EFFECTS OF INTERIM FLOWS FROM GLEN CANYON DAM ON THE AQUATIC RESOURCES OF THE LOWER COLORADO RIVER FROM NATIONAL CANYON TO LAKE MEAD

Status Report

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SUMMARY

This report summaries preliminary results of Aquatic Surveys for trips 95-01 (April 11-29,1995), and 95-02 (June 13 - July 1, 1995) lead by the Hualapai Department of Natural Resources. Personnel, sampling methods, and preliminary results are presented for ongoing research and management decisions.

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INTRODUCTION:

In 1995 the Hualapai Department of Natural Resources (HDNR) conducted an aquatic resource study in the Colorado River and its tributaries along the Hualapai Indian Reservation. The study continued to supplement research and monitoring conducted for the Hualapai Tribe by BIO/WEST during 1992, 1993,and 1994. The purpose of this investigation was to continue to gather baseline data on aquatic resources in the mainstem Colorado River and its tributaries in Western Grand Canyon, monitor the effects of interim flows from Glen Canyon Dam on fish, macroinvertebrates, algae and water quality in the Colorado River from above the National Canyon (RM 164.5) to Pearce Ferry (RM 286) at Lake Mead, and to integrate these data with existing information on the mainstem aquatic ecology in Western Grand Canyon. This 108.5 mile reach of river forms the northern boundary of the Hualapai Indian Reservation in northwestern Arizona.

Past investigation conducted by BIO/WEST during 1992, 1993, and 1994 began data collection, established sampling protocols, and provided technical assistance and training for HDNR biologists. Information from these years can be found in a 1992 Annual report (Valdez 1993) and Phase I and Phase II report (Valdez 1994 and 1995). The primary objective of these reports was to determine effects of interim flows from Glen Canyon Dam on aquatic resources and also to investigate the aquatic ecology of selected tributaries.

Tribal Involvement

The 1995 Hualapai Aquatic Study was conducted through the direction of the Hualapai Natural Resources Department. The HDNR was responsible for all aspects of project logistics and equipment, quality control, database management, GIS coordination and report preparation. SWCA, Inc. was retained to provide specific professional expertise to the HDNR. SWCA provided training and supervision of Hualapai biologists in the field, in database management and report writing.

Study Plan 1995

The 1995 Hualapai Aquatic Resources Study involved three basic components: (1) continued gathering of baseline information on aquatic resources in Western Grand Canyon. The study design utilized methodologies and rationale outlined in the original technical proposal during Phase I of the Hualapai Fisheries Study (Valdez 1992).

The mainstem Colorado River in Western Grand Canyon below Diamond Creek to Lake Mead is limited in its baseline information on aquatic resources, including fish and lower trophic level food resources. The efforts of the Glen Canyon Environmental Studies have focused primarily on the upper Grand Canyon (Department of

Interior 1998) with few studies extending into Western Grand Canyon to Lake Mead (Deacon and Baker 1976, McCall 1979, Carothers and Minckley 1981). This study provides additional baseline data to supplement and integrate with past and current information in the Colorado River in Western Grand Canyon.

The tributaries of Colorado River in Western Grand Canyon may be important to mainstem fishes, especially native species. Diamond, Spencer, Surprise, and Lost Creeks were the focus of tributary sampling. Investigations to date indicate that key tributaries and the Lake Mead inflow are productive areas that could support self-sustaining populations of native species if limiting factors can be identified and rectified.

The GCDEIS also include the study of selective withdrawal structures at Glen Canyon Dam as a common element of the preferred alternative (USDOI 1994). This structural modification to the dam would increase the temperatures of release water that may enhance native fish populations downstream. Information collected from the HDNR study will compliment the existing database on temperature affects on the aquatic food base and non-native fishes that may interact with native species in Grand Canyon.

Objectives

The objectives of the HDNR 1995 Study Plan were to; 1) supplement the existing aquatic resources database with additional baseline information 2) determine effects of interim flows from Glen Canyon Dam on aquatic resources 3) synthesize existing aquatic resource data with 1995 data for Western Grand Canyon. The following elements will be evaluated with respect to the above objectives:

1. Distribution and abundance of native and non-native adult fish.

Adult fish distribution and abundance may be affected by dam operations, physical habitat and river temperature. Analyses was conducted to determine factors that may affect young Colorado River fishes.

2. Distribution and abundance of larval and juvenile stages of native fishes.

Larval and juvenile fishes may be affected by dam operations, available physical habitat and river temperatures. Analyses was conducted to determine factors that may affect young Colorado River fishes.

3. Reproduction, food habits, movement, and patterns of habitat use of non-native fishes that may interact with native fishes.

Non-native fish reproductive seasonality use of habitat was examined to determine spawning periods and habitat preferences. Movement of potential predators (striped bass and channel catfish) was determined by analysis of mark/recapture data. Distribution

and movement of non-native fishes related to seasonal river temperatures was analyzed. Food habits of non-native fishes were analyzed to determine feeding habits with emphasis on piscivorous feeding habits.

4. Physical habitat available for native and non-native fishes; including shallow shorelines, tributary mouths, water quality, and the Lake Mead inflow.

Physical habitat was mapped in conjunction with fish capture locations to determine limiting factors for fish species, especially native fishes. Temperature profiles in the mainstem and selected tributaries were analyzed seasonally.

5. Reproductive success of native fishes in the mainstem and tributaries.

Seining, minnow trapping and light trapping were used to locate young of year and juvenile native fishes and determine seasonal abundance patterns.

6. Aquatic food base, including benthic and drifting macroinvertebrates and algae.

Important factors that affect the aquatic food base were determined by analyzing benthic and drifting organisms with respect to dam operations, temperature and habitat. Both mainstem and tributaries were sampled.

7. Tributary fish communities and interactions.

Baseline data on tributary fish communities was collected with respect to seasonality and available habitat conditions. Factors that may influence the compositions and abundance of fishes at the confluence reaches were the primary areas of attention.

II. SAMPLING METHODS:

Fish in the mainstem and tributary inflows were sampled with seven primary gear types, including; electrofishing, gill and trammel nets, hoop nets, minnow traps, seines, and angling. Striped bass and channel catfish were tagged with Floy tags to assist in evaluating seasonal movements into Grand Canyon from Lake Mead. Larval light traps and were used in spring to determine the presence of larval flannelmouth and razorback suckers. Macroinvertebrates were sampled with Hess and Surber bottom samplers and drift nets. Water quality was recorded with YSI and Ryan Tempmentor remote temperature records. River stage changes were measured with temporary staff gages.

Mainstem

Mainstem sampling was conducted within the five longitudinal geomorphic strata establishing by BIO/WEST (Valdez 1993 and 1994). Sampling was distributed within each stratum, with emphasis on tributary inflows (i.e., Diamond Creek, Travertine Creek, Spencer Creek, Surprise Creek, Lost Creek, and Quartermaster Creek) and GIS sites. Sampling was conducted from temporary camps, and sample locations accessed by 16 and 18 foot Achilles research boats, equipped for netting or electrofishing.

Mainstem sampling emphasized locales within the GCES long-term monitoring sites. These sites include sites 10, 11, 12, and 13 which correspond to the Lava Falls, Granite Park, Diamond Creek, and Emery Falls areas. All sample efforts within these sites were mapped onto Mylar overlays from 1:2400 aerial photographs. These overlays were used to transfer sample locations onto the Hualapai Geographic Information System (GIS) for long-term archival.

Tributary

Tributaries sampled for fish composition and presence of native species included Diamond Creek, Travertine Creek, Spencer Creek, Surprise Creek, and Lost Creek. These tributaries were sampled for species composition and abundance, emphasizing reaches at creek mouths that may be under the influence of mainstem river fluctuations.

Spencer Creek was sampled more intensively because it is the largest perennial tributary in the study reach and supports substantial numbers of native and non-native fishes immigrating from the mainstem on a seasonal basis. A stratified random design was used to sample fish, benthic macroinvertebrates, and algal communities. The stream was divided into a minimum of two longitudinal strata, based on geomorphic and habitat similarity, including a lower alluvial stratum with low gradient near the mainstem Colorado River and upper reaches of the creek that may include a barrier to non-native fish dispersal upstream. The absence of non-native fishes in the upper stratum suggest that a swift chute channel approximately one kilometer from the mouth is a barrier to most upstream fish movement.

Invertebrates and Algae

Drifting macroinvertebrates were collected using drift nets (30.48 x 45.72 cm) placed along shorelines with sufficient current. These nets had a mesh size of 600 micrometers and were 3 meters in length. Swoffer current meters and wading rods were used to determine current velocity through each drift net. Volume of water filtered through each net was then calculated.

Drift sampling was conducted in the mainstem Colorado River and Spencer Creek. In the mainstem, two primary objectives were sought. The first was to monitor the effects of fluctuating flows on drift density and volume, and the second was to

determine longitudinal changes in macroinvertebrate distribution from National Canyon to Pearce Ferry. Tributary drift was collected in Spencer Creek as a baseline to compare to the mainstem collections.

All drift samples were preserved in the field with 70 percent ethanol and sealed in either whirl-packs or Ziplock bags. Each sample container was labeled appropriately. Samples were analyzed in the laboratory under low magnification to assure identification of invertebrates to at least the family level. Volumetric and density estimates of aquatic macroinvertebrates and algae were determined in the laboratory and will be reported in the draft final report.

Drift data for the final report will be transformed into sample drift density (macroinvertebrates/100 cubic meters water filtered, orgs/100m^3wf), as outlined by Allen and Russek (1985). The number of macroinvertebrates per net hour were determined from the sample and the following equation used:

$$\text{Sample Drift Density} = \frac{\text{numbers per net hour}}{m^3 \text{ filtered per net hour}} \times 100$$

Benthic Macroinvertebrate

Samples were taken to determine benthic macroinvertebrate densities and distribution primarily in tributaries and in several nearshore mainstem habitats. The primary focus was to determine if the benthic community from tributaries like Spencer Creek were important in food habits of fishes and possibly responsible for structuring the fish community within Spencer Creek. Surber samplers were utilized to sample the benthos within subreaches of Spencer Creek. Hess bottom samplers were used in the limited mainstem samples. Data from benthic samples will be reported in the draft report.

Fish Food Habit

Stomach contents of non-native fishes were analyzed by sacrificing subsamples of channel catfish and striped bass. Stomach samples were preserved in the field with 70% ethanol and analyzed in the laboratory.

IV. PRELIMINARY RESULTS:

Fish Populations

Fish populations were sampled throughout the boundaries of the Hualapai Indian Reservation with heavy concentrations within GIS Sites 10,11,12,and 13.

Reach 3, National Canyon to Diamond Creek produced 10 different species with dominated presence of speckled dace, fathead minnows, and flannelmouth suckers. Refer to Tables 2 and 3 for further results.

Reach 4, Diamond Creek to Pearce Ferry, produced 16 species of fish. Dominant species were red shiners, common carp and speckled dace. Refer to Tables 4 and 5 for further results.

Native Fish

Within Reach 3 a total of 227 flannelmouth (FM) suckers were captured consisting of 52 Young of Year (YOY), 109 Juveniles (Juv), and 66 adults. Reach 4 produced 36 flannelmouths consisting of 16 YOY, 4 Juv, and 16 adults. For both reach 3 and 4, 74 flannelmouths were implanted with PIT-Tags. Recapture rate for these suckers was 13.5%.

Bluehead sucker (BH) captured within Reach 3 resulted in 14 fish consisting of 4 YOY, 6 Juv, and 4 adults. Five (5) of these nine (9) fish were implanted with PIT-Tags with no recaptures. Reach 4 produced 2 juveniles.

Four hundred and forty six (446) speckled dace (SD) were captured in reach 3; 5 YOY, 4 Juv, and 437 adults. Reach 4 produced 1 YOY, 8 juv and 268 adults.

One humpback chub was captured at RM 181.2. This chub weighed 202 grams and was 275 mm TL. It was not PIT tagged. Unfortunately, this fish was found dead in the net. The chub was found entangled along with debris associated with higher flows. This debris may have contributed to its death.

Water Quality

Water quality data was collected at 19 sites throughout the study reaches 3 and 4. Temperature, conductivity, dissolved oxygen, and pH were monitored. Fifteen of these sites were sampled within the mainstem. Temperature ranges in Trip 95-01 were from 11.5 to 14.8 degrees celsius. Within Trip 95-02 temperatures ranged from 13.4 to 16.4 degrees celsius. The remaining four sites were located in tributaries: Spencer, Travertine Falls, Bridge and Quartermaster. **Refer to Table 11 for details.**

Changes In River Stage

Six (6) mainstem sites were monitored in April 1995. Monitoring sites were as follows: Cove Canyon RM 174.3, RM 182.8, Granite Park RM 208.9, Travertine Falls RM 230.4, Spencer Creek RM 245.9, and Boundary Canyon RM 273.3. Three (3) of these sites were located in reach 3 and three (3) sites within reach 4. Eight (8)

mainstem sites were monitored during Trip # 95-02. Monitoring sites were as follows: RM 171.0, RM 183.1, Granite Park RM 208.9, Travertine Falls RM 230.4, RM 242.7, Spencer Creek RM 245.9, RM 259.8 Quartermaster, and Boundary Canyon RM 273.3. Three (3) of these sites were located in reach 3 and five (5) sites within reach 4. The maximum stage change for both trips occurred at Granite Park RM 208.9. April 16-17, 1995 the stage change was 66 cm within a 12 hour period. On June 18, 1995 the stage changed 37 cm within a 14 hour period.

Drift

Sampling for drifting macroinvertebrates and algae was conducted at four sites in April 1995 and five sites in June 1995 (Table 6). These collection sites were within the GCES long-term monitoring GIS stations (sites 10,11,12, and 13) where possible, or at least within close proximity. A total of 31 collections were made during each sampling trip.

A minimum of nine orders of aquatic invertebrates and several more orders of terrestrial invertebrates were represented in drift collections (Table 7). Occurrence of the various taxa appeared somewhat evenly distributed throughout the study reach. No larval fish were collected during drift sampling.

Benthic Invertebrates

Sampling for benthic macroinvertebrates was conducted at three sites in April 1995 and two sites in June 1995 (Table 6). Most benthic sampling was conducted in tributaries, primarily Spencer Creek. Both Hess and surber samplers were utilized. Densities, abundance, and distribution data will be included in the draft final report.

Fish Food Habits

A total of 58 fish were analyzed for dietary analysis during April and June 1995. During April 1995, 14 channel catfish and 16 striped bass were collected and stomach contents analyzed.

Channel catfish were more diverse in there diet, consuming many different invertebrate taxa (Table 8 and 9). Striped bass preyed mostly on other fish. During June 1995, striped bass consumed Simuliidae (black flies) and Chiromonidae (midges) in addition to fish (Table 9).

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Table 1. Participating Personnel for Trip No. 95-01 and 95-02, Hualapai Aquatic Studies

Personnel	Affliation	Trips	Comments
Bill Leibfried	SWCA, Inc.	95-01 Reach 3	Principle Investigator
		95-02 Reach 3	
Ben Zimmerman	Hualapai	95-01 Reach 3 and 4	Project Leader
		95-02 Reach 4	
Michael Vaughn	Hualapai	95-01 Reach 3 and 4	Biologist
		95-02 Reach 3 and 4	
Richard Beecher	Hualapai	95-01 Reach 3 and 4	Biologist
		95-02 Reach 3 and 4	
Scott Crozier	Hualapai	95-01 Reach 4	Boatman\Cook
		95-02 Reach 3	Biologist
Connie Graham	SWCA, Inc.	95-01 Reach 3 and 4	Biologist
		95-02 Reach 3 and 4	
Mimi Murov	SWCA, Inc.	95-02 Reach 4	Biologist
Duffy McCabe	OARS/SWCA, Inc.	95-02 Reach 3 and 4	Boatman\Electrofishing Boatman
Lars Niemi	OARS/SWCA, Inc.	95-02 Reach 3 and 4	Boatman\Electrofishing Boatman
Phil Beck	OARS	95-02 Reach 3	Boatman\Cook
Melissa Richmond	Hualapai	95-02 Reach 4	Cook
Gloria Hardwick	SWCA, Inc.	95-01 Reach 4	Project Leader
Jimmy Hall	OARS	95-01 Reach 3 and 4	Boatman\Cook
David Brown	OARS	95-01 Reach 3	Boatman\Cook
Bill Ellwanger	SWCA, Inc.	95-01 Reach 3	Electrofishing Boatman
Steve Bledeso	SWCA, Inc.	95-01 Reach 4	Electrofishing Boatman

****Trip # 95-01 Reach 3 = April 11-18, 1995**
Reach 4 = April 18-29, 1995

****Trip # 95-02 Reach 3 = June 13-20, 1995**
Reach 4 = June 20-July 1, 1995

Table 2. Summary of Fish Captured with Reach 3, Trip NO. 95-01, Hualapai Indian Reservation. April 11-18, 1995.								
		MINNOW TRAPS	NETTING	SEINING	ELECTRO-BOAT	TOTALS		
COMMON CARP	YOY					0		
	JUV				3	3		
	ADULT		7		73	80		
CHANNEL CATFISH	YOY					0		
	JUV					0		
	ADULT		4			4		
STRIPED BASS	YOY					0		
	JUV					0		
	ADULT		1			1		
SPECKLED DACE	YOY					0		
	JUV			1		1		
	ADULT	2		139	7	148		
RED SHINER	YOY					0		
	JUV					0		
	ADULT					0		
FATHEAD MINNOW	YOY			2		2		
	JUV				1	1		
	ADULT	4		117	16	137		
FLANNEL-MOUTH	YOY	1		18		19		
	JUV	1		17	9	27		
	ADULT		27		12	39		
RAINBOW TROUT	YOY				1	1		
	JUV					0		
	ADULT					0		
BLUEHEAD PLAINS KILLI-FISH	YOY			2	1	3		
	JUV			1	1	2		
	ADULT		4			4		
	YOY					0		
	JUV					0		
	ADULT			3		3		
TOTALS		8	43	300	124	475		

Table 3. Summary of Fish Captured with Reach 3, Trip NO. 95-02. June 13-June 20, 1995						
		MINNOW TRAPS	NETTING	SEINING	ELECTRO-BOAT	TOTALS
COMMON	YOY			6		6
CARP	JUV		1			1
	ADULT		13		18	31
CHANNEL	YOY					0
CATFISH	JUV					0
	ADULT		2	1		3
STRIPED	YOY					0
BASS	JUV					0
	ADULT		5			5
SPECKLED	YOY			5		5
DACE	JUV			3		3
	ADULT	127		131	31	289
RED SHINER	YOY					0
	JUV					0
	ADULT					0
FATHEAD	YOY			84		84
MINNOW	JUV			9		9
	ADULT	12		39	5	56
FLANNEL-	YOY			30	3	33
MOUTH	JUV	9		68	5	82
	ADULT		22		5	27
RAINBOW	YOY					0
TROUT	JUV				1	1
	ADULT		2	1		3
BLUEHEAD	YOY	1				1
	JUV			3	1	4
	ADULT					0
HUMPBACK	YOY					0
CHUB	JUV					0
	ADULT		1			1
TOTALS		149	46	380	69	644

Table 4. Summary of Fish Captured in Reach 4, Trip NO. 95-01, Hualapai Indian Reservation. April 18-29, 1995								
		MINNOW TRAPS	LIGHT TRAPPING	NETTING	SEINING	ELECTRO-BOAT	ELECTRO-BACKPACK	TOTALS
COMMON	YOY				1			1
CARP	JUV					5		5
	ADULT			79		8	3	90
CHANNEL	YOY							0
CATFISH	JUV					1		1
	ADULT			20		1	3	24
STRIPED	YOY							0
BASS	JUV					7		7
	ADULT			31		23		54
SPECKLED	YOY							0
DACE	JUV							0
	ADULT	2			1		58	61
RED SHINER	YOY					1		1
	JUV							0
	ADULT	152	2		1792	94	29	2069
FATHEAD	YOY							0
MINNOW	JUV							0
	ADULT	16			12	1		29
FLANNEL-	YOY				6			6
MOUTH	JUV	1						1
	ADULT			6	3	3		12
RAINBOW	YOY							0
TROUT	JUV							0
	ADULT							0
BLUEHEAD	YOY							0
	JUV							0
	ADULT							0
PLAINS KILLI-	YOY							0
FISH	JUV							0
	ADULT						1	1
GREEN	YOY							0
SUNFISH	JUV							0
	ADULT					1		1
THREADFIN	YOY							0
SHAD	JUV							0
	ADULT			1		7		8
BLUEGILL	YOY							0
	JUV							0
	ADULT			1				1
LARGEMOUTH	YOY							0
BASS	JUV							0
	ADULT			1				1
MOSQUITO-	YOY				1			1
FISH	JUV							0
	ADULT				13			13
TOTALS		171	2	139	1829	152	94	2387

Table 5. Summary of Fish Captured in Reach 4, Trip NO. 95-02, June 20-July 1, 1995								
		MINNOW TRAPS	LIGHT TRAPPING	NETTING	SEINING	ELECTRO-BOAT	ELECTRO-BACKPACK	TOTALS
COMMON	YOY	1						1
CARP	JUV						3	3
	ADULT			27		5	35	67
CHANNEL	YOY							0
CATFISH	JUV							0
	ADULT			62		5	31	98
STRIPED	YOY							0
BASS	JUV					3		3
	ADULT			2		6		8
SPECKLED	YOY						1	1
DACE	JUV	1				7		8
	ADULT	36			12		159	207
RED SHINER	YOY	81	9		117	18	10	235
	JUV				43			43
	ADULT	113	1		305	27	48	494
FATHEAD	YOY			1				1
MINNOW	JUV							0
	ADULT				2			2
FLANNEL-	YOY	9				1		10
MOUTH	JUV	3						3
	ADULT			3	1			4
RAINBOW	YOY							0
TROUT	JUV							0
	ADULT			1				1
BLUEHEAD	YOY							0
	JUV	2						2
	ADULT							0
PLAINS KILLI-	YOY				1			1
FISH	JUV				3			3
	ADULT	5						5
GREEN	YOY							0
SUNFISH	JUV							0
	ADULT						3	3
THREADFIN	YOY	1	6					7
SHAD	JUV							0
	ADULT			1				1
BLUEGILL	YOY							0
	JUV							0
	ADULT					1		1
LARGEMOUTH	YOY						2	2
BASS	JUV				1		1	2
	ADULT			2		1		3
BLACK	YOY	1						1
CRAPPIE	JUV							0
	ADULT			1				1
TOTALS		253	16	100	485	74	293	1221

TABLE 6. LOCATION OF PRIMARY/SECONDARY PRODUCTIVITY SAMPLING SITES FOR HUALAPAI APRIL AND JUNE 1995 RIVER TRIPS

DATE	SAMPLE.....	LOCATION(RM).....					TOTAL # SAMPLES TAKEN
9504	DRIFT	182.3	208.9	-	246	274.2	31
	HESS	182.3	209	-	246*	-	9
	SURBER	-	-	-	246*	-	1
9506	DRIFT	183.1	209	229.6	245.8	273.5	31
	HESS	-	-	229.1*	-	-	2
	SURBER	-	-	-	246*	-	3

* denotes sample was taken in a tributary.

TABLE 7. LOCATION AND INVERTEBRATE TAXA FROM DRIFT SAMPLES

	LOCATION	Lava		Granite Park		Travertine Canyon mainstem		Spencer Creek mainstem		Emery Falls mainstem	
	DATE	9504	9506	9504	9506	9504	9506	9504	9506	9504	9506
	RM	182.3	183.1	208.9	109	229.6	-	246	245.8	274.2	273.5
	# SAMPLES TAKEN	8	6	8	7	6	0	9	6	6	6
FOOD TYPE											
Simuliidae		x	x	x	x	x		x	x	x	x
Chironimidae		x	x	x	x	x		x	x	x	x
Gammarus		x	x	x	x	x			x		
Annelid						x				x	
Aquatic other		x	x		x			x	x	x	
Diptera		x	x	x	x	x		x	x	x	
Neuroptera											
Trichoptera		x	x	x	x	x		x	x	x	x
Hemiptera		x							x		x
Ephemeroptera		x	x					x	x		x
Hydracarina		x	x	x	x			x		x	x
Copepoda					x			x			
Terrestrial		x	x	x	x	x		x	x	x	x
FISH											

A total of 31 drift samples were taken during both the 9504 and the 9506 trip.
Samples were taken during rising, falling and steady flows.

TABLE 8. FOOD ITEMS CONSUMED BY CHANNEL CATFISH AND STRIPED BASS DURING HUALAPAI APRIL 1995 TRIP.

	LOCATION AND FISH TYPE															
	RM 180.9-182.7*		RM 208*		RM 224.9		RM 239.6-242.5		RM 245.9-249.5*		RM 259.0-280.5*		IN SPENCER CREEK	
	CC	SB	CC	SB	CC	SB	CC	SB	CC	SB	CC	SB	CC	SB
# fish caught	2	0	0	1	1	0	3	2	2	2	3	11	3	0
FOOD TYPE														
Simuliidae	x				x		x				x			
Chironimidae	x				x				x		x			
Gammarus	x													
Aquatic other	x								x				x	
Diptera	x				x				x		x		x	
Neuroptera														
Trichoptera	x				x						x			
Hemiptera														
Ephemeroptera									x		x			
Hydracarina														
Copepoda													x	
Terrestrial	x				x		x		x		x			
FISH				x						x		x		
CLADOPHORA	x			x			x		x		x		x	
DETRITUS							x		x		x			
FOOD SCRAPS					x				x					
VERTEBRATE														

TOTAL # CC CAUGHT DURING APRIL	14
TOTAL # SB CAUGHT DURING APRIL	16
TOTAL FISH CAUGHT IN JUNE	30

* GIS Site # 10 included in RM 180.9-182.7
* GIS Site # 11 encompasses RM 207-210
* GIS Site # 12 included in RM 224.9
* GIS Site # 13 included in RM 259.0-280.5

TABLE 9. FOOD ITEMS CONSUMED BY CHANNEL CATFISH AND STRIPED BASS DURING HUALAPAI JUNE 1995 TRIP.

LOCATION AND FISH TYPE

	RM 180.9-181.4*		RM 207.4-209.3*		RM 230.5		RM 239.6-242.0		RM 245.3-246.5*		RM 253.2-275.4*		IN SPENCER CREEK	
	CC	SB	CC	SB	CC	SB	CC	SB	CC	SB	CC	SB	CC	SB
# fish caught	0	2	3	2	0	1	5	0	6	1	2	3	4	0
FOOD TYPE														
Simuliidae			x	x		x	x		x				x	
Chironimidae			x	x		x	x		x				x	
Gammarus							x							
Aquatic other			x				x						x	
Diptera			x				x		x				x	
Neuroptera			x											
Trichoptera			x				x		x				x	
Hemiptera							x							
Ephemeroptera			x				x						x	
Hydracarina			x											
Copepoda														
Terrestrial			x				x		x		x		x	
FISH		x		x		x				x		x		
CLADOPHORA			x				x		x				x	
DETRITUS			x	x			x		x		x			
FOOD SCRAPS							x							
VERTEBRATE														

TOTAL # CC CAUGHT DURING JUNE	19
TOTAL # SB CAUGHT DURING JUNE	9
TOTAL FISH CAUGHT IN JUNE	28

* GIS Site # 10 included in RM 180.9-181.4
* GIS Site # 11 encompasses RM 207.4-209.3
* GIS Site # 12 included in RM 245.3-246.5
* GIS Site # 13 included in RM 253.2-275.4

TABLE 10. SUMMARY OF PIT AND FLOY TAGS FOR TRIP NO. 95-01 and 95-02, HUALAPAI AQUATIC STUDIES

SPECIES	DATE	TAG #	RECAPTURE	TL	SL	WT	RM	SEX
BH	12-Apr-95	1F7776581C	N	213	176	112	185.1	U
BH	12-Apr-95	1F7B5E4444	N	235	202	125	173.1	M
BH	17-Apr-95	1F7B50791D	N	241	210	166	207.3	F
BH	12-Apr-95	1F783E2B00	N	252	217	166	172.8	M
BH	12-Apr-95	1F7B16646C	N	264	226	169	172.8	F
CC	14-Apr-95	02729FLAGY	N	281	212	227	180.9	U
CC	13-Apr-95	02728FLAGY	N	333	265	-	182.2	U
CC	15-Apr-95	02730FLAGY	N	358	285	340	180.9	U
FM	17-Apr-95	1F7B5A325A	N	189	153	75	208.9	U
FM	13-Apr-95	1F7B601274	N	193	165	70	183.3	U
FM	14-Apr-95	1F7B520A0A	N	207	179	88	181.4	M
FM	16-Apr-95	1F78117464	N	213	180	110	207.4	M
FM	15-Apr-95	1F7A357042	N	221	189	110	208.6	M
FM	13-Apr-95	1F7A3A2805	N	221	187	113	183.3	M
FM	16-Apr-95	1F78342D08	N	222	187	120	207.4	F
FM	13-Apr-95	1F7820526A	N	230	203	113	183.3	M
FM	17-Apr-95	1F781C2A23	N	248	211	146	208.9	M
FM	16-Apr-95	1F7A33753F	N	264	222	178	208.6	M
FM	13-Apr-95	1F782C023B	N	264	222	188	172.9	M
FM	12-Apr-95	1F14325843	Y	280	230	249	173.5	M
FM	13-Apr-95	1F7B5F4245	N	283	245	230	183.3	M
FM	14-Apr-95	1F7878155C	N	285	243	491	182.3	M
FM	15-Apr-95	1F7A7E5B0E	N	287	243	256	208.6	M
FM	13-Apr-95	1F78205178	N	297	252	260	183.3	M
FM	16-Apr-95	1F7B140B47	N	305	262	301	208.9	M
FM	15-Apr-95	1F7B647B07	N	307	257	303	208.9	M
FM	12-Apr-95	1F7A3C3279	N	314	268	382	172.9	U
FM	14-Apr-95	1F7A1C1734	N	322	277	311	182.6	M
FM	12-Apr-95	1F7B69017C	N	324	270	311	172.8	M
FM	13-Apr-95	1F7B08104E	N	326	283	360	180.9	M
FM	16-Apr-95	1F7A7E4128	N	351	296	555	208.0	M
FM	12-Apr-95	1F7B074916	N	355	310	430	172.8	M
FM	13-Apr-95	1F78250828	N	361	304	494	184.1	M
FM	16-Apr-95	1F78707405	N	365	313	493	208.1	M
FM	16-Apr-95	1F78707405	Y	369	315	496	208.2	M
FM	14-Apr-95	1F7B065010	N	370	315	609	182.6	F
FM	14-Apr-95	1F78364F64	N	370	316	533	182.3	M
FM	13-Apr-95	1F7A7A7A73	N	379	330	502	183.3	M
FM	17-Apr-95	1F780F0F4B	N	381	329	654	208.0	M
FM	14-Apr-95	1F1F780842	Y	391	333	625	180.9	M
FM	15-Apr-95	7F7D1E1C6D	N	410	355	734	180.9	F
FM	12-Apr-95	1F7BG11C69	N	414	354	617	172.8	M
FM	14-Apr-95	1F7775462F	Y	416	346	699	180.9	F
FM	14-Apr-95	177775462F	Y	417	350	697	180.9	F
FM	14-Apr-95	1F7775462F	Y	419	354	694	180.9	F
FM	13-Apr-95	1F7B16420E	N	421	355	609	173.1	F
FM	16-Apr-95	1F78086B76	N	430	366	798	208.6	M
FM	13-Apr-95	1F7A38250A	N	442	375	888	182.3	F
FM	14-Apr-95	1F78301524	N	444	375	767	182.8	M
FM	14-Apr-95	1F7B0F1245	N	452	385	907	180.9	F
CC	26-Apr-95	02900FLAGY	N	172	130	57	275.5	U
CC	21-Apr-95	02737FLAGY	N	237	187	100	240.8	U
CC	26-Apr-95	02166FLAGY	N	249	199	170	272.1	U
CC	26-Apr-95	02170FLAGY	N	269	211	170	272.2	U

Table 10 cont.

SPECIES	DATE	TAG #	RECAPTURE	TL	SL	WT	RM	SEX
CC	26-Apr-95	02170FLAGY	N	269	211	170	272.2	U
CC	27-Apr-95	02175FLAGY	N	278	225	227	274.4	U
CC	27-Apr-95	02172FLAGY	N	316	256	794	274.4	U
CC	25-Apr-95	02158FLAGY	N	327	264	340	274.2	U
CC	24-Apr-95	02748FLAGY	N	330	258	255	248.0	U
CC	26-Apr-95	02167FLAGY	N	330	259	284	273.1	U
CC	19-Apr-95	02731FLAGY	N	332	262	340	228.9	U
CC	28-Apr-95	02895FLAGY	N	340	281	312	280.5	U
CC	20-Apr-95	02461FLAGY	N	350	280	482	274.1	U
CC	21-Apr-95	02738FLAGY	N	365	291	397	240.9	U
CC	22-Apr-95	02744FLAGY	N	365	283	397	246.0	U
FM	24-Apr-95	1F7B03243F	N	272	228	154	260.1	U
FM	21-Apr-95	1F2F384D2D	Y	287	235	212	245.8	U
FM	21-Apr-95	1F77753243	N	318	260	293	240.8	M
FM	26-Apr-95	1F7815163E	N	374	315	491	274.7	U
FM	24-Apr-95	7F7D400379	Y	402	340	598	247.9	F
FM	28-Apr-95	1F777E7379	N	449	378	961	280.5	M
LB	28-Apr-95	02893FLAGY	N	435	363	1247	280.5	F
SB	27-Apr-95	02174FLAGY	N	222	174	113	274.4	U
SB	22-Apr-95	02467FLAGY	N	240	222	142	249.6	U
SB	24-Apr-95	02154FLAGY	N	303	239	227	249.8	U
SB	21-Apr-95	02740FLAGY	N	314	250	227	240.8	U
SB	21-Apr-95	02742FLAGY	N	342	273	369	245.5	U
SB	20-Apr-95	02734FLAGY	N	346	277	348	242.0	U
SB	24-Apr-95	02747FLAGY	N	367	295	311	248.0	U
SB	23-Apr-95	02470FLAGY	N	370	345	907	246.0	U
SB	27-Apr-95	02171FLAGY	N	376	350	567	274.7	U
SB	26-Apr-95	02168FLAGY	N	382	304	680	272.1	U
SB	26-Apr-95	02899FLAGY	N	386	309	454	275.8	U
SB	28-Apr-95	02169FLAGY	N	401	316	567	280.5	U
SB	24-Apr-95	02155FLAGY	N	420	335	510	260.2	U
SB	28-Apr-95	02897FLAGY	N	433	335	964	280.5	U
SB	28-Apr-95	02894FLAGY	N	435	356	652	280.5	U
SB	28-Apr-95	02896FLAGY	N	441	363	737	280.5	U
SB	28-Apr-95	02898FLAGY	N	446	358	964	280.5	U
SB	20-Apr-95	02464FLAGY	N	500	408	936	274.1	U
FM	14-Jun-95	7F7A0F146F	N	272	224	198	168.9	M
FM	14-Jun-95	1F7B534350	N	285	234	258	169.8	M
FM	14-Jun-95	1F7A3B317B	N	300	256	277	169.8	M
FM	15-Jun-95	7F7B073964	Y	329	280	323	180.6	M
FM	15-Jun-95	1F78303E7B	N	386	330	561	181.2	U
FM	15-Jun-95	1F78216563	N	392	335	662	180.6	F
FM	15-Jun-95	1F7777591A	N	394	345	606	180.9	M
FM	16-Jun-95	1F7B10272F	N	283	239	205	181.4	M
FM	16-Jun-95	1F7A711A5L	N	500	430	1523	182.2	F
CC	17-Jun-95	02573FLAGY	N	287	235	254	208.9	U
FM	17-Jun-95	1F7A321520	N	245	205	140	208.4	M
FM	17-Jun-95	1F7A357042	Y	251	215	150	208.4	M
FM	17-Jun-95	1F7A36327F	N	277	235	210	208.4	M
FM	17-Jun-95	1F7A334F65	N	281	244	200	208.4	M
FM	17-Jun-95	1F78166D66	N	346	293	352	208.4	M
FM	17-Jun-95	1F7825556F	N	363	308	445	208.4	F
FM	17-Jun-95	1F7A7E4128	Y	371	310	500	208.4	M
FM	17-Jun-95	1F78287948	N	375	320	433	208.4	M

Table 10 cont.

SPECIES	DATE	TAG #	RECAPTURE	TL	SL	WT	RM	SEX
FM	17-Jun-95	1F7A3B2A02	N	511	440	1363	208.4	F
SB	17-Jun-95	02574FLAGY	N	611	495	2255	180.8	U
CC	18-Jun-95	02565FLAGY	N	277	217	255	208.2	M
CC	18-Jun-95	02508FLAGY	N	313	245	284	207.4	U
FM	18-Jun-95	1F78253113	N	428	355	690	208.0	F
SB	18-Jun-95	02564FLAGY	N	512	425	1134	207.4	U
FM	19-Jun-95	1F7773787F	N	240	205	123	209.3	M
FM	19-Jun-95	1F78232B1B	N	245	203	148	207.3	M
FM	19-Jun-95	1F7A2A5766	N	386	283	390	207.3	F
FM	19-Jun-95	1F780C5A03	N	402	339	593	207.4	M
SB	19-Jun-95	02563FLAGY	N	411	335	567	209.3	U
CC	21-Jun-95	02277FLAGY	N	290	240	227	230.3	U
CC	21-Jun-95	02552FLAGY	N	319	248	227	230.3	U
SB	21-Jun-95	02554FLAGY	N	349	282	284	230.3	U
CC	22-Jun-95	02285FLAGY	N	222	173	170	242.0	U
CC	22-Jun-95	02285FLAGY	N	225	175	113	242.0	U
CC	22-Jun-95	02281FLAGY	N	226	181	142	240.1	U
CC	22-Jun-95	02288FLAGY	N	240	190	113	242.0	U
CC	22-Jun-95	02279FLAGY	N	244	193	170	240.1	U
CC	22-Jun-95	02282FLAGY	N	255	200	113	240.2	U
CC	22-Jun-95	02278FLAGY	N	257	200	170	239.6	U
CC	22-Jun-95	02292FLAGY	N	258	200	170	242.0	U
CC	22-Jun-95	02290FLAGY	N	265	206	113	239.6	U
CC	22-Jun-95	02291FLAGY	N	267	213	142	240.1	U
CC	22-Jun-95	02289FLAGY	N	352	283	284	239.5	U
FM	22-Jun-95	1F7A2B0E2E	N	394	327	580	240.2	U
LG	22-Jun-95	02891FLAGY	N	228	182		236.5	U
CC	23-Jun-95	02297FLAGY	N	214	171	142	241.0	U
CC	23-Jun-95	02299FLAGY	N	244	194	113	243.1	U
CC	23-Jun-95	02232FLAGY	N	256	204	170	243.1	U
CC	23-Jun-95	02298FLAGY	N	265	209	142	141.9	U
CC	23-Jun-95	02557FLAGY	N	268	213	227	247.5	U
CC	23-Jun-95	02164FLAGY	N	272	215	227	247.5	U
CC	23-Jun-95	02570FLAGY	N	273	212	170	245.3	U
CC	23-Jun-95	02560FLAGY	N	284	223	198	245.3	U
CC	23-Jun-95	02294FLAGY	N	290	229	227	247.5	U
CC	23-Jun-95	02235FLAGY	N	291	221	170	245.3	U
CC	23-Jun-95	02293FLAGY	N	295	230	227	241.8	U
CC	23-Jun-95	02238FLAGY	N	299	240	227	245.3	U
CC	23-Jun-95	02300FLAGY	N	300	235	227	141.9	U
CC	23-Jun-95	02287FLAGY	N	333	260	340	247.5	U
CC	23-Jun-95	02556FLAGY	N	340	271	312	245.3	U
CC	23-Jun-95	02236FLAGY	N	348	283	340	246.3	U
CC	23-Jun-95	02237FLAGY	N	389	320	510	246.3	U
CC	25-Jun-95	02805FLAGY	N	258	210	155	SPENCER CREEK	U
CC	25-Jun-95	02809FLAGY	N	266	208	159	SPENCER CREEK	U
CC	25-Jun-95	02815FLAGY	N	271	234	227	SPENCER CREEK	U
CC	25-Jun-95	02810FLAGY	N	278	223	183	SPENCER CREEK	U
CC	25-Jun-95	02821FLAGY	N	282	222	170	SPENCER CREEK	U
CC	25-Jun-95	02808FLAGY	N	287	232	246	SPENCER CREEK	U
CC	25-Jun-95	02811FLAGY	N	289	233	241	SPENCER CREEK	U
CC	25-Jun-95	02806FLAGY	N	302	245	251	SPENCER CREEK	U
CC	25-Jun-95	02803FLAGY	N	308	248	288	SPENCER CREEK	U
CC	25-Jun-95	02814FLAGY	N	308	242	284	SPENCER CREEK	U

		Table 10 cont.						
SPECIES	DATE	TAG #	RECAPTURE	TL	SL	WT	RM	SEX
CC	25-Jun-95	02813FLAGY	N	318	256	305	SPENCER CREEK	U
CC	25-Jun-95	02812FLAGY	N	322	258	320	SPENCER CREEK	U
CC	25-Jun-95	02819FLAGY	N	327	265	354	SPENCER CREEK	U
CC	25-Jun-95	02804FLAGY	N	332	287	308	SPENCER CREEK	U
CC	25-Jun-95	02807FLAGY	N	349	282	362	SPENCER CREEK	U
CC	25-Jun-95	02820FLAGY	N	359	292	515	SPENCER CREEK	U
CC	25-Jun-95	02801FLAGY	N	367	310	609	SPENCER CREEK	U
CC	25-Jun-95	02802FLAGY	N	370	304	595	SPENCER CREEK	U
CC	25-Jun-95	02818FLAGY	N	387	304	490	SPENCER CREEK	U
CC	25-Jun-95	02822FLAGY	N	290	230	224	SPENCER CREEK	U
CC	26-Jun-95	02824FLAGY	N	278	215	161	SPENCER CREEK	U
CC	26-Jun-95	02823FLAGY	Y	351	285	413	SPENCER CREEK	U
CC	26-Jun-95	02825FLAGY	N	382	312	514	SPENCER CREEK	U
CC	26-Jun-95	02252FLAGY	N	320	254	280	SPENCER CREEK	U
LG	26-Jun-95	02253FLAGY	N	267	210	244	SPENCER CREEK	U
LG	26-Jun-95	02255FLAGY	N	281	230	359	SPENCER CREEK	U
CC	26-Jun-95	02275FLAGY	N	290	230		SPENCER CREEK	U
CC	25-Jun-95	02823FLAGY	N	352	282	435	SPENCER CREEK	U
CC	26-Jun-95	02254FLAGY	N	293	227	230	SPENCER CREEK	U
CC	26-Jun-95	02271FLAGY	N	275	210	142	252.7	U
CC	26-Jun-95	02269FLAGY	N	352	273	397	253.2	U
FM	26-Jun-95	1F7B3C3D4D	N	404	337	676	253.0	U
CC	27-Jun-95	02265FLAGY	N	274	215	113	259.9	U
CC	27-Jun-95	02268FLAGY	N	268	211	113	260.0	U
CC	27-Jun-95	02267FLAGY	N	262	209	113	260.0	U
CC	27-Jun-95	02266FLAGY	N	331	260	255	259.6	U
FM	27-Jun-95	1F777C4E20	N	324	266	369	259.8	F
CC	28-Jun-95	02264FLAGY	N	271	210	113	274.2	U
CC	29-Jun-95	02262FLAGY	N	350	285	482	274.8	U
FM	29-Jun-95	1F7A76343D	N	440	370	748	274.3	U
CC	30-Jun-95	02261FLAGY	N	360	285	369	280.0	U
LG	30-Jun-95	02259FLAGY	N	342	275	162	280.0	U

Table 11. Water Quality Data Collected From Trip No. 95-01 and 95-02, Hualapai Aquatic Studies.											
Hualapai Indian Reservation, Colorado River.											
		RM	**RM**	**RM**	**RM**	**RM**	**RM**	**RM**	**RM**	**RM**	
		174.3	**182.8**	**208.9**	**224.7**	**230.4**	**241.4**	**245.95**	**259.4**	**273.5**	
Date:		Apr. 12-13	Apr. 13-15	Apr.15-17	Apr. 17-18	Apr. 18-20	Apr. 20-21	Apr. 22-23	Apr. 24-25	Apr. 26-28	
TEMP. C	High	12.21	12.32	12.62	11.71	11.74	11.71	11.96	14.05	15.51	
	Low	11.48	11.49	11.33	11.45	11.44	11.39	11.61	12.88	13.7	
	Average	11.97	11.84	11.94	11.50	11.61	11.54	11.75	13.43	14.81	
COND.	High	0.95	0.97	0.97	0.96	0.96	0.95	0.94	0.97	0.98	
	Low	0.93	0.71	0.92	0.90	0.87	0.95	0.92	0.93	0.91	
	Average	0.94	0.94	0.95	0.94	0.93	0.95	0.93	0.95	0.95	
DO	High	10.56	11.35	10.49	11.74	10.63	10.59	10.88	10.49	10.24	
	Low	10.42	10.27	10.08	10.32	10.35	10.63	10.64	10.32	9.81	
	Average	10.47	10.48	10.29	10.57	10.53	10.56	10.75	10.42	10.04	
pH	High	8.58	8.57	8.69	8.68	8.81	8.78	8.88	8.91	8.92	
	Low	8.47	8.34	8.44	8.61	8.68	8.82	8.79	8.82	8.81	
	Average	8.5	8.49	8.60	8.66	8.74	8.75	8.83	8.85	8.88	
		RM	**RM**	**RM**	**RM**	**RM**	**RM**	**RM**	**RM**	**RM**	**RM**
		171.0	**183.1**	**208.9**	**224.57**	**230.4**	**242.7**	**245.95**	**252.95**	**259.5**	**273.6**
Dates:		Jun. 15	Jun. 15-17	Jun. 17-19	Jun. 19-20	Jun. 20-22	Jun 22-23	Jun 24-26	Jun. 26-27	Jun. 27-28	Jun. 28-30
TEMP. C	High	14.54	14.54	13.92	14.25	15.08	15.46	16.42	16.30	16.28	16.84
	Low	13.95	13.01	12.82	14.00	14.43	15.16	15.55	15.52	15.49	15.91
	Average	14.27	13.81	13.43	14.16	14.72	15.25	15.86	15.81	15.84	16.38
COND.	High	0.88	0.89	0.89	0.88	0.91	0.91	0.90	0.90	0.89	0.88
	Low	0.88	0.88	0.88	0.87	0.87	0.89	0.75	0.89	0.86	0.86
	Average	0.88	0.88	0.88	0.88	0.88	0.90	0.88	0.89	0.88	0.87
DO	High	10.70	10.84	10.86	10.76	10.77	10.67	10.48	10.48	10.41	10.36
	Low	10.36	10.42	10.56	10.61	10.40	10.64	10.32	10.41	10.26	10.16
	Average	10.60	10.65	10.74	10.68	10.60	10.65	10.43	10.44	10.35	10.25
pH	High	8.20	8.22	8.25	8.24	8.25	8.25	8.30	8.31	8.28	8.27
	Low	7.82	7.90	8.11	8.02	8.19	8.05	8.20	8.25	8.23	8.19
	Average	8.00	8.15	8.22	8.19	8.23	8.20	8.27	8.29	8.26	8.25

Table 11 Cont.											
		SPENCER CREEK	SPENCER CREEK	TRAV. FALLS CREEK	BRIDGE C CREEK	QUARTERMASTER CREEK					
Dates:		Apr. 23-24	Jun. 23-24	Jun. 22	Jun. 22	Jun. 28					
TEMP. C	High	23.08	28.22	21.10	25.48	22.13					
	Low	16.18	19.57	21.10	25.48	22.13					
	Average	18.73	22.33	21.10	25.48	22.13					
COND.	High	0.65	0.66	1.66	0.57	0.78					
	Low	0.61	0.55	1.66	0.57	0.78					
	Average	0.62	0.62	1.66	0.57	0.78					
DO	High	9.06	10.41	9.02	8.83	8.59					
	Low	8.21	7.70	9.02	8.83	8.59					
	Average	8.63	8.64	9.02	8.83	8.59					
pH	High	9.06	8.53	8.31	8.00	7.98					
	Low	8.90	8.21	8.31	8.00	7.98					
	Average	8.95	8.35	8.31	8.00	7.98					