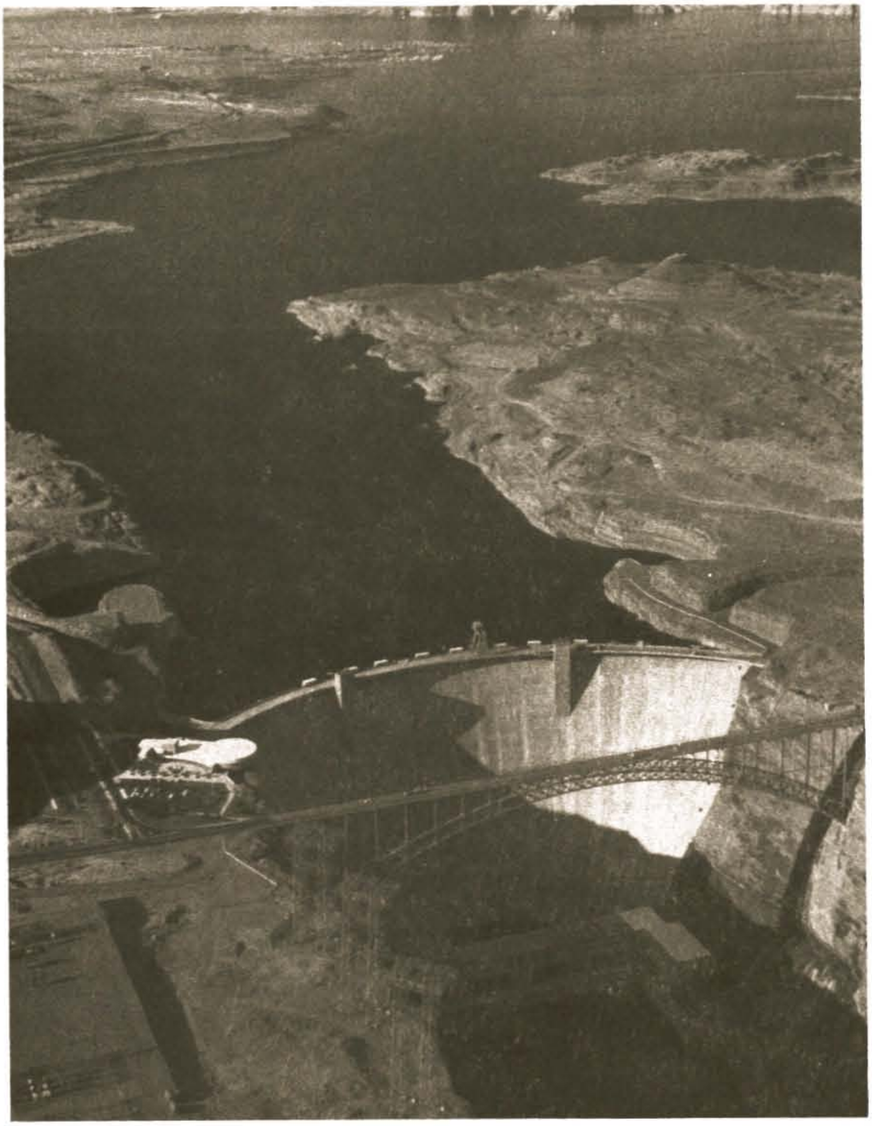
Lake Powell Fisheries Investigations



1982 (Segment 11) Annual Report

for Colorado River Drainage and Tailwaters
Dingell-Johnson Project F-28-R

Publication Number 83-9

UTAH
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UTAH WILDLIFE RESOURCES

LAKE POWELL FISHERIES INVESTIGATIONS

Annual Performance Report

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ABSTRACT

Threadfin shad, the major forage species in Lake Powell, declined to the lowest levels since sampling began in 1977. Recruitment was minimal lakewide. Striped bass predation was undoubtedly a contributing factor to the low shad numbers. Angling pressure increased 23% over 1981, indicating more anglers fished at Lake Powell in 1982 than in any other year. The overall catch rate declined slightly from 1981. Black crappie and largemouth bass were creeled most often but walleye and striped bass both reached record harvest levels. Striped bass catch rates averaged .05 fish/angler hour from April through October. Gill netting during March to monitor game fish population trends showed both walleye and largemouth numbers were down from 1981 figures. This decrease may reflect a late cold spring more than an actual decrease in the number of bass and walleye. Striped bass were caught at all spring netting sites for the first time. Electrofishing surveys indicated crappie were produced at about the same level as 1981 but largemouth bass production was up at all sampling locations. Striped bass successfully spawned for the fourth consecutive year. The 1982 year class was smaller than the dominant 1981 year class. The 1982 striped bass year class was similar to that of 1980 and may represent a more normal spawn.

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THREADFIN SHAD STUDY

JOB I

Methods

Threadfin shad (Dorosoma petenense) spawning was monitored with meter net collections. Monthly meter net samples were taken in side canyons or the backs of bays near each trawling location. The standard meter net tow was 2 minutes in length with the net towed just under the surface. Four tows were made at each station.

Monthly mid-water trawl collections were taken from July through September in Wahweap, Bullfrog, Good Hope and the San Juan (Figure 1). Sampling methods used were reported in Gustaveson et al. 1980. Shad were divided into one of three life history stages; larvae (< 25 mm), juveniles (26-50 mm), and adults (> 50 mm).

Results and Discussion

Meter netting began in late May and continued until mid-August when shad spawning ended. Threadfin shad spawning success varied from an increase from that of 1981 in the upper end of the reservoir to almost zero at Wahweap. No young-of-the-year (y-o-y) shad were collected in meter net tows in Wahweap Bay (Table 1) or on the lower end of the San Juan Arm. Meter netting in Bullfrog Bay revealed an extended spawning season from late May through mid-August 1982 (Table 2). However, only

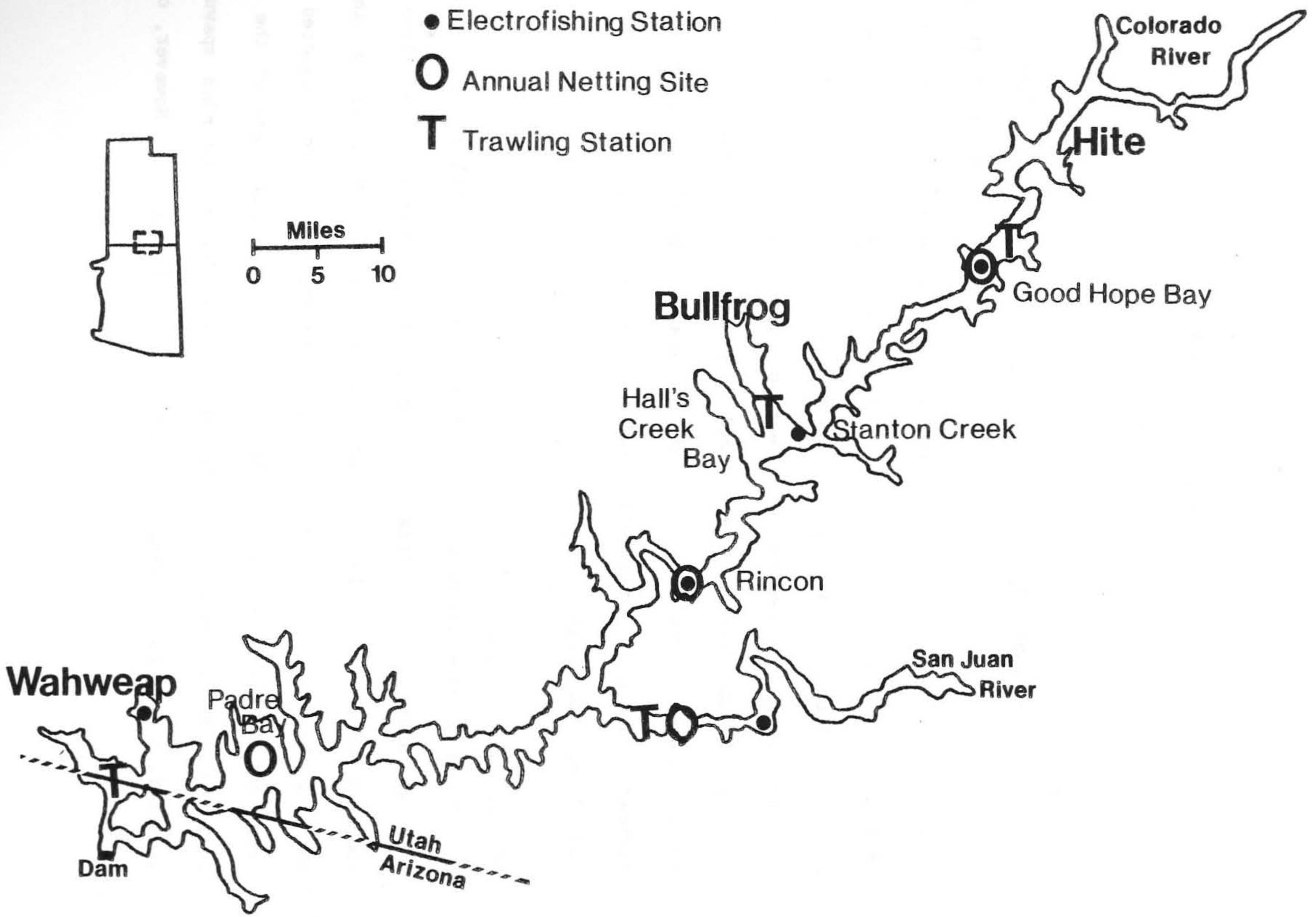


Figure 1. Map of Lake Powell showing trawling locations, annual netting sites and electrofishing stations.

Table 1. Mean number of y-o-y shad collected in meter net tows in Wahweap Bay during 1981 and 1982.

1981		1982	
Sample Date	Mean number of shad per tow	Sample Date	Mean number of shad per tow
May 27	0		
June 11	14	June 15	0
June 16	2	June 23	0
July 23	66	July 2	0
August 12	1	July 9	0
August 21	1		

Table 2. Mean number of y-o-y shad collected in meter net tows in Bullfrog Bay during 1981 and 1982.

1981		1982	
Sample Date	Mean number of shad per tow	Sample Date	Mean number of shad per tow
June 1	41	May 28	187
June 9	317	June 11	389
June 17	221	June 25	49
June 24	586	July 1	26
July 2	110	July 9	41
July 8	4	July 14	5
July 14	19	July 21	1
July 20	113	July 27	0
July 27	11	August 10	3
August 3	3		
August 12	1		

two weeks during that period produced meter net catches averaging over 100 y-o-y shad/tow. By comparison, in 1981 there were five weeks when over 100 y-o-y shad were collected per tow. Limited meter netting in Good Hope Bay indicated shad production was up in 1982 (Table 3).

Mid-water trawl catches of y-o-y shad were at the lowest levels since lakewide trawling began in 1977. In the lower half of Lake Powell trawling results reflected meter net catches. At Wahweap no y-o-y shad were collected in meter net tows and none were caught in trawl tows with the exception of August sampling when an average of one fish/tow was collected (Table 4). Trawling on the San Juan indicated very little shad recruitment (Table 5). Bullfrog Bay had an extended spawn but recruitment was low (Table 6). Meter netting in the upper end of Lake Powell showed increased spawning success in the canyons but recruitment into the open water trawling sites was severely limited (Table 7). Moczygemba and Morris (1977) reported that the open water zone is inhabited by surplus shad that are forced into open water by competition. Lack of shad in the open water area is an indication of a predation impacted shad population.

The disparity between meter net and trawl catches probably resulted from striped bass predation. Members of the unusually large 1981 year class of striped bass were present in most locations where shad spawning occurred. Unlike the adult striped bass that had to retreat to deeper, cooler water during the heat of the summer (Job IV), the yearlings stayed in the shallows with the shad and fed heavily on both adults and y-o-y shad.

Table 3. Mean number of y-o-y shad collected in meter net tows in Good Hope Bay during 1981 and 1982.

Sample Month	Red Canyon 1981	Red Canyon 1982	Ticaboo Canyon 1981	Ticaboo Canyon 1982
June	102	378	7	1,420
July	0	0	0	0

Table 4. Mean number of y-o-y shad collected in trawl tows in Wahweap Bay during 1981 and 1982.

Sample Month	Mean number of shad per tow 1981	1982
June	0	0
July	170	0
August	68	1
September	3	0

Table 5. Mean number of y-o-y shad collected in trawl tows in the San Juan Arm during 1981 and 1982.

Sample Month	Mean number of shad per tow 1981	1982
June	238	0
July	105	1
August	67	16
September	33	1

Table 6. Mean number of y-o-y shad collected in trawl tows in Bullfrog Bay during 1981 and 1982.

Sample Month	Mean number of shad per tow	
	1981	1982
June	55	0
July	971	1
August	224	11
September	92	0

Table 7. Mean number of y-o-y shad collected in trawl tows in Good Hope Bay during 1981 and 1982.

Sample Month	Mean number of shad per tow	
	1981	1982
June	1,511	0
July	426	4
August	118	8
September	38	0

In Lake E. V. Spence striped bass reduced the standing crop of gizzard shad and eliminated threadfin shad from the population (Morris 1978). Young gizzard shad that escaped predation grew rapidly, and after exceeding the desired forage size preferred by striped bass (76-178 mm), they matured and spawned. Threadfin shad because of their smaller size did not grow larger than preferred prey size and were eliminated. Threadfin shad are the only schooling bait fish in Lake Powell and they support the striped bass population. Not only was shad recruitment reduced, shad population levels were at the lowest point since sampling began in 1977.

Recommendations

Continue meter netting and trawling. The meter netting has proven important in monitoring larval shad production and the duration of the spawn.

Discontinue the June trawling. Most years the y-o-y shad have not moved from the canyons out to the trawling sites until July.

Discontinue meter netting and trawling on the San Juan. No larval shad have been collected in two years of meter netting on the San Juan. The trawling results have not contributed anything unique to the understanding of the shad population of the lake and only reflect the findings at Wahweap, Bullfrog, and Good Hope Bays.

Start biweekly meter netting at Good Hope Bay. Good Hope Bay is an important station in our shad studies and monthly meter netting the last two years has been insufficient to fully assess shad spawning in the upper reservoir. This is an area which will see increased striped bass predation in the years to come.

MEASUREMENT OF FISHERY HARVEST, PRESSURE AND SUCCESS

JOB II

Methods

A scheduled creel census was conducted from April through October 1982, at the four major access areas on the lake - Wahweap, Bullfrog, Hall's Crossing and Hite. Anglers were interviewed as they returned to launching ramps. Catch rates (fish/angler hour) were estimated from data reported by anglers for their previous day of fishing, as well as for the census day. Estimates of angling pressure were based on recreational use data collected by National Park Service personnel at access points.

Results and Discussion

A total of 4,944 boating parties was checked by creel clerks during the seven month census period. Of these, 1,945 (39%) reported angling activity. The mean number of anglers per fishing boat was 2.5 while each angler spent an average of 3.9 hours fishing per day.

While recreational boat use decreased on Lake Powell during 1982, angling pressure continued to increase (Figure 2). Proportionally more boats reported angling activity than in 1981 at all access points except at Hite. The index of angling pressure was 110,556 fishing boat days, an increase of 23% over 1981. The index of total recreational boat use

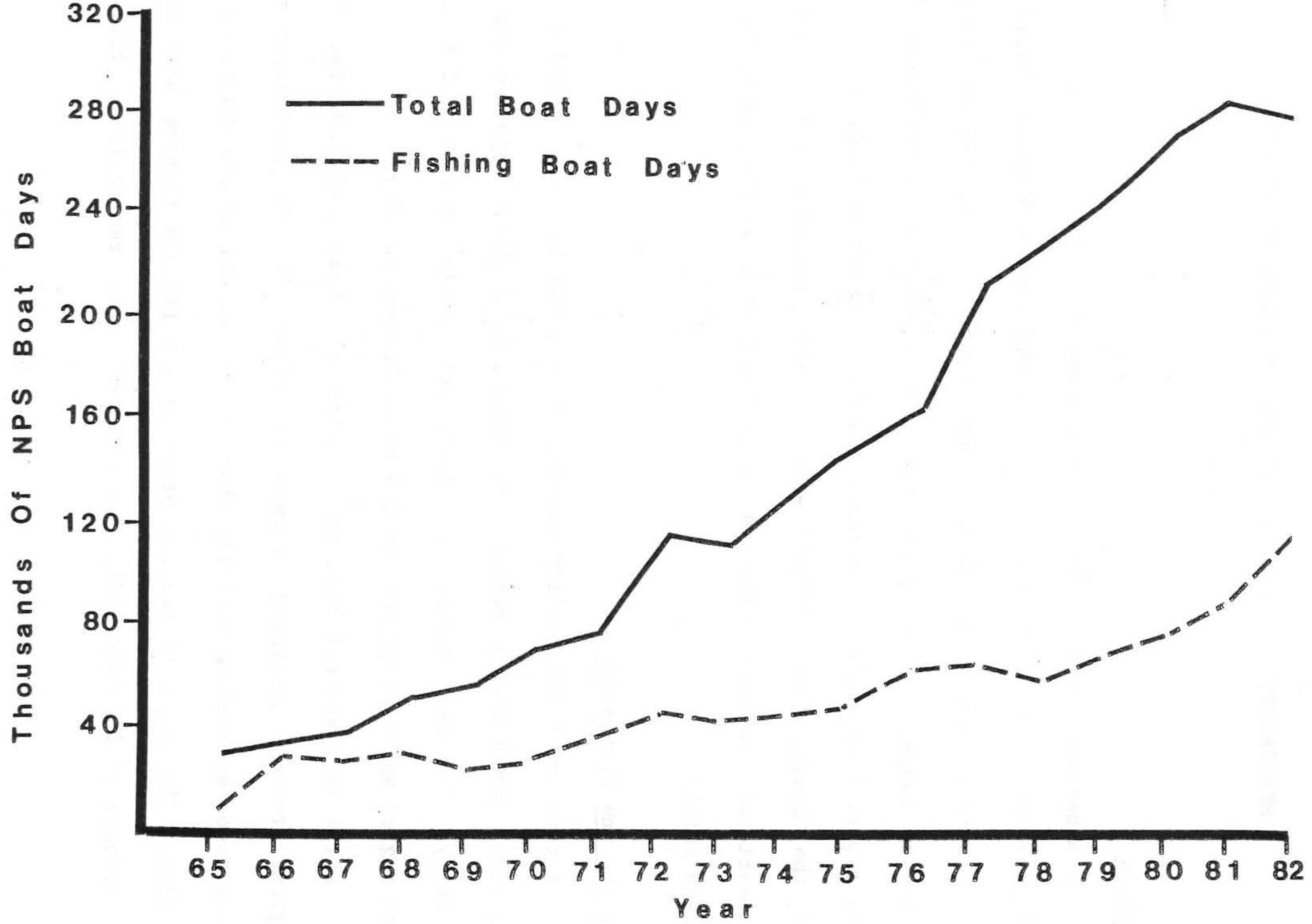


Figure 2. Indices of total recreational boat use and angling pressure, 1965-1982, Lake Powell.

(including nonfishing boats) was 278,838 boat days, compared to 290,689 boat days in 1981. As in 1981, the Bullfrog access area accounted for the highest angler use of the four major access points, while Hall's Crossing, Wahweap, and Hite accounted for 29%, 24% and 10% of angler use respectively.

Most angling pressure during the spring (April-June) was directed at largemouth bass (Micropterus salmoides) and black crappie (Pomoxis nigromaculatus), except for Wahweap where striped bass (Morone saxatilis) was the most sought after species (Table 8). During the summer and early fall (July-October), striped bass gained considerable importance at Bullfrog and interest in striped bass remained high at Wahweap (Table 9).

Creel rates (fish/angler hour) for largemouth bass (0.093), black crappie (0.091) and all species combined (0.283) were down slightly from 1981 (Figure 3). The best fishing for largemouth bass and black crappie in 1982 was in the upper reservoir (Hite), while striped bass fishing was better on the lower end of the reservoir (Wahweap) (Table 10). Those fishing for walleye had highest success in the middle of the reservoir (Bullfrog and Hall's Crossing).

The bulk of the fishery in the upper reservoir was supported by largemouth bass (Table 11). Crappie contributed a large portion of the fishery in the spring and fall, while walleye were important only in June and July. The fishery in the lower reservoir was dominated by striped bass (Table 12); largemouth, crappie and walleye were important here only in the spring.

Table 8. Species sought (%) by anglers, Lake Powell, April-June 1982.

Species	Wahweap	Bullfrog	Hall's	Hite	Total
Any	11.5	18.2	20.2	15.0	16.2
Largemouth bass	29.4	50.3	44.1	51.3	43.8
Black crappie	7.4	18.8	13.6	31.3	17.8
Striped bass	42.8	6.2	8.4	1.2	14.7
Walleye	7.6	6.2	12.3	0.8	6.7
Channel catfish	1.0	0.3	1.3	0.4	0.7
Rainbow trout	0.2	0.0	0.0	0.0	0.1
Bluegill	0.2	0.0	0.0	0.0	0.1

Table 9. Species sought (%) by anglers, Lake Powell, July-October 1982.

Species	Wahweap	Bullfrog	Hall's	Hite	Total
Any	11.6	30.1	41.3	29.2	28.0
Largemouth bass	13.9	25.2	31.5	46.2	29.2
Black crappie	0.7	1.2	1.1	4.1	1.8
Striped bass	66.9	34.6	18.5	7.6	31.9
Walleye	2.4	5.7	4.3	4.7	4.3
Channel catfish	4.5	3.3	2.2	8.2	4.5
Rainbow trout	0.0	0.0	0.0	0.0	0.0
Bluegill	0.0	0.0	1.1	0.0	0.3

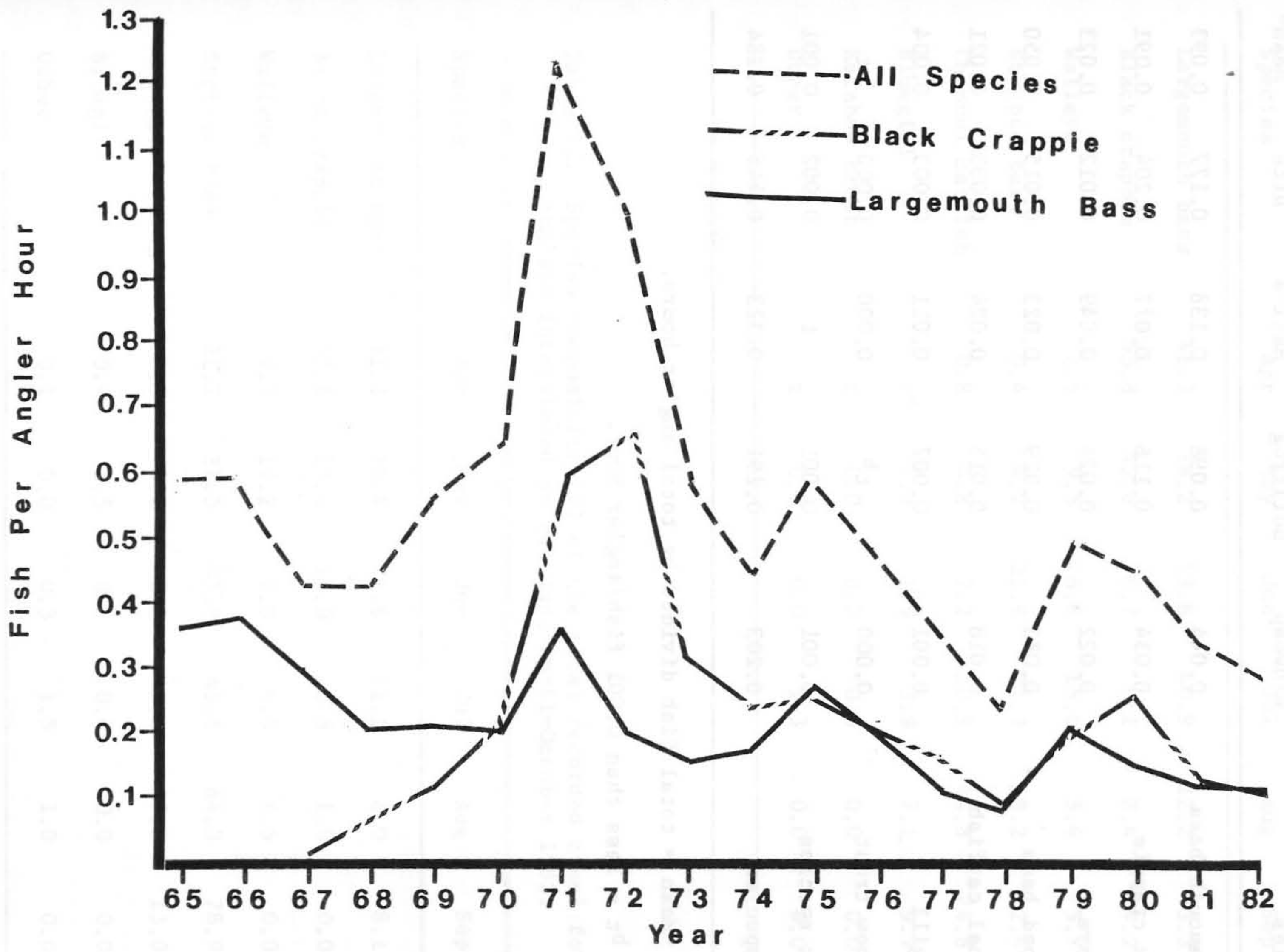


Figure 3. Catch rates (fish/angler hour) for largemouth bass, black crappie and all species during the months of April-June 1965-1982, Lake Powell.

Table 10. Sport fishery creel rates (fish/angler hour) by species and access area, Lake Powell, April-October 1982.

Species	Wahweap	Bullfrog	Hall's	Hite	Mean[a]
Largemouth bass	0.044	0.098	0.138	0.177	0.093
Black crappie	0.034	0.116	0.077	0.204	0.091
Walleye	0.022	0.024	0.049	0.012	0.023
Striped bass	0.083	0.029	0.023	0.015	0.050
Channel catfish	0.018	0.015	0.024	0.033	0.021
Bluegill	0.001	0.007	0.011	0.003	0.004
Rainbow trout	0.000	t[b]	0.000	0.000	t
Other species	0.001	0.001	t	0.002	0.001
All species	0.203	0.291	0.323	0.446	0.284

[a]Mean = total fish divided by total angler hours.

[b]t = less than 0.001 fish/angler hour.

Table 11. Species composition (%) of the total recorded creel for anglers interviewed at Bullfrog, Hall's Crossing, and Hite, April-October 1982.

Species	Apr	May	Jun	Jul	Aug	Sep	Oct
Largemouth bass	41.3	36.2	33.6	40.9	22.2	43.3	38.5
Black crappie	55.8	42.6	8.7	6.1	2.4	4.2	33.0
Walleye	1.6	9.5	26.6	15.6	5.4	5.7	4.0
Striped bass	0.4	4.2	21.9	21.3	18.2	12.4	18.4
Channel catfish	0.8	4.8	7.2	10.9	44.8	24.6	5.0
Bluegill	t[a]	1.8	1.9	3.9	7.1	9.7	1.0
Rainbow trout	t	0.0	0.0	0.0	0.0	0.0	0.0
Other	t	0.8	0.0	1.3	0.0	0.0	0.0

[a] t = 0.001 %

Table 12. Species composition (%) of the total recorded creel for anglers interviewed at Wahweap, April-October 1982.

Species	Apr	May	Jun	Jul	Aug	Sep	Oct
Largemouth bass	32.3	25.4	21.6	11.1	8.0	8.1	5.0
Black crappie	37.6	13.2	19.0	0.8	1.0	0.0	0.0
Walleye	7.8	19.2	8.8	6.5	8.5	0.0	2.7
Striped bass	21.2	31.5	43.8	46.6	64.3	78.9	86.3
Channel catfish	0.5	9.2	6.2	33.2	17.1	13.0	5.9
Bluegill	0.4	1.5	0.2	0.4	0.0	0.0	0.0
Other	0.1	0.0	0.3	1.5	1.0	0.0	0.0

Walleye were not creeled as often in 1982 as they were in 1981. This was probably not the result of a decreased walleye population but rather associated with the increasing number of anglers who fished specifically for striped bass. Fishermen that sought striped bass were considerably more effective at catching striped bass than indiscriminant fishermen, as reflected by catch rates of 0.144 and 0.017, respectively. Fishermen specifically pursuing largemouth bass similarly exhibited a higher catch rate (0.216) than the indiscriminant fishermen (0.056).

The sport fishery harvest of striped bass increased again in 1982. The overall catch rate for the seven census months was 0.050 fish per angler hour (Table 10), a considerable increase over 1981 (0.021). Although striped bass were caught reservoir-wide, catch rates were higher near the dam. More fishermen pursued striped bass there resulting in a large harvest at Wahweap. Striped bass anglers were most successful in late summer (August-October) but a year-round fishery has been created by the use of frozen anchovies as striped bass bait. Bait fishing has overshadowed trolling and casting as a preferred fishing technique. Striped bass and walleye have supplemented the sport fishery that has been declining due to the reductions in largemouth bass and black crappie populations (Job III). The strong 1981 year class of striped bass should contribute strongly to the fishery in 1983 and the bag limit will be increased from 2 to 4 striped bass; consequently, catch rates and harvest of striped bass should continue to increase during 1983.

More than half of the creeled largemouth bass were age III fish (1979 year class) and the lakewide average size was 360 mm in length. Black crappie exhibited a bimodal age distribution with peaks at ages III and V (1979 and 1977 year classes, respectively) and averaged 305 mm in length.

Recommendations

Conduct a creel census survey from April through October 1983. Methods should be consistent with those used in 1982. Special effort should be made to obtain scales, total length, and weight from all striped bass creeled. These data will provide information on the contribution of naturally reproduced fish to the creel. In addition, a sample of total length measurements will be taken from creeled largemouth bass and black crappie to determine at what size and age they become acceptable to the angler.

A computer program should be established to process data from the creel survey during 1983.

INDEX TO ANNUAL FISH POPULATION TRENDS

JOB III

Annual Netting

<u>Methods</u>

Methods for the standardized gill netting in the spring are described in Gustaveson et al. 1980. Four stations were sampled in 1982 during the first three weeks in March employing 30 net days per station.

A selected sample of walleye and largemouth bass was used to quantify fish condition according to the visceral fat index (VFI) used by the Utah Division of Wildlife Resources.

<u>Results and Discussion</u>

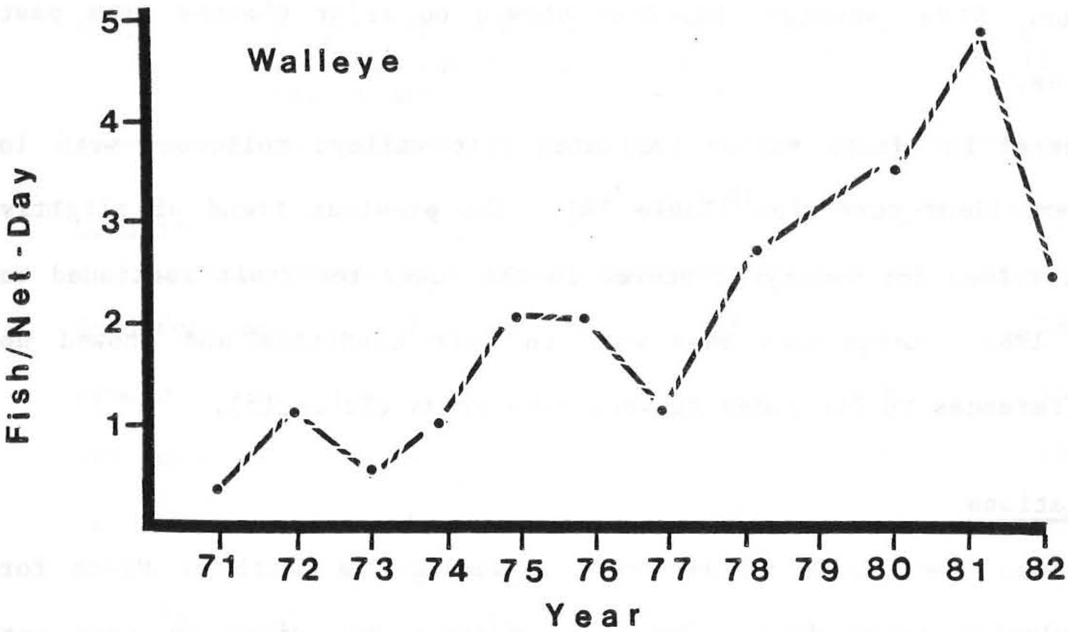
A total of 434 fish was collected in 120 net days during the annual netting. The highest catch rate (5 fish/net day) was recorded at the Rincon, followed by Padre Bay, Good Hope Bay and the San Juan (Table 13). The overall catch for 1982 was down at each station when compared to 1981. The total catch rate for all species and stations combined (3.6 fish/net day) was the lowest ever recorded since the initiation of the gill net survey in 1971. The low catch was probably due to cooler than normal water temperatures (8-10 C) which prevailed this year. Because of the cold water temperature, fish movement may have been less than normal causing a reduction in catch.

Table 13. Catch rate (fish/net day) during annual gill netting, Lake Powell, March 1982.

Species	Padre Bay	San Juan	Rincon	Good Hope Bay	Total[a]	% of Catch
Largemouth bass	0.23	0.50	0.83	0.93	0.63	17.3
Walleye	2.77	0.60	3.63	1.67	2.17	59.9
Striped bass	0.27	0.10	0.10	0.03	0.13	3.5
Black crappie	0.00	0.30	0.00	0.03	0.08	2.3
Carp	0.43	0.30	0.57	0.67	0.49	13.6
Channel catfish	0.03	0.03	0.03	0.07	0.04	1.2
Green sunfish	0.00	0.03	0.03	0.13	0.05	1.4
Yellow bullhead	0.00	0.03	0.00	0.03	0.02	0.4
Bluegill	0.00	0.00	0.00	0.07	0.02	0.4
Total	3.73	1.90	5.20	3.63	3.62	---

[a]Total = total number of fish divided by total net days.

The mean catch rate of walleye decreased by almost 3 fish per net day from 1981, and the largemouth bass catch rate reached an all time low (Figure 4). Although the catch was low, the relative abundance of various species remained the same as in the past. Walleyes made up 60% of the total catch and largemouth bass 17%. Striped bass were collected at all stations for the first time. Yearling striped bass occurred at three out of the four stations indicating a strong carry over of the 1981



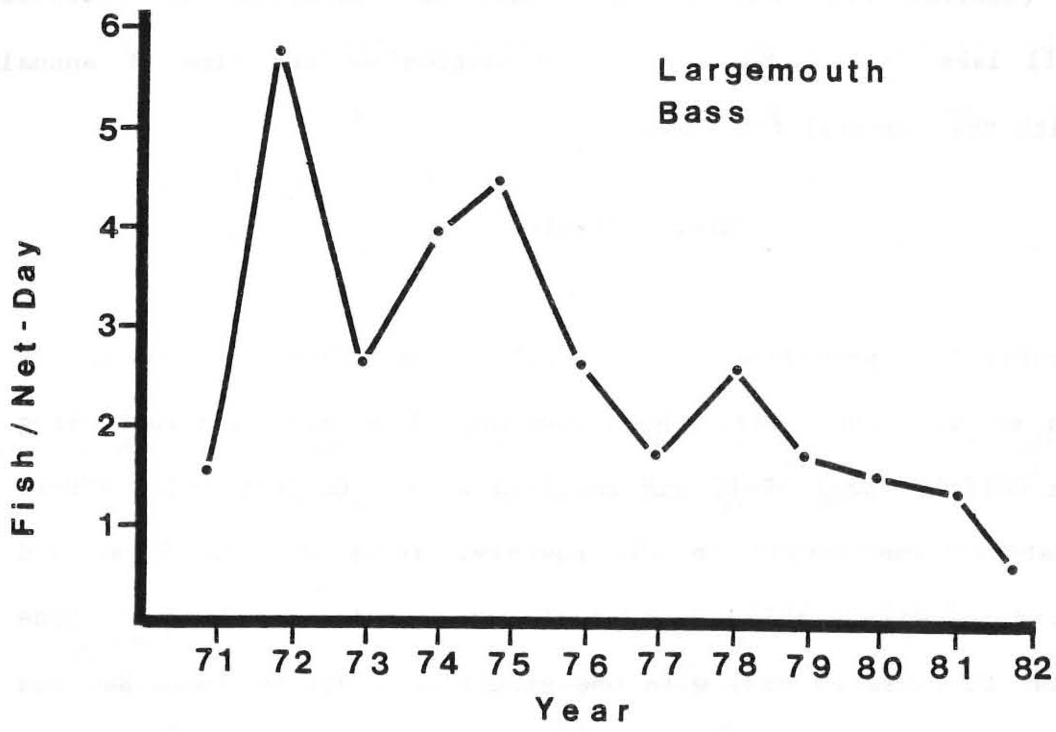


Figure 4. Catch rates (fish/net day) for walleye and largemouth bass from annual netting, 1971-1982, Lake Powell.

year class. Other species collected showed no major changes from past collections.

Visceral fat index values indicated that walleye collected were in good to excellent condition (Table 14). The previous trend of slightly lower VFI values for walleye captured in the lower reservoir continued to exist in 1982. Largemouth bass were in fair condition and showed no major differences in fat index between lake areas (Table 15).

Recommendations

Continue the annual netting program during the month of March for fish population trend data. Evaluate specific net sites so that net locations (habitat type and depth) remain as consistent as possible between all lake areas. Monitor fish condition at the time of annual netting with the visceral fat index.

Electrofishing

Methods

Electrofishing procedures were similar to those described by Gustaveson et al. 1980, with the exception of a new electroshocking unit. The Coffelt Model RF-10 was replaced with a Coffelt Model VVP-15 d.c. pulsator. The output to the positive array was 12-15 a. and 220-240 v. d.c., with a pulse rate of 80 per second. Sampling stations were similar to those in 1981 with one exception. Hall's Creek Bay was replaced by a transect in Warm Creek Bay to monitor the smallmouth bass introduction program. Five stations were sampled for one night each, approximately one hour of electrofishing per station. The index of

Table 14. Percent of total sample occurring in each category of the visceral fat index[a] for walleye collected by gill netting during March 1982, Lake Powell.

Location	Visceral Fat Index Category 0	1	2	3	4	
Good Hope Bay	0	8	16	48	28	(n = 50)
Rincon	0	9	20	58	13	(n = 55)
San Juan	0	11	33	39	17	(n = 18)
Padre Bay	1	33	44	19	3	(n = 79)

[a]Internal body fat present:

0 - None.

1 - Little, less than 50% of each caecum is covered.

2 - Approximately 50% of the caecum is covered.

3 - More than 50% of each caecum is covered.

4 - Pyloric caeca are completely covered with fat.

Table 15. Percent of total sample occurring in each category of the visceral fat index for largemouth bass collected by gill netting during March 1982, Lake Powell.

Location	Visceral Fat Index Category 0	1	2	3	4	
Good Hope Bay	5	73	22	0	0	(n = 22)
Rincon	0	46	46	8	0	(n = 24)
San Juan Arm	7	64	29	0	0	(n = 14)
Padre Bay	14	72	14	0	0	(n = 7)

abundance for the species collected at each location was mean catch rate (fish/hour of electrofishing) for each night of sampling.

Results and Discussion

A total of 1,419 fish was collected during the 5 nights of electrofishing. Mean catch rates for all species were highest at Stanton Creek, followed by Good Hope Bay, Warm Creek, Rincon and San Juan (Table 16). All stations showed little deviation from last year's catch rate for all species except Good Hope Bay where the catch rate nearly doubled. This was primarily due to the increased catch of y-o-y largemouth bass. While bluegill (Lepomis macrochirus) and green sunfish (Lepomis cyanellus) accounted for a large portion (83%) of the total catch in 1981, these two species accounted for only 36% in 1982. Young-of-the-year largemouth bass comprised over 51% of the total catch, a considerable increase over 1981 (6.3%). While largemouth bass had high catch rates, comparable with 1980, those of black crappie remained low (Figure 5). The high catch rate of y-o-y largemouth bass suggests a strong 1982 year class and should dampen the effect the low 1981 production might have on the future sport fishery harvest. Striped bass made up 1.2% of the total catch and occurred most frequently at the Good Hope Bay station. This represents a slight decrease from 1981 (5.4%) and suggests a smaller year class in 1982.

A limited number of adult threadfin shad were encountered at all stations, but were not quantitatively sampled.

Table 16. Mean catch rate[a] (fish/hour) of fish collected by electrofishing, Lake Powell, September 1982.

Species	Good Hope Bay	Stanton Creek	Rincon	San Juan	Warm Creek	% of Total Catch
Young-of-the-year largemouth bass	228	194	151	29	165	51.1
Age I and older largemouth bass	11	24	2	5	4	3.1
Young-of-the-year black crappie	4	34	13	3	10	4.3
Young-of-the-year striped bass	16	0	2	0	0	1.2
Channel catfish	30	5	0	2	6	2.9
Green sunfish	30	100	39	153	13	22.3
Bluegill	37	101	22	33	13	13.7
Young-of-the-year smallmouth bass	0	0	0	0	22	1.5
All species[a]	356	458	229	225	233	--

[a]Total fish divided by total hours of electrofishing.

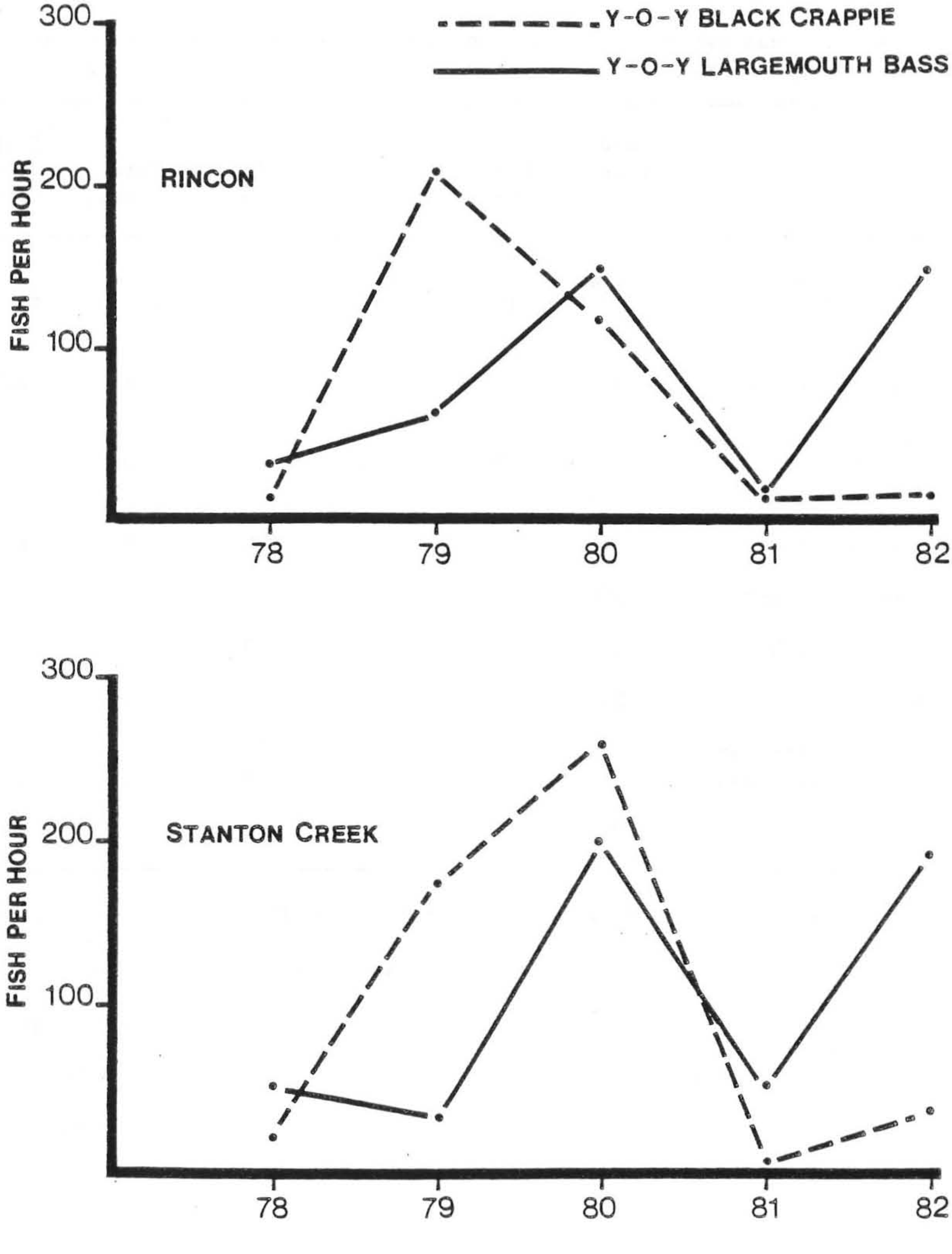


Figure 5. Mean number of young-of-the-year largemouth bass and black crappie collected/hour of electrofishing during August-September, 1978-1982, Lake Powell.

Recommendations

Continue annual electrofishing during August-September 1983. Maintain 1982 sampling stations, which coincided with the spring annual netting sites.

Conduct electrofishing in the spring, during black crappie spawning, to explore possibilities of obtaining more information on spawning habitat and size of spawning population.

MONITORING OF STRIPED BASS POPULATION DEVELOPMENT

JOB IV

Methods

Biological data were obtained from striped bass taken in gill nets, by angling, electrofishing and during regular creel census interviews. Data necessary to determine age and growth, food habits, stage of maturity, and condition factor (based on fork length) were routinely taken from all fish sampled.

During November, an annual survey of striped bass abundance was conducted by fishing 10 experimental gill nets for 42 consecutive hours (two nights and one day) at each of four previously established stations. Nets were set in similar habitat at each station. Experimental gill nets were 30.5 m long by 1.8 m deep, with four panels of 1.9, 2.5, 3.8 and 5.1 cm square mesh. Catch was quantified by striped bass caught per 1000 square feet of gill net per 12 hour set. This enumeration is a standard method developed by the AFS Striped Bass Committee (McCloskey 1980).

Striped Bass Spawning

Mature adult striped bass were found congregated in the Colorado River near Gypsum Canyon, and in Wahweap and Warm Creek Bays near Glen Canyon Dam. Striped bass tend to congregate in large schools near preferred spawning areas apparently awaiting environmental conditions that trigger spawning. These "staging areas" at Lake Powell were occupied for at least one month prior to spawning during 1982. The staging areas were in the same locations that had been used in previous years.

Evidence of spawning, usually in the form of dead floating eggs, was usually found near a staging area, indicating the fish probably did not move long distances between staging and spawning. Spawning in 1982 was delayed somewhat by unseasonably cold spring temperatures. The first ripe males were collected on 25 April 1982 near the dam. The first spent female was collected mid-lake on 15 May 1982. The spawning peak was during the last two weeks of May in 1982, compared to the first two weeks in previous years.

Spawning apparently occurred in the Colorado River above Lake Powell. The mouth of the San Juan River, on the other hand, was guarded by a silt barrier that had been deposited by the river during seasonal lake level fluctuations. Striped bass were therefore not ascending the San Juan River for spawning purposes. Subsequent collection of y-o-y striped bass in the San Juan Arm indicated that spawning had occurred during 1982, probably in the reservoired portion of the San Juan.

Striped bass were observed spawning in Warm Creek Bay, near Glen Canyon Dam, on 22 May 1982. Confirmed angler reports indicated spawning occurred from 2230 hours until dawn on 23 May 1982. Dead striped bass eggs were observed on the water surface for approximately one week following spawning.

In-reservoir reproduction also may have occurred in many other canyons, as evidenced by collection of y-o-y striped bass throughout the length of the reservoir (see fall netting results). It has been previously shown that the overflow density current cannot distribute y-o-y from the tributaries throughout the expanse of the entire reservoir (Gustaveson et al. 1982).

Annual Fall Gill Netting

Gill netting results during November 1982 confirmed that y-o-y striped bass production was well below the record year class spawned in 1981. The 1981 year class was well represented at all four stations sampled, while y-o-y were found at abundance levels similar to those of 1980 (Table 17). A slight drop in catch/unit effort at Wahweap corresponded with an increase of yearling striped bass caught at the San Juan station, indicating some migration from the southern end of the reservoir may have occurred.

The total number of striped bass caught was essentially the same in 1981 and 1982. The bulk of the catch was yearlings in 1982 instead of y-o-y, indicating an increase in total striped bass biomass. The delayed spawn, the large 1981 year class and intense competition for the small shad crop may explain the inhibited growth of the 1982 striped bass year class. Average total length of 1982 y-o-y was 40.8 mm shorter than the average total length of y-o-y caught in 1981 (Table 18).

Food Habits

Investigation of striped bass food habits (Table 19) showed marked changes from the 1980 food habits survey (Gustaveson et al. 1981). The number of empty stomachs doubled from 24% in 1980 to 56% in 1982. Threadfin shad were still the most frequently occurring food item but

Table 17. Striped bass caught per 1,000 square feet of gill net per 12 hour set[a] during fall sampling on Lake Powell compared to similar netting results obtained in 1981.

	1981			1982		
Location	Y-O-Y	1+	All SB	Y-O-Y	1+	All SB
Good Hope	4.11	0.58	4.95	0.47	4.91	6.81
Rincon	0.58	0.26	1.74	0.14	0.52	0.76
San Juan	0.31	0.05	0.79	1.00	1.52	2.71
Wahweap	6.53	0.63	7.84	0.14	3.24	4.00
Average	2.88	0.38	3.83	0.45	2.55	3.57

[a]Standard method after McCloskey, 1980.

Table 18. Average total length of young-of-the-year striped bass collected during annual fall netting in 1981 and 1982 on Lake Powell.

	1981		1982	
Location	Mean Total Length	(n)	Mean Total Length	(n)
Good Hope	288.16	(77)	208.60	(10)
Rincon	239.27	(11)	247.00	(3)
San Juan	202.67	(6)	179.81	(21)
Wahweap	199.78	(124)	170.30	(3)
Average	233.07		192.27	

Table 19. Seasonal occurrence of food items in striped bass stomachs collected during 1982. Percent occurrence of food items based on number of stomachs containing food.

	Spring Mar-May	Summer June-Aug	Fall Sep-Nov
Sample size	42	41	73
Empty stomachs	22	19	46
<u>Food Item</u>			
Fish			
Threadfin shad	35	18	33
Carp	10	4	-
Red shiner	-	-	4
Unidentified	-	-	11
Bait			
Anchovy	5	45	26
Waterdog	5	-	-
Crayfish	15	27	15
Debris	5	14	-
Zooplankton	30	5	19

low shad availability apparently caused the striped bass to utilize food items such as crayfish, carp, and plankton. Lake Powell carp are a pelagic schooling fish, due to the reservoir's relative scarcity of littoral zone and may, therefore, be more available to striped bass than they would be in many other waters. No game fish were observed in the 156 stomachs examined in 1982. Even though forage was limited, no evidence was found that striped bass utilized shorebound game fish as a food item.

The effectiveness of dead anchovies as a bait was documented by the occurrence of the bait fish in 45% of the stomachs during the summer months. This is obviously an overestimate of anchovy ingestion, caused by the collection of stomachs from angler caught striped bass. Striped bass continued to be very selective in their food requirements. If the sought after food item was not available, striped bass went without eating instead of turning to a new unfamiliar forage item.

Body Condition

Following spawning, striped bass usually begin regaining weight lost to spawning activity. During 1982 it became apparent that shad forage was low (Job I) and adult striped bass were not rebuilding body mass, but declining in body condition throughout the summer. By November adult striped bass in the southern half of the reservoir had an average condition factor (K factor) of less than 1.0 (Table 20), while yearling fish still exhibited a normal K factor of near 1.3 (Table 20). The difference in K factor between adults and subadults can be explained by thermal preference. Subadult striped bass seek water that is 20-24 C, but they can utilize warmer water. As they grow and mature they prefer

Table 20. Condition factors of yearling and adult striped bass taken during annual fall gill netting, November 1982, Lake Powell.

Location	Yearling K factor	(n)	Adult K factor	(n)
Good Hope	1.43	(30)	1.25	(11)
San Juan	1.31	(10)	0.85	(5)
Rincon	1.29	(9)	1.07	(3)
Wahweap	1.10	(10)	0.89	(9)

water that is 16-20 C (Schaich 1979). Adult striped bass avoid water warmer than 25 C (Schaich 1979) and were repeatedly caught by anglers and charted by sonar at depths near or below the metalimnion in the summer months. This change in temperature preference serves to separate year classes and reduce competition.

Lake Powell is a warmwater impoundment typified by a high degree of thermal stratification. Stratification is greatly affected by the amount of spring overflow density current. Years with a large spring flood are characterized by a deeper, more diffused metalimnion than years when runoff is low (Merritt and Johnson 1977). The epilimnion is wedge shaped, being thicker near the inflow than at the dam (Johnson and Merritt 1979). The cooler water of the metalimnion which adult striped bass prefer is often at depths of 15-30 m.

As Lake Powell's stratification intensifies during the summer a distinct oxygen minimum layer develops in the upper reaches of the metalimnion. The oxygen depletion is probably the result of organic matter collecting on the denser water of the metalimnion and being oxidized at that point (Johnson and Merritt 1979).

Threadfin shad typically inhabit the epilimnion in a stratified reservoir. Following the establishment of the striped bass population in Lake Powell, shad also sought the security of turbid water near shore and shunned the formerly safe, pelagic sanctuary they occupied when only shorebound predators existed. Consequently, a thermal separation of adult striped bass and threadfin shad has occurred annually. The vertical separation may be as much as 30 m depending on the width of the epilimnion and lake location. The boundary between the predator and prey was fenced by the oxygen depletion zone. An additional, horizontal, separation occurred in some cases when shad occupied the shallow, turbid water at the back of a long, gradually deepening canyon. It has been reported that a separation of "a few meters" was enough to prevent striped bass from foraging on shad in Cherokee Reservoir, TN during a severe low oxygen-high temperature situation (Schaich 1979).

Adult striped bass do eat shad in the summertime despite the thermal separation. To do so they must leave their preferred temperature zone, cross the oxygen depletion layer, quickly forage in the warm water layer, and then retrace their path. The warm water layer was thick and shad numbers were low in 1982. Striped bass probably expended more energy foraging than they gained from shad consumption. The result was a general decline in body condition. As condition declined, the ability to effectively perform the exhaustive foraging journey diminished. A decline in condition can also cause the fish to seek even cooler water where less energy is required for body maintenance (Schaich 1979), resulting in a wider separation of predator and prey.

Subadult striped bass were able to live in the same temperature zone (20-28 C) as the shad. The large striped bass year class produced in 1981 was never separated from the 1982 shad forage crop. Predation by these yearling striped bass probably contributed to the paucity of shad recruiting to the adult population in 1982. Body condition of these yearlings remained high (Table 20) although growth was slower than found in 1981 (Table 18).

Recommendations

1. Monitor the spawning population to determine overwinter survival, gonadal development, and possible impact of poor body condition on fecundity in 1983.
2. Determine mechanism responsible for in-reservoir reproduction in Lake Powell. To successfully complete this objective a spawning school must be found and the eggs followed until hatching occurs.
3. Quantify spawning success and recruitment with the fall gill net survey. Discontinue seining as an index of striped bass abundance because of limitations created by Lake Powell's steep rocky shoreline habitat.
4. Continue tagging striped bass to determine long range movement and distribution throughout the reservoir. Tag fish taken by different angling techniques to determine survivability of fish under catch and release conditions.

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