Conservation Assessment

for

Ofer Hollow Reedgrass (Calamagrostis porteri) A.Gray

ssp. insperata (Swallen) C.W. Greene

USDA Forest Service, Eastern Region

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This document is undergoing peer review, comments welcome

This Conservation Assessment was prepared to compile the published and unpublished information on the subject taxon or community; or this document was prepared by another organization and provides information to serve as a Conservation Assessment for the Eastern Region of the Forest Service. It does not represent a management decision by the U.S. Forest Service. Though the best scientific information available was used and subject experts were consulted in preparation of this document, it is expected that new information will arise. In the spirit of continuous learning and adaptive management, if you have information that will assist in conserving the subject taxon, please contact the Eastern Region of the Forest Service - Threatened and Endangered Species Program at 310 Wisconsin Avenue, Suite 580 Milwaukee, Wisconsin 53203.

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EXECUTIVE SUMMARY

This Conservation Assessment is a review of the distribution, habitat, ecology, and population biology of the Ofer Hollow reedgrass, *Calamagrostis porteri* ssp. *insperata* (Swallen) C.W. Greene, throughout the United States and Canada, and in the U.S.D.A. Forest Service lands, Eastern Region (Region 9), in particular. This document also serves to update knowledge about the status, potential threats, and conservation efforts regarding the Ofer Hollow reedgrass to date. Ofer Hollow reedgrass is a clonal, spreading (rhizomatous) grass normally found in clumps (cespitose) and it grows up to 1 m tall. The subspecies is found only in the United States, and it is restricted to dry, upland portions of six (or seven) states in the Midwest. It grows mainly on open, exposed, hillside slopes that are well drained in somewhat acidic thin soils over bedrock in dry-mesic upland forests, in sites that are at least seasonally wet. It appears unlikely that it reproduces by seed in natural settings, but it is capable of developing large colonies locally by means of rhizomes that can establish new individuals if isolated from the main colony. Globally, its ranking is G4T3, or T3 (the subspecies is vulnerable world-wide, the species overall is thought to be secure world-wide). Ofer Hollow reedgrass is listed as Endangered in Arkansas, Illinois, Kentucky, and Ohio. It has been listed as threatened in Indiana. This grass was previously a candidate for federal listing (C2) by the U.S. Fish and Wildlife Service. Ofer Hollow reedgrass is included on the Regional Forester Sensitive Species list (RFSS) for the Shawnee National Forest but not the Hoosier National Forest, where it has not been found.

Globally, this subspecies has been judged to be vulnerable because it is a North American endemic, an ancient relict with a limited overall range, and because it has few populations remaining. It faces extirpation in several states if it is not properly protected.

In addition to species listed as endangered or threatened under the Endangered Species Act (ESA), or species of Concern by U.S. Fish and Wildlife Service, the Forest Service lists species that are Sensitive within each region (RFSS). The National Forest Management Act and U.S. Forest Service policy require that National Forest System land be managed to maintain viable populations of all native plant and animal species. A viable population is one that has the estimated numbers and distribution of reproductive individuals to ensure the continued existence of the entity throughout its range within a given planning area.

The objectives of this document are to:

-Provide an overview of the current scientific knowledge on the subspecies.

-Provide a summary of the distribution and status on the subspecies range-wide and within the Eastern Region of the Forest Service, in particular.

-Provide the available background information needed to prepare a subsequent Conservation Approach.

NOMENCLATURE AND TAXONOMY

Scientific Name: *Calamagrostis porteri* A.Gray ssp. *insperata* (Swallen) C.W. Greene (1984)

Common Names: Ofer Hollow reedgrass; Ofer Hollow reed grass; Bartley's reed bent grass; Reed bent grass; Porter's reedgrass; Bluejoint grass

Synonymy: *Calamagrostis insperata* Swallen (1935), the basionym

Class: Magnoliopsida (Flowering Plants - Dicotyledons)

Family: Poaceae (the grass family)

Plants Code: CAPOI (USDA NRCS plant database, W-2)
http://plants.usda.gov/cgi_bin/topics.cgi

The grass genus *Calamagrostis* contains 26 species and eight additional subspecies and varieties in North America north of Mexico, according to Kartesz and Meacham (1999). The genus is widespread and most common in cooler regions of the Northern Hemisphere, and several of its species are important native forage grasses.

Ofer Hollow reedgrass was described by Swallen (1935) as *Calamagrostis insperata* based upon a collection of Bartley and Pontius from Ofer Hollow, Jackson County, Ohio, collected in 1934.

For many years (at least through 1950, see Chase 1951) it was known only from this original locality, but the species was subsequently located in several other states. It was reduced to a subspecies of *Calamagrostis porteri* by Greene (1984) and this subspecific name has been generally accepted in current studies (see Yatskievych 1999).

The common name varies in the literature. The Nature Conservancy lists the plant as 'Bartley's reed bent grass' because Bartley was one of the original collectors; the U.S.D.A. Plants Internet site (W-2) calls it 'Porter's reedgrass', as does Kartesz and Meacham (1999), using the same common name given for the typical subspecies; the Illinois Endangered Species Protection Board (IESPB 1999) lists the plant as *Calamagrostis insperata* Swallen with the common name 'Bluejoint grass', a name usually used for *Calamagrostis canadensis*. The U.S.D.A. Forest service has chosen to use the name *Calamagrostis porteri* ssp. *insperata* along with the common name 'Ofer Hollow reedgrass', a name based on the first place of its discovery in Ohio. The most recent treatment of Illinois plants (Mohlenbrock 2002) included the plant as *Calamagrostis insperata* with the common name 'Ofer Hollow reed grass'. The genus name (in Greek) means 'reedgrass', and the epithet 'insperata' means (in Latin) 'sprinkled upon' or 'interpenetrated with granules', perhaps referring to the scattered rough hairs on the margins of the leaves and the keel of the lemma.

DESCRIPTION OF SPECIES

Calamagrostis porteri ssp. *insperata* is a perennial rhizomatous grass with robust stems (culms) usually (0.3-) 0.8-1 (-1.2) m tall that are erect and in clumps connected by slender creeping rhizomes; the leaf sheaths are glabrous on the collar, the ligule is 3-8 mm long (generally 5 mm long), the blades are flat, rather thin, 3-12 mm wide and (3-) 10-22 (-40) cm long, acuminate, glabrous on the upper surface and scaberulous beneath, light green and glaucous on both sides, and the margins are scabrous (or weakly scabrous). The panicles are (10-) 12-14 (-30) cm long, open to dense with narrowly ascending branches, and some branches are naked at the base. The spikelets (glumes) are (3.5-) 5-6 mm long and have a lemma 3.0-4.5 mm long that is scaberulous on the keel; dense callus hairs are present in tufts at the sides of the lemma base and some of the hairs are about half the length of the lemma, or up to 2 mm long. The lemma has an awn about the length of the lemma and attached near its base, and is geniculate (bent at about the middle). The rhizomes may allow an individual plant to cover a relatively large area with multiple stems (*i.e.*, ramets, similar to Deerberry, see Hill 2002a) each of which is genetically identical to its neighbors, but plants are generally seen or described as multi-stemmed and cespitose (clumped) or as loose colonies of scattered tufts (Yatskievych 1999). The chromosome number is $2n = 56$; the basic diploid number in *Calamagrostis* is $2n = 14$, indicating that this is an octoploid (adapted from Chase 1951, Greene 1980, Gleason and Cronquist 1991, and Yatskievych 1999).

Some experience is needed in order to identify the Ofer Hollow reedgrass with confidence, but, when fertile, it appears to be quite distinct. The subspecies can be distinguished from the very similar and closely related *Calamagrostis porteri* A.Gray ssp. *porteri* by several technical characters. The ssp. *porteri* has a bearded leaf collar, its leaves are darker green on the underside, the leaves are scabrous on the upper surface and smooth or less scabrous beneath, and the ligules are 2-5 mm long; in addition, it is restricted to the Appalachian Mountains south of the glacial boundary. The ssp. *insperata* has a hairless leaf collar, the leaves are light green and

glaucous on both sides, the leaves are smooth on the upper surface and scaberulous beneath, and the ligules tend to be about 5 mm long (varying from 3-8 mm); it is found in the Midwest and Ozark Mountain region, also south of the glacial boundary. The two subspecies may overlap in range in Kentucky where it has been suggested that ssp. *insperata* has stouter stems than ssp. *porteri*; also, ssp. *insperata* may have a very slight indication of hair at the leaf collar in this region but ssp. *porteri* has a conspicuous fringe of hair at this leaf collar (Campbell *et al.* 1992; W-3).

HABITAT AND ECOLOGY

A review of the literature demonstrates that this grass has a wide variety of plant associates and habitats throughout its range (Ambrose *et al.* 1994 on-line at W-3; Campbell *et al.* 1992; Summers 1993; Bittner 1995a). *Calamagrostis porteri* ssp. *insperata* grows mainly in dry, moderately open rocky woods, wooded ravines, on north- and northwest-facing slopes (Herkert and Ebinger 2002, W-3), on dry limestone or dolomite cliffs and sandstone outcrops. Other recorded substrates include siltstone and granitic rhyolite (Yatskievych 1999). The dry, upland habitats can be exposed to full sun or, more frequently, the plants are in partial shade.

At its eastern range limit in Ohio, where it was first discovered, the populations are in upland oak forests on high, well-drained ridgetops and clifftops (W-3) and one is under a powerline (W-4). The soils where it occurs are said to be acidic (Spooner *et al.* 1983), and associated plants include *Kalmia latifolia* L., *Pinus virginiana* Miller, *Quercus alba* L., *Smilax* spp., and *Vaccinium* spp., among others.

At its southwestern range limit in Arkansas, a single population of this rare grass, collected in 1949 on Rich Mountain, was found in a generally forested area on non-calcareous Mississippian sandstone. This population has not been seen since and is presumed extirpated (W-3).

Ofer Hollow reedgrass was first reported in Missouri by van Schaack (1954) and verified in the state by Steyermark (1963). Steyermark described its habitat as rocky wooded ravines and open grassy rocky slopes of bluffs along creeks in the southern part of the Ozarks, with chert and limestone (dolomite). It is usually in shade and associated with dry to mesic upland forests, usually on acidic substrates, and often on north-facing exposures (Roedner *et al.* 1978, Yatskievych 1999) and it occurs on granitic rhyolite at one site in Iron County (W-3). According to Yatskievych (1999), as recently as the 1980's this grass was thought to have disappeared from Missouri because it could not be relocated. However, between 1990 and 1996, about 80 populations were found, mostly by Bill Summers of Saint Louis, Missouri, who realized that most populations exist as vegetative colonies that rarely flower (Summers 1993). Vegetatively, the plants are distinctive in their habitat and they grow as large, loose colonies of scattered glaucous (bluish-green) tufts connected by long rhizomes. Associated plants include the <u>trees</u> *Acer rubrum* L., *Acer saccharum* Marsh., *Carya texana* Buckl., *Carya tomentosa* (Poir.) Nutt., *Cornus florida* L., *Nyssa sylvatica* Marsh., *Ostrya virginiana* (Mill.) K.Koch, *Pinus echinata* Miller, *Quercus alba* L., *Quercus coccinea* Muenchh., *Quercus nigra* L., *Quercus rubra* L., *Quercus stellata* Wangh., *Quercus velutina* Lam., and *Tilia americana* L., the <u>shrubs</u> *Rhododendron prinophyllum* (Small) Millais, *Rhus aromatica* Ait., and *Vaccinium pallidum* Ait., the <u>vines</u> *Lonicera flava* Sims and *Vitis aestivalis* Michx., the <u>herbs</u> *Amphicarpaea bracteata* (L.)

Fern., *Antennaria plantaginifolia* (L.) Richards, *Aruncus dioicus* (Walter) Fern., *Aster* spp., *Coreopsis* sp., *Cunila origanoides* (L.) Britton, *Desmodium glutinosum* (Muhl.) Wood, *Eupatorium rugosum* Houtt., *Heuchera richardsonii* R.Br., *Phryma leptostachya* L., *Silphium asteriscus* L., *Solidago* spp., and *Uvularia grandiflora* J.E.Smith, the grass *Schizachyrium scoparium* (Michx.) Nash, the sedges *Carex* spp., and the ferns *Asplenium platyneuron* (L.) Oakes ex Eat. and *Woodsia obtusa* (Spreng.) Torr.

In Kentucky, this grass was discovered by 1992 (Campbell *et al.* 1992) in two different habitat types. Within the Grassy Knob Ridge system, populations occur above limestone and occasionally over sandstone. Within the Morehead Ranger District of the Daniel Boone National Forest, populations occur on ridges over siltstone near overlying limestone, and one population was found on a steep slope over sandstone with no limestone nearby. Some populations are known from open areas near roadsides and in power line rights-of-way. Associated plants include the trees *Acer saccharum* Marsh., *Carya glabra* (Miller) Sweet, *Cornus florida* L., *Fraxinus* sp., *Liriodendron tulipifera* L., *Nyssa sylvatica* Marsh., *Pinus echinata* Miller, *Pinus virginiana* Miller, *Quercus alba* L., *Quercus montana* Willd., *Quercus rubra* L., *Quercus velutina* Lam., and *Sassafras albidum* (Nutt.) Nees, the shrub *Vaccinium pallidum* Ait., the vines *Lonicera flava* Sims, *Smilax rotundifolia* L., *Toxicodendron radicans* (L.) Kuntze, and *Vitis aestivalis* Michx., the herbs *Aster* spp., *Coreopsis major* Walter, *Helianthus divaricatus* L., *Heuchera longiflora* Rydb., *Phlox carolina* L., *Phlox subulata* L., and *Solidago caesia* L., the grasses *Brachyelytrum erectum* (Schreber) P.Beauv., *Oryzopsis racemosa* (Smith) Ricker, *Dichanthelium boscii* (Poir.) Gould & Clark [= *Panicum boscii* Poir.], and *Dichanthelium dichotomum* (L.) Gould [= *Panicum dichotomum* L.], and the sedges *Carex pensylvanica* Lam., and *Carex nigromarginata* Schwein.

In Indiana, *Calamagrostis porteri* ssp. *insperata* grows on steep, west-facing mid-slopes of the rugged 'knobs' on the east edge of the Highland Rim Natural Region in thin soil over siltstone and shale (Homoya, pers. comm.). At one site (Harrison County) it grows on a level, sparsely wooded site above a limestone cliff. The dominant overstory trees are *Pinus virginiana* Miller and *Quercus montana* Willd.. This grass was not included in Indiana by Deam (1940) and was discovered in the state only in the 1990's (Homoya, 1995).

Ofer Hollow reedgrass was first discovered in Illinois in 1991 by Bill Summers (Bittner 1995). It grows on cool, mesic, north- or northeast-facing steep sandstone bluff edges and in natural tree-fall clearings in relatively undisturbed high-quality (relatively undisturbed) dry to dry-mesic upland forest community sites dominated by oak and hickory, adjoining the sandstone cliff natural community (as defined by White and Madany 1978). Stems and rhizomes occur in both leaf-litter zones and moss and lichen-dominated areas. Springs, intermittent streams, and seeps (drainages) occur within and near the populations and appear to be crucial for the plants survival (Bittner and Gibson 1998). Associated species include the dominant canopy trees *Quercus alba* L., *Quercus rubra* L., *Quercus velutina* Lam., *Carya glabra* (Miller) Sweet, and *Carya ovata* (Miller) K.Koch, along with the less common trees *Acer saccharum* Marsh., *Fagus grandifolia* Ehrh., *Ostrya virginiana* (Mill.) K.Koch, and *Sassafras albidum* (Nutt.) Nees, the shrub *Vaccinium pallidum* Aiton, the vines *Parthenocissus quinquefolia* (L.) Planch. and *Toxicodendron radicans* (L.) Kuntze, the herbs *Antennaria plantaginifolia* (L.) Richards and *Cunila origanoides* (L.) Britton, the grass, sedge and rush *Dichanthelium boscii* (Poir.) Gould &

Clark [= *Panicum boscii* Poir.], *Carex willdenowii* Schkuhr (threatened in Illinois), and *Luzula multiflora* (Retz.) Lej., the fern *Polystichum acrostichoides* (Michx.) Schott, and several mosses including mats of *Sphagnum* (Bittner and Gibson 1998). The known populations of this rare grass are all located in the Greater Shawnee Hills Section of the Shawnee Hills Natural Division of Schwegman *et al.* (1973). Botanists and ecologists have speculated on the original landscape in this part of Illinois based mostly upon land survey records and field observations (Ulaszek, pers. comm.). Evidence suggests that the original pre-settlement landscape was a 'barrens', a savanna or prairie-like community with scattered oak trees and oak brush that was periodically burned by Native Americans.

DISTRIBUTION AND ABUNDANCE

Calamagrostis porteri ssp. *insperata* is found only in the United States, and it is has been found only in six (or seven) Midwestern states, namely, Arkansas (in one county), Illinois (in one county), Indiana (three counties), Kentucky (in 1-2 counties ?), Missouri (in nine counties), and in southern Ohio (two counties), and this is its entire known range world wide. The U.S.D.A. Plants site (W-2) and Kartesz and Meacham (1999) also included Tennessee within its known range, but no documentation has been seen and this cannot be confirmed here. There are no specimens of this grass from Tennessee in the University of Tennessee Herbarium at Knoxville (Wofford, pers. comm.) and the subspecies is not included in Chester *et al.* (1997).

Ofer hollow reedgrass has been reported within several national forests in Forest Regions 8 and 9. The Ouachita National Forest in Arkansas has a single historic site at which it may no longer exist (W-3) It occurs in, and is considered to be rare on the Daniel Boone National Forest in Kentucky (Taylor, pers. comm.) and it has been included on the Regional Forester Sensitive Plant Species list for the forest. It has been found at several sites within the Mark Twain National Forest in Missouri (Summers 1993), and its only locations in Illinois are within the Shawnee National Forest. While it has not been found in the Hoosier National Forest in Indiana, suitable habitat exists and it may yet be found there (Homoya, pers. comm.).

In 1983, the total distribution of this rare grass was thought to include only five counties, two in Ohio, one in Arkansas, and two in Missouri (Spooner *et al.* 1983); it has since been found in three or four additional states as a result of increased searches. There are approximately 80-100 occurrences known currently across its range in the six states (W-3; Bittner and Gibson 1998, Yatskievych 1999). Individuals or colonies are infrequent and very local, and often only a single colony occurs at any one site. The populations are restricted to a specific habitat (see previous section), and if this habitat is infrequent the Ofer Hollow reedgrass will also be infrequent. Representative specimens of this rare grass have been listed in Appendix 1. A summary of its known distribution in the United States has been presented in Appendix 2, and additional details on the distribution can be found in the references cited there.

Populations or occurrences of this grass are normally defined as every distinct colony found rather than being defined by a set distance of one from the other. For example, Bittner (1995) distinguished five populations in Illinois, three within Bell Smith Springs Conservation Area and two within the Lusk Creek Canyon Ecological Area. Each population was said to have from 500 to over 18,000 tillers (stems). The Forest Service has confirmed that there are two small patches of this subspecies on the edge of the latter designated natural area (Shawnee National Forest staff

2001). Because rhizomes did not connect the colonies within a given area to one another, they were considered to be distinct populations.

At the current time, as indicated above, Ofer hollow reedgrass has been documented in six states, five of which have extant populations. Some additional details on these occurrences follow. In Arkansas, only a single collection of this grass is known (see Appendix 1), made on Rich Mountain in the Ouachita National Forest in 1949. The grass has not been relocated in the state and it is presumed extirpated there (W-3, Smith 1978, Bittner and Gibson 1998). In Illinois, Ofer Hollow reedgrass was found for the first time less than fifteen years ago, and so it was not included in the flora by Mohlenbrock (1986). It has been found only in Pope County, within two protected areas. Bill Summers of St. Louis, Missouri first found it in 1991 at Bell Smith Springs. The next year, John Schwegman found the grass in Lusk Creek Canyon, and in 1993 three more populations were found by Bittner (Bittner and Gibson1993, 1998; Bittner 1995; IDNR 2002). In Indiana, nine occurrences of *Calamagrostis porteri* ssp. *insperata* are known, seven in Clark County, one in Scott County, and one in Harrison County (Homoya 1995 and pers. comm.). The grass rarely flowers in Indiana, as is typical throughout its range. In Kentucky, where the grass was only recently discovered, six populations of the grass have been reported at two sites within the Daniel Boone National Forest (Campbell *et al.* 1992). In Missouri (see Habitat and Ecology above) a significant number of new populations have been discovered in recent years. More than 80 populations from nine counties are now known from the state (Summers 1993, Yatskievych 1999), but nearly all have been seen only in vegetative condition. Finally, in Ohio, the two historical populations at which the Ofer Hollow reedgrass was first discovered have been relocated, as well as several new populations in Vinton County, bringing the total number of extant occurrences up to four (Spooner *et al.* 1983; W-4).

Most native plants have reached the limits to which they can travel under present conditions of climate (that is, temperature and rainfall), substrate, dispersal mechanism, and other pertinent factors. In other words, species are in balance with their environment as long as the environment is stable. In many biological simulations as well as in natural systems, however, ecological extremes are more important than the means in controlling plant distribution (Webb *et al.* 1975; Ode *et al.* 1980; Barnes *et al.* 1983). An obvious example is that of frost tolerance (or temperature extremes). A plant species completely intolerant of freezing can persist in a site indefinitely until the first time extreme temperatures cause it to freeze. One such freeze in a century may be enough to eliminate a species entirely from a wide area of its range, and changes in climate historically have caused the greatest changes in plant distributions (see Hill 2003).

In the case of *Calamagrostis porteri* ssp. *insperata*, historical distribution appears to be dependent on hydrology, substrate type (including pH), and the openness of the habitat as well as from the high range of temperature extremes (Bittner and Gibson 1998, Havens and Holland 1998). Its distribution and preferred habitat, as well as data from these recent studies, suggest that the grass is not adapted to extreme heat and that it has an upper limiting temperature limit for growth. Interestingly, despite its apparent tolerance for cold temperatures, this grass has not been found north of the southern limit of glaciation. Data on its reproduction suggests that the subspecies may be unable to increase its current range to the north. This will be discussed further in the section below (see Life History). With a limited number of individuals currently living, and a specific habitat requirement, it may be unable to increase its range in the future.

PROTECTION STATUS

The Nature Conservancy currently lists *Calamagrostis porteri* ssp. *insperata* as a G4T3 plant, or, more specifically, as a T3 plant (W-3), indicating that the subspecies is vulnerable world-wide. In the United States, overall, the subspecies is given the National Heritage rank of N3 (for similar reasons).

Official protection for the subspecies outside of Forest Service lands depends upon state and local laws because it is not listed as Federally threatened or endangered. The state rankings vary somewhat. Ofer Hollow reedgrass is listed as Endangered in Arkansas, Illinois (listed as *Calamagrostis insperata* Swallen), Kentucky, and Ohio. It has been listed as threatened in Indiana. This grass was previously (1983) listed as a candidate for federal listing by the U.S. Fish and Wildlife Service.

Ofer Hollow reedgrass is included on the Regional Forester Sensitive Species list (RFSS) for the Shawnee National Forest but not the Hoosier National Forest, where it has not been found. It occurs in the Daniel Boone National Forest in Kentucky and the Mark Twain National Forest in Missouri, as well, and a significant number of current living populations are found within these national forests. It has been included on the RFSS list for the Daniel Boone National Forest in Kentucky.

In Missouri, *Calamagrostis porteri* ssp. *insperata* was previously listed as endangered, but current law in the state only allows the listing of federally listed taxa as state endangered (Yatskievych, pers. comm.); however, it is tracked in the state as a S3 plant.

Table 1 lists the official state rank assigned by each state's Natural Heritage program according to the Nature Conservancy at their Internet site (W-3). Appendix 3 explains the meanings of the acronyms used (W-5).

A summary of the current official protection status for the Ofer Hollow reedgrass follows:

U.S. Fish and Wildlife Service: Not listed (None). Previously a candidate for federal listing (Category 2, Federal Register, November 28, 1983).

U.S. Forest Service: Region 9, Sensitive (Illinois only, Shawnee National Forest); Region 8, Sensitive (Daniel Boone National Forest).

Global Heritage Status Rank: G4T3; T3

U.S. National Heritage Status Rank: N3

Table 1: S-ranks for *Calamagrostis porteri* ssp. *insperata* [Heritage identifier: PMPOA170Z3].

State	Heritage S-rank	State	Heritage S-rank
Arkansas	SH	Kentucky	S1S2
Illinois	S1	Missouri	S3
Indiana	S1	Ohio	S1

LIFE HISTORY

Calamagrostis porteri ssp. *insperata* is a perennial grass that may live to a great age. Colonies of the subspecies can be extensive because of the ability of the plant to produce individual clumps from a system of thin rhizomes. This can result in a colony of apparently separate individuals as the rhizomes break. It also flowers but it only very rarely, if ever, produces new individuals from seeds (see next section). No information is available on how many stems in a colony may be of the same genotype ('genets'), or how many distinct individuals exist at any particular site.

Ofer Hollow reedgrass is a cool-season grass, producing most of its growth early in the year. According to Bittner and Gibson (1998) there is considerable leaf senescence from May to August in Illinois populations. They suggest that there is an upper limiting temperature for growth that not only limits the growing season but also the ability for the plant to grow in more exposed, warmer sites and, limiting its local area of coverage. Plants die back and are dormant in the autumn and winter. This grass is said to flower in mid-June through September (Shawnee National Forest staff 2001) but, in one study, inflorescences appeared to be senescent and brown by mid-August in cultivation (Havens and Holland 1998). Specimens collected in Ohio were in flower August 1-30 (Mike Vincent, pers. comm.). Bittner and Gibson (1998) have observed that in native populations, flowering tillers (stems) are very rare and are most often seen in areas of relatively high light. As is typical in members of the grass family, pollen is dispersed by the wind and large quantities must be produced because of the ineffective nature of this pollination strategy.

POPULATION BIOLOGY AND VIABILITY

Calamagrostis porteri ssp. *insperata* rarely flowers in Illinois or anywhere else in its range, and it spreads almost exclusively through vegetative growth. For this reason, its range was not well understood until the 1990's when searches were made for vegetative colonies.

It is generally understood that fertility is reduced in inbred populations through the process of autogamy (self-fertilization). Autogamy is useful to the plant when there are small numbers of individuals per area, since the safeguarding of the success of propagation is more important than the production of new genotypes. In primary habitats, those that are generally poorly vegetated, initial success is very important. However, in subsequent periods of vegetation increase, pioneers are often substituted by other, more competitive species (W-6). In plants such as Ofer Hollow reedgrass, all stems at a site may be genetically identical. Therefore, if pollination should occur, self-fertilization is the most likely outcome because there is almost no chance of fertilization by other genotypes unless they are within dispersal range. It has already been shown

in the summaries above that existing populations are very isolated from one another. Continued self-fertilization can result in severe reproductive problems.

Studies on the factors affecting reproductive success in this rare grass have recently been conducted by Havens and Holland (1998). Until their study, the production of viable seed had never been observed in this grass. In the course of their investigation of more than 2000 flowers, only one viable seed was found. Greene (1980) found that many of the individuals of this grass lacked viable pollen, and this was seen to a lesser extent in the 1998 study as well. The 1998 study found plants that produced normal ovules and non-viable pollen in the same individual. They also found a few plants that were able to initiate seeds when self-pollinated, though Greene (1980) had speculated that the plants were self-incompatible. Havens and Holland (1998) also noted that nearly all self-pollinated ovules failed to develop after pollination during their experiments, and that nearly every seed initiated overall in all crosses (including outcrossing) aborted. They suggested that this reproductive failure may be a reflection of a high genetic load that has occurred as a result of a long history of polyploidization. High genetic load can be seen in dominant mutations that result in factors lethal to embryos, and this situation appeared to be indicated in this study. The finding during their study of a single, viable seed (that was successfully germinated) demonstrates that sexual reproduction is possible in this grass, but it is also highly unlikely, especially in natural populations. It was accomplished through transferring pollen from one genotype to plants of a different genotype grown in full sun. Other generally recognized implications of this low fertility may be that the number of genetically distinct individuals may be very low and the plant survives as a rare relict in the vegetative state only (W-3).

The information available so far on the life history of this plant fits the pattern shown by Sword moss (*Bryoxiphium norvegicum* (Bridel) W.Mitten) that was described by Hill (2002b). In a similar manner, this plant has isolated vegetative populations found just south of the southern extent of glaciation as well as a few relict populations in the driftless (unglaciated) area centered in southwestern Wisconsin. The populations of that moss in the United States are almost always infertile or unisexual, and the species appears unable to increase its range. As information accumulates, this post-glacial relict pattern of possibly ancient species that are in danger of extinction because of isolation-related reproductive problems becomes clearer.

Ofer Hollow reedgrass habitat has been observed to be decreasing (see Potential Threats below). It may or may not occur at other suitable sites in Illinois and Indiana, but only a few searches have been made specifically for the Ofer Hollow reedgrass in recent years. Suitable habitat for the subspecies appears to exist, but it appears that it may have never been common here. Additional searches are suggested. If individuals are relocated, or if new sites are found, they may persist with proper habitat management.

Maintaining the open habitat in which it grows appears to be one of the most important means to insure the survival (or viability) of this subspecies throughout its range. Its highly specific flowering conditions and poor fruiting success contribute to the very limited possibility for spread in *Calamagrostis porteri* ssp. *insperata* and some other species of the genus (Greene 1980, 1984; Havens and Holland 1998). There appears to be little chance of natural colonization of new habitat by this grass. The long-term viability of this rare grass depends entirely on the protection and management of existing populations through human intervention, and some

success in increasing genetic diversity in this grass may be achieved through continued controlled pollination experiments performed in cultivation.

POTENTIAL THREATS

Globally, Ofer Hollow reedgrass has been judged to be vulnerable because it is a North American endemic with a limited overall range and because there are few reported populations remaining. It appears to be unable to increase its range.

Threats to this subspecies include canopy closure as a result of natural forest succession or succession due to fire suppression, clear-cutting, grazing, soil compaction, recreational use of habitat, and loss of habitat to primary agriculture (W-3, Shawnee National Forest staff 2001).

The development of user-created trails are thought to pose a major threat to the few populations of this subspecies because of the resulting loss of the thin soils present as well as the destruction of the delicate rhizome systems by compaction of the soil by human or vehicular traffic. In areas where this grass occurs, equestrian use would have the same effect, and the added possibility of grazing or browsing of this grass could quickly exterminate a small local population.

In Ohio, threats are also presumed to be from herbicide treatment along the powerline and from severe disturbance from logging operations in the forested areas (W-4). The enhanced brush growth following clear-cutting suppresses growth in *Calamagrostis porteri* ssp. *insperata* and other ground-level species. The increased heat generated at open sites can severely suppress growth and prevent plant establishment as well. Conversely, overshading by woody species as forests mature is thought to be another potential threat (W-4). Excessive shading and canopy closure in woodlands may be a factor in reducing seed production in the subspecies because fewer flowers are produced in the shaded populations (Bittner and Gibson 1998). Viable seed production in this subspecies appears to be virtually non-existent, and reproduction is primarily by vegetative rhizomes (W-4; Havens and Holland 1998), therefore all vegetative colonies need strong protection and threats to vegetative growth need to be reduced.

The elimination of the natural fire regime throughout most of its historic range has resulted in the succession of savanna and open woodland habitats into closed-canopy woodlands. In the absence of fires, *Calamagrostis porteri* ssp. *insperata* can persist in significant populations today only at sites with extremely shallow soils or areas that are selectively cleared. Since settlement, much of the previously available habitat has been destroyed, converted to cultivated fields orchards or commercial forests, or has succumbed to land development (W-3). Many extant populations are in national forests or protected areas, but these have only been found as a result of careful searches at these sites in recent decades; it cannot be determined how many populations were lost at other sites before field botanists began to recognize the grass in its vegetative state and before these searches were initiated.

The Ofer Hollow reedgrass is not an aggressive or competitive grass. Competition from exotic plant species (such as *Lonicera japonica* Thunb., *Lonicera maackii* (Rupr.) Maxim., and *Rhamnus* spp.) can be a threat to the remaining populations. These species can form dense stands and eliminate ground layer herbaceous species including this grass.

The difficulty in maintaining this subspecies is that active management appears to be necessary, but the ideal means and combination of maintaining sufficient water availability along with an open canopy has not been fully determined.

Complete clearing or cutting of a forest stand could not be enacted where a colony occurs without adverse effects. In addition, the areas where these plants grow should be closed to most recreational use because of the increased erosion and physical damage possible to the shallow roots and rhizomes of this grass, and increased enforcement of these restrictions or the relocation of trails may be needed. It would appear because of the fragmentation of habitat resulting from a mix of public and private ownership that a strong effort should be made to add to the buffer around existing colonies and their habitats by purchasing nearby public lands as a means of protection for the habitat and the subspecies.

Habitat fragmentation can have profound effects on the success and persistence of local populations. Over time, as populations become increasingly more isolated, the effects of fragmentation can potentially be observed at the molecular level by reduced genetic frequencies caused by random drift (Barrett and Kohn 1991). When one is considering populations that are already isolated, as in the case of the Illinois population(s), random genetic drift may have already occurred and may have caused negative effects to the subspecies. This appears to be supported by the data of Havens and Holland (1998).

At the current time, it appears that the populations of *Calamagrostis porteri* ssp. *insperata* in the Shawnee National Forest are threatened with elimination from habitat change and disturbance unless selective management and/or increased enforcement of habitat protection is instituted.

RESEARCH AND MONITORING

Plants are being grown at the Missouri Botanical Garden from sites in Ohio, Kentucky and Missouri for studies at the Center of Plant Conservation there, and one result of these studies has been the work of Havens and Holland (1998). Some research such as this has been undertaken in the areas of basic taxonomy and reproductive problems within this rare grass and these have produced useful results. It appears that significant additional basic field research and monitoring is needed regarding *Calamagrostis porteri* ssp. *insperata* in additional aspects of its biology and management.

Calamagrostis porteri ssp. *insperata* is so rare in Illinois and Indiana that a primary emphasis should be to locate and vigorously protect all remaining populations. Similar habitat should be explored for the plant. There is a small to moderate area of additional suitable habitat in extreme southern Illinois where *Calamagrostis porteri* ssp. *insperata* could also exist, and continued searches for the subspecies should be conducted. A list of associates and indicator species has been compiled as a result of field studies in Illinois and other states (see habitat section above). These indicator plants should be very useful in facilitating the discovery of additional populations of this grass. The grass may be more frequent than the records indicate, and it could be overlooked because of its similarity to other *Calamagrostis* species (W-4). Mature flowering material is normally needed for positive identification of this grass, but this is seldom possible, and the underground parts are generally needed for identification as well; the density of basal tufts should be noted as should the color and texture of the leaves (see plant description above),

but over-collection should be avoided (W-4). One may recall that in 1983 its total distribution was thought to include only four counties, two in Ohio, one in Arkansas, and two in Missouri (Spooner *et al.* 1983); it has since been found in three (or four) additional states at over 80 sites as a result of increased interest and searches for the plant.

Botanical surveys conducted by scientists from the Illinois Natural History Survey have shown repeatedly that with sufficient time and funding, and an experienced eye, many plants thought to be extirpated or else threatened or endangered can be found at additional locations (Hill 2002). These sorts of investigations have been important in that they have led not only to the de-listing of species once thought to be rare, but they have also resulted in the discovery of species previously unknown in the state. The U.S. Forest Service and other related agencies have done a fine job in the effort to preserve rare species with the resources that they have available. Much of the locating and monitoring of known populations of rare species in southern Illinois has been conducted by Forest Service biologists in cooperation with Illinois Department of Natural Resources personnel. However, there is neither sufficient funding nor are there enough botanists available to survey the immense area that needs to be covered in the monitoring of the large numbers of sensitive plants, including this one. It appears that a high priority should be given to the training and hiring of more qualified field botanists to achieve these goals.

Basic research and on-site investigations are especially needed to determine the best management techniques to be used for this rare grass. *Calamagrostis porteri* ssp. *insperata* is a subspecies of open woodlands and savannas and most of these habitats have grown closed with trees and shrubs since the elimination of a natural fire regime (W-3). Because some states have very few populations of this grass, caution is needed in field research to avoid harming the colonies. Some limited research on prescribed fire or selective thinning of the canopy should be conducted in order to determine the effects of increased light levels to the habitat and populations for the purpose of better management (W-3). There is a need to determine the best habitat for the subspecies and how to best maintain the character of these areas (W-3). Studies of this kind in southern Illinois are ongoing through the work of David Gibson at Southern Illinois University (Bittner and Gibson 1998; W-3). It is generally recommended that the habitat quality where this plant grows should be monitored on a regular basis and an assessment of the specific threats to all populations should be made (W-3). It has been suggested that prescribed burning and selective harvesting of timber should be conducted cautiously (on an experimental basis) to determine how populations respond to the opening of the canopy; this will yield information on whether such activities can result in increased vigor, population size, and production of fertile flowers and seed (W-3; Summers 1993). Long-term monitoring of known populations should be conducted every 1-2 years to track their status with respect to these current management activities. As part of the basic research on current populations of this subspecies, data such as the counts of numbers of individuals present, the determination of the amount of yearly flowering and seed production, if any, that might occur and an assessment of recruitment rates, if any, are greatly needed in order to monitor population dynamics and to assess the viability of the individual populations found. Individual plants should be monitored over time at each site. Such basic facts as fungal associations (if any), longevity, and yearly variations in colony size over a long period are not precisely known because so many of the colonies have been only recently discovered. Counts (or reasonable approximations) should be made of individual stems, and whether or not these stems are connected, if possible, as well as the area covered by the populations; surveys should be conducted during the flowering and fruiting

periods. Some populations of *Calamagrostis porteri* ssp. *insperata* are being monitored currently by botanists working on behalf of the state Natural Heritage programs and other organizations in the areas where it is listed as endangered or threatened (W-2, W-3).

In addition to the basic effort of locating additional populations of the subspecies and conducting population counts, it would be useful to initiate a genetic investigation of the diversity within and between the known populations using DNA methodology. It would be especially important to discover if colonies are entirely clonal or if they contain some genetically different individuals. This could be expanded to compare the local populations with the nearest populations in adjoining states to assess their possible origin or degree of genetic distance between them. An interesting area of experimentation might be to initiate transplantation studies significantly farther north in the country (northern Illinois, Wisconsin, or Minnesota, for example) in a climate that may be more typical for the grass as it may have grown prior to glaciation. Many relict plants of the southern states have been shown to grow as well or better far north of their current ranges when these transplantation experiments have been conducted (*e.g.*, *Fothergilla, Franklinia, Illicium, Neviusia*, *Torreya*). The techniques for several aspects of monitoring and studying rare plant species are presented in Collins *et al.* (2001), Philippi *et al.* (2001), and Imm *et al.* (2001) and some specific management techniques for this grass are detailed by the Nature Conservancy as well at their Internet site (W-3).

RESTORATION

There are no known restoration efforts being conducted on *Calamagrostis porteri* ssp. *insperata* anywhere in its range and the restoration potential of this subspecies is largely unknown (W-3). Studies discussed above have indicated that viable fruit production in this subspecies is very rare and that reproduction (or, rather, the continuation of existing populations) is primarily by means of vegetative rhizome growth.

The generally recommended method to restore populations of this and other rare plants is to protect and manage their habitat. Protection of the hydrology and thin soil layer of the sites may be crucial, along with the maintenance of an open habitat. Girdling trees may be effective, as may be selective mowing (trimming) at a prescribed height (perhaps 1 meter). Exotic and aggressive species must be completely eliminated from each site. This would entail physically pulling them out because it is very likely that herbicide application would eliminate this subspecies at a site as well. The use of controlled burns, the thinning of the overstory, and the thinning of competing understory species may be very beneficial to this plant.

Restorations of any native plant species are recommended using only propagated material grown from native, local populations to avoid mixing genotypes not adapted to the local conditions and to avoid compromising the local gene pool. If this rule is not followed, the result is generally the loss of plants because they are not competitive under local conditions or the result could be the success of a plant or plants that cannot be considered truly native (considered by some to be a plant community reconstruction rather than a restoration). Local plants should be propagated for planting in such an effort. Grasses are normally easily propagated by means of rhizome cuttings under controlled conditions.

This grass is not known in cultivation except in controlled, experimental plantings and it is not

commercially available in this country. Continued experimentation may produce strains with viable seeds, and this might be considered desirable.

In summary, the management for extant colonies of *Calamagrostis porteri* ssp. *insperata* should include the possible relocation of trails that are causing damage to the colonies, continued experimental investigation of management techniques such as the use of prescribed fire or the selective thinning of the canopy in order to maintain suitable light levels for growth and flowering, and the elimination of woody plant encroachment in the understory, particularly that of exotic species. Habitats need protection from destructive recreational activities, land development, indiscriminate herbicide application, browsing or grazing by native and non-native mammals, and from the establishment of any exotic species (W-3). At this time, with proper management, current populations should persist and they could even increase in size, but the establishment of additional populations will be only through active human efforts.

SUMMARY

Ofer Hollow reedgrass, *Calamagrostis porteri* ssp. *insperata* (Swallen) C.W. Greene, is a perennial, clonal, spreading (rhizomatous) grass normally found growing in clumps (cespitose) up to 1 m tall. The subspecies is found only in the United States, and it has been found in dry, upland portions of six (or seven) states in the Midwest. It grows mainly on open, exposed, hillside slopes that are well drained in dry-mesic upland forests, in sites that are at least seasonally wet, in somewhat acidic thin soils over bedrock. It appears unlikely that it ever reproduces by seed in natural settings, but it is capable of developing large colonies locally by means of rhizomes that can establish new individuals if isolated from the main colony. Globally, its ranking is G4T3, or T3 (the subspecies is vulnerable world-wide, the species overall is thought to be secure world-wide). Ofer Hollow reedgrass is listed as Endangered (and probably extirpated) in Arkansas, and as Endangered in Illinois (as *Calamagrostis insperata* Swallen), Kentucky, and Ohio. It has been listed as threatened in Indiana. This grass was previously a candidate for federal listing (C2) by the U.S. Fish and Wildlife Service. Ofer Hollow reedgrass is included on the Regional Forester Sensitive Species list (RFSS) for the Shawnee National Forest but not the Hoosier National Forest, where it has not been found. Globally, this plant has been judged to be vulnerable because it is a North American endemic relict with a limited overall range and because it has few populations remaining. It faces extirpation in several states if it is not properly protected.

Suggested research priorities for this rare grass include attempts to locate additional populations, and to determine, through controlled and cautious experimentation, the best management techniques to insure its survival and increase (such as controlled use of fire and the selective thinning of canopy trees to open the habitat), to determine the genetic diversity of populations, and to determine a means to increase reproduction in the subspecies. Management through enforced protection of its habitat, either through enforcement of existing regulations or through the creation of new rules for restricted access to the sites (particularly recreational and equestrian access), appears to be necessary to allow it to persist where it may occur.

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APPENDICES

APPENDIX 1

Representative specimens of *Calamagrostis porteri* ssp. *insperata* examined or cited in the literature

Herbaria:

ILLS = Illinois Natural History Survey, Champaign. MO = Missouri Botanical Garden, St. Louis. MU = Miami University, Oxford, OH. OS = Ohio State University, Columbus. UMO = University of Missouri, Columbia. US = U.S. National Herbarium, Smithsonian Institution, Washington, D.C.

ARKANSAS: POLK CO., Rich Mountain, 1949, *Moore 55-481* (herbarium ? cited by Smith 1978)

ILLINOIS: POPE CO., Bell Smith Springs Ecological Area, Shawnee National Forest, along exposures along top edge of bluff, 19 Oct 1991, *Summers 4774* (ILLS); same location, *Bittner 348* (SIU); Lusk Creek Canyon, *Bittner 350* (herbarium ?, not at ILLS)

MISSOURI: DOUGLAS CO., Indian Creek 3.5 mi NE of Topaz, rocky grassy open cherty limestone slopes, 19 Jul 1937, *Steyermark 23350* (MO); 1 mi south of Noblett Lake in Noblett Creek valley, northwest-facing cherty slope, 6 Jun 1992, *Summers 5180* (MO); **HOWELL CO.**, 6 mi SW of Willow Springs, steep wooded chert slope on Noblett Creek, 31 Aug 1990, *Summers 3700* (MO); Twin Sinks 12.5 mi west of West Plains, 29 Apr 1991, *Summers 4204* (MO); **IRON CO.**, Crane Lake, 3.5 mi N of Minimum, ledges of northeast-facing rhyolite bluff, 25 May 1992, *Summers & Dodds 5066* (MO); **LACLEDE CO.**, Wildcat Hollow, 8 mi east of Lebanon, north-facing cherty wooded slopes, 14 Aug 1991, *Summers 4599* (MO); **OREGON CO.**, 6 mi NE of Thomasville, cherty north-facing wooded slope along the Ozark Trail, 29 May 1992, *Summers 5136* (MO); 7 mi NE of Thomasville in Spring Creek Valley in the Mark Twain National Forest, north-facing cherty slopes and sandstone exposures, 2 Jun 1992, *Summers 5167* (MO); **OZARK CO.**, Blue Springs Game Refuge, Gardner National Forest, lower chert slopes in ravine, 12 Sep 1936, *Steyermark 20043* (MO); **ST. FRANCOIS CO.**, ca. 2 mi SE of Doe Run on Weise property, shady woods along small running stream with exposed sandstone bedrock, sandy acid soil, 5 Aug 2000, *Summers, Galvin & Hall 9539* (MO); **SHANNON CO.**, Bay Creek near junction with Jacks Fork River, north-facing chert slope, 31 Oct 1990, *Summers 3919* (MO); **TEXAS CO.**, Barn Hollow, sandstone cap of dolomite cliff above Jacks Fork River, 22 Aug 1993, *Ryan 2002* (UMO); 2 mi SW of Slabtown, north-facing chert slope on Paddy Creek, 7 Sep 1990, *Summers 3739* (MO); **WRIGHT CO.**, 4 mi N of Grove Springs, Fuson Natural History Area, north-facing wooded slopes of ravine, 25 Oct 1990, *Summers & Ryan 3907* (MO).

OHIO: JACKSON CO., Ofer Hollow, Liberty Township, 1 Aug 1934, *Bartley & Pontius s.n.*, (OS - Isotype; US - Holotype); Liberty Twp., 13 Aug 1987, *Cusick 26874* (MU); **VINTON CO.**, Madison Twp., 1 Aug 1979, *Spooner 110* (MU); Madison Twp., 28 Aug 1980, *Spooner 431* (MU); Madison Twp., 30 Aug 1984, *Wrobel-Boerner s.n.* (MU).

APPENDIX 2.

The Distribution of *Calamagrostis porteri* ssp. *insperata* in the United States. Information from herbarium specimens and the literature. [Incomplete]

STATE	COUNTIES	NOTES
Arkansas	Polk	Smith (1978); cites as voucher: *Moore 55-481*
Illinois	Pope	includes Shawnee N.F.; IL Dept. of Natural Resources 2002
Indiana	Clark, Harrison, Scott [9 occurrences in all]	Homoya, pers. comm.
Kentucky	? Menifee, Rowan	see W-2; includes Daniel Boone N.F., Stanton and Morehead Ranger Districts
Missouri	Douglas, Howell, Iron, Laclede, Oregon, Ozark, St. Francois, Shannon, Texas, Wright [southern Ozark section]	see W-2; Steyermark 1963; Yatskievych 1999, pers. comm.; including Mark Twain N.F.
Ohio	Jackson (1 population), Vinton (3 populations)	see W-2, W-3, W-4; Mike Vincent, pers. comm..

APPENDIX 3.

Natural Diversity Database Element Ranking System

modified from: http://www.cnpsci.org/html/PlantInfo/Definitions2.htm [W-5]

Global Ranking (G)

G1
Critically imperiled world-wide. Less than 6 viable elements occurrences (populations for species) OR less than 1,000 individuals OR less than 809.4 hectares (ha) (2,000 acres [ac]) known on the planet.

G2
Imperiled world-wide. 6 to 20 element occurrences OR 809.4 to 4,047 ha (2,000 to 10,000 ac) known on the planet.

G3
Vulnerable world-wide. 21 to 100 element occurrences OR 3,000 to 10,000 individuals OR 4,047 to 20,235 ha (10,000 to 50,000 ac) known on the planet.

G4
Apparently secure world-wide. This rank is clearly more secure than **G3** but factors exist to

cause some concern (i.e. there is some threat, or somewhat narrow habitat).

G5
Secure globally. Numerous populations exist and there is no danger overall to the security of the element.

GH
All sites are historic. The element has not been seen for at least 20 years, but suitable habitat still exists.

GX
All sites are extirpated. This element is extinct in the wild.

GXC
Extinct in the wild. Exists only in cultivation.

G1Q
Classification uncertain. The element is very rare, but there is a taxonomic question associated with it.

National Heritage Ranking (N)

The rank of an element (species) can be assigned at the national level. The **N-rank** uses the same suffixes (clarifiers) as the global ranking system above.

Subspecies Level Ranking (T)

Subspecies receive a **T-rank** attached to the G-rank. With the subspecies, the G-rank reflects the condition of the entire species, whereas the T-rank reflects the global situation of just the subspecies or variety.

For example: *Chorizanthe robusta* var. *hartwegii*. This plant is ranked **G2T1**. The G-rank refers to the whole species range (*i.e.*, *Chorizanthe robusta*, whereas the T-rank refers only to the global condition of var. *hartwegii*. Otherwise, the variations in the clarifiers that can be used match those of the G-rank.

State Ranking (S)

S1
Critically imperiled. Less than 6 element occurrences OR less than 1,000 individuals OR less than 809.4 ha (2,000 ac). **S1.1** = very threatened; **S1.2** = threatened; **S1.3** = no current threats known.

S2
Imperiled. 6 to 20 element occurrences OR 3,000 individuals OR 809.4 to 4,047 ha (2,000 to

10,000 ac). **S2.1** = very threatened; **S2.2** = threatened; **S2.3** = no current threats known.

S3
Vulnerable. 21 to 100 element occurrences OR 3,000 to 10,000 individuals OR 4,047 to 20,235 ha (10,000 to 50,000 ac). **S3.1** = very threatened; **S3.2** = threatened; **S3.3** = no current threats known.

S4
Apparently Secure. This rank is clearly lower than S3 but factors exist to cause some concern (*i.e.*, there is some threat, or somewhat narrow habitat).

S5
Secure. Demonstrably secure to ineradicable in the state.

SH
All state sites are historic; the element has not been seen for at least 20 years, but suitable habitat still exists. Possibly extirpated.
SR
Reported to occur in the state. Otherwise not ranked.

SX
All state sites are extirpated; this element is extinct in the wild. Presumed extirpated.

Notes:

1. Other considerations used when ranking a species or natural community include the pattern of distribution of the element on the landscape, fragmentation of the population/stands, and historical extent as compared to its modern range. It is important to take a bird's eye or aerial view when ranking sensitive elements rather than simply counting element occurrences.

2. Uncertainty about the rank of an element is expressed in two major ways: by expressing the rank as a range of values (*e.g.*, **S2S3** means the rank is somewhere between S2 and S3), and by adding a '?' to the rank (*e.g.* S2?). This represents more certainty than S2S3, but less than S2.