Robert Winnie - Milwaukee

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Artificial Walleye Spawning Reefs in Jennie Webber Lake, Oneida County.

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TABLE OF CONTENTS

ABSTRACT

Three artificial walleye (Stizostedion vitreum vitreum) spawning reefs were installed in a 241-acre northern Wisconsin lake. The lake had an adult walleye population with a history of year class failures. In four years after reef construction, walleyes spawned on one reef each year and also on a second reef one year. The third reef was not utilized in any of the years of observation. Each year walleye eggs developed through the eyed stage, but no fry or fingerlings were subsequently captured. Apparently, no walleye year classes were established.

INTRODUCTION

Fish Management Surveys* indicated that Jennie Webber Lake had an adult walleye (Stizostedion vitreum vitreum) population with no apparent natural reproduction for at least seven consecutive years. Since the bottom types of Jennie Webber Lake are primarily sand and muck, it was hypothesized that addition of several gravel shoals could improve walleye reproduction. Walleye egg survival in several Minnesota waters was considerably higher on gravel and rubble bottoms than on sand or muck (Johnson, 1961). Weber and Imler (1974) noted increased young-of-the-year walleye numbers for two years after installation of rock spawning beds in Lonetree Reservoir, Colorado. Newberg (1973) reported that walleye eggs on "improved" shoals (gravel added) appeared more abundant than adjacent "unimproved" areas in Lake Osakis, Minnesota.

Spawning reefs were installed in three shoal areas of Jennie Webber Lake to provide a suitable spawning substrate and hopefully increase fishable stocks of walleyes through natural reproduction. The effectiveness of these spawning reefs as walleye reproductive sites was evaluated from 1969 through 1972. This study was also designed as a preliminary test of a possible management tool for lakes with inadequate walleye recruitment.

Water Area Involved

Jennie Webber Lake (Fig. 1) is located in Oneida County of northeastern Wisconsin. The lake is a 241-acre, roughly oval, very soft-water drainage lake with a maximum depth of approximately eight feet, and a median depth of about three feet. There are two inlets and one outlet. Much of the lake is surrounded by moderately rolling wooded or wild land with some wetlands and a few homes and cottages present. The total (methyl purple) alkalinity is 16 mg/1, pH approximately 6.6, and water color dark brown with a Secchi disc of 2.5 feet. Shoal soils are approximately 75 percent sand, 25 percent muck and less than 1 percent gravel. Due partially to the shallow, dark-water nature of the lake, water temperatures sometime fluctuate 8 to 12 degrees F. within a day or two.

The major inlet of the lake (Lost Creek) is a generally mucky or sandy-bottomed dark-water stream and flows through a swamp near the lake. A large beaver dam is present about one mile upstream from the lake and is probably an effective barrier to upstream fish movement. Upstream from the beaver dam, a branch of the stream connects to Lost Lake, which also has a walleye population. Jennie Webber's outlet has a predominantly sand and muck bottom with some limited gravel. The outlet flows approximately eight miles to the Moen Lake Chain which also contains walleyes.

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*Wisconsin Department of Natural Resources lake survey conducted October 2-4, 1967, and April 9-12, 1968.

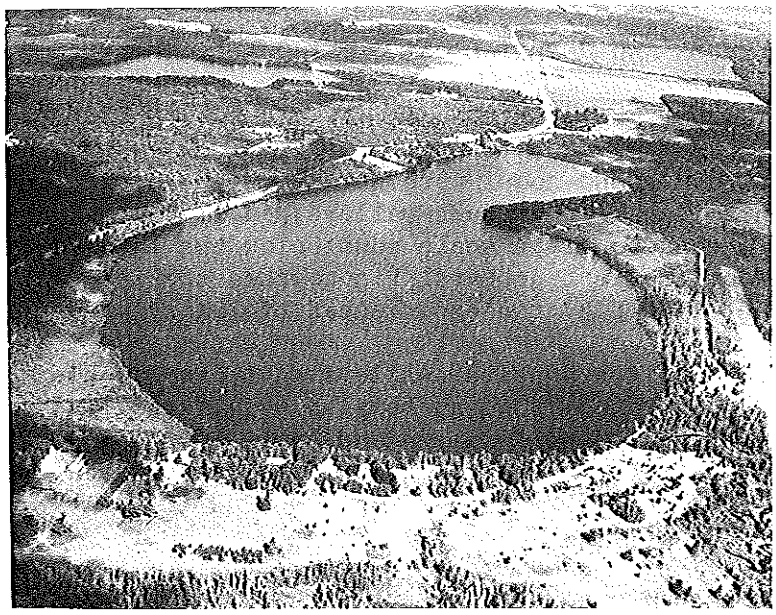

FIGURE 1. Aerial view of Jennie Webber Lake

Past Fish Stocking

From 1945 to 1955, largemouth bass (Micropterus salmoides) and walleye were stocked by the Wisconsin Department of Natural Resources at various times in Jennie Webber (Table 1). In 1960, northern pike (Esox lucius) were stocked. Since 1960 no fish have been stocked.

TABLE 1. Walleye Stocking History in Jennie Webber Lake

Year	No. of Walleye Stocked
1945	500,000 fry
1948	600,000 fry
1951	5,100 fingerlings
1952	2,600 fingerlings
1953	4,900 fingerlings
1955	4,900 fingerlings

Other fish species present in Jennie Webber Lake include yellow perch (Perca flavescens), bluegill (Lepomis macrochirus), pumpkinseed (Lepomis gibbosus), black crappie (Pomoxis nigromaculatus), rock bass (Ambloplites rupestris), white sucker (Catostomus commersoni), northern redhorse (Moxostoma macrolepidotum), black bullhead (Ictalurus melas), Johnny darter (Etheostoma nigrum), bluntnose minnow (Pimephales notatus), golden shiner (Notemigonus crysoleucas) and other minnow species, especially Notropis spp. In past years there were unconfirmed reports of muskellunge (Esox masquinongy) and smallmouth bass (Micropterus dolomieui).

METHODS AND MATERIALS

Adult Walleye Sampling

Ten fyke nets with four-foot frames and hoops were set overnight during the 1969 walleye spawning season to sample the adult walleye population. Scale samples were taken from the second to fifth scale rows below the lateral line near the point where the end of the left pectoral fin touches the lateral line. Scales were independently aged by two experienced biologists.

In order to determine viability of the "native" walleye eggs from Jennie Webber Lake, approximately 378,000 eggs from ten females were fertilized with the milt from eleven males fyke netted on April 24 and April 25, 1969, and incubated at the Wisconsin Department of Natural Resources' Woodruff Hatchery.

Construction of Spawning Reefs

In October 1968, three spawning reefs were constructed in three different areas of the lake (Fig. 2). Reef #1, located near Highway 17 on the west shore, is rectangular shaped, 60 feet long and 16 feet wide. Reef #2, north of the outlet on the southeast shore, is rectangular shaped, 100 feet long and 16 feet wide. Reef #3 consists of three circular ten foot diameter patches deposited off the large point on the east shore. All reefs were six inches thick. The reefs were placed in areas where water depths are normally between 1 and 33 inches during the walleye spawning and hatching season; the major portion of each reef is in 12 to 30 inches of water during this time. Rock material used was washed field rock picked from potato fields about 3½ miles from the lake. The rocks ranged from 1 to 10 inches in diameter with an estimated average diameter of 4 inches (Fig. 3). Reef #1 consisted of approximately 18 cubic yards of rock; reef #2, 30 yards; reef #3, 5 yards.

The three reef areas were selected by presence of walleyes in previous spring test netting, sand bottom (rather than muck, so rocks would not sink) and absence of human development.

The gravel was deposited on reefs #1 and #2 by use of a dragline (Fig. 4). Reef #3, which is inaccessible by road, was deposited by hand after the rocks were transported by barge. The rock for the reefs cost approximately $26. Hauling and installation took about 18 man days.

Egg Sampling

Walleye eggs were collected with a 12½ by 17-inch rectangular hand net with fine mesh nylon Bobbinette netting on a 2-3 day average interval, from commencement of spawning through probable hatching dates. Eggs were collected by agitating the lake bottom with one foot for approximately two seconds and passing the hand net through the roiled water in a swift arc approximately four feet long. This procedure constituted a "sample."

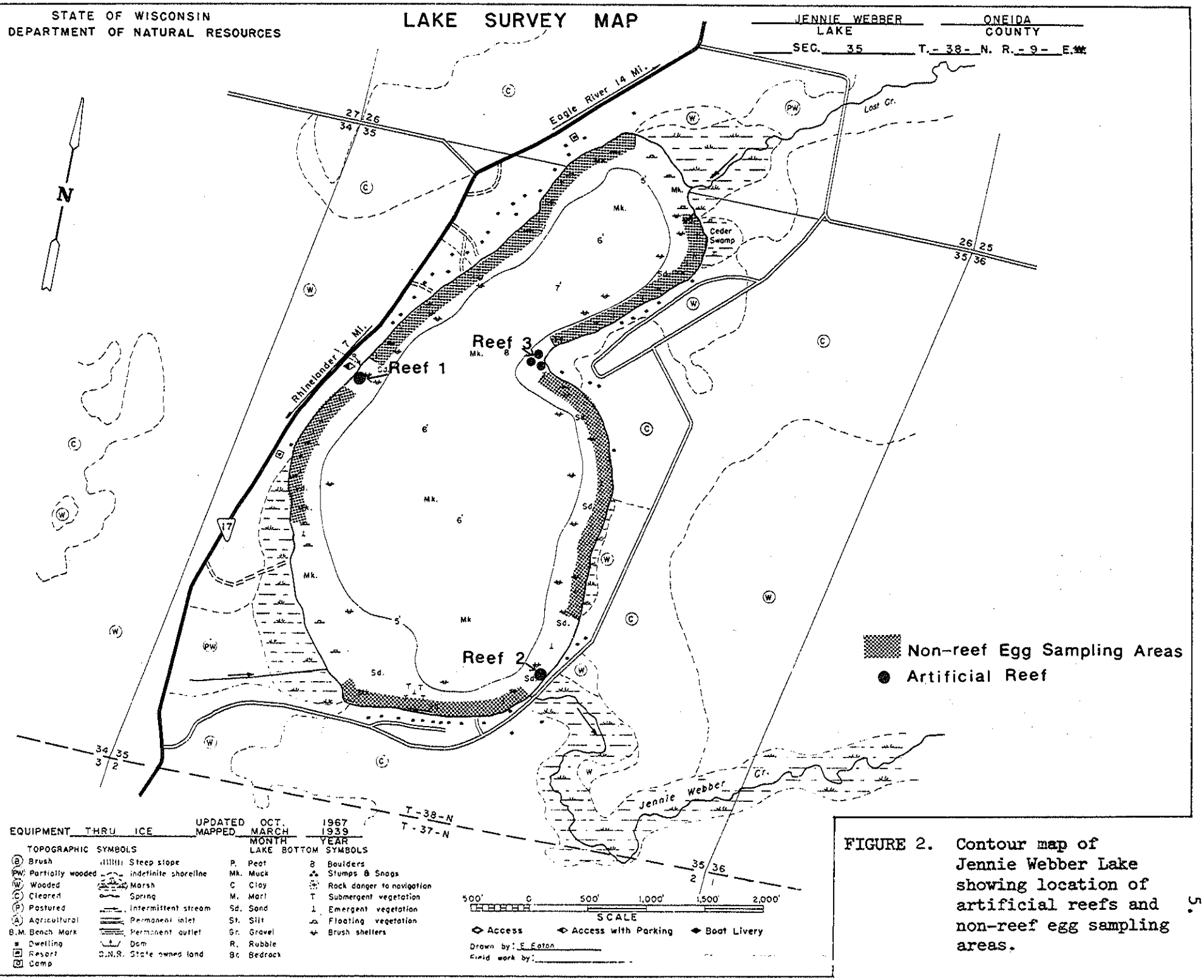

FIGURE 2. Contour map of Jennie Webber Lake showing location of artificial reefs and non-reef egg sampling areas.

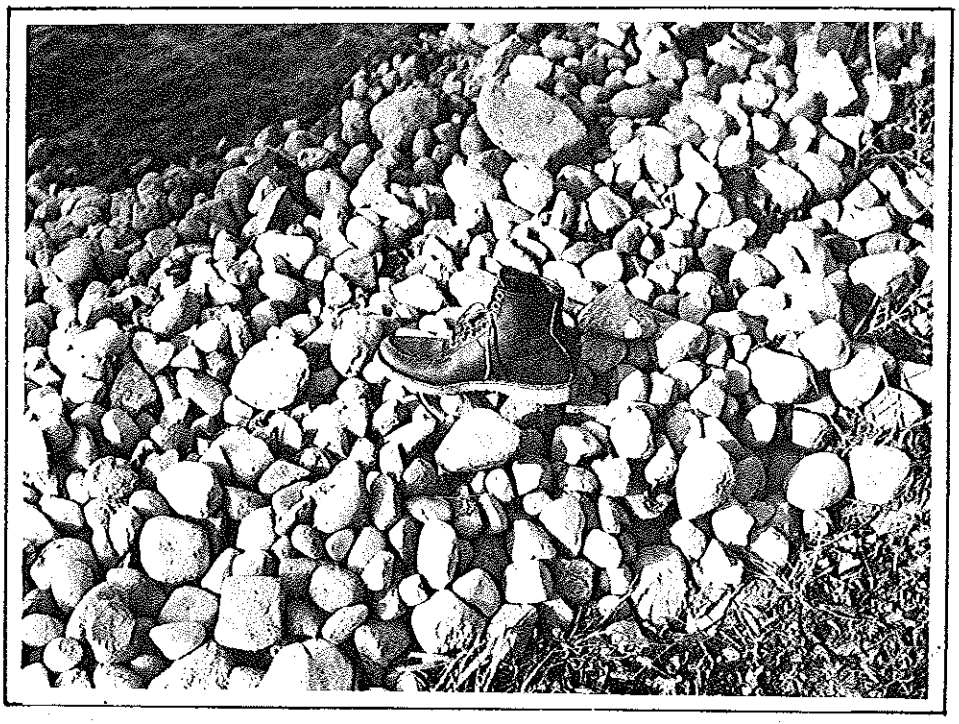

Figure 3. Typical rock material used in the reefs.

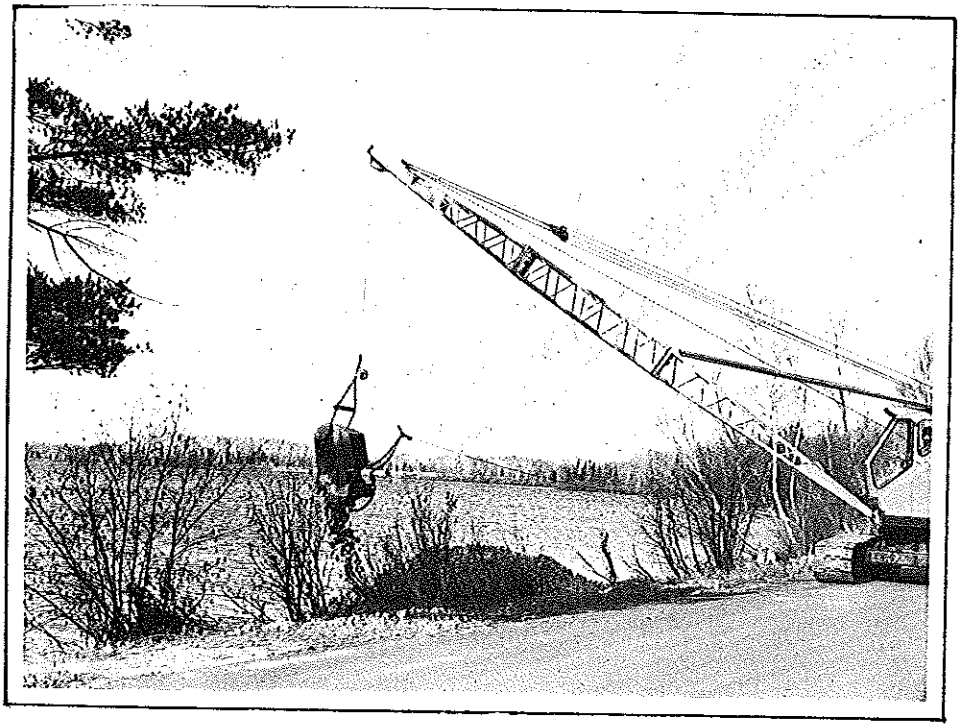

Figure 4. Dragline installing Reef No. 2

Egg condition (live or dead) was recorded in the field based on naked eye and/or hand lens examination. After counting, the eggs were returned to the reefs. Some rocks on the reefs were manually picked up and examined for eggs. Initially after spawning, walleye eggs adhered to some rocks, but after water hardening for a day or two, they usually lost this adhesion. Areas for egg sampling on the reefs were randomly selected.

Approximately two miles of shoreline (74 percent of total) were involved in non-reef egg sampling (Fig. 2). These were mainly areas where lake bottom was firm enough for walking. A water scope was used in an attempt to observe the walleye eggs but the low water transparency and the small size of the eggs prevented good observations.

Fry Sampling Attempts

Attempts to capture fry were made by towing a standard meter net (with No. 2 bolting cloth) behind a 16-foot boat with a 20-horsepower outboard for five minute periods. Various geographical parts of the shoreline and central parts of the lake were sampled. A D-frame dredge net (a 12-inch wide, 8-3/4-inch high tow net on runners) was manually dragged over reefs #1 and #2 for one to ten-minute periods. The numbers of tows were:

	1969	1970	1971	1972
Meter net	16	15	27	0
Dredge net	3	2	18	0

Both meter and dredge net tows were made during three periods: (1) When eyed walleye eggs were observed on the reefs; (2) Probable hatching periods; and (3) One to three and a half weeks after the presumed hatching. Many of the captured fry (which appeared to be yellow perch fry) were preserved and microscopically identified in the laboratory.

Fingerling Sampling Attempts

Fingerling sampling attempts were made with a 50-foot nylon minnow bag seine and with a 240 volt AC boom shocker during June, July, early August and early September. Both night and day seining were done in various geographical areas of the lake including areas of different bottom types and vegetative cover. On two evenings (September 16, 1969, and August 17, 1971), the entire lake's shoreline was shocked requiring approximately two hours each night.

Plankton Sampling

Plankton were sampled with a 12 cm Wisconsin plankton net. Four 5-minute plankton tows were taken between May 8 and May 19, 1969, near reef #3, and also in the center of the lake at depths from the surface to five feet below the surface. Samples were preserved and examined later with a compound microscope.

Water Temperature Measurement

Lake water temperatures during walleye spawning and egg development were measured with a pocket mercury thermometer about two inches below the water surface.

Eyed Walleye Egg Plant

On May 12, 1971, approximately 1,130,000 eyed walleye eggs were planted on reefs #1 and #2. This is approximately 440 eyed eggs per square foot of reef or 4,700 eggs per acre of entire lake. On reef #1 about 400,000 eggs were planted; on reef #2, about 730,000 were planted. Eggs were transported from the Woodruff Hatchery in standard plastic "fry bags" placed in cardboard boxes for support. Each bag contained 2/3 to 3/4 quarts of eggs, 12 to 14 quarts of 55°F water and some oxygen. Approximately one hour transpired between loading at the hatchery and planting on the reefs. Lake temperatures ranged from 51 to 54 degrees during planting. Eggs were released without tempering from the plastic fry bags and allowed to drift downward onto the reefs. The egg sources were from walleyes captured in northern Wisconsin lakes not connected to or in the immediate proximity of Jennie Webber Lake.

RESULTS

Existing Walleye Population

Test nets in the spring of 1969 captured 37 adult walleyes ranging from 19 to 30 inches in total lengths. Of these, 20 were females, 15 were males and two of unknown sex. Most of the walleyes were ripe, two had already spawned. The scales from 24 walleyes from 19.7 to 29.0 inches in total length were aged; all were at least seven or more years of age. The scales were difficult to age because they were from older fish and many of the annuli were packed closely in the outer margin of the scales. Therefore, some minor discrepancy in assigned ages occurred between the two biologists reading the scales. Examination of walleye ages and past stocking records revealed no correlation with past stocking. The adult walleyes could have been migrants, stocked fish, the result of limited natural reproduction in the past, or a combination thereof.

Jennie Webber walleye eggs hatched at the Woodruff Hatchery in 1969 produced a "cleanup" of 172,000 or 46 percent of the total eggs. General observations indicated a hatch of healthy fry. Although the percent success was not outstanding, the hatch was satisfactory, and indicated that infertility of walleyes was not limiting reproduction in the lake.

Use of Artificial Spawning Reefs

Walleyes spawned on reef #1 all four years of the study. This is the reef on the west shore. Walleyes spawned on reef #2 in 1972. No walleye eggs were found on reef #3 in any year. The walleye eggs deposited on the reefs developed through the eyed stages and some hatch probably occurred. The results of egg sampling on the three artificial reefs are summarized in Table 2. Details of the sampling are presented in Appendix I.

TABLE 2. Summary of Results of Walleye Egg Sampling on Artificial Reefs

Year	Reef No. 1			Reef No. 2			Reef No. 3		
	No. Samples	No. Live Eggs	No. Dead Eggs	No. Samples	No. Live Eggs	No. Dead Eggs	No. Samples	No. Live Eggs	No. Dead Eggs
1969	44	221	26	138	0	0	47	0	0
1970	171	96	17	190	0	0	188	0	0
1971	102	619	277	190	0	0	144	0	0
1972	41	191	41	65	34	17	65	0	0
TOTAL	358	1,127	361	583	34	17	444	0	0

Walleye spawning occurred two to eight days after ice out and average development time to eyed stage was 12 days for all four years (Table 3). Most walleye spawning took place when the water temperatures were in the mid-40's to high 50's degrees Fahrenheit. Water temperatures ranged from 44 to 64°F during egg development (Appendix II).

TABLE 3. Dates for Ice-Out, Walleye Spawning and Egg Development for the Consecutive Years 1969-1972

Event	Date of Occurrence of Each Event			
	1969	1970	1971	1972
Ice Out	4-19	4-20	4-20	5-3
Walleye Spawning Commenced	4-21 or 4-22	4-28	4-24	5-5
Most Walleye Eggs Eyed	5-5	5-2	5-13	5-16
Probable Walleye Egg Hatch Date	5-6	5-6	5-15	5-19

Water temperature differences among the three reefs are not considered significant. Some of the differences in temperatures recorded can be attributed to differences in time taken at different reefs and wind direction. A few water temperatures taken one to two inches into the gravel crevices of the reefs revealed temperatures similar to surface temperatures.

In 1969 and 1970 average water depths during walleye spawning were 20, 16 and 21 inches for reefs #1, #2 and #3 respectively. Water levels in Jennie Webber usually fluctuate one to two feet during spring and early summer months. Water level decreases of one foot or more were noted during the walleye incubation periods of this study. This was due primarily to decreased runoff and stream flow after snow melt.

The spawning period generally appeared to last one to three days. Development of walleye eggs from the eyed stage to probable hatch date ranged from one to four days. Water temperatures during the egg development period were generally from the mid-50's to low-60's. However, in 1972, they were in the mid-60's to low-70's due to unusually hot weather. The only other fish eggs taken on the reefs were a few yellow perch eggs.

Egg Sampling in Non-Reef Areas

In 1969, no walleye eggs were taken in 382 samples from non-reef areas. In 1970, 372 samples produced 10 walleye eggs along the south shore. In 1971, 554 samples produced approximately 200 walleye eggs. These eggs were found along the south shore, in the same area that walleye eggs were taken in 1970. In 1972, 500 samples took 18 walleye eggs; all these eggs were found in the same area of the south shore. The area where these walleye eggs were spawned consisted of a portion of the small natural gravel shoal present in a limited area of the lake. Other non-reef areas sampled consisted of either sand, muck or a mixture of both. The naturally spawned walleye eggs were in depths of one to two feet among small gravel bottom particles generally ranging from ¼ to two inches in size. Most of these gravel areas were less than ten feet in diameter and adjacent to the shoreline. Yellow perch eggs were abundant in certain non-reef areas. No white sucker eggs were found anywhere in the lake. Suckers are abundant in the lake, but their spawning areas are unknown.

Fry Sampling Attempts

No walleye fry were taken in any year in either the dredge net or meter net. Each year meter net catches had abundant yellow perch fry.

Fingerling Sampling Attempts

No young-of-the-year walleyes were taken by seining in any year. Numerous young-of-the-year yellow perch, bluegills and black crappies were taken. Other fish taken included adult walleyes, pumpkinseed, rock bass, white suckers, redhorse, northern pike, darters, largemouth bass and minnows (mainly bluntnose minnows, golden shiners and other shiner species). Some crayfish were also taken in the seines. A detailed summary of seining results is presented in Appendix III.

No young walleyes were taken by electrofishing and only two adults were taken by this method. Numerous young-of-the-year yellow perch and bluegills were taken. A number of black crappies, pumpkinseed and unidentified panfish, white suckers, golden shiners, redhorse, northern pike, largemouth bass and

minnows were seen but not captured. Visibility was poor because of the brown-stained water, and most shocking was done in depths of three feet or less. Efficiency was rated poor to fair due to the low conductivity of the water (43 mmhos at 77° F.).

Plankton Sampling

Most of the plankton taken in the Wisconsin plankton net in 1969 were Cladocerans and Copepods. Holopedium and Bosmina were the most common Cladocerans. Some Leptodora and a few Daphnia were also taken. Cyclopidae were the most abundant Copepods. It appears that the plankton of Jennie Webber Lake are typical of an infertile, bog-stained lake.

Meter net towing (for fry) captured a predominance of Holopedium and some Leptodora and Chaeborus were taken with other Copepods and Cladocerans. While the larger plankton appear somewhat limited as early walleye food, it is assumed that the abundant young-of-the-year perch could have provided forage for young walleyes at early stages of life each year of the study.

Eyed Walleye Egg Plant

On May 12, 1971, after naturally-spawned walleye eggs on the reefs reached the eyed stage and appeared to be similar in abundance to previous years, over a million eyed walleye eggs were planted on reefs #1 and #2. It was hypothesized that higher numbers of eggs on the reefs might be more successful in establishing a year class, and that resultant adults might "home in" on the reefs in future spawning runs.

Many of the planted walleye eggs disappeared within three days of placement (Table 4). It is assumed that most of these eggs hatched and/or were lost by predation. Daytime and evening visual inspections were hampered by windy weather and dark water. However, two live walleye fry were seen on the evening of May 15, 1971, on reef #2. Although the lake was meter netted, seined and shocked after this egg plant, no young-of-the-year walleye were taken.

TABLE 4. Results of Walleye Egg Sampling After Eyed Egg Plant, May 13-19, 1971*

	Reef #1			Reef #2			Reef #3**	
	Samples	Live Eggs	Dead Eggs	Samples	Live Eggs	Dead Eggs	Samples	Eggs
5-13	5	4	14	3	26	3	12	0
5-14	12	4	1	5	19	0	10	0
5-15	11	1	13	7	8	0	10	0
5-16	10	3	4	15	14	0	--	-
5-17	10	3	11	40	0	0	--	-
5-18	12	3	25	15	0	0	--	-
5-19	10	3	12	15	0	0	--	-
TOTALS	70	21	80	100	67	3	32	0

* Eggs were planted on May 12, 1971.
** No eggs were planted on Reef #3.

Other Fauna and Flora Observed on the Reefs

Fauna noted on the various reefs included clams, snails, crayfish, leeches, fresh water sponges, fingernail clams, backswimmers, dragonfly larvae, mayfly nymphs, and various amphipods and periphyton. In summer, a sparse growth of yellow waterlilies was observed on reefs #1 and #2.

DISCUSSION AND CONCLUSION

No walleye year classes apparently developed in Jennie Webber Lake for four years after reef installation but the reasons remain speculative. There may be several limiting factors to walleye reproduction in the lake. There could have been predation from the crayfish, perch or other fauna noted on the reefs during egg incubation. Lack of adequate bottom types, low spawning population and predation on eggs and/or fry can be important. A combination of such factors may be limiting natural reproduction of walleyes in Jennie Webber Lake.

Although the artificial reefs were not successful in establishing year classes, two of the three reefs were used for walleye spawning and advanced egg development occurred. This habitat improvement procedure may be useful as a management tool where bottom types are a principal limiting factor to walleye production. Although this technique was not successfully demonstrated in Jennie Webber Lake, which had a history of little or no natural reproduction, it might be more successful in lakes with sporadic or inadequate reproduction. Limited data from Minnesota and Colorado suggest that more intensive research in this area may be worthwhile (Weber & Imler 1974; Newberg 1973).

MANAGEMENT RECOMMENDATIONS

1. Further use of this technique should be encouraged on an experimental basis, with full evaluation of current walleye reproduction prior to and after reef installation. Several successful year class augmentations should be documented in several lakes before any large scale management practice is established. If successful on a trial basis, walleye year classes might be augmented in a substantial number of lakes.

2. It is suggested that lakes larger than Jennie Webber be tried, possibly with more adult spawners. The lakes should also be less turbid (for easier observations) and more fertile.

3. Perhaps a lake with sporadic reproduction would be more successful than a lake with little or no reproduction for many consecutive years. Although the sporadic situation would be more difficult to evaluate, there are probably more walleye lakes with intermittent reproduction than with no reproduction.

4. Several small reefs could be installed initially, and subsequently those that are used for walleye spawning enlarged. Reef locations should consider presence of natural spawn, private development and navigation hazard. Areas where walleye spawning is likely include bars or shoals along islands

or points, shoal area along shore and mid-stream shallows of inlets which walleyes "run up." Edges along dropoffs may produce better than long, gentle slopes (Fritz H. Johnson, Personal Communication).

5. It is recommended that reef thicknesses be increased from six inches (used in Jennie Webber) to one foot thick to accommodate ice push, sinking rocks into sand or other bottom type, and wave action filling crevices between rocks with sand or other fine materials.

6. Future studies might consider success of different sized particles used in the reef construction. Some smaller sized particles than those in Jennie Webber might also be tried.

7. If good reproduction occurs at only three to four year intervals, the reefs might be justified in terms of their cost versus periodic stocking on a long-term basis. Further study would be needed on economic aspects, however.

8. Thorough survey work and attempts to determine possible limiting factors to walleye reproduction is essential prior to selection of other study lakes.

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Edited by Betty Les

Appendix I: Numbers of Walleye Eggs Sampled on the Reefs

Date			Reef #1			Reef #2			Reef #3		
			No. Samples	No. Walleye Eggs Live	Dead	Samples	No. Walleye Eggs Live	Dead	Samples	No. Walleye Eggs Live	Dead
1969	April	23	10	160	0	8	0	0	8	0	0
		28	3	21	1	5	0	0	5	0	0
		30	-	-	-	75	0	0	6	0	0
	May	2	1	4	2	15	0	0	7	0	0
		5	4	21	4	12	0	0	9	0	0
		7	20	13	19	23	0	0	12	0	0
		8	6	2		-	-	-	-	-	-
1969 Totals			44	221	26	138	0	0	47	0	0
1970	April	18	15	0	0	15	0	0	15	0	0
		20	10	0	0	10	0	0	14	0	0
		22	15	0	0	17	0	0	15	0	0
		24	15	0	0	16	0	0	15	0	0
		25	15	0	0	15	0	0	15	0	0
		27	15	0	0	15	0	0	15	0	0
		29	7	46	2	15	0	0	15	0	0
	May	1	9	26	0	15	0	0	12	0	0
		2	3	9	3	15	0	0	15	0	0
		4	10	8	3	15	0	0	15	0	0
		6	25	5	6	15	0	0	15	0	0
		8	20	2	3	15	0	0	15	0	0
		13	12	0	0	12	0	0	12	0	0
1970 Totals			171	96	17	190	0	0	188	0	0
1971	April	20	10	0	0	10	0	0	4	0	0
		21	10	0	0	10	0	0	10	0	0
		23	10	0	0	10	0	0	10	0	0
		24	8	42	4	10	0	0	10	0	0
		26	5	11	0	15	0	0	10	0	0
		28	4	13	1	10	0	0	10	0	0
		30	4	31	8	15	0	0	10	0	0
	May	1	1	17	3	15	0	0	10	0	0
		3	2	84	22	15	0	0	10	0	0
		5	12	242	45	15	0	0	10	0	0
		6	1	35	6	15	0	0	10	0	0
		7	3	31	15	15	0	0	10	0	0
		8	4	27	12	15	0	0	10	0	0
		10	21	70	89	15	0	0	10	0	0
		12	7	16	72	5	0	0	10	0	0
1971 Totals			102	619	277	190	0	0	144	0	0
1972	May	3	10	0	0	10	0	0	10	0	0
		5	4	42	0	10	0	0	10	0	0
		8	4	103	3	10	18	1	10	0	0
		12	3	37	17	10	15	9	10	0	0
		16	5	8	19	10	1	7	10	0	0
		19	5	1	2	5	0	0	5	0	0
		25	10	0	0	10	0	0	10	0	0
1972 Totals			41	191	41	65	34	17	65	0	0

Appendix II: Water Temperatures (°F) During Walleye Spawning and Egg Development, 1969-1972.

Year	Date	Time	Water Temperature (°F) Reef #1 (Hwy. 17)	Inlet*	Reef #2 (Outlet)	Reef #3 (Point)
1969	4-23	10:00 am	44	--	44	44
	4-24	3:00 pm	53	43	55	53
	4-25	3:00 pm	52	--	54	53
	4-28	2:00 pm	47	--	48	47
	4-30	9:30 am	50	40	49	50
	5- 2	10:30 am	53	--	52	53
	5- 5	10:30 am	59	49	60	64
	5- 5	2:00 pm	64	--	--	--
	5- 7	10:30 am	62	51	64	66
	5- 8	11:00 am	60	50	--	--
	5-13	12:00 noon	57	--	--	--
1970	4-17	8:45 am	37	34	35	37
	4-18	11:00 am	37	34	38	38
	4-20	3:15 pm	37	35	37	37
	4-22	8:30 am	37	35	37	37
	4-24	9:30 am	41	35	42	42
	4-25	5:00 pm	48	37	48	47
	4-27	1:00 pm	60	41	53	57
	4-29	10:00 am	58	39	59	60
	5- 1	2:00 pm	58	38	58	59
	5- 2	2:30 pm	55	39	57	57
	5- 4	1:00 pm	55	40	55	54
	5- 6	9:00 am	50	38	--	--
	5- 6	11:00 am	--	--	52	--
	5- 6	1:15 pm	--	--	--	54
	5- 8	11:00 am	58	42	55	60
	5-13	2:00 pm	50	41	53	53

Year	Date	Time	Water Temperature (°F) Reef #1 (Hwy. 17)	Inlet*	Reef #2 (Outlet)	Reef #3 (Point)
1971	4-20	1:15 pm	47	47	41	43
	4-21	11:45 am	44	42	45	44
	4-23	1:15 pm	47	42	48	48
	4-24	1:30 pm	46	42	47	46
	4-26	1:30 pm	50	44	50	48
	4-28	2:00 pm	45	39	46	46
	4-30	12:05 pm	47	40	47	46
	5- 1	3:10 pm	47	40	46	46
	5- 3	10:40 pm	47	40	47	47
	5- 5	1:45 pm	50	42	52	51
	5- 6	2:10 pm	55	45	57	56
	5- 7	1:00 pm	59	45	60	61
	5- 8	1:00 pm	57	46	58	57
	5-10	8:30 am	60	--	--	--
	5-10	1:00 pm to 3:45 pm	65	47	68	69
	5-12	10:50 am	53	42	51	51
	5-13	1:30 pm	56	46	59	59
	5-14	1:45 pm	61	47	60	63
	5-15	12:40 pm	62	49	62	63
	5-15	10:00 pm	59	--	59	--
	5-16	9:45 am	60	47	58	--
	5-17	9:00 am	60	47	61	--
	5-18	9:45 am	59	48	60	--
	5-19	1:40 pm	55	46	56	--
	5-20	11:00 am	53	45	54	--
1972	5- 3	9:30 am	41	38	41	42
	5- 5	2:40 pm	52	47	50	49
	5- 8	2:30 pm	54	46	54	52
	5-12	9:15 am	59	44	58	59
	5-16	9:15 am	63	47	63	65
	5-17	11:30 am	72	--	--	--
	5-19	11:00 am	74	--	73	74
	5-25	10:00 am	77	56	73	75

* Small inlet by Reef #1.

Appendix III: Summary of Shoreline Seining

Year	Number Seine Hauls	Total Distance Seined
1969	39	3,615 feet
1970	23	2,775 feet
1971	23	1,780 feet
1972	28	5,200 feet

	Number Fish Taken			
Fish Species	1969	1970	1971	1972
Walleye	2 A	0	0	0
Yellow Perch	8,393 YY*; 769 A**	7,765 YY; 379 A	2,228 YY; 548 A	2,177 YY; 426 A
Bluegill	9.680 YY; 23 A	375 YY; 35 A	229 YY; 60 A	1,015 YY; 470 A
Pumpkinseed	61	46 YY; 81 A	19 A	3 YY; 240 A
Black Crappie	81 YY; 30 A	1,089 YY; 101 A	334 YY; 125 A	6,500 YY; 67 A
Rock Bass	19	0 YY; 12 A	4 A	12 A
White Sucker	5	0	1 A	1 A
Redhorse	2	0	0	2 A
Northern Pike	41 YY; 28 A	31 YY; 38 A	2 YY; 24 A	17 A
Darters	40	17	10	0
Largemouth Bass	16 YY	52 YY; 0 A	82 YY; 3 A	21 YY; 0 A
Shiners and Minnows***	135	785	1,800 YY 683 A	341 est.

* YY = Young-of-the-year;
** A = Adults, yearlings and older;
*** Shiners and minnows consisted of bluntnose minnows, golden shiners and other shiners.