

JOB COMPLETION REPORT

FILE

As required by

FEDERAL AID IN FISHERIES RESTORATION ACT

TEXAS

Federal Aid Project No. F-5-R-12

FISHERIES INVESTIGATIONS AND SURVEYS OF THE WATERS OF REGION 1-B

Job No. D-2 A Study of Factors Influencing Game Fish
Production in Waters of Region 1-B

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ABSTRACT

Project data obtained under F-5-R are reviewed and reanalyzed to detect and identify factors that are common influences on game fish production. The material is presented in three sections.

Section I contains a brief history of fishery production in 27 public reservoirs as indicated by gill net collections. Production for principal game and non-game species is graphed over a period of years. Gross production, water quality and hydrological data are similarly graphed. These briefs also contain information on the history and development of the reservoirs, their usage, and relationships with other waters. A brief discussion of factors and suspect factors that influence fish production is included and a list of references and stocking records are supplied.

Section II contains an analysis and discussion of factors and suspect factors that influence game fish production in regional perspective. Principal factors influencing production in reservoirs include: (a) stability of water levels and capacities, (b) water quality, (c) basic food production, (d) the inter-population influences of the principal species and (e) aquatic vegetation. The analysis indicates that the most common detrimental factor influencing game fish production in the region is the occurrence of a prolonged decline in water levels in reservoirs where river carpsucker and other problematic fish are abundant. The factors that influence game fish production in streams include: (a) stability of water levels and capacities, (b) permanence and volume of flow, (c) basic food production, and (d) water quality. The impact of irrigation on stream production is discussed, and the deterioration of water quality and increases in pollution, siltation, and aquatic vegetation are shown to be responsible for the reduction of game fish.

Section III presents an evaluation of past management of regional waters. Following chemical treatments to control problematic fish in reservoirs, sampling with gill nets indicate: (a) more game fish were produced, (b) more pounds of game fish were produced, (c) fewer problematic fish were produced, and (d) less pounds of problematic fish were produced. The increase in production was nearly always ten times as great as pre-treatment production within the first three years following the management effort, and benefits were indicated beyond the sixth year in some instances. The results of efforts to control problematic fish in streams cannot be fully evaluated at this time, but preliminary results indicate that where project personnel received full cooperation, the work was effective. Efforts to control aquatic vegetation have been less successful. Maximum benefits from efforts to control vegetation have not lasted beyond a few months. In general, the restocking program has been effective in stocking new waters, recently renovated waters, and waters that have recently experienced great expansion. Other stocking is less effective and much of the effort was totally unsuccessful.

JOB COMPLETION REPORT

State of Texas

Project No. F-5-R-12

Name: Fisheries Investigations and Surveys of the Waters of Region 1-B

Job No. D-2

Title: A Study of Factors Influencing Game Fish Production in Waters of Region 1-B

Period Covered: March 1, 1964 through February 28, 1965

Objectives:

To identify the factors that are common influences on game fish production throughout the region and to determine the degree of influence.

1. To organize and analyze data influencing fishery production in regional perspective, (a) to identify, isolate and measure basic influences, (b) to determine interrelationships and to correlate these influences with reference to game fish production, and (c) to catalogue data according to specific waters, basic productivity and fundamental ecological types.
2. To determine additional data required to appraise past sampling efforts.
3. To secure the means of an accurate appraisal of past management efforts and factors that influence management results.
4. To provide a more reliable basis for advancing sound harvest regulations.
5. To determine the logical limits for future reconnaissance surveys.

Procedures:

1. To review literature.
 - A. Available scientific literature dealing with basic factors that influence productivity was reviewed to provide understanding of normal population dynamics for the more common species. Seventeen additional publications dealing with population dynamics were obtained from other investigators and carefully studied.
 - B. Data from known sources were compiled according to subject and specific body of water, (i.e. all data pertaining to Lake Nasworthy were grouped; all for San Angelo Reservoir placed together etc.). Fisheries data were obtained from other fisheries biologists and from state and federal fish hatchery stocking records. Only data meeting specific standards were used in the study. Hydrological data were obtained from the United States Geological Survey, the Texas Water Commission, and from local agencies. Climatic data were obtained from the United States Weather Bureau. Related biological data were obtained from the United States Public Health Service, the Soil Conservation Service, the State Health Department and other national or state organizations.

2. To determine additional data requirements and to appraise sampling efforts.
 - A. All netting data were placed on master sheets for each body of water. The organization of data indicated month and year of each collection of fish or other data. Blanks indicated periods when samples were not taken. Only data from standard gill netting units or from the experimental gill nets used prior to the adaptation of regional standards were included.
 - B. Secondary master sheets were prepared for each primary species designating month, year, number and numerical per cent for each species and per cent by weight for each primary public water.
 - C. A reorganization of "K" factor data were started, but findings are too incomplete to provide useful information.
3. To obtain the means of appraisal of past management and factors that influence management results.
 - A. Comparisons were made between pretreatment and posttreatment samples of fish populations where management has been carried out.
 - B. Additional field work was carried out to evaluate the results of past management.
 - C. A comparison was made between samples taken prior to heavy stocking with hatchery reared fish and samples taken from the same bodies of water following such stocking efforts.
 - D. Field Procedures

In order to fill in blanks in project data and to maintain studies necessary to evaluate management, the following field investigations were carried out:

Water Investigated	No. Field Trips	Standard Gill Net Collections	Seining Collections	Studies of Vital Functions	Man Days
Lake Nasworthy	6	22	12	X	36
Twin Buttes	3	12	12	X	21
Concho River	20	48	60	X	86
Lake Sweetwater	3	16	12	X	12
Mountin Creek Reservoir	2	11	6	X	8
Lake Balmorhea	2	12	6	X	12
Lake Ascarate	2	8	7	X	10
Champion Creek Reservoir	2	12	6	X	8
Oak Creek Reservoir	2	19	8	X	14
Moss Creek Reservoir	2	12	9	X	12
Devil's River	1	7	3	X	8
Rio Grande River	1	3	6	X	3
Diablo Dam #1	1	4	2	X	6
South Llano River	1	0	8	X	6
Nueces River	1	0	8	X	6
	49	186	165		248

Although the number of gill net collections is slightly less than specified in planning, the need for such sampling was significantly less than anticipated. Twin Buttes Reservoir did not impound as much water as expected and the North Concho River was reduced to a few pools. Other activities exceeded the work planned.

Unforseeable circumstances make it impossible to complete all of the suggested procedures. (1) Approved plans specified that counseling service of a qualified statistician would be required. The contract for such service was not renewed in the 1964-65 period. (2) In many instances data were insufficient to permit the proposed analysis. (3) The nature of most of the data available were such that statistical analysis of an isolated factor was impossible or the degree of bias in sampling could not be taken into consideration.

Findings:

Throughout the remainder of this report references are made to a number of species of fish. The following checklist of species found in the region is presented to assure correct identification. Scientific and common names are those specified in "A List of Common and Scientific Names of Fishes from the United States and Canada", Second Edition, American Fisheries Society, Special Publication No. 2, 1960. In a few instances species not

listed in that publication are included. The scientific and common names of these fish are taken from "A Checklist of Texas Fresh-Water Fishes", by Clark Hubbs, Department of Zoology, The University of Texas, Division of Inland Fisheries, IF Series No. 3.

Lepisosteidae-gars

Spotted gar	<u>Lepisosteus oculatus</u>
Longnose gar	<u>Lepisosteus osseus</u>
Alligator gar	<u>Lepisosteus spatula</u>

Clupeidae-herrings

Gizzard shad	<u>Dorosoma cepedianum</u>
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Salmonidae-trouts, whitefishes, and graylings

Rainbow trout	<u>Salmo gairdneri</u>
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Characidae-characins and tetras

Mexican tetra	<u>Astyanax mexicanus</u>
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Cyprinidae-minnows and carps

Stoneroller	<u>Campostoma anomalum</u>
Mexican stoneroller	<u>Campostoma ornatum</u>
Goldfish	<u>Carassius auratus</u>
Carp	<u>Cyprinus carpio</u>
Devil's River minnow	<u>Dionda diaboli</u>
Roundnose minnow	<u>Dionda episcopa</u>
Golden shiner	<u>Notemigonus crysoleucas</u>
Speckled chub	<u>Hybopsis aestivalis</u>
Rio Grande chub	<u>Gila pandora</u>
Longnose dace	<u>Rhinichthys cataractae</u>
Suckermouth minnow	<u>Phenacobius mirabilis</u>
Plains shiner	<u>Notropis percobromus</u>
Sharpnose shiner	<u>Notropis oxyrhynchus</u>
Rio Grande shiner	<u>Notropis jemezianus</u>
Texas shiner	<u>Notropis amabilis</u>
Bluntnose shiner	<u>Notropis simus</u>
Arkansas River shiner	<u>Notropis girardi</u>
Chihuahua shiner	<u>Notropis chihuahua</u>
Blacktail shiner	<u>Notropis venustus</u>
Red shiner	<u>Notropis lutrensis</u>
Plateau shiner	<u>Notropis lepidus</u>
Proserpine shiner	<u>Notropis proserpinus</u>
Mimic shiner	<u>Notropis volucellus</u>
Ghost shiner	<u>Notropis buchanani</u>
Plains minnow	<u>Hybognathus placita</u>
Bullhead minnow	<u>Pimephales vigilax</u>
Fathead minnow	<u>Pimephales promelas</u>

Catostomidae-suckers

River carpsucker	<u>Carpiodes carpio</u>
Blue sucker	<u>Cycleptus elongatus</u>
Smallmouth buffalo	<u>Ictiobus bubalus</u>
Gray redhorse	<u>Moxostoma congestum</u>

Ictaluridae-freshwater catfishes

Blue catfish	<u>Ictalurus furcatus</u>
Black bullhead	<u>Ictalurus melas</u>
Yellow bullhead	<u>Ictalurus natalis</u>
Channel catfish	<u>Ictalurus punctatus</u>
Flathead catfish	<u>Pylodictis olivaris</u>

Cyprinodontidae-killifishes and topminnows

Rainwater killifish	<u>Lucania parva</u>
Blackstripe topminnow	<u>Fundulus notatus</u>
Rio Grande killifish	<u>Fundulus zebrinus</u>
Red River pupfish	<u>Cyprinodon rubrofluviatilis</u>
Leon Springs pupfish	<u>Cyprinodon bovinus</u> (extinct)
Comanche Springs pupfish	<u>Cyprinodon elegans</u>
Pecos River pupfish	<u>Cyprinodon sp.</u>
Devil's River pupfish	<u>Cyprinodon sp.</u>

Poeciliidae-mosquitofishes

Pecos gambusia	<u>Gambusia nobilis</u>
Largespring gambusia	<u>Gambusia geiseri</u>
Big Bend gambusia	<u>Gambusia gaigei</u>
Mosquitofish	<u>Gambusia affinis</u>

Atherinidae-silversides

Tidewater silverside	<u>Menidia beryllina</u>
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Serranidae-sea basses

White bass	<u>Roccus chrysops</u>
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Centrarchidae-sunfishes

Spotted bass	<u>Micropterus punctulatus</u>
Guadalupe bass	<u>Micropterus treculi</u>
Largemouth bass	<u>Micropterus salmoides</u>
Warmouth	<u>Chaenobryttus gulosus</u>
Redbreast sunfish	<u>Lepomis auritus</u>
Green sunfish	<u>Lepomis cyanellus</u>
Orangespotted sunfish	<u>Lepomis humilis</u>
Bluegill	<u>Lepomis macrochirus</u>
Redear sunfish	<u>Lepomis microlophus</u>
Spotted sunfish	<u>Lepomis punctatus</u>
White crappie	<u>Pomoxis annularis</u>
Black crappie	<u>Pomoxis nigromaculatus</u>

Percidae-perches

Dusky darter	<u>Percina sciera</u>
Logperch	<u>Percina caprodes</u>
Orangethroat darter	<u>Etheostoma spectabile</u>
Greenthroat darter	<u>Etheostoma lepidum</u>
Rio Grande darter	<u>Etheostoma grahami</u>

Sciaenidae-croakers, drum, and weakfishes

Freshwater drum	<u>Aplodinotus grunniens</u>
Red drum	<u>Sciaenops ocellata</u>
Spot	<u>Leiostomus xanthurus</u>
Atlantic croaker	<u>Micropogon undulatus</u>
Black drum	<u>Pogonias cromis</u>
Spotted seatrout	<u>Cynoscion nebulosus</u>

Sparidae

Pinfish	<u>Lagodon rhomboides</u>
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Cichlidae-cichlids

Rio Grande perch	<u>Cichlasoma cyanoguttatum</u>
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Bothidae-flounders

Southern flounder	<u>Paralichthys lethostigma</u>
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Organization and Limitations of Report

The choice in the order of presentation of findings was guided by three considerations. (1) The report is the best available condensation of previous findings and will serve as a convenient reference for administrators in the future. (2) The possibility of a future consolidation of federal aid inventory studies into a single publication dealing with the resource in state-wide perspective is considered. (3) In as far as practical, the material is presented in the order of objectives listed under that subheading on page 1. With these circumstances in mind a table of contents has been included which further serves to indicate the scope and limitations of the findings.

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SECTION I

A CHRONOLOGY OF GAME FISH PRODUCTION AND RELATED DATA FOR THE PRINCIPAL RESERVOIRS INVESTIGATED UNDER PROJECT F-5-R

Fisheries data presented are from gill net collections. The material in this section is the only existing measure of fish production for the concerned waters that permit comparisons over a period of several years. It is emphasized that studies, from which this information was taken, were originally designed for other purposes. With this consideration in mind, and in keeping with the primary objectives of this report, this section is intended to serve three purposes.

The primary purpose is to convert to common measure and to reduce in bulk the vast quantities of statistical data accumulated under the project. To make the report concise and easy to examine, graphics are employed. These graphs present essential basic information and indicate major changes in hydrology, water quality, and other factors. The use of graphics tends to limit accuracy. In many instances the measurement of production trends is shown to be continuous when actually there were no samples taken during one or more years. Obviously, population trends during such period are unknown and may vary considerably from the trend indicated. The trend on the graph is regarded as a logical continuance that bridges blanks in project data. Graphs where gross game fish production is compared with hydrological or other basic data, should not be regarded as being accurate in the sense that they provide a true and proportional representation of the subjects. This is impossible because the means of mathematical measure are incompatible. There are no methods where per cent game fish, a relative value, can be statistically correlated with absolute values such as parts per million or acre-feet. The limited space used for graphs also prohibits representing two or more subjects in true perspective. It is virtually impossible to accurately present, in the limited space used for the graph, capacities of a lake that may ordinarily fluctuate between 25,000 and 30,000 acre feet but that also increase to more than 100,000 acre-feet and experience reduction below a thousand acre-feet. Even if such graphing was practical and it is proposed to compare capacity dynamics with gross game fish production, the graph would have meaning only in the general trends indicated. All graphs in this section and those in the sections that follow that deal with more than one variable, are intended to denote major trends. They are sufficient for that purpose but are not intended to serve any other purpose.

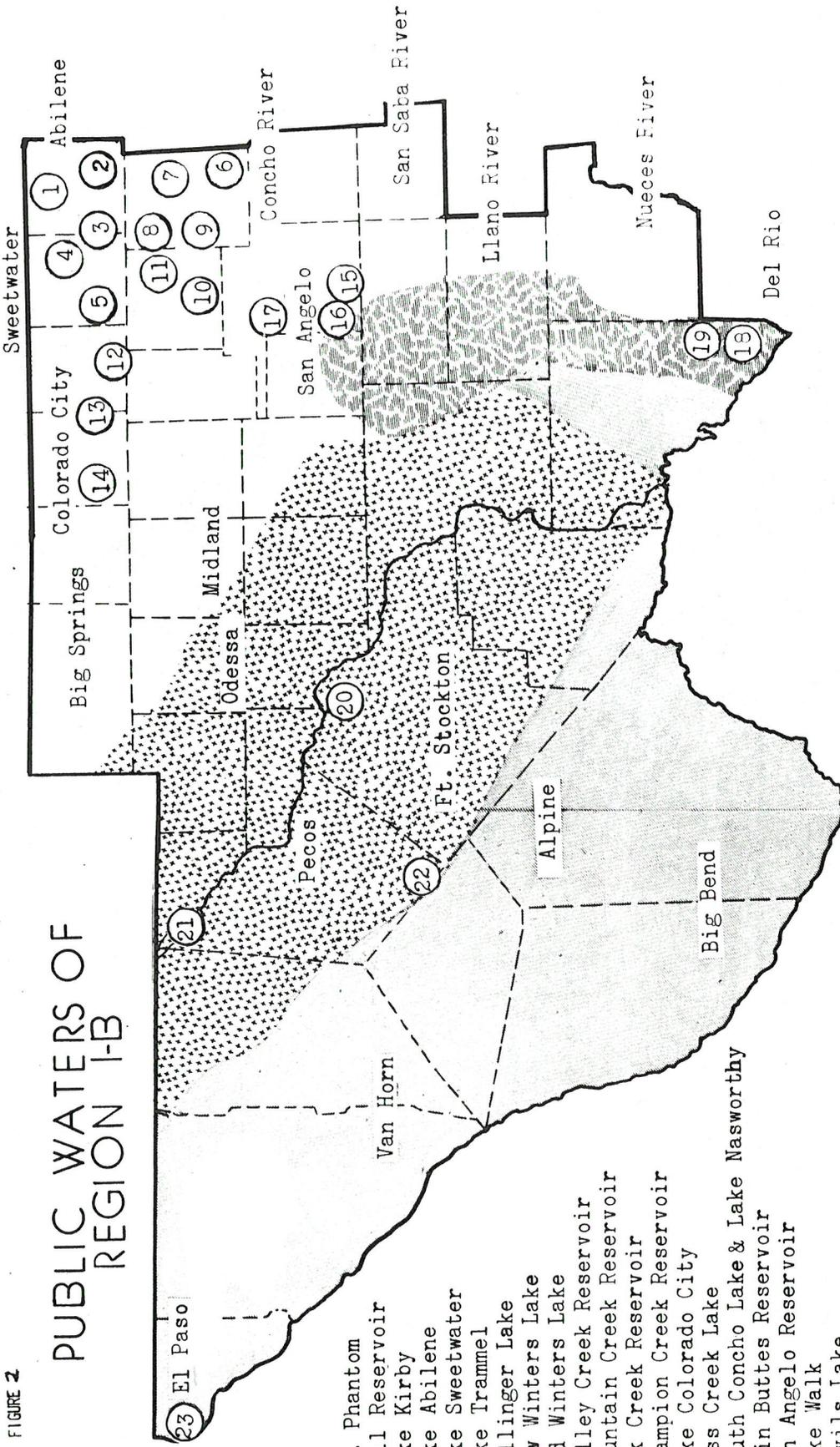
The second purpose of this section is to provide a convenient and compact reference that indicates where various data for individual waters may be found. References listed are the only known sources of information for the reservoirs. Stocking records are the only such records located for the concerned waters.

The third purpose of the section is to present brief discussions of factors and suspect factors that, in the opinion of the author, appear to influence game fish production in the individual waters. This is done to provide those unfamiliar with the area with the observations and opinions of one intimately associated with the subject. This is also done in some instances to provide a brief accounting for otherwise unexplained or unmeasured phenomena.



FIGURE 2

PUBLIC WATERS OF REGION 1-B



REGION 1-B

Area.....58,947 square miles, or 22.42 per cent of the State.
 Public Waters ..Estimated at 28,952 acres, with storage capabilities that exceed 2 Million acre feet
 PopulationOver 866,154 people

- Rio Grande River Watershed
- Pecos River Watershed
- Devils River Watershed
- Brazos River Watershed
- Colorado River Watershed

Fort Phantom Hill Reservoir

Location

Fort Phantom Hill Reservoir is in the Brazos River Basin in Jones County, 5 miles south of Nugent on Elm Creek.

Ownership and History of Development

Fort Phantom Hill Reservoir is owned and operated by the city of Abilene for municipal water supply and recreation. Permit No. 1249 issued August 9, 1937, authorized construction of a dam on Elm Creek to create a reservoir of about 73,960 acre-feet and an annual diversion of 30,690 acre-feet of water for municipal water. Construction started in June 1937 and was completed in October 1938. Other reservoirs owned by the city of Abilene include Lake Abilene and Lake Kirby. Abilene also has the right to purchase water from Hubbard Creek Reservoir.

Physical Description

The dam is rolled-earth, 70 feet high with the top of the dam at elevation 1,650.0 feet above m.s.l. The reservoir has a capacity of 74,310 acre-feet and a surface area of 4,246 acres at spillway crest. A sedimentation survey in 1953 reported that the reservoir trapped 2,654 acre-feet of sediment in 14.8 years.

History of Fisheries Investigations and Management

Prior to 1956, both Toole and LeSeur had made limited investigations of the fishery in Fort Phantom Hill Reservoir. An inventory survey was carried out under federal aid in 1956. Subsequent sampling of game fish production was carried out under Project No. F-5-R until 1964 when the reservoir became the responsibility of Project No. F-7-R. A commercial fisherman netted the lake for smallmouth buffalo in 1957-58, and again in 1959-60.

Stocking Record

For actual number of fish stocked, multiply entry by 1,000. (Records are for the 1954-1964 decade).

	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964
Largemouth bass											
fry	182	10	87		91	100	70		65		
fingerling		10			2		.5	32			28
Sunfish											
fingerling			3.5		.25		.40				
White crappie											
fingerling						1					
Channel catfish											
fingerling			6		1	12	44.5	.8			

Total largemouth bass fry: 605,000 or an average of 60,500 per year.
Total largemouth bass fingerling: 62,500 or 6,250 per year.
Total sunfish: 4,150.
Total white crappie: 1,000.
Total channel catfish: 65,301 or 6,530 per year.

Discussion

Data are less than required to accurately depict trends for individual species. It appears that game fish production increased between 1956 and 1960. This increase is attributed to an increase in volume and greater stability of water levels. It would also appear that the overall trend in game fish production has been one of increase. The general trend in water levels has been upward and volumes have been more stable. Observations include an apparent low food production in insect life, the frequent occurrence of prolonged turbidity, and the frequency of occurrence of rough waters that apparently results from the lake being located in a natural trough that aligns with the direction of the prevailing southwesterly winds. The net effect of commercial harvest on lake production cannot be determined. The production trends that indicate an increase in smallmouth buffalo and a corresponding decrease in river carpsucker warrant further study. Observations and inquiries tend to indicate the fishing reputation for the lake is less than desirable.

References

A. Fisheries Investigations

Project F-5-R-4, Job Completion Report B-18. (Inventory)
Project F-5-R-5, Job Completion Report B-18 (Inventory)
Project F-5-R-6, Job Completion Report B-22. (Resurvey)
Project F-5-R-7, Job Completion Report B-17. (Watershed Survey)
Project F-5-R-11, Job Completion Report B-32. (Reconnaissance)

B. Hydrological and Water Quality Data

Texas Water Commission Bulletin 6408
United States Geological Survey, Water Supply Papers and Records
City of Abilene Water Department Records
Records of the State Health Department

Figure 3

HYDROLOGICAL DATA FOR FORT PHANTOM HILL Water Levels



Figure 4

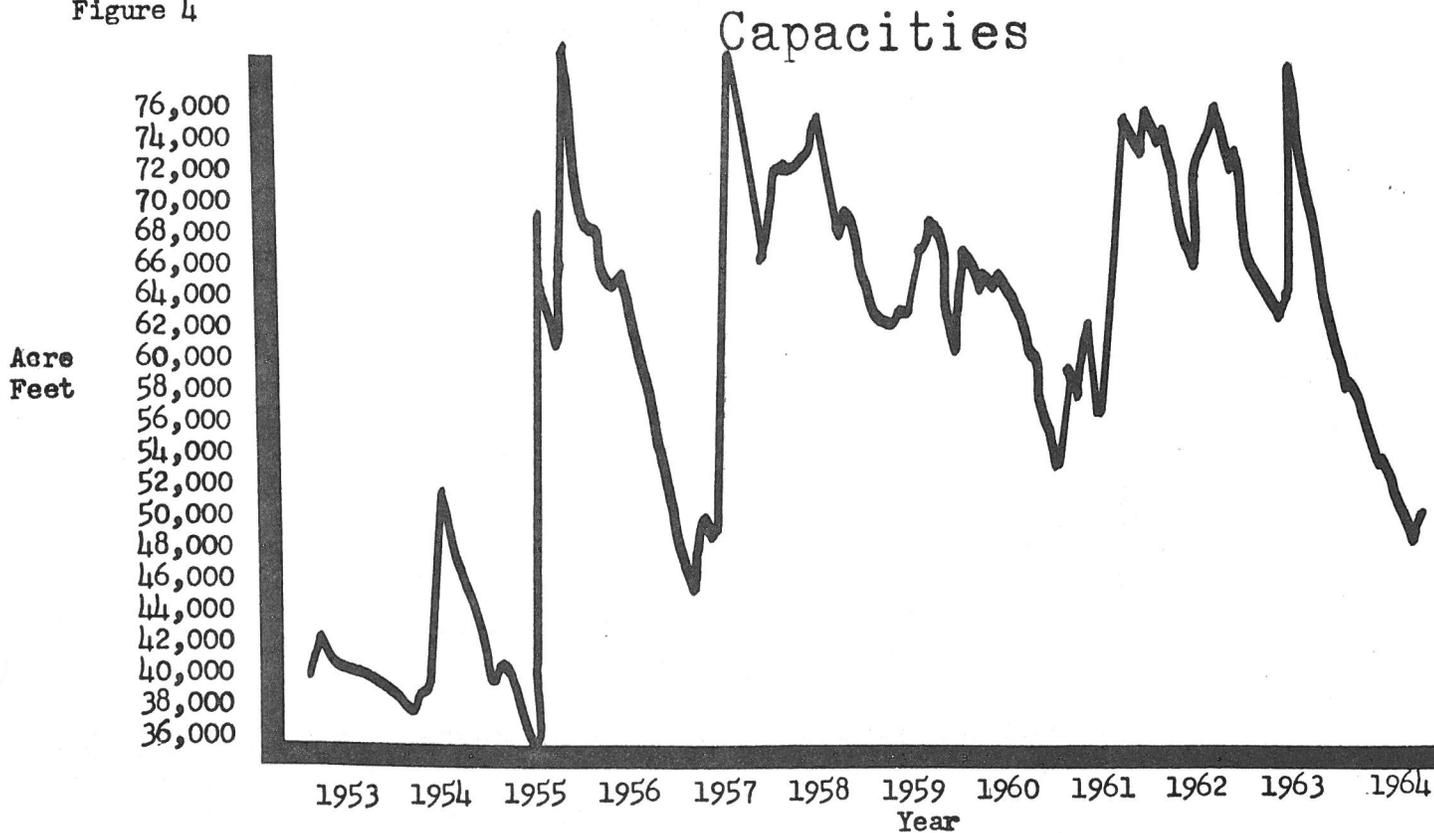


Figure 5

WATER QUALITY DATA FOR FORT PHANTOM HILL Chlorides

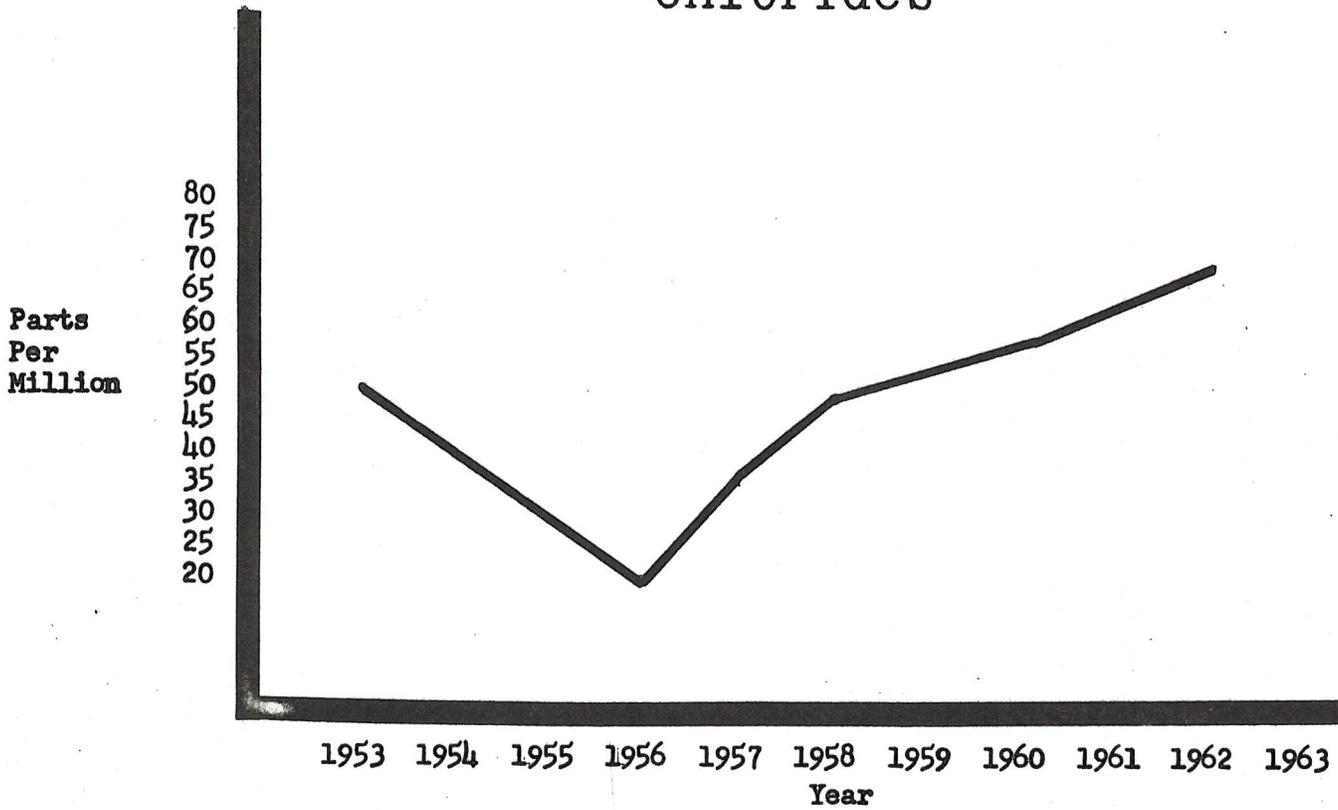
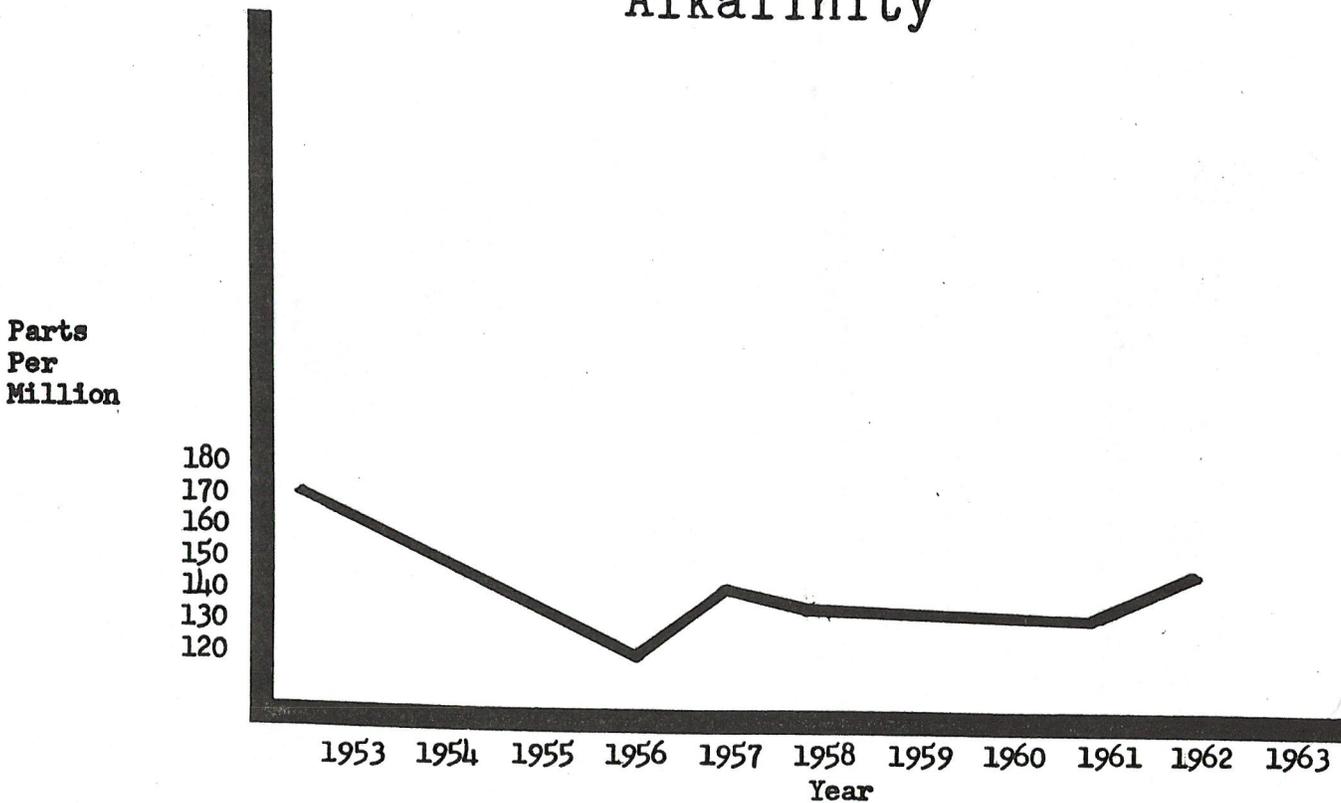


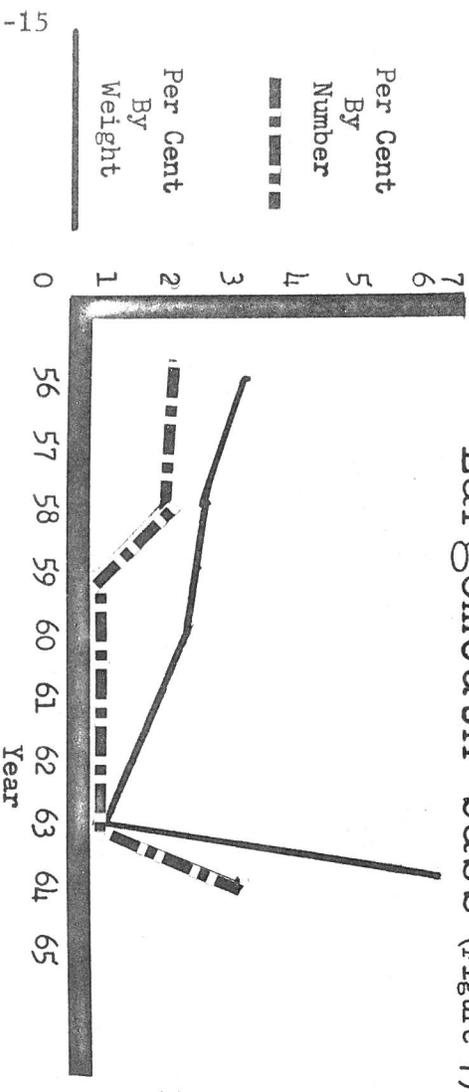
Figure 6

Alkalinity

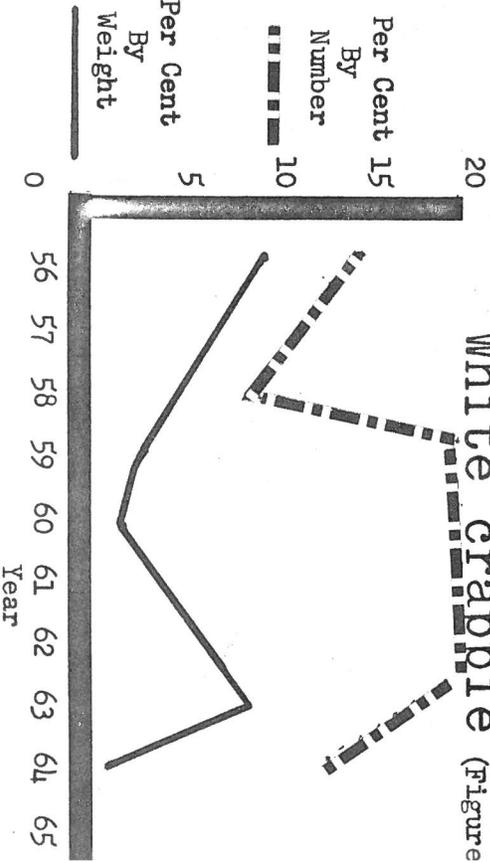


FISH PRODUCTION FROM FORT PHANTOM HILL RESERVOIR Game Fish Production

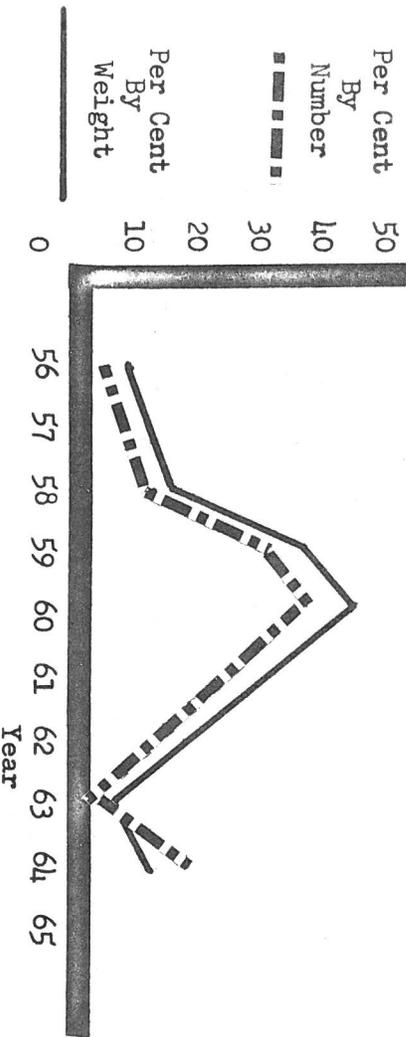
Largemouth bass (Figure 7)



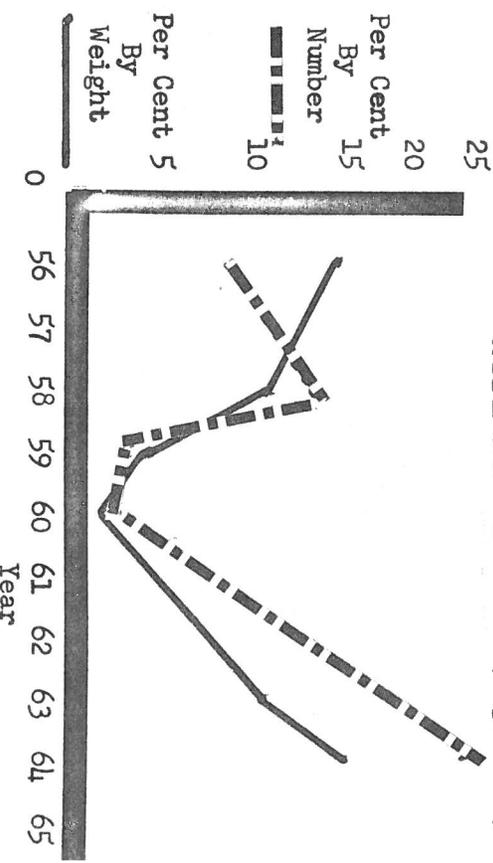
White crappie (Figure 8)



Channel catfish (Figure 9)



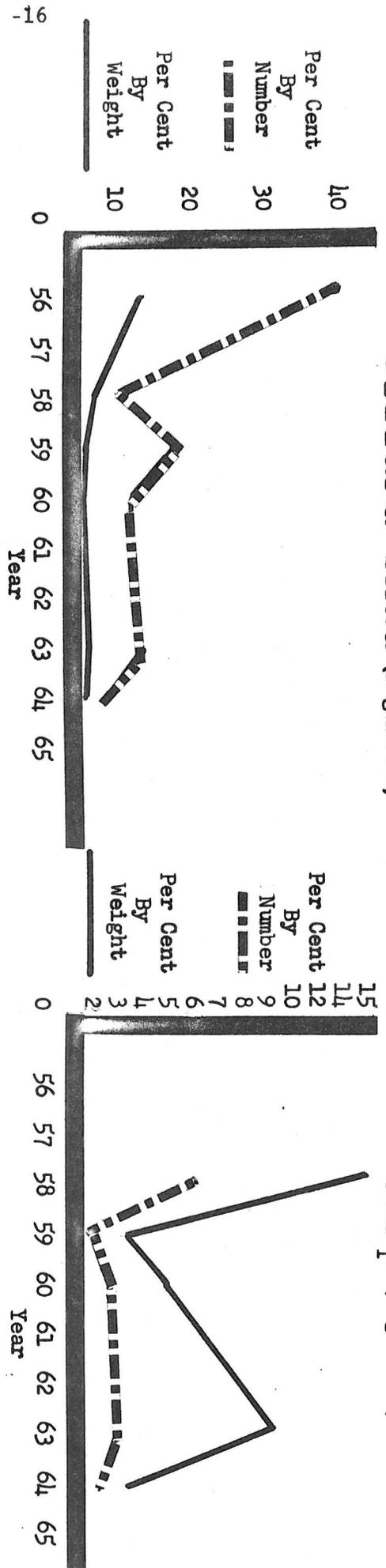
White bass (Figure 10)



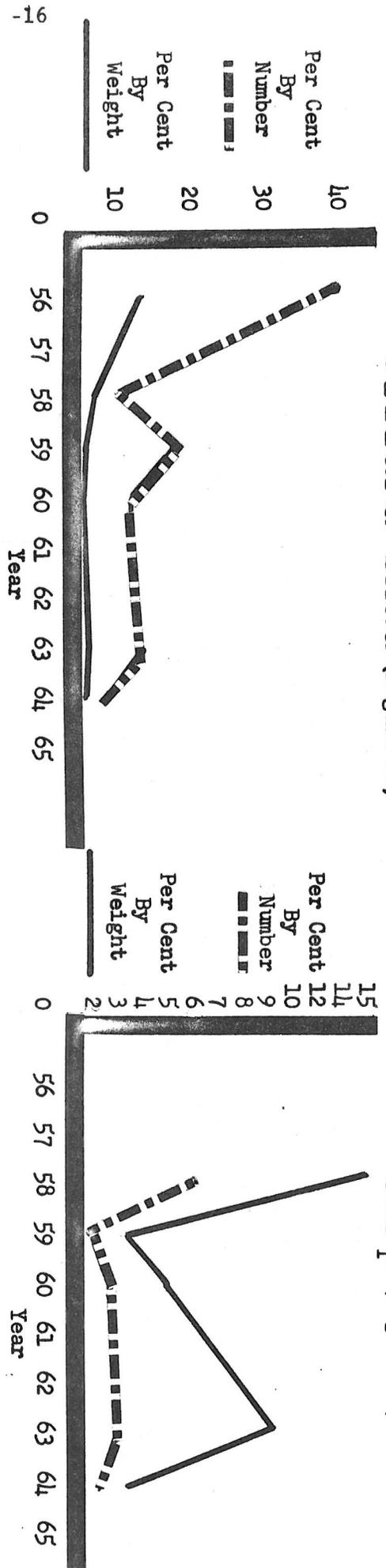
FISH PRODUCTION FROM FORT PHANTOM HILL RESERVU IR

Principal Non-Game Species

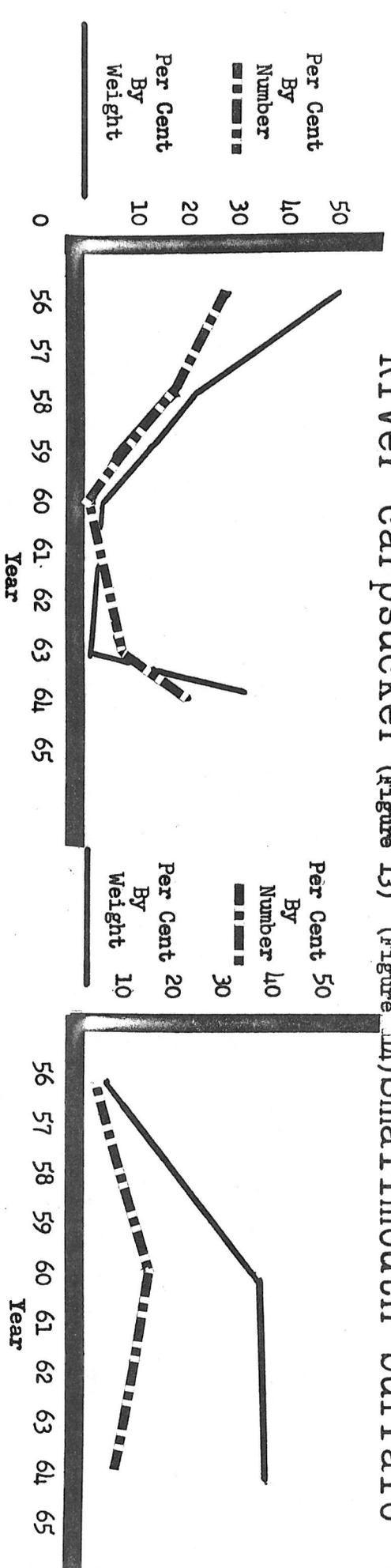
Gizzard shad (figure 11)



Carp (figure 12)

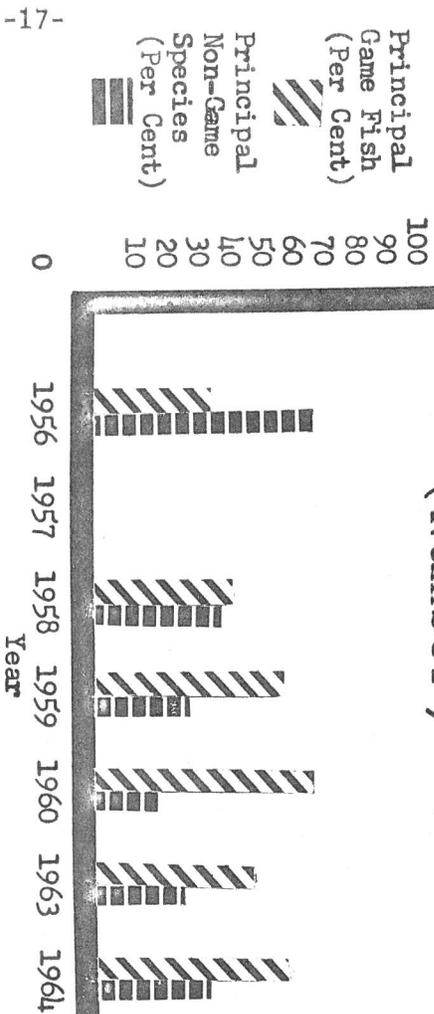


River carpsucker (figure 13) (figure 14) Smallmouth buffalo

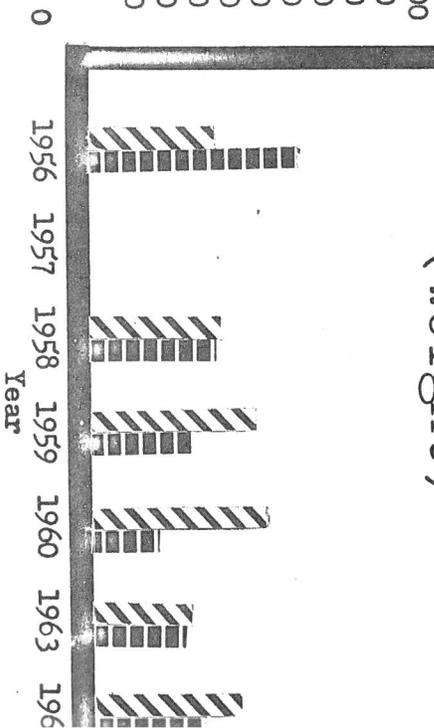


FORT PHANTOM HILL RESERVOIR

Principal Production (Figure 15)
(Number)

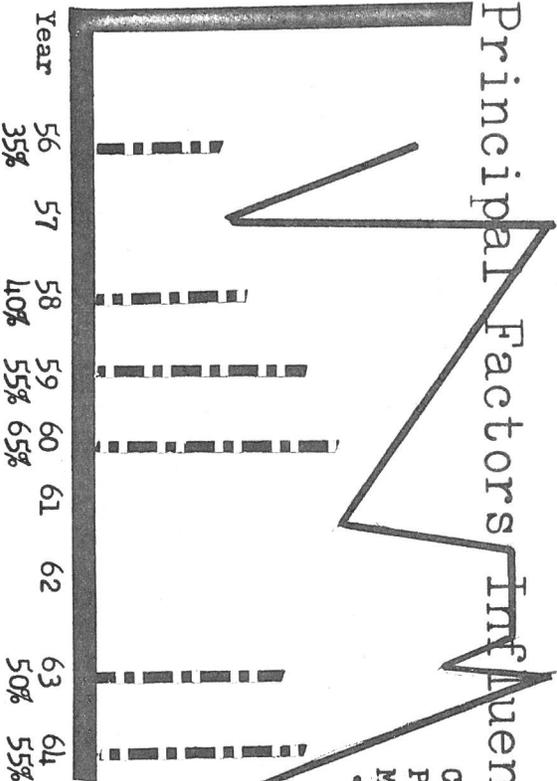


Principal Production (Figure 16)
(Weight)

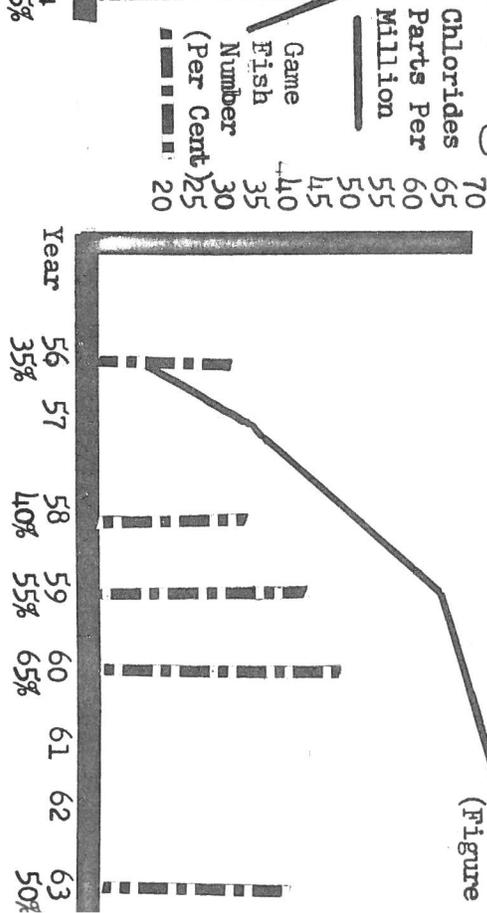


Principal Factors Influencing

(Figure 17)
Capacity 69,000
Acre 64,000
Feet 60,000
56,000
52,000
48,000
Game Fish 4,000
Number 40,000
(Per Cent) 35,000



Game Fish Production (Figure 18)



Lake Kirby

Location

Lake Kirby is located 5 miles south of Abilene on Cedar Creek in Taylor County. Cedar Creek is a tributary of the Clear Fork of the Brazos River.

Ownership and History of Development

This project is owned and operated by the city of Abilene for municipal water, but it was used for irrigation of small acreage in the beginning. Construction was authorized by Permit No. 1051 dated January 23, 1928. Water rights were for an appropriation of 14,000 acre-feet annually for municipal water and 284 acre-feet for irrigating 142 acres. The dam was completed in 1928 with impoundment and diversion of water beginning at that time.

Physical Description

The dam is earthfill, 4,200 feet long and 50 feet high with the top of the dam at elevation 1,795.5 feet above m.s.l. The lake has a capacity of 7,620 acre-feet and a surface area of 740 acres at elevation 1,785.0 feet above m.s.l. The drainage area above the dam is 44 square miles. Approximately 880 acre-feet of storage have been lost through sedimentation since the dam was constructed.

History of Fisheries Investigations and Management

Limited investigations by Marion Toole, then Director of Inland Fisheries, and LeSeur were carried out in the mid 1940's. However, the difference in the sampling equipment used does not permit accurate comparisons of data. For that reason the survey completed under federal aid in 1959-60 and periodic sampling under the resurvey and reconnaissance programs that followed are the only data that are used for the purposes of this report. Lake Kirby went dry in 1953 and was subsequently restocked in 1954.

Stocking Record

For actual number of fish stocked multiply entry by 1,000.

	1954	1955	1959	1963	1964
Largemouth bass fry			75		
fingerling	30			5	20
Sunfish fingerling	5				
White crappie fingerling		.30			
Channel catfish				.60	

Discussion

In keeping with standards adapted for the purposes of this report, statistical data do not provide a sufficiently substantial basis for determining factors that influence production. Game fish production, as shown in the accompanying graphs, has been adequate but problematic fish are apparently increasing. Observations and inquiries tend to establish that the water quality is excellent, turbidity is nearly always high, harvest of large white crappie and flathead catfish is common, but the harvest of other game fish is meager. Because of its unique characteristics and small size, Lake Kirby offers the opportunity of studying the inter-relationship between carp, river carpsucker and flathead catfish.

References

A. Fisheries Investigations

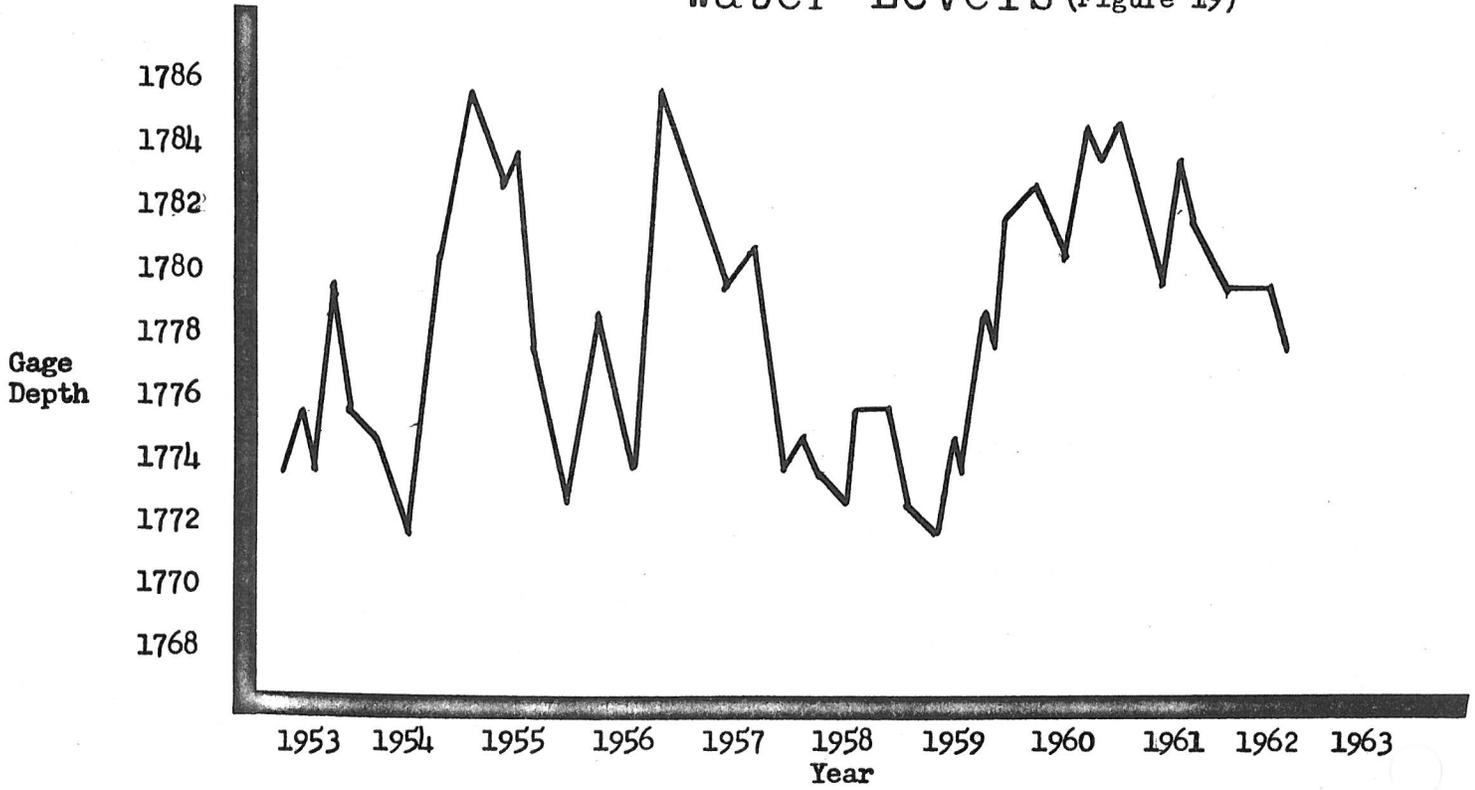
Project F-5-R-7, Job Completion Report B-16.
Project F-5-R-7, Job Completion Report B-26.
Project F-5-R-8, Job Completion Report D-1.

B. Hydrological and Water Quality

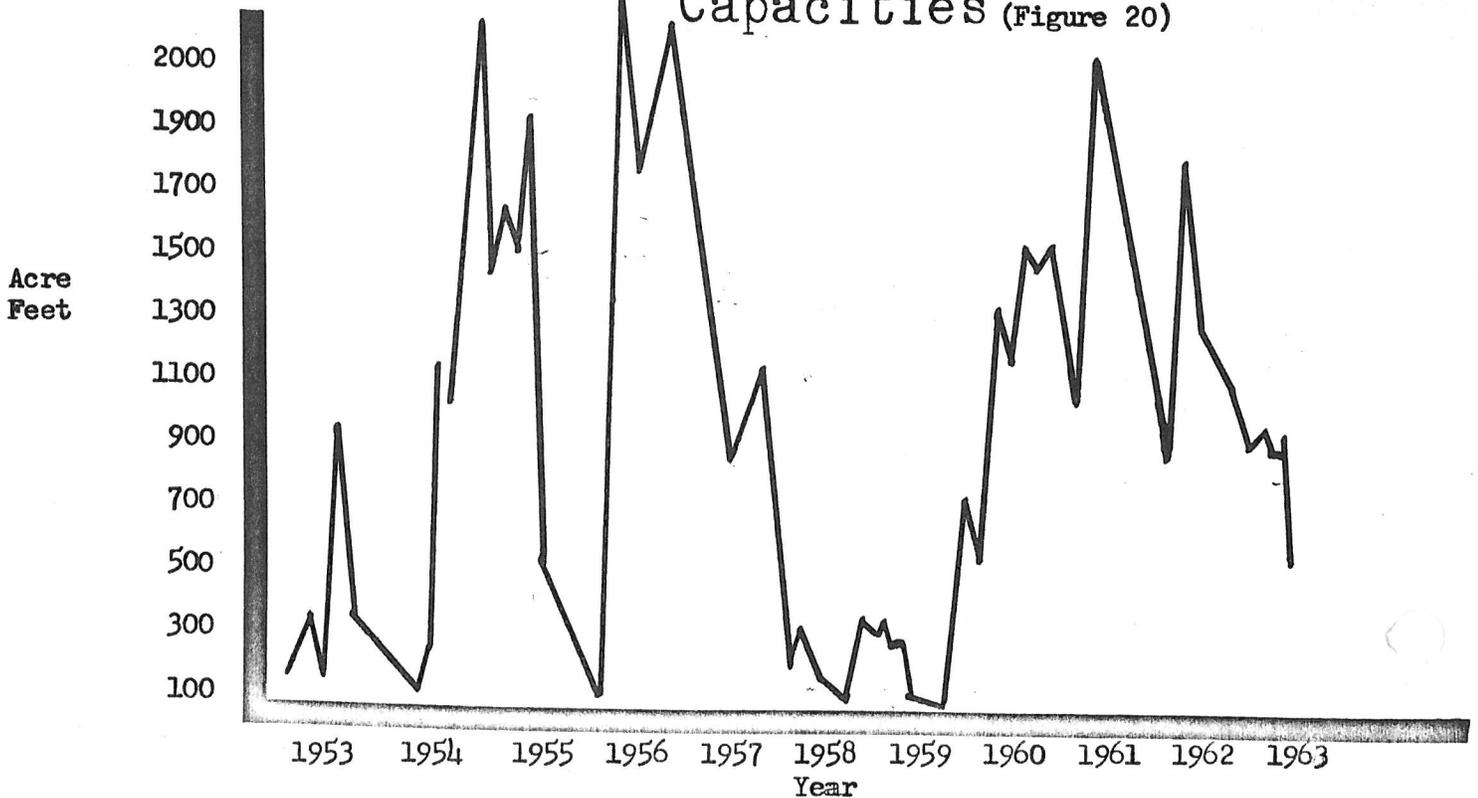
Records of Abilene Water Department.
United States Geological Survey Water Supply Papers and Records.

HYDROLOGICAL DATA FOR LAKE KIRBY

Water Levels (Figure 19)

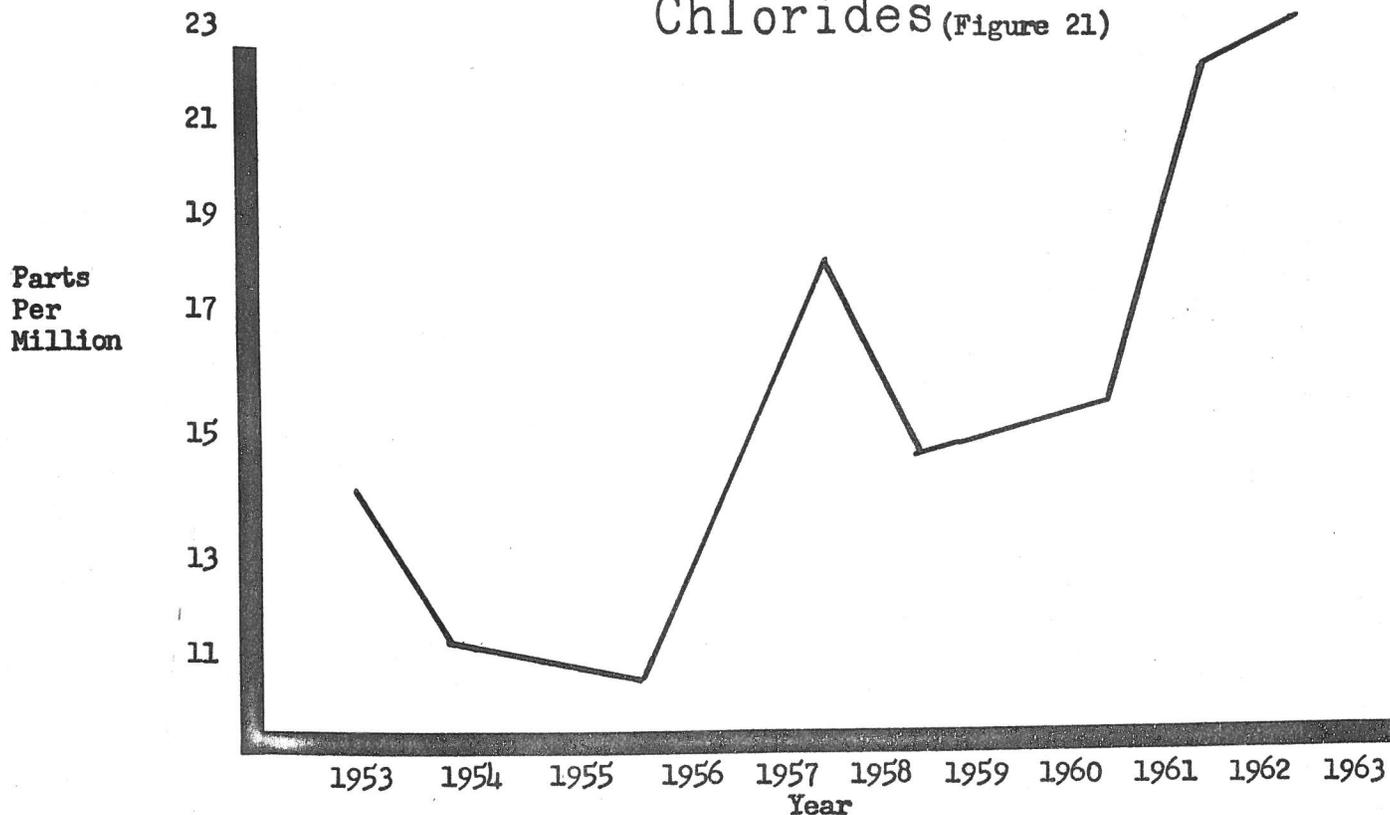


Capacities (Figure 20)



WATER QUALITY DATA FOR LAKE KIRBY

Chlorides (Figure 21)

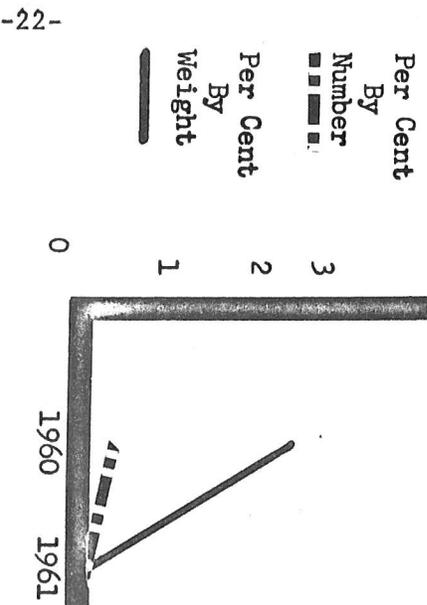


Alkalinity (Figure 22)

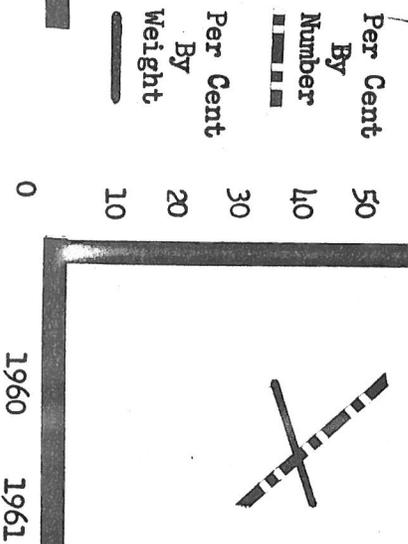


FISH PRODUCTION FROM LAKE KIRBY Game Fish Production

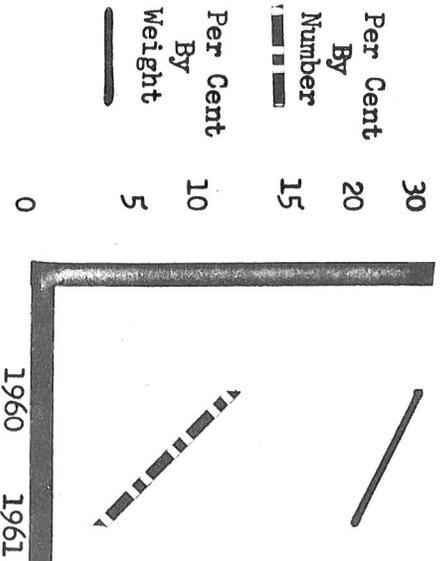
Largemouth bass (Figure 23)



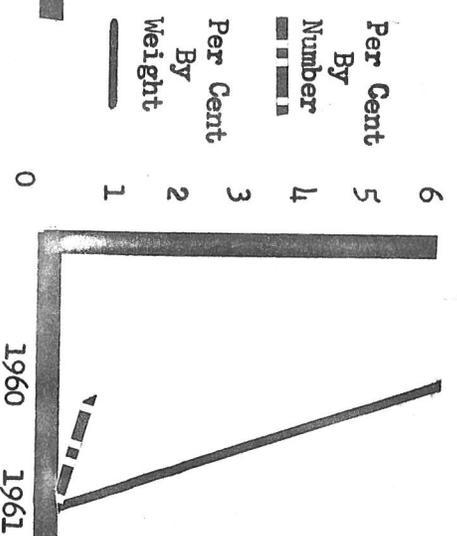
White crappie (Figure 24)



Channel catfish (Figure 25)



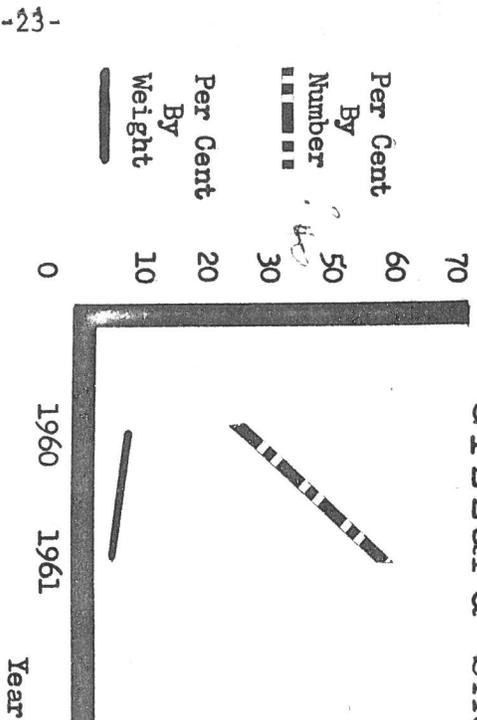
Flathead catfish (Figure 26)



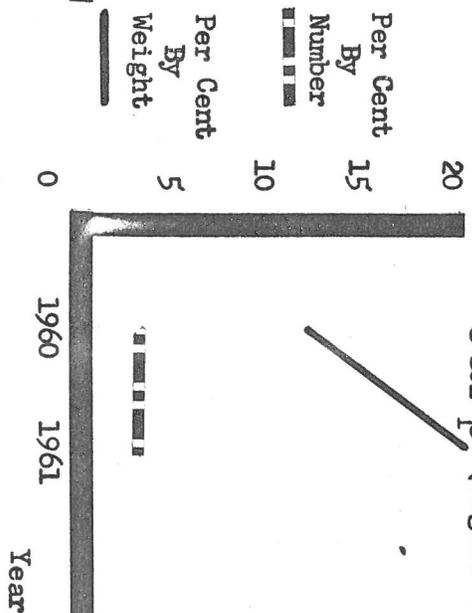
FISH PRODUCTION FROM LAKE KIRBY

Principal Non-Game Species

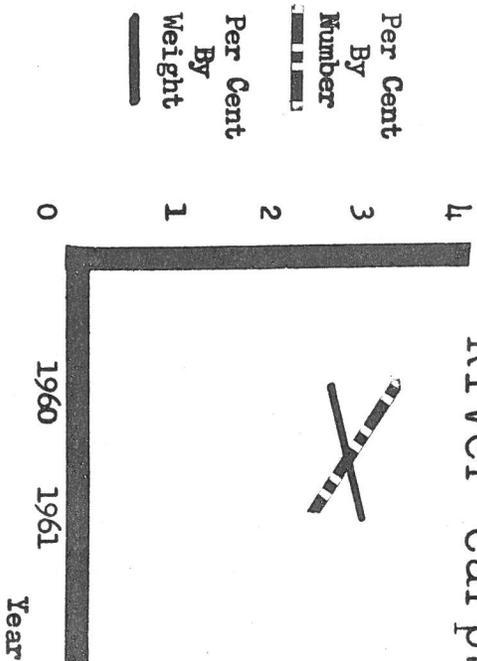
Gizzard shad (Figure 27)



Carp (Figure 28)

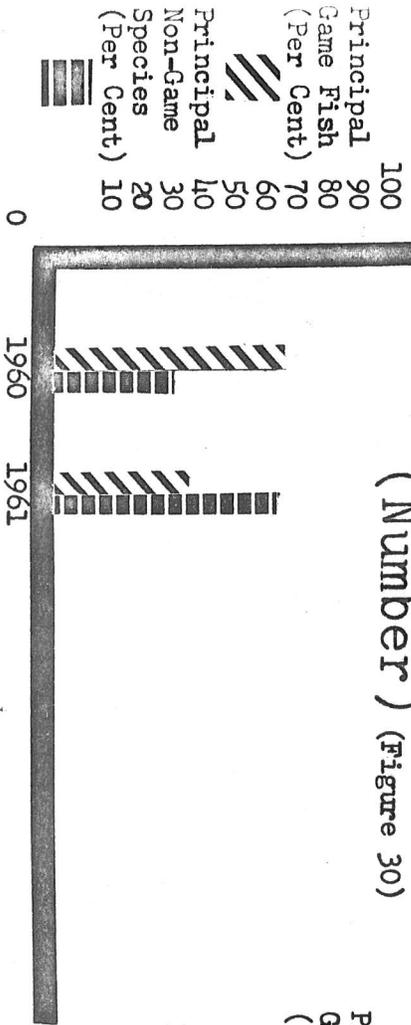


River carpsucker (Figure 29)

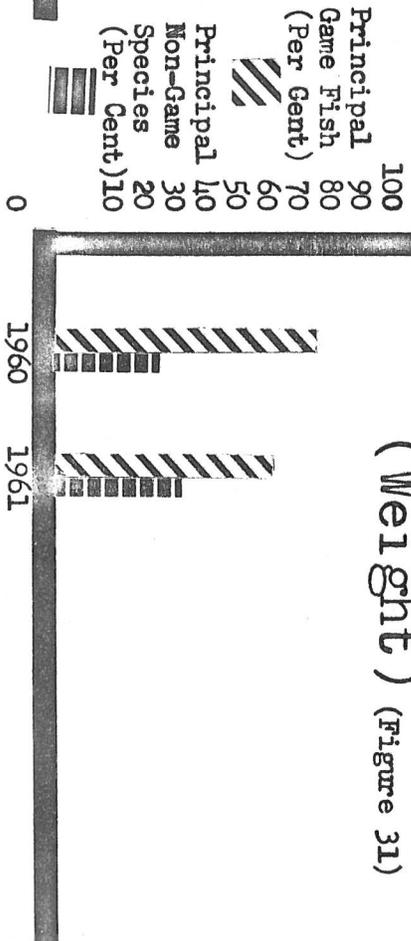


LAKE KIRBY

Principal Production (Number) (Figure 30)



Principal Production (Weight) (Figure 31)



Lake Abilene

Location

Lake Abilene is located ten miles southwest of Abilene and six miles northwest of Tuscola in Taylor County. The dam is on Elm Creek, a tributary of the Clear Fork of the Brazos River.

Ownership and History of Development

The reservoir is owned and operated by the city of Abilene for municipal and industrial water and for recreational purposes. Earthwork was completed in May 1921, and deliberate impoundment begun August 1, 1921. Original Permit No. 253 granted in 1918 allows use of 1,675 acre-feet of water. The anticipated storage of 45,000 acre-feet was not reached. Actual storage is 9,790 acre-feet.

Physical Description

The present dam is 3,400 feet long and 51 feet above creek bed, with the top of the dam at that elevation 2,031.3 feet m.s.l. Maximum storage capacity is 9,790 acre-feet, and area is 641 acres when the lake is at spillway capacity at elevation 2,018.8 feet above m.s.l.

History of Fisheries Investigations and Management

Lake Abilene was initially surveyed in 1958 to determine species present, relative abundance and distribution. Subsequent investigation was a part of a survey of the Clear Fork of the Brazos River Watershed. There has been no management other than stocking.

Stocking Record

Available stocking records began in 1946. From that year until 1951 over 120,000 largemouth bass fry were stocked. In the record that follows, the actual number of fish stocked is obtained by multiplying the entry by 1,000.

	1951	1952	1953	1954	1955	1956	1957
Largemouth bass fry	70		11			80	
fingerling				10	10		
Sunfish fingerling			6.8			3.5	2
White crappie fingerling			.95			.90	1
Channel catfish fingerling		13.5			3	4.5	3.5

	1958	1959	1960	1961	1962	1963	1964
Largemouth bass							
fry	92	70					
fingerling						4	26
Sunfish							
fingerling							
White crappie							
fingerling							
Channel catfish							
fingerling			20				1

Total largemouth bass fry stocked in the past 13 years: 323,000 (over 24,000 per year.)
 Total largemouth bass fingerling stocked: 50,000 (over 3,800 per year).
 Total sunfish stocked: 12,300 (less than 900 per year).
 Total white crappie stocked: 3,350.
 Total channel catfish: 45,566.

Discussion

It would appear that past hydrology has exercised great influence on game fish production. Water levels in Lake Abilene have been relatively unstable. As shown in figures 32 and 33 there was an overall recession from 1957 to 1960. During that period game fish declined slightly and problematic fish increased slightly. Unfortunately we do not have netting data for the critical period between 1960 and 1964. But between 1961 and 1964 a second decline in lake levels occurred. By 1964 the relative abundance of game fish had greatly diminished, and non-game fish, principally carp and river carpsucker, had greatly advanced. It is suspected that these extreme recessions and factors accompanying them, are largely responsible for this reduction. The basic hydrological trend between 1954 and 1964 has been one of recession broken by occasional significant increases. The overall trend in game fish production has been one of decline. It is also noted that increases in river carpsucker and increases in chlorides occurred during the same period. It is logical to assume that instability of water level has tended to reduce game fish production by repressing or actually preventing reproduction of some game species. The expansion of silt over much of the basin is probably detrimental and aquatic vegetation is a factor that may pose a threat to future production and harvest. Because of its small size and other attributes Lake Abilene provides the opportunity of economical study of experimental management and harvest.

References

A. Fisheries Investigations

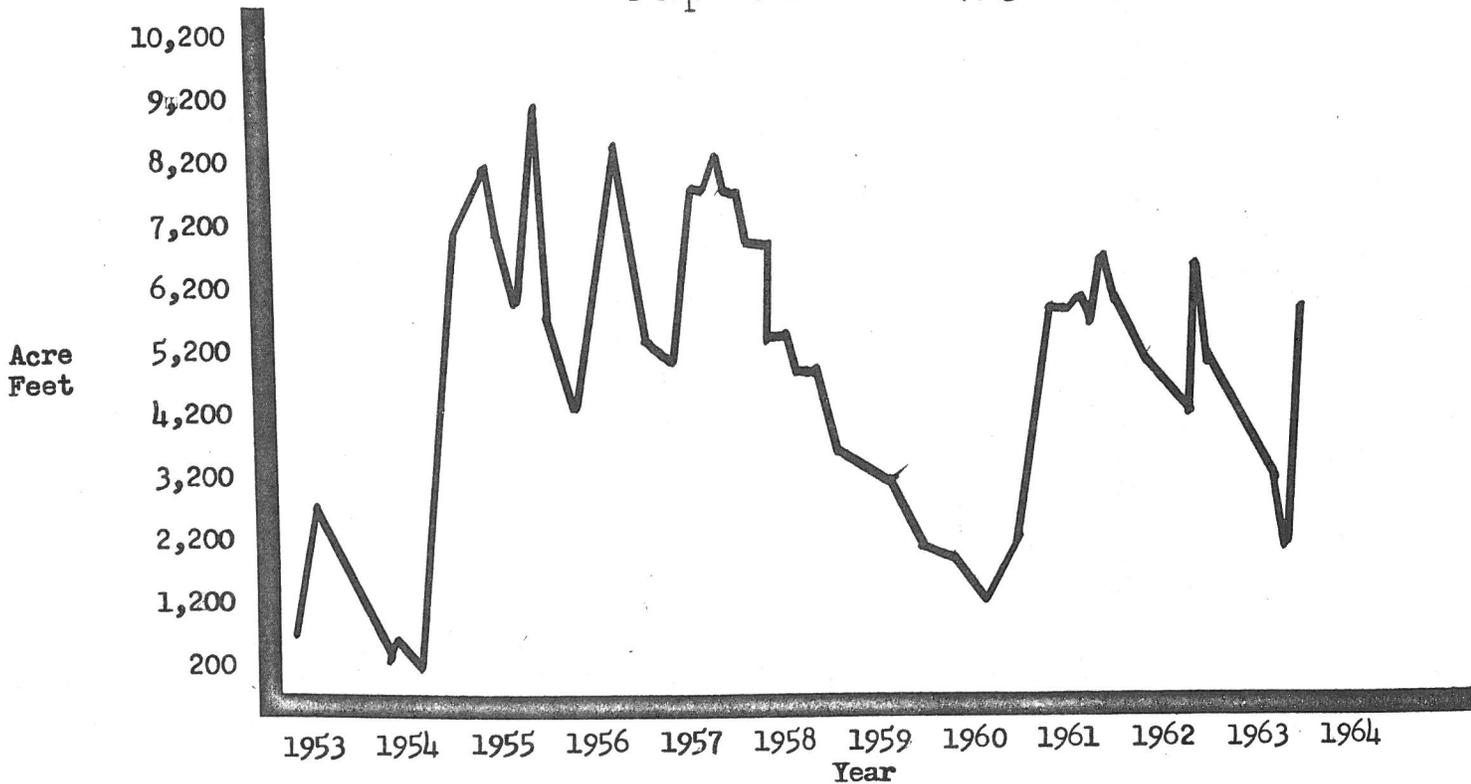
- Project F-5-R-6, Job Completion Report B-23 (Inventory)
- Project F-5-R-7, Job Completion Report B-16 (Watershed Survey)
- Project F-5-R-9, Job Completion Report B-32 (Reconnaissance)
- Project F-5-R-12, Job Completion Report B-28 (Harvest Regulations)

HYDROLOGICAL DATA FOR LAKE ABILENE

Water Levels (Figure 32)

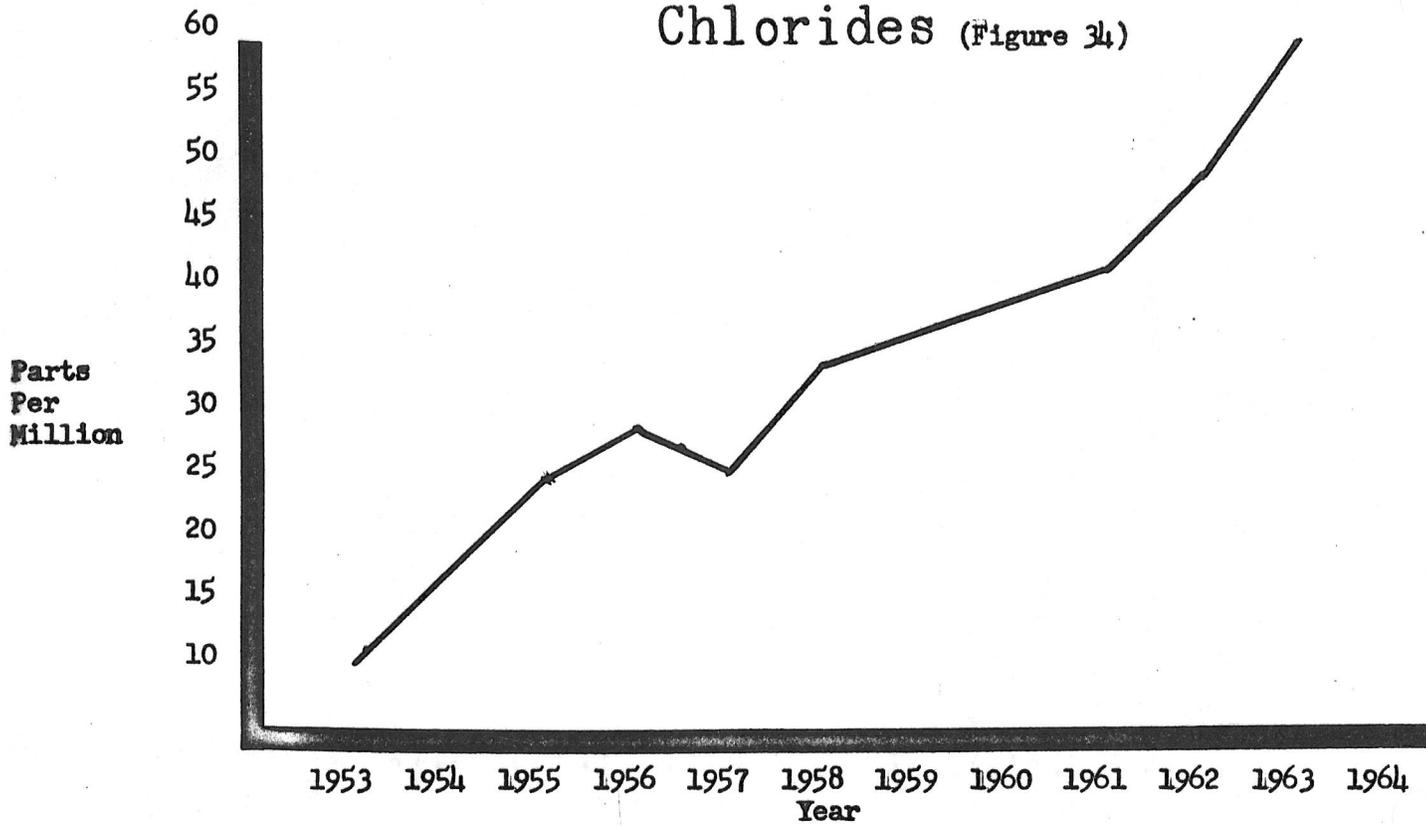


Capacities (Figure 33)

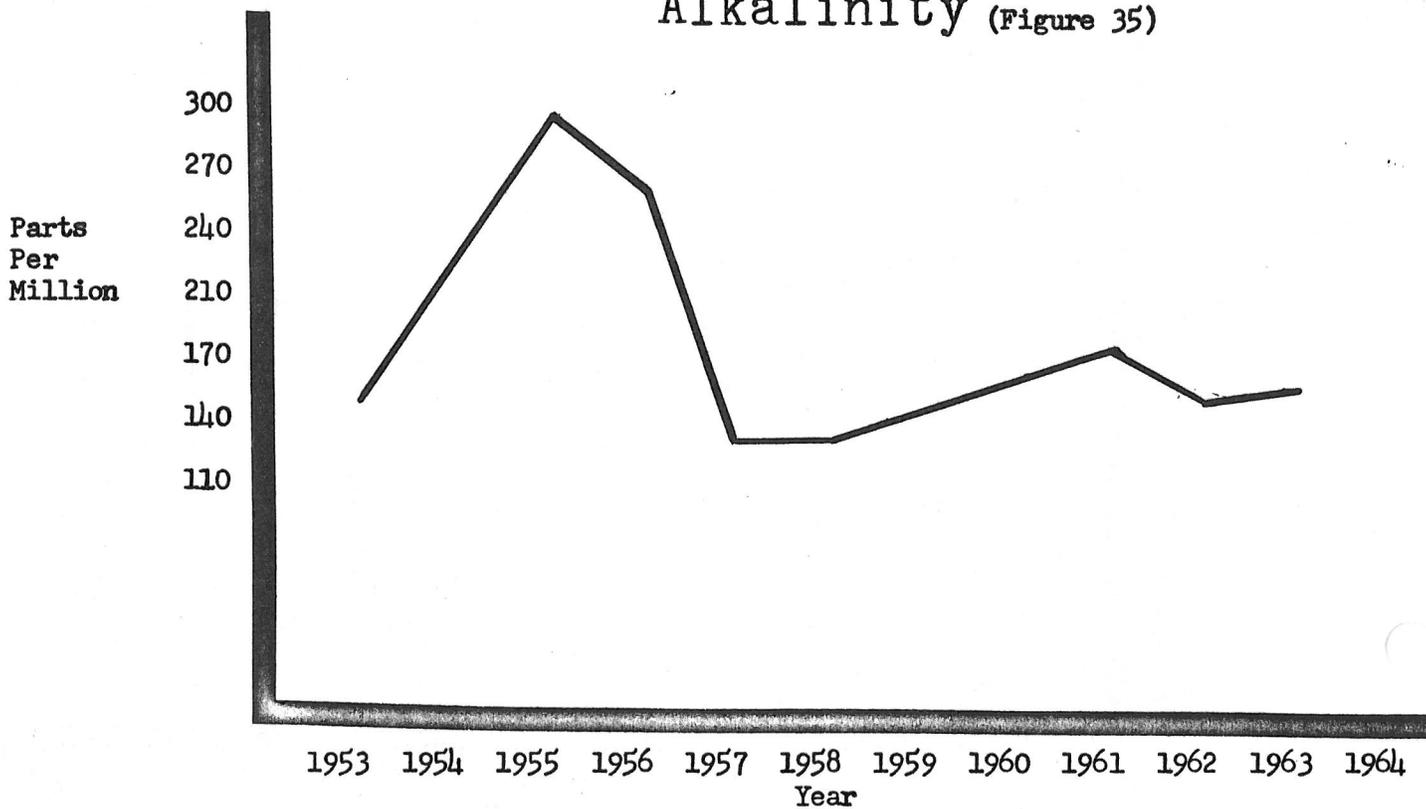


WATER QUALITY DATA FOR LAKE ABILENE

Chlorides (Figure 34)

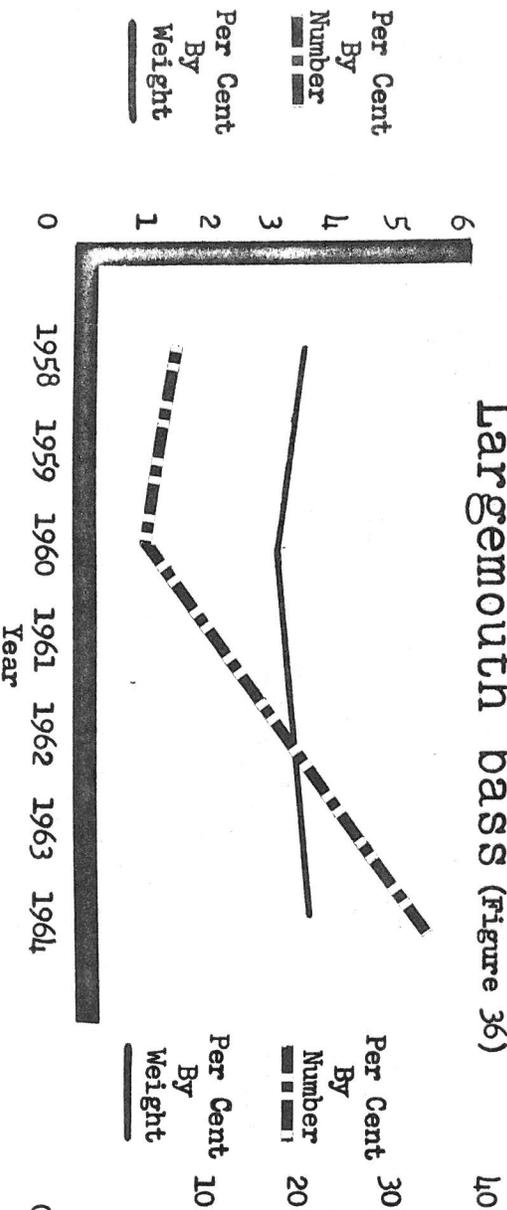


Alkalinity (Figure 35)

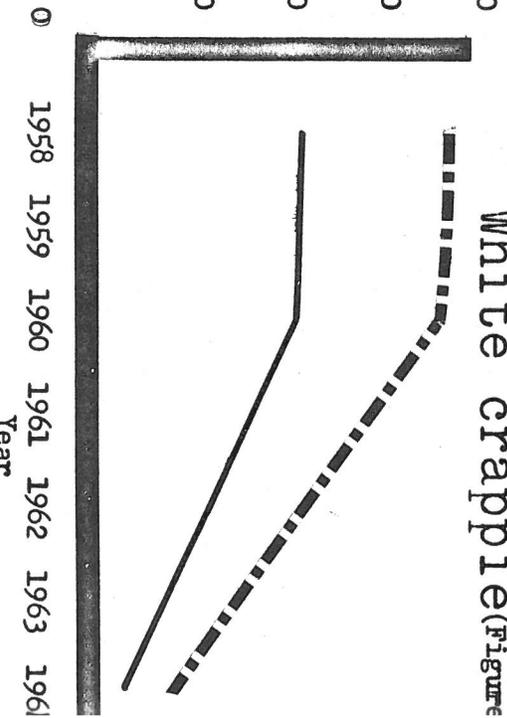


FISH PRODUCTION FROM LAKE ABILENE Game Fish Production

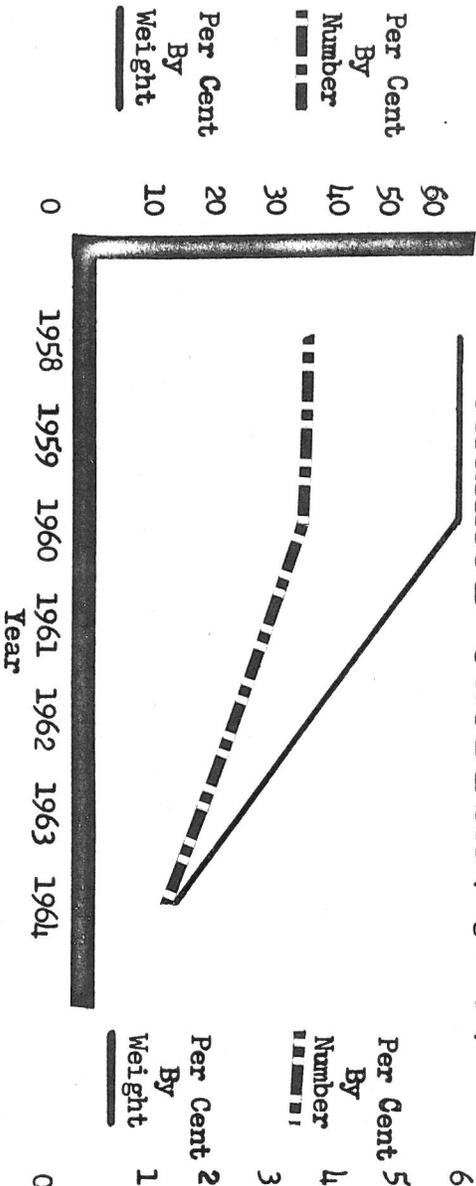
Largemouth bass (Figure 36)



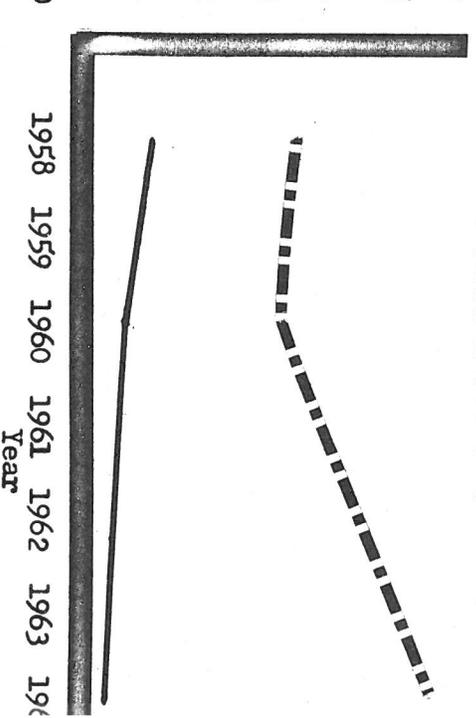
White crappie (Figure 37)



Channel catfish (Figure 38)



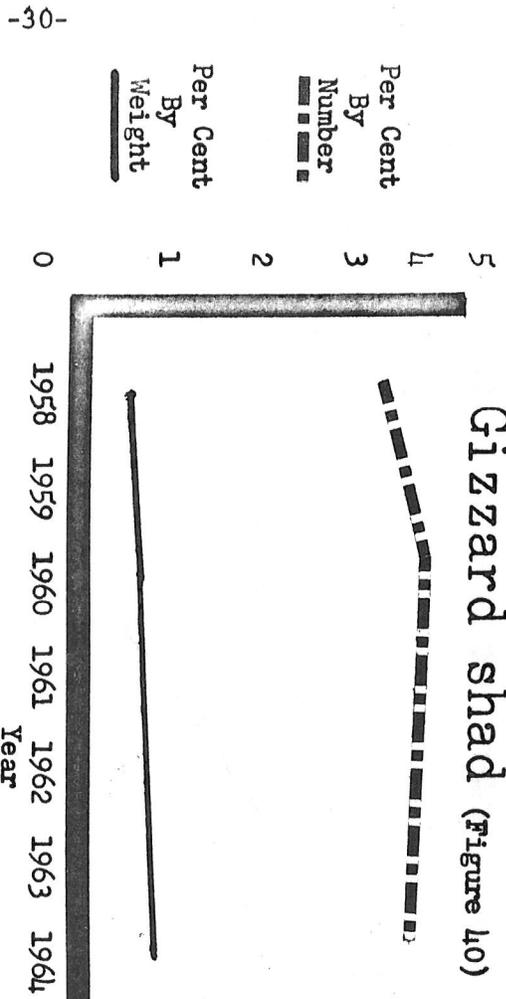
Sunfish (Figure 39)



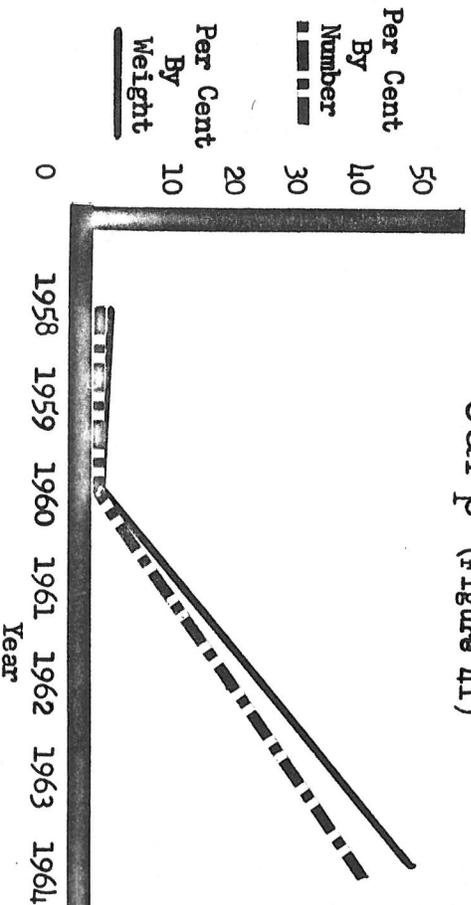
FISH PRODUCTION FROM LAKE ABILENE

Principal Non-Game Species

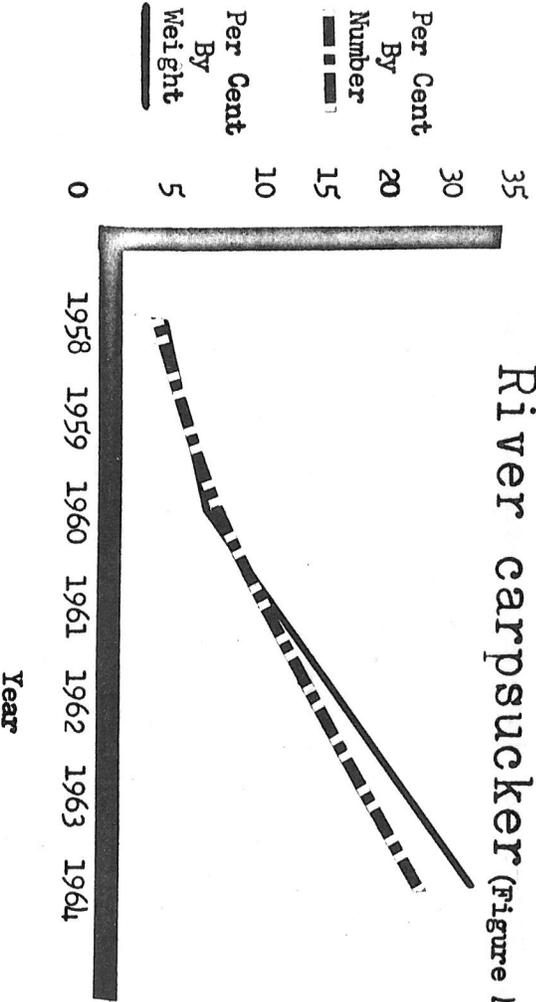
Gizzard shad (Figure 40)



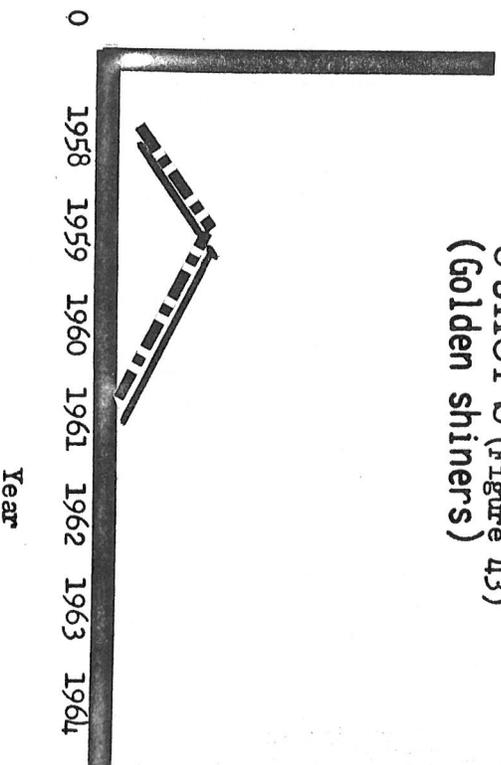
Carp (Figure 41)



River carpsucker (Figure 42)

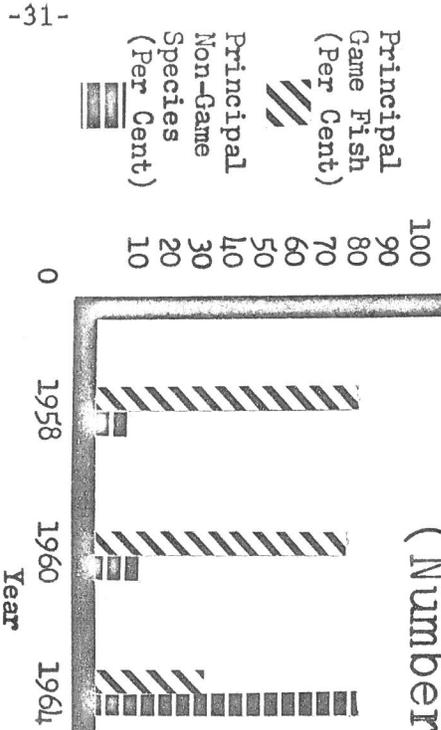


Others (Figure 43)
(Golden shiners)



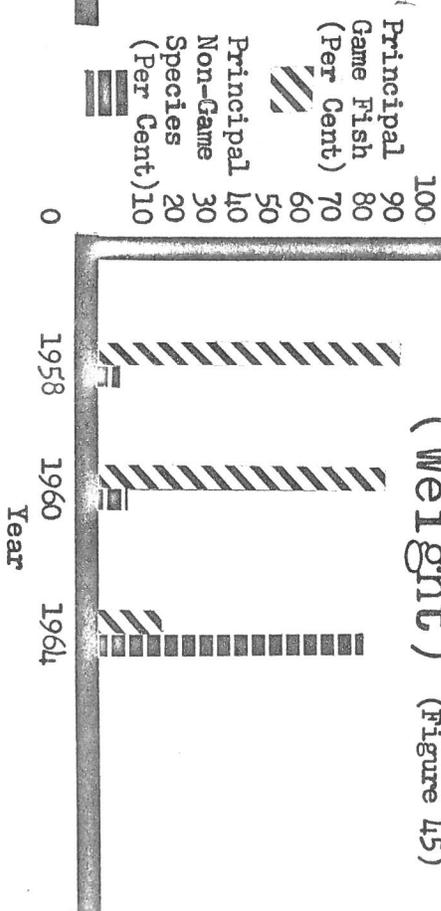
LAKE ABILENE

Principal Production (Number) (Figure 44)



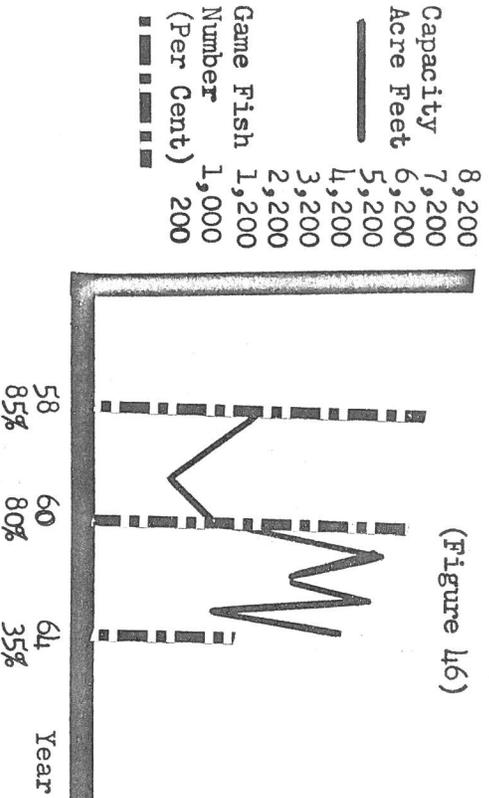
(Number) (Figure 44)

Principal Production (Weight) (Figure 45)

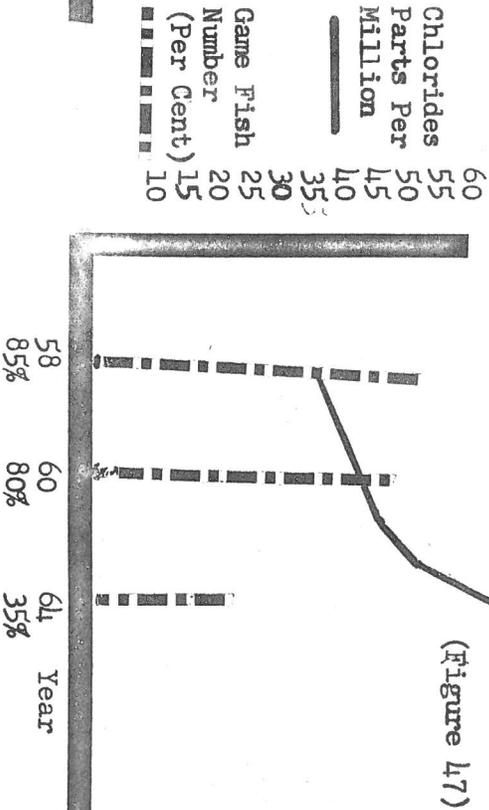


(Weight) (Figure 45)

Principal Factors Influencing Game Fish Production



(Figure 46)



(Figure 47)

Lake Sweetwater

Location

Lake Sweetwater is in the Brazos River Basin in Nolan County, 6 miles southeast of Sweetwater. The dam impounds Bitter and Cottonwood Creeks.

Ownership and History of Development

The reservoir is owned and operated by the city of Sweetwater for municipal water and recreation. The dam, authorized by Permit No. 1053, and issued in 1928, was completed in 1930. The lake first filled to spillway level in 1936 and water was first diverted to the city for filtration in June 1935. This reservoir and Lake Trammel served as the sources of water for the city of Sweetwater until Oak Creek Reservoir became the main source in 1955.

Physical Description

The dam is rolled-earth, 2,600 feet long and 50 feet high with the top of the dam at elevation 2,128.8 feet above m.s.l. The lake has a capacity of 11,900 acre-feet and a surface area of 630 acres at elevation 2,116.5 m.s.l. The drainage area above the dam is 104 square miles.

History of Fisheries Investigations and Management

With the exception of cursory examinations by Toole and other early investigators no fisheries studies had been carried out on Lake Sweetwater prior to 1957, when the first inventory survey was carried out under federal aid. This work was completed in 1958, and estimates of game fish production were maintained through resurvey and reconnaissance efforts and during the course of completing the survey of the Clear Fork of the Brazos River. In 1960 the reservoir was chemically treated to drastically reduce or eliminate existing fish populations. Following restocking, information on game fish production was obtained through further reconnaissance efforts.

Stocking Record

For actual number of fish stocked multiply entry by 1,000.

	1952	1953	1954	1955	1956	1957	1958
Largemouth bass							
fry	40		1		74		50
fingerling				20		10.3	
Sunfish							
fingerling						2.8	
White crappie							
fingerling						.70	
Channel catfish							
fingerling				10	2.5	6.25	
Flathead catfish							
fingerling							

	1959	1960	1961	1962	1963	1964
Largemouth bass						
fry	50		53	45		11
fingerling		48		.9	4	
Sunfish						
fingerling						
White crappie						
fingerling						
Channel catfish						
fingerling		37	5		1	
Flathead catfish						
fingerling				.4		

Total largemouth bass fry stocked: 324,000.
Total largemouth bass fingerling stocked: 83,200.
Total sunfish stocked: 2,800.
Total white crappie stocked: 700.
Total channel catfish stocked: 61,750.

Discussion

The most important factor to be considered in reviewing data for Lake Sweetwater is the management effort carried out in August 1960. This work was carried out in order to reduce or eliminate problematic fish whose abundance was indicated by sampling during the spring of that year. The graphs include only the data from experimental gill nets and standard gill netting units. Extensive gill netting with two and three inch nets indicated the degree of dominance by river carpsucker and gizzard shad was greater than that shown. Subsequent netting indicates that game fish may expand and grow rapidly even in receding waters, providing those waters are free of carpsucker and other problematic species. The city of Sweetwater has reduced demands on Lake Sweetwater for municipal usage and the lake should be more stable in the future.

References

A. Fisheries Investigations

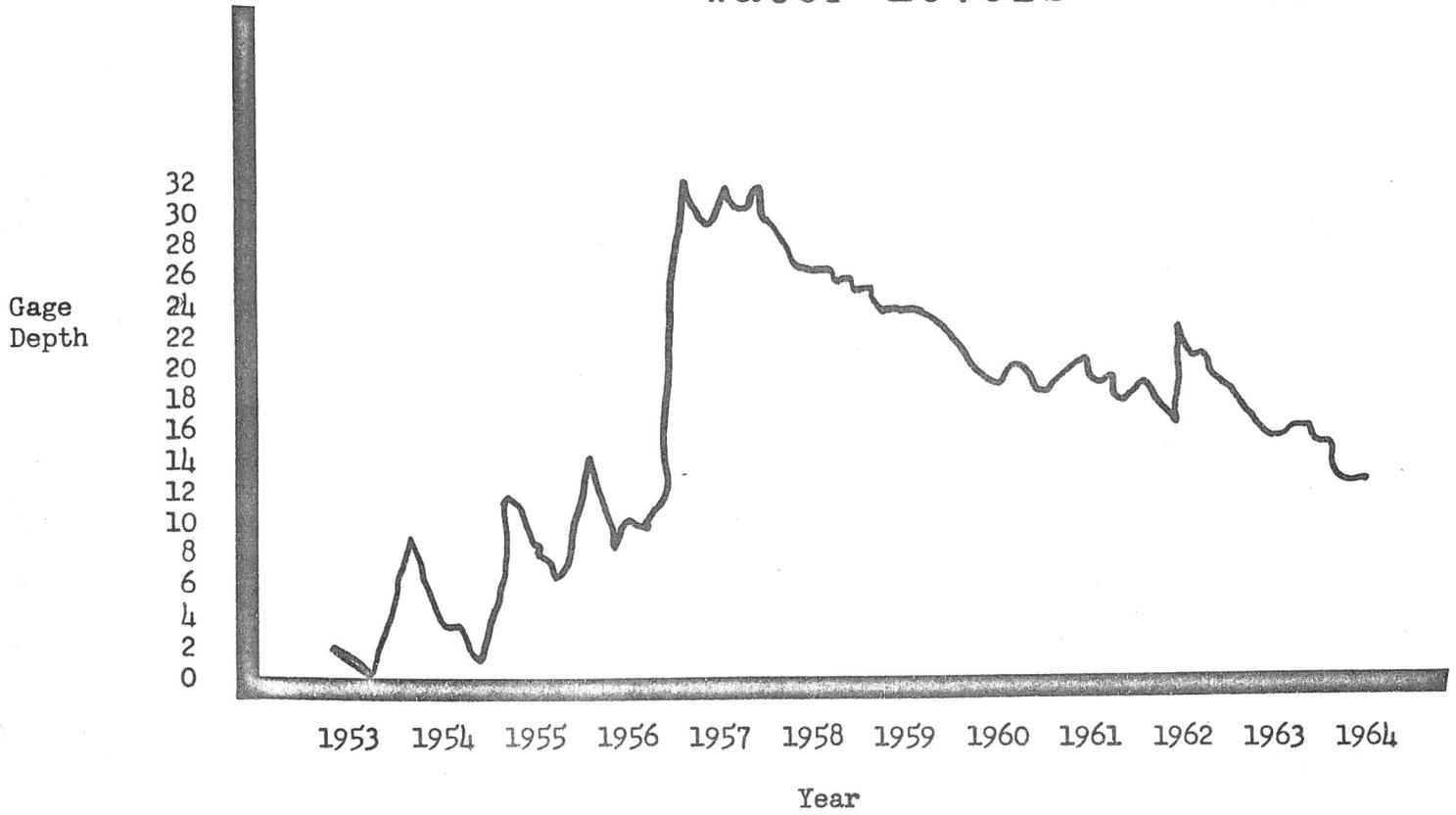
Project F-5-R-5, Job Completion Report B-21 (Inventory)
Project F-5-R-7, Job Completion Report B-16 (Watershed Inventory)
Project F-5-R-8, Job Completion Report B-22 (Resurvey)
Project F-14-D-4, Job Completion Report ~~16~~23 (Control of Fish)
Project F-14-D-5, Job Completion Report 18 all (Restocking)
Project F-5-R-9, Job Completion Report B-32 (Reconnaissance)
Project F-5-R-9, Job Completion Report D-1 (Fisheries Problems)
Project F-5-R-10, Job Completion Report B-32 (Fisheries Reconnaissance)
Project F-5-R-11, Job Completion Report B-32 (Fisheries Reconnaissance)
Project F-5-R-12, Job Completion Report B-28 (Harvest Regulations)

B. Hydrological and Water Quality Data

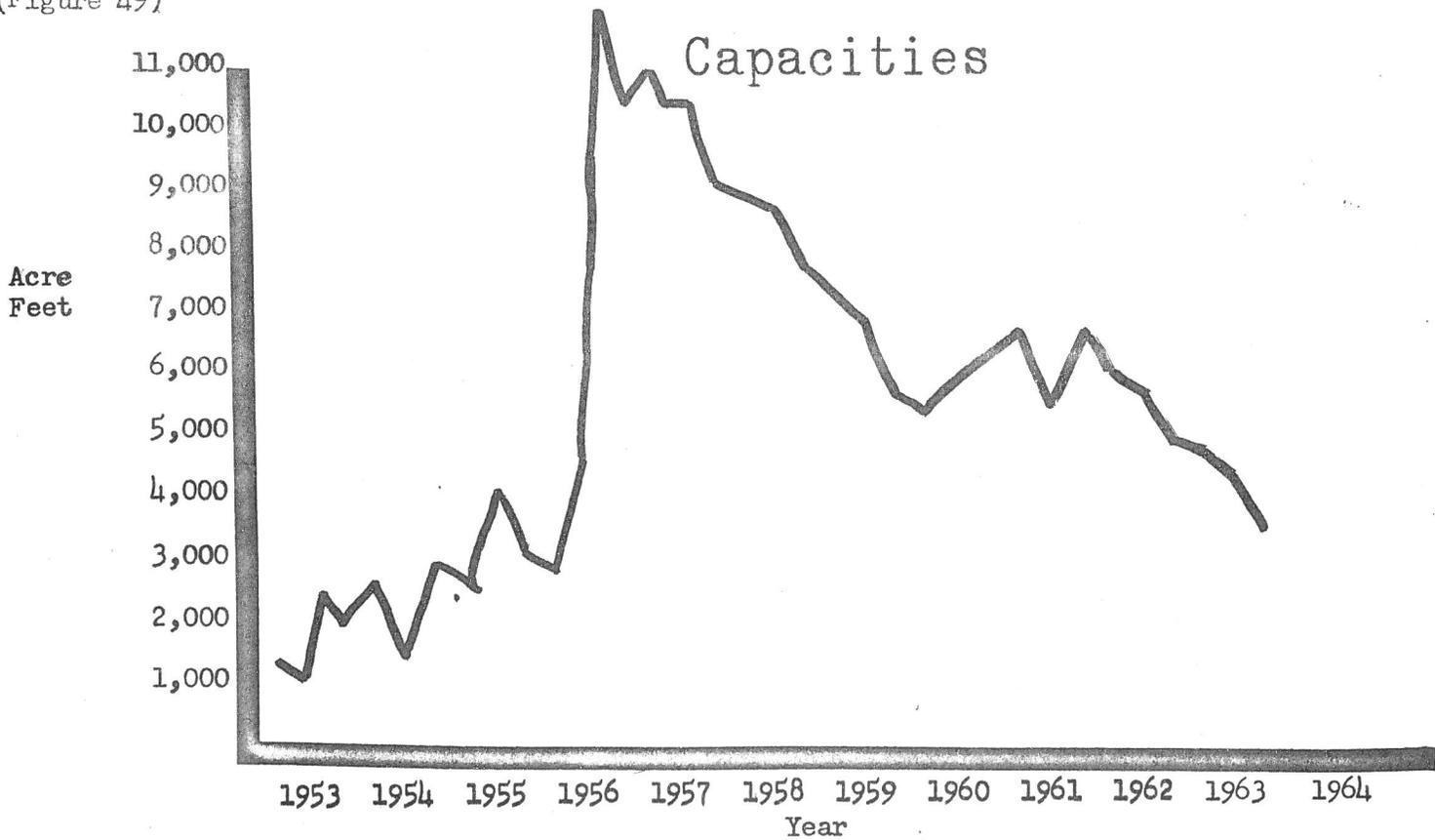
Texas Water Commission Bulletin 6408
City of Sweetwater Water Department Records
United States Geological Survey Records
Texas State Department of Health, Water Pollution Control Division

(Figure 48)

HYDROLOGICAL DATA FOR LAKE SWEETWATER Water Levels

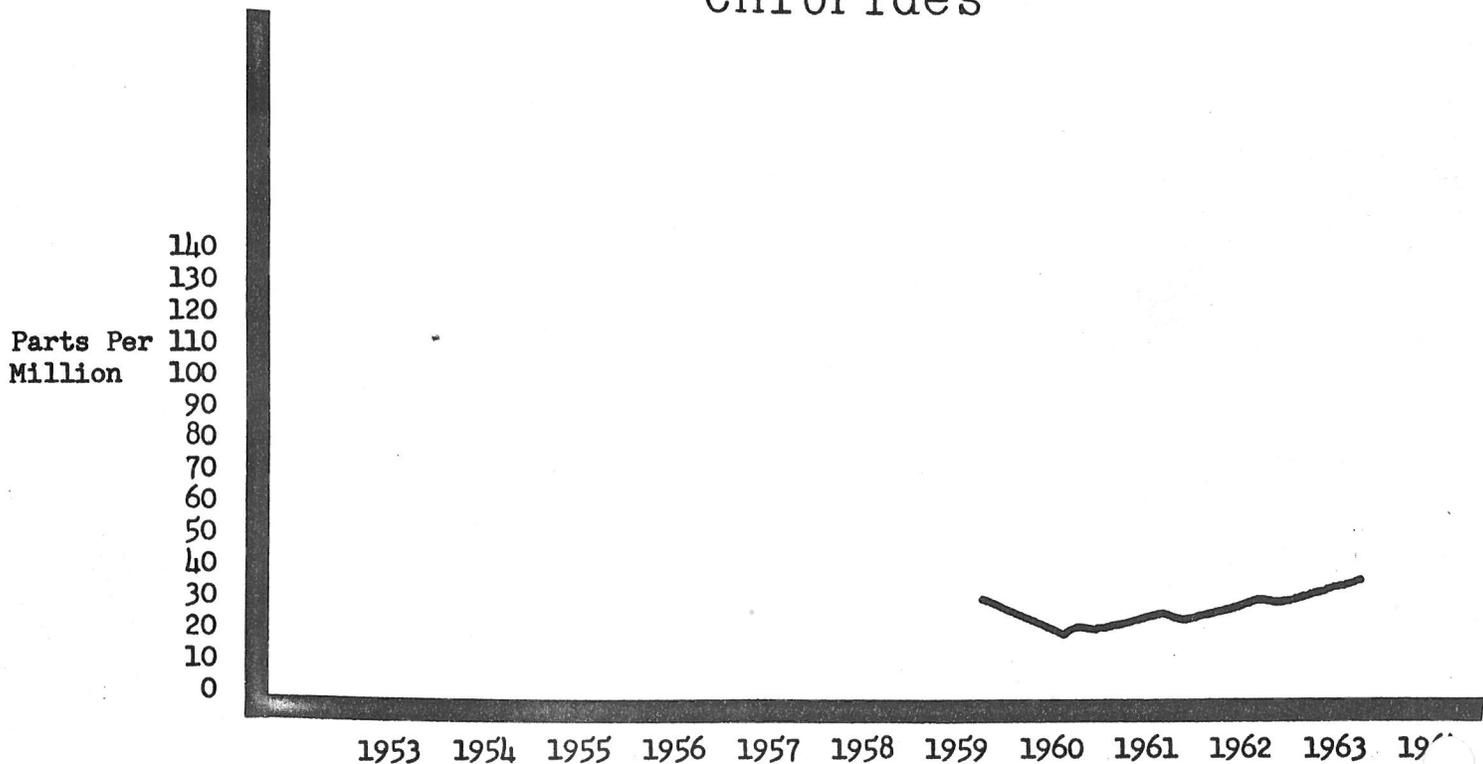


(Figure 49)



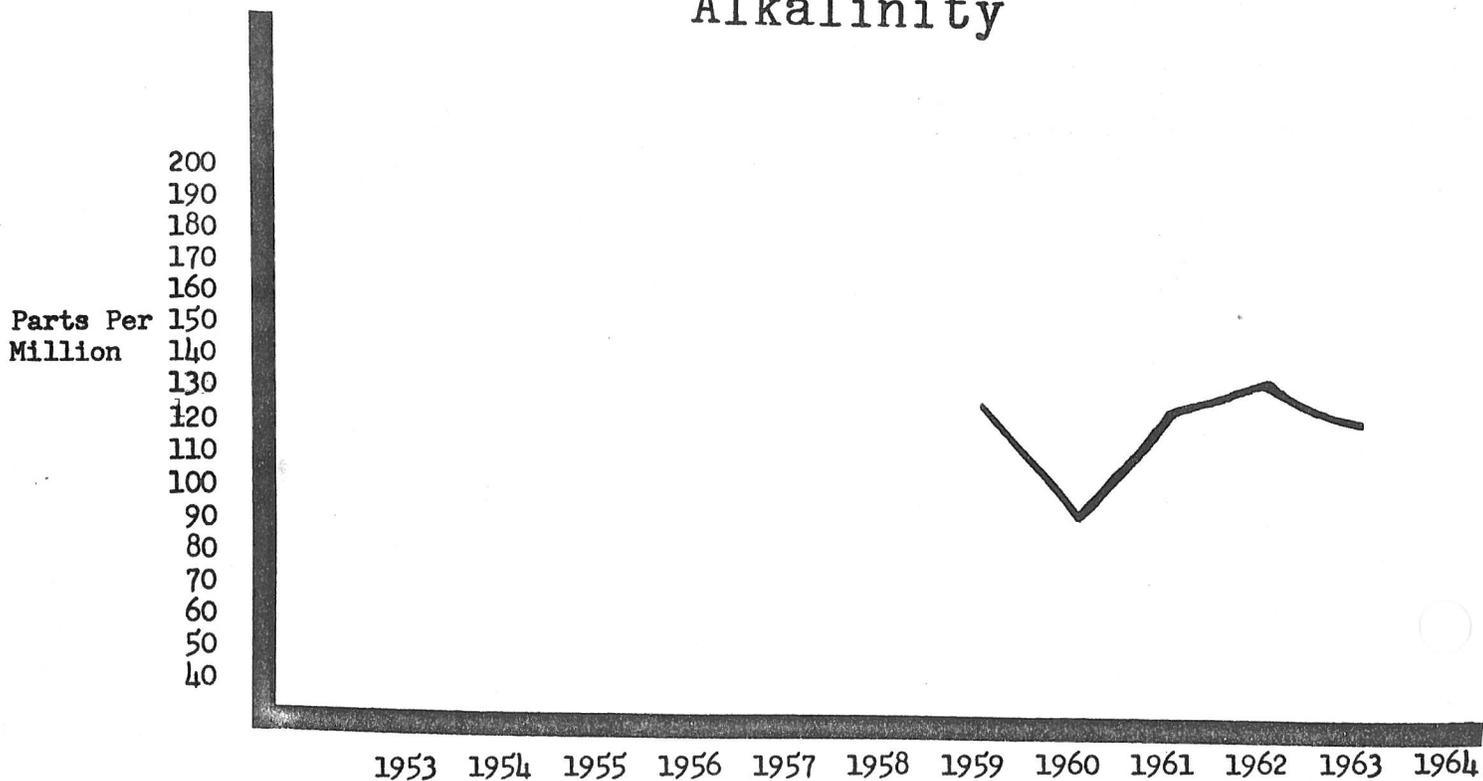
(Figure 50)

WATER QUALITY DATA FOR LAKE SWEETWATER Chlorides



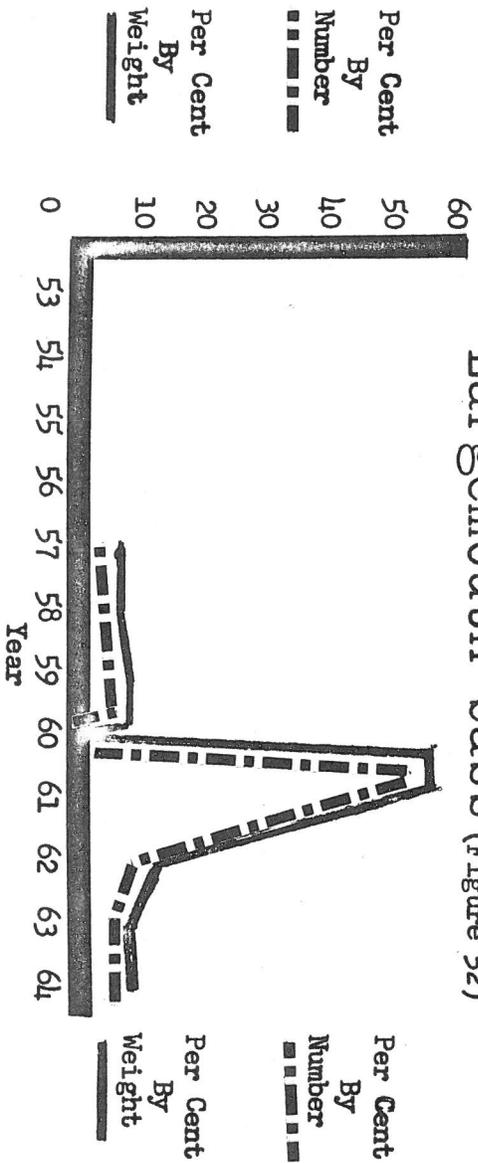
(Figure 51)

Alkalinity

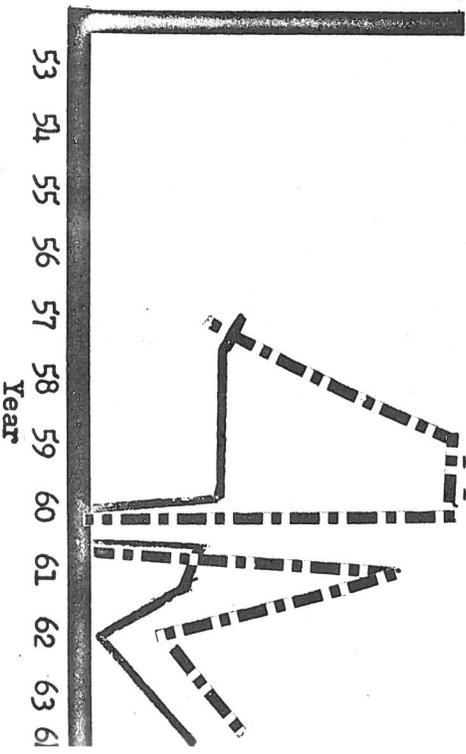


FISH PRODUCTION FROM LAKE SWEETWATER Game Fish Production

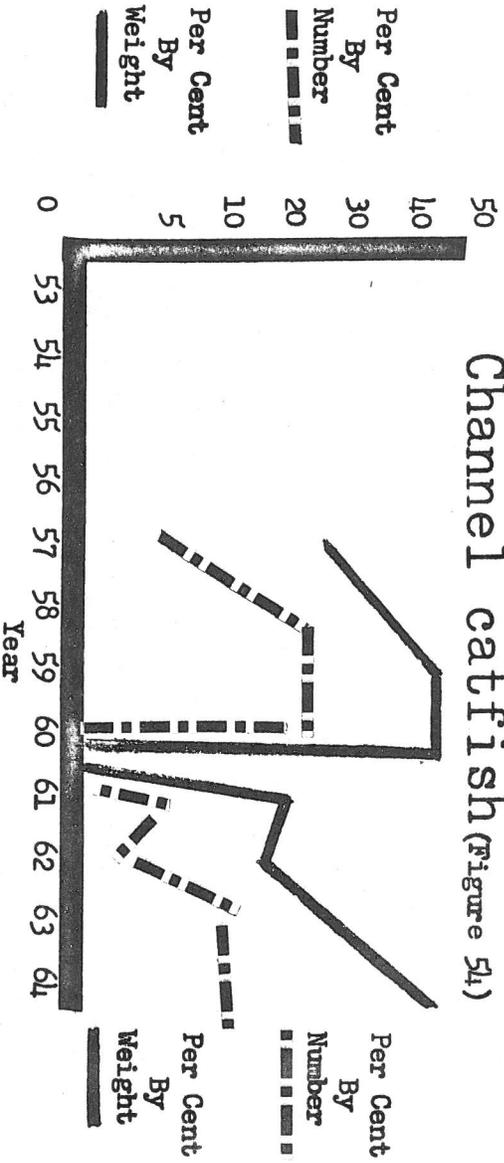
Largemouth bass (Figure 52)



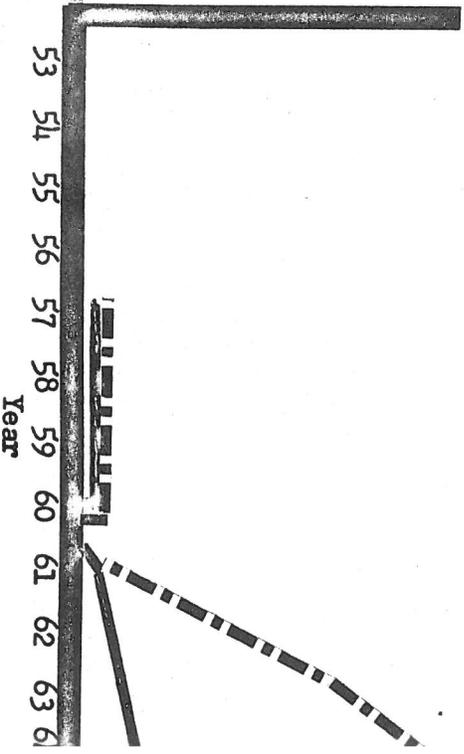
White crappie (Figure 53)



Channel catfish (Figure 54)



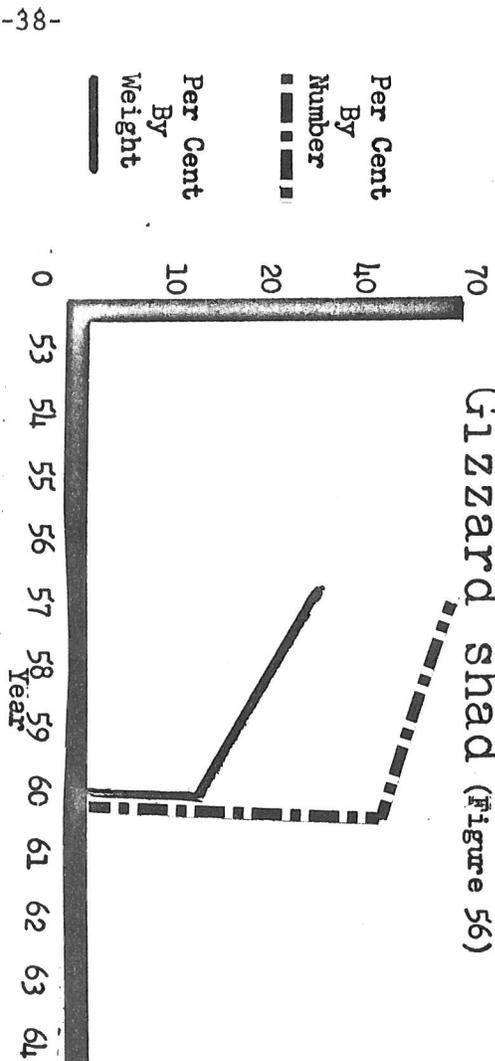
Sunfish (Figure 55)



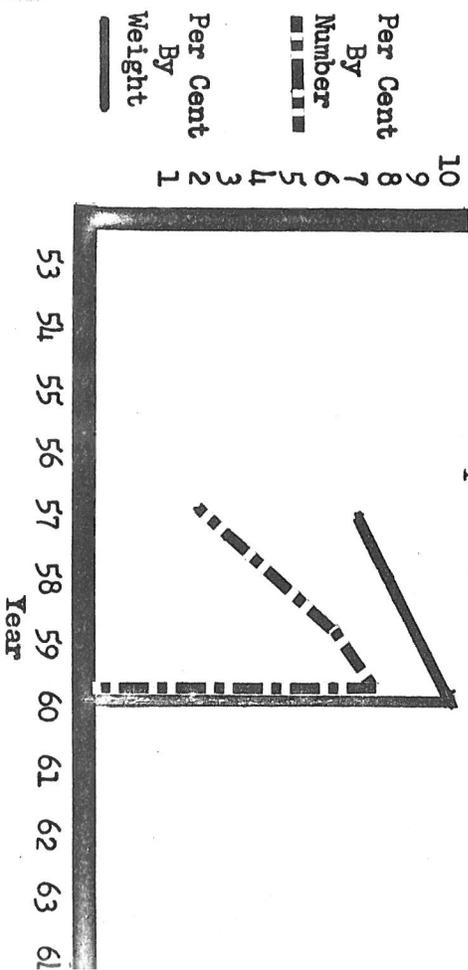
FISH PRODUCTION FROM LAKE SWEETWATER

Principal Non-Game Species

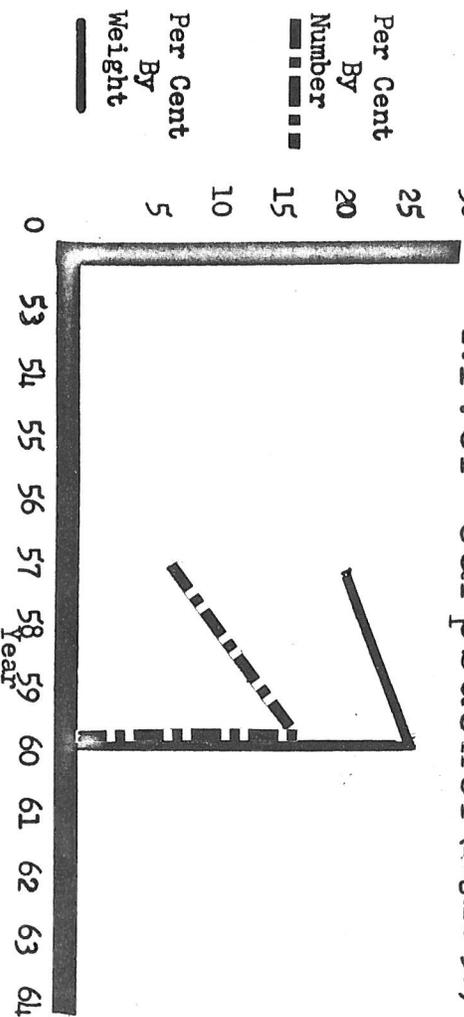
Gizzard shad (Figure 56)



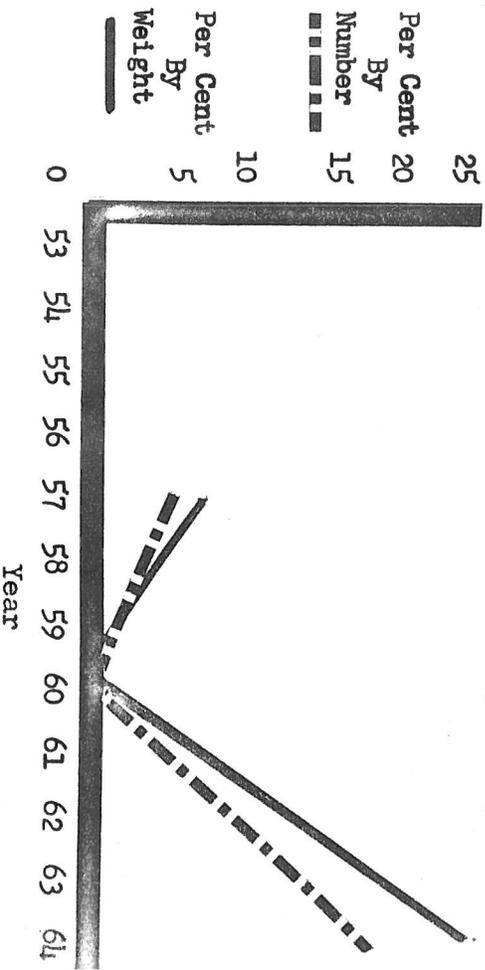
Carp (Figure 57)



River carpsucker (Figure 58)

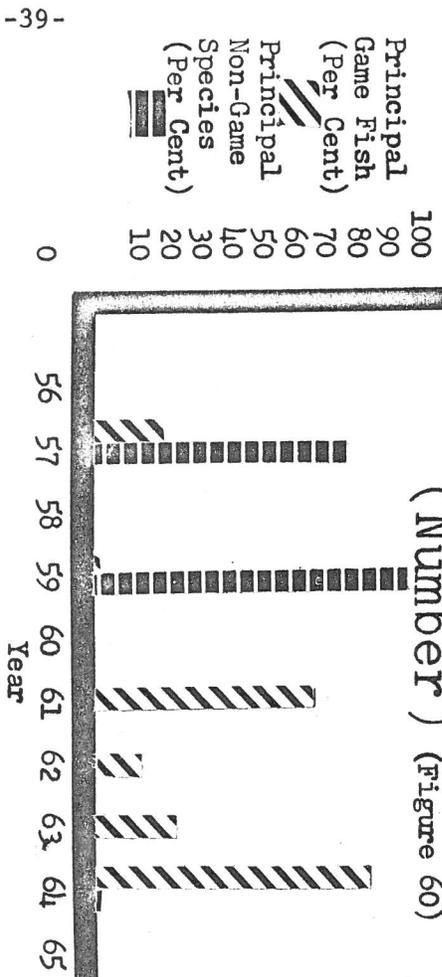


Bullheads (Figure 59)

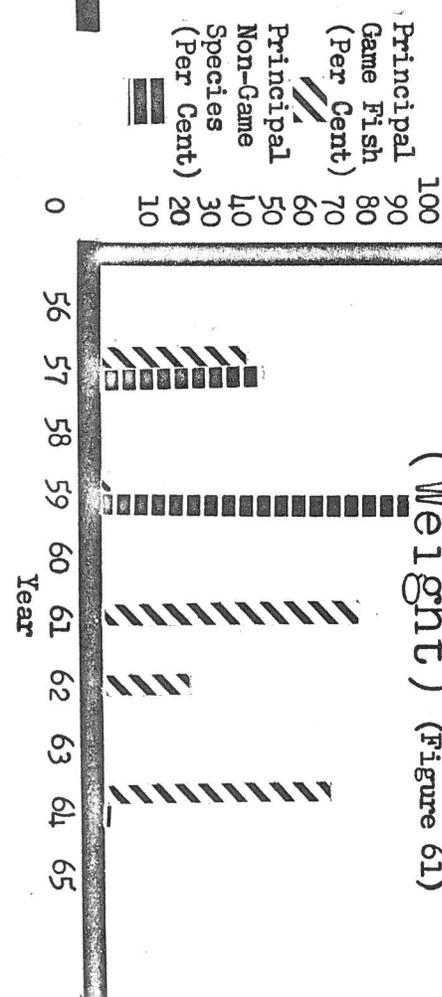


LAKE SWEETWATER

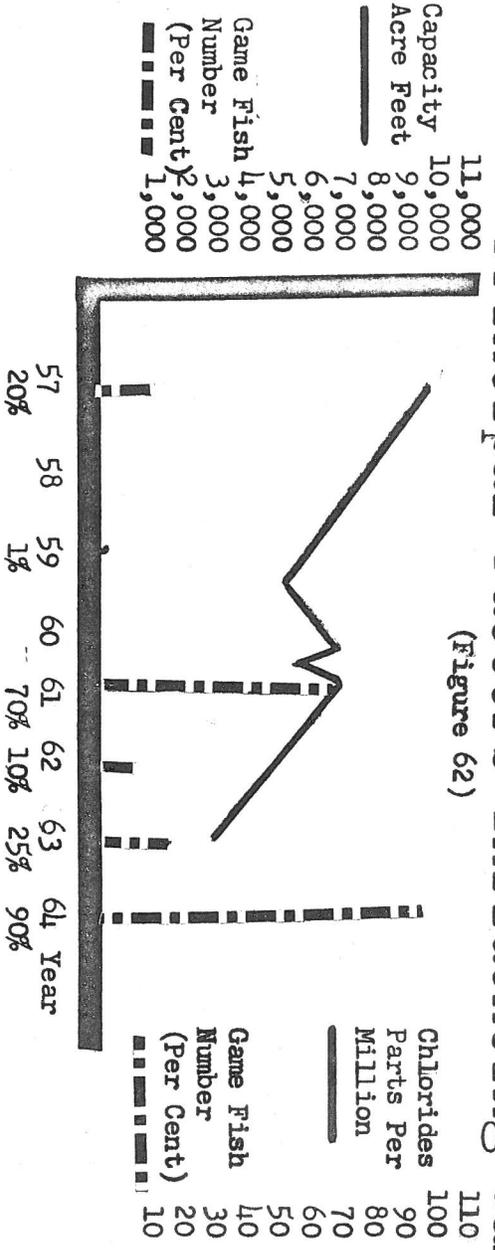
Principal Production (Number) (Figure 60)



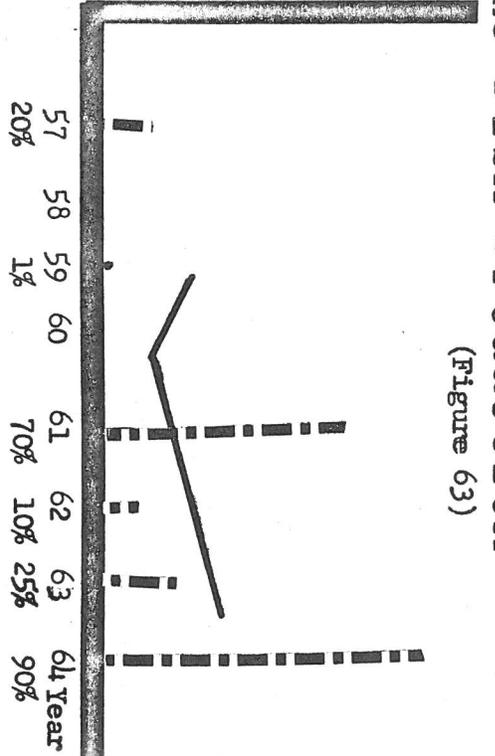
Principal Production (Weight) (Figure 61)



Principal Factors Influencing Game Fish Production (Figure 62)



Principal Factors Influencing Game Fish Production (Figure 63)



Lake Trammel

Location

Lake Trammel is on Sweetwater Creek, a tributary of the Clear Fork of the Brazos River, approximately 7 miles southwest of the city of Sweetwater in Nolan County.

Ownership and History of Development

Lake Trammel is owned and operated by the city of Sweetwater for municipal water and recreation. The reservoir was constructed in 1914 for municipal water and has served that function ever since. In addition to capture of runoff, water is pumped from Oak Creek Reservoir near Blackwell and stored in Lake Trammel.

Physical Description

Reliable engineering data are insufficient for a complete description. The reservoir was originally designed to impound 3,183 acre-feet of water and to cover 230 acres when full. However, siltation of unknown quantity has reduced the storage capacity.

History of Fisheries Investigations and Management

Prior to 1958, only seining collections had been obtained from Lake Trammel. In June of that year a full scale investigation was initiated and this inventory was completed in 1959. Following studies were limited to resurvey or reconnaissance checks of game fish production.

Stocking Record

For actual number of fish stocked multiply entry by 1,000.

	1952	1953	1954	1955	1956	1957	1958
Largemouth bass							
fry	40		10.3		41.5		231
fingerling						5.8	
Sunfish							
fingerling	1				.6	2.8	
White crappie							
fingerling			1.5		.1	.7	
Channel catfish			2.5		1.8	2.7	

	1959	1960	1961	1962	1963	1964	
Largemouth bass							
fry	110	66	10	45.9			
fingerling						4	5
Sunfish							
fingerling	.20		.40				
White crappie							
fingerling				4			
Channel catfish	250	37	5			1	

Total largemouth bass fry stocked: 554,700.
Total largemouth bass fingerling stocked: 14,800.
Total sunfish stocked: 5,000.
Total white crappie stocked: 6,300.
Total channel catfish stocked: 50,250.

Discussion

In view of the continued presence of river carpsucker in the lake for more than eight years, the unknown factors that have curbed their expansion are deemed worthy of a more detailed investigation. This circumstance is especially significant since the lake has experienced significant reductions as in the 1956-1958 period and between 1961 and 1964. Other circumstances worthy of further study include the relationship between production of centrarchids and marginal vegetation and the factors that favor reproduction of that group.

References

A. Fisheries Investigations

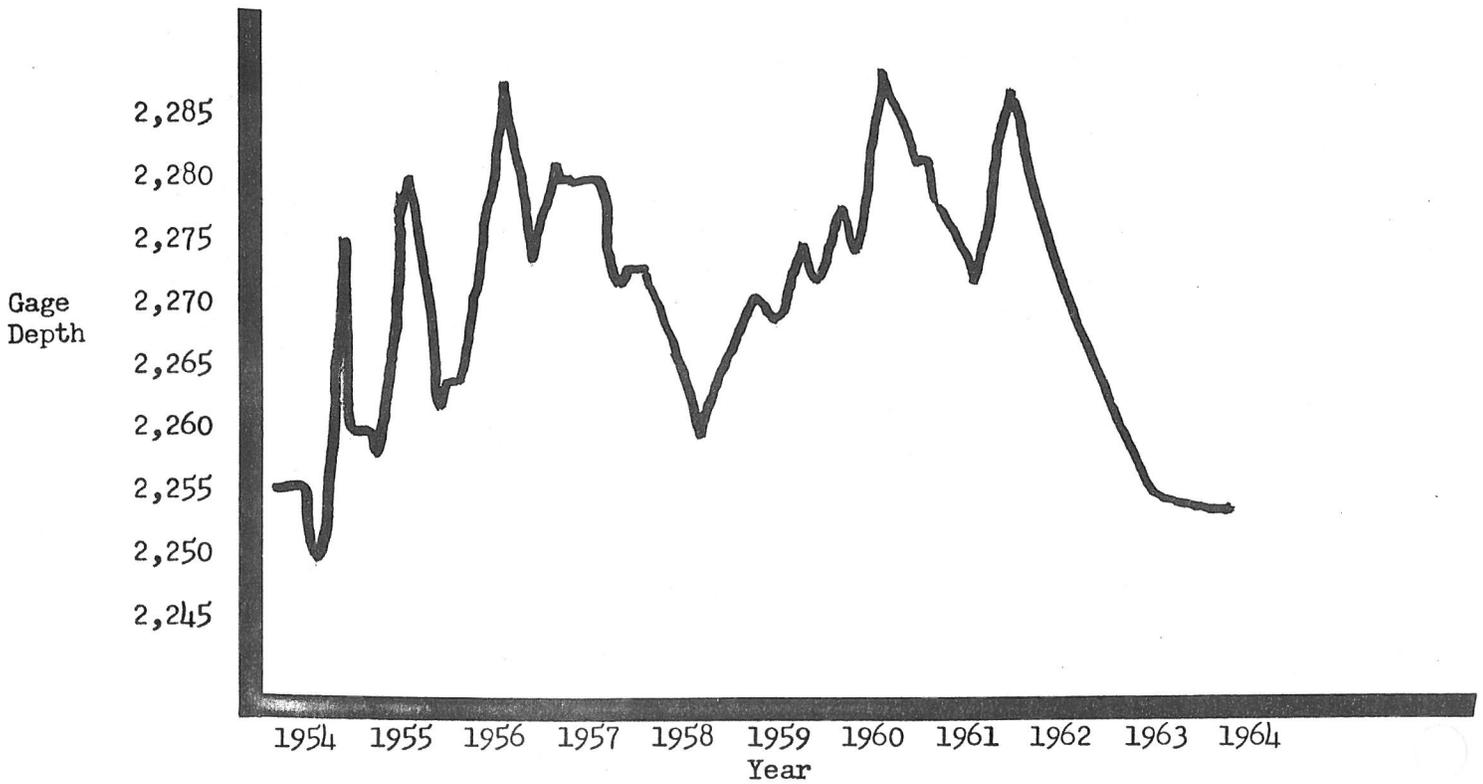
Project F-5-R-6, Job Completion Report B-24 (Inventory).
Project F-5-R-7, Job Completion Report B-16 (Watershed Survey).
Project F-5-R-9, Job Completion Report B-32 (Reconnaissance).
Project F-5-R-9, Job Completion Report D-1 (Fisheries Problems).
Project F-5-R-10, Job Completion Report B-32 (Reconnaissance).
Project F-5-R-11, Job Completion Report B-32 (Reconnaissance).

B. Hydrology and Water Quality Data

Records of city of Sweetwater Water Department
Water Supply Papers of United States Geological Survey
State Health Department Records

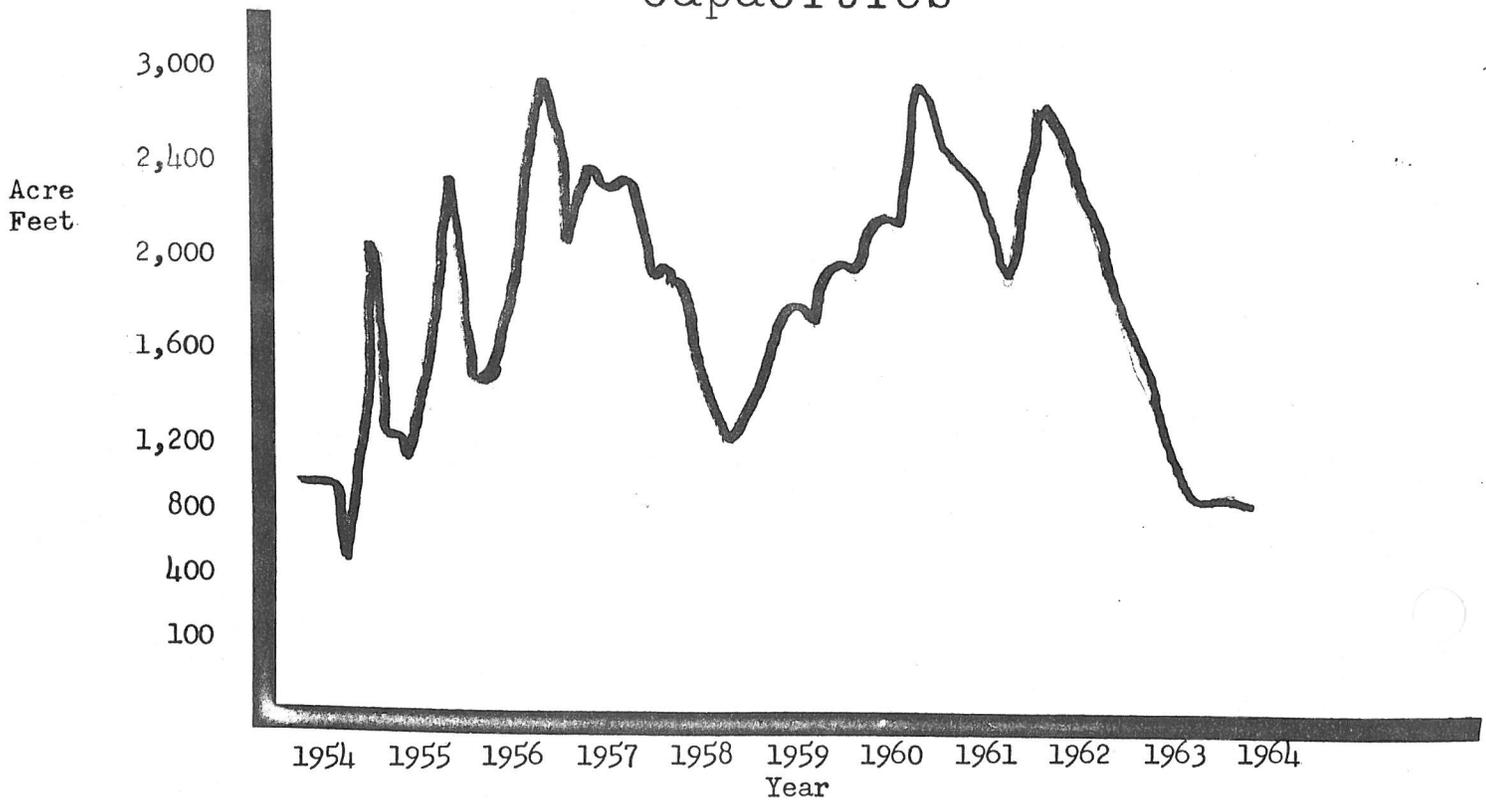
(Figure 64)

HYDROLOGICAL DATA FOR LAKE TRAMMEL Water Levels



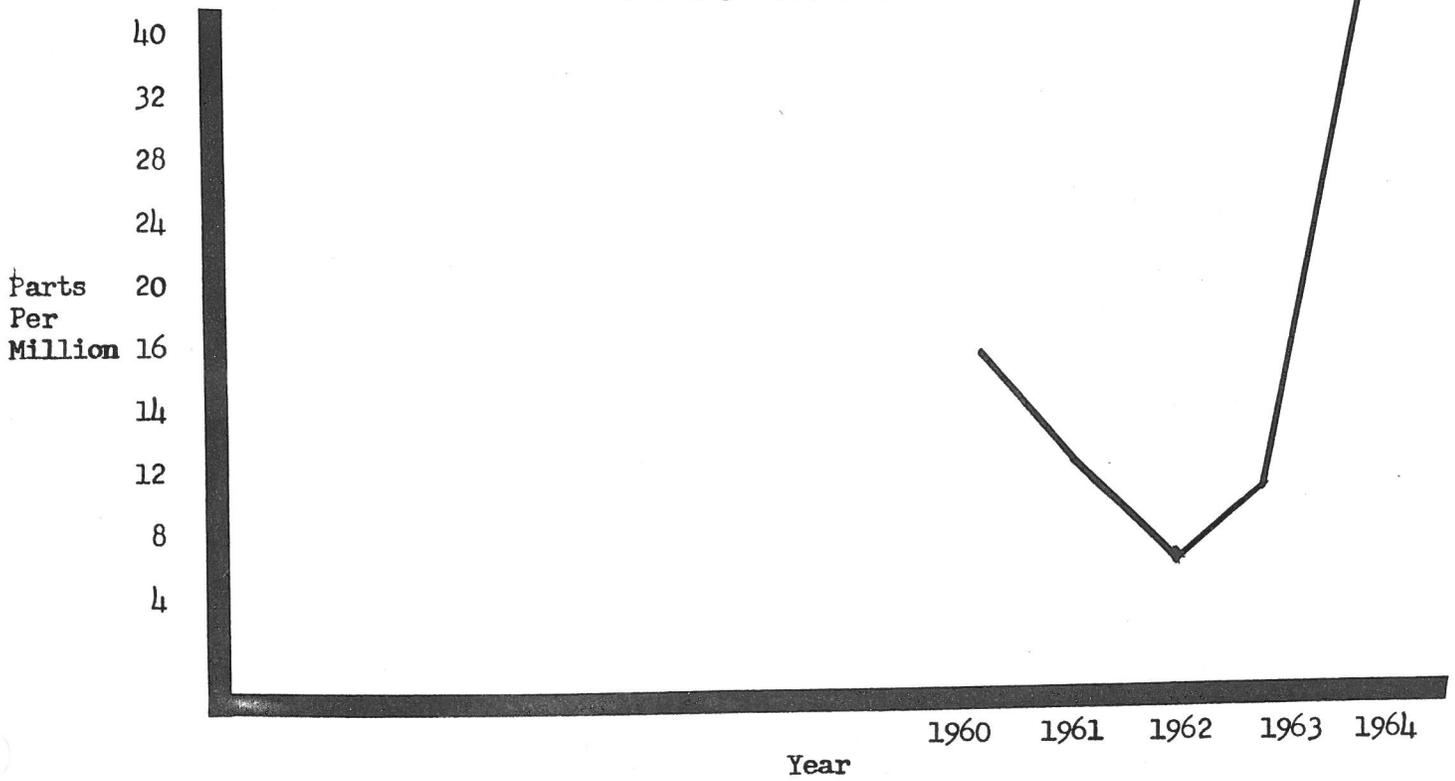
(Figure 65)

Capacities



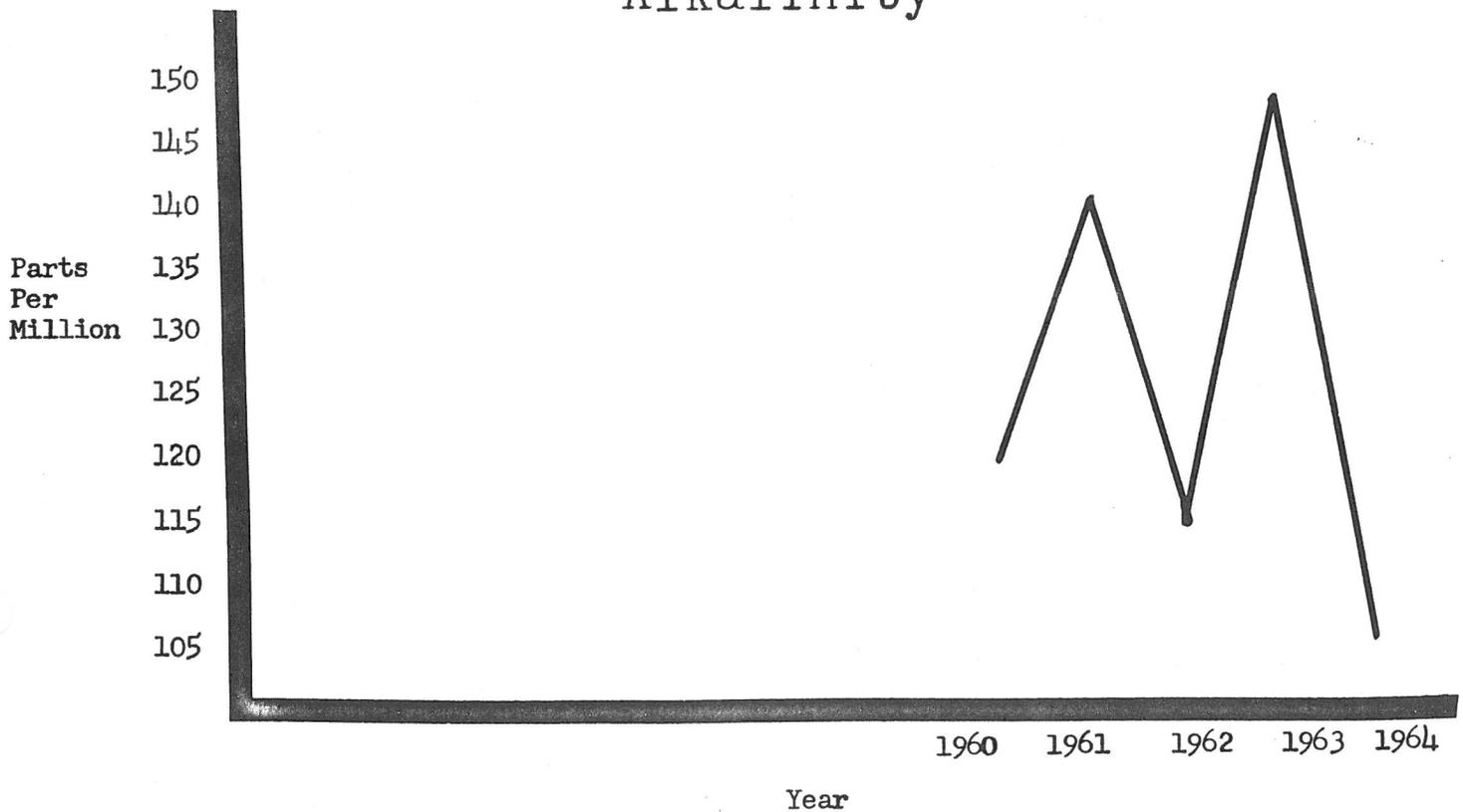
(Figure 66)

WATER QUALITY DATA FOR LAKE TRAMMEL Chlorides



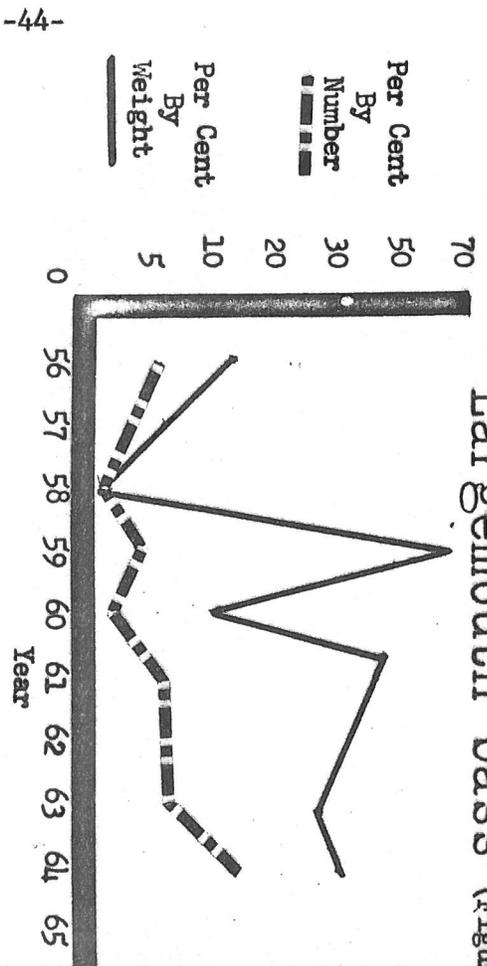
(Figure 67)

Alkalinity

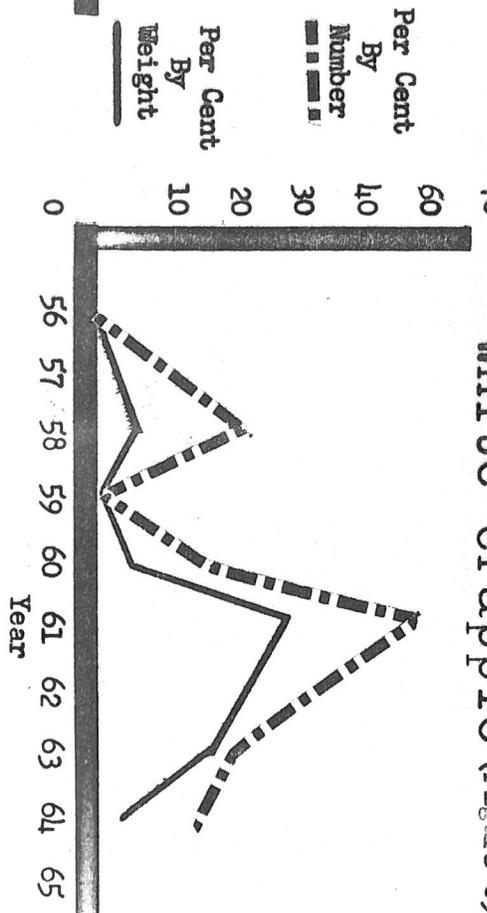


FISH PRODUCT ON FROM LAKE TRAMMEL Game Fish Production

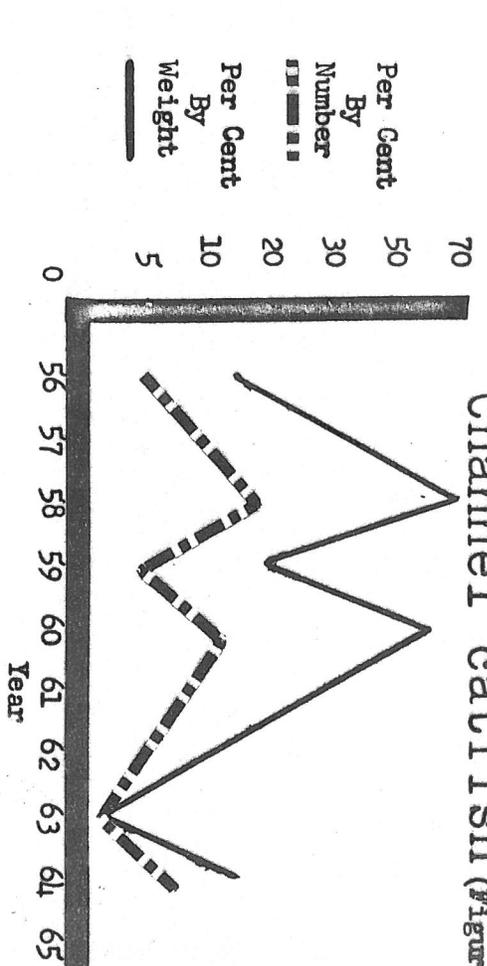
Largemouth bass (Figure 68)



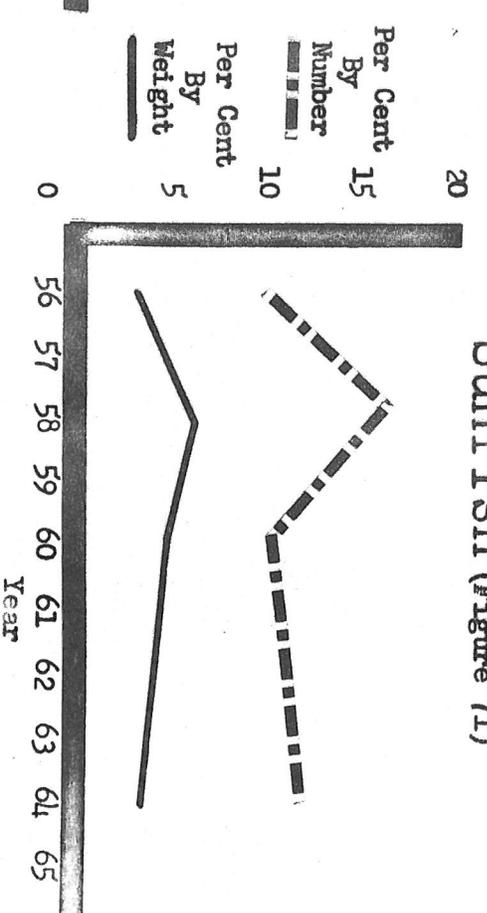
White crappie (Figure 69)



Channel catfish (Figure 70)



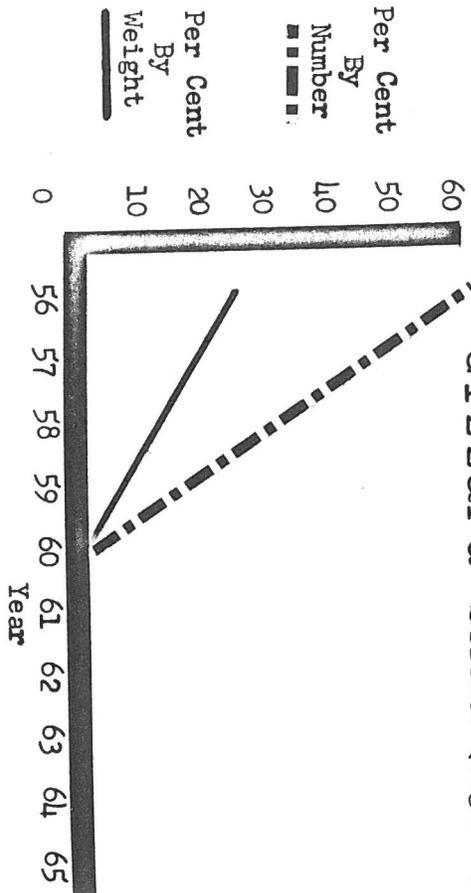
Sunfish (Figure 71)



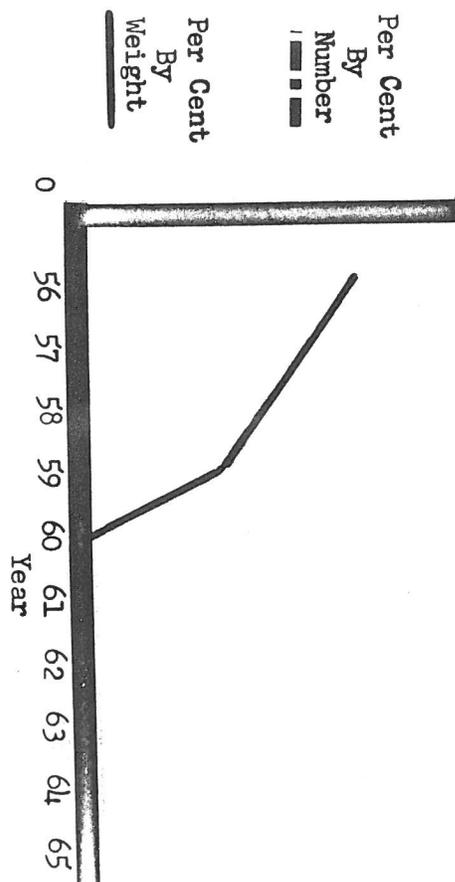
FISH PRODUCTION FROM LAKE TRAMMEL

Principal Non-Game Species

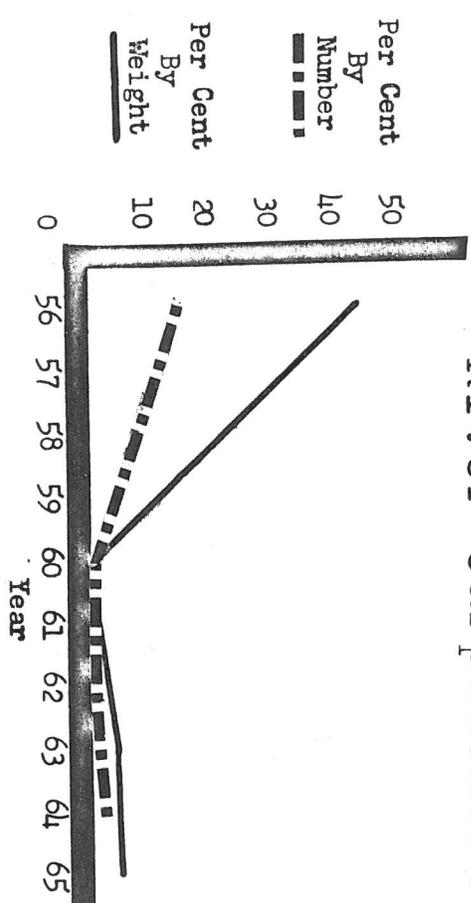
Gizzard shad (Figure 72)



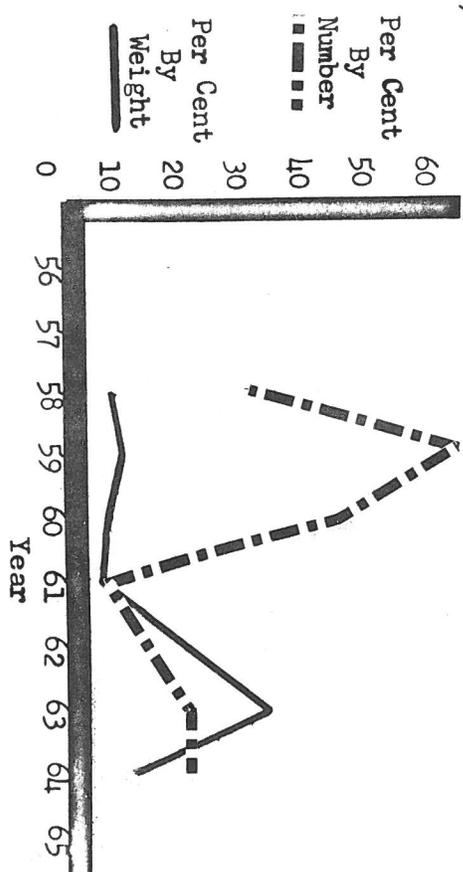
Golden shiners (Figure 73)



River carpsucker (Figure 74)

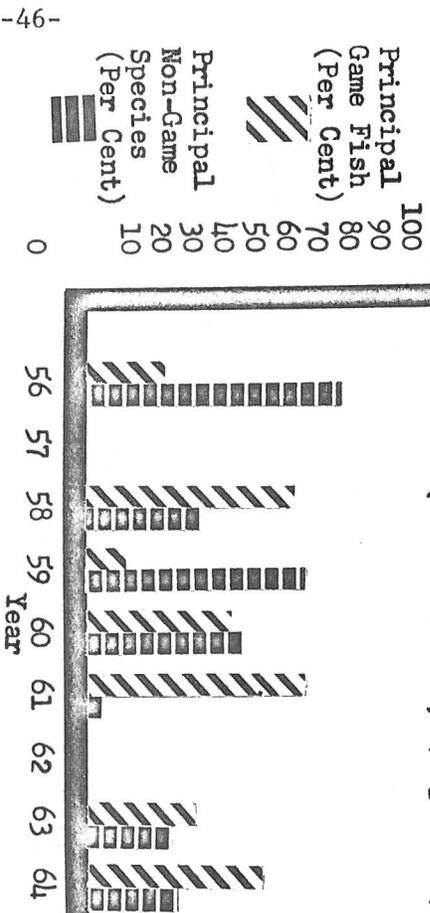


Bullheads (Figure 75)

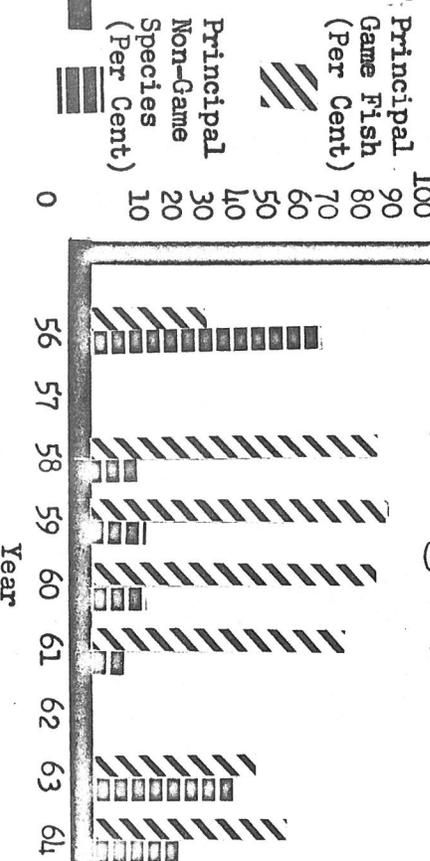


LAKE TRANEL

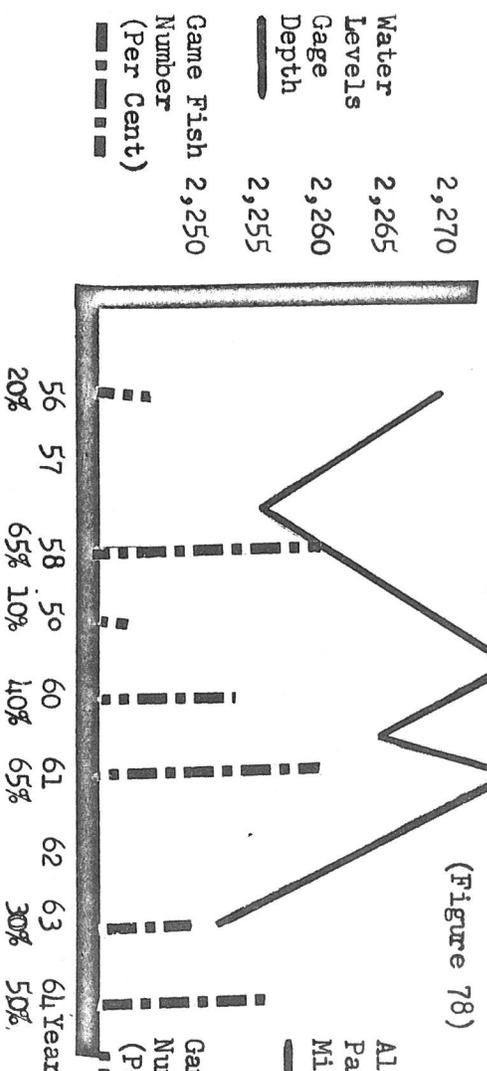
Principal Production (Number) (Figure 76)



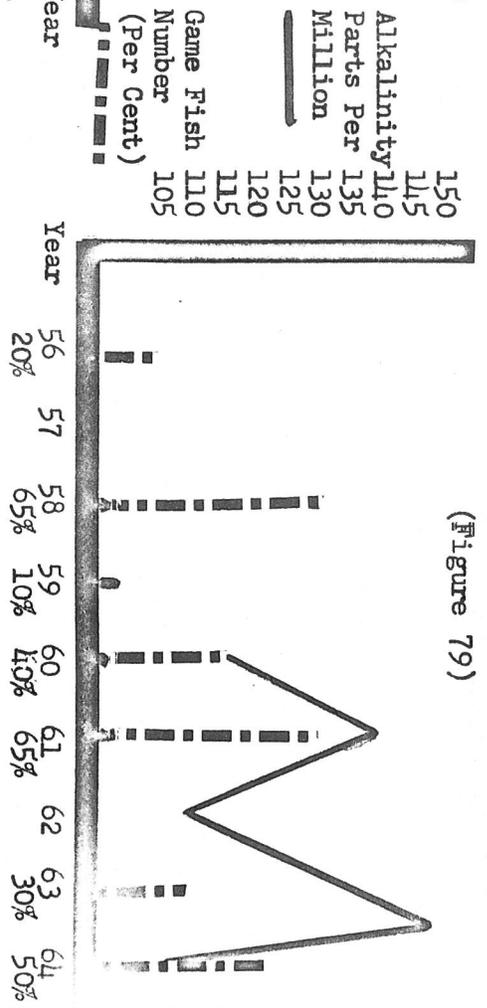
Principal Production (Weight) (Figure 77)



Principal Factors Influencing Game Fish Production (Figure 78)



Principal Factors Influencing Game Fish Production (Figure 79)



Lake Brownwood

Location

Lake Brownwood is in the Colorado River Basin in Brown County, 8 miles north of Brownwood on Pecan Bayou.

Ownership and History of Development

The reservoir and associated facilities are owned and operated by the Brown County Water Improvement District No. 1. Permit No. 1036 was issued to Brown County Water Improvement District No. 1 on December 3, 1929, and authorizes construction of a reservoir of 125,000 acre-feet capacity. This permit also allows diversion of 16,800 acre-feet of water annually for municipal, industrial, and domestic purposes and 50,590 acre-feet to irrigate land not to exceed 25,295 acres. Any amount of the above allotments may be used for the generation of hydroelectric power. The water for municipal use supplies the cities of Brownwood, Bangs, Early, and Santa Anna. Construction began in 1930 and was completed in 1933. The reservoir filled during a large flood in 1932, but the water was released to enable completion of the dam. Deliberate impoundment began in July 1933.

Physical Description

The dam is earthfill, 1,580 feet long and 120 feet high with the top of the dam at elevation 1,449.5 feet above m.s.l. Other features are given in the following tabulation:

Feature	Elevation (feet above m.s.l.)	Capacity (acre-feet)	Area (acres)
Top of dam	1,449.5	- -	- -
Spillway crest	1,424.6	143,400	7,300
Invert to irrigation outlet	1,405.5	46,510	3,150
Invert to 12-foot outlet	1,329.5	- -	- -

Sedimentation deposited during the period July 1, 1932 to September 7, 1959 was computed at 13,962 acre-feet. The drainage area above the dam is 1,535 square miles.

History of Fisheries Investigations and Management

Between 1938 and 1947 limited investigations were carried out by Marion Toole, Hardy LeSeur and by William Brown. However, the methods employed in sampling differ from standards employed from 1953 until the present and for that reason do not permit comparisons. An inventory survey was initiated in 1953 under the federal aid program and was completed in 1957. From that time until the present, periodic sampling has been included under the reconnaissance and resurvey functions. A commercial fisherman netted the lake from 1955 until 1957 in an attempt to reduce problematic fish.

Stocking Record

For actual number of fish stocked multiply entry by 1,000.

	1951	1952	1953	1954	1955	1956	1957
Largemouth bass							
fry	280	60	90	140			
fingerling					16	20	
Sunfish							
fingerling						12.5	
White crappie							
fingerling						.20	
Channel catfish							
fingerling					3.4		

	1958	1959	1960	1961	1962	1963	1964
Largemouth bass							
fry				100			
fingerling							
Sunfish							
fingerling							
White crappie							
fingerling							
Channel catfish							
fingerling				27.06			

Total largemouth bass stocked: 670,000.

Total largemouth bass fingerling stocked: 36,000.

Total sunfish stocked: 12,500.

Total white crappie stocked: 200.

Total channel catfish stocked: 30,460.

There are few reservoirs that have been more heavily stocked with largemouth bass than Lake Brownwood. In addition to the above, stocking records indicate that 715,800 fry were released in 1946; 1,350,000 fry were released in 1947; 810,000 fry were released in 1948, and 750,700 fry were released in 1949. The total for this three year period, 3,626,500 fry, is more than 1,000,000 fish per year.

Discussion

In gross production it would appear that game fish tend to follow major increases and decreases in lake capacity. There are two notable exceptions. Largemouth bass and white crappie do not follow this trend in several instances, and there are exceptions in the population dynamics of nearly all species. Production of non-game species appears to center in the advance of smallmouth buffalo and river carpsucker. The production of white bass and the influence of commercial harvest are worthy of further study. The expansion of silt deposition in the upper reservoir may be detrimental to game fish production.

References

A. Fisheries Investigations

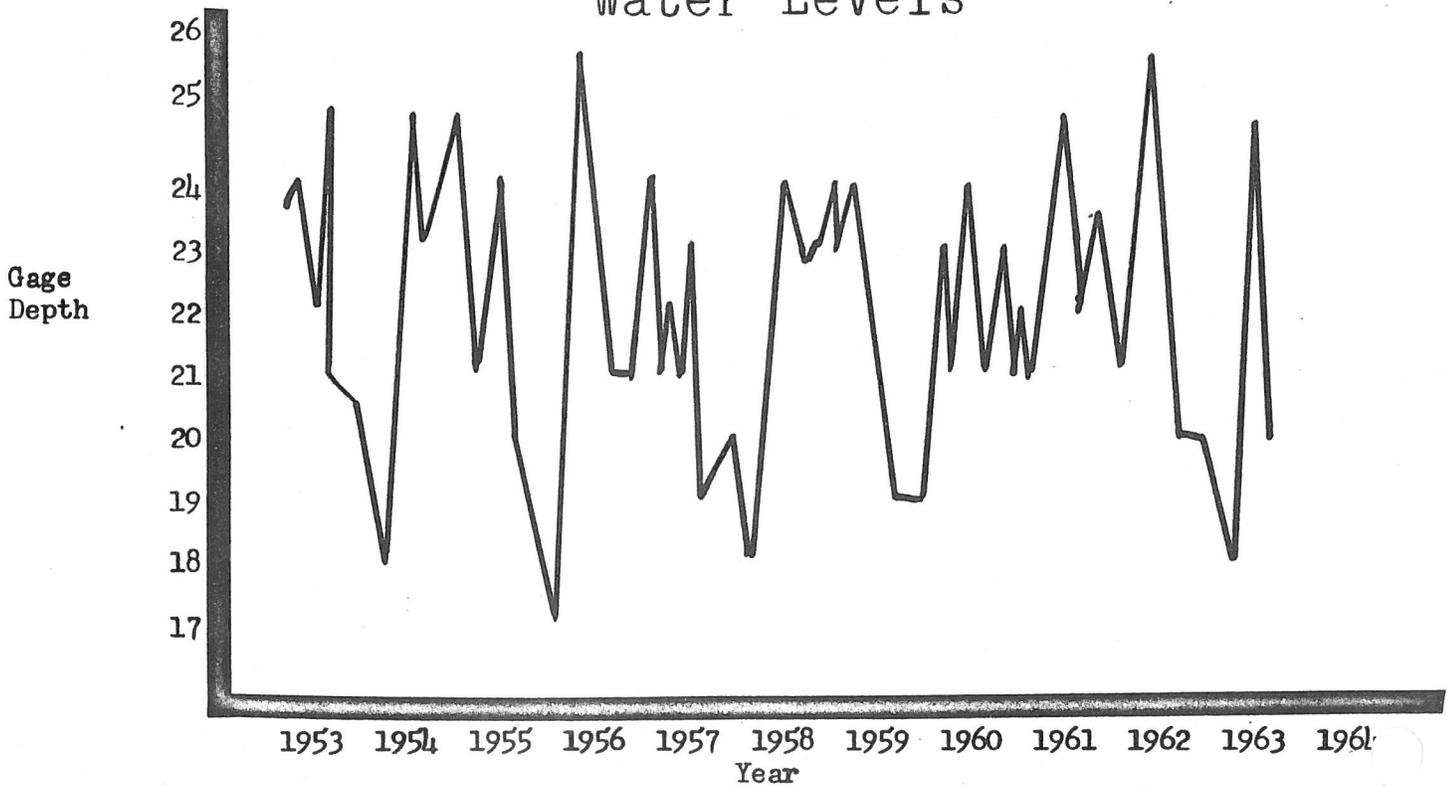
Project F-5-R-1, Job Completion Report B-5 (Inventory)
Project F-5-R-2, Job Completion Report B-5 (Inventory)
Project F-5-R-3, Job Completion Report B-5 (Inventory)
Project F-5-R-6, Job Completion Report B-22 (Resurvey)
Project F-5-R-7, Job Completion Report B-22 (Resurvey)
Project F-2-R-9, Job Completion Report B-22 (Reconnaissance)
Project F-4-R-10, Job Completion Report B-29 (Reconnaissance)
Project F-4-R-11, Job Completion Report B-29 (Reconnaissance)

B. Hydrological and Water Quality Data

Records of Brown County Water Improvement District No. 1
State Board of Water Engineers Bulletin 5807-A
Water Supply Papers of the United States Geological Survey
Texas Water Commission Bulletin 6408

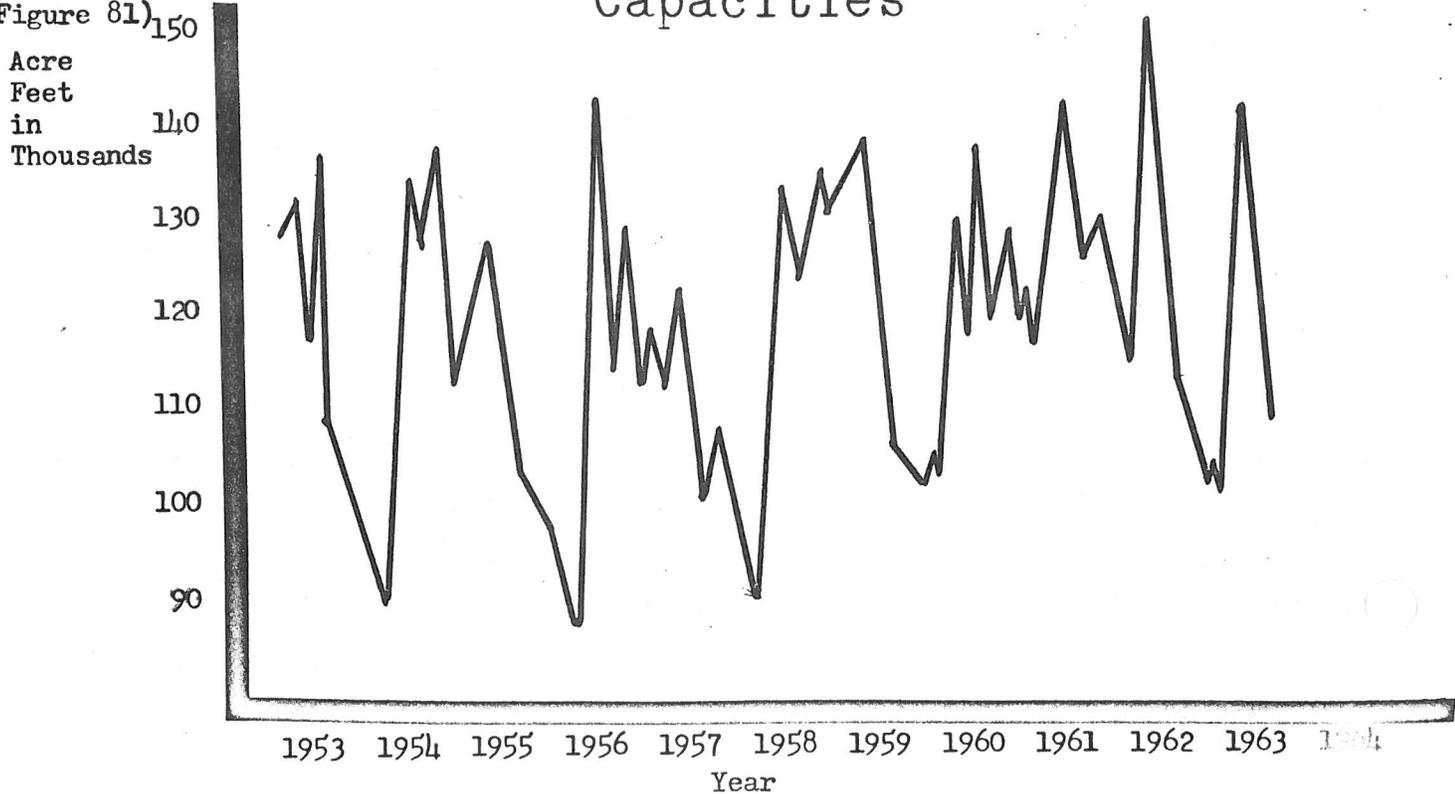
HYDROLOGICAL DATA FOR LAKE BROWNWOOD

Water Levels



(Figure 81)

Capacities

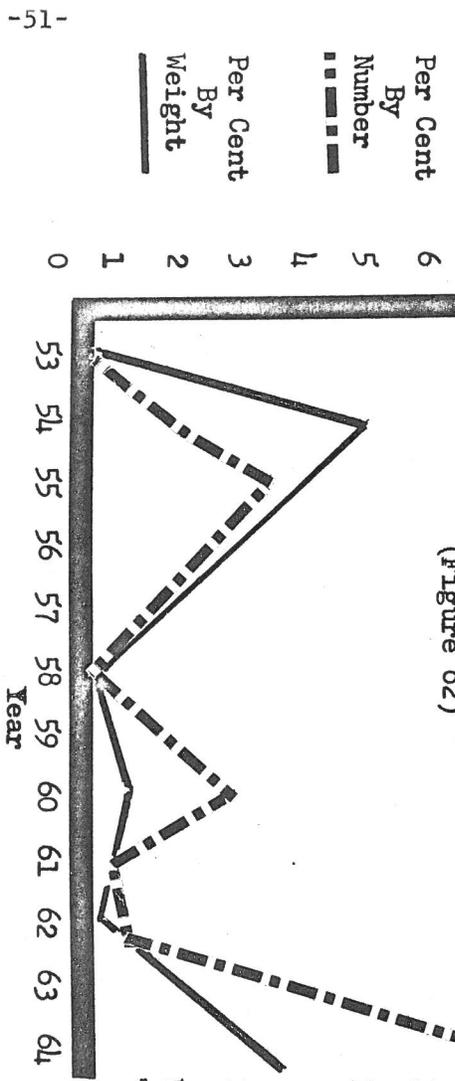


FISH PRODUCTION FROM LAKE BROWNWOOD

Game Fish Production

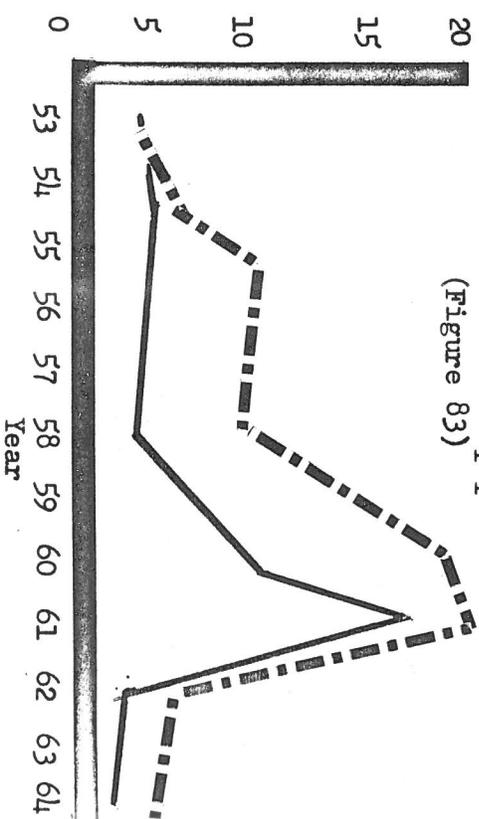
Largemouth bass

(Figure 82)



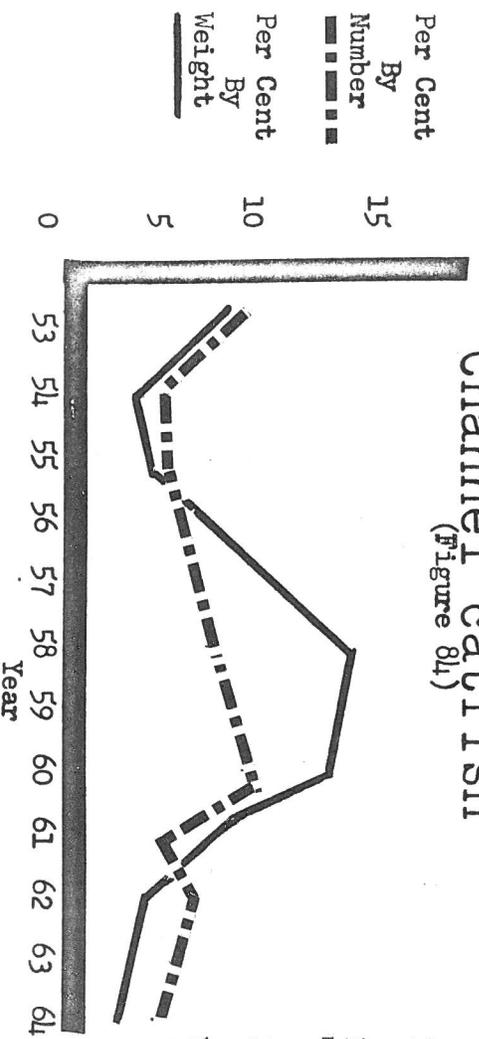
White crappie

(Figure 83)



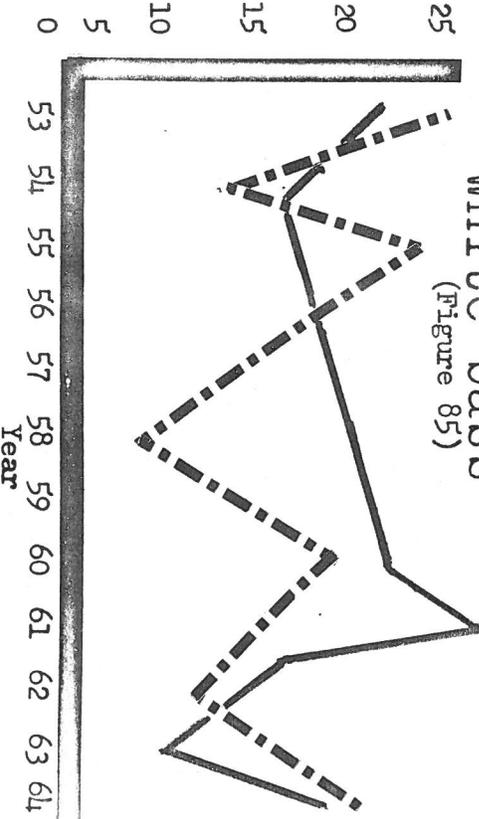
Channel catfish

(Figure 84)



White bass

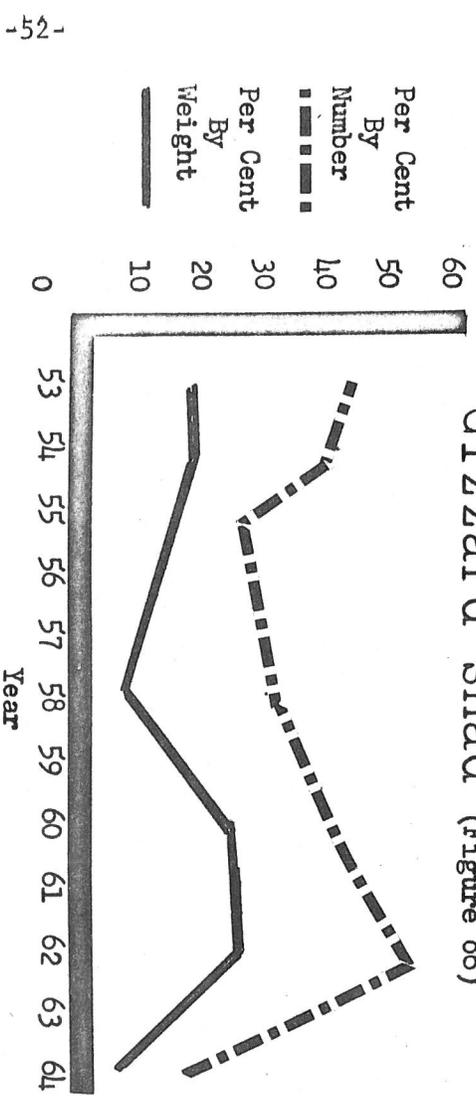
(Figure 85)



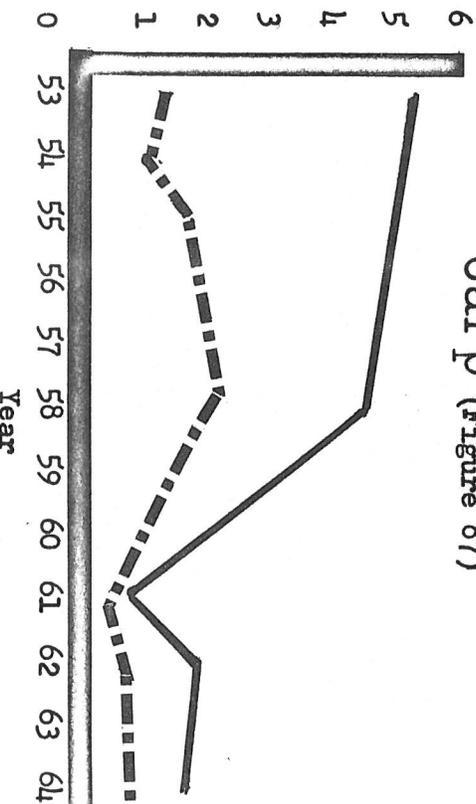
FISH PRODUCTION FROM LAKE BROWNWOOD

Principal Non-Game Species

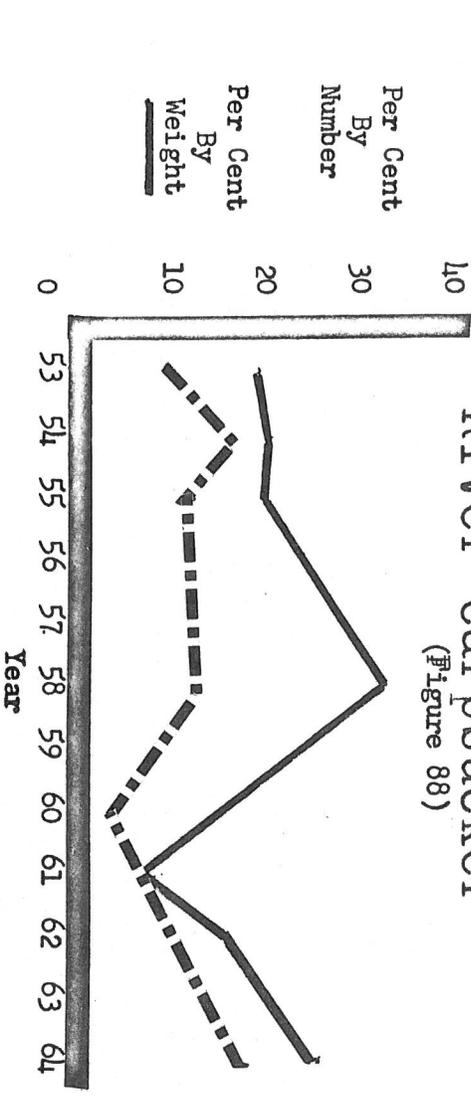
Gizzard shad (Figure 86)



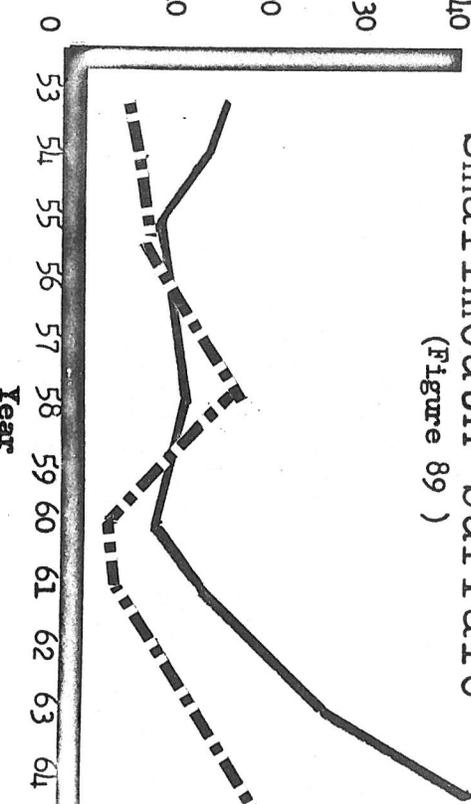
Carp (Figure 87)



River carpsucker (Figure 88)

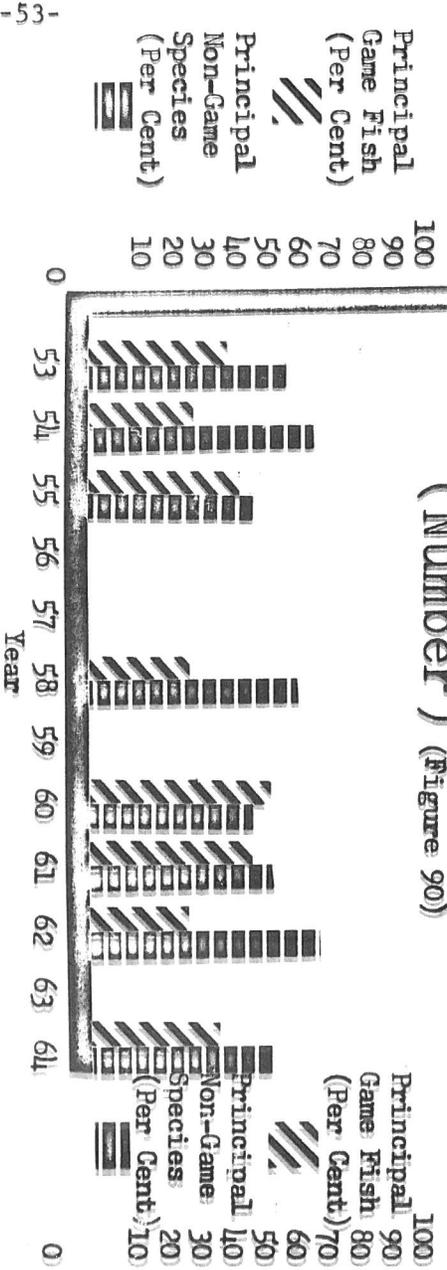


Smallmouth buffalo (Figure 89)

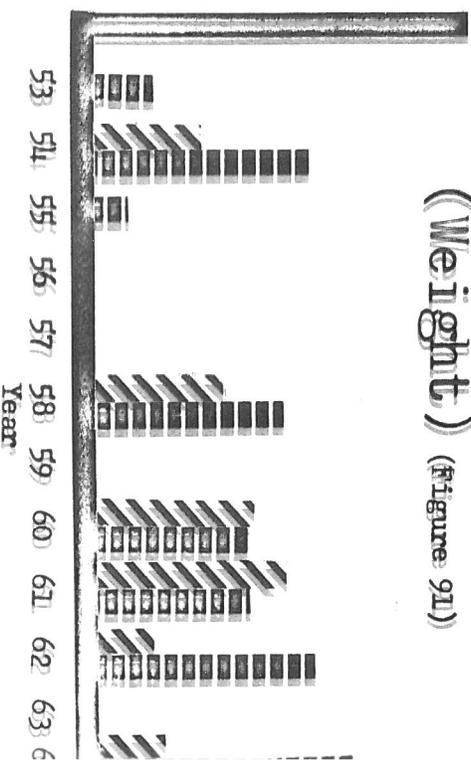


LAKE BROWNWOOD

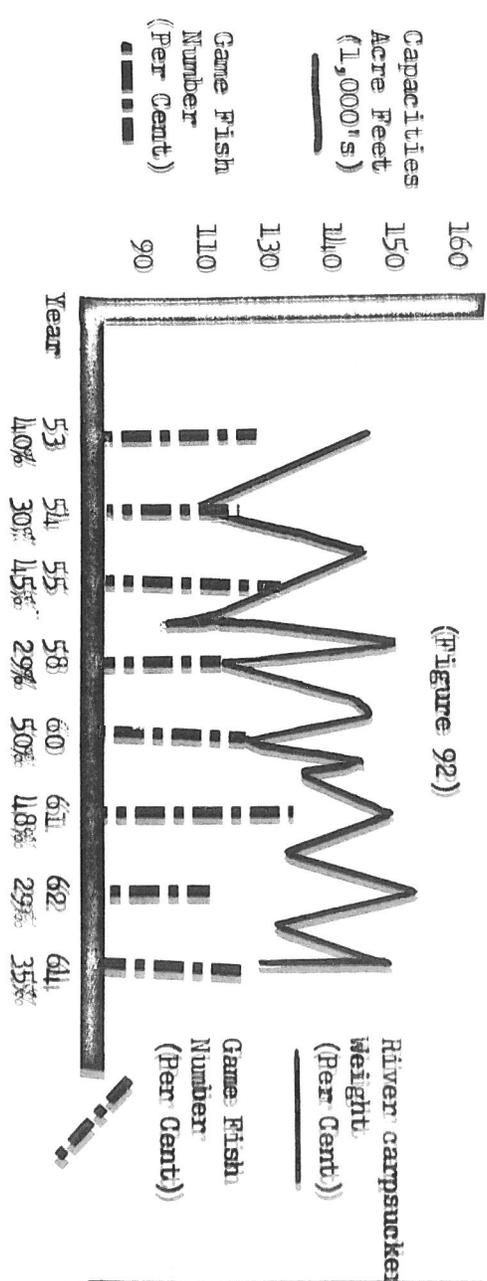
Principal Production (Number) (Figure 90)



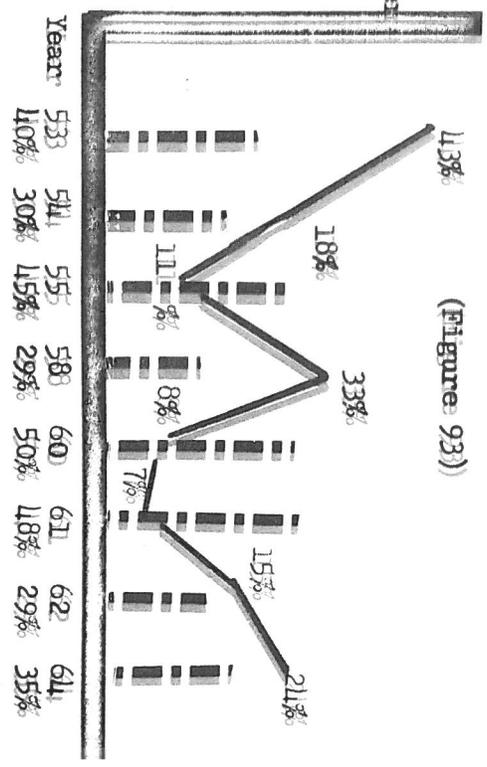
Principal Production (Weight) (Figure 91)



Principal Factors Influencing Game Fish Production (Figure 92)



(Figure 93)



Lake Sealy

Location

Lake Sealy is in Coleman County, 11 miles northeast of the city of Santa Anna on the Colorado River Watershed.

Ownership and History of Development

Lake Sealy was constructed by the Public Works Administration in 1936 for municipal water storage. The reservoir is now owned and operated by the city of Santa Anna for municipal water and recreation. In addition to impounding run-off water is occasionally pumped from Lake Brownwood into Lake Sealy.

Physical Description

Lake Sealy covers 49 acres at spillway elevation and has a maximum capacity of 246 acre-feet. Accurate engineering data is not available.

History of Fisheries Investigations and Management

The first sampling of fish production in Lake Sealy was carried out in conjunction with completing the Upper Colorado River Survey in 1954. Additional study led to the decision to eradicate fish life in order to renovate game fish production. This was done in November 1957 and stocking was completed the following spring.

Stocking Record

For actual number of fish stocked multiply entry by 1,000.

	1956	1957	1958	1959	1960	1961	1962	1963	1964
Largemouth bass									
fry				50					
fingerling		3.5							
Sunfish									
fingerling		.475							
Channel catfish									
fingerling		.425		.800					

Total largemouth bass fry stocked: 50,000.

Total largemouth bass fingerling stocked: 3,500.

Total sunfish fingerling stocked: 475.

Total channel catfish fingerling stocked: 1,225.

Discussion

The most pertinent circumstance to be considered is the management effort carried out to eliminate carp, river carpsucker and gizzard shad. These species have not been captured in post-treatment sampling, and game fish production far exceeds that before the control effort was carried out. The absence of these fish is even more remarkable because water has been pumped into Lake Sealy from Lake Brownwood several times since the 'kill' was completed. The shape of the reservoir basin, excellent water quality, and relatively stable water levels enhance the management opportunity.

References

A. Fisheries Investigations

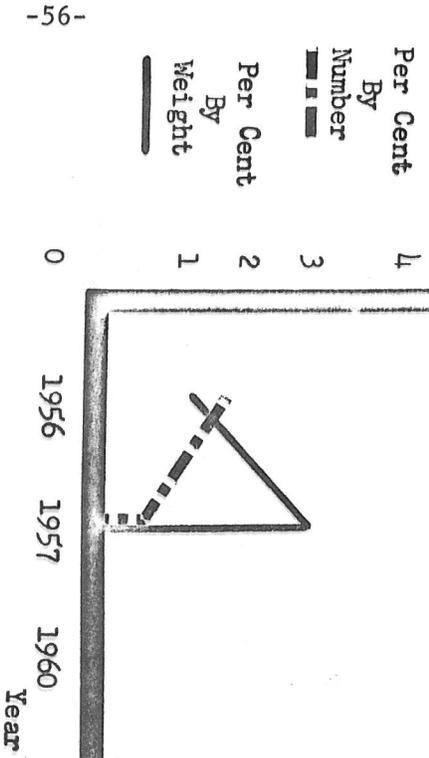
- Project F-5-R-4, Job Completion Report B-12 (Watershed Inventory)
- Project F-5-R-8, Job Completion Report B-32 (Reconnaissance)
- Project F-2-R-9, Job Completion Report B-22 (Reconnaissance)
- Project F-4-R-10, Job Completion Report B-29 (Reconnaissance)
- Project F-14-D-1, Job Completion Report 16a-5 (Population Control)
- Project F-14-D-1, Job Completion Report 18a-2 (Restocking)

B. Hydrological and Water Quality Data

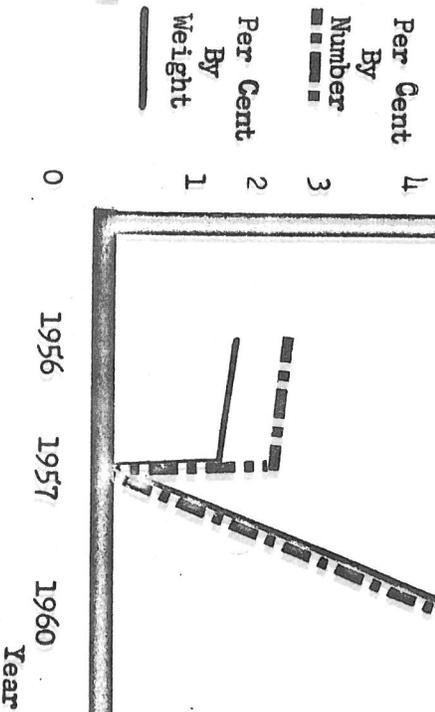
- State Board of Water Engineers Bulletin 5807-A
- Water Supply Papers of the United States Geological Survey
- Texas Water Commission Bulletin 8608
- Records of Santa Anna Water Department

FISH PRODUCTION FROM LAKE SEALY Game Fish Production

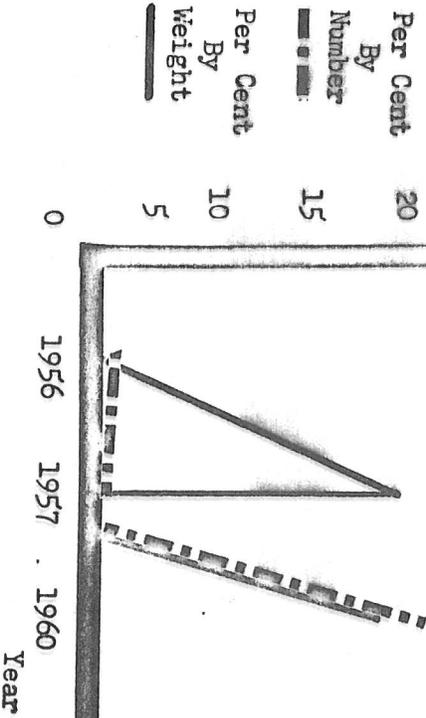
Largemouth bass (Figure 94)



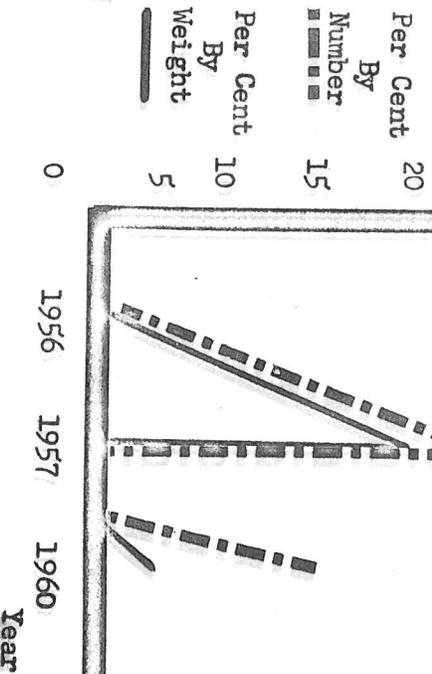
White crappie (Figure 95)



Channel catfish (Figure 96)

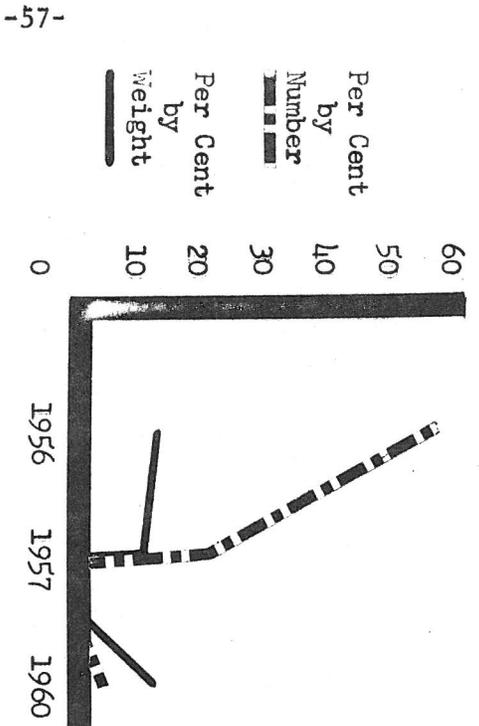


Sunfish (Figure 97)

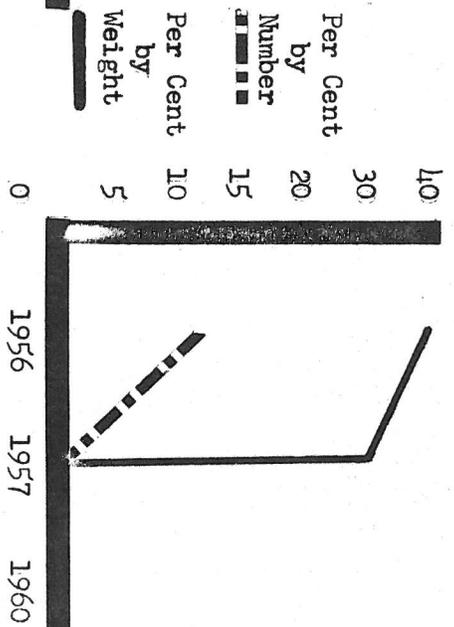


FISH PRODUCTION FROM LAKE SEALY Principal Non-Game Species

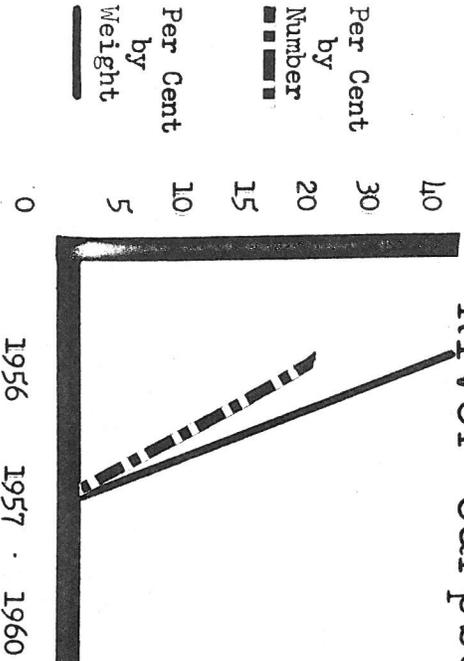
Gizzard shad (Figure 98)



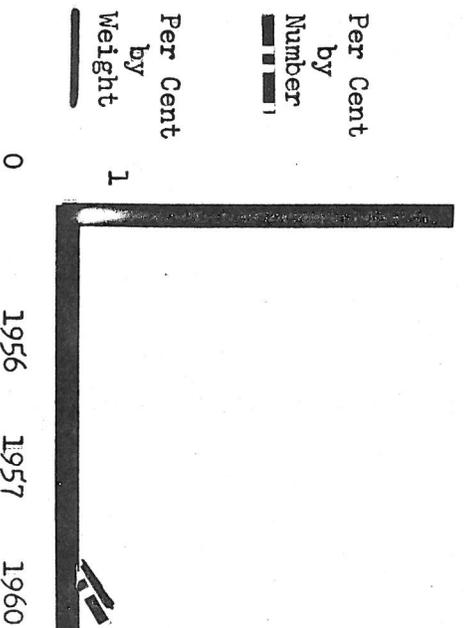
Carp (Figure 99)



River carpsucker (Figure 100)

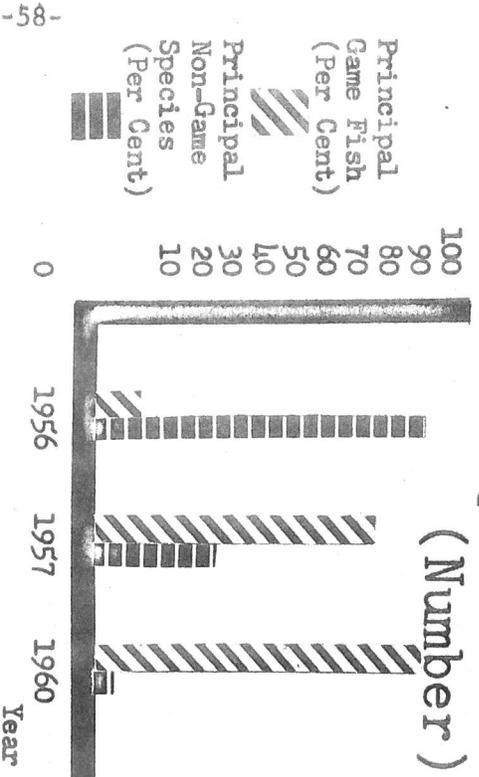


Bullheads (Figure 101)

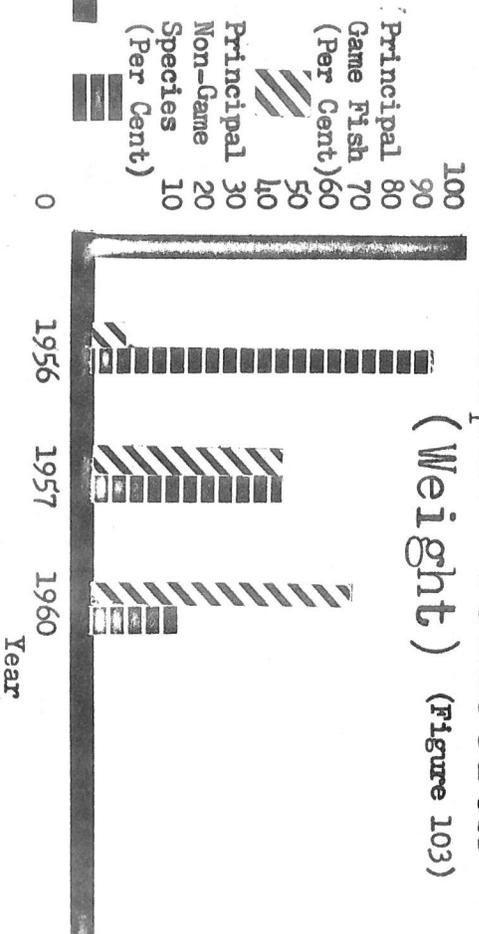


LAKE SEALY

Principal Production (Number) (Figure 102)



Principal Production (Weight) (Figure 103)



Lake Santanna

Location

Lake Santanna is in Coleman County, 11 miles northeast of the city of Santa Anna on the Colorado River Watershed.

Ownership and History of Development

Lake Santanna was constructed by the Public Works Administration in 1936 for municipal water. The reservoir is presently owned by the city of Santa Anna. The reservoir serves for municipal water and recreation.

Physical Description

At spillway elevation Lake Santanna covers approximately 75 acres and impounds about 600 acre-feet of water. Accurate engineering data is not available.

History of Fisheries Investigations and Management

Limited investigations were carried out in the process of completing the Upper Colorado River Survey. Later investigations were carried out under reconnaissance, and as a result of these studies it was decided to treat the reservoir to eliminate fish life. This was done in September 1959. Restocking was completed in the spring of 1960 and periodic checks on game fish production have been carried out under reconnaissance since that time.

Stocking Record

For actual number of fish stocked multiply entry by 1,000.

	1956	1957	1958	1959	1960	1961	1962	1963	1964
Largemouth bass									
fry	80		121			4			
fingerling			.80	2.2	1.2				
Sunfish									
fingerling	2			.80					
White crappie									
fingerling			.20						
Channel catfish									
fingerling	2		1	2,500		5,000			

Total largemouth bass fry stocked: 205,000.
 Total largemouth bass fingerling stocked: 4,200.
 Total sunfish fingerling stocked: 2,800.
 Total white crappie fingerling stocked: 200.
 Total channel catfish fingerling stocked: 10,500.

In addition to the above a large number of game fish were stocked in this lake and Lake Sealy from state hatcheries. Unfortunately many of these records are designated only as lakes owned by the city of Santa Anna. For that reason individual stocking cannot be determined. Records of this nature indicate that between 1943 and 1951 channel catfish fingerling stocked totaled 5,000, largemouth bass 19,000, white crappie 1,900 and sunfish 7,500.

Discussion

The data are insufficient to permit conclusions. It would appear that the management effort has succeeded in advancing game fish production, but sampling has been insufficient to positively establish that fact. Attention is called to Figure 104. Actually the high percentage indicated for largemouth bass is the result of stocking carried out immediately following the treatment and subsequent netting results in the spring. Factors that are suspected to influence game fish production include relatively stable water levels, clear water, and the existence of heavy marginal aquatic vegetation. This latter factor is believed to provide excessive protection for sunfish.

References

A. Fisheries Investigations

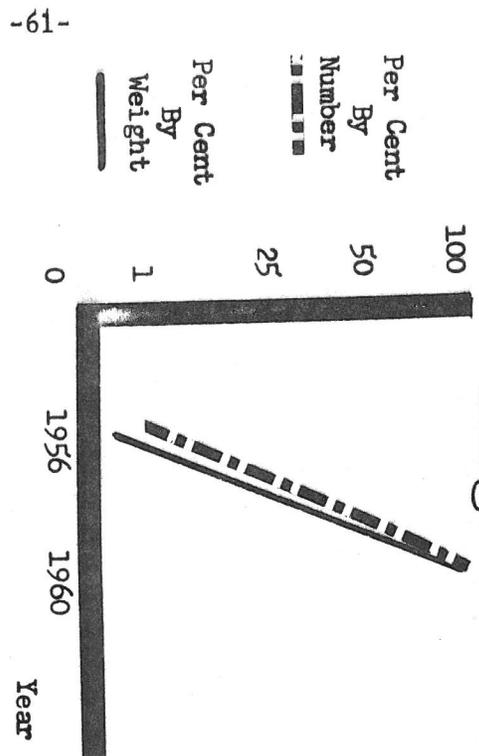
Project F-5-R-4, Job Completion Report B-12 (Inventory Watershed)
Project F-5-R-7, Job Completion Report B-22 (Resurvey)
Project F-14-D-4, Job Completion Report 16a16 (Population Control)
Project F-14-D-4, Job Completion Report 18a8 (Restocking)
Project F-2-R-9, Job Completion Report B-22 (Reconnaissance)
Project F-4-R-10, Job Completion Report B-29 (Reconnaissance)

B. Hydrological and Water Quality Data

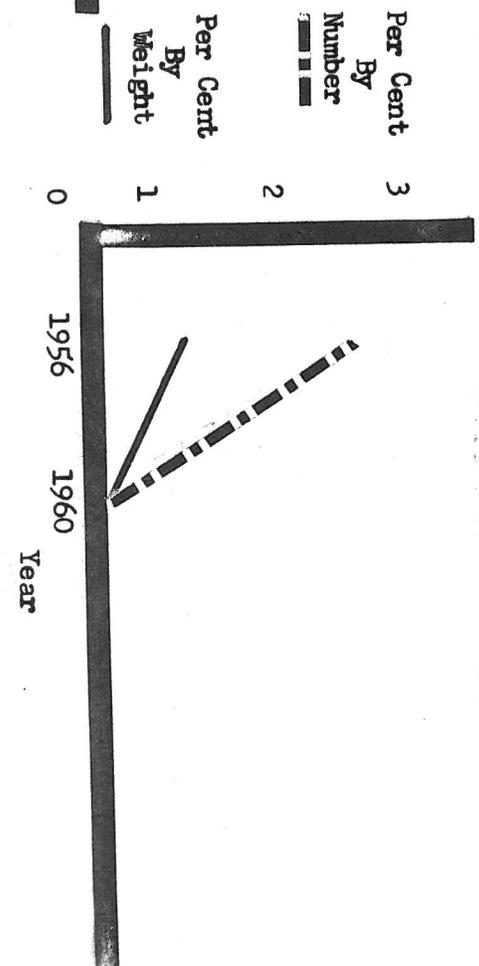
State Board of Water Engineers Bulletin 5807-A
Water Supply Papers of the United States Geological Survey
Records of Santa Anna Water Department

FISH PRODUCTION FROM LAKE SANTANNA Game Fish Production

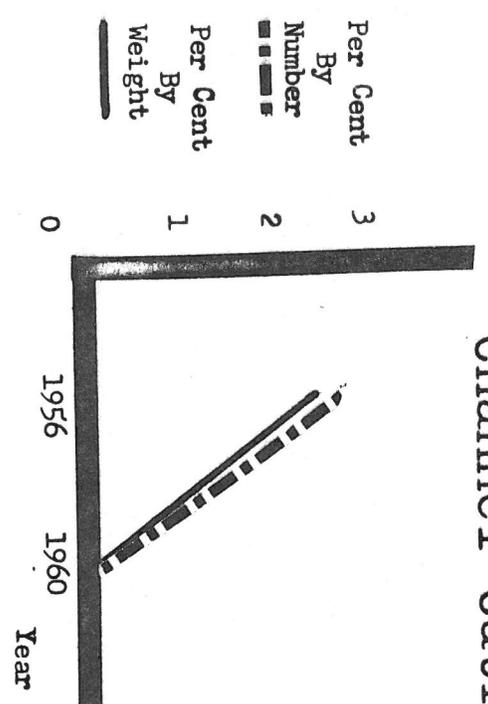
Largemouth bass (Figure 104)



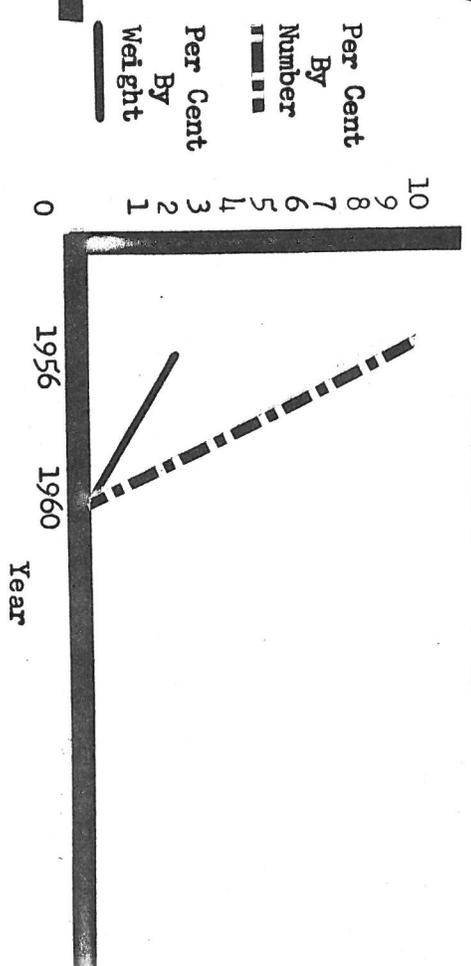
White crappie (Figure 105)



Channel catfish (Figure 106)



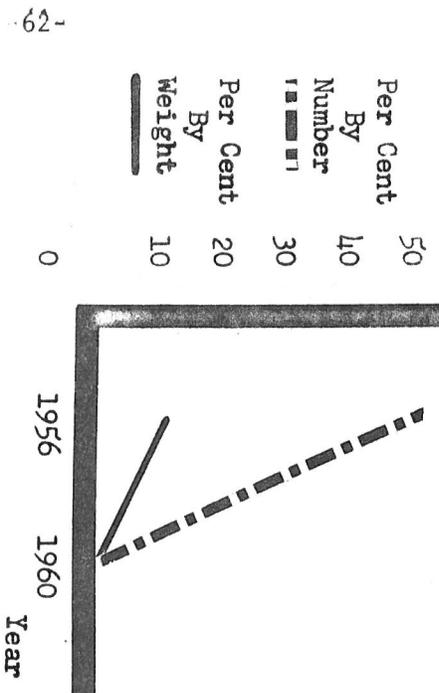
Sunfish (Figure 107)



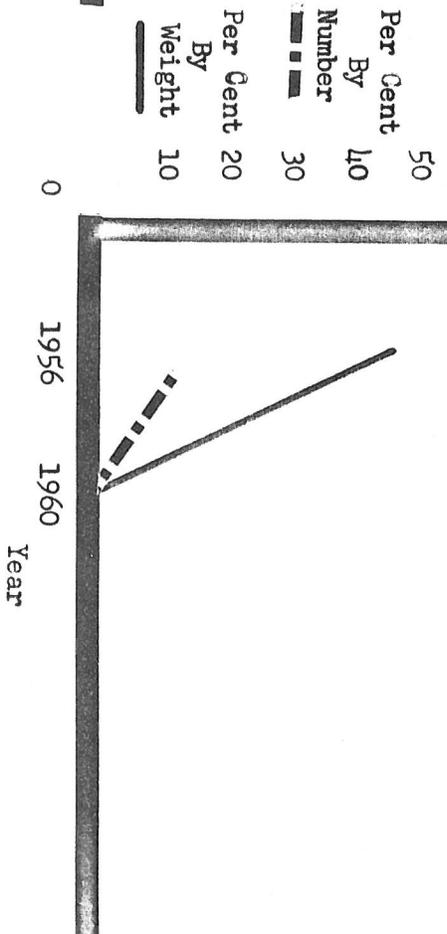
FISH PRODUCTION FROM LAKE SANTANNA

Principal Non-Game Species

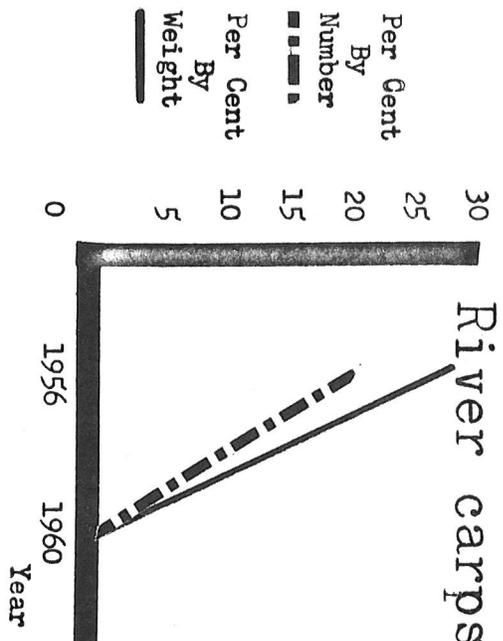
Gizzard shad (Figure 108)



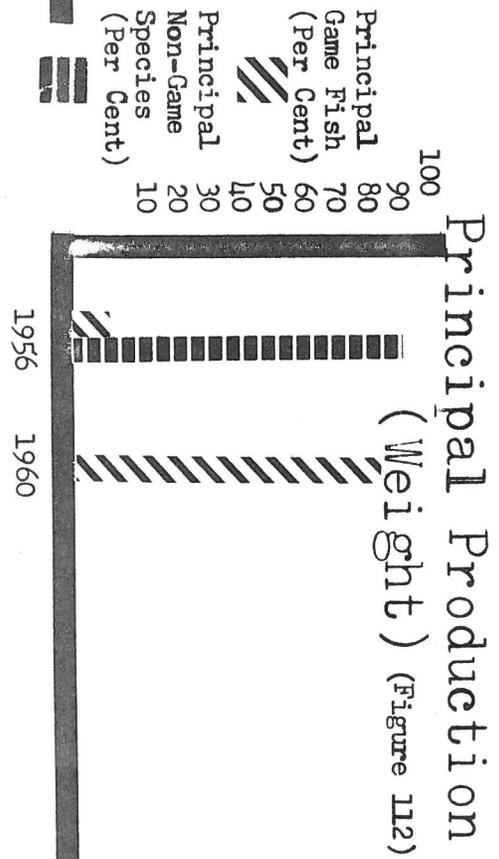
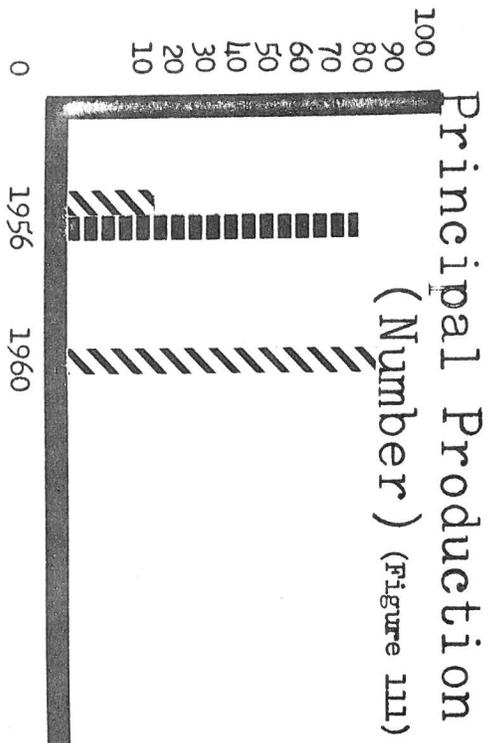
Carp (Figure 109)



River carpsucker (Figure 110)



LAKE SANTANNA



Lake Scarborough

Location

Lake Scarborough is located on Indian Creek about twelve miles above its confluence with Hoards Creek, a tributary of the Colorado River in Coleman County.

Ownership and History of Development

Lake Scarborough was constructed in 1923 by the Central Colorado River Authority. It has since been purchased by the city of Coleman for municipal water. The lake continues to serve as a second source of municipal water, Hoard Creek Reservoir now being the primary source, and for recreation.

Physical Description

The impacted earth dam is 1,000 feet long with a maximum height of 40 feet. At spillway capacity the lake contains 1,500 acre-feet and covers 138 acres.

History of Fisheries Investigations and Management

An inventory survey was completed in 1959 and periodic sampling of fish production continued until 1961. In the fall of that year a selective control for gizzard shad and freshwater drum was carried out. Following stocking in the spring of 1962, sampling was resumed and has continued to the present.

Stocking Record

For actual number of fish stocked multiply entry by 1,000.

	1958	1959	1960	1961	1962	1963	1964
Largemouth bass							
fry	10				86		
fingerling				11			
Sunfish							
fingerling			1				
White crappie							
fingerling			1				
Channel catfish							
fingerling			10	10.8	8		

Total largemouth bass fry stocked: 96,000.
 Total largemouth bass fingerling stocked: 11,000.
 Total sunfish fingerling stocked: 1,000.
 Total white crappie stocked: 1,000.
 Total channel catfish stocked: 37,800.

Between 1943 and 1951, 36,000 largemouth bass, 500 white crappie, 200 sunfish and 700 channel catfish were stocked from state fish hatcheries.

Discussion

When considering the following graphs, it would be emphasized that a selective kill of gizzard shad was carried out in the fall of 1961. Data and observations obtained prior to that date indicated that while both white crappie and sunfish were expanding the number of fish of utilizable size was decreasing. It was also apparent that largemouth bass were decreasing and gizzard shad and carp were increasing. Following the treatment reports of an increase in harvest of white crappie were received. The species were not taken in post-treatment sampling. Data also indicates that carp and gizzard shad were only temporarily curbed. For these reasons the results of the management effort are uncertain. The shape of the reservoir and water temperature may have been responsible for the indicated failure. Lake Scarborough has steep inclining shores and the ratio of shallow water to deep water is notable. There have been many instances reported where powdered rotenone was ineffective in deep waters when low temperatures were present. Observations indicate the following suspect factors: A low ratio of shallow water areas to deep water areas, low production of insects, heavily silted shallow water areas, and insufficient harvest.

References

A. Fisheries Investigations

Project F-5-R-5, Job Completion Report B-20 (Inventory)
Project F-5-R-7, Job Completion Report B-22 (Resurvey)
Project F-5-R-9, Job Completion Report B-32 (Resurvey)
Project F-2-R-9, Job Completion Report B-22 (Reconnaissance)
Project F-4-R-10, Job Completion Report B-29 (Reconnaissance)
Project F-4-R-11, Job Completion Report B-29 (Reconnaissance)

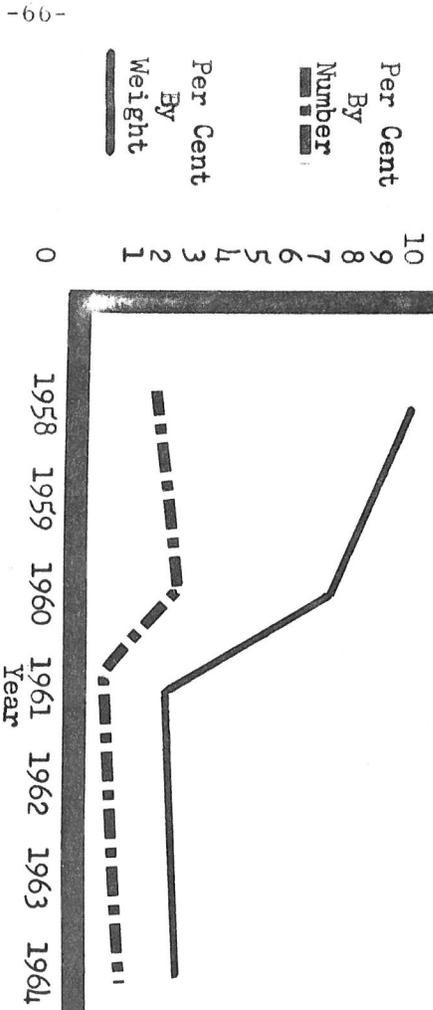
B. Hydrological and Water Quality Data

Records of City of Coleman Water Department
Records of Central Colorado River Authority
Texas Water Commission Records

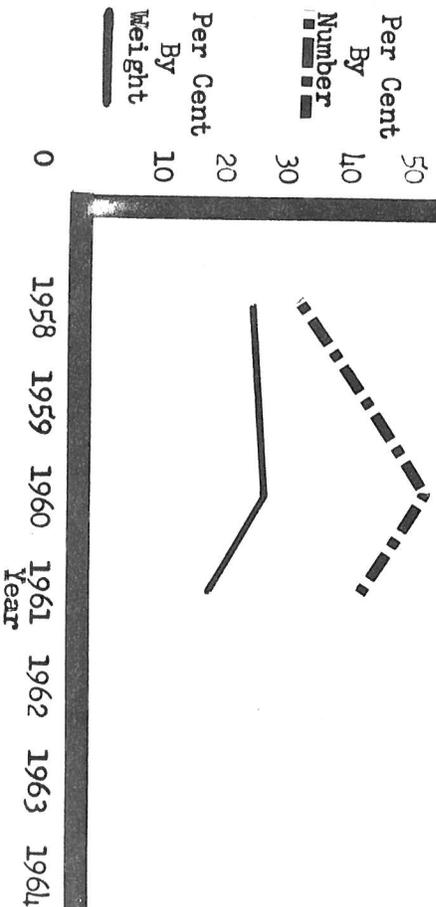
FISH PRODUCTION FROM LAKE SCARBOROUGH

Game Fish Production

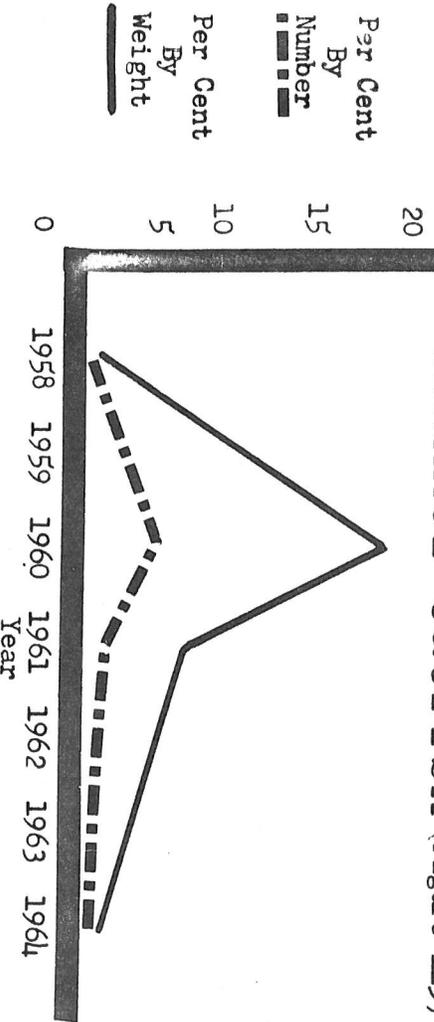
Largemouth bass (Figure 113)



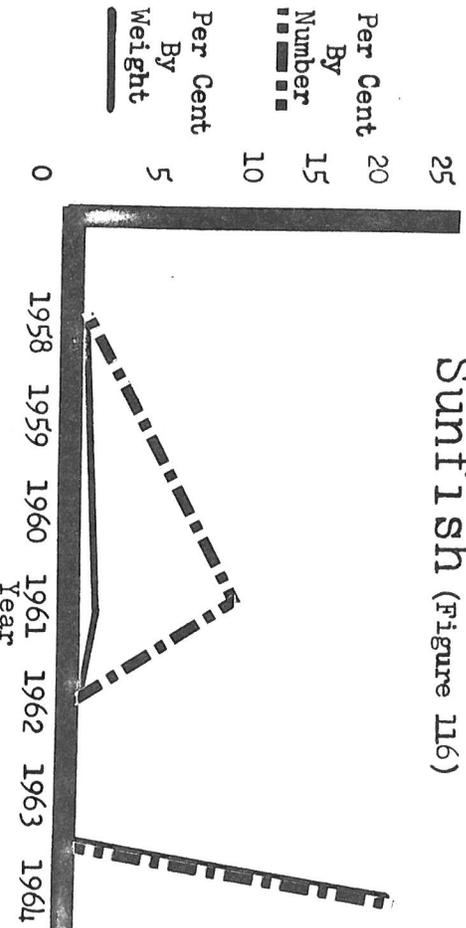
White crappie (Figure 114)



Channel catfish (Figure 115)

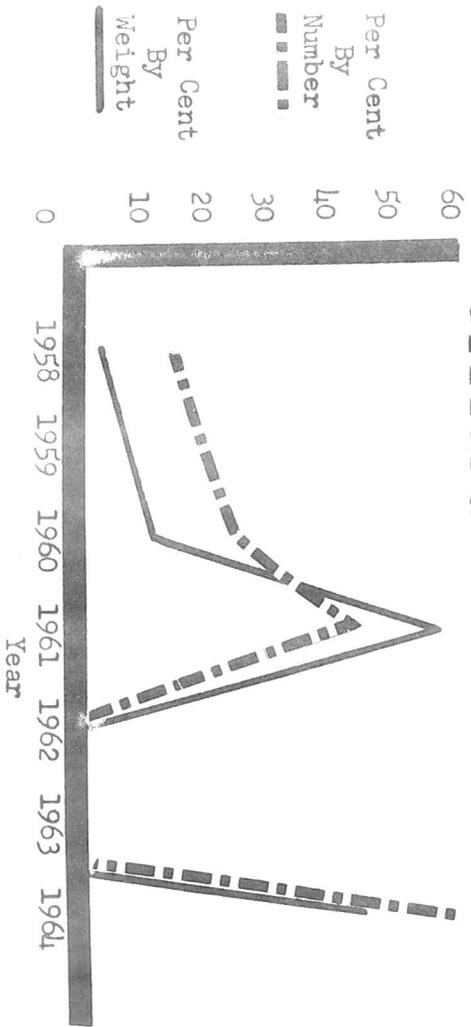


Sunfish (Figure 116)

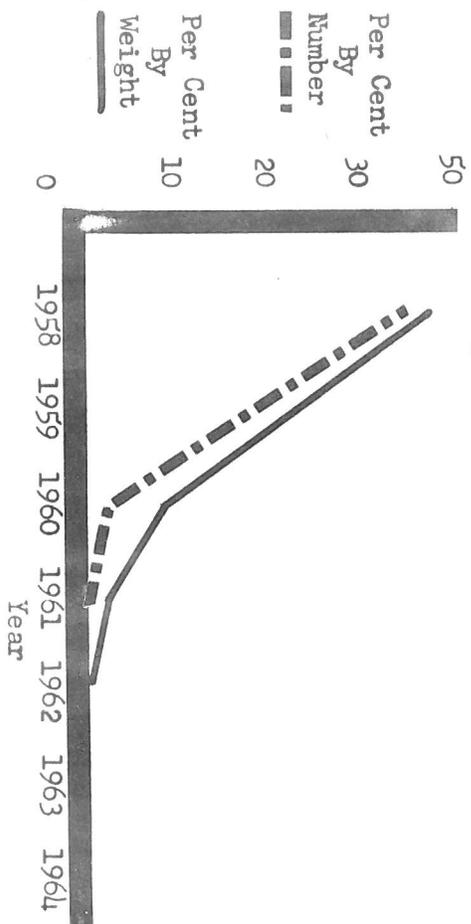


FISH PRODUCTION FROM LAKE SCARBOROUGH Principal Non-Game Species

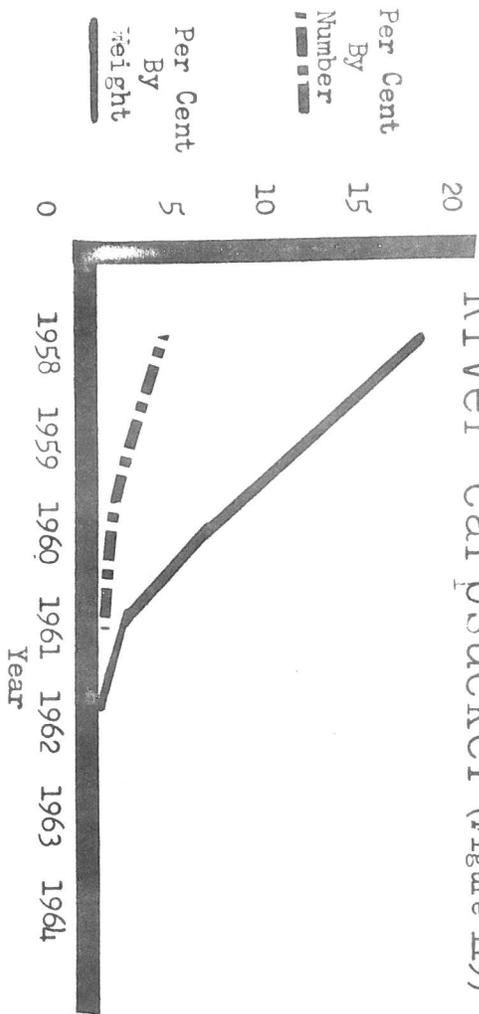
Gizzard shad (Figure 117)



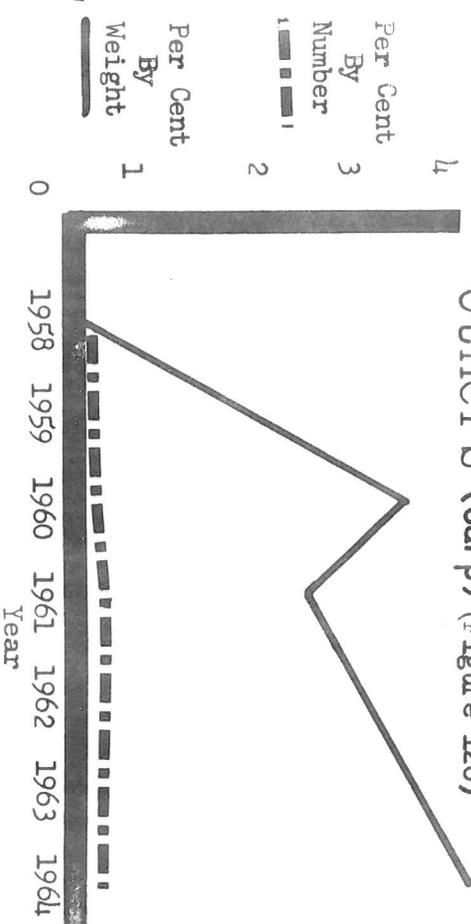
Freshwater drum (Figure 118)



River carpsucker (Figure 119)

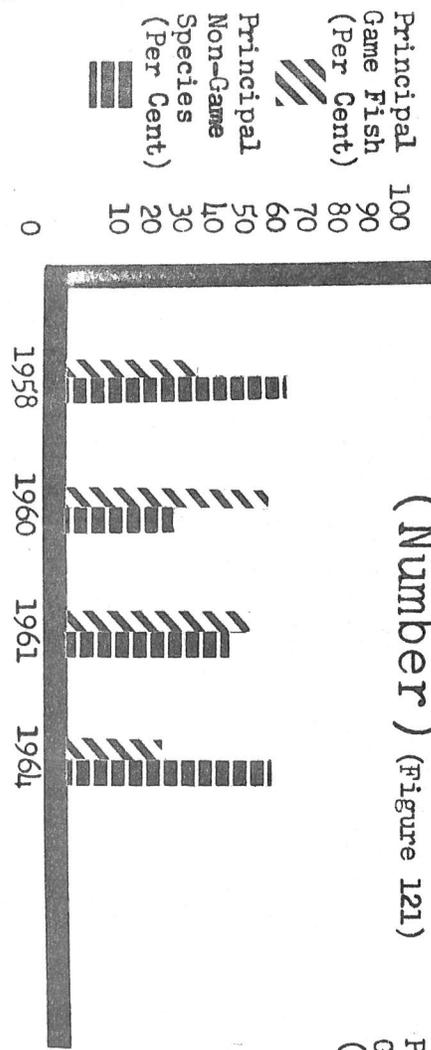


Others (Carp) (Figure 120)

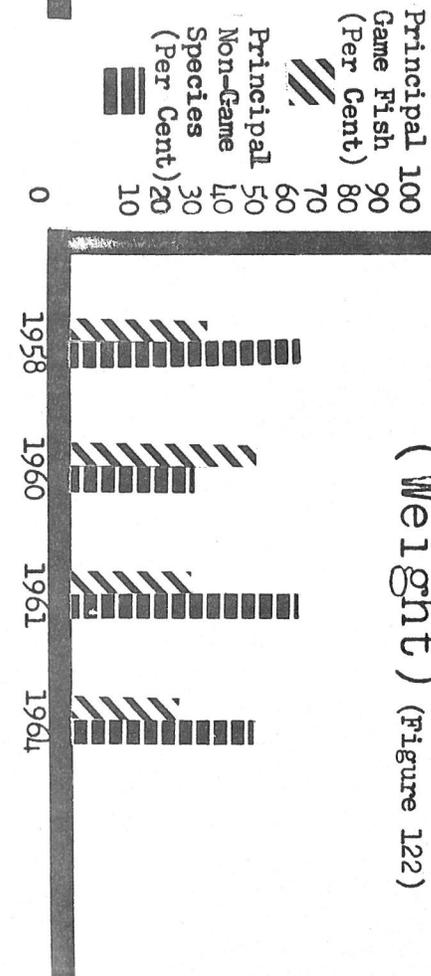


LAKE SCAR CROUGH

Principal Production (Number) (Figure 121)



Principal Production (Weight) (Figure 122)



Hoard's Creek Reservoir

Location

Hoard's Creek Reservoir is in the Colorado River Basin in Coleman County, 5 miles northwest of Valera on Hoard's Creek, a tributary of Jim Ned Creek.

Ownership and History of Development

The project is owned by the U. S. Government, and was built and is operated by the U. S. Corps of Engineers, Fort Worth District, for conservation of water and flood regulation.

The city of Coleman purchased the conservation space by the contribution of \$100,000 toward the first cost of the project that gave the city the use of that space for the useful life of the reservoir.

The dam was started in February 1947, and was completed in June 1948 with deliberate impoundment of water beginning in April 1948.

Physical Description

Pertinent data are as follows:

Feature	Elevation (feet above m.s.l.)	Capacity (acre-feet)	Area (acres)
Top of dam	1,939.0	63,150	2,810
Crest of emergency spillway	1,920.0	25,310	1,260
Top of conservation storage space (crest of service spillway)	1,900.0	8,640	510
Invert of lowest water supply outlet	1,876.5	1,690	160
Invert of slide-gates	1,856.0	- -	- -
Stream bed	1,850.0	0	0
Sediment reserve	- -	2,860	- -

History of Fisheries Investigations and Management

Seining collections were first taken from Hoards Creek Reservoir in connection with completing the Upper Colorado River Survey in 1955. The inventory survey was begun in 1956 and completed in 1957. Subsequent investigation was limited to population sampling carried out under reconnaissance and resurvey. Because of the excellent game fish production the reservoir has not required management beyond stocking.

Stocking Record

For actual number of fish stocked multiply entry by 1,000.

	1952	1953	1954	1955	1956	1957	1958
Largemouth bass							
fry	28	891					20
fingerling				4	15		2.2
Sunfish							
fingerling					6		.05
White crappie							
fingerling	5		15		.20		
Channel catfish							
fingerling	3.4			6			2
	1959	1960	1961	1962	1963	1964	
Largemouth bass							
fry	165			40			
fingerling	7.5			4			
Sunfish							
fingerling						1	
White crappie							
fingerling							
Channel catfish							
fingerling						1	

Total largemouth bass fry stocked: 114,400.
 Total largemouth bass fingerling stocked: 32,700.
 Total sunfish fingerling stocked: 7,050.
 Total white crappie stocked: 20,200.
 Total channel catfish stocked: 12,400.

Discussion

Hoards Creek Reservoir is more stable than is common for the region. It would appear that this stability plus other factors favors high production of game fish. In the past the fishing reputation for the lake has been

excellent with exceptional catches of largemouth bass and unusually large redear sunfish frequently reported. The lake continues to produce good bass fishing, but the production of large redear and other sunfish has diminished. Data indicate that between 1956 and 1960 three of the four principal game fish, largemouth bass, white crappie, and sunfish experienced declines. Reports of fishing success support these findings. During that period the reservoir underwent a gradual and prolonged recession. Since study began, the overall trend in game fish production has been downward and river carp-sucker and carp have increased. Factors that favor game fish production include the relative stability of the lake, the clear and excellent water, the shape of the reservoir basin that includes large quantities of shallow water areas, and the natural protective features of the basin.

References

A. Fisheries Investigations

Project F-5-R-4, Job Completion Report B-12 (Watershed Inventory)
Project F-5-R-5, Job Completion Report B-19 (Inventory)
Project F-5-R-9, Job Completion Report B-32 (Reconnaissance)
Project F-5-R-9, Job Completion Report D-1 (Fishery Problems)
Project F-2-R-9, Job Completion Report B-22 (Reconnaissance)
Project F-4-R-10, Job Completion Report B-29 (Reconnaissance)
Project F-4-R-11, Job Completion Report B-29 (Reconnaissance)

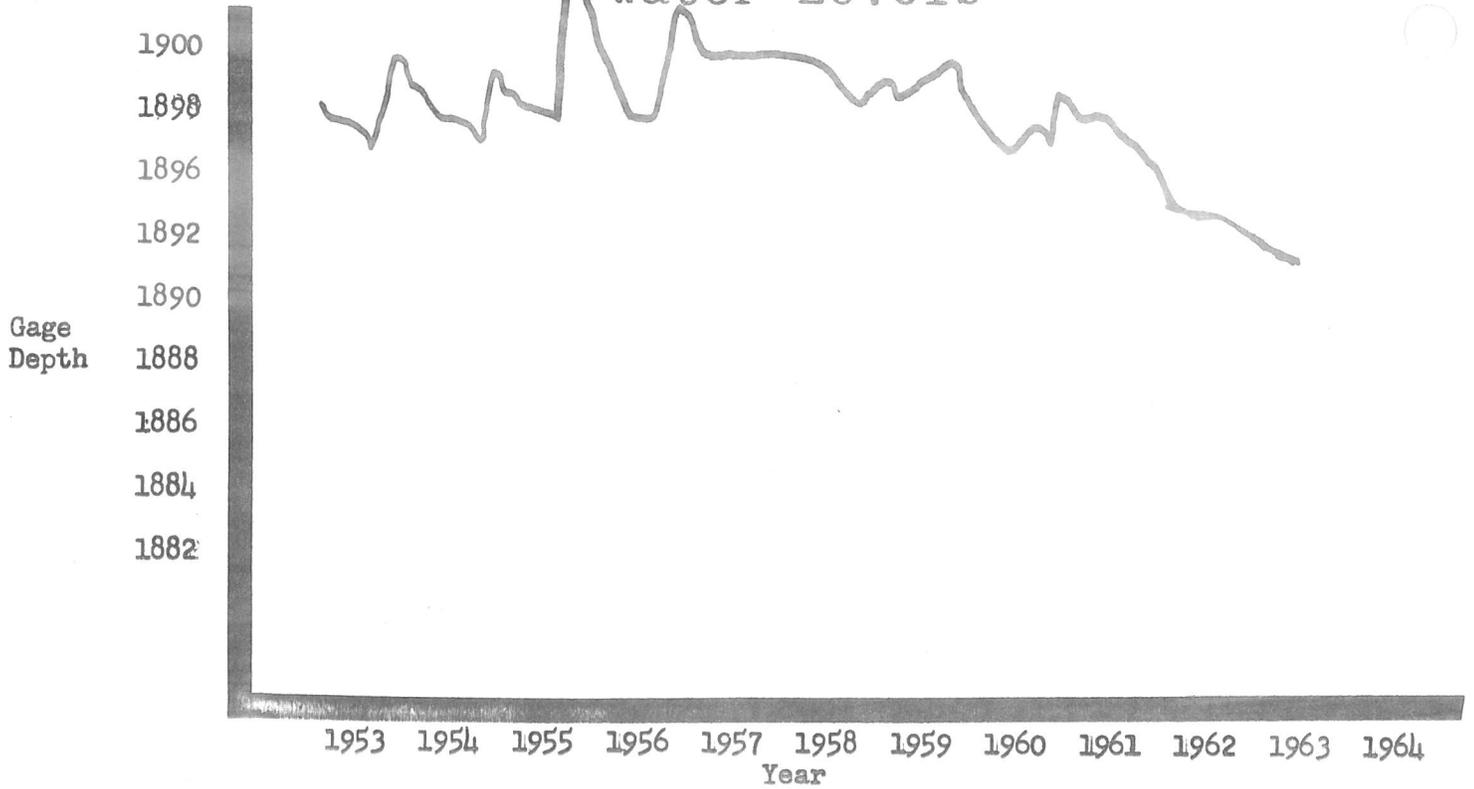
B. Hydrological and Water Quality Data

U. S. Corps of Engineers
State Board of Water Engineers, Bulletin 5807-A
Texas Water Commission Bulletin 6408
Texas State Department of Health

(Figure 123)

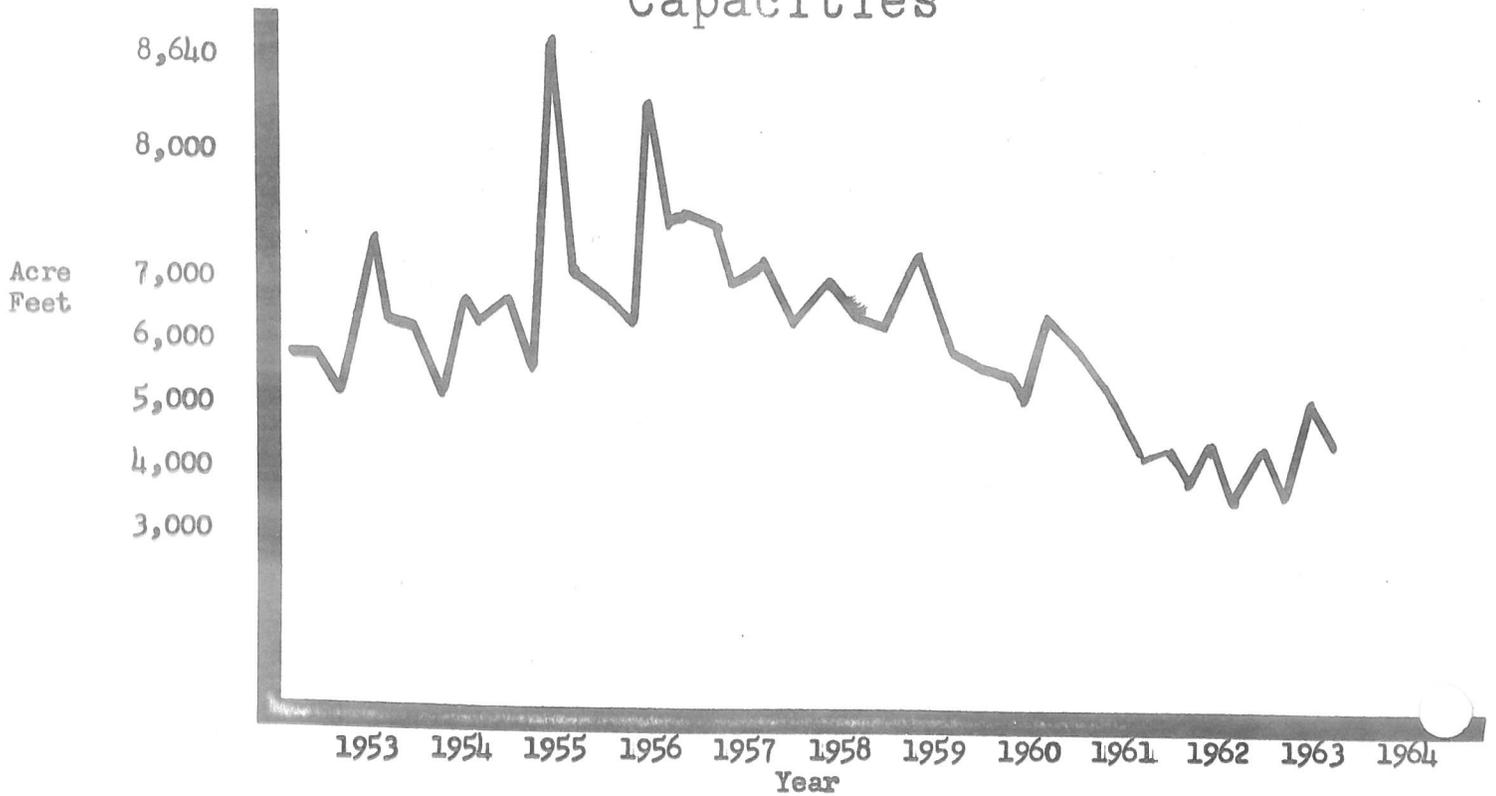
HYDROLOGICAL DATA FOR HOARDS CREEK RESERVOIR

Water Levels



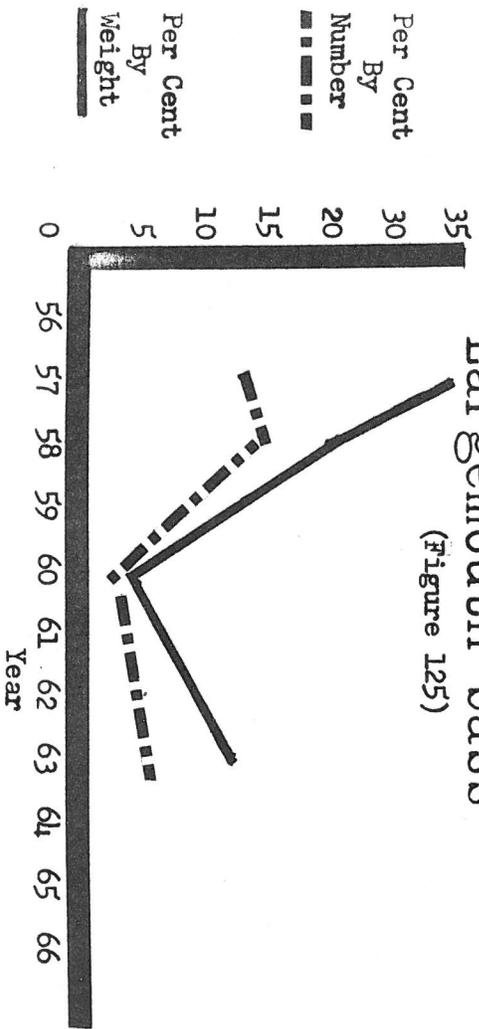
(Figure 124)

Capacities

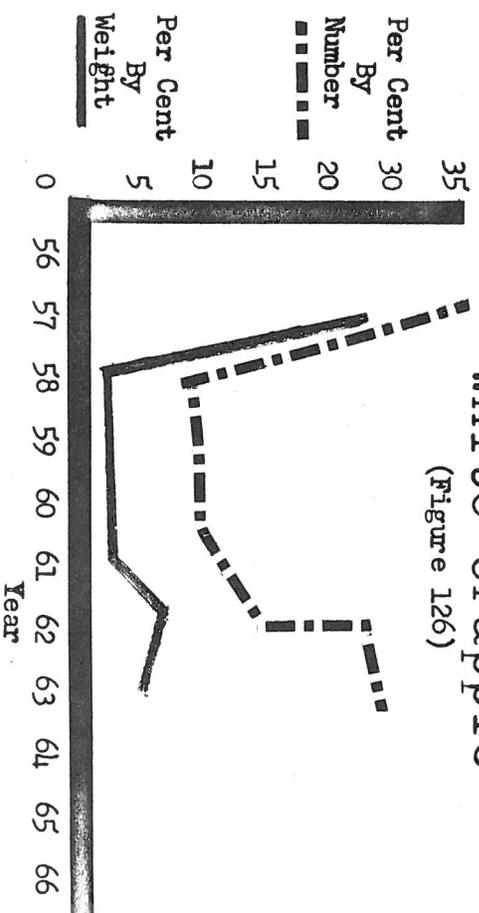


FISH PRODUCTION FROM HOARD CREEK RESERVOIR Game Fish Production

Largemouth bass (Figure 125)



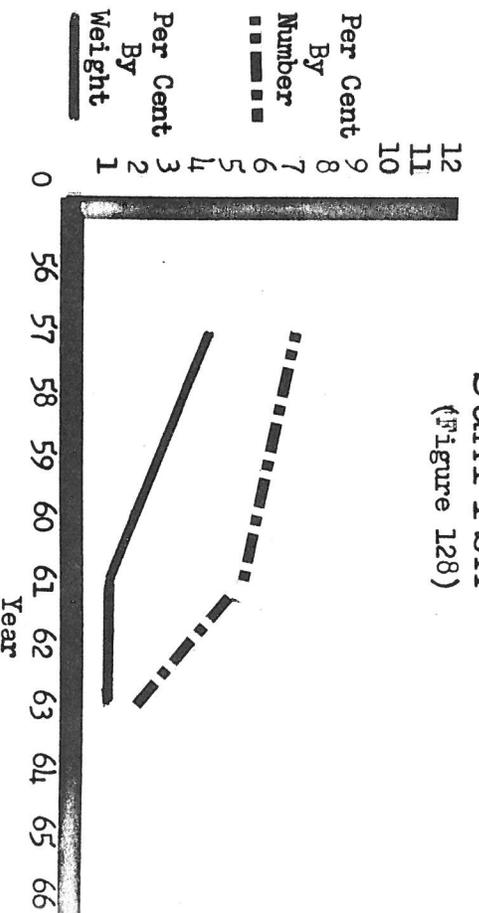
White crappie (Figure 126)



Channel catfish (Figure 127)

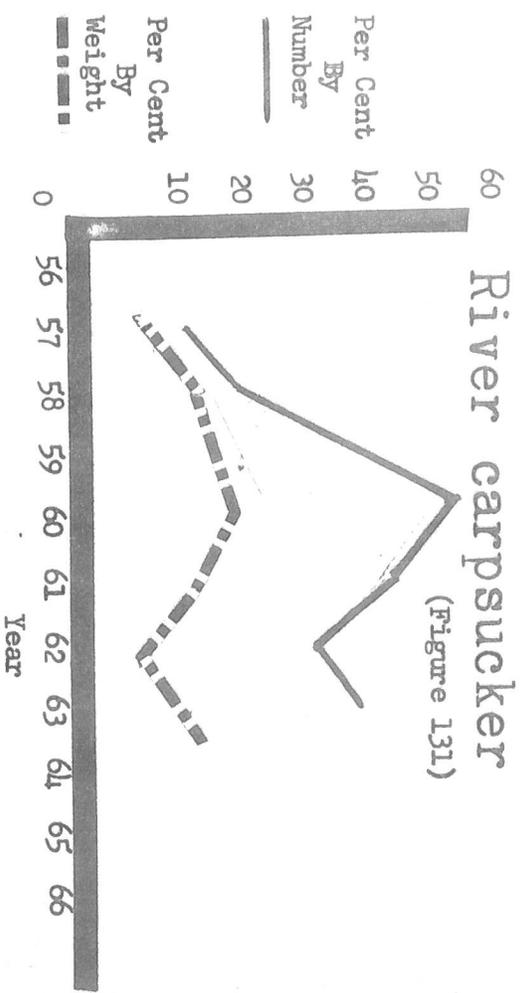
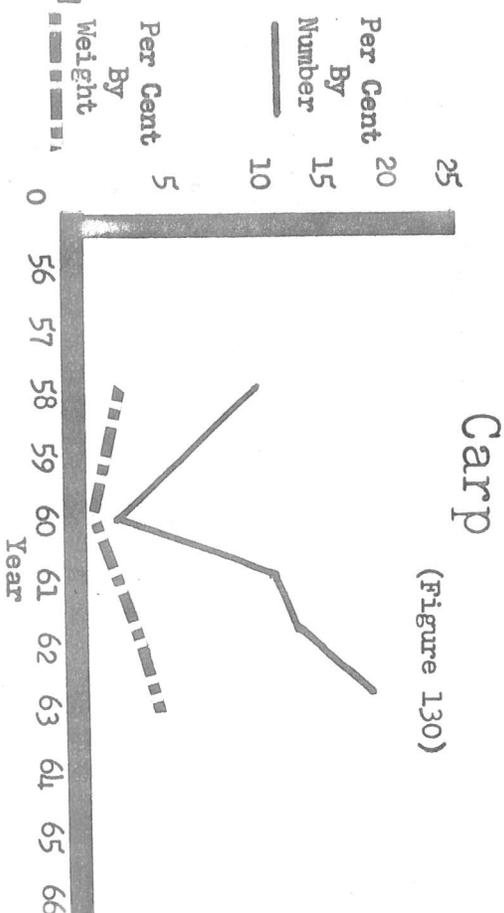
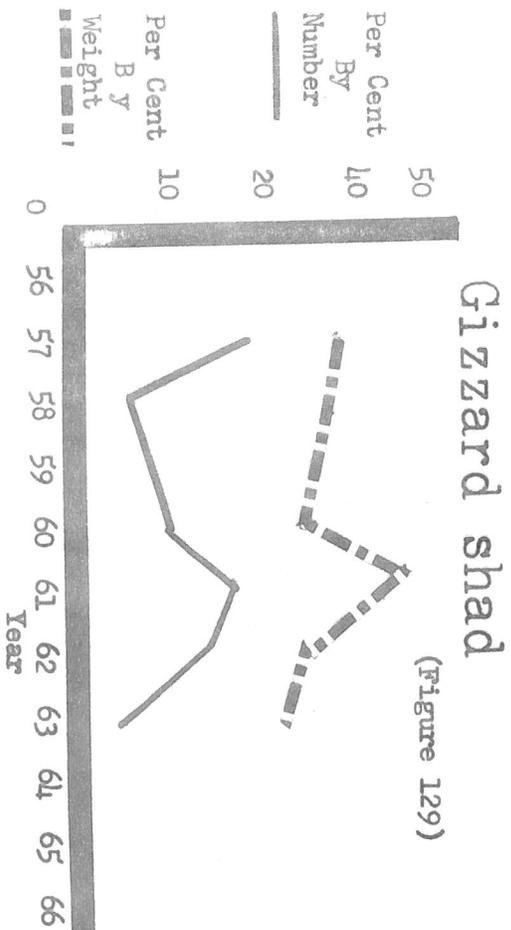


Sunfish (Figure 128)



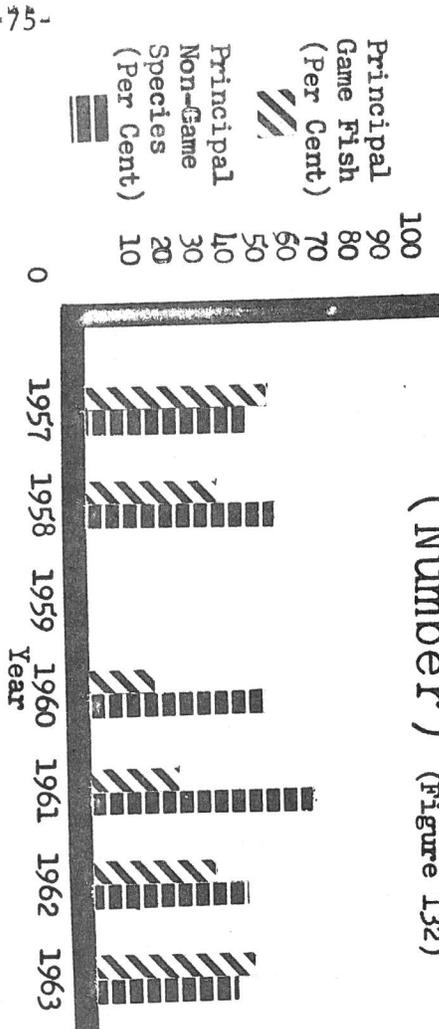
FISH PRODUCTION FROM HOARD CREEK RESERVOIR

Principal Non-Game Species

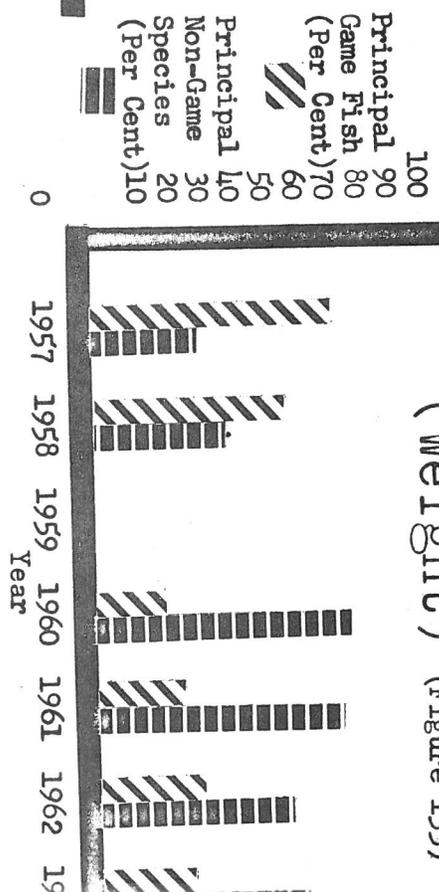


HOARD CREEK RESERVOIR

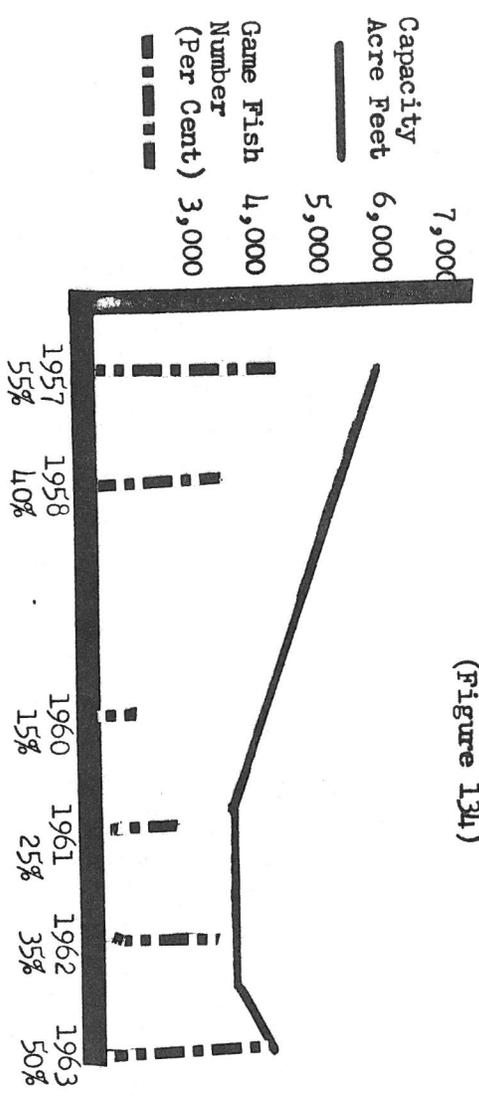
Principal Production (Number) (Figure 132)



Principal Production (Weight) (Figure 133)



Principal Factors Influencing Game Fish Production (Figure 134)



Ballinger City Lake

Location

Ballinger City Lake is located on Elm Creek in the city park north of the county seat of Runnels County. The reservoir is on the Colorado River Water-shed.

Ownership and History of Development

Old Ballinger City Lake is owned by the city of Ballinger. The reservoir served with wells to provide municipal water prior to 1952, but has been used for recreation since that time.

Physical Description

The dam creating this reservoir is of masonry blocks, limestone blocks and joined by cement mortar. The maximum capacity at spillway level is approximately 250 acre-feet and the area is 50 acres.

History of Fisheries Investigations and Management

Sampling of fish populations was first obtained under the Upper Colorado River Survey in 1955. Subsequent sampling has been under reconnaissance efforts.

Stocking Record

For actual number of fish stocked multiply entry by 1,000.

	1960	1961	1962	1963	1964
Largemouth bass					
fry			10		
fingerling	1	1			
Sunfish					
fingerling	2.5				
White crappie					
fingerling	.2	.2			
Channel catfish					
fingerling	.50	1			

Total largemouth bass fry stocked: 10,000.
 Total largemouth bass fingerling stocked: 2,000.
 Total sunfish stocked: 2,500.
 Total white crappie stocked: 400.
 Total channel catfish stocked: 150.

Discussion

As shown in the accompanying graphs, the quantity of game fish produced has been relatively low since the initiation of study. This is attributed to the large quantities of problematic fish and to pollution. Salt water under artesian head flows into Elm Creek from fissures that connect with the Coleman Junction limestone formation that underlies the area. Turbidity may also be detrimental and extensive siltation is suspected to favor the production of problematic fish.

References

A. Fisheries Investigations

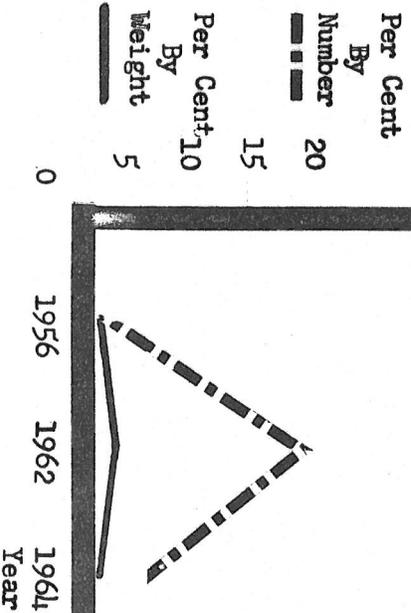
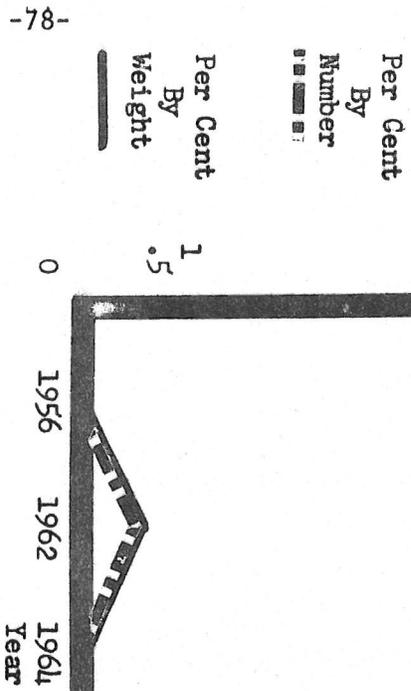
Project F-5-R-4, Job Completion Report B-12 (Watershed Inventory)
Project F-5-R-8, Job Completion Report B-1 (Small Impoundments)
Project F-5-R-10, Job Completion Report B-32 (Reconnaissance)
Project F-5-R-11, Job Completion Report B-32 (Reconnaissance)

B. Hydrological and Water Quality Data

Water Supply Papers of United States Geological Survey
State Board of Water Engineers, RECONNAISSANCE OF WATER WELL POLLUTION
AND THE OCCURENCE OF SHALLOW GROUND WATER, RUNNELS COUNTY, TEXAS
Texas Board of Water Engineers Chemical Composition of Surface Waters,
1947, 1952, 1953, 1956, 1958

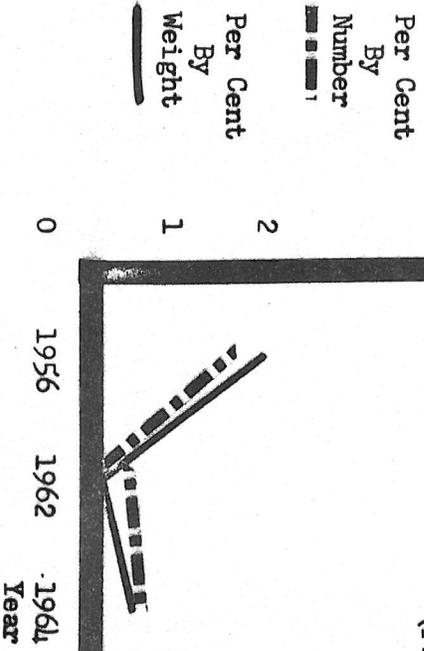
FISH PRODUCTION FROM BALLINGER CITY LAKE Game Fish Production

Largemouth bass (Figure 135)

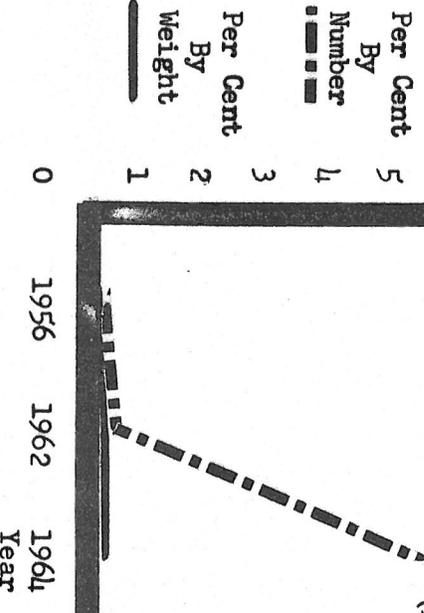


White crappie (Figure 136)

Channel catfish (Figure 137)



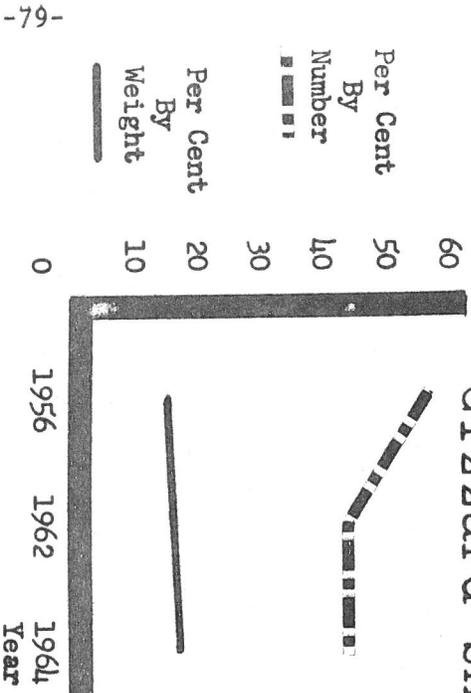
Sunfish (Figure 138)



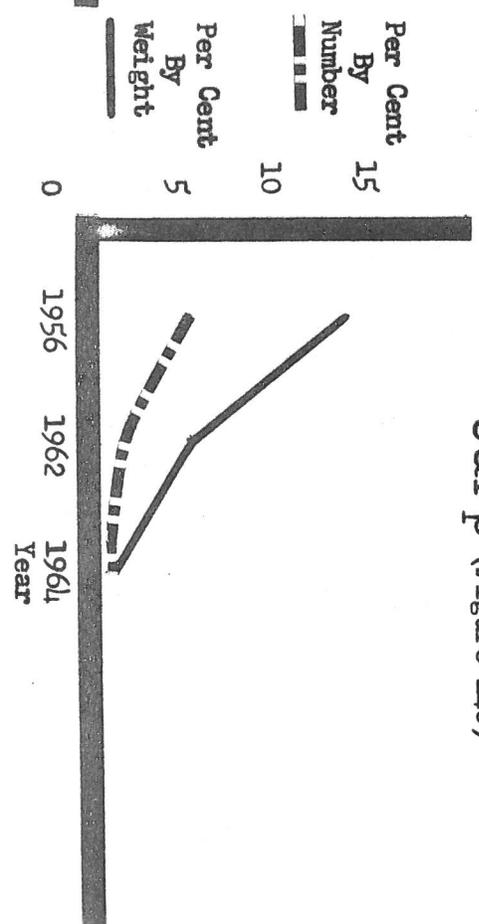
FISH PRODUCTION FROM BALLINGER CITY LAKE

Principal Non-Game Species

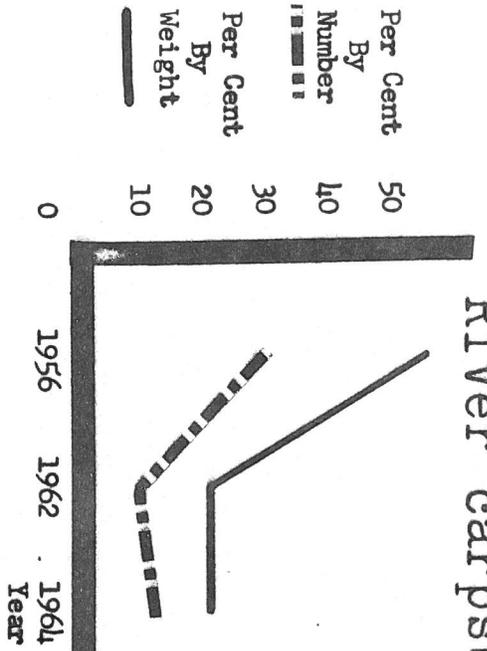
Gizzard shad (Figure 139)



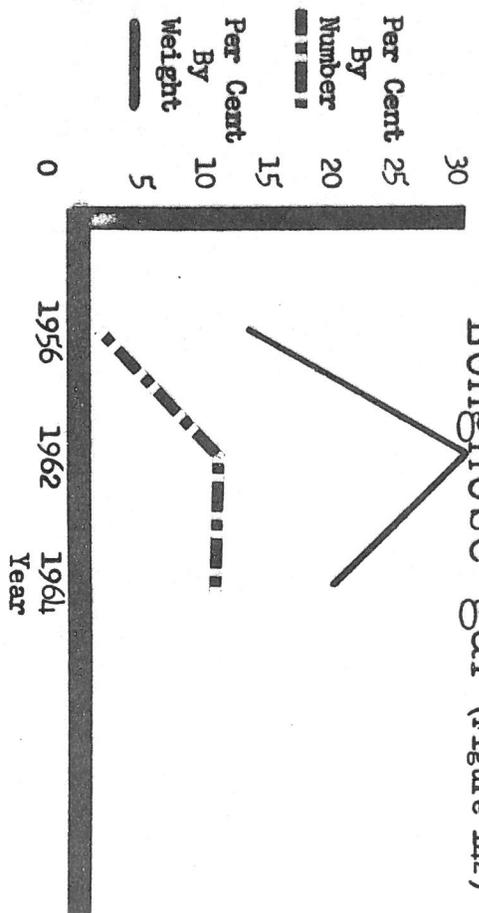
Carp (Figure 140)



River carpsucker (Figure 141)

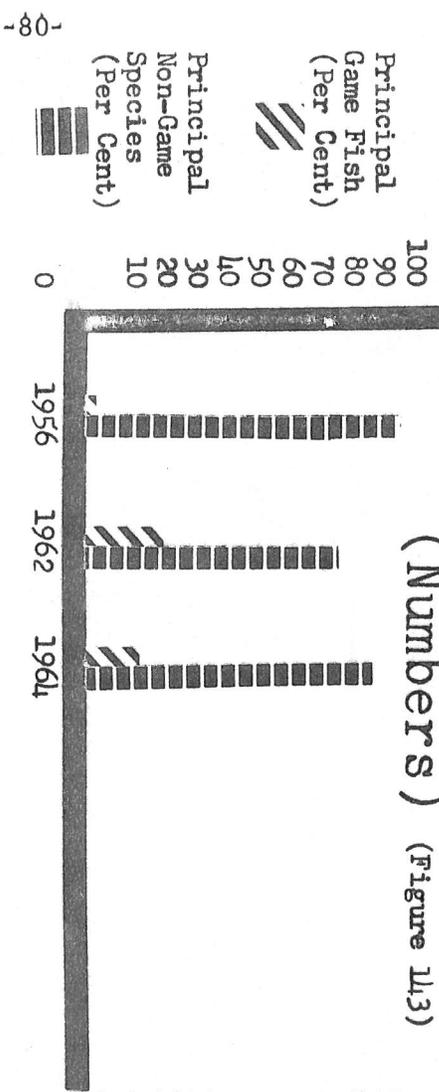


Longnose gar (Figure 142)

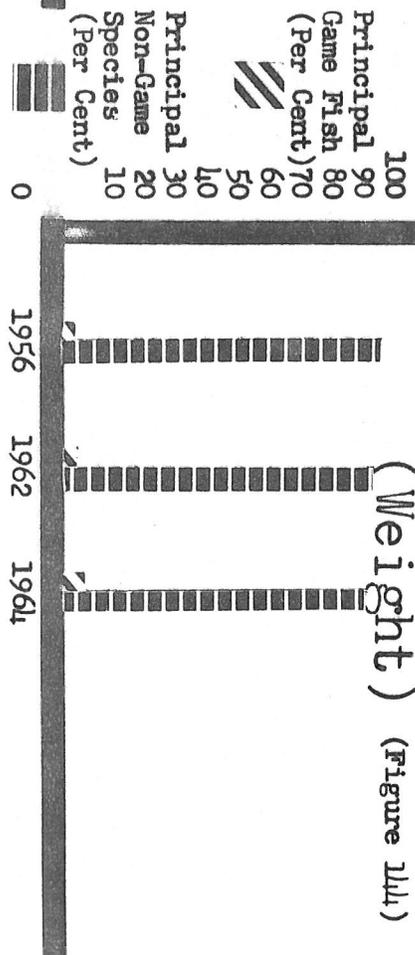


BALLINGEY CITY LAKE

Principal Production (Numbers) (Figure 143)



Principal Production (Weight) (Figure 144)



New Winters Lake

Location

New Winters Lake is located on Elm Creek, a tributary of the Colorado River, in Runnels County, approximately 2 miles east of Winters.

Ownership and History of Development

The reservoir was constructed in 1956 for municipal water for the city of Winters, and has served that community as a water supply since August of that year.

Physical Description

The dam is compacted-earth. At maximum capacity the reservoir impounds 11,000 acre-feet and covers 250 acres. At low stage the reservoir covers 180 acres and impounds 1249 acre-feet.

History of Fisheries Investigations and Management

Only limited investigations had been carried out prior to 1964. A thorough reconnaissance survey at that time indicated that the reservoir production was completely dominated by problematic fish. The city of Winters requested technical supervision and purchased the required chemical to destroy existing fish populations, and that work was completed in August of 1964. The reservoir has since been restocked and current investigations indicate management success.

Stocking Record

For actual number of fish stocked multiply entry by 1,000.

	1957	1958	1959	1960	1961	1962	1963	1964	1965
Largemouth bass									
fry			70			25			
fingerling	1	7.2	10		10				
White crappie									
fingerling		.30			.40				
Channel catfish									
fingerling	1	3.2	15		5				

Total number of largemouth bass fry stocked: 95,000.

Total number of largemouth bass fingerling: 28,200.

Total number of white crappie fingerling stocked: 700.

Total number of Channel catfish fingerling stocked: 24,200.

Discussion

Data and observations are deemed insufficient to support detailed analysis. It would appear that gross game fish production is relatively stable. Factors that are worthy of further investigation include a study of the unknown influences that are resulting in the expansion of smallmouth buffalo and river carpsucker, the degree of permanence of turbidity observed in the upper reservoir, and factors that are apparently resulting in an expansion in flatheads while channel catfish appear to be decreasing.

References

A. Fisheries Investigations

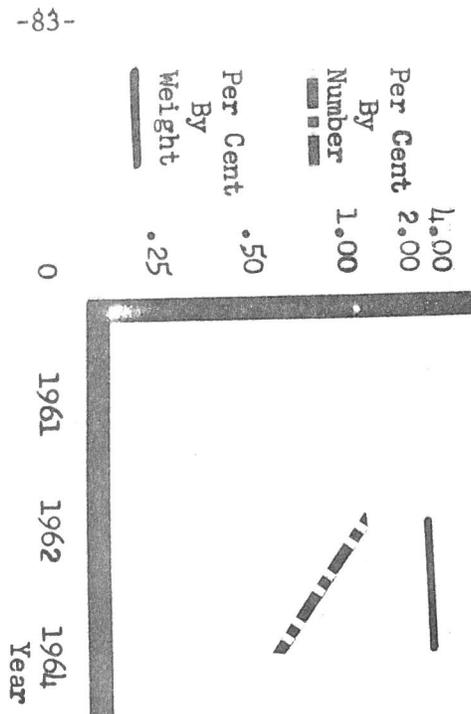
Project F-5-R-10, Job Completion Report B-32 (Reconnaissance)
Project F-5-R-11, Job Completion Report B-32 (Reconnaissance)
Project F-5-R-12, Job Completion Report B-32 (Reconnaissance)

B. Hydrological and Water Quality Data

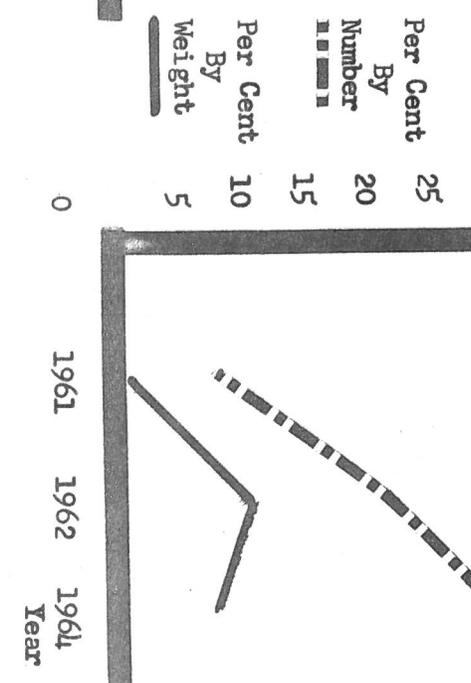
Records of city of Winters Water Department

FISH PRODUCTION FROM NEW WINTERS LAKE Game Fish Production

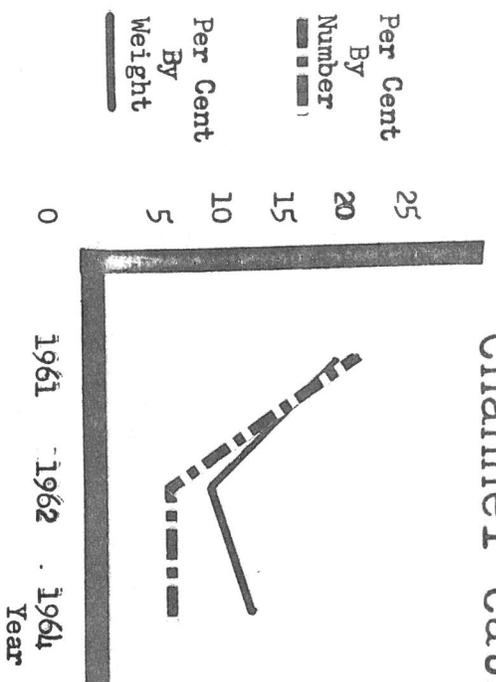
Largemouth bass (Figure 145)



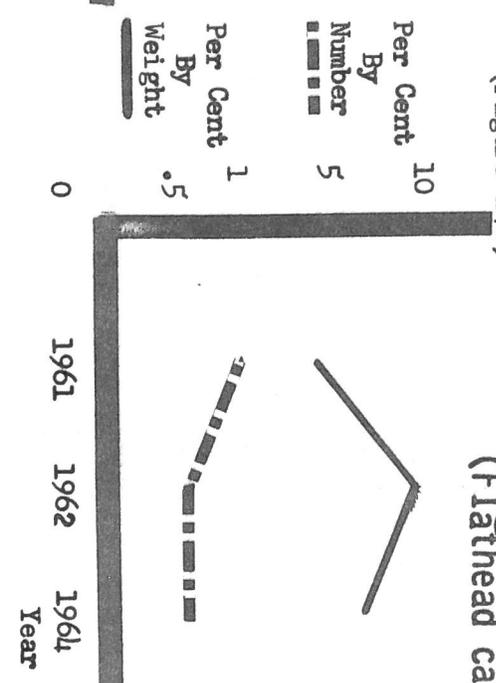
White crappie (Figure 146)



Channel catfish (Figure 147)



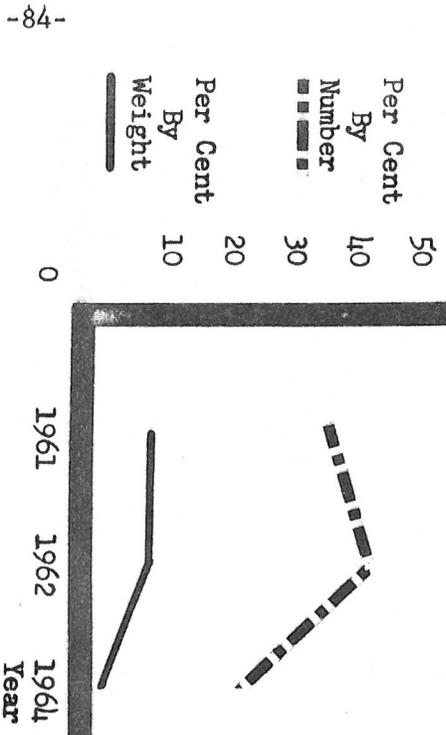
Other game species (Flathead catfish)



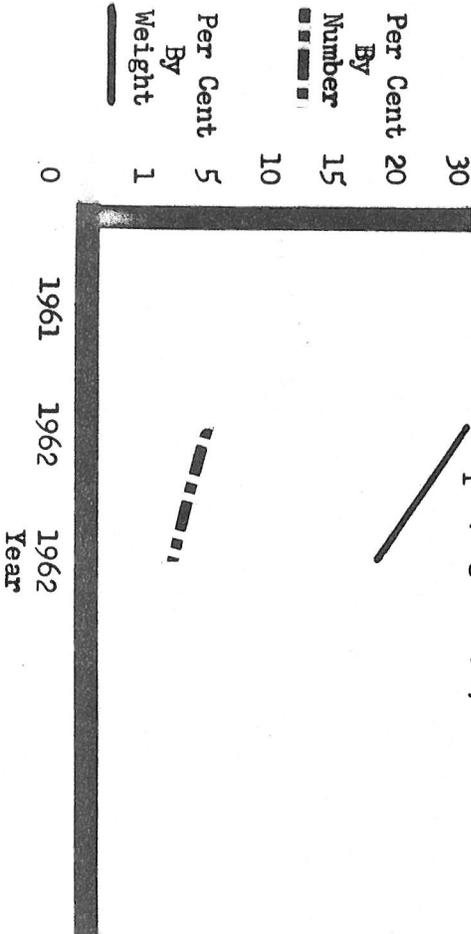
FISH PRODUCTION FROM NEW WINTERS LAKE

Principal Non-Game Species

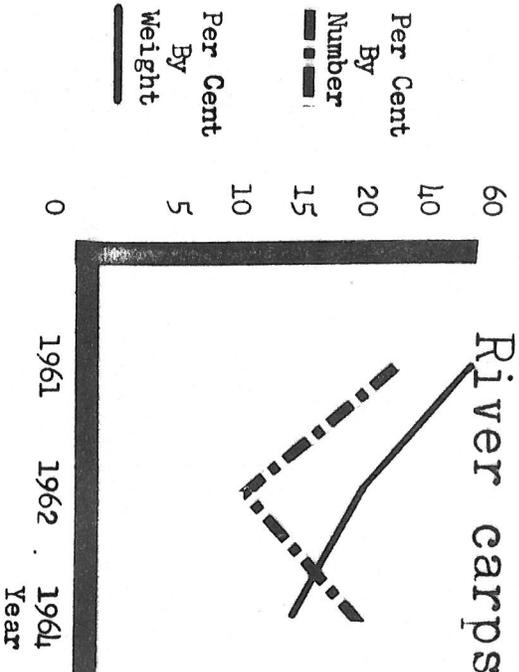
Gizzard shad (Figure 149)



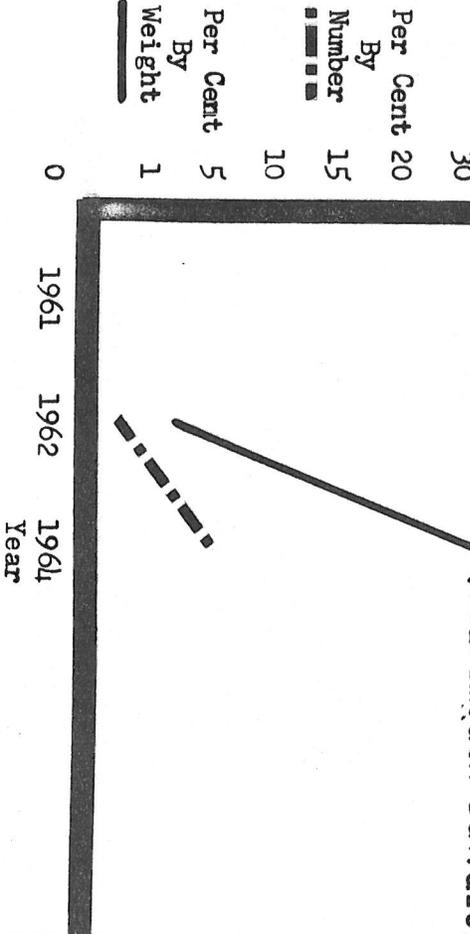
Carp (Figure 150)



River carpsucker (Figure 151)

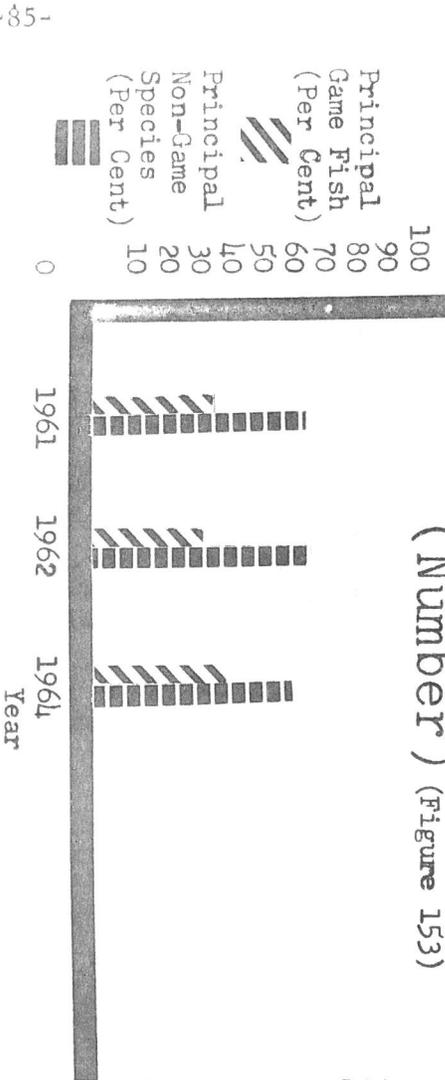


Others (Smallmouth Buffalo) (Figure 152)

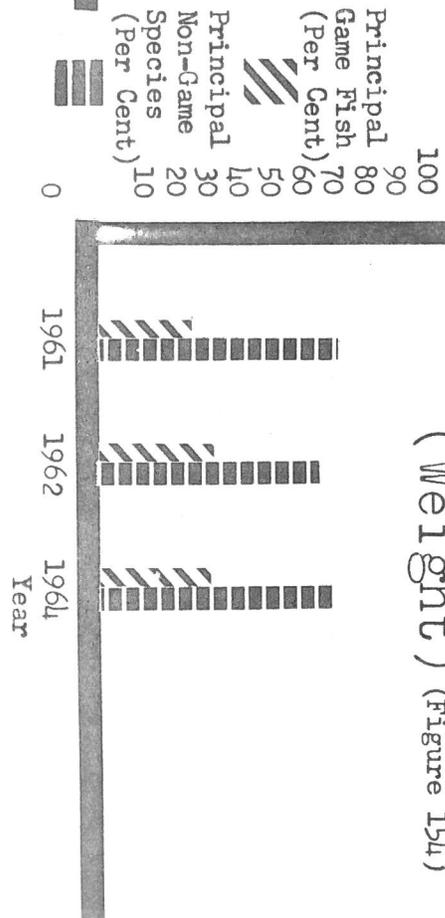


NEW WINTERS LAKE

Principal Production (Number) (Figure 153)



Principal Production (Weight) (Figure 154)



Valley Creek Reservoir

Location

Valley Creek Reservoir is located 1 mile west of the Runnels County Court House in Ballinger. The dam impounds Valley Creek of the Upper Colorado River Basin.

Ownership and History of Development

Valley Creek Reservoir is owned by the city of Ballinger. The dam was completed in 1952 and deliberate impoundment began from that date. The reservoir is used for municipal water and recreation.

Physical Description

The dam is rolled-earth construction and has a maximum height of 30 feet. The capacity at spillway elevation is 1,100 acre feet and the lake covers 87 acres at that level.

History of Fisheries Investigations and Management

A cursory examination of Valley Creek Reservoir was made in 1958 to recommend means for vegetation control. All fisheries investigations have been carried out under reconnaissance since 1962.

Stocking Record

For actual number of fish stocked multiply entry by 1,000.

	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964
Largemouth bass										
fry		90			50	22		30		
fingerling		3	2	4		5	7			
Sunfish										
fingerling	2	9.7	2	2.5						
White crappie										
fingerling				2			.60			
Channel catfish										
fingerling	1	2.5		4			9	7		

Total number of largemouth bass fry stocked: 192,000.
 Total number of largemouth bass fingerling stocked: 24,000.
 Total number of sunfish stocked: 16,200.
 Total number of white crappie stocked: 2,600.
 Total number of channel catfish stocked 25,500.

Discussion

Although data are insufficient to positively establish the production of significant quantities of game fish, harvest reports support current evaluation. The existence of dense marginal vegetation tends to suggest that observations of many apparently stunted sunfish are the result of that circumstance. Data would tend to support the hypothesis that stocking is more effective where dense aquatic vegetation is present.

References

A. Fisheries Investigations

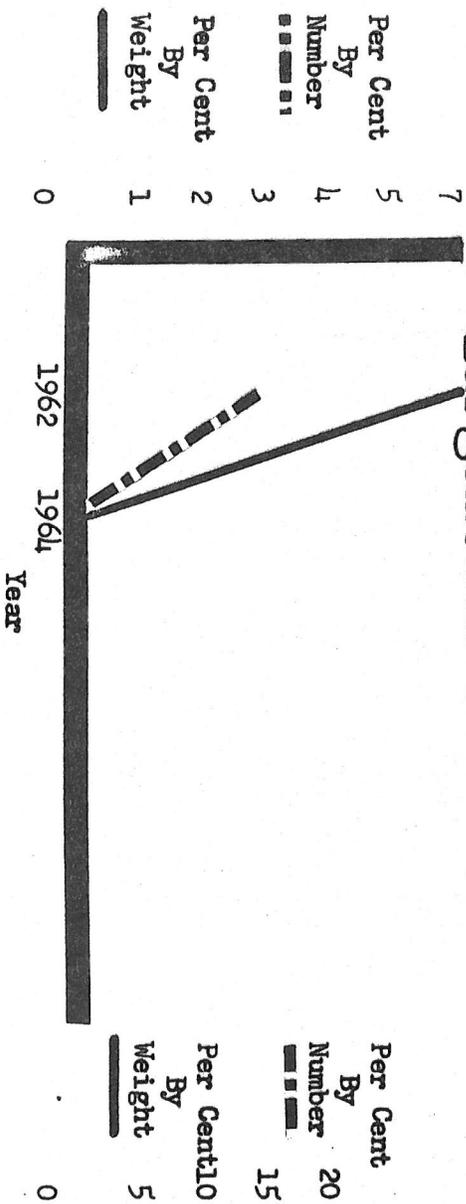
Project F-5-R-10, Job Completion Report B-10 (Reconnaissance)
Project F-5-R-12, Job Completion Report B-28 (Harvest Regulations)

B. Hydrology and Water Quality Data

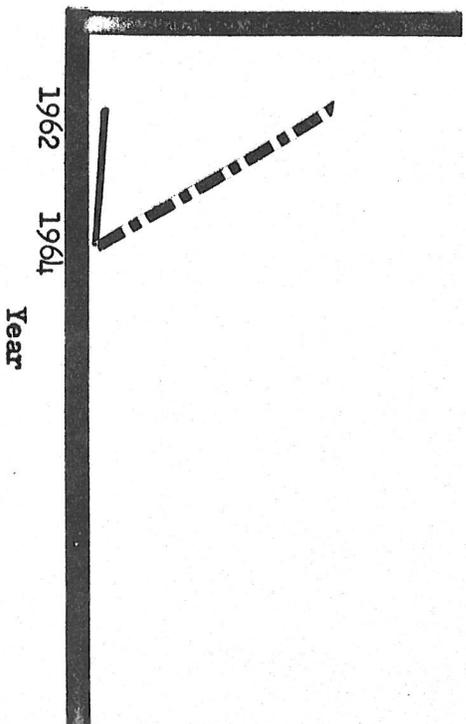
Records of Water Department City of Ballinger

FISH PRODUCTION FROM VALLEY CREEK RESERVOIR Game Fish Production

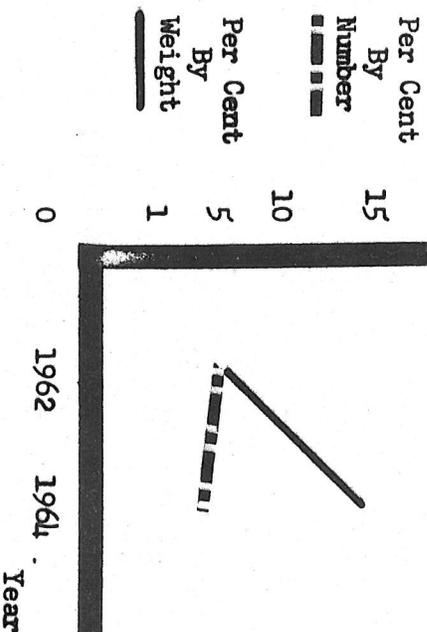
Largemouth bass (Figure 155)



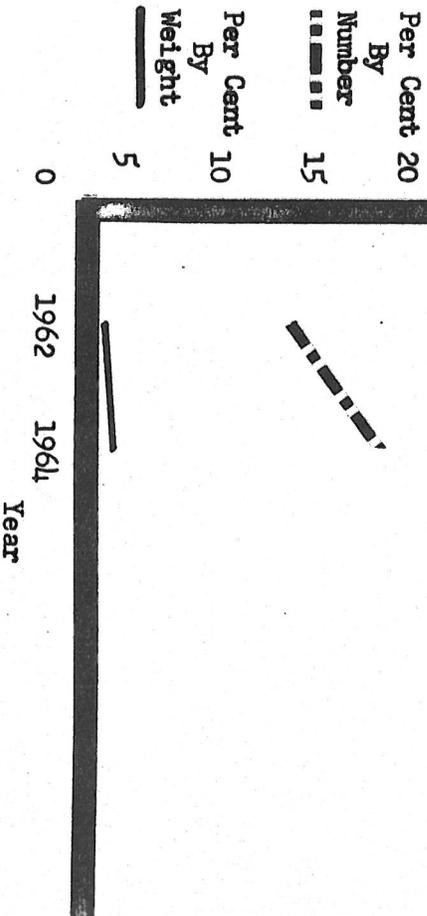
Sunfish (Figure 156)



Channel catfish (Figure 157)



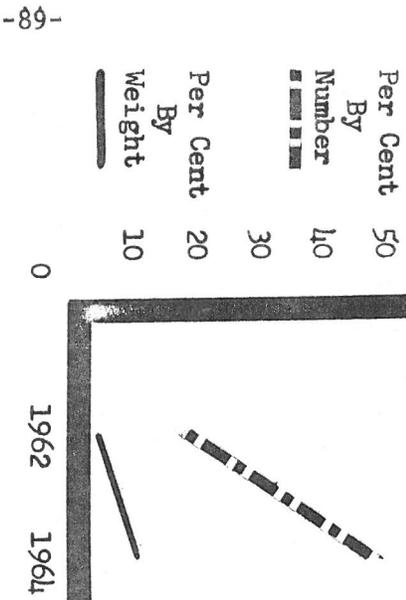
White crappie (Figure 158)



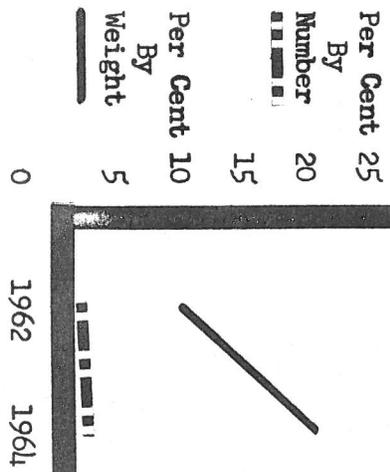
FISH PRODUCTION FROM VALLEY CREEK RESERVOIR

Principal Non-Game Species

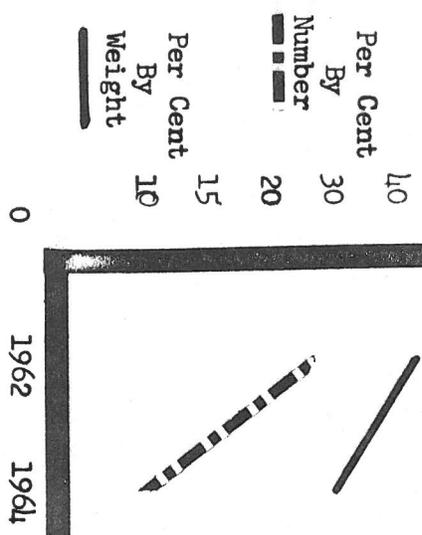
Gizzard Shad (Figure 159)



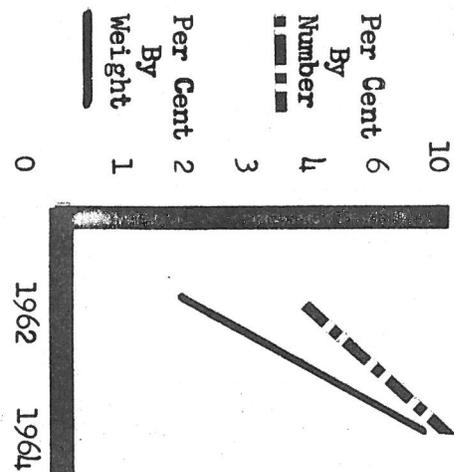
Carp (Figure 160)



River carpsuckers (Figure 161)

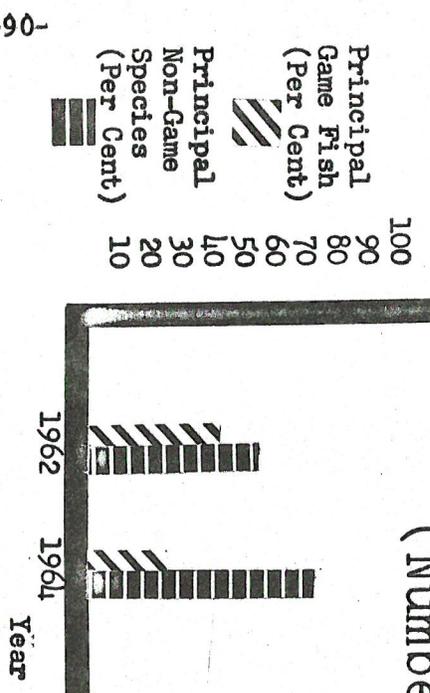


Others (Freshwater Drum) (Figure 162)

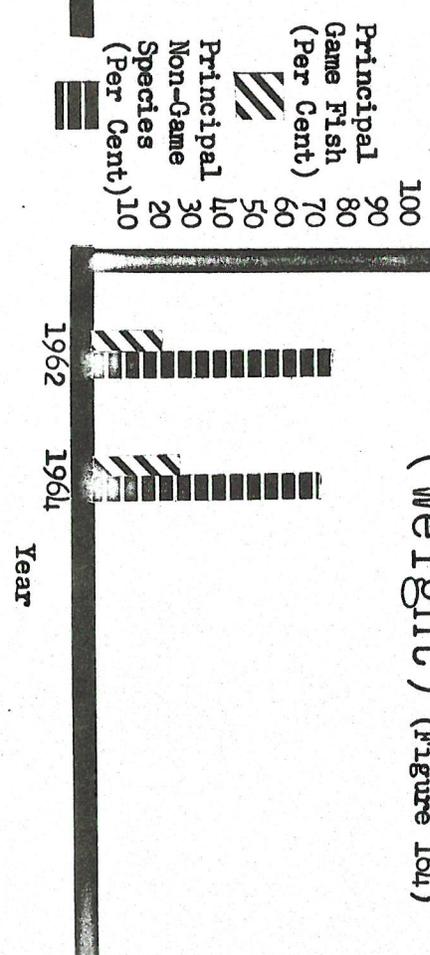


VALLEY CREEK RESERVOIR

Principal Production (Number) (Figure 163)



Principal Production (Weight) (Figure 164)



Mountain Creek Reservoir

Location

Mountain Creek Reservoir is located on the northern limits of Robert Lee in Coke County. The tributaries, Mountain Creek and others, that constitute its watershed are of the Colorado River Basin.

Ownership and History of Development

Mountain Creek Reservoir was constructed in 1950 for municipal water for Robert Lee and has served that purpose since 1951. The lake has also been used for recreation.

Physical Description

At spillway elevation the reservoir covers 77 acres, and at that level contained 950 acre-feet when first completed. A significant build up in deposited silt has obviously decreased that capacity.

History of Fisheries Investigations and Management

Investigations of Mountain Creek Reservoir began during the inventory survey of the Upper Colorado River in 1955. Spot sampling was continued until a more complete study was finished in 1960. The results of these studies established that river carpsuckers and other problematic fish dominated fish production. A chemical treatment to drastically reduce or eliminate fish was carried out in April 1961. The lake was restocked and periodic sampling of game fish production under the reconnaissance function has continued to the present.

Stocking Record

For actual number of fish stocked multiply entry by 1,000.

	1956	1957	1958	1959	1960	1961	1962	1963	1964
Largemouth bass fry					70				
fingerling		1	4						5
Sunfish									
fingerling		1	1.5						
White crappie									
fingerling				1.6					
Channel catfish									
fingerling		.30	2.5		6				

Total largemouth bass fry stocked: 70,000.
 Total largemouth bass fingerling stocked: 10,000.
 Total sunfish stocked: 2,500.
 Total white crappie stocked: 1,600.
 Total channel catfish stocked: 11,500.

Discussion

The most significant circumstance to keep in mind when examining the material is the attempt to eradicate fish life in 1961. As shown in the accompanying graphs, fish production was almost totally dominated by river carpsucker for three years prior to the management effort. The removal of these fish was followed by an enormous expansion in game fish production. This improvement is still evident three years after the kill. Reliable hydrological data are not available, but observations and reports tend to agree that water levels have been subject to annual fluctuation since 1961 and the general trend has been downward. It would appear from these circumstances that the domination of production by river carpsucker was more detrimental to game fish production than was declining capacity.

References

A. Fisheries Investigations

Project F-5-R-4, Job Completion Report B-12 (Watershed Inventory)
Project F-5-R-6, Job Completion Report B-22 (Resurvey)
Project F-5-R-8, Job Completion Report B-31 (Small Reservoirs Study)
Project F-5-R-8, Job Completion Report D-1 (Fisheries Problems)
Project F-14-D-5, Job Completion Report 16a32 (Fish Eradication)
Project F-14-D-5, Job Completion Report 18a-17 (Restocking)
Project F-5-R-9, Job Completion Report B-32 (Reconnaissance)
Project F-5-R-10, Job Completion Report B-32 (Reconnaissance)
Project F-5-R-11, Job Completion Report B-32 (Reconnaissance)
Project F-5-R-12, Job Completion Report B-32 (Reconnaissance)

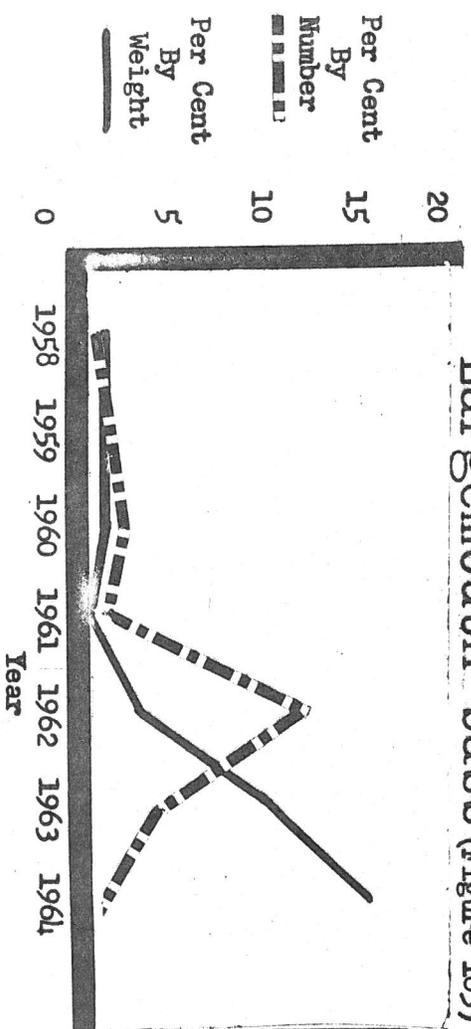
B. Hydrology and Water Quality Data

Records of Water Department of Robert Lee
Water Supply Papers United States Geological Survey

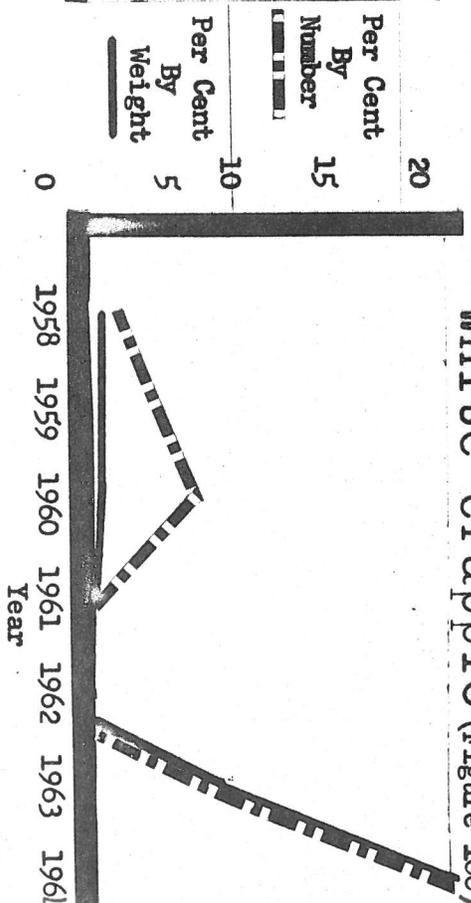
FISH PRODUCTION FROM MOUNTAIN CREEK RESERVOIR

Game Fish Production

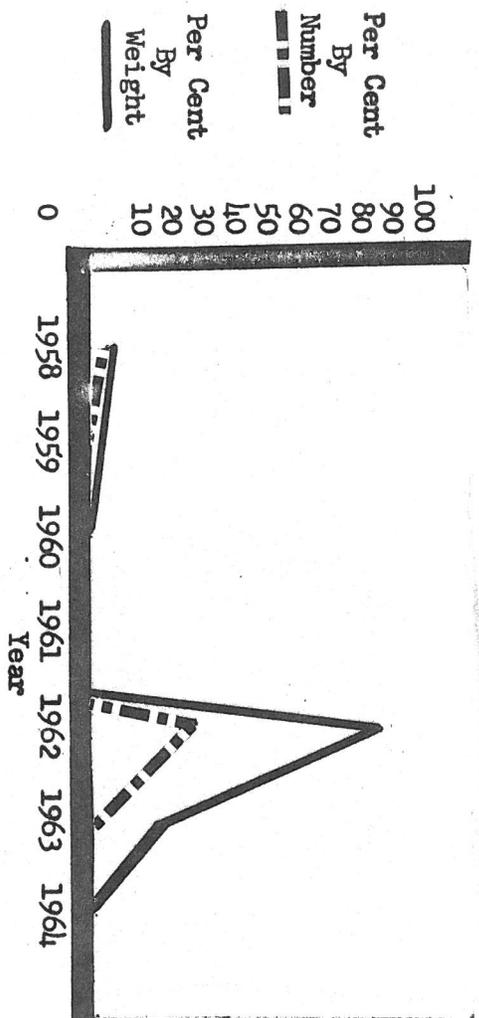
Largemouth bass (Figure 165)



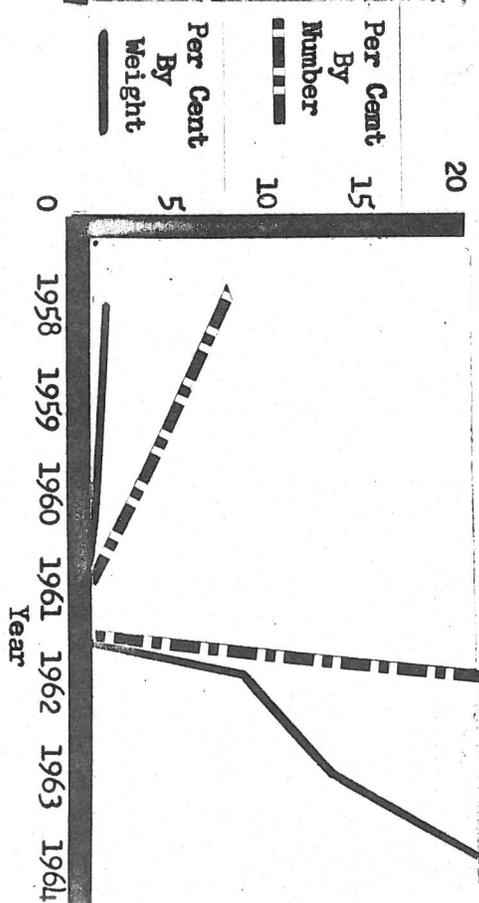
White crappie (Figure 166)



Channel catfish (Figure 167)



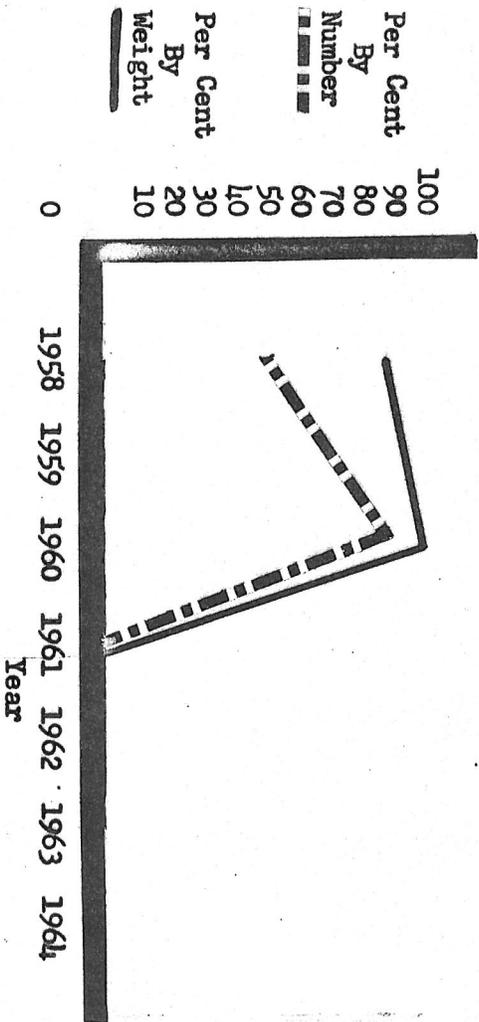
Sunfish (Figure 168)



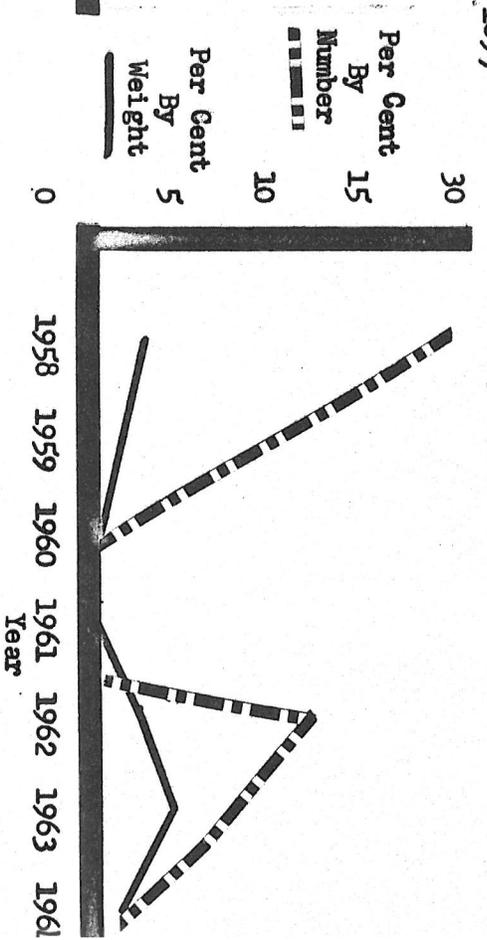
FISH PRODUCTION FROM MOUNTAIN CREEK RESERVOIR

Principal Non-Game Species

River carpsucker (Figure 169)

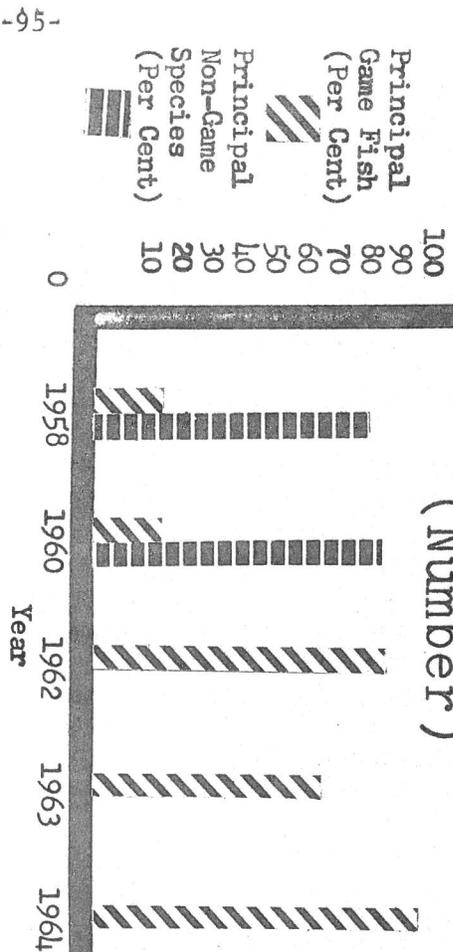


Golden shiners (Figure 17)

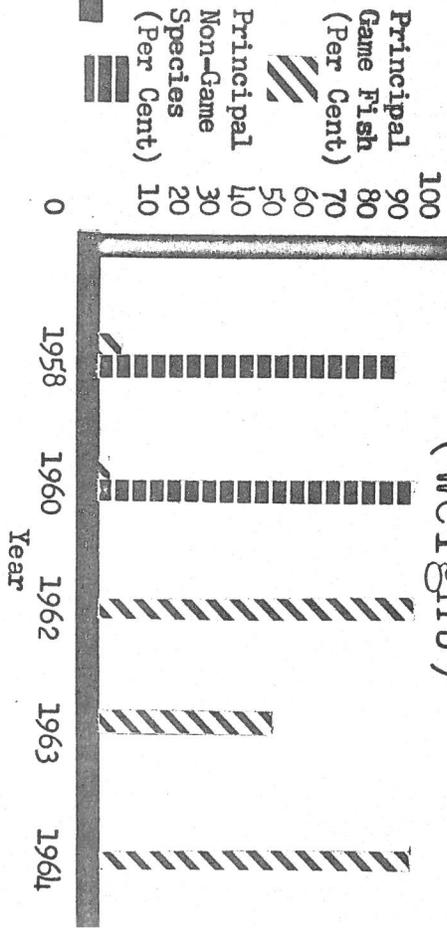


MOUNTAIN CREEK RESERVOIR

Principal Production (Figure 171)
(Number)



Principal Production (Figure 171)
(Weight)



Oak Creek Reservoir

Location

Oak Creek Reservoir is in the Colorado River Basin in Coke County, 5 miles southeast of Blackwell on Oak Creek, a tributary of the Colorado.

Ownership and History of Development

The project is owned and operated by the city of Sweetwater. The reservoir is authorized by Permit No. 1519 issued August 29, 1949 to the city of Sweetwater for water supply to Sweetwater and Blackwell in Nolan County, Robert Lee and Bronte in Coke County and other communities. The permit authorizes annual diversion of 10,000 acre-feet of water for municipal and industrial purposes with 3,000 acre-feet allocated to Bronte and Robert Lee and 7,000 acre-feet to Sweetwater and Blackwell. This reservoir supplements the water supply from Lake Sweetwater and Lake Trammel.

Construction began July 10, 1950 and was completed in May 1952. Deliberate impoundment of water began in May 1953, and use of water began in September 1953.

Physical Description

The dam is rolled-earth, 3,800 feet long and 95 feet high. Other capacities are as follows:

Feature	Elevation (feet above m.s.l.)	Capacity (acre-feet)	Area (acres)
Top of dam	2,014.0	- -	- -
Crest of emergency spillway	2,005.0	52,940	2,900
Crest of service spillway	2,000.0	39,360	2,375
Invert of service outlet	1,951.0	100	65

The drainage area above the dam is 244 square miles. One pumping station delivers water to Sweetwater and Blackwell through a 21-inch pipeline. Another pumping plant delivers water through an 8-inch pipeline to Bronte and other towns.

History of Fisheries Investigations and Management

A preimpoundment treatment of the basin area and parts of the contributing watershed was carried out under the supervision of the area fisheries biologist prior to the beginning of the federal aid program. The chemical for this treatment was provided by the sportsmen of Sweetwater. Between 1953 and 1956

an inventory survey was conducted with records of game fish production maintained. Subsequent investigations of a limited nature were carried out under the re-survey and reconnaissance functions until 1962 when a contour type chemical treatment was completed in an attempt to curb the expansion of river carpsuckers and other problematic species. From that year to the present, population sampling has continued to evaluate the results of the management effort.

Stocking Record

For actual number of fish stocked multiply entry by 1000.

	1953	1954	1955	1956	1957	1958
Largemouth bass						
fry	70	60		160		135.4
fingerling	30		21		2	4.2
Sunfish						
fingerling	.9		.1	.65	1	5
White crappie						
fingerling	15			.20		
Channel catfish						
fingerling	8		10.65	3.4	2.7	3.65
	1959	1960	1961	1962	1963	1964
Largemouth bass						
fry	81		28	190		50
fingerling	5	18	1.8	8		
Sunfish						
fingerling	2	13.5				
White crappie						
fingerling	.20	4.5	.30			
Channel catfish						
fingerling	2	20	96	104.4	5	

Total largemouth bass fry stocked: 774,400.
 Total largemouth bass fingerling stocked: 100,800.
 Total sunfish fingerling stocked: 23,150.
 Total white crappie stocked: 20,200.
 Total channel catfish stocked: 255,800.

Discussion

It would appear that game fish production has tended to follow substantial increases and prolonged and relatively unbroken decreases in lake volume. In the five year period before the general decline of the lake level in 1958, gross game fish production was indicated to be above 15 per cent.

If the indicated high production of 1960 is attributed to either the relatively high volumes that prevailed between 1956-1959 or to sampling error, the indicated loss of three-fourths of game fish production that occurred during the 1961-1962 period may be attributable to the rapid and prolonged decline that occurred between 1959 and 1962. Seining and observations with evidence obtained during the chemical treatment of the lake indicate that reproduction by game species had been insufficient or unsuccessful. The construction of a hydro-electric plant on the reservoir may result in a duplication of conditions discussed later under Lake Colorado City. The effect of these plants on game fish production warrants further study.

References

A. Fisheries Investigations

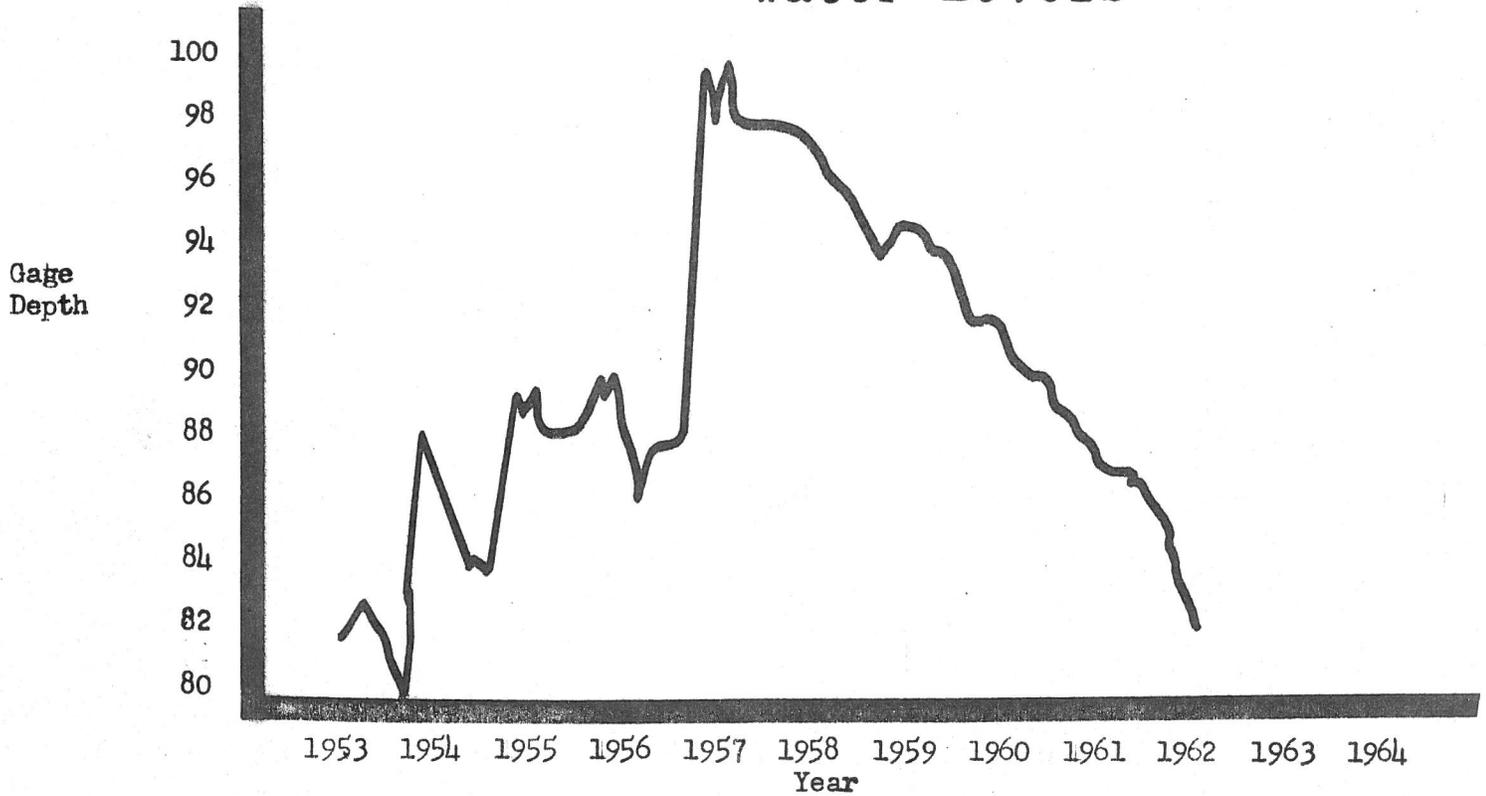
Project F-5-R-1, Job Completion Report B-4 (Inventory)
Project F-5-R-2, Job Completion Report B-4 (Inventory)
Project F-5-R-3, Job Completion Report B-4 (Inventory)
Project F-5-R-5, Job Completion Report B-22 (Resurvey)
Project F-5-R-6, Job Completion Report B-22 (Resurvey)
Project F-5-R-8, Job Completion Report D-1 (Fishery Problems)
Project F-5-R-9, Job Completion Report B-32 (Reconnaissance)
Project F-5-R-9, Job Completion Report D-1 (Fishery Problems)
Project F-5-R-10, Job Completion Report B-32 (Reconnaissance)
Project F-14-D-6, Job Completion Report 16a-36 (Population Control)
Project F-5-R-11, Job Completion Report B-32 (Reconnaissance)
Project F-5-R-12, Job Completion Report B-32 (Reconnaissance)

B. Hydrology and Water Quality Data

State Board of Water Engineers, Bulletin 5807-A
Texas Water Commission Bulletin 6408
Water Supply Papers and Records of United States Geological Survey
Records of Water Department for City of Sweetwater

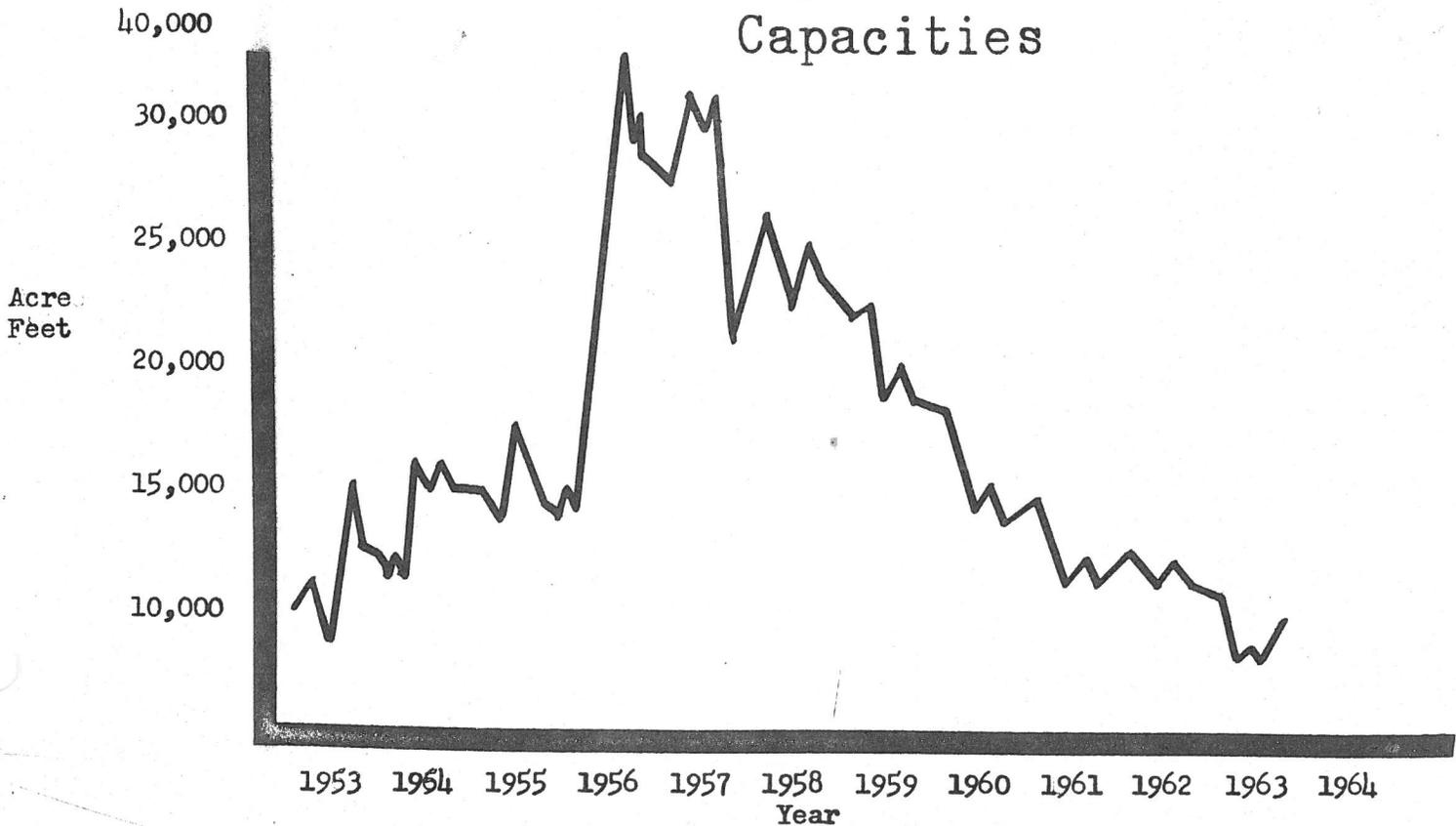
(Figure 173)

HYDROLOGICAL DATA FOR OAK CREEK RESERVOIR Water Levels



(Figure 174)

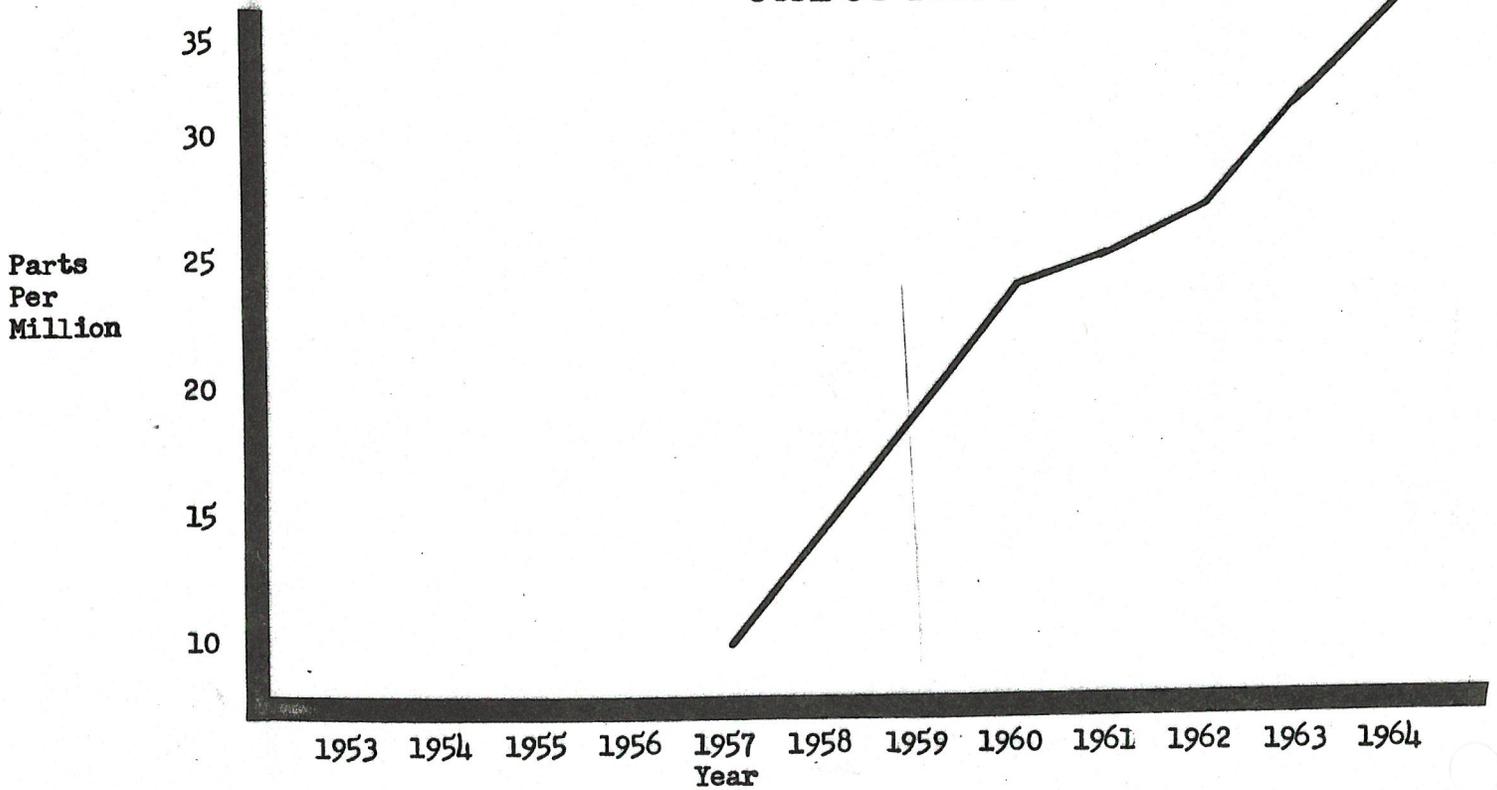
Capacities



(Figure 175)

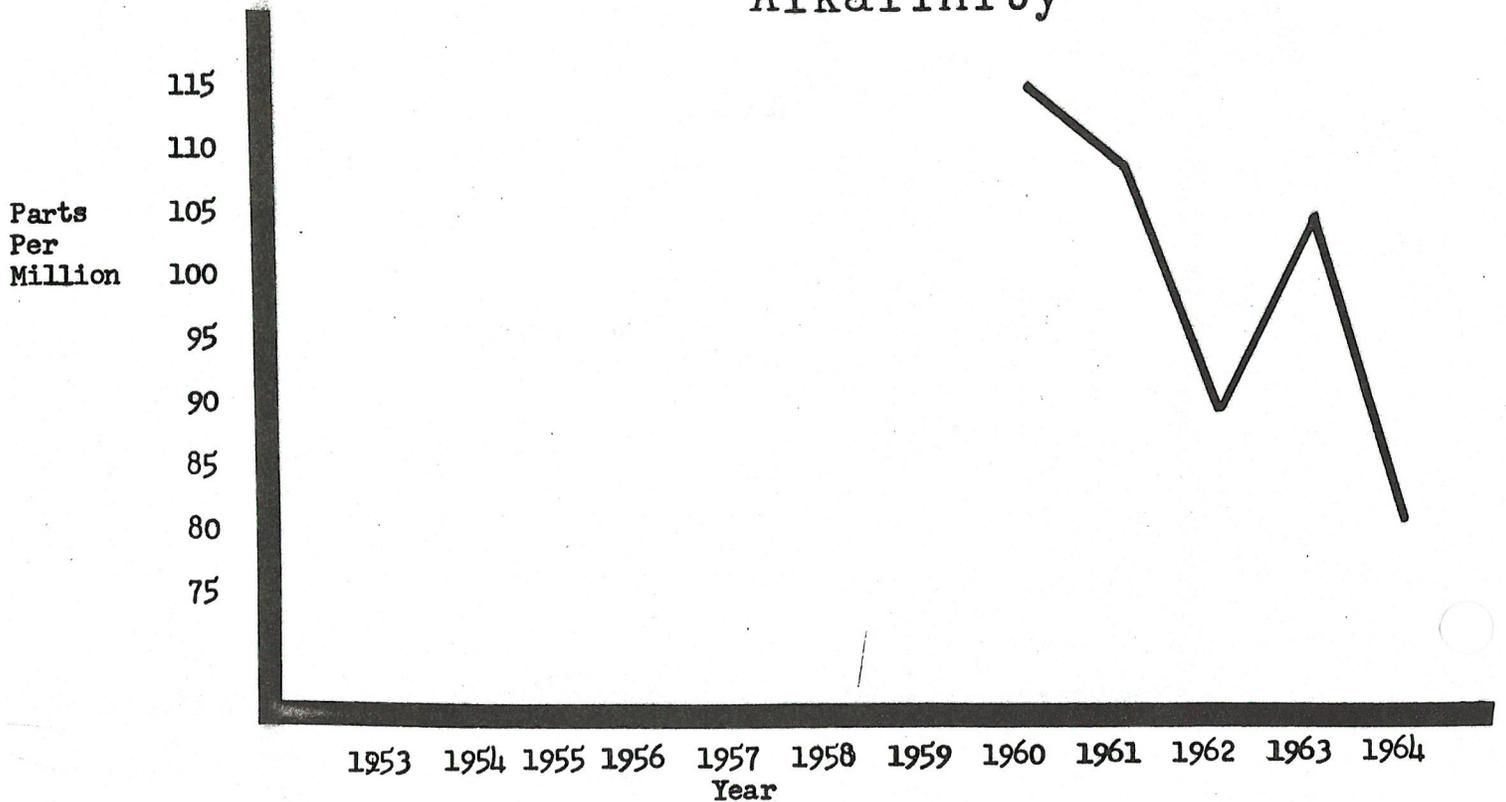
WATER QUALITY DATA FOR OAK CREEK RESERVOIR

Chlorides



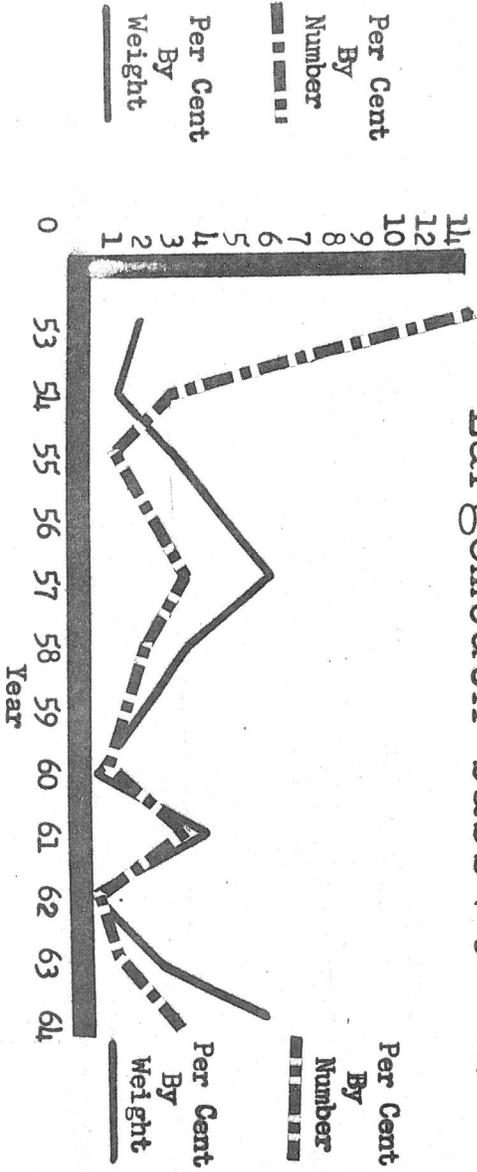
(Figure 176)

Alkalinity

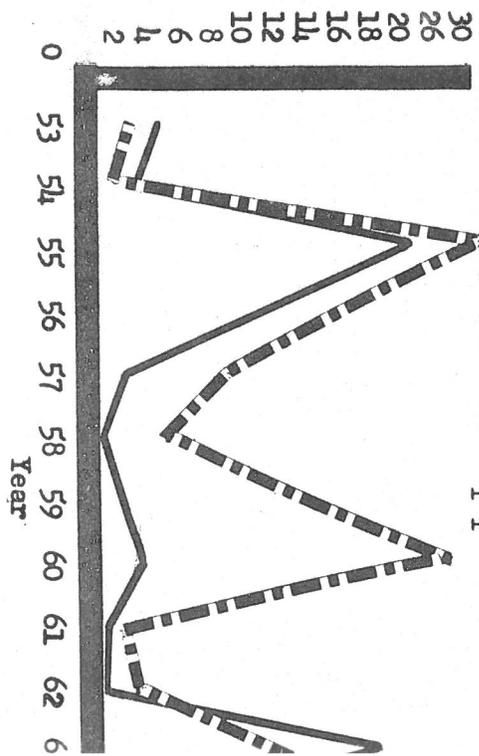


FISH PRODUCTION FROM OAK CREEK RESERVOIR Game Fish Production

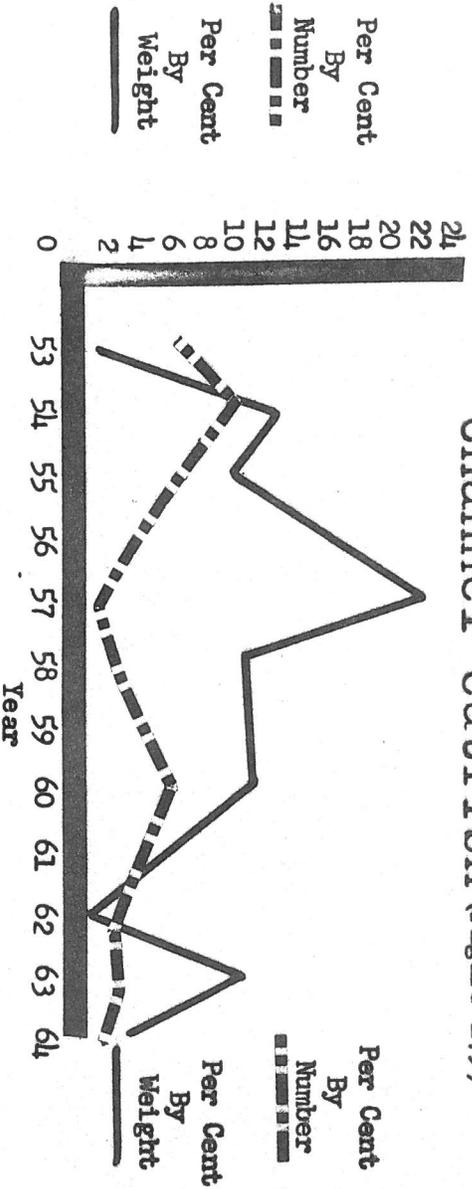
Largemouth bass (Figure 177)



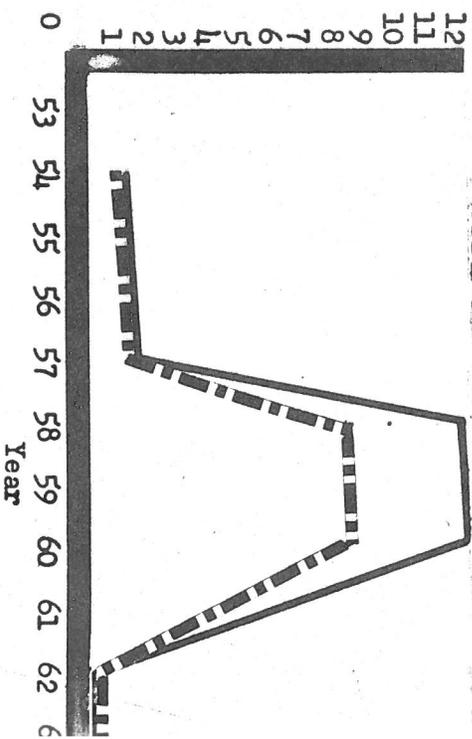
White crappie (Figure 178)



Channel catfish (Figure 179)



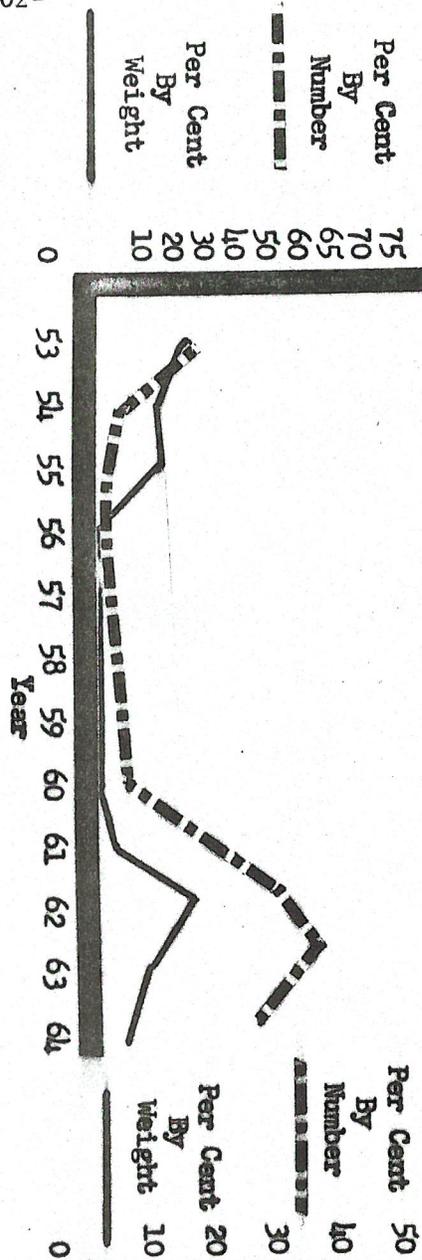
White bass (Figure 180)



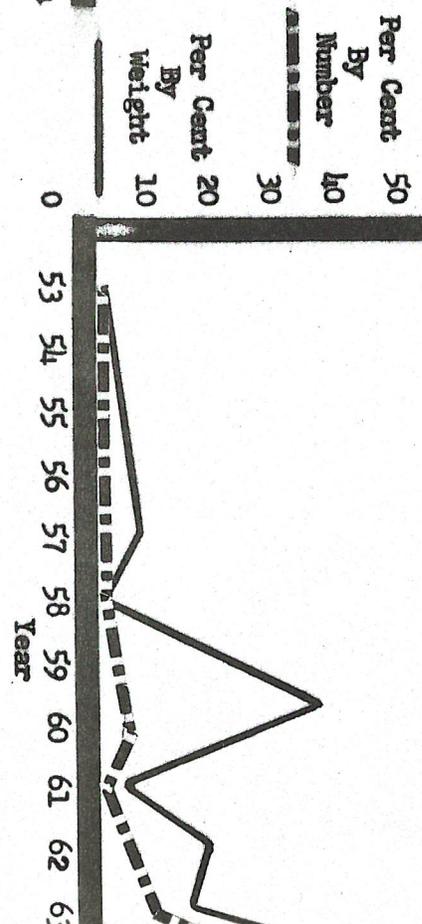
FISH PRODUCTION FROM OAK CREEK RESERVOIR

Principal Non-Game Species

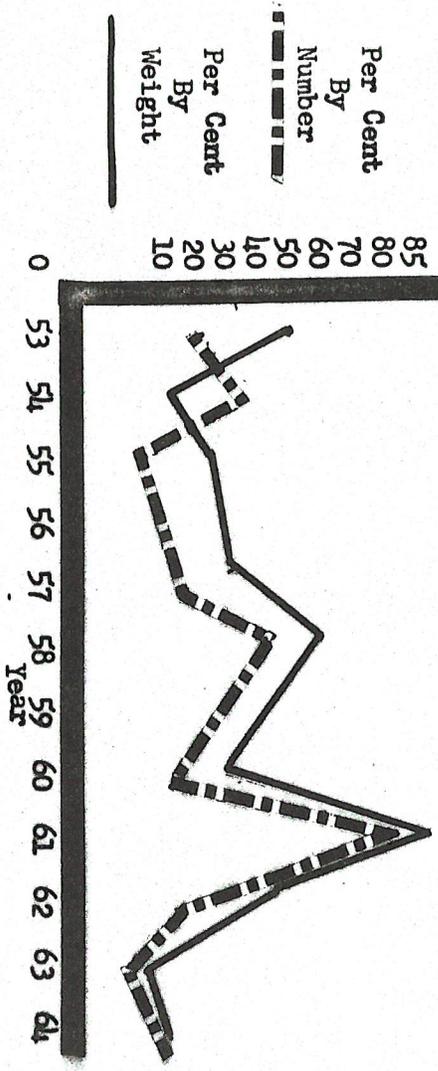
Gizzard shad (Figure 181)



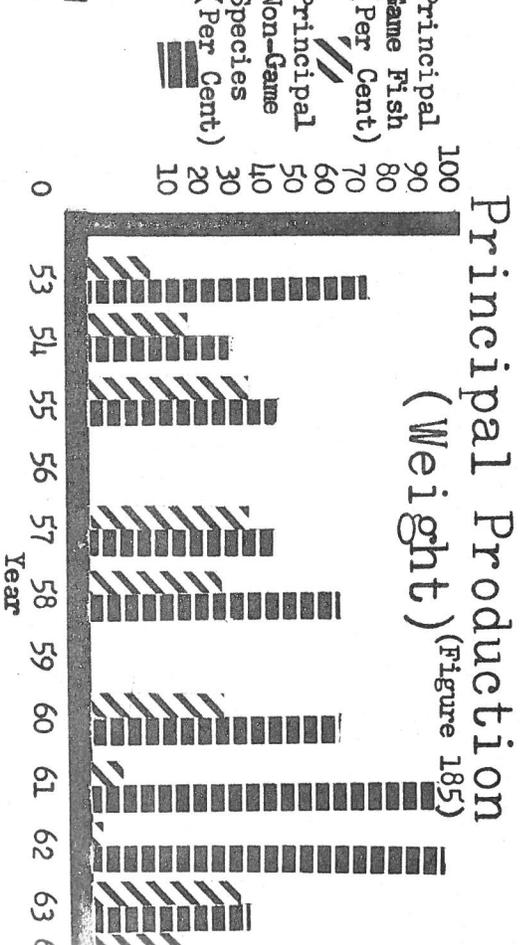
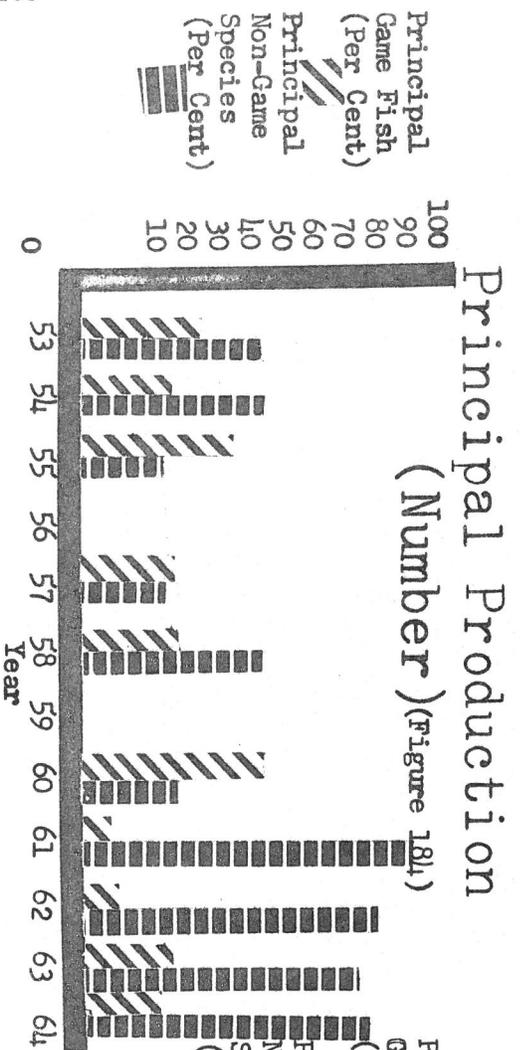
Carp (Figure 182)



River carpsucker (Figure 183)

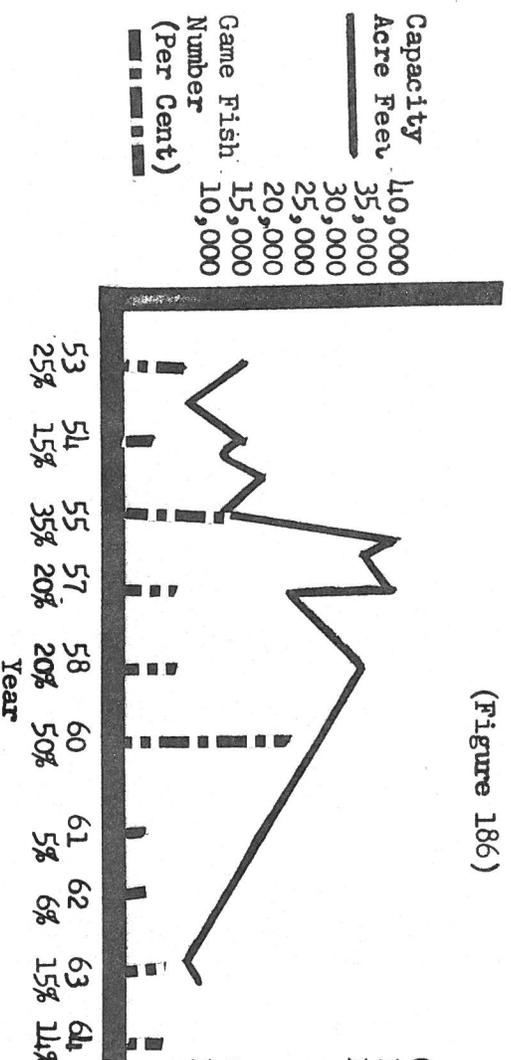


OAK CREEK RESERVOIR

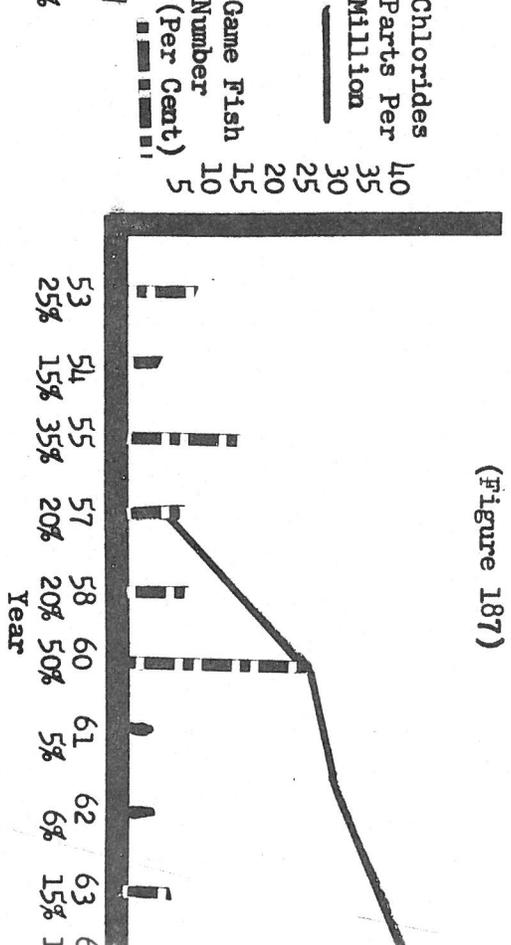


Principal Factors Influencing Game Fish Production

(Figure 186)



(Figure 187)



Champion Creek Reservoir

Location

Champion Creek Dam and Champion Creek Reservoir are in the Colorado River Basin in Mitchell County, 7 miles south of Colorado City on Champion Creek.

Ownership and History of Development

The project is owned and operated by the Texas Electric Service Company. Water rights for storage of approximately 42,000 acre-feet and annual diversion of 4,050 acre-feet for industrial use and 2,700 acre-feet for municipal use were obtained by the electric company through Permit No. 1874 dated May 28, 1957. Water is diverted by pumping from this new reservoir to Lake Colorado City as required.

Land acquisition started in 1957, and construction began May 5, 1958. The closure was made and impoundment of water started in February 1959. Construction was completed April 30, 1959.

Physical Description

The dam is rolled-earth structure 6,800 feet long with a maximum height of 114 feet above the stream bed and the top of the dam at elevation 2,109.0 feet above m.s.l. Other elevations and capacities are as follows:

Feature	Elevation (feet above m.s.l.)	Capacity (acre-feet)	Area (acres)
Top of dam	2,109.0	- -	- -
Maximum design flood stage	2,104.1	90,020	- -
Emergency spillway crest	2,091.0	56,800	2,020
Service spillway crest	2,083.0	42,500	1,560
Invert of inlet structure	2,020.0	880	- -

The drainage area above the dam is 203 square miles.

History of Fisheries Investigations and Management

Prior to the construction of Champion Creek Dam, the principal tributaries were investigated during the process of completing the survey of the Upper Colorado River. Findings from these efforts indicated a great abundance of river carpsucker and grey redhorse in North and South Champion Creeks. When the dam was completed in 1959 the basin area and virtually all of the contributing watershed was chemically treated to eliminate existing fish. Following restocking, periodic sampling of game fish production was included under the reconnaissance effort.

Stocking Record

For actual number of fish stocked multiply entry by 1,000.

	1959	1960	1961	1962	1963	1964
Largemouth bass						
fry	116					
fingerling		4	5			
Sunfish						
fingerling		10				
Channel catfish						
fingerling			5	3		
Flathead catfish						
adults				.035		

Discussion

The most important influence on fish production in this reservoir is the management that was carried out before the lake filled. This is obvious when the relative abundance of gizzard shad, carp, and river carpsucker in the Upper Colorado River and other area waters are considered. As shown in the accompanying graphs all three species were eliminated and have not been introduced. It is also apparent that a fourth problematic species were not eliminated since bullheads are abundant. The general increases in volume have probably aided production. One facet of game fish production is particularly noteworthy. Green sunfish as shown in seining collections and creels exhibited exceptional growth for the first 5 years following impoundment of significant quantities of water. This is uncommon for the area. Successful reproduction of all centrarchids was indicated in 1962 and 1963. The reservoir is connected by pipeline with Lake Colorado City, and the failure of carp and river carpsuckers to be introduced through that source is worthy of study.

A. Fisheries Investigations

- Project F-5-R-4, Job Completion Report B-12 (Watershed Inventory)
- Project F-5-R-8, Job Completion Report B-22 (Resurvey)
- Project F-14-D-3, Job Completion Report 16a15 (Population Controls)
- Project F-5-R-9, Job Completion Report B-32 (Reconnaissance)
- Project F-5-R-9, Job Completion Report D-1 (Fisheries Problems)
- Project F-5-R-10, Job Completion Report B-32 (Reconnaissance)
- Project F-5-R-11, Job Completion Report B-32 (Reconnaissance)

B. Hydrological and Water Quality Data

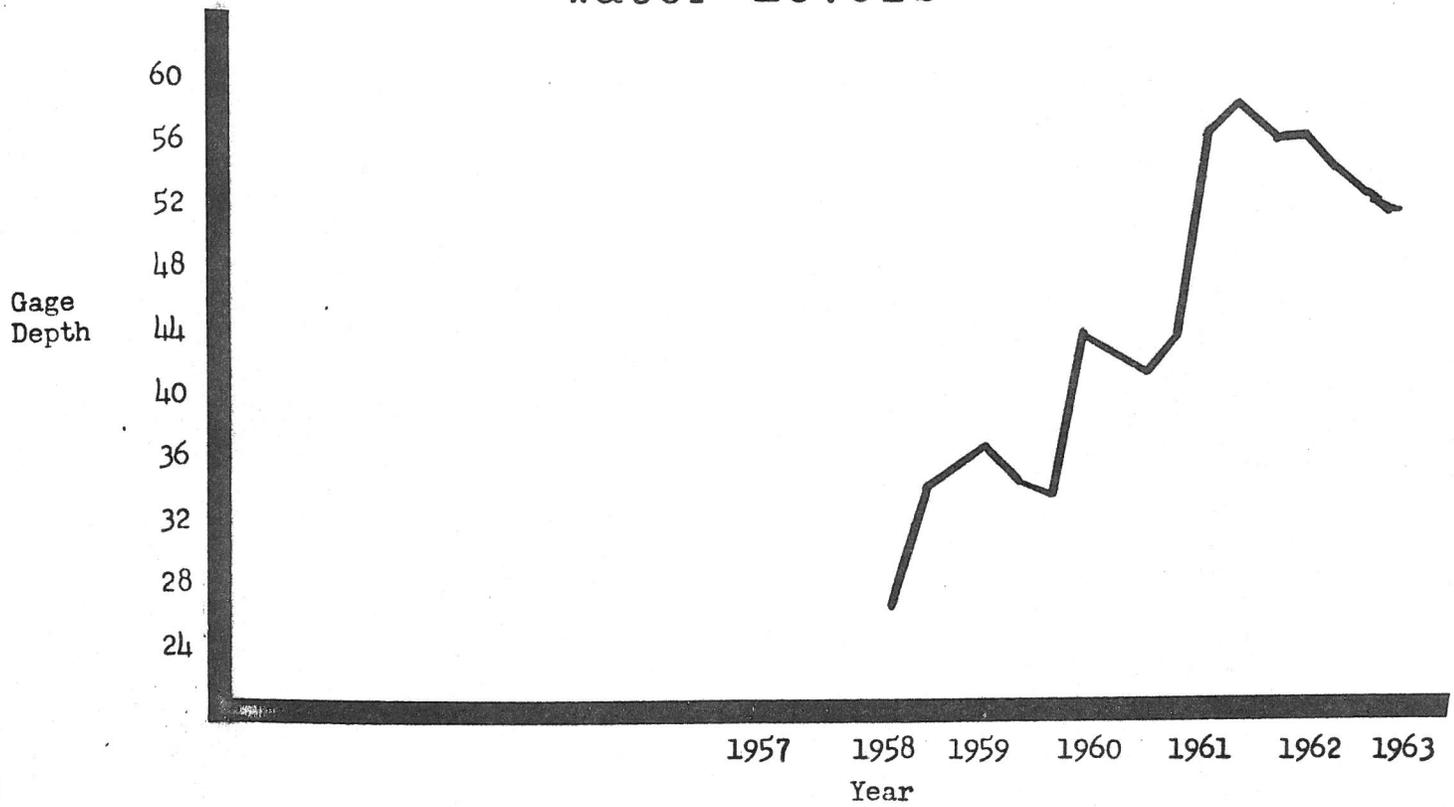
- Texas Water Commission Bulletin 6408
- Water Supply Papers of the United States Geological Survey
- Records of the State Health Department



(Figure 188)

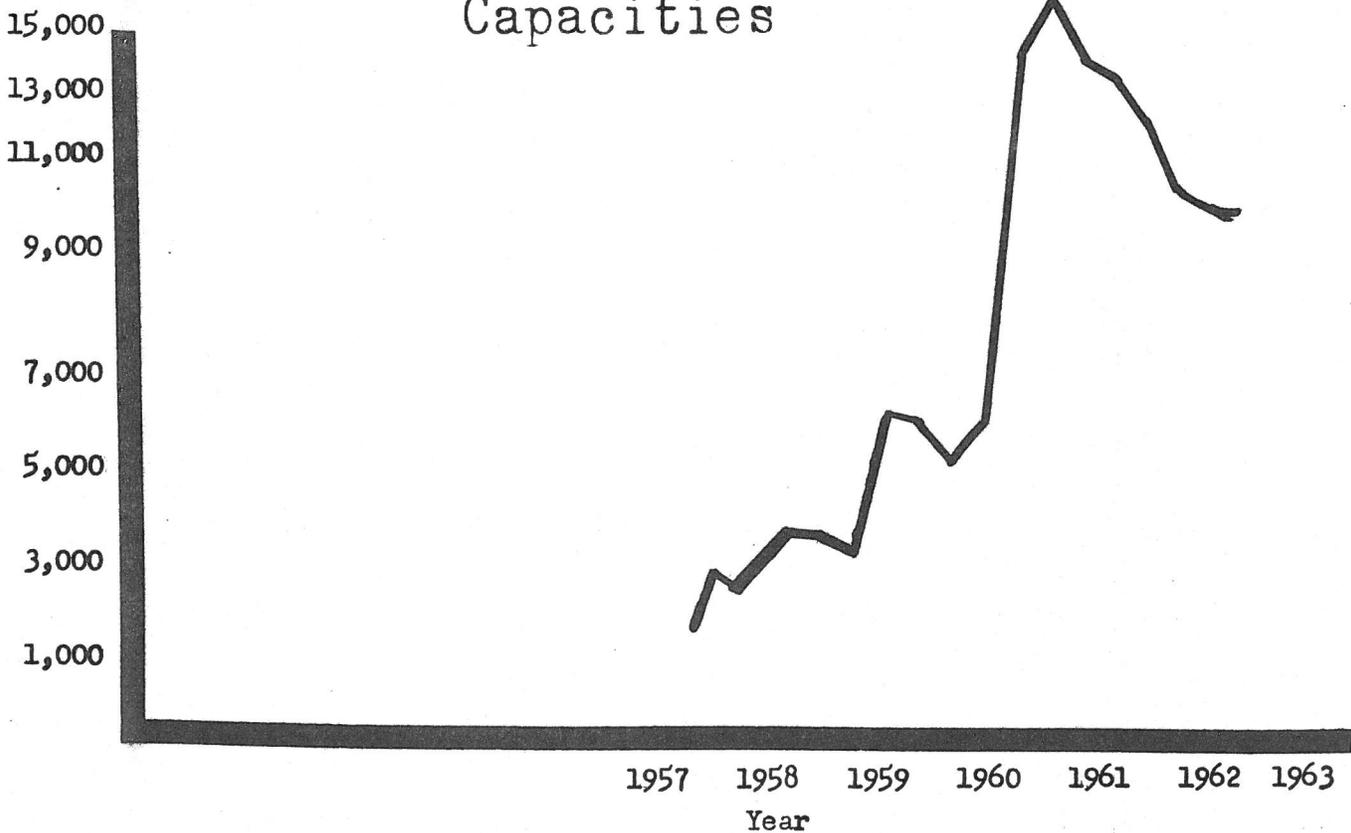
HYDROLOGICAL DATA FOR CHAMPION CREEK RESERVOIR

Water Levels



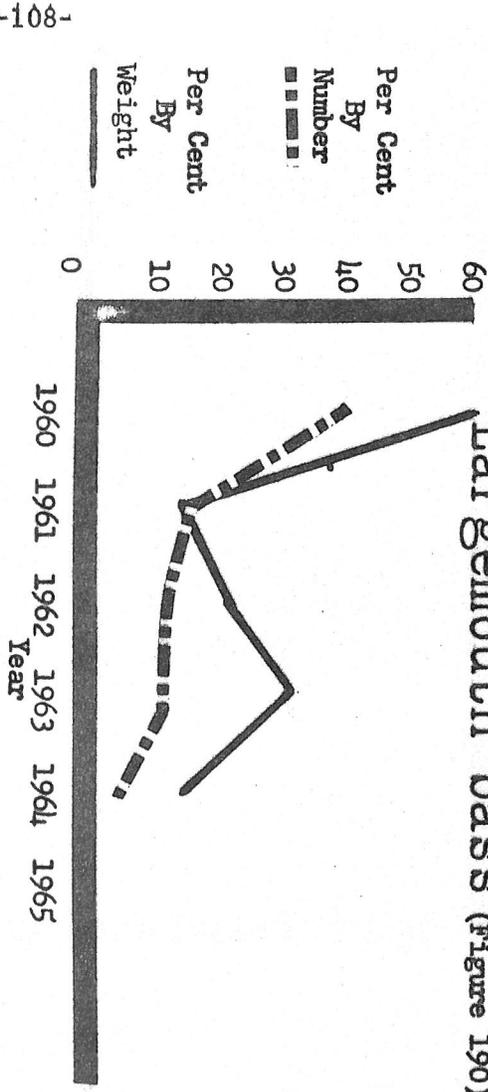
(Figure 189)

Capacities

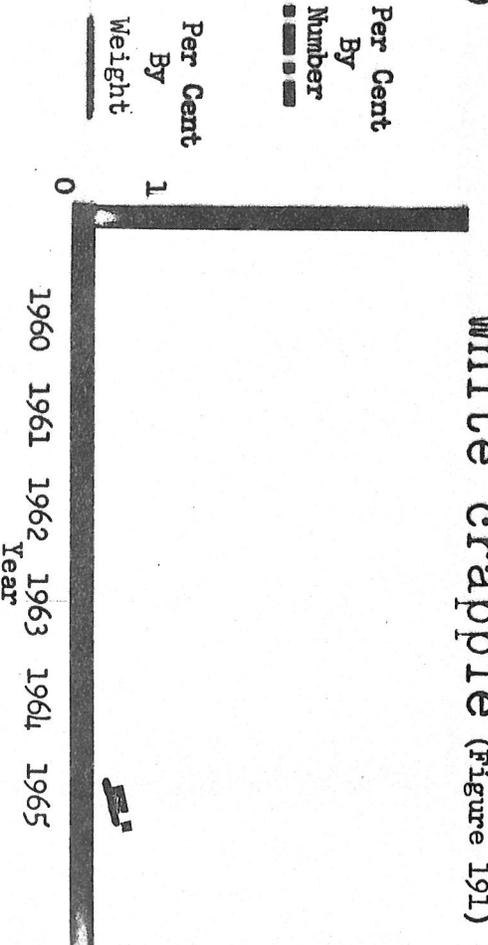


FISH PRODUCTION FROM CHAMPION CREEK RESERVOIR Game Fish Production

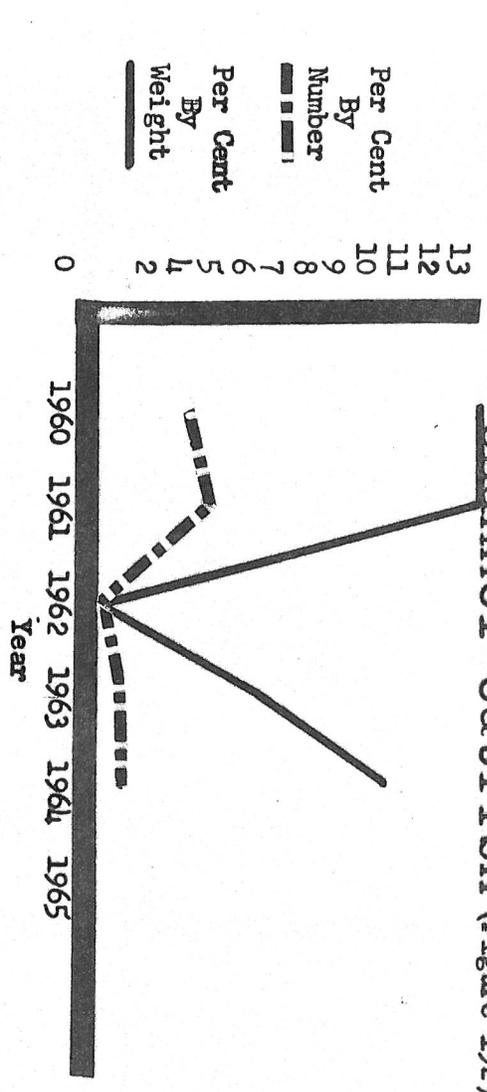
Largemouth bass (Figure 190)



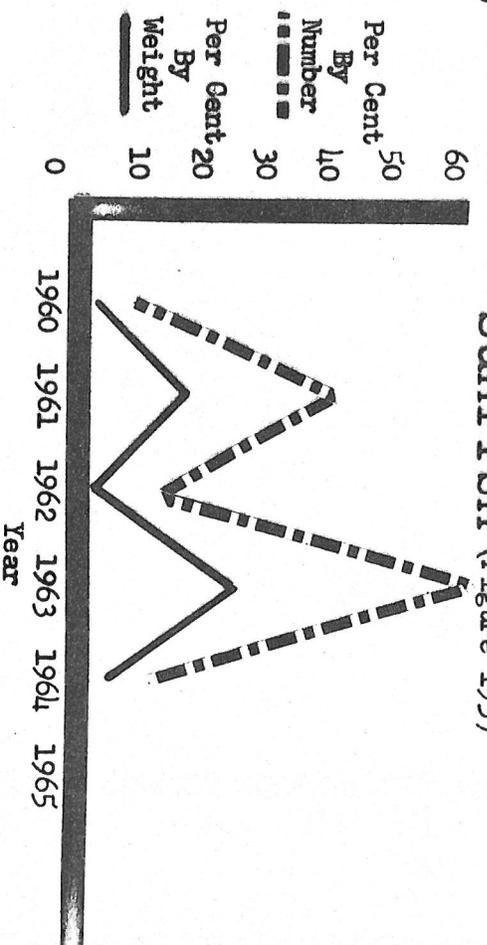
White crappie (Figure 191)



Channel catfish (Figure 192)



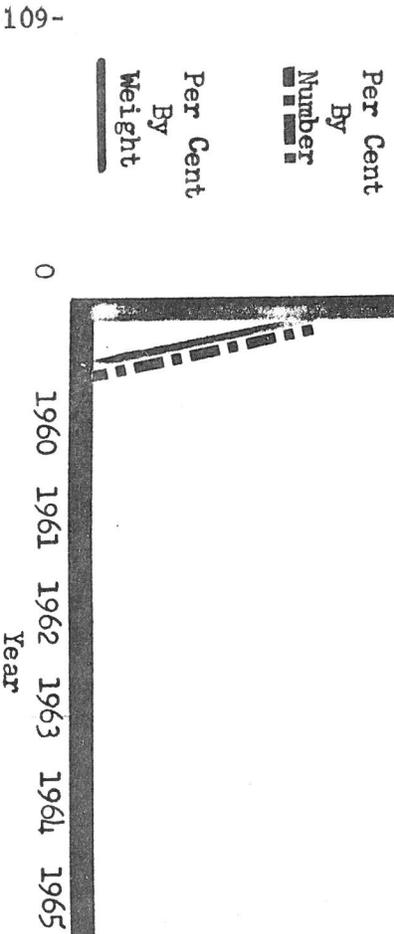
Sunfish (Figure 193)



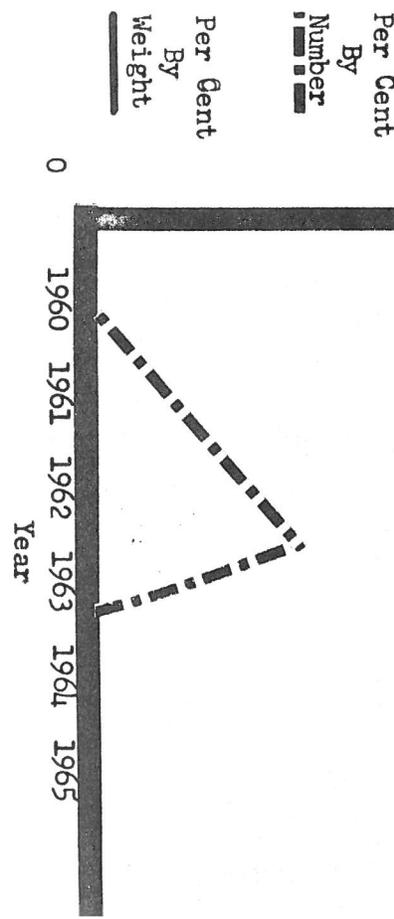
FISH PRODUCTION FROM CHAMPION CREEK RESERVOIR

Principal Non-Game Species

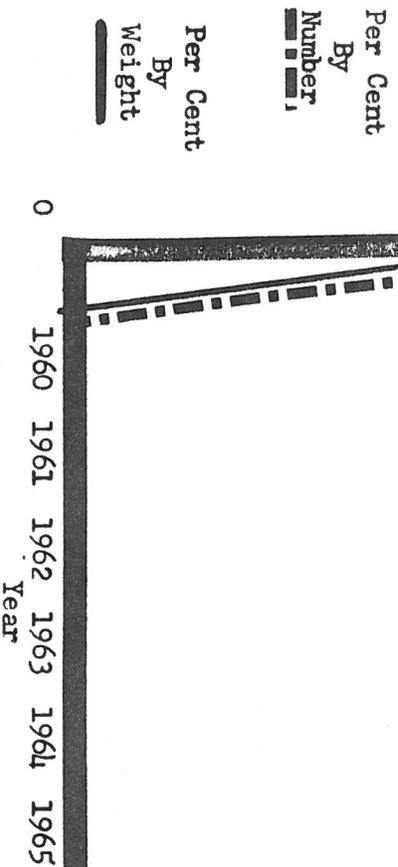
Gizzard shad (Figure 194)



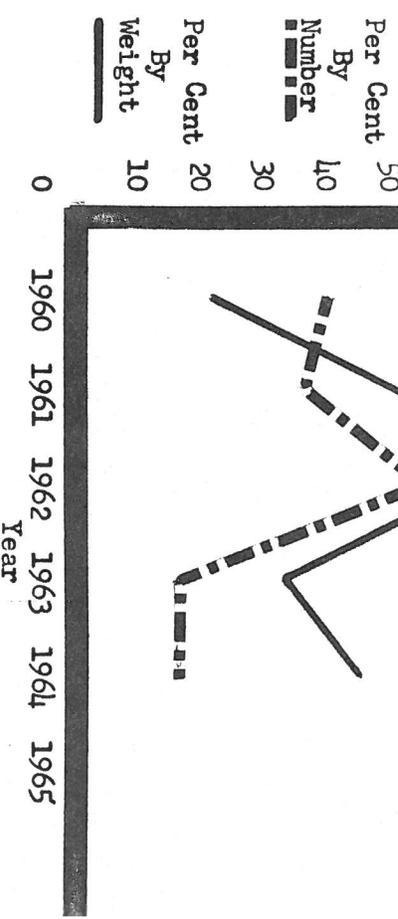
Golden shiners (Figure 195)



River carpsucker (Figure 196)

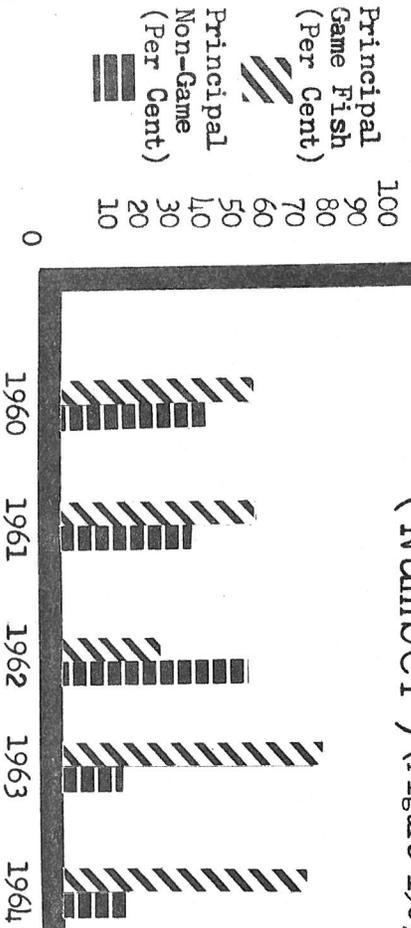


Bullheads (Figure 197)

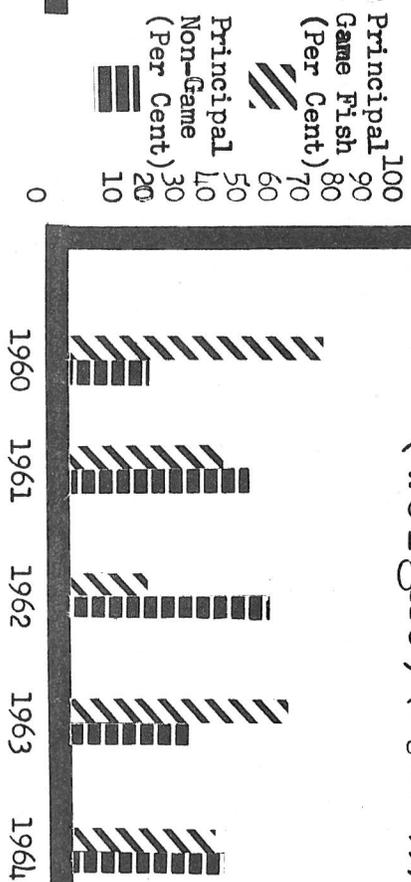


CHAMPION CREEK RESERVOIR

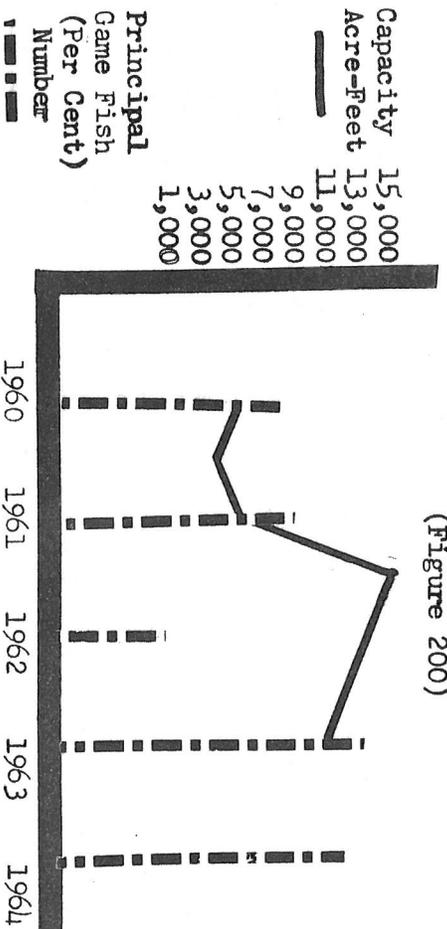
Principal Production (Number) (Figure 198)



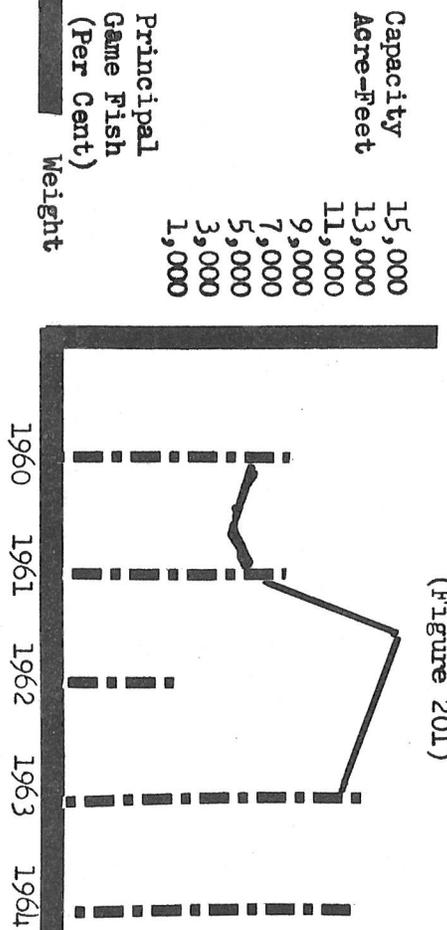
Principal Production (Weight) (Figure 199)



Principal Factors Influencing Game Fish Production (Figure 200)



Principal Factors Influencing Game Fish Production (Figure 201)



Lake Colorado City

Location

Lake Colorado City is in the Colorado River Basin in Mitchell County, 6 miles southwest of Colorado City on Morgan Creek.

Ownership and History of Development

The project is owned and operated by the Texas Electric Service Company. The project was authorized by Permit No. 1475, dated December 21, 1948, and allows 5,500 acre-feet annual diversion for municipal, domestic, industrial, and power uses. The 1961 water service report filed with the Texas Water Commission shows 1,643 acre-feet diverted for municipal use and 1,272 acre-feet used for cooling purposes.

Construction started on April 20, 1949, and the dam was completed in September 1949. Deliberate impoundment of water began in April 1949. Water use for condenser-cooling purposes began in June 1950.

Physical Description

The dam is rolled-earth, 4,800 feet long and 85 feet high above stream bed with spillway and controlled outlets.

Feature	Elevation (feet above m.s.l.)	Capacity (acre-feet)	Area (acres)
Top of dam	2,090.0	- -	- -
Crest of emergency spillway	2,073.7	37,460	1,945
Crest of service spillway	2,070.1	31,000	1,655
Low outlet invert	2,024.3	198	65
Stream bed	2,002.0	0	0

The drainage area above the dam is 322 square miles, of which 32 square miles is probably noncontributing.

History of Fisheries Investigations and Management

Prior to 1959, investigations and management had been limited to cursory examinations. In the spring of the year an inventory was undertaken that was completed the following year. Further sampling of game fish distribution, as effected by the restricted area and the hydro-electric plant, was carried out under the reconnaissance effort since that time. The only management attempted to date is stocking.

Stocking Record

For actual number of fish stocked multiply entry by 1,000.

	1952	1953	1954	1955	1956	1957	1958
Largemouth bass							
fry	45	120	10	76.8			41
fingerling				3			
Sunfish							
fingerling					2.55		
White crappie							
fingerling					400		
Channel catfish							
fingerling		.63		7.5	2	4	
	1959	1960	1961	1962	1963	1964	
Largemouth bass							
fry		245					
fingerling			4	16			
Sunfish							
fingerling			.30				
White crappie							
fingerling			600				
Channel catfish							
fingerling			15	5			

Total largemouth bass fry stocked: 537,800.
 Total largemouth bass fingerling stocked: 23,000.
 Total sunfish stocked: 2,850.
 Total white crappie stocked: 1,000.
 Total channel catfish stocked: 34,100.

Discussion

The apparent general reduction in game fish production for the 1962-1964 period is inexplicable on the basis of existing data. The following factors are deemed logical contributors: (1) During this period, a significant change in the operation of the hydroelectric plant has taken place. Previously warm water discharged from the plant in the course of its operation and was returned to the lake over a concrete weir. Gizzard shad and other species were strongly attracted to this phenomena and concentrated in that area. This discharge created a current that effected the entire restricted area, about 40 per cent of the lake. This concentrated forage, plus other factors associated with the discharge, in turn attracted large quantities of game fish. In 1962 the electric company decided to inject chlorine into the discharge in order to repel fish from the canal area and prevent their entering the mechanical structure and creating operational problems. The net effect, as indicated in project data and supported by observations, was to

greatly reduce the quantity of fish concentrated near the discharge. This may have reduced the efficiency of the predators to control the prey. (2) Whatever the causes, the increase in river carpsucker, carp, and gizzard shad, too large to be consumed by most game fish, have probably decreased production. (3) Previously, great quantities of waterfowl utilized the restricted area as a resting site and the resulting droppings may have been significant as fertilizer. During the past few years, both the city and the electrical company have discouraged waterfowl usage of the restricted area. This may have resulted in a significant loss in production of basic foods during critical periods. (4) The overall increase in recreational usage has probably tended to increase harvest, and a significant large flathead catfish population has been removed for experimental management purposes. (5) The decrease in the frequency of run-off entering the lake may have had an adverse effect on game fish reproduction. Lake Colorado City is a typical lake and because of its unique circumstances, warrants further study.

References

A. Fisheries Investigations

Project F-5-R-7, Job Completion Report B-27 (Inventory)
Project F-5-R-8, Job Completion Report B-22 (Resurvey)
Project F-5-R-9, Job Completion Report B-32 (Reconnaissance)
Project F-5-R-9, Job Completion Report D-1 (Fisheries Problems)
Project F-5-R-10, Job Completion Report B-32 (Reconnaissance)
Project F-5-R-11, Job Completion Report B-32 (Reconnaissance)

B. Hydrology and Water Quality Data

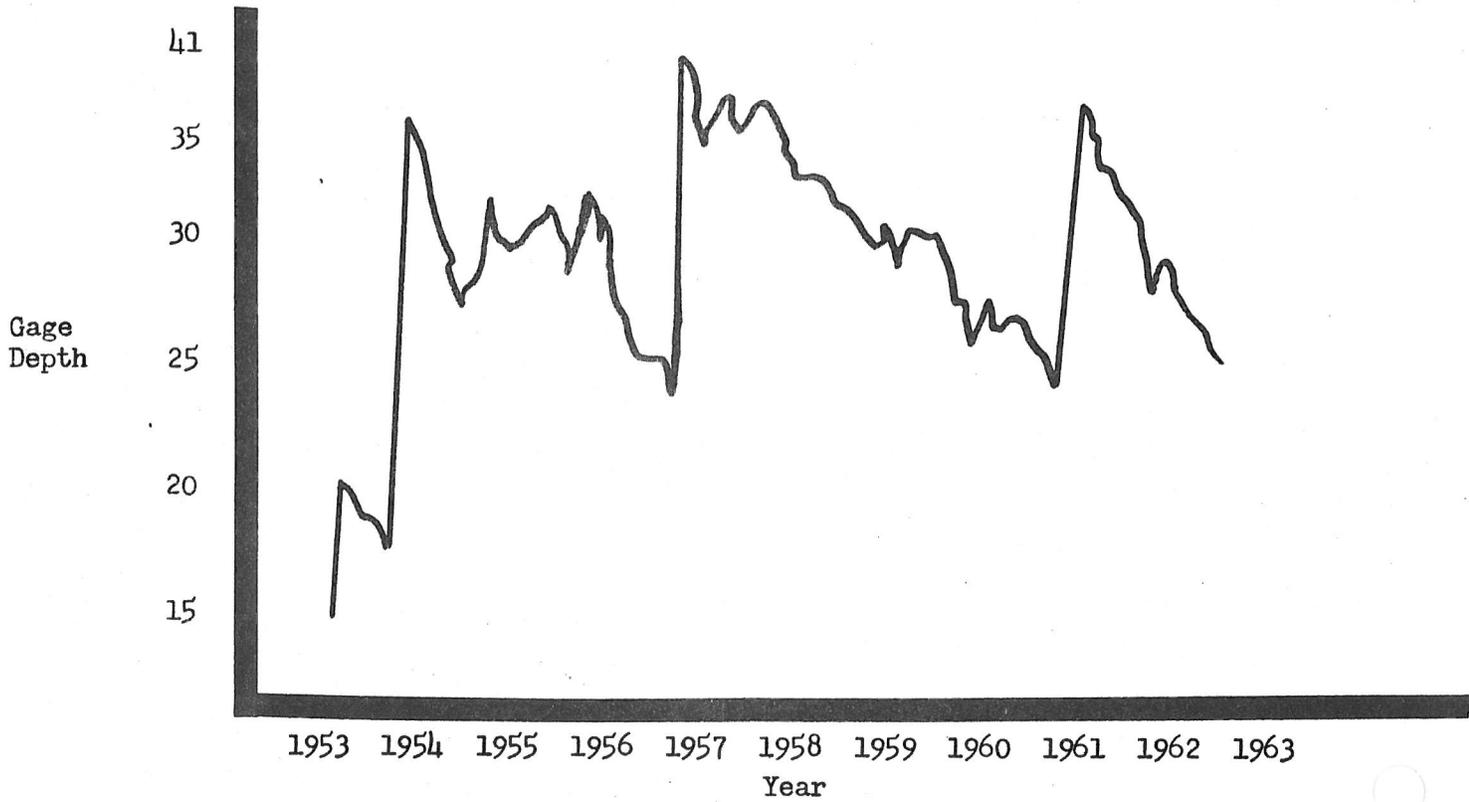
Records of Texas Electric Service

THE EFFECT OF THE ADDITION OF HEAT FROM A POWER PLANT ON THE THERMAL STRUCTURE AND EVAPORATION OF LAKE COLORADO CITY, TEXAS., Harbeck, G. E. Jr., G. E. Koberg, and G. H. Hughes. Geological Survey Professional Paper 272-B, United States Government Printing Office, Texas Water Commission Bulletin 6408.

Texas Board of Water Engineers, Bulletin 5807-A

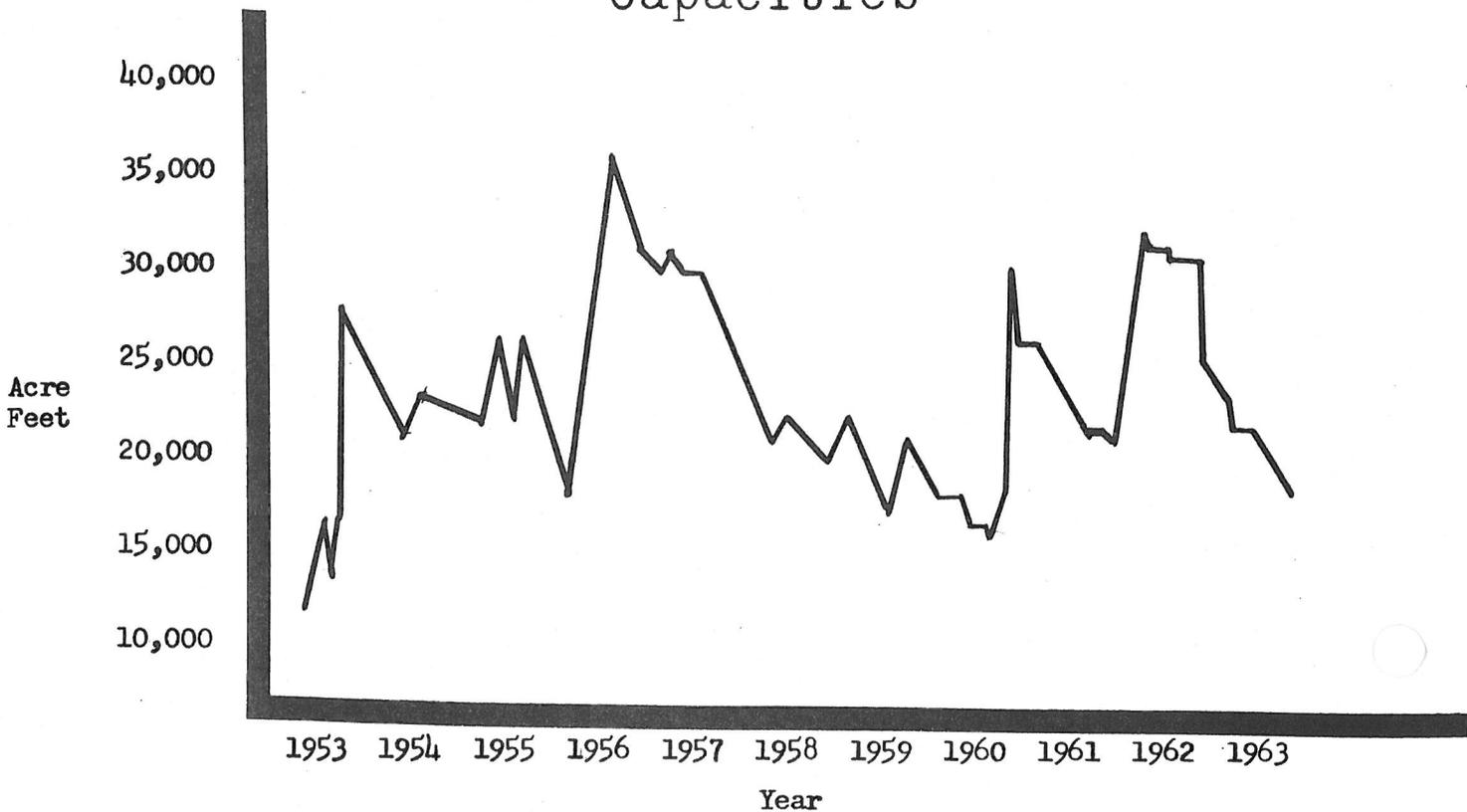
(Figure 202)

HYDROLOGICAL DATA FOR LAKE COLORADO CITY Water Levels

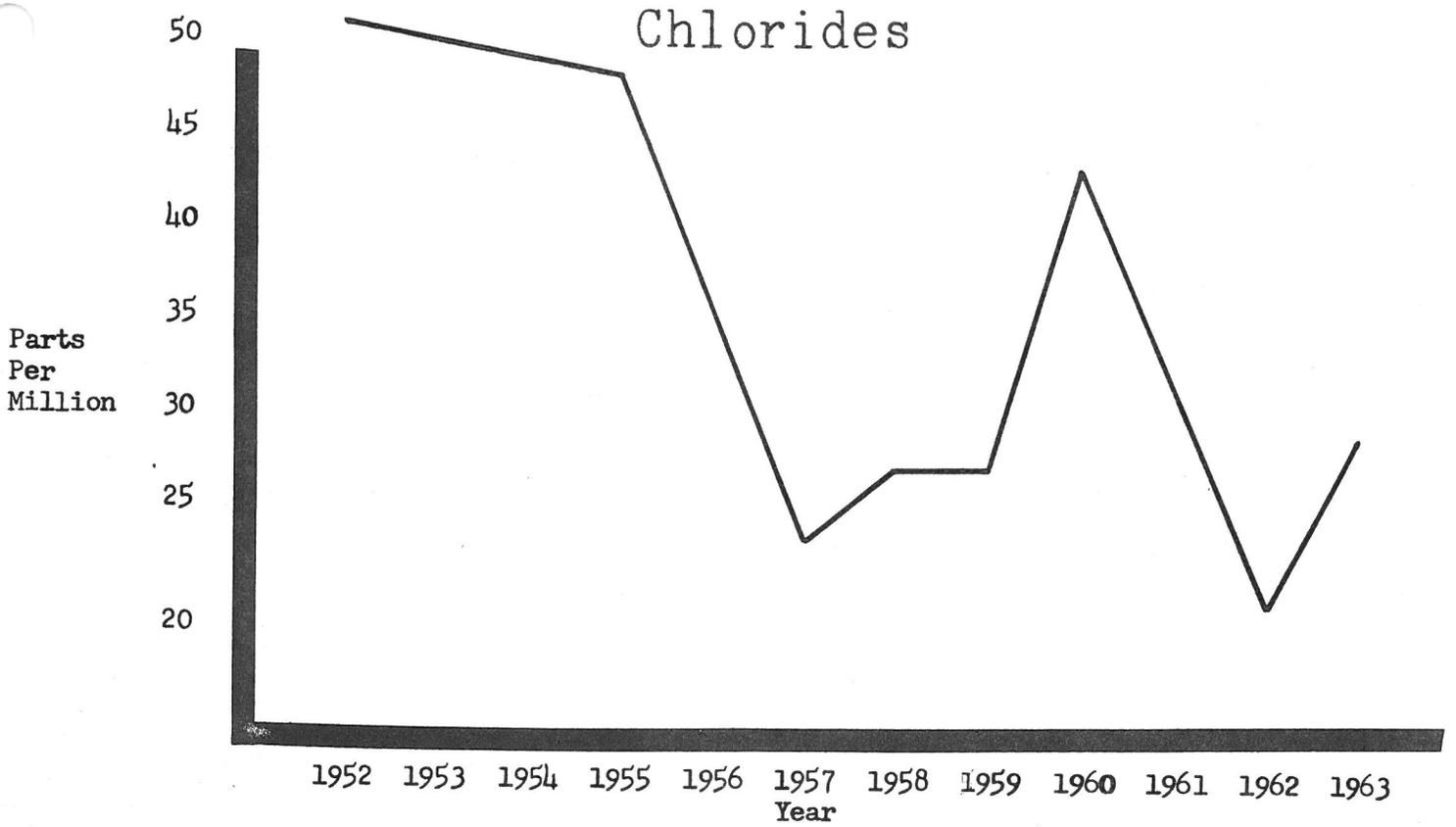


(Figure 203)

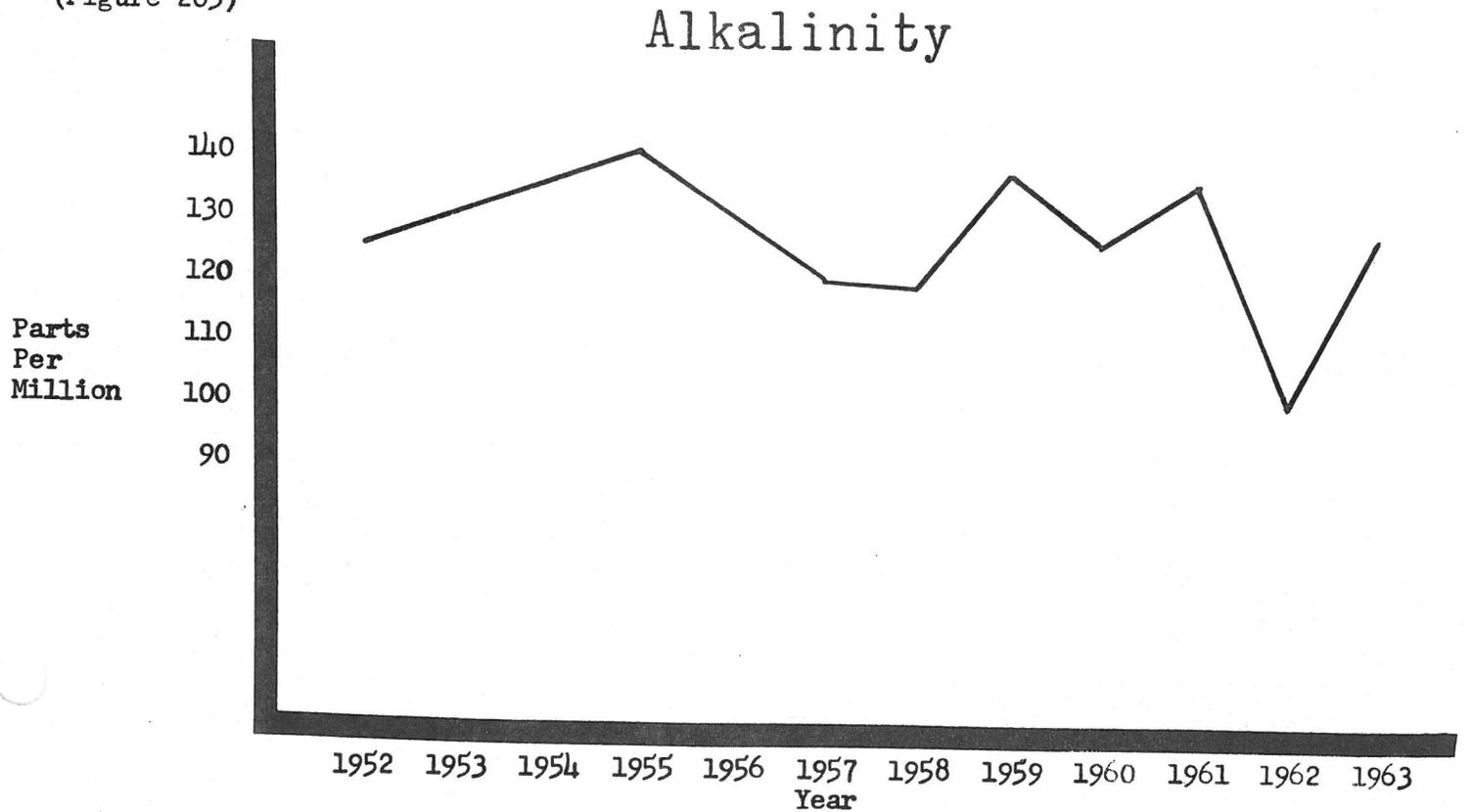
Capacities



WATER QUALITY DATA FOR LAKE COLORADO CITY



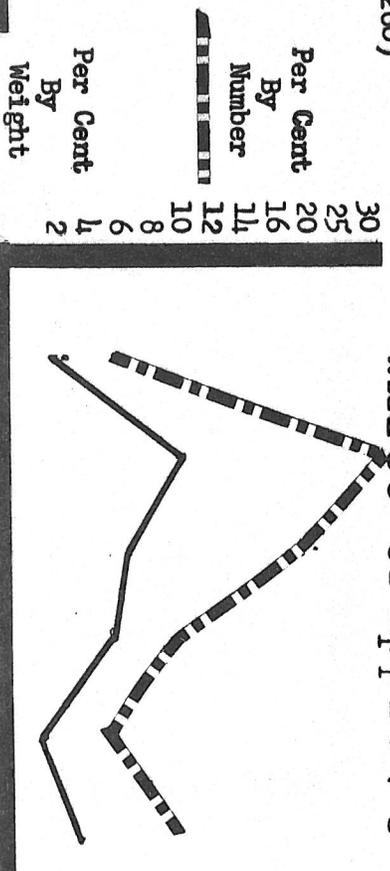
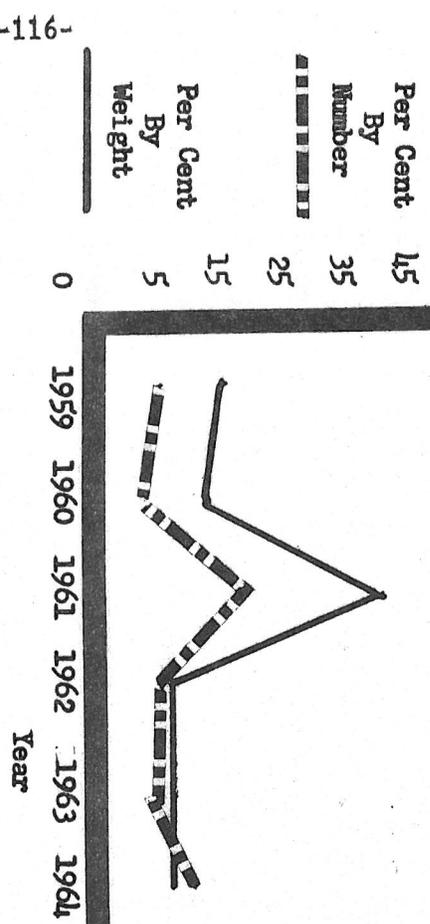
(Figure 205)



FISH PRODUCTION FROM LAKE COLORADO CITY

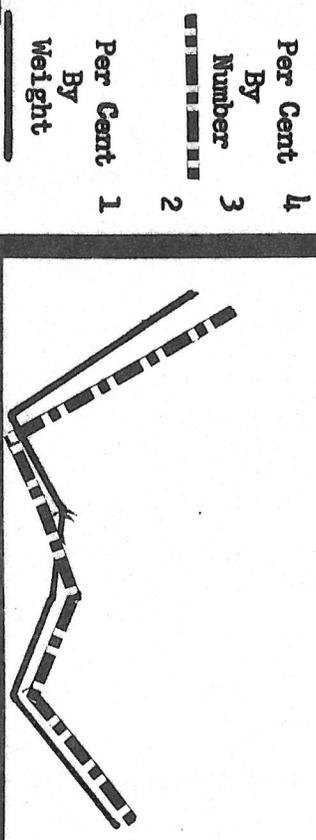
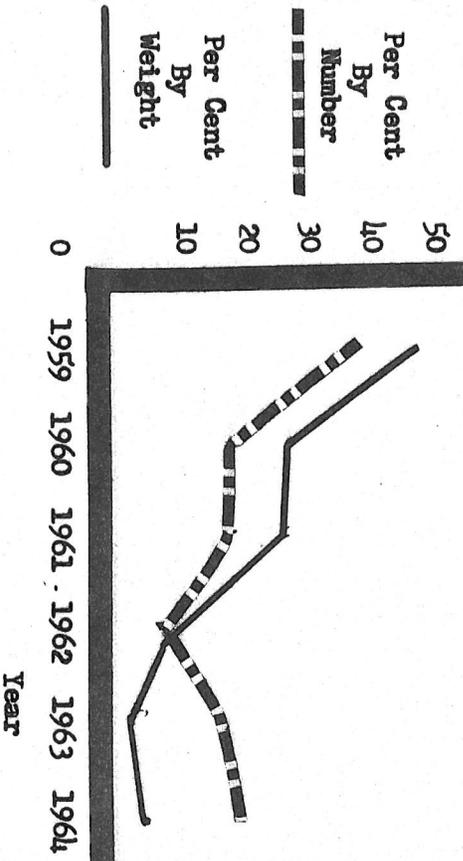
Game Fish Production

Largemouth bass (Figure 206)



White crappie (Figure 207)

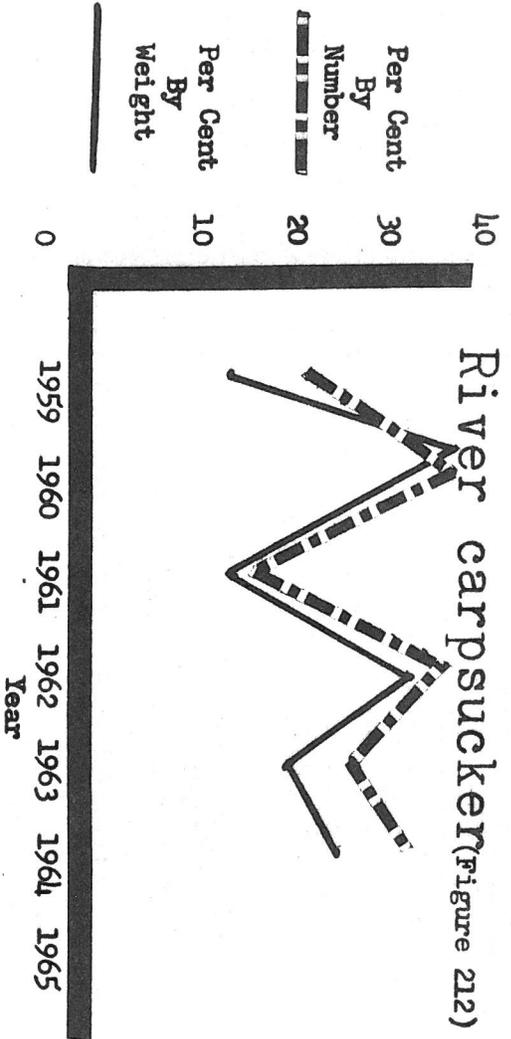
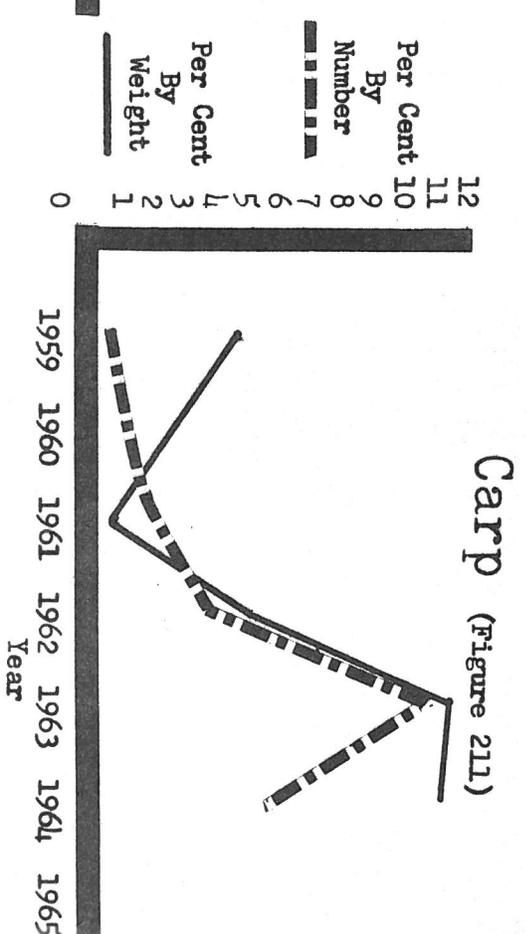
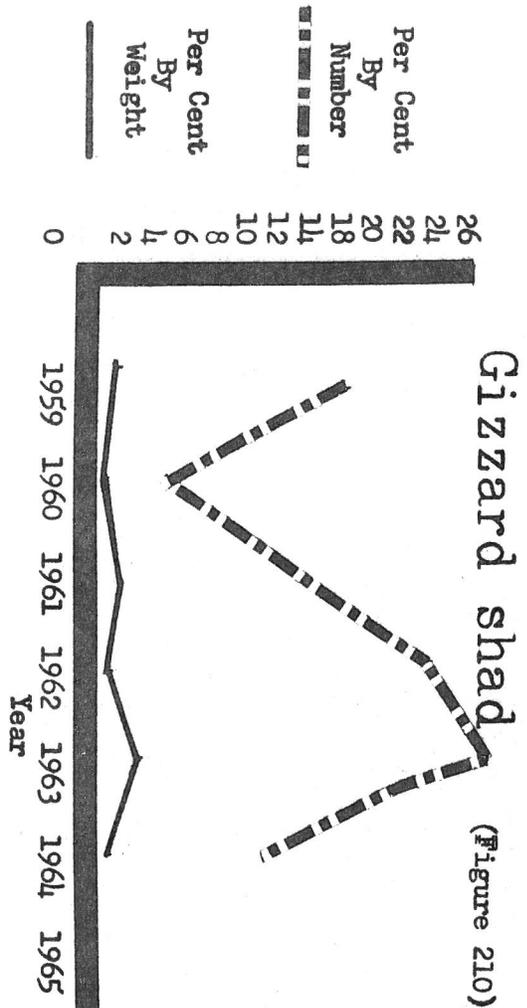
Channel catfish (Figure 208)



Other game species
WHITE BASS (Figure 209)

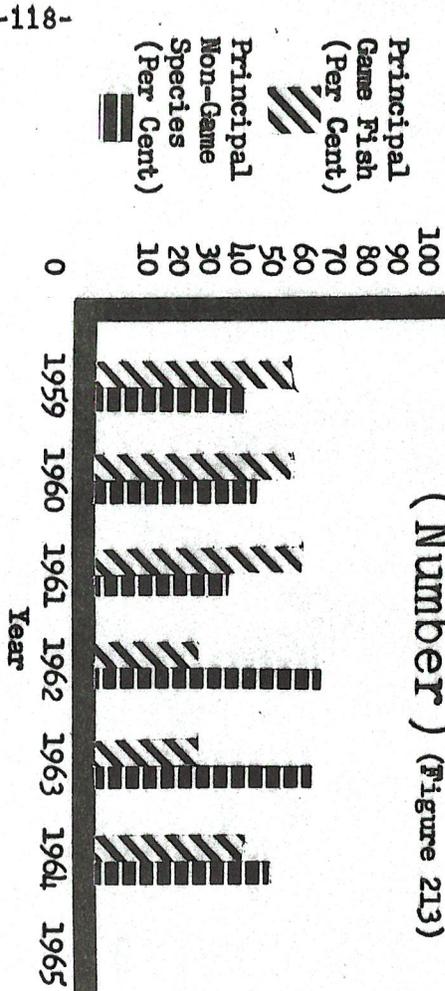
FISH PRODUCTION FROM LAKE COLORADO CITY

Principal Non-Game Species

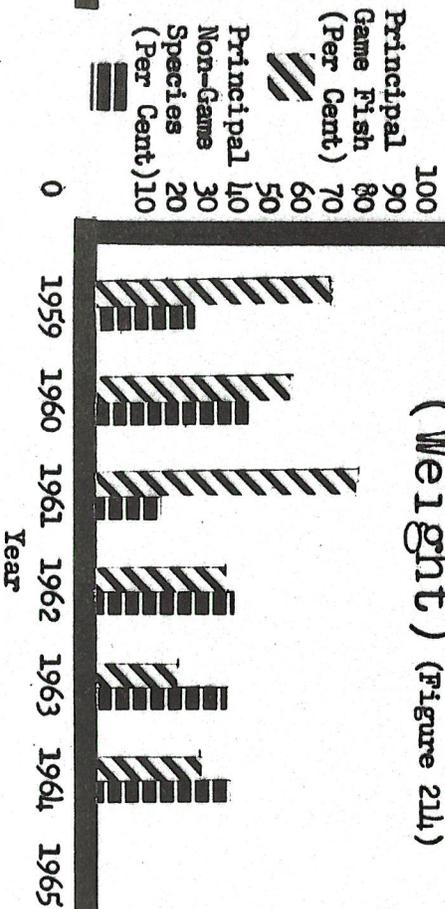


LAKE COLORADO CITY

Principal Production (Number) (Figure 213)

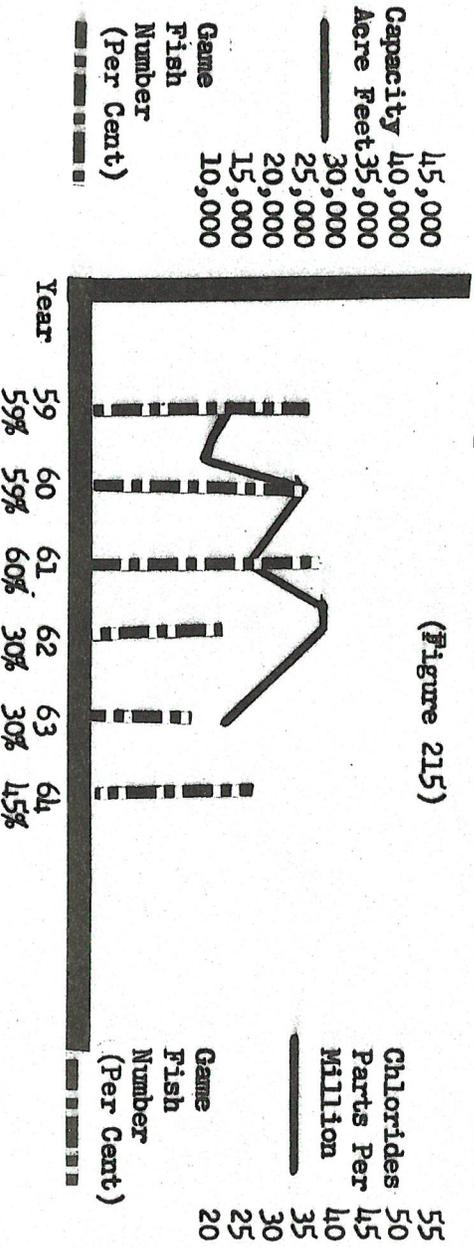


Principal Production (Weight) (Figure 214)

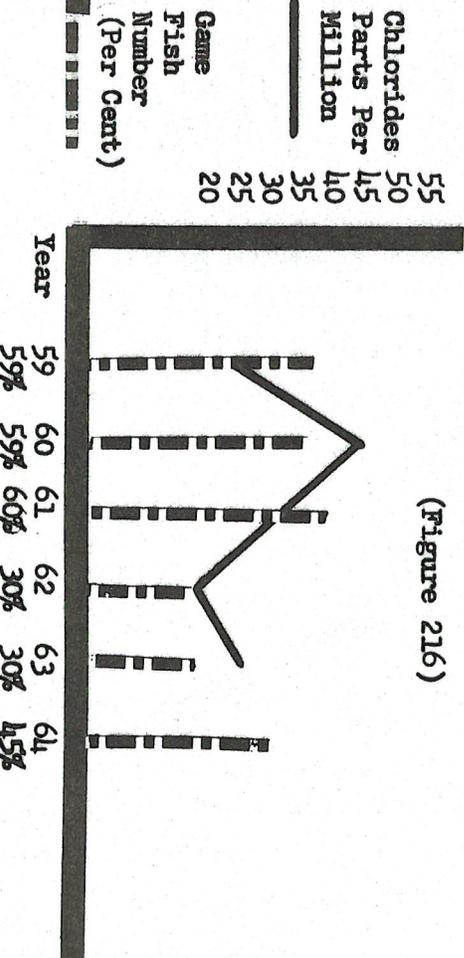


Principal Factors Influencing Game Fish Production

(Figure 215)



(Figure 216)



Moss Creek Reservoir

Location

Moss Creek Reservoir is 9 miles east of Big Spring in Howard County. The dam is 5 miles below the confluence of the north and south forks of Moss Creek, a tributary of the Colorado River.

Ownership and History of Development

Moss Creek Reservoir is owned and operated by the city of Big Spring. Construction was completed in 1938; and from that time until 1953, when Lake J. B. Thomas became the principal source of city water, the primary function of the smaller reservoir was for municipal water. Since 1953 the reservoir has served as a control reservoir and for recreation.

Physical Description

Maximum capacity at spillway elevation is 2,325 acre-feet. At that stage the reservoir has 145 acres. The average depth is 16 feet and the watershed covers 27 square miles. A flowing spring is located one mile above the lake.

History of Fisheries Investigations and Management

Prior to 1959, the management provided was limited to periodic stocking with game fish from hatcheries and from Lake Powell, a small reservoir located above Moss Creek Reservoir. An inventory survey completed during that period indicated the presence of an excessive number of gizzard shad, and a selective treatment to reduce that species was carried out in March 1959. The excellent game fishing that has been experienced since that work is attributed to that effort.

Stocking Records

For actual number of fish stocked multiply entry by 1,000.

	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964
Largemouth bass fry						45					
fingerling		2	1.025	2	1		2				
Sunfish fingerling		1		2							
White crappie fingerling				.50							
Channel catfish fingerling		.50	.63	5.5	1	.60	2				

Total largemouth bass fry stocked: 45,000.
Total largemouth bass fingerling stocked: 8,025 This figure does not include
a very large number of small bass moved from Lake Powell to Moss Creek by
lake keeper Frank Colbert and assisting sportsmen.
Total number of sunfish fingerling stocked: 3,000.
Total number of white crappie stocked: 500.
Total number of channel catfish stocked: 10,225.

Discussion

The stability of water levels, the clearness and excellent quality of the water, and other factors combine to sustain excellent game fish production. It would also appear that the chemical control to reduce gizzard shad was successful in that adequate control was provided for an undetermined period. Successful reproduction of game fish is common as indicated by studies, and frequent stocking of the lake with juvenile largemouth bass by the former caretaker and sportsmen may have been beneficial. Overproduction, possibly through excessive protection afforded by marginal vegetation, is indicated, and the expansion of silt over shallow spawning areas at the upper area of the lake is viewed as detrimental. Factors that sustain game fish production warrant further study.

References

A. Fisheries Investigations

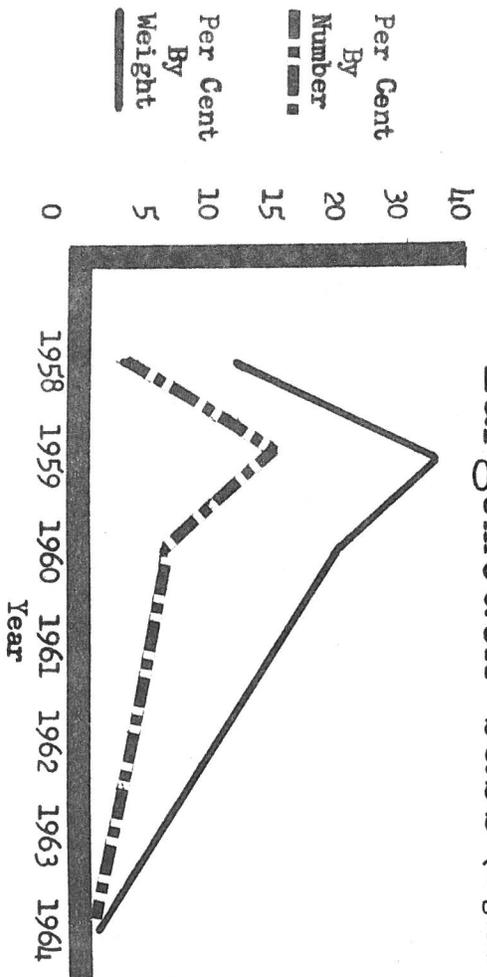
Project F-5-R-6, Job Completion Report B-25 (Inventory)
Project F-5-R-7, Job Completion Report B-22 (Resurvey)
Project F-14-D-3, Job Completion Report 16a-14 (Selective Control)
Project F-5-R-8, Job Completion Report B-22 (Resurvey)
Project F-5-R-11, Job Completion Report B-32 (Reconnaissance)

B. Hydrological and Water Quality Data

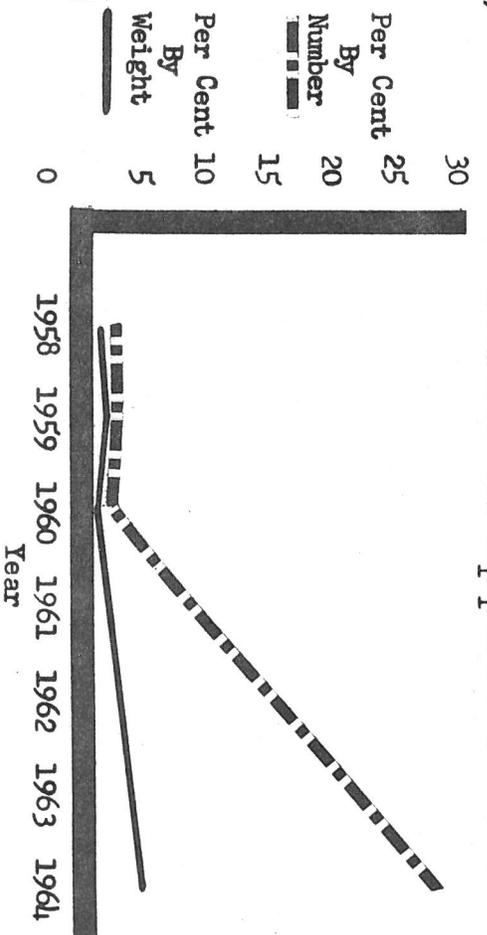
Records from Colorado Municipal Water District
Records from city of Big Spring Water Department

FISH PRODUCTION FROM MOSS CREEK RESERVOIR Game Fish Production

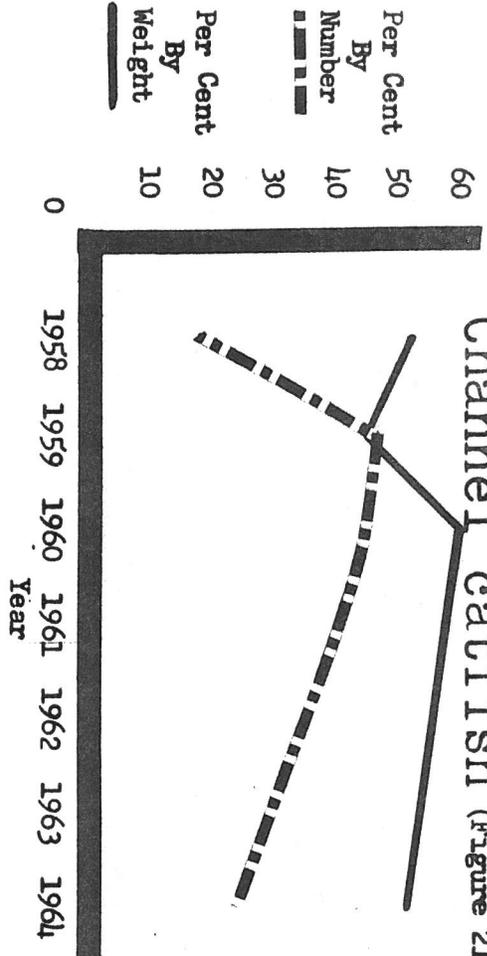
Largemouth bass (Figure 217)



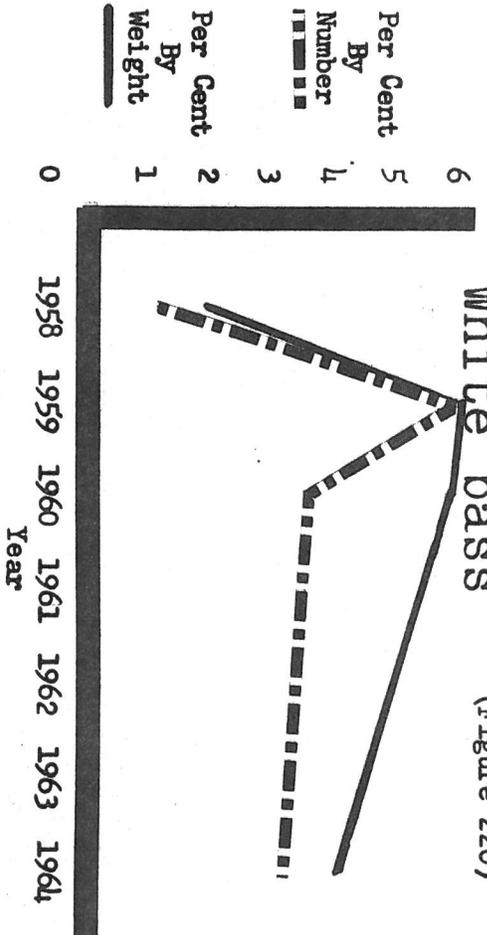
White crappie (Figure 218)



Channel catfish (Figure 219)



White bass (Figure 220)

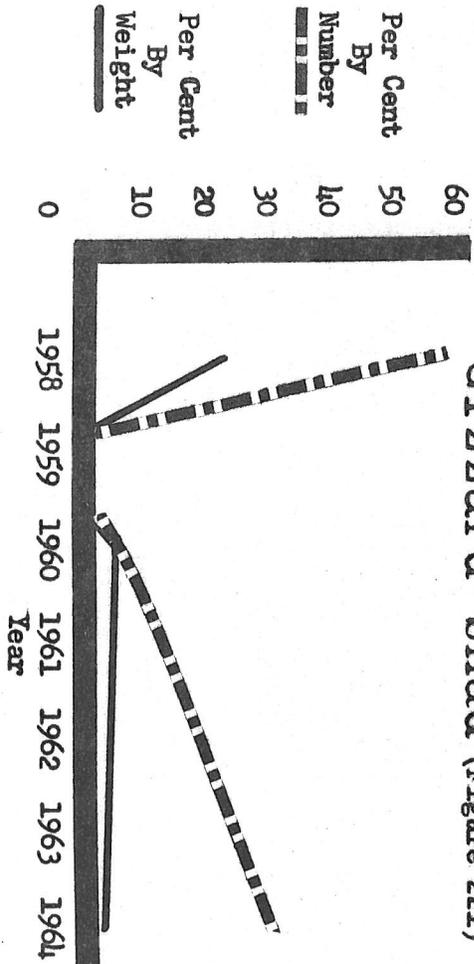


FISH PRODUCTION FROM MOSS CREEK RESERVOIR

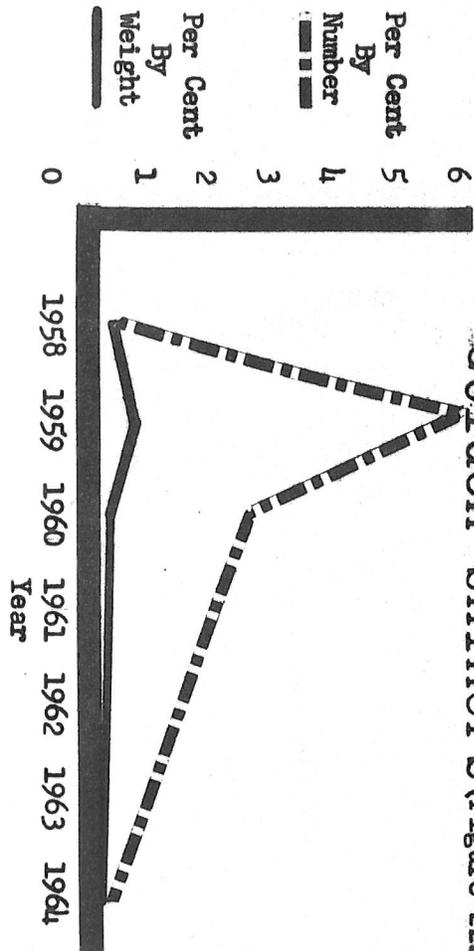
Principal Non-Game Species

-221-

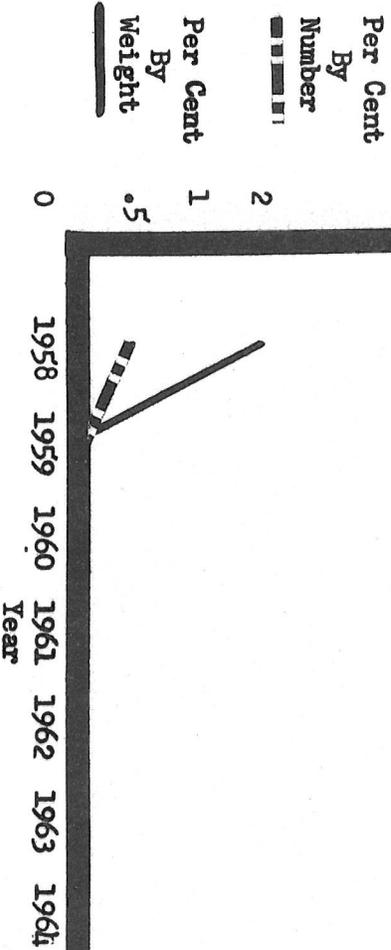
Gizzard shad (Figure 221)



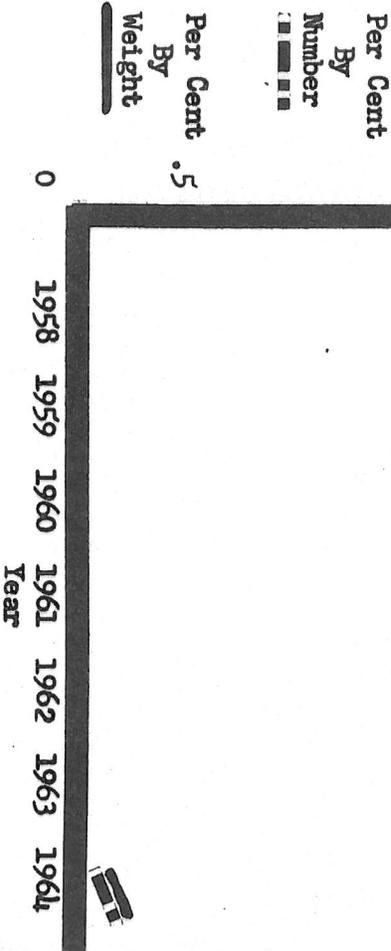
Golden shiners (Figure 222)



River carpsucker (Figure 223)

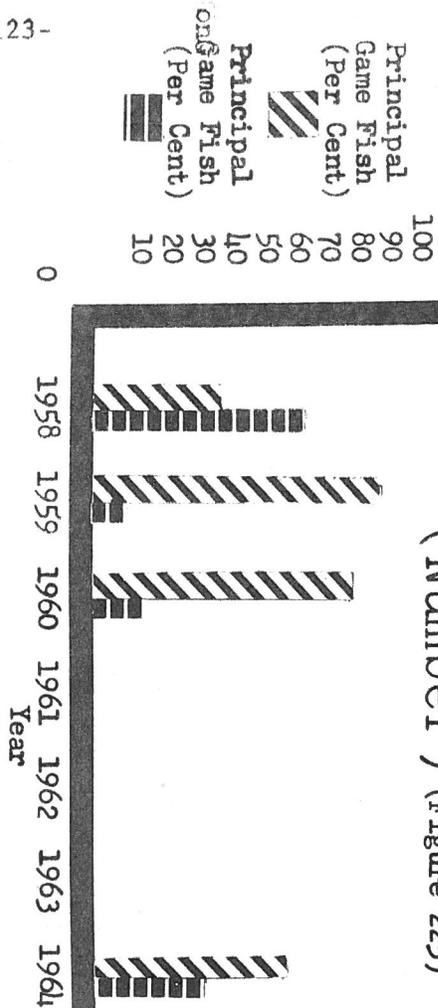


Bullheads (Figure 224)

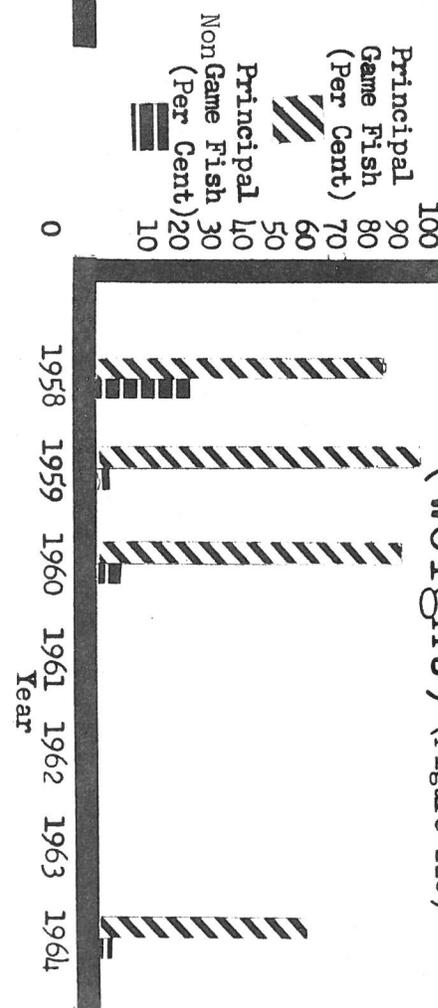


MOSS CREEK LAKE

Principal Production (Number) (Figure 225)



Principal Production (Weight) (Figure 226)



Lake J. B. Thomas

Location

Lake J. B. Thomas is in the Colorado River Basin in Scurry County, 7 miles northeast of Vincent and 16 miles southwest of Snyder. The lake extends into Borden County.

Ownership and History of Development

The reservoir is owned by the Colorado River Municipal Water District, which was created in 1949 to furnish water to the cities of Big Spring, Odessa, and Snyder.

The project was authorized by Permit No. 1394 dated August 19, 1946, and gives the right to impound 111,000 acre-feet and to divert 30,000 acre-feet of water annually for municipal and industrial use. A subsequent permit No. 1394B authorizes change in the location of the dam, increases the lake capacity to 204,000 acre-feet, and adds recreation to the water use. The later permit also authorizes the construction of a dam across nearby Bull Creek, together with a canal to divert the flow by gravity into Lake J. B. Thomas.

Construction began in March 1951 and was completed in September 1952. Deliberate impoundment began in July 1952, but there was little storage until July 1953. The canal from Bull Creek is 13,000 feet long. The diversion dam on Bull Creek was washed out by the April 1954 flood, and repairs were completed May 30, 1954.

Physical Description

The dam is rolled-earth, 14,500 feet long and at maximum height above the river bed 105 feet. Other capacities are as follows:

Feature	Elevation (feet above m.s.l.)	Capacity (acre-feet)	Area (acres)
Top of dam	2,280.0	430,600	- -
Crest of right emergency spillway	2,267.0	283,600	9,760
Crest of left emergency spillway	2,264.0	255,000	9,100
Crest of service spillway	2,258.0	203,600	7,820
Invert of service outlet	2,200.0	1,300	210
Stream bed	2,175.0	0	0

The drainage area above the dam is 3,524 square miles, of which 2,590 is probably noncontributing. Dead storage is 1,300 acre-feet. Water for the city of Snyder is released through a 24-inch valve and pumped through a 21-inch pipeline to the city and to the Sharon Ridge oil field. Water is

diverted directly from the lake by a pump station that supplies water through a 33-inch pipeline to Big Spring and then to Odessa through a 27-inch line.

History of Fisheries Investigations and Management

Prior to the impoundment of significant quantities of water in 1952, portions of the stream above the dam were seined and as many rough fish as possible removed. In 1954 an inventory survey was begun and this study continued through 1957. Subsequent investigations have been limited to those carried out under the reconnaissance and resurvey functions to maintain knowledge of game fish production. Other than stocking there has been no management attempted.

Stocking Record

For actual number of fish stocked multiply entry by 1,000.

	1953	1954	1955	1956	1957	1958
Largemouth bass						
fry	1,000		169		300	165
fingerling		9.4		8	25	
Sunfish						
fingerling	.60		16.5	18	10	8
White crappie						
fingerling		4	.6	1		
Channel catfish						
fingerling	1.5	19	7.5	1	8	
	1959	1960	1961	1962	1963	1964
Largemouth bass						
fry	84	250	100			
fingerling		16				
Sunfish						
fingerling			8			
White crappie						
fingerling			10			
Channel catfish						
fingerling	4		20			

Total largemouth bass fry stocked: 1,068,000.

Total largemouth bass fingerling stocked: 58,400.

Total sunfish stocked: 59,100.

Total white crappie stocked: 15,600.

Total channel catfish stocked: 61,000.

In addition to these fish approximately 4,500 blue catfish were stocked in 1961 and about 5,000 golden shiner minnows were stocked in 1955-1956.

Discussion

The consistency with which game fish production follows prolonged decreases and increases in volume is more apparent in Lake J. B. Thomas than is common for other lakes of the region. Sampling during the initial period of volume increase (1953-1955) indicates that all of the principal game species increased and all of the principal non-game species decreased. The second major adjustment in capacity was a gradual decrease between 1957 and 1959. During that period largemouth bass and white crappie decreased by both number and weight. Channel catfish decreased in relative abundance by weight, but remained relatively constant by number and white bass decreased in number but increased by weight. During this period all of the principal non-game species increased significantly. The third period of basic change occurred between 1961 and 1963. A general recession in volume was accompanied by an increase in largemouth bass and by significant reduction of white crappie, channel catfish, and white bass. During this period gizzard shad, carp, and river carp-sucker increased. In gross game fish production, an expansion in relative abundance of game fish has always followed periods when the lake experienced prolonged increases. During such increases all problematic species have decreased in relative abundance. An increase in chlorides apparently accompanied significant increases in gross production. Reconnaissance studies should be continued to measure basic production trends.

References

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Project F-5-R-2, Job Completion Report B-10 (Inventory)
Project F-5-R-3, Job Completion Report B-10 (Inventory)
Project F-5-R-4, Job Completion Report B-10 (Inventory)
Project F-5-R-6, Job Completion Report B-22 (Resurvey)
Project F-5-R-7, Job Completion Report B-22 (Resurvey)
Project F-5-R-8, Job Completion Report D-1 (Fishery Problems)
Project F-5-R-10, Job Completion Report B-32 (Reconnaissance)
Project F-7-R-11, Job Completion Report B-18 (Reconnaissance)

B. Hydrological and Water Quality Data

State Board of Water Engineers Bulletin 5807-A
Texas Water Commission Bulletin 6408
Records from Colorado Municipal Water District
Records from City of Big Springs Water Department
Water Supply Papers of United States Geological Survey

(Figure 227)

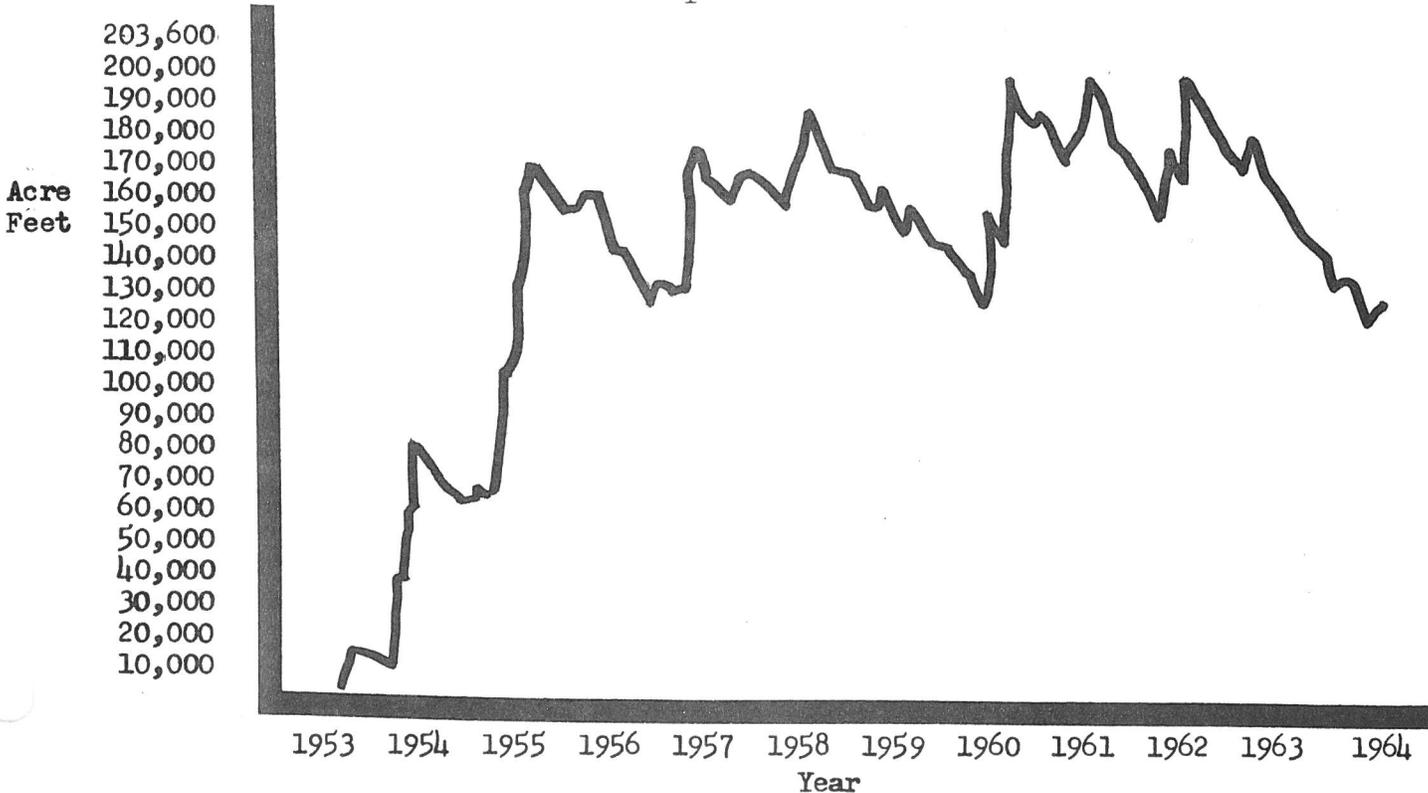
HYDROLOGICAL DATA FOR LAKE J. B. THOMAS

Water Levels



(Figure 228)

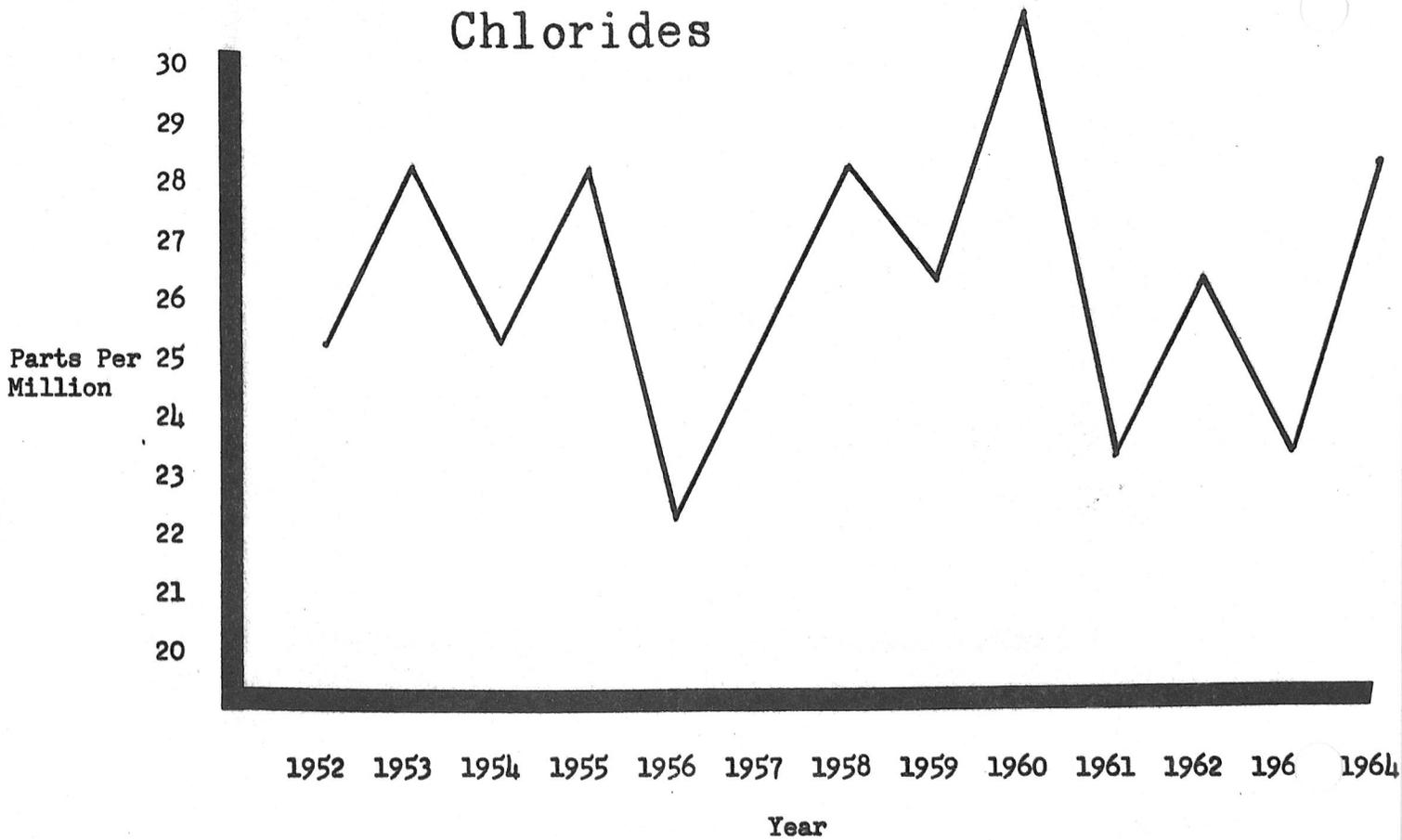
Capacities



(Figure 229)

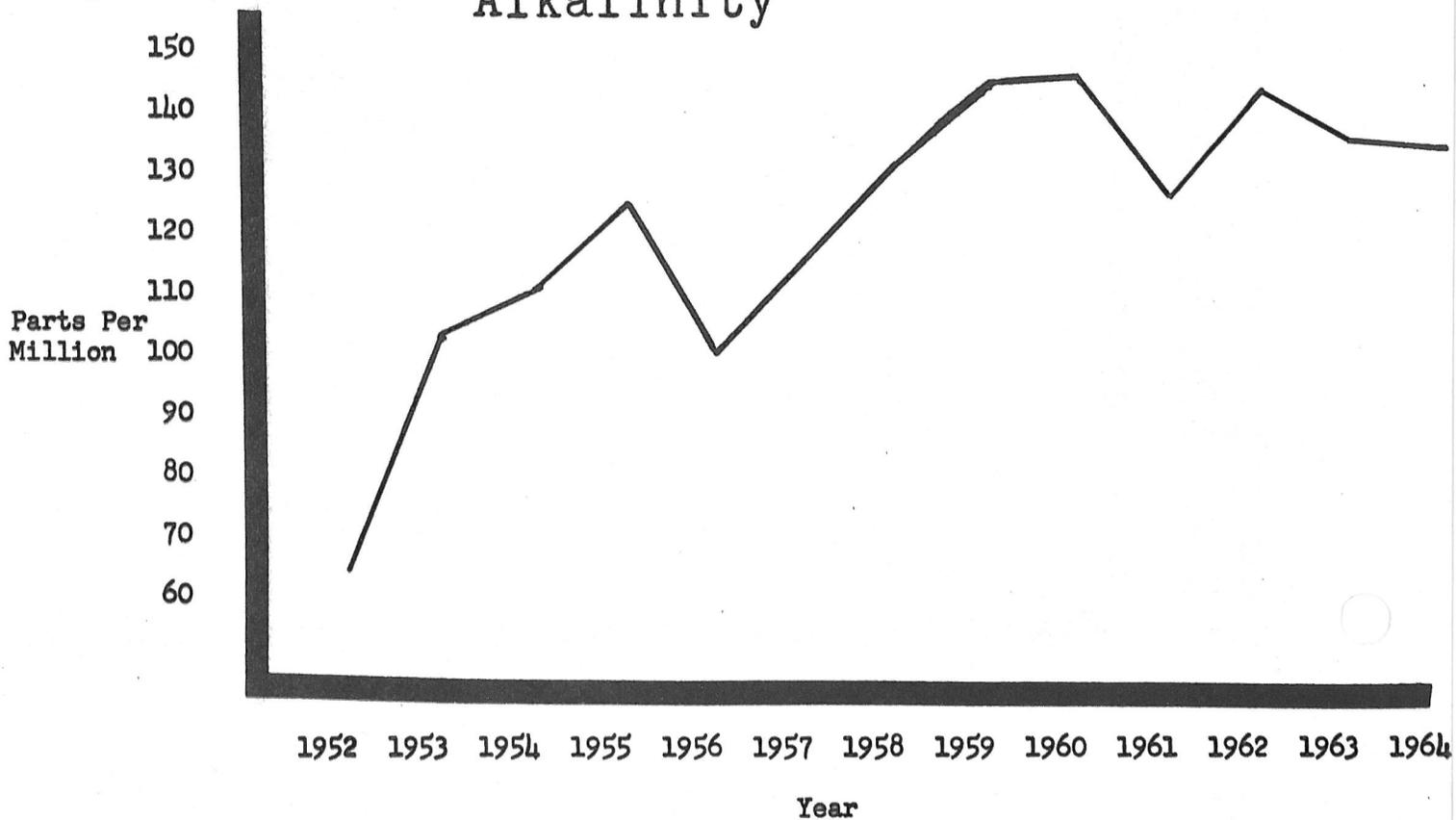
WATER QUALITY DATA FOR LAKE J. B. THOMAS

Chlorides



(Figure 230)

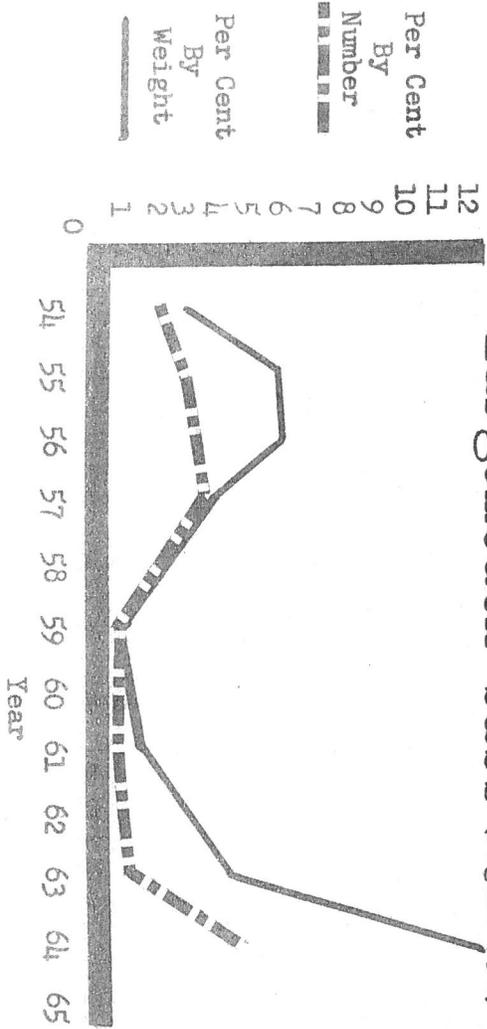
Alkalinity



FISH PRODUCTION FROM LAKE J. B. THOMAS

Game Fish Production

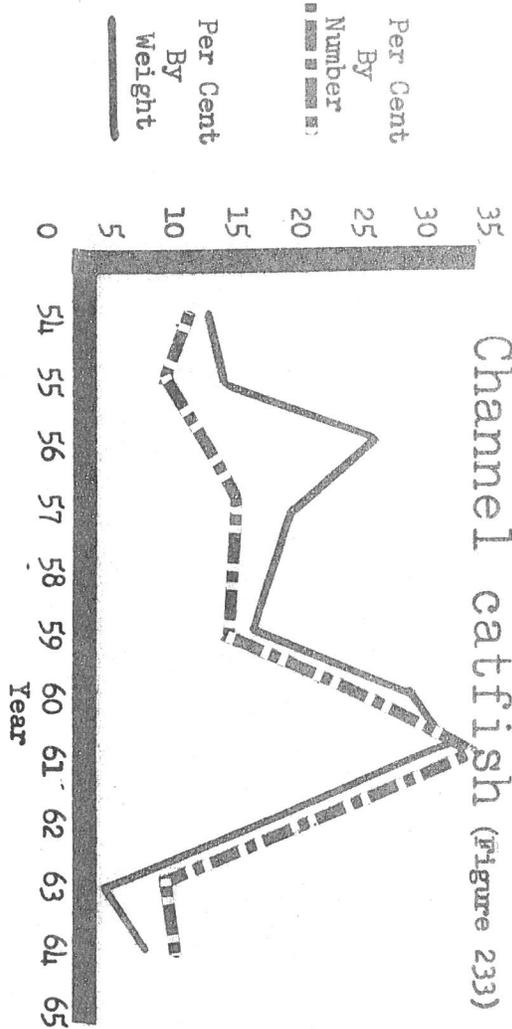
Largemouth bass (Figure 231)



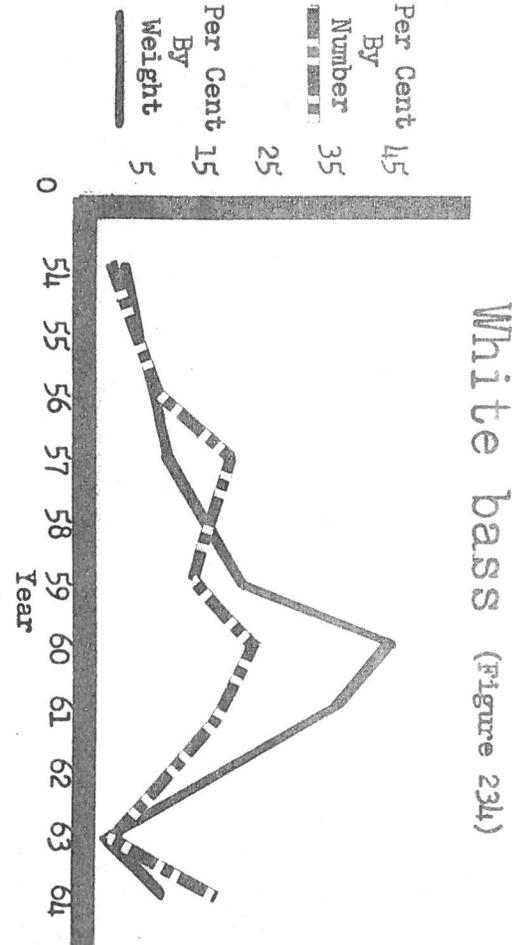
White crappie (Figure 232)



Channel catfish (Figure 233)

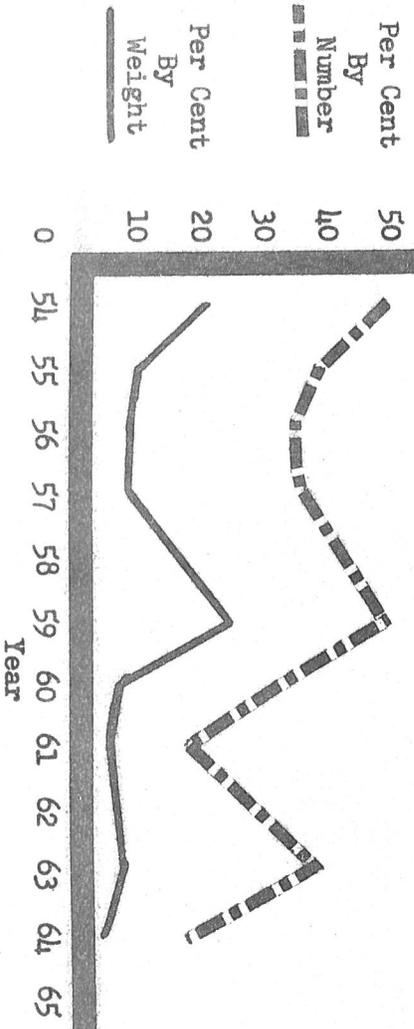


White bass (Figure 234)

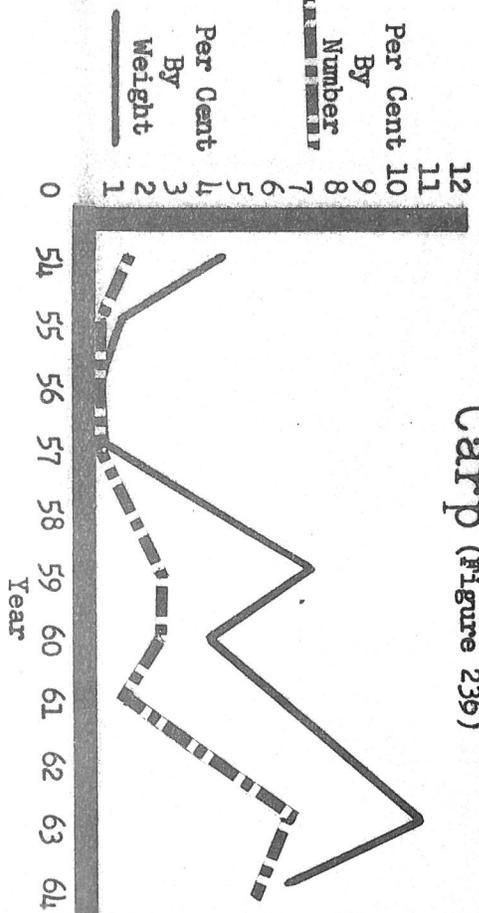


FISH PRODUCTION FROM LAKE J. B. THOMAS Principal Non-Game Species

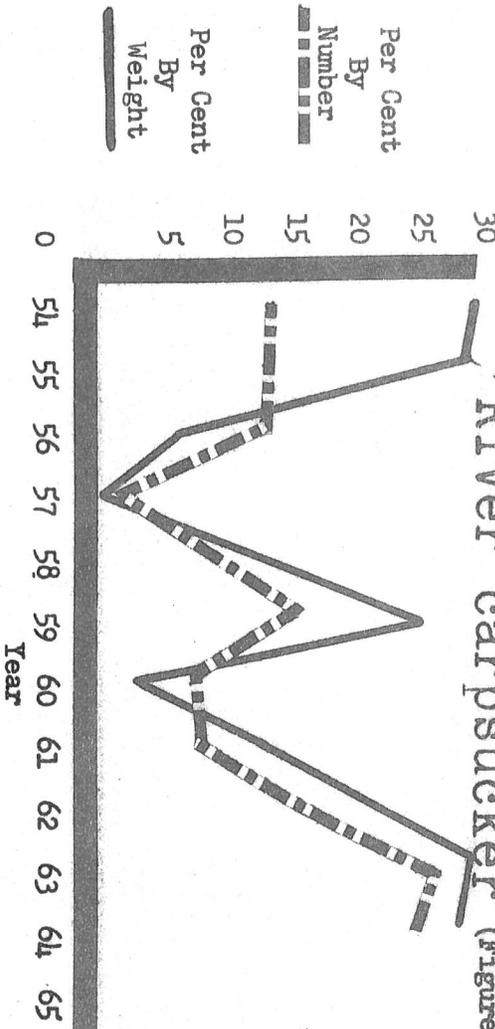
Gizzard shad (Figure 235)



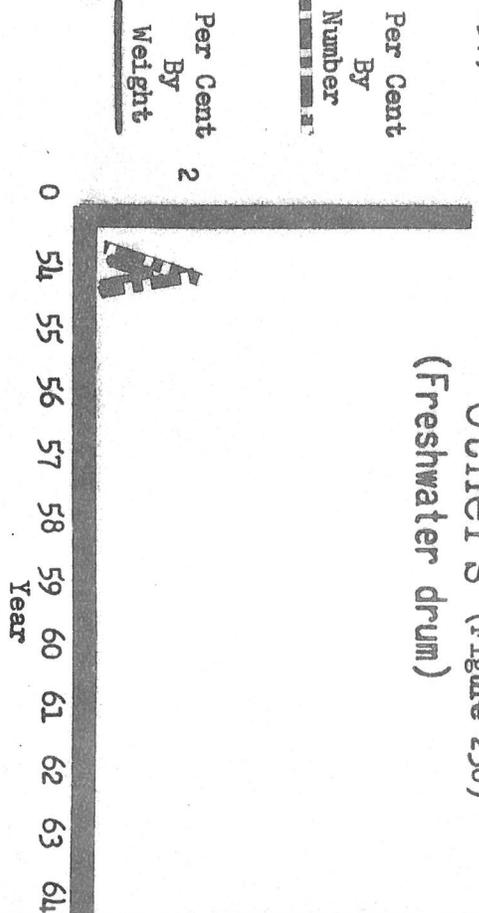
Carp (Figure 236)



River carpsucker (Figure 237)

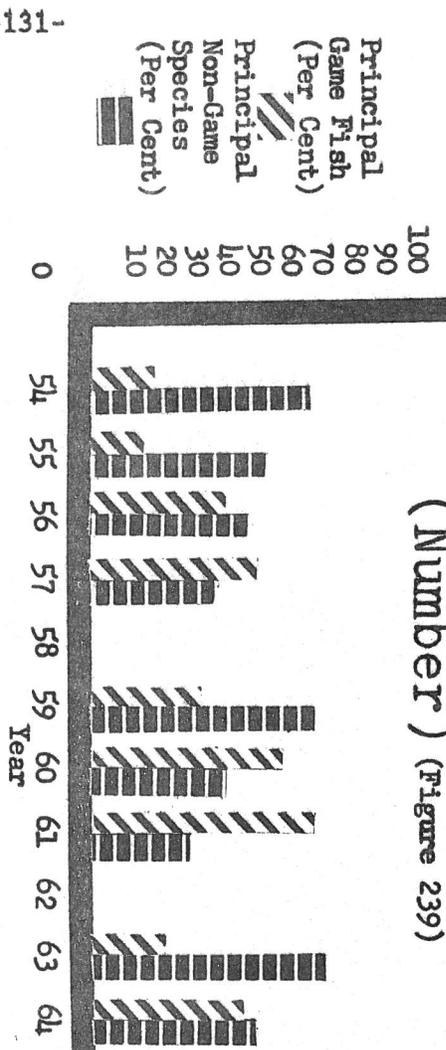


Others (Figure 238)
(Freshwater drum)

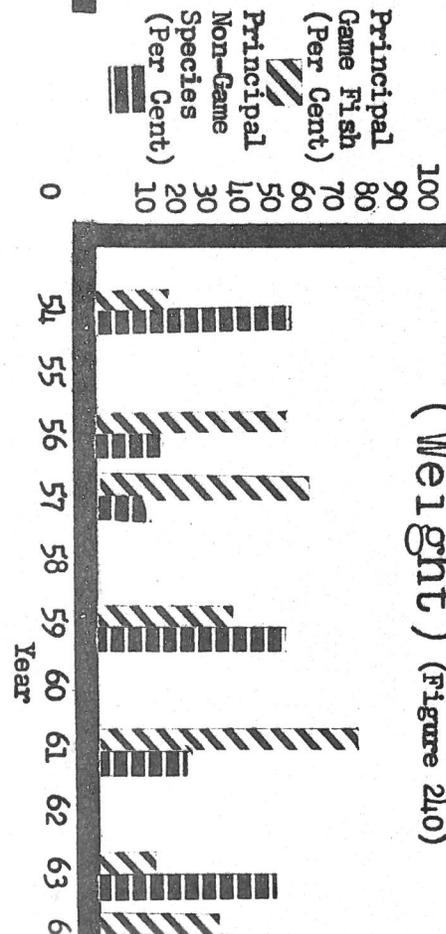


LAKE J. B. THOMAS

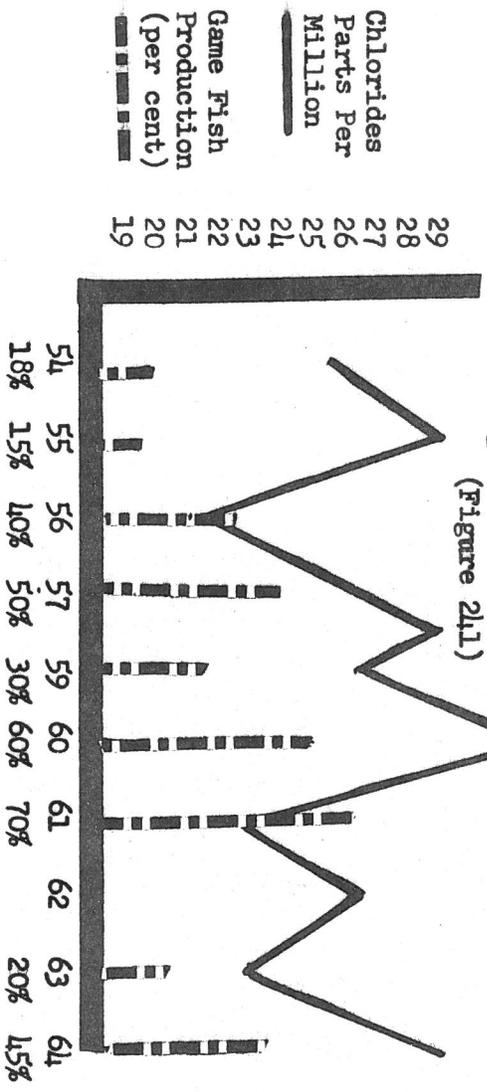
Principal Production (Number) (Figure 239)



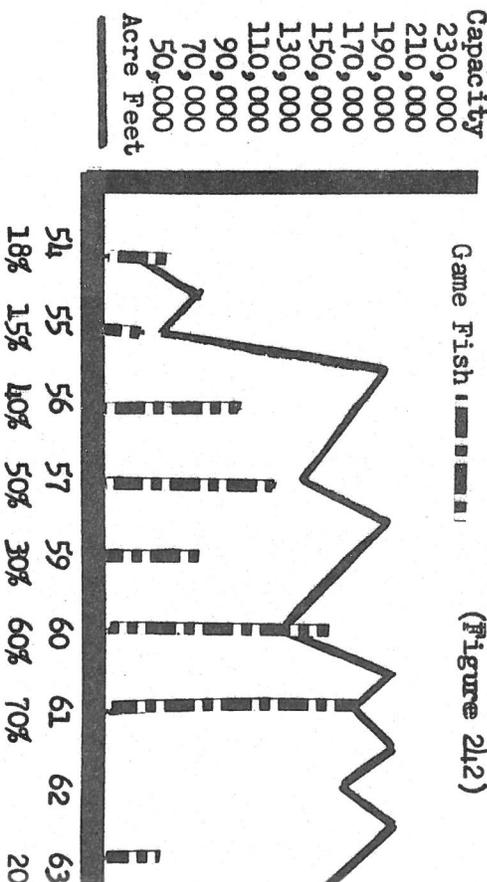
Principal Production (Weight) (Figure 240)



Principal Factors Influencing Game Fish Production (Figure 241)



Game Fish Production (Figure 242)



Lake Nasworthy

Location

Lake Nasworthy is in the Colorado River Basin in Tom Green County, 6 miles southwest of San Angelo. The dam is on the South Concho River, a tributary of the Colorado River.

Ownership and History of Development

Lake Nasworthy is presently owned by the city of San Angelo. The project was originally constructed by the West Texas Utilities Company. Permit No. 1120 authorized construction of a dam across the South Concho River that would create a reservoir with a capacity of 10,500 acre-feet. It also provided for diversion from the reservoir of 25,000 acre-feet of unappropriated water per annum from the South and Middle Concho Rivers for industrial purposes, to meet the domestic requirements of the city of San Angelo, and to irrigate up to 5,000 acres of land. The irrigation provision was cancelled by the State Board of Water Engineers by an order dated February 10, 1961, pursuant to a cancellation waiver executed by the city of San Angelo, which had previously purchased the water right from the West Texas Utilities Company. Construction of Nasworthy Dam was begun in 1929 and was completed in June 1930. Deliberate impoundment began March 28, 1930.

Since the two applications (for West Texas Utilities Company and for Concho Water Development Company) were overlapping, the State Board of Water Engineers entered an order in April 1929 that stipulated:

1. The Permit No. 1120 be granted to West Texas Utilities Company on condition that the company's dam may be submerged by and become a part of the project of the Concho Water Development Company.

2. A permit would be issued to the Concho Water Development Company to appropriate 200,000 acre-feet per annum from the South Concho River for irrigation, the operation of waterworks for cities and towns, the development of water supply and power for industrial and irrigation purposes, and the construction of a dam across the South Concho River creating a reservoir with a capacity of 200,000 acre-feet. The permit would be granted on condition that the Concho Water Development Company pay the West Texas Utilities Company for its dam, reservoir, and improvements; that the Concho Water Development Company enter into a contract with the West Texas Utilities Company to sell it the water necessary to satisfy commitments of the utilities company to supply water for the industrial and domestic needs of the city of San Angelo.

The Concho Water Development Company's project wasn't constructed, so the State Board of Water Engineers, on January 7, 1942, rescinded its order of April 1929.

Lake Nasworthy is one of three major structures providing water supply, flood control and recreation for the San Angelo area. The other two are San Angelo Reservoir and Twin Buttes Reservoir.

Physical Description

Nasworthy Dam is earthfill and concrete structure having a total length of 5,480 feet. The maximum height above stream bed is 50 feet. The drainage area at Nasworthy Dam is 3,833 square miles, of which 1,178 square miles are probably noncontributing. Flow into Lake Nasworthy is regulated by Twin Buttes Dam. Capacities and surface areas of the present lake at indicated elevations are as follows:

Feature	Elevation (feet above m.s.l.)	Capacity (acre-feet)	Area (acres)
Top of dam	1,883.5	- -	- -
Crest of 600-foot emergency spillway	1,880.1	- -	- -
Crest of 300-foot emergency spillway	1,879.1	27,470	- -
Top of service spillway taintor gates	1,873.2	13,990	- -
Top of automatic floodgate (auxiliary spillway)	1,872.2	12,390	1,596
Top of base of automatic flood gate (auxiliary spillway)	1,869.2	8,210	1,210
Invert of two 24-inch outlet pipes	1,860.0	1,580	350
Crest of service spillway	1,855.3	435	160
Invert of 36-inch diameter low-flow outlet (outlet works)	1,836.0	0	- -

History of Fisheries Investigations and Management

Investigations of the fishery at Lake Nasworthy date from the early 1940's and stocking records begin in 1931. However, investigations prior to 1952 were of a limited nature, and the difference in technical standards employed do not permit positive comparison. For that reason, only data obtained between 1952 and 1965 will be employed for the purposes of this report.

Stocking Record for Lake Nasworthy

For actual numbers of fish stocked multiply entry by 1,000.

	1953	1954	1955	1956	1957	1958
Largemouth bass						
fry		40	35	130		142
fingerling	33	12	3	16		4
Sunfish						
fingerling				6.5	8	
White crappie						
fingerling					7.4	.2
Channel catfish						
fingerling			7	7	7.2	2.5

	1959	1960	1961	1962	1963	1964
Largemouth bass fry	107	165	62		18	
fingerling				2		
Sunfish						
fingerling	2.8	25	10.5			
White crappie						
fingerling	.2	5				
Channel catfish						
fingerling	14	20	5			1

Total largemouth bass fry stocked over 10 year period: 699,000, an average of 87,475 per stocking.

Total largemouth bass fingerling stocked: 60,700, an average of 7,558.50 per stocking.

Total sunfish (all species) stocked over 10 year period: 52,800, an average of 5,280 per year.

Total white crappie stocked: 12,825, an average of 3,206.25 for each year stocked, or 1,282 for the 10 year period.

Total channel catfish stocked: 63,700 or 6,370 for each year of the period, or, 7,587.50 for the average number stocked at any one time.

Chemical Treatments

In addition to the stocking program, three major management efforts were carried out. (1) In 1952 all of the fish in Red Bluff Slough were destroyed in an effort to control carp and river carpsucker. (2) In 1960-61 a major effort was carried out to control marginal vegetation. (3) In July 1963 the major portions of the lake were treated to drastically reduce or eliminate existing fish. In addition to these major efforts, minor management efforts to control noxious vegetation in specific localities were attempted, and a contract commercial fisherman removed rough fish from the lake during 1952-53. Blue catfish were stocked on two occasions. Seeding of silt flats with millet to reduce turbidity was attempted.

Discussion

It would appear that the most detrimental factor to game fish production has been the significant decline of water levels over extended periods of time. Between 1953 and 1954 there was a drastic reduction in volume. During that period, sampling indicated all of the principal game species were significantly reduced. Gross game fish production also declined. At the same time carp, river carpsucker, and smallmouth buffalo increased, and gizzard shad increased in relative abundance by weight, although numbers declined slightly. The second major change occurred during the 1955-1960 period. Overall water levels and volume increased. During that period, sampling indicates that largemouth bass, white crappie, and white bass increased substantially, but channel catfish experienced a substantial increase

that was followed by an equal decrease. Gross production of game species increased. The relative abundance of gizzard shad and carp apparently increased during the first few years but decreased toward the end of the period. River carpsucker increased substantially. Gross production of non-game species increased. The third period of major change in volume occurred between 1960 and 1963. It was during this period, a period of major decline in water levels, that the influence of declines is most obvious. The included data indicate substantial decreases for white crappie, channel catfish, and white bass. Data also indicate an initial increase in largemouth bass followed by a slight decline. It is my opinion that the data from sampling with standard units, which was completed a significant time before the chemical treatment was carried out is misleading. Netting toward the end of the period was carried out with large mesh gill nets in order to salvage game fish and with beach seines. Data from these collections plus observations of the fish destroyed indicated that virtually all game fish perished prior to the treatment and during the drastic recession of 1962-63. The gross effect for the period was established beyond reasonable doubt to be increasing non-game fish production and drastically declining game fish production.

Unmeasured influences that are known to have occurred include minor decreases in water levels during periods when spawning of game fish normally occurs. Observations would tend to support the concept that largemouth bass spawned only three times in ten years. Accompanying recessions, there has occurred an increase in chlorides and alkalinity. It would also appear that a build up of these chemicals precedes reduction in game fish production. In the past, extremely dense aquatic vegetation, primarily bulrushes and cattails that were located in marginal waters, has tended to reduce game fish reproduction through obstruction and by preventing adequate circulation of the lake water. Lack of circulation also resulted in stagnation and excessive surface water temperatures.

Conditions and circumstances that are considered worthy of further investigation include: (1) further evaluation of the results of the management effort, including a measure of the harvest; (2) the change in game fish production that will result from increased stability of water levels when the lake is used as a control reservoir for Twin Buttes project; (3) the effect of the hydro-electric plant on game fish production and movement and (4) the effect of sudden and significant increases in volume on the reproduction habits of principal species.

References

A. Fisheries Investigations

- Project F-5-R-1, Job Completion Report B-1 (Inventory Study)
- Project F-5-R-1, Job Completion Report B-2 (Creel Census)
- Project F-5-R-2, Job Completion Report B-2 (Creel Census)
- Project F-5-R-3, Job Completion Report B-3 (Creel Census)
- Project F-5-R-5, Job Completion Report B-22 (Resurvey)
- Project F-5-R-6, Job Completion Report B-22 (Resurvey)
- Project F-5-R-7, Job Completion Report B-22 (Resurvey)
- Project F-5-R-8, Job Completion Report B-22 (Resurvey)
- Project F-5-R-8, Job Completion Report D-1 (Fishery Problems)
- Project F-5-R-9, Job Completion Report B-32 (Reconnaissance)
- Project F-5-R-10, Job Completion Report B-32 (Reconnaissance)
- Project F-5-R-11, Job Completion Report B-32 (Reconnaissance)

Project F-5-R-12, Job Completion Report B-32 (Reconnaissance)
Project F-5-R-12, Job Completion Report B-28 (Harvest Regulations)
Project F-14-D-7, Job Completion Report 16a-47 (Rough Fish Control)
Project F-15-D-2, Job Completion Report 15a-7 (Noxious Vegetation Control)

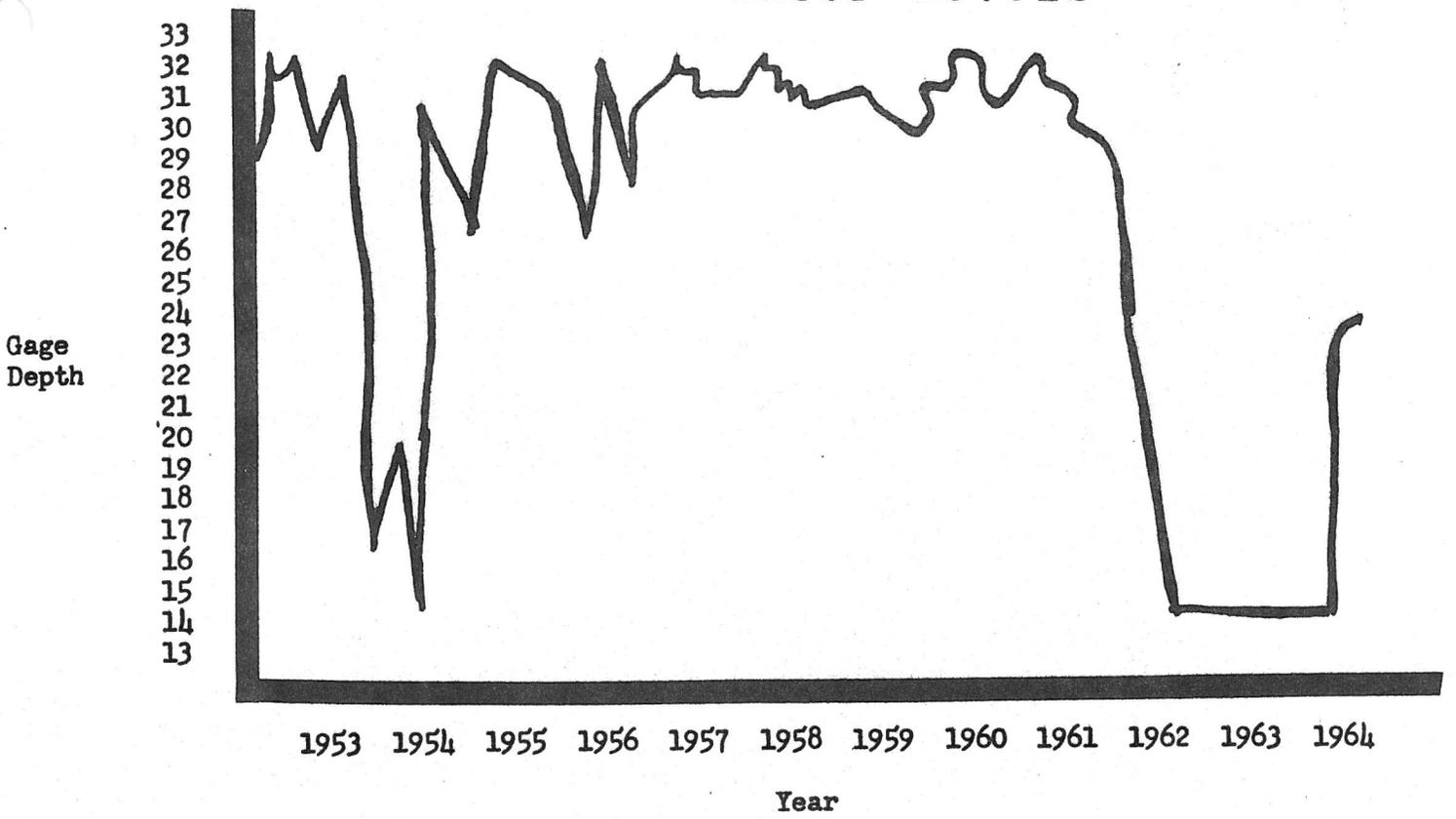
B. Hydrological and Water Quality Data

Records of City of San Angelo Water Department
Water Supply Papers and Records of the United States Geological Survey
Sedimentation Surveys by the United States Soil Conservation Service,
December 1938.
Texas Water Commission Bulletin 6408

(Figure 241)

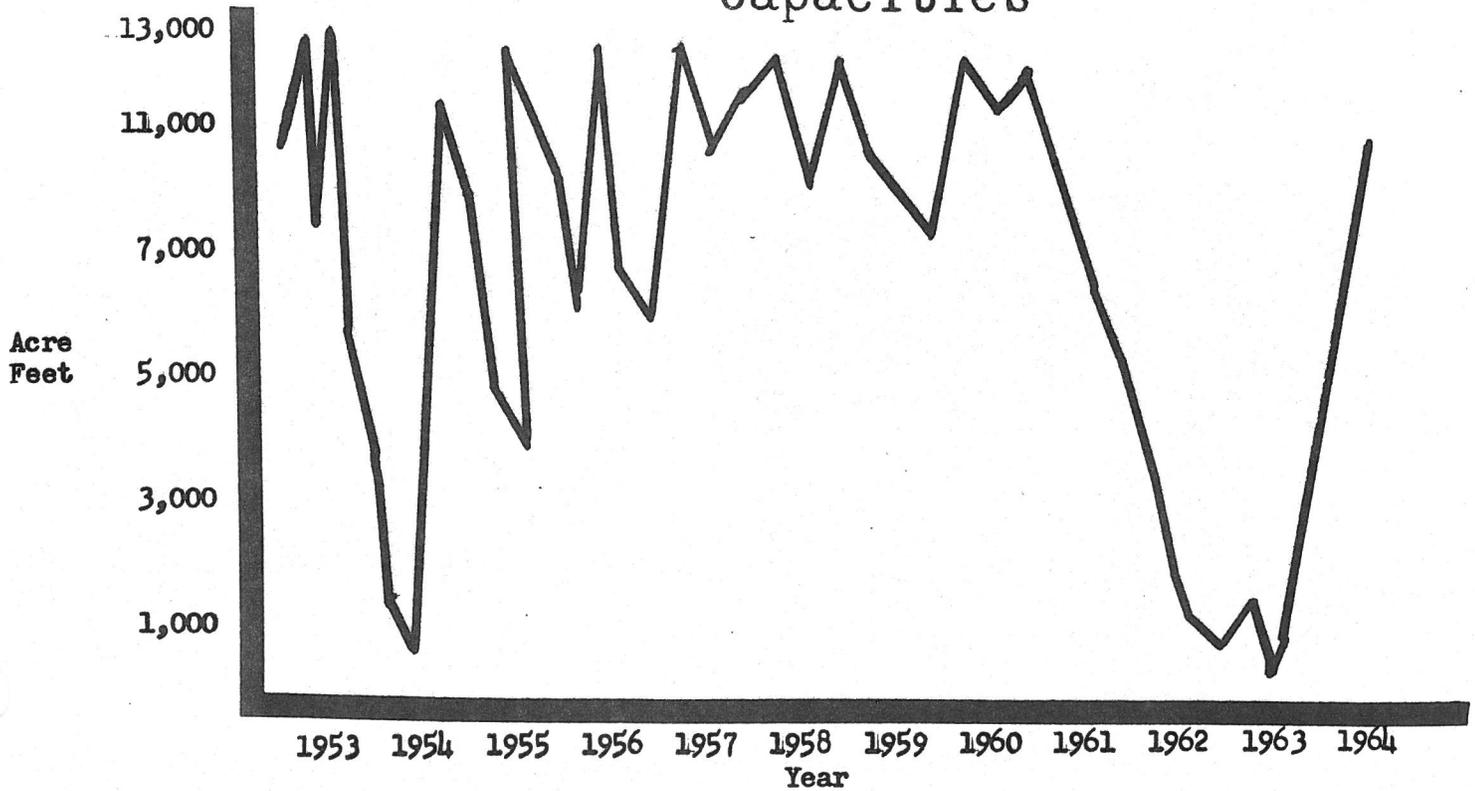
HYDROLOGICAL DATA FOR LAKE NASWORTHY

Water Levels



(Figure 242)

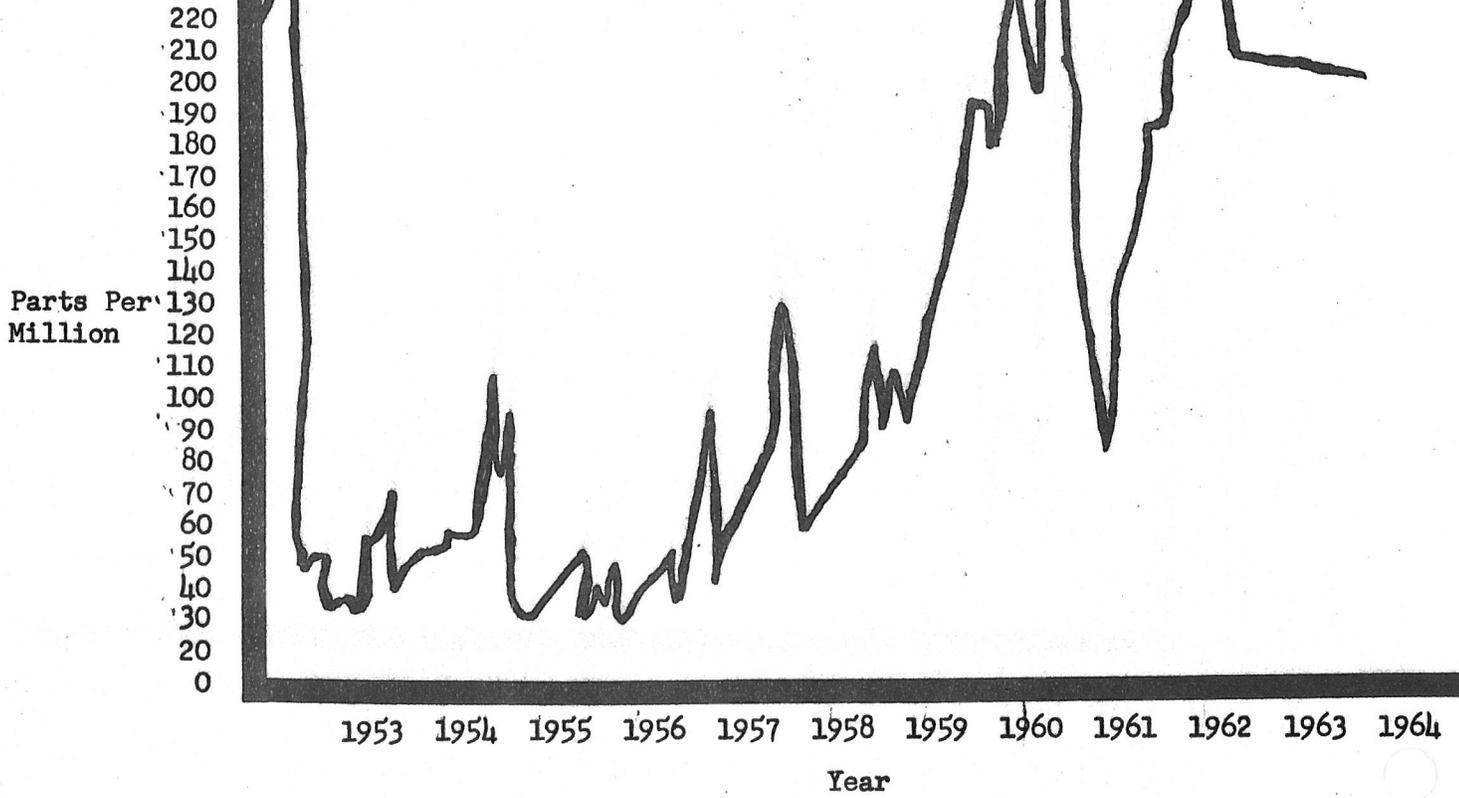
Capacities



(Figure 243)

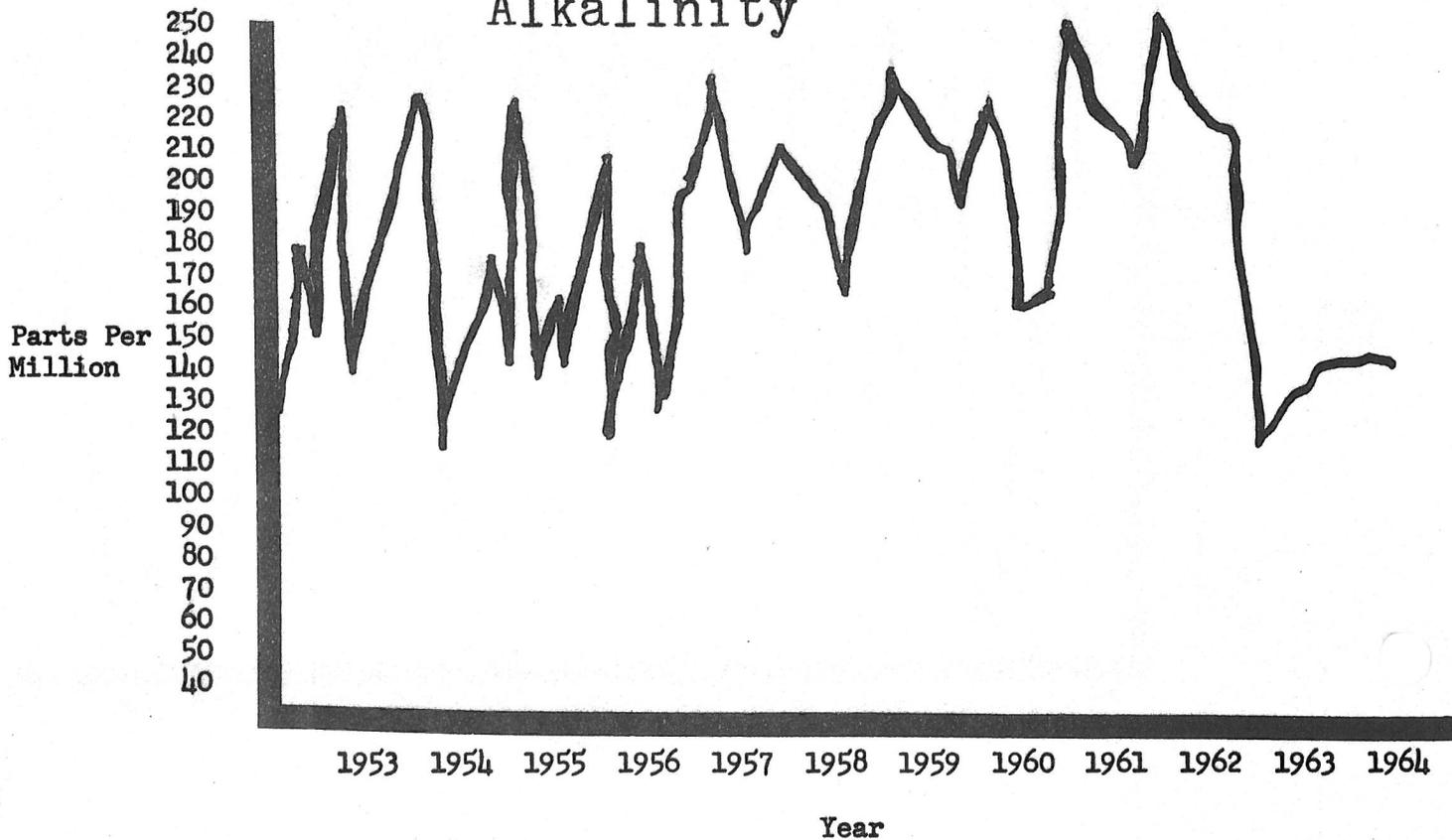
WATER QUALITY DATA FOR LAKE NASWORTHY

Chlorides



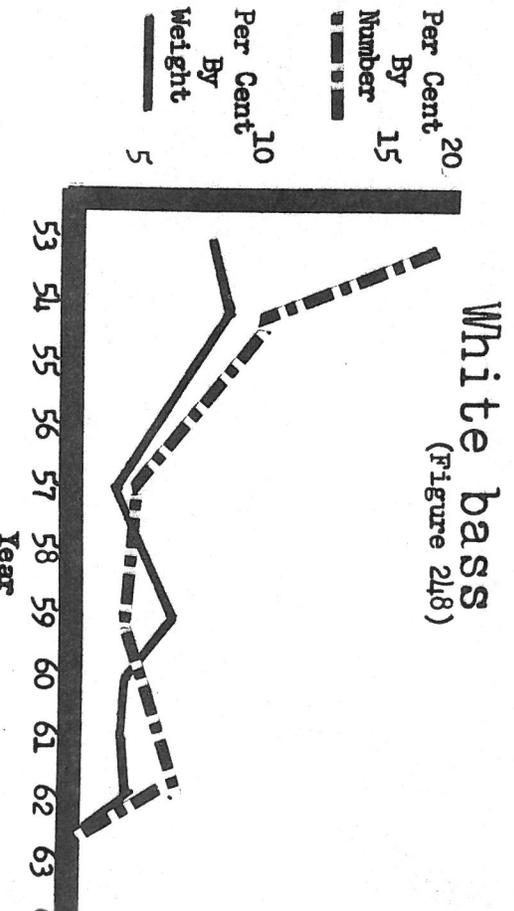
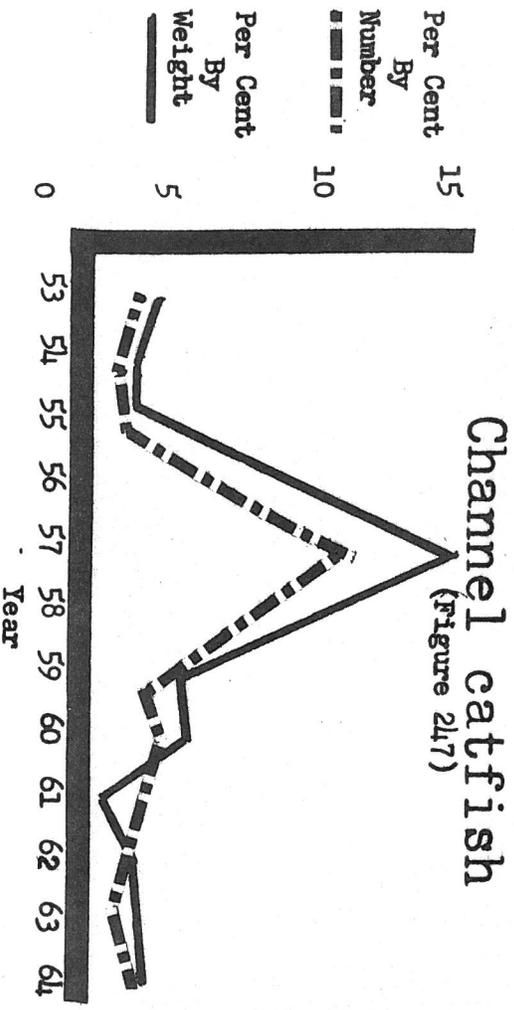
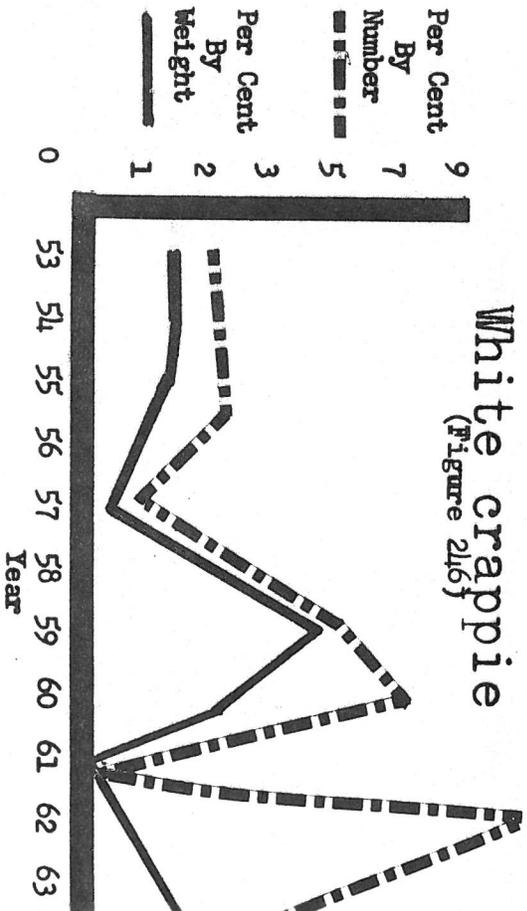
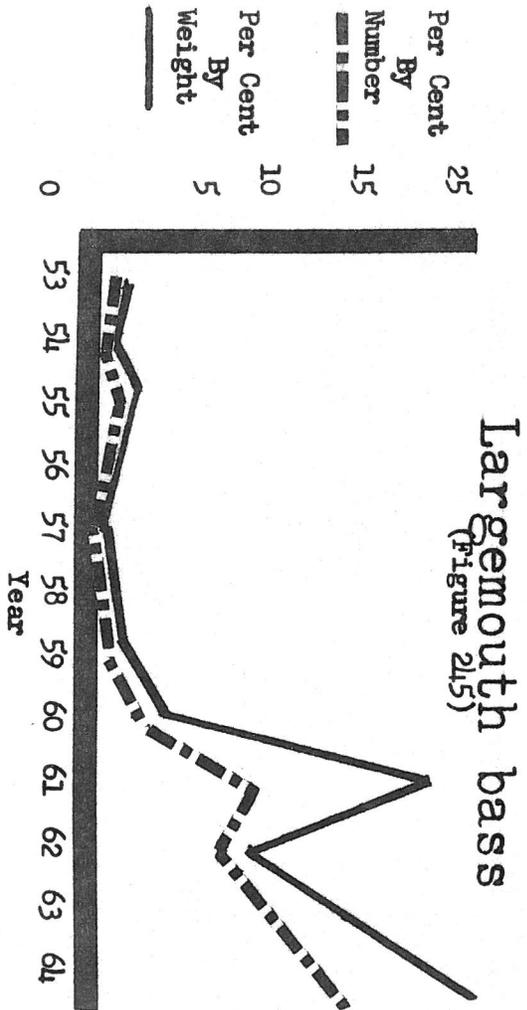
(Figure 244)

Alkalinity



FISH PRODUCTION FROM LAKE NASWORTHY

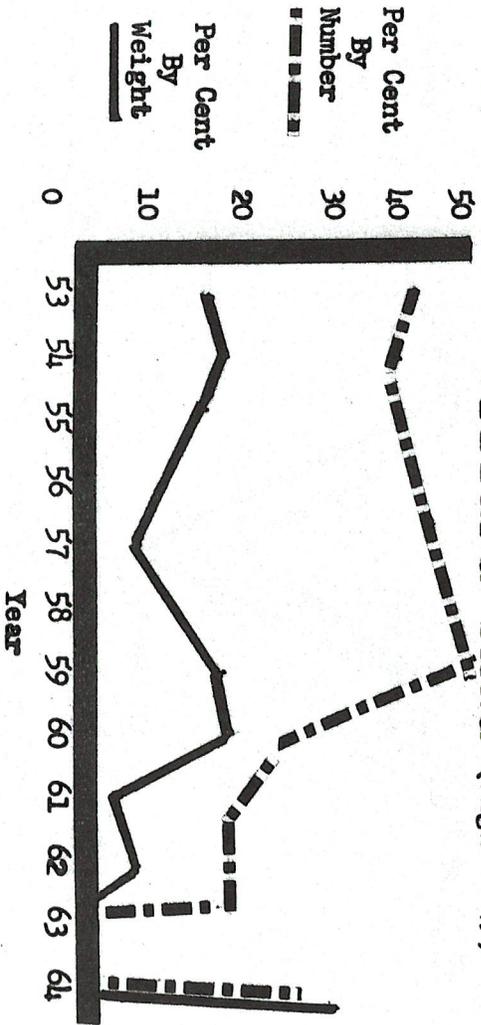
Game Fish Production



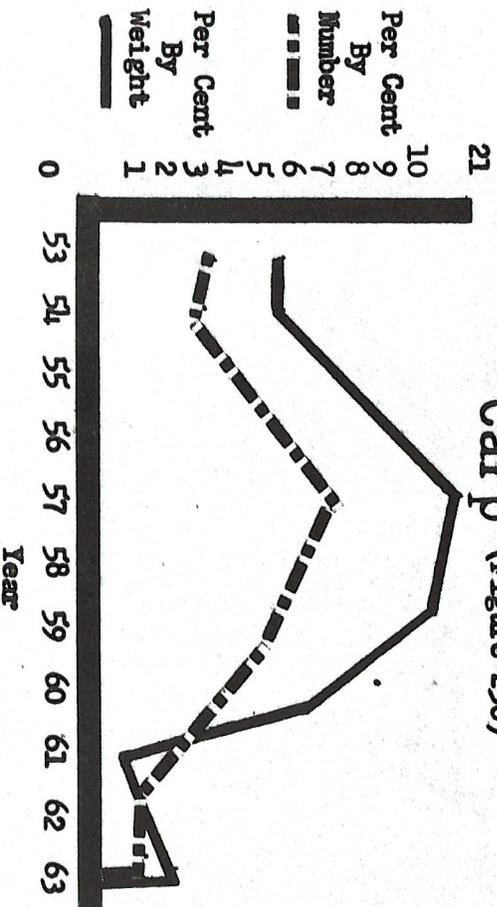
FISH PRODUCTION FROM LAKE NASWORTHY

Principal Non-Game Species

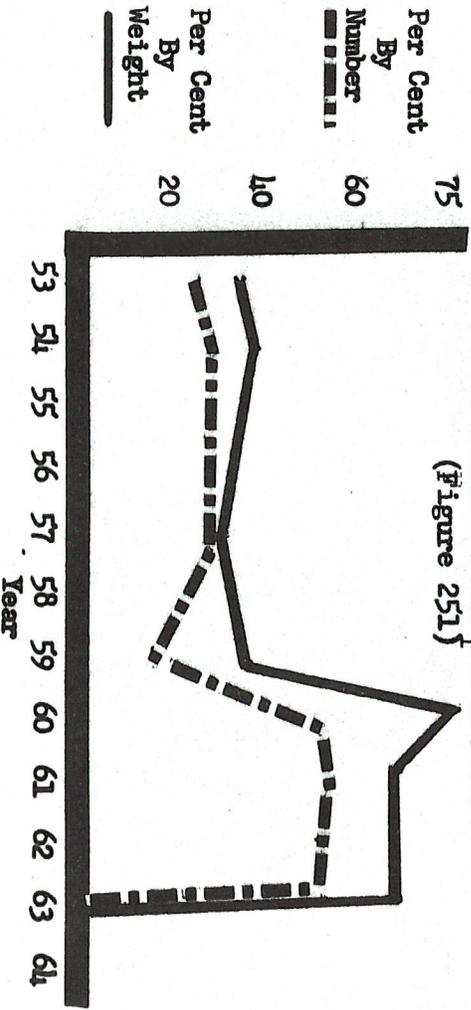
Gizzard shad (Figure 249)



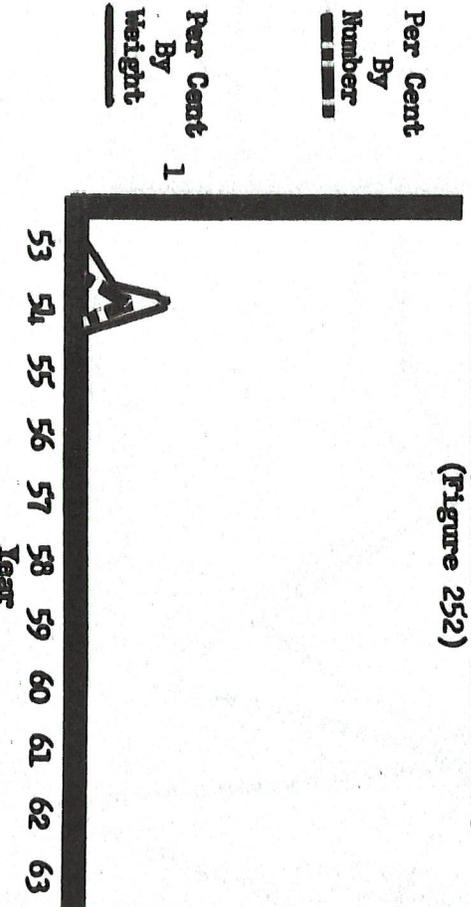
Carp (Figure 250)



River carpsucker (Figure 251)

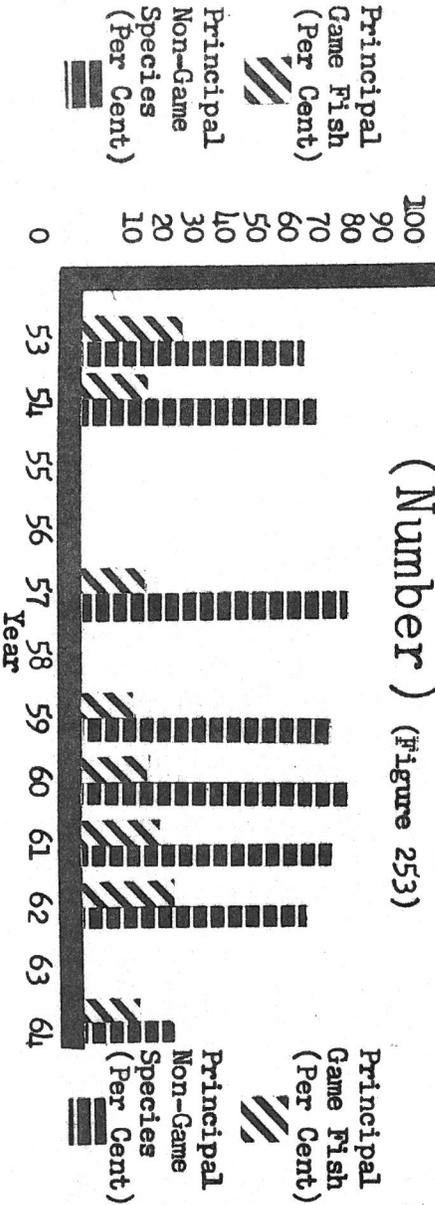


Smallmouth buffalo (Figure 252)

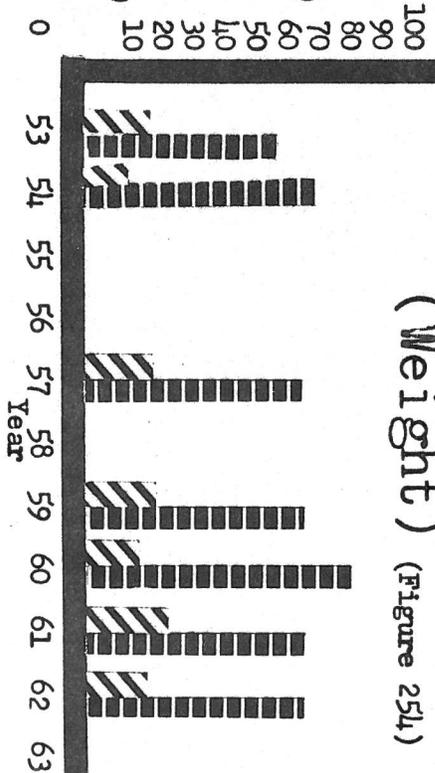


LAKE NASWORTHY

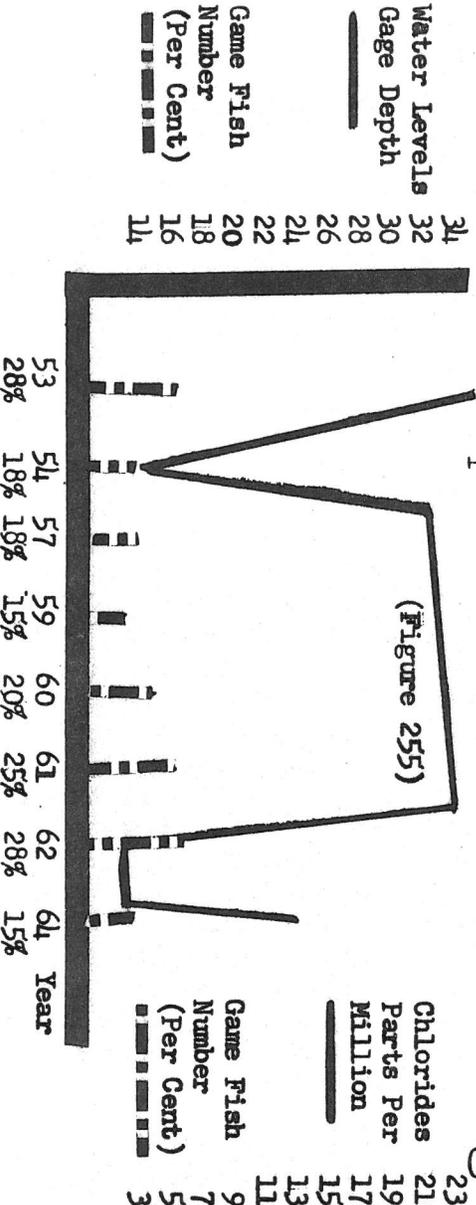
Principal Production (Number) (Figure 253)



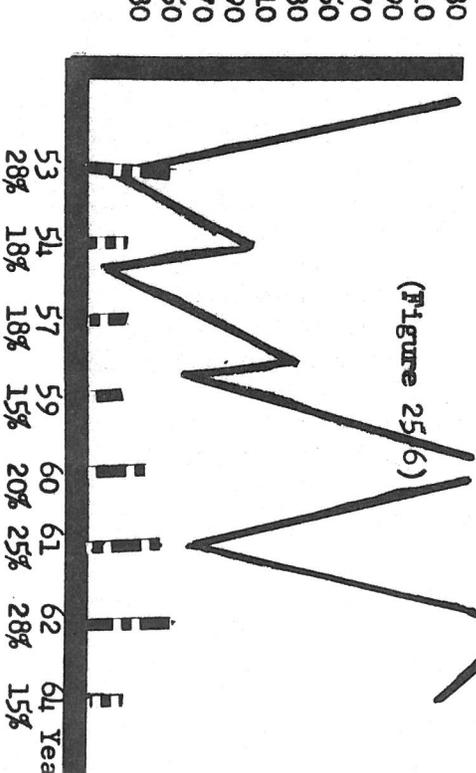
Principal Production (Weight) (Figure 254)



Principal Factors Influencing Game Fish Production (Figure 255)



Principal Factors Influencing Game Fish Production (Figure 256)



Twin Buttes Reservoir

Location

Twin Buttes Reservoir is in the Colorado River Basin in Tom Green County, 8 miles southwest of San Angelo on the South Concho River, Spring Creek, and Middle Concho River.

Ownership and History of Development

The project is owned by the U. S. Government and will be operated by the U. S. Bureau of Reclamation, Amarillo Office, for flood control, conservation uses, irrigation, and recreation. Local agencies cooperating in the project are the San Angelo Water Supply Corporation for municipal water supply and Tom Green County Water Control and Improvement District No. 1 for irrigation water. Federal authorization was Public Law 85-152, dated August 16, 1957, Permit No. 1949, dated February 3, 1960, was issued by the State Board of Water Engineers to the San Angelo Water Corporation which has contracted with the U. S. Government for storage space in the reservoir. The permit allows storage of 170,000 acre-feet of water in Twin Buttes Reservoir, annual use of 29,000 acre-feet of water for municipal supply, and 25,000 acre-feet of water for irrigation of 10,000 acres of land. The municipal water is for the city of San Angelo, which has a contract with the Water Supply Corporation whereby the city is assured an adequate supply for foreseeable future needs. The terms of Permit No. 1949 are subject to rights of downstream appropriators, and stipulated that a certain minimum flow must be maintained either by releases from the reservoir or discharge from the city's sewerage or water system. Construction started May 3, 1960, and deliberate impoundment began December 1, 1962. The dam was completed February 13, 1963 when the project was accepted from the contractor by the Bureau of Reclamation.

This project is above Lake Nasworthy and will release water from storage to keep Lake Nasworthy at a constant level. Downstream requirements will be further regulated by this reservoir.

Physical Description

The dam is the second largest earthfill structure and third largest in volume constructed by the U. S. Bureau of Reclamation. It is 8.1 miles long and 131 feet maximum height with the top of the dam at elevation 1,991.0 feet above m.s.l.

The reservoir has a controlled capacity of 600,000 acre-feet as shown in the list following this section. Because of different elevations of the three streams on which the dam is built, an equalizing channel 3.22 miles long with a bottom width of 250 feet was built connecting the South Concho and Middle Concho Rivers and Spring Creek impoundments into one common reservoir. There has been 20,000 acre-feet of storage space allocated to sediment reserve. The drainage area above the dam is 3,724 square miles, of which 1,178 square miles is probably noncontributing.

The irrigation system consists of the main canal, 16 miles long with a capacity of 165 c.f.s. The headgate for control of the flow to the canal is located at the right abutment of Nasworthy Dam. The distribution system consists of 39 miles of laterals. The main canal and laterals are lined with concrete. Pertinent data on the dam and reservoir are listed below.

Type of dam.....earthfill
 Length of dam.....8.1 miles
 Crest width of dam.....30.0 feet
 Bottom width of dam (maximum).....760.0 feet
 Height of dam (maximum).....131.0 feet

Feature	Elevation (feet above m.s.l.)	Capacity (acre-feet)	Area (acres)
Top of dam	1,991.0	- -	- -
Maximum design flood stage	1,985.0	1,034,020	31,830
Top of flood storage space	1,969.1	600,000	22,700
Top of conservation storage space	1,940.2	170,060	8,400
Bottom of equalizing channel	1,925.0	74,470	- -
Invert of low intake structure	1,885.0	760	- -
Stream bed (Middle Concho)	1,861.0	0	0

The 600,000 acre-feet of controlled capacity is allocated as follows: 20,000 acre-feet for 20 years of sedimentation; 40,000 acre-feet for municipal supply; 110,000 acre-feet for joint irrigation, municipal and industrial supply, and 430,000 acre-feet for flood control. Total dead storage in the three branches of the reservoir is 5,100 acre-feet.

History of Fisheries Investigations and Management

Studies of the Middle and South Concho Rivers date from the mid 1940's, and distribution of species records predate that period. However, the first large-scale survey of those streams was carried out in 1953, and the most complete investigation was carried out in 1962-63. Sampling of existing populations has continued to the present.

Stocking Record

Since Twin Buttes has never reached proportions that can be accurately defined the stocking designated is that for Twin Buttes Project and includes significant areas of the Middle Concho River, of Dove and Spring Creeks, and of the South Concho River. The figures are for the 1962-1965 period.

Largemouth bass: 497,100
Sunfish (including redear sunfish, redbreast, and green sunfish): 83,825
White crappie: 6,000
Channel catfish fingerling: 93,825
Blue catfish: 7,700
Minnows and shiners (including red shiners, spottail shiners, and plains minnows):
300,000

Discussion

The lake has never filled and for that reason production factors are unknown. The proposed usage indicates a probable lack of stability of water levels for the primary basin and frequent severance between the primary basin, the basin on the Middle Concho Watershed, from the secondary (diversion) basin on the South Concho Watershed. It is suggested that this circumstance may provide the means of effectuating management. Under proper conditions it would be possible to treat the smaller diversion reservoir without involving the great expense required to treat the primary basin. The diversion reservoir is maintained at a relatively stable level by continuous flow from the spring fed South Concho River. The net effect of such an effort might be to produce an abundance of brood fish that would migrate to the primary basin at the time the basins were rejoined by substantial increases in volume.

References

A. Fisheries Investigations

Project F-5-R-1, Job Completion Report A-1 (Inventory)
Project F-5-R-1, Job Completion Report B-6 (Inventory)
Project F-5-R-10, Job Completion Report B-33 (Preimpoundment Survey)
Project F-14-D-6, Job Completion Report 16a39 (Population Controls)
Project F-5-R-10, Job Completion Report B-32 (Population Sampling)
Project F-5-R-11, Job Completion Report B-32 (Population Sampling)
Project F-5-R-12, Job Completion Report B-28 (Harvest Regulations)
Project F-5-R-12, Job Completion Report B-32 (Reconnaissance)

B. Hydrological and Water Quality Data

Revised Public Use Plan Twin Buttes Reservoir, National Park Service
State Board of Water Engineers, Bulletin 5807-A
Texas Water Commission Bulletin 6408

San Angelo Reservoir

Location

San Angelo Reservoir is in the Colorado River Basin in Tom Green County, adjacent to northwest San Angelo. The dam is on the North Concho River.

Ownership and History of Development

The project is owned by the U. S. Government, and was built and is operated by the U. S. Army Corps of Engineers, Fort Worth District. Construction was authorized under the Flood Control Act of August 18, 1941, 77th Congress, first session, and 78th Congress, second session.

The Upper Colorado River Authority has purchased conservation storage space in the reservoir for \$775,000 payable over a 50-year period. Permit No. 1516 granted the Upper Colorado River Authority the use of 80,400 acre-feet of water annually for municipal, industrial, irrigational, mining and recreational purposes. The water supplements San Angelo's water supply which previously has been obtained solely from Lake Nasworthy. Twin Buttes Reservoir on the South and Middle Concho Rivers and Spring Creek will also supply water for the area's future needs. Construction started in May 1947, closure was completed March 7, 1951, and deliberate impoundment began February 1, 1952. The dedication was in May 1951, but the project was not completed until 1960. Seepage studies and grouting were still in progress at the end of 1962.

Physical Description

The dam is compacted-earth 40,885 feet long, including the spillway, with a maximum height of 128 feet, with the top of the dam at elevation 1,964.0 feet above m.s.l. San Angelo Dam and reservoir are further described by the following compilation.

Length of dam including spillway.....40,885 feet
 Height of dam above stream bed.....128 feet
 Spillway, crest length.....1,150 feet
 Shoreline at elevation 1,908.0 feet above m.s.l.....27 miles

Feature	Elevation (feet above m.s.l.)	Capacity (acre-feet)	Area (acres)
Top of dam	1,964.0	813,400	20,630
Maximum design flood stage	1,958.0	696,300	18,390
Spillway crest	1,938.5	396,400	12,700

Top of conservation storage space	1,908.0	119,200	5,440
Intake to 30-inch outlets	1,878.5	22,970	- -
Invert of six gate-controlled outlets	1,840.0	5	3
Stream bed	1,836.0	- -	- -
Sediment reserve	- -	38,800	- -

The reservoir is for flood control, conservation, and recreation purposes. The capacity of conservation storage is 119,200 acre-feet, and the reservoir has 5,440 acres at that elevation. The city of San Angelo has recently completed a pipeline connecting the city water plant with the outlet structures.

History of Fisheries Investigations and Management

A pre-inundation survey was carried out in August 1952. As a result of the findings of that work the basin area and virtually all of the North Concho River were chemically treated to drastically reduce or eliminate existing fish. Following this treatment the reservoir was stocked in the spring of 1953. Subsequent investigations included inventory surveys and creel census for the 1953-1955 period, and periodic sampling of game fish production through 1964. In the spring of 1965 the reservoir was treated for a partial kill to reduce problematic fish.

Stocking Record for San Angelo Reservoir

For actual number of fish stocked multiply entry by 1,000.

	1953	1954	1955	1956	1957	1958	1959
Largemouth bass							
fry	142	48		115.4		151.5	152
fingerling			1.9		8.9		1
Sunfish							
fingerling	20		5.5	9.1	15		1
White crappie							
fingerling	20				1.3	3.0	1
Channel catfish							
fingerling	60	80	4	2.2	19.5		1
Minnows	20						
Flathead adults		.030					
	1960	1961	1962	1963	1964	1965	
Largemouth bass							
fry		336.5	10	62		60	250
fingerling			30			3	30
Sunfish							
fingerling			10.5	4			
White crappie							
fingerling				1			
Channel catfish							
fingerling		20	5	7		3	
Minnows							
Flathead adults							

Total largemouth bass fry stocked in ten year periods: 1,327,400 or an average of 132,740 per year.

Total largemouth bass fingerling stocked: 74,700 or 7,470 per year.

Total sunfish stocked: 66,100 or 6,610 per year.

Total white crappie: 26,300 or 2,630 per year.

Total channel catfish: 201,700 or 20,170 per year.

Total flathead catfish: 30.

In addition to these fish, blue catfish were released on two occasions. The total number was approximately 3,000.

Discussion

It would appear that major changes in water levels and capacities are the principal factors that influence game fish production. Three such changes are apparent from hydrological records. Between 1954-1955 the reservoir experienced a significant and relatively unbroken recession. During that period largemouth bass, white crappie, and channel catfish declined and white bass experienced a very minor increase. In gross production game fish declined. At the same time gizzard shad, river carpsucker, and carp increased. Gross production of the principal non-game species increased. Between 1957 and 1961 the overall trend in the lake capacity was downward, but the trend was interrupted by a significant increase during 1959. During this period all of the principal game species experienced an increase that climaxed in 1959 and were subsequently reduced to near or slightly less than their abundance in 1957. Gross game fish production decreased slightly. Concurrently gizzard shad increased until 1959 when they experienced drastic reduction, and carp appeared to increase until 1959 when they also began a reduction. River carpsucker continued to increase throughout the period. Gross production of principal non-game species declined. The third major change in volume occurred between 1961 and 1963. Largemouth bass declined, rebounded, and then were drastically reduced. White crappie and white bass experienced similar dynamics and channel catfish were reduced. Gross game fish production decreased initially but returned to near its original abundance by 1963. It is noteworthy that gross game fish production was highest during the years of significant increase or immediately following such increases. Between 1961-63 the production of river carpsucker declined in an overall trend, but the species were more abundant in 1962 than for any year in the lake history. Gizzard shad and carp increased and smallmouth buffalo appeared to increase. Gross production of principal non-game species was greater in 1962 than in any preceding year but declined by 1963.

The influence of minor adjustments in water levels that is unmeasured but of significant importance is recorded in observations. During the late spring increasing demands for water for municipal and industrial purposes, plus a mounting increase in the rate of evaporation, result in minor declines in the lake level during the period when largemouth bass are attempting to spawn. Observations and seining indicate that the species has successfully reproduced only twice in ten years. The future use of the reservoir as the primary source for city water may be expected to further reduce stability during this critical period.

References

A. Fisheries Investigations

- Project F-5-R-1, Job Completion Report B-3 (Inventory)
- Project F-5-R-1, Job Completion Report B-9 (Creel)
- Project F-5-R-2, Job Completion Report B-3 (Inventory)
- Project F-5-R-2, Job Completion Report B-9 (Creel)
- Project F-5-R-3, Job Completion Report B-3 (Inventory)
- Project F-5-R-3, Job Completion Report B-9 (Creel)
- Project F-5-R-5, Job Completion Report B-22 (Resurvey)
- Project F-5-R-7, Job Completion Report B-22 (Resurvey)
- Project F-5-R-8, Job Completion Report B-22 (Resurvey)
- Project F-5-R-8, Job Completion Report B-1 (Fisheries Problems Determination)
- Project F-5-R-10, Job Completion Report B-32 (Reconnaissance)
- Project F-5-R-11, Job Completion Report B-32 (Reconnaissance)
- Project F-5-R-12, Job Completion Report B-28 (Harvest Regulations)
- Project F-14-D-8, Job Completion Report 16a-49 (Population Controls)

B. Hydrological and Water Quality Data

- United States Corps of Engineers, Records on Water Levels, Recreational Usage and Water Temperatures.
- A REPORT ON FISH AND WILDLIFE RESOURCES IN RELATION TO SAN ANGELO RESERVOIR, NORTH CONCHO RIVER, COLORADO RIVER BASIN, Prepared by Office of River Basin Studies, Fish and Wildlife Service, Region 2, Albuquerque, New Mexico.
- U. S. Geological Survey Papers, Water Supply Records.
- State Board of Water Engineers, Bulletin 5807-A.
- Water Commission Bulletin 6408.
- Records of San Angelo Water Department.

(Figure 257)

HYDROLOGICAL DATA FOR SAN ANGELO RESERVOIR Water Levels



(Figure 258)

Capacities

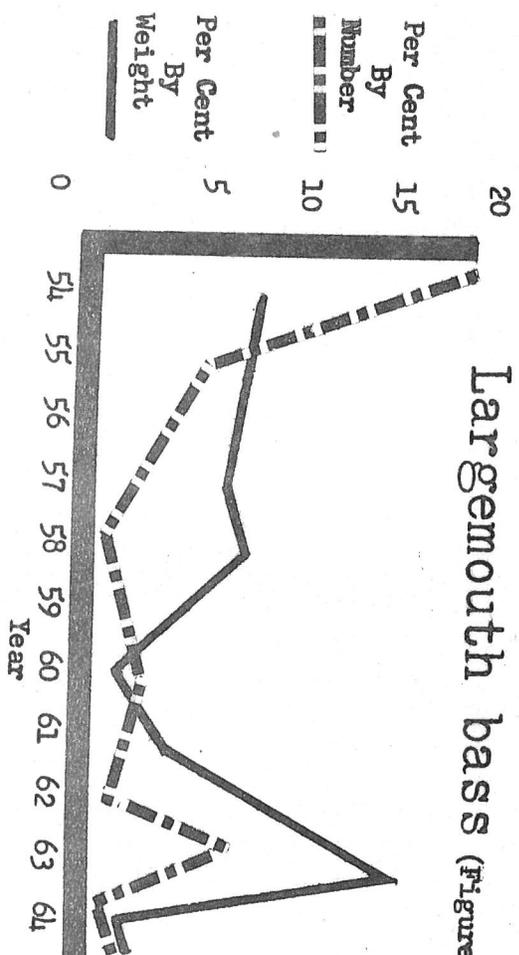


FISH PRODUCTION FRC SAN ANGELO RESERVOIR

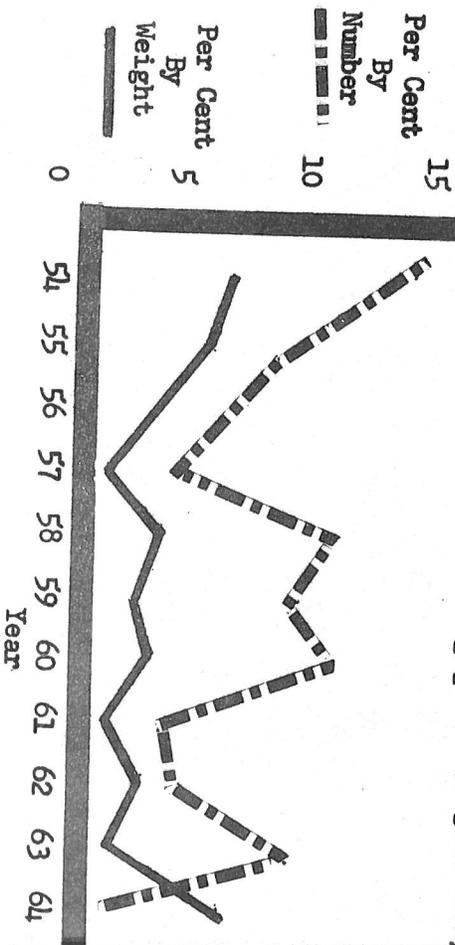
Game Fish Production

-150-

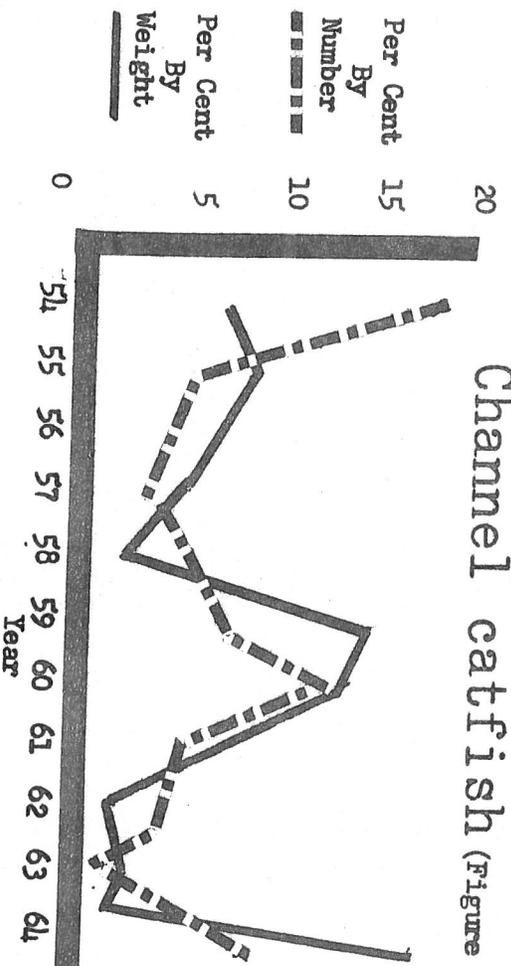
Largemouth bass (Figure 259)



White crappie (Figure 260)



Channel catfish (Figure 261)



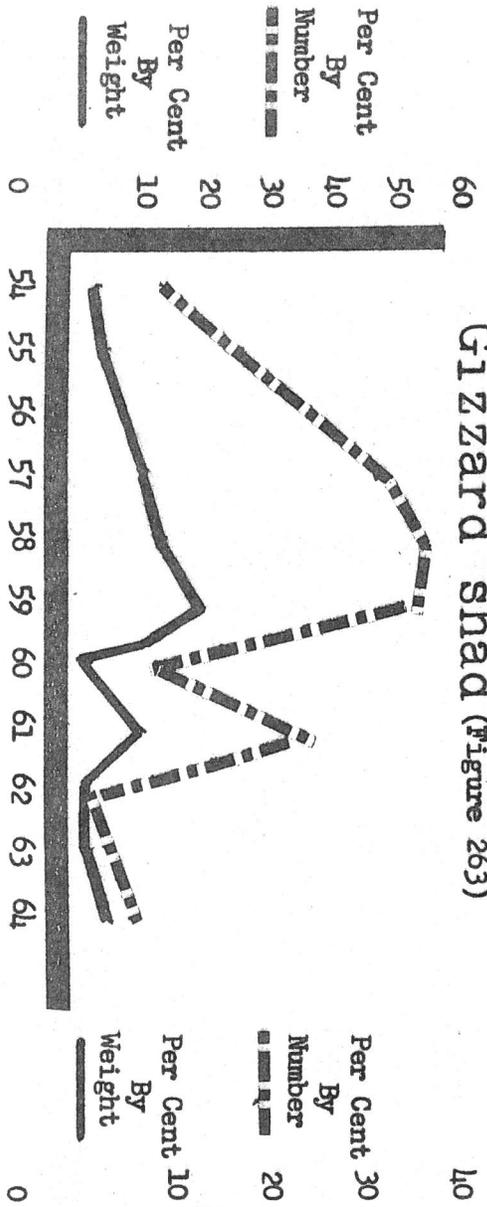
White bass (Figure 262)



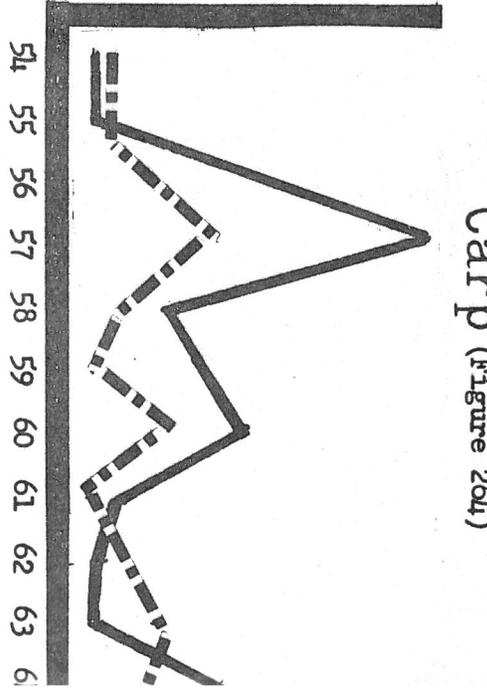
FISH PRODUCTION FROM SAN ANGELO RESERVOIR

Principal Non-Game Species

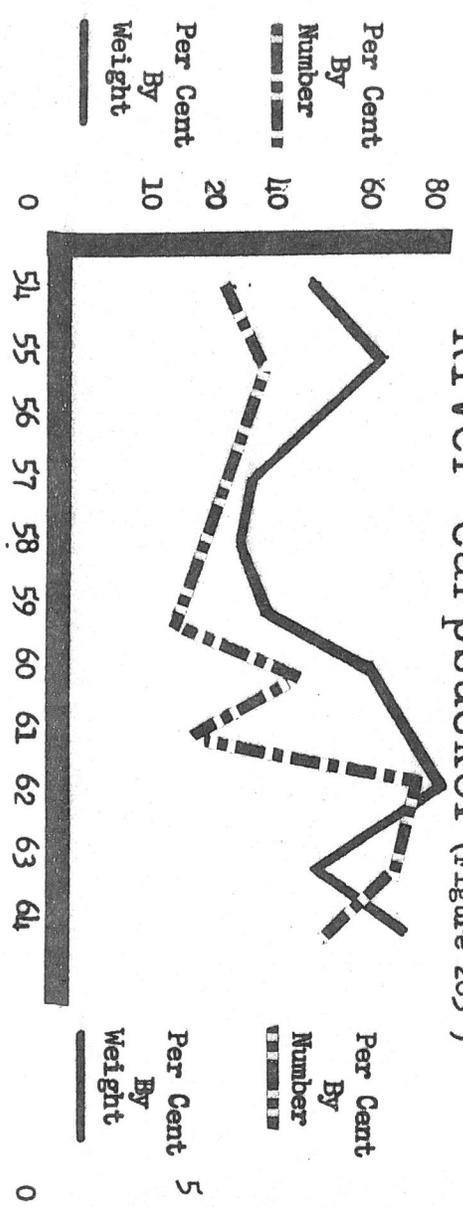
Gizzard shad (Figure 263)



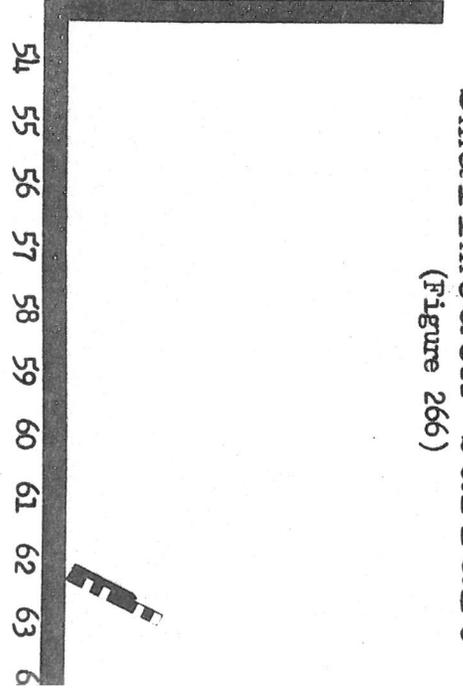
Carp (Figure 264)



River carpsucker (Figure 265)

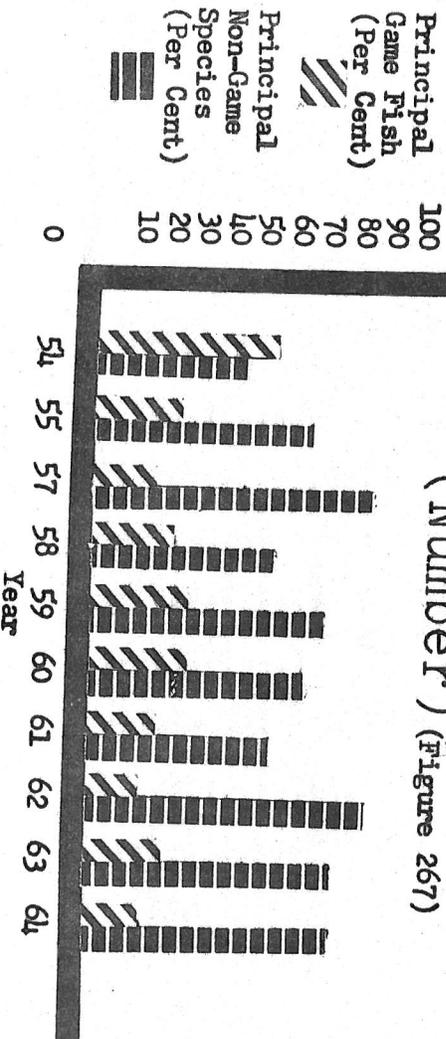


Smallmouth buffalo (Figure 266)

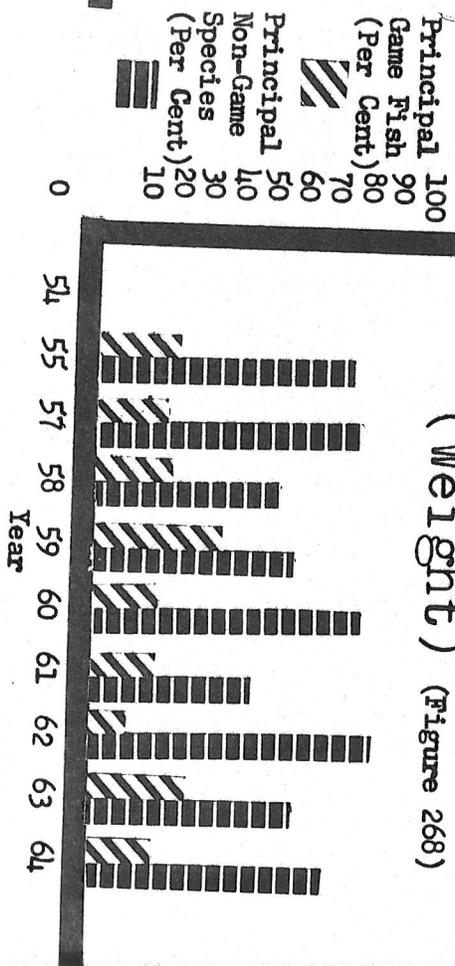


SAN ANGEL C RESERVOIR

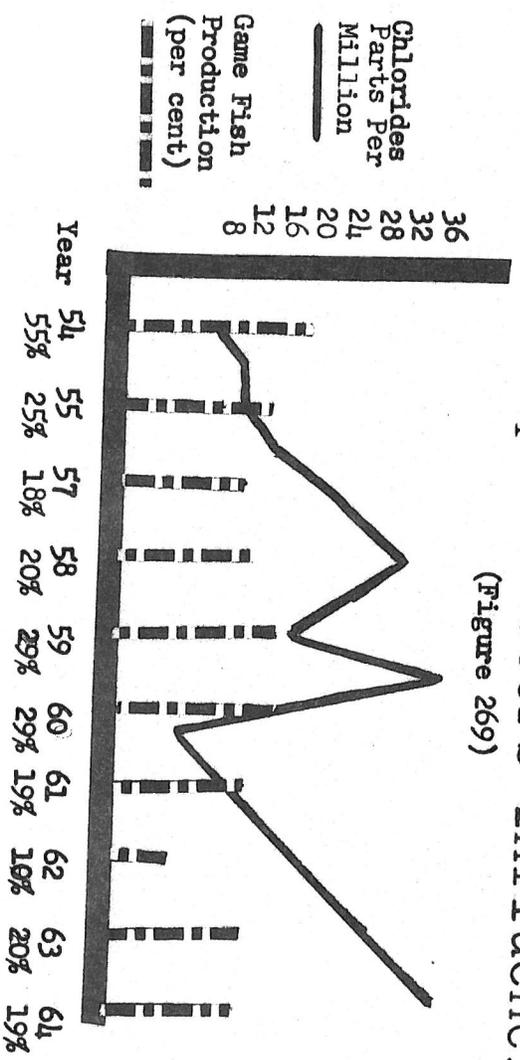
Principal Production (Number) (Figure 267)



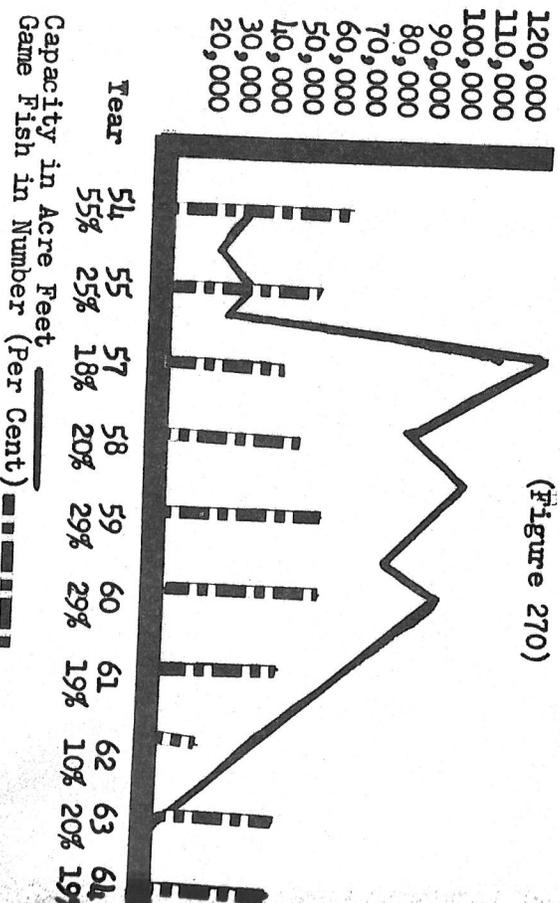
Principal Production (Weight) (Figure 268)



Principal Factors Influencing Game Fish Production (Figure 269)



Principal Factors Influencing Game Fish Production (Figure 270)



	1959	1960	1961	1962	1963	1964
Largemouth bass fry						40
fingerling	1.7	3.5	4			
Sunfish						
fingerling			1.5			
White crappie						
fingerling		.5				
Channel catfish						
fingerling	1	1.5	5			

Total largemouth bass fry: 124,300.
 Total largemouth bass fingerling: 13,000.
 Total sunfish: 22,100.
 Total white crappie: 1,200.
 Total channel catfish: 14,800.

Discussion

Lake Walk and Devil's Lake are the most stable reservoirs in the region. The power and light company that owns and operates these reservoirs maintain lake levels, except in times of flooding, within one foot of spillway capacity. It is unfortunate that data are not available for three of nine years under consideration. More complete data would be particularly valuable as a means of making comparisons between production for these lakes and lakes subject to great fluctuation. It would appear that management carried out by Deitz may have been at least initially successful since gross increases in game fish production followed that management effort. Unfortunately the occurrence of flooding, almost immediately following the treatment, prevents conclusion. When the production dynamics of the upper lake (Devil's Lake) are taken into account, it would appear that the flooding, plus accompanying factors, tended to increase game fish production and possibly may have retarded production of species usually regarded as problematic. Even with the influence of flooding apparent, the production of these lakes is indicated to be more stable and less subject to drastic change than is common in reservoirs of less stability. It is suspected that the steep walls of the canyon forming the lake and the brief shelves that are located in depths suitable for spawning tend to limit game fish reproduction, and the occurrence of dense aquatic vegetation on these shelves may inhibit reproduction. Circumstances that probably benefit production include a long growing season, favorable water temperatures created by the constant flow of spring-fed water through the lake, and limited protection of surface waters from the sun during the hottest part of the summer by the canyon walls. The excellent water quality is certain to contribute to productivity, and the propensity of floods to scour silt free from productive areas and to control aquatic vegetation is usually beneficial. As has been previously pointed out, Lake Walk and Devil's Lake may provide the means, through timely management, of providing a maximum number of brood fish for the new Amistad Reservoir.

Lake Walk

Location

Lake Walk is located in Val Verde County, 11 miles northwest of Del Rio on the Devil's River, a tributary of the Rio Grande.

Ownership and History of Development

The reservoir is owned and operated by Central Power & Light Company for generation of power, and was authorized by Permit No. 1077 dated September 17, 1928. The permit authorized the use of water at the rate of 550 c.f.s. or 401,500 acre-feet per year. The usual flow is much less than this amount. Construction was completed in May 1929, with impoundment of water beginning immediately. Power generation started in May 1929.

Physical Description

The dam is reinforced concrete, 34 feet high and 650 feet long. The lake has a capacity of 5,400 acre-feet with an area of 380 acres at spillway crest elevation of 1,001.0 feet above m.s.l. The drainage area above the dam is 4,104 square miles, but the supply of water to this lake is regulated by the operation of the power plant upstream at Devil's Lake.

This project, like Devil's Lake, will be inundated when the reservoir formed by Amistad Dam on the Rio Grande is constructed.

History of Fisheries Investigations and Management

Limited investigations were carried out in the mid 1940's by Marion Toole, Inland Fisheries Coordinator. Detailed investigations were initiated by William H. Brown in 1953 and continued by Elgin M. C. Dietz following Brown's promotion to Assistant Director. Following inventory studies an attempt was made to control excessive gizzard shad with chemicals in 1957. Subsequent investigations were carried out by personnel of Project F-5-R until the reorganization of the Inland Fisheries Function in Region I and the establishment of Project F-18-R under G. G. Henderson, Jr. in 1965.

Stocking Record

For actual number of fish stocked multiply entry by 1,000.

	1954	1955	1956	1957	1958
Largemouth bass					
fry	80		.50	3.8	
fingerling			4.5	.30	2
Sunfish					
fingerling			19.8		.8
White crappie					
fingerling			.2	.3	.2
Channel catfish					
fingerling			2.6	2.6	2.1

References

A. Fisheries Investigations

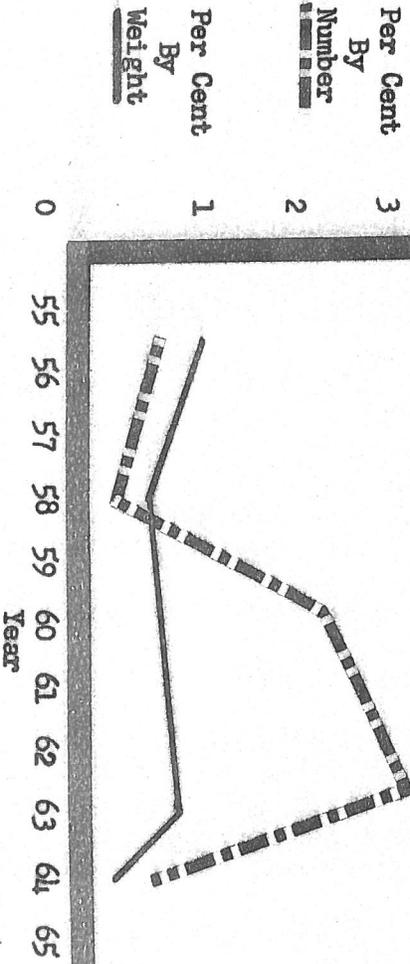
Project F-9-R-2, Job Completion Report A-1 (Basic Survey)
Project F-9-R-2, Job Completion Report B-6 (Inventory)
Project F-9-R-3, Job Completion Report B-15 (Inventory)
Project F-9-R-3, Job Completion Report B-16 (Creel Census)
Project F-9-R-5, Job Completion Report B-20 (Fish Populations)
Project F-14-D-1, Job Completion Report 16a-4 (Selective Control)
Project F-5-R-8, Job Completion Report B-22 (Resurvey)
Project F-5-R-10, Job Completion Report B-32 (Reconnaissance)
Project F-5-R-11, Job Completion Report B-32 (Reconnaissance)

B. Hydrological and Water Quality Data

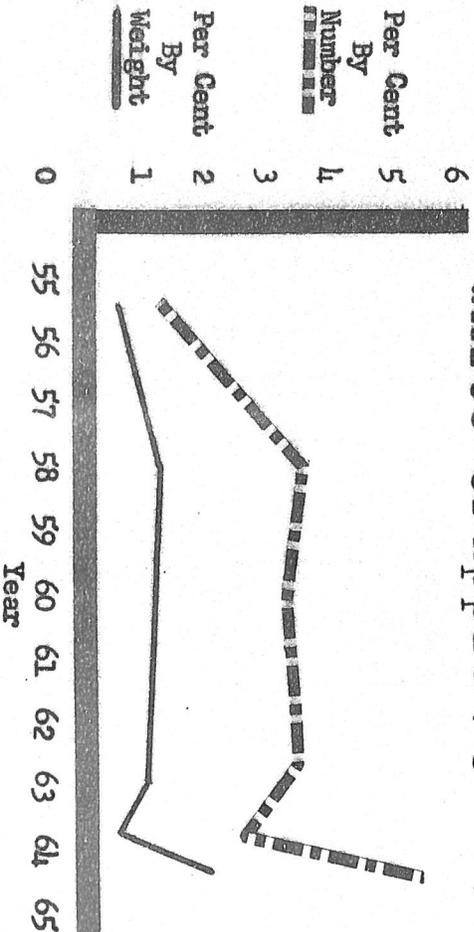
International Boundary and Water Commission, Water Bulletin 1, 5, 6, 14, 16, 25, 26, 27, 28, 30, 31, 32, 33, and unpublished records for 1965.
Records of Central Power and Light Company.
Water Quality of Texas Streams 1958 through 1963, Texas State Department of Health, Water Pollution Control Division.
Texas Water Commission Bulletin 6408.
State of Texas, Board of Water Engineers, TEXAS FLOODS 1957.

FISH PRODUCTION FROM LAKE WALK Game Fish Production

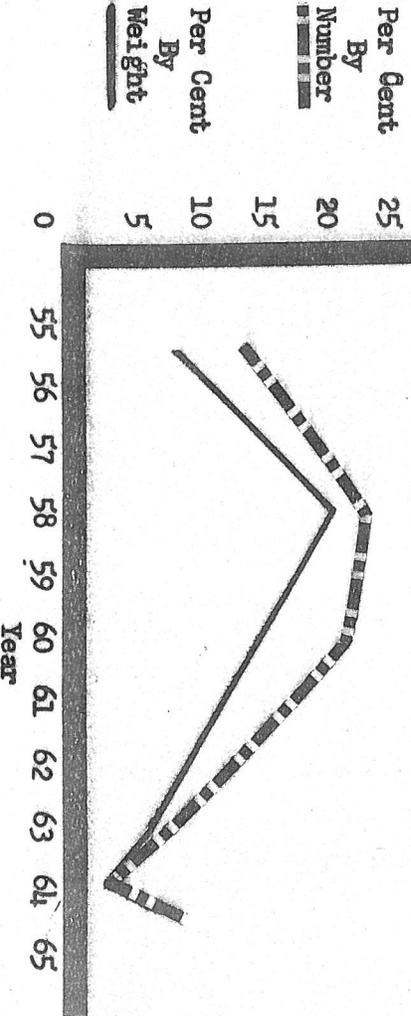
Largemouth bass (Figure 271)



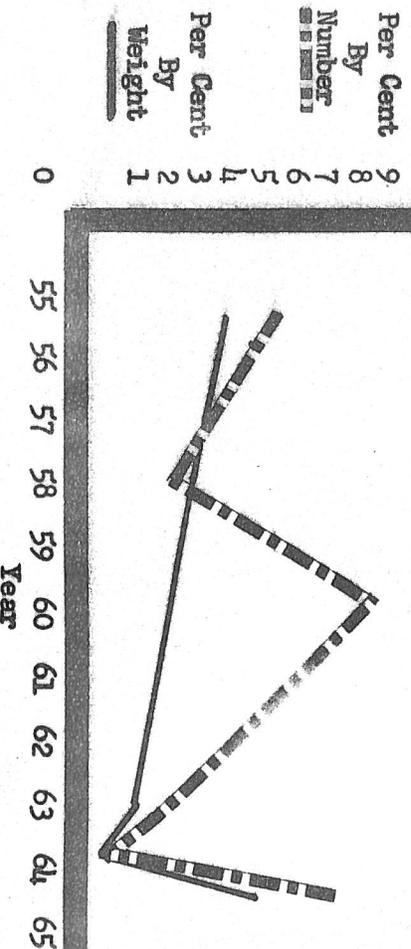
White crappie (Figure 272)



Channel catfish (Figure 273)

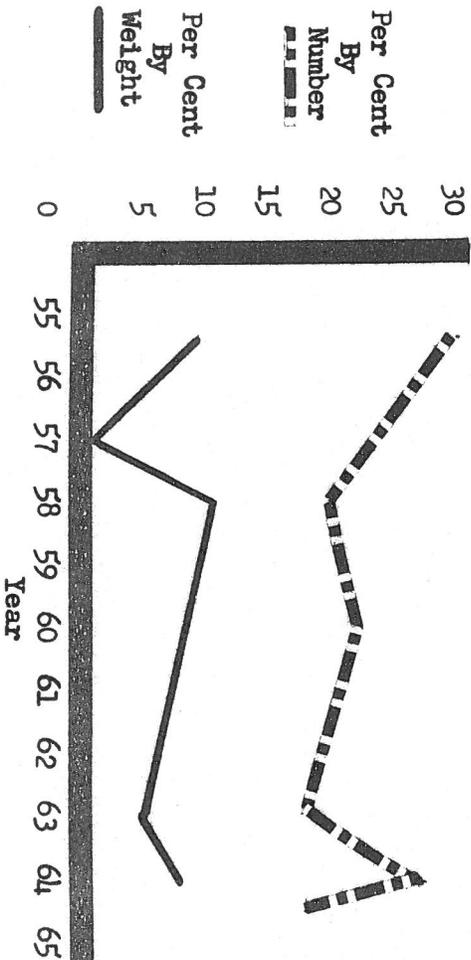


White bass (Figure 274)

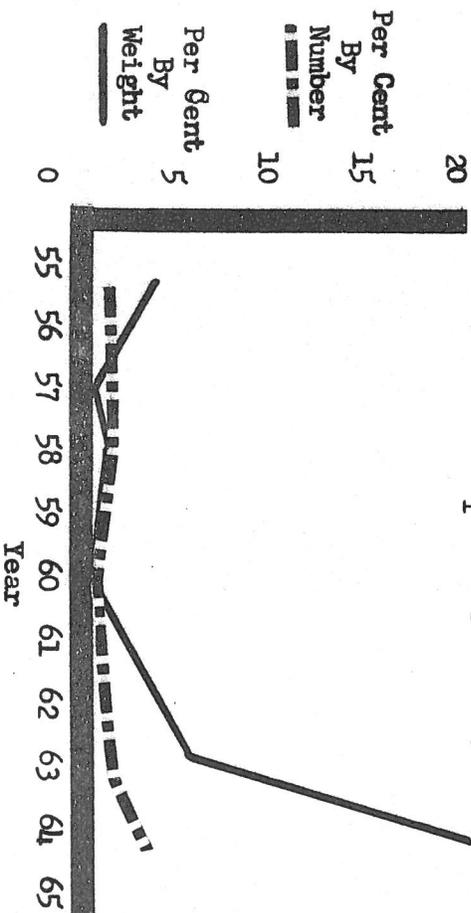


FISH PRODUCTION FROM LAKE WALK Principal Non-Game Species

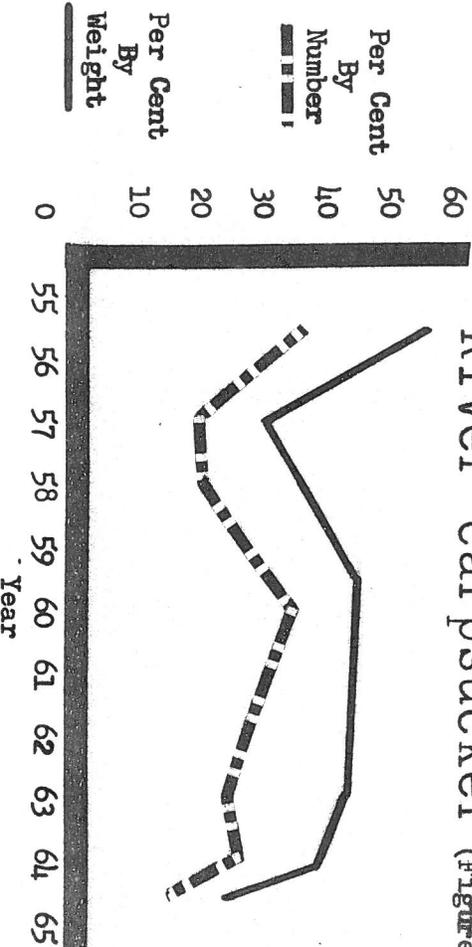
Gizzard shad (Figure 275)



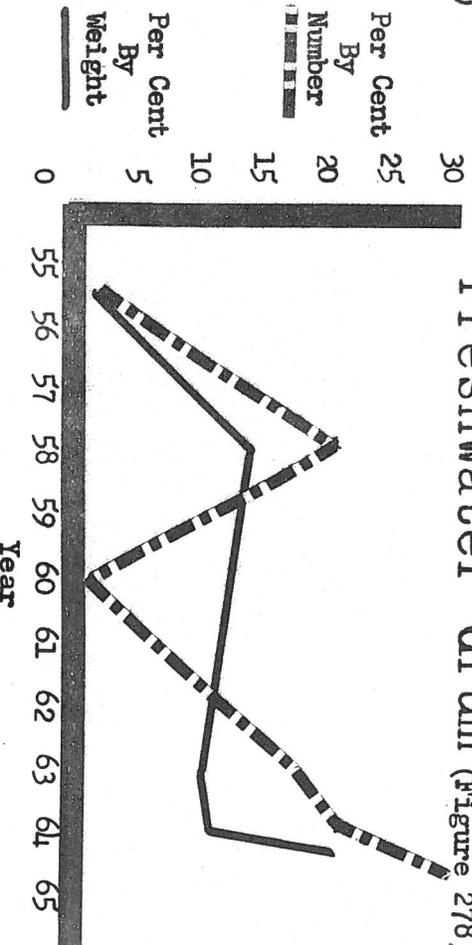
Carp (Figure 276)



River carpsucker (Figure 277)

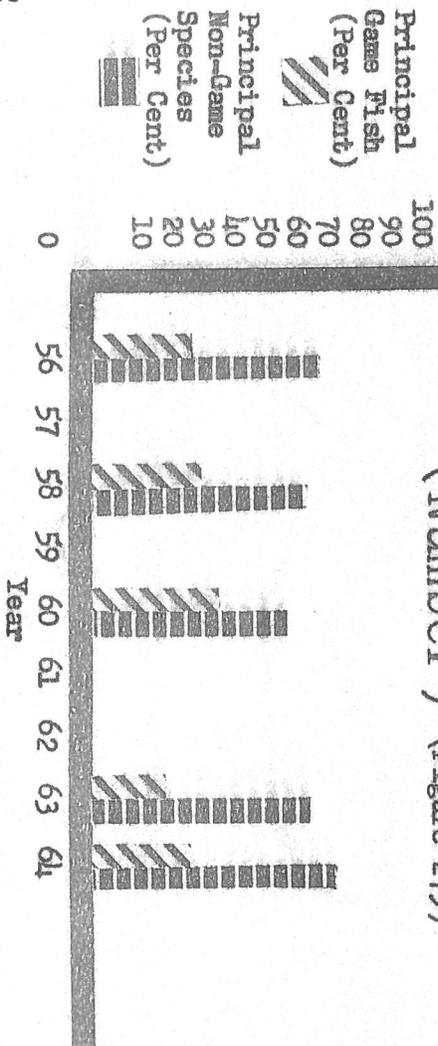


Freshwater drum (Figure 278)

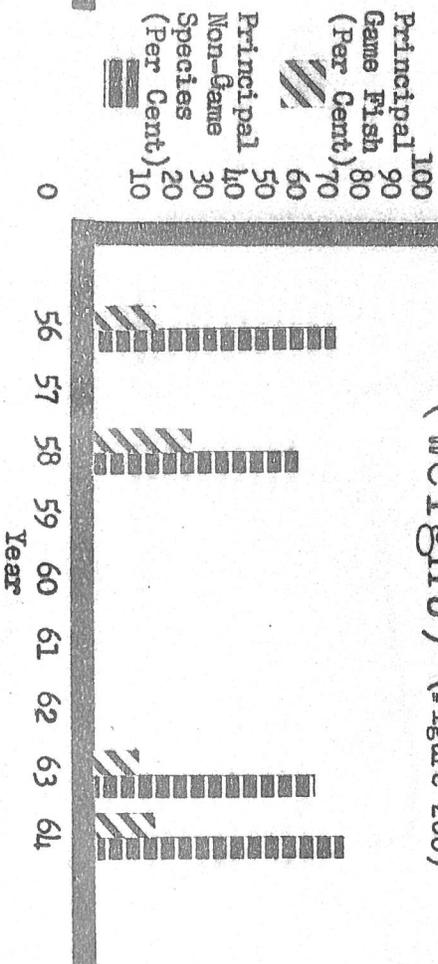


LAKE WALK

Principal Production (Number) (Figure 279)



Principal Production (Weight) (Figure 280)



Devil's Lake

Location

Devil's Lake is 16 miles northwest of Del Rio on the Devil's River, a tributary of the Rio Grande.

Ownership and History of Development

Devil's Lake is owned and operated by Central Power & Light Company for generation of power. Construction of this reservoir was authorized by Permit No. 1049 dated November 2, 1927, which allows use of all flow of the river by construction of a dam to create hydroelectric head, and impounding 10,750 acre-feet of water with the rate of use not to exceed 550 c.f.s. Construction of the dam was completed in December 1928 with impoundment of water beginning at that time.

Physical Description

The dam is of limestone blocks quarried from adjacent hills and laid with cement mortar. It is 42-feet high with provisions for 5 feet of flashboards across the 650-foot-long spillway. At elevation 1,042.3 feet above m.s.l. (top of masonry dam) the reservoir contains 9,200 acre-feet and has a surface area of 406 acres. The drainage area above the dam is 4,053 square miles.

This project will be inundated when the reservoir formed by Amistad Dam on the Rio Grande is completed.

History of Investigations and Management

Marion Toole, Inland Fisheries Coordinator, made limited investigations of this reservoir in the early 1940's. However, a full-scale study was not undertaken until 1953 when William H. Brown initiated study that included an inventory of species and creel census. This work continued through 1955 and was completed under the supervision of Elgin M. C. Dietz. Reconnaissance and resurvey maintained some knowledge of fish production until 1964. No management has been attempted. Investigations under Project F-18-R began in 1965.

Stocking Record

For actual number of fish stocked multiply entry by 1,000.

	1952	1953	1954	1955	1956	1957	1958
Largemouth bass							
fry		100					
fingerling	20			4.5	4.5	8	4
Sunfish							
fingerling	3	1.5			10.8	13	2
White crappie							
fingerling					.2	1.3	.5
Channel catfish							
fingerling	.6	1.5			2	12	2.8

	1959	1960	1961	1962	1963	1964
Largemouth bass						
fry						40
fingerling	1	1.7	4	5		
Sunfish						
fingerling	1.1					
White crappie						
fingerling		.2				
Channel catfish						
fingerling	.6	1.5	5			

Total largemouth bass fry: 140,000.
 Total largemouth bass fingerling: 43,200.
 Total sunfish fingerling: 31,400.
 Total white crappie: 2,200.
 Total channel catfish: 25,400.

Discussion

Devil's Lake is slightly less stable than Lake Walk but for practical purposes can be classified as remaining relatively stable during the study period. In general shape the reservoir basin is similar to that for Lake Walk, but the quantity of shallow water area is greater. It would appear that gross game fish production increased between 1955 and 1960 but declined thereafter. Principal non-game species decreased during the 1955-1960 period but have increased since that time. The flood of 1958 is discussed under Lake Walk and may have been responsible for these dynamics. Other factors that may influence production are identical with those outlined for Lake Walk.

References

A. Fisheries Investigations

Project F-9-R-1, Job Completion Report B-6 (Inventory)
 Project F-9-R-1, Job Completion Report B-4 (Inventory)
 Project F-9-R-1, Job Completion Report B-5 (Creel Census)
 Project F-9-R-2, Job Completion Report B-6 (Inventory)
 Project F-9-R-2, Job Completion Report B-4 (Inventory)
 Project F-9-R-2, Job Completion Report B-5 (Creel Census)
 Project F-9-R-3, Job Completion Report B-4 (Inventory)
 Project F-9-R-3, Job Completion Report B-5 (Creel Census)
 Project F-9-R-6, Job Completion Report B-19 (Resurvey)
 Project F-5-R-8, Job Completion Report B-22 (Resurvey)
 Project F-5-R-10, Job Completion Report B-32 (Reconnaissance)
 Project F-5-R-11, Job Completion Report B-32 (Reconnaissance)

B. Hydrological and Water Quality Data

International Boundary and Water Commission, Water Bulletins 1, 5, 6, 14, 15, 16, 25, 26, 27, 23, 29, 30, 31, 32, 33, and unpublished records of 1965.

Records of Central Power and Light Company.
Water Quality in Texas Streams 1958 through 1963, Texas State
Department of Health, Water Pollution Control Division.
Texas Water Commission Bulletin 6408
State of Texas, Board of Water Engineers, TEXAS FLOODS 1957

Imperial Reservoir

Location

Imperial Reservoir is located 10 miles northwest of the city of Imperial near the meeting of the Crane, Ward, and Pecos County lines.

Ownership and History of Development

This reservoir is part of the vast irrigation system owned by Red Bluff Water Power Control District. The basin is an old playa lake, the capacity of which has been increased by the construction of dykes. The basin is located in a bend of the Pecos River. Water is diverted from the river and flows by canal into Imperial Reservoir where it is stored until required for irrigation. The feeder canal that supplies Imperial Reservoir is along the same course as the Rooney Canal that was the first irrigation canal from the Pecos. The Rooney Canal was in operation before 1907, and Imperial Reservoir has been a part of the irrigation system since 1914. At that time the reservoir was part of the Buenavista Project, one of ten projects that were later consolidated to form the present district.

Physical Description

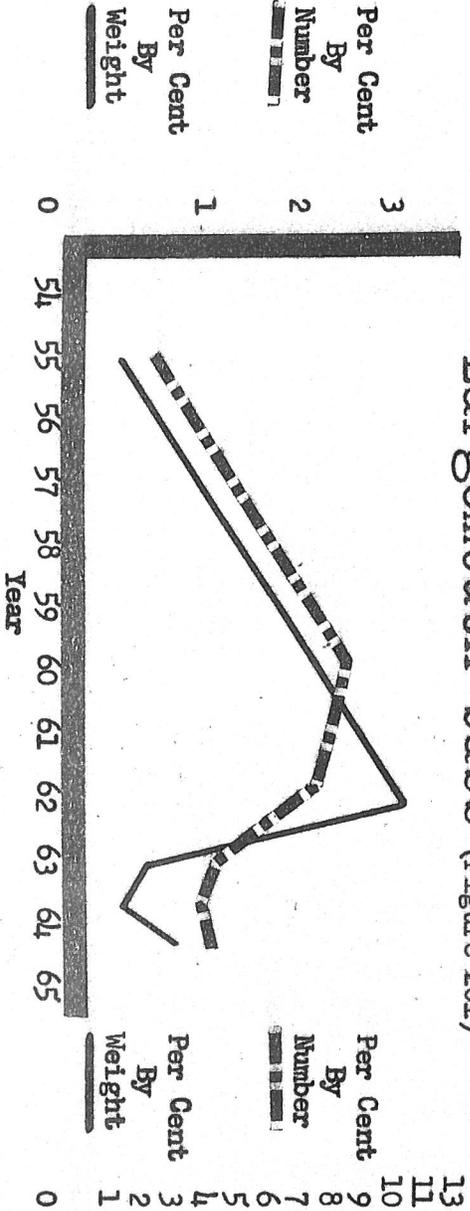
The reservoir has practically no contributing watershed. The total capacity is 2,800 acre-feet and the maximum surface area is 895 acres.

History of Fisheries Investigations and Management

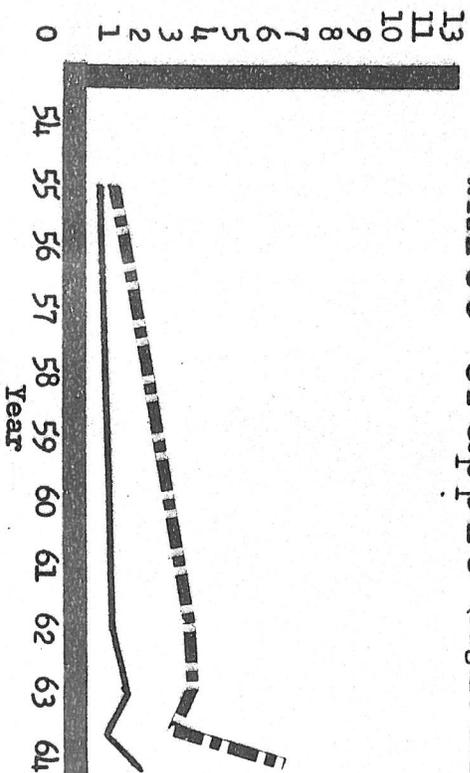
Limited investigations pertinent to distribution of species were carried out prior to 1955, but a full-scale investigation was not undertaken until 1956. An inventory study to determine relative abundance of species was completed in 1957, and subsequent studies were carried out under marine introductions and reconnaissance.

FISH PRODUCTION FROM DEVILS LAKE Game Fish Production

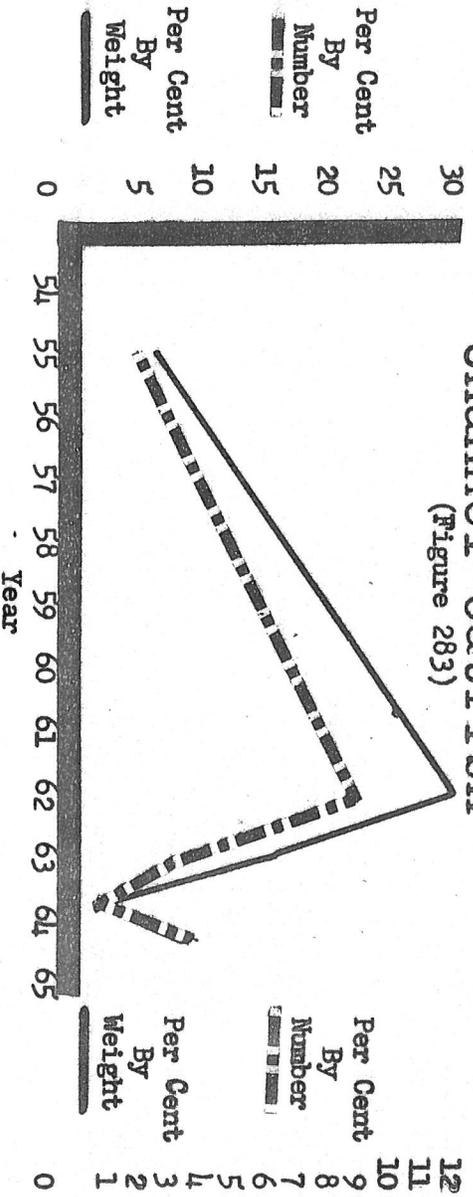
Largemouth bass (Figure 281)



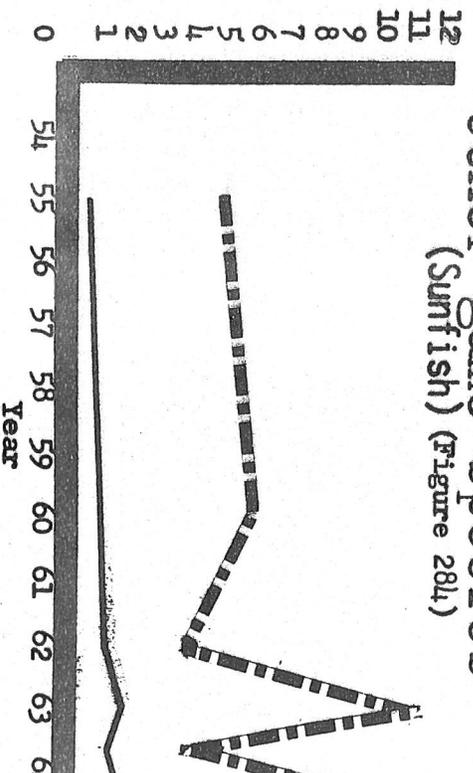
White crappie (Figure 282)



Channel catfish (Figure 283)



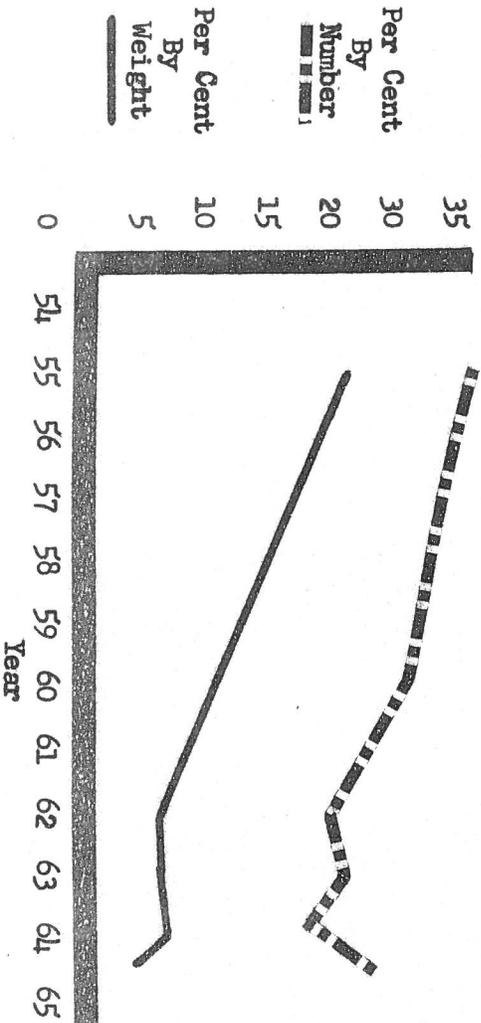
Other game species (Sunfish) (Figure 284)



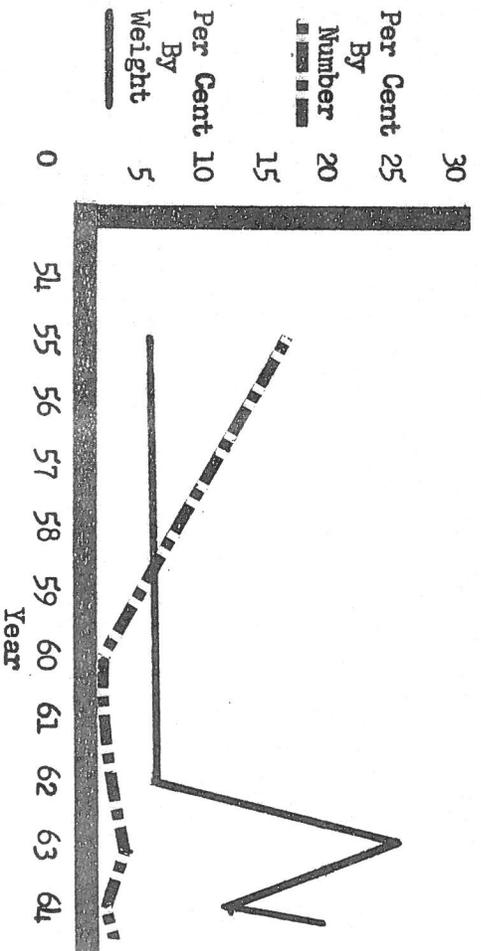
FISH PRODUCTION FROM DEVILS LAKE

Principal Non-Game Species

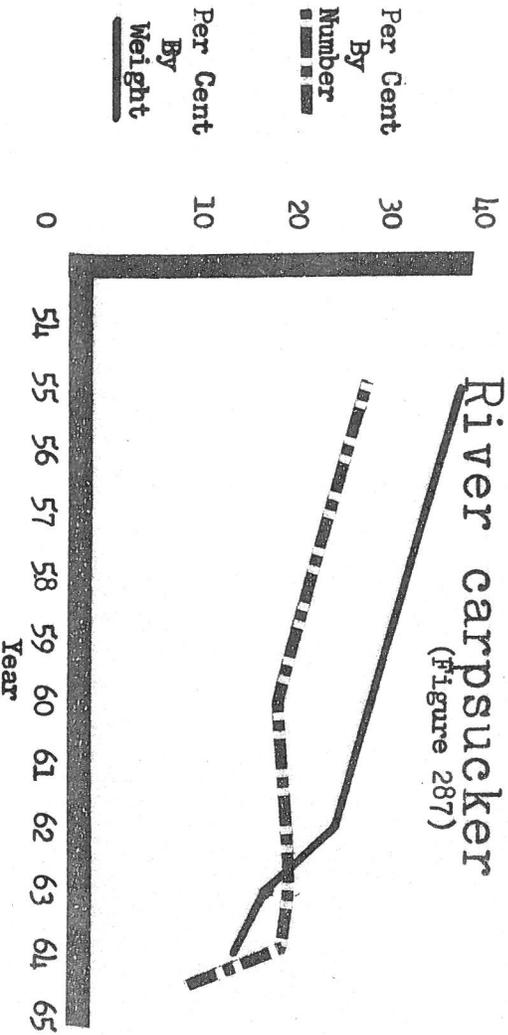
Gizzard shad (Figure 285)



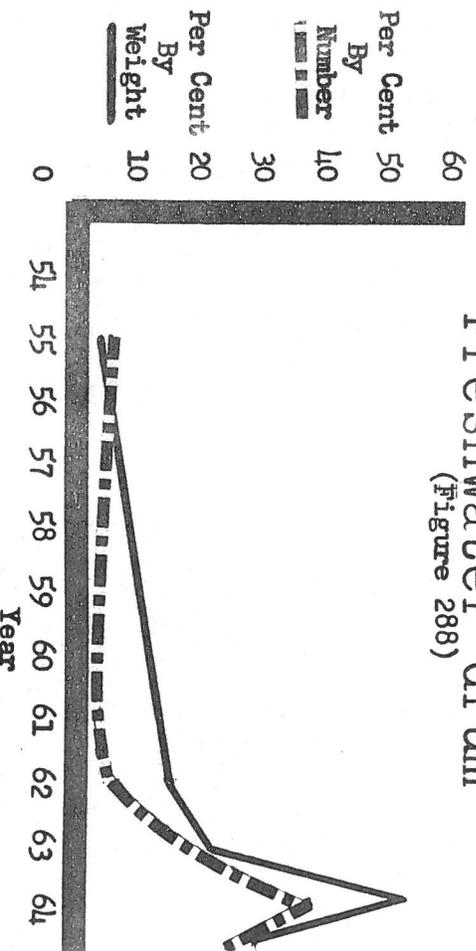
Carp (Figure 286)



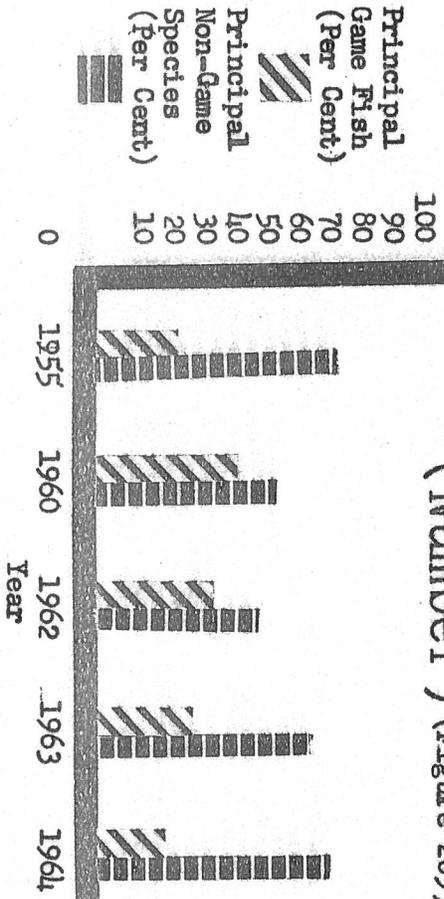
River carpsucker (Figure 287)



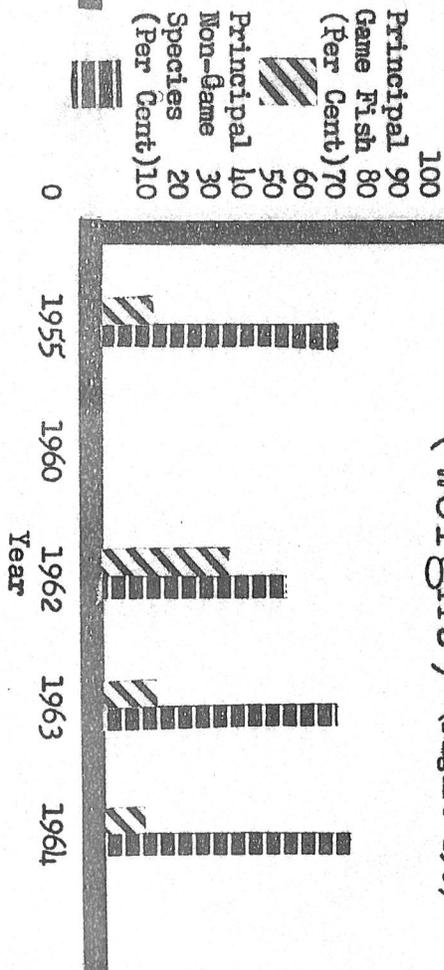
Freshwater drum (Figure 288)



Principal Production
(Number) (Figure 289)



Principal Production
(Weight) (Figure 290)



References

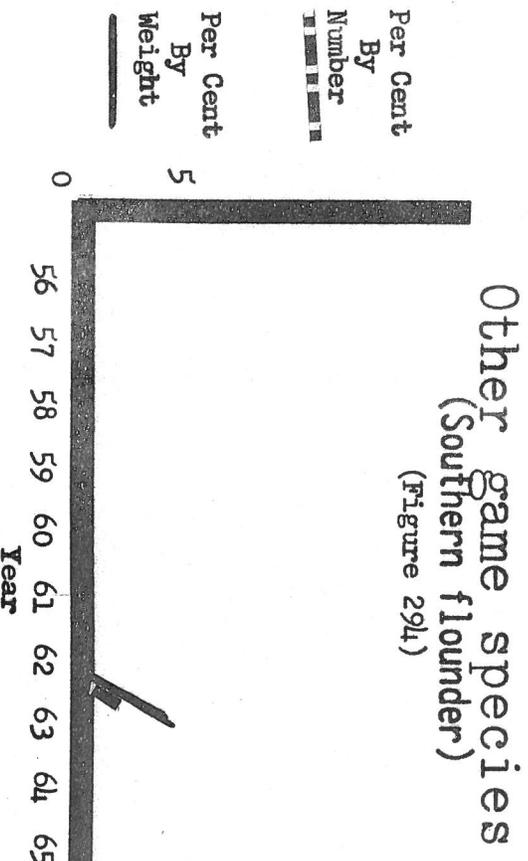
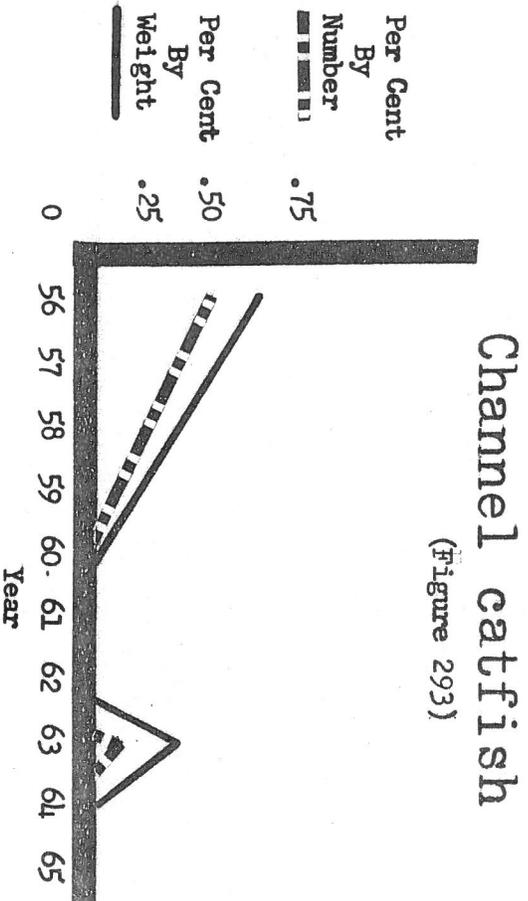
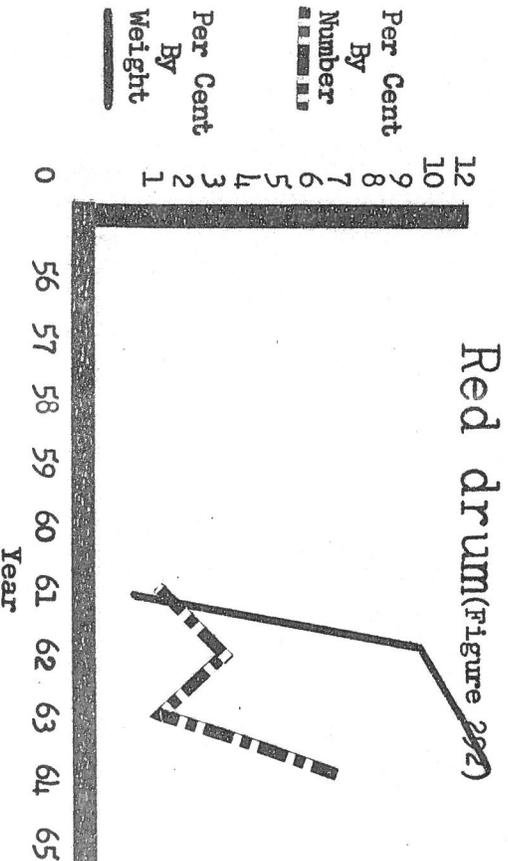
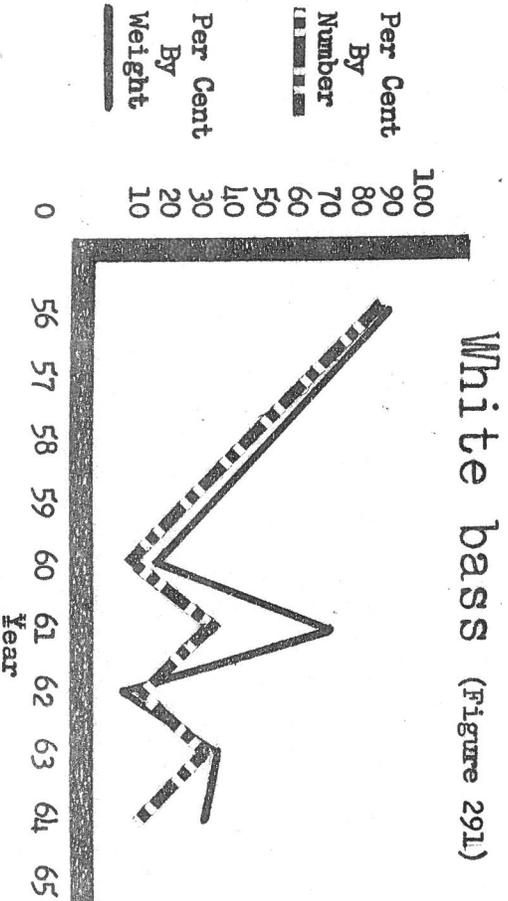
A. Fisheries Investigations

Project F-5-R-4, Job Completion Report B-20 (Inventory)
Project F-5-R-5, Job Completion Report E-1 (Marine Introductions)
Project F-5-R-6, Job Completion Report E-1 (Marine Introductions)
Project F-5-R-7, Job Completion Report E-1 (Marine Introductions)
Project F-5-R-8, Job Completion Report E-1 (Marine Introductions)
Project F-5-R-8, Job Completion Report D-1 (Fisheries Problems)
Project F-5-R-9, Job Completion Report B-32 (Reconnaissance)
Project F-5-R-9, Job Completion Report F-1 (Marine Introductions)
Project F-5-R-10, Job Completion Report B-32 (Reconnaissance)
Project F-5-R-10, Job Completion Report F-1 (Marine Introductions)
Project F-5-R-11, Job Completion Report B-32 (Reconnaissance)
Project F-5-R-11, Job Completion Report F-1 (Marine Introductions)

B. Hydrological and Water Quality Data

Records of Pecos Water Commission
Records of Red Bluff Power Water Control District
Water Supply Papers of International Boundary and Water Commission

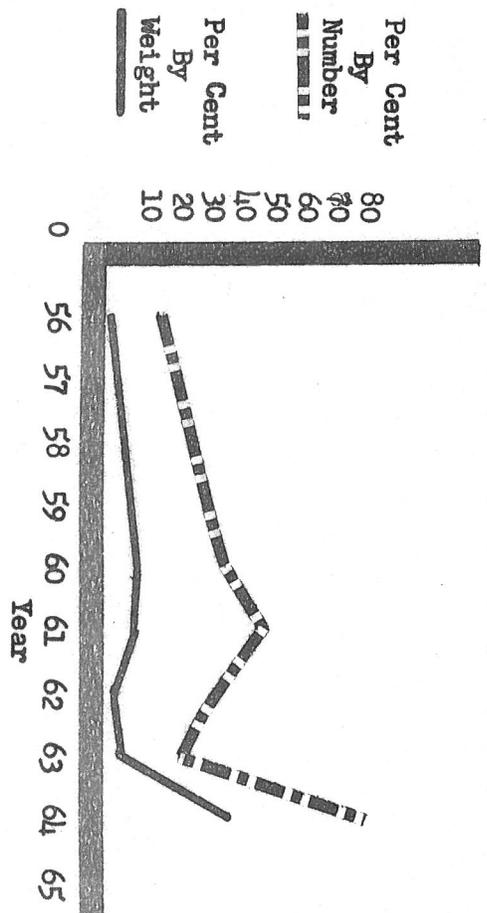
FISH PRODUCTION FROM IMPERIAL RESERVOIR Game Fish Production



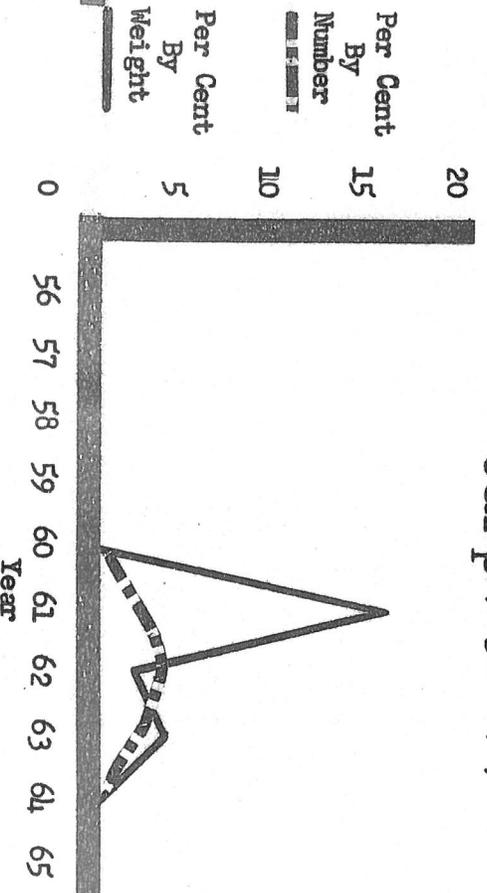
FISH PRODUCTION FROM IMPERIAL RESERVOIR

Principal Non-Game Species

Gizzard shad (Figure 295)

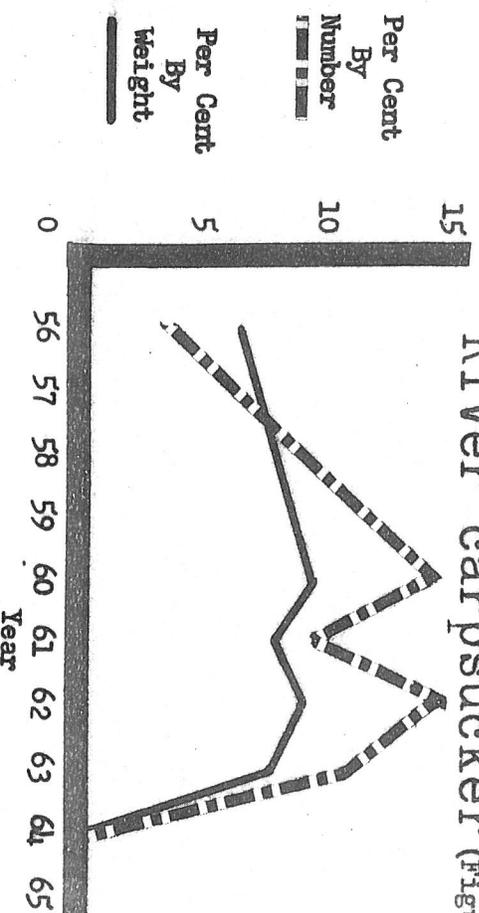


Carp (Figure 296)

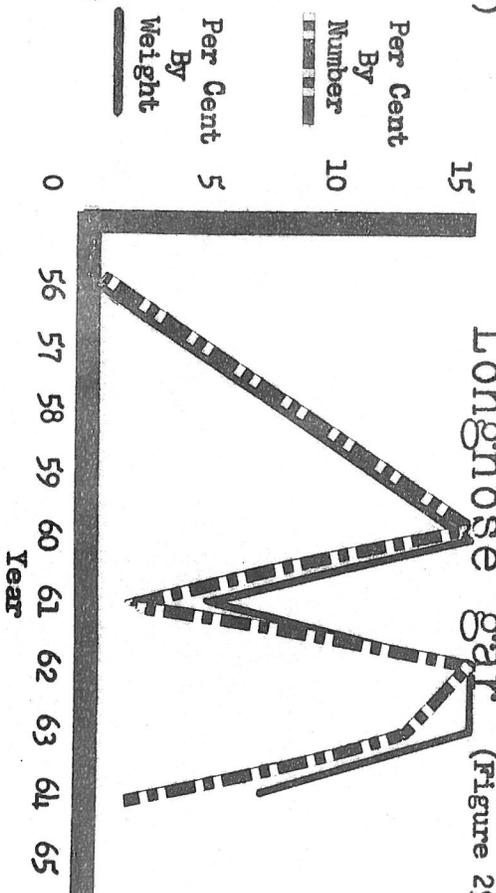


1891-

River carpsucker (Figure 297)

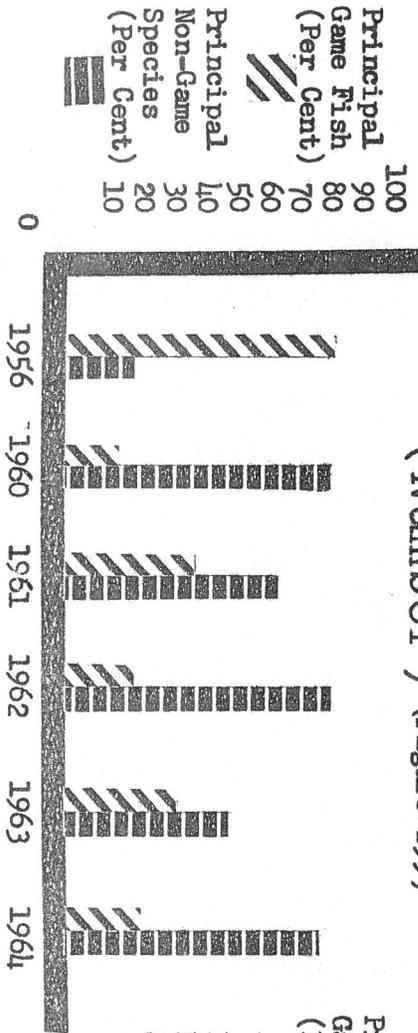


Longnose gar (Figure 298)



IMPERIAL RESERVOIR

Principal Production (Number) (Figure 299)



Principal Production (Weight) (Figure 300)



Red Bluff Reservoir

Location

Red Bluff Reservoir is on the Pecos River of the Rio Grande System in Reeves and Loving Counties. The dam is 5 miles north of Orla and the reservoir extends into Eddy County, New Mexico.

Ownership and History of Development

The project is owned and operated by the Red Bluff Water Control District under the water right granted by Permit No. 1217. The permit authorizes construction of a reservoir to impound 300,000 acre-feet of water with annual use of 300,000 acre-feet for hydroelectric power generation and irrigation of 145,000 acres of land in Reeves, Loving, Ward and Pecos Counties.

The development of irrigation in the Lower Pecos River Basin (that portion of the Pecos River Basin in Texas between the Texas-New Mexico state line and the mouth of the Pecos River) by diversion from the main stream of the Pecos began in the 1870's. However, there was no important activity until 1888. From that year until 1914 an era of dam and canal building resulted in 10 different irrigation projects from the Pecos River. In January 1914, the 10 river systems organized the West Texas Reclamation Association. This association was reorganized into the Pecos Valley of Texas Water Users Association. In 1916, the Association petitioned the Secretary of Interior to grant aid from the U. S. Reclamation Service in constructing Red Bluff Dam and for loans to finance the rehabilitation of deteriorated facilities. In addition, the Association requested that the U. S. Government supervise the apportionment of Pecos River water not only between New Mexico and Texas, but among users in Texas itself. The petition was not acted upon for several years.

In 1917, the seven surviving lower basin systems (Porterville, Farmers' Independent, Cedarvale, Barstow, Big Valley-Grandfalls, Imperial, and Zimmerman) dissolved the water users association and reincorporated as a water improvement district. In November 1927, the Red Bluff Water Improvement District was created, and this district became the Red Bluff Water Power Control District in 1933. In the 1930's the District sought to obtain funds from federal emergency-spending agencies, and in 1933 the construction of Red Bluff Project was approved by the U. S. Public Works Administration. Subsequently the district's bonds were purchased by the Reconstruction Finance Corporation.

Actual construction began in November 1934 and was completed in September 1936. Impoundment began in 1936, water use began in 1937, and the reservoir first filled in June 1937. Power generation began June 6, 1937.

The division and apportionment of the use of waters of the Pecos is provided for by the Pecos River Compact of 1948 between Texas and New Mexico. The Compact created an interstate agency known as the Pecos River Commission for the administration of the provision of the Compact. The Commission is composed of one commissioner representing each of the states of New Mexico and Texas, and, if designated by the President, one commissioner representing the United States.

Physical Description

Red Bluff Dam consists of three sections: an earthfilled embankment across the Pecos River, an uncontrolled emergency spillway at the right of the main embankment, and a concrete controlled spillway. The reservoir has a capacity of 310,000 acre-feet and a surface area of 11,700 acres at elevation 2,841.7 feet above m.s.l. The top of the dam is 102 feet above the stream bed. The reservoir has never overflowed. Other capacities are given in the following tabulation:

Feature	Elevation (feet above m.s.l.)	Capacity (acre-feet)	Area (acres)
Crest of emergency spillway	2,844.7	345,000	- -
Top of taintor gates	2,841.7	310,000	11,700
Crest of service spillway	2,826.7	166,500	- -
Invert of concrete outlet conduits	2,763.7	3,000*	

*Dead storage

The drainage area above Red Bluff is 20,720 square miles. Flow of the Pecos is controlled by a series of dams in New Mexico.

History of Fisheries Investigations and Management

Prior to 1955 fisheries investigations had been limited to pollution investigations and cursory examinations of the reservoir. In that year an inventory was begun that continued until 1958. Following that study, routine sampling of the fish populations to determine gross changes in production were carried out under reconnaissance. Additional data were obtained in determining the success of introduced marine fish.

Stocking Record

For actual number of fish stocked multiply entry by 1,000.

	1954	1955	1956	1957	1958	1959
Largemouth bass						
fry		10				
fingerling	.50	5.1				
Sunfish						
fingerling		2.56				
White crappie						
fingerling		1.2				
Channel catfish						
fingerling						

	1960	1961	1962	1963	1964
Largemouth bass					
fry		347			
fingerling	11.5				
Sunfish					
fingerling	2	8			
White crappie					
fingerling	4	7			
Channel eatfish					
fingerling	2.75	20			

		Marine Introductions
Total number of largemouth bass fry stocked:	357,000.	Red drum 1,336
Total number of largemouth bass fingerling stocked:	17,100.	Croakers 470
Total number of sunfish stocked:	12,560.	Seatrout 60
Total number of white crappie stocked:	12,200.	Flounder 96
Total number of channel eatfish stocked:	22,750.	Black drum 5
		Pinperch <u>608</u>
		2,575

Discussion

The most detrimental factor influencing game fish production in Region 1-B is a saltwater spring located immediately above Red Bluff Reservoir in New Mexico. Studies by the National Resources Planning Board indicate salt concentration at .75 ton of salt per acre-foot of water at Santa Rosa to 7 tons per acre-foot at Red Bluff gage. The Carlsbad-Malaga reach of the river is underlain by an underground reservoir of brine. In the Malaga Bend area east of Loving, New Mexico, there occurs a phenomenon which further affects the quality of the Pecos River flow. Here the rock formations which retain the brine under hydrostatic pressure at a depth of 200 feet beneath the stream have been fractured, and the underlying aquifer is discharging at about 0.4 cubic feet per second of brine directly into the river. The salt solution has a chloride concentration of about 150,000 parts per million. In other words, this brine-spring area contributes about 135,000 tons of salt per year (450 tons per day) into the flow of a river whose content is already overburdened with harmful materials. This spring is the most detrimental factor for the entire Pecos River watershed.

Prolonged recessions of the reservoir during many spring seasons appear to drastically curtail game fish production.

References

A. Fisheries Investigations

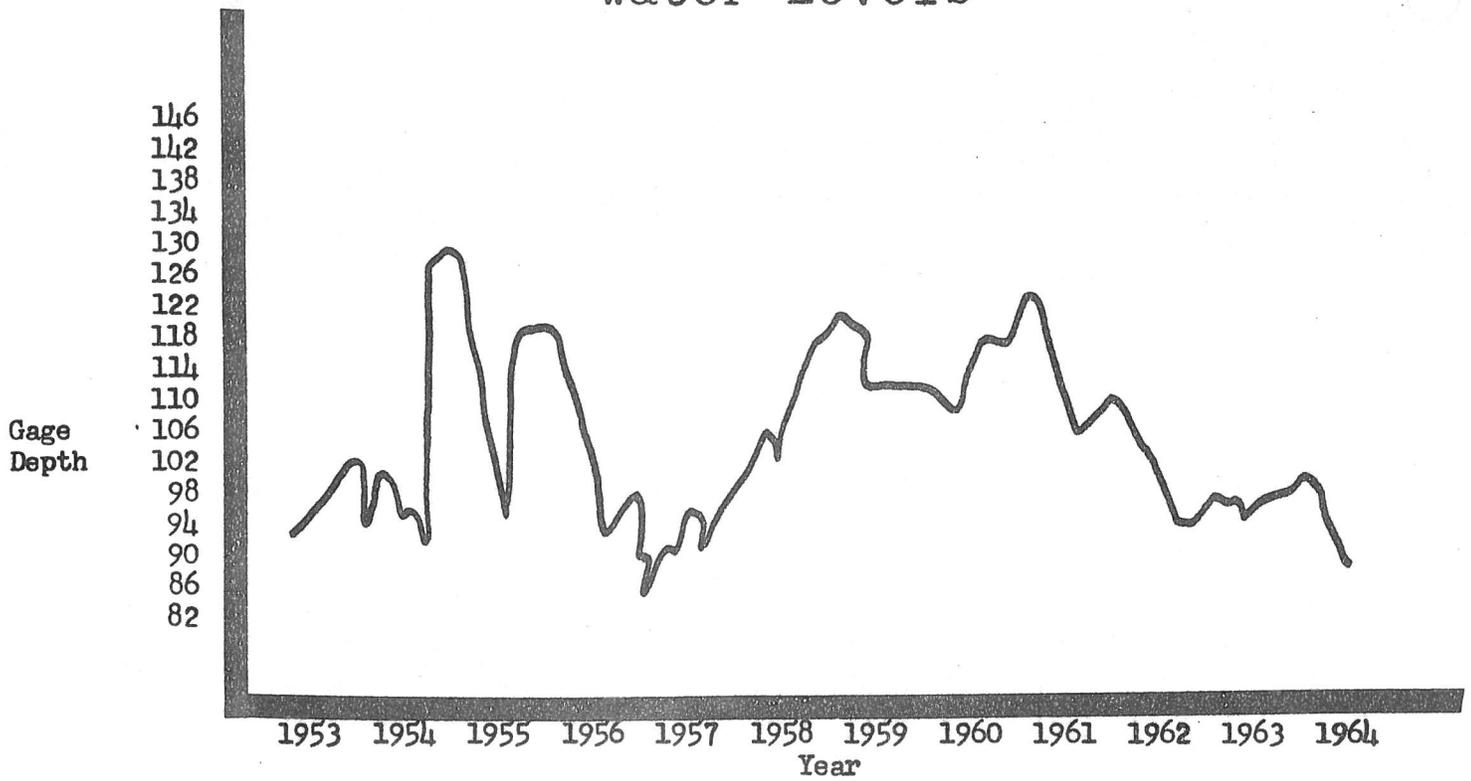
- Project F-5-R-4, Job Completion Report B-17 (Inventory)
- Project F-5-R-5, Job Completion Report B-17 (Inventory)
- Project F-5-R-6, Job Completion Report B-17 (Inventory)
- Project F-5-R-9, Job Completion Report B-32 (Reconnaissance)
- Project F-5-R-9, Job Completion Report F-1 (Marine Introductions)
- Project F-5-R-10, Job Completion Report B-32 (Reconnaissance)
- Project F-5-R-10, Job Completion Report F-1 (Marine Introductions)

B. Hydrological and Water Quality Data

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- Water Supply Papers of the U. S. Geological Survey
- Records of the Pecos River Commission
- Records of Red Bluff Power Water Control District
- Texas Water Commission Bulletin 6408
- National Resources Planning Board, 1942, Regional Planning, Part X:
THE PECOS RIVER JOINT INVESTIGATION IN THE PECOS RIVER BASIN IN NEW
MEXICO AND TEXAS---ANALYSIS AND FINDINGS.

HYDROLOGICAL DATA FOR RED BLUFF RESERVOIR

Water Levels



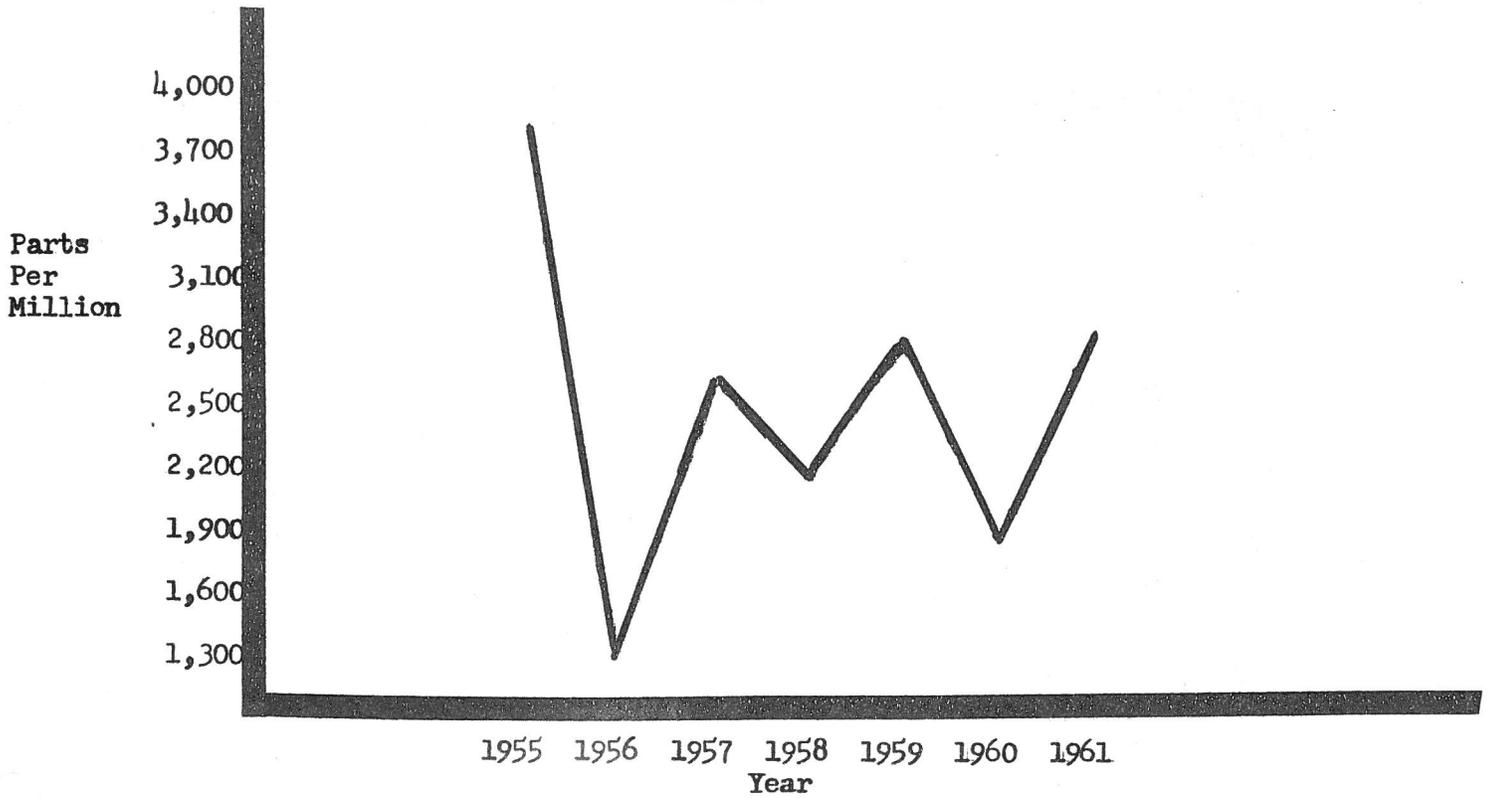
(Figure 302)

Capacities



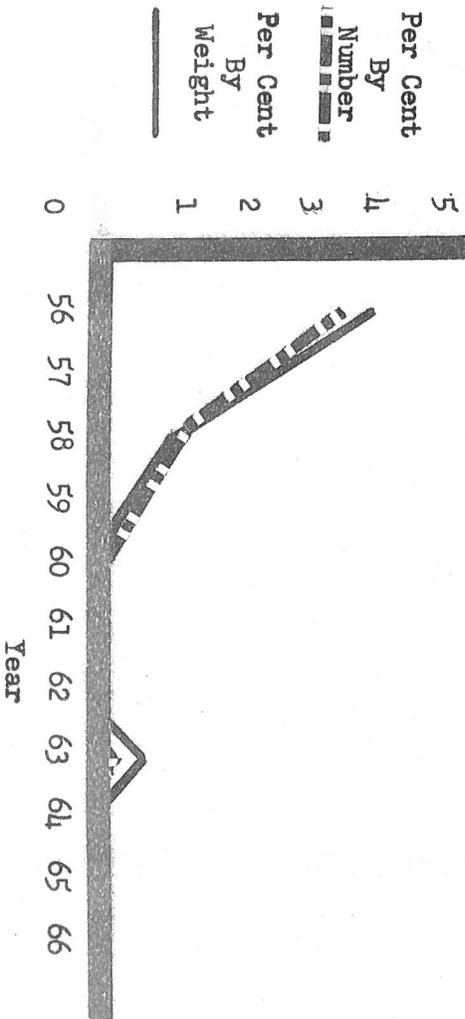
(Figure 303)

WATER QUALITY DATA FOR RED BLUFF RESERVOIR Chlorides

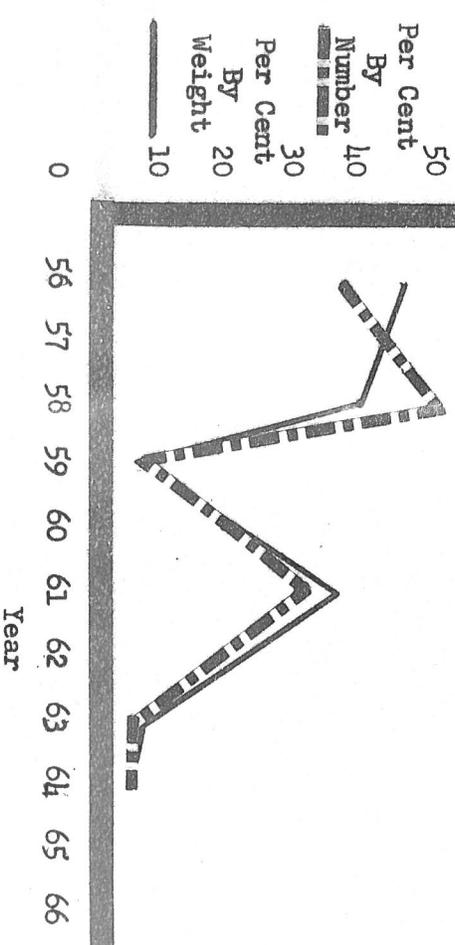


FISH PRODUCTION FROM RED BLUFF RESERVOIR Game Fish Production

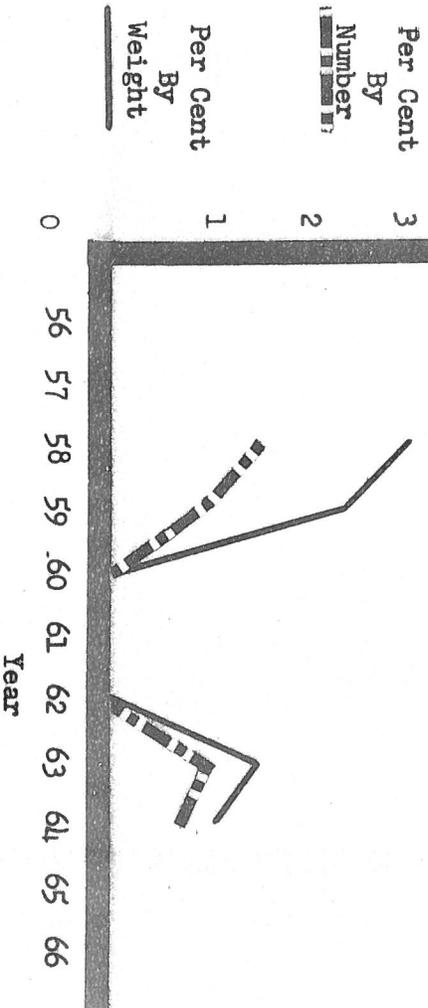
Largemouth bass (Figure 304)



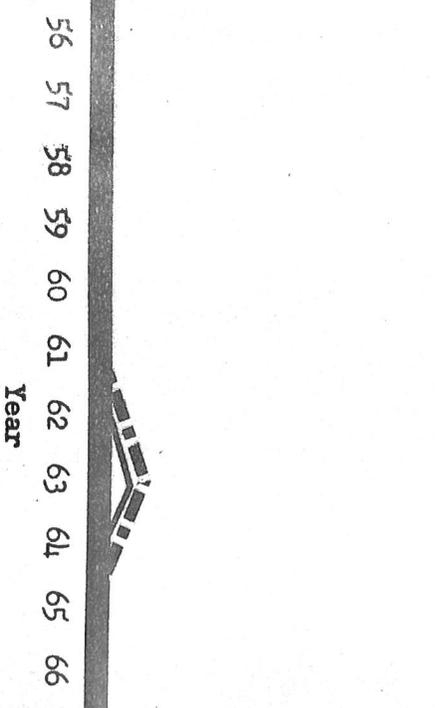
White bass (Figure 305)



Channel catfish (Figure 306)

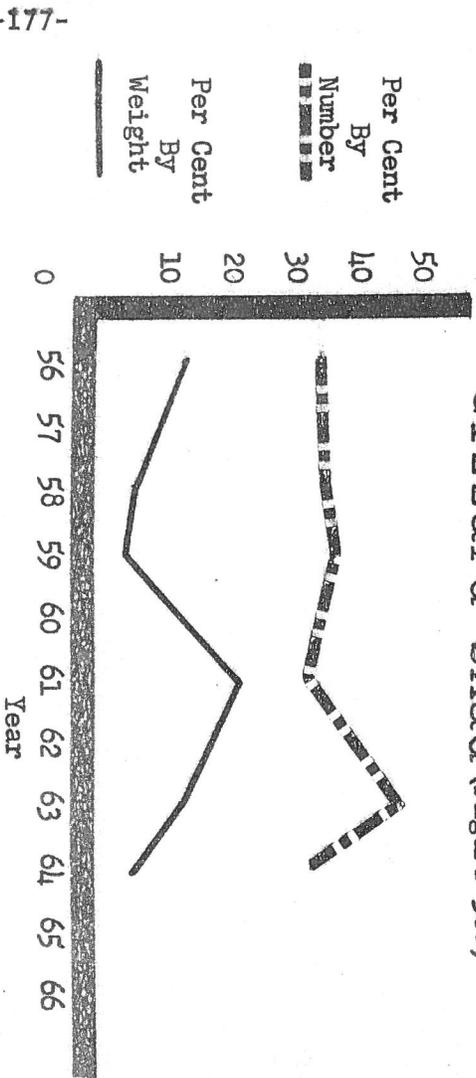


Other game species (Figure 307)

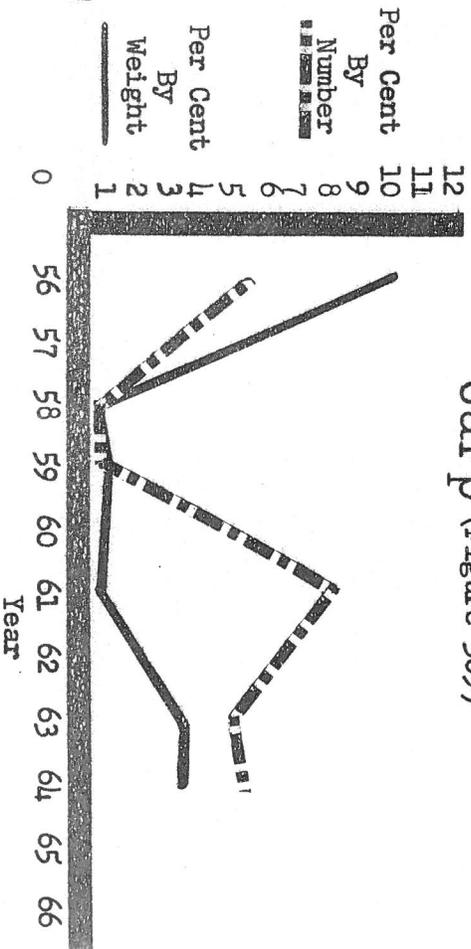


FISH PRODUCTION FROM RED BLUFF RESERVOIR Principal Non-Game Species

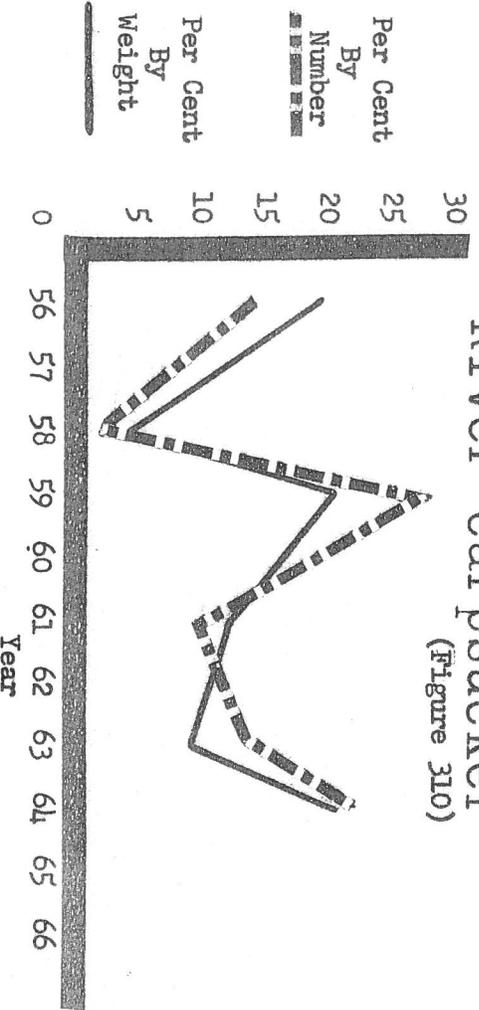
Gizzard shad (Figure 308)



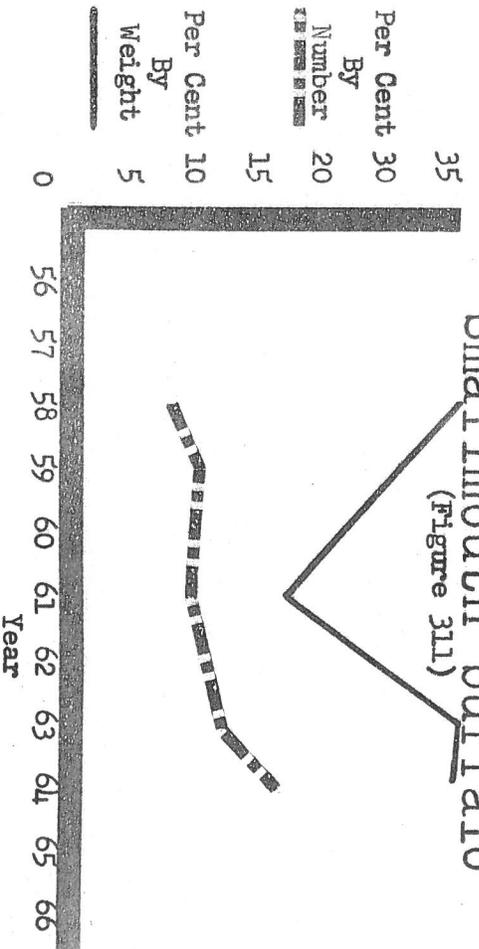
Carp (Figure 309)



River carpsucker
(Figure 310)

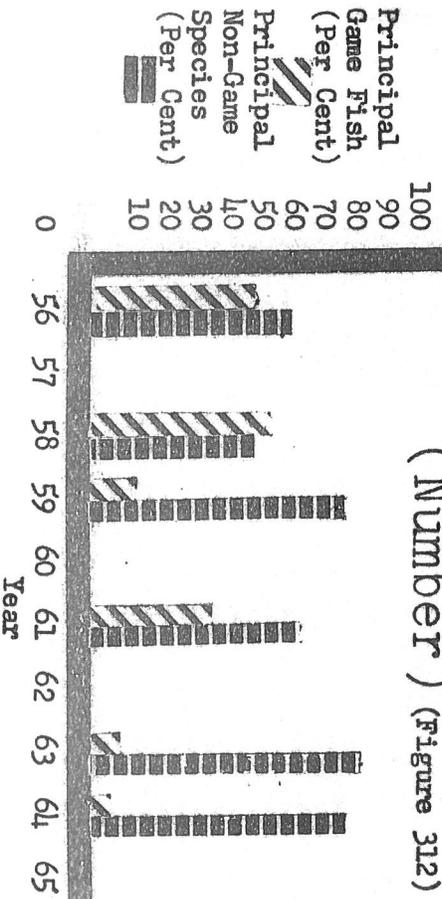


Smallmouth buffalo
(Figure 311)

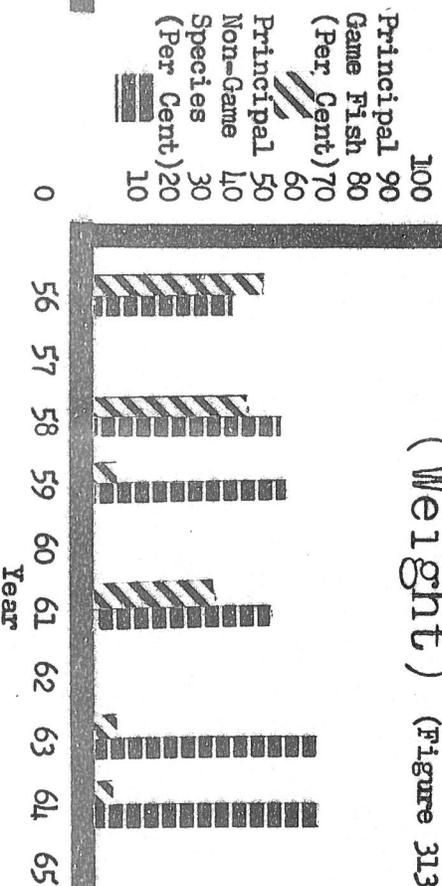


RED BLUFF RESERVOIR

Principal Production
(Number) (Figure 312)

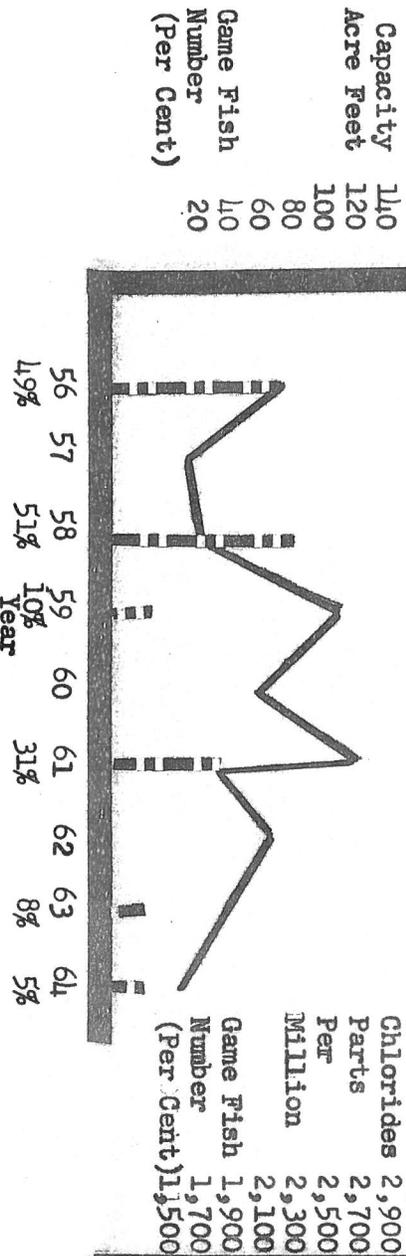


Principal Production
(Weight) (Figure 313)

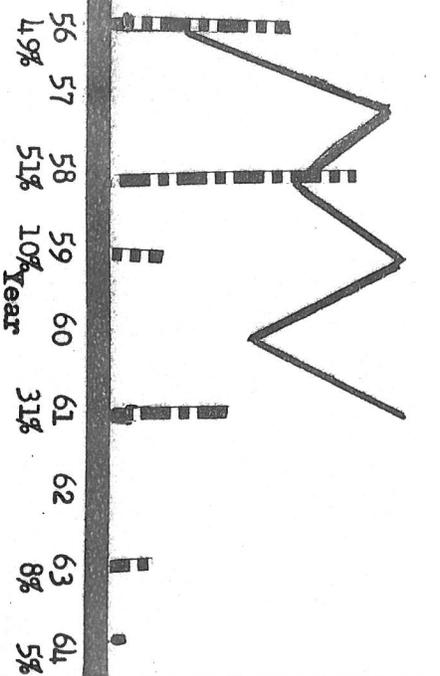


Principal Factors Influencing Game Fish Production

(Figure 314)



(Figure 315)



Lake Balmorhea

Location

Lake Balmorhea is located 3 miles southeast of Balmorhea on Sandia Creek, a tributary of Toyah Creek, which is a tributary of the Pecos River, of the Rio Grande River System.

Ownership and History of Development

The original owner, the Toyah Valley Irrigation Company, was created in 1909 by the consolidation of several smaller irrigation systems. Rights established by Permit No. 57, State Board of Water Engineers, permits 41,400 acre-feet annually to irrigate 13,800 acres of land. Prior to this permit, several certified filings provided the water right to irrigate an additional 7,500 acres of land. Land was irrigated in this area as early as 1870. The present owner of the lake and the irrigation system is Reeves County Water Improvement District No. 1, which was organized in 1914-15 and purchased the water rights from the original owners. In 1945, with financial aid from the Bureau of Reclamation, additional facilities were added that permitted water to be diverted to the lake by canals from Phantom Lake Springs and Madera Diversion Dam. In all, 18,000 acre-feet of additional water was to be developed to irrigate 10,640 acres of land out of the 21,300 acres included in Permit No. 57. This was authorized in Permit No. 1392.

Physical Description

Lake Balmorhea has a capacity of 6,350 acre-feet with a surface area of 573 acres at elevation 3,187 feet above m.s.l. Sediment accumulation from 1917 to 1948 was 1,357 acre-feet, or 44.6 acre-feet per year. The drainage area is 22 square miles.

History of Fisheries Investigations and Management

Limited investigations were carried out during the Pecos River survey to determine species distribution and other specific facts. The reservoir was surveyed in 1960 as part of a study of several small lakes. Subsequent sampling under reconnaissance resulted in the decision to eliminate fish life in order to renovate game fish production. This was done in December 1961. Periodic sampling under reconnaissance has been continued to maintain knowledge of game fish production and evaluate the results of the management effort.

Stocking Record

For actual number of fish stocked multiply entry by 1,000.

	1954	1955	1956	1957	1958	1959
Largemouth bass						
fry						
fingerling			6.5	.80	.500	1
Sunfish						
fingerling					.20	
White crappie						
fingerling						
Channel catfish						
fingerling			1.25	.80	.40	1
		1960	1961	1962	1963	1964
Largemouth bass						
fry				140		20
fingerling		1.7		4		
Sunfish						
fingerling		.60		6		
White crappie						
fingerling		.40		4		.10
Channel catfish						
fingerling				25		5

Total number of largemouth bass fry stocked: 160,000.
 Total number of largemouth bass fingerling stocked: 10,000.
 Total number of sunfish stocked: 6,800.
 Total number of white crappie stocked: 4,500.
 Total number of channel catfish stocked: 34,450.

Discussion

Although fluctuation is not indicated in hydrological records there is an annual fluctuation of the water levels that results from withdrawals for irrigation. In years of significant rainfall this factor may not be of significant consequence, but during the drouth periods when demands for irrigation are at a maximum, this usage is believed to be very detrimental to game fish production. Observations would indicate that during these severe withdrawals many game fish nests are destroyed during the late spring. Because of the clearness of the water, aquatic vegetation is a persistant problem. It is suspected that the existence of dense marginal aquatics provides excessive protection for sunfish.

References

A. Fisheries Investigations

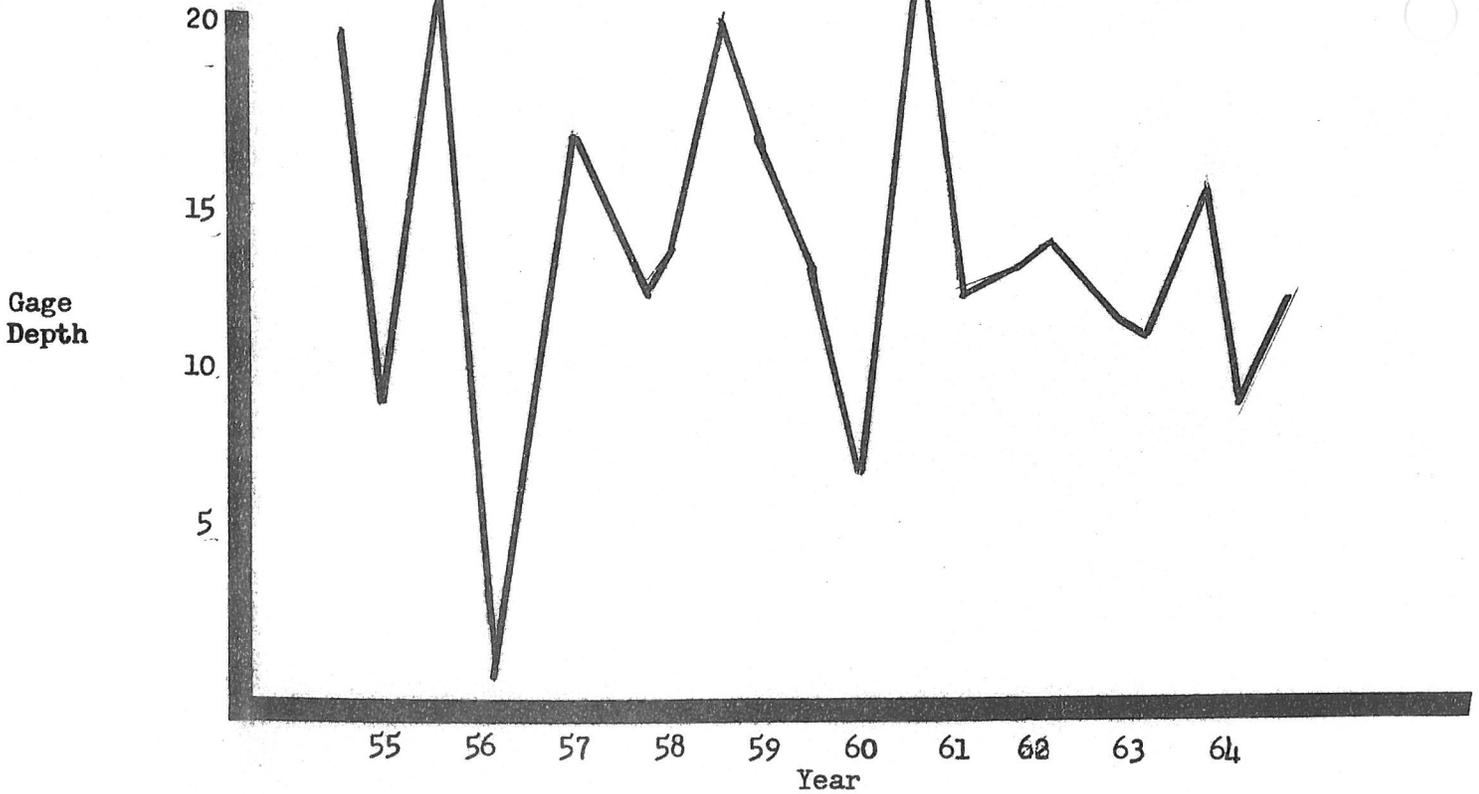
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B. Hydrological Water Quality Data

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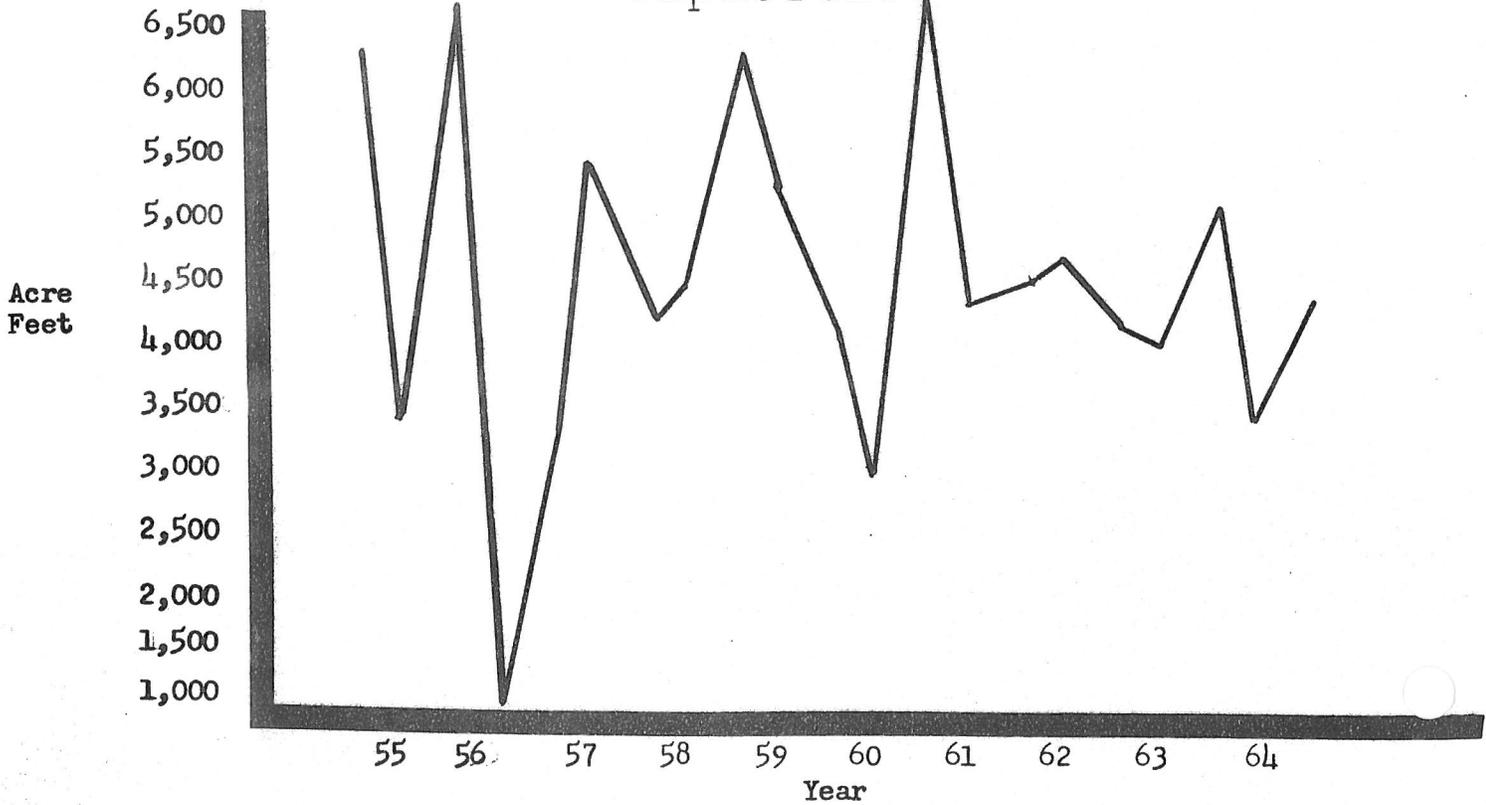
HYDROLOGICAL DATA FOR LAKE BALMORHEA

Water Levels



(Figure 317)

Capacities

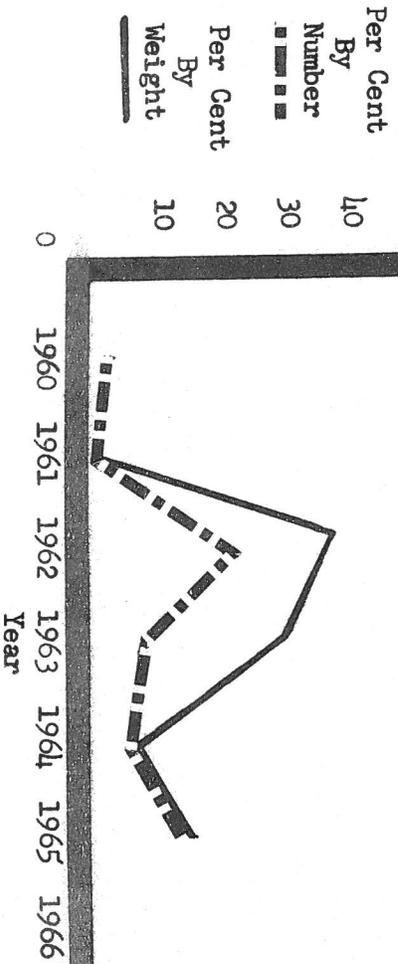


FISH PRODUCTION FROM LAKE BALMORHEA

Game Fish Production

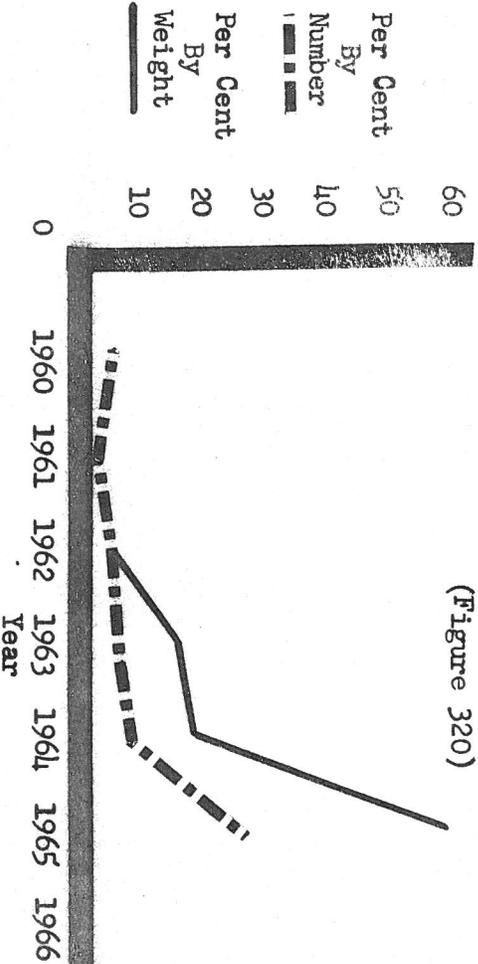
Largemouth bass

(Figure 318)



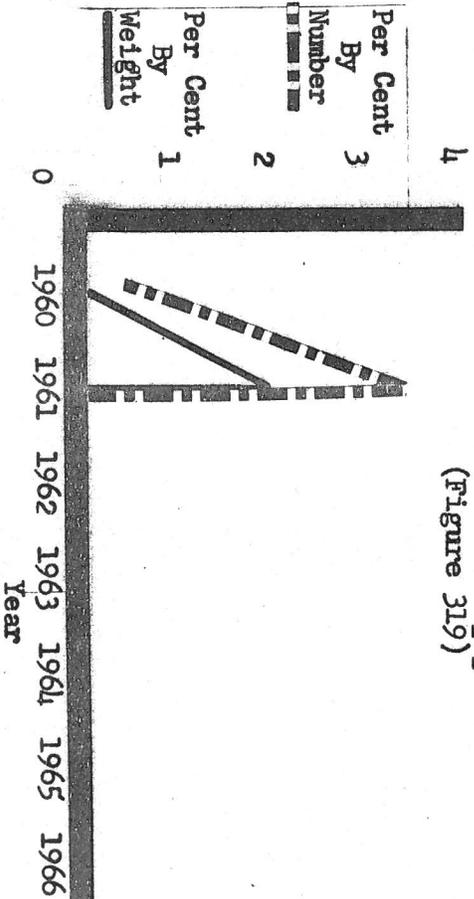
Channel catfish

(Figure 320)



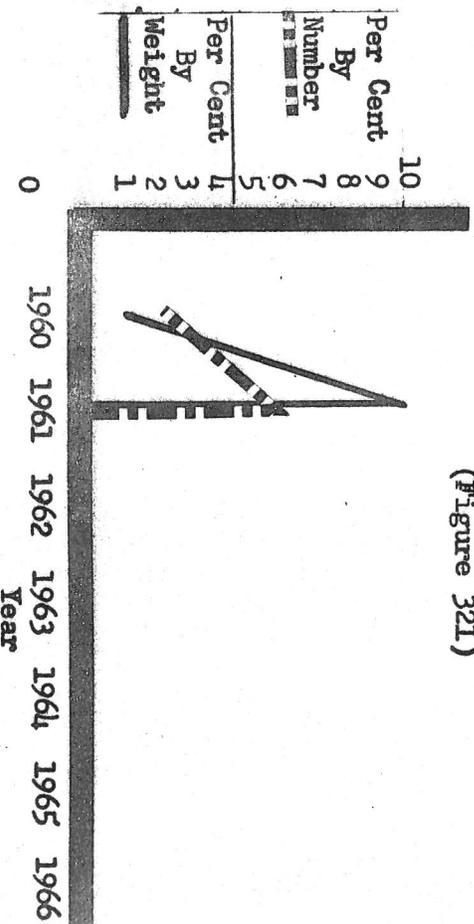
White crappie

(Figure 319)



White bass

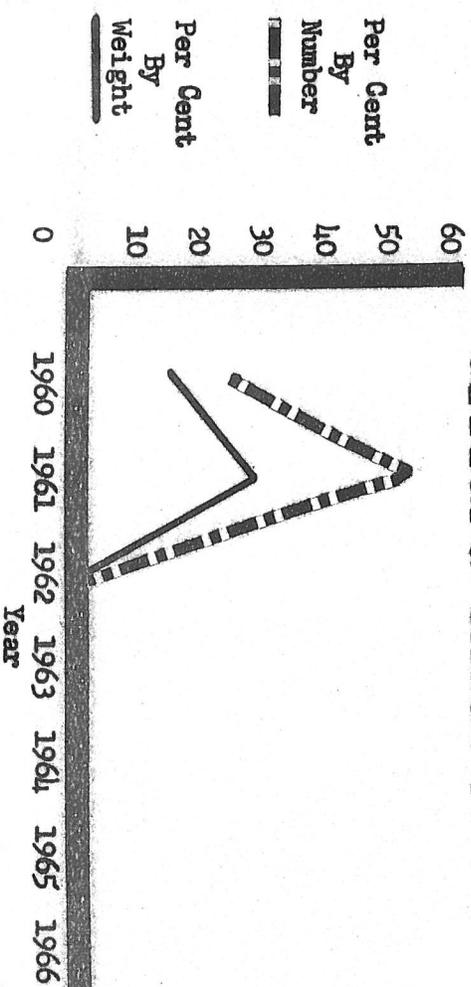
(Figure 321)



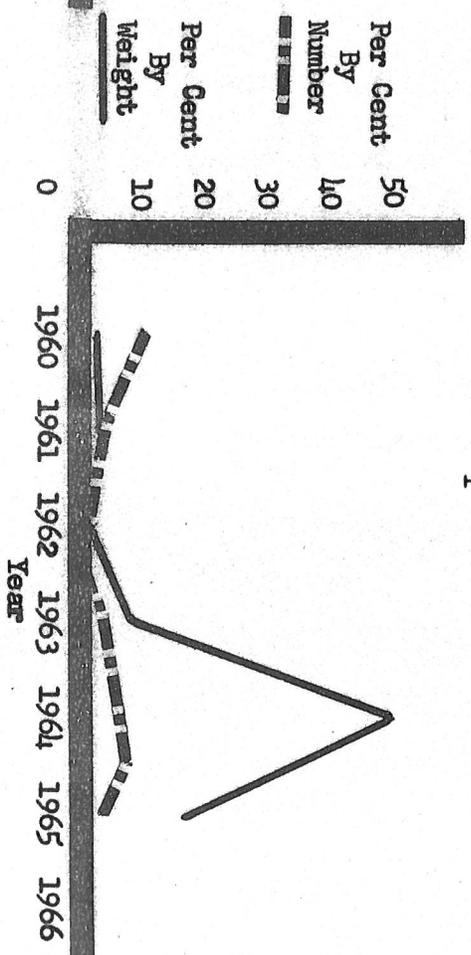
FISH PRODUCTION FROM LAKE BALMORHEA

Principal Non-Game Species

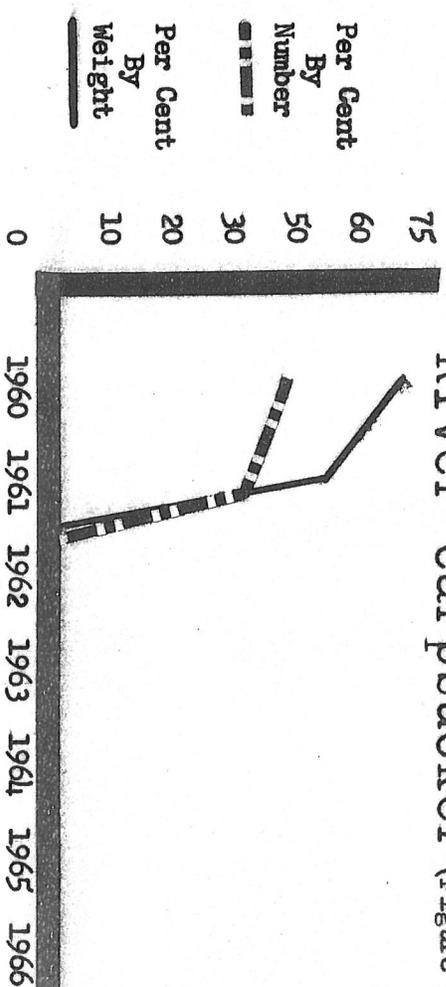
Gizzard shad (Figure 322)



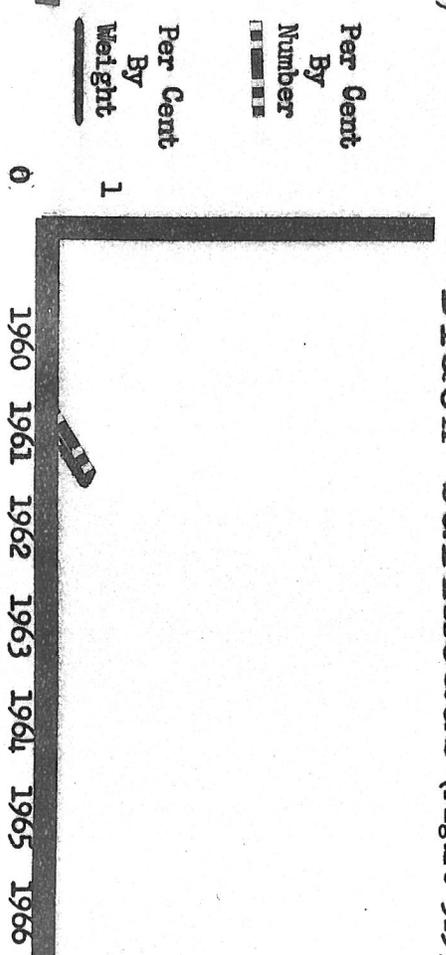
Carp (Figure 323)



River carpsucker (Figure 324)

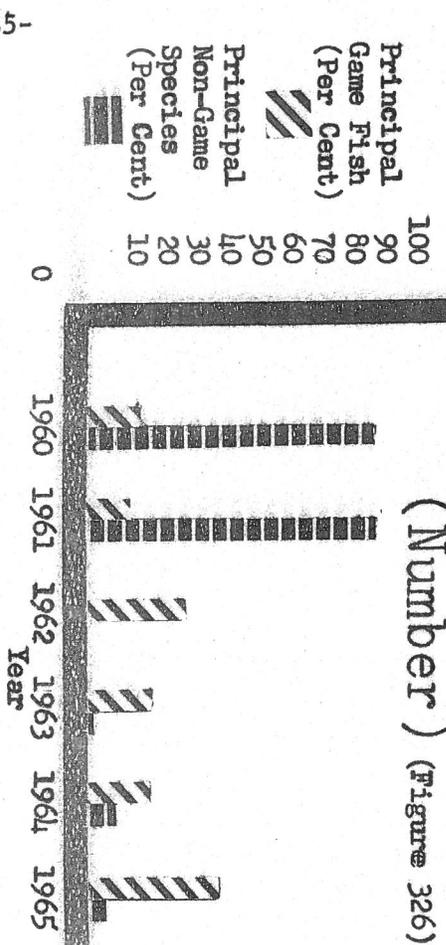


Black bullheads (Figure 325)

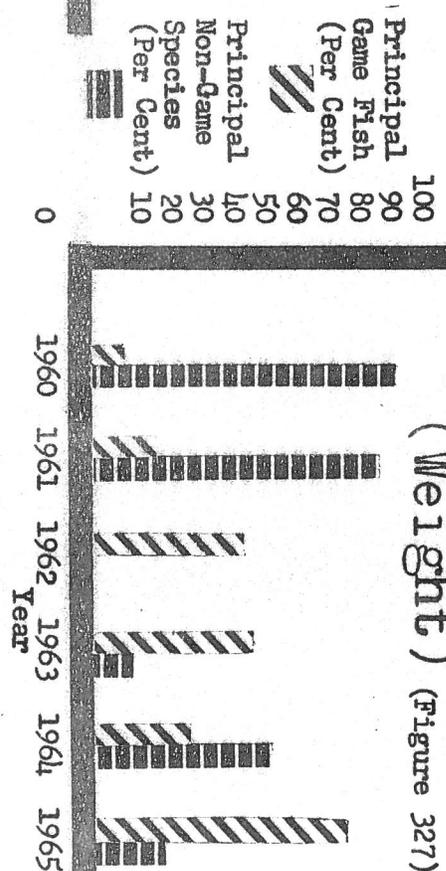


LAKE BALMORPHEA

Principal Production (Number) (Figure 326)

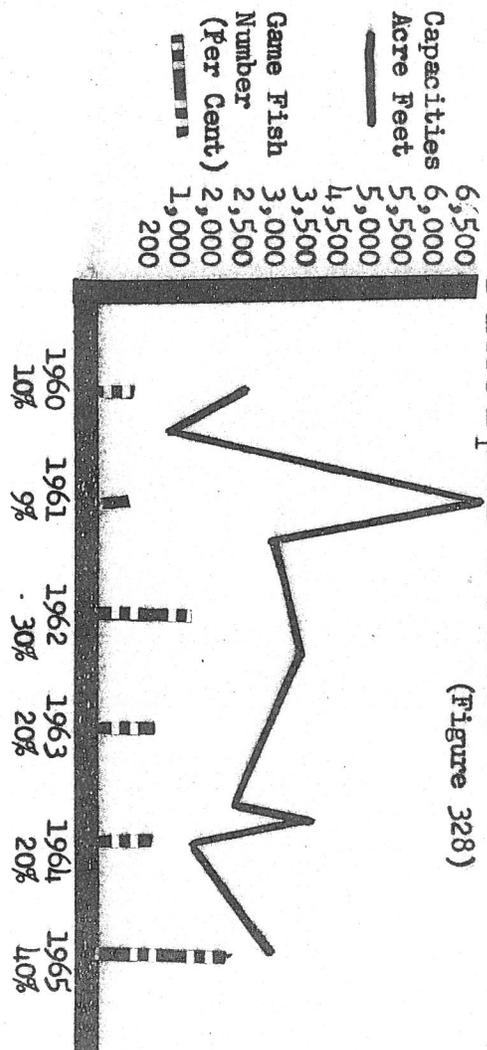


Principal Production (Weight) (Figure 327)



-185-

Principal Factors Influencing Game Fish Production (Figure 328)



Lake Ascarate

Location

Lake Ascarate is located within the city limits of El Paso in county owned Ascarate Park.

Ownership and History of Development

Lake Ascarate was constructed during World War II by the United States Air Force in the interests of the national defense. At the close of the war the reservoir was donated to the city of El Paso, and subsequently to the County Parks Commission. The lake is supplied by wells, and water is pumped from the lake to the adjoining golf course. The lake is used primarily for recreation, but also serves as a landing area for pontoon aircraft.

Physical Description

The maximum capacity of the reservoir is 246 acre-feet, and maximum area is 47 acres. There is no watershed but, in addition to wells, water can be released from the irrigation canal system into the lake.

History of Fisheries Investigations and Management

Investigations by, then Chief Aquatic Biologist, Marion Toole resulted in the decision to treat Lake Ascarate to destroy fish in 1950. This work was carried out under Toole's supervision and restocking followed. No further investigations were attempted until 1955 when the reservoir was resurveyed. Findings from the later survey indicated an increasing domination of production by river carpsucker and carp, and in December 1956, the fish life was again eradicated through the use of chemicals. The stocking in 1957 provided good fishing for three years. But in 1960 the necessity of eliminating carp to permit expansion of game fish was again necessary. A chemical control of noxious aquatic vegetation was carried out at the same time as that fish kill. The lake has produced excellent game fish since that work was completed. Limited sampling of fish populations has been carried out under reconnaissance and resurvey jobs.

Stocking Record

For actual number of fish stocked multiply entry by 1,000.

	1954	1955	1956	1957	1958	1959
Largemouth bass						
fry						16.2
fingerling	1.2	4	.60	5		
Sunfish						
fingerling		.50				.20
Channel catfish						
fingerling		.80		1.2		1.20

	1960	1961	1962	1963	1964
Largemouth bass					
fry			100		40
fingerling	4.5	5.5	1.25	1.1	2
Sunfish					
fingerling		2	3	1.1	
Channel catfish					
fingerling	4.5	4	1.025	1.1	2

Total largemouth bass fry stocked: 156,200.
Total largemouth bass fingerling: 23,150.
Total sunfish fingerling stocked: 6,800.
Total channel catfish stocked: 15,825.

Discussion

It would appear that circumstances tend to favor the production of carp and river carpsucker over game species. This complex of circumstances are not clearly indicated. Suspect factors include the heavy harvest of game fish and the relatively unimportant harvest of problematic species, the unrestricted ability of individuals to reintroduce the problematic species after they have been eliminated, and possible pollution. Dense aquatic vegetation is a persistent problem that has thus far resisted control and is suspected of affording excessive protection to some game species.

References

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Project F-5-R-8, Job Completion Report D-1 (Fisheries Problems)
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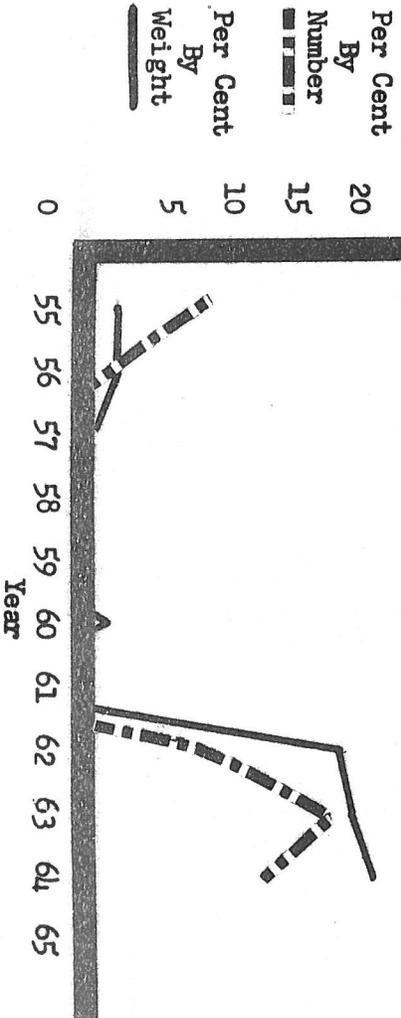
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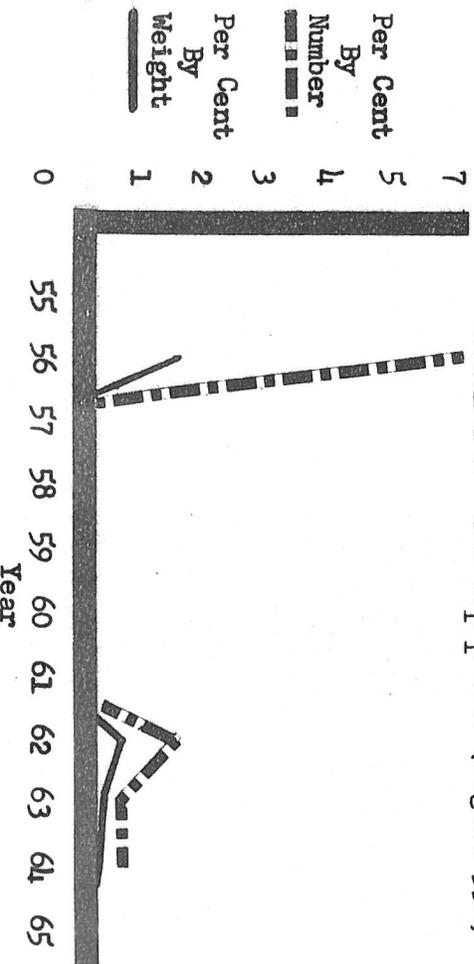
FISH PRODUCTION FROM LAKE ASCCARATE

Game Fish Production

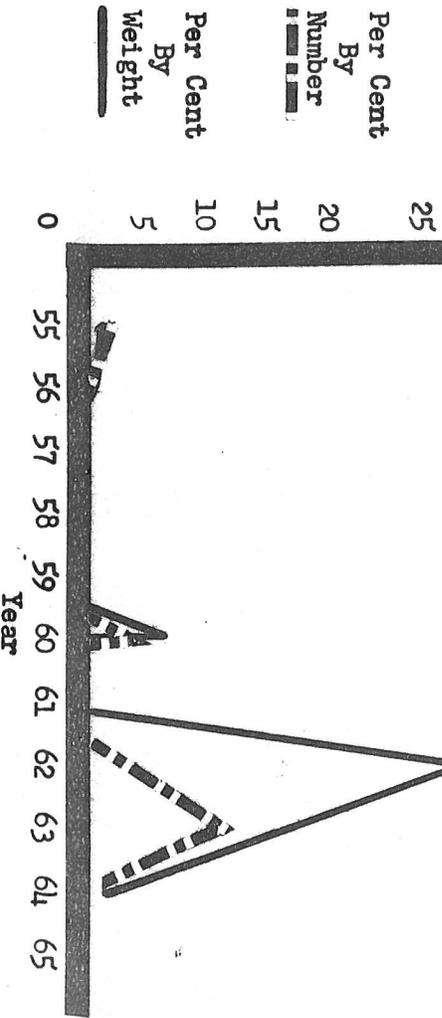
Largemouth bass (Figure 329)



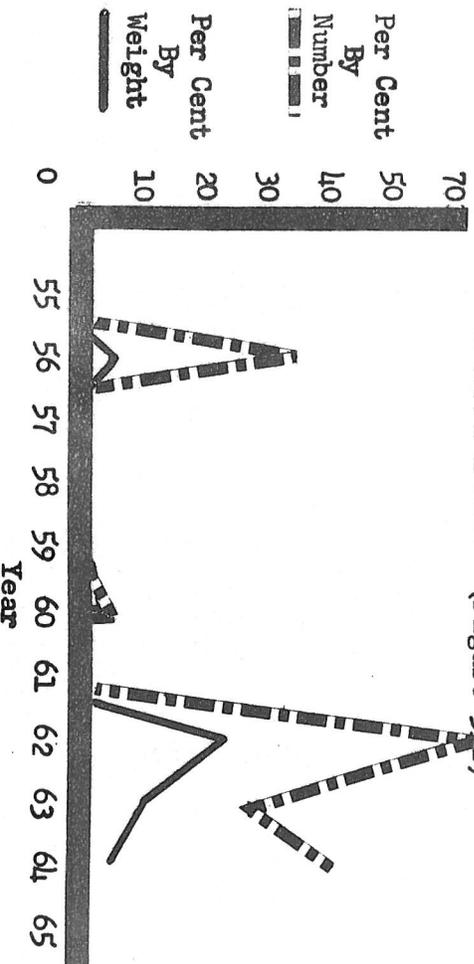
White crappie (Figure 330)



Channel catfish (Figure 331)



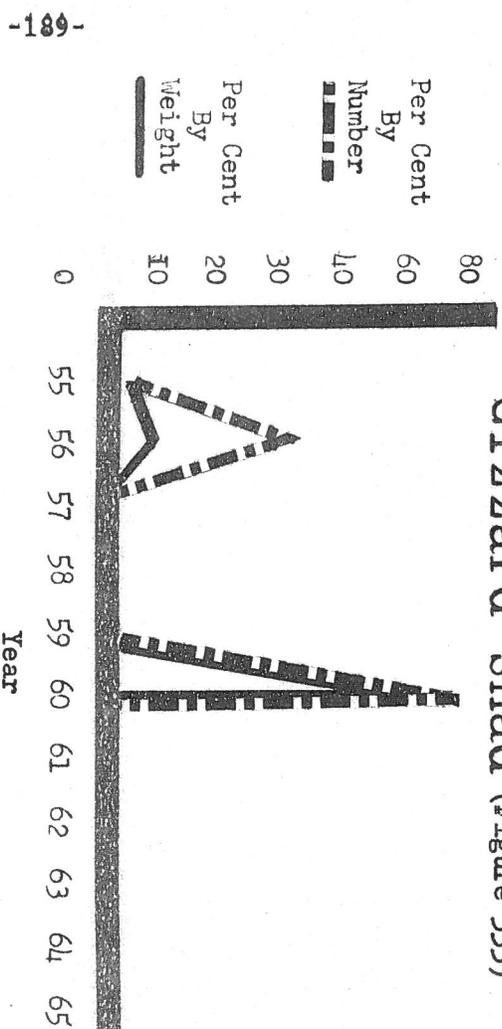
Sunfish (Figure 332)



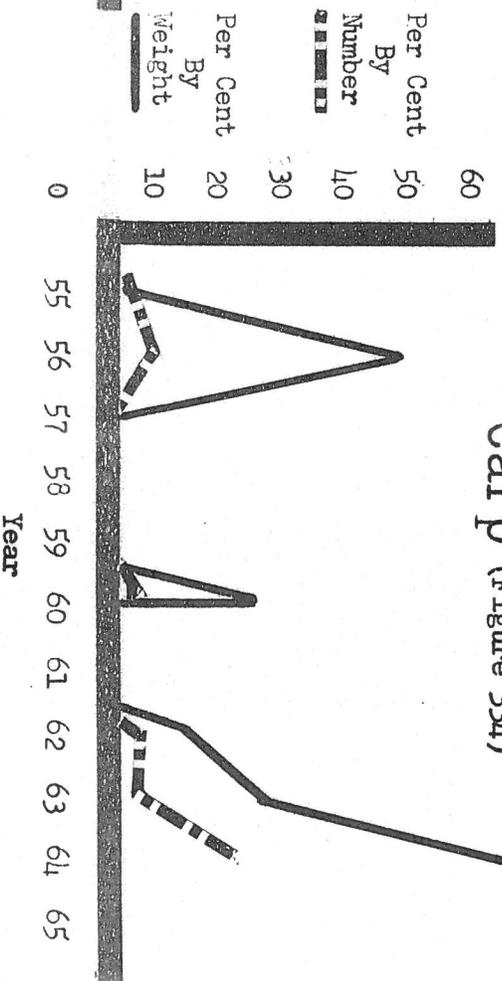
FISH PRODUCTION FROM LAKE ASCARATE

Principal Non-Game Species

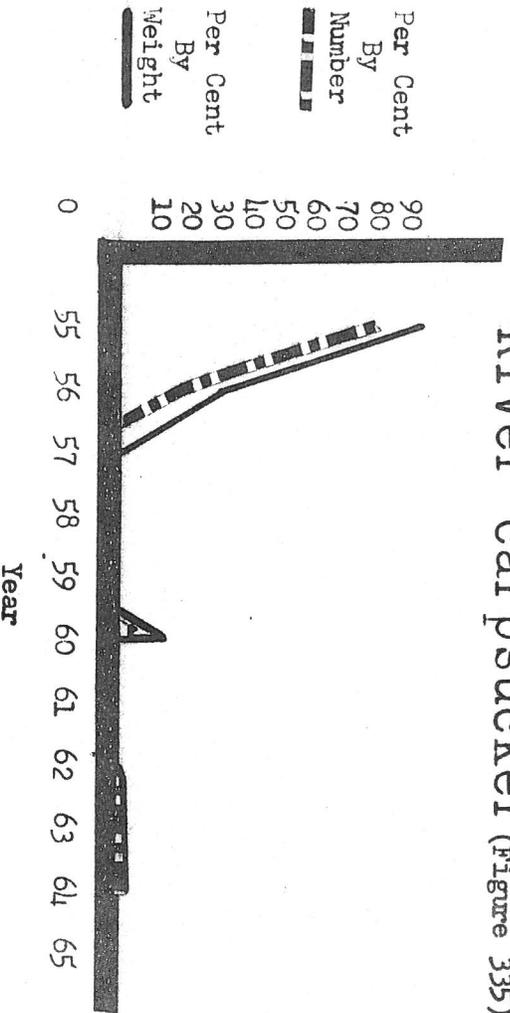
Gizzard shad (Figure 333)



Carp (Figure 334)

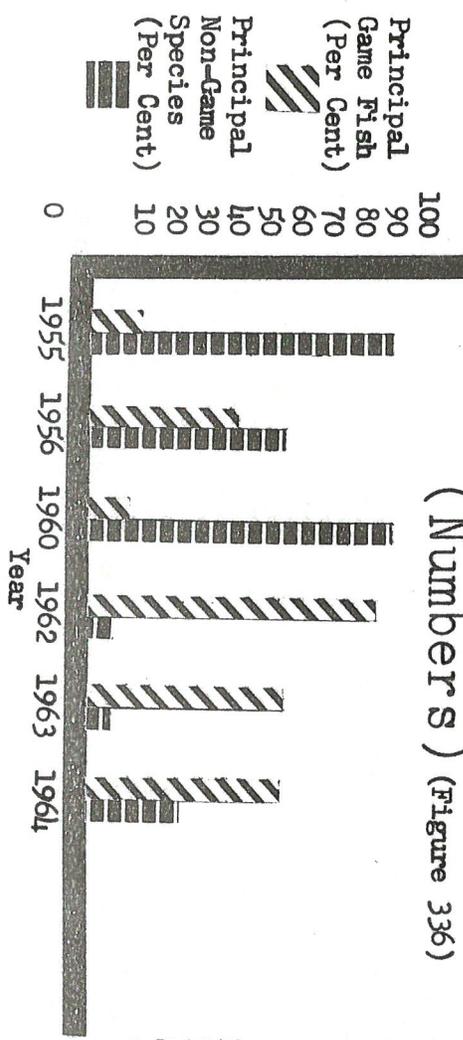


River carpsucker (Figure 335)

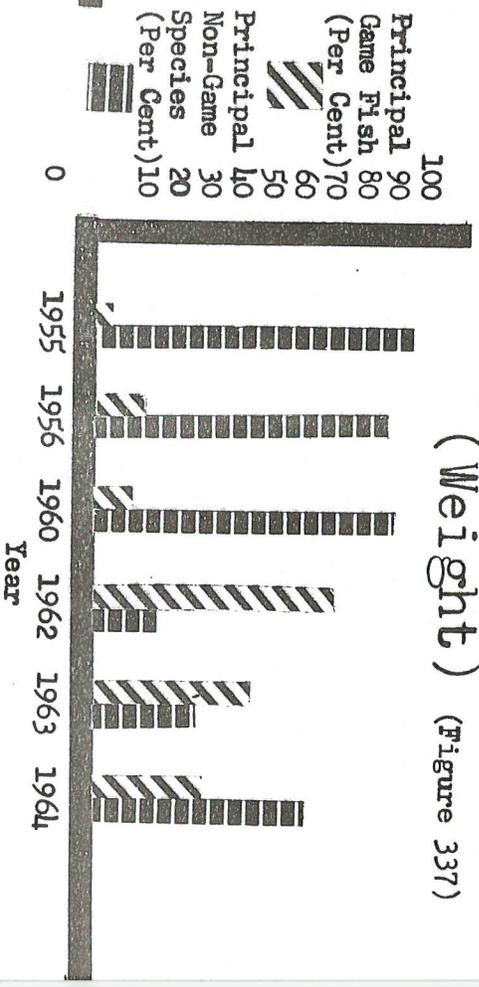


LAKE ASCARATE

Principal Production (Numbers) (Figure 336)



Principal Production (Weight) (Figure 337)



SECTION II

PRINCIPAL FACTORS INFLUENCING GAME FISH PRODUCTION IN REGIONAL PERSPECTIVE

I. Principal Factors Influencing Production in Reservoirs

A. Basic Factors

Climate

The climate for Region 1-B is diverse. In general, climate is classified as ranging from arid to desert. Annual rainfall averages about 20 inches in eastern counties and is less than 7 inches in parts of the Big Bend. The frost free growing season is 180 days in the Panhandle and 292 days along the Rio Grande. During the past fifteen years a few areas have received rainfall that exceeds the annual average, but in general the picture has been one of drouth. Much of the data obtained represents the influence of the climatic cycle during drouth. It is presently impossible to isolate and accurately measure climatic influences on game fish production. In general, the long growing season, the lengthy periods of the year when moderate temperatures prevail, and the natural fertility of soil and water favor game fish production. But the high rate of evaporation and high temperatures during the summer tend to offset these advantages. Primarily because of its climate, Region 1 is viewed as a feast or famine area for game fish production.

Factors Associated With Water Supply

The water levels of Devil's Lake and Lake Walk do not vary more than 9 inches except in times of flooding because those reservoirs are maintained by spring-fed Devil's River. During the past decade Lake J. B. Thomas and Hoards Creek Reservoir have received above average run-off. With these exceptions, the impoundment of significant quantities of water during the past twelve years have been less frequent than in preceding periods. The frequency of prolonged recessions in capacities is also more common than in the period before 1950. The causes for the decrease in run-off and other flow are numerous and complex. The influence of expanding irrigation will be discussed under a later subheading. Drouths have also reduced stream flow. A more recently evolved circumstance, and one of the most important reasons for the reduction in water impounded in public reservoirs, is the changing use of the land. Regionwide there has been a general shift from ranching to farming. Soil conservation practices that are now widely used include "pitting", construction of flood retention structures, and construction of farm and ranch tanks. All of these practices greatly retard run-off. An example of a public fishing reservoir that has suffered as a result of this change is San Estaban Lake. In 1911 when the lake was constructed on Alamito Creek, 10 miles south of Marfa, the maximum storage capacity was 18,770 acre-feet and the lake covered 762 acres. Few lakes in Texas boasted a comparable fishing reputation. Immediately following World War II the lake began to decline and finally went dry in 1962. Thousands of prime game fish were lost. The lake has remained empty since that time. An examination of the watershed at the time the fish were lost revealed the presence of many ranch tanks filled with water. The records of the Soil Con-

ervation Service indicated that many of these were constructed in the past five years. This is an extreme illustration, but the hydrological records indicate significant reductions in run-off for every major watershed in the Region. During the 1950-1960 decade the demand for municipal water has doubled and industrial demands have experienced similar increases. The construction of impoundments on watersheds that cross state and international boundaries has continued and other demands have increased. Observations indicate that the most common and overall detrimental factor influencing game fish production in this region is the occurrence of a prolonged decline in water levels in reservoirs where river carp sucker and other problematic fish are abundant.

Water Quality Factors

Chlorides have increased significantly in most of the regions reservoirs. In most instances the concentration has not been sufficient to cause direct mortality of game fish. Fish kills have occurred in both Red Bluff Reservoir and Imperial Reservoir. In several other instances basic food production has been reduced at critical times of the year. Usually, increases in chlorides correspond with diminishing capacities and expansion of problematic species. When this happens, game fish reproduction apparently ceases. Observations would tend to support the findings of Swingle, Prather and Fielding ^{1/} that excretory substances inhibit reproductive activity, and Kawamoto ^{2/} that excretory substances of fish have a marked influence on their growth.

In much of the area, sulfates have increased due to natural leaching of gypsum and other common materials. Hydrogen sulfide released as a result of decaying vegetation is a common occurrence and, as discovered by Bonn ^{3/} and associates, probably prevents successful reproduction of channel catfish in many instances.

Hardness is increasing. Occasional build up in temporary hardness due to calcium carbonate and magnesium hydroxide is the natural result of the aging of a reservoir in this region. But the increase in permanent hardness in several waters is of major concern.

Turbidity is common and may be increasing. The relationship between the increase in turbidity and the expansion of problematic fish is not adequately measured or understood. In all instances where fish have been destroyed through chemical action, there has been an immediate reduction in inorganic turbidity, a corresponding reduction in chloride content, and in some instances a significant reduction in total alkalinity. The reduction in turbidity is immediately followed by an increase in food organisms of the lower forms in

^{1/} "Commercial Fish Production in Ponds", H. S. Swingle, E. E. Prather, J. R. Fielding, M. C. Johnson and J. H. Padfield.

^{2/} "The Influence of Excretory Substances of Fish on Their Own Growth", N. Y. Kawamoto, Progressive Fish-Culturist, April 1961, Vol. 23, Number 2.

^{3/} E. W. Bonn, Project F-8-R-11, "Channel Catfish Study".

the food cycle and an increase in the efficiency of predaceous species. Silt deposited over large areas of a reservoir basin frequently decreases food production. In many instances, silt deposits are probably detrimental to adequate reproduction of primary game species through destruction of spawning sites. This is particularly true where gravel and sand deposits that were formerly kept clear through stream flow are inundated with the construction of a reservoir. The limited suitable spawning areas are frequently destroyed by silt being deposited at the upper end of reservoirs where such sand and gravel deposits are at acceptable depth to be used by game species for spawning. Existing data do not establish whether the rate of siltation in reservoirs is increasing. I believe that it may be logically assumed to be increasing in some reservoirs, such as Lake Nasworthy and New Winters Lake, where scouring floods no longer sweep silt downstream. This change is brought about as a result of expanding conservation facilities on the watersheds above such lakes.

Pollution

The increase in pollution of reservoirs is unmeasured. The enormous significance of pollution cannot be over emphasized. Pollution that enters reservoirs from streams contributing to its impoundment will be discussed under a later category only the quantity of pollution that enters public waters incidental to their recreational use is considered here. Records of increases in recreational usage of virtually every public reservoir in the region point to a mounting quantity of pollution that enters public waters through such usage. The increase in recreational use of Hoard's Creek Reservoir and San Angelo Reservoir has tripled, and the amount of boats on public lakes is probably more than 100 times as great as for the pre-war years. The cabins on Lake Nasworthy have expanded from a dozen or so to more than 300, and those on Oak Creek Reservoir from a single structure to more than 275. At least 1,000 structures have been built for recreation on the shores or near Lake J. B. Thomas. I believe that it can be assumed that the quantity of incidental pollution that accompanies such an expansion is significant.

B. Biological Factors Influencing Game Fish Production in Reservoirs

Basic Food Production

An illustration of the influence of climate on food produced, that in turn is convertible into game fish, is obtained from plankton studies by the U. S. Department of Health, Education and Welfare. ^{1/} In the graphic illustration of plankton dynamics for the Red River at Denison (Figure 338), there is no recorded instance during the three year period when phytoplankton count per milliliter reached 10,000. It is also apparent that significant drops in production occur in the extreme winter and during the hottest part of the summer.

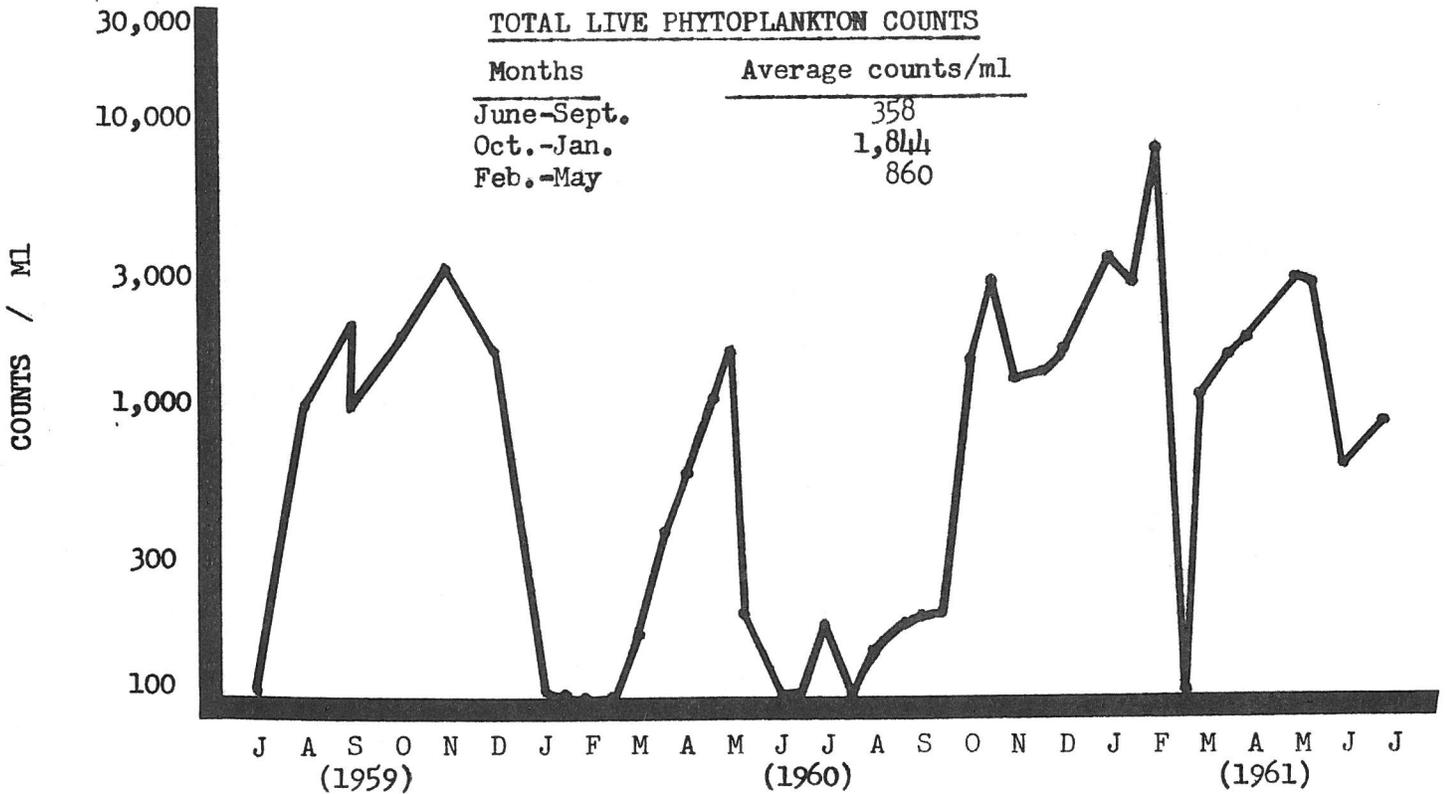
^{1/} U. S. Department of Health, Education and Welfare, Publication No. 663, Supplement No. 2, 1962. U. S. Department of Health, "National Water Quality Network", annual compilation of data October 1, 1961 - September 30, 1962.

Downstream at Alexandria, Louisiana (Figure 339), production between February and May is slightly less than for the same period at Denison. However, the October through January counts at Alexandria were nearly double the figure for Denison, and counts for June to September were more than ten times as great. In comparing these production dynamics for plankton in the Red River with those for the Rio Grande River, it is noteworthy that maximum production at El Paso does not greatly exceed that at Denison, but the average production for the three periods of the year differ significantly. Production for February to May is five times as great at El Paso (Figure 340), production from October to January is about equal, but production from June to September at El Paso is more than ten times as great. At Laredo (Figure 341) phytoplankton production is greater than at El Paso in two of three periods. The overall average production is significantly greater. The severity of the loss of production during the hottest part of the summer at Laredo is dramatically apparent. The June to September average is less than half as great as that at El Paso. These differences in plankton production and dynamics are not totally a result of the differences in climate since organic and mineral fertility of a river normally increase with its progression toward its mouth. However, in all of the plankton dynamic studies reviewed, average temperature and temperature extremes appear to be the principal factors that control dynamics. The scanty evidence available on area streams and reservoirs tends to support these findings, and observations confirm that, in general, the longer the growing season the larger the potential size of the average game fish for the first year of growth.

(Figure 338)

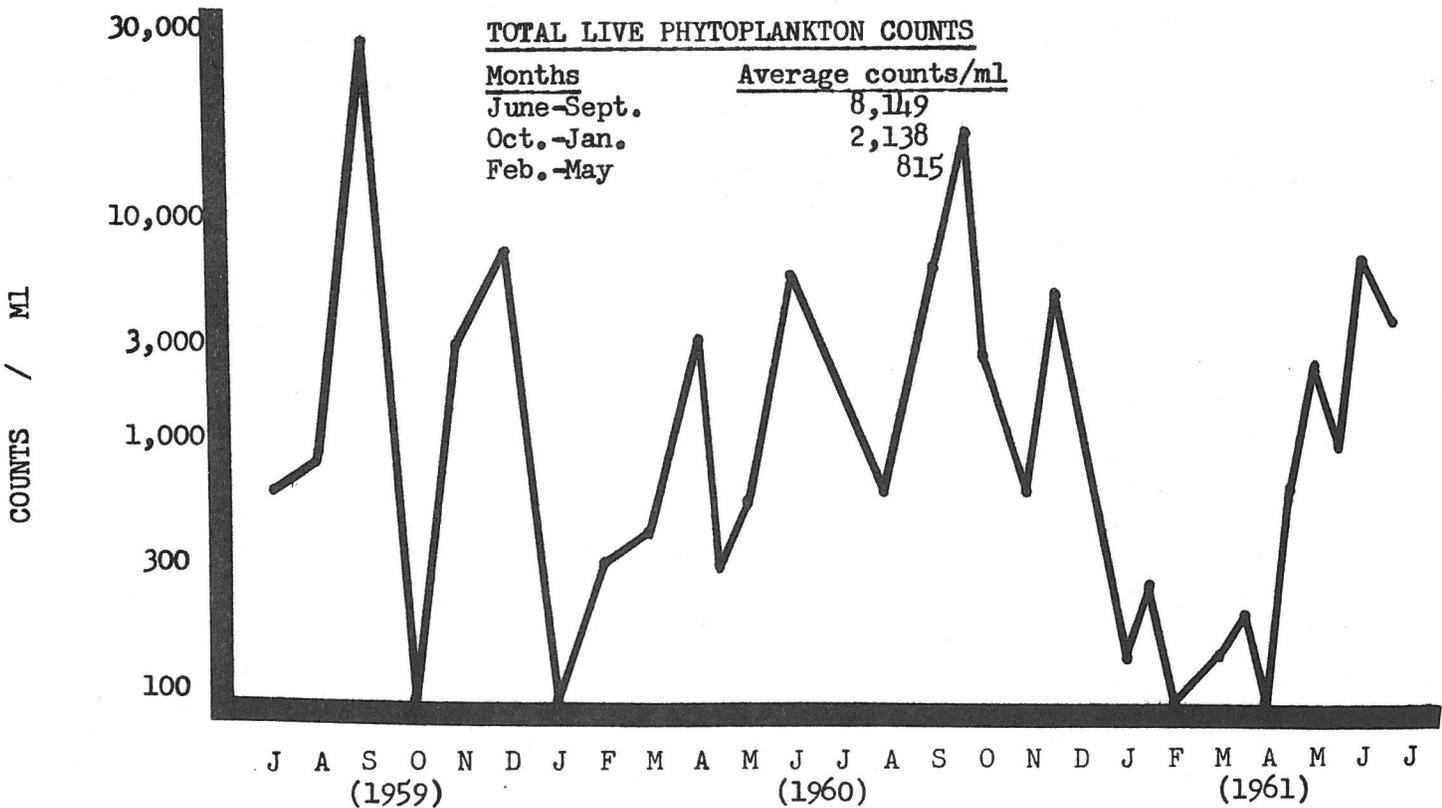
PLANKTON POPULATION DYNAMICS

Red River at Denison, Texas



(Figure 339)

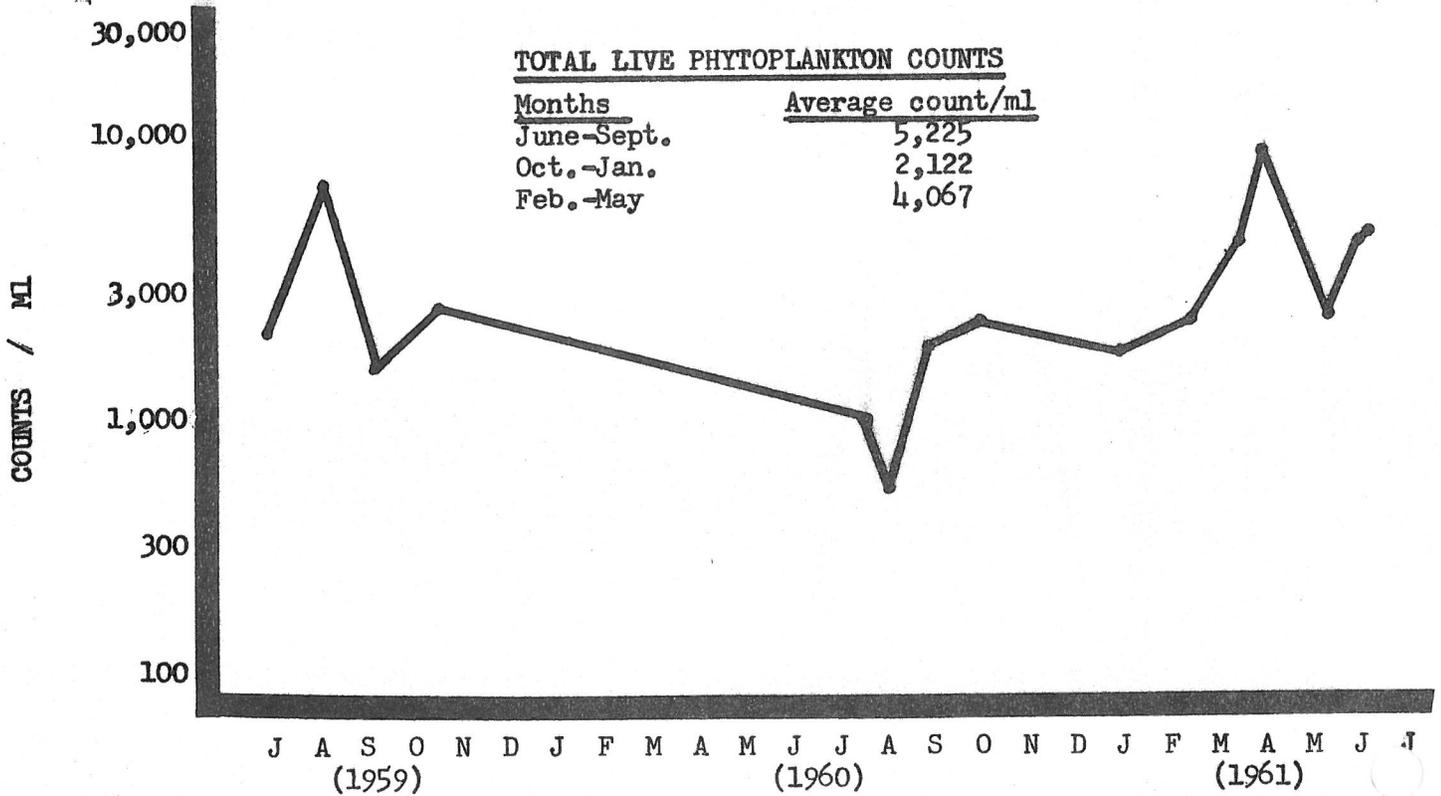
Red River at Alexandria Louisiana



(Figure 340)

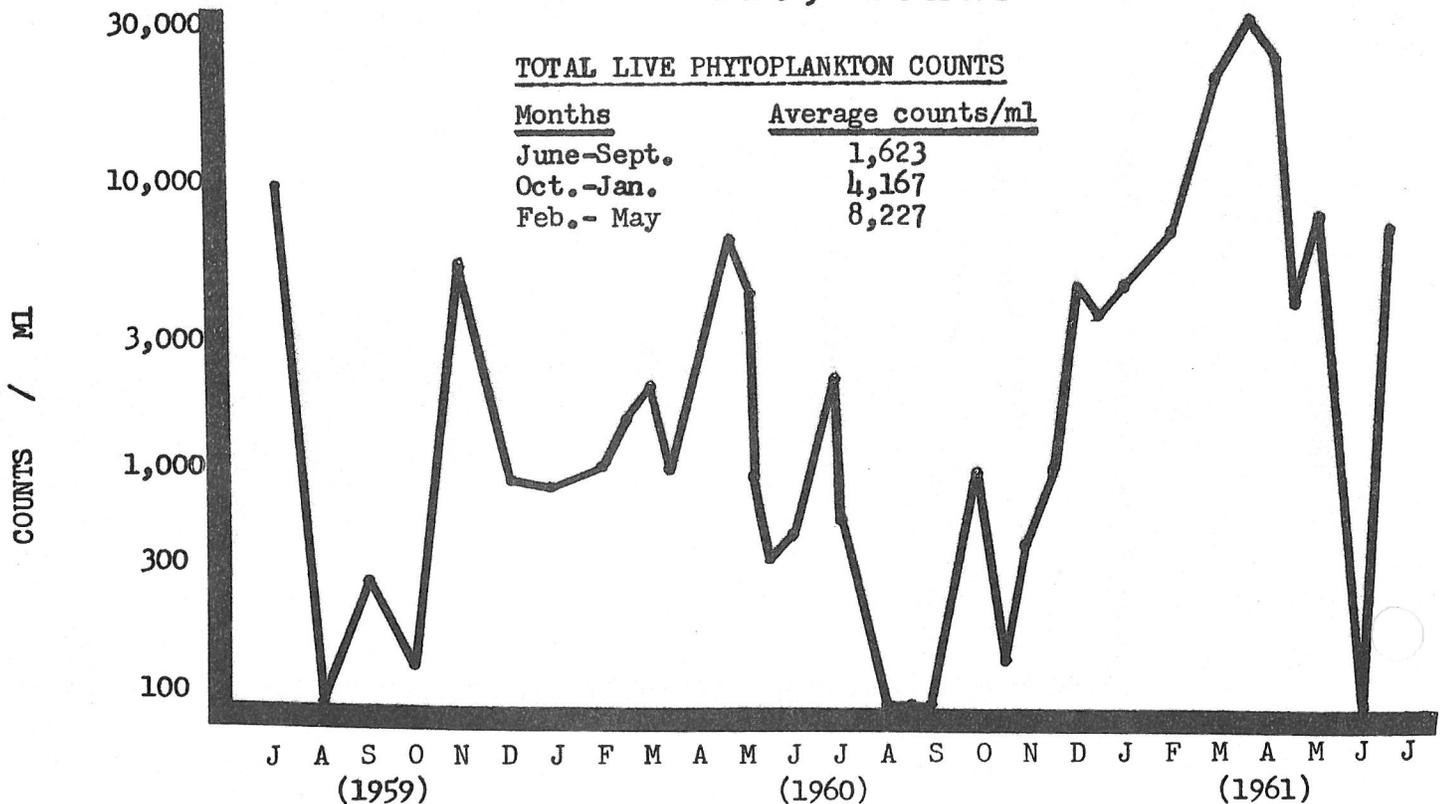
PLANKTON POPULATION DYNAMICS

Rio Grande River at El Paso, Texas



(Figure 341)

Rio Grande River at Laredo, Texas



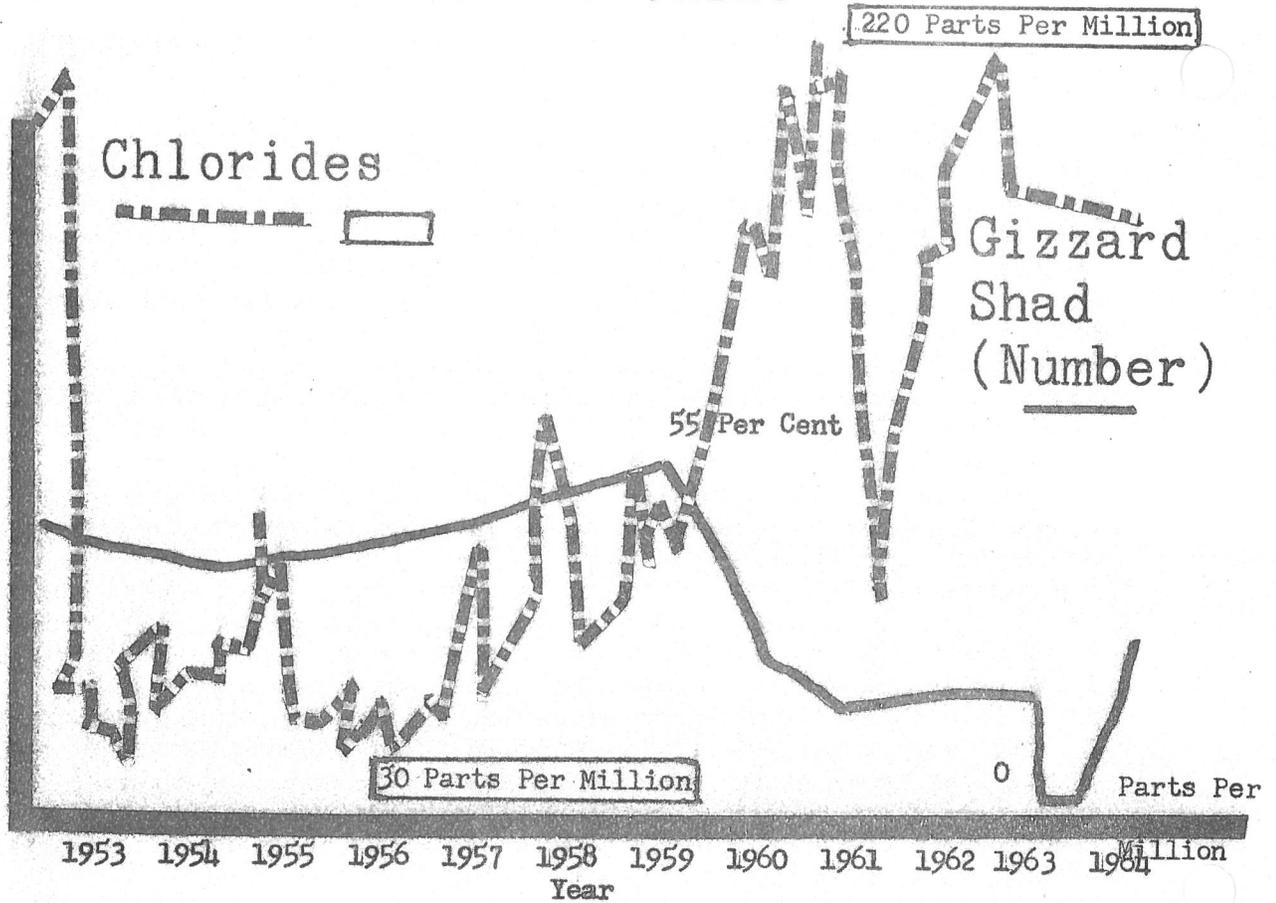
Inter Population Influences of Fish Populations and
Factors Influencing Dominance

Only that project data from sampling of fish populations with gill nets are sufficiently large and consistent to permit any sort of long term production analysis. These data could not be analyzed by using standard biometrical procedures because bias or selectivity of gill nets is unknown. It is necessary to have at least a reasonably accurate measure of that influence before valid inferences may be drawn. Because of this circumstance the primary method used in detecting influences is one which tends to confirm or disaffirm relationships through replications. Unfortunately, the method does not indicate magnitude of the influence. The process involves recording for several years the abundance of relative abundance (as indicated in gill net collections) for a particular species on a graph. The dynamics of the factor to be compared, such as chlorides (Figures 342 and 343), were similarly graphed to permit comparison with the fish population graph and were then traced onto a transparency. The image was then placed on the graph of the fish population in such a manner as to superimpose the image of the factor over the indicated record of fish production. By comparing increases and decreases, coincidences were noted, and by repeating the process for a large number of waters the probability of the relationship between the factor and the production of the species of fish indicated. In Figure 342, it would appear that chlorides increased in Lake Nasworthy and at the same time gizzard shad decreased. In Figure 343, it would appear that the influence is not as effective, possibly because maximum chlorides in San Angelo Reservoir never exceeded the minimum chloride concentration for Lake Nasworthy, or that the influence does not really exist.

When two fish populations are compared (Figures 344 and 349), the increases of one population were compared with the decreases of the other, and by repeating the process many times under similar conditions the tendency is either confirmed or disallowed. In Figures 344 and 345 the interpretation is that increases in white bass production may be and probably are dependent upon a previous increase in gizzard shad. In Figures 346 and 347 increases in river carpsucker are followed by significant reductions in largemouth bass. The interpretation for Figures 348 and 349 is that significant increases in river carpsucker were followed by decreases in gizzard shad. In Figures 350 and 351 a tendency of game fish production to follow increases or decreases in water levels is indicated. In a number of instances the dynamics of four or more factors and game fish populations were compared. In Figures 352 and 353 it would appear that a relationship exists between increasing chlorides and increasing abundance of river carpsucker, and inversely, a decrease in white bass as river carpsucker and chlorides increase.

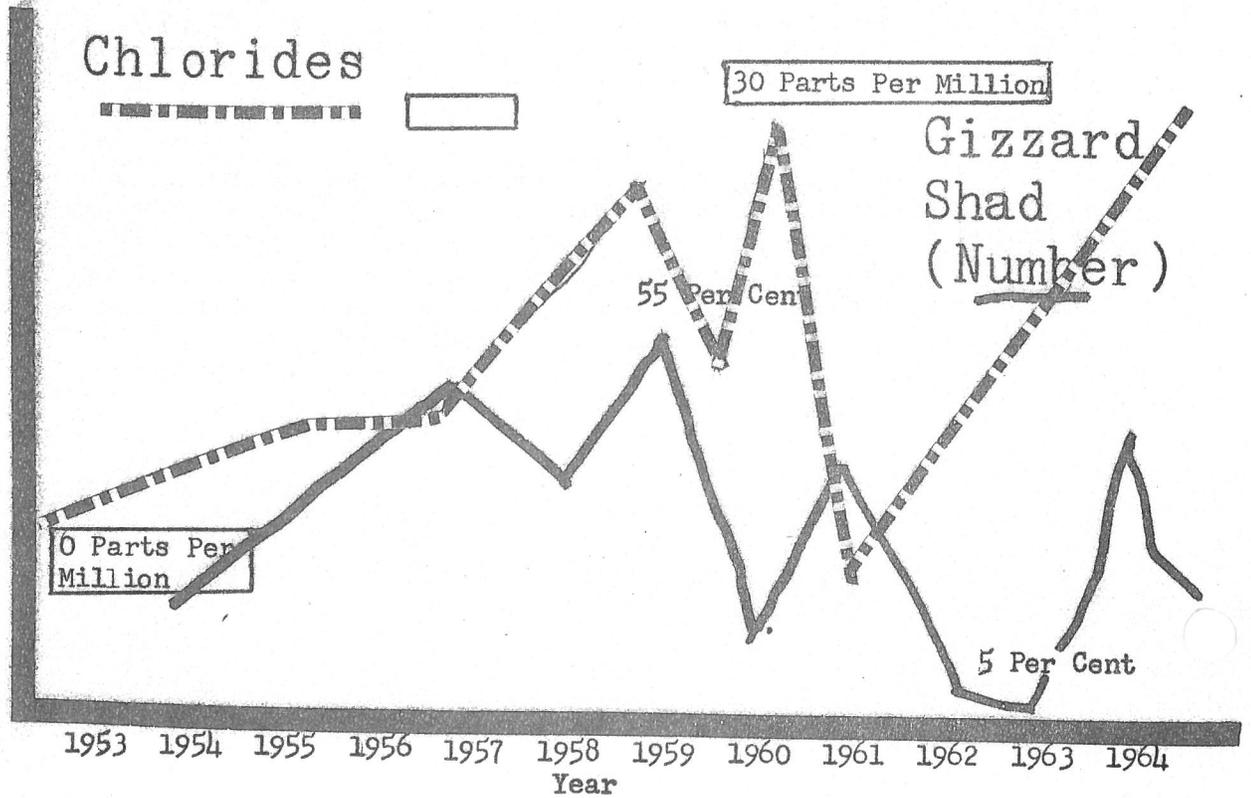
(Figure 342)

-198-
LAKE NASWORTHY



(Figure 343)

SAN ANGELO RESERVOIR



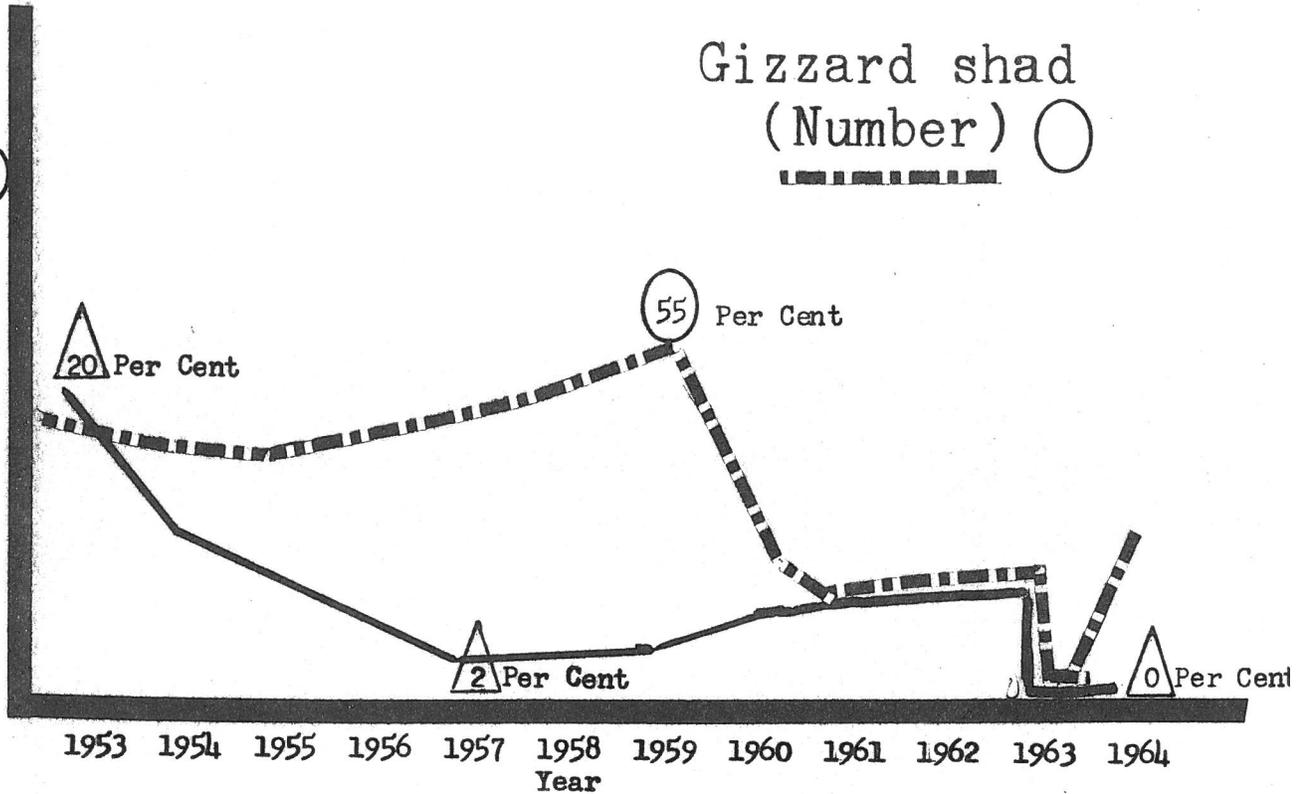
(Figure 344)

-199-
LAKE NASWORTHY

White
bass
(Number)



Gizzard shad
(Number)



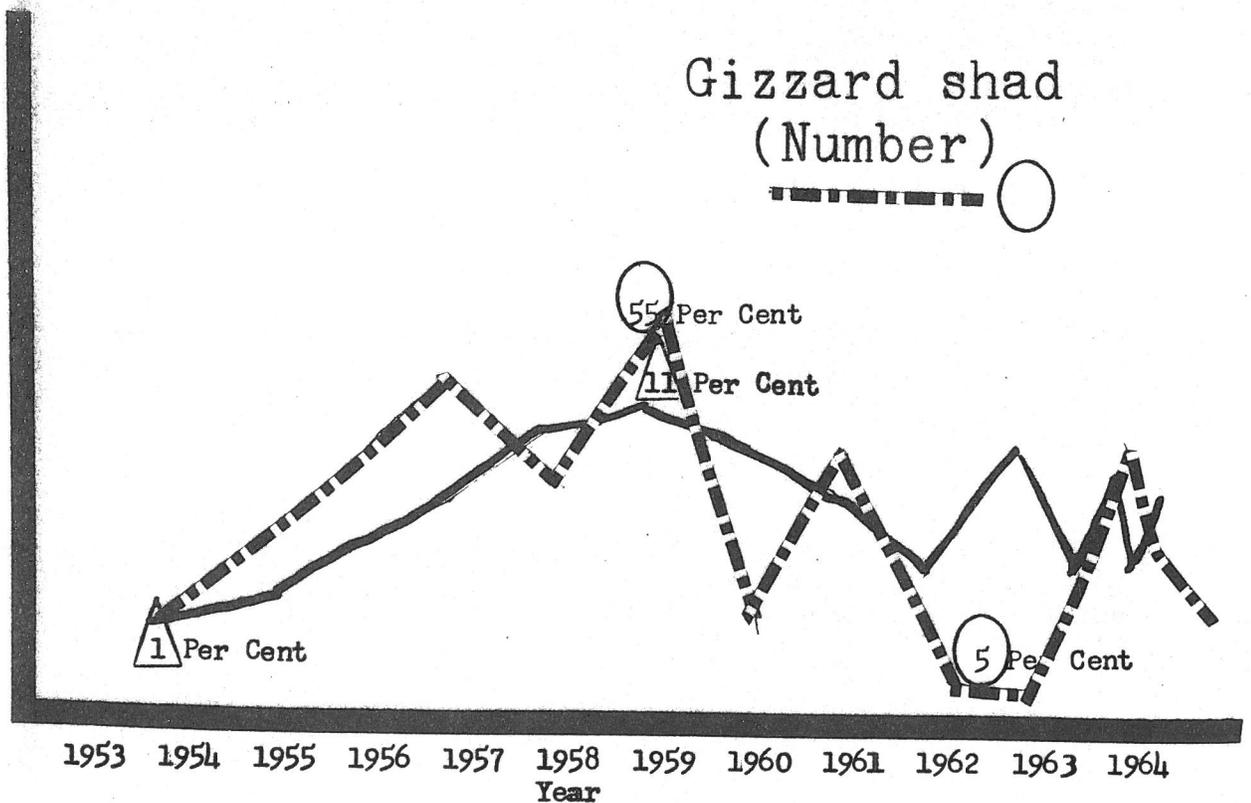
(Figure 345)

SAN ANGELO RESERVOIR

White
bass
(Number)



Gizzard shad
(Number)

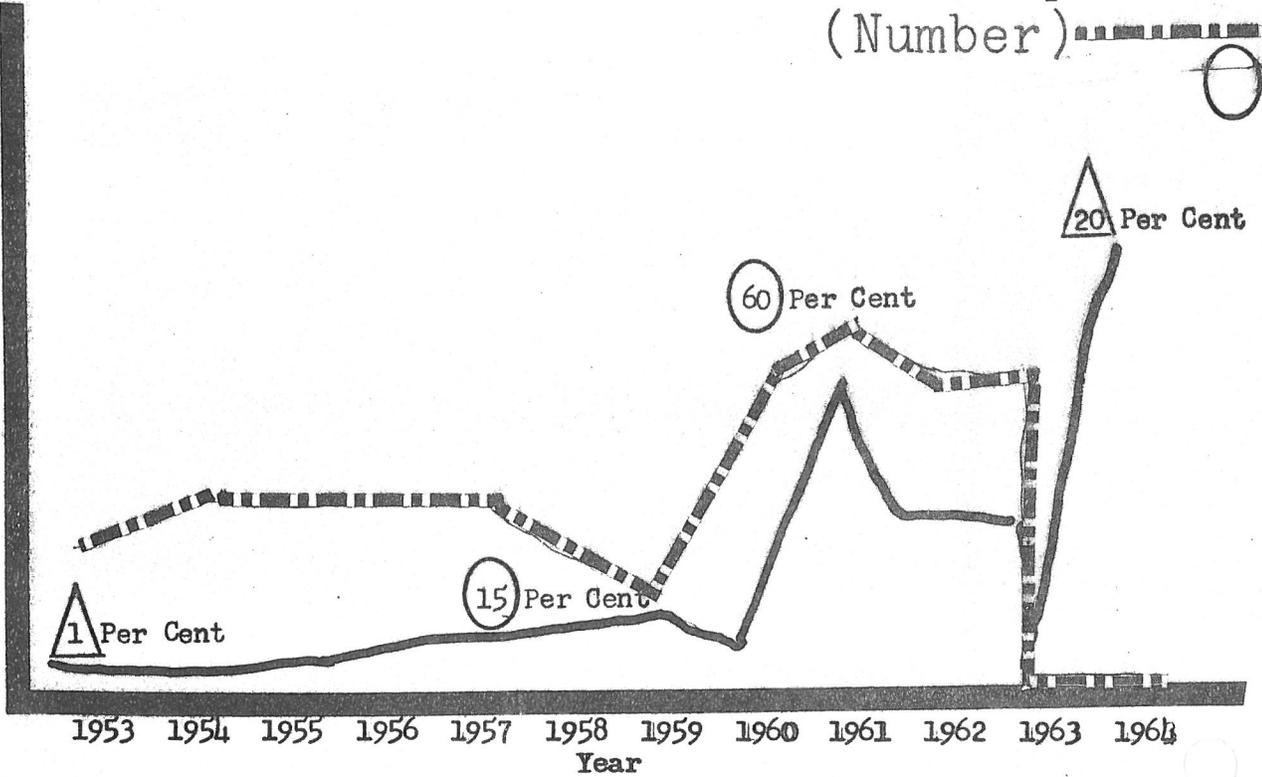


LAKE NASWORTHY

(Figure 346)

Largemouth bass
(Number)

River carpsucker
(Number)

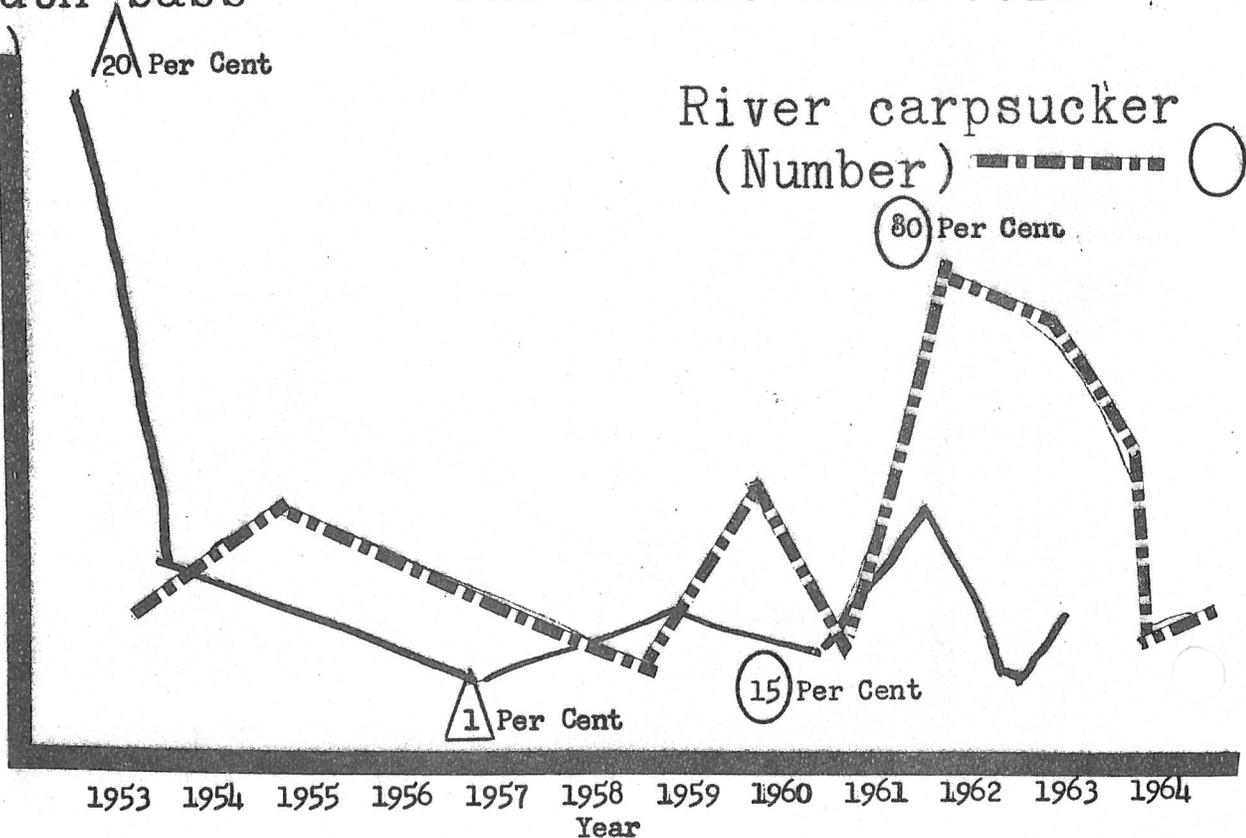


(Figure 347)

Largemouth bass
(Number)

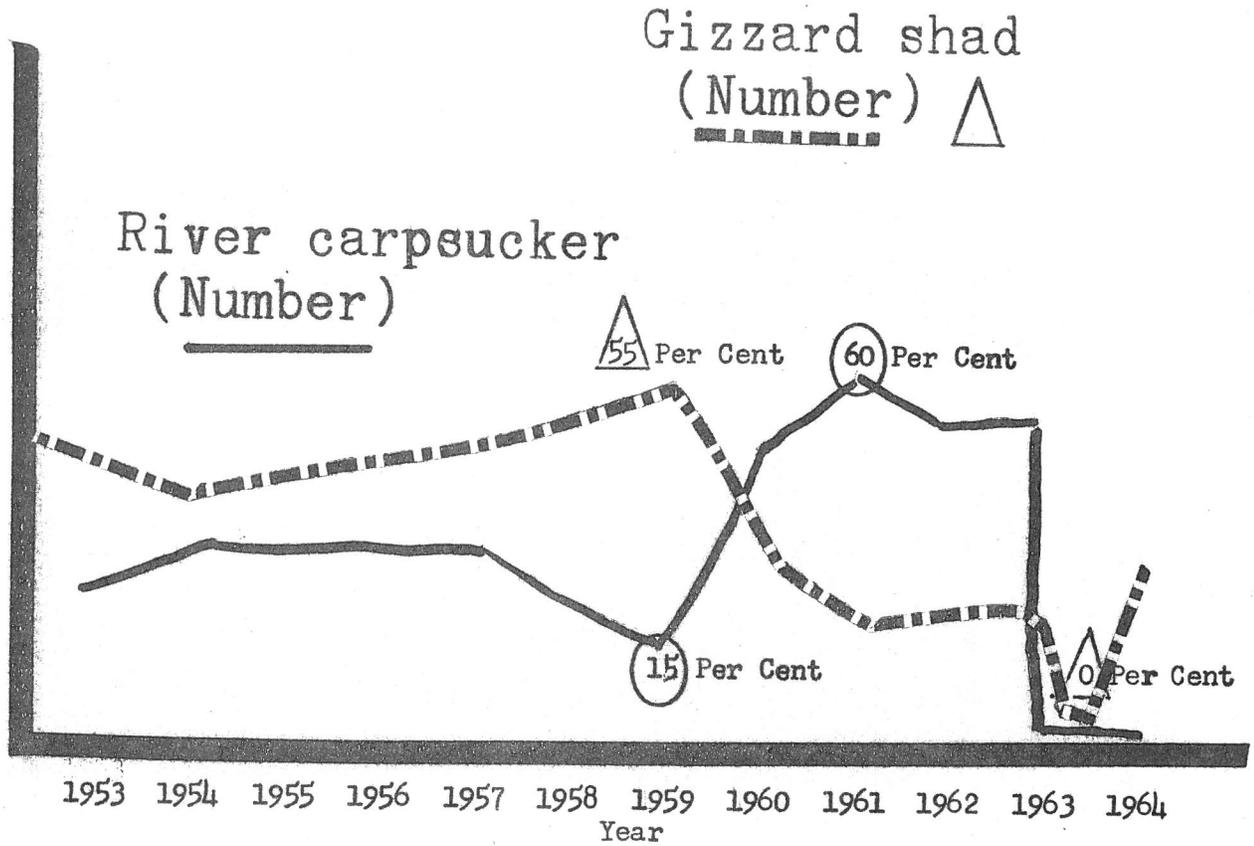
SAN ANGELO RESERVOIR

River carpsucker
(Number)



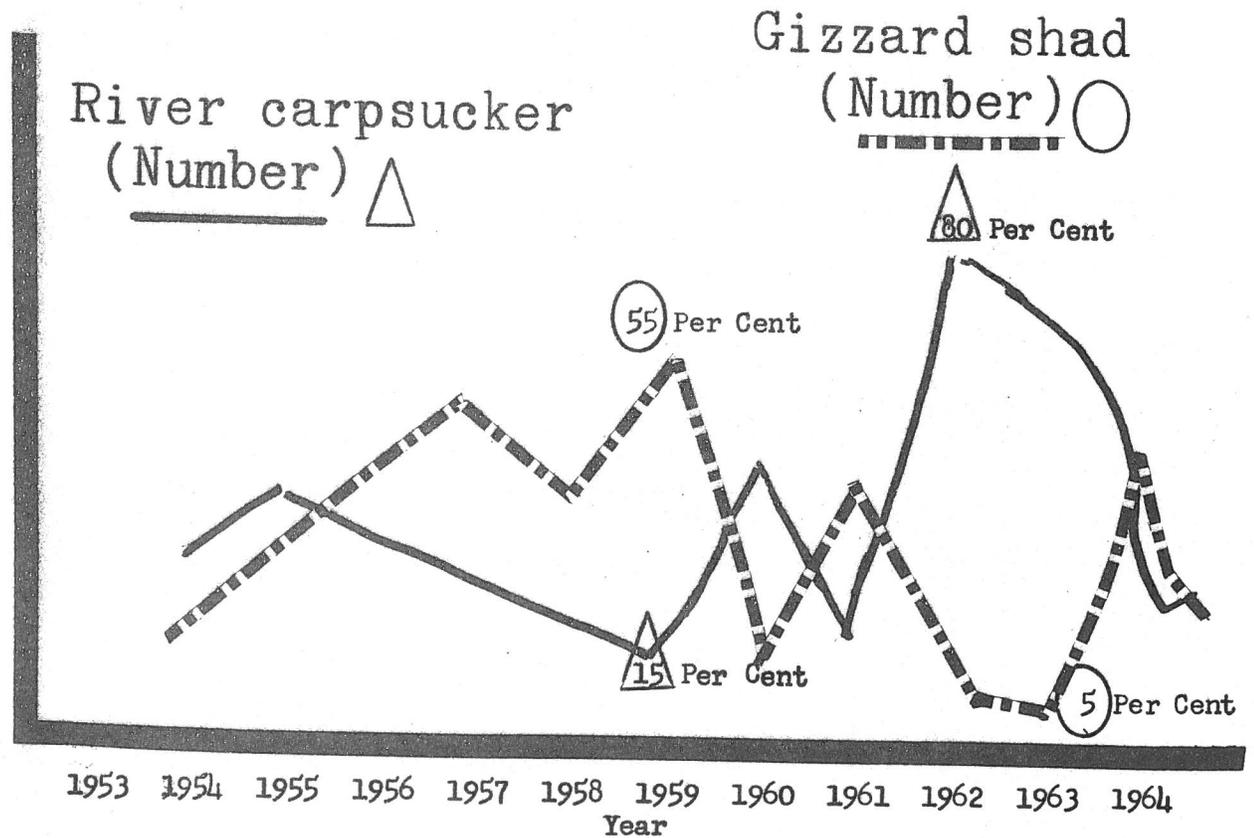
(Figure 348)

-201-
LAKE NASWORTHY



(Figure 349)

SAN ANGELO RESERVOIR

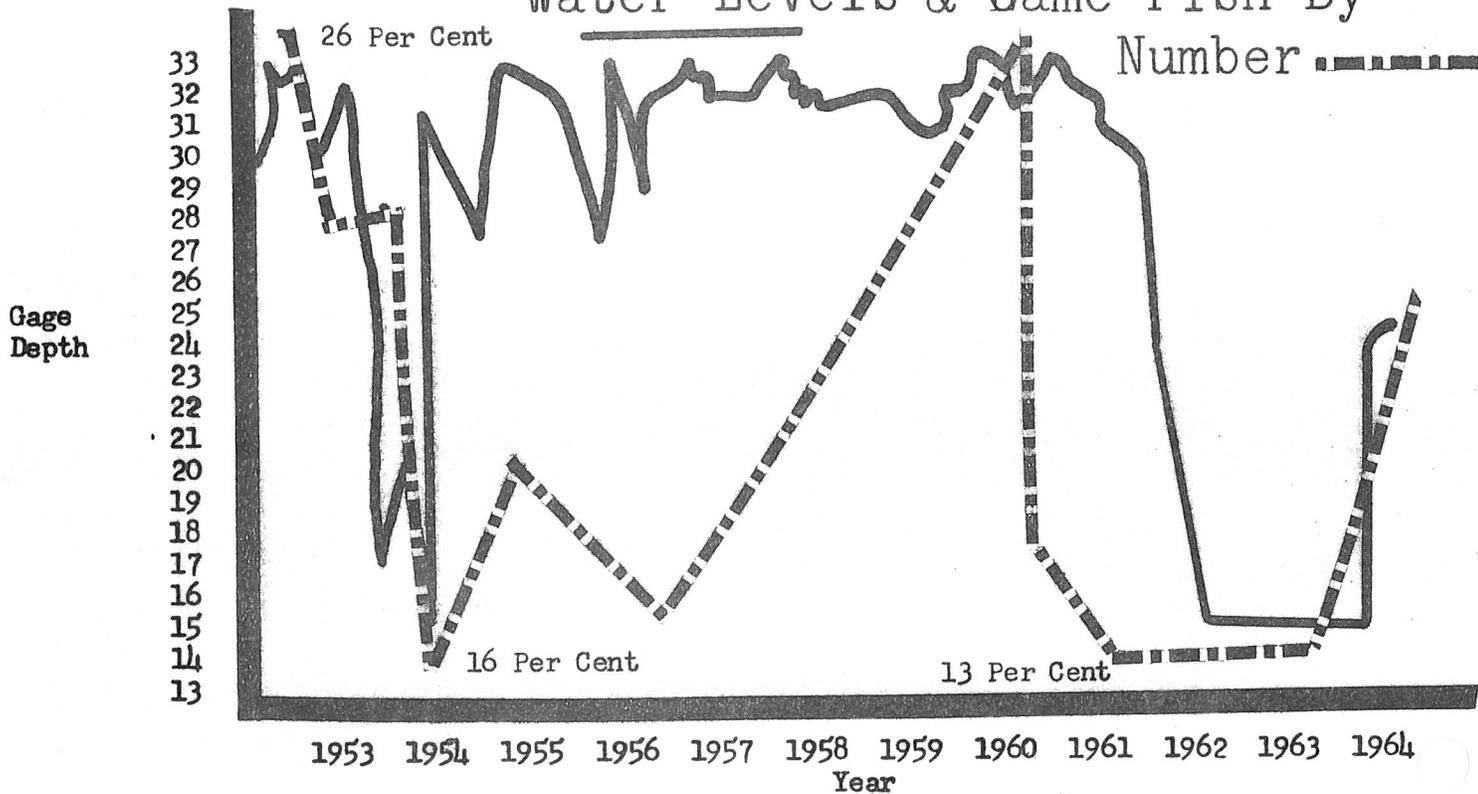


(Figure 350)

LAKE NASWORTHY

Water Levels & Game Fish By

Number 

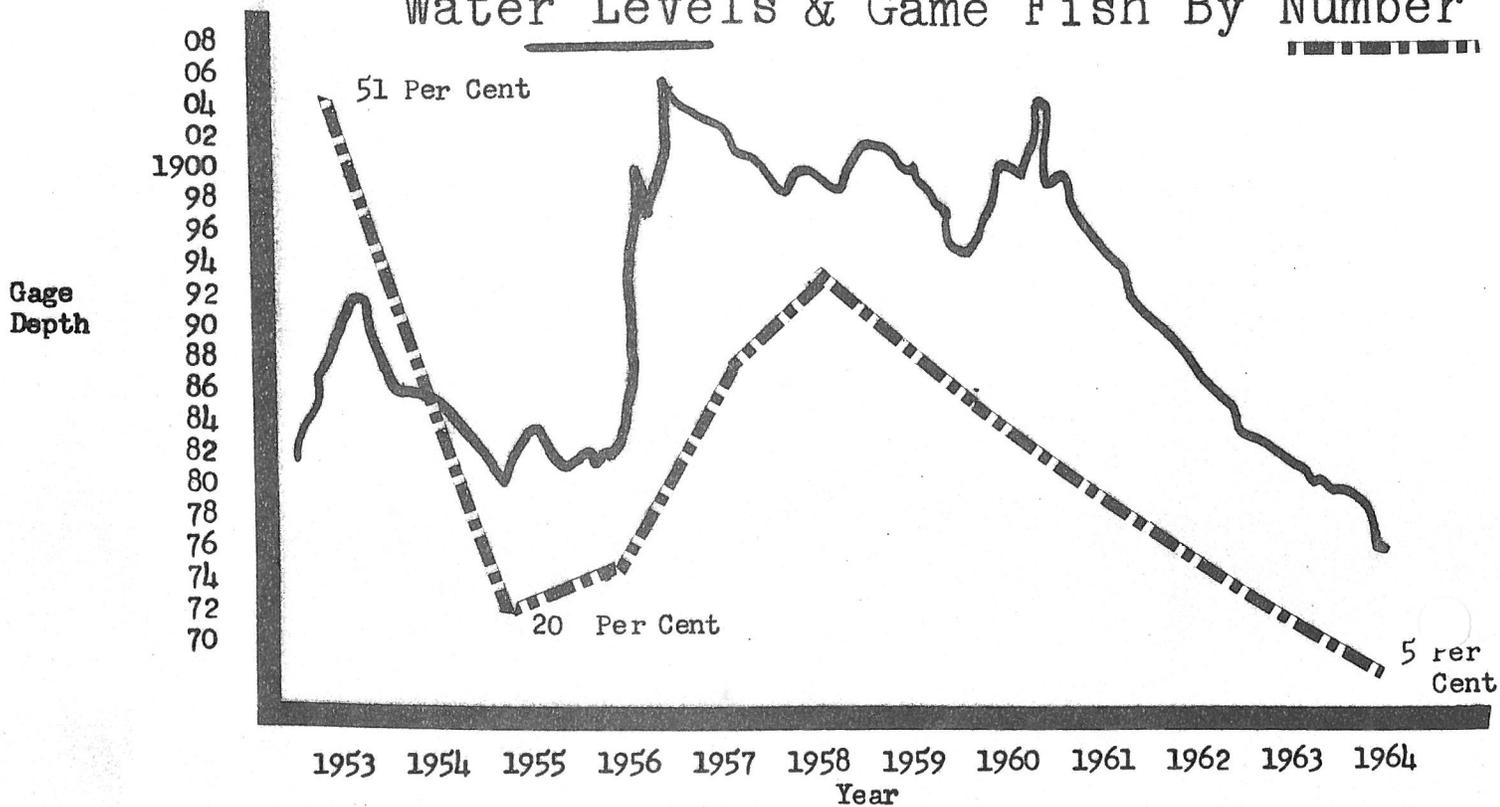


(Figure 351)

SAN ANGELO RESERVOIR

Water Levels & Game Fish By

Number 



(figure 352)

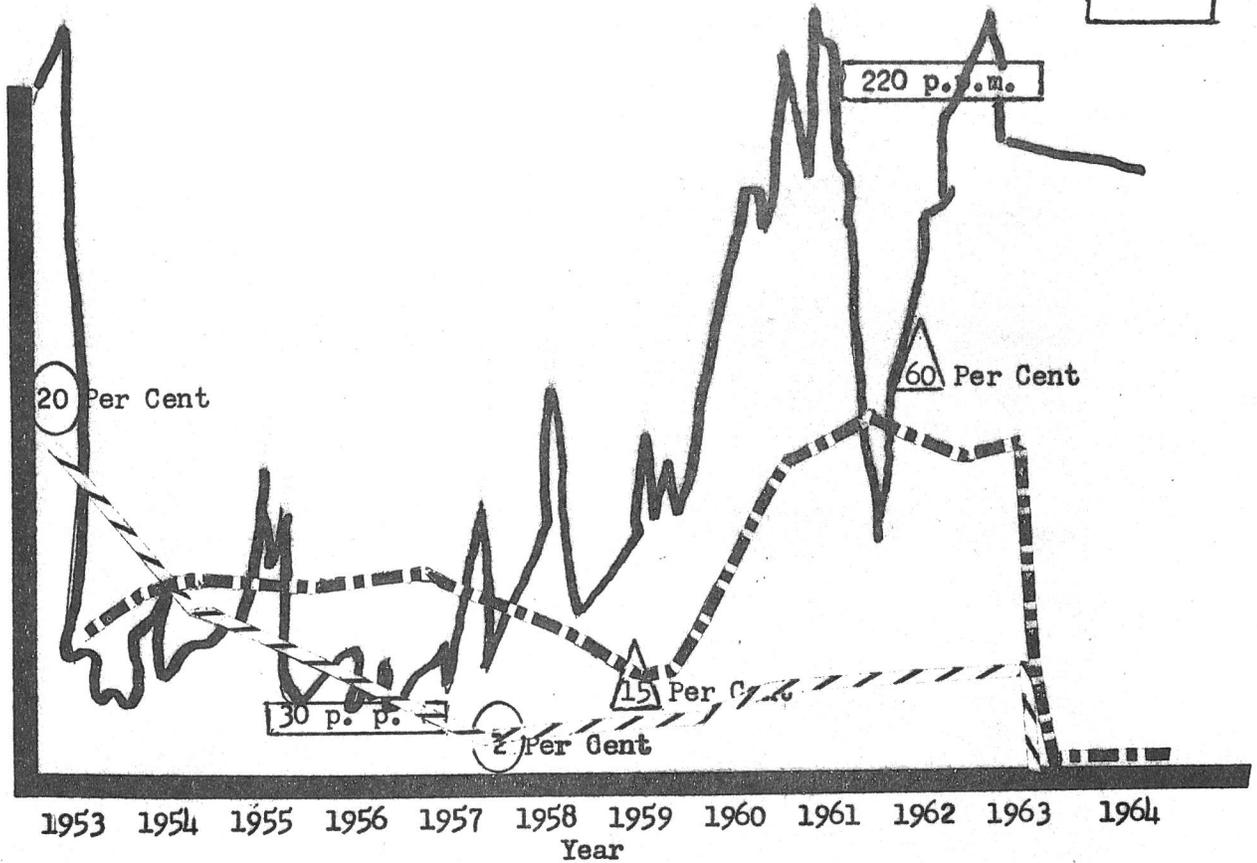
-203-
LAKE NASWORTHY

Chlorides

river
carpsucker
(Number)



White
bass
(Number)



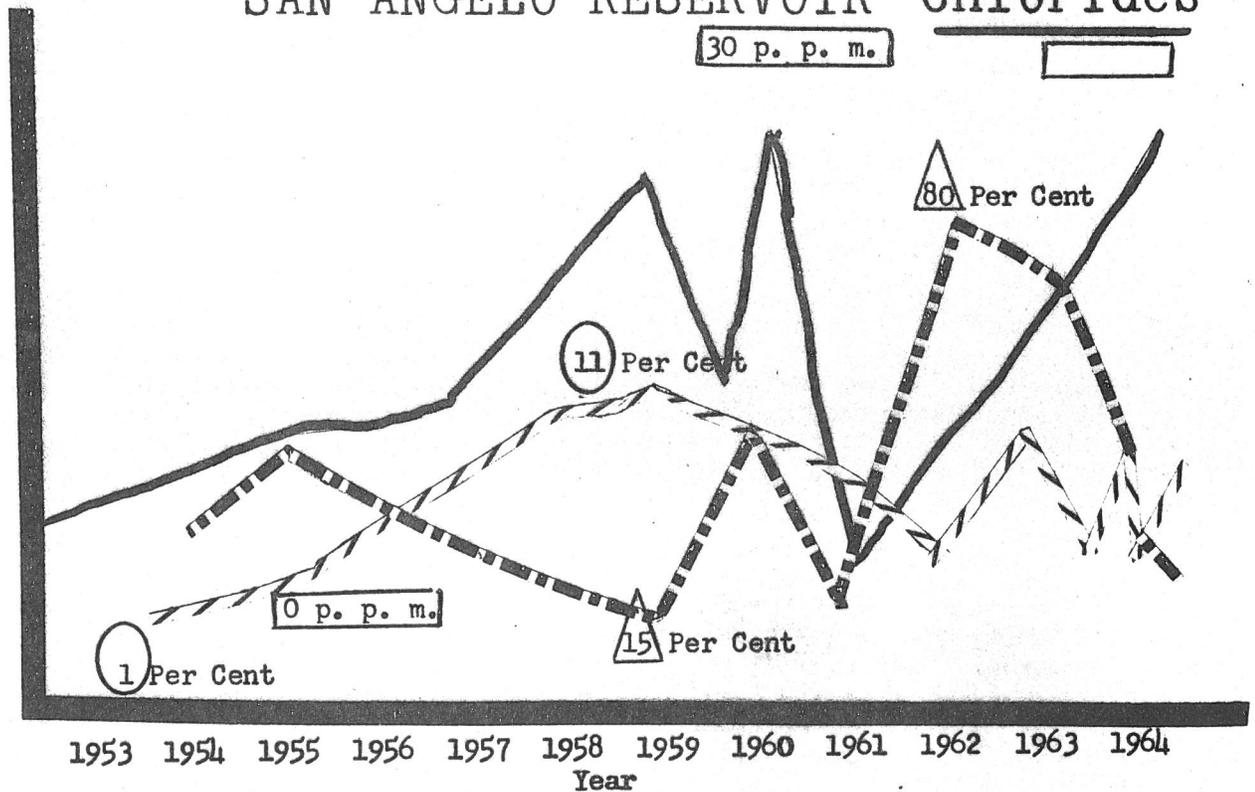
(Figure 353)

SAN ANGELO RESERVOIR Chlorides

River
carpsucker
(Number)



White
bass
(Number)



Following this procedure the following relationships are suspected:

1. The expansion in relative abundance of river carpsucker is the most detrimental factor to gross game fish production because accompanying their relative expansion (a) phytoplankton is decreased; (b) turbidity is frequently increased; (c) chloride content is usually increased; (d) the numbers and utility of primary forage species such as gizzard shad and minnows decreases; (e) the number of game fish decreases as a result of these factors or possibly because of their inability to tolerate the crowding incidental to such population pressures, and (f) reproduction by game fish is drastically inhibited, or if reproduction occurs, progeny do not survive for a significant length of time.

2. The natural factors that appear to control or that tend to influence river carpsucker production dynamics are: (a) the inherent ability of the fish to grow beyond utilizable size for forage in short periods of time or their lack of utility as forage; (b) diminishing capacities in reservoirs tend to favor expansion, or in streams, diminishing flow accompanied by diminishing capacities tend to favor expansion; (c) while expanding capacities or volumes favor reproduction of river carpsucker, this circumstance does not always result in an immediate increase in relative abundance; and (d) abrupt increases in chlorides, or possibly other salts, tends to reduce the expansion of river carpsucker (ie. as in Imperial and Red Bluff Reservoirs).

3. The intra-population dynamics of gizzard shad are probably more significant in relation to game fish production than their numerical abundance. When the average size of shad becomes too large for most game fish, particularly white bass, to utilize them for food, they exert detrimental influences on game fish production. There is also apparently a relationship between the average size of gizzard shad and declining water levels where these declines are accompanied by increases in river carpsucker and chlorides.

4. Carp are problematic only when their size prohibits their utilization for food. Carp are also of utility in what they serve as game fish in some localities. The factors that influence or curb expansion of carp appear to be: (a) their own intra-population pressures, and (b) they are reduced by high chloride content as evidenced in Imperial and Red Bluff Reservoirs. Carp normally expand with increases in volume, or where growing room is created by reduction of other species.

5. Apparently white bass populations are controlled or strongly influenced by: (a) expanding gizzard shad populations or diminishing utility of gizzard shad; (b) the occurrence of maximum spawning requirements (flow entering the reservoir at the required time and under the proper conditions); and (c) the stability of water levels and accompanying dynamics of river carpsucker populations. In most instances, drastic reductions in reservoirs were accompanied by similar reductions in the abundance of white bass.

6. Largemouth bass production is largely influenced by: (a) the expansion of problematic species, primarily river carpsucker; (b) the relative stability of water levels and population dynamics accompanying changes; (c) the presence and relative abundance of other centrarchids; and (d) the abundance of cover.

7. The factors that control white crappie production are not clearly definable. However, in most instances a prolonged reduction in volume has resulted first in the numerical expansion and stunting of the species, and second (when the reservoir is approaching desiccation) in reduction to the point of near extinction. Fall insect production appears to have a great influence on the production of white crappie.

8. The production of utilizable sunfish is apparently controlled by the maintenance of a relatively high abundance of the species that utilize them for food, and possibly other factors that are not discernable.

9. Apparently the production of channel catfish is not controlled by biological factors with the single exception that is described later under flathead catfish. Water quality and stability appear to be the primary influences on channel catfish production.

10. There appears to be relationship between the production of flathead catfish, white crappie and turbidity. In several instances, relatively high and sustained production of flatheads and utilizable white crappie are coincidental to constant turbidity.

11. Frequently relationship exists between the abundance of flathead catfish produced and a preceding high production of bullheads or channel catfish. The increase in flatheads is almost always accompanied by a decrease in the other catfish. The only game species that apparently benefits from the existence of an abundance of river carpsucker is flathead catfish.

The Influence of Aquatic Vegetation In Reservoirs

The influence of aquatic vegetation on game fish production is difficult to detect and is presently unmeasured. However, the following observations from project experiences are deemed worthy of further investigation.

1. The quantity of water required for the production of emergent vegetation is significant and may be of critical importance in specific circumstances.

2. Project data indicate that emergents may become so dense that they actually destroy fishery habitat along the margins of reservoirs.

3. Emergents, when properly controlled, serve to increase game fish production by (a) serving as desirable habitat and protection for species requiring these facilities and (b) creating currents between offshore and shore waters.

4. Submerged aquatics, when not too abundant, serve to enhance food production, provide habitat, and reduce turbidity.

5. When too dense, submerged aquatics reduce game fish production through over-protection of forage species.

6. Stunting of sunfish is frequently associated with the existence of excessive aquatic vegetation.

7. Submerged aquatics frequently become so dense that they reduce circulation of reservoir waters, resulting in cut-off waters becoming too hot during the summer, and probably reduce reproduction by game fish.

8. The collapse of dense concentrations of aquatics frequently results in fish kills.

II. Principal Factors Influencing Game Fish Production In Streams

Project data are insufficient to permit detailed analysis of game fish production in streams. I postulate the most important factors that influence production are: (1) stability of water levels and capacities; (2) permanence and volume of flow; (3) basic food production and (4) water quality. The material in this section is presented because it is persuasive evidence of the deterioration of game fish production in streams and because it points to the need for further investigations. Climatic factors are identical with those previously described. Factors that have reduced surface run-off have been discussed under water supply for reservoirs, and many of the previously indicated relationships and factors are probably applicable to streams.

The Impact of Irrigation on Streams

Last year, in the area that is Region 1, more than 7 million acre-feet of water were pumped from the ground for irrigation. A comparison may serve to better communicate the significance of that fact. If all of the public reservoirs in the region were filled to capacity once each six months and their total contents returned to sub-surface reservoirs, we would still be reducing our sub-surface deposits by more than a million acre-feet of water each year. This is nearly half the normal storage of the Regions reservoirs. With a few exceptions, watersheds are approaching maximum development of storage facilities. Most of the reservoirs now under construction will be primarily for irrigation.

The history of irrigation in Texas predates spanish colonization, but the enormous expansion that has resulted in the present development began in the 1940's. Prior to that period, irrigation for the entire state barely reached a million acres. After the war, irrigation farming boomed, and by 1958, 6.7 million acres of Texas land were irrigated. By 1964 more than 7.7 million acres were irrigated, and most of this, more than 60 per cent, is located in Region 1. Ground water continues to be the major source and has furnished all of the increase, more than 1,796,292 acre-feet annually. The rate of increase for the state is slightly more than 2 per cent, whereas the rate of increase for Region 1 is more than 20 per cent. Irrigated farms are expanding from the High Plains toward the aquifers that feed the headwaters of the Colorado, San Saba, Nueces, and Devil's Rivers. From 1958 to 1964

the quantity of water withdrawn for irrigation from Scurry, Schleicher, Gaines, Glasscock and Mitchell Counties has doubled and that for Reagan, Runnels, Tom Green, and Crockett Counties has tripled. The increase in Sutton, Coke and Sterling Counties was tenfold. Andrews County used 15 times as much of its subsurface water in 1964 as it did in 1958. In areas where extensive irrigation has been practiced for many years, such as Reeves and Pecos Counties, water level measurements logged from wells indicate that declines in ground water have averaged about 24 feet per year for the last six years, and have been as great as 150 feet. This exploitation is compounded by an inestimable, but great, expansion in small water wells for minor agricultural and domestic use, by irrigation from streams (both authorized and unauthorized) and by the erratic nature of run-off during the past few years. Average run-off figures are misleading since floods that deliver an enormous quantity of water that is of short residence are included in such averages. Without flow from springs nearly all headwater streams are near total depletion most of the time, and it is during this critical period that irrigation most often is practiced.

The means of positively establishing the degree of influence of these circumstances on springs, subsurface flow, and stability of streams is beyond my ability, and I can find no authoritative reference on the subject. I doubt if the effect can be anything but gravely detrimental and my observations of fish production tend to confirm this. Comanche and Leon Springs, on the Pecos watershed, previously provided vast quantities of water, first for streams and later for irrigation. They are now dry. These were historic springs and records of their constant abundance go back for more than a century. San Solomon, Phantom, and Givin Springs near Balmorhea have reduced flow, Escondido Spring has gone dry, and other lesser springs are no longer contributive. On the Colorado, Big Spring that provided constant flow for a hundred years is dry, and a dozen lesser springs that contributed to the North Concho or Colorado Rivers are dry. On the Middle Concho, half a dozen springs that produced permanent water during the extreme drought of the mid-1950's have failed, and the principal springs for Spring and Dove Creeks and for the South Concho River have been reduced. To a lesser degree, flow from springs on the San Saba, North Llano and Devil's Rivers have been diminishing. The impact of these circumstances on game fish production and on the preservation of rare endemic species is unmeasured but obviously detrimental.

Water Quality for Regional Streams

The intent of this brief summary is to present as simply and concisely as possible an evaluation of data available on quality of area streams. Where increases in chemical quality are noted, such increases do not necessarily indicate pollution, but should be construed as a trend which should be watched carefully. Analysis of data is for the six-year period from 1958 through 1963.

Analysis for the Upper Brazos River is based upon data on streams located between Lake Whitney and Seymour in Baylor County. Chemical quality has deteriorated. Total dissolved materials has increased by 17 per cent and the 6 year average of 3,874 parts per million of total dissolved solids is considered unsatisfactory.

The upper Colorado River has shown some improvement in chemical quality. Total dissolved solids have decreased by 13 per cent, probably due to the control of brine pollution. However, the six-year average of 4,027 parts per million is regarded as unsatisfactory.

The upper Rio Grande has exhibited deterioration. An increase of 106 per cent in dissolved solids is indicated, and an average of 118 parts per million is considered poor.

The Pecos River has continued to deteriorate. Total dissolved solids have increased by 27 per cent in the six year period. The average of 10,252 parts per million is unsatisfactory for nearly all beneficial uses and lowers the quality of the Rio Grande.

The Devil's River experienced slight chemical deterioration, increasing in total dissolved solids by 3 per cent. The average of 240 parts per million is excellent.

Pollution

The extent of pollution can only be imagined. The destruction of the fishery that previously existed in the Rio Grande and the associated canal system in the El Paso area has been thoroughly discussed in Job Completion Report B-34. But the entire findings may be summarized by stating that increases in salinities accompanied by pollution from insecticides has at least temporarily destroyed game fish production in more than 400 miles of stream and canals. The natural pollution described under Red Bluff Reservoir, plus escaping brine from oil fields and an undetermined quantity of pollution from insecticides have destroyed fish production in more than 150 miles of the Pecos River. Brine from oil field exploration has damaged all of the remaining streams, with the possible exceptions of the Devil's and the Nueces Rivers and pollution from insecticides has done unmeasurable damage.

Siltation

Reliable data on the degree of siltation is not available. But there has probably been a significant increase in siltation due to the addition of flood control structures and the reduction in stream flow. Previously, floods scoured stream beds.

Aquatic Vegetation

Aquatic vegetation has increased in most areas where observations have been sufficient to draw conclusions. This is probably due to the reduction in the frequency of floods, brought about by flood control structures, and the previously described increase in usage of stream waters for irrigation. Aquatic vegetation is particularly problematic in the upper Pecos River and the Concho River.

The net effect of the factors discussed has been to drastically reduce game fish production in area streams. Probably more than 1,000 miles of

stream have been at least temporarily destroyed for game fish production and a significant portion of this resource is beyond reclamation. Virtually every stream has experienced a significant reduction in game fish production due to these circumstances. The most critical deficiency in project data is the lack of knowledge of streams, and the factors that influence production.

SECTION III

AN EVALUATION OF MANAGEMENT FOR REGION 1-B

Introduction

The preceding sections of this report provide ample evidence that the fish populations that require control are river carpsucker, gizzard shad, carp, and in specific instances freshwater drum. In the analysis that follows, bullheads are included with problematic species in computing relative and actual abundance. However, as previously indicated, these fish are readily accepted by most sportsmen when their size is sufficiently large to justify their harvest. Bullheads also provide forage for channel and flathead catfish populations, and if they are problematic their detriment is of short duration. Longnose gar and smallmouth buffalo are also included with the problematic group. The data upon which this evaluation is based are gill netting collections taken for that purpose. The waters included in the general analysis were selected because there were sufficient data to permit comparisons over several years. In all instances, the management effort was undertaken with the objective of drastically reducing the above species to provide growing room for game fish.

Chemical Control of Fish Populations in Reservoirs

A. Comparisons in Relative Abundance as Evidenced in Pre-treatment and Post-treatment Sampling.

In Figure 354, the results of 31 samples taken after treatments are graphed, not one of these samples indicates that a substantial increase in game fish production did not follow treatment. Four years after the treatment, Lake Sweetwater and Mountain Creek Reservoir are still producing ten times as many game fish as indicated in pre-treatment sampling. Champion Creek Reservoir is producing ten times the relative abundance indicated in pre-treatment sampling. These increases cannot logically be attributed to expanding volumes. Although all three reservoirs have experienced some increase following the treatment, the reservoirs have been constantly declining for more than two years. In Figure 355, the relative abundance of problematic species netted before and after the treatment are similarly graphed. Nearly five years after the treatment there is no significant indication of build up of problematic populations in Lake Sweetwater and Mountain Creek. The occurrence of significant abundance of problematic fish in Champion Creek is incurred because bullheads are included in the category. There have been no captures of river carpsucker, carp or gizzard shad. In both Lake Balmorhea and Lake Ascarate a reinfestation of carp has occurred, but their relative abundance remains low three years following the treatment. As previously pointed out, carp have utility in the localities surrounding these lakes. The primary problematic species, river carpsucker and gizzard shad, have not been reintroduced. The treatments at Oak Creek Reservoir

and Moss Creek Reservoir were designed to reduce and control gizzard shad. Post-treatment sampling indicates that game fish production has exceeded that before the treatment, for as long as five years. As shown in Figure 355, relative abundance of problematic fish has not returned to pre-treatment proportions. A comparison of pre-treatment and post-treatment samples of fish production indicates that the relative abundance of game fish has increased following the treatment. This increase in production may last for more than six years and may be as great as ten times the pre-treatment production. Sampling also indicates that relative abundance of problematic fish is drastically reduced for at least three years and the control of river carp-sucker and gizzard shad may last for more than six years. The control of other problematic species may last for more than three years.

B. Comparisons in Abundance (actual quantities of fish captured) As Indicated in Pre-treatment and Post-treatment Sampling

The total number of fish captured per net in pre-treatment sampling exceeded the number of captured in samples following the treatment in 24 or 31 samples. This is attributed to: (a) in pre-treatment netting the fish were concentrated into a reduced area as the result of reduction in reservoir volume (b) the productivity in pounds per acre is greater for carp, river carpsucker and other problematic species than for game fish; and (c) the turbidity of the reservoir water favored netting success. When these factors are considered, it is remarkable that in 7 of 31 samples, about 25 per cent of the samples, the number of game fish captured in post-treatment sampling exceeded the total number of fish captured for all species in pre-treatment samples. (Figure 356). In only five of 31 samples were there less game fish captured than in pre-treatment sampling. It is pertinent that in all of these exceptions the sample was obtained in less than 18 months following the treatment, and in some instances restocking was not completed until more than six months following the kill (Figure 357). The effectiveness of the control for river carpsucker and other problematic species is even more clearly indicated than in data for relative abundance. In all 31 samples the number of problematic fish captured following the treatment was significantly less than that encountered before the treatment (Figure 358). The most significant data pertaining to measuring the differences in pre-treatment and post-treatment production is the pounds of utilizable game fish produced. We would not be concerned with the production of problematic species if game fish production was sufficient. In 7 of 31 instances, nearly 25 per cent, the total weight of fish captured after the treatment exceeded the pre-treatment catch in pounds of fish per net (Figure 359). In 27 of 31 samples the pounds of game fish per net exceeded the quantity taken during pre-treatment sampling. In all instances where a "total kill" was attempted the post-treatment production reached a proportion of 10 to 1 within the first three years following the treatment. In some instances a ratio of 90 to 1 was indicated and there are several instances of ratios of 25 to 1 and 35 to 1. At Oak Creek and Moss Creek Reservoirs, where selective or partial kills were carried out, the production is indicated to be at least 20 times as great for Oak Creek and was 4 times as great for 50 per cent of the five-year period following the

treatment of Moss Creek. In 30 of 31 instances the production of problematic fish was indicated to be less than in pre-treatment sampling. These data prove that following chemical treatments: (a) greater numbers and more weight of game fish were produced, and (b) fewer numbers and less weight of rough fish were produced. While data on other management efforts are insufficient to provide the means of such analysis, observations and the limited data available tend to confirm these results in nearly all instances where chemical controls have been carried out in the past six year period.

I believe these data prove beyond reasonable doubt that management of reservoirs with chemicals may increase game fish production. However, a final evaluation of this form of management cannot be adequate until a measure of the resulting harvest is obtained. While the project has obtained a reasonably adequate record of game fish present and their abundance, we still know virtually nothing of the harvest and of factors that influence it.

RELATIVE ABUNDANCE AS INDICATED IN SAMPLING WITH GILL NETS GAME FISH

	Before	Treated	After			
Lake Sweetwater	1957	1960	1961	1962	1963	1964
Mountain Creek Reservoir	1957	1960	1961	1962	1963	1964
Champion Creek Reservoir	1958	1960	1961	1962	1963	1964
Lake Balmorhea	1957	1959	1960	1961	1962	1963
Lake Ascarate	1960	1961	1962	1963	1964	
Oak Creek Reservoir	1955	1960	1962	1963	1964	
Moss Creek Reservoir	1961	1962	1963	1964		
Moss Creek Reservoir	1958	1959	1960	1964		

Per Cent By Number 

Per Cent By Weight 

RELATIVE ABUNDANCE AS INDICATED IN SAMPLING WITH GILL NETS NON-GAME SPECIES

	Before	Treated	After			
Lake Sweetwater	1957	1959	1961	1962	1963	1964
Mountain Creek Reservoir	1957	1960	1961	1962	1963	1964
Champion Creek Reservoir	1958	1960	1961	1962	1963	1964
Lake Balmorhea	1957	1959	1960	1961	1962	1963
Lake Ascarate	1960	1961	1962	1963	1964	
Oak Creek Reservoir	1955	1960	1962	1963	1964	
Moss Creek Reservoir	1961	1962	1963	1964		
Moss Creek Reservoir	1958	1959	1960	1964		

Per Cent By Number 

Per Cent By Weight 

ABUNDANCE AS INDICATED IN SAMPLING WITH GILL NETS (Fish Per Net)

	Before		After							
	Year	Treatment	Year	Treatment	Year	Treatment	Year	Treatment	Year	Treatment
Lake Sweetwater	1958	Treated August 1960	July 1961	Oct. 1962	Oct. 1963	May 1964	July 1964	Nov. 1964	July 1964	Nov. 1964
	24.05		7.8	35.50	42.66	120	91.50	120	91.50	45.83
Mountain Creek Reservoir	1960	Treated Spring 1960	Feb. 1962	March 1962	April 1962	Nov. 1963	July 1964	Sept. 1964	July 1964	Sept. 1964
	98.75		3.20	7	8.16	23.66	32.75	32.85	32.75	32.85
Champion Creek Reservoir	1957	Treated Spring 1959	April 1960	May 1961	July 1961	Oct. 1962	Oct. 1963	March 1964	Oct. 1964	Oct. 1964
	37.66		5.30	10.10	3.8	4.17	6.2	67.16	9	9
Lake Balmorhea	1961	Treated December 1961	June 1963	May 1964	Dec. 1964	Dec. 1964	Dec. 1964	Dec. 1964	Dec. 1964	Dec. 1964
	94.86		29.33	63.62	21.50					
Lake Ascarate	1960	Treated August 1960	Apr. 1962	June 1963	June 1964	June 1964	Dec. 1964	Dec. 1964	Dec. 1964	Dec. 1964
	47.12		9.83	14.50	20.25	26				
Oak Creek Reservoir	1962	Treated June 1962	Oct. 1963	March 1964	Oct. 1964					
	37.50		30.25	39.58	24.71					
Moss Creek Reservoir	1959	Treated April 1959	March 1960	March 1964						
	22.18		19.35	28.66						

ABUNDANCE AS INDICATED IN SAMPLING WITH GILL NETS
 (Number of Game Fish Per Net)

		Before		After					
Lake Sweetwater	1958 4	Treated 1960	July 1961 8	Oct. 1962 18	Oct. 1963 36	May 1964 119	July 1964 92	Nov. 1964 115	
Mountain Creek Reservoir	1960 13	Treated 1960	Feb. 1962 3	March 1962 7	April 1962 8	Nov. 1963 24	July 1964 32	Sept. 1964 33	
Champion Creek Reservoir	1957 1	Treated 1959	April 1960 5	May 1961 10	July 1961 4	Oct. 1962 4	Oct. 1963 6	March 1964 25	Oct. 1964 9
Lake Balmorhea	1961 4	Treated 1961	June 1963 29	May 1964 58	Dec. 1964 18				
Lake Ascarate	1960 4	Treated 1960	April 1962 9	June 1963 13	June 1964 17	Dec. 1964 21			
Oak Creek Reservoir	1962 3	Treated 1962	Oct. 1963 13	March 1964 6	Oct. 1964 7				
Moss Creek Reservoir	1959 7	Treated 1959	March 1960 10	March 1964 22					

ABUNDANCE AS INDICATED IN SAMPLING WITH GILL NETS
(Number of Non-Game Fish Per Net)

	Before		After							
Lake Sweetwater	1958 20	Treated 1960	July 1961 0	Oct. 1962 17	Oct. 1963 6	May 1964 1	July 1964 0	Nov. 1964 1		
Mountain Creek Reservoir	1960 86	Treated 1960	Feb. 1962 .40	March 1962 .50	April 1962 .50	Nov. 1963 1.83	July 1964 .75	Sept. 1964 0		
Champion Creek Reservoir	1957 37	Treated 1959	April 1960 .15	May 1961 0	July 1961 .30	Oct. 1962 .17	Oct. 1963 0	March 1964 .41		Oct. 1964 .17
Lake Balmorhea	1961 91	Treated 1961	June 1963 .41	May 1964 5.12	Dec. 1964 4					
Lake Ascarate	1960 43	Treated 1960	April 1962 1.33	June 1963 1.04	June 1964 3.25	Dec. 1964 4.34				
Oak Creek Reservoir	1962 34	Treated 1962	Oct. 1963 23	March 1964 32	Oct. 1964 21					
Moss Creek Reservoir	1959 14	Treated 1959	March 1960 7	March 1964 4						

ABUNDANCE AS INDICATED IN SAMPLING WITH GILL NETS (Pounds of Fish Per Net)

	Before		After									
	1958	Treated 1960	July 1961	Oct. 1962	Oct. 1963	May 1964	July 1964	Nov. 1964	April 1962	Nov. 1963	July 1964	Sept. 1964
Lake Sweetwater	10	Treated 1960	1.26	29.06	10.81	17.99	30	27				
Mountain Creek Reservoir	293	Treated 1960	2.79	3.25	3.60	8.49	5.16	4.23				
Champion Creek Reservoir	43	Treated 1959	April 1960	May 1961	July 1961	Oct. 1962	Oct. 1963	March 1964				Oct. 1964
Lake Balmorhea	79	Treated 1961	June 1963	May 1964	Dec. 1964	18.70						6.90
Lake Ascarate	32	Treated 1960	April 1962	June 1963	June 1964	Dec. 1964	35.49					
Oak Creek Reservoir	47	Treated 1962	Oct. 1963	March 1964	Oct. 1964	18						
Moss Creek Reservoir	13	Treated 1959	March 1960	March 1964	15.39	45.45						

ABUNDANCE AS INDICATED IN SAMPLING WITH GILL NETS
(Pounds of Non-Game Fish Per Net)

	Before				After							
	Year	Treated	July	Oct.	July	Oct.	May	July	Oct.	March	Oct.	
Lake Sweetwater	1958	1960	0	.12	1.19	.13	0	.38				
Mountain Creek Reservoir	1960	Treated 1960	Feb. 1962 .74	March 1962 .11	April 1962 .08	Nov. 1963 .42	July 1964 .05	Sept. 1964 0				
Champion Creek Reservoir	1957	Treated 1959	April 1960 .03	May 1961 0	July 1961 .037	Oct. 1962 .04	Oct. 1963 0	March 1964 0	Oct. 1964 0			
Lake Balmorhea	1961	Treated 1961	June 1963 .74	May 1964 23.13	Dec. 1964 3.84							
Lake Ascarate	1960	Treated 1960	April 1962 1.06	June 1963 4.59	June 1964 11.37	Dec. 1964 22.05						
Oak Creek Reservoir	1962	Treated 1962	Oct. 1963 8	March 1964 24.22	Oct. 1964 9							
Moss Creek Reservoir	1959	Treated 1959	March 1960 4	March 1960 6								

Chemical Control of Fish Populations in Streams

Management of significant areas of streams has only been attempted in conjunction with chemical controls to reduce problematic fish in Lake Nasworthy, and in conjunction with the pre-impoundment management effort for Twin Buttes. Present data are insufficient to permit a final evaluation. However, it is noteworthy that in the instances where project personnel have received full cooperation of all concerned, the effort to control problematic species appears to be successful, and an advancement in game fish production has followed. This is true in spite of deplorable hydrologic conditions such as those outlined under factors influencing game fish production in streams. Where cooperation has been limited, or where it was refused, results have suffered. However, even in these instances, control of problematic species lasted for a year, and game fish production is still greater than before the work was undertaken.

Chemical Control of Aquatic Vegetation

Only two efforts to control aquatic vegetation have been undertaken. The first involved control of emergent vegetation in the marginal waters of Lake Nasworthy. The control effort was successful for at least 18 months. The attempt to control submerged aquatic vegetation in Lake Ascarate was successful for 10 months. In general, attempts to control aquatic vegetation have been less successful than desired.

The Restocking Program

In general, the restocking program has been effective only when it was carried out on new waters, on waters recently renovated through chemical treatments, and where great expansions in volume occurred.

Conclusions and Recommendations:

1. The most pressing need is to obtain a better measure of the harvest both for unmanaged and managed waters in order that management may be more adequately evaluated and that the regional fishery production and harvest may be estimated.
2. The results of this investigation point to the need for research that will result in the ability to determine bias and selectivity in gill nets as sampling devices, since much of the data collected during the first decade of federal aid in fisheries in Texas cannot be properly analyzed using common biometrical procedures until that knowledge is available.
3. All of the factors and suspected interrelationships described warrant further investigation so that a better measure of these influences can be obtained.

4. The factors that influence streams and stream production are areas where project data are weak and these blanks should be filled.

5. Evaluation of past management should continue and a concerted effort should be made to more completely evaluate the value of stocking.

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Date December 14, 1965

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