Lake Mallalieu

Comprehensive Lake Survey Report

St. Croix County, Wisconsin 2001

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Wisconsin Department of Natural Resources

West Central Region

St. Croix River Basin

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St. Croix County, Wisconsin

Authors: **William J. Michalek, Jr. & Martin P. Engel**

Date of Report: **May 2002**

Dates of Field Work:	**Fyke Netting:**	**April 9-12, 2001**
	Electrofishing:	**April 23 & May 3,7,9,14, 2001**
	Forage Electrofishing:	**August 30, 2001**
	Forage Netting:	**September 10,11, 2001**

Field Crew: Martin Engel, Brian Spangler, William J. Michalek, Jr., Dennis Kees, Bob Baczynski, Ron Roettger, Pete Skorseth, Scott Peavy, Scott Morris, Jodi Hanson, Arno Lamm, Jordan Weeks

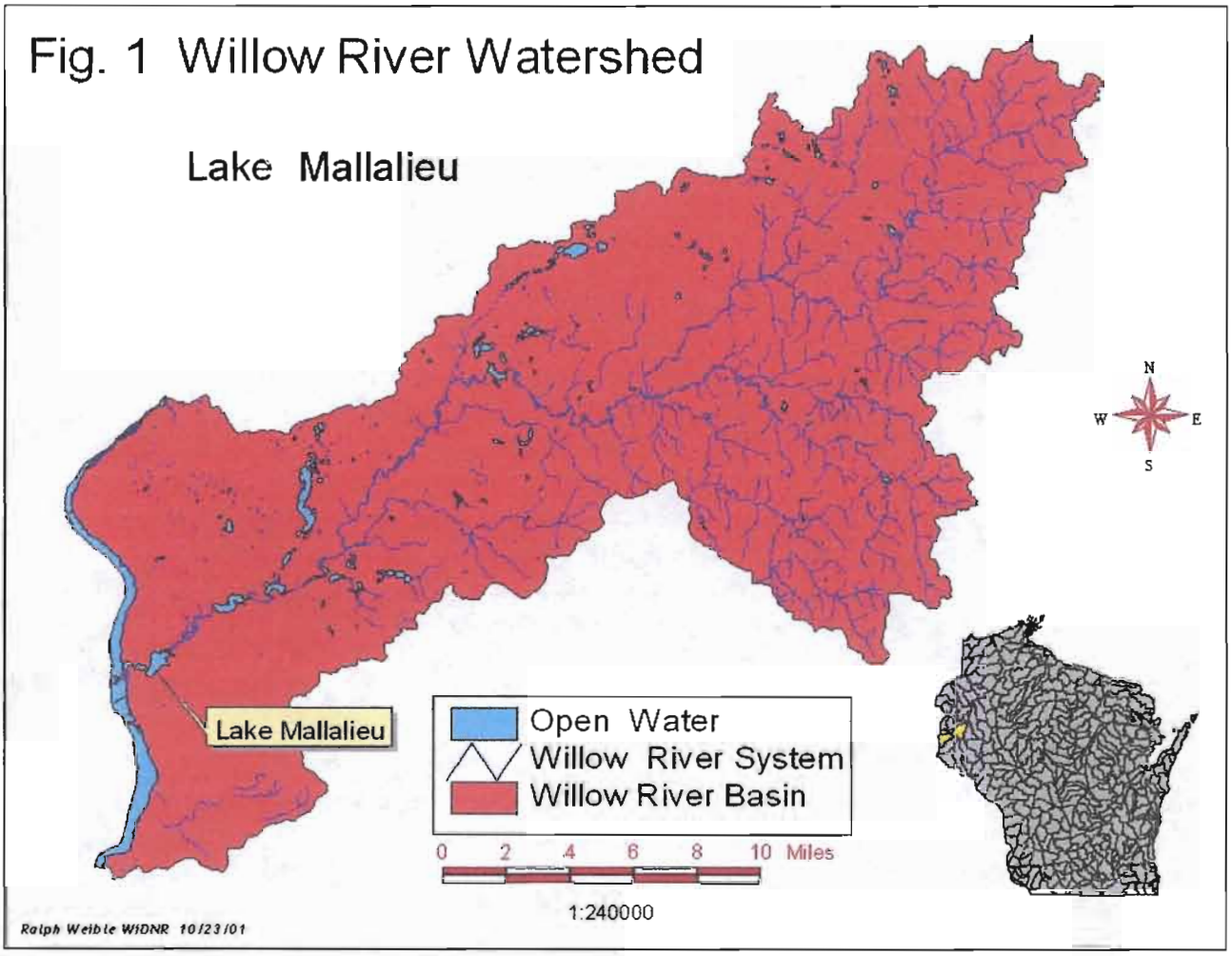
WORK PURPOSE:

A comprehensive fisheries investigation was conducted on Lake Mallalieu during the sampling period of April 4, 2001 to September 11, 2001 by the Lower Chippewa Basin's fisheries management staff from the West Central Region's Baldwin and Eau Claire offices. Lake Mallalieu was selected to be sampled by the Bureau of Fisheries and Habitat Management under the Comprehensive Lake Survey Program (Beard, 1995) guidelines. The information from this study will provide baseline data to assess and quantify the current status and long term trends in the fish community of Lake Mallalieu. This data will be used to make management decisions and to evaluate the cost-effectiveness of management strategies.

This fisheries survey documented species composition and relative abundance of fishes, gamefish population densities and composition, age and growth rates, recruitment, mortality rate estimates, reproductive status, rough fish and forage base information.

DESCRIPTION OF AREA:

Lake Mallalieu is a 270 acre flowage on the Willow River in St. Croix County, Wisconsin (T29N, R20W, Sec.18, 19, 13 & 24), (Figure 1). Lake Mallalieu's drainage basin is 300 square miles (Henrich and Daniel, 1983) and discharges an average of 59 cubic feet per second (Sather and Threinen, 1961). The Willow River is the only inlet stream to Lake Mallalieu. The first dam was constructed in 1848. The existing dam was constructed in 1934 after the former had washed out in April of that year. Lake Mallalieu has a maximum water depth of 17 feet with a mean depth of 5 feet. The watershed's primary landuse is urban/residential, agriculture and woodlands.



WATER QUALITY

Lake Mallalieu is considered to be a hypereutrophic lake with poor water quality due to high nutrient levels, high algal concentrations, and poor water clarity. The mean summer (May-September) water quality conditions in 1999 (Robertson & Lenz 2002) are as follows: total phosphorus 111 ug/l; chlorophlyll a 79 ug/l; and secchi disc depth 2.3 feet. Lake Mallalieu is considered to be phosphorus limited with some months in the summer being nitrogen limited. This means that any increase in these concentrations will lead to increased algal blooms and excess plant growth. There were a total of 24 species of aquatic plants found in Lake Mallalieu during the 1998 survey (Konkel 1999). Included were three non-native species: *Lythrym salicaria* (purple loosestrife), *Myriophyllum spicatum* (eurasian water milfoil), and *Potamogeton crispus* (curly-leaf pondweed). Plant community structure has increased in species diversity from the 1991 plant survey. In 1991, Myriophyllum spicatum was the most common plant and in 1998 Ceratophyllum demersum (coontail) was the most common. In 1998, eurasian water milfoil decreased in distribution, frequency and density while all other species increased in frequency and density. And, filamentous algae occurred at about 25% of the sites sampled (Konkel, 1999). Nonpoint source pollution from agricultural operations throughout the watershed has been contributing phosphorous and nitrogen loading and subsequent water quality deterioration.

MANAGEMENT HISTORY (Appendix A):

The first recorded fish survey conducted in 1957 was an inventory investigation conducted to set management goals and objectives. In 1961, a fish survey was conducted to obtain largemouth bass length frequencies. The surveys conducted in 1974 and 1981 were to inventory fish populations to re-evaluate management goals and objectives. Surveys conducted in 1984 and 1999 were post draw down investigations to determine if the drawdowns had harmed the fish populations. In 1995, a survey was conducted to obtain fish for contaminate analysis and to obtain a gamefish length frequency. Lake Mallalieu has been primarily managed for largemouth bass and bluegills. Walleye were stocked for a period (1942-1954) but then discontinued after 1954 because the stockings proved unsuccessful. Every survey management recommendation since 1957 promoted largemouth bass and bluegills and discouraged management of walleye and northern pike. The DNR and coldwater angling groups wanted to maintain trout populations in the Willow River. It was known that walleye and northern pike would move upstream to find cool water refuges or spawning grounds and in doing so would feed on the trout.
Populations of carp have been a concern on Lake Mallalieu throughout the years. An attempt to control carp populations involved having Hudson and N. Hudson lower lake levels for short periods during the month of June (1975) to kill carp spawn in shallow areas. Contracts for commercial harvest of rough fish were issued during 1941 and 1978. Such activities proved to be unsuccessful and are no longer recommended.

METHODS:

Fish populations were sampled in accordance with statewide comprehensive lake survey guidelines and lake monitoring guidelines established by the Wisconsin Department of Natural Resources Bureau of Fisheries and Habitat Management. Population estimates were also conducted on selected species. Five sampling periods and methods were used: spring fyke netting; spring electrofishing population estimates; fish assemblage and index electrofishing; and forage abundance assessments (Appendix B).

Spring fyke netting equipment consisted of ten -- 4-ft. X 6-ft. frames with ½ in. white nylon bar mesh with 50-foot leads. Spring electrofishing equipment consisted of a pulsed DC mini-boomshocker outfitted with two boom hoop style anode array (15 droppers per ring) and the hull as the cathode with one dipnetter using a ½ in. to ¼ in bar mesh dip net mounted on a non-conductive fiberglass handle. It was operated at 200-350 volts and 13-18 amps (pulse rate 80, duty cycle 20%).

Summer forage electrofishing was conducted using a pulsed DC outfitted fiberglass tow barge (~ 5 ft. long) unit operated at 225 volts and 6-8 amps. Three wading personnel utilized 5 ft. long non-conductive fiberglass handled electrodes with circular or diamond shaped heads and netted using 3 ft. long non-conductive fiberglass handled dipnets with $^{3}/_{16}$-in. delta mesh. Summer fyke netting equipment consisted of six -- 3-ft. X 3-ft. frames with $^{1}/_{8}$-in. white nylon bar mesh with 30-foot leads.

Species lengths to the nearest ½ inch (gamefish and rough fish) and to the nearest $^{1}/_{10}$ inch (panfish) were recorded for fish collected. Scales, spines and/or fin rays were collected from a subsample of gamefish and panfish. All gamefish were marked for identification of recaptures throughout the lake. Top caudal (TC) fin clips were given to all adult gamefish (Table 1).

Table 1: Scales, Spines, and Fin Clips from gamefish and panfish species.

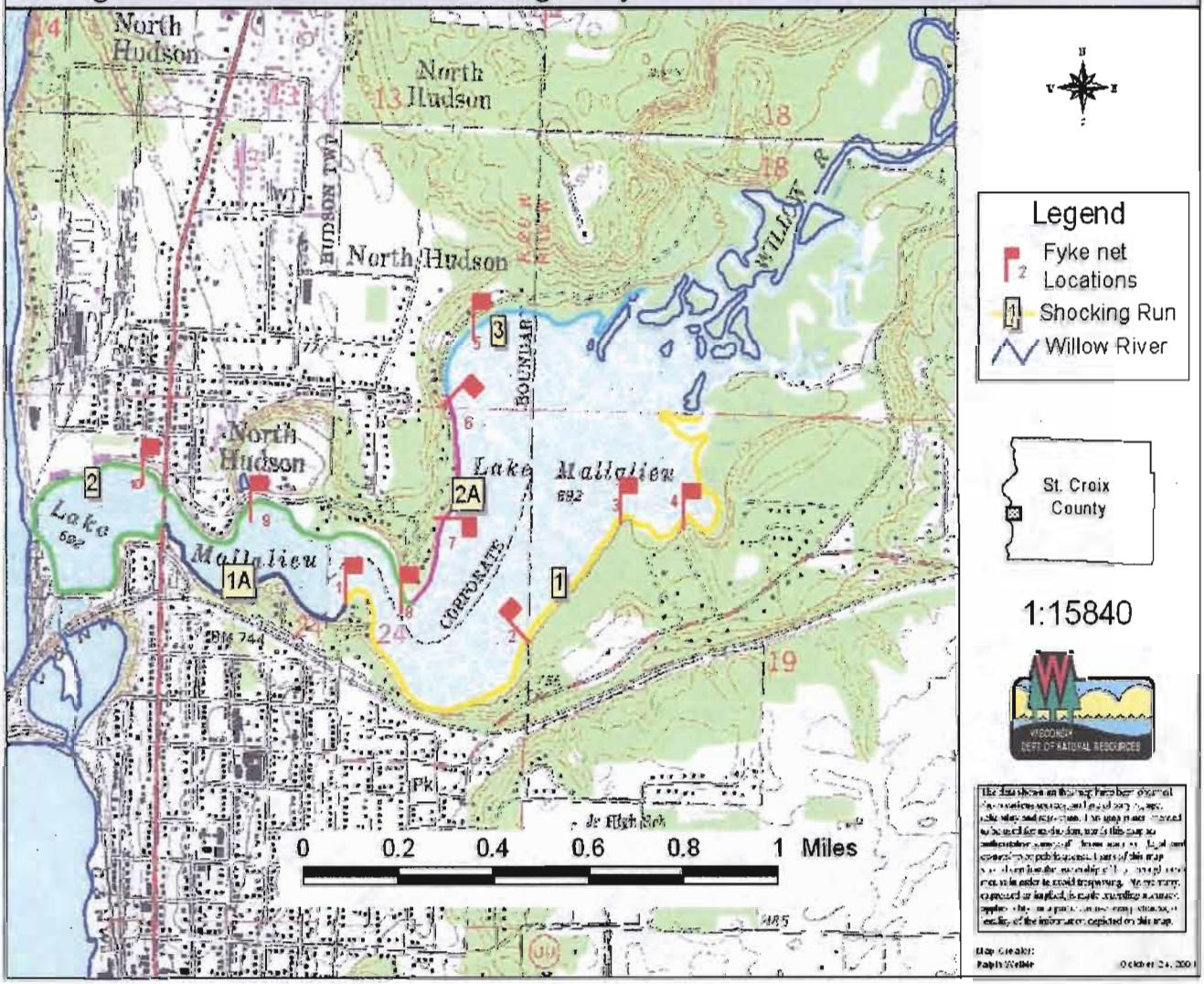
Species	Collected Scale Samples	Collected Spines/Rays	Fin Clip Given
N. Pike	5 per ½ in. per sex	>= 24 in.	TC >= 12 in.
LMB	10 per ½ in.	>= 12 in.	TC >= 8 in.
SMB	10 per ½ in.	>= 12 in.	TC >= 8 in.
Perch	10 per ½ in. per sex	none	none
Panfish	10 per ½ in.	none	none
Muskellunge	all	>= 24 in.	TC >= 20 in.
White sucker	None	None	TC >= 12 in.

Sampling Periods and Methods

Fyke nets were set at 10 different locations immediately after ice-out (Figure 2). All 10 nets were placed in the lake on April 9. Nets were checked every 24 hours, and removed April 12, giving a total of 30 net lifts.

The electrofishing sampling period divided the lake into three portions; two representative two-mile gamefish stations (1 & 2), each containing a one half-mile fish assemblage zone (1a & 2a), and one short station (3)

Fig. 2 Mallalieu Shocking & Fyke Net Locations 2001



0.6 miles long, to complete the shoreline sampling. Index electrofishing was conducted at stations 1 & 2 on two nights: one night for esocid and percid sampling, water temperature is < 45 °F (April 23) and one night for centrachid sampling, water temperature is between 55-65 °F (May 3). During this sampling

period all fish in Stations 1a & 2a were collected and identified. Only the game fish and panfish were measured and weighed.

During the May 9, 2001 sampling event, each of the three stations were electrofished to determine rough fish abundance in catch per mile (CPE).

For population estimate purposes, the entire lakeshore was divided into three portions sampled each of the five nights: April 23, May 3, 7, 9, 14 of 2001. Appendix B is a schedule of both netting and shocking activities for Lake Mallalieu and should be used to clarify data used for population estimate calculations. A recapture run for northern pike and white sucker was completed during the initial phase of the bass population estimate. The data collected throughout the population estimate was used to calculate catch per unit effort of white sucker, largemouth bass, smallmouth bass, walleye, sauger, muskie and northern pike. The Schnabel method was used for population estimate calculations on northern pike, smallmouth bass, and largemouth bass.

$$N_t = \frac{M_t * C_t}{R_t}$$

N_t = population estimate at time t

M_t = sum of the number marked at time t

C_t = sum of the total number recaptured, including both marked and unmarked fish at time t

R_t = sum of the total number of recaptured marked fish at time t.

On August 30, 2001, forage abundance assessments were conducted utilizing a stream shocker at ten - 30 meter long sites. On September 10, 2001, six mini fyke nets (3ft. x 5ft. frame, 1/8 in. Bar mesh) were set and fished on September 11, 2001 (Figure 3). All fish were identified and measured.

Age, Growth, and Mortality

Scale samples were collected from percids, esocids, and centrarchids for age determination (Table 1). To help with age determination, spines or fin rays were collected from most northern pike, smallmouth bass, and largemouth bass. Impressions were made of the scales by pressing them into one-millimeter thick acetate strips. Scale impressions were magnified and observed by use of a microfiche reader. Only scales showing no evidence of "plus" growth were used in age and growth calculations. Dorsal spines and fin rays were mounted through plastic sheeting, cross-sectioned, and viewed through the microfiche reader. Spines were relied on heavily to age older largemouth bass and smallmouth bass. Spine and fin ray samples from other species were used primarily to validate age determinations from the corresponding scale samples. Mean lengths at age and weight at length for game fish species were calculated and compared to statewide averages. Annual mortality rates (A) were estimated from catch curves for common game and panfish species.

Table 2: Lake Mallalieu Catch per Unit Effort (CPE) and comprehensive lake survey data - 2001.

	FYKE NETTING		LAKE ELECTROFISHING		PERCID/ECOSID INDEX ELECTROFISHING		CENTRARCHID INDEX ELECTROFISHING		ROUGH FISH INDEX ELECTROFISHING		FORAGE				TOTAL NO.	OVERALL
SPECIES	TOTAL	# / LIFT	TOTAL	# / MI*	TOTAL	# / MI*	TOTAL	# / MI*	TOTAL	# / MI*	TOTAL	# / LIFT	TOTAL	NO/M*	SAMPLED	SIZE RANGE
WALLEYE, MALE															—	—
WALLEYE, FEMALE															—	—
WALLEYE, UNK > 14.9"			19	1.03			10	2.50	2	0.43					19	8.0"-10.4"
WALLEYE, UNK <15.0"			15	0.82			6	1.50	4	0.87					15	16.0"-22.9"
WALLEYE, ALL			34	1.85			16	4.00	6	1.30					34	8.0"-22.9"
SAUGER			16	0.87			6	1.50	1	0.22					16	7.5"-17.4"
NO. PIKE, MALE	41	1.37			2	0.43									43	18.5"-30.9"
NO. PIKE, FEMALE	54	1.80													54	20.5"-37.9"
NO. PIKE, UNKNOWN			17	0.92			7	1.75	4	0.87					17	20.5"-33.5"
NO. PIKE, ALL	95	3.17	17	0.92	2	0.43	7	1.75	4	0.87					114	18.5"-37.9"
MUSKELLUNGE, MALE			1	0.05			1								1	28.4"
MUSKELLUNGE, FEMALE															—	—
MUSKELLUNGE, UNKNOWN			8	0.43	4	0.87	2	0.50	2	0.43					12	11.0"-24.9"
MUSKELLUNGE, ALL			9	0.49	4	0.87	3	0.75	2	0.43					13	11.0"-28.4"
SMALLMOUTH BASS			730	31.74	23	5.00	214	53.50	122	26.52	1	0.17	45	0.15	776	1.9"-19.9"
LARGEMOUTH BASS	60	2.00	836	36.35	209	45.43	188	47.00	142	30.87	3	0.50	102	0.34	1003	1.7"-21.4"
YELLOW PERCH, MALE	161	5.37			156	34.25	3	0.75							325	3.0"-8.9"
YELLOW PERCH, FEMALE	31	1.03			29	6.30	2	0.50							173	4.7"-12.9"
YELLOW PERCH, UNKNOWN	174	5.80			65	14.13	109	27.25			3	0.50	11	0.04	191	2.6"-9.2"
YELLOW PERCH, ALL	366	12.20			252	54.78	114	28.50			3	0.50	11	0.04	689	2.6"-12.9"
BLACK CRAPPIE	2766	92.20			10	10.00	27	6.75			10	1.67	7	0.02	2820	1.8"-12.5"
BLUEGILL	1360	45.33			85	85.00	576	144.00			1516	252.67	524	1.75	4061	1.2"-8.4"
ROCK BASS							1	0.25							1	5.8"
PUMPKINSEED	36	1.20			6	6.00	17	4.25			5	0.83	6	0.02	70	1.8"-6.7"
WHITE BASS							1	1.00							1	6.4"
BROWN TROUT	26	0.87			2	0.43									28	4.5"-24.9"
BROOK TROUT	3	0.10													3	4.5"-10.0"
RAINBOW TROUT	7	0.23	1	0.05											8	7.3"-16.4"
BLACK BULLHEAD	72	2.40					1	1.00							73	6.7"-11.4"
YELLOW BULLHEAD	62	2.07					2	2.00			8	1.33	8	0.03	80	3.1"-13.9"
WHITE SUCKER	1294	43.13	2022	146.52	372	80.87	554	138.50			7	1.17	15	0.05	3338	2.5"-18.9"
SHORTHEAD REDHORSE	19	0.63			2	2.00			7	1.52	2	0.33			30	12.5"-18.9"
SILVER REDHORSE									2	0.43	1	0.17			3	17.5"-23.4"
BIGMOUTH BUFFALO							6	6.00	5	1.09					11	20.5"-27.9"
SMALLMOUTH BUFFALO	1	0.03							2	0.43					3	14.5"-23.9"
QUILLBACK									13	2.83					13	5.5"-23.4"
CARP	17	0.57			2	2.00	9	9.00	107	23.26			1	0.003	136	10.5"-30.0"
GIZZARD SHAD	604	20.13					5	5.00			1	0.17			610	5.0"-19.9"
FRESHWATER DRUM									3	0.65					3	11.9"-17.4"
COMMON SHINER	189	6.30			1	1.00									190	—
GOLDEN SHINER	1829	60.97			11	11.00	2	2.00			98	16.33	6	0.02	1946	—
EMERALD SHINER					50	50.00	8	8.00			26	4.33			87	—
SPOTTAIL SHINER	388	12.93			35	35.00	22	22.00			237	39.50	2	0.01	627	—
BLUNTNOSE MINNOW							7	7.00			523	87.17	322	1.07	852	—
FATHEAD MINNOW											3	0.50			3	—
CENTRAL MUDMINNOW	1	0.03													1	—
HORNYHEAD CHUB	2	0.07													2	—
BROOK STICKLEBACK					1	1.00									1	—
LOG PERCH	2	0.07			2	2.00					6	1.00	102	0.34	116	—
IOWA DARTER													1	0.003	1	—
RAINBOW DARTER													4	0.01	4	—
JOHNNY DARTER											8	1.33	36	0.12	44	—

* # / MILE is fish per mile per 1 boat.

NOTE: Fyke netting is based on 10 nets fished for 3 days for a total of 30 net lifts.

Bass CPE is based on entire shoreline (4.6 miles) shocked 5 times (total of 23 miles).

Walleye, Sauger, Northern Pike, Musky & Trout CPE is based on entire shoreline (4.6 miles) shocked 4 times (total of 18.4 miles).

White Sucker CPE is based on entire shoreline (4.6 miles) shocked three nights (total of 13.8 miles).

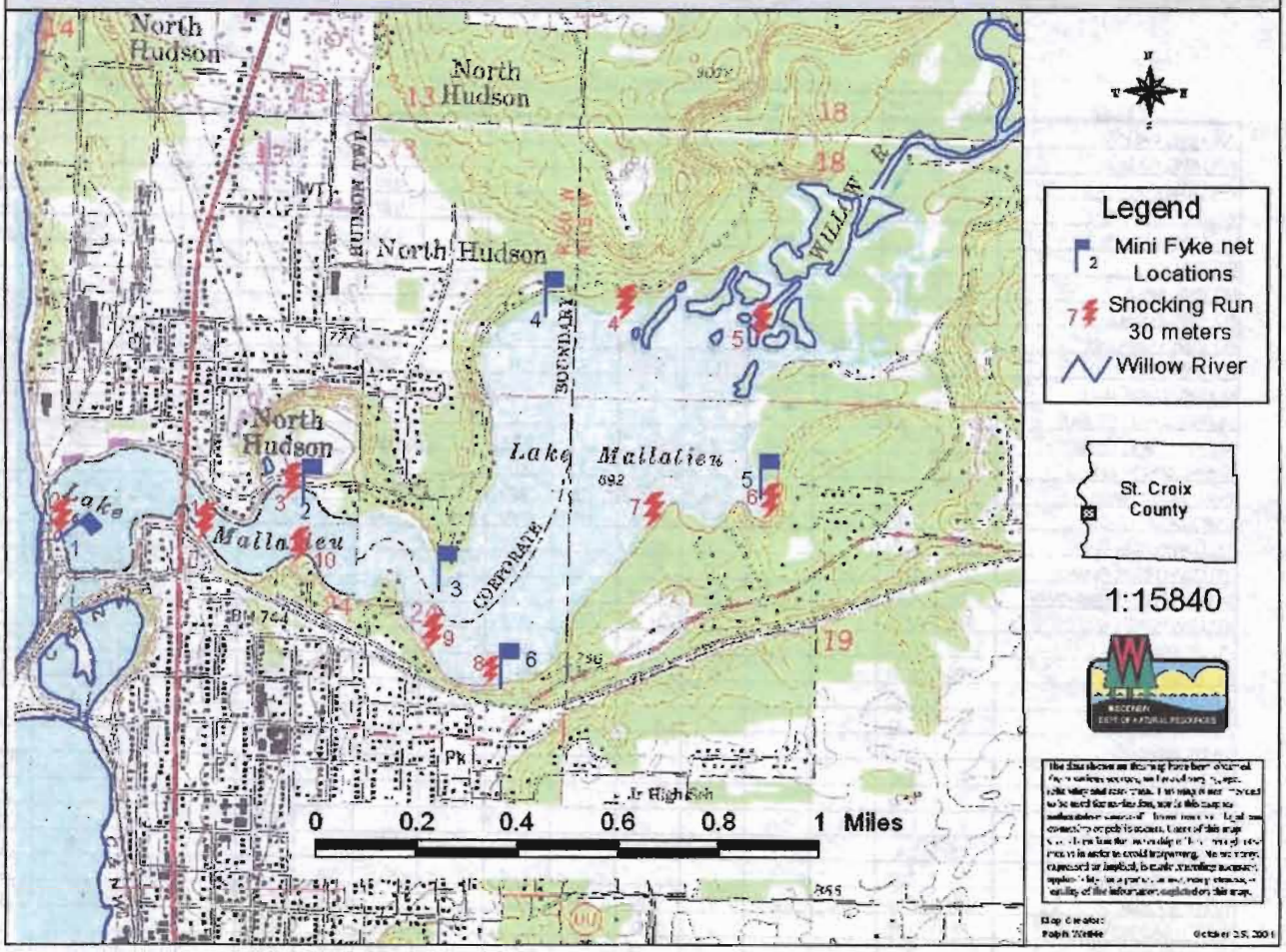
Percid / Ecosid Index CPE is based on two two-mile zones + 0.8 mile zone (total of 4.8 miles)

& all other fish based on two 1/2-mile zones shocked one night (total of 1 Mile).

Centrarchid Index CPE on two two-mile zones (total of 4 miles) & all other fish based on two 1/2-mile zones shocked one night (total of 1 Mile).

Forage is based on 6 Mini-fyke nets fished one day & 10 -- 30m shoreline sites shocked with a stream shocker one day (total of 300 m).

Fig. 3 Mallalieu Electrofishing & Mini Fyke Netting Locations 2001



Quality of Fishery

Proportional Stock Density (PSD) and Relative Stock Density (RSD) indices were chosen to indicate the quality of the fishery (Anderson and Gutreuter, 1983). PSD values range from 0-100, with 50 as the most balanced size distribution. Low PSD values indicate poor size distribution or abundant recruitment. High PSD values indicate low recruitment or populations dominated by adults. PSD is defined as the proportion of quality size fish in a stock:

$$PSD = \frac{\text{Number} \geq \text{minimum quality length} * 100}{\text{Number} \geq \text{minimum stock length.}}$$

RSD is defined as the proportion of fish of any designated size group in a stock:

$$RSD_{(\text{indicated size})} = \frac{\text{Number of quality size fish} > \text{indicated size} * 100}{\text{Number} \geq \text{minimum stock length}}$$

Quality, stock, and preferred sizes for specific fish are listed in Anderson and Gutreuter (1983). For any given species of fish, its stock size is 20-26%, quality size 36-41% and preferred size 45-55% of the angling world record (Kohler and Hubert, 1999). For RSD, preferred size was used for all fish.

RESULTS:

A total of 39 species and 17,910 individual fish were captured in Lake Mallalieu during the 2001 Comprehensive Lake Survey (Table 2). Discussion of electrofishing Catch per Unit Effort (CPE) for walleye, northern pike, smallmouth bass, largemouth bass, and white sucker are based on the population estimate period catch rates. Electrofishing CPE for panfish is based on the fish assemblage period catch rates and index station results. About mid way into this survey the system was affected by large amounts of rain, which caused flooding to occur. This flooding resulted in the St. Croix River rising above the Lake Mallalieu dam and allowed fish passage between the St. Croix River and the lake. It is believed that a few species of game fish (walleye, sauger, muskie) and rough fish (smallmouth and bigmouth buffalo, quillback, freshwater drum) were able to enter the lake during the course of this study. We do not believe that the smallmouth and largemouth bass and northern pike population estimates were impacted.

Walleye and Sauger

Walleye and sauger populations were virtually non-existent in Lake Mallalieu during this survey (n =34 & n =16 respectively). During fyke netting and the first half of the electrofishing sampling there were no walleyes or saugers found. The system then experienced flooding, allowing passage between the St. Croix River and the lake. It is believed that all the walleye and sauger captured came into the lake during this time and are not the result of natural reproduction. Electrofishing CPE was 1.85/mile for walleye and 0.87/mile for sauger overall (Table 2). Because of the low number of walleyes and saugers, length distributions, population estimates, PSD and RSD values, and mortality rates were not calculated. The length for walleye ranged from 8.0"-22.9" and for saugers 7.5"-17.4" (Table 2).

Northern Pike

Northern pike populations are very low in Lake Mallalieu (n = 114). Spring fyke net lifts averaged 3.2 pike per net and electrofishing CPE's averaged 0.9/mile. Pike ranged in size from 18" – 38" (Table 2). There were no fish under 18" caught indicating that there is no natural reproduction in the lake. The fyke net and electrofishing length distributions are presented in Figures 4 & 5. Northern pike are considered present in Lake Mallalieu. In addition, trophy pike (>32 inches) are extremely scarce.

Figure 4: Lake Mallalieu Northern Pike Length Distribution Spring Fyke Netting, 2001.

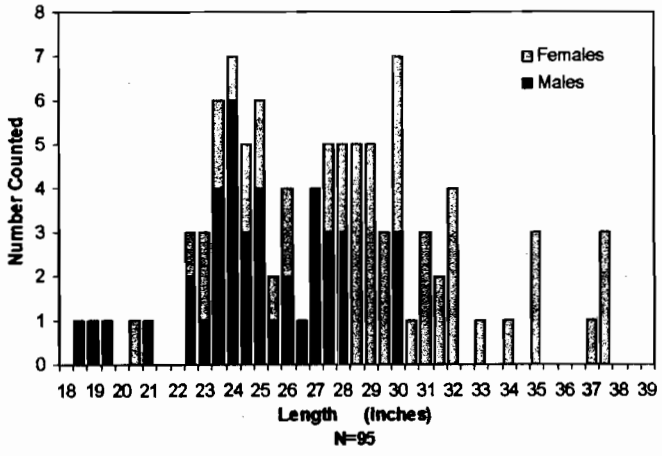
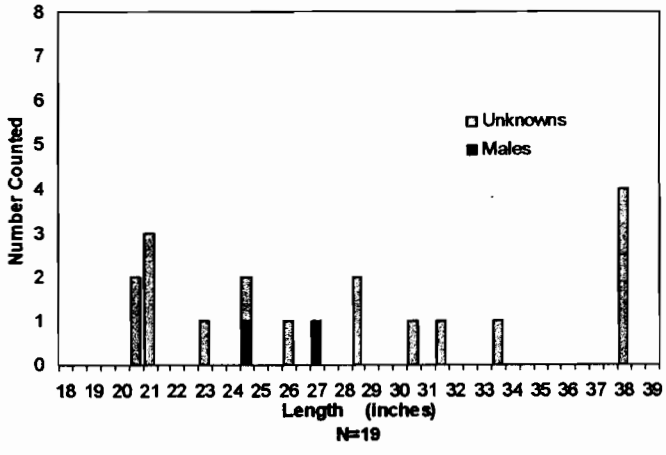


Figure 5: Lake Mallalieu Northern Pike Length Distribution Spring Electrofishing, 2001.



Lake Mallalieu population estimates (PE) of northern pike 12 inches and greater are listed in Table 3.

Table 3: Population estimates for northern pike in Lake Mallalieu, 2001

NORTHERN PIKE

SIZE	POPULATION ESTIMATE	LOWER 95% CI	UPPER 95% CI	LOWER % FROM PE	UPPER % FROM PE	NUMBER PER ACRE
>=12 INCHES	120	86	200	-32.8	48.9	0.4
ADULT MALE	46	29	105	-42.8	75.1	0.2
ADULT FEMALE	83	51	217	-45.7	84.5	0.3

In western Wisconsin lakes, densities of $\geq$ 6 adults per acre are considered abundant and $\leq$ 2 adults per acre low (King, 1996). Lake Mallalieu has a low population (0.4 per acre) of northern pike greater than 12 inches. Lake Mallalieu has a significantly (P>0.5) lower concentration of adult northern pike in comparison to the Little Falls Flowage, which is at 7.8 per acre (Table 4). Lake Mallalieu has good spawning habitat in the upper end of the lake. The forage base is very strong with gizzard shad, golden shiners, bluntnose minnows and large amounts of white sucker. However, northern pike densities were low, especially in the younger year classes. It is unclear why northern pike spawning success is limited. Little Falls Flowage, which is located two miles upstream, has similar habitat and has a self-sustaining population. Northern pike populations in Lake Mallalieu are dependent on fish passage when the St. Croix River floods into Lake Mallalieu or when northern pike migrate downstream from Little Falls Flowage.

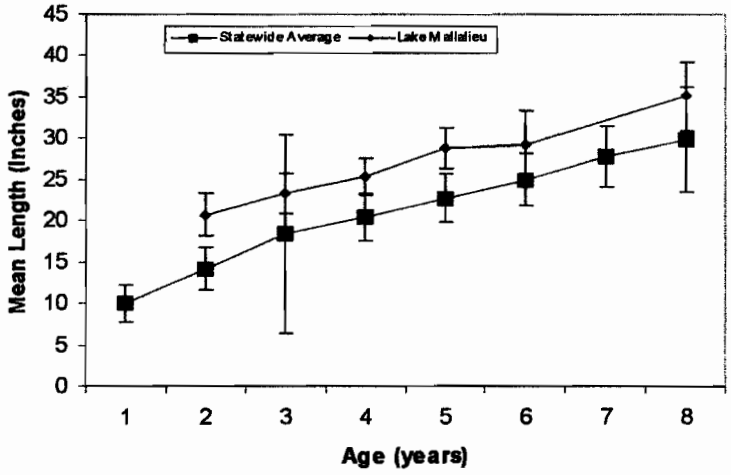
Table 4: Northern Pike per Acre from the Lake Mallalieu survey and other flowages.

Water Body	County	Acres	Year(s) Surveyed	PE's ≥ 12"	Pike/Acre Total Fish
Lake Mallalieu	**St. Croix**	**270**	**2001**	**0.4**	**0.4***
Flowages					
Chippewa Falls Flowage	Chippewa	282	1989-90	-	1.6
Tainter Lake System	Dunn/Barron	3241	1998	0.8	0.8*
Lake Menomin	Dunn	1,405	1999	4.2	4.2*
Little Falls Flowage	St. Croix	172	2000	7.8	7.8*
Lakes					
Bass Lake	St. Croix	416	1997		0.9
Squaw Lake	St. Croix	129	1996		3.6

*Total reported as fish over 12" only.

Northern pike growth rates in Lake Mallalieu show that pike generally grow faster than the statewide average (Figure 6). The length weight relationship shown in Figure 7. Even though there are few northern pike present in the lake, growth is exceptionally fast. This is due to low competition between the few northern pike present and high forage availability.

Figure 6: Northern pike mean length at age growth rates, Lake Mallalieu vs. the statewide average, 2001



Northern pike populations in Lake Mallalieu have a high PSD (96) value. The RSD_{28} (46) value is also extremely high compared to the other flowages in

the area (Table 5). These indicate that Lake Mallalieu currently has poor reproduction with the majority of the population composed of medium to large adults. Both the Age I and Age II year class currently is absent or very weak and may be responsible for higher than normal PSD values. Lake Mallalieu northern pike are probably just not reproducing under current lake conditions. The PSD value is the highest of the PSD values reported from other flowages in the area. The RSD value is also one of the highest of those reported.

Figure 7: Lake Mallalieu Northern Pike Weight at Length, 2001.

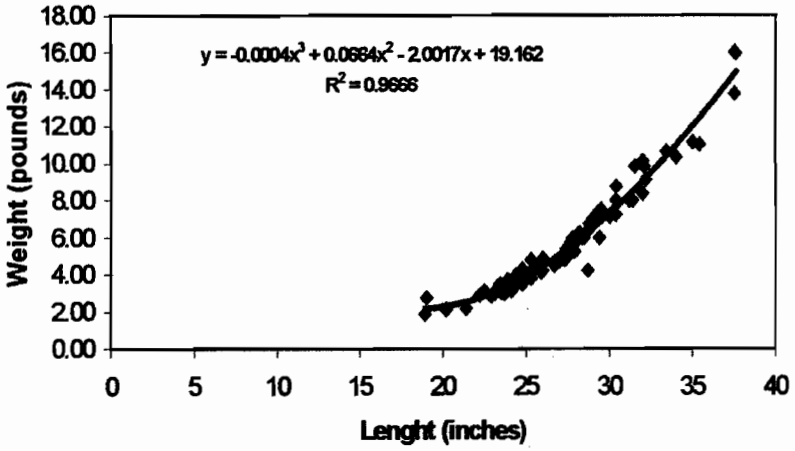


Table 5. Northern pike PSD and RSD28 values from the Lake Mallalieu survey and several other flowages.

Water Body	PSD	RSD_{28}
Lake Mallalieu (netting)	96	46
Little Falls Flowage (electrofishing)	72	5
Lake Menomin (electrofishing)	28	2
Tainter Lake (electrofishing)	49	9
Hay River	63	30
Lower Red Cedar River	27	8
Upper Red Cedar River	49	7
Old Abe Flowage (1987-88)	23	18
Chippewa Falls Flowage (1989-90)	63	41
Lake Wissota (1996)	55	52

Estimated northern pike annual mortality (A) rates from Lake Mallalieu, other flowages and natural lakes throughout the state are listed in Table 6. Lake Mallalieu has a northern pike mortality rate that is slightly higher than most other flowages within the state. This small population may not be large enough to obtain a good mortality estimate.

Based on this survey, the northern pike fishery is not self-sustaining and is poorly represented. This is due to the lack of spawning success. Little Falls Flowage, which is upstream, has a great northern pike fishery. For some unknown reason Lake Mallalieu does not have the same qualities as Little Falls Flowage to sustain northern pike.

Table 6: Summary of estimated northern pike annual mortality rates (A) for Lake Mallalieu, other flowages and natural lakes throughout the state.

Water Body	County	Acres	Year	Age Range	(A)	R^2	Reference
Lake Mallalieu	**St Croix**	**270**	**2001**	**5-8**	**60%**	**0.93**	**Present study**
Flowages							
Little Falls Flowage	St Croix	172	2000	3-6	65%	0.99	Engel (2002)
Chippewa Falls Flowage	Chippewa	282	1989	3-9	43%	0.89	Kurz (1992)
				4-9	50%	0.97	"
Lake Menomin	Dunn	1,405	1999	3-6	67%	0.99	Engel (2001)
				3-9	62%	0.97	"
Minong Flowage	Washburn	1,564	1988	4-8	56%	-	Johannes (1989)*
Tainter Lake system	Dunn/Barron	3,241	1998	3-7	49%	0.94	Engel (2000)
				4-7	56%	0.98	"
Lake Wissota	Chippewa	6,300	1989	3-9	43%	0.89	Kurz (1992)
				4-9	49%	0.95	"
Natural Lakes							
Bass Lake	St. Croix	416	1997	3-5	80%	0.97	Engel (1997)
Mason	Adams	855	1985	4-9	49%	-	Ironside (1985)*
Spooner	Washburn	1,092	1984	4+	92%	-	Johannes (1985)*

* Data found in Wisconsin Department Of Natural Resources Fish Management Reference Book. 1991. Wisconsin Department of Natural Resources, Madison.

Smallmouth Bass

Smallmouth bass are self-sustaining and were the second most common gamefish collected in Lake

Mallalieu (n=776). Electrofishing CPE was 31.7 per mile (Table 2). The electrofishing length distribution for the lake shows that all sizes are represented, recruitment varies and lengths range from 2.5"-19.9" (Figure 8).

Lake Mallalieu smallmouth bass PE's are listed in Table 7. Population estimates for smallmouth bass from across Wisconsin are scarce and not well understood. Lake Mallalieu appears to have a higher concentration of adults ≥ 14 inches (1.6 per acre) when compared to Little Falls Lake (0.7 per acre). In comparison to other lakes and flowages in the area and in northern Wisconsin, Lake Mallalieu has higher densities (1.6/acre) of legal (greater to or equal than 14 inches) and average densities of sublegal bass (3.5/acre) greater to or equal than ≥ 8 inches (Table 8).

Smallmouth bass growth rates are similar to the statewide average (Figure 9). The length weight relationship is shown in Figure 10. Both figures show the smallmouth bass to be in excellent condition.

The estimated annual mor-tality rates (A) for Lake Mallalieu smallmouth bass and comparable waters is listed in Table 9. Smallmouth bass have a mor-tality rate that is slightly higher than most other waters listed.

Figure 8: Lake Mallalieu Smallmouth Bass Length Distribution Spring Electrofishing, 2001

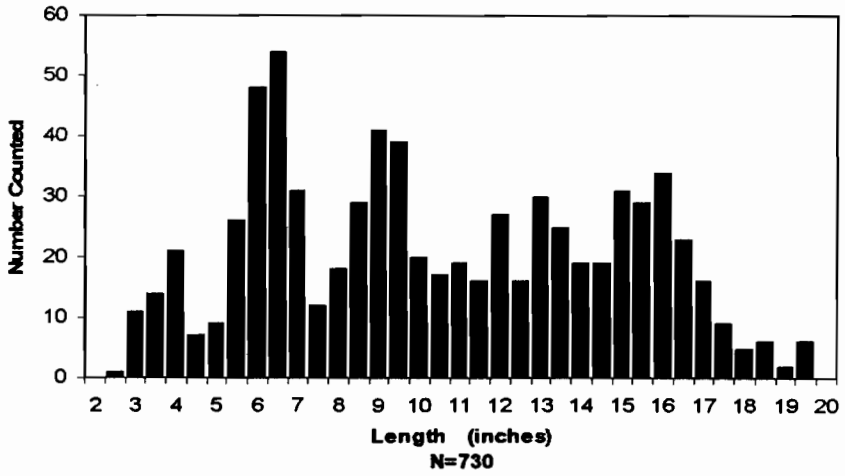


Table 7: Population estimates for smallmouth bass in Lake Mallalieu, 2001.

SMALLMOUTH BASS

SIZE	POPULATION ESTIMATE	LOWER 95% CI	UPPER 95% CI	LOWER % FROM PE	UPPER % FROM PE	NUMBER PER ACRE
>= 8 INCHES	942	779	1191	-18.8	23.2	3.5
>= 12 INCHES	638	496	894	-24.8	33.0	2.4
>= 14 INCHES	430	318	664	-29.6	42.0	1.6

Table 8: Smallmouth Bass per Acre from the Lake Mallalieu survey, other flowages and small lakes statewide.

Water Body	County	Acres	Year(s) Surveyed	PE's SMB/Acre ≥ 14"	Total
Lake Mallalieu	St. Croix	270	2001	1.6	3.5
Flowages					
Tainter Lake	Dunn	1,752	1998	0.50	2.6*
Little Falls	St. Croix	172	2000	0.7	3.8*
Lake Menomin	Dunn	1,405	1999	0.40	4.5*
Chippewa Falls Flowage	Chippewa	282	1989-90	0.64	10.20
Small Lakes					
Long	Iron	396	1996	-	0.41
Diamond	Bayfield	341	1996	-	0.90
Franklin	Forest	892	1997	0.72	1.35
Bear Skin	Oneida	400	1996	0.72	2.40
Pipe	Polk	345	1995	-	5.23
Clear	Oneida	846	1996	0.15	5.60
North Nokomis	Oneida	476	1998	0.07	0.75*

* Total reported as fish over 7.9" only

Figure 9: Smallmouth bass mean length at age growth rates, Lake Mallalieu vs. the statewide average, 2001

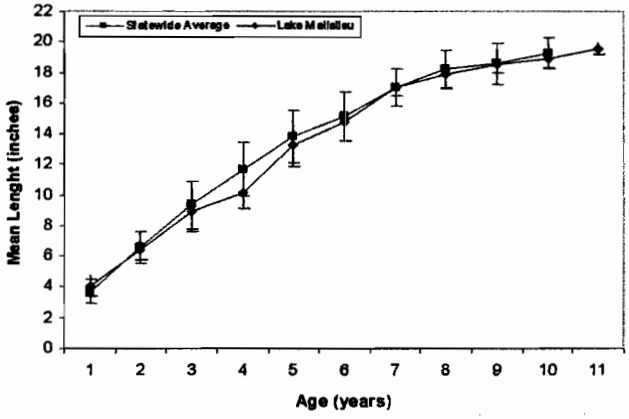


Figure 10: Lake Mallalieu Smallmouth Bass Weight at Length, 2001.

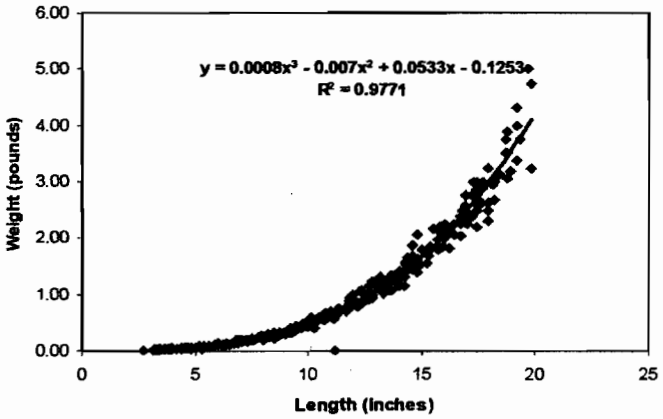


Table 9: Summary of estimated smallmouth bass annual mortality rates (A) for Lake Mallalieu, other flowages and natural lakes throughout the state.

Water Body	County	Acres	Year	Age Range	(A)	R^2	Refernce
Lake Mallalieu	**St Croix**	**270**	**2001**	**5-9**	**60%**	**0.93**	**present study**
Flowages							
Little Falls Flowage	St Croix	172	2000	5-9	48%	0.93	Engel (2002)
				4-8	58%	0.96	"
Chippewa Falls Flowage	Chippewa	282	1989	3-7	58%	0.97	Kurz (1992)
Old Abe Flowage	Chippewa	1,132	1987	3-7	64%	0.92	Kurz (1992)
				3-8	68%	0.95	"
				4-8	74%	0.999	"
Lake Menomin	Dunn	1,405	1999	3-8	39%	0.87	Engel (2001)
				4-8	43%	0.87	"
Tainter Lake system	Dunn/Barron	3,241	1998	4-9	58%	0.82	Engel (2000)
				6-9	66%	0.89	"
Natural Lakes							
Nebish Lake	Vilas	91	1974-77	3+	49%	-	Serns (1984)
			1978-81	3+	65%	-	"
Oconto Falls Pond	Oconto	167	1989	3-7	54%	-	Langhurst (1990)
Clear Lake	Oneida	846	1974-75	3+	78%	-	Marinac-Sanders (1981)

* Data found in Wisconsin Department Of Natural Resources Fish Management Reference Book. 1991. Wisconsin Department of Natural Resources, Madison.

Angler harvest, heavy competition among adult bass and loss of adults by entrainment remains as possibilities for the slightly elevated mortality rates. This mortality rate is not a major area of concern for smallmouth bass. Smallmouth populations and size distribution in Lake Mallalieu are outstanding.

The PSD value of smallmouth bass in Lake Mallalieu is comparable to the smallmouth bass in Little Falls Flowage (Table 10). PSD values can be heavily influenced by variations in annual recruitment. The PSD value represents the smallmouth bass population as being balanced between adult fish and juvenile fish at the time of sampling (Anderson 1980). The RSD value of the smallmouth bass in Lake Mallalieu is higher than Little Falls Lake and is similar to Lake Menomin (a flowage lake on the Red Cedar River in the city of Menomonie in Dunn County, WI). Both values indicated a high quality smallmouth bass fishery.

Table 10. Smallmouth bass PSD and RSD_{14} values from the Lake Mallalieu survey and several other flowages.

Water Body	PSD	RSD_{14}
Lake Mallalieu (electrofishing)	62	37
Little Falls Flowage	81	24
Lake Menomin (electrofishing)	70	33
Tainter Lake (electrofishing)	73	20
Hay River	100	15
Lower Red Cedar River	96	32
Upper Red Cedar River	97	41
Old Abe Flowage (1987-88)	44	8
Chippewa Falls Flowage (1989-90)	19	6

Largemouth Bass

Largemouth bass are self-sustaining and were the most common gamefish collected in Lake Mallalieu (n=1001). Electrofishing CPE was 36.4 per mile (Table 2). The electrofishing length distribution for the lake shows that all sizes are represented and range from 3.0"-21.4" with the most common length from 11.0"-14.0" (Figure 11). Lake Mallalieu largemouth bass PE's are shown in Table 11. Largemouth bass population per acre ($\geq$ 8.0 in.) in Lake Mallalieu is low when compared to most other flowages from the area and well within the range when compared to lakes across the state (Table 12). Densities of legal bass appear similar to other flowages and small lakes. When both largemouth and smallmouth bass densities are combined sublegal den-sities are average and legal densities are above average.

Figure 11: Lake Mallalieu Largemouth Bass Length Distribution Spring Electrofishing, 2001

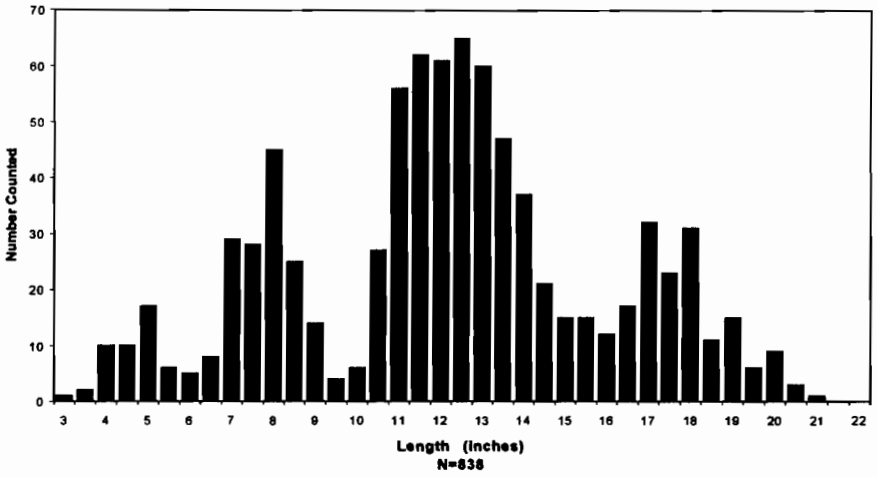


Table 11: Population estimates for largemouth bass in Lake Mallalieu, 2001.

	LARGEMOUTH BASS					
SIZE	POPULATION ESTIMATE	LOWER 95% CL	UPPER 95% CL	LOWER % FROM PE	UPPER % FROM PE	NUMBER PER ACRE
>= 8 INCHES	1257	1082	1501	-15.0	17.6	4.7
>= 12 INCHES	885	736	1109	-18.3	22.4	3.3
>= 14 INCHES	485	376	682	-25.0	33.4	1.8

Largemouth bass growth rates are shown in Figure 12. The largemouth bass in Lake Mallalieu are growing slightly faster than the statewide average until age 8, then their growth drops to the statewide average. The length weight relationship is shown in Figure 13. The length weight relationship shows that the bass population is healthy. Lake Mallalieu has a largemouth bass electrofishing PSD of 67 and an RSD_{15} of 26 (Table 13). This indicates the largemouth population has a balanced size distribution with quality fishing opportunities for bass over 15 inches (Anderson, 1980).

Table 12: Largemouth Bass per Acre from the Lake Mallalieu survey, other flowages and lakes statewide.

Water Body	County	Acres	Year(s) Surveyed	PE's ≥ 14"	LMB/Acre ≥ 8"
Lake Mallalieu	**St. Croix**	**270**	**2001**	**1.8**	**4.7**
Flowages					
Lake Menomin	Dunn	1,405	1999	0.6	1.6
Little Falls Flowage	St. Croix	172	2000	2.0	6.1
Murphy Flowage	Polk	180	1959-70	-	7.2
Nugget Lake	Pierce	116	1995	3.2	15.3
Spring Valley	St. Croix	126	1995	2.7	19.1
Glen Lake	St. Croix	84	1995	2.6	63.7
Lakes					
Loveless	Polk	141	1979	0.8	3.7
Pickerel	Polk	36	1979	1.2	4.3
Anderson	Barron	14	1976	0.6	4.9
Greenquist	Polk	58	1980	1.6	5.4
Elwood	Florence	132	1979	-	6.2
Herby	Polk	69	1977	3.5	9.4
Little Kekegama	Washburn	30	1978	0.8	9.5
Green	Sawyer	12	1976	0.7	10.4
Bass	St. Croix	417	1997	0.6	12.4
Beartrack	Washburn	65	1978	1.4	15.1
Squaw	St.Croix	129	1996	9.8	16.5
Squaw	St.Croix	129	1985	11.3	19.9*
Round	Waushara	71	1985	-	27.8
Half Moon	Eau Claire	132	1999	7.0	36.6

* Total reported as fish over 9.9" only

Figure 12: Largemouth bass mean length at age growth rates, Lake Mallalieu vs. the statewide average, 2001

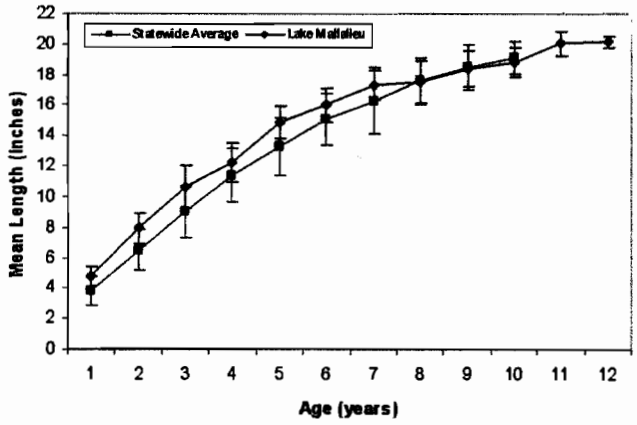


Figure 13: Lake Mallalieu Largemouth Bass Weight at Length, 2001.

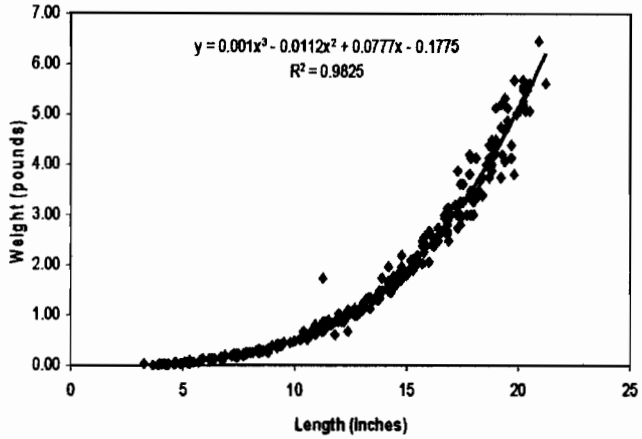


Table 13: Largemouth bass PSD and RSD_{15} values from the Lake Mallalieu survey, and several other flowages

Water Body	PSD	RSD_{15}
Flowages		
Lake Mallalieu	67	26
Little Falls Flowage 2000	55	24
Little Falls Flowage 1983	44	9
Lake Menomin (electrofishing)1999	61	25
Nugget Lake (electrofishing) 1995	87	*
Lake George (electrofishing) 1995	50	*
Glen Lake (electrofishing) 1995	22	*
Natural lakes		
Half Moon (electrofishing) 1999	46	8
Bass Lake (electrofishing) 1997	16	3
Squaw Lake (electrofishing) 1996	74	23

* RSD calculated as RSD_{14}

The estimated annual mortality rate (A) for Lake Mallalieu largemouth bass and comparable waters is listed in Table 14. The annual mortality rate appears slightly elevated. However, angling harvest, competition among abundant adults and/or entrainment of largemouth bass could be contributing to the elevated mortality.

Table 14: Summary of estimated largemouth bass annual mortality rates (A) for Lake Mallalieu, other flowages and natural lakes throughout the state.

Water Body	County	Acres	Year	Age Range	(A)	R^2	Reference
Lake Mallalieu - (electrofishing)	**St Croix**	**270**	**2001**	**4-7**	**63%**	**0.98**	**present study**
Flowages							
Little Falls Flowage	St Croix	172	2000	4-7	54%	0.94	Engel (2002)
Glen Lake	St. Croix	84	1995	5-8	75%	0.99	Engel (1996)
Nugget Lake	Pierce	116	1995	5-8	82%	0.98	Engel (1996)
Spring Valley Reservoir	St. Croix	126	1995	5-8	67%	0.88	Engel (1996)
Apple River Flowage	Polk	640	1981	6-11	48%	-	Cornelius (1983)*
Natural Lakes							
Pretty Lake	Waukesa	64	1988	4-8	59%		Lundquist (1990)
Thirty Lake	Barron	73	1986	3-8	42%		Cornelius (1988)*
Squaw Lake	St. Croix	129	1996	5-8	59%	0.94	Engel (1997)
Vermillion Lake	Barron	208	1986	3-8	42%	-	Cornelius (1987)*
Big Lake	Polk	244	1985	4-7	62%	-	Cornelius (1985)*
Irogami Lake	Waushara	289	1994	4-7	24%		Hatleli (1996)
Blake	Polk	302	1987	4-7	70%		Cornelius (1988)*
Sand Lake	Barron	322	1986	3-7	51%	-	Moody (1987)*
Browns Lake	Racine	396	1989	3-9	40%		Lundquist (1990)
Bass Lake	St. Croix	416	1986	5-8	67%	-	Engel (1988)
"	"	"	1997	4-14	43%	0.95	Engel (1997)
Deer Lake	Polk	807	1987	4-7	61%		Cornelius (1988)
Rice Lake	Barron	938	1986	3-7	50%	-	Cornelius (1987)*

* Data found in Wisconsin Department Of Natural Resources Fish Management Reference Book. 1991. Wisconsin Department of Natural Resources, Madison.

The largemouth bass mortality estimate is slightly higher than the Little Falls Flowage largemouth bass but compared to other flowages the estimate is actually lower. Overall, largemouth bass are doing well and are healthy.

Muskellunge

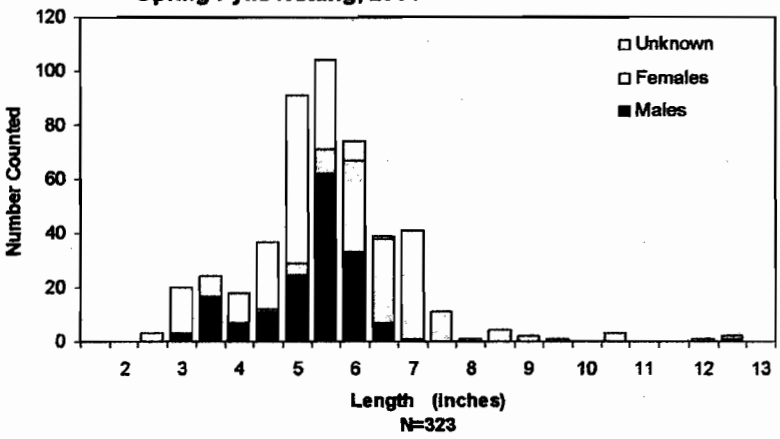
Muskellunge are present in Lake Mallalieu but are found in extremely low densities. Thirteen musky were collected during this survey. The musky that are present are believed to come from the St. Croix River, when big floods flow freely over the gates into Lake Mallalieu, and not the result of natural reproduction. Another possible reason for the presence of musky is that shore anglers are catching them in the St. Croix River and then releasing them into the lake. Anglers are able to catch musky in the St. Croix River because the Department of Natural Resources in Minnesota stock musky in Lake St. Croix just down river of Lake Mallalieu. Because of the low number of musky; length distributions, population estimates, PSD and RSD values, and mortality rates were not calculated. The few fish that were collected in the system had a length range from 11.0"-28.4" (Table 2).

Yellow Perch

Yellow Perch are considered to be common in Lake Mallalieu. There was a total of 699 yellow perch collected in the lake during this survey. CPE of yellow perch collected using fyke nets was 12.2 fish/net lift (Table 2). The length distribution ranged from 2.5" – 12.9" (Figure 14). Lake Mallalieu yellow perch, age one, are growing faster than the statewide average. Then at ages 2-4, the growth rate slowed down and dipped below the statewide average. There is a big boost in growth at ages 5-7 where perch are growing significantly faster than the statewide average (Figure 15). Slow growth rates during early ages probably is related to a bottleneck in the food supply. Abundant crappie and gizzard shad compete for zooplankton and other food resources. As perch grow to larger sizes they are able to use other fish as

forage. The length weight relationship shown in Figure 16 shows healthy growing yellow perch.

Figure 14: Lake Mallalieu Yellow Perch Length Distribution Spring Fyke Netting, 2001



Lake Mallalieu had a yellow perch netting PSD of 5 and an RSD_{10} of 2, indicating a lack of large (10" or more) individuals in the population. The low PSD value reflects abundant natural reproduction and the abundance of small fish with few adults. This high abundance of small fish over shadows the relative abundance of quality (8 inch or greater) or preferred (10 inches or greater) size perch in the population (Anderson, 1980).

Figure 15: Yellow Perch mean length at age growth rates, Lake Mallalieu vs. the statewide average, 2001

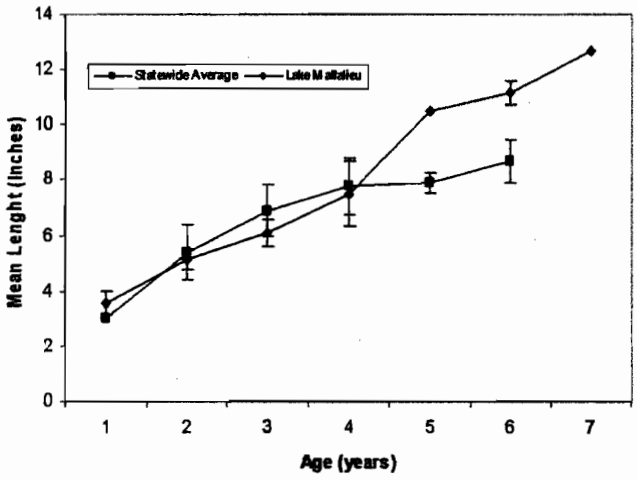


Figure 16: Lake Mallalieu Yellow Perch Weight at Length, 2001.

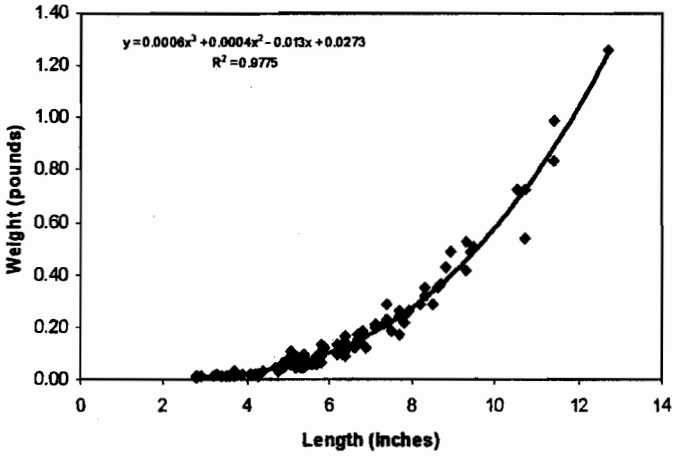


Table 15: Summary of estimated yellow perch annual mortality rates (A) for Lake Mallalieu, other flowages and natural lakes throughout the state.

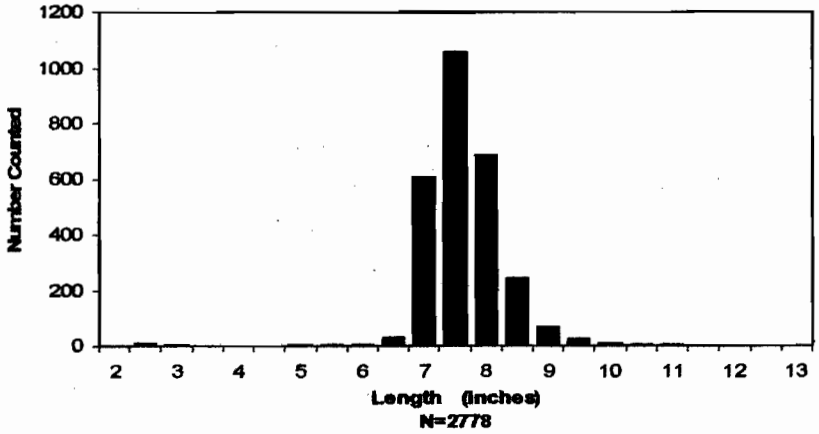
Water Body	County	Acres	Year	Age Range	(A)	R^2	Reference
Lake Mallalieu	St Croix	270	2001	4-7	72%	0.48	present study
Flowages							
Little Falls Flowage	St Croix	172	2000	3-5	73%	0.997	Engel (2002)
Lake Menomin	Dunn	1,405	1999	3-7	83%	0.980	Engel (2001)
Tainter Lake	Dunn	1,752	1998	3-7	69%	0.950	Engel (2000)
Old Abe Flowage	Chippewa	1,132	1987	3-9	25%	0.920	Kurz (1992)
Natural Lakes							
Machickanee	Oconto	463	1987	3-7	50%	-	Langhurst (1988)*
Kelley	Oconto	326	1987	3-7	54%	-	Schoenike (1988)*
Sealion	Florence	122	1986	3-7	65%	-	Kornely (1987)*

* Data found in Wisconsin Department Of Natural Resources Fish Management Reference Book. 1991. Wisconsin Department of Natural Resources, Madison.

Estimated yellow perch annual mortality rates from the current survey, several flowages and several lakes in the state are listed in Table 15. Of these waters, Lake Mallalieu has one of the highest estimated annual mortality rates (72%). Such a high mortality rate is undesirable. The exact cause of such a high mortality rate is unknown. Without angler exploitation information, the percent of total mortality caused by fishing will remain unknown. Another possible reason maybe due to entrainment into the St. Croix River. Habitat in Lake Mallalieu appears sufficient to support a modest perch fishery.

Black Crappie

Figure 17: Lake Mallalieu Black Crappie Length Distribution Spring Fyke Netting, 2001.



Black crappies are considered common to abundant in Lake Mallalieu. There was a total 2,820 black crappie collected in the lake during this survey. Netting CPE averaged 92.2 fish/net lift (Table 2). The netting length distri-bution contained fish ranging from 2.0"-11.4" (Figure 17). Seven to eight inch fish appeared to be the most abundant size. Young crappies are figured to be present, but due to sampling gear bias, they are under-represented.

The netting PSD (38) and RSD_{10} (1) represents poor recruitment at the moment and densities that are limited beyond 10 inches (Anderson, 1980). Black crappie populations are known to experience highly variable reproduction from year to year. It is not uncommon to have several weak year classes followed by one strong one. This appears to be the case in Lake Mallalieu.

Black crappie growth rates (Figure 18) in Lake Mallalieu show that ages 1-4 are growing about the same as the statewide average. The fish ages 5-7 are growing slightly faster than the statewide average. One would anticipate that black crappie would be growing faster than the statewide average in such fertile waters. Small crappies experience heavy competition for limited food resources from gizzard shad and other panfish. The length weight relationship is shown in Figure 19. Black crappie populations appear healthy.

Figure 18: Black crappie mean length at age growth rates, Lake Mallalieu vs. the statewide average, 2001

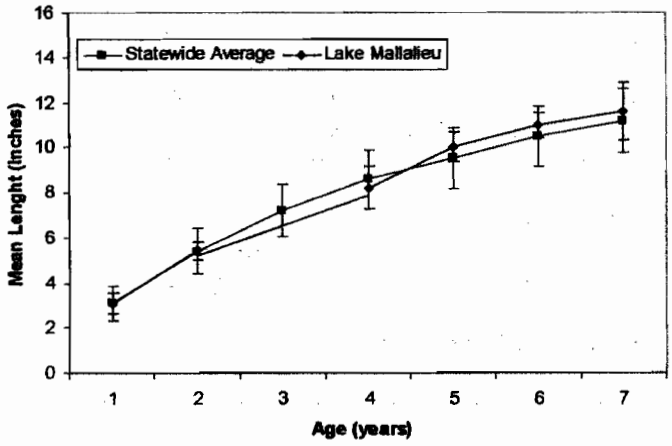
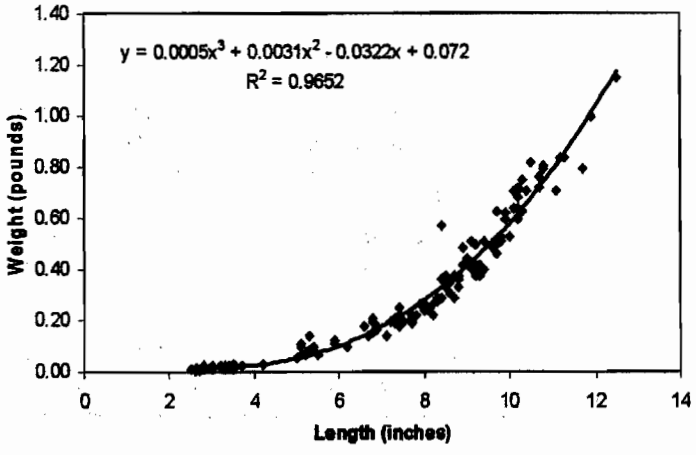


Figure 19: Lake Mallalieu Black Crappie Weight at Length, 2001.



The estimated annual mortality of Lake Mallalieu black crappies, ≥ 4 years, is higher than all other lakes and flowages listed (Table 16). The reason for a high annual mortality rate in Lake Mallalieu is uncertain, however the strong year class of age 4 crappie followed by a very weak age 5 group will artificially inflate mortality rates. Fishing remains a lesser possibility for high mortality rates. Disease such as Columnaris infections also pose increased mortality especially among spawning populations.

Table 16: Summary of estimated black crappie annual mortality rates (A) for Lake Mallalieu, other flowages and natural lakes throughout the state.

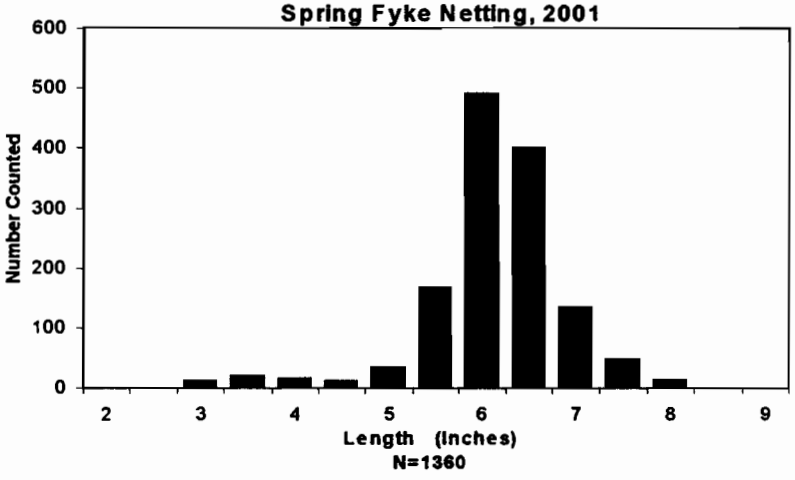
Water Body	County	Acres	Year	Age Range	(A)	R^2	Reference
Lake Mallalieu	**St Croix**	**270**	**2001**	**4-7**	**91%**	**0.97**	**present study**
Flowages							
Little Falls Flowage	St Croix	172	2000	2-4	19%	0.01	Engel (2002)
Chippewa Falls Flowage	Chippewa	282	1989	2-7	68%	0.97	Kurz (1992)
Apple River Flowage	Polk	640	1981	4-8	41%	-	Cornelius (1983)*
Old Abe Flowage	Chippewa	1,132	1987	4-9	55%	0.95	Kurz (1992)
Lake Menomin	Dunn	1,405	1999	4-6	83%	0.93	Engel (2001)
				4-7	67%	0.77	
Tainter Lake	Dunn	1,752	1998	5-7	73%	0.99	Engel (2000)
				4-7	86%	0.85	
Natural Lakes							
Round Lake	Chippewa	216	1983	5-12	33%	-	Erickson (1988)*
Lower Red Lake	Schawano	240	1984	3-7	58%	-	Langhurst (1988)*
Bass Lake	St. Croix	416	1997	3-7	54%	-	Engel (1997)
Long Lake	Fond du Lac	427	1986	3-6	73%	-	Scheirer (1988)*

* Data found in Wisconsin Department Of Natural Resources Fish Management Reference Book. 1991. Wisconsin Department of Natural Resources, Madison.

Bluegill

Bluegills are considered common to abundant in Lake Mallalieu. Bluegill were the most abundant fish collected in this survey (n=4061). The spring netting CPE was 45.3/net lift (Table 2). The spring netting length distribution contained fish 3.0" – 8.4" in length (Figure 20). This distribution shows a weak occurrence of young (3 to 4 inches) bluegill in the lake. Bluegill five to six inches are considered common. Bluegills over eight inches were scarce.

Figure 20: Lake Mallalieu Bluegill Length Distribution Spring Fyke Netting, 2001



The netting PSD was 80 and the RSD_8 was 1. The high PSD value reflects low recruitment populations, which is reflected in Figure 20. The low RSD_8 value reflects the extremely low numbers of bluegills over the preferred stock size of 8 inches. This could be due to entrainment, disease or angler harvest. Lake Mallalieu bluegill growth rates are represented in Figure 21. All fish are growing faster than the statewide average, however one would anticipate growth would be significantly faster in a fertile system. Competition with gizzard shad and other panfish results in lower than expected growth rates. The length weight relationship is shown in Figure 22. The fish sampled appear to be in great condition.

Figure 21: Bluegill mean length at age growth rates, Lake Mallalieu vs. the Statewide average, 2001

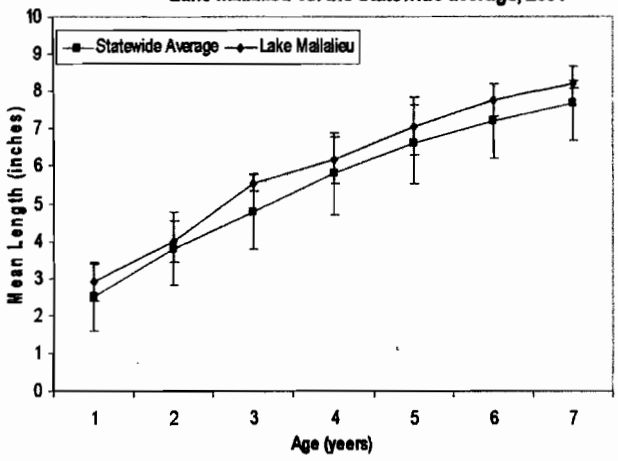
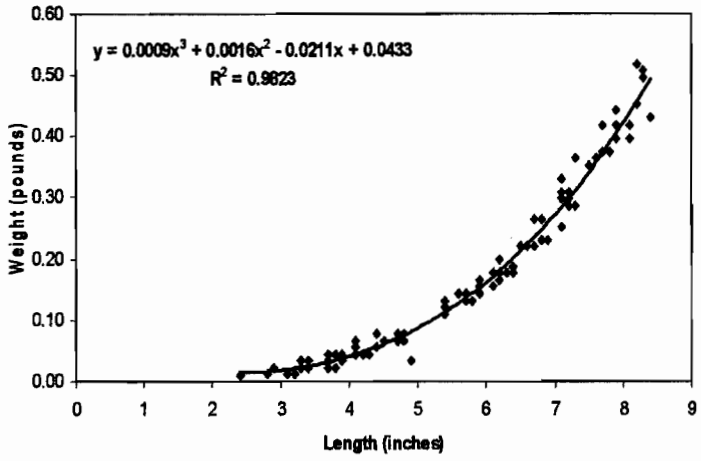


Figure 22: Lake Mallalieu Bluegill Weight at Length, 2001.



The estimated annual mortality of Lake Mallalieu bluegills is listed in Table 17. It appears that Lake Mallalieu bluegills have a higher annual mortality rate when compared to other systems throughout the state. Nugget Lake flowage is the only system that has a mortality rate as high. Little Falls Flowage, just upstream of Lake Mallalieu, has a mortality rate that is much lower, but also the length distribution of bluegill on Little Falls Flowage was represented by more fish within 3.5"-9.5". Whereas the fish in Lake Mallalieu were more concentrated in 5.0-7.9 inches. This off balance length distribution will cause the mortality rate to be higher than normal. The impacts of fishing warrant further study. Disease such as *Columnaris* infections also pose increased mortality especially among spawning populations. Loss to entrainment could also be contributing to the higher mortality rate. The lack of habitat in the lake may also be contributing to the loss of the adult population. Bluegills rely on the weed beds for protection and food. By increasing the habitat, bluegills will do better.

Table 17: Summary of estimated bluegill annual mortality rates (A) for Lake Mallalieu, other flowages and natural lakes throughout the state.

Water Body	County	Acres	Year	Age Range	(A)	R^2	Reference
Lake Mallalieu	**St Croix**	**270**	**2001**	**4-7**	**82%**	**0.94**	**present study**
Flowages							
Little Falls Flowage	St Croix	172	2000	2-6	36%	0.67	Engel (2002)
Glen Lake	St. Croix	84	1995	2-5	59%	0.63	Engel (1996)
Nugget Lake	St. Croix	116	1995	2-5	82%	0.99	Engel (1996)
L. George (Spring Valley)	St. Croix	126	1995	5-10	57%	0.8	Engel (1996)
Trego Flowage	Washburn	451	1983	3+	48%	-	Johannes (1984)*
Apple River Flowage	Polk	640	1981	5-6	69%	-	Cornelius (1983)*
Natural Lakes							
Rockland	Browns	40	1985	3-9	65%	0.88	Lundquist (1990)
Squaw Lake	St. Croix	129	1996	2-8	68%	0.94%	Engel (1997)
Irogami	Waushara	289	1994	2-7	27%		Hatleli (1996)
Browns	Racine	396	1989	3-7	56%	0.71	Lundquist (1990)
Bass Lake	St. Croix	416	1997	2-11	49%	0.92	Engel (1997)
Rice	Barron	937	1986	4-8	55%	-	Cornelius (1987)*

* Data found in Wisconsin Department Of Natural Resources Fish Management Reference Book. 1991. Wisconsin Department of Natural Resources, Madison.

Pumpkinseed and Rock Bass

Only 70 pumpkinseed were caught during the Lake Mallalieu survey. The CPE for spring fyke netting was 1.2/net lift. Over the entire survey pumpkinseed ranged in size from 1.8" – 6.7". Only one rock bass was caught during the survey. The CPE for the centrachid index was 0.3/mile (Table 2). Due to the low number of pumpkinseed and rock bass caught, growth rate, mortality rate, population estimate, PSD and RSD could not be calculated.

Trout

Brook, brown, and rainbow trout were sampled in low numbers (Table 2). Brook trout are native to the Willow River. Brown and rainbow trout are stocked in Willow River State Park. Natural reproduction of brown trout occurs just upstream of Lake Mallalieu in the Willow River Race Branch. During the winter, large brown trout utilize the lake as shelter, but shortly after iceout, most trout move upstream to the river.

Rough Fish and Bullheads

There were eight species of rough fish (white sucker, gizzard shad, carp, shorthead & silver redhorse, bigmouth & smallmouth buffalo, and quillback) collected in the lake during this survey. Because of the focus of this survey, more sportfish were collected than rough fish. An electrofishing rough fish index was used to estimate relative abundance. The most common rough fish species sampled were white sucker (n=3338) (146.5/mi) and carp (n=136) (23.3/mi). White suckers have a complete, well established length distribution. They ranged in size from 2.5" – 18.9" (Figure 23). The white sucker population in Lake Mallalieu is high when compared to other lakes and flowages from the area (Table 19). On average white sucker densities of 30-60 per acre are quite common in local reservoirs. These high numbers of white suckers are not alarming because they are not a destructive fish species and are considered a forage species for larger game fish.

Silver and shorthead redhorse were relatively scarce, as were bigmouth and

Figure 23: Lake Mallalieu White Sucker Length Distribution Spring Electrofishing, 2001

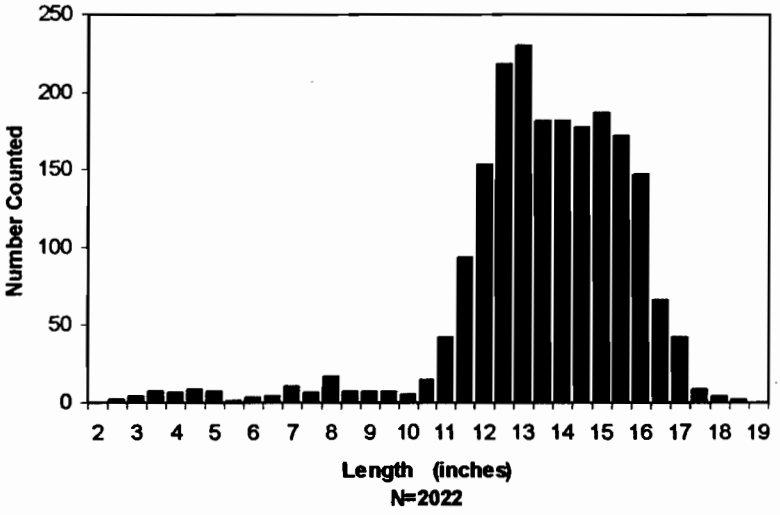


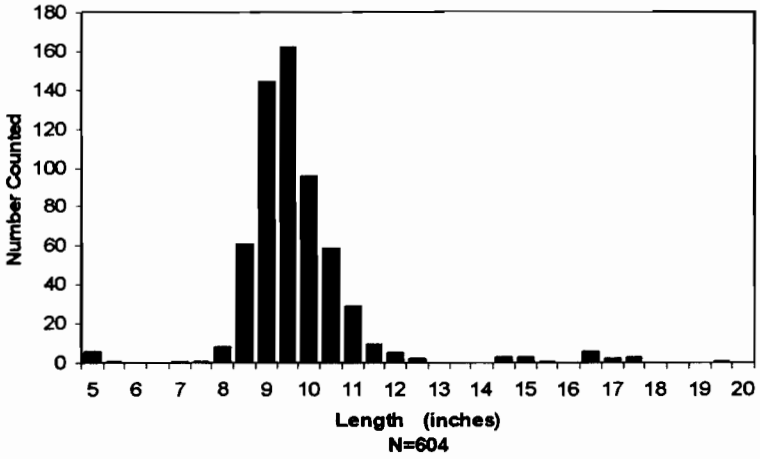
Table 19: White Sucker per Acre from the Lake Mallalieu survey, other flowages and lakes statewide.

Water Body	County	Acres	Year(s) Surveyed	PE's WHSK/Acre ≥12"
Lake Mallalieu	St. Croix	270	2001	69.6
Flowages				
Little Falls	St. Croix	172	2000	54.7
Glen Lake	St. Croix	84	1995	8.3
Nugget Lake	Pierce	116	1995	11.6
Lake George	St. Croix	126	1995	60.8
Lakes				
Bass Lake	St. Croix	417	1997	3.0
Squaw Lake	St. Croix	129	1996	<1.0

smallmouth buffalo and quillback. The main reason these fish were found was due to the fact that the St. Croix River ocassionally floods into Lake Mallalieu, which provides open access for fish passage. Black & yellow bullhead species were also present during the survey. They were collected during the fyke netting period but not during the rough fish index. The two species were present in low numbers, black (2.4/net lift) and yellow bullhead (2.1/net lift).

Gizzard shad, a river fish, were present in high numbers (20.1/net lift) and appear to be reproducing in the lake. In addition, schools of shad probably pass into Lake Mallalieu when the St. Croix River floods. The spring netting length distribution contained fish 5.0" – 19.9" in length (Figure 24). All species collected are listed with their catch rates in Table 2.

Figure 24: Lake Mallalieu Gizzard Shad Length Distribution Spring Fyke Netting, 2001.



Common carp were present in modest numbers (23.3 per mile of shoreline) and ranged in size from 10 to 30 inches. The carp population does not appear to be overly abundant at this time.

Minnows, Darters, and Forage

Most minnows and darters were collected in low numbers during fyke netting, fish assemblage electrofishing, and summer forage mini-fyke netting and seining. Several species of shiner were collected in high numbers (Table 2). The majority of minnow species collected during this survey are primarily found associated with streams and small to medium size rivers (Becker, 1983). These species include the common shiner, central mudminnow, hornyhead chub, brook stickleback, logperch, johnny darter, and rainbow darter. These species are commonly found in the Williow River system. Four species collected, the golden shiner, fathead minnow, bluntnose minnow, and Iowa darter, are commonly found associated with lakes. Two species collected, spottail shiner and the emerald shiner, are commonly found associated with big rivers and big lakes (Becker, 1983), which is a result of the flooding that occurs from the St.Croix River into Lake Mallalieu. The most abundant minnows collected are the golden shiner (n=1946), spottail shiner (n=684) and the bluntnose minnow (n=882).

The total number and species of fish collected during the forage abundance period (netting and electrofishing) are listed in Table 2. Bluegill, mostly young of year, were the most numerous fish collected during forage netting (252.7/net lift), followed by much lesser amounts of young of year black crappie, yellow perch, pumpkinseed, smallmouth and largemouth bass, and many minnow and darter species. Centrarchids may be more susceptible to capture by mini-fyke nets than other species. Young of year panfish and bass were also prevalent during stream shocker operations, however bluntnose minnow and logperch were also common.

DISCUSSION AND CONCLUSIONS:

Landuse in the Willow River Watershed has had an impact on Lake Mallalieu. The Willow River drains a large watershed that is dominated by agriculture, municipalities and urban/residential development. These activities, in combination with municipal and industrial contributions, inundate Lake Mallalieu with nutrients, of which phosphorus is the major concern. Abundant total phosphorus levels promote intense algal blooms, which limit desirable aquatic macrophytes and have the potential to create fishkills and toxic environments for terrestrial and aquatic organisms. Such algal blooms also inhibit water-based recreation, including fishing. On the other hand, fertile flowages usually are more productive (pounds of fish biomass per acre) than similar sized less fertile, clear water lakes.

Lake Mallalieu is a hypereutrophic lake with poor water clarity that experiences planktonic algal blooms. Water levels are normally stable but in the spring and fall the levels fluctuate with flooding conditions. Poor water clarity and frequently occurring water level fluctuation are limiting factors that restrict the ability of submerged macrophytes to grow (Konkel, 1999). Because the relatively large littoral zone, the density and quality of aquatic macrophyte communities found in the lake are directly related to fish habitat and lake productivity. Improvements in water clarity and water level stability can result in an expansion of aquatic plant and fish communities. For centrarchid species like bluegill and largemouth bass, the lack of submerged aquatic plants for spawning habitat, food concentration, and escape cover are probably the most limiting factors. All of the factors limiting aquatic plant growth, particularly submerged species, has likely caused the quality of Lake Mallalieu's aquatic plant community to be lower than the average lake in Wisconsin. The aquatic plant community is characterized by good diversity but low density (Konkel, 1999). Lake Mallalieu's fish and aquatic life would benefit further from improvements in water quality and expansion of desirable macrophyte growth.

Lake Mallalieu has an abundant source of large woody debris along certain parts of the flowage. Residential and shoreline development has eliminated large woody debris and natural vegetative buffers in numerous locations throughout the lake. Many shoreline lots have been converted to limestone rip-rap, which has been proven to benefit young smallmouth bass, but may also fail to provide both juvenile and adult fish cover for most other fish species. Preservation of large woody debris and natural shoreline buffers consisting of emergent and submergent plant beds, trees, shrubs, grasses and forbs will assure survival of healthy fish and aquatic life resources.

Upstream dam removals often create a one-time disturbance that can cause short term, negative impacts on downstream resources. The removal of Mounds Dam appears to have had negatively impacted reproductive success in Lake Mallalieu during the 1998 spawning season. This is evident by the lack of Age 3 bass and panfish in the flowage. Poor year class development on small reservoirs in the area is common following heavy spring floods or high turbidity events (Engel, Spangler and Michalek, 2002 and Paukert and Engel, 1996). Fisheries tend to compensate for such losses by high survival and/or excellerated growth rates of other age groups of fish. Therefore, overall populations may not show a decline. This is true for Lake Mallalieu.

Drawdowns also can have major impacts to fisheries. Lake Mallalieu has been drawn down many times for various reasons such as dam repair. A partial drawdown of 6 feet occurred during the fall and winter of 1998-'99 for dam repair and left down over the winter to eradicate Eurasian water milfoil. An attempt was made to avoid spawning periods and high water temperatures during summer. The frequency, duration, timing and magnitude of drawdowns are all important factors that need to be considered in order

to protect fish populations. Total drawdowns are devastating and often require substantial funds and years of restoration stocking to provide fishable populations again. Based on this survey, Lake Mallalieu fish populations appear to have survived the 6-foot drawdown during fall and winter without any major negative affects on the fishery.

Entrainment or fish passage does occur through the Lake Mallalieu Dam, to what extent and whether the amount of fish passage is causing adverse impacts to sport fisheries is not well understood. Other small flowages in the area also experience entrainment to various degrees. As the amount of residence time increases in a flowage, the ability of lake oriented species to survive and complete life cycles also increases. Bass populations in the lake have normal to slightly high mortality rates, however panfish have very high mortality rates. Entrainment remains as a possible cause for high mortality.

Despite these impacts, Lake Mallalieu currently provides an abundant and diverse sportfish community. Both largemouth and smallmouth bass fishing is excellent with many trophy bass present. Northern pike densities are low; however, the size distribution is well above average. Panfish populations are good but growth rates and large adult densities are lower than expected for small fertile flowages. One potential reason for less than desirable growth rates are related to forage competition at early life stages, when panfish and abundant gizzard shad seek zooplankton or other small organisms for food. The reduction of plant beds through drawdowns may have also reduced food producing areas. Slower growth and high mortality rates for larger panfish limit their abundance. It is not well understood why large panfish are lacking in number. Adult habitat may be lacking. Panfish angling does not appear to be a significant factor nor does entrainment. Disease may be responsible, many eutrophic reservoirs experience significant *Columnaris* infections and mortality during the spring spawning season. The drawdown does not appear to have impacted adult panfish fish populations, however one cannot be absolutely sure. Whatever the cause, Lake Mallalieu has not been known to be a consistent producer of large quantities of quality panfish.

Walleye and Sauger

Walleye and sauger populations are not self-sustaining. They are found in low densities in Lake Mallalieu. Flooding conditions on the St. Croix River and the Willow River, cause the lake and river to become one, allowing free passage for fish. There was no data analysis done on walleye or sauger. Historically, neither walleye nor sauger has been present in large numbers. Walleye and sauger will not be promoted to protect existing trout in the Willow River.

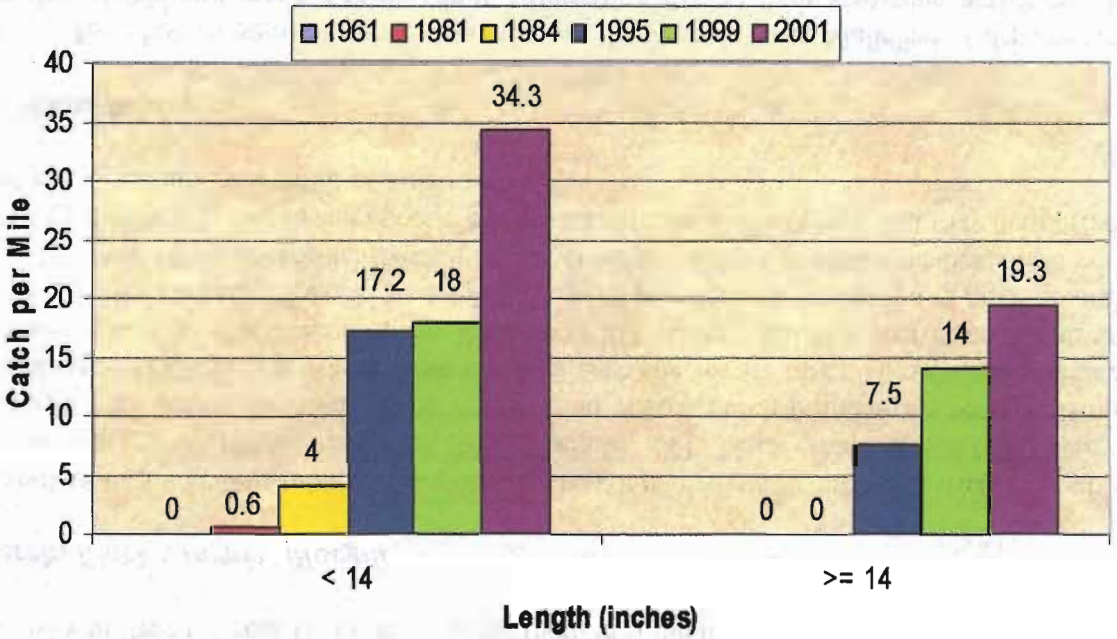
Northern Pike

Lake Mallalieu contains a low density but high quality northern pike fishery with limited natural reproduction. The slightly elevated annual mortality rates are not a concern. There was a total of 114 fish captured in this survey and adult fish ranged in size from 18"-38". The exact reason for higher than expected mortality rates is unknown. Poor water quality, lack of cool water refuge during the summer months, entrainment and diseases are some potential causes. Historically, northern pike have not been very successful in this lake and probably won't be in the future. Northern pike will not be promoted to protect existing trout in the Willow River.

Smallmouth Bass

Smallmouth bass are self sustaining and of great density and quality to support an outstanding sport fishery. A total of 776 smallmouth bass were captured with lengths ranging from 2"-20". Certain areas of Lake Mallalieu provide the habitats this species requires to be successful. Smallmouth bass concentrations occur in rocky and woody drop-offs in the lake. Figure 25 shows a comparison of smallmouth bass CPE's over the past 40 years. Smallmouth bass <14 inches increased greatly and bass ≥14 inches also increased in numbers. The mortality estimate of 60% is normal for the fish. It is just slightly higher than other waterbodies. Smallmouth bass are healthy in Lake Mallalieu. The growth rates are at the statewide average.

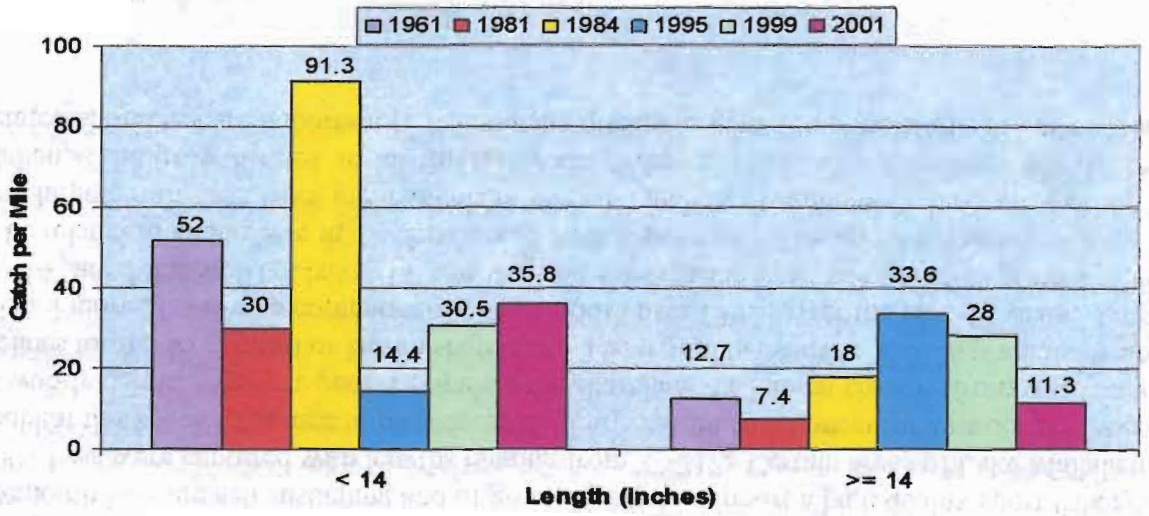
Figure 25: Lake Mallalieu Smallmouth Bass CPUE History (1961-2001)



Largemouth Bass

Largemouth bass are self sustaining and of great density to support a high quality sport fishery. A total of 1001 bass were captured with lengths ranging from 2"-21". Certain areas of Lake Mallalieu provide the habitat this species requires to be successful. Largemouth bass concentrations occur in weedy areas with woody debris. As more people populate the shoreline, the habitat changes from weedy and woody shorelines to rockier (riprap) or barren shorelines. The mortality estimate of 63% is relatively normal for the fish. Figure 26 shows a comparison of largemouth bass CPE's over the past 40 years. Largemouth bass <14" are doing well but bass ≥14" are showing a decreasing trend from 1995 to present. This decline may be related to an increase in the smallmouth bass population. The length frequency (Figure 11) data shows largemouth bass have great numbers over 14 inches. Largemouth bass are healthy in Lake Mallalieu. The growth rates are at the statewide average. Preservation of large woody debris and vegetated shorelines are important to maintaining quality largemouth populations in Lake Mallalieu.

Figure 26: Lake Mallalieu Largemouth Bass CPUE History (1961-2001)



Muskellunge

Musky are not a self-sustaining population. There were only 13 total fish captured in this survey. Musky move freely into Lake Mallalieu during floods. It is also thought that musky are coming from fishermen catching musky in the St. Croix River and placing them into the lake.

Yellow Perch, Black Crappie, Bluegill

Panfish populations are self-sustaining at various levels. All panfish were either growing at or above the statewide average growth rates. There were 4061 bluegills, 2820 black crappies, and 699 yellow perch captured during this survey. Bluegill, black crappie and yellow perch populations remain strong with excellent natural reproduction, however large adults of each species are rare. These species all have high mortality rates as adults, which result in low RSD and PSD values. Variable recruitment, entrainment, angler harvest or disease may impact large adults. Crappie populations are known to have several weak year classes followed by an occasional strong one. In order to improve panfish densities, areas with poor habitat must be improved. Increasing aquatic plant communities is one option that may help provide the needed habitat to sustain large adult populations.

Carp and White Sucker

Common carp have been a point of public concern over the years in Lake Mallalieu. Carp are large fish that are highly visible and make a tremendous commotion during their spawning activities. Even a relatively few carp can appear to be a large number because of these concentrated spawning activities in shallow water. The carp population in Lake Mallalieu is not considered a problem at this time. The majority of the rough fish population in Lake Mallalieu is made up white sucker (n=3338). This species is not destructive to habitat and water quality, as high concentrations of carp would be. White sucker young of year, yearling and small adults provide a tremendous forage base for many gamefish species. Most other rough fish species are found in low densities.

MANAGEMENT RECOMMENDATIONS:

These recommendations are based on past and present data and serve as a starting point in developing future management actions required to address fishery concerns as identified in this report. However, it is understood that alternative options may apply or certain recommendations may not be implemented due to statewide complexities. Public input should be obtained to provide guidance on a variety of available options.

Walleye

Historically the stocking of walleye proved unsuccessful. The Willow River is managed for trout populations and by introducing walleye will be detrimental to those populations. It is recommended not to manage for walleye in this water.

Northern Pike

Continue to monitor the current northern pike population and continue to protect and enhance emergent and submergent plant communities. Northern Pike stocking is not recommended. This is due to the high trout populations up in the Willow River. Northern Pike will utilized them as a food source.

Smallmouth Bass

Smallmouth are doing very well in the Lake Mallalieu. However, promotion of watershed and lakeshore activities that improve water quality and preserve large woody debris should improve and protect smallmouth habitat and spawning success.

Largemouth Bass

Largemouth Bass are doing very well in Lake Mallalieu. Protection and enhancement of the aquatic plant community and near shore habitat (woody debris) would increase the amount of preferred spawning habitat, escape cover, and forage associated with plants.

Muskellunge

Musky stocking is not recommended. Due to flooding conditions, few practical alternatives exist to prevent introductions of musky into Lake Mallalieu. The department should discourage musky relocation by anglers through education and enforcement.

Yellow Perch, Black Crappie, and Bluegill

Panfish numbers are moderately abundant for all species. All panfish species would benefit from improved water quality and an enhanced aquatic plant community that would provide more spawning sites, enhance associated forage, provide escape cover and reduce fishkills from *Columnaris* infections. Mortality is high for these species, so a reduced bag limit of 10 should be considered on Lake Mallalieu. In addition, as time and funding are available, a creel census should be considered.

Long Term Monitoring

Continue the Baseline Lakes Trends and Status Monitoring Program. Begin documentation of trends and produce comparisons to other waters.

Watershed Management

Lake Mallalieu has a tremendously large watershed that is dominated by agriculture and somewhat by urban runoff. Water quality has been heavily affected over the past fifty years by nutrient and sediment loading. The results have been decreased habitat due to poor water quality and clarity that limit aquatic plant abundance and diversity. Uninformed landowners may clear vegetation and woody debris from the shore or littoral zone areas. This will lead to increased erosion, runoff, loss of fish habitat, and decreased aesthetic quality. County and state efforts should focus on preventing further deterioration of water quality through promoting appropriate land use practices in the watershed. This is not a small task and will take a well-planned, long-term effort to make a difference. The City of Hudson should consider retrofitting stormwater drainages to reduce sedimentation and prevent habitat loss in Lake Mallalieu.

Lake Shore Management

Although much of Lake Mallalieu's shoreline remains undeveloped, residential landowners, in an attempt to improve the lakeshore, are inadvertently removing or modifying shoreline habitat and vegetative buffers. The Department of Natural Resources (DNR) and its Lake Mallalieu partners should begin a process to educate riparian landowners on the importance of Best Management Practices (BMPs) with near shore habitat and vegetative buffer strips and to implement management strategies aimed at restoring these important features while allowing riparian use. The DNR should only allow a limited number of riprap permits for shoreline stabilization.

MANAGEMENT GOALS:

1. Protect and improve the distribution, density and quality of submergent and emergent plant beds in Lake Mallalieu for the benefit of fish and aquatic life.

2. Maintain stable water levels to protect aquatic plant communities, fish and aquatic life.

3. Work with our partners and landowners to protect, improve and enhance riparian, shallow and deep-water habitat, which includes woody debris and aquatic plant communities. Allow only a limited number of riprap permits for shoreline stabilization.

4. Promote watershed management practices to improve water quality, reduce sedimentation and enhance fish and aquatic life.

5. Seek public input and support of management recommendations.

6. Continue to monitor trends in water quality, fish and aquatic life in Lake Mallalieu through implementation of a long-term fishery resource monitoring program under the Bureau of Fisheries and Habitat Management Long Term Lake Monitoring Program.

7. Continue to discourage a musky, northern pike and walleye fishery in Lake Mallalieu. Encouraging such species is counterproductive to trout management goals in the Willow River.

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Appendix A: The history of Lake Mallalieu

1848 James Purrington built the 1st dam
Known as Willow Pond

1854 Caleb Greene built a second dam on the
Willow flowage to run a gristmill

1867 D. A. Baldwin prchased the dams

1877 Comstock and Clark purchased the dams

1887 Willow Pond renamed Lake Mallalieu

1893 Christian Burkhardt purchased the dams

1900's Burkhardt build three concrete dams on
the Willow Flowage for hydropower
(not the Mallalieu dam)

1934 Mallalieu dam washed out
It was rebuilt

1941 Commercial fishermen seine lake
-removed 56,400 lbs carp
-largemouth bass, common
-northern pike, common
-walleye, scarce
-panfish, common
-bullhead, scarce

1941-54 900 to 10,944 walleye stocked annually

1945 Northern States Power purchased the dams

1950 Aquatic macrophytes abundant
-residents complain carp reduction resulted
in abundant plant growth & numerous small panfish

1951 DNR fisheries investigation
-Vegatation abundant
-panfish not stunted
-recommends continued walleye stocking

1953 Viral disease impacts northern pike population

1956 Northern pike fishing drops off
walleye stocking is unsuccessful

1957 DNR fisheries survey (summer netting)
-recommends manage bass and bluegills
-caution, removal of carp may result in
abundant vegetation

1961 Largemouth bass survey (electrofishing)
-bluegill and largemouth common to abundant

1965-66 Permit to chemically treat vegetation approved

1967 -NSP turned over ownership of Mallalieu
dams to St. Croix County, Hudson,
North Hudson and the Town of Hudson
-Wisconsin purchased the three upper dams
to form the Willow River State Park

1960's Shoreline modifications by lake owners

1970 Request to lower water level to find sewage
leakage

1974 Lake issues seminar by concerned citizens
-vegetation disappeared
-panfish scarce
-DNR conducted a survey
-DNR to contact commercial fishermen
for possible removal of carp
Results
-vegetation scarce due to weedkillers
-water clarity a problem
-carp abundant
-poor fish reproduction
Recommendations
-June drawdown to desiccate carp eggs
-change dam opperations to top draw
-reintroduce vegetation
-remove carp if commercial fisherman
are available

1975 DNR approved drawdown for carp control

1978 Commercial gillnetting for carp control
-approx. 4,000 lbs removed

1981 DNR opposes Lake Association drawdown
-drawdowns part of fishery problem
-removal of large woody debris is detrimental
DNR conducts a fishery investigation
-abundant largemouth bass population
-smallmouth bass present
-few northern pike
-adult carp common, YOY scarce

1983 Drawdown Sept. 14 - Oct. 15 of 7 ft.

1984 DNR conducts a post drawdown survey
-largemouth bass density same as past
-bluegill density still low
-redhorse abundant
-vegetation re-established in upper part of lake

1988 Fishkills reported in the winter months
-primarily gizzard shad

1991 Proposed drawdown denied for sewage system

1995 DNR contaminant and gamefish survey
-good species diversity observed

1998 Application for chemical treatment of vegetation
denied
-recommend lake management plan

1998 Two of the upper dams were removed -
Willow Falls dam & upper Mounds dam

1998-99 Drawdown approved
-dam repairs
-control of eurasian milfoil
-will impact fishery

1999 DNR conducts a post drawdown survey
-good species diversity observed
-largemouth bass density same as past
-bluegill density is higher than past

Appendix B. Schedule of netting and shocking activities for Lake Mallalieu, 2001.

MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY
April 09 Set Nets 1-10	April 10 Run Nets 1-10	April 11 Run Nets 1-10	April 12 Run Nets 1-10 Pull Nets 1-10	April 13
April 16	April 17	April 18	April 19	April 20
April 23 **Electrofishing** Ecosid / Percid Run Begin Bass PE / Pike / Sucker Recap	April 24	April 25	April 26	April 27
April 30	May 01	May 02	May 03 **Electrofishing** Centrarchid Run Bass PE / Sucker PE CPE– WAE, SAU, NP & Musky	May 04
May 07 **Electrofishing** Bass PE / Sucker PE CPE – WAE, SAU, NP & Musky	May 08	May 09 **Electrofishing** Bass PE / Rough fish CPE CPE – WAE, SAU, NP & Musky	May 10	May 11
May 14 **Electrofishing** Bass PE CPE – WAE, SAU, NP & Musky	May 15	May 16	May 17	May 18

August 27	August 28	August 29	August 30 **Electrofishing** Stream Shocker 10–30m sites	August 31
September 03	September 04	September 05	September 06	September 07
September 10 Set Nets 1-6	September 11 Run & Pull Nets 1-6	September 12	September 13	September 14