Vulnerability of the rarest plants in the Great Basin of Nevada to climate change

Steve Caicco[1], Fred Edwards[2], and Janet Bair[2]

U.S. Fish and Wildlife Service, Nevada Fish and Wildlife Office, Reno[1] and Las Vegas[2], Nevada

Introduction

Pollen, woodrat midden, tree-ring, and lake level data over the past 50,000 years show the Great Basin is a highly sensitive indicator of climatic change (Wharton et al. 1990). In the 20th Century, warming of 0.3 to 0.6 °C has occurred and projections for the next century range from 2 to 5 °C warmer; precipitation changes are less certain but include a greater proportion as rain, decreasing winter snowpack, and earlier arrival of spring affecting runoff and plant phenology (Chambers 2007).

Endemic plant species are expected to be at far greater risk of extinction from climate change (Committee on Environment and Natural Resources 2008). Our assessment focuses on the vulnerability of the rarest endemic plants of the Great Basin of Nevada based on their reported elevation range. Our underlying assumption is that those narrow endemic plants with the most restricted distribution in terms of elevation are likely to be the most vulnerable to climate change.

Methods

Reported elevations for known populations of all G1, G2, T1 and T2 plant taxa (see Global Ranking System definitions in box below) in the Great Basin of Nevada were compiled and summarized by taxon.

Eriogonum argophyllum (G1), known from a single site of less than 1 acre with an estimated 2,000 plants on siliceous sinter associated with a thermal spring. (Photo credit: Steve Caicco, USFWS (public domain)

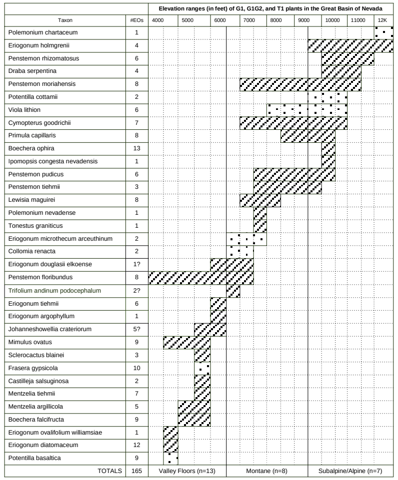
Castilleja salsuginosa (G1), confirmed from two sites, with an estimated total of 3,000 plants on several acres; found on alkaline clays and shallow sinter soils associated with a thermal spring. (Photo credit: ©Steve Caicco, Planet Plants)

Global Ranking System (*www.natureserve.org*)

G1	**Critically Imperiled**—At very high risk of extinction due to extreme rarity (often 5 or fewer populations), very steep declines, or other factors.
G2	**Imperiled**—At high risk of extinction due to very restricted range, very few populations (often 20 or fewer), steep declines, or other factors. Combined ranks indicate a range of uncertainty about the actual rank; these taxa were conservatively assigned the higher ranking.
T1 T2	Ranks assigned to an infraspecific taxon, i.e., a subspecies or variety; criteria are the same as those for G1 and G2 ranks.

Results

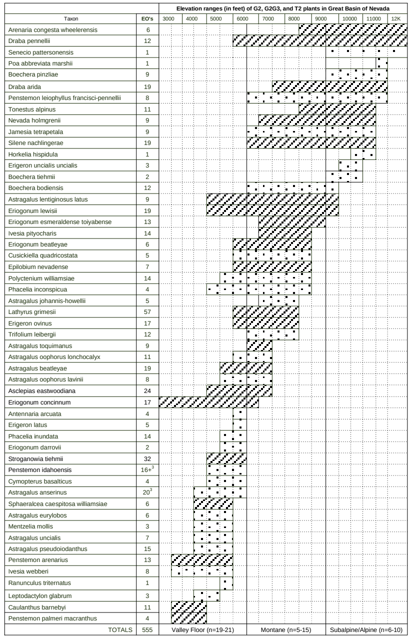
While rare plants occur at all elevations in the Great Basin of Nevada, most of the rarest plants (G1, G1G2, and T1), nearly 80% of which are Nevada endemics, occur on valley floors often within an elevation range of several hundred feet (Figure 1). The number of taxa (n=13) found only on valley floors is nearly equal to that found only in higher habitats combined (n=15). Moreover, most higher elevation taxa occur through a thousand feet or more of elevation range.



Taxon	#EOs
Polemonium chartaceum	1
Eriogonum holmgrenii	4
Penstemon rhizomatosus	6
Draba serpentina	4
Penstemon moriahensis	8
Potentilla cottamii	2
Viola lithion	6
Cymopterus goodrichii	7
Primula capillaris	8
Boechera ophira	13
Ipomopsis congesta nevadensis	1
Penstemon pudicus	6
Penstemon tiehmii	3
Lewisia maguirei	8
Polemonium nevadense	1
Tonestus graniticus	1
Eriogonum microthecum arceuthinum	2
Collomia renacta	2
Eriogonum douglasii elkoense	1?
Penstemon floribundus	8
Trifolium andinum podocephalum	2?
Eriogonum tiehmii	6
Eriogonum argophyllum	1
Johanneshowellia crateriorum	5?
Mimulus ovatus	9
Sclerocactus blainei	3
Frasera gypsicola	10
Castilleja salsuginosa	2
Mentzelia tiehmii	7
Mentzelia argillicola	5
Boechera falcifructa	9
Eriogonum ovalifolium williamsiae	1
Eriogonum diatomaceum	12
Potentilla basaltica	9
TOTALS	165

Figure 1. Known distribution of rarest plants (G1, G1G2, and T1 ranks) in the Great Basin of Nevada by elevation range; Nevada endemics are shown in diagonal hatch. Number of known element occurrences (EO's) is shown in column 2. Total numbers of E0's and the number of taxa occurring exclusively in valley floor, montane, and subalpine/alpine habitats are shown in the bottom row.

A similar pattern is seen in G2, G2G3, and T2 taxa (Figure 2), although an even higher proportion of these taxa is found exclusively on the valley floors. Only 43% are Nevada endemics and some others have their primary range in other states. In addition to being more common, these taxa typically are found through a greater elevation range. Because of their generally broader distribution, fewer taxa are exclusive to the higher life zones. Variation in the actual elevation of the life zones across the state makes the species assessment more subjective and totals are given as ranges.



Taxon	EO's
Arenaria congesta wheelerensis	6
Draba pennellii	12
Senecio pattersonensis	1
Poa abbreviata marshii	1
Boechera pinzliae	9
Draba arida	19
Penstemon leiophyllus francisci-pennellii	8
Tonestus alpinus	11
Nevada holmgrenii	9
Jamesia tetrapetala	9
Silene nachlingerae	19
Horkelia hispidula	1
Erigeron uncialis uncialis	3
Boechera tiehmii	2
Boechera bodiensis	12
Astragalus lentiginosus latus	9
Eriogonum lewisii	19
Eriogonum esmeraldense toiyabense	13
Ivesia pityocharis	14
Eriogonum beatleyae	6
Cusickiella quadricostata	5
Epilobium nevadense	7
Polyctenium williamsiae	14
Phacelia inconspicua	4
Astragalus johannis-howellii	5
Lathyrus grimesii	57
Erigeron ovinus	17
Trifolium leibergii	12
Astragalus toquimanus	9
Astragalus oophorus lonchocalyx	11
Astragalus beatleyae	19
Astragalus oophorus lavinii	8
Asclepias eastwoodiana	24
Eriogonum concinnum	17
Antennaria arcuata	4
Erigeron latus	5
Phacelia inundata	14
Eriogonum darrovii	2
Stroganowia tiehmii	32
Penstemon idahoensis	16+[3]
Cymopterus basalticus	4
Astragalus anserinus	20[3]
Sphaeralcea caespitosa williamsiae	6
Astragalus eurylobos	6
Mentzelia mollis	3
Astragalus uncialis	7
Astragalus pseudoiodanthus	15
Penstemon arenarius	13
Ivesia webberi	8
Ranunculus triternatus	1
Leptodactylon glabrum	3
Caulanthus barnebyi	11
Penstemon palmeri macranthus	4
TOTALS	555

Figure 2. Known distribution of rare plants (G2, G2G3, and T2 ranks) in the Great Basin of Nevada by elevation range; Nevada endemics are shown in diagonal hatch. Number of known element occurrences (EO's) is shown in column 2. Total numbers of E0's and the range of the number of taxa occurring predominantly in valley floor, montane, and subalpine/alpine habitats are shown in the bottom row.

Conclusions

The rarest plants in the Great Basin of Nevada occur at the lowest elevations (Figures 1, 2). Their sites are often on valley floors where they are typically restricted to specialized edaphic conditions such as old lake beds, associated alkaline and carbonate deposits including ancient spring mounds, heavy clays and/or siliceous sinter deposits associated with thermal springs, diatomite deposits, volcanic tuffs, and aeolian sands. Such habitats usually occur only within a few hundred feet of elevation range and seldom exist above the valley floor.

Although alpine ecosystems are often identified as among the most susceptible to climate change, the rarest alpine plants in our study area usually occur through a thousand feet or more of elevation range. While earlier springs, higher temperatures, and changes in precipitation and/or snowpack patterns could affect plants at all elevations, rare taxa at the lowest elevations are unlikely to be able to move to more climatically suitable sites since most are adapted to specialized habitats that do not exist above the valley floors. We conclude, therefore that rare plants at lowest elevations in the Great Basin of Nevada are the most vulnerable to climate change. In addition, these valley floor taxa are also more susceptible to other stressors such as habitat modification or destruction and invasive species.

Conservation Strategies

While monitoring is essential for determining the trend of these taxa, sufficient resources will not likely be available to adequately monitor more than the rarest. In some cases, we may be able to design efficient monitoring programs for multiple species occurring in the same habitat but it is likely that many populations will become extirpated through undetected decline, leading to eventual species extinctions.

The restriction of many of these taxa to specialized habitats may constrain or preclude such mitigation options as assisted colonization (Hoegh-Guldberg et al. 2008), if similar habitats do not exist elsewhere. Genetic resources within these plants can, however, be conserved in long-term seed banks (Guerrant et al. 2007). An integrated and comprehensive program of seed collection and *ex-situ* storage for rare plants is urgently needed. The Bureau of Land Management's *Seeds of Success* project, though focused on common species, provides a model on which an effort for rare species can be based. The Center for Plant Conservation has a well-established infrastructure for long-term seed storage in regional seed banks at partner institutions.

While seed banking should not supplant on-the-ground conservation efforts, we cannot predict which of these taxa are most vulnerable to climate change. Climate change aside, the rarity of these taxa is sufficient justification for a seed banking program. To preserve a full range of conservation options for the future, representative, and where appropriate, redundant collections of the genetic resources of these species should be conserved before they are lost forever.

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For further info, contact: Steve_Caicco@fws.gov (775.861.6341).
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