White Clay Lake Aquatic Plant Inventory

Town of Washington, Shawano County, Wisconsin

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Lumberjack RC&D Council
White Clay Lake Aquatic Plant Inventory

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Chapter 1

Introduction

Lake management is a process in which local municipalities, homeowners, citizen groups, and county, state, and federal agencies collaborate to develop a long-term protection and improvement strategy for a specific surface water resource. During the early stages of lake management planning, an inventory of the natural environmental setting and the human influences that affect the water quality is compiled. In later stages goals are defined and prioritized, and alternative restoration and protection methods are evaluated and eventually selected to reach those goals.

The White Clay Lake Aquatic Plant Inventory Study has been compiled as the initial component in the planning process for the aforementioned watershed. This report focuses on an aquatic vegetation inventory for both lakes. Data is reported within the document. A brief background on the other important geological and morphological characteristics of the lake is also presented to determine ecological appropriateness of the results.

Background and Study Area

Located in northeastern Shawano County, the Town of Washington is a community characterized by rural and lakeside nature, farmlands, open spaces, and a small community feeling. The Town’s fields, forests, streams, and lakes, provide an attractive setting for its residents and visitors.

The Town of Washington encompasses approximately 35 square miles. Dairy farming, beef livestock operations, and cash crops are the main agricultural activities in the area. White Clay Lake is one of several prominent lakes within the Wolf River drainage basin.

Surface Water Features

Surface water is one of the most important natural resources within a community. Lakes, rivers, and streams offer enjoyment, peace, and solitude. Surface waters provide recreational opportunities to anglers, boaters, hunters, water skiers, swimmers, sailors, and casual observers alike. Surface waters provide an end source for drainage after heavy rains, provide habitat for countless plants, fish, and animals, are a source of drinking water for many communities, and are a source of process water for industry and agriculture. Lands immediately adjacent to such waters have an abundance of cultural and archeological significance because they were often the location of Native American and early European settlements. For all these reasons and more, surface waters are typically the most important natural resource contained within a community.
Because of this importance, numerous federal, state, and local laws and regulations have been created to protect surface waters. They range from the commerce clause of the United States Constitution to county shore land and floodplain zoning regulations. The most heavily regulated waters are those that are determined to be natural and “navigable.” Using the direction provided in DeGayner v. DNR 70 Wis. 2d 936 (1975), a waterway within the State of Wisconsin is determined to be navigable in-fact if it is navigable by a canoe or skiff on a recurring bases (i.e. annually during freshets) and has a discernable bed and banks. The Wisconsin Department of Natural Resources (WDNR) determines whether or not a stream is navigable within the State of Wisconsin.

White Clay Lake

White Lake is a 234 spring-fed lake that is up to 46 feet in depth at its deepest point (Figure 1-2). The entire shoreline is buffered by a cattail marsh. Agricultural fields about the marsh around approximately 95 percent of the lake. A public boat landing is located on the southeast side of the lake along Lodge Road. The White Clay Lake Lodge provides a second private boat ramp access at the southern end of the lake. The White Clay Lake Lodge has several private docks, a bar and restaurant facilities, and campground with 45 seasonal and short-term sites.
White Clay Lake is a well-known year round recreational destination. According to the Wisconsin Lakes Book, the lake contains northern pike, largemouth bass, walleye, and pan fish. The lake receives high fishing pressure from ice fishing and throughout the summer months. Since the lake has nesting blue-winged teal and other waterfowl, it is a popular waterfowl hunting destination in the fall. The White Clay Lake Sportsman Club has been active since the 1970s and promotes these recreational activities. They hold an annual ice fishing tournament and actively stock fish.

The White Clay Lake Protection and Rehabilitation District was established in 1975. The district has worked with EPA, WDNR, SCS, and local government staff on the White Clay “Clean Lakes” Protection and Rehabilitation Project Watershed project. It was the first lake protection project under the new lake management program, and was also the first Lake District to attempt to address agriculturally related problems through upland treatment practices.
Chapter 2  
Aquatic Vegetation Survey

Introduction  
Aquatic vegetation is an important indicator in the overall health of a lake. Since phosphorous is the primary “food” source for plants, high nutrient concentrations can lead to an abundance of plant growth or algal blooms. In addition, the chemical parameters of a lake can limit what species of plants can grow.

Freshwater plant monitoring is completed by natural resource agencies to track aquatic plant community changes over time. In addition, these programs help identify whether invasive species have been introduced into a lake.

Invasive species are non-native plants that have been introduced to Wisconsin either accidentally or on purpose by humans. Many invasive plants were originally used in either the aquarium industry or landscaping. Invasive species typically originated in foreign countries. Once introduced, they live in an environment which lacks natural predators such as plant-eating insects or disease that normally keeps their growth in check. The lack of natural controls, combined with the plants high reproductive rates, allows the plants to thrive and out-compete desired native species.

Aquatic Vegetation Survey  
A point-intercept vegetation survey was completed for both White Clay Lake and White Lake. The survey for White Clay Lake was completed between July 12 and July 15, 2011. The survey was completed following the methodology described by Hauxwell et. al. (2010). Sample points were established across White Clay Lake by using a 50 meter by 50 meter grid. This resulted in a total of 381 sample points on White Clay as seen in Figure 2-1. Specific GPS coordinates for the points is located in Appendix 1.

A Garmin GPSMAP 60CX GPS unit was used to navigate the boat to each sample point. One side of the boat was designated as the sampling area. At each site, water depth was recorded using a measured weighted rope. A double-headed, weighted garden rake, attached to a rope was lowered into the water. At depths less than eight feet, the rake was spun in two complete circles to entwine plant material; at depths greater than eight feet, the rake was swung like a pendulum to tangle plant material. Sampling was completed to a depth at which no plants occurred. Emergent vegetation surrounding the lake not identified at the sampling points were noted and identified to species where possible. Sample points that fell on land or had dense stands of emergent vegetation were noted in the field and not included in the overall analysis.

All vegetation was identified to a species level where possible utilizing several dichotomous keys and references utilizing accepted standardized nomenclature (Crow and Hellquist, 2000; Skawinski, 2010; Vosters, 1972). When necessary, plants were identified to their genus.
Figure 2-1: White Clay Lake Point-Intercept Sampling Map

White Clay Lake
Shawano County
WBIC 326400
T27N R17E S22
236.5 acres / 95.7 ha
381 Sampling Points
50m between Points
Site 1: Lat. 44.80172157
Long. -88.41045072

Source: WDNR, 2011
Data was entered into an Excel spreadsheet and frequency of occurrence was calculated for each species as the number of sites in which a species occurred as a percentage of the total sites sampled. Water depths for each observed species were identified and distribution maps for each species were created.

Aquatic Vegetation

A total of 23 plant species were recorded by Shawano County staff in White Clay Lake. Of these, two species are classified as invasive species by the Wisconsin Department of Natural Resources. They are curly-leaf pondweed (*Potamogeton crispus*) and Eurasian water milfoil (*Myriophyllum sibiricum*). Descriptions of the species are located in following sections. The survey focused on in-lake vegetation, and the majority (57 percent) of the species found was submerged. A list of all vegetation is found in Table 2-1. The freshwater sponge was not determined to species.

### Table 2-1: White Clay Aquatic Vegetation Surveyed.

<table>
<thead>
<tr>
<th>Scientific Name</th>
<th>Common Name</th>
<th>Number of sites (visual and collected)</th>
<th>Relative Frequency (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carex comosa</td>
<td>Bottle Brush Sedge</td>
<td>2</td>
<td>0.7</td>
</tr>
<tr>
<td>Ceratophyllum demersum</td>
<td>Coontail</td>
<td>87</td>
<td>30.9</td>
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<tr>
<td>Chara spp.</td>
<td>Muskgrass</td>
<td>10</td>
<td>3.6</td>
</tr>
<tr>
<td>Cicuta bulbifera</td>
<td>Bulblet Water Hemlock</td>
<td>1</td>
<td>0.4</td>
</tr>
<tr>
<td>Elodea canadensis</td>
<td>Common waterweed</td>
<td>1</td>
<td>0.4</td>
</tr>
<tr>
<td>Lemna minor</td>
<td>Small duckweed</td>
<td>13</td>
<td>4.5</td>
</tr>
<tr>
<td>Lemna trisulca</td>
<td>Forked duckweed</td>
<td>13</td>
<td>4.5</td>
</tr>
<tr>
<td>Myriophyllum sibiricum</td>
<td>Northern water milfoil</td>
<td>3</td>
<td>1.1</td>
</tr>
<tr>
<td>Myriophyllum spicatum</td>
<td>Eurasian water milfoil</td>
<td>1</td>
<td>0.4</td>
</tr>
<tr>
<td>Nuphar variegata</td>
<td>Spatterdock</td>
<td>3</td>
<td>1.1</td>
</tr>
<tr>
<td>Nymphaea odorata</td>
<td>White water lily</td>
<td>30</td>
<td>10.8</td>
</tr>
<tr>
<td>Potamogeton crispus</td>
<td>Curly-leaf pondweed</td>
<td>29</td>
<td>10.5</td>
</tr>
<tr>
<td>Potamogeton richardsonii</td>
<td>Clasping-leaf pondweed</td>
<td>1</td>
<td>0.4</td>
</tr>
<tr>
<td>Potamogeton zosteriformis</td>
<td>Flat-stem pondweed</td>
<td>19</td>
<td>6.8</td>
</tr>
<tr>
<td>Schoenoplectus acutus</td>
<td>Hardstem bulrush</td>
<td>35</td>
<td>12.8</td>
</tr>
<tr>
<td>Spirodela polyrhiza</td>
<td>Large Duckweed</td>
<td>12</td>
<td>4.3</td>
</tr>
<tr>
<td>Stuckenia pectinata</td>
<td>Sago pondweed</td>
<td>68</td>
<td>23.7</td>
</tr>
<tr>
<td>Typha angustifolia</td>
<td>Narrow-leaved cattail</td>
<td>14</td>
<td>4.7</td>
</tr>
<tr>
<td>Typha latifolia</td>
<td>Broad-leaved cattail</td>
<td>12</td>
<td>4.3</td>
</tr>
<tr>
<td>Utricularia gibba</td>
<td>Creeping bladderwort</td>
<td>39</td>
<td>13.3</td>
</tr>
<tr>
<td>Utricularia vulgaris</td>
<td>Common Bladderwort</td>
<td>6</td>
<td>2.2</td>
</tr>
<tr>
<td>Vallisneria americana</td>
<td>Wild celery</td>
<td>1</td>
<td>0.4</td>
</tr>
</tbody>
</table>

Source: Shawano County, 2011.

The plant community within White Clay Lake is dominated by macrophytes. Macrophytes are large aquatic plants commonly referred to as “weeds,” “seaweed,” or “cabbage.” Although viewed as “weeds” and a nuisance by humans, macrophytes are essential in maintaining a
beneficial healthy lake ecosystem. Macrophytes provide cover for fish and food for aquatic invertebrates. They also produce oxygen which is essential for most aquatic life. A lack of macrophytes may indicate water quality problems such as excess water turbidity, high nutrient concentration, or herbicide pollutions. Below is a discussion of the macrophytes present in the lake.

Macrophytes were the most abundant plant type in White Clay Lake. Two of the most commonly observed macrophytes included were Coon’s tail (*Ceratophyllum demersum*) and Sago pondweed (*Stuckenia pectinatus*). They respectively had a relative frequency of 30.9 percent and 23.7 percent respectively. Relative frequency is a measure of how often a specific plant species was seen within the lake.

White Clay Lake has a diverse population of both emergent and floating plants. Emergent vegetation are rooted plants that grow to project above the water surface. Hard-stem bulrush (*Schoenoplectus acutus*) and narrow-leaf cattail (*Typha angustifolia*) were the two most common emergent plants located around the exterior of the lake. These species were respectively found at 12.8 percent and 4.7 percent of all site surveyed.

Floating vegetation has all or a significant portion of a plant that is located on the water surface. The most predominant floating plants included white water lilies (*Nymphaea odorata*) and duckweeds. Three duckweed species were present including small duckweed (*Lemna minor*), forked duckweed (*Lemna trisulca*), and large duckweed (*Spirodela polyrhiza*). White water lilies were found at 10.8 percent of the sampling sites. The three duckweeds were each found at approximately 5 percent of the sampling sites.

**Species Descriptions**

Wisconsin and White Clay Lake have a wide diversity of aquatic plants. A brief description of the major species surveyed in White Clay Lake follows. Plants are arranged in alphabetical order by common name with the submerged macrophytes followed by the emergent and floating species, respectively. Photographs are from the University of Wisconsin – Stevens Point Robert W. Freckmann Herbarium web site.

**Common Bladderwort** (*Ultricularia vulgaris*)

True free-floating bladderworts are annual plants that lack roots but have flowers on erect stems above the water. The entire floating plant is only about 8 inches long. Flowers emerge above the surface and are yellowish with 3-lobes and a spur underneath. Underwater the leaf branches or petioles are fleshy and inflated with air which allows them to float. Leaves are whorled with 4 to 10 lateral leaves which fork often giving them a very delicate capillary appearance. Bladderworts are unique in that the underwater leaves bear small oval “bladders” that trap and digest small aquatic creatures. Bladderworts are usually found in quiet shallow waters and can form dense mats.
Creeping Bladderwort (*Utricularia gibba*)

Creeping bladderwort is a small, delicate, free-floating stem. It often forms tangled mats in quiet shallow waters, often associated with bogs, or stranded on soil. It is sometimes mistaken for algae. It has short side branches that fork once or twice, a defining characteristic. Small bladders, used to capture live prey, are situated on these side branches. Small yellow flowers are produce on a short stalk.

Coon’s tail (*Ceratophyllum demersum*)

Coon’s tail is a brittle, rootless, and entirely submerged perennial. The leaves are needlelike and found in whorls around a common stem. The leaves possess two “forks” giving the illusion that each leaf is comprised of four tiny leaflets. The flat leaves which curl are densely packed around the stem giving an overall shape and appearance similar to a raccoon’s tail. Individual coon’s tail plants can exceed three feet in length.

Since the plant is rootless, it is free-floating. Since the plant is adapted to relatively low light intensities, it can be seen at depths exceeding 15 feet. Coon’s tail is common in alkaline lakes throughout the United States and Canada.

The plant produces large quantities of oxygen for aquatic animal life. Its dense leaf pattern provides ideal habitat for aquatic invertebrates such as insects, plankton, and newly hatched fish. The plant also produces an alkaloid which inhibits the growth of blue-green algae, the species associated with “toxic” algal growth in highly eutrophic environments.

Common Waterweed (*Elodea canadensis*)

Elodea can be found in shallow, slow-moving waters including streams, sluggish rivers, ponds and lakes. Elodea is a rooted multi-branched perennial plant but can survive and grow as floating fragments. It is a submerged perennial that can grow up to 6 feet long and can be rooted at 20 feet deep. The dark green finely toothed blade-like leaves (2 cm long and 1 cm wide) are in whorls of three. The flowers of Elodea have three white petals with a waxy coating that makes them float. The Elodea plant has a male and female flower on different plants that are used for reproduction. In extreme cases elodea can be detrimental in a body of water. It can spread quickly forming thick mats on the surface of the water. These mats crowd out other native plants that do not germinate as rapidly. The thick stands often trap sediments.
**Eurasian Water Milfoil** (Myriophyllum spicatum)

Eurasian water milfoil (EWM) is a submersed aquatic plant native to Europe. It is the only non-native milfoil in Wisconsin. EWM has slender stems whorled by submersed feathery leaves and tiny flowers produced above the water surface. It can be readily distinguished from native milfoils because it has over twenty pairs of leaflets on each leaf; native species have less than 13 pairs.

Eurasian water milfoil is capable of growing under a wide range of conditions. Typically, it grows in shallow water but can inhabit water up to 30 feet deep. Eurasian water milfoil can take root from a single segment of stem and leaves. Fragments of the plant clinging to boats and trailers can spread the plant from lake to lake. EWM grows best in fertile, fine-textured, inorganic sediments that receive nitrogen and phosphorous laden runoff. Local water temperatures can promote multiple periods of flowering and fragmentation.

**Northern Water Milfoil** (Myriophyllum sibiricum)

Northern water milfoil is a submersed aquatic plant native to temperate regions within North America. The plant has dark-green feathery leaves which are arranged in a whorl of four leaves at a single node. The leaves contain up to 12 pairs of leaflets. The stems are buff colored and hollow. The leaflets are fairly rigid when removed from the water. The plant forms winter buds (groups of small, brittle leaves), which serve as the growing stock for the following year.

Northern water milfoil is found in calm waters such as lakes, ponds, marshes, and sluggish rivers. This species provides important habitat for numerous invertebrates and small fish. In addition, larger game fish also use the plant as cover. Occasionally, waterfowl eat the fruit and foliage.
**Muskgrass (Chara spp.)**

Most members of the genus Chara are commonly called “muskgrass” due to its characteristic odor. Although these common lake inhabitants look similar to many underwater plants, they are actually related to algae. Muskgrass species are green or gray-green and grow completely submersed in shallow water. Individuals can vary greatly in size from a few inches to over three feet in length. The main “stem” of the stonewort bears whorls of branchlets, clustered at regularly spaced joints. When growing in hard water such as White Clay Lake, they sometimes become coated with lime giving them a gritty feel.

**Flat-stem pondweed (Potamogeton zosteriformis)**

The flat-stem pondweed grows entirely underwater except for the flower stalk which rises above the water. The leaves of flat-stem pondweed are long and narrow with smooth edges. The sharp-edged stem is flat and about the same width as the leaves. It appears the leaves and stems are continuous. Leaves are no more than 5 millimeters wide. The stem forms an angle where the leaves join them giving the plant a zig-zag appearance. The roots are fibrous, and sprout from slender rhizomes. This perennial plant is used as cover by fish and invertebrates alike.

**Illinois pondweed (Potamogeton illinoensis)**

Illinois pondweed is a submersed perennial plant that can grow up to four feet long. The alternate, lance-shaped leaves are located on a short stalk. The stem is brownish-green. Submersed leaves are between 3 to 5 inches long. Plants can grow up to seven feet tall and be found in water greater than 10 feet deep. Fruiting stalks emerge from the axils. Each fruit is approximately 4 mm long and have a beak-like appearance. The plant is often covered in a whitish-gray crust of minerals which give the plant a gritty feel. This is due to living in a hard water habitat. This species was observed at least three locations throughout White Clay Lake, but was not seen at the random sampling points.
**Clasping-leaf pondweed** (*Potamogeton richardsonii*)

Clasping-leaf pondweed is a submersed perennial plant that grows in the deeper waters within the near shore areas. The plant can be found in up to 10 feet deep. The plant spreads through rhizomes. The stem has a repeatable “wavy” pattern. The submerged oblongs leaves are alternately arranged along the stem. The heart-shaped base of the leaves completely clasp the stem. This species is distinguished from other pondweeds species by it’s long, white stipule which originates at leaf nodes and disintergrates to white fibers at the tip.

**Curly-leaf Pondweed** (*Potamogeton crispus*)

Curly-leaf pondweed is an invasive perennial that is native to Eurasia, Africa, and Australia. It was accidentally introduced to United States waters in the mid-1880s by the aquarium industry. The approximately three inch long leaves are reddish-green, oblong, and have distinct wavy edges that are finely toothed. The stem of the plant is flat, reddish-brown and grows up to three feet long.

In Wisconsin, curly-leaf pondweed usually is fully grown by the end of June. The wintering bud (turion) breaks off from the plant, falls to the bottom of the lake, and lies submerged and dormant. The turions begin to sprout in fall, responding to the shortening day length and cooling water temperatures. The new plantlets continue to grow throughout the winter. The early growing start allows the plant to crowd out other more desirable native species.

**Sago Pondweed** (*Potamogeton pectinata*)

Sago pondweed is a perennial plant that arises from thickly matted rhizomes and has no floating leaves. The stems are thin and up to 1 meter long. The stems are highly branching with very thin filament-like leaves about 1/16 of an inch wide. Each leaf can be up to 12 inches long tapering to a point. The leaves grow in thick layers and originate from a sheath. The fruit is nut-like 1/8 to 1/4 inches long and 1/10 to 1/8 inches wide.
**Water Celery (Vallisneria Americana)**

Water celery is an attractive plant. It has long ribbon-like leaves that grow from a root-stock anchored in the lake bottom. The leaves can grow up to six feet in length. There is a prominent red mid-vein which runs the entire length of the plant. The plant is usually submersed, but leaves will float on the surface in shallow waters. The plant reproduces by extending a small flower to the water surface on a cork screw stem. Male plants produce a stomach-shaped tuber. In the fall after reproduction is complete, the plant rises to the surface and floats to shore in large mats. Water celery provides important cover for fish, and the tubers and leaves that are a delicacy for waterfowl.

**Bottlebrush Sedge (Carex comosa)**

This native perennial sedge forms a large tuft of leaves and flowering culms up to 3½ feet tall. The stem or culms are light green, sharply three-angled. Alternate leaves occur along the entire length of the stem to the inflorescence. The widely spreading to ascending leaf blades are about up to 18 inches long. The center of each blade is usually furrowed along its length. Each fertile culm terminates in an inflorescence consisting of up to six pistillate spikelets, a terminal staminate spikelet, and their leafy bracts. The lowest bract is up to 16" long. Each pistillate spikelet is about 6 cm long, 1.5 cm. across, and cylindrical in shape. The spikelet has a bristly appearance from the beaks and long teeth of the densely packed perigynia (bladder-like sacs). These perigynia are widely spreading. Each perigynium is about 5-7 mm. long, 1.5 mm. across, lanceoloid in shape, and longitudinally veined. The root system is fibrous and short-rhizomatous.

**Hardstem Bulrush (Schoenoplectus acutus)**

Hard stem bulrushes are tall, stout, perennial plants with round, olive green stems that reach heights of up 5 feet. It forms larges stands with the youngest plants on the outside. The flower clusters near the stem tips are brown drooping spikelet clusters. There are up to eight spikelets in each cluster. The seeds are less than 3 millimeters long. These fruits are completely concealed by scales that are on the outside of each cluster. This species are commonly seen in marshes and along shorelines in water up to 5 feet deep. The plant provides cover for fish and waterfowl. In addition, ducks eat the seeds. Bulrushes are known in Shawano County as “pin weeds.”
Broad-leaf Cattail (*Typha latifolia*)

The broad-leaf cattail is an erect aquatic freshwater perennial growing up to 6 feet tall. The flattened leaves are 2 to 5 feet. Flowers mature in mid-summer and are comprised of velvety brown, cigar-shaped spikes 2 to 6 inches long without a gap between the male and female flowers. The male flowers are produced above the female spike, which forms a thick brown dense mass, later breaking up and allowing the fruits to disperse by wind. It reproduces by seeds and by thick, rapidly spreading, lateral rhizomes.

Narrow leaf cattail (*Typha angustifolia*)

The Narrow-leaf Cattail is an erect aquatic freshwater perennial. It grows up to 6 feet tall. The leaves are up to 5 feet long and very flattened. Flowers mature in mid-summer and are comprised of velvety brown, cigar-shaped spikes 2 to 6 inches long. There is a distinct gap between the male and female flowers. The male flowers are produced above the female spike, which forms a thick brown dense mass, later breaking up and allowing the fruits to disperse by wind. It reproduces by seeds and by thick, rapidly spreading, lateral rhizomes. This species can grow in deeper water than other cattail species.

Bulblet Water Hemlock (*Cicuta bulbifera*)

Bulblet water hemlock is an emergent plant belonging to the carrot family. Found in marshes and along lake or stream edges. This perennial grows up to 40 inches tall. The stems are light green, smooth, and shiny. The compound leaves can grow up to 1 foot long and 6 inches across. Leaves are typically larger near the base of the plant and become smaller towards the top. Lower leaflets are doubly pinnate while higher leaves are singly pinnate. Flowers are in an umbel (umbrella) shaped arrangement. Its white flowers are approximately 1/8 inch across. Each umbel is about 3 inches across. The foliage, seeds, and roots are toxic to humans. Reproduction occurs through both seeds and bulblets.
**Small duckweed** (Lemna valdiviana)

Small duckweeds are floating plants. They are commonly found in still or sluggish waters. They often form large mats. Small duckweeds are tiny (1/16 to 1/8 inch) round-oval leaves. Each plant has two to several leaves joined at the base. A single root hangs beneath. The leaf has a slightly raised midvein on its surface. Roots are small and fibrous and grow to a length of around 1 inch. The flower and fruit are nearly invisible to the naked eye.

**Forked Duckweed** (Lemna trisulca)

Forked duckweeds are “floating” plants. They are commonly found in still or sluggish waters. Forked duckweed does not float. It attaches to other plants, including other duckweeds, giving the illusion it is floating. Forked duckweeds are tiny green plants with oval leaves. Leaves are only 1/8 inch wide. Each plant has three stalked leaves joined at the base. The leaves have a “rowboat and oars” shape. A single root hangs beneath. The leaf has a slightly raised midvein on its surface. Roots are small and fibrous and grow to a length of around 1 inch. Flowers are seldom produced and can only be seen with magnification.

**Giant Duckweed** (*Spirodela polyrhiza*)

Giant, or big, duckweed is still relatively small (1/16 to 1/4 inch) with 1 to 4 leaves, or fronds. The fronds are light green in color. Three or more roots protrude from each frond. There is a red dot on the upper surface of each frond, and the lower surface is often completely red.

This is the largest duckweed species in Wisconsin. Duckweeds tend to grow in dense colonies in quiet water, undisturbed by wave action. Often more than one species of duckweed will be associated together in these colonies. Duckweed is an important food source for waterfowl.
Spatterdock (*Nuphar variegata*)

Spatterdock is a floating-leaved perennial. The plant is found in shallow lakes, ponds, and marshes. The leaves are oval to heart shaped and up to 16 inches long by 10 inches across. The leaf and flower stalks emerge from a thick spongy rhizome which is typically buried beneath the bottom of the lake. The stalk is thick and elastic. One side of the stalk is rounded while the other flares out at the edges to create wing-like structures. Each stalk supports one leaf. The flowers are yellow and ball-shaped. Both the flowers and leaves can either float on the water or stick above the surface.

Spatterdock can reproduce in two ways. First, the plant can spread through the growth of the rhizome. Alternatively, the plant produces a barrel shaped seed pod that is dropped to the lake bottom annually.

White Water Lily (*Nympha odorata*)

The white water lily is perennial plants that often form dense colonies in lake, ponds, and marshes. The leaves are round in shape, bright green, 6 to 12 inches in diameter with the slit about 1/3 the length of the leaf. Leaves float on the water’s surface. Flowers arise on separate stalks; have brilliant white petals (25 or more per flower) with yellow centers. White water lily can spread from seeds or the rhizomes.
Chapter 3

Results and Discussion

Introduction

In order to determine whether a lake is “healthy,” several factors must be analyzed. A plant inventory provides only a list of what plant species are present. It does not necessarily indicate the overall health. Instead, environmental managers rely on numerous statistical tests to determine the overall health of the lake. Several parameters are analyzed in this chapter.

Results

In following sampling protocol, 174 of the pre-determined GPS points were sampled by Shawano County Land Conservation Division staff and White Clay Lake Sportsmen Club volunteer Kent Heller. All other sites were deeper than the maximum depth vegetation was located. Aquatic vegetation was sampled at 118 points (32 percent) within White Clay Lake (Table 3-1). Vegetation occurred at approximately 79 percent of sites shallower than the maximum depth of plants. Vegetation was found to a depth of 14 feet.

Table 3-1 Environmental Statistics

<table>
<thead>
<tr>
<th>Environmental Statistic</th>
<th>Value</th>
<th>EWM Density</th>
<th>CLP Density</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total number of points sampled</td>
<td>174</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total number of sites with vegetation</td>
<td>118</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total number of sites shallower than maximum depth of plants</td>
<td>150</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Frequency of occurrence at sites shallower than maximum depth of plants</td>
<td>78.67</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Simpson Diversity Index</td>
<td>0.85</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maximum depth of plants (ft)</td>
<td>14</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of sites sampled using rake on Rope (R)</td>
<td>174</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of sites sampled using rake on Pole (P)</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average number of species per site</td>
<td>2.24</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average number of native species per site</td>
<td>2.04</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Species Richness</td>
<td>23</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Species Richness (including visuals)</td>
<td>28</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average Rake Fullness (Eurasian Water Milfoil, Curly-leaf Pondweed only)</td>
<td>3</td>
<td>1.17</td>
<td></td>
</tr>
<tr>
<td>MAX DEPTH VERIFIED</td>
<td>23</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: Shawano County, 2011

Species richness or the number of species present in a lake is a commonly used parameter to quantify the overall “healthiness” of a lake. Typically, the higher the diversity of aquatic plants, the healthier the lake is. The aquatic vegetation survey indicated that 28 species of plants were present in White Clay Lake. An average of 2.24 species was found at each site; of these, 2.04 were native species. White Clay Lake has a Simpson’s Diversity Index (SDI) of 0.85. Since
overall diversity increases as the SDI decreases to zero, this indicates that White Clay Lake is not tremendously diverse.

The plant community within White Clay Lake is healthy, but not extremely diverse. This can be determined from results obtained in 2011 and prior point-intercept (PI) surveys completed by the Wisconsin Department of Natural Resources (WDNR).

The results obtained from these PI surveys indicate that White Clay Lake is similar to other lakes throughout Shawano County. Data was available for several lakes including Beaulieau, Kolpack, Koonz, Long, Loon, Lulu, and Wilson. Shawano County staff also completed a point-intercept survey for White Lake. Most lakes had an average of 22 species present. SDI on the other lakes varied from 0.80 to 0.95. Plants also occurred to a similar depth within the water column. A study of other lakes throughout central Wisconsin indicated similar results.

Species diversity is probably the most misused value in ecology because it is often confused with species richness. Although the two measurements are interrelated, species diversity accounts for the overall number of species as well as the relative abundance of each species. Species diversity is calculated by identifying both the plant species present and the overall area they cover. Lakes with high species diversity are much more stable and more resistant to environmental changes. A lake dominated by one or two species is considered to be less diverse than one in which several different species have similar abundance.

The change in relative frequency of the species found in White Clay Lake was completed. A comparison of species distribution between the point-intercept surveys completed by the WDNR in 2005 and Shawano County in 2011 indicated several changes which have occurred. A Chi-squared analysis was completed on the plant distributions for the two surveys (Table 3-2). A Chi-squared value of 3.841 or greater indicates a significant change in relative frequency.

Several trends were observed. First, there has been a significant reduction in the amount of Chara ($\chi^2 = 22.396$). This is most likely due to the increase in Sago pondweed ($\chi^2 = 18.298$). Sago pondweed (Stuckenia pectinata) forms a dense canopy as is rather tall plant. Chara (Chara spp.) forms mats in shallow water. Chara may also have been replace by narrow-leaf cattails ($\chi^2 = 10.137$). Local anglers have reported that the lake is “being invaded” by cattails (Heller, 2011, personal communication). Cattails thrive in nutrient rich environments such as White Clay Lake. Narrow-leaf cattails (Typha angustifolia) are becoming more abundant in Shawano County. They can better compete at deeper depths than Chara. With rhizome reproduction, it is likely narrow-leaf cattails have expanded their range within the littoral zone.

Creeping bladderwort (Utricularia gibba) populations also significantly increased ($\chi^2 = 26.341$). White Clay Lake has a high nutrient content based upon seasonal algal blooms and recent WDNR water quality testing. It is likely that a lake with a high nutrient content would also have higher concentrations of aquatic invertebrates that bladderworts would prey upon (Knight and Frost, 1991). Both bladderwort species present had population increases. Lakes with high nutrient loadings often experience algal blooms. The increase in algae results in an increase in zooplankton. The zooplankton represents an increased food source for carnivorous plants such as bladderworts.
Curly-leaf pondweed (*Potamogeton crispus*, CLP) also significantly increased in overall distribution ($\chi^2 = 21.343$). Two reasons can account for this explanation. First, CLP completes its life cycle in late July or early August. By early July, many CLP plants have fallen to the lake bed. The timing of the 2005 WDNR survey occurred well after the time frame in which CLP would be observed. Second, spring and early summer 2011 were characterized by colder than average temperatures. This may have allowed CLP to remain active until late July 2011. Numerous plants were still rooted within the lake sediment. In addition, numerous turions were collected during the rake tosses.

Table 3-2 Change in Relative Frequency 2005 – 2011.

<table>
<thead>
<tr>
<th>Species</th>
<th>Change (%)</th>
<th>Chi-square</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carex Comosa</td>
<td>0.7</td>
<td>1.388</td>
</tr>
<tr>
<td>Ceratophyllum demersum</td>
<td>-12.1</td>
<td>0.639</td>
</tr>
<tr>
<td>Chara spp.</td>
<td>-16.3</td>
<td>22.396</td>
</tr>
<tr>
<td>Cicuta bulbifera</td>
<td>0.4</td>
<td>0.4199</td>
</tr>
<tr>
<td>Elodea canadensis</td>
<td>-0.3</td>
<td>0.0703</td>
</tr>
<tr>
<td>Lemna minor</td>
<td>1.1</td>
<td>2.09</td>
</tr>
<tr>
<td>Lemna trisulca</td>
<td>1.1</td>
<td>2.09</td>
</tr>
<tr>
<td>Myriophyllum sibiricum</td>
<td>0.4</td>
<td>0.4199</td>
</tr>
<tr>
<td>Myriophyllum spicatum</td>
<td>0.4</td>
<td>0.692</td>
</tr>
<tr>
<td>Nuphar variegata</td>
<td>-3.2</td>
<td>1.622</td>
</tr>
<tr>
<td>Nymphaea odorata</td>
<td>0.4</td>
<td>0.4199</td>
</tr>
<tr>
<td>Potamogeton crispus</td>
<td>10.1</td>
<td>21.343</td>
</tr>
<tr>
<td>Potamogeton illinoensis</td>
<td>-0.7</td>
<td>1.455</td>
</tr>
<tr>
<td>Potamogeton richardsonii</td>
<td>-0.3</td>
<td>0.0703</td>
</tr>
<tr>
<td>Potamogeton zosteriformis</td>
<td>6.8</td>
<td>14.008</td>
</tr>
<tr>
<td>Schoenoplectus acutus</td>
<td>-0.9</td>
<td>0.8384</td>
</tr>
<tr>
<td>Spirodela polyrhiza</td>
<td>1.1</td>
<td>2.09</td>
</tr>
<tr>
<td>Stuckenia pectinata</td>
<td>13.8</td>
<td>18.298</td>
</tr>
<tr>
<td>Typha angustifolia</td>
<td>4.7</td>
<td>10.137</td>
</tr>
<tr>
<td>Typha latifolia</td>
<td>-5.5</td>
<td>2.004</td>
</tr>
<tr>
<td>Utricularia gibba</td>
<td>12.6</td>
<td>26.341</td>
</tr>
<tr>
<td>Utricularia vulgaris</td>
<td>1.8</td>
<td>3.507</td>
</tr>
<tr>
<td>Vallisneria americana</td>
<td>0.4</td>
<td>0.4199</td>
</tr>
</tbody>
</table>

Source: Shawano County, 2011.

The number of invasive species is also a good indicator of health. Two invasive species were located within White Clay Lake. Eurasian water milfoil (EWM) was documented in 2005. One small stand was located in the northeast section of the lake. This patch is less than 0.5 acres in size. Curly-leaf pondweed (CLP) was located throughout the lake. Dense stands are located at several areas in the lake. Smaller populations and isolated plants were located along the shoreline throughout the lake. This indicates CLP may have been present for several years.
EWM has an established history within the lake. To date, EWM has not become problematic. However, a management plan should be created to reduce the overall population. The small size of the stand and its relative isolation may allow EWM to be eradicated.

CLP is currently problematic within White Clay Lake. It has formed dense, monotypic stands. An initial paddling survey in June 2011 indicates populations may be larger than discovered during the PI survey. Large areas of White Clay Lake no longer provide adequate habitat for native fish and invertebrates. Proactive steps must be taken to create an eradication and management program for the invasive plant.

Management Concerns

The Shawano County Land Conservation Division, Wisconsin Department of Natural Resources, and municipal staff members have received numerous complaints that White Clay Lakes are “weedy” lakes (Brunner, 2011, Personal Communication). There is a common perception that aquatic macrophytes are a nuisance to the recreational use of a lake. However, these plants are an essential element in a healthy and functioning lake ecosystem. Diverse aquatic vegetation provides food and habitat for a number of animals including fish, insects, amphibians, waterfowl, and mammals. Shoreline vegetation filters upland nutrients from entering a lake and littoral (near shore) vegetation provides erosion control eliminating re-suspension of nutrients through wave action. Increased education will be needed to inform Shawano County lake users of the benefits of the existing vegetation at White and White Clay Lake.

Plant communities can change in abundance and diversity over time due to a variety of environmental conditions. Land use trends and recreational activities can greatly affect macrophyte populations. With the high nutrient concentrations and invasive species present in White Clay Lake, future monitoring of vegetation populations will be needed.
Chapter 4

Aquatic Invasive Species Management

Introduction

Freshwater plant monitoring is completed by natural resource agencies to track aquatic plant community changes over time. In addition, these programs help identify whether invasive species have been introduced into a lake.

Invasive species are non-native plants that have been introduced to Wisconsin either accidentally or on purpose by humans. Invasive species typically originated in foreign countries. Once introduced, they live in an environment which lacks natural predators such as plant-eating insects or disease that normally keeps their growth in check. The lack of natural controls, combined with the plants high reproductive rates, allows the plants to thrive and out-compete desired native species. Both plant and animal species can be considered invasive if they readily adapt to their new environments and out-compete the native inhabitants.

Over 10 aquatic invasive species (AIS) have been introduced into Shawano County alone. Unfortunately, many AIS were discovered after the problem became too large to solve.

Aquatic Invasive Species

Aquatic invasive species (AIS) are species that impact aquatic ecosystems. They are non-native species that threaten the diversity or abundance of native species, the ecological stability of infested waters, human health and safety, or commercial, agricultural, aquaculture, or recreational activities dependent on such waters. Humans have created conditions where plants and animals can aggressively invade and dominate natural areas and water bodies. Aquatic invasive species are spread to new areas by various methods such as: moving watercrafts from water body to water body without removing AIS, ships releasing ballast water containing AIS, carrying seeds of AIS on footwear or pet’s fur, mowing along roadsides, and driving or biking with AIS seeds or fragments in tire treads.

The spread of AIS can cause significant economic and ecological problems. AIS can interfere with water uses (drinking water, water intakes, recreation), affect the ability of lakes and streams to support native fish and wildlife, lower water quality, and alter riparian (streamside and shoreline) conditions. Once AIS are introduced, there may be no natural controls, such as pathogens, parasites, and predators. Lack of natural controls may allow a population increase at an exponential rate. AIS can cause the disruption of native species in the ecosystem as the AIS may prey upon, out compete, or transmit disease to the native species.

Study Area

Two invasive species were found in White Clay Lake. A small population of Eurasian water milfoil (EWM) was found in the northeastern corner of the lake near a drainage inlet (Figure 4-1). Curly-leaf pondweed (CLP) was also discovered at several points throughout the lake (Figure 4-2). EWM and CLP populations do not overlap.
The EWM population is estimated to be approximately 60 meters by 60 meters in size. Although EWM was initially documented in White Clay Lake in 2005, it appears that the population has remained relatively stable in size and stature. Due to the size and density of this population, chemical treatment will be required.

**Figure 4.1: Eurasian Watermilfoil (Myriophyllum spicatum) Distributions.**

Source: Shawano County, 2011
CLP populations are located in several primary areas. A dense population is located in the northwestern-most “bay” of the lake. This area was a monoculture when observed in June 2011. Sporadic populations are also located along the western shoreline of the lake between the “sand bar” and the northern edge. Pioneer populations of CLP are appearing at the White Clay Lake Lodge boat landing, the public boat landing, and on the eastern edge of the lake north of the public boat landing. Due to the density of the stands and the widespread occurrence throughout the lake, chemical treatment will be required.

**Figure 4.2 Curly-leaf Pondweed (Potamogeton crispus) Distributions.**
AIS Control Strategies

Chemical Treatment
Aquatic Invasive Species can be controlled by a variety of means. The specific method chosen depends on the specific species, the extent of the infestation, and the individual lake. Due to the expansive invasive species populations in White Clay Lake, chemical control is recommended for both EWM and CLP. Prior to chemical control, an aquatic plant management plan (APM) must be created for White Clay Lake. APMs are documents which outline specific treatment plans for invasive species.

By Wisconsin Administrative code, APMs must contain several important topics. Maps of areas infested by invasive species and the areas planned to be treated must be included. The plan must discuss the specific chemicals which will be used in treatment. The plan must discuss treatment rates, or the amount of chemical to be used. Pre- and post-treatment plant inventories must be completed to determine the success of the treatment. An APM must be locally adopted by a lake association or municipality.

Herbicide treatments are strictly regulated by the WDNR. Typically chemical applications mandate that use restrictions are placed on the water body for a period of time to avoid human contact. Chemical applications can be costly. Most herbicides can be harmful to human health. Individuals handling herbicides must wear appropriate safety equipment, properly transport, and safely dispose of all unused herbicides.

EWM is typically controlled with 2,4-dichlorophenoxyacetic acid (2,4-D). This chemical can be able in either liquid or solid granular forms. Liquid treatments are typically completed for large-scale projects. Solid applications allow for a more direct treatment. The effectiveness of each treatment process is determined by in-lake currents, in-flows, lake traffic, and several other factors. The specific treatment method will be determined within the APM planning process. EWM treatments are usually completed for a series of at least three years. This ensures maximum success of treatment rates. Average treatment costs for liquid treatment are $350 per acre, while solid treatments cost an average of $900 per acre.

CLP is treated by 7-oxabicyclo[2.2.1]heptanes-2,3-dicarboxylic acid. It is sold under the trade name endothall. Typically endothall is applied as a liquid in lakes. The herbicide is a selective contact herbicide that must contact a plant to kill it. Treatment effectiveness is affected by the same factors as 2,4-D. Since CLP turions (seeds) remain reproductively viable for up to five years, treatments must be completed for a minimum of five years. Average treatment costs for CLP average about $775 per acre.

Following chemical control, additional control methods will be required. Past treatments in Wisconsin have shown that hand pulling EWM is required to remove sporadic plants which remain after treatment. Hand pulling by a diver or snorkeler allows the entire root system of the plants to be removed. This ensures the plant will not regenerate.

Public Education
The best control strategy for AIS is prevention. If specific species have not been found in a lake, the best way to prevent an infestation is to minimize opportunities for AIS to be transferred into the lake. New introductions of plants are found near public access sites and heavily used entryways. Therefore, prevention levels should be focused on access points.
The most likely introduction source of any invasive species to White Clay Lake is boaters. Turions and plant fragments can be carried on boats, trailers and fishing gear from one water body to another. Since there is only one public access point and one private boat landing to White Clay Lake, a concentrated effort can be made on public education. Shawano County, the Town of Washington, the White Clay Lake Protection and Rehabilitation District, and other interested stakeholders can readily focus attention on public education. Public education can be completed in several passive and active methods described below. A combination of several of the strategies listed below may be most effective in AIS education.

**Education Kiosk**
Educational kiosks are an important tool in providing a constant, consistent source of education. Several kiosks located on nearby lakes within Shawano County provide educational and informational materials including fishing regulations, county park rules, and invasive species literature. Several pamphlets have been developed by volunteer groups and professionals for distribution throughout Wisconsin. These materials could be posted on new kiosks to inform White Clay Lake users about the potential dangers of AIS. Education kiosks frequently provide pictures of the most significant invaders, identify specific areas of boats and fishing equipment which become contaminated, and offer simple strategies to remove these “hitchhikers” and dispose of them properly.

In addition, the materials will have the ability to aid in preventing the spread of new AIS infestations elsewhere in Shawano County and Wisconsin. To be most effective two sets of kiosks could need to be erected at both the public boat launch and the White Clay Lake Lodge access area.

**Clean Boats, Clean Waters**
"Clean Boats, Clean Waters," (CBCW) is a Wisconsin Department of Natural Resources program which stresses public education through individualized contact at local boat launches. The effort is completed through a combination of paid staff and volunteers. Staff and volunteers perform boat and trailers checks at local lake access points with consent of anglers. In addition, boat inspectors disseminate informational brochures and educate boaters on how to prevent the spread of AIS. Since the program’s inception, over 54,000 boats have been inspected and over 113,000 individuals have been informed of the hazards of AIS. Volunteer participation and time has steadily increased since 2004 (WDNR, 2009b). The program has been successful as a majority (57 percent) of respondents indicated they have used one or more of the preventative measurements discussed in this chapter.

Training seminars for new boat inspectors are held by University of Wisconsin Extension (UWEX) staff. In addition, UWEX coordinates volunteer efforts at specific lakes. Trained boat inspectors are able to organize and conduct localized boater education programs. Most important, CBCW volunteers serve as an early detection sources as they are required to report any new infestations. Members of the White Clay Lake Protection & Rehabilitation District, White Clay Lake Sportsmen Club, and local civic groups could assist in these efforts. Additional information can found at the UWEX CBCW website at http://www.uwsp.edu/cnr/uwexlakes/CBCW/default.asp.

**High Pressure Wash and Decontamination Stations**
High pressure wash stations allow boaters and anglers the opportunity to “clean” their watercraft prior to launching and after trailering. By spraying the entire boat hull and trailer with highly pressurized water, the plants which may have been inadvertently transferred can be removed. A
wash station has been installed at Shawano County Lake Park. In some cases, local communities combine a boat inspection program such as Clean Boats, Clean Waters with pressure washing.

High-temperature washes are more effective in decontaminating a boat. Decontamination units utilize 110°F and warmer water to kill various microscopic organisms on contact. Quagga and zebra mussel veligers and VHS are immediately destroyed at higher temperatures. Decontamination stations are eligible expenses in selected state grant programs.
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Appendices: Species Distribution Maps
Appendix A.
Carex Comosa (Bottle Brush Sedge)
Distribution in White Clay Lake

2011 White Clay Lake vegetation density survey map
Appendix B.

Coontail (Ceratophyllum demersum)
Distribution in White Clay Lake

2011 White Clay Lake vegetation density survey map
Appendix C.
Chara (Chara spp.)
Distribution in White Clay Lake

2011 White Clay Lake vegetation density survey map
Appendix D.

Common Waterweed (Elodea canadensis)

Distribution in White Clay Lake

2011 White Clay Lake vegetation density survey map
Appendix E.

Small Duckweed (Lemna minor)
Distribution in White Clay Lake
Appendix F.

Forked Duckweed (Lemna trisulca)

Distribution in White Clay Lake

2011 White Clay Lake vegetation density survey map
Appendix G.
Northern Watermilfoil (Myriophyllum sibiricum)
Distribution in White Clay Lake
Appendix H.
Eurasian Watermilfoil (Myriophyllum spicatum)
Distribution in White Clay Lake

2011 White Clay Lake vegetation density survey map
Appendix I.
Spatterdock (Nuphar variegata)
Distribution in White Clay Lake

2011 White Clay Lake
vegetation density survey map

- Low Vegetation
- Moderate Vegetation
- High Vegetation
Appendix J.

White Water Lily (Nymphaea odorata)
Distribution in White Clay Lake

2011 White Clay Lake vegetation density survey map
Appendix K.
Curly-leaf Pondweed (Potamogeton crispus)
Distribution in White Clay Lake

2011 White Clay Lake vegetation density survey map
Appendix L.
Clasping-leaf Pondweed (Potamogeton richardsonii)
Distribution in White Clay Lake

2011 White Clay Lake vegetation density survey map
Appendix M.
Flat-stem Pondweed (Potamogeton zosteriformis)
Distribution in White Clay Lake

2011 White Clay Lake vegetation density survey map
Appendix N.

Hard-stem Bulrush (Schoenoplectus acutus)

Distribution in White Clay Lake

2011 White Clay Lake vegetation density survey map
Appendix O.
Large Duckweed (Spirodea polyrhiza)
Distribution in White Clay Lake

2011 White Clay Lake
vegetation density survey map

- Low Vegetation
- Moderate Vegetation
- High Vegetation
Appendix P.
Sago Pondweed (Stuckenia pectinata)
Distribution in White Clay Lake

2011 White Clay Lake vegetation density survey map
Appendix Q.

Narrow-leaf Cattail (Typha angustifolia)

Distribution in White Clay Lake
Appendix R.

Broad-leaf Cattail (Typha latifolia)

Distribution in White Clay Lake

2011 White Clay Lake vegetation density survey map
Appendix S.
Creeping Bladderwort (Utricularia gibba)
Distribution in White Clay Lake

2011 White Clay Lake vegetation density survey map
Appendix T.

Common Bladderwort (Ultricularia vulgaris)
Distribution in White Clay Lake

2011 White Clay Lake vegetation density survey map
Appendix U.

Wild Celery (Vallisneria americana)

Distribution in White Clay Lake

2011 White Clay Lake vegetation density survey map