

**Species Status Assessment for
Columbia Basin Distinct Population Segment of
Pygmy Rabbit
(*Brachylagus idahoensis* (Merriam))**

Version 1.1



Photo of a Columbia Basin pygmy rabbit by Zach Radmer, U.S. Fish and Wildlife Service

April 2026
Pacific Region 1
U.S. Fish and Wildlife Service
Wenatchee, Washington

ACKNOWLEDGEMENTS

The Species Status Assessment (SSA) was prepared by the U.S. Fish and Wildlife Service's (Service) Washington Fish and Wildlife Office (WFWO). The assessment benefitted from the advice and assistance of many individuals, agencies, and organizations. We thank the following individuals for their assistance and apologize to anyone whose name was omitted inadvertently from this list:

Lead Authors:

Emily Orling, Biologist, WFWO, Service

Danielle Husband, Fish and Wildlife Biologist, WFWO, Service

Other Contributors:

Tara Callaway, Assistant Field Supervisor, WFWO, Service

Rebecca Migala, State Classification Coordinator, WFWO, Service

Valuable information on Columbia Basin pygmy rabbit occurrence, ecology, and/or threats was provided by the following:

Jon Gallie (Washington Department of Fish and Wildlife [WDFW]),

Stacey Nerkowski (University of Idaho/Service), and

Kim Veverka, (Service).

For participating as peer and technical reviews of a draft of this document; we thank:

Miranda Crowell (WDFW),

Jon Gallie (WDFW),

Gerry Hayes (WDFW), and

Stacey Nerkowski (University of Idaho/Service).

Literature Citation Should Read as Follows:

U.S. Fish and Wildlife Service. 2026. Species Status Assessment for Columbia Basin Pygmy Rabbit (*Brachylagus idahoensis*). Version 1.1. Portland, Oregon. 86 pp.

An electronic copy of this species status assessment is available at <https://ecos.fws.gov/ecp/species/1126>.

Note that underlined words throughout the document are defined in Appendix 1 on pages 83-84.

EXECUTIVE SUMMARY

This SSA is a comprehensive review of the biology of the pygmy rabbit population (*Brachylagus idahoensis*) in the Columbia Basin Distinct Population Segment (DPS). The SSA provides a scientific assessment of the species' status and viability, including those factors that impact or are likely to impact the species. Information in this SSA will inform the 5-year review of the species' status and will help guide future conservation planning efforts.

The Columbia Basin DPS of the pygmy rabbit (Columbia Basin pygmy rabbit) was listed as endangered under the emergency listing authority of the Endangered Species Act (ESA) in 2001 (66 FR 59734 [November 30, 2001]). We found that emergency listing action was justified because immediate and significant risks to the Columbia Basin pygmy rabbit due to decreases in population size and distribution over the previous several years. We subsequently published a final rule listing the Columbia Basin pygmy rabbit as endangered in 2003 (68 FR 10388 [March 5, 2003]). At the time of listing, the number of rabbits was extremely reduced by catastrophic environmental events, habitat/resource failure, disease, predation, and loss of genetic heterozygosity, and the Columbia Basin pygmy rabbit was near extinction.

The pygmy rabbit is the smallest leporid in North America and is distinguishable from other rabbit species by its small size, short ears, gray color, small hind legs, and lack of white on the tail. Its historical range included California, Idaho, Montana, Nevada, Oregon, Utah, Washington, and Wyoming. The pygmy rabbit is one of only two native leporids in North America that digs its own burrows. Although Columbia Basin pygmy rabbits were historically found throughout the Columbia Plateau ecoregion in Washington (also called the Columbia Basin), their current range is an approximately 90 square mile (mi²) (230 square kilometers (km²)) area of fragmented shrub steppe in Douglas and Grant Counties where Washington Department of Fish and Wildlife (WDFW) conducts captive breeding and reintroduction efforts.

Columbia Basin pygmy rabbits require tall, densely vegetated big sagebrush (*Artemisia tridentata*), and grass and forb vegetation. They also require deep, loose, sandy-loam soils that allow for burrowing. Connectivity between patches of suitable habitat is important. Resilient subpopulations need access to a sufficient amount of suitable habitat to support the species throughout all life stages. We assessed the viability of the Columbia Basin pygmy rabbit in terms of conservation biology principles of the 3Rs: Resiliency, Redundancy, and Representation.

We used the best scientific and commercial data available to analyze and describe past and ongoing changes in the species' habitat, demographic parameters, and distribution, and we assessed factors influencing the viability of Columbia Basin pygmy rabbits in this SSA. The most significant threats to the species are habitat loss, degradation, and fragmentation; wildfire; climate change; disease; and low genetic diversity. Conservation measures affecting the species' viability include regulatory and non-regulatory measures; Safe Harbor Agreements; Section 6: Cooperative Endangered Species Conservation Funds; habitat restoration; conservation easements and land donation; Conservation Reserve Program and State Acres for Wildlife Enhancement Initiative; captive breeding and reintroduction efforts, genetic/demographic rescue (i.e., interbreeding with rabbits from outside the ecoregion; hereafter genetic rescue), and disease

management. Because of the species' known threats, limited population size, and the degree of imperilment; we determined that assessing future condition of Columbia Basin pygmy rabbit in this SSA is not necessary and is precluded by higher priorities.

A resilient Columbia Basin pygmy rabbit subpopulation can be defined in terms of three habitat and demographic factors: habitat quality, abundance, and genetic diversity. For analytical units, we divided the current range of the species into three subpopulations based on a moderate dispersal distance of 1.86 miles (mi) (3 kilometers (km)). Based on our analysis, we estimate that resiliency is high for one subpopulation (Sagebrush Flat), and low for two subpopulations (Beezley Hills and Rimrock); however, we recognize that these metrics are heavily influenced by intensive management of the species. Redundancy of the species is low as only a single population composed of three subpopulations remains within a small portion of the species' historic range. Representation of the species is also low, as the population now represents a small amount of the species' historical genetic and ecological diversity.

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1.0 INTRODUCTION

1.1 Background

The Columbia Basin pygmy rabbit (*Brachylagus idahoensis*) is a Distinct Population Segment (DPS) of the pygmy rabbit, a small leporid. Columbia Basin pygmy rabbits were historically found within the Columbia Plateau ecoregion in Washington State within sagebrush-dominant habitats. The species' current range is a 90 square mile (mi²) (230 square kilometer (km²)) area of fragmented shrub steppe in Douglas and Grant counties. The Columbia Basin pygmy rabbit was emergency listed under the Endangered Species Act (ESA) in 2001 (66 FR 59734; November 30, 2001), before a final rule listed the DPS as endangered in 2003 (68 FR 10388; March 5, 2003). At the time of listing, the Columbia Basin pygmy rabbit population was reduced to 16 individuals, and the species was threatened with extinction by the combined influence of catastrophic environmental events, habitat loss, degradation, and fragmentation, disease, predation, and loss of genetic diversity.

This Species Status Assessment (SSA) is a comprehensive biological review of the current condition of Columbia Basin pygmy rabbit, a DPS of the pygmy rabbit. For the purposes of this SSA, we will refer to the Columbia Basin pygmy rabbit DPS by the term “Columbia Basin pygmy rabbit” and as a “species”, though it is a DPS. While the focus of this SSA is the Columbia Basin pygmy rabbit, the SSA will occasionally discuss pygmy rabbit populations outside of the Columbia Basin. These populations will be referred to as “pygmy rabbit” to differentiate them from the Columbia Basin pygmy rabbit.

This SSA uses the best available scientific and commercial data to conduct an in-depth review of the species' biology and threats, evaluate its current biological status, and partially assesses resources and conditions needed to maintain long-term viability of this species. The SSA will be a “living document” that will be updated periodically as new information about the species, habitat, or threats becomes available and recovery needs dictate. Information in this SSA will be used to inform reviews of the species' status, which is required by section 4(c)(2) of the ESA (50 CFR 424.21), and to help guide future conservation planning efforts.

1.2 Analytical Framework

In this SSA, the species' viability is considered by assessing its resiliency, redundancy, and representation - the 3Rs (Smith et al. 2018, p. 8; Service 2016, p. 21; Wolf et al. 2015, pp. 204-205; see below). This assessment requires identifying the ecological requirements for survival and reproduction at the individual, population, and species levels. The Service uses these ecological requirements to determine the baseline condition for the species by assessing the species' historical and current condition in relation to the 3Rs and identifying past and ongoing factors that led to the species' current condition. Because of the species' known threats, limited population size, and degree of imperilment; we determined that modeling future is precluded by

higher priorities.

To sustain itself over time, a species must have a sufficient number and distribution of healthy populations to withstand: 1) changes in its biological (e.g., novel diseases, predators) and physical environment (e.g., climate change), 2) environmental stochasticity (e.g., wet or dry, warm or cold years), and 3) catastrophes (e.g., severe and prolonged droughts, wildfires). As a species' resiliency, representation, and redundancy increases, it can better tolerate a changing environment and stressors. Sufficient resiliency, redundancy, and representation improves a species ability to adapt to change and increases its viability.

Resiliency is the ability of a species to withstand environmental variation and periodic perturbations (Smith et al. 2018, p. 3). Environmental variation includes normal variation in weather, as well as unseasonable weather events. Perturbations are stochastic events such as wildfire, flooding, and storms. To be resilient, a species must have healthy populations that are able to sustain themselves through good and bad years. Resiliency increases as the number of individuals and populations increase, and the amount and distribution of available habitat increases. For many species, resiliency is also affected by the degree of connectivity among populations and the diversity of occupied ecological niches. Connectivity among populations increases or maintains the genetic health of individuals (heterozygosity) within a population. Furthermore, by increasing the potential for movement among sites, connectivity enhances a population's ability to recover from disturbances. A diversity of climate niches improves a species' resiliency by buffering some individuals against disturbances and perturbations affecting all populations (i.e., decreases the chance of all populations experiencing bad years simultaneously or to the same extent).

Redundancy is the ability of a species to withstand catastrophic events. Redundancy protects species against unpredictable and catastrophic events for which adaptation is unlikely (Smith et al. 2018, p. 3). In short, redundancy is about spreading risk and is best achieved by having multiple widely distributed populations. Having multiple populations reduces the likelihood that all populations will be affected by a single catastrophic event. The more widely distributed populations are, the less likely they are to be affected by a catastrophic event. Given sufficient redundancy, single or multiple catastrophic events are unlikely to cause the extinction of a species. Thus, the greater redundancy a species has, the more viable it will be. Furthermore, the greater the number of populations and the greater their diversity and distribution, the greater will be the species' adaptive potential.

Representation measures the ability of a species to adapt to short- and long-term environmental changes; it is the evolutionary capacity or flexibility of a species (Smith et al. 2018, p. 3). Representation quantifies the genetic and ecological diversity a species possesses, and this variation (called adaptive diversity) is the source of species' adaptive capabilities. The greater the adaptive diversity, the more responsive and adaptable the species will be over time, thereby increasing its viability. Maintaining adaptive diversity includes conserving the ecological and

genetic diversity of a species. Ecological diversity is the physiological, ecological, and behavioral variation exhibited by individuals across their range. A common measure of genetic diversity is the number and frequency of unique alleles within and among populations.

1.3 Methodology

The following primary data sources, documents, and communications were used to develop this SSA:

- Washington State Recovery Plan for the Pygmy Rabbit and Addendum (WDFW 1995, 2001a)
- Emergency Rule to List the Columbia Basin Distinct Population Segment of the Pygmy Rabbit as Endangered (Service 2001)
- Recovery Plan for the Columbia Basin Distinct Population Segment of the Pygmy Rabbit and Amendment (Service 2012, 2019)
- State of Washington Periodic Status Review for the Pygmy Rabbit (WDFW 2018)
- Columbia Basin Pygmy Rabbit Reintroduction and Genetic Management Plan: Addendum to Washington State Recovery Plan for the Pygmy Rabbit (WDFW 2019)
- Annual Report for the Columbia Basin Pygmy Rabbit Recovery Project in 2022 (Gallie 2023a)
- Informal expert elicitation from conservation partners and species experts
- Columbia Basin Pygmy Rabbit Science Team meeting notes

The Service requested information from all parties responsible for the conservation of the species (e.g., Federal and state agencies), researchers who work on or have worked on the Columbia Basin pygmy rabbit, and other conservation partners who may have expertise with the species and their habitat. For evaluating current conditions of Columbia Basin pygmy rabbit, monitoring data and records were retrieved from the WDFW and from other species experts.

2.0 SPECIES INFORMATION

2.1 Species Description and Taxonomy

The pygmy rabbit is a member of the family Leporidae, which includes hares and rabbits. The pygmy rabbit is within the monotypic genus *Brachylagus* and classified as *B. idahoensis* (Green and Flinders 1980a, p. 1; WDFW 1995, p. 1). There are no recognized subspecies of the pygmy rabbit (Dalquest 1948, p. 390; Green and Flinders 1980a, p. 1).

The Columbia Basin pygmy rabbit is a DPS of the pygmy rabbit.

The pygmy rabbit is the smallest leporid in North America, with mean adult weights from 0.83 to 1.1 pounds (lb) (375 to about 500 grams (g)), and body lengths (nose to rump) from 9.3 to 11.6 inches (in) (23.5 to 29.5 centimeters (cm)) (Orr 1940, p. 194; Janson 1946, p. 1; Wilde 1978, p. 10; Gahr 1993, pp. 22-23; WDFW 1995, p. 1). On average, adult females weigh more than males (Orr 1940, pp. 192-194). Their overall color is slate-gray with tan on legs and tawny cinnamon-brown and neck with a whitish belly and pale buffy ear edges. Their ears are short (1.4 to 2.0 in [3.5 to 5.2 cm]), rounded, and thickly furred outside. Their tails are small (0.6 to 0.9 in [1.5 to 2.4 cm]), uniform in color, and nearly unnoticeable in the wild (Orr 1940, pp. 192-194; Janson 1946, pp. 1-2; WDFW 1995, p. 1). A single annual molt occurs, usually in mid to late summer (Bradfield 1974, p. 4; WDFW 2019, pp. 2-3). The pygmy rabbit is distinguishable from other rabbit species by its small size, short ears, gray color, small hind legs, and lack of white on the tail (WDFW 1995, p. 1; Chapman and Litvaitis 2003, pp. 101-146; WDFW 2019, p. 2).

2.2 Range and Distribution

2.2.1 Historical Range and Distribution

The historical range of the pygmy rabbit included much of the semiarid shrub steppe biome of the Great Basin and adjacent intermountain regions of the western United States (Green and Flinders 1980a, p. 1) in portions of Montana, Idaho, Wyoming, Utah, Nevada, California, Oregon, and Washington (Figure 1). Pygmy rabbits were not distributed continuously across their range, but local populations were connected by dispersal habitat such as dense vegetation along permanent and intermittent stream channels, alluvial fans, and sagebrush plains (Green and Flinders 1980a, p. 2; Weiss and Verts 1984, pp. 568-570; WDFW 1995, p. 6). Since European settlement of the western United States, more dense vegetation associated with human activities (e.g., fence rows, roadway shoulders, abandoned fields) likely provided avenues for dispersal among local populations (Green and Flinders 1980a, p. 1; Pritchett et al. 1987, entire).



Figure 1. Map of currently designated Columbia Basin pygmy rabbit currently designated DPS within the greater Columbia Plateau ecoregion (EPA 2013).

The Columbia Basin pygmy rabbit likely had a broader distribution during the mid-Holocene (roughly 7,000 to 3,000 years BP; Lyman 1991, pp. 113-114; Lyman 2004, pp. 2-3). Gradual climate change affecting the distribution and composition of sagebrush habitats is thought to have resulted in a reduction of the Columbia Basin pygmy rabbit's range during the late Holocene (3,000 years BP to present; Grayson 1987, p. 370; Lyman 1991, p. 114; Lyman 2004, pp. 2-3). The pygmy rabbit has been present within the Columbia Plateau ecoregion in

Washington for over 100,000 years (Figure 1; Lyman 1991, pp. 113-114; Lyman 2004, pp. 2-3). Based on the fossil record (Grayson 1987, pp. 370-371; Lyman 1991, entire; Lyman 2004, pp. 2-3) and population genetic analyses (WDFW 2001b, pp. 3-5), this currently designated DPS is believed to have been disjunct from the remainder of the species' range since at least the early Holocene (10,000 to 7,000 years BP). Museum specimens and reliable sighting records indicate that the Columbia Basin pygmy rabbit probably occurred in Douglas, Grant, Lincoln, Adams, and Benton Counties, Washington, during the first half of the 20th century (Figure 2; Service 2003, p. 10391).



Figure 2. Map of currently designated Columbia Basin pygmy rabbit currently designated DPS, which was informed by historical records and specimens.

2.2.2 Current Distribution

At the time of listing, museum specimens, sight records, and knowledge of historic occupied habitat informed the delineation of the currently designated DPS and where within the DPS recovery actions are implemented (Figures 1-2; Service 2003, pp. 10391-10392). The area of the DPS is 16,486,882 acres (ac; 6,672,031 hectares (ha)) encompassing Douglas, Grant, Lincoln, Adams, and Benton Counties (Figure 2). Columbia Basin pygmy rabbits currently occupy three sites in Douglas and Grant counties: Sagebrush Flat, Beezley Hills (including the Palisades, a BLM-owned site), and Rimrock (Figure 3). These three sites cover an area of approximately 90 mi² (230 km²) of fragmented shrub steppe within the Recovery Emphasis Areas (REAs) (Gallie 2023f pers. comm.). Areas in the immediate vicinity of the REAs are being secured to serve as dispersal habitat with the goal being the establishment of a metapopulation (Service 2019, p. 10).

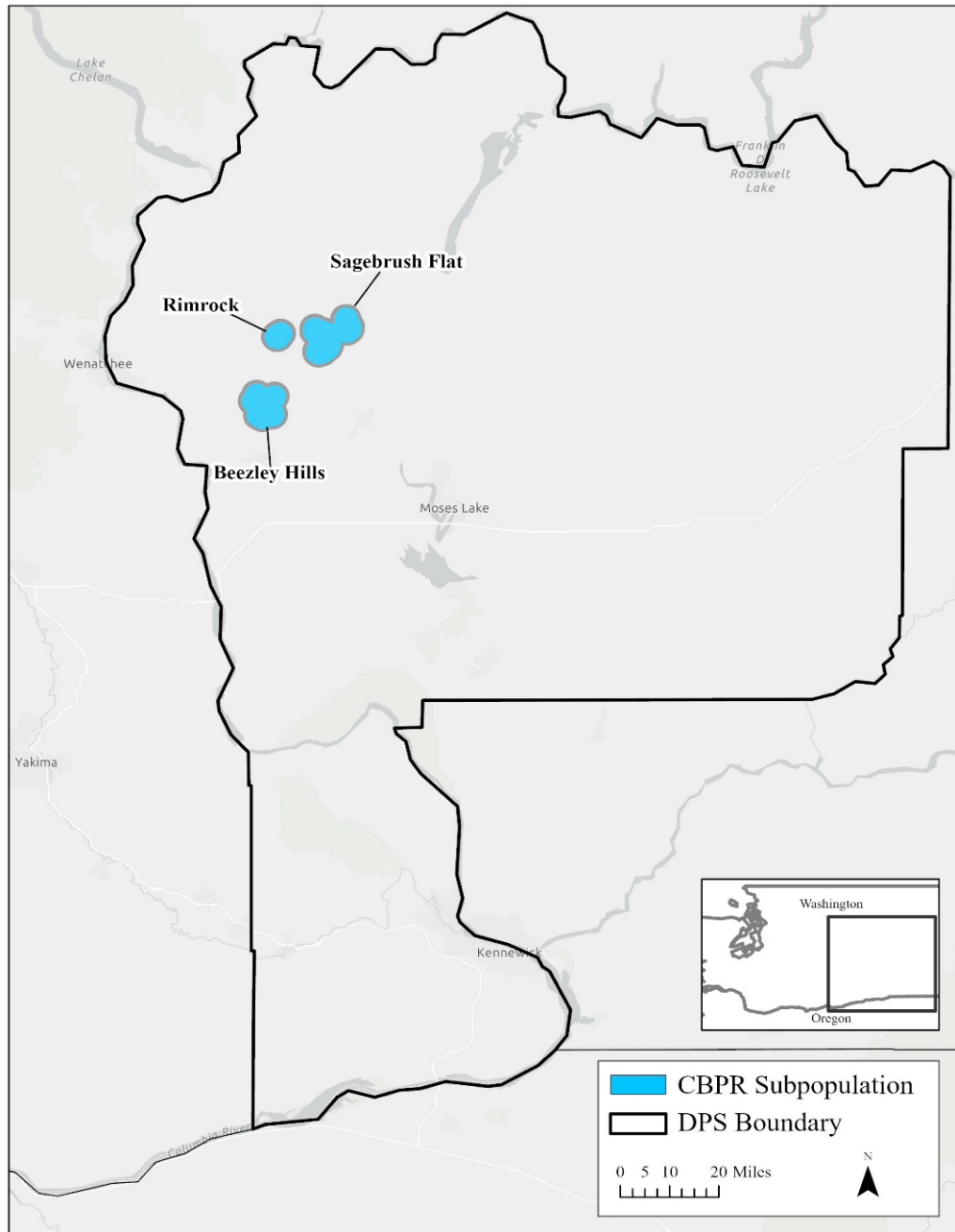


Figure 3. Map showing location of the three current Columbia Basin pygmy rabbit subpopulations (Service 2022).

The terms ‘subpopulation’ and ‘population’ have been used in prior documents such as the Service’s Recovery Plan for the Columbia Basin Distinct Population Segment of the Pygmy Rabbit (Service 2012, entire), Service’s Amendment to the Recovery Plan (Service 2019, entire), WDFW’s Washington State Recovery Plan for the Pygmy Rabbit (WDFW 1995, entire), WDFW’s Addendum to the Recovery Plan (WDFW 2001a, entire), and Columbia Basin Pygmy Rabbit Reintroduction and Genetic Management Plan (WDFW 2019, entire). However, these terms have not been clearly defined and have been used interchangeably.

In this SSA, a subpopulation is defined as a spatially clustered group of Columbia Basin pygmy rabbits occurring within 1.86 mi (3 km) of each other based on winter survey detections (i.e., burrows, pellets, or other detections) in 2021/2022 and 2022/2023. Roughly 1.86 mi is the median natal dispersal distance for female juvenile pygmy rabbits (Estes-Zumpf and Rachlow 2009, pp. 366-367). The median male juvenile dispersal distance is 0.62 mi (1 km); however, we chose the female juvenile distance because this distance encompasses male juvenile and female juvenile dispersal for Columbia Basin pygmy rabbit individuals. Using a 1.86 mi (3 km) buffered distance to define subpopulations is supported by known instances of natural dispersal of individuals from both Sagebrush Flat and Beezley Hills to private properties nearby, without any management intervention (Gallie 2024a pers. comm.). To determine the subpopulation area, each detection was mapped as an occurrence point and buffered by the 1.86 mi dispersal distance. Overlapping detections with their 1.86 mi buffer were merged into a single area, which we determined to be a subpopulation. By this definition, there are currently three subpopulations of Columbia Basin pygmy rabbits: Beezley Hills, Rimrock, and Sagebrush Flat (Figure 3). Furthermore, a population is defined as a group of one or more subpopulations that is distinct from other populations because of significant genetic differentiation, spatial isolation, and/or separation by barrier(s) over which genetic exchange is infrequent. By this definition, there is one population of Columbia Basin pygmy rabbit that contains three subpopulations.

Today, the Service and recovery partners recognize the Columbia Basin pygmy rabbit very likely historically occupied a range that extends beyond the currently designated DPS. Additionally, technological advancements in habitat suitability modeling (satellite data sources) and over twenty years of intensive work with this species confirms that suitable habitat for Columbia Basin pygmy rabbit occurs both inside and outside of the currently designated DPS (Service 2022, entire). The currently designated DPS limits where recovery actions for Columbia Basin pygmy rabbit can occur within the species' historical range. Locations for recovery actions are further constrained by limited suitable habitat and the limited amount of Federal and state land ownership within the DPS (Table 1).

Table 1. Property ownership in the historical range of the Columbia Basin pygmy rabbit.

Property Ownership	Acres (hectares) in Columbia Plateau ecoregion of Washington	Acres (hectares) in DPS	Acres (hectares) in Columbia Plateau ecoregion outside DPS
Private	24,060,446 (9,736,917)	12,882,089 (5,213,196)	11,178,357 (4,523,721)
State	3,337,726 (1,350,729)	1,551,783 (627,984)	1,785,943 (722,745)
Federal	3,204,340 (1,296,755)	1,969,997 (797,232)	1,234,343 (499,523)
Tribal	2,236,075 (904,907)	0	2,236,075 (904,907)
The Nature Conservancy	51,625 (20,891)	48,283 (19,539)	3,342 (1,352)
City or Municipality	61,026 (24,696)	9,101 (3,683)	51,925 (21,013)
County	55,022 (22,266)	25,629 (10,372)	29,393 (11,894)

2.3 Habitat Characteristics

2.3.1 Climate

The Columbia Basin pygmy rabbit is found within the shrub steppe habitat in the Temperate Desert Ecoregion of the western United States (Bailey 1998, p. 10). This ecoregion includes the Great Basin of Oregon, Idaho, Montana, Wyoming, Utah, California, and Nevada of the U.S. and the Columbia Plateau in northern Oregon and central Washington, where the Columbia Basin pygmy rabbit is found. The Columbia Plateau is characterized as semiarid with average annual precipitation of 8 in (20 cm) over half of which is from snow (Siegel Thines et al. 2004, p. 526; Western Regional Climate Center (WRCC) 2023). Winters are cold and summers are warm to hot (Daubenmire 1988, p. 6). Temperatures range from an average minimum of 21.3° Fahrenheit (F) (-5.9° Celsius (C)) in January to an average maximum of 88.8° F (31.6°C) (WRCC 2016). Pygmy rabbits occupy areas with a range of temperatures (Katzner et al. 1997, entire) and individual tolerance to extreme temperatures depends on individual's size, risk of predation, and other characteristics (Milling et al. 2017, entire; Katzner et al. 1997, p. 1059).

2.3.1 Geology and Soils

The Columbia Plateau ecoregion is composed of basalt lava flows of the Columbia River Basalt Group (Camp et al. 2017, p. 1). Columbia Basin pygmy rabbit burrows are found within deep, loose soils predominately in the Zen soil series (USDA 1991, p. 8). Zen soils are composed of well drained, aridic loess and alluvium from basalt with components of pumice and volcanic ash (USDA 1991, p. 15). Additional soil series where burrows have been historically found in central Washington include Renslow, Alstown, Horseflat, and Argabak (USDA 1991, p. 7). These soil series are primarily described as silty in texture indicative of areas where higher elevation basalt formations outwash and erode down slope and are deposited along ridges and fans (Camp et al. 2017, p. 68). These soils are underlain with basalt bedrock, indurated duripan, and sands and gravel at a depth between 7 in (17.78 cm) and more than >60 in (152.4 cm) (USDA 1991, p. 10).

2.3.2 Vegetation

Pygmy rabbits are dependent on sagebrush to provide both food and shelter throughout the year (Bailey 1936, p. 111; Orr 1940, pp. 194-195; Gzreen and Flinders 1980a, pp. 2-3; Weiss and Verts 1984, pp. 566-568; WDFW 1995, p. 9). Nearly the entire historical distribution of the Columbia Basin pygmy rabbit lies within the big sagebrush – bluebunch wheatgrass (*Pseudoroegneria spicata*) zonal habitat type (Daubenmire 1988, pp. 8-16); one of several habitat types making up the sagebrush steppe. This habitat type consists of four well defined vegetation layers. The most prominent layer consists of various shrub species, principally big sagebrush, that are intermixed with a second layer comprised of a variety of tall perennial grasses, principally bluebunch wheatgrass. The third layer is low-lying perennial and annual grasses and forbs, which are usually less than 4 in (10 cm) in height. Finally, the fourth vegetative layer is a thin, fragile cryptogamic crust, which occurs directly on the surface of the soil. Various lichen, moss, and liverwort species comprise this layer, influencing erosion susceptibility, moisture retention, and nutrient cycling. A small fraction of the Columbia Basin pygmy rabbit's historical distribution in the northern extent of its range is within the threetip sagebrush (*A. tripartita*) – Idaho fescue (*Festuca idahoensis*) zone. This habitat type differs primarily by the substitution of the dominant shrub and grass species, but otherwise has similar characteristics to that of the big sagebrush – bluebunch wheatgrass zone. Across the pygmy rabbit range, vegetation is a key factor in predicting suitable habitat (Dilts et al. 2023, p. 9). Within these habitat types, pygmy rabbits are typically found in tall, dense stands of mature sagebrush (*Artemisia* spp.) that are greater than 36 in (91 cm) in height and have a density greater than 25 percent of the area's total cover. Pygmy rabbits throughout their range avoid areas with a high density of the nonnative invasive annual cheatgrass (*Bromus tectorum*) as it forms dense root mats that makes burrowing difficult (Larrucea and Brussard 2008, p. 697).

The Columbia Basin pygmy rabbit also occupy Conservation Reserve Program (CRP) lands, which differ in vegetation composition from native shrub steppe (Nerkowski 2021, pp. 101-102). CRP lands were found to have overstory vegetation dominated by big sagebrush and an

understory dominated by cheatgrass and slender wheatgrass (*Elymus trachycaulus*) as well as forb species such as Scouler's popcorn-flower (*Plagiobothrys scouleri*), Jim Hill mustard (*Sisymbrium altissimum*), and yarrow (*Achillea millefolium*) (Nerkowski 2021, pp. 101-102). Sagebrush Flat had overstory vegetation dominated by big sagebrush and understory dominated by cheatgrass, rip-gut (*Hesperostipa comata*) and bluebunch wheatgrass, and forb cover of shaggy fleabane (*Erigeron pumilus*), cushion fleabane (*E. poliospermus*), and twin arnica (*Arnica sororia*).

2.3.3 Site Occupancy

Research on Columbia Basin pygmy rabbits and populations outside the Columbia Plateau suggests that site occupancy decreases the quality and amount of available sagebrush forage as well as cover that provides protection from predators (Parsons et al. 2016, p. 13; Nerkowski 2021, pp. 105-106). This reduced habitat quality may explain why pygmy rabbits shift the areas they use over time (Parsons et al. 2016, p. 13; Nerkowski 2021, pp. 105-106). Pygmy rabbits in Idaho are found in areas with high sagebrush and forb density (Heady and Laundré 2005, pp. 494-497); likely because they shift use areas every 5-10 years. In Washington, Columbia Basin pygmy rabbit burrow systems are typically occupied for no more than 1-2 years (Nerkowski 2021, p. 106) as rabbits shift to areas with better forage. As Columbia Basin pygmy rabbits shift to new locations, the sagebrush understory of previously occupied areas quickly recovers from browsing.

Columbia Basin pygmy rabbits may prefer certain habitats depending on how they are managed. Active Columbia Basin pygmy rabbit burrows were found in areas not grazed by cattle, which is likely an important consideration for management of occupied habitat (Siegel Thines et al. 2004, p. 529). Additionally, at the Sagebrush Flat subpopulation, roughly 95 percent of active burrows were found on lands enrolled in CRP (Nerkowski 2021, p. 93). By the 2017/2018 season, roughly 250 burrows were found on lands enrolled in CRP for 20 to 30 years compared to fewer than 50 in native shrub steppe habitat (Service 2019, p. 3).

2.4 Life History

2.4.1 Burrow Establishment and Use

The pygmy rabbit is one of only two native leporids in North America that digs its own burrows (Nelson 1909, p. 22; Green and Flinders 1980a, p. 2; WDFW 1995, p. 7). Pygmy rabbits dig their burrows into gentle slopes or mound/inter-mound areas of more level or dissected topography (Wilde 1978, p. 26; U.S. Department of Agriculture [USDA] 1991; Gahr 1993, pp. 81-82, 90). Columbia Basin pygmy rabbit burrows are typically found within 0 to 8 percent slope, although burrows are detected at 30 percent slopes (Nerkowski 2021, p. 103). Pygmy rabbits, especially juveniles, likely use their burrows as protection from predators and inclement weather (Bailey 1936, p. 111; Bradfield 1974, pp. 20, 26-27). The number of active pygmy rabbit burrows is

highest in summer when the number of juveniles is the greatest. However, estimating total active burrows is not directly related to individuals present in a given area as individual pygmy rabbits maintain multiple burrows and some burrows are used by multiple individuals (Gahr 1993, pp. 66-68).

Burrows frequently have multiple entrances, some of which are concealed at the base of large sagebrush plants (Janson 1946, pp. 2-3; Wilde 1978, p. 20; Green 1978, pp. 35-36; Gahr 1993, pp. 86-88). Small, shallow trenches, or runways, are found at burrow entrances. Individual burrows are relatively simple and shallow, often no more than 6.6 feet (ft) (2 meters (m)) in length and usually less than 3.3 ft (1 m) deep with no distinct chambers (Bradfield 1974, pp. 28-29; Green and Flinders 1980a, p. 2; Gahr 1993, pp. 63-66). The diameter of Columbia Basin pygmy rabbit burrow entrances averaged 8 in (19 cm) (Gahr 1993, p. 64).

Pygmy rabbits are most often found in areas with relatively deep (greater than 20 in [51 cm]), loose soils of wind- or water-borne origin that allow burrowing (WDFW 1995, p. 7). During winter, pygmy rabbits make extensive use of snow burrows and tunnels to access sagebrush forage (Bradfield 1974 p. 37; Katzner and Parker 1998, p. 72) and to provide thermal cover (Katzner et al. 1997, entire). Pygmy rabbits occasionally make use of natural cavities, holes in volcanic rock, rock piles, sand dunes, artificial structures, or burrows abandoned by other species, such as the yellow-bellied marmot (*Marmota flaviventris*) or badger (*Taxidea taxus*) (Green 1978, p. 37; Green and Flinders 1980a, pp. 2-3; WDFW 1995, p. 10). As a result, pygmy rabbits may occur in areas of shallower, more compact, or sandy soils that support sufficient shrub cover (Bradfield 1974, pp. 2-3). Areas with atypical burrow sites, which are typically adjacent to areas containing dense sagebrush stands and deep soils, may facilitate dispersal and function as corridors between suitable habitat (Katzner and Parker 1998, pp. 73-74).

2.4.2 Breeding

Columbia Basin pygmy rabbits begin breeding the year following their birth, and breeding occurs from January through June (Gahr 1993, p. 18). Male reproductive behaviors start in January, peak in March, and decline in June (WDFW 2019, pp. 2-3). Females can be pregnant from late February to June and 74 percent produce kits each year (Elias et al. 2006, p. 23; DeMay et al. 2016, entire; WDFW 2019, pp. 2-3). Gestation in captive pygmy rabbits is 22 to 24 days (Elias 2004, p. 22), and females can produce up to four litters per year with an average of six young (kits) per litter (Green 1978, pp. 35-36; Wilde 1978, pp. 69-70; Elias 2004, p. 23). At the Sagebrush Flat site in Douglas County, Washington, a genetic parentage analysis found that females had an average of 2.5 litters per year (up to 5) and 7.5 kits per breeding female per year (DeMay et al. 2016, entire). Males father from 1 to 33 kits a year, averaging 7 kits annually (DeMay 2016, p. 72). Adult females and males bred with an average 3.8 and 3.6 individuals per year, respectively (DeMay 2016, p. 60). Unlike other rabbits, pygmy rabbits do not produce extra litters during favorable environmental conditions (WDFW 1995, p. 13; Wilde 1978, pp. 120-126). In enclosures, Columbia Basin pygmy rabbit breeding is synchronous, but is more variable

in the wild (Gallie 2023b pers. comm.). In contrast breeding appears to be highly synchronous in wild Idaho pygmy rabbits (Gallie 2020, p. 2).

2.4.3 Nesting and Young Rearing

Pygmy rabbit parental care is similar to other lagomorphs except for the use of natal burrows (Elias et al. 2006, p. 926). Columbia Basin pygmy rabbit females excavate specialized, cryptic natal burrows that are disjunct from their resident burrow systems (Elias 2004, pp. 22-23). Natal burrows, from entrance to nest, ranged from 7 to 14 in (15.5 to 35.5 cm) long (Rachlow et al. 2005, p. 137; Elias et al. 2006, p. 923) and typically consist of a single entrance under a large sagebrush plant (Rachlow et al. 2005, p. 138). Females dig and then line the nest chamber with plucked fur, grass clippings, etc. several days prior to giving birth. Females sometimes construct additional “dead-end” burrows that appear to be associated with their natal burrows. The prevailing theory regarding the function of these burrows is that females may use them for defecation and urination while pregnant or nursing (Gallie 2023b pers. comm.).

Young are born with little fur and closed eyes (Elias et al. 2006, p. 924) and remain in the natal burrow for 13 to 21 days before emerging from the burrow (DeMay et al. 2016, entire). Females will use runways as a birthing and nursing area. After nursing, young return to the burrow and the female fills the burrow entrance with loose soil and otherwise disguises the immediate area to avoid detection (Elias 2004, pp. 22-23; Rachlow et al. 2005, p. 136). Nursing can occur from March through September and ceases around two weeks after birth (Elias et al. 2006, p. 924; WDFW 2019, pp. 2-3).

2.4.4 Diet

The Columbia Basin pygmy rabbit diet consists of shrubs (82.5 percent of diet), forbs (13.1 percent), and grasses (4.4 percent) (WDFW 1995, p. 8) and they satisfy their moisture needs through the plants they consume (Larrucea and Brussard 2009, p. 1181). The two most important shrub species to their diet are big sagebrush (*Artemisia tridentata*; 67 percent of diet) and rabbitbrush (*Chrysothamnus* species; 12.8 percent) (WDFW 1995, p. 8). Thus, pygmy rabbits rely on densely vegetated areas of big sagebrush at least 20-30 years old, with low, accessible branches (WDFW 1995, pp. 9-10; Gallie 2024b pers. comm.).

In winter, sagebrush comprises 82 to 99 percent of their total diet (Siegel Thines et al. 2004, p. 525) and shrubs are eaten during each month except September (Gahr 1993, p. 25). Grasses, which are far less available in winter than summer, represent less than two percent of their winter diet (Siegel Thines et al. 2004, p. 525). Winter reliance on sagebrush is not unique to Columbia Basin pygmy rabbits. It is estimated that up to 99 percent of the pygmy rabbit winter diet is sagebrush (Janson 1946, p. 3; Wilde 1978, p. 46; White et al. 1982, p. 108; Crowell et al. 2018, p. 571). Pygmy rabbits are more likely to forage on individual sagebrush plants higher in crude protein content compared to those with lower protein (Ulappa et al. 2014, p. 839). Unlike other cold-adapted lagomorphs, pygmy rabbits have never been observed caching food in winter

(Katzner et al. 1997, entire).

In summer, sagebrush comprises 10 to 50 percent of their diet while grasses and forbs (including *Agropyron*, *Koeleria*, *Poa*, *Achillea*, *Astragalus* and *Lupinus*) make up 53 percent of their diet (Siegel Thines et al. 2004, p. 529). Grasses are eaten March through September and forbs April through June (Gahr 1993, p. 25). This diverse summer diet is similar to pygmy rabbits across the west. In Utah, the summer diet of pygmy rabbits consists of roughly 51 percent sagebrush, 39 percent grasses (particularly native bunchgrass), and 10 percent forbs (Green and Flinders 1980b, pp. 138-139). There is evidence that pygmy rabbits prefer to forage on native grasses during this period compared to other available foods (Green and Flinders 1980b, p. 141).

Columbia Basin pygmy rabbits will occupy restored former croplands enrolled in the CRP where rotational cattle grazing and planting native plants has been undertaken. These areas have different foraging resources than in the shrub steppe (Nerkowski 2021, p. 93). Sagebrush on CRP lands have been found to be more nutritious with higher crude protein and lower levels of indigestible components than sagebrush located on uncultivated sites (Nerkowski 2021, pp. 104-105) and Columbia Basin pygmy rabbits seem to prefer CRP lands over natural shrub steppe habitats for creating new burrows (Nerkowski 2021, p. 93).

2.4.5 Home Range and Dispersal

Studying an animal's home range can reveal the habitat needed for their conservation (Gahr 1993, p. 93). Pygmy rabbits have larger home ranges in the spring and summer compared to the non-breeding season (Janson 1946, p. 5; Gahr 1993, pp. 103-105). Adult Columbia Basin pygmy rabbit females tend to make relatively short movements within a small area and have home ranges covering roughly 7 acres (ac) (3 hectares (ha)) during spring and summer (Gahr 1993, pp. 109-118; WDFW 1995, p. 7). Males tend to make longer movements during this period, possibly to find estrous females, resulting in home ranges covering roughly 50 ac (20 ha). The average estimated Columbia Basin pygmy rabbit juvenile home range after emerging during the breeding season was 17.5 ac (7.1 ha) (Gahr 1993, p. 109). Adult pygmy rabbits in southeastern Idaho have mean summer home ranges of 91.1 ac (37.2 ha) for females and 167.8 ac (67.9 ha) for males (Heady and Laundré 2005, pp. 493-494). These larger spring and summer home ranges of Idaho pygmy rabbits compared to Columbia Basin pygmy rabbit home ranges likely reflects greater habitat availability in Idaho. In winter, pygmy rabbits have relatively small home ranges (Janson 1946, p. 5; Katzner and Parker 1998, pp. 72-73). Columbia Basin pygmy rabbits remain within 100 ft (30 m) of their burrows likely due to reduced resource availability (Janson 1946, p. 5; Katzner and Parker 1998, pp. 72-73), although some snow burrows may extend over 330 ft (100 m) from their burrows (Bradfield 1974, p. 20).

Pygmy rabbit dispersal has been studied using radio telemetry of released pygmy rabbits. Radio collars use frequencies that provide fairly accurate locations using frequencies to triangulate and monitoring their location. In 2005, 41 juvenile pygmy rabbits were collared in Idaho to study

their dispersal and sex and age-specific survivorship (Rachlow and Estes-Zumpf 2005, p. 4). This cohort dispersed over 6 mi (10 km) during this study (Rachlow and Estes-Zumpf 2005, pp. 1-2) and individuals often made a single disperse at 6 to 10 weeks of age (Rachlow and Estes-Zumpf 2005, pp. 1-2). Adult pygmy rabbits have been observed to disperse over 7.5 mi (12 km) between their more restricted, seasonal use sites. While these movements are considerably farther than those documented in previous studies (e.g., 458-1476 ft [140-450 m] in Green and Flinders 1979, p. 88; 2.71 mi [3.5 km] in Katzner and Parker 1998, p. 73), it should be noted that these are maximum estimates. There appears to be large differences in the propensity of individual pygmy rabbits to disperse; many individuals remain relatively sedentary. Reflecting this, the median natal dispersal distances in Idaho were 1.86 mi (3 km) and 0.62 mi (1 km) for males and females, respectively (Rachlow and Estes-Zumpf 2005, entire).

Dispersal in Columbia Basin pygmy rabbits has been studied using fecal DNA. In 2012, 1,206 Columbia Basin pygmy rabbit captive bred kits were captured, and a tissue sample was collected to determine their genetic identity (De May et al. 2017, p. 354). Kits were released into the wild and fecal material was collected at burrows within 11,482.9 ft (3,500 m) of each release site (De May et al. 2017, p. 354). Dispersal distances were defined as the distance between the initial kit release site and fecal DNA collection site. The median dispersal distance of Columbia Basin pygmy rabbit kits was 1545 ft (471 m) and 2546 ft (776 m) for kits after release (De May et al. 2017, p. 355). Similar to the long-distance dispersal of pygmy rabbits in Idaho, Columbia Basin pygmy rabbits can disperse 164 ft (50 m) to 1.2 mi (2 km), although dispersals of up to 9.6 km (6 mi) have been observed (Gallie 2023f and 2024a pers. comm.). In the Service's One Range Habitat Distribution Model (hereafter, One Range model) for the Columbia Basin pygmy rabbit (discussed further in section 5.2 Methodology), dispersal distances between 164 ft (50 m) to 1.2 mi (2 km) were used to determine potential Columbia Basin pygmy rabbit habitat areas as informed by species experts (Service 2022, entire).

2.4.6 Life Span and Survival

Pygmy rabbit survival rates are highly variable between sexes, study sites, and years (Sanchez 2007, pp. 92-95; Crawford et al. 2010, p. 844; Price et al. 2010, pp. 44-46). Generally, they live less than 3 years with the highest mortality occurring within the first few weeks of their emergence from natal burrows (WDFW 1995, pp. 5-6; Sanchez 2007, p. 92; Zeoli et al. 2008, pp. 506-507; Estes-Zumpf and Rachlow 2009, p. 367). Mean annual adult mortality of pygmy rabbits can be as high as 88 percent (Wilde 1978, pp. 85-95). In captive Columbia Basin pygmy rabbits, annual survival across all age classes was 61 percent (Elias 2004, p. 21); whereas annual wild adult survival rates ranged from 7 percent to 45 percent in Idaho (Sanchez 2007, p. 103) and 0.3 percent to 17.3 percent in Oregon and Nevada (Crawford et al. 2010, p. 842). Early research suggested that pygmy rabbit mortality rates are generally higher in late winter and early spring when food reserves are lowest before spring plants emerge (Wilde 1978, pp. 85-88). However, recent observations suggest that Columbia Basin pygmy rabbit mortality is higher in the summer than in the winter due to low juvenile survival and loss of seasonal forage resources due to

wildfire (Gallie 2024a pers. comm.).

The chief driver of pygmy rabbit mortality is predation (WDFW 1995, p. 5). Pygmy rabbits maintain a low stance and deliberate gait and can evade predators by maneuvering through the dense shrub cover of their preferred habitats, often along established trails through the brush or by escaping into their burrows (Bailey 1936, p. 111; Severaid 1950, entire; Bradfield 1974, pp. 26-27; Rauscher 1997, p. 5). However, they are relatively vulnerable to predators in open areas. Potential predators include fossorial and terrestrial mammals such as badgers, long-tailed weasels (*Mustela frenata*), coyotes (*Canis latrans*), and bobcats (*Felis rufus*), and a variety of avian predators including, but not limited to great horned owls (*Bubo virginianus*), long-eared owls (*Asio otus*), ferruginous hawks (*Buteo regalis*), and northern harriers (*Circus cyaneus*) (Janson 1946, pp. 5-6; Robinette et al. 1960, p. 227; Green 1978, p. 37; WDFW 1995, p. 6).

2.5 Genetics and Effective Population Size

In general, genetic diversity is related to population health. Small population size can result in inbreeding and an increased likelihood of genetic drift. Both reduce the unique genetic combinations individuals can inherit. Inbreeding for multiple generations can increase the prevalence of deleterious genetic combinations that can cause birth defects and even death.

Genetic monitoring using fecal samples collected during winter burrow surveys is critical to the management of the Columbia Basin pygmy rabbit recovery program, providing data on spatial distribution, apparent survival rates, post-release dispersal distance, breeding dynamics, parentage, genetic diversity (i.e., observed heterozygosity), and the persistence of Columbia Basin ancestry (see below) within captive and wild populations (Nerkowski 2021, pp. 1-35). The resulting data have been crucial in identifying factors influencing the Columbia Basin pygmy rabbit. Genetic analyses also are used to differentiate captive bred from wild-born individuals and in turn is used to calculate the minimum number of genetically identified rabbits. The number of wild-born Columbia Basin pygmy rabbits is a critical metric in assessing the degree to which populations are self-sustaining (Gallie 2023a, pp. 3-4).

Most of the early genetic work for the Columbia Basin pygmy rabbit was associated with translocations, where pygmy rabbits were moved from other populations to Washington to prevent the extinction of the Columbia Basin pygmy rabbit. Given the intermixing of pygmy rabbits from other populations with Columbia Basin pygmy rabbits, determining ancestry was an important goal in assessing genetic diversity and genetic health (WDFW 2019, p. 5). These studies began with microsatellite marker analyses and, in 2016, single nucleotide polymorphisms (SNPs) have been used for genetic analyses (WDFW 2019, p. 5). The last purebred Columbia Basin pygmy rabbits in captivity died in 2008, and no pure Columbia Basin pygmy rabbits have been produced in the captive breeding program since 2005. In 2010, the captive population consisted of 111 interbred pygmy rabbits that averaged 65 percent Columbia Basin ancestry (ranging from 42 to 88 percent); 62 individuals were at least 75 percent Columbia Basin ancestry. Columbia Basin pygmy rabbit ancestry declined from 70 percent in 2012, to 22 to 24

percent in captive bred populations in 2019 (WDFW 2019, p. iv). Between 2012 and 2020, Columbia Basin ancestry ranged from 15 to 28 percent (Nerkowski 2021, pp. 1, 15-16). The remaining genetic makeup of these rabbits was 67 percent from the collective Great Basin population (Nevada/Oregon/Idaho), 10 percent from the Wyoming/Utah northern population, and less than 1 percent from the Utah southern population (WDFW 2021, p. iv).

Genetic diversity among all pygmy rabbit populations was assessed using Bayesian clustering to determine where ancestral clusters remained (Structure 2.3.4) (WDFW 2019, p. 5). Four genetic clusters were rendered: Washington (captive population/Idaho), Nevada/Oregon, northern Utah/Wyoming, and southern Utah (DeMay et al. 2016, p. 787). These clusters were later modified using microsatellites as well as restriction site associated DNA sequencing (RADSeq (Ali et al. 2016, entire)) which resulted in the first genome-wide set of SNP markers for the pygmy rabbit (Nerkowski 2021, entire). Analysis of SNP markers through RADSeq revised the four genetic clades to Columbia Basin, Great Basin (Nevada/Oregon/Idaho/Montana/California), northern Utah/Wyoming, and southern Utah (WDFW 2019, p. 5; Nerkowski 2021, p. 32). One of the most important findings from these genetic studies was that Columbia Basin pygmy rabbit ancestry is genetically distinct from the Idaho population that was previously grouped with captive ancestry and is now grouped with the Nevada/Oregon cluster (WDFW 2019, p. 5). These results suggest that the Columbia Basin pygmy rabbit diverged (i.e., was genetically isolated) from the remainder of the taxon at least 10,000 to 25,000 years before present (BP), and possibly as long as 40,000 to 115,000 years BP (Service 2003, p. 10395, Warheit 2001, p. 6). The genetic differences that have been identified between the Columbia Basin pygmy rabbit and other pygmy rabbit populations are similar to subspecific differences recognized in other mammal species. This divergence was used to justify the significance of the Columbia Basin pygmy rabbit within the Distinct Population Segment Final Rule (Service 2003, entire).

Additional genetic findings provided information regarding the reproductive output of Columbia Basin pygmy rabbit based on their heritage. Males with greater than 50 percent Columbia Basin ancestry had higher reproductive output than the other three ancestry groups (WDFW 2019, p. 5; DeMay et al. 2016, p. 784). The lowest reproductive output was between pygmy rabbit males with higher northern Utah/Wyoming ancestry and females with higher levels of Nevada/Oregon ancestry than other ancestry clusters (DeMay et al. 2016, entire). Variation in reproductive output across different ancestries was found to be more pronounced in male Columbia Basin pygmy rabbits than in females (De May et al. 2016, p. 792). Knowing these ancestry thresholds can inform future translocations of out-of-state pygmy rabbits to Washington. Maintaining males with greater than 50% Columbian Basin ancestry will maximize reproductive output which will increase resiliency. Female Columbia Basin pygmy rabbit reproduction may be more strongly influenced by other environmental or individual characteristics.

Heterozygosity is a measure of genetic diversity, and typically, high values equate to genetically healthy populations. From 2012 to 2023, Columbia Basin pygmy rabbit heterozygosity averaged 0.73 (range 0.72 to 0.77) and was stable (Table 2; WDFW 2019, p. iv). These values are consistent with heterozygosity of pygmy rabbits in Great Basin populations. The three Columbia Basin pygmy rabbit subpopulations' observed heterozygosity has increased, decreased, and plateaued over the years (Table 2; Nerkowski 2021, p. 1). Additionally, the effective population size of the Sagebrush Flat subpopulation ranged from 12.3 individuals in 2012 to 44.3 individuals in 2017, far below recommendations of greater than 100 individuals (Nerkowski 2021, pp. 1, 33). Therefore, given the observed heterozygosity and lower than recommended effective population sizes, the Columbia Basin pygmy rabbit remains critically endangered and at a significant risk of inbreeding and genetic drift (Nerkowski 2021, p. 1).

Table 2. Observed heterozygosity (Ho) of three subpopulations and extirpated subpopulation, Burton Draw (Nerkowski 2021, pp. 54-55; Nerkowski unpublished data, 2012 to 2022).

	2012	2013	2014	2015	2016	2017	2018	2018	2019/20	2020/21	2021/22	2022/23	Average
Season Sampled	Winter	Winter	Winter	Winter	Winter	Winter	Summer	Winter	Winter	Winter	Winter	Winter	
Sagebrush Flat	0.76	0.81	0.81	0.75	0.70	0.84	0.76	0.62	0.62	0.62	0.67	0.76	0.73
						2017/18	2018/19	2019	2019/20	2020/21	2021/22	2022/23	
Season Sampled						Winter	Winter	Summer	Winter	Winter	Winter	Winter	
Beezley						0.78	0.75	0.80	0.59	0.77	0.68	0.72	0.73
Rimrock												0.77	
Burton Draw							0.77	0.73	0.74				

2.5.1 Population Trends

Pre-captive Breeding: Before 2002

There is little information available about the historical abundance of Columbia Basin pygmy rabbits (WDFW 1995, p. 14). In the early 20th century, they were common in appropriate habitat (WDFW 1995, p. 14). However, by the mid-20th century they were presumed extirpated from Washington until a possible sighting in Benton County in 1979 (Dalquest 1948, p. 390; WDFW 1995, p. 14; Figure 4). Intensive surveys in Douglas County in 1987 and 1988 located five subpopulations; three on State lands and two on private lands (Service 2012, pp. 11-12). Of those five subpopulations, four had fewer than 100 estimated active burrows. The fifth, located on Sagebrush Flat Wildlife Area in Douglas County, had an estimated 588 active burrows in 1993 but was estimated to support fewer than 150 pygmy rabbits (Gahr 1993, p. 66). In 1997, an additional subpopulation was discovered on private land in northern Grant County (WDFW 2001a, p. 1). However, by that time only the Sagebrush Flat Wildlife Area subpopulation was still extant. The other four sites were extirpated for unknown reasons but likely due to habitat loss and fragmentation due to agriculture (Gahr 1993, p. 49; Service 2012, p. 12). By the winter of 1997 to 1998, the number of active burrows at Sagebrush Flat declined by 50 percent and continued to decline in the following years until no animals were detected in the summer of 2004 (Service 2012, p. 12). Limited access to survey private lands, other priorities, and scant suitable pygmy rabbit habitat available were cited as limiting factors when considering early searches for occupied Columbia Basin pygmy rabbit sites (Service 2012, p. 12).

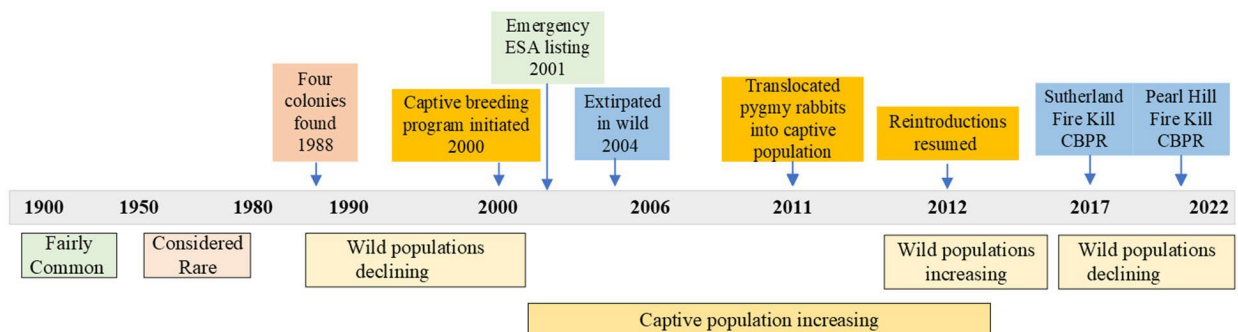


Figure 4. Timeline of Columbia Basin pygmy rabbit population trends and milestones.

Genetic Rescue

Endangered species and isolated populations may face threats associated with small populations and low genetic diversity, such as loss of genetic variation, inbreeding, and uneven sex ratios, which can lower the fitness of individuals and populations (Tallmon et al. 2004, entire).

Augmenting a small population can reduced inbreeding, recovery genetic diversity, and improve reproduction. Creating new populations can establish gene flow among existing populations and newly established populations (Tallmon et al. 2004, p. 489; Robinson et al. 2020, pp. 466-467). Small population size and isolation has led to inbreeding depression and diminished reproductive

capacity of Columbia Basin pygmy rabbits (Elias et al. 2013, pp. 1282-1283; Hayes 2018, p. 8; Nerkowski 2021, p. 1). To reduce the adverse effects of low genetic diversity and to provide adequate numbers of breeding adults, translocations of wild pygmy rabbits from populations outside the Columbia Plateau were conducted in 2004, 2011-2013, and 2020.

When the Columbia Basin pygmy rabbit captive breeding program began in 2003, the goal was to preserve the unique Columbia Basin pygmy rabbit ancestry (from the remaining wild rabbits) and produce enough rabbits for reintroduction efforts (Elias et al. 2013, pp. 1282-1283; Hayes 2018, pp. 9-10; Nerkowski 2021, p. 1). However, the founding individuals suffered from inbreeding depression resulting in a diminished reproductive capacity and they were not able to produce enough offspring to reintroduce the species to the wild. Augmentation of the captive population with additional wild Columbia Basin pygmy rabbits was impossible as the last known wild subpopulation was extirpated in 2004. Thus, in 2002, the decision was made to cross the purebred captive individuals with 20 wild pygmy rabbits from Idaho to attempt to conserve some of the unique genetic characteristics of the Columbia Basin pygmy rabbits and increase the genetic diversity of any offspring produced (Becker et al. 2011, p. 6). This effort succeeded in increasing genetic diversity and reproductive rates of the captive rabbits (Becker et al. 2011, pp. 2-5).

Genetic rescue was employed again in 2011-2013 as the captive breeding program transitioned from captive breeding to using semi-wild breeding enclosures (see above). One hundred and twelve adult pygmy rabbits were translocated from populations in Oregon, Nevada, Utah, and Wyoming to the breeding enclosures to further increase genetic diversity as well as the population size (Hayes 2018, pp. 9-10; WDFW 2019, pp. 3-4; Nerkowski 2021, p. 1). This was successful, and the number of kits born was sufficient to support releases into the wild as well as allowing for the retention of sufficient kits to sustain the semi-wild breeding program (hereafter breeding program).

After several setbacks, including major wildfires and disease, caused significant mortality in the species, genetic rescue was used again in 2020 to increase the number Columbia Basin pygmy rabbits in the semi-wild breeding enclosures (Gallie 2021, pp. 20-21). Twenty six adult pygmy rabbits from Nevada and Idaho were translocated to enclosures with resident Columbia Basin pygmy rabbits (Gallie 2021, pp. 17-18). Even though the addition of these breeding adults increased the breeding population size, it further diluted the Columbia Basin ancestry in the resulting cohort of kits. However, Columbia Basin pygmy rabbit heterozygosity is currently significantly higher than when the species was extirpated from the wild (Table 2; Warheit 2001, p. 16; Nerkowski 2021, p. 32). The breeding program is now managed to increase the representation of Columbia Basin genes.

Genetic rescue has been useful in managing the genetic diversity and population size of the Columbia Basin pygmy rabbit in the past and will remain a future option. However, our ability to use genetic rescue in the future may be more difficult due to the potential for disease transfer.

The aggressive spread of Rabbit Hemorrhagic Disease Virus Type 2 (RHDV2; discussed further in section 4.1.4 Disease) throughout the rest of the pygmy rabbit range will require disease screening of potential donor stock and implementing protocols for all future translocation to ensure disease is not transferred to Columbia Basin pygmy rabbits (Gallie 2023e pers. comm.; Hayes and Gallie 2024, pp. 10-11). Furthermore, if the forthcoming status review for the range-wide pygmy rabbit population results in a listing determination and subsequent regulations prohibiting the take of individuals in that population (89 FR 17 4884), this may impact our future ability to use pygmy rabbits for genetic rescue of Columbia Basin pygmy rabbit.

Breeding and Reintroduction Efforts: Captive Breeding 2002-2011

The Columbia Basin pygmy rabbit population has experienced severe declines and was assumed to be extinct in the wild, was rediscovered (1985, 2001), and then was confirmed to be extinct in the wild in 2004 (Figure 4; WDFW 1995, pp. 6, 14-15). In 2001, 16 purebred Columbia Basin pygmy rabbits were captured from the Sagebrush Flat Wildlife Area to start a captive breeding program at Washington State University. The captive breeding program moved to the Oregon Zoo in 2002 and later also to the Northwest Trek Wildlife Park in 2004 (Becker et al. 2011, pp. 2-5; Service 2013, p. 24). The initial goal of the captive breeding program was to produce as many purebred Columbia Basin pygmy rabbits as possible. However, due to low reproductive success likely resulting from inbreeding depression, the program was unable to produce sufficient offspring for reintroduction efforts (Becker et al. 2011, pp. 2-5; Service 2019, pp 2-3). In 2003, genetic rescue was conducted by introducing Idaho pygmy rabbits to the captive breeding program. Captive breeding was carefully managed to preserve unique Columbia Basin ancestry while maintaining the genetic health of the captive population. Even with careful management, there was still a high mortality rate of juveniles as well as high rates of infection and adult and juvenile mortality due to disease (intestinal infection, coccidiosis, and pneumonia; Elias et al. 2013, entire; Nerkowski 2021, pp. 2-5; Service 2019, pp. 2-3). In an effort to rear Columbia Basin pygmy rabbits in their geographic range, any future captive breeding will take place within their range in Washington (Hayes and Gallie 2023, p. 6).

Breeding and Reintroduction Efforts: Semi-wild Breeding 2011-Present

In 2011, the captive breeding program ended, and the semi-wild breeding program began in central Washington within three REAs. The goal of the semi-wild breeding program was to produce enough kits for reintroduction and to augment wild populations (Table 3). The semi-wild breeding program began in 2011 at Sagebrush Flat REA, owned by WDFW. Beezley Hills REA, owned by WDFW and private landowners, was added to the semi-wild breeding program in 2012; and Burton Draw REA, owned by WDFW, was added in 2015 (Figure 5; WDFW 2019, pp. 11-12). From 2011 to 2023, 1,790 kits born in the breeding enclosures were released, most at the Sagebrush Flat REA (Table 3).

Table 3. Number of Columbia Basin pygmy rabbit kits born in breeding enclosures and released in the wild in the three Recovery Emphasis Areas, Washington, 2011-2023 (Gallie 2023a, p. 3).

	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	Total
Total kits produced	0	150	381	794	590	157	122	17	35	105	71	111	6	2539
Total rabbits released	42	104	272	830	150	120	26	27	38	70	33	78	0	1790
Sagebrush Flat	42	104	272	830	150	120	0	0	0	0	0	2	0	1520
Rimrock												39	0	39
Beezley Hills				-	429	0	37	10	17	30	33	2	0	558
Palisades												35	0	35
Burton Draw									21	40				78

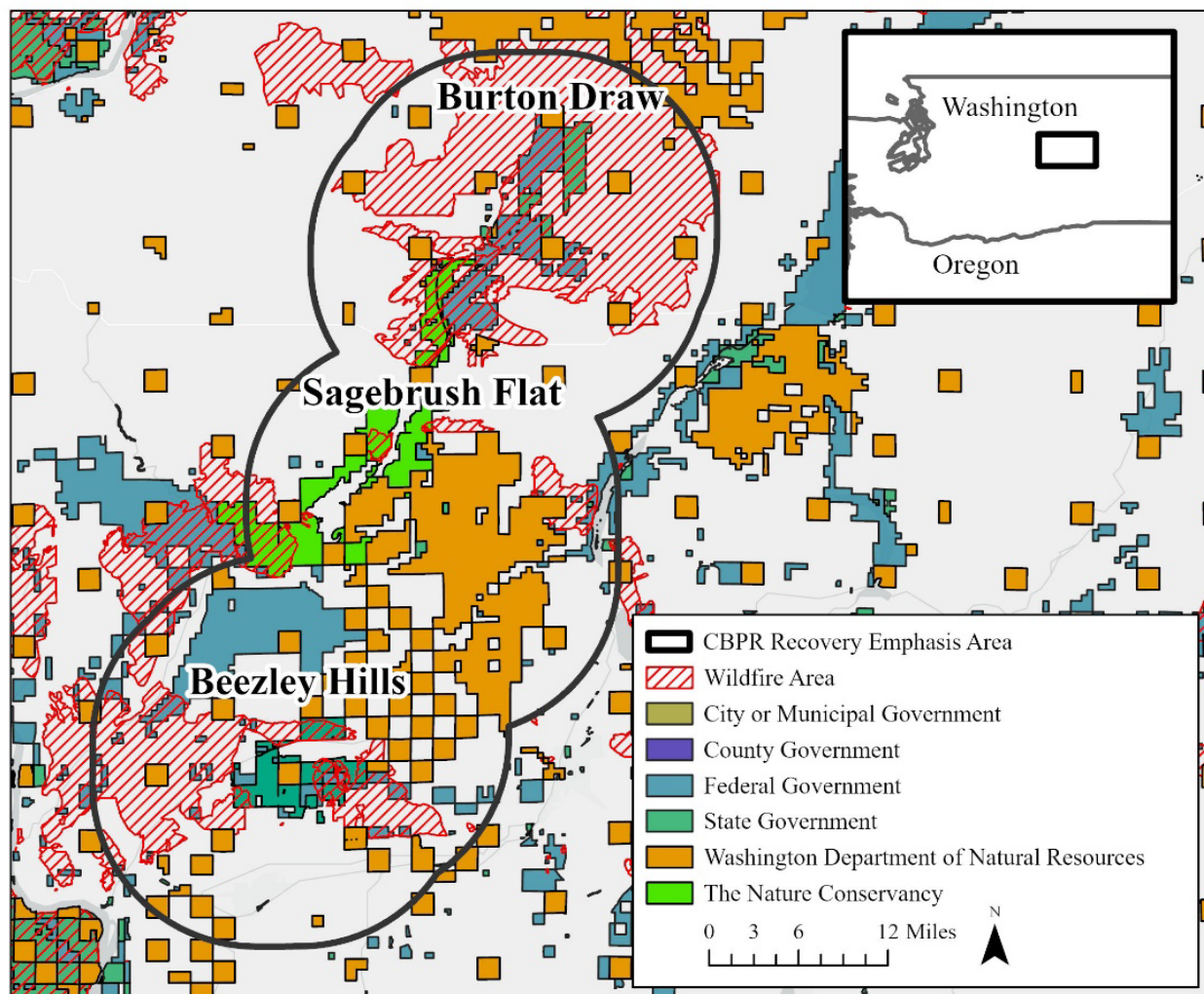


Figure 5. Map of land ownership and incidence of wildfire within three Columbia Basin pygmy rabbit Recovery Emphasis Areas (Service 2022; WDNR 2023a, WDNR 2023b; TNC 2024).

The semi-wild breeding program used various breeding enclosures and kit release methods (Figure 6). Breeding enclosure and release method strategies were adapted as needed due to unforeseen events. For example, when kit production fell, a new breeding enclosure was designed to continue producing kits for release into the wild.

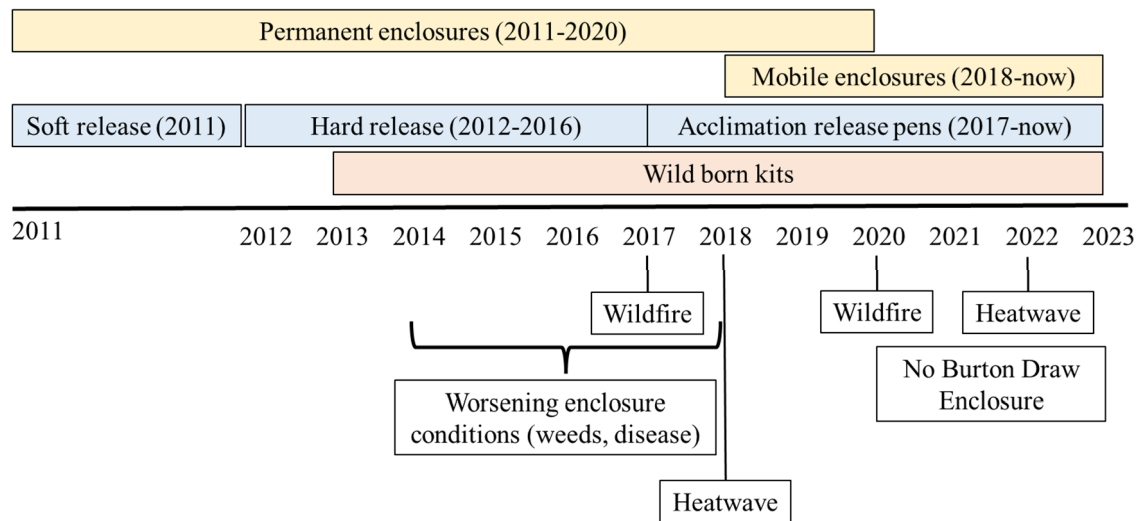


Figure 6. Timeline of semi-wild captive breeding strategies and release methods as well as the events leading to changes in management strategies.

Permanent enclosures (used from 2011 to 2020) were designed to reduce pygmy rabbit mortality and maximize kit production. Each enclosure required the installation of artificial burrows, feeding stations, raptor netting and irrigation to maximize survival (WDFW 2019, p. 14). There were four permanent enclosures constructed at two sites. In 2011, two enclosures were constructed at Sagebrush Flat Wildlife Area: a 10 ac (4 ha) enclosure and a 6 ac (2.4 ha) enclosure. In 2012, a 6 ac (2.4 ha) enclosure was constructed at the Dormaier Unit of the Sagebrush Flat Wildlife Area. In 2013, a fourth 10 ac (4 ha) enclosure, was constructed at Beezley Hills on private land (WDFW 2019, p. 14). Each permanent enclosure held 20 to 50 adults that produced kits for release into the wild. A small number of kits were retained to replace adults no longer reproducing due to old age or other factors. Kits were released into the wild using either soft release methods in 2011 (e.g., fenced artificial burrow with supplemental food and water provided) or hard release methods from 2012 to 2016 (e.g., only an artificial burrow provided). Rabbits within permanent breeding enclosures initially produced high numbers of kits, however, when released into the wild, kits had poor survival rates (20 percent) compared to wild-born kits (50 percent) (WDFW 2019, p. 12).

Despite years of successful kit production using the permanent breeding enclosures, several persistent problems emerged, including site degradation, disease outbreaks, and wildfires. Site degradation became problematic due to infestations of invasive weeds due to foot traffic, supplemental food sources, and irrigation (WDFW 2019, p. 14). Through concentrated use by pygmy rabbits and several heatwaves, native vegetation was reduced within enclosures, and it was estimated that by 2014-15, 25 percent of enclosure vegetation cover was non-native. Additionally, efforts to rehabilitate native shrub steppe vegetation within enclosures was not possible when rabbits were present (WDFW 2019, p. 14). Another persistent problem was

disease. An extensive outbreak of coccidia due to prolonged, high-density occupancy of the enclosures resulted in adult and kit mortality (WDFW 2019, p. 14). Lastly, permanent enclosures were not moveable in the event of emergencies such as wildfires. In 2017, the Sutherland Canyon Fire destroyed the Beezley Hills permanent enclosure and resulted in the loss of 50 percent of the semi-wild breeding population (WDFW 2019, p. 14).

In 2017, the hard release methods from used from 2012 to 2016 were replaced by using acclimation pens. Kits reared in enclosures were transferred to acclimation pens for release into the wild. These pens were designed to allow kits to either remain in the pen footprint and dig their own burrow or disperse under the barrier prior to fence removal after several months. The acclimation pens allow breeding and reintroduction program managers to select new recovery sites and establish subpopulations in suitable habitat within dispersal distance of occupied areas to facilitate breeding in the wild.

In 2018, the semi-wild breeding program strategy began to shift from permanent enclosures to 2 to 3 ac (0.8 to 1.2 ha) mobile enclosures that are relocated every 3 years. Mobile enclosures were designed to minimize site degradation issues and reduce the overall effort involved in husbandry and infrastructure maintenance (WDFW 2019, p. 14). Mobile enclosures require no digging or mowing and can easily be disassembled and reassembled in a new location (WDFW 2019, p. 15). After successful kit production in 2019 using one mobile enclosure, three additional mobile enclosures were constructed at Sagebrush Flat Wildlife Area, Beezley Hills, and Burton Draw; permanent enclosures were phased out entirely by 2020 (WDFW 2019, p. 15). Mobile enclosures produced fewer kits than permanent enclosures, but they produced hardier kits that were more likely to survive and reproduce. Post-release kit survival using mobile enclosures increased to 23.7 percent between 2017 and 2022, from an average of 8.5 percent between 2012 and 2016 when the permanent breeding enclosures were used (Gallie 2023b, entire).

In 2020, the Pearl Hill/Cold Springs Complex Fire burned all suitable habitat within the Burton Draw REA and destroyed an acclimation pen and resulted in the death of approximately half of the known Columbia Basin pygmy rabbits (Hayes and Gallie 2023, p. 8). Even with setbacks to recovery efforts, including site degradation, disease, and catastrophic wildfires; the semi-wild breeding program continues to be an important recovery tool for Columbia Basin pygmy rabbit. Producing rabbits remains crucial for establishing new subpopulations and augmenting existing subpopulations.

Breeding and Reintroduction Efforts: Reproduction of Released Rabbits 2011-Present

The current range of Columbia Basin pygmy rabbits is a product of reintroduction efforts, which are driven by quality habitat availability and fire. Monitoring of Columbia Basin pygmy rabbit subpopulations across that range includes presence/absence surveys for kits in the spring,

surveys for active burrows near release areas, and genetic analyses of fresh fecal pellet collections (WDFW 2019, p. 19). Additionally, each captured wild or captive born and released rabbit is PIT tagged and an ear punch sample is taken for genetic analyses (Gallie 2022, p. 11). In 2012, wild reproduction within release areas was first documented at Sagebrush Flat Wildlife Area (WDFW 2019, p. 9). From 2011 to 2015, less than 10 percent of all wild pygmy rabbits were born in the wild (Table 4; WDFW 2019, p. 9). However, by 2015, most pygmy rabbits detected at Sagebrush Flat Wildlife Area during winter burrow surveys were born in the wild (WDFW 2019, p. 9). Since the winter of 2016/2017, every Columbia Basin pygmy rabbit found at Sagebrush Flat Wildlife Area has been a wild born individual (WDFW 2019, p. 9).

Prior to the emergence of the lethal disease RHDV2, in 2020, the wild-born Columbia Basin pygmy rabbit population were not captured or handled. In 2021, the emergence RHDV2 led to an effort to trap all wild rabbits to administer a yearly vaccine (Hayes and Gallie 2023, p. 18).

Not related to RHDV2, declines in wild population at Sagebrush Flat have occurred (Table 4). Winter burrows detections at Sagebrush Flat drastically declined from 306 in the winter of 2018/2019 to 27 in the winter of 2019/2020 (Table 4). The reason for this decline is unknown, and the numbers of rabbits in the Sagebrush Flat subpopulation remains low (Hayes and Gallie 2023, p. 14). The number of active burrows has steadily increased across years at Beezley Hills (Table 4). Population monitoring of wild born Columbia Basin pygmy rabbits continues to be important to assess occupied areas, collect samples for genetic analysis, and trap individuals for vaccinations.

Table 4. Results of annual winter burrow surveys (2012-2023) for Columbia Basin pygmy rabbits at subpopulations and REAs.

Site names	Variable	Years										
		12/13	13/14	14/15	15/16	16/17	17/18	18/19	19/20	20/21	21/22	22/23
Sagebrush Flat REA	No. active burrows	52	64	174	88	146	336	306	27	80	67	130
	Percent released kits detected	37	11	10	<1	4						
	No. genetically identified rabbits	43	40	89	17	63	175	140	8	31	31	57
	Percent identified rabbits wild born	9	9	3	88	92	100	100	100	100	100	96
Beezley Hills REA	No. active burrows							6	9	43	77	84
	Percent released kits detected							30	36	33	3	6
	No. genetically identified rabbits								5	21	25	61
	Percent identified rabbits wild born						4	25	0	71	96	93
Burton Draw REA (now extirpated)	No. active burrows							11	22			
	Percent released kits detected							35	48			
	No. genetically identified rabbits								10			
	Percent identified rabbits wild born						6	0	0			
Rimrock subpopulation	No. active burrows											13
	Percent released kits detected											
	No. genetically identified rabbits											8
	Percent identified rabbits wild born											

Current Estimated Abundance

Estimating the number of wild Columbia Basin pygmy rabbits is done in two ways: genetic analysis using fecal samples (minimum number of genetically identified rabbits) and via a calculation using a combination of occupied burrows and genetic analysis (estimated number of rabbits). Beginning in 2012, fecal pellets collected during annual winter burrow survey data were sent to University of Idaho for genetic analysis to determine parentage and calculate the minimum number of genetically identified individuals. From 2012 to 2023, the minimum number of genetically identified individuals has ranged from 8 to 175 at Sagebrush Flat (Table 4). From 2018 to 2023, the minimum number of genetically identified individuals had ranged from 61 to 4 at Beezley Hills (Table 4). Because fecal pellet collection is dependent on the level of sampling effort and the ability to detect pellets, it is assumed that the minimum number of genetically identified individuals is an underestimate of the number of rabbits on the landscape.

The estimated number of rabbits is calculated as the ratio of the number of burrows with positive rabbit identification to the minimum number of genetically identified rabbits, divided by active burrows (Gallie 2024c pers. comm.). In 2023/2024, a minimum of 52 genetically identified individuals were detected at Sagebrush Flat, 37 at Beezley Hills, and 6 at Rimrock; which equates to an estimated 83 rabbits at Sagebrush Flat, 45 at Beezley Hills, and 8 at Rimrock. The total estimated number of Columbia Basin pygmy rabbits as of the winter of 2023/2024 was 136 individuals.

Table 5. Estimated number of Columbia Basin pygmy rabbits (winters 2012/13-2023/24).

	12/13	13/14	14/15	15/16	16/17	17/18	18/19	19/20	20/21	21/22	22/23	23/24	Average
Sagebrush Flat													
Active burrows	52	64	174	88	146	336	306	27	80	67	130	123	132
No. burrows with rabbit ID	52	59	145	17	68	165	195	23	50	50	120	77	85
Minimum no. genetically identified rabbits	43	40	89	17	63	158	140	8	31	20	56	52	59
Ratio of active burrow to minimum no. genetically identified rabbits	1.2	1.5	1.6	1.0	1.1	1.0	1.4	2.9	1.6	2.5	2.1	1.5	1.6
Estimated total rabbits	43	43	107	88	135	321	219	9	49	26	60	83	98
Beezley Hills													
Active burrows							6	9	43	77	84	93	52
No. burrows with rabbit ID							5	9	33	67	79	76	45
Minimum no. genetically identified rabbits							4	5	19	25	61	37	25
Ratio active burrow to minimum no. genetically identified rabbits							1.3	1.8	1.1	2.7	1.3	2.1	1.7
Estimated total rabbits							5	5	25	29	65	45	29
Rimrock													
Active burrows											13	15	14
No. burrows with rabbit ID											10	12	11
Minimum no. genetically identified rabbits											8	6	7

Ratio active burrow to minimum no. genetically identified rabbits											1.3	2.0	1.6
Estimated total rabbits											10	8	9

3.0 SPECIES NEEDS

Viability for this DPS is defined as the ability of the Columbia Basin pygmy rabbit to sustain populations in natural and / or human-modified habitats over time, and is characterized in terms of resiliency, redundancy, and representation (Shaffer and Stein 2000, pp. 307-310). In this section, we first summarize information from Section 2 identifying Columbia Basin pygmy rabbit individual resource needs, then articulate our understanding of population-level resiliency, as well as DPS-level redundancy and representation.

3.1 Individual Resource Needs

We evaluated the best available information to identify the physical and biological resources needed to support individuals at all life stages including adult, juvenile/kit, and neonate. As summarized in Table 6, the needs that are considered most critical include the following: tall, dense sagebrush; grasses and forbs; deep, loose, sandy-loam soils; and connectivity between habitat patches.

Table 6. Columbia Basin pygmy rabbit individual resource needs and functions at life stages.

Resource Need	Life Stage	Function	Citations
Areas of tall, dense big sagebrush at least 20-30 years old, with accessible branches for foraging	Adult, Juvenile, Neonates	Feeding (including via lactation), predator avoidance (including burrow placement)	Columbia Basin pygmy rabbits at all life stages require areas of tall, dense big sagebrush that is at least 20-30 years old for predator avoidance and food (Siegel Thines et al. 2004, pp. 525-526; Shipley et al. 2006, p. 2456; Gallie 2024b pers. comm.).
Perennial bunchgrasses and forbs	Adult, Juvenile, Neonates	Feeding (including via lactation)	Grasses and forbs provide supplemental nutrition to Columbia Basin pygmy rabbits; availability of this vegetation coincides with the breeding season peak in March, and most of the gestation (late February to June) and nursing (March to September) periods (WDFW 2019, pp. 2-3).
Deep, loose, sandy-loam soils that allow for burrowing and natal dens	Adult, Juvenile, Neonates	Sheltering, nesting	At all life stages, Columbia Basin pygmy rabbits require specific soil types that allow for the creation of burrows for sheltering, nesting, predator avoidance, thermoregulation, and reproduction; burrows are most often found in gently sloped or mounded areas with soils that

			are of wind-borne or water-borne origin, are loose sandy-loam, and are relatively deep, usually greater than 51 cm (20 in)), (WDFW 1995, p. 7; Wilde 1978, p. 26; USDA 1991; Gahr 1993, pp. 81-82, 90, WDFW 1995, p. 7).
Connectivity between patches of suitable habitat	Adult, Juveniles	Dispersal	Because site occupancy by Columbia Basin pygmy rabbits reduces the quality and quantity of sagebrush forage and cover over time, pygmy rabbits shift areas used for foraging to maintain sufficient food and cover resources (Edgel et al. 2014, entire; Parsons et al. 2016, p. 13; Nerkowski 2021, pp. 105-106). Therefore, individuals require a connected network of suitable habitat patches to enable dispersal of juveniles and adults across the landscape.

3.2 Population Needs

3.2.1 Resiliency

We used the best available information to assess the resources, circumstances, and demographics that most influence the resiliency of Columbia Basin pygmy rabbit subpopulations. Resiliency gauges the probability that a subpopulation can withstand or recover from environmental or demographic stochasticity, such as droughts and predation. Resiliency depends on both habitat and demographic factors.

To be resilient, Columbia Basin pygmy rabbit subpopulations need sufficient connected suitable habitat to support individuals throughout all life stages (Table 6). We used the percent of suitable habitat within a subpopulation's area as a metric of the habitat quality of a subpopulation. Based on the One Range model, subpopulations occupying an area with at least 75 percent suitable habitat is considered high quality (discussed further in section 5.1 Methodology: habitat and demographic metrics, ranking level criteria). Suitable habitat must be a connected network of habitat patches to ensure individuals have continual access to sufficient forage and cover.

From a demographic perspective, for a subpopulation to be resilient, it must have a sufficient number of successfully reproducing adults and birth rates must be greater than death rates. Generally, subpopulations with more individuals are better able to withstand stochastic events (Service 2019, p. 4) than those with fewer individuals. For Columbia Basin pygmy rabbits, we

estimate that subpopulations of 500 individuals will maximize sufficient resiliency (discussed further in section 5.1 Methodology: habitat and demographic metrics, ranking level criteria). Lastly, the genetic diversity of the subpopulation must be sufficient to allow individuals to survive, reproduce, and adapt to local conditions.

3.3 Species Viability Needs

For the Columbia Basin pygmy rabbit, resiliency is assessed at the subpopulation level while representation and redundancy are assessed across the entire range of the Columbia Basin pygmy rabbit.

3.3.1 Redundancy

Redundancy gauges a species' ability to withstand catastrophic events or those expected to result in the extirpation of a population regardless of its resiliency (Mangal and Tier 1993, p. 1083). Redundancy is about spreading risk. Species with more populations are less susceptible to extinction and more redundant than those with fewer populations, and species that are well-distributed across their range are less susceptible to extinction and are more redundant than species confined to a small portion of their range. At present, Columbia Basin pygmy rabbits occur in a single population composed of three subpopulations, all located within a 90 mi² (230 km²) area (Gallie 2023f pers. comm.). Increasing the number of resilient subpopulations across a larger area would increase the species' redundancy and increase its ability to withstand catastrophic events such as wildfires.

3.3.2 Representation

Representation gauges a species capacity to adapt to changing environmental conditions. Genetic and ecological diversity within and among subpopulations are measures of representation. Sufficient representation enhances the likelihood that the Columbia Basin pygmy rabbit population will remain viable as environmental conditions change, for example, due to climate change as well as changes in stressors such as disease. The genetic diversity of Columbia Basin pygmy rabbits is high due to a series of genetic rescues, however, much of the Columbia Basin pygmy rabbit's genetic diversity today has been lost due to rapid population declines (i.e., genetic bottlenecks) and potentially genetic drift subsequent to the bottlenecks. It is imperative to maintain genetic diversity within and among subpopulations for long-term adaptability and survival of the species. The species' ecological diversity is currently limited due to its narrow range (Gallie 2023f pers. comm.). To increase representation, the species' genetic diversity must be maintained, and its range must be expanded into more ecologically diverse areas.

4.0 FACTORS INFLUENCING THE SPECIES

Here we discuss the factors that influenced historical subpopulations of Columbia Basin pygmy rabbits and consider the degree to which these factors are still affecting current subpopulations.

We also note whether any of these factors are likely to continue affecting Columbia Basin pygmy rabbits into the future. Factors that appear to have negative effects are considered threats while those that appear to have positive effects are considered conservation measures. We summarize the information on threats and regulatory and voluntary conservation measures and their effects on the viability of Columbia Basin pygmy rabbits.

When evaluating factors under the Species Status Assessment framework (Service 2016, entire), we considered the scope and magnitude of their effects to determine their effect on the resiliency of subpopulations as opposed to individuals. For example, while predation is a threat to individuals, it is not considered a threat to a subpopulation's resiliency and was therefore not used to evaluate resiliency. While effects to individuals ultimately contribute to the condition of a subpopulation, this analysis focuses on threats and conservation measures with the greatest demographic consequences. Threats analyzed include habitat loss, degradation, and fragmentation; wildfire; climate change; disease; and low genetic diversity. Conservation measures analyzed include regulatory conservation measures, Safe Harbor Agreements (SHAs), Cooperative Endangered Species Conservation Funds (i.e., Section 6 grants), habitat restoration, conservation easements and land donations, the CRP and State Acres for Wildlife Enhancement (SAFE) Initiative, and other conservation measures. Our analysis of resiliency is limited to factors that currently demonstrate a subpopulation-level effect. Our analysis of redundancy and representation is limited to factors that currently demonstrate a species-level effect.

4.1 Threats Carried Forward

4.1.1 Habitat Loss, Degradation, and Fragmentation

Due to changes in land use, degradation of habitat from invasive species, and urban development; shrub steppe ecosystems across the Western United States now occur in less than half of their historical distribution (Pyke et al. 2018; entire). In the Columbia Plateau ecoregion in Washington, it is estimated that 10.4 million ac (4.2 million ha) of shrub steppe existed prior to the arrival of settlers in the 19th century (Dobler et al 1996, p. 10); less than 20 percent of that shrub steppe habitat is intact and ecologically functional today (Daubenmire 1988, p. 1; Franklin and Dyrness 1988, pp. 209-211; Dobler et al. 1996, pp. 1-3; WDFW 1995 pp. 15-16). In the Columbia Plateau ecoregion in Washington, large portions of the native shrub steppe habitats present prior to European settlement have been fragmented and converted to dry-land and irrigated agricultural production. Areas with the deep soils necessary for crop production, and for the Columbia Basin pygmy rabbit, were disproportionately converted to agriculture.

Loss and fragmentation of shrub steppe habitat is considered the main contributor to pygmy rabbit population declines throughout their range (Weiss and Verts 1984, p. 563; Siegel Thines et al. 2004, pp. 525-526; Larrucea and Brussard 2008, p. 691; Nerkowski 2021, p. 63). As of 2016, only 21 percent of land within the currently designated DPS is suitable for Columbia Basin pygmy rabbits (Table 7; Figure 7; Service 2022, entire). Because of their inability to occupy

agricultural lands and their relatively restricted movements, loss and fragmentation of shrub steppe habitats severely limits Columbia Basin pygmy rabbits' ability to disperse (Weiss and Verts 1984, pp. 568-569; Katzner and Parker 1998, p. 72; Service 2019, pp. 13-14). Dispersal is critical to Columbia Basin pygmy rabbits because they must move between populations to breed and establish new metapopulations (Parsons et al. 2016, p. 13; Service 2019, p. 10; Nerkowski 2021, pp. 105-106).

Table 7. Area (acres [hectares]) of potentially suitable Columbia Basin pygmy rabbit habitat in the Columbia Plateau ecoregion in Washington (EPA 2013; Service 2022).

Area	Total Area - Acres (Hectares)	Potential Suitable Habitat - Acres (Hectares)
Columbia Plateau Ecoregion	141,263,579 (57,167,342)	NA
Columbia Plateau Ecoregion in WA	33,006,260 (13,357,159)	14,817,901 (5,996,590)
Currently Designated DPS	16,486,882 (6,672,031)	6,904,135 (2,794,015)
Subpopulations	150,986 (61,101)	99,460 (40,250)

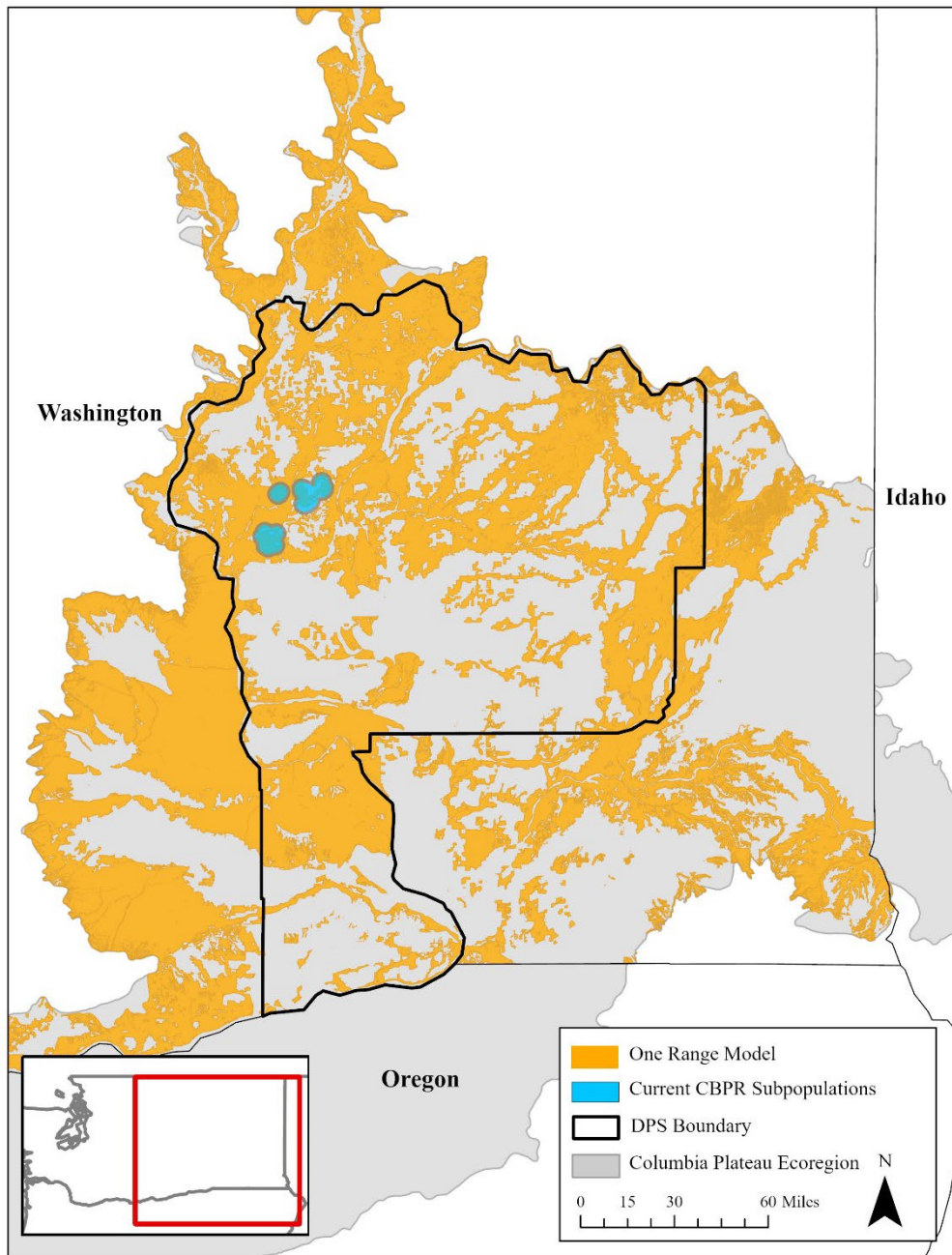


Figure 7. Map of Columbia Basin pygmy rabbit suitable habitat as delineated using the One Range Model (EPA 2013; Service 2022).

Given that Columbia Basin pygmy rabbits readily use lands enrolled in CRP/State Acres for Wildlife Enhancement (SAFE) programs, if lands are removed from these programs there would be an increased risk of suitable habitat being converted back to agricultural production (Gallie 2023a, pp. 6-7). If enrolled lands are withdrawn from the CRP/SAFE programs, mature

sagebrush habitat that Columbia Basin pygmy rabbits require could be lost (Gallie 2020, pp. 6-7) and subpopulations could face extirpation if there is no suitable habitat within dispersal distance or no suitable dispersal habitat.

Habitat loss, degradation, and fragmentation affects individuals and subpopulations via direct mortality and decreased fitness and reproductive output. These threats reduce individual Columbia Basin pygmy rabbit's access to the habitats necessary for feeding, sheltering, nesting, predator avoidance, and dispersal (Table 6). Although most loss, degradation, and fragmentation of suitable habitat throughout the Columbia Plateau ecoregion occurred historically, these threats continue to affect each subpopulation and will likely continue into the future.

4.1.2 Wildfire

Wildfire is a naturally occurring disturbance in the shrub steppe that shapes the ecological function of the ecosystem (Remington et al. 2021, p. 81). Historically caused largely by lightning strikes, shrub steppe wildfires varied in intensity depending on seasonal precipitation and fuels. Though infrequent, large, and severe wildfires did historically occur in the shrub steppe (Brooks et al. 2015, pp. 3-4, Remington et al. 2021, p. 81). The natural fire return interval may have been hundreds of years in sagebrush communities, which would have allowed for recovery of sagebrush between fires (Bukowski and Baker 2013, entire; Brooks et al. 2015, pp. 3-4; Remington et al. 2021, p. 81). Increased incidence of wildfire in the shrub steppe since European settlement is strongly associated with the introduction of nonnative invasive annual grasses that have become well established throughout the greater Columbia Plateau ecoregion (Daubenmire 1988, pp. 80-82; Franklin and Dyrness 1988, pp. 231-232; Balch et al. 2013, pp. 173-175; Brooks et al. 2015, pp. 3-4). Nonnative invasive annual grasses like cheatgrass readily invade arid and semiarid native plant communities, senesce early in the growing season, and increase the continuity of fine fuels that promote the ignition and spread of fire. These dynamics create a positive feedback loop referred to as the “invasive grass-fire cycle,” resulting in increased fire frequency and postfire conditions that favor the dominance and spread of invasive species over the recovery of native sagebrush communities (Brooks et al. 2004, entire). Based on the recent history of recurrent fires in the Columbia Plateau ecoregion, the invasive grass-fire cycle may result in the wholesale conversion of this ecosystem (Figure 8; Brooks et al. 2015, p. 37). Although shrub steppe fire return intervals may have been hundreds of years historically, intervals as little as 3 to 5 years occur in sage steppe habitats dominated by nonnative invasive annual grasses (Remington et al. 2021, p. 13). Sagebrush is fire intolerant and easily killed by fire, and it takes decades for sagebrush to mature, therefore, frequent fires prevent sagebrush recovery (Daubenmire 1988, p. 7; WDFW 1995, p. 16; Service 2019, p. 14; Brooks et al. 2015, pp. 3-4). Thus, shorter fire return intervals can result in the extirpation of sagebrush habitat.

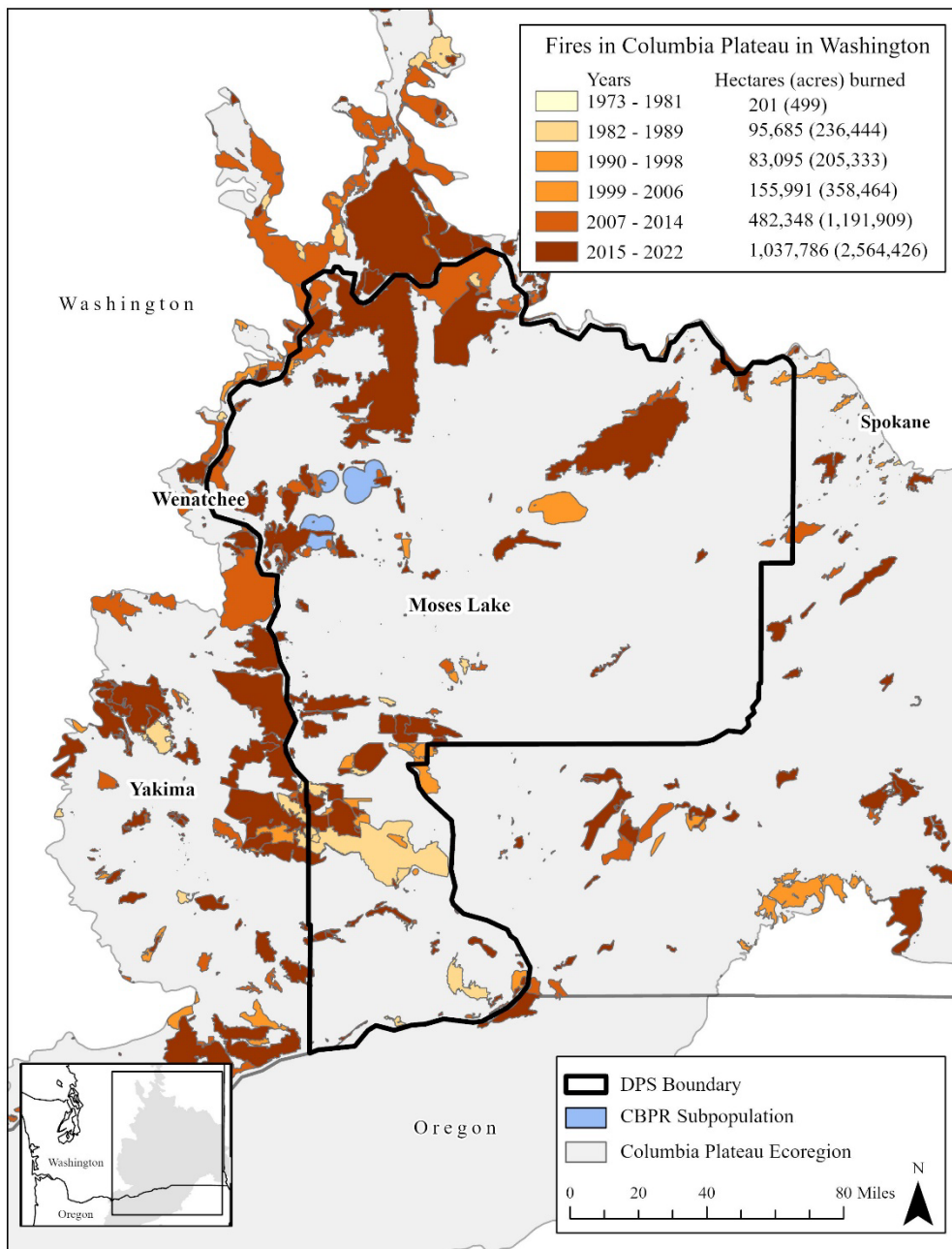


Figure 8. Map showing incidence of wildfire in the Columbia Plateau ecoregion in Washington from 1973 to 2022 (EPA 2013; Service 2022; WNDR 2022).

Wildfires negatively affect all life stages of Columbia Basin pygmy rabbits by direct mortality and reduced fitness via destruction of the habitats on which they depend (Table 6). Increased fire frequency also will reduce the amount of suitable but unoccupied habitat, thus reducing opportunities to expand the species' range (WDFW 1995, pp. 15-16). Under the best circumstances, active restoration of burned shrub steppe habitat can take at least 15-20 years before it is suitable for use by Columbia Basin pygmy rabbits (Gallie 2021, p. 8). The incidence of fire has increased both within the Columbia Basin pygmy rabbit currently designated DPS and in the Columbia Plateau ecoregion in Washington outside the currently designated DPS, impacting subpopulations and decreasing the amount of suitable habitat available for the species (Figure 8). Wildfire negatively affects resiliency and redundancy and can result in the extirpation of subpopulations (WDFW 1995, p. 20; Service 2012, p. 12; Gallie 2021, pp. 4-8).

Wildfires resulted in the extirpation of Columbia Basin pygmy rabbit subpopulations in 1979 and 1999 (WDFW 1995, p. 20; Service 2012, p. 12). In June 2017, the Sutherland Canyon wildfire burned 30,000 ac (12,141 ha) of shrub steppe habitat within the Beezley Hills REA, destroying habitat including the 10 ac (4 ha) breeding enclosure and three release pens (Hayes 2018, p. 7). At least 85 individuals were killed, including all 26 kits released in spring 2017 (WDFW 2019, p. 4). Thirty-two rabbits survived the fire and were relocated to other breeding enclosure sites. Although these individuals initially appeared healthy, they experienced high mortality and lingering health issues the winter following the fire, likely due to smoke inhalation and stress from fires and the subsequent relocations. This single fire resulted in the loss of nearly half of the semi-wild breeding population and an undetermined number of wild Columbia Basin pygmy rabbits (Hayes 2018, p. 7; WDFW 2019, p. 1).

In September 2020, the Cold Springs/Pearl Hill Fire Complex burned over 400,000 ac (167,408 ha), devastating Columbia Basin pygmy rabbit recovery efforts when the Pearl Hill Fire burned 224,000 ac (90,650 ha) in a single day (Gallie 2021, pp. 4-8). Due to extreme weather and fire behavior, it was not possible to protect project infrastructure or occupied habitat. The wildfire destroyed all occupied habitat and infrastructure at the Burton Draw REA, one of two primary reintroduction sites, where a subpopulation was established between 2018-2021 (Figure 5). Affected suitable habitat included private lands enrolled in a Safe Harbor Agreement (SHA) with the Service. Burn severity in the REA was very high and almost all vegetation, including sagebrush, was killed. The fire killed all 20 adult rabbits in breeding enclosures and 40 kits in acclimation pens intended for release into the wild. Due to the severity of the fire and magnitude of habitat and burrow destruction, it is assumed that all wild Columbia Basin pygmy rabbits occupying the approximately 1,000 ac (405 ha) REA were killed by the fire. The number of wild Columbia Basin pygmy rabbits killed is yet to be determined as fecal samples collected before the fire are still being analyzed (Gallie 2021, pp. 4-8; Gallie 2023d pers. comm.). This wildfire killed 43 percent of the semi-wild breeding population in a matter of hours, and a yet to be determined number of wild Columbia Basin pygmy rabbits. With active restoration efforts, the

habitat at Beezley Hills and Burton Draw may be suitable for Columbia Basin pygmy rabbits in 15-20 years, if native vegetation establishes and subsequent fires do not occur.

Despite the sizeable effect the Cold Springs/Pearl Hill Fire Complex had on Columbia Basin pygmy rabbit recovery efforts, only a portion of this fire occurred within the currently designated DPS. However, the 400,000 ac (167,408 ha) area burned was significantly larger than the 57,600 ac (23,310 ha) area currently occupied by Columbia Basin pygmy rabbits (Gallie 2023f pers. comm.); the burned area was approximately five percent of all potentially suitable habitat found in the Columbia Basin pygmy rabbit DPS (195,206 ac (78,997 ha); Table 7). Thus, a single wildfire could result in the species' extinction or could destroy a significant portion of the suitable habitat within the species' DPS, setting recovery efforts back decades (Gallie 2021, p. 8).

The threat of wildfire has increased in scope, magnitude, and intensity based on historical records as well as from the time of listing to today. Wildfire is now the primary threat to the Columbia Basin pygmy rabbit, and the incidence of catastrophic wildfires will likely continue to increase over time due to climate change and the invasive grass-fire cycle. During any given fire season, tens of thousands of acres of suitable habitat in the Columbia Plateau ecoregion (both in and out of the species' currently designated DPS) could burn and be unusable to Columbia Basin pygmy rabbits for decades. It is impossible to accurately predict the location, size, or severity of future wildfires; therefore, our ability to manage for the threat is limited.

The well-documented effects of wildfires on Columbia Basin pygmy rabbit demography and habitat unequivocally demonstrate that the current number and distribution of subpopulations in the DPS is insufficient to protect the species from the threat of wildfire. The growing threat from wildfire overwhelms efforts to increase the number and distribution of Columbia Basin pygmy rabbit subpopulations in the limited amount of suitable habitat available within the DPS. There is simply insufficient suitable habitat within the currently designated DPS to safeguard subpopulations against wildfire; this constrains our ability to recover the Columbia Basin pygmy rabbit.

However, an additional 7.9 million ac (3.2 million ha) of potentially suitable habitat exists in the Columbia Plateau ecoregion in Washington that are unavailable for recovery efforts, as they are outside of the currently designated DPS (Table 7). The ability to conduct recovery actions on these lands would increase our ability to enhance the redundancy and representation of the Columbia Basin pygmy rabbit and increase the species' ability to persist in the face of increasing wildlife. Given the significant and increasing threat of wildfire, these areas are a crucial to our ability to maintain this species in the wild.

4.1.3 Climate change

The Intergovernmental Panel on Climate Change (IPCC) defines climate change as a change in

the state of the climate that can be identified (e.g., by using statistical tests) by changes in the mean and / or the variability of its properties, and that persists for an extended period, typically decades or longer. Climate change may be due to natural internal processes (e.g., cyclical ocean patterns) or external forces such as modulations of the solar cycles, volcanic eruptions, and persistent anthropogenic caused changes in the composition of the atmosphere or in land use (IPCC 2018, p. 544). Climate change is currently occurring and is projected to continue with global impacts (IPCC 2018, entire). Human activities have caused a temperature increase of approximately 1.8 °F (1 °C) from pre-industrial levels and are likely to reach an increase of 2.7 °F (1.5 °C) between 2030 and 2052 if warming continues to increase at the current rate (IPCC 2018, p. 4). The average annual temperature in Douglas County, WA has trended upward since 1895 (NOAA 2023).

In the Pacific Northwest, it is expected that warming will occur in all seasons, with drier summers and wetter winters (Washington Department of Ecology 2012, pp. 36-37). In the Columbia Plateau shrub steppe, warmer temperatures and reduced summer precipitation are increasing the frequency and extent of wildfire and drought conditions, driving shifts in plant and animal community composition and expansion of non-native species (Remington et al. 2021, p. 121-125; Shirk, et al. 2021, pp. 22-23). Climate projections indicate that temperatures will continue to increase across the greater Columbia Plateau ecoregion, and the ecoregion will continue to become more arid (Snyder et al. 2019, entire). Droughts will likely occur more frequently, and will be longer, furthering the expansion of invasive annual grasses. Climate scientists expect longer and hotter fire seasons and more extreme fire weather conditions in the next 30-40 years, which will likely lead to an increase in occurrence of very large fires (Snyder et al. 2019, entire; Remington et al. 2021, pp. 121-125).

Climate change effects each of the three Columbia Basin pygmy rabbit subpopulations similarly and is expected to exacerbate other stressors effecting viability. The consequences to species' viability of climate change are likely to be severe because of historical habitat loss and land use decisions. Climate change will likely have a considerable and increasing influence on Columbia Basin pygmy rabbit viability in the future.

4.1.4 Disease

Throughout their range, pygmy rabbits often harbor a high parasite load (WDFW 1995, p. 20), and some of these parasites (e.g., ticks, fleas, lice), can be disease vectors (Gahr 1993, pp. 42-43). Episodes of plague (*Yersinia pestis*) and tularemia (*Francisella tularensis*) from these vectors have been reported in populations of other rabbit species, often spreading rapidly, and causing high rates of mortality (Quan 1993, entire). Coccidia, (*Coccidiasina*) a parasitic protozoan that resides in animal intestinal tracts, was a persistent problem for the captive Columbia Basin pygmy rabbit breeding population in 2002 through 2004, and those in permanent breeding enclosures in 2015 through 2018 (Harrenstein et al. 2006, pp. 499, 505, 510; Harrenstein et al. 2006, p. 5; Hayes 2018, p. 10; Gallie 2023a, pp. 12-13). Coccidiosis may be

most detrimental in neonate pygmy rabbits, as both adult and juveniles can apparently remain symptom free while harboring high levels of coccidia (Harrenstein et al. 2006, p. 12). In 2016, there was a 73 percent decline in kit production corresponding to the onset of a widespread coccidiosis outbreak (Gallie 2023a, pp. 12-13). When compared to pygmy rabbits from Idaho, the immune response of Columbia Basin pygmy rabbits in the captive breeding population was significantly lower, possibly due to inbreeding and a higher susceptibility to disease (Harrenstien et al. 2006, entire; Becker et al. 2011, p. 4).

Because coccidia has affected the survival, fitness, and productivity of breeding populations in both captive and semi-wild breeding enclosures, breeding populations are now closely monitored for coccidia infection, and treated as necessary, with the goal of limiting juvenile exposure to coccidia before they are translocated to the wild (Gallie 2023a, pp. 12-13). In 2022, semi-wild breeding enclosures showed the lowest coccidia levels and infection rates observed since monitoring began in 2017 and are comparable to levels observed in wild Columbia Basin pygmy rabbit populations.

Rabbit Hemorrhagic Disease Virus Type 2 (RHDV2) is an emerging threat to wild lagomorph populations across the western U.S. This highly contagious disease, which has been described as “rabbit Ebola,” has a mortality rate of about 90 percent in feral and domestic rabbit populations and no known cure (WDFW 2022, entire). This disease can be spread by humans (e.g., via tools, boots, vehicles) or transmitted via direct contact with live or dead infected rabbits or contaminated food, water, feces, and soil (USDA 2023a; Crowell et al. 2023, pp. 342-343). Rabbit Hemorrhagic Disease Virus Type 2 was first detected among wild rabbits in New Mexico in 2020 and has since been reported across 10 U.S. states (USDA 2023a; Center for Food Security and Public Health 2020). It was first detected in wild rabbits in western Washington in 2023. As of May 2024, RHDV2 has not been detected in the Columbia Basin pygmy rabbit population (WDFW 2023, entire; Gallie 2023a, pp. 13-14).

The introduction of RHDV2 has significant implications for rabbits that have restricted ranges and / or are species of special conservation concern, such as the Columbia Basin pygmy rabbit (Crowell et al. 2023, pp. 342-344). The introduction of a major new source of mortality could lead to extirpation of subpopulations. At a site in Nevada, monitoring of pygmy rabbit abundance occurred from 2016-2022. In July-December 2021, 17 pygmy rabbits were captured by researchers. In January 2022, RHDV2 was detected in a pygmy rabbit carcass at this site. From April to early July 2022, no pygmy rabbits were documented at this site. Considering the number of captures and documented level of pygmy rabbit activity at this site before and after the confirmed detection of RHDV2 infection, it appears that RHDV2 caused the extirpation of this pygmy rabbit population. There is evidence suggesting that RHDV2 can serially infect subpopulations, reappearing over and over, resulting in additional mortalities (Crowell 2024 pers. comm.). Should RHDV2 reach the range of the Columbia Basin pygmy rabbit, it could extirpate one or more subpopulations in a matter of months.

Given the emergent threat of RHDV2, in 2020, a disease management plan was implemented for the Columbia Basin pygmy rabbit (Gallie 2023c pers. comm.). Biosecurity procedures, such as washing equipment and boots, are strictly followed, and coordination with veterinarians, who procure the vaccine and provide guidance in its administration, occurs annually. Beginning in 2020, vaccinations were administered to rabbits in semi-wild breeding enclosure. In 2021, vaccinations were administered to all enclosure-bred juveniles before they were released into the wild. In late 2021, RHDV2 was detected in Oregon and Idaho and the arrival of the disease in eastern Washington appeared imminent. Since then, all adults and juveniles in semi-wild breeding enclosures are vaccinated before being released or retained for future breeding seasons. Wild rabbits are also trapped and vaccinated. While there are risks to trapping and handling rabbits and individuals must be annually vaccinated, those individuals not captured and vaccinated are at significant risk from RHDV2.

While the threat of coccidia to Columbia Basin pygmy rabbit has decreased since the semi-wild breeding efforts transitioned to mobile breed enclosures in 2017, the overall threat of disease has increased due to the emergence of RHDV2. Although the virus has not been detected in eastern Washington, RHDV2 is a threat to individuals of all life stages at each of the three Columbia Basin pygmy rabbit subpopulations. This disease would influence Columbia Basin pygmy rabbit individuals and subpopulations via direct mortality. Rabbit Hemorrhagic Disease Virus Type 2 has extirpated pygmy rabbit populations outside of the Columbia Plateau ecoregion and could be a significant source of mortality for Columbia Basin pygmy rabbits if the disease reaches the subpopulations, despite efforts to vaccinate individuals. Increasing the geographic distribution of subpopulations, thereby increasing redundancy, would decrease the extirpation risk of subpopulations or the species due to RHDV2.

4.1.5 Low Genetic Diversity

At-risk species or species that occur in small or isolated populations may lose genetic diversity due to genetic drift, inbreeding depression, or genetic bottleneck. Loss of genetic diversity may limit adaptive potential and result in a decline in individual fitness, which can lead to an increased likelihood of extinction (Tallmon et al. 2004, p. 489; Willi et al. 2006, pp. 433-435, Elias et al. 2013, pp. 1282-1283; Nerkowski 2021, p. 1). Small population size and isolation has resulted in inbreeding depression and reduced reproductive capacity of Columbia Basin pygmy rabbits (Elias et al. 2013, pp. 1282-1283; Hayes 2018, p. 8; Nerkowski 2021, p. 1).

Low genetic diversity can affect Columbia Basin pygmy rabbit individuals of all life stages by potentially reducing individual fitness, survival, and reproduction rates and can also influence the resiliency of subpopulations by impacting abundance and subpopulation growth rate. This threat has had negative effects on individuals and subpopulations in the past. As Columbia Basin pygmy rabbit abundance dwindled after the mid-1900s, the species experienced inbreeding depression and genetic diversity declined (Figure 4; WDFW 1995, pp. 6, 14-15; Service 2003, p. 10406; Service 2010b, pp. 7-8, Becker et al. 2011, pp. 3-5; Hayes 2018, p. 8). In 2001, genetic

analysis of samples collected from live rabbits in 2001 to museum specimens collected 50 years ago found a significant reduction in genetic diversity (observed heterozygosity 0.33 vs. 0.52; Warheit 2001, pp. 3-5; Becker et al. 2011, pp. 3-5). The study also indicated that the species' genetic diversity was significantly less compared to that of pygmy rabbit populations from outside of Washington (observed heterozygosity 0.69-0.85).

As a result of multiple genetic rescue efforts in the past 20 years, the genetic diversity of Columbia Basin pygmy rabbit subpopulations is significantly higher) compared to the estimates from the founding captive population in 2001 (observed heterozygosity 0.62-0.84 [between 2012 and 2021/2022] vs. 0.33) (Table 2; Warheit 2001, p. 16; Nerkowski 2021, p. 32).

Low genetic diversity could affect the three Columbia Basin pygmy rabbit subpopulations similarly in the future. This stressor influences Columbia Basin pygmy rabbit individuals and subpopulations via decreased fitness and reproductive output as well as affecting the species' ability to adapt to a changing environment. Effects of low genetic diversity on the species occurred at a greater scope, magnitude, and intensity in the recent past than today. Although genetic diversity of the subpopulations is currently higher than the remnant population in 2001 (Table 2), the number of individuals comprising the subpopulations is small and low genetic diversity could become a threat in the future, and recovery actions to maintain genetic diversity may be necessary in the future (Nerkowski 2021, pp. 33-34, 54-55; Nerkowski 2023, unpublished data).

4.2 Regulatory and Voluntary Conservation Measures

Here we summarize a subset of the known conservation measures for Columbia Basin pygmy rabbits throughout their range. We focus on protections and conservation measures implemented because of Federal and state statutes and regulations as well as voluntary efforts taken outside of this statutory and regulatory framework. While we do not attempt to summarize all conservation efforts, we acknowledge their value and cumulative benefit. We focus on a range of recovery activities from those that enhance the survival and fitness of individuals to those improving the resiliency of a subpopulation.

4.2.1 Conservation Measures

Our ability to implement conservation measures for Columbia Basin pygmy rabbit is limited because most suitable habitat within the currently designated DPS is on private property (Table 1). If more public lands were available within the currently designated DPS, we could release more captive-bred rabbits and implement more recovery actions to conserve the species.

The Columbia Basin pygmy rabbit is listed as endangered under Washington's endangered species law (WDFW 1995, entire). This law provides similar, but typically more limited, protections compared to the ESA. Under Washington state law, "take" of an endangered species,

defined as “to kill, injure, harvest, or capture,” is prohibited (RCW 77.08.010). Hunting, possessing, maliciously harassing wildlife and destroying nests or eggs of endangered species is also prohibited (RCW 77.15.120). The Washington state law does not provide any habitat protections to state-listed species, but ESA Section 6 funding does provide funds to the State for land acquisition to help protect species.

4.2.2 Safe Harbor Agreements (SHA)

Share Harbor Agreements are voluntary partnerships between the Service and non-Federal landowners and managers that provide a net conservation benefit for threatened and endangered species while providing landowners with assurances that as long as the baseline population is maintained, no future land-use restrictions can be imposed (64 FR 116 32717). Prospective participants develop a site plan in cooperation with the Service, that identifies the specific properties to be enrolled and documents the baseline conditions of the federally listed species in the agreement, existing and proposed future land use activities, and agreed-upon conservation measures that would be expected to provide a net conservation benefit for the species on the enrolled properties.

On October 24, 2006, the Service signed the Columbia Basin Pygmy Rabbit Template SHA (Template SHA), which was developed by the Service and WDFW (71 FR 52816).

Implementation of the Template SHA provides the opportunity for interested non-Federal and non-WDFW landowners and managers to voluntarily enroll their lands under the Template SHA and receive an enhancement of survival permit pursuant to section 10(a)(1)(A) of the ESA. In exchange for the incidental take authority that would be provided by issuance of permits, participants who enroll their lands under this Agreement would implement conservation measures that would be expected to provide a net conservation benefit to Columbia Basin pygmy rabbits (Table 8). The area covered by the Template SHA includes the entire DPS (Figure 7).

Table 8. Net conservation benefits for Columbia Basin pygmy rabbits in the Template SHA (Service 2006, p. 5).

	Conservation Benefit
1	Appropriate habitats will be maintained on enrolled properties and be available for Columbia Basin pygmy rabbits released to recovery emphasis areas (REAs).
2	Habitats on enrolled properties will facilitate dispersal of newly released Columbia Basin pygmy rabbits and enhance connectivity of REAs.
3	New subpopulations of Columbia Basin pygmy rabbits may form on enrolled properties through natural population expansion.
4	Additional wild Columbia Basin pygmy rabbits may be located on properties being considered for enrollment and be secured for captive breeding and / or translocation efforts, which will improve the overall recovery outlook for the population.
5	Monitoring and collection of biological information concerning the Columbia Basin pygmy rabbit (e.g. dispersal, survival, productivity) will be improved through cooperative management efforts on enrolled properties.

6	Research and adaptive management of the Columbia Basin pygmy rabbit will be more comprehensive if implemented over a large landscape, which will be facilitated by access to enrolled properties.
7	Successful implementation of cooperative, voluntary conservation measures will increase public awareness and support for Columbia Basin pygmy rabbit recovery efforts.

Implementation of the Template SHA is priority based, with emphasis given to properties within 8 km (5 mi) of the REAs and those occupied by Columbia Basin pygmy rabbits. Each site plan includes a list of covered existing and proposed future land use activities for each participant. Covered activities include those associated with ranching, farming, recreation, residential upkeep; conservation programs for the covered species; and direct management of shrub steppe including maintenance, enhancement, restoration, and conversion. Permittees on the Template SHA agree to give advance notice of proposed future land use activities, outside of designated covered activities, on enrolled properties that will disturb habitat. Biologists will survey for the species and relocate Columbia Basin pygmy rabbits to suitable and protected habitat before any activities with adverse impact occur. As of December 2023, there were 32 agreements under the Columbia Basin pygmy rabbit Template SHA with enrolled private (122,531 ac [49,586.5 ha]) and state (188,479 ac [76,275 ha]) properties (Hayes and Gallie 2023, p. 19). While the purpose of the agreements covered under the Template SHA is to provide protection for individual Columbia Basin pygmy rabbits and new subpopulations formed as they disperse from release areas, they do not permanently protect habitat. The Template SHA is set to expire in 2026 (71 FR 52816).

In 2023, regulation changes under section 10(a)(1)(A), propose combining the SHA and Candidate Conservation Agreements with Assurances (CCAA) into one type of conservation agreement, known as a Conservation Benefit Agreement (CBA) (88 FR 8380). The goal of this proposed change is to simplify the process for new conservation benefit agreements developed in support of enhancement of survival permit applications. Conservation Benefit Agreements focus on “net conservation benefit” which means the cumulative benefits provided by specific measures described in the CBA designed to improve the existing baseline condition of a covered species. The condition of the covered species and / or the amount or quality of its habitat is reasonably expected to be greater at the end of the agreement period than at the beginning. Once these proposed regulations are finalized, the Service will no longer implement the SHA and CCAA policies (88 FR § 8380).

4.2.3 Cooperative Endangered Species Conservation Funds (CESCF)

Section 6 of the ESA authorizes the Service to provide Federal financial assistance through the CESCF to states and territories to support the development and implementation of conservation programs for listed, candidate, and at-risk species on non-Federal lands. Several grant programs exist under this program, including programs for recovery actions (traditional Section 6 grants),

and land acquisition for recovery and HCPs (non-traditional Section 6 grants).

The Cooperative Endangered Species Conservation Fund provides grants to States and Territories to conduct a wide array of voluntary conservation projects for listed species. The traditional section 6 grant program has helped WDFW to increase Columbia Basin pygmy rabbit subpopulations and numbers through funding recovery actions including conducting population monitoring as well as disease management. Land acquisitions through the non-traditional Section 6 grant program have protected shrub steppe habitat to benefit Columbia Basin pygmy rabbits. In October 2023, WDFW purchased 650 ac (263 ha) of shrub steppe habitat to add to the 2,905 ac (1,175 ha) Chester Butte Unit of the Sagebrush Flat Wildlife Area near Coulee City, Washington, to enhance the recovery of the Columbia Basin pygmy rabbit.

4.2.4 Habitat Restoration

Restoration within the shrub steppe aims to reestablish habitats that are resilient and resistant to disturbances such as wildfire. Reducing or mitigating the threats that degrade shrub steppe and sustaining its ecological integrity is paramount. The major threats include overgrazing with cattle, increased fire frequency and intensity, and invasive species (Dunwiddie and Camp 2013, p. 17). Given the habitat loss due to wildfire and degradation due to the invasion of nonnative annual grasses, habitat restoration is critical to the recovery of Columbia Basin pygmy rabbits. Chemical or mechanical control of nonnative invasive plant species, thinning and removal of heavy fuels like senescent sagebrush, and planting and seeding sagebrush, grasses, and forbs can support the species. Because Columbia Basin pygmy rabbits rely on mature sagebrush, advanced planning is critical to maximize the conservation benefits to the species as obstacles, like herbicide resistant invasive plants or wildfire, can and do occur within recovery areas. Post-fire restoration includes aerial seeding, treating areas for invasive species, and outplanting native vegetation.

The Service's Partners for Fish and Wildlife Program's (PFW) strategic plan for Region 1 includes the Columbia Basin pygmy rabbit as a focal species (Service 2022, pp. 99-101). Two objectives of the PFW strategic plan promote the resistance and resilience of shrub steppe habitat to wildfires by reducing nonnative invasive annual grasses and establishing strategic patches of native vegetation within the agricultural landscape to decrease habitat fragmentation (Service 2022, p. 100). The Partners Program assists private landowners with habitat restoration projects, including those within Columbia Basin pygmy rabbit REAs. In response to the 2020 wildfires, including the Cold Springs/Pearl Hill Fire Complex, a \$2.35 million biennial allocation from the Washington State Legislature in 2021 created the Washington Shrubsteppe Restoration and Resiliency Initiative (WSRRI) that focuses on conserving and restoring wildlife habitats, enhancing wildfire preparedness and response, and supporting working lands in Eastern Washington (WDFW 2024). These funds will go to on-the-ground restoration projects and mobilize restoration resources and staff support to begin post-fire habitat restoration. In addition to PFW and WSRRI, there are many other restoration initiatives like Arid Lands Initiative and

Bipartisan Infrastructure Law (Sagebrush Conservation) that are instrumental in prioritizing and funding high priority shrub steppe restoration and Columbia Basin pygmy rabbit recovery actions. While there has been recent momentum in restoring the at-risk shrub steppe ecosystem in Washington, because Columbia Basin pygmy rabbits require mature sagebrush, restored habitat will not be suitable for the species for decades.

4.2.5 Conservation Easements and Land Donation

Conservation easements are voluntary legal agreements between a landowner and a government agency or qualified organization that restricts the type and / or the amount of development that can take place on a property, typically in perpetuity. The overall aim of conservation easements is to protect habitat for wildlife by limiting residential, industrial, or commercial development. Land donations are similar to easements in their benefits to wildlife and habitat conservation with some key differences. The future intended use of the donated land can vary given the donor's wishes. For example, donated land can have restrictions on future use as defined by the donor like allowing or prohibit hunting, vehicular access, logging, and development (Service 2023). A donor may give portions of their land annually or donate an entire area. These donations are non-purchase acquisitions unlike conservation easements.

Within the Beezley Hills REA, private land donations to TNC from 1997 to 2021 totaled 65,673 ac (26,577 ha). Although there are no known pygmy rabbits currently near these donated lands, the habitat is now protected from development in perpetuity and may serve as dispersal areas or as a future release site with the goal of establishing additional subpopulations.

4.2.6 Conservation Reserve Program (CRP) and State Acres for Wildlife Enhancement (SAFE) Initiative

One of the major contributors to habitat restoration and conservation for the species is the CRP, which is a private-lands conservation program administered by the USDA's Farm Service Agency (FSA) since 1985 (Gallie 2023a, pp. 6-7). Under CRP, agricultural producers keep enrolled lands out of production for 10-to-15-year contracts and follow practices aimed to improve water quality, prevent soil erosion, and reduce loss of wildlife habitat (USDA 2023b; Nerkowski 2021, pp. 94-95, Gallie 2023a, pp. 6-7). In exchange for following eligible practices, the FSA provides an annual payment to landowners (USDA 2023b). CRP's SAFE Initiative restores habitat on private lands by establishing vegetation that meets state wildlife conservation goals to benefit priority wildlife populations, such as Columbia Basin pygmy rabbit and other Federally listed species (USDA 2023c). When CRP contracts expire, landowners may reenroll or resume crop production. In the Columbia Plateau, reenrolling CRP lands two to four times is necessary for benefits to accrue for sagebrush obligate species like the Columbia Basin pygmy rabbit.

The CRP enrolled lands following SAFE guidance provide valuable habitat, including dispersal habitats for the Columbia Basin pygmy rabbit, particularly lands that have been enrolled long

enough for sagebrush to mature (Gallie 2023a, pp. 6-7). Given the importance of deep soils to farming, CRP lands typically have high quality, deep soils which are important to Columbia Basin pygmy rabbits for burrow creation and facilitate the growth of forage species (Gallie and Hayes 2018, p. 7). Conservation Reserve Program lands also connect fragmented patches of shrub steppe habitat, allowing for the dispersal of sagebrush obligate species (Lupis et al. 2006, p. 957; Nerkowski 2021, pp. 95-96). Many shrub steppe species, including the greater sage-grouse (*Centrocercus urophasianus*) and jackrabbits (*Lepus* spp.), prefer CRP lands with sagebrush over adjacent, undisturbed sagebrush habitat (Schroeder and Vander Haegen 2011, entire; Nerkowski 2021, pp. 95-96). In the mid-1990's, CRP fields near the Sagebrush Flat REA were seeded with native plant species, and seeds of other native species, including sagebrush, naturally dispersed from adjacent habitats.

Columbia Basin pygmy rabbit occur in Douglas and Grant counties, Washington. In 2022, Douglas County had the second largest area (156,093 ac (63,168 ha)) enrolled in CRP in the state, after Adams County (162,002 ac (65,559 ha); USDA 2022). Out of 24 eligible practices across general, grassland and continuous CRP programs, the top three practices in Douglas County in 2020 were SAFE (38 percent, 72,939 ac (29,517 ha)), native grass plantings (26 percent, 49,849 ac (20,173 ha)), and wildlife habitat enhancement (19.6 percent, 37,554 ac (15,197 ha); EWG Conservation 2023).

Lands not re-enrolled in CRP can equate to the loss of habitat critical for wildlife conservation. The number of enrolled hectares in Douglas County has fluctuated over time but has declined in recent years from 192,183 ac (77,773 ha) in 2019 to 156,093 ac (63,168 ha) in 2022 (USDA 2022). The 2018 Farm Bill limits the land area that can be enrolled in CRP each year to no more than 25 percent of a county's total area (80 FR 42000). Should state or Federal conservation priorities change, or private landowners decide to unenroll lands, valuable habitat for Columbia Basin pygmy rabbit could be lost (Gallie 2023a, pp. 6-7).

4.2.7 Other Conservation Measures

Other conservation measures for Columbia Basin pygmy rabbit include those that have been previously described in this SSA, and include:

- Captive breeding and reintroduction efforts (see section 2.5.2 Population Trends),
- Genetic/demographic rescue (see section 2.5.2 Population Trends), and
- Disease management (see section 4.1.4 Disease).

5.0 CURRENT CONDITION

We assessed the viability of the Columbia Basin pygmy rabbit in its listed range using resiliency, redundancy, and representation (Smith et al. 2018, p. 8; Service 2016, p. 21; Wolf et al. 2015, pp. 204-205). In this section, we summarize available demographic information, describe the analytical framework used to assess viability, and report our results.

5.1 Uncertainty

There is some uncertainty in the data and our analysis, including:

- There is limited life history and habitat information available for Columbia Basin pygmy rabbits. To mitigate this, we occasionally drew inferences from pygmy rabbit populations outside of the Columbia Plateau ecoregion in Washington.
- Our assessment of current condition was limited to the available data for the three subpopulations. Data has been collected since winter 2012. Little quantifiable habitat and demographic data exists for the species before 2012.
- Our assessment of habitat quality relies on the One Range model which used data from 2016 (Service 2022, entire). However, many changes to the landscape of the Columbia Plateau ecoregion have occurred since then, including, but not limited to, the Cold Springs/Pearl Hill Fire Complex and Sutherland Canyon fires in the northern extent of the species' range. Alone, these two fires drastically reduced the amount of currently suitable habitat as well as the availability of future habitat. Furthermore, the resolution of the cover data used in the One Range model could not explicitly differentiate between sagebrush vegetation and other shrub steppe shrub species. The habitat scale used by Columbia Basin pygmy rabbits is finer than the dataset captured, which likely led to an overestimate of the amount of suitable habitat. In addition, validation of the model by ground-truthing was minimal. Therefore, the current condition of habitat quality is likely an overestimation, but this was the best information available at the time of our analysis.
- Our assessment of the current condition of the Columbia Basin pygmy rabbit is limited to the extent of our knowledge of its abundance and distribution. Extensive surveys have been conducted to locate new occurrences and search for remnant populations, but no other subpopulations have been located. Despite this, it is possible that there are Columbia Basin pygmy rabbits on surveyed lands that have escaped detection and thus were not included in our analysis (Gallie 2023a, p. 19). Further, surveys are limited by land ownership and most suitable habitat in the Columbia Basin pygmy rabbit DPS is privately owned (Table 1). Therefore, abundance and distribution information are limited to private lands where landowners allow surveys to be conducted. Thus, all areas potentially supporting the species have not been surveyed. Given this, we assume that abundance and distribution estimates in this SSA are underestimates of the actual number of Columbia Basin pygmy rabbits.

- The Rimrock subpopulation was established in 2022, and we only have two years of abundance and genetic diversity data for this subpopulation. Thus, the analysis of the current condition of this subpopulation is limited.

5.2 Methodology (habitat and demographic metrics, ranking level criteria)

As described in Section 1, resiliency is evaluated within subpopulations, while redundancy and representation are evaluated at the species level. To assess the current condition of the Columbia Basin pygmy rabbit, we divided the current distribution of the species (Figure 1) into three subpopulations, Beezley Hills, Rimrock, and Sagebrush Flat (Figure 3). We define a subpopulation as a spatially clustered group of Columbia Basin pygmy rabbits occurring within 1.86 mi (3 km) of each other (Gallie 2023f pers. comm.; see section 2.2.2 Current Distribution, above). Recovery criteria are articulated at the subpopulation level; therefore, subpopulations represent a practical and intuitive analytical unit (Service 2019, pp. 3-4; Kurz 2024, pers. comm).

We used a condition category table to compute a metric of resiliency based on the unweighted mean of three metrics (habitat quality, abundance, and genetic diversity) that were measurable based on available information (Table 9). Species experts determined that these metrics were equal in importance in our analysis, so we used an unweighted mean. However, acknowledging the vulnerability of small populations (Tallmon et al. 2004, p. 489; Willi et al. 2006, pp. 433-435, Elias et al. 2013, pp. 1282-1283; Nerkowski 2021, p. 1), we developed the following rule - if a subpopulation's abundance score is 0, then the overall resiliency of the subpopulation is scored as low regardless of the habitat quality or genetic diversity scores. We considered including a metric to capture the natural growth trends of subpopulations, but ultimately decided that because of past and ongoing intensive management, including augmentation of Columbia Basin pygmy rabbit subpopulations, it was not possible to measure natural subpopulation growth or decline. However, this metric may be important in determining subpopulation resiliency in future SSA analyses when more relevant data are available.

We defined a high, moderate, low, and non-viable condition for each metric and a numeric score was assigned to each condition: high condition = 3, moderate condition = 2, low condition = 1, or non-viable condition = 0. For each subpopulation, scores were averaged across the three metrics to provide an overall resiliency condition using the scale below:

High Resiliency: 2.26 - 3.0

Moderate Resiliency: 1.51 - 2.25

Low Resiliency: 0.76 - 1.50

Non-viable: 0.0 - 0.75

Ranges are based on the difference between the highest and lowest possible average scores, divided into four equal categories.

Table 9. Condition category table for ranking Columbia Basin pygmy rabbit population resiliency based on habitat and demographic metrics.

Condition Category	Habitat Quality: Percent suitable habitat	Abundance: Average estimated number of rabbits	Genetic Diversity: Average observed heterozygosity
HIGH (Healthy subpopulation) 3 points	≥75	≥500	≥0.6
MODERATE (Moderately healthy subpopulation) 2 points	50-74	100-499	0.5-0.59
LOW (Unhealthy subpopulation) 1 point	25-49	30-99	0.35-0.49
NON-VIABLE (Not supportive of a subpopulation) 0 points	<25	1-29	<0.35

Habitat quality is based on the One Range model (Figure 7; Table 7; Service 2022, p. 1). This model identified habitat at a 98 ft (30 m) resolution in the Columbia Plateau ecoregion (EPA 2013) as suitable or unsuitable for the species based on three variables: sagebrush height, percent sagebrush cover in 2016 (USGS 2016), and absolute depth of soil to bedrock in meters. The model used 1,003 Columbia Basin pygmy rabbit occurrence points for model calibration and assumed an average individual's dispersal distance was between 164 ft (49 m) and 1.6 mi (2.5 km) as has been observed in the field; nonhabitat features such as lakes and developed areas were removed to calibrate the model (Service 2022, p. 1). The resulting model was used in this SSA as a conversion of raster to polygon areas, which is essential for calculating area. Uncertainties related to analyzing the habitat quality of subpopulations are detailed above in section 5.1 Uncertainty.

For each subpopulation, the percent of suitable habitat was calculated within the buffered area of a subpopulation (Figure 3). The thresholds for each of the condition categories were determined based on field observations by species experts and are summarized in Table 10. Habitat thresholds varied from 75% to 25% of suitable habitat within a subpopulation area.

Abundance, measured as the estimated number of rabbits (Table 5), was another metric used to evaluate to the species' current condition (Table 9). This estimate was calculated based on burrow activity during winter surveys and the number of genetically identified rabbits (Table 4). Because the species experiences "boom-and-bust" cycles typical of most rabbit species, abundance was averaged across all years with available data. Abundance data was available for Sagebrush Flat from 2012/2013 - 2023/2024; Beezley Hills from 2018/2019 - 2023/2024; and for Rimrock, from 2022/2023 - 2023/2024. Since surveys are done in winter, all rabbits detected are sexually mature adults.

In the absence of species-specific benchmarks for a viable population size, the first two condition categories for abundance (i.e., high and medium) were defined based on the first delisting criterion in the species' recovery plan: "A minimum 5-year average of at least 2,800 adult Columbia Basin pygmy rabbits in at least 12 populations. Of these, at least 4 populations have 500 or more adults each and at least 8 populations have 100 or more adults each." (Service 2019, p. 4). The high condition category was represented by subpopulations with >500 individuals and those with between 499 and 100 individuals were placed in the moderate condition category. The threshold for the low and non-viable conditions categories were determined from protocols associated with the species captive breeding program. Based on the risk of demographic stochasticity associated with small population (Zeoli et al 2008, p. 509), a cohort of 30 rabbits was the smallest group from which individuals could be taken for re-introduction efforts. In the absence of minimum population size thresholds for Columbia Basin pygmy rabbits, the low condition category was represented by subpopulations with between 30 to 99 individuals and those with 29 or fewer individuals were placed in the non-viable condition category (Table 9).

The last metric was genetic diversity (Table 9), measured using observed heterozygosity (Table 2; Nerkowski 2021, pp. 15-16). We calculated the average observed heterozygosity for each subpopulation overall years of available data. Data was available for Sagebrush Flat from 2012/2013 - 2022/2023; Beezley Hills from 2017/2018 - 2022/2023; and Rimrock for only 2022/2023. The thresholds for the high, moderate, low, and non-viable conditions were determined by species experts at the University of Idaho and were as follows: ≥ 0.6 for high, 0.5 - 0.59 for moderate, 0.35 - 0.49 for low, and < 0.35 for non-viable.

Data used in this SSA to analyze habitat and demographic factors reflect the ongoing intensive management to ameliorate threats to the species. The abundance of rabbits in each subpopulation includes individuals produced in the breeding program (Table 3) and pygmy rabbits translocated from other states as well as wild born individuals. Additionally, genetic diversity of subpopulations has been augmented by pygmy rabbits from other states. These intensive management efforts have been implemented at all three subpopulations and will likely continue into the future. The current condition values for Columbia Basin pygmy rabbit subpopulations would likely be significantly lower without intensive management. Despite this limitation, the current resiliency analysis is the most appropriate and uses the best available information.

To determine resiliency of Columbia Basin pygmy rabbit, we evaluated the habitat and demographic factors that affect the resiliency of a subpopulation (Table 10). Based on the definition of resiliency, we scored the current condition of each subpopulation by assessing its habitat quality, abundance, and genetic diversity (Table 11).

Table 10. Current condition values of each habitat/demographic factor for each subpopulation.

Subpopulation	Habitat Quality (% suitable habitat)	Abundance (average estimated # of individuals)	Genetic Diversity (average observed heterozygosity)
Beezley Hills	85	26	0.73
Rimrock	99	12	0.77
Sagebrush Flat	56	111	0.73

Table 11. Current condition scores of each habitat/demographic factor and the overall resiliency score for each subpopulation.

Subpopulation	Habitat Quality	Abundance	Genetic Diversity	Resiliency Score
Beezley Hills	3 points	0 points	3 points	1.0 Low *
Rimrock	3 points	0 points	3 points	1.0 Low *
Sagebrush Flat	2 points	2 points	3 points	2.3 High

* Because the condition scores for abundance for Beezley Hills and Rimrock subpopulations were in the non-viable condition category, the overall resiliency score is 1.0 Low.

Based on our analysis, we estimated that resiliency was high for one subpopulation (Sagebrush Flat), and low for two subpopulations (Beezley Hills and Rimrock).

Beezley Hills Subpopulation

The current condition values for habitat quality and genetic diversity for the Beezley Hills subpopulation were high, however, the abundance value fell within the non-viable condition category (Table 10). The current condition value for abundance of this subpopulation was 26, which is close to the threshold of 30 for a low score (Table 9). However, because the subpopulation's current condition score for abundance is 0, the subpopulation's overall resiliency was scored as low (Table 11).

Rimrock Subpopulation

Because the Rimrock subpopulation was established in 2022, there was limited data available on abundance and genetic diversity, therefore, the analysis of current condition of this subpopulation was limited. The current condition values for both habitat quality and genetic diversity were the highest for Rimrock of all three subpopulations, but the current condition value for abundance was the lowest of all subpopulations, at 12 (Table 10). This value fell within the non-viable condition category (Table 9). Because the subpopulation's abundance score was 0, the subpopulation's overall resiliency was scored as low (Table 11).

Sagebrush Flat Subpopulation

The longest-established subpopulation is the Sagebrush Flat subpopulation. The habitat quality value ranked as moderate condition, while the genetic diversity value was within the high condition category (Table 10). Despite a dramatic decline in abundance in 2019 (Table 5), Sagebrush Flat was the only subpopulation with a current condition value of over 30 for abundance (Table 10). While the other two subpopulations' current condition scores for abundance were non-viable, Sagebrush Flat current condition is moderate (Table 11). The overall resiliency score for this subpopulation is 2.3, which places this subpopulation in the high condition category. This value was very near the threshold of 2.25 for an overall resiliency score of moderate.

5.4.2 Redundancy

The species has one population composed of three subpopulations of varying resiliency, although other subpopulations historically existed, they are now extirpated. The current range of Columbia Basin pygmy rabbit is very restricted, and all subpopulations occur within 26.7 mi (43 km) of one another. Catastrophic events such as wildfire have occurred in the recent past and are likely to reoccur, and a disease outbreak (RHDV2) could occur in the near future. Both threats put individual subpopulations or the species at risk of extirpation / extinction. In fact, the Cold Springs/Pearl Hill Fire Complex burned a total of 400,000 ac (167,408 ha), an area that is significantly larger than the 57,600 ac (23,310 ha) area that is currently occupied by Columbia Basin pygmy rabbits (Gallie 2023f pers. comm.).

Because the three subpopulations occur within a small area, the species' redundancy is low – a single wildfire or disease event could result in the species' extinction. Increasing the number of subpopulations and / or increasing their distribution over the landscape would increase the species' redundancy and increase the species' ability to withstand a catastrophic event. To minimize the risk to the species from disease or wildfire, multiple resilient subpopulations should be distributed beyond the currently designated DPS across the Columbia Plateau ecoregion – the historical range of the species. The redundancy of the Columbia Basin pygmy rabbit is low.

5.4.3 Representation

Historically, the Columbia Basin pygmy rabbit was distributed across a much larger area within the Columbia Plateau ecoregion in Washington (Figure 1). The species' range was reduced to zero when the species was considered extinct (see section 2.5.1 Population Trends, above). As of 2023, the species occurs over approximately 90 m² (230 km²) of fragmented shrub steppe across three subpopulations (Figure 3; Gallie 2023f pers. comm.). Although Columbia Basin pygmy rabbit's range has expanded in recent years, it is significantly smaller than the area it historically occupied.

Environmental conditions across the current range of the Columbia Basin pygmy rabbit are somewhat variable within the relatively small area that is currently occupied. Although they historically occupied only native shrub steppe habitat, the Columbia Basin pygmy rabbit subpopulation at the Sagebrush Flat now also occupies CRP lands (Nerkowski 2021, p. 95). This demonstrates that the Columbia Basin pygmy rabbit can use habitats other than native shrub steppe. However, the loss of intact shrub steppe in the Columbia Plateau ecoregion suggests that most of the Columbia Basin pygmy rabbit's historical ecological representation has very likely been lost.

The Columbia Basin pygmy rabbit experienced a genetic bottleneck resulting in a decline in genetic variation. By 2001, all 16 known individuals were captured and transferred to a captive breeding program. Unfortunately, it was clear that the species was suffering from severe inbreeding depression and had diminished reproductive capacity (Elias et al. 2013, pp. 1282-1283; Hayes 2018, p. 8; Nerkowski 2021, p. 1). Due to a series of translocations of pygmy rabbits from outside the Columbia Basin, the genetic diversity of the Columbia Basin pygmy rabbit is currently significantly higher than that of the 16 founders of the captive breeding program; however, many unique Columbia Basin DPS alleles have been lost (Table 2; Warheit 2001, p. 16; Nerkowski 2021, p. 32). The population is now managed to promote Columbia Basin genetics to the extent possible, acknowledging that much of the species' genetic representation has been lost. Based on the current restricted ecological and genetic diversity, the representation of the Columbia Basin pygmy rabbit is low.

6.0 VIABILITY ASSESSMENT

The long-term viability of a species is expressed in terms of resiliency, redundancy, and representation and was assessed by determining the requirements, factors affecting survival, and current condition of Columbia Basin pygmy rabbit individuals, populations, and the species overall (Table 12). For Columbia Basin pygmy rabbit, resiliency was variable at the three subpopulations. These resiliency scores reflect the intensive ongoing management to increase the species' abundance and improve its genetic diversity. Without this management, resiliency scores would likely be lower. Given that the resiliency scores for two of the three subpopulations are low, despite being subsidized by intensive management, and redundancy and representation are also low, the species' viability is low.

Table 12. Summary of requirements, factors affecting survival, and current condition of Columbia Basin pygmy rabbit individuals, populations, and species.

Individuals	Populations	Species
Requirements		
•Areas with tall, dense sagebrush, at least 20-30 years old, with branches accessible for foraging. •Perennial bunchgrasses and forbs. •Deep, loose, sandy-loam soils that allow rabbits to dig burrows and natal dens.	•Sufficient suitable habitat to support subpopulations. •Sufficient dispersal habitat to facilitate connectivity among patches of suitable habitat. •Subpopulations with a sufficient number of individuals to withstand stochastic events. •Productivity and recruitment sufficient to maintain a stable or increasing subpopulation. •Survival sufficient to maintain a stable or increasing subpopulation.	•Resiliency: subpopulations with sufficient abundant withstand environmental and demographic stochasticity. •Redundancy: multiple stable self-sustaining resilient subpopulations and populations that are distributed widely enough to withstand catastrophic events. •Representation: ecological and genetic diversity conserved throughout the range to allow for adaptation to change over time.
Factors affecting survival		
•Changes to habitat availability, including loss, degradation, fragmentation, restoration, and protection affect habitat and forage condition negatively or positively. •Wildfire increases loss and fragmentation of suitable habitat and reduces survival. •Climate change and drought could affect forage condition and reduce habitat suitability. •Disease reduces survival and management to mitigate disease causes stress to individuals.	•Increased fire frequency and intensity impedes survival and growth of subpopulations and populations, reducing resilience. •Disease epidemics could cause extirpation of subpopulations. •Low genetic diversity can decrease reproduction, recruitment into the breeding population, and survival. •Small population size reduces resiliency. •Limited distribution increases the threat from stochastic events. •Breeding / reintroduction efforts and genetic rescue increase abundance and enhance population genetics and demographics.	•Climate change may alter the species' potential range and redundancy. •Limited geographic range results in low redundancy for the species. •Genetic rescue increases heterozygosity while leading to loss of Columbia Basin genes, reducing representation. •Breeding and reintroduction efforts increase redundancy by expanding the species' range.
Current condition		
•Amount of suitable habitat at each subpopulation is high/moderate; however, availability of suitable habitat within the currently designated DPS is limited due to habitat conversion and wildfire •Disease management efforts have successfully vaccinated many individuals against RHDV2.	•A single population consisting of 3 connected subpopulations. •Total estimated number of individuals as of the winter of 2023/2024 is 136 (Table 5). •Limited geographic distribution of approximately 90 mi² of fragmented habitat. •Breeding and reintroduction efforts have increased abundance and genetic diversity.	•Resiliency is high for one subpopulation and moderate for two subpopulations due to ongoing management. •Redundancy is low because there is only one known population with three subpopulations and the species' geographic distribution is limited. •Representation is low as the population possesses a fraction of the species' historical genetic and ecological diversity.

Our knowledge of the Columbia Basin pygmy rabbit has improved significantly since it was emergency listed in 2001. Although the threat of extinction is lower than it was when it was first listed, the species' viability is low, and the Columbia Basin pygmy rabbit is still vulnerable to extinction. Compared to its historical distribution across the Columbia Plateau ecoregion in Washington, the Columbia Basin pygmy rabbits' current range is very limited, even within the currently designated DPS. The amount of suitable habitat for the Columbia Basin pygmy rabbit has decreased and become more fragmented over time due to land use changes, habitat degradation, climate change, and catastrophic wildfires.

The threats of climate change and wildfire were likely previously underestimated within the DPS and have intensified since the species was first listed. Multiple Columbia Basin pygmy rabbit subpopulations have been extirpated due to wildfire, and a single wildfire could destroy or degrade all occupied habitat, leading to the species' extinction, or to the destruction of a significant portion of the remaining suitable habitat in the DPS. Additionally, although RHDV2 has not been detected in the species' range, the disease is spreading across the region and has caused the extirpation of pygmy rabbit populations in Nevada (Crowell 2023, pp. 342-343). Genetic rescue has been a critical management tool, however, our ability to use it in the future may be challenging due to the aggressive spread of RHDV2 throughout the rest of the pygmy rabbit's range. Furthermore, the potential listing of the pygmy rabbit across its range could prohibit the take of individuals from those populations, thereby limiting future translocations of pygmy rabbits to Washington (89 FR 17 4884).

The viability of the Columbia Basin pygmy rabbit may be improved by continuing intensive management to ameliorate threats and continuing to implement the recovery actions described in the Service and WDFW Recovery Plans (Service 2012, entire; WDFW 2003, entire). The species' overall recovery strategy is to increase redundancy and representation by reestablishing wild Columbia Basin pygmy rabbit subpopulations / populations. Key components of the recovery strategy have been the breeding and reintroduction program and genetic rescue. However, our ability to implement recovery actions for the Columbia Basin pygmy rabbit is limited by insufficient protected suitable habitat in the DPS (Table 7). Most importantly, future catastrophic wildfires will likely affect suitable habitat in the DPS further limiting suitable recovery habitat.

A possible next step in the Columbia Basin pygmy rabbit recovery strategy would be to establish REAs throughout the species' historical range with the goal of creating additional subpopulations and populations. Expanding the DPS would increase the availability of suitable habitat, allowing for the increase in the species' redundancy and representation. Ultimately, this would reduce the risk of extirpation or extinction due to catastrophic events. Expanding the area of the DPS also would increase the availability of topographical variation within protected suitable habitats. This may increase the species' ability to respond to climate change by allowing individuals to move to areas with more favorable conditions (e.g., higher and cooler habitats) in response to climate

change. This may mitigate some of the effects of a warming climate on the species' viability. Expanding the DPS also would increase the amount of state and federally owned lands available for recovery, which would increase our ability to implement recovery actions, regulate activities, and better conserve the species.

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Appendix I

Table 13. Glossary

Term	Definition
Baseline condition	The condition of a listed species in the absence of threats that may cause extinction.
Climate Change	A change in the state of the climate that can be identified (e.g., by using statistical tests) by changes in the mean and / or the variability of its properties, and that persists for an extended period, typically decades or longer (IPCC 2018, p. 4).
Columbia Plateau ecoregion in Washington	Area defined by the EPA Level 3 Ecoregion dataset. The Columbia Plateau ecoregion is also referred to as the “Columbia Basin ecosystem” in other documents about the Columbia Basin pygmy rabbit.
Conservation Reserve Program (CRP)	The Farm Service Agency administers this program. Enrolled farmers receive a yearly rental payment in exchange for performing land conservation practices to improve environmental health and quality on their lands (USDA 2023).
Dispersal	Describes the movement of animals and plant propagules (seeds, spores) from one site to another.
Effective population size	The ideal number of reproductively available individuals in a population to prevent reductions in genetic variability.
Extinct in the wild	When a taxon is known only to survive in captivity, cultivation, or within areas well outside of their historic range. This is determined after exhaustive surveys fail to detect individuals (IUCN 2024).
Fire return interval	Quantifies the average period between fires under the presumed historical fire regime.
Genetic bottleneck	A reduction in genetic variation due to a decrease in the number of individuals in a population.
Genetic/demographic rescue	An increase in population fitness owing to immigration of new individuals who have unique allelic variation (Tallmon et al. 2004, p. 489).
Genetic diversity	The genetic variation found in a population or species.
Genetic drift	Changes in gene frequencies due to random chance.
Genetic health	An individual’s DNA lacks deleterious mutations and other genetic markers that may result in suboptimal metabolic functioning.
Heterozygosity	The presence of two different alleles at a particular gene locus.
Home range	The area an animal or groups of animals regularly occupies to search for food and mates.

Minimum number of genetically identified rabbits	A genetic analysis using Columbia Basin pygmy rabbit fecal samples to confirm species ID (versus cottontail ID) resulting in a round number of individuals (Nerkowski 2021, p. 53).
Natal burrow	Burrow used specific to rear young.
Neonate	A newborn animal.
Net Conservation Benefit	A description of how the measures are reasonably expected to improve each covered species' existing baseline condition on the enrolled land (88 FR 8380).
Observed Heterozygosity	A direct estimation of from an individual's genotype that depends on the amount of genetic variation in a population and inbreeding (Schmidt et al. 2021, p. 1889). Ranges from 0 (least diverse) to 1 (most diverse)
Population	A group of individuals of the same species that live in the same geographic area and interbreed with each other .
Redundancy	The number of populations distributed across the landscape (Shaffer and Stein 2000, pp. 308-310).
Representation	The range of variation (genetic and ecological) found within a species. (Shaffer and Stein 2000, pp. 307-308).
Resident burrow	A burrow an animal occupies throughout the year. For pygmy rabbit these burrows have multiple entrances with a buildup of excavated soil and rocks, and are surrounded by fecal pellets (Rachlow et al. 2005, p. 137).
Resiliency	The ability of a population to recovery from periodic disturbances. (Shaffer and Stein 2000, pp. 308-310).
Restriction site associated DNA sequencing	A technique to sequence large amounts of genetic material with high resolution across the genome, or the genetic information of an organism (Davey and Blaxter 2010).
Site occupancy of Columbia Basin pygmy rabbit	detection of pellets, burrow, or individual that confirms Columbia Basin pygmy rabbits are living in the area.
Steppe	A dry, grassy plain occurring in temperate climates with cold winters and warm summers.
Stochastic	Unpredictable or random event (CPC 2019).
Stressors	One or more factors that may be causing a negative effect on the species or its habitat
Successional	The directional, predictable change in plant communities over time after a natural disturbance such as fire.
Suitable habitat	An area that offers characteristics needed for an organism's essential functions such as breeding, feeding, resting, or sheltering.
Translocation	The movement of animals or plants from one location to another by humans.
Viability	The ability of a species or populations to persist over time.

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Appendix II

Table 14. Columbia Basin pygmy rabbit life stages.

Life Stage	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Female receptivity ¹												
Gestation / Birthing ^{2,3,4}												
Lactation ⁴												
Juveniles ⁵												
Breeding peak												

¹ Gahr 1993, p. 18

² Elias et al. 2006, p. 23

³ DeMay et al. 2016, entire

⁴ WDFW 2019, pp. 2-3

⁵ Inferred