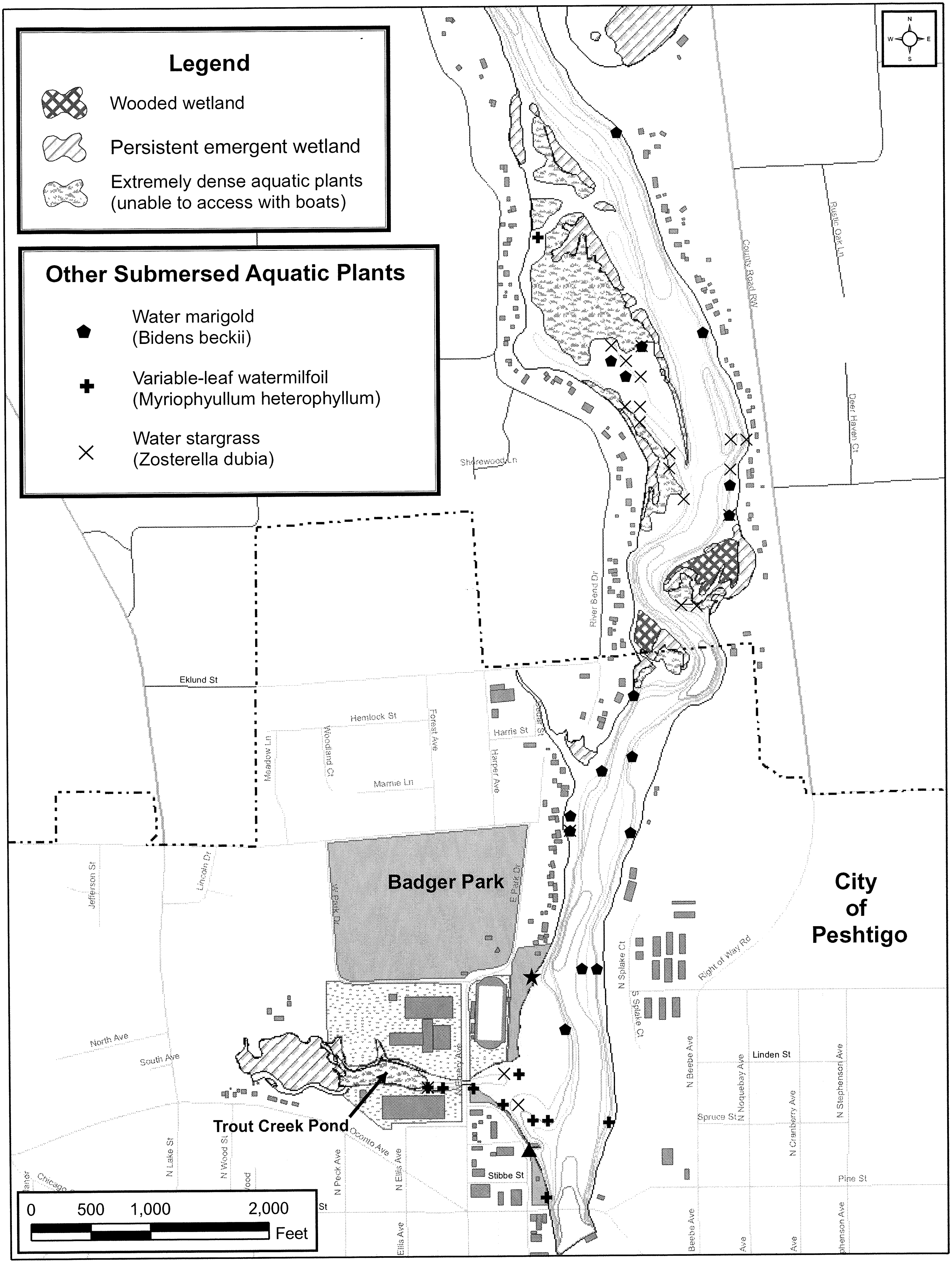
Legend
Wooded wetland
Persistent emergent wetland
Extremely dense aquatic plants (unable to access with boats)
Large Pondweeds
Clasping-leaf pondweed (P. richardsonii)
Large-leaf pondweed (P. amplifolius)
Floating-leaf pondweed (P. natans)
Badger Park
City of Peshtigo
Trout Creek Pond
Eklund St
Hemlock St
Harris St
Marnie Ln
Meadow Ln
Woodland Ct
Forest Ave
Harper Ave
Shorewood Ln
River Bend Dr
County Road RW
Rustic Oak Ln
Deer Haven Ct
Jefferson St
Lincoln Dr
North Ave
South Ave
N Splake Ct
S Splake Ct
Right of Way Rd
Linden St
Spruce St
Pine St
N Beebe Ave
N Noquebay Ave
N Cranberry Ave
N Stephenson Ave
Oconto Ave
N Ellis Ave
N Peck Ave
N Wood St
N Lake St
Stibbe St
0 500 1,000 2,000
Feet



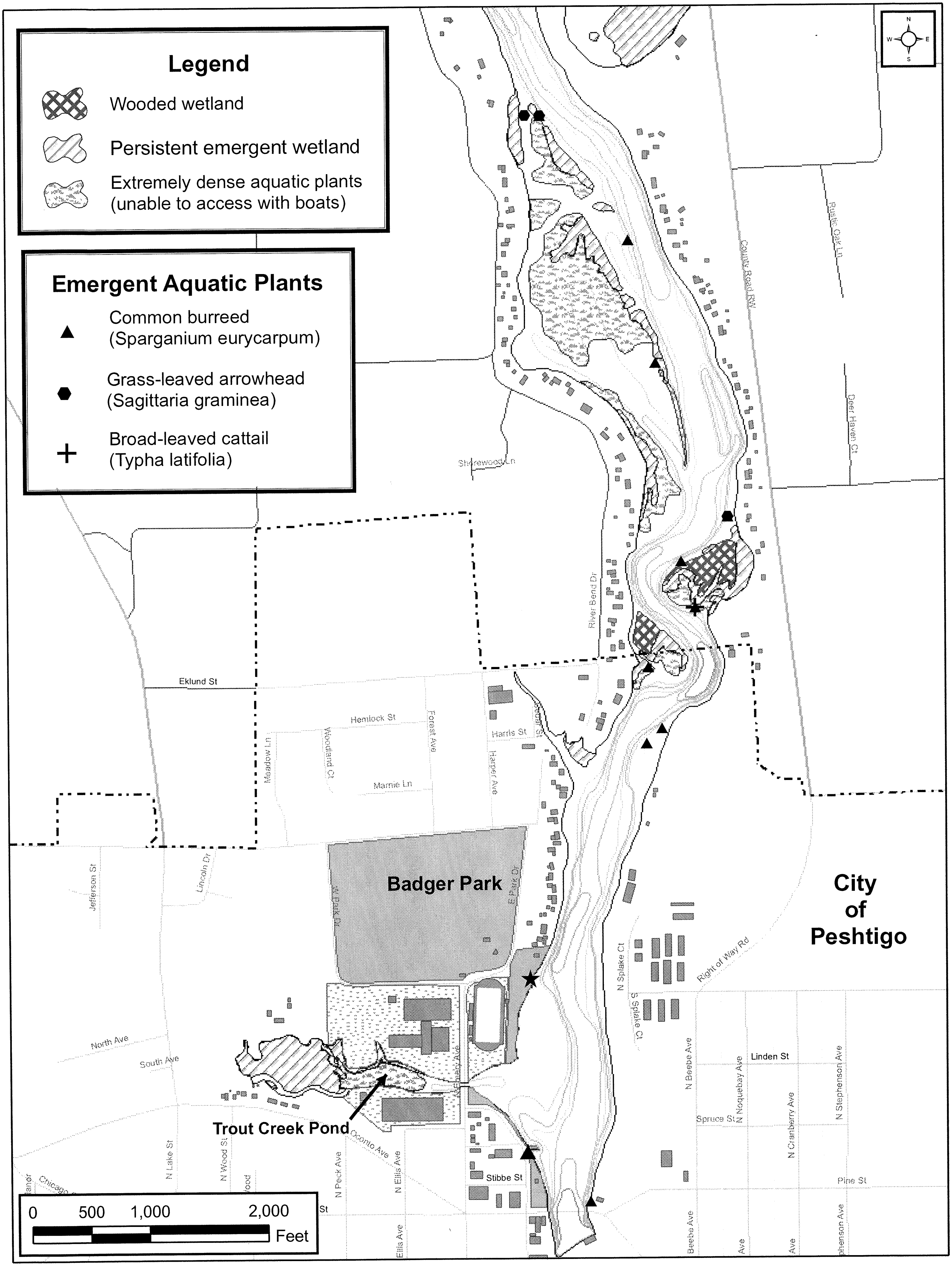
Legend
Wooded wetland
Persistent emergent wetland
Extremely dense aquatic plants (unable to access with boats)
Small Pondweeds
Bushy pondweed (Najas flexilis)
Sago pondweed (Potamogeton pectinatus)
Unknown small pondweed (Potamogeton sp.)
County Road RW
Rustic Oak Ln
Deer Haven Ct
Shorewood Ln
River Bend Dr
Eklund St
Hemlock St
Forest Ave
Harris St
Woodland Ct
Meadow Ln
Marnie Ln
Harper Ave
Jefferson St
Lincoln Dr
Badger Park
W Park Dr
E Park Dr
City of Peshtigo
N Splake Ct
S Splake Ct
Right of Way Rd
North Ave
South Ave
Linden St
N Beebe Ave
N Noquebay Ave
N Cranberry Ave
N Stephenson Ave
Spruce St
Trout Creek Pond
Oconto Ave
Stibbe St
N Peck Ave
N Ellis Ave
N Lake St
N Wood St
Pine St
0 500 1,000 2,000
Feet



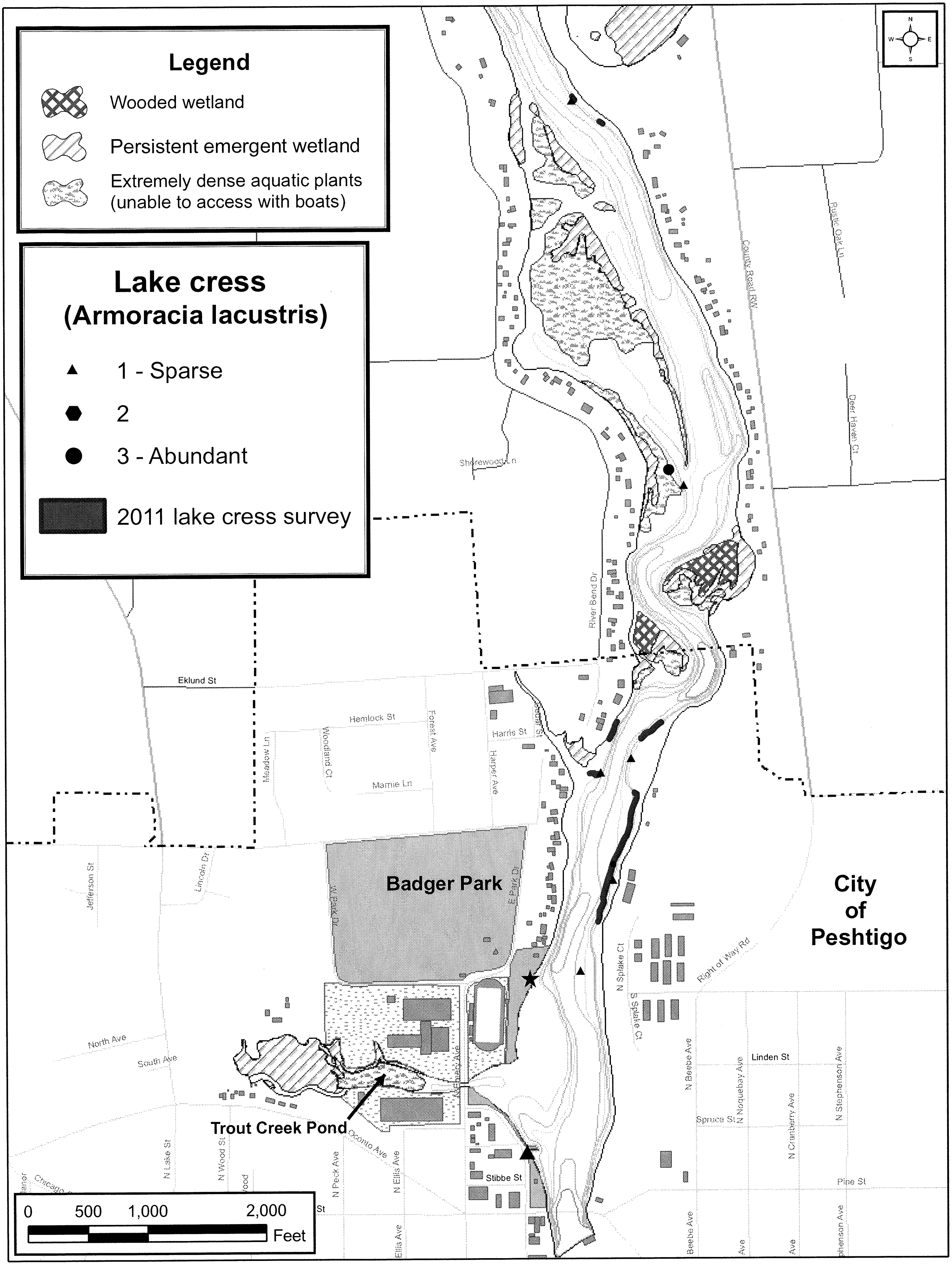
Legend
Wooded wetland
Persistent emergent wetland
Extremely dense aquatic plants
(unable to access with boats)
Bladderworts & Macro-algae
Common bladderwort
(Utricularia vulgaris)
Muskgrass
(Chara sp.)
Stonewort
(Nitella sp.)
Badger Park
City of Peshtigo
Trout Creek Pond
County Road RW
Rustic Oak Ln
Deer Haven Ct
Sherewood Ln
River Bend Dr
Eklund St
Hemlock St
Woodland Ct
Forest Ave
Harris St
Harper Ave
Meadow Ln
Marnie Ln
Jefferson St
Lincoln Dr
W Park Dr
E Park Dr
N Splake Ct
S Splake Ct
Right of Way Rd
North Ave
South Ave
Linden St
N Beebe Ave
N Noquebay Ave
N Stephenson Ave
N Cranberry Ave
Spruce St
Oconto Ave
N Ellis Ave
N Peck Ave
N Lake St
N Wood St
Stibbe St
Pine St
0
500
1,000
2,000
Feet



Legend
Wooded wetland
Persistent emergent wetland
Extremely dense aquatic plants
(unable to access with boats)
Other Submersed Aquatic Plants
Water marigold
(Bidens beckii)
Variable-leaf watermilfoil
(Myriophyullum heterophyllum)
Water stargrass
(Zosterella dubia)
Badger Park
City
of
Peshtigo
Trout Creek Pond
Eklund St
Hemlock St
Harris St
Marnie Ln
Meadow Ln
Woodland Ct
Forest Ave
Harper Ave
Shorewood Ln
River Bend Dr
County Road RW
Rustic Oak Ln
Deer Haven Ct
Jefferson St
Lincoln Dr
North Ave
South Ave
N Lake St
N Wood St
N Peck Ave
N Ellis Ave
Oconto Ave
Stibbe St
N Splake Ct
Right of Way Rd
Linden St
Spruce St
Pine St
N Beebe Ave
N Noquebay Ave
N Cranberry Ave
N Stephenson Ave
0
500
1,000
2,000
Feet



Legend
Wooded wetland
Persistent emergent wetland
Extremely dense aquatic plants
(unable to access with boats)
Emergent Aquatic Plants
Common burreed
(Sparganium eurycarpum)
Grass-leaved arrowhead
(Sagittaria graminea)
Broad-leaved cattail
(Typha latifolia)
Badger Park
City
of
Peshtigo
Trout Creek Pond
0
500
1,000
2,000
Feet
County Road RW
Rustic Oak Ln
Deer Haven Ct
Shorewood Ln
River Bend Dr
Eklund St
Hemlock St
Forest Ave
Harris St
Harper Ave
Meadow Ln
Woodland Ct
Mamie Ln
Jefferson St
Lincoln Dr
N Splake Ct
S Splake Ct
Right of Way Rd
North Ave
South Ave
N Beebe Ave
Linden St
N Stephenson Ave
Spruce St
N Cranberry Ave
Oconto Ave
N Lake St
N Wood St
N Peck Ave
N Ellis Ave
Stibbe St
Pine St

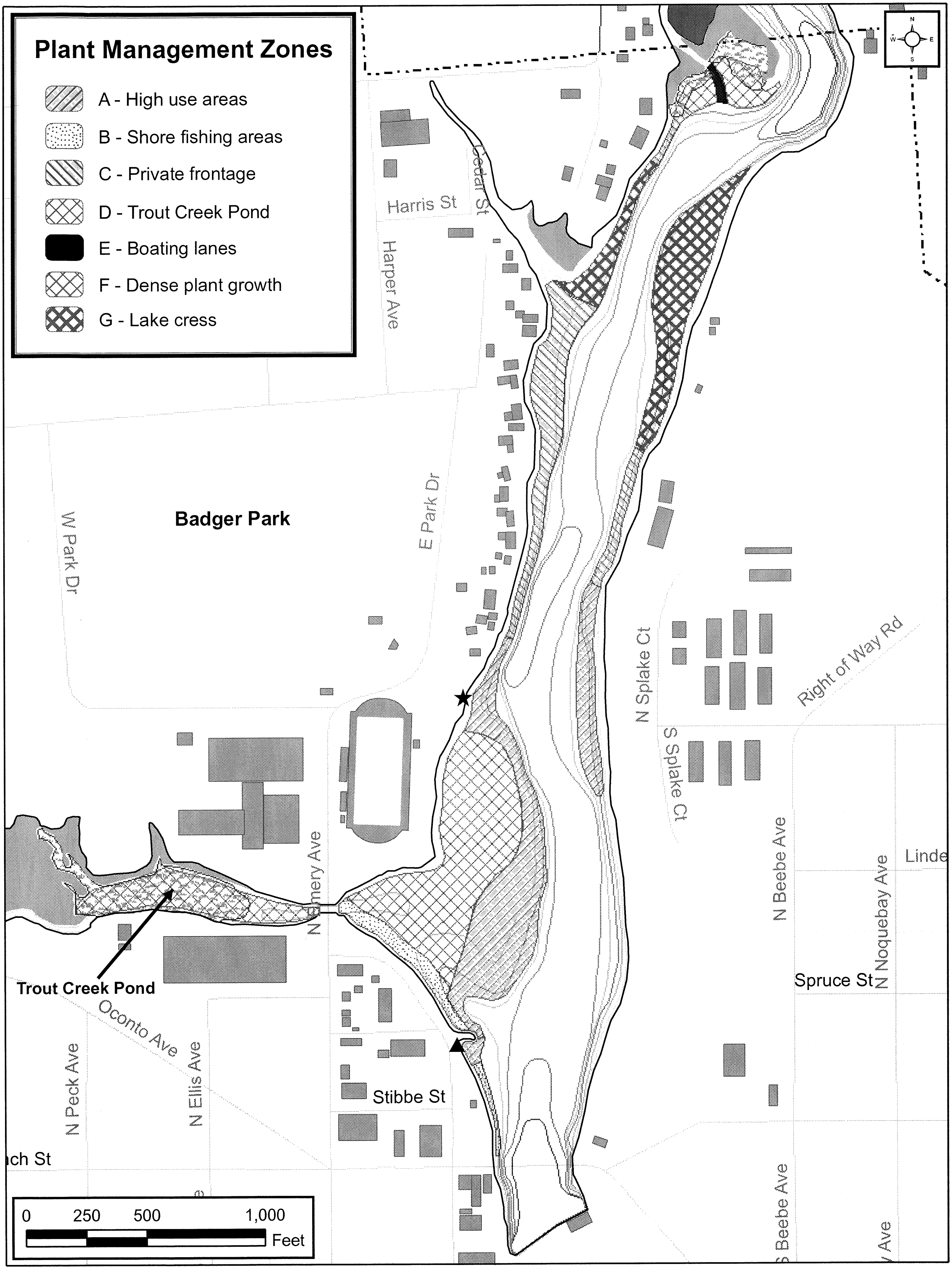

Legend
Wooded wetland
Persistent emergent wetland
Extremely dense aquatic plants (unable to access with boats)
Lake cress
(Armoracia lacustris)
1 - Sparse
2
3 - Abundant
2011 lake cress survey
Badger Park
City of Peshtigo
Trout Creek Pond
Eklund St
Hemlock St
Harris St
Marnie Ln
Forest Ave
Woodland Ct
Meadow Ln
Harper Ave
Shorewood Ln
River Bend Dr
County Road RW
Rustic Oak Ln
Deer Haven Ct
Jefferson St
Lincoln Dr
North Ave
South Ave
N Splake Ct
S Splake Ct
Right of Way Rd
N Beebe Ave
Linden St
N Noquebay Ave
N Stephenson Ave
Spruce St
N Cranberry Ave
Pine St
Stibbe St
Oconto Ave
N Ellis Ave
N Peck Ave
N Wood St
N Lake St
0 500 1,000 2,000
Feet

Appendix B

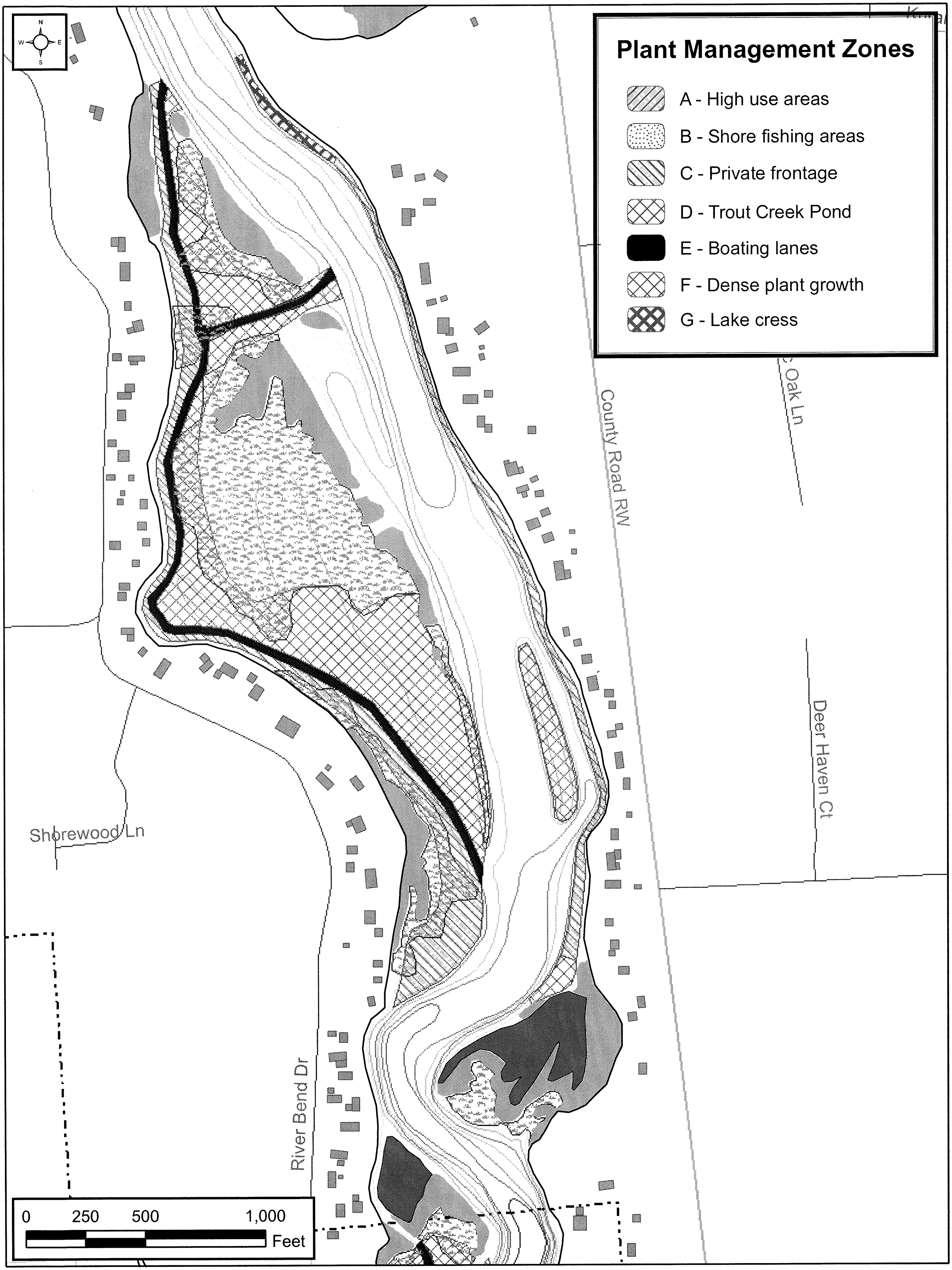
Aquatic Plant Management
&
Record Keeping

Zone		Acres	Description & Management Measures
A	**Areas of high public use**	**7**	**Areas of the flowage that receive heavy boat traffic, the public boat landing, and public beach. Boat traffic is primarily from skiers and pleasure boaters. These areas support dense submersed aquatic vegetation including EWM.**
			Harvest aquatic plants as needed to prevent EWM and native vegetation from restricting use of these important areas.
B	**Public shore fishing areas**	**1.2**	**Areas popular with shore anglers.**
			Improve fishing opportunities by harvesting lanes perpendicular to shore through dense vegetation. Where possible, remove EWM and leave native plants.
C	**Private frontage**	**13.3**	**Private developed shoreline frontage. Aquatic plant density varies in this zone from minimal to extremely dense.**
			Harvest vegetation to allow for access to docks and swim areas.
D	**Trout Creek Pond**	**2.7**	**Extremely dense vegetation that gets stagnant and very unattractive in the summer. The area is inaccessible to the harvester.**
			Use chemical control when flow is minimal or explore other options such as dredging.
E	**Boating lanes**	**2.8**	**These areas support extremely dense submersed aquatic plant growth as well as scattered floating-leaf vegetation. A mix of EWM and native species is dominant in these areas.**
			Periodically harvest plants to provide a 20 to 30 foot wide lane for boat access.
F	**Heavy aquatic plant growth**	**23.8**	**"Other" areas of dense aquatic plant growth.**
			Harvest areas supporting dense EWM growth as time and budget allows. Harvest lanes for fishing access.
G	**Lake cress areas**	**4.9**	**Areas supporting lake cress (*Armoracia aquatica*), a State endangered species.**
			No harvesting except to provide a 30-foot wide access corridor to docks.

Table 2. Recommended aquatic plant management measures for Peshtigo Flowage.



Plant Management Zones
A - High use areas
B - Shore fishing areas
C - Private frontage
D - Trout Creek Pond
E - Boating lanes
F - Dense plant growth
G - Lake cress
Badger Park
Harris St
Cedar St
Harper Ave
E Park Dr
W Park Dr
N Splake Ct
S Splake Ct
Right of Way Rd
N Beebe Ave
N Noquebay Ave
Spruce St
Stibbe St
Oconto Ave
N Ellis Ave
N Peck Ave
Trout Creek Pond
0
250
500
1,000
Feet



N
S
E
W
Plant Management Zones
A - High use areas
B - Shore fishing areas
C - Private frontage
D - Trout Creek Pond
E - Boating lanes
F - Dense plant growth
G - Lake cress
County Road RW
Oak Ln
Deer Haven Ct
Shorewood Ln
River Bend Dr
0
250
500
1,000
Feet

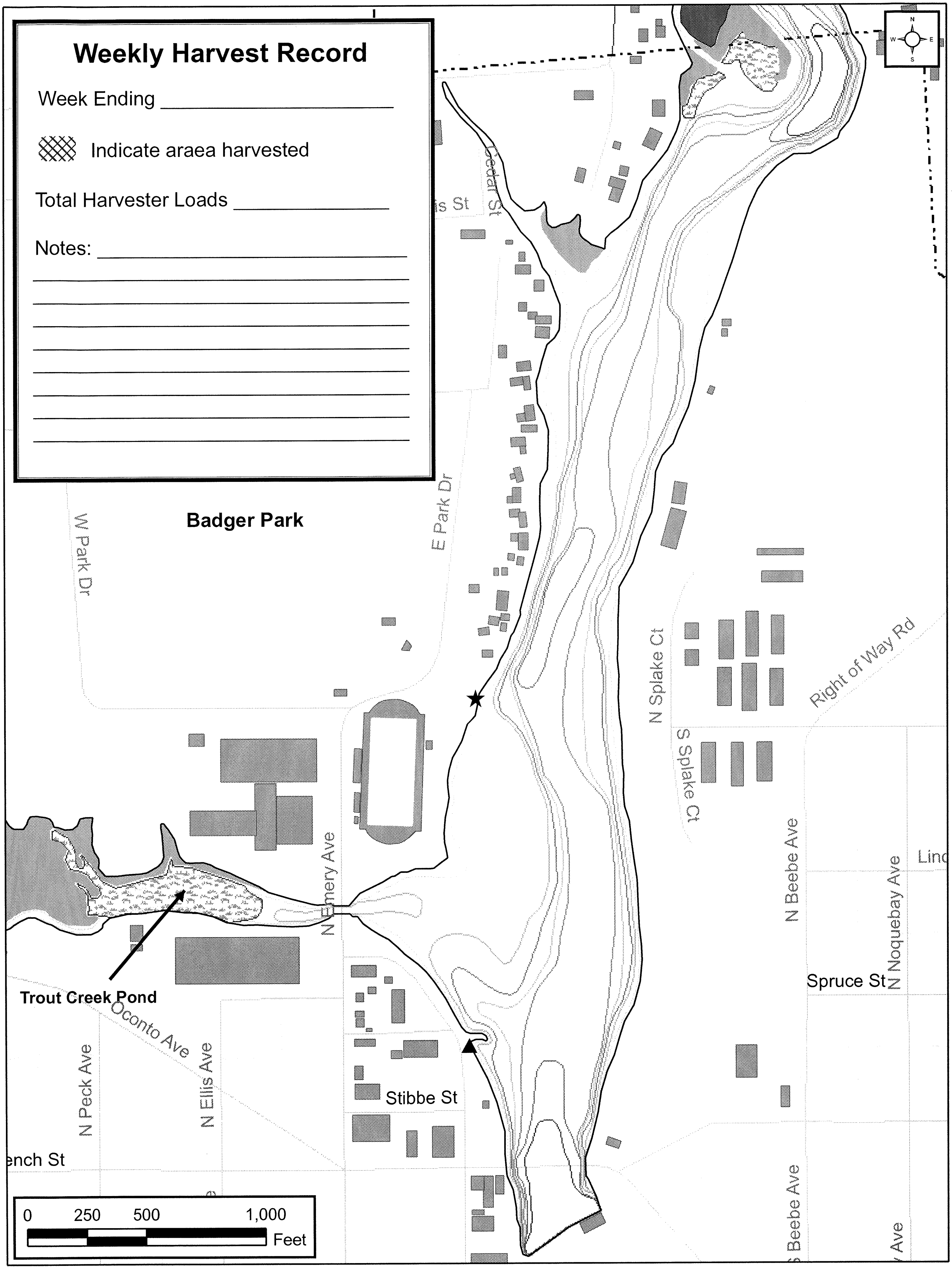
Weekly Harvest Record

Week Ending ______________________

Indicate araea harvested

Total Harvester Loads ______________

Notes: _____________________________



Weekly Harvest Record

Week Ending ____________________

Indicate araea harvested

Total Harvester Loads ______________

Notes: ____________________________

____

____

____

____

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