

A FAUNAL SURVEY OF HALL'S CREEK
CAPITOL REEF NATIONAL PARK
GLEN CANYON NATIONAL RECREATION AREA

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INTRODUCTION

Hall's Creek is an intermittent stream which flows, after rains, between the Waterpocket Fold on its eastern bank and the cliffs of the Hall and Big Thompson Mesas on its western banks. The major streamside habitats in which animals were found in this study were streamside cottonwood groves, grassy streamside vegetation, standing water pools in the creek bed, deep pools and springs of side canyons, potholes, and xeric scrub vegetation of the flood plain.

This report documents the sightings of animals and information concerning collections of animals made during three backpacking trips into the area. This report includes a fairly complete list of large diurnal vertebrates (birds, lizards, and mammals), but many migrating birds, nocturnal snakes and bats which are probably present were not seen or reported. Some aquatic insects and other invertebrates were identified to species, genus, family, or phylum, but most invertebrates (particularly terrestrial insects) are not enumerated. Although some judgment concerning the commonness or rarity of a few species is attempted, the study was not intended to be highly quantitative.

The trips were made over a 31 mile section of the creek bed between The Post and Lake Powell, including dozens of side canyons, on the following dates:

June 4-7, 1977

July 22 - July 29, 1977

August 26 - September 9, 1977

The general approach was to take note of all obvious birds, mammals and reptiles using field marks, track sign, scat collections, and calls, where each was appropriate. Collections were made of aquatic insect larvae, phyllopod crustaceans, aquatic molluscs, and flying insects. Live trapping of mammals (only very small seed-eaters) was accomplished using Sherman live traps on

eleven nights for a total of 511 trap nights.

The overall impression of the area was that of a desert riparian habitat which suffers from disturbance by cattle grazing. Although the diversity of species is fairly high, abundances of all animal groups is low.

The numerous moist side canyons are welcome havens for wildlife, and important refuges for animal species not found in other parts of Capitol Reef or drier parts of Waterpocket Fold. Potholes which are located on ledges and large expanses of slickrock are probably the only habitats which have escaped damage by cattle. This report recommends that the promotion of vegetation growth on the flood plain and the recruitment of small trees into the dying cottonwood groves could be accomplished by removal of cattle grazing and continued prohibition of vehicle use.

To this author, the most interesting potential research problems at Hall's Creek are the niche relations between a large number of co-occurring frogs and toads and the population biology of organisms which occupy the ephemeral habitats of potholes.

Information concerning the plants of Hall's Creek can be found in the report that accompanies this one: "Ecological Reconnaissance Halls Creek" by Pam Camp.

LOCATION AND SETTING OF HALL'S CREEK

The creekbed, a combination of storm wash and permanently running stream, runs for about 48 miles from the Bitter Creek Divide (elevation 5650 feet) to Lake Powell (elevation about 3640 feet, depending on rainfall patterns of the year). During the summer of 1977, low total rainfall had "lengthened" Hall's Creek so that it terminated in Lake Powell about a mile southeast of Baker Ranch. In normal years of typical rainfall, Baker Ranch buildings are partially submerged by the waters of the reservoir. During the June trip, water flowed in the bottom mile of the creek (that is, into Lake Powell). In July and August, this only happened after rains.

A summary of temperature phenomena during this study is presented here:

Water Temperatures	July 22-29	August 26-Sept. 9
Lake Powell	80°F	82°F
Hall's Creek	77-86°F	
Side Canyon Creeks	75°F	
Side Canyon Springs	62-68°F	
Side Canyon Pools	72°F	
Air Temperatures (in the shade)		
4:30-6:00 am	60-65°F	45-64°F
7:00-9:00 am	74-86°F	54-85°F
10:00-12:00 noon	86-100°F	80-94°F
12:00-3:00 pm	90-106°F	84-99°F
3:00-5:00 pm	96-106°F	88-98°F
6:00-8:00 pm	92°F	83-88°F
8:00-10:00 pm	84°F	75-79°F
10:00-12:00 midnight	76°F	62-79°F

Side canyons consistently maintain average temperatures 10 to 20°F lower than those in the Hall's Creek proper.

For the purposes of this report, the abandoned ranch house at Baker Ranch is used as a 0.0 mile reference point for measurement of distances upstream along Hall's Creek. As can be seen from the map in figure 1, more than seven miles of the study area lie outside Capitol Reef National Park, in the Glen Canyon National Recreation Area.

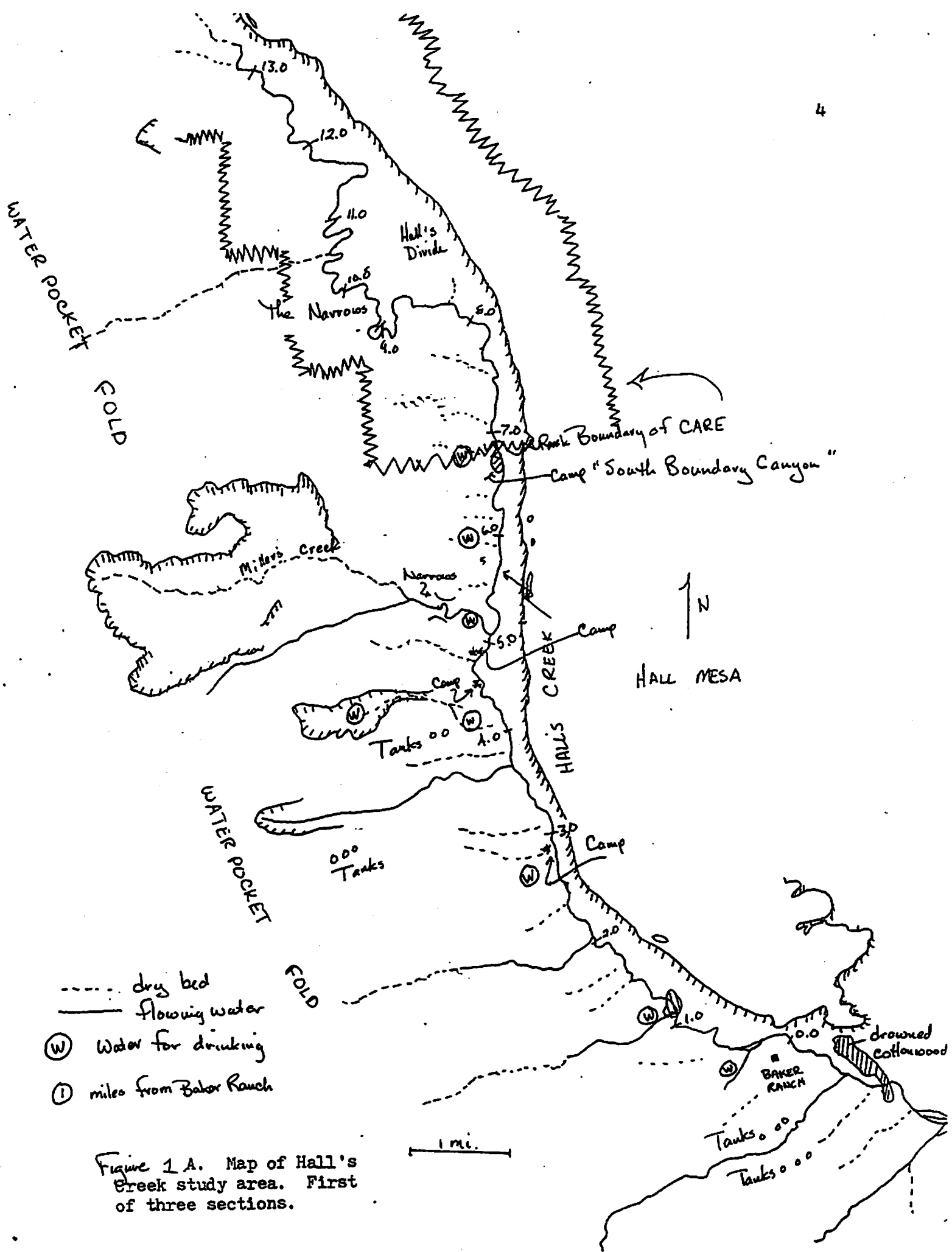


Figure 1 A. Map of Hall's Creek study area. First of three sections.

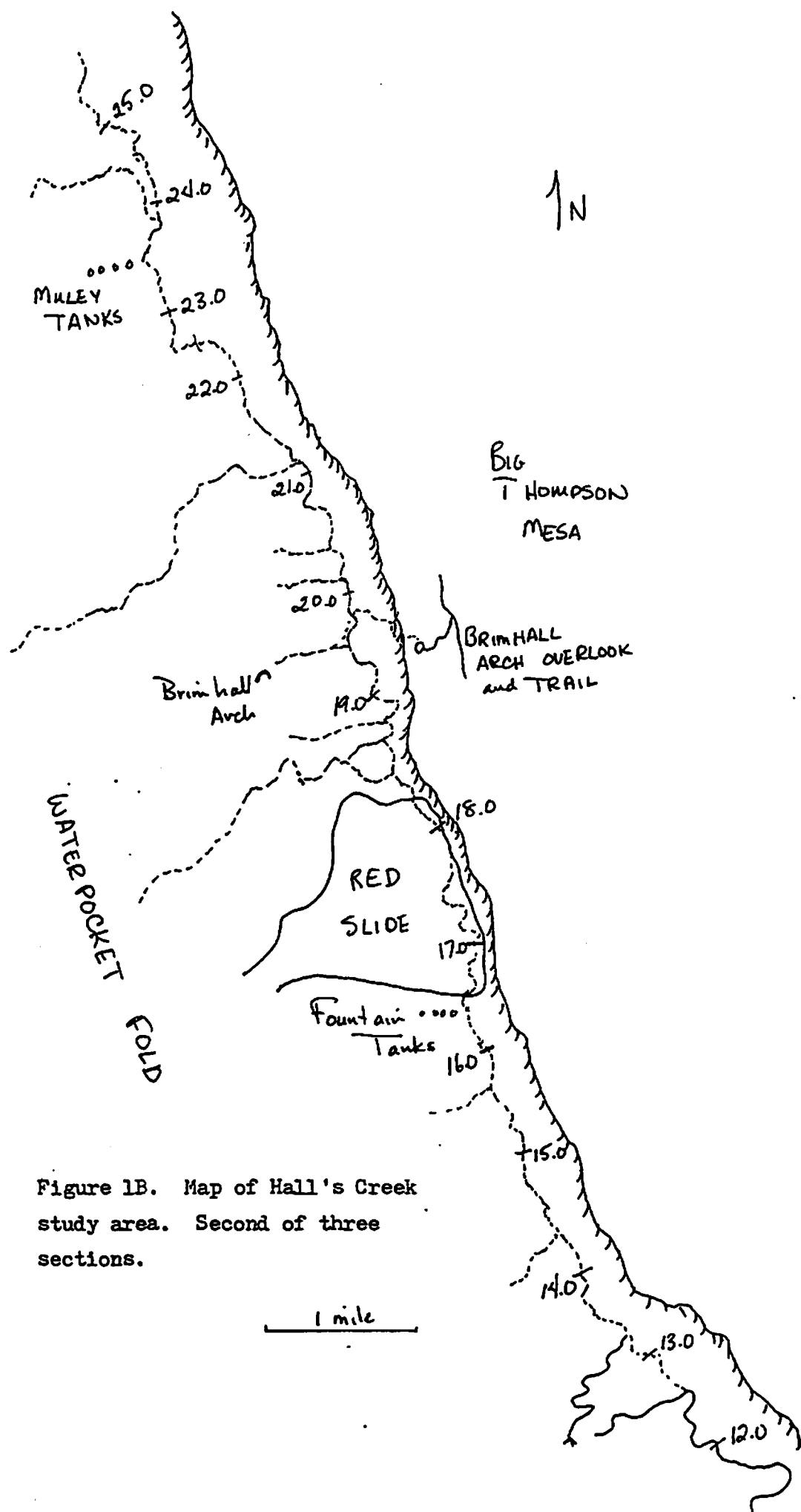


Figure 1B. Map of Hall's Creek study area. Second of three sections.

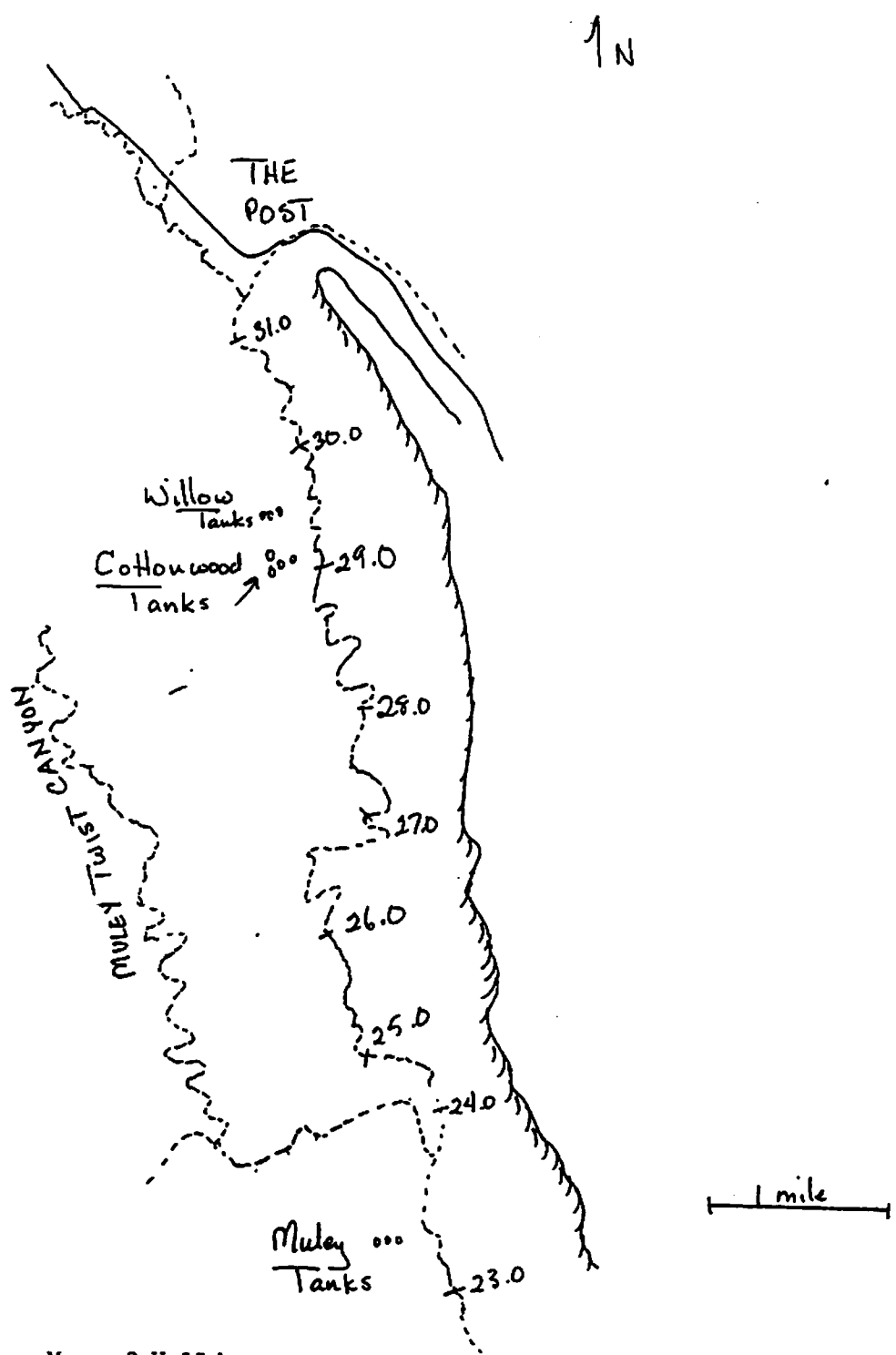
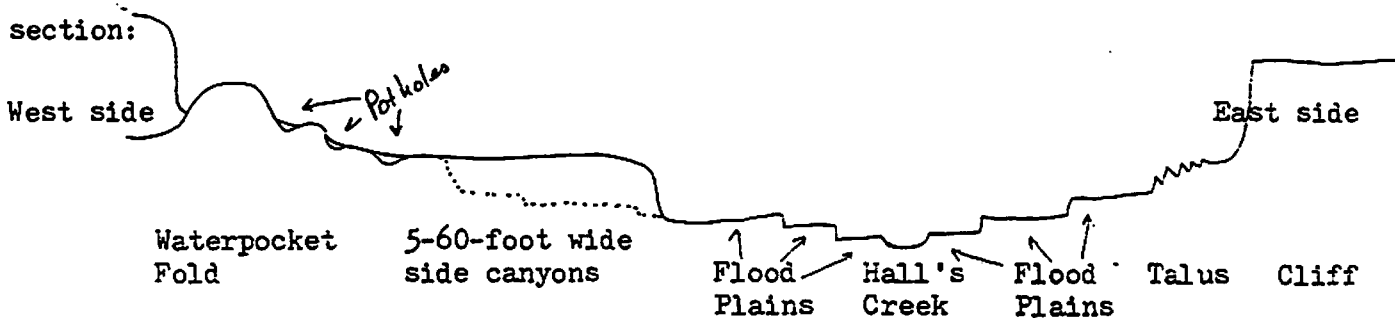


Figure 1C. Map of Hall's Creek study area. Third of three sections.

GEOLOGY

The two outstanding geological features of the Hall's Creek area are the dome-topped cliffs with incised side canyons of Navajo sandstone, the Waterpocket Fold proper, on the western and southwestern banks of Hall's Creek and the chocolate-brown Summerville formation which forms the dry rubbly cliffs on the eastern and northeastern banks. Differential erosion of these two rock formations give rise to the general land profile described in this schematic section:



The floor and flood plains of the creek bed demonstrate exposed sections of the Carmel and Entrada formations among the alluvial deposits. The Carmel is particularly conspicuous by Baker Ranch and at the Willow and Cottonwood Tanks in blue, chocolate, red, and white slanting strata. The Entrada sandstone has formed gigantic mounds below Baker Ranch and above the Red Slide. The Red Slide itself is a large landslide of red Wingate sandstone boulders which has fallen through a gap in the Waterpocket Fold. The only conspicuous areas of Wingate sandstone and Chinle formations (containing petrified wood) were seen in the upper walls of Miller's Creek canyon and ⁱⁿ Muley Twist Canyon. Lava boulders can be seen on top of the Navajo sandstone at Muley Tanks.

The cutting of the sandy rock ^{by Hall's Creek} has created a wide canyon, up to $\frac{1}{2}$ mile wide, with fairly extensive flood plains. A short "narrows" has been carved in the Navajo sandstone between 8.5 and 10.5 miles above Baker Ranch. The soils are very sandy. High erosion rates and dry conditions probably combine

to limit accumulation of organic detritus which would result from plant decomposition in a ^{more} moist, less disturbed setting. Thus, soil development is very limited.

HYDROLOGY

During the dry summer of 1977, Hall's Creek flowed continuously from Miller's Creek to Lake Powell only after rainstorms. Between those times, small sections of the creek contained flowing water, and stream-bottom pools were common. Miller's Creek and several large side canyons between Baker Ranch and the Narrows provided dependable sources of flowing water for drinking, as well as aquatic habitat for amphibians, fish, and invertebrates. In some cases, side canyons were dry at the top and bottom, but were wet in between. The lushest side canyons were located between Miller's Creek and Baker Ranch, in the Glen Canyon NRA.

Rain-filled potholes in "tank" areas were irregularly distributed along the entire length of the study area on the Waterpocket Fold. They provided the only drinking water above Hall's Divide. Some tank areas were completely dry and/or muddy, but the major "tanks"---Fountain, Muley, Cottonwood, and Willow---all contained water. Although it is difficult to see and count tanks from the vantage point of the Hall's Creek bed, I believe that there are about 15-20 easily accessible pothole tank areas along the 31-mile study area. Many more probably exist in the less accessible Waterpocket Fold cliffs. In general, they can be found in the uppermost reaches of side canyons near the greatest elevation of the Waterpocket Fold.

The few rainstorms that were witnessed during the study caused a scouring of the bottom of Hall's Creek and a 12-hour temporary swelling of creek volume, but they had little effect on the aquatic life in small side canyons. Plants were not dislodged and benthic invertebrates were not displaced.

HABITATS

Designation of major habitats found at Hall's Creek can be described as follows:

1. Lake Side Habitat

The shore line of Lake Powell attracted many species which would not be seen in a desert riparian habitat. Ducks, snowy egrets, grebes, sandpipers, and cormorants were seen among the drowned cottonwood groves. These species were presumed to be migrants or non-breeding individuals which were attracted to the large expanse of open water.

2. Cottonwood Groves

Groups of between two and forty large old cottonwood trees constituted groves beside Hall's Creek. These sites are important habitat for the desert spiny lizard, Sceloporus magister, and the following nesting birds: blue-gray gnatcatcher, yellow warbler, warbling vireo, and small numbers of other passerine birds. The groves provide valuable shade for adult toads (Bufo woodhousei) as well as other terrestrial and aquatic species. Forty large old trees make up the largest single grove, which can be found at the "South Boundary Canyon", 6.7 miles above Baker Ranch. At this site, evidence of ^{former} beaver use is seen in gnawed stumps and an abandoned lodge.

Above mile 3.6, the cottonwoods do not form continuous groves along the creek bed.

We were disturbed to note that practically no small seedlings of cottonwood trees could be found along the creek. At least some of the seedling mortality appears to be due to cattle yarding which occurs as the animals seek shade from the intense afternoon heat. The complete disappearance of the trees due to recruitment failure will result in loss of wildlife habitat and decreased flood plain stability. It appears advisable, therefore, to eliminate grazing

and prohibit vehicular use of the area before these trees are lost completely.

3. Streamside Vegetation (especially Phragmites grass)

Water-soaked sand was found to be important habitat for juvenile toads. Larvae and adults of many insects feed here, and provide the food resource for insectivorous birds (swallows, swifts, wrens, flycatchers and warblers), bats, small mammals, and the large toad population.

4. Cool, Moist Side Canyons

These are important sites for mule deer, beaver, chipmunk, canyon tree-frogs, leopard frogs, canyon wrens, great-horned owls, and a large number of aquatic invertebrates. In some canyons, cattail and sedge marshes have developed, providing habitat for Virginia rails, great blue herons, and a green heron. Small willow trees in these locations attract several species of warbler, including a yellow-breasted chat.

5. Dry Flood Plains

Here were found several species of lizards, migratory seed-eating birds, kangaroo rats (Dipodomys ordii), badgers, coyotes, and many small mammals.

6. Potholes

These basins are formed by flood scour in the Navajo sandstone and are filled by rainwater. The high evaporation rates result in drying of shallow pools (of less than 12 inches depth) very rapidly. Large tanks which measure five feet deep and five feet across (or more) probably never become completely dry. A few huge tanks harbor tremendous numbers of organisms. They may act as a refuge for aquatic organisms during droughts, thereby preventing local extinctions during dry years. Most of the largest tanks are located at the bases of tank areas and are accessible to cattle.

SPECIES LISTS

I. MAMMALS

Mammals were recorded by four means: simple sighting, identification of scats and track sign, and live trapping using Sherman live traps. The only common species were small fossorial rodents which are never found very far from water sources. Kangaroo rats (Dipodomys ordii) were trapped on the dry benches, which demonstrates their independence from water. Trap success was so low on all dates in late July, that it is likely that most small mammals aestivate during the hottest part of the summer.

The following table summarizes the results of all 11 trapping nights. All traps were baited with oatmeal.

Date	Miles above Baker Ranch	Number of Traps Set	Number of Individuals Caught	Species Caught*
5 June	4.0	50	1	DO
24 July	4.0	50	0	
25 July	6.6	50	1	PM
26 July	6.5	50	4	1PM, 3PC
27 July	6.5	50	7	3PM, 4PC
28 July	6.5	50	3	2PM, 1PC
26 August	0.0	30	13	7DO, 1NL, 2PC, 2PM, 2LC
29 August	0.0	30	11	7DO, 1NL, 2PC, 2LC
3 September	6.5	40	2	1DO, 1PC
5 September	7.5	55	4	2DO, 1NL, 1PC
6 September	11.5	56	4	1NL, 3DO

Trap nights: 511

Number of individuals trapped: 50

Overall trap success: 10% (Range: 0-43%)

Number of species identified using this method: 5

* DO=Dipodomys ordii PM=Peromyscus maniculatus PC=Peromyscus crinitus
 NL=Neotoma lepida LC=Lagurus curtatus

The total of all mammal records are summarized here. Total species number: 18

1. Western big-eared bat. Plecotus townsendi. Several individuals were seen (while we were using flashlights) among the beams of the abandoned buildings at Baker Ranch on August 26. Many other species of bats were seen, but none seen at close enough range to identify. Part of the collecting equipment which was taken into Hall's Creek included aluminum poles and mist nets to trap bats, but the

pole apparatus was insufficient to hold the nets in wet sand, and the nets themselves were not in good repair. The author of this report recommends that future bat-trapping could best be carried out by devising a means to tether a mist net to the walls of narrow canyons in which a pool is located. Bats often use the emerging insects from these areas for evening meals. An alternative would be to devise a self-supporting pole on a tripod or stand which could easily be set up on slickrock or dry shallow sand.

2. Raccoon. Procyon lotor. Tracks of this species were seen by Steve Trimble on 22 July 1977 near Baker Ranch.

3. Badger. Taxidea taxus. Many mounds from badger digging activity were seen, particularly around Baker Ranch.

4. Spotted skunk. Spilogale putorius. Tracks of this species were plentiful in the Narrows of Hall's Creek.

5. Striped skunk. Mephitis mephitis. Tracks of this species were seen between the Narrows of Hall's Creek and Fountain Tanks.

6. Ringtail. Bassaricus astutus. Tracks were seen by Steve Trimble on 10 June 1977 at the South Boundary Canyon. Scats of this species ^{contained} small mammals.

7. Coyote. Canis latrans. A single individual was seen on the dry Hall's Creek bed on August 28. Coyote calling was heard on one occasion in the Baker Ranch area on August 27. Scats from these animals were found in all parts of the drainage, and analysis of these show that coyotes eat mostly cottontails in this area. Remains of beetles, grasshoppers, small mammals, chokecherry and juniper seeds, snakes, lizards, chipmunk, grasses, and domestic beef cattle found in coyote scats demonstrate the opportunistic nature of coyote feeding habits in this area. ^{(See Appendix I).} Favored areas for den construction are the upper reaches of dry side canyons.

8. Gray fox. Urocyon cinereoargenteus. This species was identified only from tracks seen near Baker Ranch.
9. Whitetail antelope squirrel. Ammospermophilus leucurus. One questionable sighting was made on August 30, 1977 several miles south of Baker Ranch.
10. Colorado chipmunk. Eutamias quadrivittatus. Individuals were seen in low numbers in side canyons.
11. Ord's kangaroo rat. Dipodomys ordii. Burrows of this animal were seen throughout the entire drainage. Twenty-five were trapped in Sherman live traps. Very young individuals were trapped in late August.
12. Cactus mouse. Peromyscus eremicus. This is a questionable identification of an individual trapped at Baker Ranch. It is not recorded in the species totals.
13. Canyon mouse. Peromyscus crinitus. Fourteen of these were trapped throughout the study, mostly from grassy meadows and in vegetation along streams. A pregnant female was trapped on September 5. It is the most common small mouse.
14. Deer mouse. Peromyscus maniculatus. Six individuals of this ubiquitous species were trapped along streams. It would have been very surprising to find none of them.
15. Desert woodrat. Neotoma lepida. Although only four individuals of this species were caught in live traps, it appears to be common in the area judging from the amount of its fur seen in coyote, gray fox and ringtail scats and from the amount of packrat pellets seen in all arid portions of Hall's Creek. It eats mostly vegetable matter and a few beetles.
16. Sagebrush vole. Lagurus curtatus. This species is considered to be typical of great basin fauna, so it was somewhat surprising to find it in traps at Baker Ranch.
17. Blacktail jackrabbit. Lepus californicus. Only one individual of this species was seen, in a canyon one-half of the distance between Hall's Divide and Fountain Tanks.

18. Desert cottontail (Audubon's). Sylvilagus auduboni. Many individuals were frequently seen in the lower portion of Hall's Creek drainage.
19. Mule deer. Odocoileus hemionus. Many individuals were seen in deep side canyons. The total population in the drainage is estimated to be about 20.
20. Fawns were seen on July 22 and July 29 at Baker Ranch.
20. Beaver. Castor canadensis. Tracks, scats, and signs of activity of beaver were seen in a side canyon behind Baker Ranch on July 29, 1977. This species was also seen in a canyon one mile south of Baker Ranch on August 29. Beaver lodge and tree cutting activities were seen at the South Boundary Canyon and a canyon 2 miles above Baker Ranch, but it is clear that both of these areas have been abandoned by beavers for some time.

II. BIRDS

Bird activity was recorded by simple sighting, occasional identification of calls (when birds were not in sight), and the location and inspection of regurgitated pellets of raptors. The bird records are summarized here. Total number recorded: 71.

1. Western grebe. Aechmophorus occidentalis. Lake Powell only.
2. Double-crested cormorant. Phalacrocorax auritus. This species is attracted to perches provided by the dead cottonwood trees that have been drowned by Lake Powell.
3. Great blue heron. Ardea herodias. A winter visitor or migrant in the side canyons.
4. Green heron. Butorides virescens. A stray individual which was out of its normal range was seen at Baker Ranch.
5. Snowy egret. Egretta thula. Lake Powell only.

6. Canada goose. Branta canadensis. At Lake Powell shore only, migrant.
 7. Mallard. Anas platyrhynchos. Many feathers seen in side canyons. These traces may be the remains of meals by predators.
 8. Gadwall. Anas strepera. A small group was consistently noted four miles upstream from Baker Ranch.
 9. Green-winged teal. Anas crecca. Lake Powell only.
 10. Blue-winged teal. Anas discors. Lake Powell only.
 11. Cooper's hawk. Accipiter cooperii. This species was regularly seen in the dry upper reaches of the Hall's Creek drainage.
 12. Red-tailed hawk. Buteo jamaicensis. A few sightings from Baker Ranch and Hall Mesa rim (by Steve Trimby) constitute our only records of this species.
 13. Golden eagle. Aquila chrysaetos. One was sighted between Baker Ranch and Miller's Creek.
- Peregrine falcon. Falco peregrinus. Although we were looking for this species, and Tom Boner made a trip into Hall's Creek in late August to help locate potential falcon nest sites, we were not able to make a confirmed sighting. Mr. Boner is a technician for the Endangered Species Office of the Fish and Wildlife Service in Salt Lake City. He felt that the rounded holes in eroded sandstone of the Navajo formation are adequate nest sites for peregrine and prairie falcons. The cliff types appear to be inadequate for buteos and eagles. He also feels that the overall raptor density is quite low in Hall's Creek compared to other desert canyons he has studied.
14. American kestrel. Falco sparverius. Individuals of this species were commonly sighted between Baker Ranch and the Narrows. The only nest which could be located was in the Hall's Creek Narrows. Regurgitated pellets which were found near the roosts were made up of beetle parts.

15. Virginia rail. Rallus limicola. This species was seen at the shore of Lake Powell as well as in the marshes of the canyon behind Baker Ranch.
16. American coot. Fulica americana. Lake Powell only.
17. Killdeer. Charadrius vociferus. This species was seen at the shore of Lake Powell and was also seen a short distance up Hall's Creek.
18. Spotted sandpiper. Actitis macularia. This species was seen eating fish on the shore of Lake Powell.
19. Western sandpiper. Ereunetes mauri. A migrant seen on the Lake Powell shore.
20. Mourning dove. Zenaidura macroura. A widespread species that was commonly seen in all sections of the Hall's Creek drainage.
21. Screech owl. Otus asio. At least one individual resided at the South Boundary Canyon. Other individuals were heard at the dry tanks in the higher parts of Hall's Creek.
22. Great horned owl. Bubo virginianus. One individual was regularly seen in the Canyon behind Baker Ranch. A second individual was seen at the springs in Millers Creek Canyon. Owl pellets collected at Baker Ranch Canyon contained the remains of a very large scorpion, small mice, rabbit, desert woodrat, lizards and many fish scales. It is possible that the presence of this species may result in exclusion of the Spotted owl, if the latter attempted to nest in the area.
23. Common nighthawk. Chordeiles minor. Only two individuals were seen, between Baker Ranch and Miller's Creek.
24. White-throated swift. Aeronautes saxatalis. Although this species was not noted during the June trip, it was abundant in July and August.
25. Black-chinned hummingbird. Archilochus alexandri. Common in moist side canyons. A nesting pair was noted in the South Boundary Canyon.
25. Rufous hummingbird. Selasphorus rufus. Common migrant, seen in side canyons.

27. Belted kingfisher. Megaceryle alcyon. One individual seen near Miller's Creek.
28. Common flicker. Colaptes auratus. Several individuals were noted at regular intervals during the study.
29. Western kingbird. Tyrannus verticalis. Many were seen around Baker Ranch; a few were scattered throughout the entire drainage.
30. Ash-throated flycatcher. Myiarchus cinerascens. The most conspicuous, if not the most abundant bird species in the Hall's Creek drainage. It was not seen above the narrows, however.
31. Say's phoebe. Sayornis saya. Several were seen around Baker ranch; one was seen at Cottonwood Tanks.
32. Western flycatcher. Empidonax difficilis. A single individual was seen above the narrows; probably a migrant.
33. Western wood peewee. Contopus sordidulus. Regular sightings at South Boundary Canyon cottonwood groves indicates that this species probably nests at that location.
34. Cliff swallow. Petrochelidon pyrrhonota. Individuals seen at Baker Ranch were probably migrants.
35. Violet-green swallow. Tachycineta thalassina. These are a commonly-observed species at Hall's Creek. A nest was found in the buildings of Baker Ranch.
36. Bank swallow. Riparia riparia. A few were seen at Baker Ranch and a short distance up Hall's Creek.
37. Common crow. Corvus brachyrhynchos. A few were seen at irregular intervals in the canyon.
38. Scrub jay. Aphelocoma coerulescens. A common sight throughout the entire study area.

39. Black-billed magpie. Pica pica. An old nest seen at South Boundary Canyon was not in use in 1977. ^{We} saw one live individual at Baker Ranch.
40. Common raven. Corvus corax. This species was seen regularly throughout the study.
41. Piñon jay. Gymnorhinus cyanocephalus. A flock of eleven birds was sighted several times a day between the Narrows and The Post.
42. Plain titmouse. Parus inornatus. One was sighted while the observer was climbing high on the Waterpocket Fold among some Piñon pine trees.
43. House wren. Tryglodytes aedon. This species nests in the marshy areas of deep side canyons. Several were regularly sighted in the same locations.
44. Canyon wren. Catherpes mexicanus. A fairly common bird of side canyons.
45. Rock wren. Salpinctes obsoletus. A common and conspicuous bird throughout the Hall's Creek drainage.
46. Mockingbird. Mimus polyglottos. This bird was seen several times at Baker Ranch.
47. Sage thrasher. Oreoscoptes montanus. One was seen at Baker Ranch. It was possibly a migrant.
48. Robin. Turdus migratorius. This species nests at the South Boundary Canyon, and was seen throughout the Hall's Creek drainage south of the Narrows.
49. Glue-gray gnatcatcher. Polioptila caerulea. A common and conspicuous nesting bird that was found throughout the Hall's Creek drainage.
50. Loggerhead shrike. Lanius ludovicianus. Three or four individuals of this species were seen during the last trip of this study. It is likely that this predator of songbirds was following the large numbers of sparrows on their migratory path.
51. Warbling vireo. Vireo gilvus. Several males were singing from territories in cottonwood groves along the entire drainage.

52. Virginia's warbler. Vermivora virginiae. A single individual was seen in the South Boundary Canyon.
53. Yellow warbler. Dendroica petechia. Territorial males were seen singing in cottonwood groves between Baker Ranch and the Narrows.
54. MacGillivray's warbler. Oporonis tolmiei. This bird was seen at regular intervals in dense vegetation in side canyons.
- 55.. Yellowthroat. Geothlypis trichas. Males were heard calling from canyon willow thickets near the South Boundary and Baker Ranch.
56. Yellow-breasted chat. Icteria virens. This bird was commonly seen south of the Narrows. It had completed a nesting season at the South Boundary Canyon by 6 June 1977.
57. Wilson's warbler. Wilsonia pusilla. A few migrants were seen near Baker Ranch.
58. Northern oriole. Icterus galbula. Many individuals were seen in side canyons near Baker Ranch, as well as in side canyons further upstream.
59. Brown-headed cowbird. Molothrus ater. One was seen at the South Boundary Canyon by Steve Trimble on June 12, 1977.
60. Western tanager. Piranga ludoviciana. Several individuals were seen beside Hall's Creek, in cottonwood trees, and deep in side canyons.
61. Black-headed grosbeak. Pheucticus melanocephalus. A few individuals, probably migrants, were seen in moist side canyons.
62. Blue grosbeak. Guiraca caerulea. Many individuals were seen in side canyons around Baker Ranch, indicating that they may nest there.
63. House finch. Carpodacus mexicanus. Although this species was sighted frequently around Baker Ranch, it was seen as far north as Cottonwood Tanks.
64. Rufous-sided towhee. Pipilo erythrophthalmus. A single individual was seen in a canyon 3.6 miles above Baker Ranch.

65. Savannah sparrow. Passerculus sandwichensis. A few of these birds were seen around Baker Ranch, and believed to be migrants.
66. Vesper sparrow. Pooecetes gramineus. A single individual was seen at the south boundary of the park.
67. Lark sparrow. Chondestes grammacus. This species was seen throughout the study area along Hall's Creek proper, gathering seeds from this year's crop.
68. Black-throated sparrow. Amphispiza bilineata. Although only a small number of this species were seen, it obviously nested in the Hall's Creek area in 1977. A territorial male was seen singing at dawn in the shrubs of the flood plain 4 miles upstream from Baker Ranch. It is one of the few truly desert-adapted species in that it can survive without free water.
69. Chipping sparrow. Spizella passerina. This species was seen in small flocks along Hall's Creek, gathering seeds throughout the entire drainage.
70. Brewer's sparrow. Spizella breweri. The single most abundant bird seen during the study, even though it was only encountered on the August-September trip. It is clearly a migrant through this area.
71. Song sparrow. Melospiza melodia. A very isolated population of this species was found near a reedy pool of a side canyon 2.0 miles above Baker Ranch.

III. REPTILES

1. Collard lizard. Crotaphytus insularis bicinctores (Mojave subspecies). This lizard was fairly common throughout the study area.
2. Leopard lizard. Gambelia wislizenii punctatus (pale subspecies). A few individuals of this species were seen near Lake Powell and near the Narrows of Hall's Creek.

3. Desert spiny lizard. Sceloporus magister cephaloflavus (Colorado Plateau subspecies). This lizard is very common throughout the entire drainage of Hall's Creek. Most individuals are the "orange-headed" subspecies, if not all of them. Many individuals were noted that lacked the orange head, but since these could be juveniles or females, I did not feel qualified to distinguish them from the Mojave yellow-backed subspecies S.m. uniformis, which may range as far as Hall's Creek. It is interesting to note, however, that this species is not found in other drainages of Capitol Reef National Park, where it is "replaced" by another insect-eating lizard of similar habit, S. undulatus. This lizard is particularly abundant in cottonwood groves and on downed tree trunks.

4. Eastern fence lizard. Sceloporus undulatus elongatus (Northern plateau subspecies). A total of only five individuals of this lizard was seen during this study. Two were located south of Baker Ranch, one was found at Baker Ranch itself, and two were found near Muley Tanks. Considering how common this species is in the other parts of Capitol Reef NP, it is interesting to speculate that competition by S.m. cephaloflavus may limit its numbers in Hall's Creek.

5. Side-blotched lizard. Uta stansburiana uniformis (Colorado subspecies). The lizard is extremely abundant in the entire drainage, including all side canyons. It is found in the most arid sites, where no other lizard can be located.

6. Common tree lizard. Urosaurus ornatus wrighti (Northern subspecies) This small lizard is found in dry side canyons on the shaded walls of Navajo sandstone, and is particularly abundant in Miller's Creek Canyon, where 20 individuals were seen at one time on July 27, 1977.

7. Western whiptail. Cnemidophorus tigris tigris (Great basin subspecies)
Although individuals of this species were frequently encountered along Hall's Creek and in side canyons below the Narrows, it was not encountered above the narrows in the arid stretches of the drainage.
8. Pine-gopher snake. Pituophis melanoleucus deserticola (Great basin subspecies)
A single specimen of this snake was seen at the South Boundary Canyon and was identified by Steve Trimble.
9. Western black-headed snake. Tantilla planiceps utahensis (Utah subspecies)
One individual was found dead on 23 July 1977 in flood debris.

IV. AMPHIBIANS

1. Great basin spadefoot toad. Scaphiopus intermontanus. A population of these toads was found in several canyons south of Baker Ranch. Because these toads burrow during the day and feed at night, they are easily overlooked. Thus, they may be found along the entire drainage. A mating chorus can only be expected after a great rainstorm, so that we had no opportunity to detect an extensive population if it does exist at Hall's Creek. In the population that was found, tadpoles were in the process of metamorphosing into adults in a pothole, ^{on Aug. 30, 1977.} It is my impression that spadefoot toads are much more numerous along the Fremont River, in Capitol Reef NP than they are in Hall's Creek.
2. Woodhouse's toad. Bufo woodhousei australis (Southwestern subspecies).
Juveniles of this toad and the following toad were so numerous in June and July in the grassy streamside of Hall's Creek that it was at times difficult to avoid stepping on them. This species is so successful at this site that it is difficult to understand why they are rare along other drainages in

Capitol Reef (namely, the Fremont River, Pleasant Creek and Oak Creek).

Bufo tadpoles were found in Hall's Creek proper on the following dates: June 4, (at mile 1.0) and July 24 (South Boundary, mile 6.5).

Two reasonable hypotheses that might account for the large numbers of Bufo at Hall's Creek compared to Capitol Reef proper are 1.) the higher elevation ^{of the Fremont River,} hence the longer winters, may limit survival rates for Bufo, or 2.) the intermittent nature of Hall's Creek may limit fishes which prey on Bufo tadpoles, whereas no such fish limitation may occur in other drainages of the park.

3. Southwestern toad. Bufo microscaphus microscaphus (Arizona subspecies). At least some of the individuals which were identified in previous studies as Woodhouse's toad are probably, in fact, this species. This species has not been reported from a site so far north previously. Considering the similarity in appearance and the great variability of characters in both species, it is not surprising that they create some confusion concerning identification. Specimens collected from Hall's Creek during July which were sent to Dr. Richard Sage (Museum of Vertebrate Zoology, University of California, Berkeley) were tentatively identified as B. microscaphus.

Dr. Sage suggests that where B. microscaphus and B. woodhousei co-occur, they form hybrids. This has been documented in the lower Virgin River drainage in southwestern Utah. It is not known if the hybrids are fertile or if they form a true "hybrid swarm." Population biologists have the rare opportunity to study such evolutionary processes in the field under circumstances such as this species-species contact. They use protein "gene markers", detected by biochemical techniques, to evaluate actual gene flow in populations. How important or valuable Hall's Creek would be as a study area for evolutionary biologists could be determined by a census of toads, using their blood to find the genetic markers.

4. Red-spotted toad. Bufo punctatus. This toad was often common in the lower stretches of side canyons, and is particularly plentiful at about 5.8 miles above Baker Ranch, just past Miller's Creek. The species breeds in temporary potholes. Pools teeming with tadpoles were a common sight high on the Waterpocket Fold on 28 July 1977. Although the pothole breeding habit removes the potential for larval competition with the two other Bufo species, have to

B. punctatus may contend with tadpoles of Hyla arenicolor and Scaphiopus intermontanus, in the successful use of pothole resources as larval habitat. Whether actual competition really occurs, of course, is not

known. This author believes that the competitive relations between all of the amphibian species at Hall's Creek would form the grounds for a very interesting study in community ecology.

(about 20 individuals)
5. Canyon treefrog. Hyla arenicolor. The largest concentration of this amphibian was found in the northwest fork of Miller's Creek, associated with a hanging garden. Large tadpoles were associated with this population in pools of Miller's Creek on 27 July 1977, and were, presumably the same species. Small groups of H. arenicolor were also seen in side canyons 4.7 and 6.5 miles above Baker Ranch, in the creekbed near Baker Ranch, in the Hall's Creek narrows, in Fountain Tanks (by Steve Trimble), in Muley Tanks, and in Cottonwood Tanks. On September 9, many tadpoles of H. arenicolor were seen in large tanks at the Cottonwood Tanks. B. punctatus tadpoles were plentiful in nearby pools, but I was able to locate both species in one pool in only one case out of about 80 pools. The Cottonwood Tank population of H. arenicolor is the most northerly population that is known. I suspect that the Escalante River drainage contains H. arenicolor also, but I have not looked for it there.

6. Leopard frog. Rana pipiens. This species is extremely common in the plunge pools of the side canyons between the narrows and Baker Ranch. Tadpoles of this species were seen on May 24 (mile 6.5), July 27 (mile 4.7), and September

5 (mile 7.5). This species is restricted to side canyons. It was never found along Hall's Creek or on the slickrock waterpools.

V. FISH

1. Speckled dace. Rhinichthys osculus. Many individuals of this species were found in Hall's Creek and major side canyons, but it was extremely abundant in lower Miller's Creek. Here hundreds could be scooped up in a net.
2. Black bullhead. Ictalurus melas. Several seen in the canyon behind Baker Ranch.
3. Bluegill. Lepomis machrochirus. Seen in pools in the lower reaches of side canyons.

VI. INVERTEBRATES

Although it was not possible to compile systematic and distributional information for all invertebrates of the Hall's Creek drainage, many specimen samples were informally taken and taxa determined where the species appeared to be of ecological or academic interest. In some cases, only family or order designations were given to samples. Although this approach is crude and the choices of carefully documented groups appear to be arbitrary, the author of this report hopes that the information will be useful to future field workers in Hall's Creek. Since the invertebrate species, through habitat selection and/or differential mortality, sort themselves into distinct habitat groupings, the species lists and notes concerning them are grouped by major habitat. Within each of these categories, species are discussed in the same order as typical phylogenetic sequences found in most taxonomic reference works (c.f. Pennak 1953).

The suspected trophic status of each species is indicated beside each taxonomic designation as the first capital letter in parentheses. The categories are:

K = carnivore	F = filter feeder	D = detritivore
S = scavenger	H = herbivore	O = omnivore

Abundance designations for Hall's Creek follow the colon inside the parentheses. They are:

A = Abundant	The species is always found where the appropriate habitat exists.
C = Common	Individuals could be located with some searching in at least some of the available habitat.
U = Uncommon	The species was only encountered infrequently, and could only be located again with difficulty.
R = Rare	The species was only seen once or twice.

A. Pools in Side Canyons

These pools are usually vegetated and shaded from direct sun. They were rich in aquatic life and typically diverse.

1. Giant leech. Haemopsis grandis Verrill (K or S:C). This species was occasionally seen eating leopard frog adults and tadpoles.
2. A planorbid snail. Helisoma trivolvis trivolvis (H:C).
3. A pulmonate snail. Physa virgata. (H:C)

Aquatic and terrestrial snails are ^{low in diversity} ^ in this area compared to other desert canyons known to the author, such as areas in Zion NP.

4. Fairy shrimp. Streptocephalus texanus (F:R). This species is usually found only in pothole tanks, but was found in a large pool in a side canyon at mile 7.5.
5. Damselfly larvae. Argia sp. (K:U), Archilestes sp. (K:A), Ishnura sp. (K:U), and Hyponeura lugens (K:U). These are probably the major predators in pools and slow-moving portions of streams that do not contain fish. They were never

found in potholes.

6. Dragonfly larvae. Libellula sp. (K:U). Undoubtedly other dragonflies are also here, since several different species of adults were seen.
7. An amphipod (= "scud"). Hyaella azteca. (D:A). Extremely common here.
8. Ostracods. Species undetermined (D:U).
9. Mites. Species undetermined (H:U).
10. Mayfly larvae. Baetis sp. (H:C). This species is very common in Hall's Creek. It is the only species found in all three aquatic habitats: side canyons, the main creek and potholes.
11. Water strider. Gerris sp. (K:C).
12. Water treader. Microvelia sp. (O:U).
13. Backswimmers. Buenoa sp. (K:C) and Notonecta (2 species) (K:C).

Both the nymphs and adults of these ^{three} species are very important predators in these aquatic habitats. Although superficially similar to corixids in morphology and habit, these seem to be confined to side canyon pools. Corixids here are only found in the potholes.

14. Creeping water bugs (naucorids). Ambrysus sp. Very common.
15. Belostomid bugs (giant water bugs). Lethocerus sp. (K:C). Both larvae and adults are conspicuous carnivores; adults attain 55 mm. in size.
16. Caddisfly larvae. Species from the families hydropsychidae, hydroptilidae, limnephilidae, and helicopsychidae (Helicopsyche borealis) were seen. All are (H or D:C). The small caddisflies in the family hydropsychidae were particularly abundant. No caddisflies were found in the potholes.
17. Aquatic lepidopteran larva. One species was found in a side canyon at mile 3.5. Status unknown.
18. Predaceous diving beetle (ditiscid beetle). Acilius sp. (K:C). Both larvae and adults were common. Although they are capable of terrestrial

migration, they are not found in nearby potholes.

19. Whirlygig beetles (gyrinid beetles). Dineutes sp. The yellow-spotted adults of this species are very active and conspicuous. (S:U).
20. Water scavenger beetles (hydrophilid beetles). Hydrobius sp. (H or C:C), as well as several other species in the family Hydrophilidae.
21. Midge larvae and pupae. Pentaneura sp. (S:A). Abundant.
22. Blackfly larvae (simulid flies). Simulium sp. (F:U). Both larvae and pupae were found in riffles in a few side canyons.

B. Streamside Vegetation

The channel of Hall's Creek has an impoverished fauna of aquatic species, possibly due to flood scour in late summer. Casual observations and collections with a passive insect trap (a "malaise" trap), reveal that the following orders of insects can be found here. Most of them are tied in some way to the plants found on stream banks.

1. Odonata: three species of dragonflies and four species of damselflies.
2. Orthoptera: many grasshoppers, a yellow cockroach.
3. Hemiptera: toad bugs (Gelastocoris sp.), water striders (Gerris sp.).
4. Homoptera: very small leaf hoppers.
5. Coleoptera: ladybird beetles, dermestid beetles, large buzzing flower beetles, dogbane beetles, and many others.
6. Neuroptera: ant lion adults, green lacewings.
7. Trichoptera: several adult caddisflies including microcaddisflies were trapped. One species of Limnophilidae family was successful as a larva in the streambed.
8. Lepidoptera: monarch butterflies, sulfur butterflies, many species of microlepidoptera.

9. Diptera: Craneflies, mosquitos, robberflies, deer flies (Chrysops sp.), midges, picture-winged flies, horse flies, syrphid flies, soldier fly larvae (in Narrows).

10. Hymenoptera: yellow jackets, ichneumons, tarantula hawks (Pepsis augustimarginata), and many small wasps.

C. Potholes

These aquatic habitats appeared to have a completely separate fauna from the pools in nearby side canyons. Three anuran species used the tanks for larval development (canyon treefrog, red-spotted toad, and spadefoot toad). Other vertebrates undoubtedly use the tanks for drinking water. The patterns of abundance of the following invertebrate species shows a range of community pattern including empty pools, monopolization by a single species, and four or more species in one tank. It is likely that predation, timing of pothole colonization by each species, allelopathy, differential tolerance to dessication and salinity, competition for food, etc. may determine which species mixtures will be stable. The importance of these phenomena in pothole community composition has not been explored.

1. Algae: Volvox sp. and probably many other microscopic species.

2. Rotifers: Asplanchna sp., Pedalion sp. (F:C).

3. Phyllopod (Eubranchiopod) Crustaceans:

a. Fairy shrimps. Streptocephalus texanus Packard (F:A).

Branchinecta lindahli Packard (F:A).

These two species were never found in the same pool, or even in the same tank area, although both were abundant where they were found.

b. Tadpole shrimps.. Triops (Apus) longicaudatus (D:R). These were only seen in canyons south of Baker Ranch.

- c. Clam shrimps. Eulimnadia texana (F:U). These were found at the tanks at mile 3.6 and at Muley Tanks.
4. Cladocerans (water fleas): Sida crystallina (F:C) and Daphnia sp. (F:C).
The first of these two species is covered with vorticellids.
5. Copepods: Cyclops sp. (F:C).
6. Mayflies: Baetis sp. (F:C).
7. Larval dragonflies: Somatochlora sp. (K:U) and probably other species.
8. Water striders: Gerris sp. (K:U).
9. Corixid bugs (water boatmen): Graptocorixa sp. (K:C) and possibly Corisella sp. and Neocorixia sp..
10. Predaceous diving beetles (dytiscid beetles): Agabus sp. (K:C), both larvae and adults.
11. Fly larvae:
- a. Mosquitos. Aedes sp. (F:C).
 - b. Long-legged flies (family dolichopodidae). Pupae only. (status unk.)
 - c. Deer flies. Chrysops sp. (status unk.)
12. Gastropods: a few Physa virgata (H:R) in the lowest pools of Muley Tanks.

FAUNAL AFFINITIES OF THE HALL'S CREEK AREA

It is not surprising to find that Hall's Creek contains faunal elements from many western U.S. biotic provinces, since it is located on one edge of the Colorado Plateau, the Great Basin, the edge of a cordilleran system, and has a fairly direct link with the riparian habitats of the Mohave and Sonoran deserts due to its former continuity with the Colorado River. Since Hall's Creek drainage has a lower elevation^{than the rest of the park} (hence probably fewer cold winter days) and it has this direct connection to Colorado River riparian systems, a comparison of its fauna to the other drainages in Capitol Reef is likely to show some species differences. Whether these differences are due to a competitive exclusion of one type by another in the past or is due to the inability of the absent species to reach the site by migration is an open question. However, the finding of predominantly one type of resource user in one area (for instance one species only of Sceloporus) suggests that some specialization and subsequent exclusion of a similarly adapted type may have occurred.

Although the total density of animals appears to be somewhat low compared to other arid southwestern canyons, the vertebrates discovered during this study seem to fit into functional groups described by MacMahon (1977), which suggests that the species numbers conform to a guild of resource users. For instance, Hall's Creek has 3-5 heteromyid rodents which eat seeds, one diurnal ground squirrel, one Peromyscus maniculatus, one packrat, one rabbit, one hare, two carnivores, one skunk, one badger, and one vole. These numbers are the same that one would expect to find in any desert if all the mammalian "roles" were filled. This suggests that any invader would oust the resident specialist or be pushed out itself, but the two would not co-occur. Some evidence that this has happened is found in a comparison of species lists of the Fremont

River canyon with Hall's Creek. In the former area the antelope ground squirrel appears to have "replaced" the Colorado chipmunk.

The bird fauna is very similar to that which is found in the rest of the park, except for the open water habitat provided by Lake Powell.

A guild structure may be apparent in the reptile community in Hall's Creek, although this area is impoverished in numbers and diversity of species compared to Sonoran, Mojave and even Great Basin deserts, so that many "types" are not present. Snakes, in particular, were seldom noted in this study.

In the Hall's Creek drainage, Sceloporus magister appears to have replaced S. undulatus, which is the only representative of that genus in the northern sections of the park. Collared and leopard lizards are much more common near Hall's Creek than they are in the rest of Capitol Reef.

The presence of amphibians is probably not due to distinct guild associations, but rather the availability of adequate larval habitat which is free from fish predation. A migration corridor from southern populations may also be necessary to repopulate the canyons after periodic extinctions which are certain to occur locally.

Thus, the large numbers and high diversity of amphibians in Hall's Creek compared to the rest of the park is probably due to these three factors:

1. The presence in Hall's Creek of a large number of seasonally available potholes and river pools which dry up one or more times a year, thereby eliminating predatory fishes.
2. The shorter winter season of extreme cold which may limit the hibernation capabilities of adult amphibians.
3. A direct migration route to the lush canyons of the Colorado River which provide protection for larval amphibians in side canyons. The route itself provides global protection from extinction. The Fremont River is

connected to the Colorado River via the Dirty Devil River and long stretches of harsh habitat devoid of side canyons or springs, so that movement of amphibians towards the Fremont River would be exceedingly slow.

^ Hall's Creek is probably the northernmost geographic area for the populations of southwestern toads (Bufo microscaphus), red-spotted toads (B. punctatus), and the canyon treefrog (Hyla arenicolor).

Species' distributions are not usually limited to faunal "provinces" because ^ each species tends to have a highly individualized distribution compared to other species. Thus, ^ the vertebrate community at Hall's Creek can be said to be a mixture of species from all of the surrounding physiographic regions of desert, plateau and mountain. Nevertheless, a few species are often described as "characteristic" of some province because they are very common throughout that province or else they are rarely found elsewhere. At Hall's Creek I would suggest that the following species have become established at the very edge of or outside their characteristic expected range:

1. Great Basin species: sagebrush vole (Lagurus curtatus), the sage thrasher (Oreoscoptes montanus) if it was found nesting at Hall's Creek, and the Great Basin spadefoot toad (Scaphiopus intermontanus).
2. Mohave-Sonoran-Chihuahuan species: red-spotted toad (Bufo punctatus), canyon treefrog (Hyla arenicolor), desert spiny lizard (Sceloporus magister) if the yellow-backed subspecies is common, and the southwestern toad (Bufo microscaphus).

The following Sonoran-Mohave species which were suggested to be present were not found: the desert night lizard (Xantusia vigilis), the chuckwalla (Sauromalus obesus), the spotted bat (Euderma maculata), and the gray shrew (Notosorex crawfordi). The latter two species would not have been detected using the trapping techniques of this study.

It would be incorrect to state that the area is an extension of a Mohave or any other desert faunal province.

EVIDENCE OF HUMAN ACTIVITY

ORV trails were often seen near Lake Powell. Further away from the lake traces of the old road from Hall's Crossing can occasionally be seen. Across from the confluence of Miller's and Hall's Creeks, a rock wall bears the inscription: "C. E. Hubbs, 1883".

Large chunks of black petrified wood from the Chinle formation were common only in Miller's Canyon. During our first trip, we met backpackers carrying a piece out on a makeshift stretcher.

Cows are able to make their way into the backs of lush side canyons such as the one behind Baker Ranch. In lower Hall's Creek, few canyons have natural barriers to cows (such as steep slickrock). In one canyon south of Baker Ranch, I found cryptogamic earth, which indicated that no cows had used at least one side canyon. Several cows were seen in Hall's Creek after the June roundup. One was found dead in the Narrows.

There are a few messy campsites, strewn with old steel cans, packaging, etc., but they are not a problem.

Some traces of the old Sun Dog uranium mine in upper Miller's Creek can still be seen: wood, oil drums, and a primitive roadbed.

CONCLUSION AND RECOMMENDATIONS

Hall's Creek is an attractive area for study and enjoyment of natural habitats and geologic phenomena. The lush oases provided by the springs in the Waterpocket Fold make the entire drainage area desirable as desert wildlife habitat. Many species could not exist here without the waterpockets (the "tanks") and the springs in the side canyons. The valley cut by Hall's Creek contains several populations of species which constitute the geographic limits of their species' ranges. Of particular interest to biologists are (or could be) the community relations of the six species of amphibians and the ecological relations of species which are found in the temporary pools of the rain-filled "waterpockets".

I recommend that backpacking use of the area be encouraged. Grazing and ORV use should be prohibited in order to allow recovery of the cottonwood habitat and encourage revegetation of the flood plains.

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Appendix I: Summary of the Analysis of Animal Scats Collected at Hall's Creek

Scat Type	Location	Contents
Coyote	Hall's Divide	Rabbit (fur, whiskers, teeth), small mammal
Coyote	Hall's Divide	Beetle exoskeleton, cow hair
Coyote	Baker Ranch	Grass, scales of a large fish, owl feather, seeds
Coyote	Baker Ranch	Beetle elytra, rabbit fur, grasshopper
Coyote	South of Baker Ranch	Snake skin, cow hair, small mammal hair and bones
Coyote	Baker Ranch	Grass, juniper berries, <u>Neotoma</u> fur
Coyote	Red Slide	Rabbit hair, toenails
Coyote	Baker Ranch	Scavanged cow or deer, very large bones
Coyote	Baker Ranch	Rabbit fur, toe bones
Coyote	2.0 miles	Rabbit
Coyote	3.6 miles	Cow hair, chipmunk
Coyote	Baker Ranch	Rabbit
Coyote	3.6 miles	Rabbit, snake
Coyote	Baker Ranch	Large fish bones, fish scales
Coyote	Miller's Creek	Small mammals
Coyote	Baker Ranch	Rabbit, <u>Sceloporus</u>
Coyote	Hall's Divide	Cow hair, beetle elytra, rabbit
Coyote	Baker Ranch	Rabbit
Coyote	Baker Ranch	Large scavanged mammal, rabbit
Coyote	Baker Ranch	Small mammal bones, rabbit hair, claws
Ringtail	Baker Ranch	<u>Neotoma</u> fur
Owl (pellet)	Baker Ranch	Large scorpion, <u>Peromyscus</u> bones and fur, rabbit fur, <u>Nrotoma</u> fur, mouse skull, lizard jaw, fish scales
Kestrel (pellet)	Mile 7.0	Large red insect (grasshopper?)
Kestrel (pellet)	Mile 3.6	Beetle parts
Packrat	Cottonwood Tank	Vegetable matter and beetles
Gray fox	2.0 miles	Small mammal
Raccoon?	Cottonwood Tank	Insect parts, fish bones, hair
Lizard?	Miller's Creek	Small beetle parts
Lizard?	Unk.	Wasp parts, mostly heads.