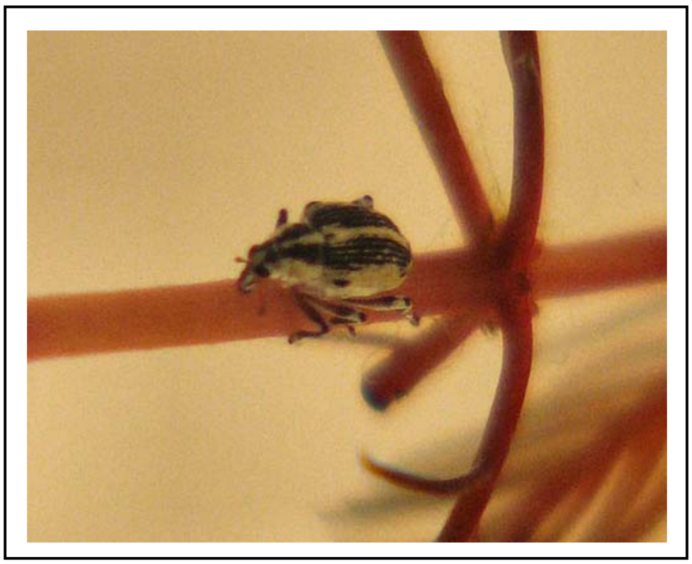
P O R T A G E C O U N T Y

EURASIAN WATER MILFOIL ASSESSMENT

Springville Pond
Thomas Lake
Lake Joanis

Summary: 2003 - 2006



Milfoil Weevil on a Eurasian Water Milfoil stem
Photo: Paul Skawinski

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Golden Sands
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See Appendices for how YOU can help stop the spread of invasives or help your milfoil weevils!

December, 2006

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I. INTRODUCTION

Eurasian water milfoil (EWM) (*Myriophyllum spicatum*) is an exotic aquatic plant that has been gaining notoriety across the United States for its aggressively invasive nature. Native to the Eurasian continent, it has been inadvertently introduced to water bodies across the U.S. by boaters, recreationalists, and various aquatic industries. Once introduced, EWM, a champion of reproductive ingenuity, spreads rapidly via stolons or fragmentation. The submersed aquatic plant goes through two flowering periods each summer, after which, it fragments into many pieces. Each fragment may sprout roots and can remain afloat and stay viable for several weeks until it drifts to a suitable site, where it can become another plant. A perennial, the plant may wait out the winter under the ice, intact, and will be growing and well established by April or May, much sooner than native aquatics. It will grow rapidly, reach the water surface and then spread into a dense, tangled mat, shading out the sunlight the other plants need. This dense mat also increases fluctuations in dissolved oxygen content, carbon dioxide content, pH level, and temperature stratification, while also inhibiting water circulation. EWM aggressively out-competes the native aquatic plants, which results in a rapid decrease in the diversity of the lake's plant community. This in turn decreases the diversity of the insect and fish populations. Dense growth of EWM can impede predator-prey relationships between fish, stunting the growth of the larger fishes as it reduces their ability to see prey. The tangled mats at the water surface can become dense enough to strand boaters, become a safety hazard for swimmers, and create a stagnant breeding ground for mosquitoes (Jester 1998).

EWM Reports in Portage Co.

Confirmed - Present:
1. Lake Emily[1]
2. Lake Joanis[2]
3. McDill Pond[1]
4. Lake Pacawa
5. Springville Pond[1]
6. Thomas Lake[1]

([1] control plan being implemented)
([2] control plan under development)

Confirmed - Not Present:
(should be watched)
1. Bear Lake[3]
2. Jordan Pond

([3] monitoring plan in place)

The cumulative effect of EWM impacts creates a chain reaction of changes in the lake's ecology, decreasing the recreational value, sporting value, and aesthetic value of the water body, which may in turn result in decreased property values (Jester 1998). A study in Minnesota found water clarity directly affects lakefront property values, and a study in Maine found that a noticeable gain in water quality could bring about $25 million in additional spending into the state (Meersman 2003 and "The Economics").

Therefore, there is a strategic, monetary benefit to understanding a lake or pond's ecosystem and preventing and/or controlling an EWM infestation. Various types of treatments are available, depending on the extent and density of the infestation, including manual removal, bottom barriers, mechanical removal/harvesting, winter water level drawdowns, herbicides, and biological control. Choosing the best treatment option is also dependant on the individual qualities of the particular water body, economic feasibility, and the restrictions/allowances of local and state ordinances.

Making the connection…

When new cases of EWM are reported, there is currently no well-defined response program. Sometimes the Wisconsin Department of Natural Resources (WDNR) has the personnel and budget to conduct an assessment, sometimes not. Sometimes there is an active lake association to implement a control plan, sometimes not. Some connection between the local level and state level is needed.

In the summer of 2003, EWM was recorded at 8 of the 29 Portage County lakes that were part of a study being conducted by Portage County and the University of Wisconsin-Stevens Point. It was determined that additional information and management plans for EWM were needed for those lakes. The Portage County EWM Study was initiated by the Portage County Land Conservation Division (LCD) of the Planning and Zoning Department to collect that information.

The Portage County EWM Studies did not seek to take on the task of EWM control at the county level, but rather to investigate the problem, devise well-informed recommendations tailored to each lake, and then to **provide the information to the appropriate lake management units** and collaborate with them on implementation details. This approach of information gathering, dissemination, and networking seems to be the best role the county can play in EWM control.

What's been done…

In October of 2003, field mapping of EWM was completed for four lakes using GPS equipment. In 2004, the remaining two lakes with known EWM infestations were mapped, and milfoil weevil (*Euhrychiopsis lecontei*) population surveys were conducted on four lakes that were candidates for biological control. In 2005, assistance was given to lake management units wishing to implement the recommendations developed by this study. Additional EWM mapping and weevil surveys were done, as well as a milfoil weevil rearing trial on Thomas Lake.

Complete summary of study findings (2003 to 2005) and treatment recommendations for all eight subject lakes was provided in the December 2005 report "Portage County Eurasian Water Milfoil Assessment: 2003-2005", available in hardcopy or electronic format from the Portage County LCD. (See Appendix C for contact information.)

This report summarizes the results of the 2006 studies, and includes all background information on only the three subject lakes (Springville Pond, Thomas Lake, and Lake Joanis). It does NOT include any study results for lakes not included in the 2006 studies. For study results on those lakes, please refer to the report referred to in the paragraph above.

Protect your favorite lake… There is too much for a county or any one governmental unit to do alone. Any citizen can learn about exotic species, help control the spread of those species, express their interest in control to local government units and be an advocate for their favorite lake.

The 'Clean Boats, Clean Waters' volunteer program is just one way you can take action to protect your favorite lake. For more information about the 'Clean Boats, Clean Waters' volunteer boat inspection program, contact the Volunteer Monitoring Coordinator, Laura Felda-Marquardt, at (715) 346-3366, or visit the UW-Extension Lakes Program website at http://www.uwsp.edu/cnr/uwexlakes/CBCW/default.asp .

"Volunteers Prevent Exotic Invader From Entering Crescent Lake"

In their first summer of operation, volunteer boat inspectors with the Crescent Lake Association stopped four boats with EWM, curly pondweed and zebra mussels from entering their lake. Not only did they protect their lake, they also taught numerous boaters how to check their boats for "hitch hiking" invasives. (WAL 2004)

II. METHODS

This project was initiated and facilitated by Steve Bradley, the County Conservationist of Portage County. Project coordination and report preparation was completed by Amy Thorstenson, Golden Sands Resource Conservation & Development (RC&D) Council, Inc. All fieldwork was performed or overseen by Amy Thorstenson, with the help of various field assistants. (See Appendix C for contact information.)

All vegetation surveys were planned with the technical guidance of WDNR personnel. Multiple personnel were contacted regarding various issues, but the main contact person was the WDNR regional Aquatic Plant Specialist, Deborah Konkel. Milfoil weevil surveys and rearing trials were planned with technical guidance from Dr. Ray Newman, University of Minnesota, and personnel from the Vermont Department of Environmental Conservation.

All EWM treatment recommendations for each lake were developed with, reviewed by and approved by Deborah Konkel (WDNR). (See Appendix C for contact information.) Survey plans and treatment recommendations were also developed with the technical guidance of Nancy Turyk, Water Resources Scientist with the Center for Watershed Sciences and Education at the University of Wisconsin-Stevens Point (UWSP).

a. Background Data Collection

Background lake data was gathered for each lake from multiple sources, including records maintained by WDNR, the UWSP Robert W. Freckmann Herbarium and the Portage County Lake Study, conducted by the UWSP and Portage County.

b. EWM Mapping Surveys

All EWM surveys, 2003 – 2006, on Lake Joanis, Springville Pond, and Thomas Lake were conducted from a canoe. In the case of Springville Pond where the waterbody is shallow enough for EWM to grow at any given point, observers paddled slowly, navigating back and forth across the waterbody until the entire waterbody had been visually searched. In 2006, Springville Pond was surveyed using a Point Intercept method used by WDNR. (These methods will be detailed in following paragraphs.) On Thomas Lake and Lake Joanis, the depth at the centers of these lakes precludes EWM from growing anywhere but around the lakeshore. In this situation, observers circled the shoreline slowly while visually searching for EWM. Thomas Lake was surveyed in 2004 and 2005, but due to problems with water clarity and time limitations, no survey was done in 2006 and, therefore, no new map was created.

During visual searches, wherever EWM was found, GPS coordinates were recorded to sub-meter accuracy with a Trimble Pro XR GPS unit. If it was a single plant or a very small colony of plants, a point feature was used to log the location. If the EWM colony was large enough to be recorded accurately as an area feature, the outline of the colony was traced, or corner points were recorded, to map the area feature. The mapping features were then overlain on aerial photographs to create GIS maps of EWM locations. If depth contours were available, contour lines were also overlain onto the aerial photographs.

Voucher specimens of EWM and northern water milfoil (*Myriophyllum sibiricum*) were collected randomly, bagged in water and kept refrigerated. These were later pressed, mounted and the species identification verified by Dr. Robert Freckmann, professor emeritus, UWSP. The mounted specimens are retained at the Robert W. Freckmann Herbarium at UWSP.

In 2006, the Point Intercept method was used on Springville Pond because of the extent of the EWM infestation making the visual search mapping method impractical. A sample grid was laid over the pond using GIS, placing a total of 87 sample points at 30-meter intervals. These sample points were navigated to in the field using a Trimble Pro XR GPS unit, and at each sample point a double-headed metal thatching rake was dropped straight down, then pulled straight back up. The plants snared with the rake were identified and "rake fullness" for each species was ranked, 1 through 3. A rating of "1" indicated few plants present on the rake head, "2" indicated the rake head about ½ full, and "3" indicated the rake was overflowing. If nothing was found, the entry was left blank. These rankings were then plotted on the map and used to interpolate boundaries of EWM beds of "sparse" ("1"), "dense" ("2") and "very dense" ("3") rankings. If a plant species was observed within 6-feet of the boat but did not appear on the sample rake, it was noted as "observed", but not included in the rankings. (See maps in Appendix E.)

Voucher specimens of plants sampled were collected, bagged in water, and kept refrigerated. These were later pressed, mounted, and the species identification declared and/or verified by Dr. Robert Freckmann, professor emeritus, UWSP. The mounted specimens are retained at the Robert W. Freckmann Herbarium on the UWSP campus.

c. Weevil Surveys

Milfoil weevil survey methodology was modeled after the 1996-97 study completed by Laura Jester, in cooperation with the WDNR, as detailed in her 1998 report *"The Geographic Distribution of the Aquatic Milfoil Weevil (Euhrychiopsis lecontei) and Factors Influencing its Density in Wisconsin Lakes"*.

Four representative EWM beds were selected for each lake. In Springville Pond, where four individual beds were not available in 2004, the largest bed was divided into two equal halves. In 2005 and 2006, four separate beds were available. In addition to the annual weevil population density survey, in 2006, Springville Pond was surveyed monthly for weevils in order to investigate factors that may be affecting the weevil population on the pond.

In Thomas Lake, where EWM grows in a complete ring around the lake, samples were randomly collected all the way around the lake, from all depth zones. In 2004, samples from the west half of the lake were kept separate from those from the east half, for comparison purposes. In 2005 and 2006, samples from the North, East, South and West quadrants of the lake were kept separate for comparison purposes.

Because the weevil, (*Euhrychiopsis lecontei*) lives within the top 20 inches of EWM stems, only the top 20-inches of the stem was retained for examination. The Jester report stated that 120 samples had been collected for each lake, but in conversations with Jester, she stated that the study had found statistical confidence at about half that number. (Jester 2003, *pers. comm.*) Therefore, in 2004, 2005, and most of the surveys from 2006, only 60 stem samples per lake (15 per sample bed or quadrant) were collected. At the end of 2006, because bed sizes were quite large, 120 stem samples per lake were collected to ensure statistical confidence.

Initially, the attempt was to collect samples from each bed along three transects extending perpendicular to shore, by snorkeling alongside the canoe and grabbing one plant stem at five roughly equidistant points along the transect, for a total of 60 stems per lake. (4 beds x 3 transects x 5 sample points) Reality proved that snorkeling through thick EWM beds was very difficult. Staying on a perfectly straight transect line at the same time was impossible.

Thus, the secondary method given in the Jester report (reaching for stems from the canoe) quickly became the preferred method. Additionally, it was decided that maintaining strict transects was not necessary for the purposes of this study, and stem samples were collected by meandering around in the EWM beds and collecting samples from all areas of the bed and across all depths within the bed. Field personnel were conscientious to refrain from visually scanning the stems before picking them, which would have introduced sampling bias. Where EWM was not close to the surface, a long-handled, steel, thatching rake was dropped overboard to snag some stems. The first intact, 20-inch long stem to be randomly selected and untangled from the rake was retained as the sample stem.

Water depth range (deepest and shallowest points) within each sample bed was recorded. Stem samples were stored with water in labeled plastic bags, kept cool in covered buckets of water while in the field and later kept refrigerated at approximately 3 to 4°C until they were examined. Any samples that could not be processed within approximately eight days of collection were preserved with ethyl alcohol or isopropyl alcohol to retain the integrity of the sample.

Extracted weevil adults preserved in a sample vial.

Samples were examined under magnification by floating them in shallow water in a clear, glass pan over a light table. All weevils of all life stages found were preserved in a labeled glass vial. Weevils found in the stem were carefully extracted with dissecting equipment so they could still be identifiable. Because RC&D personnel lacked experience in identification of *E. lecontei* in 2004, all 2004 weevil specimens were mailed to Laura Jester, of Jester Consulting in Eden Prairie, Minnesota, for species identification confirmation. The 2005 weevil specimens were examined for identification confirmation by Amy Thorstenson, the 2003-2006 project leader for RC&D. A sample of questioned 2006 specimens were sent to Dr. Ray Newman, University of Minnesota, for confirmation/determination.

d. Weevil Rearing (2005)

Weevil rearing methods in 2005 were modeled after the Vermont Department of Environmental Conservation (DEC) methods outlined in the 1995 report to the U.S. Environmental Protection Agency entitled *Field Collection, Laboratory Rearing and In-lake Introductions of Herbivorous Aquatic Weevil,* Euhrychiopsis lecontei*, in Vermont,* by Hanson, et al. Modifications to the 2005 rearing methods were made for the 2006 project, and are detailed on page 11.

The UWSP College of Natural Resources (CNR) greenhouse served as the main rearing station. An automated system in the greenhouse monitored and adjusted light intensity and temperature to maintain a temperate summer climate. A total of 40 ten-gallon glass aquaria were set-up on tables and 70 white five-gallon buckets were arranged beneath the aquaria tables. An activated carbon filter was used to filter chlorine from the water supply. A hose attached to the filter was used to fill the tanks and buckets.

A canoe was used to collect weevils from Lake Thomas. Field personnel looked for blackened, damaged milfoil stems (of either species) from the canoe. When a damaged stem was found, field personnel collected the top segment of the stem, optimally 20-inches but minimally 15-inches. Stems with flowers were not to be collected, as *E. lecontei* adults will not utilize flowering tips to lay eggs. Visual assessments of the damaged stems were then conducted to determine whether the stems actually contained weevil larvae. Damaged meristems, pinholes, or tunneling are indicators of weevil larvae. Occasionally, larvae or adults were directly observed and included in the collection. Damaged stems thought to hold weevil larvae were carefully placed into plastic bags with lake water, 15 damaged stems per bag. The bags were kept cool in five-gallon buckets of lake water then transported back to the greenhouse in the buckets. A matching number of healthy stems were also collected and placed into a five-gallon bucket of lake water.

At the greenhouse, the tanks/buckets to be used that day were filled with filtered water. The zip-lock bags holding our collected stems were then placed into the tank/buckets to allow the weevils to acclimate. When the stems were considered acclimated they were arranged in clear, glass cake pans and examined over light tables with 3x magnification goggles. Each stem was carefully examined for weevil larvae, adults, and eggs. Adults were usually easy to spot clinging to stems or leaves. Meristems were examined for eggs. This required lifting back the outer layers of the meristem as well as looking down upon the anterior end of the meristem.

Determining whether a stem contained weevil larvae was somewhat subjective. Often, larvae were easily visible in the translucent stems that were still in fair condition. However, the more deteriorated stems were darkened and opaque, making visual detection of larvae more difficult. Tunneling and pinholes indicate weevil larvae activity, but if this damage was present from one end of the stem to the other end the larvae was determined to have likely tunneled completely through the portion of stem collected and moved on to a new stem. Sometimes, with a thoroughly collapsed stem, light tapping with a dissecting probe could detect resistance in a segment of appropriate size and shape as would indicate a weevil larvae. With some experience, these larvae could be added to the tally with good confidence. Also, damaged meristems indicate activity of early instars of the weevil larvae, but due to their relatively small size and our reluctance to disturb them by fully dissecting the meristem, there is some error in confirming the presence of an early instar of the weevil larvae.

The healthy stems collected were also examined for larvae, adults, and eggs to assure an undocumented input of weevils did not occur. Any other insects were removed from stems, healthy or weevil-containing, to avoid the introduction of predator or competitor insects.

Weevils were not removed from their stems. Stems that held larvae, adults, or eggs were placed into aquaria or buckets. The number of weevils per life-stage introduced into each tank/bucket was recorded along with the tank/bucket I.D. number. Initially, each 10-gallon aquarium received up to **15** weevils (larvae, adults, or eggs), but experimentation revealed that approximately 6 to 8 weevils per tank produced higher reproduction rates. Therefore, for the remainder of the project, each aquarium received about **7** weevils (larvae, adults, or eggs). Each five-gallon bucket received about 5 weevils.

Initially, healthy stems were added to each 10-gallon tank to achieve a total of **15** stems per tank; however, experimentation found that more healthy stems seemed necessary to obtain higher production. Therefore, for the remainder of the project, even though fewer weevil-containing stems were added to the tanks, enough healthy stems were added to achieve a total of about 20 stems per tank. For each 5-gallon bucket, enough healthy stems were added to achieve a total of about 12 stems per bucket. All stems were then attached at the base to a rock with a rubber-band to achieve the correct vertical orientation.

Initially, the weevils were left in the tanks/buckets for about 13 days to reproduce. However, low reproductive rates initiated a review of protocol, in comparison to the Vermont DEC methods. Review found that our methods differed, in that they were starting with all adult-stage weevils, but we were starting with a combination of juvenile and adult weevils. Therefore, for the remainder of the project, the weevils were left in the tanks/buckets for about 20 days to reproduce.

Tanks and buckets were monitored to assure water levels were adequate. Once the reproduction interval was complete, all stems were removed from the tanks/buckets and examined. Stems were arranged in clear, glass, 9"x13" pans and examined over a light table using 3x magnification goggles. The number of weevils per life-stage extracted from each tank/bucket along with the tank/bucket I.D. number was recorded. Before cleaning the tank/buckets, the water was examined for loose adults and larvae, which were included in the tally, when found.

The weevil-containing stems removed from the tanks/buckets were then placed into zip-lock bags filled with tank/bucket water. To keep the bags cool during transportation to the lake, they were placed into a five-gallon bucket that was half-filled with fresh water.

Release of the weevils occurred at a single, pre-determined, marked release point in a milfoil bed on the southern shore of Lake Thomas. The bed was comprised exclusively of Eurasian water milfoil, which is the species preferred by *E. lecontei*.

Release was done from a canoe or by wading out to the release site. The weevil-containing stems were placed into dense mats of milfoil and intertwined with healthy, rooted milfoil to assure that the weevil larvae could easily crawl onto healthy milfoil.

This process was repeated, in rotation, from the first stem collection on June 14th until the last weevil release on August 23rd. No further rearing was done after this date, as newly released weevils would need time to acclimate and prepare for hibernation.

e. Weevil Rearing (2006)

Modifications to the 2005 rearing methods were as follows:

- No buckets were used as rearing tanks due to poor results in 2005 trials

- 120 transparent, 10-gallon, glass aquaria were used per lake (240 total)

- One, 100-gallon fiberglass tub used experimentally

- Most aquaria located in the CNR greenhouse, but two new rearing locations were initially tried:
  - Control room, where temperatures were maintained at optimum for weevil reproduction (approximately 84°F), with artificial lighting
  - Laboratory, with artificial lighting

- Netting used on all tanks to prevent weevil escape (See details in Section III.)

- 21-day hold time for “mixed stage” tanks / a 13-day hold time for “adults only” tanks
  - Some tanks received only adult weevils. These were limited to approximately 13-day hold times, as was found to be optimum by the Vermont DEC.
  - Tanks that had weevils of mixed life stages received a 21-day hold time, as was found to be a likely optimum during the 2005 biological control project.

- Weevils were “reused”
  - After hold-times expired, weevils produced were counted, then divided up to fill new tanks.
  - When possible, adults were sorted into “adult only “ tanks, to maintain the 13-day hold time optimum for adults.

- All tanks stocked with 15 healthy EWM stems
  - Regardless of the number of weevil-bearing stems stocked to a tank, all tanks received 15 healthy stems. With this method, field personnel were able to quickly prepare identical bundles of healthy stems and distribute to each tank filled that day. (All tanks were segregated by lake and received only EWM stems originating from that lake.)

- Rearing weevils for two lakes
  - Prevented genetic mixing by keeping all EWM stem samples and milfoil weevils separated by lake of origin

- Weevils were stocked to their lake of origin

➢ Stocked 7 to 8 weevils per 10-gal tank, as per optimum determined by 2005 results

f. Freeboard Measurements

The distance from the water surface to the top of the EWM, or "freeboard", was measured by cruising each sample bed and randomly taking a minimum of six measurements. Field personnel criss-crossed the entire sample bed, randomly stopping to take measurements, taking care to avoid sampling bias by attempting to control where they were stopped. Freeboard measurements were always taken with the same measuring stick, which was held fast against a marked point on the canoe, and measured the distance from the surface of the water to the first EWM stem the stick touched. If the stick did not reach to the EWM stems below, it was recorded as "greater than 36-inches".

Measuring freeboard at Thomas Lake.

g. Temperature Measurements

Water temperatures were taken at the same time as freeboard measurements, always with the same Penn Plax thermometer. The thermometer was held perpendicularly in the water, deep enough to submerge the green marking, which resulted in a measurement of the temperature approximately 2½-inches below the water surface. The thermometer was held for at least five seconds, or until the temperature stopped changing.

III. EVALUATION OF WEEVIL REARING METHODS

h. Production Results & Costs

Note: Unusual, "wart-like" pupal casings were observed during the weevil collections on Springville Pond. (See photos and further discussion in Section V.g.) Upon examination, weevil pupae were found to be housed in these casings. Although they appeared to be *Euhrychiopsis lecontei* pupae, *E. lecontei* usually develop in the center of the stem, and do not create a "wart" protruding out of the side of the stem. The EWM stems appeared to be unusually skinny, however, which was suspected to be a possible cause for the protruding casings. For species identification confirmation, samples of these "warts" and the pupae within were sent to Dr. Ray Newman, University of Minnesota. The species was determined to be *Phytobius*, a native insect of nearly identical appearance to *E. lecontei*, but with different feeding behavior. (Newman 2006, *pers. comm.*) Delayed confirmation resulted in an unknown number of Phytobius specimens being included in the rearing tanks for Springville Pond. **Due to the findings of Dr. Newman, please note that when referring to Springville Pond in Section III and Section V.g., the term "weevils" may include both *E. lecontei* and *Phytobius*, unless otherwise specified.**

Table 1. Total Production Results

	Overall	Springville Pond		Thomas Lake	
Total Tanks Filled		178, +tub[1]		109	
Total Input (Weevils Collected)	2176	1397		779	
Total Output (Weevils Released)	5078	2616		2462	
Net Increase	2902	1219		1683	
Percent Increase		187%		316%	
Average Return Rate[2]	2.40	1.88		3.23	
Total Dollars Input[3]	$8,973				
Cost per Weevil (Net Increase)	$3.09				

[1] *A 100-gallon tub was used experimentally for rearing.*
[2] *Return rate = number produced divided by number started with.*
[3] *Includes only weevil rearing costs. Excludes EWM mapping, weevil population survey time, freeboard and temperature survey time, and the one-time cost of aquarium purchases.*

Overall 2006 production cost an estimated $3.09 per weevil (net increase). This was largely due to the initial complications of lighting problems, contamination, and infestations resulting in severely reduced production. (See Section III.b. for an elaboration on these factors.) An analysis of cost per weevil where these complications were avoided will follow in Section III.b.

When examining the most cost-effective method, it appears that the 100-gallon tub may have proven the most practical. The tub was placed in a sunny location outside the CNR building, initially stocked with 90 weevils, and left largely unattended for the remainder of the summer. The tub was covered with netting to prevent predation or weevil escapes. On occasion, the tub's condition was checked, netting adjusted, water added when levels were low, and fresh EWM stems were added to provide enough food. Mid-summer, a portion of the stems were removed and 41 weevils were counted and used to stock other tanks.

In all, the tub produced 321 weevils, for a return rate of 3.57… with almost no person-hours required! Estimated cost using the 100-gallon tub was **$1.18 to $1.57 per weevil (net increase)**, based on 30-40 total staff-hours at $8.25/hr (plus fringe) for initial stocking, intermediate maintenance, and final removal/examination. However, production would likely be improved, and cost per weevil reduced, if initial stocking of the tub was at the optimum of 7 to 8 weevils per 10-gallons of water. This is an idea worth exploring.

Market purchase from EnviroScience, Inc. costs approximately $1.20 per weevil at the time of this reporting. If WDNR requires the use of native weevils, the net increase in weevils stocked goes down slightly and the cost then becomes approximately $1.33 per weevil (net increase). Pre- and post-surveys may be included at an additional cost.

The tub method does show simplicity, low risk of investment, and the potential to be cost-competitive with market purchase. The major drawback with any method of weevil rearing, however, is that it takes all summer to produce the weevils for stocking. This means that there MUST be good over-wintering habitat available for the weevils to survive well and emerge in strong numbers the next year to do their work, and that the impacts of the added weevils may not be seen, to any significant degree, until the following seasons when the population has time to build up. This may be too slow for lake residents or the public. Also, fall and spring migration to and from shore increases the likelihood that the weevils may migrate to an EWM bed other than the intended release site.

In contrast, purchased weevils are usually contracted to be added early in the season (mid- to late-June), so impacts may start to be visible within the season, although it cannot be guaranteed. (In order for the investment to be long term, of course, over-wintering habitat is still an important factor.) Stocking early in the season also increases the chances that the weevils will feed and reproduce in or near the desired location (release site) throughout the season and would not be likely to disperse until fall and spring migration times.

i. Factors Affecting Production Results

1. Aphid Infestations

Multiple factors were found to impact production rates, some to a minor degree and others quite remarkably. One unexpected factor encountered was a tiny insect, nearly the size of the milfoil weevil. These insects were determined to be a semi-aquatic aphid, *Aphis aquaticus*, in the aphid family (*Aphididae*), and proved to be quite problematic in the rearing tanks.

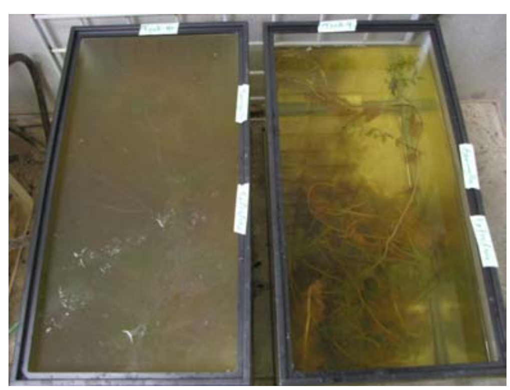
They appeared mostly on the Springville Pond stem samples, and efforts were made to remove them during stem inspections. However, if any were missed and ended up in tanks, they reproduced abundantly. Tanks where these infestations were discovered proved to have abysmal weevil production, with an average return rate (number produced divided by number started with) of 0.72, meaning that fewer weevils came out of the tanks than went in!

It is yet undetermined what problems the aphids caused in the tanks. They may have been smothering, or even predating on the weevil eggs, larvae, adults, or all three. One adult weevil was found with clusters of aphids covering it, and when the aphids were removed it was alive and moving. Therefore, it was placed into an uninfested tank.

Another possibility is that the aphids were merely in competition with the weevils for habitat. Aphids were often found clustered in great numbers at the apical meristems of the EWM stems, which is the location weevils use for laying eggs.

2. Poor, Artificial Lighting

Because space was an issue, at the start of the project, many tanks were set up in the laboratory and control room, with the assumption that enough artificial lighting could be provided to keep the EWM stems healthy for the short 21-day hold time. The intent in using the control room was also to keep the tanks at the temperature where weevil production is highest (around 84° F).



Control room tank with thick film at left. Note EWM stems are brown even in tank at right with only a minor film.

Unfortunately, the control room tanks developed a peculiar film on the surface, which occluded good light penetration. The film was examined under a microscope and appeared to be microorganisms. The tanks in the laboratory, the outdoor tub, and the greenhouse tanks did not develop this film. It was feared that the control room had some unknown contamination and the tanks were removed.

The larger issue, however, appeared to be inadequate lighting, since even EWM stems in tanks with only a minor film on the surface turned brown from lack of light, as did stems in tanks in the laboratory. The laboratory and control room tanks showed an average return rate of 0.61. Even the four best-lit tanks showed an average return of 1.21, which showed that the use of indoor space needed to be immediately discontinued.

These problems had delayed the project by nearly a month, and total weevil production would have been miserably low unless as many tanks as possible were kept full and producing weevils. The CNR greenhouse was already full of tanks, so a second greenhouse was sought. The greenhouse at the Stevens Point Area Senior High (SPASH), which is normally unused during the summer months, was found to be an ideal space and conveniently close to the rest of the project operations. The SPASH greenhouse housed approximately half the tanks used.

In addition to seeking the additional space, rearing continued until mid-September to attempt to make-up for the lost production. Although the greenhouse tanks produced well, total production was still below target. (Table 2)

Table 2. Greenhouse Production Results

	Overall	Springville Pond		Thomas Lake	
Net Increase		1122		1683	
Average Return Rate[1]	2.68[1]	2.29[1]		3.23	

[1]*Data **includes** aphid-infested tanks, which had much lower than average return rates. (Note: There were no aphid infestations in Thomas Lake tanks.)*

With an average return rate of 2.68 in the greenhouse, one could estimate that if total production had been done in a greenhouse, total net production from the 2176 weevils initially collected would have been 5831, for a net increase of 3655 weevils. Total cost per weevil would have been $2.45. Note that if aphid infestations are avoided and netting is used, this production rate could increase and effectively reduce the cost per weevil.

3. Net vs. No Net

E. lecontei is reported to not have developed flight muscles until fall. (Newman 2006, *pers. comm.*) However, some species of *Phytobius* are reported to drop from stems or fly away when disturbed (G.R. Buckingham, 1998). This may explain why, during Springville Pond weevil collections, adult weevils were found to be "jumpy" during the month of June and early July. Weevils were seen jumping around on the bottom of the canoe or jumping around outside of sorting bins or tanks, having enough flight muscles to escape the bins/tanks but not necessarily enough to fly to a more desirable location.

Therefore, netting was used (on all tanks) to reduce escape attempts. The mesh size of this netting is unknown, but it is fine enough to exclude No-see-ums and is white in color, which would reflect some sunlight. The weevils seemed to be less "jumpy" later in the summer, but tanks were kept netted for the remainder of the project.

One concern with using the netting was that it may block too much sunlight, but EWM stems remained green and healthy with use of the netting, even during prolonged hold times. To evaluate the possible effect of the netting acting as a shade cloth, recorded temperatures were examined.

Tanks appeared to fluctuate slowly, seeming to hold warmth overnight and warm slowly during the day, usually not reaching extreme high air temperatures in the afternoon. Throughout the summer, greenhouse tanks usually measured in the high 70's in the morning and low- to mid-80's in the afternoon. However, on a sunny day when greenhouse air temperature reached 95°F, tanks were measured to reach 89°F by 4:00 pm. Optimum temperature for weevil development is approximately 29°C (84.2°F), but development begins to decline with sustained temperatures of around 31°C (87.8°F). (Mazzei, et al. 1999.) Netting was found to produce only slightly lower tank temperatures, making a 1° difference during morning measurements and a 2° difference during afternoon measurements. Therefore, netting appears to affect temperature, but only slightly.

Productivity appeared to be positively affected by the use of netting. Average return rate for netted tanks was 3.71, whereas non-netted tanks produced an average return rate of only 1.71. (To isolate the effect of netting, under otherwise favorable conditions, laboratory tanks (artificially lighted), aphid-infested tanks and tanks with non-optimum hold times were not included in these calculations.) If temperature was not significantly moderated by netting, then the positive correlation of netting must be due to reduction in escapes.

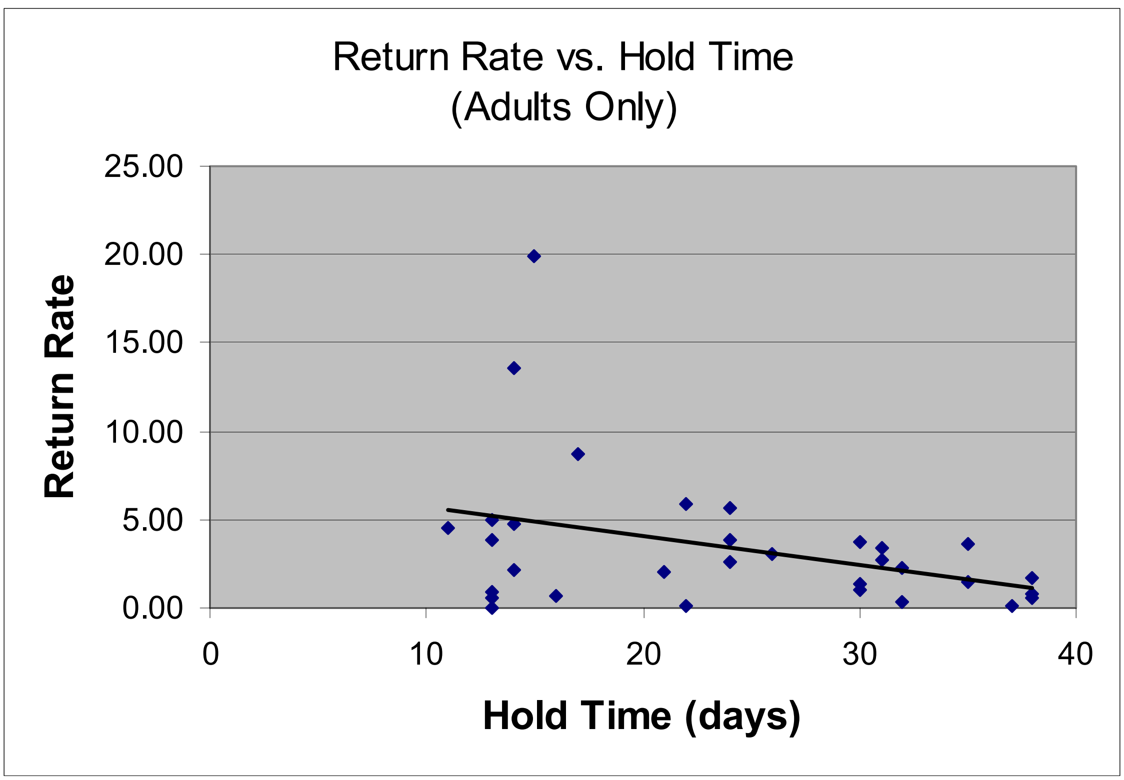
[Note that netting was not needed during the 2005 rearing project for Thomas Lake. (*Phytobius* is not known to occur in Thomas Lake.) Therefore, it may be possible that netting is not necessary when dealing only with *E. lecontei*.]

4. Exceeding Optimum Hold Times

Weevil rearing continued into September to attempt to get final production numbers up. Because field technicians were back in school and working only part time to get final weevil releases done, some tanks were not released on time. While this was not desirable, it did result in a range of hold time results to look at and examine the effect of excessive hold times on production rates. In other words, how long is too long?

Tanks that were stocked with only adults only showed an optimum hold time around 14-17 days. Results appeared to be good even up to a 25-day hold time, but drop off markedly with hold times longer than 25 days, probably due to deteriorating EWM stem (food) conditions. Although more data points would be desirable for making firm conclusions, these results are similar to the 1995 Vermont DEC report by Hanson, et al, where production rates were good at hold times between 11 and 21 days (21 days was their longest hold time), and highest production was seen at 13 days.

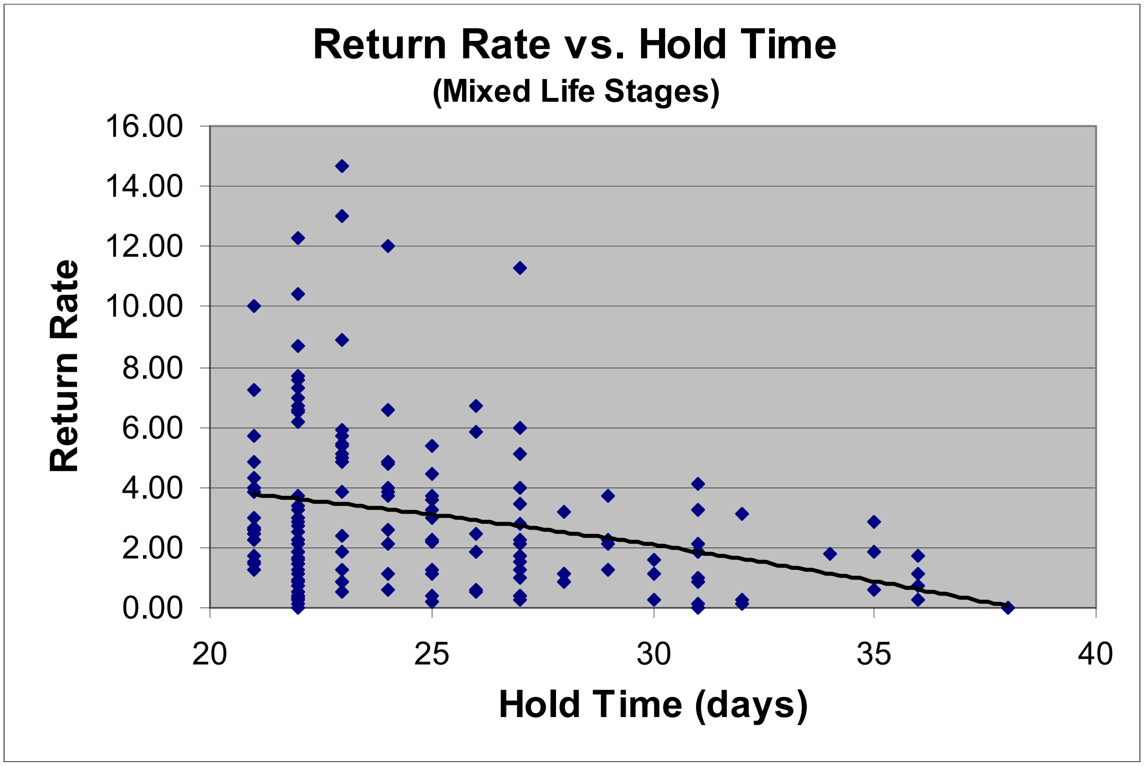
Chart 1. Return Rate vs. Hold Time (Adults Only)[1]



[1] To isolate the effect of hold time under otherwise favorable conditions, artificially lighted tanks (laboratory/control room tanks), aphid-infested tanks and un-netted tanks were excluded from this analysis.

In tanks where weevil life stages were mixed, production rates were good between 21 and 27 days, but began to decline with hold times beyond 27 days. Optimum hold time appears to be between 22 to 24 days.

Chart 2. Return Rate vs. Hold Time (Mixed Stages)[1]



[1] To isolate the effect of hold time under otherwise favorable conditions, artificially lighted tanks (laboratory/control room tanks), aphid-infested tanks and un-netted tanks were excluded from this analysis.

5. Stocking Mixed Stages vs. Adults Only

When comparing productivity of tanks stocked with only adults, to tanks stocked with mixed life stages, there does appear to be a notable difference. Adult tanks produced an average return rate of 3.47, compared to a 3.01 return rate for mixed stages. [Note: To isolate the effect of hold time under otherwise favorable conditions, artificially lighted tanks (laboratory/control room tanks), aphid-infested tanks and un-netted tanks were excluded from this analysis.] When only tanks of optimum hold times, plus or minus one day, are compared, the return rate for adult-only tanks is 5.46, compared to a return rate for mixed stages of 3.56.

It is worth noting that when the data for adult-only tanks is isolated to just these optimum factors, there are only 11 data points left, compared to 108 data points for the mixed stage tanks, but the trend does appear to hold that adult tanks tend to do better. This seems logical, since egg and larvae mortality is likely to be higher than adults, and adults stocked to a tank are likely to be ready to reproduce from day one of the hold time.

This would indicate that stocking of tanks should be done only with adult weevils. However, it is *far easier* to find and collect larvae in the field, since stem damage indicates their presence. Visually locating adult weevils is much more time consuming. One could easily make up for lower production from larvae-stocked tanks by stocking a few extra tanks with quickly-collected larvae-containing EWM stems. Ideally, one could then sort any adult weevils found in those samples into adult-only tanks, held to the optimum hold time for adults.

6. Fresh Stock vs. Reused Stock

To reduce labor, adults produced from tanks were "reused", or used to stock fresh tanks, rather than having to collect "fresh stock" from the lake. Mid-summer, it was decided that this would also be possible with larvae, if plenty of fresh EWM were stocked to the fresh tanks. It was unknown at the time how much this could affect production, but the savings in labor investment was viewed to be worth the risk.

Comparing final results, the return rates for tanks with "fresh stock" averaged 3.71, whereas the tanks with "reused stock" showed an average return rate of 3.74. [Note: To isolate the effect of recycling stock under otherwise favorable conditions, artificially lighted tanks (laboratory/control room tanks), aphid-infested tanks, and un-netted tanks were excluded from this analysis. Tanks with hold times more than one day under or over optimum were also excluded.] This negligible difference in return rate averages indicates that "reusing" weevils of any life stages can produce acceptable return rates. Taking into account the significant labor savings of using reused stock, this easily becomes the recommended method to use.

7. Mixing of *Phytobius* and *E. lecontei* (Springville Pond)

While mixing use of another species was completely unintended, having *Phytobius* and *E. lecontei* put into the same tank for reproduction would obviously impact return rates, since the two species are not likely to reproduce together. Even a tank comprised solely of *Phytobius* would likely exhibit a lower return rate, since data found on some *Phytobius* species reports they take a month to complete their life cycle. (G.R. Buckingham, 1998.) *E. lecontei* completes its life cycle in about half that time (16.6 days) at optimum temperatures (around 29°C, or 84.2°F). (Mazzei, et al., 1999.) Combine this with the more damaging feeding habits of *E. lecontei*, and these factors make *E. lecontei* appear to be the better choice for biological control of EWM.

j. Optimum Production – Summary and Recommendations

To summarize, factors that were found to negatively affect production were: artificial lighting, aphid infestations, excessive hold times, using mixed-stage weevils and not netting the tank/tub. In aquariums where all those problems were avoided, average return rate was approximately 3.71, providing an estimated cost of $1.52 per weevil (net increase).

Factors that were found to be huge labor savers were: recycling weevils, using mixed-stage weevils and using a 100-gal tub instead of individual tanks. The estimated cost of using the tub was approximately $270 to $360, based on approximately 30 to 40 staff-hours, resulting in a cost of $1.17 to $1.56 per weevil (net increase).

Based on these results, the most productive and cost-effective method may be the use of 100-gal tubs, netted, placed outdoors in full sun, with care taken to avoid the introduction of aphids or other predator/competitor insects. The tub used in the 2006 study was stocked over a period of a few days, and a total 90 weevils went in. This likely overstocked the tub and reduced productivity.

A suggested study would be to set up multiple 100-gal tubs for an entire summer. It is recommended that the tubs be initially stocked at various fractions of the optimal stocking range determined in the 2005 study (approximately 7 weevils per 10-gallon tank). For example, one tub could be started at 70 weevils, and additional tubs started at ½ and ¼ of those levels. Tubs would require regular addition of fresh, healthy EWM to feed the weevils throughout the summer. This experiment would help determine what stocking levels avoid overcrowding through the summer, and what the production potential of the tub method is.

While the tub method does show the potential to be cost-competitive with market purchase, it would take all summer to produce the weevils for stocking. Also, to have a notable effect on the EWM beds, large numbers of weevils would be needed. (A minimum of 3,000 is a suggested starting amount, but more is better.)

[Note: As per discussion in Section III.b.7., it is also recommended to use E. lecontei, and avoid use of *Phytobius* weevils, since *E. lecontei* has a shorter development cycle and more damaging feeding habits.]

IV. SPRINGVILLE POND

a. Lake Background

Springville Pond on USGS topographic map.

Located on the east side of Business 51 in the Village of Plover, Springville Pond is a small impoundment of the Little Plover River, a Class I trout stream. Total surface area of the pond is 18 acres and maximum depth is 12 feet. The water of Springville Pond mostly comes from the Little Plover River, with other contributions coming from runoff, groundwater, and precipitation. Much of the water exits the pond at the dam and some water seeps back to the groundwater. (UWSP and Portage County 2003) Because the majority of Springville Pond's water comes from the Little Plover River, the pond's watershed and the river's watershed are one and the same, with 90-95% of the water coming from groundwater (Weeks et al. 1965). The Springville Pond/Little Plover River watershed lies within the porous, sandy groundwater recharge area for some of the Village of Plover's municipal wells, and groundwater studies and protection efforts have been ongoing for decades. Extensive efforts have been made by many agencies to increase public education regarding groundwater protection.


Fall colors on Springville Pond.

The three dominant land uses (nearly equal) within the surface watershed are forest, agriculture, and residential. Perhaps of greater importance in the case of Springville Pond is the amount of development surrounding the pond. Land use within 1000 feet of the shoreline, which was dominated by open field and forest in 1960, is now primarily residential, parks, streets, and commercial land uses. (UWSP and Portage County 2003) This is a modestly recreated pond with low-impact resident usage (non-motorized watercraft) and one small public park. In the past, one trailerable boat landing existed at the public park, which was removed in recent years. Currently, there is a grassy landing for non-motorized, hand-carry watercrafts.

A lake is categorized as "eutrophic" when total phosphorus levels are 30 ppb or higher, which results in more aquatic plant growth and algae growth. Springville Pond is a eutrophic lake, with total phosphorus levels in 2002 around 34 ppb, although this level is much better than the state average for impoundments (70 ppb). (UWSP and Portage County 2003)

Water clarity in Springville Pond is considered good when compared with similar ponds in the region. Secchi depth (a measure of water clarity) in 2002 was best in August (8 feet) and poorest in September (5 feet). Fluctuations in water clarity are normal, due to increases and decreases of algae population and sedimentation. (UWSP and Portage County 2003)

b. History of Aquatic Plant Control in Springville Pond

Nuisance weed treatment and heavy sedimentation has been an ongoing problem in Springville Pond. Its very nature as an impoundment of the Little Plover River makes it the settling area for sediment and nutrients being carried by the river, including phosphorus, the nutrient most responsible for excessive plant and algae growth. WDNR Aquatic Plant Management Treatment Records show herbicide treatments for nuisance aquatic plant growth were used in the pond in 1967, 1991, 1992, 1993, 1994 and 1999. The list of chemicals used included Cutrine Plus; Diquat; Aquathol; Aquathol K; 2, 4-D; and X77 surfactant. Sediment dredging was done in 1983, 1985, and 1991. Drawdowns were done in 1985, 1988, 1991, 1996, and 1999. Mechanical harvesting was done in 1987. Planting of native aquatic vegetation was done in 1992 and 1993. (Lampert-Lee & Associates 1997 and WDNR records) Table 10 lists aquatic vegetation species documented in Springville Pond.

(Note: A drawdown *unrelated to plant control* was done in 2003 for dam repairs. According to personnel at the Village of Plover, no dredging or plant control work was done during this drawdown.)

The Little Plover River and Springville Pond Watershed Management Plan, written by Lampert-Lee & Associates in 1997, stated that while chemical treatments may have been the most effective method used in Springville Pond (no quantitative study was done to confirm this), the use of chemical treatments has drawbacks, such as toxicity to aquatic insects, residual by-products, unintended drift, and excessive plant decay causing oxygen depletion. Chemical treatments can also result in increased nutrient release and sediment enrichment, which can lead to algal blooms and excessive plant growth in following years. The plan suggested that good environmental practices in the watershed may help to reduce the nutrient loading that boosts nuisance plant growth, thereby reducing the need for chemical treatments. Also, the plan recommended against dredging, since exotics usually have an advantage over native species at repopulating bare substrates.

The watershed management plan and WDNR records show that herbicide treatments usually focused on the eastern third of the pond, which is shallowest and accumulates the most sediment and nutrients. A heavy population of EWM and an isolated bed of curly leaf pondweed (*Potamogeton crispus*, also an exotic invasive plant) persists there. Herbicide treatments also focused on one large, dense patch of EWM in the deeper water of the western end, which has been persistent throughout treatment efforts and was present in October 2003.

Table 3. List of Documented Aquatic Vegetation
(Submergent and Floating-Leaf Aquatics Only)

	Herbarium Records for Springville Pond *	
	Scientific Name	Common Name
1	*Ceratophyllum demersum*	Coontail
2	*Chara sp.*	Muskgrass
3	***Elodea Canadensis***	**Waterweed**
4	*Elodea nuttallii***	Slender waterweed
5	***Lemna minor***	**Small duckweed**
6	*Myriophyllum sibiricum*	Northern water milfoil
7	***Myriophyllum spicatum*** **(e)**	**Eurasian water milfoil**
8	***Potamogeton crispus*** **(e)**	**Curly leaf pondweed**
9	***Potamogeton pectinatus***	**Sago pondweed**
10	*Zannichellia palustris*	Horned pondweed

* Robert W. Freckmann Herbarium records through December 2006, University of Wisconsin-Stevens Point. (Note: These herbarium records are historical documentation of what has been identified to date at Springville Pond. *This is not an exclusive list.* Further, it cannot be stated with certainty that because a species has not been recorded at that lake recently that the species is no longer present in that lake. However, it has been well documented that as exotic invasives infest a lake, native vegetation is progressively less able to compete and the number of species (diversity) in the lake declines. Anecdotally, this is what has been seen at lakes in Portage County where EWM is present, however it would require quantitative vegetation surveys to confirm this.)

** Elodea nuttallii has not been documented at Springville Pond since 1974.

(e) Exotic invasive

Bolded species indicate those documented during 2006 aquatic plant surveys, described further in Section IV.g. (Note that Elodea Canadensis was only observed during the surveys, but was not recorded at a sample point.) Voucher specimens of plants collected at sample points have been submitted to the Robert W. Freckman Herbarium.

c. Mapping Results

Multiple areas of sparse to dense EWM growth were mapped during October 2003 field activities. Dense EWM growths totaled 2.1 acres and sparse growths totaled 0.7 acres. (See Figure 2.) The growths mapped were comparable in size and location to growths seen approximately six years prior.

EWM specimens were randomly collected to examine for evidence of the presence of the aquatic milfoil weevil, *Euhrychiopsis lecontei*. *E. lecontei* is a naturally occurring predator of native milfoils and may be able to keep milfoil populations in check. The weevil can effectively impact the health of the milfoil plants by removing vascular tissue and destroying apical growing tips. (Jester 1998) Examination of the EWM samples collected at Springville Pond found an *E. lecontei* pupae. Species identification was confirmed by Laura Jester, of Jester Consulting in Eden Prairie, Minnesota, confirming the presence of the aquatic weevil in Springville Pond. This is the first record of *E. lecontei* identified in Springville Pond, therefore the specimen was preserved, labeled and submitted to the UW-Stevens Point as a voucher specimen. It will be retained with the *E. lecontei* voucher specimens collected during Laura Jester's *E. lecontei* research in 1996-97.

d. Weevil Population Density Survey Results

In the 2003 EWM Assessment Report, the primary recommendation for Springville Pond was to investigate the potential for using biological control. It was suggested that, if biological control proved a viable option under the conditions present at Springville Pond, this could provide a natural, long-term solution.

Weevil population density surveys were performed in August 2004 to determine the existing natural population of the aquatic milfoil weevil, *Euhrychiopsis lecontei*. EWM stem samples were collected from Springville Pond on August 4th and 5th, 2004 and examined in the laboratory on August 9-12, 2004. Extracted weevil specimens were preserved in 95% ethyl alcohol and sent to Laura Jester of Jester Consulting, Eden Prairie, MN, for species identification confirmation. See Figure 2 for sample locations and Table 5 for summarized results.

Table 4. Weevil Population Density Survey – Results Summary (2004)

Lab Date (2004)	Bed No.*	Depth Range (ft)	Tot # Stem Samples	% Samples Algae-covered	Ave # Broken Tips	Ave # of Apical Tips	% Stems w/ Weevil Damage	Ave # Eggs per Stem	Ave # Larvae per Stem	Ave # Pupae per Stem	Ave # Adults per Stem	Ave Weevils per Stem (All Life Stages)
8/10, 8/11	**A**	6 - 10	19	58%	1.68	2.79	58%	0.00	0.47	0.00	0.00	**0.47**
8/9, 8/10	**B**	8 - 10½	15	20%	1.27	2.00	47%	0.00	0.33	0.07	0.13	**0.53**
8/12	**C**	2½ - 3½	15	27%	0.87	2.73	80%	0.27	1.27	0.07	0.07	**1.67**
8/11, 8/12	**D**	2 - 2½	14	14%	1.21	4.43	93%	1.07	3.29	0.00	0.07	**4.43**
Whole Pond Results		2 - 10½	63	32%	1.3	3.0	70%	0.30	1.25	0.03	0.06	**1.65**

*See Figure 2 for EWM sample bed locations.

<u>Survey Notes:</u>

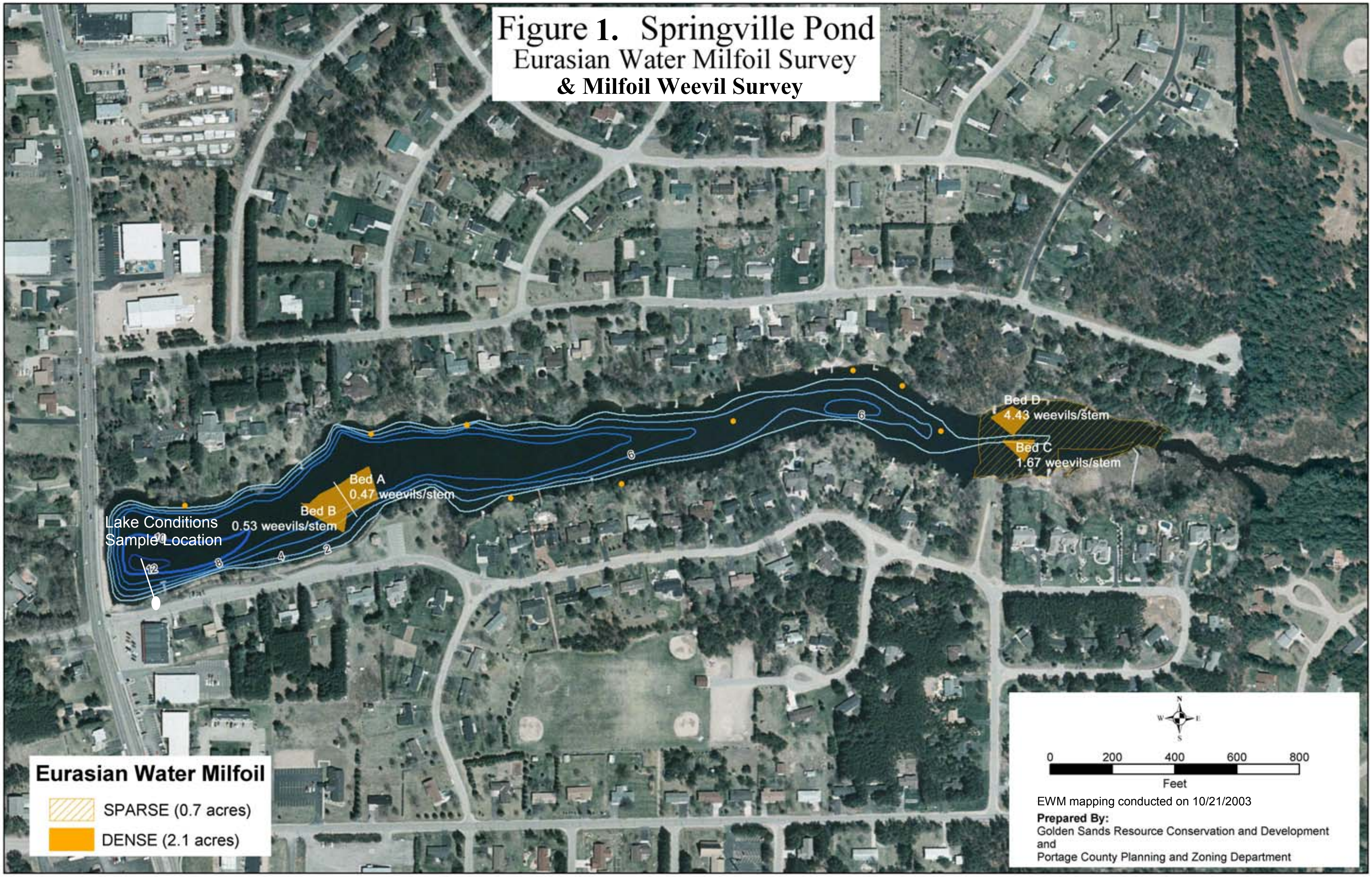
Sample Date: 8/4 – 8/5/2004

Weather Conditions: Sunny Breezy, 65 – 70°F

Land Cover @ Shore:
Bed A = Park (mowed to shoreline**), Residential (most mowed to shoreline)
Bed B = Park (mowed to shoreline**), Residential (most mowed to shoreline)
Bed C = Residential (some mowed, but more natural along shoreline)
Bed D = Residential (some mowed, but more natural along shoreline)
*****Park maintenance at Springville Pond had traditionally mowed the entire park to the shore's edge. The park was recently terraced to reduce erosion and storm water runoff into the pond. During the summer of 2004, the mowing program reduced the extent of the mowed area and frequency of mowing times, which will significantly improve the amount of available winter weevil habitat at the park.***

Sample Preservation: Samples were kept in water in labeled plastic bags at 3-4°C until time of examination. All Springville Pond samples were examine within eight days of collection, therefore, they did not require preservation with ethyl alcohol.

Other notes: Somewhat common leaf deformity = fused lower leaflets.



Bed A, B, C and D surveyed for milfoil weevils (*Eurychiopsis lecontei*) on 08/04 – 08/05/04. Stem samples collected from sample beds were examined in laboratory on 08/09 – 08/12/04. Values on map represent average number of weevils per stem for each bed. Average weevil density overall for Springville Pond was found to be **1.65 weevils per stem.**

Average milfoil weevil density for Springville Pond was found to be 1.65 weevils per stem, which seems to be a healthy natural density. Of the 31 Wisconsin lakes studied by Laura Jester from 1996 to 1997, only four had natural weevil densities over 1.5 weevils per stem. (Jester 1998) Past studies have indicated that densities greater than 2 weevils per stem are associated with EWM declines, but more recent evidence indicates that the density of weevils required to impact EWM may be less than 2 weevils per stem and is highly lake specific. In fact, researchers now suggest that, while densities at or greater than 1 weevil per stem is preferable to achieve EWM *decline*, *control* may occur at levels around 0.25 weevils per stem or lower. (Newman 2004, *pers. comm.*) Factors found to favor weevil population increases are: bed locations that are near shore and growing in shallow water, and a higher percentage of natural shoreline. A higher number of growing tips per plant (bushier plants) has also been found to have a positive correlation with high weevil populations but this may be a *result* of weevil activity, rather than a factor that attracts them. (Note: While weevil abundance is correlated with bushier plants, this may be a causal effect of weevil feeding.) (Jester, et al. 1999)

Figure 2 shows EWM sample bed locations and average weevil densities for those beds. There was notable contrast in weevil densities between sample beds. Beds A and B were distinctly lower in weevil densities than Beds C and D at the far eastern end of the pond. Some reasons for this may be the greater depth and distance to shore of Beds A and B. Another factor could be the type of land cover found around Beds A and B. The shore in this area is park or residential land that was mostly mowed to the shoreline, with some rip-rap, although recent changes to park management have greatly increased the amount of natural shoreline available there. Weevils overwinter in the mud and leaf litter along shore and, therefore, survive best with a higher percentage of natural shoreline that is not mowed, raked, rip-rapped, sand, or sea-walls. (Jester et al. 1999) Beds C and D may be better weevil habitat because they possess all three of these factors – they are nearer to shore, in shallower water, and have more shoreline maintained with more natural vegetation along the shoreline. Of these factors, the one within human control is the amount of natural shoreline.

On September 8^{th}, 2004, a site visit to Springville Pond discovered that in Beds A and B, weevil-damaged stems were observed, and EWM in Beds C and D had severely declined. During stem collections on August 5th, the EWM in Bed C and Bed D had been dense with stems trailing along the water's surface, creating a thick canopy for the filamentous algae to cling to. The result was an unattractive, dense mat of weeds and algae on the water surface. Between the August 5^{th} and September 8^{th} visits, something had severely stressed the EWM, much of it died, and the algae/weed mat broke apart and drifted away leaving behind a patch of clear water with just a few, sickly EWM stems remaining. (Note that the sparse EWM surrounding Beds C and D was still present, but weevil-damaged stems were observed.)

It cannot be said for certain whether the weevils were responsible for this sharp EWM decline, but few other naturally occurring factors could have stressed the EWM so severely and so quickly. If the weevils were indeed responsible for the EWM decline, this is a very good sign for Springville Pond.

e. Recommended Management Plan for Eurasian Water Milfoil (2004):

Maximize Biological Control and Evaluate Management Plan

In 2005, the Village of Plover opted to follow the recommendation of biological control. *(See Section X.f.)*

The use of chemical treatments has drawbacks, such as requiring repeated treatments, toxicity to aquatic insects, residual by-products, unintended drift and excessive plant decay causing oxygen depletion. Chemical treatments can also result in increased nutrient release and sediment enrichment, which can lead to algal blooms and excessive plant growth in following years. Chemical use has been unsuccessful in eradicating EWM and has become increasingly controversial with residents and area citizens. Biological control, however, would be a long-term, non-toxic control method.

1. **Maximize Biological Control – *Beginning Immediately***

Springville Pond already has a healthy population of milfoil weevils, but some steps can be taken to try to boost the weevil population and maximize the control potential the weevils hold. Of the factors suspected to be impacting weevil success in Beds A and B, the one factor within human control is the amount of natural shoreline, a necessity for successful weevil hibernation. Some of the shoreline around Springville Pond is in somewhat natural condition, but could be improved. Other areas are greatly manipulated (mowed lawn, rip-rap, sea-walls, sandy beach) and are not good weevil habitat. Because weevils are weak fliers, the day they emerge from the water to fly to shore and hibernate, they are at the mercy of the wind. The more shoreline that is in natural condition the better the weevils' chances are of landing on suitable habitat. Recent changes in park maintenance at Springville Pond are likely to provide much more habitat this winter than previously and are a step in the right direction.

To help the weevils survive and do the job we are asking of them, the parks department and private landowners can:

- ✓ Leave as much un-mowed land as possible within 35' of shore. (More is better!) Weevils hibernate in leaf litter and dead grasses.
- ✓ Minimize the area maintained as beach, mowed paths, rip-rap or otherwise disturbed/manipulated land.
- ✓ Restore disturbed/manipulated areas.
  Contact the Portage County Land Conservation Department for technical help with involved restorations. (See Appendix C.)
- ✓ Minimize fertilizer & pesticide use.
  Runoff from fertilized properties can speed EWM growth and pesticides can kill the weevils you need to do the work!

  (Also see Appendix B for more tips on providing weevil habitat.)

2. **No Additional Control Treatments**

Other control methods (mechanical, manual or chemical) should not be utilized extensively in the pond. Extensive or poorly planned use of chemicals may set back the existing weevil population and extensive mechanical harvesting would reduce the number of EWM growing tips, which would hamper weevil reproduction success.

a. **Exception: Personal Control Around Docks**

The exception to the above guideline would be in areas around docks where recreational usage is most affected. In these limited areas, hand-cutting/pulling, chemical treatments or the use of plant barriers (a fabric placed on top of the sediment, marked with buoys to prevent navigational hazards), would benefit recreational usage without significantly impeding weevil success. *(Chemical treatments or use of plant barriers require a permit from the WDNR.)*

b. **Optional Treatment: Winter Drawdowns**

A winter water level drawdown is an optional tool for control of EWM in shallow areas, which has been effective in the past and should not significantly impact the milfoil weevils. Drawdowns should be done only every few years, as frequent drawdowns can encourage prolific growth of drawdown-tolerant species, such as sago pondweed (*Potamogeton pectinatus*). Drawdowns require a *Waterway & Wetland Permit Application Form 3500* and a great deal of assistance from the WDNR. Timing and extent of drawdown is critical to accommodate the needs of the amphibians, fish and other wildlife residents.

3. **Trained Volunteer Monitoring Program -- *ESSENTIAL!!!* --**

EWM control is never permanent. Biological control is naturally dynamic and some fluctuation in EWM growths should be expected, but it will be critical to identify severe increases early if the biological control alone is not enough, and additional control methods (such as drawdown) are needed. A trained volunteer monitoring crew who can correctly identify EWM and map new EWM beds on an annual or biannual basis will be essential to the year to year management of EWM on Springville Pond. Your WDNR Aquatic Plants Specialist can arrange this training. (See Appendix B for contact information.)

Landowners can learn how to keep their docks EWM-free!

Additionally, landowners should be trained to identify EWM and learn how it is spread. Landowners can watch for EWM that washes up to shore and dispose of those plants before they take hold and start a new bed. Landowners can also pull individual EWM plants found in the shallows to prevent a new bed from developing. (Pulling individual, spotty growths should not impact weevil populations, and may help keep EWM from spreading faster than the weevils can work.) Again, landowners should be *trained* for this, so they are not pulling beneficial, native plants.

4. **Post Exotic Species Advisory Signage**

Under Wisconsin Statutes, Chapter 30.715, it is illegal to place a boat, trailer or equipment that have aquatic plants attached into a navigable waterway. (Wisconsin Legislature: Infobases). "Exotic Species Advisory" signs placed at boat landings can be a reminder to boaters to check for hitch hiking plants.

Although only non-motorized, hand-carry watercrafts are allowed on Springville Pond, these crafts are capable of introducing additional exotic species into the pond or transferring EWM or curly pondweed from the pond to other lakes. There were no signs posted during the August and September of 2004 visits to the pond, but the appropriate WDNR contacts have been notified of this need.

Once signs are posted, if they become damaged or stolen, the WDNR should be notified.

5. **Evaluate Management Plan**

EWM control should be considered to be just one part of a larger goal of total lake health. The Little Plover River and Springville Pond Watershed Management Plan covers many areas for comprehensive water quality improvement. This management plan should be reviewed with the new survey data to update and fine-tune the recommendations. Because phosphorus inputs are the main food source for excessive plant and algae growth, special attention should be paid to sources of phosphorus within the watershed. Continued conservation, restoration and public education efforts should show slow but steady results.

f. Implementation of Recommendations (2005):

Above: *Former Bed D - In 2003-04, this area was a solid weed mat of EWM, covered with a layer of algae. Weevil counts were an astronomical 4.43 weevils per stem. On June 21st, 2005, the weevils had reduced the weed bed to a few, scattered stems. Ugly blobs of algae remain.*
Below: *Former Bed D, Aug. 5st, 2005. EWM still minimal, but algae is abundant due to hot growing conditions.*

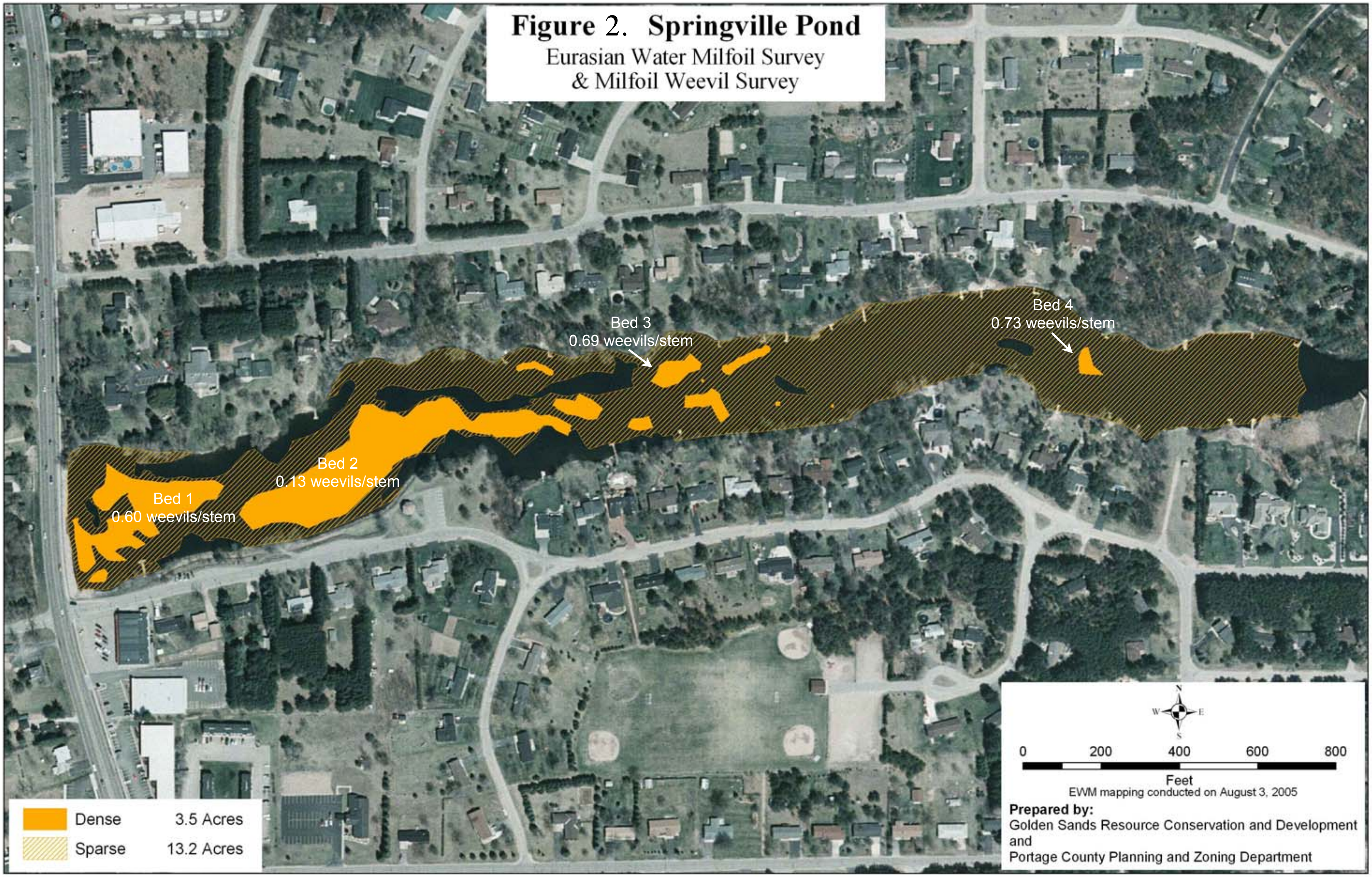
To track the milfoil weevils' activity on the pond, on June 21, 2005, field personnel from Golden Sands RC&D, working with Portage County on the EWM Studies, took random samples and made visual observations. At that time, personnel found many positive signs that weevils were active and having an impact on the milfoil. Random samples, even from isolated beds, frequently had weevils present, and a Bed D, which had disintegrated due to weevil impacts in September 2004 was still under good control. (See photos.)

Photos taken on June 21st show the difference between healthy, pink stems and black, weevil-damaged stems. Stems become weak and disintegrate.

The heat is on…. Late June brought the start of a record streak of sunny, hot, and dry weather. The Stevens Point area saw **50 days** of temperatures at or above 80°F by Labor Day Weekend. In addition, drought stress and increased demands for water in the parched watershed brought on record low water levels to the Little Plover River, which feeds into the pond. This meant almost no fresh, cool water coming into the pond during the hottest, driest parts of the summer. The stagnant water conditions, coupled with the hot, sunny weather, created extreme conditions just *perfect* for rapid EWM growth.

In August, field personnel returned to the pond to map the EWM and survey the weevil populations and found that the dense EWM beds had increased from 2.1 total acres in 2003 to 3.5 acres in 2005. (See Figure 3.) Even more dramatic was the increased area colonized by sparse growth of EWM, from 0.7 acres in 2003 to 13.23 acres in 2005. This documented that new EWM growths had appeared in almost every area of the pond.

Photo taken on August 5th of Bed 4, a dense, new EWM bed that sprang up in the summer heat, just west of Former Bed D.



Bed 1, 2, 3 and 4 surveyed for milfoil weevils (*Euhrychiopsis lecontei*) on 08/05/05. Stem samples collected from sample beds were examined in laboratory on 08/09/05. Values on map represent average number of weevils per stem for each bed. Average weevil density overall for Springville Pond was found to be **0.54 weevils per stem.**

Weevil surveys showed the average population in the pond was 0.54 weevils per stem, a decreased density from the 2004 average of 1.65 weevils per stem. (See Table 6.) It should be noted that these numbers are a ratio of number of weevils to number of EWM stems, therefore the dramatic increase in number of EWM stems gives a skewed impression of the number of weevils. **It is believed that the weevil population in Springville Pond is still healthy and increasing** but was simply unable to keep pace with the abnormally rapid EWM growth in 2005.

Table 5. Weevil Population Density Survey – Results Summary (2005)

Lab Date	Bed No.*	Depth Range (ft)	Tot # Stem Samples	Ave # Broken Tips	Ave # of Apical Tips	% Stems w/ Weevil Damage	Ave # Eggs per Stem	Ave # Larvae per Stem	Ave # Pupae per Stem	Ave # Adults per Stem	Ave Weevils per Stem (All Life Stages)
8/9/05	**1**	4-12	15	0.40	1.80	37%	0.00	0.47	0.13	0.00	**0.60**
8/9/05	**2**	6-8	15	0.20	1.60	37%	0.07	0.07	0.00	0.00	**0.13**
8/9/05	**3**	2-8	16	0.56	1.63	28%	0.06	0.56	0.06	0.00	**0.69**
8/9/05	**4**	2-4	15	0.33	2.20	3%	0.00	0.67	0.00	0.07	**0.73**
Whole Pond Results		2-12	61	0.40	2.00	26%	0.03	0.44	0.05	0.02	**0.54**

*See Figure 2 for EWM sample bed locations.

Survey Notes:

Sample Date: 8/4 – 8/5/2004

Weather Conditions: Sunny, 80°F

Land Cover @ Shore: Bed 1 = Dam, Park, Residential
Bed 2 = Park, Residential
Bed 3 = Residential (some mowed, but more natural along shoreline)
Bed 4 = Residential (mostly natural along shoreline)

Sample Preservation: Samples were kept in water in labeled plastic bags at 3-4°C until time of examination. All Springville Pond samples were examined within one day of collection; therefore, they did not require preservation.

Other notes: Exceptionally warm, sunny drought year = low water levels, stagnant conditions.

Whether due to abnormal conditions or not, the alarmingly rapid EWM and algae growth caused a great deal of concern among community members and landowners around the pond.

Weighing the options…. The Village of Plover hosted a meeting on November 29th, 2005, that gave landowners an opportunity to ask Deborah Konkel, WDNR, and Amy Thorstenson, Golden Sands RC&D, questions about options for controlling the nuisance EWM growth. In response to questions raised about chemical treatments to the EWM beds, which had been done in the past, Konkel stated that the past treatments were only temporary and were ineffective in the long-term. Further, because non-motorized recreation is not substantially impeded by the EWM growths, the risks associated with wide-scale chemical treatments outweigh the benefits to recreation, therefore, the DNR would not approve a permit for such treatments. A winter water level drawdown would not be helpful at this time either, because the 2005 surveys found the EWM beds concentrated in deeper waters. Konkel still supported biological control as the safest, most long-term and cost-effective control method best suited for Springville Pond's situation.

Thorstenson suggested the possibility of **boosting** natural milfoil weevil populations through a weevil-rearing project the Portage County EWM Studies were planning for 2006. Thorstenson stated that the weevils were likely to catch up to the EWM growth eventually, but that rearing extra weevils may speed that process. Such a project was done at Lake Thomas in 2005, with some visible success by the end of the summer. The rearing and stocking techniques have been refined for 2006, and Thorstenson stated that weevils could be reared for Springville Pond if a grant from the DNR gets approved. The residents and Village of Plover opted to pursue this plan.

RESIDENTS ARE ENCOURAGED TO PARTICIPATE:

Residents have been informed of the ways they can support biological control:

1. **Support milfoil weevils:**

   - ✓ Practice "catch and release" of large predator fish that feed on pan fish. Pan fish feed on milfoil weevils, and high populations of pan fish can be a critical stumbling block to increasing weevil numbers.
   - ✓ Provide winter hibernation habitat for weevils by avoiding mowing and raking within 35 feet (or 50 feet, if possible) of shore from Labor Day through Memorial Day. Weevils hibernate on shore under dead leaves and grasses. Shoreline vegetation is critical for weevils *and* beneficial for water quality. If residents have a disturbed shoreline (sand, rock, mowed lawn, etc...) and would like to restore it to native vegetation, they can contact the County Conservationist, at 346-1216, for technical assistance.

2. **Individual Control:**

   Controlling EWM around docks will help to minimize the spread of EWM in the pond. **Manual removal** (raking or hand-pulling) is also allowed, without a permit, to create an "access corridor" (up to 30-feet wide) to access open water. The law also allows unlimited manual removal of *non-native* plant species, such as EWM, so if you can distinguish these plants from natives, this is an option for control as well. (PLEASE NOTE the state statute requires that whatever vegetation is cut or pulled must be removed from the waterbody! This is to minimize reproduction via stem fragmentation and reduces the amount of rotting plant material in the water that contributes excess nutrients and reduces dissolved oxygen levels.*)*

   Optionally, a landowner may apply for an individual DNR permit to use herbicides to control aquatic vegetation and clear an "access corridor" (up to 30-feet wide). Permits will be evaluated for approval on a case-by-case basis. (Note: Any bare areas are prone to invasion by exotic species, so it is wise to limit the size of the access corridor to only what is necessary.)

g. Biological Control Project (2006)

To boost milfoil weevil populations, weevils were collected from the pond during the summer of 2006 and reared in a predator-free environment. (See Section II for methods and Section III for evaluation of the rearing methods.) Weevil collections began June 7th, 2004 and ended August 1st, 2006. Tanks stocked from August 1st through August 16th were stocked with "reused" weevils, or weevils produced in rearing tanks. Weevils were released throughout the course of the summer, from June 28th to September 14th, at a strategically–positioned stocking location at the near–shore edge of Bed 2. (See Figure 4.)

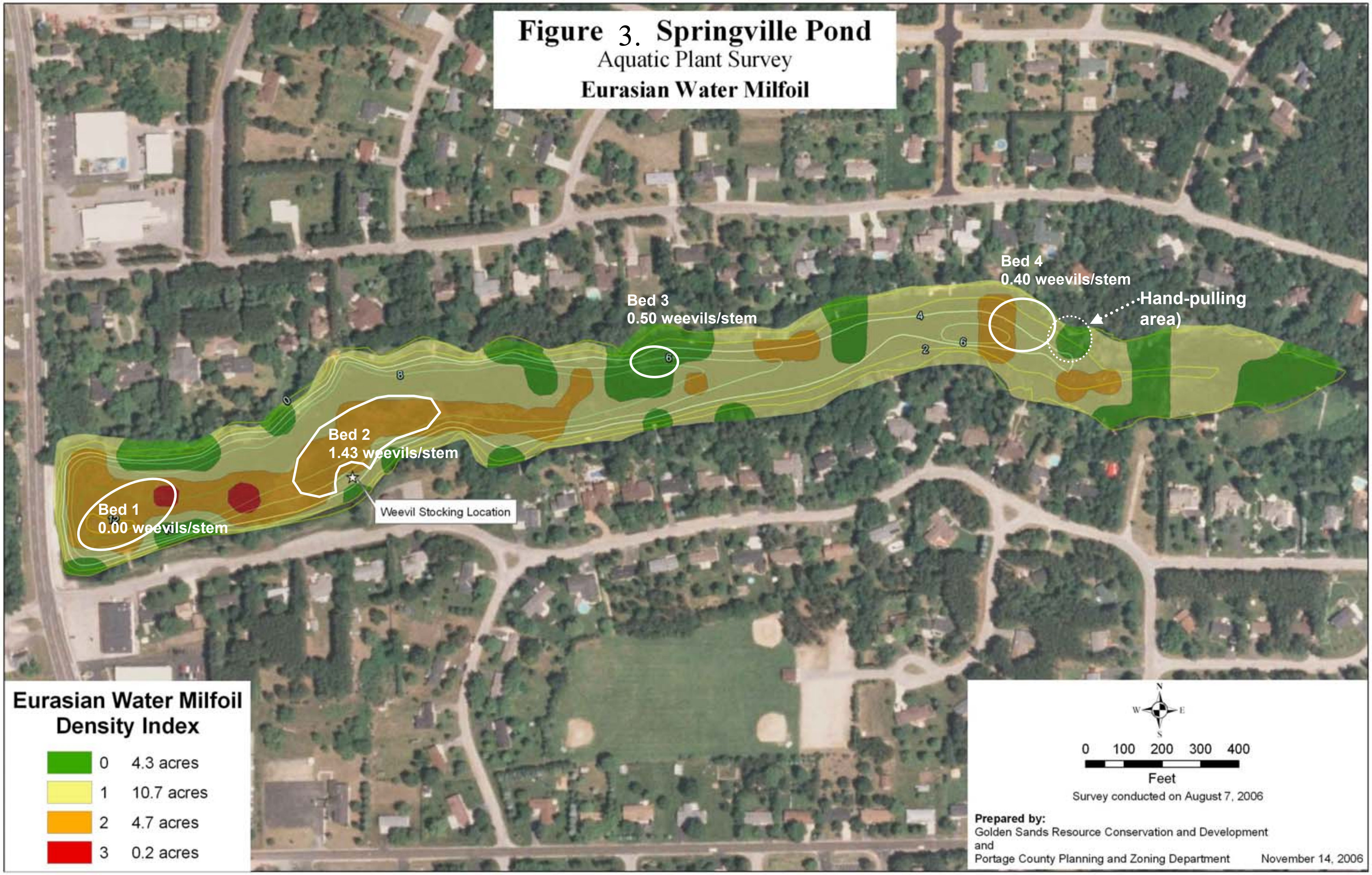
1. Field Observations

Unusual observations were made during the weevil collections. Peculiar pupae casings appearing as "warts" or "bubbles" were noticed on many of the EWM stems, primarily in Bed 2. (See Photo at left.) These "warts" were not observed at Thomas Lake. Upon examination, weevil pupae were found to be housed in these casings. Although they appeared to be *Euhrychiopsis lecontei* pupae, *E. lecontei* usually develop in the center of the stem, and do not create a "wart" protruding out the side of the stem. The EWM stems appeared to be unusually skinny, however, which was suspected to be a possible cause for the protruding casings.

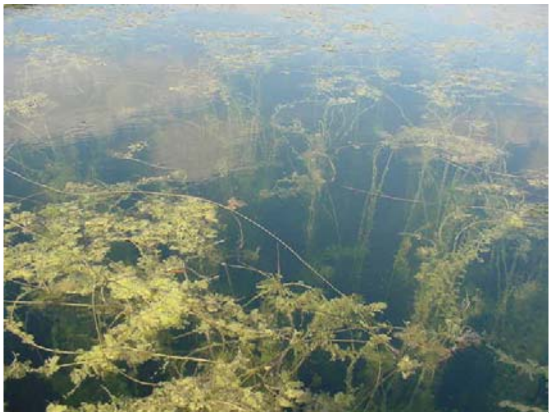
Unusual pupae casings, appearing as "warts" or "bubbles", were observed in June through early July. This was seen most prevalently in Bed 2. This turned out to be a behavior or Phytobius.
(Photo: Paul Skawinski)

To confirm species identification, samples of these "warts" and the pupae within were sent to Dr. Ray Newman, University of Minnesota. The species was determined to be *Phytobius*, a native insect of nearly identical appearance to *E. lecontei*, but with different feeding behavior. *Phytobius* feeds on the flowers, meristems (growing tips), and leaves of EWM, but does not burrow through the stem like *E. lecontei*. While this does stress the plant's health, Phytobius may not impact the plant as significantly as *E. lecontei*. (Newman 2006, *pers. comm.*) Delays in confirmation resulted in *Phytobius* specimens being unintentionally included in the rearing tanks for Springville Pond. **Due to the findings of Dr. Newman, please note that where weevils are referred to throughout Section V.g., it may include both *E. lecontei* and *Phytobius*, unless otherwise specified.**

Observations in September 2006 noted unusual "leaf stripping" in Bed 2, primarily around the stocking location. The stems appeared healthy and buoyant, but the leaves were absent. Because weevils need healthy, bushy EWM to thrive, final weevil stockings were done at up to 25- or 30-feet from the buoy, in order to find healthy EWM stems to release the weevils onto.



Aquatic plant survey conducted on 8/7/06. Sampling method: Point Intercept with rake. Density index indicates rating of "rake fullness". (See Section II.c.) Beds 1, 2, 3 and 4 surveyed for milfoil weevils on 08/10/06. Stem samples collected were examined in laboratory 08/11-8/24/06. Values on map represent average number of weevils per stem for each bed. Average weevil density overall for Springville Pond was found to be **0.58 weevils per stem.**



A close-up view of the stocking area in Bed 2 on 9/15/06. EWM exhibited stripped stems with algae still clinging at the water surface. Stripped stems are indicative of feeding damage by Phytobius.

The observed damage appears to be indicative of feeding activity from *Phytobius*, as the larvae do not mine the stems as *E. lecontei* do, but the adults readily feed on the leaves. The marked "circle of influence" around the stocking buoy may be a good visual indicator of the effect that stocking can have, even with the low numbers of weevils produced during the 2006 project. (See photo at left.)

Other observations on 9/15/06 noted nearly absent flowering in Bed 2. This is likely due to weevil activity causing a decreased vigor of the EWM plants. Flowering is the most energy intensive process plants go through, and stressed plants are unable to flower.

2. Weevil Production Results

The total number of weevils collected from Springville Pond was 1397. Total number released was 2616, for a net increase of 1219. Target increase was approximately 5000 weevils. However, the multiple difficulties encountered early in the season (discussed in Section II, Methods) critically impacted the overall production levels of the biological control project. The average return rate for Springville Pond tanks was 1.88 over the course of the project, but examining the monthly results, the impacts of the early season difficulties on the total production rate become obvious. June production was negative, due to early difficulties with the control room and laboratory tanks (all Springville Pond tanks). July and August production improved dramatically when the control room and laboratory were no longer used for rearing. (See Table 7.)

Table 6. Springville Pond Weevil Production Results

	Springville Pond **- Total -**	Springville Pond **- June only -** (excludes tub)	Springville Pond **- July only -** (excludes tub)	Springville Pond **- August only -** (excludes tub)
Total Tanks Filled	178, +tub[1]			
Total Input	1397 weevils			
Total Output	2616 weevils			
Net Increase	1219 weevils	-29 weevils	508 weevils	509 weevils
% Increase	176%			
Average Return Rate[2]	1.88	0.99	2.99	2.24

[1] *A 100-gallon tub was used experimentally for rearing.*
[2] *Return Rate = number produced divided by number started with*

3. EWM Mapping Results

Plant surveys on August 7, 2006, estimated plant densities via the point intercept method. (See Methods, Section II.) Estimated densities were based on "rake fullness", rated 0-3. EWM occurrence between sample points was interpolated from sample point data. Scattered small beds of EWM may occur between sample points, such as in the case of Bed 3. (See Figure 4.) Estimated acreage of sparse EWM (rating of 1) is 10.7 acres. Estimated acreage for dense EWM (rating of 2) is 4.7 acres, and very dense EWM (rating of 3) is estimated at 0.2 acres. This mapped dense EWM acreage is an increase compared to 2005 (13.2 acres sparse, 3.5 acres dense). Areas where rake fullness ranked a zero totaled 4.3 acres and are mapped in green. Survey points, rake fullness rankings, and locations of other aquatic plant species documented during the August 7th survey are found in Appendix E.

Hand-pulling area, 9/15/06. The area stayed mostly clear, with just the occasional straggler.

Noticeable on Figure 4 is an area of localized EWM hand-pulling efforts made by a pond resident. (See photo.) With care to remove the plant by the roots, the area remained mostly clear the entire summer, with only the occasional EWM plant remaining. This demonstrates the effectiveness of hand-pulling as a control method, when care is taken to remove the entire plant, roots included. Hand-pulling is a reasonable option for small-scale, localized efforts. Hand-pulling of exotic species requires no permits.

4. Weevil Survey Results

Weevil surveys were conducted on August 10, 2006. Results showed the average population in the pond was 0.58 weevils per stem. (See Table 8.) Please note that stem collections for surveys avoided the stocking area, but depending on how far stocked weevils may have migrated, surveys may reflect some influence of weevil stocking.

Table 7. Weevil Population Density Survey – Results Summary (2006)

Lab Date	Bed No.*	Depth Range (ft)	Tot # Stem Samples[1]	Ave # Broken Tips	Ave # of Apical Tips	% Stems w/ Weevil Damage	Ave # Eggs per Stem	Ave # Larvae per Stem	Ave # Pupae per Stem	Ave # Adults per Stem	Ave Weevils per Stem (All Life Stages)
8/23/06	**1**	4-12	30	0.33	2.6	10%	0.00	0.00	0.00	0.00	**0.00**
8/23-24	**2**	6-8	30	2.04	2.91	77%	0.77	0.40	0.17	0.10	**1.43**
8/22-24	**3**	2-8	28	1.22	4.58	54%	0.14	0.25	0.07	0.04	**0.50**
8/11-24	**4**	2-4	30	0.48	2.14	61%	0.17	0.20	0.03	0.00	**0.40**
Whole Pond Results		2-12	118	1.1	3.0	50%	0.3	0.20	0.10	0.00	**0.58**

*Refer back to Figure 3 for EWM sample bed locations.
[1]Note that sample size is twice the sample size used in 2005. Number of samples collected was increased to assure statistical confidence with large bed sizes.

Survey Notes:

Sample Date:	8/10/2006
Weather Conditions:	Partly sunny, 80°F
Land Cover @ Shore:	Bed 1 = Dam, Park, Residential Bed 2 = Park, Residential Bed 3 = Residential (some mowed, but more natural along shoreline) Bed 4 = Residential (mostly natural shoreline)
Sample Preservation:	Samples were kept in water in labeled plastic bags at 3-4°C until time of examination. Samples held for more than several days prior to examination were preserved with isopropyl alcohol.
Other notes:	Another hot, sunny drought year = low water levels, stagnant conditions. 2005 had 50 days above 80°F by Labor Day. 2006 had 55 days above 80°F by Labor Day.

A comparison of surveys over the last 3 years shows that weevil densities dropped significantly with the explosive EWM expansion between 2004 and 2005 surveys, but that weevil densities may have held steady between the 2005 and 2006 surveys, in spite of continued EWM expansion. (See Table 9.)

Table 8. Weevil Population Density Survey – Results Comparison, 2004-2006

Bed No.	Location in Pond	Survey Year	Survey Date	# stem samples in survey	% of stems algae covered	% of stems w/ weevil damage	Ave eggs per stem	Ave larvae per stem	Ave pupae per stem	Ave adult per stem	Ave weevils per stem (all stages)
A	West	2004	8/5/04	19	58%	58%	0.00	0.47	0.00	0.00	0.47
B	West	2004	8/5/04	15	20%	47%	0.00	0.33	0.07	0.13	0.53
C	East	2004	8/5/04	15	27%	80%	0.27	1.27	0.07	0.07	1.67
D	East	2004	8/5/04	14	14%	93%	1.07	3.29	0.00	0.07	4.43
								Whole Pond Average (2004):			**1.65**
1	West	2005	8/8/05	15	13%	37%	0.00	0.47	0.13	0.00	0.60
2	West	2005	8/8/05	15	7%	37%	0.07	0.07	0.00	0.00	0.13
3	Middle	2005	8/8/05	16	25%	28%	0.06	0.56	0.06	0.00	0.69
4	East	2005	8/8/05	15	13%	3%	0.00	0.67	0.00	0.07	0.73
								Whole Pond Average (2005):			**0.54**
1	West	2006	8/10/06	**30**	7%	10%	0	0.00	0.00	0.00	0.00
2	West	2006	8/10/06	**30**	73%	77%	0.77	0.40	0.17	0.10	1.43
3	Middle	2006	8/10/06	**28**	39%	54%	0.14	0.25	0.07	0.04	0.50
4	East	2006	8/10/06	**30**	97%	61%	0.17	0.20	0.03	0.00	0.40
								Whole Pond Average (2006):			**0.58**

Weevil densities were sampled monthly during 2006 in an effort to understand what factors may be influencing the weevil population in Springville Pond. The June survey showed quite low results, which may be expected if winter survival rates are low. Improvements to winter hibernation habitat may help to improve the survival rate and promote early season weevil levels. (See Table 10.)

Table 9. Weevil Population Density Survey – Seasonal Movement, 2006

2006	Bed 1	Bed 2	Bed 3	Bed 4	Whole Pond Average:
6/6/06	0.07	0.06	0.00	0.50	0.16
7/7/06	0.78	0.27	0.00	0.44	0.42
8/3/06	0.27	0.56	0.07	0.06	0.24
8/10/06	0.00	1.43	0.50	0.40	0.58

Over the course of the summer, the population did increase, although the variability in the population dynamics makes it impossible to pin down exactly *how much* the population increased. It does not appear that pan fish are critically limiting to the Springville Pond milfoil weevil population at this time. However, early season lows may indicate low winter survival rates. (Newman 2006, *pers. comm.*) Therefore, it may be worthwhile to examine the amount of overwintering habitat available on the pond and focus on improvement.

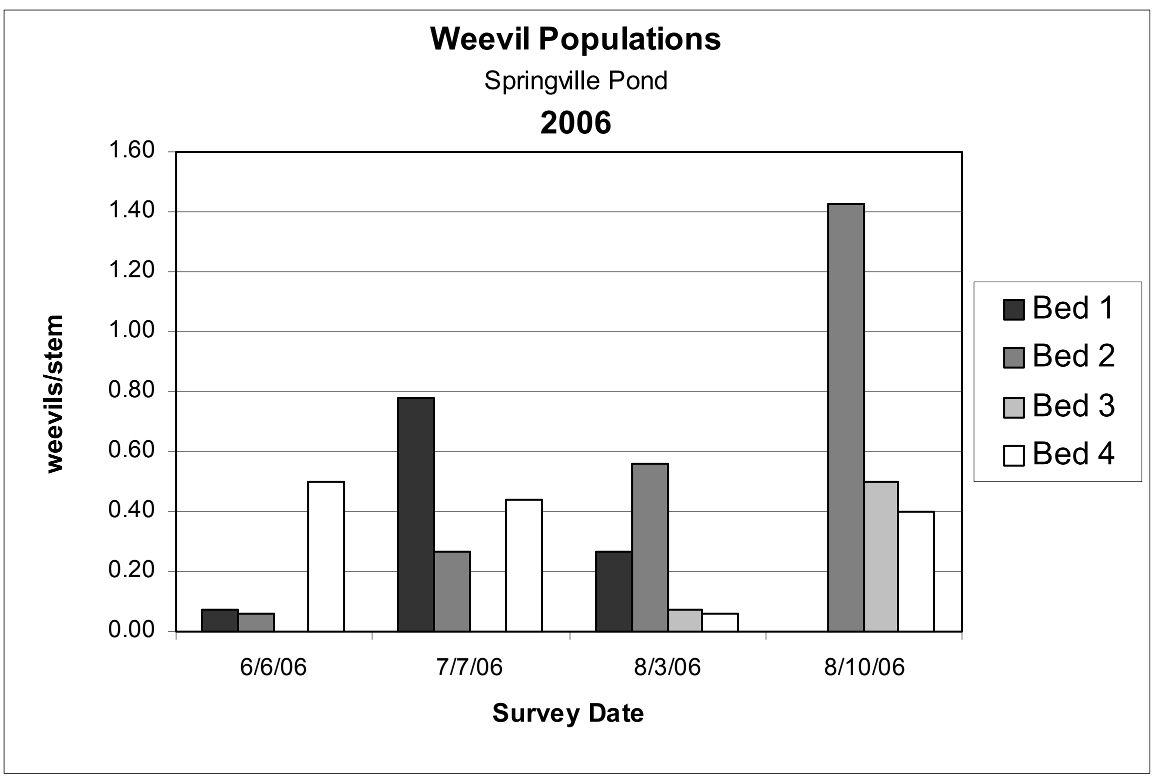
Monthly surveys in the future may be helpful in better evaluating factors affecting weevil populations.

Looking specifically at the change in populations from sample bed to sample bed, some interesting trends are visible. The weevil population in Bed 2 significantly increased over the summer, while Bed 1 showed a marked increased, followed by a marked decline. Again, please note that stem collections for surveys avoided the stocking area, but depending on how far stocked weevils may have migrated, surveys may reflect some influence of weevil stocking.

This data may reflect measurable effects of weevil stocking, but it may also reflect other factors, such as weevil movement around the pond over the summer, or possible changes in the suitability of these beds as habitat. (See Chart 3.)

Another aspect to consider is that it may be worth noting where weevils were most present early in the season. This may possibly indicate where winter survival (and over-wintering habitat) is best. Where early season numbers are low may possibly be an indicator of where over-wintering habitat may need to be improved. Similar seasonal surveys in future years may help to decipher the meaning of this seasonal change in bed densities.

Chart 4. Weevil Population Density Survey – Seasonal Movement, 2006



Freeboard and temperature measurements did not indicate discernable trends. (See Section II for detail on survey methods. Note that survey freeboard surveys avoided the immediate stocking area.) Freeboard is the distance from the surface of the water to the top of the EWM stem. A freeboard of zero inches indicates that the EWM was reaching the surface. Weevil impacts usually cause a loss of stem buoyancy, therefore, heavy weevil activity would be likely to result in a higher average freeboard.

Temperature measurements were taken at approximately 2½-inches below the water surface. Where EWM stems are dense at the surface, forming a "mat", water is restricted from circulating and sunlight is absorbed by the plants at the surface, resulting in abnormally warm and stagnant surface temperatures.

For instance, when temperatures were measured in 2006 in EWM mats, the water at the surface (zero-inches deep) was approximately four degrees warmer than temperatures measured at 2 ½ -inches below surface, and approximately 8 to 13 degrees warmer than temperatures at 12-inches below surface.

Weevil impacts cause EWM stems to lose buoyancy and drop away from the water surface, restoring more normal water cycling and temperature gradients. Therefore, where weevil activity is high, cooler surface temperature should be measurable.

Because the bulk of the stocked weevils were released late in the season, it was unlikely that measurable impacts would be present so soon. These surveys do, however, establish some historical data for comparison in future years. (See Chart 5 & Chart 6.)

Chart 4. Average Freeboard Measurements – Springville Pond

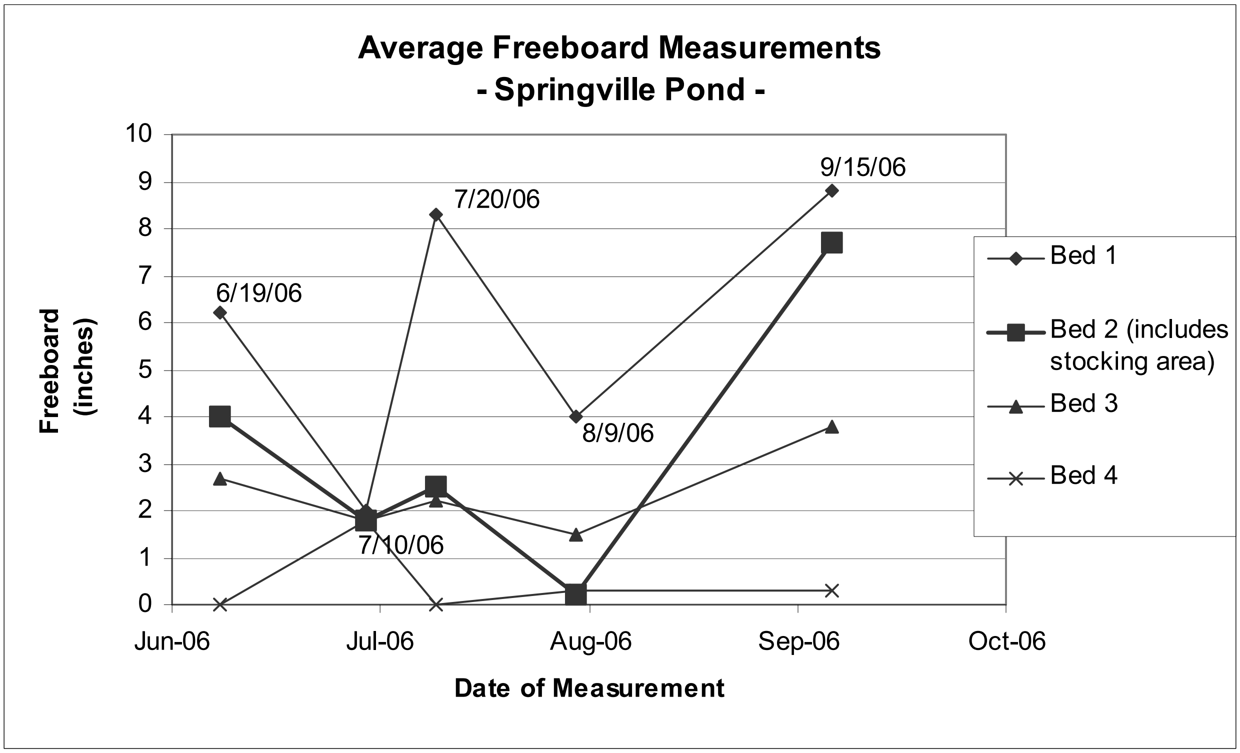
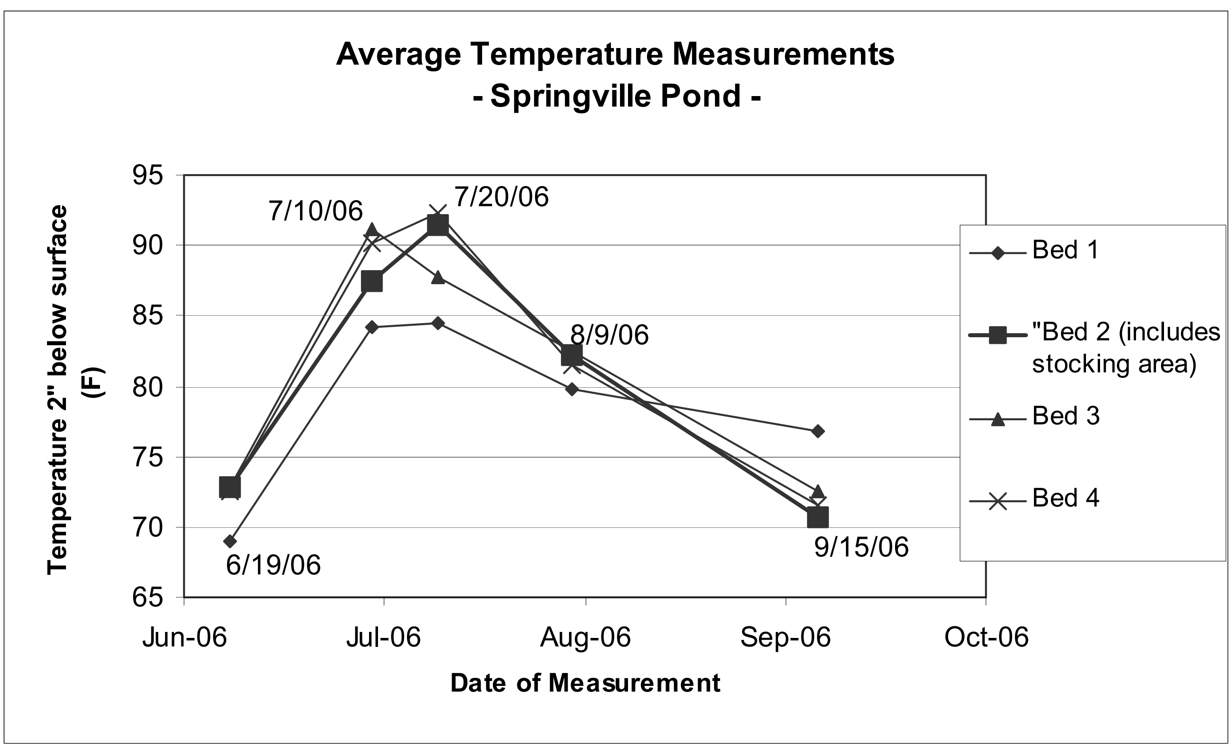


Chart 5. Average Temperature Measurements – Springville Pond



5. Summary and Recommendations – *Continue Tracking Biological Control*

   a. **Seasonal Surveys** – Results and potential of weevil stocking for biological control of EWM cannot be fairly evaluated in one season. Continued tracking of weevil activity in the pond is recommended, especially as other control methods are implemented in ways that may or may not be strategically complimentary. (i.e. – How will weevil populations respond to localized chemical treatments or hand pulling efforts?) Multiple years of biological control data has been gathered at Springville Pond – a rare occurrence – and continued tracking may provide valuable information for lake managers at Springville Pond and elsewhere around the state or beyond.

   b. **Shoreline Restoration** – "Fortifying the Lake's Immune System"
   The seasonal weevil survey data suggests that weevil winter survival rates may be low. Natural shoreline vegetation, on-shore and in the water, acts as the lake's immune system, protecting it from pollutants and invasive species. Providing natural on-shore vegetation can also provide winter hibernation habitat for weevils.

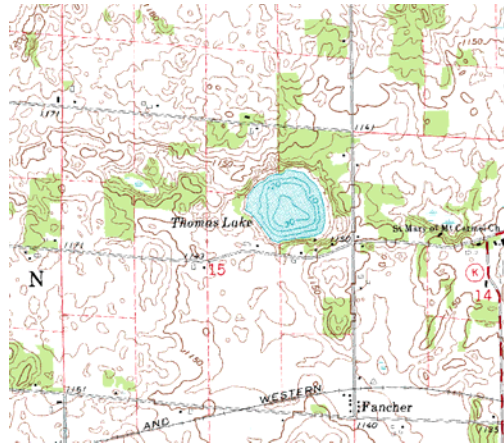
   Providing winter hibernation habitat for weevils can be as easy as avoiding mowing and raking within 35 feet (or 50 feet, if possible) of shore from Labor Day through Memorial Day. If residents have a disturbed shoreline (sand, rock, mowed lawn, etc.) and would like to restore it to native vegetation, they can contact the County Conservationist, at 346-1216, for technical assistance.

   c. **Individual Control Options** - Hand-pulling efforts by residents in 2006 showed good, long-lasting control. **Manual removal** (raking or hand-pulling) is a simple option for control in individual areas, and the law allows unlimited manual removal of *non-native* plant species, such as EWM. (PLEASE NOTE the state statute requires that whatever vegetation is cut or pulled must be removed from the waterbody! This is to minimize reproduction via stem fragmentation and reduces the amount of rotting plant material in the water that contributes excess nutrients and reduces dissolved oxygen levels.)

   Optionally, a landowner may apply for an individual DNR permit to use herbicides to control aquatic vegetation and clear an "access corridor" (up to 30-feet wide). Permits will be evaluated for approval on a case-by-case basis. (Note: Any bare areas are prone to invasion by exotic species, so it is wise to limit the size of the access corridor to only what is necessary.)

V. THOMAS LAKE

a. Lake Background



Thomas Lake on USGS topographic map.

Located approximately three miles west of Amherst Junction in the Town of Stockton, Thomas Lake is a small seepage lake with a surface area of 32 acres and a maximum depth of 28 feet. The water in Thomas Lake comes from groundwater, runoff, and precipitation. Water leaves the lake via evaporation and seepage to groundwater. Because Thomas Lake's water comes from multiple sources, one must think of its watershed in terms of a surface watershed and a groundwater shed. (See Appendix C for definition of terms.) In the case of Thomas Lake, the surface watershed and groundwater shed were historically dominated by non-irrigated agriculture, which has been on the decline since 1948 land use surveys. Currently, the surface watershed is dominated by forest cover, and the groundwater shed is dominated by shrub cover. Residential land use has increased steadily in both watersheds, but remains a lesser component. (UWSP and Portage County 2003)


Thomas Lake with mats of aquatic vegetation visible at water surface.

A lake is categorized as "eutrophic" when total phosphorus levels are 30 ppb or higher, which results in more aquatic plant growth. Thomas Lake is a eutrophic lake, with total phosphorus levels historically around 34 ppb. (UWSP and Portage County 2003)

Water clarity in Thomas Lake is considered good when compared with similar lakes in the region. Average historic Secchi depth (a measure of water clarity) was best in July (14 feet) and poorest in September (6 feet). Fluctuations in water clarity are normal, due to increases and decreases of algae population and sedimentation. Average secchi depth readings for 2002 indicated better water clarity in late summer than the historic average. (UWSP and Portage County 2003)

b. History of Aquatic Plant Control in Thomas Lake

No records of previous aquatic plant treatments were found to report for this assessment. Table 11 lists aquatic vegetation species documented in Thomas Lake.

Table 10 - List of Documented Aquatic Vegetation
(Submergent and Floating Leaf Aquatics Only)

	Herbarium Records for Thomas Lake *	
	Scientific Name	Common Name
1	*Ceratophylum demersum*	Coontail
2	*Elodea canadensis*	Waterweed
3	*Elodea nuttallii*	Slender waterweed
4	*Myriophyllum sibiricum*	Northern water milfoil
5	*Myriophyllum spicatum* (e)	Eurasian water milfoil
6	*Najas flexilis*	Slender naiad
7	*Nuphar variegata*	Bullhead pond lily
8	*Nymphea odorata*	White water lily
9	*Polygonum amphibium*	Amphibious smartweed
10	*Potamogeton amplifolius*	Large leaf pondweed
11	*Potamogeton foliosus*	Leafy pondweed
12	*Potamogeton gramineus*	Variable pondweed
13	*Potamogeton illinoensis*	Illinois pondweed
14	*Potamogeton pectinatus*	Sago pondweed
15	*Potamogeton robbinsii*	Robbin's pondweed
17	*Spirodela polyrhiza*	Large duckweed
18	*Zosterella dubia*	Water stargrass

* Robert W. Freckmann Herbarium records through November 2003, University of Wisconsin-Stevens Point. (Note: These herbarium records are historical documentation of what has been identified to date at Thomas Lake. *This is not an exclusive list.* Further, it cannot be stated with certainty that because a species has not been recorded at that lake recently that the species is no longer present in that lake. However, it has been well documented that as exotic invasives infest a lake, native vegetation is progressively less able to compete and the number of species (diversity) in the lake declines. Anecdotally, this is what has been seen at lakes in Portage County where EWM is present, however it would require quantitative vegetation surveys to confirm this.)

(e) Exotic invasive

c. Mapping Results

EWM was not identified in Thomas Lake until recent years, but the exotic plant spread rapidly, likely due to high phosphorus levels in this eutrophic lake. EWM has become a dense mass of weeds surrounding the entire periphery of the lake. In those areas, EWM has become so thick at the surface that canoeing is difficult and boating is nearly impossible. The troublesome weed is only precluded from growing in the center of the lake by the water depth.

Dense mats of EWM visible at water surface, entire circumference of lake.

Field mapping on October 22, 2003 found the EWM growth to be mostly limited to a depth or 10 or 12 feet or less. The total surface area of the infestation is approximately 10.0 acres. (See Figure 5.) An infestation of this size cannot be eradicated by methods currently available, however *control* may be possible.

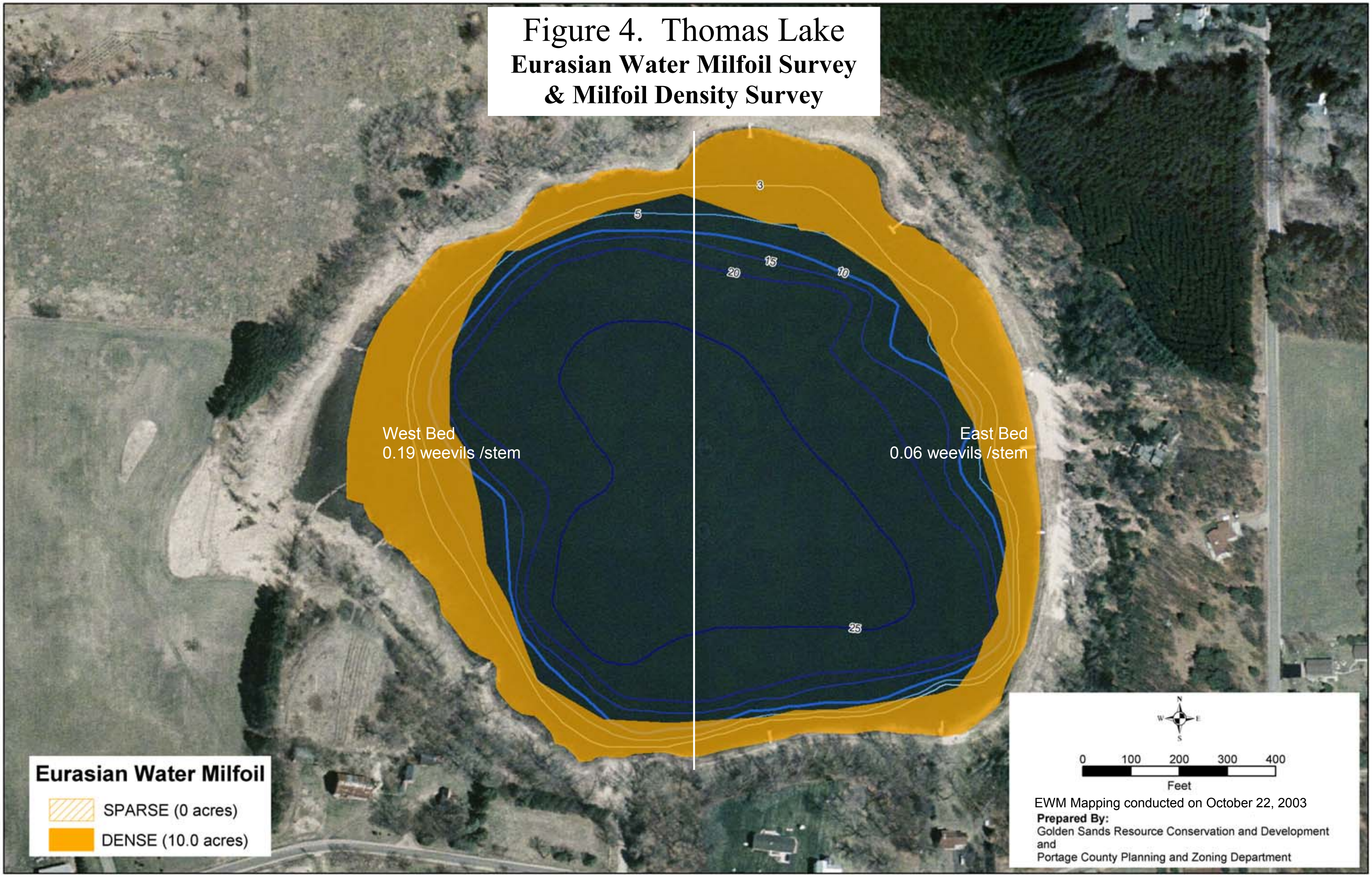
A closer view of dense EWM growth in Thomas Lake.

Several random samples of EWM were collected during 2003 field mapping exercises and later examined for evidence of the presence of the native aquatic milfoil weevil, *Euhrychiopsis lecontei*. Although no evidence of weevils could be found from these samples, it was believed that a more thorough survey would be required to conclusively determine the presence or absence of milfoil weevils.

d. Weevil Density Survey Results

The EWM infestation in Thomas Lake is beyond elimination by chemical or manual control methods. Mechanical harvesting would be impossible around docks and in very shallow water where much of the EWM is located in Lake Thomas. In the 2003 EWM Assessment Report, the primary recommendation for Thomas Lake was to investigate the potential for using biological control. It was suggested that if biological control proved a viable option under the conditions present at Thomas Lake, then this may provide a natural, long-term solution.

Population density surveys were performed in 2004 to determine the existing natural milfoil weevil population. EWM stem samples were collected from Thomas Lake on August 5th, 2004 and examined in the laboratory on August 13th, 17th and 18th, 2004. Extracted weevil specimens were preserved in labeled glass vials with 95% ethyl alcohol and sent to Laura Jester of Jester Consulting, Eden Prairie, MN, for species identification confirmation. See Figure 5 for sample bed locations and Table 12 for summarized results.



East and West Beds surveyed for milfoil weevils (*Eurychiopsis lecontei*) on 08/05/04. Stem samples collected from sample beds were examined in laboratory on 08/13, 8/17 and 8/18/04. Values on map represent average number of weevils per stem for each bed. Average weevil density overall for Thomas Lake was found to be **0.13 weevils per stem.**

Table 11. Weevil Population Density Survey – Results Summary (2004)

Lab Date (2004)	Bed No.*	Depth Range (ft)	Tot # Stem Samples	% Samples Algae-covered	Ave # Broken Tips	Ave # of Apical Tips	% Stems w/ Weevil Damage	Ave # Eggs per Stem	Ave # Larvae per Stem	Ave # Pupae per Stem	Ave # Adults per Stem	Ave Weevils per Stem (All Life Stages)
8/13, 8/17	**West**	0-12	36	31%	0.14	3.86	25%	0.00	0.17	0.00	0.03	**0.19**
8/17, 8/18	**East**	0-12	31	48%	0.23	1.87	10%	0.03	0.00	0.03	0.00	**0.06**
Whole Lake Results		0-12	67	38%	0.20	2.90	16%	0.01	0.09	0.01	0.01	**0.13**

*See Figure 4 for EWM sample bed locations.

Survey Notes:

Sample Date: 8/5/2004

Weather Conditions: Sunny Breezy, 70°F

Land Cover @ Shore: West Bed = Natural shoreline (wetland edges and trees/shrubs beyond).
East Bed = Residential (some mowed to shore, some maintained in sand/beach)

Sample Preservation: Samples were kept in water in labeled plastic bags at 3-4°C. Any samples not examined within eight days of collection were preserved with ethyl alcohol. Due to a shortage of available ethyl alcohol, only approximately 30 ml of 95% ethyl alcohol could be added to the sample bags (containing apx. 100-130 ml of lake water). All samples appeared to be in good condition at the time of examination.

Other notes: A very common leaf deformity (fused lower leaflets) was seen in the Thomas Lake stem samples. It is unknown whether this deformity may affect weevil success. Also, hardening of nodes and easy breakage of stems – stems beginning auto-fragmentation naturally, or early auto-fragmentation due to refrigeration? This was not seen in other samples, which were refrigerated under same conditions.

Common leaf deformity observed in Thomas Lake stem samples.

Average (*E. lecontei*) milfoil weevil density for Thomas Lake was found to be 0.13 weevils per stem, which seems to be a low natural density. Of the 31 Wisconsin lakes studied by Laura Jester from 1996 to 1997, the mean natural weevil density was 0.65 weevils per stem. (Jester 1998)

Past studies have indicated that densities greater than 2 weevils per stem are associated with EWM declines, but more recent evidence indicates that the density of weevils required to impact EWM may be less than 2 weevils per stem and is highly lake specific. In fact, researchers now suggest that, while densities at or greater than 1 weevil per stem is preferable to achieve EWM *decline*, *control* may occur at levels around 0.25 weevils per stem or lower. (Newman 2004, *pers. comm.*) A factor found to negatively impact weevil populations is a high density of insectivorous fish, such as sunfish. (Newman 2003) It is unlikely that fish predation is a significant limiting factor in Thomas Lake, since fish survey data collected for the Portage County Lake Study shows normal, balanced fish communities. (Turyk 2004, *pers. comm.*) Factors found to positively impact weevils are bed locations that are near shore and growing in shallow water, a higher percentage of natural shoreline, and a higher number of growing tips per plant (bushier plants). (Note: While weevil abundance is correlated with bushier plants, this may be a causal effect of weevil feeding.) (Jester, et al. 1999)

Average weevil density in the West Bed was found to be 0.19 weevils per stem, and average density in the East bed was notably lower (0.06 weevils per stem). (See Figure 6.) One possible cause for this difference between weevil counts is the high amount of natural, vegetated shoreline on the West shore, whereas the East shoreline has more mowed lawns and bare, sandy beach areas. Weevils overwinter in the mud and leaf litter along shore and, therefore, survive best with a higher percentage of natural shoreline that is not mowed, raked, rip-rap, sand or sea-walls. (Jester, et al. 1999) If investments will be made in weevil stocking it will be critical to preserve the natural shoreline on the West half of the lake and to increase the amount of natural vegetation on the East half.

e. Recommended Management Plan for Eurasian Water Milfoil (2004):

Biological Control

Biological control of EWM may be possible if the population density of milfoil weevils can be increased. The EWM infestation developed so quickly, that the weevil populations are likely having a hard time expanding quickly enough to "catch up". Although research on biological control of EWM using milfoil weevils has shown mixed results, Thomas Lake has numerous conditions that positively correlate with successful biological control: natural shoreline on over half the lake, EWM beds near shore, and EWM populations have already reached maximum distributions. (Jester, et al. 1999)

Investing in biological control would be an investment in a long-term, natural control method. Most control methods provide only temporary reductions in EWM populations. It should be understood, however, that biological control is dynamic and that natural fluctuations between EWM and milfoil weevil populations will occur.

1. **Biological Control**

Biological control requires approval from the WDNR.

The Town of Stockton opted to follow the recommendation of biological control. *(See Section XI.f.)*

a. **Weevil Stocking – *Summer 2005***

Purchase Weevils for Stocking:

Weevils can be purchased for stocking from EnviroScience, Inc. in Ohio (1-800-940-4025). (In 2004) EnviroScience, Inc. recommends that a stocking trial should consist of a minimum of 4,000 weevils released together at one location. At present (2004), follow-up surveys are required by the company to evaluate the success of the trial.

OR

Propagate From Local or Nearby Stock:

Thomas Lake, or other lakes nearby that have milfoil weevils, may be able to provide local or nearby propagation stock that would be better acclimated to local lake conditions than stock purchased from out of state. This option may be pursued if there exists the technical and financial support to produce high enough numbers of weevils. (In 2004) EnviroScience, Inc. suggests stocking should consist of a minimum of 4,000 weevils released together at one location. Follow-up surveys would be necessary to evaluate the success of the stocking.

b. **Preservation and Restoration of Natural Shoreline – *Beginning Immediately!***

Milfoil weevils require natural shoreline with leaf litter and vegetation debris to over-winter. Because weevils are weak fliers, the day they emerge from the water to fly to shore and hibernate, they are at the mercy of the wind. The more shoreline that is in natural condition the better the weevils' chances are of landing in suitable habitat. Thomas Lake currently has a good deal of natural shoreline on the West shore, but needs more natural shoreline on the East shore. If money is being invested in weevil stocking, *preservation and restoration of the natural shoreline is strongly recommended*.

Providing winter habitat may be as easy as refining your mowing schedule. See Appendix B for more tips on providing weevil habitat. (See Appendix C for contact information for assistance with shoreline restoration.)

c. **Follow-up Monitoring – *Late Summer 2005***

Biological control may take multiple stocking releases over several seasons for the weevils to become established. Only by monitoring the progress with quantitative sampling can it be determined whether the biological control is succeeding or failing. This may help guide decisions to continue or discontinue the stocking program in 2006 and beyond.

If weevils are purchased from EnviroScience, Inc., monitoring is required by the company. (2004) If weevils are propagated from local stock, monitoring is *strongly* recommended.

2. **Optional: Mechanical Harvesting of Fish Lanes**

Mechanical harvesting requires a permit from the WDNR.

Mechanical harvesting would be a strategic tool for improving the success of the biological control. Heavy pan fish predation on the weevils would greatly impact the weevil population. Mechanical harvesting can be used to create "fish lanes", or travel lanes, for larger predator fish species to use when patrolling for smaller prey fish, thereby reducing the population of the smaller-sized pan fish feeding on weevils. The fish lanes should be created in multiple locations around the lake, extending perpendicularly from shore out to the open water.

Thomas Lake currently appears to have a balanced fish community, so fish lanes may or may not be a critical element to the success of weevil stocking. However, some of these fish lanes could be strategically located at docks to double as boating lanes for residents to access the open water. The WDNR can assist with recommendations for the best spacing or frequency of these fish/boating lanes.

To reduce costs of mechanical harvesting, it may be possible to contract shared use with a nearby harvester. Lake Helen has a harvester but does not have EWM, therefore sharing a harvester with Lake Helen is NOT recommended.

3. **Trained Volunteer Monitoring Crew**

EWM control is never permanent. It will be critical to identify the problem early if the biological control begins to fail. A trained volunteer monitoring crew may help identify problems with EWM control, a new invasive species, or other emerging water quality problems, by surveying the lake annually. It should be understood that biological control is dynamic and that natural fluctuations between EWM and milfoil weevil populations will occur. However, if concerns arise about the continuing effectiveness of biological control of EWM, the WDNR Aquatic Plant Specialist should be consulted. (See Appendix C for contact information.)

4. **Maintain Exotic Species Advisory Signs**

Under Wisconsin Statutes, Chapter 30.715, it is illegal to place a boat, trailer, or equipment that have aquatic plants attached into a navigable waterway. (Wisconsin Legislature: Infobases). "Exotic Species Advisory" signs placed at boat landings can be a reminder to boaters to check for hitch hiking plants.

A well-placed and highly visible sign is currently in place at the boat landing. This sign should be maintained in good condition to help prevent boaters from bringing *additional* exotic species into Thomas Lake or transferring EWM to other lakes.

If this sign becomes damaged or are stolen the WDNR should be notified.

Exotic Species Advisory sign at Thomas Lake boat landing

5. **Lake Residents' Involvement**

The effects of these control methods may not be *immediately* visible. It may take years for weevil populations to increase enough to have an effect on the EWM population, and that effect will be *control*, not eradication. Residents should be informed about what to expect and the long-term goals of the control plans. Also, the success of the predator fish in controlling the pan fish populations may be a contributing factor. Residents can participate in supporting weevil populations by refraining from harvesting the larger predator fish.

6. **Trained Volunteer Watercraft Inspectors**

Because aquatic invasive species spread primarily by hitch hiking from lake to lake on boats and boating equipment, information about invasive species must get into the hands of every boater. The presence of trained volunteer watercraft inspectors, especially on major boating weekends, would be helpful to educate boaters about the invasive nature of exotic species and the importance of checking boats and trailers for "hitch hikers". These trained volunteers could also play a critical role in the early detection of new exotic species or other emerging water quality issues at Thomas Lake.

Thomas Lake is a quiet, minimally developed lake that provides its residents and area communities with a scenic, peaceful recreational alternative to the more heavily trafficked lakes in the area. Lake residents, as well as other conservation groups in Portage County, are encouraged to participate in the volunteer watercraft inspector training workshops and the support network offered by the 'Clean Boats, Clean Waters' Program through the Wisconsin Lakes Partnership. More information about this program is given in Section III.c.

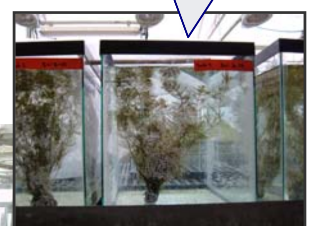
f. Implementation of Recommendations (2005):

The Town of Stockton opted to pursue the biological control plan proposed by the Portage County EWM Studies. Therefore, during the summer of 2005, the EWM Studies worked in partnership with Dr. Ronald Crunkilton and the University of Wisconsin-Stevens Point (UWSP) to boost biological control of EWM on Lake Thomas. (See Section II for methods.)

A total of 1,102 weevils were collected from the Lake Thomas, and 3,464 weevils were released, for a net increase of 2,362 weevils. The project was intended to produce a much higher number of weevils, since many more weevils are needed to notably control the EWM. Despite the disappointingly low stocking totals, by the end of summer an absence of flowering was noted within 15-feet of the release site. This appears to indicate that the weevils stocked were having an impact on plant vigor.

Field personnel searched Lake Thomas for EWM stems with weevils on/in them.

Weevil-containing stems were inspected in the UWSP greenhouse to count the number of weevils on/in them, then bundled together with healthy stems and bound to a rock.



The bundles were placed in a 10-gallon aquarium or 5-gallon bucket in the UWSP greenhouse. Weevils were held for 13-21 days to reproduce in a predator-free environment.

On the scheduled release date, stems were inspected to count the number of weevils. Weevil-containing stems were taken to the stocking site and entwined around existing EWM so weevil larvae could easily move to new stems to feed.

Some observations were made for improvements to the rearing techniques. Firstly, the use of five-gallon buckets as rearing tanks should be eliminated. Experimentation with buckets was intended to cut expenses, however, our average return rate from buckets was 0.63 whereas the tanks provided a 3.95 return rate. When this trend of lower productivity became apparent, use of the buckets was discontinued.

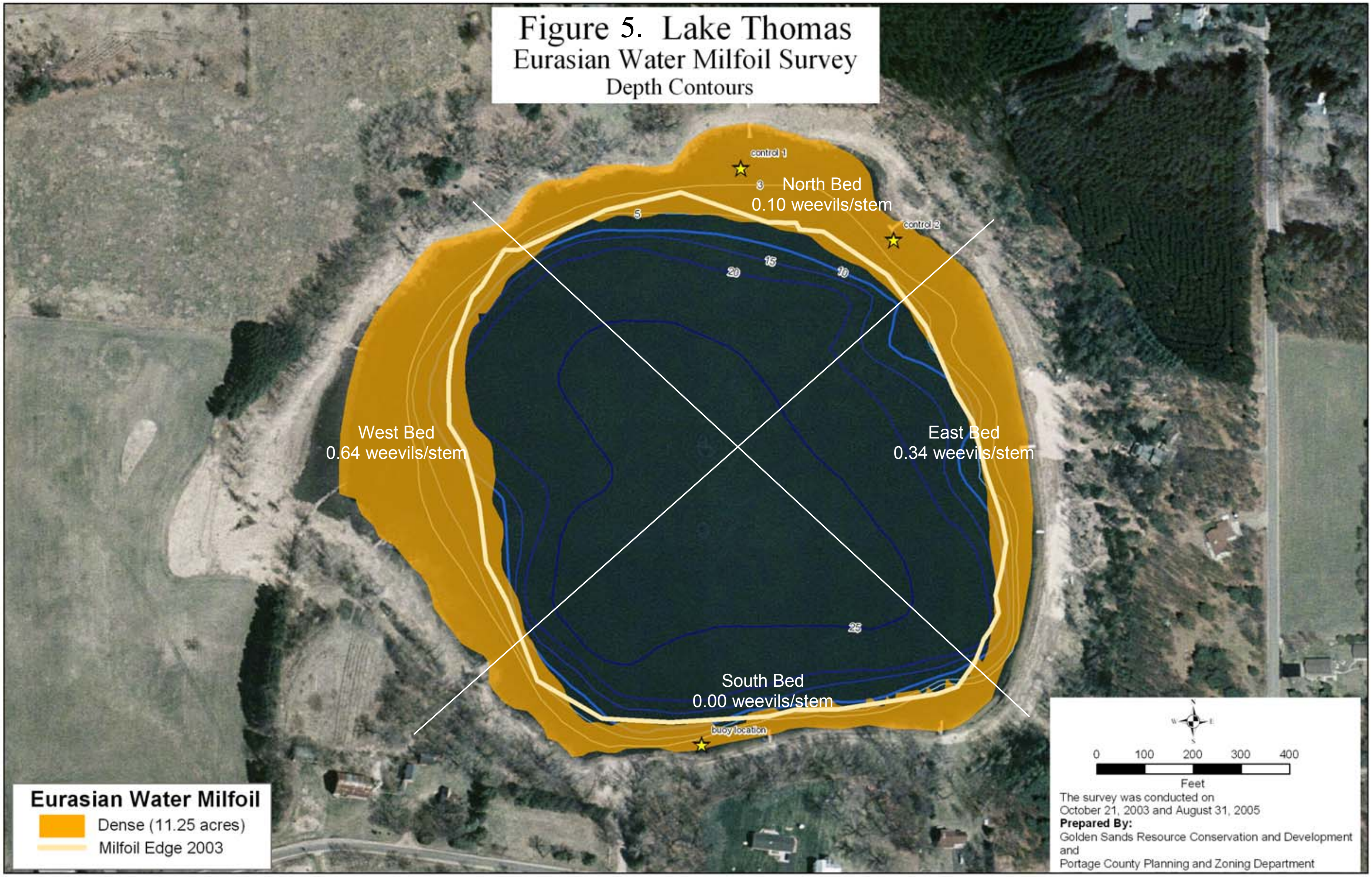
The amount of light that penetrated the sides of the buckets was very low and this was most likely the limiting factor. This was evidenced by the health of the milfoil stems within the buckets. The tips of the stems, which received uninhibited light from above, were healthy and bright green, whereas below the top few inches of the plant the stems were a dull green and in many cases turning brown. The lack of photosynthetic surfaces was detrimental to the health of the milfoil stems and, in return, is believed to have created adverse conditions for weevils. The weevils in buckets were not only struggling to reproduce, they were probably struggling to survive. In future trials, the exclusive use of glass aquaria is strongly recommended. Aquaria allow for light penetration from all directions.

Rearing labs should not only be entirely composed of glass aquaria, but subsequent attempts should be of greater magnitude. Replacing buckets with aquaria would result in a total of 80 aquaria (800 gallons). This volume should be increased by 50% to 120 aquaria (1200 gallons) or, depending on the available workforce, even larger.

In future attempts at rearing weevils, it may be worth consideration to “reuse” weevils and allow them a chance to reproduce multiple times in the ideal conditions maintained in the controlled setting. While research suggests that reproductive rates decline when adults are reused, for the time frame used during this project, this is not likely to be a significant factor. Adults, and initially some larvae, could easily be retained and placed in clean tanks with healthy milfoil stems. This method, if proven to be effective, would allow a significant number of collection hours to be applied elsewhere. The labor saved could be put towards maintaining the increased number of aquaria.

Better temperature regulation is also recommended. Although weevils will reproduce under a wide temperature range, the maximum reproductive rate and success occurs at approximately 29°C (84.2°F). (Mazzei, et al. 1999) Because the greenhouse was equipped to maintain summer conditions, monitoring of water temperatures during this project was irregular, and artificial control of water temperatures was minimally attempted. Although the greenhouse equipment would not have let temperatures drop very low at night, the abnormally *hot* summer weather (the Stevens Point area saw 48 days above 80°F during this rearing project) may have exceeded preferred reproductive conditions. A shade cloth was used experimentally to cover 8 tanks, and it was found that during the summer’s hot-spells, these tanks had the best reproduction rates. When hot-spells passed, however, the reproduction rate dropped below that of the other tanks. While it cannot be said for certain whether the drop in reproduction rate was related to temperature swings, shade cloth, more rigorously applied, could be an inexpensive tool for moderating water temperatures and keeping them closer to ideals.

Results and Observations…. On August 8th, 2005, Lake Thomas was surveyed for milfoil weevils, and on August 31st, 2005, the EWM beds were mapped. Figure 6 shows the EWM map and weevil survey results for 2005. For comparison purposes, the milfoil bed edge, as mapped in 2003, is represented on Figure 6. This comparison suggests that the milfoil may have advanced into deeper waters. Note that 2005 was a drought year, therefore, water levels may have been lower, allowing light to penetrate in areas that were otherwise too deep, which would allow the EWM to advance towards the lake’s center.



North, South, East and West Beds were surveyed for milfoil weevils (*E. lecontei*) on 08/08/05. Stem samples collected from sample beds were examined in laboratory on 08/19/05. Values on map represent average number of weevils per stem for each bed. Average weevil density overall for Thomas Lake was found to be **0.27 weevils per stem**. Buoy location on map indicates stocking site. Locations of two control sites are also indicated.

EWM stems for weevil surveys were randomly collected from the northern, southern, eastern, and western quadrants of the lake, as indicated on Figure 6. Note that samples were not collected within 30 feet of the stocking site. A summary of results is shown in Table 13.

Table 12. Weevil Population Density Survey – Results Summary (2005)

Lab Date	Bed No.*	Depth Range (ft)	Tot # Stem Samples	Ave # Broken Tips	Ave # of Apical Tips	% Stems w/ Weevil Damage	Ave # Eggs per Stem	Ave # Larvae per Stem	Ave # Pupae per Stem	Ave # Adults per Stem	Ave Weevils per Stem (All Life Stages)
8/19/05	**North**	0-13	30	0.34	1.53	17%	0.00	0.00	0.00	0.10	**0.10**
8/19/05	**South**	0-13	30	0.53	1.53	14%	0.00	0.00	0.00	0.00	**0.00**
8/19/05	**East**	0-13	30	0.37	1.84	40%	0.17	0.14	0.00	0.04	**0.34**
8/19/05	**West**	0-13	30	0.57	1.67	27%	0.47	0.14	0.00	0.04	**0.63**
Whole Lake Results		0-12	120	0.45	1.64	25%	0.16	0.07	0.00	0.05	**0.27**

*See Figure 5 for EWM sample bed locations.

<u>Survey Notes:</u>

Sample Date: 8/08/05

Weather Conditions: Sunny, 80°F

Lake Conditions: Secchi Depth = 21 ft

Land Cover @ Shore: North Bed = Residential (some mowed to shore)
South Bed = Residential / boat landing (natural residential / sandy boat landing)
West Bed = Natural shoreline (wetland edges and trees/shrubs beyond).
East Bed = Residential (some mowed to shore, some maintained in sand/beach)

Sample Preservation: Samples were kept in water in labeled plastic bags at 3-4°C. Any samples not examined within eight days of collection were preserved with ethyl alcohol. Due to a shortage of available ethyl alcohol, only approximately 30 ml of 95% ethyl alcohol could be added to the sample bags (containing apx. 100-130 ml of lake water). All samples appeared to be in good condition at the time of examination.

Other notes: At the deep edges, many masses of EWM were "laid over". This was believed to be an adventitious rooting strategy, not due to weevil impacts, which was confirmed upon examination of samples. Those areas were sampled using a plant rake and kept separate from other samples to allow for separate examination and calculations. Those numbers were later combined with the rest of the data. Therefore, this survey had twice as many stems as the others.

Average (*E. lecontei*) milfoil weevil density for Thomas Lake in 2005 was found to be 0.27 weevils per stem, which is approximately doube the 2004 average of 0.13 weevils per stem. Comparison between beds shows variation around the lake. As was the case in 2004, higher natural densities appear in the West Bed, which is the shoreline with the most undisturbed, natural shoreline.

Control sites observed showed good EWM flowering success, evenly distributed around the area. In contrast, the stocking site, located in the South Bed, had a noticeably circular area (approximately 15 feet in diameter) around the buoy that lacked EWM flowering. This indicates that the plants at the stocking location were sufficiently impacted to prevent flowering capability – an indicator of weevil damage. Weevil survey results from the South Bed found 0.00 weevils per stem, but the stocking area was excluded from sample collections. This may indicate that the weevils had not moved far since stocking began on June 17th, 2005.

Although this project had intended to produce more weevils for the stocking site, the lack of EWM flowering surrounding the stocking site does indicate that stocking additional weevils can have an impact on the health and vigor of the EWM in Lake Thomas, which may help to control its spread and reduce its density. The higher 2005 survey results, coupled with the observation of concentrations of natural weevil populations, may suggest that the natural weevil population is building in Lake Thomas. If this is the case, the weevils may become abundant enough to notably control the EWM. There is no way to know if this will happen, or how many years it may take. Artificially boosting the population through stocking may help to push this process along.

Weighing the Options…. On October 11th, 2005, Amy Thorstenson, Golden Sands RC&D Council, Inc., presented the results of the 2005 weevil rearing project and surveys to the Town Board of the Town of Stockton. Thorstenson recommended that a 2006 rearing project, using the improved methodologies, would be possible if a grant from the DNR gets approved. Thomas Lake residents at the meeting expressed the need for action on the EWM problem. The Town of Stockton later opted to pursue this plan.

RESIDENTS ARE ENCOURAGED TO PARTICIPATE:

Residents have been informed of how they can support biological control:

1. **Support milfoil weevils:**
   - ✓ Practice "catch and release" of large predator fish that feed on pan fish. Pan fish feed on milfoil weevils and high populations of pan fish can be a critical stumbling block to increasing weevil numbers.
   - ✓ Provide winter hibernation habitat for weevils by avoiding mowing or raking within 35' of shore. Weevils hibernate under dead leaves and grasses. An undisturbed, **natural shoreline** is good for weevils *and* good for water quality. At a minimum, refraining from mowing or raking after Labor Day or before Memorial Day can leave hibernation material for weevils. If residents have a bare shoreline (sand, rock, etc...) and would like to restore it to native vegetation, contact the County Conservationist, at 346-1216, for technical assistance and cost-sharing options.

2. **Individual Control:**

   A healthy return of native aquatic plant species was observed where residents had controlled EWM around their docks. Therefore, control on an individual level is recommended. Unlimited **manual removal** (raking or hand-pulling) of *non-native* plant species, such as EWM, is allowed, without a permit. If residents can distinguish EWM from native species, this is an option for control. (PLEASE NOTE the state statute requires that whatever vegetation is cut or pulled must be removed from the waterbody! This is to minimize reproduction via stem fragmentation and to reduce the amount of rotting plant material in the water that contributes excess nutrients and reduces dissolved oxygen levels.)

   Optionally, a landowner may apply for an individual DNR permit to use herbicides to control aquatic vegetation and clear an "access corridor" (up to 30-feet wide). Permits are evaluated for approval on a case-by-case basis.

g. 2006 Biological Control Project:

To further boost milfoil weevil densities, weevils were again collected from Thomas Lake during the summer of 2006 and reared in a predator-free environment. (See Section II, Methods, and Section III, Evaluation of Weevil Rearing Methods, for details.) Weevil collections began June 20th and ended August 5th. Tanks stocked from August 5th through August 22nd were stocked with "reused" weevils, or weevils produced in rearing tanks. Weevils were released throughout the course of the summer, from July 11th to September 22nd, at a strategically–positioned stocking location near shore in the South Bed. Figure 7 shows both the 2005 and 2006 stocking locations.

1. Weevil Production Results:

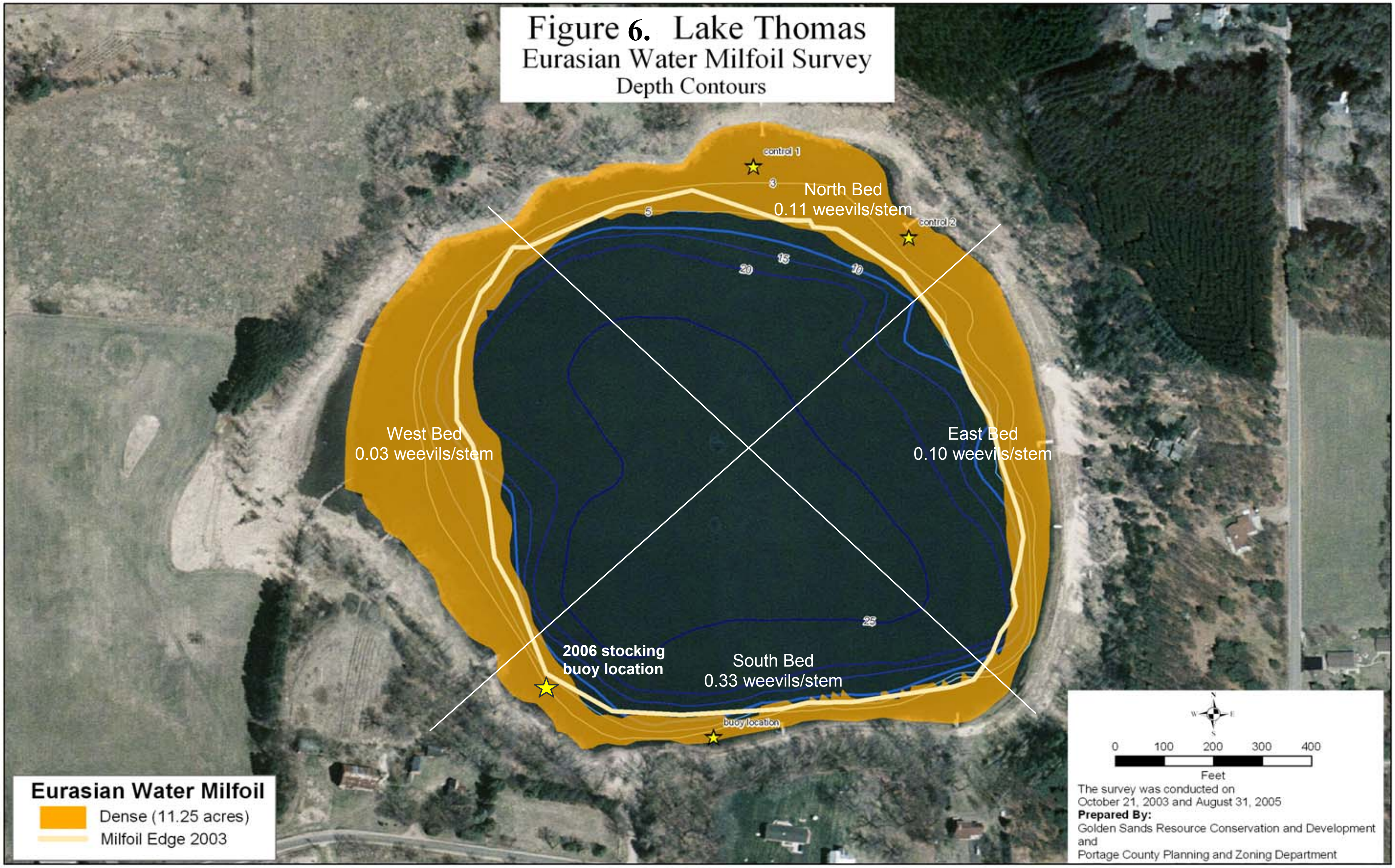
The total number of weevils collected from Thomas Lake was 779. Total number released was 2462, for a net increase of 1683. Target increase was approximately 5000 weevils. However, the multiple difficulties encountered early in the season (discussed in Section II, Methods) critically impacted the overall production levels of the biological control project.

The average return rate for Thomas Lake tanks was 3.23 over the course of the project, but examining the monthly results, the impacts of the early season difficulties on the total production rate become obvious. So much time was spent attempting to correct the early problems with the Springville Pond tanks that filling the Thomas Lake tanks was greatly delayed. June production for Thomas Lake was nearly absent. (See Table 14.)

Table 13. Thomas Lake Weevil Production Results

	Thomas Lake **- Total -**	Thomas Lake **- June only -**	Thomas Lake **- July only -**	Thomas Lake **- August only -**
Total Tanks Filled	109			
Total Input	779 weevils			
Total Output	2462 weevils			
Net Increase	1683 weevils	28 weevils	682 weevils	1001 weevils
% Increase	316%			
Average Return Rate[1]	3.23	---*	3.63	3.03

* Not enough data points for statistics.
[1] Return Rate = number produced divided by number started with



North, South, East and West Beds were surveyed for milfoil weevils (*E. lecontei*) on 08/10/06. Stem samples collected from sample beds were examined in laboratory on 08/24-09/01/06. Values on map* represent average number of weevils per stem for each bed. Average weevil density overall for Thomas Lake was found to be **0.14 weevils per stem**. See map for 2006 stocking location. Locations of two control sites are also indicated.

(*Due to problems with water clarity and time limitations, no survey was completed in 2006 and, therefore, no new map was created. Field observations noted that EWM appears to be spread to the same extent, therefore, the 2005 map created was felt to be sufficiently representative. Additionally, field observations noted that the EWM did not appear to be reaching the surface, or "topping out", as badly as the last few years. The cause for this is undetermined.)

Remarkably, the corrections made to the Springville Pond tanks benefited the Thomas Lake tanks, in that production levels were much improved for Thomas Lake over Springville Pond. A total of 178 tanks and a 100-gallon tub were filled for Springville Pond production, resulting in a net increase of only 1219 weevils, due to the numerous early complications. In contrast, fewer tanks (only 109) were filled for Thomas Lake, but these produced a net increase of 1683 weevils.

July return rate was high (3.63), since production problems had been corrected, but decreased somewhat in August (3.03) when hold times became excessive with field assistance returning to school.

2. Weevil Survey Results:

Weevil surveys on August 10, 2006, showed the average population in the lake was 0.14 weevils per stem. Averages for each sample bed varied, with the South Bed showing the highest average of 0.33 weevils per stem. This is an improvement over South Bed density counts in 2005. Note that the South Bed is where the weevil stocking locations were in 2005 and 2006. Weevil surveys excluded the 2006 stocking location, but influences (or lack thereof) of the 2005 stocking location should be reflected in the survey results. It is unknown whether the higher weevil densities are definitively attributable to weevil stocking, but these measurements may be an indication. (See Table 15.)

Table 14. Weevil Population Density Survey – Results Summary (2006)

Lab Date	Bed No.*	Depth Range (ft)	Tot # Stem Samples	Ave # Broken Tips	Ave # of Apical Tips	% Stems w/ Weevil Damage	Ave # Eggs per Stem	Ave # Larvae per Stem	Ave # Pupae per Stem	Ave # Adults per Stem	Ave Weevils per Stem (All Life Stages)
8/24-8/31	**North**	0-14	27	0.65	2.75	85%	0.00	0.04	0.04	0.04	**0.11**
9/1	**South**	0-14	30	0.48	2.18	58%	0.10	0.23	0.00	0.00	**0.33**
8/24-8/31	**East**	0-14	30	0.63	2.57	10%	0.03	0.03	0.03	0.00	**0.10**
8/31-9/1	**West**	0-14	32	0.71	2.34	44%	0.00	0.00	0.03	0.00	**0.03**
Whole Lake Results		0-14	119	0.63	2.46	34%	0.03	0.08	0.03	0.01	**0.14**

*Refer back to Figure 7 for EWM sample bed locations.

[1]Note that sample size is twice the sample size used in 2005. Number of samples collected was increased to assure statistical confidence with large bed sizes.

<u>Survey Notes:</u>

Sample Date: 8/10/2006

Weather Conditions: Partly sunny, 80°F

Land Cover @ Shore: North Bed = Residential (some mowed to shore)
South Bed = Residential / boat landing (natural residential / sandy boat landing)
West Bed = Natural shoreline (wetland edges and trees/shrubs beyond).
East Bed = Residential (some mowed to shore, some maintained in sand/beach)

Sample Preservation: Samples were kept in water in labeled plastic bags at 3-4°C. Any samples not examined within eight days of collection were preserved with isopropyl alcohol.

Other Notes: Another hot, sunny drought year.

A comparison of surveys over the last 3 years shows that overall weevil densities have remained low but concentrations from bed to bed have varied. The South Bed has shown improvement in weevil densities. Overall percentage of weevil-damaged stems appears to have increased, as well. (See Table 15.)

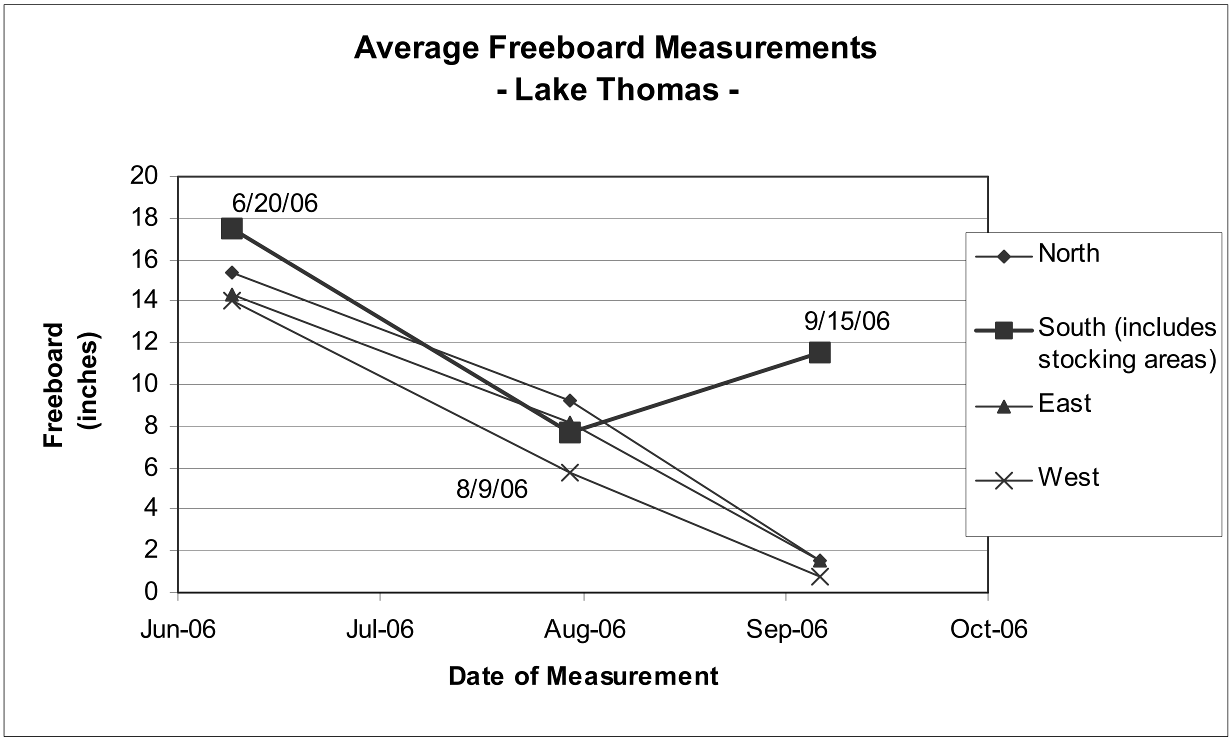
Table 15. Weevil Population Density Survey – Results Comparison, 2004-2006

Bed No.	Survey Year	Survey Date	# stem samples in survey	% of stems algae covered	% of stems w/ weevil damage	Ave eggs per stem	Ave larvae per stem	Ave pupae per stem	Ave adult per stem	Ave weevils per stem (all stages)
West	2004	8/5/04	36	31%	25%	0.00	0.17	0.00	0.03	0.19
East	2004	8/5/04	31	48%	10%	0.03	0.00	0.03	0.00	0.06
							Whole Pond Average (2004):			**0.13**
North	2005	8/19/05	30	40%	17%	0.00	0.00	0.00	0.10	0.10
South	2005	8/19/05	30	40%	14%	0.00	0.00	0.00	0.00	0.00
East	2005	8/19/05	30	20%	40%	0.17	0.14	0.00	0.04	0.34
West	2005	8/19/05	30	7%	27%	0.47	0.14	0.00	0.04	0.63
							Whole Pond Average (2005):			**0.27**
North	2006	8/10/06	**27**	90%	85%	0.00	0.04	0.04	0.04	0.11
South	2006	8/10/06	**30**	89%	58%	0.10	0.23	0.00	0.00	0.33
East	2006	8/10/06	**30**	93%	10%	0.03	0.03	0.03	0.00	0.10
West	2006	8/10/06	**32**	94%	44%	0.00	0.00	0.03	0.00	0.03
							Whole Pond Average (2006):			**0.14**

Freeboard and temperature measurements were taken to document possible differences between stocked quadrants and non-stocked quadrants. (See Section II, Methods, for more detail.) Freeboard is the distance from the surface of the water to the top of the EWM stem. A freeboard of zero inches indicates that the EWM was reaching the surface. Weevil impacts usually cause a loss of stem buoyancy; therefore, heavy weevil activity would be likely to result in a higher average freeboard.

Freeboard measurements appeared quite similar between the quadrants until late in the season, which is when weevil impacts are most likely to be measurable and/or visible. The September freeboard measurements averaged about 10-inches higher in the South Bed, which correlates with the general field observations that the EWM in the South Bed appeared less vigorous overall than elsewhere on the lake. Note that the South Bed is where the weevil stocking locations were in 2005 and 2006. It is unknown whether this is definitively attributable to weevil stocking, but these measurements may be an indication of stocking impacts. (See Chart 6.)

Chart 6. Average Freeboard Measurements – Thomas Lake

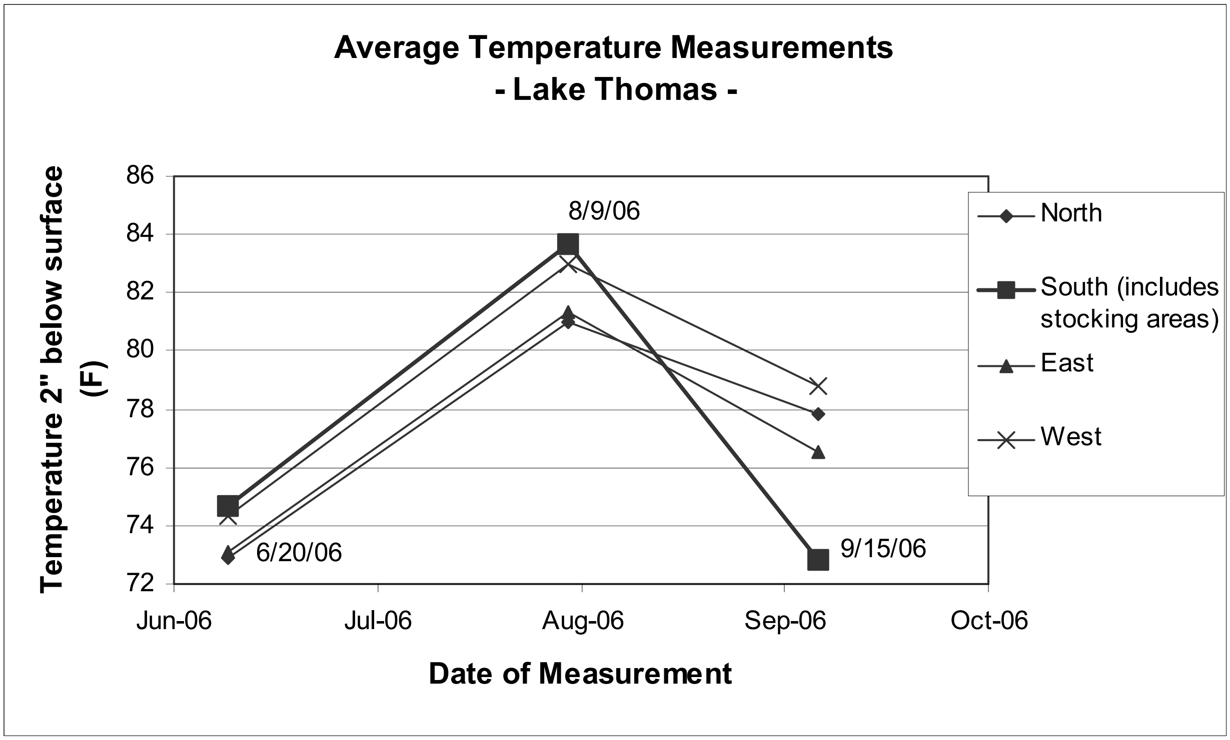


Temperature measurements were taken at approximately 2½-inches below the water surface. Where EWM stems are dense at the surface, forming a "mat", water is restricted from circulating and sunlight is absorbed by the plants at the surface, resulting in abnormally warm and stagnant surface temperatures. For instance, when temperatures were measured in 2006 in EWM mats, the water at the surface (zero-inches deep) was approximately four degrees warmer than temperatures measured at 2½ -inches below surface, and approximately 8 to 13 degrees warmer than temperatures at 12-inches below surface.

Weevil impacts cause EWM stems to lose buoyancy and drop away from the water surface, restoring more normal water cycling and temperature gradients. Therefore, where weevil activity is high, cooler surface temperature should be measurable.

Temperature measurements in the South Bed averaged approximately three degrees (Fahrenheit) less than the average temperatures in the other beds. These results correspond with the higher average freeboard measurements and field observations that EWM was less vigorous in the South Bed. Note that the South Bed is where the weevil stocking locations were in 2005 and 2006. It is unknown whether this is definitively attributable to weevil stocking, but these measurements may be an indication of stocking impacts. (See Chart 7.)

Chart 7. Average Temperature Measurements – Thomas Lake



3. Summary and Recommendations:

Although the 2006 project sought to rear a much larger number of weevils for stocking in 2006, survey data appears to indicate that stocking in 2005 has had a measurable effect. This would suggest that stocking in 2006 (of similar numbers) should also have an effect. Maintaining and/or restoring natural shoreline vegetation may help to increase the weevil population by providing suitable winter habitat.

When the weevil population becomes high enough to reduce the EWM population, native aquatic vegetation will rebound and again provide quality habitat structure for fish. Until then, residents can offer better fish habitat on a localized level through manual control of EWM.

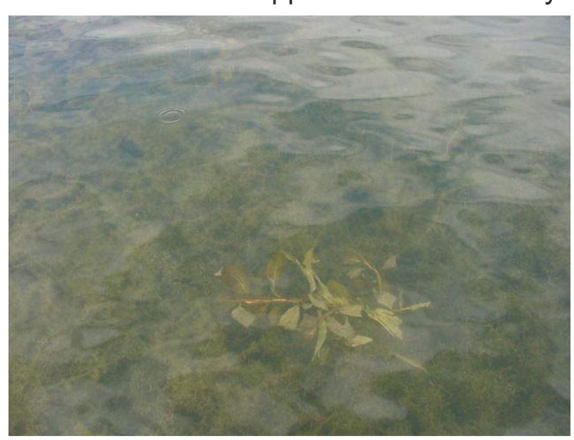
a. **Earlier and Larger Weevil Stocking** – If further stocking is desired to speed the biological control process, it is recommended to stock much higher numbers and earlier in the season, if possible. The drawback with the rearing method used in 2005 and 2006 is that it takes all season to produce the weevils. Thus, the effects are not seen until the following season. Purchasing weevils would provide early-season stocking and more immediate effects.

b. **Shoreline Restoration** – "Fortifying the Lake's Immune System"
Natural shoreline vegetation, on-shore and in the water, acts as the lake's immune system, protecting it from pollutants and invasive species. Providing natural on-shore vegetation can also provide winter hibernation habitat for weevils.

Providing winter hibernation habitat for weevils can be as easy as avoiding mowing and raking within 35 feet (or 50 feet, if possible) of shore from Labor Day through Memorial Day. More tips on supporting biological control are available in Appendix B. If residents have a disturbed shoreline (sand, rock, mowed lawn, etc...) and would like to restore it to native vegetation, they can contact the County Conservationist, at 346-1216, for technical assistance.

c. **Individual Control Options** - Hand-pulling efforts by residents in 2006 showed good, long-lasting control and the return of native vegetation. **Manual removal** (raking or hand-pulling) is a simple option for control in individual areas, and the law allows unlimited manual removal of *non-native* plant species, such as EWM. Care should be taken to remove the entire plant, roots included, to minimize re-sprouts. (PLEASE NOTE the state statute requires that whatever vegetation is cut or pulled must be removed from the waterbody! This is to minimize reproduction via stem fragmentation and reduces the amount of rotting plant material in the water that contributes excess nutrients and reduces dissolved oxygen levels.)

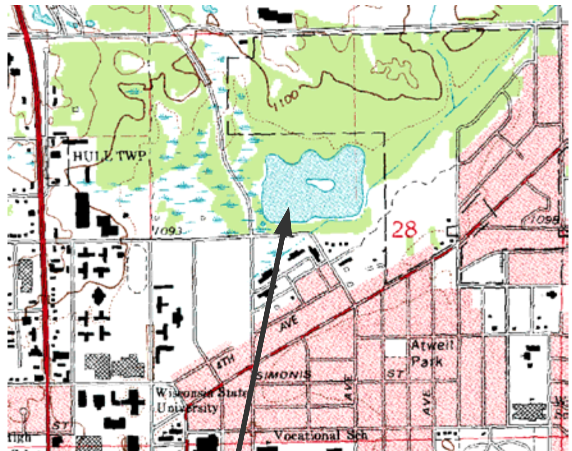
Optionally, a landowner may apply for an individual DNR permit to use herbicides to control aquatic vegetation and clear an "access corridor" (up to 30-feet wide). Permits will be evaluated for approval on a case-by-case basis. (Note: Any bare areas are prone to invasion by exotic species, so it is wise to limit the size of the access corridor to only what is necessary.)



Native vegetation thrives in an area where EWM has been manually controlled by a Thomas Lake resident. Photo taken 8/9/06.

VI. LAKE JOANIS

a. Lake Background



Lake Joanis on USGS topographic map.

Lake Joanis is located in Schmeeckle Reserve, on the north side of the City of Stevens Point. The lake was a borrow-pit for highway improvement projects that eventually filled with water. The total surface area is 23 acres and the maximum depth is 25 feet. The water of Lake Joanis mostly comes from groundwater, with some contributions coming from runoff and precipitation. Water exits the lake to groundwater. (UWSP and Portage County 2003, Preliminary Results) (See Appendix C for definitions of terms.) The lake is surrounded by a wildlife reserve with well-maintained walking trails around the periphery and hand-carry boat access only.

Lake Joanis historically has been an oligotrophic lake. Total phosphorus levels historically average approximately 14 parts per billion (ppb). Average phosphorus levels for the year 2002-03 were approximately 21 ppb, which is just over the mestrophic level of 20 ppb but is still lower than other seepage lakes in Portage County. (UWSP and Portage County 2003, Preliminary Results) (See Appendix C for definitions of terms.)

In Lake Joanis, Secchi depth (a measure of water clarity) has historically ranged from 6 to 14 feet and is considered good when compared with the regional average of 9 feet for similar lakes. Secchi depth averages for 2002-03 were better than historical averages, with best clarity in May (21 feet) and poorest in July (14 feet). Fluctuations in water clarity throughout the season are normal, due to increases and decreases of algae population and sedimentation. (UWSP and Portage County 2003, Preliminary Results) (See Appendix C for definitions of terms.)

b. History of Aquatic Plant Control in Lake Joanis

There has been no previous need for nuisance weed control, and there are no WDNR records of treatments. Table 4 lists aquatic vegetation species documented in Lake Joanis.

Table 16 - List of Documented Aquatic Vegetation
(Submergent and Floating Leaf Aquatics Only)

	Survey Records for Lake Joanis *	
	Scientific Name	Common Name
1	*Callitriche palustris*	Common water starwort
3	*Elodea Canadensis*	Waterweed
4	*Myriophyllum sibiricum*	Northern water milfoil
5	*Myriophyllum spicatum*	Eurasian water milfoil
6	*Potamogeton amplifolius*	Large leaf pondweed
7	*Potamogeton gramineus*	Variable pondweed
8	*Potamogeton spirillus*	Snail-seed pondweed

* Records collected by Robert W. Freckmann in 2003 for Portage County Lakes Study. (Note: These records are documentation of submersed and floating-leaf vegetation identified at Jordan Pond during that vegetation survey. *This is not an exclusive list.*)

(e) Exotic invasive

c. Mapping Results

On June 2nd, 2006, multiple areas of sparse to dense EWM growth were mapped. Dense EWM growth totaled 0.08 acres and sparse growth totaled 0.60 acres. Note that this mapping was done early in the season. Early-season mapping reduces confusion with native vegetation, but EWM beds may have expanded over the season. Updated mapping in 2007 is recommended to assist with EWM control planning. (See Figure 1.)

d. Recommended Management Plan for Eurasian Water Milfoil:

Hand-Pulling

Because of Lake Joanis's remarkable water clarity, EWM could easily grow to a depth of 20 feet or more, depending on suitability of sediments. Chemical treatments are not recommended at this time, since the resultant release of nutrients would likely cause a severe algal bloom in a lake of such a small size.

If hand-pulling efforts are begun right away, this small, localized infestation could be eradicated. The soft, sandy sediments of Lake Joanis should make complete removal of the root systems possible. Because of the depth of many of the beds, a volunteer diving crew would be helpful.

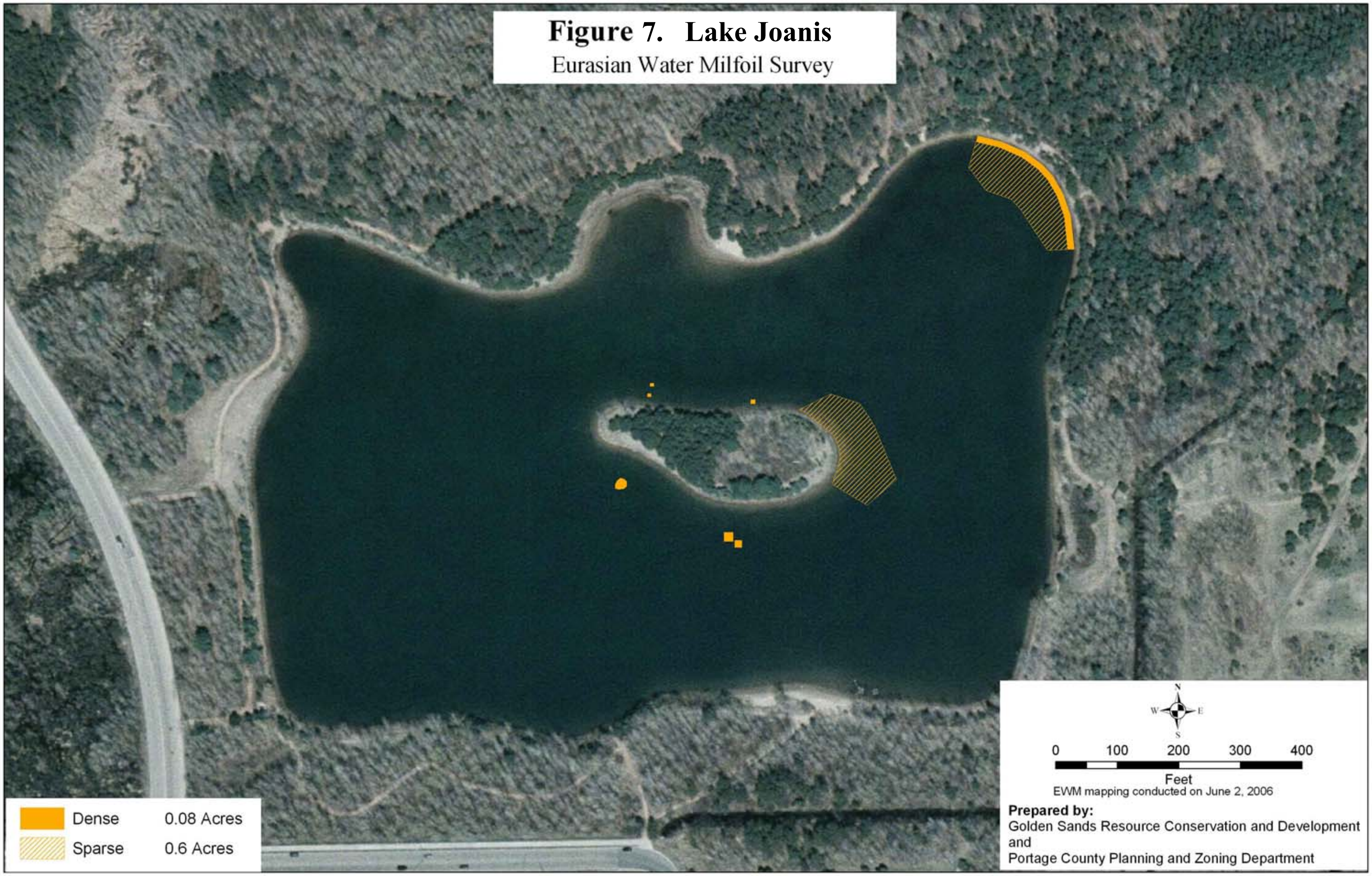
Exotic species can be pulled by hand without a permit from the WDNR. Volunteers/professionals engaged in this activity should be trained in the proper identification and removal of EWM. EWM can be cut at the sediment line or (preferably) hand-pulled, roots and all. If hand-pulling is done, the sediment may need to be loosened with a pitch fork to make total removal of the roots possible. Follow-up monitoring must be done to check for re-sprouts. ALL PLANT PARTS must be removed and destroyed or disposed of. (Any piece of EWM stem, two inches or longer, can sprout into a new plant, so removal of any loose, floating EWM stems is important!)

Investigate Biological Control

Something to consider about biological control is that it may take longer than desired for the predator (milfoil weevils) to come into balance with the prey (EWM), therefore, “control” may be a much weedier condition than what the public is currently used to seeing in Lake Joanis.

If biological control is a desired control option, careful planning and a multi-pronged approach may avoid this situation. Prior to initiating a stocking program, it is recommended that a weevil population density survey be conducted to gather background information about the native weevil population, if there is one. If stocking is done, the recommended location is the EWM bed in the northeast corner of the lake. This is a localized (not spread out) EWM bed in shallow water, close to shore and located in a small, sheltered bay. These factors all provide a strategic advantage for the weevils and correlate positively with stocking success.

It is not recommended to attempt stocking around the island, as this appears a tenuous location for starting a reliable weevil population. It is recommended that other methods, especially hand-pulling, be utilized in this area.



Field mapping on June 2nd, 2006, found only a few, isolated EWM colonies. Dense acreage totaled approximately 0.08-acres, and sparse growths totaled 0.60-acres. Depth contours not available. Note that this mapping was done early in the season. Early-season mapping reduces confusion with native vegetation, but EWM beds may have expanded over the season. Updated mapping in 2007 is recommended to assist with EWM control planning.

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VIII. APPENDICES

Appendix A. How to Prevent the Spread of Aquatic Invasive Species

(Modified from WDNR and UW-Extension Informational Materials)

Steps YOU Can Take to Help Prevent the Spread of Aquatic Invasive Species

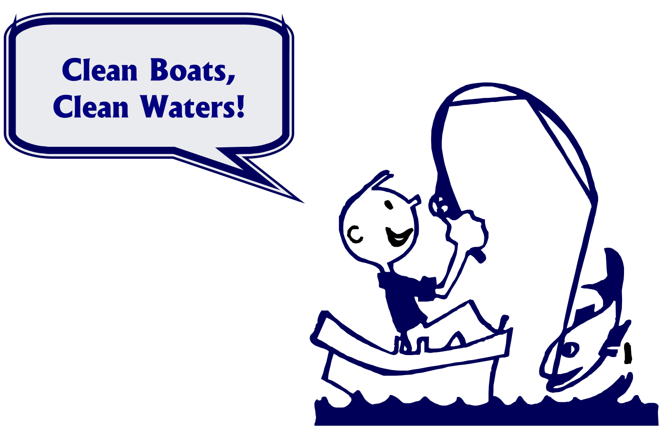
Reminder sign at Lake Emily public boat landing

- ✓ **Clean your boat**. Inspect your boat and other equipment, such as anchors, fishing lines and boat trailer for aquatic plants, animals and mud, and remove them before leaving the boat landing.

- ✓ **Drain all water**. Drain the water from your boat, motor, live wells, bilge and other equipment before leaving the boat landing.

- ✓ **Dispose of live bait**. Dispose of unwanted live bait in the trash or share it with a fellow angler. Do *not* transfer bait or water from one body of water to another.

- ✓ **Rinse your boat**. Rinse your boat and equipment with high pressure or hot water, especially if moored for more than one day,
OR
Dry everything for at least 5 days before entering another water body.



Appendix B. How to Help Your Milfoil Weevils
(Compiled from various public education materials)

How **YOU** Can Help Your Milfoil Weevils Battle Eurasian Water Milfoil

Research on distribution of the native milfoil weevil, *Euhrychiopsis lecontei*, has found the weevil to be present in almost every lake surveyed. However, some important factors may affect the success of the weevil on some lakes. Here's what you can do to help your native population of milfoil weevils do the best job they can at battling Eurasian Water Milfoil…

- ✓ **Provide Habitat**. Create "Buffer Zones" along the lakeshore, where vegetation and leaf litter within 35 feet of shore is left natural and **not mowed, raked or removed**. This will provide milfoil weevils with good winter habitat for hibernation and help keep the lake healthy, too! If tidy lawns are your preference, you can still provide winter habitat for weevils by refraining from mowing or raking from Labor Day to Memorial Day. If you don't live on the water, you can still advocate for lake health by encouraging your local park department to use buffer zones!

Natural vegetation helps milfoil weevils, adds beauty, protects water quality and attracts wildlife, too! A buffer zone of 35 feet is good, but MORE IS BETTER!

- ✓ **No-wake Zones**. Work with your lake association to establish no-wake zones, marked with buoys, around Eurasian Water Milfoil beds where stems are within reach of boat props or wash. This will help prevent the spread of Eurasian Water Milfoil and help the weevils get established in that bed.

- ✓ **Discourage Eurasian Water Milfoil**. The presence of native aquatic plants, like bull rushes or lily pads, not only provides wildlife habitat and reduces shoreline erosion, but also provides competition against new invasive species. Think of native vegetation as "the lake's immune system"!

Sandy beaches, sea-walls, rip-rap and mowed lawns do NOT offer good winter habitat for milfoil weevils or protection of water quality.

Decorative edging, bird houses, eye-catching wildflowers or a winding path to access the waterfront can add to the attractiveness of your buffer zone.

Appendix C. Contacts and Resources

- For Copies of this Report:
  Steve Bradley, County Conservationist, Portage County Land Conservation Division of the Planning & Zoning Department, Portage County Courthouse Annex, 1462 Strongs Avenue, Stevens Point, WI 54481, (715) 346-1334

- WDNR Aquatic Plants Contact:
  Deborah Konkel, Aquatic Plant Specialist, WDNR, 1300 West Clairemont Avenue, PO Box 4001, Eau Claire, WI 54702, (715) 839-2782

- Questions About this Report:
  Amy Thorstenson, Project Assistant, Golden Sands Resource Conservation & Development Council, Inc., Portage County Courthouse Annex, 1462 Strongs Avenue, Stevens Point, WI 54481, (715) 343-6215, *thorstea@co.portage.wi.us*

- Clean Boats, Clean Waters Program:
  Laura Felda, Volunteer Monitoring Coordinator, UW-Extension Lakes Program, UW-Stevens Point-CNR, 1900 Franklin Street, Stevens Point, WI 54481-3897, (715) 346-3366

- Shoreline Restoration Assistance:
  Portage County Land Conservation Division of the Planning & Zoning Department, Portage County Annex, 1462 Strongs Avenue, Stevens Point, WI 54481, (715) 346-1334. Technical assistance available. Some locations may be eligible for cost-sharing assistance.

- Contacts and Resources On-Line:
  "The Wisconsin Lakes Partnership Contacts" lists the Wisconsin Association of Lakes, WDNR contacts, UW-Extension Statewide Lake Specialists, Self–Help Lake Monitors; Adopt-A-Lake contacts and other resources. It is Publ-FH-407 "**The Lake List**" and can be viewed at http://www.WDNR.state.wi.us/org/water/fhp/lakes/contacts.htm.

- Aquatic Plant Identification Guide:
  An excellent aquatic plant field guide, *Through the Looking Glass: A Field Guide to Aquatic Plants*, by S. Borman, R. Korth and J. Temte is available from the Wisconsin Lakes Partnership, UW-Extension Lakes Program, UW-Stevens Point-CNR, 1900 Franklin Street, Stevens Point, WI 54481-3897, (715) 346-3366.

- Grant Funding for Control of EWM:
  Aquatic Invasive Species Grant Program: Provides state cost-sharing assistance for the plan development, invasive species surveys, watercraft inspections, development of educational materials and WDNR approved control plans. This program does not cover routine control, such as mechanical harvesting or annual herbicide applications for seasonal relief. For more information, contact the WDNR Lake Coordinator or Environmental Grant Specialist for the West Central Region at (715) 839-3700.

  Recreational Boating Facilities Program: Provides state cost-sharing assistance for various lake recreation improvement projects, including the routine EWM control projects not covered under the Aquatic Invasive Species Grant Program. Only government units and qualified lake associations are eligible for this program. For more information, contact the Community Services Specialist for the West Central Region at (715) 836-6574.

Appendix D. Terms and Definitions

Watershed = Land surface over which water flows before reaching a lake or water body.

Surface Watershed = Land area where water runs off the surface of the land and drains toward the lake (UWSP and Portage County 2003, Preliminary Results).

Groundwater Shed = Land area where water soaks into the ground and travels underground to the lake (UWSP and Portage County 2003, Preliminary Results).

Oligotrophic = A waterbody poor in nutrients, biomass and plant life and rich in oxygen (Collins English Dictionary ©2000). Phosphorus is the limiting nutrient in over 80% of Wisconsin's lakes (UWSP and Portage County 2003, Preliminary Results). Usually a "young" lake with very clear water.

Mesotrophic = A waterbody of intermediate levels of nutrients, biomass, plant growth and water clarity.

Eutrophic = A waterbody rich in organic and mineral nutrients and supporting abundant biomass and plant life, which while living supplies the oxygen for animal life but in the process of decaying also depletes oxygen. (Collins English Dictionary ©2000) Phosphorus is the limiting nutrient in over 80% of Wisconsin's lakes, and levels of 30 parts-per-billion indicate a eutrophic status. Excessive phosphorus leads to nuisance plant growth and frequent algae blooms. Usually an "old" lake, but lakes can be prematurely aged by excessive phosphorus inputs from human activities. (UWSP and Portage County 2003, Preliminary Results)

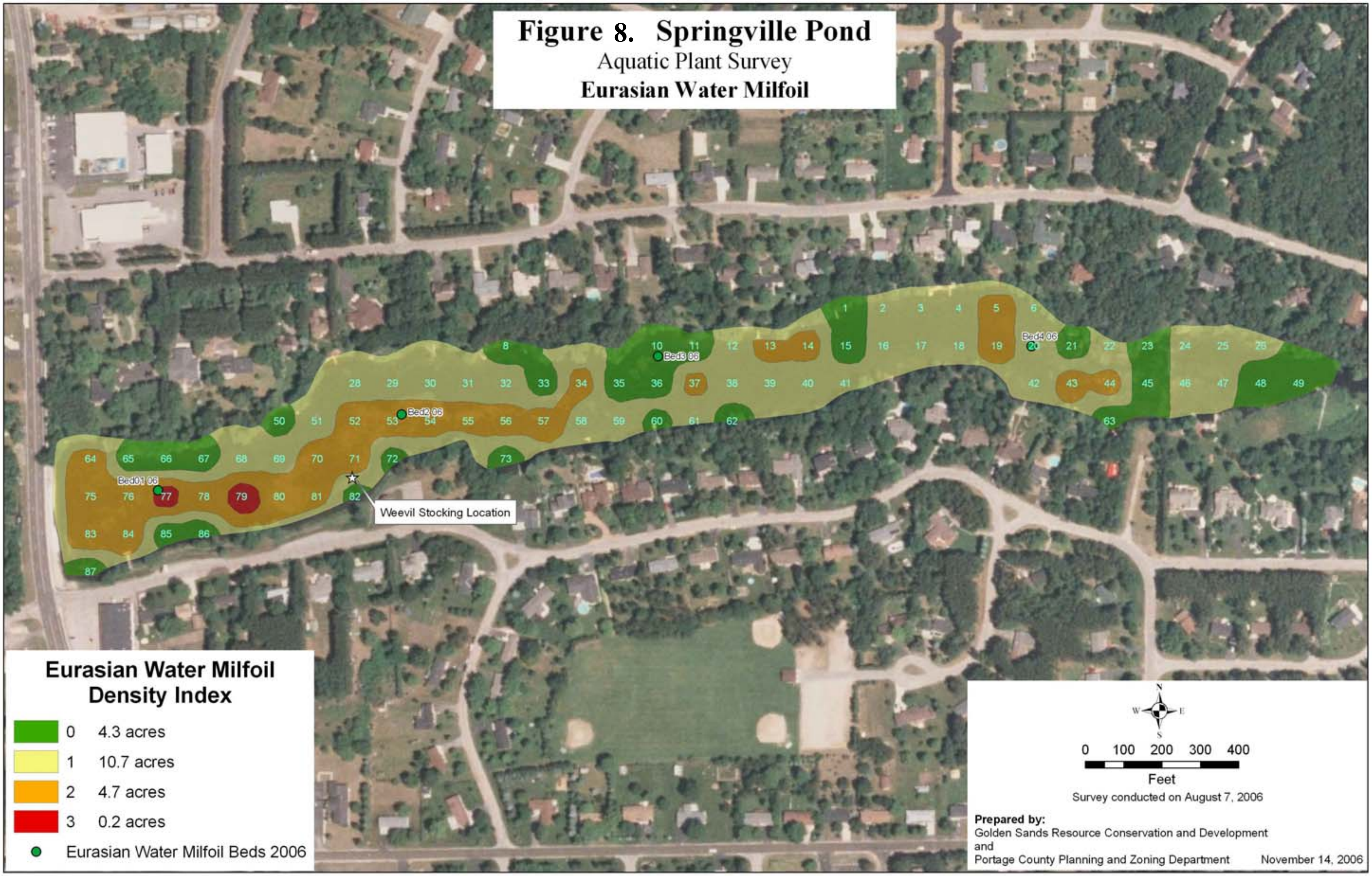
Secchi Depth Reading = The depth to which a secchi disk can be lowered into the water and still be visible. A measurement of water clarity. A low secchi depth numbers indicate poor water clarity, which may be due to sedimentation, algae blooms, tannins and other dissolved or suspended materials.

Drawdown = To lower the water level of a water body by a desired amount using a water level control structure, such as a dam.

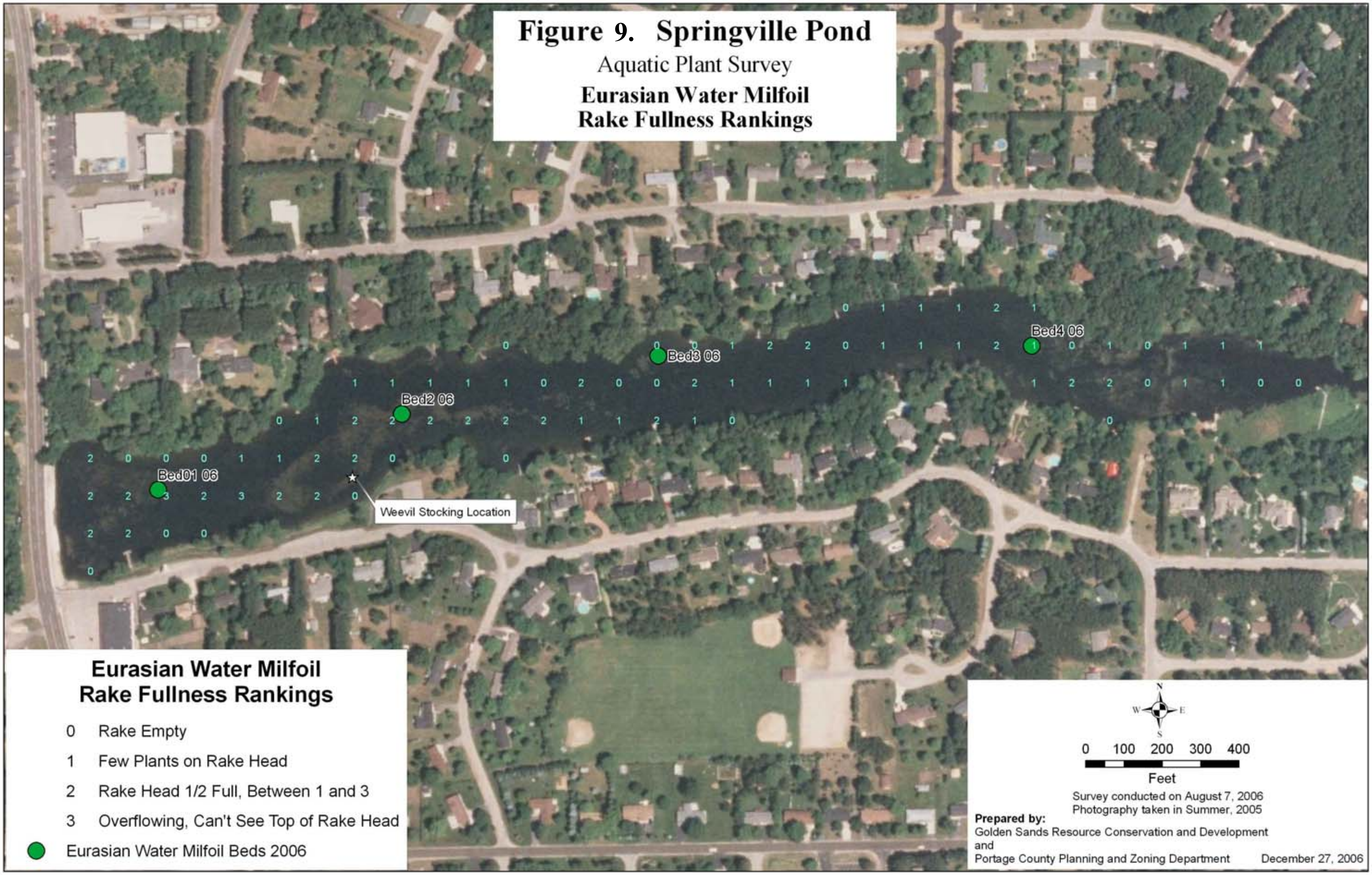
Return Rate = (As in weevil production) The number produced divided by the number started with. Average Return Rate is the average of all return rates throughout production.

Freeboard = The distance from the water surface to the top of the plant (EWM) stems.

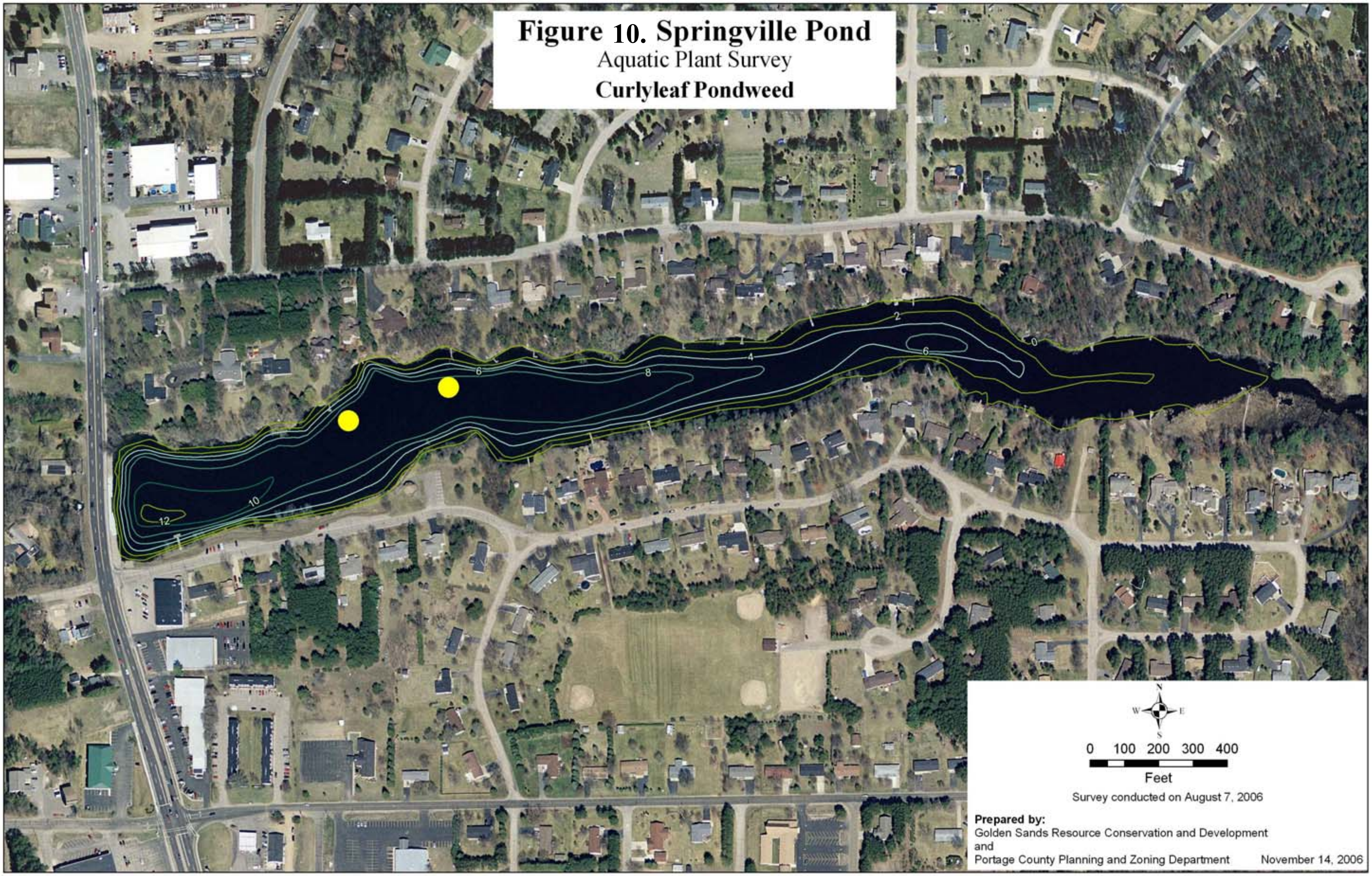
Appendix E. Aquatic Plant Survey Maps – Springville Pond



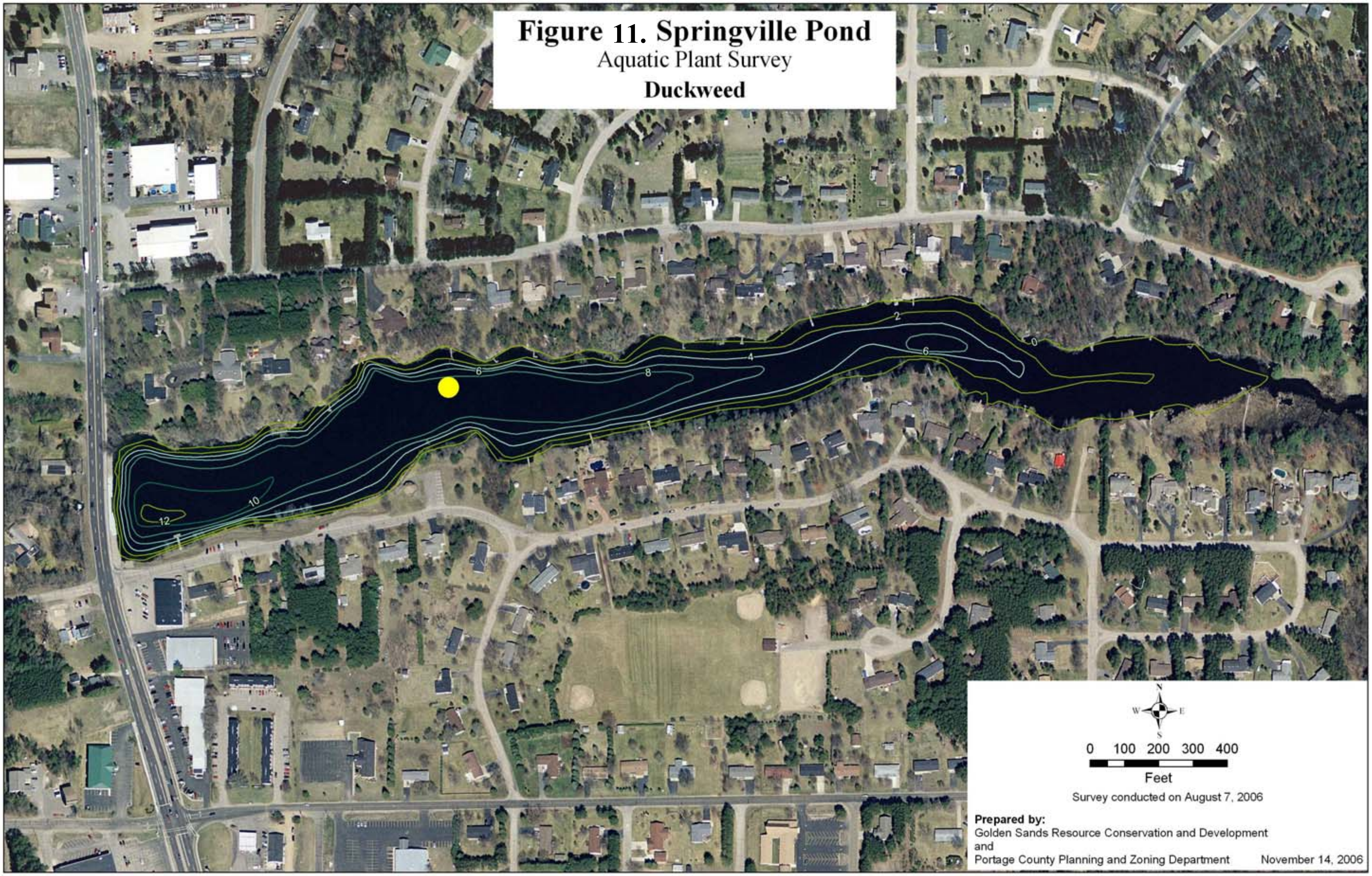
Aquatic plant survey points, shown on EWM map. Survey conducted August 7, 2006. See Section II for Methods. See Section IV.g. for discussion on mapped EWM acreages and results discussion.



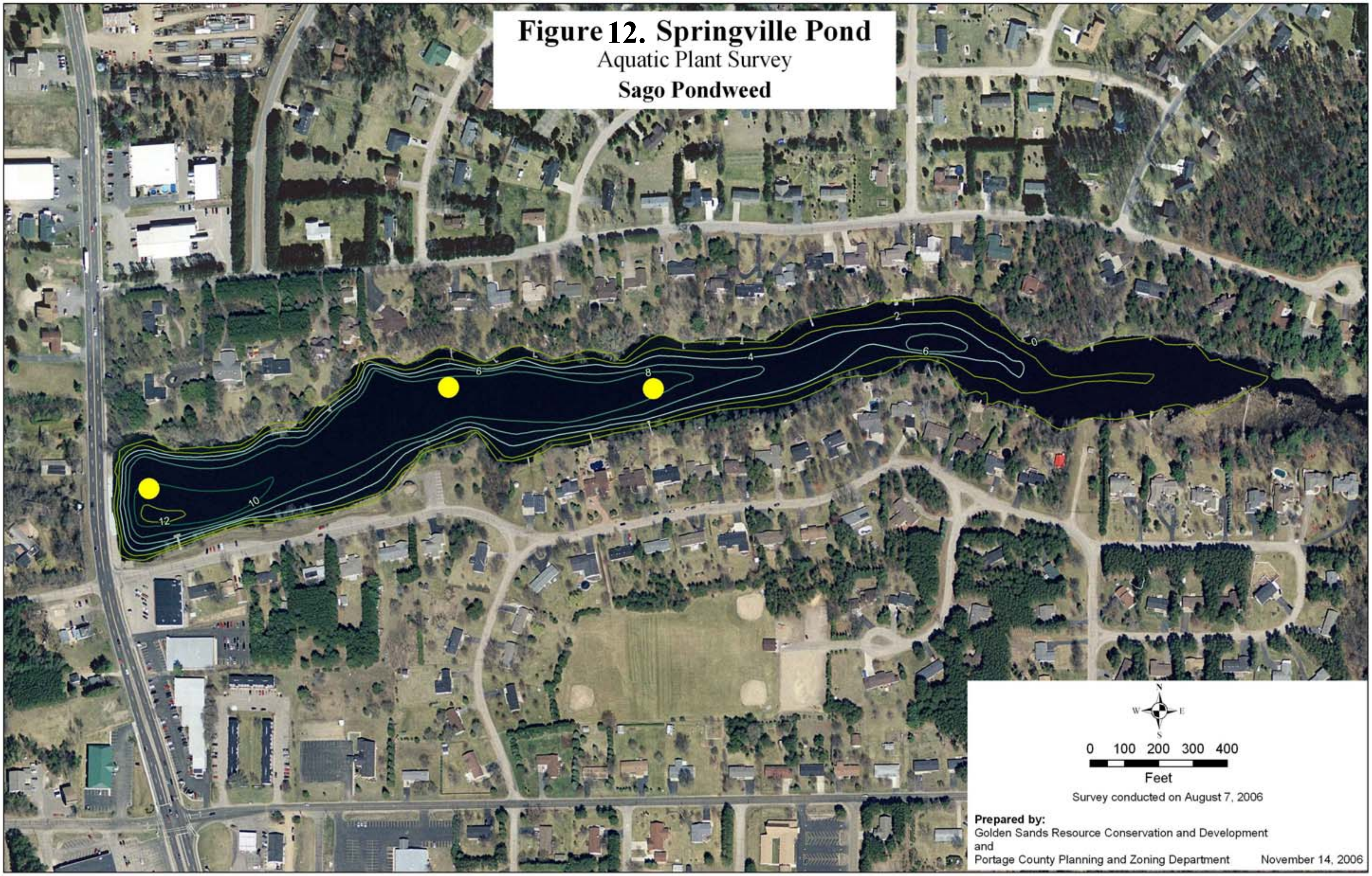
Aquatic plant survey point rake fullness rankings for EWM. Survey conducted August 7, 2006. Rankings at sample points were used to create the EWM map shown in Figure 4 and Figure 8 in Section IV.g. See Section II for Methods for further details on sampling methods. See Section IV.g. for discussion on mapped EWM acreages and results discussion.



Aquatic plant surveys on August 7th, 2006, found curly pondweed (*Potamogeton crispus*) present only minimally. Points on the map demark <u>location only</u>, not extent, of presence. Curly pondweed was ranked a “1” at each location found, meaning it was only minimally present on the rake. (See Section II for Methods.) Curly pondweed is an exotic, and often invasive, plant species that thrives in coldwater conditions. It dies back mid-summer, releasing nutrients into the water at a time that often coincides with algal blooms, exacerbating the severity of the bloom.



Aquatic plant surveys on August 7th, 2006, found duckweed (*Lemna minor*) present only minimally. Points on the map demark location only, not extent, of presence. Duckweed was ranked a "1" at the location found, meaning it was only minimally present on the rake. (See Section II for Methods.)



Aquatic plant surveys on August 7th, 2006, found sago pondweed (*Potamogeton pectinatus*) present only minimally. Points on the map demark location only, not extent, of presence. Sago pondweed was ranked a "1" at each location found, meaning it was only minimally present on the rake. (See Section II for Methods.) Sago pondweed is a drawdown tolerant plant species.