BEFORE THE SECRETARY OF THE INTERIOR

A PETITION FOR LISTING OF WASHINGTON JACOB'S LADDER – Polemonium pectinatum – UNDER THE ENDANGERED SPECIES ACT WITH A CONCURRENT DESIGNATION OF CRITICAL HABITAT

Washington Jacob's Ladder – Polemonium pectinatum – Lincoln County, Washington State

CENTER FOR BIOLOGICAL DIVERSITY

10 August 2026

Notice of Petition

Doug Burgum, Secretary of the Interior
U.S. Department of the Interior
1849 C Street, N.W.
Washington, D.C. 20240
exsec_exsec@ios.doi.gov

Brian Nesvik, Director
U.S. Fish & Wildlife Service
1849 C Street, N.W.
Washington, D.C. 20240
brian_nesvik@fws.gov

Bridget Fahey, Acting Regional Director, Pacific Region
U.S. Fish and Wildlife Service
911 NE 11th Ave.
Portland, OR 97232
bridget_fahey@fws.gov

Petitioners

Gwendolyn McManus
Staff Scientist
Center for Biological Diversity
P.O. Box 11374
Portland, OR 97211
gmcmanus@biologicaldiversity.org

Mark Darrach, M.S.
Principal
Corydalis Consulting
corydalis.mark@gmail.com
(360) 204-0233

Dear Secretary Burgum,

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 Washington Jacob's ladder (*Polemonium pectinatum*) 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 Washington Jacob's ladder 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/x38mhesc0yens7id7u5ip7zqcifyjawu.

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 1.8 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 Washington Jacob's ladder and its habitat.

Submitted this 10th day of August 2026.

Gwendolyn McManus
Staff Scientist
Center for Biological Diversity
P.O. Box 11374
Portland, OR 97211
gmcmanus@biologicaldiversity.org

Table of Contents

Executive Summary

Washington Jacob's Ladder, hereafter referred to by its scientific name *Polemonium pectinatum* or *P. pectinatum*, is a showy purple- or lavender- (rarely white-) flowered long-lived globally imperiled (G2S2) narrow endemic Washington State threatened taxon in the family Polemoniaceae. Reproduction in the species relies largely upon an obligate outcrossing insect-mediated protandrous pollination syndrome that involves a broad spectrum of pollinating insects. It has an apparent heavy reliance on native ground-nesting solitary bees – particularly in the family Andrenidae. The species apparently does not have viable seed production limitations at this time. *P. pectinatum* is confined to increasingly imperiled moist swale bottom lands and riparian margins in four counties in eastern Washington. Suitable habitat for the species is clearly being narrowed into increasingly unstable hydrologic settings. Presence of the species along riparian stream course margins relies nearly entirely on surface runoff as irrigation agriculture-induced extreme groundwater level recession throughout its range has essentially eliminated groundwater contributions to baseline stream flows. Populations that reside in mesic hydrologically isolated swale depression sites are likewise narrowed into settings highly susceptible to climate-disruption-induced elevated evaporation by summer temperature extremes and prolonged drought. As these sites subsequently become more xeric, they are no longer capable of supporting the species. Recruitment and subsequent successful establishment of *P. pectinatum* is clearly strongly tied to the presence of bare soil for recruitment. Of the 10 populations recently evaluated, only those with some element of bare soil show evidence of any recruitment. Thus, sites with significant weed infestations and/or associated dense native vegetation are essentially reliant upon the longevity of existing plants to perpetuate these populations. All indications are that these sites may ultimately be relegated to slow extirpation.

This petition provides an evaluation of the status of the species as a whole. It also provides detailed analyses of recently evaluated element occurrences (EOs) providing population censuses, pollinator observations, habitat quality evaluations, and an appraisal of risk factors.

Results of a 2025 field study of the species indicate that *Polemonium pectinatum* is in serious decline, with a significant reduction in the number of EOs presently deemed viable. As such, the protections the federal Endangered Species Act (the Act) provides are deemed necessary and prudent.

1.0 Introduction

Polemonium pectinatum Greene (Washington Jacob's-ladder) is a Washington Threatened, Bureau of Land Management sensitive, narrowly endemic, obligate outcrossing perennial taxon in the Polemoniaceae (Phlox family). The historic range of the plant spanned a broad polygon approximately 180 km east-west by 80 km north-south (Fig. 1) (WNHP 2026). The species was listed as Washington State Endangered and a candidate 1 for listing under the Endangered Species Act (ESA) until 1997 (Gilbert 1998, p. 2) when it was down-listed to a federal species of concern and state threatened (*Id.*). *Polemonium* is a cosmopolitan semi-woody or herbaceous genus of primarily perennial taxa with 26 presently recognized species, of which 21 are known from North America (Stubbs, in press, entire). The center of diversity for the genus is in the Rocky Mountains of the western United States.

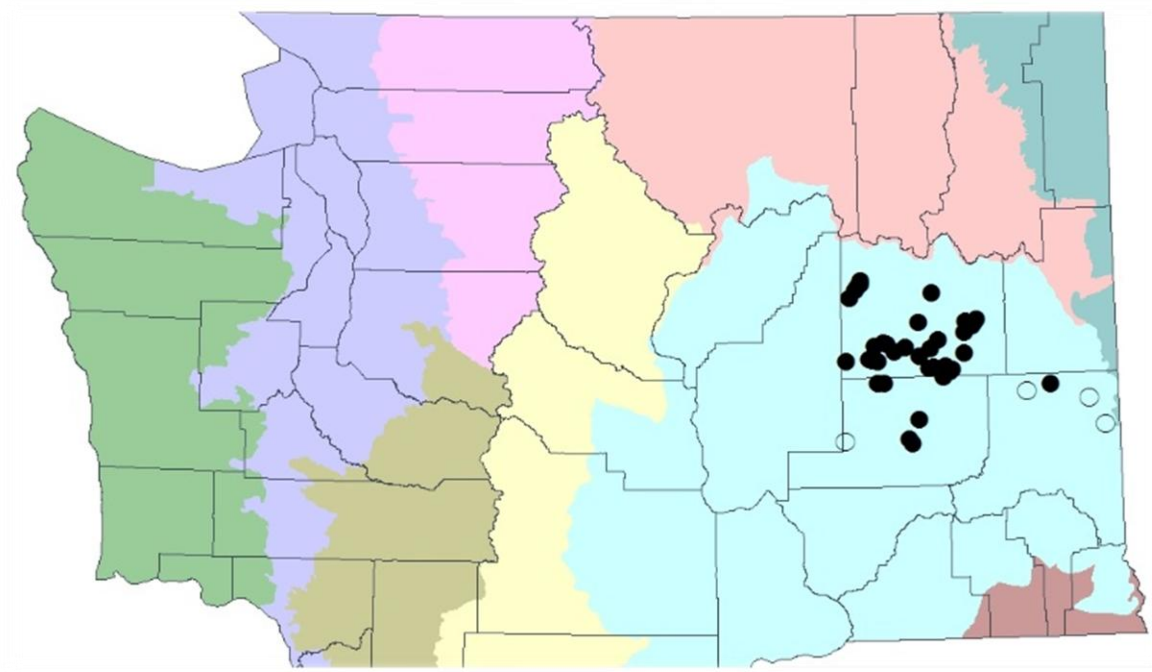

Figure 1. Range of Polemonium pectinatum. Black dots represent putatively still extant populations. Open circles are extirpated historical occurrences. Figure from WNHP Online Rare Plant Guide.

Drawing heavily upon a 2025 field season analysis by Beck and Darrach, this petition provides an assessment of the present state of 10 populations and, by extension, insight into the likely viability of the species as a whole. Previous efforts evaluating the status of *P. pectinatum* have never considered the full suite of element occurrences (EO's). Major efforts, primarily focused upon aspects of community ecology conducted by Cynthia Gilbert (1998) and the Washington Natural Heritage Program (WNHP) (Crawford and Rocchio 2012) inform this petition and are in-part incorporated into the assessment provided here.

2.0 Taxonomy

Polemonium pectinatum Greene was first described by Edward Greene in 1884 (Greene 1884, p. 10) based upon an herbarium specimen collected by Dr. Eugene Hilgard in 1882. The Greene publication erroneously described the species as having white flowers owing to color fading of the herbarium specimen from the typical lavender-purple corolla, although white-flowered individuals are occasionally found. The species is distinct and noteworthy within the genus both as a genetic entity unknown to hybridize with other taxa within the genus and for the unusually large size of the mature plants.

P. pectinatum is a glabrous, deeply taprooted (Fig. 2), large, attractive, and tufted perennial caulescent species. It blooms from May to as late as early July in some high-precipitation years. In dormancy *P. pectinatum* plants die back to the base, with perennating buds just above the ground surface or shallowly buried in duff. Senescent leaf rachises from previous seasons persist as a well-developed thatch at the base of the plant (Fig. 3). *P. pectinatum* plants range from 30 cm to 100 cm in height and can be more than 150 cm broad in robust specimens (Fig. 4). Large plants tend to collapse under their own weight in rain and wind events (Fig. 4). The number of flowering stems of adult plants range from 1 to as many as 150 or more on mature specimens. The strongly pinnate-pectinate leaves (Fig. 5) are 17—65 × 20—95 mm and are similar in size along the leaf rachis with 10-20 linear leaflets (Stubbs in press, pp. 29–31). Flowers are pale lavender to purple (rarely white) with darker purple nectar guides. They have openly rotate 5-petaled superior-ovary protandrous flowers with exerted to weakly included anthers (Fig. 6). The flowers are arranged in a sparse open cymose inflorescence. Calyces are campanulate with a well-developed glandular pubescent vestiture. Fruits are a dry 3-carpellate septicidal, nominally 9-ovule accrescent capsule with axile placentation. The plants are notorious, as is much of the genus, for a strong ‘skunky’ smell that readily volatilizes when contacting the plants or crushing leaves or calyces. This ‘skunky’ smell is attributed to terpene and thiol (mercaptan) compounds (Dorsett and Pike 1995, p. 292). Secondary chemical volatile metabolite compound separation between foliage and flower nectaries is well documented (*Id.*), indicating ecological functional partitioning.

Figure 2. Deep taproot of Polemonium pectinatum EO 42, Lincoln County, Washington.

Figure 3. Persistent thatch of rachises from previous year's vegetation at base of mature Polemonium pectinatum plant, EO 27, Adams County, Washington.

Figure 4. Large mature blooming Polemonium pectinatum plant. EO 27, Adams County, Washington.

Figure 5. Polemonium pectinatum leaf. EO 22, Lincoln County, Washington.

3.0 Species Ecology, Reproductive Biology, Life and Natural History

3.1 Physical Environment Factors and Ecology

3.1.1 Physical Environmental Factors

Polemonium pectinatum is confined to the cold desert landscape east of the Washington Cascade Mountains where precipitation averages approximately 26.5 cm per year at the Odessa, Washington weather station (code – ODSW) in the core of the species range (WRCC 2026). Its habitat is restricted to mesic settings along both perennial and ephemeral streambanks, decoupled flood plains above hydrologically altered, down-cut channels (Fig. 7), spring-fed localities, precipitation fed topographic depressions, and the mesic base of talus slopes along coulee walls. It grows on soils of mixed loess and admixtures of volcanic ash, alluvium and colluvium (Fertig 2020, p. 77). The elevation of the documented EOs range from 165 m to 700 m (WNHP 2026).

Figure 6. Protandrous Polemonium pectinatum flower

3.1.2 Plant Association Communities

Polemonium pectinatum is found as a rare element of the following associations:

- *Leymus cinereus* alkaline wet meadow (NatureServe rank G2G3Q/S1),
- *Artemisia tripartita* ssp. *tripartita* / *Festuca idahoensis* shrub grassland (NatureServe rank G3/S3)
- *Artemisia tridentata* ssp. *tridentata* / *Leymus cinereus* shrubland (NatureServe rank G2/S1) plant communities (Gilbert 1998, p. 11).

Other commonly observed associates include *Achillea millefolium*, *Amelanchier alnifolia*, *Artemisia ludoviciana*, *Bromus tectorum*, *Rosa woodsii* and *Senecio serra.*

3.1.3 Allelopathy

A noteworthy feature of some areas of ecologically healthier *P. pectinatum* populations that have been observed is the unusual density of the plants to the nearly complete exclusion of other, even exotic weedy, species (Fig. 8). This character has been noted at EO's 27, 28, 29, 33, 40, 42, and 46. The plants have very strong fragrance separation between the pleasant-smelling flowers and the very strong skunky odor of the leaves and the sticky glandular trichomes present on the stems, pedicels and calyces. The 'skunky' odor of *Polemonium* taxa is well-documented in species such as *P. foliosissimum* and *P. viscosum* (Dorsett and Pike 1995, entire). Additionally, it has noted that this character is prominent in the field with *P. californicum* and *P. pulcherrimum* as well (Darrach pers. obs.).

While allelopathy in *Polemonium* has never been formally documented, neither has anyone conducted research attempting to test the hypothesis. However, a study conducted by Dorsett and Pike (1995) documents a gas chromatography analysis of secondary chemical compounds in the species *P. foliosissimum* and finds that resinous glandular trichomes in the species produce strong peaks that correlate with α-pinene and ß-pinene, amongst other terpenoid compounds (p. 292). They surmise that the pronounced skunky odor is produced by a thiol (mercaptan) (*Id.*). Both terpenes (including α-pinene) and thiols have well-documented allelopathic properties in other unrelated taxa (Abrahim et al. 2000, entire; Singh et al. 2006, entire; Cheng et al. 2020, entire). It seems extremely likely based upon both field observations and research into allelopathic effects of thiols and terpenes that *P. pectinatum* exudes effective amounts of inhibitory compounds such that sometimes even aggressive invasive species have difficulty establishing in the populations. The significant conservation implications of this are discussed in a following section.

3.2 Reproductive Biology

3.2.1 Mating System

The genus *Polemonium* has a diverse range of both pollinators and mating strategies, with single species often having multiple systems (Hill et al. 2008, pp. 319–320; Gilbert 1998, p. 91).

Figure. Polemonium pectinatum plants on the edge of a decoupled flood plain along hydrologically altered and down-cut section of Crab Creek immediately west of Odessa, Lincoln Co. Washington, EO 46.

Figure 7. Dense Polemonium pectinatum population, EO 42.

While the community ecology and some elements of the population biology of *P. pectinatum* have seen significant attention (Gilbert 1998, entire), investigation into the mating system of *P. pectinatum* is lacking. Limited observations in the field suggest that, as with some other taxa in the genus (Zych et al. 2013, p. 95; Stpiczyńska et al. 2013, p. 61), *P. pectinatum* flowers are protandrous with the anthers dehiscing prior to stigma receptivity (Fig. 6), thus promoting a pollinator-mediated outcrossing mating strategy. There are, however, some indications that the species may be capable of selfing as well. Gilbert (1998) found that plants grown in a greenhouse setting at the University of Washington produced some seed in the 'apparent' absence of pollinators (p. 91). Some genetic data, presented in the genetics section below, is also suggestive of a possible element of self-compatibility in at least some populations of the species.

Abundant pollinator activity was observed in the field and is represented by visits to EO's 22, 28 and 29 (Fig. 7) on 20 and 21 May, 2025. Pollinator survey results are discussed below.

3.3 Life History

3.3.1 Plant Longevity

Neither the existing WNHP data set, Gilbert's (1998) abbreviated analysis of transition matrix population parameters, nor any of the BLM monitoring ecological conditions studies provide any hints as to the possible longevity of *P. pectinatum* plants. Individual plants have never been tracked for a sufficient duration to assess an understanding of how long individual plants may persist. Likewise, no herb-chronology studies into any members of the genus are to be found in the scientific literature (Schweingruber and Poschlod 2005, entire). Herb-chronology studies use annual growth rings in roots and stems to age plants. Members of the genus include annual species (e.g. *Polemonium micranthum*), apparent biennials (e.g. *Polemonium reptans*), and apparently long-lived species (e.g. *Polemonium viscosum*).

One significant field-based *P. pectinatum* observation does however provide a significant clue as to possible longevity of individuals. EO 46, just west of Odessa, Washington, is closely spatially associated with the channel of regionally prominent Crab Creek. This creek is one of the few perennial stream drainages in the central Washington portion of the Columbia Basin. The main Burlington-Northern railroad tracks parallel Crab Creek. Historically this reach of the creek has experienced infrastructure-damaging flooding – e.g. a large flood in 1925 – in which the railroad tracks were washed out (Big Bend Railroad History 2025). Observing the existing stream channel at EO 46, it is readily apparent that this reach of the stream departs radically from normal sinuosity; it has been artificially straightened and channelized to protect the railroad bed's route. Channelization of stream reaches results in increases to the power of flow, increased stream incision and downcutting, stream widening, and ecological degradation (Blake and Rhanor 2020, entire; Salas and Rhoads 2022, entire). When Crab Creek was mechanically straightened, the creek rapidly began downcutting through unconsolidated flood plain sediment deposits (Fig. 7) and became hydrologically decoupled from its historic flood plain. It was on this historic flood plain that the *P. pectinatum* population was originally established (Darrach, pers. obs.). Thus, the *P. pectinatum* plants are now marooned in a habitat where their reproductive capacity is greatly attenuated owing to a now inappropriate hydrologic regime and substrate for recruitment.

Surveys at EO 46 make it very clear that this population of almost entirely very large mature plants is essentially producing very close to no recruitment at all. One minor exception is discussed in the results section below. By extension, it is apparent that in the long-term absence of recruitment, the plants at this site are all likely very old and may well date back nearly a century to the mechanical channelization of the stream reach.

3.3.2 Pollination Ecology and Pollinator Survey

A synoptic qualitative assessment of 10 investigated EOs by Darrach and Beck (unpublished report 2025) suggests that pollinator activity is robust and broadly diverse. Neither pollen nor pollinator visitation would appear to be limiting factors for *P. pectinatum* based upon the subset of EOs they assessed. However, there are no available baseline data with respect to pollinator diversity and abundance. It seems likely that the present pollinator species richness and abundances are reduced relative to historical conditions.

Pollinator surveys were conducted over two days – May 20th and May 21st – by Washington State University entomology graduate student and bee specialist Aidan Hersh. EO's 22, 28, and 29 were evaluated. Insects observed visiting *P. pectinatum* flowers were collected when possible, while others were photographed using focal plane stacking software.

A total of 121 insect individuals were collected from *P. pectinatum* plants with the 4 bee families Adrenidae, Apidae, Halictidae and Megachilidae represented. Individuals from the two Diptera families Bibionidae and Syrphidae and the ant family Formicidae were also collected. Additional insect families observed, but not collected include one snakefly family member – Rhaphididae, one beetle family member – Cerambycidae, and one moth family member – Sphingidae.

Among the bees that were collected, a total of 9 genera were identified representing at least 24 species. The majority of individuals observed on and collected from *P. pectinatum* flowers are members of the genus *Andrena*, with one unidentified *Andrena* species noted as being particularly prevalent at EO's 28 and 29. Of the 121 individuals collected, 46 were this *Andrena* species.

The diversity of insect families observed visiting *P. pectinatum* flowers indicate the species is not likely to be overly dependent upon any particular floral specialist to provide pollination services. Its actinomorphic flowers with low-effort pollen access and nectar rewards make *P. pectinatum* flowers accessible to a diverse array of insects. While the particular undetermined *Andrena* sp. bee was the most commonly observed visitor, other bees across the observed taxonomic range were also confirmed to be actively foraging on *P. pectinatum* flowers, including but not limited to: *Eucera rufitarsus, Eucera actuosa, Halictus rubicundus* and *Andrena nigrocaerulea*. A sampling of species photographed are presented in Figures 9, 10, and 11.

3.3.3 Seed Production, Germination and Propagation

Polemonium pectinatum seed production has apparently never been assessed by other investigators. A limited investigation of seed production per fruiting capsule has been conducted as part of the Darrach and Beck (2025) field study. Ovule production per carpel in their assessment ranges from 2 to as many as 5 with nearly all ovules maturing as apparently viable seed. Average seed production in their small sample is 8 (maximum of 10) seeds per capsule. No seed predation evidence was noted when evaluating individual capsules.

Figure 8. Female Andrena sp. on Polemonium pectinatum flower with dehisced anthers.

Figure 9. Bombus centralis worker visiting a Polemonium pectinatum flower.

Figure 10. Andrena sp. nest parasite cuckoo bee in the genus Nomada perching on a Polemonium.

Assuming a typical number of mature capsules per inflorescence of approximately 10, and large mature plants producing in excess of 100 inflorescences (Fig. 4), would suggest that seed production, at least during the 2025 flowering season, is unlikely to be a limiting factor. Observations at EO 27, discussed below, lend further credence to this contention. Washington RareCare director Wendy Gibble has also observed that seed production in the species is typically prolific (Gibble pers. comm. 2025). Gilbert's (1998) quantitative seed output tables 3.4 and 3.5 (pgs. 67, 68) also support prolific seed production as most probably being typical.

Polemonium pectinatum seed accessions collected from a total of 11 EO's are presently stored at the Miller Seed Vault at the University of Washington Botanic Gardens. Currently, a total of approximately 35,000 seeds are in storage. Seed germination is high, typically ranging from 80–100% of seed tested. No ancillary treatments such as stratification or scarification are needed to enhance germination rates. The oldest seed in storage is a collection from 2008 (Gibble pers. comm. 2025). The plants are reportedly readily grown (Gibble pers. comm. 2025).

3.3.4 Seed Dispersal, Recruitment and Survivorship

Seed dispersal mechanisms in *Polemonium* have at best received sparse research attention, but in general, gravity is considered to be the primary dispersal agent for most species in the genus (e.g. Dodds 2023, p. 5). Those species with seeds that have a testa that becomes mucilaginous when wet may be secondarily dispersed via zoochory in some instances (*Id.*). Wetting *Polemonium pectinatum* seeds does indicate they become mucilaginous (Gilbert 1998, p. 60), so some zoochory by fossorial rodents in particular does seem probable and may be a significant dispersal factor for the species.

While gravity and wind dispersal are likely to be significant agents of dispersal in many circumstances for the species, hydrologic transport is almost certainly the most effective dispersal agent for *P. pectinatum*. This is particularly clear at EO 27 in Lind Coulee, and a previously unknown eastern extension of this occurrence at and east of Ralston along the Palouse-to-Cascades - old Chicago-Milwaukee railroad bed conversion trail. EO 27 is confined to a narrow artificially channelized drainage in the bottom of the coulee. On the rare occasions when the drainage has flowing water, apparent gravity and hydrologically-fed seed from *P. pectinatum* plants are transported along the drainage bottom where numerous seedlings are found in several locations (Fig. 12). These seeds likely originate from *P. pectinatum* plants growing along nascent flood plain segments on the shoulders of the drainage (Fig. 13), and further upstream. Unfortunately, these seeds are also in the bottom of this artificially channelized drainage where the highest discharge rates and attendant flow velocities occur, and plant establishment is thus ephemeral owing to active flood water scouring. No mature plants were observed in the bottom portions of the drainage. Nearly all mature plants are located along the shoulders of the drainage far above bank full flow stage (Fig. 13). Only large and very infrequent flood events seem capable of distributing seed sufficiently far upslope on the drainage walls for persistent plant establishment to occur. Alternatively, many/most of these plants may be very old and thus predate the down-cutting of the straightened channel.

Observations in the field clearly indicate that bare soil is the substrate most conducive to seed germination and, ultimately, successful recruitment and the long-term survivorship of reproductive plants. This comports well with greenhouse experiment observations by Gilbert (1998, p. 50). This observation is evident at EO's 22, 28, 46, and particularly, at EO 27 (Figs. 13 and 14). Just east of Ralston along the Lind-Ralston Road, there is a coulee section where the narrowly incised portion of the drainage between two basalt walls opens up into a flat. Apparent flash flooding has discharged large volumes of silt-sized sediment eroded from nearby plowed (bare) agricultural fields. There are as yet unmapped reproductive *P. pectinatum* plants in the narrow upstream part of the drainage and large volumes of possibly banked *P. pectinatum* seed that has washed out of the canyon and colonized the site in an astonishing display of tens of thousands of plants which essentially create a *P. pectinatum* monoculture (Fig. 14).

It is clear that this monoculture site was created by an artificial process, in that it results from erosion-inducing agricultural practices upstream. This erosion provided the site with the necessary sediment load to support such robust recruitment. It seems probable that this private land site will remain as a *P. pectinatum* monoculture for the foreseeable future except in the case of human interference.

3.3.4 Seed Banking

Information regarding the possibility of *Polemonium pectinatum* producing a seed bank that may contribute to the long-term reproductive capacity of the species is lacking.

Figure 12. Cluster of P. pectinatum seedlings on bare soil in the straightened incised channel in Lind Coulee EO 27.

Figure 13. Incised down-cut, straightened drainage in Lind Coulee at EO 27. Large numbers of Polemonium pectinatum plants occupy the old flood plain and may represent colonization from seed hydrologically transported during flood events.

There is no direct evidence of the species producing seed that is able to persist in the soil for substantial periods of time. However, seed banking studies indicate that species which produce small and compact seeds in particular are predisposed to longer term seed banking, at least in part because they offer little reward to seed predators (Thompson 1987, p. 25). *Polemonium pectinatum* seeds are small, but not particularly compact. In addition, germination data from the Miller Seed Vault *P. pectinatum* accessions indicate that the seed readily germinates with few requirements. Species with seeds that readily germinate *en masse* do not tend to correlate with seed banking (Thompson 1987, p. 28; Dodds 2023, p. 5). One piece of evidence that suggests some level of seed banking is the sheer enormity of the EO 27 Ralston extension subpopulation (Fig. 14). Such a large quasi-monoculture population suggests that some soil storage of seed may have been present in the large sediment volume associated with the flash flood(s) that inundated this site.

Figure 11. Large monoculture of P. pectinatum at Ralston just east of presently mapped extent of EO 27. See text for further explanation.

4.0 Genetics

The only genetic data available for *Polemonium pectinatum* is restricted to four populations across the range of the species and is contained in Cynthia Gilbert's PhD dissertation from 1998. She employed microsatellite markers – high mutation rate DNA simple sequence repeats – that can vary significantly across populations. These markers are useful tools for analyzing population allele heterozygosity. Gilbert chose analysis of plants from EO's 24, 27, 29 and, apparently, 38. Her conclusions support apparent inbreeding within each of these populations (Gilbert 1998, pp. 89–90). To what extent this elevated homozygous allele frequency results from a possible selfing mating strategy, geographic isolation and concomitant lack of gene flow, or a combination of these factors, remains unknown.

5.0 Hydrologic Setting

Polemonium pectinatum is intimately tied to the hydrology of the interior Columbia Basin in which all populations reside. It is a species that has not been assessed for inclusion into the National Wetland Plant List, but it is clear that it would be ranked as a FACW (facultative wetland indicator) plant based upon its preferred streamside and moist swale habitat preferences. The species does edge into habitat wherein Great Basin big sagebrush and Idaho fescue are prevalent, so it does have marginal tolerance for somewhat xeric conditions. The hydrologic settings in which *P. pectinatum* populations reside include:

- Moist swales in which precipitation as both rainfall and snowfall is seasonally retained in low depressions which may have a shallow clay-rich soil aquitard. It is assumed this variety of site has soils in part derived from devitrified silicic volcanic ash from Cascade eruptions. Lenses of silicic volcanic ash were noted in soils at EO 29 (Fig. 15) indicating that volcanic ash does accumulate in these sites.
- Sites in coulees where springs are present.
- Sites along coulee walls at the base of basalt talus piles where sufficient moisture and appropriate fine-grained soils are present.
- Streamside flood plains with some plant encroachment into distal flood plain edges where limited amounts of bare soil provide suitable recruitment sites. These sites, at least in the EOs investigated in this assessment, are restricted to locations in which stream reaches have not been decoupled from their flood plains, owing to either no manmade attempts to alter streams channels or shallow basalt bedrock limiting potential downcutting.
- Decoupled flood plains along anthropogenically straightened stream reaches wherein *P. pectinatum* plants are marooned in marginal habitat above down-cut channels that no longer provide sediment from flood events that would provide a suitable habitat for recruitment.

Figure 12. Silicic volcanic ash soil lens EO 29 – most likely from the main May 1980 Mt. St. Helens eruption.

Pervasive hydrologic concerns as they relate to the persistence of *P. pectinatum* include the following noteworthy points:

- *P. pectinatum* populations that are confined to moist swale depressions with deep soils unconnected to any active stream courses are apparently nearly entirely reliant upon the ability of these geomorphic landscape elements to concentrate any meager precipitation that gathers in these locations. As climate disruption proceeds apace and the reliability of precipitation becomes increasingly unstable (WDFW 2025), the amount of precipitation available to these populations will surely decline relative to the historical range of variability that has allowed them to persist until the present.

- Those *P. pectinatum* populations whose persistence are reliant upon the presence of groundwater dependent ecosystem elements such as springs and seeps are in particular peril as groundwater extraction within the entire geographic footprint of the species far outstrips aquifer recharge (Asante-Sasu et al. 2025, p. 7). Groundwater extraction in support of crop irrigation is particularly noteworthy in the general Odessa, Washington subarea where the large majority of *P. pectinatum* EOs are found. Extraction rates and groundwater level declines are documented to exceed 10 ft/yr in this portion of the Columbia Basin (p. 4). Groundwater recession here is so extreme that what was once the popular park and fishing location Pacific Lake, well over 10+ feet deep at one point, is now a desiccated weed-barrens where fishing and water recreation once occurred (Fig. 16).
- Extreme groundwater recession in this portion of the Columbia Basin also has a direct deleterious impact on stream courses that support *P. pectinatum* populations along Coal Creek, Crab Creek and Wilson Creek. There are likely no longer any groundwater components that are contributing to base flow of these streams. Thus, they are essentially completely reliant on precipitation runoff and any immediate near-surface storage unconnected to deeper aquifers.

Figure 13. Dry Pacific Lake near EO 42 in Lincoln County.

6.0 Population Assessments

The field work conducted by Beck and Darrach included visitation and assessment of population conditions and parameters at a total of 10 EOs. Each of these populations is discussed below in EO numerical order. A synoptic map at a scale of 1:700,000 is presented in Fig. 17 showing all known populations as compiled by the WNHP.

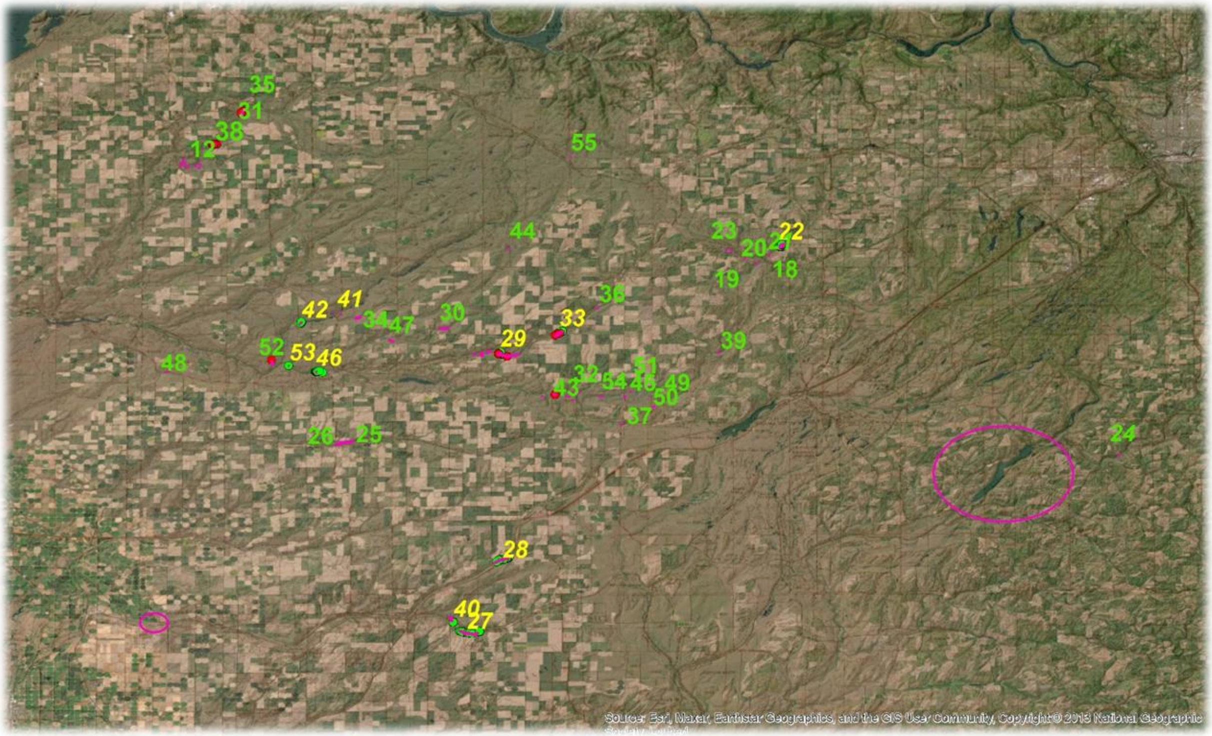

Figure 14. Synoptic map of all presently known Polemonium pectinatum EOs. Occurrences numbered in yellow were investigated for this project. Those in green were not visited. Magenta polygons are the EO extent as present in the WNHP database. Magenta ovals are extirpated historical populations that never had accurate georeferencing coordinates.

6.1 EO 22 – Private and Lincoln County Road Department Lands

EO 22 is located on private property and Lincoln County Road Department land. It was last visited on 3 June 1994 by surveyors Phyllis Baxter and John Gamon. The 1994 assessment and the previous 1985 assessment reported plant numbers of 1000+ plants in 11 groups along an ~0.25 mile stretch of the upper reaches of Crab Creek, on the flood plain of the stream and in moist depressions on adjacent hillslopes.

Beck and Darrach's 2025 field work recorded an estimated total plant count of 2,062 individuals in 7 primary subpopulations (Fig. 18). Subpopulations mapped in the northern part of the WNHP polygon have been extirpated. The subpopulations in the southern portion of the polygon are doing fairly well, with the furthest eastern subpopulation actively recruiting. These subpopulations apparently became established during the 30 years since the last WNHP survey. Beck and Darrach encountered one of the landowners in the field. He has kept an eye on the plants over the years and has also noted the expansion of *P. pectinatum* plants into this new area. However, this is the only portion of the population that showed any signs of recruitment. The large majority of the population is densely crowded with vegetation, much of which is weedy exotic species (Fig. 19).

Beck and Darrach's assessment of the long-term viability of the population is fair to perhaps good, but with caveats in that the portions of the population that are densely vegetated seem destined for decline and ultimately extirpation due to lack of recruitment. There is also significant concern that the plants are not protected as there are no constraints on land usage on private or county road department lands. The loss of the northern portion of the population over the last 30 years accentuates this concern in that it appears that intensive cattle grazing in this area is likely responsible for the demise of this subpopulation.

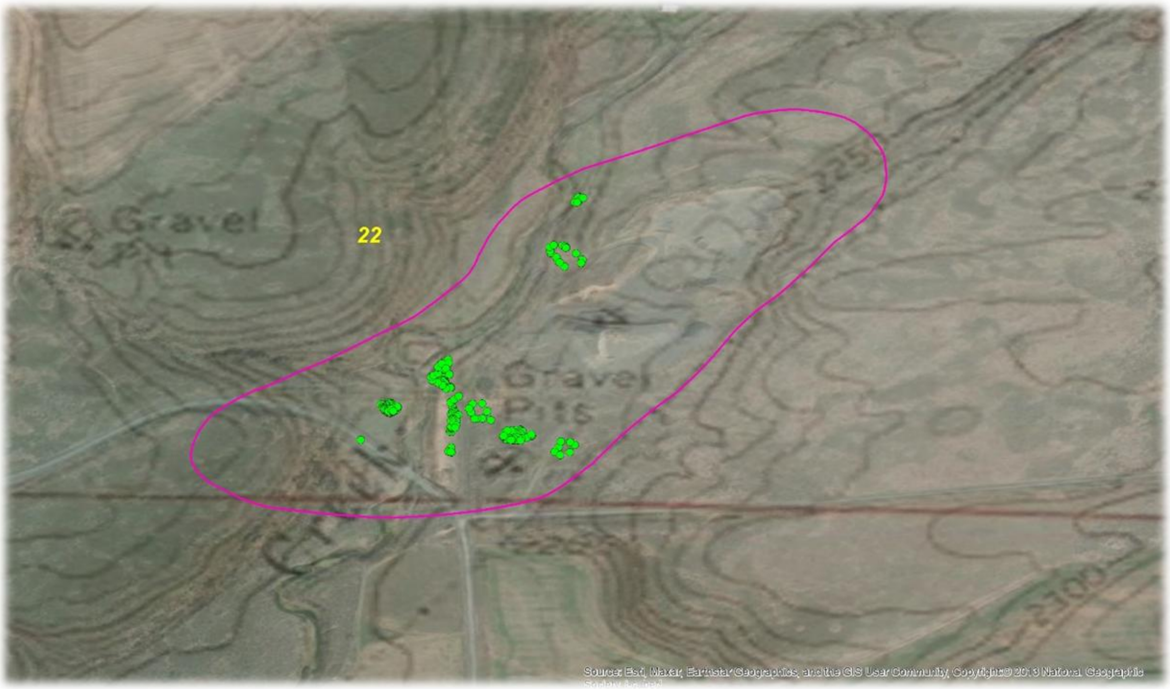

Figure 15. Point map of EO 22 - note discreet subpopulations of plants in moist topographic depressions.

6.2 – EO 27 Washington State Parks and Private Ownership

Confined to Lind Coulee, EO 27 is comprised of a very large number of plants, estimated to be between 20,000 – 30,000 individuals (Fig. 20). The last documented visit to the population was by Phyllis Baxter from the WNHP on 8 September 1994. At that time, "1000's of plants in stream channel, banks and terraces to the south of the Milwaukee RR corridor" were documented. Beck and Darrach's observations of the EO are partially discussed above in section 3.3.4, but are presented in further detail here.

Lind Coulee was heavily modified during the time that it was the route for the now defunct Chicago, Milwaukee, St. Paul & Pacific railroad line. The easement has since been converted to a trail system with most of it owned and managed by Washington State Parks. The ownership of the EO is a combination of private and Washington State Parks. As part of its previous history with the railroad, the ephemeral channel in the coulee was straightened and thus hydrologically decoupled from its narrow flood plain.

Figure 16. Dense vegetation (including weedy invasives) eliminating bare soil substrate and preventing Polemonium pectinatum recruitment at EO 22.

As evidenced by numerous clots of debris on the channel walls, there have been occasional significant flash-flood events that have filled the drainage approximately to the 4-foot level. These events (or perhaps singular event) deposited significant amounts of sediment in the drainage bottom and up the drainage walls, resulting in areas of bare substrate suitable for *P. pectinatum* recruitment and establishment (Figs. 12, 13 and 14). As discussed above, it is evident that nearly all of the sediment load in the flash flood waters is derived from barren agricultural fields upstream. The scouring effect of future flood events in the drainage can be expected to dislodge and destroy many seedlings and probably some established plants as well. It seems probable that the prominent and large *P. pectinatum* population extension discovered just upstream at Ralston (Fig. 14) was not present during the last survey date in 1994. It follows that this large subpopulation must have established since that time – perhaps as a result of the historic early February flood of 1996.

The assessment of this population is that it is likely to be viable over the long-term, but largely because of an indirect anthropogenic factor as the sediment source providing extensive amounts of recruitment substrate is derived from eroding agricultural fields further up in the watershed.

6.3 EO 28 – Private Land

EO 28 in Paha Coulee is entirely on private land owned by the Burlington Northern railroad and a small private parcel of unknown ownership in the far northeastern portion of the polygon. It was last visited on 31 May 1994 by Phyllis Baxter of the WNHP and documented to consist of “thousands of plants” at that time with a particularly large concentration of plants in the southwest portion of the polygon.

The visit to this EO on 20 May 2025 tallied approximately 2,200 plants. The densely populated southwest portion of the polygon noted in the 1994 survey has been bulldozed and is now gone.

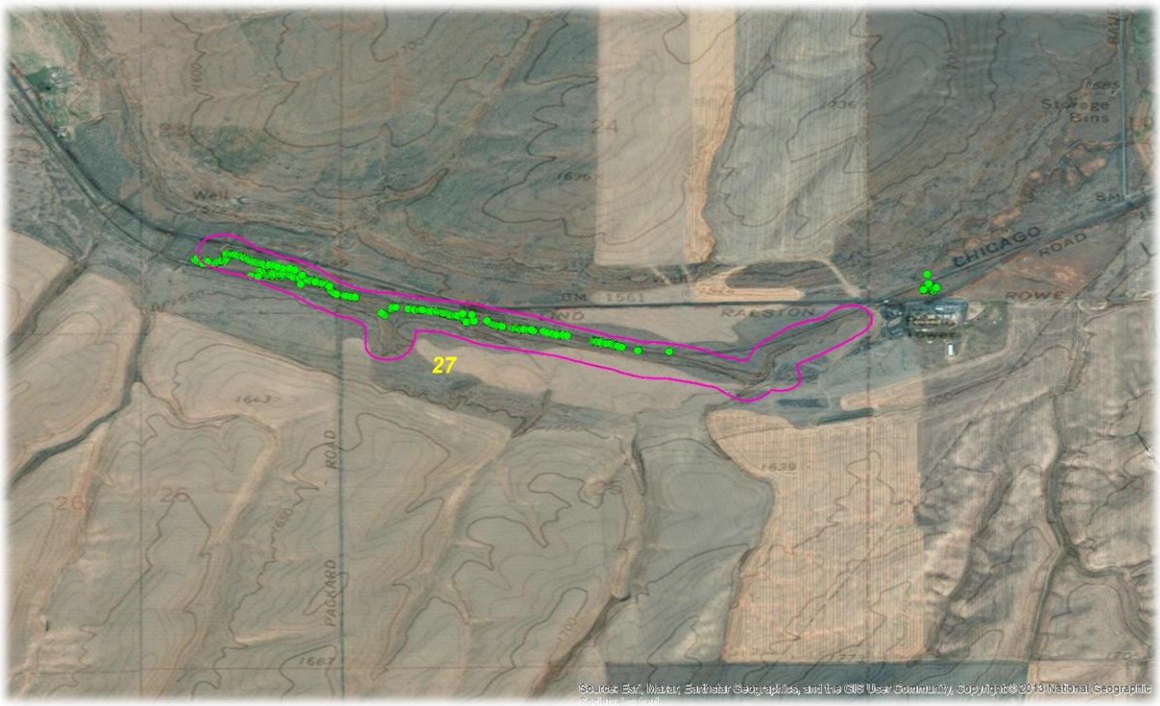

Figure 17. Mapped plant points at EO 27. The small polygon to the east corresponds to the photo in Figure 14. The mapped polygon from 1994 is in magenta. Note that the eastern portion of the 1994 polygon lacks plants suggesting that a portion of the EO as it existed in 1994 may have been extirpated. The Ralston extension of the population is the disjunct cluster to the right in the image.

The population, depicted in Fig. 21, is now extremely weedy and in poor condition (Fig. 22) with only small amounts of recruitment relegated to disturbed bare soil in an excavated ditch and small patches of bare soil south of the Burlington Northern property boundary fenceline in much less disturbed habitat. Only the portions of the population over this fence appear to have any opportunity of maintaining any long-term presence at this site. Beck and Darrach's assessment of this EO is that it has poor, to possibly fair, long-term viability. The population depends solely on precipitation to provide sufficient habitat moisture and appears to be reliant on the xeric edge of its ecological tolerance to maintain its presence (Fig. 23). The risks of relying on populations on private land to provide a conservation 'buffer' for a species are evident at this EO. The bulldozing of the previously robust southwest portion of the population demonstrates the failure of such a strategy.

6.4 EO 29 – Coal Creek ACEC Ownership: BLM

EO 29 is a robust BLM-owned population that was last visited and assessed on 22 June 2020 by WNHP botanists. An individual plant count was not done at that time, but an estimated total of 530 clumps of plants were counted – the number of plants in each clump was not defined. However, the observations by Beck and Darrach (2025) suggest that the total number of individual plants is several thousand. They did not perform a complete population count assessment of this EO as there had been a fairly comprehensive survey in 2020.

Analysis focused on the overall health of the population, hydrologic conditions, and whether the population had active recruitment and establishment of maturing plants.

Figure 18. Plant locations EO 28. The magenta polygon represents the extent of the population in the WNHP database as of 1994. Not the general lack of plants in the southwest portion of the polygon – this area was previously the most significant portion of the population as of the 1994 assessment.

.

Figure 19. A few Polemonium pectinatum plants remaining in a dense stand of Bassia scoparia *in EO 28.*

EO 29 is largely a vigorous population. It is one of the few we assessed that is clearly likely to have the potential for long-term viability. The reach of Coal Creek that harbors the population maintains hydrologic connection between the flowing channel and its flood plain. While the portion of the *P. pectinatum* population directly proximal to the channel is densely vegetated with little to no recruitment (Fig. 24), the flood plain in general still receives a significant

amount of suspended sediment load during significant flood stage events. This creates a suitable bare soil surface that promotes recruitment and establishment of plants (Fig. 25).
It is clear that EO 29 has significant recruitment and survivorship on the flood plain where the plants are interspersed with more xeric taxa such as Great Basin big sage and Idaho fescue. Beck and Darrach's assessment of the population is that it is healthy, not badly overrun with exotic weedy species and is likely to persist into the foreseeable future barring unforeseen stochastic events such as wildfire.

Figure 20. Xeric margin of Polemonium pectinatum habitat EO 28. The ecological quality of the habitat at this location is good, but it is marginal habitat for the species. There is some local recruitment here.

Figure 21. EO 29 margin of the Coal Creek active channel heavily vegetated with Leymus cinereus and Senecio serra.

6.5 EO 33 – Ownership: BLM

EO 33 is on a BLM-owned parcel adjacent to Coal Creek 5.5 km upstream from EO 29 (Fig 26). This EO consists of thousands of plants in a relatively dense stand (Fig. 27). It was last visited by Lorna Emerich on 23 May 2016. The large majority of the population resides on the Coal Creek flood plain. In this location the Coal Creek channel is naturally intact, but has become incised as the channel's base level is reset by a waterfall nick point (Fig. 28). The incised channel is sufficiently deep that the flood plain is rarely occupied by sediment-laden flood waters.

Figure 22. EO 29 flood plain with a broad range of P. pectinatum size classes interspersed with more xeric taxa.

As a result, the plants on the flood plain, while healthy and robust (some plants approach 2 meters across) are nearly all mature and likely quite old. There was, however, a small amount of recruitment noted in some locations.

The most significant concerns at this EO include an aggressive infestation of rhizomatous meadow foxtail (*Alopecurus pratensis*) and large clones of rhizomatous snowberry (*Symphoricarpos albus*) which crowd out *P. pectinatum* plants and reduce the potential for bare soil patches for plant recruitment. The entire EO was not mapped by Beck and Darrach owing to insufficient time. There are significant numbers of plants in the southwestern portion of the polygon north of Coal Creek that remain to be investigated. Beck and Darrach's assessment of this population is that it is healthy, but recruiting poorly at the present time. Its long-term viability would appear to be good barring destructive stochastic events.

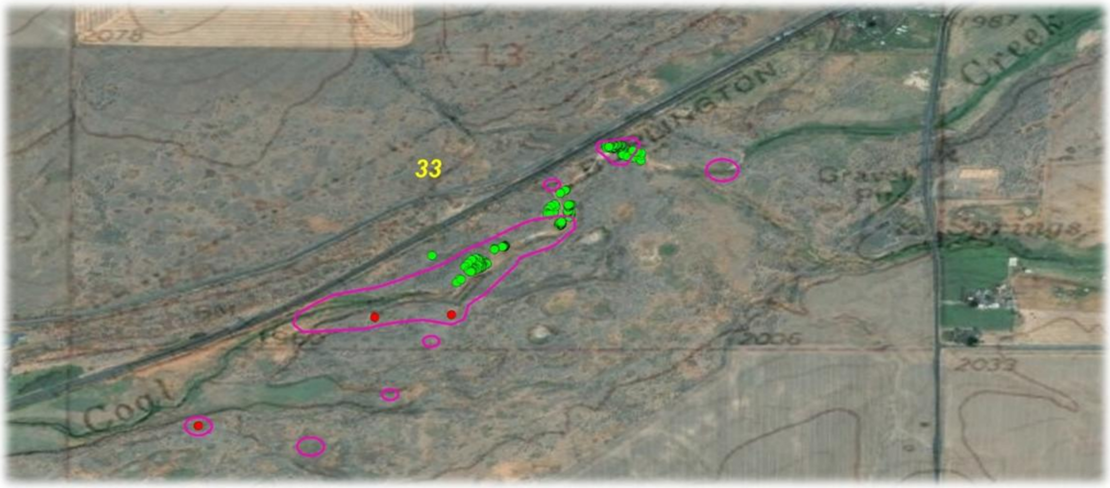

Figure 23. EO 33 along Coal Creek. Unmapped plants in the southwest portion of the polygon north of the creek.

Figure 24. P. pectinatum plants on Coal Creek flood plain north of the incised creek channel. Note the dense vegetation that inhibits recruitment of new plants, EO 33.

Figure 25. EO 33 waterfall stream baseline reset nick point that results in incised channel through the population just downstream of this feature.

6.6 EO 40 – Ownership: Private

EO 40 (Fig. 29) is believed to be located entirely on private lands in Lind Coulee downstream 1.5 km from EO 27. Beck and Darrach only briefly investigated this locality, and further mapping is warranted. This EO was last visited by Phyllis Baxter from the WNHP on 31 May 1994. Her description of plants as being present discontinuously along a half mile stretch of the coulee on both sides of the narrow shallow channel comports with Beck and Darrach's observations as well. There are likely close to a thousand plants in this population with adequate recruitment provided by sediment supply from infrequent flooding events. It seems likely that this population may have increased in size since the previous visit 31 years prior. The channel and its associated flood plain are hydrologically connected. Beck and Darrach's assessment of this population is that it is likely long-term viable in its present state even though invasive exotic species are prevalent in some abundance.

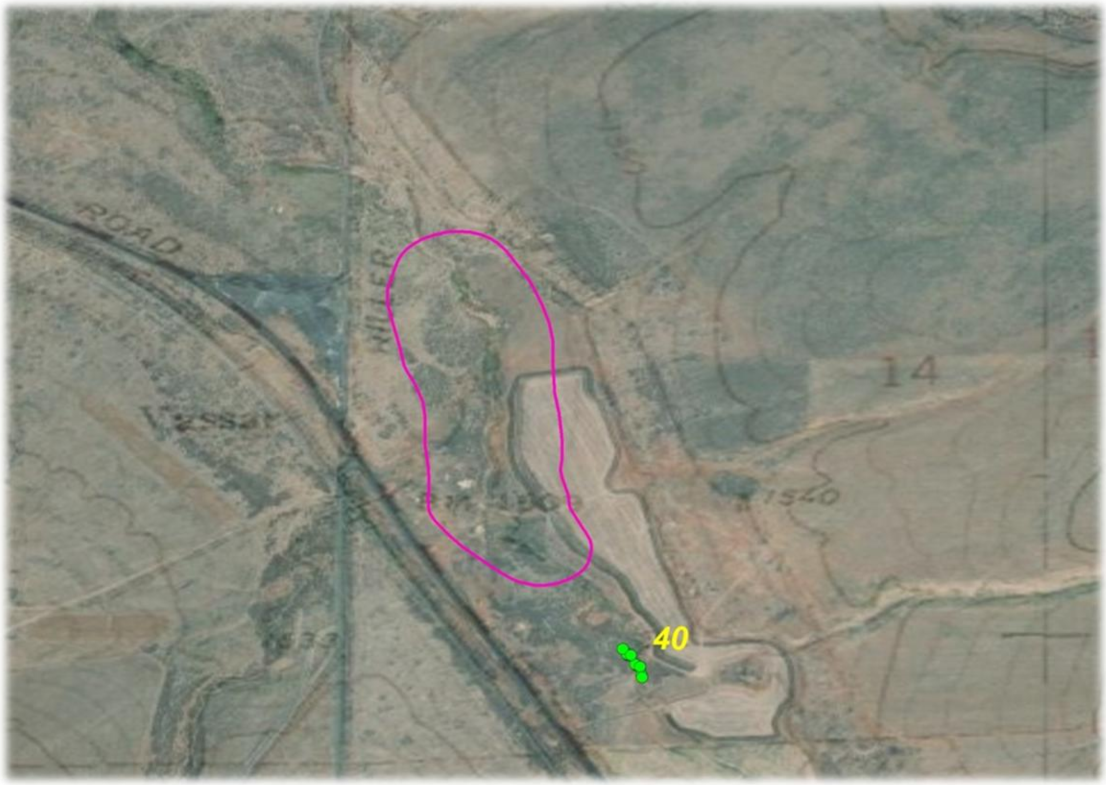

Figure 26. EO 40. Note points mapped outside of the 1994 polygon. The channel is largely in its natural state here with hydrologic connection between the channel and flood plain. This occurrence needs further survey efforts.

6.7 EO 41 – Ownership: BLM

EO 41 is BLM-owned, with two subpopulations just shy of 1 km apart (Fig. 30, 31 and 32). The subpopulations are situated in moist swales lacking exterior drainage outlets. As such, they rely entirely on accumulated precipitation. We estimate that the subpopulations combined have a total of 600 plants. This number aligns well with the two previous assessments by Kim Frymire and Lorna Emerich on 23 May 2016, and Wendy Gibble of RareCare on 2 July 2008. Both sites are in good ecological condition with low levels of invasive species.

We noted that even though the vegetation is rather dense in both polygons, there are a significant number of recruits establishing and doing well at a few locations in the western polygon with exposed soil which provides a good substrate for establishment. Exposed soil is primarily an apparent product of Great Basin pocket mouse (*Perognathus parvus*) push piles. Beck and Darrach tallied 75 recent recruits amongst the ~600 tallied plants in total. No recruitment was noted in the eastern polygon. Pollinators were in abundance at this EO, with a range of native and non-native (*Apis mellifera*) taxa noted. The primary concern regarding this EO is anticipated climate disruption. At the present time there is sufficient moisture to support the population. There is even a small vernal pool at the base of a slope adjacent to the western polygon.

As the climate becomes more xeric with precipitation events predicted to be less reliable (WDFW 2025), these moist swales supporting small area *P. pectinatum* populations are likely to lose long term viability. As a result, even though the present population is stable and perhaps even increasing, Beck and Darrach assess this population as unlikely to have long-term viability. At some point recruitment is most likely to attenuate, and the existing population will slowly decline.

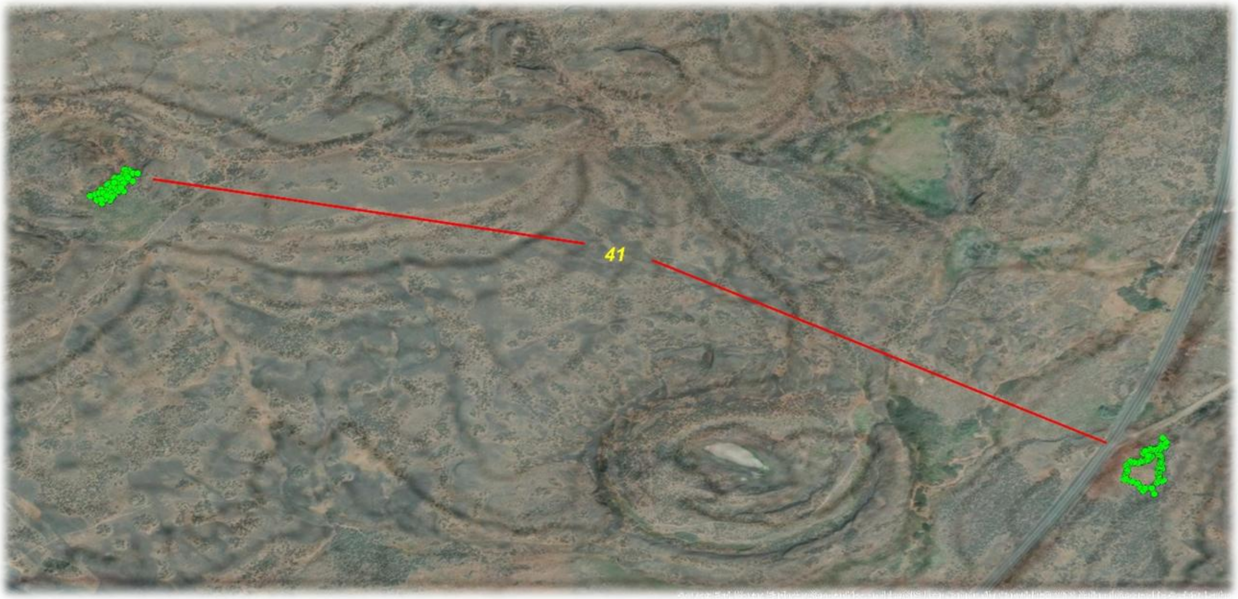

Figure 27. EO 41 Both polygons are moist swales with internal precipitation-mediated drainage.

Figure 28. West subpopulation of EO 41. The area is ecologically in good condition with P. pectinatum plants recruiting well.

Figure 29. East subpopulation of EO 41. P. pectinatum plants are in dense clumps and there is scant evidence of recruitment in this subpopulation.

6.8 EO 42 – Ownership: BLM

EO 42 (Fig. 33) is comprised of two subpopulations in moist swales with no external drainage. The largest subpopulation is quite dense (Fig. 8) and somewhat mounded suggesting a long history of accumulating plant litter. We believe the plants at the EO are likely to be quite old. Both polygons are surrounded by generally dense vegetation and thus have little bare soil with poor recruitment. Beck and Darrach (2025) tallied approximately 300 to 500 plants, which is in accord with the most recent visit to the EO on 20 June 2019. A third polygon that was mapped as part of the original EO has been extirpated, possibly because it received insufficient precipitation to support the plants that grew there. EO 42 is unlikely to be viable long-term owing to recruitment limitations and the clear instability of the hydrology at the site.

7.0.9 EO 46 – Ownership: BLM

EO 46 is discussed in a limited context above as it relates to possible plant lifespans for *P. pectinatum*. This population was last assessed by RareCare on 12 June 2014, with approximately 450 plants tallied. Beck and Darrach's assessment shows that the existing mapped polygon in the WNHP database is about half the size of the polygon they mapped (Fig. 34). Additionally, Beck and Darrach approximate the population at present to be closer to 2,500 plants. The plants are distributed in small, generally dense clumps embedded within a xeric *Leymus cinereus* and Great Basin big sagebrush community (Fig. 35). There are also significant infestations of *Bromus tectorum* and Russian knapweed (*Rhaponticum repens*) at this site. It is clear that the *P. pectinatum* plants here are not occupying typical habitat for the species as a mesic component to the vegetation is largely lacking. Additionally, there is evidence of a significant and persistent cattle grazing history at this site. While *P. pectinatum* plants appear to be unpalatable to cattle – they may actually increase to a point with light cattle grazing – the site has experienced cattle grazing related plant community degradation accordingly.

Hydrologically the population is marooned from adjacent Crab Creek, as the stream channel has been straightened with attendant down-cutting and complete decoupling of the channel and flood plain (Fig. 7). As such there is no source of sediment supply that would provide a suitable substrate for recruitment. The only recruitment noted in this population is in a small stretch of an abandoned former channel meander with minor bare soil. The abandoned meander must date back nearly 100-years to when Crab Creek still flowed in its natural channel (Fig. 36). Due to the lack of recruitment, Beck and Darrach assess this population as being non-viable into the future.

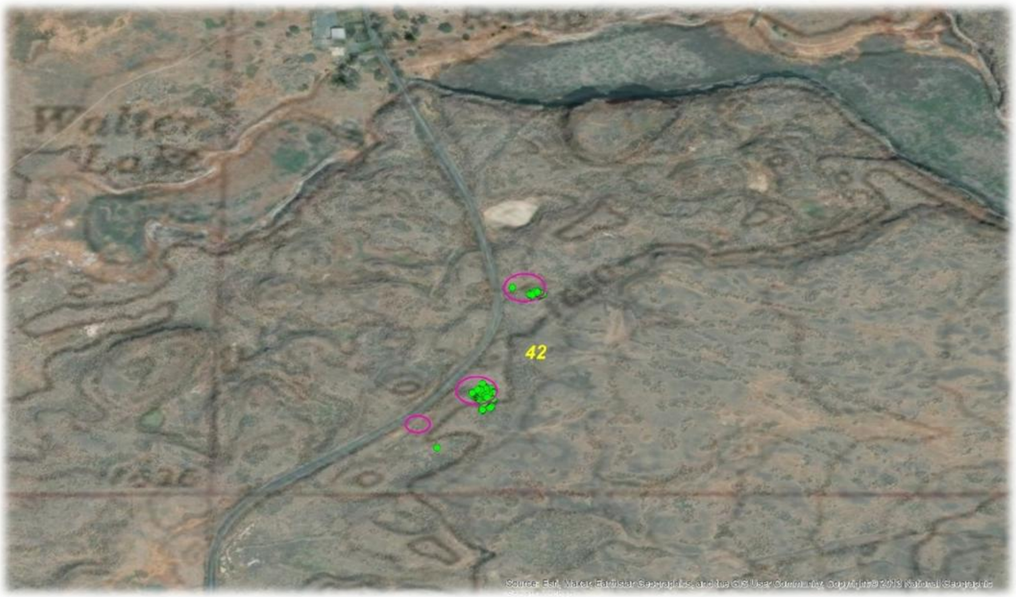

Figure 30. EO 42 The southwestern-most polygon has nearly been extirpated with only a single plant seen.

Figure 31. EO 46 The existing population is more extensive than the mapped polygon in the WNHP database. Note the artificially straightened reach of Crab Creek in the eastern portion of the figure adjacent to the Burlington-Northern railroad tracks.

Figure 32. Polemonium pectinatum individual embedded in a Leymus cinereus - Artemisia tridentata ssp. tridentata plant community with a Bromus tectorum understory.

Figure 33. Abandoned meander channel that existed prior to Crab Creek being hydrologically altered to avoid flood damage to the railroad track corridor. There is very limited recruitment of P. pectinatum at this location.

6.10 EO 53 – Ownership: BLM

EO 53 is confined to a very small mesic area sandwiched between the north bank of a straightened and down-cut portion of Crab Creek and the main Burlington-Northern railroad tracks and right-of-way (Fig. 37).

The plants are present on the remnants of a decoupled flood plain. The population has dwindled to a total of nine plants, which are being outcompeted by Russian knapweed and reed canarygrass (Fig. 38). The population is clearly non-viable and is probably a good example of what will be the end-stage of EO 46 discussed above.

Figure 34. EO 53 adjacent to the main Burlington-Northern Railroad Right-of-Way and above down cut Crab Creek.

Figure 35. EO 53 with one plant of Polemonium pectinatum present just to the left of the large Leymus cinereus in the center of the image. Burlington-Northern Railroad tracks visible in the far upper right of the photo.

7.0 Threats

Under the ESA, 16 U.S.C. § 1533(a)(1), FWS is required to list Washington Jacob's ladder 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.

The Beck and Darrach field-based study investigated 10 geographically isolated EOs amongst a total of 36 that are putatively still extant. These 10 EOs were chosen to both evaluate what seemed to be the largest populations with the best prospects for long term viability, and to sample the breadth of population settings. Most populations restricted to private land holdings were not visited. In addition, Beck and Darrach largely avoided surveying the EOs that were assessed as being in poor or fair condition as of their last field visit. These EOs are possibly already extirpated, as the most recent documented visits to these sites are mostly over 30-years old. A combination of information gained from field visits to the 10 EO's, a careful reading of the apparent existing hydrologic setting information in the WNHP database, and an ArcGIS assessment, led Beck and Darrach to believe that the number of long-term viable EOs is likely as few as four. A significantly more liberal reading of the available data increases that number to perhaps a total of 12. Table 1, below, presents a synopsis of these data.

The clear overarching present threat to the species is fundamentally the nature and stability, or lack thereof, of the hydrologic setting of each of the individual EOs. The species requires a mesic plant community setting primarily with deep fine-grained soils. A second intimately-linked essential criteria is that there needs to be a significant component of bare soil available very near or within the populations for adequate recruitment. It addition, it is important that the habitat not be dominated by invasive weed species, and even native taxa. The only populations that appear to meet these criteria are EOs 27, 29, and 33. EOs 19, 22, 30, 32, 40, 43, 45 and 47 are designated as 'uncertain' with respect to long-term viability as each needs further field verification. Each individual threat element is discussed below.

7.1 Factor 1: Present or Threatened Destruction, Curtailment, or Modification of Habitat or Range

Polemonium pectinatum possesses a narrow range of habitat parameters in order to maintain its presence on the landscape. Numerous field observations (Gilbert 1998, pp. 20–21; Beck and Darrach 2025, p. 9; WNHP 2025) clearly indicate the species requires:

1. Mesic habitat with a persistent stable moisture source
2. Deep fine-grained soils
3. Occasional exposed bare soil that provides the only reliable recruitment substrate

7.1.1 Unstable Hydrologic Settings

P. pectinatum evolved occupying a mesic/moist deep fine-grained soil ecological niche space tied to perennial stream course channel margins and associated flood plains, peripheral to springs, in closed drainage mesic swales or at the mesic base of coulee wall basalt talus slopes.

Table 1. Green text in comments column = likely long-term viable / Red = extirpated population and populations considered unlikely to persist in the comments column / Orange = population fair to good but likely to ultimately be extirpated based upon existing information / Burnt Orange = population in poor or poor to fair condition and unlikely to persist / Blue – EOs with protection potential in ownership column / text in comments column highlighted in turquoise are populations that may be viable, but need further evaluation

EO	Ownership	County	Last Observed	Observer	Previous Viability	2025 Beck & Darrach Viability Assessment	Comments	Surveyed This Study
2	Unknown	Whitman	June 20, 1920	Suksdorf	Extirpated	NA	damp ground near Oakesdale	No
3	Unknown	Garfield	July 1, 1932	J.H. Christ	Extirpated	NA	bottomland by creek	No
4	Private	Adams	June 9, 1985	J. Gamon	Extirpated	NA	converted to agriculture	No
5	Unknown	Whitman	30 May 1893	J. Leiberg	Extirpated	NA	Rock Lake – type locality for the species	No
10	Private	Lincoln	May 30, 2014	Rare Care	Fair	NA	swale at base of talus slope – ***hydrology indicates unlikely to persist long term***	No
12	Private	Lincoln	June 7, 1994	R. Naas	Fair/Good	NA	precipitation swales – ***hydrology indicates unlikely to persist long term***	No
18	Private	Lincoln	June 8, 1994	P. Baxter	Poor	NA	7 plants / precipitation swale – ***hydrology indicates unlikely to persist long term***	No
19	Private	Lincoln	May 25, 1994	P. Baxter	Fair/Good	NA	flood washout near creek – ***long term status uncertain***	No
20	Private	Lincoln	June 2, 1994	P. Baxter	Poor/Fair	NA	small upland ~75 pls / moist swale – ***hydrology indicates unlikely to persist long term***	No
21	Private	Lincoln	June 18, 1985	J. Gamon	Extirpated	NA	creek side terrace	No
22	Private	Lincoln	May 21, 2015	Darrach & Beck	Good	Fair/Good	moist swales / creek banks – ***long term status uncertain***	Yes
23	Private	Lincoln	May 10, 1985	P. Baxter	Extirpated	NA	very hostile owner – ***population assumed extirpated***	No
24	WDNR	Whitman	June 3, 2018	Rare Care	Fair/Good	NA	moist swale ~1,200 pls – ***hydrology suggests not viable***	No
25	Private/WDNR	Adams	May 16, 2024	WNHP	Good	NA	channeled bed ~750 pls – ***hydrology suggests not viable***	No
26	Private	Adams	May 31, 1994	P. Baxter	Poor	NA	down-cut stream - 6 pls – ***likely already extirpated***	No
27	WDNR	Adams	May 22, 2025	Darrach & Beck	Good	Good	down-cut channel - 1,000s of pls / ***artificial persistence, but long-term viable***	Yes
28	BNRR/Private	Adams	May 20, 2025	Darrach & Beck	Fair/Good	Poor/Fair	bulldozed by B-N railroad – ***> 1/2 population extirpated***	No
29	BLM/Private	Lincoln	May 20, 2025	Darrach & Beck	Good	Good	ACEC Coal Creek Floodplain – ***likely to persist long term***	Yes
30	Private	Lincoln	June 8, 1994	P. Baxter	Fair/Good	NA	Creek Floodplain / 1,000's pls? – ***long term viability uncertain***	No
31	BLM	Lincoln	June 3, 1994	P. Baxter	Poor	Extirpated	dry likely abandoned channel / groudwater recession	No
32	Private	Lincoln	2019	Unknown	Fair	NA	abandoned Crab Ck. Floodplain – ***long term status uncertain***	No
33	BLM	Lincoln	May 23, 2016	L. Emerich	Not Assessed	Good	floodplain terraces – incised channel / 1,000's pls – ***likely to persist long term***	Yes
34	Private	Lincoln	May 6, 1992	B. Benner	Not Assessed	NA	~50 pls / precipitation swale? – ***inferred hydrology suggests population not long-term viable***	No

35	BLM	Lincoln	May 8, 2022	B. Benner	Extirpated	Extirpated	likely groundwater recession	No
36	Private	Lincoln	May 5, 2005	T. Patten	Not Assessed	NA	precipitation swale – ***hydrology indicates unlikely to persist***	No
37	WSDOT	Adams	June 6, 2022	Rare Care	Poor	NA	precipitation swale - ***hydrology indicates unlikely to persist***	No
38	BLM	Lincoln	August 2, 2016	L. Emerich	Not Assessed	NA	~750 pls / floodplain terrace / natural channel – ***long term viability uncertain***	No
39	Private	Lincoln	June 3, 1993	B. Benner	Not Assessed	NA	margins of precipitation swale – ***hydrology indicates unlikely to persist long term***	No
40	Private	Adams	May 31, 1993	P. Baxter	Fair	Good	100's to perhaps 1000's of pls / some recruitment – ***likely to persist but further evaluation needed***	Yes
41	BLM	Lincoln	May 23, 2025	Darrach & Beck	Fair / Good	Poor / Fair	~400 pls / precipitation swales – ***hydrology indicates unlikely to persist long term***	Yes
42	BLM	Lincoln	May 18, 2025	Darrach & Beck	Poor	Poor	a few 100 pls / low recruitment / precipitation swale – ***hydrology indicates unlikely to persist long term***	Yes
43	BLM	Lincoln	May 29, 2017	Rare Care	Not Assessed	NA	population size unclear / setting appears to be swale depressions – ***hydrology indicates unlikely to persist long term, but further investigation needed***	No
44	Private	Lincoln	June 29, 2012	Rare Care	Not Assessed	NA	~250 pls / precipitation swale – ***hydrology indicates unlikely to persist long term***	No
45	BLM	Lincoln	May 22, 2023	Rare Care	Not Assessed	NA	500-1,000 pls / floodplain terraces and depressions – ***hydrology indicates unlikely to persist long term, but further investigation needed***	No
46	BLM	Lincoln	May 19, 2025	Darrach & Beck	Not Assessed	Poor	~2,500 pls / decoupled floodplain / low recruitment – ***hydrology indicates unlikely to persist long term***	Yes
47	Private	Lincoln	May 2, 2015	Thompson	Not Assessed	NA	~225 pls 2 polygons / stream floodplain, but channel erosion noted in survey notes – ***hydrology indicates unlikely to persist long term, but further investigation is needed***	No
48	Private	Lincoln	May 19, 1999	R. Crawford	Not Assessed	NA	along ephemeral stream bank – ***inferred hydrology indicates unlikely to persist long term and survey notes suggest poor viability***	No
49	BLM	Lincoln	June 3, 2014	Rare Care	Not Assessed	NA	~800 pls / precipitation swales – ***hydrology indicates unlikely to persist long term***	No
50	BLM	Lincoln	May 15, 2017	Frymire	Not Assessed	NA	~800 pls / precipitation swales – ***hydrology indicates unlikely to persist long term***	No
51	BLM	Lincoln	June 3, 2023	Rare Care	Not Assessed	NA	~100 - 300 pls / precipitation swales – ***hydrology indicates unlikely to persist long term***	No
52	BLM	Lincoln	May 5, 2015	Rare Care	Not Assessed	NA	~400 pls from 4 locations / precipitation swales – ***hydrology indicates unlikely to persist long term***	No
53	BLM	Lincoln	May 19, 2025	Darrach & Beck	Not Assessed	Poor	9 pls / no recruitment / being choked out / ***will be extirpated soon***	Yes
54	BLM	Lincoln	May 14, 2016	Rare Care	Poor	NA	~14 pls / poor prognosis / heavily grazed area – ***hydrology indicates unlikely to persist long term***	No
55	BLM	Lincoln	July 10, 2019	Frymire	Poor	NA	9 pls / moist narrow precipitation fed swale – ***hydrology indicates unlikely to persist long term***	No

Each of these settings has historically provided ample parameters for survivorship and, crucially, usually sufficient exposed bare soil to promote adequate recruitment for populations to persist.

7.1.1.1 Groundwater Extraction

Groundwater levels have declined appreciably in the region since the 1950s, and particularly since the 1970s (Burns et al. 2012, p. 15). This includes a decline of up to 10 feet per year in the Odessa, WA area (Asante-Sasu et al. 2015, p. 4), coinciding near-perfectly with the majority of extant *P. pectinatum* populations.

With the extreme loss of groundwater, the compounding effects on surface water in this part of the Columbia Basin have likewise been extreme, with lakes disappearing (Fig. 17), springs vanishing and groundwater contributions to base flow of the few perennial streams attenuated. Some groundwater applied for irrigation purposes may return as runoff and shallow recharge to some surface water features, but any such recharge is clearly insignificant relative to groundwater extractive agricultural practices as groundwater levels continue to drop precipitously (Burns et al. 2012, p. 15; Asante-Sasu et al. 2025, p. 7).

The effects of groundwater losses on the ability of *P. pectinatum* to persist on the landscape are ultimately difficult to quantify. However, it stands to reason that groundwater level retreat must have a direct and deleterious impact on spring and seep discharge as well as attenuation of groundwater contributions to base flow in streams. Thus, even though some *P. pectinatum* populations may still be extant on the landscape, those that are reliant upon these surface water features surely ultimately must be at high risk of extirpation – particularly spring and seep dependent populations.

7.1.1.2 Stream Channel Modifications

Anthropogenic, and even naturally occurring, modifications to stream channel geometries within the range of *P. pectinatum* are evident at three of the EOs investigated by Beck and Darrach (EOs 27, 33 and 46). EOs 27 and 46 in particular are noteworthy in that the respective drainages, an intermittent stream in Lind Coulee, and the regionally important perennial stream Crab Creek respectively, have been artificially straightened in order to mitigate flooding risks to infrastructure – railroad grades in both cases.

Mechanically straightening stream channels increases the erosional power of the water therein, resulting in channel incision, decoupling of the channel from the historical floodplain and major modifications to ecological functioning (Blake and Rhanor 2020, p. 35; Urban and Rhoads 2003, p. 792). At EO 27 where the existing channel has been mechanically incised intermittent flows have resulted in downcutting with attendant abandonment of the historical flood plain (Fig. 12). While there has been some recruitment in the channel bottom (Fig. 13) there has not been noteworthy survivorship as seedlings tend to be destroyed in high flow events. The large majority of plants in the coulee are clearly quite old with recruitment on the abandoned flood plain essentially non-existent (but see discussion above as it relates to Fig. 14).

As discussed in some depth above, EO 46 is also a case where the channel of Crab Creek has been mechanically straightened with resultant channel incision, loss of the historical floodplain and ecological disruption. This EO essentially has no recruitment as a result. The remaining *P. pectinatum* plants persist marooned from their normal habitat surviving only because their deep taproot structure can access moisture in the deep alluvial soil from the old floodplain.

7.1.2 Climate Disruption

As the Earth's climate rapidly warms, fundamentally as a result of anthropogenic additions of greenhouse gases to the atmosphere, major shifts in the water budget of the Columbia Basin in Washington State are being realized (WDFW 2026; WRCC 2026). "A hotter atmosphere is a thirstier atmosphere" is a phrase commonly used to describe how rising temperatures increase the air's capacity to hold water vapor with resulting elevated evaporation rates and more severe droughts accordingly.

Climatic water deficits in the Pacific Northwest are already increasing as summer and autumn precipitation decline and temperatures rise, leading to increased potential evapotranspiration (Abatzoglou et al. 2014, p. 2131). As a species with a high moisture habitat requirement (Gilbert 1998, pp. 20–21), *P. pectinatum* stands to be seriously negatively impacted by warmer temperatures. In particular, it is anticipated that those populations that reside in moist closed-drainage precipitation-dependent swales and along coulee margins along the base of talus slopes will experience elevated drought stress. At the present time EOs of *P. pectinatum* that reside in this setting – e.g. EO 42 – are already apparently essentially 'zombie' populations with little or no recruitment observed. Plants in this habitat type are living their lifespans out with apparent little hope of adequate recruitment to provide future persistence. With rapidly elevating drought stress under climate change conditions impacts must certainly be compounded.

Those EOs that are situated on still functional flood plains along the few perennial streams are probably buffered from the effects of accelerating climate disruption at present. However, the present situation for even these putatively stable populations – e.g. EOs 29 and 33 – is very likely transitory. A prolonged severe regionwide drought in this part of the Columbia Basin, perhaps similar to the present ongoing 25+ year megadrought in the southwestern U.S., is most probably an inevitability. Such a drought would surely greatly attenuate in-stream flows with attendant drops in soil moisture availability on associated flood plains. It can be anticipated that recruitment and subsequent survivorship would be greatly reduced as well. Even the long-lived deeply taprooted mature plants would be expected to endure major drought stress with likely negative outcomes.

7.1.3 Invasive and Native Species Competition Concerns

An important throughgoing observation derived from the field work conducted by Beck and Darrach in 2025 is that when vegetation intimately associated with *P. pectinatum* plants is dense, whether it be native or exotic species, recruitment of *P. pectinatum* plummets to near zero (Figs. 19, 38) . Likewise, this observation also holds up as it pertains to dense stands of *P. pectinatum* itself.

In monoculture stands of *P. pectinatum* (Fig. 8) recruitment has not been observed unless bare soil is also present. As discussed in-depth above, a bare soil substrate is apparently a fundamental requirement for successful plant establishment from seed. Those populations which struggle with the added burden of hyper-competitive exotic species such as *Alopecurus pratensis* – e.g. EO 33, *Bromus tectorum* – e.g. EO 46, and *Rhaponticum repens* – e.g. EOs 46, 53 have scant reproductive potential. Gilbert (1998) noted the correlation between the presence of Russian knapweed (*Rhaponticum repens*) in *P. pectinatum* populations and reduced vigor (p. 62).

7.1.4 Wildfire Risk

None of the 10 EOs visited by Beck and Darrach exhibit any signs that they have been subjected to wildfire in the past. Certainly, all of these EO's have abundant fuels to carry fire, but the mesic setting of the populations are likely somewhat refractory. However, *P. pectinatum* buds perennate at the ground surface or shallowly buried in accumulated duff. In the event of wildfire, it is likely the plants would be killed outright. The high density of *P. pectinatum* plants in most of the EOs places entire populations at extreme risk in the event of fire. It seems inevitable that wildfire will occur in some of the EOs at some point, and the outcomes are likely to result in wholesale losses. Populations such as EO 28 along the main Burlington-Northern railroad tracks are at particular risk as railroad corridors are well-documented point sources of ignition (Kim et al. 2025, p. 2). Agricultural development in the portion of the Columbia Basin in which all the *P. pectinatum* EOs are located is extreme (Fig. 17). This high degree of landscape fragmentation is a factor that may somewhat lessen overall wildfire risks as there are many associated fire breaks accordingly.

7.1.5 Grazing Impacts

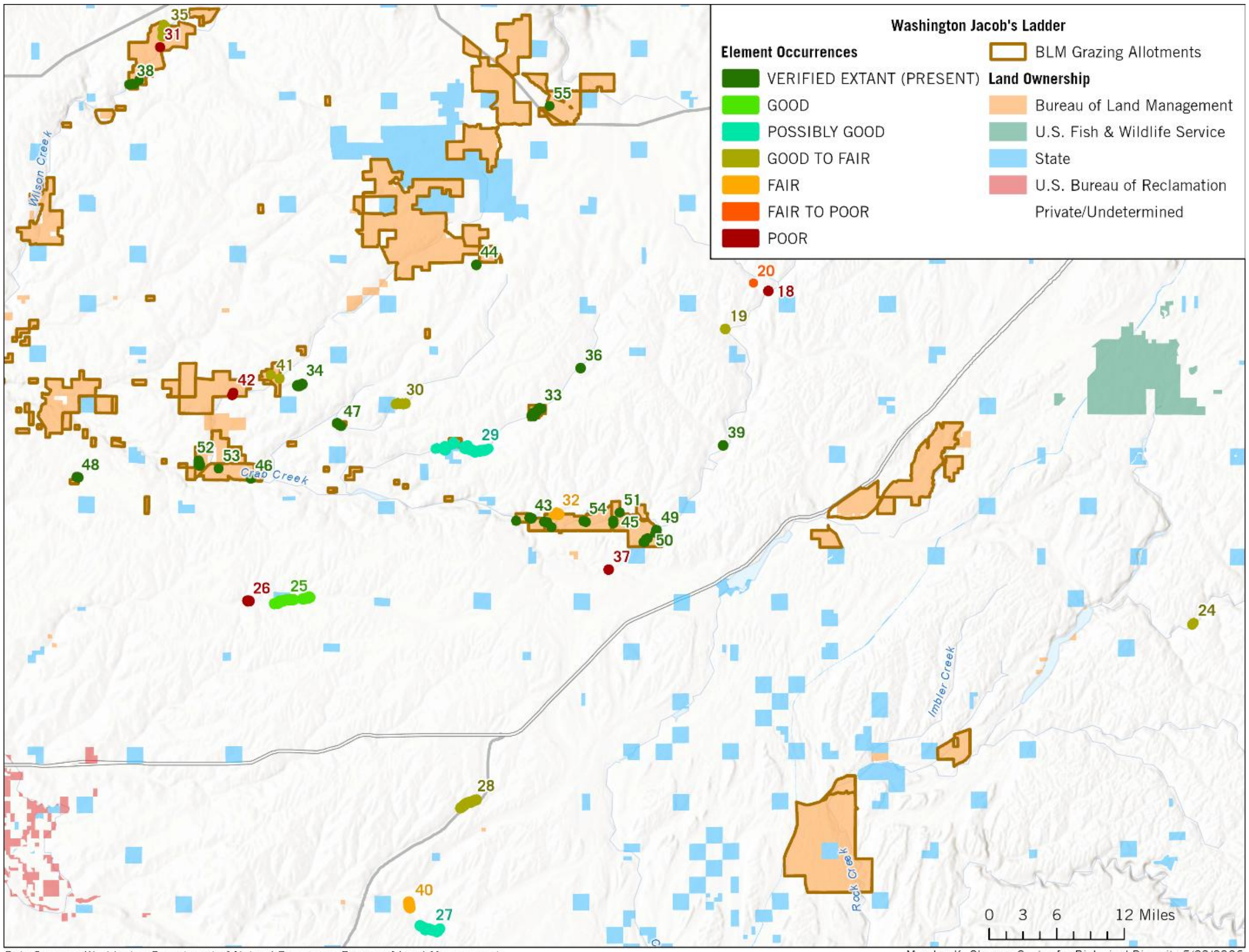

Figure 36. Map of P. pectinatum occurrences (numbered on the map) compared with land ownership and grazing. Many EOs are in active grazing allotments.

Many of the remaining EOs for *P. pectinatum* are within BLM-owned grazing allotments (Fig. 39). Cattle grazing has been noted by Beck and Darrach as a significant factor in the loss of plants at EOs 22 and likely 46 as well. The northern part of EO 22 appears to have been completely extirpated by what is interpreted to be extreme trampling (Darrach, pers obs). Heavy grazing use of the land at this location was clear and obvious. Impacts to the community structure at EO 46 with numerous cow dung patties being observed were indicated, and it is likely that loss of plants from trampling has occurred. While Beck and Darrach did note that a few *P. pectinatum* plants had been directly grazed/browsed, it is was clear that the plant is not under any intensive direct herbivory pressure – the plants are likely rather unpalatable considering their strongly glandular nature and secondary metabolite chemistry.

7.1.6 Land Conversion

Polemonium pectinatum populations have been subjected to extirpation via conversion of land to other uses. EO 28 is the primary example amongst the 10 populations assessed by Beck and

Darrach in 2025. When last assessed on 31 May 1994 there was a robust portion of the population in the southwest part of the polygon (Fig. 21). Those plants no longer exist as the entire area has since been bladed off by bulldozer to create working space for the Burlington-Northern railroad. It cannot be known how many *P. pectinatum* populations may have been lost to agricultural conversion in the past. Surely the losses must have been considerable.

7.2 Factor 2: Overutilization for Commercial, Recreational, Scientific, or Educational Purposes

As far as current information is available, *P. pectinatum* plants have not been subject to direct commercial, scientific or educational uses to any significant extent. However, the species is large and attractive as well as easy to propagate (Gibble pers. comm. 2026), so it is potentially a species that may garner some interest from the horticultural trade. The species is easy to propagate from seed, with very high germination rates suggesting any such interest would have negligible impact.

7.3 Factor 3: Disease or Predation

Evidence of significant disease or predation was not noted during the surveys conducted by Beck and Darrach in the 2025 field season. There was nothing found in the literature that suggested *Polemonium* species have particular susceptibility to either disease or predation. A few very minor leaf rust infections of unknown taxonomy were noted in the field in a few instances by Beck and Darrach..

7.4 Factor 4: Inadequacy of Existing Regulatory Mechanisms

Existing regulatory mechanisms are clearly inadequate to provide protection for *Polemonium pectinatum* and keep the species from dwindling into extinction. The species has no formal legal protections of any kind. However, as a G2S2 entity the species has been on the WNHP rare plant list since the list's inception in 1977, but the species designation as state threatened and BLM sensitive has clearly had no effect at curbing the decline of the plants' populations. Up until 1996 the species was listed as Washington State endangered by WNHP with a federal designation as a candidate 1 for Endangered Species Act listing. The U.S. Fish and Wildlife Service modified that designation downgrading the species to a 'species of concern' with removal from candidate status. The justification for this action appears to have been poorly considered as most of the existing threats to the species have clearly been present for decades.

No conservation measures of any kind, such as attempts at growing the species from seed and out-planting or rehabilitating degraded habitat, are known to have even been enacted. The University of Washington Botanic Garden Miller Seed Vault does have viable seed accessions of the species from numerous EOs, and germination and seedling establishment efforts have been undertaken. However, no on-the-ground efforts are known to have occurred.

The Spokane District of the BLM has conducted some *P. pectinatum* monitoring efforts, but the data has apparently never been analyzed to establish trend trajectories. It seems fair to say the BLM monitoring work has been piecemeal, poorly documented and poorly orchestrated in general, and with little to no follow-through. It is quite clear that present-day BLM management activities are deeply inadequate and incapable of providing any meaningful protective measures for the plants. Even the basic, and readily obvious, observation that Beck and Darrach's 2025 field work made conclusively demonstrating that recruitment relies nearly entirely upon the need for a bare soil substrate has apparently not been recognized, or at the very least acted upon, by the BLM as a critical management concern.

The majority of the remaining putatively extant EOs – 17 in total – are on private land holdings, and as such there are no protections afforded. Two of the three EOs on private land that were visited by Beck and Darrach in 2025 – EOs 22 and 40 – were deemed provisionally viable. Attempts at establishing conservation easements with willing landowners may be fruitful in some instances. Indeed, there is language in a few places in the WNHP EO narrative records that indicate some minor outreach had been done over 30-years ago. There was, however, no follow-through.

7.5 Factor 5: Other Natural or Manmade Concerns Affecting the Continued Existence of the Species

7.5.1 Genetic Data

Information regarding the genetic structure of *Polemonium pectinatum* populations relies entirely on the microsatellite marker work done by Gilbert (1998) in chapter 4 of her PhD dissertation. She chose to analyze four populations across the range of the species in the thought that this breadth would provide optimal resolution of allele diversity.

Results of her microsatellite evaluation work showed that there was significant evidence of possible inbreeding depression in each of the four evaluated populations (Gilbert 1998, p. 89). However, interpretation of low heterozygosity values at all four populations could not rule out the possibility of the influence of at least some selfing amongst individuals (p. 91). Insufficient knowledge of the intricacies of the mating system of the species indicates the need for further research in this regard. Gilbert make the anecdotal observation that some greenhouse-raised plants produced viable seed in a setting where pollinators are supposedly fully excluded (*Id.*), which does indicate selfing likely plays at least some role in the mating system for *P. pectinatum*.

Regardless of the mechanism by which low heterozygosity may have occurred, whether by attenuation of gene flow amongst outcrossing populations owing to landscape fragmentation – human or naturally mediated – or selfing – or even possibly agamospermy – the effects expected are essentially the same. There is most probably an attendant reduction in adaptive potential (Busch and Delph 2017, p. R62; Noël et al 2017, p. 241).

8.0 Designation of Critical Habitat

We request that critical habitat be designated for *Polemonium pectinatum* at all EOs in which the species is putatively or provisionally viable on lands with the possibility of instituting protection. EOs which reside on private land holdings should be considered as possible candidates for conservation easements should the landowners be amenable.

9.0 Conclusions

We the Center for Biological Diversity petitioners conclude that *Polemonium pectinatum* has undergone a steady decline in both the number of populations and the viability of those populations that remain. The Center's assessment, based primarily upon detailed field work conducted in 2025 by Beck and Darrach, in concert with an understanding of the ongoing severity of salient risk factors to extant populations concludes there are only three remaining populations on publicly owned land that retain sufficient long-term viability. Two other populations largely on private land holdings may be long term viable. All others appear to ultimately be doomed to extirpation under the present suite of conditions with attendant noted lack of recruitment and survivorship to a reproductive state. As such, we, the Center for Biological Diversity petitioners, are requesting that a listing be designated accordingly.

References Cited

Abatzoglou, J. T., Rupp, D. E., & Mote, P. W. 2014. Seasonal Climate Variability and Change in the Pacific Northwest of the United States. *Journal of Climate*, *27*(5), 2125–2142. https://doi.org/10.1175/JCLI-D-13-00218.1

Abrahim, D., L. Wellington, Braguini, A. and L. Ishii-Iwamoto. 2000. Effects of four monoterpenes on germination, primary root growth, and mitochondrial respiration of maize. *Journal of Chemical Ecology*. v.26: p. 611–624. ***Cited p.12 in petition***

Asante-Sasu, C. K., J. Turk, S. McClure, A. McLarty. 2025. Variation in vulnerability across aquifer layers in an heterogeneous aquifer system. Groundwater for Sustainable Development, v. 30: p. 1–13. ***Cited p. 21 in petition***

Beck, K, and M. Darrach 2025. A conservation assessment of *Polemonium pectinatum* *for* Washington Native Plant Society and the Washington Natural Heritage Program, 47 p. ***Cited throughout the petition***

Bigbendrailroadhistory.com viewed online 28 February, 2026. ***Cited p.14 in petition***

Blake, C. and A.K. Rhanor. 2020. The impact of channelization on macroinvertebrate bioindicators in small order Illinois streams: insights from long-term citizen science research. *Aquatic Sciences*. v. 82 #35: p. 1–11. ***Cited p.14 in petition***

Burns, E.R, D.T. Snyder, J.V. Haynes, and M.S. Waibel. 2012, Groundwater status and trends for the Columbia Plateau Regional Aquifer System, Washington, Oregon, and Idaho: U.S. Geological Survey Scientific Investigations Report 2012–5261, 52 p., http://pubs.er.usgs.gov/publication/sir20125261 ***Cited p.40 in petition***

Busch, J.W. and L.F. Delph. 2017. Evolution: selfing takes species down Stebbin's blind alley. Current Biology, v.27 #2 p. R61-R63. ***Cited p. 44 in petition***

Cheng, F., M. Ali, C. Liu, R. Deng and Z. Cheng. 2020. Garlic allelochemical diallyl disulfide alleviates autotoxicity in the root exudates caused by long-term continuous cropping of tomato. *Journal of Agricultural and Food Chemistry*. v. 68 #2: p. 11684–11693. ***Cited p. 12 in petition***

Crawford, R.C. and F.J. Rocchio. 2012. Assessment of ecological condition of *Silene spaldingii* and *Polemonium pectinatum* habitat. Natural Heritage Report 2012-08. Washington Natural Heritage Program, WA Department of Natural Resources, Olympia, WA. 34 pp. + app. ***Cited p.8 in petition***

Dodds, J.S. 2023. *Polemonium reptans* var. *reptans* rare plant profile. A report prepared for the New Jersey department of environmental protection. 18 p. ***Cited p. 17 in petition***

Dorsett, B. and A. Pike. 1995. Partition of fragrance between calyx and corolla in *Polemonium foliosissimum*. *The American Midland Naturalist*. v. 134, #2: p. 286–293. ***Cited p. 9 in petition***

Fertig, W. 2020. Potential Federal Candidate Plant Species of Washington. Prepared for U.S. Fish and Wildlife Service, Region 1. Washington Natural Heritage Program report 2020-01. 97p. ***Cited p. 11 in petition***

Galen, C. 1985. Regulation of seed-set in *Polemonium viscosum*: floral scents, pollination and resources. *Ecology*, 66 #3: p. 792–797. ***Cited p. 12 in petition***

Gibble, W. personal communication 29 January, 2026 ***Cited p. 40 in petition***

Gilbert, C. 1998. Aspects of community ecology, population growth and genetic structure applied to the conservation of *Polemonium pectinatum* (Polemoniaceae), a rare and threatened shrub-steppe perennial. PhD Dissertation, University of Washington, Seattle WA. 145 p. ***Cited throughout the petition***

Greene, E.L. 1884. *Polemonium pectinatum* in: Bulletin of the California Academy of Sciences v. 1 #1, p. 10. ***Cited p.9 in petition***

Hill, L.M., A.K. Brody, and C.L. Tedesco. 2008. Mating strategies and pollen limitation in a globally threatened perennial *Polemonium vanbruntiae*. *Acta Oecologica* 33 #3: p. 314–323. ***Cited p.12 in petition***

Kim, K., D. Spirandelli, D. Rother, E. Yamashita, M. Toner. 2025. Tracking wildfire risk to California railroads: integrating environmental data and railway operations. Transportation Research Interdisciplinary Perspectives, v. 32: p. 1-19. ***Cited p.42 in petition***

Noël, E., P. Jarne, S. Glémin, S, MacKenzie, A., Segard, V. Sarda, and P. David. 2017. Experimental evidence for the negative effects of self-fertilization on the adaptive potential of populations. Current Biology, v.27 #2 p. 237-242. ***Cited p. 44 in petition***

Salas, C.R. and B.L. Rhoads. 2022. Big Pine Creek Ditch revisited: planform recovery to channelization and the timescale of river meandering. Geomorphology. v. 403: p. 1–14. ***Cited p. 14 in petition***

Schweingruber, S.H. and P. Poschlod. 2005. Growth Rings in Herbs and Shrubs: life span, age determination and stem anatomy. Forest Snow and Landscape Research v.3: p. 195–414. ***Cited p. 14 in petition***

Singh, H.P., D.R. Batish, S. Kaur, K. Arora and R.K. Kohli. 2006. α-pinene inhibits growth and induces oxidative stress in roots. *Annals of Botany*. v.98: p. 1261–1269. ***Cited p.12 in petition***

Stpiczynska, M., M. Kaminska and M. Zych. 2013. Nectary structure in dichogamous flowers of *Polemonium caeruleum* (Polemoniaceae). *Acta Biologica Cracoviensia*. v. 52 #2: p. 61–68. ***Cited p.12 in petition***

Stubbs, R. In Press. *Polemonium* treatment in Flora of North America Volume 15. ***Cited p.8 in petition***

Thompson, K. 1987. Seeds and seed banks. *New Phytologist*. v. 106 Supplement: p. 23–34. ***Cited p.19 in petition***

Urban, M. A., & B. L. Rhoads. 2003. Catastrophic Human-Induced Change in Stream-Channel Planform and Geometry in an Agricultural Watershed, Illinois, USA. *Annals of the Association of American Geographers*, *93*(4), 783–796. ***Cited p. 41 in petition***

Washington Department of Fish & Wildlife. 2025. Climate change. https://wdfw.wa.gov/species-habitats/climate-change#changes Accessed 28 February 2026. ***Cited p.21 in petition***

Washington Natural Heritage Program. 2026. *Polemonium pectinatum*. In: Online Field Guide to the Rare Plants of Washington, https://www.dnr.wa.gov/NHPfieldguide Accessed 19 March 2026. ***Cited p.8 in petition***

Western Regional Climate Center. 2025. https://wrcc.dri.edu/cgi-bin/cliRECtM.pl?waodes viewed online 18 Oct 2025. ***Cited p.11 in petition***

Zych, M., M. Stpiczynska and K. Rogus. 2013. Reproductive biology of the Red List species *Polemonium caeruleum*. *Botanical Journal of the Linneaen Society*. v.173: p 92–107. ***Cited p.12 in petition***