the good, the bad, and the ugly

challenges in plant conservation in Oregon

| **Andrea S Thorpe**

ABSTRACT

A number of challenges affect the conservation of rare native species, including habitat availability and quality, the number and genetic diversity of existing populations, and the ease at reintroduction and augmentation of populations. Three threatened or endangered species in Oregon, Kincaid's lupine (*Lupinus sulphureus* Douglas ex Hook. ssp. *kincaidii* (C.P. Sm.) L. Phillips [Fabaceae]), Willamette daisy (*Erigeron decumbens* Nutt. var. *decumbens* [Asteraceae]), and pink sand verbena (*Abronia umbellata* Lam. ssp. *breviflora* (Standl.) Munz [Nyctaginaceae]) provide examples of how, when considering these challenges, conservation prospects for a species can fall on a continuum from good to ugly. Lessons learned from working with these species may provide valuable tools that can be used to guide future conservation efforts.

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conservation, reintroduction, Kincaid's lupine, pink sand verbena, Willamette daisy

NOMENCLATURE
Plants: USDA NRCS (2008)
Butterfly: ITIS (2008)

Native plant species are being lost at an alarming rate. In the US, the Center for Plant Conservation (2008) estimates that 20% of native plant species are in decline and more than 200 species are extinct. Despite recognition of the need to conserve remaining biodiversity, a number of challenges face land managers conducting on-the-ground conservation, including: 1) limited funding; 2) lack of species-specific knowledge; 3) quality and quantity of remaining habitat; 4) the number of remaining populations and associated genetic variation; and 5) ease of reintroduction and augmentation of populations. Because the first 2 challenges are relatively consistent, I will not discuss them further. Unfortunately, when considering the latter 3 challenges (Figure 1), rarely are there any "best-case" scenarios. Rather, species seem to fall along a continuum from good to bad to ugly. Here, I use conservation efforts on 3 rare plant species in Oregon: Kincaid's lupine (*Lupinus sulphureus* Douglas ex Hook. ssp. *kincaidii* (C.P. Sm.) L.

Figure 1. The challenges facing conservation of declining native plants.

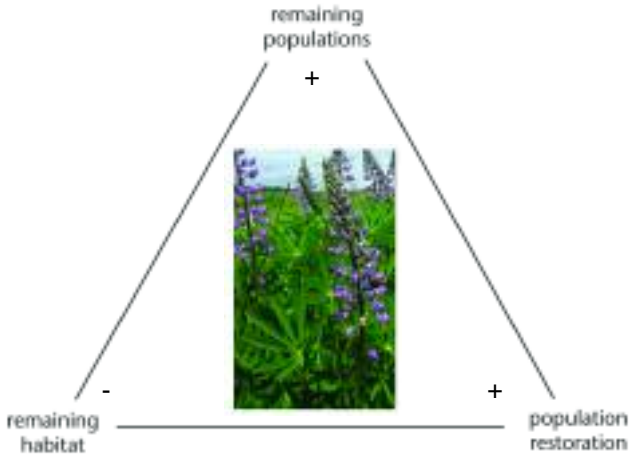

Figure 2. The good: Kincaid's lupine. Although conservation of Kincaid's lupine is limited by habitat, a number of populations remain and population restoration is relatively easy. Photo by Thomas Kaye

Phillips; syn. *Lupinus oreganus* A. Heller var. *kincaidii* C.P. Sm. [Fabaceae]—the good; Willamette daisy (*Erigeron decumbens* Nutt. var. *decumbens* [Asteraceae])—the bad; and pink sand verbena (*Abronia umbellata* Lam. ssp. *breviflora* (Standl.) Munz [Nyctaginaceae])—the ugly, to illustrate these challenges. Learning from those challenges may provide valuable tools for use with other species so that resources are used more efficiently.

THE GOOD: KINCAID'S LUPINE

Kincaid's lupine (Figure 2) is a rare member of the legume family (Fabaceae) listed by the Oregon Department of Agriculture and the US Fish and Wildlife Service as a threatened species; it is an endangered species in Washington. Kincaid's lupine is found in upland prairie remnants in the Willamette Valley and southwestern Washington, and in forest openings in Douglas County, Oregon. This species was also historically reported on Vancouver Island, British Columbia, Canada. In the Willamette Valley, this plant is the primary larval host plant for the endangered Fender's blue butterfly (*Icaricia icarioides icarioides* [Lepidoptera: Lycaenidae]), making conservation of the lupine a common goal for both species.

The major threats to Kincaid's lupine populations are habitat loss and habitat quality. Habitat loss from a wide variety of causes (for example, urbanization, agriculture, silvicultural practices, and roadside maintenance) has been the single largest factor in its decline (USFWS 2000). Land development and alteration in the prairies of western Oregon and southwestern Washington have been so extensive that the remaining populations are essen-

tially relegated to small, isolated patches of habitat. Habitat loss is likely to continue as private lands are developed; at least 49 of 54 sites occupied by Kincaid's lupine occur on private lands and are at risk of being lost unless conservation actions are implemented (USFWS 2000).

The few patches of upland prairie that remain have been severely altered by elimination of historical disturbance regimes and by competition from nonnative plants (Wilson and others 2003). When Euro-Americans initially settled the Willamette Valley, prairies accounted for perhaps 30% of the valley floor (Altman and others 2001). Prior to settlement, the native Kalapuya peoples burned the prairies nearly every year to maintain high-quality hunting and gathering grounds (Boyd 1986). As settlers arrived, not only did they convert native habitats for agricultural and urban uses, they ceased burning the prairies, allowing succession to forests take place (Habeck 1961; Johannessen and others 1971; Towle 1982). Native upland prairies now cover much less than 1% of their former area, making them among the rarest of North American ecosystems (ONHIC 1983; Noss and others 1995). These anthropogenic impacts have also facilitated invasion by many exotic species.

Although restoration of these degraded prairies presents many challenges (see Stanley and others 2008), several studies have found that relatively simple management techniques can significantly improve habitat for both Kincaid's lupine and Fender's blue butterfly. Three years of annual mowing of meadows occupied by Kincaid's lupine and Fender's blue butterfly at Baskett Butte (Baskett Slough National Wildlife Refuge, Dallas, Oregon) substantially reduced the cover of woody plants and grasses while lupine cover stayed the same or increased slightly, and inflorescence production doubled when compared with controls (Wilson and others 2003). In addition, lupine in mowed plots attracted ovipositing female Fender's blue butterflies, resulting in much greater egg numbers in mowed plots compared with unmanipulated plots (Schultz and others 2003). Similar results have been observed in prairies in the West Eugene Wetlands (Thorpe and Kaye 2007a).

Despite the loss and fragmentation of Kincaid's lupine habitat, several relatively large natural populations remain. As this species is a long-lived perennial, it is possible that much of the genetic diversity of Kincaid's lupine has been maintained. On a practical level, this allows for collection of seeds from populations throughout its range, thus preserving genetic variability while also working within recovery zones (USFWS 2008), which have been developed to maintain diversity and to protect local adaptation.

Reintroduction and augmentation of populations of Kincaid's lupine are currently conducted using transplanting and direct seeding. Planting Kincaid's lupine seedlings can be fairly costly as the seeds require cold stratification and scarification, and seedlings must be treated with *Rhizobium* inoculum. This method, however, results in higher establishment rates than does direct seeding. Direct seeding is less costly than growing transplants, and because seed availability is usually not prohibitive for this species, it is often the preferred method for reintroductions and augmentations (Kaye and Cramer 2003).

In summary, when facing the 3 challenges, the potential for on-the-ground conservation of Kincaid's lupine is "good." Although a relatively large amount of habitat has been lost and degraded, the quality and quantity of remaining habitat is good and the species responds well to relatively simple habitat management methods. Many populations remain, some of which are quite large. This plant can be readily reintroduced using simple and inexpensive direct seeding methods. As we'll see in comparison with the following species, this is close to a "best-case scenario" and may be an exception in contrast to many other declining plant species.

THE BAD: WILLAMETTE DAISY

Willamette daisy (Figure 3) is listed as an endangered species by the US Fish and Wildlife Service and the Oregon Department of Agriculture (ONHIC 2004). The species is restricted to remnant wet prairies in the Willamette Valley and is currently known from fewer than 30 sites.

As Willamette daisy is also native to prairie remnants, it faces the same habitat issues as Kincaid's lupine. Willamette daisy, however, seems to have a lower threshold for the level of habitat degradation that it will tolerate compared with Kincaid's lupine. This further restricts the amount of habitat available to the species. Finally, although fairly aggressive management actions are often required to preserve sufficient habitat quality for Willamette daisy, few studies have documented the effects of habitat management treatments on this species, and results of the few studies completed have been equivocal (Thorpe and Kaye 2007b). For example, in the West Eugene Wetlands, no change in the cover, size, or reproduction of Willamette daisy was observed after the first 2 mowing treatments (Kaye and others 2003; Kaye and Benfield 2005). After the third mowing treatment, however, the number of plants and capitula per plant declined (Thorpe and Kaye 2007b). In

Figure 3. The bad: Willamette daisy. Although restoration of Willamette daisy population is relatively easy, conservation efforts are limited by both habitat issues and the number of remaining population. Photo by Thomas Kaye

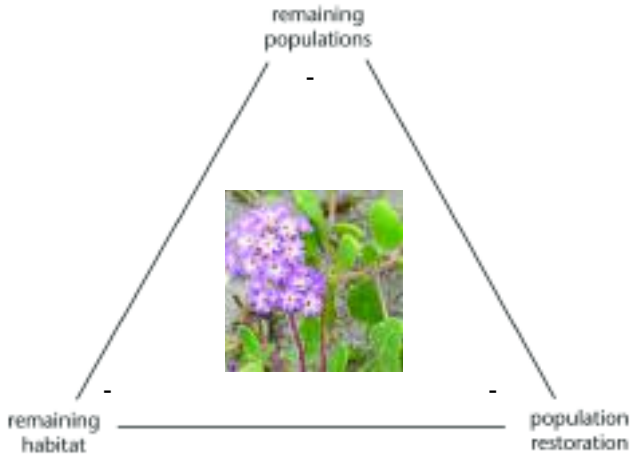

Figure 4. The ugly: pink sand verbena. Conservation of pink sand verbena is limited by all 3 challenges. Photo by Andrea Thorpe

the same study, we found that while crown cover of Willamette daisy showed a small increase the first year after a burn, cover and reproduction decreased the second year after the burn (Thorpe and Kaye 2007b).

One of the largest obstacles facing the conservation and restoration of populations of Willamette daisy is the number and size of remaining populations. Most Willamette daisy populations contain fewer than 100 plants, and in many populations, fewer than 20% of the seeds are filled (Kaye and others 2006). Thus, collections for restoration can be made from only a few, large populations, and the amount of viable seeds obtained from collecting in any population will likely be small.

Scarcity of viable seeds requires that reintroduction and augmentation of populations of Willamette daisy be through planting of seedlings and not by direct seeding, which has a much lower establishment rate. Seedling production can be difficult, requiring 3 mo of cold stratification followed by careful placement of delicate seedlings into pots that must be bottom-watered. Survival of outplanted individuals can be relatively high, however, particularly if plants are protected from herbivory and are watered throughout the first growing season (Thorpe and Kaye 2006).

In summary, when facing the 3 challenges, the potential for on-the-ground conservation of Willamette daisy is "bad." Similar to Kincaid's lupine, a relatively large amount of habitat has been lost and degraded, but unlike the lupine, it is unclear if techniques used to manage habitat are beneficial or harmful to Willamette daisy. Reproduction is quite low in many populations, which is a concern for the persistence of these populations and limits the amount of seeds available for reintroduction efforts. Propagation of this

plant is difficult, and when outplanted special precautions must be taken to ensure that plants thrive.

THE UGLY: PINK SAND VERBENA

Pink sand verbena (Figure 4) is listed as an endangered species by the Oregon Department of Agriculture and is considered a Species of Concern by the US Fish and Wildlife Service. This species is an annual with a persistent seedbank that, historically, occupied open sand habitats (predominantly sand dunes) along the Pacific Coast from Vancouver Island (British Columbia) south to northern California. The number of populations of pink sand verbena has now been greatly reduced throughout its range. In 2000, a small population (2 plants) was rediscovered on Vancouver Island, but this population did not re-establish in subsequent years. Until 2 plants were discovered in 2006 at the Willapa Bay National Wildlife Refuge, the species was believed to be extirpated from Washington State. Over the last 10 y, the number of wild populations in Oregon in any given year has ranged from 3 to 5 (Thorpe and Kaye 2007c), down from around 10 in the 1970s. In Oregon, most wild populations are on the southern coast and are small and extremely variable, sometimes occurring for only one or a few years at a time. Although California populations also vary in size and presence from year to year, they are more numerous and occur primarily in Humboldt and Del Norte counties, as well as Mendocino, Sonoma, and Marin counties (Kaye 2006).

As with Kincaid's lupine and Willamette daisy, the main challenges to conservation of pink sand verbena are habitat availability and quality. The sand dunes historically occupied by this species were subject to frequent disturbances, including erosion and sand deposition that maintained these areas as open, dynamic systems. In an effort to protect private property, European beachgrass (*Ammophila arenaria* (L.) Link [Poaceae]) was introduced in the 1900s to stabilize sand dunes. This species quickly spread across the Oregon coast and now occupies most dunes. European beachgrass threatens pink sand verbena by altering habitat and competing for limiting resources. Restoration of pink sand verbena habitat generally involves disturbance with heavy equipment, herbicides, or manual removal of invasive species (Kaye 2003). Because European beachgrass vigorously regrows after treatment, disturbances must be frequently repeated, preferably annually. Although habitat treatments during summer harm pink sand verbena, typical winter treatments after fruits have dispersed but before germination are effective. Habitat disturbances, including bulldozing, do not appear to adversely affect the seedbank (Thorpe and Kaye 2007c)

Genetic diversity is a problem when working with pink sand verbena. Only one naturally occurring Oregon population, Port Orford, is large enough to supply large quantities of seeds; others are too small and do not consistently emerge each year. A reintroduced population at Coos Bay, Oregon, also is large enough to supply seeds, but this population was started from Port Orford seeds. All of the seeds manually dispersed to sites in Oregon from 1997 through 2008 were collected from this single lineage (McGlaughlin and others 2002).

In summary, when facing the 3 challenges, conservation of pink sand verbena presents an "ugly" scenario. Frequent heavy disturbance or herbicide application is required to maintain the little habitat that remains for this species. Very few natural populations remain and only one population is large enough for seed collection. Finally, germination from introduced seed is variable across sites and years and is generally quite low.

THE UGLY: CONCLUSIONS

A number of challenges face conservation of rare species. Most projects are limited by a lack of funding and a lack of knowledge about the species' biology. Other challenges vary from species to species and should be considered separately when developing a conservation strategy. In Oregon, I have found that three of the most important of these challenges are habitat availability and quality, the number and genetic diversity of existing populations, and the ease of reintroduction and augmentation of populations. As shown in the Kincaid's lupine, Willamette daisy, and pink sand verbena examples, the details of each challenge must be considered carefully for each species so that limited funds are used most effectively. Given a long-term commitment, successful conservation may be possible even with some of the most challenging species.

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AUTHOR INFORMATION

Andrea S Thorpe
Institute for Applied Ecology
PO Box 2855
Corvallis OR 97339-2855
andrea@appliedeco.org