Gratiola heterosepala* Mason & Bacig.** is a peripheral endemic known from one occurrence (elevation 5360 feet) in Lake Co., Oregon, and from sixteen additional sites within seven counties in northern California. An annual member of the Scrophulariaceae, it is found on clayey soils in shallow water and at the margins of vernal pools and stock ponds. The species flowers from mid-June to mid-July and is believed to be facultatively autogamous (L. Housley, *pers. comm.*). Field observations have shown no evidence of pre-dispersal seed predation, and seeds are likely dispersed by migrating waterfowl. Associated species include ***Downingia *Zaeta, Marsilea vestita, Plagiobothrys scouleri* var. *penicillatus, Eleocharis palustris,* and *Camissonia* sp. surrounded by a *Juniperus occidentalis/Artemisia arbuscula/Poa sandbergii* community. An exclosure established in 1993 on the Lakeview District BLM is being monitored to determine the effects of grazing on the species. Data collected between 1982 and 1991 shows population size at the Oregon site ranging from 2000 to 18,000 individuals. Potential threats include early season grazing, invasion by exotic species, and development in some areas. Population trends are currently considered stable.

***Grindelia howellii* Steyermark** is a regional endemic with a bimodal geographic distribution; most of the occurrences are in west-central Montana, with several small occurrences also known in a very small area in north Idaho. It prefers southerly aspects in bluebunch wheatgrass/Sandberg bluegrass grasslands and openings in ponderosa pine and Douglas fir stands. The Montana occurrences, of which 60 are currently known to be extant (Pavek 1991), are in Missoula and Powell counties, in the Blackfoot, Clearwater and Swan River drainages (Shelly 1986). This species is found in a variety of disturbed and natural habitats, including roadsides, grazed pastures, pine plantations, forest openings, river terraces and native grasslands (Lesica and Shelly 1991). Numerous occurrences in Montana are adventive in disturbed habitats. Despite this ruderal response, populations in undisturbed grasslands are very uncommon. For this reason, and because the adventive populations are in most cases not likely to be viable over the long term, *G. howellii* has been retained as a Category 2 federal candidate. Follow-up surveys at 27 known sites in 1990 revealed that 10 occurrences had increased in numbers of plants, 15 had decreased, and two populations were essentially unchanged in size; ten locations have no new data available since 1986. Thus, as of 1990, a total estimate of about 16,000 individual plants, in 50 populations, was made (Pavek 1991). One of the largest populations, in native grassland habitat, was partially sprayed with herbicide in 1989, and is much smaller in size now (Pavek 1991). The invasion of its preferred sites by exotic plants is the greatest threat to the viability of this species. Historic changes in disturbance regimes and road construction are secondary but important threats. A species management guide for *G. howellii* on the St. Joe National Forest was prepared four years ago (Lorain 1991b).

***Hackefia cronquistii* J.L. Gentry** is a regional endemic of the Owyhee Uplands and adjacent Idaho. It is known from forty-one occurrences comprising four population centers in Malheur Co., Oregon, and from one population center in Idaho. It can sometimes be found with *Astragalus mulfordiae*. Some populations have hundreds of plants, and one has thousands, but many are very small. In recent years, a number of new sites in Oregon have been reported from the Vale District BLM (J. Finley, *pers. comm.*). *Hackelia cronquistii* grows in communities of *Artemisia tridentata* ssp. *wyomingensis, Festuca idahoensis,* and *Oryzopsis hymenoides. H. cronquistii* probably requires small mammals to disperse its fruits. The species is generally

found on north-facing slopes of sandy hills, in topographic depressions that hold late-season snowpack (nival zone). Site elevations range from 2100 to 3100 feet. Soils are sandy loams, possibly with argillic horizons (clay at 14-16"), that retain moisture close to the surface. Livestock grazing and exotic plant species (and the consequent increase in fire frequency) are considered the preeminent threat. The species is somewhat palatable and is highly impacted both by intense grazing and trampling. Rested sites are recovering, and it believed that population trends are stable to increasing. Off-road vehicle (ORV) traffic is a threat, and at least one site is heavily impacted. Catastrophic fires and conversion of sites to agricultural land or pasture are also potential threats.

***Hackelia venusta* (Piper) St. John** is a local endemic to Chelan County in Washington. There are three occurrences, all on National Forest Service land. A perennial, it grows in dry loose granitic sand and crevices in granite or talus. It ranges from 1000 to 7400 ft. in elevation. Disturbance may be necessary to maintain populations. Exotic plant invasion and road sanding are the greatest threats. Since it is does not compete well with other plants, fires removing competing vegetation are probably beneficial and fire suppression would affect it negatively.

***Haplopappus insecticruris* Henderson** is a local endemic found exclusively on the Camas Prairie of central Idaho and in some related meadow complexes immediately westward toward Cat Creek (in Camas and Elmore Counties, respectively). It is currently restricted to vernally wet meadows and flats with shallow, basalt derived soils. Approximately 99% of this species former habitat has been converted to agricultural uses. Population trends currently appear stable though significantly reduced from historic numbers. Extensive surveys for this species in 1994 (Blackburn) located many new populations on the northwest margin of its range. There is some inconsistency in the plants' response to livestock grazing and trampling so that it is currently unclear whether that activity is in conflict with the conservation of this species. Introduced species, land conversion, and herbicide use seem to pose the greatest consistent threats to today's populations.

***Haplopappus liatriformis* (Greene) St. John** is a regional endemic that was once widely distributed throughout the Palouse Prairie of southeastern Washington and the Craig Mountain area in adjacent Idaho. There are 26 sites in Spokane, Whitman, and Benton Counties of Washington. Most populations are under 100 individuals. Found in deep, well drained, loess soils between 2,000 and 4,800 feet, *H. liatriformis* shuns forested sites but can occur in grassland/ponderosa pine mosaics throughout its range. *H. Ziatrijbrmis occurs* with some of the other Palouse endemics and grows best in stable sites in good ecological condition and does poorly in areas grazed or weedy. Most populations of this species are very small and suffer from extreme fragmentation and isolation. All are threatened by land conversion, grazing, and herbicide spray and drift. Additionally, the invasion of exotic species is making much of *H. Ziatrijbrmis'* habitat unsuitable. The greatest challenge to the conservation of this species is that most populations occur on private land.

***Haplopappus radiatus* (Nutt.) Cronq.** is a regional endemic of the Owyhee Uplands and Blue Mountains province on the hillsides in the southern end of the Snake River Canyon , with five occurrences in northern Malheur County, Oregon, and is known from Idaho County, Idaho, and

34 occurrences in southern Baker County. It is found on steep (10-90% slope) rocky hillsides and gravely terraces at elevations between 1800 and 6,100 feet although most populations are found below 3,500 feet. *H. radiatus* occurs on basalt derived soils with high clay content or calcareous derived soil, possibly from shale. Populations across the taxa's range appear to be decreasing. Sites are relatively harsh and barren, with communities often typified by *Artemisia tridentata* and *Agropyron spicatum.* It is sensitive to annual levels of precipitation, with late summer rains appearing to be essential for this species to complete its reproductive cycle and population vigor has been observed to decline when less that 11 inches of precipitation per year. The threats to *H. radiatus* are numerous and include livestock grazing, introduced exotic plant species (and the consequent change in the historic fire regime), herbicide spray and drift, and insect seed predation. Less immediate but important threats stem from mining (at least at some sites), timber harvest, and road construction (Mancuso and Moseley 1993b). Grasshoppers also threaten some populations in years of insect outbreaks. Invasion of exotic weeds is impacting both plant survival and seedling establishment. Therefore, it is threatened by increased fire frequency and/ or intensity, and a disrupted historical pattern of wildfires. Road work activities exacerbate this situation by causing further soil disturbance and by facilitating increased traffic (more seed vectors).

***Howellia aquatilis* A. Gray** is a monotypic genus with a scattered geographic distribution in the Pacific Northwest. The following information has been compiled from numerous status reports, publications and monitoring studies, including Gamon 1992, Lesica 1992, Lesica et al. 1988, Roe and Shelly 1992, Schassberger and Shelly 1991, Shelly 1988, Shelly 1989, Shelly and Moseley 1988, and Shelly and Schassberger 1990. *Howellia aquatilis* is known to be extant in the states of Idaho, Montana and Washington. It is historically known to have occurred in California (central Coast Range) and Oregon (in the Willamette Valley and near Portland); these previously known sites have not been relocated despite intensive field surveys in both states. Within its extant range, *H. aquatilis* is currently known from a total of 110 occurrences. There are two main centers of distribution within this range - one in the Swan River valley in Montana (58 occurrences), and one in the vicinity of Spokane, Washington (48 occurrences) mostly on public land, where population sizes vary from one to 1000 plants found from 400 to 2320 ft. in elevation. Two occurrences are known in northern Idaho in private ownership, and two others are found in western Washington. Despite this seemingly large number of occurrences, the total occupied habitat known worldwide is less than 100 acres. The Montana occurrences are all in Lake and Missoula counties. *Howellia aquatilis* is strictly aquatic and is also an annual. The plants typically bloom by June in Montana; they continue flowering until late summer, depending on how quickly the wetland habitat dries out. The species is restricted to small pothole ponds or the quiet water of shallow, abandoned river oxbows. These wetland habitats typically occur in a matrix of dense forest vegetation. All known sites have at least some deciduous tree cover (usually aspen, but sometimes birch) around a portion of the pond. *Pinus ponderosa* forests surround the ponds and *Cornus stolonifera* is usually present along the perimeters. The bottom surfaces of the wetlands consist of firm, consolidated clay and organic sediments. These wetlands are generally filled by snowmelt run-off and spring rains, but then dry out to varying degrees by late summer or early fall, depending on annual patterns of temperature and precipitation. In the Swan River valley of Montana, the small ponds in which it grows lie in depressions that were left as the continental glaciers retreated approximately 10,000

years ago. These depressions occur where blocks of ice, buried in the glacial till, later melted. The ponds are typically shallow, averaging one to two feet deep during the middle of summer. This drying is critical to the species' life cycle; the seeds will only germinate if they are exposed to the atmosphere. After the seedlings appear, usually in October, they overwinter under the snowpack. Then, in late spring and early summer the plants resume growth in the water that accumulates in the ponds. This ecological relationship has a profound influence on the size of the occurrences from year to year; the summer climate determines the degree of pond drying, and hence the amount of seed germination in the fall. If fall seed germination is much reduced, few plants are present the following summer. These highly specialized ecological adaptations make *H. aquatilis* vulnerable to a variety of natural environmental changes over the short and long term, such as advancing vegetation succession or climate change. However, the species has also been affected by land management activities and habitat destruction as well. In Oregon, most of the historical locations are within urban or suburban areas that have been extensively developed, and unsuccessful field surveys in the remaining habitat in these areas indicates that these sites have been lost. Additionally, construction of dams along the Columbia and Willamette rivers has led to a decline of suitable wetland habitats. Elsewhere in its range, including the historical location in California, livestock grazing and trampling may have eliminated occurrences. In Montana, timber harvesting has occurred immediately adjacent to a number of occupied ponds, with resultant effects on the habitat. Also, roads built immediately adjacent to some ponds have resulted in increased sedimentation from road dust. In the bottomlands near the Idaho occurrences, habitat has been altered by roads, residential housing, and cultivation. Historic sites in Idaho are known to have been extirpated and the unique vernal pools that this species occupies are threatened range-wide by sedimentation, invasion of exotic species, and alterations in hydrology (including the drainage of wetlands). In Washington, several ponds near known occurrences have been altered to improve waterfowl habitat. Habitat encroachment by *Phalaris arundinacea* (reed canary grass), an aggressive wetland species, is also occurring in Montana and Washington, where all sites have been invaded. Monitoring of plant numbers in selected ponds has revealed annual fluctuations from over a thousand plants to fewer than a dozen. This fluctuation means that the seed bank is of great importance to the long-term persistence of the occurrences. The longevity of the seeds is unknown, but studies indicate that it may be short. Lesica et al. (1988) found no detectable genetic variation, either within the occurrences or across the range of the species; this is also very unique, especially considering the species' annual life cycle and wide geographic distribution - factors that typically promote genetic variation. *Howellia aquatilis* was federally listed as threatened by the U.S. Fish and Wildlife Service (USFWS) in July, 1994. In addition, the Flathead National Forest in Montana is in the process of amending its Forest Plan to adopt conservation measures for the species, including a recently approved conservation strategy (Mantas 1995). This strategy provides protection around occupied, as well as suitable but unoccupied, habitats.

Iliamna longisepala **(Torr.) Wiggins** regional endemic in Washington. In the Columbia River Basin Province, it occurs at 13 sites in Douglas, Chelan, and Kittitas Counties. Ten of these sites are on private land. Populations are small in size, usually less than 30 individuals. This showy shrub occurs in relatively lush riparian areas, but on the periphery of the riparian vegetation in draw bottoms, mid-slopes and upper slopes. It inhabits relatively dry, well-drained sites, which are generally within microsites that may retain water longer than adjacent microsites. Fire

suppression is detrimental to this plant. Changes in riparian vegetation associated with land-use could have negative impacts. Exotic weed invasion is also a threat as well as activities in the riparian area that impact the structure, function and species composition of the plant community.

Ivesia rhypara* B. Ertter & Reveal var. *rhypara is regional endemic to northern Nevada and a small portion of southeastern Oregon. This species occurs on poorly developed soils derived from hydrothermally altered welded tuff. It prefers sites at elevations between 5,390 and 5,600 feet with a southerly aspect. This plant is strongly impacted by livestock trampling and also suffers threats from mining, exotic plant species, road maintenance, range improvements, and fire suppression activities. Population trends for this species is in decline in Oregon.

***Ivesia rhypara* Ertter & Reveal var. *shellyi* Ertter** is a local endemic found in the Basin and Range physiographic province, in Lake and Harney Cos., Oregon. It was discovered in 1985 by Steve Shelly, then a BLM botanist. It is known from four occurrences within three distinct population centers, in canyons and near Juniper Mountain, east of Alkali Lake. All known sites are on federal land. The species occupies microsites created by eroding pumice inclusions within tuffaceous outcrops, generally on steep to vertical rock faces. Some populations are reported to be extremely large and cover extensive areas of rimrock. Threats to the species are minimal, and populations are considered stable.

***Lathyrus grimesii* Barneby** is a local endemic know only from the Independence Mountains of northern Nevada. It occurs on stony, clay rich soils and talus slopes in an elevational band between 6,100 and 8,300 feet. Important threats to populations of *L. grimesii* include livestock grazing, mining, the impacts of exotic plants (and the herbicides used to control them), and changes in the historic fire regime. Populations of this species are often large and currently appear to be stable.

***Lepidium davisii* Rollins** is a regional endemic with highly specific habitat requirements that is native to southwestern Idaho and adjacent Oregon. It only occurs in barren (<5% cover), internally drained and seasonally flooded, hard bottomed playas within an elevational band between 2,500 and 5,000 feet. Waterfowl are believed to aid in seed dispersal. Playa surveys in recent years have added considerably to the knowledge of this species' range. These playas are widely distributed in the range of *L. duvisii* but are infrequent and are disappearing rapidly. Playas become unsuitable habitat if they are compacted (as happens when livestock congregate there), disturbed by OHV traffic (a common occurrence), or are invaded by exotic plant species (attributable to several causes). Several populations have been lost in the last two decades from reservoir development and the increase in range fire frequency. Overall, this species is in marked decline, especially in the portion of its range north of the Snake River. Monitoring of this species is ongoing at Mountain Home Air Force Base (Bernatas and Moseley 1991). A BLM Conservation Agreement signed with the USFWS in 1995 protects sites on the Vale and Burns Districts, Oregon.

***Lepidium papilliferum* (Henderson) A. Nelson & J.F. McBride** is a regional endemic native to the Snake River Plains of southwestern Idaho. Like *L. davisii,* this species' preferred habitat is the bottom of small, internally drained playas (slick spots). *L. papilliferum* occasionally occurs

with *Texosporium sancti-jacobi*. This species is in decline throughout its range due to many threats, especially land development, livestock grazing (most through the action of trampling and soil disturbance in the slick spots), and exotic plant species (that both invade the disturbed slick spots and have increased the historic fire frequency). There are populations of *L. papilliferum* on the military training range south of Boise, Idaho that are threatened by tank traffic. Both the Boise District BLM and the Army National Guard are currently involved in monitoring and population genetics studies of *L. papilliferum* and the most recent status survey for this species is Moseley (1994).

Leptodactylon gfabrum **Patterson & Yoder-Williams** is a local endemic native to the canyons of southwestern Idaho and adjacent northern Nevada. It prefers to grow on rhyolitic cliff faces and overhangs within an elevational range of 3,300 and 4,500 feet. This species is currently being monitored in the Bruneau River Canyon of southern Idaho. Though nearly nothing is known about this species' biology, there seems to be no significant discernible threats. If there were hydrological developments in the Bruneau River Canyon a significant proportion of this species could be lost.

Leptodactylon pungens **(Torrey)** ***Nutt.*** **ssp.** ***hazeliae*** **Meinke** is a local endemic restricted to south and west aspect vertical basalt cliff faces in the middle Snake (Hells Canyon) and lower Salmon River corridors at elevations between 975 and 2,000 feet. Populations of this species appear to be stable though some loses occurred in the past when the reservoirs on the Snake River were filled. Seedling establishment has never been observed. Most of the known populations are near popular trails or roads and thus may be threatened by maintenance activities. Today, the only significant threat to this species is drift from herbicide spraying to control noxious weeds (especially yellow starthistle, *Centaurea solstitialis*).

Lesquerella carinata **Rollins var.** ***carinata.*** is a regional endemic known from the Lemhi and Lost River Ranges in Idaho and Teton County, Wyoming. It prefers rocky foothill slopes and ridges of limestone, slate and shale and the gravel of sparsely vegetated slopes and ridgecrests in the mountains at elevations between 6,500 and 8,500 feet. The vegetation at *L. carinata* sites is typically low. Though this species is often found on calcareous substrates it is not restricted to such sites. *L. carinata* is fairly common within its range.

Lesquerella carinata **Rollins var.** ***languida*** **Rollins** is a local endemic restricted to the Garnet Range in west-central Montana. This newly described variety (Rollins 1993) is currently known from four occurrences, all in Granite County, and the total known occupied area is about 200 acres (Vanderhorst 1995). It is confined to substrates derived from the Mission Canyon limestone of the Madison group (Schassberger 1991), and at least much of its range is confined to a zone of high calcium limestone. It grows in loose, gravelly soils, usually on steep, southerly exposed slopes with a hot, dry microclimate. It occurs in the ponderosa pine zone, in open woodlands, bitterbrush shrublands, grasslands, and on barren scree slopes. The taxon is insect-pollinated and primarily outcrossing, although selfing has been detected (Greenlee 1994). Evidence of a seed bank was found in monitoring transects at one site, where over twice as many seedlings were born in 1993 as the number of seeds calculated to have been produce in the plots in 1992 (Greenlee 1994). Populations of *Lesquerella carinata var. languida* are capable of high

levels of reproduction but may also be subject to high mortality. The populations may go through boom/bust cycles, with high seedling establishment, low mortality, and high population growth rates in favorable (moist) years, but few seedlings, high mortality, and population decline in stressful (dry) years (Greenlee 1994). The primary threat to populations is invasion by spotted knapweed, which has been shown to negatively impact growth and survival (Greenlee 1994). Removal of knapweed from experimental plots increased vigor and, most importantly, adult survivorship. Damage by aerial herbicide spraying and cattle trampling has also been observed (Achuff and Roe 1992; Schassberger 1991). Also, adults and seedlings were found to have a positive spatial relationship with bunchgrasses at a relatively hot, dry site; the taxon appears to use bunchgrasses as nurse plants in stressful years, but not in less stressful years (Greenlee and Calloway in prep.; Greenlee 1994). This taxon is currently proposed by the Bureau of Land Management for sensitive status on such lands in Montana (USDI Bureau of Land Management 1993), but no management policy or plan is currently in place for it. It has been recommended that this taxa be changed to a Category 1 federal candidate, owing to its limited range and threats from invasion of spotted knapweed (Vanderhorst 1995).

Lesquerella humilis **Rollins** is a local endemic, narrowly restricted to four small occurrences in the Bitterroot Mountains in Ravalli County, Montana. This species is one of the rarest plants in Montana, with approximately 2,500 to 3,000 individuals observed during the course of recent surveys (Montana Natural Heritage Program database records, Helena). It occurs at elevations from *6,900* to *9,587* feet, in krummholz stands of *Pinus albicaulis*, and in open, windswept alpine areas (Lesica and Shelly 1991; Shelly 1988). As with many taxa in the genus *Lesquerella*, it occurs in open, rocky substrates, in this case on metamorphic substrates influenced by granitic intrusions. These metamorphic rocks, mostly gneiss and schist, were locally penetrated by granite in the northern portion of the Bitterroot Mountains, and the rocks are reddish-orange in color; thus, the species appears to be edaphically restricted to this area of unusual bedrock geology (Shelly 1988). While the majority of the species' range lies within or on the border of the Selway-Bitterroot Wilderness Area, it is of conservation concern owing to its rarity. One occurrence is being impacted by recreational use, as a popular hiking trail traverses a portion of the occupied habitat (Achuff 1990; Shelly 1988). A small portion of a recently discovered population occurs in an area disturbed during the construction of a dam, but the majority of this occurrence is in undisturbed, native habitat (Montana Natural Heritage Program database records, Helena). Intensive surveys on adjacent summits, and throughout the Bitterroot Range, have failed to locate any additional populations (Achuff 1990; Shelly 1988). A species management plan should be prepared for this taxon.

Lesquerella paysonii **Rollins** is a regional endemic, currently known to occur in Idaho, Wyoming and southwest Montana. This species occurs on barren, rocky slopes and ridgelines at elevations between 6,300 and 10,000 feet. Its preferred substrates are gravely and calcareous though it is also known from talus, residuum, and areas of mass wasting. The known range of this taxa has been greatly expanded in the last five years due to greater survey intensity in western Wyoming, where populations in Wyoming are more abundant than in southeastern Idaho. The taxonomic disposition of the single occurrence suspected in Montana is currently being reevaluated, but is likely to be this species (B. Heidel, pers. comm.). Invasion by spotted knapweed is occurring along the lower slopes at this site, but has not seriously spread into the

majority of the habitat. Light grazing of the associated grasslands has occurred in the past, but does not seem to have adversely affected much of the population. The area where *L. paysonii* occurs has been proposed as a Botanical Special Interest Area by the Deerlodge National Forest; if this designation is completed, a management plan should be developed for the area and the rare species that occur there, including *L. paysonii.* Oil and gas exploration, mining and the invasion of noxious weeds are threats to this species.

***Lesquerella* sp. novum ("*pulchella*")** is a regional endemic in southwest Montana. It is currently known from seven sites in Beaverhead County, at elevations from 6,320 to 9,600 feet in the Centennial and Pioneer mountain ranges (Heidel 1993). This taxon, which was previously thought to represent *L. carinata*, has been determined to represent a new, undescribed species by Dr. R.C. Rollins, Harvard University (Heidel 1993). Within its geographic range, it is nearly restricted to Madison Group limestone. It is further restricted to plant communities where groundcover is open and competition is reduced. Lower, foothills populations are in dry Agropyron spicatum communities or *Cercocarpus ledifolius* communities. Upper elevation populations are in dry grasslands or open parklands of *Pinus albicaulis* and *A bies Zusiocarpa* on north and east aspects, extending down into *Pseudotsuga menziesii-Carex geyeri* association on south aspects (Heidel 1993). Three foothills sites are in grass-dominated communities grazed by livestock. While no plants appeared to be grazed, they are potentially affected by trampling by livestock. The upper-elevation sites in the Pioneer Mountains are in an area of concentrated mining activity, and active mines or mining claims are adjacent to five occurrences. Timber harvesting and weed invasion are not currently threatening the known occurrences (Heidel 1993). It is recommended that this taxon be designated as sensitive by both the USDA Forest Service and the USDI Bureau of Land Management (Heidel 1993).

***Limnanthesfloccosa* How. ssp. *bellingeriana* (Peck) Arroyo** is a regional endemic found on volcanic plateaus in southern Jackson and Klamath Cos., Oregon, and in north central California. Twenty-six occurrences are reported from BLM and private lands in Oregon, with the greatest concentrations found near the rim of the Klamath River Canyon. Seven of the 15 Oregon records are of the populations are within the ICBEMP assessment boundary. Subspecies *bellingeriana* is found in moist meadows and vernal pool habitats, in intermittently wet, stony flats. Soils range from extremely stony or gravelly loams to clay loams. Soil permeability is low in some sites, resulting in seasonal ponding within microtopographic depressions. Sites in Oregon are on level or moderately sloping ground at elevations between 1800 and 4200 feet. All reported sites occur within or adjacent to open coniferous forest dominated by *Pinus ponderosa,* often in association with *Quercus garryana.* Adequate moisture from winter and spring precipitation is required for successful fruit production, and for fall seed germination. A facultatively autogamous annual species, *L. floccosa* ssp. *bellingeriana* generally drops its seed in the immediate vicinity of the parent plant, although some seed may be dispersed by rodents or large herbivores. Potential threats to the species include catastrophic fire, grazing, trampling and soil compaction due to livestock activity, and timber harvest activity, including skidding and site preparation. Population trends are unknown at this time. A BLM Conservation Strategy for populations in Oregon is in preparation (1995).

***Lomatium erythrocarpum* Meinke and Const.** is a small, highly restricted local endemic. Six occurrences (Brooks 1995) are known from the Elkhorn Mountains of Baker County in Northeast Oregon. It is found between 7,000 and 8,500 feet in elevation on steep, dry, south slopes. It is found on alpine and subalpine barrens, gravelly granodiorite soils and argillite talus. Less typically it can be found on limestone substrates (Brooks 1995). It tends to grow on the ecotone between the shrub-steppe and subalpine woodland (Meinke and Constance 1984) or among whitebark pine with a canopy cover less than 20%. It frequently grows in association with *Polygonium phytolaccaefolium*, and high elevation stands of *Cercocarpus ledifolius* and *Artemisia tridentatu.* This geographically restricted, high elevation species is threatened by global warming, as refugia are limited. If populations of mountain goats in the Elkhorn Mountains increase dramatically their foraging and trailing activities could be an impact.

***Lomatium greenmanii* Mathias** is a local endemic species. It is only known from two occurrences, on Mount Howard and Ruby Peak in the Wallowa Mountains, Wallow County, Oregon. It is found between 7,500 and 9,000 feet in elevation, mostly on a course substrate of fractured basalt altered to greenstone, and influenced by adjacent Hurwall limestone formations. *L. greenmanii* inhabits ridgetops and low to moderate slopes on alpine scree, barrens, and turf. Occasionally it is found among sparse whitebark pine parklands. Primary associated species include *Eriogonum ovalifolium* ssp. *depressurn, Castilleja chrysantha,* and *Trisetum spicatum* (Kagan 1987b) Its mountain top habitat makes this parsley vulnerable to global warming. The Mount Howard population is situated among a network of trails fed by a tourist tramway, where an average of 25,00 people per season visit this location each summer (Hustafa 1995). There are significant threats at this site from trail deterioration, trail maintenance and trampling from off-trail hikers. Recent efforts to modify and control the pattern of use has been met with limited success. Monitoring of this species, initiated in 1992 by the Oregon Department of Agriculture should indicate whether the populations on Mount Howard are in decline or stable.

***Lomatium ochocense* Helliwell and Constance.** is a very restricted local endemic that was discovered in 1994. Currently it is known from one occurrence (population) on the Ochoco National Forest and four occurrences on the Prineville District of the BLM in the Ochoco Mountains of Crook County, Oregon along the North Fork of the Crooked River. It has been found between 1300 and 1400 meters in elevation, on basalt scablands (tablelands). In 1995, populations ranged from 25 to 10,000 individuals. It grows on shallow basalt lithosolic soils classified as Clayey-skeletal, frigid Argixerols. Here it is restricted to terrain where there is exposed fractured bedrock (Picture Gorge formation) supporting an *Artemisia rigida/Poa sandbergii* plant association (Helliwell & Constance 1995). In addition, *Oryzopsis hendersonii* was found at the Type location as well as four other Lomatium species. It is currently being submitted for publication (Helliwell & Constance 1995).

***Lomatium suksdorfii* (S. Wats.) Coult. & Rose** is a regional endemic of the Columbia River Gorge portion of the East Cascades. It is known from five occurrences in Hood River and Wasco Counties, Oregon, and from Klickitat County in the Klickitat and White Salmon River drainages in Washington with the largest population in Oregon in private ownership. Approximately half of the 23 occurrences in Washington are on public land in the Columbia River Basin Province. Populations usually consist of several hundred individuals. The species is found growing on

exposed, rocky, steep to shallow slopes supporting *Quercus garryana,* and often *Pinus ponderosa* and *Juniperus occidentalis* woodlands. Common herbaceous associates are *Agropyron spicatum* and *Balsamorhiza sagittata.* Substrates include poorly developed mineral soils, sands, and loams, with a fair amount of rock on the surface and basalt outcrops; but not on ridgelines or in draw bottoms. Aspects vary from northwest to southeast. It ranges in elevation from 120 to 3600 ft. While *L. suksdorfii*'s persistence on these xeric substrates is likely aided by a deeply-rooted habit, grazing and associated increases in weedy annuals may be negatively impacting seedling recruitment at some sites. Urban development and threats posed to potential lepidopteran pollinators by BT spraying have also been suggested for populations in Washington (J. Gammon, *pers. comm.*). Fruits are large, and dispersal mechanisms are not well understood. Population trends are unknown. Mining is also a threat.

***Lomatium tuberosum* Hoover** is a local endemic to Yakima, Grant, Kittitas, and Benton Counties, Washington. In the Columbia River Basin Province, 14 of the 24 occurrences in Washington are on private land. Populations usually consist of several hundred plants. It grows on unstabilized basaltic talus among shrub-steppe vegetation on 15 to 90 percent slopes. It ranges from 460 to 4000 ft. in elevation. Although the tuberous root of this perennial is eaten by Native Americans, it is not a major food source. It also provides food for small animals.

***Luina serpentina* Cronq.** is a highly restricted local endemic, known from 18 occurrences in the Aldrich Mountains of Grant county, Oregon. This stout perennial inhabits moderate to steep serpentine slopes such as those found along Fields Creek. It is found at sites between 3,300 and 5,900 feet in elevation, on talus slopes in openings among the surrounding ponderosa pine forest. *Luina serpentina* is pollinated by butterflies and in its sparse habitat, it appears to be an important local source of nectar for these insects. However studies have found that there is very little genetic variation among populations and almost all seeds are sterile. This poor seed set, in addition to being geographically and edaphically restricted to high elevations in the Aldrich Mountains, make this species easily threatened by habitat disrupting events such as global warming and ground disturbing management actions.

***Lupinus biddlei* Hend. ex C.P. Smith** is a regional endemic, found in the Great Basin and Owyhee Uplands physiographic provinces. It is known from thirty-two occurrences in Harney and Malheur Counties, Oregon. One occurrence is reported from Wheeler Co., Oregon, in the High Lava Plains province. *Lupinus biddlei* has recently been subsumed under *L. polyphyllus* by Barneby (1989). Two flowering forms, a white- and blue-flowered morphology, have been identified. *Lupinus biddlei,* the white-flowered form from Harney Co. and an adjacent site at Warm Springs Reservoir in Malheur Co. is not sympatric with the more common blue flowered form. Further study is required to determine whether the white-flowered form deserves special taxonomic status. The species is found on a variety of soil types including alluvial, aeolian, clayey-sedimentary soils, and soils derived from basalt. Major associates include *Agropyron spicatum, Poa sandbergii,* and *Artemisia tridentata.* The species grows on low hills, slopes and flats. Number of individuals within a given population, and percent of those flowering, varies with annual precipitation. Population trends are considered stable. The species is able to survive fire, but seedling recruitment may be inhibited by cheatgrass invasion. Individuals have been found growing in areas seeded with crested wheatgrass, however. Grazing and mining are

threats, especially with respect to their impact on plant community composition. The species is found at the proposed Grassy Mountain Gold Mine, south of Vale.

***Lupinus cusickii* Wats.** is a local endemic, known from one occurrence in Baker County, Oregon, near Unity Reservoir. It is found on clay and volcanic ash (pluvial lake ash sediments). This lupine grows in basins, drainage channels, and along the toe and mid slope between 3,800 and 4,000 feet in elevation. It inhabits terrain associated with juniper, sagebrush, bunchgrass and occasionally squaw apple. *Lupinus cusickii* is being impacted by off-road vehicle use and to a lesser degree, livestock trampling.

***Meconella oregana* Nutt. in T. & G.** has a scattered distribution in Washington and Oregon. It ranges west of the Cascades Mountains from southern British Columbia south to California. In the Columbia River Basin Province, it is known from three occurrences in Klickitat County, all on National Forest Service land along the Columbia River Gorge from 200 to 1000 ft. in elevation. It occurs in openings with *Agropyron spicatum* in the *Quercus garryana* and *Pinus ponderosa* zone on slopes and ridgetops. One population of this annual included several hundred plants. Winter and spring moisture are important, but sites dry out by early summer. The greatest threats are increases in annual exotics, changes in species composition from grazing, and changes in hydrologic regimes. This plant is only visible for a week and is very small, thus making surveying difficult.

***Mentzelia mollis* M.E. Peck** is a regionally endemic annual found in ash beds of the Owyhee Uplands of eastern Oregon and adjacent southwestern Idaho, and in Nevada in the Black Rock Desert. It is known in Oregon from eighteen occurrences in Malheur Co., specifically on Succor Creek and Leslie Gulch ash that has been weathered to montmorillonite (ash containing bentonite and montmorillonite) that decompose to clays (e.g., the Succor Creek formation). Suitable ashbeds occur at elevations between 2,500 and 4,800 ft. and typically have less than 15% vegetative cover. At least two sites are known to be on private land. Substrates are characterized by a high concentration of calcium, sodium and potassium ions. The timing of precipitation is key to the growth of *M. mollis*, and individuals establish within cracks in the drying clay where water availability is greatest. Communities are composed primarily of annuals, and cover is generally sparse. Associates include *Cleome platycaule, Phacelia lutea, Sitanion hystrix*, and *Artemisia tridentata* and *Chrysothamnus nauseosus* in low frequencies. Several populations of this species have been lost to mining activities and many sites have been severely degraded by livestock trampling and invasion by exotic plant species. Range improvements (such as seeding) and OHVs are also responsible for the degradation of several *M. mollis* sites. Livestock grazing and invasion of sites by exotics are threats, especially during wet years. Introduced annuals, notably yellow star thistle (*Centaurea solstitialis*) and whitetop (*Cardaria draba*) may be abundant, and whitetop encroachment has been observed at one fenced site. Fire suppression efforts have resulted in mechanical disturbance of some sites.

***Mentzeliapackardiae* Glad.** is a regional endemic, known from thirteen occurrences on the Leslie Gulch ash flow in Malheur Co., Oregon, and from one site in northern Nevada that is thought to have been extirpated. Inventory for the species is believed to be generally complete.

The species has not been found west of the Owyhee Reservoir, nor has it been located at Succor Creek. At Leslie Gulch the species grows on the Spring Creek tuff unit, on yellow-green, gravelly talus ash hydrothermally altered welded tuffs at elevations below 5,600 ft in soils that are zeolite clay-rich and have a high potassium content. *Senecio ertterae,* and occasionally *Eriogonum novonudum,* are associates. *Atriplex confertifolia* and *Agropyron spicatum* have encroached onto one of the sites, displacing some individuals of *M. packardiae.* Grazing has been identified as a threat as a decrease in *M. packardiae* has been observed where individuals are concentrated at toeslopes, in areas where cattle graze and trample the soil. Competition with exotics (especially *Bromus tectorum* and *Lepidium perfoliatum*), fire suppression activities, exotic plant species OHVs, and range improvements appear to be significant threats to the viability of this species in Nevada. The ash contains zeolites (Grimes 1984), but mining claims on occupied sites have been abolished. High recreation use in Leslie Gulch has resulted in some sites having been trampled by visitors. A BLM-USFWS Conservation Agreement established for Leslie Gulch protects known sites in Oregon. The range of *M. packardiae* has been thoroughly inventoried and the species is currently in decline.

Mimulus ampliatus **Grant (= *M. washingtonensis* Gand. ssp. *ampliatus* (Grant) Meinke)** is regional endemic that has been infrequently collected. It is probably much rarer and more vulnerable than *Mimulus washingtonensis.* It is suspected to occur in Wallowa County, Washington, though it is currently known only from Nez Perce, Idaho, and Lewis Counties, Idaho (Meinke 1995). Populations require vernal moisture but other habitat requirements are not understood. Populations trends for this taxa are unknown.

Mimulus clivicola **Greenm.** is a regional endemic, from Idaho, Washington and Oregon. In the Blue Mountain Province, this diminutive spring annual is known from 18 occurrences in Baker and Wallowa Counties of northeast Oregon, and approximately one hundred occurrences in ten northern and central Idaho counties. In the Blue Mountain Province it is found between 2,500 and 5,800 feet in elevation, on open mineral soil such as loose, basalt derived sand or fine gravel slopes, or rocky, talus outcrops on all but due north aspects. These openings appear to be shallow soiled, sparsely vegetated areas among a matrix of bunchgrass slopes, snowberry shrub-fields, and stringers of ponderosa pine timber. *M. clivicola* appears to prefer the more mesic microsites among terrain occasionally shared with *M. nanus*. Frequently populations in Hells Canyon National Recreation Area, are associated with *Cammassia cusickii* on moderate slopes. It is likely pollinated by ants (Lorain 1991) and small flies (Hustafa 1995). This species appears to have complex seed bank biology, as it exhibits erratic population fluctuations in flowering individuals in relation to annual weather conditions (Lorain 1991). *Mimulus clivicola* habitat is threatened by log decking and disturbances from livestock trampling and trailing that are greater than the historical levels associated with deer and elk travel. Habitat degradation that results in weed invasion also threatens this species. There are no specific studies that accurately reflect the long-term population trends of this taxa.

Mimulus evanescens **Meinke** is a newly described regional endemic of mid-elevation riparian sites in the Great Basin. Historically the plant occurred from SW Idaho to NE California but is currently known only from two extant populations, one near Drews Reservoir in Lake Co., Oregon, and one in Lassen Co., California. The population in California has been extant for at

least six years, while the one in Oregon has only recently been discovered. Occurrence of this autogamous annual species is highly correlated with ephemerally moist sites, including perennial and intermittent streams and receding margins of lakes, ponds and reservoirs. Sites range from approximately 3600 to 5400 feet in elevation and are found within the sagebrush-juniper vegetation zone. Substrates include muds and gravelly to rocky basaltic sands. Associated species include *Artemisia tridentata, Juniperus occidentalis,* ***Mimulus floribundus,*** *M.* ***suksdorfii,*** *Porterella carnosula, Collinsia grandijlora, C.* ***parviflora,*** *Downingia* sp., *Mimetanthe pilosa,* and *Heterocodon* ***rariflorum*** (Meinke 1995). Fall and winter precipitation is important for germination and reproduction. Seeds are dispersed by flowing water, wind and gravity. Dormancy is interrupted by cool moist stratification or, to a lesser degree, time. Reproduction may be precocious in response to drought. Population trends of this species are unknown. Significant changes in reservoir water levels is a potential threat, as a population may need to migrate into the sagebrush zone where competition with exotic annuals is high. Habitat alteration by livestock is also a potential threat. This plant is considered extremely rare and vulnerable throughout it's range (Meinke 1995).

Mimulus hymenophyllus **Meinke** is a narrowly local endemic and is found in and west of Hell's Canyon to the Grande Ronde River in eastern Oregon and one historic collection at Pittsburg Landing in western Idaho. It occurs only on rock walls and steep, vertical, shaded cliffs above shrub thickets (predominantly ***Physocarpus, Amelanchier, Ribes,*** and *Rosa)* in steep draws along perennial cold water creeks. It is often associated with species of ***Arabis, Bolandra,*** *Heuchera, Penstemon,* ***Saxifraga,*** *Sedum, Selaginella, Stellaria, Thelypodium,* ***Tonella,*** *Viola,* and a variety of ferns and bryophytes. The Pittsburg Landing site in Idaho is atypical for *M.* ***hymenophyllus*** and is heavily altered by intense cattle grazing. ***M. hymenophyllus*** is not currently directly threatened by human activities however, overstory removal and hydrological changes could seriously harm known populations.

Mimulus jungermannioides **Suksd.** is a regional endemic known from Washington and Oregon. The one occurrence in Klickitat County from the Columbia River Gorge National Scenic Area is thought to be extirpated. It is also known from 13 sites in Gilliam, Sherman, Umatilla Counties, and four occurrences in Wasco Co., Oregon. In Umatilla County it is on private land. It requires perennial seepage and grows from 150 to 1000 ft. in elevation. The species is typically found growing on shaded vertical basaltic and limestone cliff crevices and overhangs in riverine canyons, or stream bank areas or washes where ground water seeps and perched water tables maintain a moist substrate. A highly specialized, largely clonal species, *M. jungermannioides* is unique in that regeneration usually results from subterranean bulb-like turions arising at the end of negatively-phototropic stolons produced annually in the late summer and fall. Flowers are pollinated by small bees or are autogamous, and although seeds are plentiful, viable, and germinate easily, establishment of sexually developed plants is rarely observed. Preliminary molecular and morphological evidence from a study in progress at Oregon State University, funded by the Prineville BLM, suggests that clonal *growth in M. jungermannioides* may be responsible, at least in part, for local genetic fixation (R. Meinke, *pers. comm.*). The dependence of this cliff obligate species upon perennial seeps suggests that the maintenance of an available water supply is critical to population viability. Significant threats include fire, blasting of cliffs for road construction, spray drift from roadside weed control and development. The species is

currently considered stable throughout its range, though opportunities for population expansion are extremely limited. This species may represent a remnant of a pre-Hypsithermal plant community, adapted to a much wetter overall climate, that retreated to dripping cliffs as the CRB became more arid in the Holocene.

Mimulus patulus **Pennell** is a local endemic known from the Oregon portion of the Hell's Canyon NRA and extreme northeastern Oregon (Wallowa County). Historic collections from this species have been made from extreme southeast Washington and adjacent Idaho, where it may possibly still exist, though many of the historic sites are now under water from Snake River impoundments This species is similar in appearance to *M. hymenophyllus*, *M. washingtonensis,* and *M. guttatus.* This species is suspected, but not *known,* to *occur* in Idaho. *M. patulus occurs* on damp ground, cliffs, and roadcuts in the mosaic of bunchgrass and/or sparse conifer stands along the northeast slope of the Wallowa Mountains uplands. These moist microsites of basalt substrate are often located with various species of *Astragalus*, *Lomatium, Allium*, and *Delphinium,* usually with a significant weedy component dominated by annual bromes and fescues.

Mimuluspygmaeus **Grant** is a regional endemic of the Klamath River Basin, in the southern end of the East Cascades physiographic province. It is known from twenty-seven occurrences in southern Klamath and Lake Cos. and the eastern margin of Jackson Co., Oregon, with a site near Thompson Reservoir representing the northernmost population. Occurrence of this reproductively precocious annual is correlated with vernally moist, poor to moderately-drained sites characterized by heavy, ash-clay soils. Almost all occurrences are known from USFS and BLM land, and in wet years flowering plants are prolific and recent studies (Meinke et. al. 1993) indicate that this species may actually be widespread and locally common in wet years in south central Oregon. The species is often found within a narrow ecotone between wet meadow and *Artemisia* zones, in open areas of *Artemisiu arbuscula* scabrock communities, or within the high water zone of perennial streams. *M. pygmaeus* is a short-lived self-pollinator with an extensive seed bank. When in fruit, mature capsules tend to persist on the stem, and so the entire plant may act as a dispersal unit. Dihescence and dispersal are by water, as capsules must soak prior to releasing seeds. Fire and scouring by spring floods may play a role in maintaining shrub openings favorable to species viability. A conservation strategy (Meinke 1994) is in effect for the Winema and Fremont National Forests. The population trends for this taxa are unknown as the seed bank biology is not fully known.

Mimulus washingtonensis **Gand. var.** ***washingtonensis*** is a regional endemic of the Blue Mountains and High Lava Plains provinces of Oregon and from southeastern Washington in the Columbia Gorge, where it is known from one site at 3500 ft. in elevation in a wet seep along a steep intermittent stream with slopes of 20 to 75% on a southern aspect on basalt. This plant also occurs in Idaho. In Oregon the largest number of occurrences (3 17) are in the John Day Basin of Wheeler and Grant Counties (25 on Prineville BLM) from two new occurrences in Crook County (R. Halverson, *pers. comm.*), and 19 occurrences in Morrow Co. (Urban 1995). This species is edaphically limited to metamorphosed volcanic soils comprised of weathered tuffaceous sediments derived from John Day Buff formations. It has been found between 2,000 and 4,000 feet in elevation. Occurrence of this annual is correlated with ephemeral or perennial

rivulets and seeps on shallow basaltic scree and gravelly soils over bedrock, and may be locally abundant in wet years. Plant cover is commonly low (<5%) and sites are devoid of associated vegetation. Sites are nitrogen-limited and a species of *Nostoc* (cyanobacteria) is a common associate that may compensate for the lack of available soil nitrogen. As with other annual members of the *Mimulus* genus, sufficient precipitation is needed during the fall and winter months to maintain hydrologic site characteristics and to facilitate germination. It inhabits seasonally moist patches and seepage areas in otherwise dry, open, highly erodible soils. Its seed bank biology is not well understood and enormous fluctuations in populations size are observed between dry and moist years. Populations are rare or absent during drought years, but are considered stable overall. Livestock trampling is a minor threat. In Washington, timber harvest and road building would adversely impact known populations. It is also threatened by the invasion of exotic grass species, especially annual bromes, which displace this sensitive species. Where *Mimulus guttatus* shares disturbed sites with *M. washingtonensis* var. *washingtonensis,* the latter shows evidence of depressed seed set due to shared pollinators and contamination of the stigmas.

***Mirabilis bigelovii* Gray var. *retrorsa* (Heller) Munz** is a disjunct endemic known from Harney and Malheur Counties, Oregon, and from California, Nevada, Utah, Arizona and northwest Mexico. It occurs in Oregon on barren basalt outcrops and talus slopes, including sites near Owyhee Reservoir and Alvord Lake, at elevations between 2500' and 2800'. Inventories have not yet been completed for the species, but within its range the highest population concentrations are found in California. Potential threats to the species include establishment of gravel pits within its habitat. Population trends are considered stable.

***Mirabilis macfarlanei* Constance & Rollins** is a listed threatened species and an endemic found in the mid and lower Snake River and lower Salmon River canyons. It prefers sites with full exposure though it occurs on a variety of aspects and slope positions at elevations between 1,000 and 2,800 feet. It can be found on a variety of substrates ranging from deep loamy to rocky loam soils, to rocky talus or fine gravelly and sandy basalt soils. The most notable associated vegetation includes *Agropyron spicatum* on the better sites and *Asclepias cryptocerus* on some of the sparsely vegetated basalt gravel sites. This perennial grows from a deep-seated tuberous root that can send out several rhizomes to form large intermingled clones. Winter and early spring rainfall significantly affects plant vigor. Direct and indirect impacts of livestock grazing (including the introduction of exotic plant species) have significantly altered the habitat of this species in the past. Most *M. macfarlanei* sites have cheatgrass *(Bromus tectorum),* knapweeds *(Centaurea* spp.), and yellow starthistle *(Centaurea solstitialis*). The threat from exotics plants is due to both direct habitat conversion and herbicide use. Today, livestock grazing is still considered to effect populations of *M. macfarlanei* but the impact of this activity varies greatly with the season. Population trends for this species are unclear. While ongoing surveys have located additional populations, no one has yet observed a seedling in the field. *M. macfarlanei* is the host for a rare leaf mining moth's larvae, *Lithariupteryx sp. nov.* (Baker 1985). The BLM has been monitoring some populations of this for 15 years and there is an ongoing research project (Barnes and Wolf 1994) at Utah State University investigating inter- and intrapopulation genetic variability.

***Musineon lineare* (Rydberg)** is a disjunct species known in Idaho only from the Bloomington Lake cirque in the Bear River Range (Moseley, 1992). The main body of this species range is in central Utah. That population of approximately 200 individuals occurs at 8,800 feet in scree and rocky outcrops on the northwest face of the cirque. This species appears to be well protected at this site.

***Oenothera psammophiia* (A. Nelson & J.F. McBride). W.L. Wagner, Stockhouse, & Klein** is a local endemic restricted to the drifting St. Anthony sand dunes of Fremont County, Idaho. This species tends to colonize the trailing edges of the dunes where bedrock (basalt) is within one meter of the surface. The major threat to the viability of populations of *O. psammophila* is OHVs. The BLM is currently drafting a conservation strategy for this species. Populations trends for this species are considered stable.

***Oryzopsis contracta* (Johnson) Shechter** is a scattered endemic from the Wyoming Basin from Beaverhead County, Montana into northern Colorado. It is known from a limited number of sites within the assessment area, which are at the periphery of the species' range. It occupies a broad range of soil types and aspects in sagebrush grasslands at elevations between 4,800 and 7,800 feet This species is threatened by high grazing pressure and some sites may be threatened by habitat conversion. Surveys in recent years have identified many new sites and the panel suggested that 3C might be a more appropriate Federal status than C2.

***Oryzopsis (Achnatherum) hendersonii* Vasey** is a regional endemic found in Yakima and Kittitas Counties in Washington and Wasco and Crook Counties, Oregon on shallow lithosolic substrates or welded tuffs in open habitat within a matrix of ponderosa pine and bunchgrass stands. It prefers gentle slopes or level ground with soils containing a high levels of weathered basalt gravel and rock, basaltic scablands and frost-heaved soils, with stone stripes and net patterns. It is reported to be associated with *Poa secunda, Artemisia rigida, Eriogonum strictum,* and *E. douglasii* species on scablands (Vrilakas 1990). Populations of this strongly tufted perennial grass are small and scattered. Elevations range from 2200 to 5400 feet in elevation. Significant threats to the viability of *O. hendersonii* populations include livestock trampling, grazing and trailing, salt blocking, the invasion of exotic plant species, road construction and OHV traffic.

***Oryzopsis (Achnatherum) wallowensis* Maze and K.A. Robson** is a regional endemic currently being proposed as a new species by Jack Maze and Kali Robson, University of British Columbia. It is primarily found in Wallowa County, Oregon with a few populations known from the north slope of the Ochoco Mountains, in Crook County (Maze 1995). Occurrences for this species of *Oryzopsis* are likely mixed in with reports for *O. hendersonii*. It differs prominently from *O. hendersonii* in its drooping inflorescence. Although other morphological differences exists, its habitat affinity is sympatric with that described for *O. hendersonii*. Both species face similar threats.

***Oxytropis campestris* (L.) DC. var. *columbiana* (St. John) Barneby** is a regional endemic in the Pacific Northwest. The taxonomic disposition of this variety has been the subject of uncertainty, based on varying opinions of systematists who have examined specimens from

Montana; this situation is summarized by Lesica (1992). Until such time as further taxonomic work is completed, in the interest of conserving biological diversity the taxon has been nominated for Category 2 candidate status. The habitat for this taxon consists of gravel shores and river bars that are subject to wave action (Lesica 1992). In northwest Montana, six occurrences have been documented on the shores of Flathead Lake in Lake County. In addition, 13 sites were located along the North Fork Flathead River in Flathead County; however, these populations appear to be intermediate, both in morphology and habitat, between varieties. *columbiana* and ***gracilis*** (Lesica 1992). *Oxytropis campestris var. columbiana* is also known from northeast Washington, from gravelly banks along the Columbia River, but these populations are believed to have been mostly extirpated by habitat destruction as a result of the construction of Grand Coulee Dam. The habitat on Flathead Lake in Montana is threatened by residential development, and possibly also lake level regulation (Hungry Horse and Kerr dams) and invasion by spotted knapweed (Lesica 1992). Molecular systematic studies would be useful in clarifying the taxonomic status of this variety; in the interim, Category 2 candidate status is deemed appropriate.

Oxytropis campestris **(L.) DC. var. *wanapum* Joyal** is a local endemic to Grant County, Washington. The single occurrence of this recently described species is on federal land. This perennial grows on ridges and adjacent north-facing slopes on fine, sandy, and coarse-grained soil. Documented threats to this species and its habitat include exotic weed invasion and recreation. Population trends for *O. campestris wunapum* are unknown.

Papaverpygmaeum **Rydb.** is a regional endemic known to occur in northwest Montana, and in southern Alberta and British Columbia, Canada (Lesica and Shelly 1991). It is documented from nine locations in Montana (Montana Natural Heritage Program database records, Helena), in Flathead and Glacier counties, but is reported to be "locally common at many locations in Glacier National Park" (Lesica and Shelly 1991). It occurs in the Flathead, Lewis and Livingston mountain ranges. The habitat of the species consists of open, stony soil on gentle slopes and ridge tops in the alpine zone, at approximate elevations of 7,200 to 8,200 feet (Lesica and Shelly 1991). Although frequent in this geographic area, population sizes are small, and demographic population monitoring is advised to assess population stability (Montana VP panel notes). The taxonomic disposition of this species has been questioned; in an alternative treatment, Welsh et al. (1987) consider it a form of the widespread *P. radicatum,* but this opinion is not universally held (Montana VP panel notes). Known populations are in well-protected or unthreatened areas, such as Glacier National Park.

Parnassia kotzebuei **Cham. ex Spreng. var. *pumila* C. L. Hitchc. & Ownbey** is a disjunct species known from the Cascade Mountains of Okanogan County in Washington. The center of this taxa's range is the mountains of British Columbia. The Okanogan site of five individuals is on National Forest Service land near the entrance of an active mine on copper ore bedrock and talus. It is on a north aspect on moist mossy ledges at the base of an overhanging granitic cliff on soil that does not dry out. The ground surface is 30 to 100% bare and slopes are 45 to 90%. This perennial plant is a Pleistocene relict. Significant threats include mining, landslides, change in fire regimes, grazing, development, and timber harvest. There is some uncertainty concerning the validity of the variety *pumila* among taxonomists; however, given the great extent of the

disjunction, this issue does not effect the Washington Natural Heritage Program's commitment to tracking this taxa.

Penstemon barrettiae **Gray** is a regional endemic to Klickitat County in Washington and adjacent Oregon. It is restricted in Washington to the Columbia Gorge and Klickitat River, where nine of 13 occurrences are on private land. This species inhabits fractured basalt cliffs and walls with limited annual seepage, rock outcrops and open talus with less than 30% canopy cover, and above the riparian vegetation of these major rivers. It is also found on cliffs within a matrix of xeric bunchgrass, shrub steppe and/or open canopied forest margins. Slopes vary from zero to *90%. Penstemon barrettiae* occurs in the *Quercus garryana/Pinus ponderosa* zone up to 3200 ft. in elevation. The showy flowers are pollinated by large native bees, members of *Osmia* and *Bombus*, and fruit production is probably correlated with presence of these pollinators. Seeds are probably dispersed by wind and gravity, as no specialized dispersal mechanism is known. Although the range is well known, distributions within the range are not. Population trends are unknown , although rock gardeners and *Penstemon* horticultural specialists have extensively collected from wild populations in the past, depleting sites. The plant is readily propagated and is currently available at some nurseries. Hybridization of *P. barrettiae* with other species from similar habitat, including *P. fruticosus* has been noted. Significant threats include road construction and quarrying, collection, grazing, exotic weed invasion, and timber harvest. Damming of the Columbia River destroyed several populations.

Penstemon compactus **(Keck) Crosswhite** is a local endemic known only from federal lands in the Bear River Range, near the Utah border in Franklin County, Idaho. It is found on rocky, limestone or dolomite derived soils between 7,200 and 9,400 ft. Sites are in high elevation, subalpine ridges and open areas, upper slope and open rocky habitat of mountain big sage and Douglas fir parkland. There are eight sites in analysis area and, apparently, no immediate threats.

Penstemon glaucinus **Penn.** is a regional endemic of the Klamath River basin known from thirty-seven occurrences in Klamath and Lake Counties, Oregon. It is found in openings and in the understory of mid- to high elevation (5900-8400 feet) forests of *Pinus contorta, Pinus ponderosa, Pinus albicalus,* or *Tsuga mertensiana* composition. Soils are poorly developed and well-drained, usually of volcanic origin, shallow, often sandy-loamy, volcanic soil, sometimes along rocky points or ridgelines or occasionally in stony meadows. It is often associated with *Arctostaphylos, Holodiscus, Lomatium, Lupinus, Catilleja, Artemisia* and *Eriogonum.* Flowers are pollinated by members of the genera *Bombus* and *Osmia.* The species is found in communities of all successional stages, but is most abundant in early seral, post disturbance stands or stands that are naturally open. Though there are no long term data to evaluate persistence of populations in disturbed sites. A hardy perennial with extensive horizontal and vertical rhizomes, it is an early colonizer on old road beds and slash pile burns. Both fire and Silviculture prescriptions that decrease overstory cover may promote colonization. Populations reportedly spread once ground cover is removed (Vincent and Vincent 1980). Therefore, populations may be limited by fuel build up promoted by fire suppression. Fire also appears to scarify seed and thus facilitate germination. Seedlings are seldom observed, but large clonal patches are frequently found within the understory community. Population trends are considered

stable. A Conservation Strategy prepared for the Fremont National Forest (Wooley 1993) is in effect.

***Penstemon idahoensis* Atwood & Welsh** is a local endemic inhabiting tuffaceous ash beds in the Goose Creek drainage. These sites tend to be relatively barren, having less than 10% cover. *P. Zemhiensis* doesn't seem to have a preferred slope position though it is rarely found in drainage bottoms. The population trend of this species is unknown. Threats to local population viability include the invasion of exotic species, development, road construction, and herbicide spray and drift. Domestic livestock poses a threat to this species from trampling and indirectly by degrading upslope areas.

***Penstemon lemhiensis* (Keck) Keck and Cronq.** is a regional endemic occurring in southwest Montana and adjacent east-central Idaho. The species primarily occurs in sagebrush-bunchgrass community types *(Artemisia tridentata/Agropyron spicatum,* and *Artemisia tridentata/Festuca idahoensis),* but is also known from low-elevation *Pinus ponderosa/Purshia tridentata* and higher elevation subalpine forb meadows and openings; occurrences span elevations from approximately 4,000 to 8,000 feet. Populations have been found on soils weathered from granite, limestone, and other rock types with textures generally being gravelly loams. This species is adapted to natural disturbance regimes and readily invades some types of openings. This broad range of habitats and elevations is unusual for a species of restricted geographic range, and is probably a result of the biogeographic divergence pattern in this group of *Penstemons, as* opposed to selection for adaptation to specialized habitats (Shelly 1990b). This and related *Penstemon* species have an apparently close pollination relationship with vespid wasps, though these wasps are not the only insect visitors (Shelly 1990b). The effects of fire suppression on the habitat and population dynamics of this species are not well-understood quantitatively, but it is highly likely that resultant vegetation succession, especially in sagebrush-bunchgrass habitats, has caused population declines (Shelly and Achuff 1992). Demographic monitoring studies at three locations in Montana revealed drastic declines in survival of established plants from 1989 to 1993, most probably as a result of prevailing drought conditions over the last eight years (Shelly 1990a; Shelly and Achuff 1992; Shelly and Heidel 1993). Although plants will grow in disturbed habitats such as roadbanks, they are never abundant in these situations, and these small ruderal populations do not contribute substantially to the long-term viability of the species. The average population size rangewide is small, with fewer than five populations that could be considered large, core populations (Shelly 1990b). Forest management practices of the last century, especially fire suppression and timber harvest, have caused a significant decline in the frequency of natural regeneration sites for this species. The invasion of exotic species and herbicide spraying are known to threaten some sites. This species is being cultivated for garden enthusiasts, primarily from commercially grown stock plants. A rangewide species conservation strategy is currently being completed.

Penstemon "nikei". This unpublished epithet represents a series of populations with unique morphological traits, possibly related to *P. miser* Meinke unpbl. being tracked by the Vale District of the BLM (J. Findley, *pers. comm.*). Known only from Malheur County, OR in appropriate sites in the northeastern and east-central parts of the county. This edaphically restricted species has perhaps the most specialized habitat of all rare *Penstemons* in the CRB as it

occurs only on unique eroded clay/ash or diatomaceous substrates, within the sage scrub. The slopes are usually naturally barren due to the harshness of the physical environment. Additional inventory is a necessity and could be easily conducted using soil maps. Search should focus in Malheur County, Oregon and in appropriate areas of southern Idaho and northern Nevada. Mining and ORVs may be threats. Little is known about this plant and basic inventory and biological info is needed, substrate disturbance is a threat.

***Penstemon peckii* Penn.** is a local endemic of the Metolius Basin, known from seventy-four occurrences in the southern East Cascades and High Lava Plains provinces, Jefferson and Deschutes Counties, Oregon. It is found at elevations between 2600 and 4000 feet in open, early to mid-seral *Pinusponderosa* forests merging to the forest-meadow ecotone under an open or partially closed canopy of the dry meadow. Site topography is level to slightly inclined, and occasionally concave. Soils are deep, well-drained, gravelly-loam to rocky or sandy and of basaltic origin. Habitat occurs along recovering fluvial surfaces, streambanks, floodplain and sites characterized by at least vernal moisture. High soil moisture in the spring and summer is required for seedling germination and establishment. The species tolerates moderate disturbances and establishment may be facilitated by fire and silviculture prescriptions that open the canopy from below. Conversely, clearcuts and intensive site preparation have destroyed some populations. The infestation of diffuse and spotted knapweed in riparian recreation sites is a growing threat to the species. The metapopulation was considered stable (although some individual populations are declining in response to closed canopy conditions likely a result of fire suppression) until populations identified as critical for species persistence in the completed species management guide were disposed of in a land exchange.

***Perideridia erythrorhiza* (Piper) Chuang & Const.** is a disjunct endemic from the *Quercus garryana* grasslands of the west Cascades and is extremely rare in the east Cascades where it is known from two sites in Klamath Co., Oregon. Recent unpublished molecular data (Baldwin, *communication by letter)* reveals separate lineages and suggests that the eastside and westside populations are genetically distinct. Within the East Cascades South physiographic province, the species is found at elevations of approximately 4200 feet in moist meadows dominated by *Deschampsia cespitosa, Poa pratensis, Koeleria cristata,* and *Festuca idahoensis, and* surrounded by mixed coniferous forests. Soils are silt-clays and loams and are generally moister than those occupied by more common species of *Perideridia.* The tuberous roots are used as a food source by native Americans. In western Oregon this species is threatened by urban expansion. Within the East Cascades province, sites fall under Federal ownership but are threatened by trampling and soil compaction resulting from livestock grazing. Direct herbivory is minor. The diking and draining of meadows around Klamath Lake may have permanently reduced the available habitat for this species. Collectively, population trends are declining; the trend for the East Cascades populations is unknown.

***Petrophytum cinerascens* (Piper) Rydb.** is a local endemic along the Columbia River in Chelan and Douglas Counties, Washington, where there are three locations; all of which are on private land. It inhabits gneiss, rhyolite, and andesite rock cliffs and outcrops on slopes to 90% where other vegetation is sparse from 700 to 1600 ft. in elevation. This perennial forms mats from one square foot to six by three feet in size. Populations range from 100 mats to 1,000. It does not

occur north of the southern terminus of continental glaciation and may be a good indicator of global warming. Road-widening would destroy habitat.

Phacelia inconspicua **Greene** is a scattered endemic known from southwestern Idaho and northern Nevada. This rare annual occurs on sandy loams with surface sand and gravels. It prefers but is not restricted to, nival zones. In Idaho, sites range in elevation from 5,000 to 6,000 feet. Populations of *P. inconspicua* are typically small, isolated, and seasonally ephemeral. Significant threats to populations, stem from livestock grazing, mining, and introduced plant species (both from competitive exclusion and alterations of the historic fire regime). This species appears to be stable at the present time.

Phacefia lenta **Piper** is a local endemic to Douglas County, Washington. All nine of the occurrences in the Columbia River Basin Province are on private land. Populations often consist of several hundred plants. This perennial inhabits cracks and ledges in exposed basalt cliffs and talus from 1300 to 3400 ft. in elevation. This plant may fracture basalt. The showy flowers probably provide pollen and nectar for insects.

Phacelia lutea **(Hook. & Am.) J.T. Howell var.** ***calva*** is a local endemic known from 13 occurrences in Owyhee Co., Idaho. The species occurs on weathered Sucker Creek Formation ash, and grey-white to dark brown montmorillonite and bentonite clays characterized by very low percolation rates. Sites range from approximately 4000 to 4800 feet in elevation and are generally found on barren, gentle, south or southwest facing slopes. Early spring moisture is crucial to successful establishment, and abundance of individuals in a given year is highly correlated with precipitation levels. Associates may include *Sitanion hystrix, Cleomella macbrideana, Chaenactis douglasii, Lomatium* sp., *Phacelia lutea var. lutea*, and *Mentzelia mollis*. As with other ash endemics, potential threats include trampling by livestock, off-road vehicle (ORV) traffic, and mining activity. Population trends are unknown.

Phacefia lutea **(Hook. & Am.) J.T. Howell var.** ***mackenzieorum*** **Grimes & Packard** is a regional endemic known from Malheur Co., Oregon. There are three sites in Malheur County. The species occurs on green-yellow Leslie Gulch tuff-talus characterized by high percolation rates. Early spring moisture is crucial to successful establishment, and abundance of individuals in a given year is highly correlated with precipitation levels. Potential threats include trampling by livestock, off-road vehicle (ORV) traffic, and possible mining activity. Population trends are unknown.

Phacelia minutissima **Henderson** is a scattered endemic ephemeral annual known from the upper Intermountain region. Historic collections of this species list a range of habitats though most are taken from seeps in sage or aspen on vernally wet side slopes of ephemeral (zero-order) drainages or mountain meadow complexes, where the plant is dependant upon spring and summer moisture for flowering. Recent collections in southern Idaho have been made in *Veratrum* stands down-slope from aspen, especially at sites with open understories. Soil conditions are usually well drained yet silty. Typical site elevations range between 5,000 and 8,200 feet. Threats to local populations and suitable habitat for *P. minutissima* include livestock grazing (mostly through soil disturbance), mining (especially in northern Utah), the invasion of

exotic plant species, and range improvements (especially water developments). Changes in fire frequencies may also represent a threat to some populations. The conservation status of this species was assessed recently (Moseley 1995a). The Boise National Forest and the Boise District BLM are conducting extensive surveys for this species in 1995 and 1996. This species was rediscovered in the Wallowa Mountains, Oregon in 1996.

Phlox idahonis **Wherry** is a local endemic found near Headquarters, Idaho. Currently, 98% of known *P. idahonis* sites are owned by Potlatch Corp. The historic range of this species is unknown. This species is found in low gradient streamside and grass/forb meadows in cold air sinks between 2,800 and 3,300 ft. It prefers an open canopy and is adapted to periodic fire. Much of the habitat for this species has been altered by grazing, land conversion, and fire suppression (by the consequent invasion of trees into its meadow habitat). Current threats include the lack of fire and hydrological alterations to its meadow habitat. There are permanent monitoring plots in place for this species (Moseley and Crawford 1993).

Physaria didymocarpa **(Hook) Gray var.** ***lyratu*** **C.L. Hitchcock** is a local endemic restricted to talus slopes in the Challis volcanics in central Idaho. Conservation agreements between the USFWS and BLM had been in place from 1984 until 1995 when the BLM declined to renew the 1990 agreement. The major threat to the viability of *P. didymocarpa lyrata* populations is mining. All populations of *P. didymocarpa' lyrata* are in decline and all are currently experiencing some level of human disturbance.

Physaria integrifolia **(Rollins) Lichvar var.** ***monticola*** **Lichvar** is a regional endemic found in the Salt River and Wyoming Ranges of western Wyoming at fewer than thirty sites (ten within the Columbia River Basin) and in the Caribou Range in Bonneville County, Idaho. Its preferred habitat is sagebrush slopes, seeps, sloughing clays, rocky or talus slopes or ridges, or summit residuum. This taxa may be no more than a form of the species and is currently being reconsidered by Rollins (who did not include it in his recent Cruciferae of North America) and is no longer being tracked by Wyoming Heritage due to its uncertain taxonomic status (Fertig pers comm). The trend for this taxa appears to be stable.

Pleuropogon oreganus **Chase** is a regional endemic known from Lake County, in southeastern Oregon, and Union County, in northeastern Oregon. All known sites are on private land. None of the known sites occur on public land. *Pleuropogon oreganus* habitat is characterized by level, moist meadows with slow moving water at elevations between 3,600 and 5,600 feet. Common associated species include *Deschampsia cespitosa, Hordeum brachyantherum, Poa cusickii, Eleocharis palustris* and ***Carex*** *nebrascensis.* The species may have been more widespread in the past, but grazing and related activities have reduced habitat and population numbers. Livestock presence in these habitats is identified as an extreme threat, and spring grazing has proven detrimental. The specific impacts of grazing that effect this species are trampling and churning of the wet soils, and by the lowering of the water table associated with downcutting and channelization. Following site modification by cattle, subsequent increases in exotic plant species (including pasture grasses) also threaten this species. A portion of the Lake County populations are protected under a Nature Conservancy easement agreement with private landowners. Population trends are unknown, though probably declining.

***Polemonium pectinatum* Greene** has a regional distribution, endemic to east-central Washington. In the Columbia River Basin Province, 32 of the 40 occurrences in Lincoln, Whitman and Adams Counties are on private land. Populations usually include several hundred individuals. It grows in alluvial and colluvial soils, often with a mix of loess and glacially derived material. It ranges from 1480 to 2300 ft. in elevation. This perennial tends to do best in those sites that are in good ecological condition. Sites invaded with *Bromus tectorum* or *Poa pratensis* have very small populations. There is generally no or only a limited tree component in the shrub and bunchgrass communities where this perennial is found. Historically known from the Palouse, but due to land conversion to agriculture with its accompanying hydrological changes, it has been extirpated. Loss of habitat is still a high threat. Heavy grazing, invasion of exotic species, and drawing down water tables from water developments are significant threats. Isolation and fragmentation of populations may have resulted in a loss of viability.

***Potentilla cottamii* N. Holmgren** is a regional endemic found in Utah at two sites in the southern Raft River Range. It is confined to schist and quartzite substrates and occupies cracks, crevices, and recesses in high elevation (9,440-9,740 feet) rocky outcrops on north and shaded south aspect slopes. Mining is the greatest existing threat to this species though roads and livestock grazing can be a problem.

***Primula alcalina* A. Cholewa & D. Henderson** is a local endemic known from low gradient streamside meadows in the Beaverhead Mountains at elevations between 6,294 and 6,720 ft. The streams in which this species is found are continually fed by springs thereby maintaining stable flow levels throughout the year. Soils are alkaline, fine textured, and have a high organic fraction. Seed dispersal is highly localized. The conservation biology of this species has been studied in some depth (Kelso 1991, Muir and Moseley 1994, and Moseley 1995b). Land ownership of *P. alcalina* sites is mixed (25% State and Federal, and 75% private). Direct threats to population viability have been documented to stem from livestock grazing and the invasion of exotic plant species. Moderate threats from recreational use of *P. alcalina* habitat have also been noted. This species is in decline throughout its range.

***Ranunculus reconditis* Nels. & Macbr.** is a local endemic found on open grassy hillslopes underlain by rocky basaltic substrates in Lincoln and Klickitat Counties (where there are nine occurrences), Washington and Wasco County, Oregon, where there are three occurrences. Populations usually consist of several hundred plants. It grows primarily in *Festuca idahoensis, Purshia tridentata,* and *Hieracium cynoglossoides* grasslands, but also in open oak stands from 1900 to 4000 ft. in elevation. This species occurs on the upper one-third of slopes and ridges, on all aspects. This perennial withstands low to moderate grazing, but is very susceptible to prolonged or high intensity grazing. Its potential habitat has decreased from land conversion. This early flowering species probably provides an early food source for pollinators and herbivores. Threats are from loss of habitat and conversion of potential habitat though population trends are considered stable at this time.

***Rorippa columbiae* Suksdorf ex Howell** is a scattered endemic; distributed from the Columbia River south to the Great Basin and East Cascades with disjunctions in California and New

Mexico. It is known from one site in Klickitat County, Wa., in the Columbia River Gorge on private land. Species occurrences are limited to the margins of intermittent and perennial streambanks, channel bottoms, cobble bars with fine silty matrices, and lake margins that are at least seasonally flooded or sand and rocky cobble. Site elevations range from 4100 to 5320 feet. Vegetative cover is generally less than 15 percent, with overstory openings maintained by channel scouring or seasonal flooding. Common associates include *Camissonia tanacetifolia, Coreopsis akinsonia, Phalaris arundinacea Downingia* spp., *Potentilla* spp., *Rumex* spp., *Artemisia cana*, and *Juncus* spp. The species is facultatively autogamous and while there are many stems only a low percentage of these reproduce sexually. Fruits ripen in mid- to late summer and are dispersed by gravity, wind, and most effectively by moving water. The species is negatively impacted by heavy grazing and trampling, these having caused the extirpation of some sites. This species is further threatened by variable water levels from dams and the invasion of exotic plant species. The condition of many populations appears to be declining. The majority of sites occur on public land, and a range-wide Conservation Strategy is currently being developed by the USFS, BLM and Oregon Department of Agriculture.

***Rubus bartonianus* Peck** is a local endemic found in Hell's Canyon on rocky scree slopes, lower slopes, canyon bottoms, and occasionally into the river bottom at elevations between 1,000 and 4,500 feet. Its habitat is generally described as a heterogenous shrubland. Though geographically restricted, it is locally common. There are very few threats to the viability of most populations of *R. bartonianus.* In limited areas, livestock grazing and recreation trail maintenance have been a problem. Exclusion of fire may have allowed fuel loads to accumulate, leading to more intense, potentially threatening fires, but the fire ecology of *Rubus bartonianus* is not well understood. Much habitat, and likely a large number of individuals were destroyed by the construction of Hell's Canyon Dam and the reservoir it created. In 1995, the Idaho Native Plant Society recommended that this species be reduced in Federal status from C2 to 3C.

***Rubus nigerrimus* (Greene) Rydb.** is a locally distributed endemic species in the Snake River Canyon and adjacent tributaries in southeastern Washington. In the Columbia River Basin Province, the 19 occurrences are all on private land in Whitman and Garfield Counties. Populations are small. It is found in draws and canyon bottoms, although very rarely on mid- and upper slopes. Elevations range from 700 to 2400 ft. along the Snake River and up to the breaks. This perennial provides soil stabilization, berries for birds, and cover for birds and small mammals. Flooding from dams on the Snake River have probably inundated historic sites and many sites are severely impacted from grazing. Exotic species such as *Rubus discolor* and *R. laciniatus* threaten populations. A change in fire regime is a significant threat.

***Saxifraga bryophora* A.Gray var. *tobiasiae* Grimes & Packard** is a highly localized endemic known from a single area on Bruin Mountain north of McCall, Idaho on the Payette NF. It occurs on open rocky slopes of small terraces and on gravely ridge tops between 7,500 and 7,650 feet. There is no information on the threats to or viability of the known populations, however the extensive fires on the Payette National Forest in 1994 caused the extirpation of one of the five known sites for this taxa.

***Senecio ertterae* Barkley** is a local ash endemic, known from eleven occurrences in Leslie

Gulch, in the Owyhee Uplands of Malheur Co., Oregon. It is a late-flowering annual, and moisture provided by summer and early fall thundershowers appears to be critical to population fitness. The species is found on lower slopes and in desert washes on greenish-gray gravelly tuffaceous ash. Vegetative cover rarely exceeds five percent, and associated species are limited to annuals. *Senecio etterae* is favored by hydrologic disturbance, and increased significantly in abundance following a summer flash flood in 1986. Livestock grazing and trampling is a potential threat, and cattle trails exist at several sites. Invasion of sites by exotics, including peppergrass and cheatgrass, and potential invasion by whitetop, yellow star thistle, and Scotch thistle may also pose a threat. Zeolite mining is not an immediate threat, but could become one if mining were initiated within *Senecio* habitat. Recreational development and foot traffic may also be potential threats. Populations are considered stable at this time.

Sidalcea oregana **(Nutt.) Gray var. *calva* C. L. Hitchc.** is a local endemic, found in the Wenatchee Mountains in Chelan and Kittitas Counties in Washington, where three of the five sites in the East Cascades North Province are on public land. Four more are historical and probably extirpated and three other sites have not be able to be relocated. It occurs in moist seeps, springs, riparian areas, and meadows with surface water or saturated upper soil profiles in the spring, but dry by the end of the summer. This perennial grows in areas with 100% vegetative cover. It occurs from 1380 to 5060 ft. in elevation. Since this plant occurs in habitat in early successional stages, fire may play a role in the development and maintenance of populations. The addition of cattle excrement may be a threat. Physical disturbance during timber harvest, changes in fire regime as it affects hydrology, and erosion associated with grazing are significant threats.

Silene seelyi **Morton & Thompson** is a local endemic to the Wenatchee Mountains of southern Chelan and adjacent Kittitas Counties in Washington. There are 20 occurrences in Chelan and Kittitas Counties, most of which are on National Forest Service land. A perennial known from shaded crevices in ultramafic to basaltic cliffs and rock outcrops, it occasionally occurs among boulders in talus. Plants grow from 1500 to 7000 ft. in elevation. Habitat types include *Pinus ponderosa, Pseudotsuga menziesii* and *Picea engelmannii* with canopy cover less than 30% and slopes 15 to 20%. Population sizes are small, ranging from two to 50 individuals. Threats from road construction and rock climbing are significant.

Silene spaldingii **Watson** is a regional endemic and part of the Palouse Prairie flora. Globally, this species is known from southeastern British Columbia, southeastern Washington, northeastern Oregon, northwestern Montana, and northern Idaho. It occurs at elevations between 2,800 and 5,100 feet. Most of the populations are on private land. It prefers deep (loess) soils and is usually found on ridgetops and slopes (5-60%) with any aspect. It *grows* in *Festuca idahoensis* and *Pinus ponderosa* plant communities. Most populations of *S. spaldingii are* on private lands. *Silene spaldingii* is typically pollinated by bumblebees but, due to the frequently small populations sizes, the maintenance of a viable and effective pollinator fauna is problematic. Experimental exclusion of pollinators resulted in high levels of inbreeding depression, as measured by several reproductive parameters. This suggests that the presence of pollinators is critical to population viability (Lesica 1993b). Significant historic threats to this species include agricultural land conversions and the disruption of the native fire regime. Today, threats to the

viability of this species stem from continued habitat conversion, livestock grazing, the lack of fire, the invasion of exotic plant species, and herbicide spray and drift. Since most populations of *S. spaldingii* are reproductive isolated, the viability of the species is at risk from genetic and demographic stochasticity. This species has recently been recommended for placement in Category 1, and a listing petition has been submitted to the U.S. Fish and Wildlife Service by the Montana Native Plant Society and other interested parties.

Sisyrinchium sarmentosum **Suksd. ex Greene** is a peripheral species in Washington. There are two occurrences in Klickitat County, both on private land. Population sizes range from 100 to 200 plants. This perennial inhabits subalpine and montane meadows in the *Abies grandis* and *A. amabilis* zones. It is found in wet seeps and areas wet in spring and midsummer. Soils are deep to medium deep and are derived from volcanics, primarily basalt, aeolian, glacial till, colluvium, alluvium and residuum. Sites range from 1200 to 6000 ft. in elevation with slopes of less than 15%. The species is sensitive to changes in water regime. It is palatable and sensitive to grazing and trampling, as well as the exotic plants introduced by cattle and people. Fire could have a positive influence in creating openings of potential habitat, as well as a negative influence by changing the hydrology of basins. Developments also threaten its habitat.

Stanleya confertifolia **(Robins.) Howell** is a regional endemic known from the Baker Co., Oregon, to southeastern Oregon Harney, Malheur and east to Idaho in Owhyee and Washington Counties. The species is an annual (occasional biennial) found on open, barren ashy and sandy sites, on plains and low hills. Flowers bloom from May to June, and early spring precipitation appears crucial to successful establishment and seed set. Little is known regarding potential threats to, and population trends of, this species.

Stephanomeria malheurensis **Gottlieb** is a federally listed, endangered local neoendemic. An autogamous annual species, it is found at one site in the Basin and Range Province, in Harney Co., Oregon, where it grows on an ancient lake bed of very gentle slope that was uplifted during pre-Pleistocene times. Substrates are gravelly sandy loams. Almost all known extant *S. malhuerensis* is derived from an outplanting of progeny raised at the Berry Botanic Garden, Portland, Oregon, from material stored at the University of California, Davis. Population size varies annually with precipitation. Associated species at the site include *Artemisia tridentata* ssp. *wyomingensis, Chrysothamnus* spp., and *Elymus cinereus*. *Stephanomeria malheurensis* is closely related to *S. exigua*, which is sympatric, and has been derived from the latter species by a change to a self-pollinating breeding system. Historically, this species was on a decreasing trend, and the current trend remains unchanged. The site has been fenced to exclude grazing, but low seed set, seed predation and cheatgrass invasion pose considerable threats to the species' viability. The population resides on an old zeolite mining claim, and renewed interest in mining may introduce a future threat.

Sullivantia hypomania **(Counter & Fischer) Counter var.** ***hypomania*** in Idaho is disjunct from the primary range of this taxa. It is found in the lower canyons of the Middle Fork Salmon River and its tributaries. It is restricted to shaded cliff faces in the spray and splash zones around waterfalls. Idaho populations of *S. hypomania hypomania* are all located in wilderness and have no discernible threats.

***Tauschia hoverii* Math. & Const.** is a local endemic, found in Yakima and Kittitas Counties, Washington. In the Columbia River Basin Province, 20 of the 39 occurrences are on federal land. Populations of this small perennial often number into the thousands. It grows on basalt scablands in the *Artemisia rigida* and *Poa secunda* habitat type on lithosol soils on zero to five percent slopes. It ranges in elevation from 1700 to 3270 ft. It is an important root for the Yakima Wanapum Indians. Threats from grazing and roads are high.

***Texosporium sancti-jacobi* (Tuck.) Nadv.** is a regionally endemic lichen found in southern Idaho and eastern Oregon that requires good, or excellent range conditions. It is usually found on old humus or decadent *Poa secunda* clumps. Elevations of known *Texosporium* sites range between 2,400 and 3,300 ft. This species is in decline due to threats from degrading range conditions (attributed to livestock grazing, changes in fire frequency, land conversion, and introduced vascular plants). Four sites burned in range fires in 1996. A single disjunct collection of this species was made in Pinnacles National Monument, California (McCune 1992).

***Thelypodium eucosmum* Robins** is a restricted regional endemic distributed mainly within the upper John Day River watershed in Grant and Wheeler Counties, Oregon. It is found between 1,200 and 3,900 feet in elevation, on deep volcanic silt (John Day volcanics), light colored montmorillonite clays, and pyroclastic metasedimentary soils. It is associated with ephemeral streambeds, and open juniper - sagebrush - bunchgrass communities typically on ashy-clay soils in *Juniperus occidentalis* woodlands. Though most often observed to be biennial it can persist for two or three years under some conditions. It is highly palatable and desirable to wild and domestic ungulates. Livestock grazing practices and habitat conversion to agricultural lands have dramatically reduced its distribution and available habitat. Changes in the historic fire regime leading to fewer fires of greater intensity damage *Thelypodium eucosmum* rosettes and its seed bed, especially directly under juniper.

Thelypodium howellii* Wats. ssp. *howellii is a scattered endemic known from a small hand-full of historic collections in Crook, Deschutes, Grant, Harney, Lake and Klamath Counties, Oregon, and from five populations near Susanville in northeastern California. It is currently considered extinct in Oregon. It is a biennial species that occurs on moist, alkaline soils in river valleys, at the margins of ponds and lakes, and within alkaline meadows and plains. Historic site elevations ranged from 4500 to 4700 feet. Grazing by livestock is the greatest threat to the species.

***Thelypodium howellii* Wats. ssp. *spectabilis* (Peck) Al-Shehbaz** is a local endemic known from Union, Baker (Baker Valley), and Malheur Counties, Oregon. Several occurrences have been extirpated in the recent past (Youtie 1995). This species is associated with alkaline bottomlands, basins, flats, and floodplains. It is commonly associated with *Sarcobatus vermiculatus, Elymus cinereus,* and *Deschampsia cespitosa* at sites between 3,200 and 3,400 feet in elevation. This species is highly palatable and desirable to wild and domestic ungulates. Spring and summer grazing is harmful but fall grazing may provide satisfactory results by impacting competing vegetation. All known populations are on private land. This plant is one of the most imperiled plants in Oregon.

***Thelypodium repandum* Rollins** is a local endemic restricted to the Challis volcanics and associated metamorphics. This annual mustard is found exclusively on steep talus slopes. Populations appear to be stable at this time. Identified significant threats to this species include road construction and mining. Limited threats stem from livestock grazing and exotic species. Long term monitoring of *T. repandum* is ongoing.

***Tofieldia glutinosa* (Michx.) Pers. ssp. *absona* Davis** is a boreal disjunct species known from a single site on Priest Lake in northern Idaho. It is restricted to sphagnum peat substrates. Threats to this species at Priest Lake include land development and alterations to the local hydrologic regime. This species is both difficult to locate and identify. There may be more suitable habitat in northern Idaho.

***Trifolium douglasii* House** is a regional endemic only known from three sites in Whitman County, Washington and six sites in Umatilla and Union Counties, Oregon. It inhabits moist, temporarily flooded meadows and forested wetlands, and streambanks. Historically, this species was found from Spokane County, Washington to Baker County Oregon and east to adjacent Idaho. *Trzfolium douglasii* has been severely impacted by habitat conversion to agricultural uses and by seeding of exotic grass species, although it may tolerate some rotational grazing regimes. The effects of fire on this clover are not known but spring burns are likely detrimental to its early spring seed production.

***Trifolium owyheense* Gilkey** is a regional endemic species restricted to the ash deposits of southwestern Idaho and adjacent Oregon. The annual prevalence and reproductive capacity of this species depends on soil moisture availability. It prefers sparse sites (less than 30% cover) with modest slopes (0-30%). Known populations occur between 2,600 and 4,500 ft. The trend of this species is unknown. Changes in the historic fire regime, *mining, the* invasion of exotic species, and OHVs are all seen as significant and important threats to *T. owyheense.* Lesser but still important threats stem from livestock grazing and road construction.

Trifolium thompsonii* Morton** is a local endemic in Washington in eastern Chelan and Douglas Counties, where there is one occurrence on private land in Douglas County. In the rest of the East Cascades province there are 20 occurrences with the majority of sites on federal land. Although its range is restricted, its habitat is highly variable. This perennial grows on basalt scablands, as well as areas with deeper soils of loess and sandy loam. Found at elevations from 1000 to 3700 feet in plant communities of *Artemisia tridentata, Purshia* ***tridentata/Festuca *idahoensis* and *Agropyron spicatum-F. idahoensis* with less than 20% cover. It seems to be more abundant on sites with northerly aspects Population sizes range from 40 up to one with 2,000 plants scattered over several acres. The population in Douglas County in the Columbia River Basin province is atypical, as the others in eastern Washington are on moderately steep slopes in a mosaic of forest and grassland. It provides pollen and nectar for bees, and fixes nitrogen. Exotic weed invasion and development are threats.

Rare Species Habitat Group Analysis

The ICBEMP database manager used Natural Heritage Program records to produce a list of plant taxa considered rare at the state level. As for the species of rangewide conservation concern, this list was then sorted to produce sublists specific to individual panel analysis areas. The task of the expert panels was to sort these taxa into groups that share similar ecological requirements, as determined by broad habitat affinities. The Vascular Plant Task Group of the Science Integration Team provided six broad habitat types for the panelists to use in grouping the species: alpine, aquatic/riparian, forests, grasslands, rock, and shrublands.

The panelists first reviewed the analysis area list of state rare taxa and made additions and deletions as needed. They then grouped the taxa into one or more of the habitat categories, and assessed the degree of threat to those habitats.

Lastly, with reference to the 45 CRB, SRM and SAF cover types (Tables 3 and 4) that were used in the ICBEMP assessment, panelists decided how finely they wanted to subdivide the broad habitat categories (e.g., into subgroups based on more specific cover types, such as rough fescue and Idaho fescue types within the broader grassland category, or into elevation zones, such as low- and high-elevation grasslands). Lists of rare plant species associated with each habitat group or subgroup were then compiled, and environmental correlate forms were completed for those groups/subgroups in an approach similar to that used for the individual taxon assessments. Upon completion of the habitat group forms, the lists were reviewed to make sure all rare taxa were addressed.

TABLE 3. CRB, SRM and SAF cover type vegetation codes.

VEG CODE	Description
CRB003	Shrub or Herb / Tree Regen
CRB005	Alpine Tundra
CRB006	Barren
CRB007	Herbaceous Wetlands
CRB008	Pacific Silver Fir / Mt. Hemlock
CRBS01	Juniper Woodlands
CRBS02	Mixed Conifer Woodlands
CRBS03	Juniper / Sagebrush
CRBS04	Big Sagebrush
CRBS05	Shrub Wetlands
CRBS06	Agropyron Bunchgrass
CRBS07	Native Forb
VEG CODE	**Description**
CRBS08	Exotic Forbs / Annual Grass
CRBS09	Grand Fir / White Fir
CRBS10	Whitebark Pine / Alpine Larch

CRBS11	Red Fir
CRBS12	Cropland / Hay / Pasture
CRBS13	Fescue-Bunchgrass
CRBS19	Urban
CRBS20	Water
SAF205	Mt. Hemlock
SAF206	Engelmann Spruce / Subalpine Fir
SAF208	Whitebark Pine
SAF210	Interior Douglas-fir
SAF212	Western Larch
SAF215	Western White Pine
SAF217	Aspen
SAF218	Lodgepole Pine
SAF219	Limber Pine

SAF227	Western Red Cedar / Western Hemlock
SAF233	Oregon White Oak
SAF235	Cottonwood / Willow
SAF237	Interior Ponderosa Pine
SAF243	Sierra Nevada Mixed Conifer
SAF245	Pacific Ponderosa Pine
SRM104	Antelope Bitterbrush / Bluebunch Wheat Grass
SRM402	Mt. Big Sagebrush
SRM406	Low Sage
SRM414	Salt Desert Shrub
SRM421	Chokecherry / Serviceberry / Rose

TABLE 4. Forest and nonforest structural stages and their abbreviations

Acronym	Definition
si	stand initiation
seoc	stem exclusion open canopy
secc	stem exclusion closed canopy
ur	understory re-initiation
yfms	young forest multi-story
ofms	old forest multi-story
ofss	old forest single stratum
w_si	woodland stand initiation

w-se	woodland stem exclusion
w_ur	woodland understory re-initiation
w_oms	woodland old multi-story
w_oss	woodland old single stratum
nf	nonforest (not forest,shrubland or herbland)
oh	open herbland
ch	closed herbland
ols	open low and medium shrubs
cls	closed low and medium shrubs
ots	open tall shrubs
cts	closed tall shrubs

The results of this analysis is presented in appendix 3. In each section of the analysis, a list of species by major habitat group is provided with GIS attributes and themes. This information is given to facilitate planning efforts in for future ecosystem management projects. Each section is prefaced with a short description of the important general physical attributes of each habitat group and a short discussion of the impacts of current and historic land use practices. In each case, the generalities have been stressed. We recognize that there is and always will be variation with the Interior Columbia Basin with respect to the intensity and nature of threats.

Rare Plant Communities

With increases in human influences on ecological processes, vegetation structure and function, there has been a significant loss of native plant communities and ecosystems across the United States (Nature Conservancy 1974). Concerns for the maintenance of diversity exists fall all its interactive levels, including genetics, species, communities, and ecosystems (Langner and Flather 1994). Concerns such as these prompted the need to identify and assess the status of rare plant communities within the Columbia River Basin.

An inventory and assessment of the status of rare plant communities was conducted by Maria Mantas for this analysis in 1995. Lists of plant communities (including potential vegetation types, community types and plant associations) were obtained for each state in the ICBEMP assessment area, in consultation with the Natural Heritage Programs and Conservation Data Centers. Priority for assessment was placed on 223 plant communities ranked by the Heritage

Program as globally rare (G1 and G2). A G1 community is defined as: Critically imperiled globally because of extreme rarity (5 or fewer occurrences) or because of some factor making it vulnerable to extinction; G2: Imperiled globally because of rarity (6 to 20 occurrences) or because of other factors demonstrably making it vulnerable to extinction throughout its range. Communities ranked as G3 (either very rare and local throughout its range or found locally in a restricted range or because of other factors making it vulnerable to extinction throughout its range (20 to 100 occurrences)) were omitted from assessment. State-ranked communities that are not ranked as G1 or G2 were also omitted, due to the complexity of analyzing the potentially large number of communities had they been included. Where possible, rarity class, threats, trends, and distribution within the Columbia River Basin were identified. This information was gathered through the expert panel process and from Natural Heritage Program/Conservation Data Center ecologists.

Plant Communities that were inherently rare because of a unique set of abiotic features, and those that were once more common, but reduced due to management, as especially vulnerable to extirpation. For example, the bunchgrass grasslands of the Palouse region, once expansive in area, have been reduced to a few remanent stands due to agricultural conversion. Low elevation cedar/hemlock old-growth forests, on the other hand, may never have occupied a large portion of the landscape, yet have been disproportionately affected due to the extraction of large volumes of timber available in this highly productive areas. It is hoped that the information given here will assist managers by placing the concerns for sustainability of these communities in context with their status on a regional scale. In addition, potential for restoration of some communities may be prioritized and perhaps expedited by knowledge as to which communities are globally at risk, and what the known threats are for these unique areas.

Plant communities are assemblages of organisms that are repeatable over the landscape (Bourgeron and Engelking 1994). Many classification systems have been applied to characterize a grouping of plant species as a definable unit. Although there is still a need for continued classification and standardization, the Natural Heritage Program Network has gone far in compiling and standardizing a classification of plant communities in the Western United States. This work (Bourgeron and Engelking 1994) was used as the basis for identifying rare plant communities that occur in the Columbia River Basin. The results of the rare plant community analysis is presented in appendix 4.

Plant Taxa of Cultural Importance

There was a separate working group within the Interior Columbia Basin Ecosystem Management Project's Science Team dedicated to coordinating with Native American Tribes. In support of their effort, and to help assure the continued harvestabilty of culturally significant plants, an analysis of species by vegetation type and seral stage is provided in appendix 5. This list of species is not to be considered a complete listing of plants used by the Indian people of the

project area. It is apparent that there was once a much wider recognition and utilization of the native flora than there is currently. Tribal Elders will stress that all plants once had a recognized use.

The list in appendix 5 was compiled in consultation with the Tribes, and further refined by Richard Helliwell. Helliwell is currently the Forest Botanist on the Umpqua National Forest and was formally employed by the Confederated Tribes of Warm Springs. He is a recognized and respected authority on culturally significant plants.

Research, Development and Applications

The lack of knowledge concerning certain areas of species biology and ecology interfere with the land manager's ability to effectively mange and conserve rare vascular plant taxa. Broad, one size fits all, directions for rare plant management have proven to be problematic. Vague guidelines are often difficult to interpret or implement. To rectify this situation, the vascular plant task group identified research, application, and application needs that would specifically improve our ability to manage or protect species of conservation concern. This included identification of inventory, monitoring, taxonomic, and ecological studies needed in addition to studies needed to determine the impacts of management activities for the species of rangewide viability concern. The Research, Development, and Applications (RDA) database was compiled with input from expert panels conducted throughout the ICBEMP assessment area and contract reports concerning taxonomically diverse genera.

The database itself is available in a Paradox 4.0 runtime application that can be queried by species, level of endemism, key words (a list of functional key words is provided with the software), or geographic area. The RDA is summarized in tabular form in appendix 6. Copies of the database are available through the database manager for the Interior Columbia Basin Ecosystem Management Project in Walla Walla, Washington.

Flora of the Columbia River Basin

CRBFLORA is a checklist of vascular plant species found in the Interior Columbia Basin assessment area. The data was compiled by Peter Rice at the University of Montana,, the Soil Conservation Service "PLANTS" database, and several other existing sources. Much of the compilation of the CRBFLORA was completed by Karl Urban from 1994-1995. Nomenclature follows Hitchcock and Cronquist (1973). The CRBFLORA checklist is presented in appendix 7.

The CRBFLORA checklist has tremendous potential for use in additional analyses. The Floristic Biodiversity of the Camas Ecosystem Analysis Area (Urban 1995) is an excellent example. Using a matrix database of 1,234 vascular plant species for seven plant association groups, Urban as able to provide the following results:

- the number of vascular plant species presently occurring in the analysis area,
- a comparison of the floristic richness of the analysis area with other areas on the Umatilla National Forest,
- delimit ecological distributions and habitat affinities or the species within plant association groups,
- a historic listing or former or present sensitive plant species,
- a determination of other plant species that are "at risk" in the analysis area,
- a ration of introduced to native species,
- a list of noxious weeds in the analysis area,
- and a list of culturally significant plants to assure their continued harvestability.

This level of analysis is appropriate for many scales and may prove to be an invaluable tool in future ecosystem based planning efforts.

Electronic copies of the checklist are available from the database manager for the Interior Columbia Basin Ecosystem Management Project in Walla Walla, Washington.

Conservation

Appendix 2 contains a list of the species conservation reports that are completed for species of conservation concern within the ICBEMP assessment area. This information was compiled by Leah King in 1995. Again, it is important to note that this information is not current, though it does represent the first comprehensive summary for the assessment area. The following terms are used extensively in that appendix and further defined here.

Conservation strategies: Conservation strategies (also known as species management guides or plans) are typically developed for candidate and sensitive species, as a means of preventing the need to federally list them as threatened or endangered. The strategies are species-specific documents that outline the biological and ecological limiting factors that most influence the species' viability and distribution. They are compiled from the best scientific information available for the species. They provide recommended conservation measures, usually with reference to specific populations, on how to best manage or protect the species. Conservation strategies also usually include action and monitoring plans. Conservation strategies are typically internal documents prepared by a federal agency, and are usually implemented by line officer approval and/or amendment of a planning document (e.g., a Forest Plan).

Conservation agreements are formal written documents agreed to by the U.S. Fish and Wildlife Service and another federal agency; they may also involve tribes, state agencies, local governments, and/or the private sector. The objective of a conservation agreement is to reduce the threats to a candidate species and/or its habitat through voluntary cooperation, by documenting the specific actions and responsibilities for which each party agrees to be accountable. If effective, these agreements may lower the listing priority or eliminate the need to list a species.

Listing packages are compiled by the U.S. Fish and Wildlife Service, and present the information that supports a proposal to federally list a species.

Recovery plans are prepared after a species is federally listed, and present the objectives for recovering a species to the point where it can be delisted.

Status reports (also occasionally referred to as biological investigations) summarize the current biological, ecological and geographic data available for a species. These reports typically precede the development of conservation strategies or agreements, and usually are prepared as a result of focused field surveys aimed at assessing the species' status.

Ex situ conservation

The following discussion on the role of ex-situ conservation in the management of rare plants in the ICBEMP comes from a report prepared under contract by Linda McMahon and Ed Guerrant (1995) of the Berry Botanic Garden, Portland, Oregon, for this project.

Ex situ or "off-site" conservation describes a range of activities more or less separated from "on-site" or *in situ* activities. Many interactions and overlaps exist between off-site and on-site activities; however, *ex situ* activities are usually considered to be such activities as seed storage, maintaining living collections at botanical gardens, or various research activities. *Ex situ* is not an alternative to *in situ,* but both are part of a larger, comprehensive conservation effort.

The Botanic Gardens Conservation Strategy (World Conservation Union, 1989), jointly produced by the World Conservation Union (IUCN), Botanic Garden Conservation International (BGCI: formerly Botanic Garden Conservation Secretariat, or BGCS), and the Worldwide Fund for Nature *(WWF),* states: *"In situ* and *ex situ are* the opposite ends of a spectrum and there is no absolute distinction between them." That document goes on to call for a "seamless blend" of *in situ* and *ex situ* conservation as the most effective way to conserve species and ecosystems.

Several methods of off-site conservation exist that can be considered for use as part of a conservation and recovery program for rare plants within the ICBEMP assessment area.

Ex situ or off-site conservation is generally considered to consist of germplasm storage methods such as seed banks, maintaining living collections, and tissue storage (such as in tissue culture, or pollen). Also relevant are many activities that take place, at least in part, away from wild sites and habitats, but that rely heavily on material from these sites, including efforts at replanting, restoration, and transplantation, studies of soil seed banks, and laboratory research (e.g. taxonomic, life history). Off-site storage of seeds is not an end in itself, but one means among many that contribute to the end of conservation. "New populations can arise phoenix-like out of the ashes of extinction only if collections exist off-site. It is also critical to note that *ex situ* collections are not an end in themselves. Their ultimate value will be derived from how they are

used and their effect, if any, on the long-term prospects for survival of rare plant species" (Guerrant, 1992).

Relevance of Ex Situ Conservation: Why Have Off-site Collections at All?

Off-site conservation must be considered in context with other conservation activities, including outplantings to enhance existing wild populations, reintroduction to a historical site, introduction of species within an existing range to enhance species survival, and experiments with introduction or reintroduction. Reintroductions and other similar activities are far from an exact science.

In some ways, are all experimental, since the experience of the conservation community with these strategies is relatively recent, and long-term monitoring studies are just beginning. Few examples of these activities have been ongoing for over 20 years.

Mitigation activities often specify certain *types* of *ex situ* conservation, such as seed storage or transplantations of individual plants to new sites. Experience with these shows that transplantations of existing plants in the wild to new sites are rarely successful, even in the short run (Fahselt, 1988; Fiedler, 199 1; Hall, 1987). Indeed, translocation is a controversial technique, possibly with limited conservation value. The above mentioned references note that most failed because of lack of site preparation and post-establishment care. Many sites of transplantation require continued watering, mulching, shade protection, grazing protections, insecticides, pest and weed control. The more successful projects tended to be those with more planning and care invested in the project. Gordon (1994) presents a 'decision tree', in the form of a dichotomous key, that aims to inform land managers when and where translocation might be considered appropriate.

Revegetation or restoration seems to be somewhat more successful, particularly when plants are propagated specifically for this purpose. Evans and Bohn (1987) report success in cultivating many California species, particularly woody plants, for restoration projects.

Genetic Consideration

Many biologists refer to genetic considerations in the published literature when undertaking any conservation activity and stress the following of guidelines to protect and enhance genetic integrity. In the context of mitigation, this loud and repetitive voice is certainly appropriate. In the context of species recovery, *ex situ* conservation, restoration, and management, it is equally important. Ferreira and Hillyard (1978) discuss the following needs: to define "local" population, to be very careful with the genetics of plant species, to know genotype and location of all material used in any vegetation enhancement, and to tighten up contracts to account for genetic credibility.

For seed banks, protocols are becoming firmly established. Brown and Briggs (1991) advocate collecting a high amount of genetic material for seed banks--material kept separate for each maternal parent plant, collected at different times and from different plants, and from varying

numbers of populations. The Center for Plant Conservation (CPC, 1991) has compiled guidelines for this purpose.

Fenster and Dudash (1994) advocate the need to incorporate genetic considerations in any restoration project. They cite factors such as inbreeding and outbreeding depression and genetic diversity of stock material. In the same book on restoration, Pavlik (1994) cites the need to monitor projects adequately. He considers monitoring "crucial" to the success, and points out that monitoring is a highly developed science involving statistical trends analysis--census data alone are not enough.

The question of limited resources is always with us. Certainly, we must make priorities whenever possible and make sure that any overall conservation plan for a species or habitat is appropriate for that site or species. In some ways, off-site conservation brings new resources by enlisting the aid of seed storage laboratories, botanic gardens, and the research community.

Indeed, off-site conservation can lead to false security if it is not part of an integrated conservation plan. At best, by itself it does little more than conserve genetic material , an activity that has little significance without the context of its habitat. At worst, it can lure us into thinking that we have actually done something for conservation, only to later learn that we cannot germinate seeds in storage or that all suitable habitat has disappeared. The conservation strategy involving *ex situ* methods must be part of an overall plan and not act in a vacuum.

Living collections and other off-site storage methods have their risks. Living collections are far from secure in cultivation (Elias, 1978). Natural mortality and difficulty in maintaining propagated stock make the maintenance of living collections highly challenging if not impossible in the long run. For shorter durations, they may be useful if the context is right. Even more secure methods such as seed storage and tissue culture have their risks, including mutations, mechanical failure, and natural disasters. All methods need to be approached with sound science and humility.

The Role of Botanic Gardens

Botanic Gardens are relatively new partners for certain aspects of plants conservation. For many years, botanic gardens, particularly the larger gardens with research staff, have participated in research on plant taxonomy and distribution.

The role of botanic gardens does not stop with off-site germplasm storage, however. Specific projects include The Berry Botanic Garden's role is reintroduction of *Stephanomeria malheurensis* (Parenti and Guerrant, 1990) and transplantation of *Penstemon barrettiae* by The Berry Botanic Garden (Guerrant, 1990).

A census of the botanic gardens in the Center for Plant Conservation network working within the region to learn of their off-site collections for the taxa on the list is summarized in Table 5. The botanic gardens referred to are The Berry Botanic Garden in Portland, Oregon, Red Butte Gardens and Arboretum in Salt Lake City, and the Denver Botanical Garden in Denver Colorado.

Of the 173 taxa analyzed in this assessment, 63 are kept in off-site seed storage at these institutions.

The table below gives the number of accessions (seeds or living plants) of rare plant taxa from the Interior Columbia River Basin that are maintained at the Berry, Denver, and Red Butte botanic gardens.

TABLE 5. Number of accessions of rare plant taxa maintained at botanic gardens.

Species	Berry*	Denver	Red Butte
Allium aaseae	1		
Amsinckia carinata	5		
Antennaria arcuata	1		
Arabis fecunda		1#	
Artemisia campestris var. wormskioldii	4		
Astragalus applegatei	4		
Astragalus diaphanus var. diurnis	1		
Astragalus mulfordiae	10		
Astragalus peckii	2		
Astragalus sinuatus	6		
Astragalus solitarius	3		
Astragalus sterilis	3		
Astragalus tegetarioides	3		
Astragalus tyghensis	3		
Calochortus longebarbatus var. longebarbatus	3		
Castilleja chlorotica	3'		
Castilleja christii		1#	
Chaenactis cusickii	1		
Colloma mazama	2		
Cypripedium fascicula turn	1		

Delphinium viridescens	4		
Erigeron basalticus	1		
Eriogonum argophyllum			1
Eriogonum crosbyae	3		
Eriogonum cusickii	4		
Eriogonum prociduum	5		
Hackelia cronquistii	12		
Hackelia venusta	22		
Haplopappus radiatus	10		
Howellia aquatilis	live plants		
Ivesia rhypara var. rhypara	21		
Lepidium davisii	5		
Limnanthes floccosa ssp. bellingeriana	2		
Lomatium erythrocarpum	1		
Lomatium suksdorfii	5		
Luina serpentina	4		
Lupinus biddlei	8		
Mentzelia mollis	5		
Menzelia packardiae	8		
Mimulus hymenophyllus	1		
Mimulus jungermannioides	3		
Mimulus pygmaeus	1		
Mirabilis macfarlanei	39		
Penstemon barrettiae	33		
Penstemon peckii	201		
Perideridia erythrorhiza	7		
Phacelia lenta	3		

Pleuropogon oregonus	4		
Polemonium pectinatum	3		
Primula nevadensis	1		
Ranunculus reconditus	4		
Rorippa columbiae	1		
Senecio ertterae	9		
Sidalcea oregana var. calva	3		
Silene seelyi	4		
Silene spaldingii	23		
Stephanomeria malheurensis	127		1
Tauschia hooveri	1		
Thelypodium eucosmum	2		
Thelypodium howellii ssp. spectabilis		2	
Trifolium leibergii		2	
Trifolium owyheense	5		
Trifolium thompsonii	2		

* The number of accessions can indicate many things. In earlier years, some accessions from different plants in a population were accessioned together. Later, each plant from a population received a separate accession number.

Accession is split between the garden and the National Seed Storage Laboratory. May be more than one accession.

This summary information provides a rough estimate at best of off-site activities. Accessions may or not be adequate to represent the genetics of the wild populations. Germination testing has most likely been completed for only a few of the taxa. Although the number of taxa in off-site seed storage is surprisingly high, the "quality" of these collections has not been assessed for most and should not provide a sense of security that these taxa are well-represented off-site.

It would be interesting and desirable to provide a more in-depth assessment of these collections. Appropriate areas of inquiry would be how the off-site collections compare to natural population and their genetic representation, which additional species might be added to off-site storage and in which priority, which species provide challenges for germination and growth, what outstanding taxonomic questions might lead to better conservation action, and what kinds of

research are being carried out in general for life history parameters or restoration/enhancement. We know for example that re-establishment projects are underway for *Penstemon barrettiae* (Guerrant, 1990) and *Stephanomeria malheurensis* (Parenti and Guerrant, 1990) because we are involved directly, however, others may exist that we could learn of with time to inquire. Research on germination and growth of *Hackelia venusta* is being undertaken by the Cincinnati Zoo and Botanical Garden with seeds to be provided by the Berry Garden. Likewise, the Berry Garden is undertaking a long-term soil seed bank study of *Penstemon peckii.*

Centers of Endemism and Hotspots of Biodiversity

Panelists were also asked to generate a map of areas with high concentrations of endemic species and areas that they felt to be "hot spots" of biodiversity. This exercise was meant to be part of a larger effort undertaken by the Terrestrial group of the Science Integration Team. It was a very subjective effort, with little definition given as to what constituted a hot spot or how to define a center of endemism. Each panel came up with very different results and areas were drawn on several different scales. As such, none of this information has been included in this report and it is strongly recommended that this information from other reports from the ICBEMP project showing hot spots or centers of endemism for plants **NOT** be used for any type of planning effort.

If this information is desired, the following objective method could be used as a starting point for gathering this type of information. Using State Heritage Program data, and defining endemism to mean areas of high concentrations of globally rare elements, occurrence density maps could be generated for elements of G ranks of G1-3. To get an idea of biodiversity, defined as areas of high concentrations of global and state rare elements, or even state rare elements only, a map of state S1-3 and global G 1-3 could be generated. Recent large scale planning efforts have used this method to produce maps that show number of species by county, with a shading to illustrate high density areas. Figures 2 and 3 in this report show this kind of information for the ICBEMP.

CONCLUSIONS

MANAGEMENT IMPLICATIONS

Summary of threats (natural and management-induced)

Panelists also provided data on the threats to the taxa of rangewide conservation concern within the ICRB. Several species had more than one factor threatening their habitat or viability. This list did not include natural disturbances such as normal fire regimes, climate change or pathogens and pests. Major threats included exotic plant invasion, road construction and recreation. Several threats represent a complex combination of factors such as the invasion of exotic species due to livestock overgrazing, road construction, or increased fire frequency. The table below summarizes the number of vascular plant taxa of rangewide conservation concern that are judged to be at risk from the indicated threat factors.

TABLE 6. Summary of threats and number of taxa affected.

Threat	Number of taxa affected	bryophytes	fungi	lichens
agricultural conversion	16	X	X	X
development	21			
exotic plant species	89			
fire, change in native regime	12	X	X	X
fire suppression activities	24			
fire, increased frequency	4	X	X	X
fire, stand-replacing	1			
fire exclusion	1		X	X
livestock grazing, indirect effects	16	X	X	X
livestock grazing, direct effects	23	X	X	X
hydrological regime changes	18	X		
mining	9			
off highway vehicles	28	X		X
pipelines, power lines	2			

recreation	32	X		X
road construction	37			X
road maintenance	13			X
riparian disturbances	9	X	X	
timber harvest	12	X	X	X
herbicide spray and drift	15			

Mitigation measures (standards and guides) to reduce risk to species of concern

The majority of the vascular plants analyzed as part of the Science Assessment are either locally endemic in their distribution pattern, or have broader distributions but are associated with highly specialized habitats. As discussed in the previous section, determining the effects of management actions on such rare plants is difficult at the broad scale of analysis for the ICBEMP. The viability and conservation of all of these highly restricted taxa, as well as determinations of the effects of management actions on them, is best undertaken at the local, regional or provincial level. Therefore, we have suggested the following mitigation measures (standards and guides) for both the broad scale and project level that may be used in the planning, analysis, implementation and monitoring of projects to insure viability of native vascular plants and bryophytes, lichens, and fungi at all scales of planning. A further management objective is to maintain the distribution of native plant communities throughout the local planning areas, and to maintain, protect, or restore special habitat features (e.g., peatlands, bogs, fens, azonal lithologies, mineralized areas, geothermal areas).

We also recognize the need to develop a process for the conservation of local and regional endemics and disjunct and peripheral species at finer planning scales that will build on the information provided in this document and provide for continued viability of these taxa across administrative boundaries. This may be potentially accomplished at the sub-watershed or watershed level and involve a diverse group of partners such as: USFS, BLM, State Natural Heritage Programs, U.S. Fish and Wildlife Service and Native Plant Societies.

1. Broad-scale inventory needs to assure species viability:

- Develop monitoring programs and conservation strategies for local endemic, regional endemic, scattered, disjunct, and peripheral plant species across their geographic ranges. When necessary, collect basic life history and demographic information to assess viability, and make this information available to all project planners.

- Conduct floristic surveys of azonal habitat inclusions (e.g., rock outcrops, cindercones, roof pendants, serpentine soils). Surveys should focus on both vascular plants and

bryophytes, lichens and fungi. Assure that qualified specialists conduct the surveys for each separate plant group.

- For each Ecological Reporting Unit (ERU) or physiographic province, conduct inventories for rare lichens, bryophytes and fungi. These surveys shall be conducted by individuals with appropriate taxonomic expertise.

- Coordinate all inventories and monitoring for bryophytes, lichens, and fungi at a regional level to assure consistency and expertise at the Forest level, where skills in lichen, bryophyte and fungal taxonomy may be lacking.

- Identify and protect high-quality examples of intact cryptogamic soil crusts and vascular plant communities across the ICBEMP, especially in arid areas at low to mid elevations. Representative stands must be designated in each section of each province in the assessment area. Livestock must be excluded from protected areas. These areas may be designated as Botanical Special Interest Areas or Areas of Critical Environmental Concern.

- Identify and protect type localities for rare lichens, bryophytes and fungi that occur within the ICBEMP as Botanical Special Interest Areas or Areas of Critical Environmental Concern. These areas can serve as reference sites to aid in identification of potential habitat and positive species identification.

- Conduct systematic surveys by taxonomic experts to determine the composition and distribution of microbiotic crusts within the ICBEMP assessment area, as such crusts are critical to the ecological integrity of arid plant communities.

- Encourage systematic surveys by taxonomic experts in peatlands, fens and bogs. Peatlands (including bogs, fens, and shrub swamps) need protection from grazing, commercial collecting, and structural and hydrologic alteration. Basic inventories are needed throughout the assessment area to locate, identify and map peatlands.

- Conduct systematic surveys of calcareous rock habitats. Representative areas of wet and dry calcareous rock need inventory and protection from mining activities because of their habitat importance to bryophytes and lichens.

- Assess the conservation status of rare plant species at the margins of their geographic ranges (e.g., species with state ranks of S1 or S2, as determined by the state Natural Heritage Programs). Provide habitat protection measures necessary to assure the continued viability of these peripheral populations.

- Identify and protect high-quality stands of Garry oak (*Quercus garryana*) woodland occurring in the assessment area. These stands are extremely important habitat for bryophytes and lichens, and harbor the only occurrences of some taxa.

- Within proposed project areas, survey and map all rare (G1-2) plant communities, if present, and provide for their continued compositional and functional integrity.

- Continue to conduct species-specific surveys for rare species of vascular plants and bryophytes, lichens, and fungi with poorly known ranges to determine distributions and abundances and, if necessary, appropriate levels of protection. Assure that qualified specialists conduct the surveys. Incorporate newly acquired information into management decisions such that those taxa in need of protection are provided for.

2. **Broad-scale mitigation suggestions for maintaining genetic integrity of native communities:**

- To the extent practicable, seeds and plants used in erosion control, fire rehabilitation, riparian restoration, forage enhancement, and other revegetation projects shall originate from genetically local sources of native species. Follow the regional policies established for U.S.F.S. Regions 1 and 6. When project objectives justify the use of non-local or non-native plant materials, documentation explaining why non-local and non-native plants are preferred will be a part of the project planning process.

- If genetically local stock of native tree, shrub, forb, or grass species is not available for rehabilitation or revegetation projects, consider not doing, or delaying the project, or using exotic species that will not persist in the ecosystem. Sterile varieties or short-lived annuals should be specifically considered.

3. **Broad-scale planning suggestions:**

- Define existing and suitable unoccupied habitat for TES plant species by mapping locations and describing the habitat requirements necessary for the maintenance of viable populations.

- Establish conservation agreements and prepare conservation strategies to preserve habitats of sensitive plant species as a means of preventing further federal listings.

- Establish partnerships and cooperate with native plant interest groups, other agencies, and private land owners in programs for assuring the long-term survival of TES plant species.

- To assure the continued harvestability of Native American culturally significant plant species, these taxa must be identified and their biology and protection considered in the planning and implementation of projects.

4. **Broad-scale monitoring and research suggestions:**

- Determine what species of vascular plants, lichens, bryophytes, and fungi are being harvested commercially within the assessment area, and determine what impacts harvest will have on species viability. Formulate plans to monitor permit and harvest activity to protect species viability and diversity. This should be regionally coordinated to assure viability across the range of these species.

- Establish a program of monitoring and evaluation to determine the direct, indirect, and cumulative effects of management activities on the continued survival of viable populations of TES plant species occurring within the appropriate planning areas.

- Select appropriate vascular plants and bryophytes, lichens, fungi, or groups of plant species that are sensitive to changes in habitat and ecosystem conditions, for use as management indicators.

- Assess the conservation status or needs of rare plant species at the margins of their geographic range. Provide habitat protection measures necessary to assure the continued viability of these peripheral populations.

- Coordinate all inventories and monitoring for bryophytes, lichens, and fungi at a Regional level to assure consistency and expertise at the Forest level, where skills in non-vascular plant and fungal taxonomy may be lacking.

- Encourage partnerships with outside research organizations to address identified information needs, especially basic life-history information, for high-priority species of conservation concern.

- Provide training opportunities to improve knowledge of monitoring and data collection methods necessary to meet monitoring standards.

5. **Forest or project-level mitigations to be incorporated in the design, planning and implementation of projects:**

- Amend Forest plans to implement existing recovery plans and conservation strategies for Federally listed vascular plants and bryophytes, lichens, and fungi and species of conservation concern.

- Conduct species-specific and/or floristic surveys for rare species of vascular plants and bryophytes and fungi for all agency-sponsored activities. Assure that qualified specialists conduct the surveys.

- Assess the conservation status or needs of rare plant species at the margins of their geographic range. Provide habitat protection measures necessary to assure the continued viability of these peripheral populations.

- Prescribed fire plans should consider the phenology and condition of native plant

communities, and occurrences and phenology of TES plant species, in determining suitable timing and intensities of burn treatments.

- Recreational planning should include adequate consideration of biological impacts to native plant communities, including associated long-term effects. Evaluate and reduce, where necessary, the impact of dispersed recreation on rare plant sites through a program of public education and interpretive displays, and relocation of recreational sites where appropriate.

- To assure the sustainable harvestability of Native American culturally significant plants, these taxa must be identified and their biology and protection considered in the planning and implementation of projects.

6. **Recommendations specific to bryophytes, lichens, and fungi, including: those occurring on specialized substrates. that are identified within the planning area and inventory and research needs.**

Bryophytes

Appendices in Christy and Harpel (1995) list specific localities, habitats and research needs for bryophytes in the study area. The data for Nevada and Utah are scanty. Despite the fact that thousands of collections of bryophytes and lichens have been made in the Columbia River Basin over the last 150 years, vast areas have not been collected systematically or at all. In particular, liverworts have been undercollected and chronically misidentified, and need careful attention in future work.

- **Surveys for rare species.** Obviously, the rare taxa listed in the reports need to be sought throughout the study area, to better determine distributions and abundance. The localities of the taxa listed as occurring at the edge of their range (e.g., species primarily of eastern North America) are important for study for their role in migration or as relictual areas. Habitat needs for specific species are beyond the scope of this report.

- **Arid habitats and soil crusts.** Arid habitats of all types are undercollected and need further attention throughout the region. These include desert, shrub-steppe, pinyon-juniper woodland, oak woodland, and ponderosa pine forest. The composition and function of soil crusts, while relatively well studied in the Great Basin, particularly in Utah, is virtually unknown in the Columbia River basin. Some general collecting has been done in a few areas, but the problem needs to be approached on a regional basis, studying crusts in different plant associations and on different soil types. The effects of livestock trampling should be included in any such studies.

- **Old-growth and late-successional forests.** Most of the issues identified in Thomas et al. (1993) also apply to forested areas of the Columbia River Basin and need not be

repeated here. The greatest similarities in the bryophytes flora and relative biomass in these forests occur in the mesic forests of the so-called "maritime extension" area in Idaho and Montana. Commercial harvest of moss in these forests is a growing concern, and needs regulation and monitoring to ensure that rare or disjunct species are not being depleted, and that recruitment is adequate to sustain harvest levels. Ponderosa pine forests have few bryophytes as epiphytes or in the understory, but representative stands need to be protected and managed correctly to maintain floristic composition.

- **Calcareous rocks.** Calcareous substrates provide habitat for a distinctive group of bryophyte species. A few calcium-rich areas have been collected, particularly in the northern Rocky Mountains and elsewhere in Idaho, but those of Oregon and Washington are poorly known and need further work.

- **Mineralized areas.** Mineral deposits, usually occurring in areas previously mined for gold, silver, copper, mercury and other materials, often provide substrate for a distinctive group of bryophytes. While these areas have received some attention in the Rocky Mountains, other sites within the study area have not been surveyed adequately for these species. It is the same sulfides, especially in mine runoff, that pollute streams and groundwater. Mine tailings and debris undoubtedly have increased suitable habitat for some of these species, which often favor disturbed or barren soils.

- **Peatlands.** Until recently, wetlands were much ignored by land managers, and there is not a good history of collecting in these sites except by a few individuals. With the advent of wetland fill regulations and community classifications, they are receiving more attention and some records now thought rare should become more common. Included in this category are bogs and fens, the latter occurring on calcium-rich sites, which have been poorly-collected outside of the Rocky Mountain region. Impacts from grazing in peatlands have received little attention in the Pacific Northwest, but observations suggest that bryophytes are severely impacted by trampling, as noted in the wet soil group.

- **Floodplains.** These habitats have received recent attention because of wetland and riparian protection. Thomas et al. (1993) identified how important floodplains were for bryophyte species diversity, and how many species, particularly liverworts, were concentrated in old-growth forests occurring there. A similar situation exists in the Columbia River basin, especially in the "maritime extension" areas of Idaho and Montana, where species depend on shade, wet soils, logs and other organic debris, and humid microclimate. As with the aquatic and splash zone species in streams, this group of species can be affected to some degree by land ownership patterns and adverse conditions originating upstream on non-federal lands, although impacts would be less pernicious because few of these species are in the stream channel. The effects of livestock trampling should be included in any such studies.

- **Geothermal areas.** Geothermal areas are sometimes known for unusual assemblages of plants that survive outside of their normal distributional limits, because heated ground

provides snow-free conditions and a longer growing season (Lange 1973, Given 1980). Although many bryophyte specimens were collected from hot springs in Idaho and Montana, none appear to be restricted to this habitat on a regional basis, or to exhibit an unusual distributional pattern. Eversman (1990) found lichens to be absent from geyser areas, presumably because of particulate matter and sulfurous fumes from geysers, but the flora was more normal near thermal springs. More work needs to be done in these areas to better describe their effects on bryophytes.

- **Isolated gorges and narrow canyons.** Steep, narrow canyons provide ideal conditions for bryophytes to persist in areas outside their normal distributional limits. Shade, moisture and cold air drainage all contribute to unusual species being found in these areas, sometimes as relics from cooler periglacial climates. Impacts from livestock and humans are often limited here because of restricted access. More work needs to be done to inventory such sites, particularly those with historical bryological collecting that can be used for comparative purposes to monitor changes in the flora.

- **Rivers and streams.** Aquatic and splash zone bryophytes are subject to the same impacts described in Thomas et al. (1993), and need not be repeated here. Galvanized culverts, like roof flashing, may be toxic to aquatic bryophytes and may diminish species diversity on some streams.

Program needs:

- **Training for identification and management.** Agencies need to implement programs for training of field personnel to survey and manage for bryophyte, lichen, and fungal species. The limitations are essentially the same as those identified in Thomas et al. (1993). There are few bryophyte, lichen, and fungal taxonomists in the region and very few individuals are now being trained in universities.

- **Typification of flora by plant association.** Despite the great strides taken by regional U.S.F.S. ecology programs over the last twenty years to classify vegetation by plant association, no effort has been made to include bryophytes or lichens in plot data. A vast amount of habitat-specific information, with implications for management and distributional studies, could be obtained by including these plants in the classification scheme. Again, a lack of bryological and lichenological training for ecologists is the principal reason for this shortcoming.

- **Inventory of protected areas.** Research Natural Areas, ACEC's, wilderness areas, riparian zones and other administratively protected areas should be inventoried for bryophytes, lichens and fungi. Crater Lake National Park has been poorly collected, in contrast to Glacier, Yellowstone and Grand Teton National Parks, which have been collected heavily since the 1870's. Baseline data should include bryophytes to identify distributional and management issues, and to provide a historical basis to monitor future trends of the bryoflora.

Lichens

Lichens are an important component of forests and rangelands of the Columbia Basin. Yet basic knowledge about these species and their interacts are limited. Therefore, baseline inventories to document lichen species presence, abundance, biomass, habitat requirements, and geographic distribution is needed. Inventory data needs to be incorporated into the general biological inventory efforts, computerized and mapped. Standardized methods for the sampling of forest

epiphytes needs to be developed. This data should be verified with voucher specimens deposited in recognized regional herbaria. From this information identification guides and annotated catalogs for lichens in each physiographic region should be developed.

Status survey reviews should be conducted for the rare lichen species. This information needs to be shared with the State Heritage Programs in each State to compliment information from private and State lands. Conservation strategy plans should be developed for these rare species to conserve and enhance their populations.

Successional studies should be conducted of lichens, including their establishment, diversity and abundance in stands of different ages and different plant associations, substrates, and vertical succession. Conduct basic and applied research to determine lichens dispersal patterns by species, groups of species, by forest types, and recovery after fires.

Develop monitoring and research plans to evaluate the effects of forest and rangeland management practices on lichens. Monitor the impacts from management activities including timber harvesting, silvicultural practices, grazing, and recreation. For example, what species of lichens are retained in retention trees by topographic position, tree symmetry, crown type, or aggregation of the retention trees? What is the advantage of selecting leave trees that contain a diversity of lichen species and do these lichens on retention trees act as centers of dispersal for those species?

Determine nitrogen fixation rates of the lichens in the microbiotic crusts in different rangeland cover types. Determine the quantity and nutrient content of lichen litter-fall in the forest cover types. Develop a research project to address the role of lichen, through-fall and litter-fall in the nutrient cycling and biomass production of the various types and ages of forests. Conduct research into the role of small mammals (flying squirrels, and boreal red-backed voles) eating lichen litter-fall and its role in the trophic dynamics of small mammals and their predators such as, the boreal owls. Conduct research into the species preferences of lichens for nest building by flying squirrels. Conduct research on the role of lichens as habitat and food for forest invertebrates.

Develop an integrated, regional air quality monitoring program using lichens as biological indicators of forest health, including impacts on lichen species and trends in lichen populations.

Alectorioid and cyanolichens are especially sensitive to air pollution, and should be monitored to detect impacts to viability from a decline in air quality.

Fungi

The following are presented as ideas in need of further discussion and elaboration but all have a bearing on the quality of this report and the resulting assessment.

The foundation of data on which this report is written is limited because only a few herbaria were contacted for information and of the information contributed much was lacking by way of specific ecological and locational information. The distinct lack of computerization of collections in herbaria was a significant impediment to this work. The mycological community is in a transition stage of accomplishing this work but it will be a few more years before herbarium holdings are readily accessible. As more and more data on extant collections become available these data will need to be incorporated to update this report.

The data gathered for this study were from collections that were the result of systematic research, not ecological research. Taxonomic studies such as these have an emphasis on sporocarp morphology. As such much data on habitat structure is lacking and locations are often vague, i.e., from Priest River. None the less the data shows trends and offers direction for areas of special concern as emphasized in the endemism section. Additional education of members of mycological societies and clubs to include more comprehensive locational and habitat information will facilitate more accurate assessment of fungal organisms for a variety of purposes.

Numerous fungal species have significant nomenclatural difficulties and some contain species complexes. Specific taxonomic effort on these groups or individuals will reduce uncertainties concerning CRB populations and extralimital populations.

Certain fungal species, especially some *Boletus*, *Morchella* and *Cantharellus* species, are important to recreational and commercial gatherers. Some effort to elucidate the ecological parameters and specific biology and life history of these species is critical for long term management of this resource in the region.

Extensive fungal surveys are critically needed because the fungal flora of North America is poorly known or understood. It has been common in the past to rely on published descriptions, often poor ones, from the literature on fungi found in Europe and then to identify specimens in North America with keys and descriptions developed for Europe. It is now more readily apparent that overlap between species from Europe and North America is much more minimal then traditionally thought for mycorrhizal species and for saprophytic species. A modern reassessment of all fungal species from North America that carry "European" names is called for, particularly the those mycorrhizal species associated with specific hosts.

Many collections were made prior to major changes in vegetation due to forest timber harvesting

over the last thirty years. Retrospective analysis is needed for vegetation associations at time of collection.

Identification of extant specimens are not always correct due to non-expert identification prior to placement in the herbarium. Non-expert identification is a product of lack of trained professional mycologists. The last decade has seen many classical (alpha-taxonomy) mycologist positions in universities across North America became positions with a strong if not sole focus on molecular biology. This has led to a severe backlog in accession and curation of fungal specimens. This is compounded by the lack of modern species concepts and critical assessment of species complexes.

The CRB is an extremely large geographic area with an extreme diversity of habitats from alpine to desert. The complexity of the landscape makes assessment for rare fungal species extremely difficult. Of special consideration are riparian areas because of the high diversity of ectomycorrhizal hosts found in these habitats. In addition the CRB has vast areas of habitat (soil types) that are restricted in distribution that have not been explored to any degree.

Lack of specific knowledge on the function or role that each fungal species plays in the ecosystem besides that of a general saprophyte or mycorrhizal symbiont. The specific physiological functions of different fungal species even within the same genus can be marked. Effects of management activities on all species are unknown.

Information on population viability of listed fungal species does not exist. We therefore cannot make inferences on the effects of management activities on population trends except in the general category of mycorrhizal fungi which depend upon a host plant for survival. Removal of the host will negatively impact the mycorrhizal fungus or the saprophyte that is host specific. Effects of landscape fragmentation of dispersal is also unknown.

Due to the ephemeral nature of the sporocarps and the strong dependence on abiotic factors for sporulation, such as precipitation, fungal species community analysis requires five to ten years of collecting to adequately and comprehensively assess any one area. We also have no data on shifting or movement through the soil matrix of fungal populations. A particular fungal colony may or may not migrate through hyphal growth over time, i.e. decades.

A number of species are phoenicoid, fruiting after fire, these species need specific study on the effects of fire intensity on sporocarp phenology.

Species that fruit on or in dung are transitory by nature. Spores are either deposited on vegetation which is then consumed by animals or deposited on dung after deposition. In either case the dung is necessary for completion of the fungal life cycle.

Many of these fungi, both mycorrhizal and saprophytic, are somewhat to extremely dependent on plant host species, effort is needed to protect the site as well as the plant association occupying the site.

Some form of protection of type localities of fungal species should be incorporated into the plan. Type localities are specific locations for specimens that were used to describe this species for science, as such they are important historically. Protection should more often than not be in the form of a mycological preserve of varying size depending on habitat and life history of the species.

Biological and ecological information on macrofungal species is generally lacking. A more useful but not fully satisfying alternative is to manage the habitats where fungi of special concern occur or are likely to occur, particularly habitats that are threatened

7. **Recommendations specific to bryophytes, lichens, and fungi, including: those occurring on specialized substrates that are identified within the planning area.**

- Aquatic. Protect high quality, intact riparian zones and wetlands from siltation and in-stream disturbance. Provide tall tree retention and connectivity to uplands habitat.

- Decayed wood. Retain decaying wood in riparian areas and associated stream terraces for bryophytes, especially liverworts. Bryophytes in this group have the best recovery prospects in riparian and associated stream terraces, where decaying wood is best developed.

- Epiphytic. Epiphytic lichens, bryophytes, and fungi are best expressed in moist to cool forest types, especially along streams. Riparian zone buffers will provide adequate protection in all alternatives for this group.

- Humus and duff. Practices minimizing disturbance to the ground layer will benefit bryophytes in this group. Curtailment and monitoring of commercial moss collecting is recommended.

- Dry soil. Microbiotic crusts need protection in representative stands on all soil types to provide reserves for study of floristics, biology and management alternatives.

- Wet soil. Lichens, bryophytes, and fungi that occur on wet soils can be protected by riparian buffers and other wetlands protections.

- Snags. As snags are critical for the continuation of epiphytic lichens, and once fallen provide habitat as decaying large logs for bryophytes, set a limit on the upper size of fire wood at 18" diameter at the base.

- For continuation of lichen habitat, "leave trees" and snags should have a diversity of form, composition and substrates for lichens to colonize. In the moist provinces with a maritime influence, these trees should also be clustered to create a better microclimate.

ADDITIONAL ANALYSIS NEEDS FOR THE ICBEMP

1. Species that need additional broad-scale analysis prior to broad-scale decision implementation.

Based on the draft alternatives that were available during March, 1996, the final vascular plant expert panel determined that 28 of the 173 plant taxa of rangewide conservation concern could be analyzed as to the effects of the alternatives on these taxa at the broad scale. The panel further determined that, given the current information content and level of specificity of the alternatives, effects of management activities on the remaining 144 taxa could be reasonably addressed only at finer planning scales (e.g., Forest Plans, BLM LMPs, sub-basin analysis or ecosystem analysis at the watershed scale). Though it was crucial that the effects of management actions be considered across the range of these species.

As stated in the Introduction to this document, most of the analysis presented here applies to terrestrial vascular and non-vascular plants. The level of analyses for the terrestrial taxa greatly exceeds that for the aquatic plants. This is due in part to the amount of data available. At this time there is no list of algae for which there may be conservation concerns and information on aquatic macrophytes is incomplete. It is recommended that additional aquatic plant work include: analysis of the effects of aquatics as noxious weeds, development of mitigation measures for protection of aquatic plant habitat, completion of a full list of aquatic vascular and non-vascular plant species of conservation concern in the ICBEMP and identification of locations, habitat and threats.

2. Proposed processes for gathering additional data.

Should the alternatives in the DEISs be changed, a revised effects analysis may be necessary for the plant taxa of rangewide conservation concern, depending on the nature of such alternatives. If they are specific enough as to proposed implementation, a larger percentage of the 173 taxa of concern could possibly be addressed at the broad scale of the assessment. Several proposed processes have been suggested within the previous mitigation section for vascular plants and bryophytes, lichens and fungi. It is critical to remember that the data used for these analyses are based predominately on field data that was collected prior to the scientific panels conducted in Fall 1994. We have limited our consideration of new data to federally listed taxa because of the scope of the project. This list of taxa of rangewide concern may not reflect the most recent range extensions and discovery of new occurrences and threats.

SUMMARY

Of the 173 vascular plant taxa found to be of conservation concern on a rangewide scale, and whose ranges lie wholly or partially within the ICBEMP assessment area, the analyses discussed above revealed that 25 of these occur broadly enough within the CRB, or are associated with common vegetation types, such that the effects of the Draft EIS alternatives on the viability of these taxa could be estimated. Three taxa that are federally listed were also evaluated with

respect to the alternatives even thought heir distribution does not otherwise lend them to a broad scale analyses. One additional federally listed threatened species, *Spiranthes diluvialis*, Ute ladies'-tresses, was discovered within the ICBEMP analysis area in August, 1996 in Idaho and the potential effects of the alternatives on this newly discovered species have not been determined with respect to the Draft EIS alternatives. If no further information is available from the alternatives regarding specific management activities, then the potential effects of management activities on the remaining 144 taxa of rangewide conservation concern would be best addressed at a finer planning scale that is commensurate with the distribution of the taxa concerned (Forest, Provincial, Regional or state level) by resource experts most familiar with these taxa.

During the implementation of management activities, specific mitigation measures for restricted plant occurrences are best designed on a project-level basis. Site-specific mitigation is typically accomplished by changing the temporal or spacial characteristics, level of intensity, or methodology of the project. For example, the effects of livestock grazing or prescribed fire can be minimized or eliminated by timing the activity to fall outside critical periods of the species' life history (e.g., to avoid blooming or fruiting periods). Using the lists provided in the bryophyte, lichen and fungi reports and in Appendix 2 and 3 of this report, begin to consider the effect of activities on these taxa identified as having conservation concerns.

For those species whose viability may be at risk, the key considerations, when detailed demographic monitoring data are not available, include, but are not limited to:

1. the relationship of the species to vegetation succession under various disturbance regimes
2. the sensitivity of the habitat relationship; is the species highly restricted to one habitat type or is it less specific in its requirements.

Important geographic considerations are aimed primarily at the retention of the distribution of the species (i.e., whole populations or subpopulations where the species has a patchy distribution in the analysis area). This approach should be able to maintain underlying population and metapopulation structure , genetic variation patterns, demographic processes, and other less-easily analyzed aspects of population viability.

Given the broad goals of the ICBEMP scientific assessment, the Vascular Plant Task Group analysis represented a pioneering effort to integrate management and conservation of vascular plants into a basin-wide, biologically comprehensive approach to ecosystem management. This analysis uniquely spans government jurisdictional boundaries, and involved numerous federal, state, and local agencies and private organizations having an interest in plant conservation. Though it is tempting to state that the scale of the ICBEMP is not an appropriate level to consider management and conservation of many rare plants, this analysis and the contributions of those across the interior Columbia Basin to this synthesis prove otherwise.

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