Botrychium Summit

March 16, 1993

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16 March 1993

Representatives in attendance:

Carol Tyson - Winema NF-Klamath Falls
Mark Wisler - Winema NF-Chemult
Bob Woolley - Fremont NF - Silver Lake
Ron Halvorson - BLM - Prineville
Ken Stahlnecker - Crater Lake NP
Stu Garrett - NPSO - Bend
Cindi O'Neil - Deschutes NF - Bend
Christine Hopkins - Deschutes NF - Bend

Discussion Items and Decisions:

1. The Botrychium pumicola Species Conservation Strategy
   * The Species Conservation Strategy (SCS) is designed to be dynamic. Updates on the guidelines within the strategy will be provided to involved owners, and will include new populations of pumice grape fern (BOPU), results of monitoring for both managed and protected sites. Decisions regarding designation of new populations as "protected" or "managed" will be made after group concensus of land managers involved.

   * Conservation Agreement (CA) such as signed with the Winema National Forest will stand with the guide.

   * Listing Status of BOPU. The U.S. Fish and Wildlife Service intent is list all C-1 species as a result of a lawsuit settlement with the Fund for Animals. Originally, BOPU was not on that list, but Stu contacted them, and found it had been ommitted in error on the first list. Three years are allowed to plan, and preclude listing, or else do a restorative recovery plan after it is listed. We intend to be proactive!

   * Draft guide copies will be sent to WIN, FRE, NPSO, and BLM for review within a month. Opportunity for comment is welcomed.

   * Signature by all land management agencies is desired.

2. Definitions; common ground.
   * Protection: It was agreed to leave the definition as it is in the SCS, but add "protect 'potential habitat in association with existing plants" and "hands-off until we know what we are doing, as a result of management treatment studies/monitoring."

   * Managed: We envision management treatments that we suspect will enhance the species habitat. These treatments will be proposed in the guide. We invite creative thought to our proposal. We are not looking to perform high impact experiments on plants. All managed populations that are treated will be monitored.

We will continue to monitor the visitor use and may have to determine a threshold level where a certain % of habitat loss/damage to plants by human activity may require reevaluation and changes in access timing, extent of trail, etc.

Private Ownership (Crown Pacific, Bonneville Power Admin., landowners in pumice zone with potential habitat) should be kept informed of the plant's occurrence and status, with the possibility of arranging voluntary protection agreements with them.

With regards to profiteering groups, "plant collectors", permits, and restrictions, we decided to "watch" the populations for this potential threat.

5. Survey and Monitoring Needs

* We will use the same protocol in all monitoring areas.

* We need to install additional Ecological Status Monitoring Plots in key areas.

  a) Crater Lake National Park - Llao Rock, a site with historic known density. The plot is suggested to be installed at the edge 5% of the population (1400 plants) with NPSO personnel Aug. 7-8, 1993.

  -Inventory, continue surveying especially after review of aerial photographs of CLNP for likely sites in montane areas
  -Weather stations are at Crater Lake Rim and in the Munson drainage.
  -An IMPROVE climatological, Air Quality monitoring station will be installed in the park this summer.
  -CLNP will be asked to help provide ca. $100 for equipment to install plot, plus time/personnel to share in the installation and annual monitoring, reporting and data input.
  -CLNP will survey proposed prescribed burn areas, as the park attempts to restore natural fire successional communities which until recently were excluded from fire events.

  b) Winema NF - Chemult RD - To install one plot in the "unique" PIPO community in which BOPU was found last summer.

  c) BLM - To install one plot at their largest population site. Ron will discuss this with Susan Massey, and the proposed time for set-up, install, data input to be about 5 days.

* Everyone has access to and can use the Heritage Biological Conservation Data Base (BCD).

Thanks to everyone for coming. We really appreciate your input and support!

Christine and Cindi

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"Here on the bleak summits of Llao Rock and Cloudcap, both buried in pumice scores of feet deep, are plant colonies and associations that have learned to get along in the intense sunlight, dessicating winds, cold nights, and bitter exposure, plants that because of their peculiar situation have acquired characteristics more closely akin to those of desert types than to those of Alpine-Arctic members in similar high places..." Roy L. Rogers 1951

AGENDA

I. Meeting Objectives

1. To develop a common understanding between land management entities for what protection, management, and monitoring means for the pumice grape-fern.

2. To arrive at agreement for which populations of Botrychium pumicola (BOPU - Pumice Grape Fern) should be set aside as "protected", "managed", and "protected/monitored" or "managed/monitored."

II. Background

Status of Species Conservation Strategy
Current strategies for protection/management/monitoring
BLM, DES NF, WIN NF, National Park.

III. Overview current distribution of BOPU.

Populations of pumice grape fern
Surveying into likely habitat

IV. Definition of terms (group activity)

Protect =

Manage =

Monitor =

Selection Criteria =

V. Choose populations to be protected/managed/monitored (group activity)

VI. Evaluation

How close are we to agreement and implementation of plans?
Are we going in the right direction?

(02/09/93 -rev.)

-- DRAFT --

SPECIES CONSERVATION STRATEGY

Pumice Grape Fern

Botrychium pumicola Cov. in Underw.

Deschutes National Forest Sensitive Plant Program

1992

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SUMMARY

The objective of this conservation strategy is to protect, enhance or restore the pumice grape fern habitat to ensure long term species viability.

Legal Status and Population Size

The pumice grape fern (Botrychium pumicola Cov. in Underw.) is an inconspicuous fern-like species that occurs in recent (less than 6700 year-old), pale pumice (or dark pumice from South Sister) at high elevations in the Oregon Cascades and in a scattered distribution pattern in Mazama or Newberry pumice plume areas of Central Oregon which are typified as lodgepole basins or frost pockets. The pumice grape fern is endemic with a fragmented distribution pattern extending from Crater Lake National Park on the south to Broken Top in the Three Sisters Wilderness to a sage steppe/lodgepole pine habitat 65 miles east of Crater Lake.

Land on which the plants have been located are managed by federal agencies which include the Deschutes, Winema and Fremont National Forests, Bureau of Land Management, Crater Lake National Park, Newberry National Volcanic Monument, and Bonneville Power Administration. At this time there are 110 documented sites of pumice grape fern in seven known locales: Crater Lake National Park, Mt. Bachelor, Broken Top, Newberry Crater area, and three general montane lodgepole basin areas of central Oregon. Plant counts per site range from one to 1500 or more, and it is estimated that the total population size of this central Oregon endemic species is a conservative 13,000 plants.

It is designated by the Forest Service as Sensitive, federally listed as a Category 1 species and considered threatened throughout its known range by the Oregon Natural Heritage Data Base; listing by the State of Oregon is pending.

Distribution

Within its overall range, pumice grape fern exhibits a scattered and patchy distribution. The greatest concentrations are found on open exposed rocky or pumice slopes in alpine locales at Crater Lake, Broken Top, and Newberry Crater and in some montane frost pockets of lodgepole pine openings in Central Oregon. The distribution is hypothesized as being closely linked to pumice substrate from Mt. Mazama, Newberry and South Sister eruptions and the cold temperature regimes associated with the habitats. The only known dispersal mechanism available to the plant is wind dispersal of spores, although animals/insects may indirectly assist in movement of spores on fur, hooves, feet, or other means.

Life History and Threats

What we know: The life history characteristics of the pumice grape fern apparently limit it to habitats which provide for the restricted growth and propagation patterns exhibited by this fern-like plant.

* A gametophyte stage which develops in darkness (under snow cover or underground but never observed.)
* Requirement of moisture for fertilization of egg by swimming sperm.
* A mycorrhizal association to assist in gametophyte development and

probably help maintain the sporophyte when, and if, it does not produce a photosynthetic frond.

* Production of spores by an irregularly dehiscing sporangia, i.e. spores shed and dispersed primarily by gravity and air currents, and not "flung" from the sporangiophore by a more typical "advanced" fern sporangium.
* Apparently best adapted to open full sun habitats, cold temperatures and pumice substrate associated with the 6-7,000 year old Mazama, 1350 year old Newberry pumice plumes, or 1600 year old South Sister (Devils Hill) plumes.
* The plants are apparently self-fertilized, providing little means for genetic variability and adaptability.

These aspects of the species' life history may contribute directly to the species' rarity. The biological requirements of the plant in association with fungal mycorrhiza and the delicate nature of the subterranean perennial leaf primordia are hypothesized as being the species' weak links. This may also be related to its preference for the restricted and rare habitat of youthful high-silica pumice substrate.

Aspects of our current forest management pose a threat to the viability of the species when combined with the life history requirement of the pumice grape fern.

* Absence of natural fire has created closed canopies, heavy fuel accumulations and vegetative competition in frost pocket openings of the forest habitats.

* The recent epidemic of the pine bark beetle (Dendroctonus brevicomis) through central Oregon lodgepole pine forests has resulted in heavy accumulation of dead lodgepole pine in and around the frost pocket habitats of pumice grape fern. Danger of wildfire with resulting intense heat and longer duration could reduce the pumice grape fern population.

* Ground disturbing activities such as machine salvage harvesting activity of the beetle-killed lodgepole pine, with associated methods of site preparation, slashpile piling and burning, machine skidding, would cause severe ground disturbance to plants and further fragment or permanently destroy the population at the forested montane sites.

* Recreational activities such as by alpine hikers, mountain bikers and off-road vehicle users who enter pumice grape fern habitat have been observed to cause damage to exposed fronds which would reduce survival and sporulation. Vehicle churning of pumice flats and frost pockets is also detrimental to the underground perennial structure and causes soil compaction.

* Construction of new facilities, roads and trails in potential or existing habitat fragments populations and permanently eliminates habitats for the species.

What we do not know: Many aspects of the life history of pumice grape fern are unknown. Effects of most management treatments on the populations are uncertain. Determining the answers to the questions below would greatly enhance our ability to "manage habitats for pumice grape fern."

Listed in order of importance:

* Times of year when leaf primordia are most susceptible to damage.

* What timber salvage harvest operations can proceed without further fragmentation of the population or reduction of reproductive viability?

* Do plants emerge from the same rhizome every year and when does emergence begin?

* What effect do habitat/climatic changes (traffic, compaction, fire, litter cover, animal activity, and measurable global warming trends) have on population fragmentation and reproductive viability?

* What is the mycorrhizal fungus associated with this species and what is its link to other ecosystem interactions in the alpine and montane habitats?

* How does reproductive viability respond to interspecific competition which results from harvesting or other site disturbance?

* Are the plants of uniform or mixed age classes? Can we determine plant age in the field? What parameters can be used to indicate reproductive viability?

* What factors promote recruitment of plants - spore germination, development of gametophyte, mycorrhizal association, fertilization, length of time before rhizome able to develop fronds and sporangiophore?

* Response to climate change? Is the species neo-endemic or paleo-endemic?

Conservation Strategy

As of October 1992, there were 99 sites for an estimated 13,000 known pumice grape ferns located, mapped, and prepared for indication on GIS mapping. Two sets of populations have been selected as "protected populations" and "managed populations" to meet objectives outlined below:

* Protected populations: To achieve long term species viability by maintaining existing genetic variance and promoting reproductive success (by protecting healthy populations throughout the species range).

With the exception of a few, all populations have been omitted from unsupervised or unrestricted ground disturbing activities.

Any manipulations of the habitats will be designed to specifically maintain, enhance or restore these protected population sites. Permanent loss of habitat will not be allowed. Loss of individual plants is restricted, although this may be accidental until all possible habitats have been surveyed and resurveyed in successive years to ensure completeness of population figures. Habitat

enhancement treatments employed will be those which have been shown through effectiveness monitoring in "managed populations" to have successfully achieved the desired results.

* Managed populations: To develop a set of maintenance, enhancement and restoration methodologies through experimentation in "managed populations" and the effects of which are measured by censusing. The census process over time will provide data to help determine if our current stewardship is benefitting the species: a) if it is increasing or maintaining a high level of reproduction, b) maintaining numbers at appropriate levels, or c) assisting the establishment phase. (Sutter, 1986)

The remainder of the known populations are designated as "managed populations." In these populations management treatment or effectiveness monitoring studies can be initiated to establish how to diminish the most important threats and management conflicts to pumice grape fern habitats on National Forest lands. Loss of plants during these studies is not recommended, but may occur as a result of management treatment. Purposeful loss of habitat from severe ground disturbing activities is not allowed.

ACTION PLAN * CONSERVATION STRATEGY

Strategy/Action Item	FY Planned	Year Accomplished
Goal 1: Maintenance Genetic Variance and Reproductive Success		
Strategy 1a: Select Protected Populations	FY 92	FY 93
Strategy 1b: Survey in Unrepresented Habitats	FY 92	FY 94
Strategy 1c: Establish Biological Status Protected Populations	FY 92	
Strategy 1d: Develop Management Monitoring Plans	FY 92	Ongoing
Goal 2: Develop Set of Management Tools for Maintenance, Enhancement or Restoration		
Strategy 2a: Select Managed Populations	FY 92	Ongoing
Strategy 2b: Establish Biological Status Managed Populations	FY 92	Ongoing
Strategy 2c: Develop Management Treatment Monitoring Plans	FY 92	Ongoing
Existing Monitoring Studies	FY 92	Ongoing
Proposed Monitoring Studies	FY 92	Ongoing
Goal 3: Protection on Private Lands and Public Education		
Strategy 3a: Landowner Contact/Voluntary Protection Program	FY 92	Ongoing
Strategy 3b: Private Partnerships in Restoration	FY 92	Ongoing

I. INTRODUCTION

The National Forest Management Act and Forest Service policy require that Forest Service land be managed to maintain populations of all existing native animal and plant species at or above the minimum viable populations level. A viable population structure consists of the number of individuals, adequately distributed throughout their range, necessary to perpetuate the existence of the species in natural, genetically stable, self-sustaining populations. (FSM 2670.22, 2670.32.)

The Forest Service, along with other Federal and State agencies, has recognized the need for special planning considerations in order to protect the rare flora and fauna on the lands in public ownership. This includes cooperation with other state agencies (FSM 2671.1) Species recognized by the Forest Service as needing such considerations are those that (1) are designated under the Endangered Species Act as endangered or threatened, (2) are under consideration for such designation, or (3) appear on a Regional Forest Service sensitive species list.

The pumice grape fern (Botrychium pumicola Cov. in Underw.) is an inconspicuous fern-like species that occurs in recent pumice at high elevations in the Oregon Cascades and in a scattered distribution pattern in Mazama, Newberry or South Sister pumice plume areas of Central Oregon which are typified as montane lodgepole basins or frost pockets. This is an endemic species with a fragmented distribution pattern extending from Crater Lake National Park on the south to Broken Top in the Three Sisters Wilderness to a sage steppe/lodgepole pine forest habitat 65 miles east of Crater Lake.

Ownership of land on which plants have been found include the Deschutes National Forest, Winema National Forest, Fremont National Forest, Bureau of Land Management, Bonneville Power Administration (powerline corridors), Three Sisters Wilderness Area, and Crater Lake National Park.

The primary objective of this Species Conservation Strategy is to recommend management strategies for pumice grape fern which, when implemented, will ensure long-term species viability. These strategies will overlap with the biological requirements and geographic distribution needs of the species. The long-term goal of this guide is to protect, enhance and restore habitat in order for the species to be removed from the Regional Forester's Sensitive Plant List.

II. BIOLOGICAL INFORMATION

A. Nomenclature and Taxonomy

Scientific name: Botrychium pumicola Cov. in Underw.
(Our Nat. Ferns ed. 6, 69. 1900.)
Common name: Pumice grape fern
Family: Ophioglossaceae
Adder's-Tongue Family
Phylum: Pteridophyta
(Ferns and Fern-allies)

Pumice grape fern was first seen and collected in 1897 by Frederick V. Coville and E.I. Applegate. It was growing in fine pumice gravel of open slopes at about 2500 meters altitude, in the Hudsonian Zone at Llao Rock, Crater Lake National Park, Oregon. This type specimen collection #417, made on August 5, 1889, is housed in the US (Smithsonian) herbarium, with isotypes at GH (Gray Herbarium, Harvard) and NY (New York Botanical Garden Herbarium). (Clausen 1938) It was described by Coville (1900) three years later in Underwood's book, Our Native Ferns. This site, now within Crater Lake National Park, has been visited repeatedly and verified as recently as 1987.

B. Plant Description

Technical descriptions can be found in Peck (1961, pg. 46), Abrams (1940, pg. 3), and Meinke (1982, pg. 76). In addition, the following description is from Clausen (1938) with parenthetical notes by Dr. Dave Wagner:

> Plant stout and fleshy, (2) 7.5-10 cm. high; bud glabrous; fertile and sterile segments both erect in venation or the apex of the sterile portion slightly inclined; bases of previous year's leaf blade persisting as a prominent sheath about the lower half of the plant; stipe (common stalk) 5.5-8 cm long; blade sessile or almost so, coriaceous, glaucous, 1-3 (5) cm long, 1.3-2.5 (4) cm wide, usually ternately divided with each of the three major divisions ovate-deltoid; ultimate segments flabellate or obovate, lobulate, decidedly overlapping; sporophore (fertile branch) about 5 mm long; fruiting spike dense, paniculate, 1-2.5 cm long (usually barely overtopping the sterile blade); sporangia 0.8 mm in diameter.

The following is non-technical description:

> Pumice grape fern is an inconspicous plant found in central Oregon in raw, pale pumice on rocky summit slopes at high elevations or frost pockets of montane lodgepole pine openings. It is classified in Raunkiaer's plant life form categories as a geophyte - a perennial herb with a bulb or other perennating organ below the ground surface (Whitaker 1975). The above-ground portion of the plant consists of two parts: a fern-like leaf blade and a sporophore. These are joined at ground level and share a stipe that extends down to the true stem one to several inches below the surface. At the base of the short vertical and persistent underground rhizome (less than a half inch tall in the biggest plants) are plump, soft roots that branch freely and penetrate deep into the substrate. The above-ground portions (blade and sporophore) die back at the end of the

yearly growing season. The blade reaches a maximum length of about two inches above ground level, usually less. It is somewhat fleshy, pale green with a whitish or grayish cast early in the season and turning pumice-colored (yellow-brown) as it dries and spores mature. The blade is divided into many overlapping, rounded or fan-shaped segments, about one-quarter inch wide. Younger (or smaller) plants seem to have one major blade with as few as five leaflets. Apparently more mature plants display a major blade with two side branches which arise at near ground level, slightly below where the sporophore originates on the common stipe. These lateral branches may equal the main blade in size.

The sporophore is actually structured like the blade, but the leaflets are replaced by spore cases (sporangia) that are the size of mustard seeds. The sporophore is much branched and has the spore cases on two sides of the branches. They are so jammed together that they look like bunches of grapes, hence, the common name, "grape-fern." The sporophore in this plant is usually just shorter than, to just barely longer than, the blade, reaching maximum length at spore maturity. Each spore case splits open in the summer and releases its spores. There is no specialized opening mechanism, nor sorus patch on the leafy margin or underside of the segments, as shown by true ferns. (However, two plants were observed during 1992 summer field work which had 2-3 sporangia on the lowest leaf margin.) The yellow spores are like dust, and are blown away in the wind (Wagner and Vrilakas 1988, C. Hopkins, personal observations 1992).

A line drawing of the pumice grape fern is included as Figure Ia and Ib.

C. Look Alikes

This is the only grape-fern growing in high elevation pumice. The only other grape-fern which may be confused with it is B. simplex, but B. simplex does not occur on the typically alpine or montane frost pocket habitats associated with the pumice grape fern. The latter may be differentiated by its yellow-green color without the grayish cast, and a stalk on the sporophore that is (below any branching) longer than the blade.

A site with two plants reported by W.B. Cooke in 1941 on Mt. Shasta in Siskiyou County, has never been relocated. Investigations by Dr. W.H. Wagner of the U. of Michigan Herbarium led him to determine that one specimen collected on Mt. Shasta was not B. pumicola and the new revision of California flora (The Jepson Manual -1993) will indicate that B. pumicola was endemic to Central Oregon sites. (Ken Fuller, personal communication, 6/26/92). David Wagner of University of Oregon Herbarium also examined that Mt. Shasta Botrychium and believes it may be B. pumicola. (David Wagner, personal communication, 2/9/93).

Line drawings comparing similar Botrychium species is included as Figure II.

D. Listing Status and Surveys

This species is currently on the U.S. Fish and Wildlife Service notice of review as a candidate for listing (C1) under the Endangered Species Act (U.S. Fish and Wildlife Service 1985.) It is, therefore, also on the Region 6 Sensitive Plant Species List. It is considered to be Endangered Throughout Range by the Oregon Natural Heritage Data Base (1987). The 1988 Status Survey

Report for this species recommends that the U.S. Fish and Wildlife Service list it as threatened under the provisions of the Endangered Species Act of 1973 (and 1978 amendments to the Act) (Wagner and Vrilakas 1988.

Surveying of likely habitats in alpine and montane areas within the pumice plume areas of central Oregon has resulted in more sitings of pumice grape fern. See following section (E. Range and Distribution) for more information, and Appendix 2. Continued surveys should be timed to meet the peak periods of frond emergence in these habitats, as it is probable that more sites will be discovered in the forested montane frost pocket habitats where management needs to be regulated for protection.

E. Range and Distribution

This species is currently known from a) alpine sites in four areas of Oregon: Newberry Volcano, Broken Top in the Three Sisters Wilderness Area of the Central Cascade Mountains, Mt. Bachelor summit and Crater Lake rim in Crater Lake National Park in Klamath County and b) montane sites in Central Oregon typically described as frost pockets or lodgepole pine basins.

In 1902, Coville discovered the site at Cloud Cap, located on the opposite rim of the Crater Lake caldera from Llao Rock, these plants were not relocated until 1951 by Rogers, and by the American Fern Society foray in 1951 (Hoshizaki 1951).

Leroy Detling made collections further north and east in Deschutes County on July 7, 1928 for the U. of Oregon Herbarium, among which pumice grape fern (Collection #226) was identified from plants collected at "Newberry Caldera, Paulina Mountains". While attempting to find Detling's Newberry Caldera site on September 7, 1951 Roy Rogers discovered a population on The Dome, outside the caldera. His collection is housed at Crater Lake Herbarium. In 1983 this site was confirmed by Dr. Stu Garrett (Central Oregon Chapter of Native Plant Society).

Rogers also observed two plants in 1951 at Tumalo Mountain, Deschutes County, collecting at least one plant for the Crater Lake National Park Herbarium. This population has not been relocated. One plant was collected by Rogers in 1951 on Broken Top at over 8500 feet in elevation, but this site has not been positively identified. Dr. Stu Garrett in 1983, and Dr. Dave Wagner in 1986, found two more populations at Broken Top on the southeast and west ridges, respectively. These sites are probably not the same as Rogers'.

More recent high alpine sitings include one made in 1987 by Dr. Dave Wagner, on the floor of Newberry Caldera in a meadow where Botrychium simplex and B. multifidum also occur. (Additional plants were confirmed in 1992 by Cindi O'Neil (USFS), Dr. Christine Hopkins (USFS) and Dr. Dave Wagner.) Another was made while surveying the summit of Mt. Bachelor in 1987 for pumice grape fern by Dr. Stu Garrett.

Original population estimates made in 1987 had ranged from a low of 2,700 to a high of 4,700 individuals; a difference due to the range of population estimation at Llao Rock, Crater Lake National Park, from 350 in 1987 to over 2,000 in 1976.

Training of U.S. Forest Service personnel in 1990 to survey for Threatened and Endangered Plant Species resulted in the discovery of pumice grape fern sites within lodgepole pine openings (frost pockets) in the montane areas of central Oregon. As of 1992, 110 sites have been verified and the total estimated population of the endemic pumice grape fern has been raised to a conservative 13,000 plants. The site total reflects the number of "point" locations, as well as clustered locations which are presented as an area "polygon" on forest management maps. These "polygons" are typically two or more sitings of scattered clumps within a large frost pocket of one-half acre or larger. Range

and population maps are included as Appendix 1.

Locales	No. Sites, habitat	# Plants
1) Crater Lake (Crater L. Natl.Pk)	4 (alpine)	1650+
2) Sugarpine Mt/Round Butte/Stams Well	12(montane)	300+
Mt.Thielsen/Sellers Marsh(Winema)		
3) Mt. Bachelor Summit (Deschutes)	1 (alpine)	105
4) Broken Top (Deschutes)	5 (alpine)	2216+
5) Newberry Nat'l Monument (Deschutes)	3 (alpine)	850+
6) Lodgepole basins (Unit/Quads:)	(montane)	
Big Hole Q.(Deschutes/Fremont)	10	250
Katati/Spring B., Big Hole (Des.)	20	2600+
Rowdy/Grass Well, Big Hole (Des.)	15	2290+
Icy-Titanic/Crescent NE (Des.)	21	1350+
Masten Butte Q.(BLM)	7	460+
Moffit Butte Q.(Deschutes)	3	80+
7) China Hat/Plot/Fox/		
and Firestone Butte Quads. (Des.)	9 (montane)	460+
(Total	110	12,611+)

F. Habitat Description

a) Alpine Sites. In the alpine sites over 7,200 feet in elevation the species grows in open, or partially tree covered rims/ridges on loose, young (less than 6,700 years old) sites classified on Soil Resource Inventory (SRI) maps as type 3: rocky mountain peaks. These areas are characterized by "high-elevation, rocky, mountain slopes and perennial snow and ice zones above timberline. Materials include basalts, rhyolites, cinders, and other pyroclastics. Vegetation is lacking to extremely sparse." Slopes range to about 20 percent. Five plants, one at Broken Top population and four at Newberry Crater, were seen growing in red pumice. Texture of the pumice has been described as coarse (over 2 cm in diameter) (Mathews 1987) to fine (Coville 1901).

Topography ranges from largely flat ridgetops to gently rolling, convex slopes. Populations occur within openings of alpine and sub-alpine communities, usually surrounded by stands of Pinus albicaulis (white-bark pine). Density within these patches range from a high of 30 plants per square meter at Broken Top W, to a low of one plant per square meter at Cloud Cap (Wagner and Vrilakas 1988).

Alpine populations occur in areas which receive from a few feet to tens of feet of snow over the winter with temperatures dipping below freezing for over half the year. Summer precipitation is low (less than 20" average annual

precipitation) with large daily temperature fluctuations. All of the sites are in open areas and have little natural sheltering, other than the rocky crevices or associated shrubby plants as Penstemon davidsonii and prostrate Juniper (Juniperus communis).

The most common alpine plant associates include Raillardella argentea, Lupinus lepidus, Antennaria alpina, Sitanion hystrix, Trisetum spicatum, Carex breweri, Eriogonum ovalifolium, E. pyrolaefolium, E. umbellatum, Phacelia hastata, Penstemon davidsonii, Spraguea umbellata, and Hulsea nana.

b) Montane Sites. The montane sites are typically on pale coarse (over 2 cm in diameter) (Mathews 1987) to fine pumice (Coville 1901). Soil Resource Inventory (Deschutes National Forest 1976) types include Type 15, 70, 94A, and 96 which are characteristically of thick to very thick pumice or volcanic ash over an older soil of thin sandy loams over basaltic lavas or gravelly glacial outwash. Surface soils are thin pumiceous loamy sands, and subsoils are pumiceous sands. These sites are typically planer (flat) lodgepole pine forest openings or basins. The basins accumulate cold air and frost heaving is common, thus limiting the growth and reproduction of lodgepole and bitterbrush.

The typical plant association (Volland 1988) in these montane forested sites is CL-G3-11 (lodgepole pine/needlegrass basin type) with Pinus contorta/Purshia tridentata/Stipa occidentalis. "This community generally occupies lower slopes and basinlike depressions which are subject to frequent low temperatures as a result of cold air drainage. Because of the scattered distribution of lodgepole pine and the exposure of large expanses of bare soil, these areas are sometimes locally termed "pumice deserts". Tree cover seldom exceeds 30%; and bitterbrush, where present, is generally restricted to tree clumps. Although very scattered in occurrence, common herbaceous species include needlegrass, Carex rossii, Eriogonum umbellatum, Lupinus lepidus, Viola nuttallii var. vallicola, and Spraguea umbellata. (Franklin and Dryness, 1988). Another common plant association is CL-S2-11 (lodgepole pine/bitterbrush/needlegrass type). In sites where logging has occurred the plant association is typically CL-S2-14 (lodgepole pine/bitterbrush/fescue. Some occurrences are with type CL-S1-12 which is lodgepole pine/sagebrush (Rhyolite) and SD-29-14 (big sagebrush/needlegrass - Rhyolite). A complete list of plants most commonly associated with the pumice grape fern is included as Appendix 3.

G. Phenology

Blades of the plant have been detected above ground as early as mid May in montane frost pockets south of Paulina Peak to late October when dried blades can still be located at known sites. Emerging plants are a pale bluish-green to dusky tan color which dry at season's end to a yellowish-brown color. Blades blend very well with the pumice substrate and can even be confused with other dried plant leaves, such as those of tawny horkelia (Horkelia fusca). Sporulation from ripe sporangia has been observed from July through August at both alpine and montane sites. Exact figures on spore production are unknown, although reports of 2,000 to 15,000 spores per sporangia in other members of the genus have been made (Haynes 1975, Sporne 1975). Primordia for the next year's blade and sporophore overwinter within the old leaf base at a depth of 1-2 inches. Consequently, surveying for the plants is recommended between June and late July in the montane forested habitats.

At alpine sites the plants will begin to emerge as the snow pack recedes, and peak emergence has generally been detected by mid-July to mid-August. The abundance of summer rainfall in montane areas during 1992 summer seemed to promote emergence, although only repeated surveying and monitoring of known site numbers can verify this. It is also not known how many plants, if any, did not produce emergent fronds in sites where monitoring plots were established and all visible plants tagged and mapped.

H. Life History

Populations of this species have previously been described as composed mainly of one age class. The pattern of spore dispersal, the fact that sexual reproduction occurs on an underground gametophyte (presumably self-fertilized), and the specificity of the species' microhabitat requirements may produce a rather uniform population structure. Study of this plant in monitoring plots established in 1992 should provide further information on its population biology, as well as appropriate measurements to help determine plant age in the field.

Little is known about the reproductive biology of this species. No observations have been made on the timing of spore germination, gametophyte development, fertilization, development of sporophyte, and spore production. From studies of other species of the genus, it has been learned that spore dormancy is difficult to overcome and that percent germination is low. One of the germination requirements may be the necessity of darkness for a minimum of 3-4 weeks. Increasing the length of the darkness increases the percent germination, although no more than 10 percent germination was achieved under experimental conditions in other species (Whittier 1973). This seems to indicate that germination occurs either under a prolonged snow cover, after spores have been worked deeper under the surface of sand and gravel, or a combination of the two factors with cold temperatures. Ungerminated spores appeared to have normal cytoplasm which indicates that they have potential for extended survivability (Whittier 1984). No data is available on sporophyte requirements, survival or mortality.

Of considerable importance, though not well understood, is the relationship of this species to its endophytic fungal associates. Endophytic fungi are necessary for the development of the subterranean Botrychium gametophytes in nature (Whittier 1984 and 1991). The fungus (or fungi) which may be specific for this species has not been identified. There is no known report of the isolation of the gametophyte stage of this species. Its mycorrhizal relationship may limit the distribution of the species due to the inability of the fungal associate to migrate.

As data is gathered from monitoring plots, and as plant surveying and observations continue, the parameters for successful growth, reproduction and dispersal to new sites by the pumice grape fern should become identified. These would allow us to provide information to help maintain habitat of established plants and guide the surveying into other suitable habitats that are not typically surveyed for timber harvest.

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ECOLOGICAL STATUS MONITORING PLAN
for Botrychium pumicola in Crater Lake National Park

This describes the process used to establish plots to monitor populations of pumice grape fern (Botrychium pumicola) in various locations in central Oregon during the summer of 1992, and proposed for installation at one monitoring site in Crater Lake National Park during summer 1993. The cost and labor effort will be shared by National Forest Service and National Park Service according to terms agreed upon through a Challenge Cost-Share Agreement initiated by the Deschutes National Forest, lead forest for monitoring populations of the endemic plant species known as pumice grape fern.

Objectives of monitoring study at Crater Lake site:

(1) Verify any change over 30% in numbers of plants which emerge over a period of five (5) years, minimum.

(2) Verify any changes in distribution of plants (direction, number, age class). Observations and data should help provide information to help determine age class in the field.

(3) Determine characteristics of species viability (spore production, emergence of plants, etc.).

(4) Correlate observations and data with climate and weather changes in the area. (Therefore, periodically monitor every 5 years, and as long as possible?)

(5) Gather information which may help determine relationships of the species' reproductive output (fecundity) to the success of its establishment in site.

(6) Gain predictive knowledge of population dynamics from lichens and/or tree ring data with regard to disturbance history of site or longevity of pumice grape fern at the site.

Monitoring procedure: (Personnel required - minimum of two, three is helpful help prepare plant tags, read compass headings, record data. Time required - depends upon weather conditions, number of personnel, project minimum of two days for two people for travel, location of site, survey and counting plants, plot installation and another day for one person in office to "fine-tune" the records and mapping).

(1) Time of year to read/install plots: July-August, correlating with peak sporulation.

(2) Selection of plot area - hopefully to be little disturbed by human activity and accessible for monitoring personnel and equipment, as well as representing the typical pumice grape fern population. Locate all plants at site with swabs and flags, to count population and obtain a visual perspective of the population size and distribution pattern. (Swabs and plastic flagging in bundles of 50 are distributed to personnel who work through the population site, placing one swab about 3 inches to the north of each plant or plant stem cluster. These are placed near plants only for counting purposes. When the plot itself is installed, each plant within the plot circle will be mapped and individually tagged, and measured for baseline data. So far, the smallest population size within a 16 meter circular plot (0.2 Acre) has been 24 plants, and the largest 387.)

(3) Before swabs or flags are removed, it is advisable to photograph the site and establish photopoints for the plot with the meter tape extending along the microplot transect line - recording azimuth for this photopoint.

(4) Record plot location, remembering to place appropriate flagging or landmarks for directions to the plot - azimuth and yards or chains from flagging/landmark.

(5) Install permanent plot stake at plot center, stamp identifying reference number in stake cap. Install rebar with identifying plot tag for the transect along which microplots will be read. A minimum of five microplots should be readable along this transect which include pumice grape fern plants in each plot. Data sheets for each microplot should be completed as shown on enclosed sample:

a) location of plot by reference to meter numbers on tape which is to left or right of the meter square grid, and these distance numbers indicated on the grid data sheet.

b) tag individual pumice grape fern plants or clusters. If clusters, indicate number and measured stems by a,b,c, etc. or N, S, E, W heading.

c) measure height of fertile frond from ground level, height of sterile blade from where it joins the stem, and length of lateral branch from where it joins the stem. Record in cm.

d) note condition of plants - sporulating, grazed, dried up, immature, emerging, etc.

e) place dot in grid for location of plants within that grid and mark on tally its position: ex. #506 H-5

f) note associated plant species by code and place this in grid, indicating cover and any clues which may be needed to help identify species if determination is not yet known.

(6) When all microplot data has been recorded, continue around the circle plot to tag and measure remaining plants and record on macroplot data sheets:

a) continue tag numbers for plants and remove marking flags as you proceed.

b) note azimuth reading from center plot stake - changing every 5-10 degrees

c) note distance in meters from center plot stake to plant at that azimuth, trying to keep tape taut for consistency and to help future monitoring personnel locate the same plants if tags become lost.

d) record same measurements of plants taken in microplot data.

e) note any other associated plants in this plot which were not recorded from microplot readings

f) mapping of pumice grape fern plants, trees or notable land features, and placement of transect line with rebar location on circle plot grid should be possible later, in office, using the map locations and tag numbers from this data sheet.

Possible location of Ecological Status Monitoring Plot in Crater Lake National Park:

a) Llao Rock - over 350 plants counted in 1987, over 2000 in 1976
   -may be best protected site, due to isolation and distance from road
   -danger of being accessed by hikers, who may remove tags, or be attracted to tagged plants and plot marker.

b) Cloud Cap - 52 plants counted in 1987, sparsely scattered

-may be too close to public access from the viewpoint road

c) Skell Head - two plants reported in 1989, too small population for a plot

-needs to be resurveyed and counted

d) Dutton Ridge - location and numbers not specific in 1989 report

-needs to be resurveyed and counted, may provide a good inaccessible plot location, if enough plants are really there

e) Other sites need to be surveyed?

Timing - it may require two visits to the areas to complete surveying and determine emergence level of the populations before we can put in a plot. Typically, the majority of plants are sporulating at this altitude by mid-late July.

Microplot

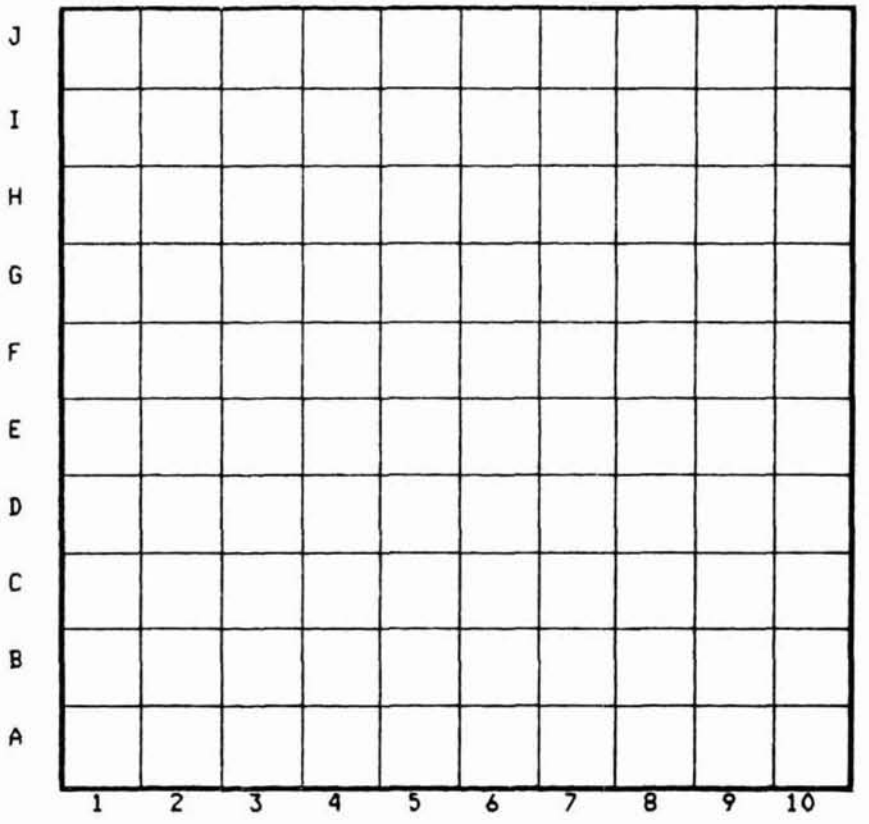
Page: _____

GRID MONITORING FORM

Mapping Data For: _____ Transect Number: _____

Site Name: _____ Plot Number: _____

Recorders: _____ Date: _____



NO.	FF	SB	SS	COMMENTS

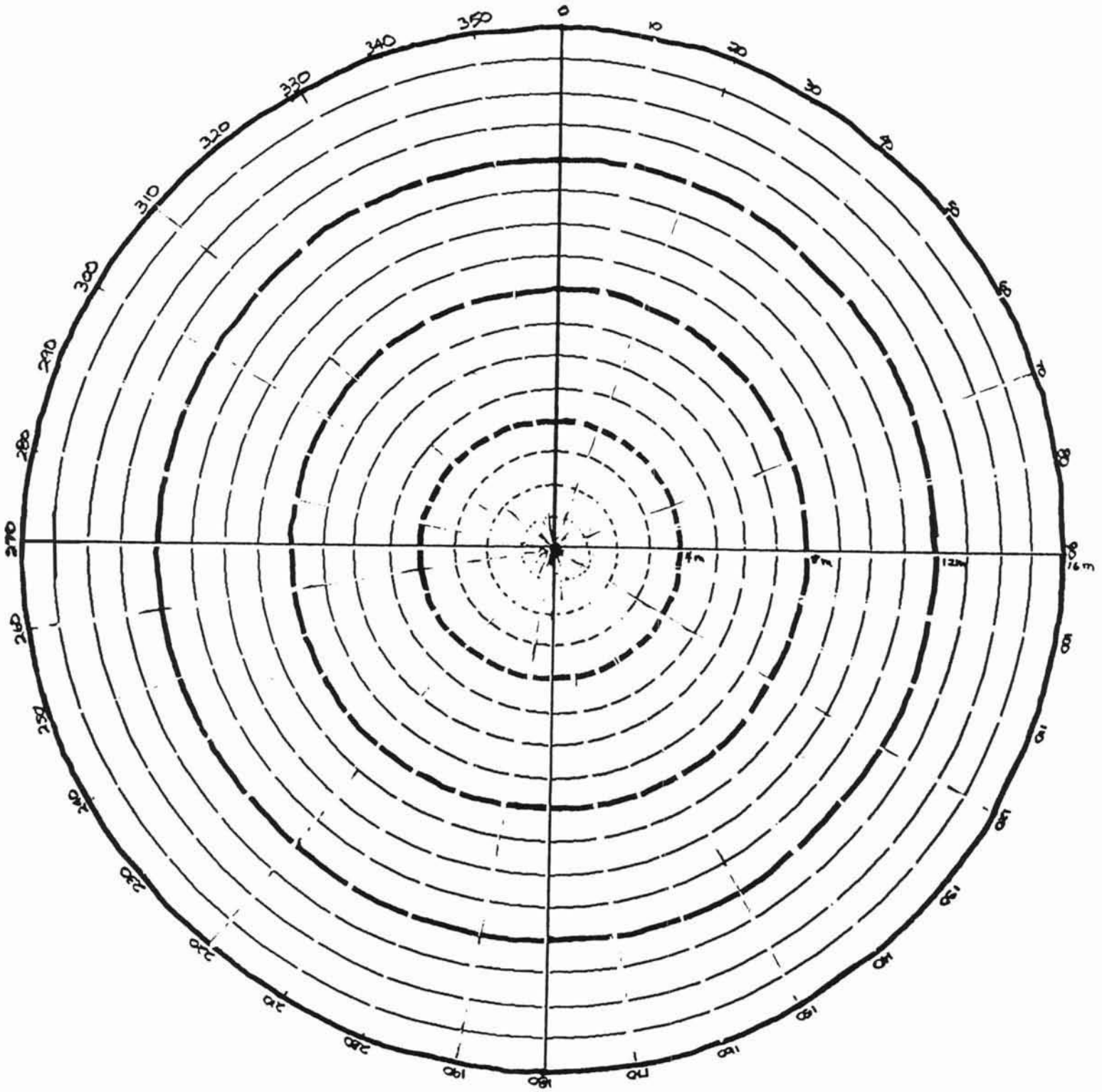
NO.	FF	SB	SS	COMMENTS

NO. = PLANT NUMBER
FF = FERTILE FROND LENGTH (cm)
SB = STERILE BLADE LENGTH (cm)
SS = SECONDARY STERILE BLADE LENGTH (cm)

(07/13/92)

Macroplot

PLOT MAP - TREES
MONITORING PLOT # _____
DATE ESTABLISHED _____
RECORDERS _____



Key: All trees PICO (lodgepole pine), unless otherwise noted.
- ● PICO - live, standing, position on map in meters from center plot stake
- o PICO - dead, standing
- ←o down tree, and direction of fall (←● if green, living)
- Ø stump of harvested/removed tree
- 16" dbh measurement (inches), 1m height, if seedling, in meters(m)

GRID MONITORING FORM

Mapping Data For: _____ Transect Number: _____

Site Name: _____ Plot Number: _____

Recorders: _____ Date: _____

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