CHARACTERIZATION OF THE LIFE HISTORY AND ECOLOGY OF THE HUMPBACK CHUB IN THE GRAND CANYON

SUPPLEMENTAL REPORT FOR EXTENSION OF INTERIM MONITORING - 1994

July 12, 1994 - July 29, 1994

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Bureau of Reclamation

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INTRODUCTION

This supplemental report was submitted to the Bureau of Reclamation by BIO/WEST, Inc., in partial fulfillment of a modification of Reclamation Contract No. 0-CS-40-09110, entitled Characterization of the Life History and Ecology of the Humpback Chub (*Gila cypha*) in the Grand Canyon. This modification was made to extend data collection, associated with specific elements of the life history and ecology of humpback chub in Grand Canyon, into 1994. One 18-day trip, during July 12 - 29, was conducted during 1994 for this investigation. This report summarizes the logistics, personnel, research schedule, results and recommendations from this supplemental investigation.

New findings made during this supplemental investigation will be integrated into the Final Report for work conducted during 1990-1993. Results related to specific objectives of this supplemental investigation are also summarized in this report and related to previous findings where applicable.

OBJECTIVES

This supplemental investigation was conducted in the mainstem Colorado River by BIO/WEST, concurrent with Arizona Game and Fish (AGF) mainstem studies. Objectives of this supplemental investigation reflect specific emphasis on canyon areas and life history aspects of humpback chub. The objectives of the supplemental investigation were to:

1. Assess distribution, abundance, growth, habitat use and survival of the 1993 HB cohort in the mainstem below the LCR.
    a. Collect additional information on sympatric native and non-native species with young HB in the mainstem below the LCR.
    b. Assess predation of young HB by non-native predators in the LCR area.

2. Evaluate food habits of adult HB longitudinally through Grand Canyon.
    a. Assess longitudinal incidence of Asian tapeworm in adult HB in mainstem.

3. Collect additional information on life history and ecology of the 30-mile and Middle Granite Gorge HB aggregations.
    a. Refine density estimates of 30-mile and Middle Granite Gorge aggregations.
    b. Evaluate HB spawning in the 30-mile area.
    c. Map and characterize water quality of tepid springs in the 30-mile area.
    d. Quantify adult HB habitat in 30-mile and Middle Granite Gorge area.
    e. Refine information on distribution of adult HB in 30-mile and Middle Granite Gorge areas.
    f. Collect additional information on sympatric native and non-native species with adult HB in the 30-mile and Middle Granite Gorge Areas.

LOGISTICS, RESEARCH SCHEDULE AND PERSONNEL

Table 1 presents a summary of logistics and the research schedule for the supplemental investigation during July, 1994. Table 2 presents personnel who were present or participated in research activities during the trip.

DATA COLLECTED AND RESULTS

Table 3 presents a summary of gear types used, sampling effort and fish captured by gear type during the supplemental investigation in July, 1994. Appendix 1 is a summary of all humpback chubs handled during July, 1994.

Reach 0 - Fence Fault (30-Mile area)

Fence Fault Springs Survey. A total of 12 springs were identified in the Fence Fault and South Canyon areas between RM 30.3 and 31.8 (Figure 1). All springs, except Spring L (Vasey's Paradise), emanated from river level between the 10,000 and 15,000 cfs stage elevation. Other springs may have been present below this level but were not detected or observed. Most springs surfaced through fractures in Redwall limestone and were located in a 0.5 mile reach (RM 30.3 to 30.8) around Fence Fault. Only three springs at river level were located below this point.

Estimated discharge from springs ranged from less than 0.1 cfs (seeps) to 10 cfs (Table 4). Discharge of at least one spring (Spring H) varied with river stage. Temperatures of undiluted springs ranged from 21 to 21.5 °C with the exception of Spring L which was 17°C. Spring L (Vasey's Paradise) was located above river level, and possibly originated from a different groundwater source than other springs in the area. Differences in dissolved oxygen, pH, and conductivity measured in undiluted spring water from Spring G and Spring J also suggested different water sources for each side of the river. At Spring G, on river left, dissolved oxygen, pH, and, conductivity measured 4.36 mg/l, 6.34, and 2,230 μmhos, respectively. Readings at Spring J, on river right were 6.0 mg/l, 7.24, and 353 μmhos, respectively.

Configuration and area of thermal plumes associated with individual springs varied depending on morphology of the river channel at the spring source and magnitude of discharge from the spring. Springs A - G and K entered the river along fast eddies and runs. High current velocities and turbulence at the mouths of these springs resulted in rapid dilution of tepid spring water. Thermal plumes were characterized by a narrow band of warm water extending downstream and compressed against the shoreline. In contrast, Springs H, I and J entered the mainstem in slow eddies or runs. Thermal plumes of these springs tended to be larger and remained relatively stable, at flow fluctuations observed during the trip (10,000 to 15,000 cfs).

Physical characteristics of Spring J were examined in detail during July 1994. Thermal characteristics and configuration of the plume were measured and hand mapped at mainstem flows of approximately 15,000 cfs (Figure 2). Temperature at the spring's source was 21.5°C. Plume temperature was approximately 15°C, 2 m from the source, 12°C, at 3 m from the source and was not perceptibly different than the mainstem at 10 m from the source. Approximate area of the plume was 3 m wide and 10 m long. The mouth of the spring was located in a limestone shelf along the shoreline. Substrates in the plume were composed of bedrock limestone, boulders and sand.

Distribution and Abundance of Humpback Chub. A total of 19 humpback chubs, including 5 adults and 14 YOY were captured in the Fence Fault area. All adults and YOY were captured at one location (RM 30.7), near the confluence of a Spring J (Figure 1). During previous BIO/WEST sampling efforts in the Fence Fault area, approximately 69% (18 of 26) humpback chubs have been captured from this same location. Larval light traps were also used during July 1994 in an attempt to capture larval fish in and around springs near Fence Fault. Traps were fished over-night in calm water near the confluence of springs where possible or downstream of spring areas in calm waters of eddies or embayments. No larval fish were captured.

Two PIT tagged adult humpback chubs, marked on previous BIO/WEST sampling efforts in the area, were recaptured in July 1994, resulting in a recapture rate of 40%. One fish was originally captured on September 10, 1993 at RM 30.7 and the second on November 9, 1993 at RM 30.6. Population estimates of adult humpback chub in the 30-Mile aggregation were recalculated with the addition of data collect in July 1994. These computations resulted in a population of 37.6 fish, with a range of 20 to 120 fish. This number is slightly lower than the previous estimate of 39.8 fish as of November, 1993.

Humpback Chub Spawning. Three of the five adult humpback chubs captured in Reach 0 during July 1994 were lightly tubercled. Of these, one was a male expressing milt, and one was a female described as 'spent' based on abrasions on the ventral surface, swelling around the vent, and a flaccid abdomen. It was estimated that the female had spawned approximately two to four weeks prior to capture based on healing of abrasions and appearance of the vent area. Other humpback chubs exhibiting signs of spawning readiness have been captured near springs on previous BIO/WEST sampling trips, including one ripe male in May of 1993, and three tubercled adults (two males and one female) in September of 1993.

Approximately 100 YOY humpback chubs were observed in the mouth of the spring at RM 30.7 on July 14 (Photo 1). Fourteen fish were captured using an aquarium dip net to verify identification. These fish ranged in size from 18 mm to 31 mm total length (TL), with an average length of 24 mm. Three additional visits were made to the spring to observe the location of the fish in the plume. During each visit a temperature was taken at the location where the fish were observed. Temperatures utilized by the YOY humpback chub ranged from 16 to 19°C. The fish were consistently observed utilizing cover provided by boulders and sparse overhanging vegetation within 1.5 m from the source of the spring.

Standard length (SL) of YOY humpback chub captured at RM 30.7 was derived using the formula:

$$SL = TL * 0.822$$

Average standard length for the 14 fish captured was computed to be 20 mm. From this, it was estimated that these fish were approximately 36 days old, or hatched on June 8, 1994, based on the growth curve developed by Muth (1990) for humpback chub cultured from brood stock from the LCR at temperatures of 18 - 23°C:

$$Y = 7.2843e^{0.0280X}, \text{ where } Y = SL, \text{ and } X = \text{days after hatching}$$

The equation was written as follows to solve for X:

$$X = \frac{\ln Y - \ln 7.2843}{0.0280}$$

The presence of numerous small YOY humpback chub and the capture of a recently spent female provided strong evidence that humpback chub utilized Spring J for spawning during 1994. Approximately 2 to 3 m^2 of the thermal plume consistently maintained temperatures greater than 15°C, suitable for spawning and egg development. Substrates in this area were primarily bedrock limestone. Several limestone boulders and small amount of sand were also present. Crevices and interstitial spaces between boulders would have provided egg deposition areas with some protection against predators such as carp, which were frequently observed in the mouth of the spring during night time sampling. Sand was the prevalent substrate in areas of the plume away from the mouth of the spring.

The concentrated use of Spring J by of humpback chub appears to be a unique phenomena in the Fence Fault area. Netting and electrofishing adjacent to other springs in the area indicated only sporadic use by humpback chub. A large slow eddy on river right, approximately 0.5 miles downstream of Spring J, is the only other location in the area where humpback chubs have consistently been captured. No springs were found in the eddy during surveys in July, but existence of spring sources below river level cannot be ruled out without more exhaustive surveys. High catch rates of gravid and ripe rainbow trout and carp, adjacent to other springs in the area, indicated that these fish may also utilize springs as spawning habitat. Large numbers of ripe male and gravid female trout were captured in the mouth of Spring A during March 1993. Carp have been consistently captured in the vicinity of Springs J and H, including several ripe males.

Reach 1 - LCR Confluence to Red Creek.

Humpback Chub Captured. A total of 267 humpback chub were captured in between RM 60.0 and RM 76.5 including 34 adults, 79 juveniles and 154 YOY. Adult humpback chubs were captured in trammel nets between RM 60.0 and RM 65.4 for purposes of food habits studies. Sampling of adults was discontinued when sufficient numbers had been captured. Two juveniles were also captured in trammel nets. One hundred seventy three humpback chubs were captured electrofishing including 71 juveniles and 102 YOY. A total of 58 humpback chubs were captured in minnow traps including six juveniles and 52 YOY.

1993 Humpback Chub Cohort. A primary objective of sampling in July 1994 was to assess the distribution, abundance, growth and survival of the 1993 year class of humpback chub in Reach 1 of the mainstem Colorado River. Intensive electrofishing and minnow trapping between RM 61.3 and RM 76.5 was conducted to address this objective. Seining was also used initially, but was discontinued because of its ineffectiveness in clear water conditions in the mainstem during July.

Longitudinal distribution of subadult humpback chub between the LCR (RM 61.3) and Red Creek (RM 76.5) appeared to change little between the last three months of 1993 and July, 1994. Longitudinal catch rates for electrofishing and minnow trapping indicated that subadult humpback chub were distributed throughout the study reach during July 1994 (Figure 3). A similar breadth of distribution was also observed during September through November of 1993. Of interest however, was the large amount of longitudinal variation in catch rates during each sampling effort in 1993 compared to a relatively uniform catch rates during July 1994. This suggested that dispersal of young

humpback chub into the mainstem Colorado River during 1993 initially resulted in a "clumpy" distribution pattern that evened out substantially prior to July 1994.

Consistently lower longitudinal catch rates during July, 1994 compared to September through November of 1993, indicated that densities of subadult humpback chub had declined in the study reach. This was particularly evident in certain specific areas, such as RM 68. Comparison of pooled catch rates in the mainstem Colorado River from the LCR (RM 61.30) to Lava Canyon (RM 65.4) also indicated densities of humpback chub decreased during the same period (Table 5). Pooled electrofishing catch rates decreased 74.2% between September, 1993 and July 1994, while pooled minnow trapping catch rates decreased 71.5% for the same period.

Growth of the 1993 year class of humpback chub could not be detected from length-frequency data collected in Reach 1 (Figure 4). Lengths of subadult humpback chub captured during July, 1994, ranged from 18 to 195 mm TL, with an average of 63 mm. Similar length distributions were also seen in September through November, 1993. Shifts in the distribution to larger size class, that would have signified growth, were not apparent. It is likely that significant overlap in length distributions between cohorts reduced the effectiveness of length-based growth analysis. Differences in growth rates between the LCR and mainstem Colorado River, protracted spawning periods, and variation in timing of immigration of young humpback into the mainchannel are factors which may contribute to an overlap of sizes between year classes. Other techniques for distinguishing cohorts and estimating growth are currently being assessed and will be presented in the Final Report for BIO/WEST humpback chub studies.

Reach 2 - Middle Granite Gorge

Distribution and Abundance of Humpback Chub. A total of 14 humpback were captured in the Middle Granite Gorge area (Reach 2) including 10 adults and 4 juveniles. All adults were captured in trammel nets between RM 127.0 and RM 127.5. The four juveniles were captured between RM 125.8 and RM 127.5, two by electrofishing and two in minnow traps. All humpback chub captured in July 1993 were within the range established for the Middle Granite Gorge aggregation during previous BIO/WEST sampling from 1990 to 1993.

Population estimates of adult humpback chub in the Middle Granite Gorge aggregation were recalculated with the addition of data collect in July 1994. These computations resulted in a population of 108.3 fish, with a range of 76.0 to 155.9 fish. This estimate was slightly higher than the previous estimate of 103.9 fish as of November, 1993.

Longitudinal Food Habits Study - Humpback Chub

A total of 39 humpback chub were stomach-pumped for food habits analysis during July 1994. The technique was successful on 31 of 39 fish, resulting in either evacuation of the stomach contents or a determination that the stomach was empty (Table 6). The eight unsuccessful attempts were related to blockages of the fish's gastrointestinal tract that prevented the typical flushing action of the pump. This block may have been associated with large amounts of algae or other course materials that could not be flushed from the fishes gut without excessive pressure. Macroinvertebrates and algal drift were collected concurrent with stomach pumping efforts to assess availability of food items in the drift. Four sampling location were used for both drift sampling and stomach analysis (Table 7).

Drift. Invertebrate relative abundance in drift samples was dominated by Chironomidae at all four sites (Table 7). At Site 1, Annelid worms, included in other aquatics represented 45% of the drift (numbers of organisms). Simuliid relative abundance tended to increase in a downstream direction, from 8% at Site 2 to over 20% at Site 4. Relative abundance of Gammarus lacustris increased from slightly from 1.56% at Site 1 to 2.51% and 2.97% at Sites 2 and 3, respectively, then declined to 0.27% at Site 4. The low value at Site 1 was unusual given its proximity to Gammarus production below Glen Canyon Dam, relative to Sites 2 and 3.

Stomach Contents. The small sample size (N=1) of humpback chub gut contents successfully sampled from Site 1 (30-Mile area) limited analysis of food habits in this area of the canyon. Stomach contents of the fish that was successfully pumped was composed of 4 ml of Cladophora and four Chironomids. Partial gut contents retrieved from one other humpback chub at Site 1 included three Annelids. This was the only occurrence of Annelids in humpback chub gut contents from the July sample.

Simuliids were found in 19 of 22 (86.4%) humpback chub gut contents and represented the most commonly utilized food item at three sites within the study area, followed by Chironomids and Gammarus (Table 8)(Figure 5). Longitudinal trends in occurrence of food items suggested that Gammarus, Chironomids and Cladophora were utilized less in Middle Granite Gorge (Site 4) than around the LCR (Sites 3 and 4). Occurrence of other aquatic and terrestrial invertebrates exhibited no apparent longitudinal trends. Terrestrial food items in Grand Canyon may be primarily associated with tributary flooding, making their availability seasonal and ephemeral in nature. Little tributary flooding was observed during the July sampling trip.

Simuliids were the most prevalent invertebrate in the humpback chub diet, comprising an average of 34.6% of the volume of gut contents (Table 9). This taxa appeared to be particularly important in the Middle Granite Gorge area, where it occupied 88% of gut content volumes of six fish. Gammarus comprised an average of 13.1% of gut content volumes, and represented the second most prevalent invertebrate food item. Highest volumes of Gammarus were observed from the two sites near the LCR, and dropped substantially at the Middle Granite Gorge site. Volume of chironimids and other aquatic and terrestrial invertebrates were very small at all sampling sites. The occurrence of a small whiptail lizard (Cnemidophorus sp.) in the gut of one humpback chub from Middle Granite Gorge was not included in volumetric analysis. Volume of this lizard would have substantially increased the volume of terrestrial food items at the site. Cladophora comprised a relatively large portion of gut content volumes at the 30-Mile and LCR sampling sites, but was not found in gut contents from Middle Granite Gorge.

Numerically, Simuliids were the most abundant organism found in humpback chub stomachs followed by Chironimids and Gammarus (Table 10). Pupal and larval forms of Simuliids were much more prevalent that adult forms in humpback chub stomachs.

Food habits data collected during July 1994 indicated that Simuliids were the dominant food item for humpback chub in most areas of Grand Canyon. A limited sample from the 30-Mile aggregation indicated that Cladophora may be an important food item higher in the Canyon. Gammarus also appeared to be an important food item for humpback chub in the LCR area. Although Chironimids were the most abundant invertebrate found in the drift, utilization by humpback chub was relatively low. The apparent selectivity for Simuliids relative to their abundance in the drift indicated that

humpback chub do not rely on drifting food items for the bulk of their diet. It appears that either Simuliid behavior predisposes them to predation by humpback chub or they are actively sought for their energetic value. Blinn et al. (1992) reported that Simuliids have the highest energy value, 22.64 joules/mg dry wt., of common aquatic food items in Grand Canyon. It is interesting that Chironomids, which have the second highest energy value at 21.38 joules/mg dry wt., were apparently not selected by humpback chub. Further investigations into food habits of humpback chub and the life history of prey items may provide valuable insight into their foraging behavior.

Incidence of Asian Tapeworm. Asian tapeworms were found in stomach contents of 3 of 30 fish (10%) successfully stomach pumped (Table 11). Only humpback chub captured in Reach 1, below the LCR (RM 61.3) were infested with tapeworms. Three of 12 (25%) humpback chubs successfully pumped in this reach had tapeworms in the gut contents. Infestations ranged from 1 tapeworm in each of two fish and a minimum of 15 tapeworms in the third fish.

Stomachs of 10 fathead minnows were also examined for tapeworm in Reach 1 below the LCR. A tapeworm was found in one of the 10 fish, indicating a infestation rate of 10% for this species.

SUMMARY OF FINDINGS

1. Twelve springs with a wide range of discharges, physical characteristics, and water quality were identified in the Fence Fault area of Marble Canyon between RM 30.3 and 31.8. Sixty-nine percent (18 of 26) of all adult humpback chubs captured in the Fence Fault area have been captured in the vicinity of one of these springs, identified as Spring J.

2. Observations of 50 to 100 YOY humpback chubs in the mouth of Spring J, confirmed that humpback chubs successfully spawned in the thermal plume of the spring in 1994. Additional evidence was provided by the capture of a spent, adult female humpback chub in the vicinity of the spring during the trip.

3. Assuming that humpback chubs spawned in portions of the plumes where water temperatures were greater than 15°C, substrates used for spawning included limestone bedrock and limestones boulders ranging from 0.25 to 1.0 m in diameter. It is speculated that eggs were deposited in crevices in the bedrock or interstitial spaces around boulders to have survived predation by adult carp that frequented the spring outflow.

4. Distribution of subadult humpback chub (<200 mm) from the mouth of the LCR (RM 61.3) to Red Creek (RM 76.5) in July, 1994, was similar to distributions observed during September through November of 1993 and indicated that young humpback chub are utilizing suitable habitats throughout the reach.

5. Decreases in electrofishing and minnow trap catch rates from September 1993 to July 1994 suggest that densities of subadult humpback chub in Reach 1 below the LCR have decreased approximately 70%.

6. Growth of humpback chubs from the 1993 year-class could not be assessed due to the inability to distinguish cohorts from length-frequency data.

7. Food habits data collected during July 1994 indicated some longitudinal variation in diet of humpback chub in Grand Canyon, with Cladophora and Gammarus utilized more frequently by fish in the 30-Mile and LCR areas. Volumetrically and numerically, Simuliids were the dominant item in humpback chub gut contents at all sites except the 30-Mile area, where they were not found.

8. Asian tapeworm was found in 3 of 30 humpback chub stomachs contents examined during July, 1994. The three chubs infested with tapeworm were captured in Reach 1, below the confluence of the LCR, suggesting a possible link between the life cycle of the parasite and the LCR.

9. Asian tapeworm was found in 10% (1 of 10) of fathead minnow stomachs examined.

RECOMMENDATIONS

1. Spawning of humpback chub in Reach 0, from the confluence of the Paria (RM 1.0) to Kwagunt Rapid (RM 56.0) should continue to be evaluated. Emphasis should be placed on spring sources around faulted areas such as Fence Fault and Eminence Break.

2. A more complete water quality analysis, including gaseous nitrogen, of springs in the Fence Fault area should be conducted. This information could provide insight into why humpback chub and other fish species appear to exhibit preference for specific springs in the area.

3. The incidence of Asian tapeworm in humpback chub and other suitable host species in Grand Canyon should continue to be evaluated. Understanding the life history and ecology of this parasite and its affects on humpback chub populations may have implications in the future management of aquatic ecosystems of the mainstem Colorado River and its tributaries in Grand Canyon.

4. Techniques for marking subadult humpback chub, less than 150 mm, should be evaluated as a research item. Marking fish would enhance the ability of researchers to evaluate growth and movement of early life stages of humpback chub in Grand Canyon.

Table 1. Logistics and Research Schedule for Supplemental Investigation, July 1994.

Date	RM	Location	Research Activities		
			T&R[1]	FS	HQ
7/12	31.6	South Canyon	X	X	X
7/13	31.6	South Canyon		X	X
7/14	31.6	South Canyon		X	X
7/15	61.3	LCR	X	X	
7/16	61.3	LCR		X	
7/17	65.4	Lava Chuar	X	X	
7/18	65.4	Lava Chuar		X	
7/19	68.3	Tanner Cr.	X	X	X
7/20	68.3	Tanner Cr.		X	X
7/21	71.1	Cardenas Cr.	X	X	X
7/22	71.1	Cardenas Cr.		X	X
7/23	76.0	Popago Cr.	X	X	X
7/24	126.5	Randy's Rock	X	X	X
7/25	126.5	Randy's Rock		X	X
7/26	126.5	Randy's Rock		X	X
7/27	180.0	Below Lava Falls	X		
7/28	224.0	Above Diamond Cr.	X		
7/29	225.0	Diamond Cr.	X		

[1] T&R = Travel and Reconnaissance
FS = Fish Sampling
TE = Telemetry
HQ = Habitat Quantification

Table 2. Personnel Participating in Supplemental Trip, July 1994.

Personnel	Affiliation	Dates	Comments
B. Masslich	BIO/WEST	7/12 - 7/29	Project Leader
R. Valdez	BIO/WEST	7/18 - 7/20	Principal Investigator
B. Cowdell	BIO/WEST	7/12 - 7/29	Senior Biologist
P. Weiss	BIO/WEST	7/12 - 7/29	
E. Prats	BIO/WEST	7/12 - 7/29	
E. Converse	BIO/WEST	7/12 - 7/29	
R. Ryel	BIO/WEST	7/13 - 7/20	Statistical Consultant
L. Neimi	OARS	7/12 - 7/29	
T. Anderson	OARS	7/12 - 7/29	Trip Leader
A. Anderson	OARS	7/12 - 7/29	

Table 3. Summary of Fish Collected and Effort by Gear Type, Trip 1, 1994. THESE DATA ARE PRELIMINARY

Gear Type	Age	HB	FM	BH	RB	BR	CC	CP	SD	FH	GS	PK	SU
Electrofishing Reach 0 N=22 3.4 hr	A				52			1					
	J				39			0					
	Y				3			0					
Electrofishing Reach 1 N=59 9.93 hr	A	0	5	0	1	0			37	74	1		
	J	71	0	3	10	2			0	5	0		
	Y	102	5	0	75	0			0	3	0		
Electrofishing Reach 2 N=20 3.09 hr	A	0	0	0	2	3		4		15			0
	J	2	3	2	11	0		0		7			0
	Y	0	0	0	0	0		0		1			9
Nets Reach 0 N=30 60.18 hr	A	5	2		31			1					
	J	0	0		0			0					
	Y	0	0		0			0					
Nets Reach 1 N=19 46.12 hr	A	34	30	1	11								
	J	2	0	0	0								
	Y	0	0	0	0								
Nets Reach 2 N=25 60.37	A	10	3	1	1			3					
	J	0	0	0	0			0					
	Y	0	0	0	0			0					
Traps Reach 1 N=190 4,099.8 hr	A	0							7	7			
	J	6							0	0			
	Y	52							1	2			

Table 3. Continued.

Gear Type	Age	HB	FM	BH	RB	BR	CC	CP	SD	FH	GS	PK	SU
Traps Reach 2 N=70 1,394.3 hr	A	0								2			
	J	2								0			
	Y	0								0			
Seine Reach 1 N=7 709 m^2	A								1	29		1	
	J								0	0		0	
	Y								0	0		0	
Dip Net Reach 0 N=3	A	0											
	J	0											
	Y	14											
Light Traps Reach 0 N=17 192 m	A												
	J												
	Y												

A = Adult
J = Juvenile
Y = Young-of-year

HB = humpback chub
FM = flannelmouth sucker
BH = bluehead sucker
RB = rainbow trout
BR = brown trout
CC = channel catfish
CP = carp

SD = speckled dace
FH = fathead minnow
GS = green sunfish
PK = plains killifish
SU = unidentified sucker

Table 4. Physical and chemical characteristics of springs in the Fence Fault area, between RM 30 and RM 31.8.

Spring	RM	Estimated Discharge (cfs)	Estimate Area of Plume (m^2)	Temperature at source (°C)	Conductivity (µS/cm)	DO (mg/l)	pH
A	30.3	0.5-5.0	15	20.9			
B	30.3	-	-	-			
C	30.3	<0.1	<1	-			
D	30.4	-	-	-			
E	30.4	< 0.1	-	-			
F	30.4	1-3	20	21.0			
G	30.4	5-10	30-40	21.0	2300	4.36	6.34
H	30.5	Variable	10-40	21			
I	30.7	0.5	1-10	-			
J	30.8	2-4	10-30	21.54	353	6.6	7.24
K	31.6	-	-	-			
L	31.8	10-15	200	17			

Table 5. Summary of pooled monthly catch rates (arithmetic mean CPE)for electrofishing and minnow traps in the mainstem Colorado River from the LCR (RM 61.3) to Lava Canyon (RM 65.4), September 1993-July 1994.

	CPE-EL # Fish/10 hrs	% Change from previous sample	% Change from Sep 1993	CPE-MT #fish/100 hrs	% Change from previous sample	% Change from Sep 1993
Sep 1993	521.72	-	-	2.77	-	-
Oct 1993	493.37	-5.4	-5.4	6.44	132.5	132.5
Nov 1993	24.37	-95.1	-95.3	3.25	-49.5	17.3
Jul 1994	134.42	451.6	-74.2	0.79	-75.6	-71.5

Table 6. Summary of stomach pumping effectiveness for obtaining gut contents from 39 humpback chub from four sites in Grand Canyon during July 1994.

	No. Unsuccessful	% unsuccessful by site	No. successful with empty stomachs	% with empty stomachs by site	No. successful	% successful by site
Site 1 30-Mile N=5	2	40.0	2	40.0	1	20.0
Site 2 Above LCR N=10	1	10.0	1	10.0	8	80.0
Site 3 Below LCR N=17	4	23.5	6	35.3	7	41.2
Site 4 MGG N=7	1	14.3	0	0	6	85.7
Totals	**8**	**20.5**	**9**	**23.1**	**22**	**56.4**

Table 7. Relative abundance[1] of food items collected in drift samples taken concurrent with food habits studies at four sites in Grand Canyon, July 1994.

Site	GAMM %	SIM %	CHIR %	AQ OTHER %	TERR %	Avg # Inverts per sample
Site 1 30 Mile (RM 31.65) N=3	1.56	0	53.77	44.67	0	176.90
Site 2 Above LCR (RM >58, <61.5) N=3	2.51	7.59	87.46	1.67	0.78	1265.24
Site 3 Below LCR (RM ≥61.5, <70) N=3	2.97	6.79	84.34	5.02	0.88	1698.62
Site 4 MGG (RM 126-130) N=3	0.27	21.41	75.18	2.12	1.02	1496.21

[1]Relative abundances were calculated in $100m^3$ H_2O.

Table 8. Incidence of specific food items in gut contents of 22 humpback chub stomach pumped from 4 sites in Grand Canyon during July 1994. N=number of fish pumped with food.

	Number with Gammarus (% by site)	Number with Simulid (% by site)	Number with Chironomids (% by site)	Number with other Aquatics (% by site)	Number with Terrestrial (% by site)	Number with Cladophora (% by site)
Site 1 30-Mile N=1	-	-	1(100)	-	-	1(100)
Site 2 Above LCR N=8	7(87.5)	7(87.5)	7(87.5)	1(12.5)	3(37.5)	2(25.0)
Site 3 Below LCR N=7	5(71.4)	6(85.7)	6(85.7)	2(28.6)	4(57.1)	2(28.6)
Site 4 MGG N=6	2(33.3)	6(100)	4(66.7)	3(50)	2(33.3)	0(0)
Totals	**14(63.6)**	**19(86.4)**	**18(81.8)**	**6(27.3)**	**9(40.1)**	**5(22.7)**

Table 9. Mean volume of five invertebrate taxa and algae found in gut contents from 22 humpback chub from four sites in Grand Canyon, July 1994. N=number of fish pumped with food.

Site		Gammarus			Simulidae	Chironimade	Other Aquatic	Terrestrial	Cladophora glomerata	Total Vol.
		Adu	Imm	Tot						
Site 1	x	0	0	0	0	0.01	0	0	4.0	4.01
30-Mile	Range	-	-	-	-	-	-	-	-	-
N=1	SD	-	-	-	-	-	-	-	-	-
	% of Total Vol	0	0	0	0	<0.1	0	0	99.9	-
Site 2	x	0.08	0.04	0.12	0.34	0.02	0	<0.01	0.25	0.86
Above LCR	Range	0-0.44	0-0.14	0-0.46	0-0.53	0-0.04	-	0-0.01	0-1.0	0.09-1.95
N=8	SD	0.15	0.05	0.14	0.23	0.02	-	<0.01	0.46	0.77
	% of Total Vol	9.3	4.7	14.0	39.5	2.3	0	1.1	29.1	-
Site 3	x	0.25	0.03	0.28	0.45	0.01	0	<0.01	0.43	1.45
Below LCR	Range	0-0.57	0-0.12	0-0.65	0-1.03	0-0.03	-	0-0.01	0-2.0	0-4.12
N=7	SD	0.25	0.05	0.28	0.41	0.01	-	<0.01	0.79	1.47
	% of Total Vol	17.2	2.1	19.3	31.0	0.3	0	0.3	29.7	-
Site 4	x	0.01	0	0.1	0.37	0.01	<0.01	<0.01	0	0.42
MGG	Range	0-0.04	-	0-0.04	0-1.27	0-0.03	0-0.01	0-0.01	-	0.01-1.31
N=6	SD	0.02	-	0.02	0.47	<0.01	<0.01	<0.01	-	0.47
	% of Total Vol	2.4	0	2.4	88.1	2.4	<2.4	<2.4	0	
Totals	**x**	**0.11**	**0.02**	**0.14**	**0.37**	**0.01**	**<0.01**	**<0.01**	**0.41**	**1.07**
N=22	**Range**	**0-0.57**	**0.014**	**0-0.65**	**0-1.27**	**0-0.04**	**0-0.01**	**0-0.01**	**0.20**	**0-4.12**
	SD	**0.18**	**0.04**	**0.20**	**0.35**	**0.01**	**<0..1**	**<0.01**	**0.94**	**1.18**
	% of Total Vol	**10.3**	**1.9**	**13.1**	**34.6**	**0.1**	**0.8**	**0.8**	**38.3**	**-**

Table 10. Mean number of individuals of five invertebrate taxa found in gut contents from 22 humpback chub from four sites in Grand Canyon, July 1994.

Site		Gammarus			Simuliidae				Chironimidae				Other Aquatic	Terrestrial	Total No. Inverts
		Adu	Imm	Tot	Adu	Pup	Lar	Tot	Adu	Pup	Lar	Tot			
Site 1	x	0	0	0	0	0	0	0	1	3	0	4	0	0	4
30-Mile	Range	-	-	-	-	-	-	-	-	-	-	-	-	-	-
N=1	SD	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	% of Total No.	0	0	0	0	0	0	0	25	75		100	0	0	
Site 2	x	1.9	1.9	3.8	7.9	52.6	23.6	84.1	0.4	6.4	1.4	8.1	0.25	0.5	96.8
Above LCR	Range	0-10	0-7	0-11	0-24	0-103	0-49	0-164	0-2	0-15	0-3	0-18	0-2	0-2	1-174
N=8	SD	3.4	2.6	3.7	9.1	38.1	16.9	55.8	0.7	6.3	1.3	7.4	0.7	0.8	60.0
	% of Total No.	1.9	1.9	3.9	8.1	54.3	24.4	86.9	<0.1	6.6	1.4	8.4	<0.1	<0.1	-
Site 3	x	5.7	1.6	7.3	4.0	74.1	30.4	109.0	0.3	2.4	2.3	5.0	0.7	0.7	122.0
Below LCR	Range	0-13	0.6	0-17	0-11	0-187	0-88	0-251	0-1	0-7	0-9	0-14	0-4	0.2	13-281
N=7	SD	5.7	2.4	7.2	4.2	69.9	30.8	101.0	0.5	2.8	3.5	5.9	1.5	0.8	108.0
	% of Total No.	4.6	1.3	6.0	3.3	60.7	24.9	89.3	<0.1	2.0	1.9	4.1	<0.1	<0.1	-
Site 4	x	0.3	0	0.3	5.8	9.5	76.0	91.3	0.3	2.0	1.3	3.7	2.7	0.5	98.5
MGG	Range	0-1	-	0-1	0-16	0-16	2-286	3-309	0-1	0-8	0-5	0-13	0-8	0-2	3-328
N=6	SD	0.5	-	0.5	6.7	7.1	107.0	114.0	0.5	3.0	2.0	4.8	3.5	0.8	120.0
	% of Total No.	<0.1	0	<0.1	5.9	9.6	77.2	92.7	<0.1	2.0	1.4	3.7	2.7	<0.1	-
Totals	x	2.6	1.2	3.8	5.7	45.3	39.0	90	0.4	3.8	1.6	5.7	1.1	0.6	101.0
N=22	Range	0-13	0.7	0-17	0-24	0-187	0-286	0-309	0.2	0-15	0-9	0-18	0.8	0.2	1-328
	SD	4.3	2.2	5.3	6.9	51.5	60.5	86.8	0.6	4.6	2.3	6.1	2.2	0.7	92.6
	% of Total No.	2.3	1.2	3.8	5.6	44.9	38.6	89.1	<0.1	3.8	1.6	5.6	1.1	0.1	-

Table 11. Summary of Asian tapeworm incidence in gut contents of humpback chub stomachs pumped during July 1994 from 4 sample reaches in Grand Canyon.

Sample Site	RM	# HB pumped	# Successful	# w/Tapeworms
30 Mile Area	30.7	5	3	0
Reach 1 - Above LCR	60.4-60.9	10	9	0
Reach 1 - Below LCR	61.7-65.3	17	12	3
Middle Granite Gorge	127.1	7	6	0
Totals		39	30	3

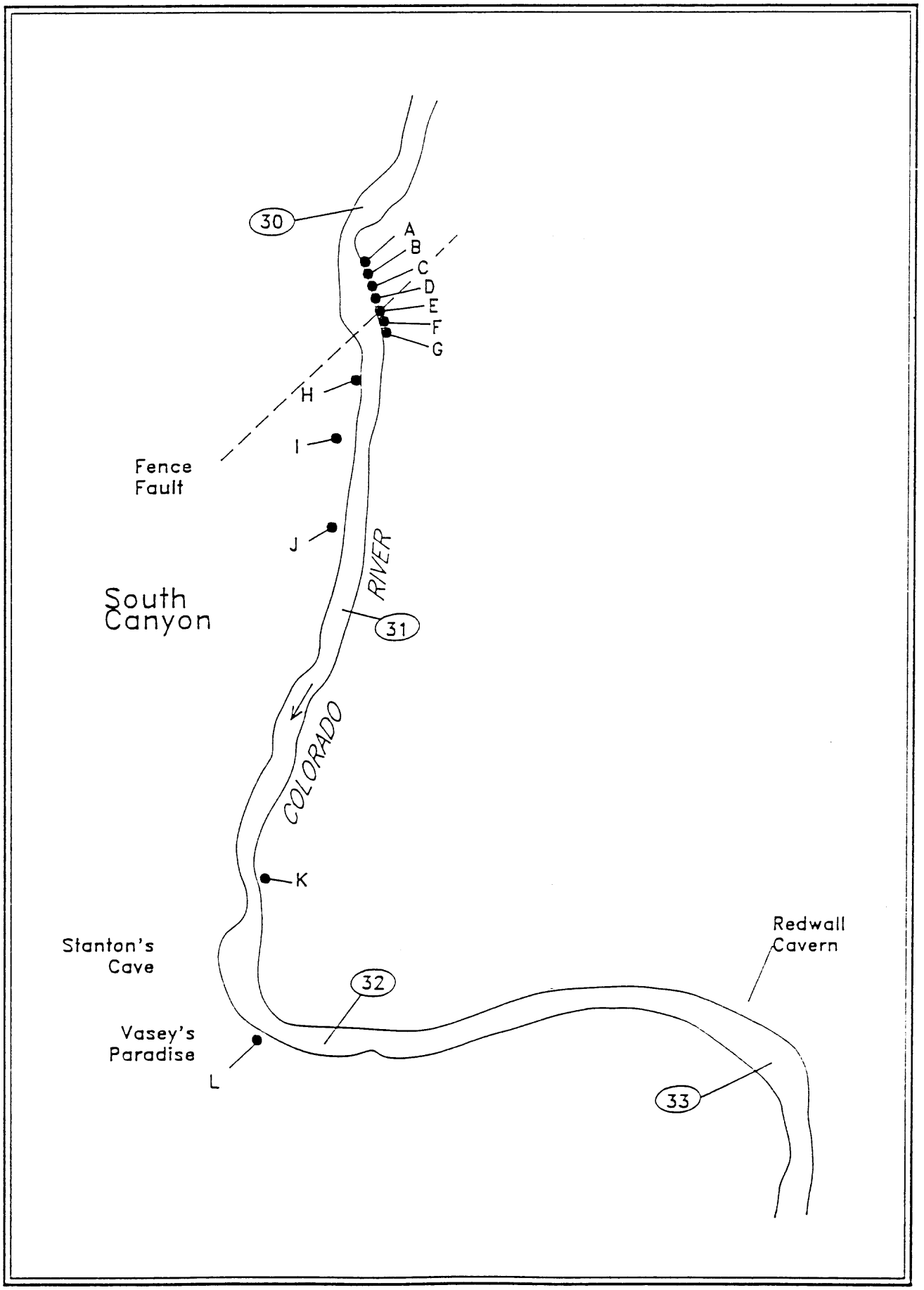


Figure 1. Locations of 12 springs (A-L) in the Fence Fault Area.

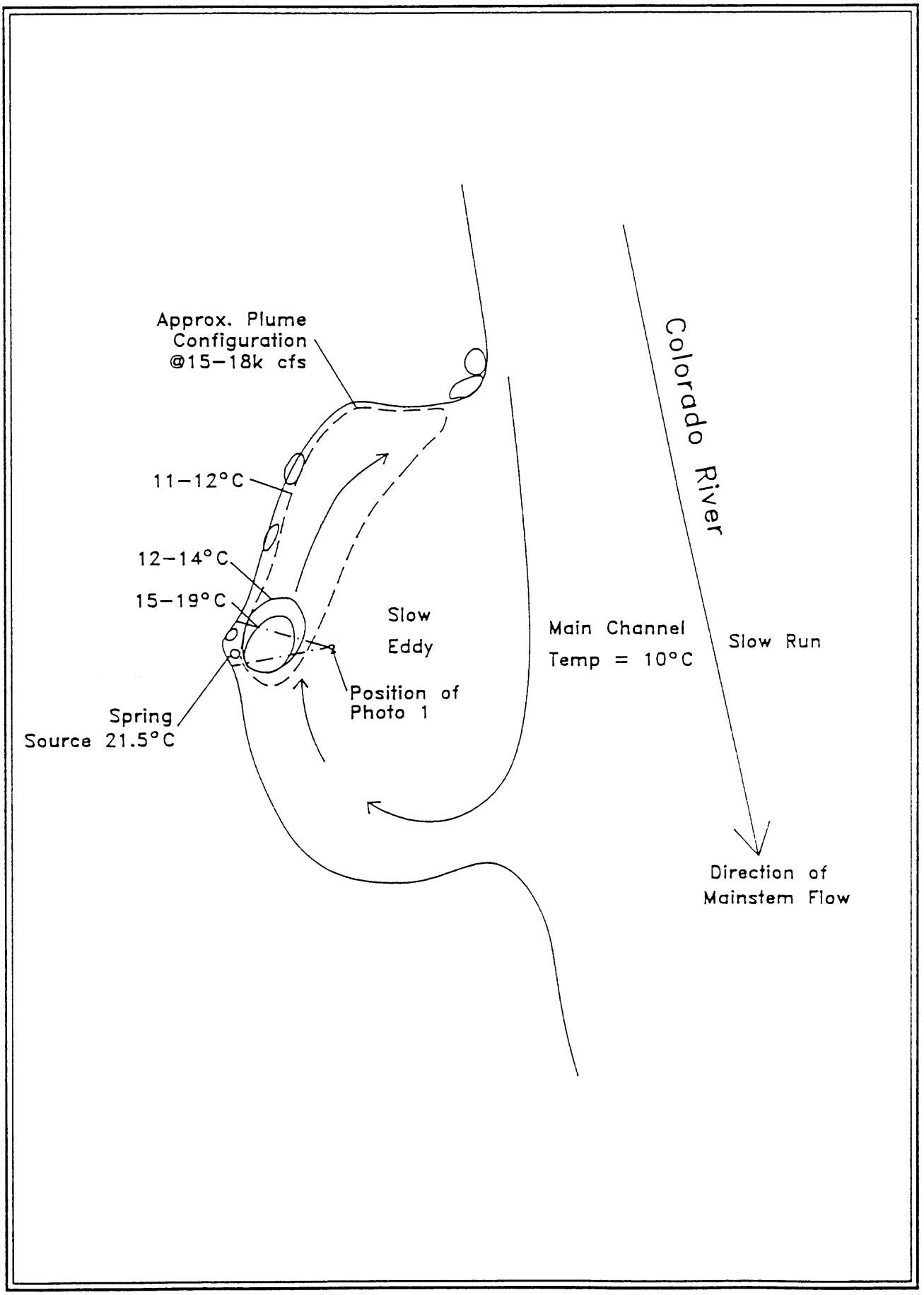
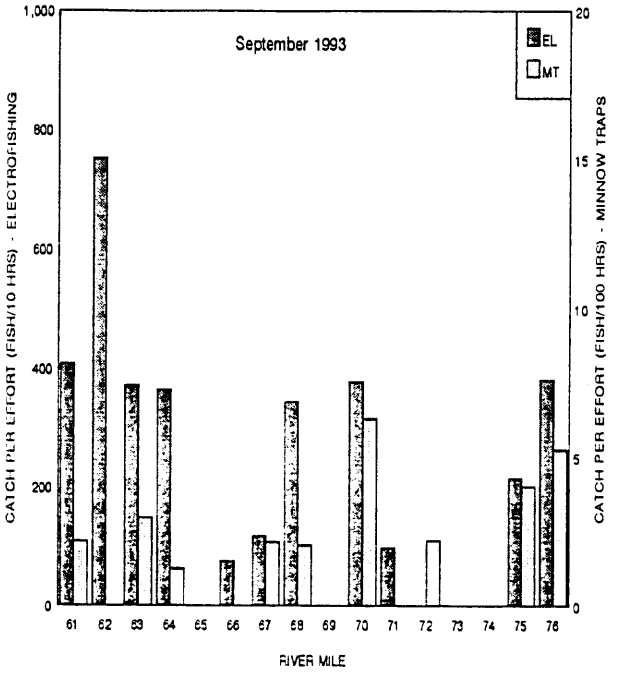
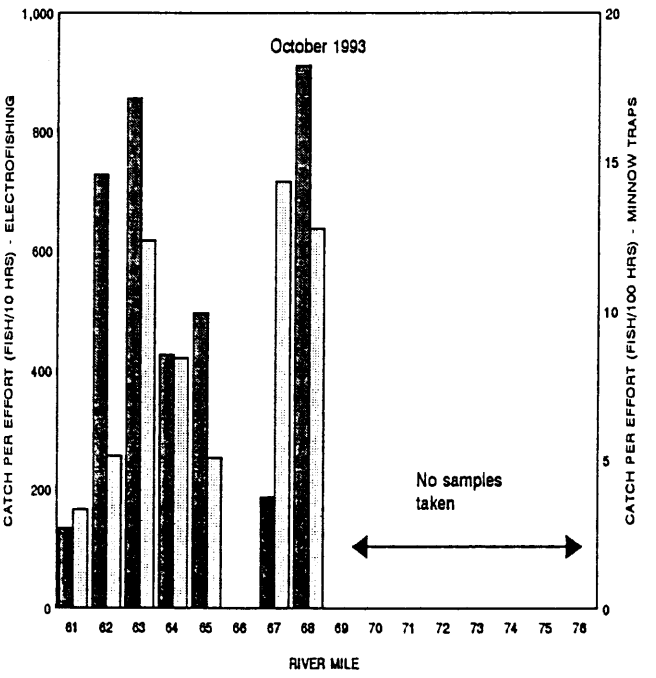
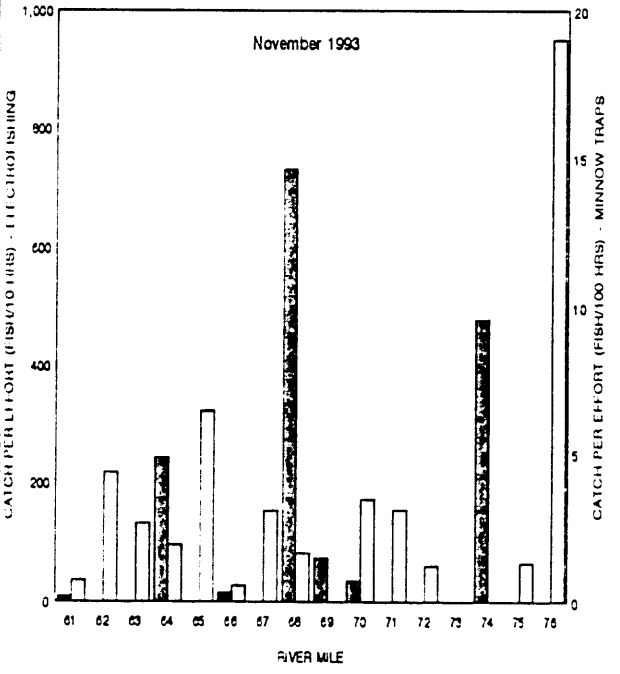


Figure 2. Approximate plume shape and thermal characteristics of Spring J at RM 30.8. Data collected July 14, 1994, with a Hydrolab Surveyor 3.







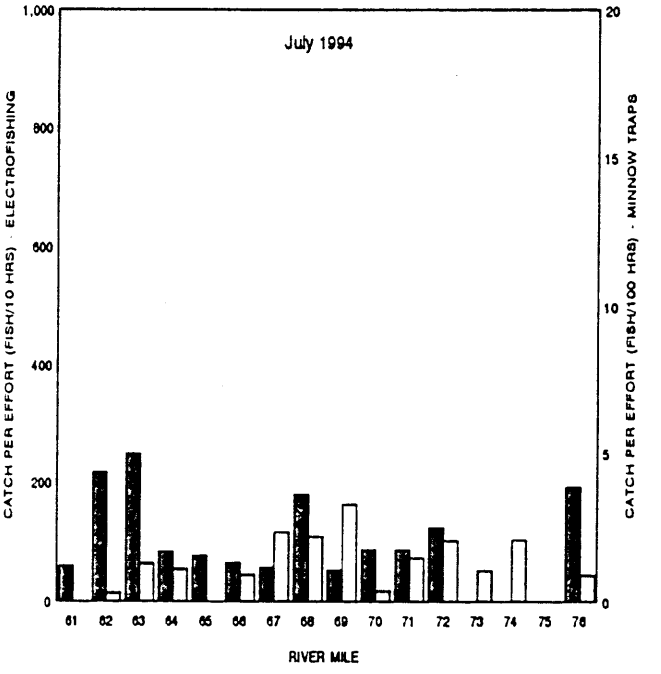


Figure 3. Longitudinal electrofishing and minnow trap catch rates (arithmetic mean CPE) by mile for Reach 1, below the confluence of the LCR, RM 61.3 to RM 76.5, for September through November 1993 and July 1994, in Grand Canyon, AZ.

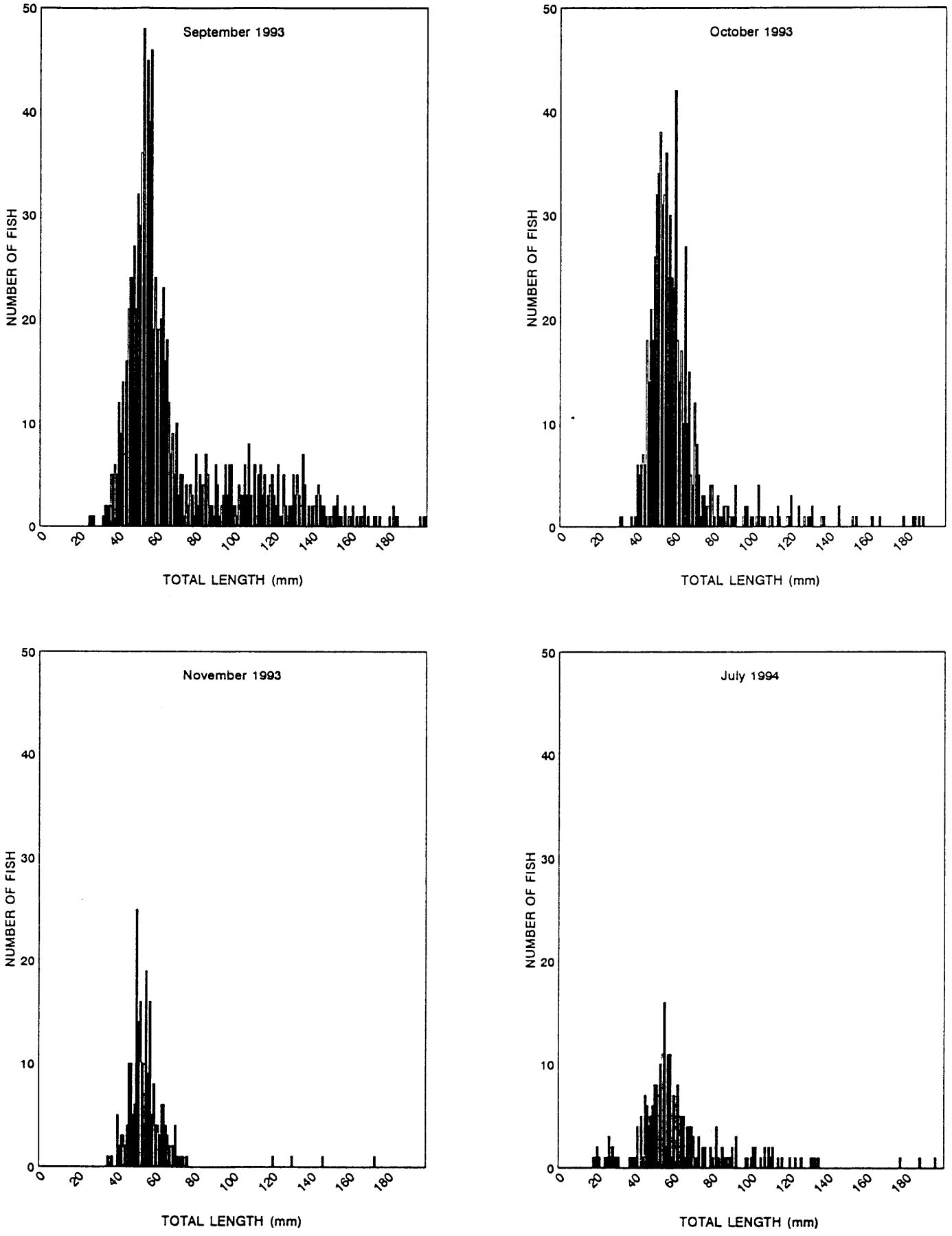


Figure 4. Length frequency histograms, by 1 mm increments for humpback chub captured in Reach 1, below the LCR, RM 61.3 to RM 76.5, for September through November 1993 and July 1994, in Grand Canyon, AZ.

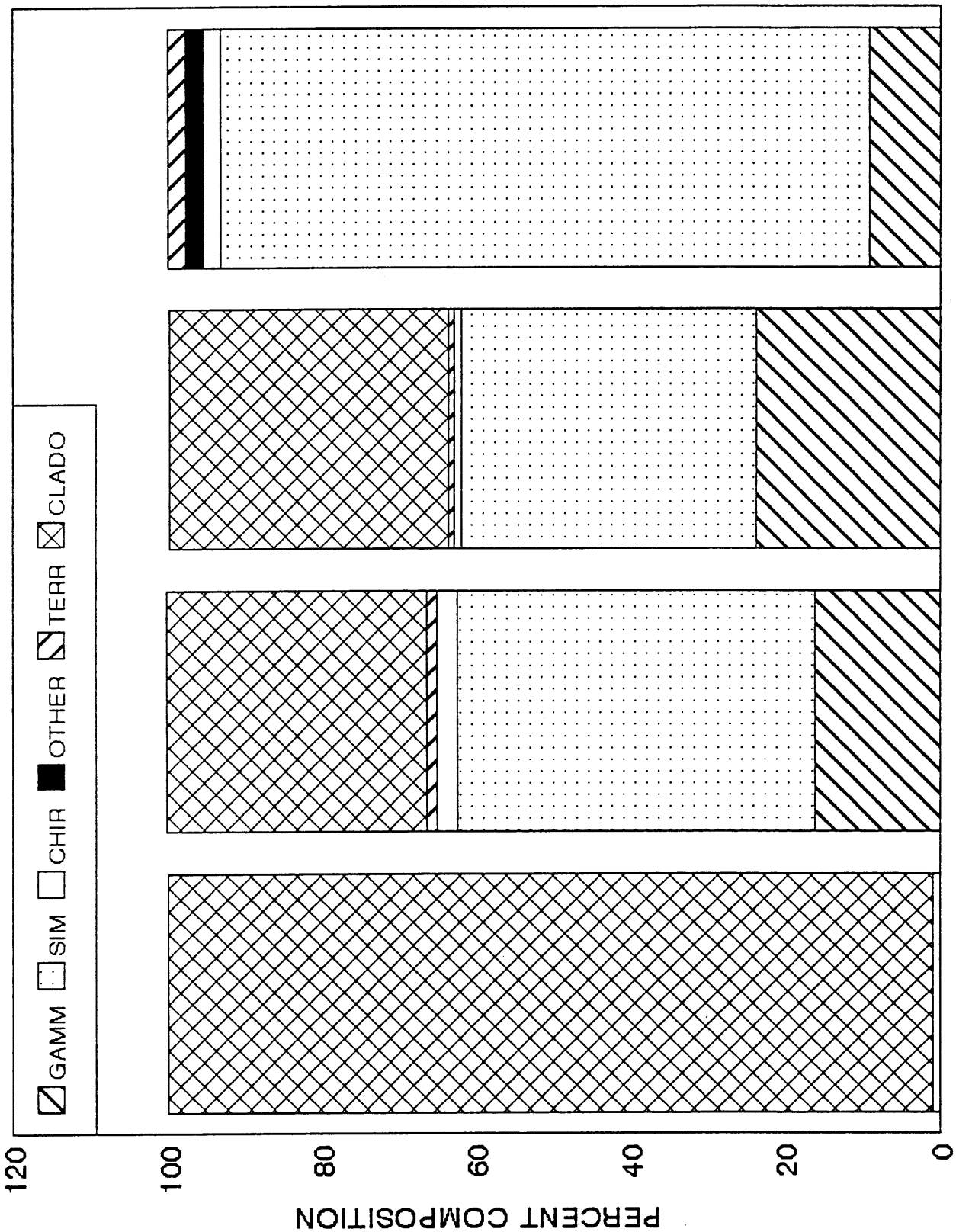


Figure 5. Percent composition of volume of food items found in 22 humpback chub at four sites during July 1994 in Grand Canyon. Site 1, N=1; Site 2, N=8; Site 3, N=7; Site 4, N=6.

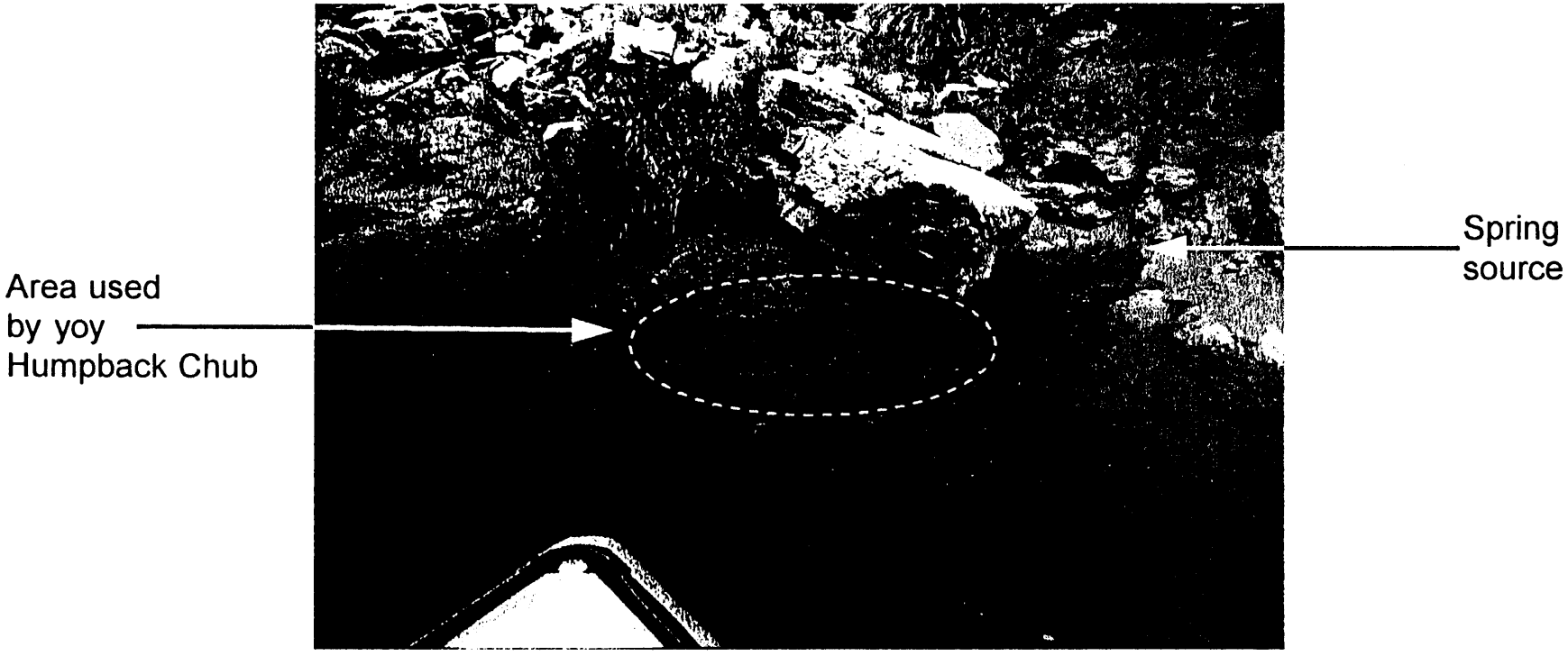


Photo 1. Photograph of Spring J at RM 30.7, Grand Canyon. Approximately 100 YOY humpback chub were observed in the mouth of the spring at the time of the photograph on July 14, 1994. See Figure 2 for location and angle of this photo.

LITERATURE CITED

Blinn, D.W., L.E. Stevens, and J.P. Shannon. 1992. The effects of Glen Canyon Dam on the aquatic food base in the Colorado River Corridor in Grand Canyon, Arizona. Glen Canyon Environmental Study-11-02.

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APPENDIX A

Summary of humpback chub handled during July, 1994

N	Date	Gear	PIT Tag	Recap	Old Tag	TL	WT	Sex	Disp	RM Capture	Radio
1	940712	TK	1F20242479	N		451	784	F	RS	30.70	N
2	940712	TK	1F20051329	Y	PITTAG	414	489	F	RS	30.70	N
3	940714	TK	7F7F284922	Y	PITTAG	428	667	U	RS	30.70	N
4	940714	TK	1F204D373D	N		352	379	M	RS	30.70	N
5	940714	TK	1F20170C1E	N		367	464	F	RS	30.70	N
6	940714	DN		N		27	0	U	RA	30.70	N
7	940714	DN		N		21	0	U	RA	30.70	N
8	940714	DN		N		19	0	U	RA	30.70	N
9	940714	DN		N		25	0	U	RA	30.70	N
10	940714	DN		N		20	0	U	DP	30.70	N
11	940714	DN		N		26	0	U	DP	30.70	N
12	940714	DN		N		26	0	U	RA	30.70	N
13	940714	DN		N		31	0	U	DP	30.70	N
14	940714	DN		N		26	0	U	DP	30.70	N
15	940714	DN		N		18	0	U	DP	30.70	N
16	940714	DN		N		24	0	U	RA	30.70	N
17	940714	DN		N		29	0	U	RA	30.70	N
18	940714	DN		N		28	0	U	RA	30.70	N
19	940714	DN		N		20	0	U	RA	30.70	N
20	940715	TK		N		201	83		DP	60.40	N
21	940715	TK	7F7F183777	Y	PITTAG	195	73	U	RA	60.75	N
22	940715	TK	7F7D18052F	Y	PITTAG	297	208	M	RS	60.75	N

N	Date	Gear	PIT Tag	Recap	Old Tag	TL	WT	Sex	Disp	RM Capture	Radio
23	940715	TK	7F7D1A483C	Y	PITTAG	338	305	F	RS	60.75	N
24	940715	TK	7F7D080274	Y	PITTAG	375	396	M	RS	60.75	N
25	940715	TK	7F7D173645	Y	PITTAG	320	306	F	RA	60.75	N
26	940715	TK	7F7F1F137B	N		235	120	F	RA	60.90	N
27	940715	TK	7F7F3F4B64	Y	PITTAG	364	338	M	RS	60.90	N
28	940715	TK	7F7D1B6D44	Y	PITTAG	331	312	F	RS	60.90	N
29	940715	TK	7F7F3E2619	Y	PITTAG	382	495	U	RS	60.40	N
30	940715	TK	7F7D170E4B	Y	PITTAG	284	190	M	RS	60.40	N
31	940715	TK	7F7B182E37	Y	PITTAG	329	329	F	RS	60.40	N
32	940715	TK	7F7F05026E	Y	PITTAG	362	435	M	RS	60.40	N
33	940715	TN	7F7D180120	Y	PITTAG	302	370	F	RS	60.90	N
34	940716	EL		N		86	4	U	RA	62.00	N
35	940716	EL		N		70	2	U	RA	62.00	N
36	940716	EL		N		53	1	U	RA	62.35	N
37	940716	EL		N		79	4	U	RA	62.65	N
38	940716	EL		N		55	1	U	RA	62.65	N
39	940716	EL		N		62	2	U	RA	62.65	N
40	940716	EL		N		58	1	U	RA	62.65	N
41	940716	EL		N		48	1	U	RA	62.65	N
42	940716	EL		N		57	2	U	RA	62.75	N
43	940716	EL		N		55	1	U	RA	62.75	N
44	940716	EL		N		50	2	U	RA	62.75	N

N	Date	Gear	PIT Tag	Recap	Old Tag	TL	WT	Sex	Disp	RM Capture	Radio
45	940716	EL		N		49	1	U	RA	62.75	N
46	940716	EL		N		100	10	U	RA	62.75	N
47	940716	EL		N		40	1	U	RA	63.20	N
48	940716	EL		N		45	1	U	RA	63.20	N
49	940716	EL		N		41	1	U	RA	63.20	N
50	940716	EL		N		49	1	U	RA	63.20	N
51	940716	EL		N		53	1	U	RA	63.20	N
52	940716	EL		N		98	8	U	RA	63.20	N
53	940716	EL		N		46	1	U	RA	63.20	N
54	940716	EL		N		52	1	U	RA	63.20	N
55	940716	EL		N		67	2	U	RA	63.20	N
56	940716	EL		N		45	1	U	RA	63.20	N
57	940716	EL		N		53	1	U	RA	63.20	N
58	940716	EL		N		92	6	U	RA	63.20	N
59	940716	EL		N		62	1	U	RA	63.20	N
60	940716	EL		N		69	3	U	RA	63.20	N
61	940716	EL		N		47	1	U	RA	63.20	N
62	940716	EL		N		47	1	U	RA	63.20	N
63	940716	EL		N		28	1	U	RA	63.20	N
64	940716	EL		N		85	5	U	RA	63.20	N
65	940716	EL		N		54	1	U	RA	63.20	N
66	940716	EL		N		53	1	U	RA	63.20	N

N	Date	Gear	PIT Tag	Recap	Old Tag	TL	WT	Sex	Disp	RM Capture	Radio
67	940716	TK	7F7F396025	Y	PITTAG	276	179	F	RS	61.95	N
68	940716	TK	7F7F196E07	Y	PITTAG	237	115	M	RA	61.95	N
69	940716	TK	1F1F786664	N		399	481	M	RS	61.85	N
70	940716	TK	1F20510967	N		406	523	M	RS	61.85	N
71	940716	TK	7F7D152D77	Y	PITTAG	363	370	F	RS	61.85	N
72	940716	TK	7F7D401470	Y	PITTAG	412	566	M	RS	61.85	N
73	940716	TK	1F0F754A13	Y	PITTAG	349	286	M	RS	61.85	N
74	940716	TK	7F7D2C1657	Y	PITTAG	384	424	M	RS	61.85	N
75	940716	TK	7F7D2B256C	Y	PITTAG	273	136	M	RS	62.10	N
76	940716	TK	7F7D225674	Y	PITTAG	349	315	M	RS	62.10	N
77	940716	TK	7F7F476C10	Y	PITTAG	330	285	F	RS	62.10	N
78	940716	TN	7F7F480E1B	Y	PITTAG	335	293	M	RS	61.70	N
79	940716	TN	1F20404A47	N		359	344	M	RA	61.70	N
80	940717	EL		N		92	5	U	RA	63.30	N
81	940717	EL		N		97	5	U	RA	63.30	N
82	940717	EL		N		83	4	U	RA	63.30	N
83	940717	EL		N		82	4	U	RA	63.30	N
84	940717	EL		N		89	5	U	RA	63.30	N
85	940717	EL		N		88	4	U	RA	63.30	N
86	940717	EL		N		75	0	U	RA	63.50	N
87	940717	EL		N		57	0	U	RA	63.50	N
88	940717	EL		N		50	0	U	RA	63.50	N

N	Date	Gear	PIT Tag	Recap	Old Tag	TL	WT	Sex	Disp	RM Capture	Radio
89	940717	EL		N		50	0	U	RA	63.50	N
90	940717	EL		N		50	0	U	RA	63.50	N
91	940717	EL		N		101	0	U	RA	63.55	N
92	940717	EL		N		50	0	U	RA	63.55	N
93	940717	EL	1F1F6E4C08	N		177	35	U	RA	64.90	N
94	940717	EL		N		39	0	U	RA	64.90	N
95	940717	MT		N		61	0	U	RA	63.75	N
96	940717	MT		N		105	0	U	RA	63.50	N
97	940717	MT		N		109	0	U	RA	63.50	N
98	940717	MT		N		82	0	U	RA	63.45	N
99	940717	MT		N		64	0	U	RA	63.45	N
100	940717	TK	7F7F3E410F	Y	PITTAG	228	110	M	RA	64.80	N
101	940717	TK	1F1E490B6F	N		248	130	M	RA	64.80	N
102	940717	TK	7F7B023022	Y	PITTAG	379	406	M	RS	64.80	N
103	940717	TK	1F2031612F	N		386	396	M	RS	64.80	N
104	940717	TK	7F7F395960	Y	PITTAG	359	398	M	RS	64.80	N
105	940717	TK	7F7F051102	Y	PITTAG	391	514	F	RS	65.30	N
106	940717	TK	1F201B3A6C	Y	PITTAG	363	396	M	RS	65.30	N
107	940718	EL		N		114	19	U	RA	64.61	N
108	940718	EL		N		111	10	U	RA	64.61	N
109	940718	EL		N		111	10	U	RA	64.61	N
110	940718	EL		N		57	0	U	RA	63.70	N

N	Date	Gear	PIT Tag	Recap	Old Tag	TL	WT	Sex	Disp	RM Capture	Radio
111	940718	EL		N		73	3	U	RA	63.70	N
112	940718	EL		N		60	3	U	RA	63.70	N
113	940718	EL		N		48	0	U	RA	63.70	N
114	940718	EL		N		52	0	U	RA	63.70	N
115	940718	EL		N		54	0	U	RA	63.70	N
116	940718	EL		N		45	0	U	RA	63.70	N
117	940718	EL		N		45	0	U	RA	63.70	N
118	940718	EL		N		46	0	U	RA	63.70	N
119	940718	EL		N		133	19	U	RA	63.65	N
120	940718	EL		N		49	0	U	RA	63.65	N
121	940718	EL		N		41	0	U	RA	63.65	N
122	940718	EL		N		51	0	U	RA	63.65	N
123	940718	EL		N		51	0	U	RA	63.65	N
124	940718	EL		N		41	0	U	RA	63.65	N
125	940718	EL		N		90	6	U	RA	63.65	N
126	940718	EL		N		73	4	U	RA	63.65	N
127	940718	EL		N		76	4	U	RA	63.65	N
128	940718	EL		N		67	0	U	RA	63.65	N
129	940718	EL		N		63	3	U	RA	63.65	N
130	940718	EL		N		43	0	U	RA	63.65	N
131	940718	EL		N		49	0	U	RA	63.65	N
132	940718	EL		N		131	17	U	RA	63.65	N

N	Date	Gear	PIT Tag	Recap	Old Tag	TL	WT	Sex	Disp	RM Capture	Radio
133	940718	EL		N		120	11	U	RA	63.65	N
134	940718	EL		N		109	12	U	RA	63.65	N
135	940718	EL		N		107	12	U	RA	63.65	N
136	940718	EL		N		102	11	U	RA	63.65	N
137	940718	EL		N		90	7	U	RA	63.65	N
138	940718	EL		N		102	8	U	RA	63.65	N
139	940718	MT		N		57	0	U	RA	64.20	N
140	940718	MT		N		68	0	U	RA	64.25	N
141	940718	MT		N		57	0	U	RA	64.25	N
142	940718	MT		N		51	0	U	RA	64.85	N
143	940718	MT		N		48	0	U	RA	64.85	N
144	940718	TK	7F7F47342F	Y	PITTAG	205	91	U	RA	64.80	N
145	940718	TK	7F7D2B147F	Y	PITTAG	378	391	U	RS	65.30	N
146	940719	EL		N		82	3	U	RA	67.20	N
147	940719	EL		N		58	0	U	RA	67.20	N
148	940719	EL		N		55	0	U	RA	67.20	N
149	940719	EL		N		55	0	U	RA	67.20	N
150	940719	EL		N		55	0	U	RA	67.20	N
151	940719	EL		N		54	0	U	RA	67.20	N
152	940719	EL		N		65	0	U	RA	67.20	N
153	940719	EL		N		57	1	U	RA	63.54	N
154	940719	EL		N		107	10	U	RA	67.20	N

N	Date	Gear	PIT Tag	Recap	Old Tag	TL	WT	Sex	Disp	RM Capture	Radio
155	940719	EL		N		110	9	U	RA	67.20	N
156	940719	EL		N		92	7	U	RA	67.20	N
157	940719	EL		N		85	5	U	RA	67.20	N
158	940719	EL		N		87	5	U	RA	67.20	N
159	940719	EL		N		79	3	U	RA	67.20	N
160	940719	MT		N		46	0	I	RA	66.90	N
161	940719	MT		N		49	0	I	RA	66.90	N
162	940719	MT		N		71	0	U	RA	67.80	N
163	940719	MT		N		68	0	U	RA	68.20	N
164	940719	MT		N		65	0	U	RA	68.20	N
165	940719	MT		N		57	0	U	RA	67.80	N
166	940719	MT		N		75	0	U	RA	67.80	N
167	940720	EL		N		54	0	U	RA	67.90	N
168	940720	EL		N		54	0	U	RA	67.90	N
169	940720	EL		N		43	0	U	RA	67.90	N
170	940720	EL		N		132	21	U	RA	67.95	N
171	940720	EL		N		60	0	U	RA	68.10	N
172	940720	EL		N		52	0	U	RA	68.10	N
173	940720	EL		N		58	0	U	RA	68.20	N
174	940720	EL		N		64	0	U	RA	68.20	N
175	940720	EL		N		56	0	U	RA	68.20	N
176	940720	EL		N		51	0	U	RA	68.20	N

N	Date	Gear	PIT Tag	Recap	Old Tag	TL	WT	Sex	Disp	RM Capture	Radio
177	940720	EL		N		37	0	U	RA	68.20	N
178	940720	EL		N		60	0	U	RA	68.20	N
179	940720	EL		N		47	0	U	RA	68.20	N
180	940720	EL		N		58	0	U	RA	68.20	N
181	940720	EL		N		44	0	U	RA	68.20	N
182	940720	EL		N		50	0	U	RA	68.20	N
183	940720	EL		N		63	0	U	RA	68.20	N
184	940720	EL		N		55	0	U	RA	68.20	N
185	940720	EL		N		53	0	U	RA	68.20	N
186	940720	EL		N		63	0	U	RA	68.20	N
187	940720	EL		N		60	0	U	RA	68.20	N
188	940720	EL		N		72	0	U	RA	68.20	N
189	940720	EL		N		80	0	U	RA	68.20	N
190	940720	EL		N		63	0	U	RA	68.20	N
191	940720	EL		N		58	0	U	RA	68.20	N
192	940720	EL		N		48	0	U	RA	67.75	N
193	940720	EL		N		52	0	U	RA	67.75	N
194	940720	EL		N		67	0	U	RA	68.20	N
195	940720	EL		N		69	0	U	RA	68.20	N
196	940720	EL		N		76	0	U	RA	68.20	N
197	940720	EL		N		54	0	U	RA	68.20	N
198	940720	EL		N		67	0	U	RA	68.20	N

N	Date	Gear	PIT Tag	Recap	Old Tag	TL	WT	Sex	Disp	RM Capture	Radio
199	940720	MT		N		65	0	U	RA	67.20	N
200	940720	MT		N		61	0	U	RA	67.20	N
201	940720	MT		N		62	0	U	RA	67.20	N
202	940720	MT		N		55	0	U	RA	67.05	N
203	940720	MT		N		45	0	U	DP	67.05	N
204	940720	MT		N		53	0	U	RA	67.05	N
205	940720	MT		N		55	0	U	RA	67.05	N
206	940720	MT		N		58	0	U	RA	67.80	N
207	940720	MT		N		57	0	U	RA	67.80	N
208	940720	MT		N		70	0	U	RA	67.20	N
209	940720	MT		N		62	0	U	RA	67.20	N
210	940720	MT		N		63	0	U	RA	67.20	N
211	940720	MT		N		69	0	U	RA	67.20	N
212	940720	MT		N		64	0	U	RA	68.20	N
213	940720	MT		N		54	0	U	RA	68.20	N
214	940720	MT		N		53	0	U	RA	68.20	N
215	940721	EL		N		135	25	U	RA	69.90	N
216	940721	EL		N		68	0	U	RA	69.90	N
217	940721	EL		N		62	0	U	RA	69.90	N
218	940721	EL		N		62	0	U	RA	70.10	N
219	940721	EL		N		55	0	U	RA	70.10	N
220	940721	EL		N		58	0	U	RA	70.10	N

N	Date	Gear	PIT Tag	Recap	Old Tag	TL	WT	Sex	Disp	RM Capture	Radio
221	940721	EL		N		66	0	U	RA	70.10	N
222	940721	EL		N		53	0	U	RA	72.35	N
223	940721	EL		N		65	0	U	RA	72.35	N
224	940721	EL		N		47	0	U	RA	72.40	N
225	940721	EL		N		57	0	U	RA	72.40	N
226	940721	EL		N		58	0	U	RA	72.40	N
227	940721	EL		N		51	0	U	RA	72.40	N
228	940721	EL		N		55	0	U	RA	72.40	N
229	940721	EL		N		50	0	U	RA	72.40	N
230	940721	EL		N		43	0	U	RA	72.40	N
231	940721	EL		N		43	0	U	RA	71.75	N
232	940721	EL		N		58	0	U	RA	71.75	N
233	940721	EL		N		58	0	U	RA	71.75	N
234	940721	EL		N		45	0	U	RA	71.75	N
235	940721	MT		N		49	0	U	RA	69.90	N
236	940721	MT		N		55	0	U	RA	69.90	N
237	940721	MT		N		61	0	U	RA	69.90	N
238	940721	MT		N		70	0	U	RA	70.85	N
239	940722	EL		N		55	0	U	RA	71.10	N
240	940722	EL		N		64	0	U	RA	71.10	N
241	940722	EL		N		101	8	U	RA	71.30	N
242	940722	EL		N		58	0	U	RA	71.45	N

N	Date	Gear	PIT Tag	Recap	Old Tag	TL	WT	Sex	Disp	RM Capture	Radio
243	940722	EL		N		51	0	U	RA	71.45	N
244	940722	EL		N		50	0	U	RA	71.45	N
245	940722	EL		N		59	0	U	RA	71.45	N
246	940722	EL		N		45	0	U	RA	71.45	N
247	940722	EL		N		46	0	U	RA	71.45	N
248	940722	EL		N		38	0	U	RA	71.45	N
249	940722	EL		N		60	0	U	RA	71.45	N
250	940722	EL		N		73	0	U	RA	70.60	N
251	940722	EL		N		62	0	U	RA	70.60	N
252	940722	MT		N		60	0	I	RA	71.45	N
253	940722	MT		N		53	0	I	RA	71.45	N
254	940722	MT		N		65	0	U	RA	72.35	N
255	940722	MT		N		64	0	U	RA	72.35	N
256	940722	MT		N		57	0	U	RA	72.35	N
257	940722	MT		N		123	16	U	RA	72.35	N
258	940722	MT		N		61	0	U	RA	72.25	N
259	940722	MT		N		53	0	U	RA	72.25	N
260	940722	MT		N		54	0	U	RA	72.20	N
261	940722	MT		N		54	0	U	RA	71.80	N
262	940722	MT		N		54	0	U	RA	71.80	N
263	940722	MT		N		57	0	U	RA	71.45	N
264	940723	EL		N		126	20	I	RA	76.20	N

N	Date	Gear	PIT Tag	Recap	Old Tag	TL	WT	Sex	Disp	RM Capture	Radio
265	940723	EL		N		82	5	I	RA	76.40	N
266	940723	EL		N		55	5	I	RA	76.40	N
267	940723	EL		N		61	5	I	RA	76.40	N
268	940723	EL		N		30	5	I	RA	76.40	N
269	940723	EL		N		43	0	U	RA	76.40	N
270	940723	EL		N		41	0	U	RA	76.40	N
271	940723	EL		N		52	0	U	RA	76.40	N
272	940723	MT		N		62	0	U	RA	75.85	N
273	940723	MT		N		61	0	U	RA	76.35	N
274	940723	MT		N		55	0	U	RA	76.35	N
275	940723	MT		N		60	0	U	RA	76.35	N
276	940723	MT		N		69	0	U	RA	76.05	N
277	940723	MT		N		52	0	U	RA	76.05	N
278	940723	MT		N		51	0	U	RA	76.05	N
279	940723	MT		N		51	0	U	RA	75.85	N
280	940724	EL		N		46	0	U	RA	76.50	N
281	940724	EL		N		55	0	U	RA	76.50	N
282	940724	EL		N		116	13	U	RA	125.80	N
283	940724	EL	1F1E43146C	N		187	60	U	RA	126.29	N
284	940724	EL		N		46	0	U	RA	76.50	N
285	940724	EL		N		55	0	U	RA	76.50	N
286	940724	EL		N		54	0	U	RA	76.50	N

N	Date	Gear	PIT Tag	Recap	Old Tag	TL	WT	Sex	Disp	RM Capture	Radio
287	940724	EL		N		68	0	U	RA	76.50	N
288	940724	EL		N		56	0	U	RA	76.50	N
289	940724	EL		N		48	0	U	RA	76.50	N
290	940724	MT		N		52	0	U	RA	62.50	N
291	940725	TK	1F20077743	Y	PITTAG	241	137	M	RA	127.10	N
292	940725	TK	1F200F6F43	N		204	92	U	RA	127.10	N
293	940725	TK	1F20376426	N		361	570	F	RS	127.10	N
294	940725	TK	1F1F677269	N		346	490	M	RS	127.10	N
295	940725	TK	1F1F6D0154	N		294	238	M	RS	127.10	N
296	940725	TK	1F201E356E	N		241	141	M	RA	127.10	N
297	940725	TK	1F1F5F756E	N		279	201	F	RS	127.10	N
298	940725	TK	7F7D087B21	Y	PITTAG	312	291	F	RS	127.10	N
299	940725	TK	7F7D090828	Y	PITTAG	352	517	F	RS	127.10	N
300	940726	TK	1F20350705	N		216	101	F	RS	127.10	N