U.S. DEPARTMENT OF THE INTERIOR

U.S. GEOLOGICAL SURVEY

Aquatic Survey of the Lower Escalante River, Glen Canyon National Recreation Area, Utah June 22-26, 1998

By

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EXECUTIVE SUMMARY

A 5 member survey team, representing U.S. Geological Survey, National Park Service, and Utah Division of Wildlife Resources surveyed the invertebrate, fish, and amphibian communities of the lower 80 km reach of the Escalante River. The objective was to begin gathering baseline biological information on the more remote sections of this unique watershed. The survey ran through June 22 to June 26, 1998. A total of eight sample sites were examined, four located between Harris Wash and Fence Canyon (10 km) and four between Fool's Canyon and Coyote Gulch. Sample sites were distanced, approximately 3 km apart.

A total of 475 macroinvertebrates representing 19 taxa were collected, 116 from the upper reach and 359 from the lower reach. The dominant families were Chironomidae, Hydrosychidae, Simuliidae, and Tricorythidae. Diversity was fairly constant throughout the study area as was the MHBI, which summarizes the overall pollution tolerances of the taxa collected.

Over 300 fish were collected representing 3 native and 8 nonnative species. This survey adds two additional species, striped bass (*Morone saxatilis*) and yellow bullhead (*Ictalurus natalis*), to the 14 species previously reported. The mainstem river between Harris Wash and Fence Canyon is remarkably endemic, consisting of roundtail chub (*Gila robusta)*, speckled dace (*Rhinichthys osculus*), and flannelmouth sucker (*Catostomus latipinnis*). Of the 88 fish collected from the mainstem, 87 (99%) were native. Downstream sites were dominated by non-natives which constituted 89% of our collections. Red shiner were quite abundant making up 85% of the fish collected downstream of Fools Canyon. Permanent pools found in side canyons were dominated by green sunfish and fathead minnows. It appears the mainstem native community is relatively stable, since species composition has changed little during the past 25 years.

Amphibian inventories were conducted at 13 stations, 7 in the upper and 6 in the lower reach. Five amphibian species have been documented in the study area, including the Great Basin spadefoot *(Spea intermontanus)*, canyon treefrog *(Hyla arenicolor)*, Northern leopard frog *(Rana pipiens)*, red-spotted toad *(Bufo punctatus),* and woodhouse toad *(Bufo woodhousei).* Surveys encountered 15 adults, 200 juveniles, 1,975 tadpoles, and 3 egg strands, all being Woodhouse toads. The absence of the other species may be attributed to the timing of the sampling.

This open-file report provides a discription of one field trip. It was not intended to represent an extensive survey effort nor a complete analysis of field data. This report represents a repository of field data, observations and discriptions of ecological conditions in June 1998, and provides some recommendations for resource managers.

INTRODUCTION

The U.S. Geological Survey (USGS), in cooperation with National Park Service, Fish and Wildlife Service, and Utah Division of Wildlife Resources, has been studying the fish communities found in the confluences and tributaries of Lake Powell, Utah. Research has focussed on the native and non-native fish communities found at the confluence of the San Juan River and Lake Powell, with specific interest in the endangered razorback sucker (*Xyrauchen texanus)*. These research tasks were finished in 1997 and remaining project resources were refocused in 1998.

National Park Service requested that remaining resources and time be directed at the Escalante River that lies within the boundaries of Glen Canyon National Recreation Area. The Escalante River in an extremely remote stream with little known about its aquatic community. We know of only one previous attempt to survey the lower river's fish community and that was conducted by Dr. Paul Holden in the early 1970's before Lake Powell filled (1980).

An extensive baseline inventory would demand resources and time that far exceeds this study. National Park Service (NPS) prepared a joint, 5-year study proposal with the Grand Staircase-Escalante National Monument (GLCA 1997). A task force was created to evaluate and make recommendations pertaining to the proposal. Members represent NPS, Bureau of Land Management, Utah Division of Wildlife Resources (UDWR), and Forest Service. The committee recommended the USGS effort be developed as a pilot survey, not only to examine aquatic resources, but to also assess collection techniques and problems associated with difficult access. This information provides additional survey information for UDWR's river drainage management plan.

A 5 member, survey team was formed of state and federal biologists, for the purpose of conducting a baseline survey of invertebrates, fish, and amphibians found in the middle and lower reaches of the Escalante River. The survey ran through June 22 to June 26, 1998.

<u>Site Description</u> The Escalante River drains approximately 830 km^2 portions of Garfield and Kane counties, Utah. There are approximately 800 km of active stream within the watershed. Its headwater is formed by Pine, Mamie, Sand, and Calf creeks which enter the Escalante upstream of Highway 12. Waters are diverted from the river to Wide Hollow Reservoir, an off stream storage facility. Pine Creek supports approximately 2,000 of irrigated crop land. Downstream of Highway 12 the river enters the Escalante Canyon, a remote sandstone canyon bracketed by the Kaiparowits Plateau to the west, Circle Cliffs to the North, and Lake Powell to the south. Headwaters are located within Dixie National Forest and lower portions of the drainage flow

through Grand Staircase Escalante National Monument and Glen Canyon National Recreation Area. An excellent discription of the physical attributes of the drainage is presented in Ottenbacher and Hepworth (1999).

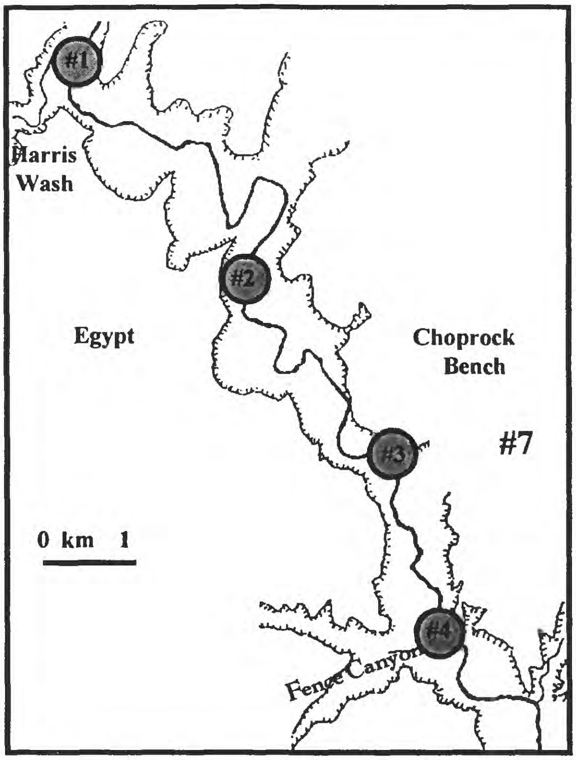
The stream is relatively small but flows are highly erratic do to spring run-off and flash flooding during the summer monsoon season (Appendix A). Low base flows that are aggravated by irrigation diversions. The furthest downstream gauging station (#09337500) is located near the town of Escalante, Utah, which is relatively high in the water shed. Additional base and storm flows are contributed to the river by tributaries or side canyons such as: Boulder Creek, Harris Wash, Silver Falls Creek, Twenty-five Mile Wash, Moody Canyon, Stevens Canyon, and Coyote Gulch.

Sampling was conducted in two sections of the river's lower 80 kms which provided access and extraction by helicopter or by boat. This was necessary do to the absence of roads. The upstream section was located between Harris Wash and Fence Canyon (10 km). The survey team was dropped off at Harris Wash and backpacked downstream sampling and photographing four sites located at 3 km intervals (Map 1 & Appendix A). Here the canyon floor is relatively broad and the stream meanders through a well developed riparian corridor composed of willow, cottonwood, and tamarisk. Stream habitat is dominated by run and riffle habitat as it drops an average of 3.2 m/km. Stream bank undercutting and riparian vegetation in some areas provide overhead cover and diverified habitat for aquatic animals. Deep pools or backwaters were rare or absent. The stream bed was composed primarily of sands and gravels.

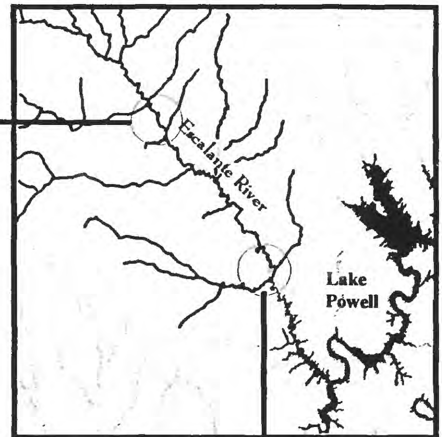
Fence Canyon had several small, entrenched pools, that were formed by rock depressions and clay. One was sampled that was located approximately 100 m upstream of the Canyon's confluence with the river.

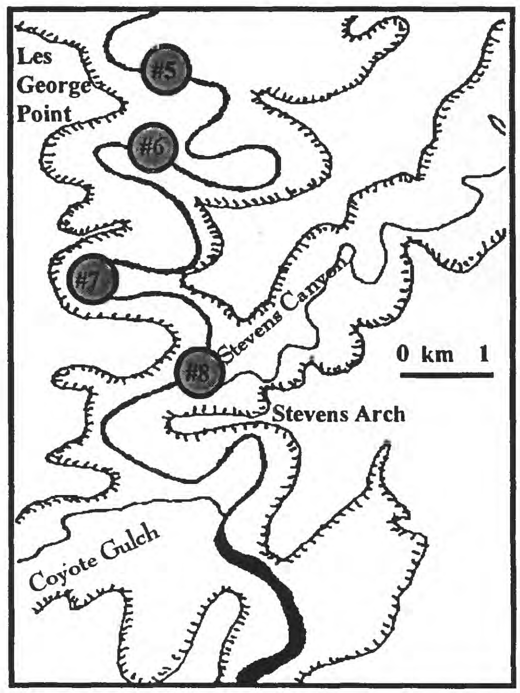
Sampling in the lower most river reach was completed between Fool's Canyon and Coyote Gulch (Map 1). In this area the river enters a narrow canyon. Stream gradient decreases (2.1 m/km) and the stream bed and banks are littered with rock rubble and large (>4 m) boulders. Fine sands replace gravels as the predominate substrate size and riparian vegetation is restricted to colonizing tamarisk and willow. Cover is limited to washouts formed around large boulders and rock rubble.

Another changes occurs further downstream at Steven's Canyon where the number of large bounders diminish and the stream bed becomes broader and shallower. The substrate is dominated by sands and fine gravels and there are narrow stands of dense willow and tamarisk. Sediment deposition is obvious not only in the mainstem river but also up Coyote Gulch. It's believed sediment loading is influenced by reservoir elevations. Again, sampling was conducted at 3 km intervals in this 10 km reach.



Upper Study Sites (1-4)





Lower Study Sites (5-8)

GPS Coordinates

Site #	UTMx	UTMy
1.	481013	4168401
2.	482546	4166119
3.	482546	4164200
4.	484200	4162874
5.	501509	4144965
6.	501406	4144565
7.	501074	4143872
8.	501532	4143206

Map 1. Map showing the locations of the sites sampled on the mainstem Escalante River during June 1998.

CHAPTER 1--INVERTEBRATES

By Lewis Boobar (NPS)

METHODS

A total of 16 Surber (30 X 30 cm sample area, 500 um net) samples (Merritt and Cummins 1996) were collected from riffles along the lower Escalante River. Two of the 16 samples were collected from each of four riffles (sites), four from the upper and four from the lower reaches (Map 1). Additionally, 30 minutes were spent at each site collecting macroinvertebrates from debris and snags. The samples and associated water were mixed with 95% ethyl alcohol to obtain a concentration (ca. 50% ethyl alcohol) high enough to temporarily preserve the animals. Later, samples were composited by type and river-section. The resulting two composite Surber samples and two composite qualitative samples (one of each type from each river-section) were processed by the Bureau of Land Management and U.S. Forest Service National Aquatic Monitoring Center at Utah State University, Logan, UT as described by Vinson and Hawkins (1996). Initially, the entire sample was sorted for large and less-numerous organisms. If the sample contained more than 250 organisms, it was sub-sampled. They took additional sub-samples until at least 250 organisms are found. The identified portion of the sample was placed in 70% ethyl alcohol, cataloged, and archived. The data was entered into a common computer database at the National Aquatic Monitoring Center. This database currently contains aquatic macroinvertebrate data and corresponding geographic information for more than 4000 samples.

RESULTS

A total of 475 macroinvertebrates representing 19 taxa were collected, 116 from the upper reach and 359 from the lower reach (Table I.1, Appendix A). The dominant families were Chironomidae, Hydrosychidae, Simuliidae and Tricorythidae (Table I.2). Diversity was fairly constant throughout the study area as was the Modified Hilsenhoff Biotic Index (MHBI)(Hilsenhoff 1987, 1988; Bode et al. 1991), which summarizes the overall pollution tolerances of the taxa collected, and the USGS Community tolerant quotient (Wingett and Mangum 1979). The taxa richness (Table I.3) and abundance (Table I.4) of functional feeding groups showed collector gatherers and collector filters to be slightly greater in the lower reach, and scrapers to be slightly greater in the upper reach.

Table 1.1. Taxonomic list and abundance of aquatic macroinvertebrates collected downstream of Harris Wash, Escalante River, Utah - 06/22/98 through 06/24/98. Abundance: QN = quantitative (per meter squared), QL = Qualitative.

Phylum / Class / Order / Family / Subfamily/Genus/species	Life Stage L/P/A	Abundance upper-[1] QL 106721	upper- QN 106722	lower- QN 106723	lower- QL 106724
Annelida					
Oligochaeta					
Haplotaxida					
Tubificidae	A	3			
Arthropoda					
Arachnoidea					
Hydracarina	A		1		
Insecta					
Coleoptera					
Elmidae	L	1			
Microcylloepus	L		2	3	
Microcylloepus	A		3		
Stenelmis	A		1		
Gyrinidae					
Gyrinus	A		1		
Diptera					
Chironomidae					
Orthocladiinae	L		3	17	119
Tanypodinae	L		1	1	
Simuliidae					
Prosimulium	L	1			
Prosimulium	P	1			
Simulium	L		24	8	9
Ephemeroptera					
Baetidae					
Baetis tricaudatus	L	8	6	40	6
Callibaetis	L				13
Heptageniidae	L	3		1	
Heptagenia	L		15	3	1
Tricorythidae					
Tricorythodes	L	9	9	15	14
Hemiptera					
Corixidae					
Neocorixa	A				1
Naucoridae					
Ambrysus	A	1	1		2
Odonata					
Gomphidae					
Erpetogomphus compositas	L		1		
Trichoptera	L	7			
Trichoptera	P			1	
Hydropsychidae					
Hydropsyche	L		13	71	22
Hydroptilidae	L				10
Mollusca					
Gastropoda					
Basommatophora					
Physidae					
Physella	A				1
Total: 19 taxa		35	81	161	198

1. Numbers listed under QN and QL allows cross referencing to Bureau of Land Management and U.S. Forest Service National Aquatic Monitoring Center Database.

Table 1.2. Community summary statistics. Abundance data is number per meter squared for quantitative samples and number per sample for qualitative samples. EPT = totals for the insect orders, Ephemeroptera, Plecoptera,Trichoptera. MHBI = Modified Hilsenhoff Biotic Index. In site descriptor, QL = qualitative and QN = quanitative samples.

			Assemblage Abundance Measures					
Site	Date	Sample ID[1]	Total abundance	EPT[2] abundance	# of families	Dominant family	Dom. Family abundance	Dom. Family % contribution
Upper-QL	6/23/98	106721	35	27	8	Tricorythidae	9	25.71
Upper-QN	6/22/98	106722	81	43	11	Simliidae	24	29.63
Lower-QN	6/24/98	106723	161	132	8	Hydrosychidae	71	44.1
Lower-QL	6/24/98	106724	198	66	10	Chironomidae	119	60.1

			Diversity Indices				
			Total taxa richness	EPT taxa richness	Shannon diversity	Simpson diversity	Evenness
Upper-QL	6/23/98	106721	8	4	1.851	0.159	0.983
Upper-QN	6/22/98	106722	13	4	2.023	0.161	0.792
Lower-QN	6/24/98	106723	10	6	1.573	0.277	0.685
Lower-QL	6/24/98	106724	11	6	1.44	0.385	0.495

			Biotic Indices			
					USFS Biotic Condition Index[4]	
			MHBI[3]	Indication	CTQa	CTQd
Upper-QL	6/23/98	106721	2.61	Slight organic enrichment	89	87
Upper-QN	6/22/98	106722	4.06	Moderate organic enrichment	96	94
Lower-QN	6/24/98	106723	3.97	Slight organic enrichment	89	96
Lower-QL	6/24/98	106724	4.93	Moderate organic enrichment	95	100

1. Allows cross referencing to Bureau of Land Management and U.S. Forest Service National Aquatic Monitoring Center Database.
2. Ephemeroptera, Plecoptera, Trichoptera - ratio considered sensitive to pollution.
3. Modified Hilsenhoff Biotic Index - summarizes the overall pollution tolerances of the taxa collected.
4. Community toerant quotient - integrates biological, physical and chemical parameters.

Table 1.3. Taxa richness by functional feeding group; number of taxa per meter squared for quantitative samples and number of taxa per sample for qualitative samples. Numbers in parentheses are percentages. In site descriptor, QL = qualitative and QN = quanitative samples.

Site	Date	Sample ID[1]	Shredders	Scrapers	Collector filterers	Collector gatherers	Predators	Unknown
Upper-QL	6/23/98	106721	0(0)	1(13)	1(13)	5(50)	1(13)	1(13)
Upper-QN	6/22/98	106722	0(0)	2(15)	2(15)	4(31)	5(38)	0(0)
Lower-QN	6/24/98	106723	0(0)	2(20)	2(20)	4(40)	1(10)	1(10)
Lower-QL	6/24/98	106724	1(9)	1(9)	2(18)	5(45)	1(9)	1(9)

1. Allows cross referencing to Bureau of Land Management and U.S. Forest Service National Aquatic Monitoring Center Database.

Table 1.4. Taxa abundance by functional feeding group; abundance per meter squared for quantitative samples and abundance per sample for qualitative samples. Numbers in parentheses are percentages. In site descriptor, QL = qualitative and QN = quanitative samples.

Site	Date	Sample ID[1]	Shredders	Scrapers	Collector filterers	Collector gatherers	Predators	Unknown
Upper-QL	6/23/98	106721	0(0)	3(9)	3(9)	22(63)	1(3)	7(20)
Upper-QN	6/22/98	106722	0(0)	16(20)	37(46)	23(28)	5(6)	0(0)
Lower-QN	6/24/98	106723	0(0)	4(2)	79(49)	75(47)	1(1)	1(1)
Lower-QL	6/24/98	106724	10(5)	1(1)	31(16)	153(77)	2(1)	1(1)

1. Allows cross referencing to Bureau of Land Management and U.S. Forest Service National Aquatic Monitoring Center Database.

DISCUSSION

The macroinvertebrate abundance in the lower Escalante have not been previously studied. The upper reaches above the confluence of The Gulch and the Escalante River and tributaries were sampled incidental to a survey of threatened and endangered fish (McAda et al. 1977). That study showed that *Baetis* sp. was ubiquitous throughout the sampling area and *Rhyacophila* sp. dominated headwaters, where as Tipulids and Anisopterans were more prevalent in the lower reaches of the study area. Vinson (1998) collected samples from the upper reaches of the Escalante River, tributaries and a couple of Tinajas. That study found about 70 taxa. Plecoptera were only collected from Steep Creek, which is a tributary of The Gulch. The Trichopteran *Rhyacophila* was not collected during the 1998 survey.

Rivers naturally change as they flow downstream. Riverain vegetation conditions, light, temperature, hydraulics, and substrate composition all change and in response to these environmental changes macroinvertebrate communities change. The macroinvertebrate abundance in the lower Escalante was low compared to the data collected from the upper Escalante by Vinson (1998). This is not that unusual for river drainages. Vinson sampled in early June when the water level was low. Just before we sampled the lower reaches the water level was elevated. Sampling was confined to the edge of the river due to the high water and scouring could have reduced the abundance. Because this is the first information on macroinvertebrates from the lower Escalante River it begins to establish baseline data against which future data can be compared.

RECOMMENDATIONS

<u>Inventory</u>: A comprehensive study that samples the macroinvertebrates within the mainstem and tributaries of the Escalante at various times of the year should be conducted. This study should include the entire watershed and should not be confined to NPS lands. The data collected would provide the spatial and temporal information required for selecting water quality monitoring sites within the watershed.

<u>Monitoring</u>: As a minimum the NPS should establish a long term monitoring site on the lower Escalante located at the north face of Steven's Arch (UTMx501532y4143206). This site can be accessed by hiking down Coyote Gulch. A suite of physical and chemical parameters should be collected with the macroinvertebrate data to help detect changes in water quality. Other sites might need to be added as information from the inventory is gathered.

REFERENCES

Bode, R. W., M. A. Novak, and L. E. Abele. 1991. Methods for Rapid Biological Assessment of Streams. New York Department of Environmental Conservation. Albany, New York.

Hilsenhoff, W. L. 1988. Rapid Field Assessment of Organic Pollution with a Family Level Biotic Index. The Journal of the North American Benthological Society. 7:65-68.

Hilsenhoff, W. L. 1987. An Improved Index of Organic Stream Pollution. The Great Lakes Entomologist. 20:31-39.

MaAda, C., C. Philips, C.R. Berry, and R.S. Wydoski. 1977. A Survey of Threatened and Endangered Fish in Southeastern Utah Streams. Utah Cooperative Fishery Research Unit, Contract No. 77-8236, Logan Utah pp 245.

Merritt, R. W. and K. W. Cummins. 1996. An Introduction to the Aquatic Insects of North America. Kendall-Hunt Publishing Company, Dubuque, Iowa.

Vinson, M. R. 1998. Aquatic Benthic Macroinvertebrate Monitoring Report. U.S.D.I. Bureau of Land Management Aquatic Ecosystem Laboratory, Logan, Utah.

Vinson, M. R. and C. P. Hawkins. 1996. Effects of Sampling Area and Subsampling Procedure on Comparisons of Taxa Richness Among Streams. The Journal of the North American Benthological Society 15:392-399.

Wingett, R.N. and F.A. Mangum. 1979. Biotic condition indexf:integrated biological, physical, and chemical parameters for management. U.S. Forest Service Intermountain Region, U.S. Department of Agriculture, Ogden, UT.

CHAPTER 2--FISH

By Gordon Mueller (USGS), Richard Wydoski (BOR), and Quentin Bradwisch (UDWR)

METHODS

Sampling was conducted to determine fish community composition, relative abundance, and changes since previous surveys (Holden and Irvine 1975) and to examine sampling gear efficiency. Sampling techniques included both active and passive netting techniques using the following equipment: a 6 mm bar mesh (1.3 X 10 m) seine, a 12 mm (1.3 x 15 m) trammel net, a 80 cm diameter, 2 hoop fyke net, and two collapsible minnow traps.

Sampling was conducted on the declining limb of spring runnoff and weather conditions were relatively cool and dry. The river was turbid, carrying a substantial sediment and debris load. Visibility was <10 cm which made it difficult to sample or make any visual observations. Gage reading at the headwaters of the Escalante River (station#09337500) fell from 32 to 6 cfs during the course of the survey. Downstream tributaries contributed additional flows increasing the river to an estimated volume of 155 cfs (131-191 cfs [3.7-5.4 m^3/s]).

A small volume (<2 cfs) of water was flowing from Harris Wash and Coyote Gulch but the stream beds at Fence, Choprock, and Steven's canyons were dry. The flow from Harris Wash was broad (3-5 m) and quite shallow (2-5 cm) and we observed schools of small (<3 cm) suckers and speckled dace. Fence Canyon had a series of spring fed pools, some more that a meter deep and several meters in length. The pools supported what appeared to be multi year classes of green sunfish and fathead minnows which suggests the pools are permanent features. These are the same species reported to be common in pools found in other side canyons by both Holden and Irvine (1975) and McAda et al. (1977). Slightly more water (est 2-4 cfs) was flowing from Coyote Gulch. At its confluence with the river it formed a large (7-10 m), long (50 m), shallow pool (0.5 m) that was full of tadpoles. We walked upstream approximately 1 km. The stream bed was composed of fine, drifting sand. Only a couple of small fish (suckers or dace ?) were observed.

<u>Flow Measurements</u>--Physical measurements of the reach's length, width (3 locations), mid-channel depths, and maximum depth were recorded. Surface water velocities were measured by timing floats released in mid-channel. A gross flow estimate was calculated using the following formula: $R = \frac{W}{T} \frac{Da\,L}{}$, were R = volume (m^3/sec), W = stream width, Da = depth X constant .8 for bottom roughness, L = length, and T = average float time in seconds (Lagler 1950). Other more complex as well as smaller areas were sampled but not measured.

<u>Seining</u>--The seine was used to collect both quantitative and qualitative information. At each study site a reach relatively free of major obstructions was sampled using three-pass, depletion seining. Prior to sampling the trammel net was set downstream to block fish escape. The sample reach was seined starting upstream and working toward the blocking net. Fish collected

from each seine haul were held in live nets. Following sampling, fish were identified, counted, measured and weighted.

Fyke Net--A single throated fyke net constructed of 6 mm nylon netting, 2.5 m in length, with two 76 cm hoops was set with the entrance facing downstream in deep channels where velocities held the net upright. Time of sets ranged from 1 to 10 hours.

Minnow Traps--Two collapsible, 2 mm mesh minnow traps (30 cm x 30 cm x 45 cm) were set it in slack water habitats near shore. Time of sets ranged from 1 to 10 hours.

Trammel Net--A 15 cm outer and 1.2 cm inter panels trammel net measuring 1.3 by 15 m was set in or near deeper holes or backwaters. Trammel nets were typically set overnight.

RESULTS

Physical measurements were taken at the first 5 sampling sites where the river was smaller, more channelized and could effectively be seined (Table 2.1). The primary purpose of measuring sample area was to calculate fish densities and biomass per surface area or habitat volume. Unfortunately, due to high flows and velocities ($>3.0m^3/>1m/s$) it was not possible to effectively seine the study sites.Seining was difficult for the lack of suitable sites and high (>1 m/sec) river velocities. Appropriate seining sites having suitable depth, velocities, and unobstructed reaches were uncommon. This might not be the case at lower flows.

We also had problems finding sites with adequate depth (>1 m) and lengths (>3 m) to set the fyke net. The trammel net proved to be the biggest challenge. There were essentially no backwater or pool habitats. We would normally set a portion of the trammel net (<7 m) in eddie pools behind large boulders. The net was fished 3 nights, 2 of which produced fish. The trammel produced the second highest species diversity: roundtail chub, flannelmouth sucker, carp, and stripped bass. It also provided good information on adult fish that are difficult to seine and provide information on reproductive status.

Insufficient data was collected to allow density or biomass estimates. Field information is limited to individual fish data, relative abundance, and species persence. Stream measurements were not taken at sites 6, 7, and 8.

Fish--Survey efforts yielded 306 fish, representing eleven species (Table 2.2). We encountered two new species, yellow bullhead and striped bass new not previously reported for the drainage and brown trout which were not reported that far downstream by Holden and Irving (1975). We did not encountered largemouth bass nor bluehead sucker which were previously reported.

Eighty nine fish, representing 4 (99%) indigenous species, were collected in the mainstem river between Harris Wash and Fence Canyon (Figures 2.0). We encountered multiple year classes (possibly 4) of roundtail chub, flannelmouth sucker (4-5), and green sunfish (2-3) (Figure 2.1).

Roundtail chub were spawning, males were tuberculate and in breeding colors and we collected one ripe female. We encountered only one non-native upstream of Fence Canyon; a juvenile brown trout. Length and weight information is provided in Table 2.3 and Figure 2.2.

Table 2.1 Physical measurements (width, depth, length, velocity) of sites 1, 2, 3, 4, 5 sampled on the Escalante River, Utah.

Site	Width (m)	Length (m)	Depth (m)	Max. Depth (m)	Travel Time (sec)	Volume (cfs) (m^3/s)
Site 1	9.8	38.7	.53	.98	33	
	8.5		.61		55	
	7.6		.67		40	
Average	**8.6**		**.60**		**43**	**3.72 (131)**
Site 2	0.4	43.3	.38	.68	35	
	10.7		.38		36	
	9.8		.45		34	
Average	**10.3**		**.40**		**35**	**5.40 (191)**
Site 3*	4.9	30.5	.31	.53	19	
	5.2		.38		22	
	4.9		.38		20	
Average	**5.0**		**.33**		**21**	**1.92 (68)***
Site 4	7.6	21.3	.38	.53	19	
	9.8		.45		18	
	11.3		.53		18	
Average	**9.6**		**.45**		**18**	**4.09 (144)**
Site 5*	4.8	29.0	.31	.53	39	
	4.0		.27		41	
	2.1		.45		41	
Average	**2.2**		**.34**		**40**	**0.43 (15)***

* measurement of side channel.

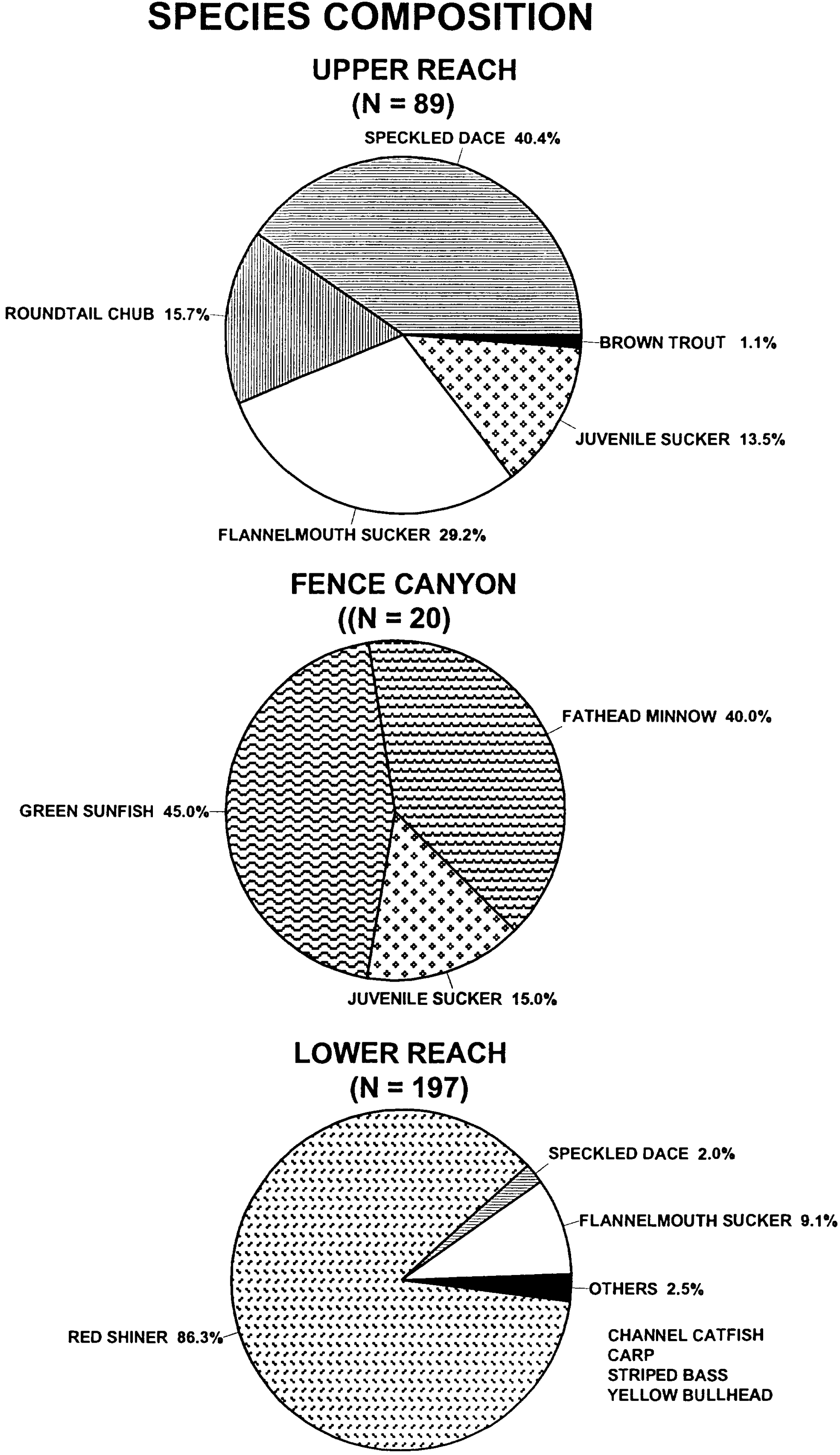


Figure 2.1. Species composition of fish collected from the lower portion of the Escalante River and its side canyons during June 22-26, 1998.

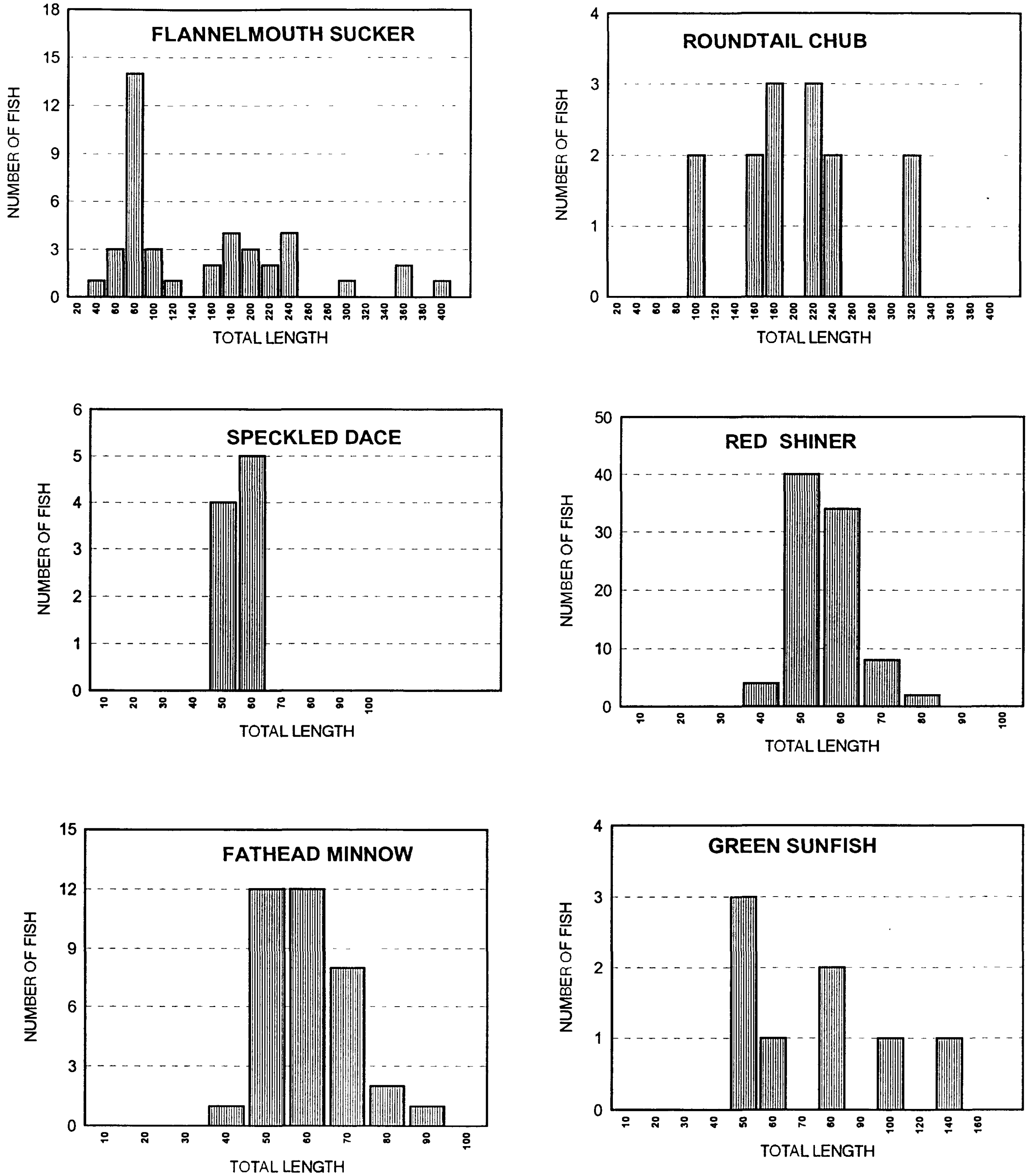


Figure 2.2. Length distribution of fish captured in the lower portion of the Escalante River and its side canyons during June 22-26, 1998)

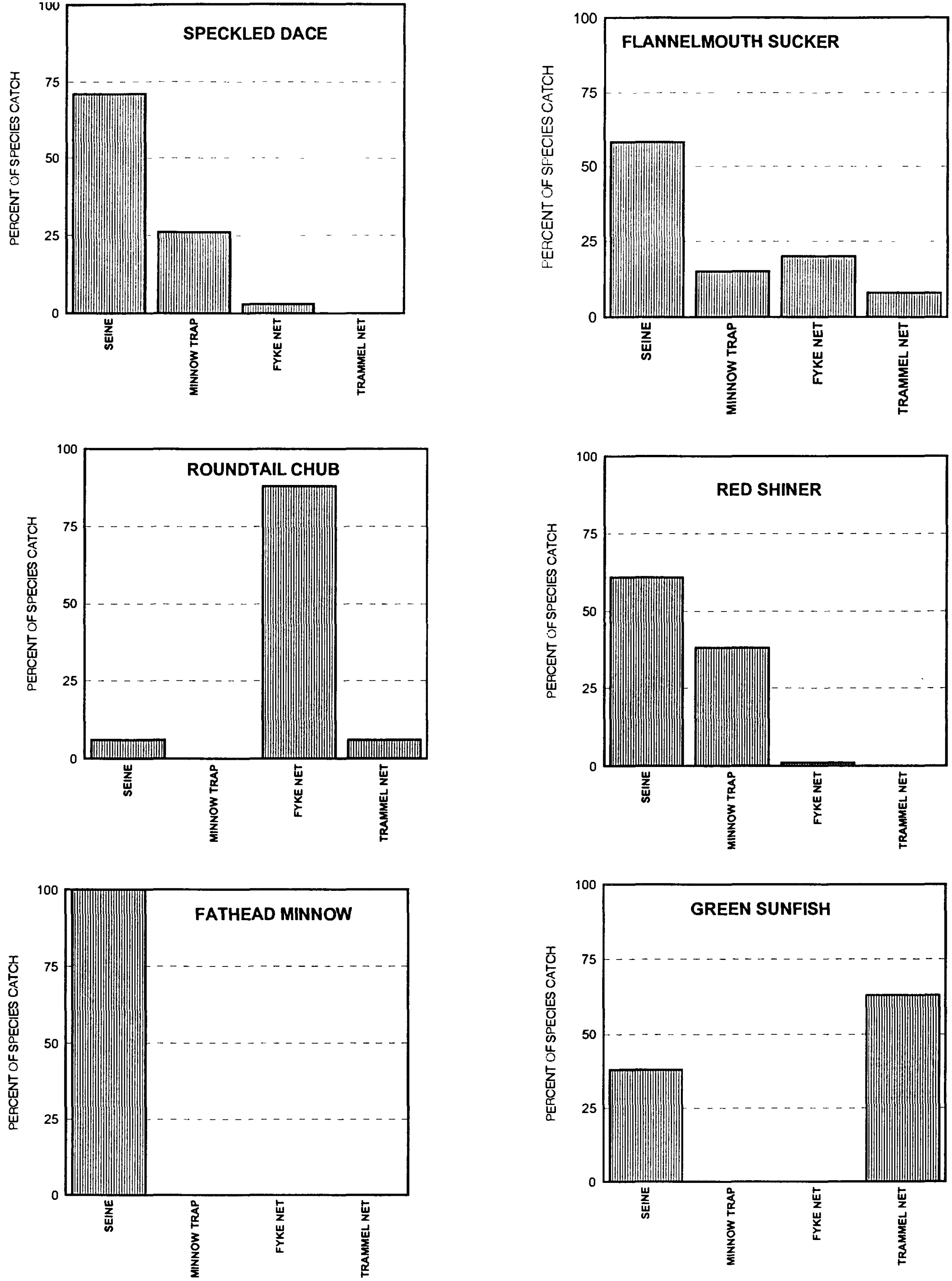


Figure 2.3. Fish captured from the Escalante River based on equipment type (seine, fyke net, minnow trap, trammel net).

There wasn't any surface flow from Fence Canyon, however, the canyon had several small pools that are entrenched in the bedrock. It appears small springs maintain these pools year-round. One pool, approximately 1 m deep, 4 m wide and 10 m long was sampled by seine and trammel net. Twenty fish were captured. Green sunfish (45%) were the most numerous, followed by fathead minnow (40%) and juvenile suckers (15%).

Table 2.2. Historical record of fish species collected or observed in the Escalante River, Utah.

Common Name	**Scientific Name**	**Holden & Irvine -- (1975)**	**McAda et. al -- (1977)**	**1998**
Flannelmouth Sucker	(*Catostomus latipinnis*)	X	X	X
Bluehead Sucker	(*Pantosteus discobolus*)	X	X	X
Roundtail Chub	(*Gila robusta*)	X	X	X
Speckled Dace	(*Rhinichthys osculus*)	X	X	X
Red Shiner	(*Cyprinella lutrensis*)	X	X	X
Fathead Minnow	(*Pimephales promelas*)	X	X	X
Carp	(*Cyprinius carpio*)	X	X	X
Channel Catfish	(*Ictalurus punctatus*)	X	X	X
Yellow Bullhead	(*Ictalurus natalis*)			X*
Striped Bass	(*Morone saxatilis*)			X*
Largemouth Bass	(*Micropterus salmoides*)	X		
Green Sunfish	(*Lepomis cyanellus*)	X	X	X
Brown Trout	(*Salmo trutta*)		X	X
Rainbow Trout	(*Salmo gairdneri)*		*X*	
Cuttthroat Trout	(*Salmo clarki)*		X	
Brook Trout	*(Salvelinus fontinalis)*		*X*	
Trout hybrids			X	

*Not previously reported

The reach downstream of Fool's canyon was predominately exotic (89%). A total of 197 fish were captured. Red shiner made up 86% of the catch followed by flannelmouth sucker (9%), speckled dace (2%), and miscellaneous others (3%) which included two new species: a 172mm yellow bullhead and a 600mm striped bass (Figure 2.1).

Sampling Gear--Sampling techniques were quite selective for some species and sizes of fish (Figures 2.2 & 2.3). For instance nearly all (85%) the roundtail chub were collected by fyke net. The fyke net also targeted larger suckers (>10 cm) and while its mesh size was relatively small (6 mm), few small fish (speckled dace or red shiners) were collected by the fyke net. This would suggest smaller fish might have been concentrated along shoreline (fringe) habitats rather than mid-stream. This contention is also supported by the fact that smaller fish were captured by the minnow traps and the seine along shore.

Table 2.3. Length, weight, and range data taken from fish collected in the Lower Escalante River, Utah during June 22-26, 1998.

Species	#	$\bar{x}$ Length (mm)	(Range)	#	$\bar{x}$ Weight (gr)	(Range)
Flannelmouth sucker	41	144	(36-400)	18	98	(6-320)
Roundtail chub	14	196	(83-313)	12	98	(25-275)
Specked dace	36	56	(36-84)	0	--	--------
Red shiner	88	52	(32-78)	0	--	--------
Fathead minnow	9	50	(44-54)	0	--	--------
Carp	1	440	--	1	1,000	-------
Channel catfish	2	77	(72-82)	0	--	-------
Yellow bullhead	1	172	--	1	16	-------
Green sunfish	8	73	(45-137)	0	--	-------
Striped bass	1	600	--	1	1,650	-------
Brown trout	1	62	--	0	--	-------

DISCUSSION

Habitat--The dissimilarities in habitat reflected three, distinct fish communities. As reported by Holden and Irvine (1974) there is a distinct change in both stream morphology and community structure between the middle and lower portions of the Escalante River. Habitat complexity and amplitude of hydraulic cycles must have a significant influence on fish community structure. The middle canyon represents a fairly broad floodplain which is typically channelized by a well developed riparian corridor bordered by willow, cottonwood and tamarisk. The combination of bank cutting and well developed riparian corridors provides ample overhead cover in the form of vegetative shade and exposed roots mass where fish can hide from predators, feed, spawn, or find refuge from the current. There is abundant evidence that high flood flows frequently swell and overbank, inundating seasonal side channels. The occurrence of woody vegetation, large snags, and piles of flood debris on higher benches of the floodplain would provide ample cover for fish during floods. The river was relatively shallow with few areas deeper than 1 m. Any habitat that could be categorized as pool, were extremely small with depths never exceeding 1.5 m. Typically, the stream was channelized with a mixture of undercut and gravel banks.

Downstream of Scorpion Gulch, the river enters and travels through a narrow and confined canyon to Lake Powell. The river has an entrenched channel. Vegetation was absent or extremely rare, being limited to young stands of willow, tamarisk, and weeds. The stream bed was strewed with large boulders, rock rubble, and fines. Cover was typically limited to rock interspace and deep pools caused by river hydraulics and rock outcroppings. During flooding, the canyon would pose extremely hostile conditions. The hostile environment may benefit endemic species by negatively impacting nonnatives.

Community Structure--We found three distinctly different fish communities: the middle portion of the river basin, the lower portion, and the side canyons. The native fish community found between Harris Wash and Fence Canyon was remarkably intact. Sampling suggests that speckled dace, roundtail chub, and flannelmouth sucker are still abundant as they were nearly 25 years ago (Holden and Irvine 1975). The maintainance or enhancement of this native fish community is identified as a management objective (Ottenbacker and Hepworth 1999). The roundtail chub is listed as threatened by Utah and the flannelmouth sucker is a state Species of Special Concern. Of the 88 fish collected from the mainstem, 87 (99%) were native. No red shiners or largemouth bass were collected. Our native sample composition was higher than the 65% endemism reported by Holden and Irvine (1975), however, they sampled side canyons where exotics were quite common. In Holden and Irvine's narrative, they discussed sampling Harris Wash, Steven's Canyon, and Coyote Gulch where they found pools dominated by non-native fishes.

They also reported that non-native species dominated (95%) the lower mainstem community as well as the side canyons. We found similar conditions. Non-natives made up 89% of the fish collected in the side canyons and lower sampling sites. Red shiner were quite abundant making up 85% of the fish collected downstream of Fools Canyon. We also collected adult carp (440 mm) and striped bass (600 mm) which undoubtedly migrated upriver from Lake Powell.

The native fish community is bracketed, both up- and downstream by exotic fish communities. The river's head waters support 4 species of non-native trout. Side canyon pools throughout the basin have been reported to contain large numbers of red shiner, fathead minnow and green sunfish (Holden and Irvine 1975, McAda et al. 1977). Our survey identified two additional exotics; the yellow bullhead and striped bass, one of which undoubtedly migrated upstream from Lake Powell. Undoubtedly, individuals periodically seed the mainstem during spring and storm runoff. It's not only encouraging, but also interesting that the middle canyon has remained essentially intact during the past 25 years. The resiliency of the endemic fish community between Harris and Fence Canyons must be partially in response to rather harsh, summer conditions where apparently, only natives can survive. The differences in physical habitat types is striking, especially in considering the conditions that fish face through the full range of annual flood and drought cycles.

Potential Threats--It appears that during the past 25 years the native/non-native fish community has remained relatively stable. While this is somewhat reassuring, the fish community will always be threatened by human activities that proliferates pollution, further water depletion, and the spread of additional fish species and their parasites and pathogens.

Previous reports did not address the possibility that fish are, or can, migrate from Lake Powell. The presence of common occurring largemouth bass, channel catfish, carp, and green sunfish may have resulted of bait bucket introductions or their escape from upstream ponds. However, the absence of largemouth bass and channel catfish from the extensive surveys conducted by McAda et al. (1977) suggests these species may have migrated upstream from the reservoir.

Holden and Irvine (1975) observed largemouth bass and carp throughout our study area and reported largemouth bass were found in breeding pairs. During our survey the river was extremely turbid which didn't allow similar sightings, however, we strongly suspect largemouth may still be found in relatively low numbers.

We also encountered two new species: a yellow bullhead and striped bass. While the origin of the yellow bullhead can be questioned, the striped bass undoubtedly came from Lake Powell. Striped bass commonly run up rivers to spawn when water temperatures reach between 15 to 20 °C (Moyle 1976) and are reported to run up the Colorado and San Juan Rivers to spawn (Gustavenson 1982). The fish was an adult and would not have survived summer river temperatures (>27 °C) (McAda et al. 1977, Moyle 1976).

The smallmouth bass *(Micropterus dolomieui)* is a relatively recent introduction to Lake Powell that could directly and indirectly threaten the Escalante native fishery. While none have been collected or reported, they have established an impressive reservoir fishery making up an estimated 20% of Lake Powell's creel (Blommer and Gustaveson 1997). Smallmouth bass were first introduced in 1982 through a decade long stocking program. Fish were stocked at 21 reservoir locations, which included the Escalante River Arm of Lake Powell (Blommer and Gustaveson 1997).

Smallmouth bass are actually better suited for small streams than largemouth bass. Habitats used by smallmouth bass are quite similar to those used by roundtail chub. In Arizona, smallmouth bass have replaced roundtail chub populations in the Verde and Salt rivers (Minckley 1973). While smallmouth bass will prey directly on native fish, they also pose an indirect threat by spreading the bass tapeworm. Lake Powell smallmouth bass have been reported to have a high infestation (Blommer and Gustaveson 1997).

RECOMMENDATIONS

Monitoring--We recommend that surveys be conducted downstream of Fence Canyon to determine the transition area where non-native fishes become more abundant. The reasons why exotics have been able to expand their range in other streams and not in the middle portion of the Escalante River deserves closer examination.

We would recommend that a monitoring program be establish to periodically (about every 5 years) monitor the fish community at selected sampling sites. The mainstem river contained an intact native fish community that could easily be impacted.

Sampling Equipment Recommendations--The sampling techniques we used worked well in remote reaches where equipment had to be packed in. Seining would be the most effective sampling method during low flows. Our efforts were less effective because of higher than normal flows.

If another trip were planned, we would recommend the following gear: 1 seine (6 mm mesh /1.3 X 7 m), 2-trammel nets (1.3 by 8 m in length), 4-6 minnow traps, 4 fyke nets (2-50 and 2-80 cm diameter), and light fishing gear. If the survey crew had access to horses or a helicopter a backpack shocker should also be considered.

REFERENCES

Blommer, G.L. and A.W. Gustaveson. 1997. Smallmouth Bass in Lake Powell, 1982--1996. Sport Fish Restoration Act Project F-46-R. March 1997, Publication No. 97-9. Utah Department of Natural Resources, Salt Lake City. pp 59.

Gustavenson, W.A., T.D. Pettengill, J.R. Wahl, and J.E. Johnson. 1982. Lake Powell Fisheries Investigations, Publication No. 82-6, DJ Project F-28-R-10. Utah State Division of Wildlife Resources.

Holden, P.B., and J.R. Irvine. 1975. Ecological Survey and Analysis of the Aquatic and Riparian Fauna and Flora of Escalante Canyon, Utah. Contract No. CS 12004 B034, Final Report to National Park Service and Cooperative Research Unit, Utah State University, Logan, Utah.

Karp, C., and G. Mueller. 1996. Annual Report of Razorback Sucker Telemetry Study in the Lower San Juan River, Utah. 1996. Bureau of Reclamation, Denver Technical Service Center, D-8220, Denver, Colorado.

Lagler, K.F. 1950. Studies in Freshwater Fishery Biology. Edwards Brothers, Inc, Ann Arbor, Michigan pp 231.

MaAda, C., C. Philips, C.R. Berry, and R.S. Wydoski. 1977. A Survey of Threatened and Endangered Fish in Southeastern Utah Streams. Utah Cooperative Fishery Research Unit, Contract No. 77-8236, Logan Utah pp 245.

Minckley, W.L. 1973. Fishes of Arizona. Arizona Game and Fish Department, Phoenix. pp 293.

Moyle, P.B. 1976. Inland Fishes of California. University of California Press, Berkeley. pp 405.

Mueller, G., and R. Wydoski. 1995. Fish survey of San Juan River inflow area of Lake Powell, March 13-28, 1995. National Biological Service, Denver, Colorado.

Mueller, G., and P.C. Marsh. 1998. Post-stocking dispersal, Habitat use, and behavioral acclimation of juvenile razorback suckers in two Colorado River reservoirs. U.S. Geological Survey Open-File Report 98-301, Denver, Colorado.

Ottenbacker, M.J., and D.K. Hepworth. 1999. Aquatic Management Plan Escalante River Drainage Hydrologic Unit 14070005. Utah Division of Wildlife Resoures, Salt Lake City, Utah. pp. 24.

Sigler, W. F., and R. R. Miller. 1963. Fishes of Utah. Utah State Department of Fish and Game, Salt Lake City, Utah. pp 203.

CHAPTER 3--AMPHIBIANS

By Kristen M. Comella and Richard A. Fridell (UDWR)

In June 1998, amphibian presence/absence surveys were conducted by the Utah Division of Wildlife Resources (UDWR) during an interagency sampling trip on the lower Escalante River. Surveys were conducted to determine the occurrence and geographic distribution of amphibians. Amphibian inventories were conducted at 13 stations within the lower 80 km (50mi) of the Escalante River. The lower 80 km of the Escalante River was divided into two sampling reaches. The upper reach, located between Harris Wash and Fence Canyon (Figure 3.1), contained seven survey stations. The lower reach, located between Fool's Canyon and the confluence of Lake Powell (approximately 0.75 miles below Coyote Gulch) (Figure 3.1), contained six survey stations.

Historic distribution of amphibians in the lower Escalante drainage (Figure 3.2) was determined by compiling locality information from museum records, unpublished literature, and Tanner (1940). Five amphibian species have been historically documented in the lower 100 km of the Escalante River, including the Great Basin spadefoot (*Scaphiopus intermontanus*), canyon treefrog (*Hyla arenicolor*), Northern leopard frog (*Rana pipiens*), red-spotted toad (*Bufo punctatus*), and woodhouse toad (*Bufo woodhousei*) (Figure 3.2, Table 3.1).

Table 3.1. Amphibians occurring in the lower 100 km of the Escalante River including common name, scientific name, and status within the State of Utah. Information is based on locality data compiled from museum records, unpublished literature, and Tanner (1940).

Common Name	Scientific Name	Status
Great Basin Spadefoot	*Scaphiopus intermontanus*	Native
Leopard Frog	*Rana pipiens*	Native
Canyon Treefrog	*Hyla arenicolor*	Native
Woodhouse Toad	*Bufo woodhousei*	Native
Red-spotted Toad	*Bufo punctatus*	Native

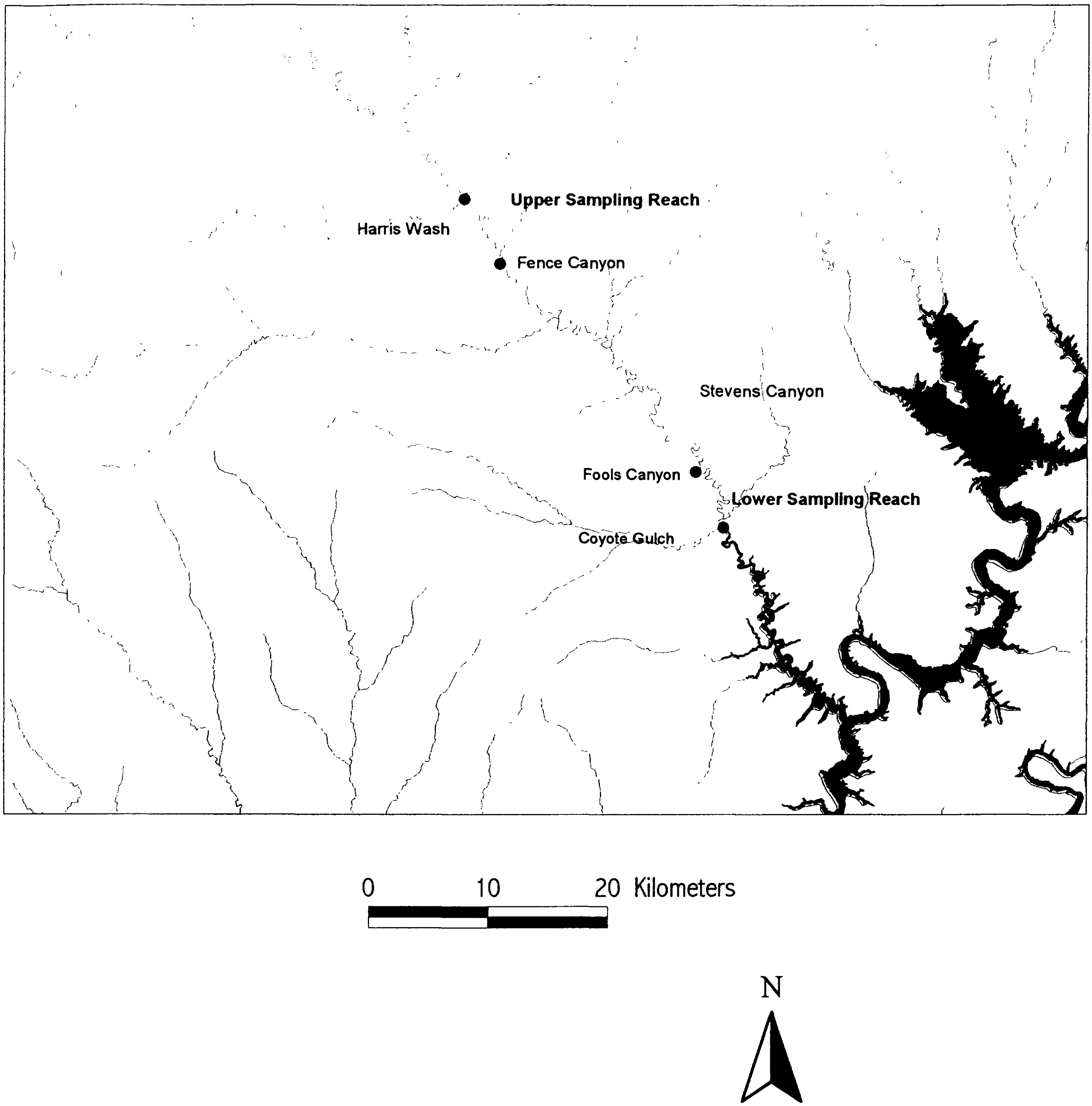


Figure 3.1. Amphibians sampling reaches, Escalante River, UT, June 22 - 26, 1998.

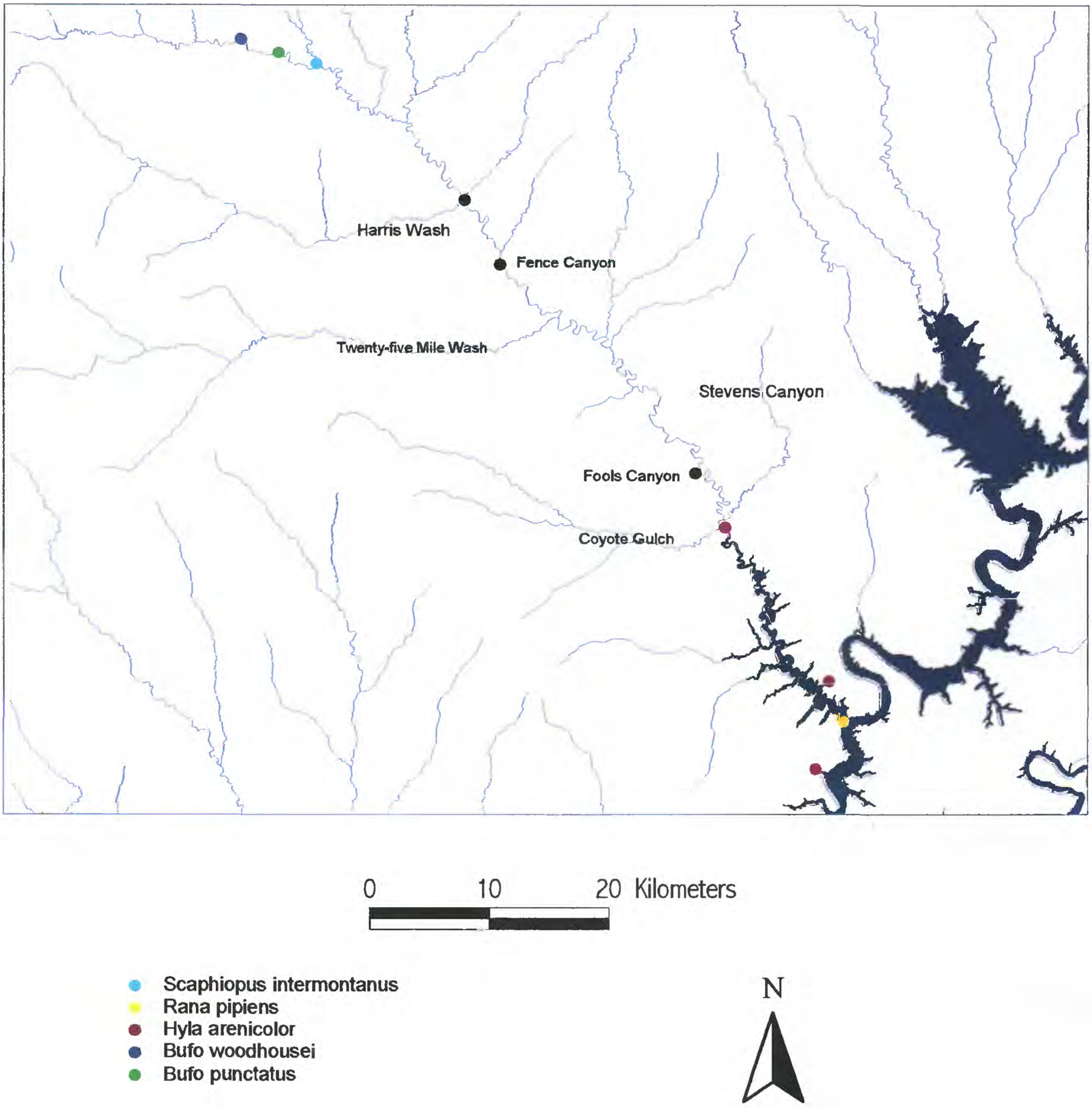


Figure 3.2. Historic distribution of amphibians within the lower 100 km of the Escalante River, UT. Locality information was compiled from museum records, unpublished literature, and Tanner (1940).

METHODS

Sampling techniques for surveying amphibians included both Visual encounter (VE) surveys (Crump and Scott 1994) and call counts (Zimmerman 1994). Visual encounter surveys were conducted at all stations by walking along the river channel and systematically searching for amphibians. During VE surveys a single person searched both sides of the channel. Bank cover was not turned over or disrupted; only those individuals visible on the surface were counted. At each station, reaches approximately 0.20 mi in length were targeted for VE surveys. However, due to habitat heterogeneity and time limitations, survey distance and search time varied among stations. Typically, channel right was searched while walking downstream and channel left was searched while returning to the upstream starting point. Any seeps or side canyons within the station were surveyed for a maximum distance of 0.25 mi. Amphibians captured during sampling were identified, snout-vent length measured (mm), and released. Total survey time, station length, number of individuals encountered and life stage, water temperature, ambient temperature, and GPS location were recorded at each station.

Approximate counts were conducted for all tadpoles and egg strings encountered. Each egg string was assigned an age class according to stage of development. Age classes were designated as follows: Class 1) string below water surface and resting on substrate or vegetation, envelopes clear and ova small, dark and round; Class 2) string starting to float to surface, envelopes opaque and ova kidney-shaped or elongated; Class 3) string at water surface and top layer of eggs crusty due to desiccation, embryos have tails and are close to hatching; Class 3+) string starting to disarticulate and often yellow in color, most of the embryos have hatched from the eggs and are feeding on the string or swimming freely as tadpoles; Dead) embryos desiccated or white to gray, with disarticulation of both the embryos and egg string.

When tadpoles were encountered a sample of 10 was collected. Samples were used for confirmation of species and stored for future tissue analysis. All samples were preserved in 95% ethanol. Tadpoles collected were verified using a dissecting scope and a dichotomous key (Altig 1970) developed by Gosner (1960).

Call count surveys were conducted near dusk at 2 stations. At each station, ten minute voice counts were conducted at two separate locations approximately 0.10 mi apart. Thirteen stations within two reaches, totaling 8.65 miles of habitat, were surveyed (Table 3.2). Total search time was 16 person hours.

RESULTS

The woodhouse toad (*Bufo woodhousei*) was the only amphibian species documented. All life stages of this species were observed, including juvenile (n=200) and adult toads (n=19), tadpoles (n=2425), and egg strings (n=4) (Table 3.2). In addition, two calling woodhouse toads were recorded. Woodhouse toads were observed at 10 of 13 stations (Table 2).

Table 3.2. Sampling date, GPS location, survey length, and life stage of woodhouse toads observed during 1998 presence/absence surveys at 13 sampling stations on the Escalante River, Utah. Tadpole numbers in parenthesis are estimates.

Station Number	Date	UTMx	UTMy	Survey length	Toads	Tadpoles	Egg strings (Age)
Upper							
1[1]	6-22-98	481013	4168401	0.10 mi	1	(50)	0
2[1]	6-22-98	482257	4167280	0.10 mi	1[a]	(100)	0
3[1]	6-22-98	482524	4165951	0.50 mi	1	0	1 (1)
4[1]	6-23-98	483214	4165111	0.10 mi	0	0	0
5[1]	6-23-98	483536	4164325	0.20 mi	0	0	0
6[1]	6-23-98	483970	4164025	0.40 mi	0	0	0
7[2]	6-23-98	484247	4162639	2.0 mi	1	(300)	0
Lower							
8[1]	6-24-98	501642	4144696	0.50 mi	1	(100)	1 (2)
9[1]	6-24-98	501386	4144219	2.0 mi	5	0	2 (Dead)
10[1]	6-25-98	501191	4143611	0.50 mi	2	(250)	0
11[2]	6-25-98	501746	4143089	1.75 mi	204	(625)	0
12[1]	6-26-98	501714	4142111	0.40 mi	0	(1000)	0
13[1]	6-26-98	501986	4141540	0.10 mi	5	0	0

[1] Only Visual encounter surveys conducted at this station.
[2] Both Visual encounter and Call count surveys conducted at this station.
[a] Dead *B. woodhousei*, partial remains only.

Upper Reach (Harris Wash to Fence Canyon): Woodhouse toads were observed at 4 of 7 stations surveyed in the upper reach (Table 3.3). Observations included adults (n=4), tadpoles (n=450), and a single egg string. Six surveys were conducted on the mainstem of the Escalante River (stations 2-7a) and resulted in 3 adult toads, approximately 100 tadpoles, and 1 egg string (Table 3.3). Tadpoles (n=100) and the remains of a dead adult toad were located in an off-channel pool at station 2 (Table 3.3). A single adult toad was observed along the channel at stations 3 and 7a. The single egg string (Age Class 1) was located in an off-channel pool at station 3. No amphibians were located at stations 4, 5, or 6. Water temperature in the mainstem Escalante River was 19°C; temperatures in the off-channel pools averaged 20°C (Table 3.3).

Table 3.3. Number and lifestage (A=adult, J=juvenile), average water depth (cm), ambient temperature, water temperature (°C), and microhabitat for woodhouse toad observations at seven survey stations between Harris Wash and Fence Canyon, Escalante River, UT.

Station Number	$T_{(A)}$ °C	$T_{(W)}$ °C	# Observed/ Lifestage	Tadpole # (depth cm)	Egg string # (depth cm)	Microhabitat
1	27	22	1J	50 (4)	0	Side wash
2	29	21	1A [1]	100 (5)	0	Off-channel pool
3	24	19	1A	0	1 (5)	River bank & off-channel pool
4	-	19	0	0	0	-
5	-	19	0	0	0	-
6	26	19	0	0	0	-
7[a]	26	17	1A	0	0	River bank
7[b]	26	23	0	300 (5)	0	Isolated pools in side canyon

[1] Partial remains of dead adult found in off-channel pool.

[a] Mainstem Escalante River

[b] Fence Canyon

Surveys were also conducted in two tributaries to the Escalante River, Harris Wash (Station 1) and Fence Canyon (Station 7b). A single adult toad and approximately 350 tadpoles were observed (Table 3.3). Water temperatures in Harris Wash and Fence Canyon were 22°C and 23°C, respectively. In Fence Canyon seven isolated pools were surveyed; only two contained amphibians. The five pools not containing amphibians supported populations of green sunfish (*Lepomis cyanellus*), fathead minnow (*Pimephales promelas*), and juvenile *Catostomus* sp. Of the approximately 450 tadpoles recorded in the upper reach, 78% (n=350) were located in side canyons. Tadpoles were typically found aggregated in shallow (<5cm), warm (20°C to 23°C), ephemeral pools in both the mainstem and side canyon stations (Table 3.3).

Call counts were conducted in Fence Canyon on the evening of June 23, 1998. No calling amphibians were recorded.

Bank cover among all upstream stations was predominantly willow, cottonwood, tamarisk, and Russian olive, however, *Equisetum* sp., *Juncus* sp., *Typha* sp., and *Phragmites* sp. were also common. The river bank substrate was primarily sand, gravel, and cobble.

Lower Reach (Fool's Canyon to Lake Powell confluence): Woodhouse toads, in various life stages, were observed at all six stations surveyed in the lower reach. Observations included juvenile (n=200) and adult (n=15) toads, tadpoles (n=1975), and egg strings (n=3). Surveys were conducted at 5 stations (8-11a, 13) on the mainstem of the Escalante River and resulted in 14 adult toads, approximately 800 tadpoles, and 3 egg strings (Table 3.4). The adult toads were observed at stations 8-11a, and 13 (Table 3.4). All toads were found along the channel less than 5 m from the water's edge. Tadpoles were observed in off-channel pools at stations 8, 10, and 11a, at an average depth of 7 cm (Table 3.4). An off-channel pool at station 11a had dried up leaving approximately 50 tadpoles dead. In addition, 2 dead egg strings, the result of a dried pool, were observed at station 9. Woodhouse toads (n=2) were heard calling at station 13, however, call counts were not officially conducted at this station. These were the only amphibian vocalizations heard during the entire survey period. The water temperature of the mainstem and off-channel pools averaged 22°C and 25°C respectively.

Two tributaries, Stevens Canyon (Station 11b) and Coyote Gulch (Station 12), were also surveyed. A single adult toad, approximately 200 metamorphs, and approximately 1175 tadpoles were observed (Table 3.4). Water temperatures in Stevens Canyon and Coyote Gulch averaged 24°C and 12°C respectively. Within Stevens Canyon, approximately 175 tadpoles were observed in two isolated pools (at an average depth of 5.5 cm) (Table 3.4). In addition, one adult toad and approximately 200 metamorphs (11mm SVL) were located in an isolated pool 0.25 miles up the canyon. Approximately 1000 tadpoles, in various developmental stages, were observed in Coyote Gulch. Of the approximately 1975 tadpoles observed in the lower reach, 59% (n=1175) were located in side canyons.

Call counts were conducted in Stevens Canyon on the evening of June 25, 1998. No calling amphibians were recorded.

Bank cover in the lower reach was predominantly willow, tamarisk, *Phragmites* sp., *Equisetum* sp., and *Juncus* sp. The river bank substrate was primarily sand, gravel, and cobble.

DISCUSSION

Although five amphibian species have been historically documented in the lower Escalante River drainage (Table 3.1), woodhouse toads were the only amphibian species observed during the interagency sampling trip. This may be attributed to the timing of the sampling. Woodhouse toads, red-spotted toads, Great Basin spadefoot toads, leopard frogs, and canyon treefrogs are all seasonal breeders. Timing of breeding activity is variable among all five species, however, it typically occurs from March to June, peaking in April and mid-May (Stebbins 1985, Wright and Wright 1995). These species may not have been observed because the surveys occurred at the end of the breeding activity period.

Table 3.4. Number and lifestage (A=adult, J=juvenile), average water depth (cm), ambient temperature, water temperature (°C), and microhabitat for woodhouse toad observations at six survey stations between Fool's Canyon and the Lake Powell confluence, Escalante River, UT.

Station Number	$T_{(A)}$ °C	$T_{(W)}$ °C	# Observed/ Lifestage	Tadpole # (depth cm)	Egg string # (depth cm)	Microhabitat
8	-	19	1J	100 (6)	1 (3)	River bank; off-channel seep & pool
9	31	24	2A, 3J	0	2 (Dry pool)	River bank; dry pool
10	26	19	1A, 1J	0	0	River bank
10	26	21	0	250 (5)	0	Off-channel pool
11[a]	31	25	0	200 (8)	0	Off-channel pool
11[a]	31	25	3A	0	0	River bank
11[a]	31	33	0	200 (9), 50 (Dry pool)	0	Off-channel pools
11[b]	30	22	0	175 (5.5)	0	Pools in side canyon
11[b]	30	26	1A, 200J	0	0	Pool in side canyon
12	20	12	0	1000 (6in)	0	Side canyon
13	23	-	3J	0	0	River bank

[a] Mainstem Escalante River

[b] Stephens Canyon

In addition to temporal variation in breeding, these species exhibit different breeding behaviors and habitat requirements. Spadefoot toads are secretive, spending long periods of time underground. Breeding activity occurs following spring and summer rains (Stebbins 1985). As a result, this toad is seldom encountered and annual timing of breeding is unpredictable. Canyon treefrogs inhabit intermittent or permanent streams, preferring to breed in quiet boulder strewn pools with solid, rocky bottoms (Stebbins 1985). Suitable canyon treefrog habitat was not observed on the lower mainstem Escalante River. However, suitable habitat may exist in unsurveyed side canyons. Red-spotted toads are primarily nocturnal. They are typically observed among streamside rocks in intermittent streams, however, they occasionally frequent open floodplains, breeding in temporary pools following spring runoff (Stebbins 1985). While preferring open marshes, ponds, and reservoirs, leopard frogs also inhabit permanent seeps, springs, and slow-moving streams with dense aquatic vegetation (Stebbins 1985). Breeding habitat consists of shallow, open water with submerged aquatic vegetation. While suitable red-spotted toad and leopard frog breeding habitat was observed in both the mainstem and side canyons, surveys did not coincide with the optimal breeding activity period.

Woodhouse toads are typically found in close proximity to permanent water sources including rivers, streams, ponds, and irrigation ditches. Woodhouse toads inhabit sandy areas, breeding in standing pools and shallow flowing stream reaches (Stebbins 1985, Sullivan 1986, Wright and

Wright 1994). Our results document that the lower 80 km of the Escalante River provides suitable habitat for Woodhouse toads, with breeding populations existing in both the mainstem and side canyons. In the upper and lower sampling reaches, woodhouse toads were associated with shallow flowing channels, off-channel pools, and seeps. Sixty-three percent (n=1525) of tadpoles were located in side canyons. Both Fence and Stevens Canyon, with isolated, warm (22°C - 26°C) pools, and Harris Wash and Coyote Gulch, with flows less than 2cfs, provided suitable breeding habitat.

The Escalante River is characterized by seasonal high flows resulting from spring runoff and rainfall. On the mainstem and side canyons, amphibian breeding habitat is restricted to shallow flowing channels, springs, seeps, and backwaters and off-channel pools created by receding high water. Temporal variation in the availability of breeding habitat may impact the distribution of amphibians. In addition, the distribution of suitable amphibian breeding habitat is limited by the presence of fish (Hayes and Jennings 1986). In the lower Escalante River, woodhouse toads were found breeding in ephemeral areas providing submarginal habitat for fish. Non-native fishes pose a greater threat to amphibians than native fishes because their habitat requirements overlap with that of breeding amphibians. Amphibian population fragmentation and declines, as a result of predation and competition by non-native fishes, have been documented throughout western North America (Orchard 1992, Corn 1994). Many non-native fishes (e.g. *Lepomis* sp., *Pimephales* sp.) are adapted to quiet pools and backwater areas and are highly tolerant of poorly oxygenated intermittent streams unsuitable for native fishes (Page and Burr 1991). Hayes and Jennings (1986) reported that surveyed localities with non-native fishes rarely supported native ranid populations. When amphibians and non-native fishes were sympatric, ranid populations were small, suggesting factors were marginal for their survival. In Fence Canyon, within the lower Escalante drainage, tadpoles were observed only in isolated pools lacking non-native fishes. Amphibian distribution within the lower Escalante River is limited by availability of ephemeral habitat associated with spring runoff. Utilization of this breeding habitat by amphibians may be limited by competition with non-native fishes.

Breeding populations of woodhouse toads occur in both the mainstem and side canyons of the lower Escalante River. While woodhouse toads were the only amphibian species observed in the lower drainage, suitable breeding habitat exists for spadefoot toads, red-spotted toads, and leopard frogs. Suitable habitat on the mainstem Escalante was not observed for canyon treefrogs, however, it may exist in side canyons. Breeding habitat in the lower drainage is ephemeral, and availability and utilization are impacted by temporal variation and the presence of fish. The timing of amphibian surveys annually is critical in order to coincide with optimal breeding activity.

RECOMMENDATIONS

Further inventory, detailing species occurrence and distribution, is necessary prior to establishing long term monitoring of amphibian species within the Escalante River. To maximize amphibian encounters, we recommend conducting intensive inventories earlier in the breeding season, coinciding with peak amphibian breeding and daily activity periods. Call count and VE techniques should be utilized and surveys should be conducted on both the mainstem and side canyons. Thorough investigation of side canyons should be conducted as they may provide more available breeding habitat, associated with seeps, springs, and seasonal runoff.

REFERENCES

Altig, R. 1970. A key to the tadpoles of the continental United States and Canada. Herpetologica. 26:180-207.

Corn, P.S. 1994. What we know and don't know about amphibian declines in the west. Pages 59-67 *in* W.W.I Covington and L.F. DeBano (technical coordinators), Sustainable ecological systems: Implementing an ecological approach to land management. USDA Forest Service, Rocky Man. Forest and Range Experiment Station, Ft. Collins, CO. General Technical Report RM-247.

Crump, L.M., and N.J. Scott, Jr. 1994. Visual encounter surveys. Pages 84 - 92 *in* W.R. Heyer, M.A. Donnelly, R.W. McDiarmid, LC. Hayek, and M.S. Foster, eds. Measuring and monitoring biological diversity. Standard methods for amphibians. Smithsonian Institution Press, Washington.

Gosner, K.L. 1960. A simplified table for staging anuran embryos and larva with notes on identification. Herpetologica. 16:183-190.

Hayes, M.P., and M.R. Jennings. 1986. Decline of ranid frog species in western North America: are bullfrogs (*Rana catesbeiana*) responsible? Journal of Herpetology 20:490-509.

Orchard, S.A. 1992. Amphibian population declines in British Columbia. Pages 10 - 13 *in* C.A. Bishop and K.E. Pettit, eds. Declines in Canadian amphibian populations: designing a national monitoring strategy. Canadian Wildlife Service. Occ. Paper 76. 120pp.

Page, L.M., and B.M. Burr. 1991. A field guide to freshwater fishes of North America north of Mexico. Houghton Mifflin Company, Boston.

Stebbins, R.C. 1985. A field guide to western reptiles and amphibians. Houghton Mifflin Company, Boston.

Tanner, V.M. 1940. A biotic study of the Kaiparowits region of Utah. Great Basin Naturalist. 1:97-126.

Wright, A.H., and A.A. Wright. 1995. Handbook of frogs and toads of the United States and Canada. Comstock Publishing Company, Inc., Ithaca, NY.

Zimmerman, B.L. 1994. Audio strip transects. Pages 92 - 97 *in* W.R. Heyer, M.A. Donnelly, R.W. McDiarmid, LC. Hayek, and M.S. Foster, eds. Measuring and monitoring biological diversity. Standard methods for amphibians. Smithsonian Institution Press, Washington.

APPENDIX A

Photographs

An aerial view of the Escalante River taken somewhere between Fence Canyon and Twentyfive Mile Wash. This section of the river is typical of the Middle Canyon where the floodplain is confined to a relatively broad corridor. This section supports a relatively intact endemic fish community.

Sample Site #2. Trammel net being used as a blocking net during seining.

Sample Site #3. Looking upstream, the seining station was the left channel.

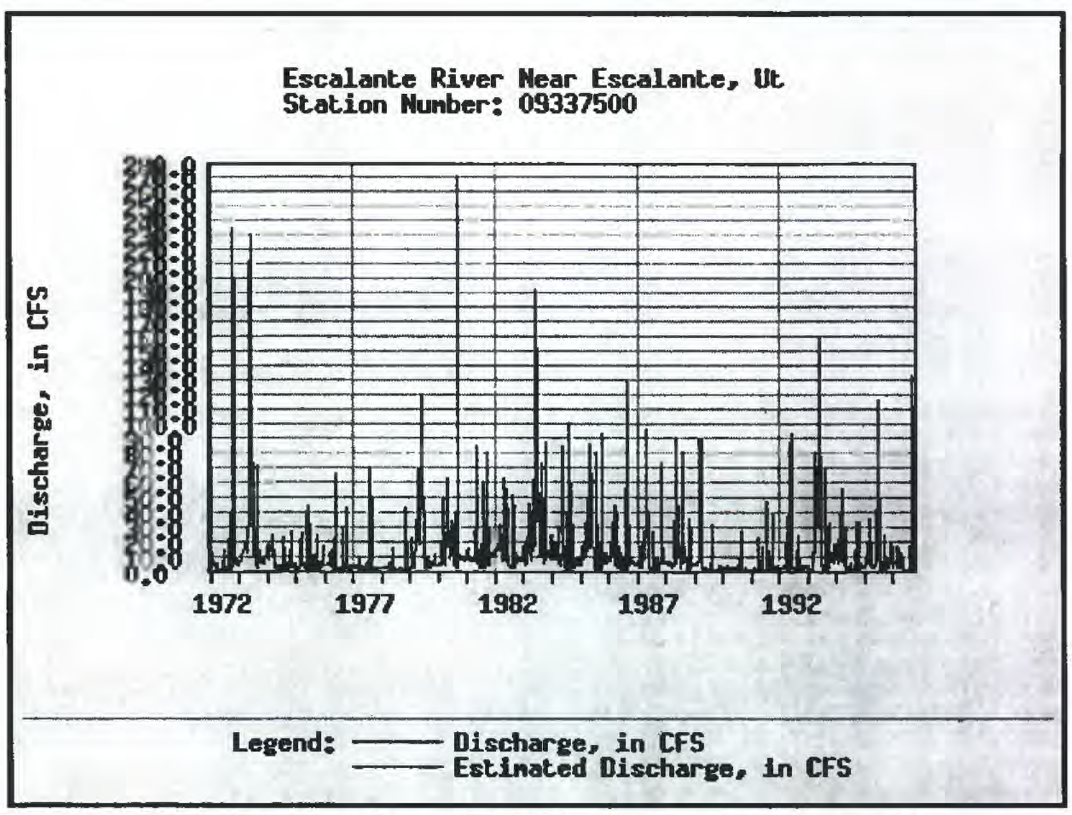
Sample Site #4. Looking downstream to the confluence of the Escalante River and Fence Canyon.

Fence Canyon Site. Isolated pool in Fence Canyon located approximately 100 m upstream from the Escalante River (note trammel net).

Sample Site #5. Looking upstream. Seining station was located further downstream.

Sample Site #6. Looking downstream. Typical of entire reach, channel obstructed with large boulders and rock rubble.

Sample Site #7. Looking downstream. Typical of entire reach, channel obstructed with large boulders and rock rubble.



Historical Streamflow Daily Values Graph for Escalante River near Escalante, UT (09337500)