

**Terrell’s Island Water Quality Assessment**

**2014**

Wisconsin Department of Natural Resources

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**Introduction**

Terrell’s Island is located on Lake Butte des Morts in Winnebago County, Wisconsin. The break wall that created Terrell’s Island was constructed in 1997. The purpose of creating Terrell’s Island was to exclude carp populations and also lessen wind and wave energy that otherwise had been major stressors on emergent and floating leaf aquatic plant communities. Initially the project was very successful, boasting a robust aquatic plant community that provided valuable habitat to fish and wildlife. Over the last decade the habitat and water quality within Terrell’s Island has deteriorated to the extent that the system is now in a turbid algal state. It is not fully understood what exactly caused the decline but it can be assumed that high populations of shore birds, rough fish and little to no water circulation are the prime candidates. Since its decline, several management actions have been taken in hopes of improving the system, all with little effect. Since very little water quality data exists for Terrell’s Island, it was determined to collect basic water quality data following standard DNR sampling procedures. At the same time, Lake Butte des Morts was also sampled, using the same procedures, to allow for comparisons to be made between the two waterbodies (Figure 1).

**Objectives**

The main objectives of this study were as follows:

1. Collect important water quality data for both Terrell’s Island and Lake Butte des Morts.
2. Compare water quality data between the two systems to determine the magnitude of any differences.
3. Utilize this information to help guide future management decisions.

**Methods**

The project consisted of four water quality sampling events, one in the spring and three during the summer. The sampling protocol closely followed that of Long Term Trend monitoring for lakes. Water quality parameters sampled were total phosphorus, chlorophyll A, Total Kjeldahl Nitrogen, NO3 + NO2 and ammonia. Two stations were sampled; one inside the breakwall that creates Terrell’s Island (SWIMS ID: 713257) and the second in Lake Butte des Morts proper (SWIMS ID: 713406). In hindsight, the sampling point chosen on Lake Butte des Morts was most likely not a true representation of the water quality of the lake. We were not aware of this when designing the project and used an already established monitoring point. The chosen point was in the wind shadow of a large island (Benedicts Island) near Terrell’s Island where many shorebirds reside. It is believed that phosphorus / Chlorophyll A concentrations near this island may have been slightly elevated as compared to the rest of the lake. Keep this in mind when interpreting the results.

Figure : Sampling Locations during 2014 Terrell's Island Water Quality Assessment

**Results**

*Phosphorus*

Total phosphorus concentrations within Terrell’s Island increased throughout the growing season while levels in Lake Butte des Morts remained relatively consistent throughout the growing season (Figure 2). Average total phosphorus concentrations in Terrell’s Island and outside in Lake Butte des Morts were 0.129 mg/l and 0.087 mg/l, respectively. Peak phosphorus concentrations in Terrell’s Island were measured on August 18, 2014 when the concentration was .196 mg/l. Lake Butte des Morts recorded its highest concentration of phosphorus on July 22, 2014 when it was measured at .099 mg/l.

Figure 2: Total Phosphorus concentrations measured during Terrell’s Island Water Quality Assessment project

*Chlorophyll A*

Chlorophyll A concentrations follow a similar pattern inside Terrell’s Island and in Lake Butte des Morts (Figure 3). As expected, spring concentrations were low and gradually built up over the growing season. Lake Butte des Morts experienced more variability which can be explained by the Fox and Wolf Rivers flowing through the system. Average Chlorophyll A concentrations for Terrell’s Island and Lake Butte des Morts were 50.6 ug/l and 53.0 ug/l, respectively. The highest concentration in Terrell’s Island was measured on August 18, 2014 at 86.3 ug/l. A high value of 104.0 ug/l was measured in Lake Butte des Morts on July 22, 2014 which helped raise the average considerably. As mentioned previously, the sampling station on Lake Butte des Morts may not accurately reflect the water quality of the Lake overall.

Figure 3: Chlorophyll A concentrations measured during Terrell's Island Water Quality Assessment project

*Secchi Depth*

The water clarity was far better in Lake Butte des Morts when compared to Terrell’s Island (Figure 4). The average secchi depth for Lake Butte des Morts in 2014 was 2.94 feet. The average secchi depth for Terrell’s Island was 1.61 feet in 2014. As expected, increased water clarity was measured in the spring and gradually deteriorated over the summer months. Factors affecting water clarity in both systems include Chlorophyll A concentrations, wind driven sediment re-suspension and sediment re-suspension from rough fish.

Figure 4: Secchi depth measured during Terrell's Island Water Quality Assessment project

*Nitrogen*

Nitrogen concentrations within Terrell’s Island and Lake Butte des Morts can be can be seen below in Figures 5 and 6. Within Terrell’s Island, nitrogen concentrations continued to increase over the summer months while Lake Butte des Morts was not subject to the continued increase over the summer months most likely due to the “flushing” of the system by the Upper Fox River and Wolf River. The average total kjeldahl nitrogen concentration within Terrell’s Island was 1.88 mg/l. The average total kjeldahl nitrogen concentration in Lake Butte des Morts was 1.45 mg/l. Nitrate-Nitrite concentrations in Lake Butte des Morts gradually increased over the summer months while concentrations in Terrell’s Island remained relatively consistent.

Figure 5: Nitrogen series within Terrell's Island in 2014

Figure 6: Nitrogen series in Lake Butte des Morts in 2014

**Discussion**

Data collected during the 2014 project shows that the water quality within Terrell’s Island is worse than the water quality of Lake Butte des Morts proper. Terrell’s Island is basically a lake within a lake that has limited hydraulic flushing and is hyper-eutrophic. The existing internal load of nutrients is further exacerbated by carp perturbation and abundant bird feces. A carp gate was installed on the only entrance to Terrell’s Island in 1998 but has only recently been thought to be functioning properly. Carp surveys were conducted by Wisconsin DNR fishery staff in the late fall of 2015 and very few carp were found. This is likely due to the carp gate being purposefully left open in the early Fall to encourage carp to leave the system. So while it is known that carp prefer to leave Terrell’s Island in the winter, it is unknown whether the carp barrier is functioning as designed to keep carp out of the system. Current plans are to close the gate in the early spring to see if carp are able to re-enter the system. The electro fishing survey will be repeated in the summer of 2106 to determine how effective the carp barrier is and if possible repairs are needed.

A meander style plant survey was also conducted in 2015 by Wisconsin DNR staff. The survey showed that there are very few aquatic plants left in the system and only three species we; Water Celery (*Vallisneria americana*), American Lotus (*Nelumbo lutea*) and White water lily (*Nymphaea odorata*).

Management actions have also been taken to reduce the number of undesirable Pelicans and Cormorants using the system. Islands created within Terrell’s Island have been shaved down to deter these bird species from nesting and nesting Pelicans have had eggs oiled to deter them from using the site. Wildlife staff believes these actions have helped deter Pelicans and Cormorants from nesting within Terrell’s Island but these birds still use the site as a loafing area.

Figure : Areas of plant growth within Terrell's Island

Some potential options for future management are as follows.

1. Partner with the U.S. Army Corp of Engineers to study the system using their Wind-Wave Model. This would help determine the energy dynamics of the system which directly affects the re-suspension of lake bed sediment. It is possible that additional interior islands are needed to further break fetch and promote aquatic plant restoration.
2. Conduct a hydraulic analysis to determine if more inter-flow of water is needed between Lake Butte des Morts and Terrell’s Island. Theoretically:
   1. If the break wall that creates Terrell’s Island was breached in strategic locations, to allow some additional water interchange, it is likely that nutrient concentrations would be lowered. In addition, the water clarity of Lake Butte des Morts has been shown to be much clearer than that of Terrell’s Island. A combination of clear water interchange along with lowered nutrient levels in a shallow - low energy environment could result in the restoration of the aquatic plant community.

**Appendix A**

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| --- | --- | --- | --- | --- | --- | --- | --- |
| **Date** | **Location** | **Temp. (°C)** | **D.O. (mg/L)** | **pH** | **Conductivity (us/cm)** | **D.O. (% Sat.)** | **Secchi Depth (ft)** |
| 05/27/2014 | Terrell's Island | 23.4 | 6.6 | 10.4 | 319 | 77.6 | 2.7 |
| Lake Butte des Morts | 23.4 | 5.25 | 9.6 | 395 | 61.7 | 3.6 |
| 06/24/2014 | Terrell's Island | 23.8 | 6.66 | 7.94 | 336.1 | 79.3 | 1.75 |
| Lake Butte des Morts | 26 | 6.5 | 7.67 | 399 | 80 | 3.75 |
| 07/22/2014 | Terrell's Island | 25 | 8.07 | 8.64 | 383.5 | 97.4 | 1 |
| Lake Butte des Morts | 25.7 | 12.15 | 8.77 | 430.9 | 147.7 | 2.5 |
| 08/18/2014 | Terrell's Island | 22.4 | 9.1 | 8.64 | 374.5 | 105 | 1 |
| Lake Butte des Morts | 23.5 | 10.35 | 8.72 | 383.1 | 121.8 | 1.92 |

Table 1: Water quality data collected during Terrell's Island Water Quality Assessment project

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Date** | **Location** | **Total phos. (mg/L)** | **Chlorophyll A (ug/L)** | **Ammonia (mg/L)** | **TKN (mg/L)** | **NO3 + NO2 (mg/L)** |
| 05/27/2014 | Terrell's Island | 0.0856 | 23.5 | 0.0258 | 1.48 | ND |
| Lake Butte des Morts | 0.068 | 25.6 | 0.0495 | 1.18 | 0.17 |
| 06/24/2014 | Terrell's Island | 0.0794 | 15.3 | 0.209 | 1.47 | 0.134 |
| Lake Butte des Morts | 0.0831 | 15.4 | 0.0455 | 1.2 | 0.172 |
| 07/22/2014 | Terrell's Island | 0.156 | 77.3 | ND | 2.02 | ND |
| Lake Butte des Morts | 0.0999 | 104 | ND | 1.79 | 0.234 |
| 08/18/2014 | Terrell's Island | 0.196 | 86.3 | 0.0259 | 2.54 | 0.0277 |
| Lake Butte des Morts | 0.0961 | 67.1 | ND | 1.61 | 0.475 |

Table 2: Water quality data analyzed by SLOH during Terrell's Island Water Quality Assessment project