MOODY LAKE PLANNING GRANT

PHASE I
INVENTORY
&
RECOMMENDATIONS

Completed by
Moody Lake Area Assoc. Inc.
&
Rand Atkinson, Aquatic Resources, Inc.

In Cooperation with
Wisconsin Department of Natural Resources
Lake Planning Grant Program

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INTRODUCTION

Background

Moody Lake is a 17.7 acre soft water seepage lake located in northwest Oconto County, Wisconsin. The lake is acid with light brown water if moderate transparency. A maximum depth of 9 feet was found at two locations on the lake.

The immediate watershed that flows into Moody Lake is small and moderately sloped. Wetlands and bogs are connected to the lake on the north and south sides. The east shore has been developed for homes and cottages. The west shore areas are bordered by State Highway 32.

The Moody Lake Area Association, Inc. was formed in 1993 to address water quality and recreational concerns of the lake community. Watershield, a floating aquatic plant, now dominates the aquatic plant community. It has grown to nuisance levels that affect, the recreational uses of this small lake.

Goals and Objectives

The objective of this study was to assess and inventory the physical, chemical and biological characteristics that affect the water quality and recreational resources of Moody Lake. This physical assessment included a soil and physical geography inventory of the watershed and surrounding area Lake physical conditions including oxygen, temperature, and water clarity were observed over a one year period. Chemical sampling was completed and analyzed during several key periods to assess the water quality as the seasons changed. Observations, sampling, and surveys were used to assess the plant and animal communities. A property owner's survey was combined with several interviews to analyze and assess lake usage and conflicts.

The goal of this planning grant was to use this resource data to identify problems that exist and formulate preliminary lake and fish management plans to address these problems.

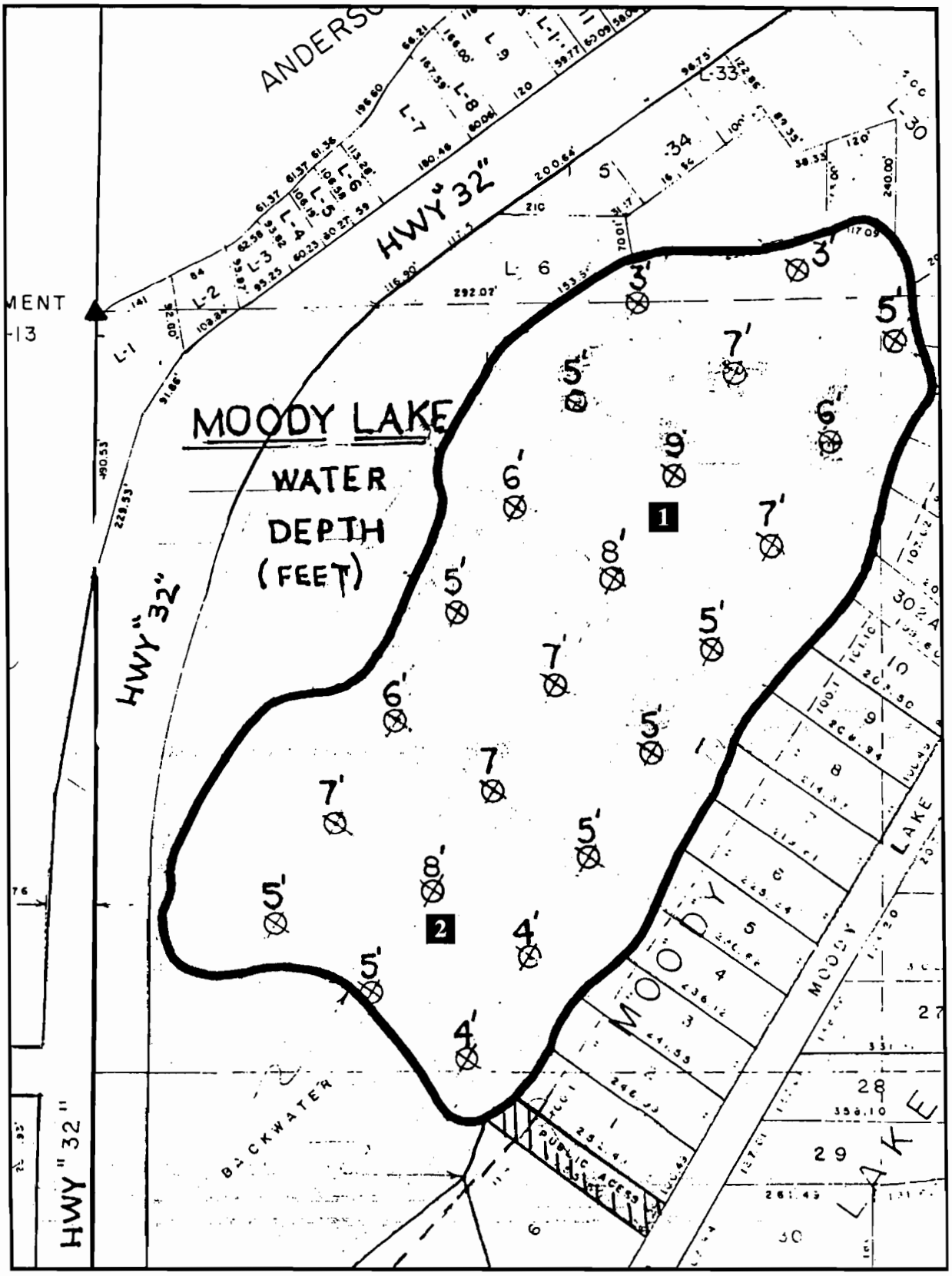
ACKNOWLEGEMENTS

A special thanks to LOU ANN and DAN CONWAY who have taken the lead in all aspects of this grant. They were able to be the consultant's "eyes" between data gathering visits. Their observations of what happened to the lake in the past were very important in understanding the lake resource. The data they gathered as part of the extended secchi disc program of the Department of Natural Resources Lake Self-Help Program helped make the consultant's objectives easier. They provided assistance in gathering information in all aspects of the study from note taking, rowing, to information gathering from residents.

A thanks also goes to two other lake community residents. Thank you, KEN ARNDT, who assured me the ice was safe during late winter sampling and was there in case it wasn't. A thanks to a fisherman named DICKIE HATFIELD who was our junior biologist catching, measuring, and pulling scales from fish.

A thank you to all the lake area residents who contributed to the raffle ticket program to gather funds for the lake's share of the grant cost. Also, thanks to the Department of Natural Resources Lake Grant Program for their funding.

Figure 1: **Water Quality Samply Locations of Moody Lake 1994 & 1995**



1 Locations of Water Chemistry Sampling and Dissolved Oxygen Temperature Profiles in 1994 & 1995.

2 Added Location of Dissolved Oxygen Temperature Profiles During the Winter of 1994-1995.

WATER QUALITY OF MOODY LAKE
OCONTO COUNTY, WISCONSIN

Assessment of the water quality of Moody Lake was made using compiled data from water chemistry sampling, physical limntic studies, and plankton sampling collected in 1994 and 1995. This information was combined with existing natural history data and other biological data collected as a part of this grant to assess the resources of Moody Lake. Past water quality data and other resource information was limited to basic water inventory data collected in 1970. An ecological assessment approach was used in understanding, interpreting, and in communicating the present information collected as part of the grant.

PROCEDURE

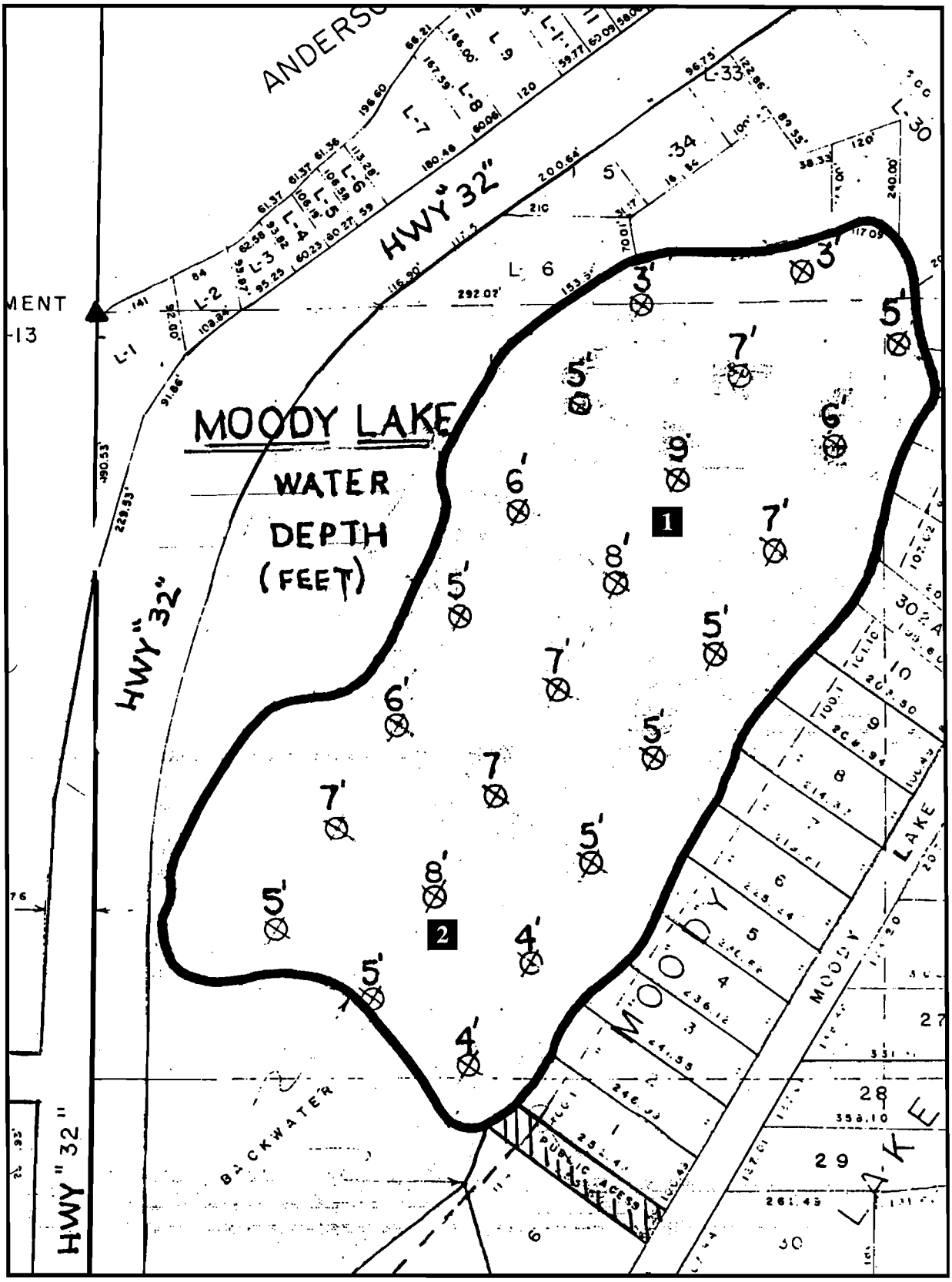
Water quality information on Moody Lake was collected form April 19, 1994 to March 27, 1995. Water chemistry sampling followed the DNR Ambient Lake Monitoring Protocol as close as possible. The consultant and Self Help Volunteer cooperated in gathering the chemical data needed for assessment and were able to gather additional physical data through this cooperation. All sampling occurred in a deep hole in the north central area of the lake except a second (south central deep) location was added to monitor the extent of winter oxygen depletion (Figure 1).

Secchi disc readings, oxygen/temperature profiling, plankton sampling, and water chemistries were all included in the water quality assessment. Under the ice oxygen/ temperature profiling sampling was added to assess the timing and impact of oxygen depletion.

RESULTS AND DISCUSSION

Moody Lake is a 17.7 acre, very soft water, seepage lake with a maximum depth of 9 feet. Approximately 70% of the bottom is made up of a peat muck substrate and sand covers the rest of the bottom along the littoral areas of the lake. The accumulation of the above organic matter and the fluctuations of water levels have considerable impact on the water quality and ecology of Moody lake. Oxygen/temperature profiles, secchi disc results, water chemistry results, and associated observations can be found in Tables A through O.

Figure 1: **Water Quality Samply Locations of Moody Lake 1994 & 1995**



1 Locations of Water Chemistry Sampling and Dissolved Oxygen Temperature Profiles in 1994 & 1995.

2 Added Location of Dissolved Oxygen Temperature Profiles During the Winter of 1994-1995.

The chemical elements described in the water chemical analyses of Tables A, M, and N provided the additional pieces needed to put the Moody Lake ecological puzzle together. The "under the ice" water chemistry taken on March 27, 1995 (Table M) is important in understanding what nutrients and minerals effect Moody Lake. It is at this late winter period when most nutrients and minerals available for biological growth during the open water growing season are dissolved in the water. Water chemistry sampling at "spring turnover" was taken shortly after ice out (Table A). It is at this time that wind and wave action mix the entire lake and temperature is the same from top to bottom. Most nutrients held on or near the bottom of Moody Lake are brought into the water column to react with minerals as temperature increase and the growing season begins. During the growing season phosphorous sampling was combined with plankton and physical sampling to trace biological activity at the base of the food chain(# Table N.) PHOPHORUS is the limiting element that controls biological activity in Moody Lake.

The statement above describing Moody Lake as 'very soft water' is reflected in several elements of the water chemistry. CALCIUM along with MAGNESIUM are the principle sources of ALKALINITY and HARDNESS in water. CALCIUM and MAGNESIUM concentrations were 2.6 and 1.4 milligrams per liter (mg/1), respectively, which support very low AKALINITY and HARDNESS levels. ALKALINITY was 11 mg/1 under the ice and 9 mg/1 at spring turnover. HARDNESS was 12 mg/1 at spring turnover.

The HARDNESS and ALKALINITY of Moody lake are affected by the amount of CALCIUM and MAGNESIUM that enter the lake from the soil and bedrock of the lake's watershed. Moody Lake being a seepage lake receives its water from rainfall and groundwater aquafers. Moody Lake with its small watershed and relatively impervious soils on three sides has limited ground water entering it. Peat or muck organic soils cover the bottom and areas north and south of the lake which are also mineral barriers. Much of the surrounding upland soils are sandy glacial till or outwash composed of quartz or other insoluble minerals that add very little CALCIUM or MAGNESIUM to Moody Lake.

In the categorization of HARDNESS Moody Lake's 12 mg/1 falls at the lower end of the soft water category (range of 0 to 60 mg/1). It is obvious from the low concentrations of all four above chemical parameters that few minerals are leached from the surrounding soil and bedrock.

The amount of ALKALINITY largely determines the pH of the lake water. The ALKALINITY is the first defense in preventing acidification. Moody lake with an ALKALINITY of 9-11 mg/1 is moderate to low in its susceptibility to acid rain.

The seasonal low oxygen conditions affect many chemical parameters. Under low oxygen conditions more carbon dioxide can be found in the water. Carbon dioxide reacts with water to form the weak acid, carbonic acid. This in turn affects the pH (ACIDITY) of water which regulates the solubility of many other minerals, including the amount of ALKALINITY in the bicaronate
(HCO3-) form and carbonate (CO3-) form.

The low to no oxygen conditions and the chemical reactions that occur because of this, oxygen affect the solubility of other minerals and organic substances that are necessary for plant and animal growth. Many of these resulting elements form compounds that can be toxic to fish and inhibit plant growth. Other elements cannot develop compounds in a form that can be used by plants and animals.

Certain nitrogen compounds can be toxic to both fish and fish food organisms if they do not break down in an oxygen rich environment. The decomposing organic matter (plant and animal) releases AMMONIA that converts to NITRITE, then to NITRATE if oxygen is present and temperatures/ph are adequate. Under the low pH/ low oxygen conditions that Moody Lake has during winter, AMMONIA-N builds up beneath the ice and further stresses fish. AMMONIA-N was detected between 0.027 & 0.085 at two feet below the ice as temperatures and lack of oxygen prevented its breackdown. The major source of these nitrogen compounds in Moody Lake is the soft substrate and decomposing aquatic plants (mainly watershield). NITROGEN is plentiful in Moody Lake and it needs oxygen to be recycled and channeled into beneficial plant and animal growth.

High levels of IRON and MANGANESE were found under the ice during the late winter water sampling. Total IRON was in Moody Lake was 1.6 mg/1 where in most natural waters concentrations are usually of the order of 0.05 to 0.2 mg/1. MANGANESE was at .140 mg/1. Both of these minerals are highly soluble in water under low oxygen conditions that have high carbon dioxide (CO2) levels and are poorly buffered (pH slightly below 7.0). All these conditions exists in Moody Lake.

The effects of low dissolved oxygen on PHOSPHOROUS, IRON, and SULFATE levels are evident in Moody Lake. PHOSPHORUS is the most important nutrient limiting the amount of algae and weed growth in Moody Lake. PHOSPHORUS is not highly soluble in water and precipitates with IRON to the lake sediments when oxygen is present. But when Moody Lake looses oxygen in winter and in deep water in summer, IRON and PHOSPHORUS become soluble again - the IRON and PHOSPHOROUS are released into the overlying water and enter the root system of the dominant plant, watershield. SULFATE levels in Moody Lake were found to be quite low and did not exeed normal background concentrations found in this geological area. In water depleted of oxygen, SULFATE can be reduced to hydrogen sulfide. Hydrogen sulfide has a rotten egg odor and is toxic to aquatic organisms. The SULFIDE ions produced under these conditions react with metal ions including IRON - which forms an iron sulfide precipatate with. Bottom sediment brought up with the anchor during sampling often smelled of this precipitate. Oxygen depletion occurred in this loose-flocculent bottom area at the deepest spot in Moody Lake except during spring and fall mixing periods (Table O).

PHOSPHORUS levels two feet off the bottom were greatest under the ice during late winter when no mixing occured and oxygen levels throughout the profile were very low (Table O & N). There was no change from levels of DISSOLVED REACTIVE PHOSPHORUS from under the ice sampling to spring turnover sampling at both top and bottom sampling locations. The concentrations were .003 mg/l and .002 mg;l at top and bottom, respectively. This compound of phosphorous dissolves in water and readily aids plant growth. DISSOLVED REACTIVE PHOSPHORUS concentrations of 0.01 or less at spring turnover has proven to deter summer plancton blooms. In Moody Lake's case, plankton blooms are light as little PHOSPHORUS enters the water column for phytoplankton growth under present conditions.

It is evident from PHOSPHORUS sampling, plankton observations, secchi disc readings, and dissolved oxygen profiling that nutrient mixing from bottom sediments into the water column is important in removing phosphorus away from the soft bottom sediments where the watershield horizontal root stems are located. Mixing in shallow water areas is also inhibited by dense beds of watershield. The lake would benefit from artificial mixing of nutrients and addition of oxygen to the bottom subtrate in summer if the oxygen demand of the bottom sediments does not exceed oxygen being added by wind and artificial aeration. Winter aerating and mixing would prevent further winterkill from occuring, thereby channeling PHOSPHORUS and other nutrients/minerals to fish food organisms and fish.

Several elements of water chemistry that indicate the presence of human induced changes in Moody Lake were part of the sampling. CHLORIDES were analyzed as an indicator of possible pollution source from septic systems or drainage from the road salting of STH 32. CHLORIDES were 4.3 mg/l during spring turnover and 4.5 under the ice in March 1995. These levels exceed the general distribution gradients for CHLORIDES which are usually less than 3.0 mg/l for the area. But a review of the geology of the area indicates that mineral soils found in more southern areas that would have higher levels of CHLORIDES may have been deposited in the area by the most recent glacial activity. SODIUM and POTASSIUM are also possible indicators of human pollution in a lake since naturally occuring levels of these minerals in soil and water are low. SODIUM is often associated with CHLORIDE and often enters the lake from the same sources. POTASSIUM is a key component in potash fertilizer and is abundant in animal waste. The sampling of these elements provided background levels, so any increases in concentration values over time can mean there are long term effects caused by pollution.

Moody Lake has a yellow-brown natural COLOR because of the effect of the flooded wetland areas that join the lake. This COLOR also reduces secchi disc depth readings which are an indicator of light penetration and therefore affects the depth at which plants can grow. Moody Lake COLOR rating was 40 units. The average color value for Wisconsin lakes is 39 units, but ranges from 0 to 320 units.

Secchi disc readings varied from a bottom reading of 9 feet at ice out to 3.25 feet during the 1994 open water period. Through most of the growing season, the readings were found to be from 4 to 4.5 feet. Volunteer self-help data and other study data were combined for eleven secchi samplings during the open water study period. Decreases of secchi disc readings from 4.5 feet to as low as 3.5 feet appeared to correspond to increased plankton levels (TABLE O.)

Water levels on Moody Lake appear to fluctuate from one to two feet. Moody Lake is a seepage lake with no inlet or outlet and is fed by rainfall and groundwater. It looses water through evaporation and groundwater moving out. Very porous soil types are found on the west and northwest sides of Moody Lake as it borders STH 32 and Anderson Lake. It appears that Moody Lake's water level is controlled by the dam and water levels maintained on Anderson Lake. These fluctuations affect the physical and chemical water quality of Moody Lake.

TABLE A. MOODY LAKE WATER QUALITY DATA COLLECTED APRIL 19, 1994

WEATHER: Sunny, Wind-W 15-30 mph, Air Temp. 60 F

DEPTH ft	DISSOLVED OXYGEN mg/1	TEMPERATURE °F	DO SATURATION percent S.L
S-1'	8.0	53.6	74 %
2'	8.5	53.6	79 %
3'	8.8	53.6	81 %
4'	9.0	53.6	83 %
5'	9.1	53.6	84 %
6'	9.2	53.6	85 %
7'	8.4	54.9	79 %
8'	8.2	54.9	77 %
9'B	6.0	54.9	56 %

SECCHI DEPTH: 8.0 FEET, OBSERVATIONS: Flocculant muck w/ organic matter and narrow-leaved brown leaf matter on anchor

SPRING TURNOVER WATER CHEMISTRY

SAMPLE	READING			UNIT
BOD 5 DAY	1.7			MG/L
CALCIUM	-			
CHLORIDE, AUTOMATED	4.3			MG/L
CHLOROPHYLL A, UNCORRECTED	8.14			UG/L
COLOR,TRUE PT-CO	40.			SU
CONDUCTIVITY (@ 25 DEG C)	36.			UMHOS/CM
pH, LAB	6.91			SU
ALKALINITY	9.0			MG/L
IRON, ICP	-			
MAGNESIUM, ICP	-			
MANGANESE, ICP	-			
AMMONIA-N				
detected between 0.005 (LOD) & 0.019 (LOQ)				MG/L
NITATE PLUS NITRATE-N	ND (LOD-0.007)			MG/L
TOTAL KJELDAHL NITROGEN	0.6			MG/L
TOTAL PHOSPHORUS	2' SURFACE		2' BOTTOM	
PERSULFATE, LOW LEVEL	0.029		0.023	MG/L
DISSOVLED PHOSPHORUS	2' SURFACE		2' BOTTOM	
LOW LEVEL	ND (LOD-0.002)	0.002		MG/L
POTASSIUM, ICP	-			
SODIUM, ICP	-			
SULFATE				
detected between 1. (LOD) & 4. (LOQ)				MG/L
TOTAL SOLIDS	60.0			MG/L
SUSPENDED SOLIDS	4.0			MG/L
TURBIDITY	1.8			NTU

TABLE B. MOODY LAKE WATER QUALITY NOTES FROM INTERVIEW & OBSERVATION ON MAY, 24 1994.

DAN CONWAY DISCUSSION

Herons, kingfishers, and eagles are fish predatory birds that visit Moody Lake. (ALL ARE SPECIFIC IN THE SIZE OF FISH THEY EAT).

Moody Lake is one of the first lakes to open up in spring. Early migrating ducks are the first to visit. An eagle that nests on nearby Chute Pond also visits (DEAD CARRION-FISH FROM WINTERKILL, DUCKS ARE FOOD FOR EAGLE.)

Frogs and muskrats have been observed on lake.

PLANT OBSERVATIONS

Plants in Bloom: Bog Rosemary, Leatherleaf, Sheep Laurel, and Marsh Cinquefoil.

Other Plants Observed: Water Arum, Stepple Bush, Cinammon Fern, Sage Willow, and Blue Flag Iris.

Aquatic Plants Observed: Water celery, Potomageton Sp., and Burreed.

TABLE C. MOODY LAKE WATER QUALITY DATA COLLECTED ON JUNE 27, 1994.

WEATHER: Sunny, Wind Light, Air Temp: 79 F

DEPTH ft	DISSOLVED OXYGEN mg/1	TEMPERATURE °F	DO SATURATION percent S.L.
S'	8.0	76	96 %
1'	8.1	76	98 %
2'	8.3	76	100 %
3'	7.9	76	95 %
4'	7.8	75	93 %
5'	6.2	75	74 %
6'	6.5	75	77 %
7'B	6.4	75	76 %

SECCHI DISC READING: 4 FEET, 6-20-94 4.5 FEET
PLANKTON SAMPLED. OBSERVATIONS: WATERSHIELD IN BLOOM, WHITE WATER LILY PRESENT.
ANDERSON LAKE OBSERVATIONS: PLANT SPECIES: soft stem bulrush, yellow water lily, pickerelweed & watershield mixed on sand substrate.

TABLE D. MOODY LAKE WATER QUALITY DATA COLLECTED ON JULY 27, 1994.

WEATHER: Mostly sunny, windl ight cool night, Air Temp: 79 F

DEPTH ft	DISSOLVED OXYGEN mg/1	TEMPERATURE °F	DO SATURATION percent S.L.
S'	6.2	74	73 %
1'	5.8	74	68 %
2'	5.6	74	66 %
3'	5.2	74	61 %
4'	5.4	72	62 %
5'	3.0	72	34 %
6'	2.8	72	32 %
7'B	1.7	73	20 %

SECCHI DISC : 39" OBSERVATIONS : Zooplankton heavy & little or no phytoplankton. Watersheild fruiting and less erect than during survey, 5% turned yellow or red in maturity, gel mass thick on new leaves, central stem, and new root sprout.

ADDITIONAL INFORMATION: Phytoplankton bloom w/ lake turning green the week of July, 1994. Fish catches from July 4-15: LMB (22"), BLCR (Abundant) , YP, BG.

TABLE E. MOODY LAKE WATER QUALITY DATA COLLECTED ON AUGUST 17, 1994.

WEATHER: Partly sunny, Wind 10 -15, Air Temp: 80 F, Cool 10 days prior.

DEPTH ft	DISSOLVED OXYGEN mg/1	TEMPERATURE °F	DO SATURATION percent S.L.
S-1'	9.4	74	111 %
2'	9.3	72	107 %
3'	6.5	68	71 %
4'	5.5	66	59 %
5'	0.07	66	.01 %
6'	0.07	65.5	<.01 %
7'	0.05	65.5	<.01 %
8'B	0.03	65.5	<.01 %

SECCHI DISC READING : 55" (4.58') OBSERVATIONS : Phyto & Zooplankton sparse and small. Water Chemistry 8-19-94

OXYGEN/TEMPERATURE PROFILE
NW Corner in Center or Watershield

S'	9.5	82
1'	8.8	73
2'	8.6	72
3'	2.0	70
3'6"B	1.8	69.5

OBSERVATIONS: Watershield roots so dense substrate cannot be reached with rake.

TABLE F. MOODY LAKE PLANT COMMUNITY OBSERVATIONS ON AUGUST 17, 1994.

WATERSHIELD - Each plant stem supports equally developed seed heads and leaves. 4-5 leaves/stem with 4-5 mature seed heads. A second seed head or set of leaves may be present on same stem but not developed. Seed heads appeared to be near maturity easily broke from seed head base.

WHITE WATER LILY - In bloom with 1 out of 3 flowers not developed. Found in 1.5 feet of water with slow decomposing oak leaves in subtrate, surrounded by watershield. WATER LEVEL DROPPED by 6-12" by high water mark causing lilies leaves to be emergent and curled. Crowds out WATERSHIELD where present on west central lake edge.

OTHER AQUATIC PLANT OBSERVATIONS

On the west shore against the bog in LEATHERLEAF areas there are pockets where WATERSHIELD is not present but LEAFY PONDWEED (the same found at water sampling site) is present in these areas.

Sandy spot on SW Shore area that was surounded by WATERSHIELD was bare to all plants. WATERSHIELD does not grow on firm subtrate.

CATTAILS were most abundant adjacent to the STH.

YELLOW WATER LILIES were also found in the shallowest water with their leaves out of the water from the 6-12" drop in water level.

PONDWEED (P. NATAS or OAKESINAUS) on inside edge of WATERSHIELD on east side of lake.

BURREED growing with SAGO PONDWEED where eastside residents have pulled WATERSHIELD.

TABLE G. MOODY LAKE WATER QUALITY DATA COLLECTED ON SEPTEMBER 23, 1994.

WEATHER: Mostly Cloudy, Wind NE at 5-10, Air Temp: 65 F

DEPTH ft	DISSOLVED OXYGEN mg/1	TEMPERATURE °F	DO SATURATION percent S.L.
S	5.2	68	57 %
1'	4.9	67	53 %
2'	4.3	66.5	46 %
3'	3.5	66.5	38 %
4'	3.2	66.5	34 %
5'	4.3	66.0	46 %
6'	4.3	66.0	46 %
7'	3.8	65.5	40 %
8' B	0.5	65.0	.05 %

SECCHI DISC READING: 52" (4'4") OBSERVATIONS: Plankton abundant- Samples Taken. Plankton Sample became colloidal 1 hour after sampling.

OBSERVATIONS AND DISSCUSSIONS

DAN CONWAY DISCUSSION - Turtles and leeches abundant in past but seem to have declined in recent years (TURTLES FEED ON DEAD FISH CARRION - WINTER KILL SITUATION WOULD CREATE AN ABUNDANANCE OF FOOD).

Canada Geese are more abundant on lake this year during the migration, in past only a small family used the lake. Are here in early AM, leave and return in late morning.

Mallards and Wood Ducks are the only nesting and resident ducks observed on the lake.

Power Boats cut through the WATERSHIELD and plants cut loose float to shore on drift to edges of WATERSHIELD beds. (NUTRIENT & SEED SOURCE FOR EDGE OF WATER-SHED TO EXPAND LAKEWARD).

PLANT OBSERVATION - WATER BLADDERWORT (UTRICULARIA GEMNISCAPA) w/ winter buds found with WATERSHIELD near west shoreline area.

Buds of WATERSHIELD easily fall off when touched.

MARSH CINQUEFOIL growing from west shoreline into lake.

Large fish disturbed in shallow water under WATERSHIELD. Temperature and Dissolved Oygen at Surface and 2" below in west shore shallows were 72 F & 6.4 mg/l for the former and 67.5 & 4.6 for the latter.

ALDER and RED OSIER DOGWOOD abundant on undeveloped West shoreline. WATERSHIELD not as abundant adjacent to these areas.

YELLOW BLADDERWORT (U. CORNUTA) in yellow flowered bloom on grassy areas on bog shore and on bog pieces that broke loose

Dead tamarack trees in bog indicator of fluctuating water levels.

TABLE H. MOODY LAKE WATER QUALITY DATA COLLECTED ON OCTOBER 19, 1994.

WEATHER: Hvy rain over wkd, Cool Air Temp: 58F, Wind SW 10-15

DEPTH ft	DISSOLVED OXYGEN mg/1	TEMPERATURE °F	DO SATURATION percent	
			S.L.	859W.L.
S	7.7	58	75 %	77 %
1'	7.6	57	74 %	75 %
2'	7.5	56.5	71 %	72 %
3'	7.5	56	72 %	72 %
4'	7.45	55.5	70 %	71 %
5'	7.45	55.5	70 %	71 %
6'	7.45	55.5	70 %	71 %
7'	7.45	55.5	70 %	71 %
8'	7.45	55.5	70 %	71 %
9' B	0.0	55.0	0 %	0 %

SECCHI DISC READING: 52" (4.3') OBSERVATIONS : plankton sample indicated detritus suspended in water column. Plankton parts seemed to be part of the detritus.

TABLE I. MOODY LAKE WATER QUALITY DATA COLLECTED ON DECEMBER 27, 1994.

WEATHER: Mostly Cloudy, Air Temp 20's, 5" Ice & 1-2 " snow cover, Lake Froze over WK of 11-21-94, Mild December weather prior

DEPTH ft	DISSOLVED OXYGEN mg/1	TEMPERATURE °F	DO SATURATION percent	
			S.L.	859W.L.
S	16.0+	38	119 %	125 %
1'	9.2	36	67 %	68 %
2'	7.8	37	58 %	57 %
3'	7.3	37	54 %	53 %
4'	7.2	37	53 %	53 %
5'	7.2	37.5	54 %	53 %
6'	7.1	37.5	53 %	53 %
7'	2.0	37.5	15 %	15 %
8'B				

* Phytoplankton & Zooplankton evident in hole & just beneath the ice - supersaturation found at this depth.

TABLE J. MOODY LAKE WATER QUALITY DATA COLLECTED ON FEBRUARY 3, 1995.

WEATHER: Snow Cover on Lake for Two Weeks Prior, Snow now drifited clear in spots, Ice 11.5" Thick

NORTH DEEP SPOT
W/ SNOW COVER
12:00

DEPTH ft	DISSOLVED OXYGEN mg/1	TEMPERATURE °F	DO SATURATION percent	
			S.L.	859W.L.
1'	3.2	32.5	22 %	22 %
2'	7.6	32	52 %	53 %
3'	2.5	32.5	17 %	17 %
4'	1.0	35	7 %	7 %
5'	0.6	35.5	4 %	4 %
6'	0.4	36	3 %	3 %
7'B	0.1	36.5	<1 %	<1 %

SOUTH DEEP SPOT
NO SNOW COVER SPOT

1'	12.6*	32.	86 %	86 %
2'	12.8*	34	90 %	90 %
3'	4.4	36	32 %	32 %
4'	1.6	36.5	12 %	12 %
5'	1.1	36	8 %	8 %
6'	1.0	35.5	7 %	7 %
7'	0.7	35.5	5 %	5 %
8'B	0.5	36.5	4 %	4 %

* High oxygen produced by abundant observed phytoplankton.

TABLE K. MOODY LAKE WATER QUALITY DATA COLLECTED ON MARCH 3, 1995 AT 12:00PM.

WEATHER: Snow Cover 3" w/ 15" ice at North Sampling Point
& 1" w/ 16" ice at South Sampling Point

NORTH DEEP SPOT

DEPTH ft	DISSOLVED OXYGEN mg/1	TEMPERATURE °F	DO SATURATION percent	
			S.L.	859W.L.
1'	6.3	32	43 %	44 %
2'	6.2	30	41 %	41 %
3'	3.0	31	20 %	20 %
4'	0.5	32.5	4 %	4 %
5'	0.0	34	0 %	0 %
6'	0.0	34.5	0 %	0 %
7'	0.0	35.5	0 %	0 %
8' B	0.0	36	0 %	0 %

SOUTH DEEP SPOT

1'	9.5 } phytoplankton	31	63 %	63 %
2'	9.6	30	64 %	64 %
3'	7.1	31	48 %	48 %
4'	0.6	32.5	4 %	4 %
5'	0.0	34.5	0 %	0 %
6'	0.0	35	0 %	0 %
7'	0.0	35.5	0 %	0 %
8'B	0.0	36	0 %	0%

TABLE L. MOODY LAKE WATER QUALITY DATA COLLECTED ON MARCH 27, 1995 AT 11:00 A.M.

WEATHER: Extremely Warm Weather One Week Prior, 1/2" New Clear Ice plus 4" Honey Comb Ice, Cloudy, cloudy two days prior

NORTH DEEP SPOT*

DEPTH ft	DISSOLVED OXYGEN mg/1	TEMPERATURE oF	DO SATURATION percent	
			S.L.	859W.L.
1'	2.6	37	19 %	19%
2'	2.5	37	19 %	19 %
3'	2.4	36.5	18 %	18 %
4'	1.5	36.5	11 %	11 %
5'**	0.2	36.5	<2 %	<2 %
6'	0.0	37	0 %	0 %
7'	0.0	37	0 %	0 %
8' B	0.0	38	0 %	0 %

SOUTH DEEP SPOT

1'	7.4	37.5	55 %	55 %
2'	8.1 }	36.5	60 %	60 %
3'	8.3 Plankton	36.5	61 %	61 %
4'	8.2}	36.5	60 %	60 %
5'	6.6	36.5	49 %	49 %
6'	5.0	37	37 %	37 %
7'	0.0	38	0 %	0 %
8'B	0.0	38	0 %	0%

* WATER CHEMISTRY TOP & BOTTOM SAMPLED

** SUSPENDED FLOCCULANTS OF IRON AT THIS DEPTH

TABLE M. MOODY LAKE, OCONTO COUNTY, LATE WINTER WATER CHEMISTRY COLLECTED ON MARCH 27, 1995

SAMPLE (6" Below Ice)	READING	UNIT
Calcium, DIG, ICP	2.6	MG/L
Chloride, Automatic	4.5	MG/L
Color, True PT-CO	40	SU
Conductivity (@ 25 oC)	40	UMHOS/CM
pH, Lab	6.57	SU
Alkalinity	11	MG/L
Hardness, Calculation Method, DIG	12	MG/L
Iron, ICP, DIG	1.6	MG/L
Magnesium, ICP, DIG	1.4	MG/L
Manganese, ICP, DIG	140	UG/L
Ammonia-N, detected between 0.027 (LOD) & 0.085 (LOQ) MG/L	0.030	MG/L
Nitrate plus Nitrate-N	.042	MG/L
Total Kjeldahl nitrogen, detected betwen 0.21 (LOD) & 1.0 (LOQ) MG/L	0.80	MG/L
Total Phosphorus	0.031 (0.02BOT)	MG/L
Dissolved Reactive Phosphorus as P(Ortho-P) detected between 0.002 (LOD) & 0.09 (LOQ) MG/L	0.003(0.002 BOT)	MG/L
Potassium, ICP, DIG, detected between 0.3 (LOD) & 0.9 (LOQ) MG/L	0.8	MG/L
Silica, Dissolved, Low Range	0.2	MG/L
Sodium, ICP, DIG	2.4	
Sulfate, detected between 1.21 (LOD) & 4.44 (LOQ) MG/L	4.0	MG/L
Total Solids	50	MG/L
Total Volatile Solids	32	MG/L
Suspended Solids	ND (LOD-4.88 MG/L)	
Turbidity	1.9	NTU
Temperature, Field	3.0(3.0 BOT)	oC
Dissolved Oxygen, Field	2.5 (0.00 BOT)	MG/L

TABLE N. MOODY LAKE, OCONTO COUNTY, OVERVIEW OF SECCHI DISC READINGS, TEMPERATURE, T. PHOSPHORUS, & OTHER OBSERVATIONS IN 1994-95

DEEP SPOT NORTH

DATE	TIME	SECCHI READING	TEMP S' M' B'	T.PHOS. S' <2' >B'	COMMENTS
		Feet	oF	ppb	
Apr 19, 1994	12:00	8.0	54 55	29 23	
May 19, 1994	13:00	4.5	72 67 64	22 23	
Jun 21, 1994	10:30	4.5	79 77 73	26 32	
Jun 27, 1994	12:00	4.0	76 76 75		
Jul 20, 1994	10:30	4.0	74 74 73	25 21	
Week of July 4 photoplankton bloom with lake turning green					
Jul 27, 1994	12:00	3.25	74 72 73		Oxygen <5blw5'
Aug 17, 1994	12:00	4.58	74 66 65		Oxygen <1blw4'
Aug 19, 1994	12:00	4.0	69 67 68	18 16	
Sep 23, 1994	12:00	4.3	68 66 65		Oxygen <5blw1'
Sep 29, 1994	12:30	4.5	56		
Oct 19, 1994	12:00	4.3	58 56 55		Oxygen thrgout
Dec 27, 1995	11:00	5" ICE	38 37 37.5		S.S. Pltn belw ice
Feb 3, 1995	11:00	11.5" ICE	32 35 36.5		
Mar 3, 1995	12:00	15" ICE	30 34 36		snw cvr 3"
Mar 27, 1995	11:00	5" ICE	38 37 38	.02 31	clr new ice ice out near

NOTE: See Oxygen/ Temperature Profile Reports & Graphs for More Information.

TABLE O. SECCHI DISC AND DISSOLVED OXYGEN DEPTH READINGS FOR 1994 - 95 FOR MOODY LAKE, OCONTO COUNTY, WISCONSIN

DEPTH IN FEET

	Surface	1	2	3	4	5	6	7	8	9	
	.	.	.	.	.	.	.	.	.	.	.
APR	---	---	---	---	---	---	---	---	---	---	-Secchi
19	8.0	8.0	8.5	8.8	9.0	9.1	9.2	8.4	8.2	6.0 ppm DO	
		+	+	+	+	+	+	+	+	+	
MAY	---	---	---	---	---	Secchi					
19	.	.	.	.	.	.	.	.	.	.	
	.	.	.	.	.	.	.	.	.	.	
JUNE	---	---	---	---	---	-Secchi					
21	.	.	.	.	.	.	.	.	.	.	
JUNE	---	---	---	---	Secchi						
27	8.0	8.1	8.3	7.9	7.8	6.2	6.5	6.4 ppm DO			
	+	+	+	+	+	+	+	+			
JULY 4		*	.								
JULY	---	---	---	---	Secchi						
20	.	.	.	.	.	.	.	.	.	.	
JULY	---	---	---	---	Secchi						
27	6.2	5.8	5.6	5.2	5.4	3.0	2.8	1.7 ppm DO			
		+	+	+	+	.	.	.	.	.	
AUG	---	---	---	---	Secchi						
19	.	.	.	.	.	.	.	.	.	.	
	.	.	.	.	.	.	.	.	.	.	
SEP	---	---	---	---	Secchi						
23	5.2	4.9	4.3	3.5	3.2	4.3	4.3	3.8	0.5 ppm DO		
	+	.	.	.	.	.	.	.	.	.	
OCT	---	---	---	---	Secchi						
19	7.5	7.6	7.5	7.5	7.5	7.5	7.5	7.5	7.5	0.0 ppm DO	
	+	+	+	+	+	+	+	+	.		
DEC	.	.	.	.	.	.	.	.	.	.	
27	16.0	9.2	7.8	7.3	7.2	7.2	7.1	2.0	0.0	0.0 ppm DO	
	*	*	+	+	+	+	+	.	.	.	
FEB		.	+	.	.	.	.	.	.	.	
3	N ICE	3.2	7.6	2.5	1.0	0.6	0.4	0.1 ppm DO			
	S ICE	12.6	12.8	4.4	1.6	1.1	1.0	0.7	0.5 ppm DO		
	*	*	.	.	.	.	.	.	.	.	
MAR		+	+	.	.	.	.	.	.	.	
3	N ICE	6.3	6.2	3.0	0.5	0.0	0.0	0.0	0.0 ppm DO		
	S ICE	9.5	9.5	7.1	0.6	0.0	0.0	0.0	0.0 ppm DO		
		*	*	+	.	.	.	.	.	.	
MAR	.	.	.	.	.	.	.	.	.	.	
28	.	.	.	.	.	.	.	.	.	.	
	N ICE	2.6	2.5	2.4	1.5	0.2	0.0	0.0	0.0 ppm DO		
	S ICE	7.4	8.1	8.1	8.2	6.6	5.0	0.0	0.0 ppm DO		
		+	*	*	*	+	+	.	.	.	

+ Oxygen Levels Adequate
. Oxygen Levels Below 5 ppm
- - - Secchi Depth in Feet/Secchi Disk deen in Water
DO Dissolved Oxygen
* Phytoplankton Abundant

AQUATIC PLANTS OF MOODY LAKE

Introduction

Moody Lake is a small (17.7 acre) lake with a maximum depth of 9.0 feet. Secchi disc readings - as an indicator of water clarity - during the 1994 growing season ranged from 3.25 - 4.5'. A 9.0' or bottom secchi disc reading was recorded shortly after ice out in the spring of 1994.

An organic layer of muck covers most of the lake bed providing nutrients to the water column and a soft substrate for aquatic plant root production. There are several sandy shallow water areas that were deposited by glacial till or outwash, shoreline erosion, or by sand fill.

Wetland communities join the lake on the northeast and south-southwest. The south-southwest wetland varies from open to conifer bog. The northeast wetland varies from sedge meadow to shub swamp.

In recent years the aquatic plant, Watershield (Brasenia schreberi), has encompassed nearly the entire lake. The objective of this study was to understand the aquatic plant community and recognize management alternatives to take care of nuisance levels of watershield.

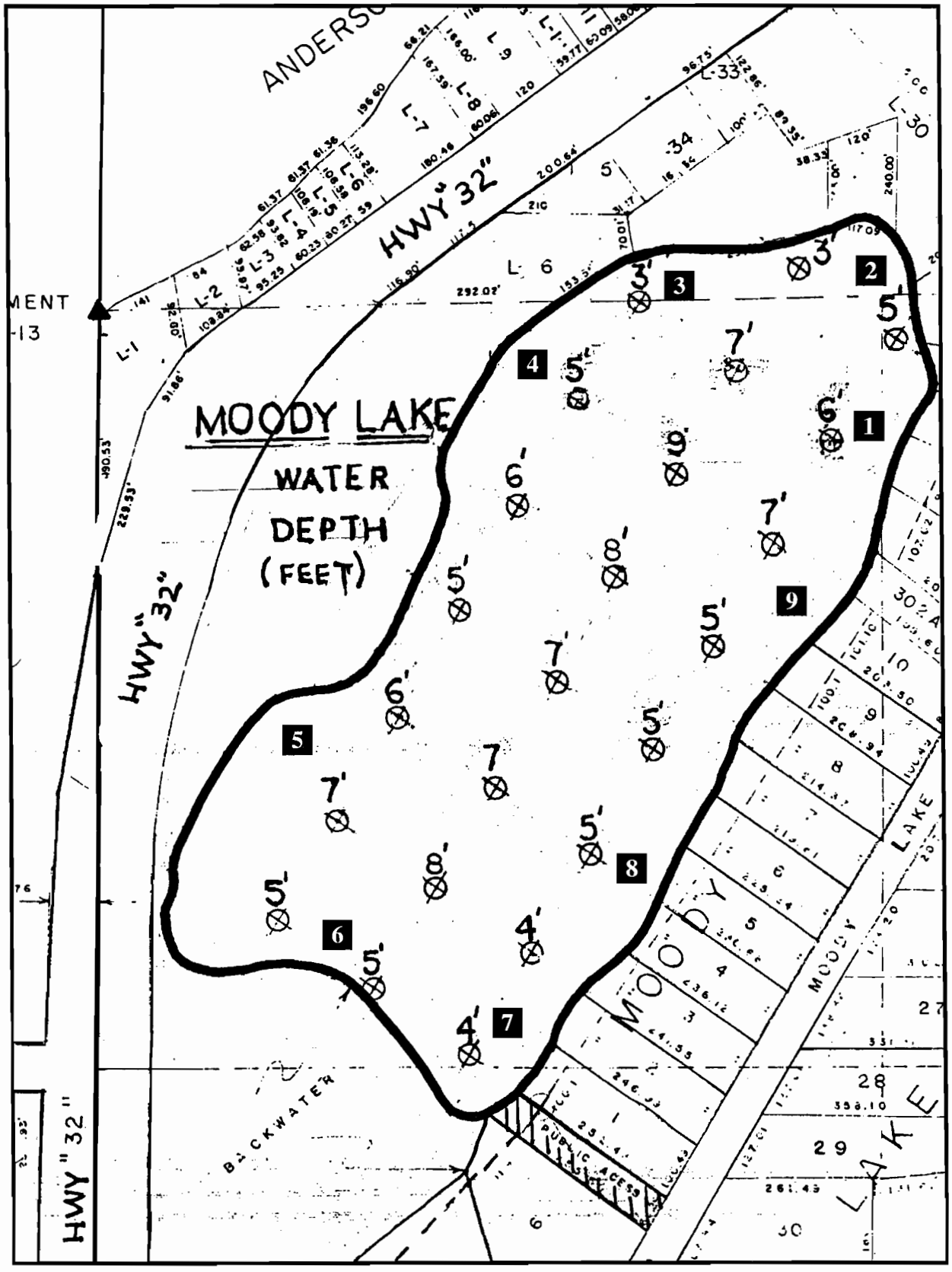
Method

An aquatic plant survey of Moody Lake was conducted on July 13, 1994. The survey used a standard transect sampling method that recognizes plant species, their density, and rooting depth. Nine sample transects were made perpendicular to the shoreline extending from shore to depths of 8.0 to 9.0 feet (Figure 2). The transects were chosen to represent a variety of habitats from wetland to steep shoreline extensions from developed (disturbed) to undeveloped (natural) shorelines.

A rake was used to sample four quandrants at 3 or 4 sampling points that represented incereasing depths along a transect. In each quadrant the aquatic plants were identified and their densities described in a numbering system from 1 to 5. One (1) being sparse and found in only one quandrant to five (5) being dense and appearing in all four quadrants.

The results of the survey were tabulated by abundance and depth. It was then analyzed to recognize the competition between plants in the plant community. These survey products were added to other observations (such as interaction of the plants with substrate, light, and physical-chemical conditions) made throughout 1994 to develop management alternatives.

Figure 2: **Moody Lake Plant Survey Transect Locations**
Oconto County, July 12, 1994



1 - **9** Locations of Plant Survey

Results

Ten aquatic plant species were identified at the nine survey transects during the aquatic plant survey conducted on July 12, 1994. Five other species were found at later dates and are listed in the survey table. Nine additional wetland plants were also identified during the 1994 growing season (TABLE 1). Aquatic plants were found from the near shore areas to the 9 feet - the deepest water found in Moody Lake (TABLE 2).

As expected, Watershield (Brasenia schreberi) was found to be the most abundant species. It was found to dominate every transect location. The mature (flowering) plant or immature (non flowering) plant was found at 21 of the 27 total sampling points along the nine transects.

Dense beds of watershield (both mature & immature plants) dominated th 0-2.5 foot and 2.6-5.0 foot sampling depths. Leafy Pondweed (Potamogeton foliosus) in both their mature and young plant stages were found growing beneath the dense canopy of the Watershield at the 2.6-5.0 foot depths around the lake. At the 5.1-9.0' depth sprouting Leafy Pondweed covered the bottom subtrate where only a few immature Watershield plants were found (Table 3 and 4).

Beds of White Water Lilies (Nyphae sp.) were found in four 0-2.5 foot deep sampling locations at undisturbed transects #2 thru 5. These lilies were successful in replacing the Watershield as the dominate floating plant where found. The emergent aquatic plant, Pickerelweed (Pontederia cordata), was found at transects #3,4, and 7. in shallow water near the shoreline.

Those aquatic plant species observed at the later date were found either near the bog area or in open water away from the dense watersheild beds. Both Water celery (Vallisneria americana) and Softstem Bullrush (Scirpus validus) were found in areas where sand substrate was deposited as fill or had washed from the nearby shoreline.

Discussion

Watershield dominates the aquatic plant community for several reasons. The physical and chemical environment of Moody Lake favors this plant over its competitors. In addition, this well established plant has also created its own physical conditions that insures its survival and dominance. The watershield plant body allows this floating plant to adapt to the fluctuating water levels that were found to occur on Moody Lake. The spread of the plant by its root system is aided by the soft phosphorus-rich sediment that covers the bottom.

During the 1994 study the relationship between Watersheild and its environment was carefully examined. Field notes (were made) documenting the plant's growth and development as well as its relationship to subtrate, depth, and interaction with other plants and animals (See Water Quality Tables).

TABLE 1. LIST OF AQUATIC & SHOREINE PLANTS FOUND IN MOODY LAKE,OCONTO COUNTY, WISCONSIN DURING THE 1994.

Surveyors: Rand Atkinson & Dan Conway

PLANT LIST

COMMON NAME	SCIENTIFIC NAME
A. Watershield	Brasenia schreberi
A1. Immature Plant	
B. Arrowhead	Sagittaria sp.
C. Yellow Water Lily	Nuphar variegatum
D. White Water Lily	Nyphae tuberosa or odorata
E. Leafy Pondweed	Potamogeton foliosus
E1. Immature Plant	
F. Bluegreen Algae	Spirogyra sp
G. Water Celery	Vallisneria americana
H. Floating-leaf Pondweed	Potamogen natans
I. Softstem Bullrush	Scirpus validus
J. Broad-leaved Cattail	Typha latifolia
K. Burreed	Sparganium sp
L. Sago Pondweed	Potamogeton pectinatus
M. Marsh Cinquefoil	Potentilla palustris
N. Horned Bladderwort	Utricula cornuta
O. Pickerelweed	Pontederia cordata

PLANTS FOUND IN ADJACENT SHORELINE*

P. Bog Leatherleaf	Chamaedaphne cayculata
Q. Sheep Laurel	Kalmia augustfolia
R. Bog Rosemary	Andromeda glaucophylla
S. Labrador Tea	Ledum groenlandicum
T. Red-osier Dogwood	Cornus stolonifera
U. High Bush Cranberry	Vibrum trilobum
V. Speckled Alder	Alnus rugosa
W. North Lake Sedge	Carex lacustris
X. Marsh Milkweed	Ascepias incarnata

* Many of the shoreline plants were observed on ther dates, during bloom or fruiting.

TABLE 2.

RESULTS OF THE AQUATIC PLANT SURVEY OF MOODY LAKE, OCONTO COUNTY, WISCONSIN ON JULY 12, 1994

PLANT LOCATION & DENSITY DATA

TRANSECT (LENGTH) (Compass Bearing) SUBSTATE >		**DEPTH 0 -2.5'**	**DEPTH 2.6 - 5.0**	**DEPTH 5.1 - 9.0**	**DEPTH 9.0 +**
# 1.	(100') (280 degrees)	A1-5, D-1 B-1, C-1,	A-3 E-1	A1-1, E-3	A1-1, E1-2
#2.	(100') (230 degrees)	E1-3, A-1, D-1, E-1	E-1, E1-4, A1-2		
#3.	(300') (180 degrees)	A-5,A1-4,	4' A-4,A1-4	6' E-1, E1-2	
#4.	(125') (140 degrees)	1.5' E1-1, A-2, D-2, O-1, J-1	4.5 A1-2 A-5	6.5'	
#5.	(225') (90 degrees)	1.5' A-4, D-2	4' A-5, A1-1	6.5' A1-1, E1-1, A-1	
#6.	(100') (40 degrees)	OPEN >	3.5' A1-1,E1-2, E-1, A-3	6' OP H2O A1-1, E1-3, 200'> A-1	
#7.	(60') (10 degrees)	OPEN > O-1	3.5' F-2, E1-4 A1-1 40'	6' 7.5' A-2 E1-4 E1-3 80' 100'	
#8.	(60') (310 degrees)	1' A-1, B-1 O-1, I-1	4' E-2, E1-3, A-2	6.5' E1-4	
#9	(100') (310 degrees)	1' G-2, A-3, I-1 A1-1, B-1	4' E1-1,	6.4 E1-4	9' E1-4

NOTE: Letters (and/or attached number) correspond to plant species listed in Table 1. Number is density rating explained in plant survey methods.

TABLE 3.

MOODY LAKE AQUATIC PLANT SURVEY DENSITY & ABUNDANCE CALCULATIONS & DEFINITIONS

I. FREQUENCY OF OCCURRENCE - the percentage of all sample points where species occurred.

II. MEAN DENSITY RATING - for all points where species occurs (where does it occur and how thick)

III. MEAN DENSITY RATING - for all sample points (lake wide) including sampling points where a particular species did not occur.

IV. MEAN DENSITY RATING - of species where any species occurred but not especially the species of interest.

TOTAL SAMPLING POINTS 27

PLANTS OCCURRED AT ALL SAMPLING POINTS

SEECHI DATA 1994

MAXIMUM : 4.5' (May 19, Jun 21, Sept 29)
MINIMUM : 3.25' (Jul 27)
VOLUNTEER AVE : 4.3' MAY - SEPTEMBER

MOST TO LEAST ABUNDANT BY DEPTH

0-2.5'	Watershield, Watershield (Immature), White Water Lily, Leafy Pondweed (Immature).
2.6-5.0'	Watershield, Watershield (immature), Leafy Pondweed (Immature, Leafy Pondweed.
5.1 - 9.0'	Leafy Pondweed, Watershield, Watershield (Immature).
9.0'+	Leafy Pondweed (Immature(, Watershield (Immature).

TABLE 4.

MOODY LAKE AQUATIC PLANT SURVEY DENSITY & ABUNDANCE CALCULATIONS BY SPECIES & DEPTH.

SPECIE v	DEPTH > 0-2.5'	2.6-5.0'	5.1-9.0'	9'+
A. Watershield	1,5,2,4, 1,3, -16	3,4,5,5, 3,2 -22	1,1,2, -4	
A1. Watershield Immature Plant	5,4,1, -10	2,4,2,1, 1,1,3, -14	1,1,1, -3	1, -1
B. Arrowhead	1,1 -2			
C. Yellow Water Lily	1,1 -2			
D. White Water Lily	1,1,2,2 -6			
E. Leafy Pondweed	1,1, -2	1,1,1,2, -5	1, -1	
E1. Leafy Pondweed Immature Plant	3,1,1, -5	4,2,4,3, 1, -14	3,2,1,3, 3,4,4, -20	2,4 -6
F. Bluegreen Algae (Spirogyra)		2, -2		
G. Water Celery	2 -2			
H. Floating-leaf Pondweed	Present Later in Year - Sparse			
I. Softstem Bullrush	1,1 -2			
J.Broad-leaved Cattail	1 -1			
K.Burreed	Found Later in Year - Sparse			
L. Sago Pondweed	Found Later in Year in Deep Water			
M. Marsh Cinquefoil	Found in Water near Shore at #5.			
N. Horned Bladderwort	Found Later in Year at 2.6-5.0' at Transect #6			
O. Pickerelweed	1,1,1,1,	-4		

Watershield is an aquatic plant in the water lily family whose branches rise through the water column from a horizontal stem that lies on or beneath the soft bottom subtrate. Leaf and flower stems (petioles) are of varying lengths extending from this root stem. The entire root stem and leaf and flower petioles are coated with a gelatinous slime. Leaves are oval-shaped, 2 to 5 inches long, green on top, and reddish underneath that float. Flowers and seed heads are approximately 1" in diameter and open at the water's surface. It is the petioles ability to grow to various lengths that allow it to thrive in water conditions with fluctuating water levels.

During 1994 the floating leaves of the Watershield had not reached the surface on May 24, but by June 27 the leaves had reached the surface and flowers were blooming. By July 27 many of the fruit or seed heads had developed and approximately 5 % of the floating leaves were mature and yellowing. By August 17 many seeds were ripe and fell from the seed head when touched but many were not ripe. By September 23 most seed heads were mature and seeds easily fell from base. Both immature and mature plants were abundant from shoreline to a 5 foot depth during the plant survey on July 13 indicating those plants that had completed their life cycle by July 27 were quickly replaced by other young maturing plants.

Watershield's reproduction (vegetative assexual) through horizontal root growth allows it to expand fast in a given season. The loose substate it is found in keeps it from freezing out over winter. Its long seed reproduction (sexual) season provides for dispersal to new areas of the lake where competition and stress from its own kind is less.

The watershield canopy is so dense it prevents light from reaching plants below that could compete with it. In areas where lakeshore residents have removed watershield other aquatic plants were found. The continuous mass of floating leaves prevents wind from mixing air with lake water therefore heat or cold can be trapped at or below the surface where watersheild is growing.

Watershield was found absent or competing with other aquatic plants in two shoreline areas of the lake. One area was in the east shore in sandy areas adjacent to the cottages where either the hard substrate prevented watershield root growth or residents had removed the plants. Other species could also be found in this disturbed area. In areas undisturbed on the west side of Moody Lake various species of water lilies and other emergent plants were found competing with the watersheild. The substrate below these competing plants contained an accumulation of leaves (mostly oak) at their base from oak trees on the adjacent bank. It is logical that the minerals from the slowly decaying oak leaves were enough to favor these plants over watershield. Other areas of the west shoreline that were without Watershield were areas near tag alder and dogwood. Was the shade in this case a limiting factor in watershield's growth? Cattails and a diversity of other minerials - loving plants were also found in the area adjacent to Highway 32 where minerals can easily enter the lake's ecosystem.

The effects of watershield go beyond the human aspects of their hinderances to lake use but are affecting all aspects of the ecology of the lake. Management alternatives and recommendations will address both aspects of this problem.

On August 17 an oxygen/temperature profile in the center of a watershield bed on the NW side of the lake indicated the following:

DEPTH	DISSOLVED OXYGEN	TEMPERATURE
S'	9.5 mg/1	82 F
1'	8.8	73
2'	8.6	72
3'	2.0	70
3' 6" B	1.8	69.5

The watershield leaf at the surface absorbs heat, and produces saturated oxygen levels at the surface but shields the water below from the heat and prevents oxygen from reaching the bottom subtrates by wind mixing. The temperature/oxygen profile in the open water at the same time indicated surface water temperature at 74 F and a temperature at 3 feet of 68 F. Dense beds of watersheild have the ability to cool bottom water temperatures that in return can hinder the development of other rooted plants that could compete with it.

Moody Lake's physical/chemical conditions contribute to the watershield's dominant presence. Moody Lake is a seepage lake. Seepage lakes are lakes without a significant inlet or outlet that are fed by rainfall and groundwater. Seepage lakes lose water through evaporation and groundwater moving on a downgrade. They have long residence times and with little water movement through them become naturally acidic. Lake levels fluctuate with local ground water levels. The watershield plants varying stem lengths accommodate this condition and the plants are particularly adaptive to the acid soft water conditions found in Moody Lake. The deep-soft sediment covering most of Moody Lake's bottom allows roots to grow and move freely-both laterally and horizontally.

Secchi disc readings, a measure of water clarity and light penetration, did not exceed 4 1/ 2 feet during most of the growing season. At the same time, oxygen levels below the 4 1/2 feet were less than 5.0 mg/l - which is a minimum standard for good fish and aquatic organism growth. Watersheild completely dominated the water depths from shoreline to 5 feet where good conditions for bottom organisms should be found. But the shading effects and oxygen circulation prevention by dense watershield beds makes even this bottom subtrate less than ideal.

Normally, Watershield would provide shade and cover for game and panfish. But dense beds can protect the panfish prey from the gamefish predation. Stunting may occur if over-abundance of panfish with a limited food source is present in the lake. Various ducks use parts of the watershield plant as food; but a lack of variety of other plant and animal food limits waterfowl use of the lake for migration or nesting (TABLE 5).

TABLE 5.

WATERFOWL THAT EAT WATERSHIELD (Brasenial Scheberi).*

P - Puddle Ducks: shallow water, diet mostly vegetable
D - Diving Ducks: larger deeper waters, diet less vegetable

1. Black Duck	P	
2. Bluebill	D	
3. Bufflehead	D	
4. Canvasback	D	prefer buds & tubers, early spring migrator
5. Gadwall	P	
6. American Goldeneye	D	
7. Mallard	P	emergent & submergent plants, early spring migrator
8. Pintail	P	
9. Redhead	D	prefer submerged leaves & stems, early spring migrator
10. Ringneck	D	
11. Ruddy	D	
12. Greater Scaup	D	
13. Lesser Scaup	D	
14. Surf Scoter	D	
15. White-winged Scoter	D	
16. Shoveller	P	
17. Blue-winged Teal	P	aquatic plants & seed, skim, late spring migrant
18. Green-winged Teal	P	
19. Widgeon	P	
20. American Widgeon	P	
21. Wood Duck	P	aquatic plants & seeds, logs

* From A Manual of Aquatic Plants by Norman C. Fassett

ANALYSIS OF FISHERIES

Introduction

Information regarding the fisheries of Moody Lake is sparse. The contents of Department of Natural Resources fisheries files in Shawano included a Waters Inventory Field Data Sheet from 1970 and a page from the SURFACE WATER INVENTORY OF OCONTO COUNTY published by the department based on the first inventory sheet. This page states "Information on the fish population is lacking although panfish and minnows may be present. The lake is reported to winterkill occasionally."

The importance of the fisheries of Moody Lake to the lake residents is documented in the property owner's survey. Public access has been developed for the use by the public for fishing. Existing conditions of seasonal low oxygen found as a part of this grant assessment supports the "occassional winterkill" reported in the 1970 inventory. A portion of this grant was targeted to assess fish habitat, make preliminary evaluation of fish species present, and develop a volunteer plan for future assessment.

Procedure

The assessment of the present fisheries was based on a limited volunteer creel survey and habitat evaluation. Fisheries creel information was gathered from a lake community volunteer that fished Moody Lake and gathered specific information during the open water period of 1994. Habitat evaluation was ongoing throughout the grant period as physical, chemical, and biological information gathered as part of the grant was collected and reviewed with the effects on the fisheries in mind.

The voluntary creel consisted of recording the species, total length of fish, date of capture, and removal of scale from the fish. Data and scales were placed on/in a small coin envelope upon capture and accumulated though 1994 for analysis at a later date. Age/growth calculations were made from scale and envelope data combined with other ecological data for interpretation.

Habitat evaluation was an ongoing process throughout the grant period as the aquatic vegetation, water chemistry, and physical characteristics of Moody Lake affect the growth and survival of species present. Oxygen/temperature profiles were extended beyond the grant goals to assess the rate and timing of oxygen depletion that can directly affect the survival of the fisheries.

Results and Discussion

Five species of fish were caught by hook and line fishing in 1994. They were smallmouth bass, black crappie, yellow perch, bluegill, and pumpkinseed. The smallmouth was the only gamefish recorded though largemouth bass have been reported caught (Table D-observations). Age/growth and length data is shown in Table P. Growth rates of the panfish (pumpkinseed, bluegill, yellow perch, black crappie) captured were slower than a small, infertile, seepage lake in Vilas County. The one smallmouth bass captured on May 31 was 7.75" and less than 1 year old - indicating excellent growth.

Pumpkinseed appears to be the dominant panfish over bluegill and yellow perch based on the capture number; but this maybe biased by the angling sampling method. Most of the pumpkinseed and bluegill were captured within a three day period from shore and were in the same size range. Water temperature & dissolved oxygen profiles and plankton sampling were also conducted during this capture period (Table P). A heavy bloom of large zooplankton was occurring in open water during this capture period. With their fine gill rakers, bluegills at this size are capable of feeding on these large zooplankton in the open water community. Pumpkinseed are a schooling fish and feed and live near shore which would increasing their exploitation by a shore fisherman.

Poor oxygen conditions were found in Moody Lake during several open water periods. This condition can stress fish or limit their presence to only parts of the lake. Poor oxygen conditions were found to extent to from the bottom (9') to 4' from the surface on July 27 (Table D.) These conditions were present until fall mixing on September 23 poor oxygen conditions extended from the bottom to within 1 foot of the surface (TableG).

Poor oxygen conditions were also found under the ice through much of the winter (Tables J, K, L). These conditions extended from February until ice out which occurred shortly after the March 28 profiling (Tables J,K,L).

On March 28, with no snow and a refreeze of the surface ice increasing light penetration, good oxygen levels were found under the ice at midday near the surface at the south deep spot sampling location. Planktonic oxygen was adequate. At the north profile plankton were not evident in hole and low oxygen was found through the profile. Therefore, the oxygen was being created by the planktonic algae at the south deep spot. These conditions were also found during the two prior profiles in early March and February where the south end of Moody Lake had snowless areas from drifting and snowmobile activity.

This oxygen data depicts a situation where occasional winterkill of the fishery is possible - especially when heavy snowfall accompanies a long winter ice cover. This situation has not occurred in recent years and the fishery may be recovering with the fish species present either survivors, offspring of survivors, or a result of planting after the last fish kill. The fish species present are all somewhat tolerant of low oxygen conditions. There is no way to determine the fish history beyond the age of fish present in the lake. Bluegill are the least tolerant of low oxygen of the fish species captured but their ability to capitalize on plankton as a food organism may also be a key to its finding an oxygen source necessary for winterkill situation survival.

The annual periodic low oxygen conditions that exist in Moody Lake could have caused the slower growth of the panfish captured in 1994. Physical stress, and lack of food organisms are also indirect results. Poor oxygen conditions also can cause water chemistry reactions that create substances that are lethal or stressful to fish. These conditions exist in Moody Lake as discussed in the water chemistry section of thes report.

Habitat for gamefish/ panfish spawning and cover is limited by areas of oxygen depletion and bottom sediment. Fish will avoid areas of low or no oxygen. These low oxygen areas also lack a variety and abundance of food organisms compared to well oxygenated areas. In Moody Lake, over 70% of the bottom area is covered with organic muck above detritus that has a high oxygen demand and causes the oxygen depletion in the water. These areas are nearly void of living organisms including fish and fish food organisms. During periods of high wind, such as spring and fall, the entire lake water volume is oxygenated. But during the summer and under the ice when mixing does not occur the effects of this oxygen demand reach through the entire water column (Table 0).

The bass and panfish (except yellow perch) found in Moody Lake during this inventory are all nest builders. They build nest on sand gravel substrates. Sand substrate is found adjacent to upland areas on the east and west shores of Moody Lake but is limited in most cases to within 15 feet of shore and a depth of only a few feet. On the eastside of Moody Lake sand blankets have been placed along the cottage shoreline that have extended the 'sand' subtrate to deeper water and added some variation to fish spawning and plant habitat.

Yellow perch and black crappies have probably gained the most from this extension of sand in the littoral zone of the east shoreline. Black crappie are deeper water nest builders. Yellow perch lay a floating ribbon of eggs over a sand substrate, and vegetation in this area can catch these ribbons. This prevents yellow perch eggs from falling to sediment void of oxygen which would kill the incubating eggs.

Light penetration and watershield are another two factors that limit fish habitat in Moody Lake. The average secchi disc reading depth of light penetration is 4.2 feet. Therefore, for most of the year very little light reaches below this depth in open water areas of Moody Lake. In addition, the shallow water (littoral) areas are almost completely covered by watershield, which can shade out light completely. In both areas this limited light penetration affects the ability of sight-feeding fish to see their food prey. The surface area of aquatic plants is important for a variety of fish food organisms from frogs to snails. All surface areas of the watershield plant, (except the top areas of its floating leaves), are covered with a gelationous coat that restricts any small fish food organisms from attaching to it. Light penetration through the watershield or replacing with other plants will benefit habitat for fish food organisms.

TABLE 6.
AGE /GROWTH AND LENGTH DISTRIBUTION DATA FROM FISH CAPTURED BY HOOK AND LINE IN MOODY LAKE, OCONTO COUNTY, WISCONSIN, 1994.

FISH>	PS	BG	YP	BLC	SMB
YEAR CLASS # **SIZE RANGE**					
I 1993					
II 1992					
III 1991					1 7.75"
IV 1990	2 4.7-4.8"			1 5.0"	
V 1989	17 5.0-5.7"	2 5.0-5.5"	3 6.0"		
VI 1988	5 6.0"	1 6.1"	1 6.5"		
VII	1	2			

LAND AND WATERSHED ASSESSMENT & DEVELOPMENT

Moody Lake has a small watershed. Development around the lake is limited by STH 32 on the west and connecting wetlands on both north and south edges. Cottage and residential development is presently limited to the east and south shores.

The immediate shoreline consists of :

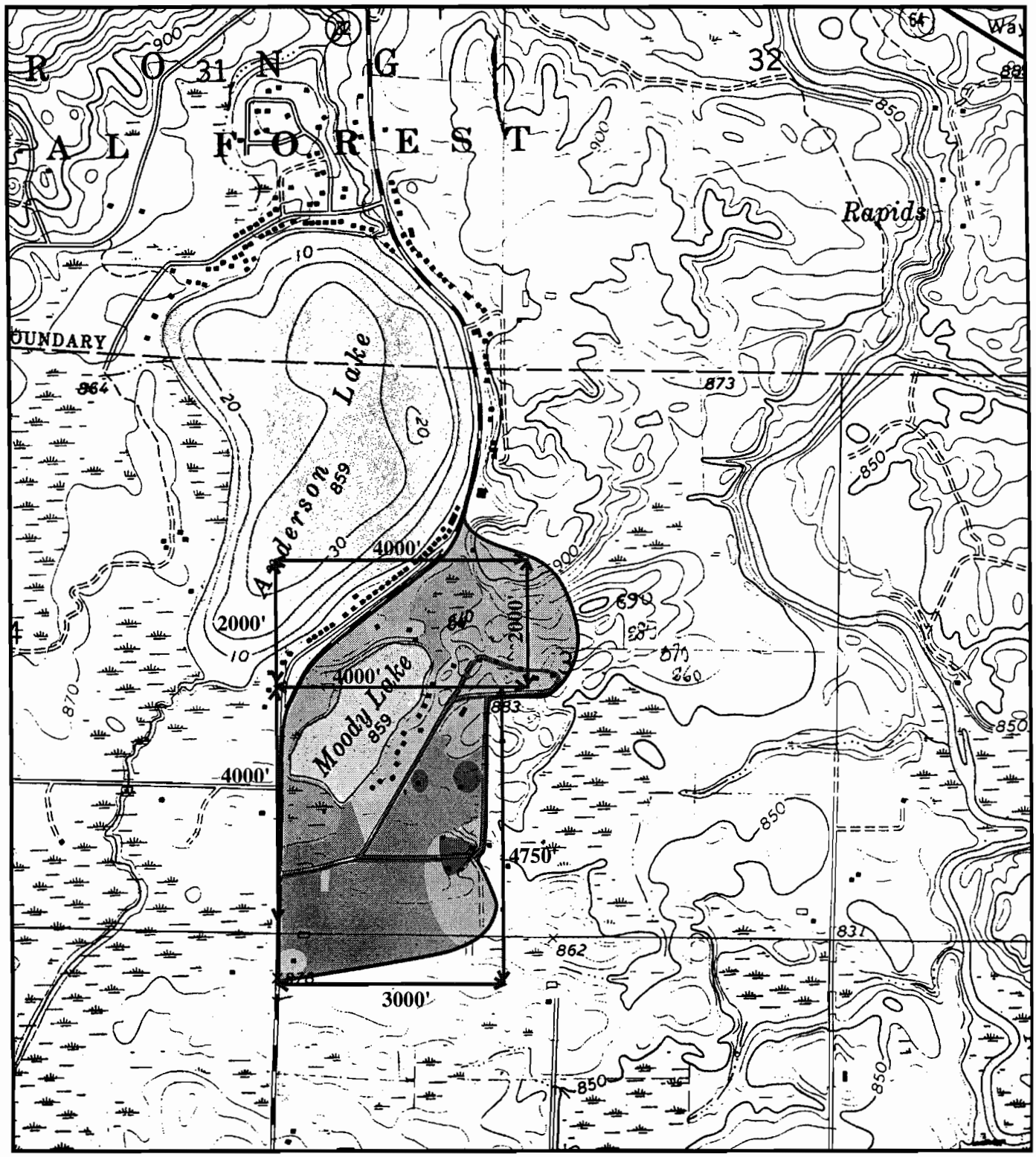
1. Moderately to steep drainage from STH 32 on the southwest, west and northwest.
2. Open bog to wet meadow to the immediate north.
3. Second growth hardwood to the northwest.
4. Extensive cottage and residents on the northeast, east, and southwest shoreline.
5. And a geographically isolated peat bog to the south.

Moody Lake watershed area covers approximately 140 acres. Land use in the watershed whose boundaries are described in Figure 3 are approximately as follows:

Agriculture: Old Pasture, & Tillable Land		35
Forestry: Second Growth Hardwoods	40	
Road Right-of-ways: STH and Town Roads	3	
Light Residential: Homes and Cottages	12	
Wetlands: Open-Tamarack Bog & Wet Meadow	10	

A larger watershed area than described affects Moody Lake. The Weso Creek watershed drains through and is dammed at the outlet of Anderson Lake. Very porous soils connect Moody to Anderson Lake beneath STH 32; therefore water level changes on Moody Lake are affected by Weso Creek flow and the Anderson Lake dam-controlled water levels.

Figure 3: **Moody Lake Sub Water Shed**



Agriculture: Old Pasture & Tillable

Forestry: Second Growth Hardwoods

Road Right-of-Ways: STH and Town Roads

Light Residential: Homes & Cottages

Wetlands: Open-Tamarack & Wet Meadow

Land and Lake Use Survey

A property owner's survey was presented at the 1995 annual spring meeting to assess current lake use and gather opinions on the problems and possible solutions to them. The survey can be found in Appendix A.

The Moody Lake shoreline area has been subdivided into 21 lots that have frontage on the lake. Several lots are off water and separated from the lake by town and access roads but still drain to Moody Lake. Out of 29 adjacent property owners belonging to the association 13 responded to this survey.

Results

The results of the survey indicate that most respondents have had dwellings on Moody Lake for quite some time. The range is from 3 months to 27 years with the largest group of respondents having owned their property for 16 to 20 years. The breakdown was as follows:

Length of Time on Property	# Respondents
0-5 years	2
6-10 years	2
11-15 years	2
16 -20 years	4
21-25 years	1
26-30 years	1
Left Blank	1

Most dwellings are used on a seasonal basis. In describing their dwelling type the respondents considered their property as follows:

Dwelling Use Description	# Respondents
Year-Round Home	2
Winterized Cottage	1
Three Seasons Home	5
Summer Cottage	5

In depicting the usage of their lake dwelling the questionnaire ask how often they used their dwelling and how many people used the facility during this use period. The main use periods were from May to September on weekends. The average was 22 weekends/year with an average of 4 people using the facility during these weekends.

Very few people, besides the permanent residents, used their lake property during the week (which includes Monday holidays). On an average, only 7 of the 13 dwellings owners responding used the lake dwelling during the week at all; (an average of 3 people/dwelling used these 7 dwellings only 96 week days/year. These include 13 vacation weeks or 65 vacation days during the week (including Monday holidays).

In relating lake use and recreational value of their Moody lake property, respondents were ask to number their priorities from 1-6 (1 being highest value, 6 being lowest value) on a list of brief recreational descriptions. The response was as follows:

Description	**#1**	**#2**	**#3**	**#4**	**#5**	**#6**
Swimming	2	5	1	2	1	
Pleasure Boating	2	3	3	1	1	1
Fishing	4	1	2	2	5	
Wildlife Viewing	1	2	4	3	1	
Scenic Beauty & Tranquility	4	1	2	2	2	
Other: Hunting (Write in)						1

Question 6 of the property owner survey related to sanitary disposal systems in regard to type, age, and maintenance. The reply was as follows:

Type	**# Respondents**
Septic System	11
Holding Tank	1
Outhouse	1
Age	
Unknown?	6
1-10 years	1
11-15 years	2
16-20 years	3
21-25 years	1
Maintenance	
Clean periodically	6
Pumping	1
None	2
(No Answer)	4
Distance from Lake	
0-50 feet	0
51-100 feet	2
101-150 feet	4
151 - 200 feet	2
> 200 feet	4
No Answer	1

Question 7 asked what were the major problems facing Moody Lake at this time. The responses were as follows:

Response	**# Respondents**
Too Many Weeds - Watershield	8
Silt Accumulation	1
Shoreline Erosion	1
Oxygen Depletion	1
Warm Water	1

The final part of the survey stated and ask the following, "THE DEPTH AND FERTILITY OF MOODY LAKE CAUSES MANY PROBLEMS FOR THE RECREATIONAL USE OF THE LAKE. WHAT PRIORITIES WOULD YOU SUGGEST TO SOLVE, PREVENT, OR KEEP THESE CONDITIONS FROM WORSENING". Listed solutions followed for rating from 1-5. The response is outlined below.

Possible Solutions	**#1**	**#2**	**#3**	**#4**	**#5**	**#6**
Machine Harvest of Aquatic Plants	6	3	0	2	1	
Chemical Treatment of Aquatic Plants	3	1	0	2	2	
Dredging/Removal of Lake Bed Material	1	0	4	0	4	
Long-Term Watershed & Shoreline Protection	0	3	2	3	0	
Water level & Flow Management	1	2	4	2	1	
Others (Write in)						
Connection to Anderson Lake	1					
Aeration		1				

Analysis & Discussion

The lake community members that responded represent individuals and their families from new owners to those who have been on the lake for 27 years. Most respondents fell in the 10-20 year ownership category. The majority use their lake property during the open water period from April to October during the weekend. The accumulative average useper dwelling was 4 people on 22 weekends/year: and averaged less than 1 person/ dwelling/year on the week-days. These figures include permanent resident occupancy and vacation time spent at the lake property. These averages are based on a 45% response (13 out of 29 lake community property owners).

Lake recreational use and value response to the survey represented a broad spectrum of needs. Highest values (ratings #1,2,&3) for all recreational categories listed received 7 or 8 total votes for each. Fishing and scenic beauty/tranquility got the highest 1st place votes; and swim-ming and pleasure boating the highest second place votes. Wildlife viewing captured the 3rd place vote. On such a small lake with a large spectrum of recreational needs during a short open water period user conflicts are bound to occur. It is apparent that swimming and pleasure boat-ing interest can conflict with fishing, wildlife, and aethetic interest during peak weekend use periods.

In response to the sanitary question several observations can be made. Septic systems are the main sanitary disposal systems used and the age of these systems in 46 % of the responses was unknown. 38% of the respondents knew their sanitary disposal systems to be between 11 and 20 years old. 54% had their systems cleaned or pumped periodically while 46% performed no maintenance or did not respond to the question. There seemed to be little correlation between lake use and septic maintenance responses.

The majority of sanitary systems are greater than 100 feet from the lake with the highest number of systems from 101-150 feet from the lake on lots 200 to 250 feet long and 100 feet wide. Most of the dwellings are located in the vicinity of the east shoreline area. This question was asked because the soil types found in this area can affect the way surface or subsurface nutrients enter the lake. Moody Lake's biological and chemical makeup is very susceptible to nutrient loading so any surface or septic runnoff can adversely effect the lake's water quality.

There are two main soil types found on this shoreline. The steeper graded area on the northeast and east shoreline has very fine sandy loam Fence soil at a 6-12% slope. The perme-ability of this soil is moderately slow and available water capacity is high. Surface runoff is medium. These conditions make for poor septic system absorption; but this limitation may be overcome with mounding with suitable fill or an enlarged absorption field. Exposed soils are suseptible to water erosion and soil blowing. This soil is suitable for trees.

The most predominant problem on Moody Lake as reported by the respondents is the abundance and dominace of the watersieild plant. Conditions that encourage and affect this plant are also mentioned to include: silt, shoreline erosion, low oxygen, and warm water. Management objectives must address this plant directly and indirectly.

Solutions to the watersieild problems will also solve other problems identified. Machine harvesting of this plant dominates the suggested solutions with 69% of the 1st & 2nd place votes. While chemical treatment had 31%. Dredging/Removal of Lake Bed material, Watershed & Shoreline Protection, and Water Level and Flow management shared the 3rd place category in solving the problem. Aeration and connection of Moody to Anderson Lake were other alternates mentioned to solve the problems of Moody lake.

Taking of nutrients and ideal conditions away from watershield while at the same time favoring conditions that support other plant and animal organisms that can compete with it for habitat, and nutrients is the objective of future management. The alternatives and goals to this objective are discussed in the recommendations.

MOODY LAKE, OCONTO COUNTY RECOMMENDATIONS FOR LONG TERM PROTECTION & MANAGEMENT

The future health of Moody Lake is dependent on area residents working together to alleviate the problems identified and described in the planning grant inventory described in this document. Water level stabilization and maintaining adequate oxygen are the two key components of Moody Lake management that must be addressed for the future welfare of the lake ecosystem.

There are plenty of nutrients available for fish and aquatic plant growth so the future of Moody Lake is also dependent on providing a suitable oxygenated environment so these nutrients can be utilized by fish, wildlife, and a diversity of plants (besides watershield). At the same time, every effort must be made so no new nutrients enter the lake that would add to those already found in abundance.

The lake community will be the one to benefit from their own actions if they follow the recommendations below. Recreational use benefits can include: a sustainable fishery, a diverse and manegable aquatic plant community for increased wildlife viewing and boating, and better water clarity for swimming. The monetary value of your lake property is reflected in the quality of your lake.

Moody Lake management options, recommendations, and, in some cases, cost are discussed under the following headings:

A. Water Level Control
B. Aeration Installation
C. Aquatic Plant Management Plan
D. Watershed Protection Plan
E. Lake Use Plan
F. Fish Management Plan

WATER LEVEL CONTROL

Background

Moody Lake's watershed was evaluated as part of this grant's inventory appraisal. Since Moody Lake is a seepage lake its water level is affected by ground water movement which is determined by the soils created in geological past times.

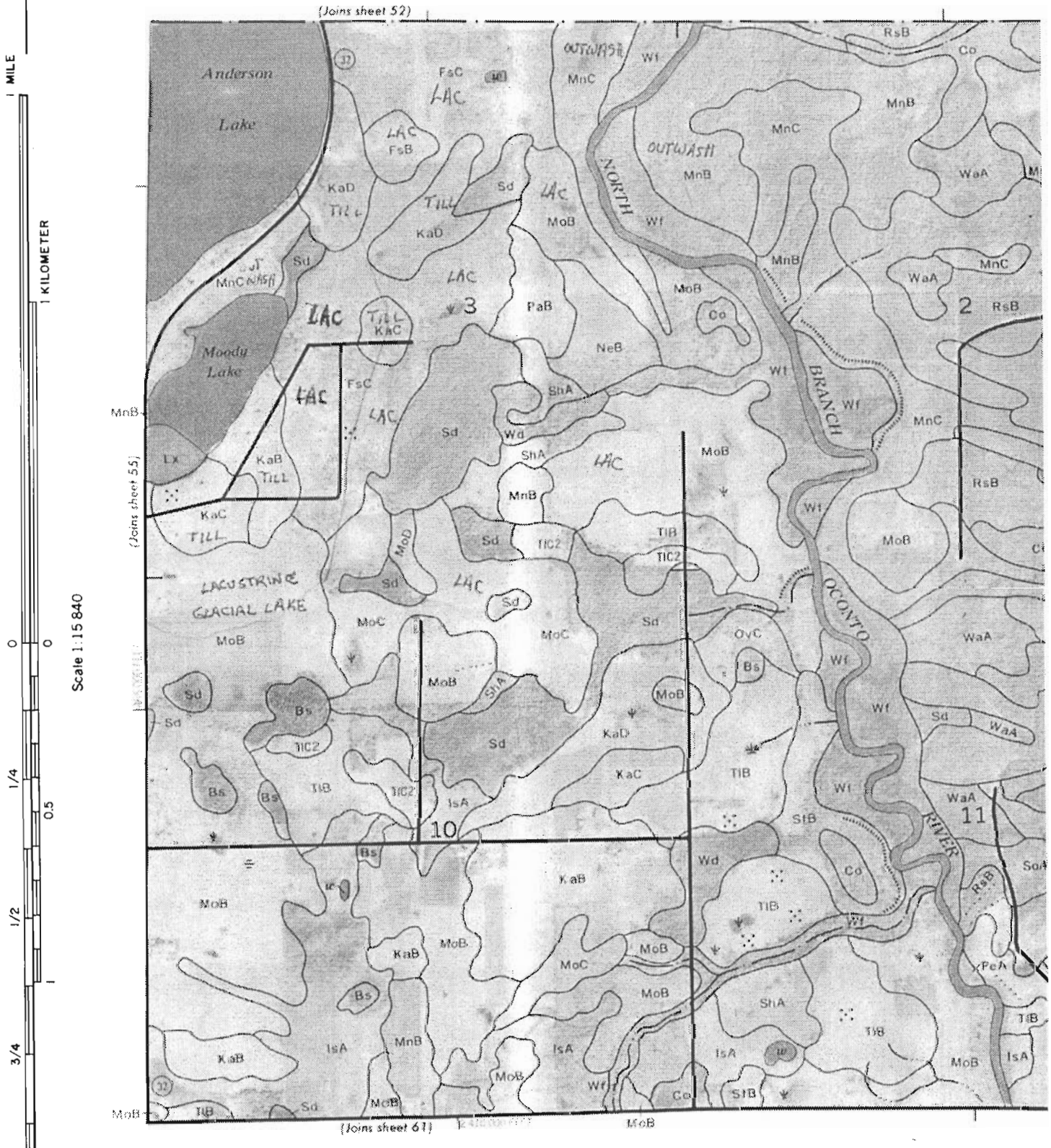
Initial investigation noted that a bog forest was located on the south end of Moody Lake the tamarack-black spruce trees appeared to have died quite some time ago but their dead trunk skeletons remained. Tree development in bogs have very shallow root systems and changes in water levels can kill the tree. It was apparent that this had happened. Further investigation found Anderson and Moody lakes elevations were listed as the same on a 1973 U.S.G.S. quad-rangle map. Since only the STH 32 road grade separates these two lakes, were these two lakes at one time joined before highway construction? An investigation into the original survey of 1839 did not show Moody Lake on the map as notes were only made at section corners. No other records could be found to verify any connection. Both Anderson and Moody lakes shorelines appear to have been platted and subdivided at the same time.

In reviewing the soils surrounding Moody Lake it was found that a very porous outwash soil separated Moody Lake from Anderson Lake. This would allow easy lateral movement of groun water beneath the STH 32 road grade, therefore water levels maintained on Anderson have a direct effect on Moody Lake's water level. The building of the dam on Anderson Lake and raising the water level 4 or 5 feet would then increase the water depth of Moody Lake from the former 4 or 5 foot depth to the present 9 foot maximum depth. This increased water level changed a pond-deep marsh community to a shallow lake community with potential for lake lot platting which did occur.

Geologically, Moody Lake is located on the border of two different glacial activity areas and the soils and vegetation support this. Soils in the bog to the south and east-northeast of Moody Lake indicate they were part of a glacial lake bed that is called Glacial Lake Oshkosh that extended south to the present Day Lake Winnebago. Glacial till soils (those carried by a glacier) make up the hill soils surrounding Moody Lake. Glacial outwash soils (those carried by melting glacial ice waters) are only found between Moody and Anderson Lake. The immediate watershed adjacent soils and delineated parameters are described in Figure 4.

It is the above described situation that has created the inventoried conditions found in Moody Lake. It is very important that as high and constant water level as possible be kept on Moody Lake to maintain a 'lake' condition and ecosystem. Many of the problems of Moody Lake, including watershield abundance and periodic fish kills, can probably be tied to fluctuating water levels on both Anderson and Moody Lake.

Figure 4: **Soils of Moody Lake With Their Origin**



KEY:

OUT - Outwash
LAC - Lacustrine
TIL - Till

MnC - Menahga Sand, 6-15% Slope
KaB - Kennan Fine Sandy Loom, 2-6% Slope
KaC - Kennan Fine Sandy Loom, 6-15% Slope
FgC - Fence Very Fine Sandy Loom, 6-12% Slope

Options

There are several options to the management of water levels but one fact is important: that high and steady water levels must be maintained. This is dependent on the operation and maintenance of the Anderson Lake dam.

Cooperation between property owners of both lakes to maintain these levels for the benefit of both lakes ecosysems is essential to all options. A management plan that regulates the water flows from the Weso Flowage and establishes legal water level parameters on Anderson Lake are equally important. The established flows and levels must by defined and managed for the long term protection of these lake ecosystems. Over time this management scenario will benefit the lake community both ecologically and economically.

The FIRST OPTION is to do nothing. The problems of Moody Lake will also be addressed by other management techniques discussed below but fluctuating and low water levels will dampen or hinder these practices in solving the problems over a long term.

The SECOND OPTION is to form a joint lake association or district for the benefit of both lake ecosystems. This joint lake community could work together in understanding the effects of water level fluctuations and help coordinate and operate the dam(s) controlled water levels for the benefit of the resource and lake community. Currently no formal lake organization exists on Anderson Lake and water level control is at issue. It appears that this is an ideal time to address this option. Joint association creation can form an organization eligible for protection and planning grant funding. Lake district creation can provide this option plus operating capital and legal authority for management of the lake community and dam.

The THIRD OPTION is for the association to operate independently and document Anderson Lake dam operation effects on Moody Lake and the water resources of the area. This information then can be used to change the operation of the dam for the best interest of the resource.

The second option is the recommended direction that the association should pursue. Appendix II includes a precursory report of the Anderson Lake dam, operation, and probable operational effects it has on the Moody Lake water levels.

AREATION INSTALLATION

Background

Periodic winterkills of fish were reported in the past. The resource inventory of Moody Lake conducted through this grant documents low oxygen condition at certain times under the ice and during open water periods when the lake does not mix. It further documents the detrimental water chemistry effects that low or no oxygen conditions have on recirculating nutrients and the aquatic plants and animals present thoughout the year. All these facts point to a need for oxygen and/or circulation of water to expose the water to air in Moody Lake.

New technologies in oxygen transfer and delivery and a new understanding of lake circulation makes aeration economical & feasible. Lake aeration is a valuable lake restoration technique. The importance of dissolved oxygen to the aquatic community of fish, plankton, and plants & animals living in the bottom, is well documented. Aeration is an effective means of improving dissolved oxygen conditions. In addition, aeration can lead to improved water quality by eliminating chemicals such as ammonia, hydrogen sulfide, manganese, and ferrous iron which currently build up in Moody Lake. Though aeration has little direct effect on the aquatic nuisance rooted plants, (such as watershield), it can lead to reduction and channeling of phosphorus, a critical plant nutrient, away from watershield to other living organisms. The prevention of periodic winterkill of fish is the first step in channeling nutrients from bottom sediments to other living organisms which includes fish and the live organisms they feed on.

There are two parameters that appear to be important to successful aeration. The first, the percent of the surface areas kept free of ice; the second, the amount of compressed air delivered. Wisconsin Department of Natural Resources suggested that greater than 1% of the surface area of a lake must be kept ice free for winterkill prevention.

Cost and Design

In Moody Lake with its maximum depth of 9' a stone diffuser/rotary vane compress or system is recommended. The system would consist of a 1/2 horsepower compressor system on shore in a covered box and hose extending to three diffuser assemblies located in the 9 foot depth area on the south end of the lake out from the boat landing. Each diffuser arrangements stone diffusers produce fine bubbles that lift water from the bottom area to the surface. The most efficient way to circulate water at the depth found in Moody Lake is with this system. With Moody Lake's shallow depth the system works as a circulator because they entrain large amount of water to the surface to allow air/water interface oxygen transfer. The cost of the purchasing, operation, and maintenance of the aeration system can be found in Appendix III.

Operation and Options

Once the aeration system is in place, the next step is determine when to operate it. The oxygen/temperature profiles conducted as a part of this planning grant is the key to initial operation.

Consideration of when to operate the system to prevent winterkill is the first use of the system. Moody Lake had excellent oxygen reading from top to bottom in mid to late October in 1984 when wind mixing and cool temperatures kept dissolved oxygen at 71-75% saturation (Table H). The lake froze over the week of November 21 and by December 27 oxygen was already depleted below the 6' depth (Table I). By February 3 oxygen was depleted through most of the water column except where phytoplankton were present producing oxygen at midday under clear ice condition. On March 3 oxygen was limited to just below the ice and was again supported by plankton with little snow cover.

By the March 28 sampling, after a partial thaw and refreeze to clear ice, poor or no oxygen conditions were found throughout the entire column at the north sampling location. The south sampling location had good oxygen to 6 feet accompanying a large phytoplankton bloom. These conditions corresponded to an increase in water temperature of 3 to 5 degrees and an ammonia build up as indicated in the water sample completed at this time.

Because of the large oxygen demand of the bottom sediments it is recommended that the operation of the aeration system begin as soon as there is any ice forming near the shoreline. This strategy would use the aeration system to maintain as much oxygen in the lake all the time rather than letting oxygen deplete to low levels beneath the ice and try to restore good oxygen conditions in later winter. Aeration should continue until ice out. Moody is one of the first area lakes to open in spring and the aeration system will free the lake of the wind-barrier ice even earlier.

The system design is conservative in the amount of water entrainment and the size of the ice opening. First, there will be only one ice opening which increases safety and the reduces the amount of safety fence that would be requiried. Second, if too much water is moved and cooled by contact with very cold air a condition of super cooling can occur. This condition increases ice thickness and could cause winterkill, especially in a shallow lake like Moody.

The second option for operation of the system is running it from around July 15 until the end of September. In 1974, low oxygen conditions were found below 4 feet on July 27 and were depleted below this depth by the September 23 oxygen/temperature profile (Tables D&E). The purpose of operation of the aeration system at this time is to mix bottom anaerobic (without oxygen) water with well-oxygenated surface water. This would create a livable habitat on the bottom for fish and other living organisms as well as prevent the release of phosphorus that is now released under the present anaerobic bottom conditions during this period. This aeration plan, again, aims at maintaining good oxygen conditions throughout the water column rather than let it be depleted and trying to restore it afterwards.

The positive results of either aeration operation option may only be found in the vicinity of the diffuser assemblies. If this is the case, fish will seek out this area and avoid poor oxygen areas of the lake. Summer winds could carry the oxygenated water and its positive effects over a larger lake area to the north.

It is recommended that the aeration system be installed and operated during both option periods. The results and effects of this operation on the lake ecosystem should be documented and compared to existing planning grant data.

AQUATIC PLANT MANAGEMENT PLAN

Background

Nuisance levels of watershield (Brasenia schreberi) have existed on Moody Lake for many years. Watershield now dominates the plant community in Moody Lake because increased and fluctuating water levels and soft sediment bottoms are ideal conditions for its growth and spread. It is the abundance of this plant that prompted the association to apply for the planning grant. Its abundance is also listed as the number one problem in the results of the property owner's survey.

Lake residents in the past have dealt with these nuisance levels of watershield on an individual basis both directly and inderectly. Plants have been cut and pulled in their shallow shoreline areas to stop the spread. In deep water areas paths have been cut with boat motors to create navigation channels. Sand blankets have been placed along some riparian shoreline areas increasing the firmness of the bed that hinders watershield growth and provides a bottom subtrate more suitable for other plant growth. Understanding the past and present methods of dealing with these nuisance levels has helped in developing this plan.

Watershield dominates Moody Lake from the shoreline to a 5 foot depth. Leafy Pondweed was found in July beneath the canopy of floating watershield leaves at 2.6 to 5.0 feet of water and covered the bottom in deeper water areas (to 9 ft depth where very few watershield plants were found). Any management plan that reduces the watershield will encourage the growth of the fine-leaved Leafy Pondweed. It will also encourage other floating and emergent plants such as water lilies and arrowheads. Many of these replacement plants are limited to less than three feet of water and are found in soft sediment. Other plants such as softstem bullrush and water lilies need firm bottom sediments to compete with watershield.

Management Options

There are several options and levels of effort to deal with the overabundance of watersiwild. Some will show results immediately such as cutting or spraying but are only a temporary solution. Other management stategies will take more time to see the results but will be more lasting and permanent. These options are discussed in detail below by category.

WATER LEVEL CONTROL and stabilization is a management option discussed earlier that will remove the advantage watersheild has over other rooted aquatic plants; its plant stem stucture is made to keep the leaf at the surface where lily pads and other emergent vegatation do not have this ability. Recognizing the effects of stabilized water levels will take years before the competition can replace the watershield but it is a very important management tool that has wide range of positive effects on the lake.

AERATION DEVELOPMENT may have an indirect effect on the watershield by increasing phytoplankton (free floating microscopic plants) that will decrease light from reaching submerged parts of the plant and compete with the plant for phosphorus. Again, the lake's response to aeration should be documented by weekly secchi disc reading. The plant survey should be repeated in 1997 to understand its affects of management changes on watersheild and other aquatic plants.

PLACEMENT OF FILL OR BARRIERS on the bottom is a management options that have several effects on watershield and other organisms. Sand blankets on the east shore are evidence that some soft sediment bottom areas have been changed that encourage growth of other plants to replace watershield. Placement of pea gravel or sand on the soft sediment directly is usually short-lived as wave action or foot traffic mix the sand with the soft sediment and the roots of watershield still can penetrate and grow through this mixture. Placement of a fabric barrier below the sand or pea gravel will help this from occuring but wave action can still carry sediment over beach wading areas or areas adjacent to docks. Permits are needed for the placement of any type of fill or fabric on the bottom of Moody Lake.

REMOVAL OF SOFT SEDIMENT is a good management option that has been considered by the association during this planning process. A soft sediment profile was completed during the winter of 1993-94 by lake residents and the results can be found in Appendix IV. From this sediment profile a preliminary dredging plan option for the east and southeast shoreline areas was developed. The plan suggested would remove soft sediment to hard substrate bottom from the east developed shoreline west 100 to 200 feet to a depth of 5 feet. Preliminary calculations (APPENDIX IV) based on the sediment profile estimate 6,259 cubic yards would have to be removed to achieve this goal at a estimated cost of $59,523 for dredging and hauling (2mi) alone. Additional regulatory permitting and sediment testing cost would add several thousands dollars to this cost.

This management option would remove the soft sediment and watershield with substrate in the shoreline area of home and cottage development. It adresses the major problems listed in the property owner's survey and got several votes as a solution (low priority) in the same survey.

The immediate effects of this dredging project on the east shore will be that it addresses the recreational problems caused by the watershield. But it is likely soft sediments will eventually enter the dredged areas from other areas of the lake. Other aquatic plants more adaptable to hard bottom sediments will probably replace the watershield and with the nutrients available in Moody Lake can in the future reach nuisance levels themselves.

The exposure of the lake to hard sediments on the east shore seepage area was another positive reason why this dredging option was developed and proposed. Moody Lake's acid water chemistry conditions create an environment that watershield thrives in. Removal of soft sediment would decrease the hydrostatic head pressure on the east shore bottom area and therefore increase seepage to the lake. This seepage would increaseing minerals entering the lake that are important for increasing and balancing the pH of Moody Lake. Production of aquatic organisms that compete with watershield is limited by the low mineral content and resulting pH in Moody Lake.

MACHINE HARVESTING OF AQUATIC PLANTS is an option to address the watershield problem on an annual basis. This solution to this problem had the most support in the property owner's survey.

Purchase, operation, maintenance of an aquatic plant harvester is very expensive and not a practical alternative for the Moody Lake Area Association. Joint purchase and operation with another nearby lake that needs a harvester could reduce these expenses. Cost sharing for purchase is also available through the state waterway commission but the minimum harvestable acre criteria could not be met on Moody Lake. These machines cost from $39,000 to $60,000 for complete harvesting & removal equipment. Operation and maintainence is additional.

There are several portable machine aquatic plant harvesters available that can be mounted in a boat and could be operated by lake volunteers or used by individual lake residents to cut channels near their own shorelines. It is the law that any weeds cut must be removed from the lake; so the plants cut by these portable machines must be pulled out of the water, placed on the shoreline, and transported them for disposal or composting. The cost of these harvesters start at $3,000 and can exceed $10,000 with additional equipment to aid in removal.

There are water weed cutters and rakes available for hand harvesting. These tools could be purchased by the association and loaned to residents to use. Plants cut can be put on shoreline, dryed, and used as mulch or compost. Moody Lake's east shoreline area with its light but non-percolating soil would benefit from these added nutrients. Cost of a cutter and rake is less than $200.00.

The hiring of a plant harvester maybe the most practical alternative for immediate results in dealing with the watershield problem. A six foot cutter can cut approximately a half acre in 1/2 hour and haul about 300 cubic feet of plants before having to unload at a landing. This cutting time can vary depending on density of the weeds and distance to landing for unloading when full. In Moody Lake watershield is very dense and is a very heavy aquatic plant due to it's gelantinous coating, therefore cutting would probably be slowed down considerably. It can cut to a maximum depth of 5 feet and cutting in water less than 2 feet is impossible or very hard on the cutting bar.

There is usually a minimum acreage needed to make the hauling and operation of the harvester economical for the owner. With Moody Lake's small size and harvesting needs, it is questionable if it can meet minimum requirements, but proper planning and negotiations could be used to work out feasible solutions to this problem. Prices to hire a contractor are $2400 (20 hour minimum), $120.00/hr for 20-40 hours of work and $100.00/hr if over 40 acres are harvested.

The timing of the harvesting of watershield is important. In 1994 the plants had not reached the surface by May 24 but by June 27 the floating leaves had reached the surface and flowers were in bloom. With this timing, cutting from 2 to 5 foot depth should be done in early to mid June. This would set the plants and canopy development back at least several weeks. This would allow other plants that are shaded by the watershield to compete and open up channels for recreational boat traffic. The timing of when the plants reach the surface is dependent on weather and light penetration through the water column.

Harvesting should concentrate on the east shore area with a strip parallel to shore in the shallowest water possible with several channels cut lakeward to open water for darting predator fish such as bass and northern pike to capture panfish protected by the present dense aquatic plant growth. Some harvesting should be done near the south shore and from the boat landing for access. Some channels should be cut perpendicular to the west shore to break up the watersheild dominance and create fishing channels. All cut channels should avoid cutting areas with other plants such as waterlilies, burreed, and pondweeds. These channel locations should be mapped/marked and harvesting should be tried for several years. Observations of changes in the channels and effectiveness of harvesting should be made and recorded.

SPRAYING OF AQUATIC PLANTS is another alternative to deal with the watershield problem. Watersheild, being a vascular plant with an extensive root system, is very hard to treat chemically. Two chemical formulas are used to treat watershield: 2,4D and Rodeo. The 2,4D is broadcast sprayed and is not selective to watershield but will kill other plants that are competing with it. Rodeo is sprayed directly on the leaf along with a sticking agent and travels to the root system to kill the plant. Very little is used but the process is slow and tedious. It is recommended that application of both be made when the water warms up and when the plant is mature in August to early September. Cost of spraying varies with amount of chemicals used and square foot area to be sprayed. Spraying must be done by a licensed sprayer and by permit only. Permits must be secured from the Department of Natural Resources district office in Green Bay and spraying is usually supervised. Bids and details of spraying should be obtained before deciding on a contractor. Correct application is critical. The chemicals used can be detrimental or toxic to other aquatic organisms that are important to the restoration of Moody Lake.

PLANTING OF COMPETING PLANTS is another alternate for dealing with the watershield. Arrowhead, white and yellow water lily, burreed, and water celery were all found in Moody Lake is various isolated patches. Some root stock can be thinned and transplanted to other areas where the watershield has been removed. They can compete with the watershield roots and leaves for space and add variety. This kind if habitat improvement added to building of wood duck houses and preserving duck nesting habitat can indirectly help the watershield problem. Watershield plants and seeds are eaten by a variety of waterfowl at different times of the year and a variety of plants can be an added draw (See TABLE N).

WATERSHED PROTECTION PLAN

Background

Direct drainage to Moody Lake is limited to approximately 140 acres surrounding Moody Lake. Agricultural activities are limited and separated from the lake by old pasture and roadways. Further development of the immediate shoreline is limited by zoning restrictions regarding wetlands and wastewater treatment.

The effects of water levels maintained on Anderson Lake on control of Moody Lake's water levels is indirectly tied to Anderson lake's watershed. How and when water drains from it and how the dam water level is controlled is important to Moody lake's ecosystem. Management options on this are presented above under the heading WATER LEVEL CONTROL.

Management Options

The soils surrounding Moody Lake are suseptable to erosion and are not particlularily good for wastewater treatment. Management practices should concentrate on addressing these characteristics of the soils. The water quality of soft water seepage lakes, like Moody Lake, is affected by groundwater quality and the use of the lake shoreline.

SHORELINE BUFFER STRIPS should be developed on all the developed lots. The width of this shoreline area is dependent on the steepness of the slope. The steeper the slope the wider the buffer strip. The purposes of these buffer strips are many.

They prevent surface water runoff from entering the lake from short grass areas, driveways, walkways, and roadways. It acts as filter of sediment, salts, and fertilizers that would come from these drainage areas.

When planted with flowering forbes and native grasses (which have extensive root - systems) they can intercept ground water. This ground water could contain nutrients from upland wastewater seepage beds.

The esthetic value of the buffer strip is also important. Using variety of plant species of different heights will not restrict the view from the residence or from the water, only provide a natural landscape frame (as a frame and matting would enhance a picture).

Design of these strips can be tailored to you personal needs and wants. An abundance of colors, shapes, and sizes of native vegetation from flowers to shrubs to trees are available for planting. They can be adapted to shady or sunny areas. Walkway approaches can be angled and/ or hidden to lessen the affects but still give access to dock or swimming areas. Plants can be selected that draw birds, butterflies, and other wildlife to your shoreline.

MAINTAINING A TREE CANOPY is also very important in the immediate watershed of Moody Lake. This practice is particularly important in short grass areas to slow the effects of heavy rains. Back lot areas on the east shoreline seem especially in need of trees. In undeveloped areas bordering the lake and the adjacent wetlands to the north and south tree areas should be protected from clear cutting that would destroy the maturing forest canopy. Selective cutting, wise lot development, and good road building techniques that consider erosion would go along way in protecting the wetlands and the lake. Mature trees can also provide nesting sites for birds including sites for wood duck nesting.

MAINTAINING SEPTICS is another key to protecting the lake. In the property owner's survey most of the respondent's did not know the age of their septic systems though many responded they periodically clean them out. Septic tanks should be cleaned when settled solid matter fills only 1/3 of the volume of the tank. If not done at this time settling time of solid waste is reduces and solid waste can enter your drain field. Paying close attention to cottage or home use and maintaining a pumping record will help in understanding when to pump.

LAKE USE PLAN

Background

Moody Lakes's small size of 17.5 acres combined with the information provided in the Property Owner's Survey indicates use conflicts in Moody Lake have already developed. Swimming, pleasure boating, and fishing were all high priorities for lake resident's as indicated in the survey. Lake use is concentrated during the warm water period of summer when these activities take place.

Water skiing and personal watercraft (jet skis) need open water areas for operation. Several state laws have been past to address safety issues associated with the operation of these activities. Fishing and swimming areas need to be protected from boat activity for practical and safety reasons.

Several laws regarding motorized boat use are particularly pertinent to Moody Lake. The first law is that motor boats may not be operated at a speed greater than "slow no wake" on lakes 50 acres or less having public access. The second law is that it is unlawful to operate a motor boat within 100 feet of any dock, raft, pier, or buoyed restricted area on any lake at a speed in exess of "slow no wake". The third law is that any person operating any type of motor boat that is towing persons engaged in water skiing, aquaplaning, or similar activity may not operate within 100 feet of any occupied anchored boat, any personal watercraft, any marked swimming area, or public boat landing.

Though Moody Lake is 17.5 acres the ring of watersheild near shore restricts recreational use during peak activity times to a even a much smaller area. Swimming rafts have been placed near the center of the open water area. Placement of swimming rafts out from a property owner's shoreline by law is a riparian right but the raft needs to be placed within 200' of the shore and cannot restrict navigation. Any anchored floating raft beyond this distance from shoreline needs to be lighted for safety reasons.

The above laws have been developed to place safety first in water-related activities. Town ordinances or lake district management laws can be more restrictive than state law but they cannot be less restrictive. The "slow no wake" and distance regulations described above cannot be circumvented by passing special regulation that allows wake creating activities such as waterskiing, jetskiing, and aquaplaning because Moody Lake is less than 50 acres.

Management Options

Lake use management should be considered on Moody Lake because of it's size and the because of the importance placed on water activities that can conflict. Any regulation ir volunteer effort to eliminate water use conflicts is only good if they are enforced, aggreed upon, or understood by all who use the lake.

THE FIRST OPTION is to do nothing. Present state law and interpretation described above if adhered to eliminates or could eliminate many conflicts such as waterskiing and swim raft placement. The fisherman, swimmer, and "no wake boaters" could share the water during peak season, high use times under crowded condition that can occur on weekends.

THE SECOND OPTION is to partition areas of the lake for certain lake uses. Partitioning means to restrict use of a particularly described area of a lake during a particular time of day or time of year. For example:

" the east shore area extending from the shore 200 feet lakeward could only be used for swimming and fishing from shore or swimming piers on weekends and extended holiday weekends from Memorial Day to Labor Day between the hours of 10:00am and 7:00 pm. During this time boating activity whether motorized or non motorized would be restricted in this area to leaving and returning from the riparian pier or shoreline."

This samle ordinance would limit swimmer conflict with fisherman/boaters in a limited area but does not restrict the swimmer to hours or where they could swim; but addresses a safety issue for swimmers during a problem time of the day and year.

Other partitioning strategies on a lake could protect critical habitat areas, e.g. fish spawning areas or waterfowl nesting areas at certain times of the year.

THE THIRD OPTION is to develop time partitioning that can be combined with the second option or stand alone to restrict conflicting activities. For example: Fishing from a boat could be time slotted from late evening to early morning while all other boating activities could be defined to a specific daylight time. Again, the quality if fishing created by this time partitioning would improve but restrict the early morning paddleboater looking for exercise.

A FOURTH OPTION is to place a horsepower restriction which could limit motor activity to a maximum horsepower or even to electric trolling motors only. This option would be used to restrict speed and noise and add to the safety factor.

There are many problems that can arise from developing lake use restrictions. If laws are developed and not respected or enforced they can be easily ignored. The restrictions can easily become complicated as the example described in option #2 and give reason to individuals to not follow them. With public access any one using the lake may not be aware of the volunteer effort and can choose to ignore it if not law, or even if it is not clearly stated at the boat landing.

Ordinances must be passed by the town board or a Lake District with a town board connection. Any ordinance development the Moody Lake Area Association, Inc. might make in the future will have to work within these legal structures. Full consequences of the ordinances must be thoroughly evaluated before seeking their passage. Volunteer actions to restrict lake use among property owners during peak use times may be adequate to solve many problems and this approach should be attempted before the legal route is used.

FISH MANAGEMENT PLAN

Background

Fish management activities on Moody Lake have either been none existent or have been conducted privately in an attempt to overcome the unofficial "periodic winterkill" status this lake has been recognized for. This planning grant inventory has documented conditions that point to this status. It has also created a species list and made a cursory examination of the fishery habitat. No fish were found older than those born in 1988 which is two years after the last heavy snow cover winter of 1986 which could of induced at least partial winter kill conditions, and possibly a total winterkill condition.

An aeration system would eliminate this problem. Once this is installed then a goal of establishing a good growing and balanced fishery community should be implemented into the lake management plan.

Options

STOCKING The evaluation of the habitat of Moody Lake and the ecology of the fisheries present indicates that northern pike should do well in the lake. Stable water levels after ice out could provide conditions for spawning. A self sustaining population could be developed if this occurs. Predator fish populations must be present in several sizes and year classes to prevent panfish over abundance and stunting.

Approximately 100 -12-16" northern pike should be initially stocked. Within a three years these fish should reach sexual maturity and spawn. it there is a successful spawn, hatch, and survival of offspring small northern pike should appear in the creel or be seen along shore the third year after introduction. The stocking of 100 fish may seem high but mortality to hook and line fishing and predators before they reach maturity is considered in this stocking rate. Largemouth bass should be considered as a second stocked specie if a spawning population does not already exist.

EVALUATION - A method of evaluating the fishery such as the volunteer fish capture/ measurement/scale assessment used in this precursory study should continue. It is an inexpensive evaluation that can also be an indicator that you lake restoration plan is working. Because of it's small size Moody Lake will probably not receive much fishery assessment attention in the future; Evaluation by the lake association with the cooperation if the local sportsmen club is even more important.

APPENDIX I. MOODY LAKE AREA ASSOCIATION PROPERTY OWNER'S SURVEY - 1995

NAME:

1. How long have you owned property on Moody Lake? ____ yrs.

2. Would you consider your property A :
   - A. Year round home _____ B. Three season home _____
   - C. Summer cottage _____ D. Winterized Cottage _____
   - E. Vacant Lot _____ F Other (explain) _____

3. How often do you use your lake dwelling or property?
   - A. Vacation weeks _____
   - B. Weekends/year _____
   - C. Weekday/year _____
   - D. Other (explain) _____

4. On an average year, how many people use your property during period(s) indicated in question #3 above?
   - A. Vacation _____ B.Weekend _____
   - C. Weekdays _____ D. Other _____

5. In describing the use and value of your lake property, number 1 thru 6 the priorty you would place on the following:
   - A. Swimming _____ B. Pleasure Boating _____
   - C. Fishing _____ D. Wildlife viewing _____
   - E. Scenic Beauty & Tranquility _____
   - F. Other (describe) _____

6. What type of waste disposal system does your property have? _____
   - How old is it? _____
   - What maintenance does it require? _____
   - How far from the lake is it? _____

7. What do you feel are the major problems facing Moody Lake at this time (Please comment on back)?

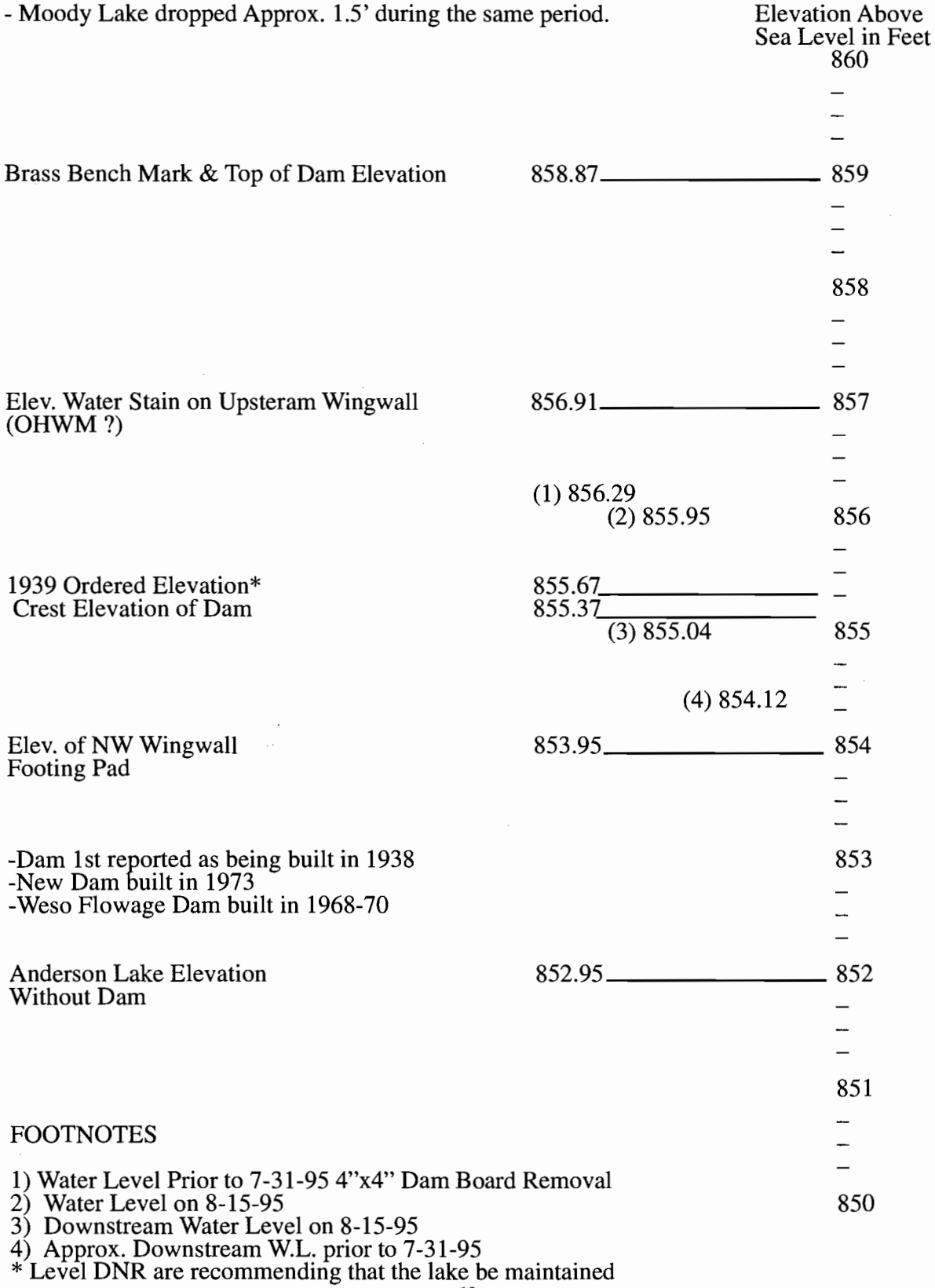
* The depth and fertility of Moody Lake causes many problems for the recreational use of the lake. What priorities would you suggest to solve. prevent, or keep these conditions from worsening. (Please number 1-5 on left in order of priority).

Machine harvesting of aquatic plants
Chemical treatment of aquatic plants
Dredging/removal of lake bed material
Long-term watershed & shoreline protestion
Water level & flow management

Please write any additional comments on back. Please return this qestionare within 10 days. The results of this survey will be used for planning - individual responses will remain confidential. Please send to:

APPENDIX II. Anderson Lake Dam Design Parameters, Operation notes, and Related Moody Lake Effects

-4.7" of rain from 7-31 to 8-15
- Moody Lake dropped Approx. 1.5' during the same period.



FOOTNOTES

1) Water Level Prior to 7-31-95 4"x4" Dam Board Removal
2) Water Level on 8-15-95
3) Downstream Water Level on 8-15-95
4) Approx. Downstream W.L. prior to 7-31-95
* Level DNR are recommending that the lake be maintained

APPENDIX III. AERATION SYSTEM COST-OPERATION-MAINTENANCE

Aeration Unit

Quantity	Description	Price	Extended price
3	Lake Diffusers	$ 65.00	$195.00
1	1/2 hp Carbon Vane Roatary Compressor (115 or 230)	415.00	415.00
1	3 Pressure Relief Valve Outlet Unit	65.00	65.00
1	Adjustable Motor Cover	15.00	15.00
4	400' Rolls of 1/4" Poly Tubing	42.00	168.00
230	Cable Ties	.18	41.40
5	1/2" Couplings	.35	1.75
20	1/2" SS Hose Clamps	.38	7.60
1	Air Filter & Element	12.50	12.50
		TOTAL	**921.25**

Add to this cost Tax, Freight, Installation, Bricks, Cabinet Construction & Power.

Maintanence

Replace air filter element annually	$12.50
Replace carbon vanes bi-anually ($50.25)	25.00
Replace pressure relief valves possibly after 5-10 years ($16.50)	3.30
ESTIMATED ANNUAL MAINTENANCE COST	**$40.80**

Operation

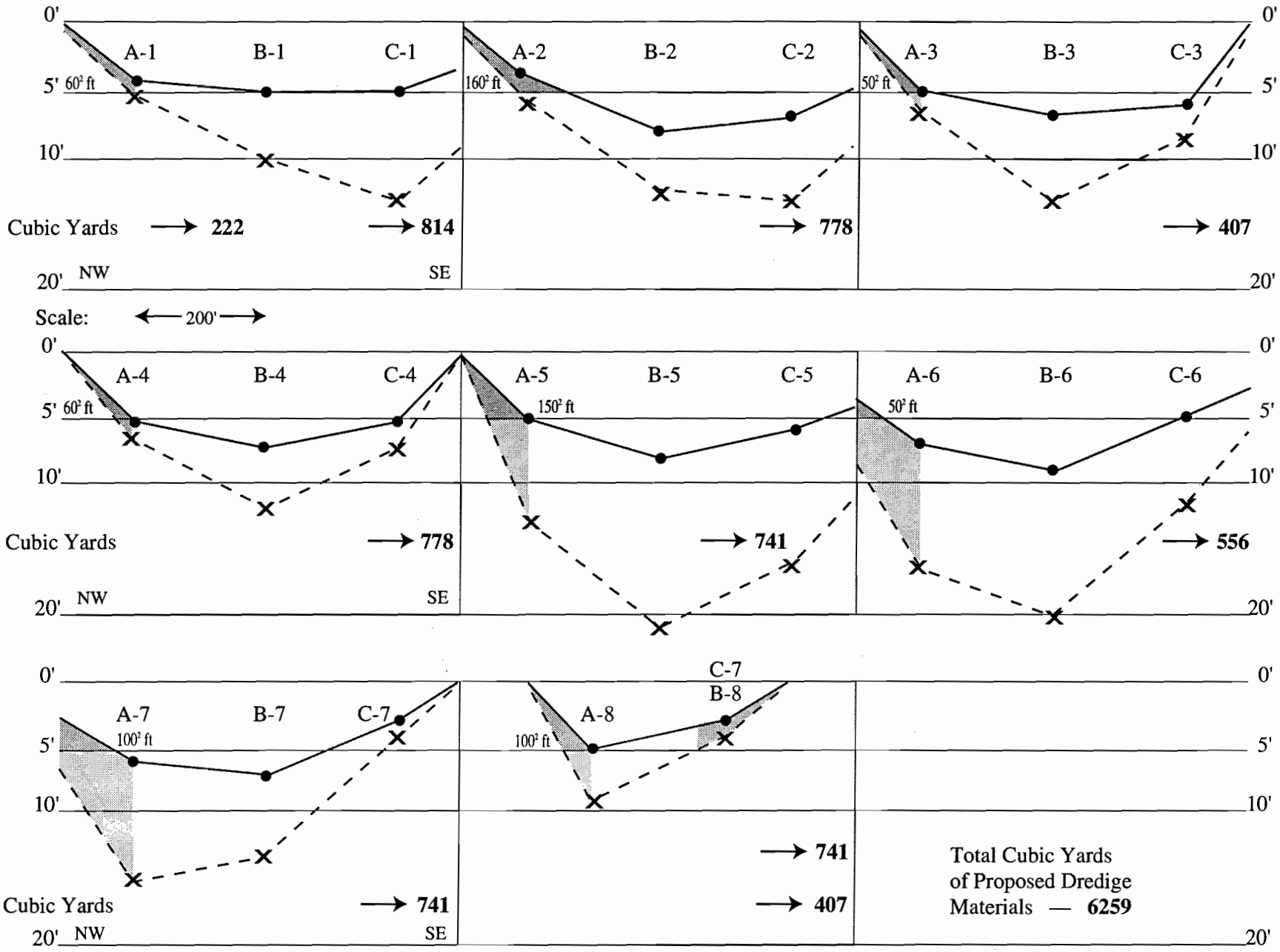
-1/2 h.p. compressor recommended draws approx. 500 watts.
500 watts - .500kilowatts; therefore uses .500 KWH
.500 KWH x 24 hrsx 30 days x $.05992 (cost/KWH) -$21.37/mo

-Cost to run Nov 15 to Apr 15 (5 mo.)	-$ 107.85
-Cost to run Jul 15 to Sep 30 (2.5 mo.)	- 53.43
EST. ANNUAL COST OF OPERATION &MAINTANENCE	**$202.08**

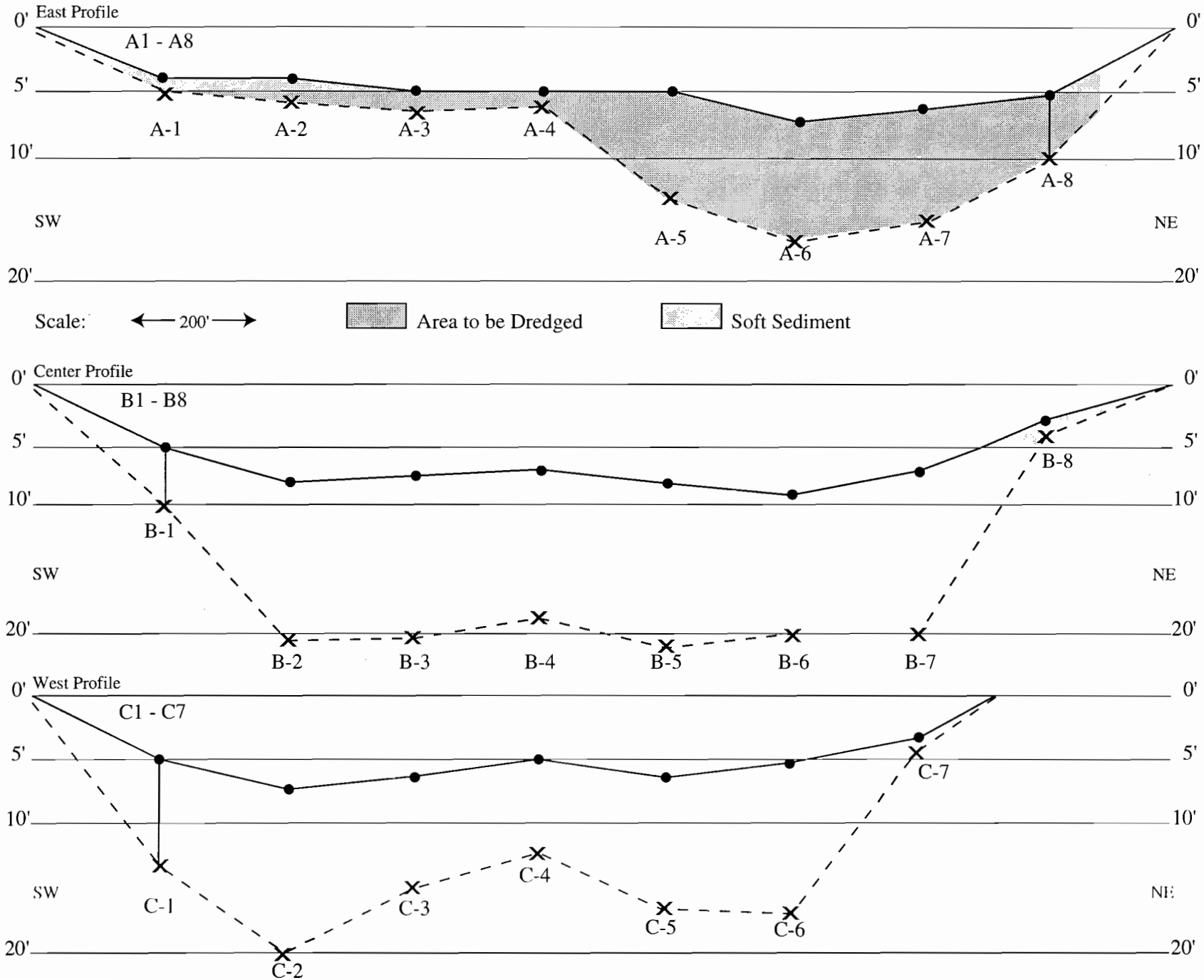
APPENDIX IV.
CROSS SECTIONAL WATER DEPTH & SOFT SEDIMENT PROFILE ANALYSIS OF MOODY LAKE, OCONTO COUNTY, 1994-1995.

X-SECTION profile #	DEPTH OF WATER ft	DEPTH OF SEDIMENT ft & inches	T. DEPTH ft-inches
A - A			
A-1	4.0'	0'9"	4'9"
A-2	4.0'	1'9"	5'9"
A-3	5.0'	1.7"'	6'7'
A-4	5.0'	1'0"	6'0"
A-5	5.0'	7'0"	13'0"
A-6	7.0'	9'6"	16'6"
A-7	6.0'	9'0"	15'0"
A-8	5.0'	5'0"	10'0"
B-B			
B-1	5.0'	5'0"	10'0"
B-2	8.0'	12'6"	20'6"
B-3	7.0'	13'0'	20'0"
B-4	7.0'	11'6"	18'6"
B-5	8.0'	12'9"	20'9"
B-6	9.0'	11'0"	20'0"
B-7	7.0'	13'0"	20'0"
B-8	3.0'	1'0'	4'0"
C-C			
C-1	5.0'	8'0"	13'0"
C-2	7.0'	13'0"	20'0"
C-3	6.0'	8'6"	14'6"
C-4	5.0'	7'0"	12'0"
C-5	6.0'	10'0"	16'0"
C-6	3.0'	11'6"	16'6"
C-7	3.0'	1'0"	4'0"

Appendix IV: Moody Lake Water Depth, Soft Sediment & Proposed Dredge Profiles Oconto County, Wisconsin 1994



Appendix IV (Continued): **Moody Lake Water Depth, Soft Sediment & Proposed Dredge Profiles**
Oconto County, Wisconsin 1994



APPENDIX V.
MOODY LAKE MANAGEMENT GOALS OPTION TIMELINE 1995

MANAGEMENT OPTION	TIMEFRAME	COST
1. WATER LEVEL CONTROL		
Support of increased water level on Anderson Lake, Request for hearing, testify to why.	Winter 95-96	?
Create a Joint Lake Association with Anderson Lake to Address Water Level Problems	1996 or ASAP	?
Docunment Water Levels and Changes & Effects, as Association	1996 & 1997	grant %
NOTES:		
2. AERATION INSTALLATION		
Secure Funds for Aeration System Purchase & Installation	ASAP	$1200.00 (grant?)
Operate System	1995 on	
Annual Maintanece Cost		40.80
Annual Electric Cost		160.00
Monitor Effects of Aeration on lake, plant survey.	1996 & 97	grant %
NOTES:		

APPENDIX V. (CONT.)
MOODY LAKE MANAGEMENT GOALS TIME LINE
3. AQUATIC PLANT MANAGEMENT PLAN

Make choice of option(s)		
Water level Control	ASAP	See Above
Aeration Development	ASAP	See Above
Placement of Fill or Barriers	1996 on	
Removal of Soft Sediment	?	$60,000
Machine Harvest		
Purchase Harvester	?	40,000
Operation & Mat.	?	10,000
Purchase Boat Mounted & Accesories	1996-97	3-10,000
Purchase Hand Harvester & Rake	1996	200.00
Hire plant harvester	1996 on	2,400/
Chemical Treatment	1996 on	1,200/
Planting of competing plants	Continuous	100/

4. WATERSHED PROTECTION PLAN

Shoreline Buffer Strips	1996 on	grant %
Plant Trees	1996 on	$ 100/
Maintain Septics	1996 on	

5. LAKE USE PLAN

Set meeting of Membership to Discuss Options	1996 spring ANNUAL MEETING	
Lake Partition Areas		
Time Partitions		
H.P. Restrictions		
Methods		

6. FISH MANAGEMENT PLAN

Stock 100 12-16" Northern Pike	1996	$700
Volunteer Fish Assessment	Continuous	$150/

NOTES: