German Lake:

German Lake is located in Le Sueur County, Minnesota and is a 791 acre lake with a maximum depth of 51 feet. In a separate June 2004 study, the Minnesota Department of Natural Resources Division of Ecological Services found 22 different native species in German Lake. However, only a few of them were recorded in more than 5% of the sample sites including: muskgrass (*Chara sp.*), coontail (*Ceratophyllum demersum*), and narrow-leaf pondweed (*Potamogeton freisii*). In the 2004 study, the deepest point sampled that contained any plants was 13 ft, therefore sampling locations over 15 feet were recorded as being too deep and without vegetation. During the 2009 early season sampling period, a total of 13 macrophytes were sampled, 11 of which are considered to be native species. Plants were found to be growing as deep as 16 feet in one location, however no location greater than 17 ft had macrophytes present in it. Therefore, points over 18 ft were considered too deep and were not sampled. Curly leaf pondweed was present in 153 out of 211 (72.5%) of sites sampled. In comparison to other lakes on the Jefferson-German Chain, the curly leaf is not nearly as dominant on German Lake. As a result, German Lake has the greatest number of plant species in comparison to all other lakes on the Chain.

<table>
<thead>
<tr>
<th>Common name</th>
<th>Scientific Name</th>
<th>Coefficient of Conservatism</th>
</tr>
</thead>
<tbody>
<tr>
<td>Curly Leaf Pondweed</td>
<td><em>Potamogeton crispus</em></td>
<td>0</td>
</tr>
<tr>
<td>Eurasian Water Milfoil</td>
<td><em>Myriophyllum spicatum</em></td>
<td>0</td>
</tr>
<tr>
<td>Sago Pondweed</td>
<td><em>Potamogeton pectinatus</em></td>
<td>3</td>
</tr>
<tr>
<td>Clasping leaf Pondweed</td>
<td><em>Potamogeton richardsonii</em></td>
<td>5</td>
</tr>
<tr>
<td>Softstem Bulrush</td>
<td><em>Scirpus validus</em></td>
<td>4</td>
</tr>
<tr>
<td>Coontail</td>
<td><em>Ceratophyllum demersum</em></td>
<td>3</td>
</tr>
<tr>
<td>White Water Lily</td>
<td><em>Nymphaea spp.</em></td>
<td>6</td>
</tr>
<tr>
<td>Yellow Water Lily</td>
<td><em>Nuphar spp.</em></td>
<td>6</td>
</tr>
<tr>
<td>Fine leafed Pondweed</td>
<td><em>Potamogeton Freisii</em></td>
<td>8</td>
</tr>
<tr>
<td>Common Waterweed</td>
<td><em>Elodea canadensis</em></td>
<td>3</td>
</tr>
<tr>
<td>Narrow leafed cattail</td>
<td><em>Typha angustifolia</em></td>
<td>0</td>
</tr>
<tr>
<td>Muskgrass</td>
<td><em>Chara spp.</em></td>
<td>7</td>
</tr>
<tr>
<td>Greater duckweed</td>
<td><em>Spirodela polyrhiza</em></td>
<td>5</td>
</tr>
<tr>
<td><strong>Average C-Value</strong></td>
<td></td>
<td><strong>3.85</strong></td>
</tr>
<tr>
<td><strong>FQI Score</strong></td>
<td></td>
<td><strong>3.85 * √13 = 14.4</strong></td>
</tr>
</tbody>
</table>
East Jefferson Lake:

East Jefferson Lake is a 646 acre lake located in Le Sueur County, Minnesota. With a maximum depth of 37 feet, East Jefferson is deeper than most lakes on the chain. Generally better water clarity in the spring allows for plant growth to extend deep into the lake basin. During this sampling period (May 2009), macrophytes were found to be growing in water as deep as 19 ft. Sites with depths greater than 21 feet were sampled until we developed a consistent enough pattern to determine that macrophytes were not present at depths greater than 21 feet. Macrophytes that grow early in the season, such as curly leaf pondweed can take advantage of spring water clarity. A total of 205 sites were sampled on East Jefferson Lake. Of those sites, 178 or approximately 87% contained curly leaf pondweed. Moreover, curly leaf was found to be growing as deep as 19 feet; a factor that attests to both early season water clarity and the life cycle of curly leaf. A low number of total species were found during the course of the study, a factor representative of the curly leaf dominance. Eurasian water milfoil (Myriophyllum spicatum), another non-native species was also found at 22 sites within the lake basin. Most of the Eurasian water milfoil was in early growth stages, very green in color, and may represent a greater proportion of macrophytes sampled later in the year. Other species found include coontail (Ceratophyllum demersum), sago pondweed (Potamogeton pectinatus), clasping leaf pondweed (Potamogeton richardsonii), white water lily (Nymphea spp.), softstem bulrush (Scirpus validus), common waterweed (Elodea canadensis), narrow leaf cattail (Typha angustifolia), greater duckweed (Spirodela polyrhiza) and Muskgrass (Chara spp.).

<table>
<thead>
<tr>
<th>Common name</th>
<th>Scientific Name</th>
<th>Coefficient of Conservatism</th>
</tr>
</thead>
<tbody>
<tr>
<td>Curly Leaf Pondweed</td>
<td>Potamogeton crispus</td>
<td>0</td>
</tr>
<tr>
<td>Eurasian Water Milfoil</td>
<td>Myriophyllum spicatum</td>
<td>0</td>
</tr>
<tr>
<td>Sago Pondweed</td>
<td>Potamogeton pectinatus</td>
<td>3</td>
</tr>
<tr>
<td>Clasping leaf Pondweed</td>
<td>Potamogeton richardsonii</td>
<td>5</td>
</tr>
<tr>
<td>Sofstem Bulrush</td>
<td>Scirpus validus</td>
<td>4</td>
</tr>
<tr>
<td>Coontail</td>
<td>Ceratophyllum demersum</td>
<td>3</td>
</tr>
<tr>
<td>White Water Lily</td>
<td>Nymphaea spp.</td>
<td>6</td>
</tr>
<tr>
<td>Yellow Water Lily</td>
<td>Nuphar spp.</td>
<td>6</td>
</tr>
<tr>
<td>Common Waterweed</td>
<td>Elodea canadensis</td>
<td>3</td>
</tr>
<tr>
<td>Narrow leaved cattail</td>
<td>Typha angustifolia</td>
<td>0</td>
</tr>
<tr>
<td>Greater duckweed</td>
<td>Spirodela polyrhiza</td>
<td>5</td>
</tr>
<tr>
<td>Muskgrass</td>
<td>Chara spp.</td>
<td>7</td>
</tr>
<tr>
<td>Average C-Value</td>
<td>3.5</td>
<td>12.12</td>
</tr>
<tr>
<td>FQI Score</td>
<td>3.5 *√12</td>
<td>12.12</td>
</tr>
</tbody>
</table>

**Aquatic Vegetation: Percent Coverage**

East Jefferson Lake

![Aquatic Vegetation: Percent Coverage](image)
Middle Jefferson Lake:

Middle Jefferson Lake is located in Le Sueur County, Minnesota. It is a extremely shallow hypereutrophic 664 acre water body with a maximum depth of 8 feet. A total of 235 points were sampled on Middle Jefferson Lake in May 2009. Aquatic macrophytes were sampled on the rake at 232 of those points. There were three points that had no aquatic plants sampled on the rake, however each of these sites had a visual identification of an aquatic macrophytes within 5 feet of the GPS location. Therefore, macrophytes exhibit nearly 100 % coverage of the entire lake basin, a factor compounded by the abundance of the curly leaf population. Near shore areas exhibited sediment comprised mostly of sand, in these areas other species besides curly leaf were able to grow. Beyond a depth of 3 feet, the sediment quickly became mucky and curly leaf pondweed became extremely dominant. Samples from 3-8 feet deep comprised 190 out of the 235 total samples. Within these 190 samples, curly leaf pondweed was present at every location; however other species were only found 9 times out of the total 190 samples taken, or less than 5% of the time. In contrast, of the 45 samples taken in water less than 3 ft deep, 17 or 38% of samples had species other than curly leaf present. This difference amongst sites clearly depicts the dominating effects an invasive species such as curly leaf can have on overall diversity.

In spring when water clarity is typically at its best in many temperate lakes, curly leaf pondweed uses its early growth life cycle to gain a competitive advantage over other species of aquatic macrophytes. Areas extremely close to shore and less than 2 feet deep display the highest level of species diversity, in these areas curly leaf pondweed is also not as dominant. As depths greater than 3 feet, the sediment quickly turns into an organic rich environment consisting mainly of muck. At these locations, curly leaf often extends to the surface of the water, forming impenetrable mats that choke out native species.

<table>
<thead>
<tr>
<th>Common name</th>
<th>Scientific Name</th>
<th>Coefficient of Conservatism</th>
</tr>
</thead>
<tbody>
<tr>
<td>Curly Leaf Pondweed</td>
<td><em>Potamogeton crispus</em></td>
<td>0</td>
</tr>
<tr>
<td>Eurasian Water Milfoil</td>
<td><em>Myriophyllum spicatum</em></td>
<td>0</td>
</tr>
<tr>
<td>Sago Pondweed</td>
<td><em>Potamogeton pectinatus</em></td>
<td>3</td>
</tr>
<tr>
<td>Narrow leafed cattail</td>
<td><em>Typha angustifolia</em></td>
<td>0</td>
</tr>
<tr>
<td>Common Waterweed</td>
<td><em>Elodea canadensis</em></td>
<td>3</td>
</tr>
<tr>
<td><strong>Average C-Value</strong></td>
<td>1.2* √5 =</td>
<td>2.68</td>
</tr>
</tbody>
</table>

Middle Jefferson Lake Macrophytes: Percent Coverage

- Curly Leaf Pondweed: 98.70%
- Sago Pondweed: 5.53%
- Common Waterweed: 8.94%
- Typha spp. (Cattails): 1.28%
- Eurasian Watermilfoil: 2.13%
West Jefferson Lake:

West Jefferson Lake is located in Le Sueur County, Minnesota. It is a 439 acre lake with a maximum depth of 24 feet. Of the 169 points sampled within the lake, curly-leaf pondweed was present at 95 of them. Furthermore, 37 out of 169 points were considered to be too deep to sample in. Given this statistic, of the 132 points that were capable of supporting macrophytes, approximately 72% or 95 of them contained curly-leaf pondweed. In addition to curly leaf pondweed, other macrophytes found included: narrow leaf cattail (*Typha angustifolia*), broad leaf cattail (*Typha latifolia*), giant burr reed (*Sparganium eurycarpum*), sago pondweed (*Potamogeton pectinatus*), softstem bulrush (*Scirpus validus*), muskgrass (chara spp.), and clasping leaf pondweed (*Potamogeton richardsonii*). The maximum depth that contained macrophytes was 12.5 ft, however all points up to 15 feet were sampled. Macrophytes were consistently absent in depths greater than 15 feet, therefore sites that were over 15 feet deep were not sampled.

A low number of total species found in addition to the general absence of non-tolerant species serves as evidence to suggest West Jefferson Lake has been significantly altered by man. Areas immediately near shore contained the highest levels of diversity, these areas were less than 3 feet deep, contained sandy sediment, and were not dominated as readily by curly leaf. As soon as water depths dropped below 3 feet, the sediment became mucky and the curly leaf stands became thick. Curly leaf was often so thick in these areas that the growth of other macrophytes was sufficiently limited. Curly leaf was present in seventy-two percent of points sampled that contained macrophytes, a testimony to its dominance within the lake.

<table>
<thead>
<tr>
<th>Common Name</th>
<th>Species</th>
<th>Coefficient of Conservatism</th>
</tr>
</thead>
<tbody>
<tr>
<td>Narrow Leaf Cattail</td>
<td><em>Typha angustifolia</em></td>
<td>1</td>
</tr>
<tr>
<td>Broadleaf Cattail</td>
<td><em>Typha latifolia</em></td>
<td>1</td>
</tr>
<tr>
<td>Water stargrass</td>
<td><em>Sparganium spp.</em></td>
<td>5</td>
</tr>
<tr>
<td>Sago Pondweed</td>
<td><em>Potamogeton pectinatus</em></td>
<td>3</td>
</tr>
<tr>
<td>Curly Leaf Pondweed</td>
<td><em>Potamogeton crispus</em></td>
<td>0</td>
</tr>
<tr>
<td>Softstem Bulrush</td>
<td><em>Scirpus Validus</em></td>
<td>4</td>
</tr>
<tr>
<td>Clasping Leaf Pondweed</td>
<td><em>Potamogeton richardsonii</em></td>
<td>5</td>
</tr>
<tr>
<td>Muskgrass</td>
<td>Chara spp.</td>
<td>7</td>
</tr>
<tr>
<td><strong>Average C-Value</strong></td>
<td></td>
<td><strong>3.25</strong></td>
</tr>
<tr>
<td><strong>FQI Score</strong></td>
<td></td>
<td><strong>9.2</strong></td>
</tr>
</tbody>
</table>

![West Jefferson Macrophytes: Percent Coverage](image)
Swedes Bay:

Swedes Bay is located in Le Sueur County, Minnesota on the south side of the Jefferson-German Lake chain. It is a 517 acre basin with a maximum depth of 6 feet. Of the 195 total points sampled, curly leaf pondweed was found at 185 or 94.87%. Despite the high percentage of sites with curly leaf present, Swedes Bay exhibited the highest plant diversity of any lake on the Jefferson German Chain as evidenced by a FQI score of 15.75. Wild celery (*vallisneria Americana*) and northern water-milfoil (*myriophyllum sibiricum*) were not found in any other lake basins, an indication that Swedes Bay is indeed less affected by human disturbance in contrast with other lakes on the Chain. In comparison with other lakes on the chain, Swedes Bay had the most amount of undisturbed shoreline, a factor that most likely contributed to an increase in plant diversity. The abundance of curly leaf pondweed in addition to a shallow lake basin makes boat navigation throughout most of this lake basin nearly impossible during the early spring and summer. Therefore, shoreline property may not be as highly coveted at this end of the lake, allowing for more shoreline to go undeveloped in contrast with other lake basins on the chain. Swedes Bay has the highest FQI of any other lake in the Jefferson-German lake chain.

<table>
<thead>
<tr>
<th>Common name</th>
<th>Scientific Name</th>
<th>Coefficient of Conservatism</th>
</tr>
</thead>
<tbody>
<tr>
<td>Curly Leaf Pondweed</td>
<td><em>Potamogeton crispus</em></td>
<td>0</td>
</tr>
<tr>
<td>Eurasian Water Milfoil</td>
<td><em>Myriophyllum spicatum</em></td>
<td>0</td>
</tr>
<tr>
<td>Sago Pondweed</td>
<td><em>Potamogeton pectinatus</em></td>
<td>3</td>
</tr>
<tr>
<td>Coontail</td>
<td><em>Ceratophyllum demersum</em></td>
<td>3</td>
</tr>
<tr>
<td>White Water Lily</td>
<td><em>Nympha sp.</em></td>
<td>6</td>
</tr>
<tr>
<td>Fine leafed Pondweed</td>
<td><em>Potamogeton Freisii</em></td>
<td>8</td>
</tr>
<tr>
<td>Flat Stem Pondweed</td>
<td><em>Potamogeton zosteriformis</em></td>
<td>6</td>
</tr>
<tr>
<td>Common Arrowhead</td>
<td><em>Sagitaria latifolia</em></td>
<td>3</td>
</tr>
<tr>
<td>Wild Celery</td>
<td><em>Vallisneria americana</em></td>
<td>6</td>
</tr>
<tr>
<td>Northern Watermilfoil</td>
<td><em>Myriophyllum sibiricum</em></td>
<td>6</td>
</tr>
<tr>
<td>Common Waterweed</td>
<td><em>Elodea canadensis</em></td>
<td>3</td>
</tr>
<tr>
<td>Narrow leafed cattail</td>
<td><em>Typha angustifolia</em></td>
<td>0</td>
</tr>
<tr>
<td>Muskgrass</td>
<td><em>Chara spp.</em></td>
<td>7</td>
</tr>
<tr>
<td>Greater duckweed</td>
<td><em>Spirodea polyrhiza</em></td>
<td>5</td>
</tr>
<tr>
<td>Giant burr reed</td>
<td><em>Sparganium eurycarpum</em></td>
<td>5</td>
</tr>
<tr>
<td><strong>Average C-Value</strong></td>
<td></td>
<td>4.0667</td>
</tr>
<tr>
<td><strong>FQI Score</strong></td>
<td></td>
<td>4.0667 * √15 = 15.75</td>
</tr>
</tbody>
</table>

Swedes Bay Macrophytes: Percent Coverage
Discussion:

According to Dr. Robert Freckmann, of the UW-Steven’s Point Freckmann Herbarium, an FQI score of 20 is indicative of a disturbed environment with little natural plant communities left. Therefore a FQI score of less than 20 provides further evidence for a disturbed environment. All basins in the Jefferson-German lake chain for the May 2009 sampling had an FQI score of <20. The low FQI scores are indicative of a lake environment that contains very little natural vegetation. Most likely the senescence of curly leaf pondweed has historically resulted in the midsummer release of phosphorus from curly leaf tissue, ultimately leading to algal blooms which in turn limit macrophytic growth. In time, this has led to a plant community that does not exhibit a high level of floristic diversity. As a result of poor water clarity during the growing season, low light penetration restricts the growth of native species resulting in a cycle that favors plant species that grow early in the year when water clarity is at its best (i.e. curly leaf pondweed). Furthermore, the natural life cycle of curly leaf pondweed has given it a competitive advantage over native species, growing early and quickly, it can shade out and outcompete native species.

<table>
<thead>
<tr>
<th>May 2009 – Jefferson German Lake Chain CURLY LEAF PONDWEED Coverage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basin Name</td>
</tr>
<tr>
<td>---------------------</td>
</tr>
<tr>
<td>German</td>
</tr>
<tr>
<td>East Jefferson</td>
</tr>
<tr>
<td>Middle Jefferson</td>
</tr>
<tr>
<td>Swedes Bay</td>
</tr>
<tr>
<td>West Jefferson</td>
</tr>
</tbody>
</table>
May 2009 – East Jefferson -- Vegetation Survey
Water Resources Center (Minnesota State – Mankato)
GERMAN LAKE

Bathymetry

DEPTH (feet)

>50
45-50
40-45
35-40
30-35
25-30
20-25
15-20
10-15
5-10
0-5
Wetland

Projection: NAD83, UTM Zone 15N
Water Resources Center
Minnesota State University, Mankato

Guam County

GERMAN LAKE

No samples collected (>17 feet)
May 2009 – German Lake -- Vegetation Survey
Water Resources Center (Minnesota State – Mankato)


curry leaf pondweed
May 2009

EURASIAN MILFOIL
May 2009
May 2009 -- Jefferson German Lake Chain -- Vegetation Survey

Water Resources Center (Minnesota State – Mankato), January 2010

PLANT DENSITY

- 4
- 3
- 2
- 1
- Visual
- Not Present
- No Data

CURLYLEAF PONDWEED
May 2009

<table>
<thead>
<tr>
<th>Basin Name</th>
<th>Size (acres)</th>
<th>CLP Coverage (acres)</th>
<th>% CLP Coverage</th>
</tr>
</thead>
<tbody>
<tr>
<td>German</td>
<td>791</td>
<td>439</td>
<td>55.5 %</td>
</tr>
<tr>
<td>East Jefferson</td>
<td>646</td>
<td>404</td>
<td>62.5 %</td>
</tr>
<tr>
<td>Middle Jefferson</td>
<td>664</td>
<td>659.5</td>
<td>99 %</td>
</tr>
<tr>
<td>Swedes Bay</td>
<td>517</td>
<td>476.5</td>
<td>92 %</td>
</tr>
<tr>
<td>West Jefferson</td>
<td>439</td>
<td>242.5</td>
<td>55 %</td>
</tr>
</tbody>
</table>
PLANT DENSITY

- 4
- 3
- 2
- 1
- Visual
- Not Present
- No Data

Increasing Rake Density
May 2009 – Swedes Bay -- Vegetation Survey
Water Resources Center (Minnesota State – Mankato), January 2010

PLANT DENSITY

- 4
- 3
- 2
- 1
- Visual
- Not Present
- No Data

Increasing Rake Density

Swedes Bay -- May 2009
CURLYLEAF PONDWEED

Miles
Swedes Bay -- May 2009

- Common Arrowhead
- Burr Reed
- White Water Lily
- Cattail

Miles