Ecological Evaluation of Selected Aquatic Ecosystems in the Biological Resources Study Area for the Southern Nevada Water Authority's Proposed Clark, Lincoln, and White Pine Counties Groundwater Development Project

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LIST OF ACRONYMS COMMONLY USED IN THIS DOCUMENT

BLM	U.S. Department of the Interior, Bureau of Land Management
BRSA	Biological Resources Study Area
ESA	Endangered Species Act
DRI	Desert Research Institute
EAV	emergent aquatic vegetation
EPT	Ephemeroptera, Plecoptera, Trichoptera
GWD Project	SNWA-proposed Clark, Linclon, and White Pine Counties Groundwater Development Project
HV	herbaceous vegetation
NDOW	Nevada Department of Wildlife
NWR	National Wildlife Refuge
SAV	submerged aquatic vegetation
SNWA	Southern Nevada Water Authority
UDWR	Utah Division of Wildlife Resources
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey

EXECUTIVE SUMMARY

The Southern Nevada Water Authority (SNWA) has proposed to construct and operate the Clark, Lincoln, and White Pine Counties Groundwater Development (GWD) Project. The majority of the proposed GWD Project Area falls within the Great Basin and is underlain by a large, carbonate aquifer system containing many complex flow paths. Water from this aquifer, as well as local groundwater runoff from the mountains surrounding the valleys, feeds local and regional aquatic systems. The aquatic systems in the Great Basin are largely isolated, giving rise to a number of unique and endemic species. Seven Federally threatened or endangered species, two Conservation Agreement species, and a host of Federal species of concern and State sensitive species are known to inhabit the aquatic systems in and adjacent to the GWD Project Area. Therefore, to obtain baseline information on the aquatic communities in and around the proposed GWD Project Area, the SNWA contracted BIO-WEST, Inc. (BIO-WEST) to conduct ecological evaluations of aquatic systems in 11 valleys of east-central Nevada and west-central Utah (Biological Resources Study Area [BRSA]).

The SNWA and BIO-WEST used a variety of criteria to select 101 aquatic systems of interest throughout the BRSA. Concurrently, we began a literature review and agency contact period to gather information about the aquatic systems of interest. We performed a reconnaissance trip to 40 aquatic systems in and adjacent to the BRSA and examined existing sampling methodologies, in order to develop a survey protocol for the aquatic systems of interest in the BRSA. We presented these protocols to a Technical Workgroup comprised of a variety of biologists and researchers from State and Federal resource agencies, as well as academia. Our goal from that meeting was to use lower-intensity surveys to inventory the aquatic communities at as many systems as possible throughout the BRSA.

Location, water quality, and physical habitat data were collected at 105 locations within the aquatic systems of interest in the BRSA. In addition, the aquatic and riparian vegetation, fish, amphibian, and macroinvertebrate communities were qualitatively inventoried at 92 locations in the BRSA. Disturbance evaluations were completed at these same 92 locations, noting the factors causing disturbance and possible restoration options.

We found that the aquatic systems of interest varied widely in their size, configuration, water quality, and habitat quality. Most survey sites were highly to moderately disturbed, with livestock-related damage, diversion, and nonnative species being the most common disturbance factors. Protection, restoration, and reintroduction/translocation alternatives are discussed, based on the disturbance level and species present at the aquatic systems of interest. We found Federal status or State sensitive species at aquatic systems in Tule Valley, Fish Springs Valley, Snake Valley, Spring Valley, Lake Valley, White River Valley, Cave Valley, Dry Lake Valley, and Pahranagat Valley. Our surveys expanded the range of the Toquerville springsnail (*Pyrgulopsis kolobensis*), the White River Valley springsnail (*Pyrgulopsis sathos*), and the Utah chub (*Gila atraria*). We may also have discovered a new species of springsnail in Tule Valley and a new amphipod species in the Pahranagat, Snake, and White River Valleys. Fish surveys in Pahranagat Valley uncovered a population of the Pahranagat speckled dace that was thought to have been extirpated by the late 1990s.

In gathering information and conducting our surveys, we identified several limitations in our survey protocol, many of which were related to the inadequacy of one-time survey efforts. Despite these limitations, the 2004-2006 field efforts, combined with information gathering (from resource agencies, academia, and other scientists), provided a baseline inventory of the aquatic communities present in various aquatic systems throughout the BRSA, thereby accomplishing our goal. More intensive baseline data collection at a subset of aquatic systems would provide a more accurate assessment of baseline conditions throughout the BRSA. Hence, we have provided recommendations for proceeding with more intensive baseline characterizations.

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INTRODUCTION

The Southern Nevada Water Authority (SNWA) has proposed to construct and operate the Clark, Lincoln, and White Pine Counties Groundwater Development (GWD) Project. The proposed GWD Project anticipates developing and conveying approximately 200,000 acre feet per year of groundwater from seven hydrographic basins in northern Clark, central Lincoln, and eastern White Pine Counties. The water would be used to serve customers of the Lincoln County Water District (LCWD) in Coyote Spring Valley and SNWA purveyor members in Las Vegas Valley. The proposed GWD Project would develop groundwater from Coyote Spring, Delamar, Dry Lake, Cave, Lake, Spring, and Snake Valleys.

The majority of the proposed GWD Project Area falls within the Great Basin and is underlain by a large, carbonate aquifer system containing many complex flow paths. Water from this aquifer, as well as local groundwater runoff from the mountains surrounding the valleys, feeds local and regional aquatic systems. The Great Basin is the driest physiographic province in North America. As such, spring systems provide the majority of reliable water sources in the region, making them “biodiversity hotspots” that are critical to the persistence of many plant and animal species found in this region (Hershler 1998, Sada and Vinyard 2002, Sada 2003). Furthermore, the Great Basin’s hydrologic history has left many of these spring systems fragmented and isolated from each other, giving rise to a host of unique and endemic aquatic organisms. Sada and Vinyard (2002) found that 118 species and 45 subspecies of aquatic organisms were endemic to the Great Basin. They also found that these isolated populations are particularly susceptible to disturbance and that the majority of these unique organisms have undergone declines in distribution or abundance in the last 140 years. During that time period, 16 Great Basin taxa have become extinct (Sada and Vinyard 2002).

Currently, several Federally listed threatened and endangered species can be found within or near the proposed GWD Project Area, including Big Spring spinedace (*Lepidomeda mollispinis pratensis*), Hiko White River springfish (*Crenichthys baileyi grandis*), Pahrump poolfish (*Empetrichthys latos latos*), Pahranagat roundtail chub (*Gila robusta jordani*), White River spinedace (*Lepidomeda albivallis*), White River springfish (*Crenichthys baileyi baileyi*), and Ute ladies’-tresses (*Spiranthes diluvialis*). The Conservation Agreement species Columbia spotted frog (*Rana luteiventris*) and least chub (*Iotichthys phlegethontis*) are also found in the proposed GWD Project Area. Additionally, a host of Federally listed species of concern and Nevada- and Utah-State listed rare and sensitive species, including fishes, amphibians, springsnails (Mollusca:Hydrobiidae), and other invertebrates, are found in and near the proposed GWD Project Area. The number of rare and endemic species found throughout the Great Basin is a function of how unique and isolated aquatic systems are in that environment.

Springs and other aquatic systems in the proposed GWD Project Area are fragile and valuable natural resources that allow for the persistence of a wide variety of sensitive and endemic aquatic organisms. Early biological surveys of this area centered on the fishes of these systems (Hubbs 1932, Miller 1943, Hubbs and Miller 1948, Miller 1948), and only recently have more detailed studies of other fauna been undertaken (Hershler 1998, Sada and Vineyard 2002, Sada 2005a). Aquatic systems without State- or Federal-status species remain undersampled and, in some cases, unsampled. Therefore, to obtain baseline information on the aquatic communities of aquatic systems in and around the proposed GWD Project Area, the SNWA contracted BIO-WEST, Inc. (BIO-WEST) to conduct ecological evaluations of aquatic systems in 11 valleys of east-central Nevada and west-central Utah. While these aquatic systems are important to the overall ecological function of each valley, our survey focused on aquatic systems (springs, ponds, streams, and wetlands) and the aquatic organisms that inhabit them. Concurrent projects by the SNWA and other contractors will examine other plant and animal communities in the Biological Resources Study Area (BRSA). The goal of our ecological evaluations was to provide an inventory of the aquatic communities inhabiting springs and other aquatic habitats that may be impacted by the proposed GWD Project.

STUDY AREA AND SITE SELECTION

The BRSA is comprised of 11 valleys in east-central Nevada and Utah's West Desert (Figure 1). Valleys that have active SNWA groundwater applications were automatically selected for inclusion in the BRSA. We also included valleys that are adjacent to valleys with active SNWA groundwater applications and are down gradient in the aquifer flow path (Eakin 1966, Harrill and Prudic 1998). An exception to this rationale was the White River Valley, which was included because it is adjacent to valleys that have active SNWA groundwater applications and it has a large number of sensitive aquatic species.

Initially, SNWA selected most of the aquatic systems of interest, obtaining some input and advice from BIO-WEST. However, as the project progressed, we worked together using literature and recommendations from resource agency personnel about additional important locations that should be added to the baseline survey list. We tried to include all large, regional spring complexes that are probably fed by deep groundwater in each valley. Additionally, we included many alluvial groundwater aquatic systems in each valley. We tried to exclude aquatic systems located off the valley floors in the mountain blocks. However, when in doubt, systems in question were either visited during a reconnaissance trip (and included or excluded from further surveys) or visited during the survey period. Springs visited during the survey period that were then determined to be in the mountain block were surveyed at the lowest-intensity level.

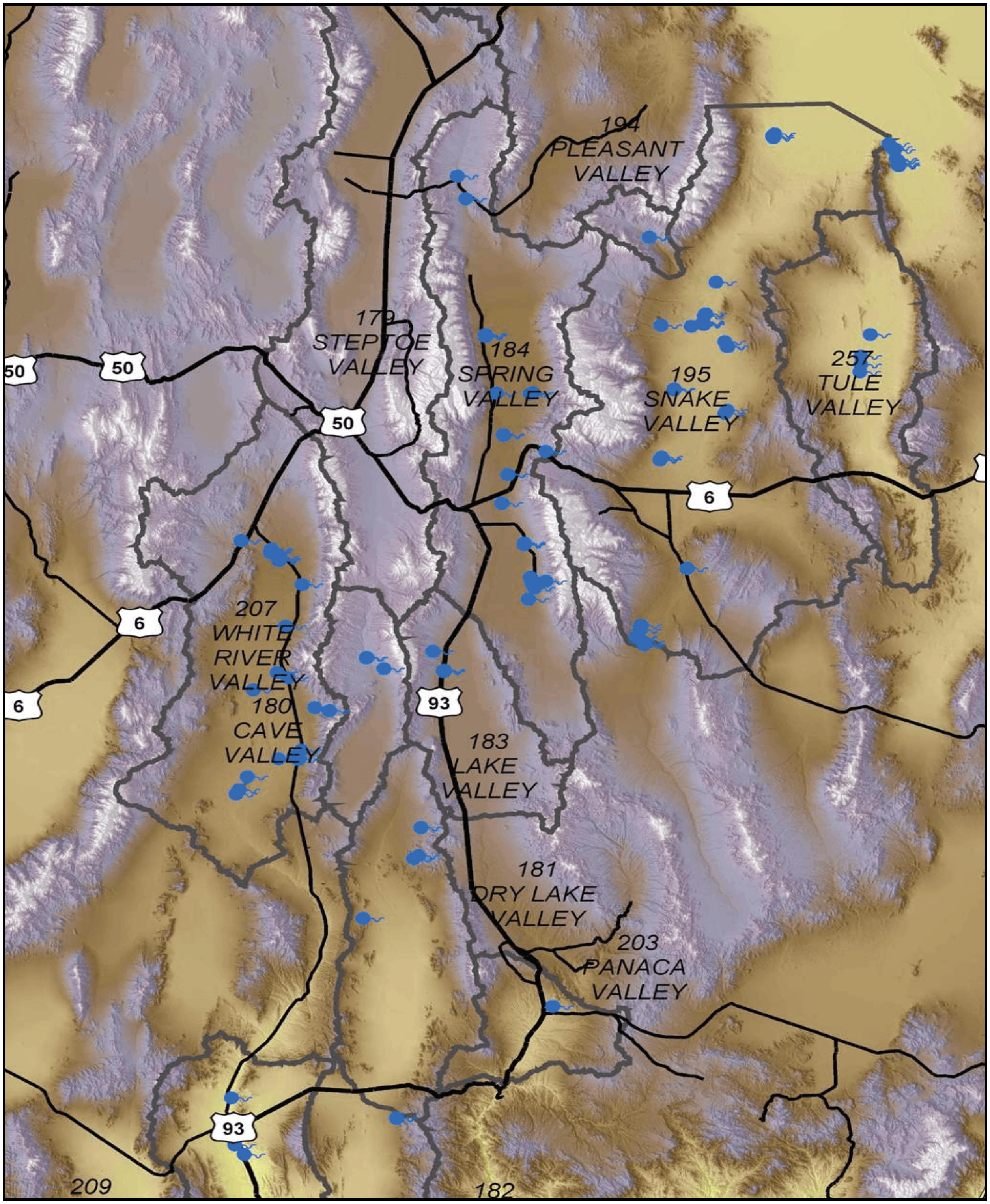

Figure 1. Biological Resources Study Area (BSRA).

METHODS

General Development and Rationale

After the initial sites were selected, we began a literature review and agency contact period to gather as much information as possible on the aquatic systems of interest to the project. We gathered peer-reviewed literature, agency reports, and other grey literature pertaining to these aquatic systems and the organisms that inhabit them. We also consulted with resource agency technical personnel who are or were directly involved with ongoing or past studies of some of the aquatic systems of interest.

Concurrent with the data gathering period, we performed a reconnaissance trip from June 28, 2004, to July 2, 2004, during which we visited more than 40 aquatic systems in and adjacent to the BRSA. The reconnaissance trip provided us with an indication of the diversity of springs in and around the BRSA, which assisted with planning our sampling strategy.

In addition to reviewing available literature and performing the reconnaissance trip, we consulted several existing templates for sampling desert springs and wetlands. We used the Desert Research Institute's Springs Database (Sada 2005a); the U.S. Bureau of Land Management's *Guide to Managing, Restoring, and Conserving Springs in the Western United States* (Sada et al. 2001); the *Draft Clark County Conservation Management Plan for Springs in Clark County, Nevada* (Sada 2003); and conversations with Dr. Don Sada to guide us in developing our survey protocols (D.W. Sada 2004, pers. comm.).

After outlining a general rationale and methods, we convened a meeting with a Technical Advisory Team in August 2004. The Technical Advisory Team consisted of biologists and researchers from State and Federal resource agencies and academia (Table 1). We provided the Technical Advisory Team with a three-tiered survey approach, similar to that described in Sada (2003), that uses surveys with increasing levels of intensity, from Level 1 to Level 3. We outlined the methods that would be used at each survey level and provided a matrix-style ranking system that would help determine the survey level at each aquatic system of interest. We gave the group an opportunity to comment on our proposed survey methods and assist us with further developing the matrix ranking system. However, we could not come to a consensus on which factors needed to be represented in the ranking system. Instead, the Technical Advisory Team proposed surveying more springs at a lower intensity level rather than using a ranking system that pinpoints springs for more intensive sampling. They did agree, however, to the proposed methods for Level 1 and Level 2 surveys, which we developed based on existing templates and conversations with other researchers.

Table 1. Technical Advisory Group meeting attendees that discussed methods development for the ecological evaluations.

AGENCIES AND GROUPS
BIO-WEST, Inc.
Desert Research Institute
Nevada Department of Wildlife
Southern Nevada Water Authority
University of Nevada Las Vegas
University of Nevada Reno, Biological Resources Research Center
U.S. Bureau of Land Management
U.S. Fish and Wildlife Service
U.S. Geological Survey, Biological Resources Division
U.S. National Park Service

The methods for Level 1 surveys were modeled after Sada (2003) (Table 2). Level 1 surveys were completed at aquatic systems suspected to be in the mountain block or otherwise thought to be less important. We also made notes on access, map locations, and the dates, times, and survey crews. More detailed methods for collection of these data are provided in the water quality/physical habitat and vegetation sections below.

The methods for Level 2 Surveys were also modeled after Sada (2003). These surveys included all Level 1 activities unless replaced by more detailed sampling (Table 3). The goal for Level 2 Surveys was to characterize existing biological conditions at the aquatic systems of interest. Detailed methods for collection of these data are provided in the sections that follow.

Water Quality/Physical Habitat

We used several methods to characterize the physical attributes of each aquatic system during Level 1 and Level 2 surveys. We noted the type of system such as streams, ponds, or springs. Springs were further defined as a “rheocrene” (spring that discharges into a defined channel), “limnocrene” (spring that discharges into an open pool before a defined channel), “helocrene” (spring without an open pool and comparatively shallow), “dry,” or “unknown spring” (Sada

Table 2. Components of Level 1 surveys.

COMPONENT	LEVEL	OVERALL METHODS
Aquatic Life	qualitative	visual estimate
Emergent Aquatic Vegetation	qualitative	species composition and percent cover
Literature Review	comprehensive	N/A
Location Information	N/A	GPS unit
Photographs	fixed-station	digital camera
Physical Parameters	qualitative	measurements and visual estimates
Submerged Aquatic Vegetation	qualitative	species composition/percent cover
Water Quality	quantitative	Hydrolab

Table 3. Additional components of Level 2 surveys.

COMPONENT	LEVEL	OVERALL METHODS
Amphibians	qualitative	visual encounter survey
Aquatic Invertebrates	qualitative	dip net and d-frame kick net
Fishes	qualitative	seines, minnow traps, dip nets, snorkeling, electrofishing
Springsnails	qualitative	modified dip net

2003). We also noted the maximum depth, maximum wetted width, riparian width and length, and spring brook length. Since the goal of the overall study was to collect biological information at as many aquatic systems of interest as possible within the BRSA, we limited the area sampled at some of the aquatic systems that had large areas of marsh and/or long streams exiting from spring heads and spring brooks. For the purposes of this investigation, we limited surveys to areas near the source of the aquatic system of interest. When systems were extensive, we surveyed the first 200 meters (m) downstream from the source or to a logical point (e.g., diversion, marsh interface, confluence with another spring brook or waterway).

We used a Quanta probe (Hydrolab) to collect physical water quality parameters at the source, terminus, and any other unique areas at each aquatic system of interest. Parameters measured included: temperature in degrees Celsius, dissolved oxygen in milligrams per liter (mg/l), conductivity in microSeimens per centimeter (µS/cm), and pH. If the spring head was piped, we estimated discharge by measuring the length of time it took to fill a container of a known volume, which we converted into liters per second (l/s). When the systems had defined channels, we calculated discharge by measuring the length, depth, and velocity across a cross section of the brook/stream using a Marsh McBirney Flo-Mate Model 2000 velocity meter. We converted the discharge measurement from cubic meters per second (m^3/s) to l/s in order to be consistent with the other discharge measurements.

We used a Garmin GPSmap 60cs hand-held GPS unit to collect UTM coordinates and elevation at the following points within each system: spring head(s) or origin of survey site, terminus(es) or termination of survey site, 5-10 points along the perimeter of the system, and any other unique features. We used a digital camera to document all aspects of each system.

Vegetation Surveys

During Level 1 and 2 surveys, we inspected the riparian and aquatic vegetation communities associated with the aquatic systems of interest and continuing a short length downstream. We identified the dominant vegetation in the open water areas of each system, as well as the wetted soil areas surrounding each system. We used several guides and reference books to assist with plant identification (Correll and Correll 1975, Eggers and Reed 1987, Welsh et al. 1987, Whitson et al. 1999). When plant structures required for identification were missing or indistinguishable, we used our best professional judgment to field identify the plant, and/or we collected and pressed a specimen to be identified at the Utah State University Intermountain Herbarium in Logan, Utah (Appendix A). After obtaining a positive identification, we revised our field identification, if necessary. We placed a representative sample, identified by the Utah State University Intermountain Herbarium, into BIO-WEST's company plant collection. Species and species groups that were difficult to identify are described in the Problematic Plant Species section.

The species list generated from this survey effort is not all-inclusive, but it does represent the aquatic and hydrologically influenced vegetation that was present at the springs during our survey efforts. To accurately gather a complete species list for an area, at least three field visits would be necessary: one in the spring, one in mid-summer, and one in late summer or early fall. This would allow for plants to be seen in their proper phenological stage for observation and identification. Subsequent visits in succeeding years to a site could also be necessary to observe plants that do not come up every year.

Vegetation Mapping

After many of the surveys were completed, SNWA contracted BIO-WEST to complete a more intensive survey of vegetation at the aquatic systems of interest, which included mapping vegetation and developing community classifications in the form of associations and alliances. The results of this vegetation mapping effort are a more accurate source of information about the vegetation communities found at the aquatic systems of interest. Field data for the vegetation mapping effort was gathered between September 12, 2005, and October 22, 2005. Aerial images (low-level multi-spectral imagery, or digital orthoquad aerial photographs) were used for mapping plant community boundaries. Some images were processed in the office with tentative boundaries, as well as numbered polygons, but most of the imagery was simply mapped in the field. Boundaries were drawn on aerial images, and polygon numbers were assigned. Boundaries were placed where obvious demarcations between communities were found.

Vegetation data was collected for each polygon by recording the estimate of the aerial cover of any species with greater than 20% cover. Plant species with less than 20% cover were recorded where total vegetative cover was low, or where the diversity of species present made it unlikely that any one species would have aerial cover above 20%. Species that comprised a lower proportion of aerial cover were also recorded when the presence of that particular species might indicate unique ecological conditions (e.g., upland species occurring within wetlands, or obligate wetland species occurring in a mix of more facultative wetland plants). Any species that were unusual for the area, or possibly rare, were also recorded.

Plant Taxonomy

Plant taxonomy for the project was somewhat problematic. Descriptions for the flora of the region are either out of date or not comprehensive. For identification in the field, the *Utah Flora* (Welsh 1997), *Field Guide to Intermountain Rushes* (Hurd et al. 1997), *Field Guide to Intermountain Sedges* (Hurd et al. 1998), and the *Intermountain Flora* (for monocots) (Cronquist et al. 1993) were used in all portions of the Project Area. In the southern portions, the Jepson Manual, *Higher Plants of California* (Hickman 1993), was also used. Many specimens were collected and were taken to the Intermountain Herbarium at Utah State University for further validation of species. Here, further references were consulted, including other volumes of the *Intermountain Flora* (Cronquist et al. 1972-1997), the *Flora of North America* (Flora of North America Editorial Committee 1993) and the *Manual of the Grasses of North America*, which is in large part included in the *Flora of North America*, but also includes maps and additional information (Barkworth et al. 2006). Scientific plant names were then cross referenced with the USDA/NRCS Plants Database (http://plants.usda.gov/) so that nomenclature was consistent.

Field Identification

Species were identified in the field where possible. Many common species are very easy to identify vegetatively and were therefore identified with a high degree of confidence. Other species, however, required that reproductive parts, roots, or other more discreet plant characteristics be examined. Whenever possible, complete specimens were used for identification. Completing fieldwork in the late summer and autumn was ideal because many plants are fully mature and exhibit flowering and fruiting parts. Once identified in the field, vegetative characteristics were used to distinguish species when collecting cover data. Some species still remained difficult to identify in the field. Plants that flower in spring or early summer that had no identifiable parts left for examination in the later months were difficult to identify. Usually, these species were rather low in number, and even lower in aerial cover, so they were not expected to alter the plant community type classification for the project. Other species, in contrast, remain difficult to field identify, no matter what their phenologic stage, such as the graminoid or grass-like group of monocot plants. Species that were difficult to identify are discussed in the Problematic Plant Species section.

Plant Community Classification

Each of the polygons mapped on the project were classified as either a plant community or other cover type. The plant community classification follows that of the National Vegetation Classification for Nevada (NVNHP 2003), which is based on the National Vegetation Classification Standard and the Standardized National Vegetation Classification System (SNVCS) (USDI 1994). Two levels of community classification are used for this project, the alliance and the association. "The alliance is a physiognomically uniform group of plant associations sharing one or more diagnostic species (dominant, differential, indicator, or character), which, as a rule, are found in the uppermost strata of the vegetation" (USDI 1994). The association level is more specific and is usually found as a repeating landscape pattern within areas of an alliance. The SNVCS description of this level of classification is rather obtuse, but also is tolerant and inclusive in its use. To summarize SNVCS: The association is a finer stratification of the plant community based on more detailed vegetative data. More information on plants in the different strata such as the canopy, ground cover, or shrub layers of a forest for instance may separate various associations within an alliance. Environmental information may also be used to separate associations, especially in wetlands. These could include substrate or soil types, length of inundation, salinity, and alkalinity.

The naming of alliances and associations are similar. Alliances, however, are most often named for the dominant or set (usually two) of codomninant species. The species are then combined with environmental descriptors and the physiognomic or plant structural type. Examples include:

1. *Allenrolfea Occidentalis* Shrubland Alliance

2. *Typha* (*Angustifolia, Latifolia*) - (*Schoenoplectus* spp.) Semipermanently Flooded Herbaceous Alliance

3. *Elaeagnus Angustifolia* Semi-natural Woodland Alliance

Associations are often named for the dominant canopy or the tallest species and the dominant species in the ground layer or shrub layer. In many single-layer communities only a single species is used in the name, or as with alliances, codominant species are used in the name. As with alliances, environmental features are sometimes used in the name of associations where these provide information that the dominant species alone would not. The physigonomic type is also usually used in the name of associations. Examples include:

- *Carex Aquatilis* Herbaceous Vegetation Association
- *Carex Nebrascensis* - *Carex Microptera* Herbaceous Vegetation Association
- *Populus Balsamifera* ssp. *Trichocarpa* / Mixed Herbs Forest Association

Some associations used on the project were not listed in the National Vegetation Classification for Nevada but were found on the SNVCS. In addition, several associations were created where no suitable type existed in SNVCS. No additional alliances, however, were created because this would require more data than was collected for this project. Some of the created associations were fit into existing alliances where obvious choices existed. However, some created associations had no apparent matching alliance, and these were designated the “Undesignated Alliance.”

Because there is no key for the associations or alliances for Nevada, assignment of polygons to them was done mostly based on examining the data and deciding on a case-by-case basis. There are descriptions of many of the associations, so these were used to help classify the polygons. Where no description existed, classification was based simply on the dominant species in the polygon and matching these to a named association.

For the newly created associations, names were created based on the dominant and codominant species recorded in the data. These are considered tentative associations because much more data, collected in a more scientifically formal and randomized manner, would be required to determine if these associations are consistent entities in the region.

For some polygons, it was necessary to forgo the classification scheme and use other cover types. These miscellaneous cover types include some types that are vegetated and some that are sparsely vegetated or completely lack vegetation. Three vegetated types were used for areas where no clear dominant species were discernable. These were “non-rooted aquatic plant and algae vegetation,” “mixed wetland forb herbaceous vegetation,” and “mixed wetland graminoid herbaceous vegetation.” Polygons designated as such were often quite heterogeneous, but on a scale that was too fine for mapping on the project. The “non-rooted aquatic plant and algae vegetation” was also classified outside of the system because these vegetation communities are ephemeral.

Lastly, two cover types were designated for areas with no plant community. These are “open water” and “sparsely vegetated.” Ponds and creeks with no emergent vegetation were classified as open water. Sparsely vegetated areas are those with less than 10% total vegetal cover. Most sparsely vegetated areas in the vicinity of the Project Area were simply not mapped; however, those that were surrounded by wetland vegetation and showed environmental features that suggested a potential for developing wetland vegetation were classified as sparsely vegetated.

Limitations

Because plant surveys and subsequent identification were based on one field visit during the season, the complete suite of plants present was not observed (NVNHP 2005). As outlined in the vegetation survey methods, to most accurately gather a complete species list for an area at least three field visits would be necessary. Subsequent visits in succeeding years to a site would also be necessary to observe plants that do not come up every year.

Problematic Plant Species

In addition to the limitations imposed by a single field visit, we also found the field identification of certain species and species groups to be problematic during both the vegetation surveys and vegetation mapping. Identification problems usually resulted from certain structures critical to identification (e.g., flowers, seeds) not being present at the time of the survey or mapping effort. Some plants are easy to identify throughout the growing season such as the cattail genus (*Typha* spp.) (although microscopic examination is needed to separate species) or hardstem bulrush (*Schoenoplectus acutus*) (Cronquist et al. 1972-1997). Others, however, are only reliably identifiable when all reproductive parts are developed such as most pondweed species (*Potamogeton* spp.) and sedge species (*Carex* spp.). Without these structures we found that several plant species present in the aquatic systems of interest were difficult to distinguish from one another.

Other plants are not even visible except during certain portions of the growing season. Some of these plants come up and flower early in the spring and die back later in the summer. Many species in the carrot (Apiaceae) and mustard (Brassicaceae) families show this trait. Others, such as the Federally threatened Ute ladies’-tresses (*Spiranthes diluvialis*) are only reliably surveyed in the late summer. Ute ladies’-tresses is also a rare example of a perennial species that is not even visible every year. It may go dormant for years, until conditions are favorable and reproductive parts are then produced. Many annual plants fit into this category also, as witnessed in the desert in spring 2005 when many annual plants were observed throughout the Southwest.

Other species were difficult to identify because they had different morphological vegetative adaptations when they were under and above the water surface. Additionally, these species have vegetative characteristics that are similar to other species, depending on whether they are growing above or below the water surface. At some systems we had difficulty distinguishing between the following plant species: watercress (*Rorippa nasturtium-aquaticum*), Brewer's bittercress (*Cardamine breweri*), Monkey flower, (*Mimulus guttatus*), poison hemlock (*Conium maculatum*), and water parsnip (*Berula bess*). Therefore, for the purposes of this investigation, the five species listed above should be termed the "watercress group." We feel that these five species are similar ecologically, in terms of the habitat they provide for other organisms. In the vegetation survey results, we present the species we identified in the field; however, in most cases it is possible that the community was not comprised entirely of that species, but of one or more other species in the watercress group.

Leafy pondweed (*Potamogeton foliosus*) and sago pondweed (*Potamogeton pectinatus*) also have very similar vegetative characteristics and are only easily identifiable in the field by differences in the seeds (which were not available during most of our surveys). The initial pondweed samples we provided to the Utah State University Intermountain Herbarium were identified as leafy pondweed. After obtaining this confirmation, we identified similar pondweeds as leafy pondweed during subsequent surveys. The Utah State University Intermountain Herbarium identified some additional pondweed specimens collected during these subsequent surveys as sago pondweed. Since we did not take pondweed samples for verification from every system, it is possible that some plants we identified as leafy pondweed may be sago pondweed. As with the watercress group, the pondweeds are similar ecologically, in terms of the habitat they provide. Therefore, we called these two pondweed species "pondweed" (*Potomogeton foliosus/ pectinatus*).

Two of the more common species found on the project were taxonomically problematic. Recent taxonomic revisions changed redtop, or creeping bentgrass, from *Agrostis stolonifera* to *Agrostis gigantea* in most areas of the western United States (Harvey 2005). Therefore, almost all of the redtop plants found on the project areas were reclassified as *Agrostis gigantea*. The common cattail (*Typha* spp.) has also undergone recent taxonomic revisions. Three species of cattail are found in the intermountain west; however, only two are likely to occur on the Project Area: broadleaf cattail (*Typha latifolia*) and southern cattail (*Typha domingensis*). Identifying these species is much more difficult than had been previously thought, resulting in most plant identification keys being outdated and inadequate. This is especially true when identifying cattail species in the field. Hybridization and wide phenotypic variation mean that microscopic characteristics are necessary to separate the species (Flora of North America 2005), making reliable field identification impossible. For this reason, and because little ecological differences are noticed between cattail species, we recorded all cattails as broadleaf cattail.

The spikerushes (*Eleocharis* spp.) are difficult to identify in the field at any time of year. They do not always produce reproductive structures, grow together in similar habitats, and descriptions of the species in the various older identification manuals are often incomplete or contradictory. Two species that occur on the project, *Eleocharis palustris* and *Eleocharis quinquefolia* were found to be particularly difficult to identify in the field. *E. palustris* can be found in a wide range of habitats, and has fairly wide phenotypic variability. It is the most likely candidate for any spikerush that one encounters in wetlands in the Project Area. However, *E. quinquefolia* is also found in many areas, and indeed may be more common than was first thought. It is more likely to occur on boggy mats, but was also identified positively in streamside riparian situations, albeit in peaty and muck substrates. Vegetatively, the two species are very similar, and even though Cronquist et al. (1972-1995) describe differences, we found the two species very difficult to distinguish. Only a small percentage of plants in many areas were found to be in flower or fruit, but when these were found the two species were discernable. *E. palustris* has two stigmas per floral structure while *E. quinquefolia* has three. When we found plants in flower or fruit, we identified the spikerush in that area as that species. However, there were areas where the species occurred together, and here the cover estimates were very difficult to make. In these cases we named the association after the more common species, *E. palustris*.

Needle spikerush (*Eleocharis acicularis*) is also difficult to identify. Various other species of similarly small stature may occur on the Project Area and are nearly indistinguishable when conducting work of this perfunctory nature. Because these small spikerushes are not particularly common, the exact identification for plant community assignment is not very important. Since these small spikerushes are not particularly common (only one area throughout the entire project), we assumed that what we found was needle spikerush.

Olney's three square bulrush (*Schoenoplectus americanus*) and common three square (*Schoenoplectus pungens var. longispicatus*) are described in the literature as being fairly difficult to distinguish in the field, and because they make up fairly large components of some plant communities, this could be very important. However, we found no real difficulty in assigning cover to these species as they seemed to be fairly distinct on the Project Area. Olney's three square bulrush was identified by its concave, three-sided stems and taller stature, while common three square bulrush was reliably shorter with convex or flat-sided stems.

Fishes

Many of the systems we sampled had little or no fish habitat and/or did not contain fish. Additionally, many of the systems that contained fish had sensitive, threatened, or endangered fish species for which semi-annual, annual, or bi-annual monitoring programs already existed. These monitoring programs are usually conducted by a Federal or State resource agency. Where such monitoring programs already existed, we did not undertake any fish sampling but instead relied on the data collected by the various State and Federal resource agencies.

In systems lacking such monitoring programs but with adequate fish habitat, we used a variety of sampling gear to qualitatively sample fish communities. The gear type we used was dependent on several factors, including ease of use within the available habitat, reduction of disturbance to the available habitat, and the presence of sensitive species. We used 2 m x 4 m x 3 millimeter (mm) seines, Gee minnow traps (48 centimeters [cm] long, 22 cm total diameter, 2.5 cm mouth diameter, and 6 mm mesh), a Smith Root LR-24 backpack electrofisher, and dip nets (34 cm x 30 cm with 2 mm mesh) at one or more locations to sample fish communities.

Amphibians

Amphibian surveys consisted of diurnal visual encounter surveys. During these surveys one field crew member would walk the entire perimeter of the system looking for amphibians. We enumerated the number of amphibians observed and, when possible, noted the species and life stage of each.

Springsnails and Benthic Macroinvertebrates

Macroinvertebrate collections at each spring were separated into two components. The first component was a search for springsnails. The springsnail search was modeled after the searches undertaken during the surveys noted in Sada (2005a). The searches consisted of disturbing substrate and aquatic vegetation at the spring head and varying distances downstream toward the terminus with a modified aquarium dip net. The modified dip net had a mouth opening of 17 cm x 19 cm and a depth of 11 cm. We removed the factory-installed mesh and replaced it with 250 micron mesh netting. After disturbing the substrate or vegetation, we examined the net for the presence of springsnails and noted the location of the sample in relation to the spring head, the substrate, and/or vegetation that was disturbed, and the relative abundance of springsnails (absent, rare, common, abundant).

If the system already had one or multiple species described by Sada (2005a), Hershler (1994, 1998, 1999, 2001), and/or Hershler et al. (1999), then we assumed that the species we collected were the same. If we collected springsnails at a system not listed by Sada (2005a), Hershler (1994, 1998, 1999, 2001), and/or Hershler et al. (1999) to contain springsnails , then we collected two sets of specimens for identification by Dr. Robert Hershler at the Smithsonian Museum's Department of Zoology. The first set of specimens consisted of 50-100 springsnails for morphologic and taxonomic analysis. We placed springsnails collected for morphologic and taxonomic analysis directly into water from the system from which they were collected and placed crushed menthol crystals into the water. We let the springsnails relax in the menthol crystals for 8-12 hours before fixing them in a 10% formalin solution. After 5 days we transferred the specimens from the formalin solution to a 70% ethanol solution. The second set of springsnail specimens were for genetic analysis. For genetic analyses we collected 50-100 springsnails and immediately preserved them in 95% non-denatured ethanol.

In addition to springsnail surveys, we also collected qualitative benthic macroinvertebrate samples at each system. We collected the samples using the modified aquarium dip net described above and/or a D-frame kick net with 500 micron mesh, depending on the habitat size and system sensitivity. Qualitative samples were taken from the source (or origin of sampling site) to the terminus (or the bottom of the sampling site) of each system. The number of samples varied on the size of the system and variety of habitats available. We rinsed the sample residue into 500 milliliter (ml) and/or 1,000 ml screw-top Nalgene jars and preserved the sample with 70% ethanol. We shipped the samples to EcoAnalysts, Inc. (EcoAnalysts) in Moscow, Idaho, for processing and identification.

EcoAnalysts sorted samples by spreading them over a gridded pan. A grid was randomly selected and all organisms were picked out of that grid. Grids were randomly selected and sorted until 300 organisms had been picked, or the entire sample had been sorted. Applying counts from the number of grids sorted to the remaining grids allowed for estimates of the total number (abundance) of each taxa collected in each sample. All organisms were identified to the genus/species level, except for worms, which were identified to the class level. Quality assurance and control (QA/QC) procedures included a QA sorting on all samples to ensure 90% sorting efficiency. Also, a synoptic reference collection was created, which was checked by a second taxonomist to ensure taxonomic accuracy. The number of each taxa collected was then entered into a spreadsheet, which was used to generate a list of approximately 50 metrics that can be used as an index of the quality and health of the macroinvertebrate community. EcoAnalysts provided the raw data and metrics to BIO-WEST, along with the synoptic reference collections.

Disturbance Evaluation

At each aquatic system of interest, we qualitatively assessed the overall level of disturbance and assigned the system to one of four categories: undisturbed, slightly disturbed, moderately disturbed, or highly disturbed. Additionally, we recorded the causes of disturbance and any potential restoration activities that may be able to improve the habitat.

Access, Collection Permits, and Sampling Schedule

We originally intended to complete surveys at aquatic systems of interest in autumn 2004. However, access and permitting issues decelerated this schedule considerably. The SNWA provided us with a list of 101 aquatic systems of interest, and almost 50% of these were on private land or required private land access (Table 4). In order to access these areas, the SNWA began to contact landowners via phone calls and letters. Contacting landowners turned out to be a lengthy process, and we did not receive permission to access certain sites until summer 2005 (e.g., Unnamed Springs at Minerva, Big Springs).

Table 4. Number of aquatic systems of interest on public and private land.

OWNERSHIP	NUMBER OF SYSTEMS
Public	54
Private	41
Mixture of Public and Private	6

In addition to getting landowner permission to sample springs on private property, we also needed to obtain collection permits from the State of Nevada and the State of Utah. Since several of the aquatic systems of interest contain Federally listed species, we had to amend our U.S. Fish and Wildlife Service (USFWS) recovery permit to allow sampling of those species or in those systems. We began the process of applying for new permits and permit amendments in summer 2004. Our State of Utah collection permit was not issued until November 24, 2004, and our USFWS permit amendment was not issued until February 14, 2005. Therefore, we could not sample any aquatic systems of interest in Utah, or aquatic systems of interest in Nevada that contained Federally listed species, until spring 2005. Our USFWS permit required that we sample outside the peak spawning times for Federally listed fish species, so surveys of some aquatic systems with Federally listed fish species had to be surveyed in summer 2005 (e.g., Shoshone). After permits were obtained, a need to sample additional springs was determined in spring 2006. After obtaining access, several of those springs were sampled in fall 2006.

The combination of permitting requirements and access issues caused our surveys to be spread out over a much longer time period than we originally anticipated, which potentially introduced the influence of seasonal and annual variations into our data collection.

RESULTS

Tule Valley

Tule Valley lies to the east of Snake Valley, sitting between the House Range and the Confusion Range in both Millard County and Juab County, Utah. Tule Valley is one of the areas in Utah's West Desert that is home to the Columbia spotted frog (*Rana luteiventris*). Previously known as the western spotted frog (*Rana pretiosa*), the Utah populations are now known as the Columbia spotted frog as described by Cuellar (1996), Green et al. (1996), and Green et al. (1997). The Columbia spotted frog is currently on the State of Utah's sensitive species list (UDWR 2005). After the Columbia spotted frog was proposed for listing under the Endangered Species Act (ESA) in 1989, the Utah Division of Wildlife Resources (UDWR) began a series of survey efforts to document Columbia spotted frog localities and habitat use (Toone 1991, Ross et al. 1994). Eventually, a Conservation Agreement and Strategy was developed in 1998 to assist with the recovery of this species (Perkins et al. 1998), and the USFWS removed Utah's Columbia spotted frog populations as candidates for listing in 1999. Columbia spotted frog populations in Utah's West Desert represent the southernmost extent of the species' range. The Columbia spotted frog is a significant biological resource inhabiting aquatic systems in Tule Valley.

Four aquatic systems of interest were identified in Tule Valley and we performed Level 2 surveys at four sites within those systems (Figure 2, Table 5).

Table 5. The UTM location, survey date, survey level, and ownership of aquatic systems of interest throughout Tule Valley in Millard County, Utah.

SYSTEM	NORTHING[a]	EASTING[a]	SURVEY DATE	BIO-WEST SURVEY LEVEL	OWNERSHIP
Coyote Springs	436679X	28592X	3/6/05	Level 2	Public/BLM
South Tule Spring	435682X	28289X	3/5/05	Level 2	Public/BLM
Tule (4a) Spring	435858X	28335X	3/5/05	Level 2	Public/BLM
Willow Springs	436088X	28347X	3/6/05	Level 2	Public/BLM

Note: UTM coordinates are in the NAD 83 projection system.
[a]Full locations withheld at the request of the Utah Division of Wildlife Resources.

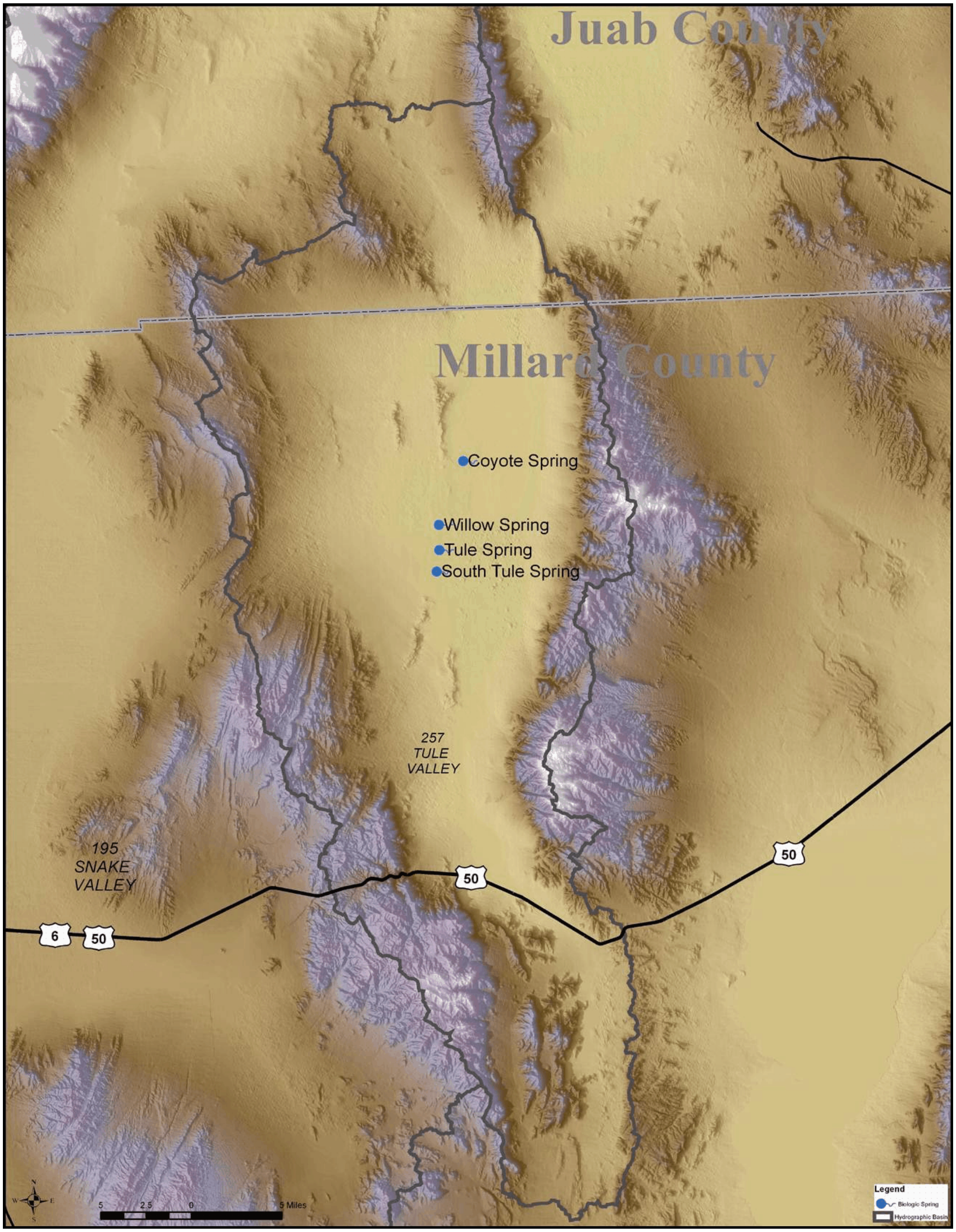

Figure 2. Map of locations of aquatic systems of interest in Tule Valley, Millard County and Juab County, Utah.

Physical Data and Water Quality

We found that the aquatic systems of interest in Tule Valley varied widely in their size and configuration (Table 6). Tule Springs and Coyote Springs are extensive complexes described in more detail by Hovingh (1984), Ross et al. (1994), and Hogrefe and Fridell (2000). We concentrated our survey of the Tule Springs complex at Tule 4a (Hogrefe and Fridell 2000), although we collected GPS locations and water quality data, and performed amphibian and springsnail searches throughout the Tule Springs complex. Coyote Springs is the largest complex in the valley. Hovingh (1984) estimated the Coyote Springs complex to have a surface area of over 97,000 m^2.

Table 6. Physical measurements taken from various locations in the aquatic systems of interest in Tule Valley in Millard County, Utah.

SYSTEM	SYSTEM TYPE	MAXIMUM DEPTH (cm)	MAXIMUM WETTED WIDTH (m)	LENGTH (m)	DISCHARGE (l/s)
Coyote Springs	Limnocrene	244-305[a]	94	166[b]	N/A
South Tule Spring	Limnocrene	25	111	378	N/A
Tule (4a) Spring	Limnocrene	180[c]	10.2	387	N/A
Willow Springs	Limnocrene	5	81	102	N/A

[a]Visual estimate of maximum depth.
[b]Continued further as a spring brook, marsh land, or onto private property.
[c]Taken from Hogrefe and Fridell (2000).

Our measurements of temperature, pH, and conductivity at various spring sources and the terminus of each system were within the range of values found by Hovingh (1993) in the early 1980s for these same spring systems (Table 7, Appendix B). Hogrefe and Fridell (2000) and Fridell et al. (2004) also found a similar range of temperature, pH, and conductivity values in these spring systems. Dissolved oxygen values varied widely and appeared to be heavily influenced by the location of the measurement within the complex. Many of the source areas we measured had dissolved oxygen levels near or below 2 mg/l, which probably indicates that groundwater from a deeper aquifer supplies those sources. We found that dissolved oxygen levels were more conducive to aquatic life in areas downstream of the sources themselves. Coyote Springs had the most extreme water quality parameters with the highest temperature and conductivity, as well as the lowest dissolved oxygen levels.

Table 7. Water quality measurements taken at the main source and the terminus or termination of the sampling site for the aquatic systems of interest in Tule Valley in Millard County, Utah.

SYSTEM	LOCATION	TEMPERATURE (C)	DISSOLVED OXYGEN (mg/l)	CONDUCTIVITY (µS/cm)	pH
Coyote Springs	Source/terminus	26.8/14.8	1.36/6.8	2,310/2,340	7.59/7.64
South Tule Spring	Source/terminus	15.9/12.2	9.50/5.02	1,870/1,510	9.06/7.95
Tule Springs	Source/terminus (4a)	25.9/11.3	2.38/7.60	1,560/1,550	7.79/7.88
Willow Springs	Source/terminus	14.5/13.3	9.15/6.93	1,610/1,640	8.26/8.01

In 2001 and 2002, eight sites in Tule Valley were surveyed in an effort to develop bioassessment protocols for Utah's desert wetland and restoration and translocation alternatives for least chub and Columbia spotted frog (Keleher et al. 2003, Keleher and Rader 2003, Keleher and Barker 2004). The temperatures we measured at springs of interest in Tule Valley were similar to those seen by Keleher and Barker (2004), but we found much higher conductivities at Coyote Springs than they listed for Tule Valley (1,618-1,655 µS/cm). Additionally, they found extremely low dissolved oxygen levels at the eight sites they sampled in Tule Valley (1.1-1.8 mg/l).

Aquatic Vegetation

The portion of the Coyote Springs complex we surveyed was dominated by emergent vegetation, as was Willow Spring (Tables 8 and 9). The Tule Springs complex and South Tule Spring had several areas with open water and submerged aquatic vegetation (SAV). We identified Olney's three square bulrush as the dominant emergent vegetation at all of the Tule Valley sites.

Hogrefe and Fridell (2000) also found Olney's three square bulrush to be the dominant emergent vegetation at all the aquatic systems of interest in Tule Valley. They listed both watercress and water parsnip at Tule Springs, as did Workman et al. (1979). Keleher et al. (2003) also listed monkeyflower in Tule Valley, indicating that our watercress group may be made up of watercress, water parsnip, and/or monkeyflower. We found horsehair algae (Chlorophyceae) muskgrass (*Chara vulgaris*), and pondweed at South Tule/and or Tule Springs. Hogrefe and Fridell (2000) did not list those species as being found at these springs. However, they found watercress in the Coyote Springs complex, where we found none. Coyote Springs is a large complex that we were only able to sample a portion of, which may explain the absence of watercress found during our survey. While we listed one species of algae, Keleher and Barker (2004) listed 15 species of algae in Tule Valley, after they sent samples to a specialist in algal taxonomy.

Table 8. Percent cover of different submergent aquatic vegetation at aquatic systems of interest throughout Tule Valley in Millard County, Utah.

COMMON NAME	SCIENTIFIC NAME	COYOTE	SOUTH TULE	TULE	WILLOW
Horsehair Algae	*Chlorophyceae* sp.	-	10	10	-
Muskgrass	*Chara vulgaris*	-	5	5	-
Pondweed	*Potamogeton foliosus/pectinatus*	-	-	5	-
Watercress	*Nasturtium officinale*[a]	-	5	10	-

[a]Watercress group.

Table 9. Percent cover of different emergent aquatic vegetation at aquatic systems of interest throughout Tule Valley in Millard County, Utah.

COMMON NAME	SCIENTIFIC NAME	COYOTE	SOUTH TULE	TULE	WILLOW
Baltic Rush	*Juncus arcticus*	5	2	-	5
Broadleaf Cattail	*Typha latifolia*	5	< 2	5	-
Common Reed	*Phragmites australis*	5	5	-	-
Foxtail Barley	*Hordeum jubatum*	-	< 2	-	-
Olney's Three Square Bulrush	*Schoenoplectus americanus*	90	95	90	95
Saltgrass	*Distichlis spicata*	-	2	5	

Hogrefe and Fridell (2000) also found rabbit-foot grass (*Polypogon* spp.) at Coyote Springs and spikerush at the Tule Springs complex, while we found neither of these species. Keleher et al. (2003) also listed spikerush and rabbit-foot grass at sites in Tule Valley, as well as common three-square. Keleher et al. (2003) found that spikerush had the highest relative abundance of all emergent vegetation species at sites in the Tule Valley. We found foxtail barley (*Hordeum jubatum*) at South Tule Spring and saltgrass at Tule Spring and South Tule Spring, while Fridell and Hogrefe (2000) did not note these species at those sites. Workman et al. (1979) listed algae (several species), alkali bulrush (*Scirpus paludosis*), and Baltic rush (*Juncus arcticus*) at Coyote Springs and muskgrass, alkali bulrush, and water parsnip at Tule Springs. Different plants grow during different times of year, and many plants only can be identified to species level when seeds or flowering parts are present. Therefore, the fact that the species found by Workman et al. (1979), Hogrefe and Fridell (2000), and Keleher et al. (2003), and during our study differ slightly is an expected result of visiting these sites only once.

Vegetation Mapping

Our second visit to Tule Valley springs to map vegetation occurred in September 2005. We documented a total of 18 vegetation associations and open water in Tule Valley during this visit (Table 10). The number of vegetation associations ranged from seven to nine at the four springs. Twenty different species were documented throughout the springs sampled in Tule Valley (Appendix C).

Vegetation at Coyote Spring was dominated by Olney's three square bulrush and cattail. Vegetation in these two associations made up nearly 70% of the 62.5 acres mapped at Coyote Springs. The other 30% was composed of salt grass and Baltic Rush Associations, as well as Common Reed (*Phragmites australis*) and Salt Cedar (*Tamarix* spp.) Associations. Contrary to our initial vegetation survey efforts, no foxtail barley, watercress, or muskgrass was found to be dominant during the mapping efforts. Tule Spring was dominated by the Olney's Three Square Bulrush Vegetation Association at the time of the sampling. As with Coyote Spring, the other associations present in significant amounts were the Saltgrass and Baltic Rush Associations.

Over 53% of the 11.6 acres mapped at South Tule Spring was comprised of adventive plant herbaceous vegetation (mixed herbaceous vegetation, tolerant to disturbance, and quick colonizing). Another 41% of the area we mapped at South Tule Spring was in the Olney's Three Square Bulrush Association. Small amounts of other associations including variations of salt grass are present in the South Tule Spring. The Olney's Three Square Bulrush Association dominated Willow Spring, which also had a smaller proportion of the area comprised of the Spikerush-saltgrass Association.

The associations found at all springs confirm the findings of Hogrefe and Fridell (2000) that Olney's three square is the dominant vegetation at the springs in Tule Valley. We also found saltgrass was common in Tule Valley, but Hogrefe and Fridell (2000) did not note saltgrass in their surveys. Unlike Workman (1979), we did not find alkali bulrush or water parsnip in Tule Valley. However, we found rabbitfoot grass as did Keleher et al. (2003) and Hogrefe and Fridell (2000) previously. While we found that associations with spikerush covered a small area at Tule Springs and very small area at South Tule Spring, Keleher et al. (2003) indicated that spikerush was the most abundant vegetation at spring systems throughout Tule Valley. Volume II contains vegetation maps that correspond with this report.

Table 10. The proportion of the 46.4 acres mapped comprised of each association (alliance) at aquatic systems of interest throughout Tule Valley in Millard County, Utah.

ASSOCIATION / ALLIANCE IN TULE VALLEY	COYOTE SPRING 31.2 ACRES (12.63 HECTARES)	TULE SPRING 7.3 ACRES (2.95 HECTARES)	SOUTH TULE SPRING 5.8 ACRES (2.35 HECTARES)	WILLOW SPRING (2.1 ACRES [0.85 HECTARE])
Adventive Plant Herbaceous Vegetation / Undesignated Alliance			53.14%	
Carex nebrascensis (Nebraska Sedge) Herbaceous Vegetation / *Carex nebrascensis* Seasonally Flooded Herbaceous				
Distichlis spicata (Inland Saltgrass) Mixed Herb Herbaceous Vegetation / *Distichlis spicata*, Intermittently Flooded Herbaceous		2.49%	2.93%	
Distichlis spicata (Inland Saltgrass) Herbaceous Vegetation / *Distichlis spicata*, Intermittently Flooded Herbaceous	9.03%	8.43%	0.79%	
Distichlis spicata (Inland Saltgrass) - *Juncus arcticus* (Baltic Rush) Herbaceous Vegetation / *Distichlis spicata*, Intermittently Flooded Herbaceous	1.62%			
Eleocharis Palustris (Common Spikerush)-*Distichlis spicata* (Inland Saltgrass) Herbaceous Vegetation / *Eleocharis palustris* Seasonally Flooded Herbaceous		8.82%		7.70%
Eleocharis palustris (Common Spikerush) Herbaceous Vegetation / *Eleocharis palustris* Seasonally Flooded Herbaceous		0.81%	0.29%	
Iris missouriensis (Rocky Mountain Iris) Herbaceous Vegetation (Undesignated Alliance)				
Juncus arcticus (Baltic Rush) Herbaceous Vegetation / *Juncus arcticus* Seasonally Flooded Herbaceous	7.04%			
Juncus arcticus (Baltic Rush) Mixed Herbaceous / *Juncus arcticus* Seasonally Flooded Herbaceous				
Open Water / Undesignated Alliance	0.8%		1.13%	
Phragmites australis (Common Reed), Herbaceous Vegetation / *Phragmites australis* Semipermanently Flooded Herbaceous)	4.57%		0.22%	
Populus angustifolia (Narrowleaf Cottonwood) - *Distichlis spicata* (Inland Saltgrass) - Woodland / *Populus angustifolia* Temporarily Flooded Woodland				
Rosa woodsii (Wood's Rose) Shrubland / *Rosa woodsii* Temporarily Flooded Shrubland				

Table 10. Continued.

ASSOCIATION / ALLIANCE IN TULE VALLEY	COYOTE SPRING 31.2 ACRES (12.63 HECTARES)	TULE SPRING 7.3 ACRES (2.95 HECTARES)	SOUTH TULE SPRING 5.8 ACRES (2.35 HECTARES)	WILLOW SPRING (2.1 ACRES [0.85 HECTARE])
Schoenoplectus americanus (Olney's Three Square Bulrush) - *Eleocharis palustris* (Common Spikerush) Herbaceous Vegetation / *Schoenoplectus americanus* Semipermanently Flooded Herbaceous		1.61%		
Schoenoplectus americanus (Olney's Three Square Bulrush), Western Herbaceous Vegetation / *Schoenoplectus americanus*, Semipermanently Flooded Herbaceous	30.69%	72.0%	41.49%	92.30%
Sparsely Vegetated / Undesignated Alliance	0.14%	4.25%		
Tamarix (Salt Cedar) spp. Shrubland / Semi-natural Temporarily Flooded Shrubland	7.82%			
Typha latifolia (Broadleaf Cattail) Herbaceous Vegetation / *Typha angustifolia, latifolia* (Narrowleaf, Broadleaf Cattail), *Schoenoplectus* (Three Square) spp. Semipermanently Flooded Herbaceous	38.29%	1.57%		

Fishes

In March 2005 we did not collect any fish during our survey of the Tule Springs complex, despite deploying a total of 12 minnow traps overnight between three different spring heads (4a, 4c, 5). Hovingh (1980, 1984, and 1993) and Ross et al. (1994) indicated that no fishes are native to the Tule Valley. Sigler and Workman (1975) and Workman et al. (1979) sampled Coyote Springs and Tule Springs in the mid 1970s and did not collect any fish, although they observed two small fish in Tule Springs. Hovingh (1980, 1984) provides some anecdotal information that introduced centrarchids, such as bass (*Micropterus* spp.) and sunfish (*Lepomis* spp.), may have been present in some of the deeper open water areas of the Tule Valley, particularly at Tule Springs and Coyote Springs. The UDWR used minnow traps to survey all the aquatic systems of interest in Tule Valley for fishes in 1999 (Hogrefe and Fridell 2000). Despite expending a large amount of effort, Hogrefe and Fridell (2000) neither collected nor observed any fishes in aquatic systems throughout the Tule Valley. They did note that part of the Tule Spring complex (Tule 4a) has adequate habitat and water quality to sustain least chub, and that this site may be good for future introductions of that species.

Amphibians

Tule Valley is known to have two native amphibians, the Columbia spotted frog and the Great Basin spadefoot toad (*Spea intermontana*). Surveys in the 1980s and early 1990s showed that Columbia spotted frog were present at all the aquatic systems of interest in Tule Valley (Hovingh 1980, 1984, 1993; Toone 1991; Ross et al. 1994). However, we only found one Columbia spotted frog egg mass in the Tule Springs complex during our amphibian visual encounter surveys in March 2005. No other frogs, toads, or egg masses were observed at that time.

Our amphibian surveys were not very intensive and occurred during daylight hours when adult frogs are less likely to be active and observed. Additionally, egg masses are often found out in open water, away from the margins of the spring system where our surveys took place. The UDWR has an annual monitoring program for Columbia spotted frog in the Tule Valley, which centers on counting eggs masses to get a relative abundance estimate (Fridell et al. 2004). The combined information from our 2005 sampling along with information collected during 2004 surveys by the UDWR shows that Columbia spotted frog are still present at all the aquatic systems of interest in Tule Valley (Table 11). Fridell et al. (2004) found 1,362 Columbia spotted frog egg masses throughout the Tule Valley in 2004. The majority of these (78%) were at Coyote Springs. Fridell et al. (2004) observed adult frogs at all locations in 2004 and estimated that the breeding population size was 2,652 individuals, which exceeds the Spotted Frog Conservation Agreement and Strategy target of 1,000 individuals (Perkins and Lentsch 1998). Survey data since 1997, as depicted in Fridell et al. (2004), shows that the 2004 Columbia spotted frog egg mass count for Tule Valley was the lowest since 1999.

Table 11. Amphibian sightings at aquatic systems of interest throughout Tule Valley in Millard County, Utah.

SYSTEM	SOURCES[a]	BULLFROG	COLUMBIA SPOTTED FROG	GREAT BASIN SPADEFOOT TOAD
Coyote Springs	1, 3	A[b]	P[c] 3	A
South Tule Spring	1, 3	A	P 3	A
Tule Springs	1, 3	A	P 1, 3	A
Willow Spring	1, 3	A	P 3	A

[a]1 = BIO-WEST survey and/or reconnaissance, 2 = Sada (2005a), 3 = UDWR (Fridell et al. 2004).
[b]Absent through visual observation.
[c]Present through visual observation.

In the 1980s Great Basin spadefoot toad was found to occur in Coyote Springs and South Tule Spring (Hovingh 1984, Hovingh et al. 1985). Hovingh et al. (1985) also found Great Basin spadefoot toad in Painter's Spring in Tule Valley. Throughout the Bonneville Basin, the Great Basin spadefoot toad utilized a wide variety of aquatic habitats including stock troughs, reservoirs, marshes, and spring heads (Hovingh et al. 1985). Hovingh et al. (1985) felt that the Great Basin spadefoot toad may breed in almost any wetted habitat within its distribution. While UDWR surveys for Columbia spotted frog in Tule Valley did not note Great Basin spadefoot toad, the UDWR concurs with Hovingh et al. (1985) that seasonal use of all the aquatic systems of interest by Great Basin spadefoot toad is probable (K. Wheeler 2005, pers. comm.).

Springsnails and Invertebrates

Hovingh (1985 et al., 1993) indicated that the Tule Valley was unlike adjacent valleys with valley floor springs because the Tule Valley springs contained no mollusks. Sada (2005a) showed that some mountain block springs in the Tule Valley contained springsnails, but Sada (2005a) had no survey records for the four aquatic systems of interest on the valley floor. In our surveys, we found that springsnails were scarce to common throughout Tule complex (4a) (Table 12). The springsnail species from Tule 4a most closely resembles *Pyrgulopsis kolobensis*, but it has enough of a morphological divergence that it may be a new species (R. Hershler 2005, pers. comm.).

Table 12. Springsnails present in aquatic systems of interest throughout Tule Valley, Millard County, Utah.

SYSTEM	SOURCES[a]	*P. KOLOBENSIS*
Coyote Springs	1	A[b]
South Tule Spring	1	A
Tule Springs	1	P[c]
Willow Spring #2	1	A

[a]1 = BIO-WEST survey and/or reconnaissance.
[b]Absent through visual observation.
[c]Present through visual observation. This is possibly a new species, *Pyrgulopsis* n sp., pending genetic analysis.

Our qualitative macroinvertebrate samples from Tule 4a found that springsnails (Hydrobiidae) were the dominant taxon (Appendix D, Appendix E). Additionally, other mollusks, including fingernail clams (Sphaeriidae/*Pisidium* sp.), freshwater limpets (*Ferrissia* sp.), and Planorbid snails (*Gyraulus* sp.), were found in qualitative samples from at least one of each of the other springs (Table 13). Overall, EcoAnalysts identified 44 individual taxa representing 12 Orders of aquatic invertebrates in our samples from the Tule Valley. Taxa richness was low in all Tule

Table 13. Total number of: invertebrate taxa; mayfly, stonefly, and caddisfly (EPT) taxa; taxa in the Phylum Mollusca; taxa in the Order Odonata; and taxa in the Subphylum Crustacea at aquatic systems of interest throughout Tule Valley, Millard County, Utah.

SYSTEM	TOTAL TAXA	EPT TAXA	MOLLUSCA TAXA	ODONATA TAXA	CRUSTACEA TAXA
Coyote Springs	15.00	0.00	1	1	2
South Tule Spring	22.00	0.00	1	1	2
Tule Springs	9.00	0.00	2	0	2
Willow Spring	27.00	1.00	2	2	2

Valley aquatic systems of interest but particularly so in Tule Spring, where only nine taxa were found. Common invertebrates found at all four systems of interest included Amphipods (*Hyallela* sp.), seed shrimp (Ostracoda), and several species of midges (Chironomidae). Keleher et al. (2003) found that mollusks dominated their macroinvertebrate samples in Tule Valley, followed by mayflies (Ephmeroptera) and Amphipods. The increased abundance of seed shrimp and midges in our samples could be a result of the smaller mesh size used in our collections versus collections by Keleher et al. (2003) (250 microns versus 1,000 microns).

Other Fauna

We observed a variety of different birds utilizing springs in the Tule Valley, including western meadowlarks (*Sturnella neglecta*), northern harriers (*Circus cyaneus*), hummingbirds, and several different unidentified songbirds. We also observed coyote (*Canis latrans*) scat and black-tailed jackrabbits (*Lepus californicus*). Hovingh (1980, 1984, 1993) documented a wider variety of birds, reptiles, and mammals utilizing the areas around spring systems in Tule Valley.

Disturbance

The aquatic systems of interest in the Tule Valley were slightly to moderately disturbed (Figure 3, Table 14). Livestock use and damage were apparent at all four systems of interest; South Tule Springs was the least disturbed. Hogrefe and Fridell (2000) listed ungulate damage as high at Tule Springs (Tule 4a and 4b) and Coyote Springs (Tule 8) but low at South Tule (Tule 6) and low to moderate at Willow Springs (Tule 1, 2, and 8). Wheeler et al. (2004) considered Tule Springs (Tule 4a and 4b) to have moderate ungulate damage. Livestock use throughout this area appears to have impacted most of these springs, but the timing of various surveys, along with annual differences in grazing practices, may have resulted in different amounts of observed ungulate damage. Additionally, disturbance evaluations involve a substantial amount of subjectivity.

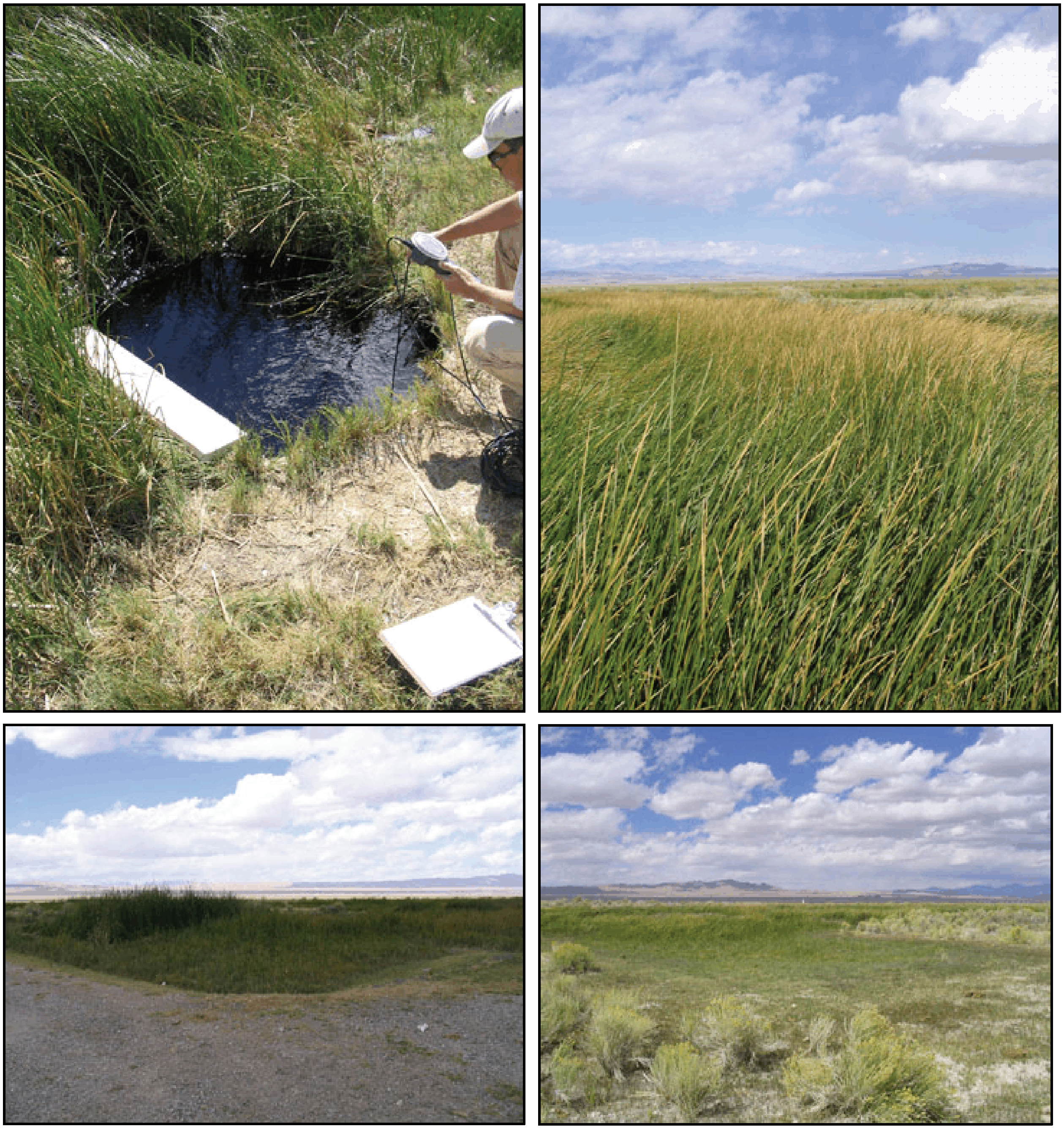

Figure 3. **Tule Valley spring heads (from left to right) at (a) Coyote, (b) South Tule, (c) Tule 4a, and (d) Willow Springs.**

Table 14. Disturbance level and factors at aquatic systems of interest throughout Tule Valley, in Millard County, Utah.

SYSTEM	DISTURBANCE LEVEL	DISTURBANCE FACTORS
Coyote Springs	Moderate	Livestock, Diversion
South Tule Spring	Slight	Livestock, Drought
Tule Springs	Slight	Livestock, Diversion, Roads
Willow Spring	Moderate	Livestock

Fish Springs National Wildlife Refuge (NWR)

Fish Springs National Wildlife Refuge (NWR) was established in 1959 and is located near the southwestern edge of the Great Salt Lake Desert in Juab County, Utah. Fish Springs NWR has 16 distinct larger spring heads as well as numerous subheads, and the refuge is divided into nine different pools (Rader et al. 2003, USFWS 2004a). Springs in the refuge appear to be associated with a fault line running parallel to the eastern side of the Fish Springs Mountain Range (USFWS 2004a). These springs feed a large, 10,000-acre saline marsh complex (Stolley et al. 1999, USFWS 2004a). Past survey efforts have shown that Fish Springs NWR is home to a number of unique fish, amphibian, and invertebrate species (USFWS 2000, Rader et al. 2003, Mills et al. 2004a, Mills et al. 2004b, USFWS 2004a, Sada 2005a). A Conservation Agreement species, the least chub, is thought to have historically occupied the Fish Springs NWR and recently was reintroduced (USFWS 2004a, Mills and Wilson 2006). Additionally, at least two known species of springsnail are currently found in Fish Springs NWR (Frest 1996, Hovingh 1998, Sada 2005a).

Least chub is a small minnow endemic to Utah's Bonneville Basin of Utah (Hubbs and Miller 1948, Sigler and Sigler 1996, Perkins et al. 1998). Least chub populations were once found in a variety of areas throughout the Bonneville Basin, but populations have been declining since the 1940s. Because of declines in the distribution and abundance of least chub, the USFWS proposed to list the species as endangered in 1995. Listing was precluded when the State of Utah developed a Conservation Agreement and Strategy for the species. Most recently, the least chub was reintroduced into Fish Springs NWR (Perkins et al. 1998, USFWS 2004a, Mills et al. 2004a, Mills et al. 2004b, Wilson and Mills 2006).

The Toquerville springsnail is widespread at Fish Springs NWR, while desert tryonia (*Tryonia protea*) are less common (Hovingh 1998). Hersler (1998) records specimens of *P. kolobensis* collected from the Virgin River basin, southwestern Utah, the Bonneville Basin (Utah, Idaho, and Nevada), the eastern Great Basin (Nevada), and from the Colorado River drainage (Utah and Nevada). Frest (1996), and Sada (2005a) also found *P. kolobensis* present and wide-spread throughout Fish Springs NWR, while *Tryonia protea* was found in only a few locations on the refuge. Least chub as well as desert tryonia are on the State of Utah's Sensitive Species List (UDWR 2005). The least chub, desert tryonia, and the Toquerville springsnail are all noteworthy aquatic biological resources of Fish Springs NWR.

Eleven aquatic systems of interest were identified in Fish Springs NWR, and we performed Level 2 surveys at 14 sites within those systems (Figure 4, Table 15).

Table 15. State, county, UTM location, survey date, survey level, and ownership of aquatic systems of interest throughout Fish Springs National Wildlife Refuge (NWR) in Juab County, Utah.

SYSTEM	STATE	COUNTY	NORTHING	EASTING	SURVEY DATE	BIO-WEST SURVEY LEVEL	OWNERSHIP
Crater Spring	UT	Juab	4411933	295593	8/21/06	Level 2	USFWS
Deadman Spring	UT	Juab	4416707	294189	7/20/06	Level 2	USFWS
House Spring	UT	Juab	4413684	295098	7/21/06	Level 2	USFWS
Lost Spring	UT	Juab	4412287	295431	8/21/06	Level 2	USFWS
Middle Spring	UT	Juab	4412618	295136	7/20/06	Level 2	USFWS
Mirror Spring	UT	Juab	4413530	295219	7/21/06	Level 2	USFWS
North Spring	UT	Juab	4417762	293699	7/20/06	Level 2	USFWS
Percy Spring	UT	Juab	4411650	295376	8/21/06	Level 2	USFWS
South Spring	UT	Juab	4411860	295450	8/21/06	Level 2	USFWS
Thomas Spring	UT	Juab	4413151	295050	7/20/06	Level 2	USFWS
Walter's Spring	UT	Juab	4415953	294540	7/21/06	Level 2	USFWS

Physical Habitat and Water Quality

We found that the size and depth of aquatic systems in Fish Springs NWR varied considerably (Table 16). All springs evaluated appeared to feed the extensive saline marsh system comprising the Fish Springs NWR.

We calculated the volume of water discharged from three of the systems of interest at Fish Springs NWR and found that discharge at the systems of interest was also quite variable (Table 16). Where discharge measurements were possible, we found the greatest volume of water being discharged from the Thomas Spring system, a relatively moderate discharge at Mirror Spring, and the least measurable discharge at House Spring.

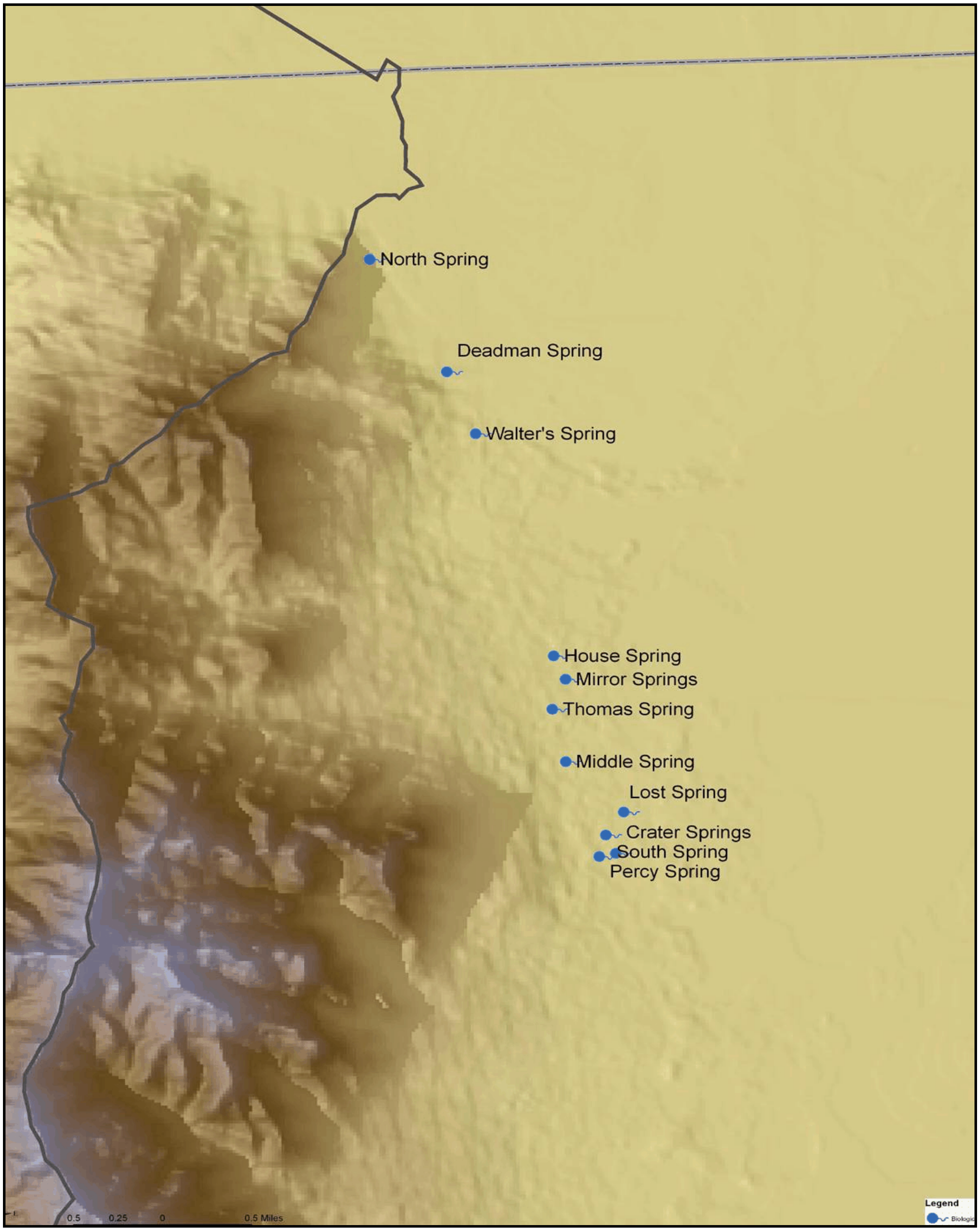

Figure 4. **Location of aquatic systems of interest at Fish Springs National Wildlife Refuge (NWR), Juab County, Utah.**

Table 16. Type of system, maximum depth, maximum wetted width, and length of survey plots, as well as measured discharge found at aquatic systems of interest throughout Fish Springs National Wildlife Refuge (NWR), Juab County, Utah.

SYSTEM	SYSTEM TYPE	MAXIMUM DEPTH (cm)	MAXIMUM WETTED WIDTH (m)	LENGTH (m)	DISCHARGE (l/s)
Crater Spring	Limnocrene	122	12	80	N/A
Deadman Spring	Helocrene	89	21	476	N/A
House Spring	Rheocrene	79	6.5	268	10.48[a]/4.1[b]
Lost Spring	Limnocrene	310	20	409	28.60[a]
Middle Spring	Limnocrene	384	100	240	236.84[a]
Mirror Spring	Rheocrene	528	20	228	39.27[b]
North Spring	Limnocrene	348	152	156	124.31a
Percy Spring	Limnocrene	216	24	239	31.71[a]
South Spring	Limnocrene	290	79	318	208.41[a]
Thomas Spring	Helocrene	241	24	208	73.62[1]/82.18[b]
Walter's Spring	Limnocrene	295	88	207	N/A

[a] Unpublished discharge data obtained from USFWS.
[b] Data collected during our surveys (July and August 2006).

The USFWS has collected discharge and water quality measurements at many of the refuge's springs for years (USFWS unpublished data) (Table 16). They have recorded and archived long-term discharge information for many of the springs we visited during our surveys. Interestingly, data we collected at Thomas and House Springs (the two springs of data overlap between our surveys and data collected during a similar date by USFWS) show fairly similar discharges, with our measured discharge being higher at Thomas Spring and lower at House Spring, compared with data collected by USFWS. Overall, long-term discharge data collected by the USFWS show fairly large, annual variations in the discharge at many of the springs of Fish Springs NWR.

Some of the measured water quality parameters also varied widely at aquatic systems of interest in Fish Springs NWR (Table 17). We found that pH to be fairly stable and neutral (7.35 - 9.12) throughout the aquatic systems evaluated. Temperature varied between systems and sometimes between the source and the terminus within a system. All springs sampled on the refuge had source temperatures greater than 20° C, while most springs tended to increase in temperature near the terminus. Dissolved oxygen also varied widely between the springs, from a low of 2.79 mg/l at the terminus of Middle Spring, and the source of House Spring, to a high of 14.05 mg/l at the source of North Spring. All springs sampled had conductivity measurements exceeding 3,100 µ**S/cm.**

Table 17. Selected water quality parameters measured at the main source and the terminus or termination of the sampling site for aquatic systems of interest throughout Fish Springs NWR in Juab County, Utah.

SYSTEM	LOCATION	TEMPERATURE (C)	DISSOLVED OXYGEN (mg/l)	CONDUCTIVITY (mS/cm)	pH
Crater Spring	Source/terminus	25.78/29.00	3.08/8.71	3190/3170	7.50/8.00
Deadman Spring	Source/terminus	30.33/33.50	13.85/12.53	3790/4260	7.91/9.12
House Spring	Source/terminus	24.00/23.22	2.79/5.82	3200/3200	7.39/7.71
Lost Spring	Source/terminus	26.83/27.28	3.84/6.02	3180/3180	7.51/7.81
Middle Spring	Source/terminus	27.44/25.61	3.90/2.79	3140/3150	7.35/7.46
Mirror Spring	Source/terminus	23.56/24.56	2.90/7.17	3180/3170	7.42/7.71
North Spring	Source/terminus	27.72/29.00	14.05/11.94	4930/5340	8.28/8.12
Percy Spring	Source/terminus	26.70/27.78	4.18/11.38	3230/3240	7.46/8.37
South Spring	Source/terminus	28.28/27.89	4.20/7.27	3160/3180	7.37/7.70
Thomas Spring	Source/terminus	20.00/28.17	3.90/3.86	3510/3150	7.49/7.37
Walter's Spring	Source/terminus	22.17/29.67	8.22/11.02	3420/3470	7.81/8.77

Other authors have also collected similar water quality information at Fish Springs NWR. Stolley et al. (1999) report conductivities ranging from 2,900 to 3,400 µS/cm. They indicate that North Spring had the highest conductivity recorded during their research on Canada geese (*Branta canadensis*) gosling survival at 5,100 µS/cm, with certain ponded areas within the refuge achieving conductivity readings of more than 25,000 µS/cm. Sada (2005a) and USFWS (2004a) reports water quality parameters for some of the systems of interest in Fish Springs NWR. Generally, our measurements fell within the range of values reported for the aquatic systems of interest. Dissolved oxygen values in Sada (2005a) at north spring were considerably lower than our values.

Aquatic Vegetation

Vegetation surveys of the Fish Springs NWR identified six different taxa of SAV in the aquatic systems of interest throughout Fish Springs NWR (Table 18). Although all springs evaluated had similar SAV, Mirror, South, and Walter's Springs had the greatest diversity of SAV with five different species. The rest of the springs evaluated had either three or four species of SAV. Muskgrass and algae were found at all of the sites we surveyed.

Table 18. Percent cover of submerged aquatic vegetation (SAV) found at aquatic systems of interest throughout Fish Springs National Wildlife Refuge (NWR) in Juab County, Utah.

COMMON NAME	SCIENTIFIC NAME	SYSTEM										
		CRATER	DEADMAN	HOUSE	LOST	MIDDLE	MIRROR	NORTH	PERCY	SOUTH	THOMAS	WALTER'S
Algae	*Algae* sp.	-	-	-	-	-	5	-	-	-	20	-
Coon's Tail	*Ceratopyllum demersum*	-	-	-	-	-	-	-	-	5	-	-
Fineleaf Pondweed	*Suckenia filiformis*	10	10	20	20	5	3	20		5	<2	20
Horsehair Algae	*Chlorophyceae* sp.	20	10	15	50	10	5	15	40	30	30	15
Muskgrass	*Chara vulgaris*	20	50	45	50	20	10	25	20	5	45	40
Spiny Naiad	*Najas marina*	40	-	-	30	2	10	10	20	25	<2	-

Stolley et al. (1999) listed wigeongrass (*Ruppia maritima*), muskgrass (*Chara* spp.), spiny and/or pond niad (*Najas marina*), and coontail (*Ceratophyullum demersum*) as common in the springs, canals, and pools of Fish Springs NWR. Keleher et al. (2004) indicate the presence of various algal species as present in Fish Springs NWR. The USFWS (2004a) also acknowledges the presence these species of SAV on the refuge.

We identified 19 different species of emergent vegetation at the aquatic systems of interest in Fish Springs NWR (Table 19). Giant reed grass and saltgrass (*Distichlis spicata*) were identified at all of the aquatic systems of interest, making them the most common emergent plants found in our surveys of Fish Springs NWR. Other common species included Baltic rush, Olney's three-square bulrush, and scratchgrass.

Table 19. Percent cover of emergent aquatic vegetation (EAV) found at aquatic systems of interest throughout Fish Springs National Wildlife Refuge (NWR) in Juab County, Utah.

COMMON NAME	SCIENTIFIC NAME	SYSTEM										
		CRATER	DEADMAN	HOUSE	LOST	MIDDLE	MIRROR	NORTH	PERCY	SOUTH	THOMAS	WALTER'S
Alkali Sacaton	*Sporolobus airoides*	2	-	-	5	-	5	-	-	-	10	-
Arctic Rush	*Juncus arcticus*	-	30	20	-	10	15	30	2	20	15	15
Aster	*Symphyotrichum* sp.	-	-	-	-	-	-	<2	-	-	-	-
Broadleaf Cattail	*Typha latifolia*	5	-	<2	20	<2	-	-	-	5	3	5
Burningbush	*Euonymus alatus*	-	-	5	-	-	3	-	-	-	-	-
Cosmopolitan Bulrush	*Scirpus maritimus*	-	-	-	-	-	<2	-	-	-	-	-
Foxtail Barley	*Hordeum jubatum*	-	-	<2	-	-	-	<2	-	-	-	-
Giant Reed Grass	*Phragmites australis*	70	50	20	70	50	20	30	80	45	50	25
Indian Hemp	*Apocynum cannabinum*	10	-	-	10	-	-	-	-	-	2	-
Nuttal's Sunflower	*Helianthus nuttallii*	5	-	-	<2	-	-	-	-	-	-	-
Olney's Three Square Bulrush	*Schoenoplectus americanus*	-	-	5	2	3	5	5	2	5	3	10
Rabbit-foot Grass	*Polypogon monspeliensis*	-	-	-	2	<2	-	<2	-	-	<2	<2
Saltgrass	*Distichlis spicata*	10	15	30	20	25	25	30	30	20	30	20
Saltlover	*Halogeton glomeratus*	-	-	-	-	2	-	-	-	-	<2	-
Scratchgrass	*Muhlenbergia asperifolia*	30	-	3	5	-	-	<2	-	15	-	-
Showy Milkweed	*Asclepias speciosa*	-	10	<2	2	-	-	2	-	5	5	5
Spikerush	*Eleocharis* sp.	-	-	3	-	-	-	-	-	-	-	<2
Water Parsnip	*Berula bess*	-	-	2	2	-	2	-	-	-	-	5
Yellow Owl's-clover	*Orthocarpus luteus*	-	-	-	-	-	-	<2	-	-	-	-

Stolley et al. (1999) found Fish Springs NWR to contain typical emergent marsh vegetation comprised of Olney's three square bulrush, cattail (*Typha domingensis*), hardstem bulrush, alkali bulrush (*Scirpus maritimus*), Baltic rush *(Juncus arcticus*), and saltgrass. Stolley et al. (1999) also indicate presence of common reed (*Phragmites australis*), pickleweed (*Allenrolfea occidentalis*), and annual samphire (*Salicornia europaea).* Keleher et al. (2003) list various grasses as well as *Eleocharis*, *Juncus*, *Phragmytes*, *S. americanus, S. pungens*, *Polypogan*, and *Nasturtium* as emergent macrophytes present at Fish Springs NWR. The USFWS (2004a) provides a synopsis of plant community types, species, and maps of vegetation habitat types at Fish Springs NWR and confirms the presence of the above-listed species of emergent vegetation.

We also identified four species of trees in the riparian areas associated with the aquatic systems of interest in Fish Springs NWR (Table 20). Iodinebush was the most common and was found at three of the springs, while interestingly we found the nonnative salt cedar (*Tamarix* sp.) only at Percy Spring. Other species observed included Fremont cottonwood (*Populus fremontii*) and willows (*Salix* spp.).

Table 20. Trees found at aquatic systems of interest throughout Fish Springs NWR, Juab County, Utah.

COMMON NAME	SCIENTIFIC NAME	SYSTEM										
		CRATER	DEADMAN	HOUSE	LOST	MIDDLE	MIRROR	NORTH	PERCY	SOUTH	THOMAS	WALTER'S
Fremont Cottonwood	*Populus fremontii*	A[a]	A	P	A	A	A	A	A	P[b]	A	A
Iodinebush	*Allenrolfea occidentalis*	A	P	A	P	P	A	A	A	A	A	A
Salt Cedar	*Tamarix ramosissima*	A	A	A	A	A	A	A	P	A	A	A
Willow	*Salix* sp.	A	A	P	A	A	A	A	A	A	A	A

[a] Absent through visual observation.
[b] Present through visual observation.

Vegetation Mapping

Vegetation at the aquatic systems of interest in Fish Springs NWR mapped during our visits in July and August 2005 varied somewhat between systems (Table 21). The Baltic Rush

Table 21. The proportion of the 1,074.8 acres mapped comprised of each association (alliance) at aquatic systems of interest throughout Fish Springs NWR, Juab County, Utah.

ASSOCIATIONS/ ALLIANCES [a] IN FISH SPRINGS NATIONAL WILDLIFE REFUGE (NWR)	CRATER/ SOUTH SPRING (10.53 ACRES [4.26 HECTARES])	DEADMAN SPRING (5.59 ACRES [2.27 HECTARES])	HOUSE/ MIRROR SPRINGS (25.10 ACRES [10.16 HECTARES])	LOST SPRING (21.62 ACRES [8.75 HECTARES])	NORTH SPRING (900.15 ACRES [364.28 HECTARES])	PERCY SPRING (15.25 ACRES [6.17 HECTARES])	THOMAS AND MIDDLE SPRING (77.60 ACRES [31.40 HECTARES])	WALTER SPRING (18.96 ACRES [7.67 HECTARES])
Allenrolfea occidentalis (Iodinebush) Shrubland *Allenrolfea occidentalis* (Iodinebush) Shrubland	2.05			8.09	5.21	25.26		
Distichlis spicata (Inland Saltgrass)- *Juncus arcticus (Baltic Rush)* Herbaceous Vegetation/ *Distichlis spicata* Intermittently Flooded Herbaceous	22.33	8.94	1.59	25.48	41.09			1.77
Eleocharis palustris (Common Spikerush) - *Distichlis spicata* (Common Saltgrass) Herbaceous Vegetation *Eleocharis palustris* (Common Spikerush) Seasonally Flooded Herbaceous					0.06			
Distichlis spicata (Inland Saltgrass) Herbaceous Vegetation/ *Distichlis spicata* Intermittently Flooded Herbaceous	3.12	3.94	17.91		21.41		2.41	1.07

Table 21. Continued.

ASSOCIATIONS/ ALLIANCES [a] IN FISH SPRINGS NATIONAL WILDLIFE REFUGE (NWR)	CRATER/ SOUTH SPRING (10.53 ACRES [4.26 HECTARES])	DEADMAN SPRING (5.59 ACRES [2.27 HECTARES])	HOUSE/ MIRROR SPRINGS (25.10 ACRES [10.16 HECTARES])	LOST SPRING (21.62 ACRES [8.75 HECTARES])	NORTH SPRING (900.15 ACRES [364.28 HECTARES])	PERCY SPRING (15.25 ACRES [6.17 HECTARES])	THOMAS AND MIDDLE SPRING (77.60 ACRES [31.40 HECTARES])	WALTER SPRING (18.96 ACRES [7.67 HECTARES])
Juncus arcticus (Baltic Rush) Herbaceous Vegetation/ *Juncus arcticus* Seasonally Flooded Herbaceous	7.09	25.04	1.18		2.96	0.66	0.17	31.23
Juncus arcticus (Baltic Rush) Mixed Herb Herbaceous Vegetation/ *Juncus arcticus* Seasonally Flooded Herbaceous				3.41				4.31
Mixed Wetland Graminoid Herbaceous Vegetation/ Undesignated Alliance		9.12						
Muhlenbergia asperifolia (Scratchgrass) Herbaceous/ *Muhlenbergia asperifolia* Intermittently Flooded Herbaceous	0.24			9.00				
Open Water/ Undesignated Alliance	18.71	9.66	3.67	7.01	3.54	3.65	8.51	3.01
Phalaris arundinacea (Reed Canarygrass) Western Herbaceous Vegetation *Phalaris arundinacea* (Reed Canarygrass) Seasonally Flooded Herbaceous			54.02	23.65				

Table 21. Continued.

ASSOCIATIONS/ ALLIANCES [a] IN FISH SPRINGS NATIONAL WILDLIFE REFUGE (NWR)	CRATER/ SOUTH SPRING (10.53 ACRES [4.26 HECTARES])	DEADMAN SPRING (5.59 ACRES [2.27 HECTARES])	HOUSE/ MIRROR SPRINGS (25.10 ACRES [10.16 HECTARES])	LOST SPRING (21.62 ACRES [8.75 HECTARES])	NORTH SPRING (900.15 ACRES [364.28 HECTARES])	PERCY SPRING (15.25 ACRES [6.17 HECTARES])	THOMAS AND MIDDLE SPRING (77.60 ACRES [31.40 HECTARES])	WALTER SPRING (18.96 ACRES [7.67 HECTARES])
Phragmites australis (Common Reed) Western North America Temperate Semi-natural Herbaceous Vegetation/ *Phragmites australis* Semipermanently Flooded Herbaceous	43.20	43.29		15.08		70.43	62.20	18.65
*Populus fremontii (*Fremont Cottonwood*)* Mixed Herbaceous Woodland *Populus fremontii* (Fremont Cottonwood) Seasonally Flooded Woodland			1.71					
*Salix exigua (*Coyote Willow*)* - Mesic Forbs Shrubland *Salix exigua, Interior (*Coyote Willow, Sandbar Willow) Temporarily Flooded Shrubland			0.56					
Sarcobatus vermiculatus (Greasewood) - *Distichlis spicata* (Inland Saltgrass) Shrubland / *Sarcobatus vermiculatus* Intermittently Flooded Shrubland					7.32			11.01

Table 21. Continued.

ASSOCIATIONS/ ALLIANCES [a] IN FISH SPRINGS NATIONAL WILDLIFE REFUGE (NWR)	CRATER/ SOUTH SPRING (10.53 ACRES [4.26 HECTARES])	DEADMAN SPRING (5.59 ACRES [2.27 HECTARES])	HOUSE/ MIRROR SPRINGS (25.10 ACRES [10.16 HECTARES])	LOST SPRING (21.62 ACRES [8.75 HECTARES])	NORTH SPRING (900.15 ACRES [364.28 HECTARES])	PERCY SPRING (15.25 ACRES [6.17 HECTARES])	THOMAS AND MIDDLE SPRING (77.60 ACRES [31.40 HECTARES])	WALTER SPRING (18.96 ACRES [7.67 HECTARES])
Sarcobatus vermiculatus (Greasewood) - *Sporobolus airoides* (Alkali Sacaton) Sparse Vegetation / Unconsolidated Material Sparse Vegetation					0.69		9.39	
Schoenoplectus americanus (Olney's Three Square) Western Herbaceous Vegetation/ *Schoenoplectus americanus* Semipermanently Flooded Herbaceous					5.99			17.61
Schoenoplectus americanus (Olney's Three Square)- *Eleocharis palustris* (Common Spikerush) Herbaceous Vegetation *Schoenoplectus americanus* (Olney's Three Square) Semipermanently Flooded Herbaceous				0.62	8.06			
Schoenoplectus maritimus (Cosmopolitan Bulrush) Herbaceous Vegetation *Schoenoplectus maritimus* (Cosmopolitan Bulrush) Semipermanently Flooded Herbaceous					0.15			

Table 21. Continued.

ASSOCIATIONS/ ALLIANCES [a] IN FISH SPRINGS NATIONAL WILDLIFE REFUGE (NWR)	CRATER/ SOUTH SPRING (10.53 ACRES [4.26 HECTARES])	DEADMAN SPRING (5.59 ACRES [2.27 HECTARES])	HOUSE/ MIRROR SPRINGS (25.10 ACRES [10.16 HECTARES])	LOST SPRING (21.62 ACRES [8.75 HECTARES])	NORTH SPRING (900.15 ACRES [364.28 HECTARES])	PERCY SPRING (15.25 ACRES [6.17 HECTARES])	THOMAS AND MIDDLE SPRING (77.60 ACRES [31.40 HECTARES])	WALTER SPRING (18.96 ACRES [7.67 HECTARES])
Sporobolus airoides (Alkali Sacaton) - *Distichlis spicata* (Inland Saltgrass) Herbaceous Vegetation/ *Sporobolus airoides* Intermittently Flooded Herbaceous			18.96		3.54		17.32	10.17
Typha latifolia (Broadleaf Cattail) Western Herbaceous Vegetation/ *Typha angustifolia*, *latifolia* (Narrowleaf, Broadleaf Cattail) - (*Schoenolectus* [Bulrush] spp.) Semipermanently Flooded Herbaceous	3.27		0.40	7.65				1.17

[a] Note that within each cell describing the associations and alliances, the associations are shown first and alliances second.

Association was common among all systems mapped in Fish Springs NWR except Lost Spring. The Saltgrass Association was present at six of eight mapped systems, but it was only the dominant association at North Springs. A mix of Baltic rush and saltgrass was also a common vegetation association, occurring at six of eight springs sampled. Phragmites was also present in six of eight systems. However, where phragmites occurred, it was the dominant vegetation association, except at Walter Spring and Lost Spring. At Walter Spring Baltic rush was the dominant vegetation association, and Saltgrass mixed with Baltic rush was the dominant association at Lost Spring.

Keleher et al. (2003) found grasses, spike rush, and Baltic rush to be the dominant vegetation species at Fish Springs NWR. Vegetation listed in Stolley et al (1999) matches closely with vegetation found during the vegetation mapping. Mapping efforts also confirm findings in Keleher et al. (2003).

Twenty different vegetation associations and 25 species (Appendix C) were identified at Fish Springs NWR during the vegetation mapping effort. Most of the springs we mapped had a similar vegetation community. Deadman Spring and Thomas and Middle Springs were least diverse, with six vegetation associations identified at each.

Fishes

Least chub, Utah chub (*Gila atraria*), speckled dace (*Rhinichthys ocsculus*), and western mosquitofish (*Gambusia affinis*) have all been found in Fish Springs NWR, although speckled dace are reported as uncommon (USFWS 2000, Mills et al. 2004a, Mills et al. 2004b). In our surveys, we captured all species except for least chub and speckled dace. We specifically avoided sampling for fish at the two locations occupied by least chub in recent years (Walter and Deadman Springs), since the UDWR has had an ongoing monitoring program for re-introduced least chub at these two areas. In 1996 and 1997 Walter's and Deadman springs were chemically treated to remove western mosquitofish (Mills and Wilson 2006). Perkins et al. (1998) noted the successful treatment and reintroduction of least chub to the Fish Springs NWR. Mills et al. (2004a) and Wilson and Davidson (2003) indicate that least chub populations in the refuge remained healthy through 2000, but that mosquito fish were observed to have re-invaded least chub habitat. Mosquitofish apparently regained access to Walter's Spring in 2000 when the eastern side of the spring eroded, enabling an influx of fishes from the adjacent marsh. Information from the UDWR and from USFWS, from 2000, 2003, and 2006 indicated the presence of all of the aforementioned species, with the exception of least chub in recent years. Least chub in Fish Springs NWR were last observed by UDWR in 2001 (USFWS 2000, Wilson and Davidson 2003, USFWS 2004a, Mills and Wilson 2006).

We performed fish surveys at all of the springs sampled with the exception of Walter's and Deadman Springs, in order to minimize potential impacts to those areas that have been monitored for least chub by UDWR and other groups (Table 22). Utah chub were captured using minnow traps at Lost, Percy, South, North, and Thomas Springs in sizes ranging from 36 to 106 mm. Numbers of Utah chub collected from individual springs ranged from 0-765 fish. We did not find any Utah chub at Middle, House, or Mirror springs, while North Spring had the highest number of Utah chub collected at any of the systems sampled. Western mosquitofish were also captured using minnow traps. They were present in all the springs sampled with the exception of North Spring. The numbers of Western mosquitofish observed during our collections ranged from 0-160 fish. We found the highest number of western mosquitofish at Percy Springs; we did not find any at North Spring. No speckled dace or least chub were observed or collected during our sampling efforts.

Table 22. Fish collections at springs of interest in Fish Springs NWR, Juab County, Utah.

SPRING NAME	SOURCES[a]	LEAST CHUB	UTAH CHUB	SPECKLED DACE[b]	WESTERN MOSQUITOFISH
Crater Spring	1	A	A	A	P
Deadman Spring[c]	2, 3	A	A	A	P
House Spring	1	A	A	A	P
Lost Spring	1	A	P	A	P
Middle Spring	1	A[d]	A	A	P[e]
Mirror Spring	1	A	A	A	P
North Spring	1	A	P	A	A
Percy Spring	1	A	P	A	P
South Spring	1	A	P	A	P
Thomas Spring	1	A	P	A	P
Walter's Spring[c]	2, 3	A	A	A	P

[a] 1 = BIO-WEST survey and/or reconnaissance, 2 = UDWR (Perkins et al. 1998, Wilson and Davidson 2003, Mills and Wilson 2006), 3 = Other (Mills et al. 2004).
[b] Speckled dace reported as present but uncommon (USFWS 2000); however, none were collected or observed during our efforts.
[c] No BIO-WEST fish sampling, because of preexisting UDWR sampling programs.
[d] Absent.
[e] Present.

Since least chub has been a species of concern since the 1970s, many surveys have been undertaken to determine the distribution and abundance of least chub throughout the Bonneville Basin (Perkins et al. 1998). Workman et al. (1979) sampled historical least chub habitat throughout the Bonneville Basin in the late 1970s and found that Snake Valley was the only area containing remnant populations. Since the reintroduction of least chub into Walter's and Deadman Springs on the Fish Springs NWR, and since the completion of the Least Chub Conservation Agreement and Strategy in 1998, the UDWR has had an ongoing monitoring program for least chub in Fish Springs NWR (Perkins et al. 1998, Wilson and Davidson 2003, Mills and Wilson 2006). Least chub have not been found in Deadman Spring since 1999, while the last observation of least chub at Walter's Spring occurred in 2001 (Mills et al. 2004a, Mills and Wilson 2006). Mills and Wilson (2006) as well as Mills et al. (2004a) indicate that least chub have suffered from competition as well as from predation by Western mosquitofish since the re-invasion of this species in Walter's and Deadman Springs. Mills and Wilson (2006) indicate that continued monitoring of least chub at Fish Springs NWR will be discontinued during future years and that other potential reintroduction sites will be evaluated.

Amphibians

Fish Springs NWR is home to at least two amphibian species including the native northern leopard frog (*Rana pipiens*) and the nonnative bullfrog (*Rana catesbeiana*). The USFWS (2000, 2004a) generally indicates that both species may have been introduced to the refuge and that the northern leopard frog population appears to be increasing (through 2000), while nonnative bullfrogs appear to be thermally distributed, typically inhabiting the warmer sections of the refuge.

We observed a number of amphibians during our surveys at Fish Springs NWR (Table 23). As noted previously, our visual encounter surveys were not very intensive and occurred during daylight hours when adult frogs are less likely to be active and observed. Additionally, egg masses are often found out in open water and away from the margins of the spring system where our visual surveys took place. Most of the springs we visited contained frogs. We observed bullfrogs in Middle, House, Walter's, South, Percy, and Lost Springs. Northern leopard frogs were found in House, South, Crater, and Lost Springs. There were 110 unknown frogs in Middle, Thomas, and South Springs. We assume that these smaller frogs were either juvenile bullfrogs or adult northern leopard frogs, but we could not get close enough to make a positive identification. Other than adults and juveniles, no other life stages of frogs were observed during our visits to the refuge.

Springsnails and Invertebrates

Frest 1996, Hovingh 1998, and Sada (2005a) listed two species of springsnails in the Fish Springs NWR. We found both species during our springsnail surveys at the aquatic systems of interest in Fish Springs NWR (Table 24). In Middle, North, House, Mirror, South, Percy, Crater, and Lost Springs, at least one species of springsnail was present (*P. kolobensis* and/or *T. protea*). Thomas Spring contained one species of springsnail (*P. kolobensis*). No springsnails were observed at any of the sites sampled at Deadman Spring, or Walter's Spring. While at least one species of snail was present at all but Deadman Spring and Walter's Spring, springsnails were not necessarily present at each site sampled within a given spring. Thomas Spring was the only location where springsnails were present at all sites sampled.

Table 23. Amphibian sightings at aquatic systems of interest in Fish Springs NWR, Juab County, Utah.

SYSTEM	SOURCES[a]	NORTHERN LEOPARD FROG	BULLFROG	UNIDENTIFIED FROG
Crater Spring	1, 2	P1	A1	A1
Deadman Spring	1, 2	A1	A1	A1
House Spring	1, 2	P1	P1	A1
Lost Spring	1, 2	P1	P1	A1
Middle Spring	1, 2	A1[b]	P1[c]	P1
Mirror Spring	1, 2	A1	A1	A1
North Spring	1, 2	A1	A1	A1
Percy Spring	1, 2	A1	P1	A1
South Spring	1, 2	P1	P1	P1
Thomas Spring	1, 2	A1	A1	P1
Walter's Spring	1, 2	A1	P1	A1

[a]1 = BIO-WEST survey and/or reconnaissance, 2 = USFWS (2000, 2004a) generally indicate that both species are present throughout the refuge; however, precise locations are unspecified, thus P/A are only based on BIO-WEST data.
[b]Absent through visual observation.
[c]Present through visual observation.

Table 24. Springsnail species present at aquatic systems of interest throughout Fish Springs NWR, Juab County, Utah.

SYSTEM	SOURCES[a]	*P. KOLOBENSIS*	*T. PROTEA*
Crater Spring	1	P	P
Deadman Spring	1	A	A
House Spring	1, 3	P	P
Lost Spring	1	P	P
Middle Spring	1, 3	P[b]	P
Mirror Spring	1, 2	P	P
North Spring	1, 2, 3	P	P
Percy Spring	1, 3	P	P
South Spring	1, 2, 3	P	P
Thomas Spring	1, 3	P	A[c]
Walter's Spring	1	A	A

[a] 1 = BIO-WEST survey and/or reconnaissance, 2 = Sada (2005a), 3 = Unpublished permit or other reports obtained from USFWS [Frest (1996), and/or Hovingh (1998)].
[b] Present through visual observation.
[c] Absent through visual observation.

Other investigations found that the Toquerville springsnail was widespread at Fish Springs NWR, while desert tryonia were less common (Frest 1996, Hovingh 1998, Sada 2005a). Frest (1996) found desert tryonia to be a rarer species, with live collections occurring only at North, House, and Middle Springs.

Hovingh (1998) noted changes in the molluscan species on Fish Springs NWR between 1986-1997. Hovingh (1998) further indicated the introduction of *Melanoides tuberculata* sometime between 1993 and 1996 at Fish Springs NWR. Recent efforts by Rader et al. (2003) highlight the widespread and invasive nature of *M. tuberculata*. They found that melanoides has become one of the most abundant species in the entire Fish Springs complex, that melanoides dominance occurred rapidly within a span of 5 to 8 years after introduction, and that average densities of the invasive species range from 4,895-7,340 organisms/m^2 (Rader et al. 2003). Our investigations also show the overall dominance of *M. Turburculata* (Table 25, Appendices D and E).

Macroinvertebrates obtained from Fish Springs NWR were collected at all springs indicated in Table 25. Macroinvertebrates were collected at Middle, Thomas, North, Deadman, House, Mirror, Walter's, South, Percy, Crater, and Lost springs in July and August 2006. In those samples EcoAnalysts identified 63 individual taxa of aquatic invertebrates (Table 25, Appendices D and E). The total number of invertebrate taxa identified from our samples at each spring varied between 16 and 26, with House Spring having the most individual taxa and Crater Spring having the least.

Crustaceans (Amphipoda and Ostracoda) were present at all systems sampled and represented at least one of the three most-abundant taxa in all springs (Appendix E). We found the invasive snail, *Melanoides tuberculata*, in all of our collections except those taken in Deadman Spring and Walter's Spring. In those springs where *M. tuberculata* was found, it was also one of the most dominant taxa. The number of mayfly, stonefly, and caddisfly taxa within the various springs on the refuge was similar overall, but numbers of these taxa were higher at Mirror Spring and Walter's Spring. EcoAnalysts found no springsnails in our macroinvertebrate samples from Deadman Spring and Walter's Spring, so springsnail numbers must have either been low in relation to other invertebrates or they were only present in areas downstream of our survey sites. At sites they surveyed within the Fish Springs NWR, Keleher et al. (2003) found that mollusks had the highest relative abundance and odenates were relatively abundant. While we found that mollusks were one of the three most-abundant taxa at all of the aquatic systems of interest, odenates were only one of the three most-abundant taxa within North Spring. Seed shrimp and scuds (Ostracoda and Amphipoda) and midges (Chironomidae) were typically one of the three most-abundant species in many locations. *Callibaetis* sp. was one of the most-dominant taxa in Mirror and Walter's Springs. We may have collected higher numbers of many of these species because we used a smaller mesh size (250-500 microns) in our sampling devices than did Keleher et al. (2003) (1,000 microns).

Table 25. Total number of invertebrate taxa; mayfly, stonefly, and caddisfly taxa (EPT taxa); taxa in the Phylum Mollusca; taxa in the Order Odonata; and taxa in the Subphylum Crustacea at aquatic systems of interest throughout Fish Springs NWR in Juab County, Utah.

SYSTEM	TOTAL TAXA	EPT TAXA	MOLLUSCA TAXA	ODONATA TAXA	CRUSTACEA TAXA
Crater Spring	16.00	2.00	3	2	2
Deadman Spring	24.00	1.00	2	2	2
House Spring	26.00	2.00	3	3	2
Lost Spring	22.00	5.00	4	3	2
Middle Spring	20.00	2.00	5	3	2
Mirror Spring	25.00	3.00	3	3	2
North Spring	21.00	4.00	5	2	2
Percy Spring	18.00	1.00	3	3	2
South Spring	20.00	4.00	4	4	2
Thomas Spring	17.00	4.00	3	3	2
Walter's Spring	27.00	4.00	2	5	3

Other Fauna

While surveying aquatic systems of interest in Fish Springs NWR, we found a variety of other wildlife utilizing these spring systems and their associated habitat. We observed many birds including Canada geese, mallards (*Anas platyrhynchos*), gadwalls (*Anas strepera*), European starlings (*Sturnus vulgaris*), snowy egrets (*Egretta thula*), kestrals *(Falco sparverius*), white-faced ibises (*Plegadis chihi*), coots (*Fulica* spp.), great blue herons (*Ardea herodias*), black-crowned night herons (*Nycticorax nycticorax*), northern harrier, killdeer (*Charadrius vociferus*), common nighthawk *(Chordeiles minor)*, Bullock's oriole (*Icterus bullockii*), ravens (*Corvus corax*), western meadowlarks, sage thrashers (*Oreoscoptes montanus*), barn swallows (*Hirundo rustica*), and several unidentified songbirds, sparrows, and owls.

We also saw, or saw sign of, coyotes (*Canis latrans*), desert cottontails (*Sylvilagus audubonii*), black-tailed jackrabbits, unidentified voles (*Muridae* spp.), mule deer (*Odocoileus hemionus*), and/or pronghorn (*Antilocapra americana*). We also noted several unidentified lizards and a single garter snake (*Thamnophis* spp.).

Disturbance

We categorized the aquatic systems of interest in Fish Springs NWR as moderately to highly disturbed (Table 26). Most of the systems of interest we highly impacted by diversion, berming and ditching from the historic frog farm that occupied the site prior to the development of the NWR. Also, since 1961, the refuge has had dikes, ponds, ditches, and water-control structures installed to manage the area for waterfowl (http://www.fws.gov/fishsprings/Building%20 the%20Refuger.htm). However, aside from these historical diversion impacts, and the presence of nonnative fish, amphibian, invertebrate, and plant species, most of the systems had few impacts. We felt that Thomas Spring and Crater Spring were only moderately impacted (Figure 5). Both of these areas appeared to have relatively fewer impacts from nonnative species, roads, and/or diversion structures. Conversely, we feel that Deadman Spring and Percy Spring provide examples of more highly impacted springs of those we evaluated on the refuge (Figure 6).

Table 26. Disturbance level and factors at aquatic systems of interest throughout the Fish Springs NWR, Juab County, Utah.

SYSTEM	DISTURBANCE LEVEL	DISTURBANCE FACTORS
Crater Spring	Moderate	Nonnative Species, Roads, Diversion
Deadman Spring	High	Nonnative Species, Roads, Diversion
House Spring	Moderate/High	Nonnative Species, Roads, Diversion
Lost Spring	Moderate/High	Nonnative Species, Roads, Diversion
Middle Spring	Moderate/High	Nonnative Species, Roads, Diversion
Mirror Spring	Moderate/High	Nonnative Species, Diversion
North Spring	Moderate/High	Nonnative Species, Roads, Diversion
Percy Spring	High	Nonnative Species, Roads, Diversion
South Spring	Moderate/High	Nonnative Species, Roads, Diversion
Thomas Spring	Moderate	Nonnative Species, Roads, Diversion
Walter's Spring	Moderate/High	Nonnative Species, Diversion

Comparing our information with surveys listed in Sada (2005a), we found that we generally rated systems as more heavily disturbed. The USFWS (2004a) recognizes the threat of invasive/ nonnative species, as well as issues associated with roads and human disturbance. This same document provides management direction and actions to alleviate disturbances on the refuge and demonstrates that these systems are managed (USFWS 2004a).

Figure 5. Photographs of systems in Fish Springs National Wildlife Refuge (NWR) we classified as only moderately disturbed: (a) Thomas Spring thermal pool (top), and (b) Crater Spring head pool (bottom).

Figure 6. Photographs of systems in Fish Springs National Wildlife Refuge (NWR) we classified as highly disturbed: (a) Deadman Spring head (top) and (b) Percy Spring canal (bottom).

Snake Valley

Snake Valley straddles the Nevada/Utah border and is bounded by the Deep Creek Mountains and Snake Range to the west and the Confusion Range to the east. Past survey efforts have shown that Snake Valley is home to a number of unique fish, amphibian, and invertebrate species (Sigler and Workman 1975, Workman et al. 1979, Cuellar 1994, Ross et al. 1994, Hershler 1998, Perkins and Lentsch 1998, Perkins et al. 1998, Oliver and Bosworth 1999, Fridell et al. 2004, Wheeler et al. 2004, Mills et al. 2005, Sada 2005a). Two Conservation Agreement species, the least chub and the Columbia spotted frog, inhabit the Snake Valley. Additionally, several species of springsnail, including the endemic sub globose Snake springsnail (*Pyrgulopsis saxatilis*), are found in the Snake Valley.

Least chub is a small minnow endemic to the Bonneville Basin of Utah (Hubbs and Miller 1948, Sigler and Sigler 1996, Perkins et al. 1998). Least chub populations were once found in a variety of areas throughout the Bonneville Basin, but since populations began declining in the 1940s the least chub is currently restricted to several populations in the Snake Valley in Millard County and Juab County, Utah, as well as three more recently discovered populations in Mills Valley and Juab Valley in Juab County and at Clear Lake Waterfowl Management Area in Millard County (Wheeler et al. 2004, Wilson and Mills 2005). Because of declines in the distribution and abundance of least chub, the USFWS proposed to list the species as endangered in 1995. Listing was precluded when the State of Utah developed a Conservation Agreement and Strategy for the species (Perkins et al. 1998).

The sub globose Snake springsnail was first described at Gandy Warm Springs in 1998, and it is assumed to be endemic to this area (Oliver and Bosworth 1999). The original description indicates that the sub globose Snake springsnail was common in a series of springs (assumed to be the main pool) at Gandy Warm Springs (Oliver and Bosworth 1999). The sub globose Snake springsnail and two of the other three species of springsnail known to occur in the Snake Valley, the longitudinal gland springsnail (*Pyrgulopsis anguina*) and the bifid duct springsnail (*Pyrgulopsis peculiaris*), are on the State of Utah's Sensitive Species List and the State of Nevada's Rare (At-risk) Species List (NVNHP 2004, UDWR 2005). The longitudinal gland springsnail is endemic to Snake Valley (Hershler 1998, Nichols 2005). The least chub, Columbia spotted frog, bifid duct springsnail, longitudinal gland springsnail, and sub globose Snake springsnail should all be considered significant biological resources in Snake Valley.

Twenty-two aquatic systems of interest were identified in Snake Valley, and we performed Level 2 surveys at 28 sites within 21 of those systems (Figure 7, Table 27). We did not survey at Redden Springs because we were denied access by the private landowner.

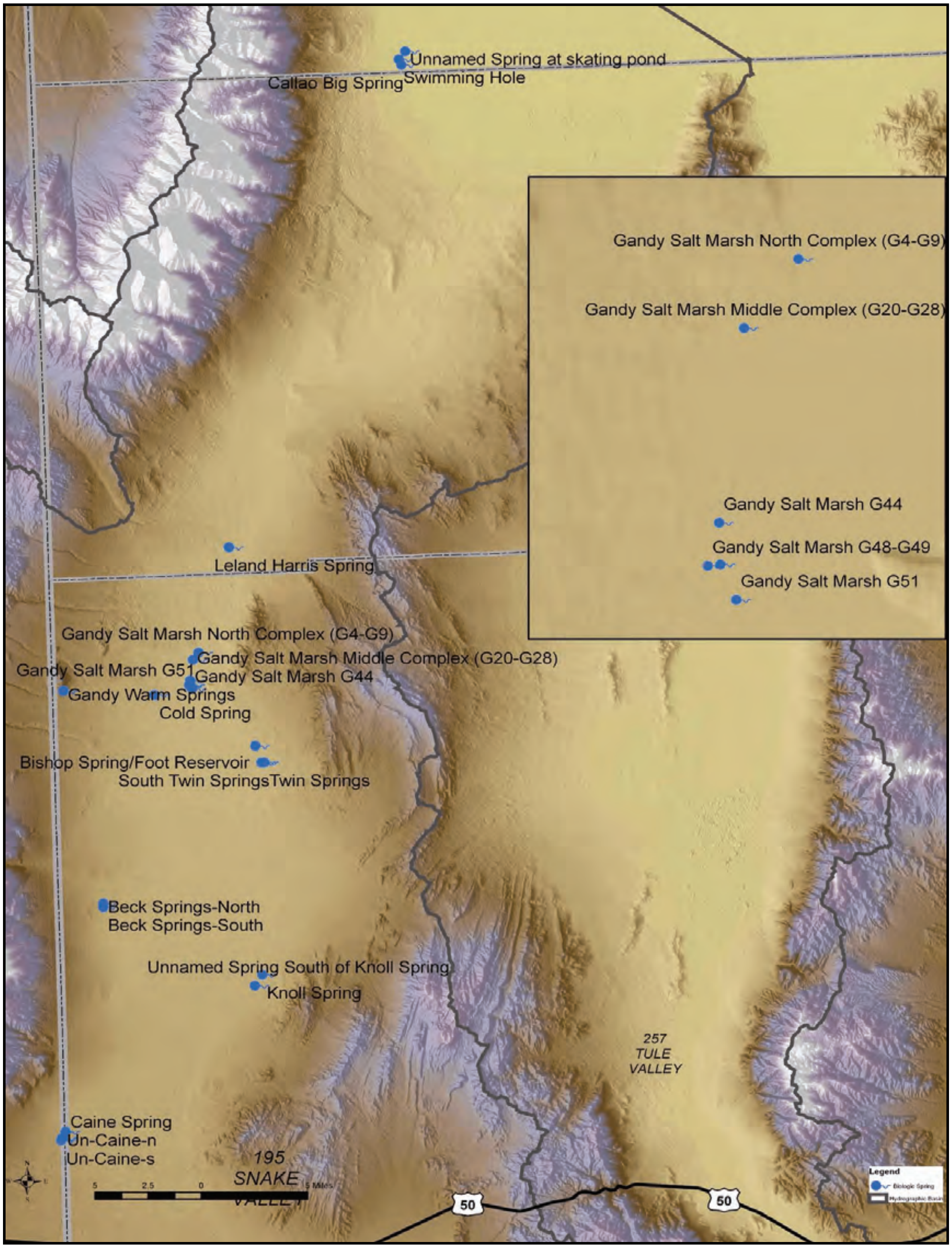

Figure 7a. **Map of locations of aquatic systems of interest within Upper Snake Valley in Millard County and Juab County, Utah, and White Pine County, Nevada.**

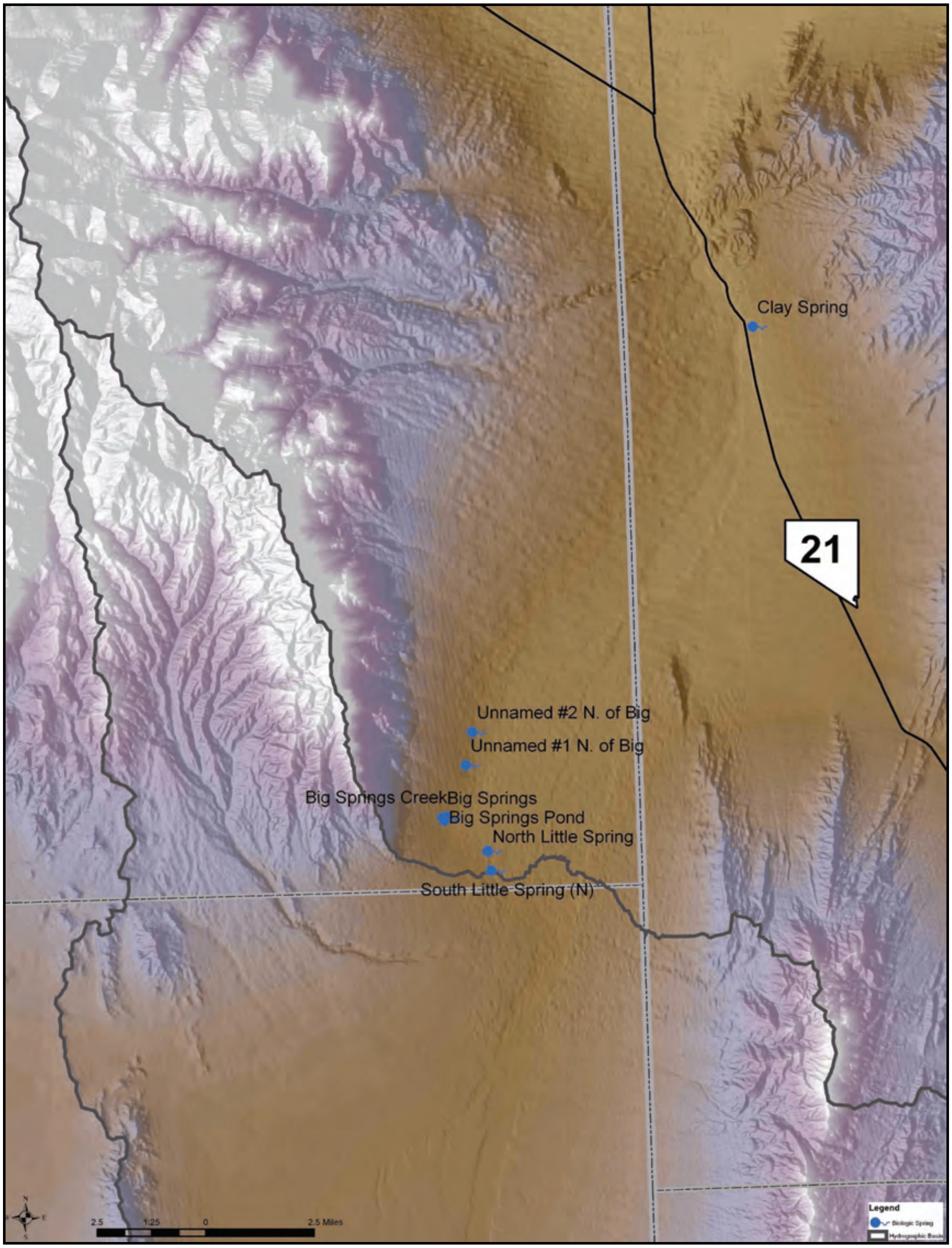

Figure 7b. **Map of locations of aquatic systems of interest within Lower Snake Valley in Millard County, Utah, and White Pine County, Nevada.**

Table 27. State, County, UTM location, survey date, survey level, and ownership of aquatic systems of interest throughout Snake Valley in Millard County and Juab County, Utah, and White Pine County, Nevada.

SYSTEM	STATE	COUNTY	NORTHING	EASTING	SURVEY DATE	BIO-WEST SURVEY LEVEL	OWNERSHIP
Big Springs	NV	White Pine	4287479	749320	8/30/05	Level 2	Private
Big Springs Pond	NV	White Pine	4287364	749384	8/30/05	Level 2	Private
Big Springs Creek	NV	White Pine	4287508	749487	8/30/05	Level 2	Private
Beck Springs - North	UT	Millard	43545XX[a]	7580XX[a]	7/18/06	Level 2	Private
Beck Springs - South	UT	Millard	43543XX[a]	7580XX[a]	7/18/06	Level 2	Private
Bishop Springs/Foote Reservoir	UT	Millard	43666XX[a]	2529XX[a]	7/18/06	Level 2	Utah
Caine Spring	NV	White Pine	4336276	755087	9/16/04	Level 2	Public/BLM
Callao Big Spring	UT	Tooele	4421004	267694	8/22/06	Level 2	Private
Clay Spring	UT	Millard	4306105	240249	3/3/05	Level 2	Public/BLM
Cold Spring	UT	Millard	4371461	245557	3/5/05	Level 2	Public/BLM
Gandy Salt Marsh North Complex (G4-G9)	UT	Millard	43744XX[a]	2491XX[a]	7/17/06	Level 2	Public/BLM
Gandy Salt Marsh Middle Complex (G20-G28)	UT	Millard	43739XX[a]	2487XX[a]	7/17/06	Level 2	Public/BLM
Gandy Salt Marsh G44	UT	Millard	43722XX[a]	2484XX[a]	7/19/06	Level 2	Public/BLM
Gandy Salt Marsh G48-G49	UT	Millard	43718XX[a]	2483XX[a]	7/19/06	Level 2	Public/BLM

Table 27. Continued.

SYSTEM	STATE	COUNTY	NORTHING	EASTING	SURVEY DATE	BIO-WEST SURVEY LEVEL	OWNERSHIP
Gandy Salt Marsh G51	UT	Millard	43715XX[a]	2485XX[a]	7/19/06	Level 2	Public/BLM
Gandy Warm Springs	UT	Millard	4372028	754911	3/4/05	Level 2	Public/BLM
Knoll Spring	UT	Millard	4348069	252260	8/23/06	Level 2	Public/BLM
Leland Harris Spring	UT	Juab	43830XX[a]	2519XX[a]	6/17/05	Level 2	Public/BLM
Miller Spring	UT	Juab	43850XX[a]	2539XX[a]	3/5/05	Level 2	Public/BLM
North Little Spring	NV	White Pine	4286205	751006	6/16/05	Level 2	Private
Redden Springs	UT	Tooele	4430215	269533	None	Denied access	Private
South Little Spring	NV	White Pine	4285465	751137	9/17/04	Level 2	Public/BLM
Swimming Hole	UT	Tooele	4421468	267536	8/22/06	Level 2	Private
Twin Springs	UT	Millard	43654XX[a]	2532XX[a]	3/5/05	Level 2	Public/BLM
Unnamed Spring at Skating Pond	UT	Tooele	4422122	268034	8/22/06	Level 2	Private
Unnamed Spring South of Knoll Spring	UT	Millard	4347420	251571	3/3/05	Level 2	Public/BLM
Unnamed Spring South of Caine Spring	NV	White Pine	4335704	754794	9/16/04	Level 2	Public/BLM
Unnamed Big Spring #1	NV	White Pine	4289474	750192	9/17/04	Level 2	Private
Unnamed Big Spring #2	NV	White Pine	4290727	750426	9/17/04	Level 2	Public/BLM

Note: The UTM coordinates are in the NAD 83 projection system.
[a]Full location withheld at the request of the Utah Division of Wildlife Resources.
[b]Water quality information from Sada (2005a).

Physical Habitat and Water Quality

We found that the size and depth of aquatic systems in Snake Valley varied considerably (Table 28). Caine Spring, Cold Spring, Knoll Spring, and the Unnamed Spring south of Caine Springs were all fairly small systems. Miller Spring, Leland Harris Springs, and Twin Springs North and South fed extensive marsh systems. Gandy Salt Marsh is a series of marshes comprised of over 50 spring heads. Big Springs and Gandy Warm Springs represented the origin of spring brook streams that continue to flow for several kilometers (km). Big Springs Creek flows for approximately 25.5 km,10.5 km of which are in Nevada, before terminating in Pruess Lake, Utah. Gandy Warm Creek historically flowed for about 8 km before feeding into the Gandy Salt Marsh.

Table 28. Type of system, maximum depth, maximum wetted width, and length of survey plots, as well as measured discharge found at aquatic systems of interest throughout Snake Valley in Millard County and Juab County, Utah, and White Pine County, Nevada.

SYSTEM	SYSTEM TYPE	MAXIMUM DEPTH (cm)	MAXIMUM WETTED WIDTH (m)	LENGTH (m)	DISCHARGE (l/s)
Big Springs	Rheocrene	67	19	150[a]	51.17
Big Springs Creek	Brook/stream	76	6	200[a]	249.82
Big Springs Pond	Unknown	200	100	150[b]	N/A
Beck Springs-North	Limnocrene	228	13.5	200[a]	2.7
Beck Springs-South	Helocrene	41	23	110	N/A
Bishop Springs/ Foote Reservoir	Unknown	437	70	241[a]	95.49
Caine Spring	Rheocrene	120	24	45	0.188
Callao Big Spring	Limnocrene	63.5	55	240[a]	N/A
Clay Spring	Limnocrene	20.5	7	202	N/A
Cold Spring	Limnocrene	15	35	122	N/A
Gandy Salt Marsh North Complex (G4-G9)	Helocrene	25-168	N/A	1.19-9.1[a]	N/A
Gandy Salt Marsh Middle Complex (G20-G28)	Helocrene/ Limnocrene	8-81	N/A	2.5-10.1[a]	N/A

Table 28. Continued.

SYSTEM	SYSTEM TYPE	MAXIMUM DEPTH (cm)	MAXIMUM WETTED WIDTH (m)	LENGTH (m)	DISCHARGE (l/s)
Gandy Salt Marsh G44	Rheocrene	81	14	240[a]	N/A
Gandy Salt Marsh G48-G49	Helocrene	173	6	350[a]	N/A
Gandy Salt Marsh G51	Limnocrene	218	14	200[a]	N/A
Gandy Warm Springs	Limnocrene	57	5	214[a]	325.77
Knoll Spring	Dry	Dry	Dry	23	Dry
Leland Harris Spring	Limnocrene	182[c]	7	208[a]	N/A
Miller Spring	Limnocrene	244-305[d]	41	173[a]	13.00
North Little Spring	Limnocrene	100	47	143	N/A
South Little Spring	Unknown	55	30	206	N/A
Redden Spring[e]	Rheocrene	4	1	N/A	N/A
Swimming Hole	Limnocrene	23	11	26	N/A
North Twin Spring	Limnocrene	244	25	193[a]	39.98
South Twin Spring	Limnocrene	183	35	292[a]	42.05
Unnamed spring south of Knoll Spring	Unknown	83	19	72	0.196
Unnamed spring at Skating Pond	Helocrene	15	126	126	N/A
Unnamed Big Spring #1	Rheocrene	15	5.6	3.8[a]	N/A
Unnamed Big Spring #2	Rheocrene	41	14	36[a]	N/A
Unnamed Spring South of Caine Spring	Helocrene	50	16	61	N/A

[a] Continued further as a spring brook, marsh land, or onto private property.
[b] Length of the pond.
[c] Depth taken from UDWR 2002 unpublished data.
[d] Depth visually estimated.
[e] Data taken from Sada (2005a).

We calculated the volume of water discharged from many of the systems of interest in Snake Valley and found that discharge at the systems of interest was also quite variable. As one might expect, we calculated that the greatest volume of water discharged from the two large stream systems, Big Springs Creek and Gandy Warm Springs Creek. Big Springs Creek gained a large volume of discharge (~ 20 l/s) between the spring heads and the downstream area of the creek that we surveyed. We received a report from local landowner that Big Springs Creek is a gaining stream, meaning that it gains in water volume discharged in a downstream direction.

The gain in discharge indicates groundwater continues to come in through small seeps, or the stream bed, throughout the length of the creek. BIO-WEST, Inc. (2002) found flows in Gandy Warm Creek to be controlled by discharge at the main pool and fairly constant throughout the year. They also found a short gaining reach not far downstream from the main pool, after which the stream began to lose discharge volume to evapotranspiration and groundwater.

The UDWR has collected length, width, and depth measurements in areas where they sampled for Columbia spotted frog and least chub in the Snake Valley (Fridell et al. 2004, Wheeler et al. 2004, Mills et al. 2005, Wilson and Mills 2005, UDWR unpublished data). They have sampled larger portions of Gandy Salt Marsh, Leland Harris, Miller, and Bishop/Twin Springs than we did during our surveys. They found a wide range of depths and sizes for individual spring heads within those areas. Their data show fairly large, annual variations in the size and depth of Twin Springs North and South.

Some of the measured water quality parameters also varied widely at aquatic systems of interest in Snake Valley (Table 29), although we found that pH was fairly stable and neutral (6.85 - 8.54) throughout the aquatic systems of interest. Temperature varied widely between systems and sometimes between the source and the terminus within a system. Bishop Springs/Foote Reservoir, Callao Big Spring, Gandy Warm Spring, Twin Springs North, and the Unnamed Spring north of Big Spring #2 all had source temperatures greater than 20° C, while Twin Springs South and Cold Spring had source temperatures lower than 10° C. Dissolved oxygen also varied widely between the springs, from a low of 1.5 mg/l at the source of G24 in Gandy Salt Marsh complex to a high of 8.66 mg/l at the terminus of Cold Spring. The G48 in the Gandy Salt Marsh complex, Miller Spring, South Little Spring, and Swimming Hole all had conductivity measurements exceeding 1,100 μS/cm, while Big Springs and North Little Spring had conductivity measurements lower than 400 μS/cm.

Table 29. Selected water quality parameters measured at the main source and the terminus or termination of the sampling site for aquatic systems of interest throughout Snake Valley in Millard County and Juab County, Utah, and White Pine County, Nevada.

SYSTEM	LOCATION	TEMPERATURE (C)	DISSOLVED OXYGEN (mg/l)	CONDUCTIVITY (µS/cm)	pH
Big Springs	Source/terminus	17.2/17.8	4.9/5.53	379.9/380.3	7.59/7.75
Big Springs Pond	Pond	21.03	6.07	401.1	8.54
Big Springs Creek	Creek	17.75	6.2	382.6	7.76
Beck Springs - North	Source/terminus	15.83/16.94	7.78/7.11	456/463	7.65/7.84
Beck Springs - South	Source/terminus	17.5/21.67	7.37/8.23	494/488	4.47/7.40
Bishop Springs/ Foote Reservoir	Source/terminus	22.5/22.17	5.39/6.46	780/783	7.46/7.5
Caine Spring	Source/terminus	15.56/19.3	5.28/6.24	452/448	7.60/7.61
Callao Big Spring	Source/terminus	20.06/22.5	6.65/5.15	701/702	8.12/7.84
Clay Spring	Source/terminus	13.2/13.5	2.47/5.99	675/613	8.02/8.04
Cold Spring	Source/terminus	9.83/14.9	5.66/8.66	663/642	7.63/8.08
Gandy Salt Marsh North Complex (G4-G9)	Sources[a]	15.61-18.56	2.2-7.23	500-552	7.11-7.62
Gandy Salt Marsh Middle Complex (G20-G28)	Sources[a]	17.6-28.78	1.5-9.0	481-559	7.41-8.14
Gandy Salt Marsh G44	Source	14.61	2.4	581	7.57
Gandy Salt Marsh G48-G49	Sources[a]	12.89-13.28	3.63-6.55	760-1,173	7.47-7.55
Gandy Salt Marsh G51	Source	16.0	5.59	459	7.58
Gandy Warm Springs	Source/terminus	20.6/23.4	4.66/4.75	489/482	7.58/7.75
Knoll Spring	Dry	Dry	Dry	Dry	Dry

Table 29. Continued.

SYSTEM	LOCATION	TEMPERATURE (C)	DISSOLVED OXYGEN (mg/l)	CONDUCTIVITY (μS/cm)	pH
Leland Harris Spring	Source/terminus	14.1/15.0	3.77/3.08	598/597	8.31/8.25
Miller Spring	Source/terminus	11.8/10.3	4.91/8.20	1194/1510	7.48/7.67
North Little Spring	Source	19.1	3.97	386	7.75
South Little Spring	Source/terminus	11.3/15.5	4.10/2.74	1112/802	7.58/6.85
Redden Spring[b]	Source	18	7.9	877	8.0
Swimming Hole	Source	22.61	2.31	1,158	7.19
North Twin Spring	Source/terminus	20.7/20.5	5.21/6.57	749/749	7.64/7.98
South Twin Spring	Source/terminus	9.74/18.8	7.53/6.13	684/749	8.24/7.91
Unnamed Spring South of Knoll Spring	Source/terminus	16.3/13.2	5.34/2.47	638/675	7.69/8.02
Unnamed spring at Skating Pond	Source	18.94	4.03	531	7.86
Unnamed Spring South of Caine Spring	Source	16.1	2.78	566	7.06
Unnamed Big Spring #1	Source/terminus	14.8/13.5	4.61/4.44	464/456	7.17/7.03
Unnamed Big Spring #2	Source	22.2	7.59	618	7.07

[a] Multiple spring heads interlocked in a marsh system. We provide a range of the water quality measurements seen at the heads indicated.

The UDWR has also collected similar water quality information at Leland Harris Springs and Bishop/Twin Springs during least chub surveys (Wheeler et al. 2004, Wilson and Mills 2005, UDWR unpublished data) since 1993. Additionally, the UDWR has collected water quality data from these two springs, as well as Miller Spring, during Columbia spotted frog surveys (Fridell et al. 2004, Mills et al. 2004). Workman et al. (1979) collected water quality information from these springs, as well as Cold Spring and Caine Spring. Sada (2005b, pers. comm.) reports water quality parameters for all systems of interest in Snake Valley, except Caine Spring, North Little Spring, and South Little Spring. Generally, our measurements fell within the range of values reported for the aquatic systems of interest. Dissolved oxygen values in Workman et al. (1979)

were considerably higher than our values and values reported by other researchers. We also found that our dissolved oxygen measurements differed substantially from Sada (2005a) at several systems.

Aquatic Vegetation

Because of logistical problems, vegetation surveys of the Big Springs area were completed separately from the remainder of the survey. Big Springs Pond was dry when our vegetation crew returned to sample it. The landowner informed us that this pond is not spring fed, as it appeared, but created by diverted water from Big Springs. Additionally, our vegetation crew could not regain access to the private land where we surveyed Big Springs Creek. Therefore, no vegetation surveys were completed at these two locations. We identified 16 different taxa of SAV in the remaining aquatic systems of interest throughout Snake Valley (Table 30). Gandy Warm Springs had the greatest diversity of SAV with seven different species, while Big and Callao Springs, as well as an Unnamed Spring in Skating Pond, had the least diversity of SAV with only one species each. We found that horsehair algae was the most common SAV (found in 16 of 23 sites). The watercress group and muskgrass were found at about 50% of the sites we surveyed.

Fridell et al. (2004) listed water parsnip and water fern (*Azolla mexicana*) as being common SAV at least chub habitats in Snake Valley. We found water parsnip at only two sites (both associated with Caine Springs) and did not find water fern. Workman et al. (1979) found water parsnip at several sites in the Snake Valley, including Leland Harris Springs, Miller Spring, Twin Springs, and Caine Springs. Keleher et al. (2003) did not list water parsnip but found monkey flower at sites in Snake Valley. We also identified monkey flower in our list of EAV (Table 31), as did Workman et al. (1979). Since one or more researchers identified bittercress, monkey flower, watercress, and/or water parsnip in Snake Valley, one or more of these species probably comprises what we would call the watercress group at the aquatic systems of interest. While we listed one species of algae (and an unknown algae), Keleher and Barker (2004) found 14 taxa of algae in Leland Harris Springs, 28 taxa in Miller Spring, 50 taxa in the Gandy Salt Marsh complex, and 54 taxa in Bishop Springs, when their algal samples were identified by a taxonomic specialist.

We identified 74 different species of emergent vegetation at the aquatic systems of interest in Snake Valley (Table 31). We identified Baltic rush at 20 of the 25 aquatic systems of interest and spikerush at 18, making them the most common emergent plants found in our surveys of Snake Valley. Other common species included Nebraska sedge (*Carex nebrascensis*) rabbit-foot grass, redtop, and Olney's three square bulrush.

Table 30. Percent cover of submerged aquatic vegetation (SAV) found at aquatic systems of interest in Snake Valley, Millard and Juab Counties, Utah, and White Pine County, Nevada.

COMMON NAME	SCIENTIFIC NAME	SYSTEMS																						
		BIG	BISHOP	CAINE	CALLAO BIG	CLAY	COLD	GANDY SOUTH G44	GANDY WARM	KNOLL	LELAND HARRIS	MIDDLE GANDY COMPLEX [a]	MILLER	NORTH BECK	NORTH GANDY COMPLEX [a]	NORTH LITTLE	SOUTH BECK	SOUTH LITTLE	SWIMMING HOLE	TWIN	UNNAMED BIG 1	UNNAMED BIG 2	UNNAMED CAINE	UNNAMED SKATING POND
Algae	*Algae* sp.	-	-	-	-	-	-	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Brewer's Bittercress [b]	*Cardamine breweri*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	--	-	-	-	-	100	80	-	-
Coon's Tail	*Ceratophyllum demersum*	-	-	-	-	-	-	-	-	-	-	5	-	-	-	-	-	-	-	-	-	-	-	-
Common Duckweed	*Lemna minor*	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Duckweed	*Spirodela* sp.	-	-	-	-	-	-	-	-	-	-	-	< 2	-	-	50	-	-	-	-	-	-	-	-
Greater Duckweed	*Spirodela polyrhiza*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	< 2	-	-	-
Horsehair Algae	*Chlorophyceae* sp.	-	2	5	5	< 2	70	-	-	50	-	<2 - 100	30	10	5-90	-	5	20	95	40	-	-	-	2
Liverwort	*Riccia fluitans*	-	-	-	-	-	-	-	< 2	-	-	-	10	-	-	-	-	-	-	-	-	-	-	-
Monkey Flower	*Mimulus glabratus*	-	-	-	-	-	-	-	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Moss	*Philonotus hypnaceae*	-	-	-	-	-	-	-	< 2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Muskgrass	*Chara vulgaris*	-	2	< 2	-	40	5	-	5	-	80	-	5	-	-	-	10	60	-	20	-	-	-	-
Pondweed	*Potamogeton foliosus/ pectinatus*	-	<2	85	-	-	-	-	-	-	-	-	-	-	-	-	-	20	-	10	-	10	-	-
Spiny Naiad	*Najas marina*	-	-	-	-	-	-	-	5	-	-	-	-	-	-	-	-	-	-	20	-	-	-	-
Star Duckweed	*Lemna trisulca*	-	-	-	-	-	-	-	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Water Parsnip	*Berula bess*	-	-	5	-	-	-	-	-	-	-	-	-	-	5	-	-	-	-	-	-	-	40	-
Watercress [b]	*Rorippa nasturtium-aquaticum*	15	-	5	-	5	5	-	20	-	20	-	-	-	-	25	-	-	-	10	< 2	10	60	-

[a] Includes multiple springs.
[b] Watercress group.

Table 31. Percent cover of emergent aquatic vegetation (EAV) found at aquatic systems of interest in Snake Valley, Millard and Juab Counties, Utah, and White Pine County, Nevada.

COMMON NAME	SCIENTIFIC NAME	SYSTEMS																								
		BIG	BISHOP	CAINE	CALLAO BIG	CLAY	COLD	GANDY SOUTH G44	GANDY SOUTH G48-49	GANDY SOUTH G51	GANDY WARM	KNOLL [a]	LELAND HARRIS	MIDDLE GANDY COMPLEX [b]	MILLER	NORTH BECK	NORTH GANDY COMPLEX	NORTH LITTLE	SOUTH BECK	SOUTH LITTLE	SWIMMING HOLE	TWIN	UNNAMED BIG 1	UNNAMED BIG 2	UNNAMED CAINE	UNNAMED SKATING POND
Alkali Buttercup	*Ranunculus cumbalaria*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**5**	-	-	-	-	-
Alkali Cordgrass	*Spartina gracilis*	-	-	-	-	-	-	2	20	2	-	-	-	-	-	-	-	-	-	5	-	-	-	-	< 2	-
Alkali Sacaton	*Sporolobus airoides*	-	-	-	-	-	-	15	<2	-	< 2	-	-	-	-	-	-	-	-	10	-	-	-	-	5	-
Analogue Sedge	*Carex simulata*	-	-	-	-	-	-	-	-	-	-	-	-	5-20	-	-	10	-	-	-	-	-	-	-	-	-
Arrowhead	*Sagittaria* sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	< 2	-	-	-	-	-	-	-	-
Aster	*Symphyothrichum eatonii*	-	-	-	-	-	-	-	-	-	< 2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Aster	*Symphyotrichum* sp.	-	-	< 2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	< 2	-	-	-	-	-	2
Baltic Rush	*Juncus balticus*	40	-	5	20	10	25	55	70	70	5	35-70	30	15-60	40	-	50	10	-	20	40	20	-	-	2	5
Bidens	*Bidens* sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	10	-	-
Blue-eyed Grass	*Sisyrinchium demlssum*	-	-	-	-	< 2	< 2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Broadleaf Cattail	*Typha latifolia*	-	-	-	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	< 2	-	-	-	-
Brook Grass	*Catabrosa aquatica*	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Canada Goldenrod	*Solidago canadensis*	-	-	-	-	-	-	-	-	-	-	-	-	5-25	-	-	<2-15	-	-	-	-	-	-	-	-	-
Cinquefoil	*Potentilla* sp.	-	-	5	-	-	-	-	-	-	-	-	2	-	-	-	-	< 2	-	-	-	< 2	-	-	-	-
Cinquefoil	*Potentilla anserina*	-	-	-	-	-	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cinquefoil (Varileaf)	*Potentilla diversifolia*	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Clustered Field Sedge	*Carex praegracilis*	-	-	-	-	-	-	-	5	-	-	-	-	5	-	-	-	40	-	-	-	-	-	-	-	-
Cockleburr	*Xanthium strumarium*	-	-	2	-	-	< 2	-	-	-	-	-	-	-	-	<2	-	-	-	-	<2	-	-	-	< 2	10
Common Duckweed	*Lemna minor*	-	-	-	-	-	-	-	-	5	-	-	-	5-20	-	-	<2-20	-	2	-	-	-	-	-	-	2
Common Three Square	*Schoenoplectus pungens*	-	-	-	10	-	-	5	-	-	-	-	-	25-70	-	-	10	-	-	-	10	-	-	-	-	20
Curly Dock	*Rumex crispus*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<2	-	-	-	-	-	-	-	2	2	-
Evening Primrose	*Denothera elata*	-	-	-	-	-	-	-	-	-	< 2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Field Sowthistle	*Sonchus arvensis*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<2	-	-	-	-	-	-	-	-	-	-
Foxtail Barley	*Hordeum jubatum*	-	-	2	-	-	< 2	<2	-	<2	-	-	-	<2	-	-	-	-	<2	2	5	-	10	-	5	-

Table 31. Continued.

COMMON NAME	SCIENTIFIC NAME	SYSTEMS																								
		BIG	BISHOP	CAINE	CALLAO BIG	CLAY	COLD	GANDY SOUTH G44	GANDY SOUTH G48-49	GANDY SOUTH G51	GANDY WARM	KNOLL [a]	LELAND HARRIS	MIDDLE GANDY COMPLEX [b]	MILLER	NORTH BECK	NORTH GANDY COMPLEX	NORTH LITTLE	SOUTH BECK	SOUTH LITTLE	SWIMMING HOLE	TWIN	UNNAMED BIG 1	UNNAMED BIG 2	UNNAMED CAINE	UNNAMED SKATING POND
Fringed Willowherb	*Epilobium ciliatum*	-	-	-	-	-	-	-	<2	<2	-	-	-	<2	-	<2	<2	-	20	-	-	-	-	-	-	-
Giant Reed Grass	*Phragmites australis*	20	-	-	-	-	-	-	-	-	20	-	-	-	-	-	-	-	20	-	-	5	-	-	-	-
Goldenrod	*Solidago* sp.	-	-	-	-	-	-	-	-	-	-	-	< 2	-	-	-	-	-	-	-	-	-	-	-	-	-
Hardstem Bulrush	*Scirpus acutus*	-	-	-	<2	-	-	-	5	-	-	-	20	-	2	5	-	-	-	-	-	-	-	-	-	-
Horehound	*Marrubium vulgare*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<2	-	-	-	-	-	-	-
Horsetail	*Equisetum* sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-
Indian Hemp	*Apocynum cannabinum*	-	-	-	-	-	-	-	-	-	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Kentucky Bluegrass	*Poa pratensis*	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Maidenhair Fern	*Adiantum* sp.	-	-	-	-	-	-	-	-	-	< 2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mint	Lamium sp.	-	-	-	-	-	-	-	-	<2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Monkey Flower	*Mimulus guttatus*	-	-	-	-	-	-	-	-	-	-	-	< 2	-	-	-	-	< 2	-	-	-	-	-	< 2	-	-
Musk Thistle	*Carduus nutans*	-	-	-	<2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	<2
Nebraska Sedge	*Carex nebrascensis*	-	-	15	-	20	5	-	-	-	-	< 2-5	-	-	-	30	5	40	-	5	-	-	-	5	30	3
Nuttall Sunflower	*Helianthus nuttallii*	-	-	-	<2	-	-	-	-	-	< 2	-	-	-	-	-	-	-	-	-	<2	-	-	-	-	2
Prickly Lettuce	*Lactuca serriola*	-	-	< 2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Paintbrush	*Castilleja* sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Panicle Aster	*Symphyotrichum lanceolatum*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5	-	-	-	-	-	-
Purple-fringed Riccia	*Ricciocarpus natans*	-	-	-	-	-	-	-	-	-	-	-	-	<2-5	-	-	-	-	-	-	-	-	-	-	-	2
Purple Loosestrife	*Lythrum lineare*	-	-	-	-	-	-	-	-	-	< 2	-	-	-	-	-	-	-	-	< 2	-	-	-	-	-	-
Rabbitsfoot Grass	*Polypogon monspeliensis*	-	<2	2	5	< 2	-	-	-	-	-	-	< 2	-	2	<2	-	-	-	2	5	2	30	2	< 2	2
Redtop	*Agrostis gigantea*	20	5	2	-	5	5	-	-	-	< 2	-	-	-	-	2	-	-	<2	-	-	2	30	< 2	20	-
Rocky Mountain Beeplant	*Cleome serrulata*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<2	-	-	-	-	-	-	-
Rocky Mountian Iris	*Iris missouriensis*	-	-	-	-	-	-	<2	-	-	-	-	< 2	-	-	-	-	-	-	-	-	-	-	-	-	-
Rough Bentgrass	*Agrostis scabra*	-	-	-	-	-	-	-	<2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 31. Continued.

COMMON NAME	SCIENTIFIC NAME	SYSTEMS																								
		BIG	BISHOP	CAINE	CALLAO BIG	CLAY	COLD	GANDY SOUTH G44	GANDY SOUTH G48-49	GANDY SOUTH G51	GANDY WARM	KNOLL [a]	LELAND HARRIS	MIDDLE GANDY COMPLEX [b]	MILLER	NORTH BECK	NORTH GANDY COMPLEX	NORTH LITTLE	SOUTH BECK	SOUTH LITTLE	SWIMMING HOLE	TWIN	UNNAMED BIG 1	UNNAMED BIG 2	UNNAMED CAINE	UNNAMED SKATING POND
Rough Bugleweed	*Lycopus asper*	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Saltgrass	*Distichlis spicata*	-	2	-	20	-	5	10	-	-	10	10	10	-	35	-	-	-	-	-	5	50	-	10	-	5
Scratchgrass	*Muhlenbergia asperfolia*	-	2	-	5	-	-	-	<2	-	-	-	-	-	-	-	-	-	-	-	25	-	-	-	-	10
Sea Milkwort	*Glaux maritima*	-	-	-	-	-	-	<2	10	-	-	5	-	-	-	-	-	-	-	-	<2	-	-	-	-	-
Sedge	*Carex lenticularis*	-	-	-	-	40	< 2	<2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Seep Monkeyflower	*Mimulus guttatus*	-	-	-	-	-	-	-	2	-	-	-	-	<2	-	<2	2	-	<2	-	<2	-	-	-	-	-
Seepweed	*Suaeda calceoliformis*	-	-	-	-	-	-	<2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Silverweed	*Potentilla anserina*	-	-	-	-	-	-	2	-	-	-	20	-	-	-	-	-	-	<2	10	-	-	-	-	< 2	-
Speedwell	*Veronica anagallis-aquatica*	-	-	-	-	-	2	-	-	-	-	-	-	<2-	--	--	--	--	--	-	-	-	-	-	-	-
Spikerush	*Eleocharis acicularis*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5
Spikerush	*Eleocharis* sp.	-	5	-	5	10	25	-	10	10	5	5	20	5-50	15	-	15	10	-	10	-	15	30	3	-	5
Sweetclover	*Melilotus officinalis*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	10	-	-	-	-	-	-	-	-	-	-
Three Square Bulrush (Olney's)	*Schoenoplectus americanus*	-	-	60	50	-	5	<2	-	5	-	60	10	-	5	30	90	< 2	15	5	50	5	-	-	20	40
Tall Wheatgrass	*Thinopyrum ponticum*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<2	-	-	-	-	10
Toadflax	*Linaria dalmatica*	-	-	-	-	< 2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Torrey's Rush	*Juncus torreyi*	-	<2	-	-	5	25	-	-	-	-	-	-	-	-	<2	-	-	-	< 2	-	-	< 2	40	5	-
Utah Samphire	*Sarcocornia utahensis*	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Valdiva Duckweed	*Lemna valdiviana*	-	-	-	<2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	-	-	-	-	-
Wapato	*Saggitaria cuneata*	-	-	-	-	-	-	-	-	-	2	-	-	-	-	<2	-	-	-	-	-	-	-	-	-	-
Watercress	*Nasturtium officinale*	-	-	-	2	-	-	-	-	-	-	-	-	-	-	15	-	-	5	-	-	-	-	-	-	-
Water Parsnip	*Berula erecta*	-	5	-	5	-	-	30	5	-	-	5	-	10-90	-	15	<2-80	-	20	-	10	-	-	-	-	-
White Sweet Clover	*Melilotus* sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	< 2	-	-	-	-	< 2	-
Wild Mint	*Mentha arvensis*	-	-	-	-	-	-	2	-	-	-	-	-	-	-	<2	-	-	2	-	-	-	-	-	-	-
Willow-herb	*Epilobium* sp.	-	-	2	-	< 2	-	-	-	-	-	-	-	-	5	-	-	-	-	5	-	-	-	-	2	-
Woollyfruit Sedge	*Carex lasiocarpa* var. *americana*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5

[a] This spring was visited in September 2005 and again in August 2006.
[b] Multiple springs in complex.

Workman et al. (1979) found considerably fewer species of emergent vegetation than we did in the Snake Valley, but we generally identified most of the same species of emergent vegetation. Keleher et al. (2003) found that spikerush and *Juncus* spp. had the highest relative abundance of all macrophytes found during their surveys in Snake Valley, supporting the information we collected about the prevalence of these plants at the systems we surveyed in Snake Valley. Fridell et al. (2004) listed several species of emergent vegetation common to least chub habitat in the Snake Valley that we did not identify including common three-square and softstem bulrush (*Scirpus validus*). Keleher et al. (2003) also identified common three square, as well as milkweed (*Asclepias* spp.) in their surveys of aquatic systems in Snake Valley. It is difficult to isolate the source of the species discrepancies between surveys. Surveys were conducted at different times of year, and many of the species that we did not find but were found in other surveys look similar to species we did identify. Therefore, we cannot be sure whether all of these species occur in Snake Valley or whether some plants were misidentified during our surveys or other surveys.

We also identified 11 species of trees in the riparian areas associated with the aquatic systems of interest in Snake Valley (Table 32). Most notably we found the nonnative Russian olive (*Elaeagnus angustifolia*) in the riparian areas of nine different systems and nonnative salt cedar (*Tamarix* sp.) at another.

Vegetation Mapping

We mapped vegetation at the aquatic systems of interest in Snake Valley in September and October 2005 and July and August 2006. We found that the vegetation communities varied considerably between systems (Table 33): No single association was common among all systems mapped in Snake Valley. We noted a Nebraska Sedge Association at 43% of the systems we mapped, and it was often the dominant association. Baltic Rush Association also occurred at 43% of the systems mapped, but it generally comprised a smaller proportion of the area at each system. Baltic rush was dominant at Clay Spring, South Little Spring, and GSM South Spring. The Baltic Rush/mixed Herbaceous Association was dominant at GSM North 1, GSM North 2, and GSM Middle Springs. Olney's three square bulrush was found at 60% of the systems we mapped. Results of the mapping effort in Snake Valley were quite similar to those from our initial vegetation surveys; however, we did find common three square bulrush during our mapping efforts, which was noted by Fridell et al. (2004) but not identified during our initial surveys. Keleher et al. (2003) also found spike rush and Baltic rush to be dominant vegetation in Snake Valley. As with our initial surveys we did not identify softstem bulrush, which was found by Fridell et al. (2004). However, we did identify hardstem bulrush, a similar species, at several systems during both the initial surveys and the vegetation mapping effort. Volume II contains the vegetation maps that correspond with this report.

Table 32. Trees found at aquatic systems of interest throughout Snake Valley, Millard and Juab Counties, Utah and White Pine County, Nevada.

COMMON NAME	SCIENTIFIC NAME	SYSTEMS																								
		BIG	BISHOP	CAINE	CALLAO BIG	CLAY	COLD	GANDY SOUTH G44	GANDY SOUTH G48-49	GANDY SOUTH GT51	GANDY WARM	KNOLL	LELAND HARRIS	MIDDLE GANDY COMPLEX	MILLER	NORTH BECK	NORTH GANDY COMPLEX	NORTH LITTLE	SOUTH BECK	SOUTH LITTLE	SWIMMING HOLE	TWIN	UNNAMED BIG SPRING 1	UNNAMED BIG SPRING 2	UNNAMED CAINE	UNNAMED SKATING POND
Bebb Willow	*Salix bebbiana*	A[a]	A	A	A	P[b]	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Cottonwood	*Populus* sp.	A	A	A	A	A	A	A	A	A	A	A	A	A	P	A	A	A	P	A	A	A	A	A	A	A
Coyote Willow	*Salix exigua*	P	A	A	A	A	A	A	A	A	P	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Crack Willow	*Salix fragilis*	P	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Lombardy Poplar	*Populus nigra*	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	P	A	A	A
Rose	*Rosa* sp.	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	P	A	A	A	A	A	A	A	A
Rubber Rabbitbrush	*Ericameria nauseosa*	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	P	A	A	A	A	A	A
Russian Olive	*Elaeagnus angustifolia*	A	P	P	P	A	A	A	A	A	A	A	P	A	P	P	A	A	P	A	P	P	A	A	A	P
Salt Cedar	*Tamarix* sp.	A	A	A	A	A	A	A	A	A	P	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
White Poplar	*Populus alba*	A	A	A	A	A	A	A	A	A	A	A	A	A	A	P	A	A	A	A	A	A	A	A	A	A
Wood's Rose	*Rosa woodsii*	A	A	A	P	A	P	A	A	A	P	A	A	A	A	A	A	A	P	A	A	A	A	A	P	A

[a] Absent.
[b] Present.

Table 33. The proportion of the 168.8 acres mapped comprised of each association (alliance) at aquatic systems of interest throughout Snake Valley in Millard and Juab Counties, Utah (values in percent).

ASSOCIATIONS / ALLIANCES [a] IN SNAKE VALLEY [b]	NORTH BECK SPRING	SOUTH BECK SPRING	BIG SPRING	UNNAMED NORTH OF BIG SPRING 1	UNNAMED NORTH OF BIG SPRING	CAINE SPRING	CALLAO BIG SPRING	CLAY SPRING	COLD SPRING	GANDY WARM SPRING	GSM NORTH 1 SPRING	GSM NORTH 2 SPRING	GSM MIDDLE SPRING	GSM SOUTH SPRING	KNOLL SPRING	LELAND SPRING	MILLER SPRING	NORTH LITTLE SPRING	SOUTH LITTLE SPRING	SKATING POND SPRING	UNNAMED SOUTH OF CAINE	SWIMMING HOLE SPRING	TWIN SPRING
Adiantum capillus-veneris (Common Maidenhair) Herbaceous *Adiantum capillus-veneris* Saturated Herbaceous										0.611													
Adventive Plant Herbaceous Undesignated Alliance															23.21					11.56			
Agrostis gigantea (Redtop) Herbaceous *Agrostis stolonifera* (Creeping Bentgrass) Seasonally Flooded Herbaceous						6.43		3.88							2.20						1.56		
Carex simulata (Analogue Sedge) Herbaceous *Carex simulata* Saturated Herbaceous																		10.32					
Carex nebrascensis (Nebraska Sedge) Herbaceous *Carex nebrascensis* Seasonally Flooded Herbaceous	17.79				88.3	24.43		3.74					4.14		13.83			89.73	19.89	7.22	49.41		
Carex praegracilis (Clustered Field Sedge) Herbaceous *Carex praegracilis* Seasonally Flooded Herbaceous																			2.96				
Distichlis spicata (Inland saltgrass) - *Juncus arcticus* (Baltic Rush) Herbaceous *Distichlis spicata* Intermittently Flooded Herbaceous																			0.41				

Table 33. Continued.

ASSOCIATIONS / ALLIANCES [a] IN SNAKE VALLEY [b]	NORTH BECK SPRING	SOUTH BECK SPRING	BIG SPRING	UNNAMED NORTH OF BIG SPRING 1	UNNAMED NORTH OF BIG SPRING	CAINE SPRING	CALLAO BIG SPRING	CLAY SPRING	COLD SPRING	GANDY WARM SPRING	GSM NORTH 1 SPRING	GSM NORTH 2 SPRING	GSM MIDDLE SPRING	GSM SOUTH SPRING	KNOLL SPRING	LELAND SPRING	MILLER SPRING	NORTH LITTLE SPRING	SOUTH LITTLE SPRING	SKATING POND SPRING	UNNAMED SOUTH OF CAINE	SWIMMING HOLE SPRING	TWIN SPRING
Distichlis spicata (Inland saltgrass) Herbaceous								2.5			1.28	1.32				10.81	64.16						
Distichlis spicata Intermittently Flooded Herbaceous																							
Distichlis spicata (Inland saltgrass) Mixed Herb Herbaceous																	16.11						
Distichlis spicata Intermittently Flooded Herbaceous																							
Elaeagnus angustifolia (Russian Olive) Seminatural Woodland	5.60	13.39				25.99	4.92				30.96					1.64	2.12					6.23	32.63
Elaeagnus angustifolia Seminatural Woodland																							
Eleocharis quinqueflora (Fewflower Spikerush) Herbaceous																6.75							
Eleocharis quinqueflora, rRostellata (Fewflower, Beaked Spikerush) Saturated Herbaceous																							
Eleocharis acicularis (Needle spikerush) Herbaceous Vegetation		2.82																					
Eleocharis acicularis Seasonally Flooded Herbaceous																							
Eleocharis palustris (Common Spikerush) Herbaceous									85.43			4.76						0.78	0.05		11.95		0.5
Eleocharis palustris Seasonally Flooded Herbaceous		11.87																					
Glycyrrhiza lepidota (American Licorice) Herbaceous															27.33								
Undesignated Alliance																							

Table 33. Continued.

ASSOCIATIONS / ALLIANCES [a] IN SNAKE VALLEY [b]	NORTH BECK SPRING	SOUTH BECK SPRING	BIG SPRING	UNNAMED NORTH OF BIG SPRING 1	UNNAMED NORTH OF BIG SPRING	CAINE SPRING	CALLAO BIG SPRING	CLAY SPRING	COLD SPRING	GANDY WARM SPRING	GSM NORTH 1 SPRING	GSM NORTH 2 SPRING	GSM MIDDLE SPRING	GSM SOUTH SPRING	KNOLL SPRING	LELAND SPRING	MILLER SPRING	NORTH LITTLE SPRING	SOUTH LITTLE SPRING	SKATING POND SPRING	UNNAMED SOUTH OF CAINE	SWIMMING HOLE SPRING	TWIN SPRING
Hordeum jubatum (Foxtail Barley) Herbaceous *Hordeum jubatum* Temporarily Flooded Herbaceous									14.57		3.43											69.16	
Juncus arcticus (Baltic Rush) Mixed Herb Herbaceous *Juncus arcticus* Seasonally Flooded Herbaceous											48.68	80.59	66.16					3.07					15.63
Juncus torreyi (Torrey's Rush) Herbaceous Undesignated Alliance								3.2															
Juncus arcticus (Baltic Rush) Herbaceous *Juncus arcticus* Seasonally Flooded Herbaceous	7.64					13.08		40.72				0.49		47.66	5.5	19.72		3.86	75.23				25.04
Mixed Wetland Graminoid Herbaceous Vegetation Undesignated Alliance			3.27	100																11.96			
Mixed Wetland Forb Herbaceous Undesignated Alliance										9.09													
Muhlenbergia Asperifolia (Scratchgrass) Herbaceous *Muhlenbergia asperifolia* Intermittently Flooded Herbaceous																							21.61
Open Water Undesignated Alliance	0.91	0.43				8.66	26.22				5.62			0.005		8.19	0.27	0.43				0.62	2.88

Table 33. Continued.

ASSOCIATIONS / ALLIANCES [a] IN SNAKE VALLEY [b]	NORTH BECK SPRING	SOUTH BECK SPRING	BIG SPRING	UNNAMED NORTH OF BIG SPRING 1	UNNAMED NORTH OF BIG SPRING	CAINE SPRING	CALLAO BIG SPRING	CLAY SPRING	COLD SPRING	GANDY WARM SPRING	GSM NORTH 1 SPRING	GSM NORTH 2 SPRING	GSM MIDDLE SPRING	GSM SOUTH SPRING	KNOLL SPRING	LELAND SPRING	MILLER SPRING	NORTH LITTLE SPRING	SOUTH LITTLE SPRING	SKATING POND SPRING	UNNAMED SOUTH OF CAINE	SWIMMING HOLE SPRING	TWIN SPRING
Phalaris arundinacea (Reed Canarygrass) Western Herbaceous								3.23															
Phalaris arundinacea Seasonally Flooded Herbaceous																							
Phragmites australis (Common Reed) Western North America Temperate Seminatural Herbaceous		16.25								40.11	3.63												2.07
Phragmites australis Semipermanently Flooded Herbaceous																							
Populus (Cottonwood) spp. Seminatural Woodland	27.42		58.41					31.01															
Undesignated Alliance																							
Populus angustifolia (Narrowleaf Cottonwood) - *Distichilis spicata* (Inland Saltgrass) Woodland	2.01																						
Populus angustifolia Temporarily Flooded Woodland																							
Nasturtium officinale (Watercress) *Berula erecta* (Cutleaf Water Parsnip) - *Veronica anagallis-aquatica* (Water Speedwell) Herbaceous	9.57	0.37	18.58		11.69										0.51		0.79	0.64					1.17
Undesignated Alliance																							
Rosa woodsii (Wood's Rose) Shrubland		33.31				8.47				16.41								0.44			33.15		
Rosa woodsii Temporarily Flooded Shrubland																							
Sagittaria cuneata (Arumleaf Arrowhead) Herbaceous																			0.035				
Undesignated Alliance																							

Table 33. Continued.

ASSOCIATIONS / ALLIANCES [a] IN SNAKE VALLEY [b]	NORTH BECK SPRING	SOUTH BECK SPRING	BIG SPRING	UNNAMED NORTH OF BIG SPRING 1	UNNAMED NORTH OF BIG SPRING	CAINE SPRING	CALLAO BIG SPRING	CLAY SPRING	COLD SPRING	GANDY WARM SPRING	GSM NORTH 1 SPRING	GSM NORTH 2 SPRING	GSM MIDDLE SPRING	GSM SOUTH SPRING	KNOLL SPRING	LELAND SPRING	MILLER SPRING	NORTH LITTLE SPRING	SOUTH LITTLE SPRING	SKATING POND SPRING	UNNAMED SOUTH OF CAINE	SWIMMING HOLE SPRING	TWIN SPRING
Salix exigua (Coyote Willow), Mesic Graminoids Shrubland *Salix exigua*, *interior* (Coyote, Sandbar Willow) Temporarily Flooded Shrubland										4.73													
Salix exigua (Coyote Willow) Temporarily Flooded Shrubland *Salix* (*exigua*, *interior*) Temporarily Flooded Shrubland			19.74					8.03		17.16													0.24
Salix exigua (Coyote Willow) - Mesic Forbs Shrubland *Salix exigua*, *interior* (Coyote, Sandbar Willow) Temporarily Flooded Shrubland										5.18													
Sarcobatus vermiculatus (Greasewood) - *Distichlis spicata* (Inland Saltgrass) Shrubland *Sarcobatus vermiculatus* Intermittently Flooded Shrubland										2.57													
Schoenoplectus americanus (Olney's Three Square Bulrush) Western Herbaceous *Schoenoplectus americanus* Semipermanently Flooded Herbaceous	26.33	21.56				12.94	63.11				6.07	10.58	21.43	0.27	17.65	44.89	16.54			56.73	3.93	23.99	

Table 33. Continued.

ASSOCIATIONS / ALLIANCES [a] IN SNAKE VALLEY [b]	NORTH BECK SPRING	SOUTH BECK SPRING	BIG SPRING	UNNAMED NORTH OF BIG SPRING 1	UNNAMED NORTH OF BIG SPRING	CAINE SPRING	CALLAO BIG SPRING	CLAY SPRING	COLD SPRING	GANDY WARM SPRING	GSM NORTH 1 SPRING	GSM NORTH 2 SPRING	GSM MIDDLE SPRING	GSM SOUTH SPRING	KNOLL SPRING	LELAND SPRING	MILLER SPRING	NORTH LITTLE SPRING	SOUTH LITTLE SPRING	SKATING POND SPRING	UNNAMED SOUTH OF CAINE	SWIMMING HOLE SPRING	TWIN SPRING
Schoenoplectus pungens (Common Three Square) Herbaceous *Schoenoplectus pungens* Semipermanently Flooded Herbaceous								3.68					8.27							12.52			
Schoenoplectus americanus (Olney's Three Square Bulrush) - *Eleocharis palustris* (Spikerush) Herbaceous *Schoenoplectus americanus* Semipermanently Flooded Herbaceous																2.44							
Schoenoplectus acutus (Hardstem Bulrush) Herbaceous *Schoenoplectus acutus - Schoenoplectus tabernaemontani* (Hardstem Bulrush - Softstem Bulrush) Semipermanently Flooded Herbaceous	2.73														9.77								4.01
Solidago missouriensis (Missouri Goldenrod) Herbaceous Undesignated Alliance											0.33												1.10
Sporobolus airoides (Alkali Sacaton) Unknown														1.04									
Sporobolus airoides (Alkali Sacaton) - *Distichlis spicata* (Inland Saltgrass) Herbaceous Vegetation *Sporobolus airoides* Intermittently Flooded Herbaceous														38.58									
Sporobolus airoides (Alkali Sacaton) Monotype Herbaceous Vegetation *Sporobolus airoides* Herbaceous														3.85									

Table 33. Continued.

ASSOCIATIONS / ALLIANCES [a] IN SNAKE VALLEY [b]	NORTH BECK SPRING	SOUTH BECK SPRING	BIG SPRING	UNNAMED NORTH OF BIG SPRING 1	UNNAMED NORTH OF BIG SPRING	CAINE SPRING	CALLAO BIG SPRING	CLAY SPRING	COLD SPRING	GANDY WARM SPRING	GSM NORTH 1 SPRING	GSM NORTH 2 SPRING	GSM MIDDLE SPRING	GSM SOUTH SPRING	KNOLL SPRING	LELAND SPRING	MILLER SPRING	NORTH LITTLE SPRING	SOUTH LITTLE SPRING	SKATING POND SPRING	UNNAMED SOUTH OF CAINE	SWIMMING HOLE SPRING	TWIN SPRING
*Spartina gracilis (*Alkali Cordgrass) Herbaceous Vegetation *Spartina gracilis* Seasonally Flooded Herbaceous												2.26		8.16									
Sparsely Vegetated Undesignated Alliance														0.45		5.56			1.43				
Tamarix (Salt Cedar) spp. Shrubland Seminatural Temporarily Flooded Shrubland										4.13													
Typha latifolia (Broadleaf Cattail) Western Herbaceous *Typha angustifolia*, *latifolia* (Narrowleaf, Broadleaf Cattail) - *Schoenoplectus* spp.(Three Square Bulrush) Semipermanently Flooded Herbaceous							5.74																12.58

[a] Note that within each cell describing the Associations and Alliances, the Associations are shown above and Alliances below.
[b] North Beck Spring = 1.05 acres (0.42 hectares), South Beck Spring = 1.85 acres (0.75 hectares), Big Spring = 0.49 acre (0.2 hectare), Unnamed North of Big Spring 1 = 0.003 acre (0.001 hectare), Unnamed north of Big Spring 2 = 0.025 acre (0.01 hectare), Caine Spring = 0.28 acre (0.12 hectare), Callao Spring = 1.22 acres (0.50 hectares), Clay Spring = 1.89 acres (0.76 hectare), Cold Spring = 0.37 acre (0.15 hectare), Gandy Warm Spring = 6.47 acres (2.62 hectares), GSM North 1 Spring = 24.22 acres (9.80 hectares), GSM North 2 Spring = 4.99 acres (2.02 hectares), GSM Middle Spring = 2.66 acres (1.07 hectares), GSM South Spring = 57.15 acres (23.12 hectares), Knoll Spring = 2.62 acres (1.06 hectares), Leland Spring = 14.92 acres (6.03 hectares), Miller Spring = 48.89 acres (19.78 hectares), North Little Spring = 1.4 acres (0.58 hectare), South Little Spring = 10.71 acres (4.34 hectares), Swimming Hole Spring = 3.21 acres (1.30 hectares), Unnamed South of Caine = 0.33 acre (0.13 hectare), Skating Pond Spring = 1.41 acres (2.02 hectares), Twin Spring = 4.88 acres (1.98 hectares).

However, we did identify hardstem bulrush, a similar species, at several systems during both the initial surveys and the vegetation mapping effort.

Forty-five different vegetation associations and 89 species (Appendix C) were identified in Snake Valley during the vegetation mapping effort. Most aquatic systems we mapped in Snake Valley had a diverse vegetation community. Twin Springs had the most diverse communities with 12 vegetation associations. Baltic rush and Russian olive comprised most of the vegetation types at Twin Springs. The Unnamed Spring north of Big Spring #1 was the least diverse, with only one vegetation association, Mixed Wetland Graminoid, identified.

Fishes

Least chub, Utah chub (*Gila atraria*), speckled dace (*Rhinichthys ocsculus*), redside shiner (*Richardsonius balteatus*), mottled sculpin (*Cottus bairdi*), and Utah sucker (*Catostomus ardens*) have all been found in Snake Valley (Sigler and Workman 1975; Workman et al. 1979; Crist and Holden 1980; Hickman 1989; Andersen and Deacon 1996; Perkins et al. 1998; Keleher and Barker 2004; Wheeler et al. 2004; Tallerico and Crookshanks 2005; K. Wilson 2005, pers. comm.). In our surveys, along with 2004 surveys by the UDWR and 2005 surveys by the Nevada Department of Wildlife (NDOW), all of those native species were found in the aquatic systems of interest in Snake Valley (Table 34) (Wheeler et al. 2004; Tallerico and Crookshanks 2005; K. Wilson 2005, pers. comm.). Additional nonnative fish species found during our surveys and 2004-2006 UDWR surveys included common carp (*Cyprinus carpio*), goldfish (*Carassius* sp.), and largemouth bass (*Micropterus salmoides*).

Big Springs and Big Springs Creek had the greatest diversity of native fishes of all the systems surveyed in Snake Valley. In 1991 Andersen and Deacon (1996) found a compliment of native fishes similar to those we found in 2005. They did not collect Utah chub, but they did collect Utah sucker. They noted that large numbers of speckled dace and redside shiner, along with a few mottled sculpin, were found near the source of the spring. Tallerico and Crookshanks (2005) noted that Utah chub, as well as brown trout (*Salmo trutta*) and rainbow trout (*Onchorynchus mykiss*) have been collected by the NDOW and others at Big Springs Creek over the past 55-60 years. They also noted several failed introductions of other sport fish into Big Springs Creek including largemouth bass, smallmouth bass (*Micropterus dolomieu*), black crappie (*Pomoxis nigromaculatus*), and channel catfish (*Ictalurus punctatus*).

We performed our electrofishing surveys in conjunction with the NDOW at Big Springs and Big Springs Creek. At two of the survey sites, one near the source of Big Springs and one just downstream in Big Springs Creek, we collected all the native fish species previously encountered in the system except for Utah sucker. We found that redside shiner and speckled dace were common to abundant near the spring source and in Big Springs Creek. Utah chub were less common, and mottled sculpin were rare. We collected large numbers of redside shiner

Table 34. Fish collections at springs of interest in Snake Valley, White Pine County, Nevada, and Millard and Juab Counties, Utah.

SPRING NAME	SOURCES[a]	LEAST CHUB	MOTTLED SCULPIN	REDSIDE SHINER	SPECKLED DACE	UTAH CHUB	UTAH SUCKER	COMMON CARP	GOLDFISH	LARGEMOUTH BASS	UNIDENTIFIED FISH
Big Springs	1,5	A[b]	P[c]1	P1	P1	P1	A	A	A	A	P5
Big Springs Pond	1	A	A	P1	A	A	A	A	A	A	A
Big Springs Creek	1, 4	A	P1, 4	P1, 4	P1, 4	P1, 4	P4	A	A	A	A
Beck Springs - North[d]	1, 2	A	A	A	P2	A	A	A	A	A	A
Beck Springs - South[d]	1, 2	A	A	A	A	A	A	A	A	A	A
Bishop Springs/ Foote Reservoir	1, 2	P2	A	A	P2	P2	A	P2	A	P2	A
Caine Spring	1	A	A	A	A	A	A	A	A	A	A
Callao Big Springs	1, 2	A	A	A	P1	P1	A	P1	A	A	A
Clay Spring[e]	1, 2	A	A	A	A	A	A	A	A	A	A
Cold Spring[e]	1, 2	A	A	A	A	A	A	A	A	A	A
Gandy Salt Marsh\ North Complex (G4-G9)[d]	1, 2	P2	A	A	P2	P2	A	A	A	A	A
Gandy Salt Marsh Middle Complex (G20-G28)[d]	1, 2	P2	A	A	P2	P2	A	A	A	A	A
Gandy Salt Marsh G44[d]	1, 2	P2	A	A	P2	P2	A	A	A	A	A
Gandy Salt Marsh G48-G49[d]	1, 2	A	A	A	A	A	A	A	A	A	A
Gandy Salt Marsh G51[d]	1, 2	A	A	A	A	A	A	A	A	A	A
Gandy Warm Spring	1, 3, 5	A	A	A	P1,3	A	A	A	A	A	A
Knoll Spring[e]	1, 5	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry

Table 34. Continued.

SPRING NAME	SOURCES[a]	LEAST CHUB	MOTTLED SCULPIN	REDSIDE SHINER	SPECKLED DACE	UTAH CHUB	UTAH SUCKER	COMMON CARP	GOLDFISH	LARGEMOUTH BASS	UNIDENTIFIED FISH
Leland Harris Spring[d]	1, 2, 5	P2	A	A	A	P2	A	A	A	A	P5
Miller Spring[d]	1	P2	A	A	A	P2	A	A	A	A	A
North Little Spring[e]	1	A	A	A	A	A	A	A	A	A	A
South Little Spring[e]	1	A	A	A	A	A	A	A	A	A	A
Swimming Hole	1	A	A	A	A	A	A	A	A	A	A
Twin Springs[d]	1, 2, 5	P2	A	A	P2	P2	A	A	P2	P2	P5
Unnamed Caine Spring[e]	1, 5	A	A	A	A	A	A	A	A	A	A
Unnamed Spring South of Knoll Spring	1	A	A	A	A	A	A	A	P1	A	A
Unnamed Spring at Skating Pond	1	A	A	A	A	A	A	A	A	A	A
Unnamed Big Spring #1[e]	1, 5	A	A	A	A	A	A	A	A	A	A
Unnamed Big Spring #2[e]	1	A	A	A	A	A	A	A	A	A	A

[a]1 = BIO-WEST survey and/or reconnaissance, 2 = UDWR (Wheeler et al. 2004, Wheeler and Fridell 2005, Wilson and Mills 2005, Mills and Wilson 2006, Wheeler 2006, unpublished data), 3 = UDWR (Hudson and Hogrefe 2000), 4 = NDOW (Tallerico and Crookshanks 2005), 5 = Sada (2005a).
[b]Absent.
[c]Present.
[d]No BIO-WEST fish sampling because of pre-existing UDWR sampling programs.
[e]No BIO-WEST fish sampling because of poor fish habitat.

by seining in a pond just south of the main spring head. While sampling in conjunction with the NDOW further downstream in Big Springs Creek, we did encounter Utah sucker (Tallerico and Crookshanks 2005). The NDOW found that speckled dace and redside shiner were more abundant in areas close to the spring source and absent in the most downstream areas surveyed. Mottled sculpin were only found near and immediately downstream of the spring head. Tallerico and Crookshanks (2005) concluded that the native fish population in Big Springs Creek appeared stable and noted that the August 2005 surveys were the first time that all five native fish species had been collected during the same survey.

Since least chub has been a species of concern since the 1970s, many surveys have been undertaken to determine the distribution and abundance of least chub throughout the Bonneville Basin (Perkins et al. 1998). Workman et al. (1979) sampled historical least chub habitat throughout the Bonneville Basin in the late 1970s and found that Snake Valley was the only area containing remnant populations. They found least chub in six of the aquatic systems of interest: Leland Harris Springs, Twin Springs, Bishop Springs complex, Gandy Salt Marsh complex, Callao Spring complex, and Redden Springs. Osmundson (1985) found no least chub in Twin Springs, the Callao Spring complex, or Redden Springs in the mid 1980s, but least chub were found in Miller Springs and Central Spring (another part of the Bishop Springs complex). By the late 1990s the least chub populations in Snake Valley were restricted to the Gandy Salt Marsh complex, the Leland Harris Springs complex, the Bishop Springs complex (including Twin Springs), and Miller Spring (Perkins et al. 1998). For a time the Miller Spring population was thought to be extirpated, but in recent surveys least chub were found in the wetlands downstream from Miller Spring, and in 2005 least chub were found in the spring head at Miller Spring (Keleher and Barker 2004; K. Wilson 2005, pers. comm.).

Since the completion of the Least Chub Conservation Agreement and Strategy in 1998, the UDWR has had an ongoing monitoring program for least chub in Snake Valley (Perkins et al. 1998; Fridell et al. 1999; Wheeler et al. 2004; K. Wilson 2005, pers. comm.;Wilson and Mills 2005; Wheeler and Fridell 2005; Mills and Wilson 2006). Their most recent surveys show that least chub and other native fish species are still present in Leland Harris Springs, Twin Springs and the rest of the Bishop Springs complex, the Gandy Salt Marsh complex, and Miller Spring. The current monitoring program uses minnow traps to sample 12 sites at the Leland Harris complex, 13 sites at the Bishop Springs complex, and 77 sites at the Gandy Salt Marsh complex (Fridell et al. 1999).

In 2004 the UDWR found least chub at 8 of the 12 long-term monitoring sites in the Leland Harris complex (Wilson and Mills 2005). The number of sites containing least chub in the Leland Harris complex has remained stable since 1999, but the total number of least chub collected has fluctuated. While least chub collected in the Leland Harris complex in 2004 (242) were nearly triple the number collected in 2003, they were close to half of the number collected in 1999. In 2005 the UDWR only surveyed four sites for least chub, but all four sites contained least chub (Mills and Wilson 2006). In addition, over 1,300 least chub were collected at those four sites, over five times more than were collected in the 12 sites sampled in 2004.

In 2004 the UDWR collected one least chub in the Twin Springs complex, whereas in 2005 they collected 11 (Wheeler et al. 2004, Wheeler and Fridell 2005). They collected Utah chub in the Twin Springs complex in 2004 and 2005, while speckled dace was only collected in 2005. They also found least chub at other areas surveyed throughout the Bishop Springs complex in 2005. The numbers of least chub collected at Twin Springs and Bishop Springs in 2005 were the highest recorded between 1999 and 2005 (Wheeler and Fridell 2005). Conversely, the UDWR found the fewest number of Utah chub in 2005. Speckled dace numbers in Twin Springs and Bishop Springs have been low but stable since 1999. The UDWR has also observed nonnative largemouth bass and goldfish in Twin Springs between 1999 and 2005, and largemouth bass and common carp in Foote Reservoir (K. Wheeler 2006, pers. comm.).

We surveyed several portions of the Gandy Salt Marsh complex, but did not sample for fish, because of the ongoing UDWR monitoring program for least chub. Historical surveys indicated that the Leland Harris and Gandy Salt Marsh spring complexes had the most abundant populations of least chub in the Bonneville Basin (Sigler and Workman 1975, Workman et al. 1979, Crist and Holden 1980, Hickman 1989, Perkins et al. 1998). From 2001-2004 the UDWR surveys showed a decline in least chub numbers and the number of sites containing least chub in the Gandy Salt Marsh complex, but there was a slight increase in both the least chub numbers and the number of sites containing least chub in 2005 (Wheeler et al. 2004, Fridell et al. 2005). However, the gradual decline in the least chub population at Gandy Salt Marsh since 1993 noted by Wheeler et al. (2004) still appears to be in effect . The latest decline in the number and distribution of least chub in Gandy Salt Marsh may be associated with dropping water levels associated with a drought from 1999-2004.

The Gandy Warm Springs area has been studied fairly intensively in the past few years in relationship to a proposal to build a warm water fish hatchery at this location. In UDWR surveys from 1999-2002, speckled dace were the only fish species present in Gandy Warm Springs (Hudson and Hogrefe 2000, BIO-WEST 2002). Anecdotal evidence suggests that largemouth bass and goldfish may also be present at this site, but none have been found in recent sampling efforts (Hudson and Hogrefe 2000, BIO-WEST 2002). While snorkeling at Gandy Warm Springs in June 2004, we observed only speckled dace. Similarly, speckled dace appear to be the only fish species inhabiting North Beck Spring. The UDWR set 16 minnow traps for between 3 and 3.5 hours there in June 2005 and collected 13 speckled dace (K. Wheeler 2006, pers. comm.).

At one time the Callao Spring complex contained least chub, but the species has been extirpated from this system since at least the mid-1980s (Workman et al. 1979, Osmundson 1985, Wilson and Davidson 2003). We set seven baited minnow traps for 4.5 hours at Callao Big Spring and three traps for 2.75 hours at Swimming Hole. We collected no fish at Swimming Hole, but we collected 22 speckled dace and 519 Utah chub in Callao Big Spring. The speckled dace ranged in size from 40 mm to 58 mm total length, while the Utah chub ranged from 37 mm to 66 mm. In addition, we observed common carp in the main pond/head area of Callao Big Spring.

We pulled several seine hauls in the pond at Caine Spring but collected no fish. After visually observing fish in a stock trough at Knoll Spring, we collected them with dip nets. We collected 11 goldfish between 56 mm and 80 mm total length in the stock trough at Knoll Spring.

Amphibians

Snake Valley is home to several amphibian species including the native Columbia spotted frog, northern leopard frog (*Rana pipiens*), and Great Basin spadefoot toad, as well as the nonnative bullfrog (*Rana catesbeiana*). Ross et al. (1994) speculated that the northern leopard frog may not be native to the Snake Valley. However, the Snake Valley is within the range of the northern leopard frog, and Hitchcock (2001) found areas with a high northern leopard frog abundance in neighboring Spring Valley. As noted in the results for the Tule Valley, the Columbia spotted frog is a Conservation Agreement species, so many surveys have been conducted for amphibians at aquatic systems within the Snake Valley in the past 20-30 years (Toone 1991, Cuellar 1994, Ross et al. 1994, Perkins and Lentsch 1998, Fridell et al. 2004, Keleher and Barker 2004, Mills et al. 2005). Additionally, amphibian sightings have been noted during least chub surveys in portions of Snake Valley from 1993-2002 (UDWR, unpublished data).

Toone (1991) found that Columbia spotted frog were present at the Leland Harris and Gandy Salt Marsh complexes in the early 1990s, but they appeared to be absent from the Bishop Springs complex (Twin Springs/Central Springs) where they had been found in the late 1960s. Cuellar (1994) completed a population study of Columbia spotted frog inhabiting the northern portion of Gandy Salt Marsh in 1992. He counted 354 egg masses during his study and marked 80 adult and juvenile Columbia spotted frog for a population estimate. Cuellar (1994) estimated that there were 149 Columbia spotted frog in his 1.5-hectare study area. In 1993 Ross et al. (1994) completed a distribution and abundance survey for Columbia spotted frog in Utah's West Desert. They estimated abundance from egg mass counts to be over 1,500 individuals at Leland Harris Springs complex, 120 individuals at Miller Springs, and over 4,500 individuals in the "Gandy area", which included the Gandy Salt Marsh and Bishop Springs (Twin Spring and Central Spring) complexes.

We observed a few amphibians during our surveys in Snake Valley (Table 35). As noted previously, our visual encounter surveys were not very intensive and occurred during daylight hours when adult frogs are less likely to be active and observed. Additionally, egg masses are often found out in open water and away from the margins of the spring system where our visual surveys took place. The UDWR has an annual monitoring program for Columbia spotted frog in

Table 35. Amphibian sightings at aquatic systems of interest in Snake Valley, White Pine County, Nevada, and Millard County and Juab County, Utah.

SYSTEM	SOURCES[a]	COLUMBIA SPOTTED FROG	NORTHERN LEOPARD FROG	GREAT BASIN SPADEFOOT TOAD	WOODHOUSE'S TOAD	BULLFROG	UNIDENTIFIED FROG
Big Springs	1, 2	A	A	A	A	A[b]	A
Big Springs Pond	1, 2	A	A	A	A	A	A
Big Springs Creek	1, 2	A	A	A	A	A	A
Beck Springs-North	1, 3	P1, 3	A	A	A	A	A
Beck Springs-South	1, 3	A	A	A	A	A	A
Caine Spring	1	A	A	A	A	A	A
Callao Big Springs	1	A	A	A	A	A	A
Clay Spring	1, 2	A	A	A	A	A	A
Cold Spring	1, 2	A	A	A	A	A	A
Gandy Salt Marsh North Complex (G4-G9)	1, 3	P1, 3	P1, 3	A	A	A	A
Gandy Salt Marsh Middle Complex (G20-G28)	1, 3	P3	P1, 3	A	A	A	A
Gandy Salt Marsh G44[d]	1,3	P3	P1,3	A	A	A	A
Gandy Salt Marsh G48-G49[d]	1,3	P3	P3	A	A	A	A
Gandy Salt Marsh G51[d]	1,3	P3	P3	A	A	A	A
Gandy Warm Springs	1, 2	A	A	A	A	A	A
Knoll Spring	1, 2	A	A	A	A	A	A
Leland Harris Spring	1, 2, 3	P[c] 3	P 3	A	A	A	A
Miller Spring	1, 2, 3	P 3	A	P 3	P 3	A	A

Table 35. Continued.

SYSTEM	SOURCES[a]	COLUMBIA SPOTTED FROG	NORTHERN LEOPARD FROG	GREAT BASIN SPADEFOOT TOAD	WOODHOUSE'S TOAD	BULLFROG	UNIDENTIFIED FROG
North Little Spring	1	A	A	A	A	A	A
South Little Spring	1	A	A	A	A	A	A
Swimming Hole	1	A	A	A	A	A	A
Twin Springs	1, 2, 3	P 3	P 3[d]	A	A	P 1, 2, 3	P 1
Unnamed Spring South of Caine Spring	1, 2	A	A	A	A	A	A
Unnamed Spring South of Knoll Spring	1	A	A	A	A	A	A
Unnamed Spring at Skating Pond	1	A	A	A	A	A	A
Unnamed Big Spring #1	1, 2	A	A	A	A	A	A
Unnamed Big Spring #2	1, 2	A	A	A	A	A	A

[a] 1 = BIO-WEST survey and/or reconnaissance, 2 = Sada (2005a), 3 = UDWR (Fridell et al. 2004; Mills et al. 2004; K. Wheeler 2005, pers. comm.; K. Wilson 2005, unpublished data; Mills and Wilson 2006; Wheeler and Fridell 2006).
[b] Absent through visual observation.
[c] Present through visual observation.
[d] Fridell et al. (2004) note that Columbia spotted frog and northern leopard frog are distributed throughout the Bishop Springs complex, but do not specifically indicate populations at Twin Springs.

the Snake Valley (Fridell et al. 2004, Mills et al. 2005, Mills and Wilson 2006, Wheeler and Fridell 2006) that centers on counting eggs masses to get a relative abundance estimate.

In UDWR surveys from 1997-2005, Columbia spotted frog were found at the Leland Harris Springs complex, Miller Spring, the Gandy Salt Marsh complex, and the Bishop Springs complex (Fridell et al. 2004, Mills et al. 2005). In addition, Columbia spotted frog was found at a new location, Beck Springs, in 2005 (Wheeler and Fridell 2006). The UDWR noted 89 egg masses in North Beck Spring and none in South Beck Spring during surveys in March 2006. They did not note any adult Columbia spotted frogs. During our surveys of these two sites in July 2006, we observed 17 adult Columbia spotted frog at North Beck Spring and none at South Beck Spring.

In 2004 Mills et al. (2005) calculated a combined abundance estimate of 1,492 individuals for Columbia spotted frog in the Leland Harris Springs complex and Miller Spring, which is similar to what Ross et al. (1994) found in 1993. The UDWR calculated a similar abundance estimate in 2005, although the Miller Spring population showed some evidence of a decline (Mills and Wilson 2006). Both the 2004 and 2005 abundance estimates exceeded the target of 1,000 individuals specified in the Columbia spotted frog Conservation Agreement and Strategy (Perkins and Lentsch 1998). Abundance estimates from 2004 and 2005 were similar to those made in the early 1990s but lower than those made in the late 1990s and early 2000s.

In 2004 Fridell et al. (2004) calculated an abundance estimate of 426 individuals at the Bishop Springs complex and 262 individuals at the Gandy Salt Marsh complex. The combined estimate for these two areas is less than 25% of what Ross et al. (1994) estimated for these two locations in 1993. While the estimate of the Bishop Springs population had risen to 850 individuals by 2006, the estimate at Gandy Salt Marsh remained similar at 205 (Wheeler and Fridell 2006). Both of the areas were below the target level of 1,000 individuals listed in the Columbia spotted frog Conservation Agreement and Strategy (Perkins and Lentsch 1998). Wheeler and Fridell (2006) showed that the number of egg masses at the Bishop Springs complex appears to have remained relatively stable since 1997, with period spikes in egg mass numbers. Conversely, the number of egg masses found at the Gandy Salt Marsh complex was substantially lower from 2002-2006 than it was from 1998-2001. We observed two adult Columbia spotted frog in the northern portion of the Gandy Salt Marsh complex, but we observed none in the remainder of the complex or where we sampled at Bishop Springs.

Cuellar (1994) indicated that northern leopard frog was scarce in the Gandy Salt Marsh complex and seemed to be restricted to the southern portion of the marsh. Ross et al. (1994) indicated that northern leopard frog adults were found in the Bishop Springs complex and the Gandy Salt Marsh complex. They also indicated that bullfrogs were found in the West Desert surveys (Snake and Tule Valleys) but did not give specific locations. The UDWR noted adult northern leopard frogs in the Leland Harris Springs complex, Bishop Springs complex, and Gandy Salt Marsh complex during least chub surveys from 1993-2002 (UDWR unpublished data). The accounts of northern leopard frog at Leland Harris Springs may be erroneous, as several researchers believe northen leopard frogs do not currently occur in the Leland Harris/Miller Springs complex (K. Wheeler 2005, pers. comm.; K. Wilson 2005, pers. comm.). The UDWR has found relatively large numbers of northern leopard frog egg masses, juveniles, and adults in both the Bishop Springs complex and the Gandy Salt Marsh complex in the past several years (Fridell et al. 2004, Wheeler and Fridell 2006). While we did not observe northern leopard frog in the area of Bishop Springs that we sampled, we did observe 17 northern leopard frogs throughout the Gandy Salt Marsh complex.

During our surveys and surveys listed in Sada (2005a), bullfrogs were present at Twin Springs, which appears to be the main area where they are concentrated in Snake Valley (K. Wheeler

2005, pers. comm.). Historically, Woodhouse's toad (*Bufo woodhousei*) was found in the Snake Valley (Hovingh 1986), and the UDWR observed both Woodhouse's toad and Great Basin Spadefoot toad during Columbia spotted frog surveys at Miller Spring (K. Wilson 2005, pers. comm.). Great Basin spadefoot toad have been observed at other locations in the Snake Valley (Hovingh et al. 1985), and this species probably utilizes many of the aquatic systems of interest in Snake Valley for a portion of its life cycle (K. Wheeler 2005, pers. comm.).

Springsnails and Invertebrates

Sada (2005a) listed four species of springsnails in the Snake Valley. We found all four species during our springsnail surveys at the aquatic systems of interest in Snake Valley (Table 36). We also found springsnails at seven systems not listed in Sada (2005a): a second Unnamed Spring south of Caine Spring (not listed in Table 34), North Beck Spring, South Beck Spring, Caine Spring, Callao Big Spring, several spring heads in the northern portion of the Gandy Salt Marsh complex, and Miller Spring. Dr. Robert Hershler identified the springsnails from all of these sites as the Toquerville springsnail (R. Hershler 2005, pers. comm.). At Caine Spring the Toquerville springsnail was abundant at the spring head, scarce downstream, and absent in the terminal pond. At Miller Spring the Toquerville springsnail was common at the outlet pipe from the spring head pond and for about 5 m downstream, but it was absent from the remainder of our survey site (throughout the ponded head and up to 175 m downstream). At North Beck Spring the Toquerville springsnail was absent in the head pond, abundant below the outflow pipe from the head pond, and common to abundant for at least 180 m downstream. In South Beck Spring the Toquerville springsnail was abundant in the north head but became scarce by 60 m downstream. In the south head and its south arm outflow, the Toquerville springsnail was scarce to common. The Toquerville springsnail was extremely scarce in Callao Big Spring: We only found them in one location approximately 50 m downstream of the north head. In the northern portion of the Gandy Salt Marsh Toquerville springsnail were scarce in spring head G8 and G9, common in spring head G4, and abundant in spring head G5.

While we found three new populations of springsnail in Snake Valley, we also found that the population of Toquerville springsnail at Knoll Spring may have been extirpated. Sada (2005a) listed springsnails as scarce to common at Knoll Spring during 1993 surveys. When we surveyed Knoll Spring in August 2005 it was dry and we could not find any springsnails. We found the Toquerville springsnail to be common in parts of both Cold Spring and Leland Harris Spring, as did 1993 surveys listed in Sada (2005a). At Twin Springs North we found the Toquerville springsnail to be common to abundant from the source pond up to 300 m downstream. We found no springsnails in Twin Springs South. Surveys from 1993 listed in Sada (2005a) showed springsnails as scarce at Twin Springs. Sada (2005a) listed the Toquerville springsnail as common at Redden Springs in 1993, but we were unable to confirm whether the springsnail is still present at this location because access was not granted.

Table 36. Springsnails present at aquatic systems of interest throughout Snake Valley in Millard County and Juab County, Utah, and White Pine County, Nevada.

SYSTEM	SOURCES[a]	*P. ANGUINA*	*P. PECULIARIS*	*P. KOLOBENSIS*	*P. SAXATILIS*
Big Springs	1, 2	P[b] 1, 2, 3	A[c]	A	A
Big Springs Pond	1, 2	P 1	A	A	A
Big Springs Creek	1, 3	A	P 1, 2, 3	A	A
Beck Springs - North	1	A	A	P 1	A
Beck Springs - South	1	A	A	P 1	A
Bishop Springs/ Foote Reservoir	1	A	A	A	A
Caine Spring	1	A	A	P 1	A
Callao Big Springs	1	A	A	P 1	A
Clay Spring	1, 2	P 1, 2	A	A	A
Cold Spring	1, 2	A	A	P 1, 2	A
Gandy Salt Marsh North Complex (G4-G9	1	A	A	P 1	A
Gandy Salt Marsh Middle Complex (G20-G28)	1	A	A	A	A
Gandy Salt Marsh G44	1	A	A	A	A
Gandy Salt Marsh G48-G49	1	A	A	A	A
Gandy Salt Marsh G51	1	A	A	A	A
Gandy Warm Springs	1, 2	A	A	A	P 1, 2
Knoll Spring	1, 2	A	A	P 2	A
Leland Harris Spring	1, 2	A	A	P 1, 2	A
Miller Spring	1	A	A	P 1	A
North Little Spring	1	A	A	A	A
South Little Spring	1	A	A	A	A
Redden Springs	2	A	A	P2	A
Swimming Hole	1	A	A	A	A
Twin Springs	1, 2	A	A	P 1, 2	A

Table 36. Continued.

SYSTEM	SOURCES[a]	*P. ANGUINA*	*P. PECULIARIS*	*P. KOLOBENSIS*	*P. SAXATILIS*
Unnamed Spring South of Caine Spring	1, 2	A	A	P 1, 2	A
Unnamed Spring South of Knoll Spring	1	A	A	A	A
Unnamed Spring at Skating Pond	1	A	A	A	A
Unnamed Big Spring #1	1, 2	P 1, 2	A	A	A
Unnamed Big Spring #2	1	A	A	A	A

[a] 1 = BIO-WEST survey and/or reconnaissance, 2 = Sada (2005a; 2005b, pers. comm.), 3= NDOW (Tallerico and Crookshanks 2005).
[b] Present through visual observation.
[c] Absent through visual observation.

Gandy Warm Springs contains an endemic springsnail, the sub globose Snake springsnail (Hershler 1998, Oliver and Bosworth 1999). Oliver and Bosworth (1999) found the snail to be abundant in the spring pool near the main source of Gandy Warm Springs, but further surveys by the UDWR found the sub globose Snake springsnail throughout Gandy Warm Creek where sampling occurred (BIO-WEST 2002, Vinson 2002). We found the sub globose Snake springsnail to be abundant in the main spring pool, as well as in a seep just downstream from the main source. Abundance decreased downstream, but we still found sub globose Snake springsnail as far as 250 m downstream from the spring pool in Gandy Warm Creek.

Clay Spring is the type location for the longitudinal gland springsnail (Hershler 1998). Sada (2005a) listed the longitudinal gland springsnail as common in Clay Spring. We found the longitudinal gland springsnail to be common to abundant from the spring source up to 50 m downstream. Sada (2005a; 2005b, pers. comm.) also listed the longitudinal gland springsnail as common at Big Springs in 1998. We found the longitudinal gland springsnail was scarce to common near the spring heads at Big Springs. The distribution of the longitudinal gland springsnail only appeared to extend for about 15-25 m downstream from the spring heads at Big Springs. We did not find any longitudinal gland springsnail at our downstream survey site in Big Springs Creek or in Big Springs Pond while we were surveying.

However, EcoAnalysts found a springsnail in our Big Springs Pond macroinvertebrate sample, which we assume is the longitudinal gland springsnail. We also observed springsnails in downstream areas of Big Springs Creek while assisting the NDOW with fish surveys. Sada (2005b, pers. comm.) indicated that these springsnails are the bifid duct springsnail.

Macroinvertebrates were collected at North and South Beck springs, Bishop Springs and Foote Reservoir, Callao Big Spring, the five sites within the Gandy Salt Marsh complex, Unnamed Spring at Skating Pond, and Swimming Hole in July and August 2006. These samples compliment those collected in 2005. In all, EcoAnalysts identified 158 individual taxa of aquatic invertebrates in samples we collected throughout the Snake Valley (Appendix D, Appendix E). The total number of invertebrate taxa identified in our samples varied between 6 and 33, with two of the smaller systems having a relatively high number of taxa (Table 37). Callao Big Springs had the highest number of taxa, while Unnamed Spring South of Caine Spring had the lowest number of taxa.

Table 37. Total number of invertebrate taxa; mayfly, stonefly, and caddisfly taxa (EPT taxa); taxa in the Phylum Mollusca; taxa in the Order Odonata; and taxa in the Subphylum Crustacea at aquatic systems of interest throughout the Snake Valley in Millard County and Juab County, Utah, and White Pine County, Nevada.

SYSTEM	TOTAL TAXA	EPT TAXA	MOLLUSCA TAXA	ODONATA TAXA	CRUSTACEA TAXA
Big Springs	25.00	8.00	3	1	3
Big Springs Creek	26.00	10.00	0	1	2
Big Springs Pond	17.00	0.00	3	1	3
Beck Springs-North	23.00	1.00	7	3	2
Beck Springs-South	26.00	1.00	5	2	2
Bishop Springs	26.00	5.00	3	1	2
Foote Reservoir	30.00	3.00	1	2	2
Caine Spring	17.00	3.00	2	1	2
Callao Big Springs	13.00	2.00	6	3	3
Clay Spring	26.00	5.00	2	1	2
Cold Spring	23.00	2.00	2	0	2
Gandy Salt Marsh North Complex (G4-G9)	27.00	1.00	5	2	3
Gandy Salt Marsh Middle Complex (G20-G28)	11.00	0.00	3	1	3

Table 37. Continued.

SYSTEM	TOTAL TAXA	EPT TAXA	MOLLUSCA TAXA	ODONATA TAXA	CRUSTACEA TAXA
Gandy Salt Marsh (G44)	12.00	0.00	3	0	2
Gandy Salt Marsh (G48-G49)	10.00	0.00	1	0	3
Gandy Salt Marsh (G51)	17.00	0.00	4	0	3
Gandy Warm Springs	26.00	8.00	4	1	2
Knoll Spring	Dry	Dry	Dry	Dry	Dry
Leland Harris Spring	24.00	1.00	4	1	3
Miller Spring	23.00	3.00	3	3	4
North Little Spring	13.00	1.00	1	0	3
South Little Spring	19.00	1.00	1	1	2
Swimming Hole	25.00	1.00	2	3	2
Twin Springs	23.00	5.00	3	3	2
Unnamed Spring at Skating Pond	24.00	1.00	3	2	3
Unnamed Spring South of Caine Spring 1	6.00	0.00	1	0	1
Unnamed Spring South of Knoll Spring	27.00	2.00	0	3	2
Unnamed North of Big Spring 1	17.00	2.00	1	0	3
Unnamed North of Big Spring 2	27.00	2.00	5	2	3

Crustaceans (Amphipoda, Isopoda, and Ostracoda) were present at all systems sampled and represented at least one of the three most-abundant taxa in all springs except Bishop Springs, Foote Reservoir, Gandy Warm Springs, and South Little Spring (Appendix E, Table 37). Nonnative crayfish (Cambaridae) were observed during sampling at Big Springs. The number of mayfly, stonefly, and caddisfly taxa was generally highest in those systems that had larger creeks or spring brooks associated with them. Snails or clams (Mollusca) were found in our invertebrate samples from every system except Big Springs Creek and the Unnamed Spring South of Knoll Spring, but as noted above springsnails were observed during NDOW fish surveys in Big Springs Creek. EcoAnalysts found no springsnails in our macroinvertebrate samples from Big Springs Creek and Unnamed Spring South of Knoll Spring, so springsnail numbers must have either been low in relation to other invertebrates or springsnails are only present in areas downstream of our survey site. The nonnative red-rimmed melania snail (*Melanoides tuberculatus*) was only found at Gandy Warm Springs, where it had been previously identified (BIO-WEST 2002).

At sites they surveyed in Snake Valley, Keleher et al. (2003) found that Amphipods had the highest relative abundance, and mollusks and mayflies were relatively abundant. While we found that Amphipods and mollusks were one of the three most-abundant taxa at many of the aquatic systems of interest, mayflies were only one of the three most-abundant taxa at Big Springs Creek, Callao Big Springs, South Little Spring, Unnamed Spring at Skating Pond, and Unnamed Big Spring #2. We found that seed shrimp (Ostracoda), midges (Chironomidae), and worms (Oligochaeta) were one of the three most-abundant species in many locations. We may have collected higher numbers of these species because we used a smaller mesh size (250-500 microns) in our sampling devices than did Keleher et al. (2003) (1,000 microns).

Other Fauna

While surveying aquatic systems of interest in Snake Valley, we found a variety of other wildlife using these spring systems and their associated habitat. We observed many birds including Canada geese, crows (*Corvus brachyrhynchos*), great blue herons, red-winged blackbirds (*Agelaius phoeniceus*), northern harriers, horned larks (*Eremophila alpestris*), killdeer, lark sparrows *(Chondestes grammacus)*, northern mockingbirds (*Mimus polyglottos*), common nighthawks, Bullock's orioles, ravens, western meadowlarks, mourning doves, redtail hawks (*Buteo jamaicensis*), sage thrashers, short-eared owls *(Asio flammeus)*, barn swallows, black-throated sparrows (*Amphispiza bilineata*), vesper sparrows (*Pooecetes gramineus*), western kingbirds (*Tyrannus verticalis*), western wood pee-wees (*Contopus sordidulus*), common yellowthroats (*Geothlypis trichas*), and several unidentified songbirds. We saw two great horned owls (*Bubo virginianus*) at Twin Springs. We also saw, or saw sign of, coyotes, desert cottontails, foxes (*Vulpes* spp.), black-tailed jackrabbits, white-tailed antelope squirrels (*Ammospermophilus leucurus*), muskrats (*Ondatra zibethicus*), pronghorn, leopard lizards (*Gambelia wislizenii*), western fence lizards (*Sceloporus occidentalis*), and zebra-tailed lizards (*Callisaurus draconoides*).

Disturbance

We categorized most of the aquatic systems of interest in Snake Valley as moderately or highly disturbed (Table 38). We found that most of the aquatic systems of interest were impacted by some sort of current or historical diversion structure. Portions of every system had livestock impacts, except for the areas inside exclosures in the Gandy Salt Marsh complex. We felt that

Table 38. Disturbance level and factors at aquatic systems of interest throughout the Snake Valley in Millard County and Juab County, Utah, and White Pine County, Nevada.

SYSTEM	DISTURBANCE LEVEL	DISTURBANCE FACTORS
Big Springs	High	Livestock, Diversion, Residence, Multiple Other Human Impacts, Drought, Nonnative Species
Big Springs Pond	High	Livestock, Diversion, Residence, Drought, Nonnative Species
Big Springs Creek	High	Livestock, Diversion, Residence, Drought, Nonnative Species
North Beck Spring	Moderate/High	Diversion, Livestock, Residence, Roads
South Beck Spring	Moderate	Livestock, Diversion
Bishop Springs/ Foote Reservoir	High	Diversion, Livestock, Nonnative Species
Caine Spring	Moderate	Livestock, Diversion, Nonnative Vegetation
Callao Big Spring	Moderate/High	Livestock, Drought, Nonnative Species
Clay Spring	High	Livestock, Diversion
Cold Spring	Moderate/High	Livestock, Diversion
Gandy Salt Marsh North Complex (G4-G9)	Slight	Livestock
Gandy Salt Marsh Middle Complex (G20-G28)	Undisturbed/ Slight	Historic Livestock Use, Overgrown
Gandy Salt Marsh G44	Slight	Livestock
Gandy Salt Marsh G48-G49	Undisturbed/ Slight	Historic Livestock Use, Overgrown
Gandy Salt Marsh G51	Moderate	Livestock, Drought
Gandy Warm Springs	Moderate	Livestock, Recreation, Nonnative Species
Knoll Spring	Moderate	Drought, Livestock
Leland Harris Spring	Slight	Livestock, Nonnative Vegetation
Miller Spring	Moderate/High	Livestock, Diversion, Nonnative Vegetation
North Little Spring	Moderate	Livestock, Diversion
South Little Spring	High	Livestock, Diversion, Drought, Nonnative Vegetation
Swimming Hole	Moderate/High	Drought, Livestock, Nonnative Vegetation
Twin Springs	Moderate	Livestock, Diversion, Nonnative Species
Unnamed Big Spring #1	Moderate	Residence, Livestock, Roads
Unnamed Big Spring #2	Moderate	Livestock, Diversion, Roads

Table 38. Continued.

SYSTEM	DISTURBANCE LEVEL	DISTURBANCE FACTORS
Unnamed Spring South of Caine Spring	Slight	Livestock, Drought
Unnamed Spring South of Knoll Spring	High	Livestock, Diversion, Nonnative Species
Unnamed Spring at Skating Pond	High	Drought, Livestock, Nonnative Vegetation

the Unnamed Spring South of Caine Springs and the area of Leland Harris Spring we sampled were only slightly impacted (Figure 8). Both of these areas had minimal impacts from cattle and no diversion structures. Conversely, the Unnamed Spring south of Knoll Springs and South Little Spring provide good examples of highly impacted springs (Figure 9). The Unnamed Spring south of Knoll Springs was boxed at the spring head, and all the flow was then piped into a cattle trough. Overflow from the cattle trough did form a small marshy terminus area that was trampled by cattle. South Little Spring was heavily trampled by livestock.

Comparing our information with surveys listed in Sada (2005a), we found that we generally rated systems as more heavily disturbed. The UDWR also characterizes disturbance through bank condition and ungulate damage, when performing least chub surveys (UDWR, unpublished data). Since the majority of spring heads in the Gandy Salt Marsh complex are within cattle exclosures, the UDWR characterized most of the areas in Gandy Salt Marsh as undisturbed by livestock (Wheeler and Fridell 2006). They noted that spring heads outside the exclosures were generally only slightly disturbed by livestock, although a few spring heads were moderately disturbed. This matched the results of our disturbance evaluations. While the exclosures prevent livestock damage, they also prevent other ungulates from using the area. Therefore, some of the spring heads within exclosures have become overgrown (K. Wheeler 2006, pers. comm.). The UDWR is evaluating the potential for vegetation removal to increase the amount of least chub habitat. Data from 2002 indicated low ungulate damage throughout Leland Harris Springs and Twin Springs. They also indicated moderate ungulate damage throughout the remainder (outside of Twin Springs) of Bishop Springs. Fridell et al. (2004) found heavy ungulate damage throughout Bishop Springs during Colombia spotted frog surveys in 2004.

Many factors may influence the disturbance ranking of individual systems between years in the same survey or between different surveys. Certain impacts, such as livestock trampling and grazing, may vary from year to year. Different surveys may only look at a certain portion of a spring system. For example, at Miller Spring the source pond has been fenced to protect least chub and Columbia spotted frog, but the outflow stream is still substantially impacted by livestock. Ultimately, disturbance evaluations are fairly subjective in any survey.

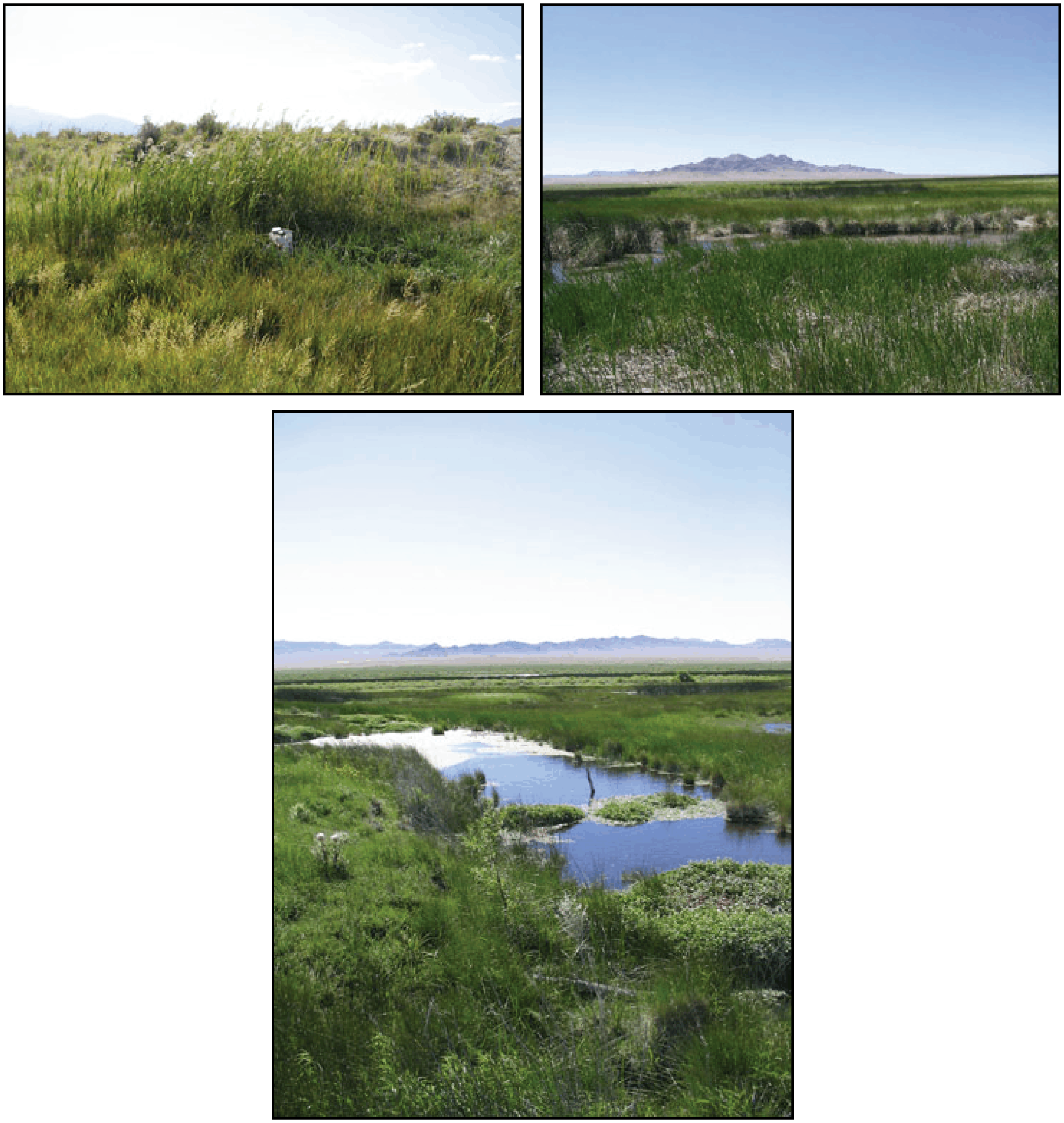

Figure 8. **Photographs of Snake Valley systems we classified as only slightly disturbed (clockwise from top left): (a) the spring source of the Unnamed Spring South of Caine Spring, (b) the spring source at Leland Harris Springs, and (c) downstream at Leland Harris Springs.**

Figure 9. **Photographs of Snake Valley systems we classified as highly disturbed (clockwise from top left): (a) boxed spring head at Unnamed Spring South of Knoll Spring, (b) cattle trough at Unnamed Spring South of Knoll Spring, and (c) cattle damage at the terminus of South Little Spring.**

Pleasant Valley

Pleasant Valley is a small tributary valley to the Snake Valley where the SNWA has filed groundwater applications. Cane Spring was the only aquatic system of interest identified in Pleasant Valley, and we performed a Level 2 survey there (Figure 10, Table 39). Aquatic species of interest known to inhabit Pleasant Valley include the Toquerville springsnail (Sada 2005a).

Table 39. The UTM location, survey date, survey level, and ownership of aquatic systems of interest throughout Pleasant Valley in White Pine County, Nevada.

SYSTEM	NORTHING	EASTING	SURVEY DATE	BIO-WEST SURVEY LEVEL	OWNERSHIP
Cane Spring	4396058	752242	10/7/04	Level 2	Public/BLM

Note: UTM coordinates are in the NAD 83 projection system.

Physical Habitat and Water Quality

Cane Springs is a rheocrene that has been bermed to make a small pond (Table 40). A stream flowed out the west side of the pond and down onto private property.

Table 40. Type of system, maximum depth, maximum wetted width, length of survey plots, and measured discharge found at Cane Spring in Pleasant Valley in White Pine County, Nevada.

SYSTEM	SPRING TYPE	MAXIMUM DEPTH (cm)	MAXIMUM WETTED WIDTH (m)	LENGTH (m)	DISCHARGE (l/s)
Cane Spring	Rheocrene	90.5	26	144[a]	N/A

[a]Continued further as a spring brook or marsh land, or onto private property.

Water quality appeared suitable for aquatic life in Cane Spring (Table 41). Sada (2005a) found substantially lower levels of dissolved oxygen at Cane Spring (1.8 mg/l), but his other water quality observations were similar to ours.

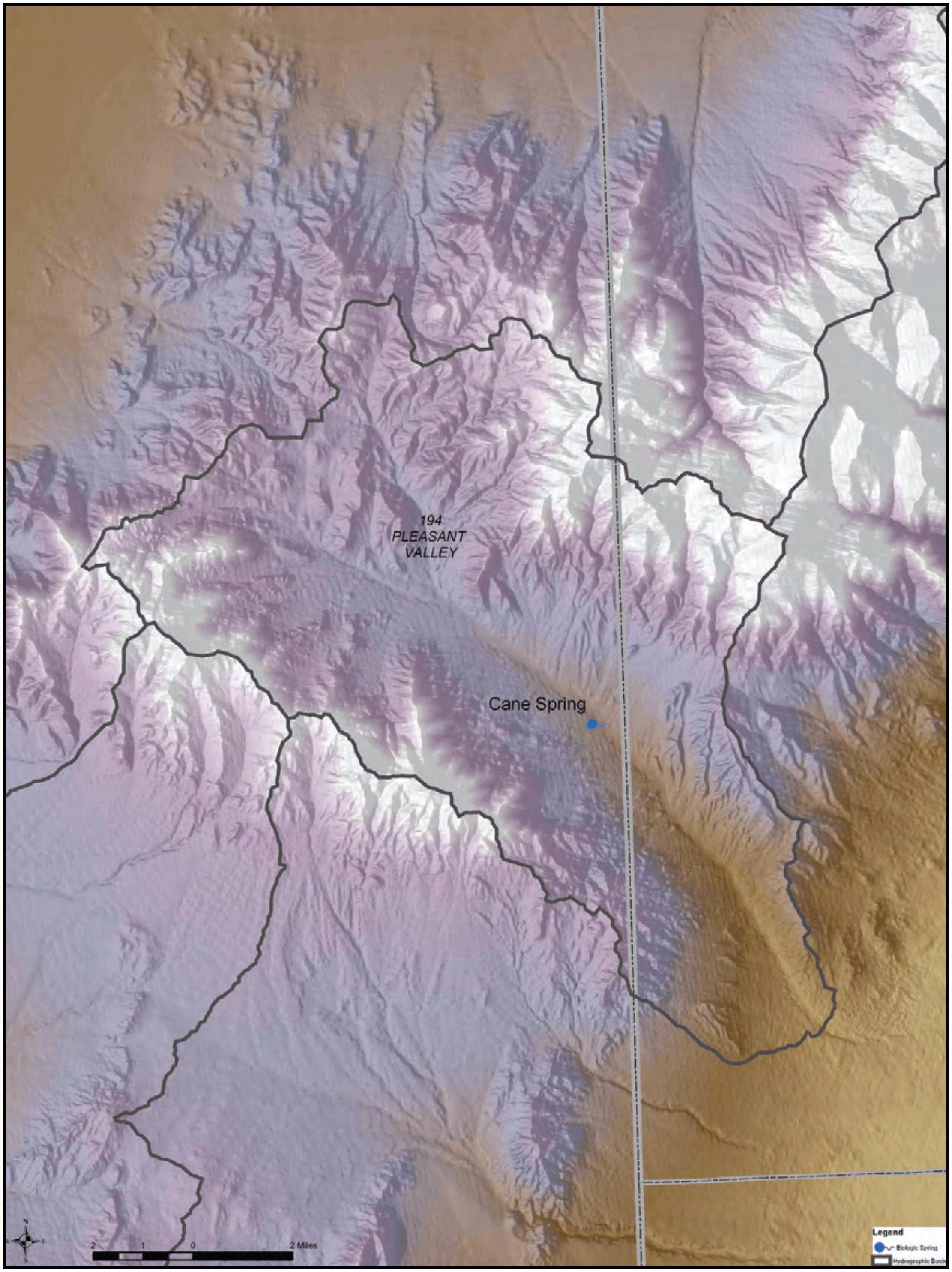

Figure 10. **Map of the location of Cane Spring in Pleasant Valley, White Pine County, Nevada.**

Table 41. Water quality measurements taken from the source and the terminus of Cane Spring locations in Pleasant Valley, White Pine County, Nevada.

SYSTEM	LOCATION	TEMPERATURE (C)	DISSOLVED OXYGEN (mg/l)	CONDUCTIVITY (μS/cm)	pH
Cane Spring	Source	13.5	5.87	539	7.53
	Terminus	15.6	7.47	407	8.46

Aquatic Vegetation

Cane Spring had a variety of habitats, which resulted in a variety of vegetation types. Watercress was dominant from the spring source to the pond (Table 42). The margins of the source area and the pond were dominated by emergent vegetation (Table 43). The center of the pond had a mixture of open water, muskgrass, pondweed, and algae. The outlet stream had emergent vegetation along the margin and some areas of watercress.

Table 42. Percent cover of different submerged aquatic vegetation at Cane Spring in Pleasant Valley, White Pine County, Nevada.

COMMON NAME	SCIENTIFIC NAME	CANE SPRINGS
Horsehair Algae	*Chlorophyceae* sp.	2
Muskgrass	*Chara vulgaris*	50
Pondweed	*Potamogeton foliosus / pectinatus*	30
Watercress[a]	*Nasturtium officinale*	18

[a]Watercress group.

Vegetation Mapping

We returned to Cane Springs to perform vegetation mapping in September 2005. The vegetation community at Cane Springs was fairly diverse, and 10 different associations were identified (Table 44). None of the associations comprised more than 25% of the 2.0 acres sampled at the spring. The Clustered Field Sedge Association covered the largest percentage of the at Cane Spring (22%). The Redtop Association covered nearly 20% of the spring area. The Wood's Rose (*Rosa woodsii*) Association comprised almost 11% of the spring area. The other 48% of the 2.0 acres mapped at Cane Spring was comprised of six other vegetation associations and open water. Thirteen plant species were identified at Cane Springs during the mapping effort (Appendix C). Volume II contains the vegetation maps that correspond with this report.

Table 43. Percent cover of different emergent aquatic vegetation at Cane Spring in Pleasant Valley, White Pine County, Nevada.

COMMON NAME	SCIENTIFIC NAME	CANE SPRINGS
Baltic Rush	*Juncus arcticus*	2
Foxtail Barley	*Hordeum jubatum*	5
Hardstem Bulrush	*Scirpus acutus*	2
Nebraska Sedge	*Carex nebrascensis*	5
Perennial Sowthistle	*Sonchus arvensis*	2
Rabbit-foot Grass	*Polypogon monspeliensis*	10
Redtop	*Agrostis gigantea*	10
Reed Canary Grass	*Phalaris arundinacea*	2
Saltgrass	*Distichlis spicata*	5
Seepweed	*Suaeda calceoliformis*	2
Silverweed	*Potentilla anserina*	10
Spikerush	*Eleocharis* sp.	10
Olney's Three Square Bulrush	*Schoenoplectus americanus*	20
Torrey's Rush	*Juncus torreyi*	10
Willow-herb	*Epilobium* sp.	10

Several species found in our initial survey at Cane Spring were not noted during the mapping effort. These species included: foxtail barley, hardstem bulrush, sowthistle (*Sonchus arvensis*), rabbitfoot grass, saltgrass, seepweed (*Suaeda calceoliformis*), silverweed (*Potentilla anserina*), and willow-herb (*Epilobium* sp.).

Fishes

Sada (2005a) listed no known fish species in Cane Spring. We set 13 minnow traps overnight in Cane Spring on March 4, 2005, and did not collect any fish.

Table 44. The proportion of the 2.0 acres mapped comprised of each association (alliance) at Cane Spring in Pleasant Valley, White Pine County, Nevada.

ASSOCIATIONS /ALLIANCES IN PLEASANT VALLEY	CANE SPRING
Agrostis gigantea (Redtop) Herbaceous Vegetation / *Agrostis stolonifera* (Creeping Bentgrass) Seasonally Flooded Herbaceous	20.11%
Carex praegracilis (Clustered Field Sedge) Herbaceous Vegetation / *Carex praegracilis* Seasonally Flooded Herbaceous	22.46%
Carex nebrascensis (Nebraska Sedge) Herbaceous Vegetation / *Carex nebrascensis* Seasonally Flooded Herbaceous	5.24%
Eleocharis palustris (Common Spikerush) Herbaceous Vegetation / *Eleocharis palustris* Seasonally Flooded Herbaceous	6.23%
Mixed Wetland Graminoid Herbaceous Vegetation / Undesignated Alliance	3.64%
Non-rooted Aquatic Plant and Algae Vegetation / Undesignated Alliance	0.62%
Open Water / Undesignated Alliance	9.44%
Phalaris arundinacea (Reed Canarygrass) Western Herbaceous Vegetation / *Phalaris arundinacea* Seasonally Flooded Herbaceous	9.90%
Nasturtium officinale (Watercress) - *Berula erecta* (Cutleaf Water Parsnip) - *Veronica anagallis-aquatica* (Water Speedwell) Herbaceous Vegetation / Undesignated Alliance	1.53%
Rosa woodsii (Wood's Rose) Shrubland / *Rosa woodsii* Temporarily Flooded Shrubland	11.28%
Schoenoplectus americanus (Olney's Three Square Bulrush) Western Herbaceous Vegetation / *Schoenoplectus americanus Semipermanently* Flooded Herbaceous	9.57%

Amphibians

Survey information from Sada (2005a) listed no known amphibian species in Cane Spring. We did not find any amphibians during our visual survey of this system in September 2004. Our visual encounter surveys were not very intensive and occurred during daylight hours when adult frogs are less likely to be active and observed. The Nevada Natural Heritage database does not list the collection of any sensitive amphibian species in Pleasant Valley (NVNHP 2004). However, it is possible the northern leopard frog, Great Basin spadefoot toad, and/or bullfrog may utilize Cane Spring, even though they were not observed during our sampling.

Springsnails and Invertebrates

The Toquerville springsnail was found in Cane Spring during our surveys and surveys listed in Sada (2005a). Sada (2005a) listed the Toquerville springsnail as scarce in Cane Springs, but we found Toquerville springsnails were abundant in aquatic vegetation (watercress group) at the spring head, and they were common for about 30 m downstream.

We collected 28 different taxa from 11 different invertebrate orders in Cane Spring and its outflow pond (Appendix D and Appendix E). Amphipods (*Hyallela* sp.), seed shrimp (Ostracoda), and the Toquerville springsnail (Hydrobiidae) dominated the collection. Mayflies (Ephemeroptera), caddisflies (Trichoptera), and damselflies (Odonata) were also collected.

Other Fauna

During our survey we observed a black-tailed jackrabbit, a ground squirrel (*Spermophilus* spp.), an unidentified lizard, and an unidentified shorebird using Cane Spring.

Disturbance

We categorized Cane Spring as highly disturbed. At Cane Spring, the spring head had been piped, and the spring brook had been bermed. A head gate had been installed in the berm to allow the resulting pond to be used for irrigation (Figure 11). In addition, we saw evidence of moderate livestock (cattle) use and found the nonnative tree, Russian olive, in the riparian zone.

Spring Valley

Spring Valley lies to the west of Snake Valley in White Pine County, Nevada, with the Deep Creek Mountains and the Snake Range to the east and the Schell Creek Range to the west. Few if any fishes were reported in most historical sampling records of Spring Valley (Hubbs and

Figure 11. Cane Spring in Pleasant Valley, White Pine County, Nevada, looking downstream from the spring head.

Miller 1948). The Shoshone Ponds Natural Area, a Bureau of Land Management (BLM) native fish sanctuary, now houses one of three refugia populations of the Federally endangered Pahrump poolfish, as well as a refugia population of the relict dace (*Relictus solitarius*) (USFWS 2004b, Hobbs et al. 2005). Both of these species are endemic to Nevada and are on the State of Nevada's Rare (At-risk) Species List (NVNHP 2004).

The Pahrump poolfish was listed as endangered with the passage of the ESA of 1973. Originally, the species was comprised of three subspecies of poolfish endemic to three different springs in Nye County, Nevada (Miller et al. 1989, USFWS 2004b). After two of the subspecies were lost to the introduction of nonnative fish species and dewatering of the springs from groundwater pumping, individuals from the population at Manse Spring were relocated to three different refugia including the Shoshone Ponds Natural Area. Subsequently, the Manse Spring population was also extirpated; hence the refugia areas contain the only known populations of Pahrump poolfish.

Relict dace are endemic to four hydrographic basins in Nevada to the north and west of Spring Valley. The relict dace was a former candidate for listing under the (ESA), but it is currently a Federal species of concern (NVNHP 2004). Relict dace were transplanted to four locations in Spring Valley throughout the 1900s: Spring Valley Creek, Stonehouse Ranch, Keegan Ranch, and Shoshone Ponds (Stein and Salisbury 1994). Both the Pahrump poolfish and relict dace are significant biological resources in Spring Valley.

The bifid duct springsnail, which is on the State of Nevada's Rare (At-Risk) Species List (NVNHP 2004), has also been found in Spring Valley (Sada 2005a). Turnley Spring, where the bifid duct springsnail was previously identified, is a mountain block spring. The bifid duct springsnail is a significant biological resource that inhabits some portions of Spring Valley.

Twenty-two aquatic systems of interest were identified in Spring Valley, and we performed Level 2 surveys at 24 sites within 19 of these systems (Figure 12, Table 45). We performed a Level 1 survey at Turnley/Woodsman Spring, since it was in the mountain block. We did not survey North Spring because we were unable to gain access.

Physical Habitat and Water Quality

Spring Valley has many aquatic systems of various sizes (Table 46). The West Spring Valley complex was one of the largest systems, with a series of at least six spring heads emanating from an alluvial fan on the west side of the valley. The Keegan Ranch area, just north of the West Spring Valley complex, also consisted of a series of spring heads feeding a large marshy area. The spring brooks and seeps from these spring heads fed a common marsh/wet meadow area further east in the valley. The artesian wells, ponds, and springs in the Shoshone Ponds Natural Area also fed a large wet meadow/marsh area, as did all three Unnamed Springs near Minerva.

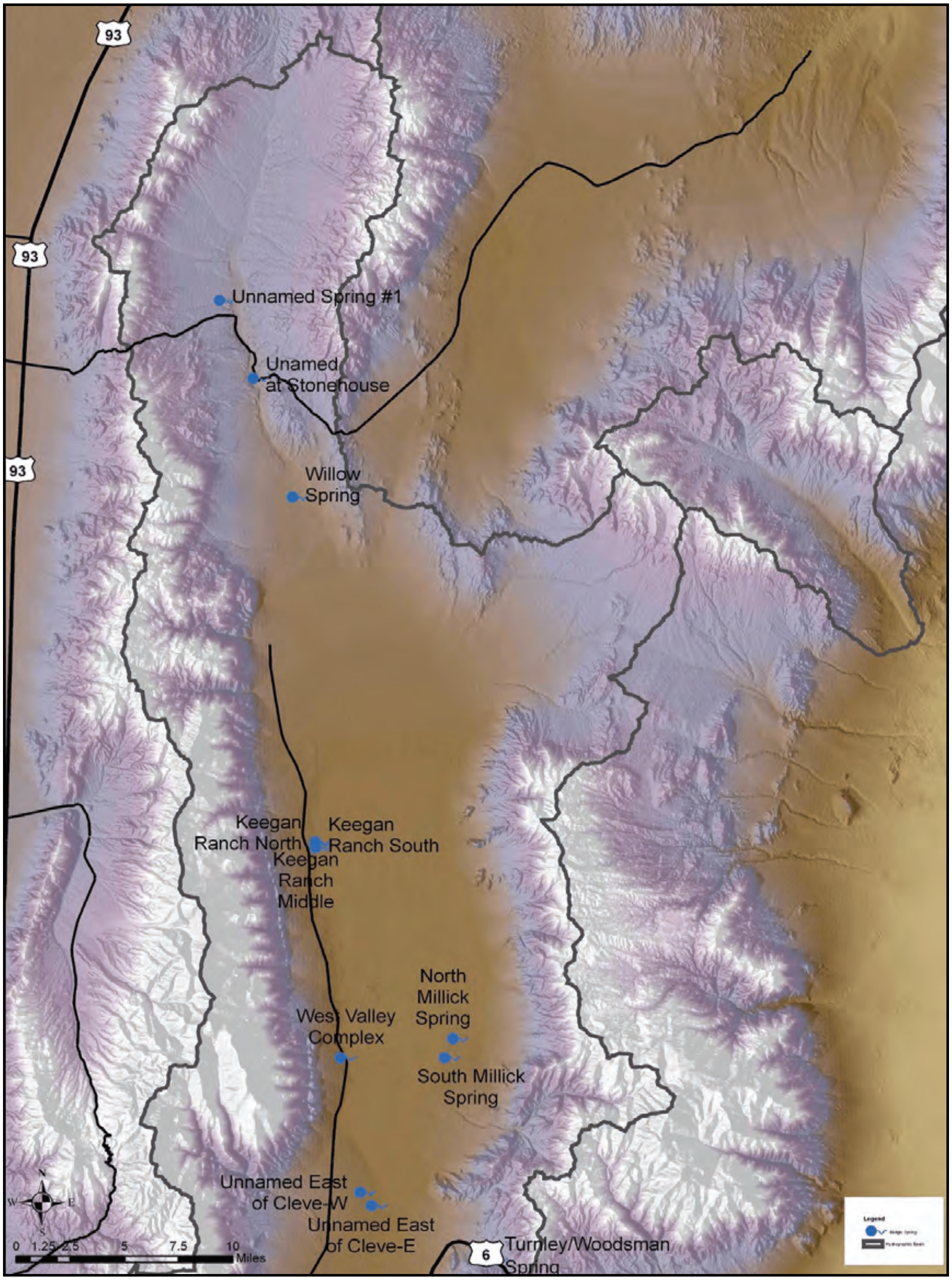

Figure 12a. Map of locations of aquatic systems of interest in Upper Spring Valley, White Pine County, Nevada.

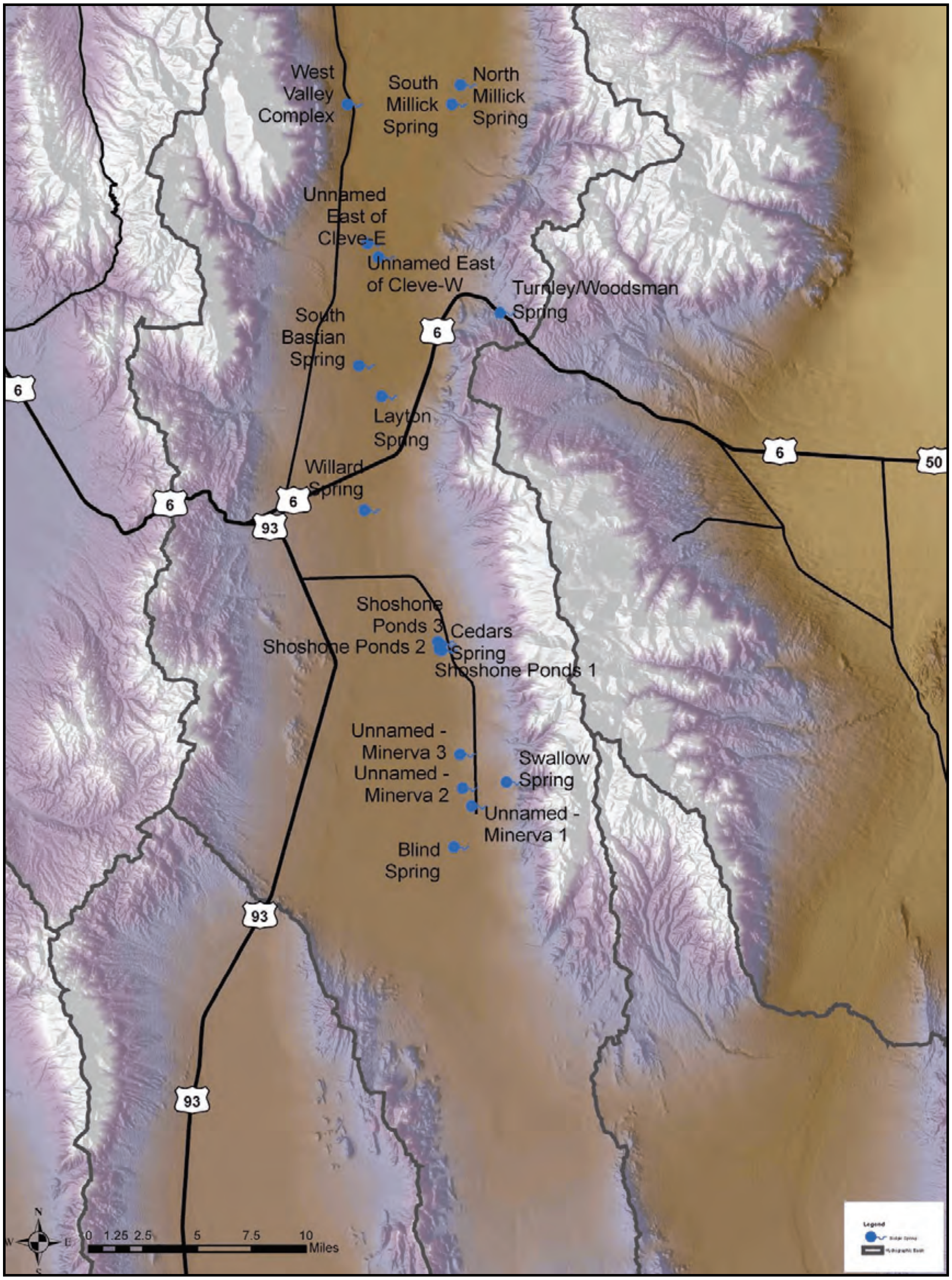

Figure 12b. Map of locations of aquatic systems of interest in Lower Spring Valley, White Pine County, Nevada.

Table 45. The UTM location, survey date, survey level, and ownership of aquatic systems of interest throughout Spring Valley in White Pine County, Nevada.

SPRING NAME	NORTHING	EASTING	DATE SURVEYED	BIO-WEST SURVEY LEVEL	OWNER
Blind Spring	4298020	724719	9/15/2004	Level 2	BLM
Cedars Spring	4312893	723713	6/15/2005	Level 2	BLM
Keegan Ranch North	4369500	714982	9/14/2006	Level 2	SNWA
Keegan Ranch Middle	4369186	714980	9/14/2006	Level 2	SNWA
Keegan Ranch South	4369008	714997	9/14/2006	Level 2	SNWA
Layton Spring	4331556	720131	9/13/2006	Level 2	BLM
North Millick Spring	4353957	725673	9/15/2004	Level 2	BLM
North Spring	4286253	750986	N/A	None/access	Private
South Millick Spring	4353609	725136	9/15/2004	Level 2	BLM
Shoshone #1 (pond)	4313252	723804	6/15/2005	Level 2	BLM
Shoshone #2 (ponds 1-3)	4312868	723708	6/15/2005	Level 2	BLM
Shoshone #3	4312769	723802	6/15/2005	Level 2	BLM
South Bastian Spring	4333936	718435	9/13/2006	Level 2	BLM
Swallow Spring	4302867	728688	6/14/2005	Level 2	Private
Turnley/Woodsman Spring	4337848	728754	8/23/06	Level 1	BLM
Unnamed Spring East of Cleve Creek (East Spring)	4342422	719103	9/14/2004	Level 2	BLM
Unnamed Spring East of Cleve Creek(West Spring)	4342539	718981	9/14/2004	Level 2	BLM
Unnamed Springs at Minerva-1	4301037	726116	6/15/2005	Level 2	Private
Unnamed Springs at Minerva-2	4302413	725447	6/16/2005	Level 2	Private
Unnamed Springs at Minerva-3	4303946	725153	6/15/2005	Level 2	Private
Unnamed Spring #1	4412633	708604	9/14/2004	Level 2	BLM
Unnamed Spring at Stonehouse Ranch	4406431	710276	8/23/06	Level 2	SNWA
Willard Spring	4324008	718664	6/14/2005	Level 2	Private
Willow Spring	4397068	713760	9/14/2004	Level 2	BLM
West Spring Valley Complex #1	4353785	717485	9/16/2004	Level 2	Private
West Spring Valley Complex #5	4352790	717494	9/16/2004	Level 2	Private

Note: UTM coordinates are in the NAD 83 projection system.

Table 46. Type of system, maximum depth, maximum wetted width, length of survey plots, and measured discharge found at aquatic systems of interest throughout Spring Valley in White Pine County, Nevada.

SYSTEM NAME	SYSTEM TYPE	MAXIMUM DEPTH (cm)	MAXIMUM WETTED WIDTH (m)	LENGTH (m)	DISCHARGE (l/s)
Blind Spring	Unknown	39.7	41	41	N/A
Cedars Spring	Artesian well	35	80	210[a]	1
Keegan Ranch North	Rheocrene	32	7	200	N/A
Keegan Ranch Middle	Rheocrene	19	N/A[a]	143	N/A
Keegan Ranch South	Rheocrene	12	N/A[a]	169	N/A
Layton Spring	Unknown	48	22	22	0.048
North Millick Spring	Rheocrene	27.5	13.3	269[b]	14.82
South Millick Spring	Rheocrene	61	32.3	156[b]	29.57
Shoshone #1 (pond)	Artesian well/Pond	91	51	163[b]	0.333
Shoshone #2	Artesian well/Ponds	> 200	12	47	N/A
Shoshone #3	Limnocrene	15	22	153[b]	N/A
South Bastion Spring	Unknown	22	11	76	0.034
Swallow Spring	Rheocrene	30	8	123[b]	N/A
Turnley/Woodsman Spring	Rheocrene	42	3.5	171	N/A
Unnamed Spring East of Cleve Creek (East spring)	Helocrene	30.5	28.8	90(138)[c]	N/A
Unnamed Spring East of Cleve Creek (West spring)	Helocrene	6.1	32	52	N/A
Unnamed Spring #1	Rheocrene	36.6	13.2	62	0.24
Unnamed Minerva Spring #1	Rheocrene	> 200	65	190[b]	193.11[d]
Unnamed Minerva Spring #2	Limnocrene	46	35	221[a]	N/A
Unnamed Minerva Spring #3	Limnocrene/ Rheocrene	51	7	96	N/A
Unnamed Spring at Stonehouse Ranch Spring	Helocrene/ Limnocrene			298	N/A
Willard Spring	Limnocrene	20	16	71(94)[c]	N/A
Willow Spring	Rheocrene	15.25	10.1	86	0.35[e]
West Valley Spring Complex #1	Limnocrene	54.9	9.8	59(109)[bc]	N/A
West Valley Spring Complex #5	Limnocrene	> 300	22	174(239)[bc]	N/A

[a]Many small springheads in area that combined into a large wet meadow/seepage complex, thus wetland width was undefinable.
[b]Continued further as a spring brook, marsh land, or onto private property.
[c]Number in parentheses is the length of the riparian zone versus the spring brook/wetted area.
[d]Combined discharge of pond outflows.
[e]Data taken from Sada (2005a).

The spring brooks from North and South Millick Springs flow to a confluence with each other and continue as a joined spring brook. Several of the other systems were quite small, including Blind Spring, Unnamed Spring # 1, and both of the Unnamed Springs east of Cleve Creek (east and west). We were unclear on which Unnamed Spring east of Cleve Creek was sampled by Sada (2005a), but they reported a discharge of 0.05 l/s for that system. Additionally, both Layton Spring and South Bastion Spring have piped spring heads with flows less than 0.05 l/s (Figure 13).

All of the measured water quality parameters varied widely between the different aquatic systems of interest in Spring Valley (Table 47, Appendix B). The artesian well-fed springs and ponds near Shoshone (Cedars Spring, Shoshone Pond #1, Shoshone Ponds #2, Shoshone #3) all had fairly high water temperatures, compared with the other aquatic systems of interest. We also found that sites surveyed around Shoshone had lower conductivities than most of the other systems we surveyed. Our lowest measured temperatures came from Swallow Spring and West Valley Spring complex #1.

Dissolved oxygen levels varied within and between systems. Interestingly, Pond #3 (south pond) in the Shoshone Ponds Natural Area (Shoshone Ponds #2) had considerably lower dissolved oxygen levels than the two ponds immediately adjacent to the north. Hobbs et al. (2005) also noted depressed dissolved oxygen levels in this pond during 2004 relict dace surveys.

Our water quality measurements at the Shoshone Ponds were similar to those taken by Hobbs et al. (2005) in July 2004, except that our dissolved oxygen measurements were slightly lower. Sada (2005a) reports water quality measurements from selected systems in Spring Valley from surveys in 1992 and 1998. Our measurements of dissolved oxygen at most of the locations we sampled in common were lower than those reported in surveys listed by Sada (2005a).

Aquatic Vegetation

We found that our watercress group and horsehair algae were the most common species of SAV growing in the aquatic systems of interest throughout Spring Valley (Table 48). Watercress was found in 20 of 25 sites surveyed, and algae was found in 16. West Spring Valley complex #5 had the highest diversity of SAV, with eight taxa. Interestingly, West Spring Valley complex #1 had only three taxa of SAV. The large, deep head pool and deeper outflow at west Spring Valley complex #5 may have provided more diverse habitat for SAV. We did not find any SAV at the Unnamed Spring East of Cleve Creek (West) and found only watercress at the Unnamed Spring East of Cleve Creek (East). We identified both watercress and water parsnip as SAV in aquatic systems of interest in Spring Valley. We also found monkey flower and Brewer's bittercress in surveys of emergent aquatic vegetation (EAV) (Table 49). Therefore, our watercress group in Spring Valley is probably comprised of one, or more, of these four species.

Figure 13. From top to bottom: Spring Valley's Layton Spring (a), and South Bastion Spring (b).

Table 47. Selected water quality parameters measured at the main source and the terminus, or termination of our sampling site, of aquatic systems of interest throughout Spring Valley in White Pine County, Nevada.

SYSTEM NAME	LOCATION	TEMPERATURE (C)	DISSOLVED OXYGEN (mg/l)	CONDUCTIVITY (µS/cm)	pH
Blind Spring	Source	17.05	2.04	449	6.85
Cedars Spring	Source/terminus	23.86/24.19	4.91/3.19	130/160	8.79/7.94
Keegan Ranch North	Source/terminus	12.16/12.44	7.10/8.30	85/84	7.23/7.36
Keegan Ranch Middle	Source/terminus	13.29/14.67	7.07/6.78	74/69	7.36/7.43
Keegan Ranch South	Source/terminus	13.01/16.70	6.75/6.66	88/91	7.27/7.6
Layton Spring	Source/terminus	16.46/10.75	5.55/6.62	313/212	7.37/8.65
North Millick Spring	Source/terminus	14.06/11.98	7.11/5.80	452/462	7.40/7.33
South Millick Spring	Source/terminus	14.66/16.08	5.24/6.66	456/466	7.03/7.36
Shoshone Pond #1	Source/terminus	21.56/19.45	4.72/7.26	120/107	9.62/9.13
	Pond 1	28.79	3.94	112	9.28
Shoshone Ponds #2	Pond 2	23.73	5.67	135	8.20
	Pond 3	22.99	1.70	128	7.87
Shoshone #3	Source	26.37	6.73	114	9.11
South Bastion Spring	Source/terminus	13.65/16.21	7.65/7.91	294/341	7.52/7.84
Swallow Spring	Source/terminus	10.59/12.44	5.82/5.51	289/276	8.02/8.41
Turnley/Woodsman Spring	Source/terminus	14.44/17.83	5.65/5.82	575/568	7.35/7.94
Unnamed Spring East of Cleve Creek (East Spring)	Source/terminus	17.63/17.83	4.21/5.79	345/315	6.93/7.51
Unnamed Spring East of Cleve Creek (West Spring)	Source	20.43	5.38	326	7.13
Unnamed Minerva Spring #1	Source/terminus	11.82/14.39	5.69/7.10	353/346	8.08/8.22
Unnamed Minerva Spring #2	Source/terminus	12.83/12.55	6.31/5.66	353/333	8.11/8.10
Unnamed Minerva Spring #3	Source/terminus	15.01/20.10	7.59/7.48	735/695	8.15/8.32
Unnamed Spring #1	Source/terminus	11.20/8.70	8.98/9.93	381/380	7.21/7.63
Unnamed Spring at Stonehouse Ranch	Source/terminus	15.89/19.94	6.98/3.69	473/478	8.01/7.73
West Spring Valley Complex #1	Source/terminus	10.47/13.21	1.92/4.49	516/311	6.74/6.99
West Spring Valley Complex #5	Source/terminus	19.05/14.6	7.84/5.51	414/456	7.49/7.54
Willard Spring	Source/terminus	26.23/26.06	3.00/4.55	366/350	7.82/8.35
Willow Spring	Source/terminus	13.52/18.93	3.56/8.90	442/416	6.96/8.30

[a]Data taken from Sada (2005a).

Table 48. Percent cover of submerged aquatic vegetation (SAV) found at aquatic systems of interest throughout Spring Valley in White Pine County, Nevada.

COMMON NAME	SCIENTIFIC NAME	SYSTEMS																								
		BLIND	CEDARS	KEEGAN-MIDDLE	KEEGAN-SOUTH	KEEGAN RANCH-NORTH	LAYTON	NORTH MILLICK	SOUTH BASTION	SOUTH MILLICK	SHOSHONE POND #1	SHOSHONE POND #2	SHOSHONE POND #3	SWALLOW	TURNLEY / WOODSMAN	UNNAMED CLEVE CREEK EAST	UNNAMED CLEVE CREEK WEST	UNNAMED MINERVA 1	UNNAMED MINERVA 2	UNNAMED MINERVA 3	UNNAMED SPRING #1	UNNAMED STONEHOUSE	WEST SPRING VALLEY COMPLEX #1	WEST SPRING VALLEY COMPLEX #5	WILLARD	WILLOW
Cinquefoil	***Potentilla* sp.**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	80	-	-	-
Columbian Watermeal	*Wolffia columbiana*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5	-	-
Common Duckweed	*Lemna minor*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	< 2	-	-
Common Mare's Tail	*Hippuris vulgaris*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	80	-	-	-	-	-	-	-	-
Coontail	*Ceratopyllum demersum*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	15	-	-
Duckweed	*Spirodela* sp.	-	-	-	-	-	-	-	-	-	-	5	5	-	-	-	-	-	-	-	-	-	-	-	-	-
Fineleaf Pondweed	*Suckenia filiformis*	-	-	-	-	-	40	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Greater Duckweed	*Spirodela polyrhiza*	-	-	-	-	-	-	2	-	< 2	-	-	-	-	-	-	-	-	-	-	< 2	-	10	-	-	-
Horsehair Algae	*Chlorophyceae* sp.	35	-	20	15	-	40	5	40	5	-	15	20	-	-	-	-	< 2	5	5	5	-	5	5	-	80
Leafy Pondweed	*Potamogeton foliosus*	-	-	-	-	-	-	-	-	-	5	70	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mare's Tail	*Hippuris vulgaris*	-	-	-	-	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Moss	*Philonotus hypnaceae*	-	-	-	-	-	-	-	-	-	-	-	-	5	-	-	-	-	20	-	65	-	-	-	-	-
Muskgrass	*Chara vulgaris*	-	80	-	20	20	30	20	50	10	30	-	-	5	-	-	-	-	10	30	-	-	-	-	-	-
Pondweed	*Potamogeton foliosus/pectinatus*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	20	20	55	15	-	-	5	-	-
Speedwell	*Veronica anagallis-aquatica*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	< 2	-
Star Duckweed	*Lemna trisulca*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	10	-	-	-	-	10	-	-
Wapato	*Sagittaria cuneata*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	< 2	-	-
Watercress[a]	*Rorippa nasturtium-aquaticum*	-	< 2	5	25	25	-	30	-	20	< 2	10	40	90	90	100	-	< 2	20	5	5	5	-	5	< 2	20
Water Millfoil	*Myriophyllum sibiricum*	-	-	-	-	-	-	-	-	-	40	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Water Parsnip[a]	*Berula bess*	30	-	-	-	-	-	-	-	35	-	-	-	-	10	-	-	-	-	-	-	-	-	-	-	-
Water Smartweed	*Polygonum amphibium*	-	< 2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Water Speedwell	*Veronica anagallis-aquatica*	-	-	-	-	15	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Whitewater Crowfoot	*Ranunculus aquatilis*	-	20	<2	-	-	-	-	-	-	20	-	-	-	-	-	-	-	-	2	-	-	-	-	< 2	-
Wild Celery	*Apium graveolens*	35	-	-	-	-	-	-	-	30	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

[a] Watercress group.

Table 49. Percent cover of emergent aquatic vegetation (EAV) found at aquatic systems of interest throughout Spring Valley in White Pine County, Nevada.

COMMON NAME	SCIENTIFIC NAME	SYSTEMS																								
		BLIND	CEDARS	KEEGAN-MIDDLE	KEEGAN-SOUTH	KEEGAN RANCH-NORTH	LAYTON	NORTH MILLICK	SOUTH BASTION	SOUTH MILLICK	SHOSHONE POND #1	SHOSHONE PONDS #2	SHOSHONE PONDS #3	SWALLOW	TURNLEY/ WOODSMAN	UNNAMED CLEVE CREEK EAST	UNNAMED CLEVE CREEK WEST	UNNAMED MINERVA 1	UNNAMED MINERVA 2	UNNAMED MINERVA 3	UNNAMED SPRING #1	UNNAMED STONEHOUSE	WEST SPRING VALLEY COMPLEX #1	WEST SPRING VALLEY COMPLEX #5	WILLARD	WILLOW
Alfalfa	*Medicago sativa*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	< 2	-	-	-	-	-	-	-
Alkali Buttercup	*Ranunculus cymbalaria*	-	-	2	<2	<2	-	-	<2	-	-	-	-	-	5	-	-	-	-	-	-	-	-	-	-	-
Alkali Cordgrass	*Spartina gracilis*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5	-	-	-	-	-	-	-	-	-
Alkali Sacaton	*Sporolobus airoides*	-	-	-	-	-	-	-	<2	-	-	-	-	-	-	-	< 2	-	-	-	-	-	-	-	-	-
Alsike Clover	*Trifolium hybridum*	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5	-	-	-	-	-	-
Analogue Sedge	*Carex simulata*	-	20	-	-	-	-	-	-	-	15	-	-	-	-	-	-	-	-	20	-	-	-	-	-	-
Arrowhead	*Sagittaria* sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	< 2	-	-	-	-	-	-	-	-
Aster	*Symphyotrichum* sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	< 2	< 2	-	-
Baltic Rush	*Juncus balticus*	< 2	15	30	15	20	10	40	30	25	30	35	10	-	30	2	2	20	-	10	2	30	20	30	25	10
Barnyard Grass	*Echinochloa crus-galli*	-	< 2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Beaked Sedge	*Carex rostrata*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	< 2	-
Beaked Spikerush	*Eleocharis palustris*	-	-	-	-	-	-	-	-	-	-	-	-	-	5	-	-	-	-	-	-	-	-	-	-	-
Bidens	*Bidens* sp.	2	-	-	-	-	-	-	-	-	-	-	-	-	-	< 2	-	-	-	-	-	-	-	-	-	-
Blue-eyed Grass	*Sisyrinchium* sp.	-	-	-	-	-	-	-	-	-	-	-	< 2	-	-	-	-	< 2	-	-	-	-	-	-	2	-
Bluegrass	*Poa* sp.	-	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	10	-	-	-	-	-	-	25	-
Bog / Bird's Foot Trefoil	*Lotus pinnatus*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	2	-	-	2	10	-	-
Brewer's Bittercress[a]	*Cardamine breweri*	-	-	-	-	-	-	15	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Broadfruit Bur-reed	*Sparganium eurycarpum*	-	-	-	<2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Broadleaf Cattail	*Typha latifolia*	5	-	-	5	2	-	-	-	-	-	-	-	-	-	2	-	-	-	-	30	10	< 2	-	-	30
Bull Thistle	*Cirsium vulgare*	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	< 2	-	5	-	-	2
Bulrush	*Scirpus* sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	10	15	-	-
Bur Reed	*Sparganium* sp.	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	< 2	-	-	-	< 2	2	-	-
Burdock	*Arctium minus*	-	-	-	-	-	-	-	-	-	-	-	-	< 2	-	-	-	-	-	-	-	-	-	-	-	-
Bur Reed / Sedge	*Carex sparganioides*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	< 2	-	-	-	-	-	-
Buttercup	*Ranunculus anemopsis*	-	-	-	-	<2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5
Canada Goldenrod	*Solidago canadensis*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2

Table 49. Continued.

COMMON NAME	SCIENTIFIC NAME	SYSTEMS																								
		BLIND	CEDARS	KEEGAN-MIDDLE	KEEGAN-SOUTH	KEEGAN RANCH-NORTH	LAYTON	NORTH MILLICK	SOUTH BASTION	SOUTH MILLICK	SHOSHONE POND #1	SHOSHONE PONDS #2	SHOSHONE PONDS #3	SWALLOW	TURNLEY/ WOODSMAN	UNNAMED CLEVE CREEK EAST	UNNAMED CLEVE CREEK WEST	UNNAMED MINERVA 1	UNNAMED MINERVA 2	UNNAMED MINERVA 3	UNNAMED SPRING #1	UNNAMED STONEHOUSE	WEST SPRING VALLEY COMPLEX #1	WEST SPRING VALLEY COMPLEX #5	WILLARD	WILLOW
Canada Thistle	*Cirsium* sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5	-	-	-
Cinquefoil	*Potentilla* sp.	-	< 2	-	-	-	-	-	-	-	-	< 2	-	-	-	-	-	< 2	< 2	-	-	-	-	-	2	-
Clasping Pepperweed	*Lepidium perfoliatum*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	< 2	-	-	-	-	-	-	-	-
Clover	*Trifolium* sp.	-	-	-	-	-	-	-	-	-	10	-	< 2	-	-	-	-	5	-	-	-	-	5	-	-	-
Clustered Field Sedge	*Carex praegracilis*	-	20	-	-	-	-	-	<2	-	-	-	20	-	-	-	-	20	20	15	-	-	-	-	-	-
Columbine	*Aquilegia* sp.	-	-	-	-	-	-	-	-	-	-	-	-	< 2	-	-	-	-	< 2	< 2	-	-	-	-	-	-
Common Dandelion	*Taraxacum officinale*	-	-	-	2	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Common Duckweed	*Lemna minor*	-	-	2	5	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<2	-	-	-	-
Common Mullein	*Verbascum thapsus*	-	-	-	-	-	-	-	-	-	-	-	-	-	<2	-	-	-	-	-	-	-	-	-	-	-
Common Reed	*Phragmites australis*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	2	-	-
Common Yarrow	*Achillea millefolium*	-	-	-	5	5	-	-	-	-	-	-	-	-	<2	-	-	-	-	-	-	-	-	-	-	-
Couch Grass	*Agropyron repens*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	< 2	-	-	-	-	-	-	-	-	-
Curly Dock	*Rumex crispus*	-	< 2	<2	<2	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5	-	2	-	-	-
Dock	*Rumex* sp.	-	-	-	-	-	-	-	-	-	-	-	< 2	-	-	-	-	-	-	-	-	-	-	-	-	-
Field Sowthistle	*Sonchus arvensis*	-	-	-	-	-	-	-	-	-	-	-	-	-	<2	-	-	-	-	-	-	-	-	-	-	-
Foxtail Barley	*Hordeum jubatum*	-	-	5	5	2	-	-	-	-	-	-	-	-	-	< 2	2	< 2	< 2	-	-	-	< 2	< 2	-	-
Fringed Gentian	*Gentianopsis thermalis*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	< 2	-	-	-	-	-	-	< 2	-	-
Fringed Willowherb	*Epilobium ciliatum*	-	-	-	3	2	-	-	-	-	-	-	-	-	<2	-	-	-	-	-	-	-	-	-	-	-
Goldenrod	*Solidago* sp.	-	-	-	-	-	-	-	-	-	-	-	-	< 2	-	-	-	-	-	-	-	-	-	-	-	-
Hardstem Bulrush	*Scirpus acutus*	15	-	-	-	<2	-	2	-	10	-	-	-	-	-	2	-	-	-	< 2	-	5	5	5	-	-
Horsetail	*Equisetum* sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	< 2	< 2	5	10	-	-	< 2	-	-	-
Indian Paintbrush	*Castilleja mutis*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	< 2	-	-	-
Kentucky Bluegrass	*Poa pratensis*	-	-	-	-	-	-	-	-	-	30	-	5	50	-	-	-	-	-	5	-	-	-	-	-	-
Little Seed Canary Grass	*Phalaris minor*	-	-	-	-	-	-	-	-	-	-	-	-	< 2	-	-	-	-	-	-	-	-	-	-	-	-
Mare's Tail	*Hippuris vulgaris*	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	< 2	-	-	-	-	-	-
Meadow Bird's-foot Trefoil	*Lotus pinnatus*	-	-	-	<2	<2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 49. Continued.

COMMON NAME	SCIENTIFIC NAME	SYSTEMS																								
		BLIND	CEDARS	KEEGAN-MIDDLE	KEEGAN-SOUTH	KEEGAN RANCH-NORTH	LAYTON	NORTH MILLICK	SOUTH BASTION	SOUTH MILLICK	SHOSHONE POND #1	SHOSHONE PONDS #2	SHOSHONE PONDS #3	SWALLOW	TURNLEY/ WOODSMAN	UNNAMED CLEVE CREEK EAST	UNNAMED CLEVE CREEK WEST	UNNAMED MINERVA 1	UNNAMED MINERVA 2	UNNAMED MINERVA 3	UNNAMED SPRING #1	UNNAMED STONEHOUSE	WEST SPRING VALLEY COMPLEX #1	WEST SPRING VALLEY COMPLEX #5	WILLARD	WILLOW
Meadow Deathcamas	*Zigadenus venenosus*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	< 2	-	-	-	-	-	-	-
Meadow Lousewort	*Pedicularis crenulata*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-
Mint	*Lamium* sp.	-	-	-	-	-	-	-	-	-	-	< 2	-	-	5	-	-	-	-	-	< 2	-	-	-	-	-
Monkey Flower [a]	*Mimulus guttatus*	-	2	-	-	-	-	-	-	-	< 2	< 2	5	-	-	-	-	< 2	< 2	< 2	-	-	-	-	< 2	-
Moss	*Bryophyta* sp.	-	-	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Musk Thistle	*Carduus nutans*	-	-	<2	-	1	-	-	-	-	-	-	-	-	<2	-	-	-	-	-	-	-	-	-	-	-
Nebraska Sedge	*Carex nebrascensis*	-	10	20	25	25	-	5	30	20	5	35	20	20	10	< 2	< 2	20	20	10	5	15	20	5	15	40
Olney's Three Square Bulrush	*Schoenoplectus americanus*	2	-	-	-	-	-	-	-	-	-	< 2	-	< 2	-	-	-	-	< 2	-	-	20	2	-	-	-
Pale Agoseris	*Agoseris glauca*	-	-	-	-	-	-	-	<2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Panicle Aster	*Symphyotrichum lanceolatum*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	< 2	< 2	-	-	-	-	-	-	-	-	-
Pea Plant	*Lotus pinnatus*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5	-	-	-	-	-	-	-
Prickly Lettuce	*Lactuca serriola*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	< 2	-	-	-	-	-	-	-	-	-	-
Purple Locoweed	*Oxytropis lambertii*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	< 2	-	-	-	-	-	-
Rabbit-foot Grass	*Polypogon monspeliensis*	5	< 2	-	-	<2	<2	2	<2	< 2	-	-	-	-	-	2	< 2	-	-	-	-	-	-	-	-	-
Red Clover	*Trifolium pratense*	-	-	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Redtop	*Agrostis gigantea*	-	-	15	20	10	-	5	2	5	-	-	5	-	10	-	5	< 2	5	-	5	15	< 2	2	10	2
Reed Canary Grass	*Phalaris arundinacea*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	< 2	-	-	-	-	-	-
Rocky Mountain Iris	*Iris missouriensis*	-	-	-	-	-	-	-	10	-	-	-	-	-	-	-	-	-	2	2	-	2	-	-	-	-
Rough Bentgrass	*Agrostis scabra*	-	-	-	-	-	-	-	-	-	-	-	-	-	<2	-	-	-	-	-	-	-	-	-	-	-
Rush	*Juncus* sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	< 2	-	-	-	-	-	-	-	-	-	-
Saltgrass	*Distichlis spicata*	-	-	-	-	-	15	-	5	-	-	-	-	-	-	< 2	-	-	-	-	-	10	-	-	2	-
Sandberg Bluegrass	*poa secunda*	-	-	-	-	-	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Scratchgrass	*Muhlenbergia asperifolia*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-
Sea Milkwort	*Glaux maritima*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<2	-	-	-	-
Seaside Arrowgrass	*Triglochin maritimum*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5	-	-	-	-	-	-	-

Table 49. Continued.

COMMON NAME	SCIENTIFIC NAME	SYSTEMS																								
		BLIND	CEDARS	KEEGAN-MIDDLE	KEEGAN-SOUTH	KEEGAN RANCH-NORTH	LAYTON	NORTH MILLICK	SOUTH BASTION	SOUTH MILLICK	SHOSHONE POND #1	SHOSHONE PONDS #2	SHOSHONE PONDS #3	SWALLOW	TURNLEY/ WOODSMAN	UNNAMED CLEVE CREEK EAST	UNNAMED CLEVE CREEK WEST	UNNAMED MINERVA 1	UNNAMED MINERVA 2	UNNAMED MINERVA 3	UNNAMED SPRING #1	UNNAMED STONEHOUSE	WEST SPRING VALLEY COMPLEX #1	WEST SPRING VALLEY COMPLEX #5	WILLARD	WILLOW
Sedge	*Carex* sp.	-	-	-	-	-	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	< 2	-
Showy Milkweed	*Asclepias speciosa*	-	-	-	-	-	-	-	<2	-	-	-	-	-	-	-	-	-	< 2	-	-	-	-	-	-	-
Sierra Rush	*Juncus nevadensis*	-	-	-	-	-	-	2	-	-	5	-	-	< 2	<2	-	-	-	-	-	-	-	-	-	-	-
Silverweed	*Potentilla anserina*	-	-	10	5	10	-	2	15	5	5	-	-	-	-	< 2	2	-	-	-	-	5	-	-	-	-
Sofstem Bulrush	*Scirpus validus*	-	-	-	-	-	-	-	-	25	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Speedwell	*Veronica anagallis-aquatica*	-	2	10	5	10	-	-	5	-	-	10	2	10	<2	-	-	< 2	10	2	-	-	-	-	-	-
Spikerush	*Eleocharis* sp.	10	15	-	-	25	30	-	15	-	-	15	10	-	10	90	85	20	30	10	10	10	20	20	-	-
Sporobolus	*Sporobolus* sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	10	-	-
Spotted Knapweed	*Centaurea stoebe* sp. *Micranthos*	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-
Starry False Lily of the Valley	*Maianthemum stellatum*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	< 2	-	-	-	-	-	-	-
Stinging Nettle	*Urtica dioica*	-	-	-	-	-	-	-	-	-	-	-	-	< 2	-	-	-	-	-	-	-	-	-	-	-	-
Tall Fescue	*Lolium arundinaceum*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5	-	-	-	-	-	-	-	-
Tapertip Rush	*Juncus acuminatus*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5	-	-	-	-	-	-	-
Thistle	*Cirsium* sp.	-	-	-	-	-	-	-	5	-	-	-	-	-	-	-	-	< 2	< 2	-	-	-	-	-	< 2	-
Torrey's Rush	*Juncus torreyi*	35	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Wapato	*Saggitaria cuneata*	2	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Watercress	*Nasturtium officinale*	-	-	5	5	10	-	-	2	-	-	-	-	-	50	-	-	-	-	-	-	-	-	-	-	-
Water Parsnip	*Berula bess*	-	< 2	-	3	-	-	-	-	-	5	-	2	< 2	5	-	-	-	10	-	-	5	-	-	-	-
Water Whorlgrass	*Catabrosa aquatica*	-	-	-	-	-	-	-	-	-	-	-	< 2	-	-	-	-	-	-	-	-	-	-	-	-	-
White Clover	*Trifolium repens*	-	-	15	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Wild Columbine	*Aquilegia canadensis*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	< 2	-	-	-	-	-
Wild Rose	*Rosa woodsii*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	2
Willow-herb	*Epilobium* sp.	5	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	2	-	10	2	-	5
Yellow Sedge	*Carex flava*	-	10	-	-	-	-	-	-	-	-	-	30	-	-	-	-	-	-	-	-	-	-	-	-	-
Yellow Sweetclover	*Melilotus officinalis*	-	-	-	-	-	-	-	-	-	-	-	< 2	-	-	-	-	< 2	-	-	-	-	-	-	-	-
Yerba Mansa	*Anemopsis californica*	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

We identified 103 taxa of EAV growing in the wetted perimeter of aquatic systems of interest in Spring Valley (Table 49). Nebraska sedge and Baltic rush were the most common taxa, and we found both of them at 23 of the 25 sites we surveyed within the aquatic systems of interest. We also found spikerush to be common (12 of 18 systems). The number of taxa we identified at site varied between 8 and 23. The Unnamed Springs near Minerva #2 had the highest diversity of EAV, and the ponds at Shoshone (Shoshone Ponds #2) had the lowest diversity of EAV. The predominance of grazing as a land use in Spring Valley was evident in the emergent plant fauna, with alfalfa (*Medicago sativa*), Kentucky bluegrass (*Poa pratensis*), and several other grass species identified during EAV surveys.

Only a few of the springs had woody vegetation associated with them. We found nonnative Russian olive in the riparian zone of West Spring Valley complex #1 and at Keegan Ranch-North. We found narrowleaf cottonwood (*Populus angustifolia*), golden currant (*Ribes aureum*), and rose (*Rosa* sp.) in the riparian zone at Swallow Spring. South Bastion had golden currant, Rocky Mountain juniper (*Juniperus scopulorum*), and Wood's rose (*Rosa woodsii*). Turnley / Woodsman Springs also had Wood's rose.

Vegetation Mapping

We mapped vegetation communities at aquatic systems of interest in Spring Valley in September and October 2005 as well as September 2006. High-resolution aerial photography was not flown for the Unnamed Spring North of Stonehouse. Therefore, while we collected data on the associations and alliances present at this sight, they were not mapped. Hence the area encompassed by those associations and alliances was not available. As high-resolution aerial photography becomes available in the future, the associations and alliances found at this system will be mapped. Thirty-five associations and 87 species were identified during the mapping effort (Appendix C). The number of associations at individual systems ranged from 3 (Blind Spring) to 17 (West Valley North Spring). We found that the Nebraska Sedge Association was common, occurring at 14 of the 19 systems mapped (Table 50). The Baltic Rush Association was also fairly common, occurring at 13 of 19 systems mapped. However, these associations were not necessarily the dominant associations at the systems containing them. Redtop was often the dominant vegetation association at the six systems where they were present. Non-rooted aquatic plants and algae were also found at many systems in Spring Valley, but generally they were a very small percentage of the 203 acres mapped in Spring Valley. Contrary to our initial surveys, alfalfa and Kentucky bluegrass were not dominant at any systems in Spring Valley during the mapping effort, but Sandberg bluegrass (*Poa secunda*) was dominant.

Table 50. The proportion of the areas mapped comprised of each association (alliance) at 203.2 acres of aquatic systems of interest throughout Spring Valley in White Pine County, Nevada (values in percent).

ASSOCIATIONS / ALLIANCES [a] IN SPRING VALLEY [b]	BLIND SPRING	CLEVE 1 EAST	CLEVE 1 WEST	KEEGAN MIDDLE AND SOUTH	KEEGAN RANCH NORTH	LAYTON	MINERVA 1 SPRING	MINERVA 2 SPRING	MINERVA 3 SPRING	NORTH MILLICK	NORTH OF STONE HOUSE	UNNAMED AT STONEHOUSE	SHOSHONE PONDS	SOUTH BASTIAN	SOUTH MILLICK	SWALLOW SPRING	WEST VALLEY NORTH	WEST VALLEY SOUTH	WILLARD SPRING	WILLOW SPRING
Agrostis gigantea (Redtop) Herbaceous *Agrostis stolonifera* (Creeping Bentgrass) Seasonally Flooded Herbaceous			46.82				37.95	91.38	56.26								1.61	0.76		
Adventive Plant Herbaceous Undesignated Alliance																		1.38		
Carex simulata (Analogue Sedge) Herbaceous *Carex simulata* Saturated Herbaceous		7.17										2.29								
Carex praegracilis (Clustered Field Sedge) Herbaceous *Carex praegracilis* Seasonally Flooded Herbaceous																	4.9			
Carex nebrascensis (Nebraska Sedge) Herbaceous *Carex nebrascensis* Seasonally Flooded Herbaceous		9.27		86.25	62.90		2.46	2.31	16.12	60.63		45.01	13.61	79.10			1.68	39.97	61.1	23.39
Distichlis spicata (Inland saltgrass) Herbaceous *Distichlis spicata* Intermittently Flooded Herbaceous																	50.13			
Distichlis spicata (Inland saltgrass) Mixed Herb Herbaceous Vegetation *Distichlis spicata* Intermittently Flooded Herbaceous												1.91		20.90						
Distichlis spicata (Inland saltgrass) / *Juncus arcticus* (Baltic Rush) *Herbaceous Vegetation* *Distichlis spicata Intermittently Flooded Herbaceous*				6.43	33.84							31.25								
Eleocharis palustris (Common spikerush) Herbaceous *Eleocharis palustris* Seasonally Flooded Herbaceous		13.03	42.76			13.04							1.48						0.17	
Eleocharis rostellata (Beaked Spikerush) Herbaceous *Eleocharis quinqueflora, pauciflora, rostellata* (Fewflower Spikerush, Beaked Spikerush) Saturated Herbaceous								0.65									0.04			
Eleocharis acicularis (Needle Spikerush) Herbaceous *Eleocharis acicularis* Seasonally Flooded Herbaceous																			26.05	
Elymus trachycaulus (Slender Wheatgrass) Herbaceous Undesignated Alliance								4.62												
Epilobium ciliatum (Fringed Willowherb) Herbaceous Vegetation Undesignated Alliance																	0.03			
Hordeum jubatum (Foxtail Barley) Herbaceous *Hordeum jubatum* Temporarily Flooded Herbaceous																	3.48			
Iris missouriensis (Rocky Mountain Iris) Herbaceous Undesignated Alliance																				0.088
Juncus nevadensis (Sierra Rush) Herbaceous Undesignated Alliance		1.3														46.20				
Juncus arcticus (Baltic Rush) Herbaceous *Juncus arcticus* Seasonally Flooded Herbaceous		68.38	10.42	6.79					21.83	36.03		2.49	66.60		73.99	3.69	13.06	46.76	5.77	21.38
Juncus arcticus (Baltic Rush) Mixed Herb Herbaceous *Juncus arcticus* Seasonally Flooded Herbaceous												13.91					4.84			7.59

Table 50. Continued.

ASSOCIATIONS / ALLIANCES [a] IN SPRING VALLEY [b]	BLIND SPRING	CLEVE 1 EAST	CLEVE 1 WEST	KEEGAN MIDDLE AND SOUTH	KEEGAN RANCH NORTH	LAYTON	MINERVA 1 SPRING	MINERVA 2 SPRING	MINERVA 3 SPRING	NORTH MILLICK	NORTH OF STONE HOUSE	UNNAMED AT STONEHOUSE	SHOSHONE PONDS	SOUTH BASTIAN	SOUTH MILLICK	SWALLOW SPRING	WEST VALLEY NORTH	WEST VALLEY SOUTH	WILLARD SPRING	WILLOW SPRING
Mixed Wetland Graminoid Herbaceous Undesignated Alliance	21.95					65.23		0.42	3.76								0.66	5.9	6.23	
Leymus triticoides (Beardless Wildrye) - *Poa secunda* (Sandberg Bluegrass) Herbaceous *Leymus triticoides* Temporarily Flooded Herbaceous																	10.43			
Non-rooted Aquatic Plant and Algae Undesignated Alliance	33.73	0.55					0.04	0.62	0.24	2.8					26.01		1.25	0.48	0.67	
Open Water Undesignated Alliance		0.3		0.27	3.26	4.34	59.25		1.66	0.54	X		0.72				0.66	1.97		
Phragmites australis (Common Reed) Herbaceous *Phragmites australis* Semipermanently Flooded Herbaceous																		0.74		
Populus angustifolia (Narrowleaf Cottonwood) - *Distichilis spicata* (Inland Saltgrass) Woodland *Populus angustifolia* Temporarily Flooded Woodland													17.59			3.65				5.53
Populus (Cottonwood) spp. Seminatural Woodland Undesignated Alliance																20.99				
Nasturtium officinale (Watercress) - *Berula erecta* (Water Parsnip) - *Veronica anagallis - aquatica* (Water Speedwell) Herbaceous Undesignated Alliance				0.26							X						0.41	1.13		
Rosa woodsii (Wood's Rose) Shrubland *Rosa woodsii* Temporarily Flooded Shrubland									0.12									0.90		8.69
Salix exigua (Coyote Willow) - Mesic Graminoids Shrubland *Salix exigua*, *Interior* (Coyote, Sandbar Willow) Temporarily Flooded Shrubland																20.36				
Salix exigua (Coyote Willow) Temporarily Flooded Shrubland *Salix (exigua, Interior*) Temporarily Flooded Shrubland																5.11				
Schoenoplectus acutus (Hardstem Bulrush) Herbaceous (*Schoenoplectus acutus* - *Schoenoplectus tabernaemontani* (Softstem Bulrush) Semipermanently Flooded Herbaceous)												0.4					6.35			
Schoenoplectus americanus (Olney's Three Square Bulrush) Western Herbaceous Vegetation *Schoenoplectus americanus* Semipermanently Flooded herbaceous												2.74								
Sparganium eurycarpum (Broadfruit Bur-reed) Herbaceous Undesignated Alliance							0.3													
Sparsely Vegetated Undesignated Alliance						17.39														
Schoenoplectus pungens (Common Three Square) Herbaceous *Schoenoplectus pungens* Semipermanently Flooded Herbaceous																	0.03			
Typha latifolia (Broadleaf Cattail) Western Herbaceous *Typha angustifolia*, *latifolia* (Narrowleaf, Broadleaf Cattail) - *Schoenoplectus* (Bulrush) spp. Semipermanently Flooded Herbaceous	44.32										X						0.46			24.63

[a] Note that within each cell describing the Associations and Alliances, the Associations are shown above and Alliances below.
[b] Blind Spring = 0.3 acre (0.12 hectare), Cleve 1 East = 1.47 acres (0.59 hectare), Cleve 1 West = 0.97 acre (0.39 hectare), Keegan Middle and South = 33.6 acres (13.63 hectares) Keegan Ranch North = 4.21 acres (1.70 hectares), Layton Spring = 0.23 acre (0.10 hectares), Minerva 1 Spring = 2.8 acres (1.13 hectares), Minerva 2 Spring = 4.27 acres (1.73 hectares), Minerva 3 Spring = 25.32 acres (10.25 hectares), North Millick 1.61 acres (0.65 hectare), Unnamed at Stonehouse Spring = 66.34 acres (26.85 hectares), Shoshone Ponds = 23.88 acres (9.66 hectares), South Bastian Spring = 0.43 acre (0.18 hectare), South Millick = 1.05 acres (0.42 hectare), Swallow Spring 4.95 acres (2.82 hectares), West Valley North = 25.52 acres (10.33 hectares), West Valley South = 6.07 acres (2.46 hectares), Willard Spring = 7.54 acres (3.05 hectares), Willow Spring = 0.24 acre (0.097 hectare).

Fishes

While Hubbs and Miller (1948) reported that few fish were found in surveys of aquatic systems in Spring Valley, they did note that an unidentified sucker and a species similar to the relict dace were found in Spring Creek at the north end of Spring Valley. They also noted that Utah chub, which they felt were probably introduced from the Bonneville Basin by Mormon settlers, were found in Shoshone Springs. During our 2004 and 2005 surveys and annual monitoring surveys by the NDOW (Hobbs et al. 2005) in 2004, Pahrump poolfish, relict dace, and Utah chub were found in Spring Valley (Table 51).

During our surveys we found Utah chub in two of three Unnamed Springs near Minerva. We collected two Utah chub that were 90 mm and 100 mm total length during qualitative electrofishing at the Unnamed Springs near Minerva #3. We set seven to eight minnow traps overnight at all three Unnamed Springs near Minerva, and we collected four Utah chub between 40 mm and 102 mm total length at the Unnamed Spring near Minerva #3. We also collected 26 Utah chub between 64 mm and 113 mm total length at the Unnamed Spring near Minerva #1. No fish were collected at the Unnamed Spring near Minerva #2.

Hobbs et al. (2005) sampled for fish at Shoshone Pond #1 (their stock pond) and Shoshone Ponds #2 (their Shoshone Ponds north, middle, and south) in July 2004. They performed a mark-recapture population estimate for fish in each of these ponds. They estimated that the Pahrump poolfish population in Shoshone #1 was comprised of 1,642 (1,630-1,805) individuals. This estimate was more than twice the 2003 estimate of 718 but still lower than annual estimates obtained between 1999 and 2002 (Hobbs et al. 2005).

Two of the ponds (the north and middle ponds) in the Shoshone Ponds Natural Area (Shoshone Ponds #2) contained Pahrump poolfish. Hobbs et al. (2005) estimated that the north pond had 496 (423-582) Pahrump poolfish, and the middle pond had 1,104 (955-1,273) Pahrump poolfish using mark-recapture data collected during the 2004 surveys. They showed that the 2004 estimates for the north and middle pond were over 10-fold higher than the 2003 estimates but within the range of estimates made from 1997-2002.

The third pond (south pond) in Shoshone Ponds Natural Area contains relict dace. Using mark-recapture information from July 2004 minnow trap surveys, Hobbs et al. (2005) estimated that only 132 (40-240) relict dace were inhabiting the south pond. The number of relict dace in the south pond was only 15% of the 2003 estimate of 840 (255-1,527), which was the highest estimate recorded. The 2004 estimate was considerably lower than any previous annual estimate (1997-2003). In the mid 1990s Stein and Salisbury (1994) estimated the relict dace population at the Shoshone Ponds Natural Area was about 1,500 individuals. Hobbs et al. (2005) speculated that the low dissolved oxygen levels they measured in the south pond may have been responsible

Table 51. Fish sightings at aquatic systems of interest in Spring Valley, White Pine County, Nevada.

SYSTEM NAME	SOURCES[a]	UTAH CHUB	PAHRUMP POOLFISH	RELICT DACE
Blind Spring	1	A[b]	A	A
Cedars Spring	1, 2	A	P[c] 2	A
Keegan Ranch	1,2	A	A	P2
Layton Spring	1,3	A	A	A
North Millick Spring	1,3	A	A	A
South Millick Spring	1,3	A	A	A
Shoshone Pond #1	1, 2	A	P 2	A
Shoshone Ponds #2	1, 2	A	P 2	P 2
Shoshone #3	1	A	A	A
South Bastion Spring	1	A	A	A
Swallow Spring	1	A	A	A
Unnamed Spring East of Cleve Creek (East spring)	1	A	A	A
Unnamed Spring East of Cleve Creek (West spring)	1	A	A	A
Unnamed Minerva Spring 1	1	P 1	A	A
Unnamed Minerva Spring 2	1	A	A	A
Unnamed Minerva Spring 3	1	P 1	A	A
Unnamed Spring #1	1	A	A	A
Unnamed Spring at Stonehouse Ranch	1,2,3	A	A	P1,2
West Spring Valley Complex #1	1	A	A	A
West Spring Valley Complex #5	1	A	A	A
Willard Spring	1	A	A	A
Willow Spring	1	A	A	A

for the low numbers of relict dace. When we surveyed the Shoshone Ponds in June 2005, we found even lower dissolved oxygen levels than those reported by Hobbs et al. (2005).

We also observed Pahrump poolfish utilizing Cedars Spring immediately north of the Shoshone Ponds Natural Area. Hobbs et al. (2005) note the presence of Pahrump poolfish in this location, although it remains unclear how these fish got into this system. One potential explanation is that during periods of high water Pahrump poolfish from Shoshone #1 made it into the wetland areas to the west of these locations and subsequently found their way into Cedars Spring.

We set baited minnow traps at the Unnamed Spring at Stonehouse Ranch in August and September 2006. In August we collected 50 relict dace in one minnow trap in the second ponded head. They ranged from 42-92 mm total length. In September 2006 we set six baited minnow traps throughout the complex and collected 313 relict dace ranging from 31-105 mm total length. In addition, in June 2006 NDOW collected 176 relict dace ranging in size from 39-99 mm total length (C. Crookshanks 2006, pers. comm.). Haskins (1995) was denied access to the Unnamed Springs north of Stonehouse Ranch Spring and Spring Creek, but the landowner indicated that fish still inhabited both these areas at that time.

The NDOW also set seven minnow traps throughout the Keegan Ranch area in June 2006 and collected 337 relict dace ranging from 31 mm to 100 mm total length (C. Crookshanks 2006, pers. comm.). Haskins (1995) surveyed spring systems on the Keegan Ranch, which is approximately 45 km (28 miles) north of Route 50 on State Route 893. He noted extensive habitat at this location and collected one relict dace in one of four minnow trap sets. Haskins (1995) felt that more fish were probably present in the springs on the Keegan Ranch. Because of issues with private land access, we did not survey the other location in Spring Valley where relict dace were transplanted, Spring Valley Creek. The NDOW was also unable to sample there.

While several of the aquatic systems of interest in Spring Valley had limited habitat for fish, both the Millick Springs complex and the Wambolt Springs complex appeared to have habitat available. We performed qualitative electrofishing surveys at North Millick and South Millick Springs, as well as at the West Spring Valley complex. We also set minnow traps in West Spring Valley complex #5 and used dip nets to survey Unnamed Spring #1. None of these survey efforts yielded fish.

Amphibians

Hitchcock (2001) felt that Lake and Spring Valleys had one of the largest remaining northern leopard frog populations in Nevada. We found northern leopard frogs at nine different survey locations in Spring Valley (Table 52). Additionally, Sada listed an unidentified frog at the Unnamed Springs east of Cleve Creek, and we saw but could not identify a frog we saw at a

Table 52. Amphibian sightings at aquatic systems of interest throughout Spring Valley in White Pine County, Nevada.

SPRING NAME	SOURCES[a]	NORTHERN LEOPARD FROG	UNIDENTIFIED FROG
Blind Spring	1, 3	A[b]	A
Cedars Spring	1, 2[c]	P[d] 1, 2	A
Keegan Ranch North	1,2[e]	P	P
Keegan Ranch Middle	1,2[e]	A	A
Keegan Ranch South	1,2[e]	P	A
Layton Spring	1, 3	A	A
South Bastion Spring	1	A	A
North Millick Spring	1, 2	P 1, 2	A
South Millick Spring	1, 3	P 1	P 3
Shoshone Pond #1	1, 2[c]	P 1, 2	A
Shoshone Ponds #2	1, 2[c]	P 2	A
Shoshone #3	1, 2[c]	P 2	A
Swallow Spring	1, 3	A	A
Turnley/Woodsman	1	A	A
Unnamed Spring East of Cleve Creek (East spring)	1, 3	A	P 3
Unnamed Spring East of Cleve Creek (West spring)	1	A	A
Unnamed Minerva 1	1, 3	A	P 1
Unnamed Minerva 2	1, 3	A	A
Unnamed Minerva 3	1, 3	A	A
Unnamed Spring #1	1, 3	A	A
Unnamed Stonehouse Ranch Spring	1,3	A	A
West Spring Valley Complex 1	1, 2[e]	P 1, 2	A
West Spring Valley Complex 5	1	P 1	A
Willard Spring	1	A	A
Willow Spring	1, 3	A	A

[a]Sources: 1 = BIO-WEST survey and/or reconnaissance, 2 = NDOW (Hobbs et al. 2005; C. Crookshanks 2006, pers. comm.), 3 = Sada (2005a).
[b]Absent through visual observation.
[c]Present through visual observation.

distance at the Unnamed Spring near Minerva #1. We assume that these frogs were probably northern leopard frogs, since we did not find any other species of frogs during our surveys.

We observed the most northern leopard frogs in the Shoshone area and at the West Spring Valley complex. We observed 10 adult northen leopard frogs and 50 small tadpoles during our June 2005 survey of Shoshone Pond #1 (NDOW's stock pond). We also saw northern leopard frogs during our July 2004 reconnaissance at this location. We saw two adult northern leopard frogs in the Shoshone Ponds Natural Area during our June 2005 survey. We found 13 northern leopard frogs at West Spring Valley complex #5 during our October 2005 survey effort, but many of these were observed when they were stunned during qualitative electrofishing efforts. We also observed one adult northern leopard frog at West Spring Valley complex #1.

In addition to these two areas, we observed northern leopard frogs at North and South Millick Springs during both the June 2004 reconnaissance trip and the September 2004 sampling effort. During our September 2004 sampling effort we saw a single adult northern leopard frog at North Millick spring and four adults at South Millick Spring. We also saw three northern leopard frogs throughout the Keegan Ranch complex. At Keegan North, we also found two unidentified frog egg masses.

Hitchcock (2001) found northern leopard frogs near all of these areas. She speculated that the northern leopard frogs in Spring and Lake Valleys may be a metapopulation, because of the large amount of potentially interconnected waterways and moist areas in these two valleys.

Spring Valley is also within the range of both the Great Basin spadefoot toad and Woodhouse's toad. Although we did not see them during our surveys, both of these species may utilize the aquatic systems of interest for a least a portion of their life cycles.

Springsnails and Invertebrates

We found springsnails at six different systems of interest in Spring Valley (Table 53). Sada (2005a) and Hershler (1998) had already identified the Toquerville springsnail at five of these locations. In addition to those five locations, we found springsnails at the West Spring Valley complex at our West Spring Valley complex #1 site. Dr. Robert Hershler (2005, pers. comm.) identified specimens from West Spring Valley complex #1 as the Toquerville springsnail. We observed that springsnails were abundant at the north spring head and common to abundant up to 60 m downstream in the north spring brook at West Spring Valley complex #1. We also found springsnails were common in the south spring head but scarce up to 10 m downstream in the south spring brook. Sada (2005a) list no prior survey efforts at the West Spring Valley complex.

Table 53. Springsnails present at aquatic systems of interest throughout Spring Valley in White Pine County, Nevada.

SPRING NAME	SOURCES[a]	*P. KOLOBENSIS*	*P. PECULIARIS*
Blind Spring	1, 2	A[b]	A[b]
Cedars Spring	1, 2	A	A
Keegan Ranch North	1	A	A
Keegan Ranch Middle	1	A	A
Keegan Ranch South	1	A	A
Layton Spring	2	A	A
North Millick Spring	1, 2	A	A
Shoshone Pond #1	1, 2	A	A
Shoshone Ponds #2	1, 2	A	A
Shoshone #3	1, 2	A	A
South Bastion Spring	1	A	A
South Millick Spring	1, 2	A	A
Swallow Spring	1, 2	A	A
Turnley/Woodsman	1,2	A	P 2
Unnamed Spring East of Cleve Creek (East Spring)	1, 2	P[c] 2[d]	A
Unnamed Spring East of Cleve Creek (West spring)	1, 2	P 2[d]	A
Unnamed Minerva Spring 1	1, 2	P 1, 2	A
Unnamed Minerva Spring 2	1, 2	P 1, 2	A
Unnamed Minerva Spring 3	1, 2	P 1, 2	A
Unnamed Spring 1 - North of Stonehouse Ranch	1, 2	P 1, 2	A
Unnamed Stonehouse Ranch Spring	1,2	P 1, 2	A
West Spring Valley Complex 1	1	P 1	A
West Spring Valley Complex 5	1	A	A
Willard Spring	1, 2	A	A
Willow Spring	1, 2	P 1, 2	A

[a]Sources: 1 = BIO-WEST survey and/or reconnaissance, 2 = Sada (2005a).
[b]Absent through visual observation.
[c]Present through visual observation
[d]Sada (2005a) found *P. kolobensis* in one of these springs, but it is unclear which one.

During our surveys and surveys in Sada (2005a), springsnails were common in Unnamed Springs #1 and the Unnamed Springs near Minerva #3 but scarce at Willow Springs. Sada (2005a) listed springsnails as abundant at Unnamed Springs near Minerva #2 in 1992 surveys. We found that springsnails were common to abundant at three spring heads in this system. Additionally, Sada (2005a) listed springsnails as abundant at Unnamed Springs near Minerva #1 in 1992 surveys, but we found them to be scarce to common. Sada (2005a) listed springsnails as common at one of the Unnamed Springs east of Cleve Creek in 1991 and 1998 surveys of that locations, but we did not find springsnails at either system east of Cleve Creek during our September 2004 surveys. Finally, Sada (2005a) also listed surveys that found the Toquerville springsnail to be common in two other unnamed springs in Spring Valley that were not on our list of systems to survey, and in the Unnamed Springs at Stonehouse Ranch, where we were unable to obtain access.

EcoAnalysts identified 144 taxa of aquatic invertebrates in our samples from aquatic systems of interest in Spring Valley (Appendix D, Appendix E). Blind Spring had the highest number of taxa (40), which was interesting since it was a heavily impacted cattle pond (Table 54). Thirteen of the taxa at Blind Spring were midges (Chironomidae), and several of the other taxa were lentic forms of true bug (Hemiptera), beetle (Coleoptera), and other (non-midge) true fly (Diptera) taxa. EcoAnalysts only identified 13 taxa from the Shoshone Ponds (#2). Crustaceans were common in our invertebrate collections in Spring Valley with seed shrimp (Ostracoda) or Amphipods found at every aquatic system of interest. Seed shrimp and/or Amphipods were one of the three most-dominant taxa at 22 of the 24 aquatic system of interest that we surveyed. Midges and worms (Oligochaeta) were also common at most systems.

Swallow Spring had a unique invertebrate community with a high number of EPT taxa, including the stonefly, *Hesperoperla pacifica*. *H. pacifica* and the riffle beetle, *Heterlimnius* sp., were not collected at any other of the aquatic systems of interest we surveyed in the BRSA. EcoAnalysts also found a relatively high abundance of the caddisfly, *Lepidostoma* sp., as well as a single specimen of the mayfly, *Baetis adonis,* in our sample from Swallow Spring. The Flag Springs complex in White River Valley, which includes two cool, swift rheocrenes, was the only other system in the BRSA from which EcoAnalysts identified these two taxa. We suspected that Swallow Spring was a mountain block spring, and the differences in the invertebrate community found there, compared with the other systems in Spring Valley, support that observation.

Table 54. Total number of invertebrate taxa, mayfly, stonefly, and caddisfly taxa (EPT taxa), taxa in the Phylum Mollusca, taxa in the Order Odonata, and taxa in the Subphylum Crustacea at aquatic systems of interest throughout Spring Valley in White Pine County, Nevada.

SYSTEM NAME	TOTAL TAXA	EPT TAXA	MOLLUSCA TAXA	ODONATA TAXA	CRUSTACEA TAXA
Blind Spring	40.00	1.00	3	5	2
Cedars Spring	28.00	1.00	3	3	2
Keegan Ranch North	21.00	3.00	1	0	3
Keegan Ranch Middle	20.00	1.00	2	0	3
Keegan Ranch South	23.00	1.00	1	2	1
Layton Spring	23.00	1.00	1	2	1
North Millick Spring	17.00	1.00	2	1	3
Shoshone Pond #1	37.00	5.00	4	3	2
Shoshone Ponds #2	13.00	0.00	0	2	1
Shoshone #3	23.00	0.00	2	2	2
South Bastian Spring	17.00	1.00	3	1	2
South Millick Spring	18.00	2.00	2	0	3
Swallow Spring	31.00	5.00	2	0	2
Unnamed Spring East of Cleve Creek (West Spring)	33.00	2.00	2	3	2
Unnamed Spring East of Cleve Creek (East Spring)	22.00	2.00	2	1	3
Unnamed Minerva Spring 1	27.00	1.00	2	0	2
Unnamed Minerva Spring 2	24.00	1.00	4	0	3
Unnamed Minerva Spring 3	25.00	0.00	3	0	3
Unnamed Spring #1	19.00	1.00	1	1	2
Unnamed Spring at Stonehouse Ranch	28.00	3.00	4	1	4
West Spring Valley Complex #1	29.00	1.00	3	3	3
West Spring Valley Complex #5	20.00	1.00	3	3	3
Willard Spring	22.00	1.00	1	0	1
Willow Spring	21.00	2.00	2	2	2

Other Fauna

We observed many different bird species using the habitat around aquatic systems of interest in Spring Valley, including barn swallow, brown-headed cowbird *(Molothrus ater*), California quail (*Callipepla californica*), common nighthawk, crow, loggerhead shrike (*Lanius ludovicianus*), marsh wren (*Cistothorus palustris*), magpie (*Pica pica*), meadowlark, mourning dove *(Zenaida macroura*), mallard (including nest with eggs), northern harrier, northern rough-winged swallow, sora (*Porzana carolina*), sparrow (Emberizidae), western kingbird, raven, red-winged blackbird (*Agelaius phoeniceus*), snipe (*Gallinago gallinago*), sage sparrow (*Amphispiza belli*), swallow (Hirundinidae), Virginia rail (*Rallus limicola*), western meadowlark, wren (*Troglodytidae* spp.), yellow-headed blackbird (*Xanthocephalus xanthocephalus*), and other unidentified songbirds, waterfowl, and shorebirds. We also flushed 6 to 10 greater sage grouse (*Centrocercus urophasianus*) at the Unnamed Spring near Stonehouse Ranch. In addition to birds we also saw or saw sign of black-tailed jackrabbits, bobcats (*Felis rufus*), coyotes, desert cottontails, garter snakes (*Thamnophis* spp.), gopher snakes (*Pituophis* spp.), white-rumped ground squirrels, horned lizards (*Phrynosoma* spp.), mule deer, pronghorn, whiptail lizards (*Cnemidophorus* spp.), and unidentified lizards, snakes, and rodents.

Disturbance

Most of the aquatic systems of interest in Spring Valley were at least moderately disturbed by diversion or livestock use (Table 55). Blind Spring, Cedars Spring, Layton Spring, the Unnamed Spring near Minerva #1, and West Spring Valley complex # 1 all had a substantial amount of livestock trampling, as well as having a piped, ponded, or excavated spring heads. Blind Spring was ponded specifically for livestock use (Figure 14). The Unnamed Spring east of Cleve Creek (West Spring) had no diversion and little impact from livestock (Figure 15). The Shoshone Ponds Natural Area is protected from livestock use and also had little disturbance, although the ponds are artificially created.

Disturbance evaluations from Sada (2005a) indicated that North Millick and South Millick Springs had a moderate to high level of cattle disturbance during surveys in 1998. Sada (2005a) also listed no diversion disturbance for any of the Unnamed Springs near Minerva and low to moderate cattle disturbance at those springs in surveys from 1992. Surveys in 1998 at Layton Spring also found a high diversion disturbance. Surveys in 1991 found a high degree of livestock disturbance at the Unnamed Spring at Stonehouse Ranch, but in 2006 we found that only portions of this complex were heavily disturbed and a large portion of the main complex was moderately disturbed (Sada 2005a). Interestingly, Sada (2005a) also found no diversion disturbance at Blind Spring during 1998 surveys and ranked this spring as minimally disturbed, whereas we found it highly disturbed. Similarly, no diversion disturbance was found during surveys at Turnley/ Woodsman Spring in 1991, while boxing of the spring head was reported in a 1998 follow-up survey and our 2006 survey.

Table 55. Disturbance level and factors at aquatic systems of interest throughout the Spring Valley in White Pine County, Nevada.

SYSTEM NAME	DISTURBANCE CONDITION	DISTURBANCE
Blind Spring	High	Livestock, Diversion
Cedars Spring	Moderate/High	Livestock, Diversion, Nonnative Vegetation
Keegan Ranch North	Moderate/High	Livestock, Diversion, Nonnative Vegetation
Keegan Ranch Middle	Moderate/High	Livestock, Nonnative Vegetation
Keegan Ranch South	Moderate/High	Livestock, Nonnative Vegetation
Layton Spring	High	Livestock, Diversion
North Millick Spring	Moderate	Livestock, Diversion
Shoshone #3	Moderate	Livestock, Diversion, Nonnative Vegetation
Shoshone Pond #1	Moderate	Livestock, Diversion, Nonnative Vegetation
Shoshone Ponds #2	Slight	Diversion, Nonnative Vegetation
South Bastion Spring	Moderate	Livestock, Diversion, Nonnative Vegetation
South Millick Spring	Moderate	Livestock
Swallow Spring	Moderate	Livestock, Diversion, Nonnative Vegetation
Turnley/Woodsman	Moderate	Diversion, Roads, Livestock
Unnamed Spring East of Cleve Creek (East Spring)	Slight	Livestock
Unnamed East of Cleve Creek Spring (West Spring)	Moderate	Livestock
Unnamed Minerva Spring 1	High	Livestock, Diversion, Nonnatives
Unnamed Minerva Spring 2	Moderate	Livestock, Diversion, Nonnatives
Unnamed Minerva Spring 3	Moderate	Livestock, Diversion, Nonnatives
Unnamed Spring #1	Slight/moderate	Livestock, Diversion
Unnamed Stonehouse Complex	Moderate	Livestock, Residence, Nonnative Vegetation
West Spring Valley Complex #1	High	Livestock, Diversion, Roads, Nonnative Vegetation
West Spring Valley Complex #5	Moderate	Livestock, Diversion
Willard Spring	Moderate[a]	Livestock, Diversion
Willow Spring	Moderate	Livestock, Recreation, Diversion

[a]A major change from June 2004 reconnaissance to June 2005 survey.

Figure 14. Spring Valley's Blind Spring, which we rated as highly disturbed.

Figure 15. The (a) head, and (b) terminus of Spring Valley's Unnamed Spring East of Cleve Creek-East, which we rated as slightly disturbed.

We ranked South Bastion Spring as moderately to highly disturbed, but different portions of this area were impacted differently. The southwest portion of the area had a piped spring head that entered a cattle trough, resulting in heavy livestock impacts. However, spring heads 2 and 3 to the northeast of the trough were in a wet meadow which was moderately impacted by cattle. Interestingly, during our June/July 2004 reconnaissance trip, the wet meadow containing spring heads 2 and 3 had no wet ground or standing water, although it contained wetland vegetation. When we returned to survey it in September 2006, we found that there were two spring heads with standing water and several other seeps. Additionally, most of the meadow had wet ground. Therefore, it appears the drought from 1999-2004 had fairly heavy impacts on a portion of South Bastion Spring.

We visited Willard Spring during our June/July 2004 reconnaissance and then performed a Level 2 survey there in June 2005. Our site visit to this location in June 2004 coincided with the last year of a multi-year drought, while our Level 2 survey took place after above-average precipitation in winter and spring 2005. The disturbance ranking of this site in June 2005 was moderate, but had we ranked it during the reconnaissance it would have been high (Figure 16). Spring vegetation growth and high water levels in 2005 obscured much of the livestock damage we observed in July 2004. It is possible that livestock use of this site was also lower in 2005 than in 2004. However, Willard Spring illustrates how annual variations in site condition, along with the subjectivity of our disturbance evaluations, can influence the disturbance ranking of individual sites.

Lake Valley

Lake Valley, just southwest of Spring Valley (Figure 17), is bordered by the Fortification Range to the east and the southern portion of the Schell Creek Range, the Dutch John Mountains, and the Pioche Hills to the west. Lake Valley is home to the endemic Lake Valley springsnail (*Pyrgulopsis sublata*), which is on the State of Nevada's Rare (At-Risk) Species List (NVNHP 2004). The Lake Valley springsnail is a significant biological resource in Lake Valley. Two aquatic systems of interest were identified in Lake Valley (Table 56). Geyser Spring was visited during the 2004 reconnaissance and determined to be a mountain block spring, so no further surveys were conducted at Geyser Spring. We performed a Level 2 survey at two spring heads within the Wambolt Springs complex.

Figure 16. Clockwise: Willard Spring in Spring Valley (a) looking downstream from the spring head in June 2004, (b) looking downstream from the spring head in June 2005, and (c) at the terminus in June 2005.

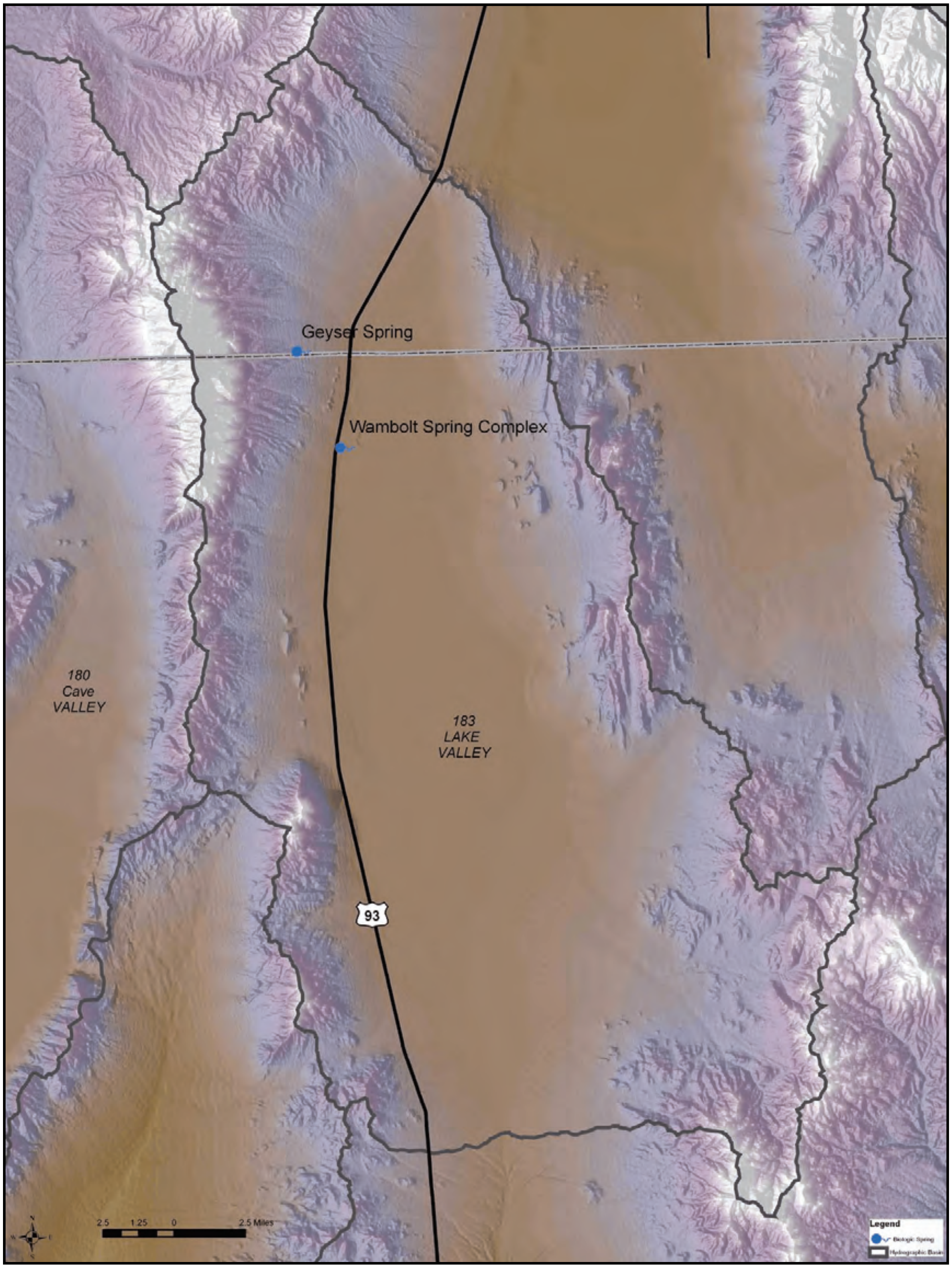

Figure 17. Map of locations of aquatic systems of interest in Lake Valley, Lincoln County, Nevada.

Table 56. Location, survey date, survey level, and ownership of aquatic systems of interest throughout Lake Valley in Lincoln County, Nevada.

SPRING NAME	NORTHING	EASTING	DATE SURVEYED	BIO-WEST SURVEY LEVEL	OWNER
Geyser Spring	4283846	702958	7/1/2004	Reconn	BLM
Wambolt Springs Complex	4278657	705475	9/18/2004	Level 2	Private

Note: UTM coordinates are in the NAD 83 projection system.

Physical Habitat and Water Quality

The Wambolt Springs complex appeared to be produced by groundwater from the mountainside being pushed out of the alluvial fan at the base of the mountains. A series of at least six spring sources flowed east from the alluvial fan on the west side of the valley, toward a large marshy area. Large areas of wet ground and EAV connected the spring heads (Table 57). We concentrated our survey effort on two main spring heads in the center of the complex.

Table 57. Type of system, maximum depth, maximum wetted width, length of survey plots, and measured discharge for the system found at Wambolt Springs Complex in Lake Valley, White Pine County, Nevada.

SYSTEM NAME	SYSTEM TYPE	MAXIMUM DEPTH (cm)	MAXIMUM WETTED WIDTH (m)	LENGTH (m)	DISCHARGE (l/s)
Wambolt Springs Complex #2/3	Limnocrene	10	205	268[a]	N/A

[a]Continued further as a spring brook or marsh land, or onto private property.

Source temperatures at spring heads 2 and 3 were very similar (Table 58, Appendix B), indicating they originated from the same source. Temperature was higher, and dissolved oxygen, conductivity, and pH were lower at the sources than at the terminal pond.

Aquatic Vegetation

Because most sites did not contain any open water, aquatic vegetation surveys of Lake Valley constituted only two of the Wambolt Springs (2 and 3). These springs were dominated by the watercress group (75% coverage). Mare’s tail comprised the remaining vegetation (25%) (Table 59). The wet areas around the Wambolt Springs complex were dominated by spikerush and Nebraska sedge (Table 60). No other studies documenting the vegetation in this spring complex were found.

Table 58. Selected water quality parameters measured at the main source and termination of our sampling site at Wambolt Springs Complex in Lake Valley, Lincoln County, Nevada.

SYSTEM NAME	LOCATION	TEMPERATURE (C)	DISSOLVED OXYGEN (mg/l)	CONDUCTIVITY (mS/cm)	pH
Wambolt Springs Complex	Source #2	18.37	3.94	331	7.35
	Source #3	18.25	3.24	348	7.32
	Terminus	14.25	4.97	779	7.85

Table 59. Percent cover of submerged aquatic vegetation (SAV) found at the Wambolt Springs Complex in Lake Valley, Lincoln County, Nevada.

COMMON NAME	SCIENTIFIC NAME	WAMBOLT SPRINGS COMPLEX #2/3
Mare's Tail	*Hippuris vulgaris*	25
Watercress[a]	*Nasturtium officinale*	75

[a]Watercress group.

Table 60. Percent cover of emergent aquatic vegetation (EAV) found at the Wambolt Springs Complex in Lake Valley, Lincoln County, Nevada.

COMMON NAME	SCIENTIFIC NAME	WAMBOLT SPRINGS COMPLEX#2/3
Baltic Rush	*Juncus arcticus*	2
Broadleaf Cattail	*Typha latifolia*	2
Curly Dock	*Rumex crispus*	< 2
Foxtail Barley	*Hordeum jubatum*	< 2
Hardstem Bulrush	*Scirpus acutus*	2
Nebraska Sedge	*Carex nebrascensis*	30
Rabbit-foot Grass	*Polypogon monspeliensis*	< 2
Redtop	*Agrostis gigantea*	< 2
Spikerush	*Eleocharis* sp.	65
Torrey's Rush	*Juncus torreyi*	< 2
Willow-herb	*Epilobium* sp.	< 2

Vegetation Mapping

When we returned to the Wambolt Springs complex in October 2005, we mapped the vegetation of the entire complex. Twenty-five species were identified within the 37 acres of springs sampled in Lake Valley. We developed nine vegetation associations, along with open water, from the vegetation data gathered at Wambolt Springs (Table 61). Approximately 50% of the 37 acres mapped at Wambolt Springs was split between the Baltic Rush and Scratchgrass (*Muhlenbergia asperifolia*) Associations. Another 15% of the area was comprised of the Baltic Rush Mixed Herb Association, thus making Baltic rush the dominant species at that spring. Other associations comprising a fair amount of area at Wambolt Springs included the Nebraska Sedge and Spike Rush Associations. With the exception of broadleaf cattail, species found during the initial survey were re-encountered as dominant species during the mapping effort.

Fishes

We did not sample for fishes at the Wambolt Springs complex, because habitat did not appear to be suitable to support a fish population. We did not observe any fishes during our surveys, nor did Sada (2005a).

Amphibians

We did not observe any amphibians during our surveys of the Wambolt Springs complex, nor did Sada (2005a). However, during reconnaissance of Geyser Springs, we observed several northern leopard frogs. As indicated in the results for Spring Valley, Hitchcock (2001) felt that Spring Valley and Lake Valley may contain a metapopulation of northern leopard frog. She felt that the population in Spring Valley and Lake Valley may represent the largest remaining population of northern leopard frog in Nevada. When Hitchcock (2001) surveyed for northern leopard frog in Lake Valley, she found 15 in and around Geyser and Wambolt Springs. Therefore, northern leopard frogs are present in Lake Valley and utilize Wambolt Springs for a portion of their life cycle.

Springsnails and Invertebrates

During our surveys springsnails were common in what we called “Spring Head #3” and scarce from 5-15 m downstream from that spring head. Springsnails were also scarce in what we identified as “Spring Head #2.” Brief investigations for springsnails at the other four spring heads reveal that springsnails were scarce in what we identified as “Spring Head #4” and absent at all other locations. Hershler (1998) identified these springsnails as the Lake Valley springsnail and noted that they were endemic to Wambolt Springs. Sada (2005a) indicated that the Lake Valley springsnail was common at the Wambolt Spring complex during surveys in 1992.

Table 61. The proportion of the 37.0 acres mapped comprised of each association (alliance) at the Wambolt Springs complex in Lake Valley, Lincoln County, Nevada.

ASSOCIATIONS / ALLIANCES IN LAKE VALLEY	WAMBOLT SPRING (36.96 ACRES [14.96 HECTARES])
Agrostis exarata (Spike Bentgrass-rough) - *Agrostis scabra* (Bentgrass) Herbaceous Vegetation / *Agrostis scabra* Temporarily Flooded Herbaceous Alliance	6.18%
Carex nebrascensis (Nebraska Sedge) Herbaceous Vegetation / *Carex nebrascensis* Seasonally Flooded Herbaceous	4.32%
Carex simulata (Analogue Sedge) Herbaceous Vegetation / *Carex simulata* Saturated Herbaceous	8.29%
Eleocharis palustris (Common Spikerush) Herbaceous Vegetation / *Eleocharis palustris* Seasonally Flooded Herbaceous Alliance	0.19%
Juncus arcticus (Baltic Rush) Herbaceous Vegetation / *Juncus arcticus* Seasonally Flooded Herbaceous	25.77%
Juncus arcticus (Baltic Rush) Mixed Herb Herbaceous Vegetation / *Juncus arcticus* Seasonally Flooded Herbaceous Alliance	15.90%
Mixed Wetland Graminoid Herbaceous Vegetation / Undesignated Alliance	0.13%
Muhlenbergia asperifolia (Scratchgrass) Herbaceous Vegetation / *Muhlenbergia asperifolia* Intermittently Flooded Herbaceous	25.58%
Non-rooted Aquatic Plant and Algae Vegetation / Undesignated Alliance	0.04%
Open Water /Undesignated Alliance	0.008%
Schoenoplectus acutus (Hardstem Bulrush) Herbaceous Vegetation / *Schoenoplectus acutus* - *Schoenoplectus tabernaemontani* (Softstem Bulrush) Semipermanently Flooded Herbaceous	1.04%
Spartina gracilis (Alkali Cordgrass) Herbaceous Vegetation /*Spartina gracilis* Seasonally Flooded Herbaceous	12.55%

EcoAnalysts identified 24 taxa from 12 invertebrate orders in Wambolt Springs complex #2 and #3 (Appendix D, Appendix E). Crustaceans and mollusks dominated the community at this complex. The two Crustacea taxa (Osctracoda and *Hyallela* sp.) were the most dominant taxa, followed by the snail *Gyraulus* sp. and the Lake Valley springsnail (Hydrobiidae).

Other Fauna

We observed meadowlarks and sandhill cranes (*Grus canadensis*), as well as other unidentified songbirds during our surveys at the Wambolt Springs complex.

Disturbance

We characterized the Wambolt Springs complex #2 and #3 as slightly disturbed (Figure 18). While livestock use of the area was prevalent, damage was minimal. Additionally, at some point a berm was created, probably to pool water near the interface of the complex with a large marshy area. Sada (2005a) listed no diversion disturbance and slight to moderate cattle impacts.

Cave Valley

Cave Valley lies to the east of Lund, Nevada, between the Egan Range and the Schell Creek Range. The majority of Cave Valley is in Lincoln County, but the northern quarter of the valley is in White Pine County. The Hardy springsnail (*Pyrgulopsis marcida*) is known to occur in Cave Valley (Sada 2005a). The Hardy springsnail is endemic to Nevada and is on the State of Nevada's Rare (At-Risk) Species List (NVNHP 2004). The Hardy springsnail is a significant biological resource in Cave Valley.

Two aquatic systems of interest were identified in Cave Valley (Figure 19, Table 62). We were unable to sample either of these two systems, because access was not granted by the private landowner. Both aquatic systems of interest are in Lincoln County.

Table 62. Location, survey date, survey level, and ownership of aquatic systems of interest throughout Cave Valley in Lincoln County and White Pine County, Nevada.

SPRING NAME	NORTHING	EASTING	DATE SURVEYED	BIO-WEST SURVEY	OWNER
Cave Spring	4279238	691751	N/A	None/access	Private
Unnamed Spring at Parker Station	4282099	688176	N/A	None/access	Private

Note: UTM coordinates are in the NAD 83 projection system.

Figure 18. Wambolt Spring complex in Lake Valley, looking downstream from spring head #3 into the wetland area.

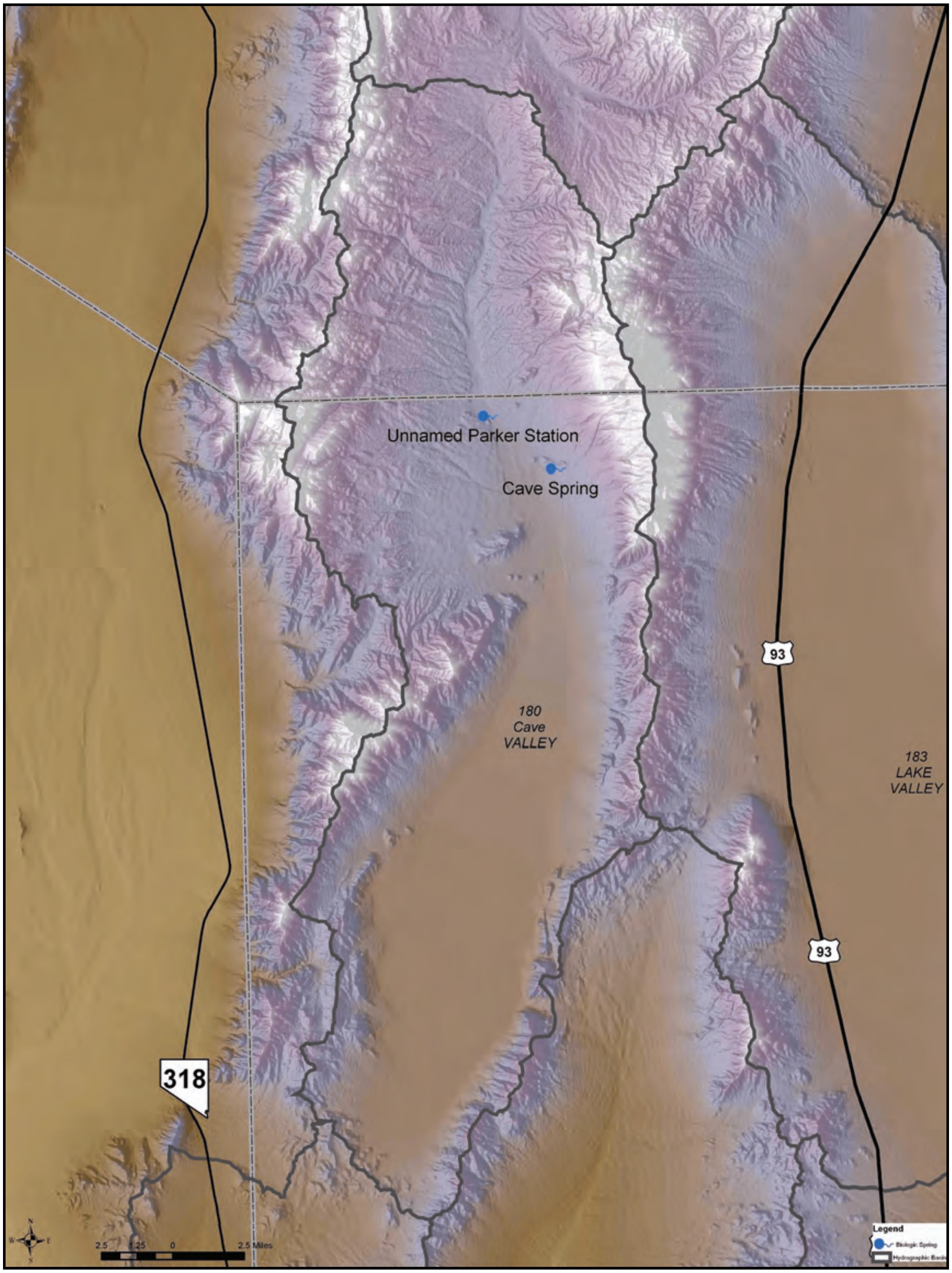

Figure 19. Map of locations of aquatic systems of interest in Cave Valley, Lincoln County and White Pine County, Nevada.

Physical Data and Water Quality

While we were unable to survey the aquatic systems of interest in Cave Valley, some physical and water quality data were available from surveys performed in June 1992 (Sada 2005a). Cave Spring appears to be considerably smaller than the Unnamed Spring at Parker Station (Table 63). Dissolved oxygen and conductivity differences between the two systems indicate that the Unnamed Spring at Parker Station probably has a deeper groundwater source than Cave Spring (Table 64).

Table 63. Type of system, maximum depth, maximum wetted width, length of survey plots, and measured discharge listed in Sada (2005a) for the aquatic systems of interest in Cave Valley, White Pine County, Nevada.

SYSTEM NAME	SYSTEM TYPE	MAXIMUM DEPTH (cm)	MAXIMUM WETTED WIDTH (m)	LENGTH (m)	DISCHARGE (l/s)
Cave	Rheocrene	3	2	N/A	N/A
Unnamed Parker Station	Helocrene	100	15	N/A	N/A

Table 64. Selected water quality parameters listed in Sada (2005a) for the aquatic systems of interest in Cave Valley White Pine County, Nevada.

SYSTEM NAME	LOCATION	TEMPERATURE (C)	DISSOLVED OXYGEN (mg/l)	CONDUCTIVITY (mS/cm)	pH
Cave	Source	12.1	9.2	116	7.8
Unnamed Parker Station	Source	14	3.2	454	7.7

Summary of Available Biological Information

Sada (2005a) indicated that both systems had watercress present and that the Unnamed Spring at Parker Station had 95% cover of EAV. They listed no EAV cover at Cave Spring. Snails in the subclass Pulmonata were the only organisms listed for Cave Spring. In addition to snails in the subclass Pulmonata, Sada (2005a) found that the Hardy springsnail was abundant at the Unnamed Spring at Parker Station. They also listed amphipods and the fingernail clam *Pisidium* sp. as present at the Unnamed Spring at Parker Station. They listed no fish or amphibian presence at either system. Hitchcock (2001) did not sample for northern leopard frogs in Cave Valley, but the species is found in several surrounding valleys, so it may be present in Cave Valley, too. Sada (2005a) listed both springs as highly disturbed by cattle and possibly excavated at one time. The June 1992 surveys listed in Sada (2005a) represent the only data we found pertaining to the aquatic communities at the aquatic systems of interest in Cave Valley.

White River Valley

White River Valley lies to the west of Dry Lake Valley in both Nye County and White Pine County, Nevada. The valley is bordered to the east by the Egan Range and to the west by the White Pine Range. The White River Valley is part of the pluvial White River drainage, which at one time flowed from northern White River Valley into the Virgin River prior to its confluence with the Colorado River (Hubbs and Miller 1948). Since that time the river system has been isolated into a few sections of flowing stream and many isolated or disjunct spring systems. As such, the White River Valley portion of the pluvial White River Basin contains a unique fish and invertebrate fauna, including the Federally endangered White River spinedace. White River spinedace were listed as endangered in 1985, because habitat modifications and nonnative species introductions had caused the extirpation of several populations of the species (USFWS 1985a, USFWS 1994). Currently, wild populations of White River spinedace are restricted to the Flag Springs complex and the upper portions of Sunnyside Creek, although they have recently been transplanted to Indian Springs (USFWS 1994, Scoppetone et al. 2004a, Hobbs et al. 2005, Nielsen 2005, Hobbs 2006a). The White River spinedace is endemic to White River Valley and is on the State of Nevada's Rare (At-Risk) Species List (NVNHP 2004).

Four other fish species and subspecies found in White River Valley are also on the State of Nevada's Rare (At-Risk) Species List: Moorman White River springfish (*Crenichthys baileyi thermophilus*), Preston White River springfish (*Crenichthys baileyi albivallis*), White River desert sucker (*Catostomus clarki intermedius*), and White River speckled dace (*Rhinichthys osculus* spp.). All four species are former candidates for listing under the (ESA) but are currently Federal species of concern (NVNHP 2004). Both subspecies of springfish are endemic to the White River Valley, while White River desert sucker and White River speckled dace are endemic to the State of Nevada but have also been found in other valleys. All four of these species, along with the White River spinedace, are significant biological resources in White River Valley.

In addition to rare fish species, several aquatic macroinvertebrate species from White River Valley are found on the State of Nevada's Rare (At-Risk) Species List (NVNHP 2004). The Flag springsnail (*Pyrgulopsis breviloba*), Emigrant springsnail (*Prygulopsis gracilis*), Butterfield springsnail (*Pyrgulopsis lata*), Hardy springsnail *(Pyrgulopsis marcida*), Pahranagat pebblesnail *(Pyrgulopsis merriami*), White River springsnail (*Pyrgulopsis sathos*), and grated tryonia *(Tryonia clathrata*) are all endemic to Nevada and found on the State of Nevada's Rare (At-Risk) Species List (NVNHP 2004). The grated tryonia and Pahranagat pebblesnail were former candidates for listing under the (ESA) but are currently Federal species of concern. All seven of these springsnail species are significant biological resources in the White River Valley.

Twenty aquatic systems of interest were identified in White River Valley (Figure 20, Table 65). We surveyed 13 sites at 11 of these systems. We performed Level 2 surveys at 12 sites, as well as one Level 1 survey at Shingle Pass Spring. Shingle Pass Spring received a Level 1 survey because we determined that it is in the mountain block. We were unable to survey the remainder of the aquatic systems of interest identified in White River Valley because we were denied access.

Physical Data and Water Quality

White River Valley has a few stream systems fed by springs that vary widely in size and discharge volume (Table 66). At one time most of these systems probably fed into the pluvial White River system, which is now represented by the relic White River in White River Valley. In the northern portion of the valley, Preston Big Spring, Arnoldson Spring, Nicholas Spring, Indian Springs, and Lund Springs are the largest tributaries to the relic upper White River (Scoppetonne et al. 2004a). Since portions of all these springs are currently diverted for agricultural and livestock use, the relic White River is ephemeral. Scoppetonne et al. (2004a) listed the combined discharge of these upper springs to be approximately 600 l/s. Large tributary springs in downstream areas of the relic White River include Flag Springs, Butterfield Springs, Hot Creek, and Moon River Springs. The three heads of Flag Springs converge to form the perennial Sunnyside Creek, which is then joined by the inflow of Butterfield Springs, prior to entering the relic White River. Hot Creek has multiple spring sources that converge to form a perennial stream that flows into Adams McGill Reservoir (Scoppetonne et al. 2004a).

Of the systems we were able to sample, we found that Hot Creek had the highest temperature and conductivity (Table 67, Appendix B). Utilizing information from our surveys and surveys in Sada (2005a), we found that Moorman and Moon River Springs also had high temperatures (> 30ºC), but most of the systems of interest had temperatures between 15-25ºC. All of the systems of interest were fairly neutral with pHs ranging from 7.2 to 8.4.

Sada (2005a) also listed water quality parameters for Arnoldson Spring, Flag Springs, Hot Creek, and Preston Big Spring. Our dissolved oxygen measurements at Preston Big Spring were lower than those (4.6 mg/l) listed from 1992 surveys in Sada (2005a) but more similar to those (3.3 mg/l) listed by Williams and Wilde (1981). Williams and Williams (1982) listed the range for dissolved oxygen levels at Preston Big Spring as between 2.7 and 5.0 mg/l. The levels of the water quality parameters we measured at Arnoldson Spring, Flag Springs, Hot Creek, and Preston Big Spring were close to the values reported by Sada (2005a), Williams and Wilde (1981), and Williams and Williams (1982). Hobbs et al. (2005) listed water quality parameters similar to ours for Indian Spring.

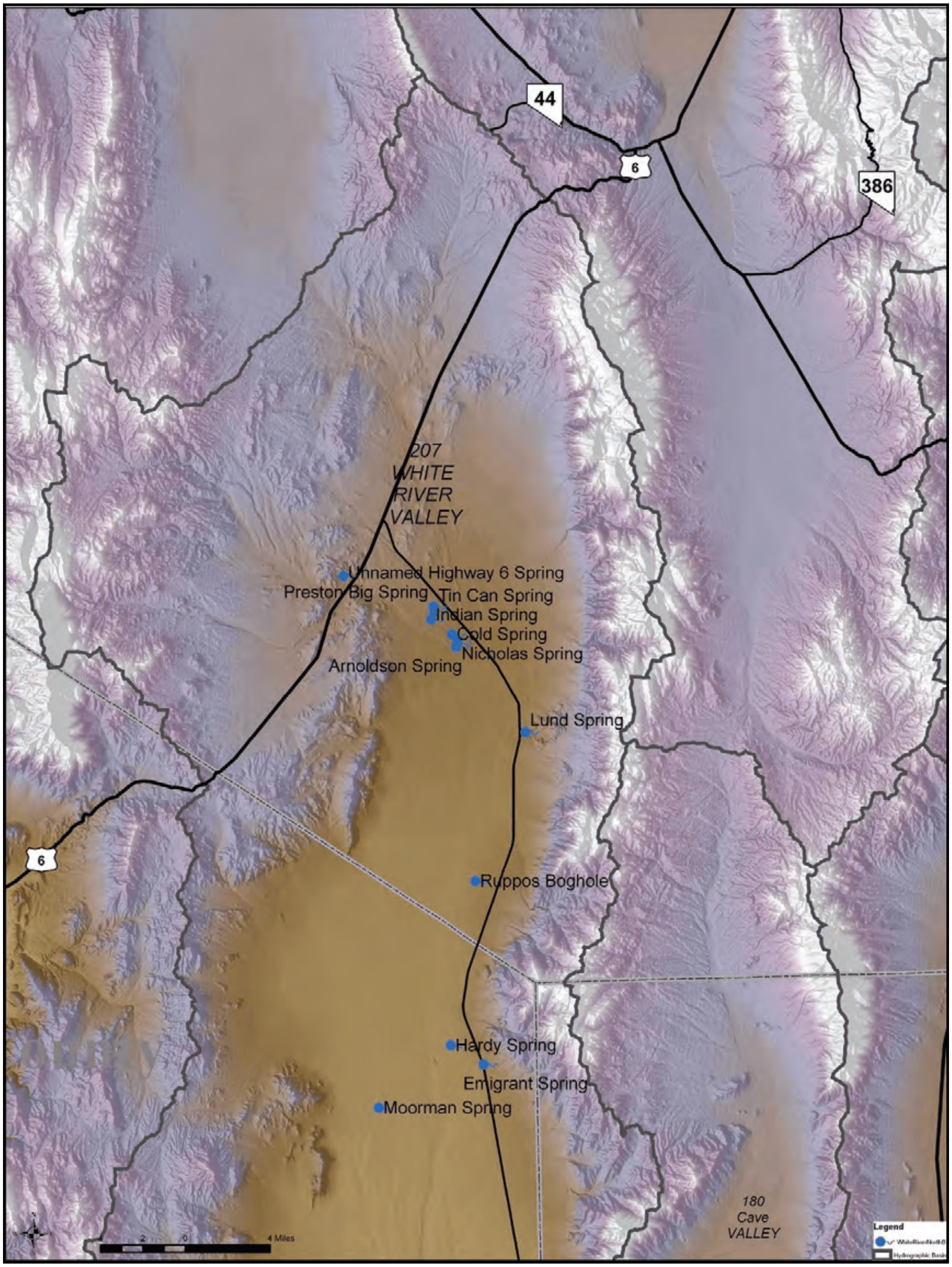

Figure 20a. Map of locations of aquatic systems of interest in Upper White River Valley, Nye County and White Pine County, Nevada.

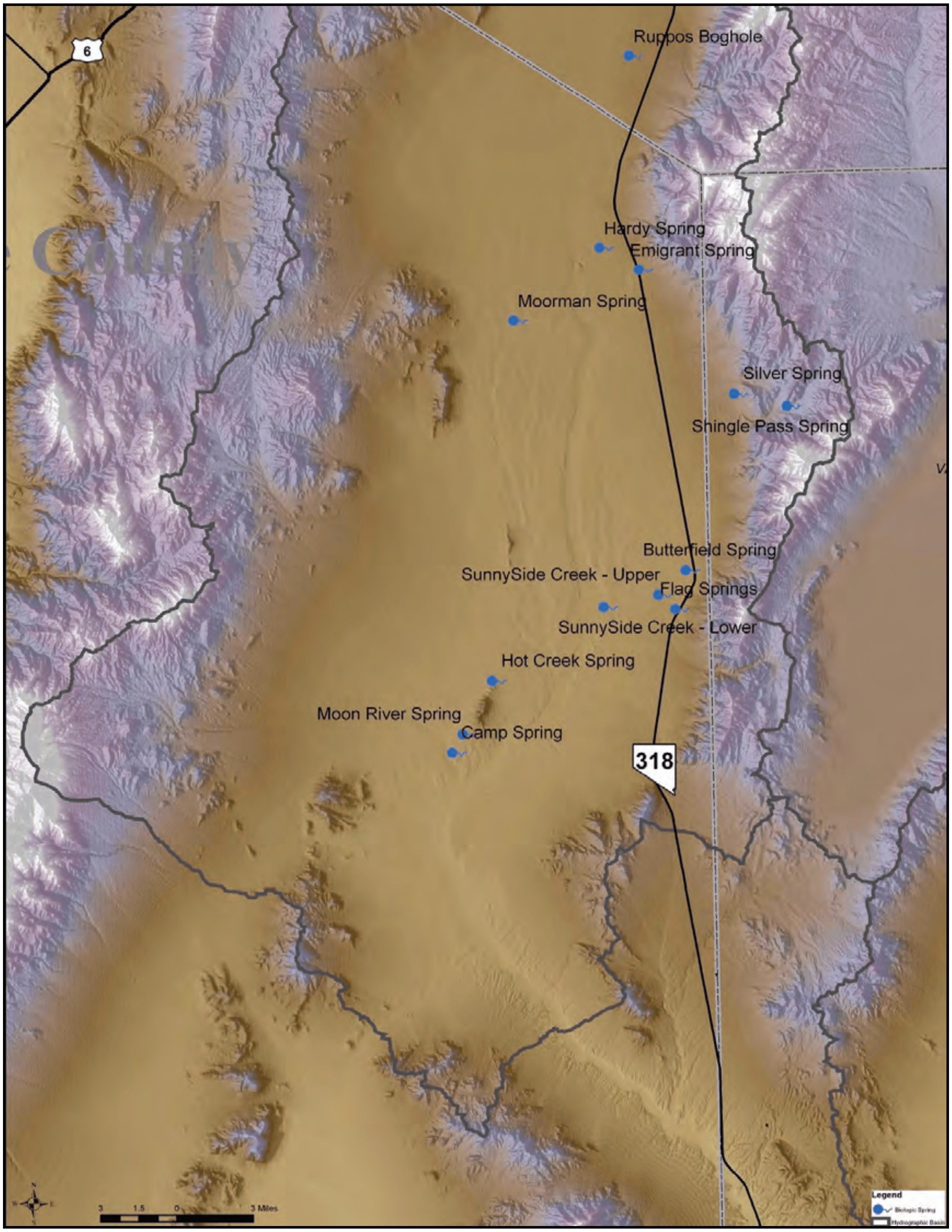

Figure 20b. Map of locations of aquatic systems of interest in Lower White River Valley, Lincoln County, Nye County, and White Pine County, Nevada.

Table 65. County, location, survey date, survey level, and ownership of aquatic systems of interest throughout White River Valley in Lincoln County, Nye County, and White Pine County, Nevada.

SYSTEM NAME	COUNTY	NORTHING	EASTING	DATE SURVEYED	BIO-WEST SURVEY LEVEL	OWNER
Arnoldson Spring	White Pine	4308300	668002	9/12/06	Level 2	Private
Butterfield Springs	Nye	4256488	673523	N/A	Denied access	Private
Camp Spring	Lincoln	4245193	658387	N/A	Denied access	Private
Cold Spring	White Pine	4309444	667613	N/A	Denied access	Private
Emigrant Spring	Nye	4276701	670008	N/A	Denied access	Private
Flag Spring Complex North	Nye	4254703	672725	3/2/2005	Level 2	NDOW
Flag Spring Complex Middle	Nye	4254555	672576	3/2/2005	Level 2	NDOW
Flag Spring Complex South	Nye	4254423	672584	3/2/2005	Level 2	NDOW
Hardy Spring	Nye	4278164	667559	N/A	Denied access	Private
Hot Creek Spring	Nye	4249920	661285	10/6/2004	Level 2	NDOW
Indian Spring	White Pine	4310587	666103	6/13/2005	Level 2	Private
Lund Spring	White Pine	4301825	673319	8/24/2006	Level 2	Private
Moon River Spring	Nye	4246372	658935	N/A	Denied access	Private
Moorman Spring	Nye	4273418	662063	N/A	None/access	Private
Nicholas Spring	White Pine	4308638	668174	8/24/2006	Level 2	Private
Preston Big Spring	White Pine	4311176	666299	6/14/2005	Level 2	Private
Ruppo's Boghole	Lincoln	4290667	669561	N/A	Denied access	Private
Shingle Pass Spring	Lincoln	4267715	679930	N/A	Level 1	BLM
Silver Spring	Lincoln	4268689	676221	N/A	Denied access	Private
Sunnyside Creek - Upper	Nye	4254964	672152	3/2/2005	Level 2	NDOW
Sunnyside Creek - Lower	Nye	4254646	668344	3/2/2005	Level 2	NDOW
Tin Can Spring	White Pine	4311371	666348	9/12/06	Level 2	Private
Unnamed Spring Near Highway 6	White Pine	4311977	658782	N/A	None/Access	Private

Note: UTM coordinates are in the NAD 83 projection system.

Table 66. Type of system, maximum depth, maximum wetted width, and length of survey plots, as well as measured discharge found at aquatic systems of interest throughout White River Valley in Lincoln County, Nye County, and White Pine County, Nevada.

SYSTEM NAME	SYSTEM TYPE	MAXIMUM DEPTH (cm)	MAXIMUM WETTED WIDTH (m)	LENGTH (m)	DISCHARGE (l/s)
Arnoldson Spring[a]	Rheocrene	86.0	12.5	121	N/A
Butterfield Spring[a]	Rheocrene	1	0.5	N/A	N/A
Camp Spring[a]	Rheocrene	3	2.0	N/A	N/A
Emigrant Spring[a]	Rheocrene	2	1.0	N/A	N/A
Flag Springs Complex North	Rheocrene	76.2	1.8	603	60.16
Flag Springs Complex Middle	Rheocrene	20	1.5	88	88.82
Flag Springs Complex South	Limnocrene	40	4.2	105	33.99
Hardy Spring[a]	Rheocrene	50	4.0	N/A	N/A
Hot Creek Spring	Limnocrene	488	42.0	225[b]	84.02/294.94[c]
Indian Spring	Limnocrene	107	10.0	207[b]	20.00/42.08[d]
Lund Spring	Limnocrene	92	33	52	N/A
Moon River Spring[a]	Rheocrene	3	7.0	N/A	N/A
Moorman Spring[a]	Rheocrene	50	1.5	N/A	N/A
Nicholas Spring	Rheocrene	37	4.0	38	N/A
Preston Big Spring	Limnocrene	46	7.5	217[b]	274.37
Ruppo's Boghole[a]	Rheocrene	100	10.0	N/A	N/A
Silver Spring[a]	Rheocrene	1	1.5	N/A	N/A
Shingle Pass	Limnocrene	25.4	1.8	18	0.025
Sunnyside Creek-Lower	Creek	130	20.6	170[b]	333.36
Sunnyside Creek-Upper	Creek	80	1.2	207[b]	161.1
Tin Can Spring	Limnocrene	152	26.0	N/A	N/A
Unnamed Highway 6 Spring[a]	Rheocrene	4	2.0	N/A	N/A

[a]Data from Sada (2005a).
[b]Continued further as a spring brook or marsh land, or onto private property.
[c]Discharge from above and below main spring pool.
[d]Discharge from spring head 1 and in the spring brook below the confluence of spring heads 1 and 2.

Table 67. Selected water quality parameters measured at aquatic systems of interest throughout White River Valley in Lincoln County, Nye County, and White Pine County, Nevada.

SPRING NAME	LOCATION	TEMPERATURE (C)	DISSOLVED OXYGEN (mg/l)	CONDUCTIVITY (μS/cm)	pH
Arnoldson Spring	Source/terminus	22.7/22.9	3.7/4.4	418/410	7.42/7.42
Butterfield Spring[a]	Source	16.5	6.6	384	7.9
Camp Spring[a]	Source	18.8	4.9	N/A	8.1
Emigrant Spring[a]	Source	17.6	5.1	324	7.6
Flag Springs - North	Source/terminus	16.28/17.7	6.74/8.55	390/413	7.18/7.93
Flag Springs - Middle	Source	19.7	5.36	407	7.32
Flag Springs - South	Source/terminus	22.59/21.6	4.55/6.61	421/417	7.4/7.63
Hardy Spring[a]	Source	13.6	6.20	431	7.60
Hot Creek Spring	Source/terminus	30.8/31.0	1.41/2.24	513/511	7.11/7.15
Indian Spring	Source/terminus	21.51/22.3	3.18/3.27	342/314	8/8.12
Lund Spring	Source/terminus	18.00/18.17	5.58/5.22	442/441	7.63/7.59
Moon River Spring[b]	Source	32.4	2.16	537	N/A
Moorman Spring[a]	Source	35.4	3.6	577	7.7
Nicholas Spring	Source/terminus	22.06/21.70	3.73/3.46	409/404	7.85/7.77
Preston Big Spring	Source/terminus	20.61/21.9	2.41/2.73	351/338	8.08/8.19
Ruppo's Boghole[a]	Source	12.6	3.9	547	7.9
Silver Spring[a]	Source	14.9	N/A	446	N/A
Shingle Pass Spring	Source	15.8	12.3	418	7.52
Sunnyside Creek Spring - Upper	Source/terminus	18.21/17.7	8.38/8.55	416/413	8/7.93
Sunnyside Creek Spring - Lower	Source/terminus	10.96/10.7	9.81/9.81	507/508	7.88/7.74
Tin Can Spring	Source	22.32	7.85	408	7.75
Unnamed Highway 6 Spring[a]	Source	16.4	6	387	8.4

[a] Data taken from Sada (2005a).
[b] Data taken from Hobbs et al. (2005).

Aquatic Vegetation

We identified 15 different taxa of SAV during our surveys in White River Valley (Table 68). The watercress group and horsehair algae, the most common vegetation types, were found at eight of the surveyed locations. We identified watercress, monkey flower, and poison hemlock during our vegetation surveys at the aquatic systems of interest throughout White River Valley, so our watercress group is probably comprised of one or more of these three species at each location. Muskgrass was also common: We found it at five locations. The upper station at Sunnyside Creek had very little SAV and only two taxa, whereas the lower station at Sunnyside Creek had the most SAV taxa (5).

We identified 47 taxa of EAV in the wetted areas of the 13 sample locations among the aquatic systems of interest (Table 69). Olney's three square bulrush, spikerush, and saltgrass were the most common vegetation types. Shingle Pass Spring had the fewest taxa of EAV (4), while the combined Flag Springs complex (North, Middle, and South) had the highest number of emergent taxa (18).

Deacon et al. (1980) found that Preston Big Spring was dominated by Olney's three square bulrush and watercress. We saw large amounts of Olney's three square bulrush at Preston Big Spring during our June 2005 survey but lesser amounts of watercress. Laboratory examination of the algal flora in Preston Big Spring showed over 74 different species, dominated by Chlorophytes such as the horsehair algae we identified (Deacon et al. 1980, Williams and Williams 1982).

We identified 13 taxa of trees in the immediate riparian zones of the aquatic systems of interest in White River Valley (Table 70). Middle Flag Springs and South Flag Springs had a narrow strip of trees around the source areas and for a short distance downstream. The nonnative tree, Russian olive, was found in the riparian zone at Indian Spring, Preston Big Spring, and Tin Can Spring.

Vegetation Mapping

The White River Valley vegetation was diverse, with 28 associations, including open water, and 52 species (Appendix C) noted among the five aquatic systems of interest where vegetation was mapped in September-October 2005 and August-September 2006. At individual springs the number of associations ranged from 2 (Arnoldson Spring) to 18 (Flag Springs complex) (Table 71). A Fremont Cottonwood forest is the dominant association at Arnoldson Spring. Flag Springs is characterized by many associations that cover small amounts of area. The system contains no associations covering more than 25 % of the 21.1 acres mapped. The Olney's Three Square Bulrush Association was the most common vegetation type across all systems mapped. We found the Olney's Three Square Bulrush Association at six of the nine systems mapped, and

Table 68. Percent cover of submerged aquatic vegetation (SAV) found at aquatic systems of interest throughout White River Valley in Lincoln County, Nye County, and White Pine County, Nevada.

COMMON NAME	SCIENTIFIC NAME	SYSTEMS												
		ARNOLDSON	FLAG COMPLEX NORTH	FLAG COMPLEX MIDDLE	FLAG COMPLEX SOUTH	HOT CREEK	INDIAN	LUND	NICHOLSON	PRESTON BIG	SHINGLE PASS	SUNNYSIDE CREEK-UPPER	SUNNYSIDE CREEK-LOWER	TIN CAN
Bladderwort	*Macrorhiza macrorhiza*	-	-	-	-	10	-	-	-	-	-	-	-	-
Water Whorlgrass	*Catabrosa aquatica*	-	< 2	10	-	-	-	-	-	-	-	-	-	-
Coon's Tail	*Ceratophyllum demersum*	-	-	-	-	-	-	-	-	-	-	-	-	20
Duckweed	*Spirodela* sp.	-	-	-	< 2	-	-	-	-	-	-	-	-	-
Greater Duckweed	*Spirodela polyrhiza*	-	-	-	-	-	-	-	-	-	-	< 2	-	-
Fineleaf Pondweed	*Stuckenia filiformis*	-	-	-	-	-	-	15	10	-	-	-	-	-
Horsehair Algae	*Chlorophyceae* sp.	5	-	< 2	-	15	5	10	15	5	-	-	< 2	80
Mare's Tail	*Hippuris vulgaris*	-	-	-	-	-	-	-	-	-	-	-	10	-
Monkey Flower	*Mimulus guttatus*	-	-	-	-	-	-	-	-	-	-	-	20	-
Moss	*Philonotus hypnaceae*	-	2	10	-	-	-	-	-	-	-	-	-	-
Muskgrass	*Chara vulgaris*	-	< 2	-	-	25	< 2	-	-	-	85	-	< 2	-
Pondweed	*Potamogeton foliosus/ pectinatus*	-	-	-	-	-	-	-	-	<2	15	-	-	-
Sago Pondweed	*Potamogeton pectinatus*	-	-	-	-	-	15	-	-	-	-	-	-	-
Star Duckweed	*Lemna trisulca*	-	-	-	-	15	-	-	-	-	-	-	-	-
Watercress[a]	*Rorippa nasturtium-aquaticum*	-	5	30	2	-	2	25	25	5	-	< 2	5	-

[a] Watercress group.

Table 69. Percent cover of emergent aquatic vegetation (EAV) found at aquatic systems of interest throughout White River Valley in Lincoln County, Nye County, and White Pine County, Nevada.

COMMON NAME	SCIENTIFIC NAME	SYSTEMS												
		ARNOLDSON	FLAG COMPLEX NORTH	FLAG COMPLEX MIDDLE	FLAG COMPLEX SOUTH	HOT CREEK	INDIAN	LUND	NICHOLAS	PRESTON BIG	SHINGLE PASS	SUNNYSIDE CREEK-UPPER	SUNNYSIDE CREEK-LOWER	TIN CAN
Alkali Sacaton	*Sporolobus airoides*	-	-	-	-	< 2	-	-	-	-	-	-	-	-
Asparagus	*Asparagus setaceus*	-	-	-	-	-	-	<2	-	< 2	-	-	-	-
Aster	*Symphyotrichum* sp.	-	-	5	-	-	-	-	-	-	-	-	-	-
Baltic Rush	*Juncus balticus*	<2	10	10	-	-	20	-	-	5	5	-	-	-
Broadleaf Cattail	*Typha latifolia*	5	5	5	5	-	10	-	-	-	-	< 2	65	-
Bur-reed	*Sparganium* sp.	-	-	-	-	-	-	-	-	-	-	-	10	-
Canada Goldenrod	*Solidago canadensis*	-	-	-	-	5	-	-	-	-	-	-	-	-
Common Reed	*Phragmites australis*	-	-	-	-	-	-	-	-	< 2	-	-	-	-
Curly Dock	*Rumex crispus*	-	< 2	-	-	-	-	-	-	-	-	< 2	2	-
Dames Rocket	*Hesperis matronalis*	-	-	-	-	5	-	-	-	-	-	-	-	-
Dudley's Rush	*Juncus dudleyi*	-	-	-	20	-	-	-	-	-	-	20	-	-
Eaton's Aster	*Symphyothrichum eatonni*	20	-	-	-	-	-	-	-	-	-	-	-	20
Foxtail Barley	*Hordeum jubatum*	-	-	-	-	-	< 2	-	-	-	-	-	2	-
Fringed Willowherb	*Epilobium ciliatum*	5	-	-	-	-	-	5	-	-	-	-	-	-
Giant Reedgrass	*Phragmites australis*	-	-	-	-	-	-	15	-	-	-	-	-	-
Goldenrod	*Solidago* sp.	-	10	5	5	-	-	-	-	-	-	-	-	-
Hardstem Bulrush	*Scirpus acutus*	<2	15	-	5	10	-	<2	-	-	-	5	-	10
Hooker's Evening Primrose	*Oenothera elata*	<2	-	-	-	-	-	<2	-	-	-	-	-	-
Horsetail	*Equisetum* sp.	-	5	-	< 2	-	-	-	-	-	-	-	-	-
Hot Springs Fimbry	*Fimbristylis spadicea*	-	-	-	-	< 2	-	-	-	-	-	-	-	-
Indian Hemp	*Apocynum cannabinum*	-	-	-	-	-	-	-	-	< 2	-	-	-	-
Kentucky Bluegrass	*Poa prtensis*	10	-	-	-	-	-	-	-	-	-	-	-	-
Milkweed	*Asclepias incarnata*	-	5	-	-	-	-	-	-	-	-	-	-	-

Table 69. Continued.

COMMON NAME	SCIENTIFIC NAME	SYSTEMS												
		ARNOLDSON	FLAG COMPLEX NORTH	FLAG COMPLEX MIDDLE	FLAG COMPLEX SOUTH	HOT CREEK	INDIAN	LUND	NICHOLAS	PRESTON BIG	SHINGLE PASS	SUNNYSIDE CREEK-UPPER	SUNNYSIDE CREEK-LOWER	TIN CAN
Mint	*Lamium* sp.	-	-	-	-	-	-	-	-	< 2	-	-	-	-
Monkey Flower [a]	*Mimulus guttatus*	-	-	-	-	< 2	20	-	-	< 2	-	-	-	-
Nebraska Sedge	*Carex nebrascensis*	-	5	10	-	-	-	5	-	-	45	-	5	-
Nuttall's Sunflower	*Helianthus nuttallii*	-	-	-	-	5	-	-	-	-	-	-	-	-
Olney's Three Square Bulrush	*Schoenoplectus americanus*	2	5	40	5	60	20	-	-	85	-	10	20	15
Poison Hemlock	*Conium maculatum*	-	-	-	< 2	-	-	-	-	-	-	< 2	10	-
Prickly Lettuce	*Lactuca serriola*	-	-	5	-	-	< 2	-	-	-	-	-	5	-
Quackgrass	Agropyron repens	-	-	-	-	-	-	-	-	-	-	-	-	5
Rabbit-foot Grass	*Polypogon monspeliensis*	-	-	-	-	-	< 2	<2	10	-	-	-	2	<2
Redtop	*Agrostis gigantea*	-	5	5	< 2	-	< 2	-	15	2	-	-	2	-
Red Willow	*Salix laevigata*	-	-	-	-	-	-	-	10	-	-	-	-	-
Rush	*Juncus torreyi*	-	-	-	-	-	-	-	-	-	-	-	2	-
Saltgrass	*Distichlis spicata*	-	< 2	-	< 2	15	< 2	5	25	-	50	5	-	-
Scouringrush Horsetail	*Equisetum hyemale*	-	-	-	-	-	-	-	-	-	-	-	-	15
Seep Monkeyflower	*Mimulus guttatus*	-	-	-	-	-	-	20	-	-	-	-	-	-
Sedge	*Carex* sp.	-	-	-	< 2	-	-	-	-	-	-	-	-	-
Showy Milkweed	*Asclepias speciosa*	<2	-	-	-	-	-	-	5	< 2	-	-	-	-
Spikerush	*Eleocharis* sp.	10	30	-	50	< 2	5	-	5	< 2	< 2	60	-	-
Tall Fescue	*Schedonorus phoenix*	10	-	-	-	-	-	-	-	-	-	-	-	-
Watercress	*Nasturtium officinale*	5	-	-	-	-	-	20	20	-	-	-	-	-
Water Parsnip	*Berula erecta*	-	-	-	-	-	-	10	-	-	-	-	-	-
Water Speedwell	*Veronica anagallis*	-	-	-	-	-	15	-	5	< 2	-	-	-	-
Willow-herb	*Epilobium* sp.	-	5	-	-	-	-	-	-	-	-	< 2	-	-

[a] Watercress group.

Table 70. Trees found at aquatic systems of interest throughout White River Valley in Lincoln County, Nye County, and White Pine County, Nevada.

COMMON NAME	SCIENTIFIC NAME	SYSTEMS												
		ARNOLDSON	FLAG COMPLEX NORTH	FLAG COMPLEX MIDDLE	FLAG COMPLEX SOUTH	HOT CREEK	INDIAN	LUND	NICHOLAS	PRESTON BIG	SHINGLE PASS	SUNNYSIDE CREEK-UPPER	SUNNYSIDE CREEK-LOWER	TIN CAN
Apple	*Malus pumila*	A[a]	A	A	A	A	A	A	P[b]	A	A	A	A	A
Black Locust	*Robinia pseudoacacia*	P	A	A	A	A	A	P	A	A	A	A	A	A
Boxelder	*Acer negundo*	A	A	A	A	A	A	P	A	A	A	A	A	A
Cottonwood	*Populus* sp.	P	A	P	P	A	A	P	A	A	A	A	A	A
Currant	*Ribes* sp.	A	A	A	A	A	A	A	A	P	A	A	A	A
Red Elderberry	*Sambucus racemosa*	A	A	A	A	A	A	A	P	A	A	A	A	A
Green Ash	*Fraxinus pennsylvanica*	A	A	P	A	A	A	A	A	A	A	A	A	A
Juniper	*Juniperus* sp.	A	A	A	A	A	A	A	A	A	P	A	A	A
Siberian Elm	*Ulmus pumila*	A	A	A	A	A	A	A	P	A	A	A	A	A
Skunkbrush	*Rhus trilobata*	A	A	A	A	A	A	P	A	A	A	A	A	A
Rose	*Rosa* sp.	A	P	P	A	A	P	P	A	P	A	A	A	A
Russian Olive	*Elaeagnus angustifolia*	A	A	A	A	A	P	A	A	P	A	A	A	P
Willow	*Salix* sp.	A	P	A	P	A	P	P	P	P	A	A	A	A

[a] Absent through visual observation.
[b] Present through visual observation.

Table 71. The proportion of the 36.5 acres mapped comprised of each association (alliance) at aquatic systems of interest throughout White River Valley in Lincoln, Nye, and White Pine Counties, Nevada.

ASSOCIATIONS / ALLIANCES IN WHITE RIVER VALLEY	ARNOLDSON SPRING (0.84 ACRE [0.34 HECTARE])	FLAG SPRINGS (21.1 ACRES [8.53 HECTARES])	HOT CREEK (9.02 ACRES [3.65 HECTARES])	INDIAN SPRINGS (1.28 ACRES [0.52 HECTARE])	LUND SPRING (1.08 ACRES [0.44 HECTARE])	NICHOLAS SPRING (0.13 ACRES [0.05 HECTARE])	PRESTON BIG SPRINGS (1.10 ACRES [0.445 HECTARE])	SUNNYSIDE SPRING (1.90 ACRES [0.77 HECTARE])	TIN CAN SPRING (0.10 ACRE [0.04 HECTARE])
Anemopsis californica (Yerba Mansa) Herbaceous Vegetation / Undesignated Alliance			0.75%						
Carex nebrascensis (Nebraska Sedge) Herbaceous Vegetation / *Carex nebrascensis* Seasonally Flooded Herbaceous		12.48%						5.69%	
Carex simulata (Analogue Sedge) Herbaceous Vegetation / *Carex simulata* Saturated Herbaceous		3.63%						3.44%	
Distichlis spicata (Inland Saltgrass) Herbaceous Vegetation / *Distichlis spicata* Intermittently Flooded Herbaceous			21.62%						
Elaeagnus angustifolia (Russian Olive) Semi-natural Woodland / *Elaeagnus angustifolia* Semi-natural Woodland Alliance				1.25%			3.72%		50%
Eleocharis palustris (Common Spikerush) Herbaceous Vegetation / *Eleocharis palustris* Seasonally Flooded Herbaceous Alliance		1.00%							
Equisetum hyemale (Scouringrush Horsetail) Herbaceous Vegetation									20%
Equisetum arvense, variegatum, hyemale (Field, Variegated Scouringrush, and Scouringrush Horsetail) Semipermanently Flooded Herbaceous Alliance									
Juncus articus (Baltic Rush), Herbaceous Vegetation / *Juncus balticus* Seasonally Flooded Herbaceous		23.13%	16.78%	13.90%					
Juncus arcticus (Baltic Rush) Mixed Herbaceous / *Juncus balticus* Seasonally Flooded Herbaceous		4.78%	35.60%						
Leymus triticoides (Bearless Wildrye) - *Poa secunda* (Sandberg Bluegrass) Herbaceous Vegetation / *Leymus triticoides* Temporarily Flooded Herbaceous		22.19%		3.85%					
Leymus triticoides (Beardless Wildrye) - *Carex* (Sedge) Spp. Herbaceous Vegetation / *Leymus triticoides* Temporarily Flooded Herbaceous		12.40%							
Mixed Wetland Forb Herbaceous Vegetation / Undesignate Alliance		0.19%							
Muhlenbergia asperifolia (Scratchgrass) Herbaceous Vegetation / *Muhlenbergia asperifolia* Intermittently Flooded Herbaceous			5.57%						
Nasturtium officinale (Watercress)/ *Berula erecta* (Cutleaf Water Parsnip)/ *Veronica anagallis* (Water Speedwell) - Aquatica Herbaceous Vegetation						7.69%			
Undesignated Alliance				2.14%					
Open Water / Undesignated Alliance	0.01%	0.61%	1.5%	10.29%	2.77%				20%
Phragmites australis (Common Reed) Western North America Temperate Semi-natural Herbaceous Vegetation / *Phragmites australis* Semipermanently Flooded Herbaceous			1.64%		9.25%		2.14%		
Populus (Cottonwood) Spp. Semi-natural Woodland / Undesignated Alliance		3.49%				7.69%			
Populus fremontii (Fremont Cottonwood) Mixed Herbaceous Woodland / *Populus fremontii* Seasonally Flooded Woodland	99%				71.29%				
Rhus trilobata (Skunkbush Sumac) Intermittently Flooded Shrubland / *Rhus trilobata* Intermittently Flooded Shrubland Alliance					2.77%		4.11%		
Rosa woodsii (Wood's Rose) Shrubland / *Rosa woodsii* Temporarily Flooded Shrubland		0.95%			13.88%				

Table 71. Continued.

ASSOCIATIONS / ALLIANCES IN WHITE RIVER VALLEY	ARNOLDSON SPRING (0.84 ACRE [0.34 HECTARE])	FLAG SPRINGS (21.1 ACRES [8.53 HECTARES])	HOT CREEK (9.02 ACRES [3.65 HECTARES])	INDIAN SPRINGS (1.28 ACRES [0.52 HECTARE])	LUND SPRING (1.08 ACRES [0.44 HECTARE])	NICHOLAS SPRING (0.13 ACRES [0.05 HECTARE])	PRESTON BIG SPRINGS (1.10 ACRES [0.445 HECTARE])	SUNNYSIDE SPRING (1.90 ACRES [0.77 HECTARE])	TIN CAN SPRING (0.10 ACRE [0.04 HECTARE])
Salix exigua (Coyote Willow) Temporarily Flooded Shrubland / *Salix exigua*, *interior* (Coyote, Sandbar Willow) Temporarily Flooded Shrubland		3.27%		15.47%		46.15%			
Salix laevigata (Red Willow) - *Fraxinus velutina* (Velvet Ash) Woodland / *Salix laevigata* Temporarily Flooded Woodland Alliance		0.28%				38.46%			
Salix exigua (Coyote Willow) - Mesic Graminoids Shrubland / *Salix exigua*, *interior* (Coyote, Sandbar Willow) Temporarily Flooded Shrubland				10.04%					
Schoenoplectus acutus (Hardstem Bulrsuh) Herbaceous Vegetation / *Schoenoplectus acutus*, *Schoenoplectus tabernaemontani* (Softstem Bulrush), Semipermanently Flooded Herbaceous		1.80%	11.29%						
Schoenoplectus americanus (Olney's Three Square Bulrush), Western Herbaceous Vegetation / *Schoenoplectus americanus*, Semipermanently Flooded Herbaceous		2.11%	5.23%	5.17%			90.03%	74.70%	10%
Schoenoplectus americanus (Olney's Three Square Bulrush) - *Eleocharis palustris* (Spikerush) Herbaceous Vegetation / *Schoenoplectus americanus* Semipermanently Flooded Herbaceous		0.36%		33.38%					
Solidago missouriensis (Missouri Goldenrod) Herbaceous Vegetation / Undesignated Alliance		1.89%							
Typha latifolia (Broadleaf Cattail) Herbaceous Vegetation / *Typha angustifolia*, lLatifolia (Narrowleaf Cattail, Broadleaf Cattail), *Schoenoplectus* (Three Square) Spp. Semipermanently Flooded Herbaceous		5.4%		4.5%				16.16%	

that association comprised more than 70% of the area of Preston Big Spring and Sunnyside Creek but only small amounts of the other systems. Deacon et al. (1980) also found that Olney's three square bulrush was a dominant vegetation type at Preston Big Spring. Most associations found in the 36.5 acres mapped in the White River Valley occurred at no more than 30% of the systems.

Fishes

The unique fish fauna of the White River Valley has stimulated an abundance of historical research on the fish communities, particularly the Federally endangered White River spinedace, as well as the Preston and Moorman White River springfish (Miller and Hubbs 1960, Deacon et al. 1980, Williams and Wilde 1981, Williams and Williams 1982, Allan 1985, Courtenay et al. 1985, Scoppetonne and Rissler 2002, Scoppetonne et al. 2004a, Scoppetonne et al. 2004b).

Currently, the NDOW has ongoing sampling programs for the remaining populations of White River spinedace and Moorman White River springfish (Table 72) (Stein et al. 2001, Hobbs et al. 2005). The most recent comprehensive survey for Preston White River springfish occurred in 1998 and 1999 (Scoppetonne and Rissler 2002). While sporadic surveys have targeted White River desert sucker and White River speckled dace in the past 10 years (Stein et al. 2000, Stein et al. 2001, Hobbs et al. 2005), the last comprehensive surveys occurred in 1991 and 1992 (Scoppetonne 2004a).

White River spinedace once inhabited at least seven spring systems in the White River Valley (Miller and Hubbs 1960), but at the time of listing (1985) the species was restricted to the Flag Springs complex and Lund Spring (USFWS 1985a). By the early 1990s only the Flag Springs population remained. By the mid 1990s Scoppetonne et al. (2004b) estimated the population at Flag Springs to be less than 20 individuals. White River spinedace currently persist in the Flag Springs complex (including upper Sunnyside Creek). At present the NDOW and USFWS are trying to establish a refugia population at Indian Springs with fish transplanted from the Flag Springs complex (USFWS 2003; Hobbs et al. 2005; B. Nielsen 2005, pers. comm.; Hobbs 2006a).

In 2002 and 2003 the USFWS completed a Safe Harbor Agreement with the private landowners of Indian Springs, so they could complete a restoration project on this system (USFWS 2003; Hobbs et al. 2005; B. Nielsen 2005, pers. comm.). In March and April 2004, 86 White River spinedace and 37 White River desert sucker were relocated from upper Sunnyside Creek and Middle Flag Springs to Indian Spring. When the NDOW surveyed Indian Spring in September 2004, they found over 450 White River speckled dace and 25 Preston White River springfish but no White River spinedace or White River desert sucker (Hobbs et al. 2005). In June 2005 the NDOW transplanted another 102 White River spinedace and 15 White River desert sucker from the Flag Springs complex to Indian Springs. Follow-up surveys over Indian Springs in October

Table 72. Fish sightings at aquatic systems of interest in White River Valley, Lincoln, Nye, and White Pine Counties, Nevada.

SPRING NAME	SOURCES[a]	WHITE RIVER SPINEDACE	MOORMAN WHITE RIVER SPRINGFISH	PRESTON WHITE RIVER SPRINGFISH	WHITE RIVER SCULPIN	WHITE RIVER DESERT SUCKER	WHITE RIVER SPECKLED DACE	GUPPIES	LARGE-MOUTH BASS	WESTERN MOSQUITO-FISH
Arnoldson Spring	1,3, 4, 6	A[b]	A	P[c] 1, 3, 4, 6	A	A	P 1,3, 4	P 1, 3, 4, 6	A	A
Butterfield Spring	2, 4, 6	A	A	A	P 2, 4	A	P 2, 4	A	A	A
Camp Spring	4, 6	A	A	A	A	A	P 4	A	A	A
Cold Spring	4	A	A	A	A	A	A	P 4	A	A
Emigrant Spring	4, 6	A	A	A	A	A	P 4	A	A	A
Flag Springs - North	1, 2, 4, 5, 6	P 2, 4, 5	A	A	A	P 2, 4	P 2, 4	A	A	A
Flag Springs - Middle	1, 2, 4, 5, 6	P 2, 4, 5	A	A	A	P 2, 4	P 2, 4	A	A	A
Flag Springs - South	1, 2, 4, 5, 6	P 2, 4, 5	A	A	A	P 2, 4	P 2, 4	A	A	A
Hardy Spring	2, 4, 6	A	A	A	A	A	P 2, 4	A	A	A
Hot Creek Spring	1, 2, 4, 6	A	P 2, 4, 6	A	A	A	A	A	P 2, 4	P 1, 2
Indian Spring	1, 2, 3, 4, 5	P 2, 5	A	P 2, 3, 4	A	P 2, 5	P 2, 3, 4, 5	A	A	A
Lund Spring	1, 3, 4	A	A	A	A	P 3, 4	P 3, 4	P 1, 3, 4	A	A
Moon River Spring	2, 4, 6	A	P 2, 4, 6	A	A	A	A	A	A	A
Moorman Spring	2, 4, 6	A	P 2, 4, 6	A	A	A	A	A	A	A
Nicholas Spring	1, 3, 4	A	A	P 1, 3, 4	A	A	A	P 1, 3, 4	A	A
Preston Big Spring	3, 4, 6	A	A	P 1, 3, 4, 6	A	A	P 3, 4, 6	A	A	A
Ruppo's Boghole Spring	6	A	A	A	A	A	A	A	A	A
Shingle Pass Spring	1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	A
Silver Spring	6	A	A	A	A	A	A	A	A	A
Sunnyside Creek Spring - Upper	1, 2, 4	P 2, 4	A	A	A	P 2, 4	P 2, 4	A	A	A
Sunnyside Creek Spring- Lower	1, 2, 4	A	A	A	A	P 2, 4	P 2, 4	A	A	A
Tin Can Spring	1	A	A	A	A	A	P 1,4	A	A	A
Unnamed Highway 6 Spring	6	A	A	A	A	A	A	A	A	A

[a] Sources: 1 = BIO-WEST survey and/or reconnaissance, 2 = NDOW (Stein et al. 1999, Stein et al. 2001, Hobbs et al. 2004, Hobbs et al. 2005, Hobbs 2006a), 3 = Scoppetonne and Rissler (2002), 4 = Scoppetonne et al. (2004a), 5 = USFWS (B. Nielsen 2005, pers. comm.), 6 = Sada (2005a).
[b] Absent through visual observation.
[c] Present through visual observation.

2005 failed to detect these species (Hobbs 2006a). Ehret and Hobbs (2006) found White River speckled dace, Preston White River Springfish, White River spinedace, and White River desert sucker. The population estimate for Preston White River springfish was 154 individuals, while the population estimate for White River spinedace was reported as 14 individuals (Ehret and Hobbs 2006a). Ehret and Hobbs (2006) recommend that additional White River spinedace and White River desert sucker be transplanted to Indian Spring and that annual monitoring be conducted in this system.

The NDOW estimated the number of White River spinedace in the Flag Springs complex twice in 2004. They performed snorkel surveys in North Flag Springs, South Flag Springs, and upper Sunnyside Creek in March and September 2004. During March 2004 surveys, 1,318 spinedace were found in Sunnyside Creek, 1,182 in South Flag Spring, and 410 in North Flag Spring. During September 2004 surveys 22 White River spinedace were found in upper Sunnyside Creek, 701 in South Flag, and 454 in North Flag (Hobbs et al. 2005). While the number of White River spinedace observed in September 2004 was considerably lower than in March 2004, the number was still within the range of numbers in recent years. Hobbs et al. (2005) speculated that spawning migrations or some other life history characteristic, combined with low visibility, may have impacted the effectiveness of White River spinedace counts in Sunnyside Creek. Recent NDOW survey results, similar to 1991 and 1992 survey results, show that White River speckled dace are abundant at the Flag Springs complex (including Sunnyside Creek), and White River desert sucker are present in lower numbers (Stein et al. 2001, Scoppetonne et al. 2004a, Hobbs et al. 2005, Hobbs 2006a). Scoppetone et al. (2004a, 2004b) also found largemouth bass in Sunnyside Creek, but the addition of two fish barriers, coupled with removal efforts, seems to have been successful at removing largemouth bass from the Flag Springs complex downstream to just above the County Road crossing at Sunnyside Creek (Hobbs 2006a). This area encompasses all of our survey sites in the Flag Springs/Sunnyside Creek system.

Williams and Wilde (1981) described the Moorman White River springfish as occurring in three locations in White River Valley: Moorman Spring, Moon River Spring, and Hot Creek. Currently, Moorman White River springfish populations exist at all three of these locations. The NDOW has a long-term monitoring program for Moorman White River springfish that provides mark/recapture population estimates at Moorman Spring and Hot Creek, as well as catch per unit effort (CPUE) data at Moon River Springs.

Moorman Spring is the type location for Moorman White River springfish (Williams and Wilde 1981). In the early 1980s Courtenay et al. (1985) noted Moorman White River springfish seemed nearly as abundant as when the spring had been sampled in the 1960s. Scoppettone et al. (2004a) found that the Moorman White River springfish was the only fish species present at Moorman Spring in 1991 and 1992. Recent sampling by NDOW shows that this population appears to be relatively stable (Stein et al. 1999, Heinrich et al. 2003, Hobbs et al. 2005). In 2004 Hobbs et al. (2005) estimated the population at Moorman Spring to be 2,034 (1,728-2,367), which is significantly lower than the October 2002 estimate of 11,031 but similar to estimates in 1998 and 2001 (Stein et al. 1999, Heinrich et al. 2003). Williams and Wilde (1981) observed that Moorman White River springfish are not found in association with other species and subsequent surveys have supported that observation, as no other fish species have been found at Moorman Spring (Courtenay et al. 1985, Stein et al. 1999, Heinrich et al. 2003, Scoppettone et al. 2004a, Hobbs et al. 2005).

Hot Creek Spring was designated as a refugium for Moorman White River springfish in 1966. The population remained stable from the 1960s through 1983 (Courtenay et al. 1985). Intermittent invasions by largemouth bass from downstream reservoirs led to several Moorman White River springfish population crashes, including one in 1991 (Scoppettone et al. 2004a). However, continued renovation of the area has kept the system free of largemouth bass in recent years and resulted in large populations of Moorman White River springfish (Stein et al. 1999; Heinrich et al. 2002, 2003). Hobbs et al. (2005) most recently estimated the Moorman White River springfish population at the Hot Creek Refugium in 2004: they calculated an estimate of 14,860 (13,419-16,650), which was significantly lower than the estimate of 43,457 from July 2001 but similar to other past estimates (Heinrich et al. 2002).

Since Williams and Wilde (1981) described Moorman White River springfish and noted their presence at Moon River Springs, the population has appeared to be relatively stable (Courtenay et al. 1985, Scoppetonne et al. 2004a). The NDOW has not calculated a population abundance estimate for the Moorman White River springfish population at Moon River Spring since 1998, when Stein et al. (1999) estimated a population size of 9,425. However, their CPUE statistics indicate that the population has remained relatively stable since then (Heinrich et al. 2003, Hobbs et al. 2003, Hobbs et al. 2005).

Preston White River springfish was considered for listing as Federally threatened or endangered, but it is currently a Federal species of concern (Scoppetonne and Rissler 2002, NVNHP 2004). Williams and Wilde (1981) reported the species as occurring at Arnoldson Spring, Cold Spring, Indian Spring, Lund Spring, Nicholas Spring, and Preston Big Spring in the late 1970s. By the early 1990s, the populations at Cold and Lund Springs had been extirpated, presumably by habitat alterations and nonnative species introductions (Scoppetone 2004a). We set six baited minnow traps at Lund Spring and collected 210 White River speckled dace and 184 guppies. The White River speckled dace ranged in size from 43 mm to 83 mm total length. Concurrent to our minnow-trap sampling, NDOW personnel performed snorkel surveys and observed large numbers of White River speckled dace and guppies but no White River desert sucker. White River desert sucker appear to persist beneath a deeply undercut bank of Lund Spring and may have been missed during the snorkel survey (B. Nielsen 2006, pers. comm.).

In September 2006 we set six baited minnow traps in Arnoldson Spring and collected 30 Preston White River springfish, 1 White River speckled dace, and 401 guppies. The White River speckled dace was 59 mm total length, and the Preston White River springfish ranged from 29 mm to 63 mm total length. In 1999 Scoppetonne and Rissler (2002) estimated the population of Preston White River springfish to be 901 (803-999) at Arnoldson Spring. In August 2006 we set six baited minnow traps at Nicholas Spring and collected five Preston White River springfish and 270 guppies. The Preston White River springfish ranged from 35 mm to 60 mm total length. Scoppetonne and Rissler (2002) estimated that their were 162 (110-214) Preston White River springfish in Nicholas Spring in 1999.

Scoppetonne and Rissler (2002) also provided a 1999 population estimates of 2,128 (2,021-2,235) for Indian Spring and 1,668 (1,491-1,845) for Preston Big Spring. Deacon et al. (1980) provided a similar estimate for Preston Big Spring in 1980. More recent NDOW surveys have noted that Preston White River springfish are still present at Indian Springs (Hobbs et al. 2005, Ehret and Hobbs 2006).

In the early 1990s, Scoppetonne et al. (2004a) found an unidentified sculpin in Butterfield Springs. The species appeared to be restricted to the spring head. During NDOW snorkel surveys in 1999, 19 White River sculpin (*Cottus* spp.) were observed, but NDOW felt that many more sculpin occupied the spring head area of Butterfield Springs (Stein et al. 2000).

In addition to fish found in our surveys above, we collected White River speckled dace at Tin Can Springs. We set six baited minnow traps and collected 1,141 White River speckled dace ranging from 33 mm to 73 mm total length. White River desert sucker and White River speckled dace once occupied the vast majority of aquatic systems in White River Valley (Miller and Hubbs 1960, Deacon et al. 1980, Williams and Wilde 1981, Williams and Williams 1982, Allan 1985, Courtenay et al. 1985). Scoppetonne et al. (2004a) undertook the last large survey for these species in White River Valley, although some additional surveys have occurred since then in conjunction with survey or restoration activities for some of the other fish species outlined above (Stein et al. 2000, Stein et al. 2001, Hobbs et al. 2005). These studies reported relatively low White River desert sucker numbers, and Scoppetonne et al. (2004a) found that White River desert sucker was extirpated from at least four locations (Arnoldson Spring, Cold Spring, Nicholas Spring, and Preston Big Spring) where it had been found previously. White River speckled dace numbers varied from rare to abundant at aquatic systems throughout White River Valley, but the species has been extirpated from at least two locations (Cold Spring and Nicholas Spring).

Amphibians

We found few amphibians during our surveys of White River Valley. We did observe bullfrog tadpoles during our June 2004 reconnaissance trip and October 2004 survey of Hot Creek. Hitchcock (2001) surveyed at Hot Creek, Sunnyside Creek, and Ruppo's Boghole, and found a single northern leopard frog at Ruppo's Boghole. Bullfrogs and Great Basin spadefoot toads have been observed on the Kirch Wildlife Management Area (WMA) (D. Johnson 2004, pers. comm.). We observed three frogs at South Flag Spring on the Kirch WMA and one frog at Arnoldson Spring, but we were not able to get close enough to identify them. Since bullfrog and northern leopard frog have both been identified in White River Valley, it is unclear which species we observed. It is possible that nonnative bullfrog, northern leopard frog, Great Basin spadefoot toad, and Woodhouse's toad all inhabit or use portions of the aquatic systems of interest in White River Valley, even though frogs were only observed at four locations.

Springsnails and Other Invertebrates

We surveyed for springsnails at 12 locations within the aquatic systems of interest in White River Valley. With the exception of Indian Springs, Nicholas Springs, Sunnyside Creek, and Tin Can Springs, all of these locations previously contained springsnails (Sada 2005a). Several of the locations we were denied access to were previously surveyed for springsnails (Sada 2005a).

According to either our surveys or surveys listed in Sada (2005a), springsnails were present in all the aquatic systems of interest in White River Valley except Shingle Pass Spring and lower Sunnyside Creek (Table 73). We did not survey for springsnails at Shingle Pass Spring, since it was determined to be in the mountain block. We found springsnail shells at Indian Springs and Tin Can Springs, but we were unable to locate any live specimens for identification at the Smithsonian Museum. Sada (2005a) list no prior surveys for springsnails at Indian Springs.

We found no prior surveys listed for Nicholas Spring. However, we found that springsnails were common to abundant throughout the 38 m of the spring head and spring brook prior to the entire system going into a pipe. Dr. Robert Hershler at the Smithsonian Museum of Natural History identified these snails as the White River Valley springsnail. Prior to our surveys, the White River Valley springsnail was known to occur in five other springs in the White River Valley: Arnoldson Spring, Camp Spring, the Flag Springs complex, Lund Spring, and Preston Big Spring (Hershler 1998, Sada 2005a). We found White River Valley springsnails to be common at the spring head and up to 50 m downstream at Preston Big Spring. Springsnails were scarce from 50 to 200 m downstream. Sada (2005a) found that the White River springsnail was scarce at Preston Big Spring. We found that the White River Valley springsnail was abundant at Lund Spring from the head to about 40 m downstream, after which it was common to the spring's entry into a piped irrigation delivery system. Sada (2005a) also found that springsnails were common to abundant at Lund Spring.

Table 73. Springsnails present at aquatic systems of interest throughout White River Valley in Lincoln, Nye, and White Pine Counties, Nevada.

SPRING NAME	SOURCES[a]	*P. BREVILOBA*	*P. GRACILIS*	*P. KOLOBENSIS*	*P. LATA*	*P. MARCIDA*	*P. MERRIAMI*	*P. SATHOS*	*T. CLATHRATA*	UNKNOWN
Arnoldson Spring	1, 2	A[b]	A	A	A	P[c] 1, 2	A	P 1, 2	A	A
Butterfield Spring	2	A	A	A	P 2	P 2	A	A	A	A
Camp Spring	2	A	A	A	A	A	A	P 2	A	A
Emigrant Spring	2	A	P 2	A	A	P 2	A	A	A	A
Flag Springs - North	1, 2	P 1, 2	A	A	A	A	A	P 1, 2	A	A
Flag Springs - Middle	1, 2	P 1, 2	A	A	A	A	A	P 1, 2	A	A
Flag Springs - South	1, 2	P 1, 2	A	A	A	A	A	P 1, 2	A	A
Hardy Spring	2	A	A	A	A	P 2	A	A	A	A
Hot Creek Spring	1, 2	A	A	A	A	A	P 1, 2	A	P 1, 2	A
Indian Spring	1	A	A	A	A	A	A	A	A	P 1
Lund Spring	1, 2	A	A	A	A	A	A	P 1, 2	A	A
Moon River Spring	2	A	A	A	A	A	P 2	A	A	A
Moorman Spring	2	A	A	A	A	A	P 1, 2	A	P 1, 2	A
Nicholas Spring	1	A	A	A	A	A	A	P1	A	A
Preston Big Spring	1, 2	A	A	A	A	A	A	P 1, 2	A	A
Ruppo's Boghole	2	A	A	A	A	P 2	A	A	A	A
Shingle Pass Spring	1	A	A	A	A	A	A	A	A	A
Silver Spring	2	A	A	A	A	P 2	A	A	A	A
Sunnyside Creek Spring - Upper	1	P 1	A	A	A	A	A	P 1	A	A
Sunnyside Creek Spring - Lower	1	A	A	A	A	A	A	A	A	A
Tin Can Spring	1	A	A	A	A	A	A	A	A	P 1[d]
Unnamed Spring Highway 6	2	A	A	P 2	A	A	A	A	A	A

[a] Sources: 1 = BIO-WEST survey and/or reconnaissance; 2 = Sada (2005a), Hershler (1998), Hershler (1999).
[b] Absent through visual observation.
[c] Present through visual observation.
[d] P1 = Only empty unknown hydrobiid shells observed. No live specimens collected or observed.

Conversely, while Sada (2005a) found the White River Valley springsnail was common in 1992 surveys at Arnoldson Spring, the springsnail was absent from the spring head and the first 50 m downstream during our survey. The springsnail was increasingly abundant from 50-100 m downstream of the spring head. Surveys from 1992 found that the White River Valley springsnail was abundant at Camp Spring.

We found that springsnails were common to abundant near the spring heads at North Flag Spring and Middle Flag Spring but scarce to common near the spring head at South Flag Spring.

Depending on available vegetation, springsnails ranged from scarce to common throughout the spring brooks of all three of the Flag Springs (North, Middle, South) to their confluence with Sunnyside Creek. We also found a few springsnails in upper Sunnyside Creek. Sada (2005a) listed the Flag springsnail and the White River Valley springsnail as being abundant at the Flag Springs complex. Flag Springs is the type locality for both of these species (Hershler 1998). The Flag springsnail is currently only known to occur in the Flag Springs complex in White River Valley and Meloy Spring in Dry Lake Valley (Hershler 1998, Sada 2005a).

The Butterfield springsnail is endemic to Butterfield Springs, and during1992 surveys the snail was abundant in this system (Hershler 1998, Sada 2005a). The Hardy springsnail is also found in Butterfield Springs. Similarly, the Emigrant springsnail is endemic to Emigrant Spring, which also has a population of the Hardy springsnail. Sada (2005a) listed both of these species as common in Emigrant Spring. The Hardy springsnail is only found in four other systems, three of which are in White River Valley. Sada (2005a) lists 1992 surveys showing that the Hardy springsnail was common at Arnoldson Spring, Hardy Spring, and Silver Spring.

Springsnails were scarce throughout most of our survey site at Hot Creek but common in a few areas. During 1992 surveys listed in Sada (2005a), the Pahranagat pebblesnail and grated tryonia were common at Hot Creek. These species were also common at Moorman Spring according to 1992 surveys (Sada 2005a, Hershler 1994, Hershler 1998, Hershler 1999). The Pahranagat pebblesnail is only found in two other systems, one of which is in White River Valley. Sada (2005a) lists 1992 survey results showing that the Pahranagat pebblesnail was common at Moon River Spring, and the Toquerville springsnail was found at an Unnamed Spring near Highway 6.

We did not collect an invertebrate sample at Shingle Pass Spring because it was determined to be in the mountain block. From the remaining sites, EcoAnalysts identified 119 taxa of aquatic invertebrates (Appendix D, Appendix E).   Our samples from Sunnyside Creek contained the highest number of different taxa, while our samples from Arnoldson Spring contained the lowest number of different taxa (Table 74).

EcoAnalysts found springsnails (Hydrobiidae, *Pyrgulopsis,* and/or *Tyronia*) in all of our samples except those from Indian Spring, Sunnyside Creek Spring Lower, and Tin Can Spring.

Table 74. Total number of invertebrate taxa; mayfly, stonefly, and caddisfly taxa (EPT taxa); taxa in the Phylum Mollusca; taxa in the Order Odonata; and taxa in the Subphylum Crustacea at Aquatic systems of interest throughout White River Valley in Lincoln County, Nye County, and White Pine County, Nevada.

SYSTEM NAME	TOTAL TAXA	EPT TAXA	MOLLUSCA TAXA	ODONATA TAXA	CRUSTACEA TAXA
Arnoldson Spring	9.00	0.00	3	0	2
Flag Springs Complex North	22.00	5.00	4	1	2
Flag Springs Complex Middle	14.00	2.00	1	2	1
Flag Springs Complex South	22.00	4.00	3	0	2
Hot Creek Spring	15.00	2.00	3	1	2
Indian Spring	24.00	0.00	2	1	2
Lund Spring	15.00	3.00	2	2	1
Nicholas Spring	15.00	1.00	2	2	1
Preston Big Spring	17.00	2.00	2	1	1
Sunnyside Creek Spring - Upper	37.00	6.00	1	2	1
Sunnyside Creek Spring - Lower	35.00	7.00	1	1	2
Tin Can Spring	20.00	1.00	2	4	2

Springsnails were also one of the three most-abundant taxa found in samples from all springs except for Indian Spring, Sunnyside Creek Spring Lower, and Tin Can Spring. Crustaceans (amphipods or seed shrimp) were one of the three most-abundant taxa at every location sampled, except for Arnoldson Spring, Indian Spring, Lund Spring, and Sunnyside Creek Spring Upper. We also found the invasive snail *Melanoides tuberculata* at Arnoldson Spring, Indian Spring, Nicholas Spring, and Preston Big Spring. Interestingly, *M. tuberculata* was one of the three most-dominant taxa only at Arnoldson Spring, which was also the system with the fewest different taxa.

Deacon et al. (1980) also found an invertebrate community dominated by springsnails and amphipods at Preston Big Spring, where they identified over 100 different taxa of zooplankton and aquatic invertebrates. They also took replicate samples with three different gear types, and they attempted to identify all organisms collected.

Other Fauna

We saw a wide variety of bird species utilizing spring systems in White River Valley including: cinnamon teal (*Anas cyanoptera*), magpie, mallard, northern harrier, red-winged blackbird, raven, sandhill crane, yellow-headed blackbird, yellow warbler (*Dendroica petechia*), house finch (*Carpodacus mexicanus*), mourning dove, northern roughed-winged swallow, barn swallow, broad-tailed hummingbird *(Selasphorus platycercus*), sage thrasher, ash-throated flycatcher (*Myiarchus cinerascens*), blue-grey gnatcatcher (*Polioptila caerulea*), brewer's sparrow (*Spizella breweri*), American crow, turkey vulture, white-crowned sparrow (*Zonotrichia leucophrys*), an unidentified hawk, and various unidentified songbirds. We also saw or saw sign of coyotes, zebra-tailed lizards, mule deer, voles, and other unidentified small mammals and lizards.

Disturbance

Hot Creek and most of the Flag Springs complex were not heavily disturbed (Table 75, Figure 21, Figure 22). Sada (2005a) listed minimal disturbance at Hot Creek and the Flag Springs complex, but we classified Middle Flag Spring as highly disturbed. Our classification of Middle Flag Spring was based upon its proximity to the main housing area of the Kirch WMA and the fact that it had at one time been moved from its historic channel. Disturbance seemed to increase as we moved downstream in the Sunnyside Creek drainage (Figure 23). Recent channelization and excavation associated with restoration activities for White River spinedace at Indian Spring made it difficult to assign a disturbance value. Sada (2005a) listed a moderate diversion disturbance at Preston Big Spring and, while we noted the diversion disturbance, we felt that the overall disturbance level at Preston Big Spring was slight. While the spring heads and a small portion of the spring brook were at most moderately impacted at Lund and Nicholas Spring, we ranked them moderately to highly for disturbed because the entire spring system entered a piped irrigation delivery system within 50-100 m at each of these sites. Similarly, Arnoldson Spring entered a piped irrigation delivery system just over 120 m downstream of the spring head.

Table 75. Disturbance level and factors at aquatic systems of interest throughout White River Valley in Lincoln County, Nye County, and White Pine County, Nevada.

SYSTEM NAME	DISTURBANCE LEVEL	DISTURBANCE FACTORS
Arnoldson Spring	Moderate	Diversion, Residence, Nonnatives, Drought
Hot Creek Spring	Slight	Recreation, Nonnatives
Flagg Springs Complex North	Slight	Livestock, Residence
Flagg Springs Complex Middle	High	Diversion, Residence, Road
Flagg Springs Complex South	Moderate	Livestock, Diversion, Residence
Lund Spring	Moderate/High	Diversion, Residence, Livestock, Nonnatives
Nicholas Spring	Moderate/High	Diversion, Residence, Nonnatives, Roads
Sunnyside Spring - Upper	Slight	Diversion
Sunnyside Spring - Lower	Moderate	Livestock, Diversion
Indian Spring[a]	Moderate[a]	Livestock, Diversion, Nonnative Vegetation
Preston Big Spring	Slight	Diversion, Nonnatives
Tin Can Spring	Moderate	Diversion, Road, Drought, Nonnative Vegetation

[a]Recent restoration made other disturbances difficult to quantify.

Figure 21. White River Valley's Hot Creek Spring (a) main spring pool (top), (b) downstream (bottom).

Figure 22. North Flag Spring head in White River Valley.

Figure 23. Sunnyside Creek, lower site, White River Valley.

Dry Lake Valley

Dry Lake Valley is in Lincoln County to the west of the towns of Pioche and Panaca, Nevada. The Burnt Springs Range borders Dry Lake Valley to the east, and the North Pahroc Range borders Dry Lake Valley to the west. The Flag springsnail has been found in Dry Lake Valley. The Flag springsnail is a significant biological resource in Dry Lake Valley, because it is endemic to Nevada and is on the State of Nevada Rare (At-Risk) Species List (NVNHP 2004).

Four aquatic systems of interest were identified in Dry Lake Valley (Figure 24, Table 76). We completed a Level 2 survey at Coyote Spring. Both Bailey and Fence Springs were visited in September 2004 and determined to be mountain block springs, so we completed a Level 1 survey at each location (Figure 25). Meloy Spring was not surveyed because we were unable to obtain access to this private property from the landowner. Meloy Spring also appears to be in the mountain block.

Physical Habitat and Water Quality Data

Physical habitat and water quality data were collected at Coyote Spring, Bailey Spring, and Fence Spring, and some physical habitat and water quality information was available from a June 1992 survey of Meloy Spring (Sada 2005a). When we visited Coyote Spring during the June/July 2004 reconnaissance trip and again in August 2006, we found a highly modified system. The springs were piped into two concrete stock tanks. The tanks are 6 m x 6 m squares adjoined in the middle. The south tank was dry when we were there. An additional steel tank was present on a knoll to the east of the concrete tanks. The vegetation around the knoll and the hose exiting the tank suggested that water can somehow emanate from this tank, too. It appeared as though a spring once originated from the hillside to the west (near the dwelling and grove of cottonwoods) and flowed through the area with the stock tanks.

Table 76. Location, survey date, survey level, and ownership of aquatic systems of interest throughout Dry Lake Valley in Lincoln County, Nevada.

SPRING NAME	NORTHING	EASTING	SURVEY DATE	BIO-WEST SURVEY LEVEL	OWNER
Bailey Spring	4227770	698974	9/18/2004	Level 1	BLM
Coyote Spring	4211323	687714	8/24/2006	Level 2	BLM
Fence Spring	4228232	700066	9/18/2004	Level 1	BLM
Meloy Spring[a]	4236040	700892	N/A	None/access	Private

Note: UTM coordinates are in the NAD 83 projection system.
[a]Data taken from Sada (2005a).

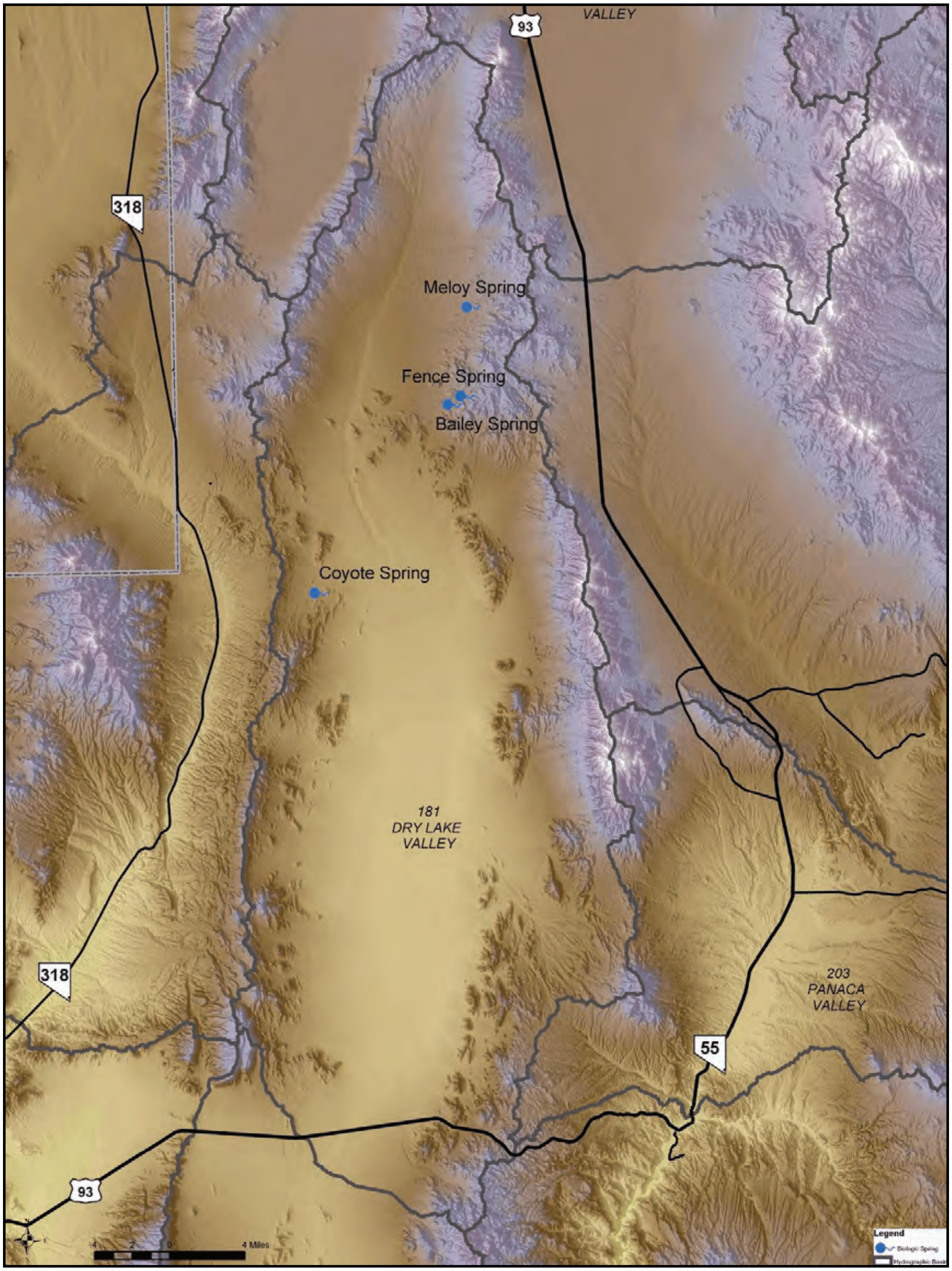

Figure 24. **Aquatic systems of interest throughout Dry Lake Valley in Lincoln County, Nevada.**

Figure 25. Top to bottom: Bailey Spring (a), and Fence Spring (b), in Dry Lake Valley.

Bailey, Fence, and Meloy Springs were all fairly small, shallow systems (Table 77). While Bailey and Meloy Springs had similar water temperatures at their sources, we found lower dissolved oxygen levels and higher conductivities at Bailey Spring (Table 78).

Table 77. Type of system, maximum depth, maximum wetted width, length of survey plots, and measured discharge found at aquatic systems of interest in Dry Lake Valley, Lincoln County, Nevada.

SYSTEM NAME	SYSTEM TYPE	MAXIMUM DEPTH (cm)	MAXIMUM WETTED WIDTH (m)	LENGTH (m)	DISCHARGE (l/s)
Bailey Spring	Rheocrene	7	9.95	48	N/A
Coyote Spring	unknown	50.5	6.1	97	N/A
Fence Spring	Rheocrene	1	3.2	37	N/A
Meloy Spring[a]	Rheocrene	2	1	N/A	N/A

Table 78. Selected water quality parameters measured at the main source of aquatic systems of interest in Dry Lake Valley, Lincoln County, Nevada.

SYSTEM NAME	LOCATION	TEMPERATURE (C)	DISSOLVED OXYGEN (mg/l)	CONDUCTIVITY (μS/cm)	pH
Bailey Spring	Source	13.4	4.3	760	7.44
Coyote Spring	Source	26.4	10.3	366	8.60
Fence Spring[a]	N/A	N/A	N/A	N/A	N/A
Meloy Spring[b]	Source	14.2	9.3	507	7.40

[a]Not enough water to obtain an accurate measurement of water quality parameters.
[b]Data taken from Sada (2005a).

Aquatic Vegetation

We identified only one species of SAV, horsehair algae, in Coyote Spring, which was abundant (100% coverage). We identified four taxa of EAV including only trace amounts of sweetclover, foxtail barley, curly dock, and an unknown species of grass. There were three tree species observed at the site, abundant Freemont cottonwood (*Populus fremontii*) (80%), skunkbrush (*Rhus trilobata*) (20%), and uncommon water jacket (*Lycium andersonii*).

Vegetation Mapping

We mapped vegetation at Bailey Spring and Fence Spring in September 2005 and Coyote Spring vegetation in August 2006. These systems are small (less than 1 acre). Nine species were identified among the three springs (Appendix C). All vegetation at Bailey Spring was classified as Adventive Plant Herbaceous Alliance (Table 79). The primary vegetation at Fence Spring was skunkbrush). A small amount of Torrey's rush (*Juncus torreyi*) was present during mapping efforts at Fence Spring. Coyote Spring was primarily Fremont Cottonwood Vegetation Association and a smaller area with the Skunkbrush Sumac Vegetation Association.

Fish

We did not survey for fish at Bailey Spring or Fence Spring, because we surveyed them using Level 1 protocols. However, we felt that no fish habitat was available at either of these sites. The only fish habitat available at Coyote Spring was in the stock tank. Water clarity was high and you could see to the bottom of the tank. No fish were observed.

Amphibians

We observed four large (> 250 mm) adult tiger salamanders (*Ambystoma tigrinum*) in the stock tank at Coyote Spring. During surveys for small mammals around Coyote Spring in May 2005, SNWA personnel also observed tiger salamanders, as well as Great Basin spadefoot toad, in the concrete stock tanks (A. Ambos 2006, pers. comm.). They also observed four or five approximately 25-mm-long adult salamanders and dozens of larvae (approximately 5-10 cm). In addition to many tadpoles in puddles near one of the stock tanks, SNWA personnel also observed four adult Great Basin spadefoot toads.

Springsnails and Other Invertebrates

We did not find springsnails at Bailey Spring, Coyote Spring, or Fence Spring. Meloy Spring has a population of the Flag springsnail. Survey results from June 1992 listed in Sada (2005a) show that the Flag springsnail was abundant in Meloy Spring. The Flag springsnail is only known to occur in one other location, Flag Springs in White River Valley. Ten other systems in Dry Lake Valley were surveyed, but no other springsnail populations were found (Sada 2005a).

At Coyote Spring we collected three different taxa of aquatic invertebrates (Appendix D and Appendix E). EcoAnalysts found that seed shrimp (Ostracoda) dominated the collection, comprising over 99% of the sample. Beetles (Coleoptera) and midges (Diptera/Chironomidae) were also identified in the collection.

Table 79. The proportion of the area mapped (less than 1 acre) comprised of each association (alliance) at aquatic systems of interest throughout Dry Lake Valley in Lincoln County, Nevada.

ASSOCIATIONS / ALLIANCES[a] IN DRY LAKE VALLEY	BAILEY SPRING (0.05 ACRE [0.02 HECTARE])	COYOTE SPRING (0.77 ACRE [0.31 HECTARE])	FENCE SPRING (0.05 ACRE [0.02 HECTARE])
Open Water/ Undesignated Alliance		1.29%	
Adventive Plant Herbaceous / Undesignated Alliance	100%	3.89%	
Juncus torreyi (Torrey's Rush) Herbaceous Vegetation / Undesignated Alliance			18%
Populus fremontii Mixed Herbaceous Woodland / *Populus fremontii* Seasonally Flooded Woodland		70.13%	
Rhus trilobata (Skunkbush Sumac) Intermittently Flooded Shrubland / *Rhus trilobata* Intermittently Flooded Shrubland		24.68%	82%

[a] Note that within each cell describing the associations and alliances, the associations are shown first and alliances second.

Other Fauna

When we visited Coyote Springs on our reconnaissance trip, we found that the north tank had dense algal growth. We also found evidence of both bird and cattle use of the tanks. No algae was present on the surface of the water during our August 2006 Level 2 survey at Coyote Springs. In addition to the tiger salamanders we observed in the tank, we also saw short-eared owls (*Asio flammeus*), American crows (*Corvus brachyrhynchos*), an unidentified warbler, and a dead raptor or owl decaying in the tank.

Disturbance

As we stated above, we found Coyote Spring to be highly disturbed by diversion and livestock (Figure 26). It appeared that the original spring head was to the west of the stock tanks and had been excavated, piped, and buried.

Figure 26. Coyote Spring in Dry Lake Valley.

Delamar Valley

Hubbs and Miller (1948) speculated that Delamar Valley may have been a tributary to the pluvial White River system, although we could find no records of fishes collected from this valley. Delamar Valley is located in Lincoln County just west of Caliente, Nevada. The valley is bounded by the Delamar Mountains to the east and the Pahroc Range to the west. Grassy Spring was the only aquatic system of interest identified in Delamar Valley (Figure 27, Table 80).

Table 80. Location, survey level, and ownership of Grassy Spring in Delamar Valley, Lincoln County, Nevada.

SPRING NAME	NORTHING	EASTING	SURVEY DATE	BIO-WEST SURVEY LEVEL	OWNER
Grassy Spring	4157322	694969	9/18/2004	Level 2	BLM

Note: UTM coordinates are in the NAD 83 projection system.

Physical Habitat and Water Quality Data

Grassy Spring consisted of a small piped spring head that emptied into a circular stock tank. The tank had overflowed into a pond approximately19 m in diameter (Table 81). When we visited Grassy Spring in September 2004, the discharge volume from the pipe was low. However, we did note that the system was larger in the past, indicating that in higher water years the spring may have greater discharge. Sada (2005a) listed considerably higher dissolved oxygen levels (7.5 mg/l) at Grassy Spring from a June 1992 survey, but the remainder of our water quality measurements were similar to those from that 1992 survey (Table 82).

Table 81. Type of system, maximum depth, maximum wetted width, length of survey plots, and measured discharge for Grassy Spring in Delamar Valley, Lincoln County, Nevada.

SYSTEM NAME	SYSTEM TYPE	MAXIMUM DEPTH (cm)	MAXIMUM WETTED WIDTH (m)	LENGTH (m)	DISCHARGE (l/s)
Grassy Spring	Unknown	64	19	52	0.02

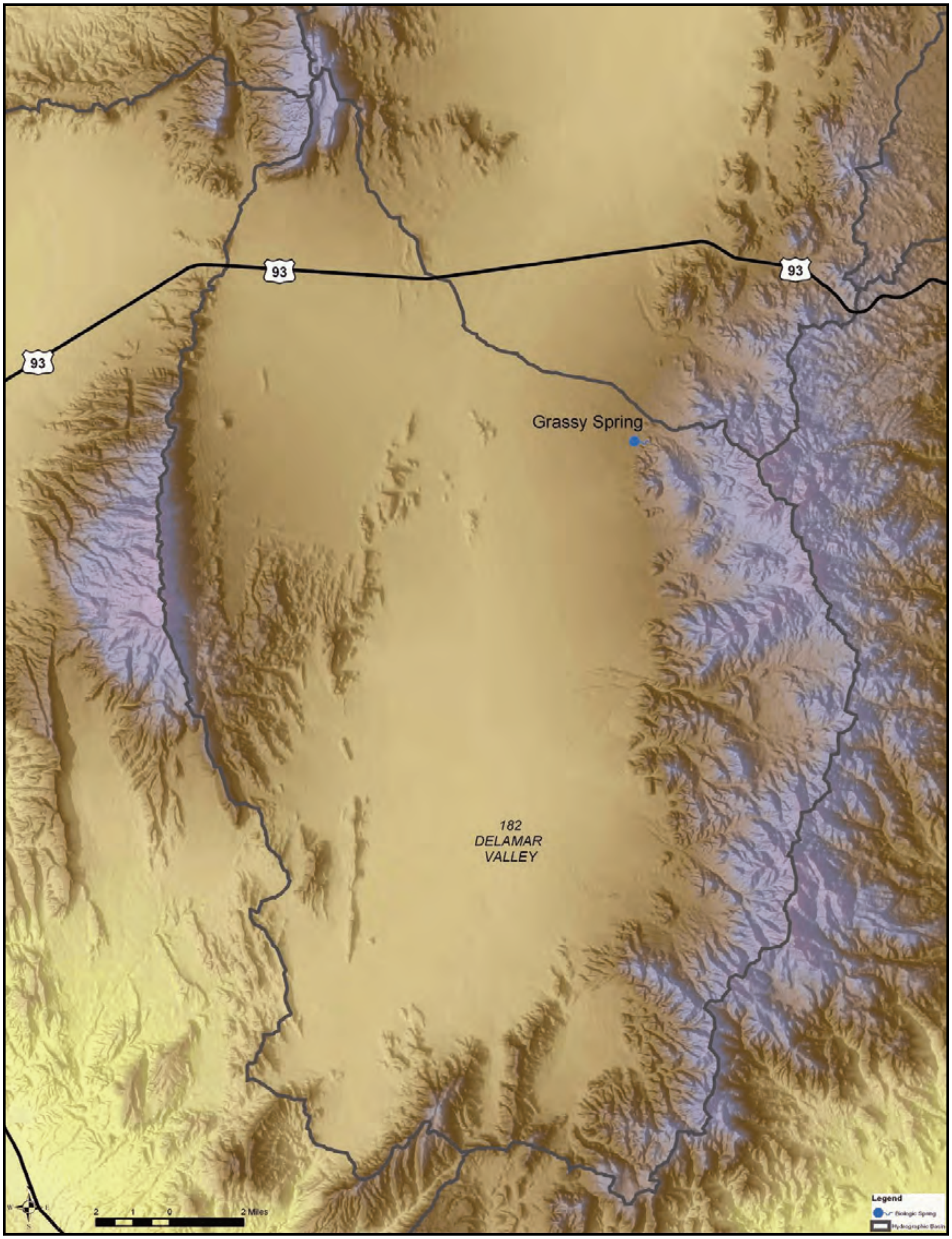

Figure 27. Map of locations of aquatic systems of interest in Delamar Valley, Lincoln County, Nevada.

Table 82. Selected water quality parameters measured at the main source and termination of our sampling site at Grassy Spring in Delamar Valley, Lincoln County, Nevada.

SYSTEM NAME	LOCATION	TEMPERATURE (C)	DISSOLVED OXYGEN (mg/l)	CONDUCTIVITY (mS/cm)	pH
Grassy Spring	Source/terminus	15.19/11.51	3.96/5.38	615/1198	7.46/8.65

Aquatic Vegetation

We only identified four species of aquatic vegetation at Grassy Spring. Muskgrass was the dominant SAV (75%), and horsehair algae (25%) was the only other SAV present. Around the terminal pond the EAV was an even mixture of rabbit-foot grass and spikerush (50% each).

Vegetation Mapping

We mapped vegetation surrounding Grassy Spring in September 2005. Most of the area at Grassy Spring was classified as open water with no vegetation (Table 83). The primary vegetation association at Grassy Spring was hardstem bulrush (*Schoenoplectus acutus*).

Table 83. The proportion of the 0.2 acre mapped comprised of each association (alliance) at Grassy Spring in Delamar Valley, Lincoln County, Nevada.

ASSOCIATIONS/ALLIANCES IN DELAMAR VALLEY	GRASSY SPRING 0.23 ACRE (0.092 HECTARE)
Open Water / Undesignated Alliance	65.6%
Schoenoplectus acutus (Hardstem Bulrsuh) Herbaceous Vegetation/ *Schoenoplectus acutus - Schoenoplectus tabernaemontani* (Softstem Bulrush) Semipermanently Flooded Herbaceous	22.6%
Non-rooted Aquatic Plant and Algae Vegetation / Undesignated Alliance	11.8%

Fishes

We did not sample for fish at Grassy Spring, because we felt adequate fish habitat was not available. In addition, we could visually observe nearly all of the aquatic habitat during our survey, and we observed no fish. Sada (2005a) did not observe fish during surveys in June 1992.

Amphibians

We did not observe any amphibians during our survey of Grassy Spring, but Sada (2005a) found unknown tadpoles in Grassy Spring during surveys in June 1992. In May 2005 SNWA personnel observed eight adult Great Basin spadefoot toad using the area in and around Grassy Spring (A. Ambos 2006, pers. comm.).

Springsnails and Other Invertebrates

No springsnails were collected or observed in surveys at Grassy Spring in Delamar Valley. Sada (2005a) found no springsnails in June 1992 surveys of Grassy Spring. In fact, EcoAnalysts only found nine taxa representing five orders of aquatic invertebrates in our sample at Grassy Spring (Appendix D, Appendix E). Over 85% of the organisms identified were seed shrimp. Sada (2005a) listed surveys of three other systems in Delamar Valley, but during those surveys no springsnail populations or other notable aquatic species were found.

Other Fauna

We observed pronghorn, coyote, and rabbit tracks around Grassy Spring.

Disturbance

Grassy Spring was highly disturbed (Figure 28). The original spring was piped into a stock tank, which overflowed into a pond. Based on our vegetation survey, it appeared as though the seepage from the tank varied as a result of large, seasonal water fluctuations. Sada (2005a) suggested, based on the invertebrate community, that the seepage was probably ephemeral. The paucity of taxa in our invertebrate samples and the predominance of vagile or drought-tolerant taxa supports these observations.

Figure 28. Top to bottom: Grassy Spring source (a), and terminus (b), in Delamar Valley.

Pahranagat Valley

South of the White River Valley, the Pahranagat Valley is also part of the pluvial White River system (Hubbs and Miller 1948). Pahranagat Valley is located completely within Lincoln County, Nevada, and is bordered to the east by the Hiko Range and to the west by the East Pahranagat Range. As in White River Valley, the long isolation of the White River system and its associated springs has produced unique and endemic species in the Pahranagat Valley. Historically, five endemic fish species inhabited the Pahranagat Valley. The sixth, and final, native fish species, White River desert sucker, is endemic to the pluvial White River drainage. Three of these species, Pahranagat roundtail chub, White River springfish, and Hiko White River springfish, are currently listed as Federally endangered, while one, the Pahranagat spinedace (*Lepidomeda altivelis*), is extinct (Miller and Hubbs 1960, USFWS 1970, Courtenay et al. 1985, USFWS 1985c, USFWS 1998). The White River desert sucker was also considered to be extirpated from Pahranagat Valley by the 1950s (Courtenay et al. 1985). The Pahranagat speckled dace (*Rhinichthys osculus velifer*) was a candidate for listing and is currently a species of special concern (NVNHP 2004). All six native fish species that historically occurred in the Pahranagat Valley are on the State of Nevada's Rare (At-Risk) Species List and should be considered significant biological resources in Pahranagat Valley (NVNHP 2004).

In addition to the unique and endemic fish species in Pahranagat Valley, there are also several unique invertebrate species and subspecies. Three species of springsnail have been identified as occurring in the Pahranagat Valley, and all are on the State of Nevada's Rare (At-Risk) Species List (NVNHP 2004). The type location for the Pahranagat pebblesnail is Ash Spring in the Pahranagat Valley, and the Hubbs springsnail (*Pyrgulopsis hubbsi*) is endemic to the Pahranagat Valley. The Pahranagat pebblesnail was once a candidate for Federal listing and is now a Federal species of concern (NVNHP 2004). The third species the grated tryonia was also a candidate for Federal listing and is now a Federal species of concern. All three of these species are significant biological resources in the Pahranagat Valley.

Two other rare invertebrates are found in Pahranagat Valley. Schmude (1999) described a riffle beetle that appears to be endemic to Ash Spring (*Stenelmis lariversi*). Polhemus and Polhemus (1995) listed eight species of true bug (Hemiptera) found in several springs in the Pahranagat Valley, one of which is the Pahranagat naucorid bug (*Pelocoris shoshone shoshone*). The Pahranagat naucorid bug was originally thought to be endemic to the pluvial White River system, but subsequently a wider distribution was found (LaRivers 1949, LaRivers 1956, Polhemus and Polhemus 1995). Both the Pahranagat naucorid bug and the Ash Springs riffle beetle are on the State of Nevada's Rare (At-Risk) Species List and should be considered significant biological resources in Pahranagat Valley (NVNHP 2004). Eleven aquatic systems of interest were identified in the Pahranagat Valley (Figure 29, Table 84). We performed Level 2

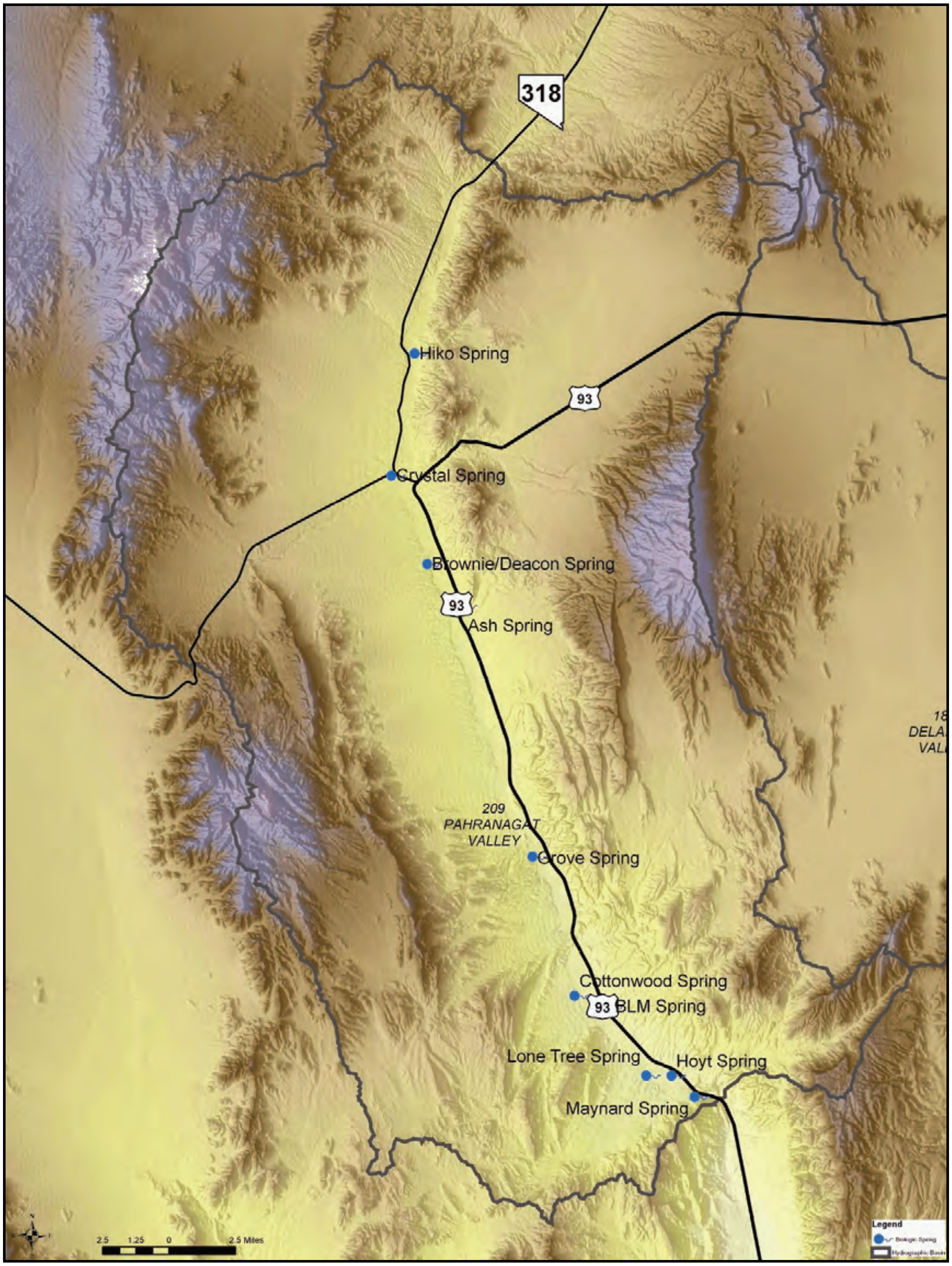

Figure 29. Map of locations of aquatic systems of interest in Pahranagat Valley, Lincoln County, Nevada.

Table 84. Location, survey date, survey level, and ownership of aquatic systems of interest throughout Pahranagat Valley, Lincoln County, Nevada.

SYSTEM NAME	NORTHING	EASTING	DATE SURVEYED	BIO-WEST SURVEY LEVEL	OWNER
Ash Spring	4147857	659836	3/3/2005	Level 2	BLM/Private
BLM Spring	4123107	668760	10/6/2004	Level 2	BLM/Private
Brownie-Deacon Springs	4149891	658155	6/13/2005	Level 2	Private
Cottonwood Spring	4123638	667261	10/5/2004	Level 2	USFWS
Crystal Spring	4155375	656095	6/13/2005	Level 2	Private
Grove Spring	4132273	664569	N/A	None/access	Private
Hiko Spring	4162551	657639	9/12/2006	Level 2	Private
Hoyt Spring	4119155	673202	10/5/2004	Level 1[a]	USFWS
Lone Tree Spring	4119014	671456	10/5/2004	Level 2	USFWS
Maynard Spring	4117909	674444	10/6/2004	Level 2	USFWS
Pahranagat Creek/Ditch	N/A	N/A	N/A	None/access	Private

Note: UTM coordinates are in the NAD 83 projection system.
[a] This site was dry during our visit.

surveys at eight of these systems. We were unable to gain access for surveys at Grove Spring and the Pahranagat River. In the remainder of this report, the Pahranagat River will be called the "Pahranagat Creek/Ditch," referring to the section of the system where Pahranagat roundtail chub were last known to occur (USFWS 1998). Hoyt Spring on the Pahranagat NWR was dry during our October 2004 site visit, so we performed a Level 1 survey at this system.

Physical Habitat and Water Quality Data

Several large spring systems exist in the Pahranagat Valley. The three largest springs in the valley are Ash Spring, Crystal Spring, and Hiko Spring (Table 85, USFWS 1998). All three of these springs have one or more spring heads that discharge into areas that have been diverted for irrigation or recreation. Historically, all three of these systems flowed into the old Pahranagat River channel (USFWS 1998). The other springs in the valley varied in size, with Cottonwood Spring and Brownie-Deacon Springs being two of the larger complexes.

Table 85. Type of system, maximum depth, maximum wetted width, length of survey plots, and measured discharge at aquatic systems of interest throughout Pahranagat Valley in Lincoln County, Nevada.

SYSTEM NAME	SYSTEM TYPE	MAXIMUM DEPTH (cm)	MAXIMUM WETTED WIDTH (m)	LENGTH (m)	DISCHARGE (l/s)
Ash Spring	Limnocrene	150	48	63[a]	161.73
BLM Spring	Rheocrene	25	19	25	N/A
Brownie-Deacon Springs	Rheocrene	46	21	28	N/A
Cottonwood Spring	Rheocrene	31	59	218[a]	111.05[b]
Crystal Spring	Limnocrene	152	29	191[a]	346.51[c]
Hiko Spring	Limnocrene	273	51	231[a]	N/A
Hoyt Spring	Unknown	Dry	Dry	Dry	Dry
Lone Tree Spring	Rheocrene	30	18	40	N/A
Maynard Spring	Rheocrene	91.5	31	113[a]	N/A

[a]Continued further as a spring brook or marsh land, or onto private property.
[b]Discharge was taken in the channel at the base of Cottonwood Spring, which represents the flow of more than just this system.
[c]Average of two measurements taken in this system.

Ash Spring is supposed to be the largest spring in the valley, with a reported discharge of 440 l/s to 598 l/s (USFWS 1998). We calculated a discharge much lower than that, but as our survey was restricted to the public land portion of Ash Spring, our discharge measurement only represented the input of the four spring heads upstream of the rock diversion dam. Our highest calculated discharge came from Crystal Spring, and it was within the range (169 l/s to 476 l/s) of previously reported values (USFWS 1998). We were not able to take a discharge measurement at Hiko Spring, but a wide range (34 l/s to 255 l/s) of discharge values were historically reported for this spring. The most recent value reported was 151 l/s (USFWS 1998).

Ash Spring was the warmest aquatic system in the valley (Table 86, Appendix B), which corresponds to the work of many other researchers (Williams and Wilde 1981, Courtenay et al. 1985, Tuttle et al. 1990, USFWS 1998). The BLM Spring had the lowest temperature of the systems we surveyed in Pahranagat Valley. Our measured temperatures fell within the range of historical measurements at Ash Spring, Crystal Spring, Hiko Spring, and Brownie-Deacon Springs (Deacon et al. 1980, Courtenay et al. 1985, Tuttle et al. 1990, Hobbs et al. 2005, Sada 2005a).

Table 86. Selected water quality parameters measured at the main source and termination of our sampling sites at aquatic systems of interest throughout Pahranagat Valley in Lincoln County, Nevada.

SYSTEM NAME	LOCATION	TEMPERATURE (C)	DISSOLVED OXYGEN (mg/l)	CONDUCTIVITY (μS/cm)	pH
Ash Spring	Source/terminus	33.85/33.88	1.71/2.04	468/463	7.26/7.21
BLM Spring	Source	13.92	2.06	1021	7.02
Brownie-Deacon Springs	Source/terminus	16.15/15.82	3.34/3.27	733/622	8.13/8.13
Cottonwood Spring	Source/terminus	20.26/15.19	2.72/5.86	801/1050	7.04/7.62
Crystal Spring	Source/terminus	27.37/27.07	1.02/3.93	398/397	8.08/8.26
Hiko Spring	Source/terminus	26.02/18.67	3.60/6.85	513/841	6.79/7.47
Lone Tree Spring	Source/terminus	18.23/14.94	2.98/6.23	1,089/1,115	7.32/7.53
Maynard Spring	Source/terminus	17.88	1.43	909	7.16

Dissolved oxygen measurements were fairly low near the sources of all the aquatic systems of interest in Pahranagat Valley, but they were particularly low (less than 2 mg/l) at the sources of Ash, Crystal, and Maynard Springs. Our dissolved oxygen readings at Ash Spring, Crystal Spring, Hiko Spring, and Cottonwood Spring were substantially lower than those reported by Sada (2005a). Deacon et al. (1980) also reported a substantially higher level of dissolved oxygen at Ash Spring, but our dissolved oxygen levels were within the range reported by Tuttle et al. (1990) for both Ash and Crystal Springs. Additionally, the dissolved oxygen levels we obtained at Brownie-Deacon Springs are within the range reported by Hobbs et al. (2005). We found conductivity at Brownie-Deacon Springs to be substantially higher than Hobbs et al. (2005).

Aquatic Vegetation

We only identified six taxa of SAV from aquatic systems of interest in the Pahranagat Valley (Table 87). We found our watercress group, which was present at four of the systems surveyed, to be the most common SAV. Ash Spring and Crystal Spring had the most diverse SAV assemblages with three species each, and the BLM Spring had no SAV. Surveys from 1992 at Ash and Crystal Springs (Sada 2005a) do not list watercress as present. The USFWS (1998) reported watercress at Crystal Spring, and Deacon et al. (1980) listed watercress, marsh pennywort (*Hydrocotyle verticellata*), pondweed, and spiny naiad (*Najas marina*) in Pahranagat Creek/Ditch just downstream from Ash Spring.

Table 87. Percent cover of submerged aquatic vegetation (SAV) found at aquatic systems of interest throughout Pahranagat Valley in Lincoln County, Nevada.

COMMON NAME	SCIENTIFIC NAME	SYSTEMS								
		ASH	BLM	BROWNIE -DEACON	COTTONWOOD	CRYSTAL	HIKO	HOYT	LONE TREE	MAYNARD
Algae	*Algae* sp.	-	-	-	-	-	5	-	-	-
Creeping Primrose-Willow	*Ludwigia repens*	5	-	-	-	5	-	Dry	-	-
Duckweed	*Spirodela* sp.	15	-	-	-	-	-	Dry	40	100
Greater Duckweed	*Spirodela polyrhiza*	-	-	-	5	-	-	Dry	-	-
Horsehair Algae	*Chlorophyceae* sp.	25	-	-	-	10	20	Dry	-	-
Watercress[a]	*Nasturtium officinale*	-	-	95	10	10	-	Dry	40	-

[a] Watercress group.

The BLM Spring had no SAV because it was completely overgrown with emergent vegetation (Table 88). We identified 27 taxa of EAV at the aquatic systems of interest in Pahranagat Valley. Yerba mansa (*Anemopsis californica*) was the most common EAV species. We found Yerba mansa at all sites, except Brownie-Deacon Springs and Hoyt Spring. Olney's three square bulrush and saltgrass were also common. Hiko Spring had the most diverse assemblage with 17 species. Cottonwood Spring and Crystal Spring each had 12 species. Deacon et al. (1980) listed Yerba mansa, saltgrass, spikerush, and common rush as the dominant EAV in Pahranagat Creek/Ditch.

We identified 10 taxa of trees and shrubs in the riparian zones of aquatic systems of interest in Pahranagat Valley (Table 89). Crystal Spring had the most diverse assemblage with five taxa. The nonnative tree, salt cedar, was found at six of the nine systems surveyed, and the nonnative tree, Russian olive, was found at Maynard Spring. Hoyt Spring, which was dry at our visit, was surrounded by a dense canopy of salt cedar (Figure 30). Deacon et al. (1980), Tuttle et al. (1990), and the USFWS (1998) list ash, cottonwood, California grape (*Vitis californica*), and willow in the riparian zone of Pahranagat Creek/Ditch.

Table 88. Percent cover of emergent aquatic vegetation (EAV) found at aquatic systems of interest throughout Pahranagat Valley in Lincoln County, Nevada.

COMMON NAME	SCIENTIFIC NAME	SYSTEMS								
		ASH	BLM	BROWNIE-DEACON	COTTONWOOD	CRYSTAL	HIKO	HOYT	LONE TREE	MAYNARD
Baltic Rush	*Juncus arcticus*	-	-	-	15	10	<2	Dry	10	-
Broadleaf Cattail	*Typha latifolia*	-	40	-	< 2	10	10	Dry	-	20
Bulrush	*Juncus nodosus*	-	-	-	-	2		Dry	-	-
Burmudagrass	*Cynodon dactylon*	-	-	-	-	-	10	-	-	-
Canada Goldenrod	*Solidago canadensis*	-	-	-	2	-	-	Dry	-	< 2
Cockleburr	*Xanthium strumarium*	-	-	-	< 2	-	-	Dry	< 2	-
Common Spikerush	*Eleocharis palustris*	-	-	-	-	-	40	-	-	-
Creeping Primrose Willow	*Ludwigia repens*	-	-	-	-	-	2	-	-	-
Foxtail Barley	*Hordeum jubatum*	-	-	-	-	5	-	Dry	-	-
Goldenrod	*Solidago* sp.	-	-	-	-	-	-	Dry	5	-
Hardstem Bulrush	*Scirpus acutus*	-	-	-	2	-	5	Dry	-	5
Indian Hemp	*Apocynum cannabinum*	-	-	-	-	10	-	Dry	-	-
Nebraska Sedge	*Carex nebrascensis*	-	-	-	-	-	5	-	-	-
Meadow Sedge	*Carex praticola*	-	-	-	-	2	-	Dry	-	-
Olney's Three Square Bulrush	*Schoenoplectus americanus*	5	-	5	30	-	20	Dry	30	30
Rabbit-foot Grass	*Polypogon monspeliensis*	-	-	-	< 2	2	15	Dry	< 2	-
Redtop	*Agrostis gigantea*	-	-	-	-	-	5	-	-	-
Saltgrass	*Distichlis spicata*	2	25	-	2	20		Dry	< 2	-
Scratchgrass	*Mulenbergia asperifolia*	-	-	-	-	-	15	-	-	-
Sedge	*Carex* sp.	-	-	-	-	-	15	-	-	-
Seaside Heliotrope	*Heliotropium currassavicum*	-	-	-	< 2	-	-	Dry	< 2	< 2
Spikerush	*Eleocharis* sp.	40	15	-	2	10	2	Dry	-	-

Table 88. Continued.

COMMON NAME	SCIENTIFIC NAME	SYSTEMS								
		ASH	BLM	BROWNIE-DEACON	COTTONWOOD	CRYSTAL	HIKO	HOYT	LONE TREE	MAYNARD
Water Parsnip	*Berula erecta*	-	-	-	-	-	5	-	-	-
Willow-herb	*Epilobium* sp.	-	-	-	2	5	-	Dry	5	-
Yellow Sweet Clover	*Melilotus officinalis*	-	-	-	-	5	<2	Dry	-	-
Unknown Grass	*Poaceae sp.*	-	-	-	-	-	20	-	-	-
Yerba Mansa	*Anemopsis californica*	50	20	-	15	20	10	Dry	45	45

Table 89. Trees found at aquatic systems of interest throughout Pahranagat Valley in Lincoln County, Nevada.

COMMON NAME	SCIENTIFIC NAME	SYSTEMS								
		ASH	BLM	BROWNIE-DEACON	COTTONWOOD	CRYSTAL	HIKO	HOYT	LONE TREE	MAYNARD
Cottonwood	*Populus* sp.	P[a]	P	P	A[b]	A	A	A	A	P
Freemont Cottonwood	*Populus fremontii*	A	A	A	P	P	A	A	P	A
Grapevine	*Vitis* sp.	A	A	A	A	P	A	A	A	A
Green Ash	*Fraxinus pennsylvanica*	P	A	P	A	A	A	A	A	A
Rabbit Brush	*Chrysothamnus* sp.	A	A	A	A	P	A	A	A	A
Red Willow	*Salix laevigata*	A	A	A	A	A	P	A	A	A
Russian Olive	*Elaeagnus angustifolia*	A	A	A	A	A	A	A	A	P
Salt Cedar	*Tamarix* spp.	A	P	A	P	P	A	P	P	P
Weeping Willow	*Salix babylonica*	A	A	A	A	A	P	A	A	A
Willow	*Salix* sp.	A	A	A	A	P	A	A	A	A

[a] Present through visual observation.
[b] Absent through visual observation.

Vegetation Mapping

We mapped vegetation at Ash, BLM, Brownie Deacon, Cottonwood, Crystal, Lone Tree, and Maynard Springs in September and October 2005. We mapped Hiko Spring in September 2006 (Table 90). While data were collected for BLM Spring, no high-resolution aerial photography

Figure 30. Dense salt cedar at Hoyt Spring in Pahranagat Valley.

Table 90. The proportion of the 32.1 acres mapped comprised of each association (alliance) at aquatic systems of interest throughout Pahranagat Valley in Lincoln County, Nevada.

ASSOCIATIONS / ALLIANCES[a] IN PAHRANAGAT VALLEY[b]	SYSTEMS							
	ASH	BLM	BROWNIE DEACON	COTTON-WOOD	CRYSTAL	HIKO	LONE TREE	MAYNARD
Adventive Plant Herbaceous							2.31%	5.29%
Undesignated Alliance								
Anemopsis californica (Yerba Mansa) Herbaceous	23.79%	21.37%		19.94%	0.73%	1.19%	15.94%	31.16%
Undesignated Alliance								
Carex nebrascensis Herbaceous Vegetation						3.55%		
Carex nebrascensis Seasonally Flooded Herbaceous								
Cynodon dactylon (Bermuda Grass) Herbaceous Vegetation						1.79%		
Cynodon dactylon Herbaceous								
Distichlis spicata (Inland saltgrass) Herbaceous		42.24%						
Distichlis spicata Intermittently Flooded Herbaceous								
Eleocharis palustris (Common spikerush) Herbaceous Vegetation						77.83%		
Eleocharis palustris Seasonally Flooded Herbaceous								
Eleocharis quinqueflora (Fewflower Spikerush) Herbaceous					6.69%			
Eleocharis quinqueflora, rostellata (Fewflower, Beaked Spikerush) Saturated Herbaceous								
Leymus triticoides (Beardless Wildrye) - *Poa secunda* (Sandberg Bluegrass) Herbaceous				16.91%				
Leymus triticoides Temporarily Flooded Herbaceous								
Mixed Wetland Graminoid				41.28%				
Undesignated Alliance								
Mixed Wetland Forb Herbaceous							73.42%	4.15%
Undesignated Alliance								
Muhlenbergia asperifolia (Scratchgrass) Herbaceous				1.48%				
Muhlenbergia asperifolia Intermittently Flooded Herbaceous								

Table 90. Continued.

ASSOCIATIONS / ALLIANCES[a] IN PAHRANAGAT VALLEY[b]	SYSTEMS							
	ASH	BLM	BROWNIE DEACON	COTTON-WOOD	CRYSTAL	HIKO	LONE TREE	MAYNARD
Non-rooted Aquatic Plant and Algae Undesignated Alliance					11.38%			
Open Water Undesignated Alliance	15.48%				9.09%	4.79%	0.13%	
Populus fremontii (Fremont Cottonwood) Mixed Herbaceous Woodland *Populus fremontii* Seasonally Flooded Woodland						0.83%	2.07%	0.69%
Populus spp. (Cottonwood Species) Semi-natural Woodland Undesignated Alliance					64.66%	0.63%		
Populus fremontii (Fremont Cottonwood) - *Fraxinus velutina* (Velvet Ash) Woodland *Populus fremontii* Seasonally Flooded Woodland	60.73%		100%					
Salix laevigata (Red willow) - *Fraxinus velutina* (Velvet ash) Woodland *Salix laevigata* Temporarily Flooded Woodland						0.85%		
Schoenoplectus americanus (Olney's Three Square Bulrush) Western Herbaceous *Schoenoplectus americanus* Semipermanently Flooded Herbaceous				17.26%		0.61%	2.39%	10.67%
Schoenoplectus acutus (Hardstem Bulrsuh) Herbaceous *Schoenoplectus acutus* - *Schoenoplectus tabernaemontani* (Hardstem Bulrush - Softstem Bulrush) Semipermanently Flooded Herbaceous						0.10%		14.17%
Schoenoplectus americanus (Olney's Three Square Bulrush) - *Eleocharis palustris* (Common Spikerush) Herbaceous Vegetation *Schoenoplectus americanus* Semipermanently Flooded Herbaceous						5.08%		

Table 90. Continued.

ASSOCIATIONS / ALLIANCES[a] IN PAHRANAGAT VALLEY[b]	SYSTEMS							
	ASH	BLM	BROWNIE DEACON	COTTON-WOOD	CRYSTAL	HIKO	LONE TREE	MAYNARD
Solidago missouriensis (Missouri Goldenrod) Herbaceous Undesignated Alliance				0.41%			3.72%	
Tamarix spp. (Salt Cedar Species) Shrubland Semi-natural Temporarily Flooded Shrubland								25.94%
Typha latifolia (Broadleaf Cattail) Western Herbaceous *Typha angustifolia*, *latifolia* (Narrowleaf, Broadleaf Cattail) - *Schoenoplectus* spp.(Three Square Bulrush) Semipermanently Flooded Herbaceous		36.39%		2.72%	7.45%	2.77%		7.93%

[a] Note that within each cell describing the associations and alliances, the associations are shown above and alliances below.
[b] Ash = 0.43 acre (0.17 hectare), Brownie Deacon = 0.61 acre (0.25 hectare), Cottonwood = 13.21 acres (5.34 hectares), Crystal = 3.6 acres (1.46 hectares), Hiko Spring = 4.81 acres (1.94 hectares), Lone Tree = 6.21 acres (2.51 hectares), Maynard = 2.99 acres (1.21 hectares).

trips were flown over BLM Spring at the time of our investigation. However, photography was later acquired, and the polygons that had been sketched in the field were digitized onto the aerial mapping. Thirty-two species were noted throughout the 32.1 acres of springs sampled in the valley during the mapping effort (Appendix C). Valley wide, the Yerba Mansa (*Anemopsis Californica*) Herbaceous Vegetation Association was the most common; it was found at seven of eight systems mapped. Yerba mansa was also common throughout the Pahranagat Valley during initial vegetation surveys. The Broadleaf Cattail Association was also common in Pahranagat Valley; it was found at five of eight systems. Twenty-three different vegetation associations, including open water, were identified during the mapping effort. The number of Vegetation associations found at individual springs ranged from 1 (Brownie-Deacon) to 13 (Hiko). However, at Hiko Spring 5 of the 13 associations cover less than 1% of 4.8 acres mapped. Spikerush is dominant at Hiko Spring, covering nearly 88% of the area.

We noted watercress during our initial surveys at several of the aquatic systems of interest, as did Deacon et al. (1980) and Sada 2005a; however, the only watercress-type plant dominant during mapping efforts was water speedwell (*Veronica anagallis-aquatica*). Similarly, while salt cedar was noted at several systems during the initial survey, it was dominant only at Maynard Spring during the mapping effort. Additionally, Russian olive was not dominant at any systems during the mapping effort, but this species was noted at Maynard Spring during the initial survey.

Fishes

As with the White River Valley, the Pahranagat Valley is part of the relic White River flow system and home to several rare, endemic fish species. Historically, the Pahranagat Valley was home to six native fish species, five of which were endemic. The endemic Pahranagat spinedace and White River desert sucker were both extirpated from the Pahranagat Valley by the 1950s (Miller and Hubbs 1960, Courtenay et al. 1985).

Currently, at least three endemic species inhabit the Pahranagat Valley. The current status of the Pahranagat roundtail chub is unknown (Table 91). Pahranagat roundtail chub were historically reported at Crystal, Hiko, and Ash Springs, as well as the Pahranagat Creek/Ditch (USFWS 1998). Tuttle et al. (1990) completed a 3-year study of Pahranagat roundtail chub life history between 1986 and 1989 and discovered that the Pahranagat roundtail chub was found in about 12 km of stream, including Ash Springs and its outflow, as well as portions of the Pahranagat Creek/Ditch.   This is the only section of the Pahranagat Creek/Ditch that has sustained, year-round flows. They found the adult population to vary seasonally between 150-260 adults throughout the course of their study.

Snorkel counts performed by the NDOW in the late 1990s and early 2000s showed a decline in the number of Pahranagat roundtail chub (Stein et al. 1999, 2000, 2001). Surveys for the species were conducted in November 2001 (Heinrich et al. 2002, 2003), and they showed a severe decline in the number of Pahranagat roundtail chub. Only 17 Pahranagat roundtail chub were observed during the November 2001 survey. From 2002-2005 no surveys for the species were completed by the NDOW, or any other group, because of private landowner disputes over access to the property. However, in 2006 the Natural Resources Conservation Service and USFWS facilitated access for surveys by NDOW. Unfortunately, they were unable to facilitate access for our survey efforts. During a recent (April 2006) survey, NDOW identified that Pahranagat roundtail chub were still present in the system and sizes of visually observed Pahranagat roundtail chub ranged from approximately 100 mm to greater than 150 mm total length (Hobbs 2006b). Hobbs (2006b) also reported observing mollies and cichlids in the system.

The NDOW surveys from 1998-2001 also showed that White River desert sucker (*Catostomus clarki* spp.) and Pahranagat speckled dace were extirpated from this reach of river, but the nonnative common carp is relatively abundant (Stein et al. 1999, 2000, 2001). In 2004 the NDOW established a refugia population of Pahranagat roundtail chub on the Key-Pittman WMA near Hiko, Nevada. They stocked over 1,000 Pahranagat roundtail chub from Dexter National Fish Hatchery and Technology Center into a pond on the WMA.

Table 91. Fish sightings at aquatic systems of interest in Pahranagat Valley, Lincoln County, Nevada.

SYSTEM NAME	SOURCES[a]	PAHARANAGAT ROUNDTAIL CHUB	WHITE RIVER SPRINGFISH	HIKO WHITE RIVER SPRINGFISH	WHITE RIVER SPECKLED DACE	LARGE-MOUTH BASS	GREEN SUNFISH	WESTERN MOSQUITO-FISH	SHORTFIN MOLLY	CONVICT CICHLID	COMMON CARP
Ash Spring	1, 2	A[b]	P[c] 2	A	A	A	A	P 1	P 1	P 1	A
BLM Spring	1, 2	A	A	A	A	A	A	A	A	A	A
Brownie-Deacon Springs	1, 2	A	A	A	P 2	A	A	P 2	A	A	A
Cottonwood Spring	1, 2	A	A	A	P 1	P 1	P 1	P 1	A	A	A
Crystal Spring	1, 2	A	A	P 2	A	A	A	P 2	P 2	P 2	A
Hiko Spring	1, 2	A	A	P 1, 2	A	A	A	P 1, 2	P 1, 2	P 1, 2	A
Hoyt Spring	1, 2	A	A	A	A	A	A	A	A	A	A
Lone Tree Spring	1, 2	A	A	A	A	A	A	A	A	A	A
Maynard Spring	1, 2	A	A	A	A	A	A	A	A	A	A
Paharanagat Creek/Ditch	2	P 2	A	A	A	A	A	A	A	A	P 2

[a]Sources: 1 = BIO-WEST survey and/or reconnaissance; 2 = NDOW (Stein et al. 2001, Heinrich et al. 2002, Hobbs et al. 2004, Hobbs et al. 2005).
[b]Absent through visual observation.
[c]Present through visual observation.

The NDOW discontinued the nonnative removal program at Ash Springs because of problems using minnow traps in that complex habitat coupled with difficulties gaining access to the private lands on which the majority of the system exists. As of 2003 shortfin mollies (*Poecilia mexicana*) and convict cichlids (*Cryptoheros nigrofaciatus*) appeared to be the dominant fish species in this system.

Williams and Wilde (1981) described the Federally endangered Hiko White River springfish as occurring in both Crystal Spring and Hiko Spring. Subsequently, a refugia population of Hiko White River springfish was established at Blue Link Spring in Mineral County, Nevada (USFWS 1998). Williams and Wilde (1981) noted that Hiko White River springfish, Pahranagat roundtail chub, and White River speckled dace had been extirpated from Hiko Spring by 1967. The extirpation appeared to be the result of negative interactions with nonnative fishes, most notably largemouth bass but also shortfin molly and western mosquitofish (Minckley and Deacon 1968, Courtenay et al. 1985, USFWS 1998). In 1983 Courtenay et al. (1985) surveyed Hiko Spring with baited and unbaited minnow traps, as well as by snorkeling, and only found shortfin molly and western mosquitofish. They noted that convict cichlids were present by 1984. Hiko White River springfish were repatriated in Hiko Spring twice in 1984 (USFWS 1998, Stein et al. 2001). The repatriated individuals reproduced and restored a population of Hiko White River springfish to Hiko Spring.

Since that time, the fish community at Hiko Spring has remained comprised of these same species. Population estimates for White River springfish fluctuated in the 1980s and 1990s (Tuttle et al. 1990, USFWS 1998, Stein et al. 1999). Hobbs et al. (2005) estimated the Hiko White River springfish population to be 853 (517-1,409), which was not a significant reduction from the 2003 estimate of 1,190 (Hobbs et al. 2004). However, both of these estimates are significantly lower than the 2000 estimate of 6,244 and lower than most of the estimates made throughout the 1980s and 1990s (USFWS 1998, Heinrich et al. 2002). As with Ash Spring, shortfin molly dominates the fish community at Hiko Spring. Given the rather intensive sampling at Hiko Spring by other groups, we did not sample for fish during our September 2006 Level 2 Survey. We did however, observe shortfin mollies, western mosquitofish, convict cichlids, and Hiko White River springfish.

Historical sampling indicated that Pahranagat roundtail chub, Pahranagat speckled dace, and White River desert sucker were found in association with Hiko White River springfish at Crystal Spring, but only Pahranagat speckled dace and Hiko White River springfish remained common throughout the 1960s (Williams and Wilde 1981, Courtenay et al. 1985). In 1984 Courtenay et al. (1985) found only convict cichlids and shortfin mollies in Crystal Spring. Tuttle et al. (1990) found Hiko White River springfish in relatively low numbers at Crystal Spring in the mid 1980s, but Pahranagat speckled dace appeared to be extirpated. Subsequent sampling efforts have shown that Hiko White River springfish numbers remained low throughout the 1990s, and Pahranagat speckled dace appear to be extirpated (USFWS 1998; Heinrich et al. 2002, 2003; Stein et al 1999, 2000, 2001).

The NDOW instituted an intensive nonnative fish, frog, and crayfish removal program at Crystal Spring in 2002 (Hobbs et al. 2003). While large numbers of shortfin molly, convict cichlid, bullfrog tadpoles, and red swamp crayfish (*Procambarus clarki*) were removed from Crystal Spring, the final 2004 Hiko White River springfish population estimate of 708 (505-1,030) was not significantly different from the initial January 2003 population estimate of 895. However, they did see a decrease in convict cichlid CPUE. Shortfin molly dominated the fish community at Crystal Spring.

While Pahranagat speckled dace have been extirpated from many of the larger springs in Pahranagat Valley, populations still exist at Cottonwood Spring and Brownie-Deacon Springs. We collected three Pahranagat speckled dace at Cottonwood Spring in qualitative surveys using a backpack electrofishing unit and minnow traps. The Pahranagat speckled dace collected at Cottonwood Spring were 43 mm, 67 mm, and 75 mm in total length. We also collected five largemouth bass, four green sunfish (*Lepomis cyanellus*), and fifteen western mosquitofish. Largemouth bass ranged from 57-85 mm total length, and green sunfish ranged from 52-57 mm. Western mosquitofish were not measured. While NDOW collected a few Pahranagat speckled dace with minnow traps here in 1985, in 1987 and 1999 no Pahranagat speckled dace were found during sampling (Stein et al. 2000). Western mosquitofish were found in 1985 and 1987, but none were collected when the area was resampled in 1999. No NDOW surveys have been conducted at Cottonwood Spring since 1999. We found the majority of our fish in a spring brook/ditch at the lower end of Cottonwood Spring, which we surmise was the area referred to as North Cottonwood Spring by Stein et al. (2000).

The NDOW found 59 Pahranagat speckled dace distributed from the spring head to almost 200 m downstream at Deacon Springs. Western mosquitofish were also present in Deacon Springs. No fish were present in Brownie Spring. The NDOW also found Pahranagat speckled dace during historical sampling at Lone Tree Spring, but no habitat was available there during a 1998 site visit (Stein et al. 2000). We found a similar lack of fish habitat during our October 2004 survey of Lone Tree Spring. The NDOW renovated Maynard Spring to remove common carp and western mosquitofish in the mid 1980s, after which Pahranagat speckled dace from the Cottonwood Spring area were introduced (Stein et al. 2000). During surveys conducted in 1999, no speckled dace were found at this location. Little if any fish habitat existed at Maynard Spring during our October 2004 survey.

Amphibians

Nonnative bullfrog was the dominant amphibian species in the Pahranagat Valley (Table 92). We only observed frogs at two of the aquatic systems of interest in Pahranagat Valley, but as stated previously our surveys were not exhaustive. We observed bullfrog adults at Crystal Spring during our June 2004 reconnaissance trip and counted six bullfrog adults during our March 2005 survey of Crystal Spring. We also saw several distant adult frogs we could not

Table 92. Amphibian sightings at aquatic systems of interest in Pahranagat Valley, Lincoln County, Nevada.

SYSTEM NAME	SOURCES[a]	BULLFROG	NORTHERN LEOPARD FROG	UNIDENTIFIED FROG	UNIDENTIFIED TADPOLE
Ash Spring	1, 2, 3, 4	P[b] 3	A[c]	A	A
BLM Spring	1	A	A	A	A
Brownie-Deacon Springs	1	A	A	A	A
Cottonwood Spring	1	A	A	A	A
Crystal Spring	1, 2, 3, 4	P 1, 3, 4	A	P 1	P 1
Hiko Spring	1, 2, 3, 4	P 1, 3, 4	A	P 1	A
Hoyt Spring	1	A	A	A	A
Lone Tree Spring	1	A	A	A	A
Maynard Spring	1, 2, 3	A	P 2,3	A	A
Pahranagat Creek/Ditch Spring	3	P3	A	A	A

[a]Sources: 1 = BIO-WEST survey and/or reconnaissance; 2 = Hitchcock (2001); 3 = NDOW (Stein et al. 2000, Hobbs et al. 2004, Hobbs et al. 2005); 4 = Sada (2005a).
[b]Present through visual observation.
[c]Absent through visual observation.

positively identify and observed over 100 tadpoles at Crystal Spring. Based on other research at this system, these were probably all bullfrogs (Hobbs et al. 2004, Hobbs et al. 2005). The NDOW has a nonnative removal program at Crystal Spring that includes bullfrogs as a target species. They removed over 1,000 bullfrog tadpoles collected in minnow traps in 2004 (Hobbs et al. 2005). Additionally, during our September survey of Hiko Spring, four adult bullfrogs and one unidentifiable frog were observed.

The same nonnative removal program was initiated at Ash Springs in 2003, but it was terminated because of land access issues. During three removal efforts no bullfrog tadpoles were collected, but bullfrogs tadpoles were collected during past nonnative removal efforts at Ash Spring by Stein et al. (2000), when the NDOW had additional property access. The NDOW has also collected bullfrog tadpoles at Hiko Spring during surveys for Hiko White River springfish. In 2004 they collected 98 bullfrog tadpoles during two surveys, which was down slightly from the 148 bullfrog tadpoles they collected during two surveys in 2003.

Hitchcock (2001) surveyed for northern leopard frog at nine locations in Pahranagat Valley, including Ash Spring, Crystal Spring, Hiko Spring, and Maynard Spring, but only found northen leopard frog at Maynard Spring. She listed this location as Lone Tree Spring, but the site description and GPS coordinates show it to be Maynard Spring. She found five northern leopard frogs in three surveys at Maynard Springs. Hitchcock (2001) surveyed three other locations on the Pahranagat NWR but did not find any additional northern leopard fogs. Stein et al. (2000) also reported a northern leopard frog sighting at Maynard Spring.

Hobbs (2006) noted that a large group of unidentified toads was observed along the Pahranagat Creek/Ditch during Pahranagat roundtail chub surveys in 1999 or 2000. Red spotted toad and Woodhouse's toad are the species most likely to be found in the Pahranagat Valley.

Springsnails and Other Invertebrates

Three species of springsnail had previously been described as occurring in three of the aquatic systems of interest in Pahranagat Valley (Table 93). We found springsnails at two of these systems, Ash Spring and Crystal Spring. We were unable to find springsnails in Hiko Spring, the third system. Additionally, during our surveys of six other systems of interest we found no new populations of springsnail.

Table 93. Springsnails present at aquatic systems of interest throughout Pahranagat Valley in Lincoln County, Nevada.

SYSTEM NAME	SOURCES[a]	*P. HUBBSI*	*P. MERRIAMI*	*T. CLATHRATA*
Ash Spring	1, 2	A[b]	P[c] 1, 2	P 1, 2
BLM Spring	1	A	A	A
Brownie-Deacon Springs	1	A	A	A
Cottonwood Spring	1. 2	A	A	A
Crystal Spring	1, 2	P 1, 2	A	A
Hiko Spring	1, 2	A	A	A
Hoyt Spring	1	A	A	A
Lone Tree Spring	1	A	A	A
Maynard Spring	1	A	A	A

[a]Sources: 1 = BIO-WEST survey and/or reconnaissance, 2 = Sada (2005a).
[b]Absent through visual observation.
[c]Present through visual observation.

Ash Spring is the type location for the Pahranagat pebblesnail (Hershler 1994). Currently, this springsnail is found in four systems, of which only Ash Spring is in the Pahranagat Valley. We found that springsnails were scarce to common at two of the spring heads in Ash Spring, absent throughout a large portion of the main pool area, and common 60 m downstream before the spring discharged onto private property. Sada (2005a) listed 1992 Ash Spring survey results showing that Pahranagat pebblesnail was abundant, and the grated tryonia was scarce.

Crystal Spring appears to contain the only known population of Hubbs springsnail. While Hiko Spring is the type location and survey results from 1992 (Sada 2005a) show that the Hubbs springsnail was abundant at Hiko Spring, these springsnails were not found in Hiko Spring during subsequent surveys in 2000 or our surveys in September 2006. Therefore, the Hubbs springsnail appears to be extirpated in this system. In addition, we found that the Hubbs springsnail was scarce in Crystal Spring. We sampled 31 different locations in various spring heads, pools, and spring brooks, and only found springsnails, which were scarce, at one of those locations. EcoAnalysts identified only one springsnail (Hydrobiidae) in their 300 organism subsample of our qualitative macroinvertebrate sample from Crystal Spring (Appendix D). Survey results from 1992 listed in Sada (2005a) showed that the Hubbs springsnail was abundant at Crystal Spring, but it was found to be scarce and only present at a single location in Crystal Spring during subsequent surveys (D.W. Sada 2005b, pers. comm.).

EcoAnalysts identified 93 taxa of aquatic invertebrates in our samples at the aquatic systems of interest in Pahranagat Valley (Appendix D, Appendix E). The aquatic systems of interest we surveyed in Pahranagat Valley had varied invertebrate communities. Ash Spring was the least diverse with only 11 taxa (Table 94). Springsnails dominated the community at Ash Spring, despite the fact that they were scarce to common in our surveys. The amphipods *Hyallela* sp. and the riffle beetle *Stenelmis* sp. were also abundant at Ash Spring.

The *Stenelmis* sp. identified by EcoAnalysts is probably the Ash Spring riffle beetle (*S. lariversi*), which may be endemic to Ash Spring (Schmude 1999). EcoAnalysts did not find any specimens of the Pahranagat naucorid bug, another rare invertebrate for which Ash Springs is the type locality (LaRivers 1956).

Hiko Spring had the most diverse invertebrate community with 37 taxa, dominated by amphipods, pond snails (*Physa* sp.), and odenates. Similar to Crystal Spring, EcoAnalysts identified the red-rimmed melania snail in our samples at Hiko Spring. This invasive species was not identified at any other systems of interest in Pahranagat Valley and was only one of the three dominant species at Crystal Spring. EcoAnalysts found midges (Diptera: Chironomidae) to be one of the three most-dominant taxa in samples from all systems we surveyed, except for Ash Spring, Cottonwood Spring, and Hiko Spring. The Maynard Spring sample was dominated by pollution-tolerant midges and worms.

Table 94. Total number of invertebrate taxa; mayfly, stonefly, and caddisfly taxa (EPT taxa); taxa in the Phylum Mollusca; taxa in the Order Odonata; and taxa in the Subphylum Crustacea at aquatic systems of interest throughout Pahranagat Valley in Lincoln County, Nevada.

SYSTEM NAME	TOTAL TAXA	EPT TAXA	MOLLUSCA TAXA	ODONATA TAXA	CRUSTACEA TAXA
Ash Spring	11.00	0.00	2	0	2
BLM Spring	19.00	1.00	1	2	1
Brownie-Deacon Springs	24.00	0.00	4	0	2
Cottonwood Spring	34.00	2.00	3	3	2
Crystal Spring	20.00	3.00	3	1	2
Hiko Spring	37.00	3.00	4	3	3
Lone Tree Spring	21.00	1.00	3	1	2
Maynard Spring	29.00	0.00	1	2	2

The nonnative red swamp crayfish was also present at several of the aquatic systems of interest in Pahranagat Valley. While EcoAnalysts did not identify any crayfish in our qualitative macroinvertebrate samples in Pahranagat Valley (except at Hiko Spring), we observed crayfish during our reconnaissance trip and/or our surveys at Ash Spring and Crystal Spring. The NDOW has removed red swamp crayfish during native fish monitoring and/or targeted nonnative removal efforts at Ash Spring, Crystal Spring, and Hiko Spring. Stein et al. (2000) also noted crayfish in the Pahranagat Creek/Ditch.

Deacon et al. (1980) found that the red-rimmed melania snail and midges dominated the invertebrate community in the outflow of Ash Springs and in Pahranagat Creek/Ditch, which differed considerably from our finding that springsnails and amphipods were the dominant taxa in Ash Spring proper. Deacon et al. (1980) found the invertebrate community in the outflow of Ash Springs and in Pahranagat Creek/Ditch to be the most depauperate of four spring systems they surveyed in four different valleys in east central Nevada. Even so, they still found four times the number of taxa that we did, mainly because they included zooplankton, utilized multiple sampling gear types, and attempted to identify every organism collected.

In 1998 Stein et al. (1999) took samples of invertebrate drift in a section of Pahranagat Creek/Ditch. They found that the drift community was primarily comprised of blackflies (Simuliidae), midges, caddisflies in the family Limnephilidae, and seed shrimp.

Other Fauna

We observed a variety of bird species utilizing habitats near the aquatic systems of interest during our surveys including: mourning dove, house sparrow (*Passer domesticus*), hummingbird, northern harrier, red-tailed hawk, red-winged blackbird, robin (*Turdus migratorius*), turkey vulture (*Cathartes aura*), western meadowlark, marsh wren, unidentified hawks, unidentified owls, unidentified songbirds, and unidentified waterfowl. We also saw or saw sign of coyotes, mule deer, western whiptail lizards, zebra-tailed lizards, and unidentified lizards.

Disturbance

Most of the systems we surveyed in Pahranagat Valley were moderately to highly disturbed by diversion for recreation and irrigation (Table 95). Nonnative fishes, frogs, invertebrates, and plants were also pervasive throughout many of the aquatic systems of interest in the Pahranagat Valley. The public portion of Ash Spring is a recreational area where flows have been diverted for swimming and bathing (Figure 31). Crystal Spring's installed head gates released water to dredged outflows in order to provide irrigation water. Hiko Spring discharges into a bermed pond that drains into a piped outflow at the northwest corner. Hoyt Spring was completely dry during our October 2004 survey and appeared as though it had been dry for some time. We found evidence of a historical diversion at Cottonwood Spring on the Pahranagat NWR, as well as the presence of nonnative fishes and a few salt cedar trees. Overall, Cottonwood Spring was only slightly disturbed (Figure 32).

Table 95. Disturbance level and factors at aquatic systems of interest throughout Pahranagat Valley in Lincoln County, Nevada.

SYSTEM NAME	DISTURBANCE LEVEL	DISTURBANCE FACTORS
Ash Spring	High	Recreation, Diversion, Nonnatives
BLM Spring	High	Livestock, Diversion, Nonnatives, Drought
Brownie Deacon Springs	Moderate	Livestock, Residence, Nonnatives
Cottonwood Spring	Slight	Diversion, Drought, Nonnatives
Crystal Spring	High	Recreation, Diversion, Nonnatives
Hiko Spring	High	Recreation, Diversion, Nonnatives, Residence, Livestock, Drought
Hoyt Spring	High	Drought, Nonnative Vegetation
Lone Tree Spring	Slight	Diversion, Drought, Nonnative Vegetation
Maynard Spring	Moderate	Diversion, Drought, Nonnative Vegetation

Figure 31. Top to bottom: The concrete bathing pool (a), and diversion for swimming hole at Ash Springs (b), in Pahranagat Valley.

Figure 32. Overview of Cottonwood Spring in Pahranagat Valley.

Panaca Valley

Panaca Big (Town) Spring was historically part of the Meadow Valley Wash drainage, located in Panaca Valley. The Meadow Valley Wash drainage dissects several valleys. The Panaca Valley is at the south end of Condor Canyon and bordered by the Panaca Hills on the east and the Chief Range to the west. Diversion now prevents connection between the spring brook of Panaca Big Spring and Meadow Valley Wash. Panaca Big Spring is the type location for the Federally threatened Big Spring spinedace, but Big Spring spinedace was extirpated from the spring head and outflows by the late 1950s (Miller and Hubbs 1960; USFWS 1985b, 1993). Big Spring spinedace is currently only found in a small portion of Meadow Valley Wash in Condor Canyon (USFWS 1993, Hobbs et al. 2004, Hobbs et al. 2005). Two other fish species from Meadow Valley, Meadow Valley Wash desert sucker (*Catostomus clarki* ssp.) and Meadow Valley Wash speckled dace (*Rhinichthys osculus* ssp.), are on the State of Nevada's Rare (At-Risk) Species List (NVNHP 2004). All three of these species are endemic to the Meadow Valley Wash drainage and significant biological resources in Panaca Valley.

Panaca Big (Town) Spring was the only aquatic system of interest identified in Panaca Valley (Figure 33, Table 96).

Table 96. Location, survey date, survey level, and ownership of aquatic systems of interest throughout Pahranagat Valley, Lincoln County, Nevada.

SYSTEM NAME	NORTHING	EASTING	DATE SURVEYED	BIO-WEST SURVEY LEVEL	OWNER
Panaca Big Spring	4187827	730510	8/29/2005	Level 2	Public

Note: UTM coordinates are in the NAD 83 projection system.

Physical Habitat and Water Quality Data

Panaca Big Spring emanates from a hillside on the east end of the complex, but it is impounded into a pond by a diversion structure at the west end of the complex, a little more than 200 m from the source (Table 97). The diversion structure has two head gates that release water directly into irrigation ditches.

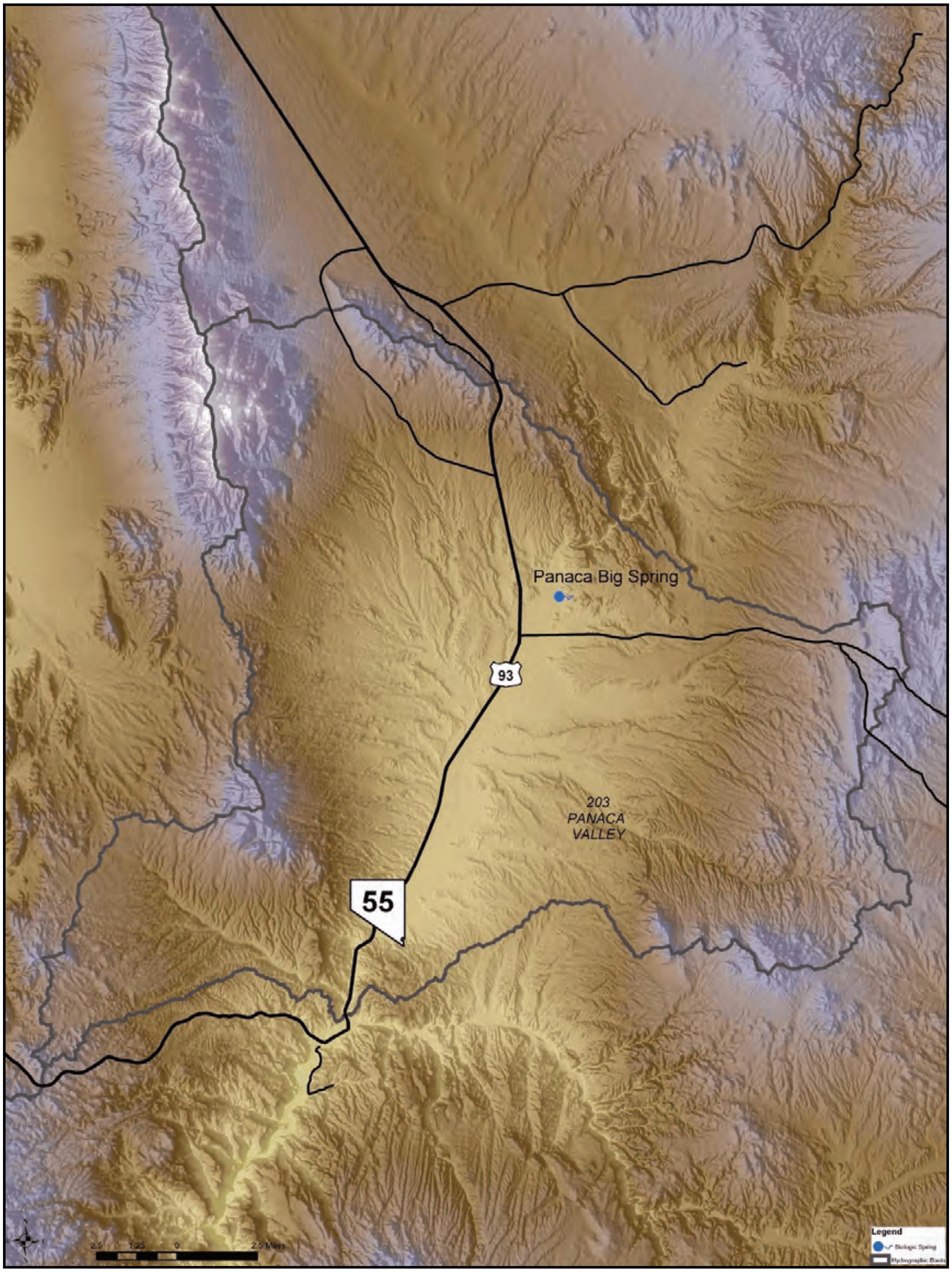

Figure 33. Map of locations of aquatic systems of interest in Panaca Valley, Lincoln County, Nevada.

Table 97. Type of system, maximum depth, maximum wetted width, length of survey plots, and measured discharge at Panaca Big Spring in Meadow Valley, Lincoln County, Nevada.

SYSTEM NAME	SYSTEM TYPE	MAXIMUM DEPTH (cm)	MAXIMUM WETTED WIDTH (m)	LENGTH (m)	DISCHARGE (l/s)
Panaca Big Spring	Rheocrene	168	33	215[a]	N/A

[a]Continued further as a spring brook or marsh land, or onto private property.

We found little difference in water quality parameters between measurements of water emanating from the hillside and in the pond, except the level of dissolved oxygen was substantially higher at the surface of the pond near the outflow (Table 98). Sada (2005a) listed similar water quality measurements during a survey conducted in May 1992.

Table 98. Selected water quality parameters measured at the main source and termination of our sampling site at Panaca Big Spring in Meadow Valley, Lincoln County, Nevada.

SYSTEM NAME	LOCATION	TEMPERATURE (C)	DISSOLVED OXYGEN (mg/l)	CONDUCTIVITY (mS/cm)	pH
Panaca Big Spring	Source	27.93	5.62	417	7.93
	Terminus	29.70	8.06	404	8.25

Aquatic Vegetation

The SAV in the pond at Panaca Big Spring was comprised solely of algae, which covered about 30% of the area. Emergent aquatic vegetation dominated and was comprised of nine different species (Table 99). We found Olney's three square bulrush, spikerush, and Indian hemp (*Apocynum cannabinum*) to be the most abundant EAV. In order to assess whether Ute ladies'-tresses were still flowering, we investigated a known population in the riparian area surrounding Panaca Big Spring. Because these plants were past the flowering period, we were only able to locate three withered plants. Hence the survey was not considered valid, and additional surveys were planned for the peak flowering period in 2007 (see Chapter 2). Miller and Hubbs (1960) noted watercress, pondweed, and rushes were present at Big Springs in the late 1930s.

Table 99. Percent cover of emergent aquatic vegetation found at Panaca Big Spring in Meadow Valley, Lincoln County, Nevada.

COMMON NAME	SCIENTIFIC NAME	PANACA BIG SPRING
Cockleburr	*Xanthium strumarium*	< 2
Indian Hemp	*Apocynum cannabinum*	10
Kochia	*Bassia scoparia*	< 2
Nuttall Sunflower	*Helianthus nuttallii*	< 2
Olney's Three Square Bulrush	*Schoenoplectus americanus*	70
Rush	*Juncus torreyi*	< 2
Spikerush	*Eleocharis* sp.	15
White Sweet Clover	*Melilotus alba*	5
Yerba Mansa	*Anemopsis californica*	2

The riparian zone around the system had a few cottonwoods and red willow, along with the nonnative Russian olive.

Vegetation Mapping

When we returned to map vegetation at Panaca Big Spring in October 2005, we found seven vegetation associations and open water (Table 100). The associations represented the 14 plant species noted at Panaca Big Spring (Appendix C). About 32% of the 1.5 acres mapped was classified as open water. The major vegetation association was Olney's three square bulrush, which covered 33% of the 1.5 acres. Spikerush and Baltic Rush Associations were also found at Panaca Big Spring.

Fishes

The Panaca Big Spring outflow and its adjacent wet meadow were the type locality for Big Spring spinedace, but the Big Spring spinedace was extirpated from Panaca Springs by 1959 (Miller and Hubbs 1960, USFWS 1993). While Meadow Valley Wash desert sucker and Meadow Valley Wash speckled dace were present in Panaca Spring and its outflow in the 1930s, only Meadow Valley Wash speckled dace remained by 1959. Sada (2005a) listed only mollies and western mosquitofish in Panaca Springs during surveys in 1992. In limited electrofishing samples we collected 17 western mosquitofish. We also pulled three seine hauls and collected 156 western mosquitofish and four shortfin molly. Currently, none of the native fish species once known to inhabit Panaca Big Spring can be found there.

Table 100. The proportion of the 1.5 acres mapped comprised of each association (alliance) at Panaca Big Spring in Panaca Valley, Lincoln County, Nevada.

ASSOCIATIONS / ALLIANCES IN PANACA VALLEY	PANACA SPRING (1.44 ACRES [0.586 HECTARE])
Open Water / Undesignated Alliance	32.15%
Schoenoplectus americanus (Olney's Three Square Bulrush) Western Herbaceous Vegetation / *Schoenoplectus americanus* Semipermanently Flooded Herbaceous	33.23%
Eleocharis palustris (Common Spikerush) Herbaceous Vegetation / *Eleocharis palustris* Seasonally Flooded Herbaceous	12.37%
Anemopsis californica (Yerba Mansa) Herbaceous Vegetation /Undesignated Alliance	2.75%
Juncus arcticus (Baltic Rush) Herbaceous Vegetation / *Juncus arcticus* Seasonally Flooded Herbaceous	9.28%
Populus fremontii (Fremont Cottonwood) Mixed Herbaceous Woodland / *Populus fremontii* Seasonally Flooded Woodland	5.72%
Apocynum cannabinum (Indian Hemp) Herbaceous Vegetation / Undesignated Alliance	3.12%
Adventive Plant Herbaceous Vegetation / Undesignated Alliance	1.38%

In the late 1970s Big Spring spinedace were rediscovered in a pool at the base of a waterfall in the Condor Canyon section of Meadow Valley Wash, upstream from Panaca Big Spring (Allen 1985). In the early 1980s some Big Spring spinedace from this pool were relocated upstream of the waterfall barrier. In the 1980s and 1990s, surveys of Condor Canyon generally found several hundred Big Spring spinedace, the majority of which were found above the waterfall (Langhorst 1991, USFWS 1993). During these surveys, Meadow Valley Wash desert sucker and Meadow Valley Wash speckled dace were present throughout Condor Canyon.

More recent surveys by the NDOW showed that the center for native fish, including Big Spring spinedace, appears to be above the waterfall barrier (Heinrich et al. 2002, 2003; Hobbs et al. 2004, 2005; Stein et al. 1999, 2000, 2001). Multiple pass, depletion electrofishing produced a population estimate of Big Spring spinedace of 2,267 individuals in 2004, which was slightly lower than the 2003 estimate of 3,219 individuals (Hobbs et al. 2004, Hobbs et al. 2005). Both of these estimates were lower than the 2000 and 2002 estimates, which were over 8,700 individuals (Stein et al. 2001, Heinrich et al. 2003). Habitat alterations resulting from fires and low flows could be reducing numbers of Big Spring spinedace. Habitat alteration could also be reducing the probability of catching Big Spring spinedace because dense emergent vegetation is growing in the stream channel (Hobbs et al. 2005). Meadow Valley Wash Desert sucker and Meadow Valley Wash speckled dace are still found throughout Condor Canyon (Hobbs et al. 2004, Hobbs et al. 2005).

The NDOW also conducts annual sampling of portions of Meadow Valley Wash downstream of Caliente to Carp, Nevada. Some of these areas are heavily impacted by livestock grazing, agricultural development, Union Pacific Railroad stream channel modifications that maintain their right-of-way through Meadow Valley Wash, invasion of terrestrial vegetation (especially salt cedar), and invasion of nonnative aquatic species. During depletion electrofishing at six fixed transects in 2003 and 2004, relatively low, variable numbers of Meadow Valley Wash speckled dace (0-50) and Meadow Valley Wash desert sucker (0-55) were found. Numbers of native fish seemed slightly higher in 2004 than in 2003, but they varied between transects.

Nonnative western mosquitofish, rainbow trout, black bullhead (*Ameiurus melas*), and red swamp crayfish were also collected during these surveys.

Amphibians

Miller and Hubbs (1960) noted that northern leopard frogs were present in 1959, but they were greatly outnumbered by bullfrogs. Sada (2005a) noted no amphibians during surveys in 1992. Hitchcock (2001) surveyed for northern leopard frogs and found none here. We observed and heard several bullfrogs during our reconnaissance trip in July 2004 and noted a single adult bullfrog during our August 2005 survey of Panaca Big Spring. Hitchcock (2001) surveyed for northern leopard frog at two other locations along Meadow Valley Wash and found none. The NDOW noted tadpoles during recent electrofishing surveys in Meadow Valley Wash (Hobbs et al. 2004, Hobbs et al. 2005). Besides the nonnative bullfrog, Woodhouse's toad and red spotted toad are possible inhabitants of Panaca Valley.

Springsnails and Other Invertebrates

We did not find any springsnails during our survey of Panaca Big Spring nor did Sada (2005a) in a 1992 survey. Panaca Big Spring had one of the lowest taxa richnesses of any of the aquatic systems sampled in the BRSA. Despite sorting the entire sample, EcoAnalysts only found four taxa of aquatic invertebrates in our sample from Panaca Big Spring (Appendix D, Appendix E). The nonnative red-rimmed melania snail comprised almost 98% of the organisms found in the sample. Two other species of snail and worms were the only other taxa found in the sample. We also observed many nonnative crayfish (presumably the red swamp crayfish) during both our survey in August 2005 and our reconnaissance visit in July 2004.

Other Fauna

We observed an American coot (*Fulica americana*), cliff swallows (*Hirundo pyrrhonota*), a mourning dove, a northern harrier, an unidentified snake, and unidentified songbirds during our survey of Panaca Big Spring.

Disturbance

We categorized Panaca Big Spring as highly disturbed (Figure 34). The system was completely impounded for irrigation and recreational use, and was dominated by nonnative species.

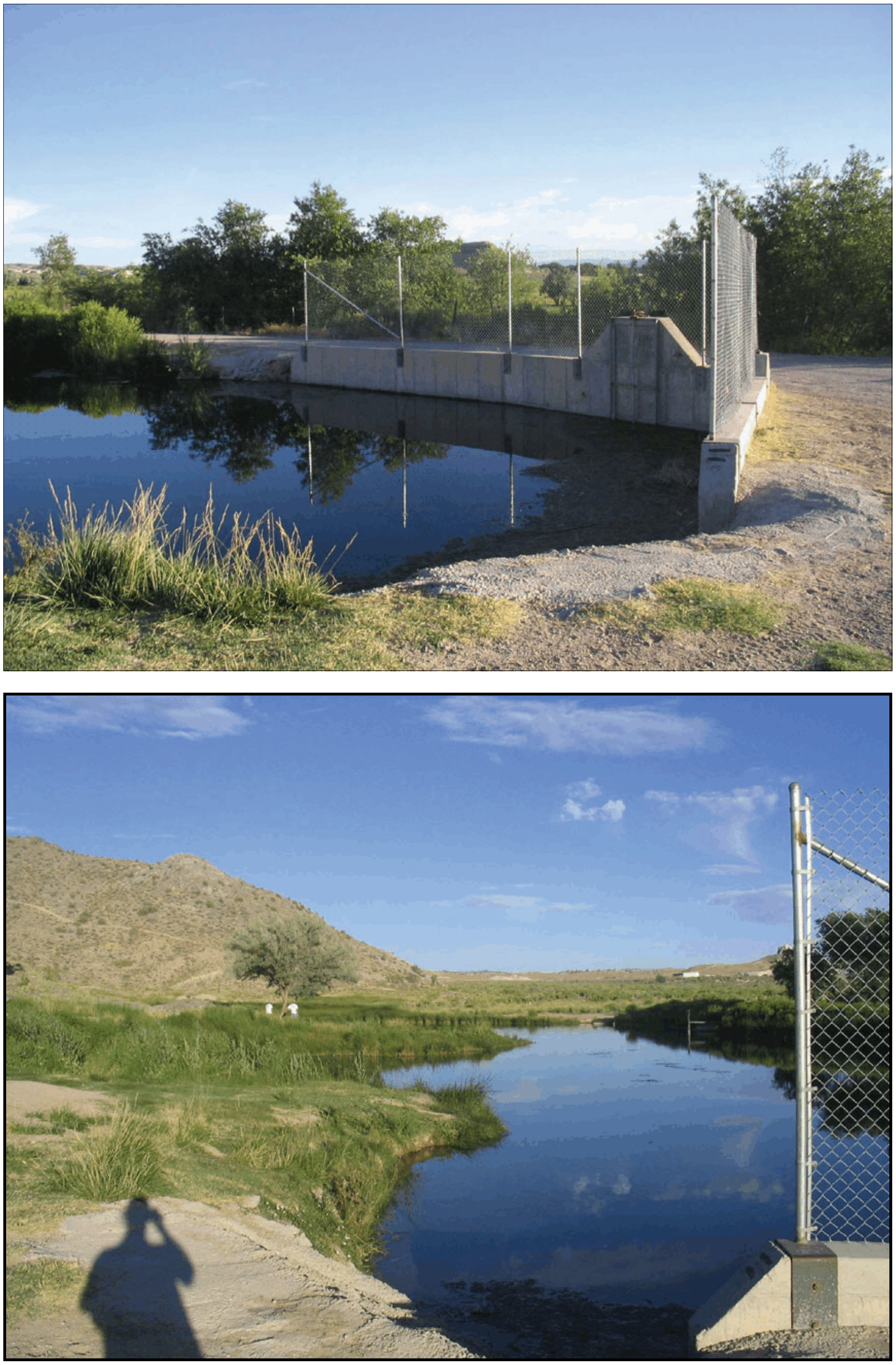

Figure 34. Top to bottom: Panaca Big Springs at the (a) head gate structure, and (b) pond looking upstream in Panaca Valley.

DISTURBANCE EVALUATION AND RESTORATION RECOMMENDATIONS

Disturbance

We completed disturbance evaluations at 93 sites in the BRSA. In addition, we performed a disturbance evaluation at Hoyt Spring, which should have received a Level 2 survey, but it was dry. Of these systems, only portions of the Gandy Salt Marsh complex were ranked as close to undisturbed (Figure 35). Both Gandy Salt Marsh complex middle (G20-G28) and Gandy Salt Marsh complex G48-G49 were completely within a livestock exclosure. These sites both showed evidence of historic cattle use, and both had some issues with possible overgrowth of vegetation. We classified most of the sites as moderately to highly disturbed, and only 22% of the sites as slightly disturbed and below (Figure 36). We had difficulty fitting several of the sites into the slightly, moderately, or highly disturbed categories, so we assigned those sites intermediate values.

We found that diversions and livestock-related damage were the most common disturbance factors at the 93 sites that received disturbance evaluations (Figure 37). We identified at least one of these factors at 96% of the sites that received a disturbance evaluation, and both of these factors at 50% of the sites. Nonnative species, which included vegetation, invertebrates, amphibians, and fish, were present at over 63% of the sites that received a disturbance evaluation. Anthropogenic disturbances other than diversion were lumped into the urban category, which included roads, recreation, dwellings and structures, and other human disturbances. Urban disturbances were noted at slightly over a quarter of the sites we visited. Finally, we saw the impact of drought at about 19% of the sites that received disturbance evaluations. Interestingly, 50% of the sites that had drought listed as a disturbance factor were surveyed in autumn 2004. Higher-than-average precipitation in spring 2005 ended a 5-year drought in many parts of the intermountain west, so it is possible that drought would have been listed as a disturbance factor at more sites had we surveyed all locations in autumn 2004.

Similarly, many other researchers have found that aquatic systems in the Great Basin and other dry landscapes of the western United States are heavily impacted by anthropogenic disturbances. Sada et al. (2001) listed several studies that implicated water diversion, livestock trampling, and nonnative species as major disturbance factors at spring systems throughout the western United States. Sada (2000) also found that over 50% of the 125 springs he surveyed in southern Nevada and southeastern California were moderately to highly impacted by anthropogenic disturbances. Sada and Nachlinger (1996, 1998) found that most of the 63 springs they surveyed in the Spring Mountains of southern Nevada in 1995 and 1997 were moderately to highly disturbed. They

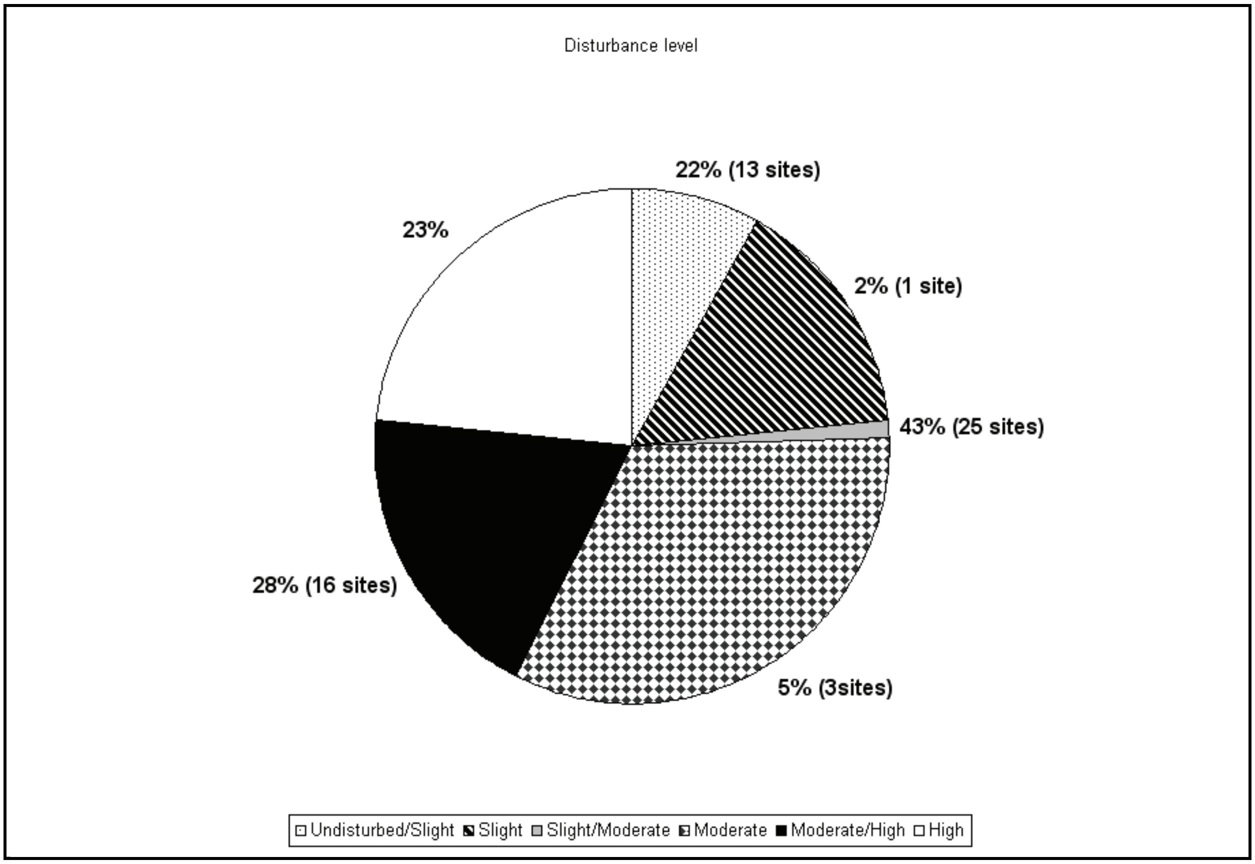

Figure 35. Percentage of sites that received Level 2 surveys classified in each disturbance category.

Figure 36. Counterclockwise: Highly disturbed Clay Spring in Snake Valley (a), moderately disturbed South Millick Spring in Spring Valley (b), and slightly disturbed North Flag Spring in White River Valley (c).

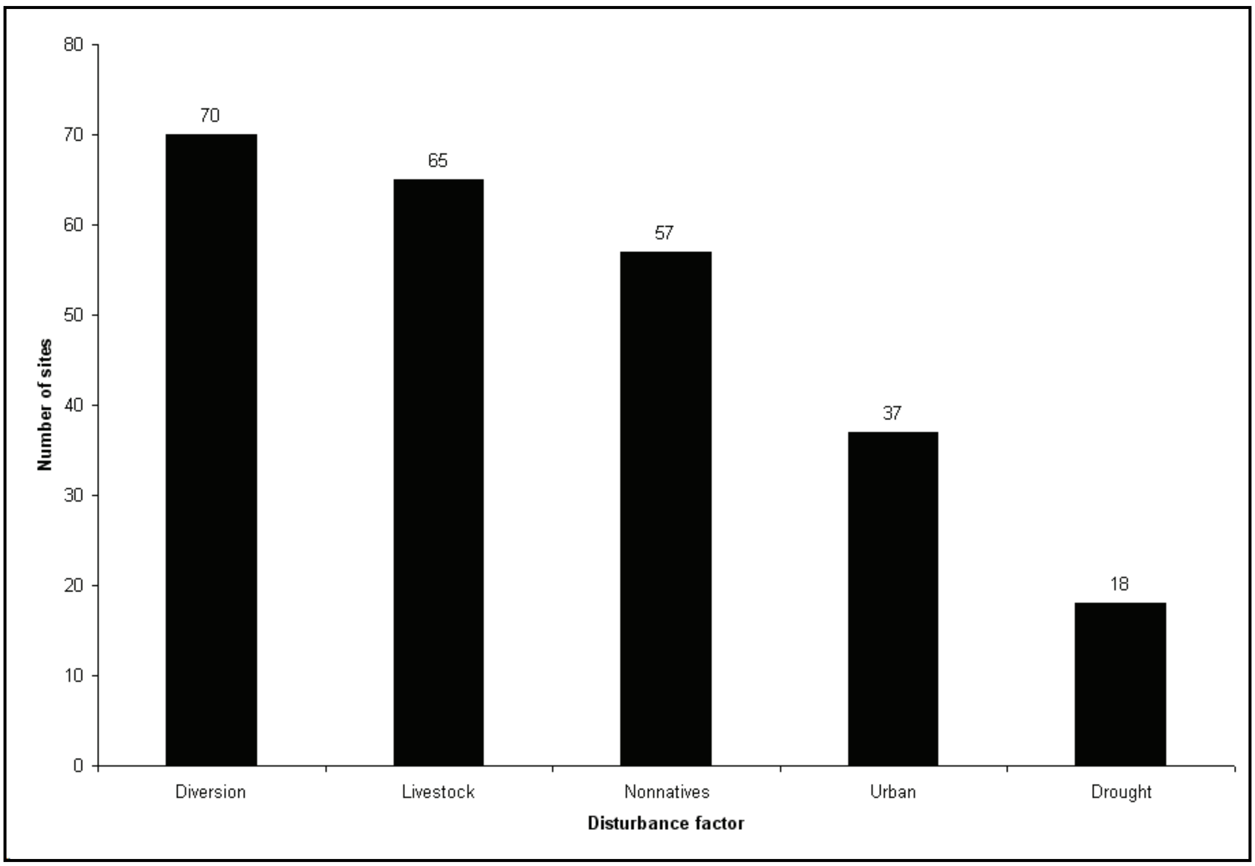

Figure 37. Number of Level 2 survey sites where each disturbance factor was noted.

also found that diversion, ungulate use, and recreation were the most frequent disturbance factors at these locations. They felt that diversion had the greatest negative impact on spring biota, followed by ungulate use.

The majority of the BRSA is located in the Great Basin. We found several studies that showed patterns of disturbance similar to patterns in our study within this same physiographic province and, in some cases, within the BRSA. Sada and Vinyard (2002) noted that most large wetlands in the Great Basin have been degraded by diversion and nonnative species, while many of the smaller springs and streams have been impacted by diversion and livestock use. They attributed the declines and extirpations of many native fauna in the Great Basin to those three factors. Keleher and Rader (2003) designed a bioassessment protocol for desert wetlands in Utah's Bonneville Basin. They performed surveys at 297 sites but found only 33 sites that represented minimally impacted conditions (reference sites). The remaining sites were impacted by anthropogenic disturbances, including diversion and livestock use, and/or nonnative species.

Protection and Restoration

Given the dominant perturbations we found during our surveys, our most common recommendations for restoration are:

- to restore flow to the historic channels/marshes by removing diversions
- to alleviate overgrazing and trampling by excluding livestock in specific portions of the aquatic system of interest, and/or reducing livestock use throughout the system
- to relieve competition and predation pressure on the native biota by removing nonnative species

These types of restoration recommendations are typical of other studies (Sada and Nachlinger 1996, Sada and Nachlinger 1998, Sada et al. 2001). Sada and Nachlinger (1996, 1998) and Sada et al. (2001) recommended that springs and a portion of their spring brooks should always be kept free of disturbance. Fencing spring sources and a portion of the brook or wetland area surrounding them would protect the most sensitive areas from livestock and ungulate damage. Similarly, Sada and Nachlinger (1996, 1998) and Sada et al. (2001) noted that diversion should be discouraged at or near the spring source and in a portion of the downstream brook/wetland. Sada and Nachlinger (1996, 1998) recommend maintaining at least 50 m of spring brook free of disturbance, while Sada et al. (2001) recommend protecting as much of the system as necessary to preserve biodiversity. Completely excluding ungulate use of aquatic systems can also pose problems. Prior to European settlement, bison, elk, and deer all utilized aquatic systems throughout the Project Area. Completely eliminating ungulate use of these areas through complete grazing exclosures can result in spring systems becoming overgrown with vegetation

(Nielsen 2006). Without a natural fire regime or some level of ungulate disturbance, spring heads and spring brooks may begin to lose the geomorphology that allows for the persistence of sensitive species in these areas. Therefore, reducing the density of livestock, the amount of time they are present, or the areas they have access to may all reduce the amount of disturbance present at aquatic systems in the BRSA.

Reducing the amount or timing of livestock use and preventing and removing diversion near the source of spring systems does not exclude the possibility of water development for agriculture or livestock. Diversions can be placed in downstream areas, and a portion of the flow can be transported to stock tanks or agricultural areas outside the riparian area. Limiting the amount of water diverted to only the amount that is actually needed would also help protect aquatic systems in the BRSA. Sada and Nachlinger (1996, 1998) recommended that at least 25% of a spring's total discharge should always remain in the spring brook and that water diversion be limited to periods when water is expressly needed.

Sada et al. (2001) and Sada (2003) provide methods for prioritizing spring system restoration. The main criteria Sada et al. (2001) used to determine restoration priority were the flow characteristics, biological community, and existing condition of the spring system (Table 101). We created a list of potentially important characteristics at the 58 sites where we performed Level 2 surveys, in order to preliminarily examine restoration possibilities (Table 102). The categories we chose included:

- whether the spring was perennial
- if springsnails were present
- if sensitive species were present
- if sensitive species had been extirpated
- if nonnative vegetation was present
- if nonnative aquatic fauna were present

Sensitive species included species that are Federally threatened or endangered, conservation agreement species, and species of concern, as well as species on the State of Utah's Sensitive Species List (UDWR 2005) and/or the State of Nevada's Rare (At-Risk) Species List (NVNHP 2004). Nonnative fauna included fishes, amphibians, and invertebrates (e.g., crayfish and red-rimmed melania snail).

Table 101. Reproduction of Table 3 in Sada et al. (2001). Evaluation guide to determine restoration priorities for individual springs in a region.

SPRING PERMANENCE	TES SPECIES VALUES	COMMUNITY COMPOSITION	EXISTING CONDITION & REGIONAL SCARCITY	RESTORATION PRIORITY
Perennial	TES species present	* Potential for natives > exotics (plant cover) * Potential for riparian community dominated by wetland plant species * Potential for macroinvertebrate community with high proportion of pollution intolerant forms * Potential for endemic or rare native macroinvertebrate species present * Potential for use by more than one species of riparian obligate migratory birds	* Functioning at risk with a downward or no apparent trend * Springs not regionally scarce	High
Perennial	TES species present, or historic or refuge habitat for TES Species	* Potential for natives > exotics (plant cover) * Riparian zone with approx. equal numbers if upland and wetland plant species * Macroinvertebrate community represented by pollution tolerant and intolerant forms * Potential for endemic or rare native macroinvertebrate species * Potential for use by riparian obligate migratory birds	* Functioning at risk with a downward or no apparent trend * Springs not regionally scarce	Moderate
Intermittent	No TES species	* Exotics > natives (plant cover) * Riparian zone dominated by upland species * Macroinvertebrate dominated by pollution tolerant forms (e.g. Chironomids, Oligochaetes * No potential for endemic or rare native macroinvertebrate species present * Not used by riparian obligate migratory birds	* Proper functioning condition or functioning at risk * Springs not regionally scarce	Low

Table 102. Potential factors influencing restoration priorities at the 58 sites where Level 2 surveys were attempted.

VALLEY	SITE	DISTURBANCE	PERENNIAL	SPRINGSNAILS	SENSITIVE SPECIES	EXTIRPATED RARE SPECIES	NONNATIVE VEGETATION	NONNATIVE ANIMALS
Pahranagat	Ash	High	Y	Y	Y	Y	N	Y
Snake	Big Springs	High	Y	Y	Y	N	Y	Y
Snake	Big Springs Creek	High	Y	Y	Y	N	N/A	Y
Snake	Big Springs Pond	High	N	Y	Y	N	N/A	Y
Snake	Bishop Springs / Foote Reservoir	High	Y	N	Y	N	Y	Y
Spring	Blind	High	Y	N	N	N	N	N
Pahranagat	BLM	High	Y	N	N	N	Y	N
Snake	Clay	High	Y	Y	Y	N	N	N
Dry Lake	Coyote	High	Unknown	N	N	N	Y	N
Pahranagat	Crystal	High	Y	Y	Y	Y	Y	Y
Fish Springs	Deadman Spring	High	Y	N	N	Y	N[b]	Y
White River	Flagg Complex Middle	High	Y	Y	Y	N	N	N
Delamar	Grassy	High	Y	N	N	N	N	N
Pahranagat	Hiko	High	Y	N	Y	Y	Y	Y
Pahranagat	Hoyt	High	N	N	N	N	Y	N
Spring	Layton Spring	High	Y	N	N	N	N	N
Meadow	Panaca	High	Y	N	N	Y	N	N
Fish Springs	Percy Spring	High	Y	Y	Y	N	Y	Y
Snake	South Little	High	Y	N	N	N	Y	N
Spring	Unnamed Minerva	High	Y	Y	N	N	Y	N
Snake	Unnamed Spring At Skating Pond	High	Y	N	N	N	Y	N
Snake	Unnamed Spring South of Knoll Spring	High	Y	N	N	N	N	N
Spring	West Spring Valley Complex #1	High	Y	Y	N	N	Y	N
Snake	Beck Springs-North	Moderate/High	Y	Y	Y	N	Y	N
Snake	Callao Big Spring	Moderate/High	Y	Y	N	Y	Y	Y
Spring	Cedars	Moderate/High	Y	N	Y	N	Y	N
Snake	Cold	Moderate/High	Y	Y	N	N	N	N
Fish Springs	House Spring	Moderate/High	Y	Y	N	N	Y	Y

Table 102. Continued.

VALLEY	SITE	DISTURBANCE	PERENNIAL	SPRINGSNAILS	SENSITIVE SPECIES	EXTIRPATED RARE SPECIES	NONNATIVE VEGETATION	NONNATIVE ANIMALS
Spring	Keegan Ranch Middle	Moderate/High	Y	N	Y	N	Y	N
Spring	Keegan Ranch North	Moderate/High	Y	N	Y	N	Y	N
Spring	Keegan Ranch South	Moderate/High	Y	N	Y	N	Y	N
Fish Springs	Lost Spring	Moderate/High	Y	Y	N	N	Y	Y
White River	Lund	Moderate/High	Y	Y	Y	Y	Y	Y
Fish Springs	Middle Spring	Moderate/High	Y	Y	N	N	Y	Y
Snake	Miller	Moderate/High	Y	Y	Y	N	Y	N
Fish Springs	Mirror Spring	Moderate/High	Y	Y	Y	N	Y	Y
White River	Nicholas	Moderate/High	Y	Y	Y	Y	Y	Y
Fish Springs	North Spring	Moderate/High	Y	Y	Y	N	N	Y
Spring	South Bastion Spring	Moderate/High	Y	N	N	N	Y	N
Fish Springs	South Spring	Moderate/High	Y	Y	Y	N	N	Y
Snake	Swimming Hole	Moderate/High	Y	N	N	N	Y	N
Fish Springs	Walter's Spring	Moderate/High	Y	N	Y[a]	Y[a]	Y	Y
White River	Arnoldson	Moderate	Y	Y	Y	Y	Y	Y
Snake	Beck Springs -South	Moderate	Y	Y	Y	N	Y	N
Pahranagat	Brownie-Deacon	Moderate	Y	N	Y	N	N	Y
Snake	Caine	Moderate	Y	Y	N	N	Y	N
Pleasant	Cane	Moderate	Y	Y	N	N	Y	N
Tule	Coyote	Moderate	Y	N	Y	N	Y	N
Fish Springs	Crater Spring	Moderate	Y	Y	Y	N	N	N
White River	Flagg Complex South	Moderate	Y	Y	Y	N	N	N
Snake	Gandy Warm Spring	Moderate	Y	Y	Y	N	Y	Y
Snake	Gandy Salt Marsh G51	Moderate	Y	N	Y	N	N	N
White River	Indian	Moderate	Y	Y	Y	Y	Y	N
Snake	Knoll	Moderate	N	N	N	N	N	N
Pahranagat	Maynard	Moderate	Y	N	N	N	Y	N
Snake	North Little	Moderate	Y	N	N	N	N	N
Spring	North Millick	Moderate	Y	N	N	N	N	N

Table 102. Continued.

VALLEY	SITE	DISTURBANCE	PERENNIAL	SPRINGSNAILS	SENSITIVE SPECIES	EXTIRPATED RARE SPECIES	NONNATIVE VEGETATION	NONNATIVE ANIMALS
Spring	Shoshone #3	Moderate	Y	N	N	N	Y	N
Spring	Shoshone Pond #1	Moderate	Y	N	Y	N	Y	N
Spring	South Millick	Moderate	Y	N	N	N	N	N
White River	Sunnyside -Lower	Moderate	Y	Y	Y	Y	N	N
Spring	Swallow	Moderate	Y	N	N	N	Y	N
Fish Springs	Thomas Spring	Moderate	Y	Y	Y	N	Y	Y
White River	Tin Can Spring	Moderate	Y	Y	Y	N	Y	Y
Snake	Twin	Moderate	Y	Y	Y	N	Y	Y
Snake	Unnamed Big Spring 1	Moderate	Y	Y	Y	N	N	N
Snake	Unnamed Big Spring 2	Moderate	Y	N	N	N	N	N
Spring	Unnamed Cleve Creek -West	Moderate	Y	N	N	N	N	N
Spring	Unnamed Minerva 2	Moderate	Y	Y	N	N	Y	N
Spring	Unnamed Minerva 3	Moderate	Y	Y	N	N	Y	N
Spring	Unnamed Spring at Stonehouse Ranch	Moderate	Y	Y	Y	N	Y	N
Spring	West Spring Valley Complex #5	Moderate	Y	N	N	N	N	N
Spring	Willard	Moderate	Y	N	N	N	N	N
Tule	Willow	Moderate	Y	N	Y	N	N	N
Spring	Willow	Moderate	Y	Y	N	N	N	N
Spring	Unnamed Spring #1	Slight/ Moderate	Y	Y	N	N	N	N
Pahranagat	Cottonwood	Slight	Y	N	Y	N	Y	Y
White River	Flagg Complex North	Slight	Y	Y	Y	N	N	N
Snake	Gandy Salt Marsh G44	Slight	Y	N	Y	N	N	N
Snake	Gandy Salt Marsh North Complex (G4-G9)	Slight	Y	Y	Y	N	N	N

Table 102. Continued.

VALLEY	SITE	DISTURBANCE	PERENNIAL	SPRINGSNAILS	SENSITIVE SPECIES	EXTIRPATED RARE SPECIES	NONNATIVE VEGETATION	NONNATIVE ANIMALS
White River	Hot Creek	Slight	Y	Y	Y	N	N	Y
Snake	Leland Harris	Slight	Y	Y	Y	N	Y	N
Pahranagat	Lone Tree	Slight	Y	N	N	Y	Y	N
White River	Preston Big	Slight	Y	Y	Y	Y	Y	N
Spring	Shoshone Ponds #2	Slight	Y	N	Y	N	N	N
Tule	South Tule	Slight	Y	N	Y	N	Y	N
White River	Sunnyside -Upper	Slight	Y	Y	Y	Y	N	N
Tule	Tule	Slight	Y	Y	Y	N	N	N
Spring	Unnamed Cleve Creek -East	Slight	Y	N	N	N	N	N
Snake	Unnamed South of Caine	Slight	Y	Y	N	N	N	N
Lake	Wambolt 2/3	Slight	Y	Y	Y	N	N	N
Snake	Gandy Salt Marsh G48-49	Undisturbed/ Slight	Y	N	Y	N	N	N
Snake	Gandy Salt Marsh Middle Complex (G20-G28)	Undisturbed/ Slight	Y	N	Y	N	N	N

[a] Somewhat unclear whether least chub persists or is extirpated here.
[b] Somewhat unclear whether all forms of phragmites in area are native.

While sites that are moderately and heavily disturbed may have the highest priority for restoration, 14 of the sites that we ranked as slightly, or less, disturbed also had sensitive species: Cottonwood Spring, North Flag Springs, Gandy Salt Marsh G44, Gandy Salt Marsh G44 and G49, Gandy Salt Marsh North complex (G4-G9), Gandy Salt Marsh middle complex (G20-G28), Hot Creek, Leland Harris Springs, Preston Big Spring, Shoshone Ponds #2, South Tule Spring, Sunnyside Creek (upper), Tule Springs, and Wambolt Springs. We feel that protecting these systems should be the highest priority, since their condition represents the closest to "reference," or minimally impacted conditions that we found during our surveys. Protection should be relatively easy at Cottonwood Spring, North Flag Springs, Hot Creek, Shoshone Ponds #2, and Sunnyside Creek (upper), since they reside on State or Federal management areas or refuges.

Additionally, management and restoration of several of the slightly impacted sites with sensitive species have already been investigated and, in some cases, implemented. The UDWR recently placed South Tule Springs and Tule Springs on the State of Utah's Watershed Initiative Habitat Restoration List, citing vegetation management and other spring renovations as potential future restoration activities (D. Auer 2006, pers. comm.). The UDWR is actively managing sites on the Gandy Salt Marsh complex, with Gandy Salt Marsh G44, Gandy Salt Marsh G44 and G49, and Gandy Salt Marsh middle complex (G20-G28) already having a livestock exclosures around them. In addition, the UDWR is investigating options for vegetation management within the exclosure to promote habitat for least chub and Columbian spotted frog (K. Wheeler 2006, pers. comm.).

The USFWS has secured funding to restore 2 km of stream habitat at Preston Big Spring for native fishes of the White River Valley. In addition to restoring fish habitat, the USFWS hopes to install fish screens at the pipeline intake structure in order to deliver water to irrigation users without entraining fish and to restore 35 acres of riparian habitat and an additional 35 acres of upland sagebrush/herbaceous understory habitat for migratory and breeding birds (B. Nielsen 2005, pers. comm.). The restoration and fish re-introductions would be accomplished through development of a Safe Harbor Agreement and Multi-species Candidate Conservation Agreement with Assurances between landowners, irrigation companies, the USFWS, and the NDOW. The White River Fishes Recovery Implementation Team is currently negotiating with private landowners and irrigation districts to begin carrying out these actions (B. Nielsen 2005, pers. comm.).

Several of the other slightly disturbed sites offer great restoration opportunities. Working with private landowners to exclude or limit livestock use around the spring heads and a short distance downstream at Wambolt Springs could help ensure the survival of endemic Lake Valley springsnail. Cottonwood Spring and Lone Tree Spring are both on the Pahranagat NWR, which is owned and managed by the USFWS. These systems are historic habitat for the Pahranagat speckled dace. The Pahranagat speckled dace was thought to be extirpated from systems on the refuge by 1999, because of habitat loss resulting from vegetation encroachment and drought (Stein et al. 2000). Our surveys found Pahranagat speckled dace at the terminus of Cottonwood Spring in a ditch that the NDOW has called North Cottonwood Spring. Cottonwood Spring, Lone Tree Spring, and Maynard Spring all could be improved for the benefit of Pahranagat speckled dace by removing some of the existing vegetation and allowing more water to flow in a defined channel.

Eight of the 93 sites that received disturbance evaluations were perennial, categorized as highly disturbed, and had springsnails, as well as a sensitive species. Two of these sites, Ash Spring and Crystal Spring, also had sensitive species that had been extirpated. In addition, both of these sites have nonnative fauna. In a third system, Hiko Spring, sensitive fish and springsnail species have been extirpated. Since Ash Spring and Crystal Spring have unique and endemic biological communities that appear to be in great peril, they should be high priorities for restoration.

Sensitive species at Crystal Springs include the Federally endangered Hiko White River springfish, as well as the endemic Hubbs springsnail. Sensitive species at Ash Springs include the Federally endangered White River springfish and the Pahranagat pebblesnail. Hiko Spring currently houses a population of the Federally endangered Hiko White River springfish and was formerly home to the only other known population of the Hubbs springsnail. Additionally, populations of the Pahranagat roundtail chub, Pahranagat speckled dace, and White River desert sucker have been extirpated from all these systems (Courtenay et al. 1985, Tuttle et al. 1990). In addition to nonnative fishes, both systems have been highly modified for irrigation and recreational uses.

Restoration opportunities exist at all of these systems, but they must be accomplished with attention to private landowners and cultural-use needs. Ideally, nonnative fishes could be completely removed from a portion of the systems, and fish barriers could be constructed to prevent re-invasion. At the same time, the concrete soaking pool and rock dam could be removed at Ash Springs. Similarly, the head gate facilities and pipes and ditches that direct water for irrigation out of Crystal Spring and Hiko Spring could be removed, or moved downstream. Any such changes to irrigation structures at these areas would require cooperation from the private landowner, within the constraints of current water rights. The concrete bathing pools and diversions at the head of Ash Springs are publicly owned (BLM). However, this area has long been a recreational swimming and picnic area, so improvements for the biota would have to be reconciled with existing recreational uses.

The NDOW has been attempting restoration efforts at these three locations. They have instituted a program to mechanically remove nonnative fishes at Crystal and Hiko Springs to benefit the Hiko White River springfish, and they attempted a similar program at Ash Spring to benefit the White River springfish (Hobbs et al. 2005). The NDOW has also been working with landowners at all three sites to oversee future development and investigate potential avenues for habitat restoration (Hobbs 2006).

Big Springs, Big Springs Creek, Clay Springs, and Flag Springs were also categorized as highly disturbed and have springsnails, and at least one sensitive species. The spring source for Big Springs and Big Springs Creek is on private land and is heavily impacted by anthropogenic impacts (including roads, residences, and diversion), as well as livestock use. Downstream public and private areas are also impacted by livestock use. Despite these perturbations the Big Springs system has managed to maintain a healthy native fish community, and two species of springsnail continue to persist. Working with the landowner at this site to reduce the anthropogenic and livestock impacts, in at least the upper portion of this system, should be a high priority. Clay Spring has a boxed head and heavy livestock trampling, but it still maintains a population of the longitudinal gland springsnail, which is considered sensitive by both the State of Utah and the State of Nevada (NVNHP 2004, UDWR 2005). Managing flows and livestock use near the spring head and a portion of the outflow channel would help ensure the future of this species. Percy Spring has a host of diversion impacts dating back to the time when Fish Springs

NWR was a frog farm. However, native Utah Chub and two species of springsnail, including the sensitive desert tryonia, still exist here. Although the system is protected from further impacts because it is part of the refuge, it may still benefit from a well-planned restoration effort.

While Middle Flag Springs was classified as highly disturbed based on its proximity to roads and the residences of the Kirch WMA, the Flag Springs complex currently supports the only wild population of the endangered White River spinedace, as well as populations of the Flag springsnail and the White River Valley springsnail. White River desert sucker and White River speckled dace are also found in the Flag Springs/Sunnyside Creek complex. Efforts have been made to remove largemouth bass and prevent re-invasion, as well as to provide additional water to portions of this complex (Scoppetone et al. 2004b, Hobbs et al. 2004, Hobbs et al. 2005). The spring complex is located on the Kirch WMA, which provides the system with protection from future perturbation.

Additional habitat restoration options have been investigated for the Flag Springs complex. A draft restoration plan was developed for Flag Springs that examined the current and historical geology and geomorphology of the complex (Gourley 2000). Gourley (2000) offered several alternatives for altering the existing and relic spring brook channels at Flag Springs to maximize fish habitat or mimic historical conditions. He also provided recommendations to increase the amount of water and sediment to the complex, as well as to remove a constructed pond in the spring system. The restoration plan was never finalized, primarily because of insufficient funds to implement the projects (Hobbs 2006a).

Most of the sites we categorized as moderately disturbed could be substantially improved by managing livestock near the spring source and a portion of the outflow channel. Potential high-priority springs that were moderately disturbed include Brownie-Deacon Springs, Coyote Springs (Tule Valley), South Flag Springs, Indian Spring, Miller Spring, Shoshone Pond #1, Sunnyside Creek (lower), Twin Spring, the Unnamed Spring North of Big Springs #1, Willow Spring (Tule Valley), and all the springs located on Fish Springs NWR. All of these systems have sensitive species concerns, and some of them already receive some level of protection, management, or restoration. For instance, the NDOW actively manages Shoshone Pond #1 for Pahrump poolfish, and Maynard Spring is on the Pahranagat NWR, which is managed by the USFWS.

The UDWR is currently managing for the protection of Columbia spotted frog at Coyote Springs and Willow Spring in Tule Valley and for least chub and Columbia spotted frog at Miller Spring and Twin Spring in Snake Valley. Miller Spring has a grazing exclosure around the ponded head, but the outflow channel is heavily impacted by livestock trampling. The Bishop Springs complex includes Twin Springs, which has a grazing exclosure around the south head. The UDWR recently added the Bishop Springs complex to the State of Utah's Watershed Initiative Habitat Restoration List, with construction of a grazing exclosure around the north head of Twin Springs, attempting to secure long-term flows from Foote Reservoir, and purchasing a conservation easement listed as potential restoration and management actions (D. Auer 2006, pers. comm.). As with the Bishop Springs complex, Coyote Springs and Willow Spring in Tule Valley have recently been added to the State of Utah's Watershed Initiative Habitat Restoration List. Potential future restoration actions identified for these systems include possible vegetation management or other spring renovations, along with maintenance of the grazing exclosure at Willow Spring (D. Auer 2006, pers. comm.).

As discussed previously, restoration activities at the Flag Springs complex, including Sunnyside Creek, have already been examined, and some have been implemented. Indian Spring is another system in White River Valley that has undergone habitat restoration for the benefit of several native species, including the Federally endangered White River spinedace. In 2002 the spring sources and their outflows were renovated by the USFWS, with cooperation from the private landowner, to provide better habitat for a refugia population of White River spinedace (USFWS 2003). Several of the systems in White River Valley that we were not able to access are moderately to highly disturbed, have sensitive species, and have other sensitive species that have been extirpated from them. The USFWS is looking into partnerships with private landowners in White River Valley to attempt to implement Candidate Conservation Agreements and/or restoration efforts at Arnoldson, Cold, Nicholas, and Lund Springs (B. Nielsen 2005, pers. comm.). The USFWS is also working with private landowners to restore the spring head and outflow at Moorman Spring, and to utilize downstream water sources for irrigation versus taking water at the spring heads of Hardy Spring and Emigrant Spring (B. Nielsen 2005, pers. comm).

The Deacon Springs portion of Brownie-Deacon Springs, along with a marshy area in the valley bottom, contain a Pahranagat speckled dace population, but the habitat at this location is less than ideal. Hobbs et al. (2005) indicated that deepening and narrowing the outflow channel at Deacon Spring may provide better habitat for Pahranagat speckled dace, while discouraging the nonnative western mosquitofish. Managing livestock use, and potentially purchasing a conservation easement, around the Unnamed Spring North of Big Springs #1 could help ensure the persistence of the longitudinal gland springsnail at that location.

Species Translocation and Refugia Possibilities

In addition to habitat restoration and nonnative species renovation, there may also be opportunities to translocate sensitive species to refugia habitats within and between valleys in the BRSA. Translocations have already occurred in several valleys to establish refugia populations of rare fish species including White River spinedace to Indian Springs and relict dace and Pahrump poolfish to the Shoshone Ponds Natural Area. The NDOW has also attempted to establish a Pahranagat speckled dace population at Maynard Spring (Stein et al. 2000). Other re-introductions and translocations have been considered. The USFWS has several restoration ideas to develop additional habitat for the reintroduction of White River spinedace (B. Nielsen 2005, pers. comm.). Hogrefe and Fridell (2000) identified Tule Springs as a possible translocation site for least chub. The Utah Department of Natural Resources funded an effort to identify translocation and range expansion sites for Columbia spotted frog and least chub throughout the Bonneville Basin in Utah (Keleher and Barker 2004).

During our 2004-2006 surveys, we identified several other areas that may be conducive to fish translocations (Table 103). We selected these sites based on a visual inspection of the habitat and a brief examination of the habitat parameters needed by the species to be potentially translocated (Sigler and Sigler 1987, Sigler and Sigler 1996, Keleher and Barker 2004). We did not embark on a full analysis of land ownership, compliance issues, and other logistical constraints. The list simply represents some possible areas that may be suitable for range expansions or refugia populations. Serious consideration of translocation or refugia populations would require additional data collection to determine seasonal fluctuations in productivity and water quality, as well as a detailed examination of the agreements and compliance documents needed for such activities.

Table 103. Potential translocation or refugia sites in the BRSA.

SITE	VALLEY	POTENTIAL SPECIES
Caine Spring	Snake	least chub, Columbia spotted frog
Callao Big Spring	Snake	least chub
North Little Spring	Snake	least chub, Columbia spotted frog
Cane Spring	Pleasant	least chub
North Millick and South Millick Springs	Spring	White River or Pahranagat speckled dace
Unnamed Spring at Minerva #1	Spring	Pahrump poolfish, relict dace, least chub, White River or Pahranagat speckled dace
West Valley Spring Complex # 5	Spring	Pahrump poolfish, relict dace, least chub, Preston White River springfish, White River or Pahranagat speckled dace
Hiko Spring	White River	Hubbs springsnail

Limitations

While we have provided a preliminary idea of some priority areas for restoration, examining additional logistical factors may provide more information on the actual feasability of implementing restoration projects at various sites. Additionally, we utilized the disturbance level we assigned the system to highlight the restoration priorities. The fact that our disturbance rankings were highly subjective is a drawback to interpreting our data on the disturbance rank for each site. While we noted the presence of different disturbance factors, we used professional judgement to provide the overall ranking for the site. Several other researchers have applied less-subjective methods to assess disturbance at spring systems and desert wetlands (Sada and Nachlinger 1995, Sada and Nachlinger 1997, Hogrefe and Fridell 1999, Sada 2000, Keleher and Rader 2003, Sada 2005a). We chose to evaluate disturbance by listing the factors contributing to perturbation and assigning an overall rank, in order to decrease our sampling time at each given location.

Our objective as assigned by the SNWA and the TAT was to conduct less-intensive surveys at as many springs as possible to provide a summary of the current biological condition of the aquatic communities at each site. However, in future survey efforts and as a portion of any long-term monitoring program, we feel that a disturbance evaluation that provides a more detailed, less-subjective disturbance ranking, as well as highlights which disturbance factors contributed the most to that ranking, would be useful. Keleher and Rader (2003) provide a disturbance evaluation system that ranks individual disturbance factors. We propose to develop a disturbance evaluation protocol based on Keleher and Rader (2003) but incorporate items from our 2004-2006 surveys that we feel are important. Information from this more detailed evaluation should better reveal seasonal and annual changes to the impacts observed at different springs, which would provide a more precise measure of the baseline disturbance level at a given location.

SUMMARY

We visited 82% (83) of the 101 aquatic systems of interest in the BRSA identified by the SNWA for surveys in 2004-2006. We performed Level 2 surveys at 92 sites and Level 1 surveys at 12 sites. Additionally, we visited one system within the BRSA during our reconnaissance trip, Geyser Spring in Lake Valley, that we chose not to survey because it was in the mountain block. We visited sites in every valley within the BRSA, except for Cave Valley.

The aquatic systems of interest we investigated in the BRSA varied in their size and configuration both within and between valleys. We found small rheocrenes, such as the Unnamed Springs East of Cleve Creek in Spring Valley, as well as springs that fed extensive streams or marsh systems such as Ash Springs in Pahranagat Valley, Big Springs in Snake Valley, and Coyote Spring in Tule Valley. The systems of interest also varied in water quality and habitat quality. During our surveys or recent surveys by other researchers, four springs (Hot Creek, Moorman Spring, Moon River Spring, and Ash Spring) were found with source temperatures in excess of 30°C, as were an abundance of springs with source temperature less than 15°C. Additionally, we found dissolved oxygen levels as low as 1.02 mg/l and in excess of 9.0 mg/l. The diversity and cover of aquatic vegetation also varied. In Spring Valley alone we found 114 taxa of plants in and around the aquatic systems of interest that we surveyed.

In our surveys or in gathering information from other current survey and monitoring programs, we found Federal status or State sensitive species at aquatic systems in Tule Valley, Snake Valley, Spring Valley, Lake Valley, White River Valley, Cave Valley, Dry Lake Valley, and Pahranagat Valley. Federally listed species included:

- the endangered White River spinedace, which can only be found in the Flag Springs/Sunnyside Creek complex in White River Valley;
- the endangered Pahrump poolfish, which was extirpated from its only known habitat and now persists only in three refugium, one of which, the Shoshone Ponds Natural Area, is located in Spring Valley;
- the endangered Pahranagat roundtail chub, whose last remaining wild population in the Pahranagat River may be extirpated, but a refugium population has been established on Key-Pittman WMA in Pahranagat Valley;
- the endangered White River springfish, known only to occur in Ash Springs in Pahranagat Valley;
- the endangered Hiko White River springfish, known only to occur in Crystal Springs and Hiko Spring in Pahranagat Valley;

- the threatened Big Spring spinedace, which is only found in the Condor Canyon section of Meadow Valley Wash; and

- the threatened Ute Ladies'-tresses, a known population of which occurs near Panaca Big Spring.

In addition to the Federally listed species, two Conservation Agreement species, the least chub and the Columbia spotted frog, were found at aquatic systems of interest in Snake Valley, Utah. Columbia spotted frog was also found at aquatic systems of interest in Tule Valley, Utah.

During our surveys or recent surveys by other researchers, at least 14 species of springsnail were found at aquatic systems of interest throughout the BRSA. With the exception of the Toquerville springsnail and the desert tryonia, all of these species are on the State of Nevada's Rare (At-Risk) species list or the State of Utah's Rare Species List (NVNHP 2004, UDWR 2005). The Pahranagat pebblesnail and grated tryonia are Federal species of concern (NVNHP 2004). While fishes, amphibians, and springsnails had been targeted by former surveys in the BRSA, we found few survey efforts that examined the entire macroinvertebrate community. Throughout the BRSA we collected 254 taxa of aquatic invertebrates in qualitative samples from the 92 sites where Level 2 surveys were performed in 2004, 2005, and 2006.

During our 2004-2006 surveys, we expanded the range of the Toquerville springsnail, finding this species at nine previously undocumented locations. Additionally, the springsnails we found at Tule Spring in Tule Valley, Utah, might be divergent enough from the Toquerville springsnail to be a new species (R. Hershler 2005, pers. comm.). We also expanded the range of the White River Valley springsnail, when we found it in Nicholas Spring. In addition to these10 sites, we also found springsnails at Indian Spring and Tin Can Spring in White River Valley, where they had not been previously noted. Unfortunately, we were only able to collect empty shells, so the species inhabiting Indian Spring and Tin Can Spring remain unknown. Nielsen (2006, pers. comm.) had translocated White River Valley springsnails into Indian Spring after restoration activities at that location. Conversely, we found that the Toquerville springsnails once present at the Unnamed Springs near Cleve Creek in Spring Valley and Knoll Spring in Snake Valley may be extirpated. Similarly, we were unable to find the bifid duct springsnail at Turnley/Woodsman Spring in August 2006. During our fish sampling at Cottonwood Spring in Pahranagat Valley, we found the Pahranagat speckled dace, a species thought to be extirpated from this location. Pahranagat speckled dace is a Federal species of concern and on the State of Nevada's Rare (At-Risk) Species List (NVNHP 2004). We also expanded the range of Utah chub, finding it in two Unnamed Springs near Minerva in Spring Valley. Hubbs and Miller (1948) acknowledged the presence of Utah chub in Spring Valley and noted that Mormon settlers probably introduced this species from the adjacent Bonneville Basin.

Uncovering new locations where springsnails exist, and possibly new species, in the BRSA is not that surprising. While aquatic systems throughout the Great Basin have been inventoried for fishes (e.g., Hubbs 1932, Hubbs and Miller 1948, Deacon et al. 1980, Courtenay et al. 1985), it was only more recently that large-scale surveys were undertaken to examine aquatic invertebrates, particularly mollusks (Hershler 1998). Hershler (1998) surveyed for springsnails in the Great Basin and found 58 previously undescribed species. Also, while some level of continued surveying and monitoring proceeds at systems with rare fish and amphibian species (Tuttle et al. 1990, Scoppetonne and Rissler 2002, Fridell et al. 2004, Scoppetonne et al. 2004a, Scoppetonne et al. 2004b, Wheeler et al. 2004, Hobbs et al. 2005, Mills et al. 2005, Wilson and Mills 2005), these surveys often target one or only a few species. We found few, recent, widespread surveys that targeted both the habitat and the biological communities in the BRSA (Hershler 1998, Keleher and Rader 2003, Sada 2005a). Most of these surveys have been targeted at specific species (springsnails) and have been single efforts. The exception to this is Keleher and Rader (2003) (see also Keleher et al. 2003 and Keleher and Barker 2004), who worked to develop a bioassessment protocol for Bonneville Basin wetlands and restoration, enhancement, and translocation options within the Bonneville Basin for least chub and Columbia spotted frog.

Our goal was to inventory spring systems throughout the BRSA in a one-time survey effort. One-time survey efforts have limitations. Wheeler et al. (2004) and Fridell et al. (2004), along with unpublished data from the UDWR, show that disturbance conditions and even the size and depth of some aquatic systems can change seasonally and annually. A one-time survey effort provides a single snapshot of potential habitat availability for aquatic organisms. We initially planned on performing these surveys during one season to minimize potential variability between sites. Unfortunately, logistical problems did not allow us to realize that goal. Therefore, our one-time surveys at different sites may not be comparable with each other because they were conducted in different seasons and, in some cases, up to 1 year apart. Not only do habitat conditions vary from year to year, but biological communities fluctuate as well. Most of the long-term monitoring data collected by other agencies showed that large, annual fluctuations can occur in fish and amphibian populations (Fridell et al. 2004, Wheeler et al. 2004, Hobbs et al. 2005, Mills et al. 2005, UDWR unpublished data, Wilson and Mills 2005). Species that occur in low numbers may not even be collected during some years. This is probably also true for invertebrates, since we saw changes in the relative abundance of springsnails within aquatic systems of interest between our survey results and survey results listed in Sada (2005a).

During our surveys we noted the inherent limitations of a one-time survey effort. Our reconnaissance trip in summer 2004 and our surveys in autumn 2004 occurred at the end of a 5-year drought period. Higher-than-average precipitation in the region resulted in considerably wetter conditions in many of the valleys within the BRSA in spring and summer 2005 and 2006. Several systems and valleys that we visited during 2004 and revisited in 2005 and 2006 (e.g., Willard Spring, South Bastion Spring, and systems throughout Spring and Snake Valleys) appeared to have considerably different habitat after the higher-than-average precipitation in winter 2005. Indian Spring provides another example of one-time survey limitations. Considerable channel change accompanied restoration efforts by the USFWS, NDOW, and private landowners at this system in the past few years. It appears as though the disturbance has impacted the springsnail community at this location as we were only able to find empty springsnail shells. Hence we were unable to identify which species may be inhabiting this system. We found no evidence of prior springsnail surveys at this location.

Despite the limitations of our surveys, the 2004-2006 field efforts, combined with information gathering (from resource agencies, academia, and other scientists), provided a baseline inventory of the aquatic communities present in various aquatic systems throughout the BRSA, thereby accomplishing our goal. We found the aquatic communities in the BRSA to be diverse and unique, harboring a number of rare and endemic species. These species are threatened by a number of disturbances, most notably water development (diversion), livestock use (trampling, fecal material, over grazing), and competition and predation from nonnative species. Our results, showing the unique fauna and high level of disturbance at many of these springs, support the work of many other researchers (Courtenay et al. 1985, Miller et al. 1989, Hershler 1998, Sada and Vinyard 2002, Fridell et a. 2004, Wheeler et al. 2004, Mills et al. 2005, Wilson and Mills 2005, Sada 2005a), once again indicating that our inventory provided suitable information for an initial baseline inventory in the BRSA. However, the selection of a subset of aquatic systems for more intensive baseline data collection and, eventually, long-term monitoring would also provide a more accurate assessment of baseline conditions throughout the BRSA.

RECOMMENDATIONS

As discussed in the summary, while our 2004-2005 survey efforts initiated a baseline inventory of aquatic communities in the BRSA, additional effort could provide a more complete inventory, as well as an initial set of baseline conditions. Toward that end we recommend the following:

1. If access becomes available, complete surveys at aquatic systems of interest identified, but not sampled during the 2004-2006 surveys.

The 18 systems of interest that we did not survey during 2004-2006 were all on private land. We did not survey these sites because we were either denied access by the landowner, or we could not make contact with the current landowner. If properties change hands, or more information becomes available about the current landowners of certain sites, the remaining systems of interest we originally identified should be surveyed.

The most critical systems that remain unsurveyed are in Cave Valley and White River Valley. We only identified two aquatic systems of interest in Cave Valley, and we were unable to gain access to survey either of these sites. Therefore, we did not perform any surveys of aquatic communities in Cave Valley. One of the systems of interest in Cave Valley contains a population of the Hardy springsnail, which is on the Nevada Rare (At-Risk) Species List. Similarly, White River Valley has several unique fish and invertebrate species. The SNWA identified 20 aquatic systems of interest in White River Valley, but we were only able to perform Level 1 or Level 2 surveys at 10 (50%) of these systems. We were denied access to nine of the remaining systems, and we could not find landowner information for one system. Several of these springs contain sensitive species and/or have had sensitive species extirpated from them (e.g., Cold Spring, Moon River Spring, Moorman Spring). Exploration of systems in Hamblin Valley may also be helpful. Continuing to pursue and gaining access to these areas will provide a more complete baseline assessment of aquatic resources in the BRSA.

2. Develop and implement more intensive baseline condition surveys at a subset of aquatic systems of interest that can be used as the basis for future long-term monitoring programs.

Based on the results of the 2004-2006 surveys and the successes and failures of other survey and monitoring efforts (e.g., Hogrefe and Fridell 2000, Keleher and Rader 2003, Sada 2005a), we recommend initiating more intensive baseline data collection at a subset of the aquatic systems of interest in the BRSA. We believe that more intensive data collection is necessary to improve upon the baseline inventory initiated by a one-time survey effort. This baseline will be critical in future determinations of impacts associated with water development and other human activities.

Developing more quantitative biological, habitat, and disturbance assessment protocols that incorporate seasonal and annual variability will be key components of this program.

As was seen in the August 2004 meeting, many resource managers and professionals had differing views on how to select the best sites for more intensive surveys. We agree that several options exist for identifying a subset of aquatic systems for additional baseline data collection. For example:

- Additional data collection could focus on systems with rare species, which already receive the bulk of the attention, or on supplementing existing programs by concentrating on systems that receive less attention.

- Additional data collection could focus on systems most likely to be impacted (based on hydrologic modeling) or systems with a full complement of aquatic organisms.

- Additional data collection could focus on tracking systems that are already in peril from disturbance or on protecting systems that represent minimally impacted conditions.

- Additional data collection could focus on providing a representation of all the biological, hydrological, and anthropogenic conditions present in the BRSA.

These are just a few of the considerations that should be discussed before selecting a subset of systems for additional data collection or long-term monitoring. Regardless of the systems selected, understanding seasonal and annual variability in these systems will provide a more complete picture of “baseline” conditions at aquatic systems of interest throughout the BRSA.

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INTRODUCTION

Ute ladies'-tresses (*Spiranthes diluvialis*), a white-flowered orchid, occurs in low- to mid-elevation wetlands and riparian zones of the Central Rocky Mountains. Ute ladies'-tresses was listed as Threatened under the ESA on January 17, 1992, because of its rarity, low population sizes, and threats of loss or modification of riparian habitats (U.S. Fish and Wildlife Service 1992). In 1995, the Section 7, Endangered Species Act, consultation guidelines for Ute ladies' tresses identified Priority Survey Areas for states containing populations, as well as adjacent states known to have potential habitat (U.S. Fish and Wildlife Service 1995). Specific habitats to be looked at includes all riparian and wetland communities below 7,000 feet.

The SNWA's proposed GWD project has the potential to affect the aquatic systems in and adjacent to the project area. Therefore, the SNWA contracted BIO-WEST to conduct surveys for Ute ladies'-tresses at aquatic systems within the BRSA. Because of immediate concerns regarding Ute ladies'-tresses habitat and long-term demographic patterns, several springs in Snake and Spring Valley, Nevada and Utah, were chosen for the initial Ute ladies'-tresses survey work. The flowering period of Ute ladies'-tresses occurs from mid to late August; hence the peak flowering period had passed when surveys were began in early September. As an alternative, and because of Ute ladies'-tresses propensity for prolonged dormancy, habitat was evaluated for potential Ute ladies'-tresses occurrence. This information is important to the examination of rarity patterns in a broader sense and the understanding of habitat relationships between common and rare species (Kunin and Shmida 1997).

Ute Ladies'-tresses Ecology

Other than its affinity for certain wetland habitats, little was known about Ute ladies'-tresses habitat requirements until recently. All populations of this species have been found on wetland sites that remain moist throughout the growing season (USFWS 1992). In Utah Ute ladies'-tresses is most often found in old stream channels and on recently deposited material within the floodplain of adjacent rivers (UNHP 1994). Groundwater and river water contribute to the wetland hydrology of such sites. Blooming Ute ladies'-tresses plants have been observed in inundated conditions and in merely moist conditions (Gecy 1994, Riedel et al. 1994, Ripple 1994). Historical accounts and herbarium records indicate that Ute ladies'-tresses was once more common within its present range (Coyer 1990, Jennings 1990, Coyer 1991). The most likely reason for the decrease in Ute ladies'-tresses abundance is disturbance and fragmentation of riparian habitat as a consequence of dam building and grazing during the last 100 years (Coyer 1990).

Vegetation associated with Ute ladies'-tresses is variable, but its physiognomy is consistent. Canopy cover above 1.5 m is low, while canopy cover below this height includes mixed densities of other species. The most important environmental parameter, apart from soil moisture, appears to be exposure to sunlight. Ute ladies'-tresses thrives in full sunlight or partial shade. While some plants in a few colonies are found at shady sites, they are often observed to be less than vigorous (the plants are leggy and the seed set seems low) (Gecy 1994, Ripple 1994).

In most instances, soils that support Ute ladies'-tresses populations are alluvial deposits containing a high percentage of gravel and sand (UNHP 1994). However, this may be a coincidental occurrence with open canopy alluvial wetland sites; some populations have been found in both clay (Manci and Wheeler 1994) and highly organic soils (UNHP 1994).

METHODS

Fieldwork

Ute ladies'-tresses plants can only be accurately identified and counted when they are in flower, preferably during the peak of the bloom period. The leaves of the plant look very much like grass blades or other narrow-leaf plants, and the senescent flower heads blend into surrounding vegetation. Therefore, to determine whether proper phenological conditions existed for a Ute ladies'-tresses survey, a site visit was conducted on September 2-3, 2006, to assess a known population of Ute ladies'-tresses near Panaca, Nevada (Figure 38). After an exhaustive search of the site, only three individual Ute ladies'-tresses plants were found. These plants were past the flowering period and in the fruiting and senecent stage of growth (Figure 39). Surveys for plants in this condition are not considered valid except when intensively conducted on very small areas. Therefore, it was decided that the late phenologic condition of the Ute ladies'-tresses at the reference site meant that a survey would not be valid at this time of year (after September 2006).

However, because information was needed to assess potential habitat for Ute ladies'-tresses in Spring and Snake Valleys in 2006, site visits were conducted. Eight springs in Snake Valley and 14 springs in Spring Valley were visited. A system of habitat criteria was established to evaluate the springs and determine the potential of Ute ladies'-tresses occurrence at each spring. Habitat criteria included: (1) wetland conditions, (2) canopy density, (3) associated species (plant species often found in Ute ladies'-tresses populations), (4) grazing/herbivory, and (5) other disturbances. These criteria were developed based on previous experience conducting surveys for Ute ladies'-tresses in Utah, Nevada, Idaho, and Colorado, and on available literature. Since an in-depth survey will be conducted during the peak flowering period in 2007, quantitative data were not collected. Instead, qualitative observations were made at each spring. The potential for Ute ladies'-tresses occurrence was then rated for each spring as "very low," "low," "moderate," or "high." A rating of "none" was not used because it is impossible to eliminate the possibility of Ute ladies'-tresses for these springs after the peak flowering or during a single visit.

All of the springs were visited between September 14 and 16, 2006. Vegetation and environmental conditions were assessed. The photos taken at each site show current conditions (Appendix F). Most of these springs have been observed by BIO-WEST personnel in previous years, and data from those visits were helpful in assessing potential habitat for Ute ladies'-tresses.

Figure 38. Ute ladies'-tresses in fruit.

Figure 39. Ute ladies'-tresses habitat near Panaca, Nevada.

RESULTS

Most of the springs assessed during site visits were classified as having moderate potential for Ute ladies'-tresses (Table 104). Although conditions at the springs are not ideal, there is some potential for Ute ladies'-tresses occurrence at these springs based on vegetative cover, hydrology, and soil types. At most of the sites, grazing is a key impact that limits the potential for Ute ladies'-tresses to occur. The Ute ladies'-tresses orchid will grow in areas where cattle graze in the spring, as long as it is not grazed during the flowering period. One spring that was assessed for potential Ute ladies'-tresses habitat, Blind Spring, was rated as very low. This spring is a bermed area with little peripherally saturated soils and is inundated with more than 10 cm of water. The banks are nearly barren, with little to no vegetation cover. In contrast, Swallow Springs was rated as high for possible Ute ladies'-tresses habitat. It exhibits ideal conditions for Ute ladies'-tresses, including saturated soils with moving water, coarse nonalkaline soils, open-canopied habitat, a diverse mix of species (including several associated with Ute ladies'-tresses populations at other locations), and low grazing pressure.

Table 104. Evaluations of springs for the potential for Ute ladies'-tresses occurrence.

SPRING NAME	WETLAND CONDITIONS	CANOPY DENSITY	ASSOCIATED SPECIES	GRAZING/ HERBIVORY	OTHER DISTURBANCES	POTENTIAL OCCURRENCE
	SPRING VALLEY					
Blind	Vegetation is all in standing water	Medium to high	None	High	Bermed	Very low
Cedars	Saturated soils with moving water	Low	Redtop, annual paintbrush	High	Road	Moderate
Layton	Exposed to wet and dry extremes, somewhat alkaline	Low to moderate	Redtop	High	Road	Low
Shoshone Pond #1	Saturation and moving water	Low to moderate	Redtop	High	None	Moderate
Shoshone Ponds #2 (Ponds 1-3)	Saturation and moving water	Low to moderate	Redtop	High	None	Moderate
Shoshone #3	Saturation and moving water	Low to moderate	Redtop	High	None	Moderate
South Bastion Spring	Saturated soils, dry in late summer	Moderate to high	Annual paintbrush, redtop, willowherb	Moderate	Road	Moderate

Table 104. Continued.

SPRING NAME	WETLAND CONDITIONS	CANOPY DENSITY	ASSOCIATED SPECIES	GRAZING/ HERBIVORY	OTHER DISTURBANCES	POTENTIAL OCCURRENCE
	SPRING VALLEY					
Swallow Spring	Saturated soil, moving water	Moderate to low	Annual paintbrush, redtop, willowherb	Low	None	High
Unnamed Spring East of Cleve Creek (East Spring)	Saturated soil, stagnant, alkaline soils	High	Annual paintbrush and willowherb	Low	None	Low to moderate
Unnamed Spring West of Cleve Creek (West Spring)	Alkaline soils, too dry	High	None	Low	None	Low
Unnamed Springs at Minerva-1	Saturated but relatively stagnant	Moderate to high	Willowherb and annual paintbrush	Moderate	None	Moderate
Unnamed Springs at Minerva-2	Saturated soil and moving water	Moderate to low	Willowherb, annual paintbrush, and redtop	High	None	Moderate
Unnamed Springs at Minerva-3	Saturated soil and moving water	Moderate to low	Redtop	Very high	None	Moderate
Willard	Wet but alkaline and highly variable	High	None	High	None	Low

Table 104. Continued.

SPRING NAME	WETLAND CONDITIONS	CANOPY DENSITY	ASSOCIATED SPECIES	GRAZING/ HERBIVORY	OTHER DISTURBANCES	POTENTIAL OCCURRENCE
	SNAKE VALLEY					
Big Springs	Saturated but stagnant	Moderate to high	None	High	Channelization	Low
Big Springs Pond	Saturated but stagnant	Moderate to high	None	High	Channelization	Low
Big Springs Creek	Saturated but stagnant	Moderate to high	None	High	Channelization	Low
Clay Spring	Moist, not saturated	High	None	Low	None	Low
North Little Spring	Saturated but alkaline	High	Some; annual paintbrush	Low	None	Moderate
South Little Spring	Saturated but alkaline	High	Some; annual paintbrush	Low	None	Moderate
Unnamed Big Spring #1	Saturated with moving water	Moderate	None	Moderate	None	Moderate
Unnamed Big Spring #2	Saturated with moving water	Moderate	None	Moderate	None	Moderate

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APPENDIX A: PLANT SPECIES COLLECTED THROUGHOUT THE BIOLOGICAL RESOURCES STUDY AREA (BRSA) DURING VEGETATION MAPPING

Plant species collected throughout the Biological Resources Study Area (BRSA) that were identified or confirmed by the Utah State University Intermountain Herbarium.

COMMON NAME	SCIENTIFIC NAME
Alkali Cordgrass	*Spartina gracilis*
Analogue Sedge	*Carex simulata*
Annual Rabbit-foot Grass	*Polypogon monspeliensis*
Ballhead Ragwort	*Senecio sphaerocephalus*
Baltic Rush	*Juncus balticus*
Birdfoot Deervetch	*Lotus corniculatus*
Boraxweed	*Nitrophila occidentalis*
Cardinalflower	*Lobelia cardinalis*
Common Bladderwort	*Utricularia macrorhiza*
Common Mare's-tail	*Hippuris vulgaris*
Creeping Bentgrass	*Agrostis stolonifera*
Creeping Primrose-willow	*Ludwigia repens*
Crested Wheatgrass	*Agropyron cristatum*
Cutleaf Waterparsnip	*Berula erecta*
Fineleaf Pondweed	*Stuckenia filiformis*
Fringed Willowherb	*Epilobium ciliatum*
Golden Sedge	*Carex aurea*
Idaho Blue-eyed Grass	*Sisyrinchium idahoense*
Liverwort	*Riccia fluitans*
Meadow Deathcamas	*Zigadenus venenosus*
Meadow Bird's-foot Trefoil	*Lotus pinnatus*
Missouri Goldenrod	*Solidago missouriensis*
Nebraska Sedge	*Carex nebrascensis*
Rabbit-foot Grass	*Polypogon monspeliensis*
Rocky Mountain Fringed Gentian	*Gentianopsis thermalis*
Roundleaf Monkeyflower	*Mimulus glabratus*
Sago Pondweed	*Stuckenia pectinatus*
Seaside Heliotrope	*Heliotropium curassavicum*
Seaside Arrowgrass	*Triglochin maritimum*
Seep Monkeyflower	*Mimulus guttatus*

COMMON NAME	SCIENTIFIC NAME
Shortspike Watermilfoil	*Myriophyllum sibiricum*
Sierra Rush	*Juncus nevadensis*
Silverweed Cinquefoil	*Argentina anserina*
Spiny Naiad	*Najas marina*
Spotted Water Hemlock	*Cicuta maculata*
Stiff Blue-eyed Grass	*Sisyrinchium demissum*
Tapertip Rush	*Juncus acuminatus*
Torrey's Rush	*Juncus torreyi*
Water Whorlgrass	*Catabrosa aquatica*
Water Speedwell	*Veronica anagallis-aquatica*
Western False Dragonhead	*Physostegia parviflora*
White Panicle Aster	*Symphyotrichum lanceolatum*
Whitewater Crowfoot	*Ranunculus aquatilis*
Wild Rose	*Rosa woodsii*
Yerba Mansa	*Anemopsis californica*

APPENDIX B: WATER QUALITY PARAMETERS AT AQUATIC SYSTEMS OF INTEREST THROUGHOUT THE BIOLOGICAL RESOURCES STUDY AREA (BRSA)

DELAMAR VALLEY

Spring Name	Location	Northing	Easting	Temperature (C)	Dissolved Oxygen (mg/l)	Conductivity (μS/cm)	pH
Grassy Spring	Source	4157124	695048	15.19	3.96	615	7.46
	Terminus	4157093	695008	11.51	5.38	1198	8.65

DRY LAKE VALLEY

Spring Name	Location	Northing	Easting	Temperature (C)	Dissolved Oxygen (mg/l)	Conductivity (µS/cm)	pH
Bailey Spring	Source	4227571	699053	13.4	4.30	760	7.44
Fence Spring *	n/a	4228033	700145	n/a	n/a	n/a	n/a
Coyote Springs	Source	4211323	687714	26.39	10.3	366	8.6

* Not enough water to sample.

FISH SPRINGS

System Name	Location	Northing	Easting	Temperature (C)	Dissolved Oxygen (mg/l)	Conductivity (μS/cm)	pH
Percy Spring	Canal at Percy inflow	4411505	295680	25.11	11.53	327	8.34
Percy Spring	Source	4411650	295376	26.7	4.18	323	7.46
Percy Spring	Source	4411674	295397	29.61	13.54	336	9.73
Percy Spring	Terminus	4411545	295620	27.78	11.38	324	8.37
Middle Spring	Source	4412618	295136	27.44	3.9	214	7.35
Middle Spring	Terminus	4412719	295302	25.61	2.79	315	7.46
Thomas Spring	Source	4413151	295050	20	3.9	251	7.49
Thomas Spring	Source	4413112	295125	25.72	4.72	215	7.44
Thomas Spring	Terminus	4413043	295241	28.17	3.86	215	7.37
North Spring	Source	4417762	293699	27.72	14.05	493	8.28
North Spring	Terminus	4417893	293884	29	11.94	534	8.12
Deadman Spring	Source	4416707	294189	30.33	13.85	379	7.91
Deadman Spring	Source			31.29	6.55	396	8.38
Deadman Spring	Terminus	4416805	294519	33.5	12.53	426	9.12
House Spring	Source	4413684	295098	24	2.79	320	7.39
House Spring	Terminus	4413530	295219	23.22	5.82	320	7.71
Mirror Spring	Source	4413530	295219	24.5	4.64	316	7.46
Mirror Spring	Source	4413506	295197	23.56	2.9	318	7.42
Mirror Spring	Terminus	4413585	295357	24.56	7.17	317	7.71
Walter's Spring	Source	4415953	294540	22.17	8.22	342	7.81
Walter's Spring	Source	4415979	294540	24.78	9.21	336	7.9
Walter's Spring	Terminus	4416019	294768	29.67	11.02	347	8.77
South Spring	Source	4411860	295450	28.28	4.2	316	7.37
South Spring	Terminus	4411849	295704	27.89	7.27	318	7.7
Crater Spring	Source	4411933	295593	25.78	3.08	319	7.5
Crater Spring	Terminus			29	8.71	317	8
Lost Spring	Source	4412287	295431	26.83	3.84	318	7.51
Lost Spring	Terminus	4412450	295673	27.28	6.02	318	7.81

LAKE VALLEY

Spring Name	Location	Northing	Easting	Temperature (C)	Dissolved Oxygen (mg/l)	Conductivity (μS/cm)	pH
Wambolt Spring	Source 1	4278458	705553	18.37	3.94	331	7.35
	Source 2	4278552	705585	18.28	3.24	348	7.32
	Terminus	4278358	705770	14.25	4.97	779	7.85

MEADOW VALLEY WASH

Spring Name	Location	Northing	Easting	Temperature (C)	Dissolved Oxygen (mg/l)	Conductivity (μS/cm)	pH
Panaca Town Spring	Source	4187628	730588	27.9	5.62	418	7.93
	Terminus 1	4187643	730495	29.7	8.06	405	8.25
	Terminus 2	4187612	730529	29.7	8.05	406	8.23

PAHRANAGAT VALLEY

System Name	Location	Northing	Easting	Temperature (C)	Dissolved Oxygen (mg/l)	Conductivity (μS/cm)	pH
Ash Spring	Source 1	4147658	659915	34.8	3.17	460	7.26
	Source 2	4147633	659936	34.0	1.97	461	7.16
	Source 3	4147622	659934	35.7	1.99	457	7.11
	Source 4	4147608	659948	33.9	1.71	468	7.26
	Terminus	4147609	659909	33.9	2.04	463	7.21
BLM Spring	Source	4122909	668839	13.9	2.06	1021	7.02
Brownie-Deacon Spring	Source	4149891	658155	16.2	3.34	733	8.13
	Terminus	4149895	658182	15.8	3.27	622	8.13
Cottonwood Spring	Source	4123440	667340	20.3	2.72	801	7.04
	Terminus	4123547	667530	15.2	5.86	1050	7.62
Crystal Spring	Source 1	4155375	656095	26.1	2.41	419	8.15
	Source 2	4155372	656060	25.4	4.78	517	8.28
	Source 3	4155332	656055	27.4	1.02	398	8.08
	Source 4	4155297	656082	27.2	1.54	204	8.02
	Terminus 1	4155339	656080	26.4	2.48	397	8.08
	Terminus 2	4155346	656246	27.1	3.93	397	8.26
	Terminus 3	4155267	656148	24.5	2.90	710	8.17
	Terminus 4	4155330	656116	27.9	4.12	395	8.39
Hoyt Spring *	n/a	4118957	673281	n/a	n/a	n/a	n/a
Lone Tree Spring	Source	4118816	4118794	18.2	2.98	1089	7.32
	Terminus	4118783	671559	14.9	6.23	1115	7.53
Maynard Spring	Source 1	4117711	674523	17.9	1.43	909	7.16
	Source 2	4117770	674415	12.1	2.01	864	7.17
Hiko Spring	Source	4162551	657639	26.02	3.6	513	6.79
	Terminus	4162403	657511	18.67	6.85	841	7.47

* Spring was dry at time of sampling (10/5/04)

PLEASANT VALLEY

System Name	Location	Northing	Easting	Temperature (C)	Dissolved Oxygen (mg/l)	Conductivity (μS/cm)	pH
Cane Spring	Source	4395858	752320	13.5	5.87	539	7.53
	Terminus	4395750	752416	15.6	7.47	407	8.46

SNAKE VALLEY

System Name	Location	Northing	Easting	Temperature (C)	Dissolved Oxygen (mg/l)	Conductivity (μS/cm)	pH
Big Spring	Source 1	4287280	749398	17.2	4.90	380	7.59
	Source 2	4287288	749404	17.2	5.05	379	7.58
	Source 3	4287306	749431	17.4	5.14	383	7.61
	Terminus 1	4287272	749457	17.8	5.53	380	7.75
	Terminus 2	4287280	749456	17.6	5.32	380	7.65
Big Spring Creek Section #2	Source	4287309	749565	17.8	6.20	383	7.76
	Terminus	4287400	749638	18.0	7.20	381	7.94
Big Spring Impoundment Pond	Source	4287165	749462	21.0	6.07	401	8.54
Caine Spring	Source	4336077	755165	15.6	5.28	452	7.60
	Terminus	4336109	755194	19.3	6.24	448	7.61
Clay Spring	Source	4305905	240331	13.2	2.47	675	8.02
	Terminus	4305903	240158	13.5	5.99	613	8.04
Cold Spring	Source	4371260	245640	9.83	5.66	663	7.63
	Terminus	4371227	245757	14.9	8.66	642	8.08
Gandy Warm Spring	Source 1	4371610	754751	20.6	4.66	489	7.58
	Source 2	4371828	754989	25.1	4.42	481	7.63
	Terminus	4371776	755198	23.4	4.75	482	7.75
Knoll Spring	Source	4347219	251653	16.3	5.34	638	7.69
	Terminus	4347290	251663	13.2	2.47	675	8.02
Leland Harris Spring	Source	4383031	251996	14.1	3.77	598	8.31
	Terminus	4383073	252177	15.0	3.08	597	8.25
Miller Spring	Source	4384885	254028	11.8	4.91	1194	7.48
	Terminus	4385008	253994	10.3	8.20	1510	7.67
North Little Spring	Source 1	4286205	751006	19.1	3.97	386	7.75
	Source 2	4286247	750985	16.6	7.24	311	8.11
South Little Spring	Source 1	4285166	751319	11.3	4.10	1112	7.58
	Source 2	4285266	751215	16.2	2.88	1062	7.16
	Terminus	4285208	751414	15.5	2.74	802	6.85
Twin Springs	Source 1	4365242	253587	20.7	5.21	749	7.64
	Source 2	4365250	253530	9.74	7.53	684	8.24
	Terminus 1	4365295	253343	20.5	6.57	749	7.98
	Terminus 2	4365118	253338	18.8	6.13	749	7.91
Unnamed Caine Spring	Source	4335505	754872	16.1	2.78	566	7.06
Unnamed Caine Spring - North *	n/a	4335562	754903	n/a	n/a	n/a	n/a
Unnamed Caine Spring - South *	n/a	4335363	754826	n/a	n/a	n/a	n/a
Unnamed Big Spring #1	Source	4289275	750270	14.8	4.61	464	7.17
	Terminus	4289284	750272	13.5	4.44	456	7.03
Unnamed Big Spring #2	Source	4290528	750504	22.2	7.59	618	7.07
North Gandy Complex	Source	4374468	249197	15.61	7.23	502	762
North Gandy Complex	Source	4374467	249220	16	5.56	502	7.32
North Gandy Complex	Source	4374459	249216	18.33	5.64	526	7.11
North Gandy Complex	Source	4374429	249219	17	2.2	515	7.36
North Gandy Complex	Source	4374433	249165	18.56	2.88	552	7.28
Middle Gandy Complex	Source	4373904	248721	20.28	6.55	524	7.68
Middle Gandy Complex	Source	4373897	248712	17.6	7.48	533	7.41
Middle Gandy Complex	Source	4373892	248712	28.78	2.78	507	7.46
Middle Gandy Complex	Source	4373887	248703	21.11	2.61	491	7.41
Middle Gandy Complex	Source	4373877	248698	15.11	1.5	501	7.46
Middle Gandy Complex	Source	4373883	248691	17.78	4.85	507	7.73
Middle Gandy Complex	Source	4373862	248663	26.61	5.77	481	8.14
Middle Gandy Complex	Source	4373845	248639	19	4.78	559	7.47
Middle Gandy Complex	Source	4373820	248587	26.39	9	508	8.13
North Beck Springs	Source	4354589	758015	15.83	7.78	456	7.65
North Beck Springs	Terminus	4354503	758183	16.94	7.11	463	7.84
South Beck Springs	Source	4354305	758019	17.5	7.37	494	7.47
South Beck Springs	Terminus/south pond	4354261	758029	21.67	8.23	488	7.4
Bishop Spring	Source	4366633	252967	22.5	5.39	780	7.46
Bishop Spring	Terminus	4366556	252938	22.17	6.46	783	7.5
Gandy South G44	Source	4372245	248410	14.61	2.4	581	7.57
Gandy South G48-G49	Source	4371885	248397	13.28	3.63	1173	7.55
Gandy South G48-G49	Source	4371880	248295	12.89	6.55	760	7.47
Gandy South - G51	Source	4371572	248503	16	5.59	459	7.58
Callao Big Spring	Source	4421004	267694	20.06	6.65	701	8.12
Callao Big Spring	Source	4420970	267738	1	4.7	560	7.81
Callao Big Spring	Source	4421049	267690	20.17	5.67	781	7.81
Callao Big Spring	Terminus			22.5	5.15	702	7.84
Unnamed Spring at skating pond	confluence of N and S heads	4422122	268034	18.94	4.03	531	7.86
Unnamed Spring at skating pond	Source	4422093	268068	25.06	4.05	774	7.42
North Gandy Complex	Source	4374412	249189	16.41	3.33	500	7.55
Swimming Hole	Source	4421468	267536	22.61	2.31	1158	7.19
Knoll Spring	DRY	4348069	252260	DRY	DRY	DRY	DRY

*Not enough water to sample

SPRING VALLEY

System Name	Location	Northing	Easting	Temperature (C)	Dissolved Oxygen (mg/l)	Conductivity (µS/cm)	pH
Blind Spring	Source	4297821	724797	17.1	2.04	449	6.85
Cedars Spring	Source	4312893	723713	23.9	4.91	130	8.79
	Terminus	4312826	723515	24.2	3.19	160	7.94
North Millick Spring	Source 1	4353757	725751	14.1	7.11	452	7.40
	Source 2	4353801	725748	13.0	4.81	456	7.07
	Terminus	4353954	725598	12.0	5.80	462	7.33
Shoshone pond #1	Source	4313252	723804	21.6	4.72	120	9.62
	Terminus	4313127	723699	19.5	7.26	107	9.13
Shoshone ponds #2	Source 1	4312868	723708	28.8	3.94	112	9.28
	Source 2	4312851	723715	23.7	5.67	135	8.20
	Source 3	4312834	723721	23.0	1.70	128	7.87
Shoshone #3	Source	4312769	723802	26.4	6.73	114	9.11
South Millick Spring	Source	4353409	725214	14.7	5.24	456	7.03
	Terminus	4353544	725135	16.1	6.66	466	7.36
Swallow Spring	Source 1	4302867	728688	10.6	5.82	289	8.02
	Source 2	4302924	728634	11.5	5.28	285	8.05
	Terminus	4302894	728568	12.4	5.51	276	8.41
Unnamed East of Cleve Ck. - Eas	Source	4342222	719181	17.6	4.21	345	6.93
	Terminus	4342171	719255	17.8	5.79	315	7.51
Unnamed East of Cleve Ck. - West	Source	4342339	719059	20.4	5.38	326	7.13
Unnamed Minerva 1	Source	4301037	726116	11.8	5.69	353	8.08
	Terminus 1	4300960	725943	14.4	7.10	346	8.22
	Terminus 2	4300921	725933	12.2	9.30	311	8.03
	Terminus 3	4300944	725913	12.1	8.17	313	7.99
	Terminus 4	4301001	725905	23.4	7.70	514	8.50
Unnamed Minerva 2	Source 1	4302413	725447	12.8	6.31	353	8.11
	Source 2	4302400	725396	13.8	3.83	560	8.12
	Source 3	4302421	725406	12.2	6.02	335	8.11
	Terminus 1	4302390	725361	12.6	5.66	333	8.10
	Terminus 2	4302450	725381	13.2	4.95	465	8.14
Unnamed Minerva 3	Source 1	4303946	725153	15.0	7.59	735	8.15
	Source 2	4303902	725158	17.0	5.23	821	7.83
	Source 3	4303883	725165	12.8	5.46	711	7.84
	Terminus	4303787	725046	20.1	7.48	695	8.32
Unnamed Spring 1 - north of	Source	4412432	708682	11.2	8.98	381	7.21
	Terminus	44123483	708700	8.7	9.93	380	7.63
West Spring Valley Complex 1	Source 1	4353585	717563	10.5	1.92	516	6.74
	Source 2	4353575	717463	12.6	4.46	429	7.02
	Terminus	4353640	717539	13.2	4.49	311	6.99
West Spring Valley Complex 2	n/a	4353399	717445	n/a	n/a	n/a	n/a
West Spring Valley Complex 3	n/a	4352831	717586	n/a	n/a	n/a	n/a
West Spring Valley Complex 4	n/a	n/a	n/a	n/a	n/a	n/a	n/a
West Spring Valley Complex 5	Source	4352590	717572	19.1	7.84	414	7.49
	Terminus	4352688	717693	14.6	5.51	456	7.54
West Spring Valley Complex 6	n/a	4352540	717561	n/a	n/a	n/a	n/a
Willard Spring	Source	4324008	718664	26.2	3.00	366	7.82
	Terminus	4324038	718600	26.1	4.55	350	8.35
Willow Spring	Source	4396868	713838	13.5	3.56	442	6.96
	Terminus	4396801	713885	18.9	8.90	416	8.30
Turnley/Woodsman	Source	4337848	728754	14.44	5.65	575	7.35
	Terminus	4337808	728588	17.83	5.82	568	7.94
Layton Spring	Source	4331556	720131	16.46	5.55	313	7.37
	Terminus	4331563	720122	10.75	6.62	212	8.65
South Bastion	HEAD 1	4333936	718435	13.65	7.65	294	7.52
	HEAD 2	4333925	718445	17.81	10.29	64	7.55
	HEAD 3	4333937	718463	21.62	11.08	15	8.43
	Terminus 2	4333931	718490	16.21	7.91	341	7.84
Unnamed Stonehouse Complex	MAIN HEAD 1	4406298	710531	15.89	6.98	473	8.01
	MAIN HEAD 2	4406463	710481	16.39	6.01	459	8.02
	MAIN HEAD 3	4406510	710459	17.61	5.51	436	7.87
	MAIN HEAD 4	4406646	710467	19	3.41	519	7.74
	MAIN HEAD 5	4406664	710500	18.22	3.95	293	7.65
	MAIN HEAD 6	4406615	710276	22.89	1.52	610	7.17
	Terminus	4406394	710308	19.94	3.69	478	7.73
Keagon Ranch-North	HEAD 1	4369500	714982	12.16	7.1	85	7.23
	HEAD 2	4369531	715019	11.96	7.45	83	7.2
	Terminus	4369466	715122	12.44	8.3	84	7.36
Keagan-Middle	Source	4369186	714980	13.29	7.07	74	7.43
	Terminus	4369129	715055	14.67	6.78	69	7.53
Keagan-South	Source	4369008	714997	13.01	6.75	88	7.27
	Terminus	4369010	715117	16.7	6.66	91	7.6

Note: n/a indicates no water quality samples taken.

TULE VALLEY

System Name	Location	Northing	Easting	Temperature (C)	Dissolved Oxygen (mg/l)	Conductivity (μS/cm)	pH
Coyote Spring	Source	4366597	286009	26.8	1.36	231	7.59
	Terminus	4366545	286167	14.8	6.80	234	7.64
South Tule Spring	Source 1	4356628	282976	15.9	9.50	187	9.06
	Source 2	4356624	282949	25.7	2.77	156	7.98
	Terminus	4356670	282970	12.2	5.02	151	7.95
Tule Spring	Source 1	4358585	283352	25.9	2.38	156	7.79
	Source 2	4358528	283190	24.8	1.88	148	7.52
	Source 3	4358576	283398	24.5	1.88	148	7.49
	Source 4	4358469	283411	14.3	3.16	159	7.62
	Terminus	4358970	283322	11.3	7.60	155	7.88
Willow Spring #1	Source *	4360069	283304	18.7	5.18	186	7.67
Willow Spring #2	Source	4360882	283478	14.5	9.15	161	8.26
	Terminus	4360801	283479	13.3	6.93	164	8.01

* Data taken on 9/19/04

WHITE RIVER VALLEY

System Name	Location	Northing	Easting	Temperature (C)	Dissolved Oxygen (mg/l)	Conductivity (μS/cm)	pH
Flag Springs - North	Source	4254503	672803	16.3	6.74	390	7.18
	Terminus	4254757	672259	17.7	8.55	413	7.93
Flag Springs - Middle	Source	4254355	672654	19.7	5.36	407	7.32
Flag Springs - South	Source	4254223	672662	22.6	4.55	421	7.40
	Terminus	4254299	672588	21.6	6.61	417	7.63
Hot Creek Spring	Source 1	4249721	661363	30.8	1.41	513	7.11
	Source 2	4249708	661374	31.4	1.65	511	7.06
	Source 3	4249675	661376	31.0	2.10	516	7.15
	Source 4	4249624	661375	31.0	1.28	512	7.05
	Terminus	4249498	661932	31.0	2.24	511	7.15
Indian Spring	Source 1	4310587	666103	21.5	3.18	342	8.00
	Source 2	4310515	666082	21.9	4.35	328	8.44
	Terminus 1	4310529	666102	22.3	3.27	314	8.12
	Terminus 2	4310520	666076	22.9	3.72	334	8.14
	Terminus 3	4310435	666208	22.9	4.30	335	8.39
Preston Big Spring	Source	4311176	666299	20.6	2.41	351	8.08
	Terminus	4311038	666295	21.9	2.73	338	8.19
Shingle Pass Spring	Source	4267515	680008	15.8	12.3	418	7.52
Sunnyside Creek - Upper *	Terminus	4254839	672035	18.2	8.38	416	8.00
Sunnyside Creek - Lower	Source	4254446	668422	11.0	9.81	507	7.88
	Terminus	4254297	668320	10.7	9.81	508	7.74
Lund Spring	Source	4301825	673319	18	5.58	442	7.63
Lund Spring	Terminus			18.17	5.22	441	7.59
Nicholas Spring (Preston Town Spring)	Source	4308638	668174	22.06	3.73	409	7.85
Nicholas Spring (Preston Town Spring)	Terminus			21.7	3.46	404	7.77
Arnoldson	Source	4308300	668002	22.77	3.71	418	7.42
Arnoldson	Terminus	4308207	668088	22.88	4.36	410	7.42
Tin Can Springs	Source	4311371	666348	22.32	7.85	408	7.75

* The source for this site is the same location as the terminus of Flag Springs - North

APPENDIX C: PLANT SPECIES IDENTIFIED IN EACH VALLEY OF THE BIOLOGICAL RESOURCES STUDY AREA (BRSA) DURING VEGETATION MAPPING

Delamar Valley

#	species code	scientific name	common name
1	JUBA	*Juncus balticus*	Baltic rush
2	Pithop	*Pithophora*	Horsehair algae
3	POMO5	*Polypogon monspeliensis*	annual rabbitsfoot grass
4	SCAC3	*Schoenoplectus acutus*	hardstem bulrush
5	VEAN2	*Veronica anagallis-aquatica*	water speedwell

Drylake Valley

#	species code	scientific name	common name
1	ROPS	*Robinia pseudoacacia*	black locust
2	POMO5	*Polypogon monspeliensis*	annual rabbitsfoot grass
3	EPCI	*Epilobium ciliatum*	fringed willowherb
4	JUTO	*Juncus torreyi*	Torrey's rush
5	RHTR	*Rhus trilobata*	skunkbush sumac
6	MEOF	*Melilotus officinalis*	sweetclover
7	GRASS	*Poaceae* sp.	unknown grass
8	HOJU	*Hordeum jubatum*	foxtail barley
9	RUCR	*Rumex crispus*	curly dock

Fish Springs National Wildlife Refuge

#	species code	scientific name	common name
1	ASSP	*Asclepias speciosa*	showy milkweed
2	DISP	*Distichlis spicata*	saltgrass
3	PHAU7	*Phragmites australis*	giant reed grass
4	JUBA	*Juncus balticus*	Baltic rush
5	HENU	*Helianthus nuttallii*	Nuttall's sunflower
6	MUAS	*Muhlenbergia asperifolia*	scratchgrass
7	TYLA	*Typha latifolia*	broadleaf cattail
8	SPAI	*Sporolobus airoides*	alkali sacaton
9	APCA	*Apocynum cannabinum*	Indian hemp
10	HOJU	*Hordeum jubatum*	foxtail barley
11	BEER	*Berula erecta*	water parsnip
12	BASC5	*Bassia scoparia*	burningbush
13	ELPA	*Eleocharis palustris*	common spikerush
14	SCAM6	*Scirpus americanus*	three square (Olney's) bulrush
15	POMO5	*Polypogon monspeliensis*	rabbit-foot grass
16	HAGL	*Halogeton glomeratus*	saltlover
17	SCMA8	*Scirpus maritimus*	cosmopolitan bulrush
18	ORLU2	*Orthocarpus luteus*	yellow owl's-clover
19	SYMPH4	*Symphyotrichum* sp.	aster
20	CHARA	*Chara vulgaris*	muskgrass
21	PITHOP	*Pithophora* sp.	horsehair algae
22	NAMA	*Najas marina*	spiny niad
23	STFIA2	*Stuckenia filiformis*	fineleaf pondweed
24	ALGAE	*Algae* sp.	algae species
25	CEDE4	*Ceratophyllum demersum*	coon's tail

Lake Valley

#	species code	scientific name	common name
1	ACMI2	*Achillea millefolium*	common yarrow
2	AGEX	*Agrostis exarata*	spike bentgrass
3	AGGI2	*Agrostis gigantea*	redtop
4	AGSC5	*Agropyron scribneri*	bentgrass
5	CADR	*Cardaria draba*	whitetop
6	CANE2	*Carex nebrascensis*	Nebraska sedge
7	CAPR5	*Carex praegracilis*	Clustered field sedge
8	CASI2	*Carex simulata*	analogue sedge
9	CIMO	*Cirsium mohavense*	Mojave thistle
10	DISP	*Distichlis spicata*	saltgrass
11	ELPA3	*Eleocharis palustris*	common spikerush
12	ELRO2	*Eleocharis rostellata*	beaked spikerush
13	GLMA	*Glyptopleura marginata*	carveseed
14	HOJU	*Hordeum jubatum*	Foxtail barley
15	JUBA	*Juncus balticus*	Baltic rush
16	JUTO	*Juncus torreyi*	Torrey's rush
17	LETR5	*Leymus triticoides*	beardless wildrye
18	MUAS	*Muhlenbergia asperifolia*	scratchgrass
19	RONA2	*Rorippa nasturtium-aquaticum*	watercress
20	SCAC3	*Schoenoplectus acutus*	hardstem bulrush
21	SCAM6	*Schoenoplectus americanus*	Olney's three square bulrush
22	SEHY2	*Senecio hydrophilus*	water ragwort
23	SPGR	*Spartina gracilis*	alkali cordgrass
24	SYEA2	*Symphyotrichum eatonii*	Eaton's aster
25	TRMA4	*Triglochin maritimum*	seaside arrowgrass

Pahranagat Valley

#	species code	scientific name	common name
1	ANCA10	*Anemopsis californica*	yerba mansa
2	APCA	*Apocynum cannabinum*	Indianhemp
3	ATRO	*Atriplex rosea*	tumbling saltweed
4	BAEM	*Baccharis emoryi*	Emory's baccharis
5	BAHY	*Bassia hyssopifolia*	fivehorn smotherweed
7	CIMO	*Cirsium mohavense*	Mojave thistle
8	DAWR2	*Datura wrightii*	sacred thorn-apple
9	DISP	*Distichlis spicata*	saltgrass
10	ELPA3	*Eleocharis palustris*	common spikerush
11	ELQU2	*Eleocharis quinqueflora*	fewflower spikerush
12	ELRO2	*Eleocharis rostellata*	beaked spikerush
13	ERNA10	*Ericameria nauseosa*	rubber rabbitbrush
14	FRVE2	*Fraxinus velutina*	velvet ash
15	HECU3	*Heliotrope curassavicum*	salt helioptrope
16	JUBA	*Juncus balticus*	Baltic rush
17	KOSC	*Kochia scoparia*	Mexican fireweed
18	LETR5	*Leymus triticoides*	beardless wildrye
19	MUAS	*Muhlenbergia asperifolia*	scratchgrass
21	POAL7	*Populus alba*	white poplar
22	POFR2	*Populus fremontii*	Fremont cottonwood
23	POHI8	*Populus hinckleyana*	poplar
24	SCAC3	*Schoenoplectus acutus*	hardstem bulrush
25	SCAM6	*Schoenoplectus americanus*	Olney's three square bulrush
26	SOMI2	*Solidago missouriensis*	Missouri goldenrod
27	SUCA2	*Suaeda calceoliformis*	Pursh seepweed
28	TARA	*Tamarix ramosissima*	saltcedar
29	TYLA	*Typha latifolia*	broadleaf cattail
30	VEAN2	*Veronica anagallis-aquatica*	water speedwell
31	VIAR2	*Vitis arizonica*	canyon grape
32	XAST	*Xanthium strumarium*	rough cockleburr

Panaca Valley

#	species code	scientific name	common name
1	AGEX	*Agrostis exarata*	spike bentgrass
2	AGGI2	*Agrostis gigantea*	redtop
3	ANCA10	*Anemopsis californica*	yerba mansa
4	APCA	*Apocynum cannabinum*	Indianhemp
5	CASI2	*Carex simulata*	analogue sedge
6	ELPA3	*Eleocharis palustris*	common spikerush
7	HEAN3	*Helianthus annuus*	common sunflower
8	JUBA	*Juncus balticus*	Baltic rush
9	KOSC	*Kochia scoparia*	Mexican fireweed
10	MEAL12	*Melilotus alba*	white sweetclover
11	MUAS	*Muhlenbergia asperifolia*	scratchgrass
13	POFR2	*Populus fremontii*	Fremont cottonwood
14	SCAM6	*Schoenoplectus americanus*	Olney's three square bulrush

Pleasant Valley

#	species code	scientific name	common name
1	AGGI2	*Agrostis gigantea*	redtop
2	BEER	*Berula erecta*	cutleaf waterparsnip
3	CANE2	*Carex nebrascensis*	Nebraska sedge
4	CAPR5	*Carex praegracilis*	Clustered field sedge
5	CIMO	*Cirsium mohavense*	Mojave thistle
6	ELPA3	*Eleocharis palustris*	common spikerush
7	JUBA	*Juncus balticus*	Baltic rush
8	JUTO	*Juncus torreyi*	Torrey's rush
10	PHAR3	*Phalaris arundinacea*	reed canary grass
11	RONA2	*Rorippa nasturtium-aquaticum*	watercress
12	ROWO	*Rosa woodsii*	Woods Rose
13	SCAM6	*Schoenoplectus americanus*	Olney's three square bulrush

Snake Valley

#	species code	scientific name	common name
1	ADCA	*Adiantum capillus-veneris*	common maidenhair
2	AGGI2	*Agrostis gigantea*	redtop
3	APCA	*Apocynum cannabinum*	Indianhemp
4	ARAN7	*Argentina anserina*	siverweed cinquefoil
5	ATRO	*Atriplex rosea*	tumbling saltweed
6	BAHY	*Bassia hyssopifolia*	fivehorn smotherweed
7	BEER	*Berula erecta*	cutleaf waterparsnip
8	CADR	*Cardaria draba*	whitetop
9	CANE	*Calamagrostis neglecta*	reedgrass
10	CANE2	*Carex nebrascensis*	Nebraska sedge
11	CAPR5	*Carex praegracilis*	Clustered field sedge
12	CASI2	*Carex simulata*	analogue sedge
13	Chara		muskweed
14	DISP	*Distichlis spicata*	saltgrass
15	ELAN	*Elaeagnus angustifolia*	Russian olive
16	ELPA3	*Eleocharis palustris*	common spikerush
17	ELQU2	*Eleocharis quinqueflora*	fewflower spikerush
18	ERNA10	*Ericameria nauseosa*	rubber rabbitbrush
19	GLLE3	*Glycyrrhiza lepidota*	American licorice
20	HOJU	*Hordeum jubatum*	Foxtail barley
21	IVAX	*Iva axillaris*	povertyweed
22	JUBA	*Juncus balticus*	Baltic rush
23	JUNE	*Juncus nevadensis*	Sierra rush
24	KOSC	*Kochia scoparia*	Mexican fireweed
25	LETR5	*Leymus triticoides*	beardless wildrye
26	LYSA2	*Lythrum salicaria*	purple loosestrife
27	MIGU	*Mimulus guttatus*	seep monkeyflower
28	MUAS	*Muhlenbergia asperifolia*	scratchgrass
29	OEEL	*Oenothera elata*	Hooker's evening primrose
30	PHAR3	*Phalaris arundinacea*	reed canary grass
31	PHAU7	*Phragmites australis*	common reed
32	POAC5	*Populus acuminata*	lanceleaf cottonwood
33	POFR2	*Populus fremontii*	Fremont cottonwood
34	POMO5	*Polypogon monspeliensis*	annual rabbitsfoot grass
35	RONA2	*Rorippa nasturtium-aquaticum*	watercress
36	ROWO	*Rosa woodsii*	Woods Rose
37	SACU	*Sagittaria cuneata*	arumleaf arrowhead
38	SAEX	*Salix exigua*	narrowleaf willow
39	SAFR	*Saxifraga fragosa*	wholeleaf saxifrage
40	SAUT2	*Sarcocornia utahensis*	Utah samphire
41	SAVE4	*Sarcobatus vermiculatus*	greasewood
42	SCAC3	*Schoenoplectus acutus*	hardstem bulrush
43	SCAM6	*Schoenoplectus americanus*	Olney's three square bulrush
44	SCPUL4	*Schoenoplectus pungens*	common three square
45	SOMI2	*Solidago missouriensis*	Missouri goldenrod
46	SPAI	*Sporobolus airoides*	alkali sacaton
47	SUCA2	*Suaeda calceoliformis*	Pursh seepweed
48	SYAS3	*Symphyotrichum ascendens*	western aster
49	TARA	*Tamarix ramosissima*	saltcedar
50	TORY	*Toxicodendron rydbergii*	western poison ivy
51	TRMA4	*Trifolium macilentum*	largehead clover
52	TYLA	*Typha latifolia*	broadleaf cattail
53	JUTO	*Juncus torreyi*	Torrey's rush
54	CAAQ3	*Catabrosa aquatica*	brook grass
55	NAOF	*Nasturtium officinale*	watercress
56	HENU	*Helianthus nuttallii*	Nuttall's sunflower
57	LEVA	*Lemna valdiviana*	valdivia duckweed
58	LYAS	*Lycopus asper*	rough bugleweed
59	CANU4	*Carduus nutans*	musk thistle
60	PODI	*Potentilla diversifolia*	varileaf cinquefoil
61	SPGR	*Spartina gracilis*	alkali cordgrass
62	EPCI	*Epilobium ciliatum*	fringed willowherb
63	LEMI3	*Lemna minor*	common duckweed
64	MENTH	*Lamium sp.*	mint
65	GLMA	*Glaux maritima*	sea milkwort
66	MEAR4	*Mentha arvensis*	wild mint
67	IRMI	*Iris missouriensis*	Rocky Mountain iris
68	SPAI	*Sporolobus airoides*	alkali sacaton
69	CAREX	*carex sp.*	sedge
70	AGSC5	*Agrostis scabra*	rough bentgrass
71	SOCA6	*Solidago canadensis*	Canada goldenrod
72	RINA	*Ricciocarpus natans*	purple-fringed riccia
73	VEAN2	*Veronica anagallis-aquatica*	water speedwell
74	RUCR	*Rumex crispus*	curly dock
75	MEOF	*Melilotus officinalis*	sweetclover
76	XAST	*Xanthium strumarium*	cockleburr
77	SOAR2	*Sonchus arvensis*	field sowthistle
78	MAVU	*Marrubium vulgare*	horehound
79	CLSE	*Cleome serrulata*	Rocky Mountain beeplant
80	RACY	*Ranunculus cymbalaria*	alkali buttercup
81	GLMA	*Glaux maritima*	sea milkwort
82	THPO7	*Thinopyrum ponticum*	tall wheatgrass
83	CALAA	*Carex lasiocarpa var. americana*	woollyfruit sedge
84	SYMPH4	*Symphyotrichum sp.*	aster
85	ELAC	*Eleocharis acicularis*	
86	POTAM	*Potomogeton sp.*	pondweed
87	PITHOP	*Pithophora sp.*	horsehair algae
88	ALGAE	*Algae sp.*	algae species
89	CEDE4	*Ceratophyllum demersum*	coon's tail

Spring Valley

#	species code	scientific name	common name
1	AGGI2	*Agrostis gigantea*	redtop
2	Algae	--	algae
3	ARAN7	*Argentia anserina*	siverweed cinquefoil
4	BEER	*Berula erecta*	Coville cutleaf waterparsnip
5	BRIN2	*Bromus inermis*	smooth brome
6	BRTE	*Bromus tectorum*	cheatgrass
7	CANE	*Calamagrostis neglecta*	slimstem reedgrass
8	CANE2	*Carex nebrascensis*	Nebraska sedge
9	CAPR5	*Carex praegracilis*	Clustered field sedge
10	CASI2	*Carex simulata*	analogue sedge
11	Chara	--	muskgrass
12	CIAR4	*Cirsium arvense*	Canada thistle
13	CIMO	*Cirsium mohavense*	Mojave thistle
14	DISP	*Distichlis spicata*	saltgrass
15	ELAC	*Eleocharis acicularis*	needle spikerush
16	ELPA3	*Eleocharis palustris*	common spikerush
17	ELQU2	*Eleocharis quinqueflora*	fewflower spikerush
18	ELRO2	*Eleocharis rostellata*	beaked spikerush
19	ELTR7	*Elymus trachycaulus*	slender wheatgrass
20	EPCI	*Epilobium ciliatum*	fringed willowherb
21	EQAR	*Equisetum arvense*	field horsetail
22	HIVU2	*Hippuris vulgaris*	common mare's tail
23	HOJU	*Hordeum jubatum*	Foxtail barley
24	IRMI	*Iris missouriensis*	Rocky mountain iris
25	IVAX	*Iva axillaris*	povertyweed
26	JUBA	*Juncus balticus*	Baltic rush
27	JUNE	*Juncus nevadensis*	Sierra rush
28	JUTO	*Juncus torreyi*	Torrey's rush
29	LEMNA	*Lemna*	duckweed
30	LETR	*Lemna trisulca*	star duckweed
31	LETR5	*Leymus triticoides*	beardless wildrye
32	MEAL12	*Melilotus alba*	white sweetclover
33	MIGU	*Mimulus guttatus*	seep monkeyflower
34	PHAR3	*Phalaris arundinacea*	reed canarygrass
35	PHAU7	*Phragmites australis*	common reed
36	Pithop	*Pithophora*	Horsehair algae
37	POAN3	*Populus angustifolia*	narrowleaf cottonwood
38	POMO5	*Polypogon monspeliensis*	annual rabbitsfoot grass
39	POSE	*Poa secunda*	Sandberg bluegrass
40	PSBR	*Psilocarphus brevissimus*	short woollyheads
41	RACY	*Ranunculus cymbalaria*	alkali buttercup
42	RHTR	*Rhus trilobata*	skunkbush sumac
43	RONA2	*Rorippa nasturtium-aquaticum*	watercress
44	ROWO	*Rosa woodsii*	Woods' rose
45	RUCR	*Rumex crispus*	curly dock
46	SAEX	*Salix exigua*	narrowleaf willow
47	SCAC3	*Schoenoplectus acutus*	hardstem bulrush
48	SCAM6	*Schoenoplectus americanus*	chairmaker's bulrush
49	SCPUL4	*Schoenoplectus pungens var. longispicatus*	common threesquare
50	SEHY2	*Senecio hydrophilus*	water ragwort
51	SPEU	*Sparganium eurycarpum*	broadfruit bur-reed
52	TRMA4	*Triglochin maritimum*	seaside arrowgrass
53	TRRE3	*Trifolium repens*	white clover
54	TYLA	*Typha latifolia*	broadleaf cattail
55	VEAN2	*Veronica anagallis-aquatica*	water speedwell
56	VEBR	*Verbena bracteata*	bigbract verbena
57	NAOF	*Nasturtium officinale*	watercress
58	LEMI3	*Lemna minor*	common duckweed
59	TRPR2	*Trifolium pratense*	red clover
60	MOSS	*Bryophyta* sp.	moss
61	CANU4	*Carduus nutans*	musk thistle
62	TAOF	*Taraxacum officinale*	common dandelion
63	ACMI2	*Achillea millefolium*	common yarrow
64	LOPI2	*Lotus pinnatus*	meadow bird's-foot trefoil
65	EPCI	*Epilobium ciliatum*	fringed willowherb
66	RANUN	*Ranunculus* sp.	buttercup
67	CAREX	*carex* sp.	sedge
68	SACU	*Sagittaria cuneata*	wapato
69	CIRSI	*Cirsium* sp.	thistle
70	SPAI	*Sporolobus airoides*	alkali sacaton
71	ASSP	*Asclepias speciosa*	showy milkweed
72	AGGL	*Agoseris glauca*	pale agoseris
73	MEOF	*Melilotus officinalis*	sweetclover
74	MUAS	*Muhlenbergia asperifolia*	scratchgrass
75	ANCA10	*Anemopsis californica*	yerba mansa
76	GRASS	*Poaceae* sp.	unknown grass
77	LURE2	*Ludwigia repens*	creeping primrose-willow
78	CYDA	*Cynodon dactylon*	bermudagrass
79	AGSC5	*Agrostis scabra*	rough bentgrass
80	CESTM	*Centaurea stoebe* ssp. *Micranthos*	spotted knapweed
81	ACMI2	*Achillea millefolium*	common yarrow
82	VETH	*Verbascum thapsus*	common mullein
83	SOAR2	*Sonchus arvensis*	field sowthistle
84	PITHOP	*Pithophora* sp.	horsehair algae
85	RAAQ	*Ranunculus aquatilis*	whitewater crowfoot
86	STFIA2	*Stuckenia filiformis*	fineleaf pondweed
87	ALGAE	*Algae* sp.	algae species

Tule Valley

#	species code	scientific name	common name
1	ALOC2	*Allenrolfea occidentalis*	iodinebush
2	BAHY	*Bassia hyssopifolia*	fivehorn smotherweed
4	CADR	*Cardaria draba*	whitetop
5	DESO2	*Descurainia sophia*	herb sophia
6	DISP	*Distichlis spicata*	saltgrass
7	ELPA3	*Eleocharis palustris*	common spikerush
8	HECU3	*Heliotropium curassavicum*	salt heliotrope
9	HOJU	*Hordeum jubatum*	Foxtail barley
10	JUBA	*Juncus balticus*	Baltic rush
11	LASE	*Lactuca serriola*	prickly lettuce
12	MUAS	*Muhlenbergia asperifolia*	scratchgrass
14	PHAU7	*Phragmites australis*	common reed
15	POMO5	*Polypogon monspeliensis*	annual rabbitsfoot grass
16	RAAQ	*Ranunculus aquatilis*	whitewater crowfoot
17	RACY	*Ranunculus cymbalaria*	alkali buttercup
18	SCAM6	*Schoenoplectus americanus*	chairmaker's bulrush
19	TARA	*Tamarix ramosissima*	saltcedar
20	TYLA	*Typha latifolia*	broadleaf cattail

White River Valley

#	species code	scientific name	common name
1	AGGI2	*Agrostis gigantea*	redtop
2	ANCA10	*Anemopsis californica*	yerba mansa
3	ARAN7	*Argentina anserina*	siverweed cinquefoil
4	ASSP	*Asclepias speciosa*	showy milkweed
5	BEER	*Berula erecta*	cutleaf waterparsnip
6	CANE2	*Carex nebrascensis*	Nebraska sedge
7	CASI2	*Carex simulata*	analogue sedge
8	DISP	*Distichlis spicata*	saltgrass
9	ELAN	*Elaeagnus angustifolia*	Russian olive
10	ELPA3	*Eleocharis palustris*	common spikerush
11	EQAR	*Equisetum arvense*	field horsetail
12	FRVE2	*Fraxinus velutina*	velvet ash
13	JUBA	*Juncus balticus*	Baltic rush
14	LETR5	*Leymus triticoides*	beardless wildrye
15	LOCA2	*Lobelia cardinalis*	cardinalflower
16	MUAS	*Muhlenbergia asperifolia*	scratchgrass
17	PHAR3	*Phalaris arundinacea*	reed canary grass
18	PHAU7	*Phragmites australis*	common reed
19	PITHOP	*Pithophora*	Horsehair algae
20	POFR2	*Populus fremontii*	Fremont cottonwood
21	PONI	*Populus nigra*	Lombardy poplar
22	RHTR	*Rhus trilobata*	skunkbush sumac
23	RIAU	*Ribes aureum*	golden currant
24	RONA2	*Rorippa nasturtium-aquaticum*	watercress
25	ROWO	*Rosa woodsii*	Woods Rose
26	SAEX	*Salix exigua*	narrowleaf willow
27	SALA3	*Salix laevigata*	red willow
28	SCAC3	*Schoenoplectus acutus*	hardstem bulrush
29	SCAM6	*Schoenoplectus americanus*	Olney's three square bulrush
30	SCAM6dead	*Schoenoplectus americanus*	Olney's three square bulrush
31	SEHY2	*Senecio hydrophilus*	water ragwort
32	SOMI2	*Solidago missouriensis*	Missouri goldenrod
33	SPAI	*Sporobolus airoides*	alkali sacaton
34	TYLA	*Typha latifolia*	broadleaf cattail
35	POMO5	*Polypogon monspeliensis*	rabbit-foot grass
36	ELRE4	*Agropyron repens*	quackgrass
37	SYEA2	*Symphyothrichum eatonii*	Eaton's aster
38	EQHY	*Equisetum hyemale*	scouringrush horsetail
39	ASSP	*Asclepias speciosa*	showy milkweed
40	POPR	*Poa pratensis*	Kentucky bluegrass
41	EPCI	*Epilobium ciliatum*	fringed willowherb
42	NAOF	*Nasturtium officinale*	watercress
43	OEEL	*Oenothera elata*	Hooker's evening-primrose
44	SCPH	*Schedonorus phoenix*	tall fescue
45	SYEA2	*Symphyothrichum eatonii*	Eaton's aster
46	ASOF	*Asparagus officinalis*	asparagus
47	EPCI	*Epilobium ciliatum*	fringed willowherb
48	MIGU	*Mimulus guttatus*	seep monkeyflower
49	VEAN2	*Veronica anagallis-aquatica*	water speedwell
50	ELAC	*Eleocharis acicularis*	
51	CEDE4	*Ceratophyllum demersum*	coon's tail
52	STFIA2	*Stuckenia filiformis*	fineleaf pondweed

APPENDIX D: MACROINVERTEBRATES IDENTIFIED FROM AQUATIC SYSTEMS OF INTEREST IN THE BIOLOGICAL RESOURCES STUDY AREA (BRSA)

TULE VALLEY

Phylum/Class/Order	Taxa	Coyote Springs	South Tule Spring	Tule Spring	Willow Spring
Ephemeroptera	Callibaetis sp.	0	0	0	17
Odonata	Argia sp.	7	2	0	1
	Coenagrion/Enallagma sp.	0	0	0	1
Coleoptera	Agabus sp.	0	2	0	0
	Hygrotus sp.	3	0	0	0
	Laccophilus sp.	0	1	0	0
	Tropisternus sp.	0	1	0	0
Diptera-Chironomidae	Ablabesmyia sp.	0	0	0	1
	Acricotopus sp.	0	0	0	5
	Apedilum sp.	0	0	0	4
	Ceratopogoninae	0	4	0	7
	Chaetocladius sp.	0	0	0	1
	Chironomus sp.	0	2	0	0
	Corynoneura sp.	0	0	1	1
	Cricotopus sp.	0	0	0	1
	Dasyhelea sp.	0	3	0	24
	Diamesa sp.	0	2	0	0
	Diptera	0	0	0	1
	Dixella sp.	0	0	0	1
	Dixidae	0	0	1	0
	Ephydridae	1	0	1	0
	Forcipomyia sp.	1	0	0	0
	Limnophyes sp.	3	1	6	3
	Micropsectra sp.	1	37	0	69
	Paramerina sp.	0	0	0	10
	Paraphaenocladius sp.	1	1	0	11
	Paratendipes sp.	0	1	0	0
	Polypedilum sp.	25	1	0	0
	Pseudosmittia sp.	0	0	0	3
	Tanypus sp.	0	1	0	7
	Thienemannimyia gr. sp.	1	1	0	3
Gastropoda	Ferrissia sp.	24	0	0	0
	Gyraulus sp.	0	0	0	3
	Hydrobiidae	0	0	190	0
Bivalvia	Pisidium sp.	0	0	0	11
	Sphaeriidae	0	1	1	0
Annelida	Oligochaeta	32	9	0	10
	Theromyzon sp.	0	0	0	0
Acari	Arrenurus sp.	0	0	0	1
	Oribatei	9	119	19	0
	Piona sp.	0	1	0	0
Crustacea	Hyalella sp.	21	22	84	50
	Ostracoda	210	119	33	90
Other Organisms	Nematoda	6	19	0	1

FISH SPRINGS NATIONAL WILDLIFE REFUGE

Phylum/Class/Order	Taxa	Middle Spring	Thomas Spring	North Spring	Deadman Spring	House Spring	Mirror Spring	Walter's Spring	South Spring	Percy Spring	Crater Spring	Lost Spring
Ephemeroptera	Caenis sp.	0	0	0	0	0	0	4	0	0	0	3
	Callibaetis sp.	8	11	14	17	25	37	57	4	3	15	4
Odonata	Argia sp.	0	1	0	0	3	1	2	0	0	0	1
	Coenagrion/Enallagma sp.	0	0	1	0	0	0	1	1	0	0	2
	Coenagrionidae	3	1	46	8	27	6	19	4	2	18	0
	Erythemis collocata	1	1	0	0	0	0	2	2	0	0	0
	Libellula saturata	0	0	0	0	0	0	0	0	0	0	1
	Libellula sp.	0	0	0	0	0	0	0	0	1	0	0
	Libellulidae	1	0	0	9	2	3	4	1	1	8	0
Hemiptera	Belostoma sp.	0	1	0	0	0	0	0	0	0	0	0
	Belostomatidae	0	0	0	1	0	0	0	0	0	0	0
	Corixidae	0	0	0	3	0	0	1	0	0	0	0
	Hesperocorixa sp.	0	0	0	1	1	0	1	0	0	0	1
	Notonecta sp.	0	0	0	1	0	0	0	0	0	0	0
	Notonectidae	0	0	0	1	0	0	0	0	0	0	0
Coleoptera	Cybister explanatus	0	0	0	1	0	0	0	0	0	0	0
	Enochrus sp.	2	0	0	0	0	0	0	0	0	0	0
	Laccophilus sp.	0	0	0	3	0	0	0	0	0	0	0
	Microcylloepus sp.	0	0	0	0	0	0	0	2	0	0	0
	Peltodytes sp.	2	0	0	0	0	2	0	0	1	0	0
Diptera-Chironomidae	Apedilum sp.	0	0	0	0	0	0	0	2	0	0	2
	Bezzia/Palpomyia sp.	0	0	0	2	0	0	1	0	0	0	0
	Ceratopogoninae	0	1	0	0	0	0	0	0	0	0	0
	Chironomini	0	0	0	0	0	1	0	0	0	0	0
	Chironomus sp.	0	0	1	18	4	0	2	0	1	0	0
	Cladotanytarsus sp.	0	0	0	10	0	0	0	0	0	0	0
	Corynoneura sp.	0	0	3	0	0	0	1	0	0	0	0
	Cricotopus bicinctus gr.	1	2	0	0	1	6	1	1	0	0	1
	Cricotopus sp.	0	0	3	9	4	3	10	0	0	0	0
	Dasyhelea sp.	0	1	0	0	2	1	0	0	1	1	0
	Ephydridae	0	0	0	0	0	1	2	0	0	0	0
	Labrundinia sp.	0	0	1	0	1	0	0	0	0	0	0
	Paratanytarsus sp.	3	0	0	0	7	4	0	9	0	0	4
	Pentaneura sp.	0	0	0	0	3	4	0	2	0	0	1
	Pentaneurini	0	0	0	0	1	0	0	0	0	0	0
	Procladius sp.	0	0	2	0	0	0	0	0	0	0	0
	Pseudochironomus sp.	2	0	2	2	6	5	74	0	1	6	4
	Tanypus sp.	0	0	0	23	2	0	0	0	0	0	0
	Tanytarsus sp.	0	0	0	1	6	4	2	0	1	2	0
	Thienemanniella sp.	0	0	0	0	0	6	0	0	0	0	0
Trichoptera	Hydropsyche sp.	0	0	7	0	3	0	0	4	0	0	1
	Hydropsychidae	0	0	1	0	0	0	0	1	0	0	0
	Hydroptila sp.	0	1	0	0	0	3	0	0	0	0	4
	Hydroptilidae	0	1	0	0	0	0	0	0	0	0	0
	Oecetis sp.	0	0	0	0	0	0	1	0	0	0	0
	Oxyethira sp.	2	3	4	0	0	2	10	1	0	1	1
Gastropoda	Gyraulus sp.	2	0	11	14	0	0	8	5	0	0	1
	Hydrobiidae	124	72	21	0	45	117	0	48	71	33	109
	Melanoides tuberculata	149	28	39	0	51	19	0	33	31	151	33
	Physa sp.	7	18	34	13	33	6	19	5	2	7	11
	Valvata sp.	1	0	8	0	0	0	0	0	0	0	0
Annelida	Erpobdellidae	0	0	0	1	0	0	0	0	0	0	0
	Helobdella sp.	0	0	0	0	0	0	0	0	4	0	0
	Oligochaeta	30	0	2	22	21	2	41	10	5	2	9
Acari	Acari	0	0	1	0	0	0	1	0	0	0	0
	Arrenurus sp.	0	0	0	0	1	0	0	0	0	1	0
	Oribatei	1	0	0	0	2	1	1	0	10	1	3
Crustacea	Gammarus sp.	0	0	0	0	0	0	5	0	0	0	0
	Hyalella sp.	43	155	140	13	68	114	28	188	85	36	133
	Ostracoda	24	16	2	175	132	4	51	11	186	56	10
Other Organisms	Hydra sp.	1	0	0	0	0	1	0	0	0	0	0
	Nematoda	0	0	0	12	5	0	0	0	1	0	0
	Prostoma sp.	0	1	0	0	0	0	0	0	1	1	0

PLEASANT VALLEY

Phylum/Class/Order	Taxa	Cane Spring
Ephemeroptera	Callibaetis sp.	30
Odonata	Argia sp.	4
	Coenagrionidae	12
Hemiptera	Hesperocorixa sp.	2
	Notonecta sp.	1
Coleoptera	Agabus sp.	4
Diptera-Chironomidae	Corynoneura sp.	1
	Lauterborniella agrayloides	1
	Orthocladiinae	1
	Paramerina sp.	7
	Parametriocnemus sp.	1
	Paratanytarsus sp.	5
	Pentaneurini	1
	Psectrocladius sp.	2
	Pseudochironomus sp.	10
	Simulium sp.	4
	Tanytarsus sp.	36
	Thienemannimyia gr. sp.	2
Trichoptera	Leptoceridae	1
	Ochrotrichia sp.	1
Gastropoda	Gyraulus sp.	11
	Hydrobiidae	41
Bivalvia	Sphaeriidae	7
Annelida	Oligochaeta	7
Acari	Arrenurus sp.	1
	Oribatei	1
Crustacea	Hyalella sp.	86
	Ostracoda	93

SNAKE VALLEY

Phylum/Class/Order	Taxa	Big Springs	Big Springs Creek	Big Springs Pond	Beck Springs-North	Beck Springs-South	Bishop Springs	Foote Reservoir	Caine Spring	Callao Big Spring	Clay Spring	Cold Spring	Gandy Salt Marsh North Complex (G4-G9)	Gandy Salt Marsh Middle Complex (G20-G28)	Gandy Salt Marsh (G44)	Gandy Salt Marsh (G48-G49)	Gandy Salt Marsh (G51)	Gandy Warm Springs	Leland Harris Spring	Miller Spring	North Little Spring	South Little Spring	Swimming Hole	Twin Springs	Unnamed Spring at Skating Pond	Unnamed Spring South of Caine Spring	Unnamed Spring South of Knoll Spring	Unnamed Big Spring #1	Unnamed Big Spring #2
Ephemeroptera	Baetidae	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Baetis tricaudatus	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Caenis sp.	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Callibaetis sp.	0	0	0	3	15	0	4	7	23	0	0	30	0	0	0	0	0	0	1	0	54	19	1	99	0	3	0	61
	Fallceon quilleri	1	94	0	0	0	42	0	0	0	5	0	0	0	0	0	0	1	0	0	0	0	0	2	0	0	0	0	0
	Tricorythodes sp.	1	1	0	0	0	1	0	0	0	14	0	0	0	0	0	0	0	0	0	0	0	0	12	0	0	0	0	0
Odonata	Aeshnidae	0	0	0	3	0	0	1	0	4	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0
	Amphiagrion sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	7
	Anax junius	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
	Argia sp.	2	13	0	3	7	0	0	0	1	0	0	0	0	0	0	0	3	0	0	0	0	0	5	0	0	0	0	0
	Coenagrion/Enallagma sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	3	0	0
	Coenagrionidae	0	0	0	0	8	10	17	3	65	5	0	2	1	0	0	0	0	1	0	0	53	29	4	23	0	1	0	92
	Erythemis collocata	0	0	0	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
	Lestidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
	Libellula sp.	0	0	1	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Libellulidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	1	0	0	0	0
Hemiptera	Ambrysus sp.	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Callicorixa sp.	0	0	0	0	0	0	0	0	0	0	0	0	3	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Cenocorixa sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0
	Corixidae	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
	Hesperocorixa sp.	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
	Notonecta sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Coleoptera	Agabus sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	6	0	1	0	0	5	0	0	0	0	0	0	0
	Colymbetes sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
	Enochrus sp.	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Gyrinus sp.	0	0	0	0	0	0	0	0	0	0	0	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Hydaticus sp.	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Hydrobius sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0
	Hydroporinae	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Hydroporus sp.	0	0	0	0	0	0	0	0	0	0	0	2	1	1	2	15	0	0	0	0	0	1	0	0	0	0	0	0
	Hygrotus sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
	Ilybius sp.	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Laccophilus sp.	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0
	Liodessus sp.	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	4	0	0	0	0	0	3	0	0	0	0	0	0
	Microcylloepus sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	55	0	0	0	0	0	0	0	0	0	0	0
	Ochthebius sp.	0	0	0	0	0	0	0	0	1	0	0	1	0	1	0	1	0	0	0	0	0	0	0	1	0	0	0	0
	Paracymus sp.	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
	Peltodytes sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
	Rhantus sp.	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Tropisternus sp.	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	6	1	2	0	0	0	1
	Zaitzevia sp.	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Diptera-Chironomidae	Aedes sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0
	Alotanypus sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	2	0	0	0	0	0	0	0	0	0
	Anopheles sp.	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0
	Bezzia/Palpomyia sp.	0	1	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3
	Ceratopogonidae	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	3	0	0	1	0	1	0
	Ceratopogoninae	0	0	3	0	0	0	11	0	0	1	4	0	0	0	0	1	0	4	0	1	0	0	5	0	0	7	0	0
	Chaetocladius sp.	0	0	0	0	0	0	0	0	0	1	5	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0
	Chironomini	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	2	1	0	0	0	0	0	0	0	1	0	0
	Chironomus sp.	1	0	3	0	0	0	24	1	8	0	0	2	0	0	0	0	0	0	0	2	9	10	0	1	0	2	0	0
	Corynoneura sp.	0	0	1	3	0	0	0	1	3	0	0	6	0	0	0	0	1	0	0	1	6	1	1	5	0	28	0	0
	Cricotopus bicinctus gr.	0	0	0	0	0	0	0	0	21	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Cricotopus sp.	33	6	1	0	0	3	22	0	0	0	0	1	0	0	0	0	4	3	0	0	0	0	0	0	0	0	0	0
	Cryptochironomus sp.	0	0	1	0	0	0	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Culicidae	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Culicoides sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
	Dasyhelea sp.	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	14	1	0	0	4	0	0
	Derotanypus sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
	Dicrotendipes sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
	Dixa sp.	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Dixella sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
	Empididae	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Ephydridae	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Eukiefferiella claripennis gr.	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
	Eukiefferiella coerulescens gr.	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Eukiefferiella sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0
	Forcipomyia sp.	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
	Hemerodromia sp.	0	0	0	0	0	7	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Holorusia sp.	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Labrundinia sp.	0	0	0	2	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
	Larsia sp.	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Limnophyes sp.	0	0	1	0	1	0	1	0	9	0	1	0	0	0	0	0	0	1	0	0	2	0	0	10	0	4	0	9
	Macropelopiini	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0
	Metriocnemus sp.	0	0	0	2	4	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Micropsectra sp.	0	0	0	0	3	0	15	0	0	0	31	0	1	0	3	4	0	45	2	2	0	0	0	0	0	0	0	0
	Nilotanypus sp.	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Orthocladiinae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
	Orthocladius Complex	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0
	Parachironomus sp.	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Parakiefferiella sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0
	Paramerina sp.	0	0	0	0	3	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	4	0	0
	Parametriocnemus sp.	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Paraphaenocladius sp.	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
	Paratanytarsus sp.	0	0	0	5	0	0	0	0	17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12	0	0
	Paratendipes sp.	0	0	0	0	0	0	3	0	0	8	0	0	0	0	0	0	0	2	0	0	0	0	0	1	0	1	0	2
	Pentaneura sp.	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Pentaneurini	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Pericoma/Telmatoscopus sp.	0	0	0	0	3	1	0	0	0	0	0	0	0	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0
	Phaenopsectra sp.	0	1	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Polypedilum sp.	0	0	0	0	1	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Procladius sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Pseudochironomus sp.	0	0	1	0	0	3	80	1	0	0	1	1	0	0	0	0	0	0	0	0	1	24	0	0	0	0	1	27
	Pseudosmittia sp.	0	0	1	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Psilometriocnemus sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
	Psychoda sp.	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Radotanypus sp.	0	0	0	0	0	0	0	0	0	0	25	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0
	Rheotanytarsus sp.	0	1	0	0	0	45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	19	0	0	0	0	0
	Simulium sp.	0	5	0	2	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Smittia sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
	Stratiomyidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	3
	Tabanidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
	Tanypodinae	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Tanypus sp.	0	0	0	0	0	0	20	16	6	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	5	0	0
	Tanytarsini	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
	Tanytarsus sp.	0	0	2	0	0	0	2	0	4	18	0	1	0	0	0	0	0	0	0	0	2	0	0	5	0	1	0	1
	Thienemanniella sp.	3	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
	Thienemannimyia gr. sp.	2	0	0	3	6	0	1	0	0	8	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12	0	0
	Tipula sp.	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Trichoclinocera sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0
	Zavrelimyia sp.	0	0	0	1	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Trichoptera	Agrypnia sp.	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Cheumatopsyche sp.	0	2	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
	Chimarra sp.	0	0	0	0	0	82	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
	Glossosomatidae	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Helicopsyche sp.	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0	0	0	0	0	0	0	0	0	0	0
	Hydropsyche sp.	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0
	Hydropsychidae	1	0	0	0	0	77	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Hydroptila sp.	0	0	0	0	0	9	0	0	0	0	8	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
	Hydroptilidae	1	2	0	0	0	0	0	0	0	6	5	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	3	0
	Leucotrichia sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
	Limnephilus sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	2	0	0
	Ochrotrichia sp.	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	16	0
	Oxyethira sp.	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	2	0	3	0	0	0	6	0	0	0	0	1
	Protoptila sp.	3	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0
	Tinodes sp.	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Triaenodes sp.	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gastropoda	Ferrissia sp.	1	0	0	0	0	0	0	0	11	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0
	Fossaria sp.	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

SNAKE VALLEY (cont.)

Phylum/Class/Order	Taxa	Big Springs	Big Springs Creek	Big Springs Pond	Beck Springs-North	Beck Springs-South	Bishop Springs	Foote Reservoir	Caine Spring	Callao Big Spring
	Gastropoda	0	0	0	0	0	0	0	0	0
	Gyraulus sp.	0	0	0	20	0	8	26	76	11
	Hydrobiidae	38	0	1	166	93	6	0	1	2
	Lymnaeidae	0	0	0	10	1	0	0	0	2
	Melanoides tuberculata	0	0	0	0	0	0	0	0	0
	Physa (Physella) sp.	2	0	0	6	8	4	0	0	17
	Planorbidae	0	0	0	0	0	0	0	0	0
	Stagnicola sp.	0	0	0	1	0	0	0	0	0
Bivalvia	Pisidium sp.	0	0	1	13	3	0	0	0	8
	Sphaeriidae	0	0	0	6	1	0	0	0	0
Annelida	Helobdella stagnalis	0	0	0	0	0	0	1	0	1
	Oligochaeta	16	1	0	5	0	42	19	1	84
	Theromyzon sp.	0	0	0	0	0	0	0	0	0
Acari	Acari	0	1	0	0	0	0	0	0	0
	Arrenurus sp.	0	0	0	0	1	0	2	4	0
	Estelloxus sp.	0	0	0	0	0	0	0	0	0
	Hygrobates sp.	0	0	0	0	0	0	2	0	4
	Limnochares sp.	0	0	0	0	0	0	1	0	0
	Oribatei	3	0	0	0	24	3	2	0	12
	Rhyncholimnochares sp.	0	0	0	0	0	0	0	1	0
	Sperchon sp.	1	0	0	0	0	0	0	0	0
Crustacea	Caecidotea sp.	0	0	0	0	0	0	0	0	0
	Cambaridae	2	0	0	0	0	0	0	0	0
	Gammarus sp.	0	0	1	0	0	0	0	0	2
	Hyalella sp.	172	175	1	55	91	5	1	25	12
	Ostracoda	12	8	3	51	55	5	11	182	4
Other Organisms	Hydra sp.	0	0	0	0	0	0	0	0	0
	Nematoda	0	1	2	0	0	3	13	1	2
	Prostoma sp.	0	0	0	0	0	24	0	0	6
	Turbellaria	1	0	0	0	0	9	0	0	0

Phylum/Class/Order	Taxa	Clay Spring	Cold Spring	Gandy Salt Marsh North Complex	Gandy Salt Marsh Middle Complex	Gandy Salt Marsh	Gandy Salt Marsh	Gandy Salt Marsh (G51)	Gandy Warm Springs	Leland Harris Spring	Miller Spring
	Gastropoda	0	0	3	0	0	0	0	0	0	0
	Gyraulus sp.	0	0	6	0	0	0	0	15	0	0
	Hydrobiidae	239	42	32	0	0	0	0	183	28	28
	Lymnaeidae	0	0	3	0	0	0	3	0	0	0
	Melanoides tuberculata	0	0	0	0	0	0	0	7	0	0
	Physa (Physella) sp.	0	0	10	14	2	0	8	0	7	1
	Planorbidae	0	0	0	0	0	0	0	0	0	0
	Stagnicola sp.	0	0	0	6	0	0	1	0	0	1
Bivalvia	Pisidium sp.	3	22	0	4	10	0	0	0	1	0
	Sphaeriidae	0	0	0	0	5	4	2	0	1	0
Annelida	Helobdella stagnalis	1	2	1	0	1	3	0	0	3	1
	Oligochaeta	1	35	16	0	0	0	0	2	5	10
	Theromyzon sp.	0	0	0	0	0	0	0	0	0	0
Acari	Acari	2	0	0	0	1	1	0	0	0	0
	Arrenurus sp.	0	0	0	0	0	0	0	0	0	0
	Estelloxus sp.	1	0	0	1	0	0	0	0	0	0
	Hygrobates sp.	0	0	0	0	0	0	0	0	0	0
	Limnochares sp.	0	0	0	0	0	0	0	0	0	0
	Oribatei	2	0	1	0	1	0	0	6	0	4
	Rhyncholimnochares sp.	0	0	0	0	0	0	0	0	0	0
	Sperchon sp.	0	0	0	0	0	0	0	0	0	0
Crustacea	Caecidotea sp.	0	0	0	0	0	0	0	0	0	20
	Cambaridae	0	0	0	0	0	0	0	0	0	0
	Gammarus sp.	0	120	18	87	259	273	219	0	6	168
	Hyalella sp.	1	0	67	184	42	60	52	9	4	77
	Ostracoda	24	10	121	34	0	1	4	3	194	9
Other Organisms	Hydra sp.	0	0	1	0	0	0	0	0	0	0
	Nematoda	2	7	0	0	0	0	2	4	2	2
	Prostoma sp.	0	0	0	0	0	0	0	0	0	0
	Turbellaria	0	26	0	0	0	0	0	0	0	0

Phylum/Class/Order	Taxa	North Little Spring	South Little Spring	Swimming Hole	Twin Springs	Unnamed Spring at Skating Pond	Unnamed Spring South of Caine Spring	Unnamed Spring South of Knoll Spring	Unnamed Big Spring #1	Unnamed Big Spring #2
	Gastropoda	0	0	0	0	0	0	0	0	0
	Gyraulus sp.	0	36	0	8	8	0	0	0	3
	Hydrobiidae	0	0	0	206	0	3	0	47	0
	Lymnaeidae	0	0	1	0	1	0	0	0	1
	Melanoides tuberculata	0	0	0	0	0	0	0	0	0
	Physa (Physella) sp.	0	0	0	9	0	0	0	0	44
	Planorbidae	0	0	54	0	0	0	0	0	0
	Stagnicola sp.	0	0	0	0	0	0	0	0	0
Bivalvia	Pisidium sp.	1	0	0	0	1	0	0	0	5
	Sphaeriidae	0	0	0	0	0	0	0	0	3
Annelida	Helobdella stagnalis	0	0	0	0	0	0	0	16	8
	Oligochaeta	3	120	23	38	99	8	195	44	16
	Theromyzon sp.	1	0	0	0	0	0	0	0	0
Acari	Acari	0	0	0	0	1	4	0	9	0
	Arrenurus sp.	0	4	1	0	0	0	0	0	0
	Estelloxus sp.	0	0	0	0	0	1	0	0	0
	Hygrobates sp.	0	0	0	0	0	0	0	0	0
	Limnochares sp.	0	0	0	0	0	0	0	0	0
	Oribatei	0	0	9	5	1	0	3	0	0
	Rhyncholimnochares sp.	0	0	0	0	0	0	0	0	0
	Sperchon sp.	0	0	0	0	0	0	0	0	0
Crustacea	Caecidotea sp.	0	0	0	0	0	0	0	0	0
	Cambaridae	0	0	0	0	0	0	0	0	0
	Gammarus sp.	229	0	0	7	20	0	0	38	3
	Hyalella sp.	1	12	2	0	21	343	7	145	49
	Ostracoda	145	5	86	61	11	0	81	17	12
Other Organisms	Hydra sp.	0	0	0	0	0	0	0	0	0
	Nematoda	0	0	1	2	2	0	3	1	9
	Prostoma sp.	0	0	0	0	0	0	0	0	0
	Turbellaria	0	0	0	0	0	0	0	3	0

SPRING VALLEY

Phylum/Class/Order	Taxa	Blind Spring	Cedars Spring	Keegan Ranch North	Keegan Ranch Middle	Keegan Ranch South	Layton Spring	North Millick Spring	Shoshone Pond 1	Shoshone Pond 2	Shoshone Pond 3	South Bastian Spring	South Millick Spring	Swallow Spring	Unnamed East of Cleve Creek - West	Unnamed East of Cleve Creek - East	Unnamed Minerva	Unnamed Minerva 2	Unnamed Minerva 3	Unnamed Spring #1	Unnamed Spring at Stonehouse Ranch	West Spring Valley Complex #1	West Spring Valley Complex #5	Willard Spring	Willow Spring
Ephemeroptera	Baetidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0
	Baetis adonis	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
	Baetis sp.	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0
	Caenis sp.	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Callibaetis sp.	27	0	2	3	0	21	0	1	0	0	5	2	0	22	7	0	0	0	4	19	16	2	0	11
Odonata	Aeshna sp.	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Aeshnidae	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
	Amphiagrion sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	11	0	0	0	0	0	0	1	1	0	0
	Anax junius	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
	Argia sp.	0	2	0	0	0	0	0	3	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0
	Coenagrion/Enallagma sp.	6	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	4	15	0	0
	Coenagrionidae	26	2	0	0	0	51	0	4	1	1	10	0	0	3	6	0	0	0	2	5	0	0	0	1
	Libellula saturata	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Libellulidae	2	1	0	0	0	5	0	0	1	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0
Plecoptera	Hesperoperla pacifica	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0
Hemiptera	Corixidae	1	0	0	0	0	0	0	1	0	0	0	0	0	2	0	0	0	0	0	3	0	0	0	0
	Hesperocorixa sp.	1	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Notonecta sp.	1	0	0	0	0	5	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0
	Notonectidae	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Sigara sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Coleoptera	Agabus sp.	0	0	0	0	0	2	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
	Anacaena sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0
	Cleptelmis addenda	0	0	0	0	0	0	0	0	0	0	0	7	3	0	0	0	0	0	0	0	0	0	0	0
	Colymbetes sp.	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
	Dytiscus marginicollis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0
	Enochrus sp.	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Haliplus sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
	Heterlimnius sp.	0	0	0	0	0	0	0	0	0	0	0	0	20	0	0	0	0	0	0	0	0	0	0	0
	Hygrotus sp.	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Laccobius sp.	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Laccophilus sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
	Liodessus sp.	0	0	0	0	0	0	0	0	0	2	0	0	0	1	0	0	0	0	0	0	0	1	0	0
	Optioservus sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0
	Stictotarsus sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0
	Tropisternus sp.	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Diptera-Chironomidae	Acricotopus sp.	3	0	0	0	0	0	0	0	1	0	0	0	0	1	1	0	0	0	0	0	13	0	1	0
	Alotanypus sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	3	0	0	0
	Anopheles sp.	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Apedilum sp.	6	0	0	0	0	23	0	0	0	0	1	0	0	0	0	0	0	0	0	0	5	0	15	0
	Bezzia/Palpomyia sp.	6	1	0	0	0	0	0	0	0	0	4	0	2	0	1	0	0	0	0	0	0	0	0	0
	Brillia sp.	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0
	Caloparyphus sp.	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Ceratopogon sp.	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Ceratopogoninae	8	3	0	0	0	0	0	6	6	1	2	0	0	17	0	0	1	5	4	0	0	0	5	0
	Chaetocladius sp.	2	1	0	1	4	0	3	1	0	2	0	2	1	1	0	3	1	1	0	0	0	0	6	0
	Chironomini	0	0	0	0	0	3	0	0	0	1	0	0	0	0	0	4	0	0	0	0	0	0	0	0
	Chironomus sp.	0	0	1	0	0	0	0	0	2	0	0	0	0	0	0	4	0	1	0	1	1	0	23	4
	Cladotanytarsus sp.	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Clinocera sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	1	0	0	0	0	0	0
	Corynoneura sp.	2	1	0	2	0	0	1	1	0	3	0	1	1	0	0	2	0	3	0	0	2	0	6	0
	Cricotopus sp.	0	5	2	11	0	2	0	0	0	0	0	0	0	1	0	27	50	24	0	56	0	0	0	0
	Culex sp.	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Dasyhelea sp.	4	4	0	1	0	1	0	2	3	0	0	0	0	0	0	0	0	0	9	0	0	0	1	0
	Derotanypus sp.	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	8	6	9	0	0	0	0	0	0
	Diamesa sp.	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
	Dicranota sp.	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
	Dicrotendipes sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
	Diptera	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	10	0	0	1	0
	Dixella sp.	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
	Dixidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
	Empididae	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
	Ephydridae	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	6	0	0	0
	Erioptera sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0
	Eukiefferiella brehmi gr.	0	0	0	0	0	0	0	0	0	0	0	0	11	0	0	0	0	0	0	0	0	0	0	0
	Eukiefferiella claripennis gr.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
	Forcipomyia sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0
	Hydrobaenus sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
	Larsia sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0
	Lauterborniella agrayloides	0	0	0	0	0	0	0	17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Limnophyes sp.	4	0	0	0	0	0	0	1	0	2	0	0	1	0	1	0	0	0	0	0	3	2	0	0
	Limonia sp.	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Macropelopiini	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
	Metriocnemus sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	2	0
	Micropsectra sp.	3	56	2	95	19	0	9	46	0	42	0	8	13	38	0	126	21	109	1	0	0	0	157	0
	Muscidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
	Nilotanypus sp.	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Orthocladiinae	0	0	1	1	0	0	0	0	0	0	0	0	0	2	1	0	0	0	1	0	0	0	0	0
	Orthocladius Complex	0	0	1	0	0	5	7	0	0	0	0	1	4	0	0	0	18	0	0	0	1	3	0	0
	Pagastia sp.	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
	Parachaetocladius sp.	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Parakiefferiella sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0
	Paramerina sp.	5	0	0	0	0	0	0	8	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	1
	Parametriocnemus sp.	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
	Paraphaenocladius sp.	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0
	Paratanytarsus sp.	8	0	0	0	0	3	0	8	0	0	0	0	0	0	2	38	1	0	0	3	0	0	0	0
	Paratendipes sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	1	0	0	0
	Pericoma/Telmatoscopus sp.	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	4	0	0	0	0	0
	Phaenopsectra sp.	0	0	1	2	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	3	0
	Polypedilum sp.	0	1	0	0	0	0	0	1	0	1	0	0	0	6	0	0	0	0	0	0	2	0	0	0
	Probezzia sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
	Prodiamesa sp.	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0
	Psectrocladius sp.	3	0	1	0	0	1	0	3	0	0	0	0	0	0	2	0	0	3	0	0	0	0	0	0
	Pseudochironomus sp.	7	79	1	0	0	17	0	49	2	8	2	0	0	40	7	0	0	0	0	0	0	1	0	0
	Pseudorthocladius sp.	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Pseudosmittia sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	1
	Radotanypus sp.	0	0	0	0	0	0	1	0	0	0	0	2	1	6	0	1	1	3	0	0	0	0	0	1
	Sergentia sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0
	Simuliidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
	Simulium sp.	0	9	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0
	Smittia sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Tabanidae	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Tanypodinae	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Tanypus sp.	12	0	0	0	0	0	0	8	5	0	0	0	0	0	4	0	0	0	0	0	0	0	1	0
	Tanytarsus sp.	1	0	0	0	0	4	0	0	0	0	0	0	0	0	0	19	0	0	0	3	0	1	0	0
	Thienemanniella sp.	0	0	7	38	11	0	0	0	0	0	0	0	12	0	0	0	2	4	0	0	0	0	0	0
	Thienemannimyia gr. sp.	0	5	0	3	5	0	0	3	0	4	0	0	0	0	0	0	0	0	0	5	0	0	0	1
	Tvetenia bavarica gr.	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0
Trichoptera	Hesperophylax sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	5	0	0	0	0	0	0	0
	Hydroptila sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
	Lepidostoma sp.	0	0	0	0	0	0	0	0	0	0	0	0	120	0	0	0	0	0	0	0	0	0	0	0
	Limnephilidae	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	3
	Limnephilus sp.	0	0	0	0	7	0	5	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0
	Nectopsyche sp.	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Oxyethira sp.	0	11	3	0	0	0	0	2	0	0	0	0	0	2	1	0	0	0	0	1	0	0	0	0

SPRING VALLEY (cont.)

Phylum/Class/Order	Taxa	Blind Spring	Cedars Spring	Keegan Ranch North	Keegan Ranch Middle	Keegan Ranch South	Layton Spring	North Millick Spring	Shoshone Pond 1	Shoshone Pond 2	Shoshone Pond 3	South Bastian Spring
	Phryganeidae	0	0	0	0	0	0	0	4	0	0	0
	Trichoptera	0	0	1	0	0	0	0	0	0	0	0
Gastropoda	Gastropoda	0	0	0	0	0	0	0	0	0	0	0
	Gyraulus sp.	9	0	0	0	0	0	0	17	0	0	0
	Hydrobiidae	0	0	0	0	0	0	0	0	0	0	0
	Lymnaeidae	1	0	1	0	0	0	0	0	0	0	2
	Physa (Physella) sp.	0	6	0	3	0	0	18	16	0	31	14
	Planorbidae	0	0	0	0	0	0	0	0	0	0	0
	Pyrgulopsis sp.	0	0	0	0	0	0	0	0	0	0	0
Bivalvia	Pisidium sp.	0	7	0	2	0	1	0	8	0	12	0
	Sphaeriidae	1	5	0	0	2	0	9	4	0	0	5
Annelida	Erpobdellidae	2	0	0	0	0	0	1	0	0	0	0
	Glossiphoniidae	0	0	0	0	0	0	0	2	0	1	0
	Helobdella stagnalis	0	0	2	0	0	0	10	0	0	1	0
	Oligochaeta	15	8	1	3	1	1	6	13	36	48	2
Acari	Acari	4	0	0	0	0	0	0	6	1	0	0
	Arrenurus sp.	0	0	0	0	0	0	0	2	0	0	0
	Estelloxus sp.	0	0	0	0	0	0	0	0	0	0	0
	Hydrodroma sp.	0	0	0	0	0	3	0	0	0	0	0
	Hydryphantidae	0	0	0	0	0	0	0	2	0	0	0
	Hygrobates sp.	0	0	0	0	0	0	0	0	0	0	0
	Lebertia sp.	0	0	1	0	2	0	0	0	0	0	0
	Oribatei	0	16	0	1	0	0	0	16	6	3	0
Crustacea	Amphipoda	0	0	0	0	0	0	0	0	0	0	0
	Gammarus sp.	0	0	4	174	159	0	123	0	0	0	0
	Hyalella sp.	53	45	33	5	259	0	128	14	0	30	18
	Ostracoda	88	25	281	28	3	41	9	82	313	55	267
Other Organisms	Nematoda	11	5	0	15	0	0	1	14	5	81	3
	Prostoma sp.	0	0	0	0	0	0	0	0	5	0	0
	Turbellaria	0	0	0	0	0	0	0	0	0	2	0

Phylum/Class/Order	Taxa	South Millick Spring	Swallow Spring	of Cleve Creek - West	of Cleve Creek - East	Unnamed Minerva	Unnamed Minerva 2	Unnamed Minerva 3	Unnamed Spring #1	Stonehouse Ranch	West Spring Valley Complex #1	West Spring Valley Complex #5	Willard Spring	Willow Spring
	Phryganeidae	0	0	0	0	0	0	0	0	0	0	0	0	0
	Trichoptera	0	0	0	0	0	0	0	0	0	0	0	0	0
Gastropoda	Gastropoda	0	0	0	0	1	0	0	0	0	0	0	0	0
	Gyraulus sp.	0	0	0	0	0	0	0	0	0	0	7	0	0
	Hydrobiidae	0	0	0	0	7	6	5	65	67	52	0	0	15
	Lymnaeidae	0	0	0	0	0	1	0	0	0	0	0	1	0
	Physa (Physella) sp.	12	0	0	12	0	1	0	0	0	10	29	0	0
	Planorbidae	0	0	0	0	0	0	0	0	1	0	0	0	0
	Pyrgulopsis sp.	0	0	0	0	0	0	2	0	0	0	0	0	0
Bivalvia	Pisidium sp.	0	9	9	5	0	0	1	0	4	5	6	0	19
	Sphaeriidae	1	10	14	0	0	2	0	0	1	0	0	0	0
Annelida	Erpobdellidae	0	0	0	1	0	0	2	0	0	0	0	0	0
	Glossiphoniidae	0	0	0	0	0	0	0	0	0	0	0	0	0
	Helobdella stagnalis	1	0	5	1	3	1	0	10	1	3	1	0	0
	Oligochaeta	1	32	31	26	103	123	29	17	0	1	1	31	39
Acari	Acari	51	3	4	0	3	9	1	0	0	1	0	0	0
	Arrenurus sp.	0	0	2	0	0	0	0	0	1	1	0	0	1
	Estelloxus sp.	0	0	0	0	0	0	0	0	0	0	0	0	1
	Hydrodroma sp.	0	0	0	0	0	0	0	0	0	0	0	0	0
	Hydryphantidae	0	25	0	0	0	0	0	0	0	0	0	0	0
	Hygrobates sp.	0	0	0	0	0	0	0	0	1	0	0	0	0
	Lebertia sp.	0	0	0	0	0	0	0	0	0	0	0	0	0
	Oribatei	1	0	0	0	0	0	0	5	0	13	2	0	1
Crustacea	Amphipoda	0	0	0	0	0	0	0	0	4	0	0	0	0
	Gammarus sp.	184	22	0	6	6	32	82	0	35	40	32	0	0
	Hyalella sp.	79	0	188	37	0	14	1	39	59	110	102	0	147
	Ostracoda	3	41	4	205	3	25	42	247	104	63	169	4	86
Other Organisms	Nematoda	0	2	1	4	9	1	2	2	0	2	0	58	11
	Prostoma sp.	0	0	0	0	0	0	0	0	0	0	0	0	0
	Turbellaria	0	1	14	4	1	0	0	1	0	3	0	0	1

LAKE VALLEY

Phylum/Class/Order	Taxa	Wambolt Spring Complex #2
Ephemeroptera	Callibaetis sp.	1
Odonata	Coenagrionidae	1
Hemiptera	Belostoma sp.	2
	Corixidae	1
	Hesperocorixa sp.	3
	Notonecta sp.	10
Coleoptera	Agabus sp.	1
	Zaitzevia sp.	2
Diptera-Chironomidae	Apedilum sp.	4
	Micropsectra sp.	4
	Natarsia sp.	1
	Paramerina sp.	2
	Pseudochironomus sp.	2
	Pseudosmittia sp.	1
Trichoptera	Oxyethira sp.	4
Gastropoda	Gyraulus sp.	55
	Hydrobiidae	39
	Lymnaeidae	23
	Stagnicola sp.	10
Annelida	Oligochaeta	5
Acari	Arrenurus sp.	3
Crustacea	Hyalella sp.	75
	Ostracoda	67
Other Organisms	Nematoda	6

WHITE RIVER VALLEY

Phylum/Class/Order	Taxa	Arnoldson Spring	North Flag	Middle Flag	South Flag	Hot Creek Spring	Indian Spring	Lund Spring	Nicholas Spring	Preston Big Spring	Sunnyside Upper	Sunnyside Lower	Tin Can Spring
Ephemeroptera	Baetis adonis	0	1	0	0	0	0	0	0	0	0	2	0
	Baetis sp.	0	0	0	1	0	0	0	0	0	0	0	0
	Callibaetis sp.	0	0	0	0	0	0	1	0	0	0	4	2
	Fallceon quilleri	0	0	0	0	0	0	0	0	0	1	28	0
	Tricorythodes sp.	0	0	0	0	0	0	0	0	0	3	2	0
Odonata	Aeshnidae	0	0	0	0	0	0	0	0	0	0	0	3
	Argia sp.	0	2	2	0	1	0	0	9	0	3	0	0
	Coenagrionidae	0	0	0	0	0	0	1	42	0	0	0	10
	Coenagrion/Enallagma sp.	0	0	0	0	0	0	0	0	0	0	5	0
	Erythemis collocata	0	0	0	0	0	0	0	0	0	0	0	1
	Hetaerina sp.	0	0	1	0	0	0	0	0	0	9	0	0
	Libellula saturata	0	0	0	0	0	1	0	0	0	0	0	0
	Libellulidae	0	0	0	0	0	0	1	0	1	0	0	5
Hemiptera	Ambrysus sp.	0	1	0	2	0	0	0	0	0	0	0	0
	Belostoma sp.	0	0	0	1	0	1	0	0	0	0	0	0
	Belostomatidae	0	0	0	0	0	0	0	0	0	0	0	1
	Cenocorixa sp.	0	0	0	0	1	0	0	0	0	0	0	0
	Corixidae	0	0	0	0	0	2	0	0	0	1	0	0
Coleoptera	Dytiscidae	0	0	0	0	0	0	0	0	0	1	0	0
	Hydrophilidae	0	0	0	0	1	0	0	0	0	0	0	0
	Microcylloepus sp.	0	0	10	28	0	0	0	1	0	5	0	0
	Optioservus sp.	0	34	0	0	0	0	0	0	0	0	0	0
	Tropisternus sp.	0	1	0	0	0	2	0	0	0	2	0	1
	Zaitzevia sp.	0	0	1	0	0	0	0	0	0	0	0	0
	Alotanypus sp.	0	0	0	0	0	0	0	0	0	0	2	0
	Apedilum sp.	0	0	0	0	0	0	0	0	1	0	0	0
	Chaetocladius sp.	0	0	0	1	0	0	0	0	1	0	2	0
	Chironomus sp.	0	0	0	0	0	10	0	0	0	0	0	0
	Corynoneura sp.	0	0	0	0	0	8	0	0	0	7	0	0
	Cricotopus sp.	0	0	2	0	0	0	0	0	0	0	0	0
	Dicrotendipes sp.	0	0	0	0	4	0	0	0	0	0	0	0
	Eukiefferiella claripennis gr.	1	0	4	0	0	0	0	0	0	0	0	0
	Eukiefferiella coerulescens gr.	0	0	0	11	0	0	0	0	3	2	0	0
	Labrundinia sp.	0	0	0	0	0	0	0	0	0	0	2	0
	Limnophyes sp.	1	0	0	3	0	0	0	0	0	18	1	0
	Microcylloepus sp.	0	0	0	0	0	0	0	0	0	0	0	0
	Micropsectra sp.	0	0	0	0	0	36	0	0	11	0	0	0
	Orthocladius Complex	0	0	4	8	0	5	0	0	21	1	0	0
	Orthocladius sp.	0	0	0	0	0	0	0	0	0	0	14	0
	Parakiefferiella sp.	0	1	0	0	0	0	0	0	0	5	17	0
	Paramerina sp.	0	0	0	0	0	0	0	0	0	0	1	0
	Parametriocnemus sp.	0	0	0	0	0	3	0	0	0	0	0	0
	Paraphaenocladius sp.	0	0	0	0	0	0	0	0	0	1	1	0
	Paratanytarsus sp.	0	0	0	0	0	15	0	0	3	0	0	0
	Paratendipes sp.	0	0	0	0	0	2	0	0	0	0	4	0
	Pentaneura sp.	0	0	0	0	0	0	0	0	0	2	1	0
	Pentaneurini	0	0	0	0	0	0	0	0	0	1	1	0
	Psectrocladius sp.	0	0	0	0	0	1	0	0	0	0	0	0
	Pseudochironomus sp.	0	0	0	0	0	22	0	0	4	0	4	0
	Radotanypus sp.	0	0	0	0	0	0	0	0	0	0	10	0
	Rheotanytarsus sp.	0	1	0	5	0	0	0	0	0	3	1	0
	Tanypus sp.	0	0	0	0	0	10	0	0	0	0	0	0
	Tanytarsini	0	1	0	0	0	0	0	0	0	0	0	0
	Tanytarsus sp.	0	0	0	0	0	2	0	0	0	0	1	0
	Thienemanniella sp.	0	0	0	0	0	0	0	0	0	10	0	0
	Thienemannimyia gr. sp.	0	0	0	0	0	0	0	0	0	0	1	0
	Tropisternus sp.	0	0	0	0	0	0	0	0	0	0	0	0
Diptera-Chironimidae	Apedilum sp.	0	0	0	0	0	0	6	1	0	0	0	0
	Bezzia/Palpomyia sp.	0	0	0	0	0	0	0	0	0	0	8	0
	Caloparyphus sp.	0	0	0	0	0	0	0	0	0	7	0	0
	Ceratopogoninae	0	0	0	0	0	1	0	0	0	1	1	1
	Chironomus sp.	0	0	0	0	0	0	0	0	0	0	0	38
	Cladotanytarsus sp.	0	0	0	0	0	0	0	0	0	0	0	0
	Cricotopus sp.	0	0	0	0	0	0	2	0	0	0	0	0
	Dasyhelea sp.	1	0	0	0	2	1	0	1	0	1	0	0
	Dicrotendipes sp.	0	0	0	0	0	0	0	1	0	0	0	9
	Diptera	0	0	1	1	1	0	0	0	0	0	0	0
	Dixella sp.	0	0	0	0	0	0	0	0	0	0	1	0
	Empididae	0	0	0	0	0	0	0	0	0	2	0	0
	Eukiefferiella claripennis gr.	0	0	0	0	0	0	0	0	0	0	0	0
	Hemerodromia sp.	0	0	0	0	0	0	0	0	0	1	1	0
	Limnophyes sp.	0	0	0	0	0	0	0	0	0	0	0	0
	Limonia sp.	0	0	0	1	0	0	0	0	0	0	0	0
	Paratanytarsus sp.	0	0	0	0	0	0	0	0	0	0	0	11

WHITE RIVER VALLEY (cont.)

Phylum/Class/Order	Taxa	Arnoldson Spring	North Flag	Middle Flag	South Flag	Hot Creek Spring	Indian Spring	Lund Spring	Nicholas Spring	Preston Big Spring	Sunnyside Upper	Sunnyside Lower	Tin Can Spring
	Paratendipes sp.	0	0	0	0	0	0	1	0	0	0	0	0
	Pericoma/Telmatoscopus sp.	0	0	0	1	0	0	0	0	0	0	0	0
	Phaenopsectra sp.	0	0	0	0	0	0	0	0	0	0	0	3
	Pseudochironomus sp.	0	0	0	0	0	0	12	0	0	0	0	12
	Simulium sp.	5	0	0	0	0	0	0	0	0	2	0	0
	Tanypodinae	0	0	0	0	0	0	0	0	0	0	0	1
	Tanypus sp.	0	0	0	0	0	0	0	0	0	0	0	98
	Tanytarsini	0	0	0	0	0	0	0	1	0	0	0	0
Trichoptera	Brachycentrus echo	0	0	0	0	0	0	0	0	0	6	0	0
	Chimarra sp.	0	4	0	6	0	0	0	0	0	0	0	0
	Helicopsyche sp.	0	4	3	0	0	0	0	0	0	0	0	0
	Hydropsyche sp.	0	4	1	4	0	0	0	0	0	0	0	0
	Hydroptila sp.	0	0	0	0	0	0	19	0	0	0	0	0
	Lepidostoma sp.	0	0	0	0	0	0	0	0	0	4	2	0
	Leptoceridae	0	0	0	0	1	0	0	0	0	0	1	0
	Leucotrichia sp.	0	0	0	0	0	0	0	0	1	0	0	0
	Limnephilus sp.	0	0	0	0	0	0	0	0	0	0	3	0
	Nectopsyche sp.	0	4	0	0	1	0	0	0	0	23	0	0
	Oxyethira sp.	0	0	0	0	0	0	3	3	1	0	0	0
	Protoptila sp.	0	0	0	1	0	0	0	0	0	1	0	0
Lepidoptera	Petrophila sp.	8	0	0	0	0	0	0	2	0	0	0	0
	Pyralidae	0	0	0	0	0	0	0	0	1	0	0	0
Gastropoda	Gyraulus sp.	0	0	0	0	0	0	0	0	0	0	1	0
	Hydrobiidae	205	92	189	149	60	0	275	128	0	0	0	23
	Melanoides tuberculata	88	0	0	0	0	32	0	1	3	0	0	0
	Physa (Physella) sp.	0	1	0	0	0	0	0	0	0	0	0	0
	Planorbella sp.	0	0	0	0	2	0	0	0	0	0	0	0
	Pyrgulopsis sp.	0	77	0	4	0	3	0	0	51	22	0	0
	Tryonia sp.	0	0	0	0	20	0	0	0	0	0	0	0
Bivalvia	Pisidium sp.	0	0	0	7	0	0	0	0	0	0	1	1
	Sphaeriidae	2	1	0	0	0	0	2	0	0	0	0	0
Annelida	Oligochaeta	42	0	0	1	13	37	42	0	3	0	12	52
Acari	Acari	0	0	0	0	0	0	0	0	1	0	0	0
	Hydryphantidae	0	0	2	0	0	0	0	0	0	0	0	0
	Lebertia sp.	0	1	1	0	0	9	0	0	0	7	0	0
	Limnesia sp.	0	0	0	0	6	0	0	0	0	0	0	0
	Oribatei	1	0	0	2	0	2	1	11	0	104	3	0
	Sperchon sp.	0	1	0	1	0	0	0	0	0	6	0	0
	Torrenticola sp.	0	0	0	0	0	0	0	0	0	12	0	0
Crustacea	Hyalella sp.	5	62	118	79	249	3	4	117	261	0	11	1
	Ostracoda	0	1	0	3	1	85	0	0	0	20	176	0
	Procambarus clarkii	2	0	0	0	0	0	0	0	0	0	0	92
Other Organisms	Nematoda	0	3	0	0	0	1	0	0	0	3	2	8
	Prostoma sp.	0	1	0	0	0	0	0	1	0	1	0	24
	Turbellaria	2	10	0	4	0	0	2	1	7	8	0	0

DRY LAKE VALLEY

Phylum/Class/Order	Taxa	Coyote Spring
Coleoptera	Microcylloepus sp.	1
Diptera-Chironomidae	Procladius sp.	2
Crustacea	Ostracoda	465

DELAMAR VALLEY

Phylum/Class/Order	Taxa	Grassy Spring
Ephemeroptera	Callibaetis sp.	2
Odonata	Coenagrionidae	3
	Libellula saturata	1
Coleoptera	Hygrotus sp.	5
Diptera-Chironomidae	Chironomus sp.	35
	Paramerina sp.	2
	Pentaneurini	1
Acari	Arrenurus sp.	1
Crustacea	Ostracoda	312

PAHRANAGAT VALLEY

Phylum/Class/Order	Taxa	Ash Spring	BLM Spring	Brownie - Deacon	Cottonwood Spring	Crystal Springs	Hiko Spring	Lone Tree Spring	Maynard Spring
Ephemeroptera	Callibaetis sp.	0	0	0	5	1	22	0	0
Odonata	Anax walsinghami	0	0	0	0	0	0	0	1
	Argia sp.	0	0	0	2	0	1	0	0
	Coenagrionidae	0	6	0	5	0	40	12	6
	Libellulidae	0	0	0	2	1	2	0	0
	Odonata	0	1	0	0	0	0	0	0
Hemiptera	Corixidae	0	0	0	0	0	5	0	0
	Hesperocorixa sp.	0	0	0	1	0	1	0	0
	Notonecta sp.	0	0	0	0	0	1	0	0
	Notonectidae	0	0	0	0	0	1	0	0
Coleoptera	Agabus sp.	0	0	0	0	0	0	0	1
	Coleoptera	0	0	0	0	0	0	1	0
	Dytiscidae	0	0	0	0	0	0	1	0
	Enochrus sp.	0	1	0	0	0	0	0	0
	Liodessus sp.	0	0	0	0	0	0	0	1
	Scirtidae	0	0	0	0	0	0	0	5
	Stenelmis sp.	10	0	0	0	0	0	0	0
Diptera-Chironomidae	Aedes sp.	0	4	0	0	0	0	0	4
	Alotanypus sp.	0	0	8	2	0	0	0	0
	Anopheles sp.	0	0	0	0	0	3	3	0
	Apedilum sp.	0	0	0	0	1	3	2	0
	Bezzia/Palpomyia sp.	0	0	0	5	0	0	0	0
	Ceratopogonidae	0	2	0	4	0	3	3	2
	Chironomidae	0	0	0	1	0	0	0	0
	Chironomus sp.	0	13	9	0	1	1	56	15
	Corynoneura sp.	0	10	0	4	13	0	0	1
	Cricotopus bicinctus gr.	0	0	0	0	27	0	0	0
	Cricotopus sp.	0	0	0	0	1	0	0	0
	Cryptochironomus sp.	0	0	0	0	1	0	0	0
	Dasyhelea sp.	0	0	0	5	0	20	4	2
	Diptera	0	0	0	0	0	3	1	0
	Dolichopodidae	0	0	0	0	0	0	0	1
	Ephydridae	0	0	0	8	0	0	0	0
	Eucorethra underwoodi	0	0	0	0	0	0	0	1
	Forcipomyia sp.	0	2	0	0	0	0	0	0
	Glyptotendipes sp.	0	0	0	0	0	1	0	0
	Larsia sp.	0	0	1	0	0	6	16	0
	Limnophyes sp.	0	7	1	0	0	0	0	2
	Micropsectra sp.	0	0	121	0	0	0	10	0
	Orthocladiinae	0	0	1	0	0	0	0	0
	Orthocladius Complex	0	0	0	0	34	0	0	0
	Paramerina sp.	0	10	5	2	0	2	13	3
	Parametriocnemus sp.	0	0	0	0	0	0	0	0
	Paraphaenocladius sp.	0	3	0	0	0	1	0	15
	Paratanytarsus sp.	0	8	0	0	1	1	0	0
	Paratendipes sp.	0	0	2	1	0	0	0	1
	Pentaneura sp.	0	0	0	3	0	0	0	0
	Pentaneurini	1	2	1	0	0	0	0	1
	Pericoma/Telmatoscopus sp.	0	0	3	0	0	0	0	3
	Polypedilum sp.	0	0	0	0	0	0	0	2
	Pseudochironomus sp.	0	0	0	0	0	1	0	0
	Pseudosmittia sp.	0	3	0	0	0	0	0	0
	Psilometriocnemus sp.	0	0	0	0	0	0	3	0
	Simulium sp.	0	0	0	3	0	0	0	0
	Stratiomyidae	0	0	0	0	0	3	0	0
	Stratiomys sp.	0	0	0	1	0	0	0	0
	Tanypodinae	0	0	1	0	0	0	0	0
	Tanypus sp.	0	0	0	0	0	4	0	0
	Tanytarsus sp.	2	0	0	3	0	4	2	0
	Thienemanniella sp.	0	0	0	2	0	0	0	0
	Thienemannimyia gr. sp.	0	0	0	0	0	0	0	3
	Uranotaenia sp.	0	0	0	0	0	0	0	1
Trichoptera	Hydroptila sp.	0	0	0	0	2	2	0	0
	Hydroptilidae	0	0	0	0	2	0	0	0
	Limnephilidae	0	1	0	0	0	0	1	0
	Oxyethira sp.	0	0	0	4	0	24	0	0
Gastropoda	Gastropoda	75	0	0	0	0	0	0	0
	Gyraulus sp.	0	0	2	0	0	0	1	5
	Hydrobiidae	194	0	0	0	1	0	0	0
	Lymnaeidae	0	0	1	0	0	8	0	0
	Melanoides tuberculata	0	0	0	0	189	8	0	0
	Physa (Physella) sp.	0	6	6	6	0	50	0	0
	Planorbella sp.	0	0	0	0	13	2	0	0
	Valvata sp.	0	0	0	34	0	0	0	0
Bivalvia	Pisidium sp.	0	0	32	23	0	0	1	0
	Sphaeriidae	0	0	27	0	0	0	2	0
Annelida	Erpobdellidae	0	0	0	1	1	0	0	0
	Helobdella stagnalis	0	0	0	0	0	1	0	0
	Oligochaeta	6	201	5	4	7	36	0	242
Acari	Acari	1	1	10	0	0	1	0	5
	Arrenurus sp.	0	0	0	2	0	1	0	0
	Estelloxus sp.	0	0	0	1	0	0	0	0
	Hydryphantidae	0	0	1	0	0	0	0	0
	Limnesiidae	0	0	0	1	0	0	0	0
	Oribatei	0	0	32	7	0	0	4	8
	Thyopsis sp.	0	0	0	3	0	0	0	0
Crustacea	Hyalella sp.	30	0	1	135	4	59	32	2
	Ostracoda	5	43	10	29	7	7	191	5
	Procambarus clarkii	0	0	0	0	0	1	0	0
Other Organisms	Hydra sp.	0	0	0	0	0	2	0	0
	Nematoda	1	0	17	13	0	1	0	2
	Prostoma sp.	0	0	0	0	1	0	0	0
	Turbellaria	1	0	4	13	0	0	0	2

PANACA VALLEY

Phylum/Class/Order	Taxa	Panaca Spring
Gastropoda	Melanoides tuberculata	259
	Physa (Physella) sp.	1
	Planorbella sp.	2
Annelida	Oligochaeta	3
		265

APPENDIX E: MACROINVERTEBRATE MATRICES GENERATED FOR AQUATIC SYSTEMS OF INTEREST IN THE BIOLOGICAL RESOURCES STUDY AREA (BRSA)

Tule Valley

Metrics	Coyote Spring	South Tule Spring	Tule Spring	Willow Spring
Abundance Measures				
Corrected Abundance	1656.00	2240.00	12902.40	1823.17
EPT Abundance	0.00	0.00	0.00	91.97
Dominance Measures				
1st Dominant Taxon	Ostracoda	Oribatei	Hydrobiidae	Ostracoda
1st Dominant Abundance	1008.00	761.60	7296.00	486.90
2nd Dominant Taxon	Oligochaeta	Ostracoda	Hyalella sp.	Micropsectra sp.
2nd Dominant Abundance	153.60	761.60	3225.60	373.29
3rd Dominant Taxon	Polypedilum sp.	Micropsectra sp.	Ostracoda	Hyalella sp.
3rd Dominant Abundance	120.00	236.80	1267.20	270.50
% 1 Dominant Taxon	60.87	34.00	56.55	26.71
% 2 Dominant Taxa	70.14	68.00	81.55	47.18
% 3 Dominant Taxa	77.39	78.57	91.37	62.02
Richness Measures				
Species Richness	15.00	22.00	9.00	27.00
EPT Richness	0.00	0.00	0.00	1.00
Ephemeroptera Richness	0.00	0.00	0.00	1.00
Plecoptera Richness	0.00	0.00	0.00	0.00
Trichoptera Richness	0.00	0.00	0.00	0.00
Chironomidae Richness	5.00	9.00	2.00	13.00
Oligochaeta Richness	1.00	1.00	0.00	1.00
Non-Chiro. Non-Olig. Richness	9.00	12.00	7.00	13.00
Rhyacophila Richness	0.00	0.00	0.00	0.00
Community Composition				
% Ephemeroptera	0.00	0.00	0.00	5.04
% Plecoptera	0.00	0.00	0.00	0.00
% Trichoptera	0.00	0.00	0.00	0.00
% EPT	0.00	0.00	0.00	5.04
% Coleoptera	0.87	1.14	0.00	0.00
% Diptera	9.57	15.43	2.68	45.10
% Oligochaeta	9.28	2.57	0.00	2.97
% Baetidae	0.00	0.00	0.00	5.04
% Brachycentridae	0.00	0.00	0.00	0.00
% Chironomidae	8.99	13.43	2.08	35.31
% Ephemerellidae	0.00	0.00	0.00	0.00
% Hydropsychidae	0.00	0.00	0.00	0.00
% Odonata	2.03	0.57	0.00	0.59
% Perlidae	0.00	0.00	0.00	0.00
% Pteronarcyidae	0.00	0.00	0.00	0.00
% Simuliidae	0.00	0.00	0.00	0.00
% Filterers	0.00	0.29	0.30	3.26
% Gatherers	77.68	56.57	37.20	84.57
% Predators	7.54	42.86	5.65	9.50
% Scrapers	7.25	0.00	56.55	0.89
% Shredders	7.54	0.29	0.30	0.30
% Piercer-Herbivores	0.00	0.00	0.00	0.00
% Unclassified	0.00	0.00	0.00	1.48
Filterer Richness	0.00	1.00	1.00	1.00
Gatherer Richness	6.00	11.00	5.00	13.00
Predator Richness	5.00	9.00	1.00	9.00
Scraper Richness	2.00	0.00	1.00	1.00
Shredder Richness	2.00	1.00	1.00	1.00
Piercer-Herbivore Richness	0.00	0.00	0.00	0.00
Unclassified	0.00	0.00	0.00	2.00
Diversity/Evenness Measures				
Shannon-Weaver H' (log 10)	0.64	0.77	0.52	1.02
Shannon-Weaver H' (log 2)	2.14	2.56	1.73	3.39
Shannon-Weaver H' (log e)	1.48	1.77	1.20	2.35
Margalef's Richness	1.89	2.72	0.85	3.46
Pielou's J'	0.55	0.57	0.55	0.71
Simpson's Heterogeneity	0.61	0.75	0.60	0.85
Biotic Indices				
% Indiv. w/ HBI Value	96.52	64.86	94.35	91.10
Hilsenhoff Biotic Index	7.60	7.45	6.15	7.51
% Indiv. w/ MTI Value	17.10	20.00	0.89	34.12
Metals Tolerance Index	2.83	2.89	3.67	1.75
% Indiv. w/ FSBI Value	0.00	0.00	0.00	0.00
Fine Sediment Biotic Index	-99.00	-99.00	-99.00	-99.00
FSBI - average	-99.00	-99.00	-99.00	-99.00
FSBI - weighted average	-99.00	-99.00	-99.00	-99.00
% Indiv. w/ TPM Value	15.94	8.86	25.00	19.58
Temp. Pref. Metric - average	1.13	1.27	0.22	0.74
TPM - weighted average	2.13	2.68	2.00	3.21
Karr BIBI Metrics				
Long-Lived Taxa Richness	0.00	1.00	1.00	1.00
Clinger Richness	4.00	4.00	1.00	4.00
% Clingers	16.52	11.71	56.55	21.96
Intolerant Taxa Richness	0.00	0.00	1.00	1.00
% Tolerant Individuals	16.45	10.32	0.96	10.30
% Tolerant Taxa	26.67	31.82	33.33	37.04
Coleoptera Richness	1.00	3.00	0.00	0.00

Fish Springs National Wildlife Refuge

Metrics	Middle Spring	Thomas Spring	North Spring	Deadman Spring	House Spring	Mirror Spring	Walter's Spring	South Spring	Percy Spring	Crater Spring	Lost Spring
Abundance Measures											
Corrected Abundance	7776.00	24000.84	5762.40	7543.74	4865.52	3081.69	16656.00	18592.00	22792.00	4068.00	7119.00
EPT Abundance	192.00	1226.88	436.80	362.27	298.76	366.66	3456.00	560.00	168.00	192.00	273.00
Dominance Measures											
Dominant Taxon	Melanoides tuberculata	Hyalella sp.	Hyalella sp.	Ostracoda	Ostracoda	Hydrobiidae	Pseudochironomus sp.	Hyalella sp.	Ostracoda	Melanoides tuberculata	Hyalella sp.
Dominant Abundance	2860.80	11885.40	2352.00	3729.25	1408.44	1021.41	3552.00	10528.00	10416.00	1812.00	2793.00
2nd Dominant Taxon	Hydrobiidae	Hydrobiidae	Coenagrionidae	Tanypus sp.	Hyalella sp.	Hyalella sp.	Callibaetis sp.	Hydrobiidae	Hyalella sp.	Ostracoda	Hydrobiidae
2nd Dominant Abundance	2380.80	5520.96	772.80	490.13	725.56	995.22	2736.00	2688.00	4760.00	672.00	2289.00
3rd Dominant Taxon	Hyalella sp.	Melanoides tuberculata	Melanoides tuberculata	Oligochaeta	Melanoides tuberculata	Callibaetis sp.	Ostracoda	Melanoides tuberculata	Hydrobiidae	Hyalella sp.	Melanoides tuberculata
3rd Dominant Abundance	825.60	2147.04	655.20	468.82	544.17	323.01	2448.00	1848.00	3976.00	432.00	693.00
% Dominant Taxon	36.79	49.52	40.82	49.44	28.95	33.14	21.33	56.63	45.70	44.54	39.23
% 2 Dominant Taxa	67.41	72.52	54.23	55.93	43.86	65.44	37.75	71.08	66.58	61.06	71.39
% 3 Dominant Taxa	78.02	81.47	65.60	62.15	55.04	75.92	52.45	81.02	84.03	71.68	81.12
Richness Measures											
Species Richness	19.00	16.00	21.00	20.00	26.00	25.00	26.00	19.00	18.00	16.00	22.00
EPT Richness	2.00	4.00	4.00	1.00	2.00	3.00	4.00	4.00	1.00	2.00	5.00
Ephemeroptera Richness	1.00	1.00	1.00	1.00	1.00	1.00	2.00	1.00	1.00	1.00	2.00
Plecoptera Richness	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Trichoptera Richness	1.00	3.00	3.00	0.00	1.00	2.00	2.00	3.00	0.00	1.00	3.00
Chironomidae Richness	3.00	1.00	6.00	6.00	10.00	8.00	6.00	4.00	3.00	2.00	5.00
Oligochaeta Richness	1.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Non-Chiro. Non-Olig. Richness	15.00	15.00	14.00	13.00	15.00	16.00	19.00	14.00	14.00	13.00	16.00
Rhyacophila Richness	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Community Composition											
% Ephemeroptera	1.98	3.51	4.08	4.80	5.48	10.48	17.58	1.20	0.74	4.42	2.06
% Plecoptera	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
% Trichoptera	0.49	1.60	3.50	0.00	0.66	1.42	3.17	1.81	0.00	0.29	1.77
% EPT	2.47	5.11	7.58	4.80	6.14	11.90	20.75	3.01	0.74	4.72	3.83
% Coleoptera	0.49	0.00	0.00	0.00	0.00	0.57	0.00	0.60	0.25	0.00	0.00
% Diptera	1.48	1.28	3.50	18.36	8.11	9.92	26.80	4.22	0.98	2.65	3.54
% Oligochaeta	7.41	0.00	0.58	6.21	4.61	0.57	11.82	3.01	1.23	0.59	2.65
% Baetidae	1.98	3.51	4.08	4.80	5.48	10.48	16.43	1.20	0.74	4.42	1.18
% Brachycentridae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
% Chironomidae	1.48	0.64	3.50	17.80	7.68	9.35	25.94	4.22	0.74	2.36	3.54
% Ephemerellidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
% Hydropsychidae	0.00	0.00	2.33	0.00	0.66	0.00	0.00	1.51	0.00	0.00	0.29
% Odonata	1.23	0.96	13.70	4.80	7.02	2.83	7.49	1.81	0.74	7.67	1.18
% Perlidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
% Pteronarcyidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
% Simuliidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Functional Group Composition											
% Filterers	0.00	0.00	2.33	0.28	1.97	1.13	0.58	1.51	0.25	0.59	0.29
% Gatherers	27.16	58.47	47.81	72.60	58.33	49.29	76.08	67.47	69.29	34.22	49.56
% Predators	1.48	1.28	14.87	15.82	10.31	4.53	8.65	2.41	3.69	8.55	2.06
% Scrapers	33.09	28.75	21.57	7.63	17.11	34.84	7.78	17.47	17.94	11.80	35.69
% Shredders	0.74	0.64	0.87	2.54	1.10	3.40	3.75	0.30	0.25	0.00	0.29
% Piercer-Herbivores	0.49	1.60	1.17	0.85	0.00	1.42	3.17	0.30	0.00	0.29	1.47
% Unclassified	37.04	9.27	11.37	0.28	11.18	5.38	0.00	10.54	8.60	44.54	10.62
Filterer Richness	0.00	0.00	2.00	1.00	2.00	1.00	1.00	2.00	1.00	1.00	1.00
Gatherer Richness	6.00	4.00	7.00	7.00	9.00	9.00	10.00	6.00	7.00	6.00	8.00
Predator Richness	4.00	4.00	5.00	7.00	10.00	6.00	8.00	4.00	5.00	5.00	4.00
Scraper Richness	4.00	2.00	4.00	2.00	2.00	2.00	2.00	3.00	2.00	2.00	3.00
Shredder Richness	2.00	1.00	1.00	1.00	2.00	4.00	3.00	1.00	1.00	0.00	1.00
Piercer-Herbivore Richness	1.00	3.00	1.00	1.00	0.00	2.00	2.00	1.00	0.00	1.00	2.00
Unclassified	2.00	2.00	1.00	1.00	1.00	1.00	0.00	2.00	2.00	1.00	3.00
Diversity/Evenness Measures											
Shannon-Weaver H' (log 10)	0.76	0.68	0.88	0.88	1.02	0.86	1.05	0.70	0.69	0.78	0.76
Shannon-Weaver H' (log 2)	2.51	2.25	2.93	2.91	3.39	2.85	3.47	2.33	2.28	2.60	2.54
Shannon-Weaver H' (log e)	1.74	1.56	2.03	2.02	2.35	1.97	2.41	1.61	1.58	1.80	1.76
Margalef's Richness	2.01	1.49	2.31	2.13	2.94	2.99	2.57	1.83	1.69	1.80	2.37
Pielou's J'	0.59	0.56	0.67	0.67	0.72	0.61	0.74	0.55	0.55	0.65	0.57
Simpson's Heterogeneity	0.75	0.69	0.78	0.73	0.86	0.77	0.88	0.64	0.71	0.75	0.73
Biotic Indices											
% Indiv. w/ HBI Value	62.72	90.42	88.63	98.87	87.72	94.05	99.42	89.46	88.70	54.57	88.50
Hilsenhoff Biotic Index	6.43	7.19	7.78	7.97	7.58	6.75	7.26	7.36	7.38	7.24	6.79
% Indiv. w/ MTI Value	5.43	5.43	29.74	26.55	19.74	21.25	56.20	9.34	2.21	12.39	6.78
Metals Tolerance Index	2.05	1.65	2.96	3.74	2.89	2.31	3.04	2.68	2.78	2.40	2.83
% Indiv. w/ FSBI Value	0.00	0.32	2.04	0.00	0.66	0.85	0.00	1.20	0.00	0.00	1.47
Fine Sediment Biotic Index	5.00	5.00	5.00	-99.00	5.00	5.00	-99.00	5.00	-99.00	-99.00	10.00
FSBI - average	-99.00	0.31	0.24	-99.00	0.19	0.20	-99.00	0.26	-99.00	-99.00	0.45
FSBI - weighted average	-99.00	5.00	5.00	-99.00	5.00	5.00	-99.00	5.00	-99.00	-99.00	5.00
% Indiv. w/ TPM Value	10.86	50.80	44.02	7.34	19.30	39.94	12.68	59.04	21.13	11.21	41.59
Temp. Pref. Metric - average	0.16	0.44	0.62	0.50	0.62	0.92	0.50	0.58	0.22	0.25	0.50
TPM - weighted average	1.98	1.99	2.07	2.92	2.13	2.23	2.64	2.01	2.00	2.00	1.99
Karr BIBI Metrics											
Long-Lived Taxa Richness	0.00	0.00	0.00	1.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00
Clinger Richness	5.00	6.00	7.00	5.00	7.00	8.00	8.00	7.00	4.00	3.00	7.00
% Clingers	33.58	30.35	22.74	13.28	20.83	40.23	12.68	19.88	18.43	12.39	37.76
Intolerant Taxa Richness	1.00	0.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.00
% Tolerant Individuals	2.42	0.93	5.05	3.57	7.19	5.83	1.37	1.37	1.40	6.08	2.71
% Tolerant Taxa	42.11	37.50	52.38	55.00	34.62	24.00	46.15	42.11	44.44	43.75	36.36
Coleoptera Richness	1.00	0.00	0.00	0.00	0.00	1.00	0.00	1.00	1.00	0.00	0.00

Pleasant Valley

Metrics	Cane Spring
Abundance Measures	
Corrected Abundance	31332.00
EPT Abundance	2688.00
Dominance Measures	
1st Dominant Taxon	Ostracoda
1st Dominant Abundance	7812.00
2nd Dominant Taxon	Hyalella sp.
2nd Dominant Abundance	7224.00
3rd Dominant Taxon	Hydrobiidae
3rd Dominant Abundance	3444.00
% 1 Dominant Taxon	24.93
% 2 Dominant Taxa	47.99
% 3 Dominant Taxa	58.98
Richness Measures	
Species Richness	28.00
EPT Richness	3.00
Ephemeroptera Richness	1.00
Plecoptera Richness	0.00
Trichoptera Richness	2.00
Chironomidae Richness	11.00
Oligochaeta Richness	1.00
Non-Chiro. Non-Olig. Richness	16.00
Rhyacophila Richness	0.00
Community Composition	
% Ephemeroptera	8.04
% Plecoptera	0.00
% Trichoptera	0.54
% EPT	8.58
% Coleoptera	1.07
% Diptera	19.03
% Oligochaeta	1.88
% Baetidae	8.04
% Brachycentridae	0.00
% Chironomidae	17.96
% Ephemerellidae	0.00
% Hydropsychidae	0.00
% Odonata	4.29
% Perlidae	0.00
% Pteronarcyidae	0.00
% Simuliidae	1.07
Functional Group Composition	
% Filterers	12.60
% Gatherers	64.34
% Predators	8.58
% Scrapers	13.94
% Shredders	0.00
% Piercer-Herbivores	0.00
% Unclassified	0.54
Filterer Richness	3.00
Gatherer Richness	13.00
Predator Richness	8.00
Scraper Richness	2.00
Shredder Richness	0.00
Piercer-Herbivore Richness	0.00
Unclassified	2.00
Diversity/Evenness Measures	
Shannon-Weaver H' (log 10)	1.02
Shannon-Weaver H' (log 2)	3.37
Shannon-Weaver H' (log e)	2.34
Margalef's Richness	2.61
Pielou's J'	0.70
Simpson's Heterogeneity	0.85
Biotic Indices	
% Indiv. w/ HBI Value	98.93
Hilsenhoff Biotic Index	7.26
% Indiv. w/ MTI Value	33.24
Metals Tolerance Index	2.77
% Indiv. w/ FSBI Value	1.07
Fine Sediment Biotic Index	3.00
FSBI - average	0.11
FSBI - weighted average	3.00
% Indiv. w/ TPM Value	36.73
Temp. Pref. Metric - average	0.82
TPM - weighted average	2.15
Karr BIBI Metrics	
Long-Lived Taxa Richness	1.00
Clinger Richness	6.00
% Clingers	26.01
Intolerant Taxa Richness	0.00
% Tolerant Individuals	0.78
% Tolerant Taxa	28.57
Coleoptera Richness	1.00

Snake Valley

Metrics	Big Spring	Big Spring Creek	Big Spring Pond	Beck Springs-North	Beck Springs-South	Bishop Springs	Foote Reservoir	Caine Spring	Callao Big Spring	Clay Spring	Cold Spring	Gandy Salt Marsh North Complex (G4-G9)	Gandy Salt Marsh Middle Complex (G20-G28)	Gandy Salt Marsh (G44)	Gandy Salt Marsh (G48-G49)
Abundance Measures															
Corrected Abundance	5618.16	8328.00	27.00	7104.00	5392.00	2952.00	748.80	12480.00	2038.08	5648.00	3494.40	4044.00	9352.00	3120.00	5648.00
EPT Abundance	275.40	2808.00	0.00	57.60	240.00	1557.18	21.60	384.00	138.96	432.00	124.80	360.00	0.00	0.00	0.00
Dominance Measures															
1st Dominant Taxon	Hyalella sp.	Hyalella sp.	Chironomus sp.	Hydrobiidae	Hydrobiidae	Cheumatopsyche sp.	Pseudochironomus sp.	Ostracoda	Oligochaeta	Hydrobiidae	Gammarus sp.	Ostracoda	Hyalella sp.	Gammarus sp.	Gammarus sp.
1st Dominant Abundance	3157.92	4200.00	3.00	3187.20	1488.00	605.16	192.00	6988.80	486.36	3824.00	1152.00	1452.00	5152.00	2486.40	4368.00
2nd Dominant Taxon	Hydrobiidae	Fallceon quilleri	Ostracoda	Hyalella sp.	Hyalella sp.	Hydropsychidae	Gyraulus sp.	Gyraulus sp.	Coenagrionidae	Ostracoda	Hydrobiidae	Hyalella sp.	Gammarus sp.	Hyalella sp.	Hyalella sp.
2nd Dominant Abundance	697.68	2256.00	3.00	1056.00	1456.00	568.26	62.40	2918.40	376.35	384.00	403.20	804.00	2436.00	403.20	960.00
3rd Dominant Taxon	Cricotopus sp.	Argia sp.	Fossaria sp.	Ostracoda	Ostracoda	Rheotanytarsus sp.	Chironomus sp.	Hyalella sp.	Callibaetis sp.	Tanytarsus sp.	Oligochaeta	Hydrobiidae	Ostracoda	Pisidium sp.	Agabus sp.
3rd Dominant Abundance	605.88	312.00	3.00	979.20	880.00	332.10	57.60	960.00	133.17	288.00	336.00	384.00	952.00	96.00	64.00
% 1 Dominant Taxon	56.21	50.43	11.11	44.86	27.60	20.50	25.64	56.00	23.86	67.71	32.97	35.91	55.09	79.69	77.34
% 2 Dominant Taxa	68.63	77.52	22.22	59.73	54.60	39.75	33.97	79.38	42.33	74.50	44.51	55.79	81.14	92.62	94.33
% 3 Dominant Taxa	79.41	81.27	33.33	73.51	70.92	51.00	41.67	87.08	48.86	79.60	54.12	65.28	91.32	95.69	95.47
Richness Measures															
Species Richness	25.00	26.00	17.00	23.00	26.00	26.00	30.00	17.00	33.00	26.00	23.00	27.00	11.00	12.00	10.00
EPT Richness	8.00	10.00	0.00	1.00	1.00	5.00	3.00	3.00	2.00	5.00	2.00	1.00	0.00	0.00	0.00
Ephemeroptera Richness	2.00	3.00	0.00	1.00	1.00	2.00	2.00	2.00	1.00	2.00	0.00	1.00	0.00	0.00	0.00
Plecoptera Richness	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Trichoptera Richness	6.00	7.00	0.00	0.00	0.00	3.00	1.00	1.00	1.00	3.00	2.00	0.00	0.00	0.00	0.00
Chironomidae Richness	5.00	7.00	8.00	6.00	9.00	5.00	12.00	5.00	9.00	8.00	9.00	7.00	1.00	0.00	1.00
Oligochaeta Richness	1.00	1.00	0.00	1.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.00	0.00	0.00
Non-Chiro. Non-Olig. Richness	19.00	18.00	9.00	16.00	17.00	20.00	17.00	11.00	23.00	17.00	13.00	19.00	10.00	12.00	9.00
Rhyacophila Richness	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Community Composition															
% Ephemeroptera	0.65	28.82	0.00	0.81	4.45	10.75	2.56	2.77	6.53	5.38	0.00	8.90	0.00	0.00	0.00
% Plecoptera	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
% Trichoptera	4.25	4.90	0.00	0.00	0.00	42.00	0.32	0.31	0.28	2.27	3.57	0.00	0.00	0.00	0.00
% EPT	4.90	33.72	0.00	0.81	4.45	52.75	2.88	3.08	6.82	7.65	3.57	8.90	0.00	0.00	0.00
% Coleoptera	0.33	0.00	0.00	0.00	0.59	0.00	0.00	0.00	0.57	0.00	0.55	0.89	0.60	0.62	1.70
% Diptera	13.07	8.36	51.85	5.41	8.31	17.50	66.03	6.46	21.88	12.75	23.35	6.23	0.30	0.31	1.42
% Oligochaeta	5.23	0.29	0.00	1.35	0.00	10.50	6.09	0.31	23.86	0.28	9.62	4.75	0.00	0.00	0.00
% Baetidae	0.33	28.53	0.00	0.81	4.45	10.50	1.28	2.77	6.53	1.42	0.00	8.90	0.00	0.00	0.00
% Brachycentridae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
% Chironomidae	13.07	6.63	40.74	4.32	6.82	13.50	62.18	6.46	21.59	11.61	21.70	5.34	0.30	0.00	0.85
% Ephemerellidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
% Hydropsychidae	0.33	1.15	0.00	0.00	0.00	39.75	0.00	0.00	0.28	0.00	0.00	0.00	0.00	0.00	0.00
% Odonata	0.65	3.75	3.70	3.78	4.45	2.50	5.77	0.92	19.89	1.42	0.00	1.19	0.30	0.00	0.00
% Perlidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
% Pteronarcyidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
% Simuliidae	0.00	1.44	0.00	0.54	0.00	1.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Functional Group Composition															
% Filterers	0.33	2.88	11.11	5.68	1.19	52.50	0.64	0.00	3.98	5.95	6.04	0.30	1.20	4.62	1.13
% Gatherers	67.97	86.17	44.44	34.05	51.63	25.50	51.92	67.69	47.44	17.00	59.89	78.34	93.41	93.23	96.03
% Predators	3.59	5.48	22.22	5.41	16.02	14.50	30.13	8.31	30.11	7.08	18.68	4.75	0.90	1.54	2.83
% Scrapers	16.34	2.88	14.81	54.59	30.56	4.50	9.62	23.69	12.22	67.71	11.81	15.13	4.19	0.62	0.00
% Shredders	10.78	1.73	3.70	0.27	0.30	0.75	7.37	0.00	5.97	0.00	0.00	0.59	0.00	0.00	0.00
% Piercer-Herbivores	0.65	0.58	0.00	0.00	0.00	2.25	0.32	0.00	0.00	1.98	3.57	0.00	0.00	0.00	0.00
% Unclassified	0.33	0.29	3.70	0.00	0.30	0.00	0.00	0.31	0.28	0.28	0.00	0.89	0.30	0.00	0.00
Filterer Richness	1.00	4.00	2.00	3.00	2.00	4.00	1.00	0.00	4.00	2.00	1.00	1.00	1.00	2.00	1.00
Gatherer Richness	9.00	10.00	8.00	9.00	9.00	9.00	10.00	8.00	12.00	11.00	10.00	11.00	5.00	4.00	5.00
Predator Richness	6.00	6.00	3.00	6.00	9.00	8.00	14.00	6.00	10.00	9.00	8.00	8.00	3.00	5.00	4.00
Scraper Richness	5.00	3.00	2.00	4.00	4.00	3.00	2.00	2.00	5.00	1.00	2.00	4.00	1.00	1.00	0.00
Shredder Richness	1.00	1.00	1.00	1.00	1.00	1.00	2.00	0.00	1.00	0.00	0.00	2.00	0.00	0.00	0.00
Piercer-Herbivore Richness	2.00	1.00	0.00	0.00	0.00	1.00	1.00	0.00	0.00	2.00	2.00	0.00	0.00	0.00	0.00
Unclassified	1.00	1.00	1.00	0.00	1.00	0.00	0.00	1.00	1.00	1.00	0.00	1.00	1.00	0.00	0.00
Diversity/Evenness Measures															
Shannon-Weaver H' (log 10)	0.73	0.72	1.17	0.85	0.92	1.07	1.16	0.61	1.18	0.64	1.01	0.93	0.55	0.34	0.34
Shannon-Weaver H' (log 2)	2.41	2.39	3.90	2.84	3.05	3.57	3.86	2.01	3.93	2.14	3.35	3.09	1.81	1.11	1.12
Shannon-Weaver H' (log e)	1.67	1.65	2.70	1.97	2.11	2.47	2.68	1.40	2.72	1.48	2.32	2.14	1.26	0.77	0.77
Margalef's Richness	2.78	2.77	4.85	2.48	2.91	3.13	4.38	1.70	4.20	2.89	2.70	3.13	1.09	1.37	1.04
Pielou's J'	0.52	0.51	0.95	0.63	0.65	0.76	0.79	0.49	0.78	0.45	0.74	0.65	0.52	0.31	0.34
Simpson's Heterogeneity	0.65	0.67	0.96	0.75	0.81	0.88	0.90	0.62	0.89	0.53	0.85	0.81	0.62	0.35	0.37
Biotic Indices															
% Indiv. w/ HBI Value	98.04	72.33	96.30	99.46	91.10	88.75	97.76	98.15	94.89	96.60	92.31	98.52	99.40	99.69	100.00
Hilsenhoff Biotic Index	7.23	7.23	6.73	6.33	6.92	5.83	7.17	8.06	7.88	5.38	6.02	7.53	7.41	6.28	6.33
% Indiv. w/ MTI Value	18.30	13.83	66.67	16.76	12.46	47.00	79.49	27.69	49.43	15.58	56.32	21.66	28.44	82.15	82.15
Metals Tolerance Index	6.57	4.42	3.94	2.95	2.33	3.75	4.08	2.90	3.33	3.44	1.82	1.93	1.15	1.07	1.18
% Indiv. w/ FSBI Value	0.65	4.32	0.00	0.81	1.19	26.50	0.32	0.00	0.28	3.97	2.20	0.00	0.00	0.31	0.57
Fine Sediment Biotic Index	9.00	19.00	-99.00	4.00	6.00	24.00	5.00	-99.00	2.00	4.00	5.00	-99.00	-99.00	5.00	5.00
FSBI - average	0.36	0.73	-99.00	0.17	0.23	0.92	0.17	-99.00	0.06	0.15	0.22	-99.00	-99.00	0.42	0.50
FSBI - weighted average	4.50	3.87	-99.00	2.33	4.00	2.56	5.00	-99.00	2.00	4.00	5.00	-99.00	-99.00	5.00	5.00
% Indiv. w/ TPM Value	70.59	65.13	14.81	17.03	32.05	57.25	8.65	7.69	11.08	12.75	3.57	20.77	55.09	13.23	18.70
Temp. Pref. Metric - average	1.32	2.12	0.53	0.48	0.54	1.15	0.40	0.12	0.36	0.81	0.57	0.37	0.18	0.67	1.10
TPM - weighted average	2.56	2.52	2.75	2.10	2.11	2.65	4.41	2.00	3.59	2.38	4.15	2.03	2.00	2.09	2.18
Karr BIBI Metrics															
Long-Lived Taxa Richness	1.00	0.00	2.00	2.00	2.00	0.00	1.00	0.00	1.00	1.00	1.00	1.00	1.00	3.00	1.00
Clinger Richness	12.00	15.00	4.00	6.00	6.00	11.00	4.00	3.00	9.00	7.00	4.00	7.00	2.00	2.00	2.00
% Clingers	29.41	41.50	25.93	55.95	33.53	70.75	20.83	24.31	19.89	80.74	23.63	16.02	4.49	0.92	1.13
Intolerant Taxa Richness	1.00	2.00	0.00	1.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00
% Tolerant Individuals	3.67	3.05	15.38	2.09	3.60	3.78	10.79	2.40	11.58	0.57	1.40	6.38	2.51	1.48	1.08
% Tolerant Taxa	20.00	15.38	29.41	34.78	26.92	30.77	43.33	47.06	42.42	19.23	13.04	40.74	36.36	33.33	20.00
Coleoptera Richness	1.00	0.00	0.00	0.00	2.00	0.00	0.00	0.00	2.00	0.00	1.00	2.00	2.00	2.00	2.00

Snake Valley (cont.)

Metrics	Gandy Salt Marsh (G51)	Gandy Warm Springs	Leland Harris Spring	Miller Spring	North Little Spring	South Little Spring	Swimming Hole	Twin Springs	Unnamed Spring at Skating Pond	Unnamed south of Caine Spring 1	Unnamed Spring south of Knoll Spring	Unnamed Big Springs #1	Unnamed Big Spring #2
Abundance Measures													
Corrected Abundance	3680.54	21840.00	4550.00	4092.00	9384.00	11592.69	942.40	6384.00	1090.74	2880.00	675.50	3312.00	977.22
EPT Abundance	0.00	1344.00	42.00	60.00	24.00	1974.78	58.90	352.00	339.57	0.00	8.75	182.40	165.54
Dominance Measures													
1st Dominant Taxon	Gammarus sp.	Hydrobiidae	Ostracoda	Gammarus sp.	Gammarus sp.	Oligochaeta	Ostracoda	Hydrobiidae	Oligochaeta	Hyalella sp.	Oligochaeta	Hyalella sp.	Coenagrionidae
1st Dominant Abundance	2472.51	12297.60	2716.00	2016.00	5496.00	4388.40	266.60	3296.00	339.57	2744.00	341.25	1392.00	245.64
2nd Dominant Taxon	Hyalella sp.	Microcylloepus sp.	Micropsectra sp.	Hyalella sp.	Ostracoda	Callibaetis sp.	Planorbidae	Ostracoda	Callibaetis sp.	Oligochaeta	Ostracoda	Hydrobiidae	Callibaetis sp.
2nd Dominant Abundance	587.08	3696.00	630.00	924.00	3480.00	1974.78	167.40	976.00	339.57	64.00	141.75	451.20	162.87
3rd Dominant Taxon	Hydroporus sp.	Gyraulus sp.	Hydrobiidae	Hydrobiidae	Psectrocladius sp.	Coenagrionidae	Coenagrionidae	Oligochaeta	Coenagrionidae	Acari	Corynoneura sp.	Oligochaeta	Hyalella sp.
3rd Dominant Abundance	169.35	1008.00	392.00	336.00	72.00	1938.21	89.90	608.00	78.89	32.00	49.00	422.40	130.83
% 1 Dominant Taxon	67.18	56.31	59.69	49.27	58.57	37.85	28.29	51.63	31.13	95.28	50.52	42.03	25.14
% 2 Dominant Taxa	83.13	73.23	73.54	71.85	95.65	54.89	46.05	66.92	62.26	97.50	71.50	55.65	41.80
% 3 Dominant Taxa	87.73	77.85	82.15	80.06	96.42	71.61	55.59	76.44	69.50	98.61	78.76	68.41	55.19
Richness Measures													
Species Richness	17.00	26.00	24.00	23.00	13.00	19.00	25.00	23.00	24.00	6.00	27.00	17.00	27.00
EPT Richness	0.00	8.00	1.00	3.00	1.00	1.00	1.00	5.00	1.00	0.00	2.00	2.00	2.00
Ephemeroptera Richness	0.00	1.00	0.00	1.00	0.00	1.00	1.00	3.00	1.00	0.00	1.00	0.00	1.00
Plecoptera Richness	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Trichoptera Richness	0.00	7.00	1.00	2.00	1.00	0.00	0.00	2.00	0.00	0.00	1.00	2.00	1.00
Chironomidae Richness	1.00	7.00	8.00	5.00	6.00	6.00	5.00	4.00	5.00	0.00	15.00	3.00	4.00
Oligochaeta Richness	0.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Non-Chiro. Non-Olig. Richness	16.00	18.00	15.00	17.00	6.00	12.00	19.00	18.00	18.00	5.00	11.00	13.00	22.00
Rhyacophila Richness	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Community Composition													
% Ephemeroptera	0.00	0.31	0.00	0.29	0.00	17.03	6.25	3.76	31.13	0.00	0.78	0.00	16.67
% Plecoptera	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
% Trichoptera	0.00	5.85	0.92	1.17	0.26	0.00	0.00	1.75	0.00	0.00	0.52	5.51	0.27
% EPT	0.00	6.15	0.92	1.47	0.26	17.03	6.25	5.51	31.13	0.00	1.30	5.51	16.94
% Coleoptera	8.90	16.92	0.62	0.00	0.00	2.21	3.95	0.25	1.26	0.00	0.00	0.00	0.55
% Diptera	1.84	3.69	20.92	2.05	2.81	7.89	17.76	7.52	8.18	0.28	22.54	1.74	13.11
% Oligochaeta	0.00	0.62	1.54	2.93	0.77	37.85	7.57	9.52	31.13	2.22	50.52	12.75	4.37
% Baetidae	0.00	0.31	0.00	0.29	0.00	17.03	6.25	0.75	31.13	0.00	0.78	0.00	16.67
% Brachycentridae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
% Chironomidae	1.23	3.69	19.08	2.05	2.56	6.94	12.17	6.02	6.92	0.00	19.69	0.87	10.66
% Ephemerellidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
% Hydropsychidae	0.00	0.92	0.00	0.00	0.00	0.00	0.00	0.25	0.00	0.00	0.00	0.00	0.00
% Odonata	0.00	0.92	0.31	2.05	0.00	16.72	13.49	2.51	7.55	0.00	1.30	0.00	27.05
% Perlidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
% Pteronarcyidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
% Simuliidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Functional Group Composition													
% Filterers	0.61	1.54	0.62	0.00	0.26	0.63	0.00	5.01	2.52	0.00	0.26	0.00	2.46
% Gatherers	86.50	23.38	79.38	85.34	99.23	66.56	61.18	32.08	85.22	97.50	89.12	75.65	50.00
% Predators	9.20	4.31	5.23	4.11	0.26	20.50	20.39	5.26	9.43	1.39	10.10	9.28	32.51
% Scrapers	3.37	66.46	10.77	8.50	0.00	11.36	18.09	55.89	2.83	0.83	0.00	13.62	13.39
% Shredders	0.31	1.23	1.85	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.52	0.00	0.27
% Piercer-Herbivores	0.00	0.92	0.00	1.17	0.26	0.00	0.00	1.50	0.00	0.00	0.00	0.87	0.55
% Unclassified	0.00	2.15	2.15	0.88	0.00	0.95	0.33	0.25	0.00	0.28	0.00	0.58	0.82
Filterer Richness	1.00	3.00	2.00	0.00	1.00	1.00	0.00	2.00	3.00	0.00	1.00	0.00	3.00
Gatherer Richness	7.00	9.00	8.00	11.00	10.00	10.00	10.00	11.00	12.00	2.00	16.00	6.00	10.00
Predator Richness	6.00	4.00	8.00	6.00	1.00	5.00	12.00	5.00	7.00	2.00	9.00	7.00	5.00
Scraper Richness	2.00	6.00	2.00	2.00	0.00	1.00	2.00	3.00	2.00	1.00	0.00	1.00	4.00
Shredder Richness	1.00	1.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	1.00
Piercer-Herbivore Richness	0.00	2.00	0.00	2.00	1.00	0.00	0.00	1.00	0.00	0.00	0.00	1.00	2.00
Unclassified	0.00	1.00	2.00	2.00	0.00	2.00	1.00	1.00	0.00	1.00	0.00	2.00	2.00
Diversity/Evenness Measures													
Shannon-Weaver H' (log 10)	0.54	0.75	0.70	0.73	0.40	0.83	1.02	0.78	0.87	0.11	0.78	0.81	1.04
Shannon-Weaver H' (log 2)	1.81	2.51	2.32	2.44	1.32	2.77	3.39	2.61	2.90	0.37	2.59	2.70	3.45
Shannon-Weaver H' (log e)	1.25	1.74	1.60	1.69	0.92	1.92	2.35	1.81	2.01	0.25	1.79	1.87	2.39
Margalef's Richness	1.95	2.50	2.73	2.65	1.31	1.92	3.50	2.51	3.29	0.63	3.99	1.97	3.78
Pielou's J'	0.44	0.53	0.50	0.54	0.36	0.65	0.73	0.58	0.63	0.14	0.54	0.66	0.73
Simpson's Heterogeneity	0.52	0.65	0.62	0.69	0.52	0.78	0.86	0.70	0.79	0.09	0.69	0.77	0.87
Biotic Indices													
% Indiv. w/ HBI Value	98.77	95.38	96.00	97.95	100.00	97.79	90.79	97.74	98.74	99.72	98.19	98.84	98.36
Hilsenhoff Biotic Index	6.34	5.29	7.43	6.65	6.81	8.26	7.25	6.00	8.10	7.95	7.48	6.98	7.94
% Indiv. w/ MTI Value	73.31	32.00	23.38	58.36	60.36	52.68	46.71	19.05	51.89	1.39	18.91	24.64	69.67
Metals Tolerance Index	1.26	3.83	2.14	1.50	1.06	2.57	3.04	2.66	1.63	5.00	3.36	2.60	2.89
% Indiv. w/ FSBI Value	0.00	0.92	0.00	0.00	0.26	0.00	0.00	3.26	0.00	0.00	0.00	0.00	0.00
Fine Sediment Biotic Index	-99.00	5.00	-99.00	-99.00	5.00	-99.00	-99.00	6.00	-99.00	-99.00	-99.00	-99.00	-99.00
FSBI - average	-99.00	0.19	-99.00	-99.00	0.38	-99.00	-99.00	0.26	-99.00	-99.00	-99.00	-99.00	-99.00
FSBI - weighted average	-99.00	5.00	-99.00	-99.00	5.00	-99.00	-99.00	3.85	-99.00	-99.00	-99.00	-99.00	-99.00
% Indiv. w/ TPM Value	17.79	6.77	2.46	22.87	0.77	5.99	0.66	9.52	8.18	95.28	5.44	42.03	13.93
Temp. Pref. Metric - average	0.29	0.88	0.42	0.35	0.77	0.37	0.08	0.65	0.17	0.33	0.56	0.12	0.19
TPM - weighted average	2.10	3.09	3.25	2.05	3.33	2.26	2.00	2.61	2.00	2.00	2.33	2.00	1.98
Karr BIBI Metrics													
Long-Lived Taxa Richness	1.00	0.00	2.00	1.00	1.00	1.00	0.00	0.00	1.00	0.00	0.00	0.00	3.00
Clinger Richness	5.00	14.00	4.00	3.00	2.00	3.00	3.00	8.00	5.00	2.00	1.00	4.00	5.00
% Clingers	5.52	87.69	24.00	9.09	0.77	12.30	20.07	63.66	5.35	1.94	0.26	21.74	1.91
Intolerant Taxa Richness	1.00	2.00	0.00	0.00	0.00	0.00	1.00	0.00	1.00	0.00	0.00	0.00	0.00
% Tolerant Individuals	1.84	0.14	4.83	3.09	1.59	2.49	18.70	1.94	24.42	12.22	43.87	6.29	29.23
% Tolerant Taxa	29.41	15.38	29.17	39.13	38.46	57.89	32.00	26.09	45.83	33.33	48.15	17.65	40.74
Coleoptera Richness	6.00	1.00	2.00	0.00	0.00	3.00	5.00	1.00	3.00	0.00	0.00	0.00	2.00

Snake Valley

Metrics	Big Spring	Big Spring Creek	Big Spring Pond	Beck Springs-North	Beck Springs-South	Bishop Springs	Foote Reservoir	Caine Spring	Callao Big Spring	Clay Spring	Cold Spring	Gandy Salt Marsh North Complex (G4-G9)	Gandy Salt Marsh Middle Complex (G20-G28)	Gandy Salt Marsh (G44)	Gandy Salt Marsh (G48-G49)
Abundance Measures															
Corrected Abundance	5618.16	8328.00	27.00	7104.00	5392.00	2952.00	748.80	12480.00	2038.08	5648.00	3494.40	4044.00	9352.00	3120.00	5648.00
EPT Abundance	275.40	2808.00	0.00	57.60	240.00	1557.18	21.60	384.00	138.96	432.00	124.80	360.00	0.00	0.00	0.00
Dominance Measures															
1st Dominant Taxon	Hyalella sp.	Hyalella sp.	Chironomus sp.	Hydrobiidae	Hydrobiidae	Cheumatopsyche sp.	Pseudochironomus sp.	Ostracoda	Oligochaeta	Hydrobiidae	Gammarus sp.	Ostracoda	Hyalella sp.	Gammarus sp.	Gammarus sp.
1st Dominant Abundance	3157.92	4200.00	3.00	3187.20	1488.00	605.16	192.00	6988.80	486.36	3824.00	1152.00	1452.00	5152.00	2486.40	4368.00
2nd Dominant Taxon	Hydrobiidae	Fallceon quilleri	Ostracoda	Hyalella sp.	Hyalella sp.	Hydropsychidae	Gyraulus sp.	Gyraulus sp.	Coenagrionidae	Ostracoda	Hydrobiidae	Hyalella sp.	Gammarus sp.	Hyalella sp.	Hyalella sp.
2nd Dominant Abundance	697.68	2256.00	3.00	1056.00	1456.00	568.26	62.40	2918.40	376.35	384.00	403.20	804.00	2436.00	403.20	960.00
3rd Dominant Taxon	Cricotopus sp.	Argia sp.	Fossaria sp.	Ostracoda	Ostracoda	Rheotanytarsus sp.	Chironomus sp.	Hyalella sp.	Callibaetis sp.	Tanytarsus sp.	Oligochaeta	Hydrobiidae	Ostracoda	Pisidium sp.	Agabus sp.
3rd Dominant Abundance	605.88	312.00	3.00	979.20	880.00	332.10	57.60	960.00	133.17	288.00	336.00	384.00	952.00	96.00	64.00
% 1 Dominant Taxon	56.21	50.43	11.11	44.86	27.60	20.50	25.64	56.00	23.86	67.71	32.97	35.91	55.09	79.69	77.34
% 2 Dominant Taxa	68.63	77.52	22.22	59.73	54.60	39.75	33.97	79.38	42.33	74.50	44.51	55.79	81.14	92.62	94.33
% 3 Dominant Taxa	79.41	81.27	33.33	73.51	70.92	51.00	41.67	87.08	48.86	79.60	54.12	65.28	91.32	95.69	95.47
Richness Measures															
Species Richness	25.00	26.00	17.00	23.00	26.00	26.00	30.00	17.00	33.00	26.00	23.00	27.00	11.00	12.00	10.00
EPT Richness	8.00	10.00	0.00	1.00	1.00	5.00	3.00	3.00	2.00	5.00	2.00	1.00	0.00	0.00	0.00
Ephemeroptera Richness	2.00	3.00	0.00	1.00	1.00	2.00	2.00	2.00	1.00	2.00	0.00	1.00	0.00	0.00	0.00
Plecoptera Richness	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Trichoptera Richness	6.00	7.00	0.00	0.00	0.00	3.00	1.00	1.00	1.00	3.00	2.00	0.00	0.00	0.00	0.00
Chironomidae Richness	5.00	7.00	8.00	6.00	9.00	5.00	12.00	5.00	9.00	8.00	9.00	7.00	1.00	0.00	1.00
Oligochaeta Richness	1.00	1.00	0.00	1.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.00	0.00	0.00
Non-Chiro. Non-Olig. Richness	19.00	18.00	9.00	16.00	17.00	20.00	17.00	11.00	23.00	17.00	13.00	19.00	10.00	12.00	9.00
Rhyacophila Richness	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Community Composition															
% Ephemeroptera	0.65	28.82	0.00	0.81	4.45	10.75	2.56	2.77	6.53	5.38	0.00	8.90	0.00	0.00	0.00
% Plecoptera	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
% Trichoptera	4.25	4.90	0.00	0.00	0.00	42.00	0.32	0.31	0.28	2.27	3.57	0.00	0.00	0.00	0.00
% EPT	4.90	33.72	0.00	0.81	4.45	52.75	2.88	3.08	6.82	7.65	3.57	8.90	0.00	0.00	0.00
% Coleoptera	0.33	0.00	0.00	0.00	0.59	0.00	0.00	0.00	0.57	0.00	0.55	0.89	0.60	0.62	1.70
% Diptera	13.07	8.36	51.85	5.41	8.31	17.50	66.03	6.46	21.88	12.75	23.35	6.23	0.30	0.31	1.42
% Oligochaeta	5.23	0.29	0.00	1.35	0.00	10.50	6.09	0.31	23.86	0.28	9.62	4.75	0.00	0.00	0.00
% Baetidae	0.33	28.53	0.00	0.81	4.45	10.50	1.28	2.77	6.53	1.42	0.00	8.90	0.00	0.00	0.00
% Brachycentridae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
% Chironomidae	13.07	6.63	40.74	4.32	6.82	13.50	62.18	6.46	21.59	11.61	21.70	5.34	0.30	0.00	0.85
% Ephemerellidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
% Hydropsychidae	0.33	1.15	0.00	0.00	0.00	39.75	0.00	0.00	0.28	0.00	0.00	0.00	0.00	0.00	0.00
% Odonata	0.65	3.75	3.70	3.78	4.45	2.50	5.77	0.92	19.89	1.42	0.00	1.19	0.30	0.00	0.00
% Perlidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
% Pteronarcyidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
% Simuliidae	0.00	1.44	0.00	0.54	0.00	1.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Functional Group Composition															
% Filterers	0.33	2.88	11.11	5.68	1.19	52.50	0.64	0.00	3.98	5.95	6.04	0.30	1.20	4.62	1.13
% Gatherers	67.97	86.17	44.44	34.05	51.63	25.50	51.92	67.69	47.44	17.00	59.89	78.34	93.41	93.23	96.03
% Predators	3.59	5.48	22.22	5.41	16.02	14.50	30.13	8.31	30.11	7.08	18.68	4.75	0.90	1.54	2.83
% Scrapers	16.34	2.88	14.81	54.59	30.56	4.50	9.62	23.69	12.22	67.71	11.81	15.13	4.19	0.62	0.00
% Shredders	10.78	1.73	3.70	0.27	0.30	0.75	7.37	0.00	5.97	0.00	0.00	0.59	0.00	0.00	0.00
% Piercer-Herbivores	0.65	0.58	0.00	0.00	0.00	2.25	0.32	0.00	0.00	1.98	3.57	0.00	0.00	0.00	0.00
% Unclassified	0.33	0.29	3.70	0.00	0.30	0.00	0.00	0.31	0.28	0.28	0.00	0.89	0.30	0.00	0.00
Filterer Richness	1.00	4.00	2.00	3.00	2.00	4.00	1.00	0.00	4.00	2.00	1.00	1.00	1.00	2.00	1.00
Gatherer Richness	9.00	10.00	8.00	9.00	9.00	9.00	10.00	8.00	12.00	11.00	10.00	11.00	5.00	4.00	5.00
Predator Richness	6.00	6.00	3.00	6.00	9.00	8.00	14.00	6.00	10.00	9.00	8.00	8.00	3.00	5.00	4.00
Scraper Richness	5.00	3.00	2.00	4.00	4.00	3.00	2.00	2.00	5.00	1.00	2.00	4.00	1.00	1.00	0.00
Shredder Richness	1.00	1.00	1.00	1.00	1.00	1.00	2.00	0.00	1.00	0.00	0.00	2.00	0.00	0.00	0.00
Piercer-Herbivore Richness	2.00	1.00	0.00	0.00	0.00	1.00	1.00	0.00	0.00	2.00	2.00	0.00	0.00	0.00	0.00
Unclassified	1.00	1.00	1.00	0.00	1.00	0.00	0.00	1.00	1.00	1.00	0.00	1.00	1.00	0.00	0.00
Diversity/Evenness Measures															
Shannon-Weaver H' (log 10)	0.73	0.72	1.17	0.85	0.92	1.07	1.16	0.61	1.18	0.64	1.01	0.93	0.55	0.34	0.34
Shannon-Weaver H' (log 2)	2.41	2.39	3.90	2.84	3.05	3.57	3.86	2.01	3.93	2.14	3.35	3.09	1.81	1.11	1.12
Shannon-Weaver H' (log e)	1.67	1.65	2.70	1.97	2.11	2.47	2.68	1.40	2.72	1.48	2.32	2.14	1.26	0.77	0.77
Margalef's Richness	2.78	2.77	4.85	2.48	2.91	3.13	4.38	1.70	4.20	2.89	2.70	3.13	1.09	1.37	1.04
Pielou's J'	0.52	0.51	0.95	0.63	0.65	0.76	0.79	0.49	0.78	0.45	0.74	0.65	0.52	0.31	0.34
Simpson's Heterogeneity	0.65	0.67	0.96	0.75	0.81	0.88	0.90	0.62	0.89	0.53	0.85	0.81	0.62	0.35	0.37
Biotic Indices															
% Indiv. w/ HBI Value	98.04	72.33	96.30	99.46	91.10	88.75	97.76	98.15	94.89	96.60	92.31	98.52	99.40	99.69	100.00
Hilsenhoff Biotic Index	7.23	7.23	6.73	6.33	6.92	5.83	7.17	8.06	7.88	5.38	6.02	7.53	7.41	6.28	6.33
% Indiv. w/ MTI Value	18.30	13.83	66.67	16.76	12.46	47.00	79.49	27.69	49.43	15.58	56.32	21.66	28.44	82.15	82.15
Metals Tolerance Index	6.57	4.42	3.94	2.95	2.33	3.75	4.08	2.90	3.33	3.44	1.82	1.93	1.15	1.07	1.18
% Indiv. w/ FSBI Value	0.65	4.32	0.00	0.81	1.19	26.50	0.32	0.00	0.28	3.97	2.20	0.00	0.00	0.31	0.57
Fine Sediment Biotic Index	9.00	19.00	-99.00	4.00	6.00	24.00	5.00	-99.00	2.00	4.00	5.00	-99.00	-99.00	5.00	5.00
FSBI - average	0.36	0.73	-99.00	0.17	0.23	0.92	0.17	-99.00	0.06	0.15	0.22	-99.00	-99.00	0.42	0.50
FSBI - weighted average	4.50	3.87	-99.00	2.33	4.00	2.56	5.00	-99.00	2.00	4.00	5.00	-99.00	-99.00	5.00	5.00
% Indiv. w/ TPM Value	70.59	65.13	14.81	17.03	32.05	57.25	8.65	7.69	11.08	12.75	3.57	20.77	55.09	13.23	18.70
Temp. Pref. Metric - average	1.32	2.12	0.53	0.48	0.54	1.15	0.40	0.12	0.36	0.81	0.57	0.37	0.18	0.67	1.10
TPM - weighted average	2.56	2.52	2.75	2.10	2.11	2.65	4.41	2.00	3.59	2.38	4.15	2.03	2.00	2.09	2.18
Karr BIBI Metrics															
Long-Lived Taxa Richness	1.00	0.00	2.00	2.00	2.00	0.00	1.00	0.00	1.00	1.00	1.00	1.00	1.00	3.00	1.00
Clinger Richness	12.00	15.00	4.00	6.00	6.00	11.00	4.00	3.00	9.00	7.00	4.00	7.00	2.00	2.00	2.00
% Clingers	29.41	41.50	25.93	55.95	33.53	70.75	20.83	24.31	19.89	80.74	23.63	16.02	4.49	0.92	1.13
Intolerant Taxa Richness	1.00	2.00	0.00	1.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00
% Tolerant Individuals	3.67	3.05	15.38	2.09	3.60	3.78	10.79	2.40	11.58	0.57	1.40	6.38	2.51	1.48	1.08
% Tolerant Taxa	20.00	15.38	29.41	34.78	26.92	30.77	43.33	47.06	42.42	19.23	13.04	40.74	36.36	33.33	20.00
Coleoptera Richness	1.00	0.00	0.00	0.00	2.00	0.00	0.00	0.00	2.00	0.00	1.00	2.00	2.00	2.00	2.00

Snake Valley (cont.)

Metrics	Gandy Salt Marsh (G51)	Gandy Warm Springs	Leland Harris Spring	Miller Spring	North Little Spring	South Little Spring	Swimming Hole	Twin Springs	Unnamed Spring at Skating Pond	Unnamed south of Caine Spring 1	Unnamed Spring south of Knoll Spring	Unnamed Big Springs #1	Unnamed Big Spring #2
Abundance Measures													
Corrected Abundance	3680.54	21840.00	4550.00	4092.00	9384.00	11592.69	942.40	6384.00	1090.74	2880.00	675.50	3312.00	977.22
EPT Abundance	0.00	1344.00	42.00	60.00	24.00	1974.78	58.90	352.00	339.57	0.00	8.75	182.40	165.54
Dominance Measures													
1st Dominant Taxon	Gammarus sp.	Hydrobiidae	Ostracoda	Gammarus sp.	Gammarus sp.	Oligochaeta	Ostracoda	Hydrobiidae	Oligochaeta	Hyalella sp.	Oligochaeta	Hyalella sp.	Coenagrionidae
1st Dominant Abundance	2472.51	12297.60	2716.00	2016.00	5496.00	4388.40	266.60	3296.00	339.57	2744.00	341.25	1392.00	245.64
2nd Dominant Taxon	Hyalella sp.	Microcylloepus sp.	Micropsectra sp.	Hyalella sp.	Ostracoda	Callibaetis sp.	Planorbidae	Ostracoda	Callibaetis sp.	Oligochaeta	Ostracoda	Hydrobiidae	Callibaetis sp.
2nd Dominant Abundance	587.08	3696.00	630.00	924.00	3480.00	1974.78	167.40	976.00	339.57	64.00	141.75	451.20	162.87
3rd Dominant Taxon	Hydroporus sp.	Gyraulus sp.	Hydrobiidae	Hydrobiidae	Psectrocladius sp.	Coenagrionidae	Coenagrionidae	Oligochaeta	Coenagrionidae	Acari	Corynoneura sp.	Oligochaeta	Hyalella sp.
3rd Dominant Abundance	169.35	1008.00	392.00	336.00	72.00	1938.21	89.90	608.00	78.89	32.00	49.00	422.40	130.83
% 1 Dominant Taxon	67.18	56.31	59.69	49.27	58.57	37.85	28.29	51.63	31.13	95.28	50.52	42.03	25.14
% 2 Dominant Taxa	83.13	73.23	73.54	71.85	95.65	54.89	46.05	66.92	62.26	97.50	71.50	55.65	41.80
% 3 Dominant Taxa	87.73	77.85	82.15	80.06	96.42	71.61	55.59	76.44	69.50	98.61	78.76	68.41	55.19
Richness Measures													
Species Richness	17.00	26.00	24.00	23.00	13.00	19.00	25.00	23.00	24.00	6.00	27.00	17.00	27.00
EPT Richness	0.00	8.00	1.00	3.00	1.00	1.00	1.00	5.00	1.00	0.00	2.00	2.00	2.00
Ephemeroptera Richness	0.00	1.00	0.00	1.00	0.00	1.00	1.00	3.00	1.00	0.00	1.00	0.00	1.00
Plecoptera Richness	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Trichoptera Richness	0.00	7.00	1.00	2.00	1.00	0.00	0.00	2.00	0.00	0.00	1.00	2.00	1.00
Chironomidae Richness	1.00	7.00	8.00	5.00	6.00	6.00	5.00	4.00	5.00	0.00	15.00	3.00	4.00
Oligochaeta Richness	0.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Non-Chiro. Non-Olig. Richness	16.00	18.00	15.00	17.00	6.00	12.00	19.00	18.00	18.00	5.00	11.00	13.00	22.00
Rhyacophila Richness	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Community Composition													
% Ephemeroptera	0.00	0.31	0.00	0.29	0.00	17.03	6.25	3.76	31.13	0.00	0.78	0.00	16.67
% Plecoptera	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
% Trichoptera	0.00	5.85	0.92	1.17	0.26	0.00	0.00	1.75	0.00	0.00	0.52	5.51	0.27
% EPT	0.00	6.15	0.92	1.47	0.26	17.03	6.25	5.51	31.13	0.00	1.30	5.51	16.94
% Coleoptera	8.90	16.92	0.62	0.00	0.00	2.21	3.95	0.25	1.26	0.00	0.00	0.00	0.55
% Diptera	1.84	3.69	20.92	2.05	2.81	7.89	17.76	7.52	8.18	0.28	22.54	1.74	13.11
% Oligochaeta	0.00	0.62	1.54	2.93	0.77	37.85	7.57	9.52	31.13	2.22	50.52	12.75	4.37
% Baetidae	0.00	0.31	0.00	0.29	0.00	17.03	6.25	0.75	31.13	0.00	0.78	0.00	16.67
% Brachycentridae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
% Chironomidae	1.23	3.69	19.08	2.05	2.56	6.94	12.17	6.02	6.92	0.00	19.69	0.87	10.66
% Ephemerellidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
% Hydropsychidae	0.00	0.92	0.00	0.00	0.00	0.00	0.00	0.25	0.00	0.00	0.00	0.00	0.00
% Odonata	0.00	0.92	0.31	2.05	0.00	16.72	13.49	2.51	7.55	0.00	1.30	0.00	27.05
% Perlidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
% Pteronarcyidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
% Simuliidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Functional Group Composition													
% Filterers	0.61	1.54	0.62	0.00	0.26	0.63	0.00	5.01	2.52	0.00	0.26	0.00	2.46
% Gatherers	86.50	23.38	79.38	85.34	99.23	66.56	61.18	32.08	85.22	97.50	89.12	75.65	50.00
% Predators	9.20	4.31	5.23	4.11	0.26	20.50	20.39	5.26	9.43	1.39	10.10	9.28	32.51
% Scrapers	3.37	66.46	10.77	8.50	0.00	11.36	18.09	55.89	2.83	0.83	0.00	13.62	13.39
% Shredders	0.31	1.23	1.85	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.52	0.00	0.27
% Piercer-Herbivores	0.00	0.92	0.00	1.17	0.26	0.00	0.00	1.50	0.00	0.00	0.00	0.87	0.55
% Unclassified	0.00	2.15	2.15	0.88	0.00	0.95	0.33	0.25	0.00	0.28	0.00	0.58	0.82
Filterer Richness	1.00	3.00	2.00	0.00	1.00	1.00	0.00	2.00	3.00	0.00	1.00	0.00	3.00
Gatherer Richness	7.00	9.00	8.00	11.00	10.00	10.00	10.00	11.00	12.00	2.00	16.00	6.00	10.00
Predator Richness	6.00	4.00	8.00	6.00	1.00	5.00	12.00	5.00	7.00	2.00	9.00	7.00	5.00
Scraper Richness	2.00	6.00	2.00	2.00	0.00	1.00	2.00	3.00	2.00	1.00	0.00	1.00	4.00
Shredder Richness	1.00	1.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	1.00
Piercer-Herbivore Richness	0.00	2.00	0.00	2.00	1.00	0.00	0.00	1.00	0.00	0.00	0.00	1.00	2.00
Unclassified	0.00	1.00	2.00	2.00	0.00	2.00	1.00	1.00	0.00	1.00	0.00	2.00	2.00
Diversity/Evenness Measures													
Shannon-Weaver H' (log 10)	0.54	0.75	0.70	0.73	0.40	0.83	1.02	0.78	0.87	0.11	0.78	0.81	1.04
Shannon-Weaver H' (log 2)	1.81	2.51	2.32	2.44	1.32	2.77	3.39	2.61	2.90	0.37	2.59	2.70	3.45
Shannon-Weaver H' (log e)	1.25	1.74	1.60	1.69	0.92	1.92	2.35	1.81	2.01	0.25	1.79	1.87	2.39
Margalef's Richness	1.95	2.50	2.73	2.65	1.31	1.92	3.50	2.51	3.29	0.63	3.99	1.97	3.78
Pielou's J'	0.44	0.53	0.50	0.54	0.36	0.65	0.73	0.58	0.63	0.14	0.54	0.66	0.73
Simpson's Heterogeneity	0.52	0.65	0.62	0.69	0.52	0.78	0.86	0.70	0.79	0.09	0.69	0.77	0.87
Biotic Indices													
% Indiv. w/ HBI Value	98.77	95.38	96.00	97.95	100.00	97.79	90.79	97.74	98.74	99.72	98.19	98.84	98.36
Hilsenhoff Biotic Index	6.34	5.29	7.43	6.65	6.81	8.26	7.25	6.00	8.10	7.95	7.48	6.98	7.94
% Indiv. w/ MTI Value	73.31	32.00	23.38	58.36	60.36	52.68	46.71	19.05	51.89	1.39	18.91	24.64	69.67
Metals Tolerance Index	1.26	3.83	2.14	1.50	1.06	2.57	3.04	2.66	1.63	5.00	3.36	2.60	2.89
% Indiv. w/ FSBI Value	0.00	0.92	0.00	0.00	0.26	0.00	0.00	3.26	0.00	0.00	0.00	0.00	0.00
Fine Sediment Biotic Index	-99.00	5.00	-99.00	-99.00	5.00	-99.00	-99.00	6.00	-99.00	-99.00	-99.00	-99.00	-99.00
FSBI - average	-99.00	0.19	-99.00	-99.00	0.38	-99.00	-99.00	0.26	-99.00	-99.00	-99.00	-99.00	-99.00
FSBI - weighted average	-99.00	5.00	-99.00	-99.00	5.00	-99.00	-99.00	3.85	-99.00	-99.00	-99.00	-99.00	-99.00
% Indiv. w/ TPM Value	17.79	6.77	2.46	22.87	0.77	5.99	0.66	9.52	8.18	95.28	5.44	42.03	13.93
Temp. Pref. Metric - average	0.29	0.88	0.42	0.35	0.77	0.37	0.08	0.65	0.17	0.33	0.56	0.12	0.19
TPM - weighted average	2.10	3.09	3.25	2.05	3.33	2.26	2.00	2.61	2.00	2.00	2.33	2.00	1.98
Karr BIBI Metrics													
Long-Lived Taxa Richness	1.00	0.00	2.00	1.00	1.00	1.00	0.00	0.00	1.00	0.00	0.00	0.00	3.00
Clinger Richness	5.00	14.00	4.00	3.00	2.00	3.00	3.00	8.00	5.00	2.00	1.00	4.00	5.00
% Clingers	5.52	87.69	24.00	9.09	0.77	12.30	20.07	63.66	5.35	1.94	0.26	21.74	1.91
Intolerant Taxa Richness	1.00	2.00	0.00	0.00	0.00	0.00	1.00	0.00	1.00	0.00	0.00	0.00	0.00
% Tolerant Individuals	1.84	0.14	4.83	3.09	1.59	2.49	18.70	1.94	24.42	12.22	43.87	6.29	29.23
% Tolerant Taxa	29.41	15.38	29.17	39.13	38.46	57.89	32.00	26.09	45.83	33.33	48.15	17.65	40.74
Coleoptera Richness	6.00	1.00	2.00	0.00	0.00	3.00	5.00	1.00	3.00	0.00	0.00	0.00	2.00

Spring Valley

Metrics	Blind Spring	Cedars Spring	Keegan Ranch North	Keegan Ranch Middle	Keegan Ranch South	Layton Spring	North Millick Spring	Shoshone Pond 1	Shoshone Pond 2	Shoshone Pond 3	South Bastian Spring	South Millick Spring	Swallow Spring	Unnamed East of Cleve Creek - West
Abundance Measures														
Corrected Abundance	5594.40	2918.40	11200.00	4680.00	2284.80	12710.40	13986.00	2968.00	8646.40	2688.00	2712.00	17424.00	2316.80	2102.40
EPT Abundance	453.60	105.60	192.00	36.00	33.60	806.40	210.00	80.00	0.00	0.00	40.00	384.00	838.40	115.20
Dominance Measures														
1st Dominant Taxon	Ostracoda	Pseudochironomus sp.	Ostracoda	Gammarus sp.	Hyalella sp.	Gyraulus sp.	Hyalella sp.	Ostracoda	Ostracoda	Nematoda	Ostracoda	Gammarus sp.	Lepidostoma sp.	Hyalella sp.
1st Dominant Abundance	1478.40	758.40	8992.00	2088.00	1243.20	5145.60	5376.00	656.00	7011.20	648.00	2136.00	8832.00	768.00	902.40
2nd Dominant Taxon	Hyalella sp.	Micropsectra sp.	Hyalella sp.	Micropsectra sp.	Gammarus sp.	Coenagrionidae	Gammarus sp.	Pseudochironomus sp.	Oligochaeta	Ostracoda	Hyalella sp.	Hyalella sp.	Ostracoda	Pseudochironomus sp.
2nd Dominant Abundance	890.40	537.60	1056.00	1140.00	763.20	1958.40	5166.00	392.00	806.40	440.00	144.00	3792.00	262.40	192.00
3rd Dominant Taxon	Callibaetis sp.	Hyalella sp.	Thienemanniella sp.	Thienemanniella sp.	Micropsectra sp.	Ostracoda	Physa (Physella) sp.	Micropsectra sp.	Ceratopogoninae	Oligochaeta	Physa sp.	Acari	Oligochaeta	Micropsectra sp.
3rd Dominant Abundance	453.60	432.00	224.00	456.00	91.20	1574.40	756.00	368.00	134.40	384.00	112.00	2448.00	204.80	182.40
% 1 Dominant Taxon	26.43	25.99	80.29	44.62	54.41	40.48	38.44	22.10	81.09	24.11	78.76	50.69	33.15	42.92
% 2 Dominant Taxa	42.34	44.41	89.71	68.97	87.82	55.89	75.38	35.31	90.41	40.48	84.07	72.45	44.48	52.05
% 3 Dominant Taxa	50.45	59.21	91.71	78.72	91.81	68.28	80.78	47.71	91.97	54.76	88.20	86.50	53.31	60.73
Richness Measures														
Species Richness	40.00	28.00	21.00	20.00	13.00	23.00	17.00	37.00	13.00	23.00	17.00	18.00	31.00	33.00
EPT Richness	1.00	1.00	3.00	1.00	1.00	1.00	1.00	5.00	0.00	0.00	1.00	2.00	5.00	2.00
Ephemeroptera Richness	1.00	0.00	1.00	1.00	0.00	1.00	0.00	2.00	0.00	0.00	1.00	1.00	2.00	1.00
Plecoptera Richness	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00
Trichoptera Richness	0.00	1.00	2.00	0.00	1.00	0.00	1.00	3.00	0.00	0.00	0.00	1.00	2.00	1.00
Chironomidae Richness	13.00	9.00	11.00	9.00	5.00	8.00	5.00	13.00	4.00	9.00	3.00	5.00	12.00	11.00
Oligochaeta Richness	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Non-Chiro. Non-Olig. Richness	26.00	18.00	9.00	10.00	7.00	14.00	11.00	23.00	8.00	13.00	13.00	12.00	18.00	21.00
Rhyacophila Richness	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Community Composition														
% Ephemeroptera	8.11	0.00	0.57	0.77	0.00	6.34	0.00	0.81	0.00	0.00	1.47	0.55	1.10	5.02
% Plecoptera	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.83	0.00
% Trichoptera	0.00	3.62	1.14	0.00	1.47	0.00	1.50	1.89	0.00	0.00	0.00	1.65	34.25	0.46
% EPT	8.11	3.62	1.71	0.77	1.47	6.34	1.50	2.70	0.00	0.00	1.47	2.20	36.19	5.48
% Coleoptera	0.60	0.66	0.00	0.00	0.00	1.51	0.00	0.00	0.00	0.60	0.29	1.93	6.35	0.46
% Diptera	24.32	55.59	6.00	39.74	9.03	18.13	6.61	42.32	4.92	20.54	3.24	4.13	17.40	27.40
% Oligochaeta	4.50	2.63	0.29	0.77	0.21	0.30	1.80	3.50	9.33	14.29	0.59	0.28	8.84	7.08
% Baetidae	8.11	0.00	0.57	0.77	0.00	6.34	0.00	0.27	0.00	0.00	1.47	0.55	1.10	5.02
% Brachycentridae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
% Chironomidae	17.42	49.67	6.00	39.49	8.82	17.52	6.31	39.89	2.59	19.05	1.18	3.86	16.30	23.06
% Ephemerellidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
% Hydropsychidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
% Odonata	10.81	1.64	0.00	0.00	0.00	16.92	0.30	1.89	0.26	0.30	2.95	0.00	0.00	3.88
% Perlidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.83	0.00
% Pteronarcyidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
% Simuliidae	0.00	2.96	0.00	0.00	0.00	0.00	0.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Functional Group Composition														
% Filterers	0.90	6.91	0.00	0.51	0.42	1.81	3.00	3.23	0.00	3.57	1.47	0.28	5.25	5.25
% Gatherers	67.57	72.37	96.00	90.51	96.43	28.40	85.89	60.65	92.49	56.85	87.02	79.34	48.90	75.11
% Predators	25.53	12.17	0.86	4.87	1.68	19.34	4.20	20.22	7.51	28.87	6.19	15.15	10.77	16.21
% Scrapers	3.00	1.97	0.57	1.28	0.00	40.48	5.41	8.89	0.00	9.23	4.72	3.31	0.00	0.23
% Shredders	0.00	2.63	0.57	2.82	1.47	0.60	1.50	1.62	0.00	0.30	0.00	1.93	34.81	1.60
% Piercer-Herbivores	0.30	3.62	0.86	0.00	0.00	0.00	0.00	0.81	0.00	0.00	0.00	0.00	0.00	1.14
% Unclassified	2.70	0.33	1.14	0.00	0.00	9.37	0.00	4.58	0.00	1.19	0.59	0.00	0.28	0.46
Filterer Richness	3.00	3.00	0.00	1.00	1.00	3.00	2.00	2.00	0.00	1.00	1.00	1.00	2.00	2.00
Gatherer Richness	18.00	9.00	13.00	13.00	8.00	10.00	8.00	14.00	6.00	9.00	6.00	10.00	16.00	11.00
Predator Richness	13.00	9.00	2.00	3.00	3.00	5.00	5.00	13.00	7.00	10.00	6.00	4.00	9.00	12.00
Scraper Richness	2.00	1.00	2.00	2.00	0.00	1.00	1.00	2.00	0.00	1.00	2.00	1.00	0.00	1.00
Shredder Richness	0.00	4.00	1.00	1.00	1.00	1.00	1.00	3.00	0.00	1.00	0.00	2.00	3.00	2.00
Piercer-Herbivore Richness	1.00	1.00	1.00	0.00	0.00	0.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	3.00
Unclassified	3.00	1.00	2.00	0.00	0.00	3.00	0.00	1.00	0.00	1.00	2.00	0.00	1.00	2.00
Diversity/Evenness Measures														
Shannon-Weaver H' (log 10)	1.20	1.06	0.40	0.75	0.52	0.89	0.72	1.23	0.36	0.98	0.44	0.67	1.08	0.98
Shannon-Weaver H' (log 2)	3.97	3.51	1.32	2.49	1.73	2.96	2.39	4.08	1.19	3.25	1.45	2.21	3.59	3.27
Shannon-Weaver H' (log e)	2.75	2.43	0.91	1.72	1.20	2.05	1.65	2.83	0.83	2.25	1.01	1.53	2.49	2.27
Margalef's Richness	4.52	3.38	2.15	2.25	1.55	2.33	1.68	4.50	1.32	2.79	2.02	1.74	3.87	4.18
Pielou's J'	0.75	0.73	0.30	0.58	0.47	0.65	0.58	0.78	0.32	0.72	0.35	0.53	0.73	0.65
Simpson's Heterogeneity	0.88	0.86	0.35	0.72	0.59	0.78	0.71	0.90	0.33	0.86	0.37	0.67	0.85	0.79
Biotic Indices														
% Indiv. w/ HBI Value	93.69	92.76	98.57	99.49	99.58	88.22	99.70	89.49	97.67	97.32	97.94	99.17	91.99	97.49
Hilsenhoff Biotic Index	7.79	6.36	7.84	6.45	7.12	7.84	7.02	6.96	7.95	6.85	7.92	6.51	4.39	7.11
% Indiv. w/ MTI Value	34.53	62.17	7.43	88.21	42.86	70.69	53.45	50.40	4.40	52.38	9.14	73.28	62.71	40.18
Metals Tolerance Index	2.89	3.14	3.19	1.84	1.28	2.97	1.68	3.07	4.29	3.72	3.16	1.95	1.80	2.90
% Indiv. w/ FSBI Value	0.30	2.96	0.00	0.00	0.00	0.00	0.30	0.00	0.00	0.00	0.00	1.93	8.29	0.23
Fine Sediment Biotic Index	5.00	3.00	-99.00	-99.00	-99.00	-99.00	3.00	-99.00	-99.00	-99.00	-99.00	2.00	20.00	5.00
FSBI - average	0.13	0.11	-99.00	-99.00	-99.00	-99.00	0.18	-99.00	-99.00	-99.00	-99.00	0.11	0.65	0.15
FSBI - weighted average	5.00	3.00	-99.00	-99.00	-99.00	-99.00	3.00	-99.00	-99.00	-99.00	-99.00	2.00	4.70	5.00
% Indiv. w/ TPM Value	17.42	22.37	12.29	14.87	57.77	3.93	40.84	5.93	0.00	10.42	5.60	23.97	49.72	45.21
Temp. Pref. Metric - average	0.50	0.89	0.95	1.20	0.85	0.70	0.76	0.24	-99.00	0.26	0.29	0.78	1.94	0.48
TPM - weighted average	2.29	2.69	3.05	5.95	2.20	4.15	2.23	1.95	-99.00	2.00	2.05	2.37	5.49	2.03
Karr BIBI Metrics														
Long-Lived Taxa Richness	3.00	2.00	0.00	1.00	1.00	1.00	1.00	3.00	0.00	1.00	1.00	2.00	5.00	4.00
Clinger Richness	6.00	5.00	3.00	3.00	1.00	3.00	2.00	7.00	1.00	2.00	2.00	3.00	6.00	4.00
% Clingers	5.71	24.01	1.43	27.95	3.99	42.30	3.00	20.49	0.26	12.80	4.72	18.18	12.43	11.19
Intolerant Taxa Richness	1.00	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	1.00	0.00	2.00	1.00
% Tolerant Individuals	4.37	3.18	2.87	0.92	11.56	2.22	1.17	5.69	4.20	6.35	11.90	0.56	3.43	12.20
% Tolerant Taxa	37.50	17.86	28.57	30.00	23.08	30.43	35.29	35.14	53.85	30.43	35.29	27.78	12.90	21.21
Coleoptera Richness	2.00	2.00	0.00	0.00	0.00	2.00	0.00	0.00	0.00	1.00	1.00	1.00	2.00	2.00

Spring Valley (cont.)

Metrics	Unnamed East of Cleve Creek - East	Unnamed Minerva 1	Unnamed Minerva 2	Unnamed Minerva 3	Unnamed Spring #1	Unnamed Spring at Stonehouse Ranch	West Spring Valley Complex #1	West Spring Valley Complex #5	Willard Spring	Willow Spring
Abundance Measures										
Corrected Abundance	7145.55	15960.00	12441.60	14238.00	19920.00	10752.56	5573.55	36480.00	1332.00	2776.00
EPT Abundance	170.64	42.00	192.00	0.00	192.00	576.03	244.32	192.00	16.00	112.00
Dominance Measures										
1st Dominant Taxon	Ostracoda	Micropsectra sp.	Oligochaeta	Micropsectra sp.	Ostracoda	Ostracoda	Hyalella sp.	Ostracoda	Micropsectra sp.	Hyalella sp.
1st Dominant Abundance	4372.65	5292.00	4723.20	4578.00	11856.00	2852.72	1679.70	16224.00	628.00	1176.00
2nd Dominant Taxon	Hyalella sp.	Oligochaeta	Cricotopus sp.	Gammarus sp.	Hydrobiidae	Hydrobiidae	Ostracoda	Hyalella sp.	Nematoda	Ostracoda
2nd Dominant Abundance	789.21	4326.00	1920.00	3444.00	3120.00	1837.81	962.01	9792.00	232.00	688.00
3rd Dominant Taxon	Oligochaeta	Paratanytarsus sp.	Gammarus sp.	Ostracoda	Hyalella sp.	Hyalella sp.	Hydrobiidae	Gammarus sp.	Oligochaeta	Oligochaeta
3rd Dominant Abundance	554.58	1596.00	1228.80	1764.00	1872.00	1618.37	794.04	3072.00	124.00	312.00
% 1 Dominant Taxon	61.19	33.16	37.96	32.15	59.52	26.53	30.14	44.47	47.15	42.36
% 2 Dominant Taxa	72.24	60.26	53.40	56.34	75.18	43.62	47.40	71.32	64.56	67.15
% 3 Dominant Taxa	80.00	70.26	63.27	68.73	84.58	58.67	61.64	79.74	73.87	78.39
Richness Measures										
Species Richness	22.00	27.00	24.00	25.00	19.00	28.00	29.00	20.00	22.00	21.00
EPT Richness	2.00	1.00	1.00	0.00	1.00	3.00	1.00	1.00	1.00	2.00
Ephemeroptera Richness	1.00	0.00	0.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00
Plecoptera Richness	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Trichoptera Richness	1.00	1.00	1.00	0.00	0.00	2.00	0.00	0.00	0.00	1.00
Chironomidae Richness	7.00	13.00	11.00	11.00	4.00	7.00	11.00	5.00	11.00	6.00
Oligochaeta Richness	1.00	1.00	1.00	1.00	1.00	0.00	1.00	1.00	1.00	1.00
Non-Chiro. Non-Olig. Richness	14.00	13.00	12.00	13.00	14.00	21.00	17.00	14.00	10.00	14.00
Rhyacophila Richness	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Community Composition										
% Ephemeroptera	2.09	0.00	0.00	0.00	0.96	4.85	4.38	0.53	1.20	3.17
% Plecoptera	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
% Trichoptera	0.30	0.26	1.54	0.00	0.00	0.51	0.00	0.00	0.00	0.86
% EPT	2.39	0.26	1.54	0.00	0.96	5.36	4.38	0.53	1.20	4.03
% Coleoptera	0.00	0.26	0.00	1.18	0.24	0.26	0.00	1.05	0.60	0.00
% Diptera	5.97	63.68	32.10	50.15	5.30	20.66	10.68	2.11	69.97	2.88
% Oligochaeta	7.76	27.11	37.96	8.55	4.10	0.00	0.27	0.26	9.31	11.24
% Baetidae	2.09	0.00	0.00	0.00	0.96	4.85	4.38	0.53	1.20	3.17
% Brachycentridae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
% Chironomidae	5.37	62.37	31.79	46.90	0.96	17.86	9.04	2.11	67.27	2.59
% Ephemerellidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
% Hydropsychidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
% Odonata	1.79	0.00	0.00	0.00	0.48	1.28	1.64	4.47	0.00	0.58
% Perlidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
% Pteronarcyidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
% Simuliidae	0.00	0.26	0.00	1.47	0.00	0.00	0.00	0.00	0.00	0.00
Functional Group Composition										
% Filterers	1.49	5.26	0.62	1.77	0.00	2.04	1.37	1.84	0.00	5.48
% Gatherers	88.06	77.37	73.46	81.71	78.07	58.16	69.04	82.11	74.17	83.29
% Predators	6.27	5.53	4.01	3.83	5.78	3.57	8.22	5.53	19.82	5.76
% Scrapers	3.88	1.84	3.09	2.36	15.66	17.86	16.99	9.47	1.20	4.32
% Shredders	0.00	7.37	16.98	7.08	0.00	14.29	2.19	0.00	0.00	0.86
% Piercer-Herbivores	0.30	0.00	0.00	0.00	0.00	1.28	0.00	0.00	0.00	0.00
% Unclassified	0.00	2.63	1.85	3.24	0.48	2.81	2.19	1.05	4.80	0.29
Filterer Richness	1.00	2.00	1.00	2.00	0.00	3.00	1.00	2.00	0.00	1.00
Gatherer Richness	11.00	12.00	10.00	12.00	10.00	10.00	12.00	8.00	13.00	7.00
Predator Richness	7.00	7.00	5.00	6.00	6.00	6.00	10.00	6.00	5.00	10.00
Scraper Richness	2.00	1.00	5.00	2.00	1.00	3.00	2.00	2.00	2.00	1.00
Shredder Richness	0.00	2.00	2.00	1.00	0.00	1.00	2.00	0.00	0.00	1.00
Piercer-Herbivore Richness	1.00	0.00	0.00	0.00	0.00	3.00	0.00	0.00	0.00	0.00
Unclassified	0.00	3.00	1.00	2.00	2.00	2.00	2.00	2.00	2.00	1.00
Diversity/Evenness Measures										
Shannon-Weaver H' (log 10)	0.69	0.91	0.92	0.90	0.64	0.96	1.00	0.72	0.81	0.77
Shannon-Weaver H' (log 2)	2.29	3.02	3.07	3.00	2.11	3.20	3.31	2.41	2.68	2.54
Shannon-Weaver H' (log e)	1.59	2.09	2.13	2.08	1.47	2.21	2.30	1.67	1.86	1.76
Margalef's Richness	2.37	2.69	2.44	2.51	1.82	2.91	3.25	1.81	2.92	2.52
Pielou's J'	0.51	0.63	0.67	0.65	0.50	0.66	0.68	0.56	0.60	0.58
Simpson's Heterogeneity	0.60	0.80	0.81	0.81	0.61	0.85	0.84	0.71	0.73	0.74
Biotic Indices										
% Indiv. w/ HBI Value	99.70	97.11	97.84	95.58	95.90	96.68	93.70	98.16	93.99	98.56
Hilsenhoff Biotic Index	7.82	6.97	7.23	6.84	7.40	7.02	7.26	7.80	6.78	7.63
% Indiv. w/ MTI Value	15.52	63.95	37.96	70.80	6.99	35.46	21.92	19.21	76.28	8.65
Metals Tolerance Index	3.12	2.63	4.78	2.17	3.48	4.70	1.94	2.49	2.37	3.20
% Indiv. w/ FSBI Value	0.00	0.79	0.00	2.65	0.96	0.26	0.00	0.00	0.00	0.00
Fine Sediment Biotic Index	-99.00	5.00	-99.00	11.00	5.00	5.00	-99.00	-99.00	-99.00	-99.00
FSBI - average	-99.00	0.19	-99.00	0.44	0.26	0.18	-99.00	-99.00	-99.00	-99.00
FSBI - weighted average	-99.00	5.00	-99.00	3.22	5.00	5.00	-99.00	-99.00	-99.00	-99.00
% Indiv. w/ TPM Value	11.04	13.42	25.93	11.50	10.60	32.40	31.23	27.89	0.30	43.80
Temp. Pref. Metric - average	0.09	0.96	0.83	1.36	0.89	0.50	0.41	0.50	0.41	0.81
TPM - weighted average	2.00	4.00	4.76	5.03	2.52	3.30	2.04	2.11	9.00	2.11
Karr BIBI Metrics										
Long-Lived Taxa Richness	1.00	0.00	1.00	2.00	0.00	3.00	1.00	1.00	0.00	1.00
Clinger Richness	0.00	7.00	5.00	7.00	2.00	7.00	4.00	2.00	3.00	1.00
% Clingers	0.00	48.95	26.85	43.66	15.90	33.42	15.34	2.11	48.65	4.32
Intolerant Taxa Richness	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00
% Tolerant Individuals	4.13	0.68	1.34	0.53	1.62	1.86	3.91	0.91	2.80	10.38
% Tolerant Taxa	50.00	11.11	25.00	28.00	26.32	32.14	34.48	40.00	22.73	28.57
Coleoptera Richness	0.00	1.00	0.00	2.00	1.00	1.00	0.00	2.00	2.00	0.00

Lake Valley

Metrics	Wambolt Spring Complex 2
Abundance Measures	
Corrected Abundance	4160.24
EPT Abundance	64.60
Dominance Measures	
1st Dominant Taxon	Hyalella sp.
1st Dominant Abundance	969.00
2nd Dominant Taxon	Ostracoda
2nd Dominant Abundance	865.64
3rd Dominant Taxon	Gyraulus sp.
3rd Dominant Abundance	710.60
% 1 Dominant Taxon	23.29
% 2 Dominant Taxa	44.10
% 3 Dominant Taxa	61.18
Richness Measures	
Species Richness	24.00
EPT Richness	2.00
Ephemeroptera Richness	1.00
Plecoptera Richness	0.00
Trichoptera Richness	1.00
Chironomidae Richness	6.00
Oligochaeta Richness	1.00
Non-Chiro. Non-Olig. Richness	17.00
Rhyacophila Richness	0.00
Community Composition	
% Ephemeroptera	0.31
% Plecoptera	0.00
% Trichoptera	1.24
% EPT	1.55
% Coleoptera	0.93
% Diptera	4.35
% Oligochaeta	1.55
% Baetidae	0.31
% Brachycentridae	0.00
% Chironomidae	4.35
% Ephemerellidae	0.00
% Hydropsychidae	0.00
% Odonata	0.31
% Perlidae	0.00
% Pteronarcyidae	0.00
% Simuliidae	0.00
Functional Group Composition	
% Filterers	0.00
% Gatherers	52.80
% Predators	4.97
% Scrapers	36.34
% Shredders	0.00
% Piercer-Herbivores	1.55
% Unclassified	4.35
Filterer Richness	0.00
Gatherer Richness	10.00
Predator Richness	7.00
Scraper Richness	3.00
Shredder Richness	0.00
Piercer-Herbivore Richness	2.00
Unclassified	2.00
Diversity/Evenness Measures	
Shannon-Weaver H' (log 10)	0.98
Shannon-Weaver H' (log 2)	3.25
Shannon-Weaver H' (log e)	2.25
Margalef's Richness	2.76
Pielou's J'	0.71
Simpson's Heterogeneity	0.85
Biotic Indices	
% Indiv. w/ HBI Value	94.72
Hilsenhoff Biotic Index	7.20
% Indiv. w/ MTI Value	33.54
Metals Tolerance Index	3.06
% Indiv. w/ FSBI Value	0.62
Fine Sediment Biotic Index	5.00
FSBI - average	0.21
FSBI - weighted average	5.00
% Indiv. w/ TPM Value	24.53
Temp. Pref. Metric - average	0.38
TPM - weighted average	2.03
Karr BIBI Metrics	
Long-Lived Taxa Richness	2.00
Clinger Richness	5.00
% Clingers	38.20
Intolerant Taxa Richness	0.00
% Tolerant Individuals	5.33
% Tolerant Taxa	41.67
Coleoptera Richness	2.00

White River Valley

Metrics	Arnoldson Spring	North Flag	Middle Flag	South Flag	Hot Creek Spring	Indian Spring	Lund Spring	Nicholas Spring	Preston Big Spring	Sunnyside Upper	Sunnyside Lower	Tin Can Spring
Abundance Measures												
Corrected Abundance	606.72	17192.00	8136.00	13482.00	34848.00	4284.00	11904.00	1430.08	17952.00	1049.58	10464.00	663.60
EPT Abundance	0.00	952.00	96.00	504.00	192.00	0.00	736.00	13.08	96.00	130.34	1344.00	3.36
Dominance Measures												
1st Dominant Taxon	Hydrobiidae	Hydrobiidae	Hydrobiidae	Hydrobiidae	Hyalella sp.	Ostracoda	Hydrobiidae	Hydrobiidae	Hyalella sp.	Oribatei	Ostracoda	Tanypus sp.
1st Dominant Abundance	393.60	5152.00	4536.00	6258.00	23904.00	1190.00	8800.00	558.08	12528.00	356.72	5632.00	164.64
2nd Dominant Taxon	Melanoides tuberculata	Pyrgulopsis sp.	Hyalella sp.	Hyalella sp.	Hydrobiidae	Oligochaeta	Oligochaeta	Hyalella sp.	Pyrgulopsis sp.	Nectopsyche sp.	Fallceon quilleri	Ostracoda
2nd Dominant Abundance	168.96	4312.00	2832.00	3318.00	5760.00	518.00	1344.00	510.12	2448.00	78.89	896.00	154.56
3rd Dominant Taxon	Petrophila sp.	Hyalella sp.	Microcylloepus sp.	Microcylloepus sp.	Tryonia sp.	Micropsectra sp.	Hydroptila sp.	Coenagrionidae	Orthocladius Complex	Pyrgulopsis sp.	Parakiefferiella sp.	Oligochaeta
3rd Dominant Abundance	15.36	3472.00	240.00	1176.00	1920.00	504.00	608.00	183.12	1008.00	75.46	544.00	87.36
% 1 Dominant Taxon	64.87	29.97	55.75	46.42	68.60	27.78	73.92	39.02	69.79	33.99	53.82	24.81
% 2 Dominant Taxa	92.72	55.05	90.56	71.03	85.12	39.87	85.22	74.70	83.42	41.50	62.39	48.10
% 3 Dominant Taxa	95.25	75.24	93.51	79.75	90.63	51.63	90.32	87.50	89.04	48.69	67.58	61.27
Richness Measures												
Species Richness	9.00	22.00	14.00	22.00	15.00	24.00	15.00	15.00	17.00	37.00	35.00	20.00
EPT Richness	0.00	5.00	2.00	4.00	2.00	0.00	3.00	1.00	2.00	6.00	7.00	1.00
Ephemeroptera Richness	0.00	1.00	0.00	1.00	0.00	0.00	1.00	0.00	0.00	2.00	4.00	1.00
Plecoptera Richness	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Trichoptera Richness	0.00	4.00	2.00	3.00	2.00	0.00	2.00	1.00	2.00	4.00	3.00	0.00
Chironomidae Richness	2.00	3.00	3.00	5.00	1.00	12.00	4.00	3.00	7.00	10.00	16.00	7.00
Oligochaeta Richness	0.00	0.00	0.00	1.00	1.00	1.00	1.00	0.00	1.00	0.00	1.00	1.00
Non-Chiro. Non-Olig. Richness	7.00	19.00	11.00	16.00	13.00	11.00	10.00	12.00	9.00	27.00	18.00	12.00
Rhyacophila Richness	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Community Composition												
% Ephemeroptera	0.00	0.33	0.00	0.31	0.00	0.00	0.27	0.00	0.00	1.31	11.01	0.51
% Plecoptera	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
% Trichoptera	0.00	5.21	1.18	3.43	0.55	0.00	5.91	0.91	0.53	11.11	1.83	0.00
% EPT	0.00	5.54	1.18	3.74	0.55	0.00	6.18	0.91	0.53	12.42	12.84	0.51
% Coleoptera	0.00	11.07	3.24	8.72	0.28	0.65	0.00	0.30	0.00	2.61	0.00	0.25
% Diptera	2.53	0.98	3.24	9.66	1.93	42.48	5.65	1.22	11.76	20.92	22.63	43.80
% Oligochaeta	0.00	0.00	0.00	0.31	3.58	12.09	11.29	0.00	0.80	0.00	3.67	13.16
% Baetidae	0.00	0.33	0.00	0.31	0.00	0.00	0.27	0.00	0.00	0.33	10.40	0.51
% Brachycentridae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.96	0.00	0.00
% Chironomidae	0.63	0.98	2.95	8.72	1.10	41.83	5.65	0.91	11.76	16.34	19.27	43.54
% Ephemerellidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
% Hydropsychidae	0.00	1.30	0.29	1.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
% Odonata	0.00	0.65	0.88	0.00	0.28	0.00	0.54	15.55	0.27	3.92	1.53	4.56
% Perlidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
% Pteronarcyidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
% Simuliidae	1.58	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.65	0.00	0.00
Functional Group Composition												
% Filterers	1.58	3.58	0.29	6.85	0.00	0.65	0.54	0.30	0.00	1.63	0.92	0.25
% Gatherers	2.53	20.85	40.41	42.37	74.66	79.74	16.13	36.59	82.09	27.12	85.02	55.19
% Predators	0.00	6.19	1.77	2.18	2.20	7.52	1.34	21.95	2.41	52.61	11.01	37.97
% Scrapers	67.41	42.67	56.64	46.73	16.53	0.00	73.92	39.63	0.27	0.33	0.31	6.58
% Shredders	0.00	1.30	0.59	0.31	0.28	0.00	0.54	0.00	0.27	8.82	1.53	0.00
% Piercer-Herbivores	0.00	0.00	0.00	0.00	0.00	0.65	5.91	0.91	0.27	0.33	0.00	0.00
% Unclassified	28.48	25.41	0.29	1.56	6.34	11.44	1.61	0.61	14.71	9.15	1.22	0.00
Filterer Richness	1.00	5.00	1.00	4.00	0.00	1.00	1.00	1.00	0.00	2.00	3.00	1.00
Gatherer Richness	4.00	3.00	5.00	10.00	7.00	15.00	5.00	4.00	8.00	14.00	15.00	9.00
Predator Richness	0.00	7.00	4.00	3.00	3.00	5.00	4.00	5.00	3.00	15.00	12.00	8.00
Scraper Richness	2.00	4.00	2.00	2.00	1.00	0.00	1.00	2.00	1.00	1.00	1.00	2.00
Shredder Richness	0.00	1.00	1.00	1.00	1.00	0.00	1.00	0.00	1.00	2.00	2.00	0.00
Piercer-Herbivore Richness	0.00	0.00	0.00	0.00	0.00	1.00	2.00	1.00	1.00	1.00	0.00	0.00
Unclassified	2.00	2.00	1.00	2.00	3.00	2.00	1.00	2.00	3.00	2.00	2.00	0.00
Diversity/Evenness Measures												
Shannon-Weaver H' (log 10)	0.41	0.82	0.49	0.77	0.49	1.06	0.46	0.65	0.51	1.17	0.89	0.96
Shannon-Weaver H' (log 2)	1.37	2.73	1.62	2.56	1.62	3.52	1.52	2.17	1.70	3.88	2.95	3.19
Shannon-Weaver H' (log e)	0.95	1.90	1.12	1.77	1.12	2.44	1.05	1.51	1.18	2.69	2.04	2.21
Margalef's Richness	1.25	2.15	1.44	2.21	1.34	2.75	1.49	1.93	1.63	5.18	3.67	2.92
Pielou's J'	0.43	0.61	0.42	0.57	0.41	0.77	0.39	0.56	0.42	0.74	0.57	0.74
Simpson's Heterogeneity	0.50	0.79	0.57	0.71	0.50	0.87	0.44	0.70	0.49	0.86	0.69	0.85
Biotic Indices												
% Indiv. w/ HBI Value	71.20	73.94	98.82	97.51	91.46	84.64	98.12	95.73	85.29	48.04	83.79	100.00
Hilsenhoff Biotic Index	5.09	5.81	6.14	5.81	7.42	7.52	5.45	6.68	7.58	5.68	7.49	8.20
% Indiv. w/ MTI Value	4.11	20.52	5.01	13.71	1.65	32.68	11.29	17.68	7.49	30.72	12.23	23.80
Metals Tolerance Index	3.77	4.44	4.41	3.70	5.00	2.63	3.95	3.16	2.46	3.47	3.60	3.78

White River Valley (cont.)

Metrics	Arnoldson Spring	North Flag	Middle Flag	South Flag	Hot Creek Spring	Indian Spring	Lund Spring	Nicholas Spring	Preston Big Spring	Sunnyside Upper	Sunnyside Lower	Tin Can Spring
% Indiv. w/ FSBI Value	1.58	12.38	0.59	1.87	0.00	0.00	5.11	0.00	0.00	1.96	0.92	0.00
Fine Sediment Biotic Index	3.00	8.00	10.00	14.00	-99.00	-99.00	5.00	-99.00	-99.00	12.00	9.00	-99.00
FSBI - average	0.33	0.36	0.71	0.64	-99.00	-99.00	0.33	-99.00	-99.00	0.32	0.26	-99.00
FSBI - weighted average	3.00	3.21	5.00	4.83	-99.00	-99.00	5.00	-99.00	-99.00	3.83	4.33	-99.00
% Indiv. w/ TPM Value	3.48	33.55	38.94	33.64	69.15	4.90	6.72	38.41	76.20	10.78	6.12	0.25
Temp. Pref. Metric - average	1.44	0.55	1.86	1.14	0.47	0.75	0.60	0.27	0.82	1.43	0.77	0.10
TPM - weighted average	3.73	2.34	2.30	2.79	2.00	4.20	2.24	2.00	2.34	4.79	2.70	2.00
Karr BIBI Metrics												
Long-Lived Taxa Richness	0.00	2.00	1.00	1.00	1.00	1.00	1.00	0.00	0.00	2.00	1.00	1.00
Clinger Richness	3.00	10.00	7.00	7.00	4.00	3.00	3.00	5.00	4.00	9.00	5.00	2.00
% Clingers	68.99	47.88	61.36	60.44	17.36	13.07	79.57	42.99	3.74	14.05	10.09	6.08
Intolerant Taxa Richness	0.00	0.00	0.00	1.00	0.00	0.00	1.00	0.00	2.00	2.00	2.00	1.00
% Tolerant Individuals	1.16	0.51	1.47	0.63	0.83	3.50	0.41	11.69	1.72	5.75	2.38	27.28
% Tolerant Taxa	33.33	18.18	14.29	18.18	33.33	37.50	33.33	26.67	11.76	13.51	22.86	45.00
Coleoptera Richness	0.00	1.00	2.00	1.00	1.00	1.00	0.00	1.00	0.00	3.00	0.00	1.00

White River Valley

Metrics	Arnoldson Spring	North Flag	Middle Flag	South Flag	Hot Creek Spring	Indian Spring	Lund Spring	Nicholas Spring	Preston Big Spring	Sunnyside Upper	Sunnyside Lower	Tin Can Spring
Abundance Measures												
Corrected Abundance	606.72	17192.00	8136.00	13482.00	34848.00	4284.00	11904.00	1430.08	17952.00	1049.58	10464.00	663.60
EPT Abundance	0.00	952.00	96.00	504.00	192.00	0.00	736.00	13.08	96.00	130.34	1344.00	3.36
Dominance Measures												
1st Dominant Taxon	Hydrobiidae	Hydrobiidae	Hydrobiidae	Hydrobiidae	Hyalella sp.	Ostracoda	Hydrobiidae	Hydrobiidae	Hyalella sp.	Oribatei	Ostracoda	Tanypus sp.
1st Dominant Abundance	393.60	5152.00	4536.00	6258.00	23904.00	1190.00	8800.00	558.08	12528.00	356.72	5632.00	164.64
2nd Dominant Taxon	Melanoides tuberculata	Pyrgulopsis sp.	Hyalella sp.	Hyalella sp.	Hydrobiidae	Oligochaeta	Oligochaeta	Hyalella sp.	Pyrgulopsis sp.	Nectopsyche sp.	Fallceon quilleri	Ostracoda
2nd Dominant Abundance	168.96	4312.00	2832.00	3318.00	5760.00	518.00	1344.00	510.12	2448.00	78.89	896.00	154.56
3rd Dominant Taxon	Petrophila sp.	Hyalella sp.	Microcylloepus sp.	Microcylloepus sp.	Tryonia sp.	Micropsectra sp.	Hydroptila sp.	Coenagrionidae	Orthocladius Complex	Pyrgulopsis sp.	Parakiefferiella sp.	Oligochaeta
3rd Dominant Abundance	15.36	3472.00	240.00	1176.00	1920.00	504.00	608.00	183.12	1008.00	75.46	544.00	87.36
% 1 Dominant Taxon	64.87	29.97	55.75	46.42	68.60	27.78	73.92	39.02	69.79	33.99	53.82	24.81
% 2 Dominant Taxa	92.72	55.05	90.56	71.03	85.12	39.87	85.22	74.70	83.42	41.50	62.39	48.10
% 3 Dominant Taxa	95.25	75.24	93.51	79.75	90.63	51.63	90.32	87.50	89.04	48.69	67.58	61.27
Richness Measures												
Species Richness	9.00	22.00	14.00	22.00	15.00	24.00	15.00	15.00	17.00	37.00	35.00	20.00
EPT Richness	0.00	5.00	2.00	4.00	2.00	0.00	3.00	1.00	2.00	6.00	7.00	1.00
Ephemeroptera Richness	0.00	1.00	0.00	1.00	0.00	0.00	1.00	0.00	0.00	2.00	4.00	1.00
Plecoptera Richness	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Trichoptera Richness	0.00	4.00	2.00	3.00	2.00	0.00	2.00	1.00	2.00	4.00	3.00	0.00
Chironomidae Richness	2.00	3.00	3.00	5.00	1.00	12.00	4.00	3.00	7.00	10.00	16.00	7.00
Oligochaeta Richness	0.00	0.00	0.00	1.00	1.00	1.00	1.00	0.00	1.00	0.00	1.00	1.00
Non-Chiro. Non-Olig. Richness	7.00	19.00	11.00	16.00	13.00	11.00	10.00	12.00	9.00	27.00	18.00	12.00
Rhyacophila Richness	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Community Composition												
% Ephemeroptera	0.00	0.33	0.00	0.31	0.00	0.00	0.27	0.00	0.00	1.31	11.01	0.51
% Plecoptera	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
% Trichoptera	0.00	5.21	1.18	3.43	0.55	0.00	5.91	0.91	0.53	11.11	1.83	0.00
% EPT	0.00	5.54	1.18	3.74	0.55	0.00	6.18	0.91	0.53	12.42	12.84	0.51
% Coleoptera	0.00	11.07	3.24	8.72	0.28	0.65	0.00	0.30	0.00	2.61	0.00	0.25
% Diptera	2.53	0.98	3.24	9.66	1.93	42.48	5.65	1.22	11.76	20.92	22.63	43.80
% Oligochaeta	0.00	0.00	0.00	0.31	3.58	12.09	11.29	0.00	0.80	0.00	3.67	13.16
% Baetidae	0.00	0.33	0.00	0.31	0.00	0.00	0.27	0.00	0.00	0.33	10.40	0.51
% Brachycentridae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.96	0.00	0.00
% Chironomidae	0.63	0.98	2.95	8.72	1.10	41.83	5.65	0.91	11.76	16.34	19.27	43.54
% Ephemerellidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
% Hydropsychidae	0.00	1.30	0.29	1.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
% Odonata	0.00	0.65	0.88	0.00	0.28	0.00	0.54	15.55	0.27	3.92	1.53	4.56
% Perlidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
% Pteronarcyidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
% Simuliidae	1.58	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.65	0.00	0.00
Functional Group Composition												
% Filterers	1.58	3.58	0.29	6.85	0.00	0.65	0.54	0.30	0.00	1.63	0.92	0.25
% Gatherers	2.53	20.85	40.41	42.37	74.66	79.74	16.13	36.59	82.09	27.12	85.02	55.19
% Predators	0.00	6.19	1.77	2.18	2.20	7.52	1.34	21.95	2.41	52.61	11.01	37.97
% Scrapers	67.41	42.67	56.64	46.73	16.53	0.00	73.92	39.63	0.27	0.33	0.31	6.58
% Shredders	0.00	1.30	0.59	0.31	0.28	0.00	0.54	0.00	0.27	8.82	1.53	0.00
% Piercer-Herbivores	0.00	0.00	0.00	0.00	0.00	0.65	5.91	0.91	0.27	0.33	0.00	0.00
% Unclassified	28.48	25.41	0.29	1.56	6.34	11.44	1.61	0.61	14.71	9.15	1.22	0.00
Filterer Richness	1.00	5.00	1.00	4.00	0.00	1.00	1.00	1.00	0.00	2.00	3.00	1.00
Gatherer Richness	4.00	3.00	5.00	10.00	7.00	15.00	5.00	4.00	8.00	14.00	15.00	9.00
Predator Richness	0.00	7.00	4.00	3.00	3.00	5.00	4.00	5.00	3.00	15.00	12.00	8.00
Scraper Richness	2.00	4.00	2.00	2.00	1.00	0.00	1.00	2.00	1.00	1.00	1.00	2.00
Shredder Richness	0.00	1.00	1.00	1.00	1.00	0.00	1.00	0.00	1.00	2.00	2.00	0.00
Piercer-Herbivore Richness	0.00	0.00	0.00	0.00	0.00	1.00	2.00	1.00	1.00	1.00	0.00	0.00
Unclassified	2.00	2.00	1.00	2.00	3.00	2.00	1.00	2.00	3.00	2.00	2.00	0.00
Diversity/Evenness Measures												
Shannon-Weaver H' (log 10)	0.41	0.82	0.49	0.77	0.49	1.06	0.46	0.65	0.51	1.17	0.89	0.96
Shannon-Weaver H' (log 2)	1.37	2.73	1.62	2.56	1.62	3.52	1.52	2.17	1.70	3.88	2.95	3.19
Shannon-Weaver H' (log e)	0.95	1.90	1.12	1.77	1.12	2.44	1.05	1.51	1.18	2.69	2.04	2.21
Margalef's Richness	1.25	2.15	1.44	2.21	1.34	2.75	1.49	1.93	1.63	5.18	3.67	2.92
Pielou's J'	0.43	0.61	0.42	0.57	0.41	0.77	0.39	0.56	0.42	0.74	0.57	0.74
Simpson's Heterogeneity	0.50	0.79	0.57	0.71	0.50	0.87	0.44	0.70	0.49	0.86	0.69	0.85
Biotic Indices												
% Indiv. w/ HBI Value	71.20	73.94	98.82	97.51	91.46	84.64	98.12	95.73	85.29	48.04	83.79	100.00
Hilsenhoff Biotic Index	5.09	5.81	6.14	5.81	7.42	7.52	5.45	6.68	7.58	5.68	7.49	8.20
% Indiv. w/ MTI Value	4.11	20.52	5.01	13.71	1.65	32.68	11.29	17.68	7.49	30.72	12.23	23.80
Metals Tolerance Index	3.77	4.44	4.41	3.70	5.00	2.63	3.95	3.16	2.46	3.47	3.60	3.78

White River Valley (cont.)

Metrics	**Arnoldson Spring**	**North Flag**	**Middle Flag**	**South Flag**	**Hot Creek Spring**	**Indian Spring**	**Lund Spring**	**Nicholas Spring**	**Preston Big Spring**	**Sunnyside Upper**	**Sunnyside Lower**	**Tin Can Spring**
% Indiv. w/ FSBI Value	1.58	12.38	0.59	1.87	0.00	0.00	5.11	0.00	0.00	1.96	0.92	0.00
Fine Sediment Biotic Index	3.00	8.00	10.00	14.00	-99.00	-99.00	5.00	-99.00	-99.00	12.00	9.00	-99.00
FSBI - average	0.33	0.36	0.71	0.64	-99.00	-99.00	0.33	-99.00	-99.00	0.32	0.26	-99.00
FSBI - weighted average	3.00	3.21	5.00	4.83	-99.00	-99.00	5.00	-99.00	-99.00	3.83	4.33	-99.00
% Indiv. w/ TPM Value	3.48	33.55	38.94	33.64	69.15	4.90	6.72	38.41	76.20	10.78	6.12	0.25
Temp. Pref. Metric - average	1.44	0.55	1.86	1.14	0.47	0.75	0.60	0.27	0.82	1.43	0.77	0.10
TPM - weighted average	3.73	2.34	2.30	2.79	2.00	4.20	2.24	2.00	2.34	4.79	2.70	2.00
Karr BIBI Metrics												
Long-Lived Taxa Richness	0.00	2.00	1.00	1.00	1.00	1.00	1.00	0.00	0.00	2.00	1.00	1.00
Clinger Richness	3.00	10.00	7.00	7.00	4.00	3.00	3.00	5.00	4.00	9.00	5.00	2.00
% Clingers	68.99	47.88	61.36	60.44	17.36	13.07	79.57	42.99	3.74	14.05	10.09	6.08
Intolerant Taxa Richness	0.00	0.00	0.00	1.00	0.00	0.00	1.00	0.00	2.00	2.00	2.00	1.00
% Tolerant Individuals	1.16	0.51	1.47	0.63	0.83	3.50	0.41	11.69	1.72	5.75	2.38	27.28
% Tolerant Taxa	33.33	18.18	14.29	18.18	33.33	37.50	33.33	26.67	11.76	13.51	22.86	45.00
Coleoptera Richness	0.00	1.00	2.00	1.00	1.00	1.00	0.00	1.00	0.00	3.00	0.00	1.00

Dry Lake Valley

Metrics	Coyote Spring
Abundance Measures	
Corrected Abundance	29872.44
EPT Abundance	0.00
Dominance Measures	
Dominant Taxon	Ostracoda
Dominant Abundance	29680.95
2nd Dominant Taxon	Procladius sp.
2nd Dominant Abundance	127.66
3rd Dominant Taxon	Microcylloepus sp.
3rd Dominant Abundance	63.83
% Dominant Taxon	99.36
% 2 Dominant Taxa	99.79
% 3 Dominant Taxa	100.00
Richness Measures	
Species Richness	3.00
EPT Richness	0.00
Ephemeroptera Richness	0.00
Plecoptera Richness	0.00
Trichoptera Richness	0.00
Chironomidae Richness	1.00
Oligochaeta Richness	0.00
Non-Chiro. Non-Olig. Richness	2.00
Rhyacophila Richness	0.00
Community Composition	
% Ephemeroptera	0.00
% Plecoptera	0.00
% Trichoptera	0.00
% EPT	0.00
% Coleoptera	0.21
% Diptera	0.43
% Oligochaeta	0.00
% Baetidae	0.00
% Brachycentridae	0.00
% Chironomidae	0.43
% Ephemerellidae	0.00
% Hydropsychidae	0.00
% Odonata	0.00
% Perlidae	0.00
% Pteronarcyidae	0.00
% Simuliidae	0.00
Functional Group Composition	
% Filterers	0.00
% Gatherers	99.57
% Predators	0.43
% Scrapers	0.00
% Shredders	0.00
% Piercer-Herbivores	0.00
% Unclassified	0.00
Filterer Richness	0.00
Gatherer Richness	2.00
Predator Richness	1.00
Scraper Richness	0.00
Shredder Richness	0.00
Piercer-Herbivore Richness	0.00
Unclassified	0.00
Diversity/Evenness Measures	
Shannon-Weaver H' (log 10)	0.02
Shannon-Weaver H' (log 2)	0.06
Shannon-Weaver H' (log e)	0.04
Margalef's Richness	0.19
Pielou's J'	0.04
Simpson's Heterogeneity	0.01
Biotic Indices	
% Indiv. w/ HBI Value	100.00
Hilsenhoff Biotic Index	8.00
% Indiv. w/ MTI Value	0.64
Metals Tolerance Index	4.67
% Indiv. w/ FSBI Value	0.00
Fine Sediment Biotic Index	-99.00
FSBI - average	-99.00
FSBI - weighted average	-99.00
% Indiv. w/ TPM Value	0.00
Temp. Pref. Metric - average	-99.00
TPM - weighted average	-99.00
Karr BIBI Metrics	
Long-Lived Taxa Richness	0.00
Clinger Richness	1.00
% Clingers	0.21
Intolerant Taxa Richness	0.00
% Tolerant Individuals	1.56
% Tolerant Taxa	66.67
Coleoptera Richness	1.00

Delamar Valley

Metrics	Grassy Spring
Abundance Measures	
Corrected Abundance	8688.00
EPT Abundance	48.00
Dominance Measures	
1st Dominant Taxon	Ostracoda
1st Dominant Abundance	7488.00
2nd Dominant Taxon	Chironomus sp.
2nd Dominant Abundance	840.00
3rd Dominant Taxon	Hygrotus sp.
3rd Dominant Abundance	120.00
% 1 Dominant Taxon	86.19
% 2 Dominant Taxa	95.86
% 3 Dominant Taxa	97.24
Richness Measures	
Species Richness	9.00
EPT Richness	1.00
Ephemeroptera Richness	1.00
Plecoptera Richness	0.00
Trichoptera Richness	0.00
Chironomidae Richness	3.00
Oligochaeta Richness	0.00
Non-Chiro. Non-Olig. Richness	6.00
Rhyacophila Richness	0.00
Community Composition	
% Ephemeroptera	0.55
% Plecoptera	0.00
% Trichoptera	0.00
% EPT	0.55
% Coleoptera	1.38
% Diptera	10.50
% Oligochaeta	0.00
% Baetidae	0.55
% Brachycentridae	0.00
% Chironomidae	10.50
% Ephemerellidae	0.00
% Hydropsychidae	0.00
% Odonata	1.10
% Perlidae	0.00
% Pteronarcyidae	0.00
% Simuliidae	0.00
Functional Group Composition	
% Filterers	0.00
% Gatherers	96.41
% Predators	3.31
% Scrapers	0.00
% Shredders	0.00
% Piercer-Herbivores	0.00
% Unclassified	0.28
Filterer Richness	0.00
Gatherer Richness	3.00
Predator Richness	5.00
Scraper Richness	0.00
Shredder Richness	0.00
Piercer-Herbivore Richness	0.00
Unclassified	1.00
Diversity/Evenness Measures	
Shannon-Weaver H' (log 10)	0.24
Shannon-Weaver H' (log 2)	0.81
Shannon-Weaver H' (log e)	0.56
Margalef's Richness	0.88
Pielou's J'	0.25
Simpson's Heterogeneity	0.25
Biotic Indices	
% Indiv. w/ HBI Value	98.07
Hilsenhoff Biotic Index	8.19
% Indiv. w/ MTI Value	11.05
Metals Tolerance Index	3.78
% Indiv. w/ FSBI Value	0.00
Fine Sediment Biotic Index	-99.00
FSBI - average	-99.00
FSBI - weighted average	-99.00
% Indiv. w/ TPM Value	0.00
Temp. Pref. Metric - average	-99.00
TPM - weighted average	-99.00
Karr BIBI Metrics	
Long-Lived Taxa Richness	0.00
Clinger Richness	0.00
% Clingers	0.00
Intolerant Taxa Richness	0.00
% Tolerant Individuals	3.72
% Tolerant Taxa	44.44
Coleoptera Richness	1.00

Pahrangat Valley

Metrics	Ash Spring	BLM Spring	Brownie - Deacon	Cottonwood Spring	Crystal Springs	Hiko Spring	Lone Tree Spring	Maynard Spring
Abundance Measures								
Corrected Abundance	7824.00	3110.40	1806.00	1407.00	2701.16	1380.27	1913.47	2736.00
EPT Abundance	0.00	9.60	0.00	37.80	43.85	200.16	5.33	0.00
Dominance Measures								
1st Dominant Taxon	Hydrobiidae	Oligochaeta	Micropsectra sp.	Hyalella sp.	Melanoides tuberculata	Hyalella sp.	Ostracoda	Oligochaeta
1st Dominant Abundance	4656.00	1929.60	726.00	567.00	1657.53	246.03	1018.03	1936.00
2nd Dominant Taxon	Gastropoda	Ostracoda	Pisidium sp.	Valvata sp.	Orthocladius Complex	Physa sp.	Chironomus sp.	Paraphaenocladius sp.
2nd Dominant Abundance	1800.00	412.80	192.00	142.80	298.18	208.50	298.48	120.00
3rd Dominant Taxon	Hyalella sp.	Chironomus sp.	Oribatei	Ostracoda	Cricotopus bicinctus gr.	Coenagrionidae	Hyalella sp.	Chironomus sp.
3rd Dominant Abundance	720.00	124.80	192.00	121.80	236.79	166.80	170.56	120.00
% 1 Dominant Taxon	59.51	62.04	40.20	40.30	61.36	17.82	53.20	70.76
% 2 Dominant Taxa	82.52	75.31	50.83	50.45	72.40	32.93	68.80	75.15
% 3 Dominant Taxa	91.72	79.32	61.46	59.10	81.17	45.02	77.72	79.53
Richness Measures								
Species Richness	11.00	19.00	24.00	34.00	20.00	37.00	21.00	29.00
EPT Richness	0.00	1.00	0.00	2.00	3.00	3.00	1.00	0.00
Ephemeroptera Richness	0.00	0.00	0.00	1.00	1.00	1.00	0.00	0.00
Plecoptera Richness	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Trichoptera Richness	0.00	1.00	0.00	1.00	2.00	2.00	1.00	0.00
Chironomidae Richness	2.00	8.00	10.00	8.00	8.00	10.00	7.00	9.00
Oligochaeta Richness	1.00	1.00	1.00	1.00	1.00	1.00	0.00	1.00
Non-Chiro. Non-Olig. Richness	8.00	10.00	13.00	25.00	11.00	26.00	14.00	19.00
Rhyacophila Richness	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Community Composition								
% Ephemeroptera	0.00	0.00	0.00	1.49	0.32	6.65	0.00	0.00
% Plecoptera	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
% Trichoptera	0.00	0.31	0.00	1.19	1.30	7.85	0.28	0.00
% EPT	0.00	0.31	0.00	2.69	1.62	14.50	0.28	0.00
% Coleoptera	3.07	0.31	0.00	0.00	0.00	0.00	0.56	2.05
% Diptera	0.92	19.75	50.83	13.13	25.65	16.92	31.48	16.67
% Oligochaeta	1.84	62.04	1.66	1.19	2.27	10.88	0.00	70.76
% Baetidae	0.00	0.00	0.00	1.49	0.32	6.65	0.00	0.00
% Brachycentridae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
% Chironomidae	0.92	17.28	49.83	5.37	25.65	7.25	28.41	12.57
% Ephemerellidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
% Hydropsychidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
% Odonata	0.00	2.16	0.00	2.69	0.32	12.99	3.34	2.05
% Perlidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
% Pteronarcyidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
% Simuliidae	0.00	0.00	0.00	0.90	0.00	0.00	0.00	0.00
Functional Group Composition								
% Filterers	0.61	0.00	19.60	8.66	0.00	2.11	2.23	0.00
% Gatherers	12.58	88.89	50.83	55.82	22.08	46.22	81.62	84.21
% Predators	1.23	6.79	23.92	17.91	1.30	19.64	13.65	10.23
% Scrapers	62.58	2.47	2.99	11.94	0.32	17.52	0.28	2.92
% Shredders	0.00	0.31	0.00	2.39	9.09	0.00	0.28	0.58
% Piercer-Herbivores	0.00	0.00	0.00	1.19	1.30	9.37	0.00	0.00
% Unclassified	23.01	1.54	2.66	2.09	65.91	5.14	1.95	2.05
Filterer Richness	1.00	0.00	2.00	3.00	0.00	2.00	4.00	0.00
Gatherer Richness	3.00	8.00	9.00	10.00	8.00	12.00	5.00	10.00
Predator Richness	4.00	6.00	9.00	13.00	4.00	13.00	6.00	12.00
Scraper Richness	2.00	2.00	3.00	2.00	1.00	2.00	1.00	2.00
Shredder Richness	0.00	1.00	0.00	1.00	2.00	0.00	1.00	1.00

Pahrangat Valley (cont.)

Metrics	**Ash Spring**	**BLM Spring**	**Brownie - Deacon**	**Cottonwood Spring**	**Crystal Springs**	**Hiko Spring**	**Lone Tree Spring**	**Maynard Spring**
Piercer-Herbivore Richness	0.00	0.00	0.00	1.00	2.00	3.00	0.00	0.00
Unclassified	1.00	2.00	1.00	4.00	3.00	5.00	4.00	4.00
Diversity/Evenness Measures								
Shannon-Weaver H' (log 10)	0.53	0.67	0.95	1.05	0.65	1.19	0.75	0.64
Shannon-Weaver H' (log 2)	1.75	2.22	3.15	3.50	2.17	3.94	2.48	2.11
Shannon-Weaver H' (log e)	1.21	1.54	2.18	2.42	1.50	2.73	1.72	1.47
Margalef's Richness	1.12	2.24	3.07	4.55	2.40	4.98	2.65	3.54
Pielou's J'	0.51	0.52	0.69	0.69	0.50	0.76	0.56	0.44
Simpson's Heterogeneity	0.58	0.59	0.80	0.81	0.60	0.90	0.68	0.49
Biotic Indices								
% Indiv. w/ HBI Value	76.99	98.15	86.38	91.94	34.09	87.31	94.99	93.27
Hilsenhoff Biotic Index	5.50	7.76	6.70	7.25	6.40	7.55	8.10	7.75
% Indiv. w/ MTI Value	4.60	15.74	66.78	29.85	6.82	37.16	28.69	18.42
Metals Tolerance Index	3.33	3.67	2.17	2.81	4.00	2.65	3.45	3.97
% Indiv. w/ FSBI Value	0.00	0.00	1.00	0.90	0.65	0.60	0.00	0.88
Fine Sediment Biotic Index	-99.00	-99.00	5.00	3.00	5.00	5.00	-99.00	5.00
FSBI - average	-99.00	-99.00	0.21	0.09	0.25	0.14	-99.00	0.17
FSBI - weighted average	-99.00	-99.00	5.00	3.00	5.00	5.00	-99.00	5.00
% Indiv. w/ TPM Value	9.82	1.23	1.33	44.48	22.08	21.75	10.03	7.60
Temp. Pref. Metric - average	0.36	0.79	0.33	0.74	0.80	0.49	0.71	0.83
TPM - weighted average	2.00	8.25	5.00	2.15	3.65	2.03	2.19	6.54
Karr BIBI Metrics								
Long-Lived Taxa Richness	1.00	0.00	2.00	1.00	0.00	1.00	3.00	0.00
Clinger Richness	4.00	1.00	4.00	3.00	5.00	7.00	3.00	3.00
% Clingers	63.50	0.31	44.52	2.39	10.71	20.24	3.62	3.51
Intolerant Taxa Richness	0.00	0.00	0.00	1.00	1.00	1.00	0.00	0.00
% Tolerant Individuals	0.68	8.39	1.54	17.01	2.28	18.50	12.98	10.19
% Tolerant Taxa	27.27	31.58	33.33	29.41	40.00	32.43	23.81	27.59
Coleoptera Richness	1.00	1.00	0.00	0.00	0.00	0.00	2.00	3.00

Panaca Valley

Metrics	**Panaca Spring**
Abundance Measures	
Corrected Abundance	265.00
EPT Abundance	0.00
Dominance Measures	
1st Dominant Taxon	Melanoides tuberculata
1st Dominant Abundance	259.00
2nd Dominant Taxon	Oligochaeta
2nd Dominant Abundance	3.00
3rd Dominant Taxon	Planorbella sp.
3rd Dominant Abundance	2.00
% 1 Dominant Taxon	97.74
% 2 Dominant Taxa	98.87
% 3 Dominant Taxa	99.62
Richness Measures	
Species Richness	4.00
EPT Richness	0.00
Ephemeroptera Richness	0.00
Plecoptera Richness	0.00
Trichoptera Richness	0.00
Chironomidae Richness	0.00
Oligochaeta Richness	1.00
Non-Chiro. Non-Olig. Richness	3.00
Rhyacophila Richness	0.00
Community Composition	
% Ephemeroptera	0.00
% Plecoptera	0.00
% Trichoptera	0.00
% EPT	0.00
% Coleoptera	0.00
% Diptera	0.00
% Oligochaeta	1.13
% Baetidae	0.00
% Brachycentridae	0.00
% Chironomidae	0.00
% Ephemerellidae	0.00
% Hydropsychidae	0.00
% Odonata	0.00
% Perlidae	0.00
% Pteronarcyidae	0.00
% Simuliidae	0.00
Functional Group Composition	
% Filterers	0.00
% Gatherers	1.13
% Predators	0.00
% Scrapers	0.38
% Shredders	0.00
% Piercer-Herbivores	0.00
% Unclassified	98.49
Filterer Richness	0.00
Gatherer Richness	1.00
Predator Richness	0.00
Scraper Richness	1.00
Shredder Richness	0.00
Piercer-Herbivore Richness	0.00
Unclassified	2.00
Diversity/Evenness Measures	
Shannon-Weaver H' (log 10)	0.06
Shannon-Weaver H' (log 2)	0.19
Shannon-Weaver H' (log e)	0.13
Margalef's Richness	0.54
Pielou's J'	0.09
Simpson's Heterogeneity	0.04
Biotic Indices	
% Indiv. w/ HBI Value	1.51
Hilsenhoff Biotic Index	8.00
% Indiv. w/ MTI Value	0.38
Metals Tolerance Index	4.00
% Indiv. w/ FSBI Value	0.00
Fine Sediment Biotic Index	-99.00
FSBI - average	-99.00
FSBI - weighted average	-99.00
% Indiv. w/ TPM Value	0.00
Temp. Pref. Metric - average	-99.00
TPM - weighted average	-99.00
Karr BIBI Metrics	
Long-Lived Taxa Richness	0.00
Clinger Richness	0.00
% Clingers	0.00
Intolerant Taxa Richness	0.00
% Tolerant Individuals	100.00
% Tolerant Taxa	50.00
Coleoptera Richness	0.00

APPENDIX F: UTE LADIES'-TRESSES HABITAT PHOTOS

Unnamed spring east of Cleve Creek (east).

Unnamed spring east of Cleve Creek (west).

Layton Spring.

Minerva Spring #1.


Minerva Spring #2.


Minerva Spring #3.

Unnamed spring #1 north of Big Spring.

Unnamed spring #2 north of Big Spring.

Shoshone Pond #1.

Shoshone Pond #2.


Shoshone Pond #3.


South Bastion Spring.

South Little Spring.

Willard Spring.