Diamond Fork and Sixth Water Creeks
Ute Ladies'-tresses
Final 2008 Monitoring Report

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1.0 INTRODUCTION

Diamond Fork Creek and its tributary, Sixth Water Creek, are part of the Spanish Fork River Watershed (Figure 1.1). Between 1916 and 2004 these streams conveyed irrigation water diverted from Strawberry Reservoir in the Uinta Basin to the Wasatch Front. This trans-basin diversion increased peak flows in Diamond Fork Creek and Sixth Water Creek, severely impacted the stream channel and aquatic ecosystem, and created unique conditions that allowed the rare orchid, Ute ladies'-tresses (*Spiranthes diluvialis*) (ULT), to flourish. The ULT was listed as a threatened species on January 17, 1992 (USFWS 1992).

Currently, the Bonneville Unit's Diamond Fork System, completed in 2004, pipes water imported from Strawberry Reservoir directly into Spanish Fork River (Figure 1.2) and, with the exception of minimum instream flow, this imported water completely bypasses Sixth Water Creek and Diamond Fork Creek (USBOR 2005). Effects of this hydrologic change on ULT populations are largely unknown. The distribution of riparian plant species is largely driven by hydrologic and soil variables, and riparian plant communities frequently occur in relatively distinct zones along streamside elevational and soil textural gradients (Dwire et al. 2006). Vegetation zones within the riparian corridor vary in maturity due to flooding regimes and elevation. Mature sections of the corridor are composed of narrowleaf cottonwood (*Populus angustifolia*) galleries and boxelder (*Acer negundo*) with an under story of willow species, grasses, and forbs. Vegetation zones in higher elevations include common snowberry (*Symphoricarpos albus*), river birch (*Betula nigra*), and skunkbush (*Rhus trilobata*). Areas that are more regularly or newly disturbed are colonized with young willows, grasses, and forbs, including numerous surfaces that support ULT populations.

The Utah Reclamation Mitigation and Conservation Commission (Mitigation Commission) initiated a long-term monitoring project in 2005, in conjunction with State and Federal agencies, in order to monitor stream channel and riparian vegetation response to the altered flow regime, address aquatic and riparian habitat restoration needs, and monitor changes within ULT colonies. Efforts in 2008 were scaled down to ULT surveys only. This report documents the results of the ULT data collection and analysis conducted in 2008, beginning with an overall introduction and project description. This is followed by descriptions of the monitoring methods and results in Chapter 2 and Chapter 3.

Chapter 2 describes methods and results, and discusses ULT surveys including previous and current population estimates. Chapter 3 presents a discussion of results, summary of findings, and recommendations for subsequent monitoring sessions.

1.1 Watershed Description

The Diamond Fork Creek Watershed, including its tributaries, covers over 150 square miles and is the largest headwater tributary of the Spanish Fork River (Mitigation Commission 2005). The streams are initiated just west of Strawberry Reservoir, and the streams in the upper portions of the watershed are initially high-gradient, confined, canyon-type streams until they reach the wider alluvial valley closer to the confluence with Spanish Fork River. Diamond Fork and Sixth Water Creeks were used as early as 1916 to divert water to the Spanish Fork River from Strawberry

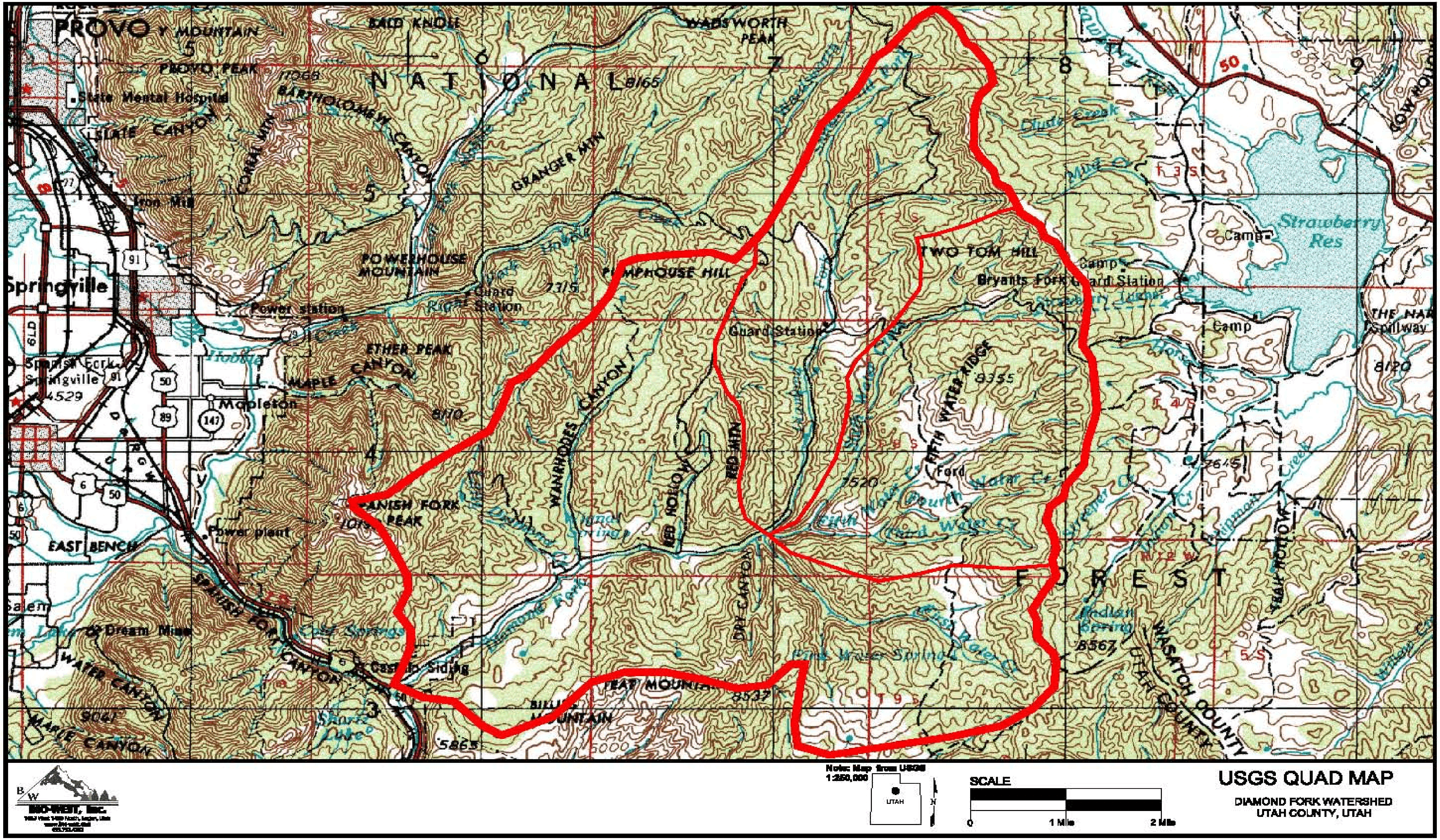

Figure 1.1. Diamond Fork Watershed.

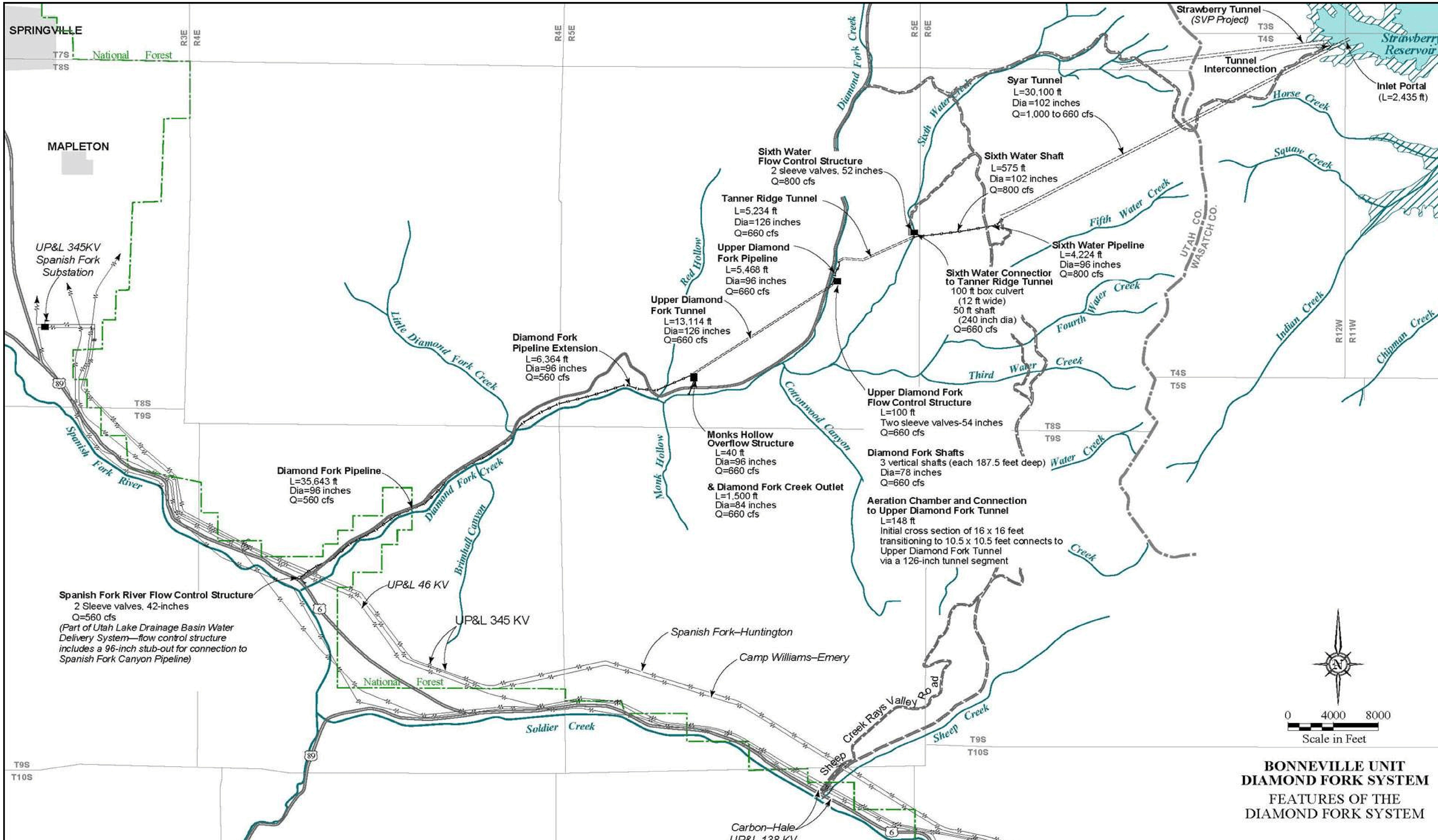

Figure 1.2. Diamond Fork System.

Reservoir through Strawberry Tunnel in order to support irrigation needs in the lower watershed area and Utah County (Mitigation Commission 2005). These streams carried a significant amount of imported water during the irrigation season, creating artificially high flows for an extended duration, causing significant changes in the sediment-transport regime, and affecting channel dimensions, pattern, and profile, as well as their interaction with the floodplain. These morphological impacts to the channel and floodplain have in turn affected water quality and the types and extent of riparian and wetland vegetation and aquatic communities. Historically, the watershed was used for agriculture, timber harvesting, livestock grazing, and recreation. Large portions of the watershed are still used for agriculture and grazing. Some of the watershed is part of the Uinta National Forest and managed by the U.S. Forest Service. Recently, Diamond Fork Creek has become a popular recreation area. The watershed has many recreational uses including both motorized and non-motorized activities.

1.2 History of the Colorado River Storage Project Act (CRSP), Central Utah Project (CUP), and Central Utah Project Completion Act (CUPCA)

The Diamond Fork System is a series of tunnels and pipelines that transport water from Strawberry Reservoir in the Colorado River Basin to Spanish Fork River in the Bonneville Basin. This system is a part of the Bonneville Unit of the Central Utah Project (CUP), which develops the portion of flow from the Upper Colorado River System allocated to Utah under various interstate compacts. The CUP was authorized by Congress in 1956 through the Colorado River Storage Project Act (CRSP) of 1956 (43 U.S.C. Sec 620 et seq.). The Bonneville Unit is the largest unit of the CUP (USBOR 2005). This system of reservoirs, aqueducts, pipelines, pumping plants, and conveyance facilities enables trans-basin water diversion to occur between the Colorado River Basin (Uinta Mountains) and the Bonneville Basin. The Central Utah Water Conservation District (CUWCD) manages this water, which is allocated to municipal and industrial uses, irrigation, and instream flows for areas in Utah. Other systems in the Bonneville Unit include the Starvation Collection System, the Strawberry Aqueduct and Collection System (SACS), the Municipal and Industrial System, and the Utah Lake System.

Before the present-day Diamond Fork System was completed, imported water went directly into Sixth Water Creek. Strawberry Tunnel transported water from Strawberry Reservoir into Sixth Water Creek, a tributary to Diamond Fork Creek. The water from Strawberry Reservoir eventually reached Spanish Fork River via Diamond Fork Creek. In 1990 the Syar Tunnel was constructed to replace Strawberry Tunnel. By 1996 water from Syar Tunnel flowed through the Sixth Water Aqueduct and entered Sixth Water Creek 6 miles farther downstream than it had when Strawberry Tunnel was the primary flow conveyance. Strawberry Tunnel is now used to convey minimum instream flows to the head of Sixth Water Creek (USBOR 2005).

In 1992 Congress passed the Central Utah Project Completion Act (CUPCA) (Title II through VI of Public Law 102-575), which authorized further construction to complete the Bonneville Unit of the CUP started in 1966. The CUPCA also mandated several modifications to the original design of the Bonneville Unit. Modifications to the Diamond Fork System consisted of constructing the Diamond Fork Pipeline to carry flow from Monks Hollow to Spanish Fork River in place of constructing the proposed Monks Hollow Dam. The legislation also established a minimum instream flow requirement. Currently, this requirement is 25 to 30 cubic feet per second (cfs) for Sixth Water Creek and 60 to 80 cfs for Diamond Fork Creek.

Under CUPCA in 1996, construction began on the Diamond Fork Pipeline, also known as Phase 1 of the Diamond Fork System of the CUP. This phase was completed in 1997 (Mitigation Commission 2000). Construction on Phase 2, the Diamond Fork Tunnel Alternative, was started in 2000 and completed in 2004. The Diamond Fork Tunnel Alternative is a pipeline and tunnel system that carries water from Syar Tunnel to the Diamond Fork Pipeline. Completing construction of Phase 1 and Phase 2 of the Diamond Fork System effectively removed all flow imports from Strawberry Reservoir to Sixth Water Creek and Diamond Fork Creek, except minimum instream flows.

The CUPCA also established the Mitigation Commission, a Federal agency responsible for mitigating impacts on fish, wildlife, and related recreation resources that resulted from construction of the Bonneville Unit. Congress also established standards for the Mitigation Commission to follow when coordinating and implementing plans for mitigation projects. The overall mitigation commitments concerning Sixth Water Creek and Diamond Fork Creek are monitoring ULT after completion of the Diamond Fork System, supporting the June Sucker Recovery Program, and monitoring stream channel responses to altered flow regimes following completion of the Diamond Fork System.

1.3 Impacts to the Diamond Fork System

Prior to completion of the Diamond Fork System, trans-basin imports from Strawberry Reservoir increased peak flow in both Sixth Water Creek and Diamond Fork Creek, particularly during periods of high irrigation demand. These artificially high flows caused the channels to scour in order to accommodate higher and longer duration peak flows. The changes in stream geomorphology and flow regime resulted in “severely limited fish production, loss of soils, loss of riparian and wetland habitat, and reduced recreation experiences” (Mitigation Commission 2005).

Before it was used to transport water from Strawberry Reservoir, Diamond Fork Creek was most likely a single-thread, meandering channel with minor backwaters and an active floodplain estimated to be about 200 to 300 feet wide (Mitigation Commission 2005) from the mouth to Brimhall Canyon. Runoff was largely controlled by spring snowmelt, with peak flow occurring in mid May. Flows returned to baseflow by late June with periodic, short-term increases in flow caused by storms. Gage station data show annual peak flows before 1915 at 250 cfs near Brimhall Canyon and 200 cfs near Red Hollow.

Using the streams to convey imported water resulted in changes in magnitude, duration, and timing of peak flows, which in turn caused major changes to the geomorphology and adjacent riparian areas in both Sixth Water and Diamond Fork Creeks. From 1915 to 2004, the annual hydrographs of Sixth Water Creek and Diamond Fork Creek were dominated by the releases from Strawberry Reservoir. Peak flows were approximately 450 cfs sustained for the duration of the irrigation season, which lasted approximately 140 days (Mitigation Commission 2005). In Sixth Water Creek, bank erosion occurred and the channel incised an average of 12 to 15 feet. Compared with 1939 conditions, parts of Diamond Fork Creek have become much wider, straighter, and steeper, particularly in the lower 3 miles (Mitigation Commission 2005). Diamond Fork Creek incised an average of 2 to 4 feet where the channel is confined. In areas where the valley is wide, the channel became braided and unstable.

Removal of most of the riparian forest for agriculture in the early 1900s compounded the impacts of increased flow on the channel and riparian areas. Rapid lateral migration of the stream channel, estimated at 40 to 60 feet per year, further impacted the existing riparian forest. High summer flows altered riparian and wetland communities by increasing the duration and extent of floodplain inundation as well as artificially increasing ground water elevations. However, now that the channel is so wide, increased flows do not increase water elevations as much as the extent of innundation. Currently, the water spreads more than it rises and lowers in response to changes in flow.

A plant species of particular concern is the ULT, which was listed as threatened by the Federal government. According to recent surveys, populations of this orchid were not documented in the Diamond Fork Watershed until 1992. The Diamond Fork Watershed populations are thought to contain about 95 percent of all individuals known to occur along the Wasatch Front. The species grows in moist areas, particularly near springs and perennial streams. The plants occur primarily within the 2- to 10-year floodplain and seem to be adapted to areas disturbed by channel migration or other sources of disturbance in the floodplain. Much of current habitat for ULT in the Diamond Fork Watershed seems to have developed in areas where lateral stream migration is occurring and willows, cottonwoods, and other types of riparian vegetation have been flooded out during growing seasons. It is possible that impacts from substantially increased flows in Sixth Water Creek and Diamond Fork Creek have created conditions that are favorable for ULT establishment (Mitigation Commission 2005).

Impacts have also occurred because of Diamond Fork Tunnel Alternative construction activities. During construction, an unexpected source of hydrogen sulfide-laden water began flooding the original tunnel. This tunnel was closed and abandoned. A new tunnel with an alternative design route was constructed to complete Phase 2. The hydrogen sulfide associated with drilling of the original tunnel continues to leak into Diamond Fork Creek upstream of Three Forks, causing some water quality impacts that could affect fish and aquatic habitat. The additional hydrogen-sulfide inputs are not known to affect any ULT colonies. Other impacts related to construction of the pipeline have been mitigated with varying amounts of stream restoration and riparian area restoration.

1.4 Vegetation Issues

Hydrologic flow regime is the major factor governing physical and biotic processes and aquatic and riparian biota in stream-riparian corridors (Poff et al. 1997, Tabacchi et al. 1998). The decreased flow in Diamond Fork Creek affects the dynamics of plant communities and species composition, altering disturbance cycles and geomorphology. Riparian areas are especially prone to establishment of exotic species because of fertile soil, water availability, and seed dissemination via water and animals—including livestock and wildlife—that heavily use and rely on riparian areas. Because of previously high disturbance rates, hydrological changes, and historical land use practices, many introduced plant species are beginning to establish in previously disturbed and drying areas. Exotic species of particular concern within ULT habitat are Canada thistle (*Cirsium arvense*) and bull thistle (*Cirsium vulgare*). These species have been found throughout the survey area within ULT habitat. Also found within areas surveyed were a small number of saltcedar (*Tamarix ramosissima*) and Russian olive (*Elaeagnus angustifolia*). Given the invasive nature of these species and their possible impacts on riparian communities, they are a particular threat to the health of the Diamond Fork Watershed riparian ecosystem.

As the amount of hydrological disturbance is reduced, plant communities have been adapting to adjusted flows and early successional species—such as grasses, forbs, and young willows—are replaced with mature woody species like coyote willow (*Salix exigua*), Booth's willow (*Salix boothii*), shining willow (*Salix lucida*), river birch, boxelder, and narrowleaf cottonwood. The ULT primarily occur in areas where the vegetation is relatively open and not overly dense or overgrown (Coyner 1989). The ULT's preference for open vegetative comminutes is also observed within the Diamond Fork Watershed, where few to no ULT individuals are found under dense willow or poplar (*Populus* spp.) canopies.

Another concern for ULT colonies is the continued observation that habitat once ideal for ULT colonization prior to creation of the Diamond Fork System (2004) may now be too dry to support populations. The ULT require moist soil throughout the growing season. The altered hydrology brought about from the Diamond Fork System may effect population numbers and/or survival of individual colonies. There is concern that reduced flow in Diamond Fork Creek may result in the reduction in size and or occurrence of suitable habitat and possibly the loss of existing ULT colonies within the watershed. However, there are many lower surfaces along Diamond Fork Creek that were wetter and/or seasonally inundated with water that now, with implementation of the Diamond Fork System, may be potential ULT habitat.

1.5 Ute Ladies'-tresses along Diamond Fork Creek

The ULT species is a small, terrestrial, insect-pollinated orchid (Sipes and Tepedino 1995) found in wet meadows, abandoned oxbow meanders, marshes, raised bogs, and along streambanks at 4,500 to 6,900 feet (Welsh et al. 2003). Scattered populations are found throughout the west-central United States (Dressler 1981, Heidel 1997, Hildebrand 1998) including the currently known range of Idaho, Montana, Nebraska, Washington, Wyoming, Utah, Nevada, and Colorado (Fertig et al. 2005). In 1992 the ULT orchid was listed as a Federally threatened species because of relatively low population numbers, fluctuations in monitored population size, and loss of the species' riparian habitat through urban development, stream channelization, recreational development, and exotic species invasion (USFWS 1992). Historical accounts and herbarium records indicate that the ULT species was once much more common than its present range (Coyner 1990, Jennings 1990, Coyner 1991). Unique conditions exist along Diamond Fork Creek, possibly created by manipulated water regimes and hydrological and geomorphological impacts, that create an ideal ecosystem for ULT populations**.**

The bloom period for the ULT populations in the Diamond Fork Watershed occurs in late summer, generally mid August through early September, although the bloom period may come as early as late July or last through late September, depending on climate and elevation. Because ULT reproductive biology requires pollinators as well as nutrients, water, and sunlight, pollinators become an important element in the preservation of this and other rare species. The most likely cause of the decrease in ULT population abundance seems to be disturbance and fragmentation of riparian habitat (Coyner 1990), which may be related to a decrease in visiting pollinators. Rare plants may suffer depressed reproduction if they occur in small or sparse populations due to lack of mates and/or pollinator visits (Levin 1972; Feinsinger et al. 1986; Kunin 1992, 1993). In addition, the introduction of exotic species that have similar bloom periods, and thus compete for pollinators, may be causing further impacts. Monitoring and maintenance of large ULT populations, such as those occurring in the Diamond Fork Watershed, are important to maintaining genetic variation and survival within the species.

1.6 Previous Studies of Ute Ladies'-tresses in the Diamond Fork Watershed

Prior to 2006 the ULT populations in Diamond Fork Watershed were monitored by HDR Engineering, Inc. (HDR). Surveys were conducted by HDR on surfaces known to support ULT populations from 1992 to 2005, and flowering ULT individuals were counted. During the 2005 monitoring period, efforts were made to monitor flowering individuals in known and potentially occupied sites, estimate the ratio of flowering to non-flowering individuals along transects, and conduct habitat analyses and piezometer readings to measure ground water elevations at known occupied surfaces and evaluate the relationship between surface and ground water elevations. Although methods were established in 2005, implementation of those monitoring methods was incomplete and much of the data collection and analysis was inadequate to identify trends, associations, and management practices required to successfully monitor and manage this unique ecosystem and its associated plant community. Comparisons were made to previous data collected by HDR and new data collected by BIO-WEST during the 2006, 2007, and 2008 monitoring periods when possible, primarily to identify coarse vegetation trends (Black and Gruwell 2005). Methodology implemented by BIO-WEST in 2006 was repeated in 2007 and 2008 in order to allow comparisons of data between subsequent monitoring years.

1.7 Purpose of and Need for Monitoring

Mitigating impacts resulting from adjustments of the Diamond Fork System is required under CUPCA (1992). The Mitigation Commission has committed to several general areas of mitigation: (1) monitoring leatherside chub (*Gila copei*) populations, (2) monitoring water quality and stream channel responses to altered flow regimes; and (3) monitoring ULT colonies and riparian vegetation in response to altered flow regimes following the completion of the Diamond Fork System.
As adjustments are made to the Diamond Fork System, effects to riparian vegetation communities, and specifically ULT populations, should be monitored. Riparian ecosystems are unusually complex, dynamic, and diverse (Sharitz et al. 1992), making these systems key for the preservation of biodiversity (Naimen et al. 1993). Monitoring and maintaining ULT populations located along Diamond Fork Creek are important for the preservation and genetic diversity of the species. The purpose and priorities of monitoring riparian vegetation communities along Sixth Water and Diamond Fork Creeks, including continued ULT surveys, are as follows:

1. Map vegetation along the entire length of Sixth Water Creek and Diamond Fork Creek to quantify baseline conditions after construction of the Diamond Fork System (completed in 2006).

2. Measure the lateral extent of riparian vegetation communities during cross-section surveys to accurately map changes to their composition and structure as flows decrease from historically altered high flows (completed in 2006 and repeated in 2007).

3. Acquire data to accurately monitor changes over time of occupied, potentially occupied, and non-occupied habitat types, and classify plant communities found within ULT known and potentially occupied sites (ongoing).

4. Continue ULT surveys within known and potentially occupied sites to monitor changes in ULT colonies and associated vegetation communities as hydrologic and geomorphic conditions change in response to the new Diamond Fork System (ongoing).

5. Use best available scientific knowledge to ensure that the Mitigation Commission meets commitments to Sixth Water Creek and Diamond Fork Creek as set forth under CUPCA (1992) (ongoing).

1.8 Scope of Work for Riparian Vegetation Monitoring

The purpose of the 2008 monitoring session was to continue ULT surveys at known and potentially occupied sites along Diamond Fork and Sixth Water Creeks. The overall 2008 study area included the entire length of Sixth Water Creek and Diamond Fork Creek. These studies are a continuation of previous surveys conducted by HDR from 1992 to 2004 (Black and Gruwell 2005) and BIO-WEST (2006 and 2007), and include adjustments incorporated into survey methods initiated during 2006 to streamline the ULT surveys and ensure a higher degree of precision and repeatability for surveys conducted in following years.

2.0 UTE LADIES'-TRESSES SURVEYS

2.1 Introduction

Ute ladies'-tresses (ULT) population surveys were during conducted late summer (August through early September) to assess population trends and relative abundance of individuals on riparian surfaces along Diamond Fork Creek. Survey methodologies used in 2006 were repeated in 2007 and again in 2008 to maintain consistency. Data collection techniques were adapted from previous surveys done by HDR Engineering, Inc. (HDR) that occurred from 1992 to 2005 (Black and Gruwell 2005). BIO-WEST, Inc.'s (BIO-WEST's) survey methodologies were designed to more rapidly assess population trends of ULT colonies located on previously occupied surfaces. First, ULT individuals were counted as a sub-sample of currently occupied surfaces; second, meandering surveys were used to estimate relative abundance of individuals located on the riparian surfaces along Diamond Fork Creek. The meandering surveys were performed to capture gross trends in abundance and distribution without counting all ULT individuals.

2.2 Methods

2.2.1 Data Collection

All ULT colonies along Diamond Fork Creek were surveyed one of two ways: actual counts or abundance estimates. Based on previous ULT counts, colonies that were most indicative of overall canyon-wide population trends (with a correlation of 50 percent or more as shown in Appendix 2.1) (J. Rice 2006, pers. comm.) were recounted in 2008—including polygons 2A, 2B, 10A, 13, (which includes 13.1, 13.2, and 13.3), 14, 17A, 20, 24B, 30, and 36—as shown in the ULT polygon maps located in Appendix 2.2. As a result of observations during the 2007 surveys, two survey sessions were conducted during 2008 to account for the likelihood of dual or multiple flowering peaks. The first ULT count occurred during the week of August 20 and the second during the week of September 9. Colonies that have shown more sporadic trends were ranked for relative abundance: none, few, moderate, and abundant. These surfaces were only surveyed once during the week of August 20. Previous surveys of the Diamond Fork ULT population have typically been surveyed during this time because it was thought the flowers where most likely to be blooming. Within each ULT colony surveyed, dominant native and any non-indigenous species observed were also recorded.

2.2.2 Habitat Known to be Occupied by Ute Ladies'-tresses

Surfaces within the Diamond Fork Watershed have historically been surveyed and monitored with an emphasis on obtaining exact counts of flowering ULT individuals. Total counts were time intensive, and the number of ULT individuals found varied between years. During BIO-WEST's initial survey in 2006, ten surfaces were selected by the Utah Reclamation Mitigation and Conservation Commission (Mitigation Commission) (J. Rice 2006, pers. comm.) that were known to have ULT and showed count trends somewhat representative of ULT colonies found throughout the watershed. The same surfaces were surveyed again 2007 and 2008. Surveys were performed along arbitrary transect lines, with surveyors spaced no more than 5 feet apart. This method provided effective detection of flowering individuals (Figure 2.1) and minimized the possibility of overlap counting. In 2008 all flowering ULT individuals were counted, and data were compared with HDR's data collected during previous years (Black and Gruwell 2005), as well as data previously collected by BIO-WEST in 2006 and 2007 in order to extrapolate possible trends. Data gathered before and after Diamond Fork System construction were summarized to clarify potential effects to the Diamond Fork ULT population as a result of construction.

Meandering surveys were conducted on remaining known ULT colony surfaces to rapidly determine relative abundance in a consistent and efficient manner (Figure 2.2). Particular attention was paid to areas of potential ULT habitat, as well as dense willow stands, to get an accurate representation of the surface. Rough counts were made, and abundance was rated by comparing numbers and overall surface sizes. Surfaces were ranked and characterized by color according to relative abundance: none, few, moderate, and abundant (Appendix 2.3).

2.2.3 Habitat Suitable for Ute Ladies'-tresses Occupation

As hydrology and geomorphology change within the Diamond Fork System, new surfaces with conditions ideal for ULT have begun to develop along Diamond Fork Creek. New surfaces with ecological conditions favorable for establishment of ULT will be identified during flowering plant surveys. As colonies are found, they will be mapped, rated for abundance, and monitored in subsequent years.

2.2.4 Occupied and Suitable Ute Ladies'-tresses Habitat

During individual ULT counts and relative abundance surveys, dominant plant species and non-indigenous species were recorded for each surface. Also included in the data collection were general observations including health of the vegetative community (e.g., drying, extent of non-indigenous species infestations).

2.3 Results

2.3.1 Known Ute Ladies'-tresses Surfaces

2.3.1.1 Counts of Flowering Ute Ladies'-tresses Individuals

During the week of August 20, 2008, counts of flowering ULT individuals on the 10 representative surfaces ranged from 0 to 160, a slight increase from observations in 2007 which ranged from 0 to 128. However, the total number of ULT counted on the representative surfaces decreased from 367 found in 2007 to 329 found in 2008. Numbers of ULT observed in both 2007 and 2008 showed a significant decrease from the 2006 surveys in which numbers ranged from 0 to 879 and totaled 2,836 (Table 2.1). The number of flowering individuals recorded since 1992 (Black and Gruwell 2005) indicates that ULT numbers generally deceased in 2002, 2003, 2004, and 2005. Counts recorded in 2006 on the 10 representative surfaces indicated no significant change in most colonies, except for 14, 24B, and 30, where numbers had increased significantly (Figure 2.3), and colony 20, where ULT numbers decreased significantly during the previous 12 years and were the lowest on record for that particular site.

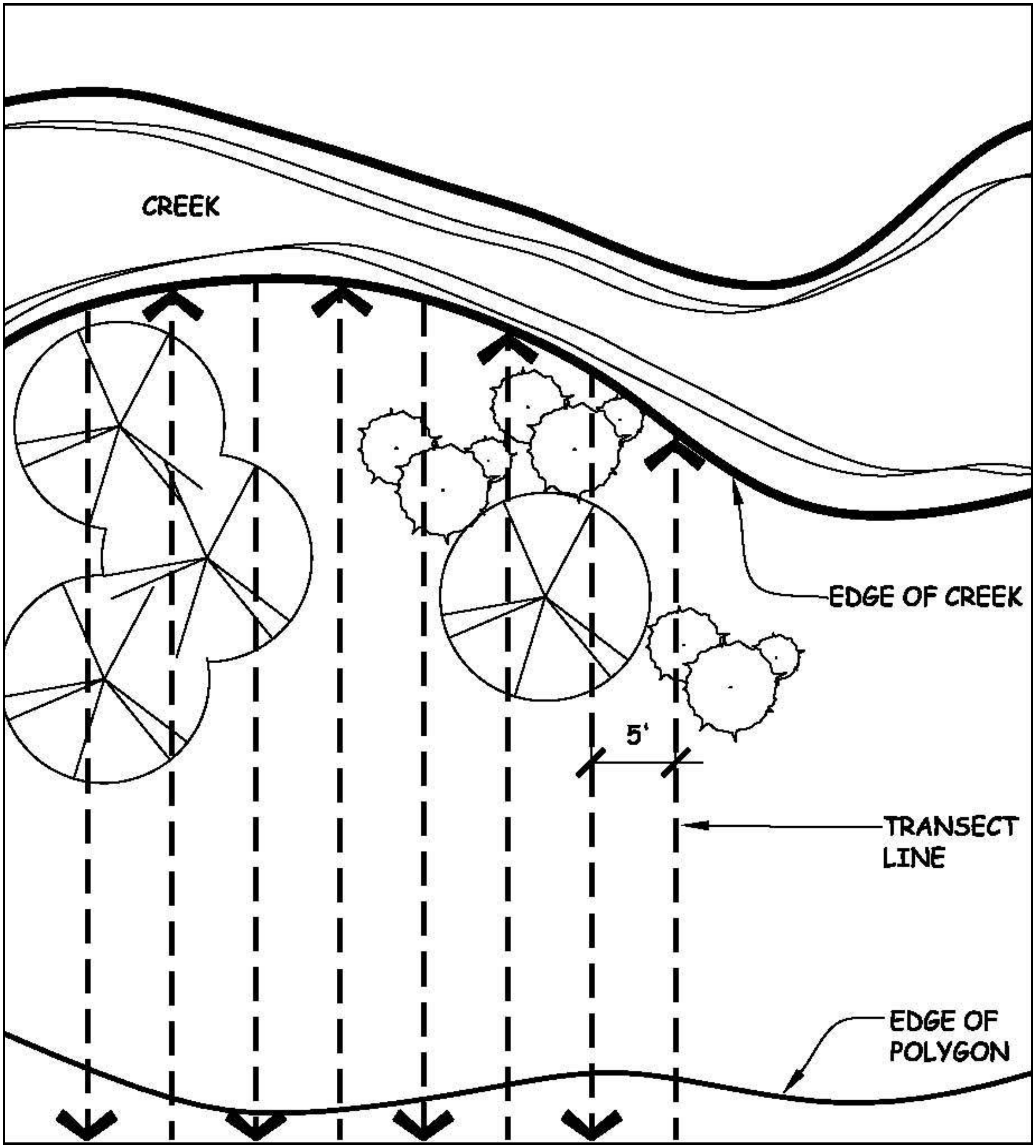

Figure 2.1. Method used for actual plant counts on known Ute ladies'-tresses-occupied sites.

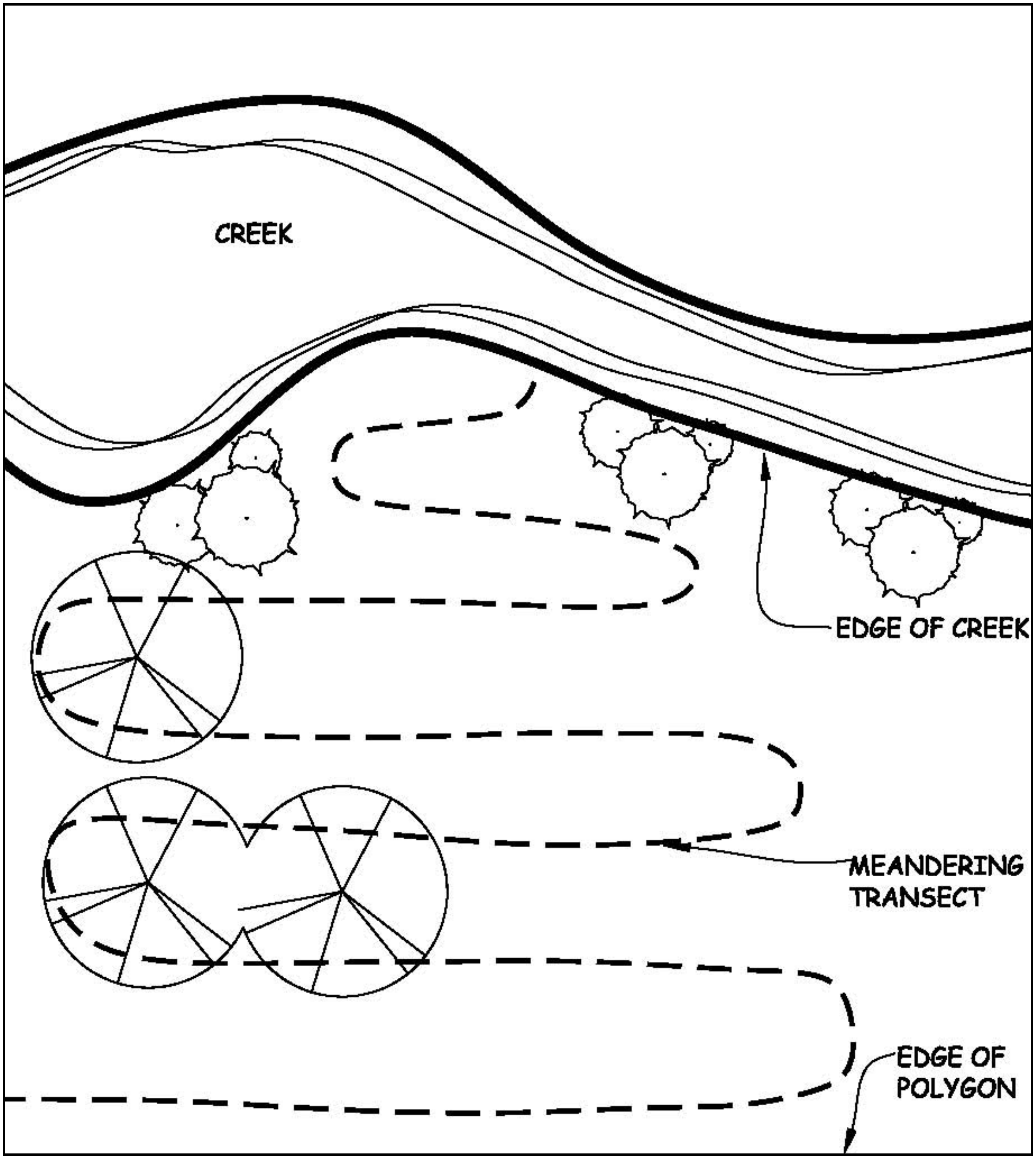

Figure 2.2. Method used for meandering Ute ladies'-tresses relative abundance estimates on known colony surfaces.

Table 2.1. Ute ladies'-tresses counts of flowering individuals on representative surfaces.

UTE LADIES'-TRESSES COUNTS															
COLONY ID	1992	1993	1994	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
2A	NA [a]	NA	NA	NA	6	0	40	63	14	4	1	0	0	0	0
2B	NA	NA	NA	NA	45	19	432	380	118	28	0	5	2	0	0
10A	NA	NA	NA	96	58	34	339	523	482	1	0	64	297	114	129
13	NA	67	0	1	52	17	83	79	1	0	0	2			11
13.1												0		0	0
13.2												0	3	0	0
13.3												0		0	0
14	NA	97	200	957	96	440	638	663	111	23	18	58	879	57	0
17A	NA	NA	NA	47	21	25	39	42	53	2	0	34	0	0	0
20	28	804	91	1,888	236	122	990	863	480	17	34	290	4	0	0
24B	NA	NA	NA	1,409	38	341	795	952	565	8	91	155	872	5	28
30	NA	8	GI*	0	89	23	54	474	289	43	6	451	680	128	160
36	NA	141	138	382	162	22	25	84	61	5	2	70	104	68	1
Average	28	223	107	597	80	104	343	412	217	13	15	113	284	37	25

Note: Filled cells indicate remnants of a larger colony that has subsequently been fragmented.
[a] NA - Flowering plants had not yet been identified at this location.
[b] Grazing impacts, no data collected.

In 2007 colonies 14, 30, and 24B all showed a significant decrease of ULT individuals compared with numbers of individuals observed during 2006 surveys. However, in 2008 there was a slight increase in the number of ULT individuals found on surfaces 24B and 30, as well as another significant decrease of blooming individuals on surface 14. The number of ULT found during the 2007 and 2008 surveys was more consistent with what was observed by HDR in 2002, 2003, 2004, and 2005 (Black and Gruwell 2005). Colonies 10A, 2B, 13.2, 14, 20, 24B, 30, and 36 all showed a decrease in the number of ULT found in 2007 compared with 2006. Of the 10 surfaces surveyed in 2007, 7 contained no flowering ULT individuals at the time of the initial survey. During 2008, 8 of the 13 colonies surveyed contained no ULT. On surfaces that contained colonies — 2A, 13.1, 13.3, and 17A — no ULT were found during the 2006, 2007, or 2008 surveys.

Generally, climatic patterns in 2006 were considered wetter than normal and in 2007 they were hotter and drier than normal. Also, many of the surfaces where ULT colonies exist had been heavily grazed during the flowering window in 2007, which likely contributed to the lower number of flowering individuals. However, climatic moisture patterns during 2008 were considered more typical. Temperatures in the region were, however, cooler than normal. There was no obvious sign that cattle had been grazing on surfaces that contained ULT during the 2008 survey bloom period. Because ULT numbers have followed no significant trends in past surveys, again, no discernable patterns can be detected in the new data.

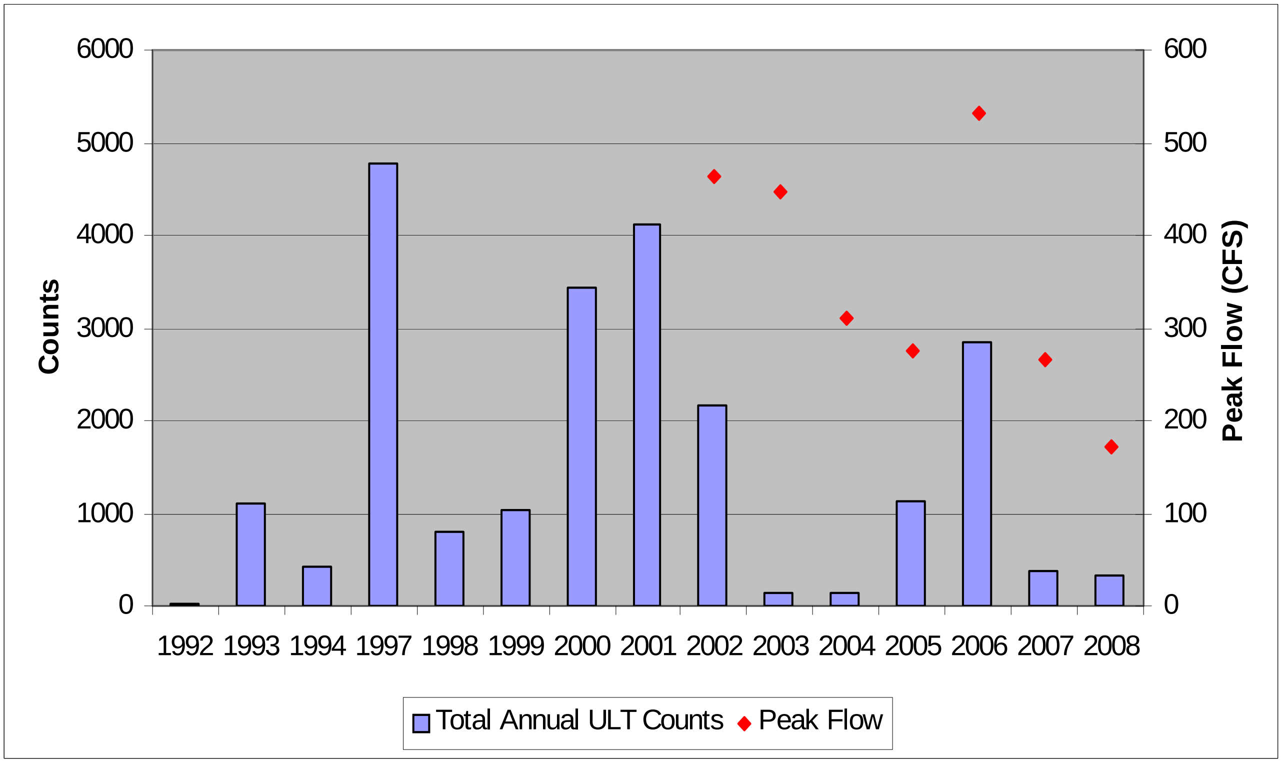

Figure 2.3. Time series counts of flowering Ute Ladies'-tresses individuals on the 10 representative surfaces and peak cubic feet per second.

Figure 2.3 includes peak discharge measurements from 2002 to 2008 (USGS 2008) for Diamond Fork Creek above Red Hollow gage. The peak discharge measurement for 2008 is provisional. When comparing numbers of actual ULT counted within this period of time, data continue to suggest a relationship between high peak flows in Diamond Fork Creek and higher ULT counts. Conversely, years of lower peak flows seem to relate to lower ULT counts. These data further indicate that higher peak flows within Diamond Fork Creek may affect ULT counts.

Adding to the confounding patterns of ULT counts observed from year to year is the possibility of dual, multiple, and/or varied flowering peaks within ULT colonies. Therefore, a second count was conducted during the week of September 9, 2008. During the 2007 actual count surveys, three surfaces were surveyed twice, once in early August (August 6, 2007) and again in mid August (August 18, 2007). During the initial 2007 survey, 114 ULT were found on surface 10A, whereas roughly 2 weeks later an excess of 500 flowering ULT were observed on the same surface. Four other surfaces were resurveyed in 2007 including 13.1, 13.2, and 13.3. No blooming ULT were found on those surfaces during the initial survey. There were no flowering ULT observed on surfaces 13.1 and 13.2 during the second count; however, surveyors counted 35 flowering ULT individuals on surface 13.3 during the second 2007 field season survey. The second survey conducted in 2008 produced similar results: There was an increase of flowering ULT observed on the majority of surfaces (Table 2.2). On 7 of the 13 surfaces surveyed, there was an increase in flowering ULT observed; on 5 of the surfaces no ULT were found during either visit, and only one surface, 30, showed a decrease in flowering individuals observed. These observations further confound the understanding of ULT flowering trends from year to year.

Table 2.2. Ute ladies'-tresses count comparisons within the 2008 field season.

Colony	August 20, 2008	September 9, 2008
2A	0	3
2B	0	2
10A	129	444
13	11	50
13.1	0	0
13.2	0	0
13.3	0	0
14	0	24
17A	0	0
20	0	0
24B	28	128
30	160	128
36	1	90
TOTAL	329	869

2.3.1.2 Relative Abundance Estimates

The relative abundance of flowering ULT individuals on known ULT surfaces ranged from none to abundant (Table 2.3 and Appendix 2.3). Patterns observed during 2008 appear to indicate that overall counts have decreased since 2006 and 2007. The numbers of ULT observed during 2007 and 2008 are similar to counts observed in 2002, 2003, 2004, and 2005. In 2006 some surveyed surfaces contained the highest number or abundance ranking recorded to date. Abundance estimates on surfaces 27A, 36B, 8A, 8B, 8C, and 4B were at the highest recorded level for those particular colonies. Abundance at colonies 1 and 23A had also significantly increased (Black and Gruwell 2005). Other decreases or slight increases observed in particular colonies may be attributed to annual fluctuations in numbers similar to those found during previous surveys. Only one surface, 24C, had a significant drop in ULT numbers in 2007. During HDR surveys (Black and Gruwell 2005), 889 flowering ULT individuals were found on this surface. During the 2006 surveys, no flowering individuals were recorded for this surface and most of the obligate vegetation on the site was drying and dying back. This appears to be a recent phenomenon as replacement species, either non-indigenous or upland, have yet to establish in this area. Abundance estimates continued to follow a generally decreasing trend during 2008. Table 2.3 lists surface number and relative abundance estimates recorded during 2008 surveys.

Table 2.3. Ute ladies'-tresses abundance estimates from surfaces 2008.

SITE	ABUNDANCE 2007	COUNT 2007	ABUNDANCE 2008	COUNT 2008
1	Moderate	38	Moderate	20
1A	Few	12	None	0
1B	None	0	None	0
2.1	Few	3	None	0
2.2	None	0	None	0
2.3	None	0	None	0
2C	None	0	None	0
2D	None	0	None	0
2E	None	0	None	0
3	None	0	Few	1
3A	Abundant	118	Few	1
3B	None	0	None	0
3C	None	0	None	0
4	None	0	Few	7
4A	None	0	None	0
4B	Abundant	290	None	0
4C	None	0	None	0
5	Few	7	Few	2
5A	Few	2	None	0
5B	Few		Few	2
5C	Few		None	0
6	None	0	Few	1
6A	Abundant	100	Moderate	33
7	None	0	None	0
8	Few	10	Few	10
8A	Moderate	55	Moderate	95
8B	Abundant	110	None	0
8C	Moderate	35	Abundant	117
9	Moderate	55	Few	7
11	None	0	Few	11
11A	None	0	None	0
12	None	0	None	0
12A	Moderate	27	None	0
14	Moderate	35	None	0
14A	Moderate	30	None	0

SITE	ABUNDANCE 2007	COUNT 2007	ABUNDANCE 2008	COUNT 2008
15	None	0	None	0
15-A1	None	0	None	0
15-A2	None	0	None	0
15B	None	0	None	0
16	None	0	None	0
16A	None	0	None	0
16B	None	0	None	0
17	None	0	None	0
17B	None	0	None	0
18	None	0	None	0
18A	Few	3	None	0
19	None	0	None	0
19A	None	0	None	0
20B	Moderate	25	None	0
20C	Moderate	21	Few	2
20D	Few	12	None	0
21	Few	2	Moderate	12
21A	None	0	Few	2
21B	None	0	None	0
21C	Few	1	None	0
23	None	0	None	0
23A	None	0	None	0
24	Few	2	None	0
24A	Few	1	Few	3
24C	Few	2	None	0
24D	Few	7	Few	22
25	Abundant	973+	Abundant	500+
25A	Moderate	73	Few	3
25B	Few	1	Moderate	25
26	Abundant	485	Moderate	60
27	None	0	None	0
27A	Moderate	55	Moderate	21
28	Moderate	60	Moderate	28
28A	None	0	None	0
29	None	0	None	0
29A	Few	2	None	0

SITE	ABUNDANCE 2007	COUNT 2007	ABUNDANCE 2008	COUNT 2008
33	Abundant	122	Abundant	236
33A	None	0	None	0
34	None	0	None	0
34A	None	0	None	0
35	Abundant	362	Abundant	300+
35A	Moderate	55	Moderate	24
35B	None	0	None	0
36A	Few	8	Few	12
36B	Abundant	135	Moderate	74
37A	Few	5	Few	3
37B	Few	3	Moderate	51
37C	Few	2	Few	3
37D	Moderate	25	Moderate	92
37E	None	0	Few	1

Of the surfaces surveyed in 2008, 60 percent contained no ULT individuals compared with 46 percent in 2007. In 2007, 24 percent contained few, 18 percent contained a moderate number, and 11 percent contained an abundant number of flowering ULT individuals, compared with 2008 when 60 percent of surfaces surveyed contained no ULT individuals, 22 percent contained few, 13 percent contained a moderate number, and 5 percent contained an abundant number of flowering ULT individuals (Table 2.4). Overall abundance estimates in 2008 indicated a more tempered flowering season, similar to observations in 2007.

Table 2.4. Abundance estimates for surfaces surveyed; percentage of surfaces ranked as none, few, moderate, or abundant.

ABUNDANCE RATING	PERCENTAGE OF SURFACES		
	2006	2007	2008
None	51%	46%	60%
Few	21%	24%	22%
Moderate	11%	18%	13%
Abundant	17%	11%	5%

Abundance estimates for the majority of ULT colonies surveyed showed no discernable differences in population trends within the Diamond Fork Watershed. The variability of counts from year to year are so great that there are no apparent trends with these data.

2.3.2 New Ute Ladies'-tresses-Occupied Sites

New surface occupation could be a result of changed hydrology, but it is likely that these colonies were missed during previously conducted surveys. Surfaces identified as new finds in 2006 were revisited. No new surfaces containing ULT were found during the 2008 surveys. However, new surfaces found during 2006 and 2007 surveys were revisited and included in the 2008 abundance estimate surveys.

2.4 Discussion

Currently, the best known method for assessing ULT populations is counting flowering individuals annually in representative colonies and determining abundance estimates for colonies with more variable historical counts. It may be appropriate in subsequent years to compare ULT abundance estimates observed before and after construction of the Diamond Fork System.

The year-to-year variability of ULT counts has made it difficult to identify patterns and extrapolate trends for flowering individuals. During the 2007 and 2008 field seasons, observations of multiple peaks in flowering individuals further indicate that conducting ULT counts once annually may be inadequate for the assessment of the ULT population health and vigor along Sixth Water and Diamond Fork Creeks. Observed actual counts, as well as abundance estimates, may be as much a function of annual variability as they are variability of flowering within the bloom period that occurs from late July through early September. The varied bloom times may be a function of climatic conditions, population genetic variance between colonies, elevation, and/or changes in competition with other vegetative species year to year.

Impacts to ULT populations in the Diamond Fork Watershed may be attributed to changes in vegetation rather than changes in water levels. Mechanisms changing vegetation composition include: competition from non-indigenous plant species, changes in disturbance regimes, vegetation structure (transition from young willows to mature stands), and establishment of late successional species. Ute ladies'-tresses are typically found in areas that are heavily vegetated by early successional species or species that are in early stages of establishment or development.

3.0 SUMMARY AND DISCUSSION

Diamond Fork Creek and its tributary, Sixth Water Creek, have conveyed water imported from Strawberry Reservoir to the Wasatch Front as an important component of the Strawberry Valley Project. The artificially high flows ceased with the completion of the Diamond Fork System, which is part of the Bonneville Unit of the Central Utah Project (CUP). Today, the Diamond Fork System transports imported water through a series of tunnels and pipes directly to Spanish Fork River and can largely bypass Diamond Fork and Sixth Water Creeks. The only flows sent through Sixth Water and Diamond Fork Creeks are waters imported to satisfy instream flow requirements (USFWS 1999) and water in excess of the system's capacity.

Mitigation of impacts that were caused by the Diamond Fork System is required under Central Utah Project Completion Act (CUPCA) (1992). In order to fulfill these commitments, the Utah Reclamation Mitigation and Conservation Commission established a long-term monitoring program to evaluate the geomorphic and ecological changes related to the new flow regime set by instream flow requirements. Long-term monitoring will allow analysis of change over time in order to set and prioritize restoration efforts and adaptively maintain the riverine and riparian ecosystem in a desirable and functional condition. The main study objectives discussed in this report include Ute ladies'-tresses (ULT) counts and relative abundance estimates to assess population trends. This report documents findings from the 2008 monitoring effort and makes comparisons when appropriate to findings from the 2006 and 2007 monitoring efforts. Because vegetation communities can take several growing seasons to adjust to changes in hydrology, riparian vegetation mapping was not conducted during the 2008 monitoring period; however, it is recommended that this mapping be conducted during the 2009 monitoring period. Cross-sectional transect data and findings from 2008 will be used as the baseline for subsequent monitoring sessions based on adjusted data collection methodology implemented in 2008.

3.1 Ute Ladies'-tresses Surveys

The year-to-year variability of ULT counts has made it difficult to identify patterns and extrapolate trends for flowering individuals. The actual counts of ULT individuals in 2008 showed a slight decrease of flowering individuals compared with data collected in 2007 and a significant decrease of flowering individuals compared with data collected in 2006. The counts were more similar to those observed by HDR in 2002, 2003, 2004, 2005 (Black and Gruwell 2005) and 2007 (BIO-WEST 2007). Counts were compared with peak discharge measurements from 2002 to 2008, and there appears to be a relationship between years where peak flow is high, possibly resulting in an increase of flowering ULT. This is an interesting correlation, which further indicates that peak flows within Diamond Fork Creek may impact ULT counts. Abundance estimates were also lower for nearly all occupied surfaces surveyed. The low counts may be a result of lower peak flows, drier-than-normal climatic conditions, grazing impacts, or a combination of these and other variables. During the 2007 field season, observations of multiple peaks of flowering individuals further indicate that ULT counts conducted once annually may be inadequate for the assessment of the ULT population status along Sixth Water and Diamond Fork Creeks. Because of these observations, two assessments were implemented for surfaces where actual counts are recorded during 2008. Data collected in 2008 also supported the theory that there are dual or multiple blooming peaks for ULT along Sixth Water and Diamond Fork Creeks. Observed actual counts, as well as abundance estimates, may be as much a function of annual variability as they are variability of flowering within the bloom period that occurs from late July through early September.

Due to historically high variability of ULT counts, possible effects of the Diamond Fork System on ULT population numbers remains unknown. Overall, counts of ULT individuals have remained low since 2003, with the exception of observations during the 2006 survey period where numbers reflected higher counts prior to the implementation of the Diamond Fork System. Some surfaces have begun to exhibit characteristics indicative of drying within the last 3–4 years of monitoring, possibly a result of decreased flows. These surfaces include: 16A, 17A, 17B, 18, 18A, 20, 19, 19A, 20D, 21, and 24. Typical characteristics on these surfaces include dry, bare soil, prematurely senescent wetland plant species, and establishment of upland plant species, which indicate a transition from wetland to an upland vegetation communities.

Integrating management recommendations and actions may be a viable addition to future Diamond Fork ULT population monitoring efforts. Possible contributions to establishing management priorities may include adjusted peak flow rates and frequency to favor periodic inundation of more area within the riparian corridor; identification, mapping, and treatment of noxious and invasive species altering ULT habitat; and exclusion of grazing livestock during ULT growing season.

In addition to possible adjustment of management practices to facilitate continued ULT occupation, annual monitoring still provides valuable data for general status of ULT populations and overall condition of occupied and potentially occupied surfaces along Diamond Fork Creek. However, additional monitoring is necessary to ensure that newly applied management practices contribute to continued ULT population health and the maintenance of existing habitat. During the 2009 monitoring session it is recommended that, in addition to continued ULT counts and abundance estimates, habitat analysis for occupied, potentially occupied, and non-occupied surfaces be resumed to determine possible changes occurring within these habitat types. Because there are many potential threats to ULT and ULT habitat (i.e., grazing pressures and inappropriate recreational use), the fragile nature of the species warrants a presence and awareness of land managers for continual assessment of habitat and population health. We therefore recommend that annual monitoring of ULT continue.

4.0 LITERATURE CITED

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APPENDIX 2.1 UTE LADIES'-TRESSES MONITORING SITE CHARACTERISTICS

Proposed ULT Total Count Sites

Colony #	R-sq	Max	Median	Min
Upper				
2A	0.62	63	3	0
2B	0.56	432	37	0
Midddle				
10A	0.69	523	61	0
13	0.56	83	27	0
14	0.36	958	104	18
17A	0.70	53	30	0
Lower				
20	0.73	1888	253	17
24B	0.58	1409	250	8
30	0.37	474	49	0
36	0.36	382	43	2
Total # Colonies	0.61	89	76	54

2A, 14	Similar trend pattern as total # flowering plants
10A, 30, 36	Same trend pattern as total # flowering plants

Sites with Correlation >50% = 10
Of these, 3 had a median <1
Substituted for these sites the three sites with the greatest correlation that had the same or similar trend pattern as the total count.

APPENDIX 2.2 UTE LADIES'-TRESSES SURFACE NUMBERS MAPS

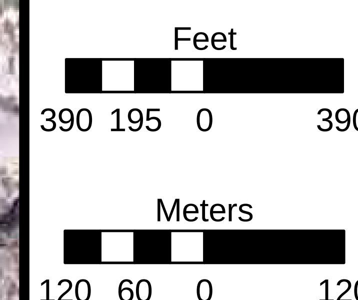
SIXTH WATER & DIAMOND FORK 2008 ULT SURFACES

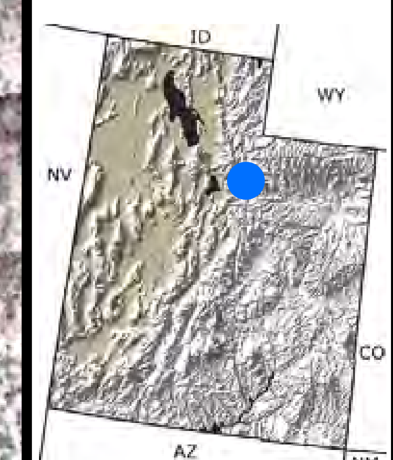
BIO-WEST
1063 West 1400 North
Logan, UT 84321
(435) 752-4202

November 10, 2008

N

1:6,500





SIXTH WATER & DIAMOND FORK 2008 ULT SURFACES

BIO-WEST
1063 West 1400 North
Logan, UT 84321
(435) 752-4202

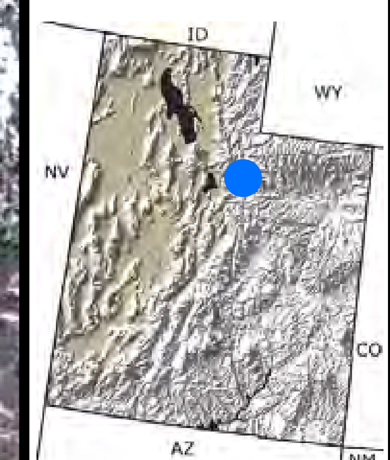
November 10, 2008

N

1:6,500

Feet
390 195 0 390

Meters
120 60 0 120



SIXTH WATER & DIAMOND FORK 2008 ULT SURFACES

SIXTH WATER & DIAMOND FORK 2008 ULT SURFACES

SIXTH WATER & DIAMOND FORK 2008 ULT SURFACES

BIO-WEST
1063 West 1400 North
Logan, UT 84321
(435) 752-4202

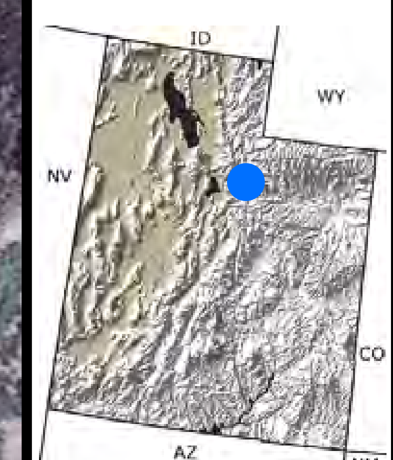
November 10, 2008

N

1:6,500

Feet
390 195 0 390

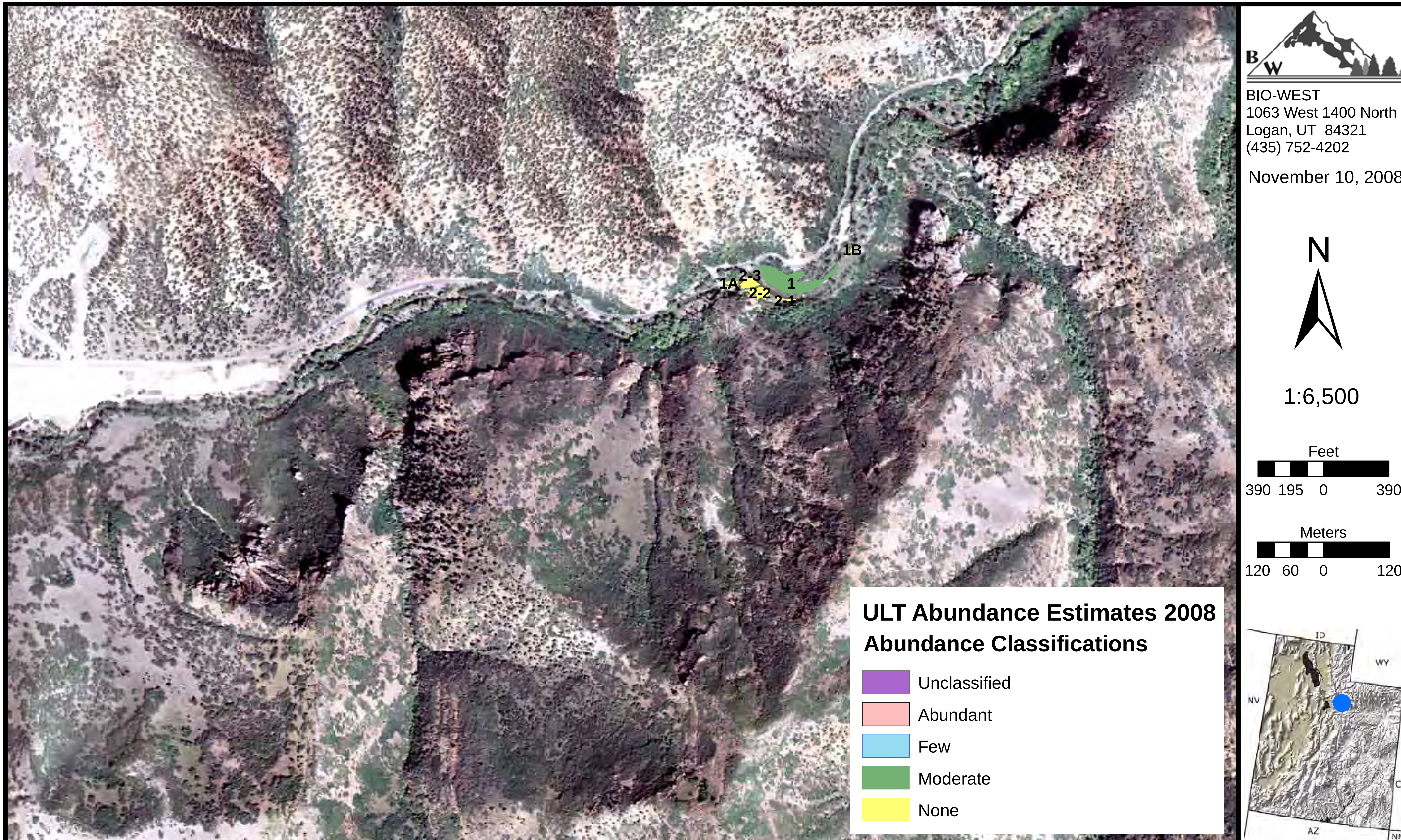
Meters
120 60 0 120



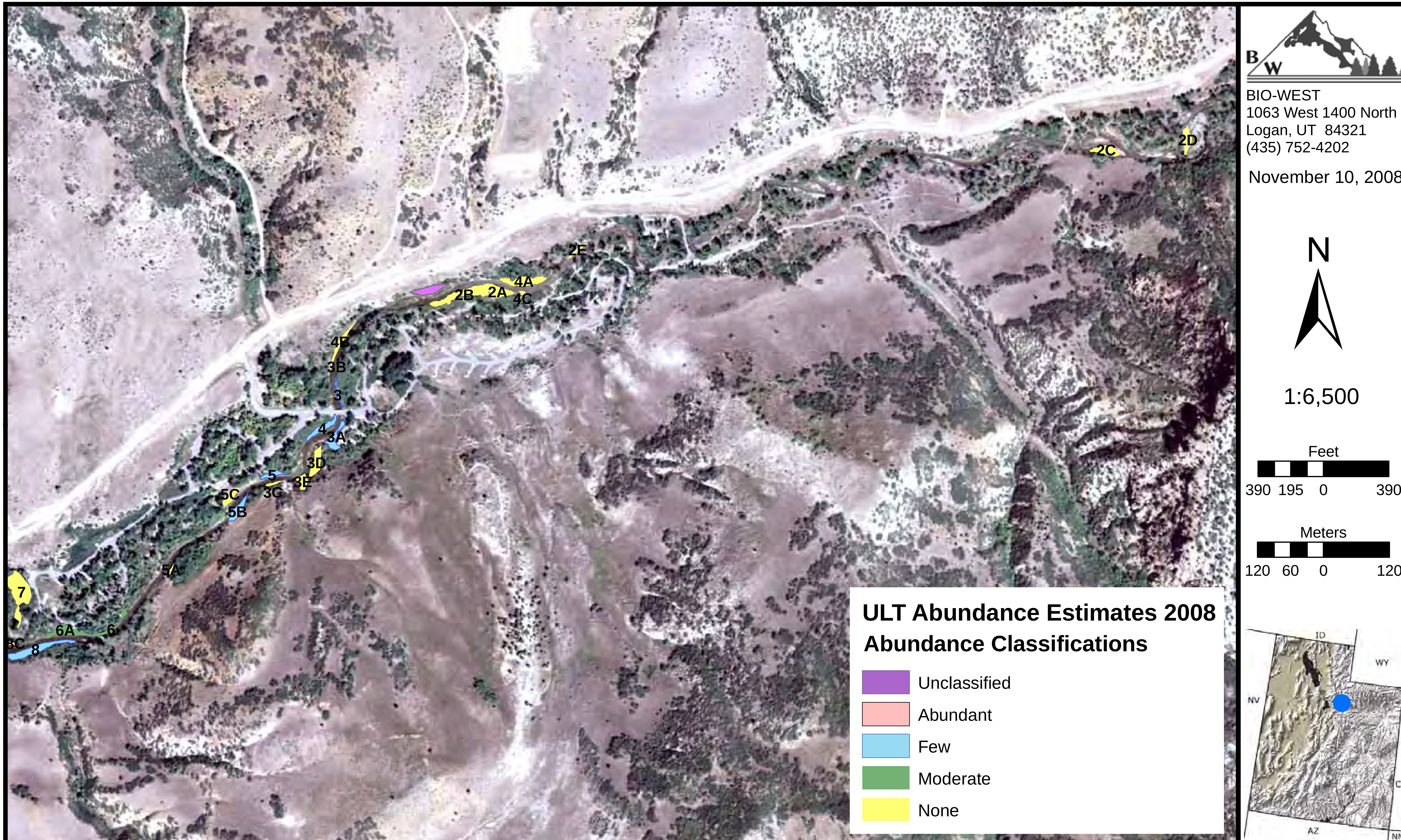
SIXTH WATER & DIAMOND FORK 2008 ULT SURFACES

APPENDIX 2.3 UTE LADIES'-TRESSES ABUNDANCE ESTIMATES

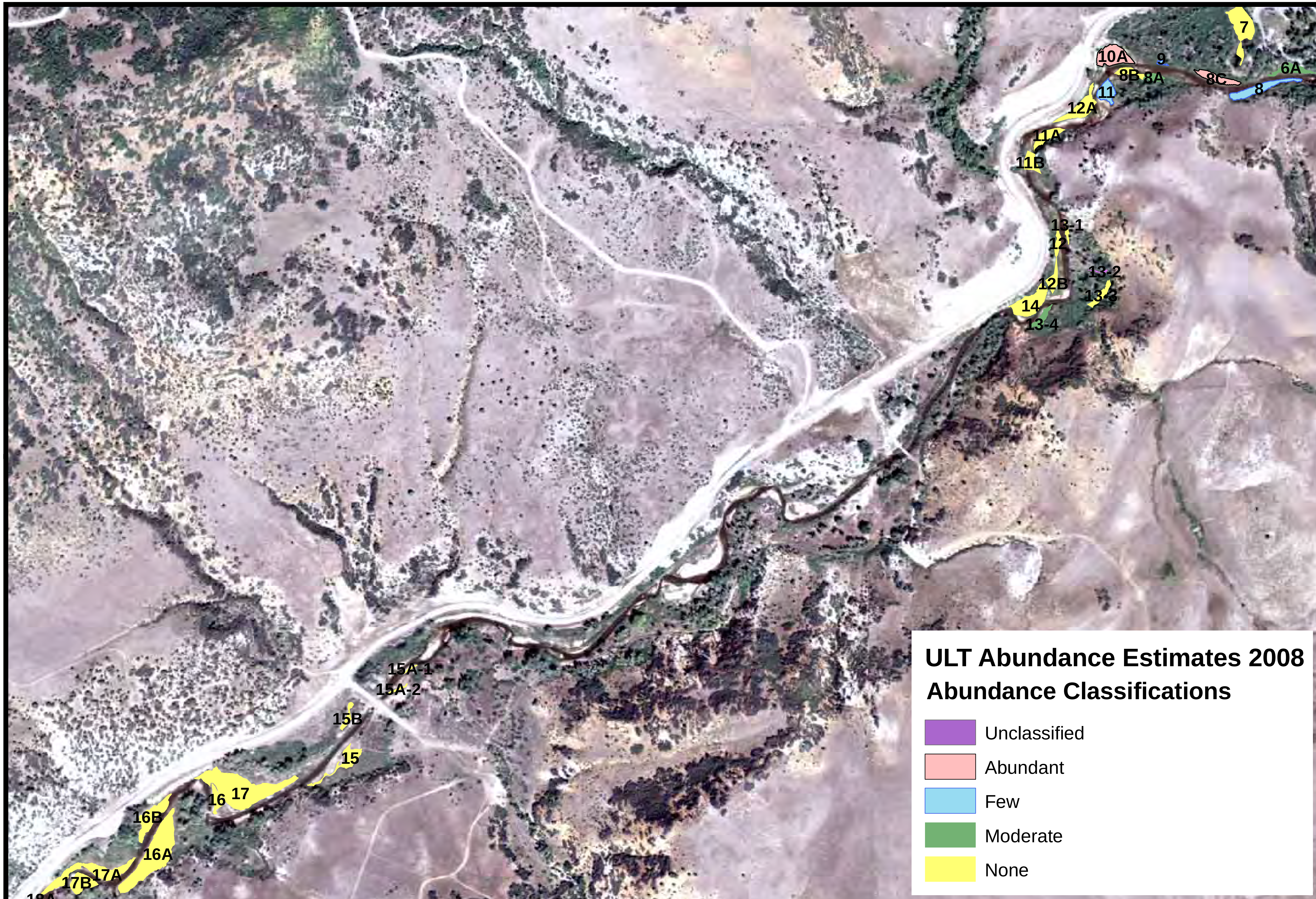
SIXTH WATER & DIAMOND FORK 2008 ULT ABUNDANCE ESTIMATE MAP



SIXTH WATER & DIAMOND FORK 2008 ULT ABUNDANCE ESTIMATE MAP

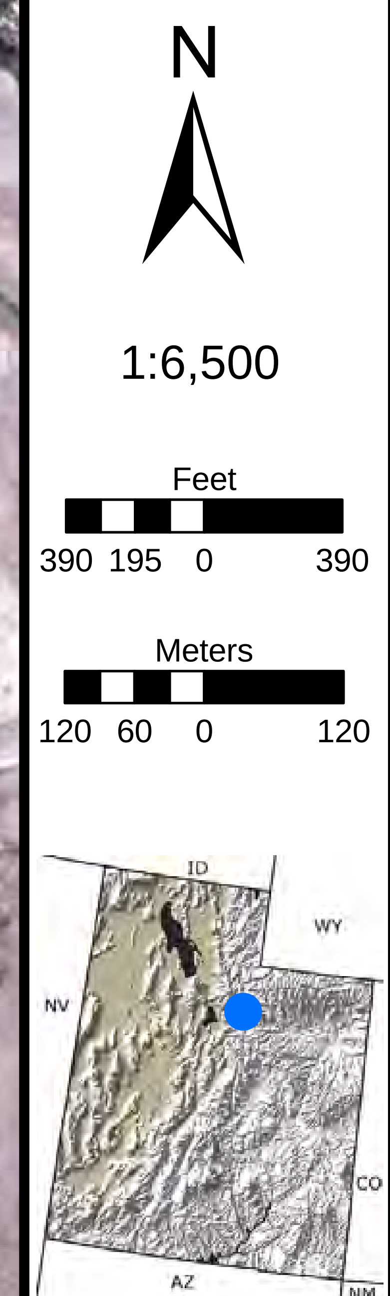


SIXTH WATER & DIAMOND FORK 2008 ULT ABUNDANCE ESTIMATE MAP

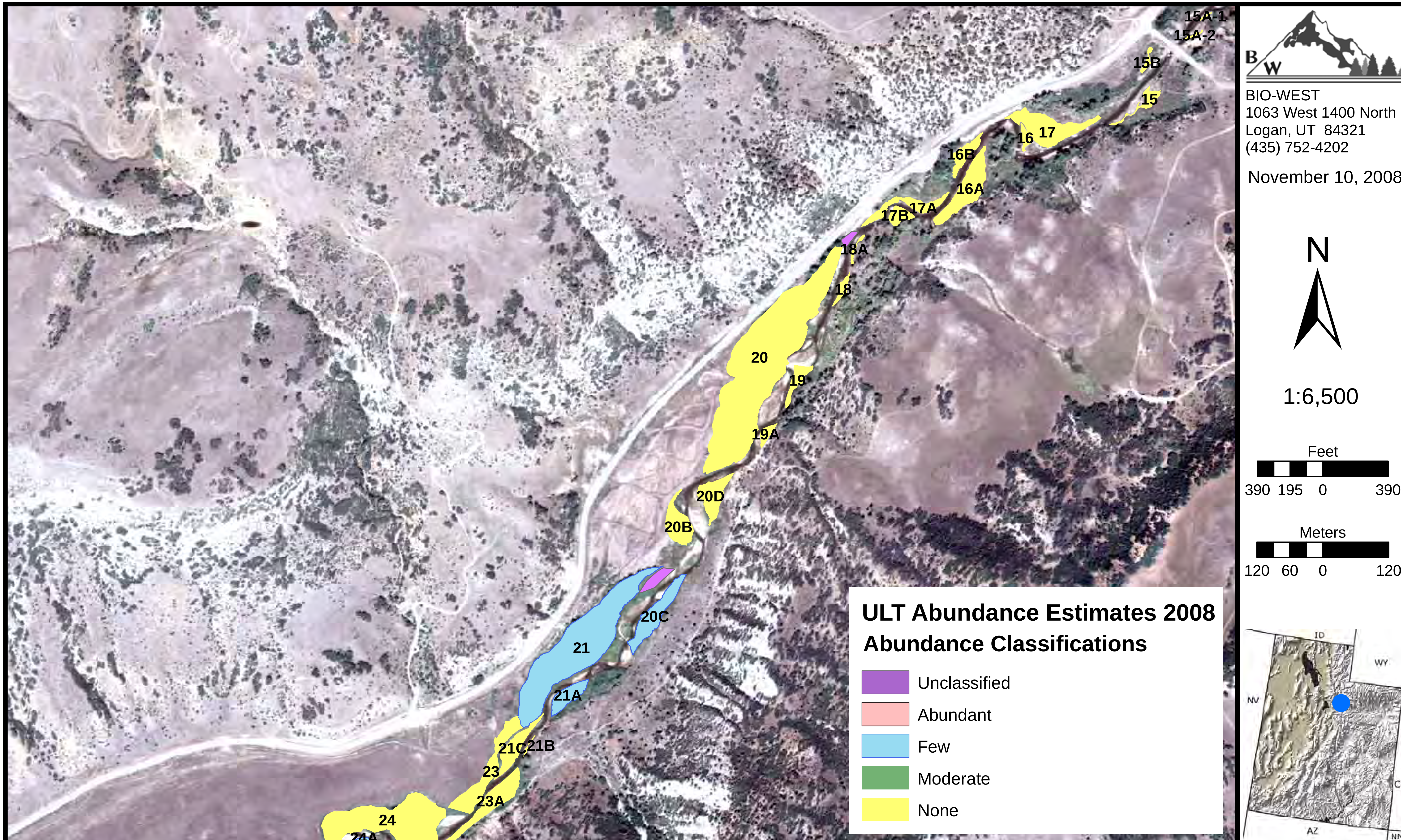


BIO-WEST
1063 West 1400 North
Logan, UT 84321
(435) 752-4202

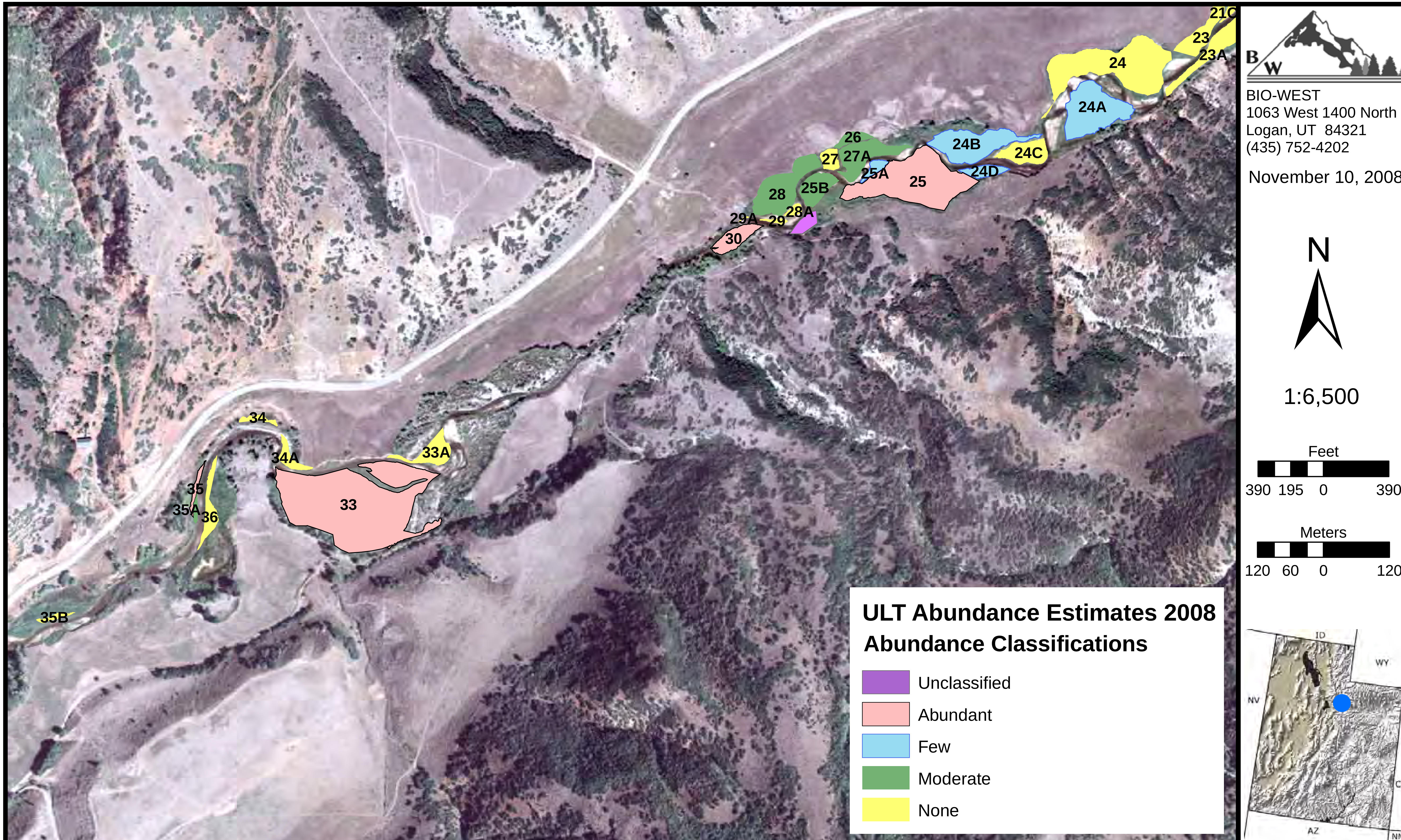
November 10, 2008



SIXTH WATER & DIAMOND FORK 2008 ULT ABUNDANCE ESTIMATE MAP



SIXTH WATER & DIAMOND FORK 2008 ULT ABUNDANCE ESTIMATE MAP



SIXTH WATER & DIAMOND FORK 2008 ULT ABUNDANCE ESTIMATE MAP