

BEFORE THE SECRETARY OF THE INTERIOR

**PETITION TO PROTECT BARREN VALLEY COLLOMIA
(*COLLOMIA RENACTA*) UNDER THE ENDANGERED SPECIES
ACT AND TO CONCURRENTLY DESIGNATE CRITICAL HABITAT**



Credit: Elaine Joyal, 1983.

CENTER FOR BIOLOGICAL DIVERSITY

5 March 2026

Notice of Petition

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Pursuant to Section 4(b) of the Endangered Species Act (“ESA”), 16 U.S.C. § 1533(b); Section 553(e) of the Administrative Procedure Act (“APA”), 5 U.S.C. § 553(2); and 50 C.F.R. § 424.14(a), the Center for Biological Diversity hereby petitions the Secretary of the Interior, through the United States Fish and Wildlife Service (“FWS” or “Service”), to protect Barren Valley Collomia (*Collomia renacta*) as a threatened or endangered species under the ESA.

FWS has jurisdiction over this petition. This petition sets in motion a specific process, placing definite response requirements on the Service. Specifically, the Service must issue an initial finding as to whether the petition “presents substantial scientific or commercial information indicating that the petitioned action may be warranted.” 16 U.S.C § 1533(b)(3)(A). FWS must make this initial finding “[t]o the maximum extent practicable, within 90 days after receiving the petition.” *Id.* If FWS makes a positive initial finding, it must then determine within 12 months after receiving the petition whether the petitioned action is warranted, and if so, the Secretary shall “promptly” propose to implement the listing action with a general notice. 16 U.S.C. § 1533(b)(3)(B). Finally, the Secretary shall finalize the regulation to implement their listing determination “within the one-year period beginning on the date on which general notice is published.” 16 U.S.C. § 1533(b)(6)(A). The petitioner also requests that critical habitat be designated for Barren Valley Collomia concurrently with the species being listed, pursuant to 16 U.S.C. § 1533(a)(3)(A) and 50 C.F.R. § 424.12. References cited in this petition will be available at the following link: <https://diversity.box.com/s/yblz0619famkbc7khzrgf4zi9sn41ayw>

The Center for Biological Diversity (“Center”) is a nonprofit, public interest environmental organization dedicated to the protection of imperiled species and the habitat and climate they need to survive through science, policy, law, and creative media. The Center is supported by more than 1.7 million members and supporters across the country. The Center works to secure a future for all species, great and small, hovering on the brink of extinction. The Center submits this petition on its own behalf and on behalf of its members and staff with an interest in protecting Barren Valley Collomia and its habitat.

Submitted this 5th of March, 2026.

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EXECUTIVE SUMMARY

Barren Valley Collomia (*Collomia renacta*) is a diminutive annual member of the phlox family, reaching only 2–6 cm in height and producing tiny blue flowers in late spring or early summer. It is found on slopes in rocky soil and is currently known from seven or fewer populations in Malheur Co., Oregon and Elko Co., Nevada. This tiny plant germinates after autumn rains, lives through the wet montane winter, and dies after dropping seeds at the onset of summer droughts. Its small populations rarely exceed a few hundred at a time.

Barren Valley Collomia's annual growth habit can lead to large interannual variation in population size, and any shift in phenology can make detecting this plant difficult for surveyors even under good conditions; however, in recent years, it has become distinctly difficult to find any plants at all. Surveyors with the Oregon Department of Agriculture have not located the plant within their state since 2014, to the point where all populations but one are presumed extirpated. Nevada's two populations have not been seen since 2008 and 2004, respectively, with 2024 surveys most recently failing to locate either one. Site visits indicate that this plant is directly imperiled by grazing, invasive species incursion, and potentially climate change. Other anthropogenic activities like road maintenance have also been implicated in its decline, or as potential future threats.

Despite being a federal Species of Concern, a Bureau of Land Management Sensitive Species, and an Oregon State Endangered species, there are no actual protections in place which will ensure the persistence of this rare Great Basin endemic. In order to ensure Barren Valley Collomia's survival, Endangered Species Act protections must be granted, and critical habitat must be designated under the provisions of the ESA.

INTRODUCTION

Barren Valley Collomia (*Collomia renacta*) is a fascinating and ecologically significant plant endemic to rocky soils in southeastern Oregon and northeastern Nevada. Despite being first documented in 1896, the species was not formally described until 1986 due to its restricted distribution and the difficulty of locating populations in the remote mountains of the northern Great Basin ecoregion. Barren Valley Collomia inhabits slopes characterized by poor, rocky soils that are prone to extreme temperature fluctuations and limited water retention. These unique environmental conditions, combined with its diminutive size and short flowering period, can make the plant difficult to detect and study.

The survival of Barren Valley Collomia is entirely dependent on maintaining the integrity of its native habitat. The plant requires undisturbed rocky slopes with sparse vegetation, which are increasingly threatened by a variety of factors. Habitat degradation due to the invasive annual grass cheatgrass (*Bromus tectorum*) has become a primary concern; this non-native species not only competes with the plant for limited resources but also increases the frequency and intensity of wildfires to levels which the native plant community is not well-adapted to withstand. Additionally, changes in climate, particularly increased drought frequency, pose a significant threat by further reducing the availability of suitable habitat and creating a harsher environment in which Barren Valley Collomia must survive. Because annual plants may fail to germinate or grow to maturity if weather conditions are not right, the impact of climate change on typical weather cycles, rainfall, and temperature have the potential to drastically reduce this plant's success in the wild. Other human activities, including livestock grazing and road maintenance, contribute to soil disturbance and pollution while allowing invasive species to spread and outcompete native flora.

Despite surveys across all sites, this tiny plant has not been seen by researchers in more than a decade. It is imperative that US Fish and Wildlife Service and the Bureau of Land Management work to locate and protect Barren Valley Collomia, allocate funds for invasive weed removal, and designate critical habitat where this plant will be most resilient to a changing climate. The provisions of the Endangered Species Act will be crucial in ensuring the survival of this narrow endemic.

BIOLOGY

I. TAXONOMY

Kingdom: Plantae
Division: Tracheophyta
Class: Magnoliopsida
Order: Ericales
Family: Polemoniaceae
Genus: *Collomia*

Species: *Collomia renacta* E. Joyal (1986)
Barren Valley Collomia

Collomia renacta is a small member of the phlox family (Polemoniaceae). It was first collected by J. B. Leiburg in 1896 in Barren Valley, Malheur Co., Oregon, at which time he suggested in his field notes that it was “probably an undescribed species,” though he then labeled it as *Collomia tinctoria*. R. Ferris later annotated it as *Collomia macrocalyx*. When H. D. Ripley and R. C. Barneby collected another *Collomia* specimen in the Pequot Mountains, Elko Co., Nevada in 1942 they matched it to Leiburg’s earlier collection. E. Joyal relocated both sites in 1983 and published the new species in 1986 (Joyal 1986, 243–245). Its specific epithet, *renacta*, comes from the Latin *nactus*, meaning “to stumble upon.” *Renacta* means “to stumble upon again.”

Collomia renacta is accepted by the scientific community, including the U.S. Fish and Wildlife Service, OregonFlora, and the Consortium of Pacific Northwest Herbaria. However, it is possible that genetic testing will reveal that this plant—confined to three clusters which are all geographically separated by at least a hundred miles—is actually multiple species, each of which will have an even smaller range and population size than the currently-understood distribution of Barren Valley Collomia. If that is the case, protection under the ESA will be even more crucial for the survival of these tiny, ephemeral plants.



Figure 1. Barren Valley Collomia in the Pequop Mountains (center, below left end of pocketknife). Credit: Elaine Joyal, 1983.

II. DESCRIPTION

Barren Valley Collomia is a diminutive annual member of the phlox family, reaching a maximum height of 2–6 cm tall (Joyal 1986, 243; see Figs. 1, 2). It is characterized by fine-haired green leaves with reddish-purple undersides and margins and tiny, trumpet-shaped flowers with blueish-purple lobes which fade to white at the throat. It blooms early in the season and completes its life cycle by the end of June. The specific timing of flowering may be highly sensitive to environmental conditions and may vary year-to-year from mid-May into early June (Marshall and Brown 2023, 5). This plant is likely a winter annual like its close relative, *Collomia macrocalyx*, which germinates in autumn, lives through the winter, and produces seed in the spring before dying. Seeds collected by Joyal germinated “readily” (Joyal 1986, 247). In *C. macrocalyx*, which has an overlapping geographic range, seed germination in nature occurred at the onset of autumn rains (Joyal 1984, 56).



Figure 2. Close-up of Barren Valley *Collomia*. Credit: Elaine Joyal, 1983.

The technical description from Joyal (1986) is as follows: “Annual, 2–6 cm tall, branching when well developed, eglandular and puberulent throughout, densely so on the peduncles and calyx teeth, ciliate on petioles and along lower edges of leaf blades and bracts; leaves entire and few, the lower petiolate and spatulate to spatulate-oblongate, (0.8) 1.7–2.2 (2.5) cm long, (2) 4–5 mm wide, (3.4) 4–5 (6.7) times as long as wide; main stem and branches terminating in dense leafy-bracteate flower clusters; bracts subtending the flowers, linear, (1.3) 1.5–2.5 (3.3) cm long, (1) 2–3 mm wide, (6) 7–11 (13) times long as wide, tapering to a slender point; calyx teeth narrow, firm, aristate-attenuate, unequal, the longer ones 3–5 mm long in fruit; corolla funnelform, about 1 cm long, the rounded lobes 2–2.5 mm long, blue with white throat; filaments ca 0.5 mm long, somewhat unequally inserted a little below the sinuses; style 5–6 mm long, stigma about level with the stamens; fruit capsular, the 3 locules each producing a single seed; the seeds mucilaginous when wet.” (p 243).

No pollinators have been observed on the flowers, and it has been suggested that autogamy (self-pollination) is the most likely method of reproduction for the species. Although reproduction has not been more deeply studied for Barren Valley *Collomia*, a study of its congener *C. macrocalyx* was conducted by Joyal in the 1980s. *C. macrocalyx*, like Barren Valley *Collomia*, produces capsular fruit with 3 locules which can produce a single seed, although not all seeds successfully

develop. Joyal found an average seed set of 76.9% per plant, less than the theoretical 100% seed development. As few as 5% of the seeds produced may become established as mature plants (Joyal 1984, 72). If Barren Valley Collomia produces seeds and mature plants at a similar rate, this suggests that each mature plant, on average, produces only one successful offspring—enough to replace itself in the population, but no more. Of course, this seed success may be dependent on other factors, such as rainfall and temperature (p 67), which may create larger populations due to higher success rate in some years.



Figure 3. Photo of Barren Valley *Collomia*'s habitat in the Pequop Mountains. Credit: Elaine Joyal, 1983.

III. HABITAT

Barren Valley *Collomia* grows on relatively undisturbed south-facing slopes, on rocky outcrops at an elevation of 1500–2300 m (5400–7500 ft). The type habitat, located in Malheur County, Oregon, is described as “high ridges with crumbling basalt ledges on unstable talus,” similar to the “rocky banks” where it was first collected in 1896 (Joyal 1986, 243; see Fig. 3 for habitat in NV). Habitat is similar for the species across its range, which includes the Barren Valley area of Malheur County as well as the Pequop Mountains in Elko County, Nevada. In Nevada, it has been described as growing in the ecotone between habitats dominated by big sagebrush (*Artemisia tridentata*) and black sagebrush (*A. arbuscula*) (Morefield 2001, 158). The herbarium specimen collected by Ripley and Barneby in 1942 was described as growing on “calcareous ground under juniper” (Joyal 1986, 244). In this habitat, the plant is growing in poorly developed rocky soils and is exposed to more considerable temperature and soil moisture fluctuations than those experienced in surrounding areas (p 247).

Other common co-occurring species across Barren Valley *Collomia*'s range include arrowleaf balsamroot (*Balsamorhiza sagittata*), desert paintbrush (*Castilleja chromosa*), Modoc hawkbeard (*Crepis modocensis*), rubber rabbitbrush (*Chrysothamnus nauseosus*), Anderson's

larkspur (*Delphinium andersonii*), matted buckwheat (*Erigeron caespitosum*), and rosy phlox (*Gilia sinuata*). There is some variation between other co-occurring species at either the plant's Oregon occurrences or its Nevada occurrences, but the overlap indicates general floristic similarity across all sites where Barren Valley Collomia grows (Joyal 1986, 247).

IV. DISTRIBUTION AND POPULATION STATUS

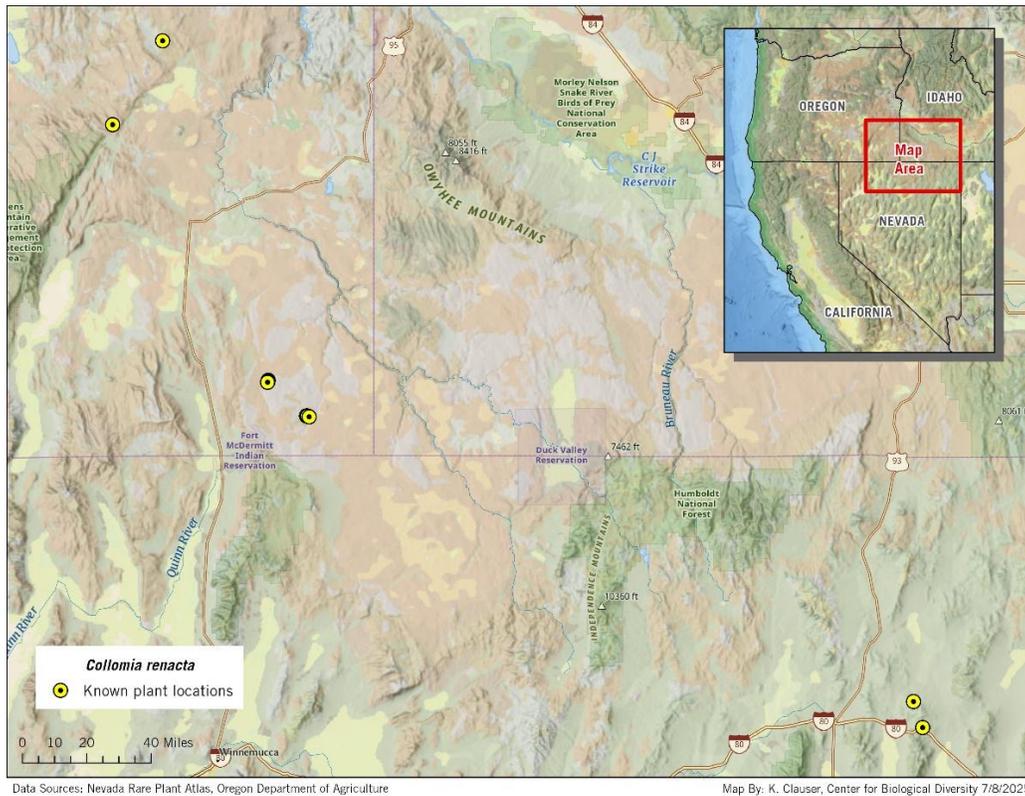


Figure 4. Known distribution of Barren Valley *Collomia* in Oregon and Nevada.

Barren Valley *Collomia* is endemic to the northern Great Basin region, and is presently known from Malheur County, Oregon and Elko County, Nevada (Fig. 4). This species is ranked as G1 (Critically Imperiled) on NatureServe, and has been regarded as extremely rare for as long as it has been recognized (Joyal 1986, 247; Marshall, pers comm 9 July 2025). The best available data suggests that this plant is imperiled throughout its entire range.

Barren Valley *Collomia* has not been successfully located by surveyors since 2008 in Nevada and 2014 in Oregon. This apparent absence may be due in part to timing, given the normal interannual variation in phenology and population size for annual plants (Marshall and Brown 2023, 5). What is most concerning is that these absences have become more common in recent survey years. For example, the Pequop Summit site in Nevada had plants found at all four surveys between 1942 and 2004, but no plants in 2022 or 2024 (Table 1). Likewise, Oregon has multiple sites with years' worth of successful surveys that have only recently become difficult to find plants at (Table 2). Changing site conditions may be altering phenology of these populations, leading to earlier timing of flowering and senescence, or they may be creating unsuitable conditions for germination and growth of Barren Valley *Collomia* which result in plants failing to emerge. Either way, these trends are of great concern.

Even past successful surveys indicate no more than a few hundred plants at each of the handful of known sites. This tiny annual is existentially threatened by such a small population size and small number of occurrences, which afford it little redundancy and may lower its resiliency in the face of other threats, such as invasive species, which are becoming increasingly prevalent in the Great Basin (NDNH, unpubl; Marshall and Brown 2023; Balch et al. 2013). Small populations are more prone to local extirpation (Matthies et al. 2004), and it is possible that some stochastic losses have already occurred for Barren Valley *Collomia*.

NEVADA

Barren Valley *Collomia* is known from two occurrences in Elko Co., NV, both in the Pequop Mountains. The species is ranked S1 on the Nevada Natural Heritage Program Sensitive List and is a Special Status Species for the NV BLM (BLM 2023). Barren Valley *Collomia* and its habitat are most severely threatened in the state by small population size and the incursion of invasive weeds. Other potential threats include road building and maintenance, off-road vehicle use, livestock trampling, fire, and climate change (Morefield 2001, 158; NDNH, unpubl data). Both populations are located close to highways, with one found along Interstate 80 and the other along US Route 93. This places both populations at risk of habitat degradation due to highway infrastructure construction and maintenance, along with the increased potential rate of invasive species introduction and nitrogen deposition (P Donnelly, pers comm 13 July 2025).

Very few Barren Valley *Collomia* plants have been observed in Nevada. When it was first collected in the state by Ripley and Barneby, they reported theirs was the only specimen of its kind at the site (Joyal 1986, 244). When Joyal revisited the site in 1983, she found fewer than 200 plants (p 247). Some plants were found in 1991 and 2004 in smaller quantities, but no plants were found in 2022 or 2024. The other occurrence of this species, first located in 2008, has not been successfully relocated since that time (Table 1; NDNH, unpubl).

Table 1. Population status for Barren Valley Collomia in Nevada. Source: Nevada Division of Natural Heritage, unpublished data; E. Miskow, pers comm 9 July 2025.

EO ID	Land		Obs.	
	ownership	Site name	Year	Count
16578	BLM Elko District, Wells FO	Pequop Summit	2024	0
			2022	0
			2004	50+
			1991	Collected
			1983	50–200
			1942	1 (Collected)
28903	BLM Elko District, Wells FO/Private	HD Summit	2024	0
			2022	0
			2008	Collected

Climate change presents a great threat to this species in Nevada. The Great Basin was marked by intense early-summer heat waves in 2024, which may have caused populations of this plant to bloom earlier or to not emerge at all if environmental conditions were poor (NDNH, unpubl). Another potential factor of concern with the apparent lack of Barren Valley Collomia in 2024 is that the Pequop Summit location was noted to have high cheatgrass invasion. The shift to an invasive-dominated habitat, rather than the shrub- and bunchgrass-dominated habitat reported by Joyal’s 1983 surveys (Joyal 1986, 243), may reduce habitat suitability by changing nutrient availability and covering the bare ground where Barren Valley Collomia germinates and grows. Such transition to invasive-dominated habitat has been underway throughout the Great Basin for many decades, representing one of the largest sources of landscape change in the region (Bollinger and Perryman 2008, 169) and leading to higher wildfire frequency and severity (Balch et al. 2013; Bradley et al. 2018). These changes put Barren Valley Collomia and its habitat at risk.

OREGON

Barren Valley Collomia was first collected in Malheur Co., Oregon, and was subsequently misidentified as *C. macrocalyx* in 1896. Unfortunately, after Joyal visited the type locality site in 1983, observing 50–200 plants, her next two visits in 1984 and 1985 yielded no plants. Joyal also searched a nearby site at that time, looking in appropriate habitat for new populations, and found none (Joyal 1986, 247). The type locality site in Oregon is now presumed extirpated, as another survey completed in 1989 also yielded no plants. D. Marshall attempted to locate the plant at this site, unsuccessfully, in 2023 (Marshall and Brown 2023, 6; Table 2). The Oregon Department of Agriculture (ODA) assessment of Barren Valley Collomia, completed in 2023, notes multiple potential and realized threats to this tiny plant within the state. These threats include invasive weeds, cattle disturbance, small population size, and inadequate regulatory mechanisms. Climate

change may also prove a concern, due to the species' limited hydrological niche (Marshall and Brown 2023, 8–10).

Unfortunately, recent survey results indicate this species may already be on the brink of extirpation at several sites. There are only five known populations of Barren Valley Collomia in Oregon, although two populations—SE of Lucky Cow Camp Seven and Starvation Spring—have had multiple observations later revealed to be *C. macrocalyx* instead, and either one or both sites may in fact have never supported Barren Valley Collomia at all (Marshall and Brown 2023, 5; Joyal, pers comm 18 September 2025; OSU Herbarium, see footnote). No plants have been observed at any of the Oregon sites in the most recent surveys (Marshall and Brown 2023, 5–7; Marshall, pers comm 9 July 2025). Some of this absence may be attributed to the timing and cycles of annual plant growth, so future surveyors should be given the resources to conduct multiple surveys during the optimal flowering time until the plant is—or is not—found at those sites.

Both Barren Valley Collomia's elusive nature and its geographic overlap with (and visual similarity to) *C. macrocalyx* have resulted in several false identifications of the plant in Oregon, some of which were not recognized by botanists until recently. A 2006 collection of "*C. renacta*" from EO 28611 (SE of Lucky Seven Cow Camp) was recently identified as *C. macrocalyx* after nearly 16 years,¹ and the 2016 observations of the species at EO 28612 (Starvation Spring) were similarly recognized to also be misidentifications of *C. macrocalyx* upon later investigation (Carr, pers comm 10 September 2025). Given the data currently available, it is not possible to determine if the two reported populations of *C. renacta* and *C. macrocalyx* are part of the same population, if they are in fact the same taxon, or if both are present in the area. In the table for population counts in Oregon (Table 2), we include misidentified specimens because they still represent a piece of the record in the search for Barren Valley Collomia.

Small population size exacerbates the threats to Barren Valley Collomia in Oregon. Most populations in the state have been recorded to number only a few hundred, with the largest reaching around 700 (Table 2). Grazing is also a direct threat to these fragile populations, particularly at the Starvation Spring and Lucky Seven Cow Camp sites. In 2005, Barren Valley Collomia plants had been "flipped out of [the] ground" by grazing activity. Another site, W of Barren Valley, is located within an active grazing lease. Only the Starvation Spring site currently has fencing to exclude cattle grazing directly where Barren Valley Collomia grows, though this population has not been observed in two decades (Marshall and Brown 2023, 8) and it is unclear what work has been done to upkeep that enclosure. Cattle exclusion on its own is not sufficient to protect rare plants, as these fenced-off areas often become overrun by invasive plant species instead. Active monitoring and invasive species removal at this site would be necessary to

¹ OSU Herbarium, Catalog # OSC-V-045852.
<https://oregonflora.org/collections/individual/index.php?occid=1030018&clid=0>. Accessed 19 September 2025.

adequately protect Barren Valley Collomia (E. Joyal, pers comm 29 January 2026). At Star Mountain, the primary threats have been wildfire and heavy incursion by invasive annuals, namely cheatgrass (*Bromus tectorum*) and medusahead (*Taeniatherum caput-medusae*) (Marshall and Brown 2023, 8).

*Table 2. Population status for Barren Valley Collomia in Oregon.
Source: Marshall and Brown 2023; Marshall, pers comm 9 July 2025.*

EO ID	Land		Presence	Obs.	
	ownership	Site name		Year	Count
16578	BLM Vale District	Star Mountain BLM poly 367	Presumed extirpated	2015	0
				2001	200
				1993	150
14226	Department of State Lands	W of Barren Valley BLM poly 366 (type locality)	Presumed extirpated	2023	0
				1989	0
				1985	0
				1984	0
				1983	50–200
				1896	Collected
28611	BLM Vale District	SE of Lucky Seven Cow Camp BLM poly 1384	May be extirpated or misidentified	2018	0
				2016	0
				2014	0
				2006	Misidentified
				2005	50+
				2003	Collected
28612	BLM Vale District	Starvation Spring SW BLM poly 1385	May be extirpated or misidentified	2018	0
				2016	Misidentified
				2014	0
				2005	100+
28665	BLM Vale District	Anderson Crossing BLM poly 1213, 1268	Presumed extant	2023	0
				2018	0
				2016	0
				2014	400
				2008	Collected
				2007	0
				2006	10
				2005	700
				2004	50–60
2002	Collected				

THREATS

Under the ESA, 16 U.S.C. § 1533(a)(1), FWS is required to list Barren Valley Collomia if it is in danger of extinction or likely to become endangered across all or a significant portion of its range. This species must meet at least one of the factors enumerated in section 4(a):

- (A) The present or threatened destruction, modification, or curtailment of its habitat or range;
- (B) Overutilization for commercial, recreational, scientific, or educational purposes;
- (C) Disease or predation;
- (D) The inadequacy of existing regulatory mechanisms;
- (E) Other natural or manmade factors affecting its continued existence.

16 U.S.C. § 1533(a)(1)(A)-(E); 50 C.F.R. § 421.11(c)(1)-(5). The review and determination by FWS must be based solely on the best scientific and commercial data available.

Barren Valley Collomia is a regional endemic with small, greatly dispersed, and few populations. This plant is threatened by three of the ESA listing factors: (A) habitat destruction due to grazing and highway development; (D) a lack of effective regulatory mechanisms; and (E) other factors including climate change, invasive species, and wildfire.

(A) PRESENT OR THREATENED DESTRUCTION, MODIFICATION, OR CURTAILMENT OF HABITAT

GRAZING

Cattle have been grazed extensively in the Great Basin for more than a century and a half, with an era of particularly destructive and unchecked rangeland use occurring between the 1880s and the 1930s (Svejcar et al. 2017, 83). Livestock grazing is the most widespread influence on Western US ecosystems, and its detrimental impacts have been reported throughout the scientific literature (see Fleischner 1994; Jones 2000; Svejcar et al. 2017). Among plant communities, these impacts include loss of biomass and species diversity; changes in community organization and nutrient cycling; and an increase in the presence of exotic grass species (Fleischner 1994, 631; Svejcar et al. 2017, 84). The invasive species cheatgrass (*Bromus tectorum*) is a particular concern in the Great Basin, where it has been dominating landscapes for several decades and dramatically altering the wildfire regimes of the region to favor larger, more frequent burns than the native community is adapted to withstand (Bollinger and Perryman 2008, 169). Grazing and rangeland use is at the heart of this severe and ongoing concern for Great Basin ecosystems.

Most of the known populations of Barren Valley Collomia are on BLM-owned lands which are presently managed as rangelands. Nevada's populations are both within grazing allotments, as are most of Oregon's—Starvation Spring SW, SE of Lucky Seven Cow Camp, and the lone state-owned W of Barren Valley site (Marshall and Brown 2023, 8). The Starvation Spring

population is protected by an enclosure which prevents cattle access, but levels of maintenance at that enclosure are unknown. One site, Anderson Crossing, does not allow grazing (*Id.*).

Barren Valley Collomia is likely not subjected to targeted grazing by cattle, due to the diminutive size and short-lived nature of the plants, but trampling and incidental grazing are still of concern. Damage from grazing was noted in 2005 at the Starvation Spring and Cow Camp sites in Oregon, where plants had been completely uprooted (Marshall and Brown 2023, 8). In small populations, even incidental damage to plants should be avoided wherever possible to ensure that each individual is able to reach reproductive maturity and produce seeds. This is particularly important if Barren Valley Collomia exhibits similar reproductive output and success to *C. macrocalyx*, which may only produce one successful offspring per plant in some years (Joyal 1984, 72). Further, this species' narrow hydrological niche may be impacted by compaction from cattle hooves, which can reduce infiltration and affect erosion (Jones 2000, 159).

PROXIMITY TO HIGHWAYS

Travel corridors such as roads and railroads constitute the fifth most common threat to rare plants in the US, with 21% of rare plants affected by their presence and use (Hernández-Yáñez et al. 2016, 262). Highways can degrade associated roadside ecosystems through habitat alteration, surface runoff of pollutants and chemicals from road coatings and automobiles, and the introduction of invasive species (p 264). In Nevada, both populations of Barren Valley Collomia are located near highways—US Route 93 and Interstate 80 (Fig. 4). This places the plant at risk of habitat degradation due to nitrogen deposition (Bettez et al. 2013; Forman and Alexander 1998), wildfires (Fusco et al. 2016), and non-native plant invasion (Hansen and Clevenger 2005, 253) in addition to the physical habitat disruptions associated with road maintenance.

Many arid and semi-arid ecosystems are naturally low in nitrogen, with native plant growth likely to be somewhat N-limited, but roadside nitrogen deposition from automobiles does not benefit native plants such as Barren Valley Collomia. In fact, nitrogen deposition has been linked to higher invasive plant density and lower native annual plant density, biomass, and species richness in the Mojave Desert (Brooks 2003, 348), and cheatgrass may become a better competitor against native species when exposed to higher levels of soil nitrogen (Vasquez et al. 2008).

Roads are also hotspots for other forms of anthropogenic degradation. Wildfires in the Great Basin are primarily caused by lightning (Bradley et al. 2018, 1503), but anthropogenic wildfires are strongly associated with roadways due to the associated fire hazards, such as cigarette butts and automotive sparks (Fusco et al. 2016, 15). Roadways are also a vector for the introduction and spread of invasive cheatgrass, which may benefit from increased nitrogen deposition; it also burns more readily than native species, which may further heighten roadside fire risk (Bradley et

al. 2018). In grasslands, non-native species are more frequent within 150 m of travel corridors, including roads (Hansen and Clevenger 2005, 253). Barren Valley Collomia, which is found near highways in Nevada, is already being invaded by cheatgrass at one site (NDNH, unpubl) and is vulnerable to these other threats as well.

(D) INADEQUACY OF EXISTING REGULATORY MECHANISMS

LACK OF RECENT SIGHTINGS

Barren Valley Collomia has not been successfully located by surveyors in many years, with Oregon's last sighting in 2014 and Nevada's in 2008. At most sites, the last date of survey where plants were present is even further back (Table 1; Table 2). Fortunately, because Barren Valley Collomia is an annual, a lack of plants in a survey is more likely to indicate a mistiming of surveys rather than a local extirpation (P. Donnelly, pers comm 13 July 2025; Marshall, pers comm 9 July 2025). Although this on its own is not a traditional threat, it should serve as a warning that present management strategies are not sufficient to ensure the persistence of this tiny plant.

THE OREGON ENDANGERED SPECIES ACT (OESA)

The Oregon Department of Agriculture Native Plant Conservation Program recommended Barren Valley Collomia for listing in 2023 (Marshall and Brown 2023), and this plant is now listed in the state of Oregon as an endangered species.²

Unfortunately, the Oregon Endangered Species Act (OESA) is ill-equipped to protect a species that exists primarily on federal land. Indeed, “the species-recovery mechanism under the OESA...is limited to state-owned land, state leased land, and land over which the state has a recorded easement. In addition, endangered species management planning is limited to state agencies” (Oregon Legislature 2010, 3). This makes the OESA poorly-positioned to protect Barren Valley Collomia, which is found primarily on BLM-owned lands. The only presently-known population to which OESA protections apply, the W of Barren Valley site on Department of State Lands property, has not had plants found since 1983 and is presumed extirpated (Marshall and Brown 2023, 6).

Further, even if the OESA could in some marginal ways protect Barren Valley Collomia, “the definition of take [under the ESA] is narrower than under federal law” (Oregon Legislature 2010, 3). These shortcomings, along with the fact that Barren Valley Collomia is not found only in Oregon, make OESA insufficient to protect the species and necessitate federal listing for the plant.

² <https://www.oregon.gov/oda/plant-conservation/pages/listed-plants.aspx>.

BUREAU OF LAND MANAGEMENT (BLM) SPECIAL STATUS SPECIES LIST

Barren Valley Collomia is considered a Special Status Species in both Nevada (BLM 2023b, 27) and Oregon (BLM 2021, 6). The Bureau of Land Management has two districts where Barren Valley Collomia has historically been found: the Wells region of the Elko District (NV) and the Malheur region of the Vale District (OR).

The lack of regulatory protections afforded in these Resource Management Plans (RMPs) may be contributing to this rare plant's decline. A more probing analysis of the protections afforded by the BLM through its RMP for Southeastern Oregon, its RMP for the Wells region of Nevada, and the BLM's policy for sensitive species underscores their inadequacy to protect Barren Valley Collomia and, consequently, the importance of ESA listing. Neither RMP mentions Barren Valley Collomia. The Wells RMP was approved in 1985, making it 40 years old and severely outdated. Barren Valley Collomia was not even described until a year later in 1986, meaning the RMP predates its discovery and there would have been no way at the time for the district to include it in any conservation planning. This RMP makes no mention even of "special status species" aside from one comment that some "species of special concern" are found in the management area (BLM 1985, S-3); in fact, the primary mentions of vegetation management are in the context of improving rangeland forage quality for livestock (BLM 1985, I-5). As Barren Valley Collomia is not a preferred forage species, and part of the BLM's plan for vegetation management involves seeding non-native crested wheatgrass (*Agropyron cristatum*) for cattle forage (p 4-8), such management actions risk further disrupting Barren Valley Collomia's already limited habitat because it may not be considered "useful" rangeland in its current state.

Further, the BLM concedes that there is a significant lack of knowledge and understanding of most BLM-sensitive species: "Most BLM Sensitive plants on the SSS species list have little quantitative trend data or formal monitoring of the number of individuals, demographic structure, seedbank viability, response to disturbance, or changing climate. A full understanding of population demographics, population trends, and annual fluctuations of populations due to climatic variability usually requires at least 10 years of monitoring" (BLM 2023, 3-164).

Notably, the Southeastern Oregon RMP explicitly states that "[h]abitat loss and disruption of ecological processes pose significant risks to Special Status plants" due to, among other things, "land conversion," "road and ROW [right-of-way] construction and maintenance," "non-native plant invasions," and "grazing by domestic livestock," all of which are threats to Barren Valley Collomia and its continued existence (BLM 2023, p. 3-164).

(E) OTHER NATURAL OR MANMADE FACTORS AFFECTING SURVIVAL

CLIMATE CHANGE

Reviews and individual studies have compiled and synthesized a large body of evidence showing that anthropogenic climate change is already impacting the cold desert ecosystems of the Great

Basin. In particular, Snyder et al. (2019) summarizes a great deal of literature on climate change in the American West. Their review reports that, since 1895, temperatures in the Great Basin have increased 0.7–1.4 °C, with the increase predicted to continue through the 21st century (pp 3–4); that more heatwaves and fewer cold snaps will contribute to declining snowpack, earlier snowmelt, and a greater proportion of precipitation falling as rain instead of snow (p 3); and that cheatgrass and wildfire will both proliferate in and contribute to these cycles of heat and dryness which are predicted to worsen into the future (pp 5, 8).

For Barren Valley Collomia, a plant with a relatively short lifespan and specific environmental needs for emergence and flowering, these changes will almost certainly have detrimental effects on its already small populations. The inability of recent survey efforts to successfully locate Barren Valley Collomia may be an indicator that climate change is already impacting the phenology of this plant, shifting it earlier in the season or possibly preventing it from emerging at all. Snyder et al. states, “In order for plants to survive [in a changing climate], they must either have large thermal tolerances or be able to migrate to locations with suitable climates” (p 2). Barren Valley Collomia has displayed neither trait: it is seemingly quite sensitive to thermal changes and, if it is similar to *C. macrocalyx*, it likely has a maximum dispersal distance of around 10 cm (Joyal 1984, 68). In addition, hot and dry summer conditions are likely the trigger for senescence in Barren Valley Collomia, so an increase in the severity of thermal and drought stress, along with an earlier seasonal onset of those conditions, may shrink the optimal growing window for this plant and prevent it from reaching maturity or producing viable seeds. The Nevada Department of Natural Heritage (NDNH) noted intense early-season heat waves throughout the Great Basin in 2024, which may have affected time of emergence or germination success of this species (NDNH, unpubl). In her 1986 description of the species, Joyal wrote, “Yearly fluctuations in population size in response to varying climatic conditions may thus affect the long-term survival of *C. renacta*. Further studies of the biology of this plant are needed to evaluate properly its status as a possibly endangered species.” (p 247). Forty years later, as the climate of the Great Basin continues to grow less predictable and more extreme, her warning should be heeded.

INVASIVE SPECIES

The encroachment of non-native grasses, particularly cheatgrass (*Bromus tectorum*) is one of the greatest threats to Barren Valley Collomia and its habitat (Marshall and Brown 2023, 8). In the Great Basin, areas dominated by annual grasses—particularly cheatgrass—have increased by more than 800% between 1990 and 2020 (Smith et al. 2021, 88), with a third of the Great Basin (~210,000 sq. km) estimated to have ≥15% cheatgrass coverage (Bradley et al. 2018, 1502). Cheatgrass impacts ecosystems by decreasing surface soil moisture and raising soil temperature (Prater et al. 2006) and forming dense mats of early-season stems and debris which crowd out other native species (Balch et al. 2013, 174). Although its impact on Barren Valley Collomia has not been specifically measured, the presence of cheatgrass has been found to reduce relative

growth rate of other Great Basin forbs by 37–80% (Parkinson et al. 2013, 177). As a small plant with a limited growth and flowering window, suppression of its growth rate may cause Barren Valley Collomia to fail to reach maturity and produce seeds quickly enough in the presence of heavy cheatgrass invasion.

Many native plants in the Great Basin produce few seeds compared to non-native annual grasses, which can lead to an imbalance in the seed bank at a given site. Borokini et al. (2020), while observing sites with the threatened species *Ivesia webberi*, found that even sites with native plants often had poor representation of native species in the seed bank when compared to invasive species (p 7). This suggests that the Great Basin’s ecosystems may have little resilience or resistance against invasion following disturbance events such as wildfires, when the invasive-dominated seed bank will determine the post-disturbance community at that site (p 8). With Nevada’s Barren Valley Collomia populations so close to highways, and therefore vulnerable to disturbance, cheatgrass incursion, and wildfire (Balch et al. 2013; Bradley et al. 2018), protecting this small plant and its habitat from disturbance—and protecting it from the ensuing conversion to an invasive-dominated community—is critical.

Cheatgrass incursion has been documented at Barren Valley Collomia populations in both Nevada and Oregon, and the continued spread of cheatgrass throughout the Great Basin suggests that uninvaded sites may become invaded in the future. In Nevada, the Pequop Summit location has high cheatgrass invasion in 2024 (NDNH unpubl), a marked change from the original observation of the site in Joyal (1986). At Star Mountain in Oregon, cheatgrass and medusahead (*Taeniatherum caput-medusae*) have both become common in Barren Valley Collomia’s habitat (Marshall and Brown 2023, 8). As of 2022, at least the Oregon site had no weed management plans in place (*Id.*), indicating that current actions (i.e., no action) are not sufficient to manage this threat to Barren Valley Collomia.

WILDFIRES

As conditions in the Great Basin grow hotter and drier, and as cheatgrass expands its range and overtakes more land, the number and severity of wildfires in the region has grown. As cheatgrass now occupies a third of the Great Basin (Bradley et al. 2018, 1502), including parts of Barren Valley Collomia’s habitat (Marshall and Brown 2023, 8), these changing wildfire regimes will directly impact this small, imperiled plant. The Star Mountain site in Oregon reportedly burned several times (*Id.*), which may have contributed to the apparent extirpation of Barren Valley Collomia there (Table 1).

Natural fire return intervals (FRIs) for the Great Basin vary by ecosystem, ranging from 169 years for montane shrubland to 1,946 years for desert shrubland. For sagebrush steppe and pinyon-juniper woodlands, both of which harbor Barren Valley Collomia, FRIs are estimated at 196 and 299 years, respectively. Conversely, cheatgrass grasslands have an FRI of only 78 years

(Balch et al. 2013, 178). Cheatgrass is twice as likely to burn as other land cover types, and is disproportionately associated with anthropogenic wildfires—75% of cheatgrass wildfires in the Great Basin are ignited by humans (Bradley et al. 2018, 1503). From 2000–2009, 13% of the cheatgrass in the Great Basin burned in wildfires, an amount more than double the proportional amount burned in other vegetation types (Balch et al. 2013, 177). Of the 50 largest fire events in this time period, 39 (78%) were associated with cheatgrass, and multi-day fires are significantly more likely to start in cheatgrass (p 178). Barren Valley Collomia may not be well-adapted to these more frequent and longer-duration burns, and such a change in their environment risks creating the level of stress which will preclude emergence of the plant in a given year.



The Pequop Mountains. Credit: Elaine Joyal, 1983.

REQUEST FOR CRITICAL HABITAT DESIGNATION

Critical habitat as defined by Section 3 of the ESA is: “(i) the specific areas within the geographical area occupied by a species, at the time it is listed in accordance with the provisions of section 1533 of this title, on which are found those physical or biological features (I) essential to the conservation of the species and (II) which may require special management considerations or protection; and (ii) the specific areas outside the geographical area occupied by the species at the time it is listed in accordance with the provisions of section 1533 of this title, upon a determination by the Secretary that such areas are essential for the conservation of the species.” (16 U.S.C. § 1532(5)).

Congress recognized that the protection of habitat is essential to the recovery and/or survival of listed species, stating that: “classifying a species as endangered or threatened is only the first step in ensuring its survival. Of equal or more importance is the determination of the habitat necessary for that species’ continued existence... If the protection of endangered and threatened species depends in large measure on the preservation of the species’ habitat, then the ultimate effectiveness of the Endangered Species Act will depend on the designation of critical habitat.” H. Rep. No. 94-887 at 3 (1976).

The Center requests that the Service propose to designate critical habitat concurrently with Barren Valley Collomia’s proposed listing. This plant’s continued survival is heavily dependent on the preservation of intact rocky soil habitat in Nevada and Oregon. Perhaps the most time-sensitive threat is that many of these sites are at risk of disappearing under carpets of invasive cheatgrass; active weed management must be undertaken to ensure that Barren Valley Collomia can persist in its native habitat.

CONCLUSION

The ESA is a “comprehensive scheme with the ‘broad purpose’ of protecting endangered and threatened species.” *Ctr. for Biological Diversity v. U.S. Bureau of Land Mgmt.*, 698 F.3d 1101, 1106 (9th Cir. 2012) (quoting *Babbitt v. Sweet Home*, 515 U.S. 687, 698 (1995)). Congress’ plain intent in enacting the ESA was “to halt and reverse the trend toward species extinction.” *Tenn. Valley Auth. v. Hill*, 437 U.S. 153, 184 (1978). In doing so, the ESA requires that “all Federal departments and agencies shall seek to conserve endangered species and threatened species and shall utilize their authorities in furtherance of [these] purposes.” 16 U.S.C. § 1531(c)(1) (2012). Endangered and threatened species are “afforded the highest of priorities.” *Tenn. Valley Auth.*, 437 U.S. at 174. Endangered species are species that are “in danger of extinction throughout all or a significant portion of its range,” and threatened species, species that are “likely to become endangered species within the foreseeable future” and are listed for protection pursuant to section 4 of the ESA. 16 U.S.C. § 1532(6), 1532(20), 1533.

The best available scientific data indicate that Barren Valley Collomia needs ESA listing across its range. This plant is a regional endemic with fragmented, isolated, and small populations which are threatened by human activity, invasive annual grasses, and anthropogenic climate change. The Oregon Department of Agriculture has already listed Barren Valley Collomia as endangered under the OESA, a decision made based upon the criteria that “[t]he species is in danger of extinction throughout all or any significant portion of its geographic range” (OAR 603-073-0030). This is the same basic criterion upon which the Federal ESA relies; the only difference is that here, Nevada’s populations must also be considered. Notably, Nevada’s two populations have not been relocated in 17 and 21 years. Although extirpation is less likely than a simple mistiming of surveys (P. Donnelly, pers comm 13 July 2025), the sudden difficulty in relocating the plant after a record of continual success warrants concern and suggests that phenological shifts or a loss in vitality or germination success may be occurring. Oregon’s ESA listing will not be sufficient to protect Barren Valley Collomia in Nevada or on the multiple BLM-owned sites in Oregon. Federal ESA protection is not only warranted but gravely needed for this species.

LITERATURE CITED

- Balch, J. K., Bradley, B. A., D'Antonio, C. M., and Gómez-Dans, J. (2013). Introduced annual grass increases regional fire activity across the arid western USA (1980–2009). *Global Change Biology*, 19: 173–183. DOI: 10.1111/gcb.12046.
- Bettez, N. D., Marino, R., Howarth, R. W., and Davidson, E. A. (2013). Roads as nitrogen deposition hot spots. *Biogeochemistry*. 18pp. DOI: 10.1007/s10533-013-9847-z.
- Bollinger, A. P. and Perryman, B. L. (2008). 20 years of natural recovery after wildfire on northern Nevada rangelands. In Kitchen, S. G., Pendleton, R. L., Monaco, T. A., and Vernon, J. (Eds.), *Proceedings—Shrublands Under Fire: Disturbance and Recovery in a Changing World; 2006 June 6–8; Cedar City, UT*. USDA Forest Service Proceedings RMRS-P-52, pp 169–173.
- Borokini, I. T., Weisberg, P. J., and Peacock, M. M. (2020). Quantifying the relationship between soil seed bank and plant community assemblage in sites harboring the threatened *Ivesia webberi* in the western Great Basin Desert. *Applied Vegetation Science*, 2020(00): 1–11.
- Bradley, B. A., Curtis, C. A., Fusco, E. J., Abatzoglou, J. T., Balch, J. K., Dadashi, S., and Tuanmu, M. (2018). Cheatgrass (*Bromus tectorum*) distribution in the intermountain Western United States and its relationship to fire frequency, seasonality, and ignitions. *Biological Invasions*, 20: 1493–1506. DOI: 10.1007/s10530-017-1641-8.
- Brooks, M. L. (2003). Effects of increased soil nitrogen on the dominance of alien annual plants in the Mojave Desert. *Journal of Applied Ecology*, (2003) 40: 344–353.
- Bureau of Land Management (BLM). (2023). Southeastern Oregon Proposed Resource Management Plan Amendment and Final Environmental Impact Statement. 381pp. https://eplanning.blm.gov/public_projects/87435/200197737/20080471/250086653/00_S EORMPA_Volume_1_Executive_Summary_and_Chapters_1-4.pdf
- BLM. (2023b). “Bureau of Land Management Nevada Special Status Species List September 2023”, US Department of the Interior Nevada BLM (8 November 2023). <https://www.blm.gov/policy/nv-im-2024-003>.
- BLM. (2021). “Final State Director’s Special Status Species List”, US Department of the Interior Oregon/Washington BLM (21 June 2021). <https://www.blm.gov/policy/or-p-im-2021-004>.
- BLM. (1985). Proposed Wells Resource Management Plan and Final Environmental Impact Statement. *United States Department of the Interior, Bureau of Land Management, Elko District Office*. 184pp.

- Fleischner, T. L. (1994). Ecological costs of livestock grazing in western North America. *Conservation Biology*, 8(3): 629–644.
- Forman, R. T. T. and Alexander, L. E. (1998). Roads and their major ecological effects. *Annual Review of Ecological Systems*, 29: 207–231.
- Fusco, E. J., Abatzoglou, J. T., Balch, J. K., Finn, J. T., and Bradley, B. A. (2016). Quantifying the human influence on fire ignition across the western USA. *Ecological Applications*, 26: 2390–2401. DOI: 10.1002/eap.1395.
- Hansen, M. J. and Clevenger, A. P. (2005). The influence of disturbance and habitat on the presence of non-native plant species along transport corridors. *Biological Conservation*, 125: 249–259.
- Hernández-Yáñez, H., Kos, J. T., Bast, M. D., Griggs, J. L., Hage, P. A., Killian, A., Loza, M. I., Whitmore, M. B., and Smith, A. B. (2016). A systematic assessment of threats affecting the rare plants of the United States. *Biological Conservation*, 203: 260–267.
- Jones, A. (2000). Effects of cattle grazing on North American arid ecosystems: A quantitative review. *Western North American Naturalist*, 60(2): 155–164.
- Joyal, E. (1986). A new species of *Collomia* (Polemoniaceae) from the Great Basin. *Brittonia*, 38(3): 243–248.
- Joyal, E. (1984). Ecology and reproduction in *Collomia macrocalyx* Brand (Polemoniaceae). Unpublished master's thesis. Oregon State University. 107pp.
- Marshall D. A. and Brown, J. (2023). 2023 listing status assessment for *Collomia renacta* (Barren Valley *Collomia*). Oregon Department of Agriculture, Salem, OR. 17pp.
- Matthies, D., Bräuer, I., Maibom, W., and Tschardtke, T. (2004). Population size and the risk of local extinction: empirical evidence from rare plants. *OIKOS*, 105(3): 481–488.
- Morefield, J. D. (Ed.). (2001). Nevada rare plant atlas. *Carson City: Nevada Natural Heritage Program*, compiled for the U.S. Department of the Interior, Fish and Wildlife Service, Portland, OR and Reno, NV. 526pp.
- Nevada Division of Natural Heritage (NDNH). Unpublished 2024 survey results for *C. renacta*.
- Oregon Legislature. (2010). Background Brief on Endangered Species. 5pp. <https://www.oregonlegislature.gov/lpro/Publications/2010EndangeredSpecies.pdf>.
- Parkinson, H., Zabinski, C., and Shaw, N. (2013). Impact of native grasses and cheatgrass (*Bromus tectorum*) on Great Basin forb seedling growth. *Rangeland Ecology & Management*, 66: 174–180. DOI: 10.2111/REM-D-11/00028.1.

- Prater, M. R., Obrist, D., Arnone, J. A. III, and DeLucia, E. H. (2006). Net carbon exchange and evapotranspiration in postfire and intact sagebrush communities in the Great Basin. *Oecologia*, 146: 595–607.
- Smith, J. T., Allred, B. W., Boyd, C. S., Davies, K. W., Jones, M. O., Kleinhesselink, A. R., Maestas, J. D., Morford, S. L., and Naugle, D. E. (2021). The elevational ascent and spread of exotic annual grass dominance in the Great Basin, USA. *Diversity and Distributions*, 28: 83–96. DOI: 10.1111/ddi.13440.
- Snyder, K. A., Evers, L., Chambers, J. C., Dunham, J., Bradford, J. B., and Loik, M. E. (2019). Effects of changing climate on the hydrological cycle in cold desert ecosystems of the Great Basin and Columbia Plateau. *Rangeland Ecology and Management*, 72: 1–12.
- Svejcar, T., Boyd, C., Davies, K., Hamerlynck, E., and Svejcar, L. (2017). Challenges and limitations to native species restoration in the Great Basin, USA. *Plant Ecology*, 218: 81–94. DOI: 10.1007/s11258-016-0648-z.
- Vasquez, E., Sheley, R., and Svejcar, T. (2008). Nitrogen enhances the competitive ability of cheatgrass (*Bromus tectorum*) relative to native grasses. *Invasive Plant Science and Management*, 1: 287–295.