BIG BOWMAN POND OUTLINE
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1. STATE OF THE LAKE REPORT

Introduction

- Big Bowman Pond is a small, glacially formed dimictic lake located in the eastern portion of New York State within the Town of Sand Lake in Rensselaer County. This lake is one of 350 lakes in the Lower Hudson River basin and is one of 55 lakes in the county. Big Bowman Pond is one of the smaller lakes within the region having a surface area of 12.2 hectares (ha), and it is located within a watershed area of 235 ha which gives the lake a total drainage basin area ratio of approximately 19:1 (Table 1, Figure 1). This lake is also shallow with a maximum depth of about 10 meters (m) (Table 1).

Waterbody classification and Lake Use

- Big Bowman Pond is classified as a Class B waterbody by the New York State Department of Environmental Conservation (NYSDEC). This means that the best intended use for Big Bowman Pond is for contact recreation, such as swimming and bathing, and non-contact recreation, such as boating and fishing. Motorized boating is prohibited due to an ordinance passed by the town of Sand Lake in 1988. This was consistent with an informal policy on the lake supporting swimming and other recreational use. There is a small dam (2 feet long by 0.5 feet high) on the west side of the lake which is used to control water level and is classified as a Class A dam. The lake has no public access and is privately owned by the surrounding land owners.

Table 1. Morphological characteristics for Big Bowman Pond and its drainage basin. All in-lake calculations are based on the bathymetry map provided by the NYSDEC. Volume was calculated following the method of Wetzel (2001) which takes the sum of truncated cones.

Characteristic	Metric	English
Surface area	12.2 ha	30.2 ac
Max depth	10.1 m	33.13 ft
Mean depth	4.5 m	14.76 ft
Relative depth		
Volume	436854.44 m^3	354.16 ac-ft
Max length	0.724 km	0.45 mi
Max effective length	0.724 km	0.45 mi
Max width	0.273 km	0.17 mi
Max effective width	0.273 km	0.17 mi
Mean width		
Shoreline length	1.93 km	1.2 miles
Shoreline development index		1.67
Drainage basin	235 ha	580.70 ac
Drainage basin: lake area ratio		19.26
Hydraulic retention time		0.4 years

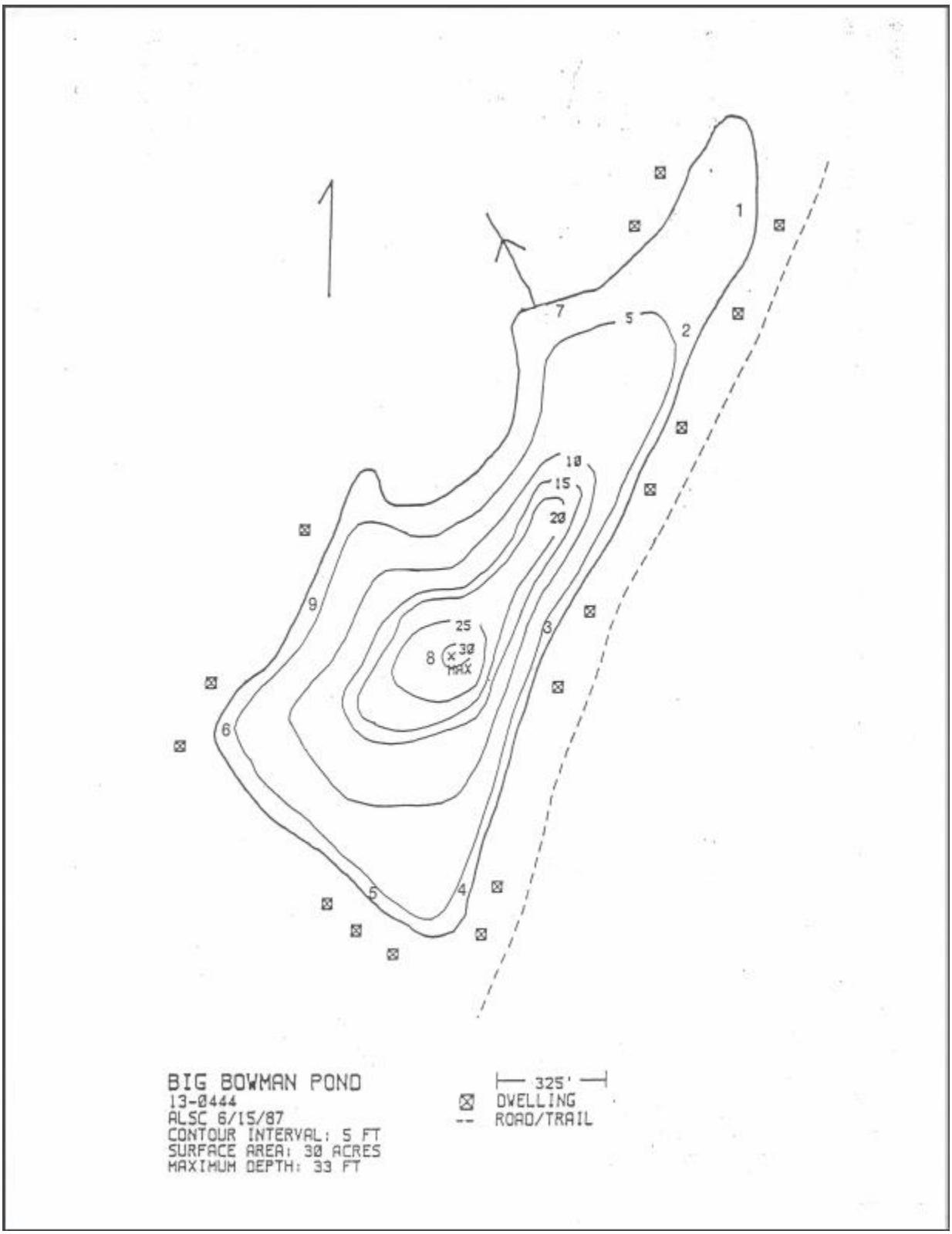

Figure 1. Bathymetric map of Big Bowman Pond in Rensselaer county NY (NYSDEC 2013).

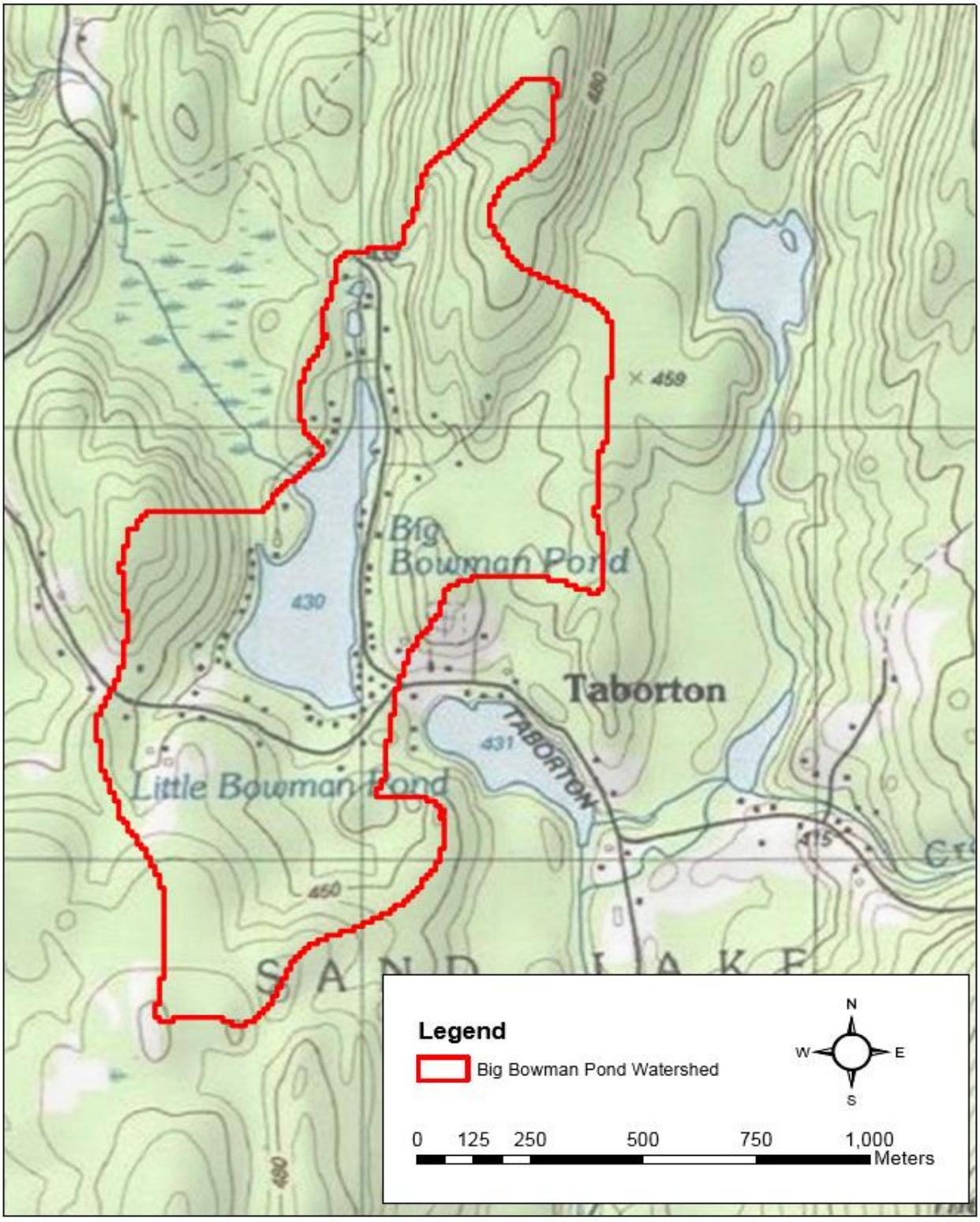

Figure 2. Watershed map of Big Bowman Pond in Rensselaer county NY.

Land Use and Land Cover

- Big Bowman Pond is located in a primarily forested watershed with moderate amounts of developed and agricultural land. Forested land is dominant and covers 81.8 % of the total area. The next largest land cover type is developed land, which covers 7.8 % of the watershed. Development is primarily residential and is concentrated at the southern end of the lake, although homes do exist along most of the shore. Finally, 10.4% of the watershed is a combination of wetlands and agricultural land (U.S. Geological Survey 2013). One wetland area surrounds the outlet at the southern end of the lake. Another wetland area is west of the center of the lake which was most like created by over-surface flow. One section of agricultural land was classified in the southwest corner of the watershed and consists of a small farm (Figure 3).

Bedrock, Soils, and Septic Suitability

- Only one type of bedrock is present within the area of interest (AOI) which was determined using the New York State Department of Environmental Conservation (NYSDEC) soil data. The bedrock description of the area is tectonic overthrust (allochthonous) sequence and is described to be mainly greywacke sandstone and shale. Greywacke sandstone is generally characterized by its hardness, dark color, and poorly sorted angular grains. Shale is described as a fine-grained sedimentary rock, which formed by the compaction of silts and clay mineral particles. This indicates that the buffering capacity of the lake is low, and that the lake is susceptible to changes in pH.

- There are five types of soil that make up the Big Bowman Pond watershed. The most abundant soil type within the watershed is Buckland very stony loam, moderately steep (BuD), which comprises 40.3% of the AOI. Following this is Buckland very stony loam, sloping (BuC), which makes up 39.0% of the AOI. These two soil types encompass the entire lake and comprise most of the watershed. The three other soil types represent a smaller percentage of the watershed and consist of Brayton very stony silt loam (BrA) (9%), Buckland very stony loam, very steep (BuF) (1.3%), and Glover very stony loam (GID) (1.3%) (Natural Resources Conservation Service [NRCS] 2017). Overall, it should be noted that each one of these soils types are classified as poorly drained, meaning water is slow to infiltrate the soil. The soils are also all classified as steeply sloping which indicates that water will flow into the lake system and may cause increased erosion on the surrounding landscape.

- Soil septic suitability was determined for the Big Bowman Pond watershed using the Web Soil Survey (WSS) tool provided by the NRCS (2017). All soils within the watershed are ranked as “very limited” for their ability to serve for on-site waste disposal (Figure 4). This means that even with careful planning or modification, the soils are poorly suited for conventional septic systems.

Socioeconomics

- As of 2010, the population in the Town of Sand Lake was 8,530 (U.S Census 2010). This population consisted of approximately of 50% males and 50% females. The average age of a person living the county was around 43 years, with 23% of the population being younger than 18, and 12% older than 65 years.

- The total number of households within the town was 3,353 in 2010, with only 89 of those households found around Big Bowman Pond (Figure 5). Seventy-four percent of these households were classified as family homes, with an average of 3 people per household. Only 8.7% of the houses in the area were classified as vacant as of 2010. Based on these numbers, I estimated that the total population in the watershed was approximately 267 people (U. S. Census 2010).

Table 2. 2010 census data for the Town of Sand Lake, Rensselaer County, New York (U.S. Census 2010).

Subject	Number	Percent
Sex and age		
Total population	8,530	100
Male population	4,229	49.6
Female population	4,301	50.4
Below the age of 18	1,969	23.1
Over the age of 65	1,040	12.2
Median age	43	N/A
Households by type		
Total households	3,353	100
Family households	2,505	74.7
Nonfamily households	848	25.3
Average household size	2.54	N/A
Average family size	2.91	N/A
Housing occupancy		
Total households	3,353	100
Occupied housing units	3,353	91.3
Vacant housing units	320	8.7

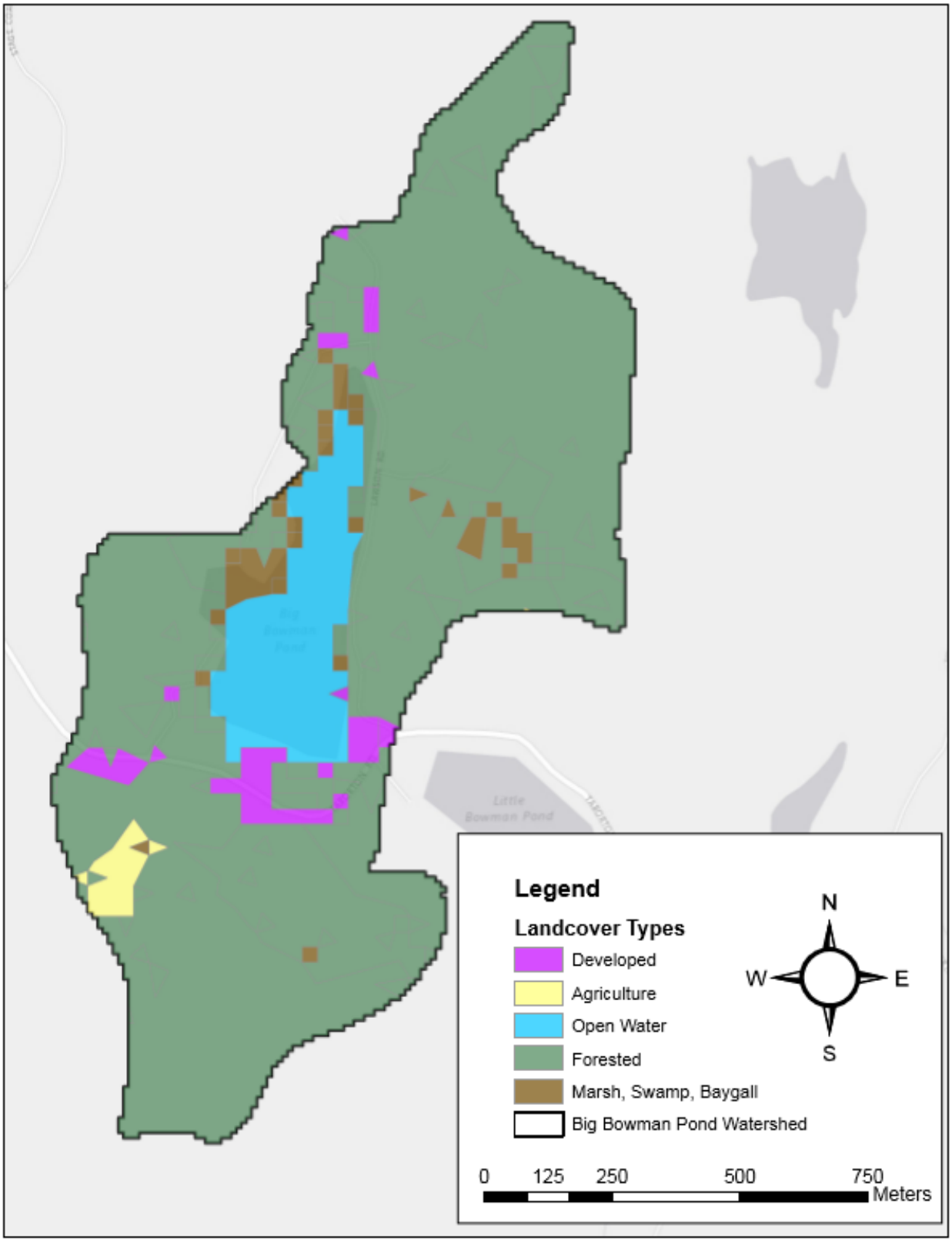

Figure 3. Land cover classification within the Big Bowman Watershed in Rensselaer County NY (NYSDEC 2013).

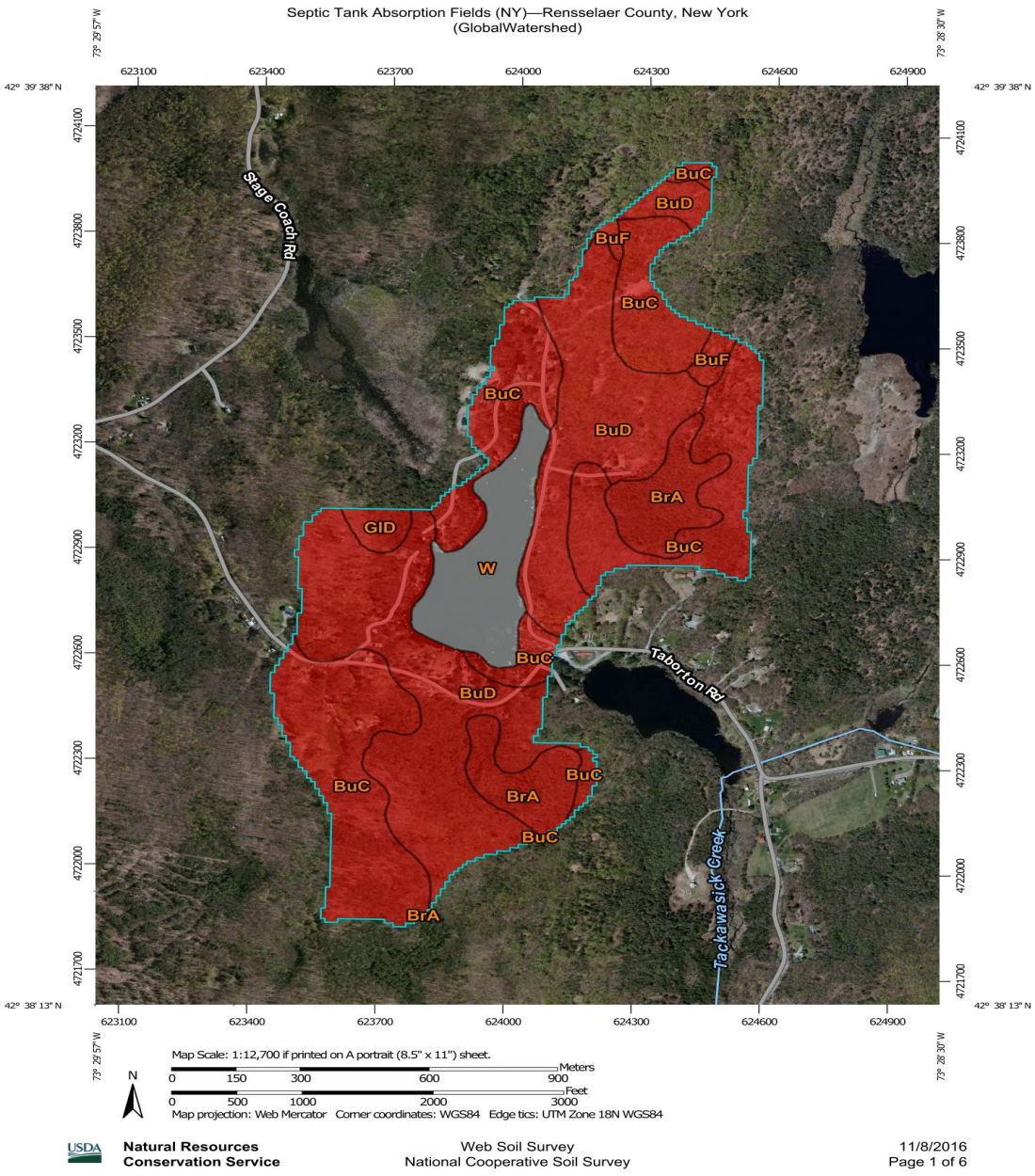

Figure 4. Septic Suitability Map of Big Bowman Pond. Red indicates that soil conditions are poor for absorption (NRCS 2017).

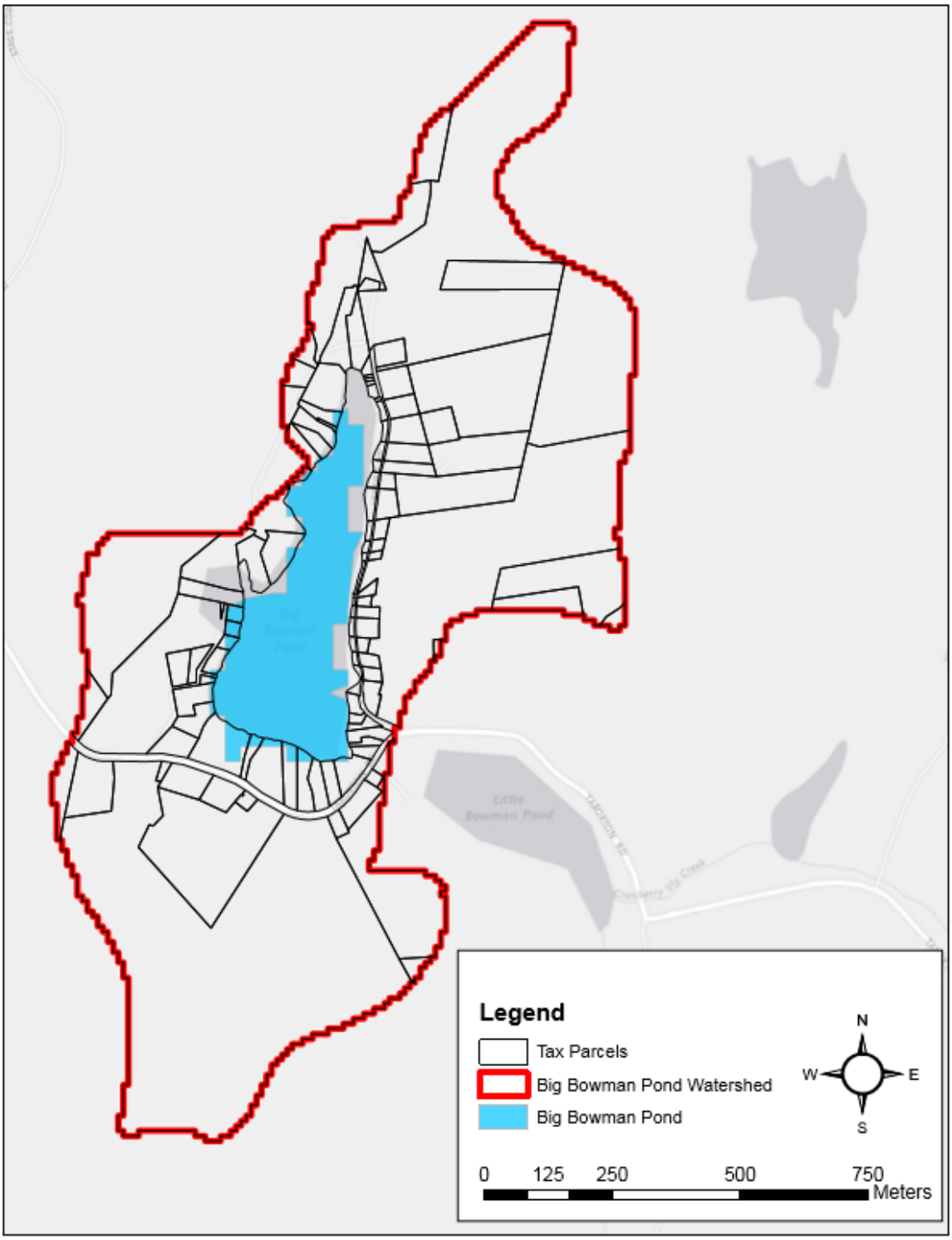

Figure 5. Tax parcels within the Big Bowman Pond watershed in Rensselaer County, NY.

History of Study

- Big Bowman Pond has always been a privately-owned lake; however, it has been sampled throughout the years by public and private agencies. The oldest study on the lake was part of a biological survey of the Lower Hudson River in 1934 conducted by the Conservation Department, the predecessor to the NYSDEC (NYSDEC 2013). The lake was also sampled in 1972, 1986, 1991, and 2003.

- In August 1934, the lake was weakly stratified, with lower oxygen levels within the hypolimnion than in the epilimnion. Water clarity was high at approximately 15 feet. There was abundant vegetation in the lake, although no species were identified. Fish were identified to species level including bullhead catfish (*Ameiurus spp.*), chain pickerel (*Esox niger*), common sunfish (*Centrarchidae spp.*), largemouth bass (*Micropterus salmoides*), smallmouth bass (*Micropterus dolomieu*), and an unknown species noted as "zebra darter" (NYSDEC 2013).

- In 1972, a study was performed by the Rensselaer Polytechnic Institute (RPI) on all lakes within Rensselaer county for the proposal for environmental management actions (Scavia 1972). This study was more detailed than the 1934 report by the Conservation Department and included data on the chemical and biological conditions in each lake, including information about water clarity, oxygen levels, calcium levels, phosphorous, fisheries community, and plant communities. At the time, water clarity in the lake was greater than in 1972 report and dissolved oxygen concentration in the hypolimnion was high. During the sampling period, it was noted that the lake was strongly stratified. Calcium levels within the lake were low, indicating that there was little to no susceptibility to invasion by zebra mussels (*Dreissena polymorpha*). Also, there were elevated chloride levels within the lake, which may have been associated with road salt application. Fisheries sampling indicated that yellow perch and rock bass were dominant in the fish community during sampling. Finally, 12 species of aquatic plants were identified, including several species of bladderwort (*Utricularia* spp.), which was the dominant species, and one invasive species, curly-leafed pondweed (NYSDEC 2013).

- In 1986, RPI conducted sampling only Big Bowman Pond. The sampling included water chemistry, water depth, degree of shoreline development, and density of aquatic weed growth. The chemistry of the lake had remained fairly stable during the 13 years between studies, except for phosphorus and nitrogen, the concentrations of which decreased (Eichler and Soracco 1986). It was reported that aquatic plants within the lake did not appear to be problematic, but the densities observed in the northern bay and, to a lesser extent, the outlet bay provided undesirable conditions for swimming. This report did not mention which species caused the undesirable conditions (Eichler and Soracco 1986).

- In 1991, a study was performed to assess the aquatic plant community, water quality and watershed activities, and was again performed by RPI. They determined that there was a shift in the plant community and a new species was present, *Nymphoides cordata* (floating heart lily). They also noticed that *Nymphaea ordorata* and *Potamogeton epihydrus* were prominent throughout the lake, where previously *Potamogeton robbinsii* and *Potamogeton amplifolius* were

dominant (Soracco, Reginald, and Taggett 1991). The report also mentioned the presence and dominance of *Utricularia vulgaris* and *Saggittaria graminea* within the northern cove, Turtle Cove as it is called today. As for water chemistry, the group concluded that runoff was the primary driver of water chemistry, which was supported by peaks in their data during heavy run off events (Soracco, Reginald, and Taggett 1991).

- In 2003, a study was performed by Adirondack Ecologist with the objective of determining the current water quality, and to assist in the creation of a benchmark for future studies (LaMere 2013). This study occurred during summer and concluded that the lake could be classified as an early eutrophic lake, but that oxygen persisted in the hypolimnion through the months of July and August. Phosphorus and conductivity levels within the lake was observed to be increasing, water clarity was decreasing, and internal nutrient loading was occurring (LaMere 2013).

- Currently, the stakeholders of Big Bowman Pond participate in the Citizen Statewide Lake Assessment Program (CSLAP) and have since 2013. The CSLAP reports indicate that Big Bowman Pond is a mesotrophic water body, and they provide additional documentation of common water quality indicators such as temperature, dissolved oxygen, pH, water clarity, total phosphorus, total nitrogen and chlorophyll a.

2. PHYSICAL AND CHEMICAL LIMNOLOGY

Introduction

- The physical and chemical characteristics of a lake effect the ecology which impacts the recreational option available to people. Any sizable change of productivity, from either anthropogenic sources or terrestrial, could have impacts on the entire lake community from altering algal to affecting the fish communities (Wetzel 2001). Depending on how the ecosystem alters the effects could be seen people as beneficial or damaging to the desired use of the lake. An example of these alteration would be an algal community shifting from green algal to cyanobacteria, as known as blue-green algae, which would be harmful to the overall community of the lake and prevent recreational uses. A beneficial example could be the improvement in fish production, which would improve the fisheries within the lake and improve angler's experiences. So, having and understanding of the overall physical and chemical limnology of the lake can be used to gauge the current state of the lake as well as be used to see the potential it has for stakeholders needs.

- As for Big Bowman Pond consistent monitor of limnological features has just really started within the last 5 years, starting in 2013, with their participation with the Citizens Statewide Lake Assessment Program, also known as CSLAP. What this program entails its yearly monitoring as long as there is participation from an association. This data includes information on total phosphorus, secchi depth, and chlorophyll a which is taken every two weeks during the summer season (NYSDEC 2003). Prior to the involvement with CSLAP this lake had monitoring occurring approximately every decade (1972, 1986, 1991, 2003) which looked at similar physical and chemical variables. This provides historical background which can be compared to current monitoring to see if the lake has experience and physical or chemical shifts since 1972. The only

issue is that the historical data general only consists of one or two sampling dates and there are prolonged periods before sampling occurred again. This prevents in-depth understanding of the limnological process that occurred up during that period of sampling. Regular monitoring is required because freshwater ecosystems are so susceptible to being influenced by environmental or cultural stressors, like road salt and runoff.

- There are three goals set for this part of the study. The first goal was to characterize the current state of the Big Bowman Pond physical and chemical limnology. The second goal was to determine if any changes have occurred within the lake since the collection of CSLAP data in 2013. Lastly, a concern brought up by the association, which was the comparison of 2018 CSLAP data to the sampling that occurred during this study within the 2018 year. These goals allow for the understanding of the current status of Big Bowman Ponds limnology which will provide valuable information that can be used for future management.

Temperature

- According to the data, Big Bowman pond has sustained period of stratification during the summer season and a period of mixing during the winter. This indicated that the lake is a warm monomictic lake. Warm monomictic lakes are lakes mix from top to bottom during one mixing period each year which occurs during the winter season (Figure 3). Stratification in 2017 occurred in late April (April 27) and continued until late November (November 26). During stratification the thermocline could be found at approximately 3-5 m.
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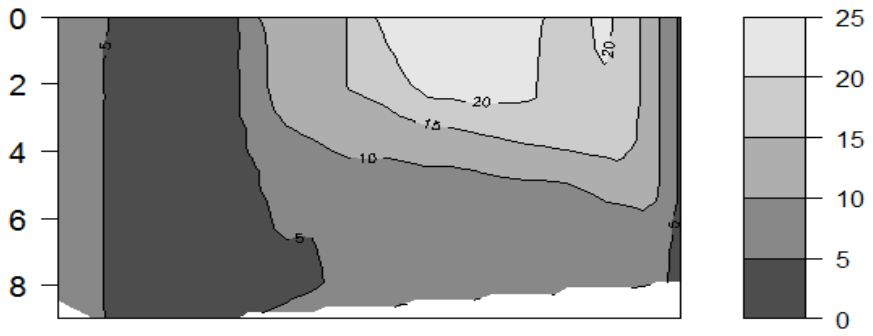

Figure 1. Temperature Isopleth (°C) detailing stratification for Big Bowman Pond.

Dissolved Oxygen

- Prior to summer stratification, DO concentrations were uniform within the water column ranging from 11-8 mg/l at the surface to 9-7 mg/l at the bottom (Figure 4). During stratification (April 27 to November 26) DO was highest at approximately 3m. Anoxia was noticed to on April 9, 2017 and persisted through October 26, 2017 and was most severe on September 9th with 5m of anoxia

present. Ice cover started to form around late December but didn't fully cover until early January. During January the DO at the surface under ice cover was 14.06 mg/l and slowly decreased through the winter season.

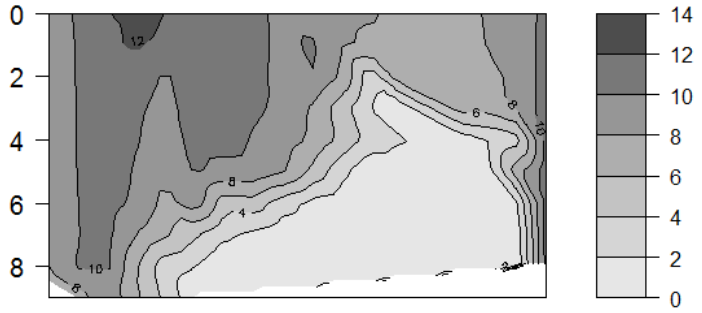

Figure 2. Dissolved Oxygen (DO) isopleth (mg/l) for Big Bowman Pond.

Total Phosphorus

- The highest TP concentration recorded at the surface of the lake was 116 µg/l on July 23rd, 2017. The highest bottom TP sample was collected on August 21st, 2017 at z = 8m. The average TP concentration among all depths and sampling dates was 17 µg/l, which is below the threshold of 20 µg/l for eutrophic levels in New York (6 NYCRR X A 2 703).

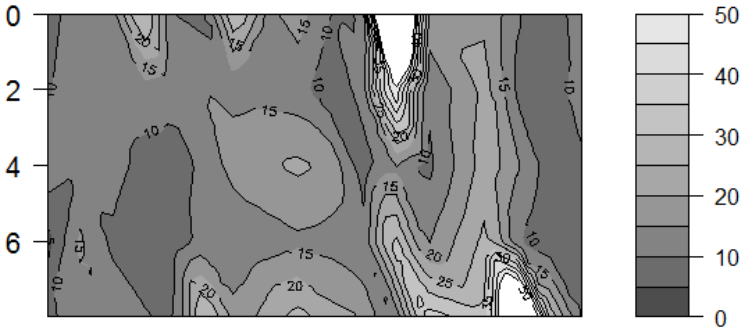

Figure 3. Total Phosphorus isopleth (µg/l) for Big Bowman Pond.

pH

- The pH of the lake averaged 6.7 when comparing data from across all sample dates and depths, which is almost natural pH of 7. At the surface of the lake the pH averaged around 7 and at z = 8m the pH averaged 6. During sampling, the max pH was observed on July 7th, 2017 at 8.05 at the surface. The lowest pH recorded during the sampling season was 5.6 at z = 6 m on May 30th,

2017. A trend that was noticed during the sampling season was pH would decrease generally by a degree of 1.

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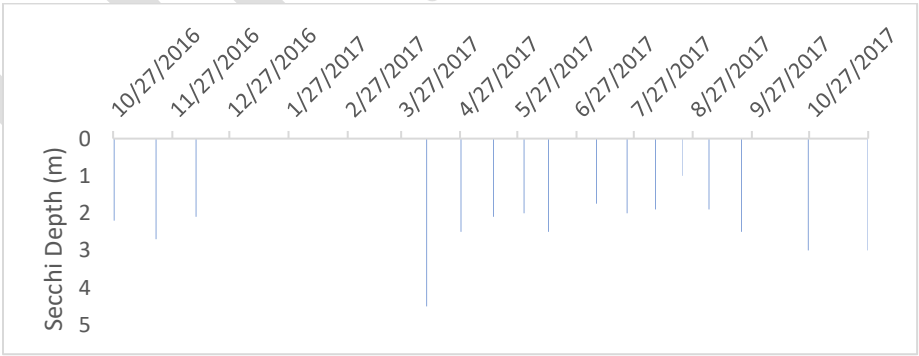
Figure 4. pH isopleth for Big Bowman Pond.

Water Clarity

- The average Secchi depth for the sampling entire sampling season was 2.35 m. The maximum SD was 4.5 m and was observed on April 9th, 2017. The minimum that was recorded was 1 m on July 21st, 2017. It was observed that there was heavy rainfall within the last 24 hours prior to sampling on April 21st, which could have influenced the SD. From December to March there was ice cover on the lake and SD was unable to be recorded.

Table 1. Secchi Depth during the sampling season. Between the months of December to March no data was collected due to ice cover.



Chlorophyll a

- it was estimated that the average water column chl. *a* concentration during the sampling season was 7.01 µg/l. The maximum chl. *a* concentration was 44.42 µg/l on August 4th, 2017 at z = 8 m while the minimum chl. *a* was 0.45 µg/l on April 9th, 2017 at z = 0 m. It should be considered that these values are estimates of primary productivity based on an equation presented by Jones and Bachmann (1976) and do not reflect actual values. Chl. *a* can also be affected by many factors such as TP, such as runoff from storm events, and suspended organic materials, which can increase TP without influencing primary productivity within the lake.

3. AQUATIC VEGETATION

Introduction

- Understanding the dynamics of the macrophyte community is a key component of any Lake management plan. Macrophytes consist of one part of the primary producers which can be found within a lakes ecosystem. These primary producers are essential within the ecosystem. Some roles for aquatic plants are harboring aquatic insects that serve as the food for fish. They also provide cover for nurseries and spawning areas for amphibians, fish, and zooplankton. This can also supply food for waterfowl and other animals which reside around the lake. They also create structural support for the soil and dampen wave action reducing sedimentation. They can also aid in water purification process by providing habitat for microbial degradation and converting toxic compounds to useful raw materials. These are only some of the ways in which aquatic macrophytes are important to and their role to why they must be managed.

- For all the benefits that aquatic plants provide us with they are also seen as a as the number one problem within New York according to a survey in the late 1980's (NYSDEC 2004). This survey had over 1,000 responses from lake residents statewide. It also ranked number 2 when compared to the state Priority Waterbody List and Waterbody Inventory (PWL-WI), which is a compendium of water-quality and use-impairment problems identified through inventories of water-quality databases, government assessments, and public input (NYSDEC 2002). The aquatic plants are seen as a nuisance is because the effects that it can have on recreational activities of those who wish to recreate within the lake itself. This is generally caused when excessive vegetation is present. Excessive vegetation can also cause problems such as reduced biodiversity and change a fish community from larger game fish to pan.

- In the case of this study most lake residents recognize the importance of the aquatic plants within their lake, but they also see some species within the lake as nuisances. According to a survey that occurred prior to sampling most homeowners around the lake agreed that the major issue is the overabundance of bladderwort spp. within the water during the summer season. It was also noted that some homeowners also mentioned that lily pad beds were also preventing recreational uses (Appendix A).
- Historically, within Big Bowman pond the excessive vegetation problem was not always present and has only been seen developing since the 1986 from a water quality report that occurred on the

lake. Prior to that report, there was a study in 1972 on all lakes within Rensselaer County which indicated that the lake only supported minimum of aquatic plants and was dominated by green algae, specifically desmids (Scavia 1972). The species bladderwort, which was identified as the problem by homeowners, was not recorded to be within the lake until 1991. From this historical data it can be stated that there had to have been a shift in the conditions of Big Bowman Pond to change the community to one dominated by algae to now being overrun within aquatic vegetation.

- The goal of this study was to determine the overall community present within the lake and to identify the areas of the lake which have the highest abundances of vegetation. This way methods can be created to manage the vegetation within the lake that are suitable for the stakeholders without effecting primary production and nursery habitat of the fisheries within the lake.

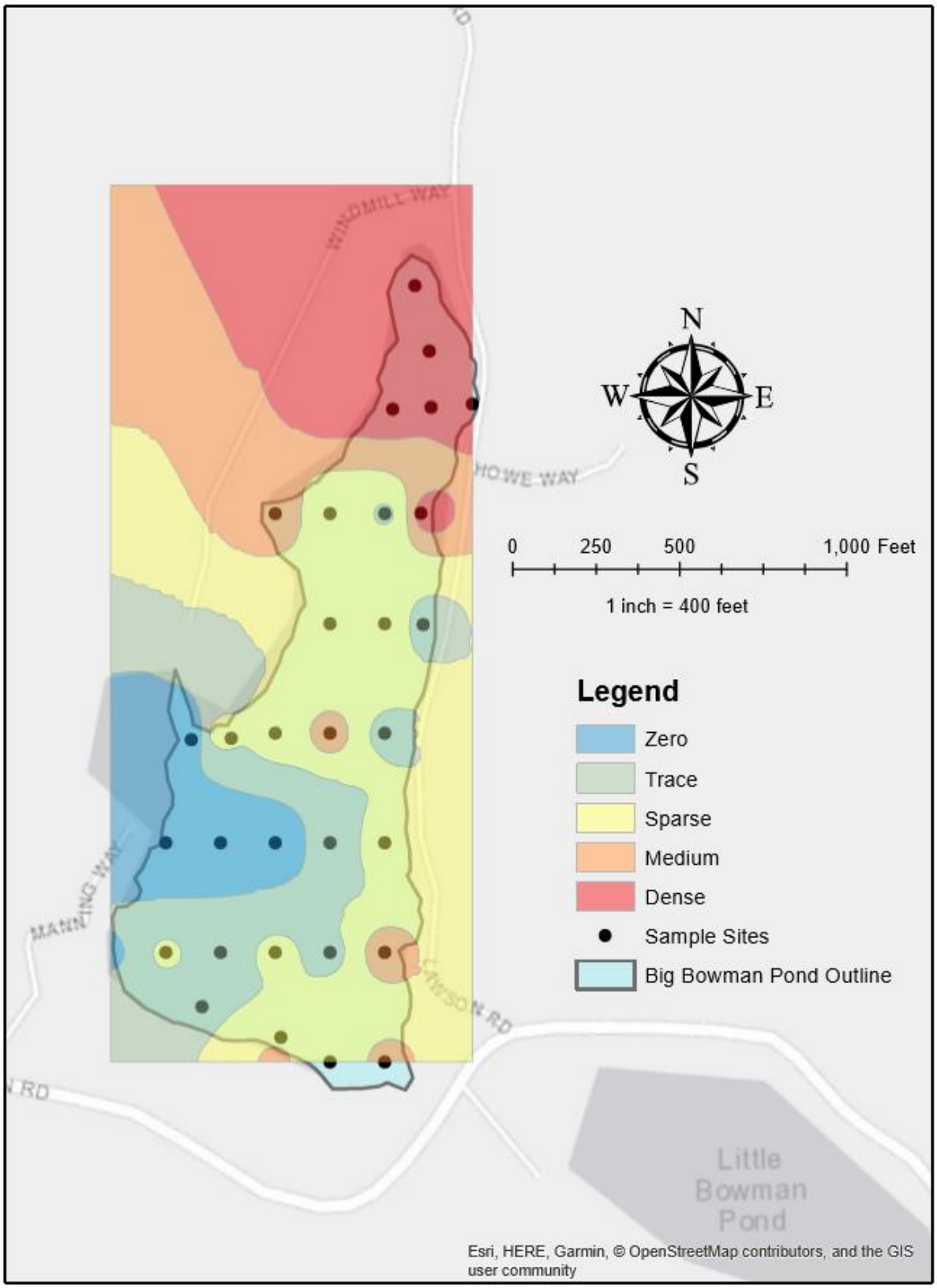


Figure 1: Vegetation abundance within Big Bowman Pond on 7/17/2017.

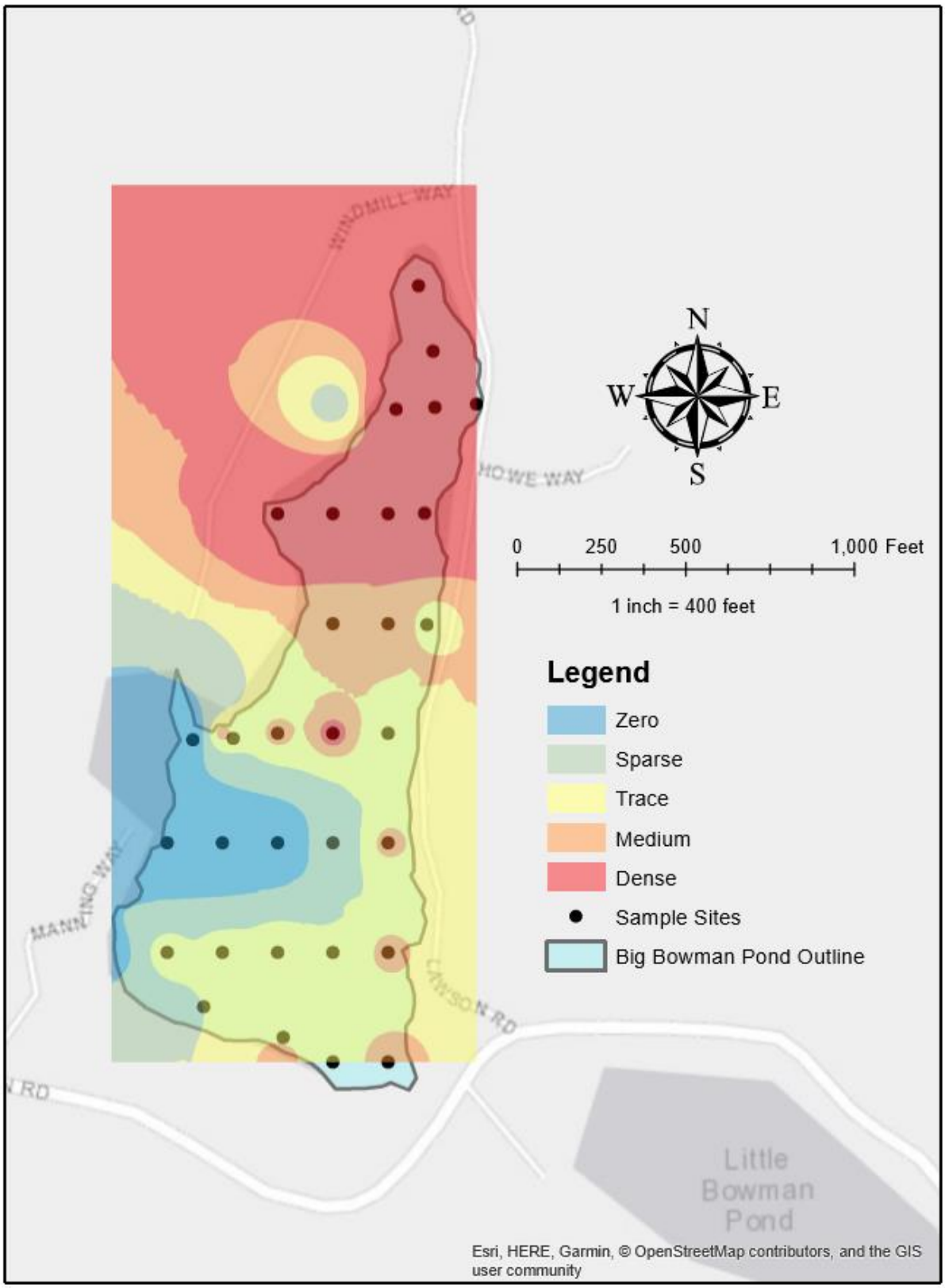


Figure 2: Vegetation abundance within Big Bowman Pond on 8/21/2017.

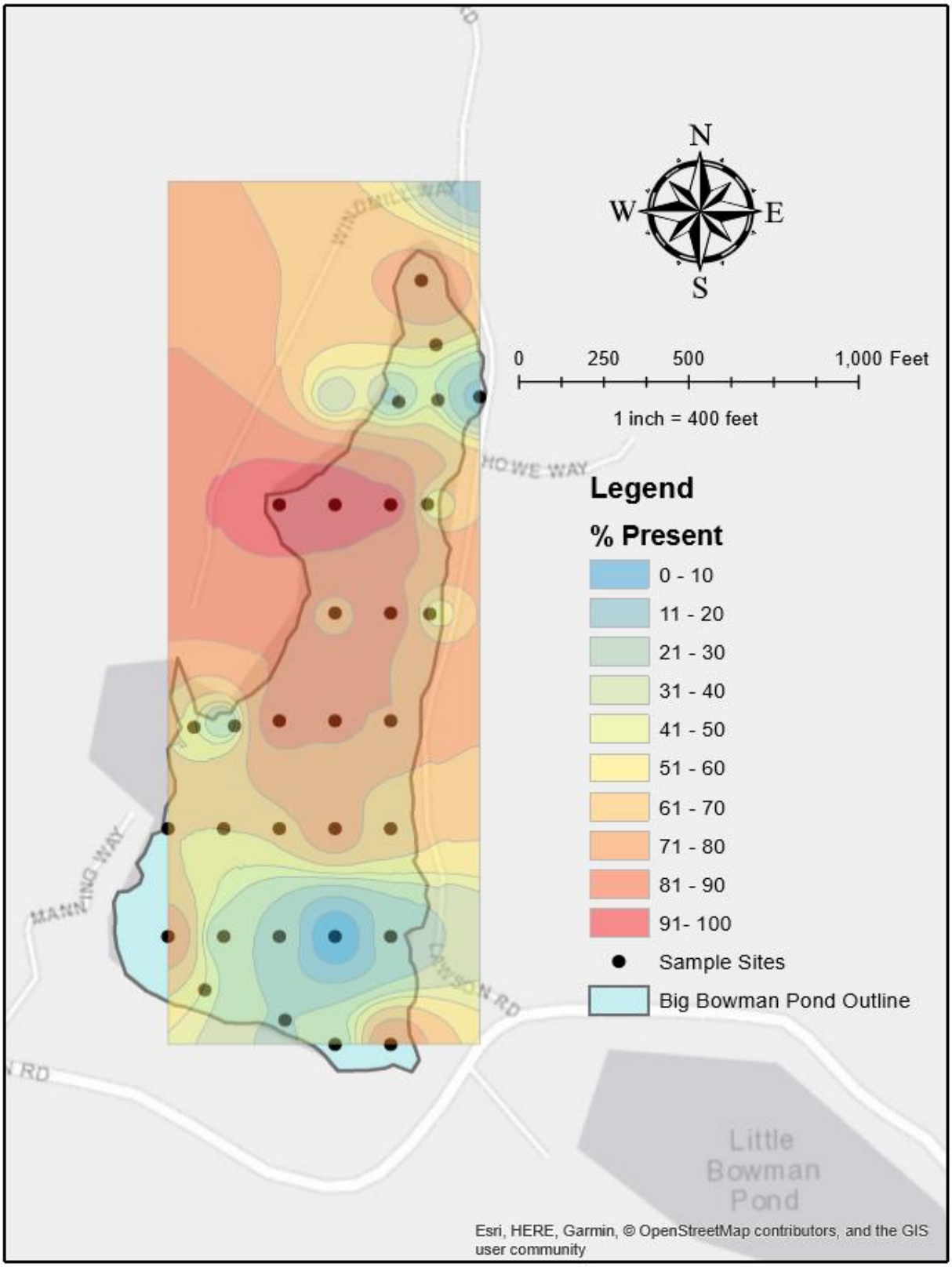


Figure 3: Amount of Bladderwort spp. in percentage coverage within big bowman pond on 8/21/2017.

Table 1. Species present within Big Bowman Pond during the two sampling events on 7/17/2017 and 8/21/2017.

Species Present		7/17/2017	8/21/2017
Scientific Name	Common Name		
Nuphar lutea	Yellow Pond Lily	x	x
Nymphaea odorata	White Pond Lily	x	x
Potamogeton epihydrus	Ribbon leaf pondweed	x	x
Nymphoides cordata	Little floating-heart	x	x
Nitella flexilis	Stonewort	x	x
Pontederia cordata	Pickerel weed	x	x
Acorus americanus	Sweetflag	x	x
Utricularia inflata	Swollen bladderwort	x	x
Utricularia vulgaris	Common bladderwort	x	x
Utricularia purpurea	Eastern purple bladderwort	x	x

- The plant survey of big bowman pond indicated that there were 10 species of plants present within the lake. During both sampling dates all species were collected but differences were noticed at many of the locations regarding plant abundance. Also, out of the 10-species present three of them consisted of bladderwort spp.: *Utricularia inflata, Utricularia vulgaris, Utricularia purpurea* (table 1). The species which primarily dominated the overall abundance of the lake were *Nuphar lutea, Nymphea odorata, Nitella flexilis* and *Potamogeton epihydrus,* and Bladderwort spp. Each of the species had their own areas within the lake where they could be approximately found to be dominate. As for white and yellow pond lily they were predominately found in the north end of the lake with a few patches located along the southern shoreline were the water was shallow. *Nitella flexilis* was found dominantly along the shore of the southern end and was not found in any noticeable quantities anywhere within the center of the lake or the northern end. *Potamogeton epihydrus* is dominating the southern end in generally the deeper water and could be also found among the *Nitella flexilis*. Lastly, bladderwort was found everywhere within the lake but densest within the northern end of the lake along the edges of the lily pads. This is most likely due to the species being a floating aquatic species and could be found anywhere along the surface.

- As for the other species present they were noted in lower abundances and where scattered within the lake. *Nymphoides cordata* was found scattered and in very small quantities within the larger lily pad beds. *Pontederia cordata* was located close to the shoreline and was only noted within the northern most point of the lake and in low abundance. Lastly *Acorus americanus* was located within two areas which was in turtle cove and the northern most point of the lake in very low abundance.

4. FISHERIES

- Fisheries studies are still currently happening on Big Bowman Pond. When enough data has been collected it will be used to create frequency distributions to see size and average catch within the lake.
- The fish survey had identified 8 species within the lake which may change within the next several months as more fish data is collected. When compared to historical data species have not changed very much within the last 31 years. Some of this may have been due to miss identification, such as the differences between black and white crappies and largemouth and smallmouth bass.

Table 1. Fish species present within Big Bowman Pond for 1986, 1991, and 2017.

Species		Years Present		
Common Name	Scientific Name	1986	1991	2017
Largemouth bass	*Micropterus salmoides*	x	x	x
Smallmouth Bass	*Micropterus dolomieu*	x		
Chain Pickerel	*Esox niger*	x		x
Brown Bullhead	*Ictalurus nebulosus*	x	x	
Pumpkinseed	*Lepomis gibbosus*	x	x	x
Rock Bass	*Ambloplites rupestris*	x	x	x
Black Crappie	*Pomoxis nigromaculatus*	x		x
White Crappie	*Pomoxis annularis*			x
Yellow Perch	*Perca flavescens*	x	x	x
Blue Gill	*Lepomis macrochirus*			x
Golden Shiner	*Notemigonus crysoleucas*		x	

5. BIG BOWMAN MANAGEMENT PLAN

Comprehensive Management Plan

- The main goal of this management plan is to assist stakeholders with managing the current and future state of Big Bowman Pond to meet their recreational goals and to maintain the aesthetic beauty of the lake. This document will identify the current ecological and recreational problems perceived by the stakeholders and will discuss desired outcomes for the lake. While this document may not address all problems, it will focus on the major issues that have been identified during the course of the study. The primary issue mentioned by stakeholders was excessive plant growth, specifically regarding nuisance abundance of bladderwort and lily species. This plan was created based on the current state as reported in the previous sections of this report. The objective of this plan is to provide scientifically supported management strategies that will address the concerns of the stakeholders and promote recreation in Big Bowman Pond for the future.

6. SURVEY AND MANAGEMENT CONCERNS

Introduction

- A comprehensive lake management plan is a dynamic document that identifies goals and actions for the purpose of creating, protecting, and/or maintaining desired conditions within a lake and its watershed. Every lake management plan is different, because content and goals depend on the conditions of the lake and watershed as well as the interests of the stakeholders involved. A lake management plan also provides a framework for future stakeholders to reference what issues have been addressed and what steps may need to be taken to improve use of the waterbody.
- For the development of the Big Bowman Pond management plan it was critical to understand the issues perceived by all of the stakeholders. The opinions and perceptions of stakeholders concerning the lake have led directly to the formation of management goals and priorities in this case. In order to gain this information, an anonymous survey was distributed to all households adjacent to the lake during 2017.

Survey Details

- The survey consisted of 10 questions that were targeted information about demographics, primary recreational uses, perceptions of problems, and thoughts on potential management strategies. This survey was available both electronically through Google forms and by hard copy upon request. Residents were made aware of the survey through email and personal communication. The response period lasted from March 2017 through August 2017.

Survey Results

- *Response Rate* – A total of 21 surveys were completed out of the 35 households, resulting in a 60% response rate. All surveys were answered by people living adjacent to the lake. Out of the 21 surveys answered 58% of homeowners were permanent residents and 32 % were seasonal and visit for the majority of the summer. The last 10% were seasonal homeowners or vacationers who only visit the pond a few weeks out of the year (Figure 1).

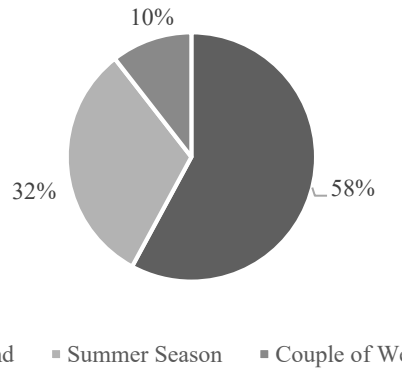


Figure 1. Depicts the residence time of homeowners around Big Bowman Pond. Question: Which of the following best describes your residence at Big Bowman Pond?

- *Lake uses* – Recreational activities in Big Bowman Pond included swimming, rowing and canoeing, and fishing, according to survey respondents (Figure 2). As for rowing and canoeing, 95% of respondents own boats, which excluded only one household out of the 21. Many homeowners also stated that being able to relax at their residences and enjoy the visual aesthetics of the lake was important to their recreational activities (Figure 2). Also, one responder included weeding as a recreational activity, most likely due to the excessive vegetation as regular weeding is needed to maintain a clear shoreline in front of their homes.

- There is generally no pattern to usage on Big Bowman Pond across respondents, which may be because most of the residents are year-round and use the lake whenever they desire. Some part-time residents recreate only within the summer season, or on weekends and holidays, but many also noted year-round use of the lake (Figure 4). It was also noted that there is a nearly even split in respondents as to which side of the lake they use for recreation (Figure 5). This was because was crucial to this study to understand if vegetation overgrowth directly affected recreational activities on one end of the lake as opposed to the other.

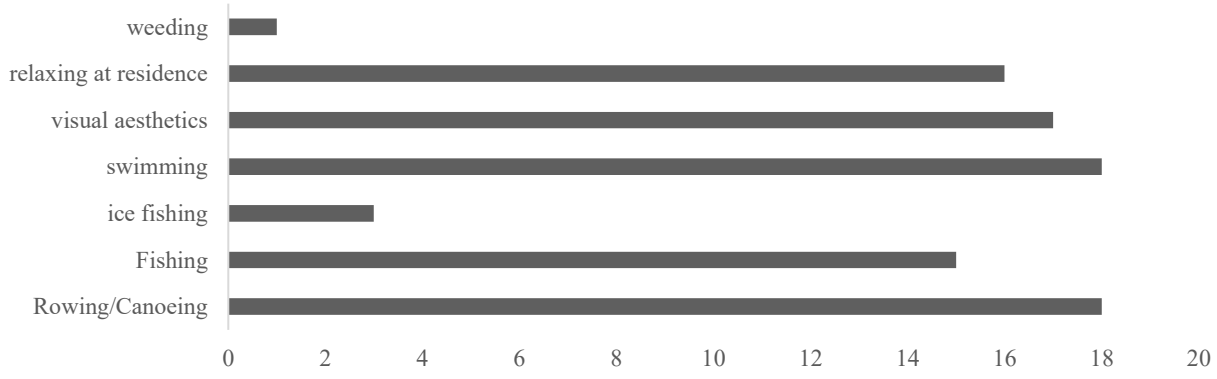


Figure 2. List of recreational activities that occur on the lake and the number of homeowners who contribute to those activities.

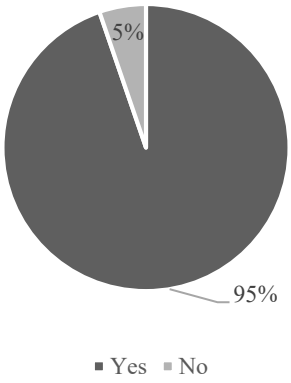


Figure 3. Number of households owning boats on Big Bowman Pond.

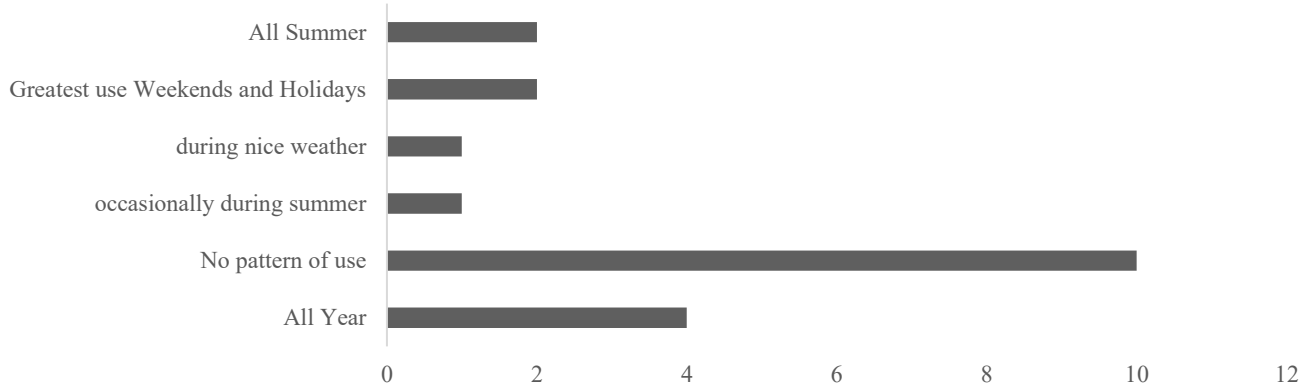


Figure 4. Times of year when the pond is used for recreational activities.

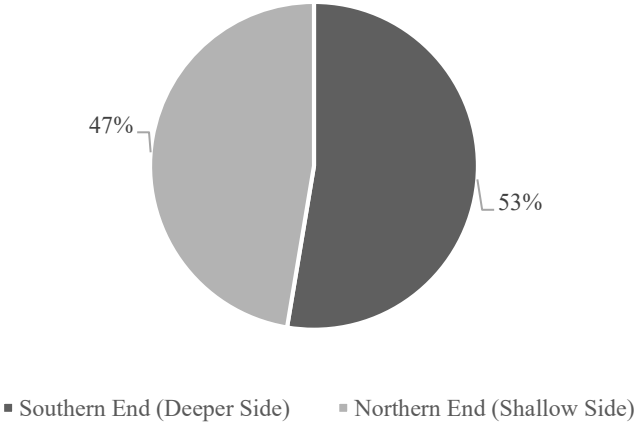


Figure 5. Areas of the lake which are generally recreated within. Light gray depicts the southern end of the lake which is deeper. Whereas, the northern end which is indicated in black is shallower.

- *Perceived Problems* – To determine general issues perceived in the lake one question was left open ended: "What aspects of Big Bowman Pond do you think are the biggest concern?". This question highlighted that the major issue of excessive vegetation was related primarily to bladderwort species within the lake, as 66% of responses directly mentioned bladderwort. The other concerns mentioned included potable water, community conflict over management, runoff, and invasive vegetation. Most homeowners were unsatisfied with the current levels of vegetation within the lake. On the other hand, homeowners were mostly satisfied with the current fisheries of the lake (Figure 6).

- A similar trend occurred when homeowners were given a list of potential issues and asked which concerned them the most. The most common concerns were with algae and weeds, as well as invasive species (Figure 7). Overall, most responded that they were worried about all of these issues, and this may indicate that homeowners are worried about the overall state of the lake, and do not with for it to deteriorate.

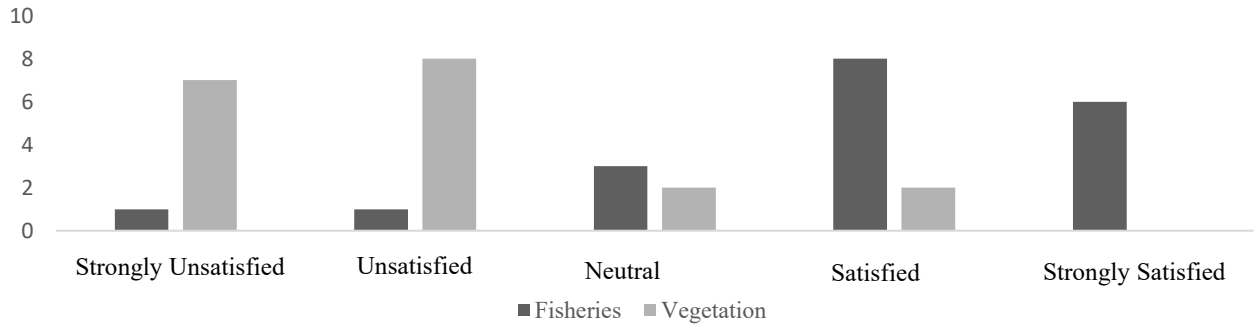


Figure 3. Satisfaction levels of homeowners with vegetation levels and with their current fisheries.

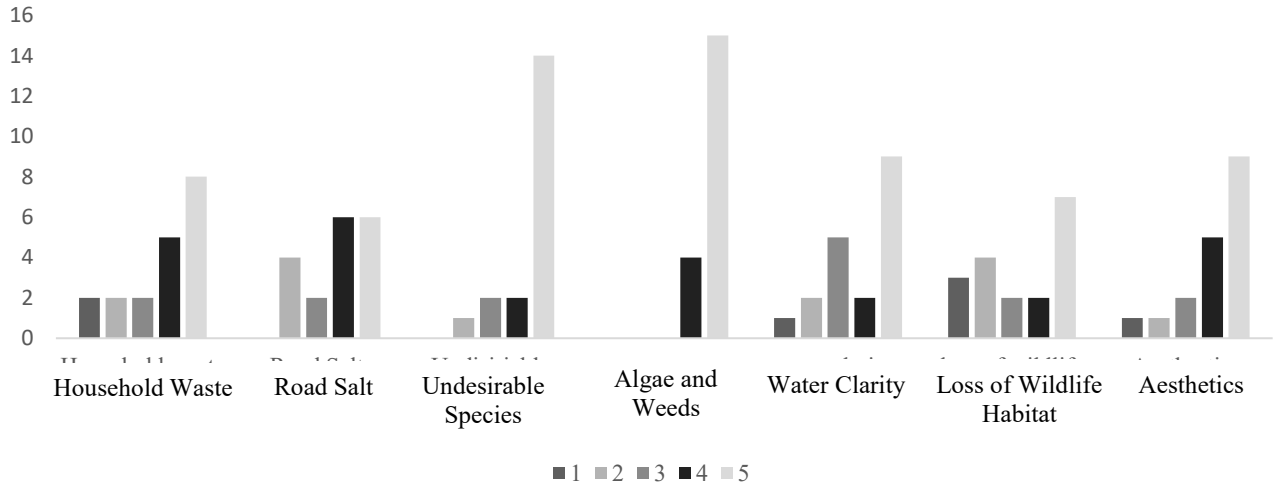


Figure 4. A list of items to gauge the concerns of homeowners relative to the management of Big Bowman Pond. A scale was used were 1 indicated non-concern to 5 indicating apparent major issues.

- *Management Strategies Opinions* – When households were asked about potential management strategies regarding excessive vegetation there was no consensus (Figure 8). This could mean that no single strategy is best suited and that multiple strategies may be needed to manage the vegetation issues. Alternatively, this could indicate that homeowners were divided on management strategies, which is supported by statements from the survey regarding conflict among residents that prevent efficient management of the lake.

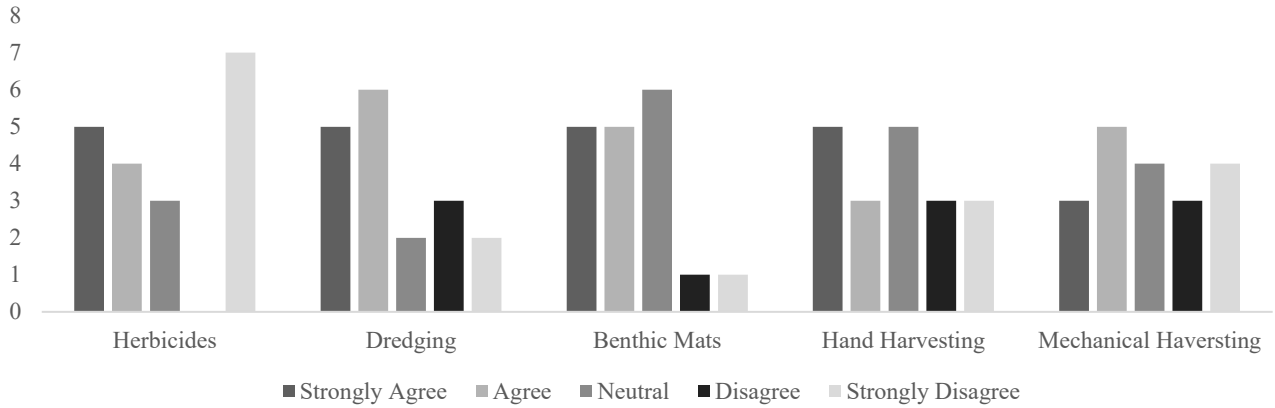


Figure 5. Opinion of homeowners on potential management strategies that can be used management vegetation issues present within the lake.

Issues Mentioned by Stakeholders

- Excessive vegetation and community conflict about lake management were among the greatest concerns expressed by stakeholders according to questions 7, 8, and 10, as well as at individual and group meetings. It is the hope that provision of scientifically supported and impartial suggestions through this document will relieve community tension over potential management strategies. Addressing these issues should meet the goals of all stakeholders involved and support better management of the lake but will require some compromise based on the diversity of perspectives surrounding management.
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7. MANAGEMENT OPTIONS

- Below is a list of potential strategies that could implemented to remove bladderwort species from Big Bowman Pond. One caveat is that this information is minimal and will give just enough information for homeowners to start discussing which strategies to use on the lake. The final document will contain more detail on specific methods including potential costs and implementation times, schedules, and goals. Also, within the final document there may be more or fewer strategies present based on current research.

7A. REGARDING BLADDERWORT

- Hand and Mechanical Harvesting
    - Hand harvesting is one of the most common methods of controlling nuisance plant species simply because it is easy to do. The relative ease of the process, which requires no permits, no expertise, and has minor risk of causing damage to the plant community, also makes this process so common. Generally, hand harvesting is used for controlling small areas of vegetation. It can be painstaking work with larger areas of vegetation.
    - Anyone can hand harvest, but not everyone can do it as well as others. Like weeding in a garden, one must make sure they are removing the entire root system along with the plant in order to ensure that the plant does not regrow. As for the case of bladderwort, it is important that the entire plant is removed prior to the structure flowering. After bladderwort spp. flower they drop seeds into the water for the next growing season.
    - Helpful tools that can be used to harvest Bladderwort are rakes and seins. Seins are especially helpful for trying to clear larger areas of bladderwort. This is done by dragging a large net on the surface of the water and bringing it onto shore where it can then be disposed of away from the water.
    - One downside to this method is that bladderwort may fragment and continue to seed and grow during the season.

- Triploid Grass Carp
    - Grass crap will seldom control aquatic vegetation within the first year they are stocked, but they will consume bladderwort and other aquatic vegetation. Suggested Grass Carp stocking sizes to bladderwort coverage are usually in the range of 7-15 carp per surface acre of bladderwort.
    - It is important to note that when stocking grass carp it is better to start stocking them in low quantities and to add more if management is not adequate. They could also be used to mitigate but not completely control the overgrowth. There are many case studies in which lake associations stock additional grass carp due to a lack of an immediate decrease in vegetation. This can cause a drastic decrease in vegetation later on when the carp are able to make a significant difference. This will often cause a shift from a heavy vegetated lake to one that is dominated by algae.
    - In New York, only triploid grass carp are legal and require a permit before they can be purchased from a certified dealer. It also requires a dam of a specific size to prevent their escape from the lake. These measures allow them to be controlled and make them a safer biocontrol option.

- Herbicides
    - 2,4-D
        - Navigate and Weedar 64 are 2,4-D compounds that have been effective on bladderwort. 2,4-D compounds are systemic herbicides. Systemic herbicides are

absorbed and move within the plant to the site of action and tend to act more slowly than contact herbicides.

- Diquat
    - Reward is a liquid diquat formulation that has been effective on bladderwort. It is a contact algaecide and herbicide. Contact herbicides act quickly and destroy all plants cells that they come in contact with.
- Fluridone
    - Sonar, Avast, and Whitecap are floridone compounds and can come in liquid and granular formulations, both of which have been effective on bladderwort. These are broad spectrum, systemic herbicides. Systemic herbicides are absorbed and move within the plant to the site of action and tend to act more slowly than contact herbicides.
- Imazamox
    - Clearcast is a liquid imazamox formulation. It is a broad spectrum, systemic herbicide. Systemic herbicides are absorbed and move within the plant to the site of action and tend to act more slowly than contact herbicides. An aquatically registered surfactant is needed for application.