THE ELLEN TRUEBLOOD SYMPOSIUM

HIGHLIGHTING IDAHO'S RARE FUNGI AND LICHENS

SPONSORED BY THE IDAHO NATIVE PLANT SOCIETY
FEBRUARY 13, 1997

WITH ASSISTANCE FROM
DOI Bureau of Land Management, Idaho Power Company,
USDA Forest Service, Idaho Fish and Game Conservation Data Center

EDITORS
Roger Rosentreter
Bureau of Land Management, Idaho State Office

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1387 S. Vinnell Way, Boise, ID 83709

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**Ellen Trueblood Symposium:
Highlighting Idaho's Rare Fungi and Lichens**

February 13, 1997; Boise, Idaho

*Sponsored by the Idaho Native Plant Society and
the Southern Idaho Mycological Association*

Ellen Trueblood: A History of an Early Idaho Mycologist

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Ellen Trueblood was born on August 1, 1911, in Boise, Idaho, the daughter of Carl Cyrus Hinkson and Rosella Blunk Hinkson. She grew up in Boise, graduating from Cole Elementary School and Boise High School.

Ellen began work as a reporter for the Caldwell News-Tribune in 1929. During the next ten years, she also worked as society editor and special reporter for the Nampa Free Press, and as a reporter for the Boise Capital News.

While she was working for the Capital News, she met Ted Trueblood, an outdoor writer and reporter. Since Ellen was already an accomplished hunter, angler and photographer, it was a natural match. Ellen and Ted were given a wedding shower at the Dewey Palace Hotel in Nampa on July 5, 1939, and were married the next day at Cascade. A summer-long honeymoon in the Salmon River Primitive Area, which later became the Frank Church River of No Return Wilderness Area, was the foundation for a lifelong interest in the study, enjoyment and conservation of nature.

Ellen began studying fungi in the 1950s. With a few college classes and years of self-education, plus study under the nationally prominent mycologist, Dr. Alexander Smith, she became the leading authority on fungi of southern Idaho eastern Oregon and northern Nevada.

Ellen also knew plants and took classes from Dr. Harold M.Tucker at the College of Idaho in the last 1960s. She made more than 6,500 collections over 30 years, including more than 30 new species that carry the scientific names *Hygrophorus ellenae* and *Leccinum trubloodii*, the latter being first collected by husband Ted on July 22, 1964 on Black Mountain.

Ellen and Ted were a great team. She photographed the mushrooms and he provided darkroom services. Family was an important part of her life and I am grateful to her son Jack for providing me with several of Ellen's papers and his personal recollections. One paper she wrote was about mushrooming in the Owyhee Mountains with grandson John. The ecology and cycle of mushrooms are artfully woven into the story.

Ellen's collections are housed at the University of Michigan Herbarium in Ann Arbor, Albertson College of Idaho, and Virginia Polytechnic Institute in Blacksburg. She donated her extensive collection of fungi photographs and books to Boise State University, where she taught classes in mushroom identification in 1975.

In one of her papers, dated December 1972, and titled, "Fungi of Owyhee County," she writes of finding a *Calvatia booniana*, named in honor of the College of Idaho's founder, Dr. William Judson Boone. "It ranges in size from eight to 24 inches in diameter and from three to 12 inches high. One we found fresh after an all-night June rain weighed 11.5 pounds."

Ellen worked with numerous professionals and collected with Marsha Wicklow Howard. She was good friends with Dr. Alexander Smith and his wife, Helen. Dr. Smith was the director of the University of Michigan herbarium. She apparently named *Calvatia packardae*, found near Dickshooter Creek, after Dr. Patricia L. Packard. Ellen always had her eyes open for a new species. She discovered *Calvatia impolita* behind a juniper while obeying the call of nature. The professional who confirmed the species was somewhat aghast, but recovered enough to accept the name of the species. Ellen was always honest in documenting her collections!

Her favorite mushroom and her specialty was the bird's nest mushrooms, the *Nidularia*.

Ellen joined the North American Mycological Association (NAMA) in 1960 and later served as the Western vice-president. She founded the Southern Idaho Mycological Association (SIMA) in 1975, while making a call from a phone booth. In 1982 she received the NAMA Award for "Contributions to Amateur Mycology" and in 1984 was honored by SIMA for "Years of Outstanding Contributions to the Mycology of Idaho." Her research was published in the United States and Europe.

Her knowledge of mushrooms was well-known and widely respected, even among nonmycologists. One day at 3 a.m., she received a call from a hospital. Six people had eaten poisonous mushrooms and they needed her help to identify the mushrooms so that the physicians would know what antidote to use. Ellen performed the analysis and found out the mushrooms were not only poisonous, but that they had decayed. It was a tough job, but she correctly identified the mushrooms, the proper medicine was given, and all of the people survived.

Pat Packard and Ellen were best of friends and often spent holidays together. Ted gave Pat's brother-in-law, Claire Conley, his start with "Field and Stream" magazine.

Pat found a huge variety of a lupine, *Lupinus polyphyllus*, on the sand dunes south of Vale, Oregon, but could never catch it in bloom. Year after year, arriving earlier each time, she tried to get there for the bloom, but was always too late. Ellen went in April one year and made a wonderful collection, but the professionals still haven't determined exactly what the species is.

When a news species was confirmed, she enjoyed further study of it by photos and investigating stages of maturity, and determining the range of the species.

In the field, the road always gave out before she did. We botanists have a phrase that has passed around and I now know who coined the term "the alleged road." It was Ellen. Pat described her as "a real bulldog, " a useful trait for mycologists.

Of all the species she found, the one that intrigues me the most is the mushroom that grows only on cowpies in Owyhee County.

Ellen was dedicated, almost to a fault, to mycology. The following is an account from Pat Packard about a trip to the desert that took place on June 2, 1973.

Ted had driven the big old GMC as far as practical — not so very far in those days — up Dago Gulch. From there, we walked, climbed and scrambled up Mahogany Mountain's Blue Point Ridge. Ellen poked around with her podger basket (mushroom basket) while Ted and I inventoried the Owyhee County stand of yellow pine (four mature trees and 45 young stuff).

Halfway back to the rig we were crossing a bench covered with deep cheatgrass when Ellen stepped on a juniper branch that rolled with her. She stood up looking a bit white around the lips. Ted asked if she could walk and Ellen indicated she thought she could in a few minutes. He went after the rig and brought it up the stream bed and angled it around to poind down stream. Ellen muttered something to the effect she thought her leg was broken, but she would just leave her boot on and did we think this was a good spot for lunch?

We had a leisurely lunch and meandered down the road, investigating promising podger sites: Ellen did allow me to check out ones on rough ground. About 4:00, we stopped opposite Three Finger, had beer and snacks and an in-depth discussion of salt blocks, grazing practices, crested wheatgrass, etc.

We got into Nampa a little after 6. Ellen said firmly — as firmly as Ellen ever said anything — that supper was in the fridge and we would have supper. We did, with Ellen doing the serving and me helpfully getting in the way. It was a little after 8:00 when the kitchen was cleaned up to her satisfaction — I did get to help with the dishes — and Ted took her to the hospital. They repaired the spiral skier's break in her leg and put on a heavy duty cast.

Ellen was a professional outdoors woman, and professionals are not distracted by trifles."

Ellen died May 17, 1994, in a Seattle care center after suffering from Alzheimer's disease and is greatly missed.

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The Roles of Fungi in the Forest

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Introduction

This paper is an introduction to the biology and ecology of fungi in forest ecosystems. Examples of their interactions with other organisms are given so that the reader will gain a greater appreciation of the importance of fungi. Also included is a short discussion of the utility of fungi to people. The primary objective is to answer several questions. What is special about fungi? What do fungi do in the forest? And why should we care?

Unique features of fungi

Fungi are characterized by their microscopic threadlike cells called hyphae, and by production of spores. A group of hyphae is called mycelium. Mycelium tends to be immersed in a substrate, such as soil, wood or living plant tissues, that is both the surrounding physical environment and source of nutrients for the fungus. Mycelium is usually concealed from view and often long-lived.

Most fungi produce sporocarps (mushrooms, truffles, etc.) that tend to be ephemeral, seasonal, and annually variable. In other words, mushrooms can only be found for a short time during the year, in particular seasons, depending on the species of fungus, and not necessarily every year. Nonetheless, rarely can we identify fungi without their sporocarps. These characteristics are very different than higher plants, or even lichens, which can often be found and identified through much of the year.

Ecology of fungi

In thinking about the ecology of fungi, it is important to consider several phases of life history. Various phases have different habitat requirements, occupy different physical locations, perform different functions, and experience different environmental conditions. For example, a portion of one mycelium may be in contact with root tissues, another portion inhabit the soil, and sporocarps be produced in yet another habitat, such as a rotting log. Studying the ecology and understanding the habitat needs of fungi is not a simple task.

It is also hard to distinguish between individuals of a fungal species. Individual mycelia are concealed from view. Some individuals produce few sporocarps, others many, and sporocarps occurring close to each other may or may not be from the same mycelium. Conservation of any rare species requires an understanding of the dynamics of individuals and populations; we have much to learn if we are to apply these principles

To many people, fungi conjure an image of decay and destruction. Although some fungi are pathogens and decomposers, they serve many other functions in the forest ecosystem. Fungi are part of a complex system that cycles matter and energy. Plants turn sunlight, water, nutrients and carbon dioxide into biomass; other organisms consume the plant tissues and cycle it back into $CO2$ and nutrients. Fungi have important roles in the forest canopy and soil where plants exchange materials with the atmosphere and soil.

1) Roles of fungi in the canopy.

Fungi in the forest canopy perform several functions. Bacteria are the only organisms capable of fixing atmospheric nitrogen, and some canopy lichens host these nitrogen-fixing bacteria. It is estimated that 10% of the nitrogen input to old growth Douglas-fir stands comes from such lichens. Most long-lived plants have fungi within their leaves known as leaf endophytes. Leaf endophytes occupy the interior spaces of leaves, but are not inside plant cells, and are normally present in healthy plant tissues. These endophytes can produce antibiotics or other substances that make leaves unpalatable to insects. Endophytic fungi may also deter pathogenic fungi.

Some fungi grow over the surface of leaves or twigs as epiphytes. Epiphytic fungi may deter pathogens and leaf-grazing insects. Another role for these fungi is in canopy food webs, where they serve as food for various organisms, particularly small arthropods. There are many defoliating insects in the forest, their populations held in check by predatory insects. Old growth forests have many times more predatory insects than do plantations, probably because of the abundance of small arthropods that the predators feed upon. The link between primary production and these predatory insects may include leaf epiphytic fungi, which serve as food for micro arthropods.

2) Roles of fungi on the forest floor.

The soil is where most fungi reside in the forest. A thimbleful of soil can have many meters of hyphae and thousands of species of fungi. Most of these species are micro fungi, which never produce mushrooms or other sporocarps. Fungi in the soil include decomposers, pathogens and mycorrhizal species.

Soil is, of course, the place where plants get their water and mineral nutrients, and fungi are involved in cycling dead material into usable nutrients. As fungi consume organic matter, they release nitrogen, phosphorus and other nutrients in the course of decomposition. Decomposition makes a contribution to forest health and should not be viewed only as the destruction of valuable wood.

Fungi can act as pathogens, but not only with negative impacts. Although pathogens can cause economic loss, from an ecosystem perspective they have many useful roles. In a closed-canopy stand, pathogens can cause large openings, called gaps, that provide the bright, sunny conditions required by early successional vegetation. This contributes to habitat diversity in the stand and allows it to support more wildlife species than closed-canopy stands. Trees killed by pathogens become snags and logs that serve as nests, perches and food sources for many birds and mammals.

Mycorrhizae

Mycorrhizae are symbiotic associations of fungi with the roots of plants. Douglas-fir root systems do not have "root hairs" in a natural environment - - the entire fine, feeder root surface is covered by a mantle of fungal tissue. Fungal tissues penetrate between outer cells of these feeder roots. Virtually all nutrients and water entering the plant are transferred through the fungal tissue. Most vascular plants depend on mycorrhizal fungi for nutrient uptake. In the forested portions of the Pacific Northwest, we have between 30-50 ectomycorrhizal host species, primarily in the pine, beech, birch and willow families; these species host several thousand species of fungi. Most other plant species form different kinds of mycorrhizae, and some are non-mycorrhizal.

Mycorrhizal fungi act as an extension of the root system. They penetrate the soil beyond the reach of roots, thereby increasing nutrient and water availability to plants. They also protect roots from some soil pathogens by acting as a physical barrier, and by producing antibiotics. Hyphae of mycorrhizal fungi can link plants of the same or different species. These linkages can transport the products of photosynthesis from one plant to another, providing energy to help seedlings get established in the understory. A striking example of this in our forests are Indian pipes. Contrary to popular belief, these plants are not saprophytes. They rely on mycorrhizal fungi to get their energy, while the fungi in turn rely on green plants that are photosynthesizing. Indian pipes are more properly called myco-heterotrophs, not saprophytes.

Mycorrhizal fungi have effects on the biological, physical, and chemical structure of soil. Mycorrhizal fungi draw photosynthate (sugars) from their hosts; this sugar is transported away from the roots by hyphae extending into the soil. Some leakage occurs from the hyphae, and the fungal exudates glue soil particles together, forming aggregates. Aggregates are important in nutrient cycling because they are sites of microbial activity, and they increase soil aeration and water-holding capacity. Carbohydrate pumped into soil through the mycorrhizal hyphae also helps support the diverse microbial communities living there. More than half of the micro arthropod species in soil are specialized fungal feeders.

Species of mycorrhizal fungi colonizing roots have a selective influence on associated soil organisms. Communities of bacteria and protozoans vary depending on which fungus species is forming the mycorrhizae. Many free-living, nitrogen-fixing bacteria associate with particular fungal species.

Plants need water to photosynthesize. Mycorrhizal fungi aid plant water uptake by penetrating soil away from roots, thus exploiting water beyond the root zone. Hyphae also get water from small pores in the soil that are inaccessible to roots.

Mycorrhizal fungi are important in reforestation, especially on harsh sites with short growing seasons. To become established, seedlings require mycorrhizal fungi. When trees are removed in logging, the mycorrhizal fungi left there can survive for some time. If a site is too harsh, and no energy is provided for the underground ecosystem, mycorrhizal fungi die. Reforestation needs to happen within a window of opportunity, before changes in the underground ecosystem occur. The duration of the window of opportunity depends upon many factors, and is an active area of research.

Mycorrhizal fungi are also key players in plant succession On glacial moraines in the Cascade Mountains, early colonization is by plant species that can either survive without mycorrhizae or form mycorrhizae with fungi that disperse their spores on the wind. Plants that depend on mycorrhizae that disperse spores with soil movement typically colonize later.

Food webs

Fungi also play a role in food webs. Sporocarps are food for many organisms, including slugs, insects and other arthropods, and mammals. Hyphae penetrating out into soil are also a source of food for other organisms such as bacteria, protozoa, and many types of invertebrates. In our region, the northern flying squirrel and red-backed vole are mycophagists (fungus feeders) almost exclusively, relying mostly on truffles. The northern flying squirrel is also the main prey of the spotted owl, so we can see a direct link between fungi and a federally listed endangered species. Efforts to create habitat for the spotted owl focus in part on flying squirrel populations and the effects of forest management on truffle production.

Sporocarps are consumed by squirrels, rodents, deer, elk, bears, and other mammals. Mushrooms are rich in certain amino acids and can be good protein source. Perhaps more important to wildlife are mineral salts that are concentrated in fungal tissues.

Animals also fall prey to fungi. The carpenter ant sometimes falls prey to a *Cordyceps* species, which colonizes the ant's body. Fungi are also consumed by other fungi. For example there is another *Cordyceps* species that parasitizes a truffle. This is interesting from an evolutionary point of view because *Cordyceps* have two major sorts of "hosts" insects (ants, beetles, butterflies) and truffles. These two unrelated groups of organisms both have chitin in their cell walls. It is interesting that *Cordyceps* has specialized on insects, and can switch to parasitizing truffles.

Importance of fungi

Fungi, with an estimated 1.5 million species, are the most diverse group of organisms after arthropods. Biodiversity is important because we need other organisms, including fungi to survive. The United States is a leader in legal protection of biodiversity. From the National Parks System, established in 1874, to the Endangered Species Act of 1970 and the National Forest Management Act of 1976, our nation has placed high value on our biological resources. The Northwest Forest Plan takes an unprecedented step in conservation of fungal diversity. Over half of the species requiring surveys or protection of known sites are macrofungi. The Bureau of Land Management and the Forest Service are now obligated to provide some level of protection to many fungi.

Protecting biodiversity is profitable. The multi-billion dollar pharmaceutical industry derives almost all new drugs from chemicals originally isolated in nature, many of them from fungi. Some species of fungi have anti-cancer properties; although no drugs have been commercially marketed for this purpose yet, it is a promising area of research. Commercial harvest of mushrooms is a growing industry, and many people enjoy picking and eating wild mushrooms. Chanterelles, morels, and matsutake are the most abundantly harvested wild mushrooms. The impacts of harvesting on later mushroom production is another area of active research.

In summary, just as there is more to the forest than the trees, there is more to fungi than rot and mold. The functions of fungi in the forest are myriad and crucial to its health. For more information about fungi, see the references listed below.

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Questions:

1. *What happens to mycorrhizal fungi in situations where orchid species are lost because of timber sales? How long do those mycorrhizae take to return to where they can support some of these orchids?*

Fungi will be impacted most by harvest of overstory trees, which are their source of photosynthate. Orchids may be associated with specific mycorrhizae; in terms of management impacts, we have almost no information on which speices are most affected by timber harvest and how long they take to come back; experiments currenlty being done on different management practices/different levels of harvest could also look at the mycorrhizal component. But, generally, very little information on this subject.

2. *Difference in diversity of fungi in terrestrial vs. saturated soils in wetlands?*

Gradient of wet to dry sites where mycorrhizal fungi was studied; wet sites border on spruce, dry bordered on Douglas fir; wet sites had lowest diversity of mycorrhizal fungi, especially of ectomycorrhizae. In wetlands, some fungi have adapted to this; but overall diversity lower. Those adapted to wetlands are rarer.

3. *Difference in fungi found in rangeland ecosystems compared to forests?*

Marcia will talk about rangelands - but there is a very different set of players; partly influenced by vegetation, physical condition of habitat.

4. *Changes in forest - like clearcutting, fire - going from mature forest stand to shrub community - does fungi stay in soil and re-innoculate new plants, or does fungi change to new group of species?*

Who knows. Difficult, because until recently we have had to rely on macro fungi to identify the species present. But, using DNA and other techniques, we can now look at species on individual root tips and begin to address this question. However, still time consuming, have to do molecular work. Preferably, would have to watch through whole cycle, before stand is cut, and then determine if original species persist or if new species come in. So far, no conclusive data on this. Do some early-fruiting species (i.e. chanterelles) persist through loggin, or do they need to be reintroduced?

5. *What is the effect of soil compaction through trampling?*

Some evidence that compaction reduces diversity of mycorrhizae.

Toward a RED List for Idaho's Macrofungi

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Two recent assessments of the diversity of organisms on federal land stimulated creation of preliminary lists of macrofungi of special concern. One assessment area encompasses the known range of the northern spotted owl in western Washington, western Oregon and northwestern California under the auspices of President Clinton's Forest Plan. The other assessment area encompasses all of Idaho, eastern Oregon, eastern Washington, and pieces of Utah, Montana, Nevada, and Wyoming under the auspices of the Interior Columbia River Basin Ecosystem Management Project (ICBEMP). I have taken the information generated from these assessments and evaluated the macrofungal species of special concern to create a preliminary RED list of macrofungi from Idaho. Procedures for this evaluation are those proposed and followed for the Oregon RED list (Castellano 1997) .

What is a RED list? "R" represents rarity for those species that are localized within restricted geographical areas or habitats or are thinly scattered over a more extensive range. "E" represents endangerment, which are species in danger of extinction throughout all or a significant portion of its range (Threatened status is regarded the same). "D" represents distribution that considers the overall species range.

Rare species are defined as those species that have 10 or fewer vouchered specimens or occurrences. Occurrences is defined as one or more collections within a square kilometer extant site; this reflects neither abundance within site or dispersal across the landscape and is independent of topography, habitat and history.

The creation of a RED list requires exchange of information between professionals and amateurs to fully evaluate the occurrence of macrofungi. The first RED list for any region in North America has been started for Oregon, and another is in process for Washington.

Until recently there had been no fungi listed on the federal list of Threatened and Endangered organisms, which is almost exclusively comprised of animal and plant species. Only one fungal species has been proposed, *Bridgeioporous nobilissimus* (formerly *Oxyporus nobilissimus*). Eventually, after further scrutiny, the macrofungi species on the Idaho RED list will draw enough additional attention from collectors that a firm understanding of their occurrence on the landscape will allow proposal of some Idaho species for federal listing.

The preferred option to maintain species viability is to develop conservation strategies and recovery plans for these macrofungi, rather than a federal listing.

Macrofungi have a significant role in the physiological function of ecosystems as has already been discussed in another chapter by T. O'Dell. Sporocarp occurrence does not reveal the extent of the individual. The thallus (body of the fungus) ramifies through the substrate, be it soil, wood, or leaves. The sporocarp is just the fruit of the organism, much like apples from a tree. Some macrofungi produce many "fruits" per individuals, while others produce few "fruits" per individual.

Macrofungi occupy a wide variety of habitats (e.g., forests, meadows, deserts, riparian areas) and substrates (e.g., leaves, rotten wood, live wood, various soil types). Many macrofungi only occur in a specific habitat or where a specific host occurs, and as such, have a limited distribution. For example, *Sowerbyella rhenea*, an Ascomycete, requires moist sites and is a regional endemic. In Idaho, it is found at Upper Priest River. *Morchella semilibera* requires burned areas to form sporocarps.

The survey and inventory of macrofungi present unique and significant challenges because of their cryptic nature, ephemeral occurrence, seasonality, clustering across the landscape, the paltry information on population biology, difficulties with identification, and destructive sampling methodologies. Timing of the survey work is critical. It must be done when the "fruits" have been produced. The season of fruiting for many species does not overlap, so repeated visits to the same location are needed throughout the fruiting season. Some species are hard to identify due to poor understanding of the taxonomy of certain species, genera, and families of fungi. Destructive sampling is sometimes needed for proper identification, particularly for the sequestrate fungi that often times form sporocarps within the substrate.

The success of the assessment for the President's Forest Plan encouraged us to attempt to assess the macrofungi for the ICBEMP. The available information for macrofungal species within the ICBEMP is less comprehensive because collecting in remote and wide-ranging habitats has been extremely limited. This limited information at times has made it difficult to determine species rarity. I have relied largely on the expertise of mycologists who have worked in this area in creating the preliminary list presented below.

The RED list for Idaho macrofungi tentatively includes 29 genera and almost 200 species. Almost half of the species are Basidiomyetes (Table 1). Note that the list is heavy toward certain genera. This is directly related to the sources of available information used to compile the list. *Galerina, Hebeloma, Macowanites, Martellia, Pholiota, Psathyrella,* and *Rhizopogon* were studied intensively in this area by Dr. A.H. Smith and thus a great deal of information is known about these genera. Many other genera not studied in depth certainly occur in this area, and are without a doubt under-represented on the list at this time. Many of the species on the list are represented by one collection. Of almost 200 species, 95 are known from one collection in Idaho, many from Dr. Smith (historical collection).

Table 1

The Basidiomycete genera of special concern in Idaho include nine genera and 95 species. The number of species represented by each genus is noted in parentheses.

Amanita (2)	*Lactarius* (2)
Crepidotus (2)	*Leccinum* (1)
Galerina (13)	*Pholiota* (27)
Hebeloma (10)	*Psathyrella* (33)
Hygrophorus (5)	

The Ascomycetes are an often overlooked group of genera because many have small somewhat inconspicuous sporocarps. Ascomycetes are clearly under-represented in this assessment (Table 2). Many Ascomycete species that fruit on soil are thought to be mycorrhizal. Some are phenocoid, requiring burned areas to complete their life cycle. Many Idaho Ascomycetes are localized in their distribution. For example, Plectania milleri, a presumed mycorrhizal associate, is a regional endemic, known from one site in Clearwater County.

Table 2

The Ascomycete genera of special concern in Idaho include six genera and eight species. The number of species represented by each genus is noted in parentheses.

Helvella (2)	*Rhodocypha* (1)
Morchella (1)	*Sowerbyella* (2)
Plectania (1)	*Wynella* (1)

The puffballs are also under-represented in this assessment having just two species listed, *Calvatia owyheensis* and *Cyathus olla f. lanatus*. The extensive dry habitat within the ICBEMP is likely habitat for these species, but the rainfall pattern and the ephemeral nature of these sporocarps make them difficult to survey for unless resident to the area.

Due to the work of Dr. Smith, the sequestrate fungi are well represented on the list (Table 3). Additional effort is necessary to survey the assessment area and redocument the occurrence of these sequestrate fungi. Some of the sequestrate species will be removed from the list as more complete information is generated through additional work to recollect sequestrate fungi in Idaho.

Table 3

The sequestrate genera of special concern in Idaho include 12 genera and 94 species. The number of species represented by each genus is noted in parentheses.

Chamonixia (1)	*Destuntzia* (1)
Gastroboletus (1)	*Genabea* [a] (1)
Gymnomyces (1)	*Leucophleps* (1)
Macowanites (12)	*Martellia* (7)
Picoa [a] (1)	*Rhizopogon* (66)
Seducula (1)	*Truncocolumella* (1)

a = Ascomycete genus of sequestrate fungi.

There are no representatives on the list of certain genera with many species in this region, but whose taxonomy is poorly understood. Some of these genera include *Cortinarius, Mycena, Ramaria,* and *Russula.* Of the almost 200 species, 116 are locally endemic, 44 are regional endemics, 33 are disjunct, and 7 are on the periphery of the range.

I hope this preliminary list will create additional interest in these groups of organisms and generate comment and critique from interested individuals. The list is recommended as a starting point to begin discussion on what should and should not be included in the RED list for Idaho macrofungi. Comments and interest should be addressed to the author by mail, FAX (541-750-7382) or e-mail [castellanom@fsl.orst.edu].

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Preliminary RED List of Idaho's Macrofungi

Fungus Name	County	Associated Vegetation or Environmental Conditions
Amanita armillariformis	Owyhee	*Salix* or *Artemisia*
Amanita aurantiasquamosa	Owyhee	*Salix* or *Artemisia*
Calvatia owyheensis	Owyhee	*Artemisia*
Chamonixia brevicolumna	Valley	*Picea engelmannii* or *Abies spp.*
Crepidotus startosus	Idaho (?)	fallen leaves and twigs
Crepidotus sububer	Bonner	wood of Populus spp.
Cyathus olla f. lanatus	Owyhee	on wood of Artemisia and Sarcobatus
Destuntzia subborealis	Bonner	conifers
Galerina anelligera	Valley	on duff under conifers
Galerina borealis	Idaho (?)	on moss
Galerina castanescens	Bonner	on conifer logs
Galerina diabolissima	Idaho	on moss
Galerina fontinalis	Valley	on wet soil
Galerina nordmanniana	Bonner	on moss
Galerina payettensis	Valley	on wet moss under conifers
Galerina pseudostylifera	Idaho	on rotting conifer logs in cold wet places
Galerina pubescentipes	Idaho	on conifer logs
Galerina stylifera var. badia	Idaho (?)	on conifer debris
Galerina stylifera var. velosa	Idaho (?)	on conifer debris
Galerina triscopa f. longocystitis	Valley	on moss covered conifer log
Gastroboletus turbinatus var. *flammeus*	Valley	*Abies* sp.
Genabea cerebriformis	Owyhee	*Pseudotsuga* with *Pinus monophylla*
Gymnomyces ferruginascens	Valley	*Picea engelmannii* or *Abies lasiocarpa*

Hebeloma alpinicola	Idaho	*Pinus albicaulis*
Hebeloma idahoense	Valley	*Picea engelmannii*
Hebeloma kelloggense	Shoshone	unknown Pinaceae
Hebeloma latisporum	Bonner	*Tsuga* sp.
Hebeloma mesophaeum var. *subobscurum*	Idaho	unknown Pinaceae
Hebeloma pseudofastible var.	Valley	unknown hosts on sandy soil
Hebeloma salmonense	French Creek Glade, Salmon River (?)	unknown hosts
Hebeloma stanleyense	Custer Co.	*Pinus* sp.
Hebeloma strophosum var. *occidentale*	Valley	*Picea engelmannii*
Hebeloma vinaceogriseum	Idaho	unknown hosts
Helvella corium	Kootenai, Valley	*Pinus* or *Salix* spp.
Helvella maculata	Latah, Bonner, Idaho	unknown Pinaceae
Hygrophorus burgdorfensis	Idaho	on soil at edge of bog under *Pinus contorta*
Hygrophorus ellenae	Boise	on gravelly soil under *Pinus* and *Abies*
Hygrophorus nordmanensis	Bonner	on soil under *Tsuga*
Hygrophorus velatus	Idaho	on soil under conifers
Hygrophorus vinicolor	Custer	on moss
Lactarius payettensis	Idaho (?)	*Abies, Alnus,* or *Populus* spp.
Lactarius rufus var. *parvus*	Boundary	*Pinus* and *Abies* spp.
Leccinum truebloodii	Owyhee	*Populus* or *Pseudotsuga* spp., or both
Leucophleps magnata	Valley	*Pseudotsuga menziesii*
Macowanites acris	Custer	*Picea engelmannii*
Macowanites citrinus	Custer	*Pinus contorta*
Macowanites fulvescens	Valley	*Picea engelmannii* or *Abies* or both
Macowanites fuscoviolaceus	Valley	*Abies lasiocarpa*
Macowanites lilacinus	Valley	*Picea engelmannii* or *Abies lasiocarpa*
Macowanites nauseosus	Valley	*Picea engelmannii* or *Abies lasiocarpa*
Macowanites olidus	Valley	*Pinaceae*
Macowanites pinicola	Boise	*Pinus contorta*
Macowanites pseudometicus	Valley	*Picea engelmannii*
Macowanites subolivaceus	Custer	*Picea engelmannii*
Macowanites subrosaceus	Valley	*Picea engelmannii* or *Abies* or both
Macowanites vinicolor	Valley	*Pinaceae*
Martellia ellipsospora	Idaho	*Pseudotsuga menziesii*
Martellia foetens	Idaho	*Pinus contorta*
Martellia fragrans	Valley	*Abies* sp.
Martellia fulvispora	Valley	*Pinaceae*
Martellia monticola	Valley	*Abies lasiocarpa*
Martellia subalpina	Valley	*Abies lasiocarpa, Abies magnifica* var, *shastensis* and *Tsuga mertensiana*
Martellia subochracea	Valley	*Abies* and *Tsuga* spp.
Morchella semilibera	Latah, Canyon	on soil usually in riparian areas or wet soil
Pholiota agglutinata	Valley	on moss under *Picea*
Pholiota atripes	from Idaho (?)	on decayed conifer wood

Pholiota aurantioflava	Bonner	on conifer debris
Pholiota avellaneifolia	Valley	on soil under *Picea engelmannii*
Pholiota baptistii	Ada	on conifer debris
Pholiota brunnea	Valley	on conifer wood
Pholiota flavida var. *graveolens*	Bonner	on conifer wood
Pholiota flavopallida	Bonner	on conifer wood
Pholiota fulvodisca	Valley	on conifer duff
Pholiota fulvozonata	Boundary	on partially burned wood
Pholiota gruberi	Nez Perce	on needle cover under *Larix occidentalis*
Pholiota heimalis	Boundary	on *Abies* log
Pholiota humii	Bonner, Idaho, Valley	on or around decayed conifer logs
Pholiota luteola	Valley	on conifer logs
Pholiota macrocystis	Valley	on conifer logs
Pholiota milleri	Bonner	on soil
Pholiota nigripes	Idaho, Valley	on conifer logs
Pholiota obscura	Adams, Idaho, Valley	on decayed wood
Pholiota occidentalis var. *luteifolia*	Boundary	on conifer debris
Pholiota pallida	Valley	on conifer logs
Pholiota pulchella var. *brevipes*	Bonner	on soil
Pholiota scamboides	Bonner	on buried wood
Pholiota subechinata	Bonner	on conifer log
Pholiota sublubrica	Boise, Custer, Idaho, Valley	on or near conifer logs
Pholiota subsaponacea	Boundary	on burned areas
Pholiota subsaponacea	Boundary	on burned areas
Pholiota umbilicata	Boundary	on debris from *Thuja plicata*
Picoa carthusiana	Valley	*Pseudotsuga menziesii* in North America
Plectania milleri	Clearwater	*Abies* sp.and *Tsuga* sp
Psathyrella abieticola	Valley	*Picea* and *Abies*
Psathyrella acuticystis	Boundary	*Picea* and *Abies*
Psathyrella annulata	Bonner	on conifer duff under old-growth *Tsuga*
Psathyrella argentata	Bonner	on cow dung
Psathyrella boulderensis	Valley	on moist earth
Psathyrella communis	Bonner, Boundary	on decayed wood
Psathyrella crassulistipes	Bonner	on sand
Psathyrella deserticola	Owyhee	under sagebrush
Psathyrella ellenae	Valley	under *Picea engelmannii* and *Abies* sp.
Psathyrella equina	Valley	on horse dung
Psathyrella fragrans	Valley	on conifer debris
Psathyrella fulva	Bonner	on debris
Psathyrella fuscospora	Valley	on soil
Psathyrella idahoensis	Idaho	on disturbed soil
Psathyrella lepidotoides	Boundary	on *Populus* log
Psathyrella mesocystis	Valley	under *Picea engelmannii* and *Abies* sp.
Psathyrella nezpercii	Bonner, Idaho, Owyhee	on mud in pastures
Psathyrella owyheensis	Owyhee	in cow pastures
Psathyrella populorum	Owyhee	under *Populus*
Psathyrella pratenuis	Bonner	on debris under *Populus*
Psathyrella pseudolimicola	Bonner, Idaho, Valley	on soil

Psathyrella psilocyboides	Adams	on soil in wet mountain meadows
Psathyrella roothaanensis	Boundary	on moss in swampy area
Psathyrella rufogrisea var. *bonnerensis*	Bonner	on sticks along stream
Psathyrella rufogrisea var. *riparia*	Valley Co.	on wet soil along stream
Psathyrella salictaria	Idaho	on moss under *Salix* and *Betula*
Psathyrella sublongipes	Idaho	under *Betula*
Psathyrella subnuda var. *velosa*	Bonner	on *humus* under *Populus*
Psathyrella subradicata	Owyhee	on burned soil
Psathyrella variata	Bonner	on *Populus* log
Psathyrella vesiculocystis	Idaho	on conifer debris
Psathyrella wapinitaensis	Bonner, Idaho, Valley	on conifer logs
Psathyrella warrenensis	Idaho	on grassy soil
Rhizopogon abietis	Custer, Idaho, Valley	*Picea engelmannii, Pinus* and *Abies* spp.
Rhizopogon albidus	Valley, Idaho	*Pinus albicaulis* or *Abies* sp.
Rhizopogon albiroseus	Bonner	*Abies lasiocarpa*
Rhizopogon alkalivirens	Adams	*Pinaceae*
Rhizopogon alpestris	Valley	*Picea engelmannii* or *Abies* sp.
Rhizopogon anomalus	Boundary	*Pinus* or *Larix* spp.
Rhizopogon arenicola	Bonner	*Pinus contorta*
Rhizopogon argillaceus	Valley, Bonner	*Picea engelmannii*
Rhizopogon avellaneitectus	Bonner	*Pinus contorta*
Rhizopogon brunneicolor	Bonner, Idaho, Valley	*Pinaceae*
Rhizopogon brunneifibrillosus	Bonner	*Pinaceae*
Rhizopogon butyraceus	Idaho, Valley	*Pinaceae*
Rhizopogon chamalelotinus	Bonner	*Pinaceae*
Rhizopogon cinerascens	Bonner	*Pinaceae*
Rhizopogon clavitisporus	Valley	*Pinaceae*
Rhizopogon colossus var. *colossus*	Valley	*Pinaceae*
Rhizopogon cylindrisporus	Shoshone	*Pinaceae*
Rhizopogon deceptivus	Adams, Bonner, Idaho	*Pinaceae*
Rhizopogon evadens var. *subalpinus*	Idaho	*Pinus albicaulis*
Rhizopogon fallax	Idaho, Custer	*Pinus contorta*
Rhizopogon flavofibrillosus	Valley	*Pinus* sp., *Picea engelmannii, Abies lasiocarpa*, or *Pseudotsuga menziesii*
Rhizopogon florencianus	Idaho	*Abies* or *Picea engelmannii*
Rhizopogon fragrans	Valley, Idaho	*Pinaceae*
Rhizopogon griseogleba	Valley	*Picea engelmannii*
Rhizopogon hysterangioides	Valley	*Picea engelmannii , Abies lasiocarpa*
Rhizopogon inquinatus	Bonner	*Pseudotsuga menziesii, Tsuga heterophylla*
Rhizopogon kauffmanii	Idaho, Boundary	*Pinaceae*
Rhizopogon laetiflavus	Valley	*Abies* or *Pinus* spp.
Rhizopogon luteoalboides	Idaho	*Pinus albicaulis, Abies lasiocarpa* or *Picea engelmannii*
Rhizopogon luteorubescens	Bonner, Idaho, Valley	*Pinaceae*
Rhizopogon lutescens	Valley, Boise	*Pinaceae*
Rhizopogon milleri	Bonner	*Larix occidentalis* or *Pinus* sp.
Rhizopogon molligleba	Idaho	*Pinus albicaulis* or *Abies* sp.
Rhizopogon obscurus	Adams, Valley	*Pinus contorta*

Rhizopogon ochraceisporus	Boise, Idaho, Valley	*Pseudotsuga menziesii, Abies* sp.
Rhizopogon ochraceobrunnescens	Bonner, Idaho	*Pinaceae*
Rhizopogon ochroleucus	Valley, Idaho	*Pinaceae*
Rhizopogon olivaceoluteus	Bonner, Idaho	*Abies* sp.
Rhizopogon parvulus	Valley, Bonner	*Abies* and *Larix* spp.
Rhizopogon pseudoaffinis	Valley	*Abies* sp. or *Picea engelmannii*
Rhizopogon pseudoalbus	Valley	*Abies* sp. or *Picea engelmannii*
Rhizopogon quercicola	Bonner	*Pinaceae*
Rhizopogon rogersii	Bonner	*Pinaceae*
Rhizopogon rubescens var. *pallidimaculatus*	Valley	*Abies* sp. or *Pinus* sp.
Rhizopogon rudus	Bonner	*Pseudotsuga menziesii*
Rhizopogon semireticulatus	Latah	*Pinus ponderosa* or *Abies grandis*
Rhizopogon semitectus	Bonner, Boundary	*Abies lasiocarpa* or *Tsuga mertensiana*
Rhizopogon sordidus	Boundary	*Pinus ponderosa*
Rhizopogon subbadius	Custer	*Pinus contorta*
Rhizopogon subcaerulescens var. *viridescens*	Bonner	*Tsuga* sp.
Rhizopogon subcinnamomeus	Bonner	*Pinus contorta* or *Pseudotsuga menziesii*
Rhizopogon subclavitisporus	Bonner	*Pseudotsuga menziesii*
Rhizopogon subcroceus	Adams, Boise, Custer, Valley	*Pinus* sp.
Rhizopogon subgelatinosus	Bonner, Valley	*Pinus* sp. or *Pseudotsuga menziesii*
Rhizopogon sublateritus	Bonner, Valley	*Pinus ponderosa* or *Abies magnifica*
Rhizopogon subolivascens	Valley	*Pinaceae*
Rhizopogon subpurpurescens	Custer, Idaho	*Pinus contorta, Tsuga mertensiana,* and *Abies lasiocarpa*
Rhizopogon subsalmonius var. *griseolilascens*	Bonner	*Abies lasiocarpa*
Rhizopogon subsalmonius var. *roseitinctus*	Idaho	*Pinus albicaulis* or *Abies lasiocarpa*
Rhizopogon subsalmonius var. *similis*	Bonner, Idaho	*Picea engelmannii* or *Abies lasiocarpa*
Rhizopogon udus	Bonner, Idaho, Valley	*Picea engelmannii* or *Pinus contorta*
Rhizopogon umbrinoviolascens	Idaho	*Larix occidentalis* or *Pseudotsuga menziesii*
Rhizopogon variabilisporus	Idaho	*Picea engelmannii* or *Abies*
Rhizopogon vesiculosus	Idaho	*Pinus contorta*
Rhizopogon villescens	Bonner	*Pseudotsuga menziesii* or *Abies* or both
Rhizopogon zelleri	Valley, Adams	*Pseudotsuga menziesii*
Rhodoscypha ovilla	Boundary	on soil under fern
Sowerbyella imperialis	Boundary	saprophytic
Sowerbyella rhenana	Boundary	saprophytic
Truncocolumella citrina var. *separabilis*	Valley	*Pseudotsuga menziesii*
Wynnella silvicola	Custer, Idaho	on moss near riparian areas

The Role of Mycorrhizal Fungi in Rangelands

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Mycorrhizae are root associations that can be important to plants for nutrient uptake, growth rate, reproduction,and overall survival. Tom O'Dell and Mike Castellano spoke primarily about ectomycorrhizae, which are found almost exclusively with woody plants and usually have a high host specificity. In rangelands, however, endomycorrhizae are more common. These fungi are also referred to as arbuscular mycorrhizae. Arbuscular mycorrhizae are commonly associated with the roots of rangeland grasses and shrubs, and have a much lower host specificity. A particular species of arbuscular mycorrhizae might associate with diverse plant species in a particular area. They produce a hyphal network extending from the root and form arbuscules inside the cells of the root. The arbuscule is the site of nutrient exchange. Arbuscular mycorrhizae also form storage vesicles and hyphal connections within the root. Hyphae exit the root and grow out into the soil. The spores can also be seen externally on the root.

There is conflicting data on how important arbuscular mycorrhizae are, and the data seem to indicate that mycorrhizal importance varies with site, soil, and host plant species.

Arbuscular mycorrhizal fungi are obligate, and they require a host plant in order to survive. Rangeland plants can be defined according to their mycorrhizal dependence. Some are non-mycorrhizal, some are facultative, and others dependent. Species of *Artemisia* (sagebrush) are an example of a rangeland shrub with a high dependence on arbuscular mycorrhizae. *Artemisia* roots are commonly 70% colonized with arbuscular mycorrhizal fungi. *Chrysothamnus* species (rabbitbrush) are also highly dependent, whereas *Atriplex canescens* (four-wing saltbush), *Sarcobatus vermiculatus* (greasewood), and *Atriplex confertifolia* (shadscale) are more facultative. *Purshia tridentata* (bitterbrush) has a high colonization by mycorrhizae. In contrast, *Ceratoides lanata* (winterfat) is commonly non-mycorrhizal, but will often be colonized when it is growing in a complex with mycorrhizal shrub species. Bunchgrasses such as *Agropyron spicatum* (bluebunch wheatgrass), *Stipa* spp. (needlegrass), *Oryzopsis hymenoides* (Indian ricegrass), *Poa* spp. (bluegrass), and others commonly have arbuscular mycorrhizae. Grasses that are nonmycorrhizal include the annual exotics *Bromus tectorum* (cheatgrass) and *Taeniatherum caputmedusae* (medusahead wildrye).

There will typically not be a great diversity of arbuscular mycorrhizae species present in a given area. These few species are able to colonize a large variety of host plants however, and it is possible to have several different grass and shrub species colonized by one species of fungus. Some research has shown that hyphal networks can even connect different plant species.

When does an arbuscular mycorrhizae become a species of concern? As with other fungi, this is a difficult question to answer. We can say that when the host plant is disturbed, it will be a problem for the obligate fungus. Topsoil disturbance or removal may eliminate the hyphae and spores that serve as innoculum for new plants. In habitats burned by range fires, grasses such as cheatgrass often replace the native sagebrush/ bunchgrass communities. Cheatgrass does not regularly form arbuscular mycorrhizae, making fungal recovery difficult. Fire removes the higher vegetation, but fungal innoculum will remain viable in soil for a limited amount of time. If mycorrhizae-forming plants do not recolonize a disturbed area, the fungus cannot become established. Soil erosion, especially following fire, limits mycorrhizae formation. Off-road vehicles remove vegetation, disturb soil structure, and disrupt hyphal networks. Livestock grazing can also have an impact on mycorrhizae in soil, especially when use levels are high-intensity. Grazing compacts soil and removes photosynthetic plant parts. Grazing itself stresses the plant, and in turn the plant does not release carbohydrates for mycorrhizal formation.

Three genera of arbuscular mycorrhizae are dominant in southwestern Idaho rangelands. They are *Glomus, Gigaspora,* and *Acaulospora*. There is not a lot of information about the importance and/or role of these genera, and hence it is difficult to know how concerned we should be about them. As we learn more about soil specificity and fertilityl, we will learn more about the arbuscular mycorrhizae in Idaho rangelands. Host plants need to be first line of concern — if the habitat is there and undisturbed, the fungi will probably be okay.

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Conservation Status of *Texosporium sancti-jacobi*

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The crustose lichen, *Texosporium sancti-jacobi*, was first discovered about 1880 near San Diego, California, so it has been known to science for a long time. However, it was essentially forgotten or overlooked from the time of its discovery until the 1960s, when it was still known from only a couple of California collections. In the early 1980s, Roger Rosentreter found *Texosporium* south of Boise, Idaho, but because of its rarity and extremely limited documentation in the literature, it took several years to identify this unusual lichen. Its identity was confirmed in 1984, when it was found to be identical to the California material from San Diego and Pinnacles National Monument. In 1990, I found *Texosporium* west of Redmond, in central Oregon, and it was subsequently found the following year less than five miles away. Jean Ponzetti found one tiny clump of *Texosporium* on a Nature Conservancy preserve in central Washington in 1997.

The common name for *Texosporium*, a monotypic genus, is woven-spore lichen. The spore is unique among lichens. The ascus essentially dissolves and the free hyphae (paraphyses) wrap around the spore, giving it a woven textured appearance. In the last ten years of extensive botanical work in southern Idaho, the 12 sites within a 25 mile radius of Boise still comprise the extent of its range in Idaho.

I have to admit that *Texosporium* is a pretty obscure lichen. It is usually found on clumps of organic material, especially clumps of dead *Poa secunda* (Sandberg bluegrass). *Texosporium* grows in "old-growth" *Artemisia tridentata* var. *wyomingensis* (Wyoming sagebrush) sites with perennial bunchgrasses such as *Agropyron spicatum* (bluebunch wheatgrass), *Sitanion hystrix* (squirreltail grass), and *Stipa thurberiana* (Thurber's needlegrass), although it also occurs in at least two *Chrysothamnus nauseosus* var. *consimilis* (rabbitbrush) sites that last burned over thirty years ago (Rosentreter 1986). *Bromus tectorum* (cheatgrass) is typically a minor component of the community. In Oregon, *Texosporium* grows either on rabbit dung or humus, but in California it is only known to grow on dung. The one small clump found in Washington was growing on humus.

One of the Oregon locations is within a Bureau of Land Management Research Natural Area (RNA) that has never been grazed. The site is dominated by bunchgrasses with very little sagebrush present. The RNA has become a popular destination due to its scientific value as an ungrazed relict, and unfortunately, human visitation has increased, with potential impacts to the *Texosporium*.

By far the greatest threat in Idaho is range fires in the Snake River Plain. In 1996 alone, fires burned over 700,000 acres in southern Idaho, with several hundred thousand acres in BLM's Lower Snake River District. Three of the fires burned through *Texosporium* sites. While *Texosporium's* response to fire has not been studied, it is assumed to respond poorly. Historically, in a pre-cheatgrass, pre-livestock grazing, extended fire interval environment, the species could presumably maintain populations, but whether it can under present environmental conditions is dubious.

A rather extensive inventory of suitable habitats from Idaho through Nevada and into California was conducted by McCune and Rosentreter (1992). While they found no significant new populations, they did successfully relocate the Pinnacles National Monument sites. People with a lichenological background have continued to look in Oregon for the past several years, but all attempts have been unsuccessful. For this reason, we feel that *Texosporium* is truly a rare species, and not simply overlooked because its obscure appearance.

The Snake River Birds of Prey National Conservation Area, where several *Texosporium* populations are known, has continued to experience large fires over the last twenty or more years. The number of sagebrush stands has declined drastically, and rehabilitation efforts have either been unsuccessful or marginal at best at restoring native vegetation.

Several of the *Texosporium* sites in Idaho are on small isolated tracts (usually 40 acres) of public land that are nearly surrounded by housing developments. The boom in landscape rock collecting has had an impact on *Texosporium* on at least one of these isolated tracts. For example, a BLM parcel near the large Columbia Village subdivision has been heavily impacted. The parcel is proposed for exchange, but even if the agency retained it in public ownership, management would be nearly impossible without a fence. And this would not alleviate the high potential to burn.

In summary, I think the outlook for this species in the Idaho portion of its range is gloomy. To further exemplify this, a recent *Texosporium* discovery east of Boise is immediately adjacent to the new Micron freeway interchange. While the Idaho Department of Transportation cooperated last year in helping to flag the *Texosporium* area for avoidance, it is only a matter of time before this parcel will be developed. For BLM to purchase the land is out of the question, as the land values associated with such high development potential properties is astronomical.

To conserve what remains of this species and its habitat, BLM, U.S. Fish and Wildlife Service (USFWS), and the Idaho Army National Guard have drafted a Conservation Strategy that outlines potential protection measures. We need to implement several of the actions proposed by this document, and the sooner the better. I have worked with a Boise State University student to transplant *Texosporium* from the freeway interchange site, but unfortunately the transplant sites burned last year (1996). For all of the reasons outlined above, *Texosporium* was recently added to the "Red Listed Lichens of the World," a list of 33 globally rare lichen species developed by an international group of lichenologists. I believe that *Texosporium* sancti-jacobi needs to be re-listed by the USFWS as a federal candidate species, which it was until February 1996, when broad sweeping changes were made in candidate species policy. The basis for this is continued loss of habitat, particularly in Idaho, and the low number of sites known regionally as well as globally. *Texosporium* appears to be more secure in Oregon and California, where it is found in relatively protected management areas, though populations are extremely small. Additional inventories in Washington and Nevada are critically needed.

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Questions and Answer Session

1. *What percentage of the species' habitat was destroyed by fire in Idaho this year?*

   Approximately 20% of the known Idaho sites burned in 1996.

2. *What percentage of the habitat has been surveyed?*

   I would say a large percentage in Idaho. However, it is difficult to survey all the numerous canyon slopes where habitat appears suitable. People look for Texosporium when they are out, but still don't find it. The Shoshone and Burley Resource Areas are possibilities. We probably need to check more in these areas, but don't really have the personnel to do it.

3. *Is the Island RNA the only site in Oregon?*

No, there is one more site about 5 miles away. I might add that there are graduate students doing microbiotic crust studies in that general area but none have found Texosporium to date.

4. *Is it always found on organic matter?*

Yes, at least I have not found it growing directly on the soil surface. It is usually on clumps of organic matter. We have not found it on rabbit dung in Idaho, but we have in Oregon and California. Might be good to have wildlife biologists check for it on dung.

5. *How does it stabilize on organic matter?*

Who knows? There are still so many unknowns.

Texosporium

• **Extant in 1996**
* **Historical sites**

Figure 1

Known world distribution of *Texosporium sancti-jacobi.* Solid circles indicate populations confirmed in the last few years. The star near San Diego indicates historical populations that have probably been extirpated. Small empty circles are major cities. The map was developed from a Goode basemap, copyright University of Chicago Press.

Idaho's Rare Lichens

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Introduction

I would like you to look closer at trees and on the ground for lichens! Yes, lichens are often found in the forest canopy and on the ground. You don't have to climb trees. You can find windblown trees or fallen tree limbs and find lichens there. Canopy lichens and mosses exist in different "zones" within the forest canopy. The lowest zone is the bryophyte zone, followed by the cyano-lichen zone, the forage lichens, and then the leafy arboreal lichen zone on the top.

I will present these rare lichens arranged by their general habitats: 1) forest, 2) rock outcroppings, 3) rangeland, and 4) alpine.

1) Forest Lichens:

One group of rare forest lichens that I want to talk about is the *Caliciales*. They are small lichens on short stalks; some species are unlichenized. They look like very minute mushrooms. They are in the same order as the former federal candidate lichen, *Texosporium*. *Caliciales* have asci formed in cups (apothecia). The asci disintegrate, and the paraphyses (sterile hyphae) wrap around spores. This group is closely associated with old growth forests. In North America, we don't know which *Caliciales* are common or rare, though; part of this is because much of their prime substrate, old growth trees were cut before they were studied.There has still has been little work done on this group in Western North America.

Another group the "forage lichens" are eaten by wildlife. One of these is a rare species, *Bryoria tortulosa*. It is very light, almost golden yellow in color, found in the lower Clearwater River basin. Two localities are known in Idaho. One is a narrow elevational band in the lower Clearwater, downstream from Lowell, Idaho, occurring on ponderosa pine. The habitat is dry effective soil but the air is humid. In the winter the habitat is subject to maritime humidity. The second site in Idaho is an even narrower elevation band of less than 1 km along the Little Salmon River.

Other rare forest lichens include some of the leafy arboreal lichens. *Cetraria subalpina* which occurs on woody substrates in subalpine habitats that are usually wet. There are three known sites in Idaho, one on the summit of Mount Gisborne west of the Priest River Experimental Station, and two on the Powell Ranger

District. *Hypogymnia inactiva* and *Platismatia stenophylla* are also rare or uncommon in Idaho. They are both found only in Northern Idaho. *Cetraria pallidula*, a yellow lichen with laminal apothecia, most frequently found on *Larix* is also uncommon in the forests of northern Idaho.

There are several rare black gelatinous lichens. One is *Collema curtisporium*. It has reddish brown apothecia. It occurs on trees, but not conifers like a lot of other arboreal lichens; it is found on hardwoods, usually cottonwoods, in low elevation forests. Low elevation forests are usually more productive, warmer and therefore, most have been harvested. So, their are a limited number of sites remaining. There are three known sites in Idaho for *Collema curtisporum*. Another rare gelatinous lichen that may occur with the above species on cottonwood trees is *Collema furfuraceum*. More inventory for this species is needed before it's range can truly be evaluated.

Another rare lichen that can be found on large old cottonwood trees is the Oregon lettuce lichen, *Lobaria oregana*. It was collected only once in Idaho on Priest Lake; we tried to re-collect it in 1995, but could not relocate it. One needs to look for it in northern Idaho. This species is bright green, looks like lettuce, with lobate margins. It was found while looking for osprey nests. *Lobaria hallii* is grayer in color than *L. oregana*, it stays gray when moist. You can find it on the North Fork of Coeur d'Alene River, at low elevations on hardwoods (cottonwoods). Unfortunately, the highway department has taken out most of these trees! Very few large cottonwoods are left along that section of road. *Lobaria scrobiculata* looks similar to *L. hallii* when dry, but gets bluer in color when wet. It has circular spots called soredia. The only known location in the Interior Pacific Northwest is along the main Salmon river. It occurs intermittently between Barth Hot Springs and the confluence of the south fork of the Salmon. On the west side of the Cascades, *Lobaria* scrobiculata is typically common on wood; however, on the east side of the Cascades it occurs on rock, it switches substrate, a little like fungi switching mycorrhizal host!

Another related large nitrogen-fixing lichen is *Pseudocyphellaria anthraspis*. It has small white spots on the under side. These false holes (pseudocyphellae) are visible without a hand lens. It is common on the west side of the Cascades, but is uncommon in Idaho. It is associated with old growth forests, but does not appear to be rare enough to be on the Idahos' sensitive or rare list at this time.

Cladonia or the "reindeer lichens" include a few rare species. One is *C. borealis*, which has large gray/green stalks. *Cladonia luteoalba* grows upon *C. borealis* and is found on the Middle Fork of Salmon River in a very shady, sheltered, rocky, mid-elevation location. Also at the same locality an alpine lichen, the white worm lichen, *Thamnolia vermicularis*, occurs and it is the only known site in for both of these lichens in Idaho. Another reindeer lichen is *Cladonia trancendens*. It occurs on trunks of trees. We are finding that it's not as rare as previously thought. It grows in the canopy all the way up and at the base of snags. Remember that there are zones in the forest canopy. You have to know where to look in the canopy when you're trying to find specific lichens. You generally can find these canopy lichens in litter after they've fallen from trees

2) Rock outcroppings:

Now let's discuss rock outcroppings, which are special habitats, or unique rocky outcrops. On talus slopes we find *Cladonia uncialus* which only occurs across from the waterfall at Post Falls, Idaho, on a north-facing talus slope where waterfall spray hits. This cold boreal site is the only known site in the Pacific Northwest, but it is common in central Canadian Rockies.

Pilophorus acicularis is found in northern Idaho on rocks, usually basalt, within forest openings. It is related to *Cladonia*. There are two known sites in Idaho, although it is common on the west side of the Cascades. This lichen has stalks with large dark globose apothecia on the ends. It is often difficult to photograph because the color is determined in part by the chemical composition of the acids in the lichen.

Other rock lichens occurring in maritime-influenced climate areas is Bulls-eye lichen, *Placopsis gelida*. It is a crustose lichen, with brown structures, green fuzzy soredia. Brown structures are cyanobacteria in special structures called cephalodia. *Placopsis* can colonize sterile rocks, and prefers basalt as a substrate. It occurs in a narrow stretch along the Little Salmon River.

3) Rangelands:

In rangeland habitats, we get the tumbleweed lichen, *Aspicilia fruticulosa*. It occurs on calcareous rangelands, which we don't have a lot of in the west. It was reported as new to North America in 1993. It is uncommon, but I expect that we may find more locations for this species. It has never been found in eastern Oregon rangelands, so we need to keep looking for it.

Rangelands are threatened by wildfires and grazing. Some of the rare soil crusts include, Buellia elegans, which grows on calcareous soil, along the main Salmon River, near Lucille Cave. Another rangeland lichen is Dermatocarpon lorenzianum. It is known in stiff sagebrush sites (Artemesia rigida) and is found on stone inter-mounds between the sagebrush. It covers the rocks and it has perithecia type reproductive structures.

It is known from only one site in Europe, and was found in 1994, in Idaho and in from one historic site in California. In Idaho, it occurs at Buckwheat Flats Research Natural Area an Area of Critical Environmental Concern (ACEC) for the Bureau of Land Management (BLM). It occurs in ephemeral water ponds over shallow basalt bedrock. In 1995, one site was found in central Oregon at a Nature Conservancy preserve in the same unique stiff sagebrush, stone inter-mound habitat.

In old-growth sagebrush communities we find a blue colored lichen, Pannaria cyanolepra (this may represent a undescribed species) at several localities. It is closely associated with old-growth sagebrush sites. Another old-growth sagebrush indicator is *Trapeliopsis wallrothii*.

In other rangeland sites, *Xanthoparmelia neochlorochroa*, referred to as "range" lichen occurs in badlands within the sagebrush zone. *Xanthoparmelia idahoensis*, occurs near Salmon, Idaho, and is subject to damage from motorcycles. This species has no rhizines on underside and grows fairly erect compared to the other species of range lichens.

4) Alpine:

In the alpine areas one finds Brodoa oroarctica and Solorina crocea are found the Sawtooth Mountains and in the Selway-Bitteroot Mountains. *Brodoa* looks like a *Hypogymnia*, but it has hyphae on inside rather than being inflated and hollow. *Solorina* is a soil-occurring lichen with a distinctive orange medulla. Then there is *Thamnolia vermicularis*, that occurs with *Cladonia luteoalba*. It is typically found in alpine areas, but in Idaho, is known only in the Challis National forest, along the Middle Fork of the Salmon River at mid-elevation.

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