Aquatic Enhancement
& Survey, Inc.

Aquatic Vegetation Management Plan 2008-2012

Meserve Lake, Steuben County

Prepared for Life of Riley Home Estates
By
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Executive Summary

Meserve Lake is a kettle lake of approximately 18.4 acres located in Steuben County, Indiana. It has an average depth of 13 feet and maximum depth of 22 feet. Meserve Lake is "oligotrophic" generally having good water quality and clarity. The water quality is high enough to sustain Cisco, a type of inland lake whitefish that is more environmentally sensitive than most other Indiana species. Meserve has a watershed area of 649 acres comprised of primarily agricultural lands and grasslands/pasture. The lake is lightly developed having only four lakeside residences. Many residents of a nearby off-lake neighborhood, the Life of Riley subdivision, use the lake and belong to the Life of Riley Association (LRA) which acts as the primary advocate organization for the lake. The LRA maintains a common area property on the shoreline with a covered pavilion and gravel boat ramp. Neighborhood members as well as the general public can gain access to the lake through this common area by joining the LRA. Fishing and swimming are the most common uses of the lake. Since about 2006 residents and users of the lake have noted the growth of a new aquatic plant. In 2008 these plants were brought to the attention of the Indiana Department of Natural Resources (IDNR) fisheries section personnel. Samples of the plant were identified as parrot feather *Myriophyllum aquaticum.* Parrot feather is a type of milfoil native to South America. It has occasionally been introduced into the wild by aquarium or garden pond owners who do not realize the potential for damage it presents. This plant has been noted in some ponds and small impoundments in Indiana, but this stands as its first known occurrence in an Indiana natural lake. Parrot feather is known to become invasive in waters outside its native range, causing extensive problems in drainage ditches and small lakes. It is possible that this plant could, if allowed to grow and spread unchecked, cause recreational and ecological impairment to Meserve Lake and other Indiana water bodies. Parrot feather is capable of spreading via fragmentation so there is a real possibility that plant fragments exiting Meserve Lake and draining through its' connection to the Pigeon Creek watershed downstream could result in significant ecological damage in Indiana waters. Because of this possibility a treatment regime and the development of this plan was undertaken with funding provided through the IDNR Lake and River Enhancement (LARE) program.

Treated areas in 2008 included parrot feather growth totaling 2.7 acres in the deeper offshore waters of the lake. This area was treated on September 17, 2008 with 200 pounds per acre Navigate® (2,4-D) granular aquatic herbicide. On September 17, 2008 a .4 acre area of the lakes outlet stream immediately downstream of the lake and a .1 acre area of the lake's inlet stream immediately upstream of the lake were treated with 200 pounds per acre Navigate® (2,4-D) granular aquatic herbicide. Scattered parrot feather plants growing along the north shoreline of the lake were treated with Weedar 64® (2, 4-D) liquid herbicide at the rate of 10 gallons per surface acre. Scattered near-shore plants along the southern perimeter of the lake were treated with Renovate 3® (Triclopyr) liquid aquatic herbicide at the rate of 2.5 ppm. Cygnet plus® non-ionic surfactant was also applied during each perimeter treatment at the rate of 1.5 gallons per surface acre. This was followed up on September 18 by treatment of emerged parrot feather plant tops in the inlet and outlet streams utilizing a backpack sprayer and five percent solution of Weedar 64® (2,4-D) liquid herbicide and 2 quarts per acre Cygnet Plus® surfactant. This plan establishes the following overall goals for the management of parrot feather and other invasive non-native aquatic plants at Meserve Lake:

1. Maintain a stable, diverse aquatic plant community that supports a good balance of predator and prey fish and wildlife species and good water quality.

2. Direct efforts to preventing and/or controlling the negative impacts of aquatic invasive species.

3. Provide reasonable public recreational access while minimizing the negative impacts on plant, fish, and wildlife resources.

Recommended management activities at Meserve Lake in 2008 have been geared toward the attainment of these goals with the objective of ultimately eradicating parrot feather and minimizing the possible escape of live plants or plant fragments downstream into other parts of the Pigeon Creek watershed. While efforts at control in other areas on the U.S. have not confirmed that complete eradication of this plant is possible the ideal goal for Meserve Lake will be complete and permanent eradication of parrot feather. With this in mind, for the 2009 season and beyond management activities at Meserve Lake should seek to attain the following benchmarks for success:

1. Produce no occurrence of live parrot feather plants in the 2009 late season IDNR protocol Tier II survey.

2. Generate a significant awareness among Steuben County lake residents and the majority of Meserve Lake users that this plant is potentially invasive and requires that measures are taken to prevent its spread.

To achieve benchmark number one a regime of chemical treatment is advised incorporating the following four separate elements as needed: 1. Up to three treatments of the lake's littoral zone (beyond 25 feet from shore) should be performed with Navigate® (2, 4-D) granular aquatic herbicide at the maximum label rate of 200 pounds per surface acre. This treatment includes the section of the Meserve Lake outlet stream extending downstream to the second road crossing (Easy Street) and the inlet stream (from Gooseneck Lake) extending upstream from the lake approximately 110 feet. 2. Up to three treatments of the lakes northern perimeter in a strip extending to 25 feet from shore with DMA-4® (2, 4-D) liquid herbicide at the maximum label rate of 2.84 gallons per acre-ft. This treatment should also include Cygnet Plus® non-ionic surfactant applied at the maximum label rate of two gallons per surface acre. 3. Up to three treatments of the southern perimeter of the lake in a strip extending to 25 feet from shore with Renovate 3® (Trichlopyr) liquid herbicide at a concentration of .82 parts per million (.74 gallons per surface acre). 4. Up to three rounds of spot treatments of miscellaneous parrot feather that is not accessible to the other treatments or otherwise unresponsive. This treatment should utilize handheld equipment to apply DMA-4® (2, 4-D) at the rate of 3 ounces per 1000 square feet and involve up to .1 acre per treatment. Two Tier II plant surveys, at least one public meeting and the preparation of an update to this plan should be included in the 2009 season management activities to help track progress, inform the public, and revise the plan's tactics and objectives as needed to provide optimal control and progress toward overall plan goals. The total cost for herbicide applications in the 2009 season is estimated to be up to $30,991.00. The total cost for surveys, meetings, and other planning and monitoring activities for the 2009 season is estimated to be $3300.00.

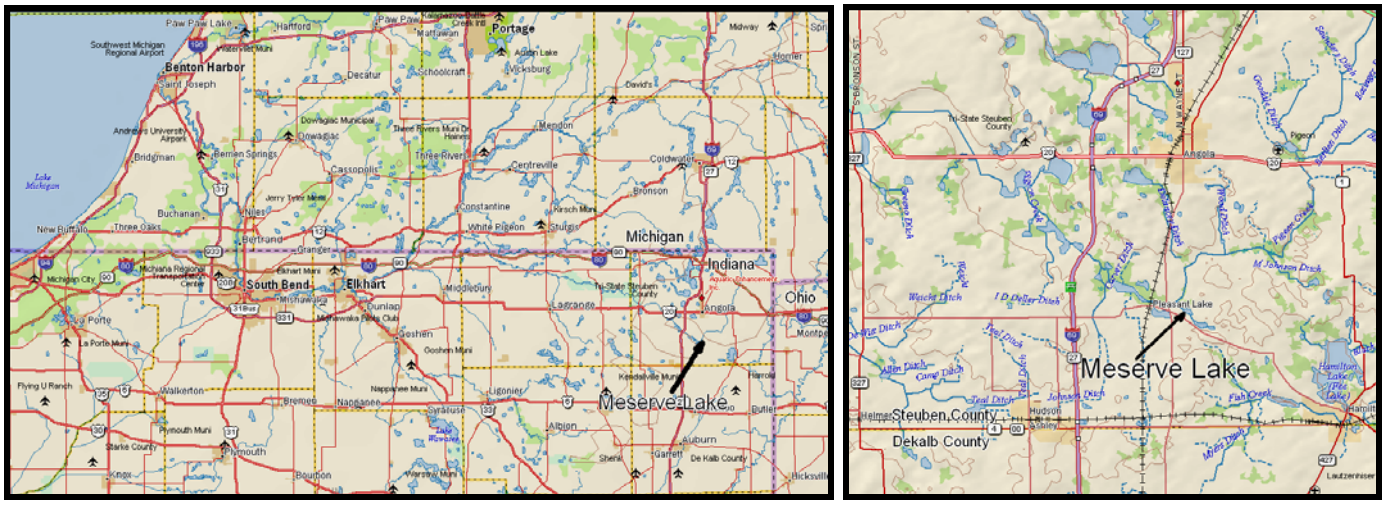

Figure 1 1, 900,000 (left) and 1 175,000 (right) Scale maps showing general location of Meserve Lake

1. Problem Statement

At some point in recent years the non-native potentially invasive aquatic plant parrot feather found its way into Meserve Lake. In June of 2008 a specimen of the plant was brought to IDNR biologists at the district two fisheries headquarters in Orland, Indiana. After initially identifying the plant as parrot feather a sample was forwarded to Dr. Robin Scribalio, a professor of biology at Purdue University North Central, who confirmed the identification. Subsequent visits to the lake by the fisheries biologists confirmed that Parrot feather had colonized Meserve Lake. This South American species of watermilfoil is commonly cultured and sold for use as an ornamental plant or "oxygenator" in aquariums and ornamental garden ponds. When introduced to habitat far outside their historical range aquatic plant species can sometimes invasively over-colonize aquatic areas forming dense growth and presenting a severe impairment to boaters, swimmers and other recreational users.

Plants that form thick growths in lakes, streams, and ponds can also seriously affect the perceived aesthetic qualities of those waterways. In drainage canals thick growths of aquatic plants can hinder flow rates causing irrigation or drainage problems in agriculturally productive or developed areas. In addition invasive non-native aquatic plants have demonstrated the ability to out complete more beneficial native plant species radically altering fish and wildlife habitat, affecting plant community diversity and the growth rates of certain species of sport fish.

Eurasian watermilfoil *Myriophyllum spicatum*, another introduced non-native species of the same genus as parrot feather was introduced to U.S. waters through the aquarium industry in the 1940's and has become widespread in Indiana Lakes causing innumerable problems for sportsmen and recreational lake users. In a 1998 IDNR analysis Eurasian watermilfoil was reported from 173 lakes or 56 percent (33,006 acres) of the total lake surface area in Indiana. (White 1998) In the analysis Eurasian milfoil was noted in 33 of 93 total lakes in Steuben County (35%). Since milfoil species can be spread by plant fragments carried on boat trailers it's no surprise that Eurasian watermilfoil has ended up in many lakes throughout the Midwest. Another invasive species, Curlyleaf pondweed *Potamogeton crispus* also has extensively colonized Indiana lakes causing treatment programs to be initiated. Also a popular aquarium plant, Curlyleaf was accidentally introduced to U.S. waters by hobbyists in the mid 1800's.

In 2008 alone IDNR issued $724,973 in grant awards to survey and treat exotic invasive plants in 49 lakes. Resident associations of an additional 30 lakes applied for funding to survey and control non-native aquatic plants but lack of funding prevented grant awards in these cases.

Many lake associations, individuals, and subdivision level groups of lake residents also carry out privately funded control programs for exotic invasive aquatic species each year.

With the discovery of Parrot feather in Meserve Lake the potential may exist for this plant to become a new problem species that can cause extensive damage to the recreational, aesthetic, and ecological integrity of Indiana's Lakes as Eurasian watermilfoil has done. This is the first known discovery of this plant in a public lake in Indiana. Meserve Lake discharges through a tributary stream to Pigeon Creek. Because parrot feather, like other milfoils, is capable of spreading by fragmentation several lake basins downstream in the same drainage could be susceptible to colonization by fragments flowing out of Meserve Lake. Introduced Parrot feather has already shown invasive tendencies by growing excessively in ponds and canals in various parts of the United States.

1.1 Myriophyllum aquaticum, History and Biology

Myriophyllum aquaticum is a member of the Haloragaceae plant family consisting of eight genera and approximately 100 species (Sutton 1985). Its genus *Myriophyllum* (the watermilfoils) includes about 40 species world wide. About 13 species are known to occur in North America of which 10 are thought to be indigenous (Sutton 1985). The literature most often refers to Parrot feather as being native to South America including Argentina, Bolivia, Brazil, Chile, Ecuador, Paraguay, and Peru(GISD 2008). Parrot feather like other milfoils grows most often as single stalks, seldom branching. The plant is capable of producing both emersed / emergent (protruding onto or above the surface) leaves, and submersed leaves. It takes its name from the attractive

Figure 2 A feather-like emersed plant at the edge of Meserve Lake

Figure 3 Deepwater plants at Meserve show the more filamentous appearance of the submersed leaves (resembling native milfoils but larger in girth). Emersed leaves are also present on some plants.

feather-like appearance of its emersed leaves.

Parrot feather leaves are arranged around the plant stem in whorls of four to six. Emersed Parrot feather leaves are grey green, flexible, and stiff. Each leaf may have 20 or more linear-filiform (10 or more per leaflet side) divisions which gives the plant its feather-like appearance (Godfrey 1981) (Fig. 2 above). Emersed leaflets are typically coated in a waxy cuticle that traps air and seems to keep the leaf surfaces dry even if the plant tip becomes submersed. Submersed leaves by comparison are relatively limp when out of the water and are more filamentous. Underwater, the submersed-form leaves have a fluffed up tubular appearance (Figure 3 above).

Upon casual observation the submersed portion of the Parrot feather plants growing in Meserve Lake bear a strong resemblance to certain native species of milfoil that grow commonly in other Steuben County Lakes, especially Variable watermilfoil *Myriophyllum heterophyllum*. One helpful way to differentiate these other species from Parrot feather is the size and look of the submersed leaves/stem and the presence of emersed leaves on Parrot feather versus emersed Bracts on the native species. Variable watermilfoil leaves are typically two to five centimeters in length. Submersed Parrot feather leaves have been described as being

Figure 4 Variable watermilfoil in a Hillsdale County Michigan lake, Inset photo is an emersed floral bract of the same species

Figure 5 Parrot feather at Meserve, Inset shows emersed leaves

only 1.5 to 3.5 cm in length (WDE 2008). However, Parrot feather plants collected from deep water in Meserve Lake had many submersed leaves over five centimeters (approx. 2 inches) in length. This makes the plants appear much larger than Variable watermilfoil (See figures above).

Emersed leaves will often be present on Parrot feather and have the typical feather-like appearance. Emersed plant parts (when present) on Variable watermilfoil are typically small lance-ovate toothed floral bracts (Fasset) that are much shorter than emersed Parrot feather leaves. There may be some differences between identifying characteristics and measurements typically given in plant keys and the literature for Parrot feather plants and those growing in Meserve Lake (Mitchell Alix personal communication). This could presumably be a result of the depth of growth in the relatively clear waters of Meserve Lake. Parrot feather is most often reported to be a plant best suited to growth in the shallows. Sutton in summarizing the *Biology and Ecology of Myriophyllum Aquaticum* stated that although it will grow submersed it is found primarily as an emersed plant and "under natural conditions, it appears to prefer a warm climate, muddy banks or shallow bodies of water, and tends to grow in isolated patches primarily as the emersed form" (Sutton 1985). In *Waterplants of New South Wales* it was noted to be growing in static and flowing waters up to two meters (6.6 feet) deep (Sainty etal 1981). At Meserve it was noted growing to a depth of 4.9 meters (16 feet) deep.

Parrot feather is a dioecious plant. Dioecious plants are those that have male and female flowers on separate individuals; however Parrot feather plants bearing male flowers are rare in the plants home range in South America (Orchard 1981) and unknown in North America (Couch and Nelson 1988). It is likely that all reproduction is vegetative, occurring by stolon (root) formation and fragmentation. The vast majority of plants found growing around the shallow edges of Meserve Lake and in the inlet and outlet streams in 2008 were free-floating fragments that had continued to grow in an un-rooted state once they had settled against the shoreline or become entangled in emergent vegetation in shallow water.

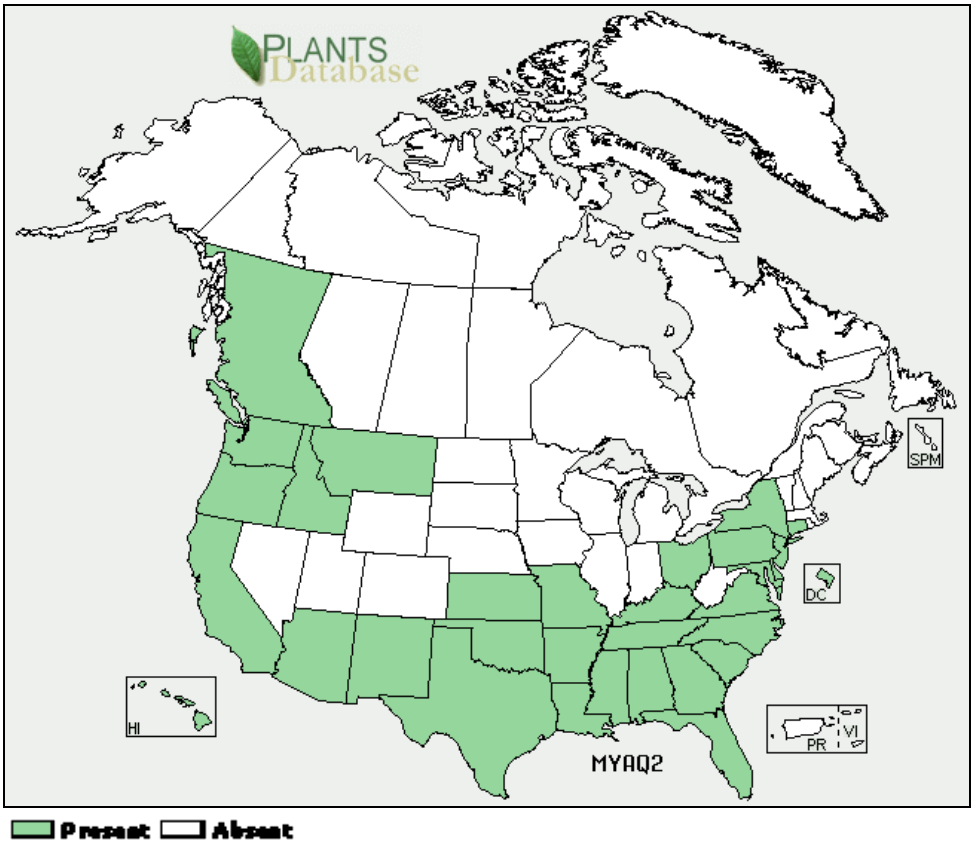

Figure 6 Current USDA NRCS Plants Database distribution map for Parrot feather

Because Parrot feather has been widely cultured and distributed as an ornamental it has colonized water bodies in many countries. It is now found on every continent except Antarctica. In many locations it is not considered a major noxious weed, but in other areas it has been noted to cause significant problems, especially in shallow ditches and small water bodies. It is estimated that its initial introduction into North America occurred in the late 1800's to early 1900's. In the United States it is now present in at least 32 states and the District of Columbia. (See USDA map above) Other countries that have encountered problems with naturalized populations of Parrot feather in irrigation or drainage canals include Australia, New Zealand, Japan, and South Africa. In certain parts of the U.S. significant efforts are carried out to control its growth. A 1985 survey of irrigation, mosquito abatement, flood control, and reclamation agencies in California indicated that Parrot feather infested nearly 600 miles of waterways and over 500 surface acres. In Washington State, the Longview Diking District estimates that it spends $50,000 a year on Parrot feather control in drainage ditches with another $30,000-$40,000 spent on controlling Parrot feather in the southwest portion of the state (WDE 2008).

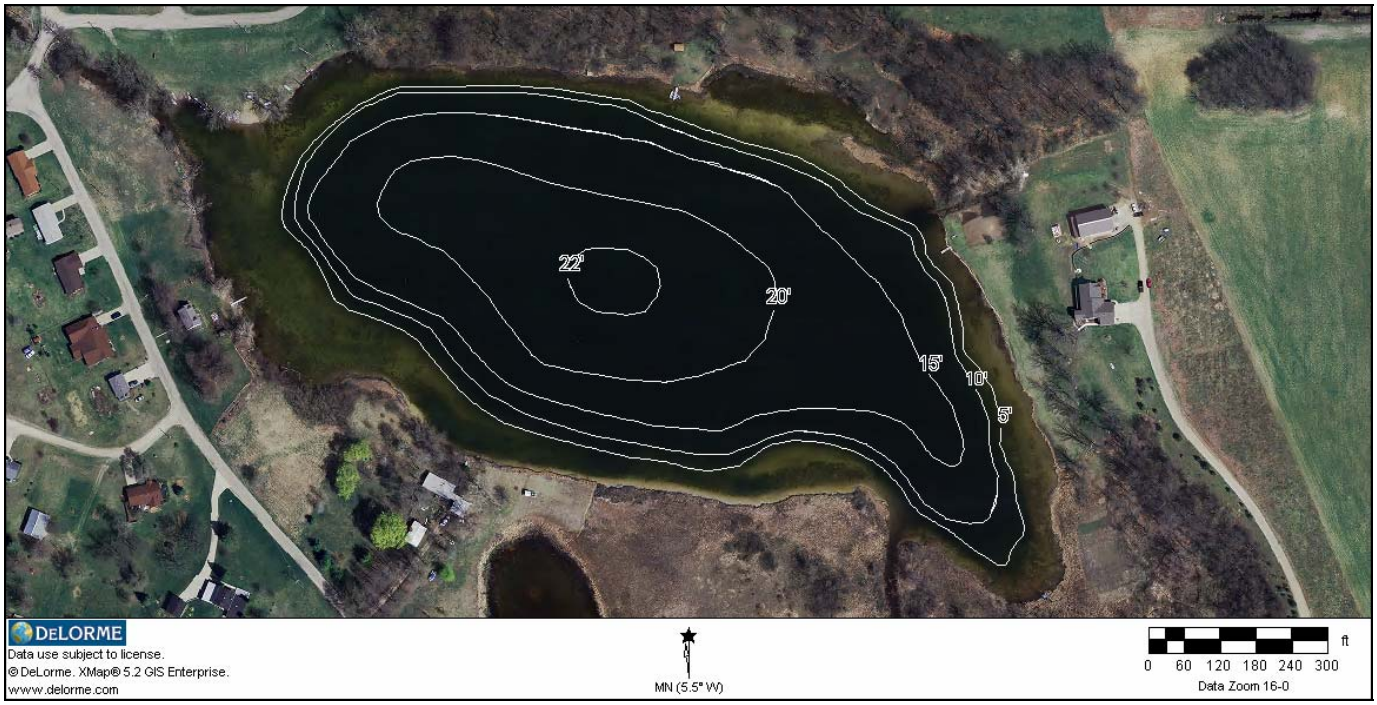

Figure 7 Contour map of Meserve Lake

2. Watershed and Water Body Characteristics

2.1 General Morphometry and Physical Characteristics

Meserve Lake is glacial "kettle" lake of approximately 18.4 acres located in Steuben County in Northeast Indiana. Like most Steuben County lakes Meserve Lake was probably formed during the late Pleistocene era approximately 10,000 years ago by a large glacial ice-block left in the landscape as glaciers that extended over the northern half of Indiana receded northward and melted. The lake is roughly oval in shape lying in a northwest-southeast orientation approximately 5000 feet due east of the town of Pleasant Lake. Meserve has a maximum depth of approximately 22 feet and a mean depth of approximately 13 feet (See contour map above). A shallow littoral shelf extends to approximately 150 feet from shore at the west end of the lake. Around the central and eastern part of the lake this shelf is narrower averaging approximately 25 feet in width. The edge of this shelf is near the five foot contour with the bottom of the lake declining sharply to deeper waters beyond that. The extreme southeast end of the lake forms a cove with its central portion having a slightly sloping bottom in approximately 10-12 feet of water.

A small tributary enters Meserve Lake in its northeast corner (See figure 8 page 16). This tributary is linked to an extensive open drainage ditch to the northeast of the lake. Watercress *Nasturtium officinale* (and Parrot feather) was noted growing in this streambed near its confluence with the lake. Because Watercress grows well in cool clean waters and is noted to be particularly common in springs it serves as an indicator that a significant amount of groundwater flow may drain to the lake through this tributary (Fassett).

In the southeast part of the lake another small tributary brings flow from Gooseneck Lake, another small kettle lake. This tributary appears to have been dredged and channelized in the past, probably to facilitate drainage. Gooseneck Lake lies just southeast of Meserve and is

comprised of two small separate basins joined by a short stream. Flow leaving Meserve Lake exits to the West through a dredged and channelized stream reach joining with Pigeon creek approximately 1500 feet downstream of the lake.

2.2 Hydraulic Residence Time

For this plan two estimates were calculated for the lake's hydraulic residence time. One calculation was based on the estimated annual runoff produced by the Meserve Lake watershed and an additional estimate was based on a flow rate measured just downstream of the Meserve Lake outlet on November 23, 2008. The hydraulic residence (retention) time is the theoretical average time that a given drop of water finding its way to Meserve Lake would spend in the lake before passing through the outflow stream.

Using annual precipitation data from the Midwestern Regional Climatic Center and data collected from a United States Geological Survey (USGS) operated stream flow gauging station stream in Steuben County a general runoff coefficient was calculated to provide an estimate of the average inches of runoff entering the lake from its 649 acre watershed. This figure is then used to calculate the volume of estimated runoff entering the lake each year. Dividing the volume of water in the lake by the volume of water flowing into it each year produces a rough estimate of the average time that water spends in the lake (see figures in table 1 below). This method assumes that the Meserve Lake watershed has similar runoff characteristics to the watershed used to produce the runoff coefficient. It should be noted that this method also can fail to correctly account for groundwater inputs to the lake. Based on this method the estimated residence time for waters in Meserve Lake is 258 days. Because runoff or direct rainfall entering the lake during the summer warm season when the lake is thermally stratified is not likely to mix with the cooler lower waters of the lake, but rather flow through the upper layer of the lake, an adjusted retention time can be produced assuming the lake to only be comprised of it's upper ten feet of volume. In this case the retention time estimate produced is 159 days. When "whole lake" type herbicide treatments are performed it's typically required that the applied herbicide be retained in the waters of the lake for an extended period of time. This initial estimate for Meserve Lake indicates the residence time of the lake's waters will be long enough to insure sufficient herbicide retention in the case of a properly performed whole lake treatment.

Alternatively a hydraulic residence time was calculated using actual flow data collected just downstream of the Meserve Lake outlet. On November 23, 2008 a basic measurement of the cross sectional area of the stream flow and a measurement of the stream flow velocity were used to calculate a flow rate of 68 cubic feet per minute (CFM) (See table 1 below). This method assumes that the flow rate on the day of measurement represents that average annual flow rate through the lake. Using the 68 CFM figure it was calculated that the total annual flow is equal to 820 acre-feet. Dividing the lake volume by this figure produces a residence time of 106 days. Again using the estimated volume of only the upper ten feet of the lake reduces this figure to a residence time of 66 days. Using the 66 day figure it still appears that a whole lake treatment may be possible, but a considerable maintenance dosing or "bump" treatment(s) may be necessary to maintain a given target concentration of herbicide in the lake for an extended period of time.

Hydraulic Residence time Calculation based on estimated runoff (assumes runoff is similar in quantity to the watershed where coefficient was calcualted)(does not include groundwater flows)		**Hydraulic Residence time Calculation based on measured flow 11/23/08** (assumes annual average flow rate is equal to 11/23/08 rate)	
Watershed Acres	649	Flow rate (CFM)	68
Est. Runoff Coefficient	0.16	C.F./Hour	4080
Est. Annual Precip. (in)	38.89	C.F./Day	97920
Est. Annual Precip. (ft)	3.24	C.F./Year	35740800
Annual Runoff (ft) (Ann. Precip.)*(runoff coeff)	.52	Annual acre-ft	820
Ann. Runoff Vol. (ac-ft) (Ft. runoff)*(ac. watershed)	338		
Lake Volume (ac-ft) (18.4 ac @ 13 foot avg. depth)	239	Lake Volume (ac-ft) (18.4 ac @ 13 foot avg. depth)	239
Residence time (yrs) (Lk vol/ann. runoff)	.71 (258 days)	Residence time (yrs) (Lk vol/ann. flow)	.29 (106 days)
Upper 10 ft Lake Volume (18.4 ac @ 8 foot depth)	147	Upper 10 ft Lake Volume (18.4 ac @ 8 foot depth)	147
Residence time of upper ten feet (yrs) assuming no mixing of rainfall/runoff below 10 feet (Lk vol/ann. flow)	.43 (159 days)	Residence time of upper ten feet (yrs) assuming no mixing of rainfall/runoff below 10 feet (Lk vol/ann. flow)	.18 (66 days)

Table 1 Estimated Hydraulic residence time calculations for Meserve Lake

2.3 Public Access and Riparian Land Uses

Life-of-Riley subdivision residents gain access to Meserve Lake via an association commons area located along the northwest shore of the lake. This area also contains a pavilion, small swimming beach and gravel boat ramp. A portion of the lake is bordered by a mix of riparian emergent and scrub-shrub wetlands, most of which lie within a marsh at the outlet in the southeast corner of the lake. Other areas of the shoreline are woodlands or natural grasslands. Developed frontages with turf grass only represent about 900 of the 3900 feet (23%) of Meserve Lake's shoreline. There are only four homes on Meserve Lake. Two of these are relatively large homes set well back from the lakes edge along the northeast side and two are smaller cottages along the southwest side of the lake.

2.4 Water Quality Characteristics

Meserve Lake generally exhibits good midsummer water clarity and good water quality. Lakes are often classified by the amount of phosphorus and other nutrients present in their waters. Low nutrient waters generally exhibit good water clarity, good oxygen levels, and a moderate to low growths of aquatic plants while waters richer in nutrients often have lower oxygen levels at depth in deeper water and poor water clarity, growing large amounts of planktonic algae or aquatic plants. The amount of nutrient enrichment and associated changes a lake has undergone is sometimes referred to as its degree of eutrophication. Eutrophication occurs naturally as part of an overall aging process experienced by lakes. Over time organic sediments, soil particles, and their associated nutrients are carried by rain runoff and winds naturally settling into the depressions on the landscape that lakes represent. As this occurs waters can become shallower, plant and aquatic animal communities shift, and overall productivity can increase dramatically. With extensive development or agricultural activity in a lake's watershed or riparian areas the process is often accelerated drastically over the natural rate of eutrophication. This can lead to unstable ecological conditions or pronounced water-quality problems. Lakes that are highly enriched with nutrients tend to have poor water clarity and poor plant community diversity in general. Usually highly turbid waters in these cases exclude all species but those that can adapt

well to low light conditions. In some cases this can give invasive exotic plants an edge, applying selective pressure away from a healthy diverse native plant community toward one of low diversity and dominance by undesirable invasives.

Because the eutrophication process can affect the ecological health and recreational viability of Indiana's lakes the Indiana Department of Environmental Management collects data on the water quality of our lakes to keep track of statewide trends in this process. Part of this sampling includes the collection of data which is used in a mathematical index (the Indiana Trophic State Index,) to produce a numeric score for lake water quality or the lake's degree of eutrophication. Data collected from Meserve Lake in the 1970's (See table 2) gave the lake an Indiana Trophic State Index (ITSI) score of 22.

ITSI Points (1970's)	Mean total phos. (ppm) (epilimnion/hypolimnion)	Secchi depth (ft)
22	<.01 ppm	10.0

Table 2 Published IDEM water quality data from Meserve Lake (1970's)

With the ITSI a total score of zero to 25 points represents generally oligotrophic (low nutrient, low productivity) conditions (Class I), 26-50 points generally represent mesotrophic (moderately productive) conditions (Class II), and 51 to 75 points generally represents eutrophic (highly productive) conditions (Class III). This places Meserve as a Class I Lake under Indiana's classification system in the 1970's indicating it was "oligotrophic" and had a low amount of nutrient enrichment and low productivity. This placed it above 90% of Indiana's lakes in terms of water quality. During the 1970's data collection a Secchi disk depth of 10 feet was recorded. A Secchi disk is a black and white disk lowered on a line into the water as a simple measurement of water clarity. The observer lowers the disk, records the depth at which the disk can no longer be seen, then raises the disk and records the depth at which it reappears. The average of the two is the Secchi depth. A Secchi reading of 14 feet was recorded during a fish survey conducted at the lake in 1992. During the plant surveys performed for this work on August 20th and October 20th 2008 Secchi depths of 8 feet and 8.3 feet were recorded respectively. This suggests that the waters of Meserve Lake are less clear than in the 1970's and 1992 but does not provided enough information to draw a clear conclusion about current water quality. The initiation of a volunteer water quality monitoring program at Meserve Lake could help generate a more complete water quality record and be useful in allowing the detection of any emerging water quality changes.

Figure 8 Meserve Lake

2.5 Watershed Characteristics

Meserve Lake has a relatively small watershed of approximately 649 acres (including water bodies) (Figure 9 page 18). The total area of lands in the watershed is 600 acres. The main watershed land uses/land covers are agricultural 217 acres (36%), residential 61 acres (10%), grass/pasture 215.5 acres (36%), and forest 25.5 acres (4%). Air photos suggest that a significant amount of wetlands in the Meserve/Gooseneck Lakes watershed may have been drained or impacted by agricultural ditching. A lake diagnostic study which highlights these areas and offers alternatives for restoration may be useful, making recommendations to help improve and protect the high water quality of this small lightly developed lake. Because a lake's watershed plays a key part in determining the nature of the lake, and ultimately the amount and type of plant and algae growth in the lake, the LRA should remain aware of potential nutrient and sediment runoff sources in the watershed such as construction sites, livestock feeding areas, and tilled agricultural areas. Because the watershed is small assessment and management may be highly feasible. This could potentially help to maintain a healthier lake and more manageable plant community. ALA members can work with the Steuben County Soil and Water Conservation District and USDA Natural Resources Conservation Service to see if agricultural best management practices (BMP's) have been implemented in the watershed. BMP's such as grassed waterways or the establishment of grasses on highly erodible lands can drastically limit nutrient and sediment runoff from cultivated fields within the watershed. With a small watershed the LRA will need to make contact with a relatively small number of landowners to address any noted problem areas.

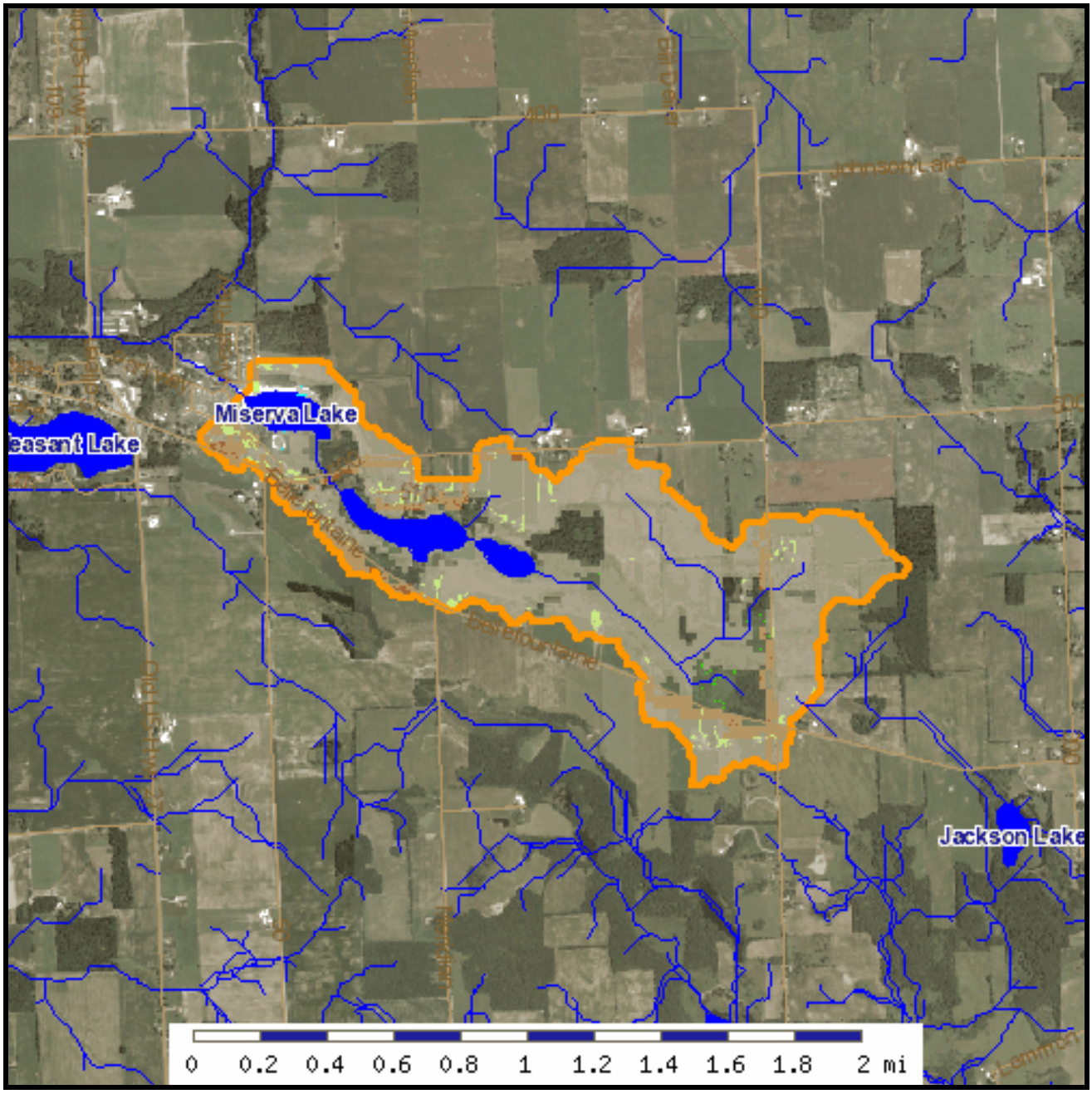

Figure 9 Meserve Lake Watershed, from (Purdue University 2008)

Watershed longest flow length: 13841.6 ft Watershed average slope: 6.9 percent		
Watershed Area (acres)	648.6	
Land use	Soil group	Area(acres)
Water	B	11.1
Water	D	38.2
Agriculture	A	7.1
Agriculture	B	177
Agriculture	C	12.8
Agriculture	D	20.7
HD-Residential	B	14
HD-Residential	C	0.7
HD-Residential	D	1.7
LD-Residential	A	0.4
LD-Residential	B	32.3
LD-Residential	C	9.6
LD-Residential	D	2.2
Grass/Pasture	A	2.2
Grass/Pasture	B	172.1
Grass/Pasture	C	23.2
Grass/Pasture	D	18
Forest	A	0.9
Forest	B	15.3
Forest	C	0.7
Forest	D	8.6
Others	Undefined	78.7
Total Area		648.6

Table 3 Meserve Lake Watershed Land Use/Land Cover (Purdue University 2008)

2.6 The Meserve Lake Fishery

According to LRA members, fishing is a primary use of Meserve Lake with lake residents and their guests pursuing primarily largemouth bass and bluegill. Indiana public freshwater lakes under 200 acres generally carry a 10 mph/no wake restriction. This makes Meserve a speed-limited lake and the Life-of-Riley residents take this limit a step further and generally do not permit the use of gasoline powered motors on the lake. General fishery surveys are performed on freshwater public lakes by IDNR to evaluate the fishery and provide management recommendations accordingly. Because of its small size and lack of a widespread use by the general public Meserve has not yet been included in a general survey. However, Meserve has commanded some attention from IDNR fisheries biologists because of its population of cisco *Coregonus artedii*, a species of Whitefish present in some high quality Indiana waters. These fish are currently thought to have been extirpated from several other lakes in Steuben County where they were once common. The cisco also called "lake herring" is a native fish belonging to the family Salmonidae. The salmonid family includes the trout, salmons, chars, and whitefishes. As

a member of the genus *Coregonus* Cisco are a close relative of the Lake whitefish. These silver colored fish grow to a size of approx. 22 inches. They are not commonly sought after as a game fish in Indiana, but are sought by anglers in areas where they are more common. Cisco habitat in Indiana has experienced an extensive decline during the twentieth century as Indiana's Lakes and rivers have undergone water quality changes, presumably in response to altered habitat conditions associated with eutrophication. The cisco along with the Lake sturgeon is one of only two lake fishes currently listed as a species of special concern by the Department of Natural Resources. IDNR fisheries managers have maintained an active program to update the population status of the Cisco and work toward the preservation of the species. Targeted gill net surveys have been used to asses Cisco populations, classifying Cisco as "extirpated", "probably extirpated", "rare", or "common" based on gill net catch rates and water quality data. At present ciscoes are thought since 1955 to have occurred naturally in at least forty six Northern Indiana Lakes. The number of lakes current thought to support populations of this species is 13. Ciscoes currently have a "rare" status in Meserve Lake and Gooseneck Lake, another small lake which drains to Meserve. The Cisco remains as an important indicator of stable, high quality aquatic habitat in Indiana. Lake residents like those at Meserve who have Cisco populations in their waters are assured to presently have exceptional water quality worth preservation.

3. Present Water Body Uses, Meserve Lake

Fishing and swimming are the most common recreational uses of Meserve Lake. The Life-of-Riley commons includes a small swimming beach and a covered pavilion where the association and residents can host activities at lakeside. Several of the Life-of-Riley residents keep small boats moored at the common area. The lake's speed limit prohibits activities such as water skiing, tubing, and riding personal watercraft. This is beneficial because it can limit the fragmentation and spread of Parrot feather likely to occur if the passage of powerboats and associated wave action were allowed to break apart Parrot feather plants. Meserve Lake users should maintain the rule prohibiting gasoline powered motors and make efforts to inform residents and visitors who operate electric boat motors at the lake that avoiding contact with the Parrot feather plants is critical. This should be stressed at any public meetings held regarding plant management at Meserve Lake as well as at all private Life-of-Riley Association meetings.

Because it is relatively rurally located and lightly developed little of Meserve Lake's area can be considered "high use". The heaviest activity typically takes place around the docks of the four riparian home owners and also at the Life of Riley commons where swimming and boat-launching take place. (See high use map below) It will be especially important to control Parrot feather plants in these areas and keep residents using these areas aware of the potential environmental hazard associated with disturbing (and potentially fragmenting) the plants.

Figure 10 High use areas of Meserve Lake

4. Management History and Goals

Development of this plan and control measures implemented at Meserve Lake in 2008 have been a rapid response to the discovery and identification of a new, potentially invasive non-native plant infestation. Prior to the discovery of Parrot Feather in Meserve no significant aquatic plant management was conducted at the lake. This plan and aquatic plant management at Meserve Lake in general has been based on three aquatic vegetation management goals developed by IDNR that apply to Meserve Lake as well as other Indiana Lakes that may potentially become colonized by Meserve's Parrot feather in the absence of active management. The goals are as follows:

1. Maintain a stable, diverse aquatic plant community that supports a good balance of predator and prey fish and wildlife species and good water quality.

2. Direct efforts to preventing and/or controlling the negative impacts of aquatic invasive species.

3. Provide reasonable public recreational access while minimizing the negative impacts on plant, fish, and wildlife resources.

Recommended management activities at Meserve Lake in 2008 were geared toward attainment of these goals with the objective of completely eradicating Parrot feather and thus eliminating the possible escape of live plants or plant fragments downstream into other parts of the Pigeon Creek watershed. While the results of efforts to control this plant in other parts of the United States have not generally resulted in complete eradication, available control measures should continue to be taken with that objective in mind. For the 2009 season and beyond management activities at Meserve Lake should seek to attain the following measurable benchmarks for success:

1. No occurrence of Parrot feather in a 2009 late season Tier II survey.

2. Generate awareness among Steuben County lake residents and the Meserve Lake users that this plant is potentially invasive and requires that measures are taken to prevent its introduction or spread.

5. Plant Community Characterization

Plant common name	Scientific name
Parrot feather	*Myriophyllum aquaticum*
Eurasian watermilfoil	*Myriophyllum spicatum*
Curlyleaf pondweed	*Potamogeton crispus*
Chara	*Chara sp.*
Spiny naiad	*Najas marina*
Illinois pondweed	*Potamogeton illinoensis*
Creeping bladderwort	*Utricularia gibba*
Great bladderwort	*Utricularia macrorhiza*
Small pondweed	*Potamogeton pusillus*
Sago pondweed	*Stuckenia pectinata*
Elodea	*Elodea canadensis*
Curlyleaf pondweed	*Potamogeton crispus*
Marsh arrow grass	*Triglochin palustris*
White water lilies	*Nymphia odorata*
Spadderdock	*Nuphar sp.*
Purple loosestrife	*Lythrum salicaria*
Coontail	*Ceratophyllum demersum*

Table 4 List of common and scientific names for plants mentioned in this work

5.1 Methods

Two primary methods of observation were used to characterize the Meserve Lake's plant community during the 2008 season. Parrot feather growth was mapped mainly by visual observation from the boat or shoreline with a handheld WAAS Enabled global positioning system (GPS) unit. The unit was used to collect waypoints to mark the location of noted plants (Figure 12 page 24). This also created navigational waypoints to assist during herbicide treatment. Extensive time was spent running a zigzag pattern over the lake's littoral zone to establish the boundaries for the exotic plant growth. This was complimented by Tier II quantitative survey plant collection data and a contour map. Figure 11 shows the extent of the pattern of dense Parrot feather growth. Plants in areas outside the noted beds were widely scattered. Curlyleaf pondweed, another potentially invasive exotic plant was present, but growth was scattered and sparse so no growth area map was produced. To characterize the lake's plant community quantitatively and produce objective data for analysis and tracking of overall plant community composition, Tier II Plant surveys were utilized as described in the next section.

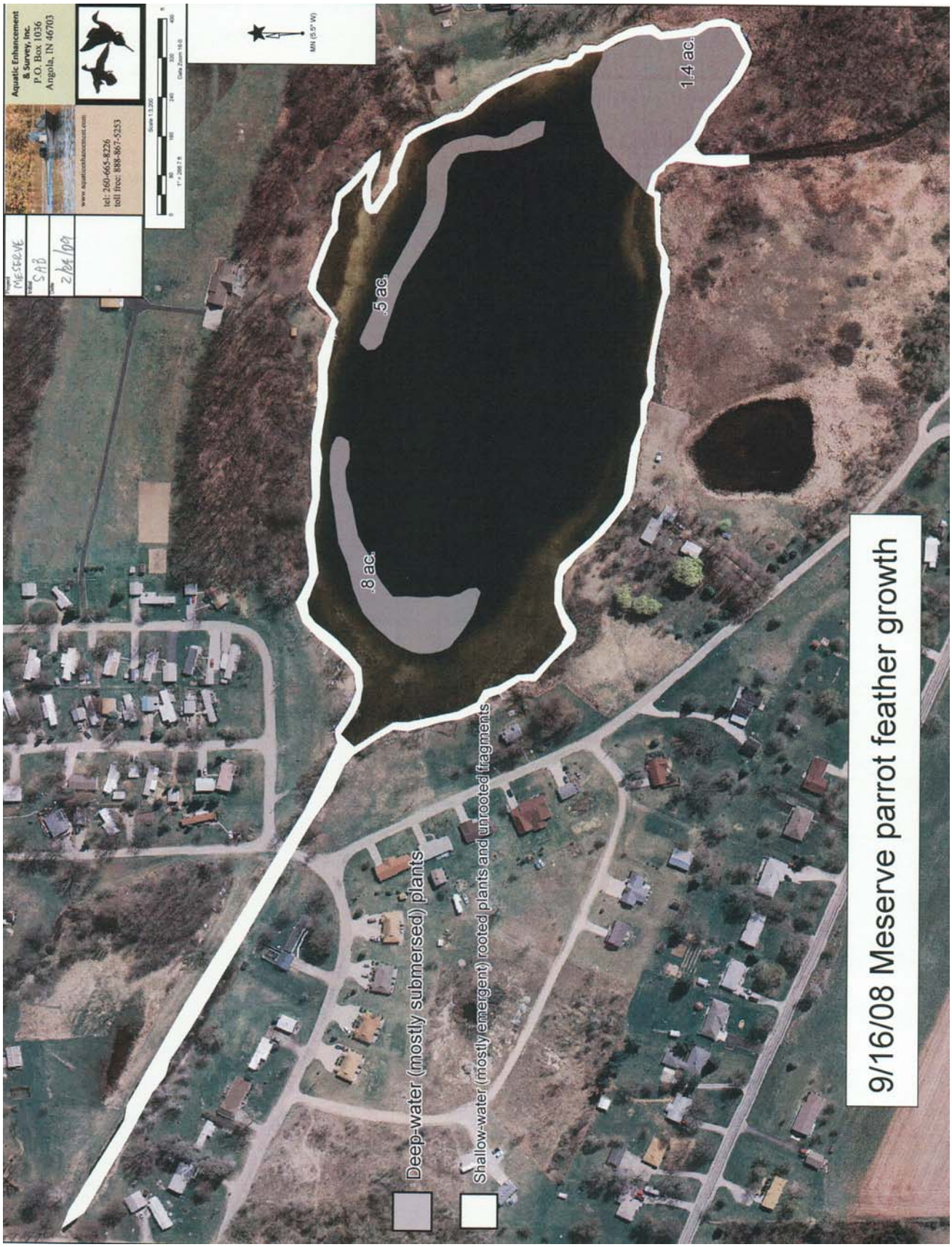

Figure 11 Parrot feather growth pattern 9/16/08

Figure 12 Waypoints collected 9/16/08 to show the general locations of growth

5.1.1 Tier II Sampling

Tier II stratified random sampling was utilized on August 30th and October 20th to establish random plant sampling points on Meserve Lake and quantify approximate species biomass at each respective point. Sampling points are depicted in figure 19 below. The Tier II aquatic plant sampling protocol used was established by INDR and is available in full in *Tier II Aquatic Vegetation Survey Protocol, May 2007* (IDNR 2007). In Tier two sampling, data collection points are established within given depth strata of the lake according to lake size and trophic status listing. Meserve has an "oligotrophic" status so sampling would normally be done to a depth of 25 feet. A toss and retrieval of a specially fabricated two sided rake (See fig. 12) on a rope is used to sample vegetation from the lake bottom at each point. After retrieval of the rake a score is assigned to each recovered plant species by separating the species and placing them back on the rake. Thickness of the plants when placed back on the rake is recorded as measured by equally spaced marks on the rake tines. This measurement assigns a rake score of one, three, or five to each species as a basic measure of biomass. Plants seen but not recovered on the rake are marked as "observed only". Filamentous algae is recorded only as "present" if recovered on the rake. Location data for sampling points was collected using a WAAS enabled GPS unit. Data points were then downloaded to geographic information system (GIS) software for placement on a map. Latitude and longitude coordinates for the sampling sites are contained in appendix E. Figure 17 shows the location of Tier II sampling points. Because aquatic plant species vary in

their prominence during various part of the growing season sampling is normally performed in both the late and early season during plant plan development. On Meserve plant management activities began late in the season as a rapid response to a new invasive exotic plant so the 2nd Tier II survey occurred after the end of the normal sampling window to be able to asses the results of the September treatment. In treatment seasons the two survey regime allows for a pre-treatment and post-treatment comparison of the lake's plant community. Data collected during the Tier II survey is then used to calculate a set of statistical descriptors developed by IDNR to help characterize plant communities in Indiana waters (Pearson 2004). The Tier II sampling points (60 in Meserve Lake) for the early and late season surveys in 2008 are displayed in the figure below. Normally only 30 sampling points would have been used on a lake the size of Meserve but being a special case a higher level of survey resolution was appropriate.

Figure 13 Tier II sampling rake

5.1.2 Tier II Sampling Results

The 2008 Tier II surveys for Meserve Lake were conducted on August 30th and October 20th in good weather conditions. A summary of results is contained in the tables three and four below. Water clarity was considered to be good with a Secchi depth of 8 feet recorded. It should be noted that this survey occurred before any treatments took place on Meserve Lake. Plants were found to a depth of 19 feet. The 25 foot sampling depth for Meserve Lake appears to be adequate. Ten species were identified in the August 30 survey slightly above the average number of 8 species for a set of 21 other northern Indiana lakes compiled by IDNR (Pearson 2004). The highest occurrence in August was Chara (56.7 percent) followed by Spiny naiad (30 percent) and Illinois pondweed (16.7 percent). Parrot feather was fourth at 10 percent. Curlyleaf pondweed occurred at 1.7 percent of sites. No Eurasian watermilfoil or other submersed invasive plants were noted in Meserve Lake. A number of Purple loosestrife *Lythrum salicaria* plants, an exotic invasive wetland species, were noted growing along the Meserve Lake shoreline.

The October 20 Tier II survey took place 32 days after all treatments had been completed. Water clarity was good with a Secchi depth of 8.3 feet recorded. Nine species were identified in the sampling. Plants occurred to a depth of 18 feet. The 25 foot sampling depth for Meserve Lake again appeared to be adequate. Chara was again most common occurring at 61.7 percent of sites, Spiny naiad was again second (26.7 percent) and Illinois pondweed was again third (20 percent).

Parrot feather had been reduced to a five percent occurrence. Overall the lake's plant community appeared to be healthy with above average diversity. Plant maps for Tier II parrot feather, chara, and Illinois pondweed are in figures 15 through 20 below.

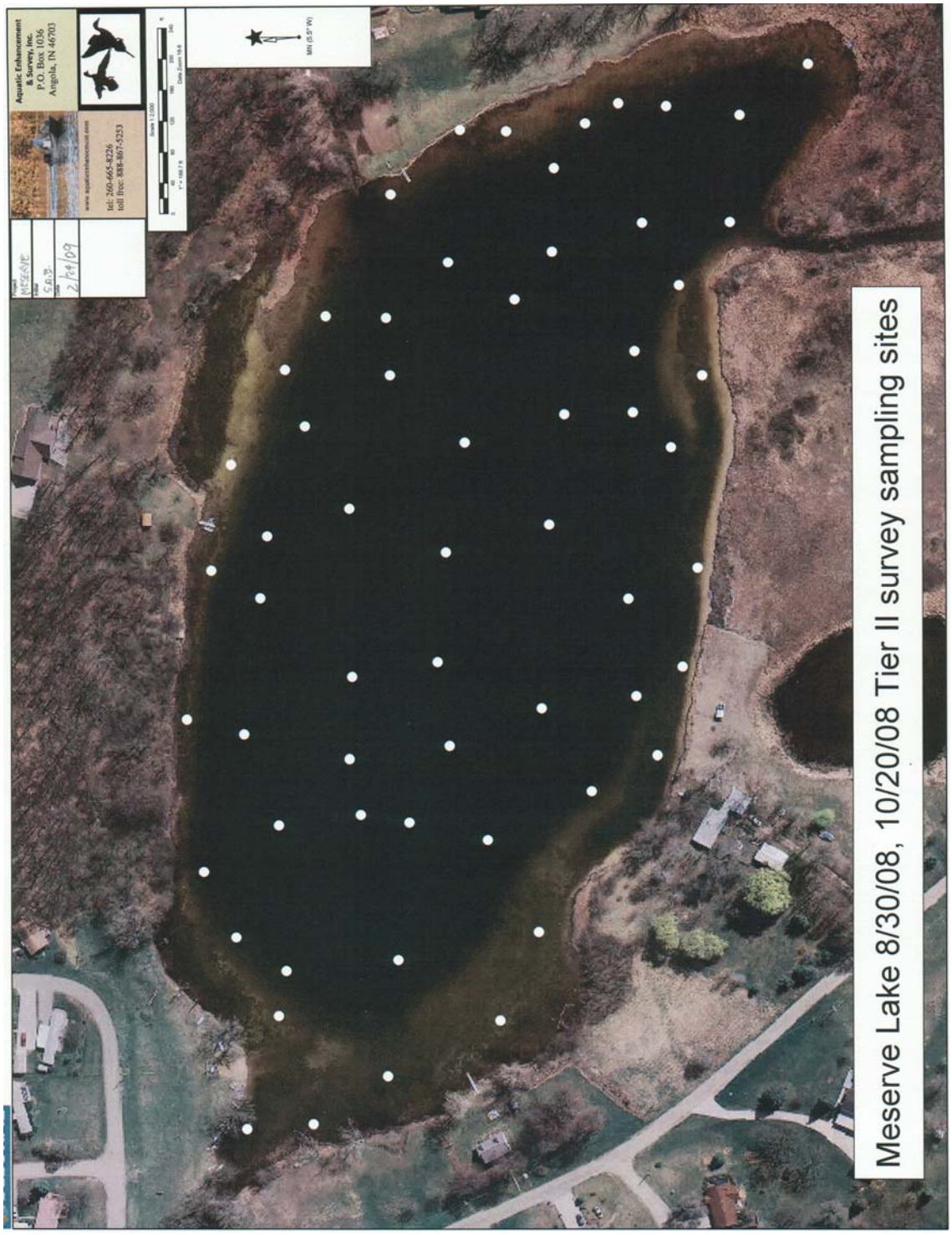

Figure 14 Meserve Lake Tier II waypoints

Occurrence and Abundance of Submersed Aquatic Plants - Overall

Lake: Meserve	Secchi(ft): 8.0	SE Mean species / site: 0.14			
Date: 8/30/2008	Littoral sites with plants: 46	Mean natives / site: 1.23			
Littoral Depth (ft): 19.0	Number of species: 10	SE Mean natives / site: 0.13			
Littoral Sites: 49	Maximum species / site: 4	Species diversity: 0.75			
Total Sites: 60	Mean species / site: 1.35	Native diversity: 0.71			

	Frequency of	Score Frequency				
Species	Occurrence	0	1	3	5	Dominance
CHAR Chara	56.7	43.3	20.0	6.7	30.0	38.0
NAJMAR Spiny naiad	30.0	70.0	20.0	3.3	6.7	12.7
POTILL Illisnois pondweed	16.7	83.3	11.7	1.7	3.3	6.7
MYRAQU Parrot feather	10.0	90.0	8.3	0.0	1.7	3.3
UTRMIN Creeping bladderwo	6.7	93.3	6.7	0.0	0.0	1.3
UTRMAC Great bladderwort	5.0	95.0	5.0	0.0	0.0	1.0
POTPUS Small pondweed	3.3	96.7	3.3	0.0	0.0	0.7
STUPEC Sago pondweed	3.3	96.7	3.3	0.0	0.0	0.7
ELOCAN Elodea	1.7	98.3	1.7	0.0	0.0	0.3
POTCRI Curlyleaf	1.7	98.3	1.7	0.0	0.0	0.3

Occurrence and Abundance of Submersed Aquatic Plants - 0 to 5 ft.

Lake: Meserve	Secchi(ft): 8.0	SE Mean species / site: 0.19			
Date: 8/30/2008	Littoral sites with plants: 20	Mean natives / site: 2.00			
Littoral Depth (ft): 19.0	Number of species: 8	SE Mean natives / site: 0.21			
Littoral Sites: 20	Maximum species / site: 4	Species diversity: 0.75			
Total Sites: 20	Mean species / site: 2.20	Native diversity: 0.71			

	Frequency of	Score Frequency				
Species	Occurrence	0	1	3	5	Dominance
CHAR Chara	80.0	20.0	35.0	10.0	35.0	48.0
NAJMAR Spiny naiad	65.0	35.0	35.0	10.0	20.0	33.0
POTILL Illisnois pondweed	20.0	80.0	15.0	0.0	5.0	8.0
MYRAQU Parrot feather	20.0	80.0	20.0	0.0	0.0	4.0
UTRMIN Creeping bladderwo	20.0	80.0	20.0	0.0	0.0	4.0
POTPUS Small pondweed	5.0	95.0	5.0	0.0	0.0	1.0
STUPEC Sago pondweed	5.0	95.0	5.0	0.0	0.0	1.0
UTRMAC Great bladderwort	5.0	95.0	5.0	0.0	0.0	1.0

Occurrence and Abundance of Submersed Aquatic Plants - 5 to 10 ft.

Lake: Meserve	Secchi(ft): 8.0	SE Mean species / site: 0.22			
Date: 8/30/2008	Littoral sites with plants: 10	Mean natives / site: 1.50			
Littoral Depth (ft): 19.0	Number of species: 4	SE Mean natives / site: 0.22			
Littoral Sites: 10	Maximum species / site: 3	Species diversity: 0.73			
Total Sites: 10	Mean species / site: 1.50	Native diversity: 0.73			

	Frequency of	Score Frequency				
Species	Occurrence	0	1	3	5	Dominance
NAJMAR Spiny naiad	50.0	50.0	50.0	0.0	0.0	10.0
POTILL Illisnois pondweed	40.0	60.0	20.0	10.0	10.0	20.0
CHAR Chara	40.0	60.0	30.0	0.0	10.0	16.0
UTRMAC Great bladderwort	20.0	80.0	20.0	0.0	0.0	4.0

Occurrence and Abundance of Submersed Aquatic Plants - 10 to 15 ft.

Lake: Meserve	Secchi(ft): 8.0	SE Mean species / site: 0.40			
Date: 8/30/2008	Littoral sites with plants: 8	Mean natives / site: 1.00			
Littoral Depth (ft): 19.0	Number of species: 7	SE Mean natives / site: 0.30			
Littoral Sites: 10	Maximum species / site: 4	Species diversity: 0.73			
Total Sites: 10	Mean species / site: 1.30	Native diversity: 0.60			

	Frequency of	Score Frequency				
Species	Occurrence	0	1	3	5	Dominance
CHAR Chara	60.0	40.0	10.0	10.0	40.0	48.0
MYRAQU Parrot feather	20.0	80.0	10.0	0.0	10.0	12.0
ELOCAN Elodea	10.0	90.0	10.0	0.0	0.0	2.0
POTCRI Curlyleaf	10.0	90.0	10.0	0.0	0.0	2.0
POTILL Illisnois pondweed	10.0	90.0	10.0	0.0	0.0	2.0
POTPUS Small pondweed	10.0	90.0	10.0	0.0	0.0	2.0
STUPEC Sago pondweed	10.0	90.0	10.0	0.0	0.0	2.0

Occurrence and Abundance of Submersed Aquatic Plants - 15 to 20 ft.

Lake: Meserve	Secchi(ft): 8.0	SE Mean species / site: 0.18			
Date: 8/30/2008	Littoral sites with plants: 8	Mean natives / site: 0.90			
Littoral Depth (ft): 19.0	Number of species: 2	SE Mean natives / site: 0.18			
Littoral Sites: 9	Maximum species / site: 2	Species diversity: 0.20			
Total Sites: 10	Mean species / site: 0.90	Native diversity: 0.20			

	Frequency of	Score Frequency				
Species	Occurrence	0	1	3	5	Dominance
CHAR Chara	80.0	20.0	10.0	10.0	60.0	68.0
POTILL Illisnois pondweed	10.0	90.0	10.0	0.0	0.0	2.0

Table 5 Summary of Meserve Lake 8/30/08 Tier II results

Occurrence and Abundance of Submersed Aquatic Plants - Overall

Lake: Meserve		Secchi(ft): 8.3			SE Mean species / site: 0.14		
Date: 10/20/2008		Littoral sites with plants: 44			Mean natives / site: 1.25		
Littoral Depth (ft): 18.0		Number of species: 9			SE Mean natives / site: 0.13		
Littoral Sites: 47		Maximum species / site: 4			Species diversity: 0.70		
Total Sites: 60		Mean species / site: 1.30			Native diversity: 0.68		

	Frequency of	Score Frequency				
Species	**Occurrence**	**0**	**1**	**3**	**5**	**Dominance**
CHAR Chara	61.7	38.3	26.7	6.7	28.3	37.7
NAJMAR Spiny naiad	26.7	73.3	20.0	0.0	6.7	10.7
POTILL Illisnois pondweed	20.0	80.0	11.7	5.0	3.3	8.7
VALAME Vallisneria	5.0	95.0	3.3	0.0	1.7	2.3
MYRAQU Parrot feather	5.0	95.0	3.3	1.7	0.0	1.7
UTRMAC Great bladderwort	5.0	95.0	5.0	0.0	0.0	1.0
STUPEC Sago pondweed	3.3	96.7	1.7	1.7	0.0	1.3
NAJFLE Common naiad	1.7	98.3	1.7	0.0	0.0	0.3
UTRMIN Creeping bladderwo	1.7	98.3	1.7	0.0	0.0	0.3

Occurrence and Abundance of Submersed Aquatic Plants - 0 to 5 ft.

Lake: Meserve		Secchi(ft): 8.3			SE Mean species / site: 0.18		
Date: 10/20/2008		Littoral sites with plants: 20			Mean natives / site: 2.10		
Littoral Depth (ft): 18.0		Number of species: 8			SE Mean natives / site: 0.18		
Littoral Sites: 20		Maximum species / site: 4			Species diversity: 0.74		
Total Sites: 20		Mean species / site: 2.15			Native diversity: 0.73		

	Frequency of	Score Frequency				
Species	**Occurrence**	**0**	**1**	**3**	**5**	**Dominance**
CHAR Chara	90.0	10.0	50.0	10.0	30.0	46.0
NAJMAR Spiny naiad	50.0	50.0	35.0	0.0	15.0	22.0
POTILL Illisnois pondweed	30.0	70.0	30.0	0.0	0.0	6.0
VALAME Vallisneria	15.0	85.0	10.0	0.0	5.0	7.0
UTRMAC Great bladderwort	15.0	85.0	15.0	0.0	0.0	3.0
MYRAQU Parrot feather	5.0	95.0	5.0	0.0	0.0	1.0
NAJFLE Common naiad	5.0	95.0	5.0	0.0	0.0	1.0
UTRMIN Creeping bladderwo	5.0	95.0	5.0	0.0	0.0	1.0

Occurrence and Abundance of Submersed Aquatic Plants - 5 to 10 ft.

Lake: Meserve		Secchi(ft): 8.3			SE Mean species / site: 0.30		
Date: 10/20/2008		Littoral sites with plants: 8			Mean natives / site: 1.30		
Littoral Depth (ft): 18.0		Number of species: 3			SE Mean natives / site: 0.30		
Littoral Sites: 10		Maximum species / site: 3			Species diversity: 0.66		
Total Sites: 10		Mean species / site: 1.30			Native diversity: 0.66		

	Frequency of	Score Frequency				
Species	**Occurrence**	**0**	**1**	**3**	**5**	**Dominance**
NAJMAR Spiny naiad	50.0	50.0	40.0	0.0	10.0	18.0
CHAR Chara	40.0	60.0	10.0	0.0	30.0	32.0
POTILL Illisnois pondweed	40.0	60.0	10.0	20.0	10.0	24.0

Occurrence and Abundance of Submersed Aquatic Plants - 10 to 15 ft.

Lake: Meserve		Secchi(ft): 8.3			SE Mean species / site: 0.27		
Date: 10/20/2008		Littoral sites with plants: 10			Mean natives / site: 1.40		
Littoral Depth (ft): 18.0		Number of species: 5			SE Mean natives / site: 0.16		
Littoral Sites: 10		Maximum species / site: 3			Species diversity: 0.63		
Total Sites: 10		Mean species / site: 1.60			Native diversity: 0.54		

	Frequency of	Score Frequency				
Species	**Occurrence**	**0**	**1**	**3**	**5**	**Dominance**
CHAR Chara	90.0	10.0	40.0	0.0	50.0	58.0
POTILL Illisnois pondweed	20.0	80.0	0.0	10.0	10.0	16.0
MYRAQU Parrot feather	20.0	80.0	10.0	10.0	0.0	8.0
STUPEC Sago pondweed	20.0	80.0	10.0	10.0	0.0	8.0
NAJMAR Spiny naiad	10.0	90.0	10.0	0.0	0.0	2.0

Occurrence and Abundance of Submersed Aquatic Plants - 15 to 20 ft.

Lake: Meserve		Secchi(ft): 8.3			SE Mean species / site: 0.16		
Date: 10/20/2008		Littoral sites with plants: 6			Mean natives / site: 0.60		
Littoral Depth (ft): 18.0		Number of species: 1			SE Mean natives / site: 0.16		
Littoral Sites: 7		Maximum species / site: 1			Species diversity: 0.00		
Total Sites: 10		Mean species / site: 0.60			Native diversity: 0.00		

	Frequency of	Score Frequency				
Species	**Occurrence**	**0**	**1**	**3**	**5**	**Dominance**
CHAR Chara	60.0	40.0	10.0	20.0	30.0	44.0

Table 6 Summary of 10/20/08 Tier II results

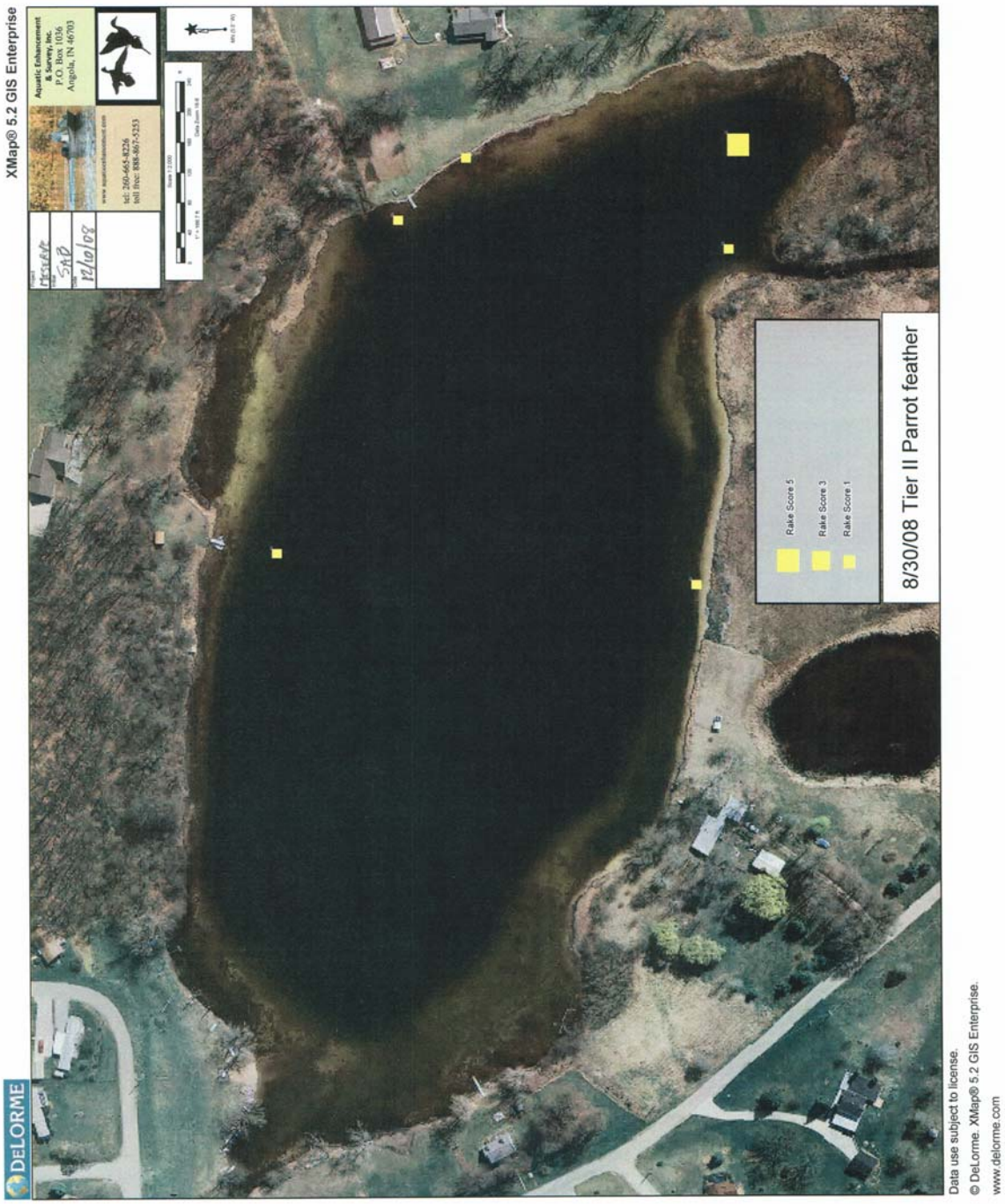

Figure 15 August Tier II Parrot feather

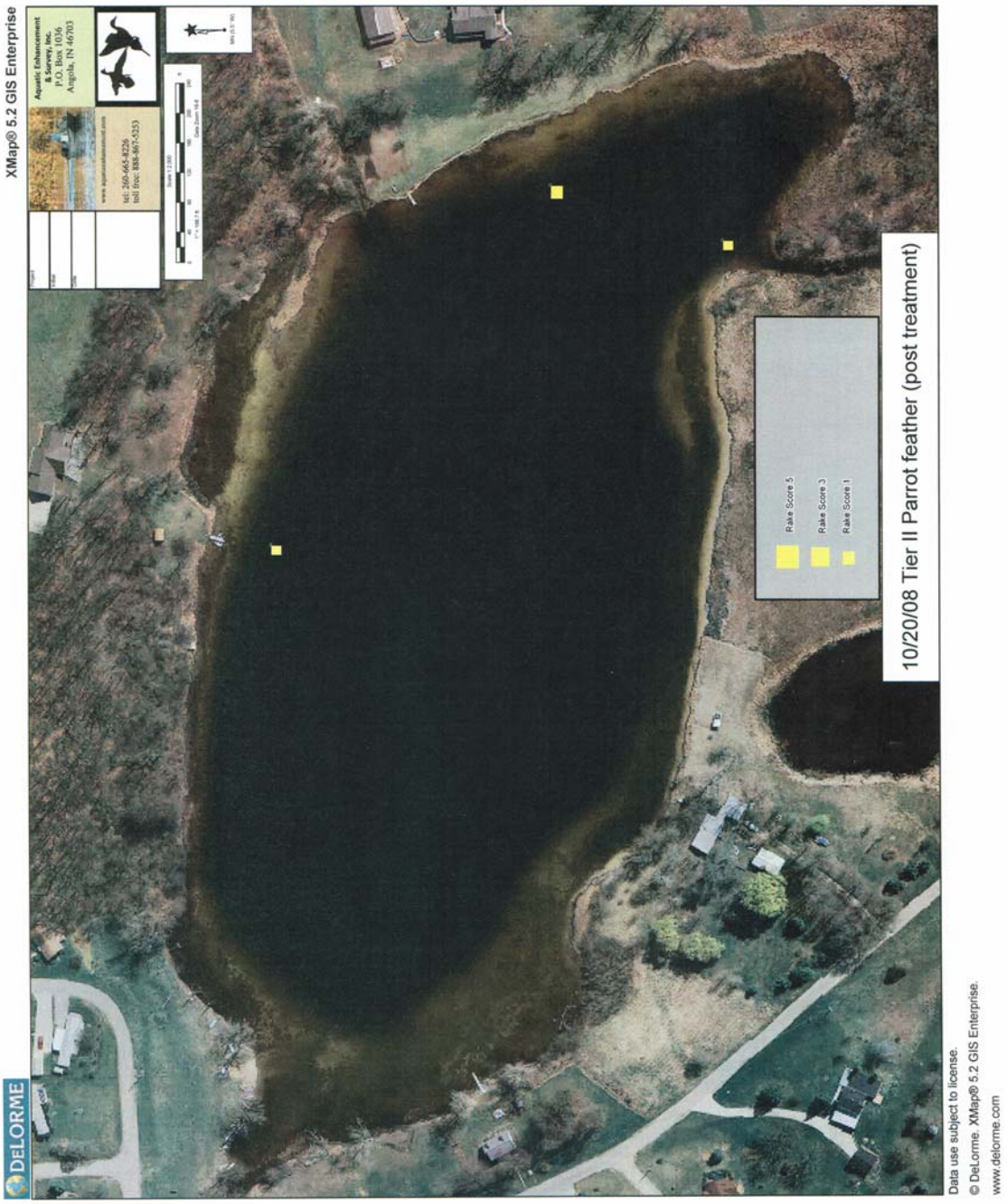

Figure 16 October Tier II Parrot feather

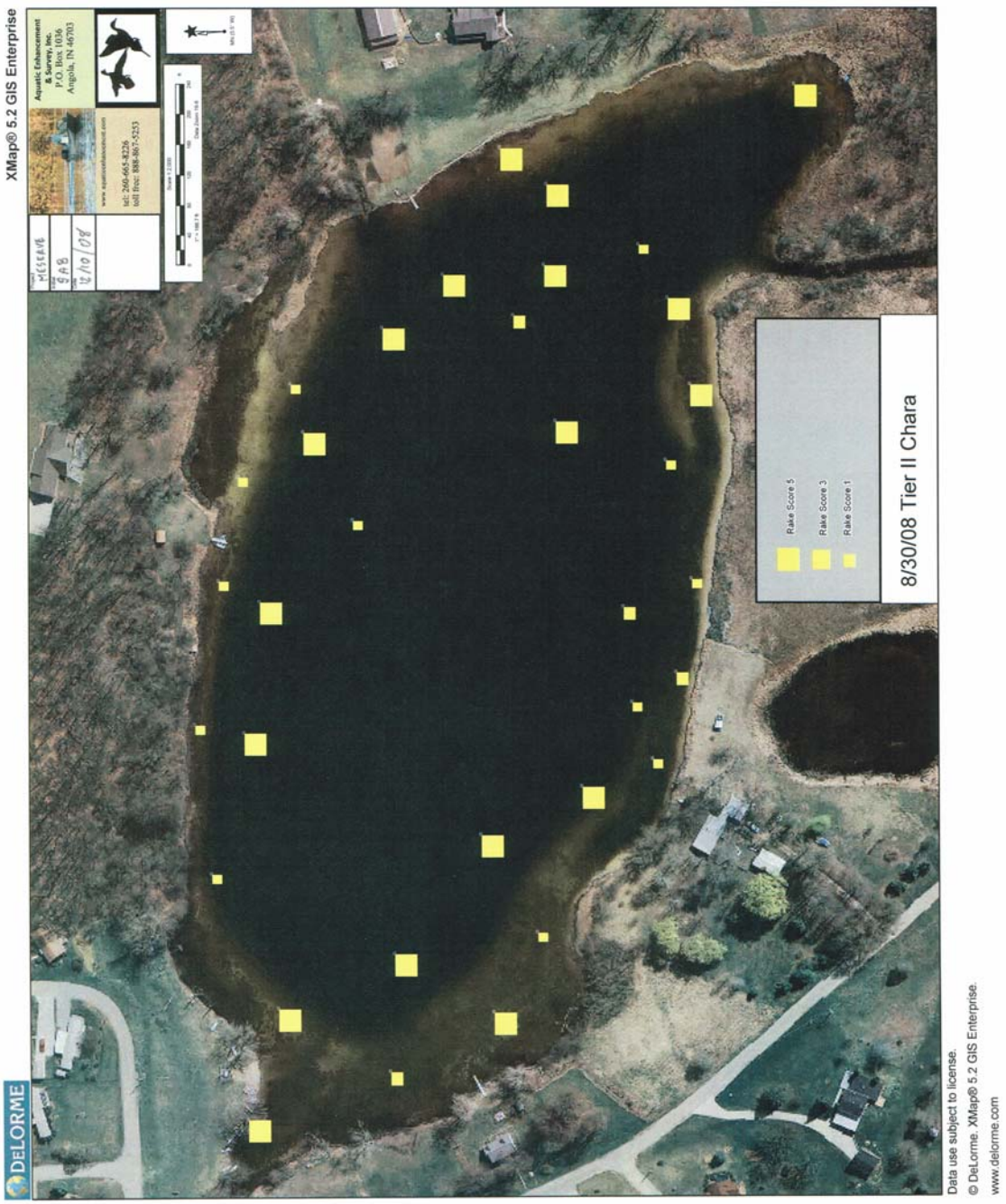

Figure 17 August Tier II Chara

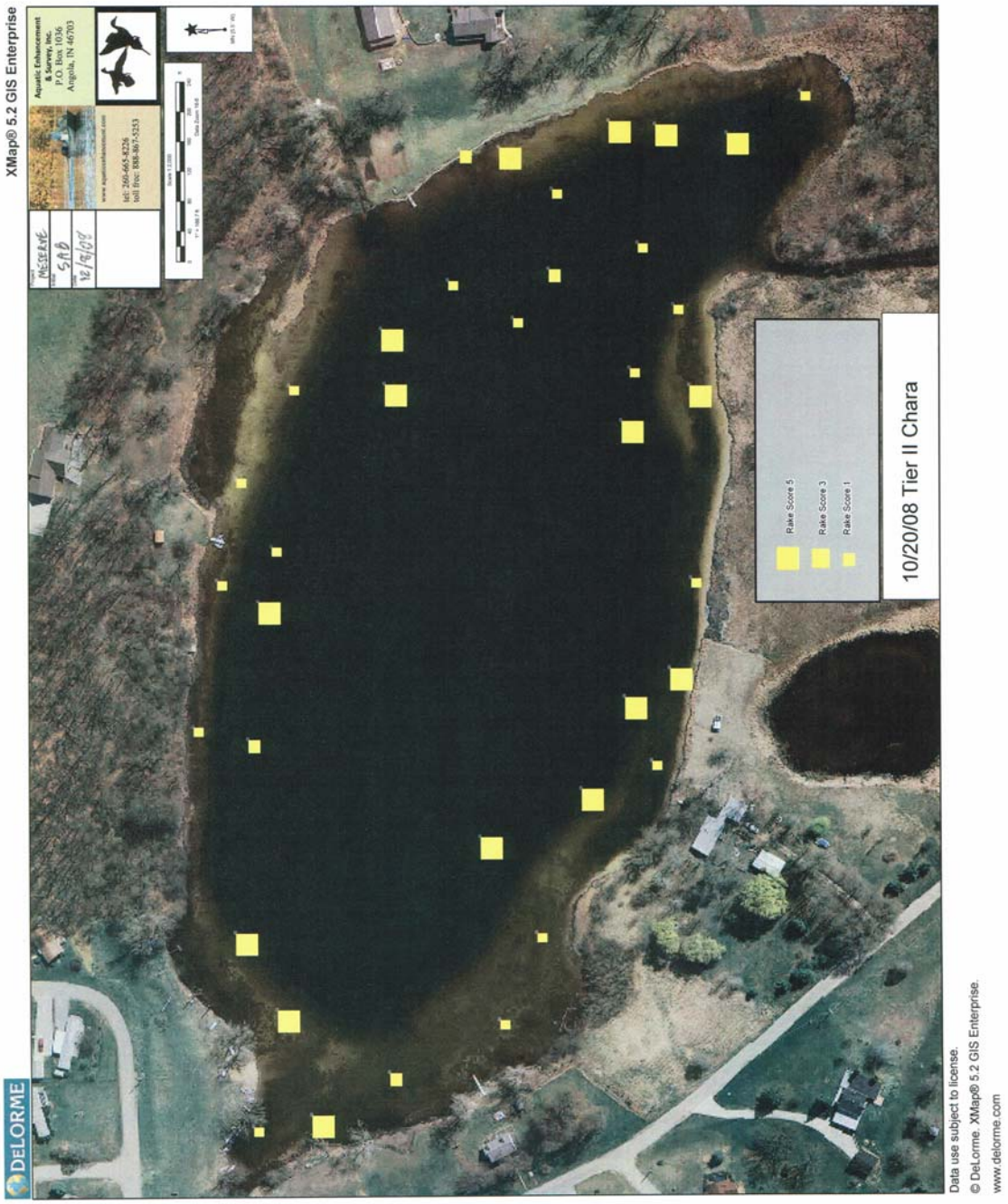

Figure 18 October Tier II Chara

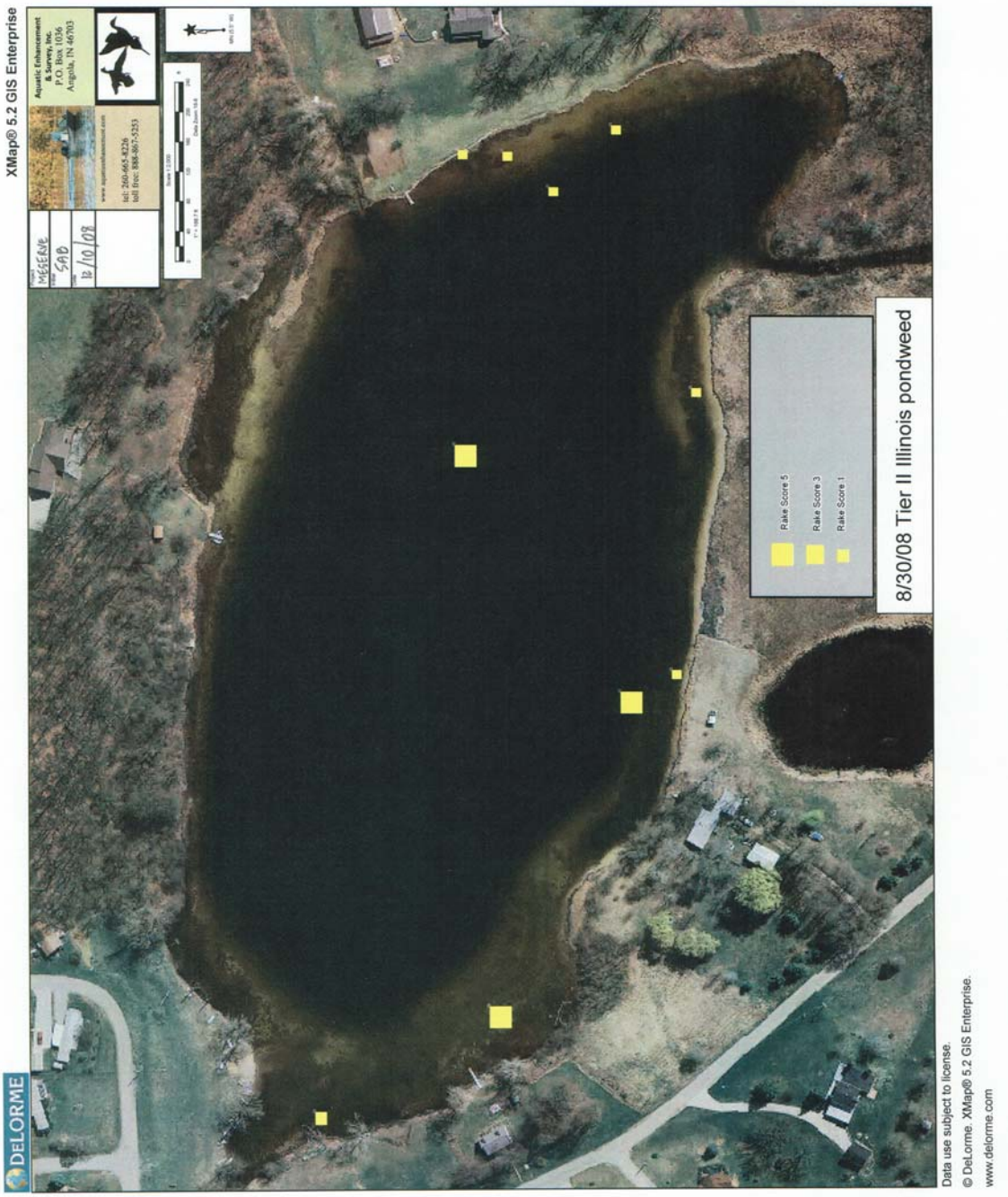

Figure 19 August Tier II Illinois pondweed

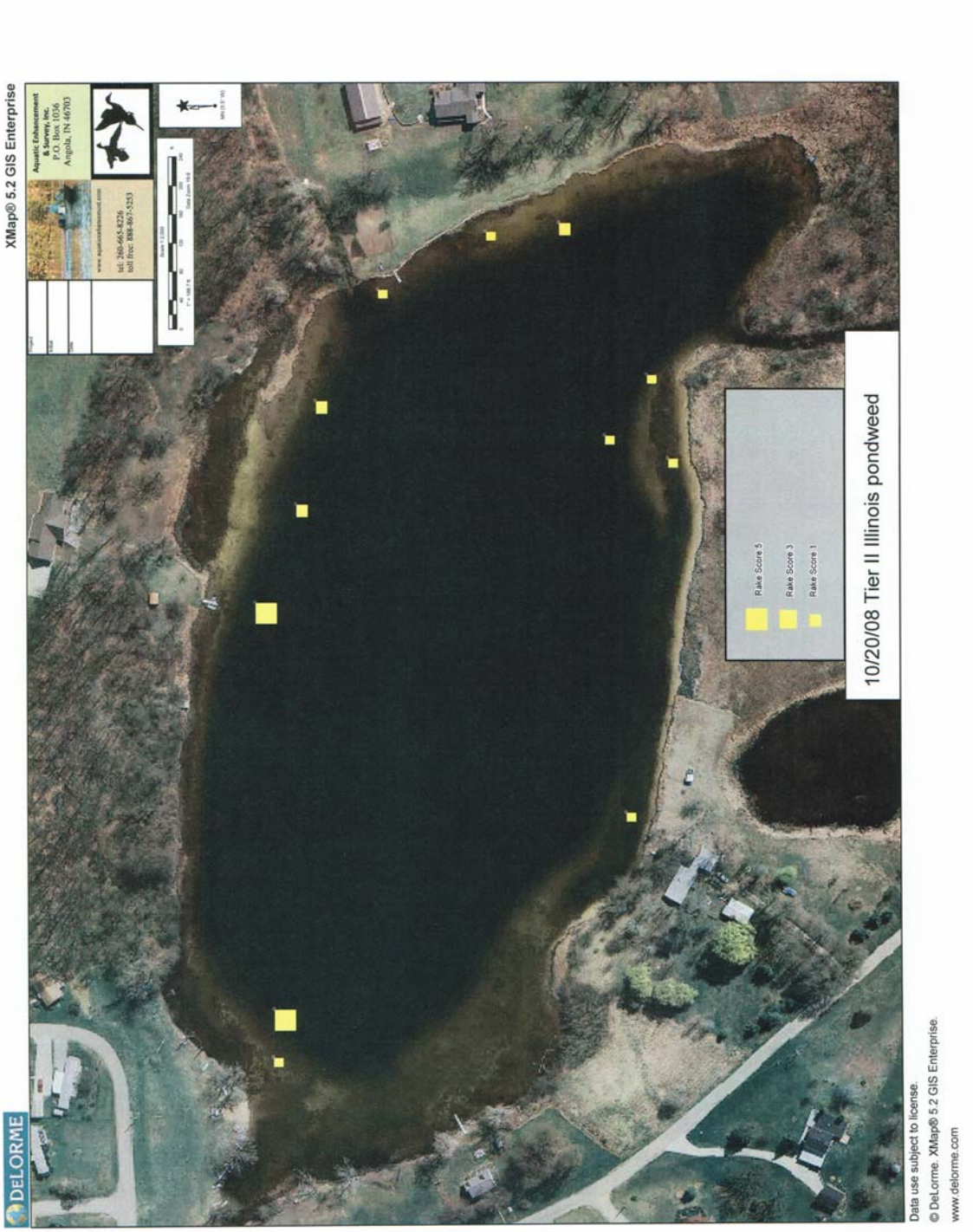

Figure 20 October Tier II Illinois pondweed

6. Threatened and Endangered Species Surveys

In December 2008 personnel from the Indiana Department of Natural Resources Division of Nature Preserves checked the National Heritage database for any known rare, threatened, or endangered species or high quality natural communities present at Meserve Lake. The following was reported:

Meserve Lake:
a. The state species of special concern fish *Coregonus artedi*, Cisco, documented from Meserve Lake in 1992 (for details see the fisheries section of this report)
b. There is a historical record of the state rare plant *Triglochin palustris*, Marsh arrow grass, documented from Meserve Lake in 1932.

If *Triglochin palustris* is still present at Meserve Lake it is not expected to be impacted by the treatments planned using broadleaf specific herbicides. No rare, threatened, or endangered species were noted during the survey work.

For preservation and further taxonomic analysis several Parrot feather voucher specimens were collected and shipped to Mitchell S. Alix, Ph.D. at the Department of Biology and Chemistry at Purdue University North Central in Westville, Indiana. Coordinates, depths, and descriptions of the collected voucher plants are contained in the table below. See figure 21 for a map of the collection sites.

approx. Lat/Lon	# of Plants	Description	Depth (feet)	Collection Date
N41° 34.4381', W84° 59.9495'	3	Plants with roots or partial roots	11.5	9/16/2008
N41° 34.4620', W84° 59.9172'	2	Plants with roots or partial roots	11.5	9/16/2008
N41° 34.4620', W84° 59.9172'	4	Plants with roots or partial roots	14.5	9/16/2008
N41° 34.4620', W84° 59.9172'	2	Plants with roots or partial roots	14.5	9/16/2008
N41° 34.3576', W84° 59.7406'	1	Plants with roots or partial roots	5	9/16/2008
N41° 34.3897', W84° 59.6989'	10	Plants with roots or partial roots	.1 to .5	9/16/2008
N41° 34.3773', W84° 59.7143'	1	Plants with roots or partial roots	11.3	9/16/2008
N41° 34.3628', W84° 59.7363'	6	plant tops with flowers	8	9/17/2008

Table 7 Location and description information for Parrot feather voucher specimens collected 9/16,17/08

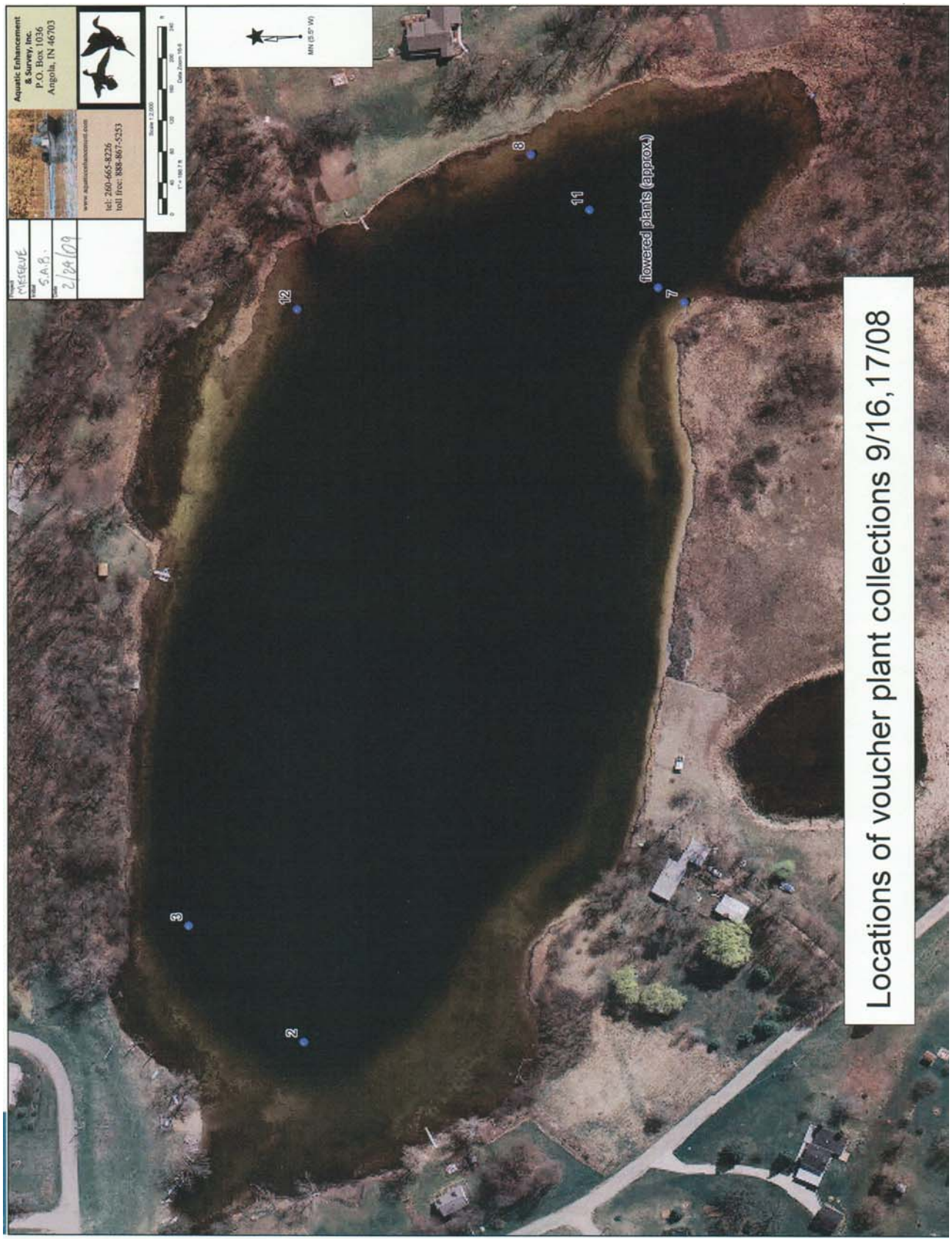

Figure 21 Parrot feather voucher collection locations 9/16, 17/08

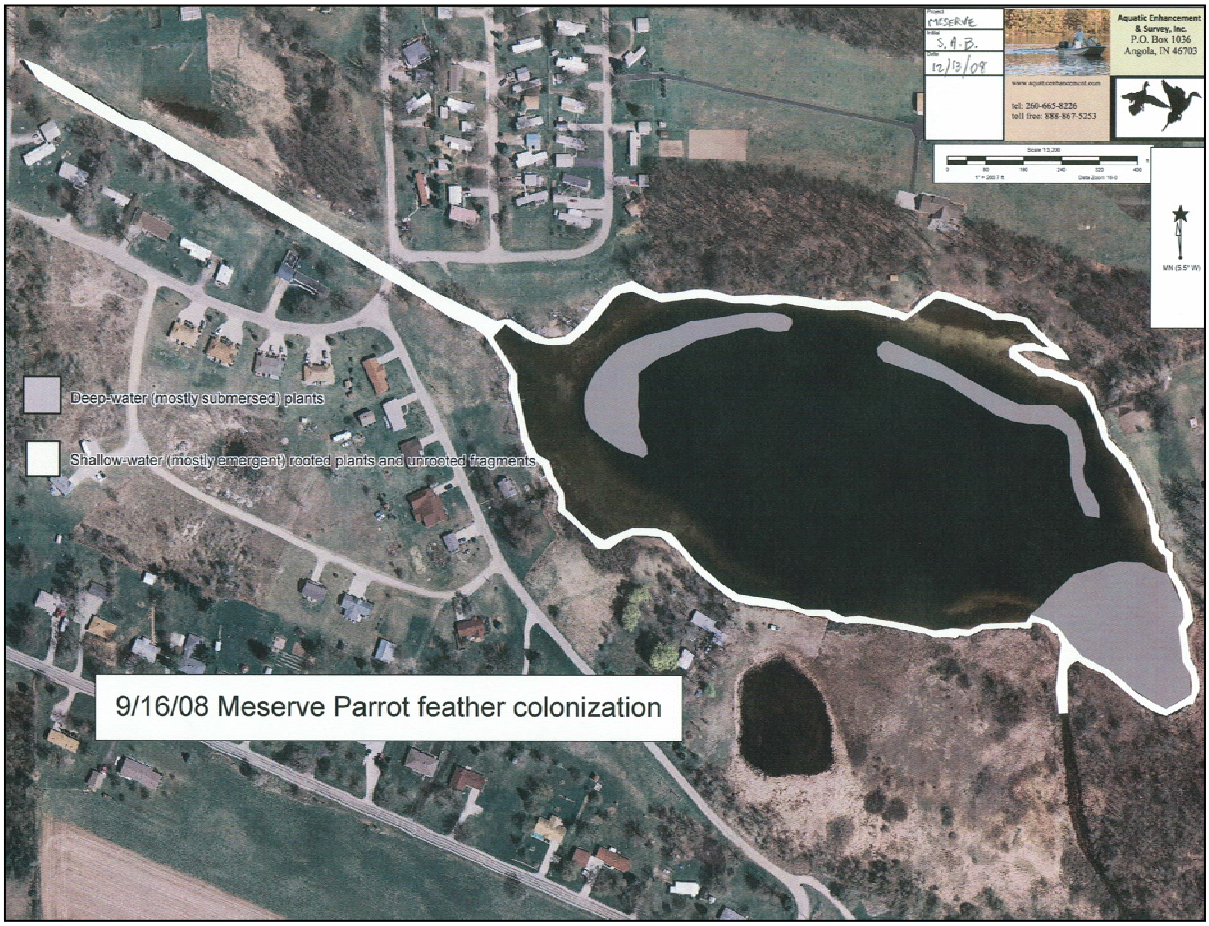

Figure 22 Pattern of Parrot feather growth at Meserve Lake (considered "problem areas") on 9/16/08

7. Description of Beneficial and Problem Plant Areas

Residents reported increasing lake use impairment caused Parrot feather near the LRA commons but overall it is not yet severe. Since fragmentation could spread this plant, however, creating a major problem in the future, all areas of significant growth should be considered problem areas. Parrot feather plants growing in Meserve Lake in 2008 appeared to be adopting two primary forms. A mostly submersed form of the plants was colonizing deeper waters growing primarily between the six and 16 foot depth contours. (Fig 23)

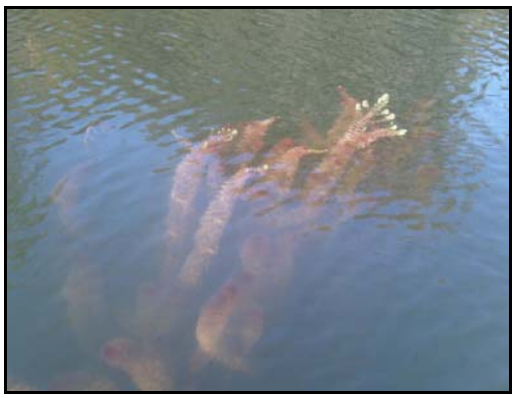

Figure 23 Parrot feather plants in deep water

Figure 24 Shallow plants along the lake's edge

This growth occupied approximately 2.7 acres of Meserve Lake and is represented by the grey areas in Figure 22. These plants have begun to form a ring around the deep part of the lake's basin along the contour break in a pattern similar to that often seen with Eurasian watermilfoil colonization. Secondarily scattered plant fragments that have drifted against the shore have taken a more emersed form and continued to grow (Fig. 24). Many of the shallow plants noted were completely unrooted while some were in well formed rooted clusters. Scattered emersed plants were also noted growing in a section of the Meserve outlet stream extending approximately 1100 feet downstream of the lake. This section of stream has been dredged and supports a luxuriant growth of emergent and submersed vegetation. Most of these plants were also unrooted, but some had taken root and started to grow as a colonies with multiple emersed plant tops. Scattered Parrot feather plants were also noted in the inlet stream to Meserve Lake extending approximately 100 feet upstream of the lake. The total area of scattered shoreline, inlet, and outlet plants was estimated to be approximately 2.4 acres.

Most of the literature and information sources on Parrot feather indicate it is a plant best suited to shallow habitat and nutrient enriched waters in relatively warm climates. None of these characteristics applies well in this case. This can be taken as a possible indicator that this plant may be more adaptive than previously assumed and simply has not yet been widely introduced in glacial lakes. Certainly habitats similar to that at Meserve exist in other area lakes so there is a likely possibility of spread. Another factor to keep in mind in this case is that the lakes downstream of this site are indeed nutrient enriched which could mean they provide suitable habitat that Parrot feather normally is found to favor. While Meserve has a healthy native plant community it is not luxuriant and significant native submersed plant beds should be considered very beneficial. (figure 25)

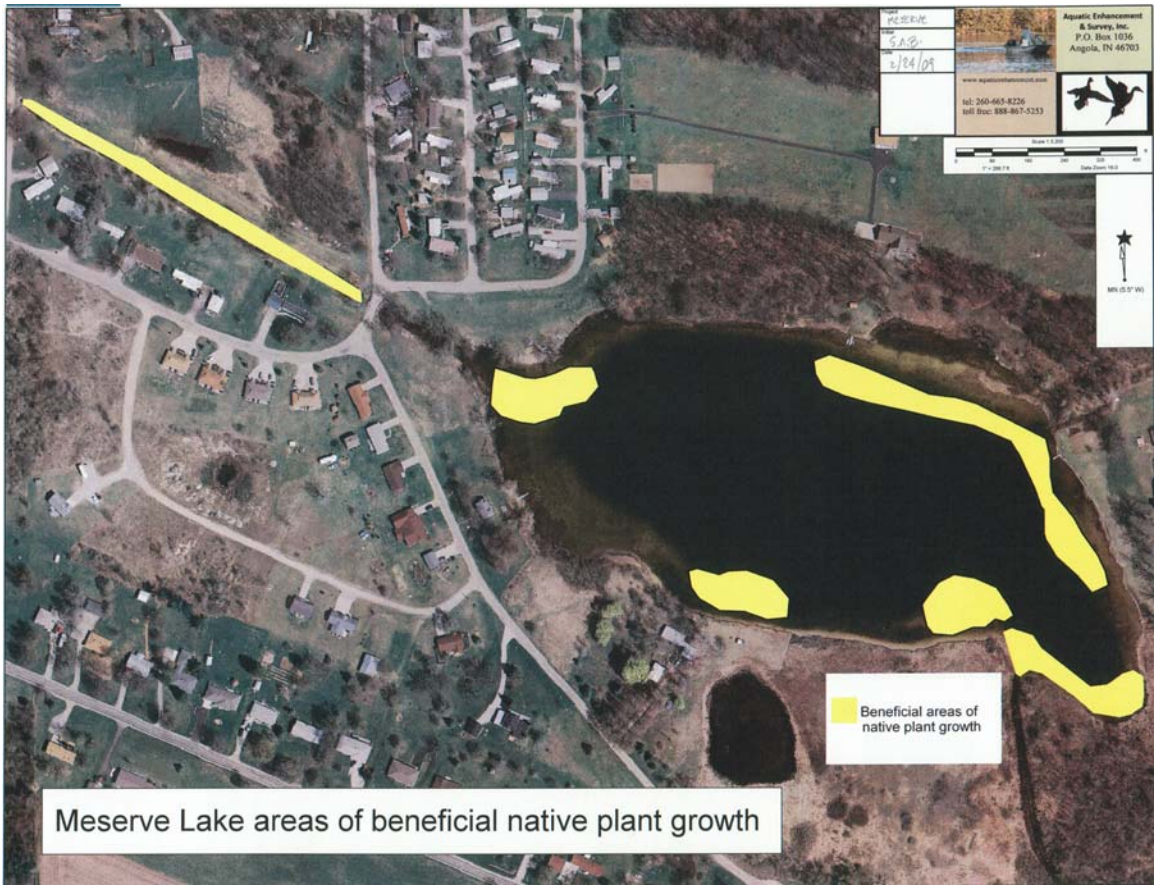

Figure 25 Beneficial areas of native plant growth at Meserve Lake in 2008

8. Aquatic Plant Management Alternatives
Options for Controlling Parrot Feather

●Insect Biological Control:
A North American Weevil *Euhrychiopsis lecontie*, may be associated with natural declines in Eurasian milfoil at northern lakes (Sheldon 1994). In recent years the weevils have been marketed and stocked as a biological control agent with varying results. Historically associated with the native milfoils, the insects are capable of grazing on Eurasian milfoil as well, while not affecting the majority of native vegetation. The weevils also appear to be able to utilize hybridized milfoil (Eurasian + Northern watermilfoil). The weevils are currently marketed by Enviroscience, Inc. of Stow, Ohio. For this work Enviroscience, was contacted regarding the potential effectiveness of the weevils for control of Parrot feather. They did not have any current information about the potential for effective control, but expressed a willingness to perform tank tests to determine if the weevils will utilize Parrot feather as a food source (Marty Hilovsky pers. comm). David L. Sutton in *Biology and Ecology of Myriophyllum Aquaticum* lists several separate species of insects that have been found to cause damage to Parrot feather growing in its native range or the southern United States (Sutton 1985).

-The flea beetle *L. flavipes* and the weevil L. . Marginicollis causes damage to Parrot feather in its South American native range but it is unknown whether they are the plants primary growth limiters.

-The flea beetle *Lysathia ludoviciana* is indigenous to the southern U.S. and Caribbean. In the laboratory Parrot feather has provided a host to its larvae. However, it is seldom found on Parrot feather in the field and may have other suitable hosts.

-Two moths, *Choristoneura parallela* and *Argyrotaenia ivana* have been found on Parrot feather in Florida. It is thought that they feed on the plants in their larval stage, but their feeding activity is not well understood.

-A leaf mining moth *Parapoynx allionealis* mines Parrot feather leaves in its first larval stage but little is known of the extent of damage caused to the plants.

-A flea beetle *Lysathia flavipes* has been seen to cause moderate damage to Parrot feather in the U.S., but has become widely established in South Africa where it is used to control Parrot feather. Extensive feeding damage has lead to defoliation and then die back of emergent plant parts.

The advantages of the use of insects as a biocontrol include the implementation of control without imposing water-use restrictions often associated with the use of chemicals. Lake users are also often more receptive to solutions that are perceived as being natural. In the case of Parrot feather, at this time there simply doesn't appear to be enough known about the use of insect biocontrols to implement a control program in the U.S. Disadvantages include the possibility of damage to non-target plants or other organisms from an imported insect. Insects typically also do not provide eradication of their host plant, so even if an effective insect control could be utilized at Meserve it is unlikely the goal of eradication could be accomplished. Another disadvantage may be a failure of many potential insect controls to control submersed plants. Observations on the effects of insects on the plants have generally been done in shallow systems where the plants are growing primarily in the emersed form. Since many plants in Meserve are growing in deep water and most have their biomass submersed the potential insect control would have to be an aquatic organism to use the plant as a host. Insects may warrant more serious consideration as a potential control if Parrot feather becomes widespread as an invasive plant pest.

●Fungal Biological Control
An isolate of the fungi *Rhizoctonia solani* collected in Panama has been shown to be phytotoxic to the tips of emersed Parrot feather (Joyner 1973). An isolate of the fungi *Pythium carolinianum* has demonstrated the ability to control Parrot feather growth when used as an inoculant (Bernhardt). The potential of these species for biological control in the United States has not yet been thoroughly investigated.

●Control with Triploid Grass Carp (White Amur):
The Asiatic Grass Carp *Ctenopharyngodon idella* have become popular as an introduced exotic biological control for rooted aquatic plants in ponds and southern U.S. lakes. Grass Carp are native to river systems of Russia and China. The species was first imported to the southern United States in 1963. Like most biological controls herbivorous grass carp have remained extremely popular despite some problems associated with their use. Stocking of Grass carp was initially illegal in many states including Indiana. Because grass carp are a possibly detrimental exotic species, resource managers feared a destructive establishment of viable wild populations. This process had already occurred with the Common carp which remains a destructive influence in our aquatic habitats.

Proponents of the plant-eating fish argued that viable breeding habitat for the carp was not present in the United States. That argument was refuted when viable reproduction was noted in the 1980's in tributaries to the Mississippi. When a technique was developed for producing

genetically altered triploid grass carp stock with greatly reduced fertility, laws in many states including Indiana were changed to allow stocking of the sterile fish in private waters.

The possibility still exists for fish producers to bypass the necessary hatchery process and market fertile fish. Illegally stocked fertile Grass carp have been found in some locations. Use of any Grass carp remains illegal in twelve states including Michigan. Despite remaining controversy, some regulatory agencies encourage their use in ponds and lakes publishing stocking guidelines and even offering the fish for sale. Grass carp have been introduced into thousands of private ponds and many larger reservoirs in the southern United States with mixed results. Often stockings in large waterbodies bring either complete eliminations of vegetation or very little decline at all (Cassani 1995).

Grass Carp are selective feeders and unfortunately tend to prefer most native plant species over Eurasian watermilfoil. Results of Grass carp stocking vary with the plant species assemblage present in stocked waters and variations in Lake Morphometry. In general, stocking at low rates can be expected to produce a shift in plant biomass away from preferred species food plants, toward unpreferred. At high stocking rates the fish will consume all rooted aquatic vegetation in the system. This causes a shift in plant biomass toward planktonic and filamentous algae as fish waste and feeding activity boosts lake nutrient levels. At sustained high numbers, the fish will consume filamentous algae, emergent aquatic plants, and even terrestrial vegetation within their reach at the lake's edge. Shoreline erosion can become a problem when this occurs. At the end result of sustained high stocking rates lake plant biomass will be maintained in planktonic algae, which the fish are unable to utilize as a food source. This can obviously lead to water clarity problems and unstable oxygen levels, especially in the temperate northern U.S. Successful use of grass carp on ponds and in large southern lakes often trades water clarity for alleviation of rooted plant problems. This technique can be effectively employed where water clarity and high oxygen levels are not a priority. In the case of most Indiana natural lakes where water quality and clarity is a high priority, use of herbivorous fish as a management technique would not be wise or legal. In the case of parrot feather most sources seem to indicate it is an unpreferred food source for grass carp and would probably not provide satisfactory control. Apparently parrot feather has a high tannin content which they find unpalatable. (Portland online)

●Harvesting:
There are several models of machines produced for cutting and removal of aquatic vegetation from lakes. Contractors who own the machines generally hire on to cut plants on an hourly basis with organizations that can provide a set minimum hours of work to cover mobilization costs. Most harvesters are constructed like a floating combine. The floating machine is driven and steered with paddle wheels. An underwater cutting bar cuts plant stems and a driven belt carries the cuttings to the back of the machine where they are deposited in a hopper. When the machines hopper is full the machine operator offloads the aquatic cuttings in a designated area or into the back of a truck for disposal. One advantage of harvesting is the actual removal of plant material and associated nutrients from the lake. Unfortunately, only a very small percentage of a lakes nutrient load is invested in plant biomass at any given time. In most cases the cutting will have to be repeated each season and often multiple cuttings per season are needed to control plant regrowth. A major disadvantage of harvesters is the amount of biological disturbance introduced to the lake during the cutting process. Most milfoils maintain the ability to recover very quickly from cutting. Native plants which cannot recover as readily from the harvesting may encounter a selective disadvantage. The end result can be a shift in plant biomass away from more beneficial native plants, toward the milfoil. Whereas Parrot feather readily breaks apart if disturbed and can reproduce through fragmentation, the potential for free floating cut plants to

spread growth by settling in other parts of the lake is a major disadvantage. This is an especially important disadvantage to consider in Meserve where fragments of parrot feather plant may leave the lake and enter Pigeon Creek passing to other lakes downstream. Aquatic plant cutters also tend to entrain a large number of small fish, turtles, and other aquatic organisms which will be removed from the lake if not screened out by the operator. Because of these problems weed harvesting has become subject to regulation and permitting by the Indiana Department of Natural Resources. Harvesters may sometimes be the only effective option for controlling excessive growths of stout native plants that do not respond well to other control methods. They are also often employed in areas where regulatory permitting excludes the use of pesticides.

●Hand Removal

Aquatic plants can be controlled by removal of the plants by hand. In many cases where the number of plants is low this can be very effective, especially if the entire plant including the root can be removed. At Meserve this technique could prove to be very effective if the number of plants can be greatly reduced with other methods before it is initiated. One major disadvantage in regard to Meserve Lake currently is the time/expense/ labor that would be required to remove the large number of plants present. Another disadvantage would be the possible spread of plant fragments if the removal is not done properly.

●Control of Parrot Feather with Aquatic Contact Herbicides:

Several aquatic contact herbicides are available for use in Indiana lakes. Aquatic pesticide applications on Indiana public lakes are subject to review and permitting on a seasonal basis with the Indiana Department of natural Resources. In addition aquatic applicators for hire must be licensed through the office of the Indiana State Chemist. In aquatic herbicide applications chemical products are typically dispersed over target plants as liquid or granular formulations using specialized boat-mounted equipment. Most contact herbicides function by eroding the cell membranes of plant tissue, disrupting plant functioning. Control is usually achieved quickly with susceptible plant species often dropping out of the water column in less than one week. Aquatic herbicide choices are somewhat limited as EPA approved products must not cause damage to untargeted organisms, provide a hazard to lake users, or leave harmful residues in the environment. Because of these requirements most contact herbicides have a short half-life in an aquatic environment, being lost to soil adhesion, photodegradation, or bacterial decomposition shortly after application.

By both accident and design, most aquatic contact herbicides are selectively effective against obnoxious exotic species with Eurasian milfoil, and Curly-leaf pondweed being especially susceptible. Stout native species such as some of the larger native pondweeds main remain unaffected by marginal applications or spot treatments on larger lakes. This provides the advantage of allowing selective control, dropping out invasive exotics and leaving the native plant community to recover and capitalize on available light. Selective susceptibility needs to be considered when making herbicide choices so that appropriate plant community effects occur.

Contact herbicides tend to leave plant root structures intact so regrowth often begins shortly after treatment. Multiple treatments can be needed in some cases to maintain full-season control. The main advantage of using contact herbicides is their speed of effect, providing a quick knock down of target plants. Use of contact herbicides typically requires that lake activities such as swimming or lawn irrigation be restricted near the treatment area during a post treatment waiting period. Water-use restrictions generally apply within 100 feet of the application area. Waiting periods for swimming and other water-uses vary between zero and 120 days depending on the product used.

Diquat (trade name Reward® or Weedtrine D®) and the endothols (Hydrothol 191® and Aquathol K®) are both noted by U.S. Army Corps of Engineers Researchers in *Aquatic plant identification and herbicide use guide; Volume II: Aquatic plants and susceptibility to herbicides* to provide control of Parrot feather either on their own or in combination with complexed copper algaecides (Westerdahl and Getsinger 1988). The Texas Agrilife Extension Service in the Department of Wildlife and Fisheries at Texas A&M University has summarized personal experience, available literature, and contacts with a number of applicators and given diquat the rating of "good" in terms of its ability to control Parrot feather: Endothol was granted the rating of "excellent" (Dr. Michael Masser pers. comm.). When used with a copper product diquat was granted the rating of "excellent". Other professional applicators consulted for this work and the author have noted only marginal results on Parrot feather when using contact herbicides at full label rates.

Damage inflicted to Parrot feather plants seemed to be limited when compared to more susceptible species like Eurasian watermilfoil. If these results are typical one serious disadvantage is the limited control provided. Another disadvantage is the lack of translocation or "systemic" activity. Results with contact herbicides are sometimes rather short-lived with plants surviving and often regrowing after treatment. This could obviously be problematic in a program with eradication of a target species as a goal. Limited selectivity can be another drawback with contact herbicides. While all plants do not respond equally to contact herbicide applications, a broad variety of plants are generally susceptible to damage in most applications. Contact herbicides also cause water-use restrictions to be imposed on water bodies where they area used. Swimming is often prohibited for a day after treatment and restrictions on the use of lake water for irrigation or household uses may also be imposed. None of the sources consulted for this work reported successful eradication with the use of contact herbicides.

●Control of Parrot Feather with 2-4-D Granular Translocated Aquatic Herbicide:
Granular formulations of 2-4-D herbicide have been used for many years to control milfoil species. Granular 2, 4-D is currently available under the trade name Navigate®. In lawn, agricultural and aquatic applications 2-4-D is used to selectively control plants which are biologically classified as "broadleaves". Aquatic plants in this category include Eurasian and Native milfoils and Coontail *Ceratophyllum demersum.* 2-4-D is a translocated or "systemic" aquatic herbicide. It is absorbed by target plants and transported through their vascular systems, affecting remote parts of the plant including the root structure. This offers the theoretical advantage of actually killing more plants and providing longer term control.

Well-timed 2-4-D applications in some cases provide seasonal control of milfoils. Occasionally reapplication is needed within the same season. With milfoil infestations, 2-4-D offers the advantage of being highly selective for milfoils, with the pondweeds, and most other native plants remaining completely unaffected. Because granular pellets sink into plant foliage or to the lake bottom and slowly release their active ingredients they can sometimes be more effective than liquid formulations in deepwater or applications or cases where there is some water movement. Granular 2-4-D use typically restricts swimming near the treatment area for one day, and requires a waiting period on the use of lake water for lawn irrigation, so ornamental and garden plants will not be damaged. It was noted by U.S. Army Corps of Engineers Researchers in *Aquatic plant identification and herbicide use guide; Volume II: Aquatic plants and susceptibility to herbicides* that 2,4-D was effective in controlling parrot feather (Westerdahl and Getsinger 1988). Sources in Washington State have indicated that granular formulations of 2,4-D were needed to provide control lasting longer than 12 months (Washington Dept. of Ecology). The Texas Agrilife Extension Service in the Department of Wildlife and Fisheries at Texas A&M University has summarized personal experience, available literature, and contacts with a number of applicators and given 2,4-D an overall rating of "excellent" in terms of its ability to control Parrot feather.

In the case of Meserve Lake a granular 2,4-D formulation offers the advantage of providing a longer contact time for submersed plant foliage in the moving waters of the inlet and outlet streams. Selectivity is another major advantage of using a broad-leaf specific herbicide formulation. The native submersed plants in Meserve Lake will remain largely unaffected by the treatment. Most rushes and sedges in shoreline areas will also be unaffected. One disadvantage is that white waterlilies and spadderdock, both desireable native emergent plants, would however be affected by treatment with granular 2,4-D, especially at maximum application rates. Another disadvantage is that temporary water use restrictions on irrigation and swimming will be imposed. Granular herbicides are also bulky and dusty which can lead to a more costly and time consuming application, adding additional expense above the cost of the herbicide. None of the sources consulted for this work reported successful eradication with the use of this option.

●Control of Parrot feather with 2-4-D Granular Translocated Liquid Aquatic Herbicide:
Liquid 2,4-D herbicide formulations are available under the trade names Weedar 64®, and DMA-4 IVM®. Liquid formulations of 2,4-D produce the same active ingredient after application that granular formulations do. One advantage of a liquid formulation is the ease of application in some situations. Liquid formulation applications lack the product bulk of granular applications and can be easily transported and applied using a backpack sprayer for spot-treating in areas inaccessible to boats and equipment. They offer the same selectivity as granular formulations. Liquid formulations also offer the advantage of being applied to emersed Parrot feather foliage. One disadvantage is that they do not produce the time-release effect of granulars, especially in a moving-water situation. Flowing waters may carry an applied liquid formulation downstream before the plants have had sufficient contact time. As with granular formulations water use restrictions are typically imposed after treatment. None of the sources consulted for this work reported successful eradication with the use of this option.

●Aquatic Plant Control with Triclopyr Translocated Aquatic Herbicide:
Available in a liquid formulation or granular flake (OTF) as Renovate 3® aquatic herbicide, trichlopyr offers broadleaf specific systemic control of aquatic plants. Results in many cases have been similar to the use of 2-4-D. Improved application techniques and the use of adjuvants show some promise of possible multi-seasonal control with the use of Trichlopyr. The current labels allows the restricted use of dosed lake water to be adjusted in accordance with lake-water assay results, greatly reducing the time of restriction in most cases. The label application rates for Renovate 3® can make deep water applications rather expensive when compared with label rates for granular 2,4-D applications.

Triclopyr has been noted by U.S. Army Corps of Engineers Researchers in *Aquatic plant identification and herbicide use guide; Volume II: Aquatic plants and susceptibility to herbicides* to provide control of Parrot feather (Westerdahl and Getsinger 1988). The Texas Agrilife Extension Service in the Department of Wildlife and Fisheries at Texas A&M University has summarized personal experience, available literature, and contacts with a number of applicators and given triclopyr an overall rating of "good" in terms of its ability to control Parrot feather. One advantage of triclopyr is its systemic action. Chances are better for providing a complete kill than with contact herbicides. Selectivity is another major advantage of using a broad-leaf specific herbicide formulation. The native submersed plants in Meserve Lake will remain largely unaffected by a triclopyr application. Rushes and sedges in shoreline areas will also be unaffected. One disadvantage is that white waterlilies and spadderdock, both desireable native emergent plants, would however be affected by treatment with triclopyr. Temporary water use restrictions on irrigation and swimming will be imposed with the use of triclopyr. The current label for these products allows a maximum seasonal application of 2.5 ppm million, so dose rates

would have to be reduced over the maximum allowable if multiple treatments are desired. None of the sources consulted for this work reported successful eradication with the use of this option.

●Parrot Feather Control with Fluridone Translocated Aquatic Herbicide:
Fluridone available under the trade names Sonar®, Avast®, and WhiteCap sc®, is an extremely effective aquatic herbicide at very small concentrations in lakes and ponds, while it displays a relatively low toxicity to fish and mammals. Unlike most other aquatic herbicides it's also environmentally persistent, often remaining in the dosed waterbody in minute, but measurable amounts over the course of several months. Fluridone is absorbed by plant shoots from water, and from hydrosoil by the roots of aquatic vascular plants. In susceptible plants, fluridone inhibits the formation of carotene. In the absence of carotene chlorophyll is rapidly photodegraded causing plants to become chlorotic (whitish) and eventually drop out.

Like many other herbicides fluridone is capable of a high degree of selective control at proper dosages. Within the assemblage of plants in most Indiana lakes, Curly-leaf pondweed and Eurasian watermilfoil are most susceptible. For control of Eurasian milfoil fluridone is introduced into a lake at the calculated rate of six to twelve parts-per-billion. Assays are often performed within the first two weeks after initial dosing to assess a hit or miss on a target concentration. A second dosage is often used to maintain the target concentration for a period of 60 to 90 days as the product is allowed to work. Control of vulnerable plants typically lasts the entire season with carryover effects during the second season and third seasons common.

One major advantage of fluridone use is its persistence and slow activity. During the extended treatment period the product mixes throughout the upper strata of the entire lake basin, allowing it to reach all exotic target plants in contact with the water. This also means that consideration must be given to possible impacts downstream from the target lake. Because of its slow rate of activity fluridone also offers the advantage of providing for gradual breakdown of target plants, providing a more gradual release of nutrients than faster acting herbicides. This decreases the chances of developing oxygen deficits or excessive algal blooms in shallow lakes. Because of the high cost of fluridone herbicides, their use is often reserved for lakes with extensive littoral areas showing profound mat-forming infestations and severely impaired recreational use. The only water-use restriction associated with fluridone is a wait on the use of lake water for lawn and garden irrigation of 14 to 30 days depending on dose rate. The Texas Agrilife Extension Service in the Department of Wildlife and Fisheries at Texas A&M University has summarized personal experience, available literature, and contacts with a number of applicators and given fluridone an overall rating of "excellent" in terms of its ability to control Parrot feather. According to Sepro Corporation, a provider of fluridone herbicides, control of Parrot feather can be achieved at a dose rate of 30 ppb (Bob Johnson, pers. comm.). One major disadvantage of fluridone use is that at the 30 ppb rate damage to non-target vegetation will be extensive. All vascular submersed plants can be expected to be eliminated or heavily impacted, significantly altering the Meserve Lake Plant community. None of the sources consulted for this work reported successful eradication with the use of this option.

●Parrot Feather Control with Imazapyr and Imazamox Systemic Aquatic Herbicides:
Imazapyr is available under the trade name Habitat®. Imazamox is available under the trade name Clearcast®. The Texas Agrilife Extension Service in the Department of Wildlife and Fisheries at Texas A&M University has summarized personal experience, available literature, and contacts with a number of applicators and given an overall rating of "good" to both imazamox and imazapyr in terms of their ability to control Parrot feather. One disadvantage of the use of these herbicides with respect to Meserve Lake is their usefulness primarily on plants that are predominantly emersed. Many Parrot feather plants at Meserve have all or most of their foliage

below the surface where these products will not be effective due to dilution. The manufacturer indicated that possible non-target effects could occur with the use of imazapyr, affecting mostly woody species along wetland shorelines of the lake where the product is used; imazamox does not offer this disadvantage(Randy Denhart pers. comm..). None of the sources consulted for this work reported successful eradication with the use of these two options.

●Benthic Barriers for Aquatic Plant Control

Sheets of plastic or rubber material have been used to exclude aquatic plant growth. Usually owners of small ponds or swimming areas will employ this technique by placing the liner on the bottom and depositing sand or pea gravel on the liner. One drawback with this technique is the tendency for gasses to build up beneath impermeable liner material pushing it up from the bottom. This occurs as decomposition in the lake sediments produces hydrogen sulfide and carbon dioxide gasses. Using mesh liners or permeated liners can alleviate this problem somewhat, but obviously will allow plants to grow through the liner. Bottom liners also effectively exclude areas of benthic habitat and are generally not permitted by IDNR in public lakes for this reason. Another probably disadvantage to the use of a benthic barrier for Parrot feather is a lack of effectiveness. Since Parrot feather can exist for an extensive time in a free-floating state many loose plants would be unaffected by the presence of the barrier on the lake's bottom.

●No Action as an Option

Taking no action at Meserve Lake has the advantage of avoiding the establishment of water-use restrictions associated with treatment. It will also provide the advantage of avoiding damage to non-target plant species that may be associated with some herbicide applications. A major disadvantage of taking no action will likely be a new and potentially damaging infestation of non-native plants to water bodies downstream of Meserve Lake. At Meserve Lake itself it appears likely that Parrot feather will continue to increase its growth area eventually providing a major hindrance to recreational activity and possibly having a major impact on the health of the native plant community present. There is also an excellent chance that this plant, if allowed to spread to lakes downstream could find its way into many Indiana Waters in other watersheds via transport on boat trailers. Table eight below contains a summary of general advantages and disadvantages of available management options.

Option	Benefits	Drawbacks
Biocontrol insects	No water-use restrictions, perceived as environmentally friendly	Not yet well researched or proven effective in U.S.
Biocontrol, fungal isolates	No water-use restrictions, perceived as environmentally friendly	Not yet well researched or proven effective in U.S.
Biocontrol Grass Carp	No water-use restrictions, perceived as environmentally friendly	Generally do not prefer parrot feather as food, illegal in Indiana public waters, may cause water clarity/quality problems,
Mechanical Harvesting	No water-use restrictions, Removes some nutrients from lake	Will hasten spread of parrot feather through fragmentation. Hydrosoil disturbance. Expensive, May result in regrowth within same season, Requires plant disposal site, Non-selective
Hand Pulling	No water-use restrictions. Perceived as environmentally friendly. Very effective if a low number of plants is present	Would require considerable labor/expense at current level of colonization. Could possibly cause fragmentation and spread.
Aquatic Pesticides (granular 2-4-D)	Highly selective control, Reported as effective for periods over 12 months, good in areas of water movement	Intermediate expense, difficult application, Swimming and irrigation restrictions. Likely to damage certain emergent species in repeated applications.
Aquatic Pesticides (liquid 2-4-D)	Highly selective control. Reported as effective. Can be applied to emersed leaves. Easy application.	May drift in areas of water movement.
Aquatic Pesticides(Triclopyr liquid or flake)	Highly selective control, Reported as effective.	Expensive- materials expense. Swimming and irrigation restrictions imposed. Limited to maximum seasonal dose of 2.5 ppm.
Aquatic Pesticides (fluridone)	Reported as effective, Multi-seasonal control in some cases. Contacts all plants in the lake.	Expensive product, irrigation restriction, extensive damage to non-target vegetation at required 30 ppb rate.
Aquatic Pesticides (contact herbicides) (diquat dibromide or endothols)	Reported as effective, fast acting, least expensive application	Generally provides short term control, Swimming, Irrigation, restrictions. Some reports of limited results.
Aquatic Pesticides (Imazapyr and Imazamox)	Reported as effective, systemic	Suitable for only emersed foliage or plants with the majority of their foliage emersed.
Benthic liners	No water-use restrictions, possible multi-seasonal control	Impairs benthic habitat, Not generally permitted in Indiana Public Waters, Not feasible in deep water, Inherent maintenance problems. Not effective for free floating fragments/plants
No Control	No dollar cost, No water-use restrictions	Loss of plant diversity, degraded fish & wildlife habitat, possible further spread causing extensive problems with lake and wetland ecology, Impeded recreational use and aesthetic problems.

Table 8 General control alternatives, advantages, and drawbacks

9. Public Involvement

Since the management program at Meserve Lake was initiated late in the season no opportunities were available for incorporating a public meeting into the Life of Riley meeting schedule. Members of the Life of Riley Association were invited to participate in a Steuben County Lakes Council meeting on February 2, 2009 when the issue of Parrot feather in Meserve Lake was addressed. The Steuben County Lakes Council serves as a county-wide lake residents advocate organization for Steuben County in Northeast Indiana. An article appearing on the front page of the local newspaper and a local radio ad provided publicity to help interested area residents learn of the problem. The president and vice president of the LRA were in attendance at the meeting as well as residents from many other area lakes and local natural resource management officials. Thirty six people were in attendance. Aquatic Enhancement & Survey, Inc. presented information about Parrot feather identification, the Parrot feather growth and potential for spread at Meserve Lake, and management activities completed in 2008. The Steuben County Lakes Council provided written material to help guide attendees in spotting Parrot feather if it should occur on their lake. Opportunity was provided for attendees to ask questions. Attendees expressed concern about the possibility of spread and were generally in favor of continued management activities that could prevent it. At least one public meeting should be incorporated into a regular LRA meeting in the 2009 season with a survey presented to gage lake user attitudes and perceptions about the ongoing management program at Meserve.

10. Implementation Strategy

Management of Parrot feather at Meserve Lake should take an approach consisting of three tiers of action working toward this plan's primary goals over the next five years:

Tier 1. Exotic Plant Control.

Addressing the Parrot feather present aggressively on a lakewide basis with professional applications of EPA approved aquatic pesticides and monitoring results closely can immediately limit spread, and preserve the native plant community while working toward the goal of eventual eradication. All parties involved including the LRA have expressed an interest in preventing the spread of these potentially damaging plants beyond Meserve Lake. At present no available control options other than herbicide application appear able to provide a serious reduction in Parrot feather plants leading toward eventual eradication. Without eradication there is an excellent chance live plants will eventually move downstream and colonize other waters. Specifically the herbicides utilizing 2, 4-D and triclopyr as their active ingredients were chosen because they will not affect native submersed plant species present, thereby preserving the Meserve Lake plant community. Granular 2,4-D in particular appears to offer the longest lasting control at present and results from 2008 season treatments have been encouraging. For shoreline plants that are spread among native vegetation liquid 2,4-D applications along with surfactant are recommended along the lake's north shore to achieve an efficient and penetrating application in hard-to-access riparian areas. Liquid 2,4-D can also be effectively mixed and applied via backpack sprayer in areas where it is needed. It is recommended to apply liquid triclopyr along the lake's south shore because it has shown effectiveness on Parrot feather and will provide a comparison of treatment results with 2,4-D. Information gained can be utilized in future seasons and incorporated into updates to this plan. The proposed treatment regime is detailed in the action plan in the next section. A treatment response benchmark of a reduction in live Parrot feather occurrence to zero in a late-season Tier II occurrence should be pursued for 2009. Curlyleaf pondweed does not appear to be a significant enough problem to warrant treatment at this time, but should be monitored as it could eventually present a secondary issue. The LRA has expressed agreement with this course of action.

Tier 2. Nutrient and Sediment control.

The LRA should be vigilant in spotting and addressing nutrient and sediment sources in the watershed, stopping pollutants at their source before water quality can be impacted. While Parrot feather obviously is not dependant on highly disturbed conditions to thrive in Meserve Lake, the protection of water quality will still be important in the protection of the lake and its overall plant community. Poor water quality could boost the emerging problem with Parrot feather or encourage the growth of other exotics such as Curlyleaf pondweed.

11. Action Plan

11.1 Management Efforts with Herbicides in 2008

District 2 IDNR Fisheries personnel made initial observations of the Parrot feather growth in Meserve Lake in 2008 and performed some limited herbicide treatments to test the reaction of the plants (Larry Koza pers. comm..). On July 1st they treated a 600 foot by two foot band in the lake from the bridge east with 5.5 pounds of Navigate 2,4-D granular herbicide (0.0275 acres). On July 2, they returned to take a better look at the lake and treated the outlet channel approximately 880 feet of the outlet channel and approximately 600 feet of shoreline in front of the LRA commons area. The majority of the shoreline treatment consisted of plants at or above the waterline. This was a backpack treatment consisting of Renovate 3® at 1.5% (7.6 oz per 4 gal and 2.7 oz of Cidekick®) (15.2 oz of Renovate 3® and 5.4 oz of Cidekick® were applied). They reported that a Parrot feather bed immediately downstream from the bridge, which was only partially sprayed, had new shoots with 10 days. The rest of the areas treated with 2,4-D and Renovate 3® looked pretty good with lots of dead or absent plants. However there were also a number of new, thimble sized plants just breaking the surface along the shoreline that was previously sprayed. The initial results suggested that the plants were responsive to the treatment, but demonstrated much more resistance than other milfoils would have.

In September LARE funding was available to initiate a management regime and prepare this plan. After LARE sponsorship was obtained by the LRA Aquatic Enhancement & Survey, Inc. was hired to initiate a three tiered treatment approach incorporating three separate herbicide formulations (See fig. 29 below). Treatments in 2008 included Parrot feather growth totaling 2.7 acres in deeper offshore waters of the lake. This area was treated on September 17, 2008 with 200 pounds per acre Navigate® (2,4-D) granular aquatic herbicide. On September 17, 2008 a .4 acre area of the lakes outlet stream immediately downstream of the lake and a .1 acre area of the lake's inlet stream immediately upstream of the lake were treated with 200 pounds per acre Navigate® (2,4-D) granular aquatic herbicide. Scattered Parrot feather plants growing along the north shoreline of the lake were treated with Weedar 64® (2, 4-D) liquid herbicide at the rate of 10 gallons per surface acre. Scattered near-shore plants along the southern perimeter of the lake were treated with Renovate 3® (Triclopyr) liquid aquatic herbicide at the rate of 2.5 ppm. Cygnet plus® non-ionic surfactant was also applied during each perimeter treatment at the rate of 1.5 gallons per surface acre. This was followed up on September 18 by treatment of emerged Parrot feather plant tops in the inlet and outlet streams utilizing a backpack sprayer and five percent solution of Weedar 64® (2,4-D) liquid herbicide and 2 quarts per acre Cygnet Plus® surfactant. Perimeter treatments utilized both triclopyr (south shore) and liquid 2,4-D (north shore) to in an attempt to asses the effectiveness of each. On 10/20/2008 all treated areas were checked for plants. Treated plants in deepwater areas consisted mainly of necrotic stems laying flat on the bottom of the lake (Fig. 28). A few defoliated plant stems remained standing. Live leaf parts were also noted on a one of the plant stems and appeared to be signs of new growth. In shallow areas treated with the backpack sprayer or from the boat the number of plants had been reduced

by an estimated 80 percent. This reduction was similar for both the north and south shores. All live plants noted in the shallows at the time of the assessment appeared to be unrooted fragments with emersed leaves.

Figure 26 A colony in the outlet stream 9/16/08

Figure 27 The same colony 10/20/08 approx. 32 days post treatment

Figure 28 10/20/08, 33 days post-treatment deepwater plants consisted of mostly defoliated stems.

Figure 29 2008 season treatment map for Meserve Lake

11.2 Proposed Management Regime for the 2009 Season

For 2009 a regime incorporating herbicide applications is proposed as the best way to proceed toward the goals of this plan. A multiple-treatment regime is proposed utilizing four separate application elements as follows:

1. Apply 2,4-D granular herbicide to the entire littoral zone of Meserve Lake between 25 feet from shore and the 19 foot depth contour. This should be done at the maximum label rate of 200 pounds per surface acre. This includes the affected sections of the inlet and outlet streams. The selection of 2,4-D granular is based on reports of it's ability to provide control of over 12 months. The maximum label rate is to be used considering multiple reports of Parrot feather being difficult to control with any herbicide in a field situation. The lack of any known reports of complete eradications was also considered. This is to be done up to three times as needed beginning at the first sign of widespread active growth. The area of this application per treatment is 13 acres (See treatment map fig. 30).

2. Apply 2,4-D liquid herbicide along the south shore of the lake, extending 25 feet from shore at the maximum rate of 2.84 gallons per acre foot. The selection of 2, 4-D liquid is based on its selectivity, reports of its ability to provide successful control and its ability to be applied to emersed plant tips and submersed foliage. The maximum label rate is to be used considering multiple reports of Parrot feather being difficult to control with any herbicide in a field situation. The lack of any known reports of complete eradications was also considered. This is to be done up to three times as needed beginning at the first sign of widespread active growth. A non-ionic surfactant should be applied simultaneously at the maximum label rate to enhance effectiveness. The area of this application per treatment is 1.33 acres.

3. Apply triclopyr liquid herbicide along the south shore of the lake, extending 25 feet from shore at the rate of .82 ppm. The selection of triclopyr liquid is based on reports of its ability to provide successful control and its ability to be applied to emersed plant tips and submersed foliage. This is to be done up to three times as needed beginning at the first sign of widespread active growth. A non-ionic surfactant should be applied simultaneously at the maximum label rate to enhance effectiveness. This will serve to continue the effectiveness trial begun in 2008. The area of this application per treatment is one acre.

4. Apply liquid 2,4-D as needed at the maximum label rate for spot treatments of emerged plant tops in areas inaccessible to the other treatments or treatment areas that have not responded. This is to be done up to three times as needed and should be timed to be performed separately from other 2, 4-D applications to avoid over-application. The area of these treatments is expected to be up to .1 acre per treatment.

Concerns associated with this regime include water-use restrictions imposed and possible impacts on non-target plant and animal species. With respect to aquatic plant management and preserving Cisco at Meserve Lake invasive plant biomass should be kept small and native submersed plant biomass should be preserved. The potential may exist for the decomposition of a large population of treated aquatic plants to produce an oxygen drain within the lake that could affect the stability of the Cisco layer, especially if the plants are in deep water. Secondarily a large area of decomposing plants could release enough nutrients to substantially boost levels of planktonic algae, causing further changes which threaten the existence of the Cisco. At the current level of colonization by Parrot feather this effect is unlikely to be pronounced enough to warrant concern, especially if the plants are treated late or early in the season when prevailing water temperatures are cool. If colonization is allowed to significantly increase warm-season treatments of plants may be able to pose a substantial threat. Triclopyr and 2, 4-D affect

primarily plants that are classified as "broadleaf" species. The proposed treatment regime will likely affect the beneficial emergent aquatic plants White water lily and Spadderdock as these species are broadleaves. The exact effects the treatments will have are unknown but non-target damage to these plants is expected. If eradication of Parrot feather can be achieved these plants can then be reestablished in areas where they are lost free of the competing Parrot feather. The affected area is expected to be less than one half acre. Submersed aquatic plants and other emergent plants present in Meserve are not expected to be significantly affected by this regime and will continue to provide valuable habitat.

Many elements of the proposed program are charting new territory. There are no known reports of Parrot feather aggressively growing in another Midwest glacial lake. Parrot feather is widely known to be more resistant to herbicides than other species of non-native aquatic plants. Most available information suggests that if eradication is achievable with the current tools available it will take multiple treatments and perhaps multiple seasons to achieve. At present it is recommended that this regime be repeated through 2012. Adjustment may no doubt be necessary based on plant response or lake user concerns. Alternative control techniques or newly labeled herbicides may be needed as planning is adjusted in future seasons. Table 10 below contains a proposed timeline and cost schedule for Meserve Lake. Important program dates for the LRA in the 2009 season are presented in table 9.

March 15, 2009	IDNR funding decisions
March 20	Send a request for proposals to planning and application contractors due in one week
March 27	Receive bids from contractors
March 31	Select and notify contractor(s)
April 10	Obtain signed contract
May 15	Schedule Lake Association Meeting(s) with contractor (s)
November 1	Last day for contractors to provide maps for management plan or plan updates and schedule a meeting with DNR Fisheries and LARE biologists
December 15	First draft of management plan or plan updates due from contractors
January 15	Grant application due for current year funding
March 1	Final copy of revised plan or update due from contractors

Table 9 Important dates for the LRA in 2009

Figure 30 2009 Meserve Lake proposed treatment regime

●**Success Benchmarks** A late-season Tier II occurrence of Myriophyllum aquaticum of zero.	**2009**	**2010**	**2011**	**2012**
Month/Activity				
April, Map and GPS mark deepwater growth if present, check shallow areas for emersed plants	200.00	200.00	200.00	200.00
April/May pre-treat Tier II	1000.00	1000.00	1000.00	1000.00
April/May, treat entire littoral zone and inlet/outlet with 2,4-D gran.	9074.00	9074.00	9074.00	9074.00
April/May treat north shoreline plants with Liquid 2,4-D	763.00	763.00	763.00	763.00
April/May treat south shoreline plants with triclopyr	333.00	333.00	333.00	333.00
Treat emersed tops as needed with liquid 2,4-D up to .1 acres	160.00	160.00	160.00	160.00
June, public meeting as arranged with IDNR and Life of Riley	200.00	200.00	200.00	200.00
July/August, if needed treat entire littoral zone with 2, 4-D gran.	9074.00	9074.00	9074.00	9074.00
July/Aug. treat north shoreline plants with Liquid 2,4-D	763.00	763.00	763.00	763.00
July/August treat south shoreline plants with triclopyr	333.00	333.00	333.00	333.00
Treat emersed tops as needed with liquid 2,4-D up to .1 acres	160.00	160.00	160.00	160.00
August/Sept, if needed treat entire littoral zone with 2, 4-D gran.	9074.00	9074.00	9074.00	9074.00
Aug./Sept, treat north shoreline plants with Liquid 2,4-D	763.00	763.00	763.00	763.00
August/Sept treat south shoreline plants with triclopyr	333.00	333.00	333.00	333.00
Treat emersed tops as needed with liquid 2,4-D up to .1 acres	160.00	160.00	160.00	160.00
August, late season Tier II Survey	1000.00	1000.00	1000.00	1000.00
October/November, Permit Meeting	200.00	200.00	200.00	200.00
December, Plan Update Document Due	1700.00	1700.00	1700.00	1700.00
Total Cost	**$35,290.00**	**$35,290.00**	**$35,290.00**	**$35,290.00**

Table 10 Proposed timeline and cost schedule for Meserve Lake through 2012

12. Education

Proper education of lake users and other area residents can help prevent the spread of Parrot feather from Lake Meserve. An active and ongoing effort should be made to make lake users aware of the possible presence of this plant, especially in Steuben County. The Indiana Lakes Management Society's annual conference and sponsored workshops will be excellent opportunities to increase awareness of this plant as a potential new invader. A short article provided to Lake Associations for inclusion in their newsletter may also prove helpful.

Information presented on area lake association websites can all be important. Additionally, educating lake users can potentially prevent a very costly infestation of new exotic plants and animals at Meserve Lake, saving resources that can be utilized to address the current problem. Meserve Lake does not presently appear to contain Eurasian watermilfoil. This plant could easily be transported into the lake on a boat trailer. Most crucial will be the prevention of the transport of Parrot feather plant fragments out of the lake. LRA personnel should carefully screen incoming and outgoing boat trailers to insure no plant fragments are transported. Signage should be placed at the boat ramp to inform those present of precautions to be taken. Lake users should be informed that Parrot feather plants present should not be disturbed as fragmentation can occur very rapidly, spreading the plants. The present policy of discouraging the use of gasoline outboards at the lake is helpful in preventing fragmentation and spread.

13. Monitoring and Evaluation of Plan

Two Tier II surveys should be planned in 2009 utilizing the same Tier II waypoints as in 2008. The reaction of the Parrot feather plants to the 2009 treatment regime is not well understood as a track record of treatment of this plant in this particular situation does not exist. Repeated visits to the lake may be needed to gauge the reaction of the plants and adjust management activities as needed. This plan should be updated annually and contractors and consultants should correspond with IDNR frequently to provide relevant information about the progress of field work and treatment.

14. Literature Cited

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Appendix A
National Heritage Database Request and Response

Aquatic Enhancement
& Survey, Inc.

Attn: Ronald Hellmich
Division of Nature Preserves
Indiana Dept. of Natural Resources
402 W. Washington St., Rm W267
Indianapolis, IN 46204
Fax # 317-233-0133

RE: National Heritage Database Request for known state endangered, threatened, and rare species, high quality natural communities, and significant natural areas at the following lakes and their immediate riparian areas:

Atwood Lake, LaGrange County, Johnson Township, Section 31, N41° 32.24639' W85° 24.82376'

Meserve Lake, Steuben County, Steuben Township, Section 14, N41° 34.40997' W84° 59.84679'

Please return fax as soon as possible to 260-665-9785 or email to sbanfield@aquaticenhancement.com

Thank you,

Scott Banfield
off. 260-665-8226
mobile 260-668-5062

DNR
Indiana Department of Natural Resources

December 11, 2008

Mr. Scott Banfield
Aquatic Enhancement & Survey, Inc.
PO Box 1036
Angola, IN 46703

Dear Mr. Banfield:

I am responding to your request for information on the endangered, threatened, or rare (ETR) species, high quality natural communities, and natural areas documented from Atwood Lake, LaGrange County and Meserve Lake, Steuben County, Indiana. The Indiana Natural Heritage Data Center has been checked and enclosed you will find information on the ETR species documented from these lakes and immediate riparian areas.

1. Atwood Lake: There is a historical record of the state species of special concern fish *Coregonus artedi*, cisco, documented from Atwood Lake in 1955.
2. Meserve Lake:
   a. The state species of special concern fish *Coregonus artedi*, cisco, was documented from Meserve Lake in 1992.
   b. There is a historical record of the state rare plant *Triglochin palustris*, marsh arrow grass, documented from Meserve Lake in 1932.

For more information on the animal species mentioned, please contact Christie Stanifer, Environmental Coordinator, Division of Water, 402 W. Washington Room W264, Indianapolis, Indiana 46204, (317)232-4160.

The information I am providing does not preclude the requirement for further consultation with the U.S. Fish and Wildlife Service as required under Section 7 of the Endangered Species Act of 1973. You should contact the Service at their Bloomington, Indiana office.

U.S. Fish and Wildlife Service
620 South Walker St.
Bloomington, Indiana 47403-2121
(812)334-4261

At some point, you may need to contact the Department of Natural Resources' Environmental Review Coordinator so that other divisions within the department have the opportunity to review your proposal.

For more information, please contact:

Department of Natural Resources
attn: Christie Stanifer
Environmental Coordinator
Division of Water
402 W. Washington Street, Room W264
Indianapolis, IN 46204
(317)232-4160

Please note that the Indiana Natural Heritage Data Center relies on the observations of many individuals for our data. In most cases, the information is not the result of comprehensive field surveys conducted at particular sites. Therefore, our statement that there are no documented significant natural features at a site should not be interpreted to mean that the site does not support special plants or animals.

Due to the dynamic nature and sensitivity of the data, this information should not be used for any project other than that for which it was originally intended. It may be necessary for you to request updated material from us in order to base your planning decisions on the most current information.

Thank you for contacting the Indiana Natural Heritage Data Center. You may reach me at (317)232-8059 if you have any questions or need additional information.

Sincerely,

Ronald P. Hellmich

Ronald P. Hellmich
Indiana Natural Heritage Data Center

enclosure: invoice

Appendix B
Tier II Plant Survey Data Sheets

0-5 30 POINTS 𝍸 𝍸 III
5-10 10 PTS IIII
10-15 10 PTS 𝍸
15-20 10 PTS 𝍸 II
IIII 20-25 10 PTS

Submersed Aquatic Vegetation Survey (Tier II) Datasheet

WATERBODY NAME: MESERVE LK	DATE: 9/30/08
COUNTY:	SECCHI DEPTH (FT): 8ft
SITE ID:	MAX PLANT DEPTH (FT):
SURVEYING ORGANIZATION: AES, INC.	WEATHER: Sunny 70° Calm Light Westerly Wind
CREW LEADER: SCOTT BENFIELD	COMMENTS (Include voucher codes - V1, V2...):
RECORDER: CARL ABRAMS	V1 - coordinates on back
CONTACT INFO: 218-665-8266	

Rake score (1, 3, 5). 9 = algae, emergent or species observed but not sampled.

Point #	R/T	Latitude	~~Longitude~~ ELODEA POTOI	Depth	Species Codes: CHARA	POTPUS	UTRMAC	POTILL	MYRAEU	UTRMIN	NYSMAR	NAJFLE	STUPEC ~~Notes~~
001				4	5						5		
002				2.5	5						3		
003				8.5							1		
004				16	5								
005				21									
006				16	5								
007				8	1		1				1		
008				2	1					1	1		
009				15.1	5			1					
010				1.5	1		1						
011				13				1	1				1
012				1.2	1								
013				14	5								
014				1.8	1								
015				18									
016				20.1									
017				22									
018				19	1								
019				17	3								
020				12	5								
021				1.5	5						1		
022				2				5	1				
023				6.8				3					
024			1 1	14.5	1	1							
025				10.2				~~5~~	5				
026				1	5			1			1		
027				3.5				1	1				
028				1	5			1					
029				18.5	5								
030				20.1									
T2 001				1.5	1				1	1	5		
002				1	3					1	1		
003				6	1						1		

Other plant species observed at lake:

Submersed Aquatic Vegetation Survey (Tier II) Datasheet

Page 2 of 2

WATERBODY NAME:	DATE:
COUNTY:	SECCHI DEPTH (FT):
SITE ID:	MAX PLANT DEPTH (FT):
SURVEYING ORGANIZATION:	WEATHER:
CREW LEADER:	COMMENTS (Include voucher codes - V1, V2...):
RECORDER:	
CONTACT INFO:	*Rake score (1, 3, 5). 9 = algae, emergent or species observed but not sampled.*

Point #	R/T	Latitude	Longitude	Depth	Species Codes: CHARA	NAJMAR	POTILL	MYRAQU	POTPUS	STUPEC	UTRMAC	UTRMIN	NAJ FLEX Notes
004				21									
005				6	1								
006				21.5									
007				15.2	5								
008				5.75	5								
009				3.5	1	1			1				
010				2	1	5							
011				1.5	5	1				1			
012				4.75	3	3							
013				3.5		5							
014				19.5									
015				22									
016				8.5			5						
017				14.9	5								
018				16.5	5								
019				9		1							
020				6		1	1						
021				5.1			1				1		
022				1	5	1						1	
023				14.7	3								
024				21.5									
025				20.2									
026				10.5									
027				21.2									
028				1.5				1					
029				14	5								
030				13									

Other plant species observed at lake:

Submersed Aquatic Vegetation Survey (Tier II) Datasheet

WATERBODY NAME: MESERVE LAKE
DATE: 10/20/08
COUNTY: STEARNS
SECCHI DEPTH (FT): 5' 4"
SITE ID:
MAX PLANT DEPTH (FT):
SURVEYING ORGANIZATION: AES, INC.
WEATHER: SUNNY 58°
CREW LEADER: SCOTT BANFIELD
COMMENTS (Include voucher codes - V1, V2...):
RECORDER: CARY ABRAMS
CONTACT INFO: 660-665-8226
Rake score (1, 3, 5). 9 = algae, emergent or species observed but not sampled.

Point #	R/T	Latitude	Longitude	Depth	Species Codes: CHA	POTFRI'S	UTRMAC	POTILL	MYRAQU	UTRVUL	NAJMAC	VASFLE	SPIPER	Notes
1				4	1						5			
2				2.5	5			1			1			
3				8.5				5			5			
4				16										
5				21										
6				16	3									
7				8							1			
8				2	1						1			
9				15.1	5									
10				1.5	1		1							
11				13	1			5	1					
12				1.5	1									
13				14				3			1			
14				1.8	1									
15				18	5				1					
16				21										
17				12										
18				19										
19				17	1									
20				12	1				3					1
21				1.5	5			1			1			
22				2				1						1
23				6										
24				14.5	1									
25				10.2	5									3
26				1	5						1			
27				3.5			1		1					5
28				1	1			1		1				
29				18.5										
30				20.1	~~2~~									
T2 001				1.5	1						1			
002				1	5									
003				6	5						1			

Other plant species observed at lake:

Submersed Aquatic Vegetation Survey (Tier II) Datasheet

Page ___ of ___

WATERBODY NAME: MESERVE LAKE	DATE: 10/20/08
COUNTY: STEARNS	SECCHI DEPTH (FT): 8'4"
SITE ID:	MAX PLANT DEPTH (FT):
SURVEYING ORGANIZATION: AES, INC.	WEATHER:
CREW LEADER: SCOTT BANELEND	COMMENTS (Include voucher codes - V1, V2...):
RECORDER: CARY ADAMS	
CONTACT INFO: 200-6655-3226	*Rake score (1, 3, 5). 9 = algae, emergent or species observed but not sampled.*

VALAME
ELOCAN ~~POTGR~~

Point #	R/T	Latitude	Longitude	Depth	Species Codes: CHA	NITAS	UTRMAC	POTIL	MYRAQU	UTRMIN	NATMAR	NASFLE	SPEC Notes
004				21									
5				(9) 6									
6				21.5									
7				15.2	5								
8				5.5	5								
9				3.5	1			1			5		
10				2	1						1		
11				1.5	1						5		
12				4.5	3						1		
13				3.5	5								
14				21.5									
15				22									
16				3.5				3			1		
17				14.4	1								
18				16	3								
19				9	1			1			1		
20				6				3					
21				5.1	5								
22				1	5		1	1				1	
23				14.5	5								
24				21.5									
25				20.5									
26				12.5	5								
27				21.5									
28				1.5	3								
29				14	5								
30				13	5								

Other plant species observed at lake:

Appendix C
Tier II Plant Survey Waypoint Coordinates

Lattitude(deg)	Longitude (deg)	wpt.
41.574320	-84.999825	8-30-08,001
41.574207	-84.999292	8-30-08 002,
41.574179	-84.999078	8-30-08 003,
41.573783	-84.999025	8-30-08 004,
41.573916	-84.998330	8-30-08 005,
41.574328	-84.997950	8-30-08 006,
41.574471	-84.998605	8-30-08 007,
41.574530	-84.997880	8-30-08 008,
41.574269	-84.997307	8-30-08 009,
41.574443	-84.997174	8-30-08 010,
41.574244	-84.997010	8-30-08 011,
41.574372	-84.996670	8-30-08 012,
41.574110	-84.996487	8-30-08 013,
41.574179	-84.996218	8-30-08 014,
41.573807	-84.996244	8-30-08 015,
41.573543	-84.996565	8-30-08 016,
41.573611	-84.997088	8-30-08 017,
41.573953	-84.996879	8-30-08 018,
41.573364	-84.995890	8-30-08 019,
41.573221	-84.995268	8-30-08 020,
41.573389	-84.995093	8-30-08 021,
41.573800	-84.995389	8-30-08 022,
41.572821	-84.994979	8-30-08 023,
41.572911	-84.995529	8-30-08 024,
41.572562	-84.995021	8-30-08 025,
41.572318	-84.994785	8-30-08 026,
41.572599	-84.995527	8-30-08 027,
41.572781	-84.995825	8-30-08 028,
41.573190	-84.996433	8-30-08 029,
41.573274	-84.997828	8-30-08 030,

Lattitude(deg)	Longitude (deg)	wpt.
41.572719	-84.997164	T2 8-30-08 001
41.572774	-84.997632	T2 8-30-08 002,
41.572938	-84.997771	T2 8-30-08 003,
41.573245	-84.996956	T2 8-30-08 004,
41.572813	-84.996590	T2 8-30-08 005,
41.573945	-84.997678	T2 8-30-08 006,
41.573465	-84.998450	T2 8-30-08 007,
41.573097	-84.998216	T2 8-30-08 008,
41.572864	-84.998049	T2 8-30-08 009,
41.573285	-84.998891	T2 8-30-08 010,
41.573422	-84.999312	T2 8-30-08 011,
41.573821	-84.999576	T2 8-30-08 012,
41.574085	-84.999802	T2 8-30-08 013,
41.574206	-84.998381	T2 8-30-08 014,
41.573642	-84.997608	T2 8-30-08 015,
41.574034	-84.995967	T2 8-30-08 016,
41.573599	-84.995711	T2 8-30-08 017,
41.573231	-84.995662	T2 8-30-08 018,
41.572940	-84.996134	T2 8-30-08 019,
41.573109	-84.995058	T2 8-30-08 020,
41.572991	-84.994964	T2 8-30-08 021,
41.572700	-84.996250	T2 8-30-08 022,
41.572965	-84.997310	T2 8-30-08 023,
41.573600	-84.998004	T2 8-30-08 024,
41.573744	-84.998366	T2 8-30-08 025,
41.574357	-84.998919	T2 8-30-08 026,
41.573955	-84.998066	T2 8-30-08 027,
41.573553	-84.995085	T2 8-30-08 028,
41.573820	-84.995974	T2 8-30-08 029,
41.572947	-84.996423	T2 8-30-08 030,

Appendix D
Flow Rate Raw Data Sheet 11/23/08

Tributary /site/waypoint name: MESERVE OUTLET STREAM

Date: 11/23/08

Description: DOWNSTREAM END OF FIRST PIPE

Aquatic Enhancement & Survey, Inc. Angola, Indiana

Depth measurement interval:

Field measurement:

	distance fm s	depth inches	velocity	Lab Result	
Tributary Width in inches 7'					
Tributary Depth in Inches Point 1	0	0	0		
Tributary Depth in Inches Point 2	1	14 cm	0		
Tributary Depth in Inches Point 3	2	45 cm	.24 FPS		
Tributary Depth in Inches Point 4	3	50 cm	3 FT IN 16 SEC.		
Tributary Depth in Inches Point 5	4	39 cm	3 FT IN 21 SEC.		
Tributary Depth in Inches Point 6	5	29 cm	3 FT IN 35 SEC.		
Tributary Depth in Inches Point 7	6	16 cm	0		
Tributary Depth in Inches Point 8					
Tributary Depth in Inches Point 9					
Tributary Depth in Inches Point 10					
Tributary Depth in Inches Point 11					
Tributary Depth in Inches Point 12					
Tributary Depth in Inches Point 13					
Tributary Depth in Inches Point 14					
Tributary Depth in Inches Point 15					
Tributary Depth in Inches Point 16					
Tributary Depth in Inches Point 17					
Tributary Depth in Inches Point 18					
Tributary Depth in Inches Point 19			Mean Tributary Depth	#DIV/0!	inches
Tributary Depth in Inches Point 20			CFM	#DIV/0!	
Tributary Depth in Inches Point 21					
Tributary Depth in Inches Point 22			pH		
Tributary Depth in Inches Point 23			D.O.		ppm
Tributary Depth in Inches Point 24			Temp.		Deg C
Tributary Depth in Inches Point 25			Specific Conductance		
Tributary Depth in Inches Point 26					
Tributary Depth in Inches Point 27					
Tributary Depth in Inches Point 28					
Tributary Depth in Inches Point 29					
Tributary Depth in Inches Point 30					
25 feet in how many seconds		15.06	E-coli (CFU/ml)		
three feet in how many seconds		1.81			
Total Phosphorus (ppm)		0.0299	Total Phosphorus Loading Kg/dy	#DIV/0!	
Nitrates (ppm)		0.73	Total Nitrate Loading Kg/dy	#DIV/0!	
TSS (mg/l)		0.80	Tss Loading Kg/dy	#DIV/0!	

Measuring Vessel
Marked Rope
Stopwatch
Plastic Bottle
Tape Measure
pH meter
D.O. meter

MEAN WIDTH = 7'
MEAN DEPTH = .90'
VEL. (.24)(.75) = .18 FPS

1.134 CFS
68.04 CFM