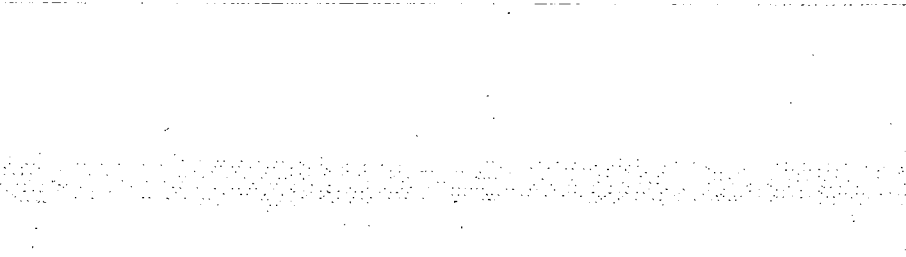


# Colorado River Research Program

REPORT SERIES  
GRAND CANYON NATIONAL PARK

United States  
Department of the Interior  
National Park Service

C-14



**COLORADO RIVER RESEARCH PROGRAM**  
Grand Canyon National Park  
Grand Canyon, Arizona 86023

The Colorado River Research Program was initiated by the National Park Service in 1974 to secure scientific data to provide a factual basis for the development and the implementation of a plan for appropriate visitor-use of the Colorado River from Lee's Ferry to Grand Wash Cliffs and for the effective management of the natural and cultural resources within the Inner Canyons. The intensified research program consists of a series of interdisciplinary investigations that deal with the resources of the riparian and the aquatic zones and with the visitor-uses including river-running, camping, hiking, and sight-seeing of these resources, as well as the impact of use and upstream development upon canyon resources and visitor enjoyment.

Final reports that result from these studies will be reproduced in a series of Program Bulletins that will be supplemented by technical articles published as Program Contributions in scientific journals.

Merle E. Stitt, Superintendent  
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SUMMER DISTRIBUTION AND REPRODUCTIVE STATUS OF FISH  
OF THE COLORADO RIVER IN GRAND CANYON NATIONAL PARK  
AND VICINITY, 1975

C. O. Minckley and Dean W. Blinn  
Technical Report No. 14

Grand Canyon National Park  
Colorado River Research Program  
Contribution Number 42

SUMMER DISTRIBUTION AND REPRODUCTIVE STATUS  
OF FISH OF THE COLORADO RIVER AND ITS TRIBUTARIES  
IN GRAND CANYON NATIONAL PARK  
AND VICINITY DURING 1975

Submitted to  
GRAND CANYON NATIONAL PARK  
NATIONAL PARK SERVICE  
DEPARTMENT OF THE INTERIOR

by

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June 1976

The research described in this report  
was supported by funds provided by  
the National Park Service under  
contract number CX821060008

## ABSTRACT

A survey of the fish of the Colorado River from Lee's Ferry to Diamond Creek was made during the summer of 1975. The objectives of the survey were to determine summer distribution and the general reproductive status of fish present in the Colorado River and its major tributaries. A total of 22 areas were surveyed during July and August, 1975 with ten species of fish being collected. Of these species 40 per cent were native, and ranked in order of abundance as: speckled dace, Rhinichthys osculus; bluehead sucker, Pantosteus discobolus; flannelmouth sucker, Catostomous latipinnis; and bonytail chub, Gila elegans. The remaining fish were exotic and were ranked in order of abundance: fathead minnows, Pimphales promelas; Rio Grande killifish, Fundulus zebrinus; rainbow trout, Salmo gairdneri; carp, Cyprinus carpio; channel catfish, Ictalurus punctatus and the black bullhead, I. melas.

Reproduction was verified in all native species by the collection of young-of-the-year fish. All native fish were considered common throughout the area with the exception of the bonytail chub which was rare and with a localized population in the vicinity of the Little Colorado River. Exotic fish, although collected in smaller numbers were also considered to be distributed throughout the system. Reproduction in three exotic forms was verified by collection of juveniles of fathead minnows, Rio Grande killifish and rainbow trout. Tapeats Creek and Bright Angel Creek were considered to have reproducing populations of rainbow trout based on our data. Spawning is also suspected in the remaining species of exotic fish however, it was not verified.

Native fish with the exception of the bonytail chub were more abundant, both in total numbers and in localities collected than exotic fish. Populations of native fish appear to be similar to population levels in 1968. All fish were examined for ectoparasites and found to be negative. Recommendations pertaining to further research and providing information to visitors on endangered species were provided to aid in preservation of the rare or endangered species present in Grand Canyon National Park.

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## INTRODUCTION

The ichthyofauna of the Colorado River within the regions of Marble and Grand Canyons has become increasingly well known during recent years. Miller (1944) provided an initial checklist of fishes; currently updated (Miller, 1975), from this region as well as describing one of the more bizarre appearing fish, the humpback chub from the mouth of Bright Angel Creek (Miller, 1946). More recently published information have included systematic works on species occurring in the Grand Canyon (Holden and Stalnaker, 1970), distributional studies (Holden and Stalnaker, 1975), and more general works including information on life histories, taxonomy, and distribution of Grand Canyon fish (Minckley, 1973). Numerous other unpublished reports are also available (e.g. Miller, 1975; Suttkus, 1975) and provide information on the species collected and reproductive information.

This report summarizes and discusses data collected during the summer of 1975 and provides preliminary observations on the reproductive status and distribution of fish. Information is presented as a list of localities where collections were made, species taken, and reproductive information. The species collected are presented individually and later combined to provide an overview of the fisheries present in Grand Canyon National Park and vicinity.

Numerous people were involved in the collection of fish during the summer of 1975. Dr. R.R. Miller and Francis H. Miller, University of Michigan, and Bob L. Minckley, Arizona State University, assisted in collecting during the July trip. Mr. Joe E. Bartoszek, Northern Arizona University assisted during the August survey. Both trips were made with the Museum of Northern Arizona Ecological Survey, and several members of that group were involved in collecting efforts; their assistance was appreciated.

## RESULTS

Fish were collected by seining numerous tributaries and occasionally the main river. A total of 22 areas were surveyed using either 6.5 m X 1.5 m X 6 mm or 3.0 m X 1.0 m X 6 mm mesh seines. Fish were preserved in 10% formalin upon capture and later stored in 50% isopropanol. All fish were measured to the nearest millimeter and were examined for ectoparasites. All lengths used in this report refer to total lengths.

Ten species of fish were taken during these trips (Table 1) and are presented with comments on where they were collected,

Table 1. Fish collected at the confluence of major tributaries and the Colorado River in Grand Canyon National Park and vicinity (1975).

LOCALITY	<u>Salmo gairdneri</u> (Rainbow Trout)	<u>Rhinichthys osculus</u> (Speckled Dace)	<u>Gila elegans</u> (Bonytail Chub)	<u>Pimephales promelas</u> (Fathead Minnow)	<u>Cyprinus carpio</u> (Carp)	<u>Catostomus latipinnis</u> (Flannelmouth Sucker)	<u>Ictalurus melas</u> (Black Bullhead)	<u>Pantosteus discobolus</u> (Bluehead Sucker)	<u>Ictalurus punctatus</u> (Channel Catfish)	<u>Fundulus zebrinus</u> (Rio Grande Killifish)
Paria River	-	6	-	-	-	-	-	-	-	-
Tatahatso Wash	-	-	-	-	-	-	8	-	-	-
Nankoweap Creek	-	200	-	-	-	-	6	-	-	-
Little Colorado River	-	-	15*	1	-	1	-	-	-	2
Carbon Creek	-	-	-	34	-	-	4	-	-	-
Chuar Creek	-	111	-	1	-	-	3	-	-	-
Lava Creek	-	49	-	1	-	-	4	1	-	-
Unkar Creek	-	39	-	-	-	-	-	-	-	-
Bright Angel Creek	1	43	-	-	-	-	-	-	-	-

Table 1. (Continued)

LOCALITY	<i>Salmo gairdneri</i> (Rainbow Trout)	<i>Rhinichthys osculus</i> (Speckled Dace)	<i>Gila elegans</i> (Bonytail Chub)	<i>Pimephales promelas</i> (Fathead Minnow)	<i>Cyprinus carpio</i> (Carp)	<i>Catostomus latipinnis</i> (Flannelmouth Sucker)	<i>Ictalurus melas</i> (Black Bullhead)	<i>Pantosteus discobolus</i> (Bluehead Sucker)	<i>Ictalurus punctatus</i> (Channel Catfish)	<i>Fundulus zebrius</i> (Rio Grande Killifish)
Pipe Creek	-	55	-	2	-	2	3	-	-	3
Hermit Creek	-	48	-	-	-	-	1	-	-	-
Crystal Creek	-	69	-	1	1	4	5	-	-	5
Shinumo Creek	-	84	-	-	-	21	27	-	-	-
River Mile 112	-	8	-	-	-	-	1	-	-	-
Elves Chasm	3	77	-	12	-	3	5	-	-	1
Tapeats Creek	14	-	-	-	1	3	-	-	-	-
Deer Creek	-	19	-	-	-	5	5	-	-	-
Stone Creek	3	14	-	-	-	-	-	-	-	1
Kanab Creek	-	30	-	2	-	17	-	-	4	-

Table 1. (Continued)

LOCALITY	<i>Salmo gairdneri</i> (Rainbow Trout)	<i>Rhinichthys osculus</i> (Speckled Dace)	<i>Gila elegans</i> (Bonytail Chub)	<i>Pimephales promelas</i> (Fathead Minnow)	<i>Cyprinus carpio</i> (Carp)	<i>Catostomus latipinnis</i> (Flannelmouth Sucker)	<i>Ictalurus melas</i> (Black Bullhead)	<i>Pantosteus discobolus</i> (Bluehead Sucker)	<i>Ictalurus punctatus</i> (Channel Catfish)	<i>Fundulus zebrius</i> (Rio Grande Killifish)
Havasu Creek	2	10	-	-	-	6	-	-	-	-
Parashont Wash	-	8	-	7	-	13	37	-	-	6
Diamond Creek	-	37	-	-	-	-	-	-	-	-

\* Released 57 *Gila elegans*.

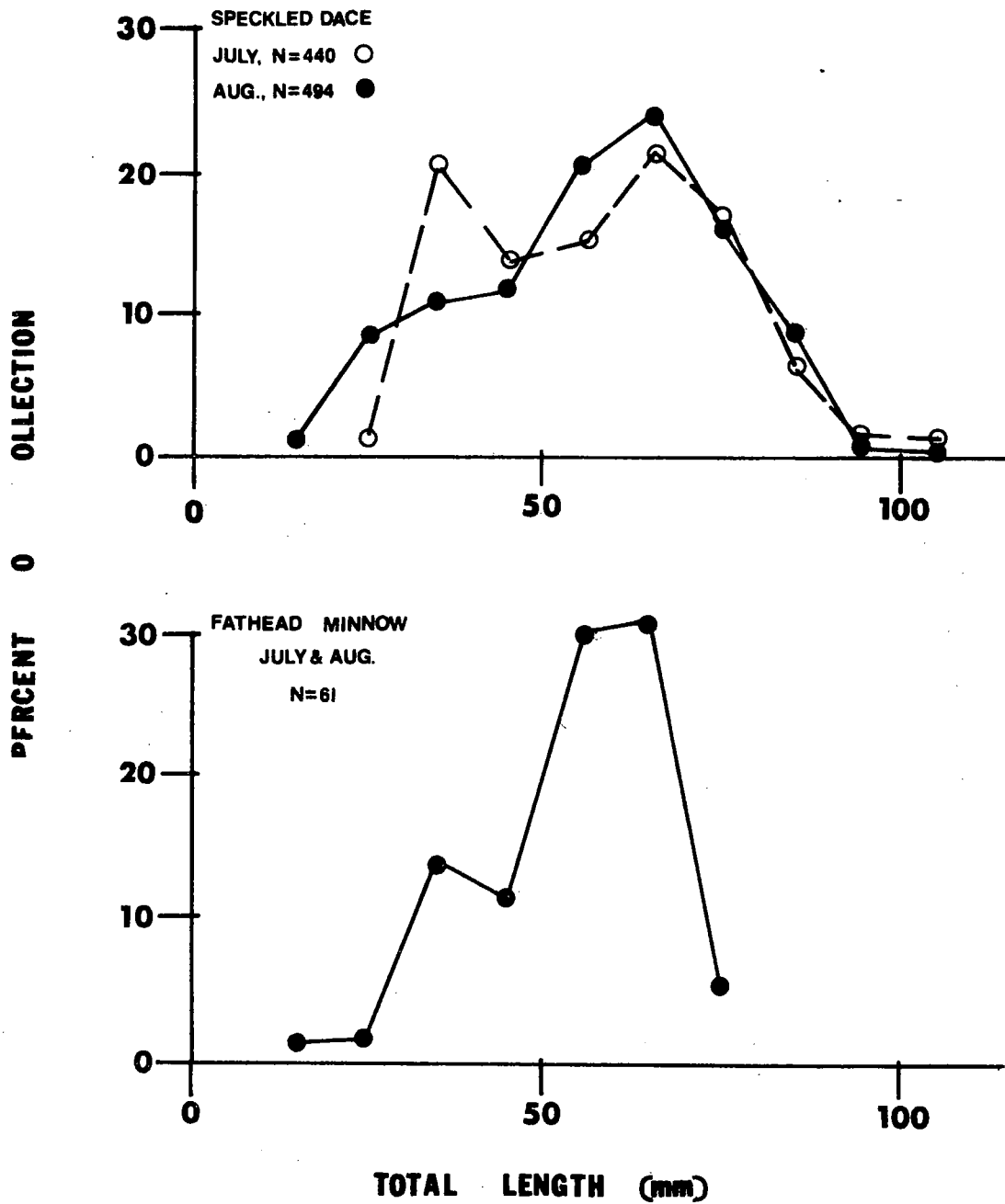
their size ranges and mean lengths, per cent of juveniles present, per cent localities taken from, with length frequency diagrams of selected species.

Sixty per cent of the species taken during this survey were introduced or exotic fish representing four families. The family Salmonidae was represented by rainbow trout; Ictaluridae by channel catfish and black bullheads; Cyprinidae by carp and fathead minnows and the family Cyprinodontidae by the Rio Grande killifish.

The fathead minnow was collected in 40.9% of the areas surveyed and represents the most commonly encountered exotic. It also was the fourth most collected species from the Grand Canyon (Table 3). Field observations and a later analysis of collections revealed fish in spawning condition at numerous tributaries including Carbon, Chuar, Garden, Crystal and Elves Chasm Creeks. Young-of-the-year fathead minnows were collected at Carbon, Lava, Garden, Elves Chasm and Kanab Creeks and Parashont Wash. Figure 1 presents the length frequencies of this species illustrating numerous fry (<50 mm in length) were present. Table 2 also reflects this as the per cent of juveniles present was 29% and 28% for July and August respectively. Also, mean lengths decreased slightly in August (Table 2) reflecting recruitment of smaller individuals into the population. Based on these numerous collections it appears that this species occurs throughout the system being maintained by reproduction and perhaps by an occasional bait bucket introduction.

The Rio Grande killifish was collected throughout most of the Grand Canyon. It was the second most encountered exotic and occurred at 31.8% of the collecting areas (Table 3). This species was taken in reproductive condition at the Little Colorado River, Garden, Crystal, Elves Chasm, Stone and Chuar Creeks. Juvenile killifish were collected at Garden, Crystal, Chuar Creeks and Parashont Wash during the summer of 1975. As with the fathead minnow, the mean size of killifish taken decreased from July to August although the per cent of juveniles present in the collections remained high and essentially identical.

Rainbow trout have been stocked for many years in numerous tributaries of the Grand Canyon (Key, 1965; Minckley, 1973; Mulch and Gamble, 1956) although in recent years this practice has been discontinued, at least by Arizona Game and Fish Department (Dave Bancroft, pers. comm.). As a result of these previous stockings, several tributaries within Grand Canyon now support reproducing populations of this gamefish. Tapeats Creek was found to be in this category based on collections of juveniles during this survey (Table 2). Bright Angel Creek also supports such a fishery



**FIGURE 1. LENGTH FREQUENCY DIAGRAMS FOR SPECKLED DACE & FATHEAD MINNOW.**

Table 2. Mean total lengths, ranges and per cent of juveniles for seven species of fish collected from Grand Canyon National Park and vicinity during the summer of 1975 (Ranges are in parenthesis ).

Species	JULY			AUGUST		
	Mean Total Length (mm)	N	% Juveniles	Mean Total Length (mm)	N	% Juveniles
Rainbow Trout	105.7 (62-243)	10	90.0	128.4 (84-240)	12	83.0
Speckled Dace	47.9 (11-109)	494	50.2	65.2 (26-109)	440	50.9
Fathead Minnow	56.2 (44-68)	35	28.5	50.6 (10-71)	26	26.9
Flannelmouth Sucker	106.1 (48-237)	6	83.0	79.4 (33-350)	44	93.8
Bluehead Sucker	107.9 (30-300)	19	92.8	82.4 (33-255)	93	96.2
Channel Catfish	-	-	-	273.0 (222-335)	4	-
Rio Grande Killifish	47.4 (18-69)	7	51.1	40.0 (26-71)	14	57.4

Table 3. Per cent occurrence of fish collected from twenty-two areas surveyed in Grand Canyon National Park during the summer of 1975.

Combined Species	Introduced Species	Native Species
Speckled Dace (86.5%)	Fathead Minnow (40.9%)	Speckled Dace (86.5%)
Bluehead Sucker (68.1%)	Rio Grande Killifish (31.8%)	Bluehead Sucker (68.1%)
Flannelmouth Sucker (45.0%)	Rainbow Trout (23.6%)	Flannelmouth Sucker (45.0%)
Fathead Minnow (40.9%)	Carp (9.0%)	Bonytail Chub (4.5%)
Rio Grande Killifish (31.8%)	Channel Catfish (4.5%)	
Rainbow Trout (23.6%)	Black Bullhead (4.5%)	
Carp (9.0%)		
Bonytail Chub (4.5%)		
Channel Catfish (4.5%)		
Black Bullhead (4.5%)		

based on 1976 collections. More extensive collecting will undoubtedly reveal several other drainages with reproducing populations of rainbow trout, however summer data currently fails to indicate this.

Table 1 indicates small numbers of rainbow trout were collected from five areas within Grand Canyon during the summer of 1975. The numbers taken do not reflect the population size as rainbow trout are commonly stocked both above and below the Grand Canyon by the respective Fish and Game Departments of Arizona, Nevada, and Utah. Also, heavy use of tributaries has been observed by Northern Arizona University personnel during spawning season suggesting a large population of trout to be present.

The ubiquitous carp was taken in small numbers (Table 1) and was the fourth most commonly encountered exotic, although one of the least encountered fish. Only moderately sized individuals were taken (e.g. 1/2 kg.) and no actual indication of reproduction was observed, although it is expected.

Members of the family Ictaluridae, the channel catfish and black bullhead, were collected from two widely separated areas of the Grand Canyon (Table 1) and have one of the lowest per cent of occurrences both of introduced species and of all species collected (Table 3). Mean total length and ranges for the channel catfish are presented in Table 2. All specimens of channel catfish and black bullhead were adults, capable of reproduction although no such activity was apparent. It is quite likely that reproduction occurs in both of these species within the Grand Canyon.

The remaining species are native to the Southwest and represent two families: the Cyprinidae including the speckled dace and bonytail chub, and the Catostomidae represented by the bluehead and flannelmouth suckers. The most abundant species was the speckled dace which is considered to be distributed throughout the river as it was collected from 86.5% of the areas surveyed. It ranked as the most commonly collected native fish and the most frequently encountered species (Table 3). Reproduction in speckled dace is apparent, as slightly over 50% of the collections made during the summer were comprised of juveniles (<60 mm in length). The presence of juveniles is also illustrated in Figure 1 where numerous smaller fish are present during the months sampled. This figure also reflects growth between months as suggested by the increase in numbers of individuals between 50 and 65 mm in length during August. The same trend of increase in mean length between months is also apparent in this species (Table 3). As a large series of speckled dace were collected, it is felt that these data reflect what was occurring in this population, at least during the summer, in Grand Canyon National Park.

The bluehead sucker occurred in 68.1% of the collections and

was the second most encountered native fish, being second in overall ranking (Table 3). Numerous juveniles (<150 mm) were taken (Figure 2) indicating successful reproduction had occurred. Table 2 also presents information pertaining to reproduction illustrating again a size decrease into August and that the percentage of juveniles was high.

The flannelmouth sucker, although not as abundant as the previous species still ranks third in overall abundance and in occurrence of native fish. This sucker exhibits a trend similar to the bluehead sucker as mean size decreased from July to August and the per cent of juveniles (<150 mm) remained similar. Figure 2 illustrates the presence of many young individuals of this species and few adults. Flannelmouth suckers are also considered common throughout the Grand Canyon as reflected by these data.

The fourth species of native fish taken was the bonytail chub which was taken only at the Little Colorado River (Table 1) and is, apparently quite rare throughout the Grand Canyon. Fish collected during July were 140-200 mm (ca.) in length while specimens taken during August were an estimated 60-100 mm in length. This species is one of the least collected fish as reflected by its ranking (Table 3). No adults of this species were collected or observed.

#### SUMMARY AND CONCLUSIONS

The native aquatic fauna of the American Southwest is becoming increasingly depauperate as the demand for more recreational and commercial use of aquatic systems increase. This is markedly apparent in fish and is becoming increasingly well documented (Miller, 1961; Minckley, 1973; Minckley and Deacon, 1968; Deacon and Minckley, 1974).

Grand Canyon National Park represents one of the few remaining refugia for several unique species of native fish as well as other distinct flora and fauna of the southwest. Forty per cent of the ichthyofauna collected were native fish representing, in order of abundance; the speckled dace, Rhinichthys osculus; bluehead sucker, Pantosteus discobolus; flannelmouth sucker, Catostomous latipinnis; and the bonytail chub, Gila elegans. All of these species, with the exception of the bonytail chub, were found to occur in many areas of Grand Canyon National Park and are considered common throughout the region. Interestingly enough, more native fish were taken than exotic fish, both in actual numbers and total collecting localities (Table 3).

Reproduction illustrated by the per cent of occurrence of smaller individuals (Figures 1 and 2) and per cent of juveniles

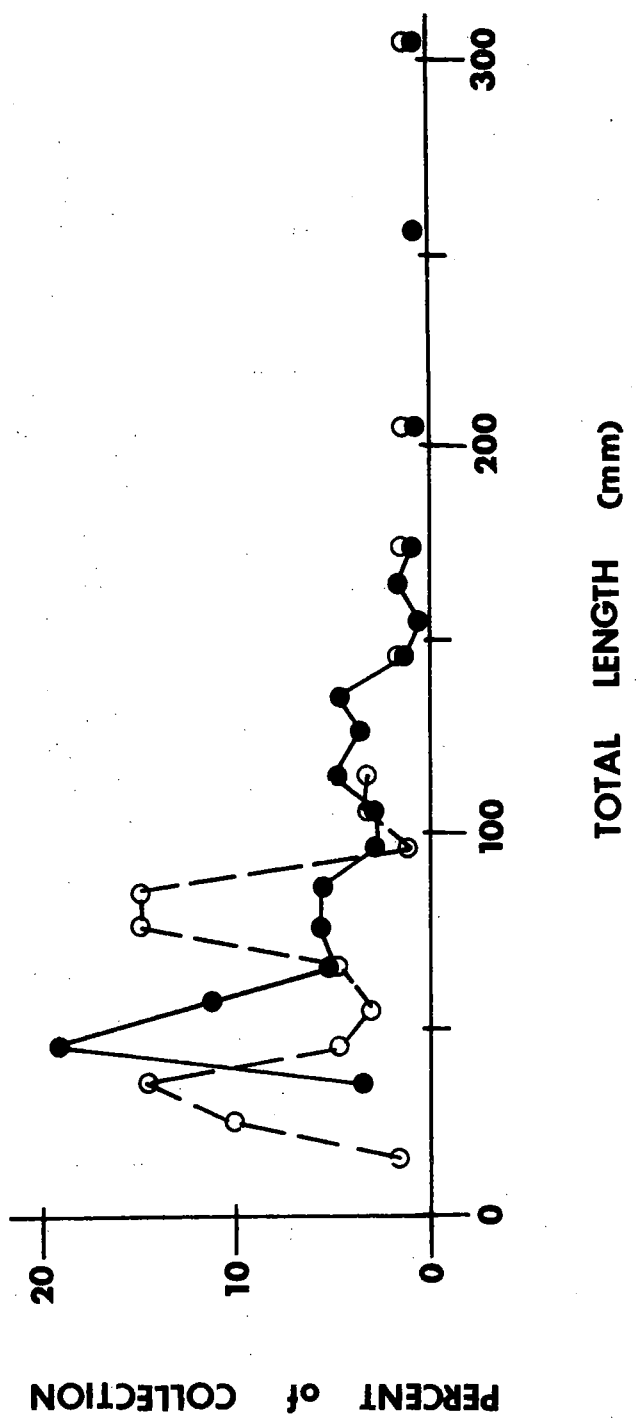


FIGURE 2. LENGTH FREQUENCY DIAGRAM FOR THE BLUEHEAD SUCKER (●, N=112) AND FLANNELMOUTH SUCKER (○, N=50). FEW SUCKERS WERE COLLECTED OVER 200mm TOTAL LENGTH.

in the collections (Table 2) was also established for the three more common native fish. Reproduction was also suggested by apparent recruitment of smaller individuals in both species of suckers, resulting in a decrease in mean total length.

9-10

The bonytail chub appears restricted to the vicinity of the Little Colorado River based on our data. Judging from the numbers of juveniles taken during the summer, it is apparent that the Little Colorado River is used as a spawning area by bonytails. There are several possible reasons for this. This river may represent the only suitable spawning habitat left in the area, and it is probable that the higher water temperatures and relative lack of turbulence also attracts these fish. It is also possible that some preferred food source is available to juveniles in this region although this cannot be determined from existing data (Czarnecki et al., 1976), as the food habits of juvenile bonytails are poorly known (Vanicek and Kramer, 1969) and no food analysis of this population has been made.

10

The fact that this species is considered rare (Miller, 1972) makes it imperative that a series of adults be taken, for propagation purposes and that this region be maintained as a refugia for this species. The possibility of the humpback chub, an endangered species, using the Little Colorado River should not be disregarded as most extant specimens came from the vicinity (Miller and Smith, 1972). If present in this area, specimens should also be taken for brood stock. As the humpback chub readily hybridizes with bonytail chubs (Holden and Stalnaker, 1970), an analysis of the Little Colorado population should also be undertaken to prevent the securing of hybrids for propagation. This problem, if it exists in this population, could easily be avoided by taking only adult fish, which are quite distinctive.

The remaining, and larger percentage of species, are introduced fish. Their ranking, in order of abundance is fathead minnows, Pimephales promelas; Rio Grande killifish, Fundulus zebrinus; rainbow trout, Salmo gairdneri; carp, Cyprinus carpio; channel catfish, Ictalurus punctatus and black bullheads, I. melas. Although relatively small numbers of all introduced species were taken, their summer distribution appears to be throughout the Grand Canyon.

5

Reproduction was illustrated in the fathead minnow through the use of length frequency diagrams (Fig. 1), per cent of juveniles in collections (Table 2), and by condition of the fish collected. Reproduction in the Rio Grande killifish and rainbow trout was established by illustrating the high percentage of juveniles per collection and by the drop in mean size after recruitment of juveniles into the population (Table 2). The remaining species of exotic fish are thought to reproduce in the

Grand Canyon, but no evidence for it was apparent based on our collections.

Competitive interaction between exotic and native fish generally results in the eventual extirpation of the native fauna or a drastic reduction in numbers (Deacon and Minckley, 1974). Although little is known about such interactions between Grand Canyon fish, it appears that most species of native fish are currently holding their own and are at levels similar to those of 1968 (Miller, 1975). The bonytail chub is apparently declining in numbers, however the reasons for this are not apparent from our samples. One factor definitely not affecting native fish in the Grand Canyon are ectoparasites, a factor which affects other native fish populations (James, 1968; Wilson et al., 1967). It is thought possible that reproductive interactions (both temporal and spatial) may occur as well as competition for some food substrate, however until further information is available, such interactions can only be inferred.

## RECOMMENDATIONS

Studies on the fish of the Grand Canyon and vicinity have been increasing in recent years and are still apparently in the survey stage. It is recommended that further studies be initiated to better define the relationships, both intra and interspecific, of the fish occurring in the region. This would include systematic surveys of selected creeks, possibly in the vicinity of Phantom Ranch, on a monthly basis and the collection of fish for analysis of food habits, general condition and reproductive condition. It is also suggested that four trips from Lee's Ferry to Pierce's Ferry be made, again to analyze the fish population as suggested and to attempt to arrive at an overview of what is occurring in the Grand Canyon and its tributaries. These trips would be seasonal e.g. summer, fall, winter, and spring.

To supplement data obtained, benthic samples would be taken at each tributary collected to aid in the identification of stomach contents and to help define key tributaries and why they are utilized by certain fish.

It is also recommended that immediate efforts be made to obtain a brood stock of the bonytail chub from the Little Colorado River. It is suggested twenty or more adult individuals be taken and placed at Willow Beach National Fish hatchery for the purpose of maintaining the species. It is also recommended that similar measures be taken for the humpback chub, if collected, to preserve this endangered species.

In order to insure that no rare or endangered fish are destroyed by anglers, it is proposed that a program designed to inform anglers and other visitors be implemented by the National Park Service. This could be accomplished by distribution of a comprehensive brochure on rare or endangered species to commercial and private boat trips and by making such brochures available at all access points to the Grand Canyon. It is also suggested that a brief description of the endangered forms present within the Grand Canyon be included in the presentations given on the rim to inform the general visiting public of these unique species. It is recommended that a brief film strip (15 minutes) be developed on this subject and that it be made required viewing by all persons prior to river trips. This film could cover basic river safety and some of the common hazards, as well as inform the public about the endangered or rare forms of wildlife present in the Grand Canyon including the peregrine falcon, humpback chub, and bonytail chub. By raising visitor awareness to the problem of rare or endangered species, the survival of some of these forms may be accomplished as, for instance, the angler will know enough to record and release the humpback chub and aid in the survival of the species. It is further recommended

that recreational and industrial utilization of the river system not be expanded beyond its present level in order to preserve this unique system in its present condition.

#### LITERATURE CITED

- Czarnecki, David, Dean W. Blinn and Terry Tompkins. 1976. A periphytic microflora analysis of the Colorado River and major tributaries in Grand Canyon National Park and vicinity. Report submitted to the Department of the Interior, National Park Service, Grand Canyon National Park.
- Deacon, J.E. and W.L. Minckley. 1974. Desert fishes. In Desert Biology, Vol. II (ed. G.W. Brown, Jr.), pp. 385-488. Academic Press, Inc.
- Holden, P.B. and C.B. Stalnaker. 1970. Systematic studies of the cyprinid genus Gila in the upper Colorado River Basin. Copeia (3): 409-429.
- Holden, P.B. and C.B. Stalnaker. 1975. Distribution and abundance of mainstream fishes of the middle and upper Colorado River Basins, 1967-1973. Trans. Amer. Fish. Soc. 104(2): 217-231.
- James, A.E. 1968. Learnea (copepod) infection of three native fishes from the Salt River Basin, Arizona. Unpubl. M.S. Thesis, Arizona State University, Tempe, Arizona.
- Key, C. 1965. Lee's Ferry. Wildlife Views. 13(3): 10-13.
- Miller, R.R. 1944. Preliminary checklist of fishes of Grand Canyon National Park. Unpubl. manuscript.
- Miller, R.R. 1946. Gila cypha, a remarkable new species of cyprinid fish from the Colorado River in Grand Canyon, Arizona. J. Wash. Acad. Sci., 36(12): 409-415.
- Miller, R.R. 1961. Man and the Changing fish fauna of the American Southwest. Pap. Mich. Acad. Sci., Arts, Lett., 46: 365-404.
- Miller, R.R. 1972. Threatened freshwater fishes of the United States. Trans. Amer. Fish. Soc. 101(2): 239-252.
- Miller, R.R. 1975. Report on fishes of the Colorado River drainage between Lee's Ferry and Surprise Canyon, Arizona. Unpubl. manuscript.
- Miller, R.R. and G.R. Smith. 1972. Fishes collected on Grand Canyon survey, Lee's Ferry to Diamond Creek, August, 1968. Unpubl. manuscript.

- Minckley, W. L. 1973. Fishes of Arizona. Sims Printing Co., Inc., Phoenix, Arizona. 293 pp.
- Minckley, W.L. and J.E. Deacon. 1968. Southwest fishes and the enigma of "endangered species". Science, 159: 1424-1432.
- Mulch, E.E. and W.C. Gamble. 1956. Game fishes of Arizona. Arizona Game and Fish Dept., Phoenix, Arizona.
- Suttkus, R.D. 1975. Report on August, 1975 Colorado River survey trip. Unpubl. manuscript.
- Vanicek, C.D. and R.H. Kramer. 1969. Life history of the Colorado squawfish, Ptychodheilus lucius, and the Colorado chub, Gila robusta, in the Green River in Dinosaur National Monument, 1964-1966. Trans. Amer. Fish. Soc., 98(2): 193-208.
- Wilson, B.L., J.E. Deacon, and W.G. Bradly. 1966. Parasitism in the fishes of Moapa River, Clark County, Nevada. Trans. California-Nevada Section of Wildlife Soc. 1966: 12-23.