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The Fish Population of Lake Poinsett, South Dakota, as Indicated By the Catch

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THE FISH POPULATION OF LAKE POINSETT, SOUTH DAKOTA, AS INDICATED BY THE CATCH OF FOUR TYPES OF GEAR

BY

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AS INDICATED BY THE CATCH OF FOUR TYPES OF GEAR

This thesis is approved as a creditable and independent investigation by a candidate for the degree, Master of Science, and is acceptable as meeting the thesis requirements for this degree, but without implying that the conclusions reached by the candidate are necessarily the conclusions of the major department.

Thesis Advisor — Date

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ABSTRACT

Gill nets, trap nets, an otter trawl, and a boom-type electric shocker were utilized to obtain samples of the fish population of Lake Poinsett, South Dakota. The species and size composition of the samples differed significantly with time of season, time of day, location on the lake, and type of gear.

Decreased activity following spawning was the apparent cause of a midsummer decline in gill net and trap net catches of black bullhead, black crappie, and white crappie. A late summer increase in the catch of yearling black bullheads, crappies, white bass, carp and bigmouth buffalo was attributed to an increase in activity or change in behavior pattern.

Diurnal migrations were felt to be the cause of diel differences in catch rate of species taken by the trawl and shocker. Different age classes of fish apparently vary in their activity patterns.

Uneven distribution of the population caused differences in the catch of each type of gear at different locations on the lake.

Types of gear differed in their effectiveness for different species and sizes of fish. Each type of gear indicated a different population structure. Gear selectivity resulted from differences in fish behavior and physical characteristics of the sampling gear. The results of the study indicated that: interpretation of population samples should be based on knowledge of the habits of species in the population, characteristics and limitations of the sampling gear,

and of the body of water being sampled; collection of samples should be intensive and over a relatively long period of time; all habitats should be sampled; and at least two types of collecting gear should be used.

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INTRODUCTION

Fishery managers frequently base management recommendations for a lake on a few "test nettings." Estimates of population parameters based on limited samples may be extremely biased due to gear selectivity. Accurate interpretation of a population sample requires that the limitations of the sampling method be understood. It is necessary to know how the catch by a type of gear is influenced by species, size of the fish, time of day or season, or habitat type.

To evaluate the selectivity of a gear it would be most desirable to compare the catch to a known population or to make an absolute population determination after sampling. This is difficult to accomplish and very few studies have been attempted. Schumacher and Eschmeyer (1943) found that population estimates by mark and recapture using hoop nets varied considerably from the actual population found when the impoundment was drained. O'Donnell (1943) compared the catch by fyke nets to the total population determined by complete eradication with rotenone. He found that the nets varied in efficiency for different species. Hall (1956) fished gill nets, trammel nets, hoop nets, and a wing net in a small impoundment prior to eradication with rotenone. He found that the efficiency with which a species was taken varied with the type of net. Sanderson (1960) sampled the fish population of a small impoundment with electrofishing gear, catfish traps, seine, and by spot poisoning. He found that the relative abundance of the species as indicated by samples collected by each method differed considerably. Latta (1959), using a different approach, found that trap nets were selective for both size and species by comparing the number and average length of recaptured fish to the number and average length of fish marked and released. Forney (1961) compared the age distributions of walleyes taken by five types of gear to determine if they were selective for size. He found that samples collected in the summer with gill nets, trap nets, trawl, and angling were not significantly different from those collected during the spring spawning run by trap nets while samples collected with trap nets in the fall and by angling in the winter were more selective for older age classes.

The present study compares the catch by four types of gear commonly used by fishery managers in the evaluation of lake fish populations. There were three main objectives at the outset of the study:

1) To determine if samples differ significantly with time of day or season, location within a lake, and collection method;
2) To determine what factors affect or cause gear selectivity;
3) To determine the relationship of the catch by a type of gear to the actual population.

Lake Poinsett is located in east central South Dakota in the northwest corner of Brookings County and the southeast corner of Hamlin County. It is the terminal lake in a chain of eight lakes composing a natural drainage system into the Big Sioux River. It is approximately 3200 hectares in area and has a maximum depth of 5.5 meters. The lake basin is almost bowl-shaped in cross-section and oval in outline with a smooth, regular shoreline (Fig. 1). The water depth increases rapidly from shore to a depth of about 4.5 meters over most of the lake.

Dry Lake connects with Lake Poinsett from the north under Stone Bridge. In 1929 a canal was dug from the Big Sioux River to the north end of Dry Lake. Water entering the canal eventually flows into Lake Poinsett and returns via the outlet on the north end of the lake to the river. The original purpose of the canal was to maintain the water level of Lake Poinsett during dry years.

Three major types of shoreline are found on the lake. The northwest and northern shores are mostly coarse sand with some gravel. The southeast shore is composed of rubble-sized material. Large boulders line the shores of the southwest end and part of the southeast side and northeast end of the lake. Sand and rubble are the dominant types. The shore material extends only a short distance out into the lake. Scattered boulders are found in deeper water out from the rock shoreline.

The bottom of the lake is predominantly sand, silt and organic material. Samples of bottom material have a strong odor of decaying matter. Rooted aquatic vegetation is scarce except for that found in the outlet channel.

High concentrations of nitrates and phosphates indicate that Lake Poinsett is eutrophic. Schmidt (1967) studied the water chemistry and his data is summarized in Table I. Eddy (1963)

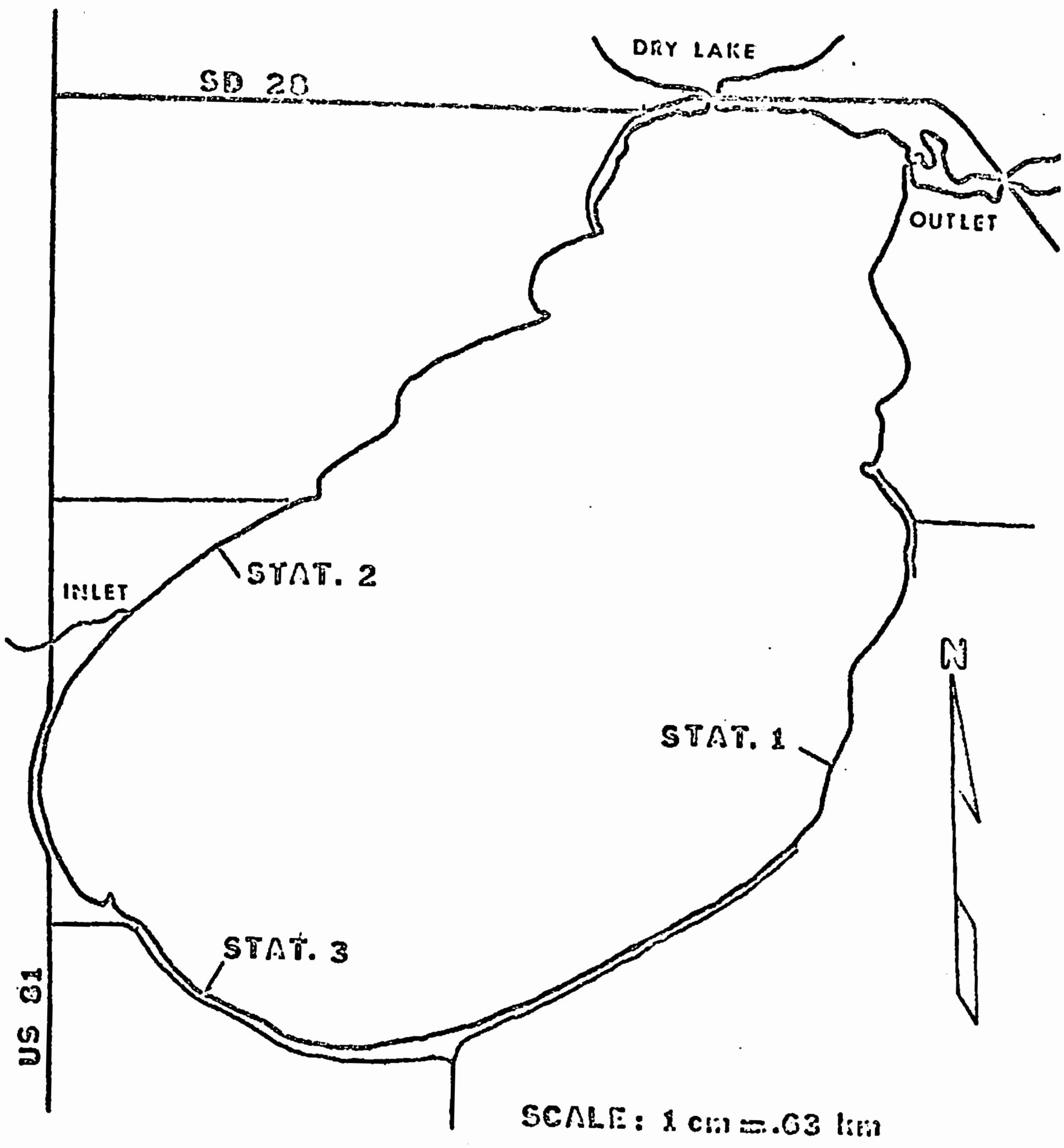

Fig. 1. Map of Lake Poinsett, South Dakota.

Table I. Chemical and Physical Characteristics of Lake Poinsett, South Dakota

	Mean[1]
Carbonate alkalinity (mg/l)	44.5
Bicarbonate alkalinity (mg/l)	181.7
Nitrates (mg/l)	0.7
Phosphates (mg/l)	1.5
Sulfate ion (mg/l)	222.0
Chloride ion (mg/l)	41.5
pH	8.6
Turbidity (J.T.U.)	41.0
Specific Conductance (micromhos/cm @ 25° C)	1033.7

[1] Mean of values obtained from samples taken from August 1965 to June 1966

classified Lake Poinsett as an alkaline or saline lake. Dense phytoplankton, zooplankton, and fish populations are present.

Except for a short period in the spring the lake is very turbid (Table I). Much of the turbidity is due to churning of the bottom sediments by wave action. Water entering from the Big Sioux River and a large carp population may also contribute to the turbidity of the lake.

The dominant fish species[1] present and the abbreviations used in the text are:

Northern pike (NP)---------*Esox lucius* Linnaeus
Carp (C)-------------------*Cyprinus carpio* Linnaeus
Fathead minnow-------------*Pimephales promelas* Rafinesque
Spottail shiner------------*Notropis hudsonius* Clinton
Bigmouth buffalo (B)-------*Ictiobus cyprinellus* Valenciennes
White sucker (WS)----------*Catostomus commersoni* Lacepede
Black bullhead (BB)--------*Ictalurus melas* Rafinesque
Channel catfish (CC)-------*Ictalurus punctatus* Rafinesque
White bass (WB)------------*Roccus chrysops* Rafinesque
White crappie (WC)---------*Pomoxis annularis* Rafinesque
Black crappie (BC)---------*Pomoxis nigromaculatus* LeSueur
Walleye (W)----------------*Stizostedion v. vitreum* Mitchill
Yellow perch (YP)----------*Perca flavescens* Mitchill

Other species present were golden shiner (*Notemigonus crysoleucas* Mitchill), common shiner (*Notropis cornutus* Mitchill), trout-perch (*Percopsis omiscomaycus* Walbaum), orangespotted sunfish (*Lepomis humilis* Girard), and bluegill (*Lepomis macrochirus* Rafinesque).

Lake Poinsett is an important lake in the sport fishery of the area and is heavily utilized by fishermen. Black bullheads dominate

[1]Names of fishes according to Trans. Amer. Fish. Soc., Spec. Publ. No. 2, A List of Common and Scientific Names of Fishes From the United States and Canada, 2nd Edition, 1960.

the catch but during the spring and early summer crappies provide a substantial catch. Catches of perch, walleye, channel catfish, northern pike, and white bass are somewhat sporadic but at times these species also provide good fishing.

A heavy stocking program for perch, walleye, channel catfish, and northern pike has been carried out by the state since 1937. Bluegill, largemouth bass, white bass, crappies, and black bullhead have also been stocked. The bluegill and largemouth bass introductions have been unsuccessful.

A fall and winter commercial seine fishery for bigmouth buffalo and carp operates on the lake. The harvest of buffalo averaged 69.7 kilograms per hectare per year from 1961 to 1967. The carp harvest averaged 17.5 kilograms per hectare per year for the same period.

Lake Poinsett is subject to severe winterkill on the average of once every 10 years. The last severe kill occurred during the winter of 1955-56. A light kill was reported in 1964-65. A large loss of bigmouth buffalo was associated with an outbreak of Argulus spp. in 1958.

METHODS

Three sampling stations were chosen; one station located off each of the three types of shoreline on the lake (Fig. 1). Station 1 was located off the rubble beach on the southeast shore about 1.6 km northeast of the state public access area; Station 2 off the sand beach about 0.8 km northeast of the inlet from Lake Albert; Station 3 off the rock shoreline at the southwest end of the lake about 1.1 km southeast of Mundt's Point. Each station was marked with two oil drums; one placed at each end of the gill nets to mark the sites and warn boaters.

Each type of gear was fished in the same manner at all stations following a predetermined sampling schedule. A random stratified sampling schedule was designed so that the number of samples taken with each gear would be equal, and also that the number of day samples would equal the number of night samples for the trawl and shocker. The summer (June 5, 1967 - Sept. 2, 1967) was divided into seven 6-day sampling periods with eight days between periods. Three samples were taken with the trawl and three with the shocker during each sampling period. Samples taken with these two gear were alternated between day and night so that in two consecutive sampling periods three day samples and three night samples were obtained with each gear (Table II). Trap nets and gill nets were fished only at night because of heavy daytime boating activity. Sets were made every other night starting with the first night of each period. To avoid

Table II. Sampling Schedule For Electric Shocker and Otter Trawl

Sampling Period	Date	Time of Day	Day of Week					
			Mon	Tues	Wed	Thurs	Fri	Sat
1	June 5 - June 10	Day	T[1]		S		T	
		Night		S[2]		T		S
2	June 19- June 24	Day	S		T		S	
		Night		T		S		T
3	July 3 - July 8	Day	T		S		T	
		Night		S		T		S
4	July 17- July 22	Day	S		T		S	
		Night		T		S		T
5	July 31- Aug. 5	Day	T		S		T	
		Night		S		T		S
6	Aug. 14- Aug. 19	Day	S		T		S	
		Night		T		S		T
7	Aug. 28- Sept. 2	Day	T		S		T	
		Night		S		T		S

[1] T = Trawl

[2] S = Shocker

competition between gear fished simultaneously the nets were not fished on the same nights as the trawl or shocker.

A 7.3 meter semi-balloon type otter trawl was used. The body and cod-end were constructed of 1.91 cm and 1.27 cm (bar measure) nylon mesh, respectively. The trawl was towed with a 5.5 meter outboard boat powered by a 100 hp engine. Towing speed was kept constant by operating the engine at 3000 rpm when making all samples. A sample with the trawl was obtained by making four 5-minute tows parallel to the shoreline at each station. Each successive tow was made in water about 0.6 meters deeper than the previous tow. Depth was determined with an echo sounder. At Station 1 the first tow could be made close to shore in water about two meters deep. At Stations 2 and 3 the trawl could not be operated closer to shore than about 200 and 75 meters respectively, or a depth of about 2.6 meters, due to underwater obstructions.

Electrofishing was accomplished using a boom-type DC electric shocker similar to that described by Sharpe (1964). Power supplied by a 2500 watt AC generator was converted to DC by a silicon diode rectifier. Current output to the electrodes was controlled with a rheostat. A current of five amperes and potential of 100 volts was used. To obtain a sample the shocker was fished for 30 minutes at each station. The shocker was run slowly along the shoreline for 15 minutes in one direction then run for the same length of time in the opposite direction along the same shore. A distance of about 0.5 km was covered in a 15 minute run. The first pass was made close to shore and the return trip further out. All sampling was done in water less than two meters in depth.

The trap nets used were constructed of two rectangular frames 0.8 meters by 1.1 meters which formed the trap mouth. A throat was located between the frames in the mouth of the trap. The body of the trap consisted of two hoops 0.6 meters in diameter and a single throat. Leads on the traps at Stations 1 and 2 were 26 meters long by 0.8 meters deep. The lead on the trap at Station 3 was 17 meters long. Both leads and traps were made of 1.91 cm mesh (bar measure). A shorter lead was used at Station 3 so that the top of the lead would not be so deeply submerged due to deeper water at that station.

The gill nets used were standard experimental nylon gill nets, 38.1 meters long by 1.83 meters deep (mesh 1.91 cm - 4.45 cm, bar measure).

Trap nets and gill nets were set just before sunset and pulled at sunrise the following morning. Trap net leads were anchored at the waterline and the traps stretched outward at a right angle to the shoreline. Gill nets were set about 60 meters out from shore at a right angle to the shoreline. At Stations 1 and 2 the shallow ends of the gill nets were set in water 1.8 meters deep. At Station 3 the depth was 2.5 meters. If a gill net was badly damaged it was replaced so that the efficiency of the nets remained constant.

At each sampling time the following information was recorded: gear used; station number; weather conditions and water temperature; total length in centimeters for all fish except black bullheads and crappies, carp, buffalo, and white bass of the 1966 year class. Preliminary work showed that crappies, carp, buffalo, and white bass of the 1966 year class could be easily separated from other year classes. These fish were counted and recorded by species. Black bullheads were counted and placed in three size classes. Adjustments in the size ranges of the classes were made to compensate for growth during the sampling season.

RESULTS

The catch by the four types of gear was composed of eleven species. Each species was divided into either two or three size classes. Size ranges for the classes were chosen primarily to emphasize the differences in the size composition of the catch taken by each gear. To a considerable extent the size classes also represented dominant year classes in the population.

The carp population consisted of two dominant year classes, the 1966 and 1961 year classes. A weak 1965 year class and a few members of the 1960 and older year classes were also present. Size Class 1 (0.0-24.9 cm) represented the 1966 year class, Size Class 2 (25.0-39.9 cm) the 1965 year class, and Size Class 3 (40.0 cm +) the 1961 and older year classes.

The bigmouth buffalo population was dominated by the 1966 and 1961 year classes. Several weaker year classes were also present. The size classes for bigmouth buffalo were the same as for carp and represented the same year classes.

Two size classes were used for white sucker: Size Class 1, 0.0-29.9 cm; Size Class 2, 30.0 cm and longer. These size ranges were chosen because of a break in the length-frequency distribution at this point. The age structure of the population was not determined.

The black bullhead population consisted of three dominant year classes: 1966 (Size Class 1), 1965 (Size Class 2), and 1964 (Size

Class 3). The age structure of the population was determined from a length frequency distribution of fish collected the previous fall (Fig. 2).

The white bass population was dominated by two year classes, the 1966 and 1964 year classes. Size Class 1 (0.0-29.9 cm) represented the 1966 year class, Size Class 2 (30.0 cm and longer) the 1964 and 1963 year classes. Only a few Size Class 2 fish were taken during the study.

The white and black crappie populations were dominated by two year classes, the 1966 and 1963 year classes. A weak 1965 year class and a few members of the 1962 and older year classes were also present. Size Class 1 (0.0-14.9 cm) represented the 1966 year class, Size Class 2 (15.0-34.9 cm) the 1965 and older year classes.

The walleye population consisted of six or seven year classes. Size Class 1 (20.0-34.9 cm) represented primarily the 1966 year class but also included a few smaller members of the 1965 year class. Size Class 2 (35.0-54.9 cm) represented the 1965-1962 year classes; Size Class 3 (55.0 cm and longer) the 1961 and older year classes.

The age structure of the yellow perch population was not determined. Large numbers of stunted perch from other lakes were released in Lake Poinsett throughout the summer by state work crews. Size Class 1 represented fish 0.0-19.9 cm in length; Size Class 2, fish 20.0-29.9 cm in length.

The age structures of the northern pike and channel catfish populations were not determined. All northern pike collected were

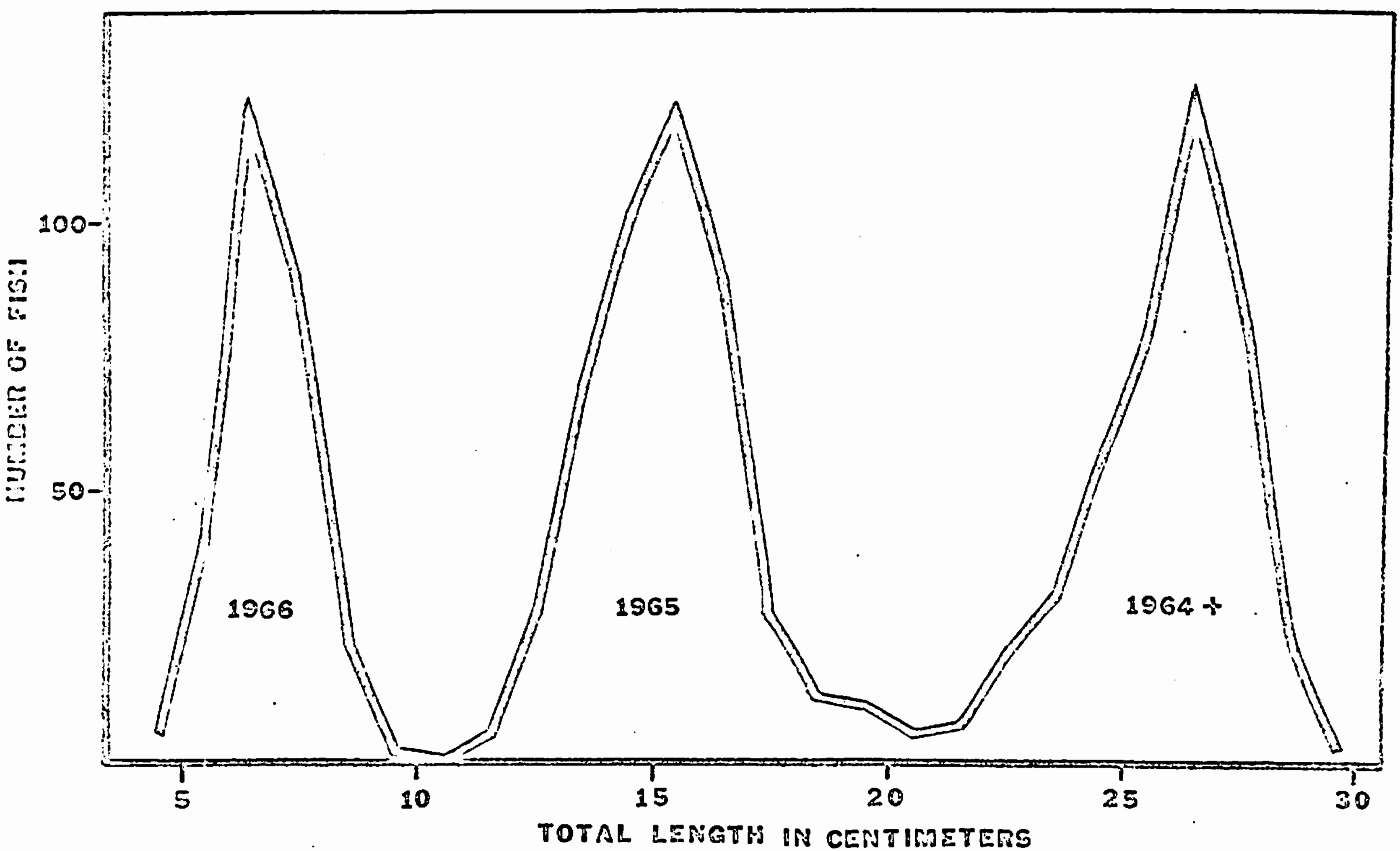

Fig. 2. Length-frequency distribution for black bullheads collected Sept. and Oct. 1966.

40.0 cm in length or longer. The channel catfish collected were either small fish under 15.0 cm in length or fish between 40.0 and 50.0 cm in length.

The terms yearling and adult, respectively, will be used in the rest of this report to refer to Size Class 1 carp, bigmouth buffalo, crappie, and white bass, and to Size Class 2 and/or 3 fish of the same species. This terminology is being used for convenience and does not necessarily refer to the sexual maturity of the fish.

Seasonal Fluctuation In Catch

The chi-square method was used to determine if the species distributions of the catch by each gear differed significantly between sampling periods. The comparisons showed that differences were highly significant (Table III). The differences in the species distributions were found to be a result of seasonal changes in catch rates of the species making up the catch. The catch rates for several species taken in the gill nets and trap nets showed seasonal trends which were particularly significant. It was also found that there were significant differences in the size composition of the catch taken at different times during the summer. The catch taken by the trawl and shocker tended to fluctuate without pattern but several species taken with these gear did show significant seasonal tendencies.

The gill net catch of carp tended to increase as the summer progressed but then declined in Period 7 (Table IV). The catch rate for adults was highest during Period 1 and then declined while the

Table III. Results of Chi-Square Comparisons of Species Distributions of the Catch By Each Gear By Sampling Period

Comparison		d.f.	Chi-Square	
Gill Net	Period 1 vs 2-7	60	2248.76	**
Trap Net	" "	48	5664.52	**
Trawl-Day	" "	50	2823.15	**
Trawl-Night	" "	45	2155.81	**
Shocker-Day	" "	42	437.38	**
Shocker-Night	" "	32	205.76	**

** Significant at the 0.01 level.

Table IV. Mean Total Catch Rate By Sampling Period For Carp and Bigmouth Buffalo Taken By the Gill Nets

	Mean Catch Per Set	
	Carp	Buffalo
Sampling Period 1	2.8	0.3
2	2.5	4.8
3	3.7	8.1
4	4.8	7.6
5	16.3	16.9
6	26.5	13.3
7	16.0	10.1

catch rate for yearling fish was lowest during Period 1 and then increased (Fig. 3). The catch rate for carp taken by the other gear tended to decline as the summer progressed. Most adult fish taken by the trawl were collected during the first five periods. Most carp taken by the shocker were collected during the first four sampling periods. All adult carp taken by the trap nets were collected during the first two periods.

The gill net catch of bigmouth buffalo tended to increase through Period 5 but then declined (Table IV). The catch rate for yearling fish tended to increase as the summer progressed while the catch rate for adults remained at about the same level (Fig. 4). Most of the adult fish taken with the trap nets and trawl were captured during the first half of the summer.

The gill net and trap net catches of white sucker were low during Periods 1-4, then increased through Periods 5 or 6 before declining in Period 6 and/or 7 (Fig. 5). Size composition of the catch remained fairly constant throughout the summer.

The catches of black bullhead showed the most extreme seasonal fluctuations. The catch rate for gill nets and trap nets was highest during Period 1, declined to a low in Period 3 or 4, and then increased. The trap net catch declined again in Periods 6 and 7 while the gill net catch tended to increase through Period 7 (Table V). The size composition of the catch changed significantly between Periods 3 and 4. The catch rate of Size Class 3 fish was lowest during the second half of the summer while the catch rate of Size Class 1 fish tended to

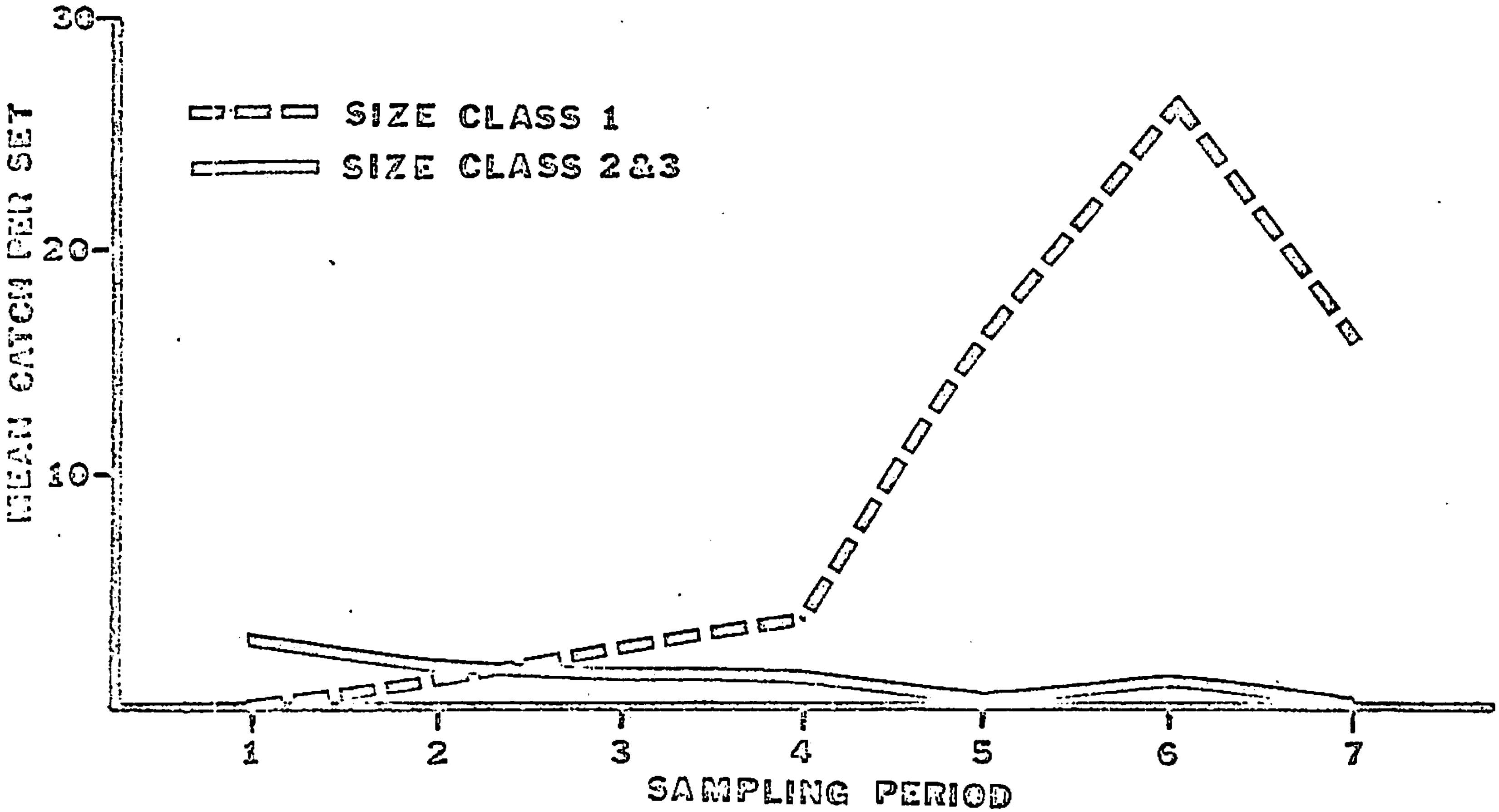

Fig. 3. Seasonal fluctuation of gill net catch of carp.

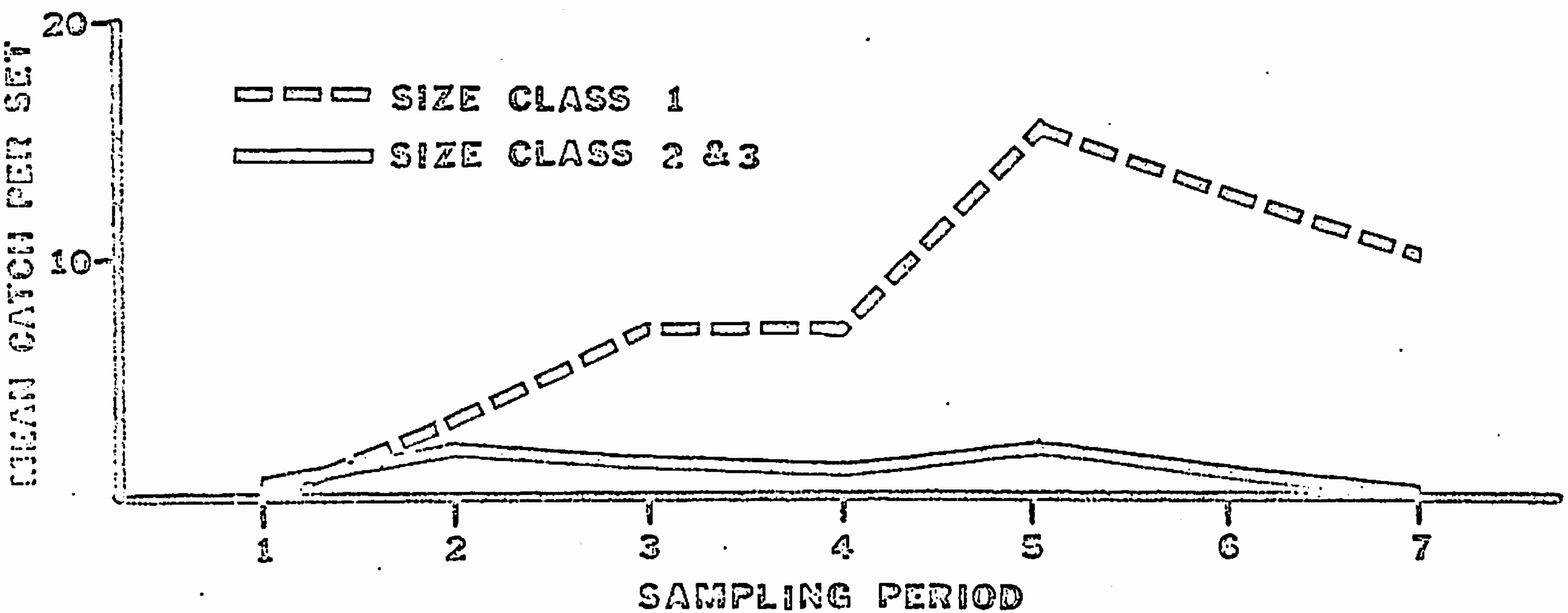

Fig. 4. Seasonal fluctuation of gill net catch of bigmouth buffalo.

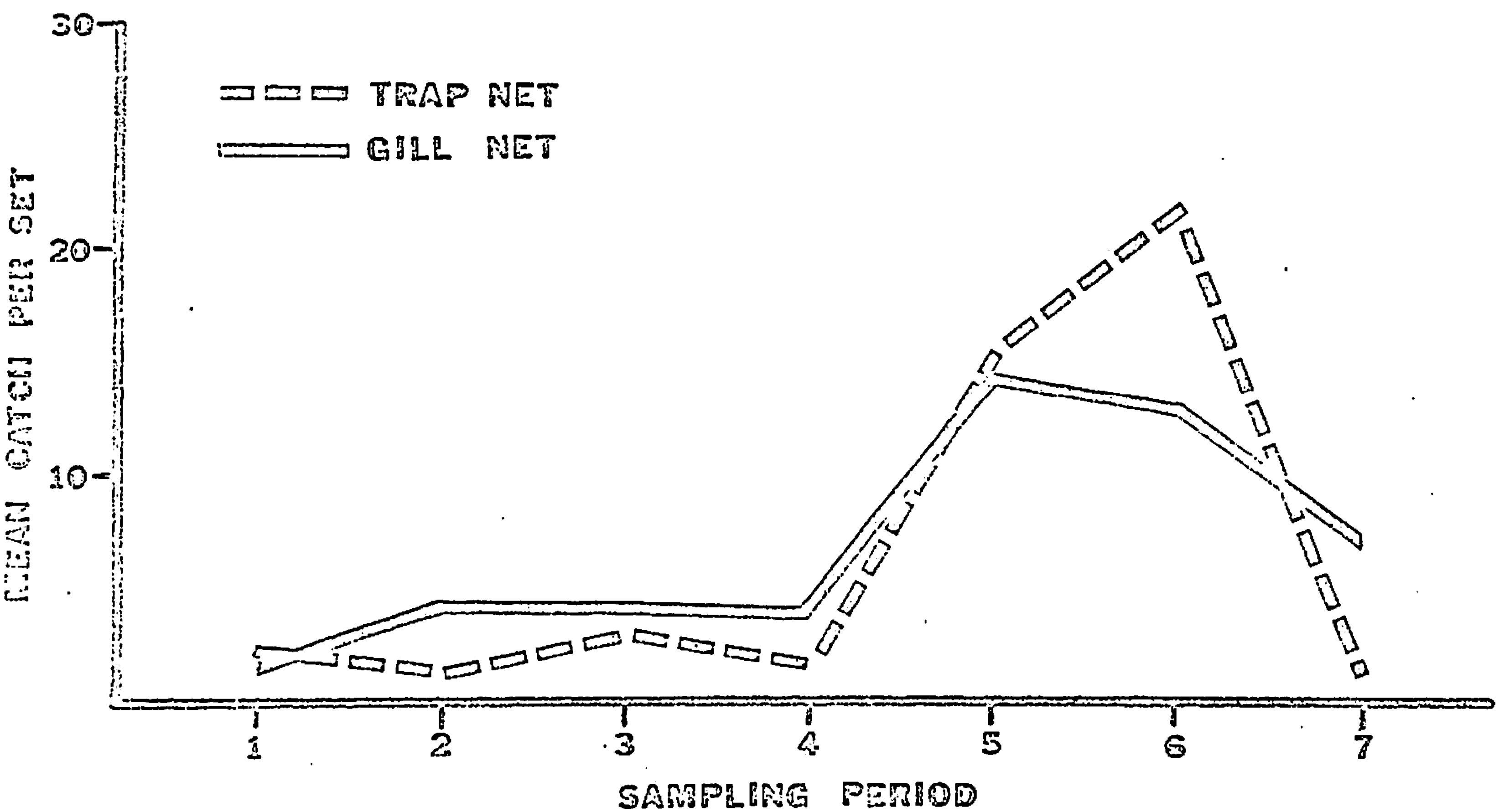

Fig. 5. Seasonal fluctuation of gill net and trap net catches of white sucker.

increase (Fig. 6 and 7). The catch rate for Size Class 2 fish was low and fluctuated very little.

The gill net catch of white bass increased from 2.3 fish per set during Period 1 to 18.3 fish per set during Period 6 then declined to 11.8 fish per set during Period 7. The catch rate represented mainly the catch of yearling as only 1.0 per cent of the total catch was composed of adult fish.

The trap net catch of white crappie fluctuated with no apparent trend (Table VI). However, significant changes occurred in the catch of individual size classes. The catch rate for adult white crappie was highest during Periods 1-3 and then began to decline. The catch rate for yearlings was lowest during the first three periods (Fig. 8). The gill net catch of white crappie tended to increase as the summer progressed. The catch rate for adult fish reached a high of 4.1 fish per set in Period 2 and then declined gradually to 0.0 fish per set in Period 7. The yearling catch increased from 0.0 fish per set in Period 1 to 39.9 fish per set in Period 6 before declining to 14.2 fish per set in Period 7. All but three white crappie taken with the shocker were collected during Periods 3 and 4 when concentrations of fish were found at Station 3.

The trap net catch of black crappie fluctuated throughout the summer (Table VI). The catch rate for adults was highest during early summer and then declined while the catch rate for yearlings

Table V. Mean Total Catch Rate By Sampling Period For Bullhead Taken By Gill Nets and Trap Nets

	Mean Catch Per Set	
	Gill Net	Trap Net
Sampling Period 1	148.5	379.6
2	49.2	189.7
3	12.5	43.4
4	25.9	38.1
5	127.1	225.8
6	79.1	114.0
7	200.0	37.7

Table VI. Mean Total Catch Rate By Sampling Period For White Crappie and Black Crappie Taken By Trap Nets

	Mean Catch Per Set	
	White Crappie	Black Crappie
Sampling Period 1	31.8	25.9
2	34.4	22.3
3	32.7	17.5
4	55.0	38.7
5	10.3	12.8
6	23.2	122.2
7	9.6	77.2

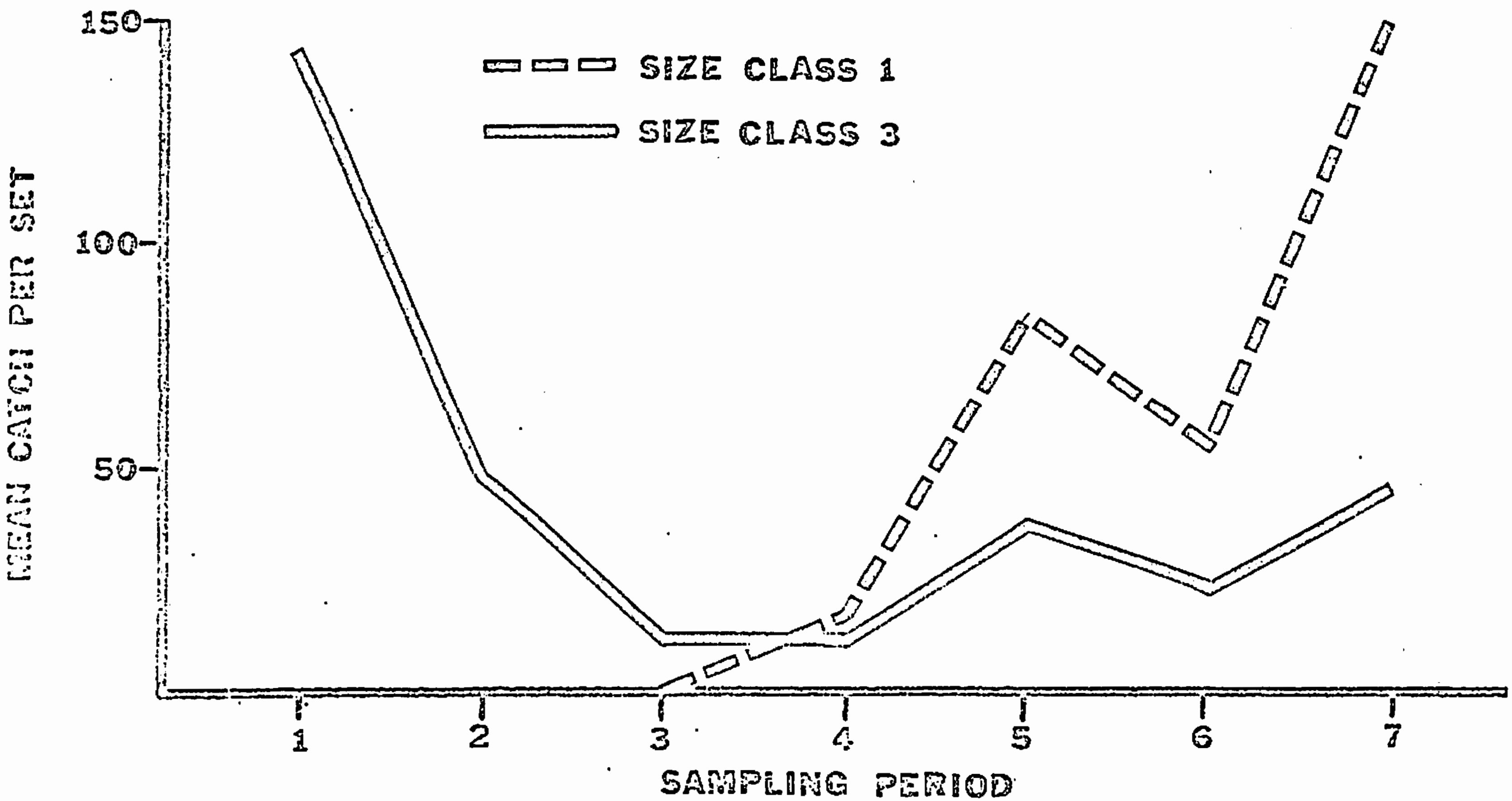

Fig. 6. Seasonal fluctuation of gill net catch of black bullhead.

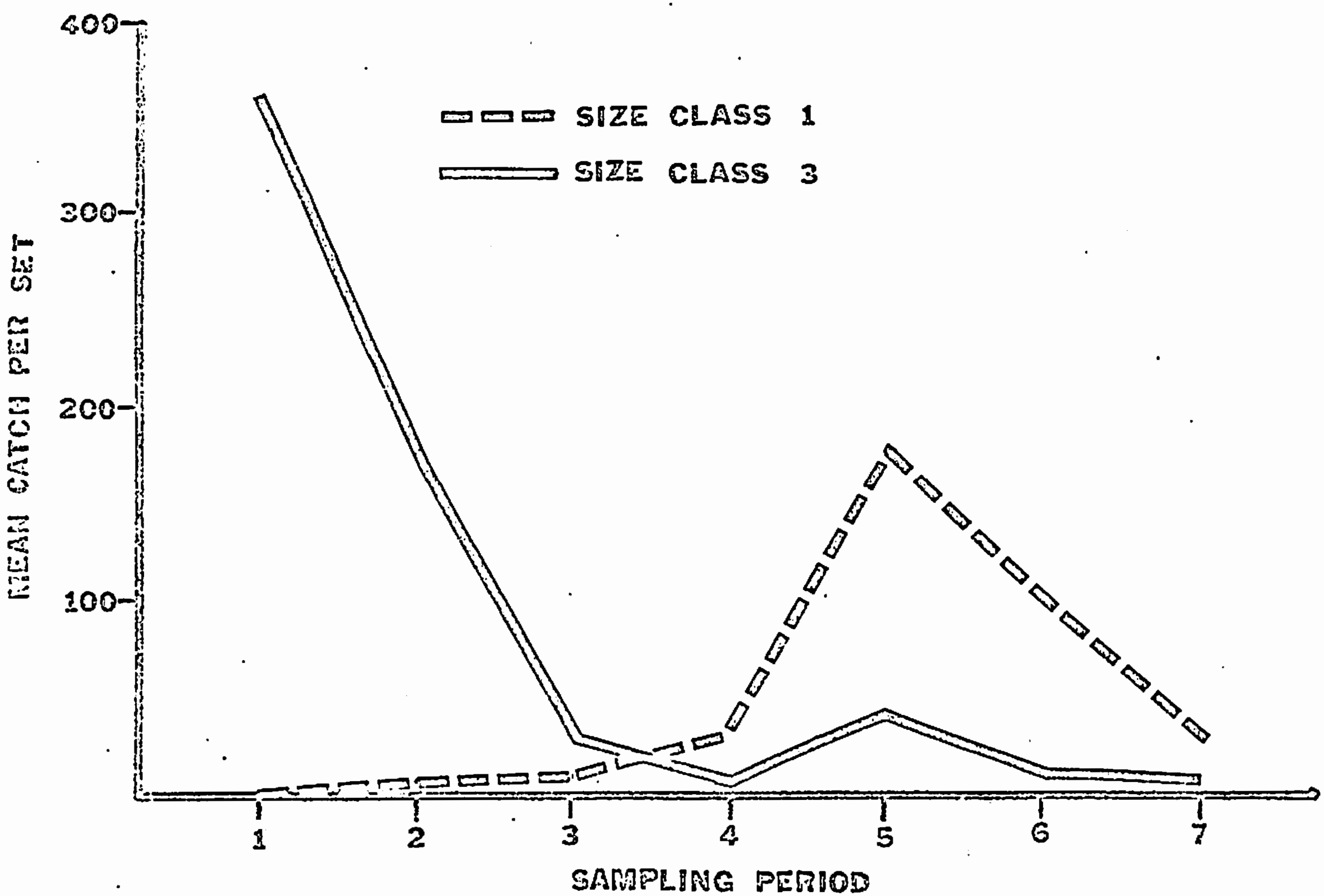

Fig. 7. Seasonal fluctuation of trap net catch of black bullhead.

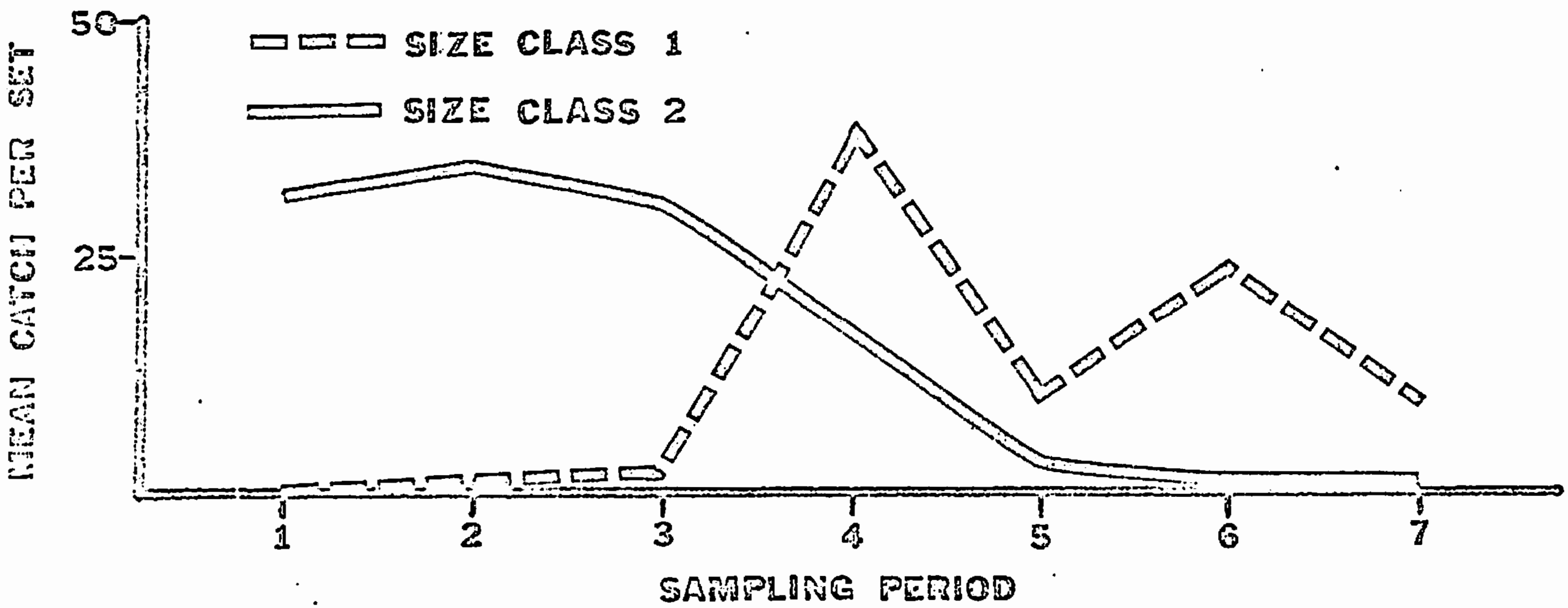

Fig. 8. Seasonal fluctuation of trap net catch of white crappie.

tended to increase (Fig. 9). The gill net catch of black crappie tended to increase as the summer progressed. Very few adult fish were taken. The catch rate for yearlings increased from 0.0 fish per set during Period 1 to 15.6 fish per set during Period 5 before declining to 6.7 fish per set during Period 7.

The gill net catch of walleye fluctuated between 10.1 and 29.8 fish per set (mean 22.3 fish per set). The catch rate for both size Class 1 and Size Class 2 fish fluctuated with no apparent seasonal pattern (Fig. 10). The catch rate for Size Class 3 fish was low (mean 0.3 fish per set) and fluctuated very little. Too few fish were taken by the other gear to determine if seasonal trends in the catch occurred.

There was no apparent seasonal pattern in the catch of yellow perch by any gear. Too few channel catfish and northern pike were taken to determine if seasonal trends occurred.

The pattern of seasonal fluctuation of the net catches of white crappie, black crappie, and black bullhead were quite similar. The decline in the catch of adults of these species was found to coincide with a 4° C increase in water temperature during Period 3 (Fig. 11). The decline in the catch of adult crappies also coincided with a apparent cessation of spawning activity. During Periods 3 and 4 most adult fish taken were ripe. After Period 4 most fish taken were spent. Spawning activity was also indicated by concentrations of crappies found during Period 3 and 4. Because of water turbidity it was not

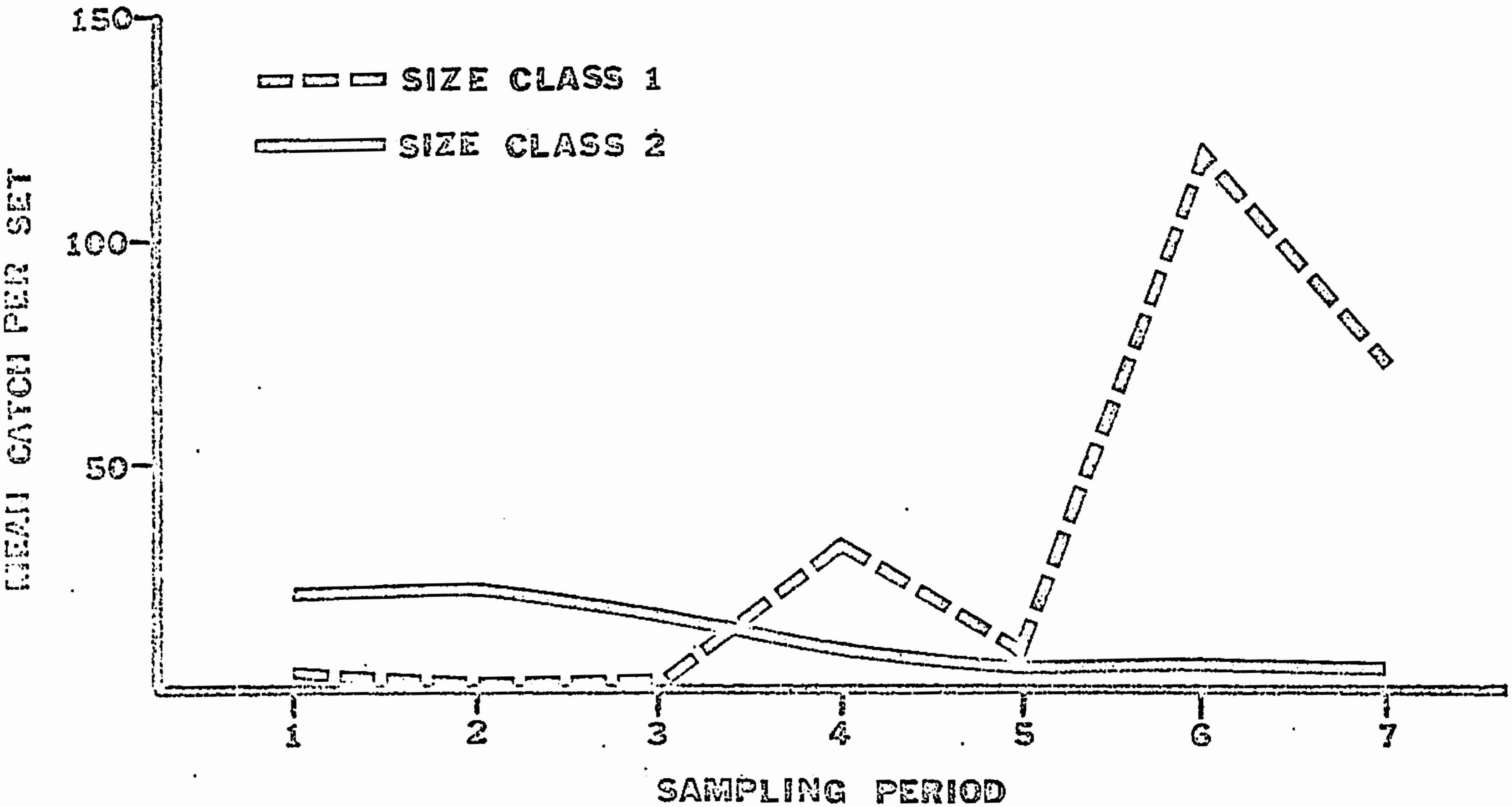

Fig. 9. Seasonal fluctuation of trap net catch of black crappie.

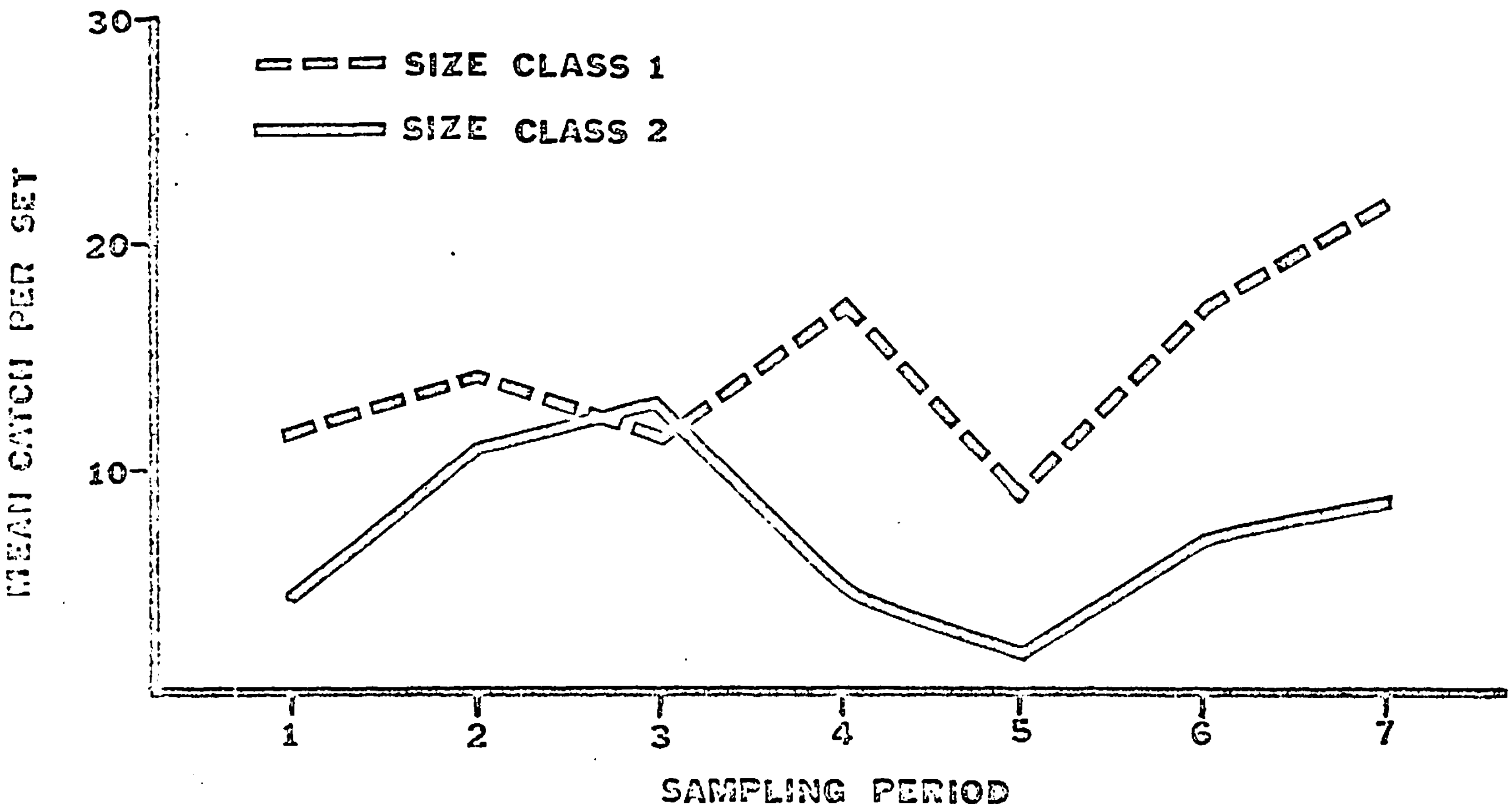

Fig. 10. Seasonal fluctuation of gill net catch of walleye.

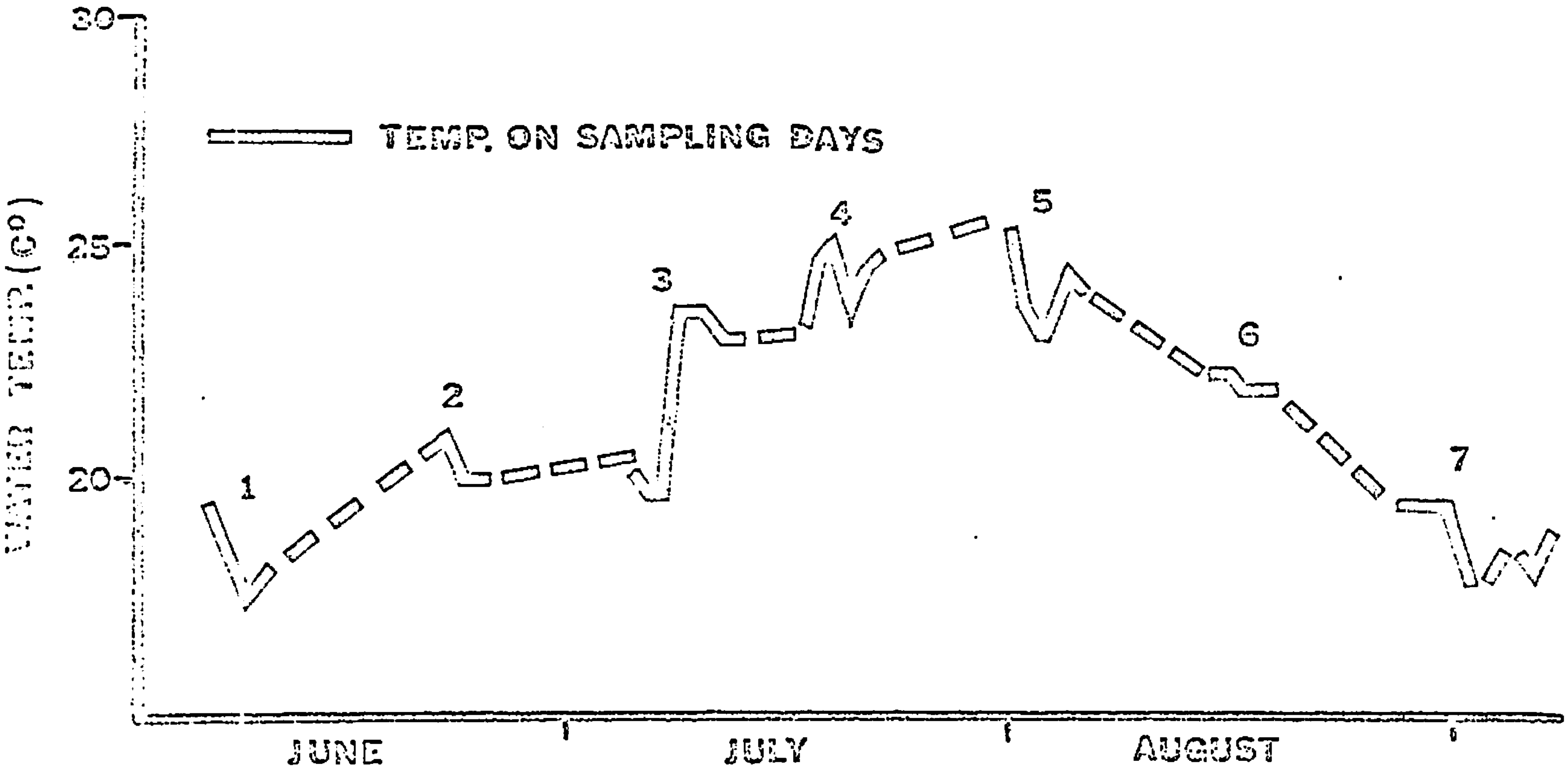

Fig. 11. Mean water temperature at time of samples.

possible to determine if the fish were actually on spawning beds. After Period 4 the concentrations of fish were no longer found.

The decline in the catch of most species during Period 7 coincided with a decline in the water temperature before and during the sampling period.

Diurnal Differences in Catch

Only the trawl and shocker were operated to obtain both day and night samples. The chi-square method was used to determine if there were significant differences in the species distributions of the day and night catches by each of the two gear. The comparisons showed that the differences were highly significant (Trawl-Day vs Trawl-Night, chi-square value 3042.74 with 11 d.f.; Shocker-Day vs Shocker-Night, chi-square value 202.22 with 9 d.f.). The data indicated that differences in species distributions were a result of diel changes in the catch rates for each species (Table VII). Bigmouth buffalo, white bass, white crappie, and black crappie were taken more effectively during the day. White sucker, black bullhead, channel catfish, walleye, and yellow perch were taken most effectively at night. Carp were taken most effectively at night with the trawl and during the day with the shocker. There were significant differences in the size composition of the day and night catches of several species (Table VIII). The night catch of carp, buffalo, white sucker, and black bullhead was composed of a higher proportion of small fish than the

Table VII. Relative Abundance and Mean Catch Per Sample of Each Species in Total Catch By Each Gear

	Species										
	NP	C	B	WS	BB	CC	WB	WC	BC	W	YP
Gill Net											
RA (%)	0.2	6.5	5.1	4.0	49.3	0.9	5.9	9.9	4.1	12.2	1.9
C/S	0.4	12.0	9.4	7.4	90.3	1.6	10.9	18.1	7.6	22.3	3.6
Trap Net											
RA (%)	0.1	1.2	0.7	2.9	59.4		2.8	11.8	20.5	0.4	0.2
C/S	0.2	2.8	1.6	6.9	139.2		6.5	27.6	48.1	0.9	0.5
Trawl-Day											
RA (%)	tr	7.0	2.2	0.9	24.7	tr	2.1	38.7	23.2	0.6	0.6
C/S	0.1	30.7	9.9	4.0	108.4	0.2	9.2	170.0	101.9	2.4	2.9
Trawl-Night											
RA (%)		7.3	0.7	1.6	55.4	0.1	0.1	22.4	9.4	0.8	2.2
C/S		43.8	4.2	9.4	331.3	0.4	0.5	133.9	55.9	4.9	13.1
Shocker-Day											
RA (%)	0.2	52.6	3.8	8.9	11.4		9.1	9.1	1.8	3.1	
C/S	tr	11.4	0.8	1.9	2.5		2.0	2.0	0.4	0.7	
Shocker-Night											
RA (%)	0.2	17.4	0.2	16.6	35.6		9.1	8.0	3.4	8.4	1.1
C/S	0.1	3.5	0.1	3.3	7.1		1.8	1.6	0.7	1.7	0.2

tr = trace - percentage of total catch or catch per sample less than 0.1

Table VIII. Size Composition of Catch of Each Species By Each Type of Gear

	Species								
	C	B	WS	BB	WB	WC	BC	W	YP
Gill Net									
Size Class 1	92.1%	89.0%	30.2%	53.8%	99.0%	94.5%	98.1%	66.5%	26.6%
2	0.5	2.8	69.8	3.7	1.0	5.5	1.9	32.3	73.4
3	7.4	8.2		42.5				1.2	
Trap Net									
Size Class 1	94.1	28.3	7.5	40.8	98.9	43.8	78.2	95.9	29.6
2	0.0	26.1	92.5	2.9	1.1	56.2	21.8	4.1	70.4
3	5.9	45.6		56.3				0.0	
Trawl-Day									
Size Class 1	30.7	16.3	58.4	71.5	100.0	99.6	99.9	92.6	85.0
2	1.7	11.2	41.6	1.8	0.0	0.4	0.1	7.4	15.0
3	67.6	72.5		26.7				0.0	
Trawl-Night									
Size Class 1	85.4	32.5	82.7	93.3	88.9	99.8	99.9	93.6	86.3
2	0.6	13.8	17.3	1.2	11.1	0.2	0.1	6.4	13.7
3	14.0	53.7		5.5				0.0	
Shocker-Day									
Size Class 1	0.9	0.0	1.9	1.4	60.0	3.6	54.5	36.8	
2	3.5	10.0	98.1	0.0	40.0	96.4	45.5	63.2	
3	95.6	90.0		98.6				0.0	
Shocker-Night									
Size Class 1	13.1	0.0	13.7	5.1	95.0	8.6	13.3	89.2	60.0
2	0.0	100.0	86.3	0.6	5.0	91.4	86.7	10.8	40.0
3	86.9	0.0		94.3				0.0	

day catch. The differences in the size composition of the catches were a result of diel changes in the catch rates of the size classes (Table IX). The trawl and shocker catch of yearling carp increased significantly at night. The catch of adult carp decreased at night. The trawl catch rate of adult bigmouth buffalo decreased at night. The trawl catch of Size Class 1 white sucker increased at night while the catch of Size Class 2 remained the same. The trawl catch of Size Class 1 and 2 black bullhead increased at night while the catch of Size Class 3 decreased. The shocker catch generally too low to show conclusive results. The size composition of the white crappie, black crappie and yellow perch catches changed little with the time of day. The trawl and shocker catches of walleye and white bass were too small to show significant differences in the size composition of the population present.

Differences Between Stations

The chi-square method was used to determine if there were significant differences in the species distributions of the catch by each gear between stations. The results showed that the differences were highly significant (Table X) indicating that the eleven major species were not equally abundant at all stations. The catch data were very inconsistant. Each of the gear varied in efficiency for a species at a station. For example, gill nets took the most bullheads at Station 2 and trap nets took the most at Station 3 (Table XI). White sucker was the only species for which the data was consistent.

Table IX. Diel Differences in Catch of Four Species by Size Class

	Day		Night	
	Size Class		Size Class	
	1	2+3	1	2+3
Carp				
Trawl	9.4	21.3	37.4	6.4
Shocker	0.1	11.2	0.5	3.0
Buffalo				
Trawl	1.6	8.2	1.4	2.8
Shocker	tr	0.3	0.0	tr
Sucker				
Trawl	2.3	1.6	7.8	1.6
Shocker	tr	1.9	0.5	2.8
Bullhead				
Trawl	79.4*	29.0	312.9	18.4
Shocker	tr	2.4	0.4	6.7

tr = trace - catch rate less than 0.1 fish per samples.

* Size Class 1 and 2 combined for bullhead.

Table X. Results of Chi-Square Comparisons of Species Distributions of the Catch by Each Gear by Station

Comparison			d.f.	Chi-Square	
Gill Net-Stat. 1 vs 2 vs 3			20	678.35	**
Trap Net	"	"	18	3125.00	**
Trawl-Day	"	"	22	1488.59	**
Trawl-Night	"	"	18	695.70	**
Shocker-Day	"	"	16	367.11	**
Shocker-Night	"	"	18	107.10	**

** Significant at the 0.01 level.

Table XI. Mean Catch Per Sample for Each Species By Station and Gear

	Species										
	NP	C	B	WS	BB	CC	WB	WC	BC	W	YP
Gill Net											
Stat. 1	0.1	12.9	8.4	11.3	90.6	2.0	9.9	13.9	7.2	23.1	1.6
2	0.2	16.1	18.2	6.1	103.8	2.2	18.2	11.6	6.9	23.6	4.0
3	0.8	7.4	2.5	4.7	77.9	0.8	5.2	27.8	8.6	20.4	5.0
Trap Net											
Stat. 1	0.2	1.4	1.1	12.4	147.6		2.2	36.3	99.1	1.2	0.2
2	0.3	3.2	1.8	4.1	52.7		17.6	12.6	37.8	1.8	0.6
3	0.1	3.7	2.2	4.7	220.5		0.4	34.9	12.1	0.3	
Trawl-Day											
Stat. 1		49.4	8.7	5.9	60.3	0.2	25.3	103.6	87.3	2.9	3.0
2		20.8	15.0	3.4	126.0	0.2	2.0	210.3	62.4	2.6	2.3
3	0.2	23.0	5.3	2.9	136.9	0.2	1.0	191.6	160.2	1.8	3.3
Trawl-Night											
Stat. 1		42.0	6.0	13.0	254.3	0.6	1.0	77.9	45.3	0.6	4.6
2		72.3	6.2	11.7	427.8	0.2	0.2	233.5	104.8	3.0	11.8
3		17.5	0.2	3.0	324.7	0.3	0.2	99.8	19.5	3.0	24.2
Shocker-Day											
Stat. 1		4.1	0.6	4.7	0.8		1.0		0.2		
2		9.5	1.9	0.3	0.8		5.0			2.0	
3	tr	20.1	0.2	0.5	5.5		0.5	5.5	0.9	0.3	
Shocker-Night											
Stat. 1		4.1	0.1	6.3	8.8		1.1	0.3		1.6	0.4
2		2.0		1.0	1.8		1.8			2.0	
3	0.1	3.9		2.1	9.4		2.5	4.1	1.9	1.5	0.3

tr = trace - catch per sample less than 0.1 fish

Differences In Catch By Gear

The chi-square method was used to determine if the species distributions of the catches taken by the gill nets, trap nets, trawl (night samples), and shocker (night samples) were significantly different. It was assumed that all gear were sampling the same population when fished at night. The results showed that the differences in the catch by these gear were highly significant (Chi-square value 7563.85 with 30 d.f.). The differences in the species distributions resulted from differences in the relative effectiveness of the gear for the eleven species (Table VII). There were also differences in the size composition of the catch of a species by the gear (Table VIII).

The largest number of northern pike was taken by the gill nets. None were taken at night by the trawl and only one by the shocker. All fish taken were 40.0 cm in length or longer. Too few fish were taken to determine if the gear were selective for size.

The largest number of carp was taken by the trawl but the shocker catch indicated the highest relative abundance. The size composition of the catches by the gill nets and trap nets were approximately equal. The trawl captured a slightly larger proportion of adult fish than the gill nets and trap nets. The proportion of adult fish in the shocker catch was much larger than for the other gear.

Gill nets took the largest number of bigmouth buffalo and the catch indicated the highest relative abundance for the species. Only one fish was taken at night with the shocker. Gill nets took a larger proportion of small fish than did trap nets or trawl.

Gill nets took the largest number of white sucker but the catch rate was only slightly larger than for the trap nets. Trap nets took a larger proportion of Size Class 2 fish than did the gill nets. The trawl captured a much larger proportion of Size Class 1 fish than did the gill nets. The shocker catch indicated the highest relative abundance for the species. The size composition of the shocker catch was intermediate between the gill nets and trap nets.

Trap nets took the largest number of black bullhead and the catch indicated the highest relative abundance for the species. The shocker catch indicated the lowest relative abundance. The trawl catch was composed of a larger proportion of Size Class 1 fish than the gill net and trap net catches. The shocker catch indicated a much higher proportion of Size Class 3 fish.

Channel catfish were taken most effectively by the gill nets. None were taken in the trap nets or with the shocker. Most fish taken were between 40.0 and 50.0 cm in length. The trawl was the only gear that took channel catfish under 15.0 cm.

The largest number of white bass was taken with the gill nets but the shocker catch indicated the highest relative abundance. The trawl was not effective for white bass at night and the catch indicated the lowest relative abundance. All four gear had a high proportion of small fish in the catch.

The trawl took the largest number of white crappie and the catch indicated the highest relative abundance. The shocker catch indicated the lowest relative abundance. The trawl and gill net catches were composed of a high proportion of yearling fish. The trap nets took a higher proportion of adult fish. The shocker took mostly adult fish.

The trap nets took the largest number of black crappie and the catch indicated the highest relative abundance. The shocker took the fewest fish and the catch indicated the lowest relative abundance. The catch of the gill nets and trawl was composed of a higher proportion of yearling fish than the trap net catch. The shocker took mostly adult fish.

Gill nets captured the largest number of walleye and the catch indicated the highest relative abundance. The trap nets, trawl, and shocker took a larger proportion of Size Class 1 than did the gill nets.

The trawl took the largest number of yellow perch and the catch indicated the highest relative abundance. The shocker was not effective for perch. The gill nets and trap nets took a larger proportion of Size Class 2 fish than did the trawl.

DISCUSSION

The present study has shown that samples from a population differ significantly with season, time of day, location within the lake, and type of gear. Each of these could be a source of sample bias. An evaluation of the differences in catch and the causes of the differences should increase understanding of gear selectivity and make possible more accurate interpretation of samples.

The pattern of seasonal fluctuation of the catches of white crappie, black crappie, and bullhead was a result of decreasing catch of adult fish and increasing catch of yearling fish as the summer progressed. Passive fishing gear such as gill nets and trap nets depend on the movement of fish for capture. Anything that affects the movement or activity of the fish will affect the catch. Two factors appeared to cause the decline in the catch of adult fish. The decreased catch of adult crappies and bullheads coincided with an increase in water temperature. The decreased catch of adult crappies also coincided with an apparent cessation of spawning activity. The decline in bullhead catch may also have coincided with decreased spawning activity as bullheads are reported to spawn at about the same time as crappies (Miller, 1966). The increased catch of yearling fish later in the summer apparently was a result of a change in behavior or activity rather than growth. The increase in catch rate was too sudden to have been the result of growth as members of the year class were taken in trap nets the previous fall.

Increased net catches of yearling carp, bigmouth buffalo, and white bass apparently were also a result of a change in behavior or activity since all these fish were large enough to have been held by the mesh when netting started. No explanation can be given for the sudden increase and decline of the white sucker catch.

Kelley (1953) found that trap net catches of white crappie, black crappie, and bluegill in the Mississippi River backwaters exhibited seasonal trends similar to those found in the present study. He also found that the catch began to increase again during the fall. Kelley attributed the decline in catch of adults to a decrease in activity resulting from water temperature above 70° F and stabilization of water level, and to mortality of the older fish in the population. He felt that spawning activity was not a factor causing the decline in catch rate. He attributed the increased catch of one and two year old fish later in the summer to an increase in activity or change in behavior.

Kelley also found seasonal trends for northern pike, white bass, channel catfish, flathead catfish (Pylodictis olivaris)[1], carp, northern redhorse (Moxostoma aureolum), carpsucker (Carpiodes spp.), and sheepshead (Aplodinotus grunniens). The catch of these species was generally highest during spring and early summer, declined during midsummer, and then increased in late summer and fall.

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[1] Common and scientific names used by the author for species which were not included in the present study.

Spawning activity may have been a more important factor than temperature in causing the decline in catch of adult crappies and black bullhead. Carter (1954) found that the catch by various types of commercial fishing gear followed a seasonal trend similar to that found by Kelley (1953) and the present study. He thought that the peak catch during April and early May was a result of movement of fish toward their spawning grounds. Hansen (1951) suggested that the midsummer decline in the catch of white crappie may have been a result of heavy midsummer mortality.

Preliminary investigations for the present study indicated that the catch of adult crappies increased in the fall as found by Kelley (1953) and Carter (1954). Both of these authors suggested that cooling of the water may have caused increased activity. The increased catch of adult fish may have been due to increased activity following the period of reduced activity due to spawning.

The decline in the trawl and shocker catches of adult carp and bigmouth buffalo appeared to be a result of the fish moving to a more pelagic habitat as the summer progressed. Generally, however, there was no apparent seasonal pattern exhibited by the trawl and shocker catches of most species. This most likely occurred because changes in activity would not effect the catch of active gear to the extent shown for the passive gear.

Though seasonal changes in activity did not appear to affect the catch of the active gear, movement associated with activity patterns may affect the vulnerability of fish to the gear. The apparent movement of carp and bigmouth buffalo to a more pelagic habitat during late summer caused a decline in the catch. Diurnal migration to different habitats may also affect the vulnerability of fish to the gear at different times of the day. This appeared to be the cause of the differences in the day and night samples collected with the trawl and shocker. The catch of passive gear would also be affected by diurnal changes in activity and habitat. Carlander and Cleary (1949) found that diurnal activity patterns and migrations caused fluctuations in the catch of gill nets. Walleye, sauger (Stizostedion canadense), tullibee (Leucichthys artedi tullibee), white sucker, and yellow bass (Morone interrupta) were caught more frequently in shallow water at night and more frequently in deep water during the day. Yellow perch and carp were caught more frequently in shallow water during the day and more frequently in deep water at night. Walleye, sauger, and tullibee were caught most frequently at night. Northern pike, yellow perch, yellow bass, and carp were caught most frequently during the day. Black bullhead did not appear to be more active at any particular time of day but showed a slight tendency to move to shallow water at night.

In the present study the catch of yellow perch with the trawl was greatest at night, the opposite of what might be expected according to the results of Carlander and Cleary's study. However, an onshore movement of yellow perch during the day may have caused the fish to move out of the area fished by the trawl and thus lowered the catch rate for day samples.

The catch rates for adult and yearling carp and bullhead showed an inverse relationship for day and night samples. Darnell and Meierotto (1965) found that young bullheads are active during the daytime and the adults are nocturnal. It appears that different age classes of other species may also vary in their activity patterns.

The differences in the catch between stations indicated that the population was not evenly distributed. This was expected but is presented to demonstrate that the differences in the populations in different habitats are significant and are a source of sample bias. Schumacher and Eschmeyer (1943) found that all species were found throughout the pond studied but that the distribution was not even. Each habitat was found to have its own species distribution. They felt that representative sampling of even a small pond would be very difficult.

Because of habitat preference it would be expected that larger numbers of a species would be found in a particular area of the lake. The catch rate for each species with a type of gear varied between stations and the different types of gear did not indicate the greatest abundance of a particular species at the same station. This can not be readily explained. The inconsistency may be a result of an interaction of the various factors effecting the catch.

Estimation of the actual abundance of large populations of fish in large lakes by any of the presently available methods would be a nearly insurmountable task. Because of limitations on time and funds that can be devoted to a particular lake by a fishery manager, population estimates are not usually possible. Measures of relative abundance of species in the population and of year to year fluctuations in abundance are more easily available. Each type of gear, however, indicates a different population structure. The fishery manager needs to know which type of gear best represents the true population or know the characteristics of the catch of the gear he is using.

An intensive study of a fish population using several types of gear, such as the present study, permits a fairly accurate estimate of the relative abundance of the species in the population. Use of the composite sample collected by all types of gear over the summer would give a better estimate of the relative abundance of the species than the catch by one type of gear. This however, is also a biased estimate because it is the composite of biased samples.

Based on the samples collected by the four types of gear, the commercial fishery catch, and the findings of other authors, I feel that black bullhead was the dominant species in Lake Poinsett and composed about 40% of the total population, numerically. White crappie and bigmouth buffalo each composed about 15% of the population. Carp and black crappie composed about 10% of the population each. White sucker and white bass each composed about 3% of the population. Yellow perch and walleye composed about 1-2% each of the population. Channel catfish and northern pike each composed less than 1% of the population. This subjective estimate will be used as a basis for evaluating the catch characteristics of each of the types of gear.

Gill nets appeared to be the least selective for species of the gear used. That is, gill nets took more species effectively than the other gear. Of the total gill net catch seven species comprised 92.9%. The trap nets were the most selective; three species comprised 91.7% of the total catch. Six species comprised 94.6% of the shocker catch; four species 94.5% of the trawl catch. The gill nets also appeared to be the least selective for size.

Though the gill nets were the least selective the catch probably did not represent the true population. The proportion of walleye, black bullhead, white sucker, northern pike, channel catfish, white bass and yellow perch in the gill net catch was greater than their estimated proportion in the population. Carp, bigmouth buffalo, white crappie, and black crappie composed a greater proportion of the population than in the catch.

Carlander (1953) used gill nets to study the fish population of Clear Lake, Iowa. He stated that gill nets are one of the most effective types of gear for collecting many species of fish and that they catch walleye and white sucker from 6 - 23 inches, and yellow perch, yellow bass, white bass and black bullhead from 4.5 inches to maximum size with little size selection. He also pointed out that some species are more susceptible to capture than others. Largemouth bass, crappies, and sunfishes may be more abundant than indicated by the gill net catch. Hall (1956) found that the proportion of black bullhead in the gill net catch was greater than in the population and that bluegills which comprised 90% of the population comprised only 0.5% of the catch. Crappies and carp, though not very abundant in the population, were not taken by the gill nets.

The proportion of black bullhead, white crappie, and black crappie in the trap net catch was greater than in the estimated population. Carp and bigmouth buffalo were much more abundant in the population than in the catch. Trap nets were selective for the larger size classes of bigmouth buffalo, white sucker, black bullhead, white crappie, and black crappie.

O'Donnell (1943), Sanderson (1960), and Schumacher and Eschmeyer (1943) found that carp, bigmouth buffalo, and largemouth bass (*Micropterus salmoides*) were not caught in proportion to their abundance in the population by fyke nets and traps. Black crappie, yellow perch, smallmouth bass (*Micropterus dolomieui*), white sucker, black bullhead, and bluegill were more abundant in the catch than the actual population. Young of all species were not taken in proportion to their actual abundance.

The shocker took the smallest total number of fish but was less selective for species than the trawl and trap nets. The effectiveness of the shocker was limited by turbidity of the water and heavy algae blooms. The proportion of northern pike, carp, white sucker, white bass, walleye and yellow perch in the shocker catch was greater than in the estimated population. Bigmouth buffalo, black bullhead, channel catfish, white crappie, and black crappie were more abundant than shown by the catch. The shocker was more selective for larger fish than the other gear.

Sanderson (1960) found that electrofishing gave a better overall indication of the population than the seine or D-traps. His results indicated that black crappie were taken in about the same proportion as found in the spot-poisoning samples. Bluegills were taken in greater proportion than found in the population. Carp were more abundant in the population than shown by the catch but were taken more effectively by electrofishing than by the other gear. Sullivan (1956) demonstrated the selectivity of electrofishing gear for larger fish in a stream.

The trawl catch was composed of a greater proportion of black bullhead, white crappie, walleye and yellow perch than was in the estimated population. Northern pike, carp, bigmouth buffalo, channel catfish, and white bass were more abundant than shown by the catch. White sucker and black crappie were taken about in proportion to their estimated abundance. The trawl generally was selective for small fish.

A comparison of the relative effectiveness and relative size selection of the gear for each species is presented in Table XII. This table is based only on the findings of the present study.

Gear selectivity appears to be a result of differences in fish behavior and the physical characteristics of the sampling gear. The

Table XII. Relative Effectiveness and Size Selectivity of Gear For Each Species

	Species										
	NP	C	B	WS	BB	CC	WB	WC	BC	W	YP
Gill Net											
Rel. Effect.[1]	1	3	1	1	3	1	2	3	3	1	2
Size Select.[2]		S	S	L	L		S	S	S	L	L
Trap Net											
Rel. Effect.	3	4	3	2	1		3	2	1	4	4
Size Select.		S	L	L	L		S	L	L	S	L
Trawl-Night											
Rel. Effect.	4	2	2	3	2	2	4	1	2	3	1
Size Select.		S	L	S	S		S	S	S	S	S
Shocker-Night											
Rel. Effect.	2	1	4	1	4		1	4	4	2	3
Size Select.		L	L	L	L		S	L	L	S	L

[1] Based on a comparison of the relative abundance of a species as indicated by each gear--ranked 1-4.

[2] S = Selective for small fish, L = Selective for large fish--based on comparison of size distributions of catches of each species.

present study has shown that behavior patterns caused seasonal and daily differences in the catch by a type of gear. Latta (1959) felt that selectivity of trap nets for larger fish was a result of greater activity of larger fish in the search for food. Hall (1956) felt that the low efficiency of nets used in his study may have been a result of the extreme clearness of the water. It appears that the ability of different species to avoid nets may be one of the causes of the differential selectivity of gear. Hunter and Wisby (1964) found that species differ in their ability to avoid nets. They rated fish as follows on a scale of one to five according to their ability to escape the test net apparatus: carp, 1 (best able to escape); rainbow trout (*Salmo gairdneri*), 2; brown trout (*Salmo trutta*) and largemouth bass (*Micropterus salmoides*), 3; pumpkinseed (*Lepomis gibbosus*), bluegill, and white bass, 4; white sucker and northern pike, 5. They found that temperature and turbidity effected the ability to avoid the net. Moyle (1950) stated that gill net catches are influenced by movement of the fish, shape and structure of the fish, and the associative pattern of the individuals of the species.

Species selectivity of electrofishing gear may result from differences in behavior when a fish encounters the electrical field. In the present study it was noted that northern pike and carp were difficult to net because of a powerful lunge away from the field. Walleye and white sucker were found to exert only a small effort to escape the electrical field. Black bullhead and crappies dived downward when the electrical field was encountered.

The physical dimensions of sampling gear may cause selectivity. Mesh size of nets limits the size of fish that can be captured effectively. Wirth (1957) found that the selectivity of a trawl for game fish was effected by the height of the float line above the bottom. Trawls with higher fishing float lines were found to catch as many as seven times more game fish than trawls with low fishing float lines. This may have been a factor in the low efficiency of the trawl for walleye, white bass, and adult crappies in the present study.

Sullivan (1956) felt that selectivity of electrofishing gear for larger fish was in part due to the fact that large fish were easier to see and thus easier to net.

The findings of the present study indicate the necessity of knowledge of the species (life history, behavior patterns, habitat preference, etc.) being sampled and the limitations of the gear used. A knowledge of the lake being sampled is also essential. Evaluation of test nettings should include consideration of changes in catchability of the fish. An effort should be made to at least sample all habitats in the body of water being evaluated. Sampling should be as intensive as possible and over as long a period of time as possible. Though it may not be possible to obtain a truly representative sample of the population, intensive sampling over a long period of time will give a much better indication of the actual population present. The use of more than one type of gear will give a better indication of the population than sampling conducted with only one gear. Preferably the gear used should be opposite in their catch characteristics so that all segments of the population can be sampled effectively by at least one gear. Samples collected for the purpose of evaluating year to year fluctuations in abundance of the population should be collected as close to the same time each year as possible because of seasonal changes in the catchability of the fish. Because of the influence of other factors on the catch all other conditions should also be as similar as possible each year.

SUMMARY

1. Gill nets, trap nets, an otter trawl, and a boom-type electric shocker were utilized to obtain samples of the fish population of Lake Poinsett, South Dakota. The species and size composition of the samples obtained differed significantly with time of season, time of day, location on the lake, and type of gear.
2. The catch rates for adult black bullhead, black crappie, and white crappie taken by gill nets and trap nets tended to decline as the summer progressed while the catch of yearling of these species tended to increase. The midsummer decline in catch of adult fish apparently was the result of decreased activity following spawning. Increased catch of yearling fish in late summer appeared to be the result of increased activity or change in behavior pattern. Gill net catches of carp, bigmouth buffalo, and white bass exhibited seasonal trends similar to those for black bullheads and crappies. The trawl and shocker catches fluctuated without pattern throughout the summer. A tendency for the catches of adult carp and bigmouth buffalo to decline appeared to be due to movement of the fish to a more pelagic habitat as the summer progressed.
3. Catch rates for species taken by the trawl and shocker varied with the time of day. The differences in catch rates appeared to be the result of diel changes in vulnerability to the gear because of diurnal migrations to different habitats. Differences in size composition of day and night samples appeared to be the result of variations in the activity patterns of different age groups of fish.

4. Variation in catch rates between stations indicated that the population was not evenly distributed throughout the lake.
5. The indicated relative abundance of species in the population varied with the collection method due to differences in the effectiveness of each type of gear for species and size. The catch by each type of gear was compared to an estimate of the population structure to determine the catch characteristics of the gear. Gill nets were the least selective gear for species and size; trap nets were the most selective gear.
6. Gear selectivity appears to be the result of differences in the behavior of fish and physical characteristics of the sampling gear. Seasonal and diurnal changes in activity and movement patterns caused differences in vulnerability to the gear. Gear design may cause physical selection for size and species.
7. Interpretation of population samples should be based on knowledge of the species in the population, the characteristics and limitations of the collection method, and the body of water being sampled. Sample collection should be as intensive and over as long a period of time as possible. All habitats of the body of water should be sampled. At least two types of collecting gear should be used. Measures of year to year fluctuations in population abundance should be made at the same time each year and under similar conditions.

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APPENDICES

Appendix Table I. Species Distribution of Catch by Station and Total for Each Gear

	No. Samples	Species											
		NP	C	B	WS	BB	CC	WB	WC	BC	W	YP	TOTAL
Gill Net													
Stat. 1	18	2	232	152	204	1630	36	179	250	130	415	29	3259
2	17	4	274	309	104	1764	37	309	197	117	402	68	3585
3	19	16	142	47	89	1480	15	98	529	163	387	95	3061
Total	54	22	648	508	397	4874	88	586	976	410	1204	192	9905
Trap Net													
Stat. 1	18	3	26	19	223	2656		39	654	1784	21	17	5442
2	19	6	58	32	73	948		316	227	681	23	10	2374
3	19	2	71	41	90	4190		8	664	230	5		5301
Total	56	11	155	92	386	7794		363	1545	2695	49	27	13117
Trawl-Day													
Stat. 1	9		445	78	53	543	2	228	932	786	26	27	3120
2	10		208	150	34	1260	2	20	2103	624	26	23	4450
3	9	2	207	48	26	1232	2	9	1724	1442	16	30	4738
Total	28	2	860	276	113	3035	6	257	4759	2852	68	80	12308
Trawl-Night													
Stat. 1	7		294	42	91	1780	4	7	545	317	58	32	3170
2	6		434	37	70	2567	1	1	1401	629	18	71	5229
3	6		105	1	18	1948	2	1	599	117	18	145	2954
Total	19		833	80	179	6295	7	9	2545	1063	94	248	11353
Shocker-Day													
Stat. 1	10		41	6	47	8		10		2			114
2	8		76	15	2	6		40			16		155
3	10	1	201	2	5	55		5	55	9	3		336
Total	28	1	318	23	54	69		55	55	11	19		605
Shocker-Night													
Stat. 1	8		33	1	50	70		9	2		13	3	181
2	6		12		6	11		11			12		52
3	8	1	31		17	75		20	33	15	12	2	206
Total	22	1	76	1	73	156		40	35	15	37	5	439
TOTAL		37	2890	980	1202	22223	101	1310	9915	7046	1471	552	47727

Appendix Table II. Species Distribution of Catch By Sampling Period For Each Gear

		No. Samples	Species										
			NP	C	B	WS	BB	CC	WB	WC	BC	W	YP
Gill Net													
Samp. Per.	1	4	2	11	1	6	594	1	9	1	1	63	9
	2	9	6	22	44	38	443	27	78	57	8	232	59
	3	6	2	22	49	25	75	12	8	60	21	149	15
	4	9	4	44	68	33	233	38	60	148	78	198	33
	5	8	6	147	135	115	1017	3	160	319	125	81	34
	6	9	2	238	120	117	712	7	165	262	106	213	22
	7	9		164	91	63	1800		106	128	71	268	20
Trap Net													
Samp. Per.	1	6	1	11	25	13	2278		180	191	154	8	2
	2	8	3	3	57	10	1517		5	275	178	5	2
	3	6	1	2	6	17	260		2	196	105	6	2
	4	9		39		6	342		88	495	348	7	2
	5	9	2	83	1	133	2032		33	93	115	5	11
	6	9	4	15	2	194	1026		45	209	1100	2	6
	7	9		2	1	13	339		10	86	695	16	2
Trawl-Day													
Samp. Per.	1	5	1	176	181	15	494	3	23	358	145	19	
	2	0											
	3	5		292	45	38	624	1	10	2181	777	24	29
	4	3	1	4	1	1	22		2	34	1	3	6
	5	6		287	38	24	347		46	587	397	5	3
	6	3		6	4	9	14	2	34	61	177		
	7	6		95	7	26	1534		142	1538	1355	17	42

Appendix Table II. Continued

		No. Samples	Species										
			NP	C	B	WS	BB	CC	WB	WC	BC	W	YP
Trawl-Night													
Samp. Per.	1	0											
	2	3		395	38	44	566		1	411	261	29	9
	3	2		44	6	19	171			242	114	9	33
	4	6		236	23	28	1474	1		517	352	9	59
	5	3		102	4	21	1090	1	2	375	83	7	69
	6	2		31		19	143		4	241	44	12	28
	7	3		25	9	48	2851	5	2	759	209	28	50
Shocker-Day													
Samp. Per.	1	3		76	19	52	4		3				
	2	6		57	2		29		3				
	3	3	1	128	1	1	16		26	47	3	16	
	4	5		41			15		8	8	3	3	
	5	3		2			4						
	6	6		8	1	1	1		13		5		
	7	2		6					2				
Shocker-Night													
Samp. Per.	1	0											
	2	0											
	3	6		50	1	1	56		5	25	11	17	
	4	3		10		2	13			7		3	2
	5	5		6		13	28		11	1	2		
	6	3		4		20	6		12			1	3
	7		1	6		37	53		12	2	2	16	

Appendix Table II. Continued

	No. Samples	Species										
		NP	C	B	WS	BB	CC	WB	WC	BC	W	YP
Trawl-Night												
Samp. Per. 1	0											
2	3		395	38	44	566		1	411	261	29	9
3	2		44	6	19	171			242	114	9	33
4	6		236	23	28	1474	1		517	352	9	59
5	3		102	4	21	1090	1	2	375	83	7	69
6	2		31		19	143		4	241	44	12	28
7	3		25	9	48	2851	5	2	759	209	28	50
Shocker-Day												
Samp. Per. 1	3		76	19	52	4		3				
2	6		57	2		29		3				
3	3	1	128	1	1	16		26	47	3	16	
4	5		41			15		8	8	3	3	
5	3		2			4						
6	6		8	1	1	1		13		5		
7	2		6					2				
Shocker-Night												
Samp. Per. 1	0											
2	0											
3	6		50	1	1	56		5	25	11	17	
4	3		10		2	13			7		3	2
5	5		6		13	28		11	1	2		
6	3		4		20	6		12			1	3
7		1	6		37	53		12	2	2	16	