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RIPARIAN LICHENS OF NORTHERN IDAHO

A. OVERVIEW
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C. *COLLEMA CURTISPORUM* DEGEL. IN RIPARIAN FORESTS OF NORTHERN IDAHO

by
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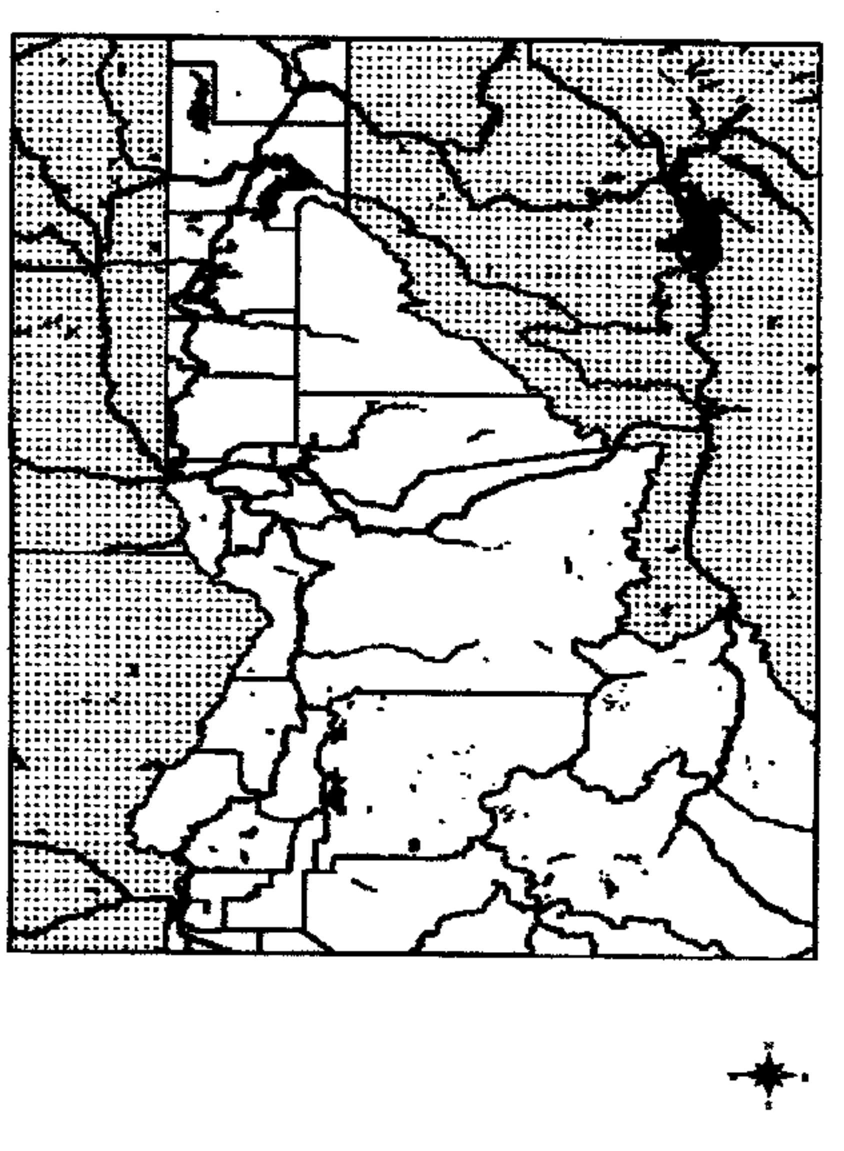

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Overview

The flora of northern Idaho is a lush mixture of adjacent regions, combining species found in the Rocky Mountains, southern interior British Columbia, and the coastal Pacific Northwest (PNW). The forests of northern Idaho contain many species commonly found on the west side of the Cascades, such as *Thuja plicata* (western red cedar), *Tsuga heterophylla* (western hemlock), and *Alnus rubra* (red alder). Some lichens common to the west side of the Cascades are also commonly found in northern Idaho, such as *Lobaria pulmonaria* and *Pseudocyphellaria anthrapsis*. Some species such as *Pseudocyphyellaria anomala* are common west of the Cascades, but are rare east of the Cascades. *Collema curtisporum*, on the other hand, grows with these oceanic species east of the Cascades to northwestern Montana, but is not found west of the Cascades. *Collema curtisporum* has disjunct populations in Scandinavia and the Pacific Northwest, generally east of the Cascades, into western Montana (McCune and Geiser 1997, McCune and Goward 1995).

Habitat loss is one of the most important factors that threatens or endangers species (Moseley and Groves 1990). It has been estimated that over 56% of the wetlands in Idaho have been lost since 1780 (Idaho Conservation Data Center 1998). *Populus balsamifera* var. *trichocarpa* (black cottonwood) communities are recognized as under-represented in northern Idaho as well in the western United States in general (Janovsky-Jones 1997), as compared to the historical distribution of riparian cottonwood forests (e.g. Dykaar and Wigington 2000). People in the western U.S. depend on water from its rivers for energy, agriculture and urban use. Consequently very few rivers in the region remain free flowing (Patten 1998). Dams and channelization reduce or eliminate cottonwood recruitment through flood control and the subsequent loss of seasonal sediment deposits (Rood et al. 1994).

There is a lack of information regarding lichens in riparian forests in general and particularly regarding lichens in cottonwood stands in northern Idaho. Previous studies of lichens in northern Idaho have not concentrated on riparian habitats. W.B. Cooke (1955) studied fungi, lichens, and mosses in eastern Washington and western Idaho, within a 150-mile radius of Pullman, Washington. A number of lists of the lichens of Idaho have been compiled (Schroeder et al. 1973, Anderegg et al. 1973, Schroeder et al. 1975, Neitlich and Rosentreter 2000). Other lichen floristic works exist for the Priest River Experimental Forest (McCune and Rosentreter 1998), Glacier National Park (DeBolt and McCune 1993), the Swan Valley in northwest Montana (McCune 1982), and for the Bitterroot Range of Montana and Idaho (McCune 1984). Notes on genera and new species include *Cladonia* in Idaho (Anderegg 1977), the description of *Cetraria idahoensis* (Esslinger 1971), and a discussion of *Lobaria hallii, Pseudocyphellaria anomala* and *P. anthraspis* (Schroeder and Schroeder 1972). None of the existing literature examines which lichens are rare in the riparian forests of northern Idaho, nor does the existing literature contain a comprehensive species list for cottonwood floodplain forests.

Riparian zones are interfaces between terrestrial and aquatic systems. They encompass sharp gradients of environmental factors, ecological processes, and plant communities. Riparian zones are mosaics of landforms, communities, and environments within the larger landscape, which can make them hard to delineate (Gregory et al. 1991).

Riparian zones have many different looks, but they all can be described in terms of landform and process gradients that result in their changing continua of characteristics. Processes can be considered on three major gradients that are nested in both space and time. The continental gradient includes the effects of latitudinal climatic gradients acting at the hydrologic basin level. An intra-riparian continuum reflects changes in elevation, stream gradient (steep or flat), fluvial processes (the way the river flows: peaks, base and timing), and sediments along the length of the stream system. A lateral trans-riparian gradient across the riparian zone is a local topographic gradient that reflects stream valley cross-sectional form and influences the local moisture and soil development (Mitsch & Gosslink 1993). Many questions arise regarding the continua of riparian zones and potential effects on lichen community composition. Effects of elevation changes, spatial placement within the various continua, climatic differences among regions, and the variety of potential substrates are all potential sources of study.

Riparian zones are important for many reasons, which include providing natural flood control and wildlife habitat, and enhancing water quality (Mitsch and Gosslink 1993). Riparian zones, and the included waterways, also have many human-centered uses. Some drainages, such as the Coeur d'Alene, have been extensively used to transport timber downstream to mills, as sources of ore and as coolant and waste disposal for the Bunker Hill lead and zinc smelter in Kellogg (Root 1997). Other rivers, such as the Clearwater River, have been extensively channelized for agricultural purposes and dammed for power and recreation (Root 1997). Activities that affect the hydrology and water quality of the river also affect the adjacent riparian corridors, including riparian forests.

Extensive stands of black cottonwood occupy the riparian zones of the large valley bottom rivers of northern Idaho. Black cottonwood is considered a keystone species, meaning that it plays a pivotal role in the ecosystem processes upon which a large part of the community depends (Kauffman et al. 2001). Cottonwoods are typically found associated with alluvial fans, low elevations, braided channels, and gravel substrates (Harris 1988). Cottonwoods are important as wildlife habitat (Kauffman et al. 2001), providing shelter, cover, and food. Cottonwoods have a strong influence on terrestrial and aquatic systems. They can change channel morphology through trapping and filtering sediment (Kauffman et al. 2001). Cottonwoods play a key role in moderating temperature and moisture during the summer, while allowing increased throughfall during the cooler parts of the year. The bark is slightly basic, which is important for nitrogen-fixing cyanolichens (Goward and Arsenault 2000). Drip zone effects from the upper canopy of *Populus* trees have been inferred to have a buffering effect on adjacent and more acidic conifers, which may increase the number of lichen species found on the conifers (Goward and Arsenault 2000).

Spatial heterogeneity in cottonwood galleries can be seen in the age bands that form along rivers, with saplings in areas with recent disturbance and the oldest trees farthest from recent flood disturbance (Kauffman et al 2001). Potential productivity, disturbance, and spatial heterogeneity are the key factors controlling local patterns of diversity. Highest diversity in vascular plants occurs when conditions are suitable for growth and competition is not severe, resulting in many co-dominant species.

Productive, frequently disturbed sites, such as some cottonwood galleries, tend to be high in diversity of vascular plants because growth rates are high, but disturbances are frequent enough that competitive exclusion does not occur (Pollack 1998). Lichen species diversity tends to be highest in cottonwood galleries that include shrubs and conifers, and receive some seasonal inundation (personal observation).

Cottonwood galleries degrade through water diversions such as dams, diversions, channelization, and draining. Other agents of degradation include: removal of streamside vegetation by cattle; alteration of structural integrity of the river through road construction, dredge mining, and splash dams for log transport; and physiological stress from pollution in the form of pesticides, feces, salts, and environmental estrogens (Kauffman et al. 2001).

Floods, which disturb vegetation through bank erosion or sediment burial via sediment deposition, are extremely important for the development and maintenance of cottonwood galleries. Floods and large woody debris interact to form new islands, which can eventually coalesce to form fully vegetated floodplains. In turn the islands, sandbars, and large woody debris reroute channels (Naiman et al. 1998), creating new possibilities for further sediment deposition on both the banks and newly formed islands. Ice formation in rivers during the winter can cause flooding that scours the bank at levels equal to or above spring flood levels. Ice scouring can remove much of the riparian vegetation and contribute large amounts of large woody debris. A moving ice gorge may have enough energy to alter stream morphology (Patten 1998). Ice scouring, woody debris and the formation of new islands lead to varied sediment deposition. Floods, as the dispersal mechanism for black cottonwood seeds as well as fresh sediment, are essential to the recruitment and survival of black cottonwood stands (Rood et al. 1994).

Floods maintain a spatially heterogeneous environment, and slow rates of competitive exclusion, making flooding probably the most important factor accounting for the unusually high levels of biodiversity in riparian corridors throughout the world (Pollack 1998). Removing low frequency/high intensity flood disturbance, or changing the hydro-period, is detrimental to cottonwood galleries. While cottonwoods can be found in any wet area, from a ditch in a clear-cut to a floodplain, true galleries require floods to scour away existing vegetation and deposit sediment for dispersal and establishment (Kauffman et al. 2001, Rood et al. 1995, Dykaar 2000, Naiman et al. 1998, Patten 1998). A long-term study of the effects of the St. Mary Dam in Alberta, Canada showed a steady decline in cottonwoods that was clearly associated with the controlled release of water for irrigation purposes. High cottonwood mortality in the St. Mary Dam study was induced as a result of insufficient flows during the summer months and abrupt flow reductions following the high flow period in the late spring. In addition, the riparian water table was found to be closely associated with the river stage, as changes in river elevation were followed by quantitatively similar changes in the water table (Mahoney et al.1995). Lowered water tables via diversions decrease moisture availability, which could adversely affect growth and survival of existing vegetation, including cottonwood.

When natural flood cycles and hydroperiods are altered, river hydrology and geomorphology are changed. In the case of black cottonwood galleries, stands are no longer sustained through new recruitment. Lowered water tables can adversely affect the survival of established trees. Other human activities, such as road construction, and urban and rural development, also contribute to the loss of riparian forests. Loss of riparian forests may increase input of nitrogen and other pollutants into the aquatic system. Riparian forests are valuable natural filter systems (Gilliam 1994) and act as nutrient sinks for nitrogen and phosphorus (Mitsch & Gosslink 1993). Other effects are loss of shading and a gradual loss of woody debris, as well as a loss of organic matter important to aquatic invertebrates.

Loss of riparian forests through human activities impacts epiphytes, such as lichens, which grow on black cottonwood and other riparian trees and shrubs. The core of this study is a group of 17 rare riparian lichens believed by lichenologists familiar with the area to exist, or have the possibility of existing, in northern Idaho. Doyle Anderegg, W.B. Cooke, Robin Jones, Bruce McCune, Roger Rosentreter, and others have made previous documented collections for the panhandle region. These "target species" are associated with cottonwood galleries and other riparian hardwoods. Many of the target species are listed with the state of Idaho as being rare or species of concern. Many questions are inherent in determining whether a species should be listed, the most basic being whether the species is truly rare. Lichens can be overlooked due to small size, or possibly misidentified as another closely related species. Questions that arise regarding epiphytic lichens on cottonwoods include possible microhabitat specificity of species such as *Collema curtisporum* and *Physconia americana*.

The objectives of this study were to understand the extent of the populations of the target species in northern Idaho, and to gather information on site characteristics and vegetation where the target species were found. In addition, we wanted to visit areas where target species were known to occur, and locate additional populations through fieldwork and contacting herbaria.

Data were collected from eighty-one sites in the Idaho panhandle between June and August, 1999. This study differs from previous studies of the lichen flora in northern Idaho not only in its focus on riparian species, but also in its discussion of the special problems of determining rarity of lichens. Furthermore, patterns of species' distribution and abundance are described within the context of climatic affinities. Determining distribution and abundance are the first steps in forming realistic management plans for lichen species. Previously documented reports of the target species occurrence in the study area have been included (OSU herbarium, McCune Herbarium, Boise State Herbarium, and University of Idaho Herbarium).

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Rare Lichens in the Riparian Hardwood Forests of Northern Idaho

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Abstract

Riparian forests along rivers and streams in the Idaho Panhandle, north of Whitebird, were surveyed for rare riparian lichen species. The region was stratified into nine geographic units and by stream size. Eighty-one plots were surveyed for lichen community, stand, and river characteristics. The strongest differences in lichen community composition were regional, followed by community differences with respect to basal area in hardwoods and differences in floodplain cross-section type. Climatic affinities appear to vary with location in the study area. Plots with the highest suboceanic affinities clustered along the eastern border (Bitterroot Mountains), while those with the highest continental affinities were clustered in the southwest corner of the study area, near Lewiston. Plots with the highest oceanic affinities were more scattered but were loosely clustered in the south central half of the study area. One hundred and twenty-six lichen species were found, including eleven of the seventeen target species. About seventy percent of the plots had at least one of the target species. Management recommendations and information on distribution and rarity are given for each of the target species.

Introduction

No previous studies address specifically the ecology and distribution of lichens in riparian forests in northern Idaho. Some studies in the area have, however, included lichens; which are enumerated here. For the region that includes northwest Montana, northeastern Oregon, eastern Washington, and northern Idaho, only two ecological studies incorporating lichens exist (Cooke 1955, Neitlich and Rosentreter 2000). A number of lists of the lichens of Idaho have been compiled (Schroeder et al. 1973, Anderegg et al.1973, Schroeder et al.1975, Neitlich and Rosentreter 2000). There are a couple of studies regarding the effects of pollution on epiphytic lichens along rivers in Idaho (Geiser, et al 2001, Hoffman 1974). Others have concentrated on the ecology of specific areas in northwest Montana, and northern Idaho (McCune and Rosentreter 1998, DeBolt & McCune 1993, McCune 1982, McCune 1984) while others have published notes on genera and new species for the region (Anderegg 1977, Esslinger 1971, Schroeder and Schroeder 1972). Some of this work includes lichens found in riparian forests, but none of the work specifically addresses the ecology and distribution of lichens in riparian forests in northern Idaho.

This study is a survey of riparian lichens including seventeen target species that lichenologists familiar with the area thought were rare in northern Idaho. Information presented here is based on data collected at 81 sites in the Idaho panhandle between June and August,1999. To make the inventory more useful, previously documented reports of target species have been included (OSU herbarium, Nimis, Degelius, Tønsberg, McCune Herbarium, Boise State Herbarium, and University of Idaho Herbarium).

This study differs from previous studies of the lichen flora in northern Idaho, not only in its focus on riparian species, but in that forms of rarity are discussed for lichens, and climatic affinities are given for relevant species. The objectives of this project were to understand the extent of the populations of the target species found in northern Idaho, and gather information on site characteristics and vegetation where the target species were found. We wanted to know what lichens are found on trees in riparian forests, particularly *Populus balsamifera* ssp. *trichocarpa* (black cottonwood) forests. In addition, we wanted to visit areas where target species were known to occur, and, potentially, locate additional populations through fieldwork and contacting herbaria. Such sampling would allow us to answer questions about whether lichens such as *Collema curtisporum* and *Physcia semipinnata*, which are considered rare in northern Idaho (ICDC 1998), really are rare, or simply under reported.

Study Area

The study area included all of Idaho, north of the latitude 45 degrees 45 minutes N (about the latitude of the town of Whitebird, ID). The Idaho panhandle is included in the North Idaho Ecoregion in the Interior Columbia River Basin Ecosystem Management Project Environmental Impact Statement (USDA/USFS 1997). The survey area is bounded on three sides by the Idaho state line. The following counties were included in the survey: Boundary, Bonner, Shoshone, Latah, Clearwater, Nez Perce, and Idaho County north of the Salmon River. This large, ecologically diverse area contains many large drainages in the following sub-basins: Priest, Kootenai, Pend Oreille, Coeur d'Alene, St. Joe, St. Maries, Clearwater, and Salmon.

Climate, canyons, and geographic position have contributed to form refugia for coastal disjuncts, such as the Clearwater drainage, a major refugium, and the lower St Joe and lower Coeur d'Alene drainages, as minor refugia (Crawford 1979). The climate is cool in most of northern Idaho, with a maritime influence, caused by large air masses moving inland from the Pacific Ocean from the west (Janovsky-Jones 1997). Orographic precipitation along the Bitterroot Range, in the eastern part of the study area, is another reason for the relatively abundant moisture. Low elevation canyons contribute to the heat load unique for forests of the northern Rockies (Crawford 1979). The canyons tend to hold warm air, which rises and warms the surrounding higher areas. Sandpoint, at 640 m (2100'), averages 12.6 cm (32 inches) of precipitation per year with most of the precipitation occurring in the winter as snow. Mean temperatures range from 10° C (18° F) in December to 36o C (65o F) in July (Ross and Savage 1967).

Major components of upland forests in northern Idaho are *Abies grandis, A. lasiocarpa, Pinus contorta, P. ponderosa, Pseudotsuga menziesii, Thuja plicata, Tsuga heterophylla*, and *T. mertensiana* (Cooper et al.1991). Black cottonwood occurs on alluvial terraces of major streams and rivers and around lakes and ponds. These sites are often flooded in the spring, but water tables lower to 91 cm (3 feet) or more below the soil surface by the end of the summer (Rood et al. 1994). In the absence of fluvial, or other, disturbance, succession continues to communities dominated by conifers. Stands in moister regions are successional to *Populus tremuloides/Thuja plicata* and the *Picea/Cornus sericea* habitat types (Janovksy-Jones 1997). Broad-leaved forests that occur on islands of major rivers are dominated by black cottonwood (Janovksy-Jones 1997).

Methods

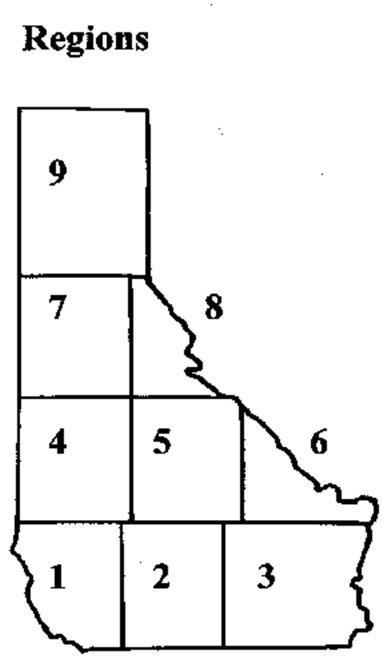
Target Species List. Botanists and lichenologists familiar with northern Idaho were consulted regarding rare riparian lichens that were known or suspected to occur in riparian forests with a hardwood component of alder, birch or cottonwood in the study area. A suite of seventeen target species was the result. These species were sought in plot sampling, herbaria, and the literature:

Cetraria sepincola
Collema curtisporum
Collema furfuraceum
Hypogymnia oceanica
Leptogium subtile
Lobaria hallii
Lobaria pulmonaria
Menegazzia terebrata
Physconia americana
Physcia semipinnata
Pseudocyphellaria anomala
Pseudocyphellaria anthraspis
Ramalina dilacerata
Ramalina obtusata
Ramalina pollinaria
Ramalina subleptocarpha
Ramalina thrausta

Sampling. The area was stratified into nine geographic areas, or regions, based on pages of the DeLorme Atlas of Idaho (Figure 2.1). Nine plots were sampled within each region. The plots were stratified by stream order classes, which were defined in relation to other streams and rivers. Stream order classes were: "large valley bottom rivers," which were the largest rivers running through the region; "major tributaries," which were rivers or streams that fed directly into rivers defined as large valley bottom rivers and/or greater than 2 meters wide (wetted width of base flow in the channel); and "minor tributaries," which were streams that fed into major tributaries, or another minor tributary, or were less than 2 meters wide (wetted width of base flow in the channel). Stream order classes were not the same as valley classes. For example, minor tributaries were often sampled on the floodplains of larger rivers because black cottonwood tends to grow where the valleys are wider. Three plots were sampled for each stream order class within each geographic region. Stream class designations were relative and were influenced by the region being sampled. For example, the Lochsa River was considered a large valley bottom river in Region 3, where it was the largest river in that region, but was considered a major tributary in Region 2, where it flows into the Clearwater River.

Figure 2.1. Key to regions in the study area. Regions correspond to DeLorme (1992):

Region: 9 = Pend Oreille / Priest Lake
8 = Wallace / North Fork of the Coeur d'Alene River
7 = Coeur d'Alene / Coeur d'Alene River
6 = Kelly Creek / St. Joe east
5 = North Fork of the Clearwater
4 = Moscow / St. Maries River
3 = Lochsa / Selway
2 = Clearwater River / South Fork of the Clearwater
1 = Lewiston / Salmon River



Plot Selection Criteria. Plots were selected using the following criteria:

1. A twenty kilometer minimum distance between plots on large valley bottom rivers within the same geographic region.

2. A minimum of five cottonwoods with a diameter at breast height (dbh) greater than 51 cm within the plot boundaries, or a minimum of 20% total canopy in hardwood trees and shrubs large enough to be taken as part of the estimate of the total canopy.

3. Lake shores were included if they were part of the riparian corridor in a broad sense.

4. Within each sampling stratum, the first site encountered that met these criteria was sampled.

Plot Dimensions. The plots were a flexible polygon of approximately 4000 m^2 in area. Most of the plots were 100 m x 40 m rectangles, except for plots on broad floodplains, where we used approximately 4000 m2 circular plots with a 35 m radius, following Forest Health Monitoring protocol (McCune et al.1997).

Information Collected. Plot information included location, river characteristics, and terrestrial characteristics, as described below. Information about plot location included assigning a plot number based on region, where "1" was the southernmost and westernmost region in the panhandle. The numbering was from west to east and south to north, making the northernmost region of the panhandle region "9" (Figure 2.1). The second digit in the plot number represented stream order class, where "1" was a large valley bottom river and "3" was a minor tributary. The last digit represented the replicate within each region. County, stream name, elevation in meters, date, state, sub-basin, latitude, longitude, and a brief description of where the plot was located were recorded for each plot, as was the date of sampling. Elevation, latitude, and longitude were obtained using Topo USA, version 2.0.

River characteristics included floodplain gradient as a percent ratio of rise over run, and width of the floodplain, using Topo USA version 2.0. The width of the active channel was estimated by sight. An ocular estimate of the percent of the channel substrate that was within the plot was made for the following categories: boulder, cobble/gravel, sand/silt, and organic-rich. If the channel was not part of the plot, percent cover of these substrates was estimated for the part of the channel closest to the plot. Floodplain cross-section type, based on Harris (1988), was recorded as one of the following categories: incised with no apparent floodplain, floodplain on one side only with talus or colluvium on the other side, floodplain on both sides of the channel, and multiple channels on a broad floodplain.

Terrestrial characteristics included site type, canopy cover, and percentage of the plot area covered by various ground surface types, shrubs by height classes, grasses, rushes, sedges, forbs, and trees by size class. Shrub height classes were tall shrubs (>2 m), medium shrubs (5 cm –2 m), and ground covering shrubs (<5 cm). Site type was a one-word description of the site recorded from the following choices: seep, creek, river, wetland, seasonally wet, lake margin, bog/fen. Canopy cover as a percent cover of the plot was estimated visually. Ground surface types could include boulder, cobble/gravel, sand/silt, organic-rich, water, and litter. See data dictionary in Appendix F.

Tree cover percentages were evaluated by tree life stages in three categories: cottonwoods, other hardwoods, and conifers. Tree life stages were recorded by growth form. Trees with flexible main stems were called saplings. If the top was still growing and had few dead branches, it was determined to be mid-seral, if it had dead limbs in the upper quarter, it was determined to be late seral.

Tree composition was based on basal area, as determined with a 10 or 20 basal area factor (BAF) wedge prism. The number of trees (hardwoods or conifers) recorded with the wedge prism was divided by the five sample points used and multiplied by the BAF of the prism to give the basal area values. Shrubs the size of sapling trees were included in basal area estimates if captured by the prism. The analysis used percent basal area in hardwoods categorized into four groups; 97 to 100% basal area in hardwoods, 72% to 96% basal area in hardwoods, 51% to 72% basal area in hardwoods, and less than or equal to 50% basal area in hardwoods.

Sketches of each plot were drawn, recording features such as water, sandbars, vegetation changes, roads, and the points where basal area was taken. Presence/absence was also collected for indicator species, which were a group of plants that area botanists thought of as riparian indicators. The presence of weeds of concern to the USFS was also included. Dominant species of trees, shrubs, grasses, and forbs was also recorded. An ocular estimate of bryophyte cover on soil/rock and on trees/shrubs was recorded as a percent cover of the plot, and dominant epiphytic lichen species were recorded. See Appendix D for the actual site forms.

The lichen community survey was terminated after ten minutes passed without finding a new epiphytic lichen species, with a minimum time for the survey being thirty minutes and the maximum time being two hours. Information on abundance and substrate was collected for all epiphytic macrolichens observed in that time. Abundance was determined to be one of four categories: 1 meant that there were less than 4 individuals, 2 was 4 to 10 individuals, 3 was more than 10 individuals, and 4 was individuals occurring on more than half of the available branches and trunks. Additional information was collected for the target species on shading on a scale of 1-3 (1 was exposed and 3 was full shade). Location data specified whether the target species was located on the upper, middle,or lower part of the tree and whether it was on branches, twigs, or bole.

Database. A database was compiled using Microsoft Access Version 2.00 (Microsoft Corporation 1989-1994). The 1999 database (Idaho.mdb) includes all of the information collected, as well as all previously known records for the target species that were found in regional herbaria and that were relevant to this report. Only records from the PNW are included. In the case of species that had many populations on the west side of the Cascades, such as *Pseudocyphellaria anomala, Pseudocyphellaria anthraspis, Physconia americana, Ramalina subleptocarpha*, and *Ramalina thrausta*, only records from the east side of the Cascade crest are included. In the case of species such as *Collema furfuraceum, Lobaria hallii, Lobaria pulmonaria, Ramalina dilacerata*, which have been collected frequently in northern Idaho, only collections from Idaho are included. In the case of species that were rare everywhere in the PNW, such as *Collema curtisporum, Physcia semipinnata, Ramalina obtusata*, and *Ramalina pollinaria*, all reports from the PNW are included. Records from both databases were combined into an Excel spreadsheet (Idaho.xls). See Appendix C for locations of each record. Each record in the table represents one collection by an individual. In some cases more than one collection was made for approximately the same location and these were included in the database if they had a unique collection number. Additional information on the plots is included in an Excel spreadsheet (Plot Data.xls). The Location Maps (Appendix B) were generated from latitude and longitude, using ArcView GIS version 3 (Environmental Systems Research Institute Inc.). Records in Appendix C that did not include latitude and longitude, or enough location information to determine latitude and longitude, and records that fell outside the map boundaries were not plotted on the maps.

Analysis. Analyses focused on answers to the following questions: How do riparian macrolichen communities differ across geographic regions, stream order classes, floodplain cross-section types, and basal area in hardwoods? Community data were analyzed using Multi-response Permutation Procedures, (MRPP; Mielke 1984; McCune & Mefford 1999), which provides a nonparametric
multivariate test of the hypothesis of no difference between two or more groups, based on a matrix of Sørensen distances. Groups were defined by categorical site variables for data collected as categorical variables (region, stream order class, and floodplain cross-section type), with the addition of basal area in hardwoods, which appeared to have natural breaks upon examining its frequency distribution. The test statistic (A) describes the separation between groups in an n-dimensional space, and ranges from 0 to 1, with 0 indicating no separation. A large value for A means that there is a large difference in lichen communities between groups. The probability value expresses the likelihood of finding a difference as extreme or more extreme than the observed difference between groups, based on all possible partitions of the data set.

When MRPP indicated that communities differed significantly for groups, Indicator Species Analysis in PC-ORD (McCune & Mefford 1999) was used to detect and describe the value of different species for indicating the environmental conditions that defined the groups. Indicator Species Analysis is based on Dufrene and Legendre's (1997) method of calculating species indicator values. The method combines information on the concentration of a species' abundance in a particular group and the faithfulness of occurrence of a species in a particular group. An indicator value for each species in each group is the result. The indicator values range from 0 (no indicator value) to 100 (perfect indicator). A perfect indicator means that the presence of a species is always associated with that particular group, and only with that group. With two or more groups per categorical variable, the indicator value for a particular species in a particular group depends on the other groups. If one drops a group, the indicator values for the remaining groups will change. The test for statistical significance for the indicator species analysis came from a Monte Carlo technique where the null hypothesis is that the largest indicator value for a particular species is no larger than expected by chance.

Measures of diversity were defined according to Whittaker (1977). Alpha is the total number of species per plot, gamma is the total number of species found in a region, and beta diversity is gamma diversity divided by alpha diversity. First order jackknife estimator of species richness was determined using:

$$\text{Jack1} = S + r1(n-1)/ n$$

where Jack1 is the first order jackknife estimator, S is the observed number of species, r1 is the number of species occurring in only one sample unit, and n is the number of sample units (Palmer 1990).

Climatic Affinities. Species were assigned to the categories "oceanic," "suboceanic," "continental," or "widespread" on the basis of known distributions:

- Oceanic climates are moist and mild, with smaller seasonal temperature fluctuations than continental climates (Trewartha 1961). We categorized as oceanic those lichen species that peak in abundances west of the crest of the Cascade Range.

- Continental climates are relatively dry with more extreme temperatures. We defined continental lichen species as those with peak abundances east of the Continental Divide and south of Idaho in the Rocky Mountains.

- Suboceanic climates are moist interior climates. Suboceanic lichen species were defined as those peaking in abundance in moist forests between the Cascade crest and the Continental Divide.

- Widespread lichen species, lichens that are common throughout the Pacific Northwest, such as *Platismatia glauca* and *Hypogymnia physodes*, or with no strong affinities were not assigned to any climatic group. These do not appear in the tabulation of climatic affinities.

The number of occurrences of species with affinities to particular climatic classes was tallied by region. For example, assume 9 plots in a region, with a total of 30 occurrences of oceanic lichen species. This means that an average of 30/9 or approximately 3.3 oceanic species per plot occurred in that region.

Weighted average ordination of presence-absence data was used to assign values for climatic affinities for each plot, calculating a score for each plot on each of the three axes of climatic affinity: oceanic, suboceanic, and continental. Weighted averaging calculates a score x_i for each plot *i* for each climatic affinity as:

$$x_i = \left(\sum_{j=1}^{p} w_j a_{ij}\right)/p$$

where the weight wj for each species is zero or one, indicating whether that species has that particular climatic affinity, p is the number of species, and a_{ij} is zero or one indicating absence or presence of species *j* in plot *i*. Because the weights and species data are both binary, the score for a given plot is simply the fraction of species in that plot belonging to a particular climatic affinity. So a score of 0.25 on the oceanic axis means that a quarter of the species in that plot had an oceanic affinity. Each plane of the ordination shows the relation of one climatic affinity to another. Pearson and Kendall correlations were used to indicate environmental variables strongly associated with the climatic affinities.

Results

Target species in an international perspective. Table 2.1 shows the status of the target species both worldwide and within the Pacific Northwest states. Appendix A gives the definitions for the status listings (Moseley and Groves 1990, ONHP 1998, Tønsberg et al. 1996, WNHP 1995). Of the taxa documented in our study area, seven: *Cetraria sepincola, Pseudocyphellaria anomala, Ramalina pollinaria, Ramalina subleptocarpha Cladonia norvegica, Collema occultatum*, and *Nephroma laevigatum*, are considered rare within northern Idaho (ICDC 1998). *Collema curtisporum* is considered rare for North America and worldwide (ICDC 1998, Tonsberg, et al. 1996).

Table 2.1. Status of Target Species and Selected Species of Interest, Worldwide and in the Pacific Northwest.

Target Species	**Norway**	**Sweden**	**Finland**	**Europe**	**ID**	**MT**	**OR**	**WA**	**USFS/BLM**
Cetraria sepincola					G?		NA		No
Collema curtisporum	E	E	E	EX*	G1,S1	G1,S1	G3,S1		S (R1)
Collema furfuraceum	present	V	present	present	G5, S1				No
Hypogymnia oceanica					absent			P2,G?,S1	SM1,3(R6)
Leptogium subtile					G?		present		
Lobaria hallii	V	E			G4,S1			P2,G?,S?	SM1,3(R6)
Lobaria pulmonaria									SM4(R6)
Menegazzia terebrata	V present	R	V	present	absent				
Physcia semipinnata	R	V	E	present	G5, S1				
Physconia americana									
Pseudocyphellaria anomala					G?				SM4(R6)
Pseudocyphellaria anthraspis					G4,S1				SM4(R6)
Ramalina dilacerata	V	present	present	present					
Ramalina obtusata	E	V	V present	E	G?				
Ramalina pollinaria					G?			P2,G?,S?	
Ramalina subleptocarpha									
Ramalina thrausta	V	E	V present	E /V **				P1,G?,S1	SM4(R6)
Other Listed/Rare Sp in N Id	**Norway**	**Sweden**	**Finland**	**Europe**	**ID**	**MT**	**OR**	**WA**	**USFS**
Bryoria tortuosa								P2,G2,S3	SM1,3(R6)
Hypogymnia apinnata					G4,S1				
Sphaerophorus globosus					G5,S1				
Unusual Finds	**Norway**	**Sweden**	**Finland**	**Europe**	**ID**	**MT**	**OR**	**WA**	**USFS/BLM**
Cladonia norvegica	present	present	present	V				P2,G3,S2	SM3(R6)
Collema occultatum	present	V present	E	present					
Flavopunctelia soredica									

Table 2.1. Status of Target Species and Selected Species of Interest, Worldwide and in the Pacific Northwest, continued.

Unusual Finds (cont.)	**Norway**	**Sweden**	**Finland**	**Europe**	**ID**	**MT**	**OR**	**WA**	**USFS/BLM**
Leptogium cellulosum									
Leptogium teretiusculum								P2,G?,S?	SM4(R6)
Melanelia glabra									
Nephroma laevigatum	present	V present	V	present					SM4(R6)
Pannaria leucostictoides									SM4(R6)
Pannaria saubinettii									SM4(R6)
Phaeophyscia ciliata									
Phaeophyscia hirtella									
Usnea chaetophora	present	V	present						
Usnea subfloridana									

Legend
NA = not listed or not present in area
present = listed as present on the World Conservation Union (IUCN) red list
EX = extinct
E= endangered
V=vulnerable
V present = vulnerable and present on the redlist of the country specified
SM = survey and manage category from USFS Spotted Owl Record of Decision, Region 6
G,S= global and state rankings by the Natural Heritage Program: 1</= 5 occurrences, 2=6-20, 3=21-100, 4>100, 5=widespread
P1,2=(WA Natural Heritage Prgrm) based on occurrence pattern, vulnerability, threats, degree of protection, and taxonomy
ID=Idaho, MT=Montana
OR=Oregon, WA=Washington
* Nimis reported *C. curtisporum* from Italy -- 1993 in The Lichens of Italy, Museo Regionale di Scienze Naturali Torino
** E in the mediterranean, V elsewhere. R6 is USFS region 6.

Species in northern Idaho. One hundred twenty-six macrolichen species were found during the 1999 survey. The estimate of the true species richness, based on the first order jackknife estimator was 148. Caution must be used regarding jackknife estimates because they are highly sensitive to the number of rare species observed (there were 22 species found only once in this study) and they may not be appropriate when sampling large heterogenous regions (Palmer 1990). Five range extensions are reported, including first records in northern Idaho for *Phaeophyscia hirtella, P. ciliata, Collema occultatum, Nephroma laevigatum* and *Leptogium cellulosum*. Table 2.2. shows species counts by region.

Table 2.2. Lichen species listed by region. Counts (number of plots in which it occurred) and p-values for the significance of the lichen as an indicator of regional difference from Indicator Species Analysis are included. Regions are shown in Figure 2.1. Total = total number of plots with the species. %F = Percent frequency, or number of plots with the species/ total number of plots. p* = probability value from a Monte Carlo Test.

	Region											
Species	1	2	3	4	5	6	7	8	9	Total	%F	p *
Alectoria imshaugii	0	0	2	1	3	3	1	6	1	17	21	0.047
Alectoria sarmentosa	1	5	9	4	9	8	5	8	3	52	64	0.054
Bryoria	0	0	0	1	2	1	1	3	1	9	11	0.44
Bryoria capillaris	1	6	6	6	5	5	5	3	4	41	51	0.723
Bryoria fremontii	0	5	8	6	2	3	1	4	3	32	40	0.007
Bryoria friabilis	0	0	2	1	0	3	2	2	1	11	14	0.7
Bryoria fuscescens	1	7	5	8	7	9	6	6	6	55	68	0.092
Bryoria glabra	0	0	1	0	0	0	0	0	0	1	1	1
Bryoria lanestris	0	0	1	3	3	1	0	2	2	12	15	0.805
Bryoria pseudofuscescens	0	0	3	5	3	0	4	4	2	21	26	0.357
Bryoria simplicior	0	0	0	2	0	0	0	0	0	2	2	0.112
Bryoria tortuosa	0	2	1	0	0	0	0	0	0	3	4	0.294

Table 2.2. Continued.

Species	Region 1	2	3	4	5	6	7	8	9	Total	%F	p *
Candelaria concolor	3	1	1	1	0	1	0	1	2	10	12	0.913
Cetraria canadensis	1	3	4	3	3	3	3	0	3	23	28	0.303
Cetraria chlorophylla	1	5	7	8	7	7	8	9	7	59	73	0.167
Cetraria merrillii	0	0	0	2	3	1	1	0	0	7	9	0.096
Cetraria orbata	0	1	6	1	4	3	5	6	2	28	35	0.269
Cetraria pallidula	0	0	0	0	2	0	0	0	2	4	5	0.003
Cetraria platyphylla	0	4	8	0	3	4	3	2	4	28	35	1
Cetraria sepincola	0	0	0	0	0	0	0	0	1	1	1	0.027
Cladonia	0	0	3	0	1	0	0	0	0	4	5	1
Cladonia albonigra	0	0	1	0	0	0	0	0	0	1	1	1
Cladonia carneola	0	1	1	0	0	0	0	0	0	2	2	0.741
Cladonia cenotea	0	1	2	0	0	1	2	0	1	7	9	1
Cladonia chlorophaea	0	0	0	0	1	0	0	0	0	1	1	1
Cladonia coniocraea	1	0	0	0	0	0	0	0	0	1	1	0.962
Cladonia fimbriata	3	3	3	0	4	2	2	4	2	23	28	0.006
Cladonia ochrochlora	1	3	6	0	2	1	1	0	0	14	17	0.003
Cladonia squamosa	0	2	5	0	1	0	0	0	0	8	10	0.871
Cladonia sulphurina	0	1	2	0	2	0	1	0	0	6	7	0.516
Cladonia umbricola	0	2	2	0	0	0	0	0	0	4	5	0.447
Collema curtisporum	0	0	0	2	1	3	5	5	3	19	23	0.153
Collema furfuraceum	2	2	0	4	2	3	8	8	9	38	47	0.002
Collema occultatum	0	0	0	0	0	1	0	0	0	1	1	1
Esslingeriana idahoensis	0	1	6	1	3	2	2	1	1	17	21	0.011
Evernia prunastri	6	8	9	9	5	5	7	4	9	62	77	0.035
Flavopunctelia soredica	1	0	0	0	0	0	0	0	0	1	1	1
Fuscopannaria leucostictoides	0	0	0	0	1	0	0	0	0	1	1	1
Fuscopannaria pacifica	0	1	0	0	2	0	0	0	0	3	4	0.28
Hypocenomyce castaneocinerea	0	0	2	0	0	0	0	0	0	2	2	0.104
Hypocenomyce scalaris	0	0	2	0	0	3	0	0	0	5	6	0.079
Hypogymnia apinnata	0	4	9	4	7	4	6	6	0	40	49	0.005
Hypogymnia enteromorpha	0	0	1	0	0	0	0	0	1	2	2	1
Hypogymnia imshaugii	1	6	9	4	7	5	7	6	5	50	62	0.055
Hypogymnia inactiva	0	0	0	0	0	0	1	0	0	1	1	1
Hypogymnia metaphysodes	0	3	4	1	3	4	2	0	2	19	23	0.607
Hypogymnia occidentalis	0	4	6	4	8	7	6	8	4	47	58	0.097
Hypogymnia physodes	3	7	8	8	9	9	8	9	9	70	86	0.567
Hypogymnia tubulosa	1	6	9	8	9	9	9	7	9	67	83	0.121
Leptogium cellulosum	4	1	0	5	5	8	2	8	5	38	47	0.041
Leptogium saturninum	4	3	0	5	3	7	6	9	8	45	56	0.017
Leptogium teretiusculum	2	1	0	2	1	2	2	4	1	15	19	0.438
Letharia vulpina	2	3	4	4	5	5	3	1	3	30	37	0.826

Table 2.2. Continued.

Species	Region 1	2	3	4	5	6	7	8	9	Total	%F	p *
Lobaria hallii	0	1	0	4	4	3	8	9	3	32	40	0.001
Lobaria pulmonaria	0	8	8	5	8	9	7	9	7	61	75	0.006
Melanelia	1	0	0	0	0	1	0	0	0	2	2	1
Melanelia elegantula	3	1	2	5	2	3	4	1	2	23	28	0.477
Melanelia exasperatula	2	3	0	6	4	7	8	3	7	40	49	0.1
Melanelia fuliginosa	0	2	2	1	3	2	6	6	8	30	37	0.005
Melanelia glabra	1	0	0	0	0	0	0	0	0	1	1	1
Melanelia multispora	4	6	6	8	8	8	8	9	8	65	80	0.202
Melanelia panniformis	0	1	0	0	0	0	0	0	0	1	1	1
Melanelia subargentifera	5	0	0	0	0	0	0	0	0	5	6	0.001
Melanelia subaurifera	3	7	7	6	7	2	2	3	0	32	40	0.011
Melanelia subelegantula	4	2	1	4	5	7	7	2	8	10	12	1
Melanelia subolivacea	1	1	0	0	0	0	0	0	1	37	46	0.265
Nephroma bellum	0	0	1	0	0	0	0	0	0	1	1	1
Nephroma helveticum	0	5	9	2	6	2	4	6	1	35	43	0.002
Nephroma laevigatum	0	0	0	0	1	0	0	0	0	1	1	1
Nephroma parile	0	3	3	1	2	3	0	2	2	16	20	0.579
Nephroma resupinatum	2	8	8	5	7	8	5	9	4	56	69	0.042
Nodobryoria abbreviata	1	1	1	3	2	2	1	0	1	12	15	0.641
Nodobryoria oregana	0	0	1	1	3	0	1	0	2	8	10	0.163
Parmelia hygrophila	6	6	8	8	9	9	9	8	9	72	89	0.621
Parmelia sulcata	7	8	9	9	9	9	9	9	9	78	96	0.637
Parmeliopsis ambigua	1	1	6	0	1	6	2	3	3	23	28	1
Parmeliopsis hyperopta	2	1	8	0	3	7	3	4	1	29	36	0.009
Peltigera	1	0	0	0	0	1	0	0	0	2	2	0.007
Peltigera aphthosa	0	0	0	0	0	0	0	0	1	1	1	1
Peltigera canina	1	0	0	0	1	0	0	0	0	2	2	0.009
Peltigera collina	1	7	4	7	8	9	7	9	5	57	70	1
Peltigera membranacea	0	1	3	1	1	0	0	0	0	6	7	1
Peltigera pacifica	0	0	0	0	2	0	0	0	1	3	4	1
Phaeophyscia	0	0	0	0	0	0	1	0	0	1	1	0.076
Phaeophyscia ciliata	0	0	0	0	0	1	0	0	0	1	1	0.128
Phaeophyscia hirtella	0	0	0	0	0	1	0	0	0	1	1	1
Phaeophyscia nigricans	1	0	0	0	0	0	0	0	0	1	1	1
Phaeophyscia orbicularis	9	2	0	4	1	0	2	0	6	24	30	0.001
Physcia adscendens	8	4	1	9	4	3	7	0	7	43	53	1
Physcia aipolia	1	3	3	2	0	0	0	0	0	9	11	1
Physcia biziana	4	2	0	1	0	2	0	0	0	9	11	0.001
Physcia stellaris	5	8	6	7	6	6	7	9	8	62	77	0.059
Physcia tenella	9	3	2	5	1	3	3	0	6	32	40	0.001
Physciella	1	0	0	0	0	0	1	0	0	2	2	0.053

Table 2.2. Continued

	Region											
Species	1	2	3	4	5	6	7	8	9	Total	%F	p *
Physciella chloantha	3	0	0	0	0	0	0	0	0	3	4	0.017
Physciella melanchra	5	2	0	1	0	0	2	0	0	10	12	0.237
Physconia americana	0	1	0	6	3	4	7	5	6	32	40	0.019
Physconia enteroxantha	8	0	0	1	0	1	1	0	4	15	19	0.122
Physconia perisidiosa	7	3	0	7	2	7	8	4	7	45	56	0.001
Platismatia glauca	0	8	8	8	9	9	7	9	6	64	79	0.486
Pseudocyphellaria anomala	0	0	0	0	1	1	0	0	0	2	2	0.028
Pseudocyphellaria anthraspis	0	5	6	1	2	2	0	0	0	16	20	0.002
Ramalina dilacerata	0	6	6	6	5	3	7	8	3	44	54	0.201
Ramalina farinacea	2	6	2	8	5	4	7	3	7	44	54	0.063
Ramalina pollinaria	0	0	0	0	0	0	0	0	3	3	4	0.011
Ramalina subleptocarpha	0	2	0	1	0	0	0	0	1	4	7	0.529
Ramalina thrausta	0	1	4	4	2	1	2	3	2	19	23	0.322
Sphaerophorus globosus	0	2	0	0	2	0	0	0	0	4	5	0.11
Usnea	0	1	0	2	1	2	1	0	0	7	9	0.714
Usnea chaetophora	0	0	1	0	0	0	0	0	0	1	1	1
Usnea diplotypus	0	0	1	0	0	0	1	0	1	3	4	1
Usnea esperantiana	0	0	0	0	0	0	1	0	0	1	1	1
Usnea filipendula	0	0	1	1	0	0	2	1	0	5	6	0.283
Usnea glabrata	0	3	4	1	0	2	1	2	3	16	20	0.272
Usnea hirta	1	1	0	1	0	1	1	0	1	6	7	1
Usnea lapponica	3	8	8	8	6	6	7	3	9	58	72	0.208
Usnea scabrata	0	4	7	0	2	2	0	1	0	16	20	0.001
Usnea subfloridana	0	0	1	1	0	0	0	0	0	2	2	1
Xanthoria candelaria	6	6	3	7	5	5	4	5	7	48	59	0.62
Xanthoria fallax	7	0	0	0	0	0	0	0	1	8	10	0.001
Xanthoria fulva	7	2	0	6	3	2	5	1	8	35	43	0.029
Xanthoria hasseana	0	0	0	1	2	0	0	0	0	3	4	0.266
Xanthoria montana	8	3	2	7	6	6	9	9	7	57	70	0.276
Xanthoria oregana	1	0	0	0	0	0	0	0	0	1	1	1
Xanthoria polycarpa	1	2	0	5	0	1	5	1	5	20	25	0.258
Xanthoparmelia cumberlandia	1	0	0	0	0	0	0	0	0	1	1	1

Regional differences in lichen communities. Lichen communities differed among regions (A= 0.370, p <0.001, from MRPP analysis; Table 2.2). Some of the best indicators of regional differences in lichen communities were *Usnea scabrata, Xanthoria fallax*, and *Lobaria hallii*, all with p-values of 0.001 from Indicator Species Analysis.

Table 2.3. Total number of species occurrences by region. Alpha, beta and gamma diversity by region are included.

	Regions								
	1	2	3	4	5	6	7	8	9
Species occurrences by region	191	263	311	301	302	306	315	292	308
α diversity	21.2	29.3	34.6	33.7	33.6	34	35.1	32.4	34.1
β diversity	2.8	2.6	2.1	2.2	2.3	2.3	2.1	1.8	2.2
γ diversity	60	76	72	74	78	77	74	58	75

Region 1 had the lowest number of species occurrences, which is the sum of the number of species for each plot for the region, and the lowest alpha diversity (Table 2.3). Region 1 included Lewiston and the Salmon River drainage and was the driest region. Lewiston has an average annual precipitation of 31 cm (Abranovich et al. 1998), compared to an average of approximately 90 cm for the entire study area. Species unique to Region 1 included: *Flavopunctelia soredica, Melanelia glabra, Melanelia subargentifera, Phaeophyscia nigricans*, and *Physciella chloantha*. This region also had the most species missing that were present in all other regions. Missing species included: *Bryoria fremontii, Cetraria orbata, Esslingeriana idahoensis, Hypogymnia occidentalis, Melanelia fuliginosa, Nephroma helveticum, Platismatia glauca, Ramalina dilacerata, Ramalina thrausta*, and *Lobaria pulmonaria*.

Region 8 had the lowest beta and gamma diversity and intermediate alpha diversity. This region includes the Silver Valley, which is in the drainage of the North Fork of the Coeur d'Alene River. Species that had the highest number of occurrences in Region 8 include: *Alectoria imshaugii, Cetraria chlorophylla, Leptogium saturninum, Leptogium teretiusculum, Lobaria hallii, Melanelia multispora, Nephroma resupinatum, Physcia stellaris*, and *Ramalina dilacerata*.

Stream class and valley class differences in lichen communities. Lichen communities did not differ significantly among stream class groups (A= 0.002, p = 0.526, from MRPP analysis), or among valley classes (A= 0.001, p = 0.486, from MRPP analysis).

Floodplain cross-section type differences in lichen communities. Riparian macrolichen communities differed among floodplain cross-section types (A= 0.046, p = 0.002 from MRPP analysis). Indicators of floodplain cross-section types are included in Tables 2.4a through 2.4c. In this analysis, the "multiple channels on a broad floodplain" was combined with the category "floodplain on both sides." "Floodplain on one side" and "incised with no floodplain" were the other two categories.

Table 2.4a. Indicator species for streams with a floodplain on one side. The numbers under the column headings, one side, both sides and incised, are indicator values (see methods). Only species with significant ($p \leq 0.1$) indicator values (IV) are included.

	Cross section Type			
Species	Floodplain one side	Floodplain both sides	Floodplain incised	p-value
Fuscopannaria pacifica	13	0	0	0.070
Sphaerophorus globosus	17	0	0	0.066
Xanthoria fallax	17	1	0	0.061

Table 2.4b. Indicator species for streams with floodplains on both sides.

	Cross section Type			
Species	Floodplain one side	Floodplain both sides	Floodplain incised	p-value
Collema furfuraceum	10	41	0	0.016
Leptogium saturninum	16	41	2	0.023
Xanthoria polycarpa	2	24	0	0.082
Collema curtisporum	4	24	0	0.085

Table 2.4c. Indicator species for incised streams (no floodplain).

	Cross section Type			
Species	Floodplain one side	Floodplain both sides	Floodplain incised	p-value
Pseudocyphellaria anthraspis	7	0	46	0.002
Cladonia sp.	1	0	29	0.007
Platismatia glauca	17	27	41	0.010
Parmeliopsis ambigua	6	4	38	0.016
Cetraria canadensis	5	5	32	0.017
Usnea scabrata	10	0	34	0.017
Cetraria platyphylla	4	7	37	0.019
Peltigera membranacea	2	0	25	0.022
Bryoria tortuosa	1	0	19	0.039

Table 2.4c. Continued.

Species	Cross section Type Floodplain one side	 Floodplain both sides	 Floodplain incised	p-value
Nodobryoria abbreviata	1	3	21	0.045
Bryoria fremontii	4	15	34	0.046
Usnea glabrata	3	3	26	0.057
Cladonia ochrochlora	9	1	25	0.062
Cladonia squamosa	6	0	21	0.066
Cladonia umbricola	1	0	17	0.068
Hypogymnia enteromorpha	0	0	10	0.089
Letharia vulpina	8	8	28	0.093

Collema curtisporum has a relatively high indicator value for "floodplains on both sides" with low indicator values for the other floodplain cross-section types, meaning that it is associated with streams and rivers with floodplains on both sides. With the exception of *Xanthoria polycarpa*, indicator species for floodplains on both sides are lichens with blue-green photobionts.

Fuscopannaria pacifica and *Sphaerophorus globosus* were both found primarily along the North Fork of the Clearwater River and on the Lochsa River where there was a floodplain on one side. *Sphaerophorus globosus* was abundant on large old western red cedar, especially in the drainage of the North Fork of the Clearwater River where there was a floodplain on one side. *Fuscopannaria pacifica* was found on red alder in the same areas as *S. globusus*. *Xanthoria fallax* was found on large black cottonwood in dry areas, especially in Regions 1 and 2 where there was a floodplain on one side of the river or stream.

Pseudocyphellaria anthraspis has the highest indicator value for cross sections that were incised with no floodplain, meaning that it is strongly associated with incised stream cross-sections. Many of the species listed in Table 2.4c are also associated with conifers (compare with Table 2.5b).

Basal area in hardwoods. Lichen communities differed among classes of basal area percentages for hardwoods (A= 0.072, $p < 0.001$ from MRPP analysis). Indicators of different basal area percentages of hardwoods are in Tables 2.5a-c. Although the tables show how different lichen species were associated with different levels of hardwood composition, they do not give any information about what substrate the lichen species was growing on.

Table 2.5a. Indicator species most strongly associated with hardwood-dominated stands. The numbers under percent basal area in hardwoods are indicator values. Only species with significant IV's are included.

	Percent basal area in hardwoods				
Species	≤50%	51-70%	72-96%	100%	p-value
Ramalina farinacea	4	13	35	11	0.003
Physciella melanchra	0	1	1	24	0.004
Phaeophyscia hirsuta	0	1	2	23	0.005
Xanthoria fallax	0	1	0	23	0.007
Melanelia subargentifera	1	0	0	16	0.017
Physconia americana	2	9	26	11	0.020
Physciella chloantha	0	0	0	15	0.036
Xanthoria montana	7	15	28	26	0.052
Physconia perisidiosa	4	11	20	27	0.054
Xanthoria fulva	3	8	14	25	0.116
Physconia enteroxantha	2	4	2	15	0.128

Table 2.5b. Indicator species most strongly associated with conifer-dominated stands.

	Percent basal area in hardwoods				
Species	≤50%	51-70%	72-96%	100%	p-value
Cladonia squamosa	26	0	1	0	0.001
Usnea scabrata	30	4	1	0	0.001
Cladonia ochrochlora	29	2	0	0	0.003
Pseudocyphellaria anthraspis	25	7	1	0	0.005
Cetraria platyphylla	27	12	5	1	0.009
Alectoria sarmentosa	30	17	12	8	0.018
Bryoria tortuosa	13	0	0	0	0.049
Esslingeriana idahoensis	19	1	1	6	0.049

Table 2.5c. Indicator species most strongly associated with mixed stands (intermediate basal area in hardwoods).

	Percent basal area in hardwoods				
Species	≤50%	51-70%	72-96%	100%	p-value
Leptogium teretiusculum	0	25	0	8	0.004
Melanelia multispora	15	22	30	15	0.026
Bryoria pseudofuscescens	7	3	20	2	0.045
Hypogymnia tubulosa	27	20	29	9	0.058
Cetraria canadensis	8	20	8	0	0.073
Evernia prunastri	29	18	24	9	0.082

Climatic Affinities. The Lochsa and Selway rivers (in Region 3) are known for large numbers of vascular plant species that are coastal disjuncts (Crawford 1979, Steele 1975). The lichen communities in Region 3 also show a high number of oceanic species (Figure 2.2). Region 5 includes the North Fork of the Clearwater that, prior to the completion of the Dworshak reservoir, had a rich coastal disjunct component that included a large *Alnus rubra* (red alder) forest (Crawford 1979). There are still red alder upstream from the dam, as well as along the edges of the reservoir, and the lichen community shows a large component of oceanic species.

When the data were examined by plots, it appeared that elevation played a role in the distribution of the climatic affinities (2.3-2.4). Elevations in the study area ranged from 235 m to 1134 m. and, in general, elevation increases from the Palouse on the west side of the study area to the Bitterroot Mountains on the east side of the study area. Oceanic affinity was not correlated with elevation ($r = 0.047$) though the most oceanic plots appeared to cluster in the middle of the study area, which is at mid-elevations (see Figure 2.3). Plots with relatively high suboceanic values were concentrated in the Bitterroot Range, which were at the high elevations (see Figure 2.3), and the suboceanic axis was positively correlated with elevation ($r = 0.618$). Most of the plots with relatively continental lichen flora were at the edge of the Palouse (see Figure 2.3) and tended to have the lowest elevations. The continental axis was negatively correlated with elevation ($r = -0.346$)

Figure 2.2. Numbers of oceanic, suboceanic, and continental lichen species per plot. Each of nine regions in northern Idaho are shown, and regions correspond to DeLorme (1992).

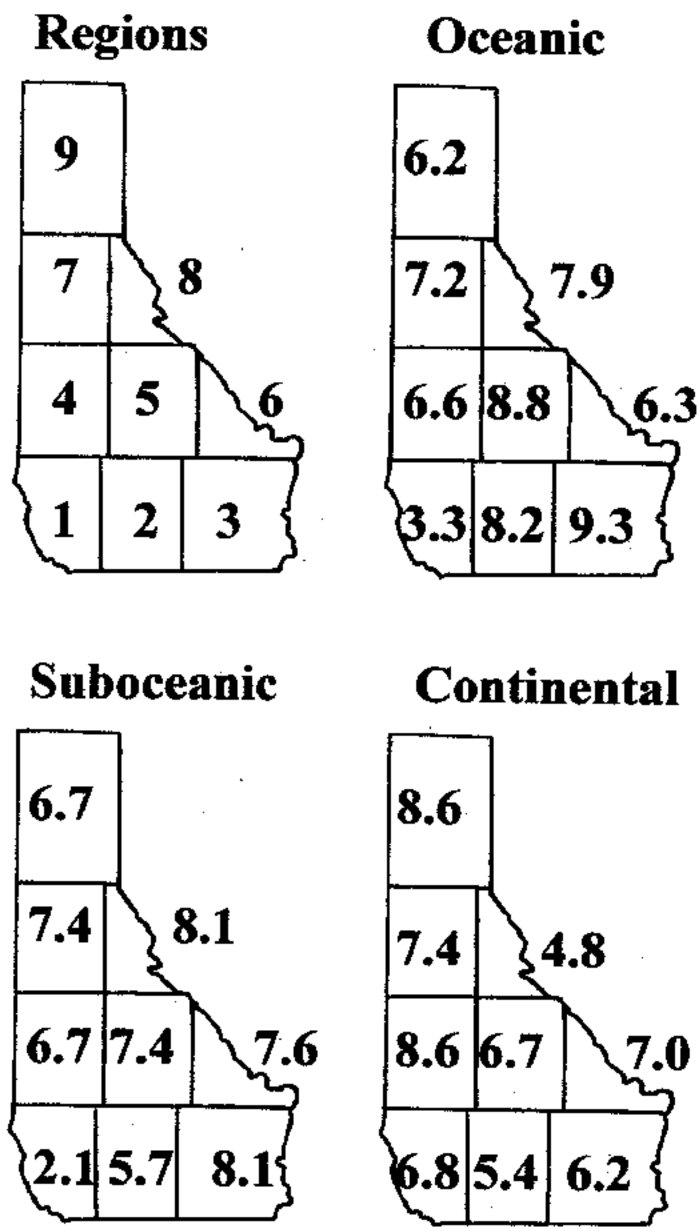
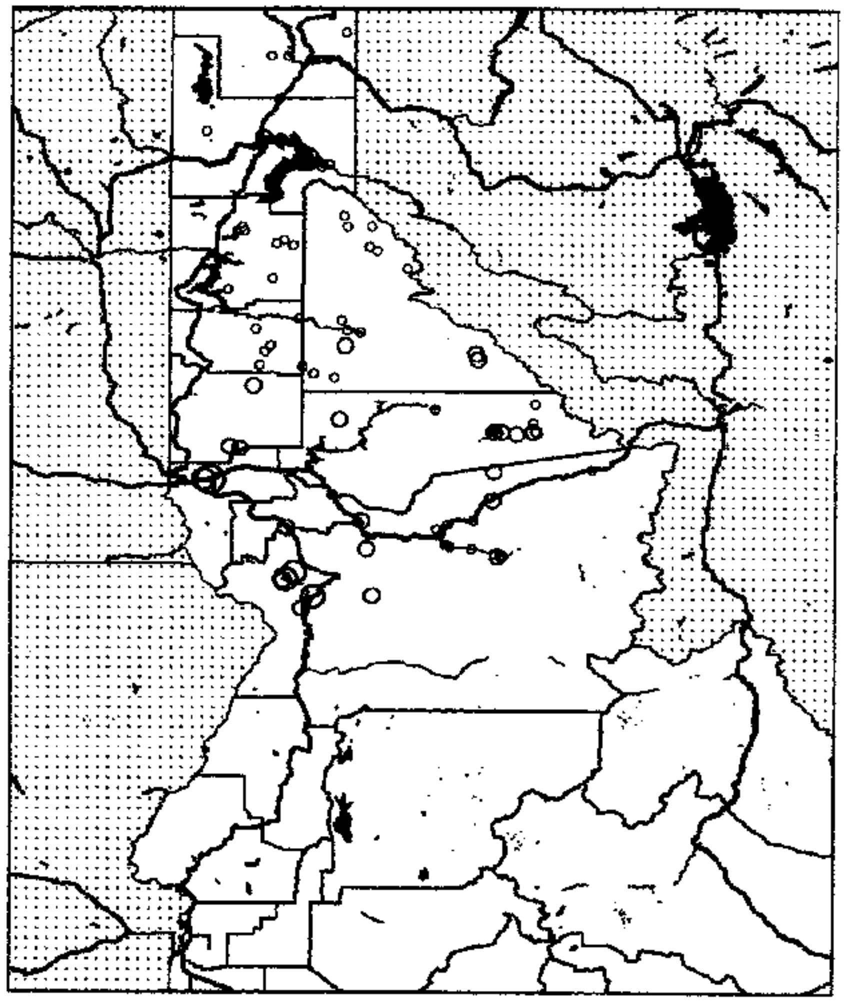


Figure 2.3a. Continental affinities by plot, using weighted average ordination. The size of the circle indicates the value for continental affinity for the plot.



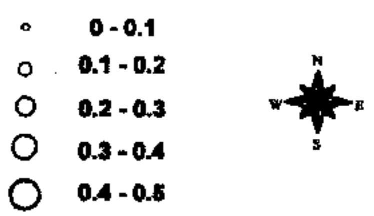


Figure 2.3b. Oceanic affinities by plot, using weighted average ordination. The size of the circle indicates the value for oceanic affinity for the plot.

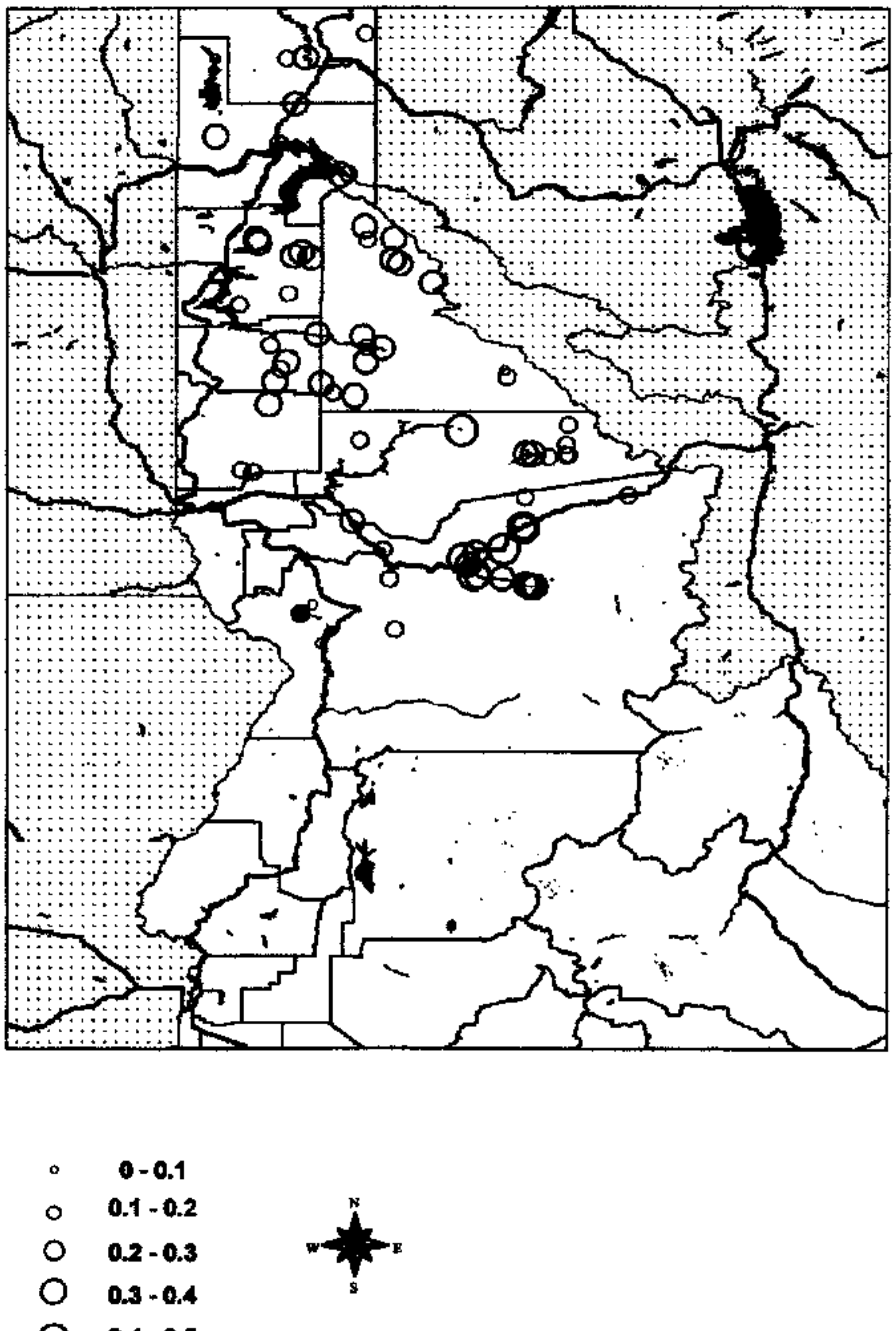


Figure 2.3c. Suboceanic affinities by plot, using weighted average ordination. The size of the circle indicates the value for suboceanic affinity for the plot.

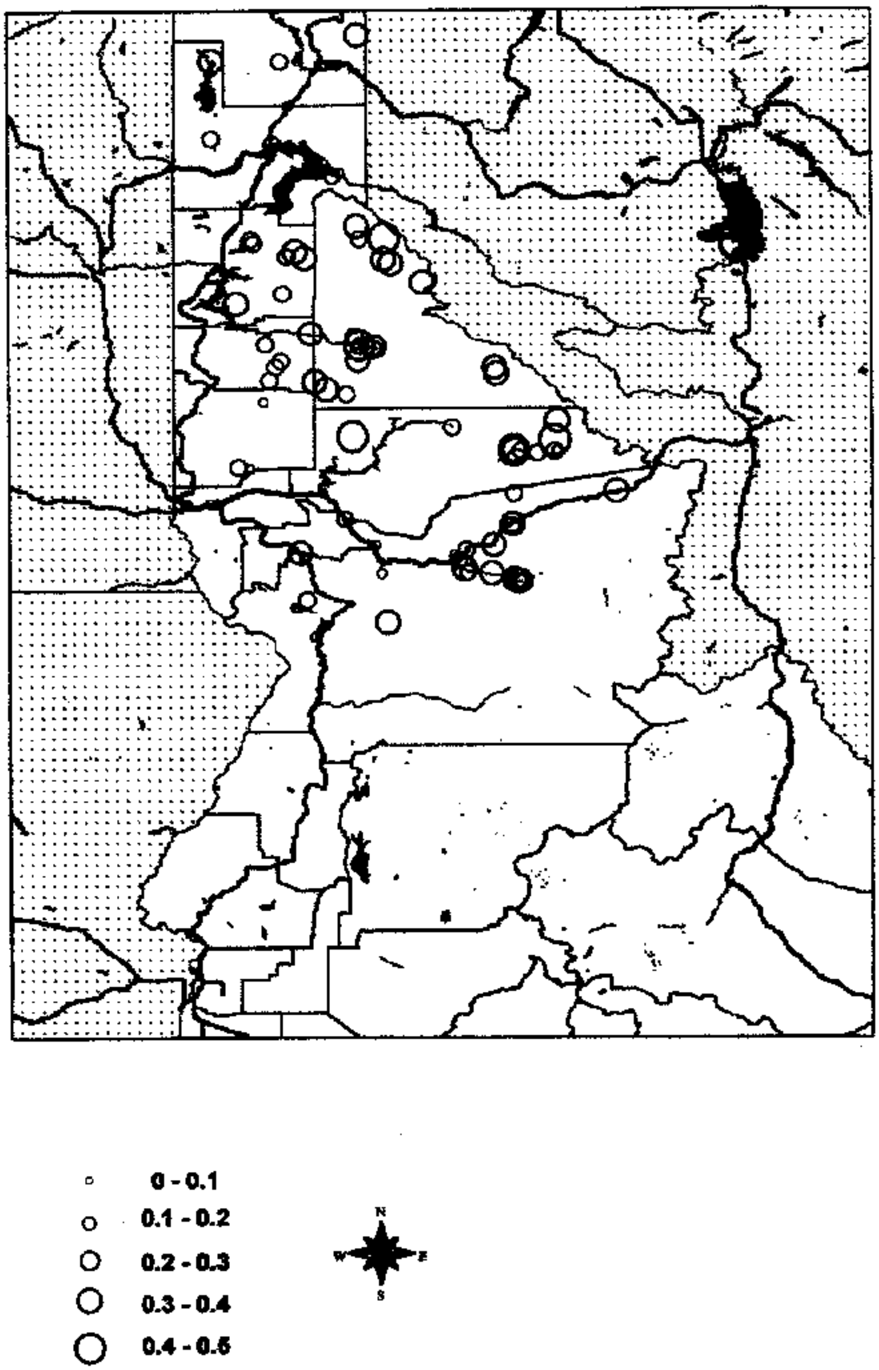


Figure 2.4a. Weighted average ordination, showing relative placement of plots on axes of continental and oceanic affinities. Plot coding system is described in methods. Axes are scaled as the proportion of the macrolichens belonging to a particular climatic affinity.

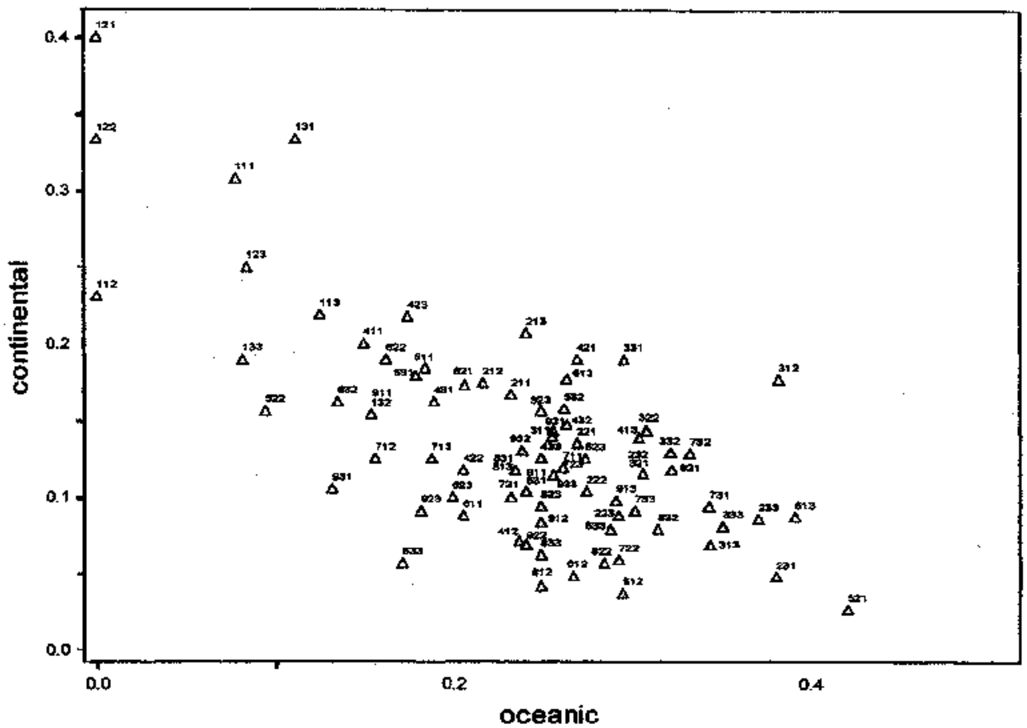


Figure 2.4b. Weighted average ordination, showing relative placement of plots on axes of suboceanic and oceanic affinities. Plot coding system is described in methods. Axes are scaled as the proportion of the macrolichens belonging to a particular climatic affinity.

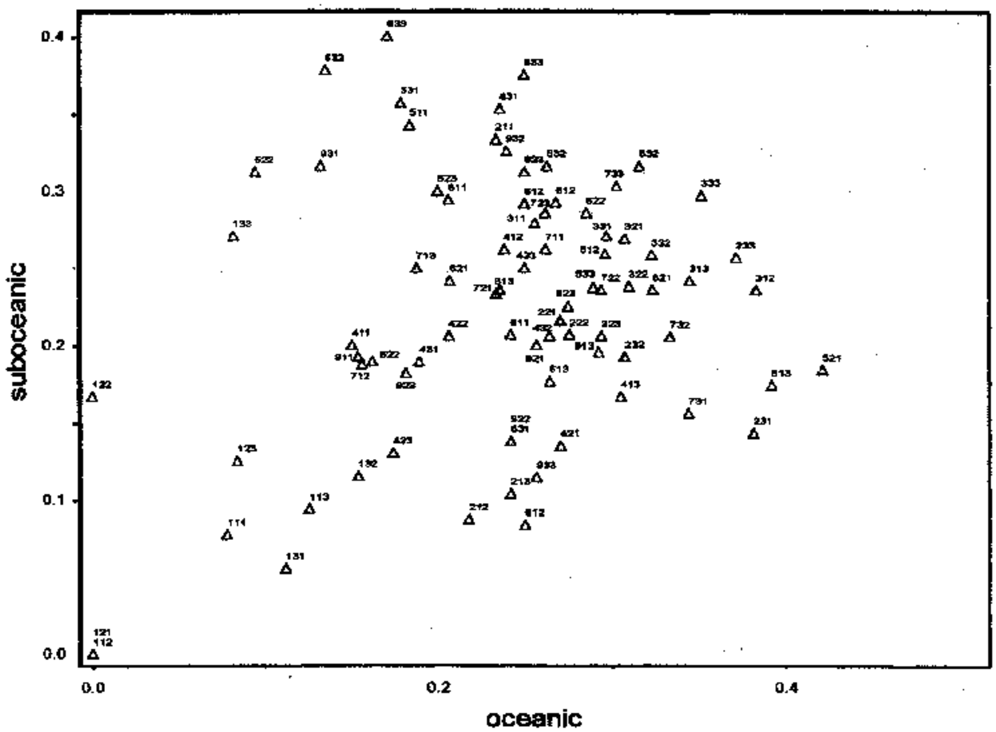
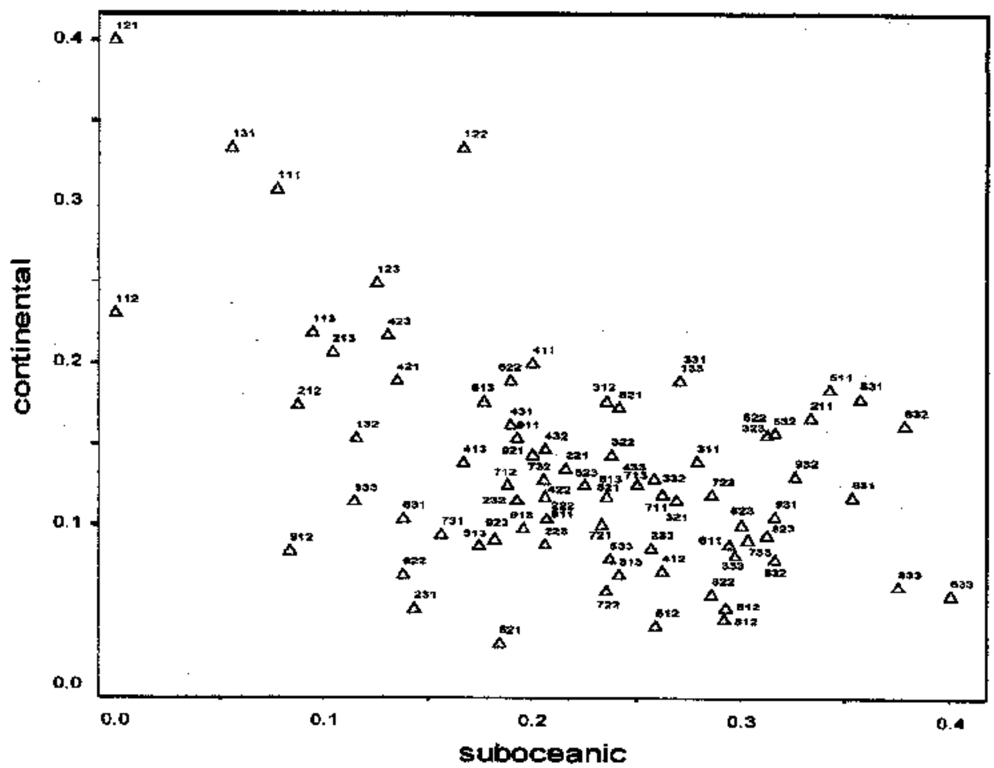


Figure 2.4c. Weighted average ordination, showing relative placement of plots on axes of continental and suboceanic affinities. Plot coding system is described in methods. Axes are scaled as the proportion of the macrolichens belonging to a particular climatic affinity.



Correlations of climatic affinities with variables describing conifer attributes in the plot (e.g. the dbh of the largest conifer, modal conifer dbh, and percent cover by sapling conifers) indicate that the size and presence of conifers on the plots was also related to climatic affinity. Plots with relatively high suboceanic values tended to support larger conifers (r = 0.352) and more cover of saplings (r = 0.560). More continental plots had less cover in conifer saplings (r = -0.307) and smaller conifer dbh (r = -0.451). Relatively oceanic plots supported larger conifers (r = 0.510 for the largest conifer, a larger correlation than was found for suboceanic plots, and r = 0.442 for typical conifer dbh).

Rarity and Ecology of the Target Species. The most practical definition of rarity comes from Rabinowitz (1981), who categorized rarity into seven forms based on large/small geographic range, narrow/wide habitat specificity, and large/small population size. We added "moderate" in addition to her small/large, narrow/wide categories. The listings below give the best information we have on both worldwide geographic distribution and more local distribution in Idaho, habitat and typical population sizes for populations.

The following information was compiled using McCune and Geiser (1997), McCune and Goward (1995), Goward et al. (1994), Tønsberg et al. (1996), and various monographs for species: Moberg (1977), Esslinger (1994), Bowler (1977), Rundel and Bowler (1976), Sierk (1964), Jørgensen and Tønsberg (1999), and Degelius (1954, 1974), as well as field data from this study. See Appendix B for distribution maps for target species. "Status in Idaho" was determined by using the information compiled in this study. Suggested rankings for the species, under "Management Recommentations" were also determined using the information compiled in this study. Global (G) is the global ranking for the species and S is the state ranking in Idaho. The numbers following G and S correspond to the number of documented occurrences: 1 = 5 or fewer occurrences, 2 = 6-20 occurrences, 3 = 21-100 occurrences, 4 = greater than 100 occurrences, 5 = widespread, abundant and secure. For more in-depth definitions see Appendix A.

Cetraria sepincola (Ehrh.) Ach. (as *Tuckermanopsis s*. (Ehrh.) Hale)
Rarity Type in Idaho: Narrow geographic range, narrow habitat specificity, small populations. There are two documented occurrences in Idaho.
Distribution: Circumpolar boreal and subarctic, Alaska to northern California and northwestern Montana, east to northeast United States. In Idaho, it is found in Kootenai County on *Betula glandulosa* twigs at Rose Lake, and in Bonner County near the Clark Fork River.
Growth Form: Small foliose lichen with apothecia. Closely appressed to the substrate and typically growing on twigs.
Ecology: Usually on shrub twigs in bogs. Often on Betula species. Elevation range for Idaho is 570 – 630 m. *Cetraria sepincola* is found almost exclusively in areas where the soil is always saturated.
Primary Threat: Dams and water diversions.
Secondary Threats: Agricultural activities, urbanization, livestock grazing, mining.
Status in Idaho: Rare.
Management Recommendations: Activities in wetlands and waterways are regulated by local, state and federal agencies; however, wetlands are often destroyed for right of way. Mitigation does not guarantee the wetland used to replace the disturbed wetland will be of the same quality or type. We suggest protection from disturbances and consideration of special botanical designation for Betula bogs. We suggest listing *C. sepincola* as G5, S1.

Collema curtisporum Degl.
Rarity Type in Idaho: Moderate geographic range, narrow habitat specificity, small populations. There are 25 documented occurrences in Idaho.

Distribution: Between the Cascades and the Rockies in Oregon, Washington and Idaho, into western Montana and possibly British Columbia. One population in Alaska. Populations in Scandinavia and in the Italian Alps. In Idaho, from the Lochsa River, north to Priest Lake.
Growth Form: Small foliose lichen with apothecia. Closely appressed to substrate.
Ecology: Usually on older *Populus balsamifera* ssp. *trichocarpa* in the PNW, or on *Populus tremula* in Scandinavia. In the PNW *Collema curtisporum* will also grow on conifers beside *Populus balsamifera* ssp. *trichocarpa* (black cottonwood) in floodplain forests. *C. curtisporum* is typically on heavily furrowed bark of mature black cottonwood boles. Seems to grow most abundantly in frequently inundated floodplains. Elevations for the Idaho sites range from 630 m to 1114 m. For more information on the ecology of *C. curtisporum*, see Hutchinson and McCune (2000).
Primary Threat: Dams and water diversions.
Secondary Threats: Agricultural activities, grazing, mining, logging and associated activities, recreation, fire suppression.
Status in Idaho: Recognized as threatened in Idaho and worldwide.
Management Recommendations: Damming rivers and draining floodplains for farming are deleterious to riparian forests containing black cottonwood. While riparian forests are protected through local, state and federal laws, there is a large and growing body of evidence showing that black cottonwood forests can only be maintained through natural flood regimes and special attention should be given to water release timing from dams based on natural cycles rather than human needs or convenience. Since *Collema curtisporum* is found almost exclusively on black cottonwood, managing for black cottonwoods in riparian forests should protect *C. curtisporum*. We recommend changing the listing of *C. curtisporum* to G2,S3. See Hutchinson and McCune (2000) for more details regarding management recommendations.

Collema furfuraceum (Arn.) DR
Rarity Type in Idaho: Wide geographic range, wide habitat specificity, small populations.
Distribution: Widespread in North America, found throughout forested parts of the PNW, including Idaho.
Growth Form: Small foliose isidiate lichen, closely appressed to substrate. Found on boles, branches, twigs and occasionally rock.
Ecology: Most common in moist low elevation riparian forests on broad-leaved trees and shrubs. In northern Idaho *C. furfuraceum* is found on *Populus balsamifera* ssp. *trichocarpa*, *Acer glabrum, Celtis* sp., *Alnus* sp., and *Rhamnus purshiana*. Elevations in northern Idaho ranged from 33 to 1115 m.
Primary Threat: Urbanization, development.
Secondary Threats: Damming and water diversion, agricultural activities, mining, air pollution, logging and associated activities.
Status in Idaho: Widespread and common in floodplain forests of northern Idaho and the PNW.
Management Recommendations: No special protection is recommended. *Collema furfuraceum* can be removed from the state list.

Hypogymnia oceanica (Goward) Goward 1988
Rarity Type in Idaho: No reports for Idaho.
Distribution: Fairly common west Cascades, from coastal Alaska to Oregon, increasingly rare southward. Not known on the east side of the Cascades in the United States, but oceanic in the interior cedar-hemlock zone in British Columbia.
Growth Form: Small to medium sized lichen. Foliose with soredia. Loosely appressed. Hollow interior.

Ecology: Most often found in moist coastal forests and *Pseudotsuga-Tsuga* forests in the Coast Range and Cascades.
Primary Threat: Logging and associated activities.
Secondary Threats: Urbanization and development and fire suppression.
Status in Idaho: Not known in Idaho.
Management recommendations: No special protection is necessary in Idaho at this time. Survey potential habitable sites, such as Douglas fir/western hemlock stands, cedar-hemlock stands and cool *Abies* stream bottoms.

Leptogium subtile (Schrad.) Torss.
Rarity Type in Idaho: There are no known sites in Idaho. *Leptogium subtile* is possibly overlooked and under collected due to its extremely small size.
Distribution: Not regarded as an American species until Goward et al. (1994) accepted *L. subtile*. It has been included in north American material by Sierk as *L. tenuissimum* and *L. perminutum*. Widespread, but distribution poorly known.
Growth Form: Tiny foliose lichen with apothecia. Closely appressed to substrate.
Ecology: On rotten or burnt wood, plant debris, rarely on standing trees.
Primary Threat: Logging and associated activities.
Secondary Threats: Livestock grazing, recreation, fire suppression.
Status in Idaho: Not known from Idaho, possibly rare or under-collected; previously collected specimens that were thought to be *L. subtile* are actually *L. cellulosum*.
Management Recommendations: Survey potential habitable sites.

Lobaria hallii (Tuck.) Zahlbr.
Rarity Type in Idaho: Moderate geographic distribution, narrow habitat specificity, small populations. There are 53 documented sites for *Lobaria hallii* in Idaho.
Distribution: Alaska to northern California, east to near the Continental Divide in western Montana. In Europe, *Lobaria hallii* is only known from Scandinavia and Greenland. In Idaho, *L. hallii* is found from Clearwater Co., north to Boundary Co.
Growth Form: Large, loosely appressed foliose lichen with soredia. On boles and branches. Tends to be smaller and more closely appressed on smaller branches and twigs.
Ecology: *Lobaria hallii* is frequently found in sheltered, moist riparian forests mainly on mature *Populus balsamifera* ssp. *trichocarpa*. It is associated with *Physconia americana, Leptogium saturninum, Collema curtisporum* and *Nephroma resupinatum*. While *L. hallii* is almost always associated with *Populus balsamifera* ssp. *trichocarpa* in northern Idaho, it will grow on other trees and shrubs associated with *P. trichocarpa*, such as *Alnus* sp., *Acer glabrum, Rhamnus purshiana, Picea englemannii*, and *Abies grandis*. It has been found on rock once in northern Idaho. Elevation range in northern Idaho was 480 to1120 m.
Primary Threat: Dams and water diversions.
Secondary Threats: Agricultural activities, grazing, mining, logging and associated activities, recreation, fire suppression, and air pollution.
Status in Idaho: Recognized as a species of concern in Idaho and rare worldwide.
Management Recommendations: Damming rivers and draining floodplains for farming are deleterious to riparian forests containing black cottonwood. While riparian forests are protected through local, state and federal laws, there is a large and growing body of evidence showing that black cottonwood forests can only be maintained through natural flood regimes and special attention should be given to water release timing from dams based on natural cycles rather than human needs or convenience. Because cottonwood forests in wetlands are vulnerable to a variety of human induced impacts, *Lobaria hallii* should still be considered at risk in Idaho. We recommend changing the state listing of *L. hallii* to G4, S3.

Lobaria pulmonaria (L.) Hoffm.
Rarity Type in Idaho: Wide geographic range, moderate habitat specificity (moist forests, upland and riparian), and large population sizes.
Distribution: Alaska to central California and inland to western Montana. *Lobaria pulmonaria* is found throughout northern Idaho.
Growth Form: Large loosely appressed foliose lichen with soredia. On boles and branches of trees and large shrubs.
Ecology: *Lobaria pulmonaria* is found in moist low to mid-elevation forests in areas with strong coastal influence. It is frequent west of the Cascades, but uncommon to rare in most areas east of the Cascades, except for northern Idaho where it can be frequent in riparian areas. In northern Idaho *L. pulmonaria* was most abundant along the Lochsa and Selway Rivers on *Thuja plicata*. It is also common in *Populus balsamifera* ssp. *trichocarpa* floodplain forests and in *Thuja plicata/ Alnus rubra* stands along the North Fork of the Clearwater River. Elevations at the sites of occurrence in northern Idaho range from 360 to 1370 m.
Primary Threat: Urbanization and development.
Secondary Threats: Logging and associated activities, air pollution, dams and water diversion, agricultural activities, mining.
Status in Idaho: Can be locally abundant along riparian corridors.
Management recommendations: Although no state listing or special protection is recommended, this species should be watched, as it has suffered huge declines in Europe.

Menegazzia terebrata (Hoffm.) Massal.
Rarity Type in Idaho: No known records from Idaho.
Distribution: Alaska to California, west Cascades in the PNW. *Menegazzia terebrata* is a northern hemisphere species found in Europe, North America, China, Russia and Japan.
Growth Form: Small to medium sized foliose, sorediate lichen. Lobes are hollow. Appressed and typically on boles of trees and shrubs.
Ecology: Moist oceanic forests, often in riparian areas, especially frequent on *Alnus rubra*. Tønsberg et al. (1996) noted that, *M. terebrata* is saxicolous in inland areas in Scandinavia. Saxicolous *M. terebrata* has not been observed in the continental United States.
Primary Threat: Logging and associated activities.
Secondary Threats: Urbanization and development, agricultural activities, dams and water diversion.
Status in Idaho: Not known in Idaho.
Management Recommendations: No special protection is necessary in Idaho at this time. Survey in potential habitable sites, i.e. swampy *Alnus rubra* forests.

Physcia semipinnata (Gmel.) Moberg
Rarity Type in Idaho: No reports for Idaho. Small and possibly overlooked.
Distribution: North America west and east, north to BC and south to New Mexico. Western Eurasia and India. The quality of information is compromised by the confusion of *P. semipinnata* with other species with similar appearance, such as *P. tenella*.
Growth Form: Small lichen with apothecia and marginal cilia. Lobes appressed or ascending. On bark.
Ecology: Most commonly found in low moist forests, on conifers, especially near streams, or lakes in the PNW. In Fennoscandia, *Physcia semipinnata* occurs on eutrophic bark of deciduous trees in well-lit habitats influenced by humans.
Primary threat: Too little information to assess threats.
Secondary threats: Logging and associated activities, urbanization and development.
Status in Idaho: Not yet recorded from Idaho.

Management Recommendations: No special protection is necessary in Idaho at this time. Possibly more surveys are needed.

Physconia americana Essl.
Rarity Type in Idaho: Moderate geographic range, narrow habitat specificity, moderate population size. There are 39 documented sites in Idaho.
Distribution: Common west of the Cascades in broad agricultural valleys and valley fringe. Widespread and occasional in northern Idaho and Rockies on *Populus balsamifera* ssp. *trichocarpa*.
Growth Form: Medium sized lichen with apothecia and pruinose upper surface. Closely appressed on boles and branches.
Ecology: Frequently found in northern Idaho on *Populus balsamifera* ssp. *trichocarpa* with *Lobaria hallii, Collema furfuraceum, C. curtisporum, Lobaria pulmonaria, Nephroma resupinatum*. Elevation range in northern Idaho is 334 to 1250 m.
Primary Threat: Dams and water diversions.
Secondary Threats: Agricultural activities, grazing, mining, logging and associated activities, recreation, fire suppression.
Status in Idaho: Widespread and occasional.
Management Recommendations: Damming rivers and draining floodplains for farming are deleterious to riparian forests containing black cottonwood. While riparian forests are protected through local, state and federal laws, there is a large and growing body of evidence showing that black cottonwood forests can only be maintained through natural flood regimes. Special attention should be given to water release timing from dams based on natural cycles rather than human needs or convenience. *Physconia americana* should be considered for listing similar to the G4, S3 listing for *Lobaria hallii*, since *P. americana* is also found mainly on black cottonwood.

Pseudocyphellaria anomala Brodo & Ahti
Rarity Type in Idaho: Narrow geographic distribution, narrow habitat specificity, small populations. There are six documented sites in Idaho.
Distribution: Alaska to California, west Cascades with rare disjuncts to western Montana. Rare and widely scattered in northern Idaho.
Growth Form: Large foliose lichen with soredia. Loosely appressed, on boles and branches.
Ecology: Low to mid-elevation moist forests including riparian areas. Rare in northern Idaho. On *Abies bifolia* and *Abies grandis* in northern Idaho and Montana. Elevations in northern Idaho and Montana range from 760 to1090 m.
Primary Threat: Logging and associated activities.
Secondary Threats: Urbanization, development, and air pollution.
Status in Idaho: Rare in Idaho
Management Recommendations: *Pseudocyphellaria anomala* is rare east of the Cascades, although it is common west of the Cascade Range. The nature of its distribution, small widely scattered populations that aren't necessarily associated with riparian areas, makes it difficult to protect. Protect known sites. Survey potential habitat prior to disturbance. We recommend listing *P. anomala* as G5, S1.

Pseudocyphellaria anthraspis (Ach.) Magnussen
Rarity Type in Idaho: Narrow geographic distribution confined to the Clearwater River Drainage, narrow habitat specificity, small to moderate population size. There are 52 documented sites in Idaho.

Distribution: Alaska to California with disjuncts into northern Idaho. Generally restricted to riparian areas in northern Idaho.
Growth Form: Large, loosely appressed foliose lichen with apothecia. On boles and branches.
Ecology: Low to mid-elevation moist forests including riparian areas. Rare in northern Idaho. Abundant along the Lochsa and Selway Rivers with *Lobaria pulmonaria* on *Thuja plicata* and other conifers. Also on *Taxus brevifolia, Alnus rubra*, and *Rhamnus purshiana*. Elevations in northern Idaho range from 360 to 1035 m.
Primary Threat: Logging and associated activities.
Secondary Threats: Urbanization, development, and air pollution.
Status in Idaho: Locally abundant.
Management recommendations: While *P. anthraspis* seems to be more locally abundant that *P. anomala*, it may be more narrowly distributed. *P. anthraspis* is not found in Montana, while *P. anomala* is. We suggest changing the state listing of *P. anthraspis* to G5, S3, and protecting old riparian forests in the Lochsa-Selway valleys and tributaries.

Ramalina dilacerata (Hoffm.) Hoff. sens. lat.
Rarity Type in Idaho: Wide geographic range, narrow habitat specificity, large population size.
Distribution: Alaska to California, west of the Cascades, inland to Montana. Circumboreal, occurring also in Asia and Europe. Widespread in riparian areas of northern Idaho.
Growth Form: Small, shrubby, fruticose lichen with apothecia. Typically on fine branches of large shrubs and trees.
Ecology: Low elevation riparian forests and shrubs. Mainly in areas with strong oceanic influence east of the Cascades. Locally common to abundant in moist riparian areas with trees and shrubs in northern Idaho. *Ramalina dilacerata* requires well-lit sites near water (Tønsberg et al. 1996). Most sites in Scandinavia seem to be fire free refugia (Tønsberg et al. 1996). Most common substrates in northern Idaho are *Alnus* and *Rhamnus purshiana*. Elevation range in northern Idaho is 360 to 1020 meters.
Primary Threat: Dams and water diversions, possibly fire.
Secondary Threats: Urbanization and development, livestock grazing, mining, agricultural activities.
Status in Idaho: Frequent in riparian areas in northern Idaho.
Management recommendations: State listing is not needed.

Ramalina obtusata (Arn.) Bitt.
Rarity Type in Idaho: No records for *R. obtusata* in northern Idaho, but records from Swan Valley, Montana and the Wallowas in Oregon, suggest *R. obtusata* should be present in northern Idaho.
Distribution: Widespread but uncommon, in the PNW mainly between the Cascades and the Rockies. Occurs in boreal regions of Europe and N. America. In Sweden it has a similar range to *Ramalina dilacerata*.
Growth Form: Small, shrubby fruticose lichen with soredia. Fenestrate (branches have hollow spots and are perforated). On twigs.
Ecology: Mostly restricted to *Picea* twigs in low elevation (approx. 900-1200 m) swamps and floodplains. Frequently found with *Ramalina pollinaria*. *Ramalina obtusata* often grows close to running water and lakes in areas with ample light and may be associated with fire free refugia (Tønsberg, et al. 1996). Mostly restricted to *Picea* twigs between the Rocky Mountains and the Cascades.
Primary threat: Dams and water diversions.
Secondary threats: Logging and associated activities, agricultural activities, livestock grazing.
Status in Idaho: Not recorded from Idaho.

Management recommendations: No special protection required in Idaho at this time. Survey potential habitable sites, i.e., bottomland forests with *Picea englemannii* and standing water in stream channels, or *Lysichitum* swamps.

Ramalina pollinaria (Westr.) Ach.
Rarity Type in Idaho: Narrow geographic distribution, narrow habitat specificity, small populations. Three documented sites in Idaho. Possibly under collected in Idaho.
Distribution: Widespread but uncommon, in the PNW mainly between the Cascades and the Rockies.
Growth Form: Small shrubby, fruticose lichen with soredia. Not hollow or perforated. On twigs. Ecology: On conifers, hardwoods and shrubs in swamps and floodplains. Generally in the same habitats as *R. obtusata*. *Ramalina pollinaria* appears to be restricted to the Pend Orielle subbasin in northern Idaho. Sometimes difficult to separate from *R. farinacea* without testing for chemistry.
Primary Threat: Dams and water diversions.
Secondary Threats: Logging and associated activities, agricultural activities, livestock grazing.
Status in Idaho: Rare.
Management Recommendations: More surveys of potential habitable sites, i.e., bottomland forests. Protect known sites. Consider state listing as G5, S2.
Taxonomic Notes: *Ramalina pollinaria* generally has flared tips and soralia scattered over the entire thallus and margins. It can be difficult to separate from *R. farinacea* in the field. When in doubt use TLC; *R. pollinaria* has evernic acid.

Purvis et al. (1992) describes *R. pollinaria* as having a rather large thallus, up to 5 cm long, and having nodulose proliferations on the thallus. The habitat for the British version of *R. pollinaria* is dry sheltered underhangs of siliceous rock, exposed tree roots and on north or east facing church walls. While the northern Idaho and the British versions both contain evernic acid, other evidence suggests that they may not be the same species.

Ramalina subleptocarpha Rundel & Bower
Rarity Type in Idaho: Narrow geographic range, narrow habitat specificity, small population size. Five documented sites in Idaho.
Distribution: British Columbia to California, on the coast and in the Puget trough. Widely scattered throughout northern Idaho.
Growth Form: Small to medium sized, shrubby to subpendant, fruticose, sorediate lichen. On boles branches and twigs of trees and shrubs.
Ecology: West of the Cascades in valley bottoms, ash swamps, and riparian hardwood forests, occasionally into the foothills, fairly frequent in agricultural and urban areas. Uncommon east of the Cascades. On *Crataegus* sp. and *Abies grandis* in northern Idaho. Elevations ranged from 365 to 810 m for specimens east of the Cascades.
Primary Threat: Urbanization and development.
Secondary Threats: Agricultural activities, mining, dams and water diversions, livestock grazing.
Status in Idaho: Rare.
Management Recommendations: *Ramalina subleptocarpha* is common west of the Cascade Range, in the Willamette-Puget trough, but it appears to be increasingly uncommon to the east of the Cascades. Protect known sites. Survey potential habitable sites prior to disturbance. Consider state listing as G5, S2.
Taxonomic Notes: *Ramalina subleptocarpha* has delaminating, or slit like marginal soralia, and tends to have wider lobes and palmate branching. However, small specimens from dry areas can be similar in appearance to PD- *R. farinacea*. TLC results for ambiguous specimens were not

always enlightening.   It appears that some PD- *R. farinacea* can have slit like marginal soralia or that some specimens of *R. subleptocarpha* either lack zeorin, or have such small amounts of zeorin that TLC doesn't pick them up. The latter idea is supported by the fact that most of the *Ramalina* I tested using TLC were difficult to extract substances from with acetone when spotting the plate.

Regarding PD- *R. farinacea*: 11 plots had PD– specimens. Two plots had collections that belonged to the hyprotocetraric race. The hypoprotocetraric race is generally limited to coastal regions with maritime influence (Bowler & Rundel 1978). Hypoprotocetraric specimens were found on *Betula papyrifera*, with an additional collection from *Crataegus douglasii* on one of the plots. Both plots that had the hypoprotocetraric race of *R. farinacea* have high relative values for oceanic affinity and low values for suboceanic and continental affinities (from weighted average ordination).

Ramalina thrausta (Ach.) Nyl.
Rarity Type in Idaho: Moderate geographic range, narrow habitat specificity, small populations. Thirty-six documented sites in Idaho.
Distribution: Boreal North America, south to Oregon and west to Montana. Worldwide *R. thrausta* has an incomplete boreal distribution, ranging through parts of Europe, Asia and North America. In Idaho *R. thrausta* is found from Idaho County to Bonner County.
Growth Form: Fruticose, fine, pendant, sorediate. On twigs.
Ecology: Sporadic in low elevation moist forests, especially riparian *Picea, Abies* and *Thuja plicata* east of the Cascades. In Idaho it grows in riparian corridors, frequently with *Lobaria pulmonaria, Nephroma resupinatum*, and *Pseudocyphellaria anthraspis* in mixed hardwood and conifer forests – on *Thuja plicata* and *Picea englemannii* branches in narrow canyons, such as the Lochsa River canyon. *Ramalina thrausta* has been found in moist sheltered habitats at timberline and on coastal cliffs in Scandinavia (Tønsberg et al 1996). Elevation ranges from 446 to 1240 m in northern Idaho.
Primary Threats: Logging and associated activities, fire.
Secondary Threats: Dams and water diversions, urbanization and development, and air pollution.
Status in Idaho: Most common in floodplain forests where there are both hardwoods and conifers.
Management Recommendations: Protect old bottomland conifer forests from fire and logging. Since *R. thrausta* is very patchy and probably dispersal limited, maintenance of old conifer stands in stream-bottoms is important to its survival in Idaho. Consider state listing as G5, S3.

Discussion

Prior to this study, virtually nothing was known about rare riparian lichens in northern Idaho. As a result of this study, much more is known regarding which species are rare, how they are distributed, and what habitats they are found in. Many of the target species listed with the Idaho Conservation Data Center (ICDC) have been considered for changes in both global and state rankings. We suggest that *Collema curtisporum, Lobaria hallii*, and *Pseudocyphellaria anthraspis* should be down listed, though *C. curtisporum* and *L. hallii* should still be regarded as species of concern.

Collema curtisporum is found only in cottonwood gallery forests with seasonal inundation. While *Lobaria hallii* is found fairly frequently in hardwood gaps as well as in riparian areas of Oregon and Washington, 92% of the specimens collected in Idaho are from riparian forests.

Pseudocyphellaria anthraspis is locally abundant in areas with oceanic influence, such as the Lochsa-Selway drainage and the North Fork of the Coeur d'Alene, but is at the easternmost limits of its range.

Physconia americana, Pseudocyphellaria anomala, Ramalina pollinaria, Ramalina subleptocarpha, and *Ramalina thrausta* should be considered for listing. *Physconia americana* is found only on large cottonwood in riparian areas. *Pseudocyphellaria anomala* is rare in northern Idaho (ten records). *Ramalina pollinaria* is rare in northern Idaho (three records for northern Idaho and seven records for northwestern Montana). *Ramalina subleptocarpha* is rare in northern Idaho (six records). *Ramalina thrausta* is locally abundant in riparian areas with oceanic influence, but isn't common otherwise and is thought to be dispersal limited

The target species *Leptogium subtile, Menegazzia terebrata, Hypogymnia oceanica*, and *Ramalina obtusata* were not found during the study. It is probable that *M. terebrata* and *H. oceanica* do not exist east of the Cascade crest in the United States. Taxonomic work done on tiny *Leptogium* (Jørgenson and Tønsberg 1999) refined the species descriptions so that specimens previously identified as *L. subtile* no longer fit the species concept. At this point, true *L. subtile* has not been found in northern Idaho. *Ramalina obtusata* has been found in the surrounding area, but hasn't been found in Idaho, which is troubling since *R. obtusata* is found in riparian forests. It isn't clear why it wasn't found in the course of this study. It is possible that sampling of *Lysichitum*-conifer swamps and old *Picea* dominated floodplains is needed to establish the presence or absence of this species in Idaho.

Collema occultatum, Nephroma laevigatum, Phaeophyscia hirtella, Phaeophyscia ciliata, and *Leptogium cellulosum* are all new records for Idaho. With the exception of *N. laevigatum*, all of the new records are for extremely small (a few millimeters in diameter) species that were found on cottonwood. *Collema occultatum* is the smallest of the group (~3mm diameter), and its distribution is uncertain. *Phaeophyscia ciliata* is rare in Idaho, but common in Utah and Colorado. *Phaeophyscia hirtella* is rare in Idaho, but common in the northeastern United States. *Leptogium cellulosum* is recently described for the PNW and more finds throughout the PNW undoubtedly will be forthcoming.

Lichen communities varied strongly among different regions of northern Idaho. Communities differed in lichen species richness, total number of species and climatic affinities. The strongest differences in lichen community composition were regional (A= 0.37 from MRPP), followed by community differences related to basal area in hardwoods (A=0.07), and differences in floodplain cross-section type (A=0.05).

Average species richness per plot is higher in riparian forests than it is for the region as a whole. Neitlich and Rosentreter (2000) show the southwestern corner of the panhandle (Region 1) as being part of the Great Plains Palouse Dry Steppe Physiographic Region, while most of the panhandle is in the Northern Rocky Mountain Forest-Steppe-Coniferous Forest-Alpine Meadow physiographic region. For the portion of the region that is in the Northern Rocky Mountain Forest-Steppe-Coniferous Forest-Alpine Meadow physiographic region as a whole, average species richness per plot was about 12 species per plot, while in this study (riparian forest only) the average richness was about 33 species per plot. Lichen species richness for the entire Great Plains Palouse Dry Steppe was also about 12 species per plot, while average species richness per plot in this study was 21 species per plot.

Species richness and total number of species were lowest in the southwest part of the study area, which was much drier than the rest of the panhandle (Region 1). This area included the edge of the Palouse, from Lewiston south to Whitebird, which included the Salmon River and main fork of the Clearwater River. The low species richness may reflect environmental conditions that are less hospitable to lichens than the conditions found in the other regions, such as low humidity, more temperature extremes, and less precipitation. This was the driest, most continental region with the lowest average elevation, and had the most species with continental affinity. The prominence of continental species in the Lewiston- Salmon area, combined with fewer oceanic species within this area, may reflect physiographic differences from the rest of northern Idaho (Neitlich and Rosentreter 2000). Hardwoods in this region include a relatively larger number of *Celtis* and *Robinia* than the other regions. It is difficult to tease out the potential effects of nitrogen pollution and climatic stress tolerance in this region. It is characterized by harsh conditions, relatively open dry areas, and relatively high continental values, and is also agricultural. It is possible that lichen communities in this area have been altered by N-enrichment from wheat farms and livestock, as well as by pollutants from a paper pulp mill at Lewiston (Geiser 2001, Hoffman 1974).

The area northeast of Wallace, along the North Fork of the Coeur d'Alene (Region 8) had relatively low regional (gamma) diversity and little differentiation among plots (beta diversity). Plots in this region may have had more homogenous elevations and vegetation than the other regions. While heavy metal pollution resulting from the operations of a zinc and lead smelter near Kellogg has had profound effects on both the river and human inhabitants, studies haven't shown much impact outside of a ten-mile radius of the smelter (Reece et al. 1978, Rabe & Bauer 1977, Ragaini et al. 1977). There have been no formal studies using lichens as bioindicators for heavy metal pollution in the Coeur d'Alene area, and since the smelter shut down in 1982, lead and zinc as air pollutants are not a large concern, although contaminated sediments entering Lake Coeur d'Alene are of great concern (La Force et al. 1998).

Plots with the most oceanic species were concentrated at mid-elevations along the Lochsa and Selway Rivers, as well as the North Fork of the Clearwater (Regions 3,5). The Clearwater Drainage has relatively high numbers of oceanic species, which most likely reflect milder, wetter conditions and possibly its history as a glacial refugium. The Clearwater and Lochsa River are known for vascular plants that are coastal disjuncts. *Fuscopannaria pacifica* and *Sphaeophorus globosus*, are oceanic species found on the Clearwater and the Lochsa.

Plots with the most suboceanic species tended to occur at higher elevations, along the east side of the panhandle, which is the Bitterroot Range. This regional pattern probably results from orographic precipitation along the west slope of the mountains.

Although the streams within regions were divided into three different stream order classes according to size and position, neither the size of the stream nor the valley was as important as the substrate available to the lichens. The reasons why there were no pronounced differences in lichen communities among stream or valley classes aren't clear. Climatic differences such as the amount, timing, and duration of annual rainfall, and temperature extremes may have more influence on lichen communities than either the size of the stream or the size of the valley. For example, light duration can vary greatly depending on the topographic orientation of the valley or canyon. Another possibility is that large valley bottom rivers have an influence on lichen communities within their entire drainage area, so that all stream classes within a large drainage are more similar to each other than to like stream classes in other regions.

There were differences in lichen communities for different stream floodplain cross-section types. Streams with no floodplain had lichen communities that one would expect to find on conifers, including species such as *Bryoria fremontii* and *Letharia vulpina*, as well as some that seem to prefer mixed canopy sites, such as *Cetraria canadensis*. Two of the lichens associated with plots having floodplains on one side, *Fuscopannaria pacifica* and *Sphaerophorus globosus*, are considered uncommon in northern Idaho. The presence of *Collema curtisporum* as an indicator species for areas having floodplains on both sides suggests that there is something about floodplain forests or cottonwoods that it requires. Many cottonwoods that were not in floodplain forests were examined during our travels, and these trees did not have *C. curtisporum*.

While *C. curtisporum* is an indicator of areas having floodplains on both sides, it is not an indicator of high basal area in hardwoods. Species that were indicators of forests with high basal area values for hardwoods tended to be nitrogen-loving species such as *Xanthoria fallax* and *X. fulva*. Bark chemistry, specifically enhanced nitrogen, of hardwoods may have an effect on lichen community composition (Goward and Arsenault 2000, Rhodes 1995, McCune 1982) as can other bark characteristics, such as sloughing and texture (Kenkel and Bradfield 1981). Indicators for forests with relatively high percentages in basal area in conifers included *Pseudocyphellaria anthraspis* and another lichen of concern in the PNW, *Bryoria tortuosa*. The remainder of species listed in Table 2.5c, are common on conifers in upland sites (personal observation).

Much work regarding rare lichens in the riparian forests of northern Idaho remains to be done. For example, more taxonomic work could be done regarding the *Ramalina farinacea* complex and *Ramalina pollinaria*. Molecular studies to determine whether the European *R. pollinaria* is genetically the same as its North American counterpart would be useful in conservation. In the case of *C. curtisporum* with the widely disjunct populations and relatively small North American population, molecular work assessing its similarity to populations in Europe could be extremely important to its conservation.

Studying the effects of natural flood cycles compared to the flood events on dammed rivers is important not only in the conservation of lichens, but to the forests themselves and river health. Idaho is bound to increase in population, making environmental monitoring extremely important in providing information essential for maintaining natural systems. Natural systems should be maintained, not only for conservation, but for quality of all life. Lichens should be included as an economical and ecologically important component of ecosystem monitoring.