IPS ENVIRONMENTAL AND ANALYTICAL SERVICES
Appleton, Wisconsin

PHASE II
EAST CHAIN O' LAKES MANAGEMENT PLAN
WAUPACA COUNTY, WISCONSIN

REPORT TO:
CHAIN O' LAKES PROPERTY OWNERS ASSOCIATION

December, 1995

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SUMMARY

The East Chain project group consists of Miner and Dake Lakes of the Chain O' Lakes, a group of 22 mostly interconnected relatively small lakes in Waupaca County, Wisconsin. Water quality is good to very good and related to substantial groundwater inflow. Water quality, along with the Chain's proximity to population centers, contribute to highly developed shoreline areas (many permanent residential) and periodic high to excessive non-resident recreational use. An initial resource assessment was made in 1992 (Phase I Chain O' Lakes Management Plans); this document supplements the 1992 report with Phase II efforts toward development of a comprehensive lake management plan.

The Chain O' Lakes watershed, primarily agricultural but with significant forested and wetland areas, is a subwatershed of the Tomorrow/Waupaca River basin which has recently been granted Priority Watershed Project Status. Variable, but generally low groundwater nitrate levels were observed in the Chain subwatershed during the appraisal phase of the Priority Watershed Project. Overland flow nutrient and sediment inputs were estimated to be lower than expected, but field estimates for nutrients were substantially higher. Modeling for some Chain lakes indicated a natural process of phosphorus removal by marl precipitation.

East Chain water quality monitoring during Phases I and II indicated in-lake nutrient levels below those expected for the region. Surface total nitrogen levels in Miner and Dake Lakes were relatively lower than in most other Chain O' Lakes. Differences between the East Chain lakes, except those related to water column stratification in Miner Lake, were small.

East Chain recreational use survey results were generally similar to those of the Chain O' Lakes overall and various resident user groups. Results indicated periodic excessive use during summer weekends or holidays with perceived safety problems and diminished recreational enjoyment of the resource related primarily to non-resident watercraft. Water safety enforcement was considered adequate at all times, slightly less so during periods of peak use, and no clear concensus was evident regarding the need for additional regulation. Residents agreed there was adequate access, disagreed with the need for a public park or swimming beach, and were slightly in favor of more water accessible public restrooms.

Purple loosestrife, an exotic potentially nuisance plant, was not present in the East Chain, but is established in nearby Chain O' Lakes project groups.

Water quality protection and water use conflict minimization are priority management objectives for the East Chain and all Chain O' Lakes residents. Specific recommendations for the East Chain include private well testing for nitrates and pesticides, event sampling where appropriate to assess overland sediment and nutrient inflows, protection/maintenance of existing aquatic plant beds, monitoring for purple loosestife establishment, and use management emphasis on the sport fishery or other more passive recreational uses.

Other recommendations are applicable to the East and other Chain project groups and emphasize continued focus and expanded involvement (designated Chain O' Lakes Property Owners Association individuals or committees) in watershed-wide surface water and groundwater quality issues, use management, and exotic species control. These recommendations, which include trend monitoring for water quality, are designed to identify potential problem areas or conflicts before they become widespread or severe.

INTRODUCTION

The Chain O' Lakes is a group of 22 mostly interconnected lakes in the Towns of Dayton and Farmington, Waupaca County, Wisconsin. The lakes are, in general, relatively small, highly developed, groundwater fed and located in a sandy, mostly level watershed. The lakes are a major tourist attraction for Waupaca County and occasionally receive excessive recreational use.

The Chain O' Lakes Property Owners Association (CLPOA), which serves as the main steward for the resource, was formed in the 1960's and currently has about 800 voting members (1). The CLPOA received its first Wisconsin Department of Natural Resources (WDNR) Lake Management Planning Grant in April, 1991. IPS Environmental & Analytical Services (IPS) of Appleton, Wisconsin was selected as their consultant for management plan development.

The Chain O' Lakes was delineated into five Project Groups (Table 1) for management planning purposes. Phase I efforts included baseline assessment activities (for water quality and aquatic plants) and a public involvement program. Specific physical properties, preliminary methods, and other introductory and technical information for the Chain O' Lakes and the respective Project Groups were presented in the Phase I reports (printed 1993).

Table 1. Lake Management Planning Project Groups, Chain O' Lakes, Waupaca County, Wisconsin.

Upper Chain	Middle Chain	Lower Chain
Otter Lake	Nessling Lake	Ottman Lake
Taylor Lake	McCrossen Lake	Bass Lake
George Lake	Round Lake	Youngs Lake
Sunset Lake	Limekiln Lake	Beasley Lake
Rainbow Lake		Long Lake
		Columbia Lake

East Chain	Little Chain
Dake Lake	Orlando Lake
Miner Lake	Knight Lake
	Manomin Lake
	Pope Lake
	Marl Lake

A Phase II grant was received in August, 1993; Phase II efforts included continuation of the water quality monitoring and public involvement programs, analysis of a recreational use questionnaire (circulated under Phase I) and more intensive assessment of areas of concern in the watershed. This report presents the results of these Phase II lake management planning efforts for the East Chain O' Lakes.

DESCRIPTION OF AREA

The Chain O' Lakes are a group of "kettle" lakes in the southwest corner of Waupaca County, Wisconsin (Fig. 1). Kettle lakes are formed when ice is pushed into the soil by retreating glaciers; the depressions subsequently filled with water when the ice blocks melted. The East Chain consists of Dake and Miner Lakes in the south-central portion of the Chain.

The Chain O' Lakes is largely groundwater fed with inflow generally from the northwest. Surface flow in the East Chain is from Miner to Dake Lake and out through a navigable channel to Columbia Lake of the Lower Chain Project group. The Crystal River drains the Chain O' Lakes to the Waupaca River.

Miner Lake is deeper (52 ft) and only slightly larger (35 acres) than Dake Lake (26 ft, 32 acres). About ten public boat ramps are available on the Chain with most of the connecting channels navigable for powerboats and all but one (Ottman - Youngs) navigable with a canoe. A boat ramp is available on Dake Lake.

Predominant shoreline area substrates for the East Chain are sand and marl with localized areas of muck and detritus. The East Chain lakes, compared to most of the other Chain O' Lakes, have relatively extensive littoral zones with more widespread and locally abundant aquatic plants.

Figure 1. Location Map, Chain O' Lakes, Waupaca County, Wisconsin.

Because of intensive recreational use, the Towns of Dayton and Farmington and the CLPOA adopted ordinances to regulate boat speeds on the Chain. Except for the largest lakes (Columbia, Long, Rainbow and Round), all lakes on the Chain have a "no wake"

speed limit. Water skiing on these lakes is limited to 10:00 a.m. - 2:30 p.m. on weekends and Holidays, 10:00 a.m. - 4:00 p.m. on Monday and Friday, and 10:00 a.m. - 7:00 p.m. on Tuesday through Thursday.

METHODS

Watershed Characteristics

Most watershed information was obtained during the appraisal process of the Tomorrow/Waupaca River Priority Watershed (TWRPW) Project. The appraisal began February, 1994 and is scheduled to be completed in 1995. Pertinent information from the appraisal as it relates to the Chain O' Lakes is included in the Results and Discussion section of this report.

Water Quality Monitoring

Water quality samples were taken on July 15 and September 22, 1992; February 3, May 19, August 17 and October 4, 1993; January 24, May 3, August 3 and September 21, 1994. Samples were collected three feet below the surface and three feet above bottom for both lakes (Table 2, Fig. 2). Parameters measured in the field were Secchi depth, water temperature, pH, dissolved oxygen (DO), and conductivity (see the Phase I document for specific equipment and methods information).

Recreational Use

A recreational use survey of the CLPOA membership was conducted to obtain property and lake use, water use opinions and demographics information. About 800 questionnaires were distributed (one per household) by CLPOA neighborhood volunteers to maximize the return rate. A sample survey questionnaire is included in Appendix I.

Table 2. Sample Station Descriptions, East Chain, 1992 - 1994.

REGULAR MONITORING

Lake	Site Number	Depth
Dake (Deepest Point)	1301	26 feet
Miner (Deepest Point)	1302	52 feet

Figure 2. Sample Station Locations, East Chain, 1992 - 1994.

Exotic Species

Visual observations [including a full shoreline cruise and in-lake observations (raking and SCUBA)] were made throughout the Phase I and II grant periods to document the occurrence of exotic species. Target species included Eurasian Water Milfoil (*Myriophyllum spicatum*), Purple Loosestrife (*Lythrum salicaria*) and Zebra Mussels (*Dreissena polymorpha*).

Public Involvement Program

Public involvement activities were coordinated to inform and educate the CLPOA about lake management in general and specifics regarding the Chain O' Lakes resource. Activities included news releases, IPS newsletters, article preparation for CLPOA newsletters, meeting attendance and presentations to the CLPOA and other interested parties. Public involvement activities are summarized in Appendix II.

FIELD DATA DISCUSSION

Watershed Characteristics

The Chain O' Lakes watershed is estimated to be 33,819 acres or 17% of the entire TWRPW (3). Land use for the Chain O' Lakes subwatershed was determined during the 1994 - 1995 inventory to be: non-irrigated agriculture, 16,931 acres (50%); irrigated agriculture, 2,205 acres (7%); forested, 10,921 acres (32%); wetland (including surface water), 1,673 acres (5%); and developed areas, 2,089 acres (6%) (Fig. 3).

There were 220 landowners who had livestock operations in the TWRPW, of which 168 (76%) had more than 20 animal units and 52 (24%) had 20 or fewer animal units. Sixty-two percent of the barnyards were surface drained; 38% were internally drained (4).

Figure 3. Land Uses in the Chain O' Lakes Subwatershed, 1994.

Groundwater

Nitrate was identified as a contaminant of concern in the Wolf River Basin Plan (5) and was targeted for analyses in the TWRPW Project groundwater appraisal. Relative to other subwatersheds in the TWRPW Project, residential well samples in the Chain O' Lakes subwatershed had the lowest average nitrate levels [2.59 milligrams per liter (mg/l)] (Table 3). Fifty-seven percent of the Chain O' Lakes subwatershed well samples were below 2 mg/l; nitrate levels over 2 mg/l are generally considered indicative of human impact on groundwater. Thirty-two well samples (8.2%) in the Chain O' Lakes subwatershed were over the health standard of 10 mg/l (4).

Table 3. Well Nitrate Data by Subwatershed for the Tomorrow/ Waupaca River Priority Watershed Project, 1995.

Subwatershed	No. of Samples	>2 mg/l	>10 mg/l	>20 mg/l	Average
Upper Tomorrow	258	168	66	20	6.82
Spring Creek	275	154	39	5	4.71
Chain O' Lakes	389	136	30	2	2.59
Crystal River	266	117	22	5	3.27
Waupaca/ Weyauwega	63	15	11	4	5.31
Total	1,251	590	168	36	4.54
Percent	100%	47%	13%	3%	

Surface water nitrate levels were also assessed during periods of highest groundwater contribution to the Tomorrow/Waupaca River system. Various creek samples taken March 1, 1994 or January 20, 1995 averaged 3.06 and 3.52 mg/l, respectively (Table 4). The highest nitrate levels were observed in Radley and Murray Creeks during January, 1995.

Table 4. Nitrate Levels (mg/l) for Surface Water in the Chain O' Lakes Subwatershed, 1994 - 1995.

	03/01/94	01/20/95
Radley Creek (South Road)	3.51	5.06
Radley Creek (1st Avenue)		7.1
Hartman Creek (Rural Road)	0.94	1.03
Emmon's Creek (Rural Road)	2.48	2.18
Emmon's Creek (3rd Avenue)		1.97
Murray Creek (South Road)	2.77	2.37
Murray Creek (10th Road)		6.0
Tomorrow/Waupaca Average	3.06	3.52

Lakes

A computer model applied by WDNR to the western portion of the Chain O' Lakes indicated that the Chain has a natural ability to

remove phosphorus from the water column via marl precipitation. Marl (calcium carbonate) binds with phosphorus and settles to the lake bottom.

Overall, the lakes modeled (Marl, Pope, Manomin, Orlando, Knight, Ottman, Youngs, Bass, Beasley and Long) showed a 36% reduction of (outflowing versus inflowing) phosphorus. Reduction ranged from 8% for Orlando Lake to 90% for Marl Lake (4). Phosphorus levels measured during Phase I and Phase II efforts for these lakes were near or below levels predicted by the model.

Sediment and Nutrient Delivery

Sediment delivery was estimated to be less than expected for the Chain O' Lakes subwatershed; the Chain subwatershed included 7.7% of the cropland draining to streams for the TWRPW but had only 6.0% of the sediment delivery (146 tons per year). With an estimated nine pounds of phosphorus per ton of sediment, phosphorus delivery is 1,313 pounds per year. Sediment was estimated to be entirely from upland sources, as none of the 21.8 miles of streambank were observed to be degraded (4).

Water Quality

Current data for Dake and Miner Lakes indicated, as would be expected given their proximity relative isolation from other Chain Lakes, similar water quality, and trends similar to those observed during Phase I (Tables 5 & 6, Figs. 4 & 5). Differences

Table 5. Water Quality Parameters, Station 1301, Dake Lake, Chain O' Lakes, July 1992 - October 1994.

PARAMETER	SAMPLE[1]	DATE									
		07/15/92	09/22/92	02/03/93	05/19/93	08/17/93	10/04/93	01/24/94	05/03/94	08/03/94	09/21/94
Secchi (feet)		10.7	10.3	NR[2]	>26.0	10.5	7.8	NR	>26.0	11.0	13.0
Cloud Cover (percent)		0	0	10	70	30	20	0	60	80	100
Temperature (degrees Celsius)	S	21.30	16.61	2.91	15.82	24.18	12.39	7.35	11.30	24.39	21.67
	B	15.61	16.68	4.61	9.28	19.54	11.96	5.97	10.00	20.68	20.09
pH (std units)	S	8.77	8.89	7.16	8.00	8.69	NR	7.10	7.60	8.56	NR
	B	7.16	8.82	6.89	7.05	6.84	NR	6.40	7.51	6.97	NR
D.O. (mg/l)	S	9.37	9.06	7.05	9.35	9.84	10.10	8.51	11.06	9.53	9.17
	B	0.13	8.47	0.68	8.18	0.47	9.16	2.41	10.48	0.48	5.74
Conductivity (umhos/cm)	S	230	223	275	247	203	230	272	253	227	211
	B	286	223	300	260	295	231	300	254	300	216
Laboratory pH (surface units)	S	NR	NR	NR	8.23	NR	NR	NR	NR	NR	NR
	B	NR	NR	NR	7.99	NR	NR	NR	NR	NR	NR
Total Alkalinity (mg/l)	S	NR	NR	NR	118	NR	NR	NR	NR	NR	NR
	B	NR	NR	NR	124	NR	NR	NR	NR	NR	NR
Total Solids (mg/l)	S	NR	NR	NR	164	NR	NR	NR	NR	NR	NR
	B	NR	NR	NR	174	NR	NR	NR	NR	NR	NR
Tot. Kjeld. Nitrogen (mg/l)	S	0.5	0.5	0.7	0.5	0.5	0.6	0.7	0.6	0.61[3]	0.71[3]
	B	0.8	0.5	0.8	0.6	0.6	0.6	0.9	0.5	0.70[3]	NR
Ammonia Nitrogen (mg/l)	S	0.026	0.017	0.252	0.071	0.013	0.016	0.147	0.071	0.012	0.12
	B	0.216	0.025	0.455	0.179	0.079	0.038	0.412	0.058	0.009	NR
NO_2 + NO_3 Nit. (mg/l)	S	ND[4]	ND	0.031	0.027	ND	ND	0.022	ND	ND	ND
	B	ND	ND	0.015	0.036	ND	ND	0.038	0.051	ND	NR
Total Nitrogen (mg/l)	S	0.5	0.5	0.731	0.527	0.5	0.6	0.722	0.6	0.61	0.71
	B	0.8	0.5	0.815	0.636	0.6	0.6	0.938	0.551	0.70	NR
Total Phosphorus (mg/l)	S	0.009	0.007	0.006	ND	0.010	0.010	0.013	0.009	0.010	0.012
	B	0.021	0.006	0.011	ND	0.012	0.013	0.016	0.013	0.011[4]	NR
Dissolved Phos. (mg/l)	S	0.002	0.002[4]	0.003	ND	ND	0.003	0.001[4]	NR	ND	ND
	B	0.003	0.001[4]	0.002	0.003	ND	ND	0.001[4]	NR	ND	NR
Nit./Phos Ratio	S	55.6	71.4	121.8	--	50.0	60.0	55.5	66.7	61.0	59.2
	B	38.1	83.3	74.1	--	50.0	46.2	58.6	42.4	63.6	NR
Chlorophyll a (ug/l)	S	5	7.66	NR	0.915	3.30	17.6	NR	.726	3.27	6.76

[1] S = surface, B = bottom; [2] NR = no reading; [3] holding time exceeded by SLOH; [4] ND = not detectable

Table 6. Water Quality Parameters, Station 1302, Miner Lake, Chain O' Lakes, July 1992 - October 1994.

PARAMETER	SAMPLE[1]	DATE									
		07/15/92	09/22/92	02/03/93	05/19/93	08/17/93	10/04/93	01/24/94	05/03/94	08/03/94	09/21/94
Secchi (feet)		12.0	12.3	NR[2]	23.2	15.0	10.4	NR	21.0	14.5	11.0
Cloud Cover (percent)		0	0	10	70	30	10	0	60	80	100
Temperature (degrees Celsius)	S	21.16	17.43	2.32	15.44	24.21	13.18	4.65	11.15	24.30	21.82
	B	6.54	7.08	3.88	5.09	6.33	6.62	4.36	5.47	7.30	7.82
pH (std units)	S	8.82	8.76	7.12	7.70	8.45	NR	6.93	7.64	8.43	NR
	B	6.47	6.85	6.78	6.11	5.69	NR	6.18	6.55	5.96	NR
D.O. (mg/l)	S	9.88	9.21	7.02	9.33	9.05	9.13	7.02	11.34	9.41	10.03
	B	0.09	0.56	0.44	0.15	0.09	0.56	0.77	0.89	0.29	0.73
Conductivity (umhos/cm)	S	233	221	249	246	216	244	249	249	234	208
	B	285	298	262	296	290	317	260	268	293	276
Laboratory pH (surface units)	S	NR	NR	NR	8.19	NR	NR	NR	8.24	NR	NR
	B	NR	NR	NR	7.49	NR	NR	NR	NR	NR	NR
Total Alkalinity (mg/l)	S	NR	NR	NR	117	NR	NR	NR	126	NR	NR
	B	NR	NR	NR	145	NR	NR	NR	NR	NR	NR
Total Solids (mg/l)	S	NR	NR	NR	158	NR	NR	NR	160	NR	NR
	B	NR	NR	NR	188	NR	NR	NR	NR	NR	NR
Tot. Kjeld. Nitrogen (mg/l)	S	0.5	0.5	0.7	0.5	0.4	0.5	0.7	0.5	0.56[3]	0.64[3]
	B	2.3	0.8	1.1	3.0	2.4	3.1	1.2	1.3	0.60[3]	NR
Ammonia Nitrogen (mg/l)	S	0.020	0.012	0.261	0.096	0.010	0.009	0.258	0.048	0.56	0.010
	B	1.173	0.050	0.607	1.02	1.80	2.42	0.647	0.778	0.60	NR
NO_2 + NO_3 Nit. (mg/l)	S	ND[4]	ND	0.026	0.028	ND	ND	0.018	ND	ND	ND
	B	ND	ND	0.012	ND	ND	ND	0.010	ND	ND	NR
Total Nitrogen (mg/l)	S	0.5	0.5	0.726	0.528	0.4	0.5	0.718	0.5	0.56	0.64
	B	2.3	0.8	1.112	3.0	2.4	3.1	1.210	1.3	0.60	NR
Total Phosphorus (mg/l)	S	0.006	0.005	0.014	ND	0.007	0.007	0.026	0.009	0.007[4]	0.010
	B	0.181	0.025	0.079	1.08	0.27	0.288	0.121	0.059	0.020	NR
Dissolved Phos. (mg/l)	S	0.003	ND	0.012	ND	ND	ND	0.017	NR	ND	ND
	B	0.093	0.001	0.066	0.033	0.152	0.222	0.088[4]	NR	ND	NR
Nit./Phos Ratio	S	83.3	100.0	51.9	--	57.1	71.4	27.6	55.6	80.0	64.0
	B	12.7	32.0	14.1	2.8	8.9	10.8	10.0	22.0	30.0	NR
Chlorophyll a (ug/l)	S	2	4.52	NR	0.982	2.02	8.65	NR	1.81	2.80	8.24

[1] S = surface, B = bottom; [2] NR = no reading; [3] holding time exceeded by SLOH; [4] ND = not detectable

Figure 4. Surface Total Nitrogen Trends for the East Chain, 1991 - 1994.

Figure 5. Surface Total Phosphorus Trends for the East Chain, 1991 - 1994.

observed appeared related to basin depth differences and the flow pattern from Miner Lake through Dake Lake.

Average surface total nitrogen levels in Miner (0.557 mg/L) and Dake (0.600 mg/L) Lakes were considerably lower than observed in most other Chain lakes; surface total phosphorus levels (0.010 mg/L in each) were generally similar that in the other Chain Lakes. Seasonal trends were present and appeared to reflect seasonal influences of stratification/mixing and surface or goundwater inflows.

Phosphorus levels for the East Chain were lower than those typical for stratified lakes (0.023 mg/l) and for lakes in the central region in Wisconsin (0.020 mg/l) (6); levels were at or below those typical for the ecoregion in which the Chain is located (0.010 - 0.014 mg/l) (7). NOTE: Some data were indicated to have exceeded the recommended maximum holding time before analysis. A study has shown, however, that the data remain accurate for samples analyzed well after the 28-day holding time (8).

Recreational Use

About 43% of all Chain O' Lakes respondents indicated they were permanent residents. Average occupancy for all respondents was 7.8 months (Table 7); seasonal residents averaged 4.7 months. Respondents indicated a total of 1222 watercraft with an average

Table 7. Comparison of Recreational Use Parameters for Various User Groups, Chain O' Lakes, Waupaca County, Wisconsin.

Parameter	User Group			
	East Chain	Fast Lakes	Slow Lakes	Entire Chain
Average monthly occupancy	8.7	7.5	8.1	7.8
Average number of watercraft (per response)	2.5	3.1	2.7	2.9
Average number of adults (per respondent household)	2.3	2.4	2.4	2.4
Average number of children 12 - 18 years old (per respondent household)	0.3	0.6	0.3	0.4
Average number of children less than 12 years old (per respondent household)	0.3	0.5	0.5	0.5
Average respondent age	57.0	59.1	57.7	58.3
Percent of respondents leaving comments	47.2	51.9	44.9	48.0

of 2.9 per household. Pro-rated (to include all landowners) results would estimate almost 2,300 watercraft on the Chain O' Lakes, or 3.2 boats per acre (not including visitor watercraft). Most common watercraft types (in order) were canoes, pontoon boats, row/paddle boats and boats with less than 25 horsepower motors.

East Chain resident responses did not differ substantially from those of the Chain, as a whole, or from "fast" [wake lake

residents (Rainbow, Round, Columbia and Long Lakes)] or "slow" [no wake lake residents (all others)] (Table 8). East Chain respondents agreed (78% "strongly agree" or "agree" responses) there are too many watercraft [primarily on weekends and holidays

Table 8. Percentage of "Strongly Agree" and "Agree" Responses for Various User Groups, Chain O' Lakes, Waupaca County, Wisconsin.

Opinion	User Group			
	East Chain	Fast Lakes	Slow Lakes	Entire Chain
There are too many watercraft on the Chain	78	79	77	77
The current number of watercraft causes safety problems	74	77	75	76
There is adequate water safety enforcement:				
weekdays	86	82	85	84
weekends	66	60	69	65
holidays	63	58	62	60
Additional water use regulations need to be enacted and enforced	56	62	61	61
There should be limits set on the number of watercraft	49	54	54	54
There is adequate public boater access to the Chain	93	92	90	91
There should be more public restrooms on the Chain	44	52	47	50
There should be a public swimming beach on the Chain	31	36	34	35
There should be a public park on the shoreline of the Chain	27	29	29	29

(App. I)] and that the number of watercraft cause safety problems (74%) (primary causes identified as non-resident watercraft) and diminish user enjoyment. They agreed there was adequate water safety enforcement on weekdays (86%); fewer agreed for weekends (66%) and holidays (63%) (Table 13). Overall concensus was only somewhat in favor of enactment of more ordinances and limiting boat numbers, East Chain respondents considered these alternatives slightly less favorable than other user groups.

Respondents agreed that there was adequate public boater access to the Chain (93%) and most disagreed ("strongly disagree" or "disagree" responses) with establishment of a park (73%) or beach (69%) on the Chain. East Chain responses favoring more public restrooms were slightly less than for the other user groups.

Exotic Species

Eurasian Water Milfoil was not observed in the East Chain O' Lakes; aquatic plant surveys (1991) and visual observations (1991 - 1994) indicated only native water milfoil species (mainly *Myriophyllum exalbescens*), present in the East Chain. There were no observations of Zebra Mussels.

Purple Loosestrife was not observed in the East Chain, but it was present and locally abundant in a several areas of other Chain project groups. Purple Loosestrife is an exotic plant with a bright purple flower, originally propagated in the United States

by the horticulture industry for flower gardens. It blooms late June to July and produces seeds soon after. The plant is able to outcompete native wetland vegetation, spread quickly and modify entire plant (and thus animal) assemblages.

BASELINE CONCLUSIONS

Watershed Characteristics

TWRPW Program well sample nitrate results, despite some instances of concern (e.g., > 10 mg/l), indicated that the Chain O' Lakes subwatershed had the lowest average nitrate readings for the entire Tomorrow/Waupaca River Watershed. Surface water samples indicated variable nitrate readings for the Chain subwatershed with highest readings in Murray and Radley Creeks.

Sediment/nutrient delivery for the Chain subwatershed of the TWRPW Project appraisal was estimated to be lower than all other subwatersheds. The Chain O' Lakes subwatershed contained almost 8% of the surface drained farmland but was estimated at only 6% of the sediment delivery; no stream degradation was observed for the 21.8 miles of streams in the Chain subwatershed.

Water Quality

Regular water quality monitoring in the East Chain during Phase II, as during Phase I, indicated good to very good water quality with in-lake nutrients for both lakes near or below levels expected for stratified lakes, lakes in the central region of Wisconsin and lakes in the ecoregion in which the Chain is located. Surface total nitrogen levels were considerably lower than observed in most other Chain lakes; surface total phosphorus levels were generally similar that in the other Chain Lakes.

Most between lake differences observed appeared related to basin depth differences and the general flow pattern from the deeper Miner Lake through Dake Lake. Miner Lake exhibited water column stratification during Summer and low dissolved oxygen near bottom on all sample dates; Dake Lake occasionally exhibited low dissolved oxygen near bottom, but surface to bottom temperature and nutrient differences were typically considerably less than in Miner Lake.

Recreational Use

East Chain resident responses to the recreational use survey were in general agreement with those from the Chain as a whole and from "fast" and "slow" lake user groups. Watercraft use on the Chain is high and respondents generally agreed that the current number of watercraft caused safety problems. They also indicated that water safety enforcement was adequate, but fewer agreed during weekend or holiday periods of heavy recreational use. Respondents were somewhat agreeable to, but rather evenly split, regarding additional use regulations or limiting the number of watercraft. There was relatively low interest in establishment of a public park or beach on the chain but respondents were more agreeable (about evenly split) as to the need for more public restrooms on the Chain.

East Chain user group <u>vs</u> other user group responses were probably not significant. The slight differences observed, however,

appeared to reflect the locational aspects of Dake and Miner Lakes, i.e., somewhat isolated and off the main thoroughfare provided by the Upper, Middle and Lower Chain Lake groups.

Exotic Species

There were no observations of Zebra Mussels or Eurasian Water Milfoil in the Chain. Purple Loosestrife, which is widely distributed in Wisconsin and Waupaca County, was not observed in the East Chain but has become established in several areas of the Upper, Middle and Lower Chains.

MANAGEMENT RECOMMENDATIONS

The East Chain is smaller and generally weedier than the Upper, Middle and Lower Chain project groups, and is located off the major recreational boat traffic routes. These conditions present somewhat different management options, particularly relative to recreational use. Management objectives in the East Chain, as in all Chain O' Lakes project groups, should include water quality maintenance and protection; the sport fishery and other passive forms of recreational could more easily be emphasized in the East Chain.

Watershed: The Chain O'Lakes is significantly influenced by groundwater and receives some surface water inflow from the watershed. Residents should be made aware of the potential effects of watershed uses on their resource. In addition to a continuous focus on "yard management" and activities on shorelines immediately adjacent, or directly draining, to the lakes, they should be strongly encouraged to keep abreast of and support the TWRPW Project.

- Residents in the Middle Chain watershed should have private wells tested for nitrates and/or pesticide levels.

- Groundwater samples should be collected at various points in

the Chain O' Lakes watershed to determine areas of concern.

Water Quality: Water quality in the East Chain is currently very good; total nitrogen levels are generally lower than elsewhere in the Chain O' Lakes. A monitoring strategy should be continued to provide a long term trend assessment and detect detrimental influences before effects become widespread or severe.

- Water quality monitoring should be continued in the East Chain lakes. Surface only samples during Winter, after ice out and three times during the Summer would minimize collection and laboratory analysis costs.

- Sampling during snowmelt or rainfall runoff events could be initiated at any sites identified as providing significant inflow. Assessment of these sites could lead to designation of the drainage area as sensitive and reduce sediment or nutrient loading to the East Chain.

- Groundwater nutrient and flow direction/rates should be collected for the Chain O' Lakes system when feasible.

Recreational Use: Chain O'Lakes resident recreational use survey results suggest that use, during summer weekends and holidays, is at or near saturation levels and that most perceive the problems related to non-resident or commercial watercraft. There does not appear, however, to be a clear concensus that additional

regulations are desirable to address the situation. The CLPOA,

then, should form a committee, or enlist some outside assistance, to address direct education or prevention measures to attempt minimization of use conflicts; these may include

- Development of maps for distribution which define best potential use zones for different recreational activities (skiing, fishing, canoeing, SCUBA diving/snorkeling, pleasure boating, dining, snowmobiling, etc.),

- Brochures, for visitors at access points, emphasizing "water use ethics" along with information an available restrooms, access points and applicable regulations and ordinances,

- Development of water accessible restrooms and waste disposal facilities for boaters,

- Initiation of a reasonable ramp fee at some/all access points with money collected directed toward access maintenance or lake management/protection activities, and

- Riparian landowners education about pertinent ordinances (dock design/size, boat numbers per pier, building near lakeshores, near-lake improvements, etc.).

The habitat conditions in and the location of the East Chain lakes appear appropriate for designation as a prime fishing area.

Exotic Species: Of the three exotic species of most current concern, only purple loosestrife appears to be established in the Chain O'Lakes.

- Identified purple loosestrife stands should be treated as soon as it is practical to do so; localized growth areas or individual plants should be treated first and more extensive growth areas later. It is best to treat plants before flowering (May to mid June). Plants are treated by cutting the top off and spraying the remainder with a Roundup-surfactant mix; plants in standing water should be treated with a Rodeo-surfactant mix. Chemicals can be applied using hand spray bottles or larger chemical sprayers. Sites should be revisited in subsequent years to treat remnant individuals.

- An exotic species watch group should be organized to monitor or remove exotic species (i.e., Purple Loosestrife, Zebra Mussels and Eurasian Water Milfoil) when encountered. Members should coordinate with the WDNR Exotic Species Program and inform the CLPOA membership and public on the hazards of exotic species as they relate to the Chain O' Lakes.

Aquatic Plants: Aquatic plant populations in Miner and Dake

Lakes, as determined in Phase I activities, are not comprised of

potentially nuisance species nor are they present at nuisance abundance levels. While fishery assessment was beyond the scope of these planning activities, aquatic plant communities in Miner and Dake Lakes are probably of substantial benefit to the fishery. Aquatic plant management in the East Chain should be limited to localized and selective removal near shore when considered necessary or desirable to improve access or aesthetics.

Public Involvement: Informational and educational programs for the CLPOA membership and public should be continued. Meetings, presentations, newsletters and/or news releases should continue to include information on groundwater and surface water quality, recreational use issues and the spread or control of exotic species.

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APPENDIX I
SAMPLE RECREATIONAL USE SURVEY
East Chain O' Lakes Management Plan

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APPENDIX II
SUMMARY OF PUBLIC INVOLVEMENT ACTIVITIES
East Chain O' Lakes Management Plan

The Chain O' Lakes Property Owners Association (CLPOA) initiated steps to develop a comprehensive lake management plan under the Wisconsin Department of Natural Resources (WDNR) Lake Management Planning Grant Program in the Fall of 1990. A public involvement program was immediately initiated as part of the planning process. The following is a summary of Phase I and Phase II major public involvement efforts.

Planning Advisory Committee

A working group comprised of the CLPOA officers, IPS and WDNR was established at the start of the program. The group provided planning direction and served as main reviewer of the draft plan document.

Brochures

A informational brochure titled "Chain O' Lakes Management Planning Program" was developed and distributed which outlined objectives, elements and ways for CLPOA members to get involved in the planning process.

A Phase I plan summary brochure was also produced. It was made available for CLPOA use and distribution when the plan document was approved by WDNR. The brochure described the main features of plan development, plan recommendations and other pertinent information. Another plan brochure will be produced upon conclusion of Phase II.

Meetings

IPS presented progress reports, provided information about the resource and interpretations of these results periodically and at CLPOA member meetings.

Print Media

After receipt of the grant award, a news release was issued to the Waupaca Post. The release highlighted information about the length and scope of the project and persons to contact for additional information.

A quarterly IPS newsletter entitled "Lake Management News" was developed and distributed to the CLPOA for the officers' use and distribution among the membership. A special "Chain O' Lakes" was also developed to notify the CLPOA of any late developments in the planning program. Information was also prepared for inclusion into the CLPOA newsletter.

PHASE II
LAKE MANAGEMENT PLAN
EAST CHAIN O' LAKES
WAUPACA COUNTY, WISCONSIN

Prepared for

Chain O' Lakes Property Owners Association

by

December, 1995