

Delavan Lake (Walworth County, Wisconsin) Integrated Sensitive Area Report

Assessment Dates: June 23, 2005 - Areas 1-3
July 8, 2005 – Areas 1 - 2
July 27, 2005 - Areas 4-5

Number of Sensitive Areas Surveyed: 5

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General Lake Information

Delavan Lake is located in the city and town of Delavan in Walworth County. The lake is fed and drained by Jackson Creek, a tributary of Turtle Creek that drains to the Lower Rock River. A dam at the lake's outlet is used to control water levels. The lake has a surface area of approximately 2,072 acres, a maximum depth of about 56 feet, a volume of approximately 44,800 acre-feet, and a mean depth of about 21 feet. (SEWRPC 2002) Delavan Lake has a shoreline length of about 13 miles, which is almost entirely developed for residential uses with the exception of a few wetland areas, most of which are discussed in this report.

Delavan Lake has a watershed (drainage area) of about 26,000 acres or 40.8 square miles. As of 1995, approximately 85 percent of the watershed consisted of rural land uses, and 15 percent of urban land uses. Major land uses included: 70 percent agriculture, 8 percent woodlands, wetlands or open lands, 7 percent residential, and 8 percent commercial, industrial, transportation, and recreational. Under planned 2020 conditions, the Walworth County development plan and regional land use plan forecast 6200 acres (24 percent of total area) of development within the watershed. (SEWRPC 2002)

In 1989 a major restoration project was begun on Delavan Lake to fix the severely deteriorated lake ecosystem. The lake was temporarily lowered 10 feet and a complete

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fishery eradication was conducted. Modifications were made at the dam, an in-lake barrier was constructed to allow for short-circuiting of lake inflows, and a sediment control channel was built at the inlet. Sediments in the deeper portions of the lake received an alum treatment, and numerous non-point source pollution controls were conducted in the watershed. The lake's fishery was then restocked and previously farmed wetlands were reestablished. As one of the largest lake restoration projects in North America, this project has given Delavan Lake international attention in the area of lake rehabilitation. The Delavan Lake project was awarded Wisconsin's top prize for lake stewardship, and the North American Lake Management Society's 1991 Technical Excellence Award in recognition of outstanding efforts in lake restoration, protection, and management. (SEWRPC 2002)

Due to restoration efforts, Delavan Lake now has multiple recreational uses including the seasonal activities of fishing, water skiing, swimming, small craft sailing, ice fishing, cross-country skiing, ice-skating, and hunting. The lake also provides natural scenic beauty throughout the year, and opportunities for walking, jogging, bird watching, and picnicking.

Delavan Lake supports a moderately diverse fish population. Wisconsin Department of Natural Resources fish surveys conducted between 1990 and 1999 reported the presence of 16 fish species including: Walleyed pike, yellow perch, northern pike, muskellunge, largemouth bass, smallmouth bass, bluegill, pumpkinseed, green sunfish, black crappie, rock bass, black bullhead, white sucker, mimic shiner, fathead minnow, and common carp.

Exotic Species

Exotic species, most notably zebra mussels, Eurasian watermilfoil, and purple loosestrife have invaded southeastern Wisconsin lakes. Boaters traveling from lake to lake often facilitate the propagation of exotic species. The introduction of exotic species into a lake ecosystem can lead to a decline in the native plant population and cause problems with nutrient loading. In addition, the disturbance of lake bottoms from human activity (boating, plant harvesting, chemical treatments, etc.) enhances the colonization and/or expansion of exotic species. Two simple steps to prevent the spread of exotic species include 1) Removing aquatic plants, animals, and mud from trailers and boats before leaving the boat access; and 2) Draining water from boats, motors, bilges, live wells, and bait containers before leaving the water access.

Eurasian watermilfoil can be found in four of the sensitive areas on Delavan Lake. Eurasian watermilfoil is one of eight milfoil species currently found in Wisconsin. It is often misidentified as one of its seven native cousins, and vice versa. In many areas within the lake, this non-native milfoil has established large monocultures and has out competed many native plants. These dense beds of milfoil not only impede the growth of native plant species but also inhibit fish movement and create navigational problems for boaters.

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The regenerative ability of Eurasian watermilfoil is another obstacle when attempting to control this species. Fragments of Eurasian watermilfoil detached by harvesting, boating, and other recreational activities can float to non-colonized areas of the lake or downstream to additional lakes in the drainage system and create new colonies. Therefore, when controlling Eurasian watermilfoil, selective chemicals and harvesting, coupled with skimming, often produces the best results. In some lakes, biological agents such as the milfoil weevil have helped suppress milfoil populations. However, the most effective “treatment” of exotic milfoil is prevention through public education.

Curly-leaf pondweed is another submerged, exotic species found in Delavan Lake. Like Eurasian watermilfoil, curly-leaf often grows into large, homogenous stands. It can crowd out native vegetation, create navigational problems, and limit fish movement. Curly-leaf pondweed dies off in mid-summer, increasing nutrient availability in the water column. This often contributes to summer algal blooms and decreasing water quality.

The unusual life cycle of curly-leaf pondweed makes management difficult. The plant germinates as temperatures decrease in fall. Curly-leaf is highly tolerant of cold temperatures and reduced sunlight, continuing to grow under lake ice and snow cover. With ice-off and increasing water temperatures in the spring, the plant produces fruit, flowers, and buds (turions). Turions are the main reproductive mechanism of curly-leaf. To control the species in lakes, the plant must be combated before turions become viable. Most plant harvesters have not started cutting when curly-leaf is most susceptible and a small window of opportunity exists for chemical treatment. Therefore, prevention through public education is once again very important.

Purple loosestrife, a hardy perennial native to Europe, is another exotic species common to Wisconsin. Since its introduction to North America in the early 1800s, purple loosestrife has become common in gardens and wetlands, and around lakes, rivers, and roadways. The species is highly invasive and thrives in disturbed areas. Purple loosestrife plants often out compete native plants, resulting in the destruction of food, cover, and nesting sites for wildlife and fish.

Purple loosestrife most often spreads when seeds adhere to animals. Humans should be aware of picking up seeds on clothing and equipment when in the vicinity of the plant. Loosestrife can be controlled manually, biologically, or with a broad-leaf herbicide. Young plants can be pulled, but adult plants have large root structures and must be excavated with a garden fork. Biological control is most effective on large stands of purple loosestrife. Five different insects are known to feed on this plant. Four of those have been used as control agents in the United States. Of the five species, *Galerucella pusilla* and *G. calmariensis* are leaf-eating beetles; *Nanophyes brevis* and *N. marmoratus* are flower-eating beetles; and *Hylobius transversovittatus* is a root-boring weevil. Only *N. brevis* has not been released in the United States (WDNR 2003). Lastly

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and most importantly, prevention through public education plays an important role in the management of this species.

Shoreland Management

Wisconsin's Shoreland Management Program, a partnership between state and local governments, works to protect clean water, habitat for fish and wildlife, and natural scenic beauty. The program establishes minimum standards for lot sizes, structural setbacks, shoreland buffers, vegetation removal, and other activities within the shoreland zone. The shoreland zone includes land within 1000 feet of lakes, 300 feet of rivers, and floodplains. Current research shows that present standards are probably inadequate for the protection of water resources (Woodford and Meyer 2003, Garn 2002). Therefore, many communities have chosen to go beyond minimum standards to ensure protection of our natural resources. This report provides management guidelines for activities within the lake and in the immediate shoreland areas. Before any recommendations in this report are completed, please check with the Department of Natural Resources and local units of government for required approvals.

A vital step in protecting our water resources is to maintain effective vegetative buffers. A shoreland buffer should extend from the water onto the land at least 35 to 50 feet. Studies have shown that buffers less than 35 feet are not effective in reducing nutrient loading. Wider buffers of 50 feet or more can help provide important wildlife habitat for songbirds, turtles, frogs, and other animals, as well as filter pollutants from runoff. In general, no mowing should occur in the buffer area, except perhaps in a viewing access corridor. The plant composition of a buffer should match the flora found in natural Wisconsin lakeshores. A buffer should include three layers - herbaceous, shrub, and tree.

In addition, citizens living on Delavan Lake and the community at large should investigate other innovative ways to reduce the impacts of runoff flowing into the lake while improving critical shoreline habitat (Greene 2003). This may include the use of phosphorus-free fertilizers, installing rain gardens, setting the lawnmower at a higher mower height, decreasing the area of impervious surfaces, or restoring aquatic plant communities.

Introduction

Department personnel conducted Delavan Lake sensitive area designation surveys on June 23, 2005, July 8, 2005 and July 27, 2005, following the Wisconsin Department of Natural Resources' sensitive area survey protocol. This study utilized an integrated team of DNR resource managers with input from multiple disciplines: water regulation, fisheries, lake biology, and wildlife. Kevin MacKinnon from the Delavan Lake Sanitary District accompanied DNR staff on June 23, 2005 and July 27, 2005. A bird list was compiled for the inlet area on July 8, 2005 by Jim Jackley and Jenny Herrmann (DNR

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wildlife). The wildlife biologist and wildlife technician canoed the inlet from 5:20 AM to 7:00 AM that morning.

Sensitive areas are defined in Wisconsin Administrative Code NR 107.05 (3)(i)(1) as *areas of aquatic vegetation identified by the department as offering critical or unique fish and wildlife habitat, including seasonal or life stage requirements, or offering water quality or erosion control benefits to the body of water*. Department resource managers determined that five areas on Delavan Lake met this definition.

Overview of Sensitive Area Designations

Sensitive areas often have aquatic or wetland vegetation, terrestrial vegetation, gravel or rubble lake substrate, or areas that contain large woody cover (fallen trees or logs). These areas provide water quality benefits to the lake, reduce shoreline erosion, and provide habitat necessary for seasonal and/or life stage requirements of fish, invertebrates, and wildlife. A designated sensitive area alerts interested parties (i.e., DNR personnel, county zoning personnel, lake associations, lake districts, towns, etc.) that the area contains critical habitat vital to sustaining a healthy lake ecosystem, or may feature an endangered plant or animal. Information presented in a sensitive area report may discourage certain permits from being approved within these sites.

Whole Lake Recommendations:

Several recommendations from Department staff pertain to Delavan Lake as a whole rather than to individual sensitive areas:

1. The aquatic plant community in Delavan Lake is not highly diverse outside of the sensitive areas. Native aquatic plant beds should be protected and maintained.
2. Prevent the spread of exotic species through sign postings, education, etc. and control exotic species where established. Post “Exotics Alert” sign at boat landing. (Already Present)
3. Comply with state and local shoreland zoning standards by maintaining no-cut buffers and setbacks, removing non-conforming structures, and limiting impervious surfaces.
4. Create shoreland buffers and maintain existing buffers, especially in areas not currently developed.
5. Continue to monitor water quality for early detection of changes and possible degradation. This monitoring has been conducted since 1983 by the United States Geological Survey and the Delavan Lake Sanitary District.
6. Implement recommendations of the SEWRPC (Southeastern Wisconsin Regional Planning Commission) lake management plan.

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Resource Value of Sensitive Area Site 1 – Delavan Lake

Sensitive Area 1 is located in the upper inlet of Delavan Lake (see Map 1). The inlet is part of Delavan Lake, but is also considered by many as a part of Jackson Creek. This sensitive area, with its rich ecological diversity, serves as 1) a nutrient buffer reducing algae blooms; 2) a biological buffer reducing the likelihood of exotic invasions; 3) a physical buffer against shoreline erosion; 4) a micro-habitat increasing biodiversity, and 5) allows for sediment stabilization. The entire inlet area is classified as Class I or Class II Wildlife Habitat Areas by the Southeastern Regional Planning Commission (SEWRPC 2002, page 124). See Appendix 1 for a complete list of aquatic plants found in sensitive areas of Delavan Lake, and Appendix 2 for fish information.

The substrate (lake bottom) in Sensitive Area 1 consists primarily of muck but also contains some silt and detritus. The water depth ranges between 1 and 1.75 ft with sensitive area habitat located along the shoreline, near-shore terrestrial, and littoral zones (i.e. the entire upper portion of the inlet is sensitive). The shoreland buffer in this sensitive area is made up of approximately 90 percent wetland and 10 percent wooded area. The wetland consists of deep marsh, shallow marsh, and sedge meadow. Large woody cover is present at the rate of approximately 1-2 pieces per 30-meter width of shoreline. Herbaceous plants are dominant, covering 76-100 percent of the buffer zone, while shrubs are present covering 1-25 percent of the buffer zone, and trees are common covering 26-50 percent of the buffer zone. This area has unique aesthetics and has undergone very little human influence or shoreline development; therefore the natural scenic beauty (NSB) rating of this sensitive area is outstanding.

The extensive development of Delavan Lake has reduced available wildlife habitat. However, this portion of the lake provides excellent shelter, nesting areas, and feeding areas for upland wildlife, muskrat, mink, geese, song birds, bitterns, rails, black terns, foresters terns, yellow headed blackbirds, frogs, toads, turtles, and snakes for the majority of the year. Emergent vegetation is the most important habitat component of this site. Table 1 displays all plants found in the sensitive area and their level of abundance.

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Table 1. Plants observed in Sensitive Area 1.

	Emergent	Submergent	Free-floating	Exotic
PRESENT (0-25% Cover)	<i>Scirpus</i> (bulrush) <i>Carex</i> (sedges) Calamagrostis (Can. BJ) Sparganium (bur reed) Verbena (blue vervain) Asclepias (marsh milkweed) Salix (willow) Sagittaria (arrowhead)	<i>Ceratophyllum</i> (coontail)	Filamentous (algae)	<i>Myriophyllum</i> <i>spicatum</i> (Eurasian watermilfoil) <i>P. crispus</i> (curly-leaf pondweed)
COMMON (26-50% Cover)	Cornus (dogwood)		<i>Lemna</i> (duckweed) <i>Wolffia</i> (watermeal)	
ABUNDANT (51-75% Cover)		<i>Potamogeton</i> nodosus (long leaf pondweed)		
DOMINANT (76-100% Cover)	<i>Typha</i> (cattail)	<i>Potamogeton</i> <i>pectinatus</i> (sago pondweed)		

Many wildlife species were personally observed by the site evaluators during the sensitive area survey. Dozens of leopard and green frogs were leaping out of the water. Hundreds of damselflies were flying around and sitting on aquatic plant vegetation. Damselflies are an important food source for many fish and wildlife species. Birds observed on the afternoon of June 23, 2005 include forester terns (2 adults and 2 juveniles), great blue herons (2), green herons, black terns (2), and red wing blackbirds. Forester terns are a state listed endangered species.

Great blue herons often congregate in this sensitive area. During a boat count conducted on August 3, 2005, between 100 and 150 great blue herons were observed (Kevin MacKinnon, personal observation). The trees behind the wetland areas in this sensitive area may potentially provide a heron rookery.

A large amount of plant biomass was present in this sensitive area. However, the water was often quite turbid. Bays and lakes that have a large amount of plants typically exhibit clear water. The turbidity in the water is likely caused by carp. Several dozen carp were observed in Sensitive Area # 1.

Management Recommendations for Sensitive Area #1

1. Attempt the planting of wild rice to help with nutrient management and sediment loading. Wild rice is also a good source of food for wildlife.
2. No alteration of the littoral zone unless to improve spawning habitat.

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3. Create a seasonal fish refuge area by not allowing motorized boats in the spring during fish spawning.
4. Maintain the current level of snags, cavity trees, perch trees, shrub and herbaceous cover, as well as aquatic vegetation.
5. Increase wildlife corridor by purchasing farmland in the watershed and turning it into grassland. This action will also reduce runoff into Jackson Creek and its tributaries.
6. A no wake zone is strongly recommended for this area (currently in place) to protect emergent aquatic vegetation. No aquatic plant removal should be allowed.
7. Boardwalks will be allowed on a case by case basis to provide open water access only for a riparian landowner. Watercraft moored at the boardwalk must be able to navigate the water without any additional dredging. The number of moorings allowed will be less than “reasonable use” as defined by state law.
8. Do not remove fallen trees along shoreline, except where navigation is impaired. If navigation is impaired by a fallen tree, cut into smaller pieces and place outside of boating lane.
9. Recommendations regarding **local and county zoning**:
 - Strictly enforce shoreland and wetland ordinances
 - New development should comply with the Walworth County Land Use Plan and the Town of Delavan master plan.
 - Require a buffer/”no touch” zone for grading projects. This buffer/”no touch” zone should be at least 100 feet from the edge of the wetland back into the (landward) upland portion of parcels.
 - Require a buffer/”no touch” zone for grading projects located along steep slopes. The zone should extend at least 100 feet from the edge of a steep slope towards the landward side of the parcel.
 - Grading proposals should be strictly examined for superior erosion control and nutrient management plans.
10. A DNR permit should not be issued for any of the following:

Dredging	Pea gravel/sand blankets
Filling of wetlands	Rip Rap
Aquatic plant screens	New Piers *
Boat Ramps	Sea Walls/Retaining Walls
Recreational floating devices	

*Boardwalks only. See Recommendation # 7.

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11. No chemical treatment allowed except to target an infestation of an exotic species such as purple loosestrife, eurasian watermilfoil or curly leaf pondweed. Biological controls such as the purple loosestrife beetle and the milfoil weevil should be considered where appropriate.
12. No mechanical harvesting should be conducted in this sensitive area.

In summary, the ecological community of Sensitive Area 1 has distinctly unique features when compared to the waterbody as a whole. This site provides a visual and audible buffer from shoreline structures, roads, and boat traffic. Aquatic plants in the sensitive area include emergents, algae, potamogetons, exotics, free floating, floating leaf and submergents. Wet edge plants include herbs, sedges, shrubs, and grasses. Game fish and forage fish are present in the sensitive area, and bass and pike use the area for spawning. **The undeveloped shoreline is extremely valuable for wildlife.** Wildlife present in the sensitive area include furbearers, songbirds, swallows, waterfowl, shore birds, and amphibians. State listed special concern species present within this site include black terns and least bitterns. This site could be used to educate citizens about wetlands and sensitive areas.

Resource Value of Sensitive Area Site 2 – Delavan Lake

Sensitive area 2 in the lower inlet of Delavan Lake serves as a fish and wildlife refuge and has diverse aquatic vegetation, terrestrial vegetation and wildlife populations. The site acts as a nutrient buffer reducing algae blooms, a biological buffer reducing the likelihood of exotic invasions, a physical buffer against shoreline erosion, a micro-habitat increasing biodiversity, and allows for sediment stabilization. See Appendix 1 for a complete list of aquatic plants found in sensitive areas of Delavan Lake, and Appendix 2 for fish information.

The average water depth in Sensitive Area 2 is between one and two feet. The sensitive area habitat includes near-shore terrestrial, shoreline, and littoral zones. The bottom substrate consists of silt, clay, muck and detritus. The heavy plant cover shaded the water below, causing the temperature of the water at 2 feet to be approximately 10 - 15 degrees Fahrenheit cooler than the water at the surface.

The shoreland buffer consists of approximately 70 percent wetland and 30 percent wooded area. The wetland consists of deep marsh, shallow marsh, and shrub carr. Large woody cover is present at the rate of approximately 1-2 pieces every 30 meters of shoreline. Herbaceous plants are dominant, covering 76-100 percent of the buffer zone, while shrubs and trees are common covering 26-50 percent of the buffer zone. This area has unique aesthetics and has undergone no human influence, therefore the natural scenic beauty rating (NSB) of this area is outstanding. The developed shoreline in the lower inlet is excluded from the sensitive area designation.

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The extensive development of Delavan Lake has reduced available wildlife habitat. However, this portion of the lake provides suitable shelter, nesting area, and feeding area for upland wildlife, beaver, muskrat, mink, duck, goose, songbird, tern, yellow headed blackbird, frogs, toads, several species of turtle, and snakes. Emergent vegetation and snag trees are the most important habitat components at this site. Table 2 displays all plants found in the sensitive area and their level of abundance.

Table 2. Plants observed in Sensitive Area 2.

	Emergent	Submergent	Free-floating	Exotic
PRESENT (0-25% Cover)	Calamagrostis (Can. BG) Scirpus (bulrush) Carex (sedges) Juncus (rush) Iris (yellow) Asclepias (marsh milkweed) Eupatorium (joe pye weed) Salix (willow) Cornus (dogwood) Sagittaria (arrowhead) Sparganium (bur reed) Eupatorium (boneset)	Potamogeton nodosus (longleaf pondweed) Ceratophyllum (coontail) Elodea (waterweed) Ranunculus trichophyllus (water crow foot)		Potamogeton crispus (Curly leaf pondweed)
COMMON (26-50% Cover)		Potamogeton pectinatus (sago pondweed)	Filamentous (algae)	
ABUNDANT (51-75% Cover)			Lemna (duckweed) Wolffia (watermeal)	
DOMINANT (76-100% Cover)	Typha (cattail)	P. zosteriformis (flat-stemmed pondweed) Myriophyllum sibiricum (northern watermilfoil)		Myriophyllum spicatum (Eurasian watermilfoil)

Management Recommendations for Sensitive Area # 2

1. No alteration of the littoral zone unless to improve spawning habitat.
2. A no wake zone is strongly recommended for this area (currently in place) to protect emergent aquatic vegetation.
3. Create a seasonal fish refuge area by not allowing motorized boats in the spring during fish spawning.

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4. Harvest exotic species (mainly curly leaf pondweed and Eurasian water milfoil) on the western edge of the sensitive area to improve habitat and improve the boat access lane.
5. A DNR permit should not be issued for any of the following:

Dredging	Pea gravel/sand blankets
Filling of wetlands	Rip Rap
Aquatic plant screens	Recreational floating devices
Boat Ramps	Sea Walls/Retaining Walls
6. Boardwalks and piers will be allowed on a case by case basis to provide open water access only for a riparian landowner. Watercraft moored at the boardwalk or pier must be able to navigate the water without any additional dredging. The number of moorings allowed will be less than “reasonable use” as defined by state law.
7. No chemical treatment allowed except to target an infestation of an exotic species such as purple loosestrife, eurasian watermilfoil or curly leaf pondweed. Biological controls such as the purple loosestrife beetle and the milfoil weevil should be considered where appropriate.
8. Maintain the current level of snags, cavity trees, perch trees, shrub and herbaceous cover, as well as aquatic vegetation.
9. Increase wildlife corridor by purchasing farmland in the watershed and turning it into grassland. This action will also reduce runoff into Jackson Creek and its tributaries.
10. Do not remove fallen trees along shoreline, except where navigation is impaired. If navigation is impaired by a fallen tree, cut into smaller pieces and place outside of boating lane.
11. Recommendations regarding **local and county zoning**:
 - Strictly enforce shoreland and wetland ordinances
 - New development should comply with the Walworth County Land Use Plan and the Town of Delavan master plan.
 - Require a buffer/”no touch” zone for grading projects. This buffer/”no touch” zone should be at least 100 feet from the edge of the wetland back into the (landward) upland portion of parcels.
 - Require a buffer/”no touch” zone for grading projects located along steep slopes. The zone should extend at least 100 feet from the edge of a steep slope towards the landward side of the parcel.
 - Grading proposals should be strictly examined for superior erosion control and nutrient management plans.

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In summary, the ecological community of Sensitive Area 2 has distinctly unique features when compared to the waterbody as a whole including its undeveloped shoreline. This site provides a visual buffer from shoreline structures. Aquatic plants in the sensitive area include emergents, algae, potamogetons, exotics, free floating, floating leaf, and submergents. Wet edge plants include herbs, sedges, rushes, shrubs, and grasses. Game fish, panfish, young of the year fry and forage fish are present in the sensitive area. Wildlife present include furbearers, waterfowl, shore birds (including wood ducks and brood), amphibians, and reptiles. **The undeveloped shoreline is extremely valuable for wildlife.** This site could be used to educate citizens about wetlands and sensitive areas, possibly by canoe.

On July 8, 2005, a Department wildlife biologist and wildlife technician conducted a bird survey of the Delavan Lake inlet which is made up of Sensitive Areas 1 and 2. A canoe was used to conduct the bird survey which begun at 5:20 am at the Mound Road crossing of the inlet. The survey ended at 7 AM at the public boat launch.

The following species were seen or heard in the northern section of the inlet between 5:20 and 5:50 am: green heron (2), great blue heron (2), song sparrow (2), swamp sparrow (6), red-winged blackbird (17), common yellowthroat (6), wood duck (3 adults with 5 young), marsh wren (12), bank swallow (14), barn swallow (3).

The following species were seen or heard in the middle section of the inlet between 5:50 and 6:15 am: swamp sparrow (2), red-winged blackbird (4), marsh wren (13), song sparrow (1), common yellowthroat (2), killdeer (1), semi-palmated plover (2), sand hill crane (2), willow flycatcher (1), blue jay (2), American robin (1), American gold finch (1).

The following species were seen or heard in the south end of the inlet between 6:15 and 7:00am: killdeer (1), wood duck (9 adults 33 young), least bittern (3 adults, 1 young), marsh wren (17), common yellowthroat (10), green heron (1), yellow warbler (1), yellow headed blackbird (12), ring-billed gull (5), black tern (2).

Resource Value of Sensitive Area Site 3 – Delavan Lake

Sensitive Area 3 in Lake Lawn Bay of Delavan Lake serves as a fish and wildlife refuge and has a diverse wildlife population. The area acts as a nutrient buffer to reduce algae blooms, a biological buffer reducing the likelihood of exotic invasions, a physical buffer against shoreline erosion, a micro-habitat that increases biodiversity, and allows

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for sediment stabilization. See Appendix 1 for a complete list of aquatic plants found in sensitive areas of Delavan Lake, and Appendix 2 for fish information.

The average water depth in Sensitive Area 3 is about two feet. The sensitive area habitat includes the near-shore terrestrial land, shoreline, and littoral zones. The bottom substrate consists primarily of sand and gravel. The shoreland buffer consists of approximately 50 percent wetland and 50 percent wooded area. Herbaceous plants are dominant, covering 76-100 percent of the buffer zone, while shrubs and trees are common covering 26-50 percent of the buffer zone. The wetland consists of shallow marsh, deep marsh, and shrub carr. Willow and ash trees along with dogwood shrubs are common along the shore. Silver maple was also noted. Large woody cover is present at the rate of approximately 1-2 pieces every 30 meters of shoreline. This area has undergone minimal human influence, therefore the natural scenic beauty (NSB) of this area is considered to be average.

This area is an important fish nursery. The sand and gravel substrate provide spawning habitat for bass, bluegill, pumpkinseed and crappie. Northern pike, musky and yellow perch deposit eggs on the chara and other available submergent vegetation. Walleye deposit their eggs on the rock and gravel. Young of the year of all of the fish species mentioned utilize the area for feeding and shelter.

The extensive development of Delavan Lake has reduced available wildlife habitat. However, this portion of the lake provides suitable shelter, nesting area, and feeding area for muskrat, mink, duck, goose, songbird, osprey, frogs, toads, several species of turtle, and snakes. A painted turtle was observed during the survey conducted on June 23, 2005. This small area provides habitat for many species and provides an important shelter away from active boating and shoreline development. Emergent vegetation and snag trees are the most important habitat components at this site. Table 3 displays all plants found in the sensitive area and their level of abundance.

Table 3. Plants observed in Sensitive Area 3.

	Emergents	Submergents	Exotics	Algae
PRESENT (0-25% Cover)	Polygonum (smartweed)	<i>Potamogeton pectinatus</i> (sago pondweed)	<i>P. crispus</i> (curly-leaf pondweed)	
COMMON (26-50% Cover)	Salix (willow) Cornus (dogwood)			Chara (muskgrass)
ABUNDANT (51-75% Cover)				
DOMINANT (76-100% Cover)	<i>Typha</i> (cattail)			

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Management Recommendations for Sensitive Area # 3

1. Maintain the current level of snags, cavity trees, perch trees, shrub and herbaceous cover, as well as aquatic vegetation.
2. Do not remove fallen trees along shoreline, except where navigation is impaired. If navigation is impaired by a fallen tree, cut into smaller pieces and place outside of boating lane.
3. No alteration of the littoral zone unless to improve spawning habitat.
4. A no wake zone is strongly recommended for this area (currently in place) to protect emergent aquatic vegetation.
5. Create a seasonal fish refuge area by not allowing motorized boats in the spring during fish spawning.
6. No chemical treatment allowed except to target an infestation of an exotic species such as purple loosestrife, eurasian watermilfoil or curly leaf pondweed. Biological controls such as the purple loosestrife beetle and the milfoil weevil should be considered where appropriate.
7. No mechanical harvesting should be conducted.
8. A DNR permit should not be issued for any of the following:

Dredging	Pea gravel/sand blankets
Filling of wetlands	Rip Rap
Aquatic plant screens	Recreational floating devices
Boat Ramps	Sea Walls/Retaining Walls
9. Boardwalks and piers will be allowed on a case by case basis to provide open water access only for a riparian landowner. Watercraft moored at the boardwalk or pier must be able to navigate the water without any additional dredging. The number of moorings allowed will be less than “reasonable use” as defined by state law.

In summary, Sensitive Area # 3 is very important as a refuge for fish and wildlife, away from active boating lanes. Important habitat components at this site include gravel bottom, submerged vegetation, and over-hanging vegetation. This area offers a spawning area, nursery area, feeding area, and protective cover to walleye, northern pike, musky, small mouth bass, large mouth bass, centrarchid, perch, sucker, and minnows. Many bird species utilize the complex of trees and shrubs and would not be present on Delavan Lake without this refuge.

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Resource Value of Sensitive Area Site 4 – Delavan Lake

Sensitive Area 4, located in Highland’s Bay of Delavan Lake, serves as an important fish nursery and has a diverse wildlife population. The area also acts as a physical buffer against shoreline erosion. See Appendix 1 for a complete list of aquatic plants found in sensitive areas of Delavan Lake, and Appendix 2 for fish information.

The average water depth in sensitive area 4 is between four and five feet. Sediment depth is 1.5 to 2 feet. The sensitive area habitat includes near-shore terrestrial, shoreline, and littoral zones. The shoreland buffer zone consists of approximately 40 percent wetland, 50 percent wooded area, and 10 percent developed land. Herbaceous plants and trees are abundant, covering 51-75 percent of the shoreland buffer zone, while shrubs and lawns are present covering 1-25 percent of the shoreland buffer zone. The wetland consists of deep marsh and shrub carr. Large woody cover is present at the rate of approximately 1-2 pieces every 30 meters of shoreline. 90 percent of this sensitive area has undergone minimal human influence, having a natural scenic beauty (NSB) rating of good, while the remaining 10 percent has undergone human disturbance, and has an NSB rating of average.

The extensive development of Delavan Lake has reduced available wildlife habitat. However, this portion of the lake provides suitable shelter, nesting area, and feeding area for frogs and toads. Ducks and turtles use this area for shelter, cover and feeding. Important habitat components at this location include emergent vegetation, submergent vegetation, floating leaf vegetation, shrubs, brush and snag trees. Table 4 displays all plants found in the Sensitive Area and their level of abundance.

Table 4. Plants observed in Sensitive Area 4.

	Emergents	Submergents	Floating Leaf	Free-floating
PRESENT (0-25% Cover)		<i>Ranunculus trichophyllus</i> (water crow foot) <i>Vallisneria</i> (wild celery) <i>Myriophyllum sibiricum</i> (northern watermilfoil)		<i>Spirodela</i> (large duckweed)
COMMON (26-50% Cover)	<i>Salix</i> (willow)	<i>Ceratophyllum</i> (coontail)		
ABUNDANT (51-75% Cover)		<i>Stuckenia pectinata</i> (sago pondweed)	<i>Nymphaea odorata</i> (white water lily)	<i>Wolffia</i> (watermeal)
DOMINANT (76-100% Cover)	<i>Typha</i> (cattail)	<i>Myriophyllum spicatum</i> (Eurasian watermilfoil)		Filamentous (algae)

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Management Recommendations for Sensitive Area # 4

1. Harvest cruising lanes for fish.
2. Harvest access lane for boats up to the edge of the cattails.
3. A no wake zone is strongly recommended for this area (currently in place) to protect emergent aquatic vegetation (especially water lilies).
4. Do not remove fallen trees along shoreline, except where navigation is impaired. If navigation is impaired by a fallen tree, cut into smaller pieces and place outside of boating lane.
5. No chemical treatment allowed except to target an infestation of an exotic species such as purple loosestrife, eurasian watermilfoil or curly leaf pondweed. Biological controls such as the purple loosestrife beetle and the milfoil weevil should be considered where appropriate.
6. A DNR permit should not be issued for any of the following along the undeveloped shoreline:

Dredging	Pea gravel/sand blankets
Filling of wetlands	Rip Rap
Aquatic plant screens	Recreational floating devices
Sea Walls/Retaining Walls	
7. New piers along the currently developed shoreline will be permitted. The number of moorings allowed will be equal to “reasonable use” as defined by state law.
8. Restrict pier, boardwalk and ramp construction along the currently undeveloped shoreline. If condos or a subdivision are built, a single shared boat ramp would be less destructive to the sensitive area than piers.
9. Sediment in this area is deep. This sensitive area is not a good place for humans to swim or wade. Homeowners should not expect a permit to be granted for dredging in order to create swimming areas.

In summary, this site provides a visual and audio buffer from shoreline structures, roads, and boat traffic. Aquatic plants in the sensitive area include emergents, algae, potamogetons, exotics, free floating, floating leaf, and submergents. Wet edge plants include herbs and shrubs. Game fish, panfish, and forage fish are present in the sensitive area. Wildlife species present include furbearers, song birds, waterfowl, shore birds,

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amphibians, and reptiles. This site could be used to educate citizens about wetlands and sensitive areas.

White water lilies patches are limited in number on Delavan Lake. The lily pads in this bay are important to the survival of many fish species. Walleye, northern pike, musky, small mouth bass, large mouth bass, centrarchid, perch, suckers, and minnows utilize this sensitive area for feeding, protective cover, and as a nursery. Additionally, northern pike, musky, perch, and minnows (various forage fish) will use this area for spawning.

Resource Value of Sensitive Area Site 5 – Delavan Lake

Sensitive Area 5, located along the View Crest and Ravenswood sections of Delavan Lake, serves as an important fish nursery, has a diverse wildlife population, aquatic vegetation, terrestrial vegetation, and provides natural scenic beauty. The area also acts as a physical buffer against shoreline erosion. See Appendix 1 for a complete list of aquatic plants found in sensitive areas of Delavan Lake, and Appendix 2 for fish information.

The average water depth in Sensitive Area 5 is approximately four feet. The sensitive area habitat includes near-shore terrestrial, shoreline, and littoral zones. The shoreland buffer zone consists of approximately 50 percent wetland, 40 percent wooded area, and 10 percent developed land. Herbaceous plants and trees are dominant, covering 76-100 percent of the shoreland buffer zone, while shrubs and lawns are present covering 1-25 percent of the shoreland buffer zone. The wetland consists of a deep marsh and shrub carr. Large woody cover is present at the rate of approximately 1-2 pieces every 30 meters of shoreline. A small part of this sensitive area has undergone human influence, having a natural scenic beauty (NSB) rating of average, while the remaining area has undergone minimal human disturbance, and has a good NSB rating.

Walleye, northern pike, musky, small mouth bass, large mouth bass, centrarchid (pan fish), perch, suckers, and minnows utilize this sensitive area for feeding, protective cover, and as a nursery. Additionally, northern pike, musky, perch, and minnows will use this area for spawning.

The extensive development of Delavan Lake has reduced available wildlife habitat. However, this portion of the lake provides suitable shelter, nesting area, and feeding area for muskrat, duck, songbirds, sandhill cranes (observed), kingbirds, kingfishers, frogs, toads, and turtles. Ducks and turtles use this area for shelter, cover and feeding. Emergent vegetation, floating leaf vegetation, shrubs, brush, and snag trees are important habitat components present at this location. Damselflies and dragonflies are abundant. Table 5 displays all plants found in the sensitive area and their level of abundance.

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<i>Table 5. Plants observed in Sensitive Area 5.</i>				
PRESENT (0-25% Cover)	Emergents <i>Eupatorium maculatum</i> (joe pye weed) <i>Phragmites australis</i> (giant reed grass)	Submergents <i>Myriophyllum sibiricum</i> (northern watermilfoil) <i>Stuckenia pectinata</i> (sago pondweed)	Free-floating <i>Wolffia</i> (watermeal) <i>Spirodela</i> (large duckweed) <i>Nymphaea odorata</i> (white water lily)	Algae
COMMON (26-50% Cover)	<i>Typha</i> (cattail)			
ABUNDANT (51-75% Cover)		<i>Ceratophyllum</i> (coontail)		
DOMINANT (76-100% Cover)		<i>Vallisneria</i> (wild celery)	Exotics <i>Myriophyllum spicatum</i> (Eurasian watermilfoil)	Filamentous (algae)

Management Recommendations for Sensitive Area # 5

1. Create a shoreline buffer along the developed shoreline using native plants. Biologs should be utilized where appropriate.
2. Protect and restore emergent aquatic plants.
3. Harvest cruising lanes for fish.
4. Harvest two access lanes for boats, one for the Ravenswood subdivision and one for the View Crest subdivision.
5. A no wake zone is strongly recommended for this area (currently in place) to protect emergent aquatic vegetation (especially water lilies).
6. Do not remove fallen trees along shoreline, except where navigation is impaired. If navigation is impaired by a fallen tree, cut into smaller pieces and place outside of boating lane.
7. No chemical treatment allowed except to target an infestation of an exotic species such as purple loosestrife, eurasian watermilfoil or curly leaf pondweed. Biological controls such as the purple loosestrife beetle and the milfoil weevil should be considered where appropriate.

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8. A DNR permit should not be issued for any of the following along the undeveloped shoreline:

Dredging	Pea gravel/sand blankets
Filling of wetlands	Rip Rap
Aquatic plant screens	Recreational floating devices
Sea Walls/Retaining Walls	

9. New piers along the currently developed shoreline will be permitted. The number of moorings allowed will be equal to “reasonable use” as defined by state law.
10. Restrict pier, boardwalk and ramp construction along the currently undeveloped shoreline. If condos or a subdivision are built, a single shared boat ramp would be less destructive to the sensitive area than piers.

In summary, the ecological community of Sensitive Area 5 provides a visual buffer from shoreline structures, roads, and boat traffic. Aquatic plants in the sensitive area include emergents, algae, potamogetons, exotics, free floating, floating leaf, and submergents. Wet edge plants include herbs and shrubs. Game fish, panfish, and forage fish are present in the sensitive area. Wildlife present in the area includes upland species, furbearers, songbirds, waterfowl / shore birds, amphibians, and reptiles. This site could be used to educate citizens about wetlands and sensitive areas.

Conclusion

Five sensitive areas have been designated on Delavan Lake, and development along the shoreline of each of the five sensitive areas should be carefully studied to prevent any further loss of habitat. This report identifies the biological components of each sensitive area, identifies sensitive area characteristics, and poses management recommendations for each of the five areas.

Wisconsin lakes attract many users, all of whom are affected by water quality. Delavan Lake attracts a diverse group of patrons, inevitably creating conflict between conservationists and recreational users. Therefore, the objective must be to create and maintain a balance between recreational use and preservation of habitat. This is essential to the lakes’ health. An integrated approach to lake management that includes the public and all of the lakes’ governing units will help to maintain this balance. Improving or at least maintaining water quality in Wisconsin lakes is critical. By protecting and restoring lake habitat, Delavan Lake will continue to sustain healthy ecosystems and responsible recreational opportunities for years to come.

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APPENDIX 1 - Aquatic plants within sensitive areas of Delavan Lake

Emergent	Area 1	Area 2	Area 3	Area 4	Area 5
Sparganium (bur reed)	X	X			
Zizania (wild rice)					
Typha (cattail)	X	X	X	X	X
Juncus (rush)		X			
Scirpus (bulrush)	X	X			
Eleocharis (spike-rush)					
Carex (sedges)	X				
Decodon (water-willow)					
Alisma (water plantain)					
Sagittaria (arrowhead)	X	X			
Acorus (sweet flag)					
Aster (aster)					
Thelypteris (marsh fern)					
Glyceria (mannagrass)					
Calamagrostis (Can. BG)	X	X			
Bidens (Beggar Tick)					
Lobelia (great blue)					
Iris (Blue Flag)		X			
Eupatorium (joe pye weed)		X			X
Eupatorium (boneset)		X			
Polygonum (smartweed)			X		
<i>Arundo</i> (giant reed)					X
Iris		X			
Mentha (mint)					
Asclepias (marsh milkweed)	X	X			
Verbena (blue vervain)	X				
Coreopsis (tick seed)					
Impatiens (jewelweed)					
Rumex (marsh dock)					
Cornus (dogwood)	X	X	X		
Salix (willow)	X	X	X	X	
Solidago (goldenrod)					

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Submergent	Area 1	Area 2	Area 3	Area 4	Area 5
<i>Myriophyllum sibiricum</i> (northern watermilfoil)		X		X	X
<i>Chara</i> (muskgrass)					
<i>Potamogeton amplifolius</i> (large-leaf pondweed)					
<i>Potamogeton nodosus</i> (longleaf pondweed)		X			
<i>Elodea</i> (waterweed)		X			
<i>Utricularia</i> (bladderwort)					
<i>Ceratophyllum</i> (coontail)	X	X		X	X
<i>Stuckenia pectinata</i> (sago pondweed)	X	X		X	X
<i>Ranunculus trichophyllus</i> (water crow foot)		X		X	
<i>Vallisneria</i> (wild celery)				X	
<i>P. zosteriformis</i> (flat-stemmed pondweed)		X			
<i>P. illinoensis</i> (Illinois pondweed)					
<i>Najas flexilis</i> (slender naiad)					
<i>P. praelongus</i> (white-stemmed pondweed)					
<i>P. richardsonii</i> (clasping-leaf pondweed)		X			

Free-floating					
<i>Nuphar advena</i> (yellow water lily)					
<i>Nymphaea odorata</i> (white water lily)				X	X
<i>Wolffia</i> (watermeal)	X	X		X	X
<i>P. natans</i> (floating-leaf pondweed)					
<i>Lemna</i> (duckweed)		X			
<i>Spirodela</i> (large duckweed)	X			X	X

Exotic					
<i>Myriophyllum spicatum</i> (Eurasian watermilfoil)	X	X		X	X
<i>P. crispus</i> (curly-leaf pondweed)	X		X		
<i>Lythrum</i> (purple loosestrife)					

Algae					
<i>Chara</i> (muskgrass) filamentous	X	X	X		X

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APPENDIX 2 – Fish Species in Delavan Lake Doug Welch, Fisheries Biologist

Walleyed pike, yellow perch, northern pike, muskellunge, largemouth bass, smallmouth bass, bluegill, pumpkinseed, green sunfish, black crappie, rock bass, black bullhead, white sucker, mimic shiner, fathead minnow, and common carp can all be found in Delavan Lake.

The shoreline of Delavan Lake is highly developed, and the sensitive areas give the fish population a natural area to sustain themselves. Walleye, northern pike, musky, smallmouth bass, largemouth bass, perch, suckers, and minnows use the sensitive areas on Delavan Lake as nurseries, feeding areas and for protective cover. The sensitive areas are also used by fish for spawning, especially the sensitive areas with sand and gravel bottoms.

The sand and gravel bottom of Sensitive Area 3 provides a spawning habitat for bass, bluegill, pumpkinseed, and crappie. Northern pike will deposit their eggs on the chara, and other submergent vegetation. Walleye will deposit their eggs on the rock and rubble. All the above mentioned fish use this site as a nursery and feeding area.

Lilly pads are limited on Delavan Lake. The lilly pads in Sensitive Area 4 (Highlands Bay) provide shade and cover habitat for many species of fish. Fish feed on invertebrates attached to lilly pads and submergent aquatic vegetation in this bay. The bay is used for feeding and protection and as a nursery by walleye, musky, bass, northern pike, bluegill, pumpkinseed, crappie, yellow perch, suckers, and minnows. This bay is used for spawning by northern pike, yellow perch, and various minnows.

Submergent and floating leaf aquatic vegetation in Sensitive Area 5 (Ravenswood and View Crest) provides spawning habitat for northern pike, musky, yellow perch, and minnows. Bass, bluegill, and pumpkinseed will construct nests in areas where silt is not too deep. Bass, bluegill pumpkinseed, yellow perch, crappie, walleye, northern pike, musky, and minnows use this site as a nursery and feeding area.