Comprehensive Management Plan of Big Bowman Pond, Rensselaer, New York

Table of Contents

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. This document will focus on the major issues identified during the course of the study as reported in the previous sections of this document. The objective of this plan is to provide scientifically supported management strategies that will address the concerns of the stakeholders and protect the quality of recreational activities in Big Bowman Pond into the future. The primary issue mentioned by stakeholders was excessive plant growth, specifically regarding nuisance abundance of bladderwort and lily species.

Chapter I: 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 in 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 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 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 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 remaining 10% were seasonal homeowners or vacationers who only visit the pond a few weeks out of the year (Figure 1.1).

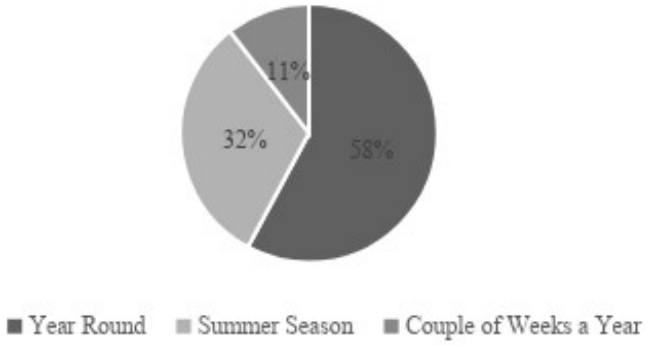

Figure 1.1 Depiction of the residence time of homeowners around Big Bowman Pond. Question: Which of the following best describes your residence at Big Bowman Pond?

Lake uses – Recreational activities in Big Bowman Pond included swimming, rowing and canoeing, and fishing (Figure 1.2). Ninety five percent of respondent's own boats, which excluded only one household out of the 21 (Figure 1.3). 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 1.2). One responder included weeding as a recreational activity, potentially a sarcastic remark, likely due to the excessive vegetation as regular plant removal is needed to maintain a clear shoreline in front of homes.

There was generally no pattern to usage on Big Bowman Pond across respondents, which may be because most 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 1.4). It was noted that there is a nearly even split in respondents as to which side of the lake they use for recreation (Figure 1.5).

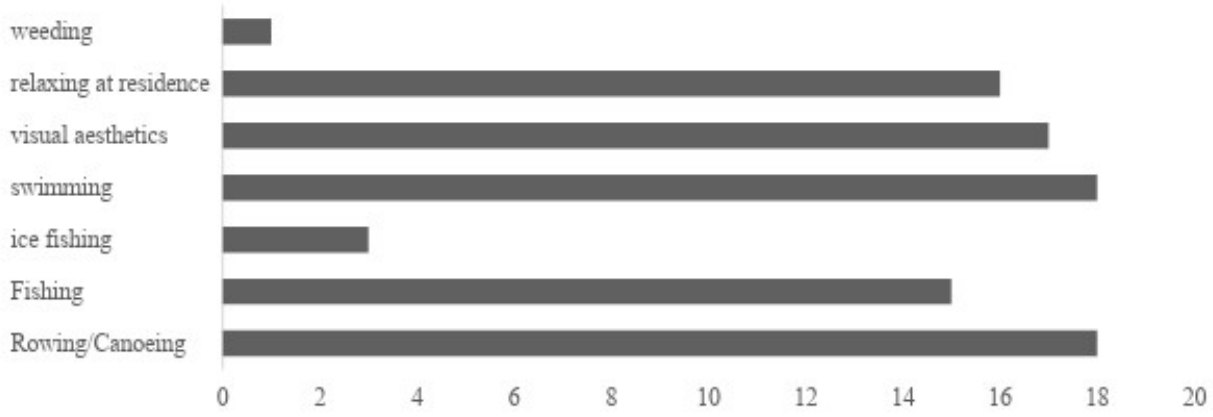

Figure 1.2 List of recreational activities that occur on the lake and the number of homeowners who contribute to those activities.

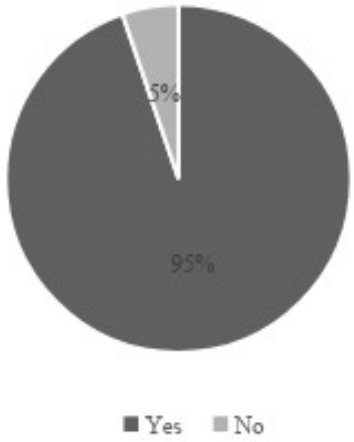

Figure 1.3 Number of households owning boats on Big Bowman Pond.

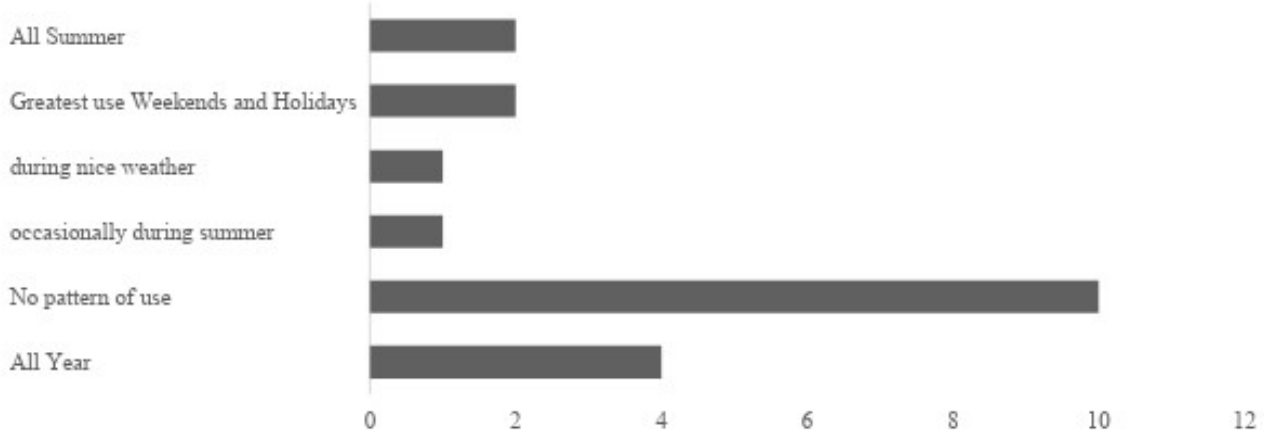

Figure 1.4 Times of year when the pond is used for recreational activities.

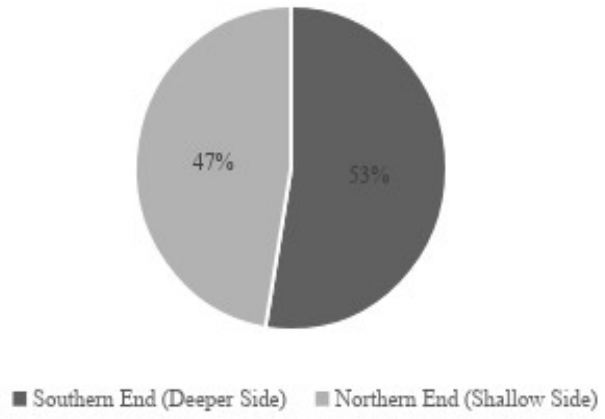

Figure 1.5 Areas of the lake which are generally recreated within. Light gray depicts the southern end of the lake which is deeper, whereas, the northern end which is indicated in black is shallower.

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?". Responses to this question highlighted that the major issue of excessive vegetation was related primarily to bladderwort species within the lake. Sixty six percent of respondents directly mentioned bladderwort. The other concerns mentioned included potable water, community conflict over management, runoff, and the introduction of invasive vegetation. Most homeowners were unsatisfied with the current concentrations of vegetation in the lake. Homeowners were mostly satisfied with the current status of fisheries (Figure 1.6).

A similar trend was evident 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 1.7). 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 want to prevent its deterioration.

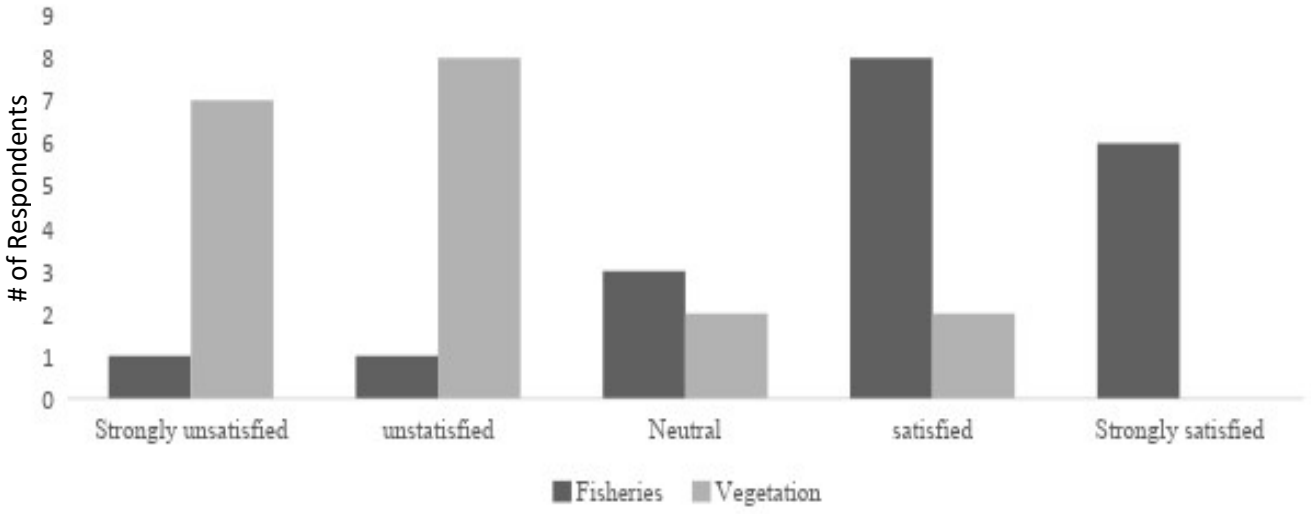

Figure 1.6 Satisfaction levels of homeowners with their current vegetation levels and with their current fisheries.

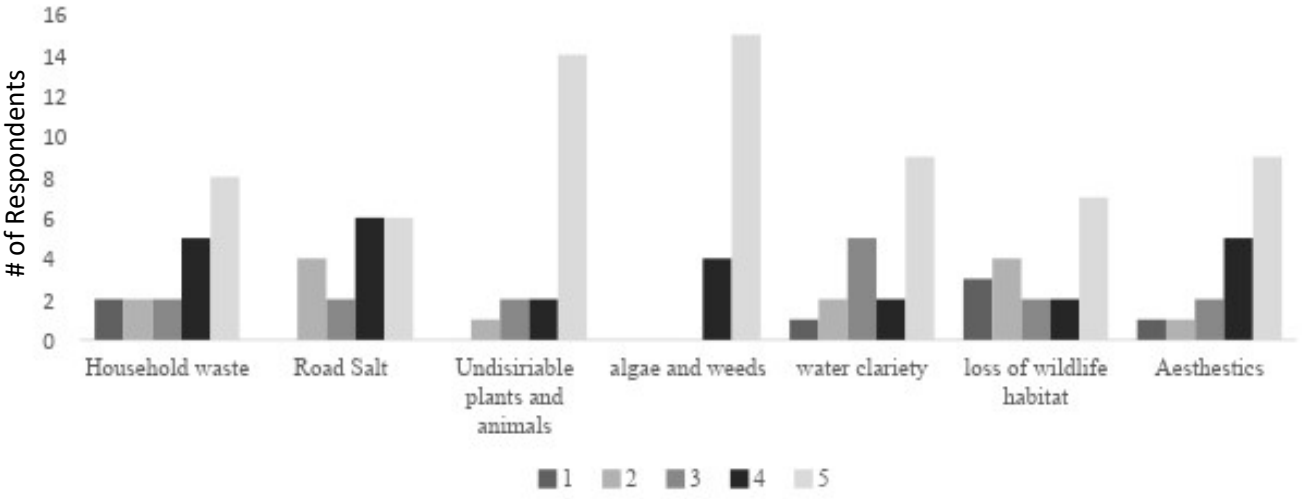

Figure 1.7. Stakeholders ranked common concerns from 1 to 5 were 1 is of least concern and 5 of greatest concern.

Management Strategies Opinions – When households were asked about potential management strategies regarding excessive vegetation there was no consensus (Figure 1.8). This could mean that

no single strategy is best suited and that multiple strategies may be needed to manage the vegetation issues or, that homeowners were divided regarding management strategies, which is supported by statements from the survey regarding conflict among residents that prevent efficient management of the lake.

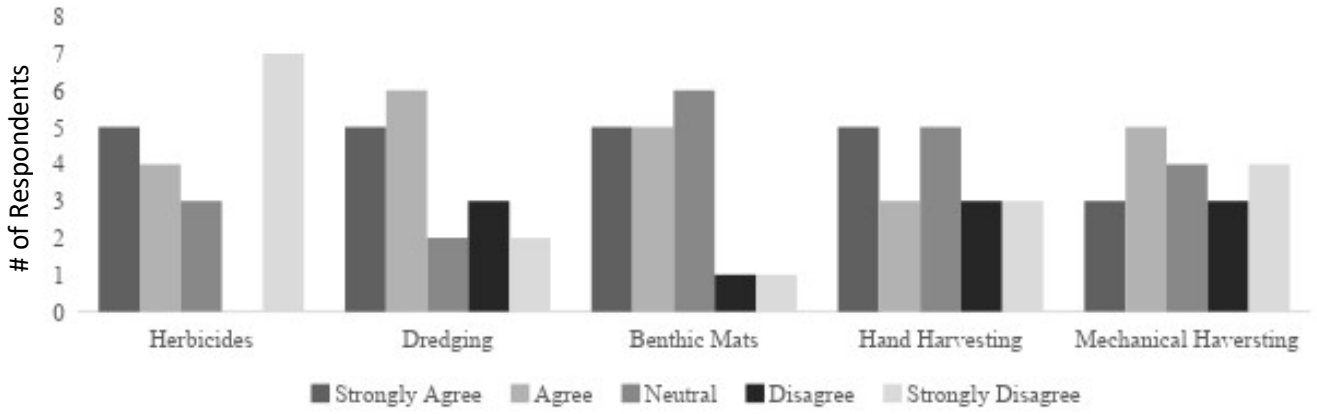

Figure 1.8 Opinion of homeowners on potential management strategies that can be used management vegetation issues present within the lake.

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 those at individual and group meetings. It is the hope that preservation of scientifically supported and objective 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.

Chapter II: Management Strategies

This management strategy section will be broken up into two parts that will address the major concerns of the stakeholders. The first part will focus on watershed management techniques and will discuss potential strategies to manage stormwater runoff. The second part will focus on in-lake treatment strategies focusing the management of nuisance macrophytes, primarily bladderwort species, and will include some information on the management of water lilies. Stakeholder concerns about invasive species will be addressed, and information about steps that can be taken to prevent invasive species from being introduced to Big Bowman Pond will be included.

Monitoring

Lakes and ponds are complex ecosystems with numerous inputs and outputs that can impact water quality in subtle or drastic ways. A monitoring system enables lake residents and lake management professionals to stay informed on the constantly changing quality of the waterbody of interest. Regular lake monitoring is important for keeping track of existing problems, detecting threats to the lake before they become a problem, and evaluating the lake's condition patterns, and to reconsider successful management strategies. Currently, Big Bowman Pond Lake Association (BLA) is a part of the NYSDECs Citizens Statewide Lake Assessment Program (CSLAP) which delivers high quality data about the lake every year. The BLA has been a part of the CSLAP program for five years and has collected a substantial amount of data. Data collection should continue in order to protect the lake and to start establishing long term trends.

Watershed Management

Storm-water Run-off

Big Bowman Pond's watershed is small with the dominate land cover type being forested; however, there are many homes and roads adjacent to the lake. The proximity of residential landcover increases the amount of nutrient runoff into the lake which potentially stimulates the growth of plants and algae but most likely has little effect on the lake. In general, best management practices (BMPs) remove no more than two-thirds of the nutrient load and on average only remove up to 50 % of the nutrient load in designated areas based on how the BMPs are designed, built, and maintained (Wagner 2016; Osgood 2017). While BMPs are limited in their ability to reduce nutrients in the short term and reduce long term management costs. Many state, federal, and non-profit resources can be found online that detail how homeowners can reduce nutrient runoff from anthropogenic sources. Homeowners should take initiative to reduce nutrient runoff from their own properties. Highway departments and local regulatory boards can and should also be involved in preventing runoff from reaching local waterways.

Big Bowman has a small portion of agricultural landcover within its watershed which contributes minor amounts of runoff. This could allow the landowners to make use of resources from the United States Department of Agriculture (USDA), Farm Service Agency (FSA), or Natural Resource Conservation (NRCS); however, the percentage of agricultural landcover in this watershed may not be enough to warrant resources from these agencies unless it can be demonstrated that agricultural activities contribute to lake degradation. All other watershed BMPs, including Navigational Use Regulations and other lakeside and in-lake regulatory strategies which address user

conflicts, can be addressed with local or with Land Use Regulations, typically promulgated by towns (Harman pers. comm. 2018)

Below is a list of potential strategies which can be used to reduce the effects of runoff and may help decrease nutrient and chloride levels within the lake.

First Runoff Alternative: Rain Barrels

Rain barrels are a simple approach to managing excess runoff. These barrels are designed to capture rainwater from the rooftops of houses and to store it for later use for lawncare or gardening (Figure 2.1). By collecting the excess rainwater from rooftops, the total amount of water runoff into the lake can be decreased. This is a great way to conserve water and to protect nearby waterbodies. Other benefits of rain barrels include cost reduction on water bills, reduced flooding from heavy rain events, easily accessible stored water sources for gardening, reduction of mosquito's infestations and even aesthetic appeal depending on design.

Note: Water collected within rain barrels can pick up pollutants such as bacteria from animals and chemicals from roofing materials. This should be taken into consideration when watering gardens that include edible plants, fruits, or vegetables.

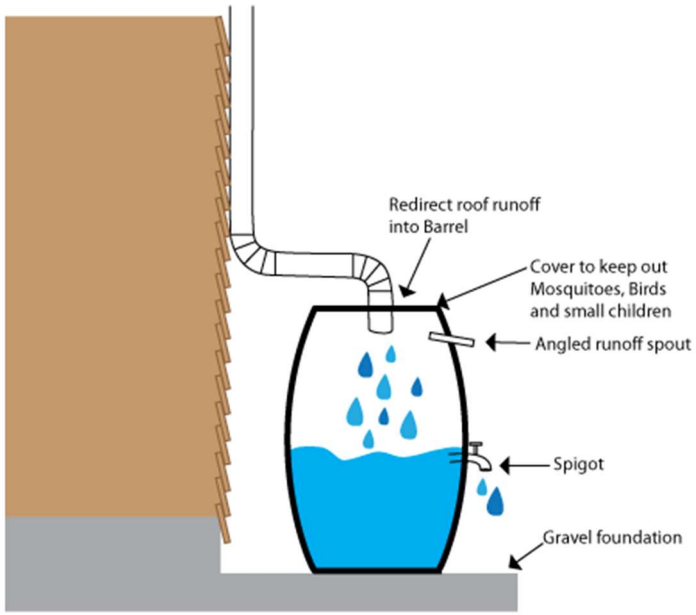

Figure 2.2 Image of a rain barrel system adapted from https://www.brickandbeamdetroit.com/resources/how-to-install-a-rain-barrel.

Second Runoff Alternative: Rain Gardens

A rain garden is defined as a depressed area within the landscape that collects excess rainwater from adjacent rooftops, driveways, or streets (Figure 2.2). The depressions are designed to allow water to it soak into the ground slowly, decreasing the chance of flooding the surrounding area (Figure 2.3). Perennial plants and grasses are often used within these types of gardens because they more tolerant to prolonged periods of saturation and provide a more visually appealing way to prevent runoff. This strategy is also quite cost effective. Additionally, rain gardens can filter out pollutants from the runoff and provide habitat for birds and butterflies, a benefit not seen with rain barrels. This strategy is best for those who enjoy gardening as rain garden maintenance is similar to that required for any other garden.

More information and potential examples can be found on the Environmental Protection Agency's (EPA's) webpage: https://www.epa.gov/green-infrastructure/what-green-infrastructure#raingardens

Figure 3.2 An example of a functional rain garden from https://www.epa.gov/green-infrastructure/what-green-infrastructure#raingardens.

Figure 2.4 An example of how a rain garden functions and prevents runoff from entering the lake, from http://kitsapcd.org/programs/raingarden-lid/rgbasics.

Third Runoff Alternative: Riparian Buffer Zones

Riparian buffer zones are defined as strips of vegetation (trees, shrubs, and grasses) planted next to waterbodies and waterways. These areas of vegetation create a space, or buffer, between the water and upland areas (Figure 2.5). It has been established that these habitats provide physical and chemical filtration processes that protect water resources (e.g. drinking water, fisheries) from siltation, chemical pollution, and increased water temperature caused by human actives such as agriculture, silviculture and urban development (Lowrance et al. 1984: Forsythe & Roelle 1990). It is generally acknowledged that riparian buffers 30-60 m wide will effectively protect water resources while buffers of smaller sizes have decreased effectiveness (Lee & Samuels 1976; Phillips 1989, Davies & Nelson 1994). This method may be hard to implement on Big Bowman Pond due to number of residences in close proximity to the lake; however, buffer zones can be used on an individual basis to provide water resource protection around the lake.

More information on riparian buffers and how to maintain and establish them can be found on the NYSDECs webpage: https://www.dec.ny.gov/chemical/106345.html

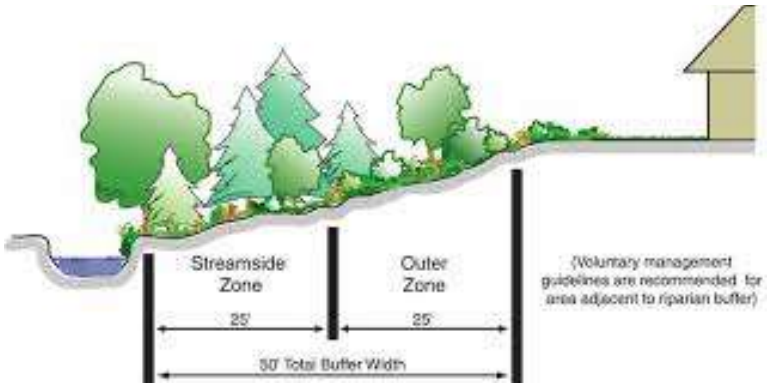

Figure 2.5 An “ideal” riparian buffer adapted from Welch (1991).

Wastewater Treatment Systems

Septic systems, also known as on-site wastewater systems, are used by homeowners within the Big Bowman Pond watershed. Septic systems typically lack tertiary treatment which reduces nutrients and bacteria in the effluent. Without tertiary treatment these pollutants can be released into nearby waterbodies and may have a negative impact on water quality. Systems which lack maintenance can lead to the leaching of pollutants over time, known as non-point pollution. Without proper maintenance these systems can also fail completely which can lead to direct pollution of the lake. This latter type of pollution is an example of point source pollution.

First Wastewater Alternative: Regulations

It may be necessary to establish or update land use policies to focus on continued maintenance of septic systems for the entire watershed. Development and enforcement of codes should be done via regular inspections of septic systems.

Second Wastewater Alternative: Upgrade Systems

Tertiary systems can be added to already existing systems that are present around Big Bowman Pond. Adding tertiary systems would filter out nutrients and bacteria to prevent them from being introduced into the lake. This strategy would be at each homeowner's expense and could be very costly.

In-Lake Management

Nuisance Macrophytes

Five species of macrophytes within the lake, all of which are native, have been growing in excessive amounts inhibiting the use of the lake for recreational purposes as well as affecting the overall aesthetics. These include *Utricularia inflata* (swollen bladderwort), *Utricularia vulgaris* (common bladderwort), *Utricularia purpurea* (eastern purple bladderwort), *Nuphar lutea* (yellow pond lily), and *Nymphaea odorata* (white pond lily). Currently, no lake-wide management strategies have been implemented, but most homeowners regularly hand harvest during the summer season to allow easier access to the lake from their homes. This method works but with less stakeholder satisfaction than desired.

When the community was asked what strategy, they believed to be the best course of action no consensus could be achieved. Due to this, management strategies will consist of all categories of management (physical, biological, and chemical) so all options can be evaluated by the community.

Macrophyte management goals will focus primarily on long-term management of the lake. This will include addressing the current issue with excessive vegetation with recommendations for strategies by which nuisance species abundance can be reduced to acceptable levels, but not impact or harm the overall ecosystem. It is important that when trying to reach ideal concentrations of macrophytes that the community of primary producers in the lake is not changed to an algal dominant system with the potential for toxic blooms. Management goals will also take into consideration negative impacts of recreational uses, such as boating and swimming, by macrophyte growth.

First Macrophyte Alternative: Bladderwort Control via Hand Harvesting

What it is

Hand harvesting is very much like weeding a garden. Nuisance species are physically removed from the area intended for use by hand or with hand tools. Once the plants have been harvested, they should be properly disposed of on land, far enough away from the shore so that the material cannot wash back into the lake. Plants can be dried and used later for mulch or fertilizers. Disposal may be confined to small, individual areas at each resident's discretion. This technique is generally restricted to small areas, unless residents are willing to put more time and effort in to clearing larger areas of the lake.

Advantages

The primary advantage of hand harvesting is that it is the ultimate selective plant management technique, since it generally removes a single plant at a time. Usually, only plants that are identified as exotic, invasive, or as otherwise a nuisance are removed. Harvesting can be conducted at minimal expense and minimal labor as anyone can participate in the hand harvesting. This technique is also very useful for preventing re-infestations after a large-scale plant management tactic is implemented. For target plants that do not reproduce vegetatively, such as bladderwort species, hand harvesting can provide some long-term control of these plants in specific areas if the plants are removed prior to the formation and fall of the seeds.

Disadvantages

Disadvantages of hand harvesting include the unwieldly and tedious nature of the task. It is difficult to pull large quantities of targeted plants up at one time, and it is inconvenient from the perspective of the puller to gather all of the scattered parts. Despite these difficulties, hand harvesting may be the best way to prevent the spread of nuisance plants. Efforts to speed up the process that cause less targeted efforts can lead to incomplete plant removal which will allow the same or a similar issue

to occur later. Additionally, the inability to remove deeply rooted or submerged plants may result in an infestation from plant beds outside of the range of shoreline harvesting. This method is also not very effective on plants that have extensive root systems, such as lilies.

Cost

The most significant expense associated with hand harvesting is the cost of labor if the task is outsourced and not performed voluntarily by homeowners. The entire operation costs about $0.25-$1.00 per plant, or upwards of $400-$1000 per acre (Holdren et al. 2001), based on the density of aquatic plants in the lake with targeted beds of targeted plants.

Regulatory Issues

In most regions of New York State hand harvesting is not a regulated activity, although some NYSDEC regional offices may require permits or approval to perform large-scale hand harvesting. Lakes that are partially or wholly encompassed within wetlands may require wetland permits.

Recommendations

Hand harvesting should occur prior to bladderwort flowering in Big Bowman Pond. This will prevent the bladderwort species from reseeding and may reduce bladderwort concentrations in future years if the methods are implemented consistently. Bladderwort flowers are yellow and are generally likened to snapdragon flowers. Seining and raking the surface of the pond with a standard garden rake can be effective techniques to hand harvest bladderwort.

Timeline

This should occur annually. Harvest should occur quickly after bladderwort spp. reaches the surface of the water and should continue regularly until after flower. Post-flower harvesting can occur based on homeowners' own needs but will not provide long-term control through inhibition of seed set.

Second Macrophyte Alternative: Bladderwort Control via Triploid Grass Carp

What it is

Grass carp (*Ctenopharyngodon idella*) have been introduced to many lakes worldwide due to their ability to control a wide variety of aquatic plant species. This fish is one of the largest members of the minnow family and can grow to be nearly 400 pounds in weight, but typically reach weights of 50-70 pounds. In the U.S. most grass carp are bred to be a sterile (triploid) form of grass carp. This reduces the risk of the fish reproduction in a waterbody, which could be detrimental to aquatic plant communities.

Advantages

The advantage of using this species for aquatic plant management is that it is an inexpensive, long-term method while other techniques, such as herbicides or mechanical harvesting, are short-term, and expensive. A study looked a cost comparison of these three methods within Lake Seminole and found that grass carp would have costed them $100/ha compared to herbicides and mechanical harvesting which would have costed $720/ha and 5,500/ha respectively (Macenina et al. 1999). This appeals those who are looking for long term management without continuous effort or financial investment on their part. If stocked at a proper rate and at correct sizes, these fish are expected to achieve close to 75-100% vegetation control within several years depending on the severity of the problem. However, complete elimination of vegetation is often not desirable.

Disadvantages

When using triploid grass carp there are many variables not under the control of managers. It is nearly impossible to control which species of plant will the grass carp target and eliminate once stocked. Studies on the dietary preferences of these fish have been conducted and show, with some confidence, which species of plants they prefer; however, this may not be the case within Big Bowman Pond. If the grass carp target a non-nuisance species, they could create more room for nuisance species to grow, which would increase the problems within the lake. The next issue is the timeline of this management strategy. Triploid grass carp will continue to eat even after lake management targets for plant abundance have been achieved, and the only way to prevent over-grazing by grass carp is to remove them from the lake. There are many studies and reports that explore the stocking rates of these fish so that they will not be overstocked, but there are also numerous examples in which desired control has been exceeded under what was believed to be an appropriate target density of grass carp. In some cases, control targets are surpassed to such an extent that algal blooms result from lack of nutrient sequestration by plants.

Cost

Costs vary and will depend on a direct quote from a distributor; however, these fish are more cost effective than herbicides as they can live for more than 20 years in some cases. Another potential cost includes a required upgrade to any dams adjacent to the stocked waterbody in order prevent the escape of the grass carp under NYSDEC permitting requirements. An upgrade such as this will need to be assessed and quoted by a professional. Dam upgrades could vary based on the quality of dams already present.

Regulatory Issues

Permits are required to stock triploid grass carp in lakes within New York State. The policy is quoted below, and can be read in more detail at: https://www.dec.ny.gov/outdoor/7973.html.

"It will be the policy of the New York State Department of Environmental Conservation, Division of Fish, Wildlife & Marine Resources to approve and issue permits for stocking of up to 15 United States Fish and Wildlife Service certified triploid grass carp per surface acre for aquatic plant management purposes in ponds five (5) acres or less in size which lie wholly within the boundaries of lands privately owned or leased by the individual making or authorizing such treatments if:

- *Aquatic plants targeted for control significantly impair the intended use(s) of the pond.*
- *The subject pond harbors no species of wildlife, fish, shellfish or crustacea identified by the Department as being endangered, threatened or special concern; or any species of plant identified as being endangered, threatened or rare.*
- *The subject pond is not contiguous to or part of a New York State regulated freshwater wetland.*
- *The subject pond is not an impoundment or natural pond on a permanent stream or a source of a permanent stream as designated by the most recent United States Geologic Survey (USGS) or New York State Department of Transportation (DOT) quadrangle covering the application site.*

- *At least two (2) years have elapsed since the last stocking of triploid grass carp, unless it can be demonstrated that a significant portion of the permitted fish were subject to mortality within the stocked pond.*

Permit applications for waters other than those meeting these criteria, including waters greater than five (5) acres will not be acted upon until evaluated on a site-specific basis in accordance with the State Environmental Quality Review Act (SEQRA) and guidelines established by NYSDEC Division of Fish, Wildlife & Marine Resources." (https://www.dec.ny.gov/outdoor/7973.html)

Recommendation

The stocking of triploid grass carp within Big Bowman Pond as a bio-control can be an effective and inexpensive strategy. If grass carp are stocked, their preference within the lake will assumedly be two of the nuisance species: pondweed and bladderwort (Stewart and Boyd 1999). It is important that these fish, if stocked, are at or below the recommended stocking density, so that no problems occur.

Timeline

It is necessary to start small when stocking and continually add grass carp if successful control is not achieved within 3-5 years. This method may take several years to show indications of control, and it is essential that patience be exercised in stocking programs to avoid over-stocking.

More information about grass carp can be located on the BLA website (http://www.bowmanlakeny.org) under the vegetation assessment performed in 2011.

Third Macrophyte Alternative: Herbicides

Note: According to a previous vegetation assessment conducted by Adirondack Ecologists (Lamere 2011) the use of chemical control was not recommended as a viable solution. The primary concerns

were risks to non-target aquatic plants (e.g., species other than bladderwort) and other organisms (e.g., amphibians, small fish, and insects), and the high cost of treatment (Lamere 2011).

What it is

There are many types of herbicides on the market today, and each category of herbicides serves different purposes ranging from broad-spectrum formulations to selective herbicides. Broad-spectrum herbicides target all vegetation within a treatment area and can be used to reduce the overall plant density in a waterbody. Selective herbicides target specific plants and can allow desirable native species to persist following treatment. There are two main modes of action for aquatic herbicides: contact and systemic. Contact herbicides are fast-acting as they cause tissue damage upon contact. Alternatively, systemic herbicides work slower because they are absorbed by the plant and then cause damage to critical areas, such as the stem, leaves, or roots. With the variety available, different herbicides will be appropriate for different scenarios and management goals. Furthermore, combinations of herbicides are often used to achieve different types of plant management goals.

Advantages

Herbicides, unlike many other aquatic management strategies, provide a fast solution. Generally, contact herbicides require only a short amount of exposure time (6-24 hours) before effects can be noticed.

Disadvantages

By comparison to biological control methods, chemical control with herbicides is generally more expensive, although costs are variable, and application can be very cost-effective. One of the primary issues with aquatic herbicides is that they are not absolutely selective to one species of plant and even when using selective herbicides other may be affected. Additionally, some herbicides do not

kill the entire plant and parts of plants can remain viable within the lake until the next season. Finally, public perception and resistance to use of chemicals present a significant challenge to the use of herbicides in Big Bowman. Much of this stems from well-founded concerns related to the past use of harmful compounds. However, the field has undergone rapid development, and today there are many herbicides that are considered safe and reliable, and these may warrant consideration for inclusion in potential management strategies moving forward.

Cost

Herbicide costs can vary based on the type and brand used. For a specific price, one would need to receive a quote from a licensed professional herbicide applicator.

Regulatory Issues

Permits are required to use aquatic herbicides within lakes in New York State and are managed by the Bureau of Pesticides Management. This bureau is responsible for the administration of the aquatic pesticide permit program in New York, under the authority granted by article 15-0313(4) of the Environmental Conservation Law and Title 6 of the Official Compilation of Codes, Rules, and Regulations of the State of New York (6 NYCRR) parts 327, 328 and 329. Regulations for type of aquatic pesticide permit can be found on the NYSDEC webpage (https://www.dec.ny.gov/regulations/8876.html). This process is generally completed by the licensed applicator.

Recommendation

If herbicides are used in Big Bowman Pond, they should be selective to bladderwort species to help preserve the non-nuisance species within the lake. Potential products that are selective to bladderwort are listed below to give examples of products that could be used. When consulting a licensed applicator, newer, safer, or more selective herbicides may be mentioned that are better than the products listed below.

Timeline

Application of herbicides should occur before bladderwort flowers to prevent future growth during the next year through seed set.

Herbicide Products Targeted for Bladderwort Species:

1. Fluridone:

   Fluridone is a broad spectrum, systemic herbicide. Systemic herbicides are absorbed and move to sites of action within the plant to cause damage. These systemic herbicides are slower than contact herbicides, and some may require extended exposure times, although restrictions on water use are minimal compared to many others (Wisconsin DNR 2012).

   Common trade or product names include, but are not limited to:

   - Sonar
   - Avast

- Whitecap
- Restore

2. Diquat:

   Diquat is a contact herbicide and algaecide. Contact herbicides kill all plant cells they come into contact with and offer quick, but loosely targeted treatments (Wisconsin DNR 2012).

   Common trade or product names include but are not limited to:

   - Reward
   - Harvester
   - Tribune
   - Tsunami DQ
   - Diquat SPC2L
   - Weedtrine

3. Flumioxazin:

   Flumioxazin is a granule that can be sprayed or injected after mixing with water. This product is a broad-spectrum, contact herbicide. This product is applied to actively growing plants and requires a surfactant to be applied to floating species. Lastly, this product needs a pH of 8.5 or less or this product will lose effectiveness (Wisconsin DNR 2012).

   Common trade or product names include but are not limited to:

   - Clipper

4. Penoxsulam:

   Penoxsulam is a broad-spectrum, systemic herbicide. This product is generally sprayed directly onto emergent and floating species. Penoxsulam loses effectiveness in areas where water becomes diluted rapidly and it is not recommended to use near inlets or outlets. This product also requires a registered surfactant, which can be found on the product label, for treatments that have exposed sediment or leaves (Wisconsin DNR 2012).

   Common trade or product names include but are not limited to:

   - Galleon

Fourth Macrophyte Alternative: Control of Lilies via Benthic Barriers

What is it

Benthic barriers, sometimes called benthic screens or benthic mats, are used to prevent plant growth by blocking out the light required for growth. This technique provides a physical barrier, which prevents the growth and expansion of vegetation to the areas covered by the mats. These barriers are made of plastic, fiberglass, nylon, burlap or other non-toxic materials that are gas permeable so that they remain against the bottom of the lake. Generally, these barriers can be installed by two to three people operating from shore and are placed in areas of either intensive use or significant concern. They are most often used around docks and swimming areas.

Advantages

Benthic barriers do not selectively control the underlying plants, though the placement of the mats restricts the ability and growth of invasive and nuisance plant species within desired areas. These barriers also require no extensive machinery to set and can be set by lake residents or by professionals.

The NYSDEC recently issued a general permit for use of benthic mats in areas of Upstate New York outside the Adirondack Park.

Disadvantages

Placing a barrier on the bottom of the lake can affect benthic invertebrates and could potentially interfere with warm water fish spawning, depending on placement and the size of the barriers. This strategy can be used anywhere within the littoral zone, but the cost of the materials and the difficulty of installation can limit spatial area of this method. Lastly, this product needs to be installed and removed every season.

Cost

Benthic barriers can be installed inexpensively if done by residents, but professional installation can be expensive. For professional installation, the cost of benthic barriers can range based on the choice of screening material and whether the application involves initial installation or re-deployment in future seasons. The cost may be initially high but if used properly the materials can be used over several years.

Regulatory Issues

In most regions of NYS, the use of benthic barriers is licensed under a "general permit". Some DEC regions may require approval or permits for large-scale operations covering large areas. This is to prevent the disruption of fisheries habitat and any effect on desirable native species. General permits can be located on the NYSDEC web page (https://www.dec.ny.gov/permits/111325.html) and contact information can be found for specific region offices for any questions if a permit is required.

Recommendation

Benthic barriers are best suited for those who are having issues with abundant lily species surrounding their docks and preventing recreational access to the lake. Those using a benthic mat must understand that all organisms in the covered area will be affected and this tool should not be used if there are other desired species present locally.

Timeline

Benthic barriers should be place within the water prior to the growing season and removed after the growing season ends to prevent ice damage to the barriers. Barriers left within the water for a small portion of time during the growing season only have positive impacts. Degradable barriers, if used, can be left in the lake as they will decompose over the duration, and these can even be seeded with native plants if desired.

Plant Monitoring

Plants should be observed as management strategies are being implemented. The easiest way to monitor successful plant management would include to quantify amount of vegetation around one's docks and observer is quantities are decreasing over time. If one strategy is not working effectively, maybe using another method or combination of methods may result in better outcomes. Another potential way to observe plant density changes within the lake would be to mimic what was done during the plant survey which was brought up in the State of the Lake report. By mimicking those results, one could compare density at specific locations and notice if any changes were occurring.

Invasive Species Concerns

Currently, there are no invasive species present within Big Bowman Pond and the goal is to prevent them from establishing within the lake.

Prevention Strategies

According to the survey, many lake residences around Big Bowman Pond are worried about the introduction of invasive species to the lake. There is a simple strategy that has been advocated by the NYSDEC to prevent the spread of invasive aquatic macrophytes known as Clean, Drain, Dry. This process refers to cleaning of boats, trailers, waders, fishing and boating equipment. Many invasives about which people are concerned are visible to the eye, such as water milfoil, but many others are too small to be readily noticed, which is why disinfection of all equipment is required to prevent the spread.

The 5 steps of the Clean, Drain, Dry process:

1. **Check**: identify if any invasives species have been on your boat or equipment.
2. **Clean**: remove all visible mud, plants, fish or animals before transport equipment. Make sure all plant remnants are placed within a designated area where they won't be brought in by runoff. Zebra mussels are an exception and need to be killed by exposure to water of at least 140°F.
3. **Drain**: Remove all water within holding compartment. For kayaks make sure that water is not trapped inside. If water is present, there is a chance invasive organism can live within.
4. **Dry**: Dry boats and all equipment for at least 5-7 days of continuous warm weather or until completely dried. If it happens to rain during that period one must resent the clock. This process is to ensure that no invasive species or fish diseases are transported to a new body of water.

5. **Disinfect**: disinfect any equipment prior to contact with water if it cannot be dried prior to use again. A list of disinfection techniques for fishing and boating equipment can be located on the DEC website (https://www.dec.ny.gov/animals/50267.html)

More information on this strategy can be located online on the NYSDEC webpage.

Early Detection Rapid Response Plan (EDRR)

There are strategies that will help reduce the chances of invasives being introduced to a lake, but even the best prevention efforts cannot stop all invasive species. One of the best ways to avoid this problem is to create an early detection- rapid response plan (EDRR). An EDRR plan is a set of actions that help to find and eliminate potential invasive species at a location before they can spread and cause harm. The effectiveness of a new EDRR plan comes down to the ability to answer questions such as (National Invasive Council 2008):

1. What is the species of concern and has it been identified already?
2. Where is the species located and is it likely to spread?
3. What harm can the species cause to the ecosystem?
4. What actions need to be taken to address the issue?
5. Who has the authority and resources to address the issue?
6. How will this be funded?

Successful EDRR programs include (National Invasive Species Council 2003):

1. Identification of potential threats in time to allow risk mitigation measures to be taken.

2. Detection of new invasive species to allow efficient and environmentally sound decisions to be made.
3. Responses to the invasion must be effective and prevent the spread and establishment of invasive species.
4. Information must be given to decisionmakers, the public, and other lakes within the area in an adequate and timely manner.
5. Lastly, lessons learned from previous efforts should be used to guide and establish future efforts.

A great example of an EDRR plan is the one being implemented on Bear Lake in Chautauqua County, New York (Appendix 1). Their plan focusses on the preservation of lake and to create plans to address the issue of potential invasive species if they are found within the lake. This plan could be used as a template to follow if the residents of Big Bowman are interested in creating an EDRR plan of their own.

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