

Lake Powell Fisheries Investigations



Annual Performance Report
May 1, 1990 – April 30, 1991

Publication No. 91-6
Sport Fish Restoration Act
F-46-R-6



UTAH
NATURAL RESOURCES
Wildlife Resources

LAKE POWELL FISHERIES INVESTIGATIONS

Annual Performance Report

A. Wayne Gustaveson
Project Leader

Henry R. Maddux
Project Biologist

Louis Berg
Special Projects Biologist

Sport Fish Restoration Act
Project F-46-R-6

May 1, 1990 - April 30, 1991

Publication No. 91-6

Utah Department of Natural Resources
Division of Wildlife Resources
1596 West North Temple
Salt Lake City, UT 84116

Timothy H. Provan
Director

An Equal Opportunity Employer

TABLE OF CONTENTS

	<u>Page</u>
LIST OF TABLES	v
LIST OF FIGURES	vii
ABSTRACT	ix
FORAGE CONDITION STUDY	1
METHODS	1
RESULTS AND DISCUSSION	1
RECOMMENDATIONS	4
MEASUREMENT OF FISHERY HARVEST, PRESSURE AND SUCCESS	7
INDEX TO ANNUAL FISH POPULATION TRENDS	9
ANNUAL NETTING	9
METHODS	9
RESULTS AND DISCUSSION	9
ELECTROFISHING	15
METHODS	15
RESULTS AND DISCUSSION	15
STRIPED BASS POPULATION DEVELOPMENT	17
METHODS	17
RESULTS AND DISCUSSION	17
RECOMMENDATIONS	23
SMALLMOUTH BASS POPULATION DEVELOPMENT	25
METHODS	25
RESULTS AND DISCUSSION	25
RECOMMENDATIONS	27
LITERATURE CITED	29

LIST OF TABLES

<u>Table</u>	<u>Page</u>
1. Mean number of larval threadfin shad collected during ichthyoplankton tows, Lake Powell, 1989-1990	3
2. Mean catch rate (fish/h) and size of threadfin shad collected incidentally by electrofishing, Lake Powell, September 1990, with a comparison to fish/h collected in 1989	4
3. Catch rate (fish/net day) by species and year, annual gill-netting, Lake Powell, 1971-1990	11
4. Catch rates (fish/net/day) during annual gillnetting, Lake Powell, March 1990	12
5. Percent occurrence of food items in stomachs of gill-netted fish, Lake Powell, March 1990. Percentage based only on number of stomachs containing food	12
6. Mean catch rate (fish/hour) of fish collected by electrofishing, Lake Powell, September-October 1990	16
7. Mean total length (mm) of age 0+ fish subsampled from electrofishing collections, Lake Powell, September-October, 1987-1990	16
8. Percent occurrence of food items in striped bass collected in gill nets and during creel census, Lake Powell, 1985-1990. (Percentage based on number of stomachs containing food.)	19
9. Mean catch rate (fish/hour) of smallmouth bass collected by electrofishing, Lake Powell, 1982-1990	26
10. Percent occurrence of food items in smallmouth bass collected from gill netting, electrofishing, and creel censusing, Lake Powell, 1988-1990. (Percentage based on number of stomachs containing food.)	27

LIST OF FIGURES

<u>Figure</u>	<u>Page</u>
1. Map of Lake Powell showing trawling and ichthyoplankton netting stations for threadfin shad, 1990	2
2. Mean number of threadfin shad collected per trawl tow, Lake Powell, July-September 1977-1989 and July 1990	5
3. Catch rate (fish/net day) for annual spring netting of largemouth bass, Lake Powell, 1972-1990	13
4. Catch rates (fish/net day) for annual spring netting of walleye, Lake Powell, 1972-1990	14
5. Average number of striped bass caught during fall netting (fish/1000 ft ² of net/12 h), Lake Powell, 1981-1990	18
6. Annual condition factor (K) of adult and juvenile striped bass, Lake Powell, 1975-1990	21
7. Comparison of striped bass collected angling to striped bass collected by gill net during November 1990, Lake Powell. The two populations are significantly different (G=237,df=50,P<.005)	22
8. Smallmouth bass collected during fall gill netting, Lake Powell, 1989-1990. A standardized sample consists of ten 30.5-m experimental gill nets set for two nights	28

ABSTRACT

After five years of poor shad recruitment, 1990 marked a resurgence in shad population abundance. More shad translated into improved growth and physical condition of striped bass. The abundance of largemouth bass and walleye were at the highest levels measured during the past five years but still below historical averages. The smallmouth bass population appeared to be established throughout the lake. No additional smallmouth bass were stocked during 1990.

FORAGE CONDITION STUDY

JOB I

METHODS

Threadfin shad (*Dorosoma petenense*) spawning was monitored with ichthyoplankton net collections in June and July (Figure 1). Samples were taken in the backs of bays at Wahweap Creek, Warm Creek, and Navajo Canyon (Figure 1). Sampling frequency was reduced in 1990 from former levels because shad numbers continued to be suppressed by striped bass predation.

Recruitment of young-of-the-year (yoy) threadfin shad into the pelagic areas of Lake Powell was monitored by midwater trawl collections and eight-minute sonar transects. Sampling was conducted in July at Wahweap, Bullfrog, and Good Hope bays. A complete description of both the ichthyoplankton and trawling sampling methods can be found in Gustaveson et al. (1990).

RESULTS AND DISCUSSION

Unlike recent years, threadfin shad were observed during late summer and fall throughout most areas of the reservoir including the marinas at Wahweap, Bullfrog, and Hall's Crossing. Within a specific area, however, they were not found to be in all canyons. For example, within the San Juan arm they were observed at Neskahi Canyon but not in Cha Canyon which historically contained large numbers of threadfin shad. Reports of threadfin shad schools were received from anglers, marina employees and National Park Service officials. The causes of this resurgence are unclear.

Larval threadfin shad production monitored by ichthyoplankton netting increased in 1990 in the backs of some canyons. Mean number of larval threadfin shad in Warm Creek increased 10 fold from 1989 levels (Table 1). However, these levels were typical for the years prior to 1988 (Gustaveson et al. 1990). The June collection of 2,743 threadfin shad in Navajo Canyon was the highest for any station since ichthyoplankton tows were initiated in 1981.

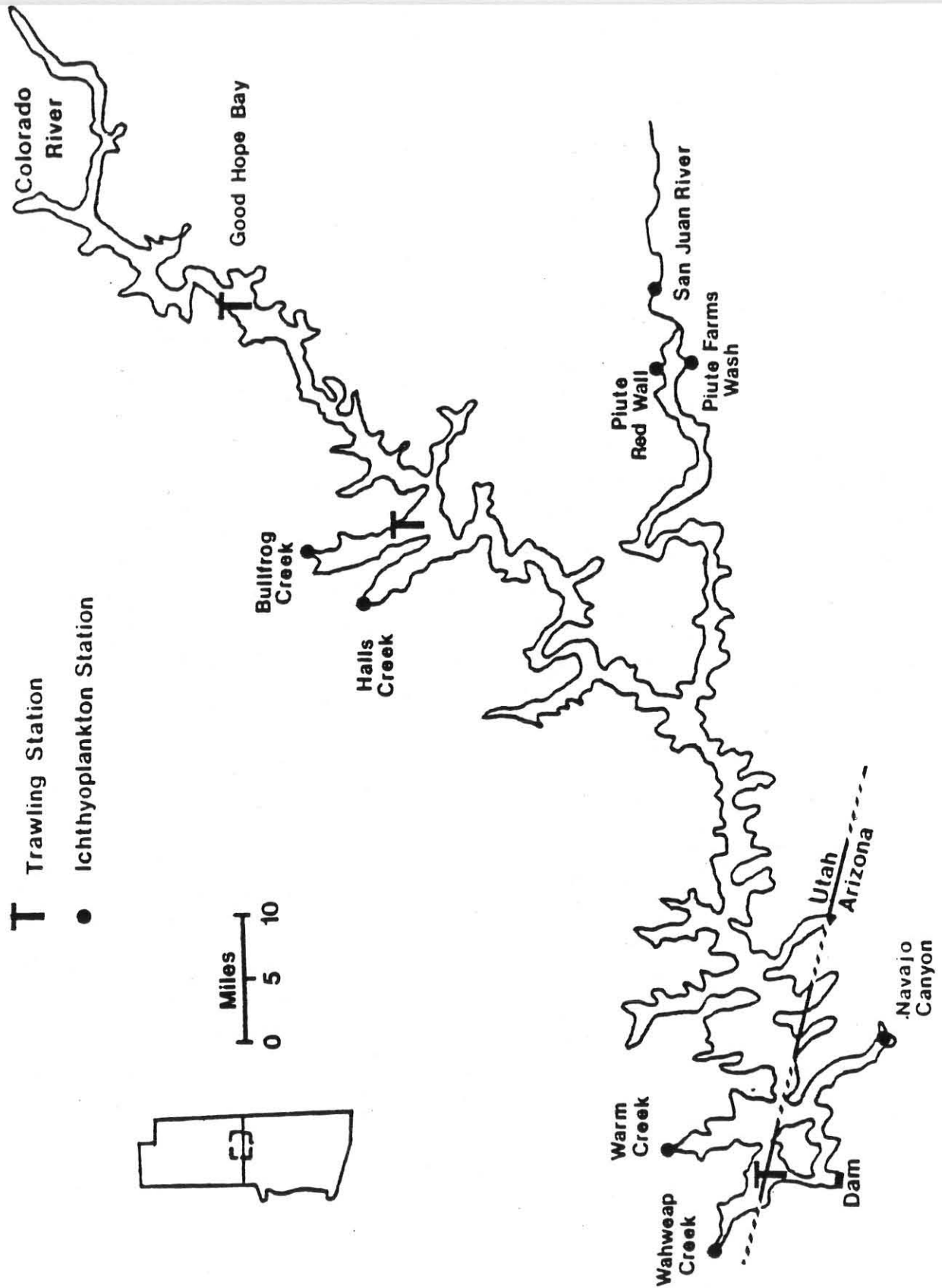


Figure 1. Map of Lake Powell showing trawling and ichthyoplankton netting stations for threadfin shad, 1990.

Production in the back of Wahweap Creek remained similar to 1989, well below averages for previous years (Gustaveson et al. 1990). Thus, the resurgence of threadfin shad appears to have occurred in some areas and not others.

Table 1. Mean number of larval threadfin shad collected during ichthyoplankton net tows, Lake Powell, 1989-1990.

<u>Sample Month</u>	<u>Wahweap Creek</u>		<u>Warm Creek</u>		<u>Navajo Canyon</u>	
	<u>1989</u>	<u>1990</u>	<u>1989</u>	<u>1990</u>	<u>1989</u>	<u>1990</u>
June	1	1	36	253	102	2743
July	<1	10	13	293	19	17

The conclusion that only a partial threadfin shad resurgence occurred was supported by the continued lack of larvae shad in the pelagic zone (Figure 2). Mid-water trawl samples failed to capture threadfin shad from the Good Hope and Bullfrog areas, whereas they were collected (1.3/trawl) from Wahweap Bay. The threadfin shad collected from Wahweap Bay were the first collected from there since 1987. If a 3-year cycle in the population exists, 1990 should have represented a peak in pelagic threadfin shad abundance. The pelagic zone was only sampled with mid-water trawl during July. Therefore it is possible that a peak in threadfin shad may have occurred later in the summer or early fall.

Although larval threadfin shad remained absent from the pelagic zone, juveniles and adults were once again available to game fish. Shad occurred in 85% and 44% of the striped bass and walleye stomachs collected during November 1990. Electrofishing surveys, used primarily to monitor yoy black bass, collected shad in sufficient numbers to report their results (Table 2). The greatest abundance (621 shad/h) occurred at Good Hope Bay. Good Hope also had

the largest mean size (105.0 mm) and largest individual (187 mm) reported for Lake Powell. Numbers collected electrofishing were considerably greater than the previous year. Length frequency data for 1990 showed 3 size groups were collected; 45-85 mm, 110-130 mm, and >150 mm. Scale data were inconclusive for age determination of these groups; no annuli could be detected suggesting that most fish collected were yoy. However, spawning knowledge obtained through ichthyoplankton tows and growth rates for Arizona reservoirs (Johnson 1971) suggests that fish in the 45-85 mm group are yoy, 110-130 mm are age 1+, and fish >150 mm are age 2+ and older. Shad collected from the Rincon appeared to be mostly yoy while those in Good Hope were age 1+.

RECOMMENDATIONS

Because of the dynamic nature of the Lake Powell threadfin shad population, a reduced sampling schedule impacted our ability to determine what population changes were occurring. It is therefore recommended that sampling periodicity be returned to its former regime. It may also be necessary to once again include areas within the San Juan arm of the reservoir.

Table 2. Mean catch rate (fish/h) and size of threadfin shad collected incidentally by electrofishing, Lake Powell, September 1990, with a comparison to fish/h collected in 1989.

<u>Location</u>	<u>Fish/h</u>		<u>Size Range (mm)</u>	<u>Mean Size (mm)</u>
	<u>1989</u>	<u>1990</u>		
Warm Creek	34	130	47 - 155 ^a	93.2
San Juan	6	106	61 - 122	99.8
Rincon	0	5	44 - 122	64.6
Stanton Creek	0	203	56 - 171 ^a	103.8
Good Hope	0	621	86 - 187 ^a	105.0

^a The largest individual fish was not included in the subsample used to calculate mean size.

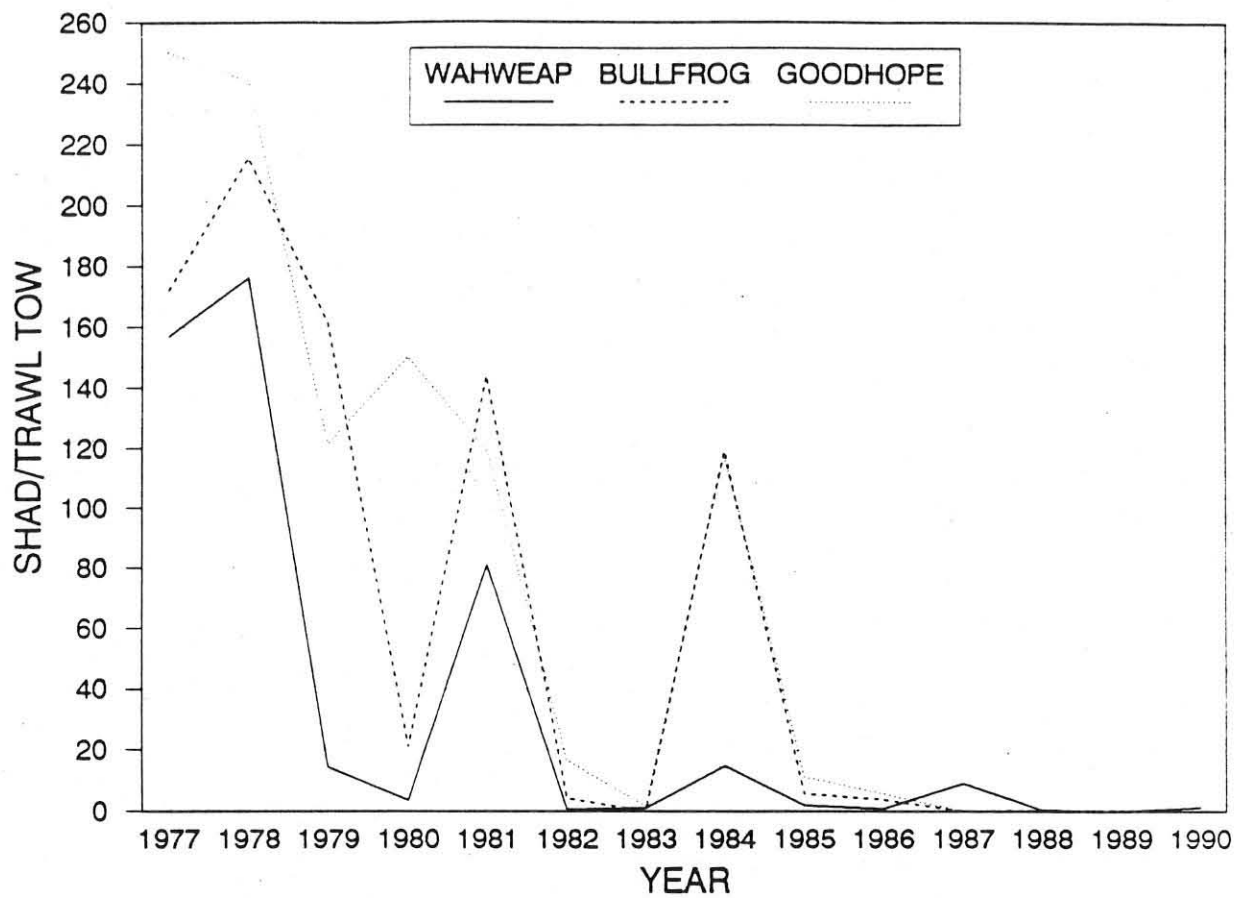


Figure 2. Mean number of threadfin shad collected per trawl tow, Lake Powell, July-September 1977-1989 and July 1990.

MEASUREMENT OF FISHERY HARVEST, PRESSURE AND SUCCESS

JOB II

No work was scheduled for this job during 1990. The next scheduled creel census will occur in 1991.

INDEX TO ANNUAL FISH POPULATION TRENDS

JOB III

ANNUAL NETTING

METHODS

Methods for standardized gill netting are described in Gustaveson et al. (1990). Four sampling areas, Good Hope Bay, Rincon, San Juan arm, and Padre Bay have been netted annually since 1972. Because the 1989 netting survey was cancelled, no data from that year were available for comparison to 1990 data. Netting at the Rincon was cancelled in 1990 due to lack of netting efficiency.

All fish collected in gill nets were measured (TL) and weighed. Sex, maturity, and percent frequency of occurrence of food items in the diet were collected from largemouth bass, walleye, and striped bass.

RESULTS AND DISCUSSION

During the early March gill net survey water temperatures are normally 9-11 C as they were in 1990. Some species were active at these temperatures and more vulnerable to capture in gill nets than other species. Walleye spawn during March at Lake Powell and largemouth bass begin to move and feed after a somewhat dormant winter period. Spring gill netting probably best describes relative abundance of walleye and largemouth bass while understating the abundance of striped bass, smallmouth bass and most other species. Fall gill netting (Job IV) provides a better estimate of population abundance of those other species.

A total of 116 fish was collected in 60 net-days during the 1990 survey. When catch rates from all stations were averaged and compared to lakewide catch rates of previous years, we found that many populations had not changed

much historically. No trends over time were discernible for green sunfish, bluegill, yellow bullhead, or channel catfish (Table 3). The previously absent smallmouth bass were captured in 1989. Although these species were captured incidentally by the survey, we can say that these populations probably stayed fairly stable over time. There was no indication of wide swings in population abundance.

Other fish such as black crappie, trout spp., and flannelmouth suckers have declined from a measurable abundance in incidental net catches, to a level at which they were no longer sampled (Table 3). The survey has realistically documented the population declines of these species.

Walleye (34%), largemouth bass (22%), and striped bass (19%) dominated the gill-net catch during the 1990 survey (Table 4). Fish were sampled in greatest abundance at the San Juan and Good Hope Bay stations which were the stations closest to the productive tributaries. The catch rate of species combined was highest in the San Juan arm (3.70 fish/net/day) where fish were more than twice as abundant as in 1988 (1.45 fish/net/day). The catch rate for all stations combined was 2.54 fish/net/day (Table 3) compared to 1.62 fish/net-day in 1988.

Catch rates during 1990 were at the highest level reported for largemouth bass since 1982 (Figure 3) and walleye since 1985 (Figure 4). The alarming decrease in population abundance of these two species has been arrested, at least temporarily, and a possible recover begun.

The percent of empty stomachs (Table 5) was at the highest level for walleyes (74%) and largemouth bass (42%) since 1985 and striped bass (43%) since 1987. As usual, crayfish was the most common food item in the diet of largemouth bass (93%), and threadfin shad dominated the diet of walleye (44%). Striped bass utilized zooplankton (56%) and crayfish (50%) more than other forage during this spring sample.

Table 3. Catch rate (fish/net day) by species and year, annual gill netting, Lake Powell, 1971-1990.

Species	Catch Rate																			
	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1990	
Largemouth bass	1.65	5.82	2.71	4.01	4.49	2.72	1.85	2.61	1.83	1.57	1.41	0.63	0.47	0.46	0.34	0.30	0.40	0.39	0.55	
Smallmouth bass	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	
Walleye	0.29	1.12	0.41	1.09	2.15	2.11	1.17	2.84	3.25	3.66	4.99	2.17	1.73	2.26	2.05	0.70	0.69	0.63	0.87	
Striped bass	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.08	0.09	0.02	0.24	0.13	0.32	0.89	3.07	0.70	0.49	0.18	0.48	
Black crappie	0.12	0.67	0.12	0.27	0.36	0.27	0.26	0.33	0.21	0.03	0.16	0.08	0.04	0.01	0.06	0.00	0.00	0.00	0.00	
Bluegill	0.12	0.52	0.06	0.05	0.04	0.10	0.09	0.04	0.03	0.01	0.05	0.02	0.01	0.05	0.06	0.01	0.11	0.04	0.03	
Green sunfish	0.10	0.16	0.09	0.13	0.06	0.04	0.09	0.10	0.10	0.02	0.07	0.05	0.02	0.09	0.04	0.01	0.05	0.04	0.03	
Channel catfish	0.12	0.43	0.21	0.14	0.25	0.16	0.20	0.29	0.38	0.36	0.17	0.04	0.27	0.19	0.17	0.16	0.13	0.13	0.25	
Common carp	1.14	0.79	0.32	0.34	0.36	0.38	0.44	0.34	0.32	0.32	0.55	0.49	0.79	0.37	0.35	0.22	0.31	0.21	0.30	
Flannelmouth sucker	0.18	0.28	0.21	0.17	0.08	0.08	0.03	0.03	0.04	0.06	0.04	0.00	0.01	0.02	0.00	0.00	0.00	0.00	0.00	
Rainbow trout	0.24	0.31	0.10	0.08	0.19	0.25	0.26	0.11	0.04	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Brown trout	0.02	0.00	0.01	0.03	0.04	0.04	0.02	0.01	0.00	0.00	0.01	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	
Yellow bullhead	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.04	0.03	0.03	0.03	0.02	0.02	0.00	0.01	0.05	0.00	0.01	0.03	
All species	3.98	10.10	4.24	6.31	8.02	6.15	4.44	6.82	6.32	6.12	7.73	3.62	3.68	4.35	6.16	2.16	2.18	1.62	2.54	

Table 4. Catch rates (fish/net/day) during annual gillnetting, Lake Powell, March 1990.

Species	Sampling station*				% of total catch
	Good Hope	San Juan	Padre Bay	All	
Bluegill	0.00	0.10	0.00	0.03	1.2
Carp	0.55	0.20	0.15	0.30	11.8
Channel catfish	0.35	0.30	0.10	0.25	9.8
Green sunfish	0.00	0.00	0.10	0.03	1.2
Largemouth bass	0.25	1.10	0.30	0.55	21.7
Striped bass	1.00	0.20	0.25	0.48	18.9
Walleye	0.50	1.80	0.30	0.87	34.3
Yellow bullhead	0.10	0.00	0.00	0.03	1.2
Total	2.75	3.70	1.20	2.54	

*Rincon station was cancelled due to lack of netting efficiency.

Table 5. Percent occurrence of food items in stomachs of gill-netted fish, Lake Powell, March 1990. Percentages based only on number of stomachs containing food.

Statistic/food item	Number (%) by species		
	Striped bass	Largemouth bass	Walleye
Sample size (n)	28	24	34
Empty stomachs	12 (43)	10 (42)	25 (74)
Stomachs with food	16	14	9
Food item			
Crayfish	8 (50)	13 (93)	0 (0)
Zooplankton	9 (56)	0 (0)	0 (0)
Fish			
Threadfin shad	1 (6)	0 (0)	4 (44)
Centrarchid	0 (0)	1 (7)	1 (11)
Green sunfish	1 (6)	0 (0)	3 (33)
Unknown fish	0 (0)	2 (14)	2 (22)

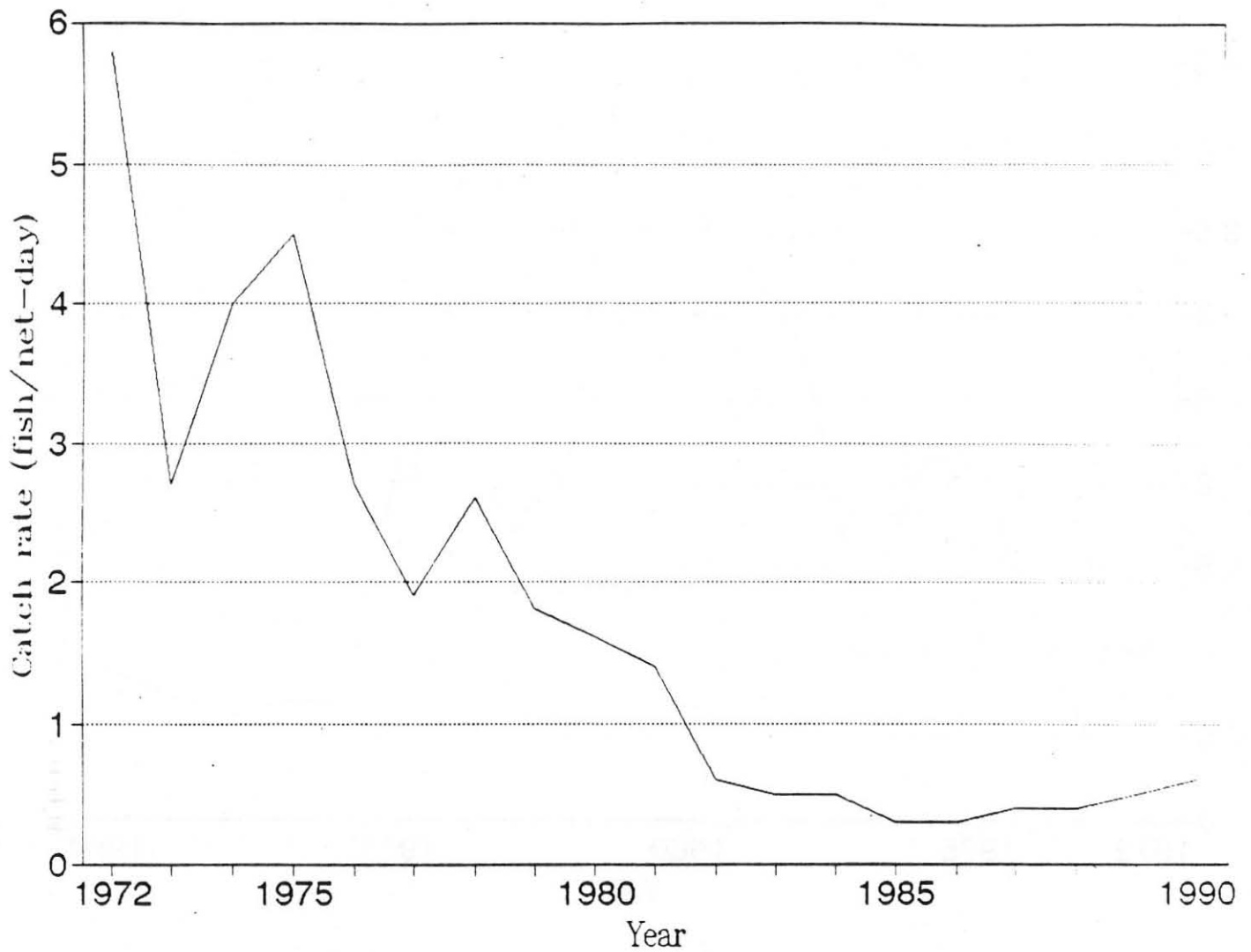


Figure 3. Catch rate (fish/net/day) for annual spring netting of largemouth bass, Lake Powell, 1972-1990.



Figure 4. Catch rate (fish/net/day) for annual spring netting of walleye, Lake Powell, 1972-1990.

ELECTROFISHING

METHODS

Electrofishing procedures were similar to those described by Gustaveson et al. (1990). Each of five areas (Good Hope Bay, Stanton Creek, Rincon, San Juan arm, and Warm Creek) was sampled for one hour of actual electrofishing time. Fish were grouped by species, counted and a subsample measured (TL). Threadfin shad collections are reported in JOB 1.

RESULTS AND DISCUSSION

A total of 1,610 fish other than threadfin shad was collected during five nights of electrofishing. This value is up from 334 fish during 1989, and is slightly higher than the 1,558 fish collected during 1988. The greatest increase from 1989 to 1990 occurred at Stanton Creek, where the catch rate rose from 107 fish/hour to 544 fish/hour (Table 6). Most of the increase at all areas resulted from increased green sunfish or bluegill abundance. Gustaveson et al. (1990) suggested that the decline in 1989 catch rates may have been caused by a decrease in gear efficiency rather than actual population declines. Electrofishing efficiency in 1990 was as good or better than seen in any previous year.

Black crappie were not collected during 1990 nor during 1989, having gradually disappeared from electrofishing samples as habitat deteriorated with reservoir aging. Recent drought years have resulted in lower lake levels and reestablishment of terrestrial brush around the exposed perimeter of the lake which could provide improved crappie habitat when reflooded.

The catch rate of age 0+ largemouth and smallmouth bass increased from 1989 levels at most areas. Smallmouth bass continued to be more abundant (43 fish/hour) than largemouth bass (7 fish/hour) during 1990. This has been the case for age 0+ fish every year after 1986, and for older bass every year after 1985. Age 0+ smallmouth bass had an average length of 101 mm compared to 132 mm for age 0+ largemouth bass (Table 7).

Table 6. Mean catch rate (fish/hour) of fish collected by electrofishing, Lake Powell, September-October, 1990.

Species	Sampling station						% of total catch
	Good Hope Bay	Stanton Creek	Rincon	San Juan	Warm Creek	All	
Bluegill, all ages	138	36	3	0	165	68	21.1
Channel catfish, all ages	1	17	0	12	93	25	7.8
Green sunfish, all ages	309	385	85	88	24	178	55.3
Largemouth bass, age 0+	4	5	0	0	23	6	1.9
Largemouth bass, age 1+ and older	0	2	0	0	3	1	0.3
Smallmouth bass, age 0+	10	26	10	26	13	17	5.3
Smallmouth bass, age 1+ and older	14	73	12	23	10	26	8.1
All species	476	544	110	149	331	322	

Table 7. Mean total length (mm) of age 0+ fish subsampled from electrofishing collections, Lake Powell, September-October, 1987-1990.

Species	Year	Mean total length (mm) and sample size (n)					Weighted lakewide mean
		Good Hope Bay	Stanton Creek	Rincon	San Juan	Warm Creek	
Largemouth bass	1987	113 (20)	116 (8)	87 (3)	97 (30)	84 (45)	99 (106)
	1988	-	130 (1)	-	-	85 (8)	90 (9)
	1989	- (0)	- (0)	84 (1)	- (0)	186 (1)	135 (2)
	1990	157 (4)	106 (5)	- (0)	- (0)	134 (23)	132 (32)
Smallmouth bass	1987	110 (74)	102 (33)	97 (67)	110 (52)	84 (21)	103 (247)
	1988	111 (64)	108 (83)	89 (71)	86 (17)	76 (58)	96 (293)
	1989	100 (16)	91 (11)	100 (2)	99 (5)	89 (3)	96 (37)
	1990	114 (10)	93 (26)	85 (10)	89 (26)	103 (13)	95 (85)

STRIPED BASS POPULATION DEVELOPMENT

Job IV

METHODS

Biological information was obtained from striped bass sampled during normal field collections. Data necessary to determine age and growth, food habits, maturity, and condition (Kfl) were routinely taken as described in Gustaveson et al. (1990).

RESULTS AND DISCUSSION

As size and condition of striped bass declined over the past several years the abundance of spawning fish also decreased. During 1989 only three ripe males and no ripe female striped bass were known to be collected by anglers near Glen Canyon Dam and from gill-net sampling from an historically identified spawning area near Antelope Island in Wahweap Bay. Only one ripe male was sampled during 1990. However, striped bass continued to spawn successfully despite poor physical condition and small size of most fish in the population. We speculated that the few remaining large (over 5 kg) females spawned with young fast-growing males and provided enough progeny to repopulate the lake annually.

Young-of-year striped bass were expected to be scarce in 1990 due to the poor condition of brood fish. Striped bass yoy were not collected during lakewide seine sampling in July. No yoy striped bass were collected during September electrofishing. Only 8 yoy striped bass were captured during the entire annual gill-netting survey conducted in November (Figure 5). While striped bass production was lower than seen in other years, yoy were found at Wahweap, Good Hope and San Juan sampling stations indicating low levels of successful natural reproduction over the length and breadth of Lake Powell.

Average total length of striped bass collected during the fall netting survey had decreased from 555 mm, to 423 mm, 393 mm, and 348 mm over the

Striped Bass Relative Abundance

Fall netting - all stations combined

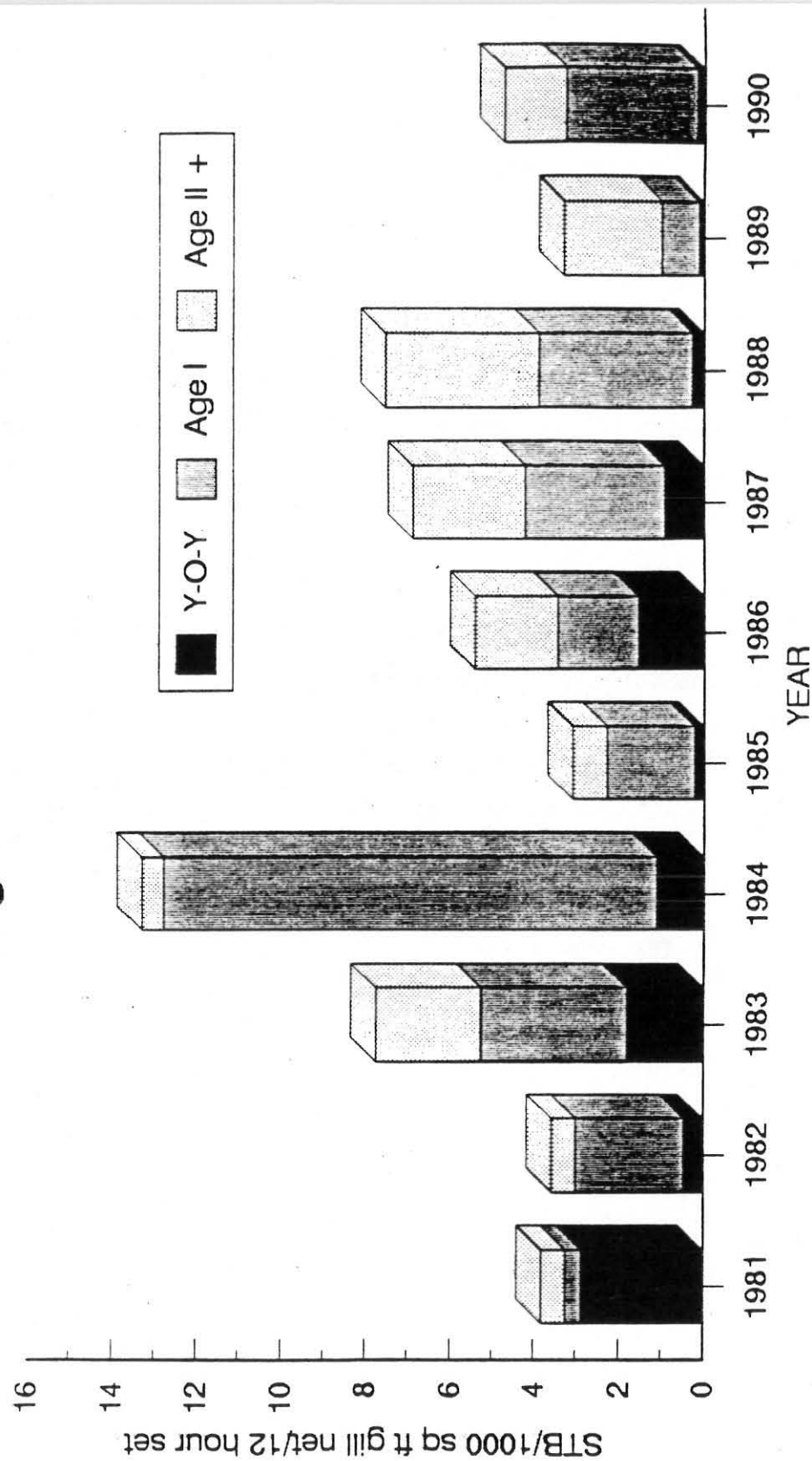


Figure 5. Average number of striped bass caught during fall netting (fish/1000 ft² of net/12 h), Lake Powell, 1981-1990.

previous four years before recovering to 353 mm in 1989. It appears that the lack of a pelagic forage fish during those years inhibited striped bass growth. The increase in the shad population during 1990 allowed the average size of striped bass collected during fall netting to increase to 383 mm.

From 1985-1989, shad occurred in an average of 25% of stomachs while plankton was found in over 45% of stomachs containing food (Table 8). The shad recovery of 1990 caused the incidence of shad consumption to increase to 85% and plankton to decrease to 6% of stomachs containing food. When shad are available to striped bass, incidence of plankton consumption is reduced.

Table 8. Percent occurrence of food items in striped bass collected in gill nets and during creel census, Lake Powell, 1985-1990. (Percentage based on number of stomachs containing food.)

	YEAR					
	1985	1986	1987	1988	1989	1990
Sample size (n)	830	54	493	987	245	151
Empty stomachs	53%	72%	46%	37%	44%	40%
Stomachs w/food	388	15	268	623	136	91
<u>Food item</u>						
Crayfish	15%	27%	21%	16%	12%	7%
Plankton	42%	47%	35%	48%	54%	6%
<u>Fish</u>						
Threadfin shad	17%	20%	42%	10%	35%	85%
Bluegill	1%	0	0	0	0	0
Green sunfish	1%	7%	1%	0	0	0
Striped bass	1%	0	1%	0	0	0
Carp	1%	0	0	0	0	0
Largemouth bass	0	0	0	0	0	<1%
Unkown Centrarchids	1%	0	<1%	<1%	1%	0
Unknown fish	8%	0	8%	12%	12%	5%
Bait (Anchovy)	19%*	0	1%	28%*	0	0

*Data collected during creel census interviews

A buoy line restricting entrance of boats to the forebay adjacent to Glen Canyon Dam was removed during April-May 1990 to allow increased angler harvest of prespawning striped bass which congregate there in the spring. A limited creel census was conducted to assess the success of the action upon striped bass harvest from this former sanctuary. From 23 April, when the buoy line was removed, until 30 April; striped bass creel rates were an amazing 3.41 striped bass/hr. Creel rates during the month of May averaged 0.8 fish/hr which is four times greater than the average striped bass creel rate at Lake Powell (Gustaveson et al. 1990). It was estimated that over 29,000 striped bass which had been protected by the buoy line were harvested from the Glen Canyon forebay during the five weeks in which the area was open to angling.

Some limited striped bass data were collected from anglers during the April-May creel census at the Glen Canyon forebay. A representative sample of 85 prespawning striped bass caught in the spring had an average K factor of 1.11 and average total length of 426 mm. The average K factor of all striped bass caught netting and angling in the fall was 1.46 for fish less than 500 mm and 1.18 for fish over 500 mm (Figure 6). These were the highest K factors reported for adult striped bass since 1984 and for juveniles since 1981. The majority of the striped bass population had a condition factor of 1.1 in April which increased to 1.4 by November. It is amazing how fast the striped bass population increased in body mass following the shad resurgence. Striped bass responded immediately to changes in forage conditions. They can make radical gains or declines in body tissue in the period of a month or two.

During fall gill-net sampling an angling survey was conducted at gill-net sites. Biologists, doing the netting, fished during the day while waiting to pull the nets. All striped bass hooked were harvested and had biological data collected. A comparison of the entire population of striped bass sampled with gill nets versus the entire population captured by hook-and-line from four sampling areas is presented in Figure 7. The striped bass population captured in nets showed a normal distribution of fish within a

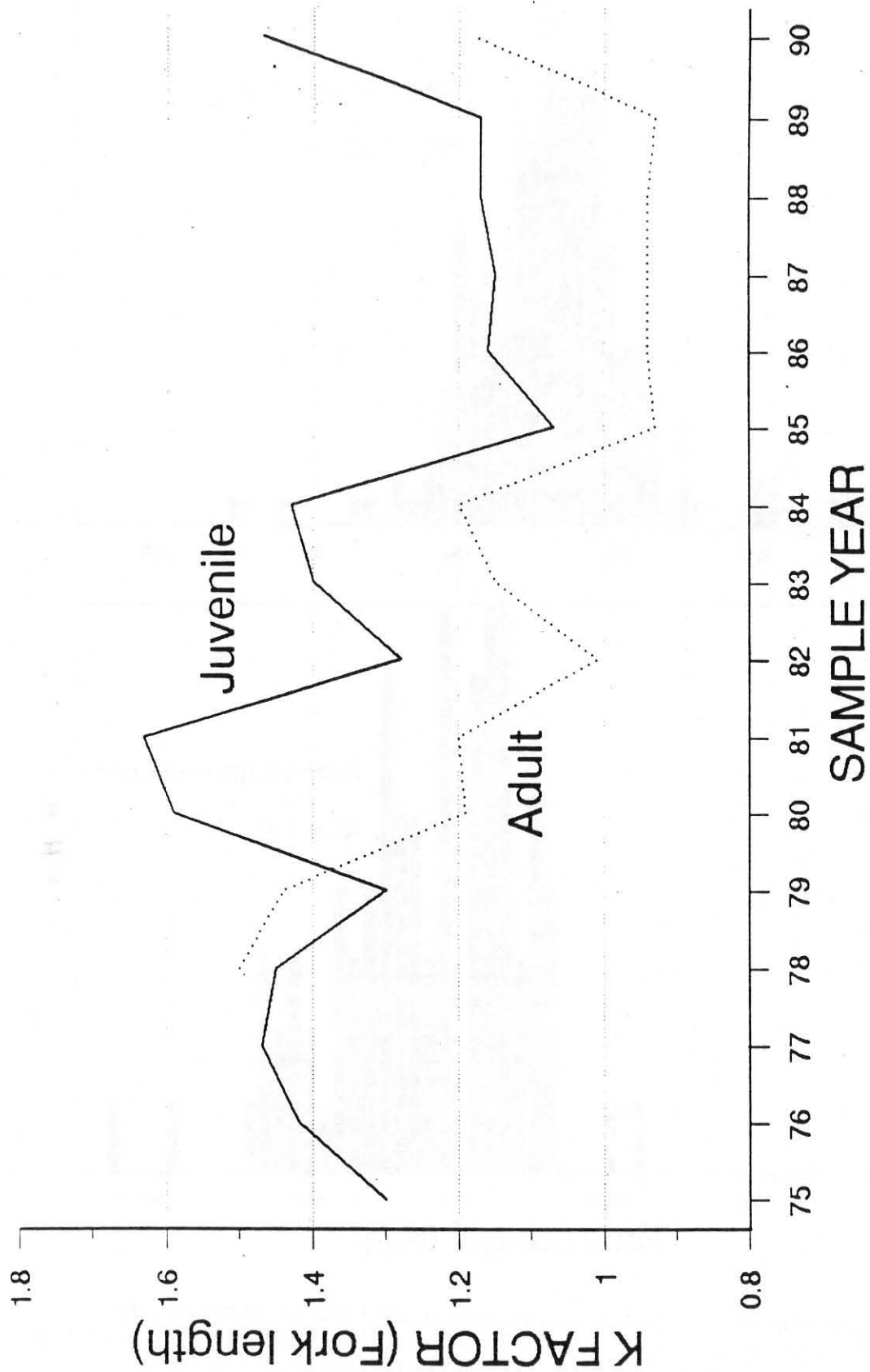


Figure 6. Annual condition factor (K) of adult and juvenile striped bass, Lake Powell, 1975-1990.

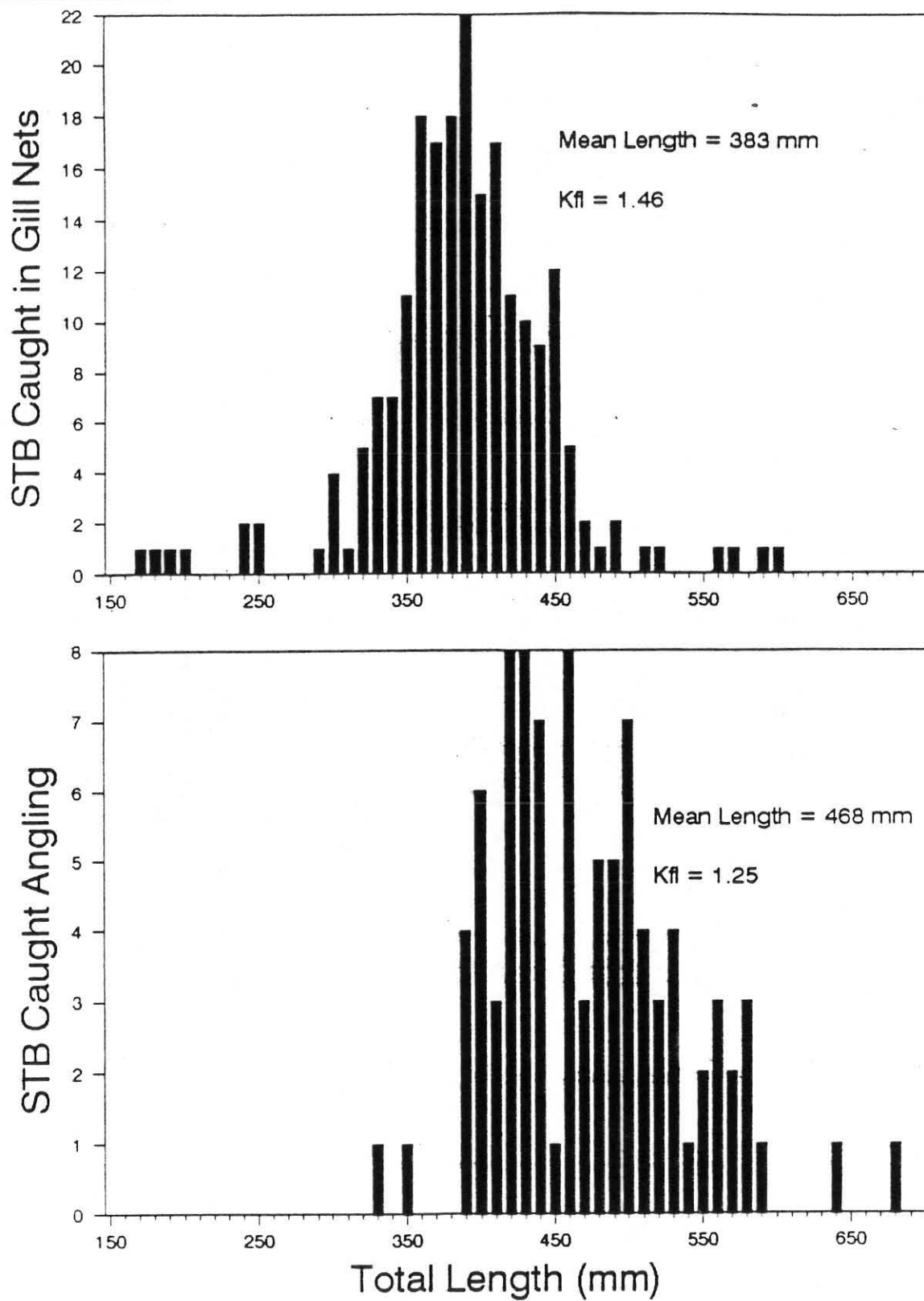


Figure 7. Comparison of striped bass collected angling to striped bass collected by gill net during November 1990, Lake Powell. The two populations are significantly different ($G=237, df=50, P<.005$).

length range of 300-480 mm. Striped bass caught angling had a larger average size and were distributed between 390-590 mm. Larger striped bass were collected by angling at a greater proportion than expected from the population exploited by experimental gill nets. Figure 7 shows that smaller striped bass (<390 mm) which were present in high numbers, were less vulnerable to the angling methods utilized than larger fish (>400 mm). These data indicated that larger striped bass may be more vulnerable to sport angling harvest than smaller fish.

RECOMMENDATIONS

The primary focus of fish management at Lake Powell during 1991 will be increasing harvest of striped bass. Improved physical condition and larger average size make striped bass more desirable to the angling public than they have been for the past few years. An intensive public relations campaign will be aimed at combining a large fishing public with an inexhaustible supply of striped bass to reduce total numbers of striped bass while they are in prime condition.

We should continue efforts to provide additional forage for striped bass with the goal of increasing the average size of fish and thereby making them more desirable and vulnerable to anglers.

SMALLMOUTH BASS POPULATION DEVELOPMENT

JOB V

METHODS

Smallmouth bass population development was monitored through collections made in Jobs II-IV. Data required to examine age and growth, food habits, and physical condition (K_{tl}) were collected as described in Gustaveson et al. (1990).

RESULTS AND DISCUSSION

As a result of natural reproduction and emigration from stocking sites, smallmouth bass populations appear to be establishing lakewide. From 1982-1989, a total of 294,372 smallmouth bass was stocked at 21 different reservoir locations (Gustaveson et al. 1990). Natural reproduction was first noted at Lake Powell in 1985 and has been observed every year since.

Smallmouth bass populations at the sampling stations appeared to be stabilizing with near equal numbers of juvenile and adult fish. Some 217 smallmouth bass were collected during the September electrofishing survey (Table 9). Large numbers of yoy were collected in 1987 and 1988. Since then yoy have represented less than 40% of the smallmouth bass catch. Catch rates at Stanton Creek remained higher (99 fish/hour) than at other sampling locations. In 1989 and 1990 the catch was dominated by 1 and 2 year old smallmouth bass.

Physical condition of smallmouth bass increased in 1990. Mean condition factors for fish >299 mm increased to 1.41 compared to 1.35 reported in 1989 (Gustaveson et al. 1990). This increase in condition occurred although there was very little change in mean fish length for fish >299 mm; mean length in 1989 was 338.6 mm compared to 328.5 in 1990. Smaller fish (<300 mm) had a mean condition factor of 1.31, which is within the average range reported for smallmouth bass in other United States waters (Carlander 1977).

Table 9. Mean catch rate (fish/hour) of smallmouth bass collected by electrofishing, Lake Powell, 1982-1990.

Year	Sampling station										Total all stations	
	Good Hope Bay		Stanton Creek		Rincon		San Juan		Warm Creek			
	Age 0+	Older	Age 0+	Older	Age 0+	Older	Age 0+	Older	Age 0+	Older	Age 0+	Older
1982	0	0	0	0	0	0	0	0	22	0	22	0
1983	0	0	0	0	0	0	0	0	0	3	0	3
1984	0	0	5	0	0	0	0	0	46	0	51	0
1985	4	0	0	1	36	0	5	0	5	1	50	2
1986	1	2	81	0	0	2	0	17	10	0	92	21
1987	134	1	33	41	67	8	52	4	21	7	307	61
1988	73	37	356	17	71	25	17	20	58	1	575	100
1989	16	16	11	69	2	7	5	12	3	0	37	104
1990	10	14	26	73	10	12	26	23	13	10	85	132

Stomachs examined in 1990 contained primarily crayfish (54%), similar to previous years (Table 10). Threadfin shad increased in occurrence in smallmouth bass stomachs in 1990 concurrent with increased threadfin shad abundance (Job I). The 6% occurrence of "other fish" in the stomachs were yoy channel catfish, which had increased in abundance according to the 1990 electrofishing survey (Table 6). Smallmouth bass in Lake Powell are apparently opportunistic feeders, feeding on whatever prey is available.

Noticeable increases in smallmouth bass in gill nets occurred at the San Juan and Good Hope sample stations during fall netting. Catches in the San Juan increased 79% from 1989 to 1990 (Figure 8). Warm Creek and Rincon catch rates changed little from 1989 levels. Spring gill netting (Job III) proved ineffective for monitoring smallmouth bass although very effective for largemouth bass. Smallmouth bass apparently become active later in the spring than largemouth bass. Early spring water temperatures (9-11 C) are well below the preferred range of 20-30 C (Carlander 1977) and the feeding threshold of 13 C (Munther 1970) reported for smallmouth bass. Spawning usually begins in Lake Powell as water temperatures approach 18 C at the beginning of April.

Table 10. Percent occurrence of food items in smallmouth bass collected from gill netting, electrofishing, and creel censusing, Lake Powell, 1988-1990. (Percentage based on number of stomachs containing food.)

	YEAR		
	1988	1989	1990
Sample size (n)	36	47	58
Empty stomachs	15 (42%)	15 (32%)	23 (40%)
Stomachs w/food	21	32	35
<u>Food item</u>			
Crayfish	17 (81%)	18 (56%)	19 (54%)
Plankton	2 (10%)	6 (19%)	4 (11%)
<u>Fish</u>			
Threadfin shad	0	3 (9%)	5 (14%)
Bluegill	0	2 (6%)	1 (3%)
Green sunfish	0	1 (3%)	0
Centrarchids	1 (5%)	1 (3%)	2 (6%)
Other fish	3 (14%)	0	2 (6%)
Unknown fish	2 (10%)	3 (9%)	1 (3%)

RECOMMENDATIONS

Spring netting, which provides largemouth bass biological data, fails to sample the smallmouth bass population. Netting dates could be moved from March to April to effectively sample smallmouth bass. Largemouth bass data would then need to be compared to previous years to determine the effect of moving the netting dates one month. Other than some habitat use by largemouth and smallmouth bass during electrofishing surveys, interactions and competition between these species have not been examined on Lake Powell. Areas still remain in Lake Powell where smallmouth bass have not colonized. These areas provide an excellent control for examining the effects, if any, of smallmouth bass on largemouth bass.

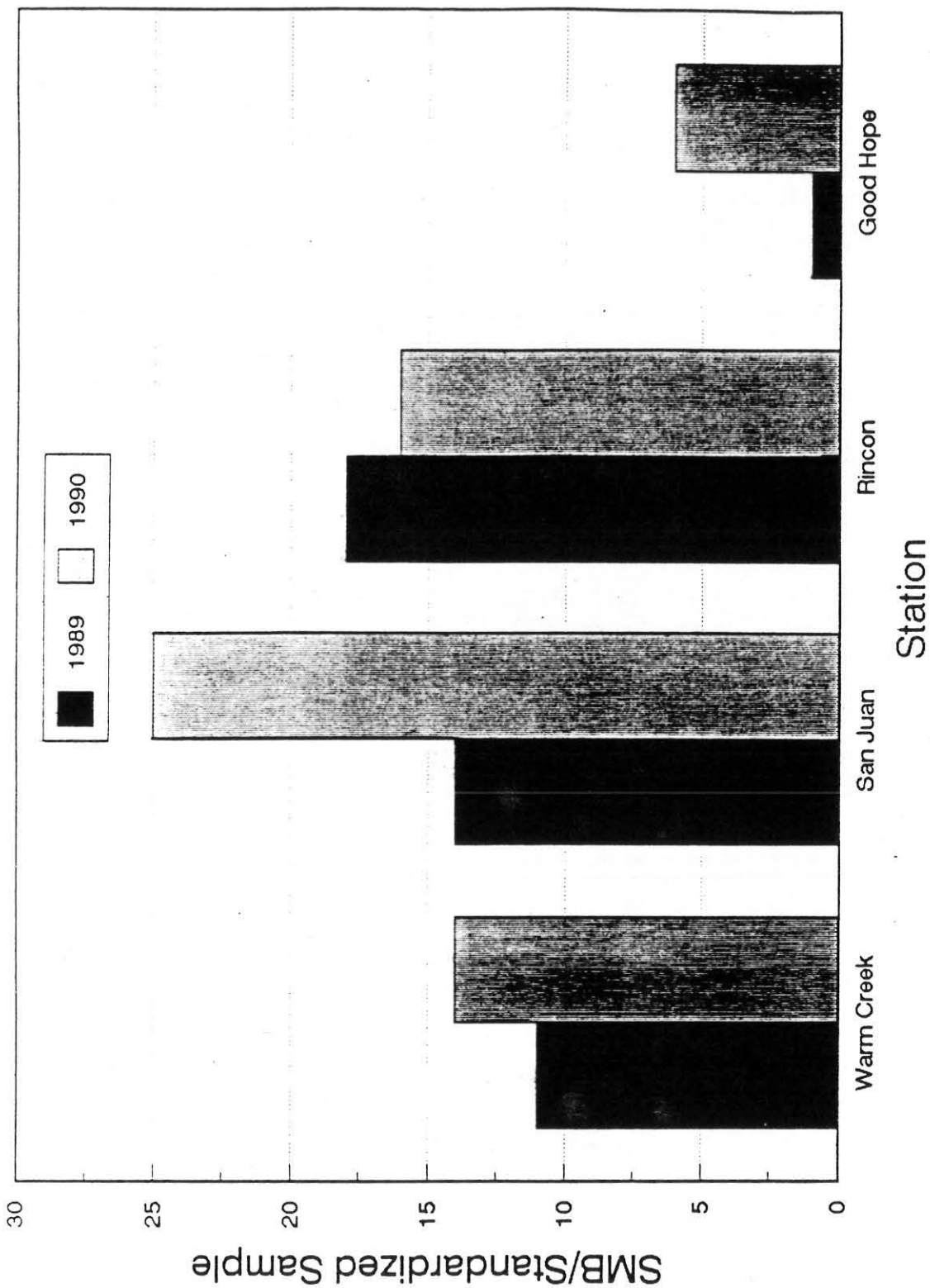


Figure 8. Smallmouth bass collected during fall gill netting, Lake Powell, 1989-1990. A standardized sample consists of ten 30.5-m experimental gill nets set for two nights.

LITERATURE CITED

- Carlander, K. D. 1977. Handbook of freshwater fishery biology. Vol. I. Iowa State University Press. Ames, Iowa. 431 pp.
- Gustaveson, A. W., H. R. Maddux, B. L. Bonebrake and K. Christopherson. 1990. Lake Powell fisheries investigations. 5-year Completion and 1989 Annual Performance Report. Dingell-Johnson Project F-46-R. Salt Lake City, Utah Division of Wildlife Resources. 67 pp.
- Johnson, J. E. 1971. Maturity and fecundity of threadfin shad, *Dorosoma petenense* (Gunther), in central Arizona reservoirs. Transactions of the American Fisheries Society 100:74-85.
- Munther, G. L. 1970. Movement and distribution of smallmouth bass in the Middle Snake River. Transactions of the American Fisheries Society 99:44-53.