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SUMMARY

Old Taylor Lake, located in Waupaca County, Wisconsin is a natural seepage lake with a maximum depth of seventeen feet and an average depth of only five feet. The lake is characterized by severe winterkills (and thus virtually no fish life), widespread aquatic plant growth, a thick organic sediment layer, and steep shoreline. The main steward for the resource is the Old Taylor Lake Advancement Association (OTLAA).

Water quality monitoring indicated nutrient levels at or near expected levels for lakes of similar lake type and regional location. Winter monitoring indicated severe dissolved oxygen stress and anoxic nutrient release. A runoff sample indicated very high nutrient levels entering the lake near the boat ramp where severe erosion was also observed. Fecal coliform monitoring indicated little sanitary system influence.

Sediment sampling indicated a soft, highly organic sediment layer throughout the lake (thickest in the deepest areas of the lake). Heavy metals analyses indicated significantly higher levels near the inlet compared to an in-lake site but, overall, heavy metal levels were well below tolerance levels.

Aquatic plant growth was widespread and dominated by water shield, white and yellow water lily, various pondweeds and filamentous algae. Exotic species (including Purple Loosestrife, Curly-leaf pondweed, Eurasian Watermilfoil and Zebra Mussels) were not observed in Old Taylor Lake throughout 1997.

Future management of Old Taylor Lake should include: continued monitoring of the resource, establishment of a sport fishery, reduction of organic sediment, reduction of channelized runoff, and continued public involvement activities.

1. Further monitoring should be implemented. Expanded self-help monitoring (for nutrients), secchi readings, and winter nutrient/oxygen monitoring should be continued at minimum. The OTLAA should also consider implementing rainfall, lake level, fecal coliform and/or nutrient runoff measurements. Also, some pre-management monitoring should be planned in order to later assess management effectiveness.

2. An aeration program for the lake should be implemented. The recommended system would include a lake-wide system of diffusers adequate enough to turn the lake volume over once per day. Aeration should be coupled with bacterial seeding to not only establish a sport fishery, but also to reduce organic sediment in the lake. Lesser systems could be installed with lesser benefits; the minimum recommended system would include fewer diffusers and provide an area of fish refuge only.

3. The road to the boat ramp should be made less erodible. A grassed road would be best for reducing nutrient runoff and erosion.

4. OTLAA public involvement efforts should be continued and include quarterly newsletters, annual public meetings and news releases as necessary. Topics of public information should include general lake management issues, lake property land use practices to benefit the lake, exotic species identification/control/prevention and as well as new information from broad and local sources.

INTRODUCTION

Old Taylor Lake is a 29.6 acre natural seepage lake located in southwest Waupaca County, Wisconsin near the city of Waupaca (Figure 1). The lake currently has widespread nuisance aquatic vegetation and concern has been expressed about pollutants entering the lake through raw sewage disposal by campground residents, failing sanitary systems, and an abandoned township dump.

Historic management of the resource has been limited to fish stocking, winterkill monitoring, and aquatic plant harvest. The Old Taylor Lake Advancement Association (OTLAA) was formed in 1995, has about thirty-five members, and serves as the main steward for the resource. It was under their direction that this Phase I Lake Management Plan was developed and undertaken. The OTLAA contracted with Aquatic Biologists, Incorporated (ABI) of Fond du Lac, Wisconsin to carry out management planning efforts. In addition to OTLAA member contributions, funding was provided by the Wisconsin Department of Natural Resources (WDNR) Lake Management Planning Program and the Waupaca County Land and Water Conservation Department. The program's prioritized objectives as established by OTLAA were:

1. Determine Old Taylor Lake's current condition and health, especially (but not limited to) water quality status . . .
   . . . in the main body of the lake (two deepest areas)
   . . . at two likely problem areas--near the Holmes campground and at the inlet on the southwest corner of the lake.
2. Identify likely sources for lake water contaminants such as bacteria, nutrients, and/or volatile organic compounds. These sources could include aquatic plants, septic systems around the lake and/or along Pryse Road, the abandoned town dump on Pryse Road, etc.
3. Based on the above, develop a project report which describes the lake's current status and health, options for improving lake water quality, and recommendations for corrective actions which have the highest probability of success.
4. Work with the OTLAA to document pertinent characteristics of the lake and its watershed to be included as a secondary part of the project report.
5. Work with and through the OTLAA to disseminate information about the lake study and its findings to Association members and the wider community.

To achieve these objectives and goals, activities completed under this program included historic data review, water quality monitoring (winter, spring, summer, and runoff event), sediment analyses (for organic and heavy metal content), aquatic plant observation, public involvement activities, and a final report.

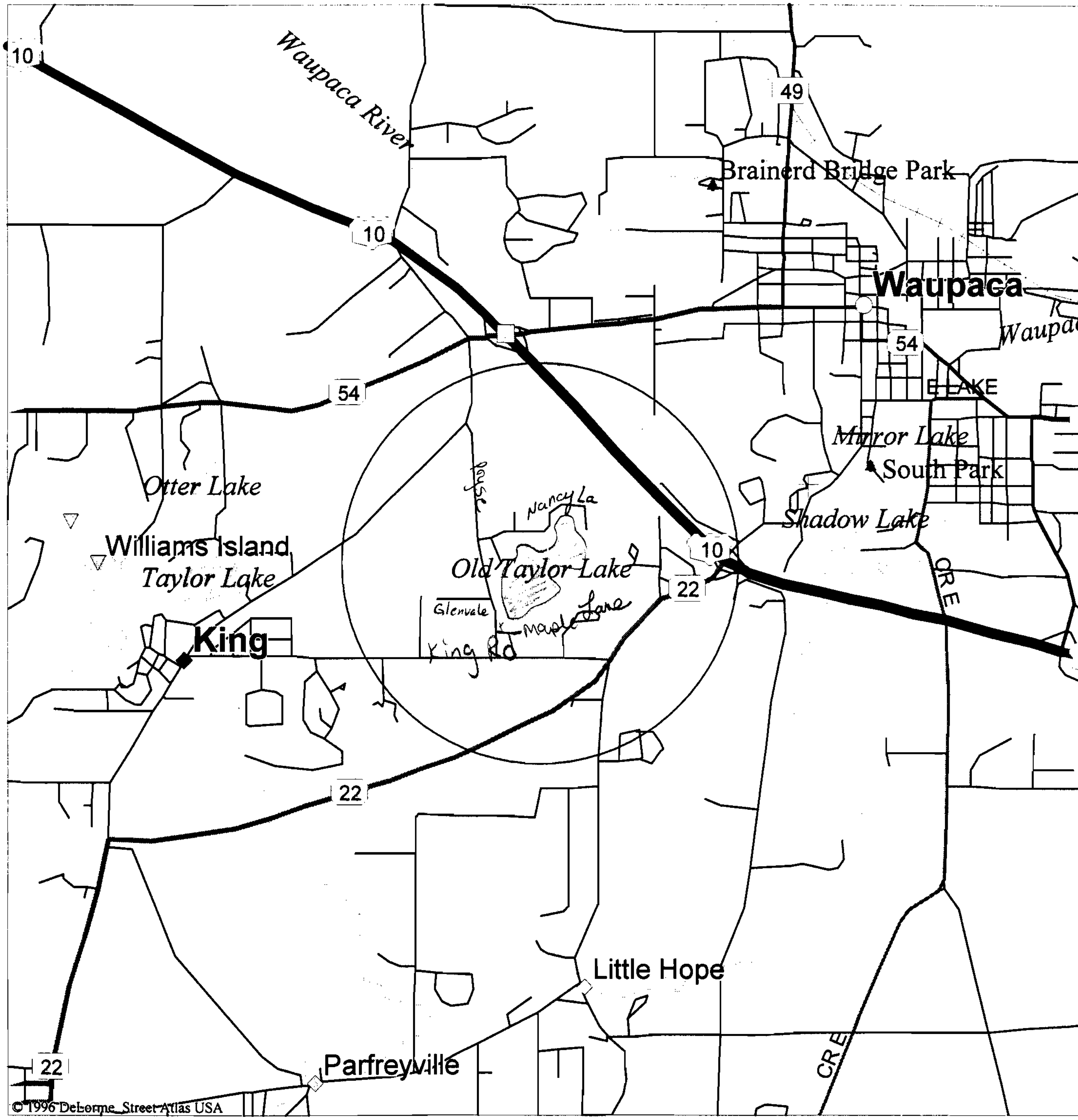

Figure 1. Project Location, Old Taylor Lake, Waupaca County, Wisconsin.

DESCRIPTION OF AREA

Old Taylor Lake is a dumbbell-shaped lake lying in a northeast-southwest orientation in Waupaca County, Wisconsin. The lake is comprised of two distinct basins: the northeast basin includes about one-third of the surface acreage and has a maximum depth of 13 feet; the southwest basin has a maximum depth of 17 feet. The average depth is 5 feet and 90 - 95 percent of the lake is habitat for aquatic plants. A small, continual, overland inflow is present at the southwest end of the lake, but the WDNR has classified the lake as a seepage lake (with no permanent inlets or outlets). This classification indicates that the major water source for the lake is groundwater inflow rather than flow from the watershed through the inlet.

Old Taylor Lake is approximately 0.44 miles long by 0.17 miles wide. The lake has 1.6 miles of shoreline of which nearly all is steeply sloped with sandy soils. There currently are 22 homes around the lake (15 permanent residents, 7 seasonal) with about 15 undeveloped lots (1). There are two areas of public access on the lake with one developed as a public boat ramp. A private campground with 113 sites (37 seasonal recreational vehicle sites) also exists on the southeast shore of the lake.

The Old Taylor Lake drainage basin comprises about 0.75 square miles (about 480 acres). About one-third of the watershed is forested and two-thirds are open areas which include wetlands (about 44 acres), fields and farmed areas (273 acres). Thirty percent of the drainage basin (144 acres) drains directly to the lake and 70 percent (336 acres) drains to the lake via the inlet at Pryse Road. Typical flow at the inlet was observed to be about 20 to 30 gallons per minute on all dates. The drainage basin to lake area ratio (the ratio of land drained to lake size, DB:LA) for Old Taylor Lake is about 16:1. The average DB:LA for seepage lakes is 8:1; the average for drainage lakes is 88:1.

Historic management of Old Taylor Lake has been limited to fish stocking and winterkill monitoring (1969 - 1979) and aquatic plant harvest (1995). Seven separate stocking efforts were undertaken in an eleven year period; seven winterkills were also recorded over those same eleven years (2) (Table 1). Stocking

Table 1. Summary of Fish Stocking Efforts and Winterkills, Old Taylor Lake (2).

Year	Species Stocked	Number
1968*	none	
1969	Northern Pike fry	15,000
	Walleye	550,000
1970*	none	
1971*	Northern Pike fry	50,000
1972*	none	80,000
1973	Yellow Perch (spawning)	200
1974	none	
1975*	none	
1976*	Northern Pike fry	50,000
	Yellow Perch (spawning)	2,000
1977	Northern Pike fry	50,000
1978*	none	
1979	Northern Pike fry	30,000

* denotes winterkill year

and winterkill monitoring efforts were abandoned in 1980 and will not be reconsidered by WDNR until the winterkill problem is alleviated (2). A few minnows and one four inch bullhead were observed during this study. A winterkill of fish and several hundred turtles was also observed.

One aquatic plant harvest was undertaken in the summer of 1995 by OTLAA. Schmidt Landscaping of Iola was the contractor, and removed 206 tons of plant material from the lake. The effort was completed in 72 machine hours at a cost of $5,334.18. Species removed (in order of abundance) were watershield, milfoil, pondweeds and lily pads (3).

During this study aquatic plant growth was widespread throughout Old Taylor Lake. Most dominant plants include floating filamentous and rooted species and submerged rooted species. Aquatic plant observations during this study included very abundant species: white water lily, yellow water lily, watershield, and large-leaf pondweed. Abundant species included water celery, leafy pondweed and coontail. White water crowfoot, naiad and sago pondweed were also present in Old Taylor Lake.

METHODS

WATER QUALITY MONITORING

Old Taylor Lake management planning program (LMPP) water samples were collected seasonally on February 12, April 21, June 24, July 29 and September 2, 1997. Samples were collected sub-surface (three feet below the water surface) and near bottom (three feet above the lake bottom) at Stations OTLNE (northeast basin) and OTLSW (southwest basin) and at mid-depth at Station OTLI (inlet at Pryse Road) (Table 2, Figure 2).

Field measurements included air temperature, water temperature, pH and dissolved oxygen (DO). Water temperature and DO were measured with a YSI Model 59 DO meter which was calibrated prior to and subsequent to daily use. A Hach Model FF-1A test kit was used for pH measurements. All water quality samples were collected between 9 a.m. and 11 a.m. on each sample date.

Samples for laboratory analysis were collected with a Kemmerer water bottle. Samples were immediately labeled, packaged, iced and otherwise preserved as necessary. All water quality laboratory analyses were completed by the Wisconsin State Laboratory of Hygiene (SLOH) per WDNR protocol.

Event monitoring was designed to estimate nutrient loading from runoff events. A single runoff event was sampled on September 16, 1997 at Station OTLI and at an area of channelized flow near the public boat ramp (Figure 2). Samples were collected by an OTLAA member and shipped to the SLOH for analysis.

Fecal coliform monitoring was also completed to determine the impact of septic systems on the lake. On July 29 and September 16, 1997 water was collected at twelve sites and analyzed for fecal coliform content. Fecal coliform analysis was also completed by the SLOH.

Table 2. Sample Station Descriptions, Old Taylor Lake, 1997.

SEASONAL WATER QUALITY MONITORING

Site	Description	Depth
OTLI	Inlet (Pryse Road)	0.25 feet
OTLNE	Northeast Basin	13.0 feet
OTLSW	Southwest Basin (Deepest Point)	17.0 feet

EVENT WATER QUALITY MONITORING

Site	Description	Depth
OTLI	Inlet (Pryse Road)	0.25 feet
Boat Ramp	Channelized flow at boat ramp	0.10 feet

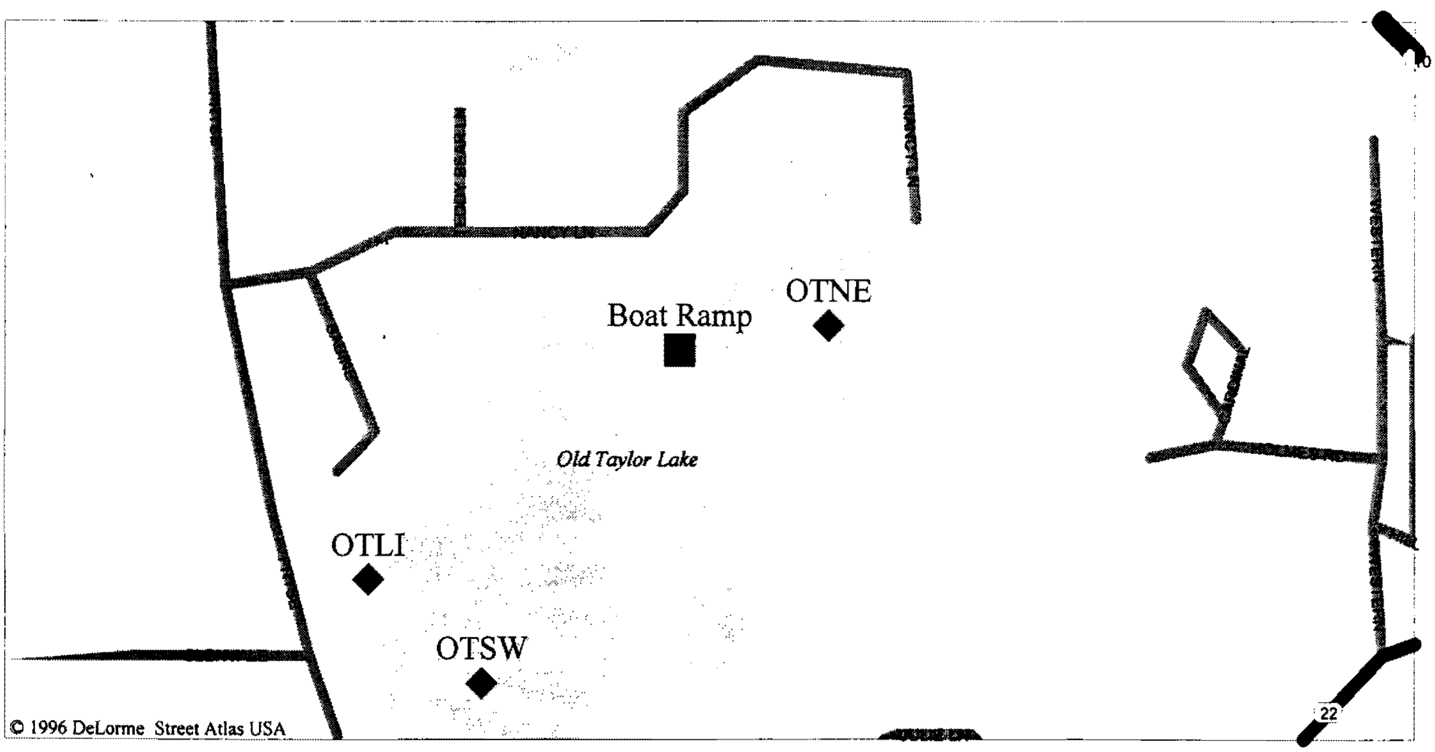

Figure 2. Sample Station Locations, Old Taylor Lake, 1997.

In addition to monitoring under this program, the OTLAA also began Expanded Self-Help Water Quality Monitoring through the WDNR Self-Help Monitoring Program (SHMP). Secchi readings were collected May through October; chlorophyll a and total phosphorus samples were collected on May 17, June 22, July 31, August 31, and October 2, 1997.

SEDIMENT ANALYSIS

An area of concern for the OTLAA is potential runoff from an abandoned township dump located across Pryse Road. The concern is that the dump may be leaching contaminants (i.e., heavy metals) to the lake. Since this planning effort had limited scope (and funds), it was agreed to collect a sediment sample in an area of probable influence from dump runoff, as well as another "control" site.

Samples were collected by pushing a 2.5 inch PVC pipe into the sediment to a depth of one foot. Contents were removed and placed into sample bottles, iced and shipped for analysis. A heavy metals scan was conducted for sediment near water quality sampling site OTLI (area of probable influence) and also near site OTLNE (control). Percent organic content was also determined for the two samples.

PUBLIC INVOLVEMENT PROGRAM

Public involvement activities were coordinated to inform and educate the OTLAA about lake management in general and specific information regarding the Old Taylor Lake resource. Activities included news releases, ABI newsletters, meetings and presentations to the OTLAA at board meetings. All current members of the OTLAA were also put on the "Lake Tides" mailing list.

DISCUSSION

WATER QUALITY MONITORING

Seasonal Monitoring

Total phosphorus levels (LMPP data) at the deepest point (OTLSW, ave. = 0.022 mg/l) (Table 3), were near observed levels for natural lakes (ave. = 0.025 mg/l), seepage lakes (ave. = 0.021 mg/l), drainage lakes (ave. = 0.040 mg/l) and lakes in the central region of Wisconsin (ave. = 0.020 mg/l; Figure 3) (4). Readings indicated slightly higher total phosphorus content for Station OTLNE (ave. = 0.025 mg/l, Table 4) and significantly higher content at Station OTLI (ave. = 0.051 mg/l, Table 5).

In-lake sampling showed highest levels of total phosphorus during winter, when dissolved oxygen (DO) was near zero indicating anoxic nutrient release (the release of phosphorus from sediment under low oxygen). Under conditions of adequate DO, total phosphorus levels would likely be much lower. Also, it appears that anoxic nutrient release was reflected in samples from the inlet where the water on the south side of Pryse Road is stagnated. Total phosphorus levels were significantly higher at the inlet throughout the open-water season and similar during the winter sampling period.

Nitrogen levels (LMPP data) at the deepest point (OTLSW, ave. = 0.68 mg/l) (Table 3), were below observed levels for natural lakes (ave. = 0.82 mg/l), seepage lakes (ave. = 0.76 mg/l), drainage lakes (ave. = 0.95 mg/l) and lakes in the central region (ave. = 0.72 mg/l; Figure 3) (4). In-lake nitrogen levels were slightly higher at Station OTLNE (ave. = 0.73 mg/l, Table 4) and Station OTLI (ave. = 0.82 mg/l, Table 5).

Water soluble metals information was also collected per WDNR protocol for the Spring sample date. These data are highly variable and mainly used to describe a lake rather than to assess its status. Data for all sites was very consistent and within typical ranges for Wisconsin lakes (4) (Table 6).

Table 3. Seasonal Sampling Water Quality Data, Station OTLSW (Southwest Basin), Old Taylor Lake, February 1997 - September 1997.

PARAMETER	SAMPLE[1]	DATE				
		02/12/97	04/21/97	06/24/97	07/29/97	09/02/97
Air Temperature (degrees Fahrenheit)		20	48	80	77	65
Water Temperature (degrees Fahrenheit)	S	36.7	48.2	80.4	78.4	71.8
	B	41.4	43.7	59.5	68.6	67.5
pH (surface units)	S	7.0	7.75	7.75	7.75	8.0
	B	7.0	7.25	7.0	7.0	7.0
Dissolved Oxygen (mg/l)	S	0.25	12.20	8.87	8.27	7.97
	B	0.20	10.27	3.54	3.04	3.14
Total Kjeld. Nitrogen (mg/l)	S	0.8	0.4	0.6	0.8	0.8
	B	1.23	0.6	0.690	1.19	1.4
Ammonia Nitrogen (mg/l)	S	0.133	ND[2]	0.015	ND	ND
	B	0.540	0.022	0.041	ND	ND
NO_2 + NO_3 Nitrogen (mg/l)	S	ND	ND	ND	ND	ND
	B	0.024	ND	ND	ND	0.118
Total Nitrogen (mg/l)	S	0.8	0.4	0.6	0.8	0.8
	B	1.254	0.6	0.690	1.19	1.518
Total Phosphorus (mg/l)	S	0.032	0.024	0.013	0.021	0.022
	B	0.0820	0.027	0.021	0.067	0.094
Dissolved Phosphorus (mg/l)	S	ND	0.002	ND	ND	ND
	B	0.034	0.003	ND	ND	ND
Nit./Phos Ratio (mg/l)	S	25.0	16.7	46.2	38.1	36.4
	B	14.9	22.2	32.9	17.8	16.1
Chlorophyll a (ug/l)	S	NC[3]	4.47	5.3	8.63	8.75

[1] S = surface, B = bottom; [2] ND = not detectable; [3] NC = not collected;

Table 4. Seasonal Sampling Water Quality Data, Station OTLNE (Northeast Basin), Old Taylor Lake, February 1997 - September 1997.

PARAMETER	SAMPLE[1]	DATE				
		02/12/97	04/21/97	06/24/97	07/29/97	09/02/97
Air Temperature (degrees Fahrenheit)		20	48	80	77	65
Water Temperature	S	39.0	48.6	82.0	77.7	72.3
(degrees Fahrenheit)	B	41.0	45.9	69.1	69.8	69.3
pH	S	7.0	8.0	7.75	7.75	8.0
(surface units)	B	7.0	7.0	7.0	7.0	7.0
Dissolved Oxygen	S	1.30	11.37	8.17	8.56	8.37
(mg/l)	B	0.90	9.02	7.28	3.40	3.73
Total Kjeld. Nitrogen	S	1.0	0.4	0.750	0.76	0.7
(mg/l)	B	1.1	0.5	0.950	1.80	1.5
Ammonia Nitrogen	S	0.025	ND[2]	0.004	ND	ND
(mg/l)	B	0.197	ND	0.005	0.535	0.024
$NO_2 + NO_3$ Nitrogen	S	0.013	ND	0.010	ND	ND
(mg/l)	B	0.020	ND	0.010	0.022	ND
Total Nitrogen	S	1.013	0.4	0.760	0.76	0.7
(mg/l)	B	1.120	0.5	0.960	1.822	1.5
Total Phosphorus	S	0.052	0.019	0.013	0.024	0.015
(mg/l)	B	0.032	0.027	0.032	0.067	0.049
Dissolved Phosphorus	S	ND	ND	ND	ND	ND
(mg/l)	B	ND	ND	ND	ND	ND
Nit./Phos Ratio	S	19.5	21.1	58.5	31.7	46.7
(mg/l)	B	35.0	18.5	30.0	27.2	30.6
Chlorophyll a (ug/l)	S	NC[3]	2.87	4.88	9.41	6.5

[1] S = surface, B = bottom; [2] ND = not detectable; [3] NC = not collected;

Table 5. Seasonal Sampling Water Quality Data, Station OTLI (Inlet at Pryse Road), Old Taylor Lake, February 1997 - September 1997.

PARAMETER	SAMPLE[1]	DATE				
		02/12/97	04/21/97	06/24/97	07/29/97	09/02/97
Air Temperature (degrees Fahrenheit)		20	48	80	77	65
Water Temperature (degrees Fahrenheit)	M	46.9	54.3	74.3	74.7	73.8
pH (surface units)	M	7.0	6.75	7.0	7.0	7.25
Dissolved Oxygen (mg/l)	M	1.80	9.51	7.52	5.70	4.92
Total Kjeld. Nitrogen (mg/l	M	0.84	0.5	0.7	1.04	1.0
Ammonia Nitrogen (mg/l	M	0.302	ND[2]	0.081	0.013	0.013
$NO_2 + NO_3$ Nitrogen (mg/l)	M	0.020	ND	ND	ND	0.016
Total Nitrogen (mg/l)	M	0.86	0.5	0.7	1.04	1.016
Total Phosphorus (mg/l)	M	0.0590	0.025	0.030	0.080	0.059
Dissolved Phosphorus (mg/l)	M	0.014	0.003	0.005	0.012	0.006
Nit./Phos Ratio (mg/l)	M	14.6	20.0	23.3	13.0	17.2
Chlorophyll a (ug/l)	M	NC[3]	4.87	4.49	NR[4]	5.18

[1] M = mid depth; [2] ND = not detectable; [3] NC = not collected; [4] NR = no reading--laboratory accident;

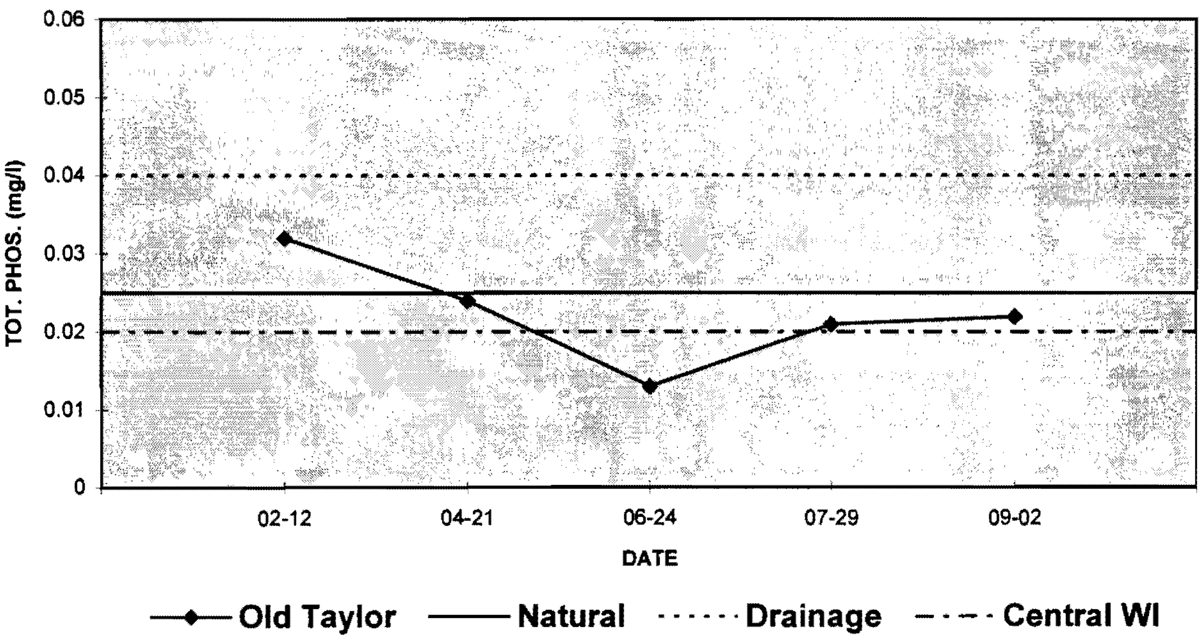

Figure 3. Total Phosphorus Comparison, Southwest Basin, Old Taylor Lake, 1997.

Table 6. Spring Water Quality Metals Data, Old Taylor Lake, April 21, 1997.

PARAMETER	SAMPLE[1]	SITE		
		OTLNE	OLTSW	OTLI
Iron (mg/l)	S	0.20	0.35	0.47
Magnesium (mg/l)	S	9.8	10	9.2
Manganese (ug/l)	S	6	17	33
Potassium (mg/l)	S	1.3	1.2	1.1
Sodium (mg/l)	S	4.0	3.8	3.6

[1] S = surface;

Event and Self-Help Monitoring

Event total phosphorus and total nitrogen levels (0.057 mg/l and 0.924 mg/l, respectively) for Station OTLI were near the seasonal monitoring average (Tables 5 and 7). The sample from the boat ramp, however, showed very high levels of total phosphorus (0.976 mg/l) and total nitrogen (3.095 mg/l, Table 7). Also, erosion was so severe in this area that the road had to be repaired.

Self-help secchi information was collected by two OTLAA volunteers and included nineteen measurements for Station OTLNE and five at OTLSW. The average secchi depth for OTLSW was 6.65 feet (range = 5.5 - 8.5 feet); OTLNE had an average secchi depth of 7.2 feet (range = 5.25 - 12.25 feet, Figure 4). Site OTLNE showed a trend of highest clarity in spring and fall readings and lowest clarity during the summer months. Average secchi transparency for different lake types indicates: natural lakes, 7.9 feet; seepage lakes, 8.9 feet; drainage lakes, 6.2 feet; and central region lakes, 7.9 feet (4).

Table 7. Event Sampling Water Quality Data, Old Taylor Lake, September 16, 1997.

PARAMETER	SAMPLE[1]	SITE: INLET	SITE: BOAT RAMP
Total Kjeld. Nitrogen (mg/l)	M	0.9	2.4
Ammonia Nitrogen (mg/l)	M	0.037	0.163
NO_2 + NO_3 Nitrogen (mg/l)	M	0.024	0.695
Total Nitrogen (mg/l)	M	0.924	3.095
Total Phosphorus (mg/l)	M	0.057	0.976
Dissolved Phosphorus (mg/l)	M	0.007	0.278
Nit./Phos Ratio (mg/l)	M	16.2	2.119

[1] M = mid depth;

Self-help monitoring indicated a total phosphorus average of 0.025 mg/l (LMPP was 0.024 mg/l). Chlorophyll a averaged 9.0 ug/l (LMPP was 6.79 ug/l). Self-help data was consistent with LMPP data.

Fecal Coliform Monitoring

Another area of concern for OTLAA was that there may be several failing sanitary systems around Old Taylor Lake. Twelve samples were collected on each of two dates to test the presence of fecal coliform bacteria, which is found in human feces and detected near failing sanitary systems. Samples were collected on July 29 and September 16, 1997. July samples indicated an average of 17.3 fecal coliform colonies per 100 milliliters (MFFCC), with a range from 0 to 60 MFFCC. The September average was 14.2 MFFCC (range = 0 - 110, Figure 5).

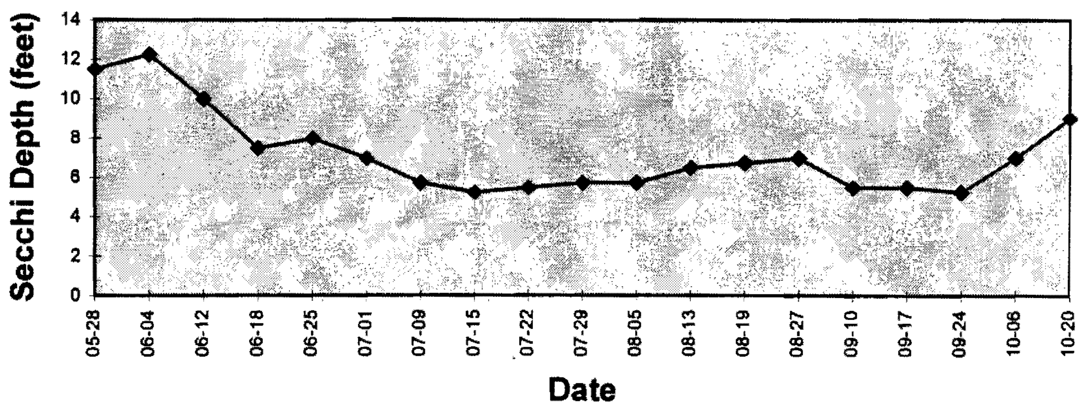

Figure 4. Secchi Transparency, Northeast Basin, Old Taylor Lake, 1997.

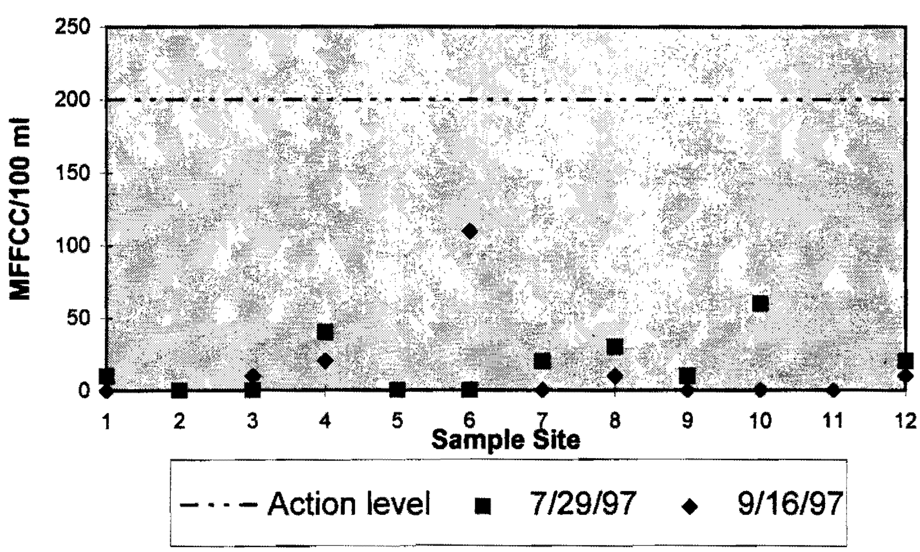

Figure 5. Fecal Coliform Levels, Old Taylor Lake, 1997.

Standards for public beaches indicate an "advisory level" at 100 MFFCC and an "action level" at 200 MFFCC for an average of least five samples collected in a one month period. A single sample collected on the September sample date did exceed the advisory level, but the average for all samples on that date was lower than the July samples and both dates indicated very low levels overall.

SEDIMENT ANALYSIS

There is some variance with respect to lake sediment heavy metals' "lowest effect levels" (LEL, i.e., the lowest level of a particular metal which begins to effect biological activity) among resource management agencies. When comparing data for Wisconsin lakes there are a number of different standards available including the United States Environmental Protection Agency (5), WDNR (6) and the Ontario Ministry of the Environment (OME) (7). For our comparisons, data will be compared to the most stringent standards (those allowing the lowest amount of pollution) which is the OME set of standards.

In Old Taylor Lake, Site OTLI measured much higher than OTLNE in heavy metal content for almost all parameters measured (Table 8). The highest readings (at Station OTLI), however, fall below the Lowest Effect Level (LEL) established by the OME for cadmium, chromium, mercury and lead, and slightly higher than those levels for arsenic (Table 9) with an average of 73.0 % of the LEL. When OTLI data are compared to the Limit of Tolerance (LOT, the highest acceptable level for a particular metal) they average only 10.2 % of the LOT.

NOTE: The differences in metals levels between OTLI and OTLNE are most likely related to proximity of the OTLI sample site to Pryse Road. The low metals levels overall, do not indicate significant impact (if any) from the abandoned town dump.

Organic content was also determined for the same two sites and measured much higher at OTLNE (77.3 percent organic matter) compared to OTLI (17.2 percent) and was evident by the "mucky" nature of the depositional site OTLNE compared to the sandy material at the periodically flushed area of OTLI (Table 8).

Table 8. Sediment Heavy Metal and Organic Content Data, Old Taylor Lake, 1997.

PARAMETER	SITE			
	OTLNE[1]	OTLI[1]	Lowest Effect Level	Limit of Tolerance
Arsenic	3.08	7.41	6	33
Barium	66.7	38.0	NE[3]	NE
Cadmium	ND[2]	0.34	0.6	10
Chromium	4.20	8.15	26	110
Lead	3.39	27.5	31	250
Mercury	ND	0.13	0.2	2
Selenium	1.27	ND	1.7	NE
Silver	ND	ND	NE	NE
Organic matter content (percent)	77.3	17.2		

[1] All values in mg/kg (dry weight) unless otherwise noted; [2] ND = not detectable; [3] NE = none established;

Table 9. Heavy Metal Data Comparison to Established Effect Levels (7), Station OTLI, Old Taylor Lake, 1997.

Parameter	% of Lowest Effect Level	% of Limit of Tolerance
Arsenic	123.5	22.5
Cadmium	56.7	3.4
Chromium	31.3	7.4
Lead	88.7	11.0
Mercury	65.0	6.5

CONCLUSIONS AND RECOMMENDATIONS

Old Taylor Lake is a lake out of balance. While the lake is minimally affected by outside contamination (i.e. failing sanitary systems, abandoned dump runoff), it is internal recycling of nutrients already present in the lake which cause this imbalance. Extensive shallow areas and good water clarity allow sunlight penetration to almost the entire lake bottom. This condition combined with thick, nutrient rich sediment, provides an excellent environment for aquatic plant growth. In addition, unstable dissolved oxygen levels cause additional nutrient release and severe winterkills, which further contribute to an imbalanced food chain. Excessive plant growth and the lack of an established fishery combine to limit a balanced biology for the lake as well as limiting recreational opportunities.

WATER QUALITY

Findings:

1. There were extremely low dissolved oxygen (DO) levels during winter (less than 1 mg/l) and fairly low levels during the summer (2 - 4 mg/l) for bottom sample sites. Most game fish require levels of 3 - 5 mg/l to survive.
2. Average annual nutrient levels (nitrogen and phosphorus) were near expected levels for similar lake types and regional location. Levels would be reduced with adequate DO throughout the water column.
3. Very high nutrient levels were observed during a runoff event at the boat ramp. These levels indicate not only nutrient contamination to the lake, but also probably reflect significant sediment and other contaminants entering the lake at this site. Also, severe erosion of the boat ramp occurred during 1997.
4. Self-help monitoring indicated similar levels of nutrients as collected through the planning program.
5. Fecal coliform levels were very low and sanitary system influence on the lake is minimal.

Recommended Actions:

1. Water quality monitoring should be continued. At a minimum, expanded self-help monitoring (5 times per year) and secchi depth (weekly) monitoring should be undertaken. OTLAA should also consider, however, taking further nutrient (nitrogen and phosphorus) samples in winter (when self-help is not conducted), measuring lake level and rainfall, sampling runoff events, and fecal coliform monitoring.
2. An adequate aeration system should be installed. The system should be large enough to turn the volume of lake water over at a rate of once per day. Aeration will provide stable DO levels during winter and increase lake bottom DO levels during summer. A lake-wide aeration system is recommended and would not only provide adequate DO for the fishery, but also reduce anoxic nutrient release and coupled with bacterial seeding (see Sediment) will reduce organic sediment. Lesser systems could be installed with lesser results. Aeration may actually be detrimental to the lake if not properly designed.
3. Subsequent to any aeration project, water quality should be monitored for a year before introducing compatible fish species. Important measurements would include continued nutrient and DO monitoring.
4. The road at the boat ramp should be made less erodible. Instead of paving, some type of grassed road (Geo-Web, cement blocks that allow grass to grow through) should be considered in the future. The township may consider utilizing nonpoint source funds available through the Waupaca/Tomorrow Priority Watershed Program for this work.

SEDIMENT

Findings:

1. There were significant differences in heavy metal content of in-lake and inlet sites and are probably a result of road runoff rather than runoff from the abandoned dump. Even the highest levels of the highest parameters are well below the lowest standards of tolerance (LOT), however.
2. The soft sediment layer is highly organic and thick, especially in deepest area of the lake.

Recommended Actions:

1. Testing to more accurately determine the source of metals near the inlet would likely be very expensive and should not be pursued, given the low measured levels.

2. Depth and organic content of sediment should be measured at locations where measurements can be reproduced in the future. This will allow determination of the effectiveness of future management efforts.

3. Bacterial seeding (natural spiking of the bacteria in the lake) should be undertaken to reduce the organic sediment in the lake. The bacteria digest the organic matter and are then eaten by invertebrates and fish. Instead of fueling plant growth, the nutrients become part of the animal food chain.

4. Aeration must be used in conjunction with bacterial seeding in order to effectively reduce organic sediment. Aeration/seeding has proven effective when used lake-wide on a number of lakes. In some cases, organic sediment has been reduced by over six feet in areas. Localized seeding programs (i.e., small areas of the lake) have also been successful and may be applicable here.

OTHER

Findings:

1. Purple Loosestrife and other exotic species (Curly-leaf Pondweed, Eurasian Watermilfoil and Zebra Mussels) were not observed during this planning program but are present in Wisconsin.

2. Watershed inputs to the lake were relatively minimal. Plant growth is more a function of internal recycling of nutrients.

3. Aquatic plant growth is widespread and at nuisance levels in many areas. Nuisance species include watershield, white and yellow water lilies, various pondweeds, and filamentous algae.

Recommended Actions:

1. Fish stocking efforts should be undertaken with WDNR assistance when appropriate. The WDNR has expressed interest in providing fish for stocking only if an adequate aeration system is in place.

2. A volunteer should be appointed to watch for Purple Loosestrife. Plants should be removed immediately after flowering. The OTLAA membership should also be educated about Purple Loosestrife.

3. Management of aquatic plants could be continued to enhance lake aesthetics and recreational opportunities. Control methods could include aquatic plant harvest or herbicide treatments in selected areas. Use zones should be determined and plants managed according to each zone's use. Management of aquatic plants should be considered only after the effectiveness of aeration and/or other management options is assessed.

4. Public involvement efforts should be continued. Newsletters, news releases and meetings are all effective means of keeping people involved and aware of management issues.

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