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WALLEYE AND SAUGER SPAWNING AREAS STUDY,
POOL 7, MISSISSIPPI RIVER 1960 - 1970

DuWayne F. Gebken
Mississippi River Biologist

Kenneth J. Wright
Mississippi River Biologist

Drafting by Dennis Leveque

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ABSTRACT

On April 14, 1969, a small congregation of ripe walleye and sauger was located by electrofishing over a rock riprapped dike adjacent to Lock and Dam 6 on the Mississippi River. Egg sampling at the location of the congregation recovered walleye eggs but no sauger eggs. No spawning concentrations of walleye and sauger were located in 1970 and 1971.

Walleye in Pool 7 apparently spawn on similar substrates as those used by walleye in other waters. Spawning areas used by sauger were not located.

Length frequencies, age of maturity, and sex ratios of Pool 7 walleye and sauger have been compared to those from other pools of the Mississippi River and from waters other than the Mississippi River.

The possible correlation of walleye and sauger year class strengths with flood stages which occur during spawning is discussed. Integration of Corps of Engineers flood and erosion control measures with walleye and sauger management is evaluated.

INTRODUCTION

Attempts have been made by Wisconsin and other U.M.R.C.C. member states to determine locations and bottom types utilized by walleye and sauger as spawning grounds on the Mississippi River; however, most of these attempts have been unsuccessful. Very little is known about the spawning habits and the location of specific spawning areas for walleye and sauger in this western Wisconsin boundary water.

Since walleye and sauger are important game fish on the Upper Mississippi River, any loss of spawning habitat could have a significant impact on subsequent reproduction. Walleye and sauger are not only important predators but they are also highly sought after food fish.

During the 1967-1968 U.M.R.C.C. coordinated creel census of the Upper Mississippi River, 917 walleye and 1,193 sauger were caught by anglers in Pool 7. An estimated catch of 11,125 sauger and 9,600 walleye was projected for the entire Pool 7 area for a one year period. Listed in order of abundance, bluegill, crappies, yellow perch, sauger, and walleye were, respectively, the most abundant species in the sport catch of Pool 7 (Wright, 1970).

Description of Pool 7

Pool 7 is one of 26 navigation pools created by the construction of locks and dams on the Mississippi River in the 1930's between Hastings, Minnesota and Alton, Illinois--a distance of approximately 928 miles. Pool 7 is 12 miles long, contains 13,600 acres, and is located between Lock and Dam No. 7 at Dresbach, Minnesota and Lock and Dam No. 6 at Trempealeau, Wisconsin.

The navigation channel in Pool 7 follows the Minnesota shoreline closely in much of the pool. It is maintained at a minimum depth of 9 feet by Corps of Engineers dredging and is marked by lights and bouys. The shoreline along the channel is riprapped with rock in many places to increase bank stability. A series of islands which were created by the flooding of bottomlands when the dam was completed border the channel for much of the pool's length.

Extending outward from the shoreline toward the sailing line are many rock wing dams. Prior to construction of the large navigation dams, these wing dams were used to maintain a 6-foot channel by constricting the river's flow. Establishment of the present 9-foot channel has submerged most of these structures. They now provide a focal point for some of the better fishing on the Upper Mississippi River.

Included in Pool 7 are a number of backwater lakes which are directly connected to the navigation channel. The most important of these is Lake Onalaska which is a 7,300-acre area that was impounded when Lock and Dam No. 7 and its dike was built. Lake Onalaska is virtually flat and shallow throughout with a maximum depth of approximately 6 to 8 feet. It contains numerous stump areas and many small islands and is noted for its abundant weed growth which fills much of the lake by late summer. Lake Onalaska is the most important fishing area in Pool 7.

Extensive marsh areas interlaced by sloughs and side channels are present above Lake Onalaska. Much of this portion of the pool is not easily accessible except to local fishermen who are familiar with channel locations.

A series of five natural backwater lakes known collectively as the Trempealeau Lakes lie at the upper end of Pool 7. They are all interconnected and exhibit typical backwater lake characteristics such as scant current and an abundance of aquatic vegetation.

The upper boundary of the pool is Lock and Dam No. 6 which is located at Trempealeau, Wisconsin. The rapid passage of water through the gates of the dam influences the navigation channel for a distance of approximately one-half mile downstream depending upon the volume of water passed. This area is classified as tailwater, and at most dams it is known to provide excellent angling for the larger game fish species. Just below Lock and Dam No. 6 is a permanently moored fishing barge.

The most important tributary entering Pool 7 is the Black River of Wisconsin. This stream enters the Mississippi River in Lake Onalaska where its old channel has been submerged since the 1930's. Other tributaries with lower flows are Halfway Creek, Tank Creek, and Shingle Creek in Wisconsin, and Dakota Creek in Minnesota.

Towns found along Pool 7 are Trempealeau and Onalaska in Wisconsin and Dresbach and Dakota in Minnesota. La Crosse, Wisconsin is the largest city in the area with a population of over 50,000 and is located just below Pool 7.

MATERIAL AND METHODS

Efforts at locating walleye and sauger spawning areas were limited to the upper end of Pool 7 in 1969, 1970 and 1971. Electrofishing to locate walleye and sauger concentrations was initiated on April 11, 1969 and continued to April 14, 1969 on six stations shown on Figure 1. Sampling operations were carried out on two nights during this period. Electrofishing operations in 1970 and 1971 failed to locate any spawning concentrations of walleye and sauger.

The electrofishing gear used during the study was a boom type shocker powered by a 230 volt A.C., three phase, 180 cycle, 3000 watt, Homelite Model FS180 generator. Current from the generator was monitored by a control unit, Model 180-2EES, which was handcrafted for Wisconsin by the Michigan Department of Natural Resources. The control unit had an output of 0-265 volts A.C. and 0-7.5 amps. During electrofishing operations, the ouput was held close to 4 amps but varied from 3-5 amps depending on the conductivity. A three man crew, one boat operator and two dipnetters were used. Captured fish were placed in a 96 gallon holding tank.

Total lengths were measured to the nearest 0.1 inch, and weights were recorded to the nearest 0.01 pound. Criterion for sexual maturity was determined by the extrusion of milt or eggs upon putting pressure on the abdominal area.

When the concentration of walleye and sauger was found during electrofishing operations on April 14, 1969, an egg pump patterned after the design described by Gennings (1967) was used to recover eggs. Egg sampling stations are shown in Figure 1. Figures 2 and 3 show the egg pump in use. Mr. John Spinner of the Iowa Conservation Commission identified the eggs which were collected.

Additional data on lengths, weights, age, and sexual maturity of walleye and sauger were gathered at four permanent sampling stations in 1969, 1970, and 1971 and from the special spring sport fishery creel census in 1969 and 1970. The location of the four permanent sampling stations is shown in Figure 4. Sampling was initiated on April 3 and continued to May 29 in 1969, from April 1 to May 4 in 1970, and from April 14 to May 27 in 1971. The creel census started on March 1 and continued to April 30 in 1969 and 1970. A creel census clerk was stationed at the Trempealeau landing below Lock and Dam 6 in both years.

Scale samples were collected at the tip of the depressed pectoral fin and below the lateral line. Scales were aged by Mr. Gordon Slifer by magnifying them with a binocular microscope. No aging data are available for walleye and sauger captured in 1971 since scale samples were not collected due to a lack of personnel.

RESULTS

Spawning Characteristics

Table 1 shows the results of night time electrofishing surveys at six stations in Pool 7 from 3:50 to 5:30 P.M. on April 11, 1969. Although ripe walleye and sauger were captured, most were males. Figure 5 shows the river gauge readings which were above 10.0 feet at La Crosse during April and May of 1969. On April 11, 1969, the river stage was 11.7 feet, 0.3 foot below flood stage. The water temperature was 44°F., the air temperature was 50°F., the conductance was 210 mmhos, the pH was 7.9, and the secchi disk depth was 13 inches.

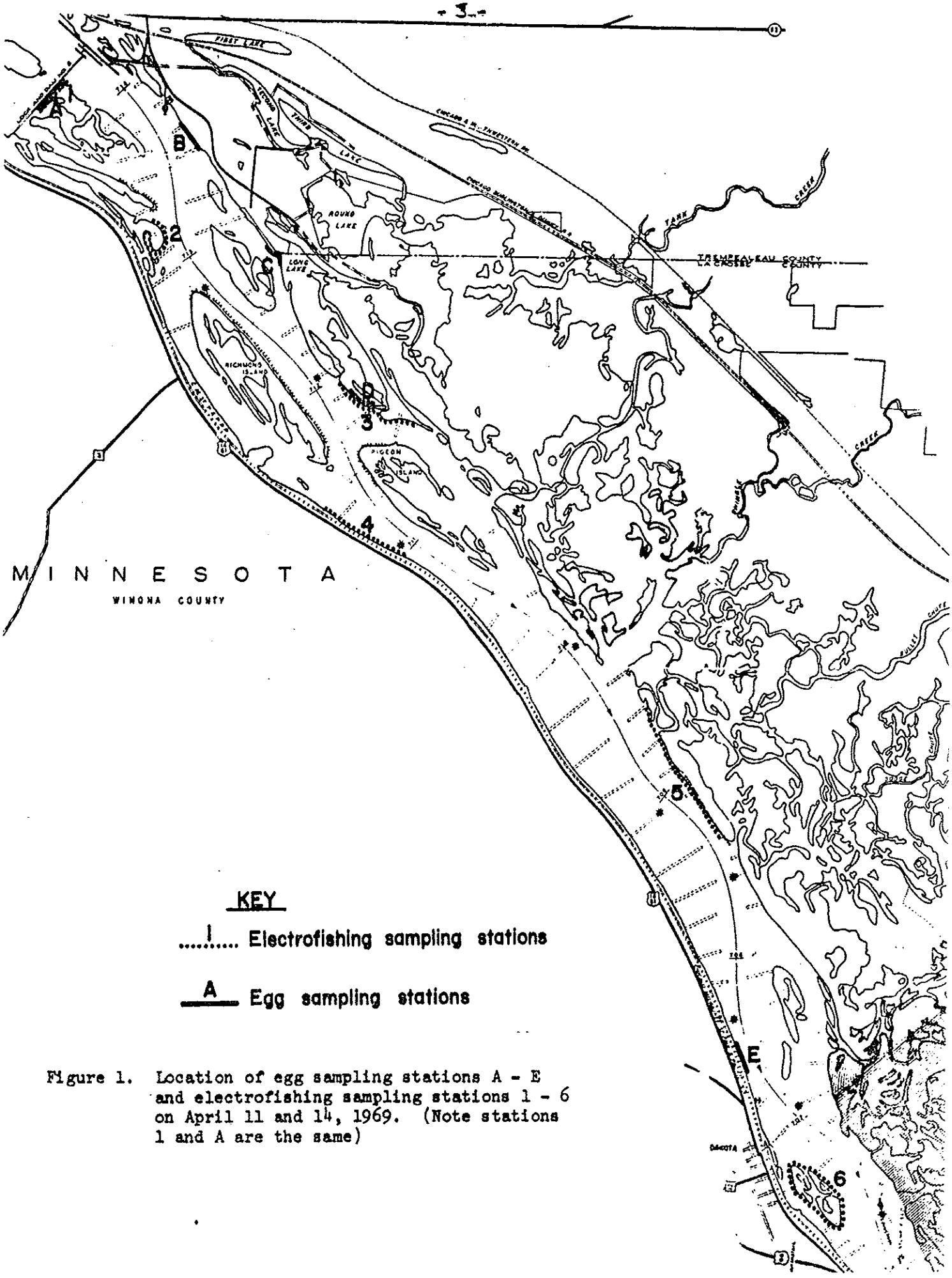


Figure 1. Location of egg sampling stations A - E and electrofishing sampling stations 1 - 6 on April 11 and 14, 1969. (Note stations 1 and A are the same)

Figure 2. Egg pump in use on April 15, 1969 at station 1 (Figure 1).

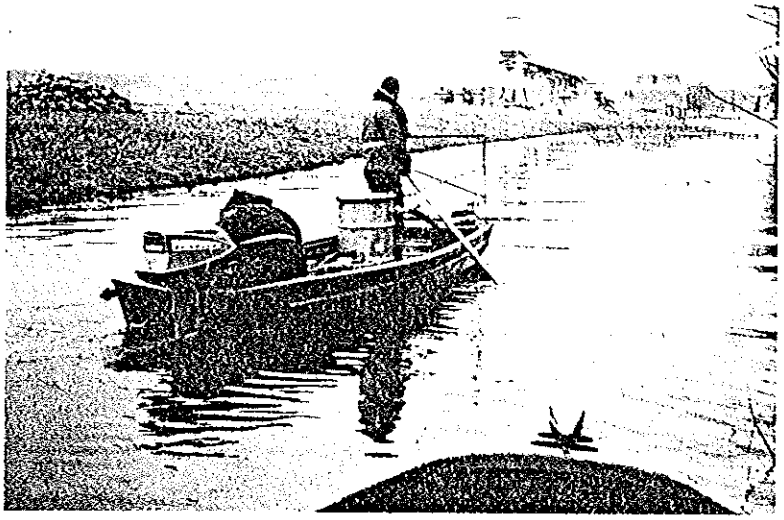


Figure 3. Egg pump in use on April 15, 1969 at station 1 (Figure 1). Lock and Dam 6 can be seen in the upper right-hand corner.

Table 1. Sex, spawning condition, and mean length of walleye and sauger captured on April 11, 1969 at stations 1 - 6 (Figure 1).

Station Number	Total Number		Male								Female							
			Ripe Walleye				Ripe Sauger				Ripe Walleye				Ripe Sauger			
	Walleye	Sauger	No.	%	Length (in.)		No.	%	Length (in.)		No.	%	Length (in.)		No.	%	Length (in.)	
					Mean	Range			Mean	Range			Mean	Range			Mean	Range
1	7	5	6	86	16.5	13.3-23.6	3	60	10.4	10.2-10.7	0				0			
2	1	0	0				0				0				0			
3	7	6	1	14	16.7	-	0				2	28	24.6	23.2-25.9	0			
4	0	0																
5	2	0	1	50	15.0	-	0				1	50	23.4	-	0			
6	0	0																

Table 2. Sex, spawning condition, and mean length of walleye and sauger captured on April 14, 1969 at the two stations of the previous six with the most fish.

Station Number	Total Number		Male								Female							
			Ripe Walleye				Ripe Sauger				Ripe Walleye				Ripe Sauger			
	Walleye	Sauger	No.	%	Length (in.)		No.	%	Length (in.)		No.	%	Length (in.)		No.	%	Length (in.)	
					Mean	Range			Mean	Range			Mean	Range			Mean	Range
1	37	10	21	57	14.9	10.9 - 20.8	4	40	10.7	10.0-11.3	3	8	21.4	18.4-26.0	1	10	19.5	-
3	14	2	8	57	15.6	13.8-17.5	0				1	7	26.5	-	0			

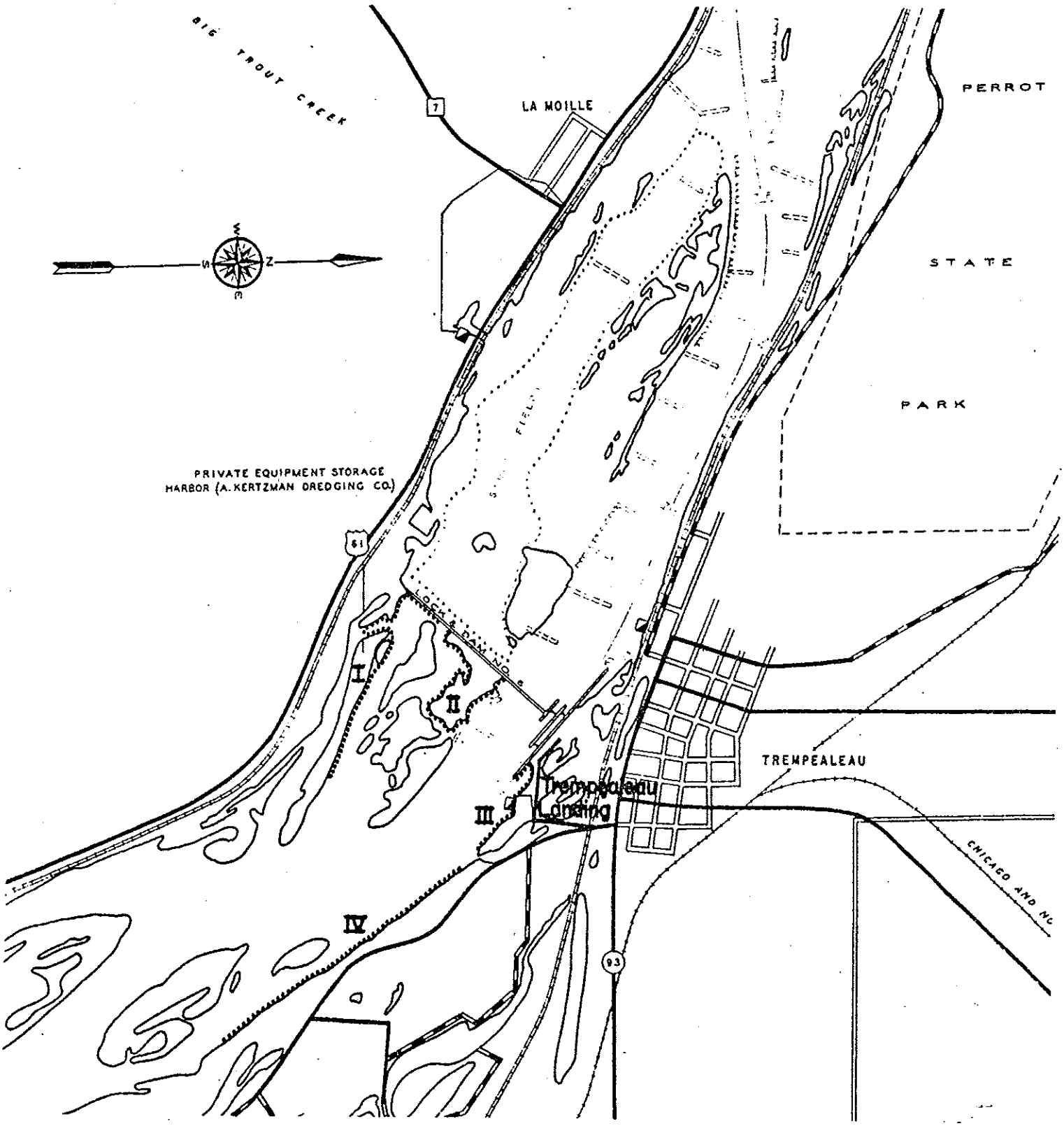


Figure 4. Location of permanent sampling stations I - IV in 1969-1971.

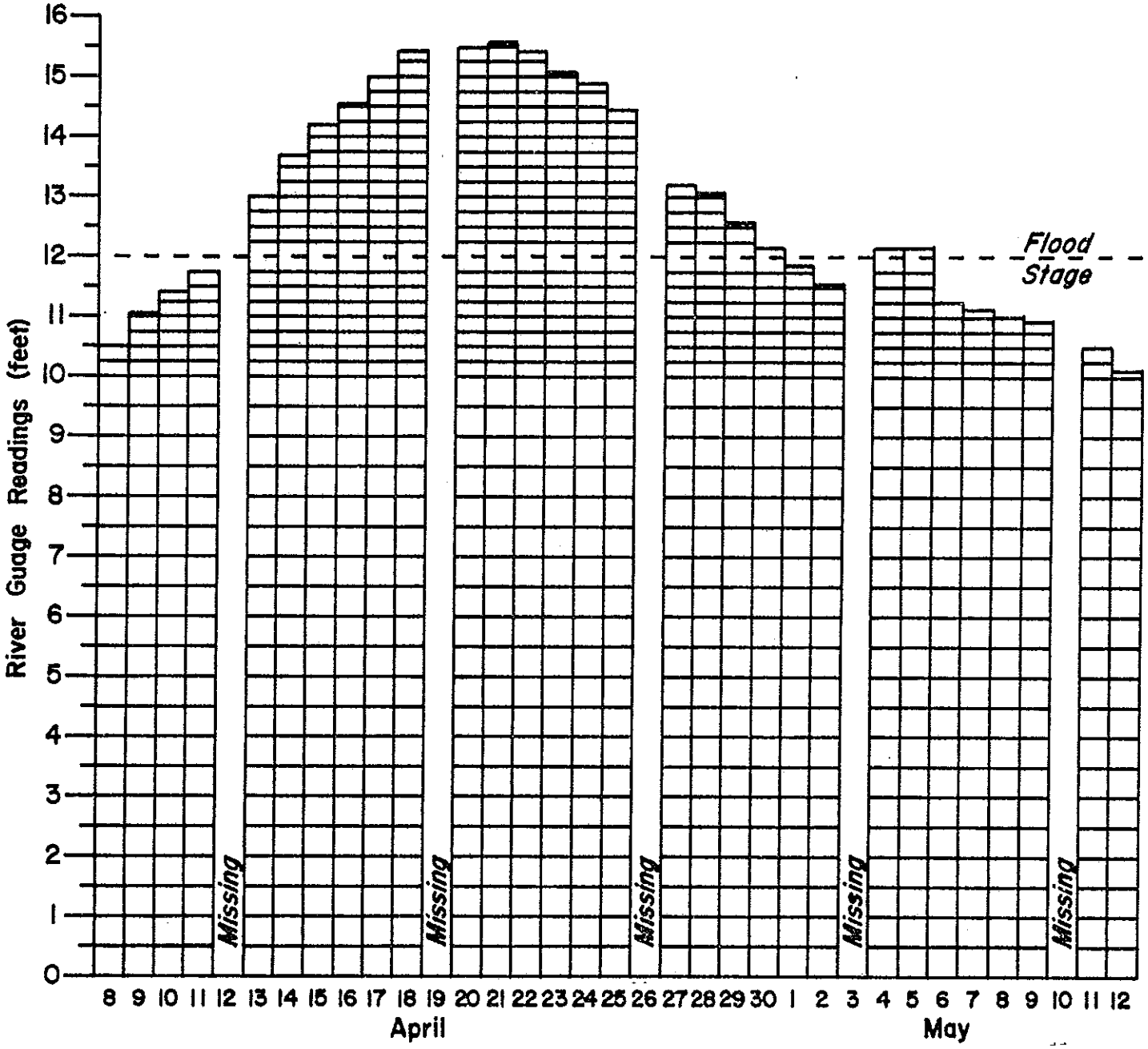


Figure 5. River gauge readings above 10.0 feet at LaCrosse during April and May of 1969.

Table 2 shows the results of nighttime electrofishing surveys conducted from 9:50 to 11:00 P.M. on April 14, 1969 at the two stations of the previous six which had the most walleye and sauger. In one five-minute electrofishing transect parallel to the downstream side of the dike at station 1 (Figure 1), 37 walleye and 10 sauger were captured. Approximately 65 percent of the walleye and 50 percent of the sauger were ripe. The river stage was 14.7 feet, 2.7 feet above flood stage. The concentration of walleye and sauger was located in 2.5 to 6.5 feet of water along a rock riprapped dike parallel to Lock and Dam 6. The water temperature was 47°F., the air temperature was 49°F., the conductance was 175 mmhos, the pH was 7.4, and the secchi disk depth was 20 inches.

Figure 6 shows station 1 (Figure 1) when the dike is flooded. Figure 7 shows the spawning area during normal water conditions. Figure 8 shows the size of the spawning substrate (12 to 15 inches). Debris piled in the forefront of Figure 8 indicates the extent of flooding in April, 1969.

After the walleye and sauger spawning concentration was found on April 14, 1969, an egg pump was used to locate eggs at stations A-E (Figure 1). The river stage was 14.2 feet on April 15, 1969 when two northern pike eggs and one walleye egg was found at station A. The water temperature was 46°F. Eggs were not found at the other four stations.

On April 17, 1969, the egg pump was used again at station A (Figure 1). The water temperature was 47°F., and the river stage was 15.0 feet. One northern pike egg and 24 walleye eggs were found.

On April 24, 1969, the egg pump was used on station A (Figure 1) when one walleye egg was recovered. The flood stage was 14.8 feet, and the water temperature was 55°F.

Electrofishing operations in March and April of 1970 and 1971 failed to locate any spawning concentrations of walleye and sauger at the sampling stations shown in Figures 1 and 4. In 1970, the maximum flood stage at La Crosse was 8.4 feet on May 4 and 5. In 1971, the maximum flood stage at La Crosse was 12.6 feet and occurred on April 19. Flood stages of 12.0 feet or more lasted from April 15-20 in 1971 at La Crosse.

A flood stage of at least 14.0 feet is required to cover the spawning area in Figures 6, 7, and 8 with 2 feet of water. A flood stage of 12.0 feet barely comes to the edge of the spawning substrate.

Table 3 shows the species and numbers of fish captured at stations 1-6 (Figure 1) during the period of April 11-14, 1969. Walleye were the most abundant and sauger were the next most abundant species. Walleye made up 34.4 percent and sauger made up 11.6 percent of the total catch.

Age and Size at Maturity

Figures 9 and 10 show the length frequencies of mature male and female walleye and sauger captured at stations 1-6 (Figure 1) during the period of April 11-14, 1969. Thirty-seven mature male walleye had an average total length of 15.4 inches, and 7 mature female walleye had an average total length of 23.3 inches. Seven mature male sauger had an average total length of 10.6 inches. Only one female sauger with a total length of 19.5 inches was captured.

Combined length frequencies irrespective of sexual maturity for all walleye and sauger captured at stations 1-6 (Figure 1) during the period of April 11-14, 1969 are shown in Figure 11. A total of 44 walleye had an average total length of 16.7 inches, and 8 sauger had an average total length of 11.7 inches.

Tables 4 and 5 have been compiled from combined data collected at stations 1-6 (Figure 1) during April 11-14, 1969, at permanent sampling stations I-IV (Figure 4) in 1969 and 1970, and during creel census operations at the Trempealeau Landing in 1969 and 1970.

Comparisons of ages of sexual maturity between male and female walleye indicate that males mature at an average weighted age of 4.6 years old and that females mature at an average weighted age of 7.8 years old. Male walleye apparently mature as early as age II, and female walleye may mature as early as age III. Twenty-four mature male walleye average 16.8 inches in total length and 2.07 pounds, and 18 mature female walleye averaged 23.1 inches in total length and 5.50 pounds. The mean length and weight of mature female walleye is about double that of mature male walleye (Table 4).

Data on the age of attainment of sexual maturity for sauger is scanty. Only one four year old mature male sauger was aged (Table 5). It was 13.7 inches in total length and weighed 0.70 pounds. Four mature female sauger were aged. Their average weighted age was five years old. The four female sauger averaged 15.0 inches in total length and 1.40 pounds. Female sauger apparently mature as early as three years old.

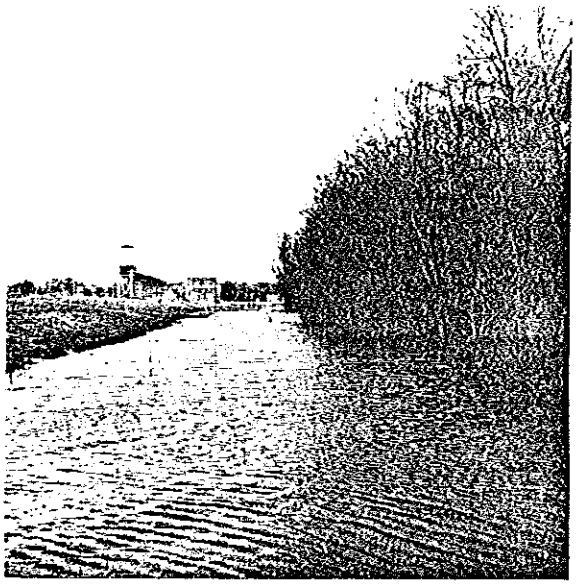


Figure 6. Appearance of station 1 (Figure 1) when the spawning area is flooded in April, 1969.

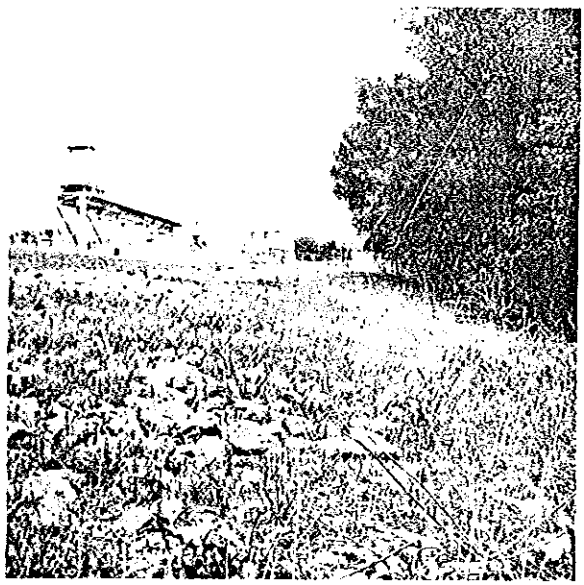


Figure 7. Appearance of the spawning area at station 1 (Figure 1) during normal water conditions.

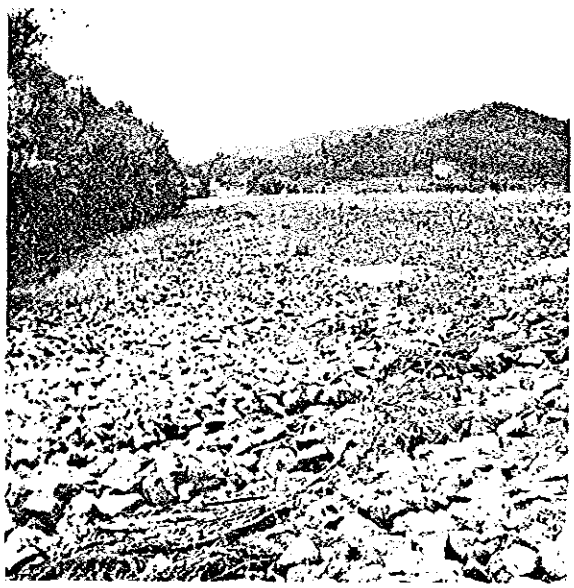


Figure 8. The size of the spawning substrate at station 1 (Figure 1) is about 12 - 15 inches. Debris piled in the forefront of the picture indicates the extent of flooding in April, 1969.

Table 3. Species and numbers of fish captured at stations 1 - 6 (Figure 1) during April 11 - 14, 1969.

Game Fish Species	Number	Nongame Fish Species	Number
Walleye	68	Carp	20
Sauger	23	Freshwater Drum	11
Largemouth Bass	2	Quillback Carpsucker	4
Black Crappie	8	Gizzard Shad	1
White Crappie	10	Mooneye	6
Bluegill	6	Golden Redhorse	8
White Bass	1	Northern Redhorse	3
Channel Catfish	1	Spotted Sucker	20
Black Bullhead	1	Longnose Gar	3
		Shortnose Gar	1
Total	120		77

Figure 9. Length frequencies of mature male and female walleye captured at stations 1 - 6 (Figure 1) during the period of April 11 - 14, 1969.

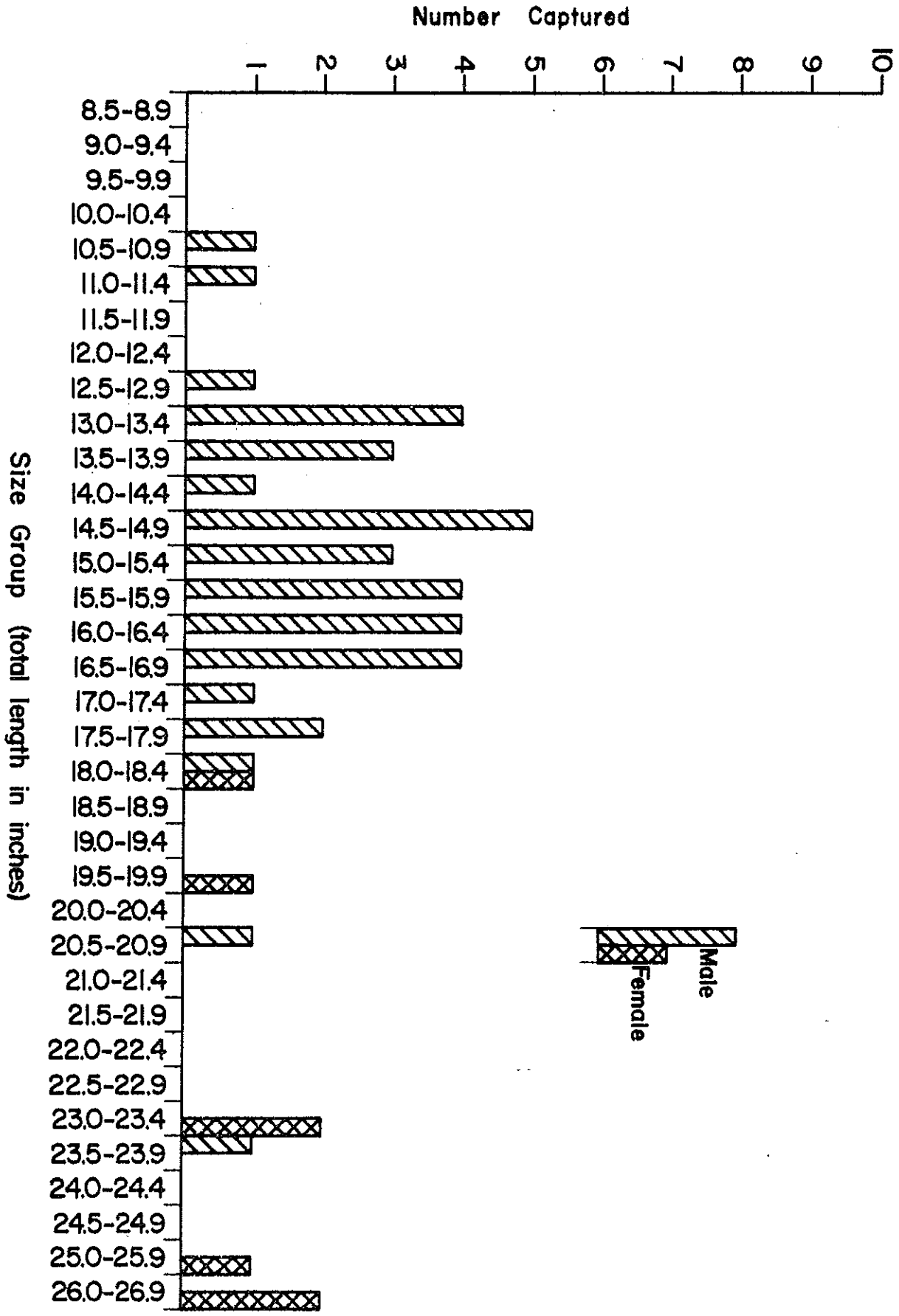


Figure 10. Length frequencies of mature male and female sauger captured at stations 1 - 6 (Figure 1) during the period of April 11 - 14, 1969.

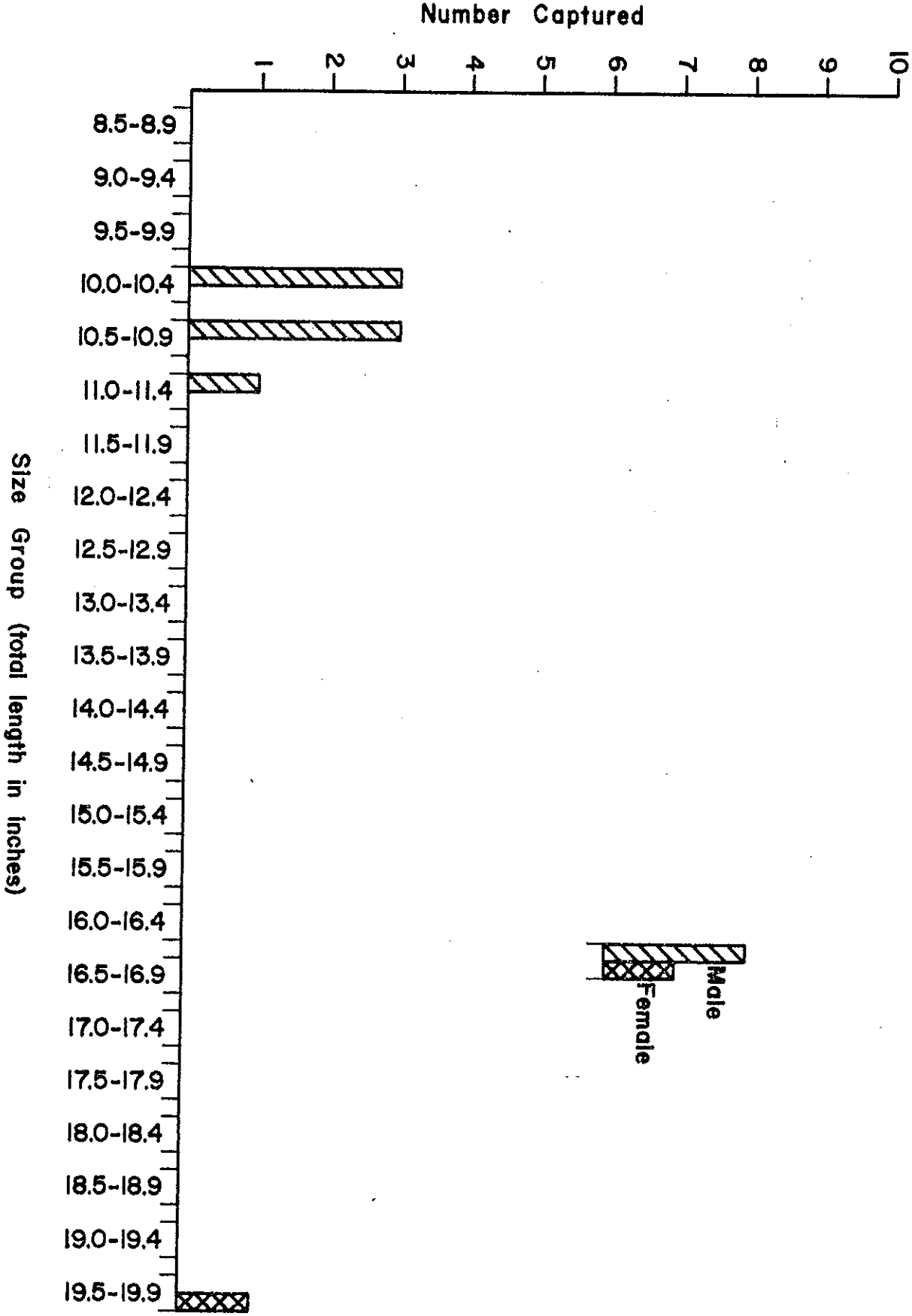


Figure 11. Combined length frequencies irrespective of sexual maturity for all walleye and sauger captured at stations 1 - 6 (Figure 1) during the period of April 11 - 14, 1969.

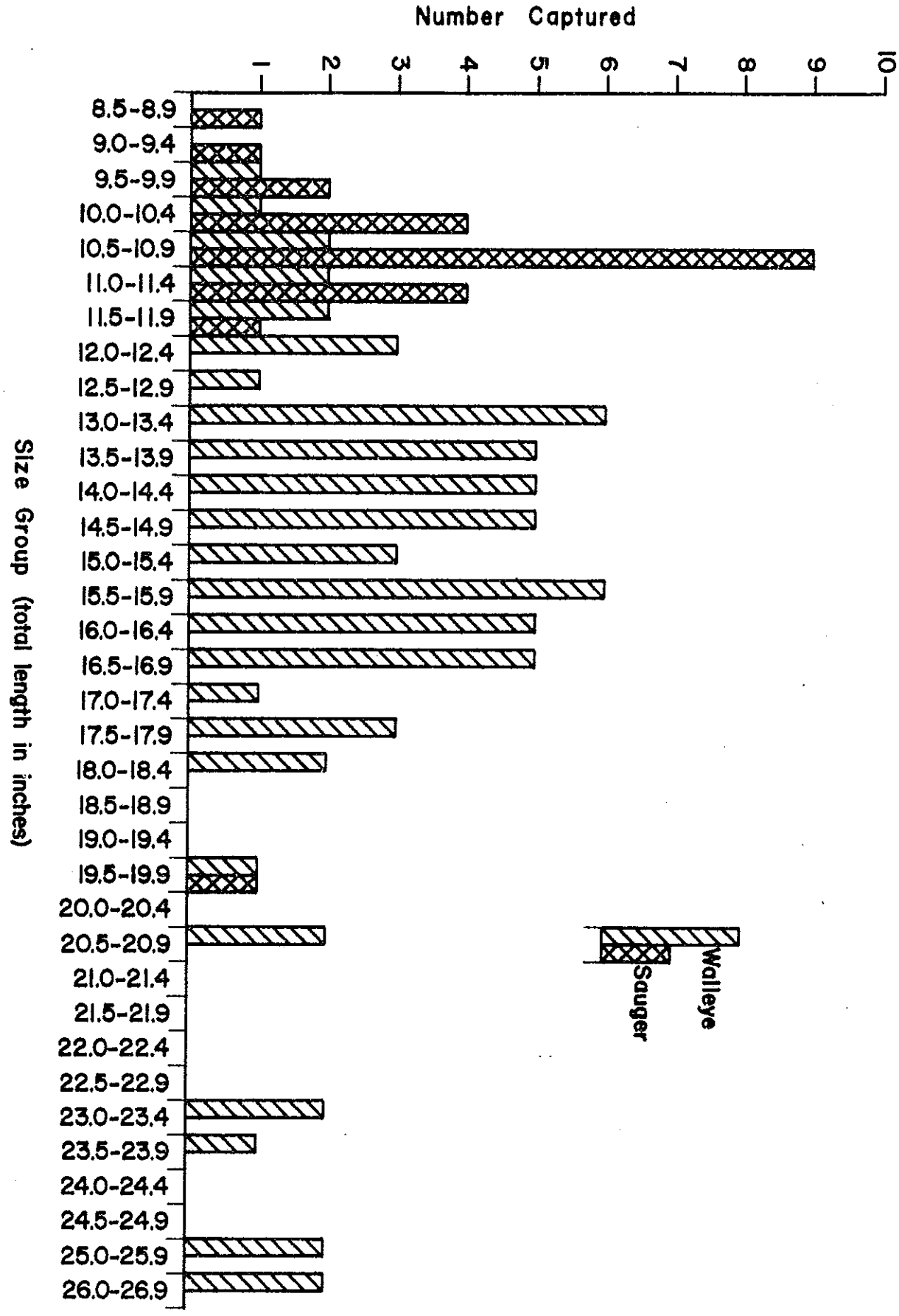


Table 4. Mean length and weight of mature male and female walleye captured in 1969 and 1970.*

Age	Male					Female				
	No.	Length (in.)		Weight (lbs)		No.	Length (in.)		Weight (lbs)	
		Mean	Range	Mean	Range		Mean	Range	Mean	Range
II	2	12.2	11.4-12.9	0.60	0.50-0.71	0				
III	7	14.0	10.9-16.2	1.00	0.50-1.40	1	16.5	-	1.62	-
IV	5	17.2	16.5-18.2	2.00	1.60-2.40	0				
V	2	16.6	15.8-17.5	1.65	1.40-1.90	1	18.4	-	2.50	-
VI	6	18.6	15.7-20.8	2.79	1.50-4.75	3	19.3	18.9-19.7	3.14	2.51-3.70
VII	0					0				
VIII	0					3	24.6	23.6-25.4	6.62	5.50-7.75
IX	1	24.0	-	5.00	-	5	24.4	23.2-27.9	6.49	5.00-9.00
X	1	23.5	-	6.50	-	4	24.6	22.7-26.0	6.42	6.00-7.00
XI	0					1	25.9	-	8.00	-
Total Mean	24	16.8		2.07		18	23.1		5.50	

Table 5. Mean length and weight of mature male and female sauger captured in 1969 and 1970.*

Age	Male					Female				
	No.	Length (in.)		Weight (lbs)		No.	Length (in.)		Weight (lbs)	
		Mean	Range	Mean	Range		Mean	Range	Mean	Range
III	0					2	13.4	12.9-13.8	0.69	0.66-0.72
IV	1	13.7	-	0.70	-	1	14.5	-	1.02	-
V	0					1	19.5	-	3.2	-
Total Mean	1	13.7		0.70		4	15.0		1.40	

*Combined data collected at stations 1 - 6 (Figure 1) during April 11 and 14, 1969, at permanent sampling stations I - IV (Figure 4) in 1969 and 1970, and during creel census operations at the Trempealeau Landing in 1969 and 1970.

Fewer walleye and sauger were aged than actually were measured and weighed in 1969 and 1970 since scale samples were not taken from all of the mature fish that were collected.

Tables 6, 7, 8, and 9 show the correlation between age, mean length, size range, mean weight, and weight range irrespective of sexual maturity for walleye and sauger collected at stations 1-6 (Figure 1) during April 11-14, 1969, at permanent sampling stations I-IV (Figure 4) in 1969 and 1970, and during creel census operations at the Trempealeau Landing in 1969 and 1970. The number of walleye and sauger weighed in Tables 7 and 9 does not correspond with the number aged and measured in Tables 6 and 8 since not all walleye and sauger aged and measured were weighed.

A total of 187 walleye were aged and measured (Table 6). The mean total length was 15.4 inches. Walleye sizes ranged from 5.4 to 28.0 inches in total length. One 12 year old walleye was captured.

The mean weight of 174 walleye was 2.17 pounds (Table 7). Weights ranged from 0.06 to 11.54 pounds.

A total of 111 sauger were aged and measured (Table 8). The mean total length was 11.5 inches. Sauger sizes ranged from 4.5 to 21.4 inches in total length. One seven year old sauger was captured.

The mean weight of 103 sauger was 0.70 pounds. Weights ranged from 0.06 to 4.30 pounds (Table 9).

Possible Correlation of Yearling Walleye and Sauger Year Class Strengths With River Stages Occurring During the Spawning Period

Figures 12 and 13 were compiled from data collected on walleye and sauger at permanent sampling stations I-IV (Figure 4) during March and April of 1969, 1970, and 1971. Stations were sampled several times each month. These data are assumed to be comparable from year to year since individual station lengths were maintained at a standard distance during each of the years. Walleye and sauger over one year old were not analyzed due to the wide overlap of size ranges for these age classes.

In Figure 12, the numbers of yearling walleye captured and the percentages of yearling walleye comprising the total walleye sample of each yearly survey in 1969, 1970, and 1971 have been plotted for the various yearling size groups. In order of numbers of walleye captured, the 1970 year class was highest followed by the 1969 and 1968 year classes respectively.

The 1968 year class of walleye was hardly detectable. Converting the numbers of yearling walleye captured to percentages of the total annual walleye catch reveals that the 1969 year class made up 61.8 percent of the 1970 catch, the 1970 year class made up 55.0 percent of the 1971 catch, and the 1968 year class made up 12.2 percent of the 1969 catch. The largest size group of 7.0-7.4 inches in the 1969 year class made up 17.5 percent, the largest size group of 7.0-7.4 inches in the 1970 year class made up 15.4 percent, and the largest size group of 9.5-9.9 inches in the 1968 year class made up 2.9 percent of the total walleye catches for 1970, 1971, and 1969 respectively.

In Figure 13, the numbers of yearling sauger captured and the percentages of yearling sauger making up the total sauger sample of each annual survey have also been plotted for various size groups. Like walleye numbers, the 1970 year class catch was highest followed by the 1969 and 1968 year classes respectively. The 1968 year class of sauger was minimal. In converting the numbers of yearling sauger captured to percentages of the total sauger catch for a survey year, sauger made up a smaller percentage of the total catch than walleye. The 1970 year class made up 26.5 percent, the 1969 year class made up 20.7 percent, and the 1968 year class made up 2.3 percent of the total 1971, 1970, and 1969 sauger catches respectively. The largest size group of 6.0-6.4 inches in the 1969 year class made up 9.0 percent of the total 1970 sauger catch, the largest size group of 7.0-7.4 inches in the 1970 year class made up 7.9 percent of the total 1971 sauger catch, and the largest size group of 6.5-6.9 inches in the 1968 year class made up 1.0 percent of the total 1969 sauger catch. Contributions by individual yearling sauger size groups was considerably less than for individual size groups of yearling walleye.

DISCUSSION

Attempts at locating walleye and sauger spawning areas were initiated by Hubley in 1960. Twenty-three nighttime traverses of 25 minutes each were conducted along riprap areas and sand bottoms of Pools 6, 7, and 8. On April 13, 1960, a small concentration of adult walleye was captured in three feet of water over a sand bottom in flooded willows about 300 yards below Lock and Dam 7. Twelve ripe males (14 to 17 inches total length) and 14 unripe females (17 to 26 inches total length) were captured.

Table 6. Age, mean length, and size range irrespective of sexual maturity for walleye captured in 1969 and 1970.*

Age	Number Aged	Mean Total Length (inches)	Size Range (inches)
I	44	7.7	5.4 - 10.8
II	23	11.4	9.5 - 13.2
III	30	14.0	10.9 - 16.5
IV	15	16.8	14.5 - 20.2
V	15	18.6	15.8 - 21.0
VI	17	18.9	16.3 - 20.8
VII	11	20.7	18.2 - 23.1
VIII	13	23.8	21.5 - 26.3
IX	8	23.9	22.0 - 27.9
X	6	24.8	22.7 - 26.0
XI	4	26.1	25.2 - 28.0
XII	1	26.5	26.5
Total	187		
Mean		15.4	

* Combined data collected at stations 1 - 6 (Figure 1) during April 11 and 14, 1969, at permanent sampling stations I - IV (Figure 4) in 1969 and 1970, and during creel census operations at the Trempealeau Landing in 1969 and 1970.

Table 7. Age, mean weight, and weight range irrespective of sexual maturity for walleye captured in 1969 and 1970.*

Age	Number Weighed	Mean Weight (lbs.)	Weight Range (lbs.)
I	38	0.19	0.06 - 0.50
II	21	0.53	0.30 - 0.80
III	30	0.95	0.46 - 1.62
IV	15	1.86	1.00 - 3.20
V	15	2.55	1.40 - 3.97
VI	16	2.75	1.50 - 4.75
VII	9	3.33	2.21 - 5.00
VIII	12	5.84	4.12 - 8.00
IX	8	5.95	4.56 - 9.00
X	5	6.56	6.00 - 7.03
XI	4	8.39	6.70 - 11.54
XII	1	7.00	7.00
Total	174		
Mean		2.17	

* Combined data collected at stations 1 - 6 (Figure 1) during April 11 and 14, 1969, at permanent sampling stations I - IV (Figure 4) in 1969 and 1970, and during creel census operations at the Trempealeau Landing in 1969 and 1970.

Table 8. Age, mean length, and size range irrespective of sexual maturity for sauger captured in 1969 and 1970.*

Age	Number Aged	Mean Total Length (inches)	Size Range (inches)
I	20	6.1	4.5 - 7.9
II	28	9.6	8.0 - 12.0
III	34	12.4	10.0 - 15.5
IV	21	15.0	13.7 - 17.3
V	3	18.6	18.0 - 19.5
VI	4	19.0	17.8 - 19.9
VII	1	21.4	21.4
Total	111		
Mean		11.5	

* Combined data collected at stations 1 - 6 (Figure 1) during April 11 and 14, 1969, at permanent test sampling stations I - IV (Figure 4) in 1969 and 1970, and during creel census operations at the Trempealeau Landing in 1969 and 1970.

Table 9. Age, mean weight, and weight range irrespective of sexual maturity for sauger captured in 1969 and 1970.*

Age	Number Weighed	Mean Weight (lbs.)	Weight Range (lbs.)
I	15	0.08	0.06 - 0.12
II	27	0.24	0.12 - 0.51
III	33	0.59	0.20 - 1.33
IV	21	1.14	0.70 - 2.43
V	3	2.55	1.88 - 3.20
VI	3	2.44	2.05 - 2.68
VII	1	4.30	4.30
Total	103		
Mean		0.70	

* Combined data collected at stations 1 - 6 (Figure 1) during April 11 and 14, 1969, at permanent sampling stations I - IV (Figure 4) in 1969 and 1970, and during creel census operations at the Trempealeau Landing in 1969 and 1970.

Figure 12. Numbers and percentages of total annual catch of yearling walleye taken at permanent sampling stations I - IV (Figure 4) during March and April of 1969, 1970 and 1971.

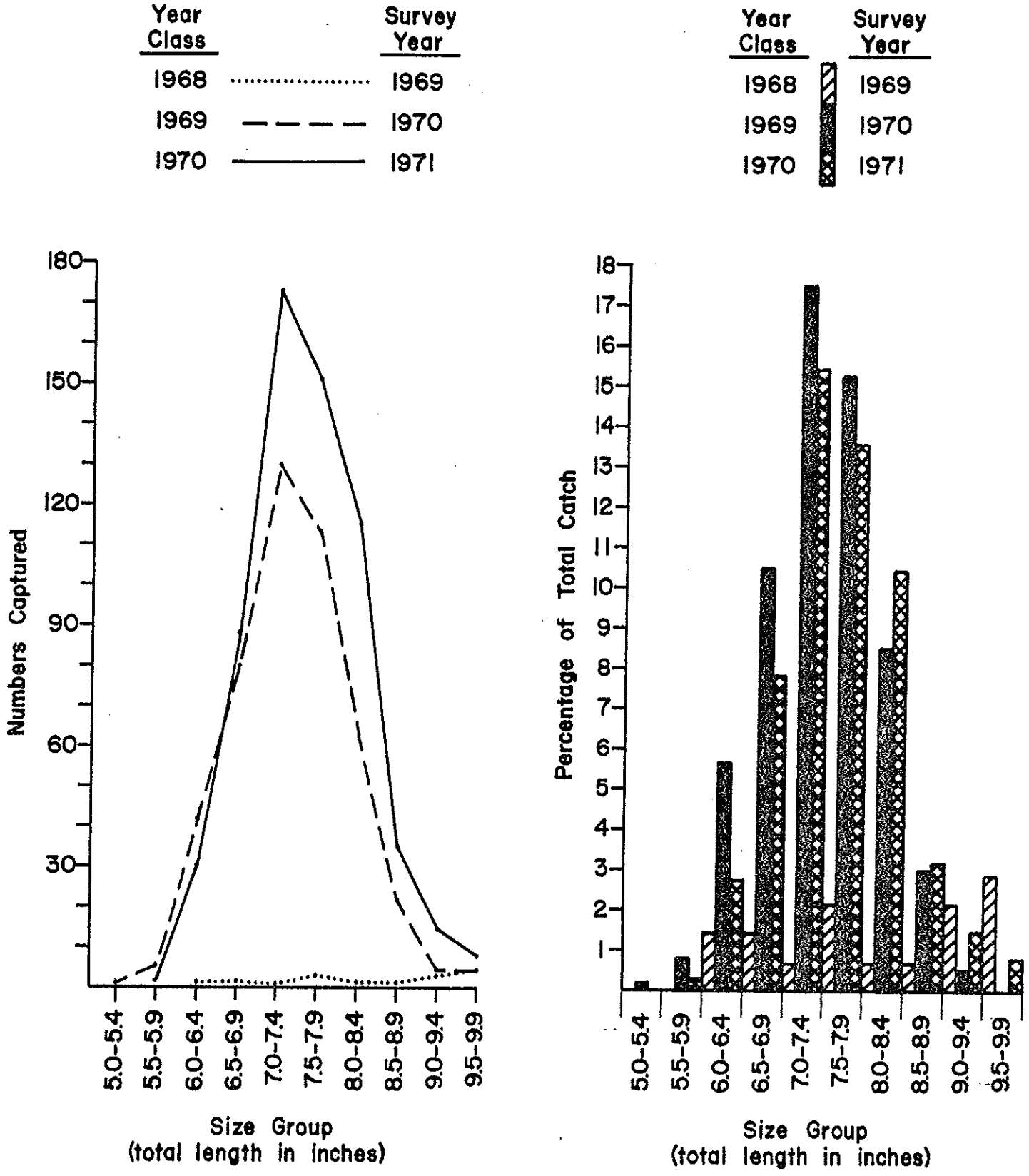
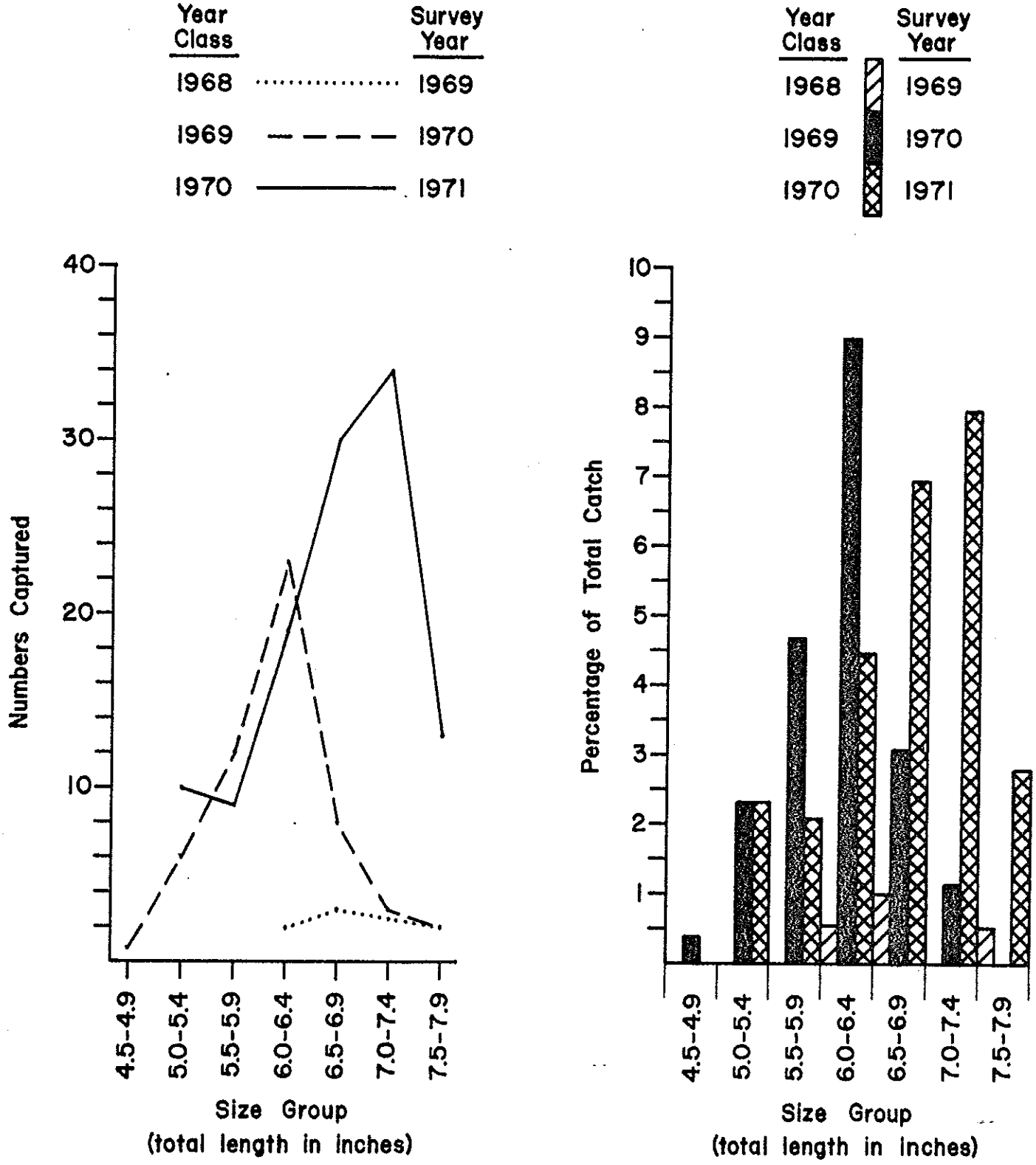


Figure 13. Numbers and percentages of total annual catch of yearling sauger taken at permanent sampling stations I - IV (Figure 4) during March and April of 1969, 1970 and 1971.



In 1961, Hubley concentrated efforts at locating spawning walleye in the marshes of Pool 7. Trap nets were set in the mouths of chutes and sloughs leading into the marshes, and electrofishing traverses were conducted on the marshes at night. No spawning walleye were located.

Finke in 1965 set buffalo nets in the chutes off the main river channel. A record flood with a flood stage of 17.9 feet at La Crosse caused suspension of operations.

In 1967, Trimberger concentrated efforts at locating walleye and sauger spawning areas in the upper half of Pool 7. Electrofishing gear and trap nets were used to capture walleye and sauger. Fluorescent styrofoam balls were attached by a line to the dorsal spines of 20 mature walleye and 2 sauger in order to follow their direction of movement. Eight of the balls were recovered from one to three days later without the fish and near the initial release area. Electrofishing near the area where the balls were recovered failed to locate additional fish, and egg pumping recovered only northern pike, sucker, and yellow perch eggs.

Efforts at locating walleye and sauger spawning sites in 1969 were aimed at the upper end of Pool 7 due to the poor success of operations in other parts of the pool. Observations of gravid walleye and sauger being taken by anglers in the tailwaters of Pool 7 during March and April substantiated this approach.

The rock riprapped dike used as a spawning area in April of 1969 is available only during periods of extreme flooding. A flood stage of at least 14.0 feet is needed to partially cover the area. In the ten year period previous to 1971, the only flood comparable to the 1969 flood occurred in 1965; so, this spawning area was potentially available only once every five years.

Most of the ripe walleye located at the spawning site in Pool 7 were males. According to Niemuth, et al (1959) and Eschmeyer (1950) males arrive at the spawning area earlier and remain longer after spawning than females. Ripe males outnumbered ripe female walleye by a factor of 7:1 in 1969 at the spawning area in Pool 7. Trap netting data from Lake Gogebic indicate that a maximum ratio of males to females reaches 3.9:1.0 on the spawning ground, and then the numbers of females taper off sharply (Eschmeyer, 1950). Vasey (1967) found a mean ratio of 1.4 ripe females to 1.0 ripe male during the first two weeks of April in 1957, 1958, 1959, 1961, and 1962 in Pool 11 of the Mississippi River.

The 1969 spawning concentration of walleye in Pool 7 was located in 2.5 to 6.5 feet of water. The temperature of the water at the surface was 47°F. Spawning in Wisconsin reaches a peak from mid-April to May first when water temperatures are 48° to 50°F. Eggs are generally deposited in water less than two feet deep and no more than four feet deep (Niemuth, et al, 1959).

Apparently the concentration of walleye located on April 14, 1969 in Pool 7 was just beginning to form due to the higher proportion of ripe males to females and the depth at which the fish were located. Limited spawning may have occurred on April 14, 1969 since one walleye egg was found at the spawning area on April 15, 1969.

The maximum numbers of walleye eggs, 24, were recovered on April 17, 1969. One walleye egg was collected on April 24, 1969. Apparently, maximum spawning activity at station 1 (Figure 1) occurred sometime between April 14-17 in 1969. It is possible that electrofishing operations disrupted spawning activities and delayed spawning for a period of time.

In April, 1969, recovery of eggs was hampered by the swift currents adjacent to the dike at station 1 (Figure 1). The swift currents would rapidly carry the eggs downstream. As the time after water hardening increases, the adhesive qualities of walleye eggs are lost. Eschmeyer (1950) found adhesive walleye eggs infrequently in Lake Gogebic. It is likely that the vast majority of eggs deposited on the spawning area in Pool 7 were carried farther downstream. Also, it is doubtful that the egg pump could recover eggs which fell into the crevices between rocks. Deposition of eggs in shallow areas and abrasion may have had an impact on subsequent hatching success. Egg predation by fish other than walleye may also be considerable. No loss of eggs by predation was observed by Eschmeyer (1950) at Lake Gogebic due to the few fish associated with walleye on the spawning grounds. Unlike Lake Gogebic, there were several other fish species associated with the spawning walleye in Pool 7 in April, 1969.

Niemuth, et al (1959) states that broken rock or gravel is the preferred walleye spawning substrate; however, spawning may occur on sand. In Lake Gogebic spawning took place on a mixture of gravel, rubble, and boulders with a substratum of sand and fine gravel (Eschmeyer, 1950). Priegel (1972) found that Lake Winnebago walleye spawn in marshes adjacent to the Wolf River. All of these marshes have an inlet and outlet which provides a continous flow of water over the marsh area during high water periods. Priegel considered that this flowing water was a key to spawning success and escapement of the newly hatched walleye fry into the river. The substrate used for spawning at station 1 (Figure 1) in Pool 7 was broken rock from 12 to 15 inches in diameter. Spawning by walleye and sauger may also occur in the tailwaters of Pool 7. Carufel (1963) and Nelson, et al (1965), in Priegel (1969b), reported that spawning of sauger occurs in the tailwaters of reservoirs on the Missouri River. If walleye and sauger do spawn in the tailwaters of Pool 7, the effect of currents depositing eggs in unsuitable areas, such as heavily silted locations, could have a significant impact on hatching success and subsequent year class strengths.

According to Niemuth, et al (1959), male walleye mature at two to three years old and 12 to 13.5 inches long. Females mature at four to five years old and 15 to 17 inches. Priegel (1969a) found that 37 percent of the male walleye at age II were mature, and that 8 percent of the females were mature at age IV. Priegel considered the average age of maturity as that age at which 50 percent of the walleye attained maturity. In Lake Winnebago, male walleye would be considered mature at the end of the third year of life at 12.7 inches, and female walleye would be considered mature at the end of the sixth year of life at 18.9 inches. Carlander and Whitney (1961) found that the youngest fish of each sex of mature walleye in Clear Lake was age III. In considering only ages III through VII of mature walleye, Carlander and Whitney calculated that 88 percent of the males and 59 percent of the females were age III to V.

Mature male walleye captured at the spawning area in Pool 7 in 1969 averaged 14.9 inches, and females averaged 21.4 inches total length. The average of all walleye was 15.7 inches total length. Scale samples collected during operations in 1969 and 1970 in Pool 7 reveal that males mature at an average weighted age of 4.6 years, and females mature at an average weighted age of 7.8 years, which is higher than Priegel's determination of sexual maturity for Lake Winnebago walleye. Only two mature male walleye at age II and one mature female walleye at age III were detected in Pool 7 in 1969 and 1970.

Mature male walleye from Pool 7 in 1969 and 1970 averaged 16.8 inches, and mature female walleye averaged 23.1 inches total length. One sample of 3,363 mature male walleye captured at Lake Gogebic averaged 16.9 inches total length, and another sample of 190 mature male walleye average 16.2 inches. A sample of 428 mature female walleye averaged 18.8 inches, and another sample of 493 female walleye averaged 17.9 inches total length (Eschmeyer, 1950).

Tables 10 and 11 compare the mean of measured total lengths of walleye and sauger captured in Pool 7 with the calculated mean lengths from other waters. For age I walleye sampled in the Mississippi River, only Vasey's calculated mean total length was less than the mean observed in Pool 7. For age II-XI walleye, calculated mean total lengths by Jergens, Childers, and Vasey for Mississippi River walleye were higher than the means of walleye from Pool 7 (Figure 10).

Comparing calculated mean total lengths for age I sauger from the Mississippi River, only Vasey's calculated mean was lower than the mean for Pool 7 sauger. For age II-IV sauger, Jergens', Childers', and Vasey's calculated means were higher than the mean of sauger in Pool 7; and for age V-VII sauger, Jergens', Childers', and Vasey's calculated means were lower than the Pool 7 mean (Figure 11).

The impact of flooding on the spawning success of walleye and sauger has been suspected by earlier workers as being a causative agent for varying year class strengths. Comparisons of percentages of age I walleye and sauger making up each annual collection show that the 1969 year class of walleye and the 1970 year class of sauger was highest in Pool 7. The 1968 year classes of walleye and sauger were low. The maximum flood stage was 8.4 feet in 1970, 15.6 feet in 1969, and 8.9 feet in 1968 at La Crosse. The highest flood stage was reached on May 4 and 5 in 1970, April 21 in 1969, and May 22 in 1968 at La Crosse.

One spawning concentration of walleye was located during the flood of 1969; however, spawning sauger were not located in the three year period of 1969-1971. It is suspected that walleye and sauger will spawn in Pool 7 during periods of moderate or low floods. Rock riprapping is used for flood protection on railroad grades, highway rights-of-way, and private property. Suitable spawning areas would become increasingly available as flood waters raise depending on the slope and size of the riprapped substrate. Movement to suitable spawning areas probably takes place to search out the most ideal sites under a given flood condition. As a result, spawning sites could vary from year to year.

Perhaps a more critical factor would be the time at which floods occur in relationship to the spawning period. Optimum water temperatures for spawning may not correspond with flooding which might, in part, account for the poor 1968 year class of walleye and sauger. Increased calefaction of the Mississippi River by power plants may disrupt this natural synergistic effect by advancing the spawning period to a time when flooding is minimal. On the other hand, dredging the existing channel to twelve feet might lower water temperatures enough to delay spawning by shunting more water to the confined, deeper main channel. Their combined effect would be hard to assess at this time.

MANAGEMENT POSSIBILITIES

Past investigators have noted a spring run of ripe walleye and sauger being caught in the emergency spillway, auxiliary lock, and main lock of Lock and Dam 6. The strong current existent in the tailwater apparently serves as a rheotactile force during spawning. Evidence collected during the study suggests that the establishment of gradually sloping riprapped areas in the immediate vicinity of the tailwaters may serve as suitable spawning substrates for this spring run of walleye and sauger. Ideally, the riprap should slope in such a manner as to provide suitable depths under a variety of water conditions.

Table 10. Comparison of mean lengths of walleye from Pool 7, Mississippi River, with walleye from other waters.

Area	Number of Fish	Mean Total Length at Each Annulus											
		1	2	3	4	5	6	7	8	9	10	11	12
Pool 7, Mississippi River[1]	187	7.7	11.4	14.0	16.8	18.6	18.9	20.7	23.8	23.9	24.8	26.1	26.5
Pools 7, 8, 9, and 10[2] [3] Mississippi River (Jergens and Childers, 1959)	109	12.5	13.5	16.4	17.3	21.2	21.6	24.8					
Pool 11, Mississippi River[2] (Vasey, 1967)	152	6.9	12.1	16.3	19.4	21.3	23.0	24.0	24.7	25.5	26.2	26.8	
Pools 13, 14, 15, and 19[2] [3] Mississippi River (Jergens and Childers, 1959)	36	8.2	13.2	-	19.1	22.8							
Lake Winnebago[2] (Priegel, 1969)	411 males	5.6	10.2	12.7	14.1	15.1	15.8	16.4	17.1				
	585 females	6.0	10.1	13.3	15.5	17.3	18.9	20.1	21.1				
Lake Gogebic[2] (Eschmeyer, 1950)	252 males	4.4	9.3	11.8	13.9	15.2	16.3	16.9	17.3	17.7	18.0		
	267 females	4.9	9.4	12.4	14.5	16.3	17.9	18.9	19.8	20.4	21.0		
Clear Lake[2] (Carlander and Whitney, 1961)	8,664	7.0	11.3	14.7	17.1	18.9	20.7	22.0	23.8	25.3	27.0	27.5	27.8

[1] Mean derived from measurement of total lengths of samples collected in March and April of 1969 and 1970.
[2] Calculated from body-scale relationship.
[3] Unweighted means of one inch group midpoint.

Table 11. Comparison of mean length of sauger from Pool 7, Mississippi River, with sauger from other waters.

Area	Number of Fish	Mean Total Length at Each Annulus							
		1	2	3	4	5	6	7	8
Pool 7, Mississippi River[1]	111	6.1	9.6	12.4	15.0	18.6	19.0	21.4	
Pools 7, 8, 9, 10[2] [3] Mississippi River (Jergens and Childers, 1959)	259	9.8	11.8	13.8	15.4	16.2	16.8	18.8	
Pool 11[2] (Vasey, 1967)	218	5.7	10.6	14.0	16.3	17.7	18.9	20.2	
Pools 13, 14, 15[2] [3] 19, Mississippi River (Jergens and Childers, 1959)	267	8.5	13.1	15.1	17.9				
Lake Winnebago[2] (Priegel, 1969)	784 males	4.9	9.5	12.1	13.2	14.0	14.8	15.3	15.8
	957 females	5.3	9.9	12.2	13.3	14.1	14.9	15.4	15.8
Lewis and Clark[2] Reservoir (Vanicek, 1964)	479	6.3	12.2	16.3	19.0	20.5	21.2		

[1] Mean derived from measurement of total lengths of samples collected in March and April of 1969 and 1970.
[2] Calculated from body-scale relationship.
[3] Unweighted means of one inch group midpoint.

Since the Corps of Engineers acts as a consultant for public and private projects, the feasibility of integrating flood and erosion control measures with optimum substrate size and gradient requirements for walleye and sauger spawning areas should be investigated. Locations and physical characteristics of walleye and sauger spawning grounds in Pool 7 should be studied further to determine specific and alternate spawning area requirements. In view of the increased use of riprapping on the Mississippi River, this may prove to be a valuable aid in the evaluation of riprapping as a mitigation device.

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Gordon E. Slifer	- West Central District Environmental Impact Coordinator
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Alan H. Finke	- Former Mississippi River Biologist
Eugene J. Trimberger	- Former Mississippi River Biologist
Richard G. Ranthum	- Mississippi River Biologist
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Roy A. Schumacher	- Fish Conservation Aid
John Spinner	- Hatchery Foreman, Iowa Conservation Commission, Lansing
Theresa A. Breidel	- Stenographer

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Dist.: Dist. Staff Spec.--Fish
List 2
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Area Fish Biologists
Area Fish Mgrs.

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