Planning Phase Final Report: Deep Creek Watershed Pygmy Rabbit (*Brachylagus idahoensis)* Project

Conservation Partnership Initiative

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Reporting Period:
May 2005 through December 2006

Pygmy rabbit photographed February 10, 2006 south of Ibapah within boundaries of Deep Creek Watershed

This report is a summary of research activities conducted between receipt of the contract (May 2005) at Brigham Young University (BYU) and the agreed upon extension date of December 31, 2006 as part of the Conservation Partnership Initiative for the Deep Creek Watershed. BYU was designated the responsible party (for pygmy rabbits) charged with completion of a final report that includes the following deliverables outlined by the NRCS: 1) GPS locations of extant populations, 2) population estimates, 3) multi-dimensional habitat analysis, 4) soil profile sampling, 5) GIS theme map of relevant data, 6) map showing occupied and potential habitat, and 7) results of any additional parameters measured. Research activities and information are outlined below under subheadings that generally track agreed-upon objectives. In addition, we have included each of the quarterly reports in full at the end of the report in an appendix.

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PROJECT PARTNERS & PROPONENTS:

Natural Resource Conservation Service (NRCS), Bureau of Land Management (BLM), and Utah Division of Wildlife Resources (UDWR)

PROJECT LOCATION:

Deep Creek Watershed located on the Utah-Nevada border. We have also incorporated data collected by the same research team as part of a statewide effort funded by the Utah Division of Wildlife Resources from various areas of southern Utah for comparative purposes. Comparison is made to a

population of pygmy rabbits in Grass Valley, Utah generally considered by managers to be one of the more robust populations in the state.

ACKNOWLEDGEMENTS:

This project was a collaborative effort made possible only through the assistance of the Great Salt Lake Resource and Development Council and Natural Resource Conservation Service. In particular we recognize the help and support of Jeff William, Alison Rogers and Jeremy Maestas. The Utah Division of Wildlife Resources contributed additional funding and provided legislative oversight throughout. We thank Kevin Bunnell, Tom Becker, Kim Asmus, and Anis Aoude for their respective roles in greatly facilitating completion of the planning phase. We appreciate the support of Goshute tribal leaders who allowed access to tribal lands.

BACKGROUND INFORMATION:

Throughout the Intermountain West the pygmy rabbit (*Brachylagus idahoensis*) has seen severe population declines and limited knowledge is available to properly conserve this specialized lagomorph (Flinders 1999; Janson 2002). Unique in several respects, the pygmy rabbit is the smallest leporid in North America and an obligate sagebrush-steppe resident that inhabits self-made burrows (Green & Flinders 1980a, 1980b). Sagebrush comprises up to 99% of a pygmy rabbit's winter diet and 51% of their summer diet (Gahr 1993; Green & Flinders 1980a, 1980b). Pygmy rabbits are only found in association with sagebrush habitats and are considered sagebrush obligates that generally prefer taller and denser sagebrush associated with older stands.

Due to the recent decline of pygmy rabbits and the severe diminution and degradation of their habitat, a petition was filed in 2003 to the United States Fish and Wildlife Service (USFWS) by Western Watersheds (2003). This petition calls for the listing of the pygmy rabbit as Threatened or Endangered under the Endangered Species Act of 1973. In May of 2005 the USFWS made a 90 day finding to

preclude a more formal 12 month review. Nonetheless, continued efforts are underway by several organizations to list pygmy rabbits as Threatened or Endangered and threats to this leporid have not diminished. Several states including California, Idaho, Wyoming, Montana, Nevada, and Utah have already taken steps towards preservation by listing the pygmy rabbit as a state species of special concern.

Pursuant to these concerns, the NRCS as part of a broader conservation partnership initiative (CPI) funded study within the Deep Creek Watershed to identify extant populations of pygmy rabbits, determine their abundance, and describe habitat features found in association with pygmy rabbit occurrence. This inclusive report summarizes efforts to meet stated objectives. This study was established to be a multi-year project and conclusions drawn from the results must consider the short duration of work within the boundaries of the watershed. These data should be considered important, but only preliminary.

INITIAL FAMILIARIZATION WITH STUDY SITE:

A critical amount of initial investigation was completed during the summer of 2005 wherein we became familiar with the watershed, created a map of land ownership, and made important contacts. We have identified, with the help of Steve Forsee (Nevada Division of Wildlife), perhaps the closest known extant population of pygmy rabbits to the study site; this population is located in Nevada approximately 84 kilometers (52 miles) to the northwest and has been surveyed within the last five years prior to treatments designed to improve livestock grazing conditions. Only limited knowledge is available concerning adjacent areas known to harbor pygmy rabbits in Utah, but it is presumed that the nearest occupied sites on the Utah side are much farther than 80 kilometers (50 miles) leaving this

population very isolated given limited movements and dispersal distances always reported to be less than 5 kilometers (Gahr 1993; Green & Flinders 1979; Katzner & Parker 1998; Wilde 1978).

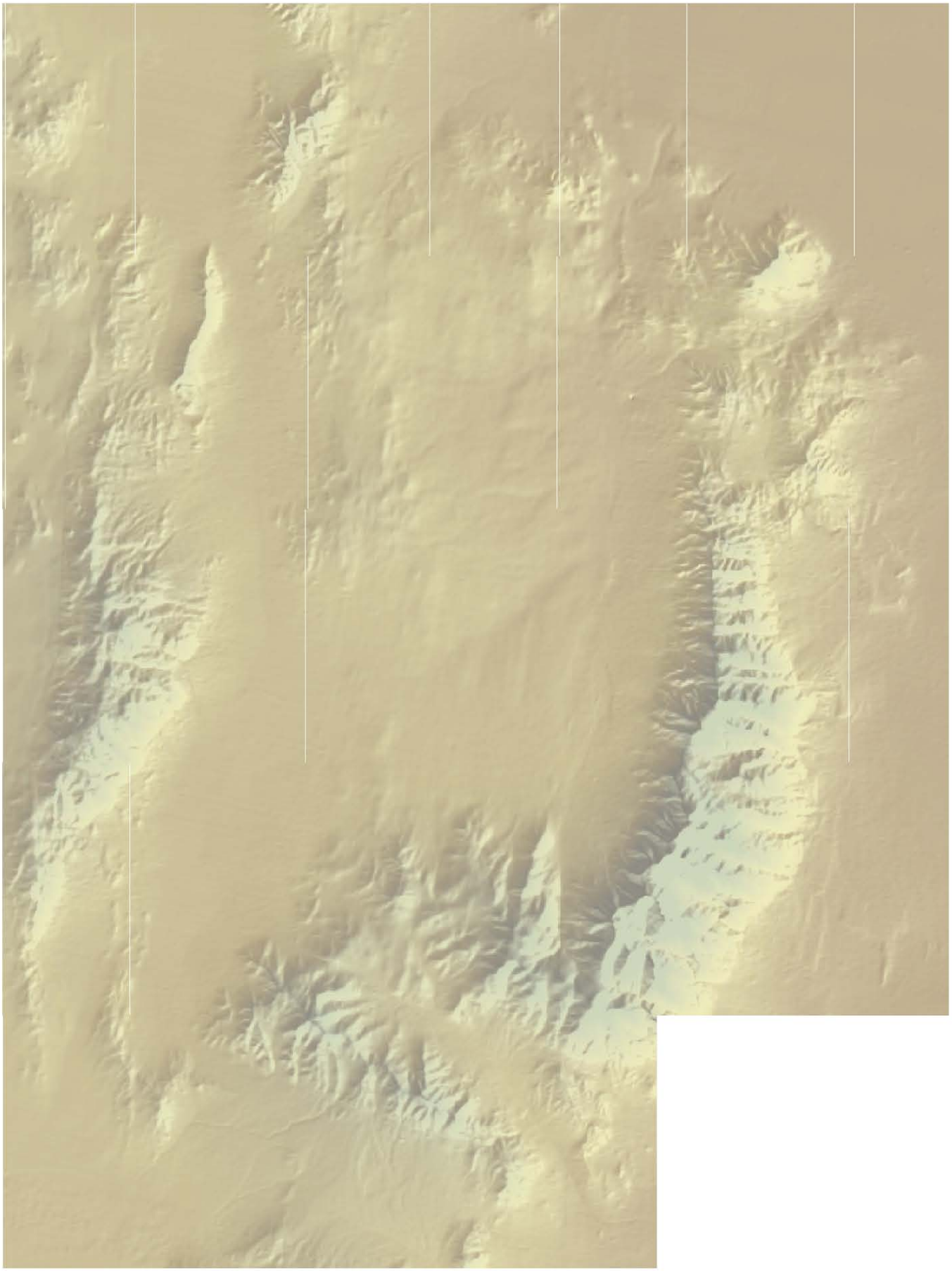
Part of this initial investigation included visits to each of four historical locations where pygmy rabbits were collected over fifty years ago (Oliver 2004). The historic locations and closest known extant population (Table 1) are shown below (Figures 1-10) and on the included map (Map 1). These locations come from the database of Utah's Natural Heritage Program and from personal conversation

Table 1. Descriptive information for historic locations and the closest known active population

ID	Map ID	Date	County	Land Ownership	UTM_X	UTM_Y	Zone
19976	C	4/29/1905	Juab		249535	4396868	12
19984	D	before 2002	Juab	BLM	249115	4384657	12
9860	B	8/11/1951	Tooele	private	249616	4434729	12
9859	A	8/11/1951	Tooele	private	245313	4435835	12
Closest Active Population--Nevada	E	6/1/2005	Elko	BLM	684114	4478328	11

Utah locations come from the Utah Natural Heritage Database; The Nevada location is courtesy of Steve Forsee (Nevada Department of Wildlife)

with Steve Forsee of the Nevada Department of Wildlife. No evidence of present occupation by pygmy rabbits was noted. The four sites are representative of various threats faced by pygmy rabbits throughout their range to include conversion of sagebrush to farmland or development, increases in the frequency of fire cycles due to cheatgrass invasion, transition from sagebrush to greasewood (*Sarcobatus vermiculatus*) due to overgrazing and other factors, and suppression of fire and subsequent encroachment by pinyon (*Pinus edulis*)-juniper (*Juniperus* sp.) communities.



Historic Location A: Near the present location of the school house (Figures 1 and 2)

Fig 1. Photo of historic location A where pygmy rabbits were collected over 50 years ago. Presently, very little sagebrush exists due to conversion to pasture land (background) and greasewood (foreground).

Fig 2. Historic location A from a different angle showing the school. Interestingly, old remnants of caved in burrows are still present at this site.

Historic Location B: East of Ibapah on upper bench (Figures 3 and 4).

Fig 3. Historic location B. Fire suppression has allowed pinyon-juniper to invade traditional sagebrush communities at this site.

Fig 4. Second view of historic location B. No evidence of pygmy rabbits noted despite a thorough search.

Historic Location C: East of watershed on southeastern flanks of Deep Creek Mountains (Figures 5 and 6.

Fig 5. Historic location C (looking to north west) showing the effects of increased fire cycles and invasion by cheatgrass (*Bromus tectorum*).

Fig 6. Historic location C (looking south and east). Sagebrush has been eliminated from the local area and we were unable to document any evidence of current pygmy rabbit activity.

Historic Location D: East of watershed on southeastern flanks of Deep Creek Mountains (Figures 7 and 8).

Fig. 7. Historic location D showing similar habitat type conversion as location C due to altered fire frequencies and cheatgrass invasion.

Fig. 8. Historic location D has undergone a tremendous amount of change in ~50 years.

Nevada Location E: Northwest of watershed and south of Spruce Mountain, Nevada (Figures 9 and 10).

Fig. 9. Valley bottom where pygmy rabbits are found in untreated areas (foreground) as opposed to treated areas (background). This location represents the closest known extant population viz. pygmy rabbits within the watershed.

Fig. 10. This photo shows and active burrow from this Nevada location.

LOCATIONS OF EXTANT POPULATIONS:

To guide search efforts, our approach involved completion of a predictive map depicting suitable pygmy rabbit habitat within the watershed. The pygmy rabbit is a sagebrush obligate species that digs its own burrows and thus requires soils suitable for digging and sagebrush as essential habitat components. The predictive map (Map 2) is based on two primary layers depicting vegetation and soils data. Vegetation data were obtained from the 2004 Southwestern Regional Gap Analysis Project—a recently completed remote sensing of several southwestern states that categorizes vegetation type into one of more than 120 detailed categories (Lowry et al. 2005). Spatial data of soil type and characteristics was obtained from the Natural Resource Conservation Service (NRCS). In addition, we added a third layer to analysis accounting for slope because it has been suggested that pygmy rabbits do not use areas with a slope over 15% (Simons & Laundre' 2004), and that topography influences soil features (Gabler et al. 2000).

With the addition of slope and to more accurately describe predicted pygmy rabbit habitat within the watershed, we generated a predictive map in raster format rather than using a vector based approach. Doing so, involved the merging and conversion of the soils data set (vector) to a raster grid. This conversion was accomplished by assignment of a value from one to three based on suitability of soil to each 30 square meter pixel with one being unlikely to be suitable, two as somewhat suitable, and three as likely to be suitable. Overlay of these three layers (vegetation, soils, and slope) involved the reclassification of the 2004 Southwestern Gap Analysis into categories depicting sagebrush communities and those that do not. Sagebrush communities were assigned a value of one and non-sagebrush communities a value of zero. The slope data set, generated from a digital elevation model (DEM) obtained from the United States Geological Survey (USGS) was treated the same way with

reclassification based on a value of 15 percent—everything below this threshold received a one, whereas everything above a zero.

Overlay of the three layers was performed with ArcMap®'s raster calculator using a multiplication function so that pixels depicting non-sagebrush communities or slopes over 15 percent are multiplied by a zero rand thus receive a final value of zero after combination. Pixels categorized as a sagebrush community with slopes less than 15 percent receive a value from one to three depending on the suitability of described soils.

Faculty and resources from the Geography Department at Brigham Young University (BYU) were very helpful with this analysis. The overlay of these three layers has both excluded large areas of the watershed as now unsuitable to pygmy rabbits and highlighted areas where these leporids could occur. This map was used as a primary tool to guide search efforts and enabled efficient and wise use of resources.

Sampling on the ground in areas highlighted by the overlay of vegetation type and soil characteristics (as well as some assessment in areas deemed by the predictive map as unsuitable) was the focus in the search effort. Sampling involved both a point-based approach where random points within each categorization were visited and the immediate area searched for pygmy rabbits and a vector-based line transect approach. These transects involved carefully walking through areas of seemingly suitable habitat looking for burrows and fecal pellets—key indicators of pygmy rabbit occurrence. Transects were recorded on global positioning system (GPS) units as tracks, removed weekly, and stored electronically for import into mapping software. GPS locations of likely burrows were recorded and burrows discovered were classified into the categories outlined by Rachlow & Witham (2004) and then separately reclassified according to Ulmschneider et al. (2004).

Burrow densities in several areas of predicted suitable habitat within the watershed are very high. Several species of animals including pygmy rabbits appear to use these burrows and there is preliminary evidence that classification of these burrows using either Rachlow and Witham's (2004) or Ulmschneider et al.'s (2004) criteria is somewhat inaccurate in predicting the current utilization of burrows by pygmy rabbits. Consequently, we employed remote cameras placed at burrow sites as a primary detection tool (Eveline Sequin, University of Nevada Reno personal communication) to document with photographic evidence the occurrence of pygmy rabbits within the watershed. Remote cameras were also used to verify the presence or absence of pygmy rabbits in comparison to burrow classification. Dual classification of burrows coupled with evaluative data from remote cameras should allow for refinement of census techniques and burrow classification schemes.

Remote cameras were placed within 2 meters of burrows and set to take a picture upon detection of both heat and movement with a lapse time of 30 seconds. Cameras were set to operate continuously throughout the day and night and generally (a few exceptions) rotated to newly discovered burrows every two weeks. We evaluated images from these cameras for evidence of pygmy rabbits based on morphological and pelage cues. We surveyed burrows for more than 15,000 total camera hours within the watershed during the period of study. Use of remote cameras greatly multiplied our ability to sample the watershed and allowed for positive documentation via photographic evidence of pygmy rabbits.

Pygmy rabbits were first documented in late fall of 2005 when a single individual was photographed southwest of Ibapah (Figures 11-13). This individual was likely a disperser as only one burrow complex with three entrances was noted and the rabbit appeared to have vacated the area by early 2006. Subsequent discoveries of pygmy rabbits in two additional areas occurred during 2006. These areas show much more vigorous activity with hundreds of burrows and are described in detail below. In

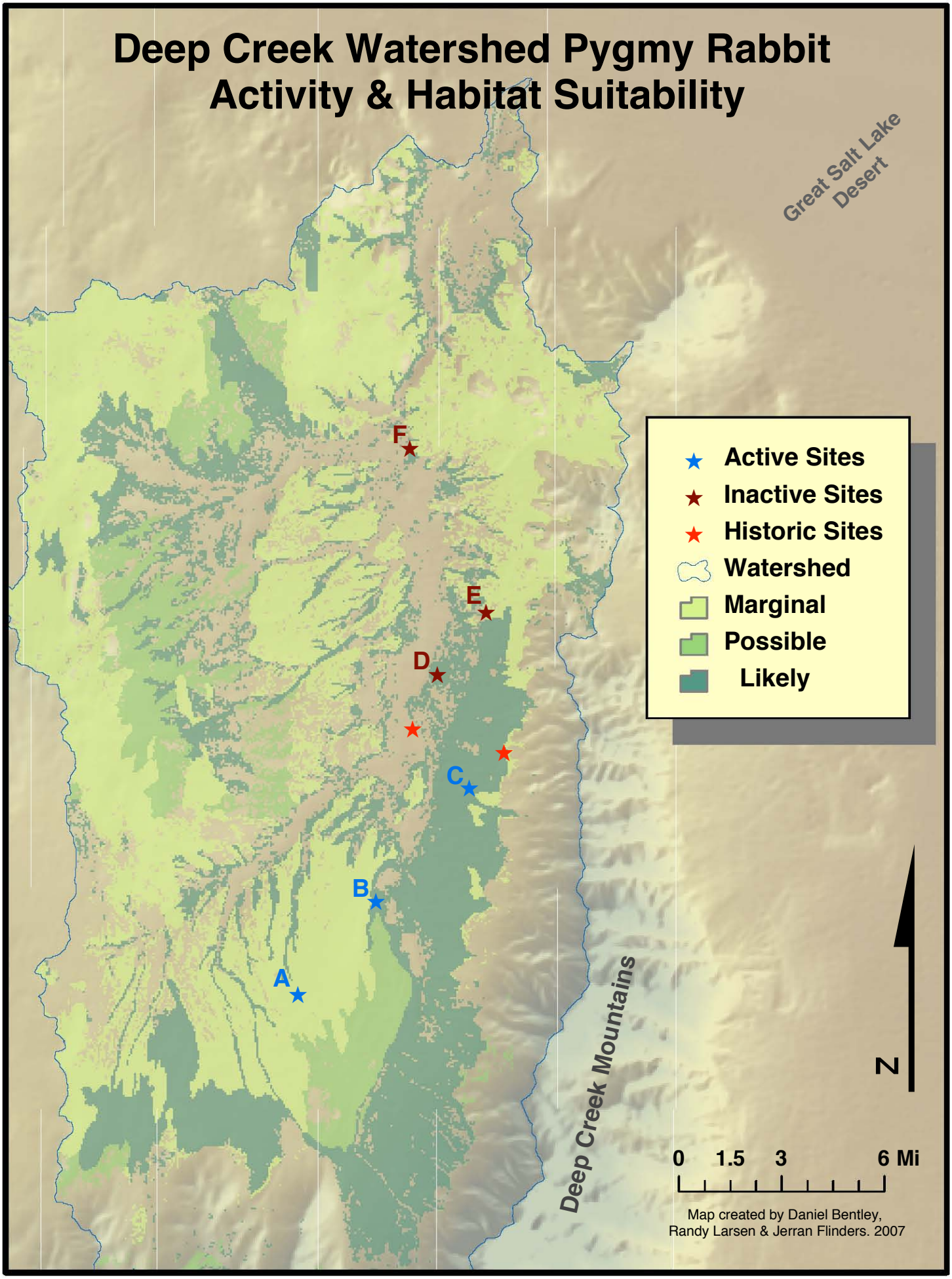
addition to active areas where pygmy rabbits were photographed, we discovered three areas with extensive and relatively recent burrowing activity. Despite hundreds of hours of remote camera observation, pygmy rabbits were not photographed in any of these areas and given a lack of fresh fecal pellets we believe all three were inactive during the study period. Nonetheless, given their obvious recent activity and the potential to become occupied again, we believe all three inactive sites are important to preservation of pygmy rabbits within the watershed.

General information for these locations is included below (Table 2) and shown on the associated map (Map 2) with universal transverse mercator (UTM) coordinates presented in North American datum 83 (NAD83). Reported UTM coordinates are general locations intended to be near the center of areas with evidence of current or recent pygmy rabbit activity. Detailed information for each site follows the map.

Table 2. Descriptive information of pygmy rabbit locations

Map ID	Easting	Northing	Active	Zone	Comments
A	752632	4423303	Yes	11	First area rabbits discovered
B	756004	4427921	Yes	11	East of Cemetery Road
C	247920	4433255	Yes	12	Greasewood Springs
D	246418	4438594	No	12	Thin strip of sage amongst invading greasewood
E	248712	4441508	No	12	South of pony express road
F	245117	4449228	No	12	North of Ibapah in valley along creek

UTM coordinates for areas showing evidence of pygmy rabbit occurrence. Coordinates are reported from Zone 11 and Zone 12 using NAD83 format. Coordinates are generally near the center of areas showing current or recent activity.


Deep Creek Watershed Pygmy Rabbit
Activity & Habitat Suitability
Great Salt Lake
Desert
F
E
D
C
B
A
Active Sites
Inactive Sites
Historic Sites
Watershed
Marginal
Possible
Likely
Deep Creek Mountains
N
0 1.5 3 6 Mi
Map created by Daniel Bentley,
Randy Larsen & Jerran Flinders. 2007

Location A: Near tribal boundary; active during reporting period (Figures 11-13).

Fig 11. One entrance to a single burrow system at location A. Burrow entrances were back filled by January 2006 and given limited activity (only one burrow complex) we believe the rabbit photographed here was dispersing

Fig. 12. Photograph of pygmy rabbit from location A taken on October 29, 2005

Fig 13. Likely the same pygmy rabbit photographed at another entrance of the same burrow complex on October 29, 2005. Given limited activity at this site, we believe the photo depicts a dispersing rabbit.

Location B: Area sandwiched between highway and lower cemetery road. This area consists of very tall and dense big sagebrush. Site was active during reporting period with multiple burrows and multiple photographs documenting rabbits (Figures 14-16).

Fig. 14. Photo of location B showing tall and dense big sagebrush.

Fig 15. Pygmy rabbit photographed from location B. This area is comprised of tall and dense sagebrush that is difficult to walk through.

Fig 16. Image of a pygmy rabbit from the same general area identified by pelage (relatively dark coat and lacking of a white, cotton tail) and morphological cues (relatively small ears, small body size, etc.).

Location C: With the use of the GIS predictive map, walk transects, and remote cameras we were able to document pygmy rabbit presence in this area to the east of the highway surrounding what is labeled on maps as "greasewood spring". The site seems oriented around a degraded spring with pygmy rabbits occupying the remaining sagebrush areas surrounding the immediately impacted spring. The spring flows several hundred meters and pygmy rabbits appear to occupy the fringe surrounding the spring and it's effluence in a somewhat "pear-shaped donut" with no evidence of activity in the severely impacted zone where dominants include greasewood (*Sarcobatus vermiculatus*), stinging nettle (*Urtica dioica*), and other invasive species (Figures 17-20).

Fig 17. Photo showing severely impacted "pear-shaped donut hole" around Greasewood Springs that lacks pygmy rabbits due to the absence of sagebrush.

Fig 18. Fringe area from location C not completely dominated by greasewood where pygmy rabbits were found.

Fig 19. Photo of location C and the area inhabited by pygmy rabbits. Shrub height and density are greater in this area than other areas of the watershed.

Fig 20. Image of a pygmy rabbit from location C and spring area.

Location D: South of the pony express road, east of main highway. The area consists of small remnant islands of big sagebrush surrounded by greasewood. Burrows are found within and near sagebrush, but no current activity detected. We would not be surprised to see pygmy rabbits come and go from these inactive areas—they may well serve as sinks to the two main centers of activity (Figures 21-23).

Fig. 21. Remnant island of big sagebrush in location D with evidence of recent burrow activity, but no pygmy rabbits photographed

Fig 22. Putative pygmy rabbit burrow in sagebrush island—no rabbits photographed, but burrow configuration and dimensions fit those of pygmy rabbits

Fig. 23. Cottontail (*Sylvilagus* sp.) from location D; no pygmy rabbits were photographed.

Location E: South of the pony express road, east of main highway (Figures 24-26).

Fig 24. Area in location E with multiple burrows, but no sign of pellets denoting current pygmy rabbit activity and no photographic evidence of present occupation.

Fig 25. Location E suffers from greasewood invasion from the West.

Fig. 26. Badger (*Taxidea taxus*) photographed at location E. Despite effort with cameras, no pygmy rabbits were detected.

Location F: North of Ibapah, west of main highway. This area is remnant big sagebrush found along the creek flowing north out of Ibapah Valley (Figures 27-29).

Fig 27. Location F consists of pockets of big sagebrush (above) surrounded by greasewood (below)

Fig. 28. Photograph of greasewood surrounding islands of big sagebrush in location F.

Fig 29. Photograph of a cottontail rabbit from Location F. This area seemed to have recent activity based on burrowing activity, but we were not able to obtain a photograph that provided conclusive evidence of current pygmy rabbit activity.

DENSITY:

Pygmy rabbits are difficult to enumerate due to cryptic behavior and short life spans. One available technique focuses on indirect estimation based on the number of active burrows (Rachlow & Witham 2004). This technique can be time intensive and is fraught with challenges as classifications do not necessarily reflect true levels of activity and we do not have a good understanding of how many burrows are used by an individual rabbit. Consequently, we elected to estimate density via fecal dropping counts (Forys & Humphrey 1997; Murray et al. 2002) and use data from Grass Valley, Utah collected during the same time period to calibrate fecal dropping counts to indirect estimation and provide a density estimate.

Fecal pellet plots were established to monitor deposition, thus leporid presence, over timed periods beginning in early fall of 2006 in core areas showing evidence of pygmy rabbit activity. Each plot consisted of 12 quarter meter square areas oriented from a randomly selected location adjacent to active

burrows. Values were summed for each plot and standardized by day to generate the number of pellets deposited per day. We set up a total of nine plots within core areas harboring pygmy rabbits.

Comparison was made to a site in Grass Valley, Utah where complementary pellet plots were counted and more robust populations of pygmy rabbits are known to exist. Results (Table 2) show significantly lower pygmy rabbit pellet counts and significantly higher jackrabbit (*Lepus californicus*) pellet counts for the Watershed compared to Grass Valley. Mean pygmy rabbit pellets counted per day were more than 4.5 times higher for Grass Valley than counts made within the watershed.

Table 2. Results of fecal pellet counts for the Deep Creek Watershed and Grass Valley, Utah.

	Grass Valley (n =38)	Deep Creek Watershed (n = 9)	Direction	P Value
	Mean (SE)	Mean (SE)		
Pygmy rabbit	7.06 (.65)	1.52 (.48)	lower	<.01
Cottontail	0.90 (.18)	0.75 (.08)	unchanged	0.46
Black-tailed jack rabbit	0.63 (.11)	1.33 (.15)	higher	<.01

Shown here are pellets per day for three species of leporid compared between plots counted within the watershed and those from a relatively high density area of southern Utah.

Indirect estimates of density for Grass Valley based on active burrow extrapolation suggest a density of 0.79 rabbits per hectare. Given pellet counts more than 4.5 times greater for Grass Valley than those from within the Deep Creek Watershed, we estimate density of the core areas within the Deep Creek Watershed to be 0.17 rabbits per hectare. This value is lower than recent published estimates of rabbit density that range from .38 to 2.72 rabbits per hectare (Rachlow & Witham 2004) and considerably lower than other estimates using a variety of techniques that range from 1.8 (Janson 2002) up to 45 rabbits per hectare in ideal habitat (Green & Flinders 1981). Estimates are much more similar to those from eastern Washington provided by Gahr (1993) who calculated 0.27 rabbits per hectare in ungrazed areas and 0.22 rabbits per hectare in grazed areas. This Washington population had experienced an alarming decline and severe reduction in range prior to study. The precipitous decline eventually lead to capture of rabbits and a subsequent captive breeding program that remains active today in an effort to

save the Washington population which has been labeled distinct. A self-sustaining wild population of pygmy rabbits is not known to exist in Washington.

Given these results from investigation to date, we believe pygmy rabbits persist at very low density and in only two core areas indicative of a more precarious position for pygmy rabbits within the watershed relative to more robust populations in central and southern Utah. Low density and severe isolation may create genetic problems such as inbreeding depression similar to that experienced by pygmy rabbits in Eastern Washington. Unfortunately we have no knowledge of population status before investigation. Furthermore we are making assessments based on a very short time interval (< 2 years) and have no way of determining trend without additional funding. Nonetheless, we believe the current distribution and estimated density of pygmy rabbits within the watershed are cause for alarm.

MULTI-DIMENSIONAL HABITAT ANALYSIS:

Random points were chosen in core areas and the following measurements taken originating from each point: slope, GPS location, aspect, distance to habitat edges, vertical obscurity, horizontal obscurity, canopy cover (line transects extending 15 meters in each direction), distance to nearest shrub, shrub density, and composition of understory. Horizontal and vertical obscurity were measured with cover boards according to methodology described by Bunnell et al. (2004). These detailed measurements allow for meaningful comparisons between both occupied and unoccupied habitat within the watershed as well as comparisons of habitat within the study area to habitat in southern Utah where more robust populations of pygmy rabbits occur. Given that rabbits were found to occupy only a few relatively small core areas, sample sizes were limited. Nonetheless, information gained is important and showed similar patterns to southern Utah for differences between occupied and unoccupied habitat.

We anticipate inclusion of data collected within the watershed into a much more detailed and technical analysis involving information collected throughout the southern portion of Utah over the last

three years as part of a joint effort between BYU and the Utah Division of Wildlife Resources. This analysis will be similar to a successfully completed analysis for Sage Grouse (*Centrocercus urophasianus*) habitat in Strawberry Valley, Utah (Bunnell et al. 2004) and will likely comprise the use of logistic regression (Hosmer & Lemeshow 2000) in a multivariate framework to differentiate between occupied and unoccupied based on our habitat measurements. Analysis will also likely involve a validation step wherein assessment of model accuracy is made on withheld observations not used in model selection to provide a better measure of model precision. This analysis should be complete within six months to one year and will be made available to interested parties.

Occupied sites within the watershed were found to have taller shrubs, a greater composition of sagebrush, higher shrub density, and shrubs exhibiting lower levels of decadence (Table 3) than unoccupied areas. Other observations of note included determination that shrub height and density in occupied areas was similar to that found at Grass Valley where populations are more robust.

Table 3. Descriptive statistics for habitat measurements taken at burrow sires and compared with habitat characteristics found in randomly selected unoccupied sagebrush habitat.

	Shrub Composition	**Average Shrub Height**	**Average Shrub Decadence**	**Average Shrub Density**
Deep Creek Watershed Burrow Locations (3 m radius)	ARTR N = 19 (56%) SAVE N = 13 (38%) CHVI N = 2 (6%)	64.13 cm N = 67	26.29% N = 67	1.12 m²
Deep Creek Watershed Random Sites (unoccupied)	ARTR N = 28(42%) SAVE N = 32 (48%) GUSA N = 2 (3%) ATCO N = 5 (7%)	48.04 cm N = 140	40.26 % N = 140	.98 m^2
Grass Valley Burrow Locations (3 m radius)	ARTR N = 205 (76%) CHNA N = 28 (10%) CHVI N = 37 (14%)	69.75 cm N = 288	55.74% N = 288	1.48 m^2

ARNO = *Artemesia nova*; ARTR = *Artemesia tridentata*; ATCO = *Atriplex confertifolia*; CHNA = *Chrysothamnus nauseosus*; CHVI = *Chrysothamnus viscidiflorous*; GUSA = *Gutierrezia sarothrae*; SAVE = *Sarcobatus vermiculatus*

Horizontal obscurity values (a measure of thickness and cover) were higher for occupied sites compared to unoccupied habitat for all readings. Values diverged and the distance between values for occupied versus unoccupied habitat increased from low to high readings indicative of a more developed shrub structure at occupied sites compared to unoccupied sites (Table 4).

Table 4. Average percent horizontal obscurity values from burrow sites (occupied habitat) compared to random sites in unoccupied habitat.

Height	Occupied Habitat	Unoccupied Habitat	Difference
0 to 33 cm	85%	72%	13%
34 to 66 cm	75%	41%	34%
67 to 100 cm	67%	23%	44%

Preference for tall and high density big sagebrush (*Artemisia tridentate*) has been noted by other researchers (Dobler & Dixon 1990; Gabler 1997; Gahr 1993; Green & Flinders 1980a, 1980b; Heady & Laundre' 2005; Katzner et al. 1997), as well as a negative correlation between greasewood and rabbit density (Conde 1982). Greasewood (*Sarcobatus vermiculatus*) within the watershed appears to have invaded historic sagebrush communities and now occupies and dominates much of the low elevation areas where historic rabbit populations were found (Figure 30). Relictual islands of big sagebrush speak to a former more wide-spread occurrence of sagebrush in these low areas. Greasewood invasion threatens most of the areas identified as having rabbits or recent rabbit activity (see Map 2). We found greasewood comprising 26% of canopy cover (line-intercept method) compared to only 16% for sagebrush in occupied habitat.

Fig. 30. An area east of the highway that was once formerly sagebrush and is now dominated by greasewood.

Degradation and diminution of pygmy rabbit habitat within the watershed has occurred over the last fifty years likely contributing to the current low density and distribution. Nonetheless, several areas of the watershed—in particular large portions of the bench areas to the east of the highway—remain intact and seem suitable for pygmy rabbits despite no evidence of present occupation. Other factors such as inbreeding depression may also help explain current low abundance levels.

SOIL PROFILE:

We queried the soils layer (available from the NRCS soils database) to return soil types in areas where pygmy rabbits were photographed or recent burrow activity noted. The results returned five soil types presented below. Although soil characteristics are important, pygmy rabbits are sagebrush obligates and loss, fragmentation, and/or degradation of sagebrush habitat is the most immediate threat to habitat within the watershed.

Map unit: 43 - Medburn fine sandy loam, saline, 2 to 4 percent slopes
Component: Medburn
Text kind/Category: Nontechnical description/GENSOIL

The Medburn component makes up 85 percent of the map unit. Slopes are 2 to 4 percent. This component is on fan remnants, lake terraces. The parent material consists of alluvium and/or lacustrine deposits derived from sedimentary rock. Depth to a root restrictive layer is greater than 60 inches. The natural drainage class is well drained. Water movement in the most restrictive layer is high. Available water to a depth of 60 inches is low. Shrink-swell potential is low. This soil is not flooded. It is not ponded. There is no zone of water saturation within a depth of 72 inches. Organic matter content in the surface horizon is about 2 percent. This component is in the R028AY202UT Semidesert Alkali Loam (black Greasewood) ecological site. Nonirrigated land capability classification is 7s. Irrigated land capability classification is 4s. This soil does not meet hydric criteria. The calcium carbonate equivalent within 40 inches, typically, does not exceed 22 percent. The soil has a slightly saline horizon within 30 inches of the soil surface. The soil has a moderately sodic horizon within 30 inches of the soil surface.

Map unit: 42 - Medburn fine sandy loam, 2 to 8 percent slopes
Component: Medburn
Text kind/Category: Nontechnical description/GENSOIL

The Medburn component makes up 85 percent of the map unit. Slopes are 2 to 8 percent. This component is on fan remnants, lake terraces. The parent material consists of alluvium and/or lacustrine deposits derived from sedimentary rock. Depth to a root restrictive layer is greater than 60 inches. The natural drainage class is well drained. Water movement in the most restrictive layer is high. Available water to a depth of 60 inches is moderate. Shrink-swell potential is low. This soil is not flooded. It is not ponded. There is no zone of water saturation within a depth of 72 inches. Organic matter content in the surface horizon is about 2 percent. This component is in the R028AY220UT Semidesert Loam (wyoming Big Sagebrush) ecological site. Nonirrigated land capability classification is 7s. Irrigated land capability classification is 3e. This soil does not meet hydric criteria. The calcium carbonate equivalent within 40 inches, typically, does not exceed 20 percent. The soil has a moderately sodic horizon within 30 inches of the soil surface.

Map unit: 55 - Scalade-Jericho-Medburn association, 2 to 15 percent slopes
Component: Jericho
Text kind/Category: Nontechnical description/GENSOIL

The Jericho component makes up 30 percent of the map unit. Slopes are 2 to 15 percent. This component is on fan remnants. The parent material consists of alluvium derived from igneous rock. Depth to a root restrictive layer, duripan, is 14 to 20 inches. The natural drainage class is well drained. Water movement in the most restrictive layer is high. Available water to a depth of 60 inches is very low. Shrink-swell potential is low. This soil is not flooded. It is not ponded. There is no zone of water saturation within a depth of 72 inches. Organic matter content in the surface horizon is about 2 percent. This component is in the F028AY232UT Unspecified ecological site. Nonirrigated land capability classification is 7s. This soil does not meet hydric criteria. The calcium carbonate equivalent within 40 inches, typically, does not exceed 28 percent. The soil has a slightly sodic horizon within 30 inches of the soil surface.

Map unit: 59 - Skumpah silt loam, saline, 0 to 2 percent slopes
Component: Skumpah
Text kind/Category: Nontechnical description/GENSOIL

The Skumpah component makes up 90 percent of the map unit. Slopes are 0 to 2 percent. This component is on lake terraces. The parent material consists of mixed alluvium and/or mixed lacustrine deposits. Depth to a root restrictive layer is greater than 60 inches. The natural drainage class is well drained. Water movement in the most restrictive layer is moderately low. Available water to a depth of 60 inches is moderate. Shrink-swell potential is moderate. This soil is not flooded. It is not ponded. There is no zone of water saturation within a depth of 72 inches. Organic matter content in the surface horizon is about 1 percent. This component is in the R028AY004UT Alkali Flat (black Greasewood) ecological site. Nonirrigated land capability classification is 7s. This soil does not meet hydric criteria. The calcium carbonate equivalent within 40 inches, typically, does not exceed 28 percent. The soil has a moderately saline horizon within 30 inches of the soil surface. The soil has a strongly sodic horizon within 30 inches of the soil surface.

Map unit: 21 - Hiko Peak gravelly loam, 2 to 15 percent slopes
Component: Hiko Peak
Text kind/Category: Nontechnical description/GENSOIL

The Hiko Peak component makes up 90 percent of the map unit. Slopes are 2 to 15 percent. This component is on fan remnants. The parent material consists of mixed alluvium. Depth to a root restrictive layer is greater than 60 inches. The natural drainage class is well drained. Water movement in the most restrictive layer is high. Available water to a depth of 60 inches is moderate. Shrink-swell potential is low. This soil is not flooded. It is not ponded. There is no zone of water saturation within a depth of 72 inches. Organic matter content in the surface horizon is about 2 percent. This component is in the R028AY215UT Semidesert Gravelly Loam (wyoming Big Sagebrush) North ecological site. Nonirrigated land capability classification is 6s. Irrigated land capability classification is 4e. This soil does not meet hydric criteria. The calcium carbonate equivalent within 40 inches, typically, does not exceed 35 percent. The soil has a moderately sodic horizon within 30 inches of the soil surface.

WILDLIFE PHOTOGRAPHED:

Wildlife photographed at burrow entrances included the following species: black-tailed jackrabbit (*Lepus californicus*), cottontail (*Sylvilagus* sp.), coyote (*Canis latrans*), badger (*Taxidea taxus*), long-tailed weasel (*Mustela frenata),* kangaroo rat (*Dipodomys* sp.), least chipmunk (*Eutamias minimus*), pygmy rabbit (*Brachylagus idahoensis*), sage sparrow (*Amphispiza belli*), sage thrasher (*Oreoscoptes montanus*), and an unidentified lizard. Additional notable documentation includes several pictures of cottontail rabbits with ear damage (Figure 31) consistent with parasites and/or disease. We attempted to harvest infected rabbits, but were unable to do so.

Fig. 31. Cottontail rabbit with ear damage consistent with parasites and/or disease.

CONCLUSIONS & RECOMMENDATIONS:

This study was established to be a multi-year effort and conclusions drawn from the results should take into consideration the short duration of study. Further study should be carried out to more fully understand pygmy rabbits within the Deep Creek Watershed. Additional work is needed to more fully understand limiting factors and potential mitigation strategies available to properly manage and conserve pygmy rabbits within the Deep Creek Watershed. Further research looking at the distribution of rabbits, their abundances, movement behavior, and habitat use both within and outside of the watershed are warranted.

The distribution and abundance of pygmy rabbits within the watershed was found to be reduced and very low. The abundance estimate (0.17 per hectare in core areas) is the lowest value we have come across and most similar to Washington estimates prior to capture and captive breeding efforts. These values likely represent a lower abundance than historical values due to habitat degradation coupled with severe isolation.

Pygmy rabbits appear to utilize habitat based on predator avoidance and forage considerations as occupied habitat was found to include taller and denser stands of sagebrush. Furthermore, obscurity in occupied habitat was greater and found divergent moving from low to high readings indicative of an increased shrub structure in the upper part of shrubs in occupied areas. Damage to this structure could have negative impacts for pygmy rabbits. Because pygmy rabbits rely on sagebrush for cover and food, this shrub is critical to pygmy rabbit preservation. Sagebrush within the watershed—and hence pygmy rabbits—are threatened by greasewood invasion, pinyon-juniper encroachment, and increased fire cycles due to cheatgrass.

Given these data and following initial efforts we make the following specific recommendations:

1) Protect areas where pygmy rabbits were photographed and/or recent burrowing activity was noted. Of primary concern are locations B & C (Map 2) surrounding greasewood springs and to the east of little cemetery road where we were able to consistently photograph pygmy rabbits and where large numbers of burrows are found. For whatever reason, pygmy rabbits have persisted in these areas and they should represent the core areas in a conservation plan. Perturbations in these areas that reduce the height, density, or structure of sagebrush are likely to negatively affect pygmy rabbits within the watershed. Complete removal of sagebrush and/or conversion to other habitat types will preclude use of these areas and force pygmy rabbits into areas they currently do not occupy. Greasewood springs should be further protected by fencing of fragile riparian areas in such a way to allow cattle and other ungulates to drink in a small sacrifice area while minimizing more widespread degradation that threatens damage to adjacent big sagebrush communities inhabited by pygmy rabbits. Big sagebrush areas east of little cemetery road consist of fenced private lands and these areas may be candidates for purchase and/or negotiation of habitat easements. Preservation

of native and relictual habitat types currently occupied by pygmy rabbits will also help preserve the host of species associated with sagebrush communities—and more specifically those considered sagebrush obligates.

2) Continue efforts to understand pygmy rabbit biology and ecology within the watershed. This population is severely isolated and pygmy rabbits are poorly understood range wide—little is known of this population's trend, movement patterns, survivorship, etc. Determination of these measures is crucial to an understanding of limiting factors and potential mitigation strategies. Revisiting and resampling in identified areas (Map 2) with both a density estimation (pellet plots) and an occupancy-based approach (presence/absence—e.g. remote cameras) over successive time periods will help determine trend and further clarify the status and risks to this population. Continued research on our part would require funding of the implementation phase. In addition, we were unable to document pygmy rabbits occurring in large areas of predicted suitable habitat in the southern part of the watershed (Map 2). Reasons for this discrepancy are unclear and further evaluation seems warranted to confirm our conclusions and explore possible explanations. Much of this area is Goshute tribal land and based on our observations seems to provide suitable habitat despite our lack of success in finding pygmy rabbits.
3) Consider a multi-agency habitat restoration project to enhance riparian areas within the watershed. Although pygmy rabbits do not need to drink free water, we found pygmy rabbits in association with fringe areas near a couple of springs. Shrubs in these areas are much taller than many of the other "dry" parts of the watershed and pygmy rabbits may be attracted due to the shrub composition and structure. Many of the riparian areas within the watershed are in poor condition (Figures 32 and 33) and could be restored relatively easily with fencing

and gravel. An effective strategy would involve fencing most of the riparian area, creating a flow-through area with a graveled bottom for ungulates to drink, and removing exotic weed species. Such a project would benefit many species and could be a high profile win-win scenario for all parties involved.

Fig. 32. Riparian area in need of restoration.

Fig 33. Area of "greasewood springs" that seems a perfect candidate for restoration project. Fencing, exotic weed removal, and a graveled flow-through area for cattle to drink would improve conditions here for many species of wildlife including pygmy rabbits that inhabit the fringe of this riparian area.

4) Additional habitat preservation and restoration projects that maintain corridors between patches of tall and dense sagebrush seem critical to rabbit preservation given limited dispersal distances. Pygmy rabbits will cross areas of unsuitable habitat, but dispersal and gene flow are greatly enhanced within a landscape maintaining high connectivity. Tall and dense sagebrush habitats in the northern part of the watershed are fragmented. Parts of the southern and eastern part of the watershed remain in large contiguous blocks of sagebrush habitat.
5) We caution against traditional habitat treatment (Figure 34) aimed at reduction of sagebrush cover (e.g. dixie harrow, burning, application of herbicide, etc.) in areas where pygmy rabbit burrows are found given the seemingly precarious status of pygmy rabbits within the watershed. Preliminary results from Grass Valley, Utah where pellet plots were established to monitor deposition, thus leporid presence, over timed periods show the potential for reduction of suitable habitat due to treatment. Fecal pellet plots were placed inside mature stands of big sagebrush and adjacent areas where stands had been removed via the treatment with a Dixie harrow. The results (Table 4) show pygmy rabbit activity restricted to a narrow band adjacent to mature stands of big sagebrush and significantly decreased use within the treated areas. We suggest walking proposed treatment areas prior to habitat manipulation and planning treatments with pygmy rabbits in mind. Any proposed treatments should be done in a mosaic that leaves areas of dense sagebrush interconnected with corridors.

Table 4. Shown here is a comparison of average (n=7) fecal pellet counts in relation to distance from treatment edge in Grass Valley, Utah.

	Mature big sagebrush	10m within treatment	20 m within treatment
Pygmy Rabbit	6.2	0.9	1.5
Cottontail	1.1	2.5	1.9
BTJackrabbit	6.0	14.2	16.1

*Pygmy rabbit fecal pellet counts were significantly higher ($P < 0.04$) in untreated areas.

Fig. 34. Proposed habitat manipulation and treatment areas such as the completed treatments above should be thoroughly searched and resultant prescriptions considerate of pygmy rabbit activity.

6) Consider translocation of pygmy rabbits from more robust populations to the low-density population within the watershed. Such and effort would be groundbreaking research that will become essential in efforts to preserve pygmy rabbits in the future as habitats continue to fragment and degrade throughout their range. We believe, based on our assessments both with GIS and efforts on the ground, that suitable but currently unoccupied habitat exists within the watershed and that limiting factors affecting this population include more than habitat loss and/or degradation (despite noted challenges). Translocation will have the immediate effect of increased genetic diversity and may provide the impetus for population growth and expansion. This suggestion is made following assessment within the watershed and given success by this lab in Strawberry Valley, Utah with Sage Grouse. Sage Grouse in Strawberry Valley were estimated at < 100 birds five years ago and are now estimated at more than 500—largely due to an

> aggressive transplant program. We feel it important to move rabbits before local extinction of pygmy rabbits within the watershed. A timely effort to translocate rabbits would ensure intact burrow systems are present for new arrivals give pioneering rabbits the opportunity to gain experience from local animals.

Unfortunately, pygmy rabbits face many threats within both the Deep Creek Watershed and throughout their range. These threats are expected to intensify over the next few decades. Despite these challenges, however, rabbits are still present within the watershed (albeit at very low density) and a tremendous opportunity awaits those interested in preservation of pygmy rabbits, other sage brush obligates, and the big sagebrush habitat type.

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