AMSINCKIA CARINATA (MALHEUR VALLEY FIDDLENECK) DRAFT SITE MANAGEMENT PLAN[1]

Common name: Malheur Valley fiddleneck
Scientific name: *Amsinckia carinata* Nels. and Macbr.
Site name: Range-wide (see discussion below)
Legal description: The entire geographic range of the species is covered by the plan (see rationale under *Assumptions, objectives, and definition of study area*, below). This includes a series of yellowish, tuffaceous sandstone outcrops occurring a few miles north and south of Highway 20 in Malheur County, Oregon (additional details are included in the report). Approximate areas known to have habitat and populations include: T20S R41E (Secs. 10, 14, 15, 22, 23, 24, 25, 26, 27, 35, and 36); T20S R42E, (Secs. 17, 19, and 20); and T21S R41E (Secs. 2, 11, 14, 15, and 22). UTM data for specific study sites are provided in the Appendix 1 (see Appendix 3 for map of project location).

GOALS OF THIS MANAGEMENT PLAN

The goal of this draft Site Management Plan (SMP) is to facilitate the conservation of *Amsinckia carinata in situ*, with desired outcomes being the eventual de-listing of the species (currently threatened) at the state level, and the prevention of federal listening under the ESA. Towards these ends, management efforts should focus on (1) curtailing further habitat degradation , (2) sustaining current population numbers, and (3) supporting off-site cultivation efforts to produce seed for re-introduction and augmentation efforts, as well as *ex situ* germplasm storage. Unlike more localized, site-specific SMPs that focus on one or a few populations, this plan emphasizes a management approach applicable to all *A. carinata* populations on public land, due to their high degree of similarity and close proximity to each other.

PROJECT BACKGROUND

Assumptions, objectives, and definition of study area

This report, prepared for the Bureau of Land Management (Vale District), represents the final draft of a *Site Management Plan* (including work from 2009 through 2013) to guide conservation efforts for the rare endemic *Amsinckia carinata*. BLM determined that evaluating populations and habitat over five years would be the minimal time frame for gathering the necessary trend observations, with a final management plan due in 2013. Creating a plan for the conservation of the species is important due to (1) the extreme rarity and vulnerability of *A. carinata*, which is already listed as *threatened* by the State of Oregon;

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(2) the entire known range of the species being limited to a few square miles of public land; (3) the fact that populations currently or may coincide with off road vehicle activity, grazing-related site disturbance, weed infestations (both exotic species and the native *Amsinckia tessellata*), and (though unlikely) zeolite mining; and (4) the potential to avoid future federal listing as threatened or endangered if reasonable conservation measures are put in place.

The Interagency Special Status/Sensitive Species Program (ISSSSP) describes Site Management Plans as "optional tools used to address the management of an individual population or site, or a collection of sites with similar characteristics. The "site" or area to be managed is defined by the field unit personnel responsible for managing the particular population/individual site. Site Management Plans (SMPs) are typically developed for those species/habitats that require active management of the site in order to meet the desired goal for the species/habitat. The plans are usually very specific as to what management actions need to occur, where, and what the timeline is for each action." Most SMPs for plants tend to focus on individual vulnerable populations or narrowly defined tracts.

However, as outlined by the ISSSSP, field personnel can identify broader criteria for determining what constitutes a *site*. In this case, we have decided that it makes sense to delineate the site for this plan as the entire geographic range of *Amsinckia carinata*, since its distribution as a whole clearly represents a "collection of sites with similar characteristics." The occurrence of the species on the landscape is strictly governed by edaphic conditions, resulting in clusters of small populations or patches, often occurring in close proximity. The overall distribution of *A. carinata* is quite narrow, and the number of populations and amount of habitable substrate limited. Moreover, all populations share the same habitat as well as threats (both actual and potential), and the management issues affecting them are essentially identical.

Following the ISSSSP protocol for SMPs, the primary focus of this project has been to (1) review the abundance, life history, and ecology of the species; (2) evaluate habitat condition and current threats (focusing on OHV impacts, weed encroachment, and grazing activities); and (3) qualitatively assess population trends. A secondary goal of the work was to try and evaluate habitat quality by establishing a monitoring program at selected sites across the range of the species, which ultimately turned out to be impractical. Field visits during the first year of the project, as well as reviews of previous work, suggested that for management purposes, the range of *A. carinata* could be subdivided into several *population centers*, with each of these comprising a varying number of geographically-affiliated populations of varying sizes.

Six population centers were subsequently identified, two north of U.S. Highway 20, and four to the south (these are described in more detail below. Five of these were used during the field assessments for this project (see Appendix 3 for study area map):

(1) Harper Junction population center (T20 S R42 E). [*Populations assessed: 13*] Located in Secs. 17 (scattered through mostly the W½), 19 (SW¼ of the NE¼), and 20 (NE¼ of the NW¼), this group of over a dozen clustered patches occurs almost entirely east of Crowley Rd., with the exception of the most southerly population (occurring in Sec. 19). Population areas and habitat are visible on the left (heading south on Crowley Rd.) from about 1.5 to 2.5 miles south of Highway 20 at Harper Junction (in Secs. 17 and 20), with the lone population in Sec. 19 about 3.2 miles south of the highway, on a sloping butte to the immediate west of the road (more or less across from an isolated windmill just east of Crowley Rd.).

(2) Highway 20 population center (T20 S R41 E). [*Populations assessed: 0*] This group comprises four known populations in Secs. 24 (extreme E½ of the NW¼, and NE¼ of the SW¼) and 25 (NW¼ of the NW¼). As a group, they occur less than a half mile in from, and more or less parallel to, the highway. This smaller population center (with four known sites) is more isolated than the previous one, and is less exposed to disturbance (especially off-road vehicle activity). This group was not visited or evaluated due to access issues.

(3) West Crowley Road population center (T20 S R41 E). [*Populations assessed: 11*] Anchored by an impressive butte 5.5 miles south of Harper Junction and immediately west of Crowley Rd. in Sec. 36 (SE¼ of the NE¼), this population cluster skips west from Sec. 36 (concentrated in the NE¼) into portions of Sec. 35, and just crosses into the NW¼ of Sec. 2 (in T21S R41E). Occupied habitat in Sec. 36 is easily accessed and readily visible from Crowley Rd., with the populations occurring in Sec. 35 more isolated.

(4) Cottonwood Creek population center (T21 S R41 E). [*Populations assessed: 5*] This population group represents the southernmost occurrence of *A. carinata,* with the tuffaceous sandstone layers that supports the species not known to be exposed further south. The populations here occur from about 8.8 to 10.1 miles south of Harper Junction, on either side of Crowley Rd., and are known to occur in Secs. 11 (SE¼ of the SW¼), 14 (N½ of the NW¼), 15 (SE¼ of the NE¼, and SW¼ of the SE¼), and 22 (SE¼ of the NW¼), with those in Sec. 14 the easiest to access.

(5) South Copeland Road population center (T20 S R41 E). [*Populations assessed: 3*] This population complex, whose habitat is easily visible to the north from Highway 20 across the Malheur River, occurs on hillsides immediately above Copeland Road, which winds along its lower slope and provides easy access. The populations here primarily occur on south-facing exposures in Sec. 27 (across the N¼ of the section), with habitat also extending just north into Sec. 22 (along the lower edge of the SE¼) (T. 21 S. R 40 E).

(6) Northern Periphery population center (T20 S R41 E). [*Populations assessed: 6*] This population center includes two prominent series of adjoining slopes, each with scattered patches of *A. carinata*. They represent the northernmost occurrence of *A. carinata,* with the yellowish-orange to ochre-colored substrate that typically supports the species not known to occur further north. The more southerly of the two occurs in the S½ of the SE¼ of Sec. 15, with a significant extension into the NE¼ of the NE¼ of Sec. 22. *Amsinckia* habitat then continues east into the S½ of the SW¼ of Sec. 14, and also extending south into the NW¼ of the NW¼ of Sec. 23. Limited habitat also occurs in the NE¼ of the SE¼ of Sec. 15, and the NW¼ of the SW¼ of Sec. 14. The most northerly series of populations extends from the SW¼ of the SE¼ of Sec. 10, south and east across the northern edge of the NE¼ of Sec. 15, and then east across much of the N½ of the NW¼ of Sec. 14.

A note about *populations assessed*. For the most part, the above population centers consisted of more populations than were actually visited and assessed during field work. Populations that were reasonably accessible and which seemed representative were chosen for evaluation, with the assumption that the conclusions reached by observing these sites would be applicable to the species as a whole. Thirty-eight populations (some really no more than isolated small patches, with others having thousands of plants), situated across the range of the species, were assessed during this project. Prior to this work, these were arbitrarily selected and last visited as a group by the author in 1994. They were sampled again in 2009,

2010, or 2011 for this study, to establish overall abundance, trends, and threats for the species range-wide.

It's worth noting that due to their annual life history, *Amsinckia carinata* populations will likely vary from year to year on the landscape, both numerically and spatially, and this may or may not indicate population decline. Even though the habitat for the species is sharply defined (discussed in more detail elsewhere in the report), plants that come up each spring don't necessarily occupy the same locations every year, with sites that harbored large *A. carinata* patches one year being potentially devoid of plants the next. So future status evaluations or monitoring of the species should not be based on precisely relocating and censusing the populations and patches that were visited during this study. To do so runs the risk of over- or underestimating causality in relation to fluctuations in site demographics.

Accordingly, the boundaries of sampled populations were not delineated using GPS, since the goal of the SMP was not to take a snapshot of individual populations at a particular point in time. Rather than delineating study populations by creating GPS polygons for future reference, an estimated mid-point (or centroid) was simply taken for each sampled site (these are provided later in the report as UTM data—see Appendix). The idea is that this GPS point, in combination with the easily recognized edaphic characteristics that define all *A. carinata* habitat, should allow future observers to reliably relocate most if not all sites, even if the population has shifted demographically or changed position on the slopes.

Species overview

Amsinckia carinata (Fig. 1) is a narrow edaphic endemic, adapted to cobbly talus substrates of tuffaceous origin, and found on only a few steep hillsides in northern Malheur County, Oregon (Cronquist, 1984). It is considered a *species of concern* by the U.S. Fish and Wildlife Service and *threatened* by the State of Oregon (OAR 603), and is managed as a *special status species* by the BLM.

A stout herbaceous annual in the forget-me-not family (Boraginaceae), *A. carinata* was believed to have gone extinct until it was relocated during general floristic surveys in the mid 1980's (Joyal, 1984, 1985). Based on general appearance, and a lack of detailed information, *A. carinata* had been considered by some botanists to be conspecific with *A. vernicosa*, a rare California species also found on unusual soils (Ganders, 1993). However, research (Meinke, 1993) confirmed that *A. carinata* is a localized and very distinctive taxon. Although *A. carinata* bears more similarity to *A. vernicosa* (which is limited to central and southern California) than to any of the other known fiddleneck species, the relationships and evolutionary history of the two taxa have yet to be formally studied.

Amsinckia carinata is one of several edaphic endemics in far eastern Oregon with an extremely limited natural range, whose distributions coincide with a number of actual and potential threats, including mining, off-road recreation, grazing, and competition with weedy species. The landscape immediately surrounding the known populations of *A. carinata* (which are more or less elevated above the surrounding countryside on steep, knobby hills) was once dominated by various native species of bunchgrass, sagebrush, and numerous annual and perennial forbs. Today these areas are often characterized by fields of annual exotics (Fig. 2), in particular cheatgrass and medusahead wild rye. Scattered native shrubs, are still present, but indigenous herbaceous species have generally been replaced by non-natives, with the notable exception of a few unpalatable (to livestock) native forbs, which

Figure 2. *Amsinckia carinata* plants in talus habitat (plants are 25-40 cm tall).

Figure 1. *Bromus tectorum* dominates many areas near slopes that provide habitat for *Amsinckia carinata.* Disturbance allows *B. tectorum* to move upslope and invade *A. carinata* habitat.

have increased their numbers as other taxa have been depleted. As a result, the natural biodiversity of the rangeland surrounding the rocky "islands" of *A. carinata* habitat appears, in general, to have been severely reduced.

Due to difficult access, lack of water, and loose footing, the harsh slopes occupied by *A. carinata* have historically been less impacted by cattle and exotic species invasions than the surrounding sagebrush-bunchgrass habitat below, and most species associating with *A. carinata* high on the slopes are native forbs or low shrubs. However, cattle do impact the lower slopes in a number of areas, and off-road vehicles create further disturbances. Such activities pose a threat, considering that the talus-covered substrate that supports the species is extremely fragile, and successful site rehabilitation after disturbance would be problematic, if not impossible.

A range-wide evaluation of the species has not been attempted since ecological and taxonomic studies were completed in the early 1990's. Observations since then have suggested that off-road traffic patterns have expanded on multiple slopes harboring the species (especially in the last decade or more), and other perturbations may have increased as well. BLM implemented a Conservation Agreement for *A. carinata* with the U.S. Fish and Wildlife Service in 1992, and although it is largely unknown how the species and its habitat have fared since then and prior to this project, casual observations suggest that disturbances have increased over that time and viable habitat has decreased.

The current project was set up to re-evaluate the status of *A. carinata* roughly two decades since the last comprehensive observations of the species, with the goal of developing a management guide applicable to any populations on public lands. Specifically, information gaps centered around population trends (through a range-wide survey of habitat and population condition) and factors affecting environmental conditions are addressed as part of the planning effort. The extremely limited distribution, narrow habitat requirements, and apparent threats to *A. carinata* could qualify the species for federal listing if it is shown to be significantly declining, or any remaining populations are destroyed. The results of this project will facilitate improved management, and may reduce the likelihood of federal listing.

Figure 3. Tuffaceous sandstone outcrops that provide parent material for the substrate required by *Amsinckia carinata.*

Overall species range, distribution, historical abundance, and trends

General range and distribution. *Amsinckia carinata* is a narrow endemic restricted to a few, scattered occurrences in northern Malheur County, Oregon, within the Northern Basin and Range ecoregion (Appendix 3). The Vale

BLM District is the only federal agency with direct jurisdiction over the species, managing an estimated 95% or more of the existing habitat and known populations.

The known range of Malheur Valley fiddleneck is scattered among about 17 square miles (based on quad sections where *A. carinata* plants have been recorded, or where habitat is clearly present). The natural distribution of the species is bisected by U.S. Highway 20 (Appendix 3), with the majority of habitat and populations occurring to the south, but a significant number to the north as well. The necessary habitat is very patchy, however, and the known populations probably occur within a combined area of less than a few hundred acres range-wide (with the actual surface extent of populations each year dependent on precipitation and disturbance, in addition to edaphic parameters). The essential substrate, i.e., friable outcroppings of a whitish-yellow tuffaceous sandstone that weathers to a deeper yellow or burnt orange, emerges sporadically within this range, and the relatively few sites that support (or could potentially support) the species in this area are easily recognized (Fig. 3), even from a distance.

Overall abundance and trends. Meinke (1990) reported an estimated 33,150 *A. carinata* plants present in 1989, after visiting the known populations at the time. Thirty-eight sites were then visited in 1994 (see Appendices 1 and 3), and surveys at that time resulted in an estimate of 36,450 plants for all populations. A subsequent census of the same sites in 2009-2011 for this work (see Appendices 1 and 3) yielded an estimate of 40,406 *A. carinata* plants. Occasional field observations by the author between 1994 and the start of this study suggested that populations naturally fluctuate from year to year (unfortunately no census data are available for this time), evidently being affected by winter and spring precipitation patterns, insect predation levels, and other factors. Disturbances levels at the sites also appeared to vary from year to year, and this presumably has affected population numbers, as well.

Here are some demographic trends for the 38 study sites observed over the years (based on figures in Appendix 1):

- The number of *A. carinata* plants observed in the last two to four years were higher by about 10% (40,406 vs. 36,450) over the overall numbers recorded in 1994. It's important to note, however, that all 38 sites were censused in 1994, while site visits for this project were spread over three years (2009-2011).
- Although overall plant numbers increased (which in itself may simply reflect a more thorough survey in 2009-2011), sampled populations during this project were more likely to have declined since 1994 than increased (23 out of 38 sites had fewer plants).
- Populations north of Highway 20, which were typically less exposed to OHV traffic (Appendix 1), accounted for the bulk of the overall population increase for the species. Nineteen out of 29 populations south of the highway declined since 1994.

The above information notwithstanding, it is important to note that for many annual species, trend and abundance data may have limited conservation and management value. Seed bank-dependent species found in arid environments, such as *A. carinata* (see life history notes in the following section), often exhibit dramatic fluctuations in terms of abundance from year to year. As mentioned earlier, annual shifts in the location and size of populations, which may, at least in part, simply be natural responses to environmental condition, are not necessarily indicators of an actual downward (or upward) trend for an annual species. Rather

than developing a management strategy based on demographic variation over time for such species, a better approach may be to simply shield known habitat (especially high quality sites) from further disturbance regardless of annual swings in population numbers.

Species life history, identification, and comparison with similar taxa

Life history. *Amsinckia carinata* (Fig. 4) is a single- to multi-stemmed forb, usually robust and up to five or six dm high (though often shorter), which produces up to four shiny, one-seeded fruits (or nutlets) per flower. Plants are strictly annual, appearing in the early spring and completely senescing by July. Foliage and stems are sub-glabrous to sparsely bristly, and usually somewhat glaucous to even succulent. The corollas are striking for an *Amsinckia* species (in Oregon, at least), and are deep yellowish-orange (Fig. 4), marked with orange nectar guides, and generally larger than other species of the genus in the Pacific Northwest. The flowers typically exceed 10 on each inflorescence, and are prolific seed producers in nature. The size and reproductive vigor of any particular plant relates to winter precipitation, abiotic microsite characteristics, and competitive interactions with other plants.

Figure 4. *Amsinckia carinata* plant and flowers.

Plants normally flower (depending on the year) from early to mid-May through mid-June, with plants in both flower and fruit by June or earlier. Timing of seed germination in the field is unknown (probably late winter), although collected seeds will often germinate readily in the lab after soaking in water for several days (but more work is needed regarding the potential for after-ripening, delayed dormancy, and other germination-related mechanisms). The seeds (or technically speaking, nutlets) have a hard coat that protects against pathogens, promotes longevity, and facilitates the maintenance of a seasonally dormant seed bank from which the species regenerates populations each spring. Unlike the seeds of other Northwest fiddleneck species (which have a rough, cobbly exterior), those of *A. carinata* have a smooth, almost slippery, glass-like surface. This may make it easier for seeds to slide into the cracks and crevices of the talus substrate the species occurs on, thereby facilitating the local maintenance of seed banks in favored habitat patches.

Greenhouse studies and field observations (Meinke, unpublished) show *A. carinata* plants are fully capable of self-pollination, and do not have the heterostylic breeding systems (which enforce outcrossing) that a number of *Amsinckia* species possess. However, many insects have been observed foraging on *Amsinckia carinata* plants in nature, so the species presumably has a mixed mating system (i.e., often producing cross-pollinated seed, but able to self-pollinate if all else fails). Floral visitors observed during this study were virtually all native bees, usually recognizable as either the genus *Osmia* or *Megachile*. Both are common genera in eastern Oregon. These bees are moderately large (6 to 12 mm), and capable of probing deeply into flowers, and observations show that they will visit numerous inflorescences on different plants in a patch before moving on. They appear to forage mainly for nectar, but the *Megachile* bees in particular had evident ventral pollen accumulations. Whether or not this was *Amsinckia* pollen is not known, but it seemed likely since few (if any) other species with orange pollen were in flower nearby. Honeybees (*Apis*) were also occasionally observed visiting sites closest to agricultural fields, but were not seen on the plants elsewhere.

No adult lepidopterans were observed on the flowers, although several small butterflies were seen visiting weedy crucifers and composites in the immediate vicinity, and considering the longish tube of *A. carinata* corollas, butterflies may occasionally serve as pollinators. An unidentified larvae of a butterfly or moth has been observed feeding on the foliage of *A. carinata*, but is not considered a serious pest.

Identification and comparisons with similar species. At least three other *Amsinckia* species may occur within the range of *A. carinata*, including *A. lycopsoides*, *A. menziesii*, and *A. tessellata*. All three tend to flourish in ruderal environments in eastern Oregon, unlike *A. carinata*. Only *A. tessellata* is common in the study area, and it is often sympatric with *A. carinata*. *Amsinckia carinata* is distinguished from these mostly weedy (although native) and geographically more widespread congeners by *the combination of* partially fused sepals; relatively showy orange flowers; the glassy-smooth, often black nutlets; sub-glabrous, nearly succulent lower stems (which are commonly pinkish at the base); and sparsely hirsute, sub-succulent foliage (with leaf blades often hairless dorsally, though noticeably punctate).

As mentioned above, *A. carinata* often co-occurs with *A. tessellata*, although along the hillsides *A. carinata* is more apt to be found higher upslope, in areas with larger talus fragments and greater talus depth than is generally tolerated by *A. tessellata* (which prefers bare soil to weakly gravelled sites). Morphologically-intermediate hybrids between *A. carinata* and *A. tessellata* have been observed in areas where the two species directly overlap—such zones are normally narrow or non-existent in sites with little or no disturbance, but may be very significant in areas where disturbance is (or has been) heavy (such as along the lower periphery of hillsides if grazing is an issue, or even far upslope in habitat damaged by off-road vehicle traffic). The threats posed by *hybridization* with *A. tessellata* are the subject of a companion study that will be completed in 2015 (also see further comments on the topic on the following pages).

Site description and ecological processes

How large is the area to be managed? As discussed previously, the area to be managed covers the entire geographic range of *A. carinata*, which exists as small, edaphically-defined parcels scattered over 17 sections (approximately two-thirds of the

habitat and number of populations occur south of Highway 20, and a third to the north). This approach was considered the most reasonable, from both an administrative as well as biological viewpoint, considering that the range of the species is very localized (probably no more than 200 acres of occupied habitat), and the various sites (which have been subdivided here into six population centers, as described above) are virtually identical in terms of habitat, threats faced, and general management issues.

Current site condition, description, and required habitat (covering the entire range of the species for this project). Although the unique habitat varies little between sites, site condition (i.e., site quality) across the limited distribution of the species *is* variable, ranging from essentially untouched at a few sites to heavily disturbed at others. In general, conditions south of Highway 20 are less pristine than those for *A. carinata* populations to the north (although there has been more cattle trailing here), which have been impacted somewhat less by off-road vehicles. Major portions of two of the four population centers south of the highway are facing significant substrate disturbance from off-road traffic on slopes that have (or formerly had) populations of *A. carinata*. And then all populations have been impacted, to one degree or another, by cattle trailing. Livestock do not readily consume

Figure 5. Talus substrate required by *Amsinckia carinata* populations.

A. carinata, but may trample the lowest slopes inhabited by the species, which spreads weed seeds and disrupts the substrate.

The elevation for the species ranges from roughly 800 to 1050 meters. Other than this minor gradient, *Amsinckia carinata* exhibits preference for a very specific, consistent habitat type (Fig. 5). Populations occur almost entirely on loose, unstable, talus slopes with

warm (during the growing season), southern exposures, on the middle to upper reaches of steep buttes and rolling hills. The slopes supporting *A. carinata* populations are usually topped by one or more ragged outcroppings (see Fig. 3) of welded tuffaceous rock (ranging from a few meters across, to 20 to 50 meters or more), which break down over time, sending small boulders and sharp-edged cobbles cascading downslope. The largest fragment sizes (commonly 10 to 30 cm, with sharp, broken edges) and greater accumulated talus depth (up to 5 dm) are found in the immediate vicinity of the outcrops, usually just below or near the summits. The layers of loose rocks then steadily decrease in depth (to a few cm) as the talus chutes move downhill, with fragments far downslope more weathered and averaging much smaller. The parent material is a whitish-yellow, tuffaceous sandstone that weathers to a rich tannish-yellow or burnt-orange, and with experience, is easily identified even from a distance as likely habitat for *A. carinata*. Populations of the species have only been found on this substrate, and there is an apparent positive correlation between population frequency and greater talus depth and size (see below)

Ecological processes and species interactions. Few native plant species occur directly with *A. carinata* in this severe habitat. Among those that regularly do are *Oenothera brevipes*, *Asclepias cryptoceras*, *Phacelia lutea*, *Malacothrix torreyi*, *Tetradymia glabrata*, *Hordeum jubatum*, *Atriplex spinosa*, *Penstemon miser*, *Mentzelia albicaulis*, *Blepharipappus scaber*, *Cymopterus corrugatus*, and *Amsinckia tessellata* (mostly on lower slopes, although *A. tessellata* intermingles with *A. carinata* on upper slopes occurs in association with disturbance—see comments below). Most of these species occur sparingly on the tuff outcrops, even in good years, so that *A. carinata* typically appears to have minimal competition when it grows in the heavier talus fields. At the lower margins of *A. carinata* populations, however, competing species such as *A. tessellata* become increasingly common.

Of the non-natives, *Bromus tectorum* (cheatgrass), essentially absent on undisturbed upper slopes, is particularly prevalent below in areas subject to grazing, where it often dominates the rangeland (refer to Fig. 2). However, it can readily spread upslope into *A. carinata* habitat in association with expanded disturbance. It's worth noting that other exotic species are widespread below the slopes as well, yet to date very few examples of these have been seen moving into *A. carinata* habitat, even in areas where substrate disturbance has been severe. It is unknown if this has to do with physical characteristics of the substrate, soil chemistry, or other factors. However, even if cheatgrass is the only non-native that gains a foothold after slopes are disturbed, the threat is significant, considering the tendency for that species to form monocultures and outcompete natives in much of eastern Oregon.

Ironically, an even greater threat to *Amsinckia carinata* may come from the native, related species *Amsinckia tessellata*. Without disturbance, the two *Amsinckia* species occupy separate though nearby microsites on the slopes. The size of talus fragments is thought to play a role in determining which species, *Amsinckia carinata* or *Amsinckia tessellata*, prevails at a given point along a hillside. Previous work (Meinke, 1993) confirmed that larger talus fragments occur along the upper slopes, typically near the exposed, rocky summits. As the slope extends down and away, the size of the talus fragments decrease, so that ultimately the base of the slopes end up with a mix of pea-sized gravel and finer particles, and then transitioning to bare soil. Talus depth along the slopes was measured at varying points (using transects on an *undisturbed hillside* within the West Crowley Rd. population center), and this indicated that the two species largely replace each other along what can be termed a talus size/depth gradient. In areas with larger rock fragments and deeper talus *Amsinckia carinata*

predominates, but as talus depth and size decreases (typically corresponding with downslope microsites) *A. tessellata* becomes more common and *A. carinata* is abruptly excluded.

The problem arises when substrate disturbance destroys the balance between the niches occupied by and separating the two species, resulting in a mixing of the taxa that sets the stage for apparent hybridization, as well as probable competition for space and resources during spring germination. Previous work (Meinke, 1993; personal observation) has reported the presence of what are likely *Amsinckia carinata x Amsinckia tessellata* hybrids (Fig. 6) within

Figure 6. *Amsinckia tessellata* (left), *A. carinata* (right), with ±sterile hybrid (middle).

selected populations, corresponding with areas that have been disturbed by grazing or off-road vehicle traffic. Accordingly, measurements were made in 2009 at a site from the Harper Junction population center, to determine how the hybrids and two putative parent species sorted out along the talus size/depth gradient where extensive cattle trailing was occurring. The hybrids occurred mainly in moderately deep to shallow talus that had small fragments, typically along the base of the slopes where cattle trails were common. The zone where the parents and hybrids co-existed was usually disturbed by livestock in some fashion, through trampling and the subsequent displacement and mixing of larger fragments.

Observations implied that cattle seldom traverse the upper slopes, and the highest upslope populations of *Amsinckia carinata* at the site discussed above (and, in fact, at most sites) appeared virtually unaffected by livestock. However, increasing off-road vehicle traffic is another issue. To evaluate this, observations were recorded in 2009 and 2010 at the same site reported above, which had been undisturbed roughly 18 years earlier (see Fig. 7).

Currently, the site has several extensive off-road trails extending from the bottom to the summit of the butte. A transect run along the edge of the main track recorded both *A. carinata* and *A. tessellata* on the upper slopes, together with numerous apparent hybrids, where before (in 1989) only *A. carinata* had existed. The inescapable conclusion is that off-road vehicle use at the site has introduced *A. tessellata* upslope (also see following section), resulting in reduced habitat for the *A. carinata* population, hybridization, and probable increase in competition between the rare species (*A. carinata*) and the weedy relative (*A. tessellata*).

Site and population threats

As described in the preceding section, *livestock* movement within Malheur Valley fiddleneck sites degrades the habitat and destroys plants by direct trampling (thereby reducing seed production), and also displaces or crushes talus fragments (the preferred substrate of *A. carinata*). Invasive exotic weeds (largely *Bromus tectorum*), often introduced by grazing activity, may compete with and negatively impact the species, most notably in those sites where the species occurs on lower slopes.

Figure 7. Off-road vehicle damage to an *Amsinckia carinata* population (PC1-8) south of Highway 20. This site was relatively undisturbed in 1989, and has since been severely impacted.

Off-highway vehicle traffic (also see previous section) can likewise impact important microsites for the species, on lower as well as upper slopes. This potentially inflicts much greater damage to the sites than grazing-related disturbances, which tend to be less focused and mostly limited to downslope areas. Based on field observations, OHVs are the most serious threat the species faces, by damaging habitat (Fig. 7) as well as causing the introduction of weedy species into disturbed areas. Off-road activities are more apt to affect the entire slope, including higher areas (with the best habitat) often inhabited by the largest patches of *A. carinata* at a given site.

Niche overlap and greater sympatry between *A. carinata* and the common native weed *A. tessellata* is much more apt to occur in areas that have been impacted by surface

disturbances, increasing the likelihood of negative interactions between the species. In particular, *hybridization* between *A. carinata* and *A. tessellata* (also see previous section), a result of pollinator sharing, has been observed in the field where the two species co-occur. Although F_1's are partially sterile, some seeds are produced, and in extensive hybrid zones this may in time result in extensive introgression (i.e., the "swamping" of a population as it becomes dominated by genetically intermediate individuals). The increased pre-emption of habitat and resources by *A. tessellata* and hybrid plants, particularly in newly disturbed upslope areas formerly occupied solely by *A. carinata*, is a serious potential threat.

Although not a current threat, *surface mining* activities could seriously impact the species and its unique habitat. If mining occurred at the sites, the substrate would obviously be severely disrupted. Considering the unique nature of the talus slopes, the potential for post-mining rehabilitation to a standard suitable for *A. carinata* population re-establishment would be very low.

Local pesticide application on adjacent private land may also pose a limited, yet potential, risk to the species by eliminating insect pollinators near populations. Although *A. carinata* can self-pollinate, a loss of pollinators could, over time, reduce opportunities for cross-pollination and diminish genetic diversity within the species.

Finally, *climate change* poses hypothetical risks as well. Near complete post-germination population loss was noted at three sites of *A. carinata* in 1990, a severe drought year, in areas where thousands of plants were observed the previous year (Meinke, 1993). A successive series of years with high pre-reproductive mortality after germination—due to unfavorable climatic conditions, for example—could potentially deplete seed banks, which are critical to the survival of *A. carinata* populations. In combination with other threat factors, this could pose a substantial risk to the long-term prospects for the species.

Here are some threat summaries for the 38 populations visited during this project (from Appendix 1):

- Only two out of 38 sites did not have at least some level of livestock trailing or other impacts in 2009, 2010, and/or 2011. However, the effects of this on existing *Amsinckia* populations was minor, as most disturbance was confined to lower slopes that had few *A. carinata* plants. Notable exceptions were at populations PC6-1, -2, and -3, where populations extended much lower on the slopes than other sites.
- Nine of the 38 sample sites had what was characterized as "significant disturbance" (see Appendix 1 for discussion). All of these had substrate damage due to OHV traffic, and eight of the nine were south of Highway 20. Only two sites had OHV use that was not considered "significant," both north of the highway.
- Sites with significant OHV use each included areas where *A. carinata* and *A. tessellata* grew together in substrate disturbance zones, and all showed evidence of hybridization between the species (based on the presence of putative F_1 plants). Only one site south of the highway (PC3-11) had a mixed population and a small number of hybrid plants without also having OHV damage. This may have been the result of past grazing patterns or other unknown factors.
- Unlike populations to the south, mixed species populations and the presence of suspected hybrid plants at sites north of the highway was mostly not linked to OHV activity. Here, mixed hybrid *Amsinckia* populations occurred along the broad base of slopes where cattle trailing was evident, especially at the PC1-1, -2, and -3 population group. Suitable habitat south of the highway did not typically extend to the base of

the hillsides, and *A. carinata* was naturally confined to the higher, unstable slopes (in areas unattractive to livestock). The habitat of the northern sites included steep areas as well, but the deeper, loose talus required by *A. carinata* also extended lower on the slopes, extending *A. carinata* patches into areas more accessible to cattle. All six populations in the PC6 group had hybrid plants present, but also had significant upslope habitat where *A. carinata* occurred without *A. tessellata*.

- Only one site (PC1-4) had a notable substrate impact not caused strictly by OHV use. A significant area here has been used as a makeshift gravel quarry, resulting in weed encroachment and hybridization between the *Amsinckia* species.

To summarize, livestock grazing is widespread and present (or has been present in the past) at nearly all *A. carinata* sites. However, cattle are considered a secondary threat in many areas since the upslope microsites preferred by *A. carinata* generally do not overlap with areas experiencing livestock use.

The exception is for sites north of Highway 20, where the local geology extends *A. carinata* habitat down to the toe slopes of several hills, where cattle are more likely to disturb the substrate. The much greater threat to the species is posed by OHV use, which is responsible for most of the heavy damage to *A. carinata* habitat. This damage has been shown to destroy *Amsinckia* plants, facilitate the introduction of weedy species, and is associated with hybridization between *A. carinata* and *A. tessellata*, which can threaten the genetic integrity of *A. carinata*.

Current land allocations and BLM site management history

Amsinckia carinata populations occur on lands generally managed for livestock production. Specifically, the areas surrounding the steep slopes that support *Amsinckia* populations, if not the higher slopes themselves, have been subject to an array of range management actions over many decades, including (in addition to actual grazing) fire suppression, weed control work, historic seeding of forage grasses, etc.

That said, these management actions have probably had little effect on *A. carinata*, since the species naturally occurs in steep, unstable terrain, well outside the sagebrush-grassland habitats favored by cattle. Signs of off-road vehicle activity are also evident throughout much of the range of the species. Although *A. carinata* has clearly persisted despite grazing, the presence of livestock has very likely contributed to an historical decline in population size as well as available habitat, in the sense that cattle are known to routinely trail through the lower margins of *A. carinata* populations in many areas (especially north of Highway 20, discussed above).

So cows are not observed to browse the species, but their presence has contributed to a reduction in habitat (i.e., substrate) quality, which in turn is associated with the incursion of weedy species, subsequent hybridization issues, and potential interspecific competition (discussed previously). But livestock have been present in this part of Malheur County for many decades, and in all probability whatever detrimental effects they may have had on *A. carinata* populations have more or less reached equilibrium at this point. The upper slopes where *A. carinata* is most prevalent today lack water and significant forage, and are steep and unstable. Little evidence has been seen to suggest that cattle are attracted to these sites.

Damage has certainly been done over the years, but the likelihood of a significant continuing decline for the species caused solely by grazing appears minimal.

However, recreational use of *A. carinata* habitat by off-road enthusiasts has been a more recent phenomenon, and poses a serious threat. Observations by the author of this report, starting in 1989, suggest that impacts by off-road vehicles has persisted at as many as a quarter of the populations of the species over the last 20-25 years. Despite the fact that a 1992 Conservation Agreement between BLM and the U.S. Fish and Wildlife Service states that "BLM shall restrict off-road vehicle use in *Amsinckia carinata* habitat," off-road traffic has been difficult to control and has continued through to the present time.

MANAGEMENT NEEDS

Desired site conditions (also see Appendix 2)

As noted earlier, the goals of this Site Management Plan are to facilitate the conservation of *Amsinckia carinata*, by reducing further habitat loss and maintaining or elevating current population levels. Desired outcomes are the eventual de-listing of the species (currently threatened) at the state level, and the prevention of federal listening under the ESA. To accomplish this, management efforts should focus on (1) controlling activities that result in habitat destruction, (2) evaluating the feasibility site restoration using methods available to BLM, and (3) developing a plan for off-site cultivation efforts, to produce seed for re-introduction and augmentation efforts as well as *ex situ* germplasm storage.

Current site conditions vary from essentially undisturbed for some populations, to dramatically altered (with substrate displacement, destruction of plants and seed banks, and the introduction of weedy species caused principally by OHV traffic, but occasionally livestock as well). Sites should have little or no substrate displacement (as in Fig. 7) for *A. carinata* populations to thrive. The deep, shifting talus favored by the species (see Figs. 1 and 5) serves as a barrier to weedy competitors, which are not adapted to such harsh conditions, and under normal conditions *A. carinata* occurs with just a handful of native forbs. When the sites are disturbed, the substrate balance is upset, and undesirable species, including *Bromus tectorum* (Fig. 2), *Amsinckia tessellata* (which may hybridize with *A. carinata*), and various other weeds invade.

Management goals can best be achieved and maintained in the long term by (1) ensuring that competitive weed populations (including, but not limited to *Bromus tectorum* and *Amsinckia tessellata*) are not allowed to further encroach into areas still occupied by *A. carinata* populations (by regulating OHV traffic where appropriate); (2) assessing the pattern of livestock usage on slopes inhabited by *A. carinata* (both current and planned), and determining where, when, and to what extent cattle can be restricted from these few slopes, to reduce further damage to the talus substrate, and (3) supporting projects to produce *A. carinata* seed in cultivation, for use in on-site recovery efforts.

Actions Needed

Appendix 2 outlines conservation actions for *A. carinata* and how these might be accomplished. Three primary areas of recommended management emphasis can be

considered: ***protecting existing habitat*** (especially sites not yet damaged by heavy OHV or livestock use); ***restoration of damaged areas*** through site rehabilitation; and ***replenishing destroyed or naturally small populations*** by sowing seed produce in cultivation to increase population sizes and improve genetic diversity. Each approach has challenges and limitations.

The protection of existing habitat would require more than administrative action. It is unlikely that OHV traffic would cease, for example, if signs banning OHV use were posted without barriers or access trails closed off. That said, fences are not fool-proof, either, yet fencing of sensitive habitat as part of an overall OHV outreach and education strategy has proven successful elsewhere, and could be a potentially useful too here. Fencing can be expensive, of course, and BLM would need to consider its budget and staffing priorities in developing a strategy to physically protect populations. But of all the management options available, protecting high quality existing sites is often the best, and *A. carinata* is a good candidate for it. Assuming the definitive goal is to prevent extinction of a species, saving intact habitat is ultimately less expensive than trying to restore damaged sites.

Sites with significant OHV or excavation impacts would need substrate rehabilitation to re-establish or maintain healthy, self-sustaining *A. carinata* populations. However, the feasibility of this is questionable, considering the nature of the habitat (i.e., the talus formations discussed earlier) and a lack of proven methodology. Replicating the unique substrate gradients that support *A. carinata* populations (see Meinke, 2012 for discussion) would be extremely challenging, and such an undertaking probably has not been attempted before for a specific rare species.

And although weeds (exotic species as well as *Amsinckia tessellata*) clearly pose serious threats to *A. carinata* where its habitat has been disturbed, application of a weed control program has some drawbacks. First, controlling weeds (by spraying or pulling) would likely cause as much harm as good, as the slopes would be subject to further disturbance during application. Secondly, even if local weed control were achieved on a given site, the reprieve would almost certainly be temporary, considering the massive seed pool already existing in surrounding areas for the target weed species. So the chances of ever permanently eliminating most weed species from a heavily disturbed *A. carinata* site are probably nil. All the more reason for setting aside remaining intact (and as yet weedless) habitat while we still can.

However difficult site rehab may be, a re-introduction program for *A. carinata* does have potential, since cultivation of the species is not difficult (Meinke, 2012). Even though the *A. carinata* has narrow habitat requirements in nature, it is easily grown to maturity in pots or flats as long as plants are kept watered, fertilized, and free of competition with weeds (Meinke, unpublished). And although flowers are commonly visited by insect pollinators in nature, which promote gene exchange via cross-pollination, they aren't actually required for seed production since the species can also self-pollinate if it needs to.

So this means that cultivating *A. carinata* plants and harvesting their seeds (which have a long shelf-life) for later restoration efforts could easily be accomplished with the right facilities. (And growing plants by using multiple wild populations as seed donors would help reduce the risk for inbreeding depression among cultivated seeds.) So BLM might consider offsetting previous *A. carinata* habitat losses (and reduce the on-going spiral towards ESA listing) by producing seeds in cultivation, which could then be sown at sites with low density populations (see Appendix 2), or even used in experimental re-introduction efforts in areas

where wild populations have been destroyed. Cooperators (such as universities or nurseries) could potentially assist in the effort.

Details involving budgets, timelines, target dates, and general feasibility of these proposed management actions are, of course, up to BLM, and should be part of any final SMP developed for *A. carinata* (see following section).

Adaptive Management

Once a final SMP is approved by BLM, the ISSSSP protocol suggests setting up a schedule for tracking actions and completing revisit dates, for (1) assessing the effectiveness of management actions (i.e., checking to see if they have reduced threats, etc.), (2) censusing populations (bearing mind, in this case, the limitations of relying too much on demographic data in the conservation of an annuals specie, as discussed earlier in this report), and (3) determining if other management actions and timeframes may need to be adopted to help keep the conservation effort on track.

These details are ultimately up to BLM, depending on their work schedule, but it is suggested here that re-surveys of populations take place at least within three to five years, and that when interpreting the demographic results of surveys, workers take into account information about precipitation levels the preceding fall and winter. This will help determine if any significant shifts in population numbers are potentially due to management actions, or perhaps mostly the result of favorable (or unfavorable) climatic conditions. Census comparisons between years may have the most meaning if the years being compared have had equivalent rainfall levels (which obviously have a great influence on germination and reproduction in a species such as *A. carinata*). For some actions, such as sowing *A. carinata* seeds or determining if site closures are being respected, site re-visits should be conducted annually, to better track progress. This can be determined on a case-by-case basis.

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Appendix 1. Demographic and site disturbance data for 38 *Amsinckia carinata* sample sites. Sites were originally selected more or less randomly in 1994 (as part of an earlier, unrelated Oregon Dept. of Agriculture survey), and then these were resampled for the current project. Study sites are distributed over the entire geographic range of *A. carinata*, and include populations from 5 out of the 6 "population centers" identified in this report (see main text). ***Surveyed Population:*** Population numbers were assigned randomly (PC1=Harper Junction; PC3=West Crowley Road; PC4=Cottonwood Creek; PC5=South Copeland Road; and PC6=Northern Periphery—see text on pp. 2-3). PC2 (the Highway 20 population center) was excluded from the study due to the small number of sites and access issues. ***UTM:*** *Amsinckia carinata* consists of annual populations that are spatially unpredictable, following favorable microsites that are generally not consistent on the landscape each year. Rather than try and construct (via GPS, for example) precise polygons defining the boundaries of each population during sample years, an estimated center point data for each site was taken, assuming that this would allow future surveyors to relocate populations based on this point in combination with the easily recognizable substrate (see text for discussion). ***Est. 1994 Abundance:*** Number of plants counted or estimated at study sites in 1994. Estimates (and not counts) were made of larger populations, by observing from the edges of sites (sometimes with binoculars), to reduce walking through the easily damaged habitat. ***Est. Recent Abundance:*** These are counts and estimates made during this study (this and other data below were collected in 2009 for PC1; 2010 for PC3 and PC4, and 2011 for PC5 and PC6). ***Significant Disturbance:*** A measure based on visual estimates of the amount of displaced substrate at sites as a result of OHV traffic or other action (25% or more qualified as "significant"). ***Cattle trailing:*** Visual confirmation (or not) of livestock activity within sites. Although common, cattle trailing did not impact quality habitat to the same extent as OHV use, and it seldom contributed to "significant" disturbance at a site**.** ***OHV Activity:*** Visual confirmation (or not) of OHV use within sites. More often than not, OHV use resulted in significant disturbance. ***AMCA-AMTE Mixed:*** Indicates the presence of mixed patches of *Amsinckia carinata* and *A. tessellata*. The two species rarely overlap at undisturbed sites. ***Hybrids present:*** This means that plants that were likely hybrids between the above species (see Fig. 7, and discussion on pp. 11-12) were present in mixed patches. Putative hybrids are much larger than either parent (typically by 25-50%; Fig. 7), have intermediate morphological traits, and exhibit much lower seed set than either parent species. ***Est. Hybrid Ratio:*** This is an estimate of the percentage of the population at the site that consisted of suspected hybrids. The number was generated by initially walking into a population and confirming that plants with the above traits were present, and then visually estimating, by walking site perimeters, the number of obviously "larger" plants present relative to the estimated total population size. This is admittedly a rough estimate, but short of tramping through sites and causing as much or more disturbance than cattle, it was the best option.

Surveyed Population	UTM (Zone 11)	Est. 1994 Abundance	Est. Recent Abundance	Significant Disturbance	Cattle Trailing	OHV Activity	AMCA-AMTE Mixed	Hybrids Present	Est. Hybrid Ratio
PC1-1	451162 E, 4853794 N	45	19	No	Yes	No	No	No	0
PC1-2	451307 E, 4853715 N	25	0	No	Yes	No	No	No	0
PC1-3	451102 E, 4853506 N	78	340	Yes	Yes	Yes	Yes	Yes	1%
PC1-4	451126 E, 4853427 N	3,800	1,250	Yes	Yes	Yes	Yes	Yes	20%
PC1-5	450462 E, 4852641 N	77	0	No	Yes	No	No	No	0
PC1-6	450610 E, 4852131 N	25	60	Yes	Yes	Yes	Yes	Yes	5%
PC1-7	450173 E, 4852002 N	190	18	Yes	Yes	Yes	Yes	Yes	<5%
PC1-8	450211 E, 4851592 N	5,900	3,600	Yes	Yes	Yes	Yes	Yes	25%

PC1-9	451186 E, 4852599 N	109	266	No	Yes	No	Yes	No	0
PC1-10	451067 E, 4852751 N	171	20	Yes	Yes	Yes	Yes	Yes	1%
PC1-11	451183 E, 4853015 N	210	366	No	No	No	No	No	0
PC1-12	451068 E, 4853151 N	58	5	No	Yes	No	No	No	0
PC1-13	451542 E, 4853316 N	117	32	No	Yes	No	No	No	0
PC3-1	448684 E, 4848969 N	68	0	No	Yes	No	No	No	0
PC3-2	448914 E, 4848881 N	12	25	No	Yes	No	No	No	0
PC3-3	448941 E, 4848607 N	215	13	No	Yes	No	No	No	0
PC3-4	448804 E, 4848430 N	5,460	2,800	Yes	Yes	Yes	Yes	Yes	5%
PC3-5	448590 E, 4848589 N	580	850	Yes	Yes	Yes	Yes	Yes	<5%
PC3-6	448443 E, 4848337 N	75	15	No	Yes	No	No	No	0
PC3-7	447867 E, 4848515 N	55	2	No	Yes	No	No	No	0
PC3-8	447452 E, 4848817 N	88	60	No	No	No	No	No	0
PC3-9	446668 E, 4848137 N	442	81	No	Yes	No	Yes	No	0
PC3-10	446178 E, 4847880 N	200	265	No	Yes	No	No	No	0
PC3-11	446360 E, 4847478 N	215	89	No	Yes	No	Yes	Yes	1%
PC4-1	446734 E, 4844056 N	88	165	No	Yes	No	No	No	0
PC4-2	446214 E, 4844553 N	150	365	No	Yes	No	No	No	0
PC4-3	445879 E, 4843669 N	240	70	No	Yes	No	No	No	0
PC4-4	445048 E, 4843256 N	77	6	No	Yes	No	No	No	0
PC4-5	444732 E, 4842404 N	340	105	No	Yes	No	Yes	No	0
PC5-1	444441 E, 4850522 N	370	114	Yes	Yes	Yes	Yes	Yes	5%
PC5-2	445221 E, 4850660 N	105	265	No	Yes	No	No	No	0
PC5-3	445423 E, 4850722 N	700	950	No	Yes	No	Yes	Yes	5%
PC6-1	445388 E, 4852460 N	3,700	14,000	No	Yes	No	Yes	Yes	5-10%
PC6-2	445651 E, 4852295 N	9,600	11,000	No	Yes	No	Yes	Yes	5-10%
PC6-3	446090 E, 4852306 N	2,100	1,850	No	Yes	No	Yes	Yes	1%
PC6-4	445308 E, 4853928 N	380	290	No	Yes	Yes	Yes	Yes	<5%
PC6-5	445760 E, 4853811 N	275	450	No	Yes	Yes	Yes	Yes	5%
PC6-6	445999 E, 4853810 N	110	600	No	Yes	No	Yes	Yes	1%
TOTAL		**36,450**	**40,406**						

Appendix 2. Summary of current and desired site conditions, actions needed, and suggestions for accomplishing management goals. Refer to Appendix 1 for explanation of data headings. Three primary areas of recommended management emphasis can be considered: ***protecting existing habitat*** (especially sites not yet damaged by heavy OHV or livestock use); ***restoring damaged areas*** through site rehabilitation; and ***replenishing destroyed or naturally small populations*** by sowing cultivated seed to improve population sizes and potentially improve genetic diversity. Each approach has challenges and limitations. Additional information is provided in the text on pp.16-18.

Harper Junction Population Center

Surveyed Population	UTM (Zone 11)	Est. 1994 Abundance	Est. Recent Abundance
PC1-1	451162 E, 4853794 N	45	19
PC1-2	451307 E, 4853715 N	25	0
PC1-3	451102 E, 4853506 N	78	340
PC1-4	451126 E, 4853427 N	3,800	1,250
PC1-5	450462 E, 4852641 N	77	0
PC1-6	450610 E, 4852131 N	25	60
PC1-7	450173 E, 4852002 N	190	18
PC1-8	450211 E, 4851592 N	5,900	3,600
PC1-9	451186 E, 4852599 N	109	266
PC1-10	451067 E, 4852751 N	171	20
PC1-11	451183 E, 4853015 N	210	366
PC1-12	451068 E, 4853151 N	58	5
PC1-13	451542 E, 4853316 N	117	32

Current vs. Desired Site Condition

This populations are the first encountered heading south from Highway 20 on Crowley Rd. Two especially important sites (in terms of plant numbers) are PC1-4 and -8, and both have been heavily impacted by OHV use (as well as gravel excavation at PC1-4), but other sites in this group have been hit by OHV use as well. These sites, especially PC1-4 and -8, show clear evidence of hybridization between *A. carinata* and *A. tessellata* within disturbance zones (see Appendix 1). Cattle trailing also occurs here, and although limited to toe slopes at most sites, it also coincides with areas where hybrids have been observed. Non-OHV impacted populations in this group are in somewhat better shape, although the damaged sites happen to have much larger populations. For sites lacking heavy disturbance, the ***desired site condition*** would be simply maintaining current habitat quality. Sites with significant OHV or excavation impacts need substrate rehabilitation to re-establish healthy and maintain *A. carinata* populations. However, the feasibility of this is questionable, considering the nature of the habitat and a lack of proven methodology.

Actions Needed

For populations having limited disturbance, maintain current site condition, by taking action to exclude or prevent OHV and other disturbances associated with (1) increased substrate disruption and weed infestations, (2) likely hybridization with *A. tessellata*, and (3) subsequent declines in *A. carinata* population numbers. Sites already showing significant damage from OHV traffic (or other serious substrate disturbance) would benefit from surface rehabilitation and weed control where feasible. For sites with fewer than 500

individuals, augmentation of populations using cultivated seed could potentially restock depleted seed banks and reduce the potential for genetic bottlenecks.

How to Accomplish

Fencing occupied habitat is the most effective on-the-ground way to exclude OHV traffic, cattle trailing, hiking, excavating, or other threats associated with repeated substrate disturbance. The inconvenience to ranchers from fencing sites should be minimal, since actual acreage with *A. carinata* habitat is very limited, and trailing cattle mostly avoid these areas anyway due to a lack of forage and water. But OHV activity here would be curtailed by fencing, since a number of slopes with *A. carinata* habitat are used by dirt-bikes and other OHVs. ***Public education and outreach***, specifically aimed at identifying alternative sites for OHV recreation, may also be a productive approach for reducing habitat destruction for the species. ***Rehabilitation of damaged substrate*** (such as at PC1-4 and -8) would be required to allow *A. carinata* to replenish and sustain populations long-term, and to reduce or avoid problems associated with the introduction of undesirable species (such as hybridization with *A. tessellata*). Further study would be needed before attempting this. Meanwhile, fencing would at least slow the negative impacts of OHV use at heavily hit sites. ***Augmentation or introduction*** could be attempted by cultivating *A. carinata* off-site (from small batches of wild-collected seed), collecting seeds produced, and sowing these back into smaller populations or into currently unoccupied (but apparently suitable) habitat within the range of the species.

Crowley Road Population Center

Surveyed Population	UTM (Zone 11)	Est. 1994 Abundance	Est. Recent Abundance
PC3-1	448684 E, 4848969 N	68	0
PC3-2	448914 E, 4848881 N	12	25
PC3-3	448941 E, 4848607 N	215	13
PC3-4	448804 E, 4848430 N	5,460	2,800

Current vs. Desired Site Condition

This population group occurs in the middle of *A. carinata*'s range. Sites just west of Crowley Rd. (including PC3-4 and -5) have been seriously damaged by OHV traffic. Cattle trailing also occurs here, though is limited to the base of slopes, which are quite steep. Other populations in this group are in better shape, although the damaged sites have much larger populations. For sites lacking heavy disturbance, the ***desired site condition*** would be to simply

PC3-5	448590 E, 4848589 N	580	850
PC3-6	448443 E, 4848337 N	75	15
PC3-7	447867 E, 4848515 N	55	2
PC3-8	447452 E, 4848817 N	88	60
PC3-9	446668 E, 4848137 N	442	81
PC3-10	446178 E, 4847880 N	200	265
PC3-11	456360 E, 4847478 N	215	89

maintain current habitat quality. Sites with significant OHV or excavation impacts need substrate rehabilitation to re-establish healthy and maintain *A. carinata* populations. However, the feasibility of this is questionable, considering the nature of the habitat and a lack of proven methodology.

Actions Needed

For populations having limited disturbance, maintain current site condition, by taking action to exclude or prevent OHV and other disturbances associated with (1) increased substrate disruption and weed infestations, (2) likely hybridization with *A. tessellata*, and (3) subsequent declines in *A. carinata* population numbers. Sites already showing significant damage from OHV traffic (or other serious substrate disturbance) would benefit from surface rehabilitation and weed control where feasible. For sites with fewer than 500 individuals, augmentation of populations using cultivated seed could potentially restock depleted seed banks and reduce the potential for genetic bottlenecks.

How to Accomplish

Fencing occupied habitat is the most effective on-the-ground way to exclude OHV traffic, cattle trailing, hiking, excavating, or other threats associated with repeated substrate disturbance. The inconvenience to ranchers from fencing sites should be minimal, since actual acreage with *A. carinata* habitat is very limited, and trailing cattle mostly avoid these areas anyway due to a lack of forage and water. But OHV activity here would be curtailed by fencing, since a number of slopes with *A. carinata* habitat are used by dirt-bikes and other OHVs. ***Public education and outreach***, specifically aimed at identifying alternative sites for OHV recreation, may also be a productive approach for reducing habitat destruction for the species. ***Rehabilitation of damaged substrate*** (such as at site PC3-4) would be required to allow *A. carinata* to replenish and sustain populations long-term, and to reduce or avoid problems associated with the introduction of undesirable species (such as hybridization with *A. tessellata*). Further study would be needed before attempting this. Meanwhile, fencing would at least slow the negative impacts of OHV use at heavily hit sites. ***Augmentation or introduction*** could be attempted by

cultivating *A. carinata* off-site (from small batches of wild-collected seed), collecting seeds produced, and sowing these back into smaller populations or into currently unoccupied (but apparently suitable) habitat within the range of the species.

Cottonwood Creek Population Center

Surveyed Population	UTM (Zone 11)	Est. 1994 Abundance	Est. Recent Abundance
PC4-1	446734 E, 4844056 N	88	165
PC4-2	446214 E, 4844553 N	150	365
PC4-3	445879 E, 4843669 N	240	70
PC4-4	445048 E, 4843256 N	77	6
PC4-5	444732 E, 4842404 N	340	105

Current vs. Desired Site Condition

This population group comprises the southern end of *A. carinata*'s range. Sites west of Crowley Rd. are behind a fence, which for the most part appears to have blocked access to OHVs. However, even sites to the east of Crowley Rd. (such as PC4-1 and -2), which are easily access from the road, have (as of 2012) not been substantially damaged by OHV traffic. Cattle trailing is also limited here, and virtually no hybridization between *A. carinata* and *A. tessellata* was observed (also see Appendix 1). Consequently, the sites here are probably in better shape, overall, than other areas. So the ***desired site condition*** for this complex is to try and maintain current habitat quality.

Actions Needed

Maintain current site condition, by taking action to exclude or prevent (as needed) OHV and other disturbances associated with (1) increased substrate disruption and weed infestations, (2) likely hybridization between *A. carinata* and *A. tessellata*, and (3) subsequent declines in *A. carinata* population numbers. Any future significant damage from OHV traffic (or other serious substrate disturbance) would benefit from surface rehabilitation and weed control where feasible. For sites with fewer than 500 individuals, augmentation of populations using cultivated seed could potentially restock depleted seed banks and reduce the potential for genetic bottlenecks.

How to Accomplish

Fencing specific areas with known habitat is the most effective on-the-ground way to exclude OHV traffic, cattle trailing, hiking, or other threats associated with repeated substrate disturbance. The inconvenience to ranchers from fencing sites should be minimal, since actual acreage with *A. carinata* habitat

is very limited, and trailing cattle mostly avoid these areas anyway, due to a lack of forage and water. But any OHV activity here would be curtailed, since selected slopes with *A. carinata* habitat are often used by dirt-bikes and other OHVs***. Public education and outreach***, specifically including efforts to identify alternative sites for OHV recreation, may also be productive approaches for reducing habitat destruction for the species. Should OHV traffic become a problem, ***rehabilitation of damaged substrate*** would be required to allow *A. carinata* to replenish and sustain populations long-term, and to reduce or avoid problems associated with the introduction of undesirable species (such as hybridization with *A. tessellata*). Further study would be needed before attempting this. Meanwhile, fencing would be a proactive approach to prevent future habitat loss from OHV use. ***Augmentation or introduction*** could be attempted by cultivating *A. carinata* off-site (from small batches of wild-collected seed), collecting seeds produced, and sowing these back into smaller populations or into currently unoccupied (but apparently suitable) habitat within the range of the species.

South Copeland Road Population Center

Surveyed Population	UTM (Zone 11)	Est. 1994 Abundance	Est. Recent Abundance
PC5-1	444441 E, 4850522 N	370	114
PC5-2	445221 E, 4850660 N	105	265
PC5-3	445423 E, 4850722 N	700	950

Current vs. Desired Site Condition

This population center occurs immediately north of Highway 20 (it's easily visible from the roadside), north of the Malheur River. Although Copeland Rd. winds just below the sites, this easy access has apparently resulted in little impact from OHV use as of this study. Livestock trailing along the lowest slopes does occur, and limited hybridization between *A. carinata* and *A. tessellata* was noted (at PC5-1 and -3) in areas with extensive cattle trails. But similar to Population Complex 4 (at Cottonwood Creek), sites in this area are in better shape compared to the species as a whole due to limited OHV traffic. Although recorded population numbers were modest at the sampled sites, the habitat here is extensive, and a more thorough census may in time show populations to be more extensive and larger than current numbers show. So the ***desired site condition*** for this complex is to maintain current habitat quality.

Actions Needed

Maintain current site condition, by taking action to exclude or prevent (as needed) OHV and other disturbances associated with (1) increased substrate disruption and weed infestations, (2) likely hybridization between *A. carinata* and *A. tessellata*, and (3) subsequent declines in *A. carinata* population numbers. Any future significant damage from OHV traffic (or other serious substrate disturbance) would benefit from surface rehabilitation and weed control where feasible. For sites with fewer than 500 individuals, augmentation of populations using cultivated seed could potentially restock depleted seed banks and reduce the potential for genetic bottlenecks.

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How to Accomplish

Fencing specific areas with known habitat is the most effective on-the-ground way to exclude OHV traffic, cattle trailing, hiking, or other threats associated with repeated substrate disturbance. The inconvenience to ranchers from fencing sites should be minimal, since actual acreage with *A. carinata* habitat is very limited, and trailing cattle mostly avoid these areas anyway, due to a lack of forage and water. However, any OHV activity here would be curtailed by fencing, since a number of slopes with *A. carinata* habitat are often used by dirt-bikes and other OHVs. ***Public education and outreach***, specifically including efforts to identify alternative sites for OHV recreation, may also be productive approaches for reducing habitat destruction for the species. Should OHV traffic become a problem, ***rehabilitation of damaged substrate*** would be required to allow *A. carinata* to replenish and sustain populations long-term, and to reduce or avoid problems associated with the introduction of undesirable species (such as hybridization with *A. tessellata*). Further study would be needed before attempting this. Meanwhile, fencing would be a proactive approach to prevent future habitat loss from OHV use. ***Augmentation or introduction*** could be attempted by cultivating *A. carinata* off-site (from small batches of wild-collected seed), collecting seeds produced, and sowing these back into smaller populations or into currently unoccupied (but apparently suitable) habitat within the range of the species.

Northern Periphery Population Center

Surveyed Population	UTM (Zone 11)	Est. 1994 Abundance	Est. Recent Abundance
PC6-1	445388 E, 4852460 N	3,700	14,000
PC6-2	445651 E, 4852295 N	9,600	11,000
PC6-3	446090 E, 4852306 N	2,100	1,850
PC6-4	445308 E, 4853928 N	380	290
PC6-5	445308 E, 4853928 N	275	450
PC6-6	445999 E, 4853810 N	110	600

Current vs. Desired Site Condition

This northern-most group of populations occurs north of Highway 20 on two crescent-shaped series of slopes. Similar to the Copeland Rd. group (above), there is less impact here from OHV use than in population groups occurring south across Highway 20 (where access to slopes is more straightforward, via the well-traveled Crowley Rd.). However, unlike other areas, livestock trailing is more of a serious issue here, and hybridization between *A. carinata* and *A. tessellata* is widespread within areas of cattle use (site PC6-1 is a prime example). The hills here are more extensive and the slopes with *A. carinata* habitat less steep, and unlike other areas, habitat encroaches into areas where cattle are more regularly present. Upper slopes are in much better condition, but the lower slopes are more susceptible to weed infestations and on-going interspecific hybridization due to livestock-related disturbances. So the ***desired site condition*** for this population complex is to maintain current habitat quality on upper slopes, but improve lower slopes by excluding cattle (or any other substrate disturbance) and (if feasible) through substrate rehabilitation and weed control.

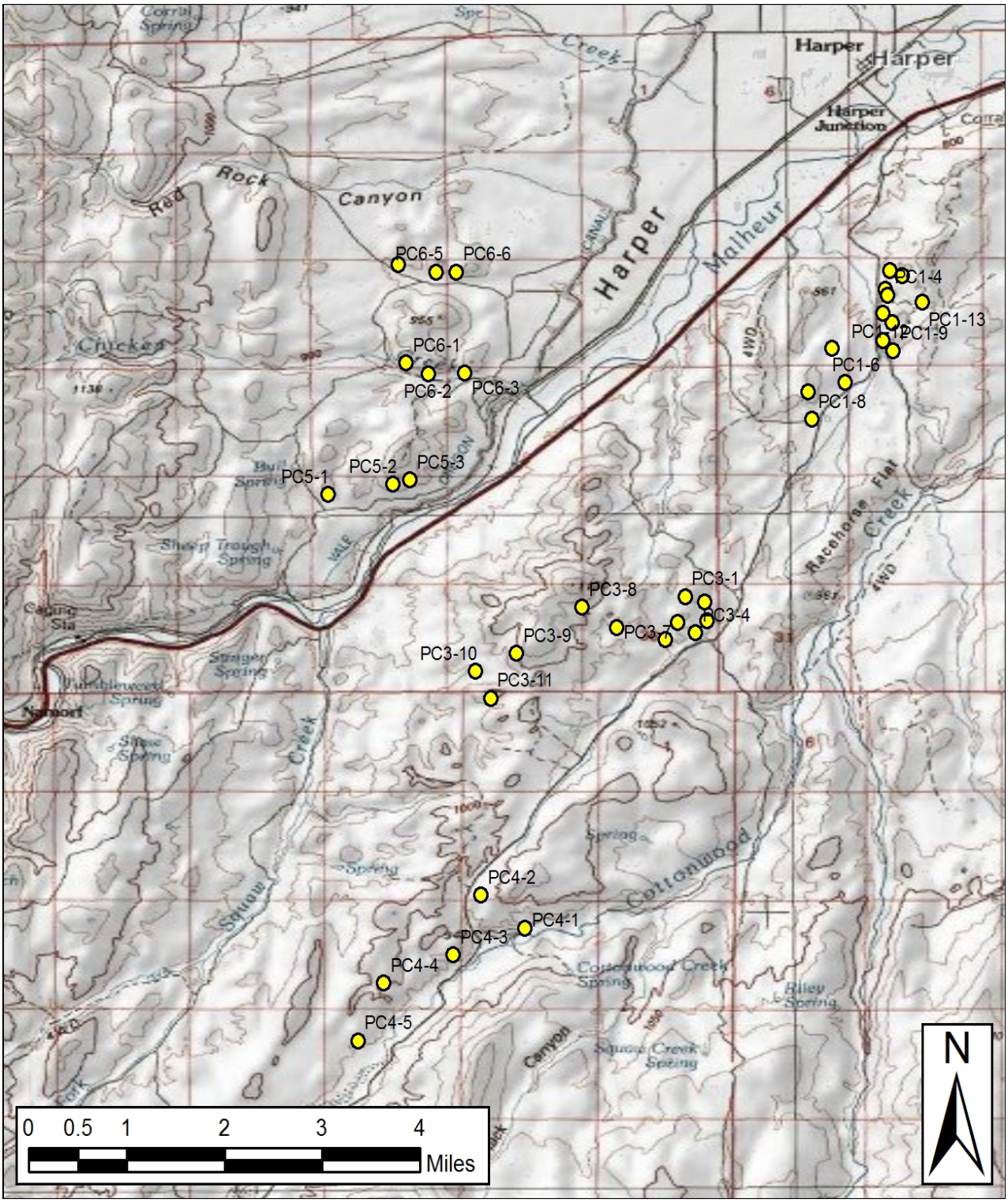
Actions Needed

Maintain current site condition, by taking action to exclude or prevent (as needed) OHV and other disturbances associated with (1) increased substrate disruption and weed infestations, (2) likely hybridization between *A. carinata* and *A. tessellata*, and (3) subsequent declines in *A. carinata* population numbers. Any future significant damage from OHV traffic (or other serious substrate disturbance) would benefit from surface rehabilitation and weed control where feasible. For sites with fewer than 500 individuals, augmentation of populations using cultivated seed could potentially restock depleted seed banks and reduce the potential for genetic bottlenecks.

How to Accomplish

Fencing specific areas with known habitat is the most effective on-the-ground way to exclude cattle trailing, hiking, OHV traffic, or other threats associated

with repeated substrate disturbance. The inconvenience to ranchers from fencing sites should be minimal, since actual acreage with *A. carinata* habitat is very limited (even in this area). But OHV activity here (current or future) would be curtailed, since selected slopes with *A. carinata* habitat are often used by dirt-bikes and other OHVs. This is limited here so far, but that could change. ***Public education and outreach***, specifically including efforts to identify alternative sites for OHV recreation, may also be productive approaches for reducing habitat destruction for the species. ***Rehabilitation of damaged substrate*** (such as at PC6-1, for example) would be required for *A. carinata* to replenish and sustain populations here long-term, and to reduce problems associated with weeds (and hybridization with *A. tessellata*). Further study would be needed before attempting this. Meanwhile, fencing would be a proactive approach to prevent future habitat loss from OHV use, and a positive measure to exclude cattle from affected areas. ***Augmentation or introduction*** could be attempted by cultivating *A. carinata* off-site (from small batches of wild-collected seed), collecting seeds produced, and sowing these back into smaller populations or into currently unoccupied (but apparently suitable) habitat within the range of the species.



Appendix 3. General map locations of *Amsinckia carinata* sample sites from population centers 1, 3, 4, 5, and 6 (see text on pp. 2-3 for more detail). The total geographic range of *A. carinata* is reflected by the points, with the species not occurring south of PC4-5 or north of PC6-5.