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FISH POPULATION RESPONSES TO IMPROVED LAKE HABITAT UTILIZING AN EXTREME DRAWDOWN[1]

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ABSTRACT

An extreme drawdown conducted on Lake Tohopekaliga rejuvenated littoral substrate, stimulated development of desirable aquatic plants and increased macroinvertebrate production. As a result of these beneficial changes standing crops of fish in littoral areas increased from a high of 191 pounds per acre before the drawdown to 455 pounds per acre within two years after reflooding. Limnetic standing crops increased from 59 pounds per acre to 127 pounds per acre during the same period. Biomass of sportfish nearly doubled, although forage fish accounted for a higher percentage of the population following reflooding. Individual species response to the drawdown varied. Numbers of harvestable size sportfish increased following reflooding. The monetary value of the Lake Tohopekaliga fishery increased by 37 percent, or $6,222,186.

INTRODUCTION

Fish management efforts for large lakes in the southeast are generally oriented towards increasing or improving sport fisheries. Avenues for accomplishing these aims are quite diverse, but can be categorized into two basic approaches: directly managing one or more species of a population or indirectly managing the fishery by altering aquatic habitat.

The use of water fluctuation as a fish management tool was proposed by many early workers, although incorporating adequate and timely fluctuations into large reservoirs specifically for sportfish management purposes is a relatively new technique. Hulsey (1958) recommended drawdowns to induce predator cropping, control noxious vegetation, aid in rough fish removal, and improve bottom substrate. In recent studies, Herman, Campbell and Redmond (1969) attributed increased growth rates for largemouth bass and a decline in forage bluegill populations to a short summer drawdown on Little Dixie Lake in Missouri. Lantz (1974) documented a correlation between increased fishery production and extreme annual water fluctuation for several Louisiana lakes.

Studies concerning lake drawdowns have generally dealt either with predator cropping for species management of a fish population or with reduction of "nuisance"

[1]This is a contribution from Dingell-Johnson Project F-29-R, Florida.

vegetation. Most have been attempts at limiting the density of aquatic plants, a situation which is neither necessary nor desirable in most Florida lakes and is, in fact, harmful to sportfish populations.

The lack of adequate knowledge on this subject was noted by Boyd (1967) who stated, "From the standpoint of fish production most workers consider higher plants to be detrimental, but, with the exception of ponds, there is little reliable information on the correlation between macrophytes and fish production." Unfortunately, beneficial relationships between aquatic plants, invertebrates, and fish are rarely considered in developing management plans. Evaluation of an experimental drawdown conducted on Lake Tohopekaliga in 1971 generated worthwhile information on this subject.

The drawdown resulted in a net improvement in lake habitat and biota. Exposed organic sediments were dried and consolidated, providing a firm, suitable substrate for plants and invertebrates. Desirable aquatic vegetation increased in density and diversity, and it was determined that the lakeward limit of emergent aquatic plant communities and their healthy maintenance were governed by extreme lows of water level fluctuation during growing seasons (Holcomb and Wegener, 1971). Subsequently, invertebrate organisms commonly utilized by fish experienced significant numerical increases (Wegener, Williams and McCall, 1974, in press). This paper describes the response of fish populations to changes in the lake system caused by the drawdown.

MATERIALS AND METHODS

Lake Tohopekaliga covers 22,700 acres located in western Osceola County, Florida. It is a typical Florida lake, being quite shallow with a maximum depth of 15 ft., having a gently sloping bottom, and wide expanses of rooted emergent vegetation. As a result of fluctuating water levels in past years plant communities include true aquatic, semi-aquatic, and terrestrial forms throughout the lake basin and associated floodplain.

Water levels are controlled by the Central and Southern Florida Flood Control District which permits only a three foot annual fluctuation, compared to a historical variation of 10.47 feet for the period of record (1942-64). This represents a 71% decrease from natural fluctuation (Holcomb and Wegener, 1971).

The immediate results of water level regulation were elimination of a considerable portion of natural flood plain and permanent reduction in lake surface area. Encroachment on the flood plain by agriculture and urban development quickly followed. Secondary effects of stabilized lake levels in Florida are rapid accumulation of organic detritus and unconsolidated muds, loss of important rooted aquatic vegetation and concentration of nutrient laden wastes. These factors contribute to accelerate rates of eutrophication, culminating in continual bluegreen algae blooms and essentially complete loss of desirable sport fisheries.

Based on preliminary investigations conducted in 1968, an extreme drawdown was recommended as an experimental management effort to reduce, moderate, or reverse symptoms of habitat degradation. By early 1970 the basic program had been developed and accepted by the local community.

The drawdown consisted of a seven foot vertical drop in water level from high pool stage, with drawdown pool (48.0 ft msl) being reached by early spring of 1971. Lake elevation remained low for nearly 6 months, with approximately 50 percent of the lake bottom exposed. As a result of drought, refilling to normal regulation pool was not completed until March 1972. A monthly water level hydrograph is included in Figure 2 for reference.

Biannual fish population sampling was conducted during the months of April and October utilizing the blocknet - rotenone technique. Locations of the one acre sample stations are indicated on Figure 1. *Non-fish* toxicant was distributed within the enclosed areas at 2.0 ppm. Fish were collected for three consecutive days, identified to species, separated into inch groups, counted and weighed. Scientific and common names used are those accepted by the American Fisheries Society (Bailey, 1970). Data is expressed in average pounds and numbers per acre, presented and analyzed separately for littoral and limnetic zones.

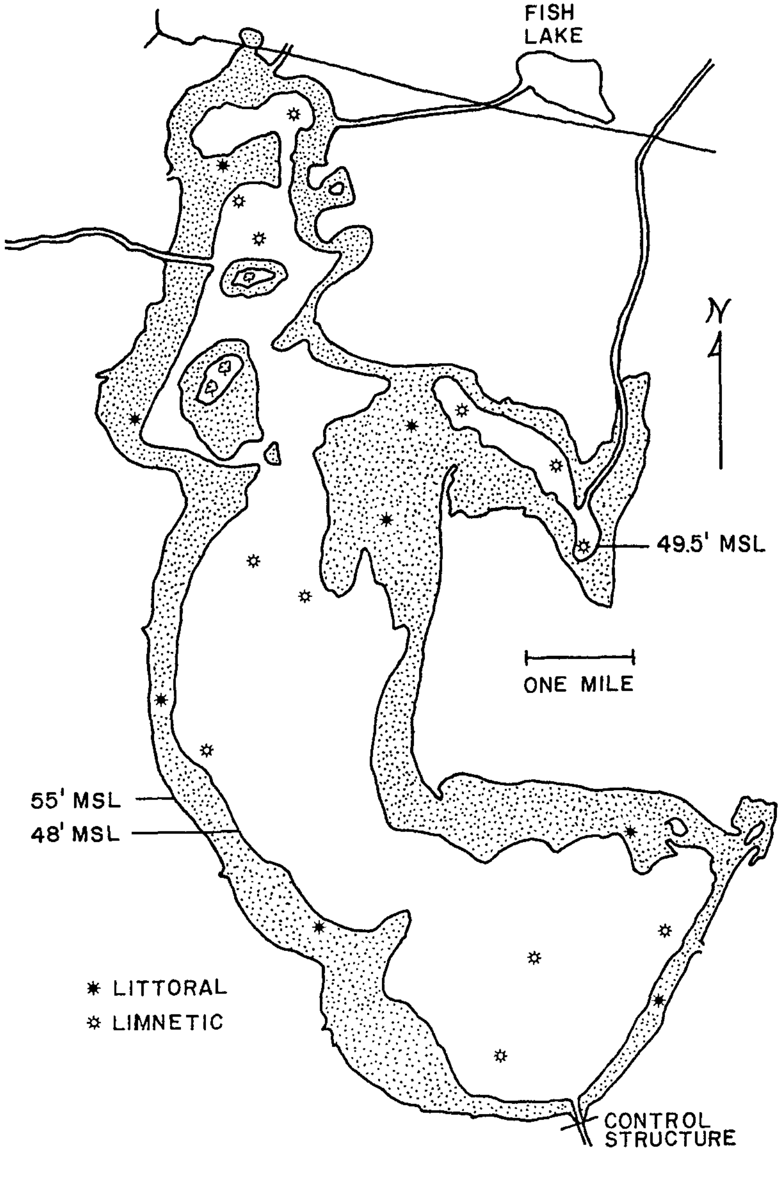

Figure 1. Littoral and limnetic blocknet sampling locations on Lake Tohopekaliga. (Shaded area indicates extent of littoral vegetation and bottom area exposed during drawdown).

Table 1 lists the number of locations surveyed for each period. No littoral samples were taken during spring 1971, as this area was dewatered at the time. Data from one limnetic net taken in the fall of 1972 was discarded as being atypical, as it contained 803 pounds of gizzard shad and 502 pounds of threadfin shad. Extensive scavenging by a flock of 200 to 300 white pelicans during the spring of 1973 invalidated data collected from 7 nets; data presented for this period is based on only 6 net sets (3 littoral and 3 limnetic).

Table 1. Number of one acre blocknet samples taken in littoral and limnetic areas of Lake Tohopekaliga.

Period	Number of One Acre Samples Littoral	Limnetic
April 1970	7	5
October 1970	7	7
April 1971		11
October 1971	7	9
April 1972	7	8
October 1972	7	6
April 1973	3	3
October 1973	8	7

RESULTS AND DISCUSSION

Average standing crops for sport versus forage fish in littoral and limnetic areas are illustrated, along with water level elevations, in Figure 2. Littoral areas supported a biomass at least three times greater than the limnetic, with the exception of the 1971 drawdown period. An increase in limnetic standing crop was anticipated in the spring of 1971 as a result of fish being displaced from the dewatered littoral zone. A slight overall increase occurred, but data indicates sportfish were reduced by more than 50 percent. Constant surveillance during the low water period did not reveal any abnormal fish mortalities and the abrupt increase in standing crop recorded for fall of 1971 leads to the conclusion that estimates for spring 1971 are conservative. During this low water period fish may have been heavily concentrated in localized areas of the lake which were not sampled, or moved out of shallow areas during net setting operations.

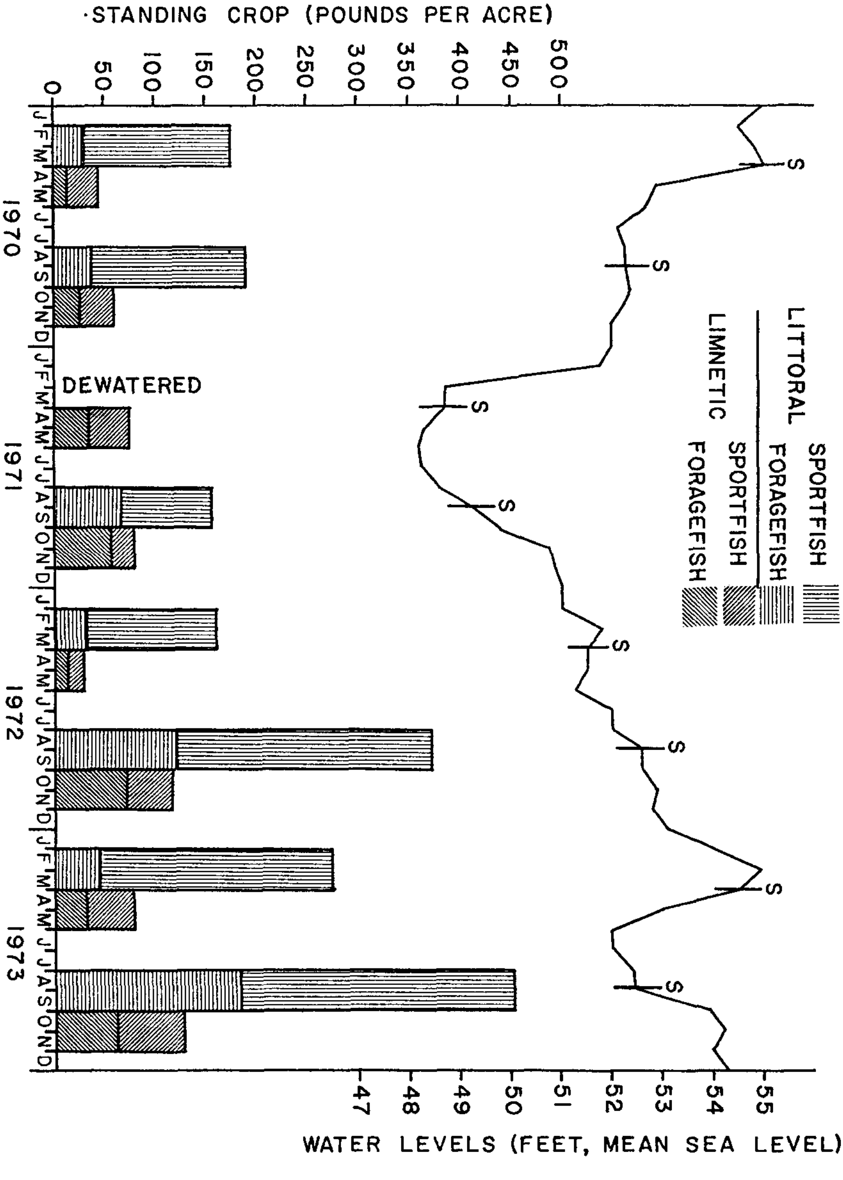

Figure 2. Water level hydrograph and average standing crop per acre of sport and forage fish for both littoral and limnetic areas of Lake Tohopekaliga.

Fall samples show a steady increase in biomass from a low in 1971 to a high in 1973. Littoral standing crops ranged from 191 pounds per acre prior to dewatering in 1970 to 455 in 1973. This represents an increase of 138 percent. Fall limnetic standing crops show a steady rise throughout the four year study from 59 to 127 pounds per acre, an increase of 115 percent.

Spring samples show increases for littoral and limnetic zones of 57 percent ard 70 percent respectively. However, the unusual bird activity which interfered with spring 1973 sampling adversely effected results, so that any conclusions drawn on this sampling period would be more or less conjecture.

Percent composition of sportfish varied throughout the study. The highest value obtained in littoral samples was 84 percent for spring 1970, the lowest 53 percent for fall 1973. This decrease is largely a result of expanded forage populations, even though sportfish biomass nearly doubled during the same period. Sportfish biomass peaked at 255 pounds per acre in the littoral zone during fall 1972, and has remained seasonally constant through fall of 1973. In the limnetic zone, spring 1970 accounted for a high of 76 percent sportfish, with a low of 29 percent occurring in fall 1971, as sportfish population shifted into newly flooded littoral areas. Limnetic zone sportfish biomass peaked at 65 pounds per acre during fall 1973, the lowest estimated being 16 pounds per acre in spring 1972.

Tables 2 through 5 list numbers and weights of individual species collected from both littoral and limnetic areas of Lake Tohopekaliga from April 1970 to October 1973. The following discussion includes all tables, however, not necessarily in order.

Table 2. Average number of fish per acre collected in the littoral zone of Lake Tohopekaliga from April 1970-October 1973.

	S 1970	F 1970	S 1971	F 1971	S 1972	F 1972	S 1973	F 1973
Largemouth Bass	87.4	68.0		107.3	512.6	292.7	45.0	112.0
Chain pickerel	8.9	4.9		2.9	3.4	4.6	2.3	6.3
Black crappie	81.3	39.7		18.0	11.1	39.9	6.3	220.8
Bluegill	104.7	4229.3		541.4	1445.0	2596.3	1233.0	4199.0
Redear sunfish	53.3	373.7		1703.4	244.1	876.6	729.0	742.3
Warmouth	20.6	27.7		51.3	59.1	56.1	60.3	134.3
Gizzard shad	5.4	16.9		3.3	12.1	179.0	42.7	406.3
Threadfin shad	.4	18.6		395.7	174.3	2554.3	208.0	1207.6
Lake chubsucker	15.9	7.0		11.6	1.6	77.9	14.3	51.8
Golden shiner	110.1	664.7		14.4	343.9	481.0	111.0	572.5
Channel catfish						.1		1.6
White catfish	.6	.1		2.0		.9	.7	1.9
Brown bullhead	1.6			85.6	4.9	26.3	1.7	37.6
Yellow bullhead	1.1							
Florida gar	.7	.4		10.3	1.3	1.6		1.1
Bowfin	.7	1.3		1.9	.3			
Atlantic needlefish	.3	1.6		.4	.7	1.0	.7	1.8

Seminole killifish	.7	29.9		4056.9	604.4	249.3	33.7	105.8
Taillight shiner	6.7	7.9		913.3	29.0	80.9	107.0	125.1
Bluespotted sunfish	2.7				1.4	4.1		22.1
Dollar sunfish						11.1	42.7	233.4
Golden topminnow	2.0	.7		2.3	2.1	.9		3.6
Brook silversides	.1	9.1		158.7	47.6	10.0	.3	9.3
Swamp darter	.3			1.7	.1		.3	
Tadpole madtom	12.1	41.4		30.4	30.9	4.9	16.7	5.8
Notropis spp.		.1						
Bluefin killifish				210.3	232.3	8.0		2.6
Flagfish				39.9	1.6			
Mosquito fish				4.0	5.3	.6		4.1
Spotted sunfish					.6			
Pirate Perch								1.4
Sailfin molly						.1		
TOTALS	1117.7	5543.0		8429.8	3769.7	7558.2	2655.7	8210.1

Table 3. Average number of fish per acre collected in the limnetic zone of Lake Tohopekaliga from April 1970-October 1973.

	S 1970	F 1970	S 1971	F 1971	S 1972	F 1972	S 1973	F 1973
Largemouth Bass	32.4	6.7	7.2	5.2	29.4	18.5	10.3	9.9
Chain pickerel	1.2		.5	.3	.1	.2	.7	.3
Black crappie	289.0	119.6	14.5	11.9	3.5	11.8	15.0	95.9
Bluegill	112.6	535.3	245.2	67.9	64.7	158.7	150.3	275.3
Redear sunfish	48.0	169.6	36.5	25.7	23.2	201.3	147.0	164.0
Warmouth	1.4	12.0	.4			4.5	3.0	7.7
Gizzard shad	13.0	333.0	26.1	63.3	11.6	164.0	57.7	108.1
Threadfin shad	12.2	483.3	20.3	1309.8	382.4	1815.0	381.7	678.9
Lake chubsucker		.4	.9			1.5	5.7	4.3
Golden shiner	3.8	21.7	6.2	.9	30.5	16.5	11.7	3.4
Channel catfish		.4	.2	.1		2.7	1.3	.1
White catfish		18.3	.7	6.1	.9	7.2	3.3	16.9
Brown bullhead			.4	.4		2.0	2.0	1.1
Florida gar			7.2	6.3				
Longnose gar			.1					
Bowfin			.5	.6				
Atlantic needlefish	.4	4.9	1.8	2.0	.2	2.8	.7	3.7
Seminole killifish	.6	.9	1.6	28.4	7.1	2.8	.7	1.4
Taillight shiner	6.4	11.7	1.9	7.3	16.7	492.7	27.7	2.0
Dollar sunfish						.5		1.1
Brook silversides			.6	2.8	6.1			
Swamp darter				.1		.3		
Tadpole madtom	6.0	28.4	26.0	4.1	6.9	29.0	4.3	
Notropis spp.	.8	228.0	.9					
Bluefin killifish					.2			.1
Flagfish								.4
Pirate perch							.3	
Least killifish								.1
TOTALS	527.8	1974.1	399.6	1543.3	583.7	2932.0	823.4	137.5

Loss of the 1971 year-class of largemouth bass, *Micropterus salmoides*, was anticipated as a result of drawdown occurring during spawning season; however, excellent reproduction did occur during the low water period as indicated in the fall samples. Spring 1972 produced substantial reproduction in the newly reflooded littoral zone, with survival rates remaining high through the fall. This fall period accounted for the highest standing crop encountered for bass, nearly 64 pounds per acre.

Chain pickerel, *Esox niger*, and black crappie, *Pomoxis nigromaculatus*, appeared to be adversely affected by dewatering. Either reproduction failed during 1971 or survival rate of progeny was extremely low. Adult losses were high with little or no recovery through spring 1972. Black crappie show a significant improvement in both littoral and limnetic areas during fall 1973, at which time populations exceeded pre-drawdown estimates. The data also shows improved size distribution for this species. Chain pickerel show slight recovery by fall 1973, however population estimates are still lower than those existing prior to dewatering.

Bluegill, *Lepomis macrochirus*, populations declined during drawdown and early reflooding with little reproduction occurring during this period. The following spring (1972) and spring 1973 produced excellent year-classes. Data demonstrates larger bluegill were present in the population by fall 1973. Numbers remained similar for 1970 and 1973, but biomass increased from 90 to 140 pounds per acre. Limnetic populations also show numerical recovery by fall of 1973, with biomass higher than pre-drawdown estimates. The latter increased from 10 pounds per acre in fall 1970 to 31 pounds in fall 1973.

Unlike bluegill, redear, *Lepomis microlophus*, seem to be favored by the low water period. Excellent reproduction is indicated in fall 1971 littoral samples. Numbers and weights remained high throughout the study. Standing crops increased from 18 pounds per acre in fall 1970 to 37 pounds per acre in fall 1972. By fall 1973 weights decreased to 27 pounds per acre, which is still higher than pre-drawdown estimates. Limnetic areas increased from 9 pounds per acre in fall 1970 to 20 pounds per acre in fall 1973.

Table 4. Average weight of fish per acre collected in the littoral zone of Lake Tohopekaliga from April 1970-October 1973.

	S 1970	F 1970	S 1971	F 1971	S 1972	F 1972	S 1973	F 1973
Largemouth Bass	46.69	34.41		35.38	49.82	63.93	24.65	47.87
Chain pickerel	15.42	9.57		5.37	3.26	5.40	2.72	8.11
Black crappie	8.44	1.34		.68	2.56	3.59	2.23	14.67
Bluegill	68.38	89.84		31.21	47.52	132.37	89.32	140.46
Redear sunfish	5.71	17.68		13.22	22.27	37.09	106.97	27.08
Warmouth	1.80	.71		.61	1.53	1.91	3.10	4.56
Gizzard shad	3.97	5.85		.73	7.94	41.44	19.23	120.14
Threadfin shad	trace	.13		1.54	2.89	18.22	2.63	9.41
Lake chubsucker	12.22	5.29		15.36	1.51	28.96	8.47	31.40
Golden shiner	8.05	19.80		1.09	4.56	27.94	12.90	22.23
Channel catfish						.31		3.25
White catfish	.41	.01		.01		.09	.53	1.51
Brown bullhead	.62			1.91	.84	7.51	1.13	21.09
Yellow bullhead	.47							
Florida gar	.96	.79		11.32	4.01	1.23		.61
Bowfin	2.44	5.14		9.19	1.02			
Atlantic needlefish	.03	.09		.04	.09	.16	.15	.18
Seminole killifish	.01	.31		26.71	10.62	3.56	.73	1.16
Taillight shiner	.01	.01		1.13	.06	.16	.30	.18
Bluespotted sunfish	.01				trace	.01		.15
Dollar sunfish						.02	.30	.78
Golden topminnow	.01	trace		trace	trace	trace		.01
Brook silversides	trace	.03		.12	.05	.03	trace	.03
Swamp darter	trace			trace	trace		trace	
Tadpole madtom	.02	.03		.06	.08	trace	.25	.01
Notropis spp.		trace						
Bluefin killifish				.25	.26	.01		.01
Flagfish				.03	trace			
Mosquito fish				trace	trace	trace		.01
Spotted sunfish					.01			
Pirate perch								trace
Sailfin molly						trace		
TOTALS	175.69	191.07		155.95	160.91	373.94	275.61	454.91

Table 5. Average weight of fish per acre collected in the limnetic zone of Lake Tohopekaliga from April 1970-October 1971.

	S 1970	F 1970	S 1971	F 1971	S 1972	F 1972	S 1973	F 1973
Largemouth Bass	6.75	7.97	8.55	3.92	2.77	3.43	2.78	5.84
Chain pickerel	3.09		.95	.76	.40	.60	.83	.41
Black crappie	5.56	4.19	3.17	2.41	.92	3.80	4.10	7.84
Bluegill	13.50	10.41	18.13	10.52	8.72	16.45	22.88	31.34
Redear sunfish	6.52	9.43	9.55	4.88	3.57	18.35	12.37	19.66
Warmouth	.05	.13	.02			.08	.22	.24
Gizzard shad	9.57	17.89	20.46	30.79	7.71	49.81	18.67	43.42
Threadfin shad	.16	6.80	.37	10.68	5.01	19.94	9.08	11.26
Lake chubsucker		.40	.89			.48	3.12	2.53
Golden shiner	.64	.41	.53	.09	.25	.96	1.80	.41
Channel catfish		.01	.02	.06		.12	.07	.01
White catfish		.84	.43	.25	.01	.67	.82	2.89
Brown bullhead			.45	.03		.43	1.15	.31
Florida gar			9.75	13.15				
Longnose gar			.09					
Bowfin			1.89	2.02				
Atlantic needlefish	.08	.53	.15	.27	.04	.57	.23	.85
Seminole killifish	.03	.01	.06	.16	.10	.07	trace	.04
Taillight shiner	.01	.03	trace	.01	.04	.48	.08	trace
Dollar sunfish						.01		.01
Brook silversides			trace	trace	.01			
Swamp darter				trace		trace		
Tadpole madtom	.06	.09	.06	.01	.02	.13	.05	
Notropis spp.	trace	.30	trace					
Bluefin killifish					trace			trace
Flagfish								trace
Pirate perch							trace	
Least killifish								trace
TOTALS	46.02	59.44	75.52	80.00	29.58	116.38	78.25	127.06

The extremely high weight estimate for redear in spring 1973 was a result of one blocknet being inadvertently placed around a redear spawning area. This error was compounded by the small number of samples used for these estimates as previously explained.

Gizzard shad, *Dorosoma cepedianum*, have generally continued to increase since reflooding. Threadfin shad, *D. petenense*, and golden shiners, *Notemigonus* crysoleucas, were the only soft-rayed forage species, of acceptable size to be utilized by predators, present in adequate numbers during fall 1970. These were cropped severely during the 1971 drawdown. Threadfin, being summer spawners, increased soon after reflooding began, as indicated in fall 1971 samples. Golden shiners did not show recovery until fall 1972, at which time their populations experienced a tremendous increase in littoral areas.

Seminole killifish, *Fundulus seminolis*, representing an insignificant portion of the forage population before the drawdown, responded phenomenally as reflooding occurred. Littoral biomass increased from less than 1 pound per acre in 1970 to approximately 27 pounds per acre in the fall of 1971. Significant reproduction and growth occurred during dewatering when extremely shallow water offered relief from predation. As water depths increased by the spring of 1972 predator populations shifted from open water into newly flooded, vegetated areas. Biomass of Seminole killifish decreased to approximately 11 pounds per acre, as these organisms became significant forage items in the diets of largemouth bass (Chew, unpublished, 1972, D-J Federal Aid Project F-24, Tallahassee, Florida, Annual Report). Their continued decrease is further documented in subsequent samples. Numerically other small forage species responded favorably to the drawdown. Because of their size, weights were insignificant.

The average number per acre of harvestable size largemouth bass, black crappie, bluegill, and redear from littoral and limnetic areas of Lake Tohopekaliga are shown in Table 6.

Table 6. Average number of catchable size sportfish per acre for littoral and limnetic zones in Lake Tohopekaliga, Florida.

	Littoral				Limnetic			
Sampling Periods	Bass (10")	Redear (6")	Bluegill (6")	Crappie (8")	Bass (10")	Redear (6")	Bluegill (6")	Crappie (8")
Spring 1970	22.0	14.7	229.9	12.9	2.4	16.8	52.6	5.0
Fall 1970	17.4	50.4	232.4	0.6	4.3	28.9	32.0	4.7
Spring 1971	NO SAMPLES - DEWATERED				6.1	20.6	57.5	3.9
Fall 1971	15.9	13.7	105.3	0.1	3.1	18.1	39.1	3.2
Spring 1972	27.9	50.0	99.4	3.6	2.2	12.1	30.1	2.0
Fall 1972	41.3	83.3	363.1	3.6	1.3	54.8	56.3	6.0
Spring 1973	18.0	273.7	257.3	3.0	3.3	37.3	76.3	5.3
Fall 1973	24.1	69.2	340.6	17.9	1.3	63.9	111.4	11.3

In the littoral zone bass reached a peak of 41 harvestable size fish per acre in the fall of 1972, approximately one year after reflooding began. The average weight of harvestable size specimens declined slightly during this period, although total poundage per acre increased. No distinct trends are indicated in limnetic numbers, which remain considerably lower than littoral numbers.

Harvestable size redear show good post-drawdown response through fall 1972, with a dramatic increase to 274 harvestable fish per acre the following spring. Spring 1973 data is based on fewer blocknet samples and must be considered in view of the problems previously discussed. Although it is obvious significant improvements occurred throughout the study, it is doubtful that redear populations increased to the extent indicated. Numbers declined significantly in the fall of 1973, to 70 harvestable fish per acre, but still remained higher than pre-drawdown estimates. Average weight of harvestable size redear increased in fall of 1973. Numbers in the limnetic zone peaked in fall 1972, and showed a slight decline the next spring. Average weight of harvestable size individuals decreased slightly during this period.

Harvestable size bluegill in littoral areas decreased significantly during and immediately following the drawdown. Substantial recovery occurred in fall 1972, with numbers remaining above pre-drawdown estimates for the duration of the study. Average weight, however, appears to have decreased slightly. Limnetic populations increased slowly following reflooding, and were still improving by fall 1973.

Black crappie are the only major sportfish found in significant numbers in limnetic areas of Lake Tohopekaliga. Populations of harvestable size fish in both limnetic and littoral zones appeared to be adversely affected during the low water period. Recovery was much slower than for other centrarchids species. The number of catchable size was highest in fall 1973, at which time pre-drawdown estimates were exceeded.

Justification of any large scale management program requires economic as well as biological enhancement figures. Wegener and Holcomb (1972) calculated the value of the fishery in Lake Tohopekaliga prior to dewatering at $16,601,756. Table 7 compares monetary values for total estimated numbers of fish in Lake Tohopekaliga before dewatering (1970) and after refilling (1973). Values were derived from blocknet data using Florida Department of Air and Water Pollution Control values as described by Wegener, et al (1972). Based on these figures the value of the fishery in Lake Tohopekaliga increased $6,222,186 in three years as a result of the drawdown to $22,823,942. The increased fishery present in the original 9,080 acre littoral zone accounted for $3,019,172 of this figure, an increase of $332.51 per acre; the limnetic zone accounted for $104,079, an increase of $9.17 per acre; the remaining $3,098,935, nearly 50 percent of the total increase, was generated by converting 2,270 acres of limnetic zone to higher value/acre littoral zone as a result of new vegetation established in previously unvegetated areas.

Table 7. Monetary values of the Lake Tohopekaliga fish population before (1970) and after (1973) an extreme drawdown.

	1970			1973		
Area	Acres	Ave/acre	Value	Acres	Ave/acre	Value
Littoral	9,080	$1,333.33	$12,266,636	11,350	$1,683.46	$19,107,271
Limnetic	13,620	321.12	4,335,120	11,350	327.46	3,716,671
TOTAL			$16,601,756			$22,823,942

CONCLUSIONS

There is no doubt the increased fishery present in Lake Tohopekaliga was a result of the drawdown. This management technique improved littoral substrate, increased density and diversity of desirable aquatic vegetation, stimulated production of fish food organisms and obviously induced predator cropping. Since it is difficult to separate cause and effect in determining which of the interrelated improvements were mainly responsible, a generalized statement is in order. The drawdown apparently funnels energy flow within the lake system into the fishery. This is substantiated by increased standing crops of fishes in both littoral and limnetic areas of the lake. Littoral biomass increased from a high of 191 pounds prior to dewatering to 455 pounds within two years after reflooding. Limnetic standing crops increased from 59 pounds per acre to 127 pounds per acre during the same period. The increased standing crop following the drawdown was accompanied by a decrease in percent composition of sportfish, even though total poundage nearly doubled. This percent decrease resulted from an even greater increase in forage populations.

With the exception of chain pickerel, sportfish exhibited favorable responses to the drawdown. Largemouth bass reproduction during the low water period of the drawdown produced a strong year-class. By fall 1972 there were 41 harvestable size fish per acre in the littoral zone. This period accounted for the largest standing crop of bass, an average of 64 pounds per acre. Redear, like bass, were favored by the low water period, and responded with increases in both standing crop and number of harvestable size specimens.

Bluegill and black crappie populations declined during the drawdown and early reflooding period with little reproduction occurring. Excellent reproduction and growth occurred after spring 1972 for bluegill and spring 1973 for crappie. The number of harvestable size specimens continued to increase.

Chain pickerel were the only species which appeared to be adversely affected by dewatering. Although recovery is evident by fall 1973, populations remained lower than pre-drawdown estimates.

Significant increases in forage species occurred as a result of dewatering and reflooding. Standing crops for major species doubled. Gizzard shad increased throughout the study.

Predation on threadfin shad and golden shiner was significant during the drawdown, however, rapid recovery was evident during reflooding. Seminole killifish populations responded phenomenally during the low water period but were cropped severely as reflooding occurred.

The monetary value of the drawdown, based solely on increases in fish population, was estimated at $6,222,186.

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DIEL AND SEASONAL OCCURRENCE OF IMMATURE FISHES IN A LOUISIANA TIDAL PASS[1]

by

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ABSTRACT

A 15-month study of a natural tidal pass on the southeastern Louisiana coast revealed that the pass and adjacent inshore waters are utilized by a variety of immature fishes as immigration pathway and/or nursery. Eighty species representing 39 families were found to occur in the pass area, including young of several commercial and sport fishes. Two seasonal assemblages of immature fishes were identified, cold- and warmwater. Coldwater species were mostly immigrating young of offshore spawners, while warmwater species were mostly young of inshore spawners. The catch of coldwater species was influenced more by tidal stages than light periods; warmwater species exhibited varied diel catch patterns but the catch of predominant warmwater species was more closely associated with light periods than tidal stages. The similarity in diel patterns exhibited by some of the coldwater assemblage indicates that this group may react similarly to the problem of inshore transport (immigration).

INTRODUCTION

Barrier islands border more than half the shoreline of the northern Gulf of Mexico (Kwon, 1969). West of the present bird-foot delta of the Mississippi, barrier islands around the abandoned Mississippi-LaFourche delta enclose one of the most productive estuarine areas in North America (Gunter, 1967). These barrier islands are interspersed by relatively narrow openings, the tidal passes, which allow organismal, nutrient and tidal exchange between the Gulf and estuarine bays and marshes. Most commercial and sports fishes of the Gulf of Mexico spawn in the Gulf and their postlarval and juvenile stages enter the estuaries through the tidal passes. The early life history stages are the most critical part of a fish's life cycle (Gunter, 1967; Fore, 1970a) and many estuarine dependent marine species spend a portion of this critical period in tidal passes. Some fishes spawn in the immediate vicinity of tidal passes and a few complete their entire life cycles there.

There are few published studies directed specifically to investigations of the ichthyofauna of Louisiana's tidal passes or to the state's coastal-marine immature fishes. Moreover, there is a paucity of information on the diel occurrence of marine immature fishes in general. This paper presents some of the findings of a 15-month diel study of immature fishes associated with Caminada Pass, Grand Isle, Louisiana.

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