1995

A FISHERIES SURVEY OF RUNYAN LAKE, 1995

WITH RECOMMENDATIONS AND A MANAGEMENT PLAN

Study performed: 16 September 1995

Presentation to Group: 30 August 1996

Final report submitted: 25 October 1996

Prepared by: David J. Jude, Ph.D
Limnologist, Fishery Biologist

Joseph L. Ervin, M.S.
Aquatic Ecologist

FRESHWATER PHYSICIANS, INC
5293 DANIEL
BRIGHTON MI 48116
810-227-6623

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INTRODUCTION

We were asked by the Runyan Lake Association to do a fisheries survey of the lake and develop short-term and long-term management plans for the fish populations. The residents are concerned about the quality of the lake and wish to maintain it in its current form and desire to know what kinds of fish management practices and other measures that they can institute to help improve and preserve the fishery in the lake.

Runyan Lake is about a 200-acre lake with an outlet stream eventually reaching the Shiawassee River. Runyan Lake has three very deep basins, ranging in depth from 40 to 55 feet. During its history, trout and walleye have been introduced to the lake to attempt to establish these species. There are an estimated 300 or more residences around Runyan Lake, which can lead to increased denuding of the watershed and degraded water quality in the lake. In addition, fishing pressure can be quite severe on top predators if a good majority of these people fish in the lake. Freshwater Physicians, Inc. has done three prior studies on Runyan Lake limnological and fishery characteristics during 1977, 1980, and 1986 and has advocated installation of sewers around the lake to prevent further nutrient additions. These data will be used where appropriate to contrast current findings with those found during the past.

We would like to gratefully thank Bob Thompson, 10548 Runyan Lake Court who provided us with fish samples and in addition, a most comfortable aquatic platform from which to do our fish sampling. Elizabeth Lynn assisted us in collection of fish and arranged logistics on the lake. We are also appreciative for all those fishermen who took the time to respond to the survey and those who saved stomachs and collected data for us to analyze. We are indebted to these people and the residents should be appreciative that there are people on the lake who are very concerned about the current and future status of Runyan Lake and are willing to give of their time, equipment, and talents to help preserve its quality.

METHODS

Our study involves physical, chemical, and biological measurements and observations by professional aquatic biologists who have conducted lake management studies since 1972. We use specialized samplers and equipment designed to thoroughly examine all components of an aquatic ecosystem. Shallow water, deep water, sediments, animal and plant life as well as inlet and outlet streams are intensively sampled and analyzed at several key stations (sites on the lake). Our SCUBA divers examine aquatic plants, sediments, and fish and assist in some other data collections. Some samples are analyzed in the field, while the balance are transported to our laboratory for measurements and/or identification of organisms found in samples.

After the field study, we compile, analyze, summarize, and interpret data. We utilize a comprehensive library of limnological studies, and review all the latest management practices in constructing a management plan. All methods used are standard limnological procedures, and most chemical analyses are according to Standard Methods for the Examination of Water and Wastewater.

STATION LOCATIONS

During any study we choose a number of places (stations) where we do our sampling for each of the desired parameters. We strive to have a station in any unusual or important place, such as inlet and outlet streams, as well as in representative areas in the lake proper. One of these areas is always the deepest part of the lake. Here we check on the degree of thermal and chemical stratification, which is extremely important in characterizing the stage of eutrophication (nutrient enrichment), invertebrates present, and possible threats to fish due to production of toxic substances due to decomposition of the bottom sediments. The number and location of these stations for this study are noted in that section.

BIOLOGICAL PARAMETERS

Fish

The top carnivores in most aquatic ecosystems, excluding man, are the fish. They are integrators of a vast number and variety of ever-changing conditions in a body of water. They, unlike the zooplankton and benthos which can reflect short-term changes, are indicative of the long-range, cumulative influences of the lake or stream on their behavior and growth. The kind of fish, salmon or sunfish, can tell us much about how oligotrophic (low productivity) or eutrophic (high productivity) a lake is. We collect fish with seines, gill nets and from lucky fishermen on the lake.

Most fish are weighed, measured, sexed, and their stomach contents removed and identified. Fish are aged using scales, and breeding condition is observed and recorded. The catches from our nets and age information on the fish will tell us how your length-at-age data compare with state averages and whether or not fish growth is good. Another problem, "stunting", can be detected using these sources of information. We set a 125-foot experiment nylon and monofilament gill net at two locations (station J and H - see Table 1, Fig. 1). The nylon net was set on 2:20 PM 16 September 1995 at station J in 10 to 20 feet of water. The net was pulled at 1:00 PM on 17 September 1995. At station H, the net was set at 2:34 PM in 15-35 feet of water after determining that the thermocline crossed the bottom about in this area. This net was pulled at 12:40 PM on 17 September 1995. A 50-foot seine was deployed in three areas of the lake, stations SA, SB, and SC (see Fig. 1).

Table 1. Listing of the stations used to sample fish on Runyan Lake, September 16 and 17, 1995.

Location	Gear	Description
SA	Seine	On east side of lake, shallow, several macrophytes species present sediment soft in some places
SB	Seine	West end of the lake; shallow, many macrophytes present, thick sediments
SC	Seine	On north end of the lake; shallow to deep; thick sediments, macrophytes common
J	Gill net	West side of lake, deep.
H	Gill net	East side of lake; deep; set in the thermocline area.

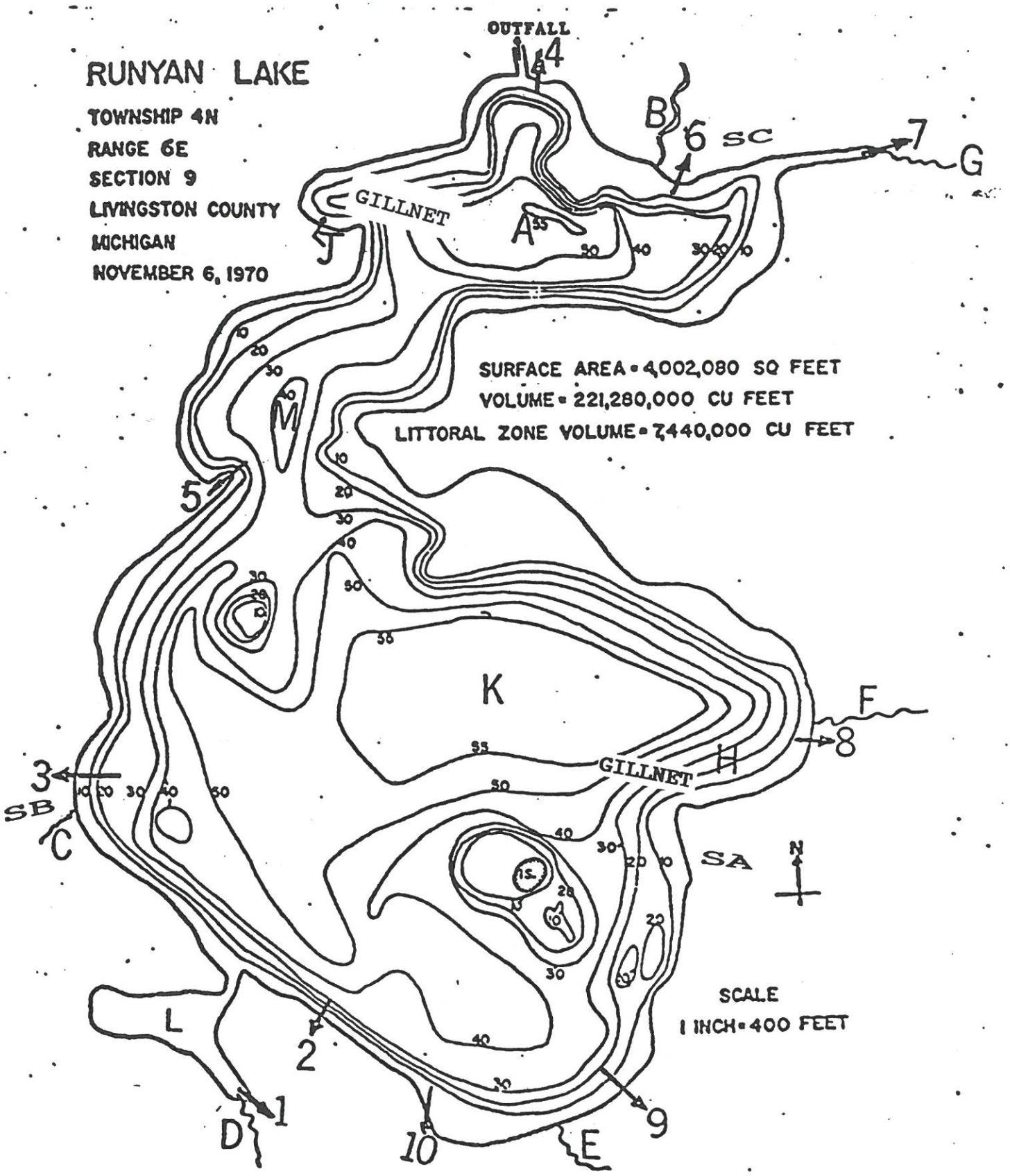

Figure 1. Map of Runyan Lake showing deep basins and sampling stations for seining (SA, SB, and SC) and gill netting (GILLNET) activities.

Stomach contents of fish document whether or not good sources of food are present and help confirm age and growth conclusions. Imbalances in predator-prey relationships are a closely related problem which we can usually ascertain by examining the data and through discussions with local fishermen. From studying the water chemistry data and supportive biological data, we can make recommendations, such as habitat improvement, stocking of more predators, and chemical renovation. We can also predict for example, the effects of destroying macrophytes through chemical control. All elements of the ecosystem are intimately interrelated and must be examined to predict or solve problems in a lake.

RESULTS

CHEMICAL PARAMETERS

Although we were not asked to examine the water quality of Runyan Lake, our previous surveys had identified a dissolved oxygen depletion in the bottom waters of Runyan Lake which was important for two reasons. First, it indicated that the lake was deteriorating in quality and it was a threat to one of the premium water quality bioindicators that are present in Runyan Lake, the lake herring, a member of the Salmonidae family, the trout and whitefishes. Second, this finding was a prime reason for recommending sewers for the lake along with the increasing trends of more people living on the lake full time.

Progressive Engineers provided recent dissolved oxygen and water quality data and we measured dissolved oxygen during our survey to ascertain current conditions and to determine the best place to set our gill net in order to be in optimal habitat for lake herring. Both the data of Progressive Architecture, Engineering, and Planning, and ours indicated that water quality compared with our data from previous surveys, has improved. There was dissolved oxygen depletion from the bottom waters in 1979, while in August 1996 there was still dissolved oxygen on the bottom, although it was in low amounts. This is an excellent finding for it portends a positive effect from the efforts of the residents to control nutrients, especially the decision to obtain sewers for the the lake.

BIOLOGICAL PARAMETERS

Aquatic Plants

Since one of the main concerns of the residents in the meeting we had and from those we spoke with during our sampling concerned aquatic plants, and fish use aquatic macrophytes for spawning, cover, fish-food organisms live on them, and use as nursery areas, and since we had personal

knowledge of them during sampling, we intend to offer a few comments about them in this report. There is no doubt that aquatic macrophytes appear to be much denser than when we did our earlier surveys in the 1970s. In addition, two of the seining stations (SB, SC) had deep and highly organic accumulation of sediments on which dense accumulations of plants were growing profusely. *Chara*, a green alga, was common in several areas of the lake. This is a positive feature, since *Chara* removes nutrients from the lake when it grows and it precipitates calcium carbonate which ties up phosphorus during this process, thereby acting as a phosphorus remover in that manner. It also grows fairly close to the bottom and tends to prevent or retard other plants, especially the long stemmed *Potamogetons* from growing, which can cause problems for boaters and swimmers. Therefore, we strongly recommend that *Chara* be only removed if a beach is desired in a specific area and that it only be removed mechanically (with a rake or other devices).

Secondly, we support some type of aquatic plant control program to give relief to those who are desirous of a small beach on which to swim or for boat egress. However, this should be minimal and it should be kept in mind that some parts of the lake are more prone to growing plants than others. We support harvesting where possible, but some herbicides may be necessary to control especially dense stands of plants. Remember however, that part of the reason that the fish population is doing well in the lake is because of the productivity of the plants.

Fish

-Fish Diversity

We collected the following 17 species of adult and juvenile fish in seines and gill nets from Runyan Lake during our 1995 survey: largemouth bass, bluntnose minnow, sand shiner, bluegill, brook silversides, yellow perch, lake herring, longnose gar, pumpkinseed, spotfin shiner, banded killifish, johnny darter, warmouth, northern pike, logperch, black crappie, and rock bass (Table 2, Table 3). In addition, we have reports from fishermen that bowfin, walleye, and one species of bullhead (black bullhead) inhabit the lake. In addition, our 1979 survey documented the appearance of Iowa darters, green sunfish, yellow bullhead, and white suckers, making the total number of species noted in the lake 25 at least.

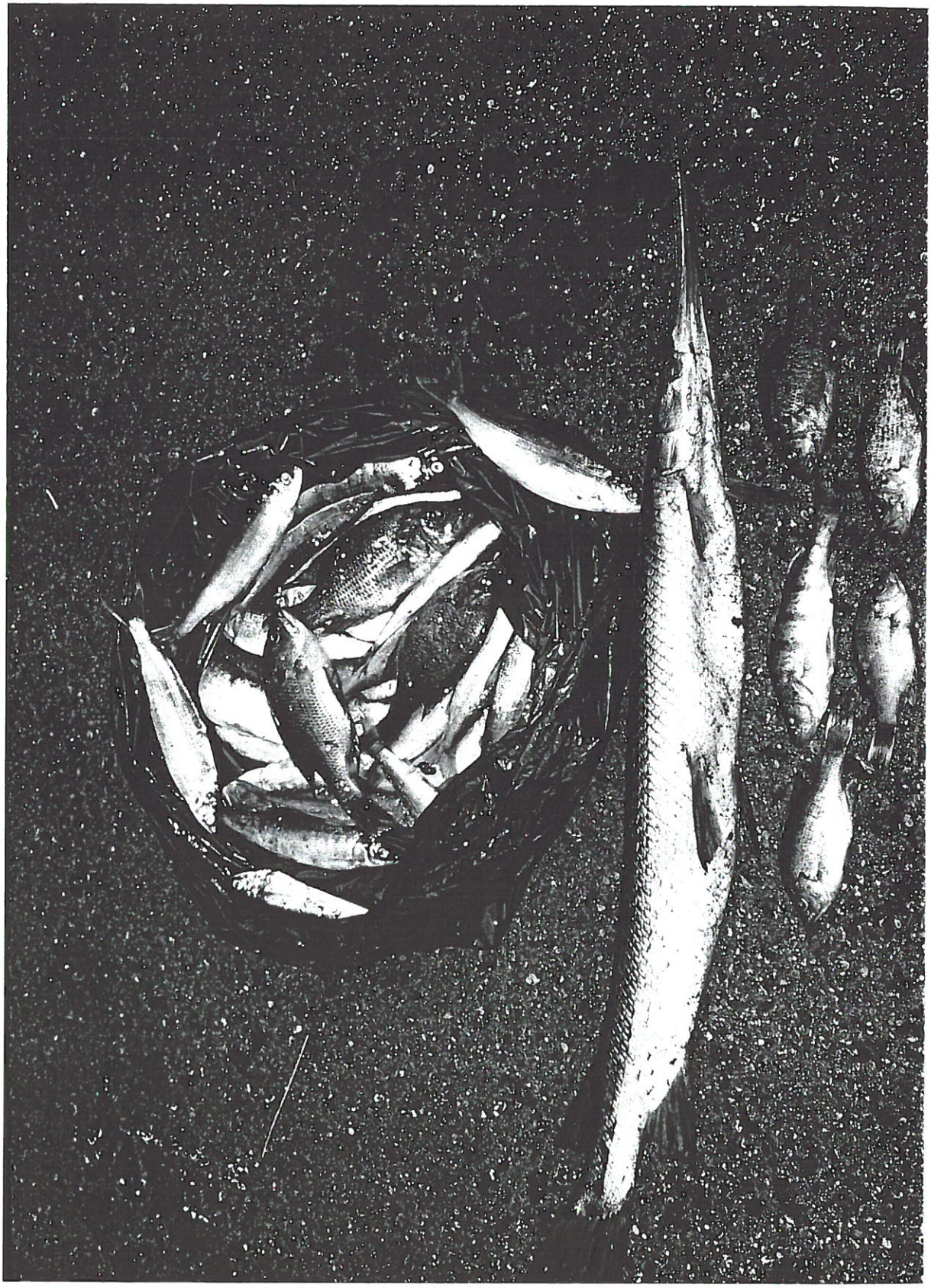

Table 2. Length, weight, sex, and food consumed by fish collected in Runyan Lake, 16 September 1995. Fish were collected via seine and gill net. Length is in inches, weight in ounces. Under sex, M = male, F = female, I = immature. Under gonad condition, 1 = poorly developed gonads, 2 = moderately developed gonads, 3 = well developed gonads. MT = empty stomach. SV = brook silversides, XX = unknown fish, BG = bluegill, CHIRON = chironomids or midges, aquatic insect larvae, ZOOP = zooplankton or invertebrates in the water column, HY = *Hyalella*, amphipod or fairy shrimp, *Hexagenia* = large mayfly. R = released alive.

Species	Length	Weight	Sex	Gonad Cond.	Age	Food eaten
			STATION SA			
YELLOW PERCH	7.4	2.5	F	1	3	1 SV
	6.2	1.4	F	1	3	1 DRGN. FLY
	4.6	0.5	F	1	2	2 DRGN. FLY
ROCK BASS	5.1	1.3	M	1	4	XX FISH
LARGEMOUTH BASS	7.2	2.4	F	C	2	MT
	5.3	1.0	F	C	1	1 BG
	2.2	0.1				
PUMPKINSEED	4.6	1.2	F	1	3	
	4.1	0.8	F	C	3	DETRITUS
LOGPERCH	3.3	0.2				
	3.3	0.2				
	2.3	0.1				
	2.4	0.1				
BROOK SILVERSIDES	3.1	0.1				
	3.2	0.1				
	2.9	0.1				
	4.0	0.2				
	3.0	0.1				
	3.1	0.1				
BLUNTNOSE MINNOW	2.2	0.1				
	1.7	<0.1				
	1.9	0.1				
	2.0	0.1				
	2.0	0.1				
SAND SHINER	1.8	<0.1				
	2.2	0.1				
	1.8	<0.1				
	1.9	0.1				
	2.4	0.1				
	2.0	0.1				
	1.7	<0.1				
	1.4	0.1				

Table 2. Continued.

Species	Length	Weight	Sex	Gonad Cond.	Age	Food eaten
			STATION SA			
SPOTFIN SHINER	2.8	0.1				
	2.2	0.1				
	1.8	<0.1				
	2.0	0.1				
	2.6	0.1				
	2.2	0.1				
	2.2	0.1				
BLUEGILL	7.3	3.3	F	1	5	*Hexagenia*, ANTS
	6.2	2.2	F	1	4	*Hexagenia*
	6.5	1.6	F	2	4	DETRITUS
	5.7	1.6	F	1	4	8 *Hexagenia*
	5.7	1.6	F	1	4	*Hexagenia*
	5.9	1.7	F	1	4	3 *Hexagenia*
	5.6	1.6	F	1	4	8 *Hexagenia*
	5.6	1.3	F	1		HEX., DRGN. FLY
	5.4	1.3	C	C	3	*Hexagenia*
	4.6	0.8	F	1	2	3 *Hexagenia*
	3.3	0.2				
	2.0	0.1				
	2.6	0.2				
	3.3	0.3				
	3.3	0.3				
	2.3	0.1				
	2.2	0.1				
	1.9	0.1				
	2.0	0.1				
	3.0	0.2				
			STATION SB			
LARGEMOUTH BASS	9.5	6.0	F	1	4	4 SV
	7.4	2.9	I	I	2	MT
	8.1	3.7	M	1	2	3 SV
	6.3	1.7	F	1	2	1 XX
	6.7	2.1	I	I	2	1 SV
	5.6	1.2	I	I	2	1 SUNFISH,2 SV
	5.7	1.3	F	1	2	1 XX FISH
	5.7	1.3	F	1	2	MT
	5.4	1.2	E	C	1	FISH REMAINS
	5.0	0.9	F	1	1	1 SV
	5.3	1.0	E	C	1	MT
	3.0	0.2	I	I	0	1 XX FISH
	2.0	0.1	I	I	0	MT
	2.2	0.1	I	I	0	1 XX FISH

Table 2. Continued.

Species	Length	Weight	Sex	Gonad Cond.	Age	Food eaten
			STATION SB			
BLUNTNOSE MINNOW	2.4	0.1				
	2.0	0.1				
	1.7	<0.1				
	1.9	<0.1				
	2.6	0.1				
	2.3	0.1				
FATHEAD MINNOW	1.6	<0.1				
	1.6	<0.1				
	1.9	0.1				
	2.0	0.1				
BANDED KILLIFISH	1.5	<0.1				
BROOK SILVERSIDES	2.6	0.1				
	3.0	0.1				
	2.8	0.1				
	2.8	0.1				
	2.6	0.1				
SAND SHINER	2.2	0.1				
	2.2	0.1				
	2.0	0.1				
	2.0	0.1				
	1.8	<0.1				
	2.2	0.1				
	1.9	0.1				
LOGPERCH	2.0	0.1				
	2.0	0.1				
	2.0	0.1				
	2.2	0.1				
	2.0	0.1				
	2.2	0.1				
	2.0	0.1				
SPOTFIN SHINER	2.8	0.1				
	2.4	0.1				
	1.8	<0.1				
	2.9	0.1				
	2.9	0.1				
	2.8	0.1				
	2.3	0.1				
	2.7	0.1				
	1.8	0.1				
PUMPKINSEED	3.9	0.6	F	1	2	MT

Table 2. Continued.

Species	Length	Weight	Sex	Gonad Cond.	Age	Food eaten
			STATION SB			
YELLOW PERCH	6.0	1.2	F	1	4	MT
	5.2	0.8	F	1	2	MT
	4.9	0.6	F	1	2	1 SUNFISH
	2.4	0.1	I	I	0	MT
BLUEGILL	1.2	<0.1				
	1.3	<0.1				
	1.9	<0.1				
	1.9	<0.1				
	1.7	<0.1				
	1.2	<0.1				
	1.3	<0.1				
	1.2	<0.1				
	2.4	0.1				
	1.9	<0.1				
	2.2	0.1				
	1.9	<0.1				
	1.3	<0.1				
	2.1	<0.1				
	5.1	1.2	C	C	3	*Hexagenia*
	5.3	1.3	F	1	3	INSECTS
	5.6	1.4	F	1	3	*Hexagenia*
	4.9	1.0	C	C	3	*Hexagenia*
	4.1	0.6	F	1	2	DETRITUS
			STATION SC			
LONGNOSE GAR	16.3	3.5	C	C		MT
BLACK CRAPPIE	2.0	<0.1				
SPOTFIN SHINER	2.6	0.1				
	2.7	0.1				
	2.8	0.1				
	3.1	0.1				
	1.7	<0.1				
	2.7	0.1				
	2.4	<0.1				
SAND SHINER	1.9	<0.1				
	2.2	<0.1				
	1.9	<0.1				
LARGEMOUTH BASS	8.9	4.6	M	1		2 LP
	7.6	3.0	M	1		1 SV
	4.8	0.6	I	I		MT
	3.1	0.2	I	I		MT
	3.2	0.2	1	1		MT

Table 2. Continued.

Species	Length	Weight	Sex	Gonad Cond.	Age	Food eaten
			STATION SC			
LARGEMOUTH BASS						
	8.9	3.6	M	1		2 LP
	7.6	3.0	M	1		1 SV
	4.8	0.6	I	I		MT
	3.1	0.2	I	I		MT
	3.2	0.2	1	1		MT
YELLOW PERCH	6.1	1.3	F	1	2	1 LEECH
	4.3	0.5	F	1	2	MAYFLIES, HY
	3.8	0.2	F	1	1	*Hyalella*
	6.1	1.3	F	1		1 LEECH
	4.3	0.5	F	1		MAYFLY, HY
	3.8	0.2	F	1		MT
	3.7	0.3				
	13.1	13.1	F	1		PLANTS, MUD
	4.9	0.5	F	2		MT
	11.5	8.0	F	2		CRAYFISH, .1 OZ
	12.4	10.4	F	2		CRAYFISH, .3 OZ
	6.9	1.6	F	2		YP 1.5 IN,.1 OZ
	11.3	8.1	F	2		MT
	11.1	6.0	F	2		MT
	12.5	10.7	F	2		XX FISH 2.0 IN
	10.4	12.8	F	2		MT
	12.0	9.9	F	2		MT
	11.7	9.5	F	2		XX 0.1 OZ
	12.4	11.0	F	2		MT
	10.9	6.5	F	2		MT
	11.5	8.7	F	2		MT
	10.9	9.5	F	2		MT
	11.2	7.6	F	2		MT
	11.2	6.3	F	2		YP 2.4 IN .1 OZ
	11.2	6.8	F	2		MT
	4.3	0.4	M	3		10 Chironomids
PUMPKINSEED	4.5	1.1	M	1	2	MT
	4.5	0.1	M	1		MT
	1.9	<0.1				
BROOK SILVERSIDES	3.3	0.1				
	2.4	<0.1				
	2.4	<0.1				
	2.8	<0.1				
	2.4	<0.1				
	2.2	<0.1				
	3.0	<0.1				
	3.0	0.1				

Table 2. Continued.

Species	Length	Weight	Sex	Gonad Cond.	Age	Food eaten
			STATION SC			
BLUNTNOSE MINNOW	2.7	0.1				
	1.5	<0.1				
	1.8	<0.1				
	2.2	0.1				
	1.3	<0.1				
	2.0	<0.1				
	2.0	<0.1				
	1.6	<0.1				
	2.0	<0.1				
LOGPERCH	3.3	0.2				
	3.3	0.2				
BROOK SILVERSIDES	3.3	0.1				
	2.4	<0.1				
	2.4	<0.1				
	2.8	<0.1				
	2.4	<0.1				
	2.2	<0.1				
	3.0	<0.1				
	3.0	0.1				
BLUNTNOSE MINNOW	2.7	0.1				
	1.5	<0.1				
	1.8	<0.1				
	2.2	<0.1				
	1.3	<0.1				
	2.0	<0.1				
	2.0	<0.1				
	1.6	<0.1				
	2.0	<0.1				
	1.6	<0.1				
	2.0	<0.1				
LOGPERCH	3.3	0.2				
	3.3	0.2				
	3.7	0.2				
	2.2	<0.1				
	3.6	0.2				
BLUEGILL	6.1	1.9	F	1	4	DRGN. FLY
	5.7	1.7	F	1	4	SNAIL
	5.6	1.6	F	1	3	MT
	5.7	1.5	F	1	3	SNAIL, EARWIGS
	1.5	<0.1				
	2.0	0.1				
	2.0	<0.1				

Table 2. Continued.

Species	Length	Weight	Sex	Gonad Cond.	Age	Food eaten
			STATION SC			
LARGEMOUTH BASS	3.3	0.3				
	3.0	0.2				
	2.1	0.1				
	1.8	<0.1				
	1.9	<0.1				
	0.9	<0.1				
	3.1	0.2				
	1.0	<0.1				
	7.4	0.4	F	1		CHIRONOMIDS
GOLDEN SHINER	4.9	0.5	F	2		DETRITUS
			GILL NET STATION H			
ROCK BASS	8.0	4.6	M	1		CHIRONOMIDS
	8.1	4.8	F	5	9	MT
NORTHERN PIKE	26.8	R			8	
LAKE HERRING	7.4	1.6	M	3	1	ZOOP, 2 CHIRON.
	9.3	2.6	F	3	3	ZOOP
	8.7	2.8	M	3	2	MT
	8.3	2.5	F	3	2	ZOOP
	8.5	2.7	M	3	2	ZOOP
	7.8	1.8	F	1	1	ZOOP
	9.1	3.5	M	3	2	ZOOP
	8.5	2.5	M	3	?3	ZOOP
	9.3	3.7	M	3	2	ZOOP
	8.9	3.2	M	3		ZOOP
	8.9	3.0	F	3		ZOOP
	7.5	1.7	F	1		ZOOP
	8.8	3.0	M	3		ZOOP
	9.0	3.2	F	3		ZOOP
	9.3	3.4	M	3	3	MT
	8.7	2.7	M	2	3	ZOOP
	9.1	3.3	M	3	2	MT
	7.5	1.7	F	1	3	ZOOP
	8.9	3.0	F	3	2	MT
	8.9	3.1	F	3		ZOOP
	7.5	1.8	F	1		ZOOP
	7.5	1.7	F	3		ZOOP
	8.8	3.3	M	3		ZOOP
	7.6	1.9	F	1		MT
	7.6	1.9	M	1		ZOOP
	9.3	3.7	F	3		ZOOP
	9.0	3.4	F	3		ZOOP
	8.8	3.4	F	3		ZOOP
	9.2	3.4	F	3		ZOOP

Table 2. Continued.

Species	Length	Weight	Sex	Gonad Cond.	Age	Food eaten
			GILL NET STATION J			
ROCK BASS	5.8	1.8	F	1		CRAYFISH,1.0 OZ
	6.1	1.5			5	
	8.2	4.9				
YELLOW PERCH	8.0	3.0	F	1		MT
	8.0	3.1				
WARMOUTH	6.2	2.8	F	1	5	MT
	6.3	2.8				
BLUEGILL	6.1	2.0	F	1		MT
	5.3	1.4	F	1		MT
	5.6	2.1				
	6.3	2.1				
	7.6	3.7				
	8.1	4.4				
LONGNOSE GAR	37.1	67	F	2		SUNFISH
NORTHERN PIKE	ca. 25	R		9 or 10		

Table 3. Families and species of fishes observed or collected in Runyan Lake based on two Freshwater Physicians' surveys (1979**, 1995) and fishermen's observations*.

Family	Species
Centrarchidae - Sunfishes	
	1 Bluegill
	2 Pumpkinseed
	3. Green Sunfish**
	4 Rock Bass
	5 Largemouth Bass
	6 Warmouth
	7 Black Crappie
Cyprinidae - Minnows	
	8 Bluntnose Minnow
	9 Sand Shiner
	10 Spotfin Shiner
Percidae - Perches	
	11 Yellow Perch
	12 Johnny Darter
	13 Logperch
	14 Walleye*
	15 Iowa Darter**
Cyprinodontidae - Killifishes	
	16 Banded Killifish

Table 3. Continued.

Family	Species
Atherinidae - Silversides	
	17 Brook Silversides
Salmonidae - Trout And Whitefishes	
	18 Lake Herring
Lepisosteidae - Gars	
	19 Longnose Gar
Esocidae - Pikes	
	20 Northern Pike
	21 Grass Pickerel
Amiidae - Bowfins	
	22 Bowfin*
Ictaluridae - Bullheads	
	23 Black Bullhead*
	24 Yellow Bullhead**
Catostomidae - Suckers	
	25 White Sucker**
Total	11 Families - 25 Species

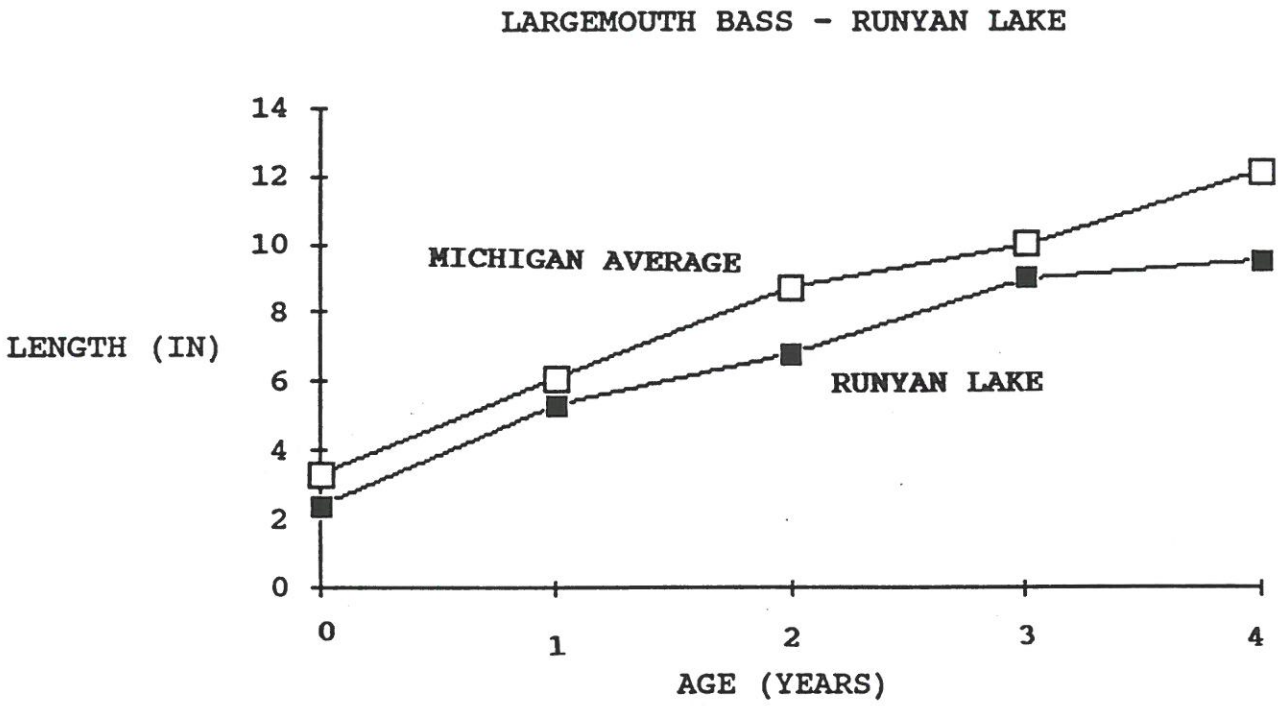

Figure 2. Growth of largemouth bass in Runyan Lake compared with state averages. Michigan data are from Latta (1958).

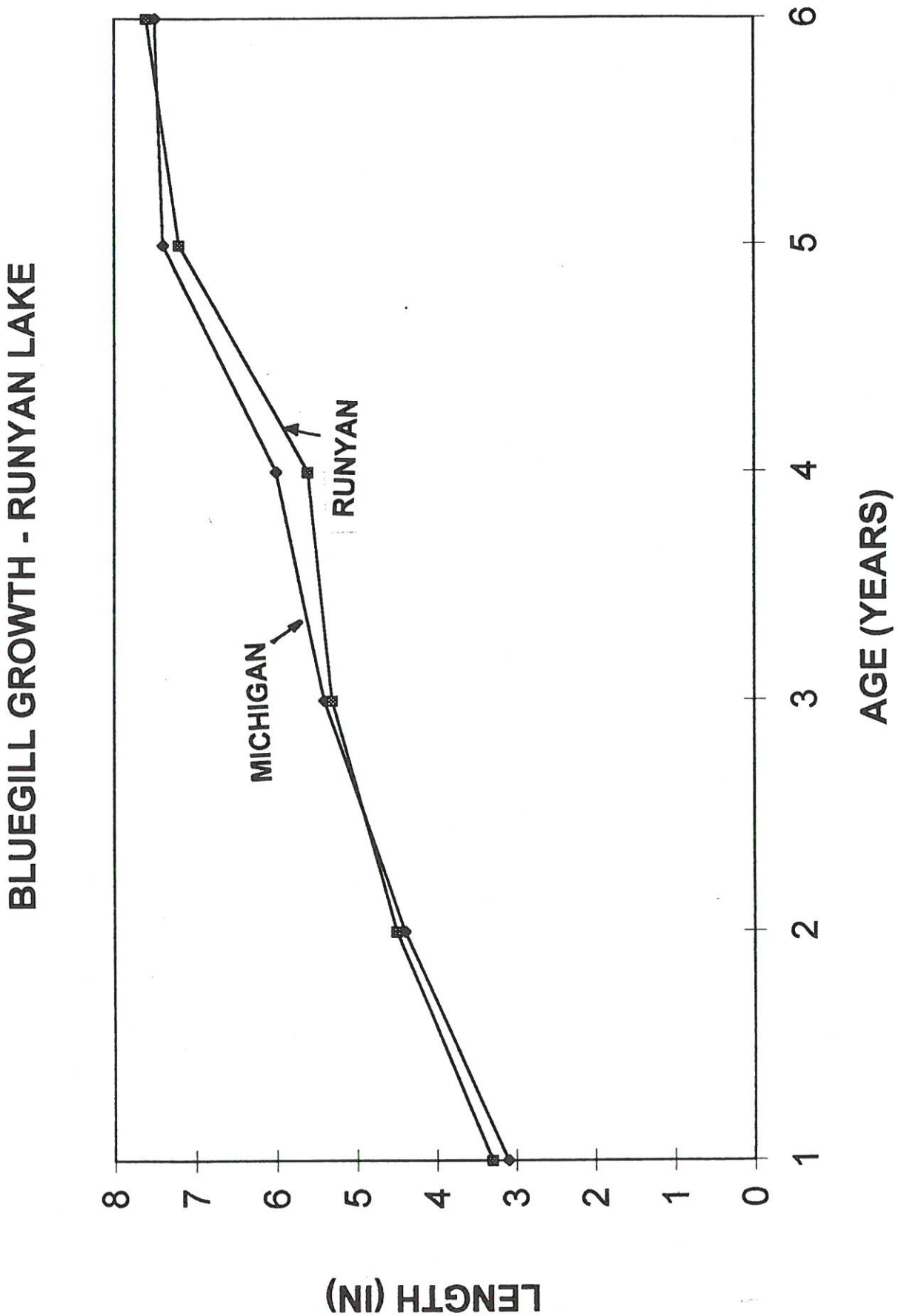

Figure 3. Growth of bluegill in Runyan Lake compared with state averages. Michigan data are from Latta (1958).

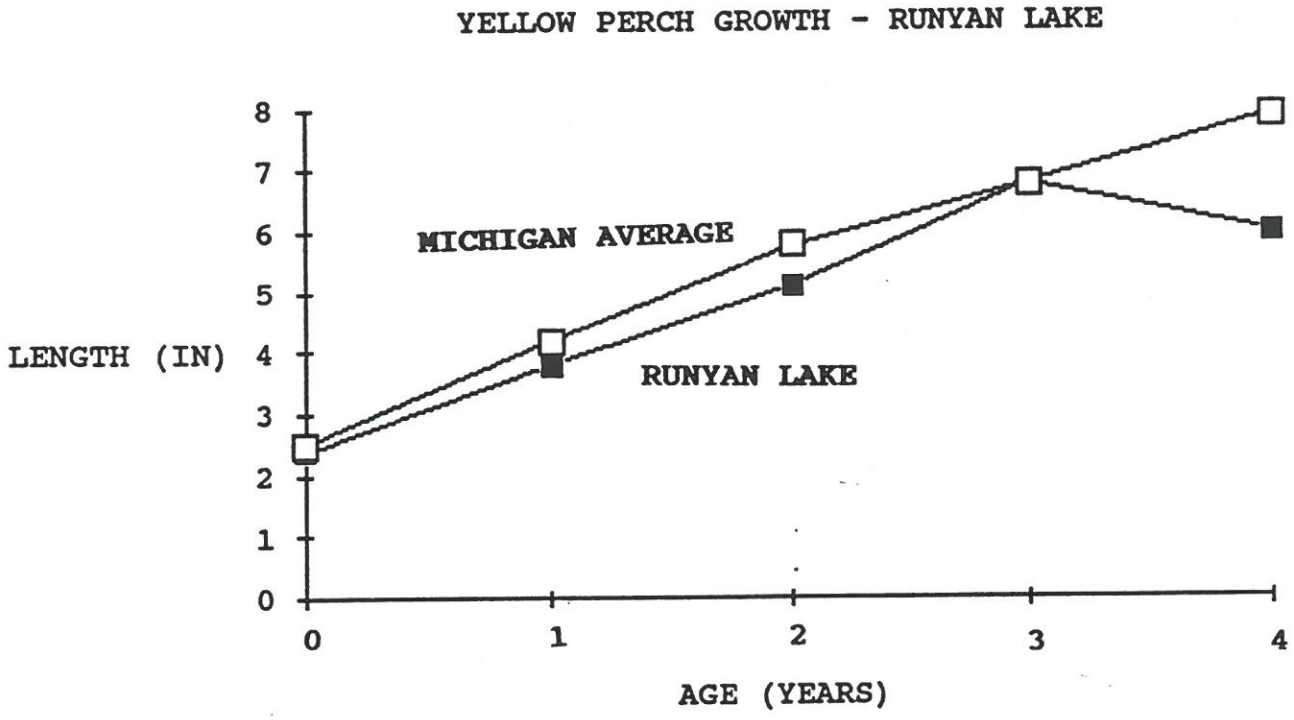

Figure 4. Growth of yellow perch in Runyan Lake compared with state averages. Michigan data are from Latta (1958).

First we will go through a discussion of the 11 families and 25 species of fish present, since it is very unusual to obtain as many species in a survey as we have. This is a good sign that Runyan Lake provides a diverse set of habitats and has high water quality to support some of the species that are present. Probably the most unusual fish present is the lake herring, a member of the Salmonidae, the same family that has trout and salmon in it. Lake herring need cold temperatures and high dissolved oxygen in the lake, hence our concern for the water quality, especially dissolved oxygen in the bottom waters. As noted above, dissolved oxygen appears to have improved in the lake and there are certainly a large number of lake herring present based on the high catches in our gill net.

There were seven members of the Centrarchidae or sunfish family present in the lake, with many reports of smallmouth bass being caught or observed in the lake. We do not think based on our surveys that there are any smallmouth bass in the lake. In addition, we do not think they reproduce in Runyan Lake if stocked there, because of the large number of predators and competition from largemouth bass.

We found three minnow species, members of the family Cyprinidae and five species in the perch family. Walleyes are probably the most prominent member; these have been stocked in the past, have not survived well in the lake despite the outstanding water quality, and very few have been caught by fisherman. Based on this experiment, we are of the opinion that walleyes should not be stocked again in the lake and that the native species that evolved in the lake should be encouraged and managed, rather than bringing some exotic species that was never a member of the Runyan Lake ichthyofauna. Yellow perch are preferred prey of northern pike, so we suspect that they will suffer heavy predation from these fish.

There are two other families of fish represented by one member each in the lake, the banded killifish, a member of the killifishes and the brook silversides. The brook silversides is unusually abundant in the lake, we have never seen them that dense in any lake we have ever examined. They are small fish, live only 2 years, feed near the surface, many times on plankton and terrestrial insects, and are important forage fish for a host of predators in the lake. We found them in many of the stomachs of fish we examined.

The longnose gar and bowfin are two other fishes that are members of a family represented in the lake. These fish are predators and will help control the sunfish populations. There is no need to be fearful of this fish, since first they are rare in the lake and second they fear humans.

There are two members of the pike family in the lake and in this recent survey we did not get any grass pickerel, when in 1979 we captured a few. Why they are rare now is

unknown. Northern pike is an excellent top predator in the lake and are present in modest numbers based on our capture of two, one in each gill net we set. Both were released, after we removed a scale sample for ageing. As we noted in our earlier study, more work needs to be done to determine whether spawning is occurring in the lake, by a survey of fishermen (whether they catch small ones - hammer handles) and by close monitoring of the creeks in the spring spawning run. If there is little or no spawning or low success and continued heavy fishing pressure on this species, stocking is warranted to maintain the population levels.

There are apparently two species of bullheads present in the lake: black bullhead and yellow bullheads. These are valuable additions to the fish fauna, since they feed on the bottom and convert benthos to fish flesh and they can be important predators of other fish, including sunfish, helping to keep the species of sunfish growing well by thinning numbers of young fish.

Lastly, there is the white sucker, an important forage fish and a fish that spawns in streams that enter the lake, about the same time as northern pike.

-Fish diet

Stomachs of fish collected during the survey and from those obtained by fishermen were examined and the data are presented in Table 2. For largemouth bass, a fish predator at large sizes, most were eating fish, including brook silversides, sunfish, logperch, and several we could not identify.

Bluegills were eating *Hexagenia*, the large mayfly that prompts fishermen to fish the big rivers up north. *Hexagenia* is another indicator of clean water and high dissolved oxygen concentrations. They were also eating other benthic organisms, including dragonfly naiads, snails, chironomids, and terrestrial insects.

Rock bass were eating benthos as well (aquatic insects), crayfish, and larger fish were eating fish. Yellow perch were eating fish (sunfish), dragonflies, leeches, mayflies, and the amphipod, *Hyalella*, crayfish, and one appeared to be cannibalistic.

The longnose gar had an empty stomach and the northern pike were released. The literature suggests that lakes with a large population of lake herring make for excellent northern pike growth, for two reasons. First, there is a cool water refuge to which northern pike can live in during the heat of the summer. Second, the lake herring provide an excellent forage fish which promotes fast growth of northern pike. This may be part of the reason that the fish are difficult to catch - adequate food supply - or it may be that they are overfished and uncommon in the lake. Our survey was unable to ascertain which is correct.

-Fish growth

Largemouth bass growth in Runyan Lake appears to be slightly below the state averages for growth of these fish, which is somewhat surprising considering the abundant forage fish supply in sunfish and brook silversides (Fig. 2). We did not obtain any large fish so we were unable to determine if they growth faster once they get past the 12 inch stage.

Bluegills are growing at or slightly below the Michigan state averages, but these differences probably are not statistically different (Fig. 3). There is apparently a good crop of benthos present for these fish, as attested to by the presence of *Hexagenia*, chironomids, and other aquatic insects.

Pumpkinseeds were also aged, but we had a low sample size. Fish were 2-yr olds and ranged in length from 3.9 to 4.5 inches. Michigan state average length of a 2-yr old fish is 4.1 inches (Appendix 1), making these fish comparable to state averages.

There were three rock bass aged including: 5.1 inches - 4 yr old, 6.1 inches - 5 yr old, and 8.1 inches - 9 yr old. the comparable Michigan average total lengths at each of these ages are: 6.2, 7.3, and 9 inches respectively for fish 4, 5, and 9 yr old (Appendix 1). All the rock bass were growing below state averages.

A warmouth (they have a large mouth and a colorful sometimes pink blotches on their scales), another species of sunfish, which is present in Runyan Lake in low numbers, was aged at 5 years and was 6.2 inches; the state average for a 5-yr old fish is 6.1 inches (Appendix 1). Therefore it appears that at least this one specimen was growing at state average rates.

Yellow perch appear to be not too abundant in Runyan Lake, due partially to northern pike predation. Growth should also be high, but Runyan Lake fish lag behind state of Michigan averages (Fig. 4). There seems to be an adequate supply of benthos for bluegills; yellow perch range out into deeper water where other food is present, so it is unclear what factors may be affecting their growth.

For northern pike, we have two specimens, one was about 27 inches and aged at 8 yrs; the Michigan average length for 8 yr old northern pike is 37 inches (Appendix 1), making Runyan Lake fish considerable below that average. For the other specimen, we found a 25-inch fish to be 9 or 10 yr old, these fish should be about 35-44 inches, again making Runyan Lake fish below state averages. Northern pike are difficult to age (and their lengths were estimated), so this may be part of the problem, but generally one misses annuli. From the forage fish present, especially the lake herring, the northern pike should be growing way above state averages. The only point that can be reliably made is that it takes a long time to grow a northern pike to a large size, many of these fish may contain high levels of mercury, so this argues strongly that catch and release fishing

should be done for these valuable top predators in the lake. They can then contribute to controlling the forage fish populations and provide recreational opportunities for the sport fishermen over and over again.

Lake herring averaged the following lengths (in inches) at given ages (data from Table 2, Appendix 1):

Age (Yr)	Runyan Lake Average TL	Michigan Averages
1	7.6	9.0
2	8.8	9.6
3	8.7	10.3

It appears, like several other species of fish in Runyan Lake, that growth of lake herring is reduced compared with state averages. This could be due to the lack of adequate control by an overfished northern pike population or production of a large year class of lake herring recently due to favorable weather, allowing production of a large population of lake herring, which in turn are reducing their food supply. This is not of great concern.

Fish Survey

As part of the lake study in 1995, questions about fishing were sent out to residents (Table 4). Many replied and we attempted to summarize those answers in Table 4, while the comments were summarized in Table 5. These questions were used to alert us to concerns about the lake and what fishermen who spend large numbers of hours on the lake may have learned to assist us in making recommendations tailored for Runyan Lake. We thank all those who took the time to answer our questionnaire.

Table 4. Results of a mail survey to residents of Runyan Lake. Given first is the question asked of residents, second is the answer that was most frequently given.

Questions asked of Runyan Lake Residents:
55. Are you a fisherperson? yes no. If yes, answer questions 56-66
56. Do you do most of your fishing during the summer or winter or split your time between both?. What species do you generally catch during the summer and what species do you generally catch during the winter? **Answer:** Most Fishing In Summer
57. Have you ever caught any walleyes? if so, when, about how many, and what sizes? **Answer:** 14 Walleyes Caught In Last 10 Years
58. Have you caught any walleyes in 1995? **Answer:** No Walleye In 1995
59. Have you caught any northern pike or largemouth bass in 1995? if so, about how many and what sizes? **Answer:** Mostly Bass And Few Northern Pike
60. Do you think that the panfish (pumpkinseed, bluegill, green sunfish) fishing has been good this year? **Answer:** Panfishing Generally Good
61. Have you caught any crappies in 1995? if so, about how many and what sizes? **Answer:** Few Black Crappies Caught Often
62. Do you practice "catch and release" fishing or do you keep the fish you catch? **Answer:** Mostly Catch And Release; Some Both
63. Have you ever caught or observed other species of fish, such as smallmouth bass, bowfin or dogfish, longnose gar, or lake herring, a whitefish species? when, what size, and how many? **Answer:** Other Species:golden shiner, bowfin, longnose gar, lake herring, smallmouth bass, catfish.

Table 4. Continued.

Questions asked of Runyan Lake Residents:
64. What fish populations seem to be down and which ones seem to be ok? **Answer:** Fishing Down To Average
65. What sort of fish management efforts would you like to see implemented on Runyan Lake? **Answer:** A. Stock smallmouth bass, walleye, lake trout, and muskellunge B. Catch And Release C. Slot Limits D. Is mercury a concern? E. None F. Non-residents Off Lake G. Conflict Between Fisherman And Boats
66. Have you observed any fish kills or dead fish during the summer or winter? what species were involved? **Answer:** Some Noted Spring, Summer

Table 5. Summarized Comments Made By Residents Of Runyan Lake In A Survey Sent Out During 1995.

Resident Comments:
-Sewage Spill In 1995
-Test Soils For P Content
-Use P-free Fertilizer
-Green Belts, Leaf Burning
-Discourage Break Walls
-No Fowl Hunting Advocated
-Use Conflicts:fisherman Vs. Skiers
-Advocate Working Together -Lovely Thought!
-Concern About Oil Or Gas Spill
-Lake Has Not Changed That Much
-Plant Control In Beaches; Rake Them
-Multiple Use: Boating First, Fish And Water quality 2nd
-Sand Bars To Be Removed
-Discourage Ducks And Geese
-Sewers Good For Lake:observed Improvements

Some interesting responses were made to our questionnaire. We will try to address and summarize these responses in the following paragraphs. From what we got back, most fishing occurs in the summer, but there is a considerable fishery in the winter as well, especially for black crappies, northern pike, and to a lesser degree yellow perch and bluegills.

As most are aware, an experimental stocking of walleyes was done in the past. These were large fish and we were called in after they were stocked because of a report of many dead "largemouth bass". The largemouth bass turned out to be walleyes, some of which died after the long trip to the lake, stress, or prior infections. One of the questions we were concerned about was whether this experiment was successful, which is measured by fishermen success. From the responses we got about 14 walleyes were caught over the last 10 years; none were caught by responding fishermen in 1995. This is not a success and we conclude that walleyes should probably not be stocked in the lake for two reasons: they gave poor return rate in the past, they are not native to the lake and we would like to see native species, those that evolved in this lake and which are adapted to those conditions, be encouraged. This also extends to other exotic predators, such as muskies and trout. Trout would be especially threatened because of the sometimes marginal dissolved oxygen conditions.

Fishermen generally catch largemouth bass and a few northern pike. A common problem with small lakes, is that overfishing of top predators can easily occur because of the large number of hours that these fish are sought, because of friends and outsiders who come in and have no regard for the

fish population and remove fish, and because large piscine predators are susceptible to overfishing in these situations. Catch and release fishing and stocking of northern pike may be the solution to assist in balancing the predators and prey in the lake.

We caught a good number of sunfish and they were growing at or slightly below state averages. Fisherpeople also thought that the panfishing was generally good to adequate, confirming that at least they seem to be providing a fishery for those wishing to catch these fish. We would encourage fishermen to catch and eat these fish, as they have a tendency to overpopulate a lake and with reduced predation from top predators, this problem may be exacerbated.

There is a modest population of black crappies in the lake, since some are routinely caught, apparently more often in winter. Fishermen are already practicing mostly catch and release of top predators, some keep a few fish and release others.

Several "other" species of fish were reported as being observed or caught including: golden shiners, bowfin, longnose gar, lake herring, smallmouth bass (this is questionable, we think they were mis-identified), white sucker, and catfish (we think these are probably bullheads, either yellow or black bullheads which are in the catfish family). There is no evidence that there are any true catfish (channel catfish with a deeply forked tail) in the lake at this time.

We were somewhat surprised to find that several fish kills have been observed in the lake. It is not uncommon to find dead fish in the spring that did not overwinter or sometimes a disease outbreak will kill a number of fish. There was also a sewage spill reported which has implications for evaluating the water quality of the lake and for fish kills.

Overall the consensus of fisherpersons was that fishing success was down to average for Runyan Lake. Many solutions were suggested to correct the fish management "problems" in Runyan Lake including:

A. Stock smallmouth bass, walleyes, lake trout, or muskies.
B. Catch and release fishing
C. Slot limits
D. Mercury analyses of fish
E. None required
F. Keep non-residents off the lake
G. Reduce the conflict between fishermen and boats and jetskis.

We eschew the thinking that "stocking" fish can solve a problem. Stocking fish is a viable fish management technique that requires specific conditions before it should be invoked. Generally fish are stocked into lakes that have been reclaimed to renew the fish population, that prior to

that time may have been dominated by rough fish. It was used as a short term solution to controlling alewives in the Great Lakes, and it can be used to bolster a top predator population if natural reproduction is depauperate. All of the species suggested for stocking can be considered "exotic" flashy fish, and all of them except muskies and smallmouth bass, are adapted for cold "oligotrophic" (those low in nutrients and having vast areas of cold water, such as Lake Superior) lakes. Muskies may do well in the lake, but again it is not native, will probably not spawn in the lake, and there would be a whole raft of people that would be tempted to come and fish the lake if they knew muskies were present. Go to some other lake that has them present if there is a thrill for making the 1000 casts to catch one. Therefore in the case of Runyan Lake, we would like to determine if the northern pike population is spawning and that there is natural reproduction going on. This can be ascertained by having fishermen report any small pike caught and released (make sure they are not grass pickerel which have a short black vertical bar on their cheeks) and by checking whether there is a spring spawning run after iceout. If it is shown that there are two few fish present, stocking of northern pike is a recommended solution to upgrading the northern pike population in Runyan Lake.

Catch and release fishing is also recommended to the general fishing public on the lake. It takes a very long time to grow a large bass or pike, they are critical keystone predators in the aquatic ecosystem, and they are also probably contaminated with mercury anyway, so they should be released. Regarding the mercury problem, some analyses can be done, should that be desired, however, fish of large sizes (bass over 15 inches and pike over 20 inches) will probably exceed the Michigan guidelines of 0.5 mg/kg (see your fishing guide), so fish consumption should follow the rule of no more than one meal a week of these fish. This is a problem with inland lake fish throughout Michigan and is due to air deposition of mercury on the watershed, from coal burning and garbage incineration across the nation. Dispose of your batteries which contain mercury, in a recycle program; do not send them to a landfill (mercury can volatilize from the batteries) or to an incinerator.

There were several suggestions that no fish management is required and that may be an alternative to consider as well. Apparently a modest group of people think that the fish population is in good shape, which we also share. It appears that the only glaring problem we are aware of is the northern pike spawning conundrum.

The last two suggestions involve human influences and behavior problems. The first is a concern that non-residents are coming to the lake and fishing and that residents are allowing friends onto the lake. These can then increase conflict among the resident users because of increased boat traffic leading to safety problems and the concern that fish are being caught and not thrown back by

these people who have no attachment to the lake. This is a problem, the extent of which is difficult for us to evaluate. It should probably be addressed through some kind of board action to determine the rules for guests and enforcement of the non-resident rule. In some lakes, associations have given out large stickers for placing on boats so that resident and non-residents can be discriminated.

Secondly, there was a large response from people on this question and in the comments section (Table 5) about conflict between fishermen and boaters and the other closely related problem of jet skiers. It would seem clear to us that some type of guideline to start with should be enacted to preserve the lake for fishermen in the morning and evening hours, times when skiing and jet skiing can be dangerous because of reduced lighting conditions. Again this is a board issue that should be addressed. Permanent rules could be established if the guidelines work to reduce conflict.

RECOMMENDATIONS

CATCH AND RELEASE FOR TOP PREDATORS; KEEP PANFISH IF DESIRED

Fish are doing very well in Runyan Lake. There is a diverse population of game fish (24 species total at least in the lake) and growth is generally good. Because of the decline in dissolved oxygen from the hypolimnion (bottom strata of the lake) in the summer, there is some loss of habitat that will be experienced by the lake herring, benthic fish, and large predators in the lake, especially northern pike, which require cold water to grow well. In addition, we have been quite concerned about the fate of lake herring, which are indicators of oligotrophic (low nutrient) lakes. Even back in 1977, we expressed concern for these fish, as any further deterioration of the lake water quality of the bottom waters during summer would result in their demise. This has been averted and comparisons with the dissolved oxygen data of the past indicate that conditions have actually improved; however, several years of data should be examined before a definitive conclusion can be reached. For example, the type of year (whether a cold year or hot one) can affect the amount of dissolved oxygen depleted from bottom waters, but indications are in the right direction. During 11 August 1977, when Freshwater Physicians monitored the dissolved oxygen at the deep basin in mid lake (station K), there was 4 mg/L at 35 feet, and it was anoxic (no dissolved oxygen) at the bottom. Progressive Engineering data from the same station on 4 August 1995 showed levels of 7.6 mg/L at 30 feet, 7.0 mg/L at 40 feet, and 0.2 mg/L on the bottom. If these relationships hold up, it is positive proof that water quality conditions in the lake have improved over the ca. 20 years since our dissolved oxygen data were collected. One

recommendation to the fishermen is to try to exploit the lake herring population. Ice fishing for this species can be a rewarding activity. We have heard of reports of fishermen who used their fish finders in the fish house and they could monitor fish movement, determine which depth to fish at, and even see the fish bite their lures.

We encourage catch and release fishing for the top predators, first because they can be caught again, they are important in maintaining healthy forage fish populations, and thirdly the large ones probably contain high levels of mercury anyway. Panfish should be kept or killed to promote better growth of surviving fish. Brook silversides are at all time high population levels; they provide an excellent food supply for top predators of intermediate sizes and therefore are very important in transferring energy up the food chain.

DO NOT PLANT ANY WALLEYE

As noted in the text, the walleye experiment has been a failure, since few were caught and dissolved oxygen conditions may have been marginal anyway. They should not be seriously considered for this lake.

DOCUMENT NORTHERN PIKE SPAWNING

Northern pike are important top predators in the lake, they may be overfished, and we need to know if successful spawning is occurring. Once this is determined, then we would or would not support stocking fish. The normally recommended rate is two fish per acre of the largest size that can be afforded. They should be at least 6 inches or larger to avoid ending up largemouth bass food.

EXPLORE WAYS TO REDUCE USE CONFLICTS

Obviously there is considerable concern about conflict between fishermen and boating activities, including jet skiers. We recommend that the board seriously consider bringing this issue up at a meeting and enact some type of temporal guidelines to separate fishermen from skiiers and jet skiiers. Compromise and safety should be paramount goals in this endeavor.

TREAT PLANTS CONSERVATIVELY; PRIME FISH HABITAT

Aquatic plants are very dense in some places in Runyan Lake, causing residents concern about what to do to obtain a useful beach or boat access. Our recommendation is that the *Chara* (a green alga) should be protected and not treated as it can take up nutrients and prevent other more noxious plants from being established. They can be raked from a beach area. Plants are very important fish habitat, they provide food in the form of aquatic insects, shelter, and

are used for spawning substrate and as a nursery for fish. We recommend minimal elimination or control of plants in areas of high use or to gain egress to the lake. Mechanical harvesting is the treatment of choice since they remove the plant material from the lake, thereby retarding sediment buildup, and they do not involve killing the plants with a chemical. Chemical treatment can also be used in areas where a harvester cannot be used. Conservative should be the watchword in the control of plants.

CONTINUE IMPLEMENTATION OF NUTRIENT REDUCTION STRATEGIES

Nutrients (fertilizers) cause the enrichment of Runyan Lake. A major source of input has been controlled with the installation of sewers around the lake. The environmental awareness must continue, as with the battery (contains mercury) recycling recommendation. In addition, the other sources of input, humans, runoff from residents, and the incoming streams need to be addressed. Remember that all residents live in the watershed and that everything that is dumped on the land has the potential to end up in the lake through runoff. A whole raft of recommendations apply here and include such activities as greenbelts, low phosphate car soaps, no leaf burning, no drains into the lake, and careful monitoring of development in the watershed and input streams. These activities directly contribute to nutrient reduction, which in turn reduces the amount of plant production and hence organic matter which can decompose and cause dissolved oxygen depletion from the bottom of Runyan Lake.

SUMMARY

1. WATER QUALITY

Water quality has generally improved based on a comparison of 1995 with previous data. More data are required to confirm this trend, but results are very encouraging.

2. AQUATIC MACROPHYTES - *CHARA* SPP.

Aquatic plants should be controlled judiciously, with *Chara* protected wherever possible. Harvesting mechanically is recommended, with chemical control used only as a last resort in places where harvesting is not practical.

3. FISH

A. Fish Diversity - High, 24 Species
B. Fish Growth - Good generally, below average in some
C. Lake Herring - Excellent numbers present
D. Walleye - Missing, few caught in past
E. Northern Pike - Determine successful spawning; stocking may be required
F. Brook Silversides - Very abundant, important forage for largemouth bass and other piscivores.

4. CONFLICTS ON LAKE USE

Attempt to resolve the concern expressed by fishermen and other residents that do not fish to eliminate the conflict between fisherman and boaters and skiers and express formally the communities' forboding regarding the sometimes unsafe use of jetskis on the lake.