Lake Powell Fisheries Investigations

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Dingell-Johnson Project F-28-R

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LAKE POWELL FISHERIES INVESTIGATIONS

Annual Performance Report
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A. Wayne Gustaveson, Project Leader
Bruce L. Bonebrake, Project Biologist
Steven J. Scott, Project Biologist
James E. Johnson, Fisheries Program Coordinator

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

William H. Geer
Acting Director

ABSTRACT

Threadfin shad, the major forage species in Lake Powell, rebounded during 1983 from the population low point reached in 1982. Although y-o-y were produced in large numbers, few migrated to the open bays, indicating the shad population was predator impacted. Angling pressure and boat use declined from the peak in visitation experienced in 1982. The total sport fishery catch rate was similar to 1982's fairly low catch rate; however, striped bass were harvested at record levels while largemouth bass harvest declined to a new low. Annual gill net sampling to monitor game fish population trends substantiated a further decline in walleye and largemouth bass abundance while striped bass numbers continued to increase. Electrofishing surveys showed a positive response in centrarchid production to spring flooding conditions of 1983, that saw Lake Powell fill to 8 ft above the designated full pool level. Bluegill and green sunfish production responded to the high water with record numbers of young produced, while black crappie and largemouth bass were produced at moderate levels. Adult striped bass overwintered in poor physical condition but managed to produce a fairly strong year class.

Evidence of lacustrine as well as tributary spawning was seen for the third consecutive year. Adult striped bass condition improved later in the year as y-o-y shad began contributing to their diet. Juvenile striped bass were able to maintain good condition through all seasons of the year despite forage limitations.

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THREADFIN SHAD STUDY

JOB I

Methods

Threadfin shad (Dorosoma petenense) spawning was monitored with ichthyoplankton net collections, which began in May and continued until September. Weekly samples were taken in the backs of bays at Wahweap Creek, Warm Creek, Bullfrog Creek and Hall's Creek. Biweekly samples were collected at Red and Ticaboo Canyons, while monthly monitoring was conducted at Farley, White, Copper and Chaol Canyons, and at Piute Farms and the San Juan River Inflow (Figure 1). A one-meter, 505 micron net was towed just below the water's surface. Three tows, two minutes in duration, were taken at each station. Because previous findings have demonstrated that shad in Lake Powell prefer to spawn in turbid waters (Gustaveson et al. 1982), shallow, turbid water sites at the backs of canyons and bays were chosen for sampling. Sample locations were adjusted periodically to account for fluctuating water levels.

All samples were preserved in the field with 0.5% formalin. A solution of biological stain, Phloxine B, was mixed with the preserving formalin to aid in separating larval fish from sample debris. Larval fish were picked from the debris and identified to species. All larval threadfin shad ($<$ 25 mm TL) were counted and an average number of shad per tow was computed from triplicate tows at each station. A monthly

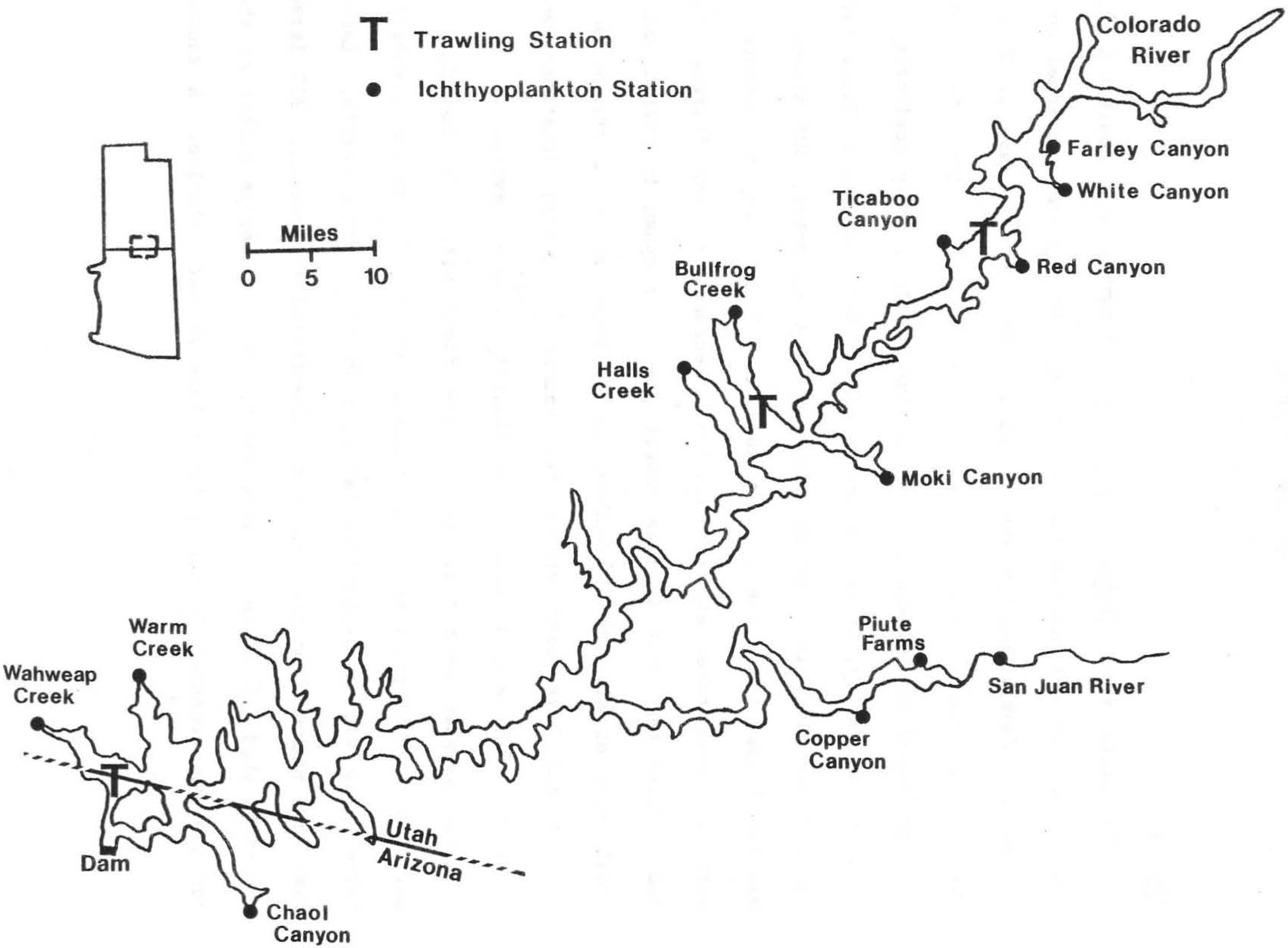

Figure 1. Map of Lake Powell showing trawling and ichthyoplankton netting stations for threadfin shad, 1983.

average of shad per tow was then calculated from the weekly and biweekly samples.

Recruitment of threadfin shad into the pelagic areas of Lake Powell was to be monitored by monthly midwater trawl collections. Sampling methods have been described in Gustaveson et al. 1980. Trawl samples were scheduled to be taken from July through September at Wahweap, Bullfrog and Good Hope Bays (Figure 1). Equipment breakdowns, however, prevented sampling during August and September. Sonar techniques were used to provide information on shad recruitment into the open water areas during these months. Eight-minute sonar transects were made at each of the trawling sites with Lowrance model 1510 B and C recorders using LPT-101 transducers.

Results and Discussion

Ichthyoplankton netting began in May and continued until September when shad spawning ended. Compared to 1982, spawning success for threadfin shad increased in the lower lake, decreased at midlake, and remained about the same in the upper lake (Figures 2, 3, & 4). Spawning intensity in the lower reservoir remained high throughout June 1983 and peaked in the 23 June sample with 1,033 fish/tow at Warm Creek and 257 fish/tow at Wahweap Creek. Threadfin shad spawning at Warm Creek was nearly over by mid-July, but continued at a lower intensity into mid-August at Wahweap Creek (Figure 2). Limited ichthyoplankton netting in Chaol Canyon indicated good shad production during June (335 fish/tow) but little production during the rest of 1983 in that portion of the lake (Figure 1).

Spawning success at midlake was down in 1983 with most larval shad collected at Bullfrog Creek during the 29 June sample (199 fish/tow).

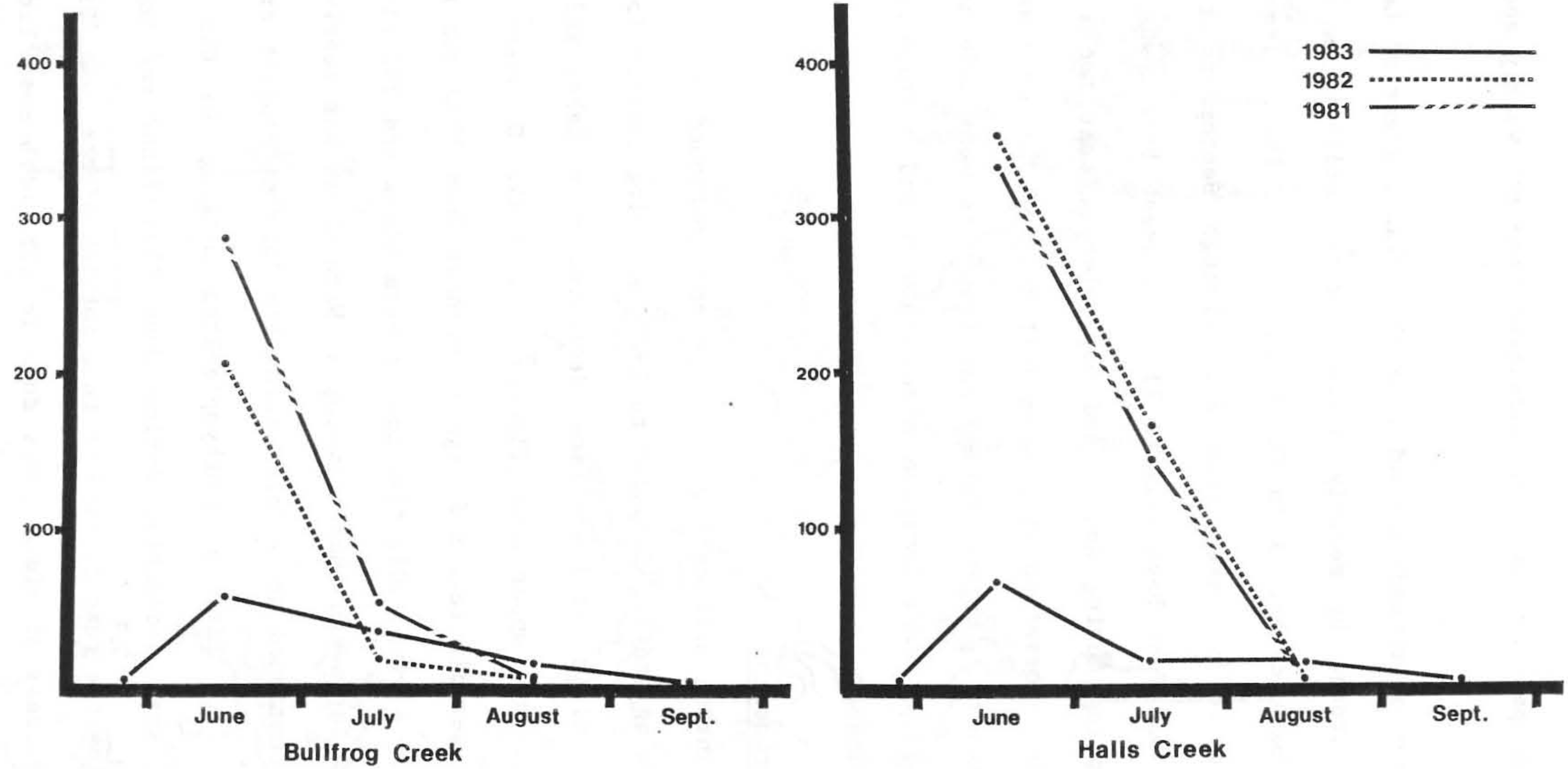

Figure 2. Mean number of larval shad collected per ichthyoplankton net tow, Lower Lake Powell, 1981-1983.

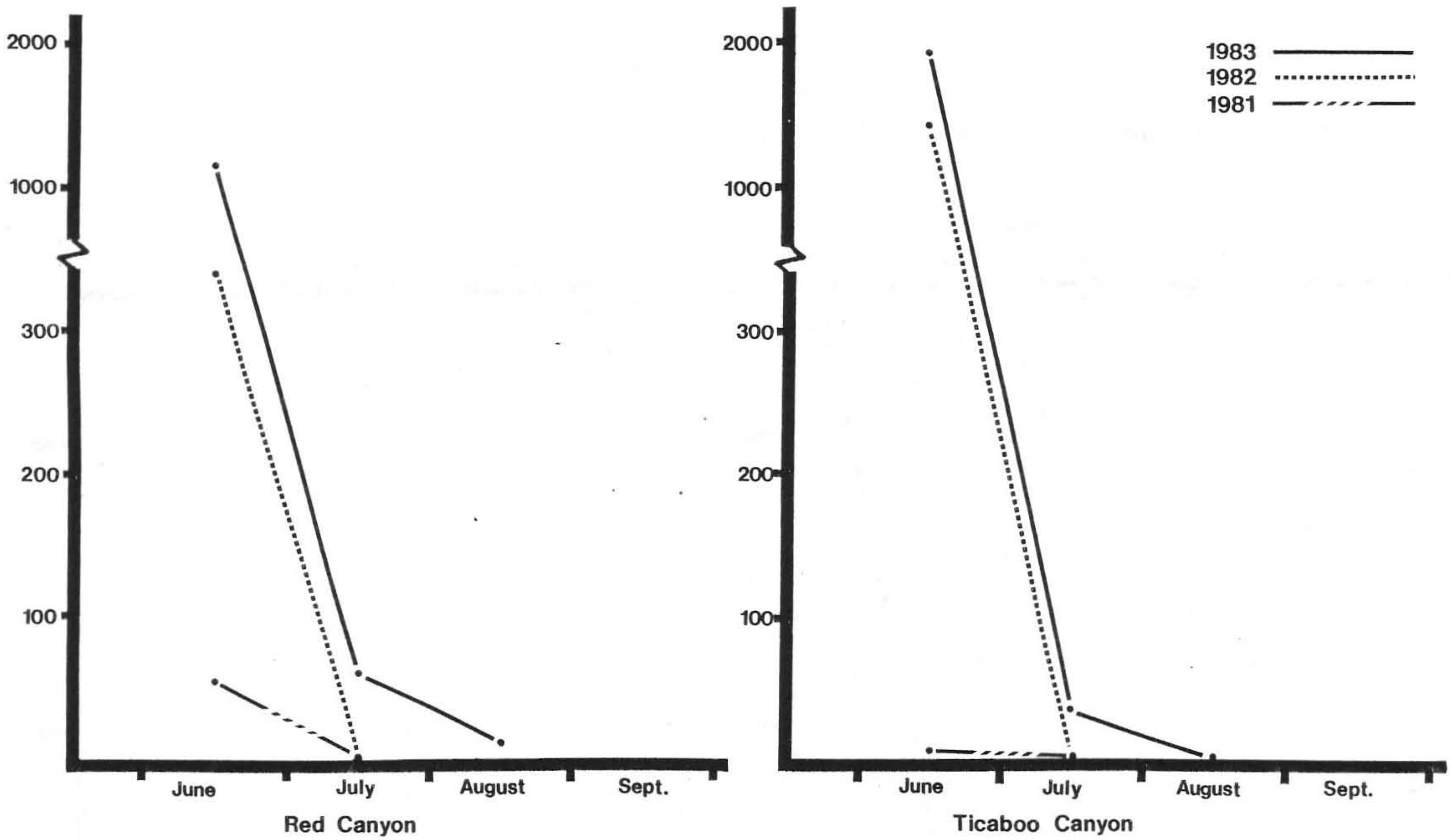

Figure 3. Mean number of larval shad collected per ichthyoplankton net tow, Mid Lake Powell, 1981-1983.

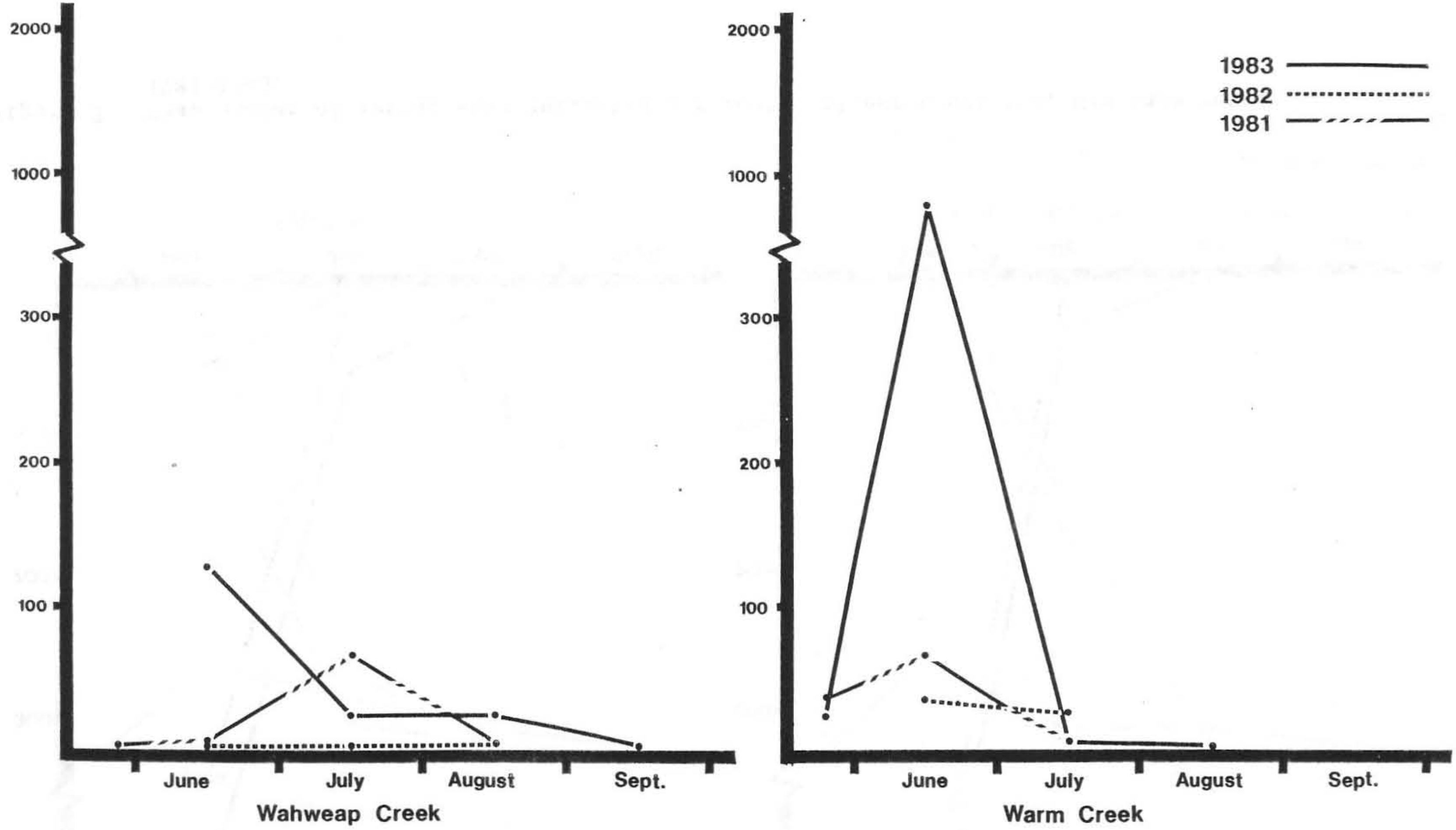

Figure 4. Mean number of larval shad collected per ichthyoplankton net tow, Upper Lake Powell, 1981-1983.

Low intensity spawning, however, did occur through August at both Halls and Bullfrog Creeks (Figure 3).

Shad production in the upper lake appeared similar to production in 1982 and much higher than in 1981 (Figure 4). Mid-June samples contained 1,920 fish/tow and 1,414 fish/tow, respectively, at Ticaboo and Red canyons.

Limited netting conducted in the upper end of the San Juan Arm revealed a good shad spawn during June near Piute Farms (665 fish/tow) and fair reproduction in July (Table 1). No larval shad were found in any samples from the San Juan River inflow. Although threadfin shad did not use the San Juan River for spawning in 1983, the interface at Piute Farms where the turbid waters of the San Juan River mix with the lake waters was obviously preferred spawning habitat (Piute Farms sample, Table 1). Because this area of mixing is quite large, substantial shad production occurred in the upper San Juan Arm during 1983. Only limited

Table 1. Mean number of larval threadfin shad collected per ichthyoplankton net tow, San Juan River Arm, Lake Powell, 1983.

Sample Date	Copper Canyon	Piute Farms	San Juan River Inflow
June 5	16	665	0
July 4	15	67	0
August 3	1	0	0

shad reproduction was found in Copper Canyon, probably due to decreasing turbidities found down-lake of the San Juan River mixing zone.

Midwater trawl catches of young-of-the-year (y-o-y) shad were quite low in July 1983 (Table 2). The low catches were similar to those of 1982 and probably reflect the low shad recruitment into the pelagic zone of the lake observed in 1982. Echograms run during August and September also revealed few y-o-y shad in the pelagic zones of Lake Powell, except at Good Hope Bay. Fair numbers of shad were graphed during the September sample at Good Hope, but due to equipment breakdowns no trawl samples were collected.

Moczygemba and Morris (1977) reported that the open water zone is inhabited by surplus shad that are forced into the open water by competition. Lack of shad in the pelagic zone is an indication of a predator-impacted shad population. The disparity between threadfin shad reproduction and recruitment into the pelagic zones of Lake Powell probably resulted from striped bass predation. Members of the large 1982 year

Table 2. Mean number of y-o-y shad collected per midwater trawl tow, Lake Powell, July 1982 and 1983.

Location	Mean number of shad per tow 1982	1983
Wahweap	0	0
Bullfrog	1	0
Good Hope	4	1

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 shallow water with the shad and fed heavily on both adults and y-o-y shad.

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. After exceeding the desired forage size preferred by striped bass (76-178 mm) they matured and spawned. Threadfin shad, because of their smaller size, were unable to outgrow the preferred prey size and were eliminated. Threadfin shad are the only schooling forage fish in Lake Powell and they support the striped bass population. Not only was shad recruitment low in 1983, but the available broodstock may have been impacted.

In summary, there appears to have been good production of larval shad in the upper and lower ends of Lake Powell during 1983. Production at midlake was at a somewhat lower intensity but did occur over an extended season. Recruitment of y-o-y shad into the open water zones of the lake, however, was only recorded in significant numbers at Good Hope Bay.

Recommendations

Continue ichthyoplankton netting and midwater trawling. The ichthyoplankton netting has proven useful in monitoring larval shad production and the duration of the spawn. Midwater trawling has been useful in evaluating y-o-y shad recruitment into the pelagic zone of the lake. The use of echosounding to add support to trawling data should be continued. More effort should be directed at gaining expertise with echosounding techniques for evaluating the Lake Powell fisheries.

Discontinue ichthyoplankton netting at Farley and White canyons. Little additional information has been gained by sampling these sites and costs could be reduced by eliminating these samples.

Add a biweekly ichthyoplankton netting site at Moki Canyon. A midlake sample on the south shore is needed to better assess midlake spawning. Because of its close proximity to Bullfrog, Moki Canyon will require little additional expense to sample.

Discontinue ichthyoplankton netting at Copper Canyon. This portion of the San Juan Arm was not heavily used by threadfin shad for spawning in 1983 and requires considerable boat travel time to sample.

Add another monthly sample site at Piute Farms. The turbid waters at Piute Farms have proven to be an important spawning area for shad and a second site would provide a better data base.

MEASUREMENT OF FISHERY HARVEST, PRESSURE AND SUCCESS

JOB II

Methods

Creel census was conducted from April through October 1983, 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 the census day, as well as for their previous day of fishing. Estimates of angling pressure were based on recreational use data collected by National Park Service personnel at access points. A computer program to summarize data collected from the creel survey has now been completed and was utilized on 1983 data.

Results and Discussion

A total of 3,483 boating parties was checked by creel clerks during the seven month census period. Of these, 1,514 (43%) reported angling activity. The mean number of anglers per fishing boat was 2.6, while each angler spent an average of 4.9 hours fishing per day.

Both angling pressure and recreational boat use decreased on Lake Powell during 1983 (Figure 5). The index of angling pressure was 98,550 fishing boat days, a decrease of 11% from 1982. The index of total recreational boat use (including fishing and nonfishing boats) was 266,364, compared to 278,838 boat days in 1982. Bullfrog access area

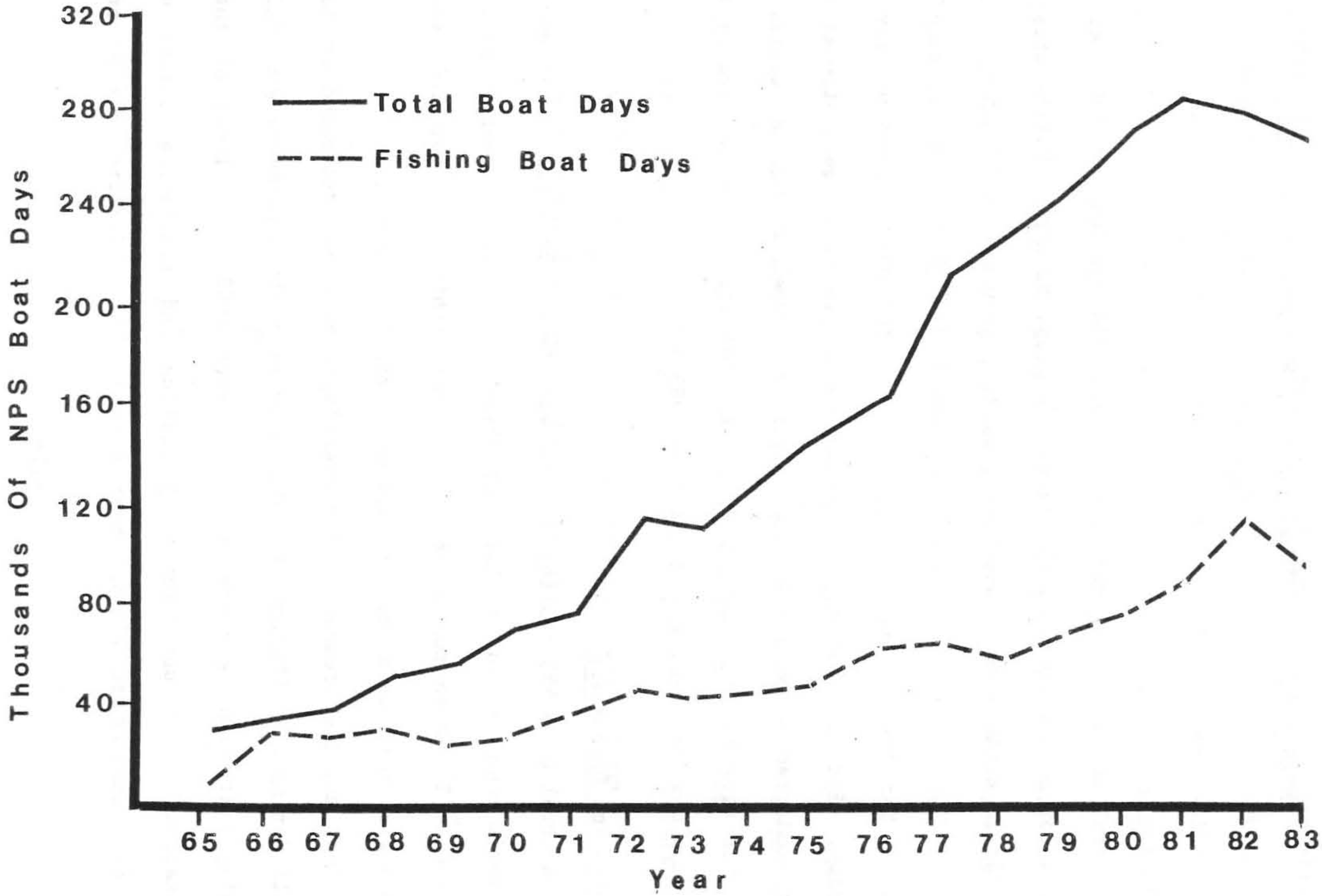

Figure 5. Indices of total recreational boat use and angling pressure, Lake Powell, 1965-1983.

accounted for the highest angler use (46%) of the four major access points, while angler use at Wahweap, Hall's Crossing and Hite access points was 28%, 17% and 9% 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 3). During the summer and early fall (July-October), striped bass and indiscriminate angling became more important (Table 4).

Creel rates (fish/angler hour) for largemouth bass (0.040), black crappie (0.047) and all species (0.209) were down slightly from 1982 (Figure 6). The best fishing for largemouth bass and black crappie in 1983 was in the upper reservoir (Hite), while striped bass fishing was better on the lower reservoir (Wahweap) (Table 5). Those fishing for walleye had highest success at mid-reservoir (Bullfrog and Hall's Crossing).

The bulk of the fishery in the upper reservoir was supported by largemouth bass, while striped bass were only important in the summer (Table 6). Black crappie made up a large portion of the catch in the spring and fall, while walleye were important only in May through July. The fishery in the lower reservoir was dominated by striped bass (Table 7). Largemouth bass and channel catfish were caught most often in the late summer and fall.

Table 3. Species sought (%) by anglers, Lake Powell, April-June 1983.

Species	Wahweap	Bullfrog	Hall's	Hite	Total
Any	11.5	29.2	33.1	31.4	22.4
Largemouth bass	11.0	38.4	31.4	37.0	25.2
Black crappie	3.2	16.3	23.0	28.4	13.7
Striped bass	70.6	10.6	6.7	0.3	34.3
Walleye	3.4	4.7	5.4	0.3	3.5
Channel catfish	0.3	0.2	0.4	2.6	0.7
Rainbow trout	0.0	0.5	0.0	0.0	0.1
Bluegill	0.2	0.0	0.0	0.0	0.1

Table 4. Species sought (%) by anglers, Lake Powell, July-October 1983.

Species	Wahweap	Bullfrog	Hall's	Hite	Total
Any	42.7	43.4	49.1	43.9	44.1
Largemouth bass	14.0	23.1	16.7	45.1	20.2
Black crappie	0.3	2.1	1.8	0.0	0.9
Striped bass	40.9	28.0	26.3	3.7	31.2
Walleye	0.3	2.1	0.9	2.4	1.0
Channel catfish	1.8	0.7	3.5	4.9	2.2
Bluegill	0.0	0.7	1.8	0.0	0.4

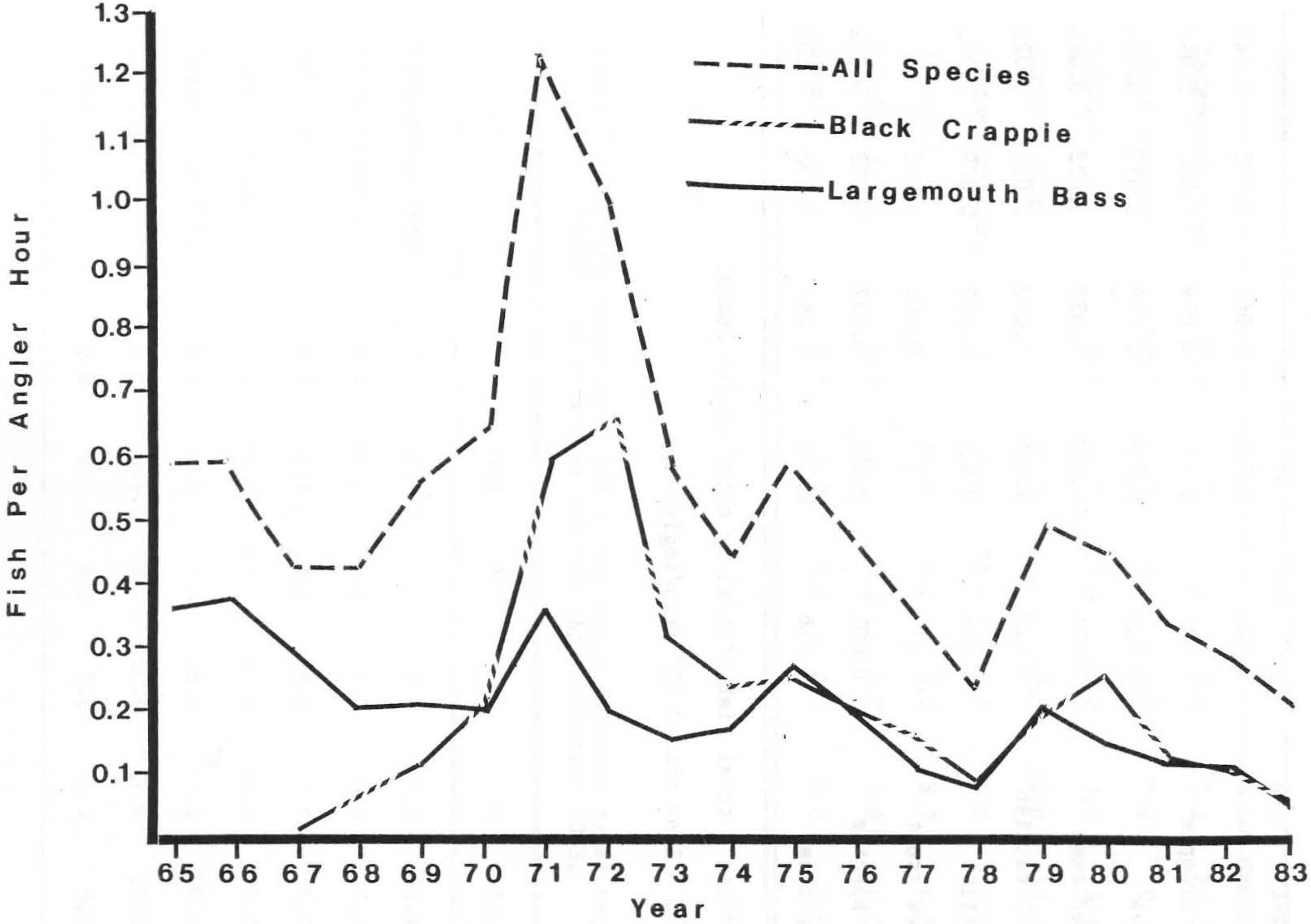

Figure 6. Catch rates (fish/angler hour) for largemouth bass, black crappie and all species, Lake Powell, April-June 1965-1983.

Table 5. Sport fishery creel rates (fish/angler hour) by species and access area, Lake Powell, April-October 1983.

Species	Wahweap	Bullfrog	Hall's	Hite	Mean[a]
Largemouth bass	0.028	0.033	0.060	0.075	0.040
Black crappie	0.025	0.052	0.054	0.081	0.047
Walleye	0.010	0.016	0.020	0.015	0.015
Striped bass	0.154	0.027	0.035	0.023	0.064
Channel catfish	0.020	0.016	0.030	0.028	0.020
Bluegill	0.008	0.016	0.067	0.009	0.022
Rainbow trout	t[b]	t	0.000	0.000	t
Other species	0.001	0.001	0.002	0.002	0.001
All species	0.246	0.160	0.267	0.233	0.209

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

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

Table 6. Species composition (%) of the total recorded creel for anglers interviewed at Bullfrog, Hall's Crossing, and Hite, April-October 1983.

Species	Apr	May	Jun	Jul	Aug	Sep	Oct
Largemouth bass	25.3	26.1	17.6	13.0	27.2	46.3	42.2
Black crappie	65.4	28.7	4.8	0.0	9.8	0.5	12.4
Walleye	5.6	12.8	19.6	15.8	3.2	3.6	0.0
Striped bass	2.7	12.8	22.2	49.6	19.0	25.4	10.8
Channel catfish	0.6	7.1	25.5	12.1	26.8	17.8	15.4
Bluegill	0.2	11.8	8.2	9.5	13.9	6.5	16.1
Rainbow trout	0.0	0.1	0.0	0.0	0.0	0.0	0.0
Other	0.3	0.7	2.0	0.0	0.0	0.0	3.0

Table 7. Species composition (%) of the total recorded creel for anglers interviewed at Wahweap, April-October 1983.

Species	Apr	May	Jun	Jul	Aug	Sep	Oct
Largemouth bass	7.7	6.4	8.3	5.7	7.5	42.4	41.9
Black crappie	15.4	14.2	1.9	1.9	0.0	0.7	2.4
Walleye	1.8	4.5	7.6	8.5	2.8	1.4	0.8
Striped bass	74.9	71.7	72.5	35.2	14.1	12.8	34.8
Channel catfish	0.1	2.9	9.1	38.2	53.2	20.6	10.7
Bluegill	0.0	0.1	0.3	10.4	21.0	22.2	7.9
Other	0.0	0.1	0.3	0.0	1.4	0.0	1.6

The expansion of the striped bass creel limit from 2 to 4 fish and a high angling success rate in the Wahweap area combined to produce a record harvest of striped bass.

Most striped bass were harvested in March-May in the Wahweap area where prespawning fish were congregated. The most popular angling technique was to cast dead anchovies from boat or shore and wait for a striped bass school to find the bait. The harvest and catch rate of striped bass should continue to increase in the future as the current limit of four striped bass has been increased to six fish in 1984.

The first confirmed occurrence of lake trout (*Salvelinus namaycush*) in Lake Powell was recorded during creel census in May 1983. While its origin is only speculative, most probable possibilities include Flaming Gorge Reservoir, Utah, and Blue Mesa Reservoir, Colorado.

Recommendations

Conduct a creel census survey from April through October 1984 at the Bullfrog, Hall's and Hite access areas. Due to an increase in harvest of striped bass near the dam in March 1983, an intensified creel should be initiated in the Wahweap area during March 1984. Methods should be consistent with those used in 1983. 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.

Stomach samples will be collected from all walleye to gain information on food habits.

For two decades the Wahweap access area contributed the major portion of angler use at Lake Powell. Beginning in 1980 and continuing through the present, the Bullfrog access area surpassed Wahweap in angler use. This trend seems likely to continue thoughout this decade. Therefore, higher creel census sampling intensity is no longer justified at Wahweap. In 1984, Bullfrog and Wahweap will be sampled at the same intensity.

INDEX TO ANNUAL FISH POPULATION TRENDS

JOB III

Annual Netting

Methods

Methods for the standardized gill netting conducted in the spring are described in Gustaveson et al. 1980. Four stations were sampled in 1983 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 by inspecting the visceral fat.

Results and Discussion

A total of 431 fish was collected in 117 net days during the annual netting. The highest catch rate (6 fish/net day) was recorded at Good Hope Bay, followed by the Rincon, Padre Bay, and the San Juan respectively (Table 8). The overall catch for 1983 almost doubled at Good Hope Bay while the rate at the Rincon suffered a substantial reduction from 1982. The total catch rate for all species and stations combined (3.68 fish/net day) was almost identical to 1982 (3.62 fish/net day), which was the lowest recorded since the initiation of the gill-net survey in 1971.

Table 8. Catch rate (fish/net day) during annual gill netting, Lake Powell, March 1983.

Species	Padre Bay	San Juan	Rincon	Good Hope Bay	Total[a]	% of Catch
Largemouth bass	0.07	0.40	0.53	0.93	0.47	12.8
Walleye	1.93	1.00	1.93	2.15	1.73	46.9
Striped bass	0.55	0.10	0.47	0.19	0.32	8.8
Black crappie	0.00	0.03	0.00	0.15	0.04	1.2
Carp	0.62	0.23	0.60	1.85	0.79	21.6
Channel catfish	0.28	0.17	0.40	0.26	0.27	7.4
Green sunfish	0.00	0.00	0.00	0.07	0.02	0.5
Yellow bullhead	0.00	0.00	0.00	0.07	0.02	0.5
Bluegill	0.00	0.00	0.00	0.04	0.01	0.2
Flannelmouth sucker	0.00	0.00	0.00	0.04	0.01	0.2
Total	3.45	1.93	3.93	5.74	3.68	---

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

The mean catch rate of both walleye and largemouth bass continued to decrease in 1983 (Figure 7). Consequently these two species combined represented a smaller proportion of total catch (60%) than they have in the past. The largemouth bass catch rate has declined steadily for five consecutive years. These reductions were offset by moderate increases in the catch of carp, striped bass and channel catfish.

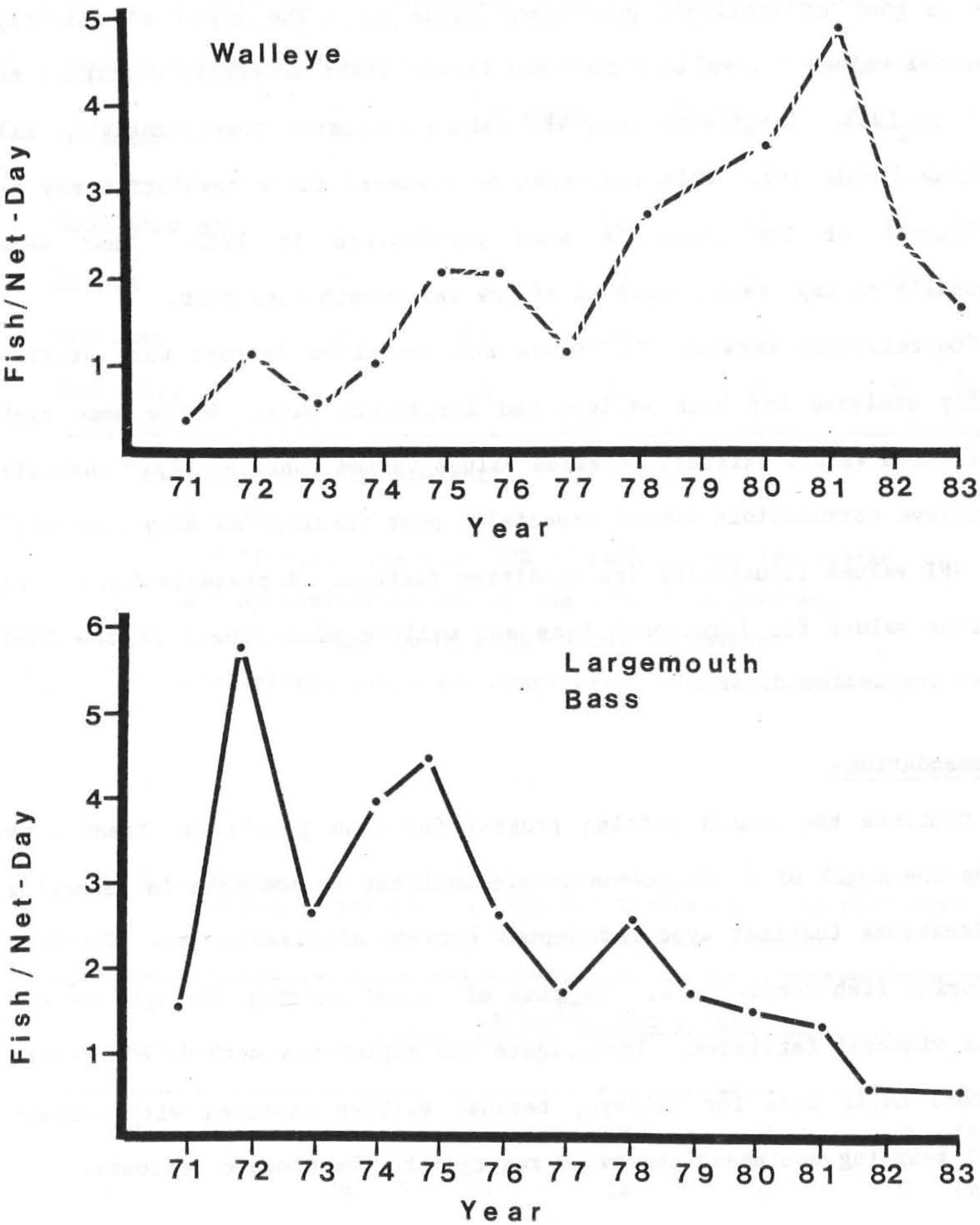

Figure 7. Catch rates (fish/net day) for walleye and largemouth bass from annual netting, Lake Powell, 1971-1983.

Visceral fat index (VFI) values indicated that walleye collected were in good to excellent condition (Table 9). The trend of slightly lower VFI values for walleye captured in the lower reservoir continued to exist in 1983. Largemouth bass VFI values decreased considerably at all stations (Table 10). This reduction in visceral fat accumulation may be the result of low threadfin shad populations in 1982. Shad were seasonally an important component of the largemouth bass diet.

Correlations between VFI values and condition factors were statistically analyzed for both walleye and largemouth bass. While some high correlation values existed, lakewide values varied considerably. Analysis of walleye correlations showed especially poor results, as many fish with high VFI values illustrated low condition factors. A presentation of VFI baseline values for largemouth bass and walleye will appear in the 1985 5-year completion report.

Recommendations

Continue the annual netting program for fish population trend data during the month of March. Remain as consistent as possible in selecting net locations (habitat type and depth) between all lake areas. Continue monitoring fish condition at the time of annual netting through the use of the visceral fat index. Investigate and employ new methods of obtaining food habit data for walleye, because walleye captured with conventional sampling equipment generally regurgitate the stomach contents.

Electrofishing

Methods

Electrofishing procedures were similar to those described by Gustaveson et al. 1980, with the exception of a new electroshocking

Table 9. Percent of total sample occurring in each category of the visceral fat index[a] (VFI) for walleye collected by gill netting during March 1983, Lake Powell.

Location	Visceral Fat Index 0	1	2	3	4	
Good Hope Bay	0	3	20	67	10	(n = 30)
Rincon	0	0	19	34	47	(n = 47)
San Juan	8	13	29	37	13	(n = 24)
Padre Bay	7	22	26	37	8	(n = 27)

[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 10. Percent of total sample occurring in each category of the visceral fat index (VFI) for largemouth bass collected by gill netting during March 1983, Lake Powell.

Location	Visceral Fat Index 0	1	2	3	4	
Good Hope Bay	45	46	9	0	0	(n = 11)
Rincon	38	50	12	0	0	(n = 16)
San Juan Arm	38	50	12	0	0	(n = 8)

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 the same as in 1982. Five stations were sampled for one night each, approximately one hour of electrofishing per station. The index of 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 2,536 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, the Rincon, Warm Creek, and the San Juan in descending order (Table 11). All stations nearly doubled last year's catch rate for all species except the San Juan where catch increased only slightly. This was primarily due to the substantial increase in catch of bluegill (*Lepomis macrochirus*) and green sunfish (*Lepomis cyanellus*), which collectively accounted for a large portion (69%) of the total catch in 1983. The high sunfish recruitment was apparently the result of flooding conditions inundating virgin soil and terrestrial vegetation, creating abundant nursery and escape cover. The 1983 flooding simulated filling conditions that existed prior to 1980 when Lake Powell first reached full pool. The last peak in catch rate for all species was also in 1980 (Figure 8). However, largemouth bass catch rates showed a substantial decrease at all stations in 1983 (Figure 9). They apparently did not benefit from flooded conditions and may have been limited by other factors such as low brood fish populations. The lowest catch rate

Table 11. Mean catch rate[a] (fish/hour) of fish collected by electrofishing, Lake Powell, August 1983.

Species	Good Hope Bay	Stanton Creek	Rincon	San Juan	Warm Creek	% of Total Catch
Young-of-the-year largemouth bass	32	110	79	18	64	11.3
Age I and older largemouth bass	12	30	24	2	7	2.8
Young-of-the-year black crappie	65	68	50	0	12	7.3
Young-of-the-year striped bass	136	30	32	0	1	7.4
Channel catfish	8	4	9	8	15	1.6
Green sunfish	190	189	283	194	24	32.9
Bluegill	201	281	119	56	318	36.5
Age I and older smallmouth bass	0	0	0	0	3	0.1
All species[a]	644	712	596	278	444	--

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

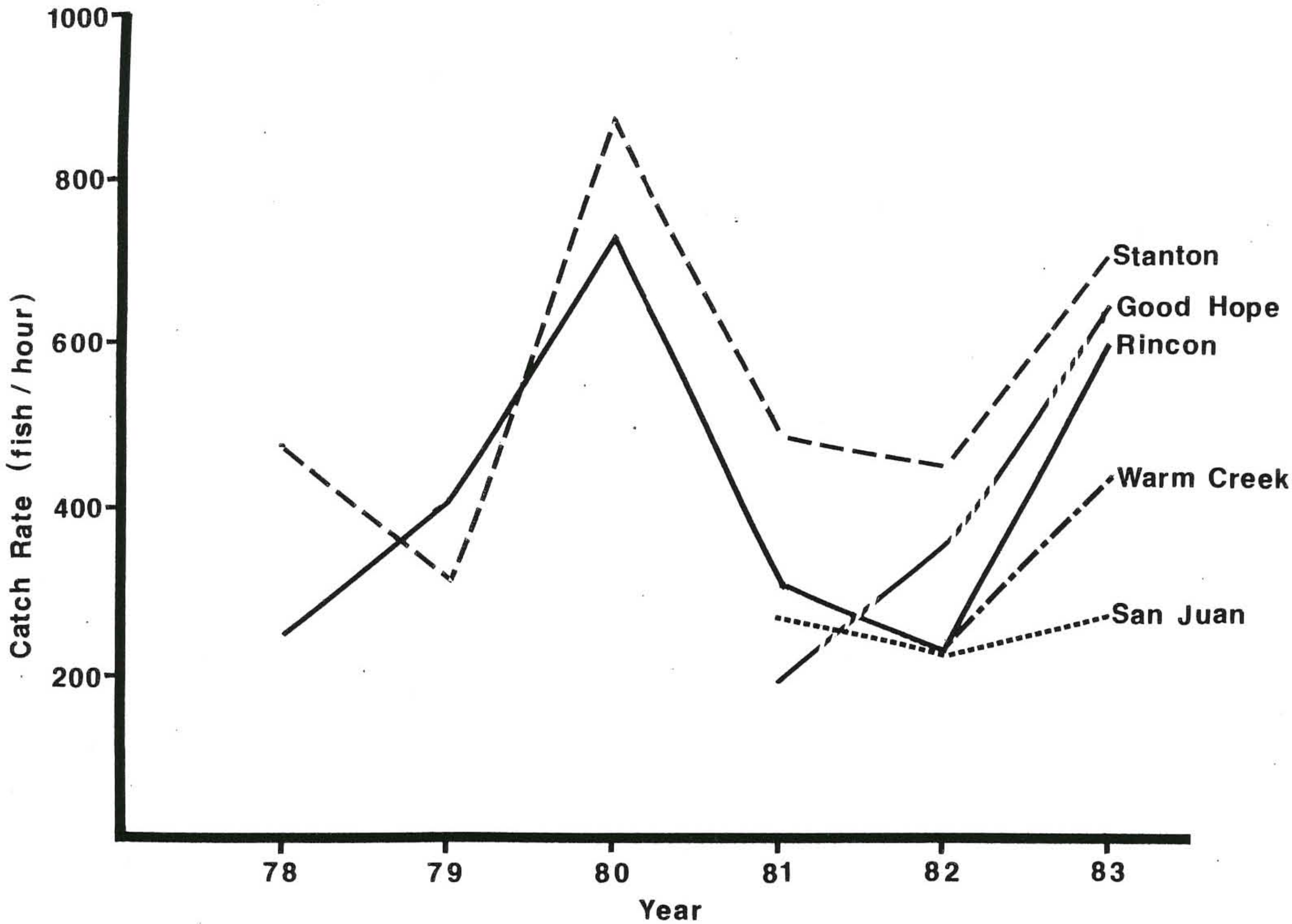

Figure 8. Mean catch rates (fish/hour) for all species collected by electrofishing, Lake Powell, August-September, 1978-1983.

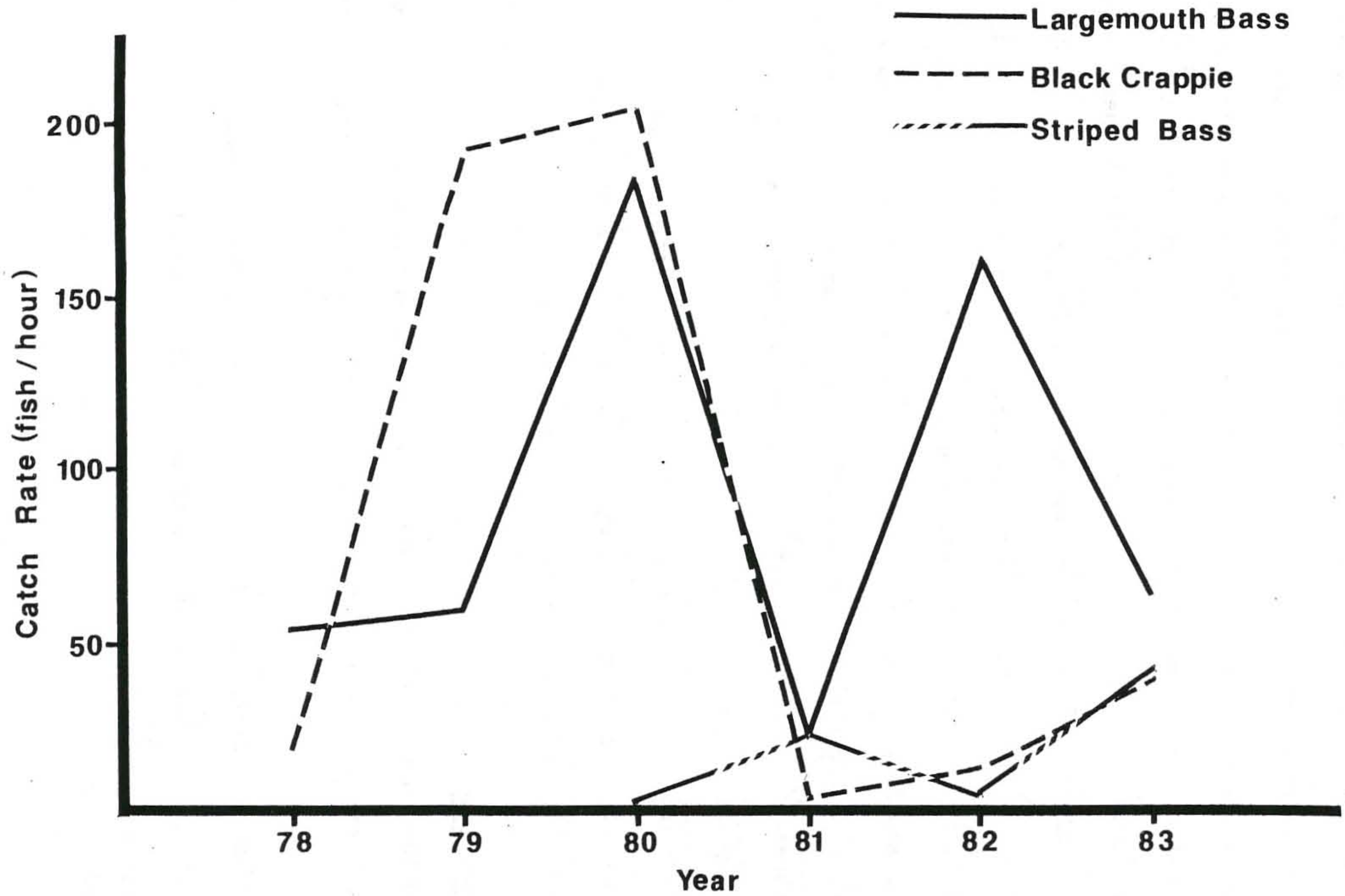

Figure 9. Mean catch rates (fish/hour) for largemouth bass, black crappie, and striped bass collected by electrofishing, Lake Powell, August-September, 1978-1983.

of largemouth bass in thirteen years of annual netting (Job III) suggests that the broodstock has reached extremely low numbers. However, it should be pointed out that young-of-the-year largemouth bass were readily observed along the shallow shoreline in 1983. It is possible that their true abundance was underestimated for reasons unknown at this time.

The overall catch rate for striped bass was the highest recorded since the electrofishing survey was initiated (Figure 9). Y-o-y STB were sampled at rates exceeding 130 fish/hour in the upper reservoir. No young-of-the-year smallmouth bass were collected this year, however, four yearling smallmouth bass were collected in Warm Creek Bay representing survival of 3,100 fish stocked in 1982. As in the past, large schools of adult threadfin shad were sporadically encountered at all stations, but were not quantitatively sampled.

Exploratory electrofishing for black crappie was conducted intermittently during May and June 1983. Only a few black crappie were collected and further exploration will be required.

Recommendations

Continue annual electrofishing during August-September 1984. Maintain 1983 sampling stations, which coincided with the annual netting sites.

Conduct electrofishing in the spring during black crappie spawning to explore possibilities of obtaining relative abundance estimates on this species.

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 in terms of striped bass caught per 1,000 square feet of gill net per 12 hour set. This enumeration is a standard method developed by the AFS Southern Division Striped Bass Committee (McCloskey 1980).

Striped Bass Spawning

Successful striped bass spawning apparently occurred in the upper reservoir, the San Juan Arm, and the lower reservoir near Glen Canyon Dam. Prespawning staging areas, which were identified in previous years, (Gustaveson et al. 1983) were again utilized in 1983. Mature adult striped bass were collected from staging areas at Gypsum Canyon (near the Colorado River inflow) and in Wahweap Bay (near the dam). A great difference was observed in gonadal development between fish from these two areas. Female striped bass collected in the forage-rich upper reservoir showed normal ovarian development, while mature females collected near the dam were found to have a high incidence of atrophied or undeveloped ovaries.

This difference in development was directly correlated with physical condition of adult striped bass (four years and older) during the spring of 1983. Average K factor of adult striped bass found near Gypsum Canyon was 1.38, while K factors of adult fish collected near the dam averaged only 0.89. Due to poor condition during the normal spawning period in May, less than half of the mature females observed in the lower reservoir appeared capable of spawning viable eggs. Mature males four years and older had low K factors similar to the mature females. The faster maturing 2-3 year old males, however, exhibited normal gonadal development.

The peak spawning period was apparently delayed until near 1 June 1983 by cooler than normal water temperatures caused by high snowmelt runoff in May. Ripe females were first observed on 26 May 1983 and the first spent female was not collected until 7 June 1983. Thus, spawning was assumed to have occurred during late May and early June throughout the length of the reservoir. Floating egg masses or other evidence of spawning, however, was not detected near either staging area during 1983.

Physical Condition

A distinct difference in physical condition existed between adult and juvenile striped bass throughout most of the reservoir in 1983. Mature adult fish (TL exceeding 600 mm) consistently exhibited a K factor of near 0.90 during the spring and summer. Juveniles and young mature males (TL less than 600 mm) maintained substantially higher K factors during the same period of time (Figure 10). Adult striped bass condition factor improved as y-o-y shad began contributing to their diet in the fall. By October the average K factor for adult fish had increased to 1.04, but adults larger than 600 mm were not abundant and seldom sampled. It appeared that a significant decrease in numbers of striped bass exceeding 600 mm in TL occurred during the summer.

Environmental factors, such as forage availability and thermal tolerance of adult striped bass, are apparently limiting adult striped bass survival in Lake Powell. These conditions act to effectively separate adult fish from their prey during the summer and, consequently, lower their general condition (see Job I). These environmental factors, however, favor the proliferation of subadult fish. Young striped bass are able to utilize plankton to supplement their shad diet. Their less specific thermal tolerance also allows them to forage in the warm thermal zone occupied by the bulk of the shad population during the heat of summer in the stratified reservoir.

Annual Gill Net Sampling

November gill net sampling provided evidence that striped bass natural reproduction was substantial in 1983 despite poor physical

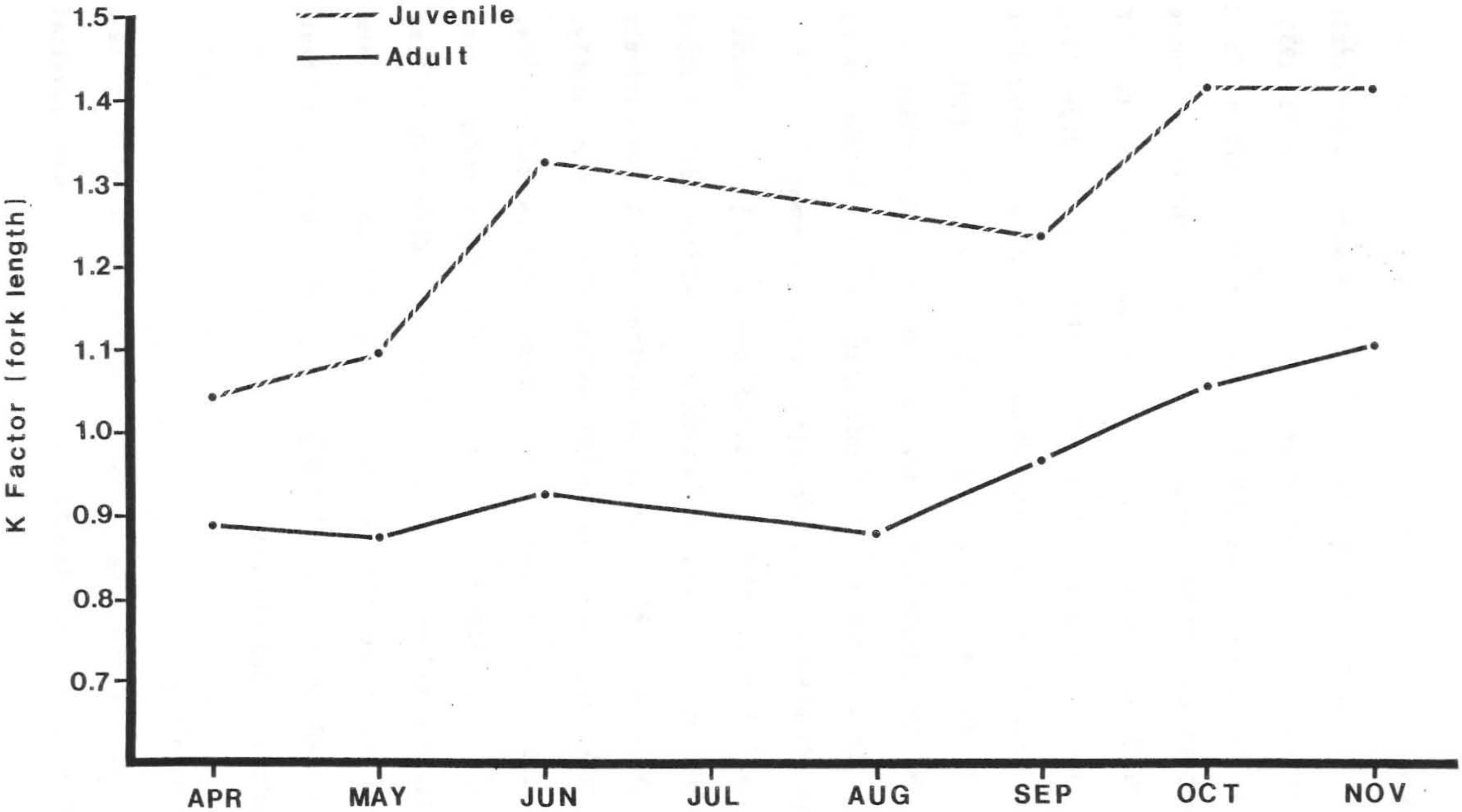

Figure 10. Monthly condition factor of adult striped bass (> 600 mm) and juvenile striped bass (< 600 mm), Lake Powell, 1983.

condition of the broodstock prior to the spawning season. Y-o-y were caught at the rate of 3.19 fish/1,000 square ft of gill net/12 hour set in the upper reservoir, 0.19 midreservoir, and 2.24 in the lower reservoir (Table 12). The distribution of y-o-y suggested that lacustrine spawning again occurred near Glen Canyon Dam in 1983 as well as in the upper reservoir (Gustaveson et al. 1983; Gustaveson et al., in press). Fish spawned in the Colorado River and distributed through the lake by the intense flood waters entering Lake Powell in 1983 would have been found in decreasing numbers as distance from the inflow increased. There is no reason for the bimodal distribution of y-o-y at opposite ends of the reservoir observed in 1983, unless reproduction occurred at both locations.

The survey identified a strong carryover population of one and two year old striped bass at all sampling locations. Fish density was again strongest at the stations nearest the inflow and at the dam (Table 12). Striped bass older than three years of age were not common in the gill net samples and lend further support to the premise that older fish have decreased in abundance.

The high catch rate during 1983 of yearling striped bass from the 1982 cohort was surprising due to the low catch rate of that cohort in 1982 (Table 13). It is apparent that the 1982 year class was initially underestimated. Actual 1982 year class strength was greater than the bumper crop of striped bass produced in 1981. The lack of shad forage in 1982 may have forced the y-o-y striped bass into the pelagic zone to forage on plankton, excluding them from our shoreline gill net sample.

Table 12. Striped bass caught per 1,000 square feet of gill net per 12 hour set during fall sampling on Lake Powell, 1983.

Sample Location	Age				Total Catch
	0+	1+	2+	Older	
Good Hope	4.11	0.58	4.95	0.47	4.91
Rincon	0.19	1.48	0.81	0.10	2.58
San Juan Arm	1.62	1.76	2.33	0.33	6.04
Wahweap	2.24	3.43	1.48	0.00	7.15
Average catch	1.81	3.44	2.48	0.22	

[a]Standard method after McCloskey, 1980.

Table 13. Relative abundance of striped bass year classes expressed as fish caught per 1,000 square feet of gill net per 12 hour set during fall sampling on Lake Powell, 1981-1983.

Year Class	1981	1982	1983
Abundance at age			
0+	2.88	0.45	1.81
1+	2.55	3.44	
2+	2.48		

The recovery of the shad population in 1983, however, allowed the 1982 cohort to forage in the limnetic zone and enabled them to be sampled at rates more indicative of their true abundance. Because yearling striped bass seem most vulnerable to our gill netting survey, the relative abundance of yearling fish is probably the most reliable estimate for year-to-year comparison.

Reproduction of striped bass apparently occurred in the San Juan Arm in 1983, but whether the site was lacustrine or riverine is uncertain. The gill net survey showed the San Juan to be well stocked with the three youngest cohorts of striped bass in fall of 1983 (Table 12).

The high relative abundance of age 0, 1, and 2 striped bass, combined with the decline in abundance of older fish, suggest the need to harvest the small fish before they overburden the recovering shad population. The striped bass limit was raised from four fish to six fish in 1984. With the abundance of small fish found in gill net samples it is possible that striped bass creel limits should be relaxed even further. By encouraging the harvest of small striped bass it is hoped that we may offset another decline in physical condition, such as was observed in the adult striped bass in 1983.

Growth

The oldest striped bass in the reservoir continued to increase in size. The lake record was bested twice in 1983 with a 31 pound 7 ounce striped bass taken in July, followed by a 36 pound 6 ounce fish in December. Both fish were estimated to be nine years old and resulted from the original stocking of striped bass in 1974.

Growth rate of 0 age striped bass in 1983 was essentially the same as observed in 1982 (Table 14). Fish from the inflow area grew somewhat slower than in previous years probably as a result of increased intraspecific competition.

Age 1 fish sampled in 1983 had an average TL of 345 mm whereas age 2 fish averaged 488 mm. As striped bass population levels have increased, growth appears to have slowed. A comprehensive age and growth summarization will be included in the 1984 5-year completion report.

Table 14. Average total length (mm) of young-of-the-year striped bass collected during annual fall gill netting, Lake Powell, 1981-1983.

	1981 (n)	1982 (n)	1983 (n)
Good Hope Bay	288.16 (77)	208.60 (10)	200.75 (55)
Rincon	239.29 (11)	247.00 (3)	209.33 (3)
San Juan	202.67 (6)	179.81 (21)	195.00 (34)
Wahweap	199.78 (124)	170.30 (3)	184.00 (47)
Weighted average	233.07	192.27	194.27

Recommendations

1. Monitor adult striped bass population to determine overwinter survival, physical condition, gonadal development, and distribution, particularly during thermal stratification.
2. Determine mechanism that allows lacustrine reproduction in Lake Powell. To successfully complete this objective, a school of spawning striped bass must be located and the eggs sampled until hatching occurs.
3. Quantify spawning success and recruitment with fall gill netting.
4. Complete an age and growth survey of striped bass collected during the past decade for inclusion in next year's completion report.
5. Continue tagging striped bass to determine long range movement and distribution throughout the reservoir.

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