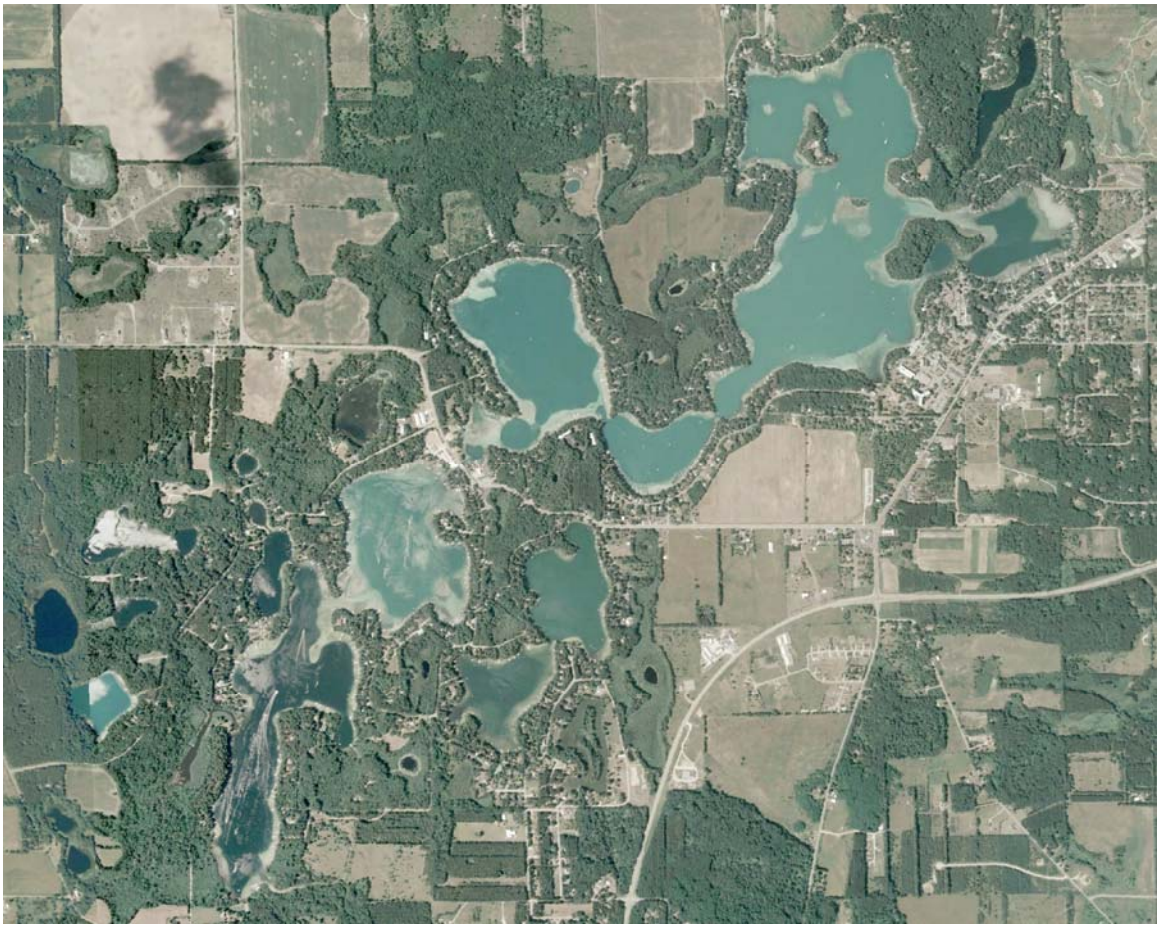
Waupaca Chain O' Lakes Critical Habitat Designation Report

4/17/2009

Site Evaluators:	Scott Provost: Water Resources Specialist – Wisconsin Rapids Scott Koehnke: Water Management Specialist – Shawano Al Niebur: Fishery Biologist – Shawano Steve Hoffman: Wildlife Biologist – Hartman Creek Ted Dremmel: Conservation Warden
Authors:	Scott Provost, Andrew Sabai, Steve Hoffman, Al Niebur, Ted Johnson and Scott Koehnke
Contact:	Ted Johnson: Water Resource Specialist – Wautoma



Waupaca Chain O' Lakes Critical Habitat Designation Report

Table of Contents

Waupaca Chain O' Lakes Critical Habitat Designation Report

Introduction

The Waupaca Chain O' Lakes is important to the ecology, economy, and residents of Northeast Wisconsin. In order to protect the unique features and ecology of these lakes, the Department of Natural Resources has designated areas within the Chain O' Lakes as Critical Habitat. This report will: discuss the unique ecology of the area, explain what critical habitat designations are, discuss the importance of each critical habitat designation (CHD), and make management recommendations.

The Waupaca Chain O' Lakes is a unique collection of 22 interconnected lakes in Southwestern Waupaca County. Theses lakes are fed by springs along with Emmons and Hartman Creeks. Water exits the system from Long Lake through the Crystal River. The lakes of the Waupaca Chain are very deep in comparison with their surface area. This creates a narrow littoral zone--the area of a lake where light can reach the bottom allowing the growth of rooted vegetation.

Critical Habitat Designations Explained

Critical habitat designations are designed to identify areas within lakes that provide important habitat for fish and wildlife, areas important to maintaining water quality, and scenic beauty. CHD's also identify areas that are important for navigation and other public uses. By identifying these areas as critical habitat, lakefront property owners and other users of public waterways can learn about habitats vital to the health of the lakes they use and minimize their disturbance to these areas. CHD's do not prohibit lakefront property owners from any specific use, but will require that some disturbances such as aquatic plant removal or pier construction be permitted by the DNR. The DNR will work with lakefront property owners to minimize the impact of these kinds of activities.

Critical habitat designations fall under two categories; Sensitive Area Designations (SADs) and Public Rights Features (PRF's).

The DNR makes SADs under Wisconsin Administrative Code NR 107. "Sensitive areas are areas of aquatic vegetation identified by the department as offering critical or unique fish and wildlife habitat, including seasonal or lifestage requirements, or offering water quality erosion control benefits to the body of water."

Public rights features are described under NR 1.06 as having any of these features:
(a) Fish and wildlife habitat, including specific sites necessary for breeding, nesting, nursery and feeding. (b) Physical features of lakes and streams that ensure protection of water quality. (c) Reaches of bank, shore or bed that is predominantly natural in appearance (not man-made or artificial) or that screen man-made or artificial features. (d) Navigation thoroughfares traditionally used for navigation during recreational boating, angling, hunting or enjoyment of natural scenic beauty.

Wildlife

The designated sensitive areas on the chain are a stark contrast to the majority of the shoreline. In general, most shoreline areas are developed and highly degraded, providing little wildlife habitat. In contrast, the sensitive areas provide natural, undeveloped shoreline with a high degree of diversity needed by wildlife. These areas have well-developed vegetative growth with ample amounts of woody debris in the water and on the shore. They provide wildlife with an easy transition between the water and land. This is especially important to reptiles and amphibians that use these areas in all stages of their life cycle. A large number of bird species utilize this same type of shoreline habitat. For example, waterfowl feed and loaf in these shallow water areas.

Emergent and submergent vegetation are used directly as food by many species. Vegetation also provides substrate for a wide variety of invertebrates which in turn provide food for both fish and wildlife. Emergent beds of bulrushes in the lake provide a unique habitat not only below the waterline but above as well. These stands of bulrush provide an important above-water habitat for some bird species. They also provide important shelter and food for waterfowl broods.

The areas where streams enter and leave the lakes are very important areas to preserve natural shoreline vegetation as much as possible. These areas act as corridors for species traveling through the area. They also provide a diversity of habitat types in a relatively small area important to many species.

A number of wildlife and plant species listed as threatened or special concern are found in this area. Wood turtles and Blanding's turtles have been found in the area. Both need undeveloped shoreline and streamside habitat. Bald eagles are listed as species of special concern and are regularly seen in the area. Red-shouldered hawks are threatened species that are also found in the area. The potential exists for both to nest in undeveloped shoreline areas.

The sensitive areas provide good examples of shoreline plant communities that benefit wildlife and the natural ecosystem. Preservation of these areas is extremely important to wildlife. The restoration of other shoreline areas to this quality of habitat should be a goal, wherever possible. These actions will greatly benefit all species of plants and wildlife on the chain.

Vegetation

There is only a narrow band of shallow water hugging the shore of most lakes of the Waupaca Chain (known as the littoral zone). This narrow band provides a place for the optimal growth of rooted aquatic vegetation. The vegetation growing here is the base of the food chain. Because the water of the chain is relatively low in nutrients, phytoplankton (algae) is not a major base of the food chain. The rooted vegetation on the Chain provides other critical functions. Underwater leaves provide refuge for young fish, and a place for larger predatory fish to ambush prey. Plant beds prevent erosion by reducing wave energy. They increase water clarity by acting as living filters. As mentioned in the wildlife section, emergent vegetation provides cover for waterfowl broods. Both humans and nature benefit from the plants of the Waupaca the Chain O' Lakes.

A total of 35 species of aquatic plants were indentified in the Chain. In addition, the macroalgae genera of *Nitella* and *Chara* were counted along with filamentous algae and moss. Appendix A lists all the species observed in each lake. Showy lady slipper and cuckooflower are two plant species of special concern listed as being found in this area in the past. Preservation of natural shoreline habitats protects these plant species and many others.

The aquatic invasive plants curly-leaf pondweed (Potamgeton crispus) and Eurasian watermilfoil (*Myriophyllum spicatum*) have been found in the chain. These two species need to be monitored and controlled to prevent their further spread. We recommend the DNR and the Lake District and Lake Association work together to reduce the impact of these species.

Fisheries

The Waupaca Chain O' Lakes supports one of the most diverse fish communities found in Central Wisconsin with representatives from all major fish assemblages (i.e. warmwater, coolwater, and coldwater). Comprehensive fish surveys conducted over recent years (2000, 2005- 2006) showed a well-balanced population of gamefish and panfish species. Gamefish species are comprised of northern pike (*Esox lucius*), walleye (*Zander vitreum*), largemouth bass (*Micropterus salmoides*) and brown trout (*Salmo trutta*). Panfish species are dominated by bluegill (*Lepomis macrochirus*), rockbass (*Ambloplites rupestris*) and black crappie (*Pomoxis nigromaculatus*). Nongame species are dominated by several sucker species, darters, and shiners. Of special interest is the presence of banded killifish (*Fundulus diaphunus*) a statewide special concern species and greater redhorse (*Moxostoma valenciennesi*) a state threatened species.

Based on the most recent surveys, gamefish populations appear to be at acceptable levels. Abundance, size structure and growth indices for most major gamefish species were average to above average. Largemouth bass, the dominant predatory gamefish, exhibited above average abundance, size, and growth. Northern pike abundance was at low levels and may be indicative of poor spawning habitat and low recruitment (i.e. number of fish reaching spawning age). Sensitive area designations to protect emergent and shallow submergent vegetation would be of major importance for this species. Walleye abundance was also low but at acceptable levels considering the type of spawning and juvenile rearing habitat in the Waupaca Chain. Walleye are stocked on an annual basis to maintain this fishery. Panfish, especially the sunfish species, were found in good abundance. Growth rates were slightly below regional averages but at acceptable levels. Due to the high amount of development within the Waupaca Chain, maintenance of shallow (0-5 ft) submergent vegetation would be particularly important to maintain habitat for juvenile panfish and gamefish species.

One of the more unique fisheries of this waterbody is the coldwater species including cisco or lake herring (*Coregonus artedii*) and brown trout. Both species require cold water temperatures – preferably below 65 F, and oxygen concentrations above 3 or 4 ppm (Becker, 1983).

Cisco populations are rare in Central Wisconsin lakes but tend to exhibit above-average abundance in the Waupaca Chain. They are important prey species for brown trout, northern

pike, and walleye. They are also good indicators of environmental stressors to water quality (e.g. lake eutrophication, thermal pollution).

Brown trout, a naturalized exotic, provides an important sport fishery in the Waupaca Chain O' Lakes. Of particular interest is the unique life history of this population where adults reside in the lake and make spawning migrations up coldwater tributaries of the chain. DNR studies (Niebur, 1995) of this fishery were conducted during 1993-1995 and documented brown trout spawning migrations up the Emmons Creek, a Class I tributary to Long Lake. A weir placed approximately 1.4 miles upstream of the confluence captured several hundred mature adults with an average length of 18.0 inches with some adults exceeding 30 inches. A rotary screw fish trap (device designed to catch downstream migrations of fish in streams and rivers) was placed near the confluence of the Emmons Creek and Long Lake and showed significant out-migrations of brown trout yearling and juvenile age fish during April – June time period. There are few lakes in Wisconsin that support natural populations of trout and care should be taken to preserve this unique fishery.

The greatest threats to cisco and trout are increased eutrophication and thermal impacts. These impacts would most likely occur in the summer when depletion of oxygen in the hypoliminion and/or thermocline would force cisco and trout into the epilimnion where temperatures and oxygen levels are unfavorable for survival. If these fish were forced into these areas for prolonged periods it could result in significant mortality (i.e. summerkill). No summerkills of cisco have been documented for the Chain O' Lakes, however, in other area lakes (e.g. Gilbert Lake, Waushara County) significant summerkills have greatly reduced or even eliminated cisco populations (DNR file, 1978).

The banded killifish was found in very low abundance and although it is a special concern species, its lack of abundance may not necessarily indicate any special habitat concerns. It is typically sampled on sandy and sparsely vegetated sites.

The greater redhorse, a state threatened species, was also found in low abundance. This species is more of a riverine species not commonly found in lake environments. Surveys conducted by DNR (Piette 2006) in the Crystal River (outlet river from Long Lake) showed a remnant population in good abundance. Most likely the redhorse that inhabit the Chain O' Lakes are migrants from the Crystal River and could possibly be using the lakes as overwinter habitat with a small number residing year round.

Management Recommendations

Some land and water uses conflict with maintaining habitat quality in lakes and streams. It is important to discourage these activities and encourage beneficial practices in areas that a partially sensitive or critical to the health of the lake or stream. We recommend the following practices for all SAD's and PRF's on the Waupaca Chain O' Lakes. Management recommendations that are specific to a particular area can be found following that area's description. The WDNR, Waupaca County, and the lake association and district, other non-

governmental organizations and concerned citizens can work together to implement these management recommendations.

- Limit the removal of native plants by physical, mechanical, or chemical means.
- Protect the natural character of the shoreline. Limit the installation of shore erosion control to only those areas that clearly exhibit erosion. Install bio-engineering where appropriate instead of placing rock riprap.
- Control numbers and sizes (surface area) of structures placed below the ordinary high watermark and within the near shore littoral zone habitat.
- Monitor exotics and manage them when discovered.
- Leave woody debris along the shoreline. If woody debris is a navigational hazard, relocate it to improve habitat elsewhere.
- Encourage shoreline restoration projects along the perimeter of the lake.
- Continue to monitor boat landings for invasive species and educate boaters through Clean Boats Clean Waters program.
- Development should be limited or done with the goal to minimize disturbance to the highest degree practicable.
- Minimize disturbance to bottom sediments. Disturbances such as dredging should be intensively reviewed. For some areas, it may be appropriate to limit boating activities to "slow no wake" speed or non-motorized boats only. Management Recommendations

There are many issues concerning dredging projects that must be addressed through the permit process. First, is the physical action of the dredging itself. Depending on the equipment and access to the site, the logistics can be very difficult. Regardless of whether or not it is hydraulically dredged or a drag line is used to scoop the material out, the resulting action can remove or kill individuals in the location of the dredging and it destroys the existing fish and wildlife habitat in the short term and can lead to an overall loss of usable habitat in the long term. Several fish species utilize this shallow water area for foraging, feeding, loafing as well as many turtles, kingfishers, shorebirds and waterfowl which use the existing coarse woody debris as sunning and loafing areas as well. The submerged substrate (sand, gravel, woody debris) provides a surface on which we see a lot of production of inverts as well as periphyton growth - both major food sources for fish and wildlife. In addition, largemouth bass and other panfish utilize this area for spawning activity in the spring.

Next, are the secondary impacts as a result of the dredging. Resuspension of bed material can lead to sedimentation and siltation. In some cases, existing habitat can be covered as a result of this action (ie. spawning areas and food production). Some of this bed load has the potential to contain toxicants such as heavy metals or other toxicants which were bio-unavailable before the dredging but have become available either in the water column or through bed exposure. In order to prepare for this, any dredging project is required to collect sediment samples for contaminant testing prior to applying for a permit. This testing can be very expensive and if toxicants are noted, the bed material may be treated as a hazardous waste for disposal or the dewatering process (elutriate) may have to be tested as well.

Other secondary impacts resulting from large scale dredging is the potential for exotic invasive species to take over the disturbed area. Otter Lake has a highly diverse plant community and the

introduction of exotic invasive species would have an increased adverse environmental impact on the plant community.

Methods

Aquatic plant surveys were conducted in August 2005 using the Wisconsin Department of Natural Resources Aquatic Plant Survey guidelines. The guideline use a point intercept mapping method. The purpose of the plant survey was to identify areas that have unique characteristics based on the aquatic plant community, along with fish and wildlife usage.

Sensitive Area Designations were identified using the point intercept method and applying best professional judgment. These areas were mapped using a Trimble GeoXM GPS unit. Critical Habitats vary greatly from one water body to another. Aquatic vegetation that is important to the Waupaca Chain O' Lakes may not be critical to another water body with more nutrients.

A Floristic Quality Index (FQI) was created for individual large lakes. Some data from closely spaced small lakes were combined to form one FQI. FQIs give us an objective, standardized way of assessing habitat quality. The higher the FQI, the less disturbed the habitat. Species have been given a predetermined number on a scale of 1 to 10 called the coefficient of conservatisim (C). A species such as Coontail (*Ceratophyllum demersum*) that tolerates most disturbances is assigned a value of 3, whereas a species that tolerates little disturbance such as Wild Calla (*Calla palustris*) is given a 9. Although a species may receive a low rating it may still have excellent fish or wildlife values and a species with a high rating may have low wildlife and fish values due to its scarcity. The mean C is multiplied by the square root of the total number of species at the sight to give us the FQI. FQIs for all lakes can be found in figure 1.

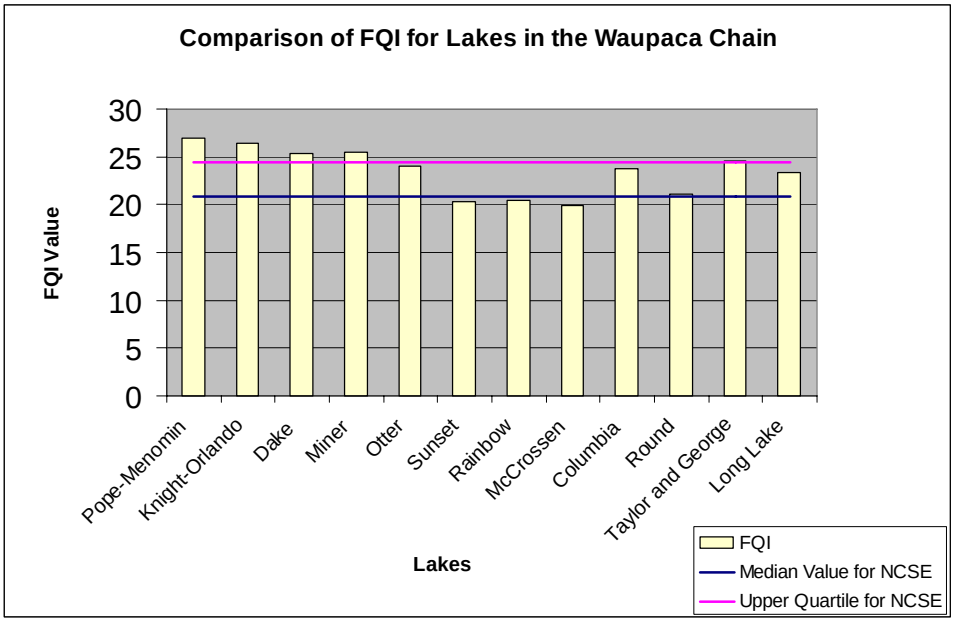


Figure 1. Floristic Quality Indices for Lakes of the Waupaca Chain and how they compare to the region.

Critical Habitats

Columbia Lake Sensitive Area Designation (CL 1) 9.32 acres

Figure 2. Columbia Lake CHD

Columbia Lake is 81-acres located on the Waupaca Chain O' Lakes near Waupaca, Wisconsin (Figure 2). The maximum depth is 72 feet with an average depth of 25 feet. Columbia Lake is one of the larger lakes of the Chain. It is connected to Lime Kiln Lake to the east and Long Lake to the west. One public access boat ramp exists on the east side. Columbia Lake is one of the four lakes that have speeds in excess of no wake.

Primary reasons for site selection were fishery values, wildlife values, and water quality protection and aesthetic qualities. The presence of the bulrush bed with a diverse stand of vegetation is a rare occurrence on the Chain. This location is bisected by a slow no-wake navigation channel. Excess speeds in the area could result in a loss of this critical habitat.

This SAD encompasses the mouth of Columbia Lake before discharging to Long Lake. It begins on the east side of the peninsula and proceeds out into the lake in an easterly direction to capture the bulrush bed. Then runs to the south shoreline where it meets the undisturbed portion of the shore, continuing to the apex of the south peninsula. The SAD meshes with a SAD in Long Lake. Near shore aquatic vegetation is mainly submergent species consisting of Musk Grass (*Chara spp.*), Illinois Pondweed (*Potamogeton illinoensis*) and Sago Pondweed (*Stuckenia pectinata*). Floating leaf species consisted of White Water Lily (*Nymphaea odorata*) and Floating-leaf Pondweed (*Potamogeton natans*). Emergent species consist of Bulrushes (*Schoenoplectus spp.*) and Cattails (*Typha spp.*). Swamp Loosestrife (*Decodon verticillatus*) was found along the south shore line of the SAD.

In addition to the SAD, Columbia Lake has the potential to restore portions of the littoral zone in the sunken islands near the southeast side of the lake. The lighter areas on the aerial photograph show the locations. By limiting wave action directly on the island more prime habitat could be

gained. Just like other lakes of the Chain, any littoral area is essential for this lake if it is to function and thrive properly. Protecting the island from wave action could enhance and/or increase the littoral area of the lake. Columbia Lake is a popular boating lake and as a result there is a lot of disturbance to plant communities from props and wave action. Maintaining the habitat that is left is very important.

Management Recommendation:

- Continue Slow-No-Wake restriction in the navigational channel and atop of sunken islands

Dake Lake Sensitive Area Designation (DK 1) 1.96 acres

Figure 3. Dake Lake CHD

Dake Lake is a 32-acre lake connected to Miner Lake of the Waupaca Chain. The maximum depth is 26 feet and the average depth is 10 feet. The relatively larger area of shallow water is not common to lakes on the Chain. Dake Lake is connected to the Chain via an excavated channel to Columbia Lake, thus leaving it somewhat isolated from the Chain. One public access boat ramp exists on the south west side. Dake Lake has a No-Wake Speed restriction.

One sensitive area was selected because it contains critical or unique habitat that would benefit from additional protection. Near shore aquatic vegetation is very diverse, and is mainly comprised of floating leaf species like White Water lily (*Nymphaea odorata*) and submergent vegetation mainly composed of Muskgrasses (*Chara spp*.), Water Celery (*Vallisneria Americana*) and many Pondweeds (*Potamogeton spp*.).

George Lake Sensitive Area Designation (GL 1) 5.65 acres

Figure 4. George Lake and Government Island CHDs

George Lake is a 5-acre lake connected to Taylor and Rainbow Lakes of the Waupaca Chain (Figure 4). The maximum depth is 30 feet and the average depth is 10 feet. Government Island Williams Island (aka Williams Island) borders the lake on the west and north while the Kings Veteran Home borders the lake to the east where the only development occurs.

High value aquatic plants are found in this area, specifically emergent species, and they buffer waves from transient boating. Lake George receives a great deal of boating pressure as boats of all sizes pass through traveling between Taylor and Rainbow Lakes. A portion of the Veteran home frontage is developed with large areas of lawn and several piers. No public access is directly available to George Lake other than by way of water. George Lake has a no-wake boating restriction.

The entire lake is designated as a sensitive area because it holistically contains critical or unique habitat. Primary reasons for site selection were fishery values, wildlife values, water quality protection and aesthetic qualities. The sheltered area between the lakes provides rest and relaxation for people (including residents of the Veteran's Home) and wildlife. This area has a diverse aquatic plant community that provides important habitat for fish and wildlife. The protected nature of Lake George allows for extensive growth of shoreline emergent vegetation that is not seen on many other areas of the chain. It is common to see great blue herons stalking prey in this area along with various species of waterfowl. The woody debris that is exposed provides roosting and hunting area for birds as well as basking areas for reptiles and amphibians. During the blooming of the lilies this site is very colorful and adds a great deal of beauty to the lake and the Chain.

Government Island Public Rights Feature (GI 1) 9.58 acres

General Information:
Government Island (aka Williams Island) is owned by the Wisconsin Veterans' Home, and is surrounded by Taylor, Rainbow, Sunset, and George Lakes of the Waupaca Chain. The island is an obvious physical feature and is a landmark well known by people in the area. Many people use the south island shore as a recreational area. This area abuts the George Lake Sensitive Area on the east side of the island, contributing to the uniqueness of George Lake. It is immediately south of the major boat landings of the Chain, providing a thoroughfare for boaters, including two large paddle-wheel tourist boats. Along the west shore traveling south, a gravelly sand shore provides spawning habitat for many species of fish. Traveling south, rocks start to appear, giving way to areas of large boulders not found elsewhere on the Chain.

There is no development on the island. The landscape is wooded and secluded as access is limited. The island forested with a variety of species, ages and sizes. The unbroken shoreline that tapers into a well vegetated aquatic ecosystem is perfect habitat for wildlife and fish on the Chain. Many fallen trees act as bridges from the aquatic to the terrestrial world. Indeed, the island serves as a reserve for many species of plants and wildlife.

The four major qualities that designate this area as a Public Rights Feature are described as follows:

1. *Fish and wildlife habitat, including specific sites necessary for breeding, nesting, nursery and feeding*. Government Island provides undeveloped shoreline coupled with undeveloped forested uplands that are not commonly seen on the Chain O' Lakes. This area provides habitat for a wide variety of aquatic and forest wildlife species. The well vegetated shoreline gives reptiles, amphibians, water birds and water dwelling mammals a safe haven in an aquatic system that has been highly impacted by human development. An outbreak of oak wilt on the island will provide dead snags and den trees for cavity nesting birds and wildlife for the foreseeable future. Given the relatively undisturbed nature of the island it provides an opportunity for a variety of raptors, including ospreys and eagles, to establish nesting sites. The island setting may also provide some protection to ground nesting birds from predators which may be more abundant on the mainland.

2. *Physical features of lakes that ensure protection of water quality*. Government Island serves several major purposes to protect water quality. Most notably is the fact that it buffers wind and boat generated waves from Rainbow Lake, creating the calm waters of George Lake as well as protecting Taylor Lake. Government Island has a rich emergent shoreline around most of the island. The emergent vegetation helps attenuate nutrients that could otherwise increase algae concentration.

3. *Reaches of bank, shore or bed that are predominately natural in appearance.* The entire Island is undeveloped with no obvious man-made structures. It provides a visual barrier to developed shorelines on Rainbow and Taylor Lake respective of location.

4. *Navigation thoroughfares or areas traditionally used for navigation during recreational boating, angling, hunting or enjoyment of natural scenic beauty.* There are two main thoroughfares around the island. There is a corridor between Rainbow and Taylor through George Lake which is widely traveled daily. A restaurant and marina on Taylor Lake is a major hub that people reach via this corridor. The second main corridor on the north side is equally travelled but also has a tour boat lane. One of the largest and busiest boat landings of the Chain is located here also. Both corridors have No-Wake Speed Restrictions that are critical to protect against erosion.

Management Recommendation:

- Some of the developed shoreline, associated with the Veterans' Home, could be restored to native plant communities while still allowing for free access to the lake.
- Monitor to prevent inappropriate use by people recreating off the surrounding lakes.
- Continue Slow-No-Wake restriction
- Any timber harvesting on the island should employ BMP's
- Maintain habitat suitable for eagle and osprey nesting sites
- Complete Threatened and Endangered Species Inventory on the Island

Lime Kiln Lake Sensitive Area Designation LKL 1 and LKL 2

Figure 5. Lime Kiln Lake CHD.

Lime Kiln Lake is a 14-acre lake located between Round and Columbia Lakes (Figure 5). The Maximum depth is 46 feet and the average depth is 10 feet. The lake has a no-wake speed restriction. Floating leaf and submergent vegetation are very common in the littoral zone of the lake where piers do not impede growth. Areas in the north and west part of the lake hold the majority of vegetation because of the shallow depth and lack of disturbances from boating. The abundant vegetation of this area, specifically the floating leaf species, buffers waves generated from boaters. The south and east side of Lime Kiln Lake is the deepest and serves as a major travel corridor for boaters. Fortunately the boating corridor is located in deeper water so that

damage to aquatic plants from boat motor props is not a major concern. However, the remaining areas of the lake, especially those in the SAD, are extremely vulnerable to disturbances due to the shallow water and marl-covered bottom.

Lime Kiln Lake sensitive area designation (LKL 1): .20 acres

This site begins at the north side of the channel and proceeds up the north shore as indicated in figure 5. A shoreline restoration project was completed here in 2005, which contains many high value wetlands species. Near shore, aquatic vegetation is mainly submergent composed primarily of Muskgrasses (*Chara spp*.) and Illinois Pondweed (*Potamogeton illinoensis*). The mix of shoreline vegetation transitioning into a submergent plant community adds great resource value and provides a good buffer from runoff, especially from the nearby road.

Primary reasons for site selection were fishery values, wildlife values, water quality protection and aesthetic qualities. A vigorous stand of vegetation contributes greatly to the reduction of erosion from wave action thereby protecting water quality. The aquatic vegetation provides excellent habitat for the production of macroinvertebrates (aquatic insects), which is an essential part of the food chain. Some macroinvertebrates depend on overhanging vegetation for parts of their lifecycle, which the restored shore provides.

Lime Kiln Lake sensitive area designation 2 (LKL 2): 3.34 acres

This site begins at the north side of the lake, proceeds along the east shore encompassing the large shallow area as shown in Figure 5. The area has a robust stand of Floating-leaf Pondweed (*Potamogeton natans*) mixed with other pondweeds and Water Celery (*Vallisneria americana*). Habitat values could be improved by augmenting bulrush stands in the shallowest areas near mid lake.

Primary reasons for site selection were fishery and wildlife values. This quite spot is a popular area for anglers and wildlife.

Management Recommendation:

- Continue Slow-No-Wake restriction
- Augment bulrush stands in shallow areas

Long Lake Sensitive Area Designations (LL 1-5)

Figure 6. Long Lake CHDs

Long Lake encompasses 104-acres and is the second deepest lake of the Chain (Figure 6). The maximum depth is 76 feet with an average depth of 30 feet. Long Lake is the second largest lake of the Chain. It is connected to Columbia, Bass and Beasely Lakes with Emmons Creek flowing into the lake. Long Lake is also the origin of Waupaca County's popular river, the Crystal River. There is no direct public access to the lake other than via water. Long Lake is the last of the lakes of the Chain that have speeds in excess of no wake.

Like other lakes in the Chain, Long Lake has limited littoral zone habitat. Protecting the remaining natural areas is essential for the well-being of the Lake and to preserve the unique character of the Chain. Five locations exhibit high quality species and are unique relative to other areas of Long Lake. Two of the five areas are set apart due to their association with a riverine system. The other three CHD's have quality habitat largely due to the fact that there is limited nearby development.

Long Lake sensitive area designation 1 (LL 1) 6.90 acres:

This encompasses the southern most shoreline of Long Lake, including the outlet to the Crystal River. It begins on the east side and wraps along the southern shoreline to north of the outlet. Most of the area is undeveloped due to wetland conditions and a large tract of private ownership. The owners of this parcel have demonstrated unwavering stewardship and kept the area in a natural state adding a great deal of habitat value and aesthetics to the area. The forested wetlands transition to a diverse stand of native aquatic plants from the shore outward into the lake. The plant bed provides shelter and a food source for fish and wildlife. Near shore aquatic vegetation is mainly submergent species with species such as Muskgrass (*Chara spp*.), Large-leaf Pondweed (*Potamogeton amplifolius*) and Bushy Pondweed (*Najas flexilis*). Floating leaf species consisted of White Water Lily (*Nymphaea odorata*) and Floating-leaf Pondweed

(*Potamogeton natans*). Emergent species consist of Bulrushes (*Schoenoplectus spp*.) are present but are only found in isolated areas

Primary reasons for site selection were fishery values, wildlife values, water quality protection and aesthetic qualities. Minimal disturbance to the shoreline and the unique characteristics of the outlet are the main reasons this site has the qualities to be considered a SAD. The broad area allows connectivity of the terrestrial to the aquatic world, which in turns creates habitat for a wide range of plant and animal species. This relatively undeveloped shoreline allows reptiles and amphibians unrestricted use of the land and water. The overhanging vegetation also provides excellent habitat for the production of macroinvertebrates (aquatic insects), which is an essential part of the food chain. This area provides habitat for a wide variety of bird species and offers undisturbed nesting sites not available at other sites on the Chain. The bulrush bed acts as spawning media for Yellow Perch and Northern Pike and provides a food source and habitat for wildlife.

This area receives excess wave energy as boaters make their turns to head back north. Keeping motorboats in deeper water (>8 feet) and allowing more distance from shore while making turns would help prevent erosion. Due to the well-rooted natural shoreline, erosion has been minimal. However, continual wave energy in the future may lead to further erosion and a loss of this critical habitat. The recreational area near the outlet has generated many complaints mainly due to littering and human waste. Litter decreases the natural beauty of this area. Enforcement of existing laws should help control this factor.

Management Recommendation:

- Enforce current littering ordinances in the recreational area.
- Create a Slow-No-Wake restriction that exceeds current statute through a town ordinance. Consideration should be given to depth as well as distance from shore.

Long Lake Sensitive Area Designation2 (LL 2) 1.67 acres:

Site 2 is composed of the Emmons Creek outlet to Long Lake found along the west side of the Lake (Figure 6). The creek acts like a freshwater estuary where riverine and lacustrine ecosystems mesh together. This unique trait is rare on the Chain, but the reason for SAD selection is much more elaborate than that. Areas such as this can be thought of as a gateway for fish and wildlife to travel from one area to another. This is a somewhat secluded area, which allows unhindered natural movement of fish and animals. Indeed, many predators travel the corridor for the same reasons. Areas like this are important to species like river otter and mink as they move through the environment following stream corridors into the lakes. Freshwater estuaries like the Emmons Creek outlet also have great diversity due to the transition of habitat types. The greater diversity creates a very rich and complex ecosystem that can serve many niches.

Like LL 1, most of the area is undeveloped due to wetland conditions and a large tract of private ownership. The forested wetlands transition to a diverse stand of native aquatic plants along the shore.

Primary reasons for site selection were fishery values, wildlife values and water quality protection. The secluded setting also adds a great deal of value to this area.

Management Recommendation:

- Exotics should be monitored and managed when discovered
- Do not remove native plants by physical, mechanical, or chemical means
- This area should not have any bank armor such as riprap; only biologically engineered practices should be considered.
- Enforce current littering ordinances in the recreational area.
- Encourage shoreline restoration projects along the perimeter of the lake.
- Monitor and appropriately control invasive species found here.
- Control numbers and sizes (surface area) of structures placed below the ordinary high watermark and within the near shore littoral zone habitat.

Long Lake Sensitive Area Designation (LL 3) 3.29 acres:

The eastern bay makes up this SAD (Figure 6). It begins at the entrance of the bay and encompasses the entire area. The bay is similar to a separate smaller lake like George Lake. With a small littoral zone that quickly drops to a depth of greater than 30 feet, the bay certainly mirrors the smaller lakes of the Chain. What is most unique about this shoreline is the presence of emergent species such as Swamp Loosestrife (*Decodon verticillatus*) and Blue Flag Iris (*Iris versicolor*) – one of the few locations with Iris on the entire Chain. Steep forested shorelines transition to wetlands on the south side of the bay and a diverse stand of native aquatic plants that ring the perimeter of the bay. Near shore aquatic vegetation is mainly submergent species with species such as Muskgrass (*Chara spp*.), Large-leaf Pondweed (*Potamogeton amplifolius*) and Northern Watermilfoil (*Myriophyllum sibiricum*). Floating leaf species consists of White Water Lily (*Nymphaea odorata*). Other emergent species consist of Arrowhead (*Sagittaria spp*.).

Primary reasons for site selection were fishery values, wildlife values and aesthetic qualities. The minimal disturbance to the shoreline and the unique characteristics of the outlet are the main reasons this site has the qualities to be considered a SAD.

Management Recommendation:

- Enforce Slow-No-Wake restriction

Long Lake Sensitive Area Designation (LL 5) 9.32 acres:

This is the largest SAD on Long Lake. It includes the connection to Columbia Lake and southward to the shallow area containing a large bulrush bed (Figure 6). The area serves many important functions to the lake that include: spawning area for pike and panfish, food and habitat for wildlife, and a healthy plant bed to absorb nutrients and buffer wave energy. The shoreline has development, but overall is relatively undisturbed. Emergent shoreline vegetation transitions into a Chara bed intermingled with some Bulrushes. Near shore aquatic vegetation is mainly submergent species with species such as Muskgrass (*Chara spp*.) with some sporadic occurrences of Illinois Pondweed (*Potamogeton illinoensis*) and Water Celery (*Vallisneria americana*). The most dominant emergent species consists of Bulrushes (*Schoenoplectus spp*.).

Primary reasons for site selection were fishery values, wildlife values, and water quality protection. The stand of bulrushes that ultimately connects this area to the Columbia Lake SAD also contributes to this designation. The area is another example of connectivity from one lake to another and an important transition from pelagic (deep water) to littoral (shallow water) habitats.

This area receives excess wave energy as boating activities are concentrated here. Waves are also capable of scouring the shallow areas where boaters make their turns to head south. Keeping motorboats in relatively deep water (>8 feet) and allowing more distance from the shore and bulrush beds will help prevent erosion. This area should be monitored as continual wave energy may lead to further erosion and a loss of this critical habitat.

Management Recommendation:

- Create a Slow-No-Wake restriction that exceeds current statute through a town ordinance, which considers depth as well as distance from shore.
- Monitor bulrush beds for changes in distribution and density.

Long Lake Sensitive Area Designation 4 (LL 4) 5.66 acres:

This particular SAD covers the northwest shoreline and along the point into Beasley Lake (Figure 6). The point is undeveloped and comprised of forested wetlands that transition into a diverse stand of shoreline emergent plants. Near shore aquatic vegetation is mainly submergent species with species such as Muskgrass (*Chara spp*.), Common Water Weed (*Elodea canadensis*) and Coontail (*Ceratophyllum demersum*). Floating-leaf Pondweed (*Potamogeton natans*) and Spatterdock (*Nuphar variegata*) comprise most of the floating leaf species. Emergent species consist of Swamp Loosestrife (*Decadon verticillatus*), Arrowhead species (*Sagittaria spp*.) and Bulrushes (*Schoenoplectus spp*.). The inlet of Beasely Lake has a very diverse submergent aquatic plant bed that harbors a large number of fish, visible at any time.

Primary reasons for site selection were fishery values, wildlife values, water quality protection and aesthetic qualities. The minimal disturbance to the shoreline and the unique characteristics of the submergent species found in the inlet to Beasely Lake are the main reasons this site was selected. Like other inlet/outlets the area allows connectivity of one water body to another. The overhanging vegetation along the shoreline also provides excellent habitat for the production of macroinvertebrates and nesting sites for waterfowl and shorebirds.

Miner Lake Sensitive Area Designation (ML 1) 0.68 acres

Figure 7. Miner Lake CHD.

Miner Lake is a 35-acre lake connected to Dake Lake of the Waupaca Chain (Figure 7). Maximum depth is 52 feet and the average depth is 24 feet. Miner Lake is connected to the Chain by a small natural opening to Dake Lake. Due to Miner Lake's location it is somewhat isolated from the rest of the Chain. One public access boat ramp exists on the west side. Miner Lake has a No-Wake Speed restriction.

The Sensitive Area Designation:
One sensitive area was selected because it contains critical or unique habitat that would benefit from additional protection.

This site, ML 1, begins on the south side of the peninsula and proceeds towards the apex along the north shore (Figure 7). Near shore aquatic vegetation is mainly White Water lily (*Nymphaea odorata*) and submergent vegetation is composed mainly of Muskgrasses (*Chara spp*.) and Water Celery *(Vallisneria Americana*). Large white pines dot the shoreline with some leaning over the lake. Submerged wood is present in the plant bed adding more habitat values

Primary reasons for site selection were fishery values, wildlife values, water quality protection and aesthetic qualities. The presence of submerged wood with a diverse stand of vegetation contributes greatly to overall habitat value. This location is nestled into a shallow bay along the peninsula that provides a great resting area and is very aesthetically pleasing.

Management Recommendation:
- Continue Slow-No-Wake restriction

Otter Lake Sensitive Area Designation (OL 1)

Fig. 10 Otter Lake CHD

Sensitive Area Designation:

Otter Lake is a 14-acre lake located on the northeastern edge of the Waupaca Chain O' Lakes near Waupaca, Wisconsin (Figure 10). Maximum depth is 40 feet and the average depth is 14 feet. Otter Lake is connected to Sunset and Taylor lakes via a shallow channel, near the public boat landing. A diverse aquatic plant community occupies much of the littoral zone, bordered by a shoreline covered with shrubs and large trees. Fallen timber is common along the channel and other parts of the shoreline. This woody debris provides excellent habitat for both fish and wildlife

Plant survey results show a diverse native aquatic plant community (Appendix A). There were 17 species of plants found during the survey. Muskgrass (*Chara* spp.), Northern Watermilfoil (*Myriophyllum sibiricum*), White Water Lily (*Nymphaea odorata*) and Sago Pondweed (*Stuckenia pectinata*) were the most common species.

Due to the diversity of the aquatic plant community and the relative small size of the littoral zone, the entire shoreline including the channel has been designated a Sensitive Area. Otter Lake contains critical or unique habitat that benefits the entire Chain.

Primary reasons for site selection were fishery values, wildlife values, water quality protection and aesthetic qualities. This area has a diverse aquatic plant community that provides important habitat for wildlife and fish. This site also offers a physical buffer that protects water quality by anchoring and stabilizing sediments and protecting shorelines from wave erosion. During the blooming of the lilies this site is very colorful and adds a great deal of beauty to the lake.

Upper Chain Lakes

Bass Lake, Beasley, Knight, Manomin, Marl, Orlando, and Pope

Figure 11. Upper Chain CHD.

General Lake Information:

The Upper Chain is made up of several small lakes that have minor development and little human disturbance (Figure 11). These lakes are very aesthetically pleasing and well suited for quiet sports. The undisturbed nature of the Upper Chain Lakes also provides much needed fish and wildlife habitat and serves as a nursery for the entire area. All lakes of the Upper Chain have a Slow No-Wake Speed restriction.

The Upper Chain is the last remnant of what the entire chain most likely looked like prior to development. It is also a model for what riparian owners can reference for shoreline restoration projects. The stark difference between the Upper Chain lakes and the others is the relatively high frequency of emergent species such as bulrushes (*Schoenpletus spp.*) and Arrowheads (*Sagitaria spp.*) in the shallow areas and along the shorelines.

The Upper Chain has similarities to the remainder of the Chain. The lakes have generally steep contours, limited littoral zones and similar water quality. Due to the pristine nature of the Upper Chain, the entire area warrants a sensitive area designation.

Sensitive Area Designation

Primary reasons for site selection were fishery values, wildlife values, water quality protection and aesthetic qualities. The aquatic vegetation on these lakes is the most diverse of the entire

system (Appendix A). As a result, all of the above mentioned values are highest in the Upper Chain Lakes.

Management Recommendation:

- Development should be limited or done with the goal to minimize disturbance to the highest degree practicable
- Continue Slow-No-Wake restriction

Acknowledgements

The DNR would like to thank the Lake District and Lake Association for their support of the SAD concept and communication of through their members. Their passionate concern with past and current water quality issues has been an asset to the DNR and all concerned with water quality in the state. We would also like to thank landowners who promote natural shorelines and protect aquatic vegetation. With your help the Waupaca chain will maintain and improve its wildlife habitat, water quality and fisheries.

References

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

DNR File. Gilbert Lake Survey. 1978.

Niebur, Alan. 2000. Waupaca Chain of Lakes Comprehensive Survey, Summary Report. Wisconsin Department of Natural Resources, Wautoma.

Niebur, Alan. 1995. Waupaca Chain of Lakes and Emmons Creek Brown Trout Assessment. Wisconsin Department of Natural Resources, Wautoma.

Piette, Randal. 2006. Status and distribution of greater and river redhorse in the Waupaca River. Final Report. Wisconsin Department of Natural Resources. Oshkosh.

Appendix A

Water Body ID Code (WBIC), and current designations as Area of Special Natural Resource Interest (ASNRI) and Priority Navigable Waterway (PNW) and trout stream class. All ASNRI's are also considered PNR.

Water Body Name	WBIC	Other Designations	Trout Stream Class
Bass Lake	264200	PNW	
Beasley	262300	PNW	
Columbia Lake	262400	PNW	
Dake Lake	264700	PNW	
George Lake	265400	ASNRI	
Knight	262700	PNW	
Lime Kiln Lake	264900	ASNRI	
Long Lake	261200	ASNRI	
Manomin	262800	ASNRI	
Marl	264100	ASNRI	
Miner Lake	264800	PNW	
Orlando	262000	PNW	
Otter Lake	265700	PNW	
Pope	262900	ASNRI	
Rainbow Lake	265300	ASNRI	
Sunset Lake	265500	ASNRI	
Taylor Lake	265600	PNW	
Emmons Creek	261300	ASNRI	Class I
Crystal River	258200	ASNRI	Class II
Hartman Creek	263000	ASNRI	Class II

Appendix B
Lake Flora

Scientific Name	Common Name	Columbia	Dake	Long	Miner	Otter	Rainbow	Knight and Orlando	Round and Lime Kiln	Pope and Monomin	Taylor and George	Marl
Ceratophyllum demersum	Coontail			P	P	P	P	P		P		
Chara sp.	Muskgrass species	P	P	P	P	P	P	P	P	P	P	P
Decodon verticillatus	Swamp loosestrife	P	P	P				P		P		
Elodea canadensis	Common waterweed	P	P	P	P	P	P	P		P		
Heteranthera dubia	Water star-grass		P		P	P		P				
Lemna minor	Small duckweed			P						P		
Myriophyllum sibiricum	Northern water milfoil	P	P	P	P	P		P	P	P	P	P
Myriophyllum spicatum	Eurasian water milfoil	P	P	P			P	P	P		P	
Myriophyllum verticillatum	Whorled water milfoil									P		
Najas flexilis	Bushy pondweed	P	P	P	P	P	P	P	P	P	P	P
Najas gracillima	Northern naiad				P							
Nitella sp.	Nitella species		P	P	P				P	P		
Nuphar variegata	Spatterdock			P		P		P	P	P	P	
Nymphaea odorata	White water lily	P	P	P	P	P	P	P	P	P	P	P
Polygonum amphibium	Water smartweed										P	
Potamogeton amplifolius[1]	Large-leaf pondweed	P	P	P			P	P	P		P	
Potamogeton crispus	Curly-leaf pondweed			P				P		P	P	
Potamogeton epihydrus	Ribbon-leaf pondweed										P	
Potamogeton foliosus	Leafy pondweed		P									
Potamogeton gramineus	Variable pondweed	P	P	P	P	P	P	P	P		P	
Potamogeton illinoensis	Illinois pondweed	P	P		P	P	P	P	P	P	P	P
Potamogeton natans	Floating-leaf pondweed	P	P						P	P		P
Potamogeton nodosus	Long-leaf pondweed			P								
Potamogeton richardsonii[1]	Clasping-leaf pondweed	P	P		P	P	P	P	P	P	P	P
Potamogeton sp. unknown	Unknown pondweed			P								
Potamogeton zosteriformis	Flat-stem pondweed	P	P		P	P	P	P		P	P	
Ranunculus aquatilis	Stiff water crowfoot					P		P				
Sagitaria Sp. Unkown	Unknown Arrowhead							P				
Sagittaria cuneata	Arum-leaved arrowhead									P		
Sagittaria graminea	Grass-leaved arrowhead	P	P				P	P			P	
Sagittaria latifolia	Common arrowhead		P			P	P		P	P	P	

Schoenoplectus acutus[1]	Hardstem bulrush	P						P		P		P
Schoenoplectus pungens[1]	Three-square									P		
Schoenoplectus tabernaemontani[1]	Softstem bulrush			P						P		
Stuckenia pectinata	Sago pondweed	P	P	P	P	P	P	P	P	P	P	
Typha latifolia	Broad-leaved cattail	P	P					P		P	P	
Utricularia vulgaris	Common Bladderwort					P						
Vallisneria americana[1]	Wild celery	P	P	P	P	P	P	P	P	P	P	P
	Filamentous algae			P								P
	Moss		P		P							

[1] species listed as high value under NR 107.08(4)