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BIO/WEST, Inc.

STATUS OF THE VIRGIN SPINEDACE
(Lepidomeda mollispinis mollispinis)
IN THE VIRGIN RIVER DRAINAGE, UTAH

**A Report on Current Distribution,
Abundance, and Threats**

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ABSTRACT

The distribution, abundance and status of the Virgin spinedace (*Lepidomeda*) were assessed in the Virgin River Drainage in Utah. Sampling was conducted by the Utah Division of Wildlife Resources with assistance from other agencies and individuals during six field sample trips between September 1986 and January 1990. These six field investigations were designed to assess upstream and downstream distribution of the species in each tributary, approximate abundances with population estimates where possible, and to identify possible threats. The results of these investigations were compared with past collections and studies to determine habitat losses and areas of population decline, and to assess the current status of the species.

The historic distribution of the indigenous Virgin spinedace is not well documented, but based on past collections and pre-existing habitat conditions, it was probably common to abundant throughout most of the clear streams and tributaries of the Virgin River as well as in upper reaches of the mainstem. Presently, Virgin spinedace are found in portions of nine tributaries or subtributaries of the Virgin River including Beaver Dam Wash, Santa Clara River (and Moody Wash), Ash Creek, La Verkin Creek, North Creek, North Fork Virgin River, and East Fork Virgin River (and Shunes Creek). They are also found in the upper Virgin River above La Verkin, and incidentally in the lower mainstem from the confluence of Ash and La Verkin creeks to Mesquite, Nevada. We estimate that the original range of the Virgin spinedace in Utah of 143.9 miles of stream has been reduced by 40% to 87.0 miles. In addition to this loss, existing and impending water developments, water degradation and exotic species threaten to further deplete the distribution and abundance of the species. Of 13 populations, none is considered secure and totally free of man-imposed threats. Three populations are considered good with existing threats, six are showing evidence of decline with persistent threats, and one (Santa Clara River) is showing a rapid decline and is in danger of extirpation. The populations in Magotsu Creek, Quail Creek, and Leeds Creek are extirpated.

The factors that threaten the survival of the Virgin spinedace are insidious and difficult to control. Most are associated with water diversions, degraded water quality, and exotic species. Some habitats have been inundated by dams or physically altered beyond repair, while others have been so degraded that rehabilitation would take years and many corrective measures. There are however, a number of occupied habitats that can be made more secure with practical management practices. The population at Lytle Ranch, for example, should be secured from a possible invasion of largemouth bass in case of a flood from Nordin Ranch on the East Fork of Beaver Dam Wash; bass are abundant in two small ponds and numerous in the stream. If these can be eliminated from this area, the East Fork of Beaver Dam Wash would be a desirable place to introduce Virgin spinedace. The population at Lytle Ranch can be further secured by preventing additional water diversions within the Lytle Ranch Preserve. Beaver populations in this area should be controlled to reduce the amount of habitat conversion from flowing stream to impoundment. Also, the population of Virgin spinedace in La Verkin Creek can be augmented by introducing the species above a series of falls. The area should be further sampled to assess habitat and the presence and abundance of non-native species.

The Virgin spinedace is currently a candidate species, category 2, under the Endangered Species Act of 1973, as amended. Although this status does not offer federal protection, it is classified as threatened by the Utah Division of Wildlife Resources. The 40% reduction in distribution within Utah and its apparent continued decline with impending threats may warrant proposing the Virgin spinedace as threatened under the Endangered Species Act of 1973. Continued investigations are needed to determine the biological vulnerability and threats to this unique species. Accordingly, a monitoring program should be developed for the Virgin spinedace to regularly estimate population sizes and assess trends.

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INTRODUCTION

The Virgin spinedace (*Lepidomeda mollispinis mollispinis*) is endemic to the Virgin River Drainage, a tributary of the Colorado River (Figure 1). It is a 'candidate species', category 2, under the Endangered Species Act of 1973, as amended, and as such receives no federal protection. It is further classified as 'threatened' by the Utah Division of Wildlife Resources (UDWR) and by the American Fisheries Society in the states of Utah, Nevada and Arizona (Williams et al. 1989).

The precise historic distribution of the Virgin spinedace is unknown, but it was probably once abundant throughout most of the clear tributaries of the Virgin River and in some mainstem reaches (Holden 1977). Declines in distribution and abundance have occurred since the 1930's (Cross 1975), and may be accelerated by recent and current water development and habitat encroachment. Reasons for decline are identified as (1) dewatering from diversions and dam structures, (2) habitat alteration from agricultural and livestock practices, (3) diminished water quality from agricultural and municipal developments, (4) introduction of non-native species, and (5) inundation of habitat by reservoirs.

The purpose of this report is to integrate historic and recent findings on the distribution and abundance of the Virgin spinedace to assess the current status of the species in Utah. This report incorporates findings from literature and compare historic information with the results of six field investigations by UDWR from 1986 to 1990. Sampling was conducted during the following periods: (1) September 23-24, 1986, (2) October 14-17, 1986, (3) November 11-14, 1986, (4) June 24-25, 1987, (5) July 6-10, 1987, and (6) January 9-14, 1990.

SPECIES DESCRIPTION

The Virgin spinedace has a silvery body with a brassy sheen and light sooty blotches on the sides (Photo 1). The bases of the paired fins are reddish-orange. The species has a well-scaled body, terminal



Photo 1. Virgin spinedace (*Lepidomeda mollispinis mollispinis*) from the Lytle Ranch diversion of Beaver Dam Wash, Utah. Total length = 97 mm, Weight = 10 g. Photo by R.A. Valdez.



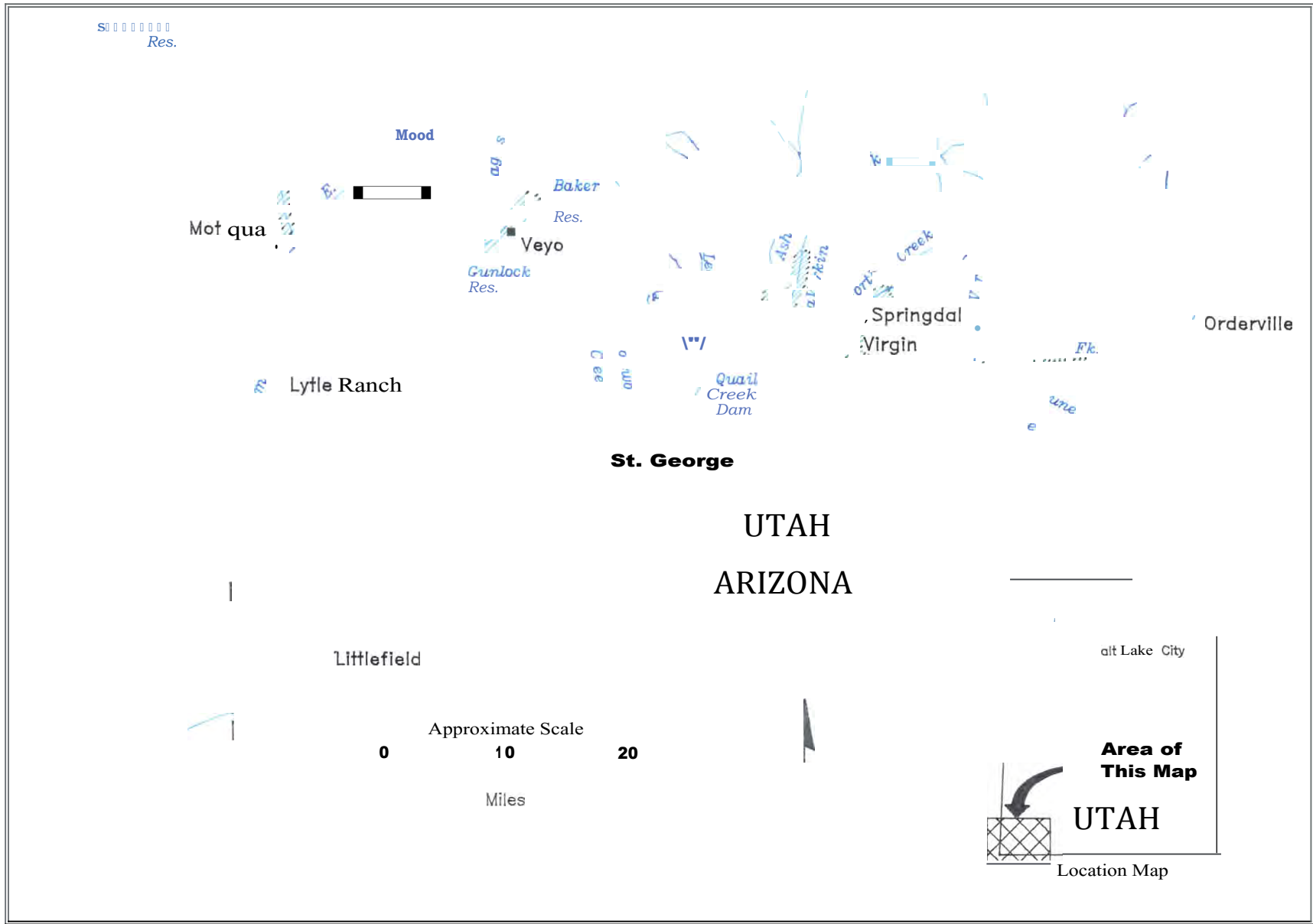


Figure 1. Known distribution of Virgin **Spinedace** in the Virgin River Drainage. Shaded areas represent presently occupied habitat.



mouth, and a rounded head and belly (Sigler and Miller 1963). The dorsal fin has two anterior hard spiny rays, and originates slightly behind the insertion of the pelvic fins. There are eight dorsal rays and usually nine anal rays that vary from eight to ten. The species has 77 to 91 scales on the lateral line, and the pharyngeal teeth are in two rows and typically number 2, 5-4, 2.

The Virgin spinedace is one of three genera of a unique, endemic tribe of western cyprinids, the Plagopterini (Miller and Hubbs 1960). The tribe Plagopterini is characterized by the presence of two anterior hard spiny rays in the dorsal fin and is comprised of three genera: *Meda*, *Plagopterus*, and *Lepidomeda*. *Meda* and *Plagopterus* are monotypic genera and are represented by the spikedace (*Meda fulgida*) and the woundfin (*Plagopterus argentissimus*). The genus *Lepidomeda* is represented by four species: White River spinedace (*L. albivallis*), Little Colorado spinedace (*L. vittata*), Pahrnagat spinedace (*L. altivelis*), and Virgin spinedace (*L. mollispinis mollispinis*) as well as the subspecies Big Springs spinedace (*L. mollispinis pratensis*) (Hubbs and Miller 1960, Robbins et al. 1980). The spikedace and the Little Colorado spinedace are listed as 'threatened' under the Endangered Species Act of 1973, as amended, and the woundfin and White River spinedace are listed as 'endangered', while the Virgin spinedace is a 'candidate'. The Big Springs spinedace and Pahrnagat spinedace are considered extinct (Hubbs and Miller 1960).

Lepidomeda from the Virgin River was first referred to as *L. vittata* (Tanner 1932, Eddy 1957, Moore 1957, Davis 1962). Miller (1952) recognized it as distinctive (*Lepidomeda* sp.) and Miller and Hubbs (1960) described it as a new species with subspecific designations.

LIFE HISTORY

The life history of the Virgin spinedace was described by Rinne (1971). The species generally matures after the first year of life and lives only three years. It reaches a maximum size of about 125 mm standard length (SL), and the greatest proportion of most populations usually consists of young-of-the-year (YOY) and one year old fish.

Virgin spinedace are difficult to age with the use of scales and opercula because the mild climate of their southwest habitat provides nearly continuous growing conditions. Rinne (1971) found that age group 0 fish were up to 55 mm SL, age group I fish were 55 to 76 mm SL, age group II fish were 76 to 85 mm SL, and age group III fish were over 85 mm SL. Although Miller and Hubbs (1960) stated that *L. mollispinis mollispinis* seldom exceeds 88 mm SL, Rinne (1971) found a maximum size of 128 mm SL. Most mortalities occur in summer and winter of the first two years of life.

Sexual dimorphism is not apparent in *L. mollispinis mollispinis* (Rinne 1971). Some external features enable distinction of sexes during the peak spring spawning period. Females are more robust and plump with the region near the vent swollen and the ovipositor a reddish color, while males usually remain more streamlined. Tuberculation occurs sporadically in both sexes, primarily on the head and sometimes on the body of older ripe males. The degree of spawning coloration varies but larger individuals tend to be more spectacular. Both sexes exhibit a bright, iridescent, reddish-orange color along the base of the lower caudal lobe, the pelvic fin bases, and sometimes the pectoral fin bases. An orange spot is located high on the lateral part of the body immediately behind the operculum. Although females are usually larger than males, size is not a reliable distinguishing feature because of variation in size at maturity.

Rinne (1971) reported spawning by Virgin spinedace from April to June at mean daily water temperatures of 13 to 17°C with maximum temperatures of 21°C. Spawning occurred at the downstream shallow end of deep pools over gravel and sand substrate in water depths of 15 to 30 cm (6-12 inches). A small group of males patrolled the shallow area and converged on single females as they emerged from the deeper portions of the pool. The females deposited their eggs in the shallow downstream end of the pool and several males fertilized the eggs. The most important environmental factors controlling timing of spawning

were photoperiod and temperature. Virgin spinedace generally have a single annual spawning season lasting throughout the spring (April-June) Rinne (1971) found that one year old fish had the lowest mean relative fecundity with an average of 459 eggs, while two year-olds averaged 788 eggs, and three year olds averaged 693 eggs per female. Although females of age groups II and III produced a greater number of eggs than age group I, age groups II and III often represented less than 10% of the population.

ECOLOGICAL REQUIREMENTS

Ecological requirements of the Virgin spinedace were described by Rinne (1971) and habitat suitability index curves for depth, velocity and substrate were developed by Hardy et al. (1989) in a detailed analysis of population dynamics of the fishes of the Virgin River. These studies and those by Deacon and Rebane (1989) show that Virgin spinedace prefer clear, cool flowing streams comprised of pools, runs and riffles. Rinne (1971) found that pools were most often used, particularly those offering some form of cover such as undercut banks, small boulders or lodged debris. Heavily shaded pools were occupied less often. Deacon and Rebane (1989) found similar use of pools, but the degree of use varied by stream. In Beaver Dam Wash, for example, Virgin spinedace avoided the deeper beaver ponds in favor of runs, probably to avoid the mud-silt substrate, absence of cover, lower dissolved oxygen, and lack of drifting food. They also found that Virgin spinedace in Beaver Dam Wash occurred in narrow, shallow runs in areas with high velocity but with large amounts of emergent and riparian vegetation to buffer the current. Virgin spinedace in the North Fork used quiet pools produced by boulders and cobble rockfalls. Deacon and Rebane (1989) reported that Virgin spinedace mostly utilized depths between 0.9 and 91 cm, velocities between 0.3 and 3.0 feet per second, and sand, gravel, and less commonly cobble substrates. They most often occurred near a shear zone between low and high velocities in cover such as undercut banks, vegetation, debris or large boulders. Hardy et al. (1989) found similar habitat utilization.

Rinne (1971) reported that Virgin spinedace usually maintain equilibrium in the midwater portion of the stream where they rise to the surface to inspect and feed on floating material, primarily Diptera, Coleoptera, plant material and organic debris. Larval forms dominated the first two categories and the relative amount of each category eaten was dependent on season and size of fish. Rhine (1971) also found that insects were utilized as they were available and most common, which was in the spring and summer. The fish were in poorest condition when plant material was the main food, indicating that insect availability was probably one of the most important factors regulating spawning and growth of fish.

Critical thermal maxima and thermal preferenda indicate that Virgin spinedace have a low thermal lability that corresponds well to distribution and abundance in streams (Deacon et al. 1987). An upper preferendum of 23.1°C corresponds to its greatest abundance in lower tributaries and the upper mainstem of the Virgin River. More downstream occurrences are primarily associated with cool inflows such as tributaries and springs.

SPECIES COMMUNITY COMPOSITION AND INTERACTION

Thermal preferenda studies of the six native fishes of the Virgin River (woundfin, *Plagopterus argentissimus*; Virgin River roundtail chub, *Gila robusta seminuda*; Virgin spinedace, *Lepidomeda mollispinis mollispinis*; speckled dace, *Rhinichthys osculus*; desert sucker, *Catostomus clarki*; and flannelmouth sucker, *Catostomus latipinnis*) reveal that these species are "thermal generalists" but respond opportunistically when preferred thermal situations are encountered (Deacon et al. 1987). Although all six species were observed in temperatures of 10 to 34°C, except for desert sucker and speckled dace, optimal thermal niches were defined for each species. Speckled dace, with the lowest (coolest) temperature preferendum are found highest in the watershed in cool, clear tributaries or springs. Virgin spinedace with the next highest temperature preferendum prefer slightly warmer water and are found more downstream in lower tributaries and the upper mainstem. Flannelmouth sucker have the highest (warmest) temperature preferendum and are found in

warmer areas throughout the middle to lower reaches of the system.

Although temperature tolerance and preferenda appear to correspond well to distribution of the Virgin River fishes, other factors are also important in niche partitioning such as food, space and other resources (Deacon et al. 1987, Cross 1975, Hardy et al. 1989). The introduction of non-native species into the system has caused direct interactions with native species when these share similar temperature and habitat requirements. Rinne (1971) reported that the Bonneville redbside shiner (*Richardsonius balteatus hydrophlox*) posed the greatest threat to *L. mollispinis mollispinis* through direct competition resulting in a reduction in fecundity due to food shortage. Redside shiner have not been reported recently in the Virgin River Drainage, and their decrease in numbers is unexplained. Predation by brown trout (*Salmo trutta*) may also be occurring in upper reaches of the distribution of the Virgin spinedace, and predation by largemouth bass (*Micropterus salmoides*) may be occurring in lower reaches. In 1986, the red shiner (*Notropis lutrensis*) invaded the lower Virgin River resulting in a decline of woundfin and posing a threat to the Virgin spinedace.

SAMPLE SCHEME

UDWR conducted six field trips from September 1986 to January 1990 to determine the distribution and relative abundance of the Virgin spinedace in the Virgin River Drainage, and to assess the status of the species in Utah. Various agencies and individuals assisted in the field work. The last of the field trips was a 9-day cooperative effort with BIO/WEST, Inc. during January 8-16, 1990, that included sampling of 23 sites primarily in Beaver Dam Wash, Moody Wash, Magotsu Creek, and the upper Santa Clara River. The purpose of this field investigation was to fill data gaps for areas that had not been previously visited or sampled, and to determine distribution of Virgin spinedace in certain drainages. Although minimum streamflows in this region of Utah generally occur August through October, flow conditions observed in mid-January, 1990, approximated minimum flows because of the dry winter. Thus, the distribution of fish at that time probably reflected minimum range.

Various gear types were used to sample the Virgin River drainage. Backpack electrofishing gear (110-volt Coffelt BP-1C, BP-4) was commonly used in flowing stream habitats to assess distribution and in multiple catch efforts to estimate relative abundances. Ten and 15-foot seines with 1/4-inch mesh were used in pools and the more quiescent habitats to assess distribution and species composition. Also, bank electrofishing gear (110-volt Coffelt VVP-2C) was used in portions of the main Virgin River to assess distribution and species composition as well as to attempt estimates of relative abundance. All Virgin spinedace were measured, weighed, and released, and all other species were enumerated and samples were weighed and measured.

Tables 1 and 2 are provided to itemize sample station locations and sample sites with fish collected. Each sample station is identified with a unique number (e.g. I-1, 1-2, etc.) that corresponds to locations shown on maps provided later in this report. Quadrangular map names and coordinates (7.5-minute USGS maps) are provided to assist other investigators in locating these sample stations. Station location descriptions are also provided to relate locations to known or readily identifiable landmarks.

This report emphasizes the status of the Virgin spinedace. It provides information on distribution, abundance, and threats to the species in each stream of the Virgin River Drainage and compares this information with past collections. Upstream and downstream distribution points may not be definitively assessed for some streams and are identified as data gaps for future investigations to confirm, update and refine. Population estimates of Virgin spinedace are provided for fourteen populations in nine tributaries based on two-catch population estimates and expanded for representative reaches.

Table 1. Locations of sample stations in tributaries of the Virgin River, Utah, identified on Figures 2, 4, 5, and 6.

Station No.	Location Description	Quad Map Coordinates
SAMPLE TRIP I September 23-24, 1986.		
I-1	Beaver Dam Wash, 8.9 mi. above Motoqua (cable across road)	Doc's Pass T39S, R20W, S7
I-2	Beaver Dam Wash, 6.9 mi. above Motoqua	Doc's Pass T39S, R20W, S20
I-3	Beaver Dam Wash, 4.4 mi. above Motoqua	Motoqua T39S, R19W, S32
I-4	Beaver Dam Wash, 2.4 mi. above Motoqua	Motoqua T40S, R19W, S5
I-5	Beaver Dam Wash, Lytle Ranch	Scarecrow Peak T42S, R19W, S7, SW 1/4
I-6	Santa Clara River, 1.5 mi. above Gunlock Dam	Gunlock T40S, R17W, S28
I-7	Santa Clara River, 2.2 mi. above Gunlock Dam	Veyo T40S, R17W, S22
I-8	Santa Clara River, immediately below Baker Reservoir Dam	Central West T39S, R16W, S22
I-9	Santa Clara River, road crossing above Baker Reservoir Dam	Central West T39S, R16W, S22
I-10	Moody Wash, 7.35 mi. above Gunlock Dam	Veyo T40S, R17W, S2, SE 1/4
SAMPLE TRIP II October 14-17, 1986		
	La Verkin Creek, Hwy. 17 bridge crossing	Hurricane T41S, R13W, S14, SE 1/4
11-2	La Verkin Creek, above end of road on Jones property	Hurricane T41S, R13W, S11, SW 1/4
11-3	La Verkin Creek, 350 yds. above Jones Diversion	Hurricane T41S, R13W, S11, SW 1/4

Table 1 Continued

Station No.	Location Description	Quad Map Coordinates
SAMPLE TRIP III November 11-14, 1986		
	Ash Creek, across from flat-roofed wood house	Hurricane T41S, R13W, S11
111-2	Ash Creek, below Gedman property fence	Hurricane T41S, R13W, S2
111-3	Ash Creek, 350 yds. below concrete spring apron	Hurricane T41S, R13W, S2
111-4	North Creek, adjacent to top end of Sunset Ranch	The Guardian Angels T40S, R11W, S32
111-5	North Creek, 2nd Hwy. bridge crossing below Sunset Ranch	Virgin T41S, R12W, S12
111-6	North Creek, below lower field, 1.2 mi. above Hwy.	Virgin T41S, R12W, S23
111-7	Virgin River, North Fork, bridge crossing at Watchman Camp	Springdale East T41S, R 10W, S28
111-8	Virgin River, North Fork, across from campground	Springdale East T41S, R10W, S21
III-9	Virgin River, North Fork, across from campground	Springdale East T41S, R10W, S21
III-10	Virgin River, East Fork, end of road on Jim Tree's property	Springdale West T42S, R10W, S5
	Virgin River, East Fork, end of road on Jim Tree's property	Springdale West T42S, R10W, S5
III-12	Virgin River, East Fork, end of road on Jim Tree's property	Springdale West T42S, R10W, S5
III-13	Virgin River, East Fork, end of road on Jim Tree's property	Springdale West T42S, R10W, S5
111-14	Virgin River, East Fork, above Park boundary through Tree's	Springdale East T42S, R10W, S2
111-15	Virgin River, East Fork, above Park boundary through Tree's	Springdale East T42S, R10W, S2

Table 1. Continued

Station No.	Location Description	Quad Map Coordinates
111-16	Virgin River, East Fork, above Park boundary through Tree's	Springdale East T42S, R10W, S2
111-17	Virgin River, East Fork, above Park boundary through Tree's	Springdale East T42S, R10W, S1
111-18	Virgin River, East Fork, above Park boundary through Tree's	Springdale East T42S, R10W, S1
111-19	Virgin River, East Fork, above Park boundary through Tree's	Springdale East T42S, R10W, S1
111-20	Virgin River, East Fork, above Park boundary through Tree's	Springdale East T42S, R10W, S1
111-21	Virgin River, East Fork, adjacent to Tree's garden plot	Springdale West T42S, R 10W, S5
111-22	Virgin River, East Fork, adjacent to Tree's garden plot	Springdale West T42S, R10W, S5
111-23	Virgin River, East Fork, adjacent to Tree's garden plot	Springdale West T42S, R10W, S5
111-24	Virgin River, East Fork, adjacent to Tree's garden plot	Springdale West T42S, R10W, S5
111-25	Virgin River, East Fork, adjacent to Tree's garden plot	Springdale West T42S, R10W, S5
111-26	Virgin River, East Fork, adjacent to Tree's garden plot	Springdale West T42S, R10W, S5
111-27	Virgin River, East Fork, adjacent to Tree's garden plot	Springdale West T42S, R10W, S5
111-28	Virgin River, East Fork, adjacent to Tree's garden plot	Springdale West T42S, R10W, S5
111-29	Virgin River, East Fork, adjacent to Tree's garden plot	Springdale West T42S, R10W, S5
111-30	Virgin River, East Fork, adjacent to Tree's garden plot	Springdale West T42S, R10W, S5

Table 1. Continued

Station No.	Location Description	Quad Map Coordinates
111-31	Virgin River, East Fork, adjacent to Tree's garden plot	Springdale West T42S, R10W, S5
111-32	Virgin River, 1.1 mi. above North Creek bridge	Virgin T41S, R12W, S25
111-33	Virgin River, 1.1 mi. above North Creek bridge	Virgin T41S, R12W, S25
111-34	Virgin River, 1.1 mi. above North Creek bridge	Virgin T41S, R12W, S25
111-35	Virgin River, 1.1 mi. above North Creek bridge	Virgin T41S, R12W, S25
111-36	Virgin River, 1.1 mi. above North Creek bridge	Virgin T41S, R12W, S25
111-37	Virgin River, 1.1 mi. above North Creek bridge	Virgin T41S, R12W, S25
111-38	Virgin River, 1.1 mi. above North Creek bridge	Virgin T41S, R12W, S25
111-39	Virgin River, 1.1 mi. above North Creek bridge	Virgin T41S, R12W, S25
111-40	Virgin River, 1.1 mi. above North Creek bridge	Virgin T41S, R12W, S25
111-41	Virgin River, 3.8 mi. above North Creek bridge	Virgin T41S, R11W, S31
111-42	Virgin River, 3.8 mi. above North Creek bridge	Virgin T41S, R11W, S31
111-43	Virgin River, 3.8 mi. above North Creek bridge	Virgin T41S, R11W, S31
111-44	Virgin River, 3.8 mi. above North Creek bridge	Virgin T41S, R11W, S31
111-45	Virgin River, 3.8 mi. above North Creek bridge	Virgin T41S, R11W, S31

Table 1. Continued

Station No.	Location Description	Quad Map Coordinates
111-46	Virgin River, 3.8 mi. above North Creek bridge	Virgin T41S, R11W, S31
111-47	Virgin River, 3.8 mi. above North Creek bridge	Virgin T41S, R11W, S31
111-48	Virgin River, 3.8 mi. above North Creek bridge	Virgin T41S, R11W, S31
111-49	Virgin River, at Grafton, 6.6 mi. above North Creek bridge	Springdale West T42S, R11W, S3
111-50	Virgin River, at Grafton, 6.6 mi. above North Creek bridge	Springdale West T42S, R11W, S3
111-51	Virgin River, at Grafton, 6.6 mi. above North Creek bridge	Springdale West T42S, R11W, S3
111-52	Virgin River, at Grafton, 6.6 mi. above North Creek bridge	Springdale West T42S, R11W, S3
111-53	Virgin River, at Grafton, 6.6 mi. above North Creek bridge	Springdale West T42S, R11W, S3
111-54	Virgin River, at Grafton, 6.6 mi. above North Creek bridge	Springdale West T42S, R11W, S3
111-55	Virgin River, 10 mi. above North Creek bridge	Springdale West T42S, R11W, S1
111-56	Virgin River, 10 mi. above North Creek bridge	Springdale West T42S, R11W, S1
111-57	Virgin River, 10 mi. above North Creek bridge	Springdale West T42S, R11W, S1
111-58	Virgin River, 10 mi. above North Creek bridge	Springdale West T42S, R11W, S1
111-59	Virgin River, 10 mi. above North Creek bridge	Springdale West T42S, R11W, S1
111-60	Virgin River, 10 mi. above North Creek bridge	Springdale West T42S, R11W, S1

Table 1. Continued

Station No.	Location Description	Quad Map Coordinates
111-61	Virgin River, bridge crossing at top of Gorge	Hurricane T41S, R13W, S27
111-62	Virgin River, bridge crossing at top of Gorge	Hurricane T41S, R13W, S27
111-63	Virgin River, bridge crossing at top of Gorge	Hurricane T41S, R13W, S27
111-64	Virgin River, bridge crossing at top of Gorge	Hurricane T41S, R13W, S27
111-65	Virgin River, bridge crossing at top of Gorge	Hurricane T41S, R13W, S27
111-66	Virgin River, bridge crossing at top of Gorge	Hurricane T41S, R13W, S27
111-67	Virgin River, bridge crossing at top of Gorge	Hurricane T41S, R13W, S27
111-68	Virgin River, bridge crossing at top of Gorge	Hurricane T41S, R13W, S27
111-69	¼-mi above Jim Tree diversion	Springdale East T42S, R10W, S11
SAMPLE TRIP IV June 22-25, 1987		
IV-1	Santa Clara River, above Jacob Hamlin home	St. George T42S, R16W, S16, W 1/2
IV-2	Santa Clara River, 3000 W. Chapel St.	St. George T42S, R16W, S16, S 1/2
IV-3	Santa Clara River, Lava Flow Road crossing	St. George T42S, R16W, S27, NW 1/4
IV-4	Santa Clara River, Bloomington Hwy. bridge	St. George T42S, R16W, S27, E 1/2
IV-5	Santa Clara River, Bloomington Golf Course	St. George T43S, R16W, S1
IV-6	Santa Clara River, 40 yds. above Gunlock Dam gage	Gunlock T40S, R17W, S28
W-7	La Verkin Creek, 400 yds. below upstream waterfall	Hurricane T41S, R13W, S12, NW 1/4

Table 1. Continued

Station No.	Location Description	Quad Map Coordinates
SAMPLE TRIP V July 6-10, 1987		
V-1	Santa Clara River, 75 yds. above Veyo Spring picnic tables	Veyo T40S, R16W, S6
V-2	Moody Wash, 0.8 mi. below Veyo Springs road crossing	Veyo T40S, R17W, S2, SE 1/4
V-3	Virgin River, North Fork, above Angels Landing	Temple of Sinawava T41S, R10W, S3
V-4	Virgin River, North Fork, service road bridge to Park housing	Springdale East T41S, R10W, S21
V-5	Virgin River, North Fork, river mile 33.9	Straight Canyon T39S, R8W, S7
V-6	Virgin River, North Fork, river mile 29.5	Straight Canyon T39S, R9W, S13
V-7	Virgin River, North Fork, river mile 27.2	Straight Canyon T39S, R9W, S26
V-8	Stout Creek, East Fork Site #1	Long Valley Junction T39S, R7W, S36
V-9	Virgin River, East Fork, 1 mi. upstream from lower Zion Park boundary	Springdale East T42S, R10W, S1
V-10	Virgin River, East Fork, 0.6 mi. above Zion Park boundary	Springdale East T42S, R10W, S1
V-11	Virgin River, East Fork, 200 yds. above diversion below Mt. Cannel Jct.	Mount Cannel T41S, R7W, S30
V-12	Virgin River, East Fork, below gaging station	Mount Cannel T41S, R7W, S30
V-13	Virgin River, East Fork, 250 yds. below 2nd bridge on Tree's	Springdale East T42S, R10W, S5
V-14	Shunes Creek, Station #1	Springdale East T42S, R10W, S11

Table 1. Continued

Station No.	Location Description	Quad Map Coordinates
SAMPLE TRIP VI January 9-14, 1990		
VI-1	Beaver Dam Wash, East Fork, 0.5 mi. below Bull Canyon	Maple Ridge T39S, R18W, S9, S 1/2
VI-2	Beaver Dam Wash, East Fork, 1.5 mi. above Nordin Ranch	Motoqua T39S, R19W, S34, E 1/2
VI-3	Beaver Dam Wash, East Fork, 0.6 mi. above Goldstrike	Goldstrike T39S, R18W, S17, E 1/2
VI-4	Beaver Dam Wash, East Fork, 0.8 mi. above Goldstrike	Goldstrike T39S, R18W, S17, E 1/2
VI-5	Beaver Dam Wash, Lytle Ranch Water Diversion, 0.7 mi. above Lytle Ranch	Scarecrow Peak T42S, R20W, S7, NW 1/4
VI-6	Beaver Dam Wash, 1.0 mi. above Lytle Ranch	Scarecrow Peak T42S, R20W, S6, SW 1/4
VI-7	Beaver Dam Wash, 1.3 mi. above Lytle Ranch immediately above ranch diversion	Scarecrow Peak T42S, R20W, S6, W 1/2
VI-8	Beaver Dam Wash, 1.6 mi. above Lytle Ranch	Scarecrow Peak T42S, R20W, S6, NW 1/4
VI-9	Moody Wash at confluence with Magotsu Creek	Veyo T39S, R17W, S36, SW 1/4
VI-10	Moody Wash, 3.0 mi. above Magotsu Creek at dirt road crossing, directly beneath double powerlines.	Central West T39S, R17W, S23, N 1/2
VI-11	Cove Wash, 5.5 mi. above Moody Wash at campground from Veyo Shoal Creek Road, 9.3 mi. north of Veyo	Maple Ridge T39S, R17W, S8, E 1/2
VI-12	Moody Wash, 8 mi. above Magotsu Creek, 2 mi. above Racer Canyon where pack trail intercepts Moody Wash	Maple Ridge T38S, R17W, S32, NW 1/2
VI-13	Magotsu Creek, 2 mi. above Moody Wash 1/2 mi. below Bingham Ranch House	Veyo T39S , R16W, S30, NW 1/4
VI-14	Beaver Dam Wash, Beaver Dam State Park below Schroeder Reservoir	Doc's Pass T5S, R71E, S21, S 1/2

Table 1. Continued

Station No.	Location Description	Quad Map Coordinates
VI-15	Beaver Dam Wash, 1.5 mi. below Nevada-Utah state line, 0.2 mi. below road end	Doc's Pass T38S, R20W, S25, E1/2
VI-16	Beaver Dam Wash, 1.1 mi. above Holts Cabin at Deep Canyon, 9.6 mi. above Motoqua Road	Doc's Pass T39S, R20W, S1, SE 1/4
VI-17	Beaver Dam Wash, 3.0 mi. below Holts Cabin 0.3 mi. below Slaughter Creek, 5.5 mi. above Motoqua Road	Docs Pass T39S, R19W, S20, SW 1/4
VI-18	Santa Clara River, 0.7 mi. below Gunlock Dam	Shivwits T41S, R17W, S7, S 1/2
VI-19	Moody Wash, 0.9 mi. below Ford, 100 yards above Cottonwood Wash	Veyo T40S, R17W, S11, NW 1/4
VI-20	Santa Clara River, 1.0 mi. below State Highway 91 crossing on Shivwits Indian Reservation	St. George T41S, R17W, S35, W 1/2
VI-21	Santa Clara River, upstream of State Highway 91 crossing on Shivwits Indian Reservation, 5.5 mi. north of Santa Clara City	St. George T41S, R17W, S34, N 1/2
VI-22	Magotsu Creek, 1.0 mi. above Moody Wash	Veyo T39S, R17W, S36, NE 1/4
VI-23	Santa Clara River, 2.3 mi. above Baker Reservoir, upstream of road crossing south of Central	Central East T38S, R16W, S11, S 1/2

Table 2. Recent collections of Virgin spinedace and associated species by UDWR In the Virgin River Drainage.

COLLECTORS	DATE	LOCATION (STATION NO.)	AREA					SPECIES''								
			SAMPLED	VSD	SD	DS	MS	FM	BRT	BKT	RBT	CT	RBxCT	GS	LMB	CP
Beaver Dam Wash																
Radant	09-24-86	8.9 mi above Motogua (cable across road) (I-1)	75 yds	25'	x											
Radant	09-24-86	6.9 mi above Motogua (I-2)	30 yds	11 ^e	x											
Radant	09-24-86	4.4 mi above Motogua (I-3)	25 yds	4 ^e												
Radant	09-24-86	2.4 mi above Motogua (I-4)	30 yds	6e2	x											
Radant	09-24-86	Lytle Ranch (I-5)		x												
Valdez et al.	01-10-90	0.7 mi above Lytle Ranch (irrigation canal) (VI-5)	73 ft	45'	7	9										1
Valdez et al.	01-10-90	1.0 mi above Lytle Ranch (VI-6)	154 ft	9 ^e	50	13										
Valdez et al.	01-10-90	1.3 mi above Lytle Ranch (VI-7)	240 ft	96 ^a												
Valdez et al.	01-11-90	1.6 mi above Lytle Ranch (VI-8)	132 ft	241	217	54										
Knight, McKay	01-12-90	1.0 mi below Dam (VI-14)	120 ft	0	17	3					9					
Knight, McKay	01-12-90	Just above Narrows (VI-15)	70 ft		21	3					19					
Valdez et al.	01-13-90	5.5 mi above Motogua (VI-17)	196 ft		64	4					82					
Valdez et al.	01-13-90	9.6 mi above Motogua (VI-16)	195 ft	3	90	7					1					
East Fork Beaver Dam Wash																
Valdez et al.	01-9-90	0.5 mi downstream from Bull Canyon (Daggett Flat Road Crossing) (VI-1)	250 ft	0'	105	110	-									
Valdez et al.	01-9-90	1.5 mi above Nordin Ranch (VI-2)	30 ft	0		7					3				2	
Valdez et al.	01-9-90	0.6 mi above Goldstrike (VI-3)	100 ft	0	32	10										
Knight, McKay	01-9-90	0.8 mi above Goldstrike (VI-4)		0 ^e												
Santa Clara River																
Radant, Hickman	09-23-86	1.5 mi above Gunlock Dam (I-6)														
Radant, Hickman	09-23-86	2.2 mi above Gunlock Dam (I-7)			x	x										
Radant, Hickman	09-23-86	Immediately below Baker Res. Dam (I-8)														
Radant, Hickman	09-23-86	Road crossing above Baker Res. Dam (I-9)														
Radant, Archer	06-24-87	Above Jacob Hamlin home (IV-1)														
Radant, Archer	06-24-87	3000 W. Chapel St. (IV-2)														
Radant, Archer	06-24-87	Lava Flow Road crossing (IV-3)		0												
Radant, Archer	06-24-87	Bloomington hwy. bridge (IV-4)		0'	x	x										
Radant, Archer	06-24-87	Bloomington Golf Course (IV-5)		2 ^e												
Radant, Archer	06-25-87	40 yds above Gunlock Dam gage (IV-6)	240 ft	147 ^e	817	270								1		
Radant, Holden, Deacon	07-10-87	75 yds above Veyo Spring picnic tables (V-1)	100 ft	10	2	4				1						
Valdez et al.	01-13-90	0.7 mi below Gunlock Reservoir (VI-18)	150 ft	0	67											
Valdez et al.	01-14-90	1.0 mi below hwy. 91 road crossing (VI-20)	200 ft	0	64	21										

Table 2. Continued

COLLECTORS	DATE	LOCATION (STATION NO.)	AREA				SPECIES**												
			SAMPLED	VSD	SD	DS	MS	FM	BET	BKT	RBT	CT	□	□	□	GS	LMB	CP	CRAY
<u>North Fork Virgin River</u>																			
Radant, Smith-Berry	11-14-86	Bridge crossing at Watchman Camp (III-7)	40 yds ²	3 ^a		3		3											
Radant, Smith-Berry	11-14-86	Across from campground 111-8	40 yds ²	0'															
Radant, Smith-Berry	11-14-86	Across from campground (III-9)	40 yds ²	1 ^a															
Radant, et al.	07-06-87	Above Angels Landing V-3	300 ft	51'	117	265		11	9		1								
Radant, et al.	07-08-87	Service road bridge to Park housing (V-4)	200 ft	21 ^a	52	91	-	5	-										
Radant, et al.	07-08-87	River mile 33.9 V-5	110 ft							11	9	4	1						
Radant, et al.	07-08-87	River mile 29.5 V-6	160 ft	0 ^e								11	1						
Radant, et al.	07-08-87	River mile 27.2 (V-7)	144 ft									6							
<u>Stout Creek</u>																			
Radant, et al.	07-09-87	East Fork Site #1 V-8	190 ft	0					49	-	1								
<u>East Fork Virgin River</u>																			
Radant, Smith-Berry	11-13-86	End of road on Jim Tree's property (III-10)	40 yds ²	1'				2											
Radant, Smith-Berry	11-13-86	End of road on Jim Tree's property (III-11)	40 yds ²	14'	3			1											
Radant, Smith-Berry	11-13-86	End of road on Jim Tree's property (III-12)	40 yds ²	0 ^a															
Radant, Smith-Berry	11-13-86	End of road on Jim Tree's property (III-13)	40 yds ²	8'															
Radant, Smith-Berry	11-13-86	Above Park boundary through Tree's (III-14)	40 yds ²					1											
Radant, Smith-Berry	11-13-86	Above Park boundary through Tree's (III-15)	40 yds ²	1'				3											
Radant, Smith-Berry	11-13-86	Above Park boundary through Tree's (III-16)	40 yds ²	5'		1													
Radant, Smith-Berry	11-13-86	Above Park boundary through Tree's (III-17)	40 yds ²	61'															
Radant, Smith-Berry	11-13-86	Above Park boundary through Tree's (III-18)	40 yds ²	2'		1		1											
Radant, Smith-Berry	11-13-86	Above Park boundary through Tree's (III-19)	40 yds ²	14'		1		2											
Radant, Smith-Berry	11-13-86	Above Park boundary through Tree's (III-20)	40 yds ²	7'	1	2		2											
Radant, Smith-Berry	11-13-86	Adjacent to Tree's garden plot (III-21)	40 yds ²	42'															
Radant, Smith-Berry	11-13-86	Adjacent to Tree's garden plot 111-22	40 yds ²	25 ^a		2		4											
Radant, Smith-Berry	11-13-86	Adjacent to Tree's garden plot (III-23)	32 yds ²	18'	1														
Radant, Smith-Berry	11-13-86	Adjacent to Tree's garden plot 111-24	40 yds ²	33 ^a	3														
Radant, Smith-Berry	11-13-86	Adjacent to Tree's garden plot 111-25	40 yds ²	0'	2														
Radant, Smith-Berry	11-13-86	Adjacent to Tree's garden plot 111-26	40 yds ²	8'															
Radant, Smith-Berry	11-13-86	Adjacent to Tree's garden plot 111-27	40 yds ²	23 ^a	4	1													
Radant, Smith-Berry	11-13-86	Adjacent to Tree's garden plot (III-28)	40 yds ²	26'				2											
Radant, Smith-Berry	11-13-86	Adjacent to Tree's garden plot (III-29)	40 yds ²	27'	1	1		1											
Radant, Smith-Berry	11-13-86	Adjacent to Tree's garden plot (III-30)	40 yds ²	13'															
Radant, Smith-Berry	11-13-86	Adjacent to Tree's garden plot (III-31)	40 yds ²	13'	2			8	-										
Radant, et al.	07-07-87	1 mi upstream from lower Zion Park boundary (V-9)	147 ft	136 ^c	23	35		23	-										

Table 2. **Continued**

COLLECTORS	DATE	LOCATION (STATION NO.)	AREA				SPECIES**											
			SAMPLED	VSD	SD	DS	MS	FM	BRT	BKT	RBT	CI'	RBxCT	GS	LMB	CP	CRAY	
Radant, et al.	07-07-87	0.6 mi above Zion Park boundary (V-10)	158 ft	31°	36	56		8										
Radant, et al.	07-09-87	200 yds above diversion below Mt. Cannel Jct. (V-11)	200 ft	0°	12		1											2
Radant, et al.	07-09-87	Below gaging station (V-12)	170 ft				7	-	68		6							
Radant, et al.	07-09-87	250 yds below 2nd bridge on Tree's (V-13)	250 ft	116°	81	75		13	-									
Shune's Creek																		
Radant, et al.	07-07-87	Station #1(V-14)	84 ft	e ⁵	16	50												
Radant, Smith-Berry	11-14-86	0.25 mi above Jim Tree's diversion (111-69)	160 ft	14°	7	30												
Virgin River																		
Radant, Smith-Berry	11-12-86	1.1 mi above North Ck bridge (III-32)	72 yds [^]	132 ^a				8										
Radant, Smith-Berry	11-12-86	1.1 mi above North Ck bridge (111-33)	32 yds ²	1 ^a														
Radant, Smith-Berry	11-12-86	1.1 mi above North Ck bridge (111-34)	40 yds ²	1'	1													
Radant, Smith-Berry	11-12-86	1.1 mi above North Ck bridge (111-35)	40 yds ²	79 ^a				4										
Radant, Smith-Berry	11-12-86	1.1 mi above North Ck bridge (111-36)	40 yds ²	0°				1										
Radant, Smith-Berry	11-12-86	1.1 mi above North Ck bridge (111-37)	40 yds ²	0	1			2										
Radant, Smith-Berry	11-12-86	1.1 mi above North Ck bridge (111-38)	60 yds ²	27 ^a				2										
Radant, Smith-Berry	11-12-86	1.1 mi above North Ck bridge (111-39)	40 yds ²	0 ^a				1										
Radant, Smith-Berry	11-12-86	1.1 mi above North Ck bridge (III-40)	40 yds ²	5 ^a				1										

¹ Fish sampled with seines

² Two bullfrogs were observed

³ Gambusia and bullfrogs also captured

⁴ Canyon treefrogs observed

⁵ Canyon treefrogs and Red spotted toads and tadpoles observed

• Fish sampled with electrofishing gear

x Species present, not counted

** VSD - Virgin Spinedace; SD - Speckled Dace; DS - Desert Sucker; MS - Mountain Sucker; FM - Flannelmouth Sucker; BRT - Brown Trout; BKT - Brook Trout; RBT - Rainbow Trout; CT - Cutthroat Trout; RBxCT - Rainbow-Cutthroat Trout Hybrid; GS - Green Sunfish; LMB - Largemouth Bass; CP - Carp; CRAY - Crayfish

RESULTS

The following is a description of the past and present distribution and status of the Virgin spinedace in each of the tributaries of the Virgin River. It includes a detailed physical description of each tributary to provide a perspective of habitat conditions and present and impending threats. It also assesses the distribution of the species within each tributary and provides a density estimate expanded to a population estimate for the occupied habitat.

Beaver Dam Wash

Beaver Dam Wash is an intermittent drainage that originates on the east slope of the Clover Mountains in southeastern Nevada near the town of Acoma. It is impounded in Nevada by Schroeder Reservoir at Beaver Dam State Park and then flows southeast into Utah (Figures 1 and 2). Two miles downstream of the stateline, the stream flows through a roadless section about 2 miles long known as The Narrows. It then parallels the Utah border, flowing past Motoqua and Lytle Ranch before entering the extreme northwest corner of Arizona where it flows into the Virgin River near Littlefield.

During January 9-13, 1990, there was surface flow in Beaver Dam Wash from above Schroeder Reservoir downstream through The Narrows to approximately 1 mile upstream of Motoqua (Figure 2). There was no flow in Beaver Dam Wash between Motoqua and Lytle Ranch. Bentley Spring was dry and Jackson Well had a small outflow from a large open storage tank that went underground. There were numerous goldfish in the tank. Surface flow resumed approximately 2 miles above the Lytle Ranch house or about 1 mile below Horse Canyon, and continued for about 2.4 miles to a point of diversion at the main road crossing. At that point, the entire flow of Beaver Dam Wash was diverted into a 6,000-foot long underground pipe and into a newly constructed (summer 1989) pond on the Iverson Ranch. The pond was built as part of a bird hunting preserve developed by a recent lessee. There was little flow below this diversion and through Iverson Ranch, although a series of beaver ponds on the ranch appeared to be retaining water that was surfacing from the stream bed. There was no surface flow downstream of Iverson Ranch and the stream bed was reportedly dry to a point just above the confluence with the Virgin River near Littlefield, Arizona (Personal communications with Mark Hopkins, Lytle Ranch Caretaker, January 10, 1990). Numerous recently-constructed beaver ponds were noted in the vicinity of Lytle Ranch. Although beaver have always inhabited Beaver Dam Wash, recent droughts may have allowed greater retention of dams and a proliferation of the population.

A major tributary of Beaver Dam Wash, the East Fork, originates on the west slope of the Bull Valley Mountains and flows southwest into Beaver Dam Wash at Motoqua (Figure 2). Flow above Bull Canyon and in Bull Canyon was intermittent in mid-January, and there was consistent surface flow for a distance of about 2 miles, from Bull Canyon to a point about 0.25 miles above Goldstrike. Surface flow resumed downstream, about 1.5 miles above Nordin Ranch to about 1 mile below the ranch, or about 1.2 miles above the confluence of Beaver Dam Wash. The flow above Nordin Ranch originates primarily from three adits (horizontal shafts bored into waterbearing limestone) which were drilled to develop surface water in about 1970 (Personal communication with Herb Fletcher, Nordin Ranch, January 9, 1990). According to Mr. Fletcher, the three adits are responsible for perennial surface flow at Nordin Ranch. Prior to these adits, the only surface flow in the area was a small spring located at the ranch. Flow from the East Fork entered two ponds on the Nordin Ranch and was piped from the upper pond for 6 miles upstream to a large open-pit heap leach gold operation located in Arsenic Gulch, about 0.5 miles southeast of Goldstrike. This diversion dewatered the East Fork from about 4 cfs down to 2 cfs (as observed in early January 1990). Mr. Fletcher noted that surface flow in the East Fork rarely extends downstream to Beaver Dam Wash, even during spring runoff. He also reported that UDWR began holding largemouth bass brood stock in two ponds on his property about 5 years ago, and that 10,000 fingerling rainbow trout were introduced into the ponds in 1989 as forage for the bass. We



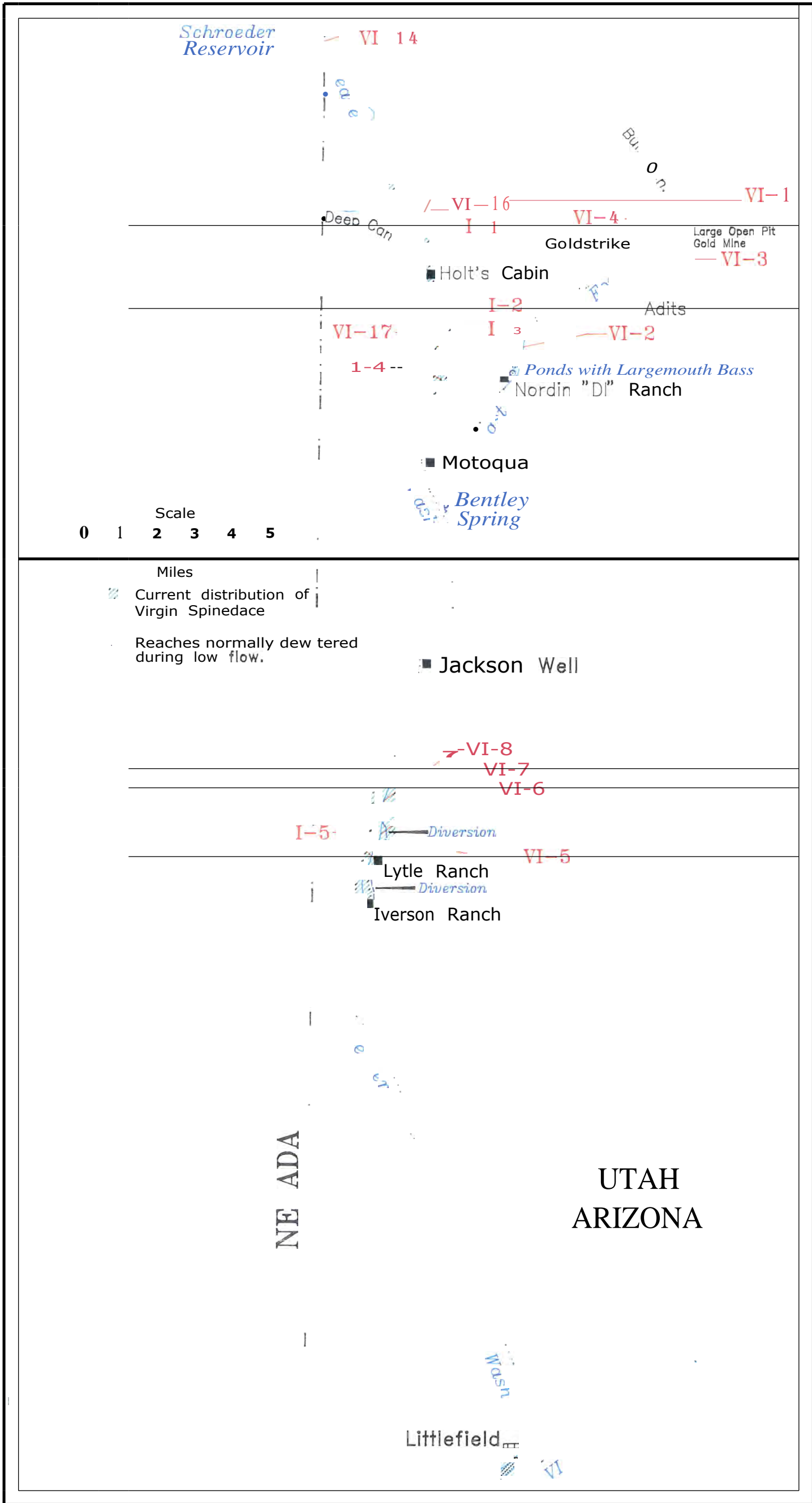


Figure 2. Beaver Dam Wash and its major tributary the East Fork. Sample stations are numbered.



captured and saw numerous largemouth bass and rainbow trout in the East Fork indicating escapement from the ponds and reproduction by bass in either the ponds or the stream, or both. Crayfish were abundant in this river reach. Mr. Fletcher also reported stocking brook trout into the stream near Nordin Ranch, but that the stock was apparently unsuccessful.

Virgin spinedace were first reported from Beaver Dam Wash by Miller and Hubbs (1960) as type specimens collected at the U.S. 91 crossing near Littlefield, Arizona, Coconino County, July 28, 1942. Rinne (1971) confirmed the presence of Virgin spinedace in Beaver Dam Wash and reported that the stream supported two isolated populations--one near its head in the Beaver Dam Mountains of Nevada, directly below Schroeder Reservoir, and a second at the downstream end at its mouth near Beaver Dam, Arizona. Minckley (1973) reported that the lowermost segment of Beaver Dam had been drastically modified by channelization, but that Beaver Dam Wash and the Santa Clara River were still considered the prime habitats for Virgin spinedace. Cross (1975) reported Virgin spinedace from Beaver Dam Wash above the confluence with the Virgin River, but failed to find the species above and below Schroeder Reservoir at the Beaver Dam State Park. Deacon and Rebane (1989) reported higher mean densities (total number of spinedace per square foot) in Beaver Dam Wash near Lytle Ranch than in the East Fork Virgin River, North Fork Virgin River, and tributaries of the Virgin River. Koch (Personal communication with Ed Koch, Idaho State University, January 4, 1990) found high densities of Virgin spinedace at the Iverson Ranch in the spring of 1989, prior to the diversion of the stream into the pond at the ranch. None of these investigations, however, conducted population estimates.

Five stations were qualitatively sampled in Beaver Dam Wash on September 24, 1986 (stations I-1 to I-5). Virgin spinedace, speckled dace, and desert sucker were found at all stations, and rainbow trout were present in the upper station above Motoqua. The region extending from 1 mile above Motoqua to above Lytle Ranch was dry which was the same reach that was dry during the January 9-13, 1990 visit.

Twelve stations were sampled January 9-13, 1990, including four each in the upper reach above Motoqua, the area of Lytle Ranch, and the East Fork (Table 1, Figure 2). Virgin spinedace were found only in the first two reaches, and were absent from the East Fork. The upstream distribution of the Virgin spinedace in this upper region of Beaver Dam Wash was Does Pass Canyon at the lower end of the steep gradient of The Narrows, based on the absence of Virgin spinedace at Station VI-15 (above The Narrows) and their presence at Station VI-16 (below The Narrows). The downstream distribution was estimated to be about 1.0 miles above the road crossing to Motoqua. Thus, Virgin spinedace were distributed in a 7-mile reach of upper Beaver Dam Wash. The relatively greater size of the fish in Stations VI-16 and VI-17 (Table 3, average lengths of 113.0 and 103.3 mm TL) when compared to other populations, and the absence of YOY indicates that this reach represents marginal upstream conditions for the species. Large numbers of rainbow trout were also found in large pools occupied by Virgin spinedace about 5.5 miles above Motoqua.

Table 3. Lengths and weights of Virgin spinedace captured in tributaries of the Virgin River, January 8-16, 1990.

Station No.	No. Caught'	Range TL (mm)	Ave. TL (mm)	Ave. Wt. (g)	Condition KTL
VI-5	45	46-109	67.8	3.0	0.83
VI-6	9	64-90	77.9	4.8	1.02
VI-7	96				
VI-8	241	37-97	71.3	3.8	0.99
VI-9	8	55-126	74.3	4.0	0.78
VI-10	5	30-77	51.0	1.7	1.85
VI-16	3	107-127	113.0	10.3	0.63
VI-17	3	88-113	103.3	11.0	0.93
VI-19	65	34-97	58.1	2.6	1.25

a From 2 electrofishing passes, except for 1 seine haul in sample VI-7; only 100 fish weighed and measured in sample VI-8.

Population estimates conducted at station VI-17 revealed 3 fish per 196 feet of stream (Table 4). Assuming a uniform density, and stream configuration (width and depth), we estimated a total of 568 Virgin spinedace in this 7-mile reach. Similar population estimates for Virgin spinedace in the area of Lytle Ranch indicate three distinct density levels reflecting habitat availability and quality. The 0.6-mile long diversion canal for Lytle Ranch had an estimated density of 80 fish per 73 feet of stream for a total of 3472 fish. The 1.5-mile reach from the Lytle Ranch diversion to the Iverson Ranch diversion yielded a density of 11 fish per 154 feet of stream (Station VI-6) or a total of 566 Virgin spinedace. This estimate was based on the density of fish in stream habitat, and may be lower in the beaver dams. Deacon and Rebane (1989) reported that the substrate in the beaver ponds at Lytle Ranch was mostly silt and that fish were almost totally absent. The uppermost 1 mile of surface water above the Lytle Ranch diversion had the highest density of spinedace encountered. An estimated 269 Virgin spinedace occurred in a 132-foot section (Station VI-8), which equalled to about 10,760 Virgin spinedace in the 1-mile reach.

Length-frequency histograms for Virgin spinedace from two sites on Beaver Dam Wash (Figure 3) revealed three age groups, with the first two being the strongest. When compared with a histogram for fish from Moody Wash, it was apparent that the relative sizes of Virgin spinedace from Lytle Ranch were larger, suggesting better habitat conditions or earlier spawning time.

Thus, Virgin spinedace were found in two areas of Beaver Dam Wash within the State of Utah. This included a 7-mile reach above Motoqua and a 2.4-mile reach near Lytle Ranch (Figure 2). The number of Virgin spinedace in the upper 7 miles was low at an estimated 568. The total number of spinedace in the 2.4-mile reach of Lytle Ranch was 14,798. The uppermost mile of surface flow above Lytle Ranch supported the highest density of Virgin spinedace encountered and should be considered an important reach for the species since it still provides natural flow and relatively undisturbed habitat (although some bank erosion and siltation from cattle grazing was evident). This reach of Beaver Dam Wash is in the Lytle Ranch Preserve, purchased by The Nature Conservancy in 1985 and transferred to Brigham Young University in 1986. There may be small numbers of Virgin spinedace in the seeps below the Iverson Ranch diversion, but our visit in early January 1990 indicated that this area had been recently dewatered and the high densities of fish observed by investigators from Idaho State University in spring 1989 are probably greatly diminished or gone.

Table 4. Summary of population estimates by UDWR for Virgin spinedace in tributaries of the Virgin River.

Station No.	Sample Date	Location Description	Station Length (feet)	Number Caught*	Population Estimate	95% C.L.	Representative Stream Reach	Stream Segment (feet)	Total Population
<u>Beaver Dam Wash</u>									
VI-5	1/10/90	Diversion 0.7 mi. above Lytle Ranch	73	45	80	45-158	Lytle Ranch Diversion Canal = 0.6 mi.	3,168	3,472
VI-6	1/10/90	1.0 mi. above Lytle Ranch	154	9	11	9-22	Lytle Ranch Diversion to Iverson Ranch or end of surface flow = 1.5 mi.	7,920	566
VI-8	1/11/90	1.6 mi. above Lytle Ranch	132	241	269	247-290	Start of surface flow to Lytle Ranch Diversion = 1.0 mi.	5,280	10,760
VI-17	1/13/90	0.3 mi. below Slaughter Creek	196	3	3	3-6	Narrows to 1 mi. above Motoqua = 7.0 mi.	36,960	568
<u>Moody Wash</u>									
V-2	7/10/87	1 mi. above Santa Clara River	155	106	120	106-136	0.5 mi. above Magotsu Creek to Santa Clara River = 3.5 mi.	18,480	14,307
VI-19	1/14/90	1.0 mi. above Santa Clara River	136	63	74	65-88	0.5 mi. above Magotsu Creek to Santa Clara River = 3.5 mi.	18,480	10,055
<u>Santa Clara River</u>									
V-1	7/10/87	75 yards above Veyo Spring	100	10	10	10-11	Baker Dam to Moody Wash = 7.8 mi.	41,358	4,136
IV-6	6/25/87	Bridge crossing above gauge above Gunlock Res.	240	147	147	147-148	Moody Wash to Gunlock Res. = 4.0 mi.	21,378	13,094
<u>Ash Creek</u>									
III-1	11/11/86	Above Gedman's	165	30	31	30-35	Highway 17 to Gedman's = 0.8 mi.	4,224	794
111-2	11/11/86	Below Gedman's	180	291	318	298-338	Gedman's to Virgin River = 1.9 mi.	10,032	17,723
111-3	11/11/86	First spring in gorge 350 yds below outlet	200	61	78	61-102	Spring to Highway 17 = 0.6 mi.	3,168	1,236
<u>LaVerkin Creek</u>									
IV-7	6/22/87	400 yds below upper barrier falls	180	40	40	40-41	Not used.		

Station No.	Sample Date	Location Description	Station Length (feet)	Number Caught ^a	Population Estimate	95% C.L	Representative Stream Reach	Stream Segment (feet)	Total Population
11-3	10/17/86	350 yds above Jones diversion	200	34	34	34-36	Chute falls to upper diversion = 2.6 mi.	13,728	2,334
11-2	10/14/86	Highway 17 bridge	100	137	138	137-141	Upper diversion to Highway 17 = 1.5 mi.	7,920	10,930
II-1	10/14/86	Below Highway 17	162	48	50	48-55	Highway 17 to lower diversion = 1.5 mi.	7,920	2,444
<u>North Creek</u>									
111-6	11/14/86	Below lower field	162	28	28	28	Mountain Dell to Virgin River = 3.5 mi.	18,480	3,194
111-4	11/12/86	Top of Sunset Ranch	145	96	98	96-102	Confluence of left/right fork to Sunset Ranch = 1.0 mi.	5,280	3,569
111-5	11/12/86	2nd Hwy bridge crossing below Sunset Ranch	175	56	57	56-60	Confluence to Mountain Dell = 3.0 mi.	15,840	5,159
<u>N. Fork Virgin River</u>									
V-4	7/8/87	Service road bridge	200	21	21	21	Visitor Center to Virgin River = 4.5 mi.	23,760	2,495
V-3	7/6/87	Above Angel's Landing	300	51	67	51-94	Sinawava to Visitor Center = 8.0 mi.	42,240	9,434
<u>Shunes Creek</u>									
V-14	7/7/87	EF #1	84	26	26	26	Major fork to irrigation diversion = 2.0 mi.	10,560	3,269
<u>E. Fork Virgin River</u>									
V-13	7/9/87	250 yds below 2nd bridge Jim Tree's	250	116	136	117-157	Shune's Creek to Virgin River = 2.4 mi.	12,672	6,894
V-9	7/7/87	Zion Pk. Bounday 1 mi. above S. boundary	147	136	139	136-144	1 mi. above Dennett Canyon to Shunes Creek = 6.8 mi.	35,904	33,950
V-10	7/7/87	0.5 mi. above Zion boundary	158	31	31	31-33		7,920	1,554

^a From 2 electrofishing passes.

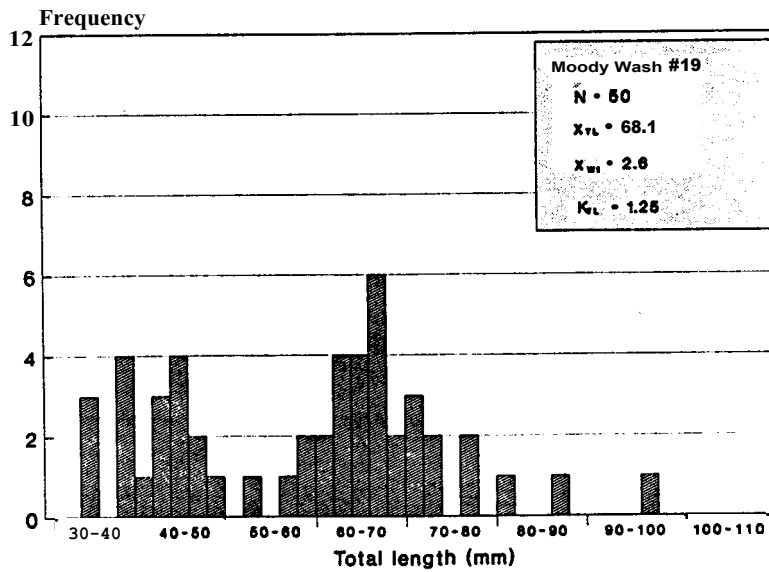
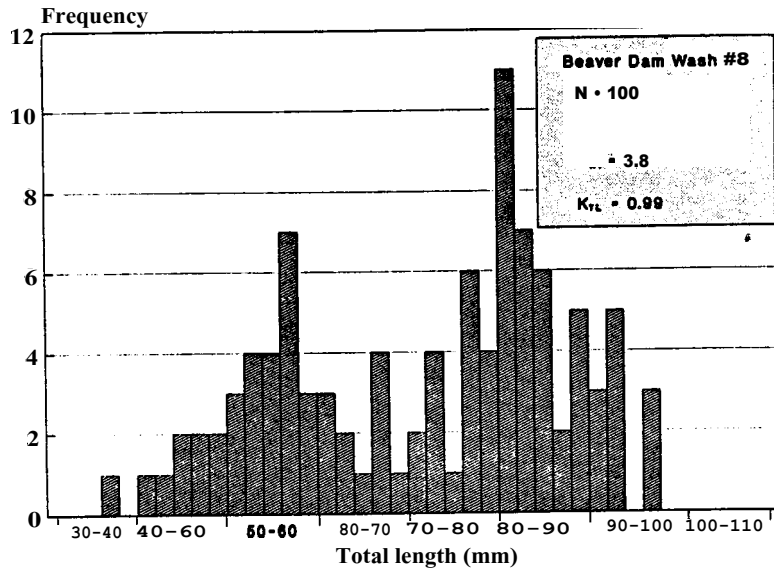
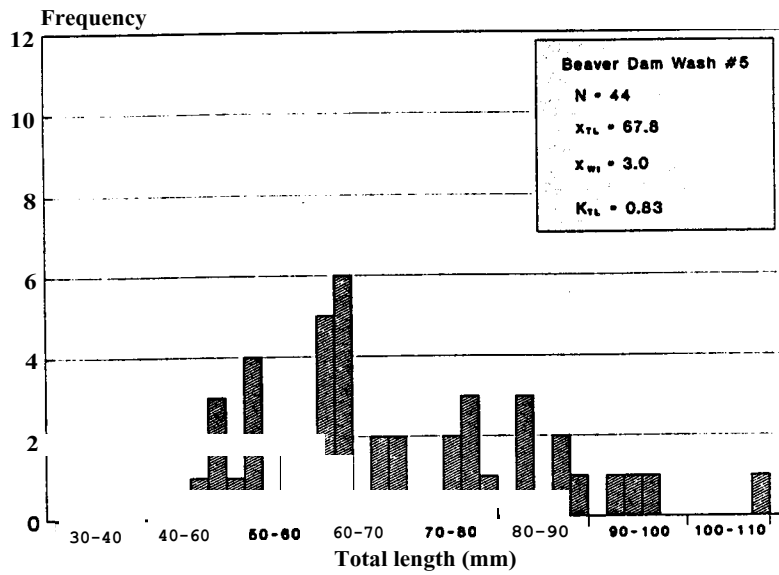


Figure 3. Length-frequency distribution for Virgin spinedace from three sample sites on Virgin River tributaries.

Investigators on January 10, 1990 encountered approximately the same surface flows in Beaver Dam Wash as reported on September 24, 1986, except for the recent diversion reported above at the Iverson Ranch. Four stations sampled in 1986 above Motoqua (Table 2) yielded the following numbers of Virgin spinedace for the indicated stream distance by a single electrofishing pass: 25/75 yards, 11/30 yards, 4/25 yards, and 6/30 yards. These catches were all higher than those made during the January 1990 sampling (3/65 yards and 3/64 yards), indicating that either the latter investigation randomly selected stream reaches with fewer fish, or that the numbers of fish were down dramatically from 1986. Both investigations also reported speckled dace, desert sucker, and rainbow trout from each sample station.

Santa Clara River

The Santa Clara River originates in the Pine Valley Mountains of southwestern Utah and flows in a semicircular west and southerly direction into the Virgin River south of St. George, Utah (Figure 4). The mainstem is impounded by Baker Dam Reservoir and Gunlock Reservoir. A major tributary of the Santa Clara River is Moody Wash with its tributary Magotsu Creek.

During the period January 11-14, 1990, the Santa Clara River flowed intermittently. Flow was continuous downstream to Gunlock Reservoir, but there were no releases from Gunlock Dam and the stream bed was dry for about 0.5 miles. A small amount of surface flow (<1 cfs) was noted for a distance of about 0.5 mile. Continuous flow resumed about 2 miles downstream from Gunlock Dam and continued to its confluence with the Virgin River. Throughout the Santa Clara River, erosion and siltation from livestock grazing were evident, as well as municipal and domestic pollution.

During the same period Magotsu Creek flowed continuously from its headwaters to a diversion about 5 miles above its confluence with Moody Wash. The stream was dewatered from this diversion downstream for about 2.5 miles where seepage and return flow at the Bingham Ranch resumed surface flow. According to Dr. Bingham (Personal communication, January 1990), this is the first year since 1970 that Magotsu Creek has been dry at his ranch house. We encountered a 12-foot high waterfall at the lower end of the Bingham property (Station VI-13), or about 2 miles above the confluence of Moody Wash, that we considered to be an upstream barrier to fish.

Moody Wash was an intermittent stream during the January investigation. It flowed intermittently in the upper reaches above Racer Canyon about 8 miles above the confluence of Magotsu Creek. Springs at and below Racer Canyon presumably resumed surface flow into Moody Wash for a distance of about 6 miles and the lower 1.5 miles above the confluence of Magotsu Creek was dewatered. Only the lower 0.5 miles of Moody Wash had surface flow.

The holotype for *L. mollispinis mollispinis* was collected from the Santa Clara River, 3 miles southeast of Shivwitz and 4.5 miles northwest of Santa Clara, Washington County, Utah (Miller and Hubbs 1960). Secured with the holotype were 103 paratopotypes. The Santa Clara River and Beaver Dam Wash were once identified as the prime habitats for the Virgin spinedace (Rinne 1971, Cross 1975, Minckley 1973), but these have been drastically modified by construction of dams and channelization, respectively. Sampling in January 1990 near the site of the holotype revealed a dewatered stream with eroded banks, a depauperate riparian zone, piles of junked cars, and deep sediment with the odor of organic pollution. We failed to capture any Virgin spinedace at this site and captured few speckled dace and desert sucker.

Five locations were sampled in the Santa Clara River Drainage from above Baker Dam downstream to Santa Clara City September 23-24, 1986; six locations were sampled on June 23-25, 1987; two were sampled July 6-10, 1987; and ten on January 9-14, 1990 (Table 1). No Virgin spinedace were found above or immediately below Baker Dam (Table 2), but they were found 1.5 and 2.2 miles above Gunlock Dam as well

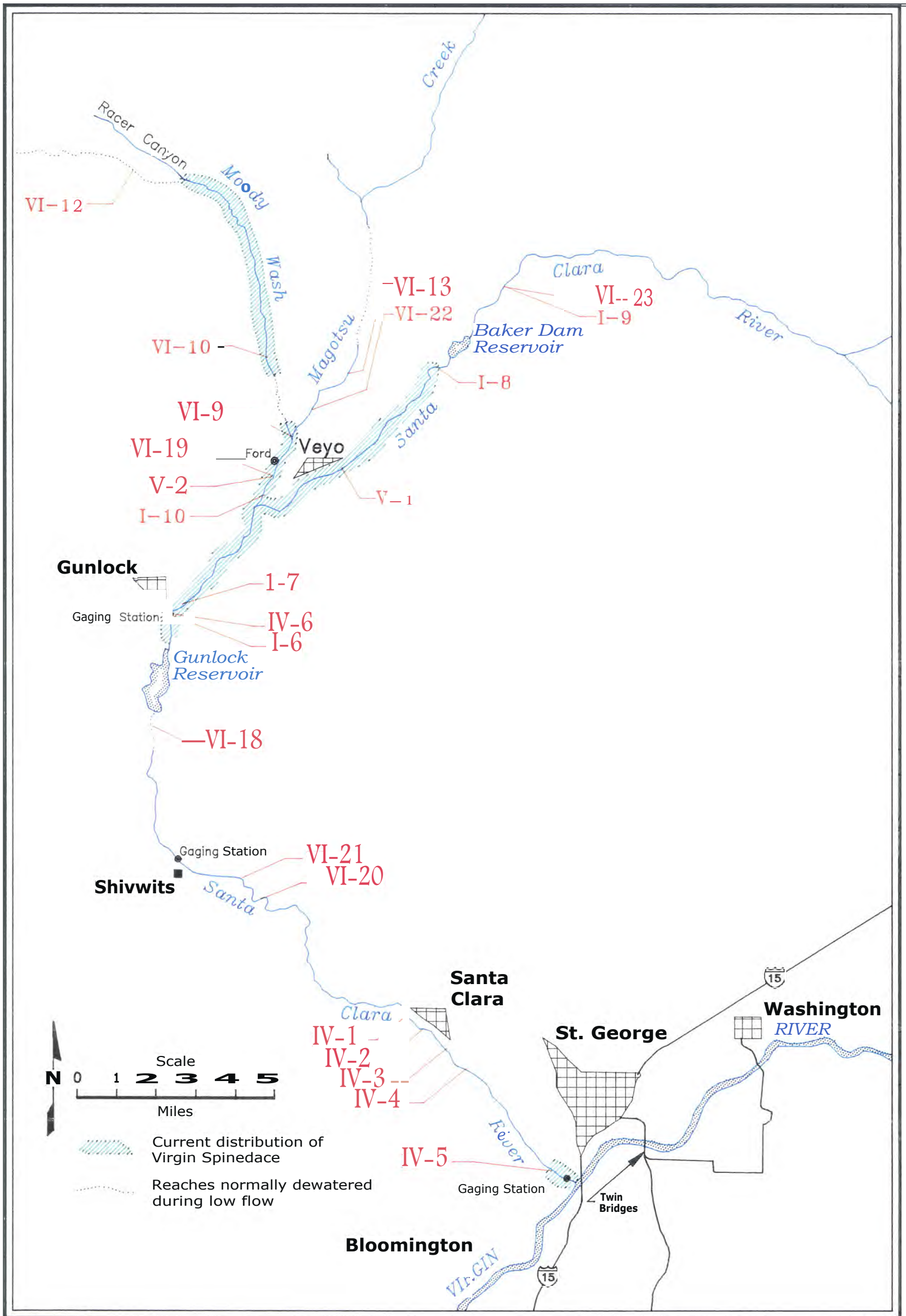


Figure 4. The Santa Clara River and its tributaries, Moody Wash and Magotsu Creek. Sample stations are numbered.



as at the gaging station immediately above the dam. Of five sites sampled June 24, 1987 between the Jacob Hamlin home in Santa Clara and the bridge crossing at the Bloomington Golf Course, only two Virgin spinedace were found at the latter site. Several irrigation diversions and returns were noted in this reach as well as turbidity, organic pollution, and sections of vegetation-choked stream channel. There was also an abundance of crayfish at these lower sample sites. A survey on July 10, 1987, yielded 10 Virgin spinedace in two electrofishing runs through 100 feet of stream about 75 yards above the Veyo Springs picnic tables.

The January 1990 survey revealed two populations of Virgin spinedace in Moody Wash. The upper population extended from approximately Racer Canyon downstream for 6.0 miles to a point about 1.5 miles above the confluence of Magotsu Creek. No population estimate was conducted in this reach and only five Virgin spinedace were captured in electrofishing 30 feet of stream.

The lower population was distributed from 0.5 miles above the confluence of Magotsu Creek to the confluence of the Santa Clara River. A two-catch population estimate conducted in the 3.5-mile reach of lower Moody Wash 1.0 miles above the Santa Clara River on January 14, 1990, revealed a density of 74 Virgin spinedace in 136 feet of stream or 10,055 fish in the 3.5-mile reach of lower Moody Wash (Table 4). A similar estimate conducted on July 10, 1987, revealed an estimate of 120 fish in 155 feet of stream or 14,307 fish in the 3.5-mile reach. These estimates were comparable for this reach of Moody Wash. The higher estimate of 14,307 was conducted following recruitment of the age-0 fish into the population while the lower estimate of 10,055 represents low winter densities.

Similar population estimates in the Santa Clara River conducted in June and July 1987 revealed two levels of density (Table 4). The upper portion of the population was distributed 7.8 miles from Baker Reservoir downstream to the confluence of Moody Wash and was represented by an estimate of 10 Virgin spinedace in 100 feet of stream for a total of 4,136 fish (July 10, 1987). The lower portion of the population was distributed 4.0 miles from the confluence of Moody Wash to Gunlock Reservoir with a density of 147 fish in 240 feet of stream or 13,094 fish for the reach (June 25, 1987).

No spinedace were collected from three sample stations in the lower 2 miles of Magotsu Creek in January 1990. Speckled dace were common in the pools below a 12-foot waterfall 2 miles above the Moody Wash confluence, but the species was rare further downstream. On September 23, 1986, two Virgin spinedace were captured in Moody Wash at the road crossing downstream of Magotsu Creek. The species is present in Moody Wash but may be absent from Magotsu Creek.

Ash Creek

Ash Creek flows from the New Harmony Mountains past the northeast slope of the Pine Valley Mountains then south past Pintura and Toquerville to its confluence with the Virgin River at La Verkin. It is impounded by Ash Creek Dam near Interstate Highway 15. South of the reservoir it closely parallels La Verkin Creek separated by the Hurricane Cliffs by distances of 3 miles to less than 1/4 mile at its confluence with the Virgin River (Figure 5).

When Ash Creek was sampled November 11, 1986, there were no releases from Ash Creek Dam and the stream was dry at Anderson Junction. Flow was found 1/8 to 1/4 mile above the main Toquerville Spring where speckled dace and desert sucker were captured. Most of the flow into Ash Creek was from this spring which had been capped above an old diversion structure. The entire flow of Ash Creek was diverted into a second diversion structure and irrigation ditch about 1/4 mile downstream. This short stream section contained only small numbers of speckled dace and desert sucker and no Virgin spinedace. Below this section, the stream bed was dewatered past the highway bridge crossing to Toquerville and into the gorge until about 1/4 mile above a concrete structure where a spring released water into the streambed. There was major flow

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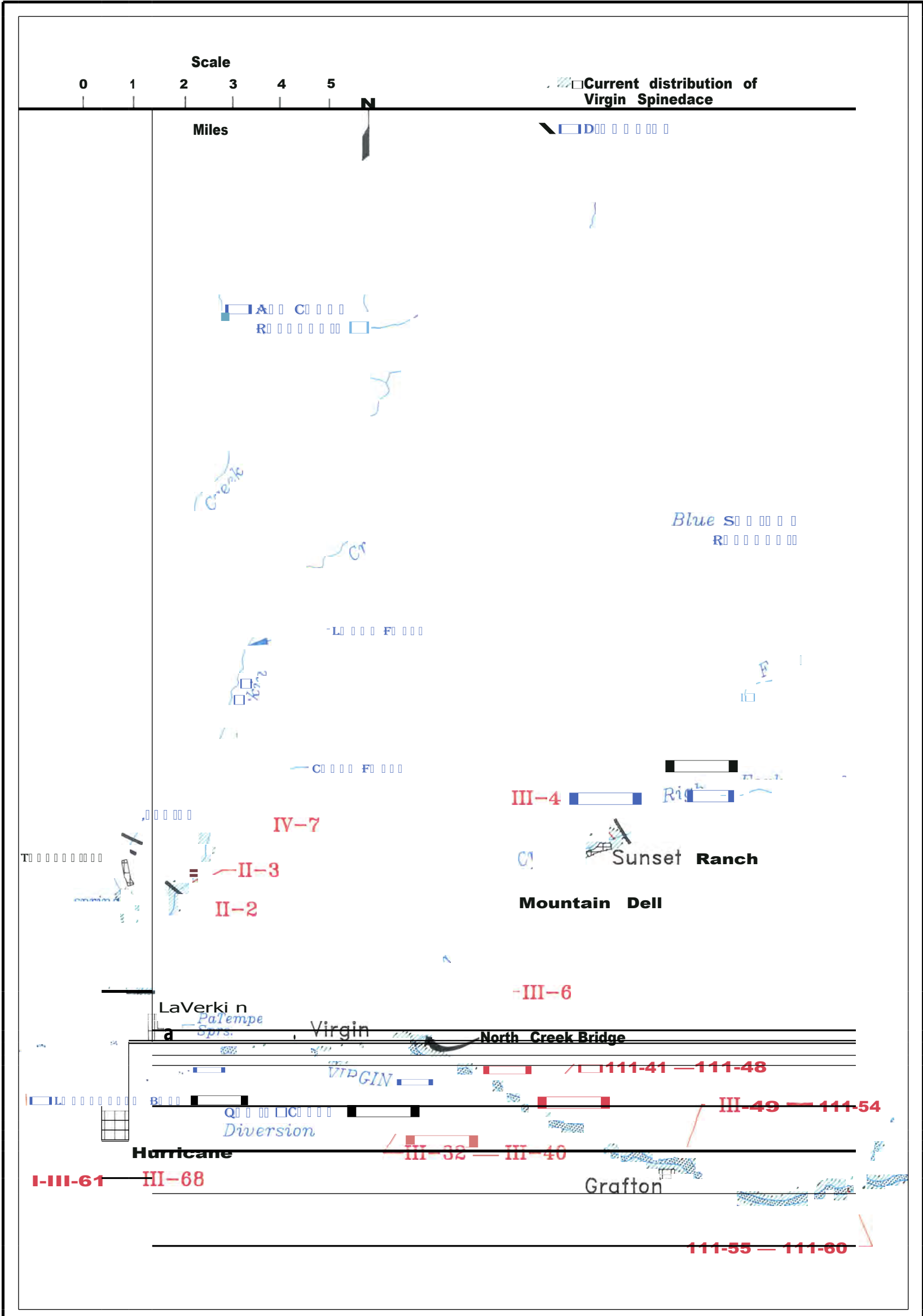


Figure 5. Ash Creek, LaVerkin Creek and North Creek. Sample stations are numbered.



from the spring and Virgin spinedace were found 50 yards below. Speckled dace and desert sucker were common from this point downstream. It was determined that Virgin spinedace occur in Ash Creek from *this* spring downstream to the Virgin River for a distance of about 3.3 miles.

The reach of Ash Creek occupied by Virgin spinedace contained some obstacles to upstream fish movement such as debris, rock ledges, and small rock dams built by locals. There was also considerable residential development along the lower reach of Ash Creek. One parcel of private property had two small ponds that may contain exotic fish species. Also, the stream channel had been impacted in some places by bulldozing. The streambed in lower Ash Creek was composed primarily of shifting sand. Further upstream in the canyon, rocky riffles were present, but the substrate continued to be dominated by sand. Overall, flow was good from the concrete structure downstream. The habitat was fair for Virgin spinedace with a combination of pools, riffles, and runs.

Three densities of Virgin spinedace were encountered in lower Ash Creek on November 11, 1986. The upper reach was a 0.6-mile reach of low density below the spring at the concrete structure which contained an estimated 78 Virgin spinedace per 200 feet of stream, or about 1,236 fish in the 0.6-mile reach (Table 4). The middle reach extending through the Gedman property contained an estimated 794 Virgin spinedace for 0.8-mile, and the lower 1.9-mile reach from Gedman's to the Virgin River contained about 17,723 Virgin spinedace.

La Verkin Creek

La Verkin Creek originates in the Cedar Mountain Region northwest of Zion National Park, flows south through the park and into the Virgin River below La Verkin. It is separated from Ash Creek by the Hurricane Cliffs by distances of 3 miles to less than 1/4 mile at the confluence with the Virgin River.

La Verkin Creek was sampled October 14 and 17, 1986, and then again June 22, 1987. Three recorded samples in October 1986 and one in June 1987 revealed that Virgin spinedace were below a steep chute falls located about 7.4 miles above the Virgin River (Figure 5). Additional qualitative sampling above the chute falls and a second larger falls further upstream failed to yield any fish, although habitat looked suitable.

Sampling in October 1986 about 350 yards above the Grant Jones property revealed Virgin spinedace restricted to quiet deep pools with little velocity although this habitat was not common. A population estimate at this location (II-3) was used to represent the 2.6 miles from the chute falls barrier to a small concrete diversion at the Jones property for an estimate of 2,334 fish. A second estimate (II-2) of 10,930 fish represented the 1.5-mile reach from the upper diversion to the Highway 17 Bridge. The reach had few deep pools and mostly riffle/run habitat. All of the Virgin spinedace captured were in deep pools. Although large specimens were not present at this site, a variety of smaller size classes were captured. A third estimate of 2,444 fish (II-1) was taken to represent the 1.5-mile reach from Highway 17 to a lower concrete diversion. Virgin spinedace in this reach were found primarily in deep pools, which were limited in number. All sizes of Virgin spinedace were observed in this station. This diversion reduced streamflow from this point to the Virgin River such that fish presence in this reach was unlikely.

In summary, La Verkin Creek appears to support moderate numbers of Virgin spinedace, but the population in the lower reaches is threatened by several irrigation diversions as well as largemouth bass from three small streamside ponds. The habitat appears good above the upper diversion and is important to the population of this tributary. There is an opportunity to expand the population of Virgin spinedace in La Verkin Creek by introducing fish above the chute fall and the large falls. Habitat in these upper reaches appears suitable but needs to be assessed.

North Creek

North Creek is **formed** by the Right Fork and Left Fork which originate from the Kolob Plateau just north of Zion National Park (Figure 5). The main branch is the Left Fork which is impounded near its source by Blue Springs Reservoir. Much of the Right Fork and Left Fork flow through the heart of Zion National Park, and their confluence is about 1 mile inside the park **boundary** north of the Sunset Ranch.

Three stations were sampled in North Creek November 12-14, 1986: at the upper end of Sunset Ranch, at the second highway bridge below Sunset Ranch, and 1.2 miles above Highway 9 (Figure 5). All three stations yielded Virgin spinedace.

The upper station near Sunset Ranch contained one good **pool** about 3 feet deep, other smaller pools, and long slow-flowing runs. Much of the substrate was cobble and rubble interspersed with large boulders. The Sunset Ranch diversion was immediately above this station, and Virgin spinedace were found at the base of the structure but not above. Limited sampling above the diversion failed to yield Virgin **spinedace** in what appeared to be good habitat. However, the gradient steepened above the diversion and it is doubtful that the species occurs in great numbers. The water at the Sunset Ranch was clear and of good quality. Population estimates at this station (III-4) yielded 98 fish per 145 feet of stream, which was expanded to 3,569 fish for the 1.0 miles from Sunset Ranch diversion to the first confluence (Table 4). Ponds at Sunset Ranch contained rainbow trout and perhaps other exotic species that could pose a threat to Virgin spinedace in North *Creek*.

The middle station below Sunset Ranch (III-5) contained a deep pool, 3.5-4.0 feet deep. The rest of the station was mainly boulders and riffles around which small pools were formed. The substrate was primarily silt/sand. North Creek in this reach was a stream of moderate gradient considered good habitat for Virgin spinedace. It contained many large boulders with occasional deep pools and a few long runs with good water quality. An old rock diversion appeared nonfunctional and a small pond probably contained exotic fish species. It was noted that there were not as many large Virgin **spinedace** in this reach as were observed in Ash Creek and La Verkin Creek. Population estimate in this middle station yielded 57 Virgin spinedace per 175 feet of stream, and was expanded to a total of 5,159 fish for the 3.0 mile reach from the confluence to Mountain Dell.

The lower station (III-6) was located 1.2 miles above Highway 9 and had good pool/run habitat with some undercut banks and grass as cover. Less flow was noted here than in the upper stations, and maximum pool depth was 2.0 to 2.5 feet. The station had sand substrate in runs and **pools**, and cobble in riffles. Population estimates in this lower station yielded 28 Virgin spinedace per 162 feet of stream which was expanded to 3,194 fish for the 3.5 miles from the lowest reach. This lower reach of North Creek is reportedly dewatered at times.

North Fork Virgin River

The North Fork of the Virgin River drains the south slope of the Markagunt Plateau south of Cedar Breaks National Monument (Figure 6). It is fed by a number of major tributaries including Deep Creek, Kolob Creek, and Orderville Canyon. Much of the middle and lower reaches-of the North Fork are in Zion National Park. The North Fork and the East Fork join south of Zion to **form** the Virgin River.

The North Fork of the Virgin River is a **difficult** stream to quantitatively sample. It is too large for small backpack electrofishing units, and is too small to navigate with a boat. Furthermore, it has a wide, open channel with many shallow cobble/boulder riffles and a few deep pools. The habitat is more conducive to suckers which represent the major biomass. The preferred manner for sampling this stream is with a bank shocking system and a crew of at least eight people.

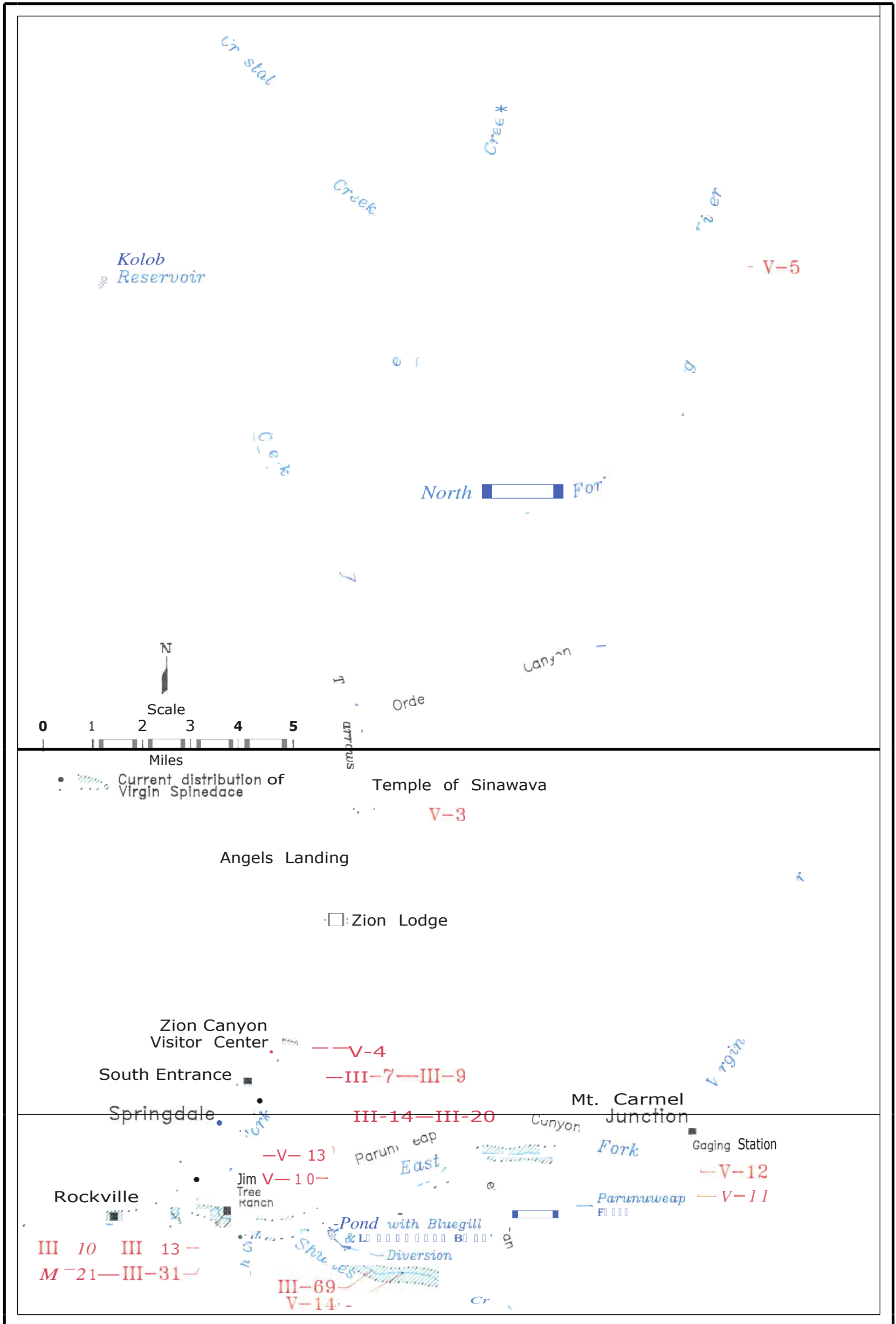


Figure 6. North Fork and East Fork of the Virgin River and their tributaries. Sample stations are numbered. Station V-8 was located on Stout Creek, east of this map area.



The North Fork was sampled November 14, 1986, and July 6-8, 1987 (stations 111-7 to 111-9). Sampling in 1986 was done by seining, and sampling in 1987 was done with a bank shocking crew of eight people. Three stations were sampled November 14, 1986: the bridge crossing at Watchman Campground, and two samples across from the campground. The first and one of the second seine hauls yielded Virgin spinedace (3 and 1/40 yds², respectively). The sample at the Watchman bridge also yielded three desert sucker and three flannelmouth sucker. High water clarity made seining conditions poor in 1986 but presented good conditions for electrofishing conditions in 1987.

Sampling in July 1987 with a bank shocker and a large crew yielded population estimates for Virgin spinedace at two locations: (1) the service road bridge downstream of the Zion National Park Visitor Center and (2) above Angel's Landing (Figure 5). The first site at the service bridge was an open rocky channel with moderate gradient and a substrate of boulder and rubble. There was less flow noted here than at Angel's Landing because of a water diversion in Zion National Park. The electrofishing effort at this site (V-4) yielded an estimate of 21 Virgin spinedace in 200 feet of stream. This estimate was expanded to a 4.5-mile reach from the Visitor Center downstream to the Virgin River and yielded 2,495 fish (Table 4).

A second electrofishing effort above Angel's Landing in similar habitat, but in greater flows, yielded an estimate of 67 Virgin spinedace per 300 feet of stream. This station (V-3) was used to represent the 8.0-mile reach from the Temple of Sinawava downstream to the Visitor Center and yielded about 9,434 fish.

Additional electrofishing efforts in the upper reaches of the North Fork above Zion National Park in July 1987 yielded no Virgin spinedace from three stations (V-7, V-6, V-5) located 27.2, 29.5, and 33.9 miles upstream of the confluence of the North and East Forks of the Virgin River (Figure 6). The only species in these samples were brook, cutthroat, and rainbow trout (Table 2).

Nevertheless, the upstream distribution of Virgin spinedace in the North Fork is unknown. Workman (1980) found Virgin spinedace in four stations of the North Fork below The Temple of Sinawava, but did not sample in The Narrows above that point. We suspect that Virgin spinedace may be found at least as far upstream as Orderville Canyon, but that hypothesis needs to be confirmed.

East Fork Virgin River

The East Fork of the Virgin River originates in the southern region of the Dixie National Forest and flows south past Glendale, Orderville, and Mt. Carmel, then west through Parunuweap Canyon to its confluence with the North Fork to form the Virgin River south of Zion National Park (Figure 6). Generally, the East Fork is considered to be better habitat for Virgin spinedace than the North Fork. Reaches of the East Fork contain excellent habitat conditions for the species.

The East Fork was sampled in a similar fashion to the North Fork as described above. Seine hauls were made at four stations on November 13, 1986: (1) at the end of the road above Jim Tree's property, (2) above the end of the road and in Zion National Park, (3) adjacent to Tree's garden plot, and (4) at the lower end of Tree's garden plot (Figure 6). A total of 4 (stations III-10 to III-13), 7 (stations III-14 to III-20), 5 (stations III-21 to III-25), and 6 (stations III-26 to III-31) seine hauls were made at each station, respectively. Virgin spinedace were found in 3 of the 4 hauls at the first station, 6 of the 7 hauls at the second, 4 of the 5 hauls at the third, and in all 6 hauls at the fourth station. The average density of Virgin spinedace for all these samples combined was 3.07 fish/10 m². This was not considered to be a reliable density estimate because the fish seined were difficult to contain in the shallow open rocky channel.

Subsequent sampling with bank electrofishing and a crew of eight was conducted at five stations July 7-9, 1987. Spinedace were found only in the lower three stations located in the same reach as the stations sampled in November 1986 and described above (Table 1). The uppermost station (V-9) was located about

1 mile above the Zion National Park boundary. The site was characterized as pool/run habitat with sand and gravel substrate and maximum pool depth was about 4 feet. A population estimate yielded 139 Virgin spinedace in 147 feet of stream. This estimate was expanded to a 6.8-mile reach from a Parunuweap Falls downstream to Shunes Creek and yielded a total of 33,950 fish.

Virgin spinedace were not found in stations (V-11 and V-12) above Parunuweap Canyon. Jim Deacon has suggested that Parunuweap Falls (about 10 miles above the North Fork confluence) acts as a physical barrier to Virgin spinedace and is probably the upstream-most distribution (Letter from Nancy J. Hoefs, December 18, 1989). Ms. Hoefs also indicated that she had observed Virgin spinedace throughout the summer of 1987 at a site approximately 1 mile upstream from Dennet Canyon or about 1.3 miles below Parunuweap Falls (Figure 6). This observation is used as to confirm that Virgin spinedace are presently found in the East Fork as far upstream as Parunuweap Falls.

Although Virgin spinedace were not found at stations V-11 and V-12 above Parunuweap Canyon and below Mt. Carmel Junction, speckled dace and mountain sucker were present The East Fork at these stations was nearly dewatered in the summer by the Mt. Carmel Junction golf course. Environmental conditions and suitable habitat for fish were extremely limited in the area of Mt. Carmel Junction. A substantial flow from springs replenished the stream between Mt. Carmel Junction and Parunuweap Canyon. These springs appear critical to maintaining flows for the species below Parunuweap Canyon.

A second station (V-13) located about 0.6 miles above the confluence of the North Fork was electrofished July 9, 1987, and yielded an estimated 136 fish per 250 feet of stream. The station had one good pool that was formed on a bend in the river along a rock wall. The substrate was rubble and sand interspersed with large boulders. The estimate from this station was expanded for a 2.4-mile reach from Shunes Creek to the Virgin River for a total of 6,894 fish.

Shunes Creek

Shunes Creek is a tributary of the East Fork Virgin River entering that system about 2.4 miles upstream from the confluence of the East and North Forks (Figure 6). It supports marginal habitat for Virgin spinedace because of low flow, and the lower 1 mile is dewatered by an irrigation diversion.

Shunes Creek flows through a corner of Zion National Park and through private property owned by Mr. Jim Tree. Just before it leaves the park and about 1 mile above its confluence with the East Fork, most of the flow is diverted by an earthen diversion into a ditch leading to a large pond used for holding and releasing irrigation flows. The pond contains bluegill and possibly largemouth bass. The earthen diversion is susceptible to being washed out by floods but it is unlikely that the bluegill and bass could make their way into *Shunes Creek*. Thus, the lower 1 mile of Shunes Creek is generally dewatered and cannot support fish.

Shunes Creek was sampled on November 14, 1986 (Station No. III-69), and on July 7, 1987 (Station No. V-14, Table 1). Flow above the diversion in November, 1986, was about 3 cfs and there were few pools and runs for habitat. Desert sucker, speckled dace, and 10 Virgin spinedace were collected about 1/4 mile above the diversion. Six large Virgin spinedace were also captured in a pool 6-20 inches deep and 3 feet in diameter, and 3 more were captured at various locations up to a major fork in the stream about 2 miles above the diversion. A 160-foot station established for a 2-catch population estimate in this upper reach yielded 30 desert sucker and 7 speckled dace, but no Virgin spinedace. This sampling indicates that Virgin spinedace in Shunes Creek occur in a 2.0-mile reach from the earthen diversion upstream to the major fork (Figure 6). This upstream distribution needs to be confirmed.

Additional sampling was conducted above the irrigation diversion on July 7, 1987. A sampling station (V-14) was located about 1 mile above the irrigation diversion, and about 2 miles above the East Fork (Figure

6). The station consisted of some of the best habitat encountered for Virgin spinedace in Shunes Creek. Although the stream was small and water temperature was 88° F at 1500 hours, the habitat was good with pools and slow runs. An estimate of 26 Virgin spinedace was computed for 84 feet of stream, which was expanded to 3,269 fish for the 2-mile reach from the irrigation diversion to the stream fork.

Quail Creek

Quail Creek is a tributary of the Virgin River approximately 5 miles downstream of La Verkin (Figure 1). Its major tributary is Leeds Creek which enters about 3 miles above the confluence with the Virgin River. Virgin spinedace were once found in Quail Creek (Cross 1975). The species was considered common to abundant in the basin in 1984, as a result of collections by Radant and Hickman. This population was extirpated by the construction of Quail Creek Dam (Figure 1) in 1985 primarily as a result of habitat inundation and predation by exotic fishes that flourished in the newly created impoundment.

Leeds Creek

The extent of historic occupation by Virgin spinedace in Leeds Creek is not documented. Rinne (1971) did not sample the Quail Creek drainage, and sampling by Cross (1975) failed to yield any spinedace from Leeds Creek. However, because it is similar to Quail Creek and shares a common basin, Leeds Creek probably supported Virgin spinedace historically for a 3-mile reach from the confluence with Quail Creek upstream to Silver Reef. An irrigation diversion at Silver Reef dewatered most of Leeds Creek prior to any fish sampling and probably led to the elimination of this population prior to the construction of Quail Creek Dam in 1985. The stream gradient above Silver Reef is probably too steep to support the species.

South Creek

South Creek enters the East Fork Virgin River near Shunesburg, about 3 miles upstream from the confluence of the East Fork and North Fork Virgin River (Figure 6). There are no records of fish sampling from this tributary prior to our efforts on November 13, 1986. Although South Creek is considered an intermittent stream, flow in mid-November was comparable to that of nearby Shunes Creek (about 3 cfs). Electrofishing yielded no fish about 1/4 mile above the confluence of the East Fork. The stream channel appeared to be scoured by periodic high flows and habitat did not appear suitable for Virgin spinedace. An inoperable irrigation diversion is located about 1/4 mile upstream from the East Fork confluence. This stream should be sampled again to confirm the absence or presence of fish.

Virgin River

The Virgin River is formed by the North Fork and East Fork which join just south of Springdale, Utah (Figure 6). The river generally flows in a southwesterly direction across the southwest corner of Utah, into the extreme northwest corner of Arizona, and then into southeastern Nevada (Figure 1). Much of the flow of the upper Virgin River is diverted at the Quail Creek Diversion about 1 mile upstream of Pa Tempe Springs. This diversion is a 7-mile long underground pipeline constructed in 1985 as the primary source of water for Quail Creek Reservoir located about 6 miles downstream on Quail Creek (Figure 1). The Virgin River is frequently dewatered by the Quail Creek Diversion for about 1 mile to Pa Tempe Springs. Pa Tempe Springs (also known as La Verkin Springs or Dixie Hot Springs) near La Verkin modifies the quality and temperature of the Virgin River near the town of La Verkin (Figures 1 and 5). These hot springs may vary in volume (Blakey and Hetzel, no date) but consistently preclude fish presence in the Virgin River downstream for about 2 miles to the confluence of La Verkin Creek and Ash Creek. Thus, a 3-mile reach of the Virgin River between the Quail Creek Diversion and the confluence of La Verkin and Ash Creeks is not inhabited by fish.

Outflow from Quail Creek Reservoir enters the Virgin River 6 miles below La Verkin. During *peak* irrigation, the Virgin River is frequently dewatered for 8 miles below the Washington Fields Diversion to just above the Washington Bridge. **Irrigation** returns resume surface flow in the Virgin River near St. George, and are augmented by Ft. Pearce Wash and the Santa Clara River. These flows maintain marginal fish habitat during dry years to about the Utah/Arizona stateline where the Virgin River periodically flows underground until it is augmented by springs and inflow from Beaver Dam Wash. During wet years, the Virgin River has continuous **surface** flows.

The Virgin River was sampled on November 14, 1986, at selected locations between the North and East Forks confluence and the gorge above the Quail Creek Diversion (Figure 5). Altogether, four sites were sampled with multiple seine hauls at each. The stations (and number of seine hauls) were located 1.1 miles (III-32 to III-40, 9 hauls), 3.8 miles (III-41 to III-48, 8 hauls), 6.6 miles (III-49 to III-54, 6 hauls), and 10.0 miles (III-55 to III-60, 6 hauls) above the North Creek Bridge.

The upper stations were generally steeper gradient with more rock and cobble and swifter flows. The middle reaches had less gradient with some channel braiding and a sand/silt substrate. As the river entered the gorge, it became steeper with more large rocks, rubble, and boulders. During the mid-November sampling, the East Fork flowed turbid while the North Fork was clear. At the first station below the **confluence**, the water was slightly turbid (visibility about 1 foot) and shallow sand bars were visible. The mainstem of the Virgin River from the East and North Forks to the gorge formed by the Hurricane Cliffs contains good habitat for Virgin spinedace. The species occurred in relatively high numbers in slackwaters and pools below riffles. The habitat in the gorge is probably too steep for the species with altered flows by the Quail Creek Diversion.

Below La Verkin and Ash Creeks, Virgin spinedace occur incidental in the mainstem Virgin River. Small concentrations of the species can sometimes be found at tributary inflows, but these fish are probably not able to sustain themselves in the mainstem independent of these tributaries. The mainstem Virgin River has a lower gradient than the tributaries and is warmer and more turbid. In addition to marginal habitat conditions, Virgin spinedace may be excluded from the mainstem by exotic species. Sampling at Twin Bridges south of St. George (Figure 4) by the **Woundfin Recovery** Team since 1978 (Radant and Coffeen 1986) has yielded Virgin spinedace on only 2 years. One fish was caught in each 1981 and 1983.

Virgin spinedace also occur at the confluence of the Virgin River and Beaver Dam Wash at **Littlefield**, Nevada (Figure 1). This small population is dependent on the clean inflow of Beaver Dam Wash which **surfaces** just upstream of the confluence. The larger numbers of spinedace which once occurred in streamside ponds of lower Beaver Dam Wash have vanished with the elimination of these ponds (Jim Deacon, Personal communication, University of Nevada, Las Vegas).

The historic and present status of the Virgin spinedace in Cottonwood Creek (Figure 1) is unknown. The species is not reported from this tributary and recent investigations *have* not sampled this stream.

SUMMARY OF VIRGIN SPINEDACE POPULATIONS IN UTAH

The following is a summary of Virgin spinedace populations in Utah, their estimated abundance, general habitat, major threats, and data gaps. Table 5 is further provided to show the status of each population, areas presently occupied, areas where the species is gone, and the total amount and percentage of occupied habitat lost. There is also a security rating that identifies the current security level of the population as footnoted in the table.

Beaver Dam Wash

Population #1: The Narrows to 1 mile above Motoqua = 7.0 miles

Total Population Estimate: 568

General Habitat: High gradient stream with boulder, cobble, gravel substrate; few pools in higher reaches becoming more numerous downstream; cover provided by pool depth, boulders, streamside vegetation, fallen trees.

Major Threats:

1. dewatering at Motoqua (water diversion)
2. mining activity throughout
3. exotic species (rainbow trout, bullfrogs, crayfish)
4. flows altered by Shroeder Reservoir
5. eroded stream banks and siltation, degraded water quality from cattle grazing

Data Gaps:

1. exact upstream distribution in The Narrows unknown
2. population estimate needed just upstream of Motoqua

Population #2: 2.0 miles above Lytle Ranch to Iverson Ranch Diversion + diversion canal = 2.5 miles

Total Population Estimate: 14,798

General Habitat: Excellent pools in upper 1 mile reach above Lytle Ranch Diversion with good water quality and abundant instream vegetation and overhanging cover, but becoming impounded by beaver just above the diversion; area below diversion is narrow swift stream with few pools but abundant instream vegetation used as cover; extensive beaver pond system at Lytle Ranch and Iverson Ranch.

Major Threats:

1. dewatering from Lytle Ranch Diversion
2. complete stream diversion into Iverson Ranch has reduced or eliminated recently-reported high densities
3. extensive beaver ponding is reducing stream habitat
4. exotic species (bullfrogs, crayfish)
5. potential invasion of largemouth bass from Nordin Ranch on East Fork
6. eroding stream banks and siltation from cattle grazing

Table 5. Status of the Virgin spinedace in the Virgin River drainage.

Tributary Stream	Historic Range		Presently Occupied Area			Total Habitat Lost	
	Description	Miles	Description	Miles	Miles	Percentage	Security Rating
Beaver Dam Wash	Surface flow from NV-UT Stateline to AZ-UT Stateline	20.0	Narrows to Motoqua Lytle Ranch to Iverson Ranch	7.0 2.5	10.5	53	3
Santa Clara River	Pine Valley to Virgin River Confi.	40.1	Baker Dam to Gunlock Res. Bloomington Golf Course to V.R.	11.8 1.0	273	68	4
Moody Wash	Racer canyon to Santa Clara River	11.8	Racer Canyon to 1.5 mi. above Magotsu Magotsu to Santa Clara River	6.0 33	2.3	20	3
Magotsu Creek	Bingham Falls to Moody Wash	2.0		0	2.0	100	5
Ash Creek	Hwy 17 Spring to Virgin River	43	Hwy 17 Spring to Virgin River	33	1.0	23	3
La Verkin Creek	Chute Falls to Virgin River	7.4	Chute Falls to Virgin River	5.6	1.8	24	3
North Creek	Sunset Ranch to Virgin River	8.1	Sunset Ranch to Virgin River	8.1	0	0	2
North Fork Virgin River	Sinawava to Virgin River	12.5	Sinawava to Virgin River	12.5	0	0	2
East Fork Virgin River	Parunuweap Falls to East Fork	9.2	Parunuweap Falls to East Fork	9.2	0	0	2
Shunes Creek	Main fork to mouth	3.0	Main fork to Diversion Dam	2.0	1.0	67	3
Quail Creek	Lower 5 miles	5.0	–	0	5.0	100	5
Leeds Creek	Silver Reef to Quail Creek	3.0	–	0	3.0	100	5
Virgin River	North/East Fork to La Verkin	17.5	North/East Fork to La Verkin	145	3.0	17	3

Table 5. Continued

Tributary Stream	Historic Range		Presently Occupied Area			Total Habitat Lost	
	Description	Miles	Description	Miles	Miles	Percentage	Security Rating
Summary		143.9		87.0	56.9	40	3.3

¹ 1 = population secure - no threats, 2 = good population but existing threats, 3 = evidence of decline, persistent threats, 4 = rapid decline, in danger of extinction, 5 = extirpated

Data Gaps:

1. assess effect of Iverson Ranch diversion on population reported by ISU
2. assess impact of beaver ponding on available habitat and population

Recent Declines:

1. area below Iverson Ranch diversion, reported abundant by ISU (1989)

Santa Clara River

Population #3: Baker Reservoir to Gunlock Reservoir = 11.8 miles

Total Population Estimate 17,230

General Habitat: Moderate gradient with boulder, cobble, gravel substrate, open channel shaded by riparian zone.

Major Threats:

1. flow alteration/depletion by Baker Reservoir releases
2. inundation of habitat by Gunlock Reservoir filling during spring runoff
3. bank erosion and siltation from cattle grazing
4. exotic species (reidside shiner, green sunfish, brown trout, crayfish)
5. degraded water quality

Data Gaps:

1. effect of flow releases from Baker Dam
2. lake levels in Gunlock Reservoir
3. abundance and effect of predators
4. extent and effect of water quality degradation

Population #4: Bloomington Golf Course to Virgin River = 1.0 miles

Total Population ~~Estimate~~: None Available, probably small numbers

General Habitat: Moderate to low gradient with sand/silt substrate, undercut banks, long shallow pools and slow runs.

Major Threats:

1. water diversions
2. degraded water quality from organic pollution and cattle grazing
3. crayfish

Data Gaps:

1. population estimate
2. effect of crayfish

Moody Wash

Population #5: Racer Canyon to 1.5 miles above Magotsu Creek = 6.0 miles

Total Population Estimate None Available

General Habitat: Steep gradient, intermittent in upper reaches with boulder, cobble, gravel, sand substrate; upper and lower extent limited by intermittent flow.

Major Threats:

1. limited natural flow and diversions
2. mining activity in tributary drainages
3. bank erosion and siltation from cattle grazing

Data Gaps:

1. determine precise upstream distribution
2. estimate population
3. assess use during high flows

Population #6: 0.5 miles above Magotsu Creek to Santa Clara River = 3.5 miles

Total Population Estimate: 10,055

General Habitat: Moderate gradient with good pool, run habitat, overhanging banks and vegetation, instream logs, boulder, cobble, sand substrate.

Major Threats:

1. dewatering from irrigation diversions
2. bank erosion and siltation from cattle grazing
3. degraded water quality from livestock yards

Data Gaps: None

Recent Declines:

Magotsu Creek. No Virgin spinedace found in January 1990 survey at three sample sites; possibly because of reduced flow from dewatering above Bingham Ranch or livestock yards; located 12-foot waterfall barrier 2 miles upstream of Moody Wash; speckled dace below barrier were few to common.

Ash Creek

Population #7: Spring below Highway 17 to Virgin River = 3.3 miles

Total Population Estimate: 19,753

General Habitat: Upstream reach a canyon habitat with rocky riffles and sand substrate, lower reach consisting of a shifting sand bottom; habitat throughout is fair pool/riffle/run providing reasonable habitat for Virgin spinedace; overall water flow is good from concrete structure down.

Major Threats:

1. considerable residential development
2. bulldozing of stream channel
3. exotic fish species and bullfrogs in **streamside ponds**
4. possible obstacles for movement during low flows

Data Gaps: None

La Verkin Creek

Population #8: Chute falls to Virgin River = 5.6 miles

Total Population Estimate: 15,708

General Habitat: Upper and middle reaches with intermittent steep falls and chutes which constitute barriers to fish movement; habitat above falls appears suitable for Virgin spinedace; occupied habitat below falls is good consisting of pools and **run/riffles**; middle reach threatened by diversions with few pools, mostly **run/riffle** habitat with spinedace mainly in pools; lower end largely diverted with no **spinedace present**.

Major Threats:

1. dewatering from several irrigation diversions in lower reach
2. natural waterfalls limit upstream distribution and movement
3. channelization and habitat alteration
4. exotic fish from streamside ponds in lower reach (i.e. largemouth bass)

Data Gaps:

1. further assess habitat, barriers, and **presence** of other fish species above chute falls for introductions to extend range of Virgin spinedace

North Creek

Population #9: Sunset Ranch to Virgin River = 8.1 miles

Total Population Estimate: 18,719

General Habitat: Upper reach with good pool habitat and long slow-flowing runs, substrate of cobble, rubble interspersed with large boulders; middle station contains deep (3.5-4.0') pools with small pools around large boulders and a substrate of silt/sand; lower reach with good pool/run habitat with some undercut banks and grass as cover but dewatered at times.

Major Threats:

1. irrigation diversions/dewatering in lower reaches
2. exotic fishes in streamside ponds
3. construction of North Creek Reservoir

Data Gaps:

1. confirm upstream distribution above Sunset Ranch

North Fork Virgin River

Population #10: Temple of Sinawava to Virgin River = 12.5 miles

Total Population Estimate: 11,929

General Habitat: stream throughout wide and open with moderate gradient and a substrate of boulders, rubble, and sand; flow is depleted by water diversion in Zion National Park.

Major Threats:

1. impoundments in upper reaches, above Zion National Park
2. reduced water quality from cattle grazing far upstream
3. water diversion in Zion National Park
4. upstream water development

Data Gaps:

1. determine upstream distribution is Orderville Canyon

East Fork Virgin River

Population #11: Parunuweap Canyon fall to North Fork Virgin River = 9.2 miles

Total Population Estimate: 42,398

General Habitat: upper reach below Parunuweap Canyon characterized as pool/run habitat with sand and gravel substrate and maximum pool depth of 4 feet; area below similar with good pool habitat, rubble and sand substrate interspersed with large boulders.

Major Threats:

1. continued stream flow reduction from Mt. Carmel Golf Course diversion
2. degraded water quality from cattle grazing in upstream reaches
3. exotic fishes in streamside ponds
4. upstream water development

Data Gaps:

1. confirm Virgin spinedace to base of Parunuweap Falls

Shunes Creek

Population #12: Main fork to Diversion Dam = 2.0

Total Population Estimate: 3,269

General Habitat: largely dewatered by irrigation diversion 0.9 miles upstream, habitat below diversion poor; better above diversion because of better flow; few small and medium pools with Virgin spinedace and some overhanging cover from streamside vegetation and large boulders.

Major Threats:

1. dewatering from irrigation diversion
2. degraded water quality from livestock grazing

Data Gaps:

1. confirm upstream distribution

Virgin River

Population #13: Confluence of North and East Forks to Quail Creek Diversion = 15.5 miles

Total Population Estimate: None available

General Habitat: large riverine habitat with pools at base of riffles, generally open channel with some braiding; upper reaches with steep gradient, swift flow, and rock and cobble substrate; middle reach more gentle with some channel braiding and a sand/silt substrate; lower reach much steeper as river enters gorge with large rocks, rubble and boulders.

Major Threats:

1. degraded water quality and siltation from livestock grazing and feed lots

Data Gaps:

1. estimate numbers of Virgin spinedace

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