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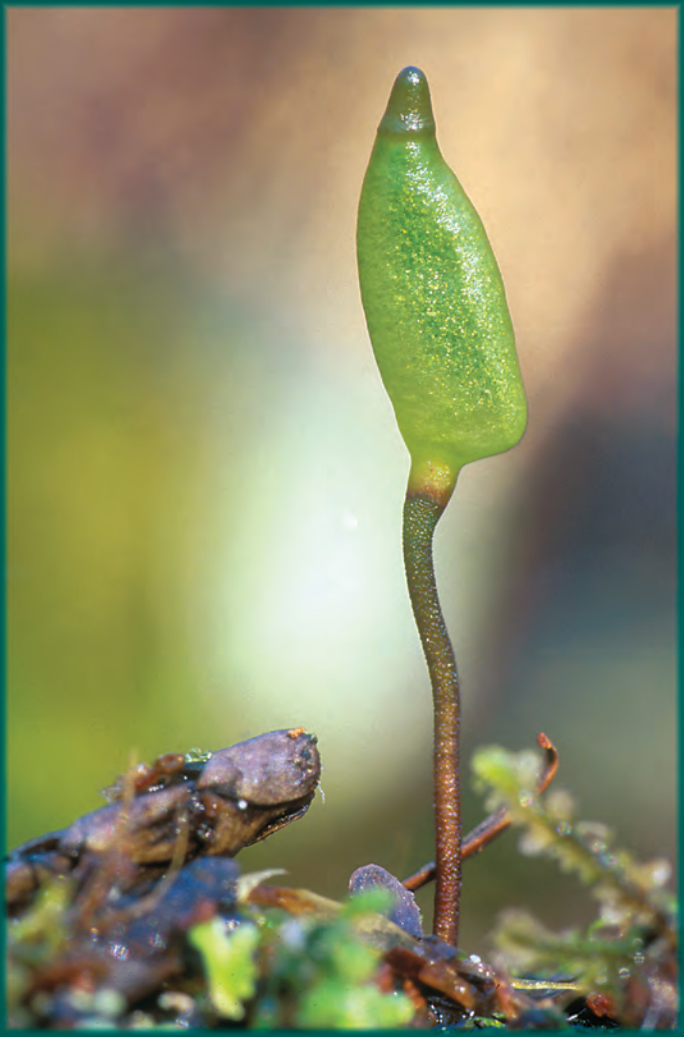
Inventory of the Mosses, Liverworts, Hornworts, and Lichens of Olympic National Park, Washington: Species List



Scientific Investigations Report 2005-5240

U.S. Department of the Interior
U.S. Geological Survey

Inventory of the Mosses, Liverworts, Hornworts, and Lichens of Olympic National Park, Washington: Species List

By Martin Hutten
Andrea Woodward
Karen Hutten

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U.S. Department of the Interior
U.S. Geological Survey

U.S. Department of the Interior
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Units of Measure for Conversions

1 meter = 39.37 inches
1 kilometer = 0.62 miles
1 square centimeter (cm^2) = 0.15 square inches (in^2)
1 square kilometer (km^2)= 0.39 square miles (mi^2)

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Inventory of the Mosses, Liverworts, Hornworts, and Lichens of Olympic National Park, Washington: Species List

By Martin Hutten[1]
Andrea Woodward[2]
Karen Hutten[1]

Abstract

The identification of non-vascular cryptogam species (lichens, mosses, liverworts, and hornworts) is especially challenging because of their small size, their often microscopic or chemical distinguishing features, and their enormous diversity. Consequently, they are a poorly known component of Olympic National Park, despite their ecological and aesthetic importance. This project is the first attempt at a systematic, comprehensive survey of non-vascular cryptogams in the Park and presents the current species list with descriptions of the substrate and vascular vegetation type where they were observed. The authors strove to collect from as many park environments as feasible, and distributed collections along important environmental gradients in different regions of the park using vascular vegetation as an environmental indicator. They also collected opportunistically when interesting habitats or microhabitats were encountered. Finally, the authors updated the nomenclature in the Park's previous collection of non-vascular plants. This study identified approximately 13,200 bryophyte and lichen species, adding approximately 425 new species to the Olympic National Park Herbarium. These data, combined with select literature reports and personal data from Martin and Karen Hutten, added more than 350 species to the previously documented Olympic Peninsula lichen and bryophyte list. The authors discuss the list in a local, regional, and global context of rarity, as well as cryptogam conservation and further work needed in Olympic National Park. The improved inventory of Olympic National Park cryptogams represented by this project enables Olympic National Park to protect populations of rare and sensitive species, assess the damage caused by illegal harvest, and contribute information to the Bureau of Land Management and U.S. Forest Service Sensitive Species Programs.

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Introduction

The identification of cryptogam species (lichens, mosses, liverworts, and hornworts) is especially challenging because of their small size, their often microscopic or chemical distinguishing features, and their enormous diversity. Consequently, they are a poorly known component of Olympic National Park (ONP), despite their ecological and aesthetic importance. Although experts have created partial species lists for ONP (Sharpe, 1956; Harthill, 1964; Thomson, 1969; Kunze, 1980; Hong and others, 1989) based on surveys of limited areas, a systematic, comprehensive survey has not been conducted. The improved inventory of ONP cryptogams represented by this project enables ONP to protect populations of rare and sensitive species, assess the damage caused by illegal harvest, and contribute information to the Bureau of Land Management (BLM) and U.S. Forest Service (USFS) Sensitive Species Programs.

This document presents the current species list of mosses, liverworts, hornworts, and lichens of ONP, along with descriptions of substrate and vascular vegetation type where they were observed. The authors discuss the list in a local, regional, and global context of rarity, as well as address some general topics regarding cryptogam conservation and further work needed in ONP. The authors do not believe it to be a complete list, nor do they analyze or summarize species distribution or community structure.

Although ONP comprises slightly less than 10 percent of the Olympic Peninsula (OP), it protects the bulk of the unmanaged ecosystems and thereby represents the flora that may once have been present on the entire OP. Because some collections and some of the records in the Park's herbarium come from outside of the Park, conclusions and generalizations are sometimes applied only to ONP and sometimes to the entire OP.

Geographic and Biologic Context for the Inventory

ONP is the centerpiece of the OP, which is a 13,800-km^2 landmass in the extreme northwest corner of the conterminous United States (fig. 1). The Peninsula resembles an island because it is surrounded on three sides by water and on the fourth by a deep river valley: the Pacific Ocean to the west, the Strait of Juan de Fuca to the north, Hood Canal to the east, and the Chehalis River Valley to the south. The Olympic Mountains (Olympics) rise from sea level to culminate at Mount Olympus near the center of the Peninsula at 2,430 m. Geologic uplift, heavy precipitation, and a dynamic glacial history have created a radial pattern of 11 major river valleys centered on the mountains. ONP covers 3,700 km^2 in two units: 3,530 km^2 in the central mountainous core and a narrow 170-km^2 strip extending 84 km along the coast (Olympic National Park, 1999).

Mountainous areas in general are characterized by steep moisture and temperature gradients, resulting in substantially different environments over short distances. The moisture gradient is especially steep in the Olympic Mountains, reflecting the wet maritime climate, and results in exceptionally high levels of precipitation along the western slope. The substantial climatic and elevation gradients of the Peninsula create a diversity of habitats within the park. Environmental regimes range from mild, maritime conditions on the coast to harsh, alpine areas at high elevations to dry, near-continental climate in the northeast. Consequently, cold-stressed alpine vegetation exists within 15 km of intertidal communities and even closer to lush temperate rainforest with some of the world's largest trees (Buckingham and others, 1995).

The geologic and glacial histories of the Peninsula and western Washington provide a diversity of parent materials for soil formation. The ocean floor contributed sedimentary and marine-deposited basaltic bedrock. The continental glaciers deposited a variety of soil material including granitic rocks from the Cascade Range along the east and north sides of the Peninsula. Mass wasting and glaciers have mixed, washed, and eroded all three materials, creating a complex of montane and riverine soil materials (Tabor, 1987). Olympic soils are considered to be young and, in general, are relatively infertile, except in the lower Dungeness River Valley. Local soil characteristics (for example, soil moisture, sub-surface flow, soil temperature, and chemical properties) vary greatly, being influenced by the parent material, climate, and biotic communities of the area. Common soil orders include spodosols, inceptisols, entisols, histosols, and andisols (Henderson and others, 1989).

Vegetation reflects the diverse physical environment. West-side lowland forests are in the Sitka Spruce (*Picea sitchensis*) Zone, including the temperate coniferous rainforest for which ONP is famous. Here, massive Sitka spruce trees grow to 90 m, and deciduous bigleaf maples (*Acer macrophyllum*) are laden with epiphytes. Lowland and mid-elevation forests on the drier east side and mid-elevation forests on the west side are in the Western Hemlock (*Tsuga heterophylla*) Zone. This is the most widespread zone and it is dominated by Douglas-fir (*Pseudotsuga menziesii*) and western hemlock, with red cedar (*Thuja plicata*) as a fairly common constituent. Montane forests are in the Pacific Silver Fir (*Abies amabilis*) Zone on the cool, moist slopes of much of the Peninsula, whereas Douglas-fir inhabits south-facing montane slopes in the northeast. Subalpine areas are a matrix of tree islands and meadows at high elevation. Subalpine areas with snow packs deeper than 3 m are in the Mountain Hemlock Zone (*Tsuga mertensiana*) and include mountain hemlock, subalpine fir (*Abies lasiocarpa*), and sometimes Pacific silver fir. The Subalpine Fir Zone occurs in areas with snowpacks less than 3 m deep and may also include lodgepole pine (*Pinus contorta*) or whitebark pine (*P. albicaulis*). Treeline occurs at 1,615 m in wetter areas and 1,890 m in drier zones where trees finally give way to alpine meadows (Henderson and others, 1989).

The glacial history, geographic isolation, and steep climatic gradients have important consequences for the biogeography of the area. First, the Peninsula was never completely covered by ice during the last glaciation at least, when a complex of ridges and mountains were above ice. Moreover, when glacial ice was thick, sea level was lower, exposing considerable new lands along the coast for a long period of time (Booth, 1987; Tabor, 1987). The role of the OP as a glacial refugium is conjecture, but the theory is well supported by its biogeography (Buckingham and others, 1995). The OP is home to a surprising number of endemic and disjunct vascular species whose distribution patterns are consistent with the refugium theory. Not enough is known about the distribution of non-vascular species to reach conclusions, but the disjunct distribution patterns of several species support the theory (for example, *Rhytidium rugosum* and *Vulpicida tilesii* are both arctic Tertiary relics now disjunct from their main distributions).

Significance of Cryptogams for ONP

Non-vascular cryptogams (mosses, liverworts, and lichens) make up a significant portion of the biomass and annual production in temperate rainforests (Vitt and others, 1988), and are known to play important ecological roles in hydrologic (Norris, 1990; Boucher and Nash, 1990) and nutrient cycling (Nadkarni, 1985). They are also known to be sensitive to precipitation chemistry and air quality (Hawksworth and Hill, 1984). Consequently, non-vascular cryptogams are crucial components of the long-term ecological monitoring program currently under development in ONP. Cryptogams require management attention because they are harvested illegally for sale to the floral industry, and because some rare species may require special protection.

Additionally, mosses, liverworts, and lichens were included in the list of Survey and Manage species identified in the Record of Decision (U.S. Department of Agriculture and U.S. Department of the Interior, 1994) for the Northwest

Forest Plan, to which the National Park Service (NPS) is a party. The Northwest Forest Plan was adopted by the BLM and USFS in 1994 to guide forest management in the range of the northern spotted owl after the owl's designation as endangered under the Endangered Species Act. Part of the plan required the Forest Service to survey for certain species (in other words, Survey and Manage Species) before allowing ground-disturbing activities. The Survey and Manage List included a large number of bryophytes and lichens, among other taxa, and was based on minimal knowledge of the distribution and abundance of these species. ONP can fulfill its obligation to aid regionally based management of bryophytes and lichens mandated by the USFS and BLM Sensitive Species Programs by providing information about the status of bryophyte and lichen populations within its borders.

Project Description

There have been few previous attempts to systematically describe the biodiversity of cryptogams in ONP. Collectors have explored specific areas or places within short walking distance of parking lots. Consequently, the authors strove to expand collections to as many park environments as feasible and distribute them along important environmental gradients in different regions of the park using vascular vegetation as an environmental indicator. They also collected opportunistically when interesting habitats or microhabitats were encountered. Finally, the authors updated the nomenclature in the Park's previous collection of non-vascular plants. Because of the size of this collection (approximately 5,000 specimens), only obvious misidentifications were corrected. The outcome of this project is a more comprehensive survey and more complete species list than previously available, documentation of cryptogam communities, and improvement of the Park's herbarium collection.

Methods

Field Methods

Two types of field methods were employed over three field seasons during this project. In 1999 data were collected intuitively, by searching for specific types of microhabitats. Select diversity hot spots were visited to collect and photograph rare cryptogams. A more systematic inventory of selected major vegetation types was begun in 2000 of Sitka Spruce, Douglas-fir, dry Western Hemlock, moist Western Hemlock, dry Silver Fir, moist Silver Fir, Mountain Hemlock, and Subalpine Fir Zones and alpine parkland throughout the Park. Data were collected according to a modified U.S. Department of Agriculture (USDA) Forest Service Forest Health Monitoring (FHM) protocol (U.S. Forest Service, 1999, described below). Incidental collections and observations using the intuitive approach were also made in 2000. Field methods in 2001 were the same as during 2000, but data were collected in only a few plots.

- Modified FHM Method

Survey sites were selected to include major environmental gradients in ONP and to achieve a distributed geographic sample by using vascular vegetation to indicate environmental conditions. Because there is no map of ONP vegetation at the desired plant-community scale, the Potential Natural Vegetation Map (Henderson and Peters, 2000) and the Park's geographic information system (GIS) were used to stratify ONP by selected major vegetation types. Foot trails that pass through areas of the park having the highest diversity of major vegetation types were selected as sampling routes. The authors planned to complete three plots in each selected vegetation type during the field season. Plots were selected by locating five random points (changed to 10 later in field season) within 200 m of the trail in the section with the target vegetation types. Areas having slopes of more than 35^{o} were rejected at this stage for safety reasons. The Universal Transverse Mercator (UTM) coordinates of the random points were plotted on maps along with an associated random priority ranking for each. A two-person field crew used a global positioning system (GPS) unit to locate collection points. Data were collected at the highest priority UTM point if actual vegetation type matched projected vegetation type and if the collection site was safe to sample. If the vegetation was incorrect or the site unsafe, the crew continued to the next priority site until the target number of plots was completed. The final selection of plots produced a well-distributed and diverse sample of the Park (fig. 1).

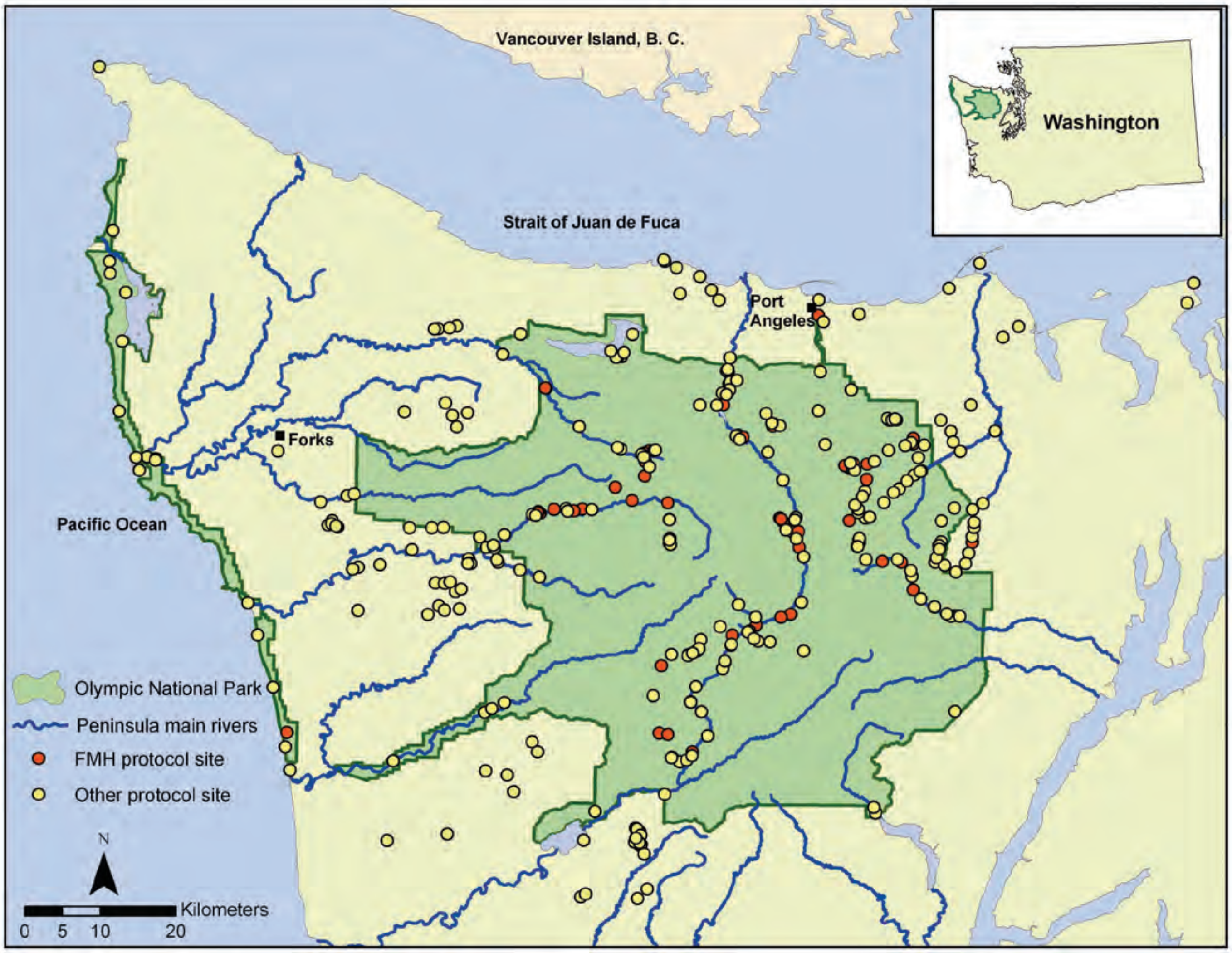

Figure 1. Collection localities on the Olympic Peninsula. Collection localities marked with orange dots are associated with extensive Forest Health Monitoring (FHM) type community data, generated in 2000 and 2001. Localities marked with yellow have collections (one to many) generated from non-FHM search protocols. Most collections outside Olympic National Park are personal data collected by M. Hutten.

- Intuitively Controlled Method

Many bryophytes and lichens are highly microhabitat-specific. Whereas microhabitats are easily targeted when encountered in the field, they are often missed in a sampling method based on more general macrohabitats. Consequently, an intuitively controlled sampling method is more effective in locating certain rare microhabitat- and substrate-specific species. For example, some species of cyano-lichens are found nearly exclusively on semi-exposed conifer twigs in perennially cool and moist microhabitats. Typically, they are further restricted to older forest, in areas where the common cyano-lichens are particularly abundant. When such places were encountered en route between randomly selected plots in the back country, they were checked for the presence of such specialized species if time allowed.

Data were collected using the lichen protocol employed by USFS for the FHM plots. It is a time-constrained search method for epiphytic macrolichens in 36.6-m radius plots for up to 2 hours (U.S. Forest Service, 1999) or until no new species have been found in 10 minutes. The authors modified this approach in several ways.

1. Instead of limiting the sample to epiphytic lichens, field observers searched for all macrolichens, including terrestrial lichens; crustose lichens were collected only accidentally or randomly. Although this modified method leads to a somewhat larger sampled community than the FHM method, the diversity of terrestrial lichens is not high in most heavily forested vegetation types. Within parkland plots, essentially all species are terrestrial, so parklands were a significant departure

from the conditions for which the FHM method was designed. This new environment did not create any problems.

2. Because the main goal of this project was to increase understanding of non-vascular plant occurrence in ONP, the 2-hour time constraint built into the FHM method was not fully appropriate. The authors suspected that 2 hours would not be sufficient to sample the bryophyte community completely. Therefore, if the observer felt it necessary, sampling could be continued beyond 2 hours (this rarely happened). For each specimen the 15-minute time interval of collection was recorded, enabling these data to be compared with FHM data.

3. With the relatively high diversity of macrolichens in ONP's mature forests, the authors suspected that sampling bryophytes and macrolichens simultaneously would be too demanding of one observer. Typically, two people would work on a single plot simultaneously, one taking lichen data, the other bryophyte data. At other times it was deemed most efficient for the crew to split up so that each observer would complete an entire plot alone (4 hours).

4. For lichens, the FHM abundance ratings are based on the frequency of individual thalli.

   1 = rare (less than four individuals)

   2 = occasional (four to 10 individuals

   3 = common (more than 10 individuals)

   4 = more than half of the branches and trunks seen have this species

   Bryophyte data (mosses, liverworts, and hornworts) were collected analogous to lichen data. To apply the lichen abundance rating to bryophytes, however, requires a slightly different concept of 'individual'. For bryophyte species that grow in large mats, the authors defined an individual as a patch of approximately 10 cm^2. This follows a concept used by Abbey Rosso (2000) in western Oregon.

5. It was not expected that the FHM method would be effective at discovering rare species that occur only in specialized microhabitats. Consequently, the authors planned to use an intuitively controlled method to search for species not found in the FHM plot, but in the same target vegetation and nearby the structured plots. The authors called these extra-plot searches. Conducting intensive searches in areas with the highest potential for locating a target species is a method employed by the USFS and BLM (U.S. Department of the Interior, 1998). Because overall trip goals tended to be ambitious, extra-plot searches were not always done thoroughly, and sometimes were omitted.

6. It would have been impossible to pack out voucher specimens for all species on longer trips. Therefore, the authors allowed observational data to be collected for species that can be identified with confidence in the field. Nevertheless, if an easily identified species was interesting for any reason (for example, rare, elevation minimum or maximum, or a first collection in a geographic area in ONP), a voucher specimen was collected.

Processing of Specimens

Upon returning from the field, specimens were air dried. Some liverwort genera with ephemeral identification characters (for instance, oil bodies) were placed in a refrigerator, but refrigeration capacity was quickly exceeded. As a result, many liverworts had to be identified without oil-body characteristics. Specimen data were entered into a database. Dried vouchers were filed alphabetically in their respective taxonomic group (lichens, mosses, and liverworts/hornworts). Specimens were placed in a temporary holding area in the ONP herbarium, in bryophyte boxes with labeled tabs marking genera and species.

Identification Methods

• Equipment and Chemicals

Standard tools and methods were used to identify bryophytes (Schofield, 1985) and lichens (McCune and Geiser, 1997; White & James, 1988). Identifications were made by M. and K. Hutten, with some specimens sent to taxonomic experts for verification.

• Processing Method

Cryptogam specimens were grouped by genus and identified one genus at a time. This allowed the determinations to proceed efficiently, building familiarity with the diversity of characteristics within each genus and the available generic key. Importantly, this processing method increased the determination accuracy, especially for difficult genera. Associated species frequently were identified as well. Many of the smallest lichens and liverworts overlooked in the field are often associated with larger species in voucher specimens. In some plots the associated species contributed 30 percent to the overall plot list. When an interesting associated species was found during determinations, the voucher would be refiled under the generic name of the associate, and identified later with others of that genus. Identifications within previously completed genera were made without delay.

• Identification Literature

Initially, "Moss Flora of the Pacific Northwest," by Elva Lawton (1971), was the basis for specimen identification. All other literature was acquired as the project continued and the need for better keys arose.

Mosses

Subclass *Sphagnidae*: Crum (1984)

In 2004 a new key became available (Zander, 2004), which includes at least two species not reported in Crum that are found on the OP: *Sphagnum pacificum* (Flatberg, 1989) and *Sphagnum alaskense* (Andrus & Jenssens, 2003). Using the old keys, *S. pacificum* would key to *S. recurvum* s.l. During this project we often determined *S. recurvum* var. *brevifolium*. This is a problematic taxon for western North America (W. B. Schofield, written commun., 2004). For these reasons, all collections in the *S. recurvum* group need to be redetermined. *S. alaskense* was recently reported from ONP, but it is not likely the authors overlooked this species in their collections. *S. cuspidatum*, determined twice in this project, is misidentified (W. B. Schofield, written commun., 2004).

Subclass *Andreaeidae*: Lawton (1971); Murray (1986, 1988)

The authors initially used Lawton (1971) but later switched to Murray (1986, 1988). At some time in the future, the *Andreaea* identifications should be verified, identifying any newer species not included in Lawton (1971) that may have been overlooked. This probably resulted in the misdetermination of *A. megistospora* as *A. rothii* (W.B. Schofield, written commun., 2004). A subset of the substantial Harthill collections, predating this project and kept at ONP, should also be redetermined.

Subclass *Bryidae*: Lawton (1971)

For the following select genera in this large subclass we used more recent keys as listed after each genera: *Pohlia* (Shaw, 1982), and *Didymodon* (Zander, 1999). The complex genus *Racomitrium* was started using Lawton (1971), but later the authors switched to Frisvoll (1983, 1988), in which several species aggregates are differentiated. As a result, a portion of the *Racomitrium* collections should be re-examined at some time in the future, as well as a subset of the substantial Harthill collections predating this project that are kept at ONP. The Frisvoll volumes do not cover all species in the genus *Racomitrium,* so we used Lawton (1971) for the remainder of the species. At present Norris and Shevock (2004a) should be considered (see also Bednarek-Ochyra, 2000). *Dicranum* species were verified using Lawton (1971), and for Washington this key is probably adequate. Rare species were verified using a recently published key (Zander 2004), which is more up to date. The many ONP *Dicranum bonjeanii* collections in the ONP Herbarium submitted by Harthill and others are probably *Dicranum howellii* and *D. scoparium*. These should be verified using the new *Dicranum* key in Zander (2004). Some species concepts/groups have been revised fairly recently and our ONP specimens should therefore be re-examined (in part) at some point in the future, including *Hedwigia ciliata*; ours is now called *H. stellata* (Buck & Norris, 1996).

Liverworts

A complete key to liverworts and hornwort (hepatics) genera recently became available (Schofield, 2002). Unfortunately, this work does not contain keys to the species level. At present there is no single work that can be used to identify all hepatic species that occur in ONP. For keys and descriptions of most species found at ONP, one of the best single resources is Judith Godfrey's thesis (1977). The authors used this work extensively, along side updated versions of the Christy and Wagner (1996) keys, the Schuster volumes (1966-1992), and versions of hepatic keys by Dan Norris (unpublished). Rather late in the identification process the authors acquired "The Liverwort Flora of the British Isles" (Paton, 1999), which helped resolve many problems in segregating taxa using the keys in the resources listed above. The "Illustrated Flora of Nordic Liverworts and Hornworts" (Damsholt 2002) would also be useful for some genera, but unfortunately was unavailable. None of the above resources cover all species found in ONP, consequently a myriad of additional literature is needed to identify some of the lesser-known species. Some of this literature was not available to this project.

Lichens

Fortunately, the literature relevant to macrolichens is much more consolidated than is the bryophyte literature. The keys in McCune and Geiser (1997) cover all but a few macro lichens. In general, the omitted lichens are more northern species that can be found in Goward (1999) and Goward and others (1994). For *Leptogium*, *Pseudocyphellaria*, *Usnea*, and *Xanthoria* (McCune, 2000), the authors used updated keys available from Bruce McCune (2000).'s website: (*http://oregonstate.edu/~mccuneb/getkeys.htm*). Some species concepts/groups have been revised fairly recently and ONP specimens should therefore be re-examined (in part) at some point in the future, including *Pannaria/Fuscopannaria*, *Menegazzia*, *Physconia* (*P. fallax* is a species now known from the ONP, but was not in the keys used by the authors for the ONP material), *Pyrrhospora*, and so forth. Most crustose lichens were omitted in this project, but can be keyed to genus using McCune (2002). Many crustose lichens can be keyed to species using Noble (1982) and Purvis and others (1992).

- Names and Titles of Experts Who Were Consulted

The following people have verified specimens during this project. Bruce McCune provided the majority of lichen verification.

1. Dr. Rick Dewey, USFS Botanist: *Riccia, Tritomaria*
2. Chiska Derr, USFS lichen Taxa Expert: Survey and Manage lichens
3. Dr. Linda Geiser, USFS Ecologist and Air Quality Specialist: *Bryoria capillaris*
4. Dr. Katie Glew, University of Washington Herbarium (WTU): *Alectoria samentosa* subsp. *vexillifera*
5. Dr. Judith Harpel, Regional Interagency Bryologist: Survey and Manage bryophytes
6. Sarah Jovan, Ph.D. candidate, student under McCune: *Physconia fallax*
7. Dr. Bruce McCune, Professor, Oregon State University (OSU): lichens
8. Dr. Wilfred Schofield, Professor, University of British Columbia (UBC): bryophytes

Curatorial Methods

- Archival-Quality Voucher Envelopes

Archival-quality voucher envelopes were produced showing standard collection information for each species (fig. 2). A map of the plot locality is also printed on the inside of each voucher envelope. Both the label and the map are printed on the laserprinter in grayscale on acid-free paper.

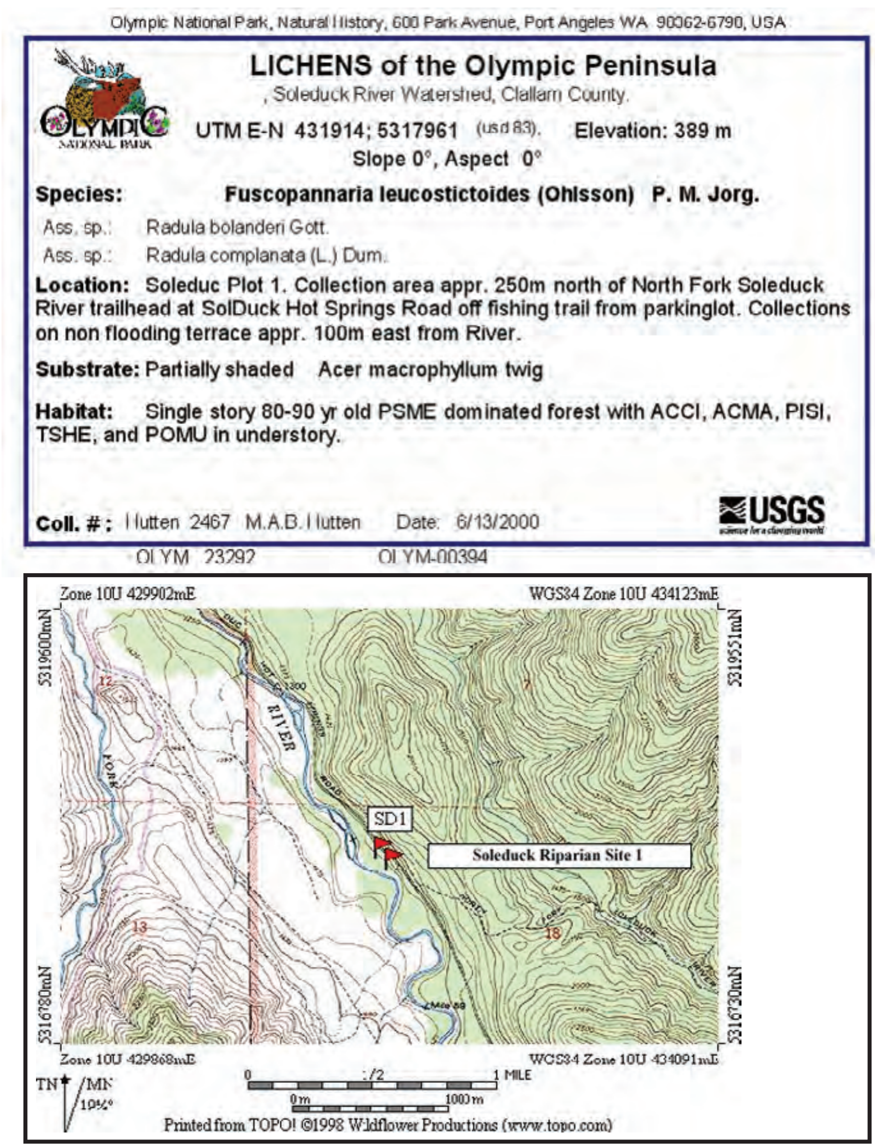

Figure 2. Example of the information on a typical voucher envelope generated during this project.

- Database

A back-end database retains and provides for the integrity of all raw data. See metadata for a detailed description of back-end database structure *(http://mercury.ornl.gov/nbii/full.jsp?index=0&recidx=0&pageMax=1,* November 2005). A front-end database was developed by M. Hutten to create data summaries and additional utilities.

- Quality Assurance/Quality Control for Data Entry

Various database tools were employed to ensure accurate and complete data entry. For example, certain mimimum collection-site data are required before the database will connect voucher data to that site. Similarly, certain collector data must be entered before a collector can be connected to a voucher. A voucher record that lacks these and other critical fields cannot be saved until problems are corrected. The user will be prompted to add the missing data. In several fields, such as the abundance rating, the entry is limited to pre-defined valid entries. The data entry in such fields is usually via drop-down lists from which the applicable entry is selected, expediting the data-entry process, and reducing data-entry errors. These drop-down lists can be embedded directly into the definition of the data table or be associated with specific data-entry forms. More extensive, dynamic drop-down lists are easier to handle as a (lookup) data table. When the specimens had been identified and the data entered, new voucher labels were printed on acid free paper. If key fields are lacking or out of bounds (for example, elevations above 3,000 m), the database does not allow the label to be printed. Printed label data were compared and verified with the field label and associated identification notes before transferring the specimens in the new archival-quality envelope.

- Storage

Specimens are stored at Olympic National Park, 600 Park Avenue, Port Angeles, WA 98362-6798, USA (fig. 3).

Results

Bryophyte and lichen data were collected from 65 modified FHM-style plots throughout ONP (fig. 1) as the main focus of the project. Less formal data collection occurred opportunistically and intuitively from other localities in ONP during the project. The bulk of the opportunistic collections were made near trails and roads while traveling to plot locations. The scope of these collection efforts ranged from a single interesting species found along a trail, to substantial collections from an area of interest. Many of the 'other protocol plots' indicated on figure 1 are localities that were visited by M. and K. Hutten during trips not related to this project. These data are included in the species list and map because they provide additional documentation of the OP bryophyte and lichen flora.

Species List

During the course of this study, some 13,200 bryophyte and lichen species were identified (table 1), adding approximately 425 new species to the ONP Herbarium. These data, combined with select literature reports and personal data from M. and K. Hutten, added more than 350 species to the already extensive OP lichen and bryophyte list compiled from literature by Fred Rhoades (written comm., 1997). A few species were removed from Rhoades' list because the reports were not based on actual collections, or they were based on misdeterminations (for example, all reports of *Scouleria marginata*; J. Harpel, oral commun., 2002). Verification of literature reports requires finding and verifying the determinations of voucher specimens that the literature reports were based on. This was beyond the scope of this project, and it is therefore conceivable that some species listed on the Rhoades' list are in error. Species such as *Rhizomnium appalachianum*, *Scapania nemorosa*, and *Telaranea nematodes* were removed, as they are known exclusively from eastern North America. Currently, more than 1,280 non-vascular plant species, subspecies, and varieties have been documented from the OP (table 1). Some reports still may contain errors, but the authors made no attempt to verify any specimens that were not available at ONP. Only a number of the approximately 5,000 non-vascular plants in the ONP collections predating this project were verified. Checking previous collections was not a goal of this project, and typically records were examined only when errors were suspected. Therefore, many determinations in the ONP collection still need verification. Moreover, some of our determinations need further work for several reasons. Some groups of non-vascular plants were challenging to identify, in part due to the lack of complete and accurate keys for all species in the Pacific Northwest (PNW). Ecological and distributional information for many species, especially bryophytes, is still very incomplete. Plot work often yields many imperfect specimens, which may be small, lack needed structures (for example, sexual), or specimens were not examined when sufficiently fresh (for instance, some liverworts have ephemeral characters), making identification especially challenging.

Figure 3. Part of the lichen collection at the Olympic National Park curatorial facility.

Scientific name	Rhoades [1]	OLYM [2]	Source/comment [3]	OP elevation range (meters) [4]	OP localities [5]	Major vegetation type (FHM- style sampling protocol) [6]															Substrate category [7]				
						Parkland	TSME	ABLA	ABAM dry	ABAM	ABAM wet	PSME dry	PSME	PSME wet	TSHE dry	TSHE	TSHE wet	PISI	ALRU	BOG	Bare Soil	Rock	Epiphyte	Fine Organic	Wood Debris
HORNWORTS																									
Anthoceros fusiformis	✓	✓		47-1068	**10**									1							7				2
Anthoceros punctatus	✓	✓		103-879	**2**																2				
2 HORNWORT species on Rhoades list (1997)						**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**2**	**0**	**0**	**0**	**1**

2 HORNWORTS in ONP Herbarium (OLYM) (1997)

2 HORNWORT species found on OP (2004)

Number of HORNWORT species found in each major vegetation type

Number of HORNWORT species found per substrate category

Scientific name	Rhoades [1]	OLYM [2]	Source/comment [3]	OP elevation range (meters) [4]	OP localities [5]	Parkland	TSME	ABLA	ABAM dry	ABAM	ABAM wet	PSME dry	PSME	PSME wet	TSHE dry	TSHE	TSHE wet	PISI	ALRU	BOG	Bare Soil	Rock	Epiphyte	Fine Organic	Wood Debris
LICHENS																									
Abrothallus welwitschii			OP specimen at BG Herbarium																						
Acarospora fuscata	✓																								
Acarospora smaragdula	✓																								
Ahtiana pallidula	✓	✓	OLYM coll. F. Rhoades	335-1627	**16**				1	4	1	1	3	1	2	1					1		14		1
Ahtiana sphaerosporella	✓	✓	Glew 1998, WNHP Jefferson	1150-2032	**2**																		3		
Alectoria imshaugii				202-1807	**14**		1	1		1												1	11		
Alectoria lata	✓		? McCune: intergr. w ALSA	1461	**1**			1																	
Alectoria nigricans	✓		Glew 1998, WNHP Clallam, Jefferson	1627-2032	**6**	2															2	1		3	1
Alectoria ochroleuca	✓		verif. K. Glew	1873-2032	**4**																	4			
Alectoria sarmentosa subsp. sarmentosa	✓	✓	OP specimen at BG Herbarium	5-2032	**102**	1	17	9	5	11	4	3	3	4	4	5	1	1	1			4	133	2	5
Alectoria sarmentosa subsp. vexillifera	✓		Glew 1998	685-2032	**6**	1					1										1	1	3		
Alectoria vancouverensis	✓			17-1163	**25**		1						5			2	1						18		3
Allantoparmelia alpicola	✓		Glew 1998																						
Amandinea punctata	✓																								
Amygdalaria panaeola	✓																								
Arctomia interfixa	✓																								
Arthonia ilicina			Tønsberg 1995, 1999																						
Arthonia leucopellaea			Tønsberg 1998																						
Arthonia pruinata	✓		OP specimen at BG Herbarium																						
Arthonia radiata	✓																								

Table 1. Species list of mosses, liverworts, hornworts, lichens and associated vegetation types and substrate in Olympic National Park, Washington. (Footnotes on page 52.)

Scientific name	Rhoades[1]	OLYM[2]	Source/comment[3]	OP elevation range (meters)[4]	OP localities[5]	Major vegetation type (FHM- style sampling protocol)[6]: Parkland	TSME	ABLA	ABAM dry	ABAM	ABAM wet	PSME dry	PSME	PSME wet	TSHE dry	TSHE	TSHE wet	PISI	ALRU	BOG	Substrate category[7]: Bare Soil	Rock	Epiphyte	Fine Organic	Wood Debris
Arthonia stellaris	✔		Tønsberg 1995, WNHP Clallam, Jefferson																						
Arthothelium norvegicum			OP specimen at BG Herbarium	5	1																		1		
Arthothelium spectabile			det. John Villella	1031	1																				
Arthrorhaphis aeruginosa			OP specimen at BG Herbarium																						
Arthrorhaphis citrinella	✔																								
Aspicilia aliena	✔																								
Aspicilia caesiocinerea	✔		Glew 1998																						
Aspicilia candida		✔	Brodo et al. 2001, Glew 1998																						
Aspicilia cinerea	✔																								
Aspicilia gibbosa	✔																								
Aspicilia laevata	✔																								
Bacidia arceutina	✔																								
Bacidia heterochroa			OP specimen at BG Herbarium																						
Bacidia salmonea			OP specimen at BG Herbarium																						
Bacidia viridifarinosa			Tønsberg 1997																						
Bacidina arnoldiana			OP specimen at BG Herbarium																						
Bacidina inundata	✔																								
Bacidina phacodes	✔																								
Baeomyces rufus	✔		OP specimen at BG Herbarium	16-907	7																4	1		1	
Bellemerea alpina	✔																								
Bellemerea cinereorufescens	✔		Glew 1998																						
Biatora cuprea	✔	✔																							
Biatora efflorescens			OP specimen at BG Herbarium																						
Biatora flavopunctata	✔		Printzen & Tønsberg 1999 (Tønsberg 16659 in ONP)																						
Biatora hypophaea			Printzen & Tønsberg 1999																						
Biatora meiocarpa var. tacomensis			Printzen & Tønsberg 1999																						
Biatora pausiaca			OP specimen at BG Herbarium																						
Biatora porphyrospoda	✔		Tønsberg 1993																						
Biatora subduplex			OP specimen at BG Herbarium																						
Biatora toensbergii			Printzen & Tønsberg 1999																						
Biatora vacciniicola	✔		Printzen & Tønsberg 1999 (Tønsberg 16660 in ONP)																						

Table 1.—continued (Footnotes on page 52.)

Scientific name	Rhoades[1]	OLYM[2]	Source/comment[3]	OP elevation range (meters)[4]	OP localities[5]	Major vegetation type (FHM- style sampling protocol)[6]: Parkland	TSME	ABLA	ABAM dry	ABAM	ABAM wet	PSME dry	PSME	PSME wet	TSHE dry	TSHE	TSHE wet	PISI	ALRU	BOG	Substrate category[7]: Bare Soil	Rock	Epiphyte	Fine Organic	Wood Debris
Biatora vernalis	✓																								
Brodoa oroarctica	✓	✓	WNHP Clallam	1630-2032	**8**	5																12		1	
Bryonora sp.	✓		B. castanea specimen at OLYM, not verif.																						
Bryoria bicolor			verif. R. Rosentretter	5-814	**3**																		6		
Bryoria capillaris	✓	✓		5-1271	**23**			2				1	6			1	1		1				26		
Bryoria chalybeiformis	✓	✓		948-2032	**7**	2																9	2	2	
Bryoria fremontii	✓	✓		157-1746	**26**		2	4	3	3	1	1			1	1	1					1	23	1	
Bryoria friabilis	✓		WNHP Clallam	79-758	**3**							1											3		
Bryoria furcellata				657-1233	**2**			1															1		
Bryoria fuscescens	✓	✓		419-1958	**37**		6	11		4	1	3	2		1	2							49	1	2
Bryoria glabra	✓			123-1623	**16**		1	7	2	1		1											16		
Bryoria implexa				775-1807	**6**		1	1															7		
Bryoria lanestris	✓		OLYM spec. misdeterm																						
Bryoria 'mystery species'				180-1627	**9**		1	5	1	1													6		
Bryoria nitidula			2 specimens need verification	1807-2032	**2**																	2			
Bryoria pikei	✓		WNHP Clallam																						
Bryoria pseudocapillaris			L. Geiser 2000																						
Bryoria pseudofuscescens	✓	✓		48-1620	**18**			5	2			2											25		
Bryoria subcana			L. Geiser 2000																						
Bryoria tenuis			ID quite firm but will be sent to Brodo	16-825	**2**																		2		
Bryoria tortuosa			verif. T. Tønsberg, WNHP Clallam	79-424	**2**																		3		
Bryoria trichodes				5-624	**4**							1											5		
Bryoria trichodes subsp. americana	✓			17-28	**2**																				
Bryoria trichodes subsp. trichodes	✓																								
Buellia disciformis	✓	✓		289	**1**																		2		
Buellia erubescens	✓		Tønsberg 1998																						
Buellia geophila		✓	Glew 1998																						
Buellia griseovirens		✓	Tønsberg 1998																						
Buellia microbola	✓																								
Buellia muriformis			OP specimen at BG Herbarium																						
Buellia oidalea	✓	✓	OLYM coll. Cooke																						

Table 1.—continued (Footnotes on page 52.)

Scientific name	Rhoades[1]	OLYM[2]	Source/comment[3]	OP elevation range (meters)[4]	OP localities[5]	Major vegetation type (FHM- style sampling protocol)[6]: Parkland	TSME	ABLA	ABAM dry	ABAM	ABAM wet	PSME dry	PSME	PSME wet	TSHE dry	TSHE	TSHE wet	PISI	ALRU	BOG	Substrate category[7]: Bare Soil	Rock	Epiphyte	Fine Organic	Wood Debris
Buellia papillata	✓																								
Buellia stillingiana	✓																								
Buellia turgescens	✓																								
Bunodophoron melanocarpum	✓	✓	verif. B. McCune, OP specimen at BG Herbarium	8-167	**4**																		3	1	2
Byssoloma marginatum			OP specimen at BG Herbarium																						
Calicium abietinum	✓	✓	OLYM coll F. Rhoades																						
Calicium glaucellum	✓	✓	OLYM coll F. Rhoades																						
Calicium lenticulare				182	**1**																				1
Calicium salicinum	✓																								
Calicium viride	✓			123-624	**3**							1					1						2		
Caloplaca ammiospila			Glew 1998																						
Caloplaca atroalba	✓																								
Caloplaca atrosanguinea	✓		Tønsberg 1999c																						
Caloplaca bolacina	✓																								
Caloplaca cerina	✓																								
Caloplaca cf. *borealis*			ONP specimen det. C. Wetmore 2004																						
Caloplaca citrina	✓		OP specimen at BG Herbarium																						
Caloplaca crenularia	✓																								
Caloplaca dispersa			Glew 1998																						
Caloplaca epithallina	✓		Glew 1998																						
Caloplaca ferruginea	✓																								
Caloplaca flavogranulosa	✓																								
Caloplaca flavorubescens	✓																								
Caloplaca holocarpa group	✓		ONP specimen in BG Herbarium specimen conf. C. Wetmore 2004																						
Caloplaca jungermanniae	✓																								
Caloplaca lamprocheila		✓	Glew 1998																						
Caloplaca litoricola			OP specimen at BG Herbarium																						
Caloplaca luteominia var. *luteominia*	✓																								
Caloplaca marina subsp. *americana*	✓																								
Caloplaca rosei	✓																								
Caloplaca saxicola			Glew 1998																						

Table 1.—continued (Footnotes on page 52.)

Scientific name	Rhoades[1]	OLYM[2]	Source/comment[3]	OP elevation range (meters)[4]	OP localities[5]	Major vegetation type (FHM- style sampling protocol)[6]: Parkland	TSME	ABLA	ABAM dry	ABAM	ABAM wet	PSME dry	PSME	PSME wet	TSHE dry	TSHE	TSHE wet	PISI	ALRU	BOG	Substrate category[7]: Bare Soil	Rock	Epiphyte	Fine Organic	Wood Debris
Caloplaca sinapisperma	✓	✓																							
Caloplaca sorocarpa	✓		ONP specimen in BG Herbarium specimen conf. C. Wetmore 2004																						
Caloplaca tiroliensis			Glew 1998																						
Candelaria concolor				93	**1**								1												
Candelariella aurella	✓		Glew 1998																						
Candelariella reflexa			OP specimen at BG Herbarium																						
Candelariella terrigena			Glew 1998																						
Candelariella vitellina	✓		Glew 1998																						
Candelariella xanthostigma			OP specimen at BG Herbarium																						
Catapyrenium cinereum	✓																								
Catapyrenium daedalum			verif. B. McCune	1627	**1**																	1			
Catillaria franciscana	✓																								
Catinaria atropurpurea	✓																								
Cavernularia hultenii	✓		OP specimen at BG Herbarium	5-1307	**42**		9				5			1									53		
Cavernularia lophyrea	✓			2-939	**24**																	1	15		
Cetraria aculeata	✓	✓		1630-2032	**7**	5															3	3		10	
Cetraria arenaria	✓	✓																							
Cetraria ericetorum				1167-2032	**10**	2															2	4		7	
Cetraria ericetorum subsp. ericetorum	✓																								
Cetraria ericetorum subsp. reticulata	✓																								
Cetraria islandica subsp. crispiformis	✓																								
Cetraria islandica subsp. islandica	✓	✓		1482-2032	**10**	4															1	3		13	
Cetraria laevigata	✓																								
Cetraria muricata	✓			1238-2032	**8**	4															2	6		9	1
Cetrelia cetrarioides		✓		5-289	**7**												2						5		1
Chaenotheca ferruginea			OP specimen at BG Herbarium																						
Chaenotheca furfuracea	✓		OP specimen at BG Herbarium	5-1271	**4**		2	1														3			
Chrysothrix candelaris	✓	✓	Tønsberg 1999c	5-707	**8**											1	1						2		1
Chrysothrix chlorina	✓			130-822	**3**								1									1	2		
Chrysothrix chrysophthalma			OP specimen at BG Herbarium																						
Chrysothrix granulosa			OP specimen at BG Herbarium																						

Table 1.—continued (Footnotes on page 52.)

Scientific name	Rhoades[1]	OLYM[2]	Source/comment[3]	OP elevation range (meters)[4]	OP localities[5]	Major vegetation type (FHM- style sampling protocol)[6]: Parkland	TSME	ABLA	ABAM dry	ABAM	ABAM wet	PSME dry	PSME	PSME wet	TSHE dry	TSHE	TSHE wet	PISI	ALRU	BOG	Substrate category[7]: Bare Soil	Rock	Epiphyte	Fine Organic	Wood Debris
Cladina arbuscula	✓		Glew 1998																						
Cladina arbuscula var. beringeriana			Brodo et al. 2001																						
Cladina mitis	✓	✓		212-1978	**12**	5															2	2		9	1
Cladina portentosa	✓			46-778	**5**																1			1	1
Cladina portentosa subsp. pacifica				16-176	**3**																			1	
Cladina rangiferina	✓			176-1238	**17**										1						2	2		12	1
Cladina stellaris	✓																								
Cladonia albonigra				28-1271	**3**			1																1	2
Cladonia artuata	✓																								
Cladonia asahinae	✓																								
Cladonia bacilliformis				182-685	**2**						1														1
Cladonia bellidiflora	✓	✓		5-1746	**48**	2	8		5	2			2	1	2	4		3	1	3	5	5	11	21	18
Cladonia cariosa	✓	✓	Glew 1998	1511-1958	**3**			1													1			1	
Cladonia carneola	✓			28-1678	**30**	1	6	3	3	1		1		3		1		2				2	1	11	19
Cladonia cenotea	✓			159-778	**3**											1									2
Cladonia cervicornis subsp. cervicornis				948-1886	**5**																	1	1	3	1
Cladonia cervicornis subsp. verticillata	✓	✓		1348	**1**																			1	
Cladonia chlorophaea	✓	✓		5-1745	**22**	2	3	7	1	2						2	1				5	5	2	15	6
Cladonia coccifera	✓	✓		1160-1930	**2**																1				
Cladonia coniocraea	✓	✓		134-1620	**19**		4	2		3		1	1	1		3	1	1	2			1	6	2	10
Cladonia cornuta subsp. cornuta	✓			5-182	**2**																				1
Cladonia crispata var. crispata	✓			16-389	**5**									1				2			1		3	2	
Cladonia cyanipes	✓			637	**1**						2														2
Cladonia decorticata	✓	✓		1167	**1**																				
Cladonia deformis	✓																								
Cladonia digitata				159-634	**6**					1						2							2		4
Cladonia dimorpha	✓																								
Cladonia ecmocyna	✓	✓		723-2032	**15**	4															1	4		18	
Cladonia ecmocyna subsp. ecmocyna	✓	✓																							
Cladonia ecmocyna subsp. intermedia				825-1437	**4**	1																1		2	
Cladonia ecmocyna subsp. occidentalis				825-1807	**8**	1	2								1						1	1		4	

Table 1.—continued (Footnotes on page 52.)

Scientific name	Rhoades[1]	OLYM[2]	Source/comment[3]	OP elevation range (meters)[4]	OP localities[5]	Major vegetation type (FHM- style sampling protocol)[6] Parkland	TSME	ABLA	ABAM dry	ABAM	ABAM wet	PSME dry	PSME	PSME wet	TSHE dry	TSHE	TSHE wet	PISI	ALRU	BOG	Substrate category[7] Bare Soil	Rock	Epiphyte	Fine Organic	Wood Debris
Cladonia fimbriata	✓	✓		5-1627	**18**			4		2		1				1					3	2	1	5	3
Cladonia furcata	✓	✓		176-1167	**14**							1			1	1					3			11	
Cladonia gracilis	✓	✓	Glew 1998	1437-1746	**4**	1															1			2	
Cladonia gracilis subsp. elongata				1627	**1**																				
Cladonia gracilis subsp. turbinata	✓			1160	**1**																			1	
Cladonia gracilis subsp. vulnerata				1807	**1**																	1			
Cladonia grayi	✓			1093-1627	**3**					1														2	1
Cladonia humilis	✓																								
Cladonia macilenta	✓			93-1164	**3**				1				2										1		2
Cladonia macilenta var. bacillaris	✓																								
Cladonia macrophylla	✓	✓																							
Cladonia macrophyllodes	✓			1325-1958	**6**	2															4			2	
Cladonia merochlorophaea	✓			210-1292	**5**		1			2								1					2	1	2
Cladonia metacorallifera	✓			1218	**1**				1														1		
Cladonia multiformis	✓	✓		16-1160	**2**																			1	
Cladonia norvegica	✓		OP specimen at BG Herbarium, Tønsberg & Goward 1992, WNHP	196-1292	**13**		4	3		4	1		1					1					2	1	14
Cladonia novochlorophaea				1950-1978	**2**	2																		1	
Cladonia ochrochlora				5-1629	**28**		7	4	6	5	2	1	3				2	1	2		1	1	10	1	25
Cladonia phyllophora				1167	**1**																			1	
Cladonia pleurota				624-1160	**2**							1										1	1		
Cladonia pocillum	✓			1167-1958	**4**																1			3	
Cladonia pyxidata	✓	✓		5-1978	**18**	3	1								1					1	3	5	1	4	1
Cladonia rei	✓	✓		637-1292	**2**		1				1														1
Cladonia scabriuscula	✓			5-1958	**27**		2			1		2	1	2		4		6	2	1	4	1	9	9	11
Cladonia schofieldii				1745-1950	**2**	1																		1	
Cladonia singularis				822-1348	**2**																				1
Cladonia sp.1				19-564	**5**					1						2							2	1	3
Cladonia squamosa var. squamosa	✓	✓		0-1437	**30**	1	2		2	3	2			1	4	2					2	2	4	15	17
Cladonia squamosa var. subsquamosa	✓	✓		5-1164	**28**				1	1	1	1	7	1		3	1	3		5		1	7	1	18
Cladonia stricta	✓																								
Cladonia subulata	✓			1002	**1**											1									1

Table 1.—continued (Footnotes on page 52.)

Scientific name	Rhoades[1]	OLYM[2]	Source/comment[3]	OP elevation range (meters)[4]	OP localities[5]	Major vegetation type (FHM- style sampling protocol)[6] Parkland	TSME	ABLA	ABAM dry	ABAM	ABAM wet	PSME dry	PSME	PSME wet	TSHE dry	TSHE	TSHE wet	PISI	ALRU	BOG	Substrate category[7] Bare Soil	Rock	Epiphyte	Fine Organic	Wood Debris
Cladonia sulphurina	✓			723-1476	**6**		1	1															1		4
Cladonia symphycarpa				1629	**1**																1				
Cladonia transcendens	✓	✓		5-1261	**29**		2		1	1	2		4	3	2	4		7	2	2			11	2	24
Cladonia turgida	✓																								
Cladonia umbricola				5-1511	**31**		4	2		5	3	2	5	2				1	2				14	1	24
Cladonia uncialis	✓																								
Cladonia verruculosa	✓			1134-1511	**4**	3		1													2	1		2	
Cliostomum flavidulum			Tønsberg 1997																						
Cliostomum griffithii	✓		Tønsberg 1999c																						
Cliostomum leprosum			OP specimen at BG Herbarium																						
Coccotrema pocillarium	✓		Tønsberg 1998 WNHP Clallam	5	**1**																		2		
Collema fecundum				2	**1**																	1			
Collema furfuraceum			OP specimen at BG Herbarium																						
Collema fuscovirens			cf. (M. Hutten specimen)	1624	**1**																	1			
Collema glebulentum				1630	**1**																	1			
Collema occultatum	✓		OP specimen at BG Herbarium																						
Collema sp. 1			preliminary, to be verified	948	**1**																				
Collema undulatum var. granulosum			preliminary, to be verified	2032	**1**																	1			
Cornicularia normoerica	✓	✓	WNHP Clallam	1630-2032	**9**	4																11			
Cyphelium inquinans	✓	✓		123-778	**3**												1						1		
Cyphelium lucidum	✓																								
Cyphelium pinicola	✓																								
Cyphelium tigillare	✓	✓																							
Cystocoleus ebeneus	✓		OP specimen at BG Herbarium, WNHP Grays Harbor																						
Dactylospora parasitica			OP specimen at BG Herbarium																						
Dendriscocaulon sp.			verif. C. Derr	5-317	**2**																		2		
Dermatocarpon intestiniforme	✓			1958	**1**																			1	
Dermatocarpon luridum	✓		WNHP Clallam, Jefferson, S&M documents																						
Dermatocarpon miniatum	✓	✓		822-2032	**4**																	2	1	1	
Dermatocarpon moulinsii				948	**1**																				
Dermatocarpon reticulatum	✓			1539-2032	**5**																	2			

Table 1.—continued (Footnotes on page 52.)

Scientific name	Rhoades[1]	OLYM[2]	Source/comment[3]	OP elevation range (meters)[4]	OP localities[5]	Major vegetation type (FHM- style sampling protocol)[6]: Parkland	TSME	ABLA	ABAM dry	ABAM	ABAM wet	PSME dry	PSME	PSME wet	TSHE dry	TSHE	TSHE wet	PISI	ALRU	BOG	Substrate category[7]: Bare Soil	Rock	Epiphyte	Fine Organic	Wood Debris
Dermatocarpon rivulorum	✓	✓		1348-1950	**6**	1																4			
Dimerella lutea			OP specimen at BG Herbarium																						
Dimerella pineti			OP specimen at BG Herbarium	1044	**1**					1														1	
Diploschistes scruposus	✓	✓																							
Diplotomma alboatrum	✓																								
Diplotomma penichrum	✓																								
Endocarpon pusillum				1886	**1**																	1			
Endococcus apiciicola			OP specimen at BG Herbarium																						
Erioderma sorediatum	✓		verif. B. McCune, OP specimen at BG Herbarium	5-289	**3**																		3		
Esslingeriana idahoensis				265-1525	**8**							1			1								7		
Euopsis granatina	✓																								
Evernia prunastri	✓	✓		0-419	**12**								2				3						8		1
Fellhanera bouteillei			OP specimen at BG Herbarium	7-180	**3**																		6		
Fellhaneropsis vezdae			OP specimen at BG Herbarium																						
Fissurina insidiosa																									
Flavocetraria cucullata	✓	✓		1630-2032	**8**	3															2	2		5	
Flavocetraria nivalis	✓			1807-2032	**7**	3															2	1		8	
Flavopunctelia soredica	✓																								
Fuscopannaria laceratula			verif. B. McCune	5-861	**5**		1					1		1								2	3		1
Fuscopannaria leucophaea	✓		OP specimen s.l. at BG Herbarium																						
Fuscopannaria leucostictoides			OP specimen at BG Herbarium	5-865	**15**							3		2		1			3			2	17	1	
Fuscopannaria maritima			Note our material needs to be be redetermined																						
Fuscopannaria mediterranea			Note our material needs to be be redetermined	389	**1**									1									1		
Fuscopannaria pacifica			OP specimen at BG Herbarium, ours: re-determinations required	5	**1**																				
Fuscopannaria praetermissa	✓			574-1807	**5**			1				1			1							1	1		
Fuscopannaria saubinetii			re-determinations required	183-1181	**25**				1					1		6			1			2	19		3
Graphis elegans	✓		OP specimen at BG Herbarium																						
Graphis scripta	✓	✓	OP specimen at BG Herbarium	123-289	**4**														1						1
Gyalideopsis anastomosans	✓		Tønsberg 1995																						
Gyalideopsis muscicola			Tønsberg and Henssen 1999																						
Gyalideopsis piceicola	✓		Tønsberg 1995	465	**1**																		1		

Table 1.—continued (Footnotes on page 52.)

Scientific name	Rhoades [1]	OLYM [2]	Source/comment [3]	OP elevation range (meters) [4]	OP localities [5]	Major vegetation type (FHM- style sampling protocol) [6]: Parkland	TSME	ABLA	ABAM dry	ABAM	ABAM wet	PSME dry	PSME	PSME wet	TSHE dry	TSHE	TSHE wet	PISI	ALRU	BOG	Substrate category [7]: Bare Soil	Rock	Epiphyte	Fine Organic	Wood Debris
Haematomma persoonii		✓	specimen at ONP herbarium, not verified																						
Halecania viridescens	✓		Tønsberg 1998, WNHP Clallam																						
Heterodermia leucomela			L. Geiser 2000																						
Hydrothyria venosa	✓				**1**																				
Hypocenomyce castaneocinerea				16-1624	**10**			2				2					1						3	1	7
Hypocenomyce friesii	✓			900-1624	**2**																				2
Hypocenomyce leucococca			1 tentative ONP spec.	1511	**1**			1																	1
Hypocenomyce scalaris	✓			618-1629	**5**			1				2											2		2
Hypogymnia apinnata	✓			5-1627	**67**		5	3		2	11	3	3	1	2	6	1	3	1	3			64	1	1
Hypogymnia austerodes	✓		Glew 1998	1958	**1**																	1	1		
Hypogymnia bitteri	✓																								
Hypogymnia duplicata	✓		verif. C. Derr, WNHP Clall, Jeff, Grays H.	8-1627	**48**		4			1	1			2		3						1	55		1
Hypogymnia enteromorpha	✓	✓	OP specimen at BG Herbarium	0-1629	**81**		11	3	4	14	8	2	14	4	4	8		3	4		1	1	110	1	5
Hypogymnia imshaugii	✓	✓		123-2032	**49**	1	6	12	2	4	1	2	2		3	3	1					2	49		
Hypogymnia inactiva	✓			5-1261	**33**		2						2	1								1	26		
Hypogymnia metaphysodes	✓	✓	verif. B. McCune	618-1620	**21**		3	6	1	2		2			1	1							16		2
Hypogymnia occidentalis	✓			177-1886	**21**		3	4		2	4				1								17	1	2
Hypogymnia oceanica	✓	✓		190-822	**5**						1			1		1		1					5		
Hypogymnia physodes	✓	✓		0-1807	**51**		2	3		1	1	1	6	1	2	3	2		2			1	38	1	3
Hypogymnia rugosa	✓	✓		624-2032	**36**		8	8	3	2	2	1				2					1		27		3
Hypogymnia tubulosa	✓			0-1299	**14**																		9		1
Hypogymnia vittata	✓		verify sources! WNHP Grays Harbor																						
Hypotrachyna sinuosa	✓		OP specimen at BG Herbarium	5-829	**16**								1							3			9		
Icmadophila ericetorum	✓	✓		5-1271	**28**			1		2	2		1	1		5		2		1			1	1	16
Ionaspis lacustris																									
Japewia subaurifera			OP specimen at BG Herbarium																						
Kaernefeltia californica		✓	verif. B. McCune, WNHP OP data in error?	5	**1**															1			1		
Kaernefeltia merrillii	✓	✓		130-2032	**18**		3	1	1			2	1										17		
Koerberia sonomensis			McCune says our Vestergrenopsis isidiata are KOSO	1478-1624	**2**																	2			
Lecanactis abietina	✓																								
Lecania cyrtella	✓																								

Table 1.—continued (Footnotes on page 52.)

Scientific name	Rhoades[1]	OLYM[2]	Source/comment[3]	OP elevation range (meters)[4]	OP localities[5]	Major vegetation type (FHM- style sampling protocol)[6]: Parkland	TSME	ABLA	ABAM dry	ABAM	ABAM wet	PSME dry	PSME	PSME wet	TSHE dry	TSHE	TSHE wet	PISI	ALRU	BOG	Substrate category[7]: Bare Soil	Rock	Epiphyte	Fine Organic	Wood Debris
Lecania naegelii	✓																								
Lecanora albella var. albella	✓																								
Lecanora allophana	✓	✓																							
Lecanora bicincta			Glew 1998																						
Lecanora cadubriae	✓																								
Lecanora cenisia	✓																								
Lecanora cinereofusca var. cinereofusca	✓		OP specimen at BG Herbarium																						
Lecanora circumborealis	✓																								
Lecanora dispersa	✓		Glew 1998																						
Lecanora epibryon	✓		Glew 1998																						
Lecanora expallens	✓		OP specimen at BG Herbarium																						
Lecanora farinaria	✓		Tønsberg 1995, 1999	289	1																		1		
Lecanora fuscescens	✓																								
Lecanora hagenii	✓		Glew 1998																						
Lecanora jamesii			Tønsberg 1997, 1999																						
Lecanora malaena			Glew 1998																						
Lecanora muralis	✓																								
Lecanora pacifica	✓																								
Lecanora polytropa	✓	✓	Glew 1998																						
Lecanora pulicaris	✓	✓		5-5	2																		1		
Lecanora rupicola	✓																								
Lecanora symmicta	✓																								
Lecanora umbrosa	✓																								
Lecanora varia	✓																								
Lecanora xylophila																									
Lecidea atrobrunnea	✓		Glew 1998																						
Lecidea cascadensis			Glew 1998																						
Lecidea furvonigrans	✓																								
Lecidea fuscoatra	✓																								
Lecidea lapacida	✓		Glew 1998																						
Lecidea praenubila	✓																								

Table 1.—continued (Footnotes on page 52.)

Scientific name	Rhoades[1]	OLYM[2]	Source/comment[3]	OP elevation range (meters)[4]	OP localities[5]	Major vegetation type (FHM- style sampling protocol)[6]: Parkland	TSME	ABLA	ABAM dry	ABAM	ABAM wet	PSME dry	PSME	PSME wet	TSHE dry	TSHE	TSHE wet	PISI	ALRU	BOG	Substrate category[7]: Bare Soil	Rock	Epiphyte	Fine Organic	Wood Debris
Lecidea roseotincta			OP specimen at BG Herbarium																						
Lecidea tessellata	✓		Glew 1998																						
Lecidea wulfenii			Glew 1998																						
Lecidella anomaloides	✓																								
Lecidella elaeochroma	✓		Tønsberg 1998																						
Lecidella euphorea	✓			1134-1167	**3**																	1	9		1
Lecidella stigmatea	✓																								
Lecidella wulfenii	✓	✓																							
Lecidoma demissum			Glew 1998																						
Leioderma sorediatum			verif. B. McCune, pers. com. Tonsberg 2004	8	**1**																		1		
Lepraria cacuminum			Glew 1998																						
Lepraria caesioalba				181-948	**3**																		1	1	1
Lepraria diffusa var. diffusa	✓																								
Lepraria eburnea			OP specimen at BG Herbarium																						
Lepraria incana	✓	✓		134-1218	**4**				1										1				2		1
Lepraria lobificans			OP specimen at BG Herbarium	109-1629	**14**		1				2		1	2		1		3					14	1	5
Lepraria neglecta	✓	✓	Glew 1998	182	**1**																				
Lepraria vouauxii	✓	✓																							
Leprocaulon microscopicum	✓																								
Leprocaulon subalbicans			Glew 1998	1150-2032	**7**																3	6			
Leptochidium albociliatum				775-1150	**4**																	4			
Leptogium brebissonii			OP specimen at BG Herbarium	5-317	**6**																		9		
Leptogium californicum				208-1002	**4**							1				1		1				2	1		
Leptogium corniculatum	✓		OP specimen at BG Herbarium	0-1167	**22**							2		1	2	1		1			6	5	6	13	
Leptogium cyanescens			OP specimen at BG Herbarium	5-1233	**15**			1				2				6		3				4	7	1	
Leptogium gelatinosum				5-165	**2**																		1		
Leptogium lichenoides	✓			307-1630	**12**							2				1						8	1	1	1
Leptogium minutissimum				948-2032	**2**																	2			
Leptogium platynum	✓			775-2032	**3**																	1		2	
Leptogium polycarpum			OP specimen at BG Herbarium	5-1265	**14**								1	2		1		4				3	5		2
Leptogium saturninum				1807	**1**																	1			

Table 1.—continued (Footnotes on page 52.)

Scientific name	Rhoades[1]	OLYM[2]	Source/comment[3]	OP elevation range (meters)[4]	OP localities[5]	Major vegetation type (FHM- style sampling protocol)[6]: Parkland	TSME	ABLA	ABAM dry	ABAM	ABAM wet	PSME dry	PSME	PSME wet	TSHE dry	TSHE	TSHE wet	PISI	ALRU	BOG	Substrate category[7]: Bare Soil	Rock	Epiphyte	Fine Organic	Wood Debris
Leptogium subaridum				778	**1**																				
Leptogium tenuissimum				392-1160	**3**																2	1			
Leptogium teretiusculum				182-1000	**7**							2						1				3			
Letharia columbiana	✓	✓	OP specimen at BG Herbarium	1590-2032	**6**																		2		1
Letharia vulpina	✓	✓	OP specimen at BG Herbarium	248-2032	**16**		1	2		1		1											4	1	2
Lichenodiplis lecanoricola			OP specimen at BG Herbarium																						
Lobaria hallii	✓		OP specimen at BG Herbarium, WNHP Jefferson	180-778	**7**						1								1				8		1
Lobaria linita	✓	✓	verif. C. Derr	202-2032	**40**		6			1	1											12	29	1	
Lobaria oregana	✓	✓	OP specimen at BG Herbarium	5-1096	**47**		5			2	5	1	1	4	3	4		5	1				54		1
Lobaria pulmonaria	✓	✓	OP specimen at BG Herbarium	5-1292	**33**		1			2	1	2	3	1		1	1		2			1	17		
Lobaria scrobiculata	✓		OP specimen at BG Herbarium	5-1150	**15**						1				1							1	12		
Lobaria silvae-veteris			Tønsberg 1998																						
Lopadium disciforme			McCune 26896 submitted to OLYM	5	**1**																		1		
Lopadium pezizoideum	✓																								
Loxospora elatina			Tønsberg 1998																						
Loxosporopsis corallifera			OP specimen at BG Herbarium	5-814	**6**																		4		1
Massalongia carnosa	✓			26-1627	**16**		4	4		4											3	6	1	1	
Megalaria brodoana	✓		Ekman & Tønsberg 1996																						
Megalaria pulverea			OP specimen at BG Herbarium																						
Megaspora verrucosa			Glew 1998																						
Melanelia commixta			Glew 1998	1181	**1**				1													1			
Melanelia disjuncta	✓		Glew 1998	1630	**1**																	1			
Melanelia elegantula	✓			1807-1958	**4**																	10		1	
Melanelia exasperata	✓																								
Melanelia exasperatula	✓		Glew 1998	1807	**1**																	1			
Melanelia fuliginosa				5-1624	**6**								1				2		1	1		1	6		
Melanelia hepatizon	✓		Glew 1998	1347-2032	**8**	6																7		1	
Melanelia infumata	✓		Glew 1998	1807-2032	**2**																	3			
Melanelia multispora	✓		Geiser 2000 data																						
Melanelia panniformis			Glew 1998	1403-1950	**2**	1																1			
Melanelia sorediata	✓		Glew 1998	1059-1807	**2**																	2			

Table 1.—continued (Footnotes on page 52.)

Scientific name	Rhoades[1]	OLYM[2]	Source/comment[3]	OP elevation range (meters)[4]	OP localities[5]	Major vegetation type (FHM- style sampling protocol)[6]: Parkland	TSME	ABLA	ABAM dry	ABAM	ABAM wet	PSME dry	PSME	PSME wet	TSHE dry	TSHE	TSHE wet	PISI	ALRU	BOG	Substrate category[7]: Bare Soil	Rock	Epiphyte	Fine Organic	Wood Debris
Melanelia stygia	✓		Glew 1998	1807-2032	**6**	2																6			
Melanelia subargentifera	✓																								
Melanelia subaurifera	✓			5-778	**3**															1			2		
Melanelia subelegantula				948-1807	**3**			1														1	2		
Melanelia subolivacea	✓			134-1620	**3**			1				1							1				3		
Melanelia tominii			ONP 335 needs work, it may be too convex for METO	1807	**1**																	1			
Menegazzia subsimilis		✓	Bjerke, J.W. 2003																						
Menegazzia terebrata	✓	✓	OP specimen at BG Herbarium, ours: redeterminations needed	5-317	**16**													5	1	4			12		1
Micarea cinerea			OP specimen at BG Herbarium																						
Micarea micrococca			OP specimen at BG Herbarium																						
Micarea myriocarpa			Tønsberg 1999a																						
Micarea peliocarpa			OP specimen at BG Herbarium																						
Micarea prasina			in need of revision: most, if not all represent M. micrococca (pers. com.																						
Micarea prasinella			OP specimen at BG Herbarium																						
Micarea synotheoides			Tønsberg, T. and B. Coppins 2000																						
Micarea xanthonica			Coppins & Tønsberg 2001	5	**1**																				1
Microlychnus epicorticis			OP specimen at BG Herbarium, WNHP Clallam	157	**1**																		1		
Multiclavula mucida				165-877	**4**											1									3
Multiclavula vernalis				103-1134	**3**																3				
Mycobilimbia berengeriana	✓			179	**1**																		1		
Mycobilimbia sabuletorum			Glew 1998																						
Mycoblastus affinis	✓		OP specimen at BG Herbarium, Glew 1998.																						
Mycoblastus alpinus	✓	✓																							
Mycoblastus caesius			Tønsberg 1999c	157	**1**																		2		
Mycoblastus fucatus	✓		Tønsberg 13956, Tønsberg 13765 NOT in ONP, but on OP																						
Mycoblastus sanguinarius	✓	✓	OP specimen at BG Herbarium	5-1511	**22**		2	4		1		1	2		1	1							15		3
Mycoporum antecellens			Tønsberg 1998																						
Neofuscelia verruculifera				1624	**1**																	1			
Nephroma bellum	✓		verif. C. Derr	26-1163	**22**		1				4			1	1	1			1			1	26		2
Nephroma helveticum	✓		OP specimen at BG Herbarium	134-1093	**28**		2			2	1	1		4	2	4			1			1	23		
Nephroma laevigatum	✓	✓	OP specimen at BG Herbarium	93-473	**12**									1		3		2	2				6		1

Table 1.—continued (Footnotes on page 52.)

Scientific name	Rhoades[1]	OLYM[2]	Source/comment[3]	OP elevation range (meters)[4]	OP localities[5]	Major vegetation type (FHM- style sampling protocol)[6]: Parkland	TSME	ABLA	ABAM dry	ABAM	ABAM wet	PSME dry	PSME	PSME wet	TSHE dry	TSHE	TSHE wet	PISI	ALRU	BOG	Substrate category[7]: Bare Soil	Rock	Epiphyte	Fine Organic	Wood Debris
Nephroma occultum			verif. C. Derr	441-1164	**10**				1		2				1	2							9		1
Nephroma parile	✓			183-1745	**40**		1	3		4	2				2	2		1			3	10	20	1	
Nephroma resupinatum	✓	✓	OP specimen at BG Herbarium	93-1627	**31**					1	1	1	1	1		7	1	3	1			3	26		
Niebla cephalota	✓		verif. B. McCune, OP specimen at BG Herbarium	2	**1**																		1		
Nodobryoria abbreviata			Glew 1998	1511-2032	**5**			1															3		2
Nodobryoria oregana	✓			335-2032	**47**	2	9	22	5	4	2	2	1		1							1	55	1	1
Nodobryoria subdivergens				1511-2032	**5**	2		1														3			1
Normandina pulchella			OP specimen at BG Herbarium	5-1134	**9**											3			1			6	9		
Ochrolechia androgyna	✓		Tønsberg 1998	1629	**1**																1				
Ochrolechia farinacea			specimens, verification requested	389-1807	**2**									1									1		
Ochrolechia inaequatula	✓																								
Ochrolechia juvenalis	✓	✓																							
Ochrolechia laevigata	✓			134-1271	**7**			1			1	1							1				6		
Ochrolechia oregonensis	✓			5-1950	**34**	1	3	4	2		1		1	1		2	2						37	2	6
Ochrolechia subathallina	✓	✓																							
Ochrolechia subpallescens				1147-1511	**3**			2		1													3		
Ochrolechia szatalaënsis	✓																								
Ochrolechia tartarea	✓	✓																							
Ochrolechia upsaliensis	✓	✓	Glew 1998	419-2032	**7**	2																1		6	
Omphalina umbellifera	✓			5-1299	**20**			3					1	1		1				1	3			1	4
Opegrapha atra	✓																								
Opegrapha fumosa			Tønsberg 25900, in Tønsberg 1999c, Tønsberg 1997																						
Opegrapha protuberans	✓																								
Opegrapha sorediifera	✓		Tønsberg 1998, WNHP Clallam																						
Opegrapha thelotrematis			Tønsberg 1997, 1999																						
Opegrapha varia	✓																								
Ophioparma lapponica	✓	✓	OLYM det. B. Ryan, WNHP Clall, Jeff																						
Orphniospora moriopsis	✓																								
Pannaria rubiginosa	✓			24	**1**																		1		
Parmelia hygrophila	✓	✓		0-1930	**63**		4	10	3	5	8	4	6	1	3	5	2		2		1	2	67		5
Parmelia omphalodes	✓			1930-1958	**2**																	2			

Table 1.—continued (Footnotes on page 52.)

Scientific name	Rhoades [1]	OLYM [2]	Source/comment [3]	OP elevation range (meters) [4]	OP localities [5]	Major vegetation type (FHM- style sampling protocol) [6]: Parkland	TSME	ABLA	ABAM dry	ABAM	ABAM wet	PSME dry	PSME	PSME wet	TSHE dry	TSHE	TSHE wet	PISI	ALRU	BOG	Substrate category [7]: Bare Soil	Rock	Epiphyte	Fine Organic	Wood Debris
Parmelia pseudosulcata				134-1167	**10**						1			1				1	1				7		2
Parmelia saxatilis	✓	✓		17-2032	**20**	2	1			1		1				1						15	3		2
Parmelia squarrosa				5-1167	**9**															1			9		
Parmelia sulcata	✓	✓		5-1623	**56**		1	8		3		1	6		1	3	6	2	7	2		4	47		8
Parmeliella cyanolepra	✓			47-1624	**4**																2				
Parmeliella parvula			OP specimen at BG Herbarium	5-1292	**18**		2												1			1	23		
Parmeliella triptophylla			OP specimen at BG Herbarium, ONP spec. not separated perfectly, some	182-512	**7**											1							7		
Parmeliopsis ambigua	✓	✓		93-2032	**16**			3	1	1			2			1							9	2	2
Parmeliopsis hyperopta	✓	✓		93-1950	**58**	2	7	9	3	4	4	4	5		3	2		1	2				47	1	6
Parmotrema arnoldii	✓	✓		5-91	**9**																		14		1
Parmotrema chinense	✓			4-5	**2**																		2		
Parmotrema crinitum				5-28	**6**																	1	5		
Parmotrema praesorediosum	✓																								
Peltigera aphthosa	✓	✓		825-1147	**3**					1											2			1	
Peltigera britannica	✓		OP specimen at BG Herbarium	5-1299	**46**		2	1		3	4	3		1	2	6					4	4	13	16	7
Peltigera canina	✓	✓		1134-1807	**4**																			4	
Peltigera cinnamomea				5-574	**2**										1									1	
Peltigera collina	✓	✓	OP specimen at BG Herbarium	5-1630	**33**		1						1	1		6		2	3			5	23	1	3
Peltigera degenii	✓	✓		1746	**1**																	1			
Peltigera didactyla	✓	✓		511-1978	**7**	3															3			1	1
Peltigera horizontalis	✓																								
Peltigera kristinssonii			Glew 1998	1233	**1**			1													1				
Peltigera lepidophora			Glew 1998, WNHP Clallam																						
Peltigera leucophlebia	✓	✓	OP specimen at BG Herbarium	265-1629	**20**	2	1	2	1	2					1						4	1	1	10	
Peltigera malacea	✓	✓		1233-1978	**5**	3		1													1	1		3	
Peltigera membranacea	✓	✓		5-1299	**40**		2	6	2	3	4	2	1	2			1	2		1	3	1	5	14	11
Peltigera neckeri				5-1509	**8**					1		1		1						1				2	2
Peltigera neopolydactyla	✓			5-1261	**36**		2			3	3			1	1	6		4		3	2	1	7	4	15
Peltigera pacifica				8-1509	**19**		1						1	1		1	1		1			4	2		4
Peltigera polydactylon	✓	✓		5-1261	**11**		2				1					1	1				1			1	4
Peltigera ponojensis				778-1978	**11**	2		3													3	2		4	

Table 1.—continued (Footnotes on page 52.)

Scientific name	Rhoades[1]	OLYM[2]	Source/comment[3]	OP elevation range (meters)[4]	OP localities[5]	Major vegetation type (FHM- style sampling protocol)[6]: Parkland	TSME	ABLA	ABAM dry	ABAM	ABAM wet	PSME dry	PSME	PSME wet	TSHE dry	TSHE	TSHE wet	PISI	ALRU	BOG	Substrate category[7]: Bare Soil	Rock	Epiphyte	Fine Organic	Wood Debris
Peltigera praetextata	✓			409-1807	**19**		2	3			1	1			1	1					1	8	1	6	
Peltigera retifoveata				1886	**1**																			2	
Peltigera rufescens	✓	✓		1160-2032	**13**	5	1														3	4		7	
Peltigera scabrosa	✓																								
Peltigera venosa	✓	✓		5-1620	**16**	1		1		1				1		1					4			1	1
Pertusaria amara	✓		OP specimen at BG Herbarium	5-79	**3**																		1		
Pertusaria borealis	✓		OP specimen at BG Herbarium	182-210	**2**													1					2		
Pertusaria cocodes			Tønsberg 1999a																						
Pertusaria glaucomela	✓		OP specimen at BG Herbarium																						
Pertusaria leioplaca	✓			16	**1**																		1		
Pertusaria ophthalmiza	✓	✓	OP specimen at BG Herbarium	16-182	**2**																		1		
Pertusaria pupillaris			OP specimen at BG Herbarium	157	**1**																		1		
Pertusaria subambigens	✓	✓	OP specimen at BG Herbarium																						
Phacopsis oxyspora																									
Phaeocalicium curtisii	✓																								
Phaeographis smithii			Tønsberg 1999a																						
Phaeophyscia constipata	✓																								
Phaeophyscia endococcinea	✓																								
Phaeophyscia orbicularis	✓			1807-1886	**2**																	3			
Phaeophyscia sciastra	✓		Glew 1998	1807	**1**																	1			
Phaeorrhiza nimbosa			Glew 1998																						
Phlyctis argena			OP specimen at BG Herbarium																						
Phlyctis speirea			OP specimen at BG Herbarium																						
Physcia adscendens	✓			2-190	**8**												1		3			1	7		
Physcia aipolia	✓			74-778	**9**												1		4				7		1
Physcia biziana				1630-1930	**3**																	3			
Physcia caesia	✓	✓	Glew 1998	26-2032	**4**																	4			
Physcia callosa			cf. very poor specimen	2032	**1**																	1			
Physcia dimidiata			Glew 1998	948	**1**																	1			
Physcia dubia	✓			1807	**1**																	1			
Physcia leptalea	✓																								

Table 1.—continued (Footnotes on page 52.)

Scientific name	Rhoades[1]	OLYM[2]	Source/comment[3]	OP elevation range (meters)[4]	OP localities[5]	Major vegetation type (FHM- style sampling protocol)[6]: Parkland	TSME	ABLA	ABAM dry	ABAM	ABAM wet	PSME dry	PSME	PSME wet	TSHE dry	TSHE	TSHE wet	PISI	ALRU	BOG	Substrate category[7]: Bare Soil	Rock	Epiphyte	Fine Organic	Wood Debris
Physcia phaea		✓	OLYM seastack; P. cascadensis?	26	**1**																	1			
Physcia tenella			OP specimen at BG Herbarium	0-134	**5**														1			1	6		
Physconia americana				473-1807	**2**														2						2
Physconia detersa	✓																								
Physconia fallax			det. Sarah Jovan, 2003	43	**1**																				
Physconia muscigena	✓			43-2032	**6**																	8		4	
Pilophorus acicularis	✓		OP specimen at BG Herbarium	153-1292	**25**					3		2	1		2	2						10			
Pilophorus clavatus	✓			153-1348	**18**		5			4					1							9			
Pilophorus nigricaulis			verif. C. Derr	634-1627	**4**					1												6			
Placopsis gelida	✓			702	**1**																				
Placopsis lambii			most of Placopsis gelida is P.lambii acc. McCune	374-877	**4**																	1			
Placynthiella uliginosa	✓	✓	Glew 1998																						
Platismatia glauca	✓	✓		0-1930	**97**		14	14	4	7	5	2	7	1	3	7	2	3	2	2		1	92	1	6
Platismatia herrei	✓	✓		5-1511	**81**		7	8	3	5	6	3	4	1	3	8	2	1	4	3			60		1
Platismatia lacunosa	✓	✓	verif. C. Derr, OP specimen at BG Herbarium	3-1012	**32**		2					1							2				28		2
Platismatia norvegica	✓	✓		5-1307	**54**		6			6	4	1	1	1	3	5		2	1	1			36		3
Platismatia stenophylla	✓			829-1012	**3**																		2		
Pleopsidium chlorophanum	✓	✓		1807	**1**																	1			
Pleopsidium flavum			verif. K. Glew	1958	**1**																	1			
Polychidium Aff. contortum			OP specimen at BG Herbarium	5-1012	**31**								2	1	2	2							39		
Polychidium muscicola	✓			389-1627	**8**		1							1		1					1	6			
Porina leptalea			Tønsberg 1999c																						
Porina radicicola			McCarthy and Tønsberg 1998																						
Porpidia carlottiana	✓																								
Porpidia contrapoenda	✓																								
Porpidia crustulata	✓																								
Porpidia thomsonii	✓																								
Protopannaria pezizoides	✓		Glew 1998	5-1698	**21**	3	7	1		3											8	6	4	5	3
Protoparmelia badia	✓																								
Pseudephebe minuscula	✓	✓		948-2032	**9**	5																14			
Pseudephebe pubescens	✓	✓		948-2032	**12**	11																31			

Table 1.—continued (Footnotes on page 52.)

Scientific name	Rhoades[1]	OLYM[2]	Source/comment[3]	OP elevation range (meters)[4]	OP localities[5]	Major vegetation type (FHM- style sampling protocol)[6]: Parkland	TSME	ABLA	ABAM dry	ABAM	ABAM wet	PSME dry	PSME	PSME wet	TSHE dry	TSHE	TSHE wet	PISI	ALRU	BOG	Substrate category[7]: Bare Soil	Rock	Epiphyte	Fine Organic	Wood Debris
Pseudocyphellaria anomala	✓		OP specimen at BG Herbarium	5-907	**30**		1			1	5		1		3	1			1				23		1
Pseudocyphellaria anthraspis	✓	✓	OP specimen at BG Herbarium	5-822	**17**						1			1		3			3				19		
Pseudocyphellaria crocata	✓	✓	verif. C. Derr, OP specimen at BG Herbarium	74-1048	**25**					1				4		5			1				29		
Pseudocyphellaria mallota		✓	verif. B. McCune, Tønsberg 1999b	177-907	**17**								1	1	2	2		1					20		
Pseudocyphellaria perpetua	✓		USFS, verif. C. Derr, pers. com. D. McConnal																						
Pseudocyphellaria rainierensis	✓		verif. C. Derr	202-867	**24**		2			1	1			1		1			1				21		
Psilolechia lucida			OP specimen at BG Herbarium																						
Psora decipiens			OP specimen at BG Herbarium																						
Psora nipponica				571-2032	**3**																	3			
Psoroma hypnorum	✓			182-2032	**26**	2	6	3		8		5									4	12	7	17	1
Psorula rufonigra	✓																								
Pyrenula acutispora			OP specimen at BG Herbarium																						
Pyrenula laevigata	✓																								
Pyrenula occidentalis			McCune 26900 submitted to OLYM, OP specimen at BG Herbarium	5	**1**																		1		
Pyrrhospora cinnabarina	✓	✓	Most (all?) OP PYCI records concern PYGO	182-1511	**8**			2		1							1						6		
Pyrrhospora elabens	✓																								
Pyrrhospora gowardiana			T. Spribille verified several OP collections	181-1167	**4**							1											6		2
Pyrrhospora quernea	✓		L. Geiser 2000, WNHP Clallam, OP specimen at BG Herbarium																						
Pyrrhospora subcinnabarina			pers. com. Tønsberg 2003, WNHP Clallam																						
Pyrrhospora varians	✓																								
Ramalina dilacerata	✓		OP specimen at BG Herbarium	91-778	**7**														1				6		
Ramalina farinacea	✓	✓		5-335	**19**								5				2		2	4			13		
Ramalina menziesii	✓	✓	WNHP Clallam, Grays Harbor, OP specimen at BG Herbarium	4-69	**5**																		4		
Ramalina pollinaria	✓		L. Geiser 2000, WNHP Clallam																						
Ramalina roesleri	✓			5-79	**9**																		9		
Ramalina sp. 2				0-2	**2**																		2		1
Ramalina subleptocarpha	✓			6-43	**2**																		4		
Ramalina thrausta				130-190	**2**								2				1						2		
Rhizocarpon badioatrum	✓																								
Rhizocarpon bolanderi	✓		Glew 1998																						
Rhizocarpon cinereovirens	✓																								

Table 1.—continued (Footnotes on page 52.)

Scientific name	Rhoades[1]	OLYM[2]	Source/comment[3]	OP elevation range (meters)[4]	OP localities[5]	Major vegetation type (FHM- style sampling protocol)[6] Parkland	TSME	ABLA	ABAM dry	ABAM	ABAM wet	PSME dry	PSME	PSME wet	TSHE dry	TSHE	TSHE wet	PISI	ALRU	BOG	Substrate category[7] Bare Soil	Rock	Epiphyte	Fine Organic	Wood Debris
Rhizocarpon concentricum	✓																								
Rhizocarpon disporum			Glew 1998																						
Rhizocarpon geminatum	✓																								
Rhizocarpon geographicum	✓	✓		1347-1886	**7**			1														4	1		
Rhizocarpon grande	✓																								
Rhizocarpon hochstetteri	✓																								
Rhizocarpon lecanorinum	✓		Glew 1998																						
Rhizocarpon obscuratum	✓																								
Rhizocarpon oederi	✓																								
Rhizocarpon riparium	✓	✓																							
Rhizoplaca chrysoleuca			Glew 1998	1316-1627	**2**																	2			
Rhizoplaca melanophthalma	✓	✓	Glew 1998	1624-2032	**8**	2																13			
Rimularia insularis			Glew 1998																						
Rinodina disjuncta	✓		Tønsberg 1998																						
Rinodina hallii	✓		OP specimen at BG Herbarium																						
Rinodina mniaraea	✓																								
Rinodina stictica	✓		Sheard & Tønsberg 1995																						
Ropalospora viridis			Tønsberg 1998																						
Sagiolechia rhexoblephara	✓																								
Santessoniella grisea			Tønsberg & Henssen 1999																						
Schaereria corticola			Tønsberg 1995																						
Scoliciosporum sarothamni			OP specimen at BG Herbarium																						
Skyttea caesii			OP specimen at BG Herbarium																						
Skyttea lecanorae			OP specimen at BG Herbarium																						
Solorina crocea	✓	✓		1325-1930	**8**	1															9			1	
Solorina saccata	✓																								
Sphaerophorus globosus	✓	✓		5-1747	**86**		6	4	3	6	4	2	5	3	2	6	1	3	2	3		2	60	2	7
Sphaerophorus globosus var. gracilis	✓	✓		69-153	**3**																		1		
Spilonema sp.1			det. McCune, several specimens	177-270	**3**								1										1		
Spilonemella americana			Henssen & Tønsberg 2000, type loc. in Hoh	53	**1**																		1		
Sporastatia testudinea	✓		Glew 1998																						

Table 1.—continued (Footnotes on page 52.)

Scientific name	Rhoades[1]	OLYM[2]	Source/comment[3]	OP elevation range (meters)[4]	OP localities[5]	Major vegetation type (FHM- style sampling protocol)[6] Parkland	TSME	ABLA	ABAM dry	ABAM	ABAM wet	PSME dry	PSME	PSME wet	TSHE dry	TSHE	TSHE wet	PISI	ALRU	BOG	Substrate category[7] Bare Soil	Rock	Epiphyte	Fine Organic	Wood Debris
Staurothele areolata	✓																								
Staurothele drummondii			Glew 1998																						
Staurothele fissa	✓																								
Stereocaulon alpinum	✓			1873-2032	**3**																2	1			
Stereocaulon botryosum	✓			1630	**1**																	1			
Stereocaulon condensatum			we need ref. Specimens	1930-1950	**2**	1															1				
Stereocaulon glareosum	✓		Glew 1998	1348-1747	**4**	1															1	1		2	
Stereocaulon grande	✓			1950-1978	**3**	2																		2	
Stereocaulon intermedium	✓			419	**1**																	1			
Stereocaulon paschale	✓			392-1930	**4**																2	1			
Stereocaulon rivulorum	✓		Glew 1998																						
Stereocaulon sasakii var. simplex	✓																								
Stereocaulon sasakii var. tomentosoides	✓			392-1461	**17**	1				1											6			11	
Stereocaulon tomentosum	✓	✓		374-810	**2**																	1			
Stereocaulon vesuvianum			we need ref. Specimens	1163	**1**		1																		
Sticta beauvoisii s.l.	✓	✓	verif. C. Derr, WNHP Jefferson	177-814	**20**									3		3		2					20		
Sticta fuliginosa	✓		OP specimen at BG Herbarium	5-966	**38**					1	3	1	1	2	2	6		2				5	34	1	
Sticta limbata	✓		OP specimen at BG Herbarium	5-711	**11**									1								1	10		
Sulcaria badia	✓		extinct? Peterson et al. 1998, WNHP Clallam																						
Szczawinskia tsugae		✓	det. B. McCune, WNHP Clallam, OP specimen at BG Herbarium	53	**1**																		1		
Tephromela atra	✓		OP specimen at BG Herbarium																						
Thamnolia subuliformis	✓			1238-2032	**11**	3															3	3	1	8	
Thamnolia vermicularis	✓	✓		539-2032	**11**	3															3	6		6	
Thelomma occidentale	✓		det. J. Villella																						
Thelotrema lepadinum	✓	✓	OP specimen at BG Herbarium	5-1048	**17**											3		4		2			16		2
Tholurna dissimilis	✓		E.Tisch has OP spec.																						
Topeliopsis toensbergii		✓	OLYM coll. Tønsberg																						
Trapelia corticola			OP specimen at BG Herbarium																						
Trapeliopsis gelatinosa	✓	✓																							
Trapeliopsis granulosa	✓	✓	Glew 1998																						
Trapeliopsis pseudogranulosa			OP specimen at BG Herbarium																						

Table 1.—continued (Footnotes on page 52.)

Scientific name	Rhoades[1]	OLYM[2]	Source/comment[3]	OP elevation range (meters)[4]	OP localities[5]	Major vegetation type (FHM- style sampling protocol)[6]: Parkland	TSME	ABLA	ABAM dry	ABAM	ABAM wet	PSME dry	PSME	PSME wet	TSHE dry	TSHE	TSHE wet	PISI	ALRU	BOG	Substrate category[7]: Bare Soil	Rock	Epiphyte	Fine Organic	Wood Debris
Tremella cladoniae			OP specimen at BG Herbarium																						
Tremolecia atrata	✓		Glew 1998																						
Tuckermannopsis chlorophylla	✓	✓	OP specimen at BG Herbarium	4-1678	**59**		2	10	1	5	3	5	2		3	3	4	1	1			1	51		4
Tuckermannopsis orbata	✓	✓		3-1476	**30**		1	2			1	2	5			2	1		1				15		2
Tuckermannopsis platyphylla	✓	✓		419-2032	**28**		3	5	3	4		3	3		1	3							28		2
Tuckermannopsis subalpina	✓	✓		822-1807	**22**	2	10		5	3											3		16	6	
Umbilicaria angulata	✓		WNHP Jefferson	624	**1**							1										1			
Umbilicaria arctica	✓	✓	OLYM coll. Verif. B. Ryan	1886-1958	**3**	1																4			
Umbilicaria cylindrica				1150-2032	**5**	1																5			
Umbilicaria decussata	✓		verif. B. McCune, WNHP Clallam	1950-1958	**2**	1																1		1	
Umbilicaria deusta				1347-1807	**3**																	4			
Umbilicaria havaasii	✓	✓	verif. B. McCune, WNHP Clallam	948-2032	**5**	2																2			
Umbilicaria hirsuta				1134	**1**																	1			
Umbilicaria hyperborea	✓	✓		948-2032	**12**	9																28		1	
Umbilicaria krascheninnikovii	✓		Glew 1998, WNHP Clallam, Jefferson	1886-2032	**4**	1																6			
Umbilicaria lambii	✓	✓	verif. B. Ryan																						
Umbilicaria lyngei			verif. B. McCune	1950	**1**	3																			
Umbilicaria nylanderiana				1958	**1**																	2			
Umbilicaria phaea	✓																								
Umbilicaria polyrrhiza	✓			948	**1**																	1			
Umbilicaria proboscidea	✓		verif. B. McCune, WNHP Clallam	1930-2032	**4**	4																3			
Umbilicaria rigida	✓	✓	verif. B. McCune, WNHP Clallam, Jefferson	1807-2032	**5**																	14			
Umbilicaria scholanderi	✓		WNHP Mason																						
Umbilicaria torrefacta	✓		Glew 1998	728-2032	**9**	6																14			
Umbilicaria vellea	✓			1982	**1**																	1			
Umbilicaria virginis	✓		Glew 1998	1325-2032	**5**	2																4			
Usnea cavernosa				512	**1**																		1		
Usnea ceratina	✓																								
Usnea chaetophora				69-1271	**9**			2					1			1	2						9		1
Usnea cornuta			OP specimen at BG Herbarium	5-69	**8**															1			21		
Usnea diplotypus				5-452	**9**															1			5		

Table 1.—continued (Footnotes on page 52.)

Scientific name	Rhoades[1]	OLYM[2]	Source/comment[3]	OP elevation range (meters)[4]	OP localities[5]	Major vegetation type (FHM- style sampling protocol)[6]: Parkland	TSME	ABLA	ABAM dry	ABAM	ABAM wet	PSME dry	PSME	PSME wet	TSHE dry	TSHE	TSHE wet	PISI	ALRU	BOG	Substrate category[7]: Bare Soil	Rock	Epiphyte	Fine Organic	Wood Debris
Usnea esperantiana				69-74	**2**																		2		
Usnea filipendula	✓			5-1233	**25**			1				1	3				2		1	2			23		1
Usnea fragilescens	✓																								
Usnea fragilescens var. mollis				5-1233	**9**			1															16		
Usnea fulvoreagens				28	**1**																				
Usnea glabrata				4-265	**4**														1				3		
Usnea glabrescens subsp. glabrela	✓																								
Usnea hesperina			L. Geiser 2000	5-69	**4**																		7		
Usnea hirta	✓	✓																							
Usnea lapponica	✓			2-134	**6**														1	1			3		
Usnea longissima	✓	✓	WNHP Clallam, Jefferson, Grays Harbor, OP specimen at BG	5-877	**23**									1									26		
Usnea occidentalis				5-289	**3**																		3		
Usnea pacificana				5-1233	**12**			1		1		1	5						2	9			21		
Usnea rubicunda	✓		L. Geiser 2000																						
Usnea scabrata	✓			69-1271	**11**			4				2	1		2		1						14		
Usnea scabrata subsp. nylanderiana				778	**1**																				
Usnea silesiaca				8-624	**6**							2											8		
Usnea sphacelata				2032	**1**																	2			
Usnea subfloridana	✓	✓		5-845	**11**		1						2				2		1	1			13		
Usnea substerilis				5-17	**2**																				
Usnea trichodea	✓																								
Usnea wasmuthii				5-624	**4**							1								1			4		
Usnea wirthii	✓			5-182	**10**															3			12		1
Verrucaria acrotella	✓																								
Verrucaria hydrela	✓																								
Verrucaria maura	✓																								
Vulpicida canadensis	✓			419-1160	**4**							1	2			1							3		2
Vulpicida tilesii	✓		K. Glew 1998, WNHP Clallam																						
Xanthoparmelia chlorochroa	✓																								
Xanthoparmelia coloradoensis	✓			330-2032	**6**																	9		2	
Xanthoparmelia cumberlandia	✓			6	**1**																	1			

Table 1.—continued (Footnotes on page 52.)

Scientific name	Rhoades [1]	OLYM [2]	Source/comment [3]	OP elevation range (meters) [4]	OP localities [5]	Major vegetation type (FHM- style sampling protocol) [6]: Parkland	TSME	ABLA	ABAM dry	ABAM	ABAM wet	PSME dry	PSME	PSME wet	TSHE dry	TSHE	TSHE wet	PISI	ALRU	BOG	Substrate category [7]: Bare Soil	Rock	Epiphyte	Fine Organic	Wood Debris
Xanthoparmelia wyomingica	✓	✓	Glew 1998																						
Xanthoria candelaria	✓			0-26	**3**																	2	1		
Xanthoria elegans	✓	✓	Glew 1998	1624-2032	**8**	1																13		1	
Xanthoria fallax				43-1958	**2**																			1	
Xanthoria polycarpa	✓			5-134	**7**								2						1				4		
Xanthoria sorediata	✓			1950	**1**	1																			
Xylographa hians	✓																								
Xylographa parallela	✓																								
Xylographa vitiligo			OP specimen at BG Herbarium																						
463 LICHEN species on Rhoades list (1997)						**68**	**79**	**77**	**37**	**75**	**56**	**73**	**64**	**58**	**49**	**84**	**40**	**43**	**57**	**32**	**68**	**174**	**217**	**115**	**117**
150 LICHENS in ONP Herbarium (OLYM) (1997)						*Number of LICHEN species found in each major vegetation type*															*Number of LICHEN species found per substrate category*				
711 LICHEN species found on OP (2004)																									
LIVERWORTS																									
Anastrophyllum minutum	✓	✓	Clark & Frye 1928	822-1509	**7**	1		1													1	2		2	1
Aneura pinguis	✓			47-1747	**11**																	2		7	
Anthelia juratzkana				1685-1747	**3**																			2	
Apometzgeria pubescens	✓	✓		93-861	**13**											7		1				2	14		
Asterella gracilis	✓	✓		47-1747	**8**	1		1														1		3	
Asterella lindenbergiana	✓			571-1747	**7**	2															4	2	1	1	
Asterella saccata				1348	**1**																	1			
Athalamia hyalina	✓			1159-1623	**3**																2			1	
Barbilophozia floerkei	✓	✓		678-2032	**26**	2	13	1							1						9	14		11	4
Barbilophozia hatcheri	✓			775-2032	**28**	7	4	10		4											3	19		11	1
Barbilophozia kunzeana	✓			778-1163	**3**		1															1		1	
Barbilophozia lycopodioides	✓		Hong et al. 1989	254-1678	**6**		1	1														1		1	1
Bazzania ambigua	✓	✓		134-845	**5**		1																1		1
Bazzania denudata	✓	✓		5-822	**26**					2						6		2		10	1		13	5	22
Bazzania tricrenata	✓	✓		5-167	**6**															4			2	1	1
Blasia pusilla	✓			5-879	**15**						1		2								12	1		1	

Table 1.—continued (Footnotes on page 52.)

Scientific name	Rhoades[1]	OLYM[2]	Source/comment[3]	OP elevation range (meters)[4]	OP localities[5]	Major vegetation type (FHM- style sampling protocol)[6]: Parkland	TSME	ABLA	ABAM dry	ABAM	ABAM wet	PSME dry	PSME	PSME wet	TSHE dry	TSHE	TSHE wet	PISI	ALRU	BOG	Substrate category[7]: Bare Soil	Rock	Epiphyte	Fine Organic	Wood Debris
Blepharostoma arachnoideum			Norris 1997 (specimen deposited at ONP B. trichophyllum)	202-1093	**4**		1				1											3			
Blepharostoma trichophyllum subsp. trichoph	✓	✓		5-1745	**74**		25	6	1	16	13	2	1		1	6	1	2		2	14	13	14	27	86
Calypogeia azurea	✓			5-1745	**31**		3	1		1	1			1		1		3		1	8	2	1	10	12
Calypogeia fissa	✓			5-1746	**32**		6	4	1		1		1		3	3		2			9	2	2	6	14
Calypogeia integristipula	✓	✓		5-1096	**10**		2						1					1			1			2	10
Calypogeia muelleriana	✓	✓		5-1437	**48**	1	11		1	3			4			8		9		3	21	2	1	8	32
Calypogeia neesiana	✓	✓		109-1292	**9**		2			2						1		2			1			1	13
Calypogeia sphagnicola				5-287	**4**															3				2	
Calypogeia suecica	✓	✓		5-1292	**10**		1	3		2	1					1									10
Cephalozia ambigua	✓			5-1746	**10**		4															2		9	
Cephalozia bicuspidata	✓	✓		5-1627	**59**	1	8			5	2		7	3	1	6	2	19		10	11	8	3	15	101
Cephalozia catenulata			Norris 1997 (Should be verified, few records in WA on Hong's 2002 WA																						
Cephalozia connivens	✓			28-1164	**17**				1		2			2		1					2		5	2	19
Cephalozia leucantha	✓	✓																							
Cephalozia lunulifolia	✓	✓		5-1307	**64**		20	3	4	9	11	1	10		4	8		9	3	1	2		10	4	106
Cephalozia macounii	✓	✓																							
Cephalozia pleniceps	✓	✓		28-1746	**5**																			4	
Cephaloziella divaricata	✓	✓		5-1745	**34**		1	4		2		2	1		1	3		1		2	5	7	3	5	13
Cephaloziella divaricata var. scabra	✓	✓																							
Cephaloziella rubella	✓																								
Cephaloziella stellulifera	✓			157	**1**																				
Cephaloziella turneri	✓			289-948	**4**										3						4				1
Chiloscyphus pallescens	✓	✓		5-1623	**23**	1	3	1	2	2			3			1					1	3	3	4	5
Chiloscyphus polyanthos	✓	✓		5-1746	**32**		2	1		2	2		1			1		1			7	18	1	4	3
Chiloscyphus polyanthos var. rivularis	✓																								
Conocephalum conicum	✓	✓		8-1630	**32**		2			1	1	1				2		4	1		21	6	1	15	3
Diplophyllum albicans	✓	✓	verif. J. Harpel	5-1093	**47**		4			4						4				3	18	32	3	9	5
Diplophyllum obtusifolium	✓	✓		26-1745	**18**					1						3					15	5			
Diplophyllum plicatum	✓	✓	verif. J. Harpel	5-1261	**18**		1									1				5	2		20	2	7
Diplophyllum taxifolium		✓	Norris 1997	8-1747	**41**	4	27	3	2	6	1										13	36	3	7	2
Douinia ovata		✓		5-1031	**61**		3			3		1	1	3		6				1		3	74		5

Table 1.—continued (Footnotes on page 52.)

Scientific name	Rhoades[1]	OLYM[2]	Source/comment[3]	OP elevation range (meters)[4]	OP localities[5]	Major vegetation type (FHM- style sampling protocol)[6]: Parkland	TSME	ABLA	ABAM dry	ABAM	ABAM wet	PSME dry	PSME	PSME wet	TSHE dry	TSHE	TSHE wet	PISI	ALRU	BOG	Substrate category[7]: Bare Soil	Rock	Epiphyte	Fine Organic	Wood Debris
Fossombronia foveolata	✓																								
Fossombronia longiseta			Norris 1997 (Should be verified, single source on Hong's 2002 WA list)																						
Frullania bolanderi	✓			43-624	**5**							1					1						4		
Frullania californica	✓	✓		419	**1**																	1			
Frullania franciscana	✓	✓		2-123	**11**															3			23	1	
Frullania nisquallensis	✓	✓		5-1012	**102**		3			5	5	1	14	7	3	19	1	8	3	6		6	160	3	8
Geocalyx graveolens	✓	✓		5-1150	**17**		1			1	2					2					1			1	12
Gymnocolea inflata				10-167	**4**																2			1	
Gymnomitrion concinnatum	✓	✓	Schofield 1967	1348-1627	**4**	1																4		1	
Gymnomitrion obtusum	✓	✓		1061-1509	**7**	3	2														1	8			
Gyrothyra underwoodiana	✓	✓		8-1096	**24**		2							1		2					22	2		3	4
Harpanthus flotovianus				1093-1740	**6**		3			1											1	1		3	1
Herbertus aduncus	✓	✓	verif. J. Harpel	5-176	**12**															3	1		7		3
Hygrobiella laxifolia	✓																								
Jamesoniella autumnalis		✓	OLYM coll. Norris	5-1079	**6**														1		2	23	2	1	6
Jungermannia atrovirens	✓			5-1048	**11**											3					5	4			
Jungermannia confertissima			needs work, NEW to WA	1147-1747	**2**					1											1			1	
Jungermannia exsertifolia subsp. cordifolia	✓	✓		571-1747	**11**																	14		2	
Jungermannia gracillima				5	**1**																				1
Jungermannia hyalina	✓			219-1685	**3**																1	3			
Jungermannia leiantha	✓			5-1461	**11**			2			1					1					2	1	1		4
Jungermannia pumila	✓				**1**																	1			
Jungermannia rubra	✓	✓		5-702	**16**																24	2		1	2
Jungermannia sphaerocarpa	✓			1391	**1**																	1			
Kurzia pauciflora			det. Schofield and Harpel. NOT on Hong 2002 list with hepatics.	8-134	**3**																			2	1
Kurzia sylvatica	✓	✓																							
Lepidozia filamentosa	✓		Suspect verify!																						
Lepidozia reptans	✓	✓		5-1307	**58**		5	1		6	4	3	7	6	2	8		6	2	2			8	2	60
Lophocolea bidentata	✓	✓		5-618	**7**							1	2						1				1		1
Lophocolea heterophylla	✓	✓		5-1620	**27**		5	10	4	8	6	2	13	1		4					3	11	13	7	22
Lophozia ascendens	✓			1620	**1**			1																	1

Table 1.—continued (Footnotes on page 52.)

Scientific name	Rhoades[1]	OLYM[2]	Source/comment[3]	OP elevation range (meters)[4]	OP localities[5]	Major vegetation type (FHM- style sampling protocol)[6]															Substrate category[7]				
						Parkland	TSME	ABLA	ABAM dry	ABAM	ABAM wet	PSME dry	PSME	PSME wet	TSHE dry	TSHE	TSHE wet	PISI	ALRU	BOG	Bare Soil	Rock	Epiphyte	Fine Organic	Wood Debris
Lophozia collaris	✓			1391-1590	**2**																	1		1	
Lophozia excisa				2032	**1**																	1			
Lophozia gillmanii		✓		211-1391	**2**																				
Lophozia heterocolpos	✓			28-1271	**6**			1		1		1					1				1	2		2	1
Lophozia incisa	✓	✓		5-1740	**68**		8	6	7	6	6		4	3		6		3	3	1	2	3		5	61
Lophozia longidens				778-1627	**4**			1	1															1	3
Lophozia longiflora	✓	✓	Norris 1997 as L. guttulata	5-1678	**39**		14	18	8	8	3				6	2		1			1	1	3	4	64
Lophozia obtusa	✓			1271	**1**			1																	
Lophozia opacifolia	✓	✓		702-1590	**14**																5			5	
Lophozia sudetica	✓	✓		1096-1930	**14**	6	3	1													3	2		6	1
Lophozia ventricosa	✓	✓		778-1740	**20**	1	5	8	1	3						1					4	7		5	8
Lophozia wenzelii		✓		845-1747	**14**		10														5	4		18	1
Mannia sibirica			Norris 1997 Should be verified as this would be new to WA (not on																						
Marchantia polymorpha	✓	✓		47-1747	**9**				1	1			2								1			2	
Marsupella brevissima				1261-1509	**4**	3	1														1	3		1	
Marsupella commutata	✓	✓																							
Marsupella condensata				1348-1627	**2**																			2	
Marsupella emarginata	✓	✓		76-1348	**20**		3			3	2										4	21			1
Marsupella emarginata var. aquatica			cf. only fragments, revisit!	1348-1685	**2**																1				
Marsupella sparsifolia	✓	✓	Hong et al. 1989																						
Marsupella sphacelata	✓	✓		172-1403	**8**		2														3	5		1	
Marsupella sprucei			pers. com. Norris 2004																						
Metzgeria conjugata	✓	✓		5-800	**28**											5		10			3	8	32		3
Metzgeria temperata				8-305	**15**											1		7					16		
Moerckia blyttii	✓			5-1478	**6**															3	1			3	
Moerckia hibernica	✓			153-1747	**5**																2	1		1	
Mylia anomala	✓			8-172	**4**																			1	
Mylia taylorii	✓	✓		5-1093	**12**															6	1		2	2	9
Nardia breidleri			should be checked again, very few records in WA	1096	**1**		1																		1
Nardia geoscyphus				1348-1539	**5**																2	1		2	
Nardia japonica	✓			1093-1740	**7**																3	2		3	

Table 1.—continued (Footnotes on page 52.)

Scientific name	Rhoades[1]	OLYM[2]	Source/comment[3]	OP elevation range (meters)[4]	OP localities[5]	Major vegetation type (FHM- style sampling protocol)[6]: Parkland	TSME	ABLA	ABAM dry	ABAM	ABAM wet	PSME dry	PSME	PSME wet	TSHE dry	TSHE	TSHE wet	PISI	ALRU	BOG	Substrate category[7]: Bare Soil	Rock	Epiphyte	Fine Organic	Wood Debris
Nardia scalaris	✓	✓		10-1539	**25**		1									1					11	9		1	1
Odontoschisma denudatum	✓	✓		5-176	**9**															6	1		2	1	8
Pellia endiviifolia	✓	✓		822-1525	**4**																1			1	
Pellia epiphylla	✓	✓																							
Pellia neesiana	✓	✓		5-1747	**47**		2			4	1					4		6		1	23	3		16	4
Plagiochila asplenioides	✓	✓		5-1271	**13**			1												1	4	5	1	13	12
Plagiochila porelloides	✓	✓		5-1403	**45**		3			1	3	2		1		7				3	4	19	8	8	4
Pleuroclada albescens var. albescens			verified 2005		**1**																				
Porella cordaeana	✓	✓		5-1807	**25**	1		2		3			13			2			4		2	15	15		1
Porella navicularis	✓	✓		5-1807	**48**		1				2	1	13	3	3	4	1	4	12			3	53	1	4
Porella roellii	✓	✓		3-707	**20**							4	1	1		9		1	1			5	15		1
Porella roellii fo. crispata	✓	✓																							
Preissia quadrata	✓			703	**1**																2				
Ptilidium californicum	✓	✓		5-1950	**103**	1	18	13	8	9	9	3	4	3	2	8		5	1			8	69	4	47
Ptilidium ciliare	✓		Specimen needs to be tracked down, probably P. pulcherrimum																						
Ptilidium pulcherrimum	✓	✓	Hong et al. 1989	8-1271	**4**			1															1		2
Radula bolanderi	✓	✓		5-1093	**53**						7	2	4	8	3	14	1	1	6			1	72		2
Radula complanata	✓	✓		2-1292	**35**		4			2		2	6	3		9			7			9	39		2
Radula obtusiloba subsp. polyclada	✓		Schofield 1967, OP specimen at UBC	877	**1**																	1			
Reboulia hemisphaerica	✓																								
Riccardia chamedryfolia		✓		5-1163	**11**		1			1			1					2			1	4			5
Riccardia latifrons	✓	✓		5-1307	**26**		3	1		2	6		1	2	2			1		1	1		1	1	31
Riccardia multifida	✓	✓		5-861	**29**		2				2		1	2		1		4			13	3		3	11
Riccardia palmata	✓	✓		5-1307	**42**		5			3		1	1	1		5	2	4		3				2	41
Riccia beyrichiana			Suspected from specimen & photo, needs verification																						
Riccia glauca				728-1563	**2**																2				
Ricciocarpos natans	✓			79	**1**																			1	
Scapania americana	✓	✓		5-1746	**44**		1	2	1	2	2	5				5				1	5	36	3	1	5
Scapania bolanderi	✓	✓		5-1511	**91**		6	4	1	15	6	3	14	7	3	12	1	11	5	7	2	6	38	9	98
Scapania curta	✓	✓		254-1238	**2**																	1			1
Scapania irrigua	✓			1261-1299	**2**		1															1		1	

Table 1.—continued (Footnotes on page 52.)

Scientific name	Rhoades[1]	OLYM[2]	Source/comment[3]	OP elevation range (meters)[4]	OP localities[5]	Major vegetation type (FHM- style sampling protocol)[6]: Parkland	TSME	ABLA	ABAM dry	ABAM	ABAM wet	PSME dry	PSME	PSME wet	TSHE dry	TSHE	TSHE wet	PISI	ALRU	BOG	Substrate category[7]: Bare Soil	Rock	Epiphyte	Fine Organic	Wood Debris
Scapania mucronata	✓			24-1325	**7**	1	2														1	2			1
Scapania obscura			needs verification	1401-1740	**4**	1															1			2	
Scapania paludosa		✓		845-1747	**6**		4															2		4	
Scapania subalpina	✓	✓		1147-1747	**7**					2											2	2		5	1
Scapania uliginosa	✓			1348-1348	**2**																1			2	
Scapania umbrosa	✓	✓		5-1261	**31**		5			1			3	2	2			2	1	1	2	3	5	2	22
Scapania undulata	✓	✓		5-1623	**28**		4			1											3	17		3	5
Scapania undulata var. oakesii	✓			289-893	**2**																1	1			
Schofieldia monticola	✓	✓	Norris 1997	1159-1478	**7**	1															4			2	
Tritomaria exsectiformis			verif. R. Dewey	778	**1**																				2
Tritomaria quinquedentata	✓	✓	verif. R. Dewey	822-1746	**6**		1			2											4	2		1	
118 LIVERWORT species on Rhoades list (1997)						**19**	**58**	**32**	**16**	**43**	**29**	**20**	**29**	**20**	**16**	**44**	**9**	**30**	**15**	**28**	**79**	**80**	**47**	**88**	**75**
84 LIVERWORTS in ONP Herbarium (OLYM) (1997)						***Number of LIVERWORT species found in each major vegetation type***															***Number of LIVERWORT species found per substrate category***				
151 LIVERWORT species found on OP (2004)																									
MOSSES																									
Alsia californica	✓	✓	locality threatened	43	**1**																		6		
Amblystegium serpens	✓	✓		134-265	**2**														1		1				
Amphidium californicum	✓	✓		47-1048	**6**											1						2			
Amphidium lapponicum	✓	✓		179-1685	**6**																	4			
Amphidium mougeotii	✓			5-1261	**4**		1									1						4			
Anacolia menziesii	✓	✓		47-1150	**10**											1						6			
Andreaea alpestris		✓		1163	**1**		1															1			
Andreaea blyttii	✓	✓	Schofield 1967																						
Andreaea heinemannii		✓	OLYM coll Norris (verify!)																						
Andreaea nivalis	✓	✓		1061-1620	**7**			1													1	9			
Andreaea rupestris	✓	✓		581-1807	**19**		7	2		2	1										1	21			
Anoectangium aestivum	✓		Schofield 1967																						
Antitrichia californica	✓	✓		43-861	**12**								1			1	2		3			2	8		1
Antitrichia curtipendula	✓	✓		8-1299	**57**		3			2	3	1	6	2	1	7	1	4	3				42	2	8

Table 1.—continued (Footnotes on page 52.)

Scientific name	Rhoades [1]	OLYM [2]	Source/comment [3]	OP elevation range (meters) [4]	OP localities [5]	Major vegetation type (FHM- style sampling protocol) [6]: Parkland	TSME	ABLA	ABAM dry	ABAM	ABAM wet	PSME dry	PSME	PSME wet	TSHE dry	TSHE	TSHE wet	PISI	ALRU	BOG	Substrate category [7]: Bare Soil	Rock	Epiphyte	Fine Organic	Wood Debris
Arctoa fulvella				1627	**1**																	1			
Atrichum selwynii	✔	✔		5-1461	**33**			2		1	2		7	1		2			1		19	1		1	2
Atrichum undulatum		✔		10-758	**4**																2	1			
Aulacomnium androgynum	✔	✔		0-1629	**36**			3		1	1	4	5		4	4			1		3	2	2	17	11
Aulacomnium palustre	✔	✔		5-1747	**21**															2	1	1		6	1
Barbula convoluta	✔			1678-1930	**2**		1														1	1			
Barbula unguiculata	✔		Schofield 1967																						
Bartramia ithyphylla	✔	✔		948-1930	**8**	4	1	1													2	4		1	
Bartramia pomiformis	✔	✔		47-1167	**26**						1	2			1	1			1		5	14			1
Blindia acuta	✔	✔		452-1678	**11**	2	1				1					1					1	12			
Brachydontium olympicum	✔		Norris 1997, WNHP Clallam																						
Brachythecium albicans	✔	✔		6-1978	**33**	3	1	5		1		1	1			1					8	8	3	13	1
Brachythecium asperrimum				5-1525	**9**		2		1				1				1	1			2	1		3	1
Brachythecium bolanderi		✔	OLYM verify (Harthill)																						
Brachythecium collinum	✔	✔		1325-1950	**9**	3		4													5	2			
Brachythecium erythrorrhizon	✔	✔		1147-1950	**4**	1		1		1											1	1		2	
Brachythecium frigidum	✔	✔		5-1746	**42**		2	1	3	1	2		1			3	1	1	4		5	9	4	13	4
Brachythecium holzingeri				825-1620	**7**	1	1	3		1												1	2	2	1
Brachythecium hylotapetum	✔	✔		634-1620	**8**		3	3		2	1													8	1
Brachythecium leibergii	✔	✔		1044-1886	**13**	2	1	9	1	2											5	4	2	6	1
Brachythecium oedipodium			single specimen	1511	**1**			1													1			1	
Brachythecium plumosum	✔	✔																							
Brachythecium reflexum var. pacificum	✔	✔		1325	**1**	2																			
Brachythecium rivulare	✔			6-897	**6**																3			1	
Brachythecium salebrosum	✔	✔																							
Brachythecium starkei	✔	✔		165-1325	**2**	1																1			
Brachythecium starkei var. explanatum				861	**1**																			1	
Brachythecium velutinum			varieties not entered	130-1950	**9**	1		1		1			2			1		2			4	2	2		1
Brachythecium velutinum var. velutinum	✔																								
Brachythecium velutinum var. venustum	✔	✔	Norris 1997	179-1807	**7**			1				1									2	1		3	4
Brotherella roellii			USFS, extinct? Pers. com. J. Harpel 2004, WNHP Clall., Jeff																						

Table 1.—continued (Footnotes on page 52.)

Scientific name	Rhoades[1]	OLYM[2]	Source/comment[3]	OP elevation range (meters)[4]	OP localities[5]	Major vegetation type (FHM- style sampling protocol)[6]															Substrate category[7]				
						Parkland	TSME	ABLA	ABAM dry	ABAM	ABAM wet	PSME dry	PSME	PSME wet	TSHE dry	TSHE	TSHE wet	PISI	ALRU	BOG	Bare Soil	Rock	Epiphyte	Fine Organic	Wood Debris
Bryoerythrophyllum recurvirostre	✓																								
Bryum amblyodon	✓	✓																							
Bryum argenteum	✓	✓		0-1978	**3**	1																	1	1	2
Bryum caespiticium	✓	✓		5	**1**															1					
Bryum calobryoides	✓		Spence 1983, WNHP Jefferson																						
Bryum canariense			Norris 1997																						
Bryum capillare	✓	✓		5-1167	**23**							2	4	1	3		1	1			8	6	1	6	4
Bryum cyclophyllum				1348	**1**																	1			
Bryum dichotomum	✓	✓																							
Bryum flaccidum	✓		Spence 1983																						
Bryum gemmiparum				151-1511	**2**			1													1	1			
Bryum lisae		✓		1325-1950	**5**	2															4				
Bryum lisae var. cuspidatum	✓																								
Bryum miniatum	✓			47-1740	**6**																	5			
Bryum muehlenbeckii	✓			5-1093	**3**																1			1	
Bryum pallens		✓		1348	**1**																1				
Bryum pallescens	✓	✓		707-1629	**5**					1						1					3	1			
Bryum pseudotriquetrum	✓	✓		5-1745	**13**	1		2													3	2		1	
Bryum turbinatum	✓	✓	J. Harpel in Rhoades 1997																						
Bryum weigelii	✓	✓		76-1747	**26**	1	2		3	1		1				1					7	2		12	1
Buxbaumia aphylla	✓		D. Vitt 1977 data, in Rhoades 1997, WNHP Clallam																						
Buxbaumia piperi	✓	✓		140-1307	**10**		1	1		1	2					1			1						12
Buxbaumia viridis	✓		Schofield 1967																						
Calliergon cordifolium		✓		5	**1**																				
Calliergon giganteum	✓			778	**1**																				
Calliergon stramineum	✓	✓		778-1348	**5**																			2	
Calliergonella cuspidata	✓	✓		93	**1**								2												
Calliergonella lindbergii		✓	Norris 1997																						
Campylium polygamum	✓	✓																							
Campylium stellatum	✓		Schofield 1967	1348	**1**																1				
Campylopus introflexus			M. Hutten, verif. J. Harpel		**1**																1				

Table 1.—continued (Footnotes on page 52.)

Scientific name	Rhoades[1]	OLYM[2]	Source/comment[3]	OP elevation range (meters)[4]	OP localities[5]	Major vegetation type (FHM- style sampling protocol)[6]: Parkland	TSME	ABLA	ABAM dry	ABAM	ABAM wet	PSME dry	PSME	PSME wet	TSHE dry	TSHE	TSHE wet	PISI	ALRU	BOG	Substrate category[7]: Bare Soil	Rock	Epiphyte	Fine Organic	Wood Debris
Ceratodon purpureus	✓	✓		0-1978	**19**	4		2													12	4		2	2
Cirriphyllum cirrosum	✓																								
Claopodium bolanderi	✓	✓		123-1627	**52**	1	15	5		8	1	11				12		1			5	60	9	9	3
Claopodium crispifolium	✓	✓		5-1150	**40**								8	4		7	1	4	3		4	13	21		5
Claopodium whippleanum	✓	✓	Schofield 1967	707-1648	**10**	1	3	2								1					1	6		1	
Climacium dendroides	✓	✓		5-778	**3**																1			1	1
Conostomum tetragonum	✓		Norris 1997																						
Coscinodon calyptratus	✓		Spence 1983																						
Cratoneuron filicinum	✓	✓		47-1623	**14**						1					3		1			3	4		3	1
Crumia latifolia			pers. com. J. Harpel 2002, WNHP Clallam	0-47	**2**																	4			
Cynodontium jenneri	✓	✓	Schofield 1967	977-1134	**2**																1				
Cynodontium strumulosum		✓	Norris 1997 syn C. strumiferum?																						
Dendroalsia abietina	✓	✓		130-459	**4**								3										3		
Desmatodon latifolius	✓	✓		1325-1978	**9**	7		1													6	2		4	
Dichelyma falcatum			pers. com. J. Harpel 2004																						
Dichelyma uncinatum	✓																								
Dichodontium olympicum	✓	✓		1292-1678	**7**	4	2	1													2	4		2	
Dichodontium pellucidum	✓	✓		5-1648	**33**		2	2		1	3	1					1				4	25			2
Dicranella crispa	✓			2-289	**3**																1				
Dicranella grevilleana	✓																								
Dicranella heteromalla	✓	✓		5-1437	**23**	1				2			1			2		1	1		20				3
Dicranella howei		✓	Norris 1997																						
Dicranella pacifica	✓		Schofield 1967	211	**1**																				
Dicranella palustris	✓	✓	Schofield 1967	1227-1539	**2**																				
Dicranella rufescens	✓			289-728	**2**																1				
Dicranella schreberiana	✓	✓	Hermann 1969	190	**1**													1			1				
Dicranella varia	✓	✓	Schofield 1967	211-335	**2**								1								1				
Dicranoweisia cirrata	✓	✓		93-1292	**5**					2			5								1		3		2
Dicranoweisia crispula var. contermina	✓	✓	Norris 1997 (we did not record var.)																						
Dicranoweisia crispula var. crispula	✓	✓		1044-1950	**20**	6	6	9	1	2											1	22			2
Dicranum fuscescens	✓	✓		5-2032	**80**		4	6	5	7	5	3	7	3	3	7	1	7	2	3	8	2	32	20	33

Table 1.—continued (Footnotes on page 52.)

Scientific name	Rhoades[1]	OLYM[2]	Source/comment[3]	OP elevation range (meters)[4]	OP localities[5]	Major vegetation type (FHM- style sampling protocol)[6]															Substrate category[7]				
						Parkland	TSME	ABLA	ABAM dry	ABAM	ABAM wet	PSME dry	PSME	PSME wet	TSHE dry	TSHE	TSHE wet	PISI	ALRU	BOG	Bare Soil	Rock	Epiphyte	Fine Organic	Wood Debris
Dicranum howellii	✓	✓		0-2032	**60**			2		1	1	4	6	2	2	5	2	9	3	5	5	12	13	23	20
Dicranum majus	✓			134-167	**3**																				
Dicranum pallidisetum	✓	✓		822-1746	**24**	2	13	3	4	3											5	8		13	4
Dicranum polysetum			OLYM (Harthill) det. K. Hutten																						
Dicranum rhabdocarpum																									
Dicranum scoparium	✓	✓		441-1265	**8**			3				2				1					1	1		8	1
Dicranum tauricum	✓	✓		0-1511	**37**		1	7	1	3	2	2	7		1	2	1		3			3	9	3	15
Dicranum undulatum	✓	✓		157	**1**																				
Didymodon rigidulus var. gracilis	✓																								
Didymodon tophaceus	✓																								
Didymodon vinealis	✓			5-817	**8**											1					2	1		1	
Didymodon vinealis var. brachyphyllus		✓	Schofield 1967	6	**1**																1				
Didymodon vinealis var. flaccidus	✓		verif. D. Norris 1997 as D. insularis	389	**1**									1							1				
Didymodon vinealis var. vinealis	✓	✓		5-1160	**18**							1	2	1		1			1		12	2	3	1	1
Discelium nudum			verif. Schofield, WNHP Jefferson	289	**1**																2				
Distichium capillaceum	✓	✓		689-1958	**7**			1														3			
Ditrichum ambiguum	✓	✓		211-810	**6**									1	1						3				
Ditrichum flexicaule	✓																								
Ditrichum heteromallum	✓	✓		8-1292	**2**					1											3				
Ditrichum montanum	✓	✓	Schofield 1967	822-1461	**5**			1	4	3											8				
Ditrichum pusillum		✓	specimen in ONP Herbarium, not verified																						
Ditrichum schimperi		✓	OLYM Norris WNHP Clallam, Grays Harbor	210	**1**													1			1				
Ditrichum zonatum var. scabrifolium			needs verification	1629	**1**																1				
Drepanocladus aduncus var. aduncus	✓	✓		8-1747	**3**																1			1	
Drepanocladus aduncus var. kneiffii	✓																								
Drepanocladus sendtneri			Norris 1997	1271	**1**			1																	
Dryptodon patens	✓	✓		452-1746	**23**		2	6	2	1					1						1	23			1
Encalypta affinis	✓		Schofield 1967																						
Encalypta ciliata	✓	✓		211-1150	**4**																	2			
Encalypta procera	✓	✓		1630	**1**																	1			
Encalypta rhaptocarpa	✓	✓		1807	**1**																1				

Table 1.—continued (Footnotes on page 52.)

Scientific name	Rhoades [1]	OLYM [2]	Source/comment [3]	OP elevation range (meters) [4]	OP localities [5]	Major vegetation type (FHM- style sampling protocol) [6]: Parkland	TSME	ABLA	ABAM dry	ABAM	ABAM wet	PSME dry	PSME	PSME wet	TSHE dry	TSHE	TSHE wet	PISI	ALRU	BOG	Substrate category [7]: Bare Soil	Rock	Epiphyte	Fine Organic	Wood Debris
Encalypta vulgaris	✓	✓																							
Epipterygium tozeri	✓	✓	Norris 1997	2-1292	**29**			1		2	1		1			4		4	2		24			1	
Eucladium verticillatum				47	**1**																	2			
Eurhynchium oreganum	✓	✓		0-1629	**72**		2			2	1	2	9	3	3	8	1	6	2	1	12	8	14	27	17
Eurhynchium praelongum	✓	✓		0-1160	**33**						1		3	1		5	1	6	1	2	11	3	5	17	4
Eurhynchium pulchellum var. pulchellum	✓	✓		140-1958	**23**	2	1	1		1						3					11	12	1	16	
Eurhynchium serrulatum			verification needed	767	**1**					1															
Fissidens adianthoides	✓	✓		571	**1**																	2			
Fissidens bryoides	✓	✓		37-728	**5**								1			1					3		1		
Fissidens crispus	✓	✓		5-728	**14**								5			1	1	1	1		10				
Fissidens fontanus			WNHP Grays Harbor																						
Fissidens grandifrons	✓	✓	Norris 1997, WNHP Mason	104-822	**8**												2					6			
Fissidens pauperculus			WNHP Clallam																						
Fissidens ventricosus	✓		WNHP Clallam, Schofield 1967. Several records by Winter et al. 2000	149	**1**																	1			
Fontinalis antipyretica var. antipyretica	✓																								
Fontinalis antipyretica var. oregonensis	✓	✓		5-1275	**5**																				
Fontinalis neomexicana	✓	✓		5-1093	**14**								1					1	1		1	1			3
Fontinalis patula	✓		Wallace 1976 (suspect?)																						
Funaria hygrometrica	✓	✓		2-259	**4**								1								2			1	
Grimmia affinis	✓		Norris 1997																						
Grimmia anodon	✓		Spence 1983																						
Grimmia anomala	✓	✓	Norris 1997	825	**1**																	1			
Grimmia donniana		✓	Norris 1997																						
Grimmia holzingeri	✓		Hermann 1969																						
Grimmia montana	✓	✓	Norris 1997	1316-1958	**9**	9		1													1	7			
Grimmia ovalis		✓		1807	**1**																	1			
Grimmia pulvinata	✓																								
Grimmia tenerrima	✓	✓		1227-1950	**9**	6		2													2	12			
Grimmia torquata	✓	✓		266-1150	**9**																	6			
Grimmia trichophylla	✓	✓	Schofield 1967	5-775	**3**							1										1			
Gymnostomum recurvirostre	✓			2	**1**																				

Table 1.—continued (Footnotes on page 52.)

Scientific name	Rhoades[1]	OLYM[2]	Source/comment[3]	OP elevation range (meters)[4]	OP localities[5]	Major vegetation type (FHM- style sampling protocol)[6]															Substrate category[7]				
						Parkland	TSME	ABLA	ABAM dry	ABAM	ABAM wet	PSME dry	PSME	PSME wet	TSHE dry	TSHE	TSHE wet	PISI	ALRU	BOG	Bare Soil	Rock	Epiphyte	Fine Organic	Wood Debris
Hamatocaulis vernicosus	✓	✓																							
Hedwigia stellata	☐	☐	Schofied 1967as H. ciliata																						
Herzogiella seligeri	✓	✓	Schofield 1967, WNHP Clallam	634-634	**2**					1	1										1	1			
Heterocladium dimorphum	✓	✓		140-1930	**6**		1														2	5			
Heterocladium macounii	✓	✓		5-1307	**33**		3			5	2		3	1		5		1			3	40	4	1	
Heterocladium procurrens	✓	✓		134-1627	**36**		7	2	1	6	2	20				8			1		5	39	6	11	3
Homalia trichomanoides	✓	☐	pers. com. J. Harpel 2004																						
Homalothecium aeneum	✓	✓		265-1082	**4**							1										4			
Homalothecium arenarium	☐	☐		0-47	**4**																2				
Homalothecium fulgescens	✓	✓		5-1082	**27**		1			1		1	6	3			1		2			7	9		3
Homalothecium nevadense	✓	✓		707-1630	**6**											2						5	1		
Homalothecium nuttallii	✓	✓		5-707	**20**								8	1		1	1	3	4			1	21		3
Homalothecium pinnatifidum	✓	✓																							
Hookeria lucens	✓	✓		5-822	**17**															1	2			6	4
Hygrohypnum bestii	✓	✓		123-1698	**5**				1	1												1			
Hygrohypnum duriusculum	☐	☐	Schofield 1967																						
Hygrohypnum luridum	✓	✓	WNHP Clallam, Jefferson	177-1348	**3**																	3			
Hygrohypnum molle	✓	✓		452-1093	**2**																	1			
Hygrohypnum ochraceum	✓	✓		5-1747	**18**	1	1			1											5	5	2	3	2
Hylocomium splendens	✓	✓		5-1347	**62**			1		2	3	2	4	4	3	7	1	5	2	1	1	2	5	30	9
Hypnum callichroum	✓	✓	Schofield 1967																						
Hypnum circinale	✓	✓		5-1629	**103**		17	9	4	7	7	2	13	5	5	11	1	8	3	2		4	88	3	38
Hypnum cupressiforme	☐	✓																							
Hypnum dieckii	✓	✓		5-1648	**43**		6			1	1	1			1	2			1		5	23	2	5	9
Hypnum lindbergii	✓	✓		179-1623	**4**																				2
Hypnum revolutum	✓	☐	Schofield 1967, OP specimen at UBC	1807	**1**																	1			
Hypnum subimponens	✓	✓		99-1048	**25**		2			1	1	1	2	3		8	1	3	2		2	3	19	1	5
Hypnum vaucheri	✓	✓																							
Isopterygiopsis pulchella	✓	☐	Schofield 1967	109-1630	**5**		1															2		1	1
Isothecium cardotii	☐	☐	Norris 1997. This species is not accepted by ITIS, nor on the BC list.	130-1292	**17**		1						1			1						11	2	3	2
Isothecium cristatum	✓	✓	Schofield 1967																						

Table 1.—continued (Footnotes on page 52.)

Scientific name	Rhoades[1]	OLYM[2]	Source/comment[3]	OP elevation range (meters)[4]	OP localities[5]	Major vegetation type (FHM- style sampling protocol)[6]: Parkland	TSME	ABLA	ABAM dry	ABAM	ABAM wet	PSME dry	PSME	PSME wet	TSHE dry	TSHE	TSHE wet	PISI	ALRU	BOG	Substrate category[7]: Bare Soil	Rock	Epiphyte	Fine Organic	Wood Debris
Isothecium myosuroides	✓	✓		5-1624	**95**		3			7	5	7	16	2	2	13	2	15	6	1	3	21	98	7	23
Iwatsukiella leucotricha			verif. J. Harpel	600-907	**18**																		40		
Kiaeria blyttii	✓	✓	Spence 1983	1437	**1**	1																1			
Kiaeria falcata	✓	✓	Schofield 1967	1509	**1**																1				
Kiaeria starkei	✓	✓	Hermann 1969	822-1886	**15**	3	8	1													1	16		3	
Leptobryum pyriforme	✓			93	**1**								1								1				
Leptodictyum riparium	✓		Schofield 1967	5-424	**5**								1												
Leskea polycarpa				707-1620	**2**			2								1						2	1		
Leskeella nervosa	✓		Schofield 1967																						
Leucolepis acanthoneuron	✓	✓		5-987	**43**					2	1	1	5	2	1	3	1	6	3		5	2	8	11	6
Meesia uliginosa	✓		WNHP Clallam, Jefferson																						
Metaneckera menziesii	✓	✓		93-948	**25**							1	6	1		4	4	4	1			3	26	1	
Mnium ambiguum	✓	✓		897-1807	**2**																1	1			
Mnium blyttii	✓		Schofield 1967	1271-1630	**2**			1													1	1			
Mnium lycopodioides			Schofield 1967	103-1150	**5**					2											3	1	2	1	
Mnium marginatum	✓	✓		179-689	**3**																1	1			
Mnium spinulosum	✓	✓		389-1629	**30**		5	5		4	1	1	1	1		2					5	5	2	21	7
Mnium thomsonii	✓	✓	Schofield 1967 as M. orthorrhynchum	1048-1807	**3**	1										1						1			
Myurella julacea	✓	✓	Schofield 1967, WNHP Jefferson, Mason																						
Neckera douglasii	✓	✓		5-845	**37**		1					2	15	5		9	3	7	5				38	2	11
Oligotrichum aligerum	✓	✓		5-1391	**15**															2	21	1		1	
Oligotrichum hercynicum	✓	✓		685-822	**2**						1										1			1	
Oligotrichum parallelum	✓	✓		289-1551	**13**		1			1	2										4	1		4	
Oncophorus virens	✓	✓	Schofield 1967																						
Oncophorus wahlenbergii		✓	Norris 1997																						
Orthothecium chryseum	✓		WNHP Clallam																						
Orthotrichum affine	✓	✓	2 unverif. OLYM Brown, Harthill	758-1233	**3**			1															3		
Orthotrichum alpestre				153-1958	**4**																	4			
Orthotrichum anomalum				1958	**1**																	1			
Orthotrichum consimile	✓	✓		2-1044	**23**					1			5	3		1	2		7				22		3
Orthotrichum laevigatum	✓	✓		1630-1807	**2**																	3			

Table 1.—continued (Footnotes on page 52.)

Scientific name	Rhoades[1]	OLYM[2]	Source/comment[3]	OP elevation range (meters)[4]	OP localities[5]	Major vegetation type (FHM- style sampling protocol)[6]: Parkland	TSME	ABLA	ABAM dry	ABAM	ABAM wet	PSME dry	PSME	PSME wet	TSHE dry	TSHE	TSHE wet	PISI	ALRU	BOG	Substrate category[7]: Bare Soil	Rock	Epiphyte	Fine Organic	Wood Debris
Orthotrichum lyellii	✓	✓		2-1271	**31**			1				4	3			1	2	1	7	3		1	35		
Orthotrichum obtusifolium	✓			43-778	**4**																		1		
Orthotrichum pellucidum				778-1807	**3**																	3	1		
Orthotrichum pulchellum	✓	✓		5-1271	**16**			1				1	1	3		1		1	2	2		1	15		1
Orthotrichum pylaisii	✓		WNHP Clallam																						
Orthotrichum rivulare	✓		Norris 1997	26-897	**4**																	2			
Orthotrichum rupestre	✓	✓		265-1150	**2**																	1			
Orthotrichum speciosum	✓			130	**1**								1										1		
Orthotrichum striatum	✓			218	**1**																		1		
Palustriella commutata	✓	✓	Schofield 1967, Norris 1997 as Cratoneuron commutatum var.	211-1623	**5**																1	1		1	
Palustriella falcata			Norris 1997 as Cratoneuron commutatum var. falcatum																						
Paraleucobryum enerve	✓																								
Philonotis capillaris	✓	✓		728	**1**																				
Philonotis fontana var. americana	✓	✓	Norris 1997	265-1698	**10**			1	2												1			4	
Philonotis fontana var. caespitosa	✓	✓		822-1747	**8**			1			1										3	1		2	
Philonotis fontana var. fontana	✓	✓		123-1747	**18**				1					1							8	4		4	1
Philonotis fontana var. pumila	✓	✓	Norris 1997	1164-1685	**4**				1															1	
Philonotis muehlenbergii				1886	**1**																			1	
Philonotis yezoana			Norris 1997	822-822	**2**																				
Physcomitrium pyriforme	✓		Rhoades 1994																						
Plagiobryum zierii	✓		Schofield 1967																						
Plagiomnium ciliare		✓	Norris 1997	134-165	**2**														1			1		1	
Plagiomnium ellipticum	✓			897	**1**																1				
Plagiomnium insigne	✓	✓		5-1271	**44**			4	1	3	2		5	2		5	1	5	3		9	5	1	21	2
Plagiomnium medium	✓	✓	Schofield 1967	5-1299	**6**			1	1													1		4	
Plagiomnium rostratum	✓	✓		159-1164	**17**				2			1				2		1			2	5		2	1
Plagiomnium venustum	✓	✓		26-822	**24**						1	1	5	2		2	3		4		2	1	16		2
Plagiopus oederiana	✓		Schofield 1967		**1**																				
Plagiothecium cavifolium		✓	Norris 1997	5-1627	**10**		1	3			1											3		5	1
Plagiothecium denticulatum	✓	✓		5-1620	**14**			3	2										2		2	3	3	3	6
Plagiothecium laetum	✓	✓		5-1678	**54**		8	9	4	5	5	1	9		1	6	2	4	2		7	6	22	20	26

Table 1.—continued (Footnotes on page 52.)

Scientific name	Rhoades [1]	OLYM [2]	Source/comment [3]	OP elevation range (meters) [4]	OP localities [5]	Major vegetation type (FHM- style sampling protocol) [6]: Parkland	TSME	ABLA	ABAM dry	ABAM	ABAM wet	PSME dry	PSME	PSME wet	TSHE dry	TSHE	TSHE wet	PISI	ALRU	BOG	Substrate category [7]: Bare Soil	Rock	Epiphyte	Fine Organic	Wood Debris
Plagiothecium piliferum	✓	✓		99-1561	**17**		2	1			1					1			1			7	7	1	
Plagiothecium undulatum	✓	✓		5-1271	**59**		3	1		3	4	1	5	1	2	7	1	6	1	5		4	18	13	27
Platydictya jungermannioides	✓	✓		47-1630	**9**			1								1					1	3			
Platyhypnidium riparioides	✓	✓	WNHP Grays Harbor		**1**																	2			
Pleuridium subulatum			Norris 1997																						
Pleurozium schreberi	✓	✓		8-1238	**17**										1						3	2	1	6	1
Pogonatum contortum	✓	✓		5-822	**27**					2			2			2	1	1		2	17	1	2	6	1
Pogonatum urnigerum	✓	✓		5-1740	**17**	2	1			1				1							6	4			
Pohlia annotina				179-1511	**4**			1		1											3				
Pohlia atropurpurea	✓	✓	OLYM coll. Harthill	5-1476	**3**			1													4				
Pohlia bolanderi				289-1978	**17**	4	1	4		2											13	4	1	2	
Pohlia bolanderi var. seriata				1511-1958	**2**			1													1				
Pohlia camptotrachela			needs verif.	1511	**1**			1													1				
Pohlia columbica			needs verif.	103	**1**																1				
Pohlia cruda	✓	✓		8-1807	**26**		4	3		4	1					3					14	10		3	
Pohlia drummondii	✓	✓																							
Pohlia elongata		✓	OLYM coll. (Harthill)																						
Pohlia erecta			Norris 1997	1698-1746	**2**																	1		1	
Pohlia filum				6-1348	**2**																1				
Pohlia lescuriana		✓	OLYM coll. Harthill																						
Pohlia longibracteata	✓	✓		8-512	**7**																10				1
Pohlia ludwigii	✓		Norris 1997	1476	**1**			1													1				
Pohlia nutans	✓	✓		5-1678	**20**	1	2	8	4	2			1	1						2	10	1	2	9	5
Pohlia obtusifolia				1163	**1**		1																	1	
Pohlia pacifica				8-512	**4**											1					5				
Pohlia proligera				1147	**1**					1											1				
Pohlia vexans	✓	✓	Schofield 1967																						
Pohlia wahlenbergii	✓	✓		5-1678	**23**	1	1	1		1	1				1					2	27			2	
Polytrichastrum alpinum var. alpinum	✓	✓		5-1629	**39**	2	2	6		2	2	1	1	4	1	2			1		13	10	1	9	3
Polytrichum commune	✓	✓		5-1348	**14**															1	2		1	8	1
Polytrichum formosum	✓	✓		134-182	**3**																				

Table 1.—continued (Footnotes on page 52.)

Scientific name	Rhoades[1]	OLYM[2]	Source/comment[3]	OP elevation range (meters)[4]	OP localities[5]	Major vegetation type (FHM- style sampling protocol)[6]: Parkland	TSME	ABLA	ABAM dry	ABAM	ABAM wet	PSME dry	PSME	PSME wet	TSHE dry	TSHE	TSHE wet	PISI	ALRU	BOG	Substrate category[7]: Bare Soil	Rock	Epiphyte	Fine Organic	Wood Debris
Polytrichum juniperinum	✓	✓		0-1740	**26**				1	1		2	3	1	2						12	2	1	6	3
Polytrichum longisetum	✓		verify specimens	5-1698	**9**	1	1			2						1				1	3			6	
Polytrichum lyallii	✓	✓		825-1950	**8**	1		8													4	3		4	
Polytrichum piliferum	✓	✓		214-2032	**29**	10	1	8													20	7		12	1
Polytrichum sexangulare	✓		Schofield 1967																						
Polytrichum strictum	✓	✓	Norris 1997, WNHP Clallam	99-157	**2**																				
Porotrichum bigelovii	✓	✓		5-1048	**17**						1	3				4		4				17	3		2
Porotrichum vancouveriense	✓			134-165	**2**														1			2			
Pseudobraunia californica	✓		Schofield 1967																						
Pseudoleskea atricha	✓	✓		799-1509	**6**	1	1	1														5	1		
Pseudoleskea baileyi	✓	✓		845-1238	**3**		4															1	3	1	
Pseudoleskea incurvata		✓		1261-1627	**4**	1	1	1														1	2	1	
Pseudoleskea incurvata (intermediate form)				799-1678	**8**		7	1														8	1		
Pseudoleskea incurvata var. gigantea	✓			1082-1620	**4**		1	1														4			
Pseudoleskea incurvata var. incurvata	✓			1002-1958	**8**			3								1					1	6	1	1	1
Pseudoleskea patens	✓	✓		165-1747	**15**	3	1	9		1											2	14	2	3	1
Pseudoleskea radicosa	✓	✓		1147-1437	**2**	1				1												1		1	
Pseudoleskea radicosa var. radicosa				1044-1950	**7**	3	1	1		1											1	5		1	
Pseudoleskea saviana				1509	**1**																			1	
Pseudoleskea stenophylla	✓	✓		558-1886	**20**		4	5		4												3	17	1	1
Pseudoscleropodium purum			M. Hutten data																						
Pseudotaxiphyllum elegans	✓	✓		5-1745	**67**	3	7	5	1	11		2	2	5	2	5		5	2	1	26	23	8	10	24
Pterigynandrum filiforme	✓			822-1950	**9**	1	1														1	6	5		
Pterogonium gracile	✓																								
Racomitrium aciculare	✓	✓		10-1391	**18**			1						1		1						18			
Racomitrium affine		✓		948-1233	**5**			1								1						5			
Racomitrium aquaticum	✓	✓	verif. J. Harpel, WNHP Clallam	212-966	**17**					1												20			
Racomitrium brevipes	✓	✓		574-1886	**25**	1	2	5	3	3		2			1						1	24		4	
Racomitrium canescens var. canescens	✓	✓																							
Racomitrium elongatum	✓	✓		0-1629	**33**	4	3	4	1	1		1									11	13		13	1
Racomitrium ericoides	✓	✓		176-1539	**7**	4		1		1											3	2			

Table 1.—continued (Footnotes on page 52.)

Scientific name	Rhoades[1]	OLYM[2]	Source/comment[3]	OP elevation range (meters)[4]	OP localities[5]	Major vegetation type (FHM- style sampling protocol)[6]: Parkland	TSME	ABLA	ABAM dry	ABAM	ABAM wet	PSME dry	PSME	PSME wet	TSHE dry	TSHE	TSHE wet	PISI	ALRU	BOG	Substrate category[7]: Bare Soil	Rock	Epiphyte	Fine Organic	Wood Debris
Racomitrium fasciculare	✓	✓																							
Racomitrium heterostichum	✓	✓		151-1624	**28**		1	2		2		2			2	1					1	24			1
Racomitrium lanuginosum	✓			539-1347	**4**																	6			
Racomitrium macounii	✓			419-1745	**15**	2	1	1					1			1						11			
Racomitrium microcarpon		✓	needs verification	767-1886	**11**	3	1	1		2											2	10		1	
Racomitrium obesum		✓	Norris 1997	1325-1627	**4**	1																2		1	
Racomitrium occidentale	✓	✓		822-1678	**13**		12		2	4												19			
Racomitrium pacificum			needs verification	1093	**1**																	1			
Racomitrium pygmaeum	✓	✓	Norris 1997																						
Racomitrium sudeticum	✓	✓		1163-1678	**5**	1	2															2			
Racomitrium varium	✓	✓		37-1978	**23**	2							1	2							3	14		3	1
Rhabdoweisia crispata		✓	OLYM coll. Harthill (missing?) unlikely acc Schofield 2004																						
Rhizomnium glabrescens	✓	✓		5-1271	**69**		1	2		5	5	1	7	2	1	8	2	13	2	3	5	4	16	4	52
Rhizomnium magnifolium	✓	✓		5-1698	**33**		2	2	2	2	1					1				1	5	1	1	8	
Rhizomnium nudum	✓	✓	verif. J. Harpel	202-1698	**26**	1	3	1	1	5	3										4	1	1	15	1
Rhizomnium pseudopunctatum				8-1623	**2**																1				1
Rhizomnium punctatum		✓	Norris 1997																						
Rhytidiadelphus loreus	✓	✓		5-1476	**67**		8	3		5	7	2	4	2	1	6		5	2	3	4	4	15	23	16
Rhytidiadelphus squarrosus	✓	✓		93-1233	**21**		4	2		3	1		2			1		3			3	1		10	3
Rhytidiadelphus subpinnatus		✓		5-1147	**5**					1											2			1	1
Rhytidiadelphus triquetrus	✓	✓		0-1167	**43**					2		2	3	2	1	6	2	4	3		4	2	7	19	5
Rhytidiopsis robusta	✓	✓		441-1678	**52**		9	13	4	7	4	2			1	1					2	8	1	27	7
Rhytidium rugosum	✓		Spence 1986 (nearly extinct?), WNHP Clallam	1807	**1**																			1	
Roellia roellii	✓	✓		758-1950	**35**	1	7	11	4	4	1					1					6	3	1	20	1
Sanionia uncinata	✓	✓		897-1698	**9**			3		1											3	3		3	1
Sarmenthypnum sarmentosum	✓																								
Schistidium agassizii	✓		Norris 1997	151	**1**																	1			
Schistidium apocarpum	✓	✓		180-1950	**17**	3	1	1													1	15			
Schistidium maritimum	✓	✓		0-26	**4**																1	5			
Schistidium rivulare var. latifolium	✓	✓																							
Schistidium rivulare var. rivulare	✓	✓		26-1299	**9**											1					1	7			

Table 1.—continued (Footnotes on page 52.)

Scientific name	Rhoades[1]	OLYM[2]	Source/comment[3]	OP elevation range (meters)[4]	OP localities[5]	Major vegetation type (FHM- style sampling protocol)[6]: Parkland	TSME	ABLA	ABAM dry	ABAM	ABAM wet	PSME dry	PSME	PSME wet	TSHE dry	TSHE	TSHE wet	PISI	ALRU	BOG	Substrate category[7]: Bare Soil	Rock	Epiphyte	Fine Organic	Wood Debris
Schistidium tenerum	✓	✓																							
Schistostega pennata	✓	✓	verif. J. Harpel, WNHP Grays Harbor, Jefferson	176-255	**7**											1					10				
Scleropodium cespitans var. cespitans	✓	✓		2-153	**3**																	1	1		
Scleropodium cespitans var. sublaeve	✓																								
Scleropodium obtusifolium	✓	✓		5-1747	**19**							1				2			1		2	15			1
Scleropodium touretii var. colpophyllum	✓		Norris 1997																						
Scleropodium touretii var. touretii	✓	✓	Schofield 1967	26-1167	**5**																	2			
Scouleria aquatica	✓	✓		47-1563	**16**											2					1	11			
Sphagnum alaskense			Andrus & Janssens 2003, OP specimen at UBC																						
Sphagnum angustifolium	✓		(syn. S. recurvum Crum 1984)																						
Sphagnum austinii	✓		WNHP Clallam, OP specimen at UBC																						
Sphagnum capillifolium		✓	Norris 1997	8-134	**3**																			1	
Sphagnum capillifolium var. tenellum				8-172	**4**																			1	
Sphagnum fallax			Norris 1997																						
Sphagnum fimbriatum				153	**1**																				
Sphagnum fuscum	✓		OP specimen at UBC	153-157	**2**																				
Sphagnum girgensohnii	✓	✓		5-1079	**13**		1			1														8	2
Sphagnum henryense	✓																								
Sphagnum magellanicum	✓	✓		8-16	**2**																				
Sphagnum mendocinum	✓		OP specimen at UBC	8-778	**3**																				
Sphagnum pacificum	✓		Flatberg 1989 OP specimen at UBC (incl. Schofield 1967 record of S.																						
Sphagnum palustre	✓	✓		5-424	**8**															3	1			3	
Sphagnum papillosum	✓	✓		8-172	**5**																1			1	
Sphagnum quinquefarium		✓	1 unverif. spec. OLYM Harthill	172	**1**																				
Sphagnum russowii		✓		153	**1**																				
Sphagnum squarrosum	✓	✓		5-1561	**17**		1			1												1		5	1
Sphagnum subsecundum			Norris 1997	778	**1**																				
Sphagnum subsecundum var. rufescens				5-778	**6**															2				1	
Sphagnum teres	✓	✓		1227-1227	**2**																			2	
Sphagnum warnstorfii	✓																								
Splachnum ampullaceum			Norris 1997	157-176	**2**																				

Table 1.—continued (Footnotes on page 52.)

Scientific name	Rhoades[1]	OLYM[2]	Source/comment[3]	OP elevation range (meters)[4]	OP localities[5]	Major vegetation type (FHM- style sampling protocol)[6]															Substrate category[7]				
						Parkland	TSME	ABLA	ABAM dry	ABAM	ABAM wet	PSME dry	PSME	PSME wet	TSHE dry	TSHE	TSHE wet	PISI	ALRU	BOG	Bare Soil	Rock	Epiphyte	Fine Organic	Wood Debris
Splachnum sphaericum	✓	✓		157-289	**3**																				
Splachnum vasculosum	✓																								
Tayloria serrata	✓	✓	Norris 1997, WNHP Clallam	5-1620	**7**		1	1												1	1	2	1	2	1
Tetraphis geniculata	✓		verif. J. Harpel, WNHP Grays Harbor, Jefferson	85-565	**15**											3		1							14
Tetraphis pellucida	✓	✓		5-1164	**36**				2		1		4			6	1	12	5						43
Tetraplodon angustatus			needs verification	157	**1**																				
Tetraplodon mnioides	✓		Norris 1997, WNHP Clallam	5-167	**6**															2		1			1
Thamnobryum neckeroides	✓	✓	Norris 1997	179-822	**3**											1						3	2		
Timmia austriaca	✓	✓		101-1620	**18**			2		1		1				3					4	3		1	
Timmia megapolitana		✓	Norris 1997																						
Timmiella crassinervis				47-728	**2**																				
Tortella fragilis	✓																								
Tortella tortuosa	✓	✓		822-1958	**6**			1														6			
Tortula amplexa			Norris 1997 (as S.amplexa)																						
Tortula bolanderi	✓			5	**1**																1				
Tortula muralis	✓	✓		0-1978	**4**	1																5		1	
Tortula norvegica	✓	✓		1233-1886	**5**	1		3													2	1		1	
Tortula papillosissima	✓			1082-1958	**5**	1		2													2	1		2	
Tortula princeps	✓	✓	Schofield 1967	2-265	**4**																	1		1	
Tortula ruralis	✓	✓		0-1978	**20**	3										2					4	7	4	3	1
Tortula subulata	✓	✓	Norris 1997																						
Trachybryum megaptilum	✓	✓		6-1167	**16**					1		2			2	2					2	1		4	
Trichodon cylindricus	✓			93-1271	**4**			1		1			1					1			4				
Tripterocladium leucocladulum			Norris 1997																						
Ulota megalospora	✓			123-1461	**72**		3	3	2	7	5	1	2	1	6	3			4				106		3
Ulota obtusiuscula	✓	✓		2-931	**40**							1	2	1	1	6		5		7			43		2
Ulota phyllantha	✓	✓		4-26	**8**																	2	15		
Warnstorfia exannulata	✓	✓	Schofield 1967	5-1539	**9**																1			3	
Warnstorfia fluitans	✓	✓		5-1275	**8**															1				2	
Weissia controversa	✓			265-1159	**3**																			1	
Zygodon viridissimus	✓																								

Table 1.—continued (Footnotes on page 52.)

Scientific name	Rhoades[1]	OLYM[2]	Source/comment[3]	OP elevation range (meters)[4]	OP localities[5]	Major vegetation type (FHM- style sampling protocol)[6]: Parkland	TSME	ABLA	ABAM dry	ABAM	ABAM wet	PSME dry	PSME	PSME wet	TSHE dry	TSHE	TSHE wet	PISI	ALRU	BOG	Substrate category[7]: Bare Soil	Rock	Epiphyte	Fine Organic	Wood Debris
Zygodon viridissimus var. rupestris				179-179	3																		3		
Zygodon viridissimus var. viridissimus		✓																							
322 MOSS species on Rhoades list (1997)						59	83	103	33	88	50	50	63	40	31	89	33	44	49	29	171	195	88	135	99
262 MOSSES in ONP Herbarium (OLYM) (1997)						*Number of MOSS species found in each major vegetation type*															*Number of MOSS species found per substrate category*				
419 MOSS species found on OP (2004)																									
905 Lichen and Bryophyte Species on Rhoades OP list (1997)						146	220	212	86	206	135	143	156	119	96	217	82	117	121	89	320	449	352	338	292
498 Lichen and Bryophyte Species in ONP Herbarium (OLYM)(1997)						*Total number of lichen and bryophyte species found in each major vegetation type*															*Total number of lichens and bryophytes found per substrate category*				
1283 Total # species documented from the Olympic Peninsula (2004)																									

[1]Checkmark indicates species reported by Rhoades (written comm., 1997)

[2]Species without data in other columns but with a checkmark under OLYM are in the ONP collection, pre-dating this project. Species with data in other columns are part of this project.

[3]Species also collected by others are cited; lichens with “OP specimen deposited in herbarium BG” were collected by T. Tønsberg and are in the University of Bergen’s collection.

[4]Elevation range data are based on records generated during this project. Elevation records in the NPS curatorial database were excluded because of inadequacies in the spatial data.

[5]The number of collection localities indicates unique sites, although unique sites may be close together.

[6]Tallies are based on FHM-style sampling protocol; vegetation types are bog (BOG), red alder (ALRU), Sitka spruce (PISI), western hemlock (TSHE), Douglas-fir (PSME), silver fir (ABAM), mountain hemlock (TSME), and a variety of timberline habitats ranging from scree slopes to alpine tundra (Parkland).

[7]Generalized substrates were provided to give an approximate idea of the species’ microhabitat.

Table 1.—continued

Other products

Several products resulted from this project in addition to a significantly enhanced list and herbarium of cryptogam species for ONP.

- Field Guide

A field guide entitled "101 Common Mosses, Liverworts, and Lichens of the Olympic Peninsula" (Hutten and others, 2001) is a pocket-sized, waterproof guide to cryptogams of the Olympic Peninsula, and it is also useful throughout western Washington. It is easy to use, with close-up color photos and non-technical descriptions that offer tips for identification. Species are grouped by substrate, and elevational range is indicated for each. It includes a glossary and diagrams to teach new terms, and differentiates 140 species. This field guide is for sale to the public and will also be used to train vegetation-monitoring crews in the future.

- Illegal Commercial Moss Harvests

Images and reports describing two significant incidents of illegal harvest of cryptogams from the Park are available to ONP staff members at the park-accessible network address I:\all\crypto\Commercial Moss Harvest\ (restricted access).

- Fact Sheet

A four-page fact sheet describing cryptogams, their ecological role, and their need for conservation is available from USGS as a PDF file at *http://fresc.usgs.gov/products/fs/fs-154-02.pdf*, November 2005. This fact sheet is also available in hard copy from USGS-FRESC, 777 NW 9th St., Suite 400, Corvallis, OR 97330.

Images that have been provided to other agencies can be seen at *http://www.or.blm.gov/surveyandmanage/about.htm,* temporarily unavailable November 2005 and *http://www.fs.fed.us/pnw/pubs/gtr573.pdf,* November 2005. Other images have been requested for use in a general biology textbook, and 50 images have been published (Hutten, 2003; *http://www.cnps.org/publications/fremontia/Fremontia_Vol31-No3.pdf*, November 2005).

- Websites

General project information is available at *http://fresc.usgs.gov/olympic/research/indivproj.asp?OFSProj_ID=12*, November 2005. Results from the ONP non-vascular plant inventory through 2001 can be found at *http://ocid.nacse.org/nbii/crypto/*, November 2005. This is an online database searchable by watershed (to generate species lists), genus, species (to generate locality listings), and so forth. Several hundred low-resolution photographs can be viewed and downloaded from this site (higher resolution cryptogam images are accessible to ONP employees at the ONP network drive address *I:\all\crypto\images, restricted access*).

- GIS Layer

All records of cryptogam species and their locations are available as a data layer in the ONP GIS system.

- Metadata

Metadata for this project and the resulting database can be found at *http://mercury.ornl.gov/nbii/full.jsp?index=0&recidx=0&pageMax=10*, November 2005.

- Collaboration with Other Agencies

Data of federally listed Survey and Manage species found in ONP have been shared with the Northwest Forest Plan Interagency Bryologist and Lichen Coordinator with permission of the ONP Chief of Natural Resource Management. Species included in the Survey and Manage List required special surveys in areas on USFS and BLM land where ground-disturbing activities are planned. Sharing data contributed to the understanding of the habitat requirements and distribution of these species, which is used to refine search protocols. ONP data were included in species habitat models, which predict likely sites for rare species (R. Lesher, written commun., 2002). Some species (such as *Leptogium brebissonii, Ptilidium californicum,* and *Ulota megalospora*) were dropped from the former Survey and Manage List because they were either common or because habitat data showed that they were not exclusively associated with old-growth forests, a requirement for the federal listing associated with the Northwest Forest Plan. Some former Survey and Manage species are locally common in ONP and rare elsewhere in the PNW (for instance, *Schistostega pennata*, *Tetraphis geniculata, Diplophyllum plicatum* [fig. 4], *Kurzia* spp., and *Herbertus aduncus* [fig. 5]). Botanists of several agencies have visited populations of former Survey and Manage species in ONP to improve their ability to locate these species elsewhere in the region. Washington State Department of Natural Resources, USFS (*http://www.fs.fed.us/pnw/pubs/gtr573.pdf*, November 2005), and BLM (*http://www.or.blm.gov/surveyandmanage/about.htm,* temporarily unavailable November 2005) have also used images generated during this project.

Some rare species found in ONP were new to Washington and have been proposed and subsequently added to the Washington Natural Heritage Program (WNHP) list. Thus far, the authors have proposed the lichens *Bunodophoron melanocarpum* (fig. 6), *Spilonema* sp.1 (Goward, 1999), and *Pseudocyphellaria mallota* (fig. 7). Suggested for listing review is *Bryoria tenuis,* a very rare species in Washington (possibly new to Washington), with only one or two sites on the OP. Proposed mosses include several species in the *Splachnaceae,* including *Splachnum ampullaceum* (fig. 8). To date, the WNHP list has not included liverworts, but a working list is currently being compiled and ONP data can be made available to support this effort.

ONP has made its data available to other agencies, but informal data requests by ONP are not always answered.

Figure 4. *Diplophyllum plicatum.*

Figure 6. *Bundophoron melanocarpum.*

Figure 7. *Pseudocyphellaria mallota.*

Figure 5. *Herbertus aduncus.*

Figure 8. *Splachnum ampullaceum.*

As a result, ONP has no information on the location of the following critically endangered species: *Brachydontium olympicum* (WNHP G3S1; see Appendix A for explanation of species status), *Dermatocarpon luridum* (WNHP G?S2), and *Umbillicaria scholanderi* (WNHP G1S1).

Discussion

Cryptogam Diversity of the Olympic Peninsula

Because of its tremendous habitat complexity, pristine condition, and moderate maritime climate, ONP has an astonishing diversity of non-vascular plants. In the Hoh rainforest, a single old-growth Sitka spruce may support more than 60 bryophyte and lichen species and a few epiphytic vascular plants (Hutten, unpub. data, 2001). More than 1,280 species of mosses, liverworts, hornworts, and lichens have been catalogued from the OP (Rhoades, 1997, supplemented with data from this project), and species new to the area are still frequently discovered. Within ONP, collections and locality data are available for some 900 species. The sheer biomass of bryophytes and lichens is as impressive as the species diversity. ONP is internationally known for the "Hall of Mosses", one of few places in the world where one cannot see the forest for the moss carpets.

It is not just the lush rainforests that support a high abundance and diversity of cryptogams. The unique biogeography of the OP includes a variety of other habitats with large numbers of species, including many rare and endemic vascular plants, relative to its geographic area (Houston and others, 1994; Buckingham and others, 1995). In fact, the OP has the greatest number of rare vascular plant taxa listed by WNHP as compared to any geographic area within Washington (*http://www.nps.gov/olym/ea/Fmp2/fmpaf2.htm*, November 2005). The number of rare non-vascular plants is even higher than vascular plants, and can also be attributed to the broad range of habitats on the OP. Intact examples of many of these habitats are rare elsewhere due to human activity.

Bryophytes and lichens have a high degree of habitat and substrate specificity, which also contributes to the high diversity and frequency of rare taxa on the OP. Though some species are clearly generalists, many bryophytes and lichens are decidedly microhabitat specific. For example, *Splachnum ampullaceum* and *S. sphaericum* are mosses found only on excrement in open and perennially moist *Sphagnum*-dominated coastal bogs. Both species were proposed for listing in WNHP, as there are few, if any, other known occurrences in Washington. Occurrences of *Tetraplodon mniodes* (G5 S1) and *Tayloria serrata* (G4? S1; fig. 9) on the OP are primarily on moist and exposed coyote excrement. The widespread crustose lichen *Fellhanera bouteillei* is one of the few epiphylls found in this area and lives on live needles of conifers in moist forests. With species occupying such small ecological niches, the wide variety of habitats on the OP could indeed be expected to harbor a multitude of cryptogams.

Rare Species on the Olympic Peninsula

Determining whether a given species is common, infrequent, or rare requires a large amount of distributional data. Despite having access to more than 20,000 data points for non-vascular plants on the OP, the data are still inadequate for determining the status of a flora of more than 1,250 species, forcing reliance on data from elsewhere in the region. The most relevant source is the list of endangered, threatened, and sensitive plants in Washington, produced by the Washington Natural Heritage Program (WNHP) (1997), a Washington State Department of Natural Resources project. Documents associated with the former Survey and Manage program of the Northwest Forest Plan provide information on species thought to be rare due to their association with old-growth forests. The authors also included the British Columbia (BC) listing of red- and blue-listed mosses and lichens. The BC status data are particularly relevant for those species at the northern extent of their range in this area.

The current list of rare species reported from the OP (Appendix A) includes data from this project, supplemented with select literature reports and personal communications with other lichenologists and bryologists. More than 220 bryophytes and lichens found on the ONP are listed as rare in the Washington and Oregon Heritage Plans (ONHIC, 2004) and in former Survey and Manage documents (about 18 percent of the OP flora). The authors expect that the total number of rare species will increase in the future for a number of reasons.

1. There is currently no status information for Washington liverwort species, despite a recent catalog (Hong, 2002). Liverworts, therefore, have not yet been incorporated into the WNHP. The authors used data from ONHIC as an indicator of liverwort rarity (Appendix A), but these Oregon data cannot be used for Washington without caution. There are several OP species that do not occur in Oregon (such as *Odontoschisma denudatum* and *Blepharastoma arachnoideum* [fig. 10]). For lack of Washington distribution data, such species were omitted from our list, although they almost certainly belong on it.

2. Some species are so poorly known that their distributional status cannot yet be determined. Such species are omitted from this list of rare species (Appendix A). For example, *Stigonema* sp. 1, (Goward, 1999) probably is genuinely rare, but lichenologists have not been aware of this species for very long.

3. The ONP/OP inventory is far from complete, and many crustose lichens and less common bryophytes and macro-lichen species are yet to be recorded.

There are also species on the WNHP list that appear to be quite frequent on the OP (such as the lichens *Ahtiana pallidula* and *Usnea wirthii* and the liverworts *Douinia ovata* and *Diplophyllum albicans*). The status of these lichens may be updated if evidence shows that they are also frequent elsewhere in Washington. Both liverworts were removed recently from the former Survey and Manage list. The moss *Racomitium aquaticum* is now considered to be the distinct species *Racomitrium ryszardii,* an endemic to the PNW found mainly on the western part of the OP (Bednarek-Ochyra, 2000). The lichen *Karnefeltia californica* is apparently over-reported in Washington because of mis-identifications; there are perhaps only four or five accepted locations in Washington (L. Geiser, written commun., 2004), hence its status should be G2S1.

Surveyor attention often focuses on species listed as rare. The Survey and Manage species in particular receive much more attention than other species and are specifically sought in the field. On the OP, for example, the authors have collected the rare lichen *Pseudocyphellaria rainierensis* (fig. 11) from more locations than the common *P. anthraspis*. It is therefore necessary to use caution in drawing conclusions from the collection frequency of these species on the OP, as indicated in Appendix A. However, a few species do appear to be more frequent here than elsewhere in Washington and Oregon, and future work may demonstrate that they are not truly rare on the OP (for example, *Metzgeria temperata* and *Platismatia lacunosa*).

Endemic Species

Clues from biogeography help us to understand patterns of endemism. Endemic species are those with narrow distributional ranges, and are considered special for being unique to a region. Endemism may occur when an area has been isolated for a significant time or serves as a refuge for relict populations of a formerly common species following widespread extinction. Vascular plants endemic to OP were thought to have been isolated by its island-like geography and its potential to have been a refuge during the last ice age (Buckingham and others, 1995). Whether the distribution of non-vascular endemic plants supports this hypothesis remains to be seen.

Among the non-vascular flora, approximately 105 moss species and varieties are endemic to western North America, representing about 18 percent of the moss flora (Lawton, 1971; Schofield, 1985). Of these, some 20 mosses are found west but not east of the Cascade Range (Lawton, 1971). The proportion of endemic liverworts is similar, about 16 percent (Schofield, 1985). Nine moss and three (monotypic) liverwort genera are endemic to Pacific North America (Schofield ,1985; 2002). The proportion of the lichen flora that is endemic to western North America is high, but the number is unknown to the authors. At present, no mosses, liverworts, or lichens are known to be endemic exclusively to the Olympic Mountains. In Pacific North America, almost all endemic bryophytes occupy geographic areas that are larger than the OP, hence the Peninsula may not be sufficiently isolated to produce endemic bryophytes. With respect to lichen endemism on the OP, Rhoades (1997) comments that “the general response from lichenologists concerning endemism is that the Olympic Peninsula has a diverse and abundant lichen flora but that, with perhaps a few exceptions, the flora is no different from that of nearby areas.”

Even though there is no current evidence of endemism in the OP non-vascular flora, it may be too early to draw a firm conclusion. Many of the areas suspected of having been glacial refugia in ONP have not been surveyed. The state of knowledge of cryptogam distribution is also still dynamic, as new species are frequently added to the non-vascular plant lists of the OP, Washington, and North America. Species altogether new to science are described frequently, particularly among the crustose lichens. Often, with the increased attention brought on by the publication of a new species description, the species is soon reported from other areas. For example, the moss *Brachydontium olympicum* was initially believed to be restricted to the Olympics when discovered by Dr. Frye in 1907. It was later found in Oregon, Washington, British Columbia, and Japan. The small fruticose lichen *Spilonemella americana* was recently described and placed in a new genus. Originally collected adjacent to the Hoh River (type locality), it is now also known from other areas in Pacific North America (Henssen and Tønsberg, 2000). The ‘arboreal hairball,’ another fruticose lichen species, tentatively called *Stigonema* sp. 1, was included in a species key for British Columbia by Goward (1999). During this project it was found on Sitka spruce branches from the upper canopy in the Hoh and Quinault rainforests, and it was also found in Oregon (B. McCune,written commun., 2002). During this project, two macro-lichens in the genus *Dermatocarpon* were found in ONP that are thought to be undescribed. One liverwort in the genus *Scapania* did not fit any key we had available. If these are undescribed, these species may be endemics, or they may be found elsewhere now that taxonomists are aware of them.

Conservation of Cryptogams

- Regional Context for Rare Species

Bryophytes and lichens fulfill many important roles in the ecosystem and are a major component of the floristic biodiversity of the Olympics. In turn, the OP is of major floristic importance to the region because of its large habitat diversity and because of the occurrence of many species that are known from only a few localities in the PNW (such as *Vulpicida tilesii*), the conterminous 48 States (such as *Bunodophoron melanocarpum*, fig. 6), or Washington (such as *Splachnum sphaericum,* fig. 12). The liverwort *Tritomaria exsectiformis* (ONHIC list 2; SEIS J2-8a) occurs in a single site (on Olympic National Forest land), which represents the only known site in Washington and Oregon west of the Cascade Range for this species (J. Harpel, oral commun., 2003). The preservation of biological diversity is becoming increasingly important with the advance of anthropogenic habitat conversion. It seems inevitable that the main reservoir of diversity is going to be the National Park system and other unmanaged areas. ONP is essentially an unmanaged island in a managed landscape. Species associated with old-growth forests in Washington and Oregon, such as the mosses *Schistostega pennata* (WNHP G4 S2, fig. 13), *Tetraphis geniculata* (WNHP G5 S2, fig. 14), and *Iwatsukiella leucotricha* (WNHP G2/3 S1) were once more widespread, and generally only occur in the managed landscape on legacy substrates from the original old-growth forest. *Schistostega* requires large, shaded, upturned, soil-clad root wads. *Tetraphis geniculata* requires large, shaded wood debris in an advanced state of decay. After these legacies have been depleted, commercial forests are unlikely to provide a spatially and temporally continuous habitat for these species. Their persistence may only be guaranteed in large tracts of old-growth forest, where their microhabitats have greater temporal and spatial continuity.

Although some species of cryptogams seem to disperse easily via light-weight, airborne spores, many spores are not robust to long distance/time travel (Tan and Pocs, 2000). Most species depend on vegetative propagation and slow dispersal through forests (Tan and Pocs, 2000). Consequently, if populations of rare species are lost, they would probably return slowly, if ever. Attempts to revitalize managed landscapes will need to restore the ecological infrastructure and the connectivity to centers of diversity that still remain on the landscape. The large relatively pristine ecosystems in ONP are some of the last few places that still harbor healthy and extensive populations of some of these obligate old-growth associated species. Because of the island-like nature of the OP, species cannot easily recolonize the area once extirpated. A comprehensive list of ‘special concern species’ for ONP is unavailable as there is insufficient information to adequately assess the frequency of many species. Nevertheless, some candidate species can be identified. The macro-lichen *Platismatia stenophylla* is common in Oregon and other parts of Washington, including the San Juan Islands, and is hence not listed on any State or federal list. However, this distinctive species is known from a few thalli on a single ridge on the northern OP, and hence may represent a critically endangered element of the flora. The southern OP is less well explored, but our limited fieldwork there did not yield additional records of this species. Other examples of species that are apparently rare on the OP, but may be more frequent elsewhere in Washington, are the PNW endemic mosses *Bryolawtonia vancouveriensis* and *Alsia californica* and the lichen *Ramalina subleptocarpha*.

• Threats

People often assume National Parks are in little need of active management, but human impacts are far reaching and will continue to increase and affect the National Parks. The direct threats are easiest to control and many activities are already regulated or prohibited in National Parks: commercial and scientific collection of bryophytes and lichens, construction of human infrastructure such as trails, roads (runoff), parking lots, and buildings. The indirect effects of fire suppression, air pollution, the introduction of invasive exotic organisms, and rapid climate change induced by global warming all can have major impacts on natural systems in the long term.

Wildfire and fire suppression. In the event of wildfire, Park managment may attempt to protect critical locations of rare organisms. Periodic fire, on the other hand, maintains habitat diversity and continuity at the landscape level. Low-intensity fires help create open-forest conditions where many lichens and bryophytes thrive. For example, the Blue Mountain fire in ONP eliminated many corticolous lichens, but favored others, including some thriving *Bryoria* cf. *fremontii* (fig. 15). A rare PNW endemic lichen, *Sulcaria badia* (WNHP G? S1), formerly known from a single locality in Washington on the Dungeness Spit, may have gone extinct from the OP as a result of habitat conversion and the effects of fire suppression (Peterson and others, 1998). Other lichens grow exclusively on charred wood (for instance, *Hypocynemyces* species), which is still a common sight in many areas of the ONP. However, a policy of fire suppression in National Parks may jeopardize the long-term supply of charred wood.

Air pollution. Air quality is generally good on the OP, but this may change with increasing human population. Pollutants from Asia are now periodically measurable in ONP (Edmonds and others, 1998), and may increase in the future, eventually to a level where they are harmful to pollution-sensitive lichens. This effect can be monitored in the critically endangered *Usnea sphaecelata* (WNHP Priority 1, G?S1, fig. 16). It is found in only a few places in Washington, and was recently discovered in ONP. The high fog-bound peaks and ridges favored by this species intercept aerosols, which present a serious threat to this pollution-intolerant species. Much could be learned from mapping the population of this rare species and seeking other populations on nearby ridges. If the population size is sufficient, pollutant concentrations in its tissue could be monitored periodically along with tissue from common species nearby. Although only an informal survey was conducted, many other rare species were found in the immediate vicinity, making a pollutant monitoring effort even more worthwhile. Examples include *Alectoria nigricans* (Priority 1 G4 S1), *A. ochroleuca* (Priority 1 G4 S2), *Ahtiana sphaerosporella* (Priority 2, G? S?), *Brodoa oroarctica* (Priority 1, G2 S1), *Bryoria nitidula* (to be verified, possibly new to Washington), *Collema undulatum var. granulosum* (Washington status unknown), *Cornicularia normoerica* (Priority 2, G? S2), *Leptogium minutissimum* (Washington status unknown), *Leptogium platynum* (Washington status unknown), *Lobaria linita* (Priority 2 G? S?), *Nodobryoria subdivergens* (Washington status unknown), *Umbilicaria cylindrica* (Priority 2 G3 S1), *U. havaasii* (Priority 2 G3 S1), *U. krascheninnikovii* (Priority 2 G3 S1), *U. proboscidea* (Priority

Figure 10. *Blepharostoma arachnoideum.*

Figure 11. *Pseudocyphellaria rainierensis.*

Figure 12. *Splachnum sphaericum.*

Figure 13. *Schistostega pennata.*

Figure 14. *Tetraphis geniculata.*

Figure 9. *Tayloria serrata (composite photograph).*

2 G4S1), and *U. rigida* (Priority 2 G2 S1, fig. 17). The liverwort *Lophozia excisa* (Washington status unknown) found at the same site is not known from anywhere else on the OP.

Exotic cryptogams. The introduction of exotic species of non-vascular plants is not yet a major problem, though it seems inevitable that parks will see them in the future. *Orthodontium lineare* (fig. 18), a Southern Hemisphere species, was accidentally imported to Europe, apparently via raw log transports. It has proved an aggressive, invasive species and is now widely distributed in western Europe (Schofield, 1985; van Dort and others, 1998). It may have contributed to the decline of a related species native to England, now critically endangered (*http://www.ukbap.org.uk/UKPlans.aspx?ID=485*, access restricted, November 2005). Another moss, *Campylopus introflexus* (fig. 19), has spread across western Europe and now is also spreading rapidly in California and Oregon (Christy and Wagner, 1996). In 2001, it was found on the OP for the first time, along the Moclips highway in Grays Harbor County. In 2004 it was found in ONP on Tivoli Island, Lake Ozette. This species grows in thick sods and can replace native vegetation on sandy soils (van Dort and others, 1998). The European species *Pseudoscleropodium purum* is one of at least six introduced mosses that are now established in British Columbia (*http://srmapps.gov.bc.ca/apps/eswp/*, November 2005). It is common in lawns of south coastal British Columbia (Schofield, 1992) and Seattle. It has also been found on the San Juan Islands (Harpel, 1997) and recently in Port Angeles and Quilcene, Washington. It grows in forests of western Europe, but so far has not been detected growing in forested habitats on the OP. Other introduced mosses, liverworts (such as *Lunularia cruciata*) and lichens (such as *Xanthoria parietina* and *Phaeophyscia rubrapulchra*; McCune and Geiser, 1997, and possibly *Scoliciosporum sarothamni*; Tønsberg, 1995) have established and are spreading in the PNW.

Other exotic species. Exotic species can exert a major influence on pristine ecosystems from another angle as well. White pine blister rust (*Cronartium ribicola*) has decimated white bark pine (*Pinus albicaulis*) in ONP and is also taking a toll on western white pine (*P. monticola*). Species associated with white bark pine also undergo population declines, but these may have gone unnoticed or undocumented. The lichen 'whitebark candlewax' (*Ahtiana sphaerosporella;* WNHP Priority 2, G? S?, fig. 20) was found in the park in only two places, once on dead whitebark pine and once on dead western white pine (*Pinus monticola*).

Climate change. Humans are influencing ecosystems in major ways. Spatial and temporal patterns of the landscape composition and process are very different than those a few hundred years ago due to human activities. Specifically, continuous mosaics of ecosystems have been disrupted so that habitat continuity and connectivity have been diminished. This will be of major concern in light of climate change (whether natural or anthropogenic) and the need for species to migrate. Most plants and animals cannot evolve fast enough to adapt apace with the changing conditions, so they must survive by migrating to new habitats. Those species that cannot migrate or adapt along with the rate of environmental change will likely be out-competed by other species moving into their habitats. The cascading effects of rapid climate change could have a major impact on an island-type flora where species may be more easily lost than replaced. Especially if climate is changing at an unprecedented rate, it will be necessary to restore the ecological infrastructure of the landscape to accommodate the migration of species.

Further Work in Olympic National Park

Bryophytes and lichens are an important component of the ecosystem, fulfilling many roles in nutrient and hydrologic cycles and providing nesting material for many animals and birds and housing for numerous invertebrates. Bryophytes and lichens are used as powerful tools in biomonitoring, have commercial value, are a major component of the biodiversity, and in many areas define the aesthetic appearance of ONP. Consequently, there are many kinds of research into ecosystem function that could benefit ONP and the scientific community, but because of the taxonomic focus of our project, this section is devoted to suggestions for additional floristic work.

• Needs for Existing Bryophyte and Lichen Data

Complete the identification and verification of difficult and interesting specimens. It is important that the identity of some of the most interesting taxa be verified, either by taking specimens to a regional herbarium, by requesting reference specimens, or by sending specimens to taxonomic specialists. Specific needs include the following.

o *Chilocyphes gemmiparous* (G2 S1), a liverwort collected from a high mountain basin. If verified, it would be new to Washington. This species requires work at an herbarium where it can be compared with a specimen, or it could be sent to Dr. D. H. Wagner (Northwest Botanical Institute).

o There may be two different undescribed *Dermatocarpon* aff. *luridum* in ONP. One came from near the Hurricane Ridge Visitor Center; the other specimen came from the park interior and differs from the first. McCune tentatively examined both specimens and recommended that they be sent to Starri Heiðmarsson

Figure 17. *Umbilicaria rigida.*

Figure 16. *Usnea sphaecelata.*

Figure 15.
Bryoria cf. *fremontii.*

Figure 18. *Orthodontium lineare* (photographed in The Netherlands).

Figure 19.
Campylopus introflexus (photographed in Coos Bay, Oregon).

Figure 20. *Ahtiana sphaerosporella.*

(Icelandic Institute of Natural History), a taxonomic expert on *Dermatocarpon*.

- o There may be an undescribed liverwort in the genus *Scapania* that was collected from a few localities in ONP. Further work could elucidate whether this species is undescribed, or perhaps is one of the more recently described species from the region. Additional literature will be needed.

Correcting problems in ONP non-vascular plant herbarium. During the past century, independent of this project, some 55 collectors deposited more than 5,000 non-vascular plant collections at ONP. Recently, the outdated nomenclature of many of these collections was revised: the lichen nomenclature during this project and the bryophyte nomenclature with support from ONP Cultural Resources Management (CRM) where the collection facility is housed. K. Hutten, with support of CRM, determined 400 specimens with incomplete identifications, collected by N. Buckingham. Only specimens with obvious identification errors were re-determined. Other obvious identification errors have been identified, but at present no funds are allocated for work on the historic collections (for example, most if not all *D. bonjeanii* are probably *D. scoparium*/*D. howellii*, many *Claopodium whippleanum* are *Pseudoleskea patens;* the determinations in the genus *Sphagnum* have proved unreliable). Some species concepts have been modified recently, requiring work on all previously determined collections of *Pyrrospora cinnabarina* for instance, as many pertain to the recently described *P. gowardiana* (Spribille and Hauck, 2003); similarly, most of the *Menegazzia terebrata* are *M. subsimilis* (Bjerke, 2003), several species groups in the lichen genus *Fuscopannaria* have recently been reworked (Jørgensen, 2000), and so forth.

Generating spatial data from ANCS+ records. Bryophyte and lichen data from other collectors are stored in ANCS+, the NPS-mandated curatorial database. Because of major inadequacies of the spatial component of ANCS+, these historic data cannot easily be mapped. With some further effort, however, one could generate coordinates for the roughly 600 different localities where these 5,000+ specimens were collected. These spatial data would allow the addition of thousands of data points to the cryptogam distribution maps of the OP. Geographic and elevational distribution maps also provide a useful tool for identifying outliers that often signal misdeterminations.

Obtain data from other sources. The diverse and abundant non-vascular plant flora of ONP has inspired considerable interest. In the last 30 years, 25 researchers were issued a collecting permit for lichen and bryophyte work in Olympic National Park. Several workers renewed their permits for several years, sometimes accompanied by peer scientists. Apparently, some researchers worked in ONP without a permit or with oral permission, leaving no records at the Park. Although the combined effort was substantial, it left a comparatively small research legacy at ONP. Many researchers did not deposit voucher specimens at ONP, or deposited few specimens while making sizeable collections. Many researchers apparently did not submit an informal collection report, and only one researcher submitted electronic records. Only a limited amount of the gathered data was published in the scientific literature, and few researchers sent copies of their published work to ONP. Therefore, databases are missing data for thousands of specimens collected in ONP. ONP lacks locality data on hundreds of species known from the ONP and OP, including:

o *Dermatocarpon luridum*	WNHP Priority 1, G? S2 lichen, Clall, Jeff County,
o *Tholurna dissimilis*	WNHP Priority 1, G? S2 lichen, Hurricane Ridge,
o *Umbilicaria scholanderi*	WNHP Priority 1, G1 S1 lichen, Mason County,
o *Brachydontium olympicum*	WNHP G3 S1 moss, Clallam County,
o *Brotherella roellii*	WNHP G4 S1 PNW endemic moss, Clallam, Jefferson Counties,
o *Sphagnum alaskense*	newly described moss, not yet listed, Cape Alava Andrus & Janssen 2003,
o *Gymnomitrion concinnatum*	ONHIC G5 S2, liverwort, park interior Jefferson County? (Christy and Wagner, 1996; fig. 21),

- o and possibly other rare species.

Although a portion of these missing specimens may be adequately cared for in a university or agency collection, the data are effectively inaccessible to ONP, because most facilities do not have their herbarium data available electronically. The storage of all inventory data in an appropriate database is a critical component in ONP's mandate to protect its floristic diversity. From such databases, researchers can begin to understand how species are distributed in the park and where rare species are located. Rapid assessments can be made using GIS in the event of environmental or human-induced impacts. ONP could considerably advance its baseline cryptogam data by requesting and compiling data published in the scientific literature, from ONP collections deposited in regional herbaria, from other agencies, and from previous collectors.

• Needed Field Work

Geographic areas. The cryptogam diversity encompassed within the boundaries of ONP is not fully known because there are still many areas that remain unexplored or under-explored by bryologists or lichenologists. Entire river drainages have not been visited (for instance, Bogachiel, Queets, Skokomish, Duckabush; fig. 1). The focus of the largely plot-based work described here was on specific forest types, therefore many other areas were not surveyed, examples of which are addressed below.

Ecological zones. Some ecological zones have not been adequately surveyed. Significantly, the importance of a high-elevation, hyper-maritime (fog-intercepting) belt to bryophytes and lichens was not fully appreciated until 2002. A USFS project in this zone yielded the first record in Washington of a particularly interesting disjunctive moss, *Iwatsukiella leucotricha* (fig. 22), just outside of the Park. In North America, this arboreal moss is known only from a few locations along the West Coast. It is considered critically endangered in Washington, and was listed WNHP G2/3 S1 in 2004 (J. Harpel, written commun., 2004). In Oregon and Washington, its high-elevation, ocean-influenced habitat has been nearly completely logged. The remaining populations, including some that predictably exist in ONP, are of vital importance for the westward reintroduction of this species, should habitats become suitable again.

Other rare taxa also exist in the hyper-maritime zone. The lichen *Bryoria tenuis* is new to the OP and possibly Washington (suggested for listing WNHP), and *B. bicolor* is listed in Oregon. The former Survey and Manage moss *Racomitrium aquaticum* (WNHP G5 S3, fig. 23), considered rare throughout the PNW, is frequent on fog-intercepting ridges on the OP. It has recently been redescribed as *R. ryszardii*, and in that interpretation is a PNW endemic. At least four other regionally rare former Survey and Manage species were frequently encountered in this zone (these occur outside the zone as well), including the endemic lichen *Pseudocyphellaria rainierensis* (WNHP Priority 2, G? S2, fig. 11) and the yet unlisted *P. mallota (*Tønsberg, 1999b; fig. 7*)*, called “one of our rarest lichens” *(http://www.proaxis.com/~mccune/mallota.htm*, November 2005*)*. The number and relative abundance of rare taxa in this high-elevation belt suggest that further surveys would be appropriate.

Macrohabitats. Several habitat types remain underexplored.

- o Mountain ridges provide habitat for many rare species and should be surveyed using an intuitively controlled method (see “Air Pollution” under subsection “Threats” for an example of the number of rare species that may be found on some high-elevation ridges in ONP).

- o Deciduous forests have a diverse lichen and bryophyte flora. Some types that have not been explored during this project include forest types dominated by *Acer* spp., *Alnus sinuata*, *Arbutus menziesii*, *Salix* spp., *Populus trichocarpa, P. tremuloides*, or *Prunus emarginata*.

- o *Alnus rubra*-dominated riparian and floodplain forests bear diverse lichen floras when old and not too shaded, particularly on nutrient rich soils (Tønsberg, oral commun., 2003). Several rare lichens are known from these habitats, for example *Szczawinskia tsugae* (WNHP G? S1) and *Spilonemella americana* (not yet listed, recently described from type locality at the Hoh River).

- o *Quercus garryana* forests are becoming exceedingly rare on the northern OP. The authors have only examined a polluted fragment, slated for development, near the city center of Sequim. It contains our only collection of the moss *Alsia californica,* blue listed in BC (S2S3). A recently described lichen species, *Physconia fallax,* is found on oak trunks and is known from only one other place in Washington (S. Jovan, oral commun., 2003). The oak trunks also support *Pyrrhospora quernea* (WNHP, G? S?; S&M ‘E’). A cedar fencepost in the area supports *Thelomma occidentale* (WNHP G? S1). The oaks also support a large population of another rare lichen, *Ramalina subleptocarpha*, on the OP. It reaches the north end of its range here and is listed in British Columbia (S1), but not in Washington. The moss *Tortula laevipila* var. *meridionalis* (WNHP G3/G4 T1, S1; J. Harpel, written commun., 2004) was reported by Lawton (1971) from only one locality in North America, on oak in Victoria, British Columbia. It is now known from a few additional localities in the PNW, and it should also be sought in the few oak stands remaining on the Peninsula.

- o The immediate coast needs further surveys. Several rare lichens are exclusively coastal and are expected to occur on the OP coast but have not yet been found (for example, *Hypogymnia heterophylla* and *Heterodermia sitchensis*). These and several others are expected because they have been found farther north and south along the coast. The critically rare coastal species *Heterodermia leucomelos,* and *Bryoria subcana* were recently found on Mt. Walker on USFS land (L. Geiser, written commun., 2003)*,* but their distribution along the OP coast is unknown. Because many of these lichens are arboreal, they are more likely to be found after high winds when freshly fallen branches are common. An opportunistic project after a major wind event would be ideal to assay these lichens. One liverwort that may be found this way on the immediate coast is *Scapania scandica* (only two records in Washington).

- o Bogs in ONP urgently need detailed surveys to detect and protect rare species. *Splachnum ampullaceum* (fig. 8) and *S. sphaericum* (fig. 12) are new to Washington, per this project, and hence are not on the Washington list. The former is known from a single historic locality in Oregon, the latter appears to be new to the PNW. Both species are known from only one coastal bog complex on the OP. *Tetraplodon mnioides* (WNHP G5 S1; see figure 30) is known from six forested bogs, all outside of the Park, but Christy and Wagner (1996) show a record within ONP (details not known).

Tayloria serrata (WNHP G4? S1; fig. 9) is a rare PNW species in the *Splachnaceae* that on the OP is less restricted to bogs than the other species. It has been found in five localities, including an alpine location. Another bog associated moss *Tetraplodon* cf. *angustatus* (blue listed in BC: G4, S2S3), if verified, would also be new to the PNW. Of the 25 *Splachnaceae* collections, only two were found during the systematic sampling effort, indicating that these distinctive species are more easily detected by an intuitively controlled sampling method. It is very easy, however, to unwittingly damage these populations by trampling and indiscriminate collecting. Any future surveys of ONP coastal bogs should have the important goal of treading especially lightly, and all surveyors should be aware of the fragile and critical habitats of the *Splachnaceae*.

- o Some mountain and ridge tops are floristically very interesting and may be impacted by view-seeking visitors. One of the most frequently visited peaks in ONP supports the only known Washington population of the moss *Rhytidium rugosum* (G4 S1; fig. 24). Its presence provides support for the glacial refugia hypothesis. Spence (1983) indicated that the population was quite large in 1983, but this population was not relocated during an informal survey in 2000. A detailed survey to relocate and map the population would enable it to be monitored and protected in the future. The lichen *Leptogium saturnicum* is also restricted to this mountain on the OP.

Microhabitats. Bryophytes and lichens often occur on specific substrates or in specific microhabitats. Because such places are not evenly distributed on the landscape, such species cannot be adequately sampled with a stratified random sampling scheme based on vascular plant associations. Instead, they must be found by seeking specific microhabitats in the field using an intuitively controlled sampling method. Many habitats, microhabitats, and substrates have been underexplored.

- o Areas in and around waterfalls, streams, springs, and other wet areas typically have a diverse bryoflora that differs markedly from nearby floras not influenced by flowing water. Several rare species are known from these habitats. *Crumia latifolia* (WNHP G3 S1; fig. 25) is a moss that is known from only four places in Washington, three of which are on the OP. *Fissidens grandifrons* (WNHP G4 S2; fig. 26) is found on rock in seeps or in gentle streams that are always calcium-enriched including several watersheds on the OP. *Preissia quadrata* (ONHIC List 3, G5 S2) is known from a single locality near a calcium-enriched waterfall in ONP. There are also lichens that are associated with wet areas. *Hydrothyria venosa* (WNHP G? S2; fig. 27) is known from one alpine wetland in ONP.
- o Rock and rocky outcrops often have stable exposure and moisture regimes on which diverse bryophyte and lichen communities develop. Many rare non-vascular plants are known from such habitats. *Pilophorus nigricaulis* (WNHP Priority 1, G?, S2; fig. 28), for example, has recently been found (new to OP list) when surveyors passed through areas with exposed rock on Colonel Bob and the Skyline trail. *Myurella julacea* (WNHP Priority 2 G4 S1) is a rare moss that in Washington is only known from rock crevices on the OP. *Radula obtusiloba* subsp. *polyclada* is a rare liverwort that has been found on rock walls on the OP. Neither bryophyte has been collected in the past two decades. The authors suspect that these species still occur, but their habitats have not been surveyed.
- o Mineral soil habitats (roadcuts, stream/creek banks, floodplain) are very common but have not been surveyed. *Discelium nudum* (WNHP G5 S1; fig. 29) in Pacific North America occurs on steep (vertical) stream banks in the Hoh and the Bogachiel Rivers and may be under-reported.
- o Animal waste provides a nutrient-enriched growth substrate for a number of non-vascular plants. Several lichens grow on exposed rocks where raptors perch, and a handful of moss species grow exclusively on coyote or elk excrement (and possibly owl pellets; fig. 30). All of these mosses are very rare.
- o *Dermatocarpon* sp. nov., a lichen possibly new to science, is known only from natural drainages that now receive runoff from the NPS Visitor Center parking lot. Surveys of similar drainages would ascertain the status of this suspected new lichen species. Additional species of interest occur on soil nearby, including the liverworts *Riccia* sp., *Athalamia hyalina* (fig. 31), and *Asterella saccata,* known only from this location in ONP. The liverworts can only be detected shortly after snowmelt in spring, and may be more widespread than we realize, considering the strong summer bias in the present data. Surveys after snowmelt are recommended to find additional populations of these rare alpine liverworts in ONP.
- o There are other rare species needing further surveys, but are not mentioned here. For a more exhaustive list, see Appendix A.

Species-specific surveys. There are a number of critical species for which more detailed surveys are particularly needed.

- o Relocate populations of rare species. Several rare species were collected from ONP many years, even decades ago. If general collection localities can be determined, it would be important to attempt to relocate populations of these taxa (see examples in section "*Obtain data from other sources*").

Figure 21. *Gymnomitrion obtusum* is very similar to *G. concinnatum* and occurs in the same habitat.

Figure 22. *Iwatsukiella leucotricha*

Figure 24. *Rhytidium rugosum* (photograph of specimen from Denali National Park, Alaska).

Figure 25. *Crumia latifolia.*

Figure 23. *Racomitrium aquaticum.*

- The only known locality for the lichen *Karnefeltia californica* is adjacent to an NPS sewage-evaporation field. The species is currently listed in WNHP as G2 S2. The State listing should probably be S1, however, (see "Rare species on the OP") since there are only five collections in Washington. Many early reports of this species are the more inland species *Karnefeltia merrillii*. Because the species is also federally listed, a USFS crew has surveyed for this and other rare coastal lichens on the OP as part of a project ranging from California to Washington in 2000. These surveys did not yield further detections of this species (L. Geiser, written commun., 2004). Surveys of adjacent forest bogs would put the status of this population into perspective in advance of the planned expansion of the sewage facility and the presumed increase in human impacts around the evaporation field.

- The only known population of the rare moss *Rhytidium rugosum* may be declining and may be affected by Park visitors (see mountain tops, under macrohabitats). Surveys are needed to locate and assess the population and the potential for impacts.

- A lichen species in the genus *Dermatocarpon,* suspected to be new to science, was found in a natural drainage area receiving runoff from an NPS parking lot. Further surveys are needed to assess the extent of the population in nearby drainages.

- The lichen *Bunodophoron melanocarpum* (fig. 6) was not previously known from the lower 48 States, and it was proposed for listing by WNHP in 2003. A few years after its initial discovery, it is still known from only four or five sites on the OP. Locations near Ozette are the only known locations of this lichen on federal land. The ONP therefore has considerable responsibility for the protection of this species, yet the extent of the population and the existence of other populations is unknown.

- *Splachnum ampullaceum* (fig. 8)*, S. sphaericum* (fig. 12)*, T. mnioides* (fig. 30), and *T.* cf. *angustatus* are species that occur on elk excrement deposited in coastal bogs. Several species are new to Washington and so far are known only from one coastal bog complex on private land. Elk herds may be diminishing in the coastal zone, providing added reason for concern.

- *Sulcaria badia* (WNHP G? S1) may be extinct from the Dungeness (Peterson and others, 1998), the only known site in Washington. It is one of the region's rarest lichens and one of few that has been placed as critically endangered on the global red list (Peterson and others, 1998). Surveys conducted in other suitable areas, in especially the northeast OP, may locate extant populations. In Oregon and California it has been found most often on oak, but also on bigleaf maple, Douglas fir, Oregon ash, and ponderosa pine (*http://www.fs.fed.us/r5/mendocino/projects/hfi/docs/sulcaria-badia.pdf*, November 2005).

- *Brotherella roellii* (WNHP G3 S2, Survey and Manage) is a PNW endemic moss that was found in the Dosewallips decades ago. Relocation efforts have not been successful (J. Harpel, written commun., 2004), but surveys of adjacent ONP may locate more populations.

- A rare liverwort, *Marsupella emarginata* var. *aquatica* (ONHIC G5 S1; S&M 'B')*,* was collected in association with another species from the Park interior. A better specimen and a population survey are needed.

- Only a few populations of *Discelium nudum* (WNHP G5 S1; fig. 29) are known from the lower 48 States, two in the Hoh River valley, the other along the Bogachiel River. The specialized sites that this species occupies are often eroded or quickly invaded by vascular plants, so the sites are often quite ephemeral. In British Columbia, where the species is red-listed, there are no known currently occupied sites (W. Schofield, written commun., 2004) and the only other site known in Pacific North America is in California (Norris and Shevock, 2004b). Notably, the Pacific Coast population of *Discelium nudum* bears sporophytes that are often four to five times the size noted in the rest of its world range. The capsules are often elongate rather than subspheric, and setae can exceed 3 cm, compared to less than 1 cm elsewhere in its range (Schofield, 2003). If the Pacific Coast population is isolated enough to be genetically distinct, the global ranking in the WNHP would increase considerably.

- The Olympics are suspected to provide good habitat for a number of regionally rare species that have not yet been recorded. Christy and Wagner (1996) and Harpel (oral commun., 2000) predicted that *Iwatsukiella leucotricha* (fig. 22)*,* one of the region's rarest species, would likely occur in the Olympics. When the USFS ordered a survey for this species, several populations were detected from areas on the west OP. Although it is not yet known from ONP, it is likely to be there. Other rare species suspected to occur in the Olympics include *Bartramiopsis lescurii* (R. Lesher, oral commun., 2000), *Pleuroziopsis ruthenica,* and *Radula brunnea* (Christy and Wagner, 1996; *http://www.or.blm.gov/surveyandmanage*, temporarily unavailable November 2005).

- Request specimens and data from future collectors. As mentioned previously (under: Obtain data from Other Sources), valuable information has been lost to ONP or is essentially inaccessible, because many collectors did not deposit voucher specimens at ONP. The authors have been unable to find locations for rare species documented from ONP, and verifying a rare species is

Figure 26. *Fissidens grandifrons.*

Figure 28. *Pilophorus nigricaulis.*

Figure 27. *Hydrothyria venosa* inspection by James Walton.

Figure 29. *Discelium nudum.*

Figure 30. cf. *Tetraplodon mniodes* (WNHP G5 S1) on an owl pellet or coyote scat.

Figure 31. *Athalamia hyalina.*

difficult without a voucher specimen. Furthermore, a good reference collection makes specimen identification easier and increases confidence in identifications. Travel to other herbaria for reference material can be costly, leaving some very interesting specimens unidentified. Moreover, data deposited at the University of Washington (WTU) and many other herbaria are not yet entered electronically, making it very time-consuming for ONP staff to locate any quantity of ONP data in the large WTU collection. It may not be necessary to retain every specimen of the most common species at ONP, and certainly not type specimens, but ONP should at least retain those data electronically. North Cascades National Park already requires scientists to submit delimited electronic collection data from collectors, relieving curatorial staff from cumbersome data entry. Because data deposited at ONP are entered electronically, they can easily be made available to researchers elsewhere. The ONP collection is particularly deficient in crustose lichens, such that they were excluded from the present project because they could not be efficiently identified. Requesting duplicate specimens of crustose lichens from future collectors is an important need for ONP. Considering the importance of having distributional data on any species, collectors should be encouraged to deposit all data at ONP. Storage space at ONP is not a limitation, because a new facility is planned.

Conclusions

The importance and uniqueness of the non-vascular flora of ONP are hard to exaggerate. Not only are cryptogams key to the ecosystem function and aesthetic appeal of ONP forests, they represent a biogeographically significant array of rare and endemic species and a sizable component of the Park's biodiversity. This project has made important steps toward a comprehensive survey of these organisms. It has put the Park's resources in a regional context by documenting rare species, some for the first time in the conterminous United States, and a few species that are apparently undescribed. ONP has healthy populations of some species that are rare outside of the Park, where habitats have been destroyed. This data set can form the basis for further research on community stucture and successional patterns, and could be used as a tool for eventual restoration efforts outside of the Park.

Forests are one of the most important habitats for bryophytes and lichens globally, and conservation of forests is key to maintaining their biodiversity (Tan and Pocs, 2000). The NPS has had a long-standing mandate to protect habitats and a more recent mandate to inventory its resources so it can better protect biodiversity (National Park Service, 2001). Conservation of bryophytes and lichens worldwide has usually been a by-product of saving habitat for larger flagship, charismatic, or keystone species (Tan and Pocs, 2000). ONP is one of few places in the world where bryophytes and lichens, collectively, are conspicuous flagship organisms themselves. Consequently, ONP has the opportunity to bring them to the attention of the public, government, and other conservation agencies. The inventory described here is a tool to help ONP understand and conserve its non-vascular resources.

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Appendix A

Rare bryophytes and lichens known from Olympic Peninsula.

Scientific Name	Special Status									
	WNHP[1]	ONHP[2]	ROD[3]	SM 2001 SEIS[4]	SM 2002 ASR[5]	SM 2003 ASR[6]	2005 BLM[7]	2005 USFS R6: OR/WA[8]	SM rating[9]	BC rating[10]
MOSSES										
Alsia californica										BLUE G4 S2S3
Amphidium mougeotii										BLUE G5 S2S3
Andreaea heinemannii										BLUE G3G5 S1S3
Brachydontium olympicum	G3 S1	List 2 G2? S1								BLUE G2G3 S1S3
Brachythecium holzingeri										BLUE GU S1S3
Brachythecium reflexum var. pacificum										BLUE G4G5TNR S1S
Brachythecium velutinum var. venustum										BLUE G5TNR S1S3
Brotherella roellii	G3 S2		1,3	E	E	E			G2 N1 SH	BLUE G3 S3
Bryum calobryoides	G3 S1	List 2 G3 S2								BLUE G3 S1S3
Bryum canariense										RED G3G5 S2
Bryum cyclophyllum										BLUE G4G5 S2S3
Bryum gemmiparum										BLUE G3G5 S1S3
Bryum muehlenbeckii										BLUE G4G5 S2S3
Bryum turbinatum										BLUE G5 S2S3
Buxbaumia aphylla	G4 S3	List 3 G5 S2								YELLOW G4G5 S3S4
Buxbaumia viridis	G5 SU		1,3 PB	X-WA,OR, E-CA	E-CA	E-CA			G3 N3 S4	YELLOW G4 S3S4
Conostomum tetragonum	G4 S1	List 2 G5 S1								YELLOW G5 S3S5
Crumia latifolia	G3 S1	List 2 G3 S2								BLUE G3 S2S3
Dichelyma falcatum										BLUE G4G5 S2S3
Dicranella howei										RED GU S1
Dicranoweisia crispula var. contermina										BLUE G4G5TNR S2S
Didymodon vinealis var. brachyphyllus										RED G5TNR S2
Discelium nudum	G5 S1									RED G3G4 S1
Ditrichum schimperi	G4 S1									BLUE G3G5 S2S3
Ditrichum zonatum var. scabrifolium	G5 S1									BLUE G3G5T2T3 S2S
Drepanocladus aduncus var. kneiffii										BLUE G5T4T5 S2S3

(Footnotes on page 78.)

Scientific Name	Special Status									
	WNHP[1]	ONHP[2]	ROD[3]	SM 2001 SEIS[4]	SM 2002 ASR[5]	SM 2003 ASR[6]	2005 BLM[7]	2005 USFS R6: OR/WA[8]	SM rating[9]	BC rating[10]
Drepanocladus sendtneri										BLUE G5? S2S3
Epipterygium tozeri										BLUE G4? S2S3
Eucladium verticillatum		List 3 G4 S1								BLUE G4 S2S3
Fissidens fontanus	G5 S1									RED G5 S1
Fissidens grandifrons	G4 S2	List 3 G4 S2								YELLOW G3G5 S3S5
Fissidens pauperculus	G3 S1	List 3 G4 S1								RED G3? S1
Fissidens ventricosus	G4 S3									BLUE GU S2S3
Fontinalis patula										RED GNR S1
Grimmia affinis										BLUE G4G5 S2S3
Grimmia anomala		List 3 G5 S1								BLUE G5 S1S3
Grimmia holzingeri										BLUE GNR S2S3
Grimmia montana										BLUE G5? S2S3
Hedwigia stellata		List 3 G3 S1								
Herzogiella seligeri	G4 S1									BLUE G3G4 S2S3
Homalia trichomanoides	G5 S1									YELLOW G5 S3S4
Homalothecium arenarium										BLUE G4 S2S3
Hygrohypnum duriusculum										BLUE G3G5 S2S3
Iwatsukiella leucotricha	G2G3 S1	List 2 G4 S1	1,3	B	B	B	BA,O:BS,W	SS	G2G3 N2 S2	YELLOW G4 S3S4
Meesia uliginosa	G5 S1	List 2 G4 S1								
Mnium blyttii		List 3 G5 S1								YELLOW G5 S3S4
Myurella julacea	G4 S1									YELLOW G5 S3S5
Oncophorus wahlenbergii	G5 S1									YELLOW G5 S3S4
Orthothecium chryseum	G4 S1									YELLOW G5? S3S5
Orthotrichum affine										BLUE G3G5 S2S3
Orthotrichum alpestre										BLUE G4G5 S2S3
Orthotrichum pellucidum		List 3 G4 S1								YELLOW G3G5 S3S4
Orthotrichum pylaisii	G5 S1									BLUE G4G5 S1S3
Orthotrichum rivulare										RED G4 S1
Philonotis fontana var. americana										BLUE G5TNR S2S3
Philonotis fontana var. pumila										BLUE G5T4T5 S2S3
Philonotis yezoana										RED G2G3 S2
Physcomitrium pyriforme										BLUE G5 S2S3
Plagiomnium ciliare										BLUE G5 S1S3
Plagiopus oederiana	G5 S2									YELLOW G5? S3S4
Platyhypnidium riparioides	G4 S1	List 3 G4 S1								

Appendix A—continued (Footnotes on page 78.)

Scientific Name	Special Status									
	WNHP[1]	ONHP[2]	ROD[3]	SM 2001 SEIS[4]	SM 2002 ASR[5]	SM 2003 ASR[6]	2005 BLM[7]	2005 USFS R6: OR/WA[8]	SM rating[9]	BC rating[10]
Pohlia atropurpurea										BLUE G4G5 S2S3
Pohlia bolanderi										BLUE GU S2S3
Pohlia camptotrachela										BLUE G3G5 S1S3
Pohlia columbica	G2 S1									BLUE G3G5 S1S3
Pohlia elongata										BLUE G4G5 S2S3
Pohlia erecta	G3 S1									RED G3G5 S1
Pohlia filum										BLUE G4G5 S2S3
Pohlia lescuriana										BLUE G4? S1S3
Pohlia ludwigii										BLUE G5? S2S3
Pohlia obtusifolia										BLUE G2G4 S2S3
Pohlia pacifica										BLUE GU S1S3
Pohlia vexans										BLUE G3G5 S2S3
Polytrichum longisetum										BLUE G5 S2S3
Polytrichum sexangulare		List 3 G4 S1								YELLOW G4 S3S5
Polytrichum strictum	G5 S2	List 2 G4 S1								YELLOW G5 S3S5
Racomitrium aquaticum	G5 S3	List 3	1,3	E	E	E			G3Q N3Q S2	YELLOW G2G4 S3S
Racomitrium microcarpon	G5 S1									
Racomitrium pacificum		List 2								BLUE G3 S3
Racomitrium pygmaeum										BLUE GU S1S3
Rhabdoweisia crispata										BLUE G5 S2S3
Rhizomnium nudum		List 3 G4 S2	1,3	B	X-WA, B-OR (CA)	B-OR (CA)	As	SS-O	G4 N4 S4	YELLOW G3G5 S3S
Rhizomnium punctatum										BLUE G5 S1S3
Rhytidium rugosum	G4 S1	List 2 G5 S1								YELLOW G5 S3S4
Schistidium agassizii										BLUE G3G5 S2S3
Schistostega pennata	G4 S2	List 2 G4 S2	1,3	A	A	A	As	SS	G3G4 N3N4 S3	YELLOW G4 S3S4
Scleropodium touretii var. colpophyllum										BLUE G4TNR S1S3
Sphagnum quinquefarium										BLUE G5 S2S3
Splachnum ampullaceum		List 2 G4 S1								YELLOW G4 S3S5
Splachnum vasculosum										BLUE G3G5 S1S3
Tayloria serrata	G4 S1	List 2 G4 S1								
Tetraphis geniculata	G4 S2	List 2 G4 S1	1,3 PB	A	A	A	As	SS	G3 N3 S3	YELLOW G3G5 S3S
Tetraplodon angustatus										BLUE G4 S2S3
Tetraplodon mnioides	G5 S1	List 2 G4 S1								YELLOW G4 S3S4
Thamnobryum neckeroides	G3 S2	List 3 G4 S2								YELLOW GU S3S5
Timmia megapolitana										BLUE G5 S2S3

Appendix A—continued (Footnotes on page 78.)

Scientific Name	Special Status									
	WNHP[1]	ONHP[2]	ROD[3]	SM 2001 SEIS[4]	SM 2002 ASR[5]	SM 2003 ASR[6]	2005 BLM[7]	2005 USFS R6: OR/WA[8]	SM rating[9]	BC rating[10]
Tortula amplexa										BLUE G2G4 S2S3
Tortula bolanderi										RED G3G5 S1
Tortula subulata		List 3 G5 S1								BLUE G5? S2S3
Tripterocladium leucocladulum		List 2 G3 S2								BLUE G3 S2S3
(Total 100 MOSSES)										
LIVERWORTS										
Anastrophyllum minutum		List 3 G4 S1								
Barbilophozia lycopodioides		List 2 G5 S1								
Calypogeia sphagnicola		List 2 G4 S2								
Diplophyllum albicans			1,3		X	X effective			G5 N4 S4	
Diplophyllum plicatum		List 2 G4 S2	1,2	B	B	B	As		G4 N3 S2	
Gymnomitrion concinnatum		List 2 G5 S2								
Harpanthus flotovianus		List 3 G5 S1								
Herbertus aduncus		List 2 G5 S2	1,3		E	E	As		G5 N3N4 S1	
Jamesoniella autumnalis		List 3								
Lophozia gillmanii		List 3 G5 S1								
Marsupella condensata		List 3 G3 S1								
Marsupella emarginata var. aquatica		List 2 G5T3 S1	1,2	B	B	B	As		G5T3 N3	
Marsupella sparsifolia		List 3 G3 S1								
Metzgeria temperata		List 2 G4 S1								
Nardia japonica		List 3 G5 S2								
Preissia quadrata		List 3 G5 S2								
Ptilidium pulcherrimum		List 2 G5 S1								
Radula obtusiloba subsp. polyclada										
Scapania obscura		List 3 G3 S1								
Schofieldia monticola		List 3 G3 S1								
Tritomaria exsectiformis		List 2 G5 S2	1,2	B	B	B	As		G5 N4 S2	
Tritomaria quinquedentata		List 2 G5 S1	1,3	B	B	B	As		G5 N4 S1	
(Total 22 LIVERWORTS)										
LICHENS										
Ahtiana pallidula	Priority 2 G? S?									
Ahtiana sphaerosporella	Priority 2 G? S?									
Alectoria lata	Priority 1 G? S2									

Appendix A—continued (Footnotes on page 78.)

Scientific Name	Special Status									
	WNHP[1]	ONHP[2]	ROD[3]	SM 2001 SEIS[4]	SM 2002 ASR[5]	SM 2003 ASR[6]	2005 BLM[7]	2005 USFS R6: OR/WA[8]	SM rating[9]	BC rating[10]
Alectoria nigricans	Priority 1 G4 S2									
Alectoria ochroleuca	Priority 1 G4 S1									
Alectoria vancouverensis										S1
Arthonia stellaris	Priority 2 G? S?									
Arthrorhaphis citrinella	Priority 2 G? S?									
Brodoa oroarctica	Priority 1 G3 S1									
Bryoria bicolor		List 3 G4 S1								
Bryoria friabilis	Priority 1 G3 S1									
Bryoria pikei	Priority 1 G2 S2									
Bryoria pseudocapillaris		List 2 G2? S1	1,3	B	A	A		SS?	G1G2 N1N2 S1	
Bryoria subcana		List 3 G4 S1	1,3	B	B	B			G2G4 N2N3 S1	
Bryoria tortuosa	Priority 2 G2 S3		1,3	A-WA OP +1	A-WA OP +1	A-WA OP +1			G5 N5 S3	
Buellia oidalea	Priority 2 G? S2	List 3 G4 S1	1,3	E	E	E			G3? N3? S1	
Bunodophoron melanocarpum	d as new WNHP									
Calicium abietinum	Priority 2 G? S?	List 3	4	B	B	B			G4G5 N4 S2S3	
Calicium glaucellum	Priority 2 G? S?		4	F	F	F			G4G5 N4 S4	
Cetrelia cetrarioides	Priority 2 G? S3	List 3	4	E	E	E		SS-WA?	G4G5 N4 S2	
Chaenotheca ferruginea	Priority 2 G? S?	List 4	4	B	B	B			G4G5 N4 S4	
Chaenotheca furfuracea	Priority 2 G? S?	List 3	4	F	F	F			G4G5 N4 S3	
Cladina portentosa subsp. pacifica	Priority 2 G? S2									
Cladonia norvegica	Priority 2 G3 S2	List 3	3	B	B	B			G4G5 N2N3 S2	
Coccotrema pocillarium	Priority 1 G2 S1									
Collema fecundum										S2
Collema furfuraceum										S2
Cornicularia normoerica	Priority 1 G? S2									
Cystocoleus ebeneus	Priority 2 G? S1									
Dendriscocaulon sp.	Priority 1 G? S1	List 2 G3 S1	1,3	B	A-WA +3	A-WA +3		SS-WA?	N4Q S2	
Dermatocarpon luridum	Priority 1 G? S2	List 3	1,3	B	E	E		SS?	G4G5 N4 S1S2	
Dermatocarpon moulinsii	Priority 1 G? S?									
Erioderma sorediatum	Priority 1 G? S1	List 2 G3 S1	1,3	X	-			SS?		S1
Fuscopannaria laceratula										S2
Fuscopannaria pacifica									G5? N5 S4S4	
Fuscopannaria saubinetii			4	F	F	F			G3G5 N2 S1?	
Gyalideopsis anastomosans	Priority 2 G? S1									
Halecania viridescens	Priority 1 G? S1									

Appendix A—continued (Footnotes on page 78.)

Scientific Name	Special Status									
	WNHP[1]	ONHP[2]	ROD[3]	SM 2001 SEIS[4]	SM 2002 ASR[5]	SM 2003 ASR[6]	2005 BLM[7]	2005 USFS R6: OR/WA[8]	SM rating[9]	BC rating[10]
Heterodermia leucomela			1,3	X	-			SS?		S2
Hydrothyria venosa	Priority 1 G? S2		1,3	X	-					S2
Hypogymnia duplicata	Priority 2 G? S3	List 3	1,2,3	A	C	C		SS-OR?	G4 N4 S3	
Hypogymnia oceanica	Priority 2 G? S1	List 2	1,3	F	X	-				
Hypogymnia vittata	Priority 2 G? S?		3	E	E	E			G4G5 N3 SNA	S?
Kaernefeltia californica	Priority 2 G2 S2		1,3	X	-					S2
Leioderma sorediatum		List 2 G3 S1	1,3	X	-			SS?		S1
Leptogium brebissonii			1,3	X	-			SS?		S1
Leptogium cyanescens		List 3	4	A	A	A		SS?	G5 N4 S1	S1
Leptogium platynum										S2
Leptogium polycarpum										S1
Leptogium teretiusculum	Priority 2 G? S?	List 3	4	E	E	E			G4G5 N4	
Lobaria hallii	Priority 2 G? S?		1,3	X	-					
Lobaria linita	Priority 2 G? S?	List 2 G4 S1	1,2,3	A	A	WC S Snoqualmie F		SS-OR?	G4G5 N3 S3	
Lobaria silvae-veteris	Priority 1 G? S1									S1
Loxospora elatina	Priority 2 G? S?									
Loxosporopsis corallifera	Priority 2 G? S?		1,3	X	-					
Microlychnus epicorticis	Priority 2 G? S1									
Nephroma bellum			4	F	E-WA (OP) +4	E-WA (OP) +4		SS-WA?	G3G5 N3N4 S2	
Nephroma occultum	Priority 1 G? S1	List 3 G3 S3	1,3	B	A	A		SS?	G3 N3 S1	
Niebla cephalota	Priority 1 G? S1	List 3 G4 S2	1,3	A	A	A		SS?	G1G3 N2 S1	S1
Opegrapha sorediifera	Priority 2 G? S1									
Ophioparma lapponica	Priority 1 G? S1									
Pannaria rubiginosa		List 2 G4 S1	1,3	E	E	E		SS?	G4G5 N4 S1	S2
Parmotrema chinense										S1
Parmotrema crinitum										S2
Peltigera lepidophora	Priority 1 G? S1									
Peltigera pacifica			4	E	E	E		SS?	G3 N2N3 S2?	
Pilophorus nigricaulis	Priority 1 G? S2	List 2 G4 S2	1,3	X	-			SS?		S1
Platismatia lacunosa	Priority 2 G? S3	List 3	4	C	C	(except OR Coast F		SS-WA?	G3G4 N3 S2	
Pseudocyphellaria crocata	Priority 2 G? S3		4	X	-					
Pseudocyphellaria mallota		List 2 G4 S1								
Pseudocyphellaria perpetua			1,3	B	B	B			G2G4 N2	
Pseudocyphellaria rainierensis	Priority 2 G? S2	List 3 G3 S1	1,2,3	A	A	A		SS?	G3G4 N3N4 S3	S1
Pyrrhospora quernea	Priority 2 G? S?	List 3	1,3	E	E	E		SS?	G4 N4 S1S2	

Appendix A—continued (Footnotes on page 78.)

Scientific Name	Special Status									
	WNHP[1]	ONHP[2]	ROD[3]	SM 2001 SEIS[4]	SM 2002 ASR[5]	SM 2003 ASR[6]	2005 BLM[7]	2005 USFS R6: OR/WA[8]	SM rating[9]	BC rating[10]
Pyrrhospora subcinnabarina	Priority 2 G? S1									
Ramalina menziesii	Priority 2 G? S3									
Ramalina pollinaria	Priority 2 G? S?	List 2	3	E	E	E		SS?	G4G5 N4 S1	
Ramalina subleptocarpha										S1
Ramalina thrausta	Priority 1 G? S1		4	A	A	A			G3G4 N3 S1	
Solorina saccata	Priority 2 G? S?									
Sticta beauvoisii s.l.	Priority 2 G? S?		4	X	-					
Sulcaria badia	Priority 1 G? S1	List 2 G2 S2								
Szczawinskia tsugae	Priority 2 G? S1									
Thelomma occidentale	Priority 2 G? S1									
Tholurna dissimilis	Priority 1 G? S2	List 3 G4 S1	1,3	B	B	B south of Col R.		SS?	G3G5 N3 S2	
Umbilicaria angulata	Priority 2 G2 S2									
Umbilicaria arctica	Priority 2 G3 S1									
Umbilicaria cylindrica	Priority 2 G3 S1									
Umbilicaria decussata	Priority 2 G3 S1									
Umbilicaria havaasii	Priority 2 G3 S1									
Umbilicaria krascheninnikovii	Priority 2 G3 S1									
Umbilicaria lambii	Priority 1 G? S1									
Umbilicaria lyngei	Priority 2 G3 S1									
Umbilicaria polyrrhiza	Priority 2 G1 S1									
Umbilicaria proboscidea	Priority 2 G4 S1									
Umbilicaria rigida	Priority 2 G2 S1									
Umbilicaria scholanderi	Priority 2 G1 S1									
Umbilicaria vellea	Priority 2 G3 S2									
Usnea hesperina		List 3 G4 S3	1,3	B	E	E			G4G5 N4 S1?	
Usnea longissima	Priority 2 G? S2	List 3	4	F-WA +2	F-WA +2	F-WA +2		SS?	G3G4 N3 S2	
Usnea rubicunda		List 3 G4 S2								
Usnea sphacelata	Priority 1 G? S1	List 3 G4 S1								
Usnea wirthii	Priority 2 G2 S2									
Vulpicida tilesii	Priority 1 G4 S1									

(Total 103 LICHENS)

Appendix A—continued (Footnotes on page 78.)

Scientific Name	Special Status									
	WNHP[1]	ONHP[2]	ROD[3]	SM 2001 SEIS[4]	SM 2002 ASR[5]	SM 2003 ASR[6]	2005 BLM[7]	2005 USFS R6: OR/WA[8]	SM rating[9]	BC rating[10]

Indexes created over all recent 1998- current data (USGS/ONP data _M. Hutten personal data), but excluding ANCS data because of several problems associated with that dataset. These data are provided as an indicator of the relative frequency of the species collected. The OP localities count is generated from unique sites only, i.e. duplicate collections from a single site are excluded. Such unique sites however may occasionally be in close proximity to each other.

Note that the Washington Natural Heritage Program has not yet included liverworts in their listings.

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[1]WNHP= Washington Natural Heritage Program
- G = Indicator of global status
- S = Indicator of state status
- 1 = Critically imperiled because of extreme rarity or because it is particularly vulnerable to extinction or extirpation; typically 5 or fewer occurrences
- 2 = Imperiled because of rarity or because it is vulnerable to extinction or extirpation; typically 6 to 20 occurrences
- 3 = Either very rare and local throughout its range or found locally (even abundantly) in a restricted range; typically 21 to 100 occurrences.
- 4 = Apparently secure; typically more than 100 occurrences
- 5 = Demonstrably widespread, abundant and secure.
- U = Status uncertain; additional information is needed.
- ? = Additional information needed
- Note that the WNHP has not yet included liverworts in their listings.

[2]ONHP = Oregon Natural Heritage Program
- 1 = Critically imperiled because of extreme rarity (5 or fewer occurrences, or very few remaining individuals), or because of some factor of its biology making it especially vulnerable to extinction.
- 2 = Imperiled because of rarity (6–20 occurrences), or because of other factors demonstrably making it very vulnerable to extinction throughout its range.
- 3 = Either very rare and local throughout its range, or found locally (even abundantly at some of its locations) in a restricted range, or vulnerable to extinction throughout its range because of other factors; in the range of 21–100 occurrences.
- 4 = Apparently secure, though it may be quite rare in parts of its range, especially at the periphery.

[3]ROD = Record of Decision; applicable to Forest Service and Bureau of Land Management forest management in range of the Northern Spotted Owl.
- 1 = Manage Known Sites
- 2 = Survey Prior to Ground-Disturbing Species
- 3 = Extensive Surveys
- 4 = General Regional Surveys

[4]SM = Survey and Manage; the program implementing the ROD was amended several times, and revisions were made to the status of ROD species (USDA and USDI 2001). In 2001 a Supplemental Environmental Impact Statement (SEIS) was released.
- A = Rare, Pre-Disturbance Surveys Practical
- B = Rare, Pre-Disturbance Surveys Not Practical
- C = Uncommon, Pre-Disturbance Surveys Practical
- D = Uncommon, Pre-Disturbance Surveys Not Practical or Not Necessary
- E = Rare, Status Undetermined
- F = Uncommon or Concern for Persistence Unknown, Status Undetermined
- X = Species removed from list

[5]2002 Survey And Manage Annual Species Review (ASR) rating (see 4)
- +1: A – WA OP, WA W Lowlands, WA W Cascades, OR W Cascades, OR Coast Range, OR Willamette Valley, and CA Coast Range
  - D – WA & OR
  - E – Cascades, OR & CA Klamath, & CA Cascades
- +2: F – WA, OR,
  - A – CA,OR (Curry, Josephine, Jackson)
- +3: A – WA,
  - E – CA,
  - E – OR (Coos, Douglas, Curry, Josephine, Jackson)
  - A – OR remainder
- +4: E – WA (W-Cascades outside GPNF),
  - E – Cascades, OP)
  - E – OR (Klamath, Willamette Valley & East Cascades)
  - X – Removed elsewhere

[6]2003 Survey And Manage Annual Species Review data (see 5)

[7]2005 Bureau of Land Management (BLM) ratings
- SS = Sensitive Species
- BS = Bureau Sensitive

[8]United States Forest Service (USFS) Special Status Species Rating
- SS = Sensitive Species

[9]Survey and Manage Rating (see WNHP ratings for explanation of the rating system)

[10]British Columbia (Goward 1996):
- 1 = Critically imperiled because of extreme rarity (5 or fewer occurrences, or very few remaining individuals), or because of some factor of its biology making it especially vulnerable to extirpation or extinction.
- 2 = Imperiled because of rarity (6 to 20 extant occurrences or very few remaining individuals), or because of other factors demonstrably making it vulnerable to extirpation or extinction.

Hutten, M., Woodward, A. & Hutten, K.—**Inventory of the Mosses, Liverworts, Hornworts, and Lichens of Olympic National Park, Washington: Species List—Scientific Investigations Report 2005-5240**

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