Swan Lake Management Plan

Columbia County, Wisconsin

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The Swan Lake Management Plan (LMP)

Each lake has unique strengths and challenges. Oftentimes, the more a lake is used and the greater the development around it, the more maintenance is needed for the system to stay in balance.

The Swan Lake Management planning process provided an opportunity to review information known about the health of the lake, identify existing or potential problems, and develop strategies to keep the lake and its fishery healthy.

The development of this lake management plan (LMP) incorporated scientific knowledge, community perspectives, and rules and regulations.

GOALS

1. Recreation on Swan Lake will be safe for lake users and lake health.
2. Swan Lake will host a healthy fishery and a balanced aquatic plant community.
3. Swan Lake will have healthy water quality for swimming.

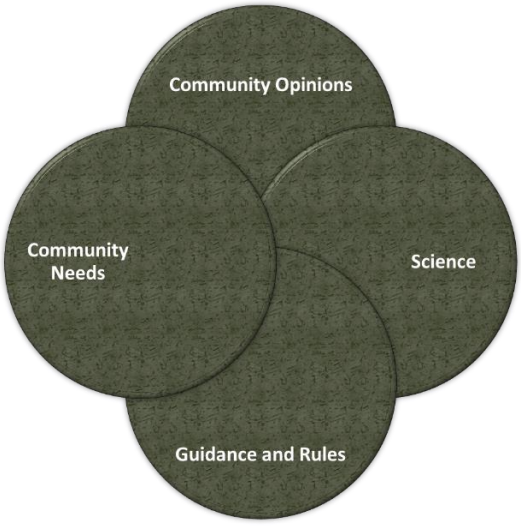
How were community members able to share opinions about Swan Lake?

Community perspectives were obtained through participation in the planning sessions and from a mailed survey.

Four public discussions were held between January and April 2017. Each gathering focused on different topics with guest speakers and a summary of related survey responses. Shoreland property owners received notification about the sessions by mail.

A total of 233 surveys were returned from the 854 sent, giving a response rate of 27.3%. Responses were obtained from households around the lake, including the Swan Lake shorelands, Saddle Ridge, Country Club, Highland Meadow, and those living south of the lake.

In addition to providing opinions on a variety of topics, the survey provided insight about trust in organizations, willingness and motivations for change, and where local investments should be made. Survey responses are provided throughout this document. The full survey report can be found in the Appendix H.



GOAL 1

RECREATION ON SWAN LAKE WILL BE SAFE FOR LAKE USERS AND LAKE HEALTH

GOAL 1. RECREATION ON SWAN LAKE WILL BE SAFE FOR LAKE USERS AND LAKE HEALTH

Outcome 1.1: People recreating on Swan Lake will be knowledgeable about courtesies and rules related to safety and lake health.

1.1A **What: Ensure up to date information is available for lake users. Keep information on kiosks current. If something new is added, change the display enough that people will notice it.**

Who: SLA Designee

When: Ongoing

Measure of Success: Lake users will follow safety courtesies and rules and the lake will not be negatively impacted by recreational activities.

1.1B **What: Create a map showing the 100' buffer from shore to improve safety and reduce shoreland erosion. Include information about the red flags and no wake on the brochure. Map will be distributed in annual newsletter, located in landowner pamphlet and located in the kiosk at the boat launch.**

Who: Columbia County Land and Water staff will create the map. SLA will distribute in various forms.

When: 2019

Measure of Success: Lake users will have a reference for the no-wake area in Swan Lake.

Outcome 1.2: Improve safety on and near Swan Lake.

1.2A **What: Enforce boating ordinances**.

Who: WDNR Warden

When: Ongoing

Measure of Success: Boaters will observe rules and do their part to ensure Swan Lake is safe for a variety of recreational users.

1.2B **What: Reduce impacts from waves and wakeboarding by providing information in newsletters, hosting guest speakers about ways to reduce shoreland impacts by the use of healthy shoreland practices and woody substrate.**

Who: SLA

When: Ongoing

Measure of Success: Shoreland impacts from waves and wakeboarding will be reduced.

GOAL 1. RECREATION ON SWAN LAKE WILL BE SAFE FOR LAKE USERS AND LAKE HEALTH

Outcome 1.2: Protect shorelands when water levels are high.

1.2A **What: Assure needed monitoring equipment and information is in place. Paint a line on the boat launch to indicate the high water mark. Survey the elevation of the placard.**

Who: Columbia Co.

When: 2018 and as needed.

Measure of Success: Water levels can be assessed with accurate monitoring equipment.

1.2B **What: Develop a county ordinance to guide the steps needed to enact slow no-wake when water levels are high**.

Who: Columbia County LWCD and EMS

When: 2018/2019

Measure of Success: Slow no-wake is efficiently enacted when water levels are at 781.10 feet above mean sea level (FAMSL).

C **What: Monitor for high lake levels and enact communication steps. Lake levels are observed at the placard on the boat launch on the south end of the lake. If water levels are at the mark, photograph the high water level at the placard and contact the SLA President.**

Who: SLA designee

When: As water levels begin to rise.

D **What: Send text with picture to Columbia County**

Who: SLA Designee

When: When water levels are at 781.10 feet above mean sea level (FAMSL).

E **What: Notify shoreland property owners and lake users when slow no-wake is in effect. Post slow no-wake signs at the boat launch and on roads. (Reference the county ordinance on signs.) Red flags are raised at a minimum of 2 sites around the lake.**

Who: SLA

When: When slow no-wake is enacted.

F **What: Notify shoreland property owners and lake users when slow no-wake is in effect. Post on the County website (http://www.co.columbia.wi.us/ColumbiaCounty/sheriff/SheriffsOfficeHomePage/tabid/551/Default.aspx). Notify media through a press release. Initiate text message to those that requested to receive one.**

Who: Columbia Co. EMS

When: When slow no-wake is enacted.

Measure of Success: Shorelands are protected from boat induced waves when water levels are high.

GOAL 1. RECREATION ON SWAN LAKE WILL BE SAFE FOR LAKE USERS AND LAKE HEALTH

Outcome 1.3: Develop an understanding about the causes associated with high lake levels.

1.3 **What: Swan Lake residents have expressed an interest in further studying the relationship between Swan Lake inlets, outlets and elevation of the water level.**

Who: Columbia Co. and WDNR lake grants

When: 2019

Measure of Success: This information will be used to aid the conversation in years to come to determine the necessary height of the current slow no wake rules.

Recreating in Swan Lake

Swan Lake is enjoyed by many local residents and visitors. While recreation can provide pleasurable and memorable experiences, not all forms of recreation are compatible and some can potentially result in conflicts. Conflicts can be reduced through an understanding of courtesies for a given lake, directional boating, no-wake hours or other regulatory or non-regulatory efforts. Providing information for users about actions aimed at the reduction of conflicts or for safety concerns can be accomplished through signs or brochures at boat launches, newsletters, and conversations at meetings or with neighbors.

People's Perceptions

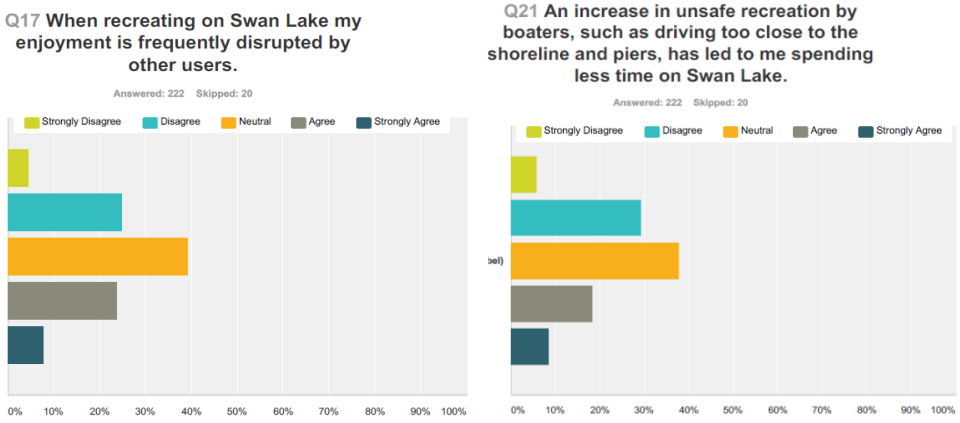
Questions about safety and disruption while recreating drew a variety of responses from those surveyed. Some seemed to feel at ease while recreating while others did not. This variation may be related to the type of recreation or the location that recreation is occurring in Swan Lake. The average survey respondent somewhat disagreed that "motorboats/ski boats are being used appropriately on Swan Lake" and that "the boat use is not causing damage to the shoreline". The shoreland owners felt strongest about this. Some of the problems identified with this statement included disruption to the lake users and a lack of feeling safe, resulting in reduced use of the lake.

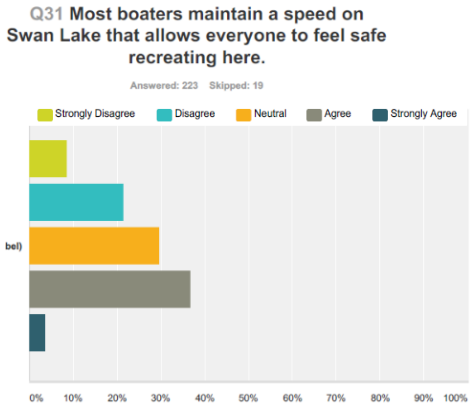
High water levels in Swan Lake

Periodically, the water levels in Swan Lake increase. During these periods, waves generated by boating and winds can damage the shoreline, which can create erosion and add nutrients to the water from the disturbance of sediment.

Monitoring water levels, communication about the levels, and during high water periods, enacting a slow-no wake prevision to protect shorelands and Swan Lake have been identified in this plan developed a Columbia County Ordinance No. 198-18, Sec. 21-4-1(d)(2) Appendix A.

Figure 1. Swan Lake Community Survey & Social Assessment





Addressing High Water Levels in Swan Lake

1. Lake levels are observed by an SLA designee at the placard on the boat launch on the south end of the lake.

2. If the water level is at the mark, the SLA president will be contacted.
3. The SLA President or designee will contact the Deputy Director of Columbia County Emergency Management Services (EMS) to enact the slow-no wake ordinance.
4. Shoreland property owners and lake users will be notified by the following methods.
    - EMS will post a notification on their website and/or the Columbia County website.
    - EMS will initiate a press release
    - Swan Lake Association and/or CCLWCD will text message to those requesting one.
    - Slow No-Wake signs will be posted at the boat launch and on roads.
    - Red flags will be raised at 2 sites around the lake.

GOAL 2

SWAN LAKE WILL HOST A HEALTHY FISHERY AND A BALANCED AQUATIC PLANT COMMUNITY

GOAL 2. SWAN LAKE WILL HOST A HEALTHY FISHERY AND A BALANCED AQUATIC PLANT COMMUNITY

Outcome 2.1: Provide sufficient habitat to support all stages of the fishery lifecycles in Swan Lake.

2.1A. **What: Improve the habitat in Swan Lake. Install woody habitat adjacent to WDNR Land. Obtain appropriate permits.**

Who: SLA, shoreland property owners

Resources: WDNR Fishery biologist, WDNR Healthy Lakes Grants, local fishing clubs

When: 2018 and ongoing

Measure of Success: Increased reproductive success of the fishery.

Outcome 2.2: Understand the conditions of the fishery and habitat in Swan Lake.

2.2A. **What: Conduct a habitat survey for woody structure and substrate. Develop a strategy for improvement.**

Who: SLA, consultant **Resources:** WDNR Lake Planning Grant

When: 2019

Measure of Success: Locations of woody habitat and substrate types will be known to guide augmentation strategies.

2.2B. **What: Conduct a survey of the fishery and share the results with SLA.**

Who: WDNR Fishery biologist

When: 2017/2018 The survey will begin at ice-out in March or April with trap netting and early electrofishing targeting northern pike, walleyes, and muskies, followed by May electrofishing targeting bass and panfish, and a fall electrofishing survey in early October targeting gamefish with a special focus on walleyes.

Measure of Success: The composition of the fish community will be known and used to make management decisions.

2.2C. **What: Information about the fishery in Swan Lake will be made available for shoreland property owners and lake users through newsletters, speaker at an SLA meeting, and on the website.**

Who: SLA, Fishing clubs **Resources**: WDNR Fishery biologist

When: 2018 or when available

Measure of Success: Shoreland property owners and lake users interested in the fishery will have access to information about the fish community.

Outcome 2.3: Enhance sport fishing opportunities in Swan Lake.

2.3 **What: Walleye stocking will occur based on surveyed needs and available funding.**

Who: WDNR Fishery biologist

When: Stocking in odd years

Measure of Success: Walleyes will be part of the sport fishing opportunity in Swan Lake and tax dollars expended on stocking will be reduced.

GOAL 2. SWAN LAKE WILL HOST A HEALTHY FISHERY AND A BALANCED AQUATIC PLANT COMMUNITY

Outcome 2.4: Healthy shore lands will exist around Swan Lake for resiliency from waves, and to improve water quality and habitat. New and existing shore land property owners will understand the importance of healthy shore lands and will receive support.

2.4A. **What: Provide informative Shoreland Packet to existing shoreland property owners about the importance of healthy shorelands**.

Who: Columbia County Planning and Zoning .

Resources: Columbia Co. LWCD will work with SLA to develop a Shroeland Packet, UWEX Lakes – educational materials

When: Ongoing as properties are sold

Measure of Success: Shoreland property owners will be knowledgeable about the benefits of good shoreland management practices and respond accordingly.

2.4B. **What: Provide welcome packets to new shoreland property owners so they understand how to keep Swan Lake healthy and are aware of what they can/cannot do in the shoreland.**

Who: A SLA designee will deliver packet to new lake residence

Resources: UWEX Lakes – educational materials

When: Ongoing as properties are sold

Measure of Success: Shoreland property owners will be knowledgeable about the benefits of good shoreland management practices and respond accordingly.

2.4C. **What: Columbia Co. LWCD staff can provide guidance on healthy lake improvements for a given property.**

Who: Shore land property owners

When: Upon request

Measure of Success: Shore land property owners will know the best options for shore land improvements on their property.

2.4D. **What: The County will actively enforce its shore land zoning ordinance.**

Who: Columbia Co. Zoning Dept. **Resources:** Columbia Co. LWCD, Columbia Co. Board Members

When: Ongoing

Measure of Success: Swan Lake's shore lands will be better protected.

2.4E. **What: Provide positive feedback/incentives for healthy shoreland practices by acknowledging healthy shoreland protection and/or restoration.**

Who: Swan Lake Association

When: Bi-annually in the Swan Lake Association Newsletter

Measure of Success: Shoreland property owners with good shoreland management practices will be acknowledged

GOAL 2. SWAN LAKE WILL HOST A HEALTHY FISHERY AND A BALANCED AQUATIC PLANT COMMUNITY

Outcome 2.5: Understand the conditions of the aquatic plant community in Swan Lake.

2.5A. **What: Evaluate the native and invasive aquatic plant communities in Swan Lake.**

Who: SLA **Resources:** WDNR Aquatic Plant biologist, consultants

When: 2018 (WDNR) and every 5 years

Measure of Success: The status of the aquatic plant community and invasive species (AIS) will be known for management decisions.

2.5B. **What: Share the results of the aquatic plant survey with shoreland property owners and others interested in Swan Lake. Any necessary management efforts will be discussed and strategies will be developed.**

Who: SLA **Resources:** WDNR Aquatic Plant biologist, consultants

When: 2019 and every 5 years

Measure of Success: The status of the aquatic plant community and invasive species (AIS) will be known and used for management decisions.

Outcome 2.6: New AIS will be prevented from becoming established in Swan Lake. Those living and recreating on Swan Lake will do their part to limit the spread of AIS to and from the lake.

2.6A. **What: Host an AIS identification training session for interested lake users and have examples of AIS at SLA meetings.**

Who: SLA **Resources:** WDNR Aquatic Plant biologist, consultants

When: 2019/2020

Measure of Success: A group of SLA members and others will be able to monitor for and identify AIS.

2.6B. **What: Individuals trained in AIS identification will look for new invasive species. The WDNR Aquatic Plant Biologist will be contacted if new AIS is suspected.**

Who: SLA **Resources:** WDNR Aquatic Plant biologist, consultants

When: Ongoing during the growing season

Measure of Success: New AIS will not become established in Swan Lake.

2.6C. **What: Information about AIS will be distributed to shoreland property owners in the spring and provided to Saddle Ridge and the boat club for their posting and distribution.**

Who: SLA **Resources:** UWEX Lakes – educational materials

When: Spring of each year

Measure of Success: Introduction of new AIS to Swan Lake will not occur.

GOAL 2. SWAN LAKE WILL HOST A HEALTHY FISHERY AND A BALANCED AQUATIC PLANT COMMUNITY

Outcome 2.6 (cont): New AIS will be prevented from becoming established in Swan Lake. Those living and recreating on Swan Lake will do their part to limit the spread of AIS to and from the lake.

2.6D. **What: Place a signed receptacle at the boat launches for aquatic plants removed from boats. Coordinate the removal and disposal of the content away from the lake and other wetlands and waterways.**

Who: SLA

When: 2019 and then annually for the Boating Season

Measure of Success: Swan Lake will not be a source of AIS spread to other lakes.

Outcome 2.7: Lake and river groups across the county will work together to minimize the spread of AIS.

2.7A. **What: Participate in countywide AIS informational campaign and hiring or finding volunteers to staff launches.**

Who: SLA **Resources:** UWEX Lakes – educational materials, CBCW, Columbia County

When: Ongoing

Measure of Success: A group of SLA members and others will be able to monitor for and identify AIS.

2.7B. **What: Communicate about new AIS found in the county and necessary prevention/control efforts.**

Who: SLA **Resources:** WDNR Aquatic Plant biologist

When: Ongoing

Measure of Success: SLA members will be aware of new AIS and prevention steps needed to avoid its spread.

Swan Lake's Ecosystem

A variety of plants and animals comprise the Swan Lake ecosystem; many are dependent on one another. The types and abundance of plants and animals that encompass the lake community also vary based on the water quality, and the health and characteristics of the shoreland and watershed. Healthy habitat in Swan Lake includes the aquatic plants, branches, and tree limbs above and below the water.

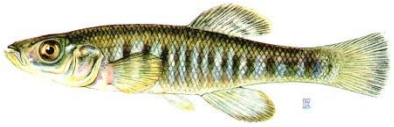
Swan Lake's habitat extends beyond the lake, and includes its shorelands, and for some species, it even extends into its watershed via the Fox River. Many animals that live in and near the lake are only successful if their needs – food, a healthy environment, and shelter – are met.

Native vegetation, including wetlands along the shoreline and adjacent to the lake, provides habitat for safety, reproduction, and food, and can improve water quality and help balance water quantity. Some lake visitors such as birds, frogs, and turtles use limbs from trees that are sticking out of the water for perches or to warm themselves in the sun. Aquatic plants infuse oxygen into the water and provide food and shelter for waterfowl, small mammals, and people.

The Swan Lake Fish Community

2015 Fish Survey Design

In 2015, a series of surveys were conducted to evaluate the fish community and compare the data to what was known from past surveys of Swan Lake. The surveys were conducted by fishery biologists David Marshall and Tim Larson. This section includes excerpts from their report which can be found in its entirety in the APPENDIX C.



Banded Killifish, photo credit: NOAA

The sampling design and gear were chosen to evaluate the different niches, behaviors and habitat preferences of diverse fish populations in Swan Lake. The survey included nearshore electrofishing, which is effective at sampling fish species from habitats such as boulders, woody habitat and artificial structures.

The 2015 surveys included nearshore and nongame fish. According to Marshall and Larson, some nearshore fish species are very sensitive to environmental degradation, and have been described as *canaries in the coal mine*. These fish provide important food-chain linkages; population declines can reveal ecosystem stresses that traditional lake monitoring overlooks. Non-game fish species are rarely surveyed since they offer no perceived economic benefit compared to gamefish. Nearshore surveys also collect information about young gamefish.

2015 Fish Survey Results

Swan Lake supports 34 fish species. Juvenile largemouth bass were the most abundant fish collected and were found at every site. Green sunfish were the second most abundant fish, which were often found along rocky shorelines. Iowa darter, fathead minnow, blunt nose minnow, Johnny darter, tadpole and madtom were all present. The Iowa darter is classified as environmentally sensitive and can be vulnerable to environmental changes.

Table 1. 2009 Swan Lake Sport Fishery Species List contains the list of species found in Swan Lake and their level of tolerance to environmental degradation.

Common Name	Scientific Name	Tolerance of Degradation	2015	1969 UWSP	1957-2013 (14 surveys) WDNR
Banded Killifish	*Fundulus diaphanu*	*SSC*		x	
Black bullhead	*Ameiurus melas*	*T*	x	x	
Black crappie	*Pomoxis nigromaculatus*	*M*			x
Blackstripe topminno	*Fundulus notatus*	*M*	x	x	
Bluegill	*Lepomis macrochirus*	*M*	x	x	x
Bluntnose minnow	*Pimephales notatu*	*T*	x		
Bowfin	*Amia calva*	*M*			x
Brook silverside	*Labidesthes sicculu*	*none*	x	x	x
Brook stickleback	*Culaea inconstans*	*T*	x		x
Central mudminnow	*Umbra limi*	*T*	x	x	
Channel catfish	*Ictalurus punctatus*	*M*			x
Common carp	*Cyprinus carpio*	*T*	x		x
Fathead minnow	*Pimephales promelas*	*T*	x		
Freshwater drum	*Aplodinotus grunniens*	*M*			x
Gizzard shad	*Dorosoma cepedianum*	*M*			x
Green sunfish	*Lepomis cyanellus*	*T*	x	x	
Hybrid sunfish	*Lepomis*	*none*	x		
Iowa darter	*Etheostoma exile*	*I*	x		
Johnny darter	*Etheostoma nigrum*	*M*	x		
Largemouth bass	*Micropterus salmoides*	*M*	x	x	x
Logperch	*Percina caprodes*	*M*	x		x
Longnose gar	*Lepisosteus osseus*	*M*	x	x	x
Muskellunge	*Esox masquinongy*	*I*			x
Northern pike	*Esox lucius*	*M*			x
Pumpkinseed	*Lepomis gibbosus*	*M*		x	x
Rock bass	*Ambloplites rupestris*	*I*	x		x
Smallmouth bass	*Micropterus dolomieu*	*I*			x
Spotfin shiner	*Cyprinella spiloptera*	*M*	x	x	
Tadpole madtom	*Noturus gyrinus*	*M*	x		
Walleye	*Sander vitreus*	*M*			x
White bass	*Morone chrysops*	*none*			x
White sucker	*Catostoma commersoni*	*T*	x		x
Yellow bullhead	*Ameiurus natalis*	*T*	x	x	
Yellow perch	*Perca flavescens*	*M*	x		x
Total Species			20	12	20

TOLERANCE LEGEND
I intolerant, **M** medium tolerance, **T** tolerant, **SSC** species of special concern

The majority of the species have medium tolerance levels, 4 are intolerant, 8 are tolerant, and the tolerance level has not been established for 3 species. The banded killifish was the only rare species listed as State Special Concern. It was only collected during the 1969 nearshore seining survey and its current status in Swan Lake is unknown. This fish has declined across its range. The banded killifish has a strong affinity for aquatic plants and its decline often coincides with other environmentally sensitive nearshore species in Wisconsin due to loss of habitat, including aquatic vegetation, and/or water quality. In Swan Lake, areas devoid of aquatic plants held few fish.

Swan Lake's Sport Fishery

Periodically, fishery surveys have been conducted in Swan Lake. The surveys have been conducted for various purposes, during different seasons, using various types of sampling techniques.

According to Nate Nye, fishery biologist with the WDNR, 2009 was the most recent WDNR fishery survey conducted with a completed analytical report in Swan Lake. The most recent survey was done in 2018 and some preliminary reports are included in Appendix F and the plan will be updated when the comprehensive report is finalized. The 2009 survey revealed 33 species which represents a relatively high diversity of fish species. This is a higher diversity when compared to most other lakes in the county and is due to Swan Lake's connection with the Fox River.

Fish species that are commonly pursued by anglers in Swan Lake include black crappie, bluegill, yellow perch, largemouth bass, smallmouth bass, white and yellow bass, channel catfish, walleye, northern pike, and muskellunge. The walleye and muskellunge populations are maintained though routine stocking of state-raised

fish, while the other species are self-sustaining in Swan Lake. Recent evidence suggests that some natural reproduction of walleye is occurring in Swan Lake and the upper Fox River downstream of Park Lake.

The latest WDNR fish survey in Swan Lake was completed in 2018, and will provide a snapshot of the status of the various fish populations in the lake. It should also offer a more thorough understanding of the source and amount of natural reproduction of walleye.

Swan Lake Habitat


Painted Turtles - A.B. Sheldon

A balanced fish community has a mix of predator and prey species, each with differing food, habitat, nesting substrate, and water quality needs. Activities in and around the lake that can affect the fishery may involve disturbances to the native aquatic plant community or substrate, excessive additions of nutrients or harmful chemicals, removal of woody habitat, shoreline alterations, and/or an imbalance in the fishery. Shoreland erosion can cause sediment to settle onto the substrate, causing the deterioration of spawning habitat.

Lake habitat exists in the water and also extends onto the land. Taller flowers and grasses provide cover and food. Shrubs and trees overhanging the lake provide habitat for young fish and aquatic insects, shade that can provide cooler water temperatures nearshore, and perching and sunning sites for birds and turtles.

Habitat can be improved by allowing shoreland vegetation to grow, minimizing the removal of aquatic plants, providing fallen trees or limbs in suitable areas, and protecting wetlands and other areas of critical habitat.

People's Perceptions

According to property owner survey results, investing in the shoreline vegetation, protection of nearby wetlands, and providing better opportunities for fish and wildlife habitat is important to many of the respondents and are motivation for protection and restoration.

Woody Habitat / Fish Sticks

The term "fish sticks" refers to partially or fully submerged fallen trees that are anchored to the shore, preferably in groups of two or more. These trees provide habitat for fish and wildlife. Near shore habitat can provide cover for small fish, their prey, and other aquatic organisms. In addition, they provide areas for turtles and frogs to sun and perching areas for birds. The trees also reduce shoreline damage from waves generated by wind or boating activity and reduce ice heave, especially during spring melt.

According to the WDNR Fishery Biologist, the nearshore areas of Swan Lake are predominantly comprised of shallow flats that terminate in steep drop offs. These flats are largely devoid of any hard structure that would act as fish habitat, particularly large woody structure. The addition of fish habitat measures such as fish sticks would serve to greatly increase the amount of cover for fish in nearshore areas.

Fish sticks are recommended for habitat improvements rather than fish cribs. Fish cribs tend to congregate larger fish in deeper parts of the lake, resulting in a higher capture rate without helping the fishery. Cribs do not provide habitat for young fish and species that reside near shore. Any fish attractant structures placed in deeper water should be constructed from whole or parts of freshly cut live trees, and not from pallets, concrete culverts, or any other processed raw materials.

People's Perceptions

Some of the shoreland property owner survey respondents were interested in installing near shore fish sticks. A slight majority did not feel fish sticks add to the attractiveness of shorelands. Most felt that financial incentives should be provided to shoreland property owners

Healthy Shoreland Vegetation

Healthy shoreland vegetation extends at least 35 feet inland from the water's edge and includes a mixture of native grasses, flowers, trees, and shrubs.

Greater depths of shoreland vegetation provides more habitat, protection from soil erosion, improved water quality, and reduced shoreland erosion from reduced runoff. Shoreland vegetation holds soil in place and stabilizes the shoreland.

Trees and shrubs reduce the impact of rain on barren ground and provides habitat for song birds and other wild life. Natural leaf litter or pine needles act as a sponge by retaining water, thus reducing runoff.

Not all shoreland property owners find healthy shoreland vegetation appealing and over half felt they should not be asked to install it without financial incentives. Functional healthy shoreland vegetation can range from a very natural look to a more landscaped appearance. Each property owner should choose the look that they prefer to ensure the restored healthy shorelands remain in place.

Diversions

Diversions use a berm or shallow trench to intercept runoff from a path, road, or rooftop and divert it into an infiltration area. This reduces runoff to the lake, which may carry sediments and pollutants. Sediments can alter the lakebed material and reduce the quality of fish spawning areas in the lake. Some pollutants can increase the growth of aquatic plants and others can harm fish and wildlife.

About half of the shoreland property responses did not find diversions appealing. Many felt that they should not be asked to install diversions without financial incentives.

Making Changes

Strategies for enhancing shoreland health need to consider people's understanding about their ability to make changes that will improve Swan Lake along with their perspectives about differing healthy shoreland practices. If people are not aware of the relationship between their land management and lake health, this understanding

needs to be developed before shoreland property owners will make improvements. There are a variety of ways to develop the community's knowledge including the use of demonstration projects with descriptive signs or brochures, information in newsletters, speakers, backyard tours, youth projects, awards, or friendly competitions. Acknowledgement of improvements made by shoreland property owners is also important.

People's Perceptions

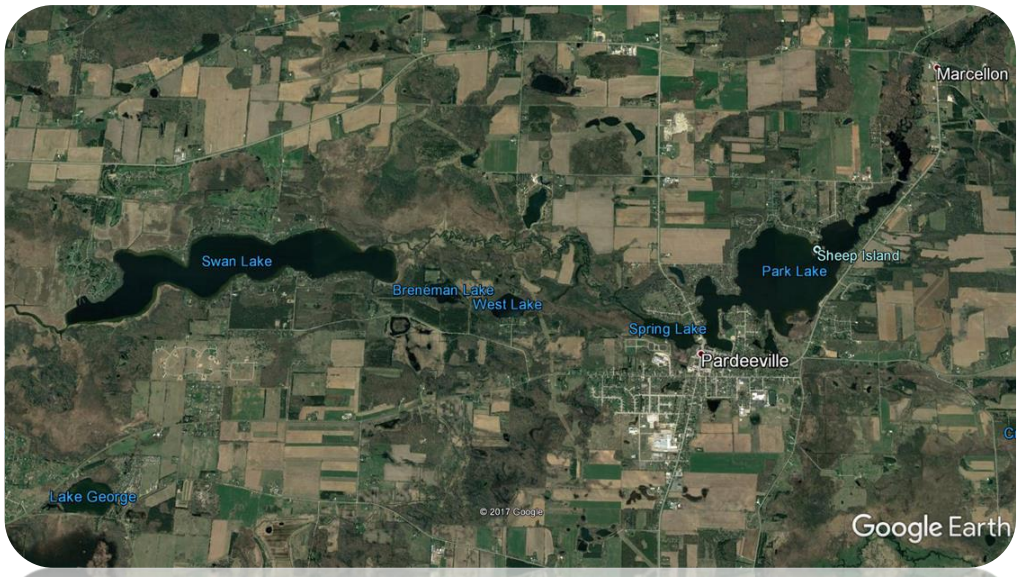
The importance of financial incentives for the implementation of better shoreland management was identified by survey respondents for all of the practices identified in the survey which included fish sticks, shoreland vegetation, and diversions. Financial incentives can be offered as reductions in association fees, or participation in programs that are supported by the county or state.

In many cases, when conversations about healthy shorelands begins to take place around a lake and neighbors are able to view changes being made on other properties, community change begins to occur. Oftentimes, starting small and testing the waters with incremental changes can be the best approach for a setting like Swan Lake.


HOW WILL YOU IMPROVE YOUR LAKE?
Illustration by Karen Engelbretson
Healthy Lakes
1 FISH STICKS
Fish sticks are large woody habitat structures that utilize whole trees grouped together. fish sticks are anchored to the shore and are partially or fully submerged.
2 NATIVE PLANTINGS
Native flowers, shrubs and trees are planted adjacent to the lake in a 350 ft contiguous area. You can design your planting to thrive on the lakeshore or in the woodland, to be low-growing or deer resistant, or to promote bird/ butterfly habitat.
3 DIVERSION
Diversion practices use a berm or shallow trench to intercept runoff from a path or road and divert it into an area where water can filter into the ground. Depending on the site, multiple diversion practices may be necessary.
4 ROCK INFILTRATION
This excavated pit or trench filed with rock reduces runoff by storing it underground to soak in slowly. A catch basin and/or perforated pipe surrounded by gravel and lined with sturdy landscape fabric may be integrated into the design to capture, pre-treat, and redirect water to the pit or trench. Pit and trench size depend on the area draining to it and how much the underlying soil can absorb.
5 RAIN GARDEN
A rain garden is a landscaped, shallow depression with loose soil designed to collect roof and driveway runoff.
IMPROVE HABITAT AND NATURAL BEAUTY ~ SLOW, DIVERT, CLEAN AND FILTER RUNOFF

GOAL 3

SWAN LAKE WILL HAVE HEALTHY WATER QUALITY FOR SWIMMING



GOAL 3. SWAN LAKE WILL HAVE HEALTHY WATER QUALITY FOR SWIMMING

Outcome 3.1: Reduce algae blooms by improving water quality to levels observed in the 1990s; average summer water clarity measurements should be greater than 6 feet. Swan Lake will advocate and work their partners to reach the Wisconsin Phosphorus Standard of 40 ug/L.

3.1A. What: Reduce nutrients from the watershed

Who: Columbia County LWCD **Resources**: Columbia Co. Board Members, NRCS, DATCP funding

When: Ongoing

Measure of Success: Water clarity measurements will average more than 6 feet during the summer.

3.1B. What: Reduce nutrients from the shorelands with an information campaign to protect and restore shoreland vegetation.

Who: Shoreland property owners

Resources: UWEX Lakes – educational materials, Columbia Co. LWCD, WDNR Healthy Lakes Grants

When: Ongoing Swan Lake Association will distribute articles on shoreland protection and shoreland stabilization and restoration in their Bi-Annual newsletter.

Measure of Success: Swan Lake shorelands will improve rather than decrease water quality.

Outcome 3.2: Understand the current water quality conditions through routine monitoring.

3.2A. What: Identify a volunteer to conduct monitoring and ask them to be trained through the WDNR's Citizen Lake Monitoring Network (CLMN) program.

Who: SLA **Resources:** CLMN coordinator

When: When position is vacated.

Measure of Success: An individual or group of individuals is/are responsible for monitoring water quality in Swan Lake.

3.2B. What: Measure water clarity, total phosphorus, and cholorphyll *a* (algae)

Who: SLA volunteer monitor **Resources:** CLMN coordinator

When: A minimum of 3 times between June and Sept.

Measure of Success: Sufficient data will be available to determine current water quality conditions and trends.

3.2C. What: Collect samples for analysis of TP in spring and fall.

Who: Volunteer monitor **Resources:** UWSP Water and Env. Analysis Lab or other state certified lab

When: In spring and fall, when the lake is mixed (overturn).

Measure of Success: Sufficient data will be available to determine current water quality conditions and trends

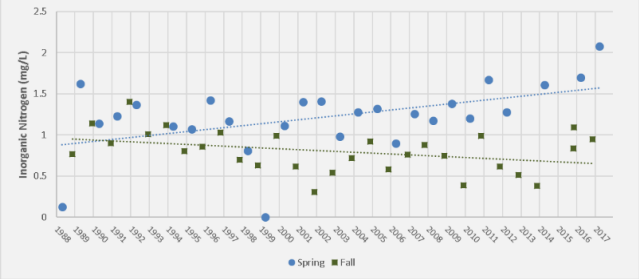
GOAL 3. SWAN LAKE WILL HAVE HEALTHY WATER QUALITY FOR SWIMMING

Outcome 3.2 (cont): Understand the current water quality conditions through routine monitoring.

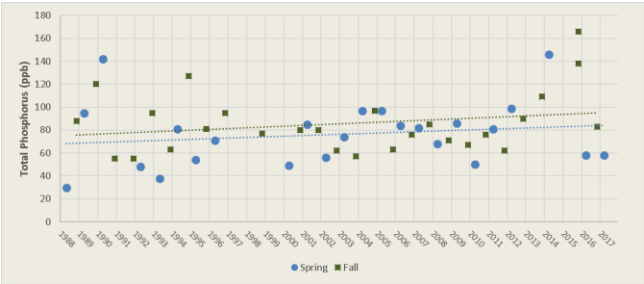
3.2D. What: Routinely report monitoring results to the WDNR SWIMS database for storage and use.
Who: Volunteer monitor **Resources:** CLMN coordinator
When: At least annually
Measure of Success: Water quality monitoring data for Swan Lake is stored safely and is accessible to anyone.

3.2E. What: Review monitoring data annually and take action if it appears to be declining.
Who: SLA **Resources:** WDNR Lake Specialist, Columbia Co. LWCD
When: Annually
Measure of Success: SLA and its members will be aware of current water quality conditions and trends.

Water Quality and Land Management



It is evident that water quality is important to the users of Swan Lake. Typically, good water quality enhances the enjoyment of most recreational activities on the lake, especially swimming. Water quality was ranked as the most important of 10 lake characteristics presented in the survey. However, nutrient management was ranked as a lower priority, suggesting that the respondents may not be familiar with the connection between nutrient management on the landscape and the water quality in Swan Lake.



The water quality in Swan Lake is the result of many factors, including the underlying geology, the climate, and land management practices. Since we have little control over the climate and cannot change the geology, changes to land management practices are the primary actions that can have positive impacts on water quality.

Water Quality in Swan Lake

Since 1988, volunteers have been monitoring the water quality in Swan Lake. This provides a good database from which trends can be assessed and decisions made. Continued monitoring is recommended.

How does water quality effect the growth of aquatic plants and algae?

Like terrestrial plants, algal and aquatic plant growth is dependent upon the amount of nutrients in the water. In Wisconsin, phosphorus and nitrogen are the primary nutrients initiating plant growth.

The forms of nitrogen most readily available for plant use, ammonium and nitrate, have been increasing in Swan Lake, especially during the spring (shown in blue on the graphs). The lines on the graphs indicate the long-term trend of the data. Overall, spring concentrations of these forms of nitrogen have been increasing and fall concentrations decreasing.

Total phosphorus has been slowly increasing over time during spring and fall. Ideal concentrations of total phosphorus for a lake like Swan Lake would be 40 ppb. The concentrations in Swan Lake exceeded this level in most of the samples, resulting in increased algal growth.

Changing the way the land is managed is the best way to reduce nitrogen and phosphorus in Swan Lake. The main sources of nutrients in the Swan Lake watershed include fertilizers (lawn, garden, agricultural), animal waste, septic systems, eroding soil. Wetlands can be a sporadic natural source. Typically, the land nearest the shore has the most direct impact on the lake.

How is the algae responding to increasing nutrients in Swan Lake?

Water clarity measurements can help to assess how the algae and/or sediment in the water has been changing over time. This is measured by lowering a black and white disc into the water and measuring how deep it is visible.

During the summer, average water clarity has been decreasing in Swan Lake. In 2010, the average water clarity was only 3 feet deep. This poor water clarity runs the risk of Swan Lake shifting to a "turbid state" where rooted plants no longer survive and the water is dominated by algae. The loss of aquatic plants would result in significant impacts to the fishery and other aquatic biota.

Increases and decreases in water clarity can be related to variation in algal blooms, sediment due to agitation in the water or runoff from the land, and changes in color – with dark brown water periodically released from wetlands.

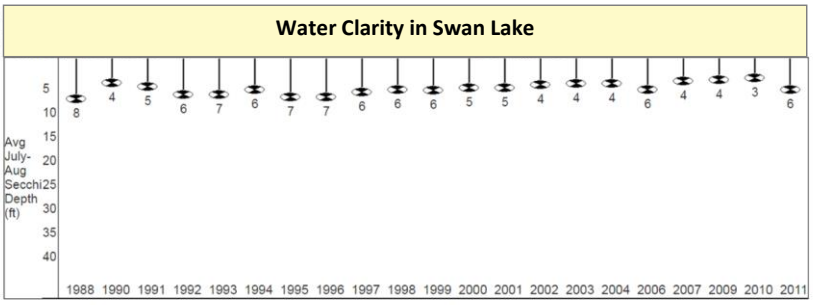
Studies have shown that property values are related to water clarity, increased water clarity can increase property values and vice versa.

People's Perceptions

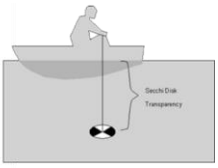
Overall, the survey respondents felt that water quality has not been changing or effecting property values. This suggests that the majority of survey respondents were less familiar with the lake in former years, or that the changes in water clarity are subtle enough that people do not view them as problematic.

Why is routine monitoring of water quality important?

The best use of long-term water quality data collection is to address problems before they are highly evident. The average survey respondent agreed that it is important to invest in protecting the quality of Swan Lake through locally funded efforts to address water quality issues.

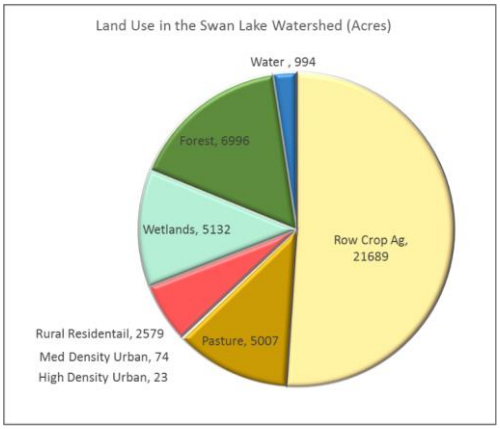


Past secchi averages in feet (July and August only).



Swan Lake's Watershed

The patchwork of land that surrounds Swan Lake and within its watershed provides positive and negative effects on its water quality. While forests, grasslands, and wetlands allow a fair amount of precipitation to soak into the ground, resulting in less runoff and good water quality, other types of land uses may result in increased runoff and less groundwater recharge. Agricultural and developed land may also be sources of pollutants that can impact the lake and its inhabitants.



Areas of land with exposed soil can generate soil erosion. Soil entering the lake can make the water cloudy and cover fish spawning beds. Soil also contains nutrients that lead to increased growth of algae and aquatic plants.

Development on the land may result in changes to natural drainage patterns and alterations to vegetation on the landscape, and may be a source of pollutants. Impervious (hard) surfaces such as roads, rooftops, and compacted soil prevent rainfall from soaking into the ground, which may result in more runoff that carries pollutants to the lake. Wastewater, animal waste, and fertilizers used on lawns, gardens and crops can contribute nutrients that enhance the growth of algae and aquatic plants in our lakes.

Land Management Practices for Good Water Quality

Land management practices can be put into place that better mimic some of the natural processes, and the reduction or elimination of nutrients added to the landscape will help to improve the quality of water in Swan Lake. In general, the land nearest the lake has the greatest impact on the lake water quality and habitat.

The majority of land in the Swan Lake watershed is being used for row crops. In general, this type of land use yields a fair amount of soil and phosphorus loss in runoff. This can vary depending on the types of crops, how the soil is managed, and the type, amount, timing of fertilizers applied to the land.

Forests are the second most abundant land use in the watershed. Depending on the type of forest and the harvesting techniques, in general forests yield minimal runoff and hence, minimal loss of soil and nutrients.

Although residential areas comprise a relatively low percentage of the watershed, acre-for-acre they can yield a relatively high amount of runoff with nutrient loss. In addition, many are located adjacent to the lake. Management practices can be put onto the landscape that reduce runoff from the impervious surfaces. These options may include raingardens, rain barrels, winding pathways, and landscaping options can be selected that reduce mowing and do not use additional fertilizer or pesticides.

Swan Lake watershed management strategies

Lake management alternatives include both watershed management measures and in-lake rehabilitation techniques. Watershed management, including land-use planning and zoning, and non-point source pollution control, is used to maintain or improve the quality of water before it reaches the receiving body of water. In this section, we will focus on the discussion of implementing watershed management strategies for the improvement of Swan Lake.

Managing inputs into nutrient-rich systems like Swan Lake is very important to realizing long-term water quality improvements. Managing and reducing these inputs is traditionally accomplished through the identification, design and installation of "best management practices" or BMPs. BMPs are techniques or structures that are designed to reduce non-point source pollution at construction sites, agricultural lands and developed areas. BMPs include things such as barnyard runoff systems, silt fences, detention or retention ponds, manure storage, vegetated buffers, reduced tillage and other associated practices.

The success of the watershed management strategy hinges on the collective ability to reduce the amount of phosphorus and sediment entering Swan Lake.

There are many individual sources of non-point source pollution within any one watershed. The greatest and most important challenge is to identify and remediate as many of those sites as possible. Some areas of concern may seem minor but the cumulative impacts from multiple small sources can create large impacts, overall. In the Swan Lake watershed, there are over 40,000 acres of small sources, many can be reduced with the use of BMPS. In 2007, the Columbia County LWCD began to implement a long-term water quality monitoring program in the Swan Lake watershed.

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Categories of non-point source pollutants in the Swan Lake Watershed.

Within the Swan Lake watershed, four main categories of non-point source impacts exist. They include:

Storm Water Management and Construction Site Erosion Control
Septic System Management
Waterfront Property Management
Upland Agricultural Source Management

Each category includes different levels of severity of impacts.

Storm Water Management and Construction Site Erosion Control

Storm water runoff has the ability to impact Swan Lake by increasing the amount of runoff from hard surfaces (impervious areas) such as roofs and driveways. The increased runoff travels overland, picking up pollutants and

transporting them to the lake or river. In addition, the increased amount of runoff combined with the increased rate of runoff can create increased erosion on upland sites.

In the Swan Lake watershed, impacts from storm water runoff have not yet been fully assessed. There are likely opportunities to increase efficiency and effectiveness of current local and state storm water management requirements. The implementation of a county-wide storm water ordinance would help streamline the effectiveness of storm water impacts on a watershed basis.

It is important for the Swan Lake Association to be the catalyst in a process to analyze current storm water issues affecting Swan Lake. This would include a cooperative effort between the Village of Pardeeville and the towns of Pacific, Scott, Wyocena, Marcellon and Springvale.

The control of erosion coming from sources such as construction sites could also be a potential source of increased sedimentation in the lake. Currently, erosion control measures are required under several local and state permit requirements.

The SLA could initiate a process to work closely with local municipalities to identify areas of concern associated with construction site erosion. There is a need for increased utilization and regulation of the BMPs for construction sites. The benefits of both of these factors will depend on the amount and types of land-use changes occurring within the Swan Lake watershed. It is critical for the SLA and the community to embrace and understand the associated implications of land-use changes and associated mitigation options.

Waste and Septic Systems

One municipal sewage treatment plant, in the Village of Pardeeville, exists within the Swan Lake watershed. This system, completed in 1985, includes primary and secondary treatment and a polishing pond with a capacity of 330,000 gallons per day. The treatment plant does not release effluent to the river; all treated effluent is infiltrated into the ground via an infiltration pond. There are three infiltration ponds and their usage is rotated monthly.

Around Swan Lake, increased numbers of septic systems for residential development, combined with the permeable sandy soils in the area, could have severe negative impacts on the lake's water quality from nitrogen and phosphorous loading and possible fecal coliform contamination. Impacts associated with existing individual septic systems have been discussed as a possible source of increased nutrients in the lake. Septic systems are not designed to remove nutrients but are designed to remove bacteria and some solids. If bacteria discharge to the lake is identified as a major issue, there is value in identifying systems that are failing to remove bacteria. In addition, it is likely that a number of systems on waterfront properties are not functioning properly or are undersized.

Waterfront Property Management

The shorelands of Swan Lake have a wide array of naturally buffered lands as a result of extensive marshes and steep slopes. It also has an adjacent golf course and the remaining shorelands are a mix of single family and condominium residential development. When comparing turf lawns to native cover, soils with sod cover produce a phosphorous load 4 to 7 times greater than a site in native cover. As a result, opportunities exist for nutrient reductions from the majority of Swan Lake's developed waterfront properties. On Swan Lake, typical residential waterfront shorelines have a turf lawn up to the lake instead of native cover. In addition, fertilizers and other pollutants are likely being applied to the turf.

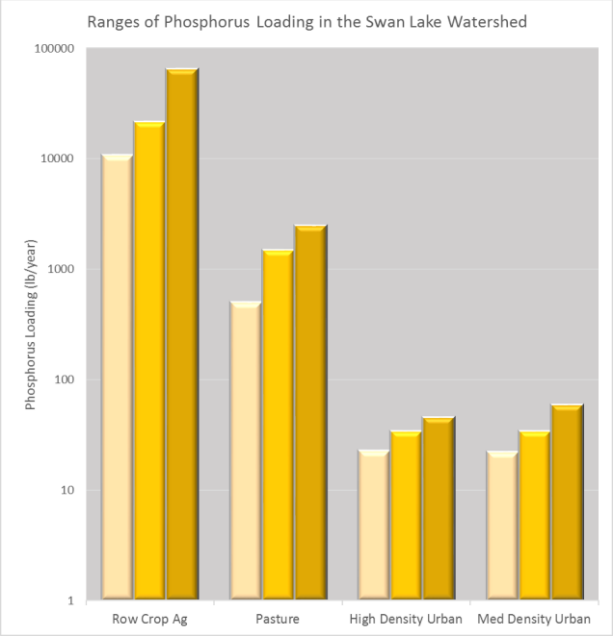
The inclusion of native buffers along the shoreline of Swan Lake, combined with a reduction in use of commercial fertilizers, will provide a reduction in nutrient loading from waterfront properties and provide increased fish and wildlife habitat while reducing landowner maintenance costs.

The SLA should promote and foster a program targeted at increasing adoption and acceptance of native shoreline buffers and elimination or science-based utilization of commercial lawn fertilizers based on the results of soil analysis. The use of a demonstration project funded through the SLA and WDNR grant would be an ideal avenue to gain acceptance of native buffers. There are opportunities to install buffers on both public and private land holdings. Public acknowledgement of existing healthy shorelands can also be effective.

Upland Agricultural Source Management

Access to the most current water quality monitoring data indicates that the Fox River watershed is carrying large amounts of nutrients downstream and delivering some into Park Lake and some into Swan Lake. The current and historical nutrient delivery into this system have provided a surplus of nutrients and are playing a large factor in the algae and aquatic plant abundance in Swan Lake. The best available science has shown that reduction of nutrients entering the system will be very important for the vitality and management of the system.

The Columbia County LWCD has been working with various partners on watershed improvement efforts, especially since 2001. In 2006, the Columbia County LWCD completed a watershed-scale inventory to identify issues in the watershed. This inventory provides a solid foundation to begin to understand many of the challenges we face in regards to nutrient reductions. In Wisconsin, the majority of land management improvements must be done on a voluntary basis. However, interested parties can often receive financial subsidies for the installation of BMPs.



Ranges of Phosphorous Loading Low, Medium, and High

Communication and Partnerships

There are a number of individuals, groups, agencies, and municipalities that are involved in the management of Swan Lake. Many contributed to and are listed in the plan. A continuation of the partnerships that were developed will help to achieve the goals for Swan Lake, without over-burdening an individual or organization.

A number of interest groups are associated with Swan Lake. The planning participants feel it is important for these groups to communicate with one another about some of the topics identified in this plan and suggested that representatives attend one another's meetings. This will also help to build trust among the various organizations. Survey respondents identified their greatest levels of trust with the Swan Lake Association and Columbia County LWCD, followed by the WDNR and knowledgeable neighbor.

Appendices

Appendix A

Slow No Wake Ordinance

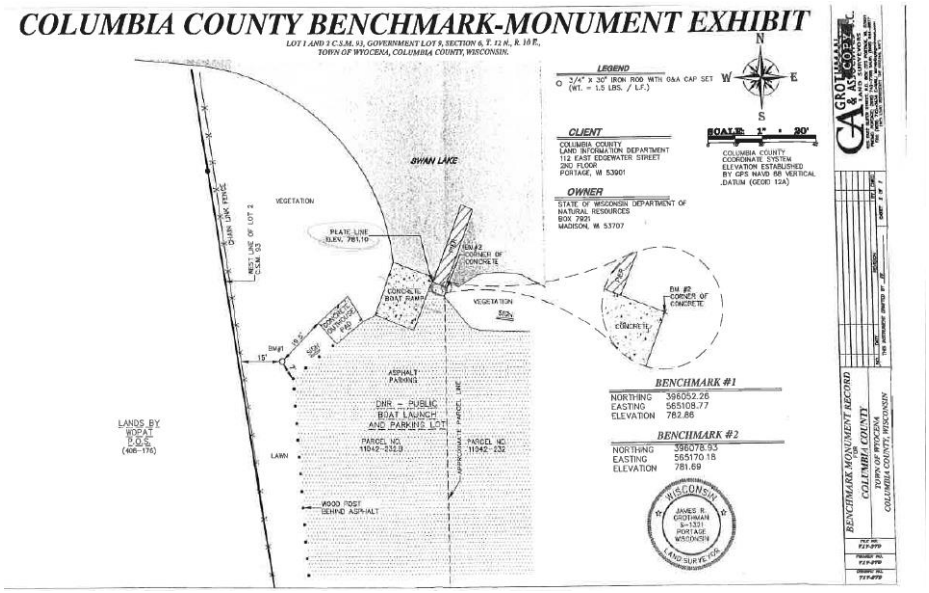
Columbia County Ordinance No. 198-18, Sec. 21-4-1(d)(2).

Slow-No-Wake Water Elevation - Swan Lake. 33

No person shall operate a boat faster than slow-no-wake in any waters of 34 Swan Lake when the water level exceeds an elevation of 781.10 feet above 35 sea level as based on the Columbia County Benchmark on the concrete wall at 36 the WDNR Swan Lake Boat Launch located at -89.35609506 43.54497285.

Appendix B

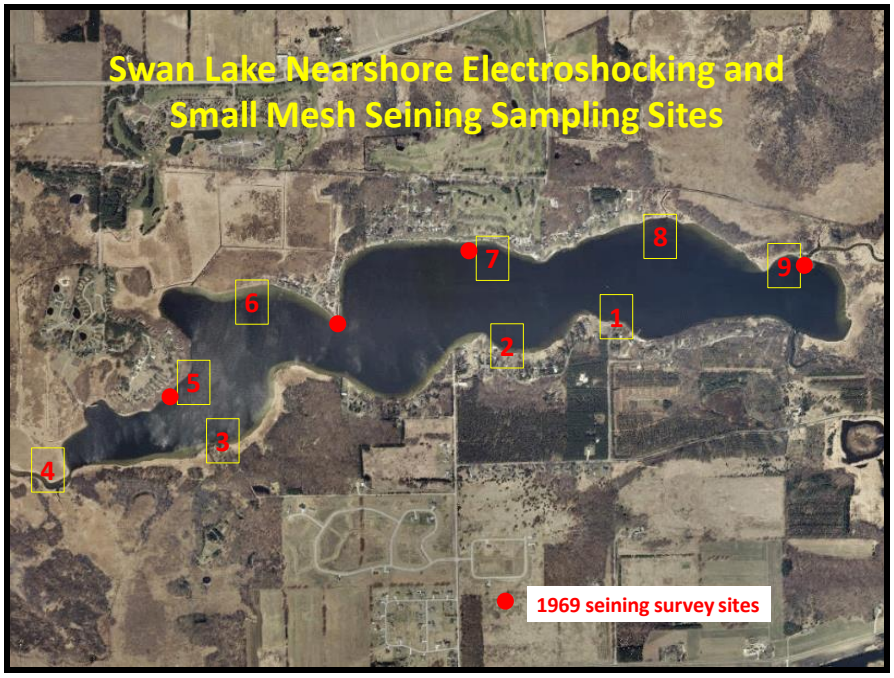
Swan Lake NO WAKE Elevation Survey



Appendix C

Fishes of Swan Lake Full Report

Fishes of Swan Lake



Columbia County Land and Water Conservation Department

Prepared by
David W. Marshall, Underwater Habitat Investigations LLC
Tim R. Larson, Fisheries Biologist

July 2015

Summary

Limnologists typically focus on traditional trophic status indicators (i.e., TSI secchi water clarity, TSI phosphorus and TSI chlorophyll), macrophyte surveys, plankton analysis, and sportfish inventories when assessing the environmental conditions in lakes. Important ecosystem indicators such as nearshore and nongame fish diversity are often overlooked. Some nearshore fish species are very sensitive to environmental degradation, and have been described as "canaries in the coal mine." These fish provide important food chain linkages and population declines can reveal ecosystem stresses that traditional lake monitoring will overlook. Nongame fish species are rarely surveyed since they offer no perceived economic benefit compared to more familiar gamefish populations. Nearshore fish surveys are also useful since immature stages of more popular sportfish are also collected and yield information on recruitment.

Periodic inventories of these biological indicators are useful in assessing individual population status, community diversity, and overall ecosystem stability. The survey conducted 2015 represents the first comprehensive nearshore inventory of nongame fish species and associated immature sportfish in Swan Lake. The map on the cover page identifies nine nearshore seine and towed electroshocking sites while the four red circles represent a less intensive seining survey that was completed in 1969. Three of the survey sites were sampled in both 2015 and 1969 and are useful for temporal comparisons. Wisconsin DNR had also conducted numerous fish population surveys on Swan Lake, but these surveys focused on sportfish using either boomshockers or fyke nets that were designed to sample larger bodied fish. Results of these surveys revealed several large bodied fish species that were not collected as part of the 2015 nearshore surveys.

Twenty-one species of fish were collected in 2015 using both small mesh seine and towed DC electroshocking gear at the nine sites, including six species that had not been previously reported. WDNR had also reported twenty-one fish species but these are based on 14 separate boomshocking and fyke netting surveys conducted from 1957 through 2013. Twelve species were identified in 1969 as part of a UW Stevens Point seining survey of nearshore species at four sites. The State Special Concern banded killifish was collected at two of four sites in 1969 but none were found at the nine sites sampled with greater effort in 2015. This species has been declining across its range, including losses in many Wisconsin lakes and streams. Future nearshore fish surveys are warranted to better assess the status of the banded killifish in Swan Lake and to assess potential trends in nearshore fish populations. Collectively, surveys conducted since 1957 revealed 34 fish species in Swan Lake.

Methods

The 2015 survey was specifically designed to sample nearshore nongame fishes and juvenile gamefish. It was not designed as a tool for evaluating the growth rates and size distributions of gamefish populations that require boomshocking and fyke netting gear. Instead, a towed DC electro-shocker barge and a 20' small mesh seine were used as part of the 2015 nearshore survey to sample nine sites (cover map). Latitude and longitude locations were recorded at the start and end of each electroshocking sites. Electroshocking distances at each site were approximately 100 yards long that was determined with the trip odometer function of a handheld Garmin GPSmap 76. Seine hauls, perpendicular to shore, were completed at the start point of each electroshocking site (except Site 5 that was too deep for seining). Small mesh (1/8 inch) seining was designed to sample fish populations in slightly deeper water (up to waist deep) than the shoreline electroshocking zone. The combination of gear types was chosen to more effectively sample the different niches, behaviors and habitat preferences of diverse fish populations. Nearshore electrofishing is more effective at sampling of fish species from habitats such as boulders, woody debris and artificial structures.

General habitat features were noted for each site. The primary habitat features were summarized as rock, submersed aquatic plants, emergent aquatic plants and woody debris. Dissolved oxygen and temperature were measured at each site using a YSI ODO meter. Specific conductance was measured with an Extech ExStik II. The WDNR Fish Mapping Application (2015) was used to access the historic Swan Lake fish database for comparisons with the 2015 nearshore survey.

Results

Tables 1 and 2 display the species collected in 2015 and are separated for towed electroshocking and small mesh seining. Twenty species were collected with the towed DC electroshocker and eleven species using the small mesh seine. The brook silverside was the only species collected using the seine and not the electroshocker. Several areas of the lake lacked habitat beyond the nearshore zone, best characterized as shallow marl flats lacking aquatic plants. At Site 7 for instance, the first seine haul took place in an area lacking aquatic plants and no fish were found. A second haul a short distance away targeted a native aquatic plant bed and numerous fish were caught.

Table 1: Swan Lake Fish Collected with DC Towed Electroshocking Barge

Site	1	2	3	4	5	6	7	8	9
Longnose gar		1							
Central mudminnow	1			22		2		5	
Common carp									1
Fathead minnow									1
Bluntnose minnow	4		14				12	2	
Spotfin shiner							1		
White sucker				2					
Black bullhead	2								
Yellow bullhead	7						1		
Tadpole madtom				1					
Brook stickleback				2					
Blackstripe topminnow									3
Brook silverside									
Bluegill	3		2	1		5	2	9	
Green sunfish	57	29	23	1	30	2	10		
Hybrid sunfish	1		1						
Rock bass							1		
Largemouth bass	34	17	9	7		66	15	19	25
Yellow perch				2				1	
Johnny darter	3	1	2		3		4		
Iowa darter	1					4			2
Logperch					7		2		

Table 2: Swan Lake Fish Collected with 20' small mesh seine

Site	1	2	3	4	6	7	8	9
Longnose gar								
Central mudminnow								
Common carp								
Fathead minnow								
Bluntnose minnow						2		
Spotfin shiner						14		
White sucker								
Black bullhead								
Yellow bullhead								
Tadpole madtom								

Brook stickleback	1							
Blackstripe topminnow								
Brook silverside	1					2		
Bluegill	4					2		1
Green sunfish								
Hybrid sunfish								
Rock bass								
Largemouth bass	7	9			1	45	9	45
Yellow perch			4					
Johnny darter	7	9	1					
Iowa darter		8		1			3	
Logperch		33	3					

Juvenile largemouth bass were the most abundant fish collected and were found at every site. Green sunfish was the second most abundant fish in 2015 and was often found along rocky shorelines. We collected the Iowa darter, fathead minnow, bluntnose minnow, johnny darter, tadpole madtom and Iowa darter in 2015 but none of these species had not been reported in earlier fish surveys based on accepted species listed in the WDNR Fish Mapping Application database for Swan Lake. The Iowa darter is classified as environmentally sensitive and can be vulnerable to environmental changes.

In general, favorable environmental conditions were found around the lake with clear water and numerous species of desirable native aquatic plants. However, we collected few fish where plants were scarce,. We also observed a stand of nonnative Eurasian watermilfoil near the outlet. Specific conductance levels averaged 443 uS/cm (range 438 – 448). Dissolved oxygen levels averaged 9.5 mg/l (range 7.8 – 13.2).

Discussion

Based on the new species documented as part of this project, Swan Lake supports 34 fish species. Table 3 contains the updated Swan Lake fish species list along with the environmental indicator category; I = Intolerant to environmental degradation, M = Medium tolerance to environmental degradation and T = Tolerant of environmental degradation. Four species in the list are Intolerant, 17 species have Medium tolerance to degradation, 8 species are Tolerant of environmental degradation and others have not been assigned a tolerance category. The banded killifish is the only rare species listed as State Special Concern. It was only collected during the 1969 nearshore seining survey and its current status in Swan Lake is unknown. The banded killifish is one of the “canaries in the coalmine” fish that has declined across its range (Gaumitz

2005, Lyons et al. 2000). The banded killifish has a strong affinity for aquatic plants and its decline often coincides with other environmentally sensitive nearshore species in Wisconsin due to loss of habitat, including aquatic vegetation, and/or water quality degradation (Marshall and Lyons 2008). In Swan Lake, areas devoid of aquatic plants held few fish. While reason or reasons for the areas devoid of aquatic plants are unknown, (Asplund and Cook 1997) documented impacts of motorboats on submerged aquatic plant communities in two marl lakes in southern Wisconsin.

Table 4 compares species found as part of the 1969 UW Stevens Point nearshore seining survey, 14 WDNR surveys from 1957 – 2013 and this survey. Results demonstrate that a variety of sampling gear is needed to assess fish populations ranging from sportfish to nongame species to invasive nonnative species such as common carp. Our data demonstrate the periodic nearshore fish sampling is needed to better understand the lake ecosystem and potential indicators of environmental change.

Table 3: Updated Swan Lake Fish Species List with Environmental Indications

Common Name	**Scientific Name**	**Envir. Tol.**
Bowfin	*Amia calva*	M
Longnose gar	*Lepisosteus osseus*	M
Gizzard shad	*Dorosoma cepedianum*	M
Central mudminnow	*Umbra limi*	T
Northern pike	*Esox lucius*	M
Muskellunge	*Esox masquinongy*	I
Common carp	*Cyprinus carpio*	T
Fathead minnow	*Pimephales promelas*	T
Bluntnose minnow	*Pimephales notatus*	T
Spotfin shiner	*Cyprinella spiloptera*	M
White sucker	*Catostoma commersoni*	T
Black bullhead	*Ameiurus melas*	T
Yellow bullhead	*Ameiurus natalis*	T
Tadpole madtom	*Noturus gyrinus*	M
Channel catfish	*Ictalurus punctatus*	M
Brook stickleback	*Culaea inconstans*	T
Blackstripe topminnow	*Fundulus notatus*	M
Banded Killifish	*Fundulus diaphanus*	SSC
Brook silverside	*Labidesthes sicculus*	none

Freshwater drum	*Aplodinotus grunniens*	M
Bluegill	*Lepomis macrochirus*	M
Green sunfish	*Lepomis cyanellus*	T
Hybrid sunfish	*Lepomis*	none
Pumpkinseed	*Lepomis gibbosus*	M
Rock bass	*Ambloplites rupestris*	I
Largemouth bass	*Micropterus salmoides*	M
Smallmouth bass	*Micropterus dolomieu*	I
Black crappie	*Pomoxis nigromaculatus*	M
White bass	*Morone chrysops*	none
Yellow perch	*Perca flavescens*	M
Johnny darter	*Etheostoma nigrum*	M
Iowa darter	*Etheostoma exile*	I
Logperch	*Percina caprodes*	M
Walleye	*Sander vitreus*	M

I – Intolerant, M – Medium tolerance, T – Tolerant of degradation

Table 4: Swan Lake Fish Species List Based on Different Sampling Methods and Periods.

Common Name	**Scientific Name**	**2015**	**1969**	**WDNR Surveys***
Bowfin	*Amia calva*			x
Longnose gar	*Lepisosteus osseus*	x	x	x
Gizzard shad	*Dorosoma cepedianum*			x
Central mudminnow	*Umbra limi*	x	x	
Northern pike	*Esox lucius*			x
Muskellunge	*Esox masquinongy*			x
Common carp	*Cyprinus carpio*	x		x
Fathead minnow	*Pimephales promelas*	x		
Bluntnose minnow	*Pimephales notatus*	x		
Spotfin shiner	*Cyprinella spiloptera*	x	x	
White sucker	*Catostoma commersoni*	x		x
Black bullhead	*Ameiurus melas*	x	x	
Yellow bullhead	*Ameiurus natalis*	x	x	
Tadpole madtom	*Noturus gyrinus*	x		
Channel catfish	*Ictalurus punctatus*			x

Brook stickleback	*Culaea inconstans*	x		x
Blackstripe topminnow	*Fundulus notatus*	x	x	
Banded Killifish	*Fundulus diaphanus*		x	
Brook silverside	*Labidesthes sicculus*	x	x	x
Freshwater drum	*Aplodinotus grunniens*			x
Bluegill	*Lepomis macrochirus*	x	x	x
Green sunfish	*Lepomis cyanellus*	x	x	
Hybrid sunfish	*Lepomis*	x		
Pumpkinseed	*Lepomis gibbosus*		x	x
Rock bass	*Ambloplites rupestris*	x		x
Largemouth bass	*Micropterus salmoides*	x	x	x
Smallmouth bass	*Micropterus dolomieu*			x
Black crappie	*Pomoxis nigromaculatus*			x
White bass	*Morone chrysops*			x
Yellow perch	*Perca flavescens*	x		x
Johnny darter	*Etheostoma nigrum*	x		
Iowa darter	*Etheostoma exile*	x		
Logperch	*Percina caprodes*	x		x
Walleye	*Sander vitreus*			x
Total Native Species		**20**	**12**	**20**
* 14 boomshocking and fyke netting surveys 1957 - 2013				

Recommendations

Swan Lake supports a relatively diverse aquatic plant community with numerous beds of floating-leaf and submersed native aquatic plants. Efforts can be made to protect these important habitats and even expand them, in part because of their fish habitat importance. Aquaculture can be a way increase otherwise declining nongame species such as the State Special Concern banded killifish (Marshall and Dearlove 2013)

References

Asplund, T.R. and C.M. Cook. 1997. Effects of motorboats on submerged aquatic macrophytes. Lake and

Reservoir Management 13:1-12.

Becker, G.C. 1983. Fishes of Wisconsin. The University of Wisconsin Press.

Gaumitz, L. 2005. Shoreline Sentinels. Wisconsin Natural Resources Magazine. http://dnr.wi.gov/wnrmag/html/stories/2005/feb05/shore.htm

Lyons, J. 2012. Development and validation of two fish-based indices of biotic integrity for assessing perennial coolwater streams in Wisconsin, USA. Ecological Indicators 23:402-412.

Lyons, J., Fago, D. and Cochran, P. 2000. Wisconsin Fishes: Status and Distribution. University of Wisconsin Sea Grant Institute.

Lyons, J. 1992. Using the index of biotic integrity (IBI) to measure environmental quality in warmwater streams of Wisconsin. USDA General Technical Report NC-149.

Marshall, D.W. and J. Lyons. 2008. Documenting and halting declines of nongame fishes in southern Wisconsin. In: Waller and Rooney (Editors), The Vanishing Present, The University of Chicago Press.

Marshall, D.W. and P. Dearlove. 2013. Feasibility of restoring nongame fish populations in Lake Ripley, Jefferson County Wisconsin.

WDNR. 2015. Fish Application Mapping Program. https://cida.usgs.gov/wdnr_fishmap/map/

Sampling Site Locations and General Habitat Conditions

	Site 1	Site 2	Site 3	Site 4	Site 5
Start					
Lat	43.54497	0.54398	0.53984	0.53824	0.54296
Long	89.35529	0.36222	0.37691	0.38779	0.37963
End					
Lat	43.54522	0.54435	0.53971	0.53836	0.54374
Long	89.35644	0.3631	0.37821	0.38688	0.37959
Primary Habitat	rock	sub. plants	emergent	emergent	rock
continued				sub. Plants	
Temp. C	22.3	24	23.5	24.4	24.6
D.O. mg/l	8.4	8.5	7.8	8.8	8.6
Sp. Cond. uS/cm	438	444	446	448	441

	Site 6	Site 7	Site 8	Site 9
Start				
Lat	0.5464	0.54852	0.54916	0.54763
Long	0.37713	0.36455	0.35062	0.34476
End				
Lat	0.54661	0.54847	0.54861	0.54755
Long	0.37589	0.36325	0.34943	0.34619
Primary Habitat	emergent	rock	sub. plants	sub. plants
continued		sub. Plants	wood	emergent
Temp. C	24.7	24.7	25.6	24.8
D.O. mg/l	8.3	9.1	12.4	13.2
Sp. Cond. uS/cm	445	441	438	444

Selected Swan Lake Fish Images

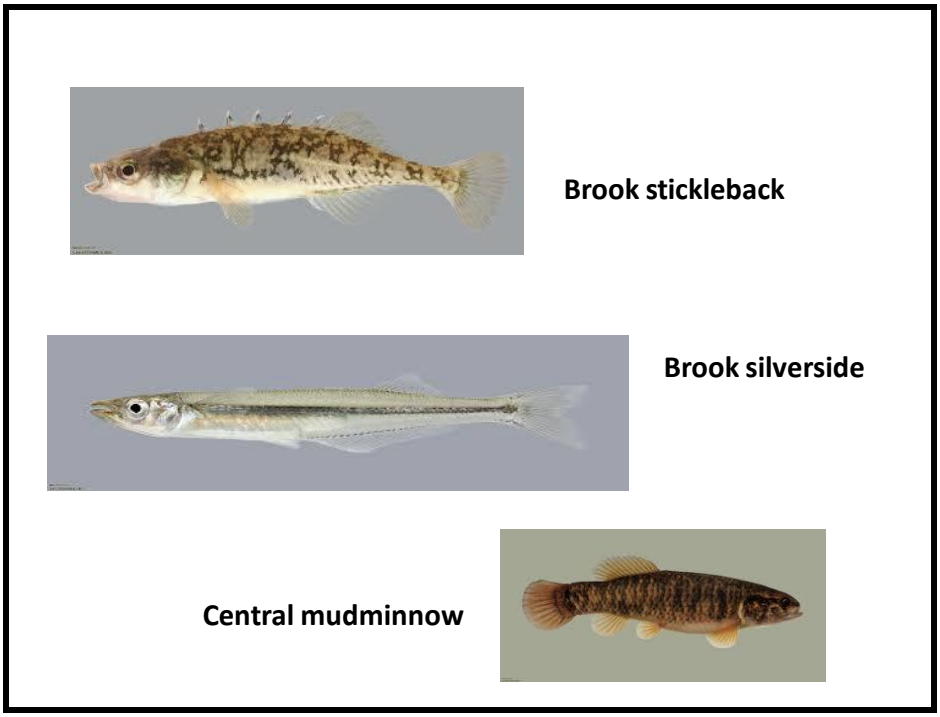
Bowfin and Longnose gar, "rough" fish with primitive features. Both of these interesting species are important for maintaining ecological balance in lakes but they carry an image problem from earlier days in the Twentieth Century when they were thought to be a nuisance.

Bowfin

Juvenile Longnose gar

Bowfin – up to ~43 inches long. Longnose gar – up to ~54 inches long.

Three nongame species representing three different families; Stickleback Family, Silverside Family and Mudminnow Family.



Brook stickleback – up to ~2 inches long. Brook silverside – up to ~4 inches long.
Central mudminnow – up to ~4 inches long.

Minnow Family members in Swan Lake.

Fathead minnow

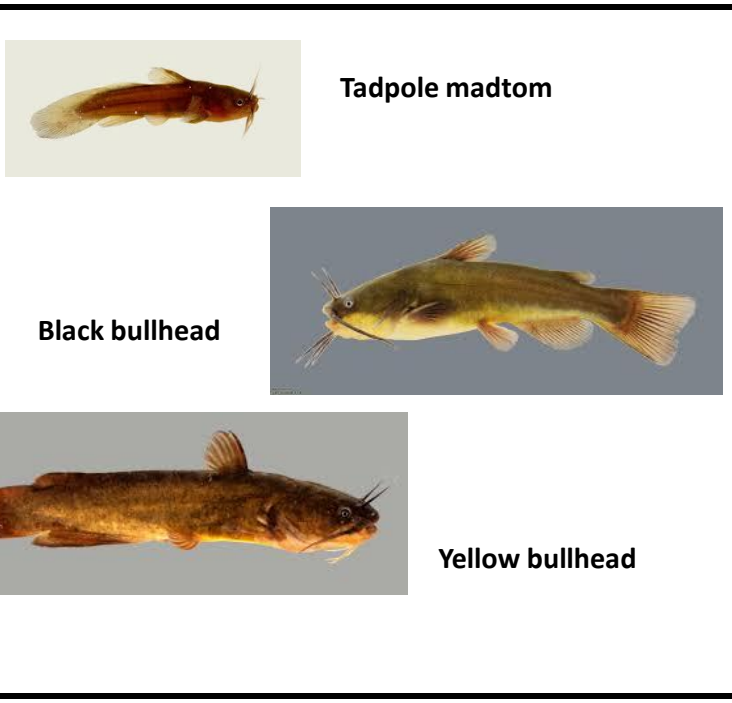
Spotfin shiner

Bluntnose minnow

Common carp

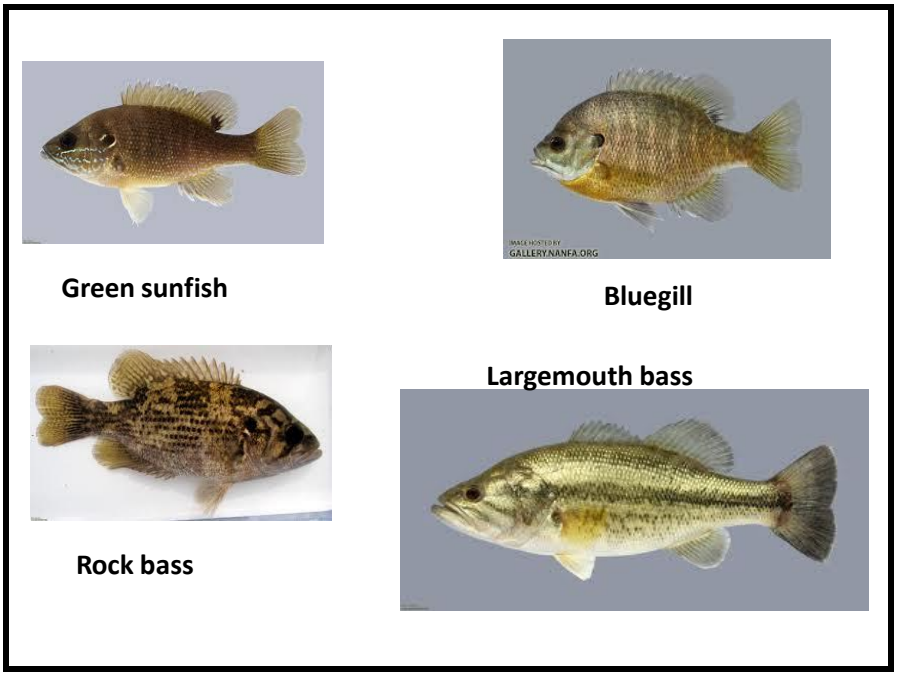
Fathead minnow – up to ~2 inches long. Bluntnose minnow – up to ~3 inches long.
Spotfin shiner – up to ~4 inches long. Common carp – up to ~30 inches long.

Three of the four Catfish Family members found in Swan Lake.



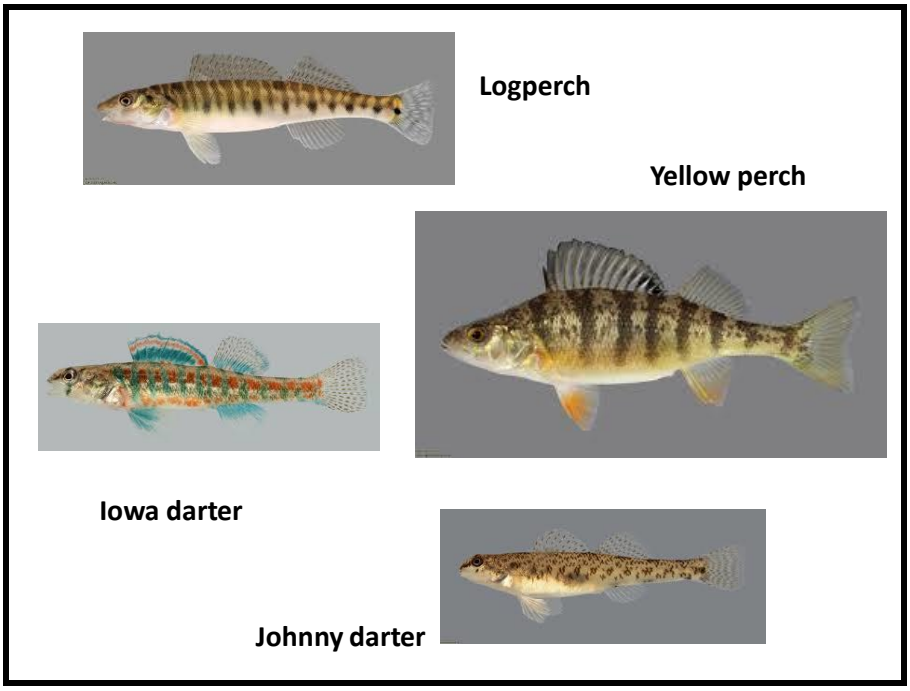
Tadpole madtom – up to ~3 inches long. Black bullhead – up to ~24 inches long.
Yellow bullhead – up to ~8 inches long.

Four of the Sunfish Family members in Swan Lake.



Green sunfish – up to ~7 inches long. Bluegill – up to ~12 inches long.
Rock bass – up to ~13 inches long. Largemouth bass – up to ~28 inches long.

Four Perch Family members found in Swan Lake, July 2015.



Logperch – up to ~5 inches long. Yellow perch – up to ~14 inches long.
Iowa darter – up to ~2 inches long. Johnny darter – up to ~2 inches long.

Two of the three Topminnow Family members that occur in Wisconsin have been found in Swan Lake.

Banded killifish

Blackstripe topminnow

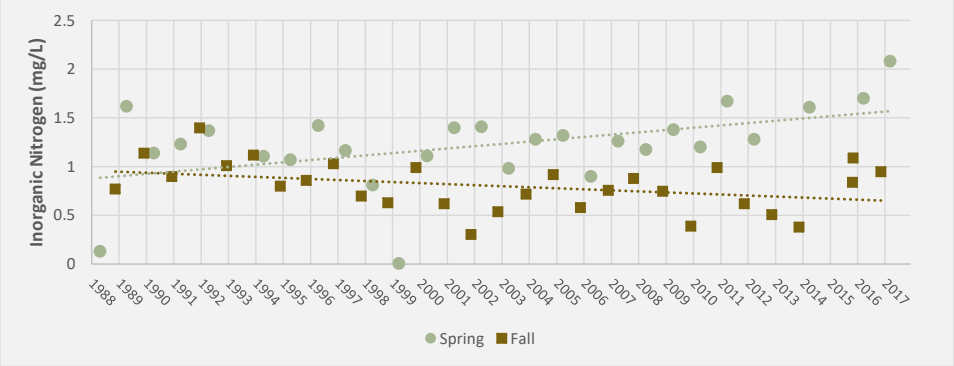
Banded killifish – up to ~3 inches long. Blackstripe topminnow – up to ~3 inches long.

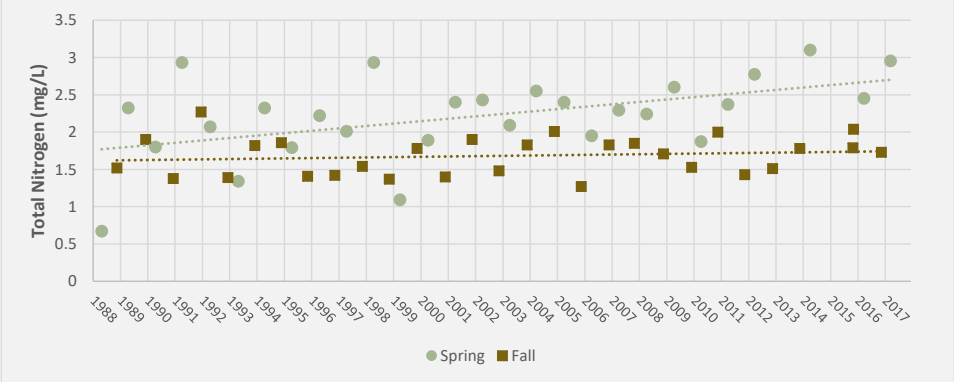
Fish Survey Results

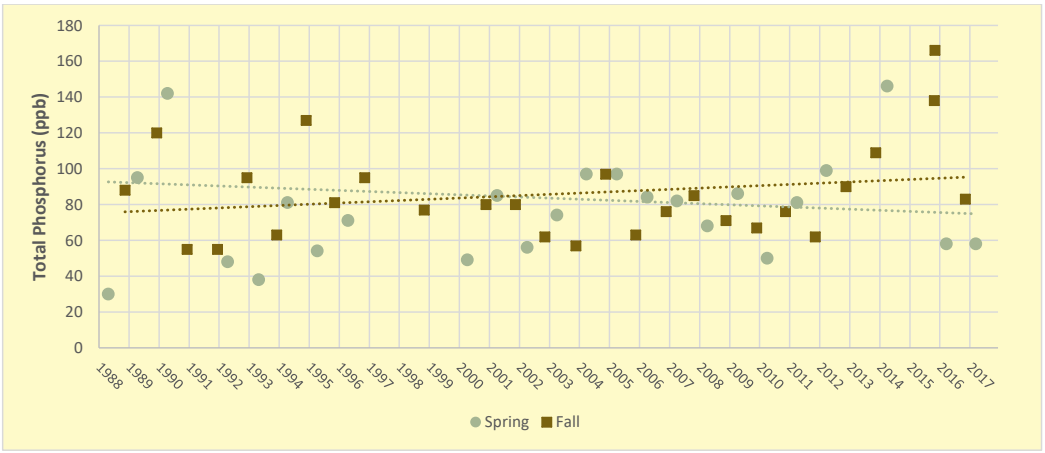
Common Name	Scientific Name	Tolerance of Degradation	2015	1969 UWSP	1957-2013 (14 surveys) WDNR
Banded Killifish	*Fundulus diaphanu*	*SSC*		x	
Black bullhead	*Ameiurus melas*	*T*	x	x	
Black crappie	*Pomoxis nigromaculatus*	*M*			x
Blackstripe topminno	*Fundulus notatus*	*M*	x	x	
Bluegill	*Lepomis macrochirus*	*M*	x	x	x
Bluntnose minnow	*Pimephales notatu*	*T*	x		
Bowfin	*Amia calva*	*M*			x
Brook silverside	*Labidesthes sicculu*	*none*	x	x	x
Brook stickleback	*Culaea inconstans*	*T*	x		x
Central mudminnow	*Umbra limi*	*T*	x	x	
Channel catfish	*Ictalurus punctatus*	*M*			x
Common carp	*Cyprinus carpio*	*T*	x		x
Fathead minnow	*Pimephales promelas*	*T*	x		
Freshwater drum	*Aplodinotus grunniens*	*M*			x
Gizzard shad	*Dorosoma cepedianum*	*M*			x
Green sunfish	*Lepomis cyanellus*	*T*	x	x	
Hybrid sunfish	*Lepomis*	*none*	x		
Iowa darter	*Etheostoma exile*	*I*	x		
Johnny darter	*Etheostoma nigrum*	*M*	x		
Largemouth bass	*Micropterus salmoides*	*M*	x	x	x
Logperch	*Percina caprodes*	*M*	x		x
Longnose gar	*Lepisosteus osseus*	*M*	x	x	x
Muskellunge	*Esox masquinongy*	*I*			x
Northern pike	*Esox lucius*	*M*			x
Pumpkinseed	*Lepomis gibbosus*	*M*		x	x
Rock bass	*Ambloplites rupestris*	*I*	x		x
Smallmouth bass	*Micropterus dolomieu*	*I*			x
Spotfin shiner	*Cyprinella spiloptera*	*M*	x	x	
Tadpole madtom	*Noturus gyrinus*	*M*	x		
Walleye	*Sander vitreus*	*M*			x
White bass	*Morone chrysops*	*none*			x
White sucker	*Catostoma commersoni*	*T*	x		x
Yellow bullhead	*Ameiurus natalis*	*T*	x	x	
Yellow perch	*Perca flavescens*	*M*	x		x
Total Species			**20**	**12**	**20**

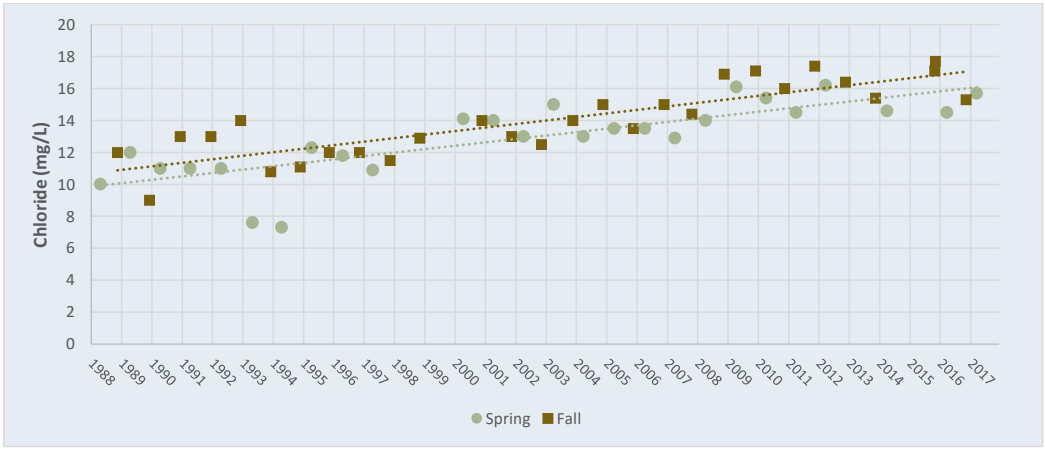
Water Quality Data Summary – Spring and Fall

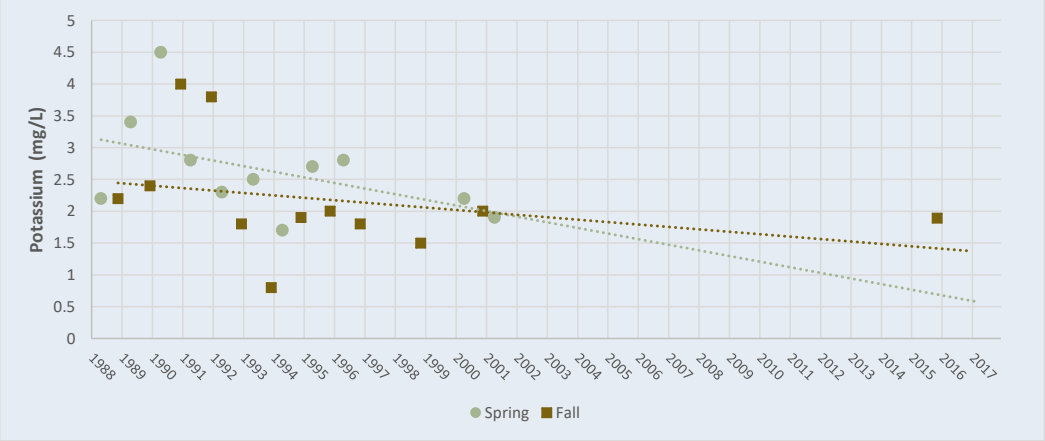
Source: UW-Stevens Point Water and Environmental Analysis Lab

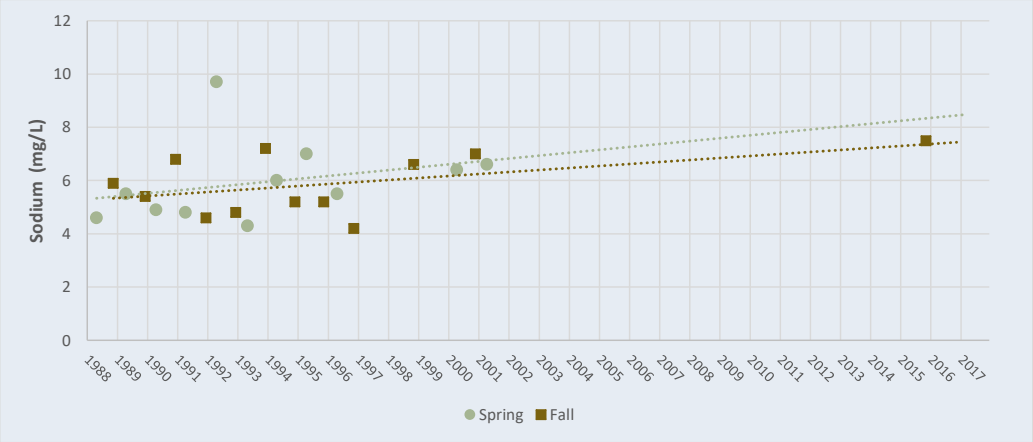





Total Phosphorus (ppb)
180
160
140
120
100
80
60
40
20
0
1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017
Spring
Fall

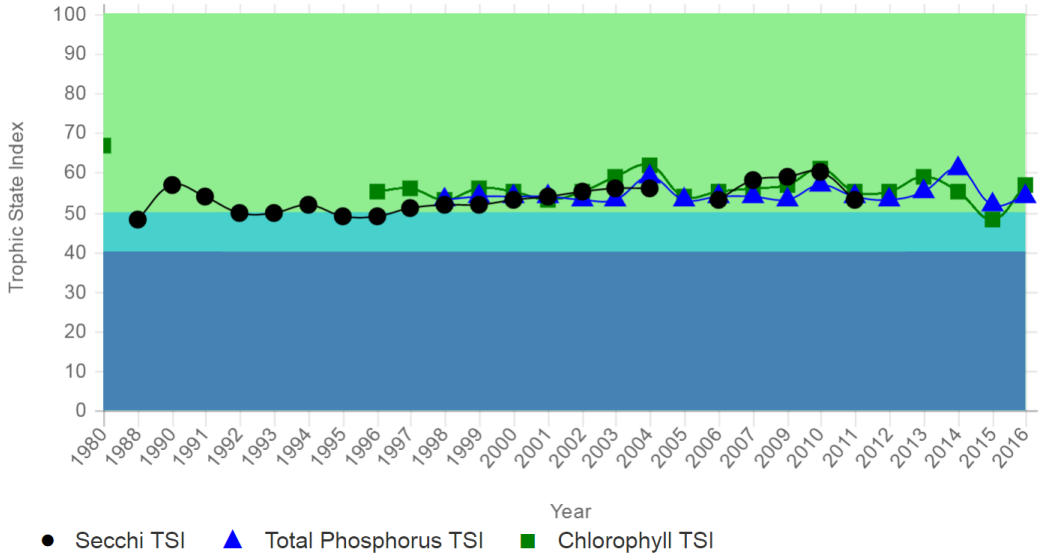

Chloride (mg/L)
20
18
16
14
12
10
8
6
4
2
0
1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017
Spring
Fall

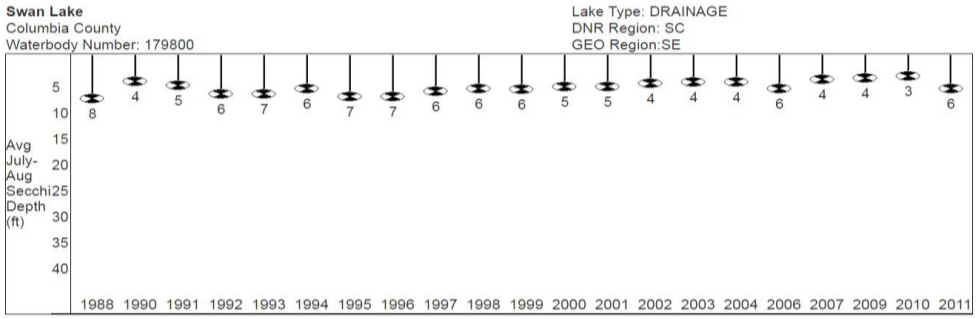

Potassium (mg/L)
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017
Spring
Fall


Sodium (mg/L)
12
10
8
6
4
2
0
1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017
Spring
Fall

Water Quality – Summer

Source: Wisconsin Dept. of Natural Resources





Past secchi averages in feet (July and August only).

Appendix D

Reporting Boating Violations

Reporting Boating Violations

When reporting violations:

Place Phone Call to

429.2188	Pardeeville Police Office/Columbia County Sheriff's Department
1.800.TIP.WDNR	Wisconsin Department of Natural Resources

Helpful Information

Boat Identification Number

Description of Activities

Photo Documentation (Not necessary but always helpful)

Appendix E

Boating Ordinance Creation Procedures

Boating Ordinance Creation Procedures

First Step:

Complete **Waterway Marker Application and Permit** Form 8700-058 (R 11/06)
Form 8700-058 Located in Appendix with directions
Attach diagrams and maps showing proposed location of the markers
Identify exact location of water marker(s) in distance from one or more fixed objects, whose location id known or provide the GPS coordinates of the marker(s) placement.
Receive local government approval
Complete a form for each Local Government
Village of Pardeeville
Town of Wyocena
Have Local Government Complete **Section 3: Local Government Authorization**
Receive county approval
Bring application to Columbia County Clerk's Office
Carl Frederick Administration Building, 400 Dewitt Street, Portage, Wi 53901
Form including lake area in Village of Pardeeville
Attention
Columbia County Board District 11 Supervisor
Judiciary Committee Chair
Form including lake area in Town of Wyocena
Attention
Columbia County Board District 11 Supervisor
Columbia County Board District 17 Supervisor
Judiciary Committee Chair
Receive WDNR Game Warden approval
Game Warden Office
MacKenzie Center, W7303 County Highway CS, Poynette, WI 53955
Game Warden passes Application onto WDNR Recreational Safety Warden for approval
Conformation sent back to local government
Included will be a recommendation for buoy placement

Appendix F

Swan Lake Game Fish Survey

Waterbody: Swan Lake (WBIC 179800)
Location: Columbia County between Portage and Pardeeville
Size: 406 acres
Depth: 82 feet maximum
Author: Nathan Nye, January 24, 2019
Subject: Update on 2018 Swan Lake comprehensive fishery survey

Swan Lake is located on the upper Fox River and has no water control structure regulating the water level. The Fox River flows in at the east end of the lake and exits at the west end. A fishway located at the Buffalo Lake Dam on the Fox River in Montello provides fish passage from Lake Puckaway all the way up through Buffalo, Swan, and Spring lakes to the Park Lake Dam in Pardeeville. The Wisconsin Department of Natural Resources conducted a comprehensive fishery survey of Swan Lake in 2018. The comprehensive survey included two spring netting surveys (SN1, SN2), two spring electrofishing surveys (SE1, SE2), and a fall electrofishing survey. Dates of survey work and a summary of survey effort can be found in Table 1. The recent stocking history for the lake (2003-2018) can be found in Table 2. A summary of catch-per-unit effort (CPUE) for the 2018 comprehensive survey can be found in Table 3. In total 14,670 fish representing 33 species and hybrids were collected. Species diversity is high in Swan Lake compared to most other lakes in Columbia and Sauk counties because of its open connection to the Fox River. Most species that inhabit the upper Fox River are likely to be found in the lake. Swan Lake receives a comprehensive fishery survey every 10 years but fall electrofishing surveys targeting walleye may occur every year to evaluate stocking success in stocked years and natural recruitment in non-stocked years.

During the 2018 survey, aging structures (scales, spines, or otoliths) were collected from 5 fish per half-inch group for black crappie, bluegill, channel catfish, largemouth bass, and smallmouth bass. Structures were collected from 5 fish per half-inch group for both sexes from muskellunge, northern pike, walleye, and yellow perch. As of this report, age and growth analysis was complete for bluegill, yellow perch, and black crappie. Age and growth analysis for other species collected during the 2018 survey is expected to be completed during the winter of 2018-2019 and will provide the remaining information necessary to make management recommendations for the fishery in Swan Lake. Results will be published in a report that should be available to the public at some point in 2019 or 2020. The final report will also include a more complete stocking history for Swan Lake. Area averages for mean length at age referenced in this report are based on data collected during surveys of lakes in Columbia, Sauk, and northwestern Dane counties since 2008.

Panfish

Bluegill, yellow perch, and black crappie combine to form a quality panfish fishery. In total, 8,648 bluegills were collected during spring netting and electrofishing (Table 3). The largest bluegills were collected using fyke nets and this is typical. Bluegills up to 9.2 inches were sampled and approximately 2% of bluegills caught in fyke nets were larger than 8 inches. The length frequency distribution of bluegills sampled during the two spring netting periods can be found in Figure 1. During late spring electrofishing (SE2), the bluegill catch rate of 74.0 fish/mile placed Swan Lake in the 43rd percentile, near the middle of the pack when comparing catch rates across lakes statewide. The length frequency distribution from SE2 is represented in Figure 2. Bluegill growth is very good in Swan Lake; mean length at age is generally higher than area and state averages (Figure 3).

In total, 979 yellow perch were collected during the survey (Table 3). Yellow perch were most common during spring netting, particularly during the second netting period in late April which coincided with the spawning period. Catch rates for each sampling period are found in Table 3. In total, 887 yellow perch were measured during spring netting and lengths ranged from 5.0 to 12.0 inches, averaging 7.3 inches. Of those larger than 5 inches, 27% were larger than 8 inches and 2% were larger than 10 inches. An additional four yellow perch were collected during SE2 ranging from 3.3 to 5.2

inches, averaging 3.9 inches. The yellow perch length frequency distribution from the two spring netting periods is represented in Figure 4. Yellow perch growth in Swan Lake is generally better than the statewide average based on mean length at age which is represented in Figure 5.

In total, 596 black crappies were collected during the survey and catch rates for each sampling period can be found in Table 3. Crappies were most common during spring netting, particularly during the second netting period in late April when water temperatures were generally in the 50s. Catch rates for each sampling period are found in Table 3. In total, 513 black crappies were measured during spring netting and lengths ranged from 3.3 to 13.0 inches, averaging 9.2 inches. The 12 crappies collected during the May electrofishing survey ranged from 6.7 to 11.3 inches, averaging 9.0 inches. For crappies larger than 5 inches, 78% were larger than 8 inches, 43% were larger than 10 inches, and 1% were larger than 12 inches. The black crappie length frequency distribution from the two spring netting periods is represented in Figure 6. Black crappie growth in Swan Lake is generally better than the area and state averages based on mean length at age which is represented in Figure 7.

Walleye

Swan Lake is a stocked walleye fishery and it receives 35 state-raised small fingerling walleyes per acre in odd-numbered years (1.7-inch fingerlings stocked in June). Because of Swan Lake's turbid nature, the small walleyes survive well despite high predator densities. There is also some limited natural reproduction of walleyes in Swan Lake. A mark-recapture population estimate calculated from 2018 survey data placed the population of adult walleyes ≥ 15 inches in Swan Lake at 1.8 fish/acre, or 731 total adult fish. This is slightly better than the average for a stocked walleye population in Wisconsin (1.7 adults/acre).

In total, 906 walleyes (including recaptures) were collected across all spring netting and electrofishing periods and the catch rate for each sampling period can be found in Table 3. After subtracting recaptures, 654 unique walleyes ranged from 7.4 to 26.4 inches, averaging 16.0 inches. Seventy-seven percent of walleyes sampled in the spring were at least 15 inches in length, the minimum length limit. The length frequency distribution of walleyes collected during all spring 2018 sampling periods is represented in Figure 8. Walleyes ≥ 12 inches were tagged during spring sampling (n = 583) and 39 were later reported caught by anglers. Of those, 38 were reported caught in Swan Lake and one was reported caught in the Fox River in Marquette County upstream of Buffalo Lake. Thirty-five were legal harvest size when caught and of those, 28 were harvested and 7 were released.

An additional 99 walleyes were sampled during fall electrofishing which ranged from 8.2 to 18.3 inches in length, averaging 13.8 inches. The catch rate of age 0 walleyes representing natural reproduction was 0.1 fish/mile (one 8.2-inch fish), far below the 10 fish/mile which is considered successful natural reproduction in Wisconsin. The length frequency distribution of walleyes collected during the fall electrofishing survey are represented in Figure 9.

Largemouth and smallmouth bass

In total, 333 largemouth bass were collected during spring netting and electrofishing surveys (including recaptures) and the catch rate for each sampling period can be found in Table 3. After subtracting recaptures, 307 unique largemouth bass ranged from 4.7 to 21.2 inches, averaging 12.2 inches. Twenty-nine percent of all bass sampled in the spring were larger than the 14-inch minimum length limit. The length frequency distribution of largemouth bass sampled in spring 2018 is represented in Figure 10. The 11 largemouth bass sampled during fall electrofishing ranged from 10.1 to 17.5 inches, averaging 13.2 inches. Electrofishing catch rates of largemouth bass in the late spring (SE2) and fall surveys in 2018 were markedly lower than in past spring (2009) and fall surveys (2017) and the reason for this is not clear.

Smallmouth bass are present at low abundance in Swan Lake and in total, 13 were sampled in 2018; catch rates can be found in Table 3. None were collected in fyke nets and this is typical; smallmouth bass are generally net-shy to a greater degree than largemouth bass. Seven smallmouth bass were collected during SE2 ranging from 8.4 to 17.5 inches and

averaging 12.8 inches. The 6 smallmouth bass collected during fall electrofishing ranged from 10.9 to 16.4 inches, averaging 13.0 inches. All smallmouth bass were collected from the rocky shoreline around the bluff on the northwest end of the lake near Saddle Ridge. Smallmouth bass catch rates from this survey, although relatively low, were far higher than those observed in past years.

Northern pike

Stocking of northern pike is not necessary because Swan Lake has good spawning habitat, abundant prey, and is deep enough to provide a cool water refuge for pike during extended periods of hot weather when surface water temperatures approach the lethal range for pike. Early spring netting (SN1) is the preferred method of sampling northern pike in Wisconsin because it effectively samples sexually mature pike that are concentrated in the shallows to spawn. In total, 268 unique northern pike were collected during the two spring netting periods and the two spring electrofishing surveys and the catch rate for each sampling period can be found in Table 3. The SN1 catch rate of 1.0 fish/net night puts Swan Lake in the middle of the pack compared to other area lakes (Table 4). These fish ranged from 8.8 to 33.5 inches, averaging 22 inches and 24% of northern pike sampled during the spring were larger than the 26-inch minimum length limit. The length frequency distribution of northern pike collected during spring 2018 netting and electrofishing surveys is represented in Figure 11. During the fall electrofishing survey, 7 northern pike were collected that ranged from 17.2 to 29.0 inches, averaging 23.4 inches.

White bass and yellow bass

Although not typically the target of WDNR fishery surveys, white bass and yellow bass can provide an exciting fishing opportunity for anglers, particularly in larger lakes or lakes connected to large river systems where they are able to grow to larger sizes. In Swan lake, white bass were primarily captured in fyke nets during the second netting period (SN2), and many were also observed during late spring electrofishing (SE2) in stations where only traditional gamefish were being collected (bass, pike, musky, walleye, catfish). Yellow bass were primarily collected during SE2 in stations where all species were collected. The few yellow bass caught in fyke nets were captured during SN2 when water temps reached the 50s.

Catch rates for each species from each sampling period can be found in Table 3.
In total, 172 white bass ranged from 8.5 to 16.3 inches in length, averaging 13.8 inches. The length frequency distribution for all white bass sampled can be found in Figure 12. One hundred twenty yellow bass ranged from 3.1 to 10.7 inches, averaging 5.9 inches. The length frequency distribution for all yellow bass sampled can be found in Figure 13.

Channel catfish

Channel catfish are present in Swan Lake in much higher abundance than most other lakes in the area, and this is due to the lake's connection to the Fox River. Catch rates for all sampling periods are found in Table 3. During the SN2 survey in late April 2018, channel catfish were caught at a rate of 2.2 fish/net night. In total, 152 unique channel catfish were collected across all spring netting and electrofishing surveys. These fish ranged from 7.9 to 29.9 inches, averaging 22.3 inches and the length frequency distribution is represented in Figure 14. The largest catfish sampled weighed 13.6 pounds. An additional three channel catfish were collected during the fall electrofishing survey measuring 10.4, 13.5, and 23.4 inches, respectively.

Muskellunge

Muskellunge are stocked in Swan Lake which receives one state raised large fingerling musky per acre stocked at an average length of around 11 inches, generally in late September. In total, 24 muskellunge were collected during spring netting and electrofishing (including recaptures). Catch rates for all sampling periods can be found in Table 3. Muskellunge collected in other surveys of Swan Lake since 2013 have been implanted with a passive integrated

transponder (PIT) tag, and new unmarked fish collected in the 2018 survey were also marked with PIT tags. These tags are very small and are implanted in the muscle, just under the skin near the dorsal fin. After subtracting recaptures, 19 unique muskellunge ranged from 11.0 to 48.5 inches, averaging 35.4 inches. Ten out of 19 muskellunge sampled were larger than the 40-inch minimum length limit. Four fish were between 11.0-12.5 inches and would have been stocked in the fall of 2017. Three fish were found to have PIT tags from previous surveys. Data for each individual musky are found in Table 5. Muskellunge catch rates were relatively low in 2018 despite a 31-year history of stocking in Swan Lake (1987-2018) and the exact reason for the low catch rates are unclear. A few possibilities could include low survival of stocked fish, fish utilizing deeper habitat where they are less vulnerable to sampling gear, and emigration to other waters. The WDNR plans to return to Swan Lake in the spring of 2019 to attempt netting muskellunge again during their spawning period similar to netting that occurred in late April 2018.

Detrimental species

Common carp were introduced across Wisconsin in the late 1800s and are now common in many waterbodies in the state. They can be detrimental when present in high densities because their feeding activities destabilize bottom sediments (bioturbation) leading to a loss of aquatic plants and re-suspension of nutrients which can then fuel algal blooms. Common carp are present in Swan Lake but appear to exist at relatively low abundance. Only 16 carp were collected during the 2018 survey and catch rates for each sampling period are found in Table 3.

Table 1. Survey effort descriptions for the comprehensive fishery survey of Swan Lake, Columbia County, Wisconsin in 2018.

Survey period	Begin date	End date	Water temperature (◦F)	Primary target[1]	Secondary target	Effort (net nights)	Gamefish effort (miles)	Panfish effort (miles)
Spring Netting 1 (SN1)	03/27/2018	04/21/2018	38-42	NOP, WAE	All species	147		
Spring Netting 2 (SN2)	04/23/2018	05/02/2018	48-58	MUE	All species	63		
Spring electrofishing 1 (SE1)	04/22/2018	04/22/2018	44	WAE	All gamefish		7.0	0.0
Spring electrofishing 2 (SE2)	05/22/2018	05/22/2018	67	Bass, panfish	All species		7.0	1.5
Fall Electrofishing	10/04/2018	10/04/2018	61	WAE	All gamefish		7.0	0.0

[1]Northern Pike is abbreviated NOP, walleye is abbreviated WAE, and muskellunge is abbreviated MUE.

Table 2. Recent stocking history for Swan Lake, Columbia County, Wisconsin, 2003-2018.

Year	Species	Age Class	# Stocked	Avg. Length (in)	Source Type
2003	WALLEYE	FRY	406,000	1.0	DNR HATCHERY
2003	MUSKELLUNGE	YEARLING	416	14.0	DNR HATCHERY
2003	NOP X MUE	YEARLING	454	13.5	DNR HATCHERY
2003	MUSKELLUNGE	LARGE FINGERLING	270	10.9	DNR HATCHERY
2004	MUSKELLUNGE	LARGE FINGERLING	812	10.5	DNR HATCHERY
2004	WALLEYE	SMALL FINGERLING	20,300	1.5	DNR HATCHERY
2005	WALLEYE	SMALL FINGERLING	32,308	2.2	DNR PONDS
2006	MUSKELLUNGE	LARGE FINGERLING	447	10.8	DNR HATCHERY
2006	WALLEYE	SMALL FINGERLING	15,185	2.9	DNR PONDS
2008	MUSKELLUNGE	LARGE FINGERLING	406	10.8	DNR HATCHERY
2008	MUSKELLUNGE	LARGE FINGERLING	338	10.7	DNR HATCHERY
2008	WALLEYE	SMALL FINGERLING	7,308	1.3	DNR HATCHERY
2010	WALLEYE	SMALL FINGERLING	3,209	1.8	DNR HATCHERY
2011	MUSKELLUNGE	LARGE FINGERLING	812	9.4	DNR HATCHERY

Species	Catch SN1	Catch SN2	Catch SE1	Catch SE2	Catch Fall EF	Total catch	CPUE SN1	CPUE SN2	CPUE SE1	CPUE SE2	CPUE FE
Bigmouth buffalo	12	1		1		14	0.1	0.0		0.7	
Black bullhead	11	8		0		19	0.1	0.1		0.0	
Black crappie	124	460		12		596	0.8	7.3		8.0	
Bluegill	7,806	731		111		8,648	53.1	11.6		74.0	
Bowfin	64	55		0		119	0.4	0.9		0.0	
Brook silverside	0	0		1		1	0.0	0.0		0.7	
Brown bullhead	0	2		0		2	0.0	0.0		0.0	
Channel catfish	5	139	0	14	3	161	0.0	2.2	0.0	2.0	0.4
Common carp	6	8		2		16	0.0	0.1		1.3	
Freshwater drum	0	33		4		37	0.0	0.5		2.7	
Gizzard shad	82	36		4		122	0.6	0.6		2.7	
Golden shiner	0	2		0		2	0.0	0.0		0.0	
Grass pickerel	16	0		0		16	0.1	0.0		0.0	
Green sunfish	18	1		0		19	0.1	0.0		0.0	
Highfin carpsucker	0	0		1		1	0.0	0.0		0.7	
Largemouth bass	183	27	71	52	11	344	1.2	0.4	10.1	7.4	1.6
Longnose gar	0	4		0		4	0.0	0.1		0.0	
Muskellunge	8	9	4	3	0	24	0.1	0.1	0.6	0.4	0.0
Northern pike	153	145	4	16	7	325	1.0	2.3	0.6	2.3	1.0
Pumpkinseed	151	3		0		154	1.0	0.0		0.0	
Pumpkinseedxbluegill	5	1		0		6	0.0	0.0		0.0	
Quillback carpsucker	49	42		5		96	0.3	0.7		3.3	
River carpsucker	44	4		0		48	0.3	0.1		0.0	
Rock bass	32	59		5		96	0.2	0.9		3.3	
Shorthead redhorse	0	1		0		1	0.0	0.0		0.0	
Silver redhorse	0	1		0		1	0.0	0.0		0.0	
Smallmouth bass	0	0	0	7	6	13	0.0	0.0	0.0	1.0	0.9
Walleye	392	355	48	111	99	1,005	2.7	5.6	6.9	15.9	14.1
White bass	6	166		0		172	0.0	2.6		0.0	
White sucker	12	2		3		17	0.1	0.0		2.0	
Yellow bass	0	11		110		121	0.0	0.2		73.3	
Yellow bullhead	965	526		0		1,491	6.6	8.3		0.0	
Yellow perch	46	929		4		979	0.3	14.7		2.7	
Totals	10,190	3,761	127	466	126	14,670					

2011	WALLEYE	SMALL FINGERLING	7,308	1.5	DNR HATCHERY
2012	MUSKELLUNGE	LARGE FINGERLING	400	9.7	DNR HATCHERY
2013	MUSKELLUNGE	LARGE FINGERLING	408	10.7	DNR HATCHERY
2013	WALLEYE	SMALL FINGERLING	7,308	1.7	DNR HATCHERY
2014	MUSKELLUNGE	LARGE FINGERLING	405	8.9	DNR HATCHERY
2015	MUSKELLUNGE	LARGE FINGERLING	329	10.9	DNR HATCHERY
2015	WALLEYE	SMALL FINGERLING	14,281	1.6	DNR HATCHERY
2016	MUSKELLUNGE	LARGE FINGERLING	406	10.3	DNR HATCHERY
2017	MUSKELLUNGE	LARGE FINGERLING	406	10.9	DNR HATCHERY
2017	WALLEYE	SMALL FINGERLING	14,262	1.7	DNR HATCHERY
2018	MUSKELLUNGE	LARGE FINGERLING	406	12.3	DNR HATCHERY

Table 3. Catch and catch-per-unit effort (CPUE) for two netting surveys (fish/net night) and three electrofishing surveys (fish/mile) of Swan Lake in 2018.

Table 4. Northern pike catch-per-unit effort from fyke net surveys of Columbia, Sauk, and northwestern Dane County lakes, 2008-2018.

Lake	County	Survey Year	CPUE (fish/net night)
Dutch Hollow	Sauk	2016	4.6
Delton	Sauk	2014	4.4
Mirror	Sauk	2014	4.2

Devils	Sauk	2013	2.4
Fish	Dane	2015	2.0
Wisconsin	Columbia/Sauk	2017	1.9
White Mound	Sauk	2013	1.6
Park	Columbia	2011	1.3
Swan	Columbia	2009	1.0
Spring	Columbia	2018	1.0
Crystal	Columbia/Dane	2015	0.5
Seeley	Sauk	2008	0.4
Mud (Marx Pond)	Dane	2015	0.1
Redstone	Sauk	2010	0.1

Table 5. Data from individual muskellunge captured during the 2018 comprehensive fishery survey of Swan Lake, Columbia County, Wisconsin.

Date of Capture	Survey	Length (inches)	Weight (pounds)	Sex	Tag number given	Tag number found
04/02/2018	SN1	11.0	0.2	U	989001004068069	-
04/07/2018	SN1	11.1	0.2	U	989001004068160	-
04/07/2018	SN1	11.2	0.2	U	989001004068143	-
04/02/2018	SN1	12.5	0.4	U	989001004068227	-
05/22/2018	SE2	29.5	6.9	U	-	989001004302733
04/05/2018	SN1	36.2	13.7	M	989001004068186	-
04/22/2018	SE1	38.2	15.4	M	-	956000008970431
04/26/2018	SN2	39.3	16.8	F	989001004068011	-
04/28/2018	SN2	39.5	19.6	M	989001004068054	-
04/26/2018	SN2	41.2	19.9	M	989001004067989	-
04/12/2018	SN1	41.3	21.9	F	989001004068159	-
05/22/2018	SE2	41.4	21.7	U	989001004068047	-
04/11/2018	SN1	43.8	23.2	F	989001004068157	-
04/22/2018	SE1	44.3	-	F	989001004068072	-
04/26/2018	SN2	44.4	32.5	F	-	989001004301353
04/27/2018	SN2	46.4	36.7	F	989001004068056	-
04/25/2018	SN2	46.5	34.8	F	989001004068155	-
04/26/2018	SN2	47.1	35.5	F	989001004068031	-
04/26/2018	SN2	48.5	35.9	F	989001004067961	-

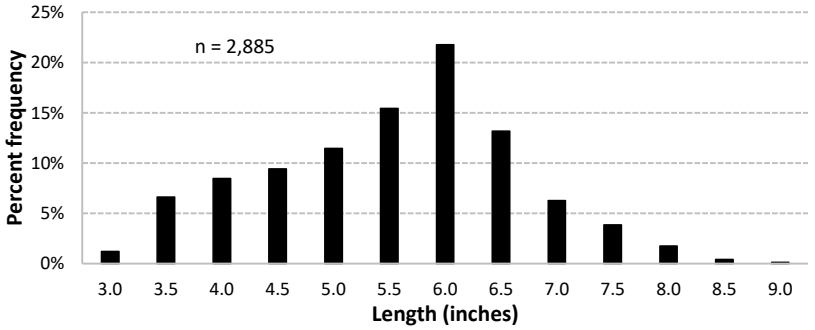


Figure 1. Length frequency distribution of bluegills collected during two spring fyke netting surveys (SN1, SN2) of Swan Lake, Columbia County, Wisconsin in 2018.

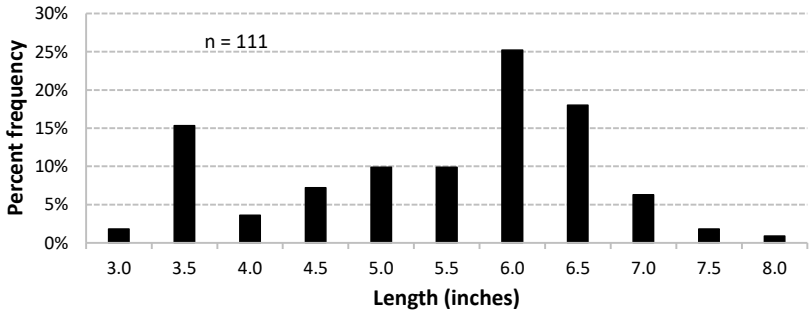


Figure 2. Length frequency distribution of bluegills collected during a late spring electrofishing survey (SE2) of Swan Lake, Columbia County, Wisconsin in 2018.

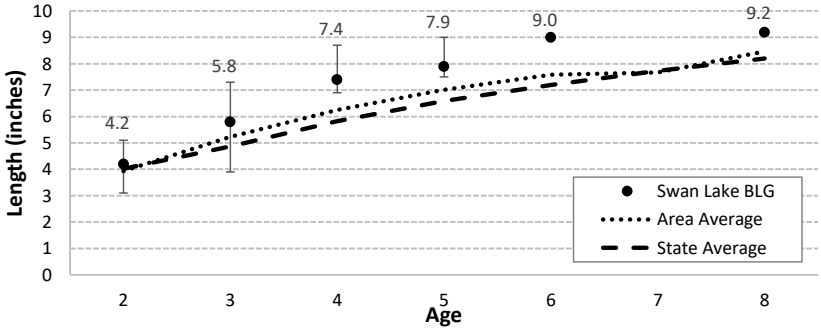


Figure 3. Mean length at age of bluegills collected during the comprehensive fishery survey of Swan Lake, Columbia County, Wisconsin in 2018. Error bars cover the range of length values for each age.

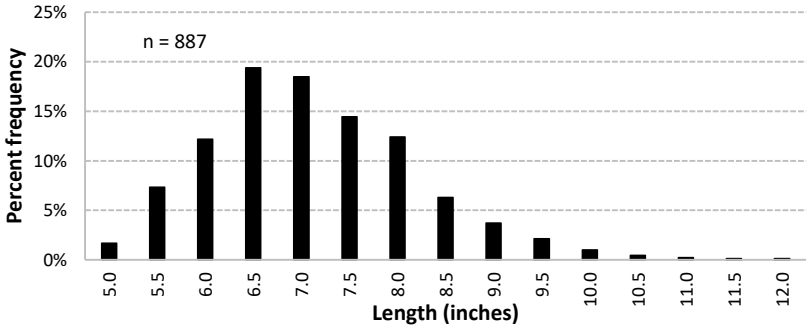


Figure 4. Length frequency distribution of yellow perch collected during two spring fyke netting surveys (SN1, SN2) of Swan Lake, Columbia County, Wisconsin in 2018.

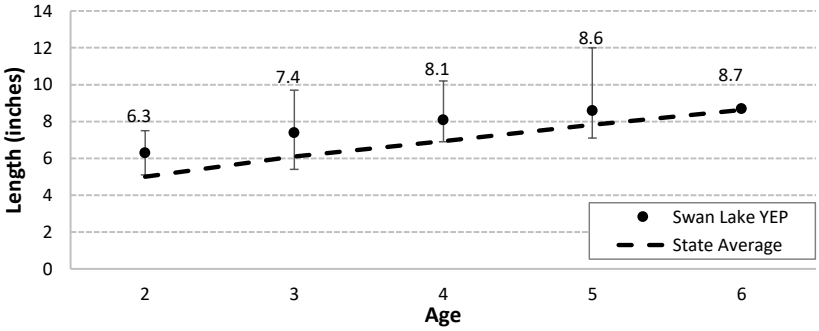


Figure 5. Mean length at age of yellow perch collected during the comprehensive fishery survey of Swan Lake, Columbia County, Wisconsin in 2018. Error bars cover the range of length values for each age.

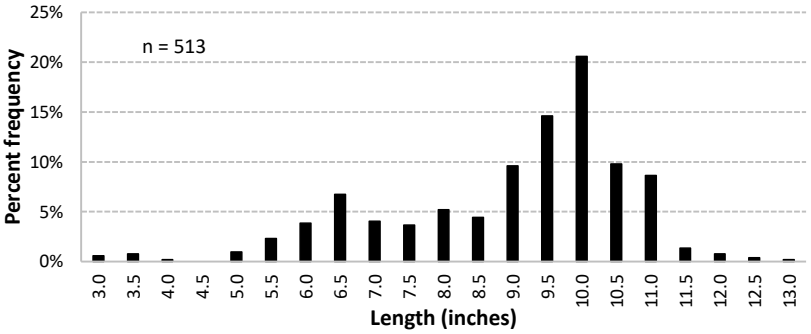


Figure 6. Length frequency distribution of black crappie collected during two spring fyke netting surveys (SN1, SN2) of Swan Lake, Columbia County, Wisconsin in 2018.

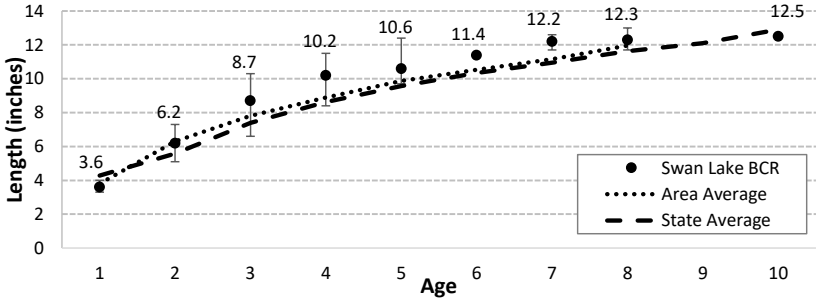


Figure 7. Mean length at age of black crappie collected during the comprehensive fishery survey of Swan Lake, Columbia County, Wisconsin in 2018. Error bars cover the range of length values for each age.

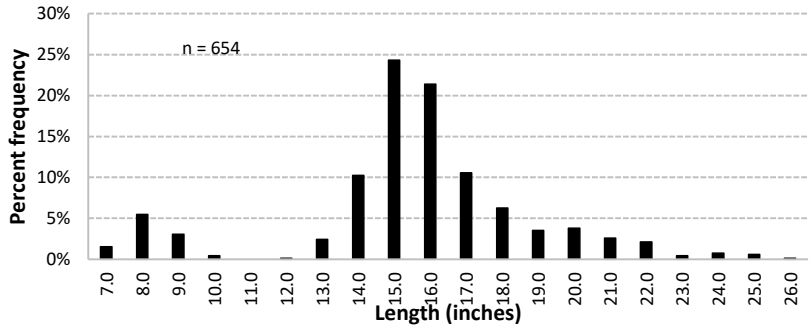


Figure 8. Length frequency distribution of walleyes collected during two spring netting surveys (SN1, SN2) and two spring electrofishing surveys (SE1, SE2) of Swan Lake, Columbia County, Wisconsin in 2018.

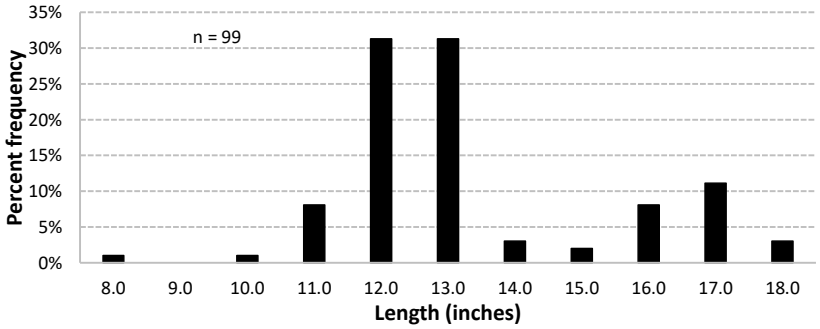


Figure 9. Length frequency distribution of walleyes collected during the fall electrofishing survey of Swan Lake, Columbia County, Wisconsin in 2018.

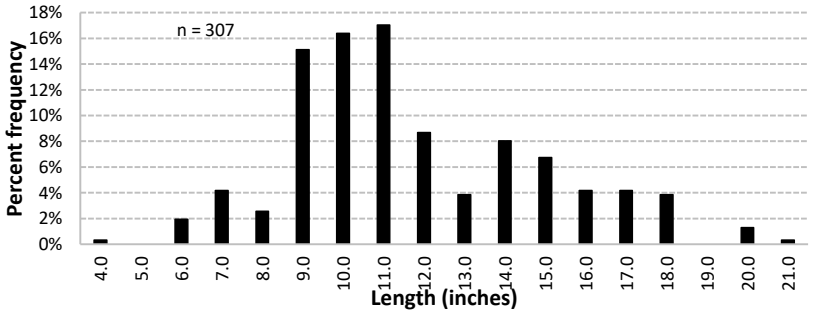


Figure 10. Length frequency distribution of largemouth bass collected during two spring netting surveys (SN1, SN2) and two spring electrofishing surveys (SE1, SE2) of Swan Lake, Columbia County, Wisconsin in 2018.

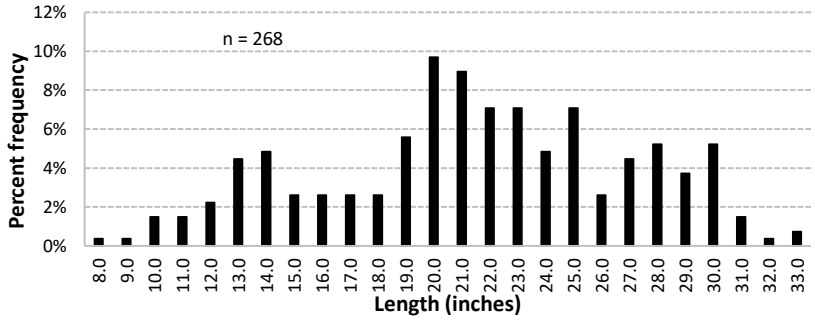


Figure 11. Length frequency distribution of northern pike collected during two spring netting surveys (SN1, SN2) and two spring electrofishing surveys (SE1, SE2) of Swan Lake, Columbia County, Wisconsin in 2018.

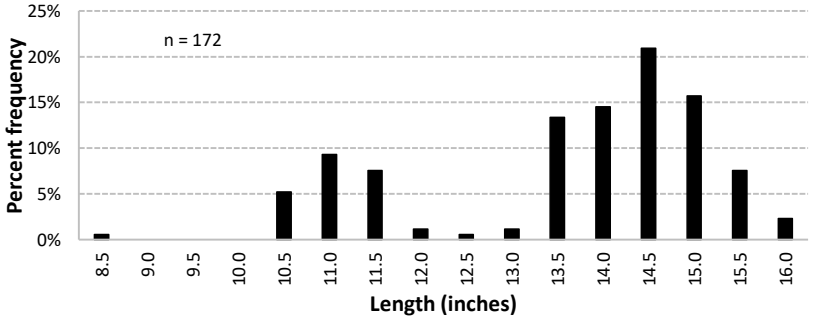


Figure 12. Length frequency distribution of white bass collected during two spring netting surveys (SN1, SN2) of Swan Lake, Columbia County, Wisconsin in 2018.

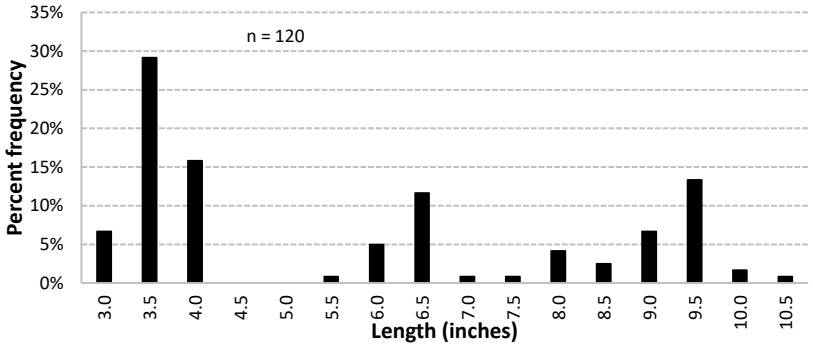


Figure 13. Length frequency distribution of yellow bass collected during a spring netting survey (SN1) and a spring electrofishing survey (SE2) of Swan Lake, Columbia County, Wisconsin in 2018.

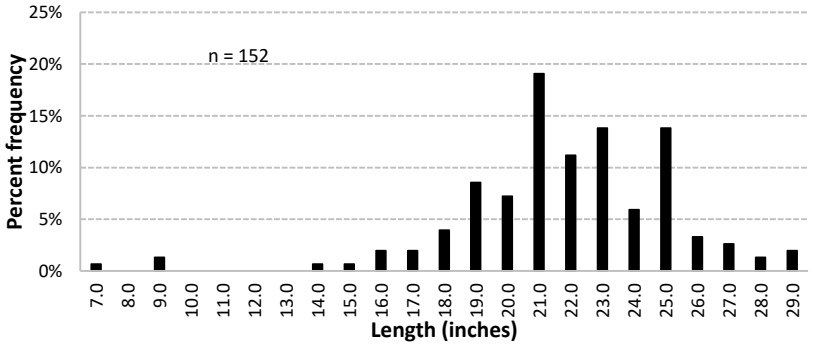


Figure 14. Length frequency distribution of channel catfish collected during two spring netting surveys (SN1, SN2) and a spring electrofishing survey (SE2) of Swan Lake, Columbia County, Wisconsin in 2018.

Appendix G

Swan Lake Aquatic Plant Survey

To whom it may concern:

This summer you requested information regarding an aquatic plant survey that staff from the Wisconsin Department of Natural Resources conducted on June 22nd, 2017 on Swan Lake in Columbia County, WI. The plant survey was conducted as part of a statewide monitoring project. This data will be used by the Department to understand the variation in aquatic plant growth among lakes across the state, how aquatic plant populations respond to management regimes, and how plant communities change over time. Swan Lake is one of the waterbodies chosen for this project because it meets certain criteria (size, region, nutrient levels, presence of aquatic invasive plant species, timing of invasive plant establishment, etc.) for this study.

Importance of Aquatic Plants

Aquatic plants form the foundation of healthy lake ecosystems. They not only protect water quality, but also produce life-giving oxygen. Aquatic plants are a lake's own filtering system, helping to clarify the water by absorbing nutrients like phosphorus and nitrogen that could stimulate algal blooms. Plant beds stabilize soft lake bottoms and prevent shoreline erosion by reducing the effect of waves and currents. Healthy native aquatic plant communities help prevent the establishment of invasive non-native plants such as Eurasian water milfoil and curly-leaf pondweed. Native aquatic plants also provide important reproductive, food, and cover habitat for fish, invertebrates, and wildlife. By leaving or restoring a natural buffer area of emergent vegetation along the shoreline, property owners can reduce erosion, help maintain water quality, and provide habitat and travel corridors for wildlife.

Invasive Aquatic Plant Species

Invasive aquatic species are a huge threat to Wisconsin lakes both ecologically and economically. Ecological impacts of introduced invasive species can range in severity depending on differing ecosystem variables. Specific impacts are difficult to predict. Invasive plants are problematic because they can grow to nuisance levels. These dense populations of non-native plants often have a negative impact on native plant communities because they are able to out-compete them for available resources needed for survival. Changes in the native plant community have far-reaching effects on fish, birds and invertebrates that need native plants to survive. Nuisance levels of non-native aquatic plants may also inhibit recreational activities (such as fishing, swimming, boating, etc.), decrease aesthetic value, and negatively effect water quality. Some industries such as sport and commercial fishing and raw water users (power companies and utilities), are also negatively affected by invasive species. It is important that everyone utilizing Wisconsin's lake resources do their part to help prevent and stop the spread of aquatic invasive species.

Point-Intercept Sampling Method

Based on area and depth specific to Swan lake, we mapped a 965-point sampling grid over the entire lake surface. Using a GPS, we navigated by boat to each of the pre-determined grid points. At each point we used a two-sided rake to sample approximately 1 foot along the bottom. After pulling the plants to the surface, the

overall rake as well as individual species on the rake were assigned a fullness rating of 1, 2 or 3 to estimate density of plant growth (see Figure 1 for descriptions of rake fullness ratings). We also recorded visual sightings of species within six feet of the sample point, as well as any additional species seen in the lake during a general boat survey. For more detailed information on the point-intercept sampling method and how data were collected please visit: http://www.uwsp.edu/cnr-ap/UWEXLakes/Documents/ecology/Aquatic%20Plants/PI-Protocol-2010.pdf

Species frequencies of occurrence reflect the percentage of times a species was found out of the total number of points sampled. Littoral frequency of occurrence (given in Table 1) indicates how often a species was found considering only areas of the lake that are capable of supporting plant growth (known as the "littoral area"). The maximum depth of plant growth is the deepest depth at which plants were found in the lake. Species richness is a count of the total number of different plant species found in a lake. The Floristic Quality Index (FQI) is a metric that evaluates the closeness of the flora in a lake to that of an undisturbed condition. The higher a FQI value, the closer that plant community is to an undisturbed ecosystem. Statewide and ecoregion averages are calculated from a subset of approximately 250 lakes across Wisconsin.

Table 1: Species Present

% Frequency of Occurrence (Littoral): This estimation of frequency of occurrence is calculated by taking the total number of times a species is detected in a lake divided by the total number of points in a lake at which the growth of plants is possible. Voucher specimens have been sent to the UW-Stevens Point Herbarium, therefore all species identifications are subject to change pending verification.

Species	FOO (%)
Myriophyllum spicatum,Eurasian water milfoil	50.4201681
Ceratophyllum demersum, Coontail	26.0504202
Stuckenia pectinata, Sago pondweed	22.6890756
Potamogeton amplifolius, Large-leaf pondweed	15.1260504
Potamogeton crispus, Curly-leaf pondweed	5.8823529
Filamentous algae	4.2016807
Chara globularis, Globular stonewort	4.2016807
Elodea canadensis, Common waterweed	2.5210084
Potamogeton zosteriformis, Flat-stem pondweed	2.5210084
Zannichellia palustris, Horned pondweed	2.5210084
Nuphar variegata, Spatterdock	1.6806723
Schoenoplectus tabernaemontani, Softstem bulrush	1.6806723
Chara contraria, Fetid stonewort	1.6806723
Najas flexilis, Slender naiad	0.8403361

Potamogeton gramineus, Variable pondweed	0.8403361
Schoenoplectus acutus, Hardstem bulrush	0.8403361
Typha angustifolia, Narrow-leaved cattail	0.8403361
Vallisneria americana, Wild celery	0.8403361

Table 2: Survey Summary
A summary table of the statewide, Southwestern Till Plains, and Swan lake frequency of occurrence (FOO), maximum depth of colonization (MDC), species richness, and floristic quality index (FQI).

	Statewide	Ecoregion	Lake
Vegetated Frequency of Littoral Occurrence (%)	0.74	0.79	0.53
Maximum Depth of Plant Colonization (feet)	15.3	15.4	13.0
Species Richness	16.8	15.0	17.0
Floristic Quality Index (FQI)	24.1	20.0	18.0

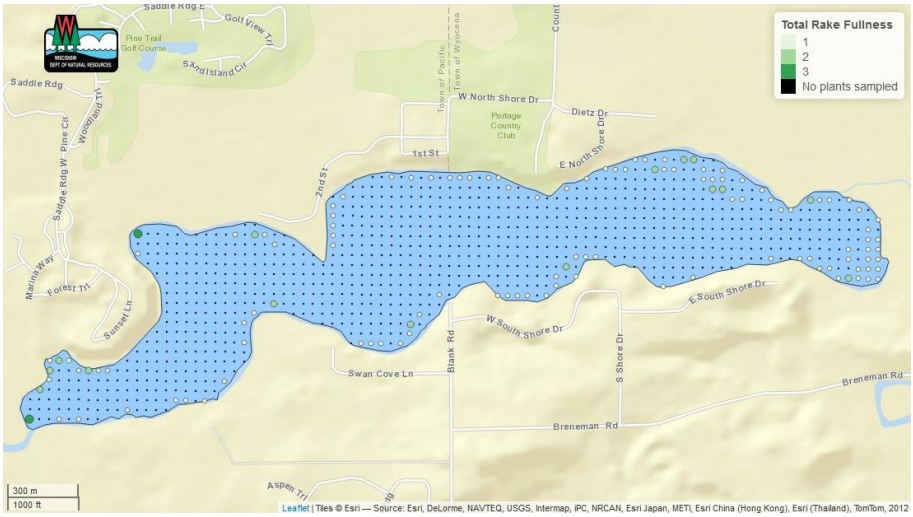


Figure 1: A map of the total rake fullness on Swan lake.

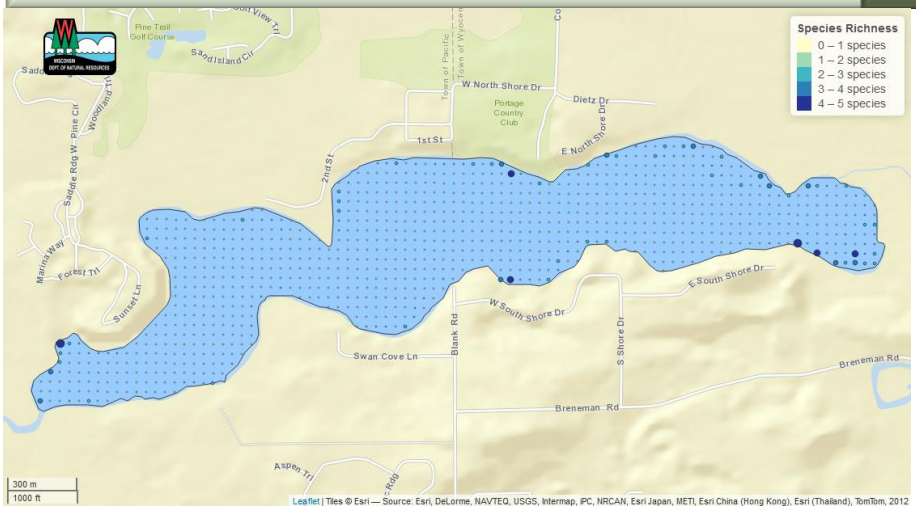


Figure 2: A map of the species richness identified on Swan lake.

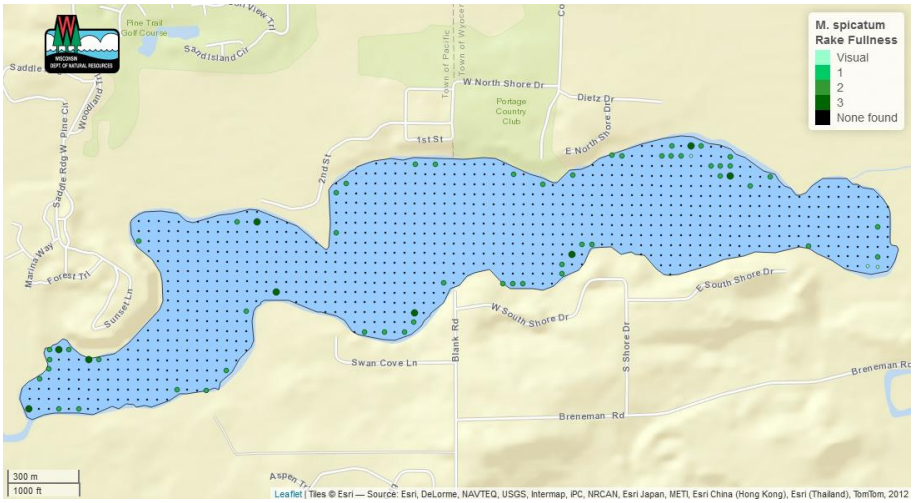


Figure 3: A map of the approximate location of *Myriophyllum spicatum*.

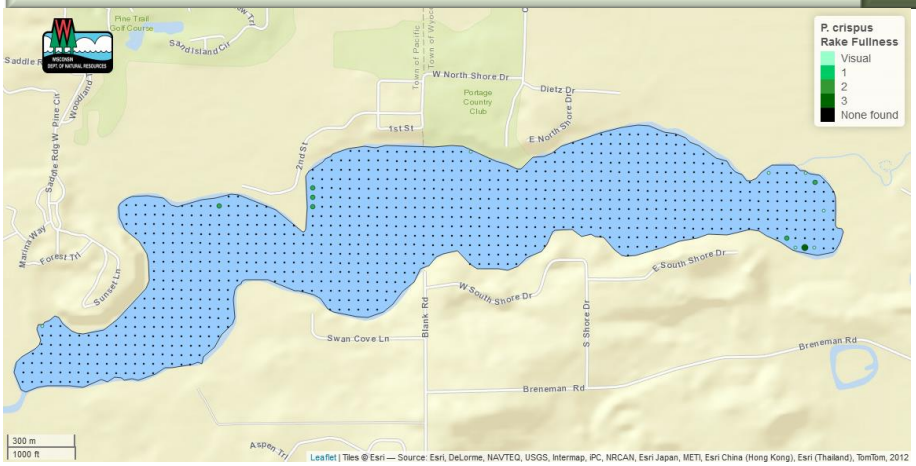


Figure 4: A map of the approximate location of *Potamogeton crispus*.

Additional Resources:

Wisconsin State Herbarium and Plant Identification http://www.botany.wisc.edu/wisflora/

Invasive Species in Wisconsin http://dnr.wi.gov/topic/Invasives/

Wisconsin's Lakes http://dnr.wi.gov/lakes/

Aquatic Plant Management in Wisconsin http://www.uwsp.edu/cnr-ap/UWEXLakes/Pages/ecology/aquaticplants/default.aspx

Please note that while this study conforms to statewide protocol and standards for baseline data collection, it may not be suitable for management purposes. For information as to whether this survey meets requirements for management plans or permitting requirements, please contact your local DNR lake coordinator (copied below).

If you have any additional questions regarding the DNR's survey or study, please feel free to contact us.

Sincerely,

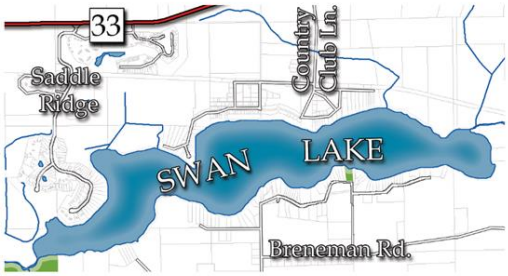
Michelle Nault
Lakes and Reservoir Ecologist
Wisconsin Department of Natural Resources
(608) 513-4587
Michelle.Nault@Wisconsin.gov

Appendix H

Swan Lake Community Survey & Social Science Assesment

University of Wisconsin-Stevens Point
College of Natural Resources

Swan Lake
Community Survey & Social Science Assessment



FINAL REPORT: JANUARY 2017

SURVEY INVITATION LETTER

We're asking for your help! This survey, which we expect should take about 20 minutes to complete, is an important step to help in the development of a new management plan for Swan Lake. Please share your experiences with and priorities for Swan Lake, along with some demographic information to help us understand who responded. The survey is being conducted as a partnership between UW-Stevens Point and the Columbia County Land & Water Conservation Department- **so please contribute to this effort by completing the online survey!**

Here are a few important notes about this study:

- Remember all results will be kept confidential, we're just looking for your important perspective about how to better manage Swan Lake and the surrounding watershed.
- All responses will be treated as anonymous and records used to contact respondents containing identifying information will be destroyed prior to the research team reviewing data.
- Please skip any questions that make you feel uncomfortable or that you don't know how to answer.
- We do not anticipate any potential for risk or harm due to participation in this study; however, if you have any complaints about your treatment as a participant in this study please contact Dr. Debbie Palmer, IRB Chair at (715) 346-3953, e-mail at dpalmer@uwsp.edu, or mail at University of Wisconsin-Stevens Point, Science Building D240, Stevens Point Wisconsin 54481.

While your participation is voluntary your input can help bring local voices into these important efforts to enhance Swan Lake! If you have any questions or comments about this project you may contact me using the information provided below.

Thank you for your time and we're looking forward to hearing from you!

Dr. Aaron Thompson, Associate Professor
University of Wisconsin-Stevens Point
E-mail: aaron.thompson@uwsp.edu Phone: 715.346.2278

Chris Arnold, Resource Management Specialist
Columbia County Land & Water Conservation Dept.
Phone: 608.742.9674

UW Extension
University of Wisconsin-Extension

Swan Lake Social Science Assessment: A Community Profile of Lake Stakeholders

Principal Investigator:

Aaron W. Thompson, Associate Professor
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Acknowledgements

This work was made possible by support from the Wisconsin Department of Natural Resources and Columbia County Land & Water Conservation Department. Specifically, a unique aspect of this project was the extensive role of local county staff in managing the data collection for this project – this work was not possible without their efforts. Additional support was also provided by the University of Wisconsin-Stevens Point College of Natural Resources and the UW-Extension Center for Land Use Education.

I would also like to take this opportunity to thank the more than 190 community members who took the time to participate in the survey process. Their combined involvement represents more than 60 hours of volunteer time to help inform the watershed planning process – this work is not possible without the contribution of these individuals!

Suggested Citation

Thompson, Aaron (2017). Swan Lake Social Science Assessment: A Community Profile of Lake Stakeholders. Retrieved from the University of Wisconsin-Stevens Point, UWEX Center for Land Use Education website: http:www.uwsp.edu/cnr/landcenter/

For additional information or if you have questions about the work contained in this report contact:

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Swan Lake Management Plan, Columbia County, Wisconsin 2019

Introduction

This report summarizes the results of a confidential survey of landowners designed to support the development of a lake management plan for Swan Lake in Columbia County, Wisconsin. A social science assessment is used to better understand the stakeholders responsible for and impacted by the decisions that will be made as part of this planning process. The study objectives work to provide leaders with a clear picture of the priorities of stakeholders, an understanding of factors influencing behaviors related to water quality, and information on factors that influence engagement in efforts to preserve or enhance the watershed.

Method

Dr. Aaron Thompson with the UW-Extension Center for Land Use Education conducted a social survey to inform the development of lake management plans for Swan Lake in Columbia County, Wisconsin. The surveys were sent to 854 local landowners identified as nearby households by Columbia County staff as part of the process of developing the lake management plan. The 8-page survey was administered using a web survey approach and respondents were recruited using 2 contacts (including an invitation letter and a reminder postcard) from September to December 2016. This method is not a preferred approach for collecting social science data and was only selected due to restrictions on funding availability for this project.

Response Rate

The original mailing list did not yield any bad address or surveys returned by the postal service as undeliverable, so the total census size is 854 households. A total of 233 surveys (along with 30 completed supplemental questionnaires described below) were returned, which produced a response rate of approximately 27.3 percent.

Project Timetable

- July – August 2016
  - Mailing list developed by Columbia County
  - Survey materials created and final question wording approved
  - August 26,2016: Final survey questionnaire received approval from UWSP IRB
- September – November 2016
  - September 5th, 2016: Advance letter mailed (Contact #1)
  - November 1st, 2016: Reminder postcard mailed (Contact #2)
- December – January 2017
  - Final data collection date – closed collectors (December 30, 2016)
  - Data analysis and final report development
  - Report Submitted to Columbia County (January 6, 2017)

Sample and Non-Response Considerations

As with all scientific data collection it is important to evaluate the data to determine the best way to utilize the results and reveal any possible limitations. For this study we attempted a complete census of shoreline landowners and nearby residents of Swan Lake. Ensuring that non-response bias didn't limit the dataset was addressed at various stages of the research design and implementation, including:

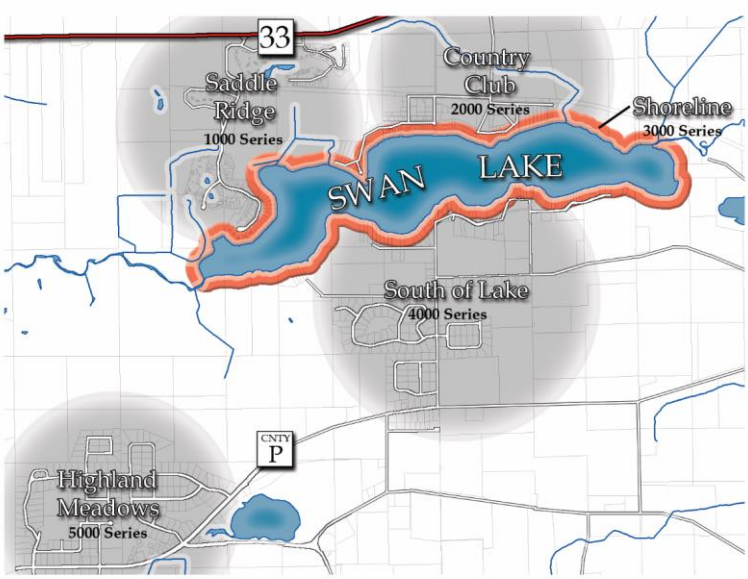
- Eliminating participant selection bias -- the mailing list was generated by Columbia County and was intended to ensure that no landowners within the selection criteria were excluded from the opportunity to participate.
- Eliminating interviewer bias – the survey cover / recruitment letter clearly outlined that the data would be treated as anonymous, including the destruction of mailing addresses prior to examining results.
- Non-response bias – the dataset suffered from an unusually low response rate that varies by stakeholder group. The lower response rate was influenced by several factors, including:
  - The online format was not accessible to everyone, specifically those potential respondents that struggled with entering the IP address (many early complaints were that their search engines didn't recognize the www.surveymonkey.com format).
  - Few individuals followed up to request a paper copy be sent when the web version was unsuccessful. A better practice for future research would be to automatically send a paper copy to non-respondents who do not respond to the web survey; however, severe budget limitations prevented this from happening in this case.
  - The sample itself included many non-lake residents in nearby subdivisions who didn't see the survey as relevant as they are not riparian owners and among those who responded several reported rarely recreating on Swan Lake.

Analysis work presented in this report describes the results of the survey (descriptive statistics) and differentiates stakeholder groups (factor analysis modeling) to create a stakeholder profile that supports understanding the unique differences amongst Swan Lake landowners. Acknowledging the limitations of the low response rate the data below have been analyzed in a way that documents even minority opinions, recognizing the possibility that these views may be representative of those stakeholders that did not participate in the survey.

Response Rate Breakdown by Stakeholder Group

The non-response bias can also be broken down further as the web survey was individually tailored to recruit participation from 5 unique stakeholder groups (and 2 supplemental categories), representing the following response rates for key stakeholder groups as shown in Figure 1 below.

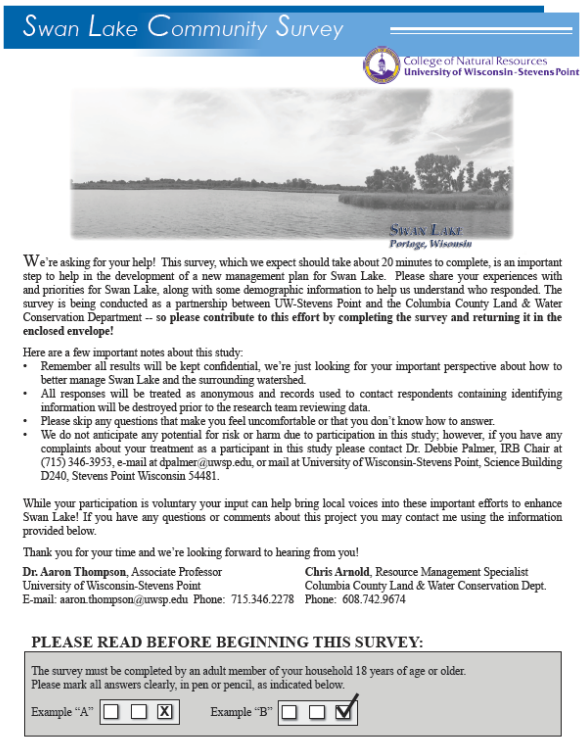
FIGURE 1: Sample Description



Series	Responses	Invited	Res. Rate	Stakeholder Group
1000	57	297	19.2%	Saddle Ridge
2000	24	68	35.3%	Country Club
3000	61	118	51.7%	Shoreline
4000	29	127	22.8%	South of Lake
5000	62	244	25.4%	Highland Meadow
6000	21	n.a.	n.a.	Boat Club
7000	9	n.a.	n.a.	Other / 2nd surveys

Note: **The response rate excludes the Boat Club (6000 series) and the 2nd surveys from an individual household (7000 series) as these are supplemental with an unknown number of potential respondents.**

Swan Lake Community Survey



Swan Lake Community Survey

College of Natural Resources
University of Wisconsin-Stevens Point

Swan Lake
Portage, Wisconsin

We're asking for your help! This survey, which we expect should take about 20 minutes to complete, is an important step to help in the development of a new management plan for Swan Lake. Please share your experiences with and priorities for Swan Lake, along with some demographic information to help us understand who responded. The survey is being conducted as a partnership between UW-Stevens Point and the Columbia County Land & Water Conservation Department -- so **please contribute to this effort by completing the survey and returning it in the enclosed envelope!**

Here are a few important notes about this study:

- Remember all results will be kept confidential, we're just looking for your important perspective about how to better manage Swan Lake and the surrounding watershed.
- All responses will be treated as anonymous and records used to contact respondents containing identifying information will be destroyed prior to the research team reviewing data.
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- We do not anticipate any potential for risk or harm due to participation in this study; however, if you have any complaints about your treatment as a participant in this study please contact Dr. Debbie Palmer, IRB Chair at (715) 346-3953, e-mail at dpalmer@uwsp.edu, or mail at University of Wisconsin-Stevens Point, Science Building D240, Stevens Point Wisconsin 54481.

While your participation is voluntary your input can help bring local voices into these important efforts to enhance Swan Lake! If you have any questions or comments about this project you may contact me using the information provided below.

Thank you for your time and we're looking forward to hearing from you!

Dr. Aaron Thompson, Associate Professor
University of Wisconsin-Stevens Point
E-mail: aaron.thompson@uwsp.edu Phone: 715.346.2278

Chris Arnold, Resource Management Specialist
Columbia County Land & Water Conservation Dept.
Phone: 608.742.9674

PLEASE READ BEFORE BEGINNING THIS SURVEY:

The survey must be completed by an adult member of your household 18 years of age or older.
Please mark all answers clearly, in pen or pencil, as indicated below.

Example "A" ☐ ☐ ☒ Example "B" ☐ ☐ ☑

A social science assessment is simply another tool that can be used to help develop a lake management plan and the implementation strategies that are needed to achieve the goals laid out by the planning process. This work is guided by the process shown in the graphic outline below that begins by collecting and analyzing (a) demographic characteristics of a key stakeholder audience and (b) key attitudes and beliefs that affect the development of the management plan for Swan Lake as described in the following sections.

Data Analysis

Unless otherwise labeled, mean scores represent responses to the Likert-type format shown here with a range from Strongly Disagree (-2) to Strongly Agree (+2).

The type of statistical analysis used to produce the results included in this section is a difference of means test called an ANOVA. These tests require a minimum number of cases to create reliable estimates of whether or not there is a statistically significant difference in the mean score between different groups. For the purpose of this analysis 3 groups were created to ensure >60 responses in each group, as specified in the table below:

Group #	Series	Responses	Stakeholder Group
G2	1000	57	Saddle Ridge
G2	2000	24	Country Club
G1	3000	61	Shoreline
G3	4000	29	South of Lake
G3	5000	62	Highland Meadow
G2	6000	21	Boat Club

The rationale for this grouping largely based on a desire to understand the priorities of those most affected by lake management efforts (G1) the shoreline landowners, as compared with (G2) those who live or belong to one of the key groups (Saddle Ridge, Country Club, or Boat Club) around Swan Lake, and finally (G3) to those who reside nearby in rural residences or neighborhoods to the south of Swan Lake.

Demographics

	G1: Shoreline Landowners	G2: Key Groups	G3: Nearby Residents	All Responses
Gender *(% male)*	64.4%	63.6%	69.1%	65.9%
Age *(years)*	62.7	64.4	68.5	65.4
Education ***(mean score: 1=some high school to 6=graduate degree)***	4.6	4.3	4.3	4.4
Political Orientation ***(mean score: 1=liberal to 5=cons.)***	2.6	2.6	2.7	2.6
Hunt *(% who hunt)*	30.5%	37.5%	43.2%	37.7%
Income ***(mean score: 1=<$25k to 6=>$250k)***	3.8	3.4	3.2	3.4
Swan Lake Activity & Residence Characteristics				
Activity: Do you frequently swim in Swan Lake? *(% yes)*	76.7%	39.4%	24.4%	42.9%
Activity: Do you frequently fish on Swan Lake? *(% yes)*	57.6%	42.2%	34.8%	43.3%
Activity: Do you frequently recreate in lawn (turf grass) areas along the shoreline? *(% yes)*	66.7%	35.4%	25.6%	39.4%
Activity: Do you frequently recreate using a ski, pontoon, or other motorboat? *(% yes)*	81.7%	56.1%	36.7%	55.2%
Activity: Do you frequently participate in silent sports (such as canoeing, kayaking, or paddle boards)? *(% yes)*	68.3%	25.8%	30.0%	37.7%
Residence ***(mean score: 1=permanent residence, 2= vacation home (year-round), 3 = vacation home (summer)***	1.9	1.3	1.2	1.5
Residence: Years ***(mean score: 1=<5 years to 4=>20 years)***	3.1 *(10-20 years)*	2.8 *(5-10 years)*	2.5 *(5-10 years)*	2.8 *(5-10 years)*
Membership %: ***Swan Lake Association***	70.1%	28.4%	7.7%	31.1%
Membership %: ***Portage Boat Club***	6.5%	16.7%	7.7%	11.0%
Membership %: ***Portage Country Club***	9.8%	16.7%	3.3%	10.2%
Membership %: ***Saddle Ridge Condo Association***	18.0%	43.1%	n.a.	22.1%

Current Conditions

	G1: Shoreline Landowners	G2: Key Groups	G3: Nearby Residents	All Responses
Trend: Quality of Fishing ***(mean score: 1=decline, 2= same, 3=improved)***	2.5	2.2	2.3	2.3
Property Value: Quality of Fishing ***(mean score: 1=decreased, 2= same, 3=increased)***	2.1	1.9	1.8	2.0
Trend: Water Quality ***(mean score: 1=decline, 2= same, 3=improved)***	2.1	2.3	2.2	2.2
Property Value: Water Quality ***(mean score: 1=decreased, 2= same, 3=increased)***	2.0	1.9	1.9	2.0
Trend: Shoreline Quality ***(mean score: 1=decline, 2= same, 3=improved)***	2.3	2.1	2.3	2.2
Property Value: Shoreline Quality ***(mean score: 1=decreased, 2= same, 3=increased)***	2.0	1.9	1.9	2.0

***Note:* **Don't know / Unsure or blank responses accounted for 27.8-53.2% of all responses to each of the trend questions and 52.1-61.2% on the impact on property value questions, which suggests that many stakeholders don't feel that they have the information to make an informed statement on trends or their impact on property values.**

Community Perspectives

Scale 1: The quality of Swan Lake is declining with an increased presence of aquatic plants, algae, and other unwanted weeds reducing desire to spend time on the water. {Cronbach's alpha = .764}

The scale is constructed by compiling an average score from the following items identified by a factor analysis procedure:

- #3: Recently there has been a large increase in the amount of weeds and other unwanted vegetation in Swan Lake.
- #6: The presence of a lot of algae in the water during the summer months has greatly reduced my desire to spend time on Swan Lake.
- #10: The water in Swan Lake is dirty and seems to be getting worse.
- #17: The presence of aquatic plants in Swan Lake during the summer months has greatly reduced my desire to spend time here.

Results for this scale indicate:

- **Average respondent slightly disagrees that the condition is declining, while those with a more direct connection (shoreline landowners and key groups) view conditions more positively than those who do not live or belong to one of the Swan Lake groups.**
- A significant difference exists between G2 and G3.

	G1: Shoreline Landowners	G2: Key Groups	G3: Nearby Residents	All Responses
Scale #1: Decreased enjoyment due to weeds & algae ***(mean scores)***	-.25	-.32	-.07	-.21

Scale 2: Swan Lake is currently a safe and enjoyable place for using a large motor or ski boat, which are not causing damage to the shoreline. {Cronbach's alpha = .676}

The scale is constructed by compiling an average score from the following items identified by a factor analysis procedure:

- #2: Being able to safely use a large motor on my boat is an important part of my recreation on Swan Lake.
- #12: The waves created by ski boats are not damaging the shoreline on Swan Lake.
- #18: Most boaters maintain a speed on Swan Lake that allows everyone to feel safe recreating here.

Results for this scale indicate:

- **The average respondent somewhat disagrees (although this is still a near-neutral average response) that motorboats / ski boats are being used appropriately on Swan Lake and that their use is not causing damage to the shoreline.**
- A significant difference exists between G2 (key groups) and G1 (shoreline) & G3 (nearby residents), specifically with shoreline landowners being the most negative about this issue.

	G1: Shoreline Landowners	G2: Key Groups	G3: Nearby Residents	All Responses
Scale #2: Support for large boat recreation ***(mean scores)***	-.34	+.08	-.17	-.12

Scale 3: Investing in protection of the shoreline vegetation, protection of nearby wetlands, and providing better opportunities fish and wildlife habitat motivate support for Swan Lake. {Cronbach's alpha = .751}

The scale is constructed by compiling an average score from the following items identified by a factor analysis procedure:

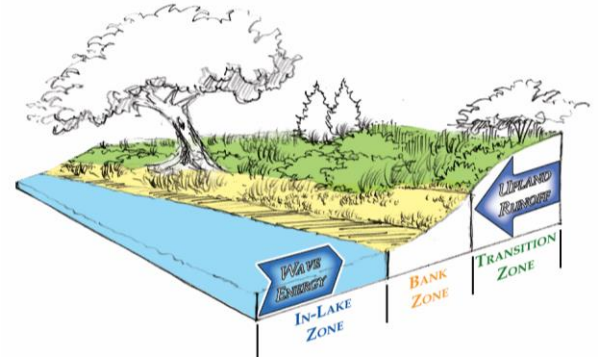
- #9: It is important that more vegetation be planted along shorelines to reduce runoff pollution from surrounding properties.
- #13: Local funding to address issues affecting water quality in Swan Lake is a great investment in our future.
- #14: The marshes and wetlands surrounding Swan Lake must be protected as they support clean water for swimming and boating.
- #15: Providing better habitat for fish and wildlife motivates me to support efforts to improve Swan Lake.

Results for this scale indicate:

- **The average respondent agrees that it is important to invest in protecting the quality of Swan Lake through locally funded efforts to address water quality issues.**
- No significant differences exist between groups for this scale.

	G1: Shoreline Landowners	G2: Key Groups	G3: Nearby Residents	All Responses
Scale #3: Support local investment in lake protection ***(mean scores)***	+.89	+.82	+.75	+.81

Landscape Practices



Transition Zone: Diversion Practices

	G1: Shoreline Landowners	G2: Key Groups	G3: Nearby Residents	All Responses
Impact: Installing DIVERSION PRACTICES on shoreline properties will help improve the condition of Swan Lake by protecting water quality or preventing shoreline erosion. ***(mean scores)***	+.30*	+.57	+.64	+.53
Appearance: Installing DIVERSION PRACTICES will make shoreline properties look less attractive. ***(mean scores)***	+.53*	-.07	-.15	+.06
Financial Support: Landowners shouldn't be asked to install and maintain DIVERSION PRACTICES unless there is financial support from other lake users. ***(mean scores)***	+.64*	-.02	.01	+.16
Interest: SHORELINE LANDOWNER ONLY -- I'm interested in installing DIVERSION PRACTICES as they seem like a good fit for my yard. ***(mean scores)***	-.64	-.22	n.a.	-.48

**Significant difference with other groups*

Bank Zone: Native Plantings

	G1: Shoreline Landowners	G2: Key Groups	G3: Nearby Residents	All Responses
Impact: Installing NATIVE PLANTINGS on shoreline properties will help improve the condition of Swan Lake by protecting water quality or preventing shoreline erosion. ***(mean scores)***	+.38*	+.69	+.86	+.67
Appearance: Installing NATIVE PLANTINGS will make shoreline properties look less attractive. ***(mean scores)***	+.07*	-.22	-.49	-.24
Financial Support: Landowners shouldn't be asked to install and maintain NATIVE PLANTINGS unless there is financial support from other lake users. ***(mean scores)***	.75*	-.08	-.04	+.15
Interest: SHORELINE LANDOWNER ONLY -- I'm interested in installing NATIVE PLANTINGS as they seem like a good fit for my yard. ***(mean scores)***	-.27	-.26	n.a.	-.21

**Significant difference with other groups*

In-Lake Zone: Fish Sticks

	G1: Shoreline Landowners	G2: Key Groups	G3: Nearby Residents	All Responses
Impact: Installing FISH STICKS on shoreline properties will help improve the condition of Swan Lake by protecting water quality or preventing shoreline erosion. *(mean scores)*	+.25	+.31	+.40	+.33
Appearance: Installing FISH STICKS will make shoreline properties look less attractive. *(mean scores)*	+.55*	+.05	.00	+.16
Financial Support: Landowners shouldn't be asked to install and maintain FISH STICKS unless there is financial support from other lake users. *(mean scores)*	+.93*	+.12	+.19	+.36
Interest: SHORELINE LANDOWNER ONLY -- I'm interested in installing FISH STICKS as they seem like a good fit for my yard. *(mean scores)*	-.80	-.65	n.a.	-.57

**Significant difference with other groups*

Emergency Slow-No Wake Zones

	G1: Shoreline Landowners	G2: Key Groups	G3: Nearby Residents	All Responses
Familiarity with Issuance ***(mean score: 1=Very Unfamiliar to 4=Very Familiar)***	3.5	2.8	2.4	2.8
Notification of No Wake Zones ***% Signal flags on docks***	29.5%	33.3%	29.7%	31.1%
Notification: ***% Signs posted at landings***	72.1%	61.8%	74.7%	68.9%
Notification: ***% E-mail alert***	54.1%	36.2%	14.3%	32.7%
Notification: ***% Text message alert***	52.5%	23.5%	16.5%	27.9%
Notification: ***% Local radio alert***	21.3%	17.6%	18.7%	18.9%
Notification: ***% Other: Newspaper***	1.6%	2.0%	1.1%	1.6%
Notification: ***% Other: Signs on all entry roads***	11.5%	3.8%	3.3%	6.7%
Level of Agreement: I avoid recreating on Swan Lake when an Emergency Slow-No-Wake Zone is being enforced. ***(mean score)***	-.12	+.02	-.05	-.04
Level of Agreement: An Emergency Slow-No-Wake Zone to prevent wave energy damage to shorelines should go into effect as soon as high water conditions are observed on Swan Lake. ***(mean score)***	+1.35	+1.0	+1.1	+1.12
Level of Agreement: The use of an Emergency Slow-No-Wake Zone does not help to protect Swan Lake shorelines from wave energy damage. ***(mean score)***	-1.42	-1.02	-.97	-1.11

Trust in Organizations

	G1: Shoreline Landowners	G2: Key Groups	G3: Nearby Residents	All Responses
Wisconsin Department of Natural Resources (WDNR) ***(mean scores)***	+.63	+.58	+.57	+.58
Columbia County Land & Water Conservation Department ***(mean scores)***	+.92	+.76	+.73	+.79
Swan Lake Association ***(mean scores)***	+.93	+.85	+.65	+.80
Portage Boat Club ***(mean scores)***	-.14	+.38	+.10	+.14
Saddle Ridge Condo Association ***(mean scores)***	-.22	+.21	-.11	-.02
Portage County Club ***(mean scores)***	-.24	+.40	-.06	+.07
Knowledgeable Neighbor ***(mean scores)***	+.66	+.64	+.38	+.55

Lake Characteristics

	G1: Shoreline Landowners	G2: Key Groups	G3: Nearby Residents	All Responses
Water Clarity ***(mean scores: out of 100 points)***	27.5	25.2	21.6	24.6
Lack of Invasives ***(mean scores: out of 100 points)***	15.3	14.4	16.6	15.4
Wildlife ***(mean scores: out of 100 points)***	7.9	9.5	9.6	9.1
Fish (diversity) ***(mean scores: out of 100 points)***	9.5	11.5	9.7	10.3
Fishing (quantity) ***(mean scores: out of 100 points)***	10.0	11.5	11.3	11.0
Shore land buffers ***(mean scores: out of 100 points)***	6.0	10.1	10.1	8.9
Silent Recreation ***(mean scores: out of 100 points)***	7.8	8.6	9.6	8.7
Nutrient Management ***(mean scores: out of 100 points)***	8.0*	11.8	13.8	11.4
Public Access ***(mean scores: out of 100 points)***	3.1	8.3	13.9*	8.8
Aquatic Plants ***(mean scores: out of 100 points)***	4.1*	10.2	10.6	8.6

Landscape Preference

Scale 1: Preference for well-kept lawn that doesn't look weedy or overgrown, generally with lawn across the entire shoreline to ensure visibility. {Cronbach's alpha = .792}

The scale is constructed by compiling an average score from the following items identified by a factor analysis procedure:

- #2: Maintaining a lawn across my entire shoreline is necessary to ensure visibility that allows for safe water recreation.
- #4: Developed shorelines with lawns to the water's edge have little impact on clean water quality in the lake.
- #6: An attractive shoreline landscape is one that is well kept and doesn't look weedy or overgrown with vegetation.
- #10: Tall grasses and other vegetation along the shoreline should be removed because they are full of ticks or other unwanted insect pests.

Results for this scale indicate:

- **The average respondent is neutral (or slightly negative) toward highly maintained landscapes; however, the full range of scores shows that variation exists within each of these groups** *(see minimum and maximum scores below)*:
  - G1: 2.00 Maximum, -1.75 Minimum values within group
  - G2: 1.50 Maximum, -2.00 Minimum values within group
  - G3: 1.00 Maximum, -2.00 Minimum values within group
- There are significant differences between G1 (shoreline) and both other groups (G2 & G3).

	G1: Shoreline Landowners	G2: Key Groups	G3: Nearby Residents	All Responses
Scale #1: Maintained (lawn) landscapes ***(mean scores)***	+.16	-.17	-.40	-.16

Scale 2: Preference for landscapes that appear undeveloped with large vegetative buffers and near shore vegetation in the water, as long as safe access is being maintained. {Cronbach's alpha = .818}

The scale is constructed by compiling an average score from the following items identified by a factor analysis procedure:

- #1: An attractive shoreline landscape is one that maintains some of the wild characteristics of an undeveloped shoreline.

- #3: Shoreline properties that have a large vegetative buffer between the lake and the house have a big impact on clean water quality in the lake.
- #5: As long as there is safe access to the water I don't need a lawn near my shoreline.
- #7: Leaving vegetation in the water near shore allows me to enjoy the fish and wildlife that use this habitat.

Results for this scale indicate:

- **The average respondent is slightly positive toward natural, or undeveloped, landscapes; however, the full range of scores shows that variation exists within each of these groups** *(see minimum and maximum scores below)*:
  - G1: 1.75 Maximum, -2.00 Minimum values within group
  - G2: 2.00 Maximum, -2.00 Minimum values within group
  - G3: 2.00 Maximum, -1.50 Minimum values within group
- Significant differences exist between all 3 groups, with G3 (nearby residents) holding the strongest preference for natural shorelines and G1 (shoreline landowners) holding the least positive view of these landscape characteristics.

	G1: Shoreline Landowners	G2: Key Groups	G3: Nearby Residents	All Responses
Scale #2: Natural (undeveloped) landscapes ***(mean scores)***	+.12	+.41	+.66	+.42

Next Steps

	G1: Shoreline Landowners	G2: Key Groups	G3: Nearby Residents	All Responses
Regular newsletters or meetings ***(mean scores)***	+1.22	+.89	+.65	+.89
Meeting one-on-on with expertise ***(mean scores)***	+.23	+.02	-.22	0.0
Made aware, left alone ***(mean scores)***	+.56	+.33	+.21	+.35
Access to small grants: Landowners only ***(mean scores)***	+.63	+.36	n.a.	+.56

References

Dillman, D.A., Christian, L.M., Smyth, J.D. 2000. Internet, mail, and mixed mode surveys: The tailored design method. Wiley, John & Sons, Inc. 1.

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