BEFORE THE SECRETARY OF THE INTERIOR

A PETITION FOR LISTING OF GRAY CAT'S-EYE – Oreocarya leucophaea – UNDER THE ENDANGERED SPECIES ACT WITH A CONCURRENT DESIGNATION OF CRITICAL HABITAT

Gray Cat's-Eye – Oreocarya leucophaea – Wanapum Dunes, Washington State

CENTER FOR BIOLOGICAL DIVERSITY

17 April, 2024

Deb Haaland, Secretary
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Deb Haaland, Secretary
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Dear Secretary Haaland,

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(e); and 50 C.F.R. §424.14(a), the Center for Biological Diversity herby petitions the Secretary of the Interior, through the U.S. Fish and Wildlife Service (USFWS), to protect gray cat's-eye – *Oreocarya leucophaea* – as a threatened or endangered species under the ESA.

Petitioner request that critical habitat be designated concurrently with the listing, pursuant to 16 U.S.C §1533(a)(3)(A) and 50 C.F.R. §424.12.

The USFWS has jurisdiction over this petition. This petition sets in motion a specific process, placing definite response requirements on USFWS. USFWS 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). USFWS must make this initial finding "(t)o the maximum extent practicable, within 90 days after receiving the petition."

The Center for Biological Diversity ("Center") is a non-profit, public interest environmental organization dedicated to the protection of native species and their habitats through science, policy, and environmental law, supported by more than 1.7 million members and online activists. The Center works to secure a future for all species, great or small, hovering on the brink of extinction.

We submit this petition on behalf of our staff and members who hold an interest in protecting Gray cat's-eye – *Oreocarya leucophaea*.

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Executive Summary

Gray cat's-eye – hereafter referred to by its scientific name *Oreocarya leucophaea*, is a globally imperiled (G1S1) Washington State endangered narrow endemic species in the family Boraginaceae. Reproduction in the species relies entirely upon an obligate outcrossing heterostylous pollination syndrome. The species is a sand dune obligate entity confined exclusively to semi-stabilized dune sites in a restricted portion of the lower Columbia Basin in central Washington State. The large majority of extant populations are in close proximity to the Columbia River; all are well to the east of the Cascade Mountains.

Initially known from 45 element occurrences, the number of existing long-term viable occurrences has apparently dwindled to only two with a third that is here considered provisionally viable. A combination of a loss of sand supply, frequent wildfires with attendant post-fire encroachment of exotic annual grasses – cheatgrass in particular, extreme declines in pollinating insects in part mediated by landscape-scale pesticide usage, habitat conversion and, likely, accelerating climate disruption, groundwater regime changes, habitat loss owing to intensive conversion of much of the occupied area to industrial-scale agricultural and other uses, and a lack of adequate regulatory mechanisms have combined to result in steep and rapid population declines with numerous and ongoing large population extirpations. This petition provides an evaluation of the status of the species as a whole. It also provides detailed analyses of recently evaluated element occurrences – EO's – providing population censuses, pollinator observations, habitat quality evaluations and an appraisal of risk factors.

Results of a 2023 field study of the species indicate that *Oreocarya leucophaea* is very rapidly approaching extinction and immediate conservation interventions are critically needed to preserve its presence on the landscape. As such, the protections the federal Endangered Species Act (the Act) provides are deemed necessary as an emergency listing.

1.0 Introduction

Oreocarya leucophaea (Douglas ex Lehmann) Greene – common name gray cat's-eye – at present is a Washington State endangered, BLM sensitive rare heterostylous obligate out-crossing perennial species in Boraginaceae. Previously, and more familiarly, the species has been assigned to the large polyphyletic genus *Cryptantha* in subgenus *Oreocarya* (Greene) L.C. Higgins. This Washington State narrow endemic has recently been reassigned to *Oreocarya* at the generic rank resulting from a comprehensive genus-wide molecular phylogenetic systematic analysis (Hasenstab-Lehman and Simpson 2012).

Oreocarya is a genus of approximately 65 perennial species restricted to western North America. The center of diversity of the genus is concentrated in the Great Basin and the western slope of the Rocky Mountains in Colorado. Members of the genus are particularly well adapted to harsh xeric conditions on well-drained soils, and are typically poor competitors restricted to largely barren ecological settings (Hasenstab-Lehman et al. in press).

Oreocarya leucophaea has been tracked by the Washington Natural Heritage Program (WNHP) for over 40-years as a rare species. Until very recently rank assessment by NatureServe placed the rounded status of the species as a G2 entity. However, as presented in detail in this petition, this G2 assessment no longer reflects the conservation status reality on the ground, and the G-rank has been upgraded by NatureServe to a G1 critically imperiled ranking. Likewise, WNHP has reassigned the species to state endangered status.

This petition provides an assessment of the present state of long-term viability of the species incorporating previous work and, in particular, based upon 2023 field work (Beck and Darrach 2023) conducted at the remaining selected element occurrences (EO's) thought to perhaps still be successfully recruiting. Previous efforts evaluating EO's conducted by the Washington Botanic Garden Rare Care program, the Washington Natural Heritage program, the Spokane field office of the Bureau of Land Management, and SEE Botanical LLC are incorporated supplementally into the assessment provided here. These previous efforts were instrumental in helping to provide the broadest view presently possible with respect to the present conservation status of *Oreocarya leucophaea*.

Based upon long-term monitoring efforts of several of the populations by professional botanists, it has been known for at least 25 years that occurrences of the species have been in decline across its range as suitable semi-stabilized sand dune habitats have been lost to large scale agricultural conversion, development and ecological degradation of occupied sites and repeated landscape-scale wildfire events. Invasive plant species, most notably cheatgrass – *Bromus tectorum*, but also diffuse knapweed – *Centaurea diffusa*, Russian thistle – *Salsola tragus*, tumble mustard – *Sisymbrium altissimum*, and rush skeletonweed – *Chondrilla juncea* have overrun heretofore ecologically intact locations in part contributing to numerous wholesale population extirpations.

Current trends and catastrophic declines of what were until fairly recently deemed healthy recruiting populations clearly show, with the likely exception of a single population, that, lacking immediate conservation measures and protections, the species has entered a terminal phase of its existence.

2.0 Biology and Natural History

2.1 Taxonomy

What is now referred to as *Oreocarya leucophaea* was initially collected and described at the specific rank as *Myosotis leucophaea* in a short paragraph published by explorer David Douglas ex. Johann Lehmann (1830). The species was subsequently variably recognized under the same specific epithet in the genera *Eritrichium* (deCandolle 1846) and *Krynitzkia* (Gray 1885). Edward Greene in in the journal Pittonia (1887) later reassigned the plant to the newly erected genus *Oreocarya*. These early circumscriptions were quite broad and vague until Payson (1927) reassigned the plant to the genus *Cryptantha* subgenus *Oreocarya*. His description was highly detailed and indicated the species was to be found in south-central Washington, had been reported by Macoun in southern British Columbia, Canada and was to be expected in northern Oregon.

The species remained circumscribed under the genus *Cryptantha* until Hasenstab and Simpson (2012) published a broad genetic sampling phylogenetic study of the group. This effort clearly showed the monophyly of *Oreocarya* relative to *Cryptantha*. The forthcoming volume 15 of the Flora of North America (Hasenstab et al. in press) reflects this new understanding. Hence, Greene's treatment has been resurrected and the name *Oreocarya* reestablished. Later workers refined the distribution of the species solely to south-central Washington sand dune habitats, and a collection in northern Oregon identified as *Oreocarya leucophaea* has, on further analysis, turned out to be incorrect (Feuillet 2020).

2.2 Species Description

Oreocarya leucophaea is a showy short to moderately long-lived perennial species known historically from a series of populations along and near the Columbia River in central Washington State. The species blooms from late April to very early June in typical years. *Oreocarya leucophaea* in dormancy dies back to the base each year with perennating buds at or very near the ground surface. It is best classified as a chamaephyte subshrub, with herbaceous growth that transitions to a somewhat woody base and a distinctly woody, sometimes sparsely branched taproot.

The plants range from 15–40 cm in height with flowering stems of individual mature plants averaging about 30 to as many as 100 on exceptional specimens. Stems are spreading-ascending from the base to, on average, a breadth of approximately 25–40 cm. Stem vestiture is densely

spreading setose with an underlying secondary population of softer strigose hairs. Setae become rigid with age and are an effective deterrent against any potential herbivory.

Leaves are both basal and cauline, gray sericeous and linear-lanceolate to linear-oblanceolate. Abaxial leaf surfaces are densely strigose with appressed pustulate-based setose hairs. Adaxial surfaces are densely strigose sericeous and usually lack pustulate setose hairs.
Inflorescences are irregular cylindrical thyrses to 35 cm, cymules are solitary and spreading-ascending that are 1-2 cm in fruit with narrowly lanceolate photosynthetic bracts 1-3 cm long. Senescent infructescence stems persist in dormancy through to the following blooming year. Each Inflorescence consists of 25 to as many as 100+ flowers. Blooming can, but doesn't always, occur in the first year of growth.

Flowers are distylous being either brevistylous (thrum–Figure 1) or longistylous (pin–Figure 2).

Figure 1. Brevistylous - thrum - flower of Oreocarya leucophaea

Figure 2. Longistylous - pin - flower of Oreocarya leucophaea

There is, however, apparent considerable variability with absolute stigma placement relative to stamen insertion across EO's. Flowers have oblong to narrowly ovate calyces from 6–8 mm at anthesis, accrescent to 15 mm in fruit with abundant widely spreading setose hairs. Calyces have a distinct abcission region at the base that facilitates decoupling from the infructescence upon desiccation and senescence. Corollas are actinomorphic and white. Petals are 5 and salverform with the tube equal to shortly exceeding the calyx. The exerted portion of the tube on some flowers is distinctly ochroleucous to pale yellow. The limb is up to 11 mm broad and flat to weakly reflexed. Fornices are exerted, free to the base and narrowly triangular becoming reflexed with age. As with many Boraginaceae taxa, fornices are bright yellow prior to pollination becoming white post pollination or with senescence. Upon development styles can exceed mature nutlets by 2 – 5 mm.

Mature nutlets are in contact, narrowly ovate, and with acute apices and margins. Nutlet vestiture is smooth and glossy, typically with an irregularly speckled white appearance (Figure 3). The adaxial scar is closed and straight. The number of mature nutlets ranges from 1 to 4 with broad variability across the EO's analyzed.

Figure 3. Mature Oreocarya leucophaea nutlets. Abaxial view left, Adaxial view right. Photos courtesy of Michael Simpson Lab U.C. San Diego. Scale bar is 1mm

2.3 Species Ecology, Reproductive Biology, Life and Natural History

Oreocarya leucophaea is found only in the cold desert landscape east of the Cascades in a precipitation regime that averages approximately 18-23cm per year (WRCC 2023). It is an obligate species of sand substrates (WNHP 2023; FNA in press). In particular, partially vegetation-stabilized sand dunes or other areas of aeolian-induced sand movement are the most productive and only long-term viable habitats for the plants. Occasional plants will, however, be encountered in high ecological quality interdune areas, but there has been no field evidence observed to date that they persist in any significant abundance in this setting. Narrow habitat requirements in an already uncommon habitat type – inland mobile sand substrates with consistent replenished sand supply – is a primary factor influencing the rarity of the species. Another important factor the species typically requires is a high-quality ecologically intact plant community. With one notable investigated exception, *Oreocarya leucophaea* can only be found successfully recruiting embedded within a broader plant community with diverse structure, overall high vascular plant species richness and an attendant suite of usually native pollinating insect groups. Field observations indicate that once occupied habitat has been degraded, particularly with cheatgrass – *Bromus tectorum* – invasion due to disturbance, whether it be wildfire, grazing or a combination of disturbance agents the species rapidly declines and ultimately is extirpated.

2.4 Physical Environmental Factors

Sand dune habitats require a consistent replenishing supply of sand size particles and an appropriate consistent wind regime in order to persist on the landscape over the long term. High velocity and consistent winds are a salient character of the weather in the entire lower Columbia Basin. Historically sand has been supplied to the areas that support *Oreocarya*

leucophaea populations by expansive unconsolidated sand-bearing deposits emplaced by the numerous Ice Age flood events that occurred late in the Pleistocene epoch (Bjornstad 2021). Prior to European settlement it is certain that there was an abundant regional-scale sand supply available. Accordingly, it follows that there was a much larger and surely stable suite of populations of the species occupying suitable sites. Post European settlement agrarian uses of the region converted large swaths of this sand-bearing landscape to crop production. This landscape conversion has greatly accelerated over the last 50 years until today a large majority of the landscape has been nearly completely given over to industrial scale agriculture. Thus, a major source of sand for the establishment of dune fields has been effectively eliminated.
A secondary, but critical, source of sand size particles has been the banks of the Columbia River. During low-flow periods prior to emplacement of large dams significant areas of unconsolidated sand were exposed to sand mobilizing wind events. Since the last of the dams were constructed these sources of sand have been largely eliminated with a single exception at the Hanford Nuclear Reservation Dunes Element Occurrence (EO) of the species in Benton County. In this locale a conjunction of geologic and climatic factors in concert with meso-scale meteorological effects have combined to apparently allow for a partial continuation of sand supply from both sand flats along the banks of the river and, during appropriate high wind events, from elsewhere to the north and west interior on the reservation as well.

The Hanford Dunes EO is the largest remaining population of the species and it lies directly adjacent to the only remaining free-flowing segment of the river – the Hanford Reach (Figure 4). As such, lower river flows expose sand flats to wind events. While most regional winds clearly emanate from the southwest, there are events that can occasionally mobilize sand under surprisingly prevalent east-oriented winds. Regionally, wind directions from the east are in general a very uncommon occurrence. However, a subset of the longer-term data indicates sand mobilizing high wind events (e.g. >20 mph) occur with some frequency from easterly azimuths. These occur specifically in this particular area because the Ice Age floods scoured a large incised channel (Ringold Coulee) through the Columbia River Basalts that allows for air flow from the east.

Figure 4. Satellite Image of the Hanford Dune Field with an Ice Age Flood Channel East of the Columbia River

The Winchester Dunes EO in Grant County is situated in a dune field that historically received most of its sand supply from sand deposition derived via west-oriented winds. Satellite images of the area clearly show well-formed parabolic style dunes with dune 'horns' oriented nearly due west. These morphologies indicate wind directions predominately from the west.

Sand composition at this locale is much different than the largely quartz-feldspar dominated nutrient-poor sands present along the Columbia River and in the adjacent *Oreocarya leucophaea* EO's. These sands were directly derived from Ice Age Flood deposits that were dropped out of transport in large ephemeral lakes that backed up behind the Frenchman Hills and Saddle Mountains at the Sentinel Gap pinch point (Bjornstad 2021). Sand composition at the Winchester Dunes EO is predominately fragments of pulverized basaltic rock parentage as is clearly indicated by the grey colour of the sand (Figure 5). Thus, these sands are chemically much different and most probably offer a broader suite of nutrients for plants. This substrate difference may influence *Oreocarya leucophaea* population dynamics in undefined and perhaps unexpected ways.

The sand source for the dunes at the Winchester Dunes EO was apparently restricted when the O'Sullivan Dam directly adjacent to the east was built in 1949. This removed a sediment source and created the Potholes Reservoir. This lack of, or severe reduction of a continuing source of sand has at least in part resulted in a decrease in dune activity. In conjunction with loss of sand supply owing to adjacent agricultural development this has allowed for an invasion of other vascular plant species that have stabilized most of the dunes and accordingly decreased viable habitat for *Oreocarya leucophaea*.

Figure 5. Active Dunes at Winchester Dunes EO – Note Grey Colour of the Sand

2.5 Reproductive Biology

Oreocarya leucophaea is considered an obligate outcrossing species characterized by a heterostylous (distyly) mating system (Figures 1 and 2) in which each plant has brevistylous

(thrum) or longistylous (pin) flowers, but not both on the same plant (Habenstab-Lehman et al, in press).

This mating system largely ensures that pollen will be transferred to receptive stigmas only from those flowers of the opposite morphology. Self-fertilization will not take place owing to this self-incompatibility strategy. However, while this mating system seems a compact and efficient pollination mechanism, there are deviations on this theme, and some hints of departure are present in *Oreocarya leucophaea*. Observations of numerous flowers during the course of conducting seed set analysis (Beck and Darrach 2023) suggests that brevistylous plants are significantly more abundant than longistylous plants in the species. Additionally, there are some plants with a few flowers that are neither longi-nor-brevistylous forms suggesting that there is the possibility that autogamy may indeed be occurring in some limited cases.

2.6 Life History

Oreocarya leucophaea is consistently observed in the field, both in this study and in historical observations documented in the WNHP EO data set, with nearly the entire population of plants blooming profusely each season. Tracking of one of the subpopulations of the Wanapum Dunes EO has occurred frequently since 1997. At each point in this timeline nearly the entire suite of plants has been observed blooming. During the Beck and Darrach study (2023) study over 99% of all plants observed in the investigated EO's bloomed – the large majority bloomed profusely. This consistent year-to-year strategy of intense blooming in a perennial heterostylous species is unusual and it is apparently undocumented in the literature. Intuitively it makes some evolutionary sense that heterostylous putatively obligate out-crossing plants apparently incapable of vegetative reproduction would invest large energy expenditures into blooming in order to persist – perhaps even more so in a pollen-limited scenario. It seems likely that there is a disadvantage to this strategy, however, in that it surely places the plants under significant metabolic stress each year – particularly in the common occurrence of drought years – when energy reserves are likely scarce. This may significantly influence plant longevity. Hence, this evolutionary strategy likely plays a role in population declines of the species in pollen limited scenarios – e.g. depauperate pollinator populations transporting insufficient pollen to provided necessary seed set for population-sustaining reproduction.

Herbaceous plant lifespans are in general an understudied field of research (Schweingruber and Poschlod 2005), and there is no literature available addressing this topic in either the genus *Oreocarya* nor *Boraginaceae* in general. Collecting, cross-sectioning and polishing of a small sample size of several woody roots of dead *Oreocarya leucophaea* plants reveal the presence of well-developed easily-counted annual growth rings in secondary root xylem tissue (Beck and Darrach 2023). These few samples indicate that the species has a short life-span of perhaps a maximum of 10-years (Figure 6).

Figure 6. Cross-section view of an Oreocarya leucophaea root from a dead plant showing annual growth rings in secondary xylem. Scale bar is in millimeters

2.7 Pollination and Related Factors

Field observations of pollinator visits to flowers at the various occupied EO's were documented by Beck and Darrach (2023). Most pollinators they observed are native bees in the genera *Anthophora*, *Bombus* and *Osmia* (Figure 7). A suite of diurnal Lepidopterans was also noted. At some of the EO's, particularly those that are near agricultural sites, non-native European honeybees – *Apis mellifera* – also clearly provide significant pollinator services. They observed a similar suite of pollinators at the few EO locations that are still largely ecologically intact.

It is clear at all investigated EO's that still harbour *Oreocarya leucophaea* individuals that ecological conditions are closely tied to both pollinator abundance and pollinator species richness. EO's, or portions of the EO's, that have recently experienced wildfire and the typical attendant conversion to a cheatgrass dominated vegetation community are severely deficient in pollinating insects. In some locations burned habitat is apparently essentially devoid of pollinators in the limited landscape sample Beck and Darrach evaluated. Conversely, those EO's or portions of EO's that remain ecologically intact with both a native forb community and a structurally complex native shrub component invariably possess an active and much more robust suite of pollinators. The contrast between these two extremes is invariably stark with a traverse across these boundaries in the field clearly delineated and easily recognized. Patches of

intact native shrub community as small as perhaps five hectares appear to be able to support a suite of native pollinators sufficient for providing some modicum of pollination services.

Figure 7. Bombus griseocollis queen pollinating Oreocarya leucophaea flowers Wanapum Dunes EO

3.0 Baseline Population Data

At present, *Oreocarya leucophaea* is ranked by NatureServe as a G1 entity – critically imperiled, which is a recently heightened level of conservation concern from its previous G2 rounded ranking. In accordance, as mentioned above, WNHP has elevated the conservation status of the plant to state endangered, S1. Populations of the species have been noted as being in decline since at least 1998 (personal observations by Beck, Darrach, Robson and others).

Long-term monitoring by Katy Beck of select sub-populations on lands owned by Grant County PUD indicate the species has entered a period of accelerated decline. *Oreocarya leucophaea* has been tracked by the Washington Natural Heritage Program (WNHP) as a rare species since the inception of the program in 1977. WNHP files provide documentation of 45 separate EO's for the species. Analysis of these WNHP data, data from Beck Botanical Services provided to the Grant County PUD, a BLM Spokane field office report (Benner and Stutzman 2006) assessing the previously large but now extinct Juniper Dunes population in Franklin County, and data provided by SEE Botanical Consulting LLC indicates the present-day number of EO's suspected of being possibly long-term viable is extremely small. The WNHP online field guide to the rare plants of Washington (WNHP 2023) states that of the 45 EO's 37 are still considered to be extant.

However, reviewing Rare Care records and all other available information an updated assessment shows that this number is in need of a major revised downgrading. Table 1 is based upon available data and provides a more realistic snapshot of the conservation status of the WNHP EO records prior to conducting field work presented in the 2023 Beck and Darrach report.

Table 1. Oreocarya leucophaea EO Baseline Status Matrix Prior to 2023 Field Work by Beck and Darrach

Population Trend Categories	*Number of Element Occurrences*	*Notes*
Extinct	14 – EO's 1, 2, 4, 8, 10, 13, 17, 22, 24, 25 27, 36, 42, 45	Multiple visits indicate population extirpation
Apparently Extinct	11 – EO's 44, 47, 48, 51, 52, 53, 56, 57, 58, 59, 60	Insufficient number of visits indicate likely population extirpation
Steep Decline	7 – EO's 3, 18, 23, 29, 34, 40, 63	Multiple visits indicate rapid downward trend
Decline	1 – EO 62	Insufficient number of visits indicate population declining – possibly rapidly
Unknown / Undefined	8 – EO's 5, 6, 11, 19, 30, 35, 49, 61	Insufficient data for full assessment
Possibly long-term viable	4 – EO's 20, 32, 33, 46	EO 32 – Winchester Wasteway ǀ EO 33 – Wanapum Dunes ǀ EO 35 – Dodson Road Dunes ǀ EO 46 - Hanford Nuclear Reservation dune field

Using the available data sources it immediately becomes clear that *Oreocarya leucophaea* has experienced large population reductions and numerous EO extirpations over the last 25 years and that this concerning trend is accelerating. Beck and Darrach adopted the Rare Care program criteria of declaring a given EO as extirpated if 3 visits to the EO resulted in finding no plants present. These data helped inform which of the remaining EO's were targeted for field their evaluations. The field investigations in Beck and Darrach were winnowed down to 7 possibly still extant EO's as presented in Table 2.

4.0 Selected Element Occurrence Assessment Results

All field tallies of *Oreocarya leucophaea* plants whether they be live flowering, live vegetative, seedling or dead plants are presented in Table 3. Each EO visited by Beck and Darrach is discussed with a separate narrative subsection in this petition.

4.1 Babcock Bench – EO 18

The Babcock Bench EO was last visited on 27 May 2007 when only 12 living plants were tallied. The 2023 survey was conducted on 9 May. The EO is located along the Old Vantage Highway adjacent to the Columbia River. The disturbance history of this area is not known, but burned sagebrush stumps indicate wildfire has occurred, and an extensive grazing history is also probable. Ecologically this EO has been essentially completely converted to a cheatgrass-dominated annual grassland with scattered *Artemisia tridentata* ssp. *tridentata*, *Ericameria nauseosus* and a few largely annual forbs with scattered *Hesperostipa comata* and *Sporobolus*

cryptandrus (Figure 8). The site is entirely degraded and cannot be expected to recover sufficiently to support *Oreocarya leucophaea* at any point in the future. No plants were found, nor were dead plants observed by Beck and Darrach.

Figure 8. Degraded habitat in the Babcock Bench EO. Oreocarya leucophaea plants have been extirpated

4.2 Babcock Ridge – EO 19

Directly adjacent to Interstate-90, the Babcock Ridge EO was last visited on 28 May 2015 when 91 living plants were tallied amongst two polygons.

The 2023 survey was conducted on 9 May. Since the 2015 survey the area has undergone a mosaic wildfire and an associated vegetative transformation (Figure 9). A survey of the area turned up no *Oreocarya leucophaea* plants living or dead. The entire area is now largely dominated by cheatgrass with a few interstices of lithosol habitat punctuated with sandy loam soil mounds. There are no areas of active sand movement in the area and there is little possibility that any *Oreocarya leucophaea* plants will be able to exist here. A sand source for this EO is no longer present and the EO is considered extirpated and unrecoverable.

Figure 9. Degraded habitat at the Babcock Ridge EO

Table 2. Oreocarya leucophaea 2023 EO Field Visit Evaluations

Element Occurrence	***Putative Element Occurrence Status Prior to Field Work***	***Notes***
EO 18 – Babcock Bench	steep decline	last assessment visit – May 2007
EO 19 – Babcock Ridge	steep decline	last assessment visit – May 2015
EO 20 – Beverly Dunes	possibly long-term viable	last assessment visit – May 2015
EO 29 – Moran Sands	in decline or steep decline	last assessment visit – May 2022
EO 32 – Winchester Dunes	apparently long-term viable	last assessment visit – May 2015
EO 33 – Wanapum Dunes	apparently long-term viable	last assessment visit – 2016
EO 46 – Hanford Dunes	apparently long-term viable	last assessment visit – May 2021

4.3 Beverly Dunes – EO 20

The Beverly Dunes EO is an outlier population amongst those evaluated in the Darrach and Beck report. The population is in part situated directly adjacent to a cherry orchard along its western margin. Pollination services for the orchard are provided by hives of European honeybees that are seasonally present during flowering. Vegetation in the Beverly Dunes EO is by-and-large degraded by a variety of disturbance factors (Figure 10). These disturbances include at least one patchy to complete vegetation replacement wildfire, significant offroad vehicle impacts, and a likely long-term light grazing history as well. As with other degraded EO's the dominant species on the site is cheatgrass. Even though the area is ecologically compromised the plants are persisting fairly well.

Figure 10. Degraded Oreocarya leucophaea habitat directly adjacent to an actively cultivated cherry orchard

Table 3. EO Survey Results from Beck and Darrach 2023 Assessment

Location	***WNHP EO***	***Most Recent Survey Date | # Plants***		***Juvenile / Seedling 2023***	***Vegetative 2023***	***Adult / Flowering 2023***	***Dead 2023***	***Total Living Plants 2023***
Babcock Bench	EO 18	27 May 2007	12	0	0	0	0	0
Babcock Ridge	EO 19	28 May 2015	91	0	0	0	0	0
Beverly Dunes	EO 20	2016	135*	25	0	375	40	400
Moran Sands	EO 29	2015	262*	1	1	10	1	12
Winchester Dunes	EO 32	May 2015	2,429	23	0	227	12	250
Wanapum Dunes	EO 33	no full survey ever done		19	0	795	111	814
Hanford Dunes	EO 46	May 2015	6,200*	insufficient data	insufficient data	insufficient data	insufficient data	insufficient data

* = tally of plants is not comprehensive for the EO

There is one notable segregate area of the EO that has not burned at any time in the recent past. This area is characterized by old-growth big sagebrush – *Artemisia tridentata* ssp. *tridentata* – intermixed with spiny hopsage – *Grayia spinosa* – and various sand substrate facultative and obligate forb and graminoid species. Beck and Darrach report that native pollinating insects are noticeably much more abundant in this remnant polygon. This observation suggests that even though remnant ecologically intact polygons in a severely fragmented landscape may be small – e.g. a few hectares – they can be capable of supporting an ecologically meaningful suite of native pollinating species.

The most recent prior survey of the Beverly Dunes EO was conducted by Beck for the Grant County PUD in April of 2022 with a total tally of 135 plants; this was, however, not a

comprehensive survey effort. The 2023 survey conducted on 12 May and again on 24 May 2023 greatly exceeded this total. Four hundred plants were tallied including 25 seedling/juvenile and 40 deceased plants. Observations at the Beverly site make it clear that even though a given *Oreocarya leucophaea* EO may be ecologically compromised by wildfires and attendant exotic plant invasion with native pollinators accordingly in general severely depauperate, effective pollination services by European honeybees can prop up what would otherwise be a declining population. The Beverly Dunes EO is partially on Grant County PUD right-of-way for high voltage power lines. The larger portion of the EO is on private land holdings.

4.4 Moran Sands – EO 29

The Moran Sands EO was last surveyed in May of 2016 by Beck for the Grant County PUD. A total of 48 plants were observed in the subset of the area delineated by the PUD. A much broader survey of the EO by Clark et al. in the previous year – 2015 – tallied a total of 218 plants. The 2023 survey was conducted by Beck with the entire area evaluated – a total of 12 plants were seen with a single seedling/juvenile, 1 vegetative established plant, 1 dead plant and 10 established flowering plants. No pollinating insects were noted as being present during the survey. Since 2015 the *Oreocarya leucophaea* population has collapsed even though the ecological quality of the habitat is fair to good. A dearth of pollinators is most probably the primary controlling factor in the extreme reduction of the size of the population. It is anticipated that this EO will be extirpated within the next few years.

4.5 Winchester Dunes – EO 32

The Winchester Dunes EO was last visited in May of 2015 by personnel from the University of Washington Botanic Gardens Rare Care Program. At that time a total of 2,429 plants were tallied with 99% flowering / 1% vegetative. The field visits conducted by Beck and Darrach occurred on 8 May and again on 25 May and June 10th. Beck and Darrach duplicated the Rare Care field effort of 2015 as delineated by subpopulation polygons provided in an WNHP ArcMap geodatabase (Figure 11). When combined, the 2023 efforts of Beck and Darrach revealed the presence of a total of 250 living plants with 23 of them being seedlings/juvenile and with a total of approximately 50 dead plants noted. A total of ~21 person hours were expended conducting the searches.

The total of 250 plants found in the same area surveyed in 2015 represents a 90% decline in the population over an 8-year period. Most probably not all living plants in this substantial, largely stabilized, dune field were tallied, but the 2023 effort not only included the 2015 survey areal extent, but also extended the survey beyond 2015 polygon boundaries (Figure 11). Field surveys were primarily conducted when the plants were flowering and clearly visible from a distance both with the naked eye and with high-quality binoculars. Beck and Darrach believe the survey effort to be thorough based upon the data provided by WNHP.

The loss of ~90% of this previously robust population is deeply concerning. It is clear from an ecological standpoint that most of the area has been degraded by exotic weed invasion –

primarily *Bromus tectorum* – with attendant vegetative anchoring of the previously active portions of the dune field.

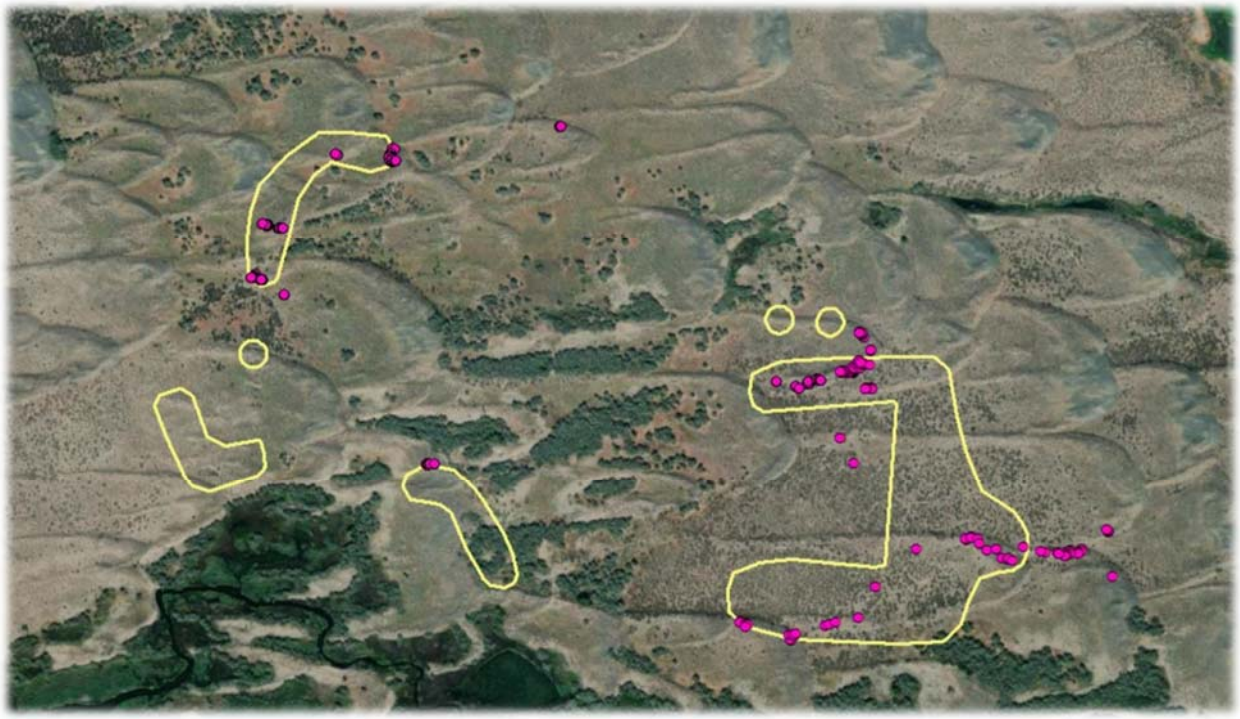

Figure 11. Winchester Dune EO Oreocarya leucophaea population. Yellow polygons were occupied in the 2015 survey. Fuschia coloured dots represent plants tallied during the 2023 Beck-Darrach effort. Parabolic dune 'horns' trending west indicates prevailing wind di

This vegetation transformation has greatly reduced viable habitat for *Oreocarya leucophaea*. As partially discussed above, factors influencing this transformation include a loss of a sand size sediment source owing to the presence of the Potholes Reservoir, an adjacent landscape-scale conversion to agricultural uses, and an attendant apparent collapse of pollination services. Observations in the field at Winchester Dunes indicate that potential pollinating insects are very nearly absent from the landscape. It is assumed that large scale usage of agricultural chemicals on adjacent lands has played a major role in this reduction of critically important insect populations.

With the loss of pollinators and an apparent likely *Oreocarya leucophaea* lifespan maximum of ~10-years a population reduction of 90% is understandable for an obligate outcrossing species. Seed set data collected from 2 inflorescences from 3 separate plants in the population yielded an average seed set of 1.65 apparently viable seeds per flower out of a total of 378 individual flowers evaluated. The Beck and Darrach analysis considers the Winchester Dunes population at present to no longer be viable. It is anticipated this population will be extirpated within 5 years.

4.6 Wanapum Dunes EO 33

This occurrence is a multi-polygon EO spread across a mix of Grant County PUD, U.S. Bureau

of Reclamation and private land holdings. The individual polygons in this meta-population were variously last visited in July 2000, 12 June 2002, April and May 2006, 30 May 2012, 12 May 2013, 7 May 2015, May 2016 and April 2022. WNHP records for the EO are confusing with polygons having been merged in the past in their database and with mismatches between the ArcMap geodatabase data and their text records. Field visits for this study were conducted by Beck and Darrach on 24 April, 10 and 11 May and again on 24 May, 2023 (Figure 12).

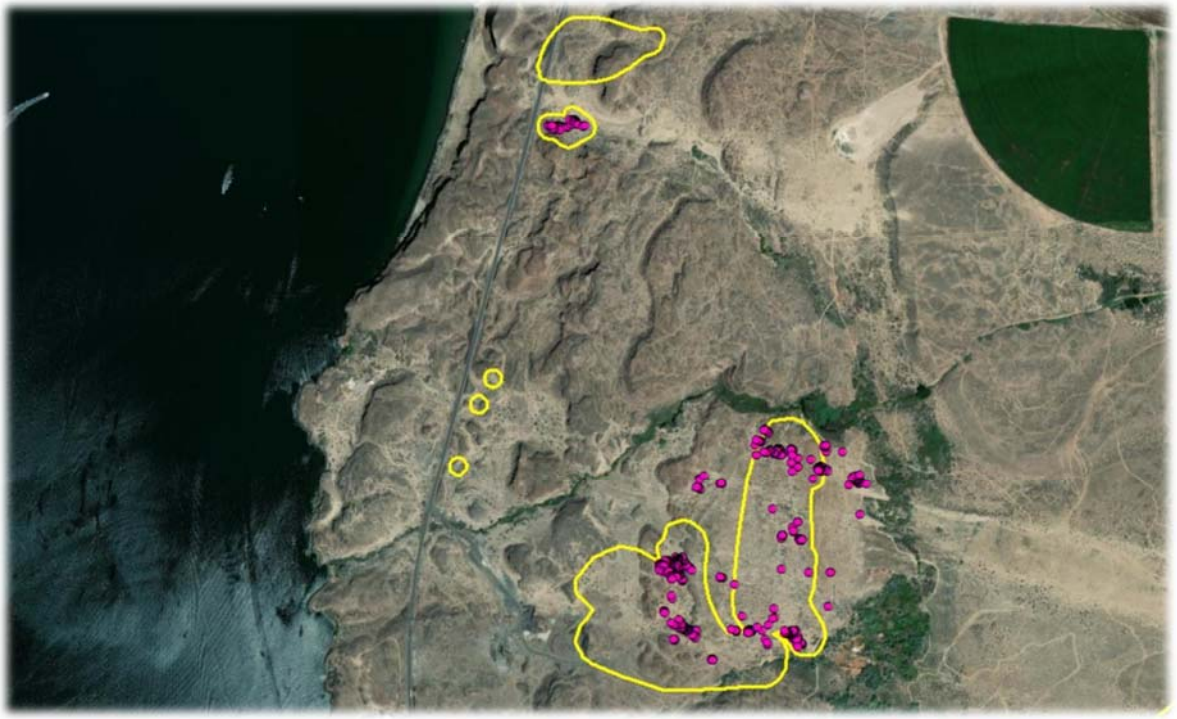

Figure 12. Wanapum Dunes EO 33. Fuschia points are Oreocarya leucophaea plants or clusters of plants. Yellow polygons

The area is characterized as an intricately interwoven admixture of exposed basalt bedrock, shallow soil basalt lithosol plant communities and high quality semi-active quartz-feldspar dominated sand substrates which are largely in excellent ecological condition (Figure 12). Native facultative and obligate sand dwelling shrubs and forbs are dominant with *Achnatherum hymenoides*, *Artemisia tridentata* ssp. *wyomingensis*, *Eriogonum niveum*, *Grayia spinosa*, *Psoralidium lanceolatum* and *Purshia tridentata* being notable species. Native pollinating insects observed in the field are common to abundant in the area. European honeybees are frequently observed as well.

Owing to confusion surrounding WNHP text records, and a lack of waypoint data, it is not possible to accurately parse the total number of *Oreocarya leucophaea* plants from previous visits to this segmented EO. Beck and Darrach's 2023 survey tallied 814 living plants with 795 flowering, 19 seedling/juveniles and 75 recently dead plants. This count includes significant portions of the private land holdings within the EO as there are apparently no delineating property boundary markers present on the ground.

Sand supply to perpetuate the presence of the active dunes and sandy soils that support the *Oreocarya leucophaea* population has historically been provided by persistent strong westerly winds moving sand from exposed beaches along the Columbia River during low water. Since the Wanapum Dam pool was filled beginning in 1963 that sand source has largely been eliminated with the possible exception of rare draw-down or drought events that expose sand expanses. As such, the persistence of a sand source for the perpetuation of this EO is in question. At present Beck and Darrach interpret that this dune field is both sufficiently intact ecologically and has enough active sand transport to support a sustainable population of *Oreocarya leucophaea* into at least the near future. This is contingent upon satisfactory populations of pollinators being maintained. Fortunately, the risk of a landscape resetting fire is generally low at this site as fuel loads are mostly low and the intricately interwoven landscape of sand dune pockets and basalt bedrock is probably at least somewhat refractory to fire transmission across the area.

4.7 Hanford Dunes EO 46

The Hanford Dunes complex is the largest population of *Oreocarya leucophaea.* Broad scale, but not comprehensive surveys conducted by Rare Care between 12 May 2015 and 18 June 2015, SEE Botanical Consulting LLC in 2016, further partial surveys conducted in the spring of 2021 by SEE Botanical Consulting LLC, and minor population information additions with the Beck and Darrach survey indicate the overall EO is apparently viable (Figure 13). The 2015 surveys tallied a total of 6,200 plants distributed over approximately 1,141 hectares. Significant portions of this EO that have yet to be adequately evaluated for plant census totals.

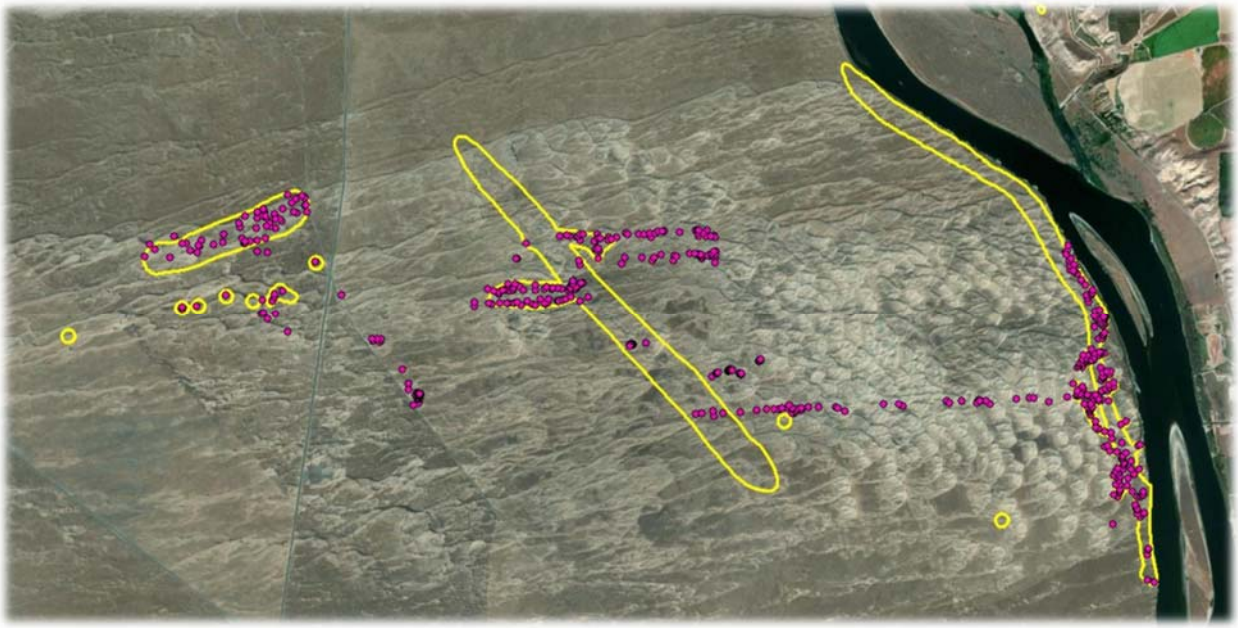

Figure 13. Hanford Dunes EO #46. WNHP Polygons in Yellow. Fuschia dots are plant clusters. Plants outside of polygons are additions by Beck and Darrach during 2023 surveys.

Beck and Darrachs' surveys added plants that had hitherto not been documented (Figure 13). Considering the very steep decline (~90%) in the population in the Winchester Dunes (EO 35)

between 2015 and 2023 discussed above, it is important to conduct another comprehensive survey of the entire Hanford Dunes complex at the nearest opportunity.

The ecological integrity of this EO varies greatly as a function of the fire history. Much of the area has burned in the recent past, and all areas that have burned have few or no *Oreocarya* plants at all. Only ecologically intact semi-stabilized dune sites with low exotic plant cover have significant clusters of plants. The ecological condition of the EO dramatically declines in quality progressively to the west. These previously active dunes along the western reaches of the EO are nearly entirely immobilized by exotic vegetation. As elsewhere, cheatgrass is by far the dominant species, but other exotic species such as diffuse knapweed (*Centaurea diffusa*), rush skeletonweed (*Chondrilla juncea*) and tumble mustard (*Sisymbrium altissimum*) are locally codominant.

Throughout the portion of the EO investigated by Beck and Darrach no *Oreocarya leucophaea* plants were observed in any of the interdune areas where exotic vegetation is dominant. As with other EO's investigated, Beck and Darrach found the abundance and diversity of pollinating insect species at the Hanford Dunes site is strongly correlated with the fire history. All observed portions of the EO that have recently burned and are now accordingly largely given over to exotic vegetation very nearly completely lack a suite of pollinators of any kind according to Beck and Darrach's survey work. However, as in other EO's as soon as one traverses from a burned area into a portion of the EO that has not burned the pollinator populations dramatically increase in both abundance and species richness.

A critical factor that keeps this EO a viable, although clearly fragile, population is the active nature of the core group of dunes along the eastern portion of the EO. This active area of wind-driven moving sand acts as a natural fire break. The lack of fuels in this area allows *Oreocarya leucophaea* plants and the attendant ecological elements upon which they depend to persist in a reduced-risk wildfire setting. This condition is however clearly contingent upon inputs of fresh sand from exposed banks of the adjacent Columbia River and inputs from other areas of the site in high wind events when sands are appropriately desiccated. Fresh sand appears to still be actively provided to the area in some limited capacity from various directions at the present time. It is clear that the volume of mobile sand has greatly decreased as general exotic vegetation stabilization of large areas of the Hanford Site and water flow regulation from upstream dams affects the areal extent of exposed sand along the banks of the river and islands. Google Earth satellite images of the Hanford Dunes taken in 1986 have been compared with Hanford Dunes images taken in 2023 (Figures 14 and 15). In side-by-side comparison standout features of these two images include the clear decrease in the number of active dunes – especially directly adjacent to the river.

This argues that the active dunes have retreated inland over the past 37 years and that the sand source perpetuating the dune formation at least from the river bank inland has been attenuated.

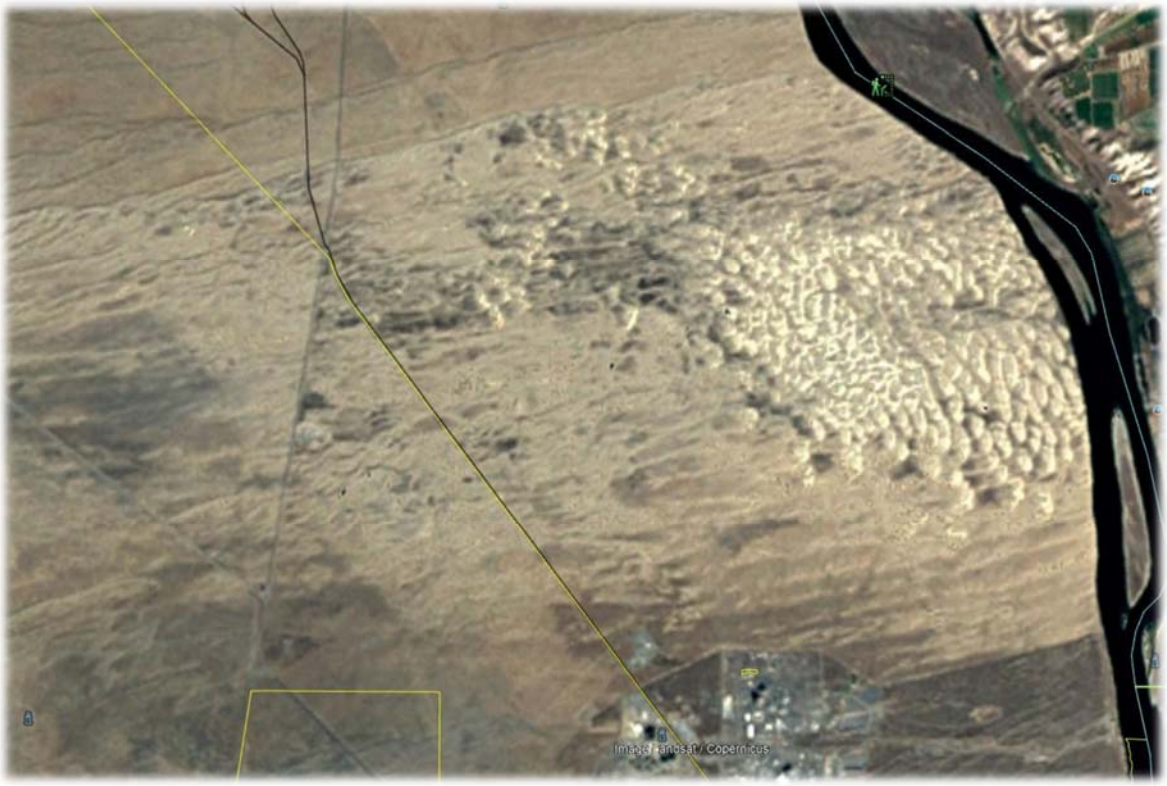

Figure 14. Hanford Dunes EO - Google Earth satellite image from 1986. Note high albedo from open sand area

Figure 15. Hanford Dunes EO - Google Earth satellite image from 2023. Note the decreased albedo resulting from massive increase in cheatgrass cover.

As meteorological data indicates (Perry, personal communication) however, the wind field in the Hanford Dunes area is complex and a full accounting of sand movement is accordingly difficult to interpret. The other feature that is noteworthy, and clear, is the encroachment of exotic vegetation into the dunes as indicated by the greatly reduced albedo of the landscape (Figure 15). The colour change to a darker shade in the 2023 image is indicative of the invasion of cheatgrass. This is perhaps most noteworthy adjacent to the Energy Northwest Columbia Generating Station. The 1986 image clearly shows open sand abutting the generating station northern perimeter while the 2023 image shows open sand has retreated significantly to the north as cheatgrass has halted sand movement.

5.0 Seed Set Data

Seed set evaluation data was conducted by Beck and Darrach on infructescences from each of the occupied EO's investigated for their study. These data are presented in Table 4. The data presented, while meager relative to the number of plants in the EO's with the exception of the Moran Sands population, does have elements of interest that align with field observations of ecological conditions.

The Beverly Dunes EO is of particular interest in that it is known that pollination services are artificially elevated at this location by the presence of directly adjacent European honeybee hives. While this EO is by-and-large in poor ecological condition owing to wildfire and other disturbances the presence of a large number of European honeybee workers is apparently propping up the *Oreocarya leucophaea* population. Considering the ecological state of the site a poor seed set would be expected, but Beck and Darrach's small data set suggests otherwise even though a more robust data set would be preferred for statistical validity.

Another element of the data that is commensurate with the field observations of Beck and Darrach is the data from the Moran Sands EO. While this site is in general in moderately good ecological condition the field observations indicate a nearly total lack of the presence of diurnal pollinators of any kind. Indeed, the seed set values for the Moran Sands plants are clearly very low and are in line with the field survey data.

It is also of interest that the seed set data for the Winchester Dunes EO indicates the possibility that pollination services may be somewhat more robust than the field visit to the site would suggest.

6.0 Threat Factors

The field-based study of the conservation status of *Oreocarya leucophaea* by Beck and Darrach provides a broad-scale yet intricate view of the present condition of the health of the species and the biotic and abiotic threats to its continued existence.

Table 4. Oreocarya leucophaea Seed Set Data

Element Occurrence	*Number of Flowers Per Infructescence*	*Average Viable Seeds Per Flower*	*Number of Infructescences on Plant*	*Comments*
EO 20 – Beverly Dunes				
plant 1 infructescence 1	37	0.95	37	high ecological quality / unburned landscape fragment / pollinators frequently observed with high species richness
plant 1 infructescence 2	25	1.08		
plant 2 infructescence 1	73	2.07	52	low ecological quality / burned & weedy / pollinators depauperate & infrequent / Apis mellifera occasional / directly adjacent to cherry orchard
plant 2 infructescence 2	73	1.82		
plant 3 infructescence 1	33	2.12	30	low ecological quality / burned & weedy / pollinators depauperate & infrequent / Apis mellifera occasional / 850 m from cherry orchard
plant 3 infructescence 2	71	1.83		
EO 29 – Moran Sands				
plant 1 infructescence 1	55	0.65	34	moderate ecological quality / minimally weedy / pollinators depauperate to nearly absent
plant 1 infructescence 2	79	0.68		
plant 2 infructescence 1	30	0.70	21	moderate ecological quality / minimally weedy / pollinators depauperate to nearly absent
plant 2 infructescence 2	40	0.53		
EO 32 – Winchester Dunes				
plant 1 infructescence 1	27	2.30	23	fair ecological quality / significant weeds nearby / pollinators infrequent low species richness
plant 1 infructescence 2	104	1.83		
plant 2 infructescence 1			20	fair ecological quality / significant weeds nearby / pollinators infrequent low species richness
plant 2 infructescence 2	74	1.50		
plant 3 infructescence 1	58	1.40	25	fair ecological quality / significant weeds nearby / pollinators infrequent low species richness
plant 3 infructescence 2	47	1.04		
EO 33 – Wanapum Dunes				

plant 1 infructescence 1	21	1.00	26	high ecological quality / unburned landscape / pollinators frequently observed with high species richness
plant 2 infructescence 1	61	1.26	30	high ecological quality / unburned landscape / pollinators frequently observed with high species richness
plant 2 infructescence 2	53	1.19		
EO 46 – Hanford Dunes				
plant 1 infructescence 1	45	0.82	38	high ecological quality, but weedy interdune area directly adjacent / unburned site / pollinators frequently observed with high species richness
plant 1 infructescence 2	32	1.13		
plant 2 infructescence 1	31	1.26	48	high ecological quality / unburned landscape / pollinators frequently observed with high species richness
plant 2 infructescence 2	41	1.20		
plant 3 infructescence 1	49	0.77	29	high ecological quality / unburned landscape / pollinators frequently observed with high species richness
plant 3 infructescence 2	38	1.10		

The species clearly faces a daunting breadth of threats contributing to its steep decline across its narrow range and specialized habitat. These factors, discussed in-depth below, have compounded notably over the last several decades to the point that there now appear to be only two remaining populations that have probable natural viability over a moderate timeline, provided active conservation measures are enacted. However, even these two populations, the Hanford (EO #46) and Wanapum Dunes (EO #33) need further evaluation work and the threats they face are more a matter of degree than of kind relative to those populations that are clearly in steep decline and at imminent threat of extirpation.

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

Active inland sand dune systems in Washington State were assessed in 1970 at approximately 181,371 hectares. A comprehensive reassessment of these dune habitats in 2006 tallied 43,282 hectares – a 76% reduction (Hallock et al. 2007).

Amongst the causative factors behind this decline approximately 35% of the loss is attributed to dune stabilization by exotic and also, to some extent, native vegetation species. Other important factors contributing to this decline include conversion of dune systems to agriculture, development conversion of dune systems for housing and other uses, loss of dunes due to flooding behind reservoirs and elevated groundwater tables caused by irrigation on adjacent agricultural lands (Hallock et al. 2007). Adding to, and often directly connected to these factors, is loss of consistent sand supply.

It is apparent that an entire ecosystem element of the landscape in eastern Washington is at extreme risk of total disappearance with *Oreocarya leucophaea* and numerous other often rare sand obligate species in tow. While it is not possible to know how much sand dune habitat may have historically been occupied by *Oreocarya leucophaea*, it is clear that the losses must be very large.

Inclusive in the reduction of overall sand dune habitat is the major contribution of catastrophic landscape-scale wildfires and the subsequent attendant invasion of exotic noxious hyper-competitive annual and perennial species. The deleterious effects of wildfire on native vegetation communities in the lower Columbia Basin are very well-documented and are a critical issue across the entire region (WNHP 2023, SEE Botanical Consultants LLC unpublished data; Higuera & Abatzoglou 2021; Shinneman and McIlroy 2016; Brooks et al. 2015, Bunting et al. 2003).

Once an area occupied by *Oreocarya leucophaea* burns the plants are typically killed outright if exposed to flame as the buds of the species perennate above ground and are thus destroyed. As invasive exotic vegetation gains a strong foothold – cheatgrass in particular – sand dune habitats are rapidly transformed, typical native vegetation species abundance rapidly declines, formerly active dunes are anchored in place and sand supplies feeding still active elements of dune fields are attenuated or outright eliminated. This can generate a positive feedback loop in which more and more viable habitat is degraded as sand input to dune fields is obstructed and wildfire risk elevates as exotic vegetation encroaches.

Prior to the Beck and Darrach species assessment documented loss and/or steep declines of individual EO's in the WNHP database as a result of habitat loss and ecological degradation were already extreme as depicted in Table 1 above. The losses of a large majority of the 43 either extirpated / likely extirpated / declining or steeply declining populations can be directly correlated with risk elements associated with wildfire, exotic vegetation encroachment and attenuation of sand supply. However, loss of EO's can also be directly ascribed to other risk factors as well. EO loss has also occurred owing to polygons of previously occupied habitat being converted to housing, other development and agricultural purposes. WNHP EO's #8, #27 and #58 have all been lost to urban development in the immediate Tri-Cities, WA area and conversion of EO #33 near Vantage, WA to center pivot agriculture occurred in 2015.

In addition to the above suite of habitat threat factors the prevalence of off-road OHV usage in some of the EO's is concerning. In particular the Beverly Dunes EO #20 and the Wanapum Dunes EO #33. Both have had significant impacts. However, recreational off-roading in the Wanapum Dunes EO in particular has indeed been significant, and plant loss has been documented (Fig.16).

Numerous trails transecting occupied polygons are present (Figure 17), and have acted as thoroughfares for exotic species introduction. One of the occupied polygons has had sufficiently severe off-road activities that someone or group felt it necessary to attempt to block

off the primary access point with a buck-and-pole fence. Shortly after the fence was erected, illegal off-road users destroyed the fence (Figure 18) and resumed use of the area again. See further discussion of this fence in section 6.4, below.

Figure 16. Off-road vehicle damage Wanapum Dunes EO

No one has made an attempt to fix the fence or erect a more imposing structure since the damage occurred several years ago.

Construction of the large hydropower dams along the Columbia River have also indirectly contributed to loss of viable habitat for *Oreocarya leucophaea*. The Wanapum dam in particular has most probably had a deleterious effect on the Wanapum Dunes EO #33 through drastic reductions of exposed sand bars that previously provided persistent sand supply to this population. That sand supply is now largely attenuated.

Indeed, release of water from the entire chain of dams up the Columbia River from the McNary dam has also most probably contributed to habitat loss for the species. All of these dams release water according to needs agendas that may not align with natural river flow regimes. Resultingly, water flows through the Hanford Reach portion of the river are likely to be inordinately high at times when, historically, they were lower and therefore allowed for greater sandbar exposures that would have resulted in enhanced sand supply nourishing the dune communities.

Lastly, the Beverly Dunes EO #20 has apparently experienced light grazing – most probably by horses according to available evidence. It is also assumed that the Babcock Bench EO # 18 had a grazing usage previously. Grazing in such sensitive habitat can be expected to have resulted in direct loss of some *Oreocarya leucophaea* plants from direct trampling and indirectly via introduction of exotic weed seed.

Salient examples of extreme habitat loss are probably best illuminated by the decline of the Winchester Dunes population EO# 32 and the now completely extirpated Juniper Dunes population EO# 17. As elucidated above EO# 32 has seen a ~90% population decline in 8 years from 2,429 individuals to just 250 individuals. As recently as 1978 the Juniper Dunes population consisted of thousands of plants scattered over 12 separate sections – none remain.

Figure 17. Damaged buck and pole fence Wanapum Dunes EO on Bureau of Reclamation Land

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

These threat factors have by-and-large not played the outsize role that habitat loss has. The plants have not been subject to commercial, scientific or educational uses to any significant extent.

6.3 Factor 3: Disease or Predation

Evidence of disease in *Oreocarya leucophaea* plants was not noted during the field investigations conducted by Beck and Darrach in 2023. Seed predation was however noted when conducting the microscope work for the seed set analysis portion of the study conducted by Beck and Darrach. Several mature seeds clearly had entrance holes with consumed endosperm, but amongst the hundreds of seeds evaluated the number of damaged or consumed seeds overall was low. Seed predation by harvester ants (genus *Pogonomyrmex*) however, is possibly locally significant, and what are assumed to be saline harvester ant (*Pogonomyrmex salinus*) or perhaps western harvester ant (*Pogonomyrmex occidentalis*) crater mound nests have been noted in a few interdune areas adjacent to EO's.

6.4 Factor 4: Inadequacy of Existing Regulatory Mechanisms

Existing regulatory mechanisms are clearly woefully inadequate to provide protection for *Oreocarya leucophaea* and keep the species from collapsing into extinction. The species has no formal legal protections of any kind. The species has however been on the WNHP rare plant list since the list's inception in 1977, but the species designation as state threatened has clearly had no effect at curbing the precipitous decline of the plants' populations. No significant conservation measures of any kind, such as attempts at growing the species from seed or rehabilitating degraded habitat, are known to have even been enacted. The species has been ranked until very recently by NatureServe and WNHP as a rounded G2S2 entity, but the updated information contained in the 2023 conservation assessment by Beck and Darrach has

resulted in a re-ranking of the species. It is now ranked G1S1 and has accordingly been uplisted from state threatened to state endangered by WNHP and to 'critically imperiled' by NatureServe (2024).

Although *Oreocarya leucophaea* has no formal legal protections of any kind, many of the remaining occupied or putatively occupied EO's reside on either federal, Washington State or Grant County Public Utility District (GCPUD) owned lands. Table 5, below, provides a synopsis of land ownership amongst the remaining EO's that are still, or presumed, to be extant. The preponderance of government owned occupied habitat is fortuitous in that it may provide largely unobstructed avenues for future conservation and recovery efforts.

EO #42 is the single most critical remaining population of the species. The Hanford Dunes population is situated entirely within the Department of Energy managed Hanford Site. As such, management of *Oreocarya leucophaea* as a rare plant resource falls within the purview of the Hanford Site Biological Resources Management Plan (2017). In this document rare plant resources are only broad-brush mentioned very briefly in section S.5.5 and again with a single paragraph in section 5.3.16 with no specific species of any kind mentioned. The language says "*populations of these species* [rare plants] *are found throughout the Hanford Site and could be impacted by site activities. DOE will continue to monitor known populations of rare plants* [EO #42 inclusive] *on the Hanford Site and use the impact assessment process"* The wording here is vague at best and there is no specific language suggesting that monitoring be conducted on known rare plant occurrences that might never be directly impacted by on-site activities.

Other than the extensive, but incomplete, inventory and broader-scale ecological assessments conducted by SEE Botanical Consulting (Salstrom 1994, and SEE Botanical Consulting 2016 and unpublished data) *Oreocarya leucophaea* has never had any focused quantitative monitoring protocol written or enacted. It is clear that there has never been any attention paid to the overall population trend with transect and quadrat-derived metrics applied. It is quite clear that present-day management mechanisms are seriously inadequate and incapable of providing any meaningful protective measures for the plants.

Hanford Reach National Monument lands largely envelope the Hanford Site proper. These lands are subjected to a different, and far more extensive management plan (Hanford Reach Conservation Plan 2008). Unfortunately, there are no known remaining populations of *Oreocarya leucophaea* residing on Monument land. There is, however, suitable habitat that has historically been occupied. A few remaining plants in these areas may still exist on the Monument.

U.S. Bureau of Reclamation (USBOR) land holdings include part of EO #33 at Wanapum Dunes. Aside from the Hanford Site EO #42, the Wanapum Dunes population is the next most critical occurrence. The document that provides direction for managing the rare plant resources at this site is the Columbia Basin Scattered Tracts Resource Management Plan (1998). While this document and its appendices mention *Oreocarya leucophaea* (nee *Cryptantha*), in a short list that

merely acknowledges its existence on BOR land holdings, there are no management directives of any kind specific to the species or any other rare plants on BOR scattered tract lands in the Columbia Basin. The existing, now partially destroyed, buck and pole fence at this location indicates that someone apparently recognizes the general sensitivity of the area, but no effort has been made to rebuild the fence or erect a more imposing structure. A phone discussion with Rebecca Doolittle – BOR Ephrata Field Office Resource Management Supervisor – held on 15 April, 2024 indicates this fence was not constructed under the auspices of the BOR, so its origins remain unknown. Again, the inadequacy of regulatory oversight relative to *Oreocarya leucophaea* is readily apparent.

EO #62 Winchester Dunes is located on the Columbia Basin Wildlife Area (CBWA) managed by the Washington State Department of Fish and Wildlife (WDFW). This important, though rapidly dwindling, population falls under the purview of the Columbia Basin Wildlife Area Management Plan (2022). No mention is made of the species as a target for any specific management directives although the species is listed in a table (p. 188) with other rare plants known to occur in the CBWA. *Oreocarya leucophaea* is recognized in the table as being of moderate risk for climate change impacts. Other than RareCare inventories no management of any kind for the species has occurred here. The inadequacy of regulatory attention is clear.

6.5 Factor 5: Other natural or manmade concerns affecting the continued existence of the species

Several risk concerns can be considered under this heading. As discussed in some depth above, the extreme, apparently permanent, conversion of sand dune habitat that exotic invasive plant species causes is clearly a major driver behind the steep population declines of *Oreocarya leucophaea*. Once exotic species, especially cheatgrass, advance to the point where it is dominant there is little hope of meaningful habitat recovery without major, and expensive, conservation measures.

As population sizes decrease and the degradation of viable habitat owing to conversion to other uses, exotic weeds and wildfire proceeds fragmentation and associated truncation of gene flow occurs. Loss of gene flow is very well documented across many biota categories, including plants, as a major risk factor leading to population declines and extirpation in that it fosters inbreeding depression and attendant loss of fitness and reproductive capacity. Clearly Oreocarya leucophaea writ large as a species is embedded nearly entirely within a radically fragmented landscape wherein gene flow between remaining EO's, many of them very small but perhaps harboring unique genes, is effectively attenuated if not outright halted. Also negatively affecting the species is the termination of sand supply that maintains the existence of the dune fields that provide habitat for the species. A combination of surface water hydrologic changes, groundwater incursion associated with irrigation-induced elevated water tables, erection of massive dams along the Columbia River and stabilization of potential sand supply sources by exotic vegetation has left interior Columbia Basin dune fields starved for the feedstock

Table 5. Presumably Extant Element Occurrence Land Ownership

Element Occurrence	*Federal*	*WA State*	*Grant County PUD*	*Private*
EO–3 West Bar	------	WDFW	------	------
EO–20 Beverly Dunes	------	------	✓	✓
EO-5 Ginkgo State Park	------	WA Parks	------	------
EO-23 China Bar	Bureau Reclamation/Dept. of Energy	------	------	------
EO-29 Moran Sands	Bureau of Reclamation	------	✓	------
EO 30-Frenchman Hills	------	WDFW	------	------
EO-32 Winchester Dunes	------	WDFW	------	
EO-33 Wanapum Dunes	Bureau of Reclamation	------	✓	✓
EO-34 S. Columbia Basin	------	WDFW	------	------
EO-35 Dodson Dunes	------	WDNR	------	------
EO-40 Johnson Creek	Department of Defense	------	------	------
EO-46 Hanford Dunes	Dept. of Energy	------	------	------
EO-49 White Bluffs	Dept. of Energy	------	------	------
EO-61 Crab Creek	------	WDFW	------	------
EO-62 WSW Winchester	Bureau of Reclamation	------	------	------
EO-63 East Wenatchee	------	WDFW	------	------

sources by exotic vegetation has left interior Columbia Basin dune fields starved for the feedstock they require to exist over the long term.

Ongoing and clearly accelerating climate disruption owing to anthropogenic causes must also be considered a very significant risk to *Oreocarya leucophaea*. With a warming climate and associated elevated substrate desiccation in an already xeric setting drought effects are amplified. Stochastic drought events can be expected to greatly limit reproductive success for the plants. *Oreocarya leucophaea* is an unusual perennial species in that it is apparently genetically programmed to bloom profusely every year. In drought years this must place the plants under elevated stress and can be expected to result in some metabolic stress-induced mortality accordingly.

Another salient risk factor, as discussed in the context of individual EO's above is the clearly significant loss of pollinating insects in the lower Columbia Basin. Directly related to habitat degradation owing to wildfire and invasive vegetation encroachment, the effects of the *Oreocarya leucophaea* populations being embedded within an industrial-scale agricultural landscape must also be considered. The entire area encompassing all of the EO's has undergone massive landscape conversion over the last several decades to agricultural uses of many kinds.

These developed lands are both a source of exotic weeds and are managed with numerous agricultural chemicals whose fate and transport on and across the landscape is typically poorly constrained (Maggi et al. 2023; Tang et al. 2021). Pesticide drift distances can however be significant, persistent and diverse in highly managed agricultural landscapes (Coscolla et al. 2010). Additionally, in intensive agriculture settings pollinating insects can be expected to

forage into pesticide impacted areas and return contaminated pollen and nectar to the nesting or hive site (Knapp et al. 2022).

It can be reasonably assumed that pollinator decline amongst the few remaining EO's can be traced, at least in part, to the long history of agricultural pesticide usage in the area. The particular pesticide load exposure of individual pollinating species – *Apiodea* bees in particular – most probably correlates with foraging distance of individual taxa (Knapp et al. 2022). Species such as the European honeybee are expected to have the largest foraging radii, with *Bombus* spp. and smaller solitary bee taxa having progressively smaller foraging radii. Thus, pesticide load should typically be most pronounced and impactful to the long-distance foraging species.

Evidence of the loss of pollinating insects, as discussed partially above, is abundant in the field and correlates essentially perfectly with the loss of occupiable habitat for *Oreocarya leucophaea*. Only in those rapidly retreating ecological settings wherein the habitat is still largely intact are pollinator populations perhaps sufficient to provide adequate reproductive potential for the perpetuation of the species. Pollinating species both worldwide, and at the much-reduced scale of the range of *Oreocarya leucophaea*, also must contend with the accelerating effects of climate disruption on the landscape they occupy. Stochastic extremes of variation in the broader climate as evidenced by intense droughts, heat episodes, flooding events and other phenomena have become significant stressors of pollinating insect populations worldwide (Sanchez-Bayo and Wyckhus 2019). Owing to the fact that most pollinators within the range of the species have an annual life cycle, populations can accordingly shift markedly from year to year. Stochastic weather events such as extreme summer heat episodes can have outsize effects accordingly (Ogilvie and CaraDonna 2022) and may place some species of pollinators as risk of local extirpations.

Being that the species relies on an obligate heterostylous outcrossing pollination syndrome. Extreme and protracted weather events can be expected to directly impact insect populations – we may very well already be seeing this effect play out in some EO's such as the Moran Sands site wherein suitable habitat is present but insects are largely absent.

7.0 Designation of Critical Habitat

We request that a prioritization of critical habitat to be designated for *Oreocarya leucophaea* in all EO's in which the species appears to still be viable or provisionally viable: EO# 20 Beverly Dunes, EO# 33 Wanapum Dunes and EO# 46 Hanford Dunes and, possibly, pending field investigations EO# 35 Dodson Road.

The Hanford Dunes EO# 46 is particularly crucial. Without its designation as critical habitat the risk of extinction of the species will be greatly elevated. Additionally, it is requested that all government owned properties, state and federal, within the historical range of the species wherein suitable habitat exists be designated critical habitat as well. These sites can be considered as possible reintroduction sites as part of any recovery plan.

8.0 Conclusion

We the Center for Biological Diversity petitioners conclude that *Oreocarya leucophaea* has undergone a rapid multi-factorial and radical decrease in the number of its populations to the point wherein only 2 remaining EO's – Wanapum Dunes and Hanford Dunes appear to have any long-term viability. Beverly Dunes is considered here to be provisionally viable as the population there is clearly being artificially propped up by the presence of European honeybee hives providing otherwise likely inadequate pollination services by native insects.

The collapse of the previously robust Winchester Dunes population by 90% over an 8-year period boldly underlines the critical stage of decline which this species has entered. A combination of exotic plant species invasion of suitable habitat – particularly by cheatgrass, conversion of large tracts of previously viable habitat to agriculture and other uses, landscape-scale wildfires, sand supply attenuation and the clearly major attenuation of native pollinating insect populations conspire together to place the species at extreme and immediate risk of extinction. As such the only remaining hope for this species is immediate protection under the federal Endangered Species Act. As such, we, the Center for Biological Diversity petitioners, are requesting that a listing be designated accordingly.

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