VASCULAR FLORA OF THE PENOBSCOT EXPERIMENTAL FOREST, WITH PROVISIONAL LISTS OF LICHENS AND BRYOPHYTES

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Abstract.—A compilation of plant lists from all available sources since the 1950s represents the flora of the Penobscot Experimental Forest (PEF), Bradley, Maine. More than 300 taxa of vascular plants in 71 families and 186 genera are included. Approximately 85 percent of the taxa are native to Maine. Ten of 45 nonnative species are considered invasive. Infraspecific taxa have not necessarily been resolved, though 14 subspecies are included as they represent the species in the region. Two rare plants, *Carex oronensis* and *Clematis occidentalis*, have been documented. Omitted taxa overlap known species (e.g., "*Salix* sp." in which a single species is indicated), or are thought to be misidentifications. Sixty-two lichen and 49 bryophyte species are included provisionally. More species could be found in surveys for (1) ruderal plants in disturbed ground; (2) species found in the 1960s that are unknown today at the PEF; (3) expected, common species of spruce-fir that have not been documented; (4) graminoids, which seem underrepresented; and (5) species in riparian zones and wetlands. The plant checklist could be especially useful in documenting shifts in the flora that might be attributable to climate change. Nomenclature in a new flora of New England differs from the U.S. Department of Agriculture, Natural Resources Conservation Service database in significant ways; both sources should be considered in vegetation research in the PEF.

INTRODUCTION

Plant lists have value for estimating species diversity, summarizing large data sets, pointing out rare species and invasive plants, and stimulating additional study of an area, among many other uses (Palmer et al. 1995). This report is the first comprehensive vascular plant list for the Penobscot Experimental Forest (PEF) in Bradley, Penobscot County, Maine. The PEF is a long-term research site of the Northern Research Station of the U.S. Department of Agriculture (USDA), Forest Service, and is owned by the University of Maine Foundation. Ongoing research is conducted jointly and separately by the Forest Service and the university. The plants have been studied since the 1950s (Kenefic et al. 2006), yet plant species mentioned in peer-reviewed publications have not been compiled into a plant list for the 1,618-ha forest until now. Vegetation has been reported especially regarding changes in overstory composition and tree regeneration in response to silvicultural experiments (Brissette 1996, Kenefic et al. 2006). Earliest studies focused entirely on valuable timber species, and by the late 1960s, 105 woody plant species were on a list (Safford et al. 1969). Recent studies not only have included silvicultural treatments but also have broadened the focus, emphasizing the herb layer (Dibble et al. 1999, Schofield 2003), epiphytic lichens (Miller et al. 2007, 2008), and invasive plants (Bryce 2009). Observations and surveys apart from the system of Continuous Forest Inventory (CFI) plots (also called permanent sample plots or PSPs) have included some of the roadsides, successional forest, and former agricultural land.

Any flora can have significance for conservation planning in that emphasis tends to fall on species that are seldom collected. Once their rarity is recognized, attention might flow toward further understanding of habitat requirements for such species, and management activities can help assure their continued occurrence within an area. However, common and

abundant species could be consequential if they are affected by disease or insect attack, with profound consequences for ecosystem processes, functions, and biodiversity (Ellison et al. 2005). Examples are the attack of American chestnut (*Castanea dentata*) by blight (*Cryphonectria parasitica* [Murrill] Barr), and the decimation of eastern hemlock (*Tsuga canadensis*) by hemlock woolly adelgid (*Adelges tsugae* Annand).

Checklist and atlas preparation have been developing in recent years and numerous new opportunities are now available. For example, Allard (2004, updated through 2011) continually updates an online statewide list of bryophytes of Vermont. This atlas includes global rankings and synonyms, with information at the level of the township, rather than state or county. Ability to update rapidly and to obtain feedback increases the utility of the atlas. Internet technology allows expanded opportunities for understanding species distributions, habitat requirements, and gaps in knowledge. Eventually, overlays with forest cover type, natural community classification, soils, bedrock, drainage, and land use could enable prioritization of habitat protection or at least recognition of conditions that are conducive to certain rare species.

At the same time, a push toward standardization of floras (Palmer et al. 1995) should help assure that the best possible data are reported in a manner that allows comparison across regions, continents, or the world. Palmer and associates have developed the Floras of North America project (Palmer 2013) with explorations of ways in which floristic inventories can be used across regions. We do not know all the uses that future researchers will find for the plant lists we prepare today, but those who work on checklists and atlases are alert to how easily errors might be perpetuated. These errors may occur because of (1) misidentifications, (2) duplicate entries that result when a species is identified and its genus (typically with "sp." for an undetermined species) is also included, or (3) failure to represent nomenclatural changes. Despite the many challenges, the preparation of a flora is worthwhile for its many uses, not the least of which are serving as a hypothesis to test, and assigning research priorities.

The purpose of this report is to establish a baseline list of vascular plants for the PEF in the form of a checklist. Though lichens and bryophytes have not yet been comprehensively surveyed in the PEF, these two groups are included as provisional lists. A secondary objective is to set the checklist in the context of what is known about plant species diversity in Maine. In this paper the PEF checklist is related to an ongoing effort to standardize floras, and the discussion includes a projection of uses for the checklist under several scenarios.

METHODS

All data reported here were collected at the PEF (44°49.8' to 44°52.1' N, 68°39.5' to 68°36.2' W) in Bradley, Penobscot County, Maine. Since 1994, the property has been owned by the University of Maine Foundation, Orono, Maine, with its flagship campus only 1.6 km away as the crow flies. About 500 ha of adjacent properties in the Dwight Demeritt Forest are owned by the University of Maine system but are not part of the PEF.

The PEF is in the Penobscot River watershed with a primary stream, Blackman Stream, as the major drainage. This is a glaciated low-elevation (< 75 m) landscape with mostly flat topography, ranging from 29-77 m, without significant bedrock outcrops and containing only a few large glacial erratics. The soils are diverse, with an average depth of organic matter at <16 cm, over about 50-100 cm of glacial till. Safford et al. (1969) summarized the B-horizon as having a soil texture that ranges from silt-loam to sandy-loam, and drainage characteristics that range from good to poor. A cool, humid climate prevails, with mean annual temperature of 6.7 ±0.3 °C (±SD, 1971-2000). About half the annual precipitation of 1,066 ±137 mm falls between May and October, with average annual snowfall of 289 ±78 cm (Larouche et al. 2010). The growing season is 183 ±15 days (Brissette 1996).

Dominant vegetation consists of mixed northern conifers, and has been described as representative of the Acadian Forest (Sendak et al. 2003), an ecotone between the conifer-dominated boreal forest and the hardwoods prevalent southward. The type is characterized especially by red spruce (*Picea rubens*), an economically valuable conifer with low genetic variability (Hawley and DeHayes 1994) that is common in parts of Maine, New Brunswick, and Nova Scotia, with smaller populations in New Hampshire, eastern New York, Vermont, high elevations of the Appalachians farther to the south, and Quebec, and an outlying population in Ontario. With it grow balsam fir (*Abies balsamea*), eastern hemlock (*Tsuga canadensis*), eastern white pine (*Pinus strobus*), and northern white-cedar (*Thuja occidentalis*). Also present but rarely dominant are white spruce (*Picea glauca*), black spruce (*P. mariana*), tamarack (*Larix laricina*), and red pine (*Pinus resinosa*). Hardwoods include especially red maple (*Acer rubrum*), paper birch (*Betula papyrifera*), gray birch (*B. populifolia*), quaking aspen (*Populus tremuloides*), and bigtooth aspen (*P. grandidentata*). Additional hardwoods are American beech (*Fagus grandifolia*), northern red oak (*Quercus rubra*), white ash (*Fraxinus americana*), and sugar maple (*Acer saccharum*).

In the Acadian Forest, natural disturbances tend to be in the form of small gaps rather than stand-replacing events. Fire-return interval and catastrophic windthrow events are thought to occur on a cycle of no less than 800 years, though human disturbance can alter this frequency (Seymour et al. 2002). Longevity of red spruce, eastern hemlock, and northern white-cedar contribute to a stable shade environment unless stands are influenced by timber harvest, insect outbreak, or similar canopy disturbances.

Land use at the PEF has consisted of some timber harvest since the 1790s, especially near Blackman Stream, but not much clearing for agriculture except at the west end of the property. The PEF has been the site of continuous, ongoing silvicultural treatments and monitoring conducted by the U.S. Forest Service, Northern Research Station since the 1950s. Repeated harvests have been conducted in 10 replicated treatments that include even-age and uneven-age prescriptions with entries from 5-20 years (Kenefic et al. 2006, Safford et al. 1969, Sendak et al. 2003). Approximately 580 CFI plots are arranged within the treatment compartments on a more-or-less evenly distributed pattern that typically avoids the road system and wetter areas. Data have been collected especially on more productive sites and uplands, whereas the wetlands contain fewer plots and have not been thoroughly inventoried.

Valuable knowledge about sustainable forest management has been derived from the data collected in these experiments, with focus on timber management, spruce budworm, coarse woody material, economics, biodiversity, growth and yield modeling, avian habitats, invasive plants in relation to soil properties and silvicultural treatment, and much more. Few stands at the PEF are unharvested old growth; at one time or another, most or all of the forest has been cut. Numerous stump sprout hardwoods and cut stumps are in evidence in most stands. In some areas, entry might have been more than 100 years ago. A reference compartment, which lacks any recent harvest, represents baseline conditions, and features a hiking trail enjoyed by visitors to the Maine Forest and Logging Museum at Leonard's Mills Historic Settlement, which is adjacent to the PEF. A general overview of the PEF as managed by the Northern Research Station and additional details can be found on the U.S. Forest Service's Web page for the PEF (U.S. Forest Service 2012).

For this report, a list of vascular plant, lichen, and bryophyte taxa on the PEF was derived from any relevant PEF publications and from some additional collecting in 2011. Most plant specimens were identified to the nearest species, though for 14 taxa a particular subspecies is the one known for this region; thus the list includes subspecific taxa. This aspect of plant identification was inconsistent between studies, and in some cases a taxon is represented at the genus

level only. Nomenclature for vascular plants follows the USDA Natural Resources Conservation Service (NRCS) database, an atlas of all vascular plants and some bryophytes in the United States, which is online. The NRCS database is used by the U.S. Forest Service's Forest Inventory and Analysis Program and has gained acceptance for many uses, though its practicality as a sole nomenclatural source for a flora is questionable. Resources such as Haines (2011) that have gained popular usage among Maine botanists make a nationwide treatment less relevant unless the NRCS database reflects recent name changes.

The papers consulted include, in chronological order: Safford et al. 1969, Rinaldi 1970, Dibble et al. 1999 (including unpublished data for PEF vascular plant species that had not occurred with sufficient frequency to be included in analyses for the study), Schofield 2003, Miller et al. 2007, Miller et al. 2008, and Bryce 2009. Effort was made to consult every written document that contains a plant list, including unpublished masters theses that are not in peer-reviewed journals. For observations of ferns, graminoids, shrubs, subshrubs, vines, and forbs, only growing-season data were used. For trees, data collected during other times of year were also used.

Because study objectives and sampling methods differed between studies, plant lists are not directly comparable. For example, in some studies percentage cover of every vascular plant species was included (Bryce 2009, Dibble et al. 1999); in another, percentage cover of grasses, sedges, and rushes was not to the species level (Schofield 2003). The list was evaluated for plausibility as some identifications could be incorrect. Voucher specimens for questionable entries were examined if they were available. Nomenclature for species and family names, and native status (i.e., plants thought to be native to Maine rather than introduced or adventives) follow the NRCS database. Each taxon was assigned a growth form, e.g., fern (or fern ally), herb, graminoid, shrub, subshrub, tree, and vine. No abundance metric was assigned.

In addition to published reports, the checklist includes data from an informal list of lichens that were observed by James W. Hinds and Patricia Hinds during a field meeting of the Josselyn Botanical Society at the PEF in 1994. Nomenclature follows Hinds and Hinds (2007). Bryophyte species information came from several sources. Some bryophytes were included in plot data by Dibble et al. (1999) and Bryce (2009) but most of those were at the genus level. Miller et al. (2007, 2008) found certain epiphytic bryophytes and lichens to be important to invertebrate diversity. Otherwise bryophyte and lichen observations have been incidental in just a few studies at the PEF. Some common species to be expected in such a large conifer-dominated area were not yet listed. To increase the utility of this paper, I made additional observations in 2010-11 in three locations: (1) a mature red spruce-dominated stand at the Field Demonstration Trail, (2) a riparian mature northern white-cedar swamp called Dismal Swamp, and (3) low-lying mixed conifer forest near the freshwater marsh at Blackman Stream. Bryophyte nomenclature follows Allen (2005) through the Timmiaceae, and Crosby et al. (1999) for additional moss genera. For liverworts, nomenclature follows Stotler and Crandall-Stotler (1977).

Additional records, not published, that were considered for the plant list include (1) Orono sedge, *Carex oronensis*, which I documented at four locations in the PEF; (2) slippery elm, *Ulmus rubra*, determined by field crew during data collection for the Forest Inventory and Analysis Program in the 1990s, but not vouchered or confirmed, and otherwise undocumented in Maine since 1935; and (3) purple clematis, *Clematis occidentalis*, which is State Special Concern (Maine Department of Agriculture, Conservation, and Forestry 2010).

To understand whether species richness is high or low, species richness at the PEF (minus 34 questionable taxa) was compared to that for several other areas in Maine that are of a relevant size and occupied almost entirely by forest and wetlands. The other sites

were: Massabesic Experimental Forest in Alfred and Lyman, York County (Dibble et al. 2004); Great Pond Mountain Wildlands in Orland, Hancock County; and Coastal Mountains Land Trust properties at Bald and Ragged Mountains, Camden, Knox County. A very well documented land holding, Acadia National Park with headquarters in Bar Harbor, Maine, was used as a far outlier in this comparison because the flora has been recently updated (Mittelhauser et al. 2010), and because bryophytes and lichens are especially well documented there. All these other areas are not necessarily similar to the PEF in terms of elevation; topography; soils; proximity to major water bodies, including the Atlantic Ocean; or forest management. Plant lists for two of the sites[1] are contained in in-house natural resource inventory reports prepared for land trusts, and are used in development of management plans.

As part of the effort to standardize checklists worldwide, this report was contrasted with Palmer et al. (1995) and with a list of desired components for floras, which is under development (M. Palmer, Oklahoma State University, pers. communication). The PEF checklist of vascular plants reported here is in compliance with Palmer's working list of features so that it could be referred to as an example in the standardization of florae and to assure best utility in the future.

[1] Dibble, A.C.; Rees, C.A. 2006. Great Pond Mountain Wildlands Natural Resource Inventory. Proprietary document held by the Great Pond Mountain Wildlands Trust.

Dibble, A.C. 2005. Ecological inventory of Bald Mountain Preserve, Camden, ME. Addendum 2008, in cooperation with C.A. Rees. Proprietary document held by the Coastal Mountains Land Trust.

Dibble, A.C. 2007. Ecological inventory of Ragged Mountain Preserve, Camden, ME. Addendum 2008, in cooperation with C.A. Rees. Proprietary document held by the Coastal Mountains Land Trust.

RESULTS

More than 300 vascular plant taxa in 71 families and 186 genera were considered appropriate for the PEF checklist (Appendix I), of which 45 species (about 15 percent) are not native to Maine. The list contains five genera for which "sp." is given, meaning that a species was not determined but, in my opinion, is likely to be other than those listed. Ideally the list would be fully resolved to infraspecific taxa; it includes 14 subspecific taxa but for some species it was not possible to resolve further. Vouchers are available for many of these taxa, but not all; collections by Olson et al. (2011), which were examined for this report, are especially useful in documenting the flora. Most are deposited at the Hart Building on the PEF, and unusual species were deposited at the University of Maine Herbarium in Orono. Families that are especially well-represented are the Asteraceae, Rosaceae, Cyperaceae, and Caprifoliaceae (Appendix II, based on NRCS designations). Perennials consisting of forbs, graminoids, shrubs, and trees were the majority of growth forms, with fewer ferns and fern allies, subshrubs, and only a few vines. Two rare plants, *Carex oronensis* (Fig. 1) and *Clematis occidentalis*, have been documented. Ten of the 45 nonnative plants are considered invasive or potentially so according to an unpublished list kept by the Maine Natural Areas Program: *Berberis thunbergii*, *Celastrus orbiculatus*, *Euonymus alata*, *Frangula alnifolia* (Fig. 2), *Lonicera morrowii*, *Lonicera xylosteum*, *Lythrum salicaria*, *Poa nemoralis*, *Rosa multiflora*, and *Rhamnus cathartica*. Several other nonnative species appear to persist and spread at the PEF under closed canopies or in openings, and might be considered invasive where they outcompete native vegetation, e.g., *Epipactis helleborine*, *Hylotelephium telephium*, *Solanum dulcamara*, *Valeriana officinalis*, and *Veronica officinalis*. Omitted taxa and unresolved genera are shown in Appendix III. They either are unlikely in southern Penobscot County and are thought to be misidentifications (e.g., *Krigia virginiana*, *Rosa*

Figure 1.—*Carex oronensis*, Orono sedge. It is known from several small populations in the PEF and at Leonard's Mills. (Photo courtesy of A.C. Dibble.)

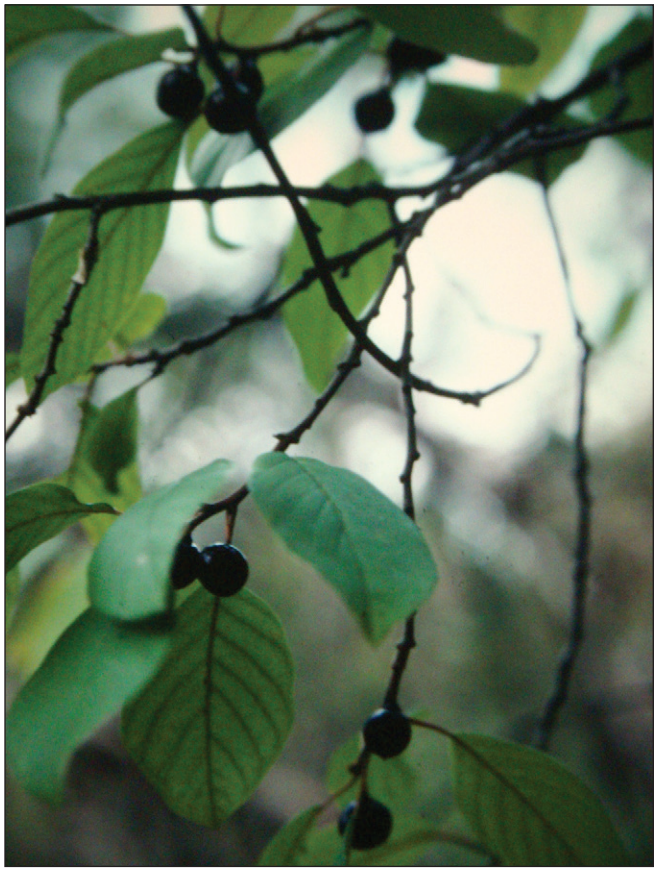

Figure 2.—*Frangula alnifolia*, glossy buckthorn. This shade-tolerant tall shrub is spreading in the PEF in part because birds eat the fruits in autumn and spread them ever deeper into the forest. (Photo courtesy of A.C. Dibble.)

johannensis) or are believed to overlap known species (e.g., "*Salix* sp."); voucher specimens could not be found to check these.

Plant name changes make preparation of a checklist more complicated. Of the taxa in Appendix I, revisions in Haines (2011) have led to 34 changes in family designation, compared to the NRCS database. For 32 taxa, species became recognized at the subspecific level because that subspecies is the only one known in Maine. For 16 taxa, genus has changed, and these are likely to present particular challenge as some are common and likely in many parts of the PEF, such as northern starflower, *Trientalis borealis* (now *Lysimachia borealis*), and bunchberry, *Cornus canadensis* (now *Chamaepericlymenum canadense*). Five taxa had a change in specific epithet, and there were numerous changes in naming authority, though some are slight.

Most species on the list are common and widespread in Maine and elsewhere in northeastern North America. Some are shade-associated, and are not usually abundant in forest openings; examples are *Goodyera repens* (Fig. 3), *Mitchella repens*, *Monotropa uniflora*, *Moneses uniflora*, *Oxalis montana*, and *Trillium undulatum* (Fig. 4). Their presence in the silvicultural treatment at the PEF suggests their resilience to canopy disturbance.

Plants listed as rare in Maine are not frequent or abundant in the PEF, but I documented one, *Carex oronensis* (Orono sedge) (Dibble and Campbell 2001), state threatened, at two widely separated sites on the forest (at Leonard's Mills and on a roadside at

Figure 3.—*Goodyera repens*, lesser rattlesnake plantain. This native terrestrial orchid is shade adapted and with potential as an indicator of closed-canopy conifer stands. (Photo courtesy of A.C. Dibble.)

Figure 4.—*Trillium undulatum*, painted trillium. It can tolerate the low shade under balsam fir and other conifers, where few other vascular plants thrive. (Photo courtesy of A.C. Dibble.)

Compartment 10) in 1991. In 2011, I found another subpopulation along a woods road. Another listed rare plant is *Clematis occidentalis* (western virginsbower), State Special Concern, documented by Molly Schauffler near the beaver dam at Compartment 26.

Some plants are unusual in Maine, though not yet on a state rare plant list. An example is ditch stonecrop (*Penthorum sedoides*), which occurs in sandy oxbows along small rivers. Its presence at the PEF is noteworthy because habitat was not typical, perhaps reflecting a general lack of knowledge about this undercollected plant, and not necessarily a status as rare. There was no reference specimen at the University of Maine Herbarium until recently when the gap was noticed, an omission that might indicate the plant is infrequent and local.

Sixty-two lichens (macrolichens and crustose lichens) have been documented in the PEF (Appendix IV) from published lists; in-house lists; recent, brief surveys at three sites in the PEF; and other sources. None of the lichens is rare or highly unusual. Nine liverworts species and 40 mosses were found (Appendix V). Again, none is considered rare.

DISCUSSION

Vascular plant species richness is not particularly high for this size area of forested land in Maine, and is at least 13.5 percent lower than for the other areas compared in Appendix VI. Only 16.5 percent of the total number of 2,103 vascular plant taxa recorded in Maine (Campbell et al. 1995) are documented on the PEF. Characteristic of the shady understory in spruce-fir forest types, low species richness is due in part to thin, acid soils; acidifying needle litter; and "low shade," in which the conifer lower canopy excludes direct sunlight except for brief exposure to sun flecks. The proportion of the light spectrum in red : far red light is important for seed germination of forest plants (Jankowska-Blaszczuk and Daws 2007). Because this proportion differs between coniferous and deciduous canopies, growing conditions might be poor under spruce-fir and hemlock for otherwise common understory herbs and shrubs.

The percentage of the PEF flora comprising nonnative plants is lower than the overall percentage in Maine, which has 634 naturalized vascular plant species. At the PEF, 42 naturalized species have been found,

representing 12.1 percent of the flora, whereas in the entire state, 30.1 percent are nonnative. The percentage at the PEF is not particularly low for small florae (Palmer, pers. communication).

The changes in focus over time for observations at the PEF are reflected in the checklist. Earliest studies focused on the trees valuable for timber; then shrubs were included in the list of Safford et al. (1969). Rinaldi (1970) quantified trees, shrubs and herbs and the latter were in broad groups, not to species. In the early 1990s, I included percentage cover estimates for all vascular plant species and some bryophytes and lichens in a study of red spruce regeneration habitat that included plots in the PEF, but species with low frequency were dropped for analyses, and a complete list for the PEF was not published. The most comprehensive plant list for the PEF was Bryce (2009), who found 234 plant species on CFI plots. That total includes some entities identified to genus only, with possible overlap for entities identified to species. Abundance data are available on plots and as a frequency of measured plots. Common lichens and bryophytes were included in that study, but were a low priority with 13 genera and only 5 identified to species. I added 43 moss species based on observations at two sites in autumn 2010 and spring 2011. Schofield's (2003) list was for the Acadian Forest Ecosystem Research Program section of the PEF and is not as comparable to the other lists, though it contains many similarities, especially for woody plants.

There are numerous sources of error in the exercise of preparing plant checklists. Selection of taxa for inclusion in the list is somewhat arbitrary. The list reported here could be improved if a group of botanists familiar with the flora of southern Penobscot County and the entire state were to go through the list line by line and reach a consensus about what must be excluded, but in this report, only one botanist made those choices. Standard methods for treating questionable species have not yet been adopted. In the PEF checklist, excluded taxa had a variety of problems that led to their removal. If a genus was already represented in the list by one or more likely species, then it seemed that duplication would result by also listing the genus with no specific epithet (e.g., *Amelanchier* sp.).

Misidentifications were apparent—Safford et al. (1969) identified a plant as wickopee, *Dirca palustris* (Fig. 5), but the voucher specimen housed at the PEF is *Viburnum*. In recent years, Olson spotted *D. palustris* on the forest at the PEF, and verified it through use of a photo; this species is included in Appendix I. A few of Schofield's (2003) determinations were omitted due to extreme rarity in Maine, out of known range, inappropriate habitat, lack of confirmation because no voucher could be located, or a combination of these reasons. Examples are: *Asplenium* sp., *Corylus americana*, *Cystopteris* sp., *Krigia virginiana*, and *Rosa johannensis*.

Another challenge is plant name changes, which can be confusing—some names change and then change back again to the original name. Even more problematic is that name changes in taxon concepts or taxon ranks—such as when a subspecies is elevated to full species status—can generate complications when subspecies and varieties are lumped together (Palmer, pers. communication). Most of these entities

Figure 5.—*Dirca palustris*, wickopee. Known at the PEF from a single small plant, it flowers in early spring. (Photo courtesy of A.C. Dibble.)

can be updated and cross-referenced with powerful and widely available Web tools, but the NRCS plant database lags behind important taxonomic treatments including Haines (2011). There is wide expectation that Haines (2011) will serve as the standard for field botanists in New England, and eventually the NRCS plant database could adopt plant names that are likely to be in common usage. Further, the NRCS plant database contains at least a few subtle errors that could influence a plant checklist project, e.g., an erroneous name for *Carex foenea*, which has become confused with *C. siccata*. The NRCS currently includes only a few lichens and bryophytes, so its full utility for those groups is not realized. Haines (2011) includes only vascular plants. Additional complications in the PEF checklist can arise through published errors; for example, Miller et al. (2008) referred inadvertently to three species prominent in their study of arboreal arthropod diversity as "bryophytes," but those are epiphytic lichens.

The PEF checklist matches Palmer et al. (1995) regarding the recommended standards in most ways. The list is presented by genus, and other components such as elevational range are included. The PEF list departs in that precision of location data is not to standard. If latitude and longitude could be obtained for every population of each taxon, then relative abundance could be derived. This level of information might be prohibitive, even in a well-studied forest area. Bryce (2009) calculated species relative abundance based on frequency of each taxon in her study plots, providing a start toward finding associations between certain plant species and overstory conditions, soils, and other environmental variables.

Ways in Which the PEF Checklist Can Be Improved

Researchers can approach this checklist in several ways to identify gaps in our knowledge, and in doing so, can expand and improve the checklist itself. Not in any particular order by priority, these approaches include:

1. Further document the weedy plants of roadsides and log landings. Disturbed areas should be checked for invasive plants on a regular basis because of the threat such plants place upon the long-term silvicultural experiments if they are not controlled.
2. Survey the recently harvested 1,200 ha that are adjacent to the PEF. The parcel was recently added to ownership by the University of Maine System. Additional plant species are likely for the checklist.
3. Monitor known rare plant populations in the PEF periodically, perhaps every 5 years, in conformity with the New England Wild Flower Society and Maine Natural Areas Program reporting protocols.
4. Seek and document common plants of spruce-fir forests in Maine that are not yet on the checklist, such as: *Dulichium arundinaceum*, *Equisetum sylvaticum*, *Glyceria canadensis*, *Monotropa hypopithys*, *Osmunda regalis*, *Vaccinium vitis-idaea* var. *minus*, and *Viola macloskeyi* ssp. *pallens*.
5. Seek and document common nonnative plants, including *Rumex acetosella*, *Trifolium pratensis*, *Phalaris arundinacea*, and *Festuca filiformis*. These species might be present but were not found on plots. Because plots tended to be on better-drained soils, weedy plants of disturbed ditches might be underrepresented. Or there could be worker bias in that graminoid identification requires training and experience, is time-consuming, and might not be pertinent to project goals in some forest studies.
6. Many fern, graminoid, and other plant species can be resolved to species or subspecies only when their spore-bearing structures, flowers, or fruits are present. For the sake of best-quality data, and mindful of budget constraints, efforts should be made to verify questionable species wherever possible by returning to a plant population later in the season and pressing a voucher specimen.

7. Survey habitats that are underrepresented in Appendix I such as wetter areas that have not been actively managed for timber. Riparian zones, forested wetlands, swales, and boggy areas have not yet been investigated beyond walk-throughs between plots and a few casual visits by botanists and other researchers. Bryophytes are not well-inventoried in any of the habitats and should be sampled as part of a rigorous inventory (see Newmaster et al. 2005).
8. Survey taxonomic groups that are underrepresented in PEF research, including the lichens, bryophytes, and fungi. Of these the crustose lichens and liverworts need particular attention to make the list more representative of the flora and thus more useful. Crustose lichens were a major influence on the lichen checklist for Katahdin in Baxter State Park (Dibble et al. 2009, Hinds et al. 2009). At Acadia National Park, Sullivan (1996) found that more than half of the lichen diversity was in crustose lichens (198 of 379 species, Appendix VI). Although the PEF has hosted mycological field meetings, no list of fungi could be found for this report. I suggest that a requirement for use of the PEF as a field trip site for any botanical organization should be the understanding that species lists will be presented to the University of Maine and U.S. Forest Service.
9. Give particular thought to relative abundance when designing studies. An abundance rank for each species would be possible for many species in Appendix I, especially trees using the PEF plot data, and for many understory plants using Bryce's thesis data (2009), but the actual abundance on the forest might not be accurate based on purposes for which the sampling was designed. Data collected on plots do not always represent actual abundance in the area. Relative abundance is of sufficient importance to warrant a thoughtful approach in other studies.
10. Seek the "lost" species. A few species were reported by Safford et al. (1969) and have not been documented since, including *Acer saccharinum*, *Andromeda glaucophylla*, *Arceuthobium pusillum*, *Aronia melanocarpa*, and *Cephalanthus occidentalis*. For each of these, relocation of a population seems likely. At Acadia National Park, 200 of the total 862 species known for the park have not been seen for more than 20 years, such as numerous orchid species. This apparent loss could reflect change in land use, overcollection, or other factors (Greene et al. 2005, Mittelhauser et al. 2010).

    On the other hand, Safford et al. (1969) featured plants such as *Frangula alnifolia* and *Rosa multiflora*, which are widely recognized now as invasive. They did not mention whether they considered them invasive. They did not list Oriental bittersweet, *Celastrus orbiculatus*, which can now be found in numerous places on the PEF, suggesting that it is a recent arrival. Because Oriental bittersweet spreads rapidly due to bird dispersal of the fruits, this invasive vine should be given priority in management of the PEF. Oriental bittersweet, perhaps more than most of the other invasive plants present, could impact forest regeneration on study plots in the silvicultural treatments.
11. Prepare vegetation maps for the PEF to include recently described natural communities of Gawler and Cutko (2010). Although forest types as categorized by the Society of American Foresters (SAF) and other vegetation classification schemes have been assigned to some of the vegetation in the PEF, especially regarding the silvicultural treatments, there is not yet a complete map of vegetation at the PEF. Broad forest types might not be sufficient to understand habitat requirements of certain plants of interest. Types assigned by timber stocking conditions might be used as a surrogate for canopy closure, which could be helpful in study of the shade-associated understory plants such as *Goodyera repens* (Fig. 3) and *Trillium undulatum* (Fig. 4). Bryce (2009) measured canopy closure on a subset of her plots and

found that species that had been shown in other studies to frequent shady understory conditions did not always do so at the PEF, so other factors could be involved in their distribution.

Plant checklists for land trusts are sometimes prepared by habitat or community type, and such an approach at the PEF would require some careful investigation for many of the plant species, to establish their plant associations and see how the natural community descriptions depart from what is actually found on the property. Natural communities as described by Gawler and Cutko (2010) in coordination with NatureServe have not yet been applied to the vegetation at the PEF, but some stands could be considered for possible classification as the spruce-pine woodland (state rank S4), spruce-northern hardwoods forest (S5), lower elevation spruce-fir forest (S5), hemlock forest (S4), early successional forest (S5), with small patches of black spruce woodland (S2) or black spruce bog (S4), red maple swamp (S4), and northern white-cedar swamp (S4). Such community designations might be at a finer scale than the SAF forest types, and a plant checklist could eventually be prepared to reflect those natural communities. A purpose for such an exercise would be to recognize plant species that occur in only one or a few such communities; then management of the overstory might differ from what is otherwise being done. It should be noted that the northern white-cedar swamp at Dismal Swamp has not had any obvious recent harvest and apparently is outside of the CFI plot system. Cedar regeneration has been studied recently by Larouche et al. (2010) using data from the PEF, but not from Dismal Swamp.

12. To improve data quality in general, all studies in the PEF should include voucher specimens, particularly for any woody species not yet in Appendix I, and for herbs, grasses, sedges, and rushes; and lichens, mosses, and liverworts. If a plant is present in sufficient abundance, two specimens should be collected, one for the University of Maine Herbarium, where specimens can be examined if any questions arise, or for further study, and the other specimen for retention at the Hart Building on the PEF for handy access by field crews. This procedure would increase the utility of the specimens, but might involve administrative prioritization because a curation of vouchers takes up space, requires some preparation, and needs some maintenance over time. A maintenance schedule and curation protocols should be implemented at the PEF because even though the number of specimens is small compared to the Herbarium's collection, the voucher specimens are of untold importance for future studies, and are vulnerable to insect attack, mold, and other damage.

Future of the PEF Checklist

The usefulness of a plant checklist is only partly known. The PEF checklist might become incorporated into a larger study with many other checklists from other areas (see Palmer et al. 1995). There could be vast changes to the PEF that would make this checklist a vital record by which to compare to future conditions. For instance, climate change could bring about disruption to the canopy due to increased intensity and frequency of storms, and spread of nonnative insect pests (e.g., balsam woolly adelgid, *Adelges piceae*) as minimum temperatures in winter are elevated. With increased canopy opening—apart from harvest activities related to ongoing experiments at the PEF—climate change could be accompanied by the accelerated spread of invasive plants and native ruderal plant species. Some of these plants might interfere with regeneration of desirable tree species. Increased shrub and graminoid cover might alter fuel characteristics in the PEF (Dibble and Rees 2005); in turn, these changes in fuel could affect fire-return interval and intensity of burns (Dibble et al. 2008). Presence of invasive plants might also alter fuels; plant species of northeastern North America differ in their combustion properties and some invasive plants are more flammable than their native counterparts (Dibble

et al. 2007). By comparing the number of more flammable species in a checklist to those thought to be relatively unflammable, differences in the fuels might be assessed.

Many changes are likely to be made to the PEF checklist in coming years. Like any snapshot of data, a presence-absence checklist is not a true reflection of the vegetation so much as a tool by which workers can know whether they are within the realm of possibility as they identify plants they have found on the forest. Toward that end, this checklist will be especially useful.

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APPENDIX I.

Checklist of the vascular plants of the Penobscot Experimental Forest, Bradley, Maine, at the level of species, with family name, growth form, status as nonnative (= *) or nonnative invasive (= **). Nomenclature follows that used in the NRCS database (NRCS 2013). Changes in family ("→"), genus, species, or subspecies in Haines (2011) are shown.

Family	NRCS species with naming authority	Haines (2011), new name and change in family if applicable	Growth form	Native
Alismataceae	*Sagittaria latifolia* Willd.		forb	1
Anacardiaceae	*Rhus typhina* L.	*Rhus hirta* (L.) Sudworth	shrub	1
Anacardiaceae	*Toxicodendron radicans* (L.) Kuntze		subshrub	1
Apiaceae	*Hydrocotyle americana* L.		forb	1
Apiaceae	*Sium suave* Walter		forb	1
Aquifoliaceae	*Ilex mucronata* (L.) Powell, Savolainen & Andrews		shrub	1
Aquifoliaceae	*Ilex verticillata* (L.) A. Gray		shrub	1
Araceae	*Arisaema triphyllum* (L.) Schott		forb	1
Araceae	*Calla palustris* L.		forb	1
Araliaceae	*Aralia hispida* Vent.	(→ Apiaceae)	subshrub	1
Araliaceae	*Aralia nudicaulis* L.	(→ Apiaceae)	subshrub	1
Araliaceae	*Aralia racemosa* L.	*Aralia racemosa* L. ssp. *racemosa* (→ Apiaceae)	shrub	1
Araliaceae	*Aralia spinosa* L.	(→ Apiaceae)	shrub	1
Asteraceae	*Achillea millefolium* L.*	*Achillea millefolium* L. ssp. *lanulosa* (Nutt.) Piper	forb	
Asteraceae	*Anaphalis margaritacea* (L.) Benth. & Hook.*		forb	
Asteraceae	*Doellingeria umbellata* (Mill.) Nees		forb	1
Asteraceae	*Erechtites hieraciifolia* (L.) Raf. ex DC.	*Erechtites hieraciifolius* (L.) Raf. ex DC. var. *hieraciifolius*	forb	1
Asteraceae	*Eurybia macrophylla* L.		forb	1
Asteraceae	*Eurybia radula* (Aiton) G.L. Nesom		forb	1
Asteraceae	*Euthamia graminifolia* (L.) Nutt.		forb	1
Asteraceae	*Hieracium aurantiacum* L.*		forb	
Asteraceae	*Hieracium caespitosum* Dumort.*		forb	
Asteraceae	*Hieracium lachenalii* C. C. Gmel.*		forb	

(Appendix I continued on next page)

Appendix I (continued)

Family	NRCS species with naming authority	Haines (2011), new name and change in family if applicable	Growth form	Native
Asteraceae	*Hieracium pilosella* L.*		forb	
Asteraceae	*Hieracium piloselloides* Vill.*		forb	
Asteraceae	*Lactua canadensis* L.		forb	1
Asteraceae	*Lapsana communis* L.*		forb	
Asteraceae	*Leontodon autumnalis* L.*	*Scorzoneroides autumnalis* (L.) Moench	forb	
Asteraceae	*Oclemena acuminata* (Michx.) Greene		forb	1
Asteraceae	*Petasites frigidus* (L.) Fr.	*Petasites frigidus* (L.) Fries var. *palmatus* (Ait.) Cronq.	forb	1
Asteraceae	*Solidago altissima* L.	*Solidago altissima* L. ssp. *altissima*	forb	1
Asteraceae	*Solidago canadensis* L.		forb	1
Asteraceae	*Solidago gigantea* Ait.		forb	1
Asteraceae	*Solidago hispida* Mulh. ex Willd.	*Solidago hispida* Mulh. ex Willd. var. *hispida*	forb	1
Asteraceae	*Solidago juncea* Ait.		forb	1
Asteraceae	*Solidago nemoralis* Ait.	*Solidago nemoralis* Ait. var. *nemoralis*	forb	1
Asteraceae	*Solidago puberula* Nutt.	*Solidago puberula* Nutt. var. *puberula*	forb	1
Asteraceae	*Solidago rugosa* Mill.		forb	1
Asteraceae	*Symphyotrichum ciliolatum* (Lindl.) A. Löve & D. Löve		forb	1
Asteraceae	*Symphyotrichum lateriflorum* (L.) A. Löve & D. Löve		forb	1
Asteraceae	*Symphyotrichum novi-belgii* (L.) G.L. Nesom		forb	1
Asteraceae	*Symphyotrichum puniceum* (L.) A. Löve & D. Löve		forb	1
Asteraceae	*Symphyotrichum racemosum* (Eliott) G.L. Nesom		forb	1
Asteraceae	*Taraxacum officinale* F.H. Wigg.*	*Taraxacum officinale* G.H. Weber ex Wiggers*	forb	
Balsaminaceae	*Impatiens capensis* Meerb.		forb	1
Berberidaceae	*Berberis thunbergii* DC.**		shrub	
Betulaceae	*Alnus incana* (L.) Moench ssp. *rugosa* (Du Roi) R.T. Clausen		shrub	1
Betulaceae	*Betula alleghaniensis* Briton		tree	1
Betulaceae	*Betula papyrifera* Marsh.		tree	1
Betulaceae	*Betula populifolia* Marsh.		tree	1

(Appendix I continued on next page)

Appendix I (continued)

Family	NRCS species with naming authority	Haines (2011), new name and change in family if applicable	Growth form	Native
Betulaceae	*Corylus americana* Walter		shrub	1
Betulaceae	*Corylus cornuta* Marsh.	*Corylus cornuta* Marsh. ssp. *cornuta*	shrub	1
Betulaceae	*Ostrya virginiana* (Mill.) K. Koch		tree	1
Brassicaceae	*Erysimum cheiranthoides* L.*		forb	
Callitrichaceae	*Callitriche palustris* L.	(→ Plantaginaceae)	forb	1
Campanulaceae	*Lobelia inflata* L.		forb	1
Caprifoliaceae	*Diervilla lonicera* Mill.		shrub	1
Caprifoliaceae	*Linnaea borealis* ssp. *longiflora* (Torr.) Hulten	*Linnaea borealis* L. ssp. *americana* (Forbes) Hultén ex Clausen	subshrub	1
Caprifoliaceae	*Lonicera* × *bella* Zabel [*morrowii* × *tatarica*]**		shrub	
Caprifoliaceae	*Lonicera canadensis* Bartram ex Marsh.		shrub	1
Caprifoliaceae	*Lonicera morrowii* A. Gray**		shrub	
Caprifoliaceae	*Lonicera villosa* (Michx.) Schult.		shrub	1
Caprifoliaceae	*Lonicera xylosteum* L.**		shrub	
Caprifoliaceae	*Sambucus nigra* L. ssp. *canadensis* (L.) R. Bolli	(→ Adoxaceae)	shrub	1
Caprifoliaceae	*Sambucus racemosa* L. var. *racemosa*	*Sambucus racemosa* L. (→ Adoxaceae)	shrub	1
Caprifoliaceae	*Viburnum acerifolium* L.	(→ Adoxaceae)	shrub	1
Caprifoliaceae	*Viburnum dentatum* L.	(→ Adoxaceae)	shrub	1
Caprifoliaceae	*Viburnum lentago* L.	(→ Adoxaceae)	shrub	1
Caprifoliaceae	*Viburnum nudum* var. *cassinoides* (L.) Torr. & A. Gray	(→ Adoxaceae)	shrub	1
Caprifoliaceae	*Viburnum opulus* var. *opulus* L.*	*Viburnum opulus* ssp. *opulus* L.* (→ Adoxaceae)	shrub	
Caryophyllaceae	*Moehringia lateriflora* (L.) Fenzl		forb	1
Celastraceae	*Celastrus orbiculatus* Thunb.**		vine	
Celastraceae	*Euonymus alata* (Thunb.) Siebold**	*Euonymus alatus* (Thunb.) Siebold**	shrub	
Convolvulaceae	*Calystegia sepium* L.		forb	1
Cornaceae	*Cornus alternifolia* L. f.	*Swida alternifolia* (L. f.) Small	shrub	1
Cornaceae	*Cornus amomum* P. Mill. ssp. *amomum*	*Swida amomum* (P. Mill.) Small	shrub	1
Cornaceae	*Cornus canadensis* L.	*Chamaepericlymenum canadense* (L.) Aschers. & Graebn.	subshrub	1

(Appendix I continued on next page)

Appendix I (continued)

Family	NRCS species with naming authority	Haines (2011), new name and change in family if applicable	Growth form	Native
Cornaceae	*Cornus rugosa* Lam.	*Swida rugosa* (Lam.) Rydb.	shrub	1
Cornaceae	*Cornus sericea* L.	*Swida sericea* (L.) Holub	shrub	1
Crassulaceae	*Hylotelephium telephium* (L.) H. Ohba ssp. *telephium**		forb	
Crassulaceae	*Penthorum sedoides* L.	(→ Penthoraceae)	forb	1
Cucurbitaceae	*Echinocystis lobata* (Michx.) Torr. & A. Gray		vine	1
Cupressaceae	*Juniperus communis* L. var.*depressa* Pursh		shrub	1
Cupressaceae	*Thuja occidentalis* L.		tree	1
Cyperaceae	*Carex arctata* Boott ex Hook.		gramin	1
Cyperaceae	*Carex bromoides* Schkuhr ex Willd.	*Carex bromoides* Schkuhr ex Willd. ssp. *bromoides*	gramin	1
Cyperaceae	*Carex brunnescens* (Pers.) Poir.		gramin	1
Cyperaceae	*Carex communis* L.H. Bailey	*Carex communis* Bailey var. *communis*	gramin	1
Cyperaceae	*Carex debilis* Michx.		gramin	1
Cyperaceae	*Carex deflexa* Horem.	*Carex deflexa* Hornem. var. *deflexa*	gramin	1
Cyperaceae	*Carex deweyana* Schwein.	*Carex deweyana* Schwein. var. *deweyana*	gramin	1
Cyperaceae	*Carex disperma* Dewey		gramin	1
Cyperaceae	*Carex gracillima* Schwein.		gramin	1
Cyperaceae	*Carex gynandra* Schwein.		gramin	1
Cyperaceae	*Carex intumescens* Rudge		gramin	1
Cyperaceae	*Carex lacustris* Willd.		gramin	1
Cyperaceae	*Carex leptalea* Wahlenb.	*Carex leptalea* Wahlenb. ssp. *leptalea*	gramin	1
Cyperaceae	*Carex leptonervia* (Fernald) Fernald		gramin	1
Cyperaceae	*Carex lucorum* Willd. ex Link	*Carex lucorum* Willd. ex Link ssp. *lucorum*	gramin	1
Cyperaceae	*Carex lurida* Wahlenb.		gramin	1
Cyperaceae	*Carex normalis* Mack.		gramin	1
Cyperaceae	*Carex oronensis* Fernald		gramin	1
Cyperaceae	*Carex projecta* Mackenzie		gramin	1
Cyperaceae	*Carex scoparia* Schkuhr ex Willd.		gramin	1
Cyperaceae	*Carex stipata* Muhl. ex Willd.	*Carex stipata* Muhl. ex Willd. var. *stipata*	gramin	1

(Appendix I continued on next page)

Appendix I (continued)

Family	NRCS species with naming authority	Haines (2011), new name and change in family if applicable	Growth form	Native
Cyperaceae	*Carex tenera* Dewey		gramin	1
Cyperaceae	*Carex tribuloides* Wahlenb.	*Carex tribuloides* Wahlenb. var. *tribuloides*	gramin	1
Cyperaceae	*Carex trisperma* Dewey		gramin	1
Cyperaceae	*Scirpus cyperinus* (L.) Kunth		gramin	1
Cyperaceae	*Scirpus hattorianus* Makino		gramin	1
Dennstaedtiaceae	*Dennstaedtia punctilobula* (Michx.) T. Moore		fern	1
Dennstaedtiaceae	*Pteridium aquilinum* (L.) Kuhn var. *latiusculum* (Desv.) Underw. ex A. Heller	*Pteridium aquilinum* (L.) Kuhn ssp. *latiusculum* (Desv.) Hultén	fern	1
Dryopteridaceae	*Athyrium filix-femina* (L.) Roth.	*Athyrium angustum* (Willd.) C. Presl. (→ Woodsiaceae)	fern	1
Dryopteridaceae	*Dryopteris campyloptera* Clarkson	*Dryopteris campyloptera* (Kunze) Clarkson	fern	1
Dryopteridaceae	*Dryopteris carthusiana* (Vill.) H. P. Fuchs		fern	1
Dryopteridaceae	*Dryopteris clintoniana* (D.C. Eaton) Dowell		fern	1
Dryopteridaceae	*Dryopteris cristata* (L.) A. Gray		fern	1
Dryopteridaceae	*Dryopteris intermedia* (Mulh. ex Willd.) Gray		fern	1
Dryopteridaceae	*Dryopteris marginalis* (L.) A. Gray		fern	1
Dryopteridaceae	*Gymnocarpium dryopteris* (L.) Newman	(→ Woodsiaceae)	fern	1
Dryopteridaceae	*Onoclea sensibilis* L.	(→ Onocleaceae)	fern	1
Dryopteridaceae	*Polystichum acrostichoides* (Michx.) Schott		fern	1
Equisetaceae	*Equisetum arvense* L.		fern	1
Equisetaceae	*Equisetum pratense* Ehrh.		fern	1
Ericaceae	*Andromeda polifolia* L. var. *glaucophylla* (Link) DC.		shrub	1
Ericaceae	*Chamaedaphne calyculata* (L.) Moench		shrub	1
Ericaceae	*Epigaea repens* L.		subshrub	1
Ericaceae	*Gaultheria hispidula* (L.) Muhl. ex Bigelow		subshrub	1
Ericaceae	*Gaultheria procumbens* L.		subshrub	1

(Appendix I continued on next page)

Appendix I (continued)

Family	NRCS species with naming authority	Haines (2011), new name and change in family if applicable	Growth form	Native
Ericaceae	*Gaylussacia baccata* (Wangenh.) L. Koch	*Gaylussacia baccata* (Wangenh.) K. Koch	shrub	1
Ericaceae	*Kalmia angustifolia* L.	*Kalmia angustifolia* L. ssp. *angustifolia*	shrub	1
Ericaceae	*Ledum groenlandicum* Oeder.	*Rhododendron groenlandicum* (Oeder) Kron & Judd	shrub	1
Ericaceae	*Rhododendron canadense* (L.) Torr.		shrub	1
Ericaceae	*Vaccinium angustifolium* Ait.		shrub	1
Ericaceae	*Vaccinium corymbosum* L.		shrub	1
Ericaceae	*Vaccinium macrocarpon* Ait.		shrub	1
Ericaceae	*Vaccinium myrtilloides* Michx.		shrub	1
Ericaceae	*Vaccinium oxycoccos* L.		shrub	1
Euphorbiaceae	*Euphorbia* sp.*		forb	
Fabaceae	*Lotus corniculatus* L.*		forb	
Fabaceae	*Trifolium hybridum* L.*		forb	
Fabaceae	*Trifolium repens* L.*		forb	
Fabaceae	*Vicia cracca* L.*	*Vicia cracca* L. ssp. *cracca*	forb	
Fabaceae	*Vicia tetrasperma* (L.) Schreb.*		forb	
Fagaceae	*Fagus grandifolia* Ehrh.		tree	1
Fagaceae	*Quercus rubra* L.		tree	1
Geraniaceae	*Geranium* sp.		forb	1
Grossulariaceae	*Ribes hirtellum* Michx.		shrub	1
Grossulariaceae	*Ribes lacustre* (Pers.) Poir.		shrub	1
Hamamelidaceae	*Hamamelis virginiana* L.		shrub	1
Iridaceae	*Iris versicolor* L.		forb	1
Juncaceae	*Juncus effusus* L.		gramin	1
Juncaceae	*Juncus* sp.		gramin	1
Juncaceae	*Juncus tenuis* Willd.		gramin	1
Juncaceae	*Luzula acuminata* Raf.		gramin	1
Juncaceae	*Luzula multiflora* (Ehrh.) Lej.		gramin	1
Lamiaceae	*Galeopsis tetrahit* L.*		forb	
Lamiaceae	*Lycopus americanus* Muhl. ex W. Bartram		forb	1
Lamiaceae	*Lycopus uniflorus* Michx.		forb	1
Lamiaceae	*Prunella vulgaris* L.*		forb	

(Appendix I continued on next page)

Appendix I (continued)

Family	NRCS species with naming authority	Haines (2011), new name and change in family if applicable	Growth form	Native
Lamiaceae	*Scutellaria galericulata* L.		forb	1
Lamiaceae	*Scutellaria lateriflora* L.		forb	1
Liliaceae	*Clintonia borealis* (Aiton) Raf.		forb	1
Liliaceae	*Maianthemum canadense* Desf.	(→ Ruscaceae)	forb	1
Liliaceae	*Maianthemum racemosa* (L.) Link	*Maianthemum racemosum* (L.) Link ssp. *racemosum* (→ Ruscaceae)	forb	1
Liliaceae	*Medeola virginiana* L.		forb	1
Liliaceae	*Polygonatum pubescens* (Willd.) Pursh	(→ Ruscaceae)	forb	1
Liliaceae	*Streptopus lanceolatus* (Aiton) Reveal		forb	1
Liliaceae	*Trillium erectum* L.	(→ Melanthiaceae)	forb	1
Liliaceae	*Trillium undulatum* Willd.	(→ Melanthiaceae)	forb	1
Liliaceae	*Uvularia sessilifolia* L.	(→ Colchicaceae)	forb	1
Lycopodiaceae	*Lycopodium annotinum* L.	*Spinulum annotinum* (L.) A. Haines	fern	1
Lycopodiaceae	*Lycopodium clavatum* L.		fern	1
Lycopodiaceae	*Lycopodium hickeyi* W.H. Wagner, Beitel & Moran	*Dendrolycopodium hickeyi* (W.H. Wagner, Beitel & Moran) A. Haines	fern	1
Lycopodiaceae	*Lycopodium obscurum* L.	*Dendrolycopodium obscurum* (L.) A. Haines	fern	1
Lythraceae	*Lythrum salicaria* L.**		forb	
Monotropaceae	*Monotropa uniflora* L.	(→ Ericaceae)	forb	1
Myricaceae	*Comptonia peregrina* (L.) J. M. Coult.		shrub	1
Myricaceae	*Myrica gale* L.		shrub	1
Oleaceae	*Fraxinus americana* L.		tree	1
Oleaceae	*Fraxinus nigra* Marsh.		tree	1
Oleaceae	*Fraxinus pennsylvanica* Marsh.		tree	1
Onagraceae	*Chamerion angustifolium* (L.) Holub ssp. *angustifolium*	*Chamerion angustifolium* (L.) Holub ssp. *circumvagum* (Mosq.) Kartesz	forb	1
Onagraceae	*Circaea alpina* L.	*Circaea alpina* L. ssp. *alpina*	forb	1
Onagraceae	*Circaea lutetiana* L. ssp. *canadensis* (L.) Aschers. & Magnus	*Circaea canadensis* (L.) Hill ssp. *canadensis*	forb	1
Onagraceae	*Epilobium ciliatum* Raf.		forb	1
Onagraceae	*Epilobium coloratum* Biehler		forb	1
Onagraceae	*Epilobium leptophyllum* Raf.		forb	1

(Appendix I continued on next page)

Appendix I (continued)

Family	NRCS species with naming authority	Haines (2011), new name and change in family if applicable	Growth form	Native
Onagraceae	*Ludwigia palustris* (L.) Elliott		forb	1
Onagraceae	*Oenothera perennis* L.		forb	1
Orchidaceae	*Cypripedium acaule* Aiton		forb	1
Orchidaceae	*Epipactis helleborine* (L.) Crantz*		forb	
Orchidaceae	*Goodyera repens* (L.) R. Br.	*Goodyera repens* (L.) R. Br. in Ait. & Ait. f.	forb	1
Orchidaceae	*Goodyera tessellata* Lodd		forb	1
Osmundaceae	*Osmunda cinnamomea* L.	*Osmundastrum cinnamomeum* (L.) C. Presl	fern	1
Osmundaceae	*Osmunda claytoniana* L.		fern	1
Osmundaceae	*Osmunda* sp.		fern	1
Oxalidaceae	*Oxalis corniculata* L.		forb	1
Oxalidaceae	*Oxalis montana* Raf.		forb	1
Oxalidaceae	*Oxalis stricta* L.		forb	1
Pinaceae	*Abies balsamea* (L.) Mill.		tree	1
Pinaceae	*Larix laricina* (Du Roi) K. Koch		tree	1
Pinaceae	*Picea abies* (L.) Karst*		tree	
Pinaceae	*Picea glauca* (Moench) Voss		tree	1
Pinaceae	*Picea mariana* (Mill.) Britton, Sterns & Poggenb.		tree	1
Pinaceae	*Picea rubens* Sarg.		tree	1
Pinaceae	*Pinus resinosa* Aiton		tree	1
Pinaceae	*Pinus strobus* L.		tree	1
Pinaceae	*Tsuga canadensis* (L.) Carriere		tree	1
Poaceae	*Agrostis perennans* (Walter) Tuck.		gramin	1
Poaceae	*Agrostis scabra* Willd.		gramin	1
Poaceae	*Anthoxanthum odoratum* L.*		gramin	
Poaceae	*Brachyelytrum aristosum* (Michx.) Trel.	*Brachyelytrum aristosum* (Michx.) Trel. in Branner & Coville	gramin	1
Poaceae	*Calamagrostis canadensis* (Michx.) P. Beauv.		gramin	1
Poaceae	*Cinna latifolia* (Trevis ex Goepp.) Griseb.		gramin	1
Poaceae	*Danthonia compressa* Austin	*Danthonia compressa* Austin ex Peck	gramin	1

(Appendix I continued on next page)

Appendix I (continued)

Family	NRCS species with naming authority	Haines (2011), new name and change in family if applicable	Growth form	Native
Poaceae	*Danthonia spicata* (L.) P. Beauv. ex Roem. & Schult.		gramin	1
Poaceae	*Dichanthelium acuminatum* (Sw.) Gould & C.A. Clark		gramin	1
Poaceae	*Glyceria striata* (Lam.) A. S. Hitchcock		gramin	1
Poaceae	*Muhlenbergia uniflora* L.	*Muhlenbergia uniflora* (Muhl.) Fern.	gramin	1
Poaceae	*Oryzopsis asperifolia* Michx.		gramin	1
Poaceae	*Poa nemoralis* L.**		gramin	
Polygalaceae	*Polygala paucifolia* Willd.		forb	1
Polygalaceae	*Polygala sanguinea* L.		forb	1
Polygonaceae	*Fallopia scandens* (L.) Holub.		forb	1
Polygonaceae	*Polygonum convolvulus* L. var. *convolvulus*	*Fallopia convolvulus* (L.) A. Löve	forb	1
Polygonaceae	*Polygonum sagittatum* L.	*Persicaria sagittata* (L.) H. Gross	vine	1
Polygonaceae	*Polygonum* sp.		forb	1
Polygonaceae	*Rumex orbiculatus* A. Gray	*Rumex britannica* L.	forb	1
Primulaceae	*Lysimachia quadrifolia* L.	*Lysimachia quadrifolia* Sims (→ Myrsinaceae)	forb	1
Primulaceae	*Lysimachia terrestris* (L.) B.S.P.	(→ Myrsinaceae)	forb	1
Primulaceae	*Trientalis borealis* Raf.	*Lysimachia borealis* (Raf.) U Manns & A. Anderb. (→ Myrsinaceae)	forb	1
Pyrolaceae	*Moneses uniflora* (L.) A. Gray	(→ Ericaceae)	forb	1
Pyrolaceae	*Orthilia secunda* (L.) House	(→ Ericaceae)	forb	1
Pyrolaceae	*Pyrola americana* Sweet	(→ Ericaceae)	forb	1
Pyrolaceae	*Pyrola elliptica* Nutt.	(→ Ericaceae)	forb	1
Ranunculaceae	*Actaea rubra* (Aiton) Willd.		forb	1
Ranunculaceae	*Anemone quinquefolia* L.	*Anemone quinquefolia* L. var. *quinquefolia*	forb	1
Ranunculaceae	*Clematis occidentalis* (Hornem.) DC.	*Clematis occidentalis* (Hornem.) DC. ssp. *occidentalis*	vine	1
Ranunculaceae	*Coptis trifolia* (L.) Salisb.		forb	1
Ranunculaceae	*Ranunculus abortivus* L.		forb	1
Ranunculaceae	*Ranunculus acris* L.*		forb	
Ranunculaceae	*Ranunculus hispidus* L.	*Ranunculus hispidus* Michx.	forb	1
Ranunculaceae	*Ranunculus recurvatus* Poir.	*Ranunculus recurvatus* Poir. var. *recurvatus*	forb	1

(Appendix I continued on next page)

Appendix I (continued)

Family	NRCS species with naming authority	Haines (2011), new name and change in family if applicable	Growth form	Native
Ranunculaceae	*Thalictrum pubescens* Pursh		forb	1
Rhamnaceae	*Frangula alnus* Mill.**		shrub	
Rhamnaceae	*Rhamnus alnifolia* L. Her.		shrub	1
Rhamnaceae	*Rhamnus cathartica* L.**		shrub	
Rosaceae	*Amelanchier arborea* (Michx. f.) Fernald		tree	1
Rosaceae	*Amelanchier bartramiana* (Tausch) M. Roemer		shrub	1
Rosaceae	*Amelanchier canadensis* (L.) Medik.		shrub	1
Rosaceae	*Amelanchier laevis* Wiegand		shrub	1
Rosaceae	*Crataegus macrosperma* Ashe		tree	1
Rosaceae	*Dalibarda repens* L.	*Rubus dalibarda* L.	forb	1
Rosaceae	*Fragaria vesca* L.*		forb	
Rosaceae	*Fragaria virginiana* Duchesne		forb	1
Rosaceae	*Geum laciniatum* Murray		forb	1
Rosaceae	*Malus pumila* Mill.*		tree	
Rosaceae	*Malus sylvestris* (L.) Mill.*		tree	
Rosaceae	*Photinia melanocarpa* (Michx.) K.R. Robertson & Phipps	*Aronia melanocarpa* (Michx.) Ell.	shrub	1
Rosaceae	*Potentilla norvegica* L.		forb	1
Rosaceae	*Potentilla simplex* Michx.		forb	1
Rosaceae	*Prunus pensylvanica* L. f.	*Prunus pensylvanica* L. f. var. *pensylvanica*	tree	1
Rosaceae	*Prunus serotina* Ehrh.	*Prunus serotina* Ehrh. var. *serotina*	tree	1
Rosaceae	*Prunus virginiana* L.	*Prunus virginiana* L. var. *virginiana*	tree	1
Rosaceae	*Rosa multiflora* Thunb.**	*Rosa multiflora* Thunb. ex Murr.	shrub	
Rosaceae	*Rosa palustris* Marsh.		shrub	1
Rosaceae	*Rosa virginiana* Mill.		shrub	1
Rosaceae	*Rubus alleghaniensis* Porter		shrub	1
Rosaceae	*Rubus* cf. *vermontanus* Blanch.		shrub	1
Rosaceae	*Rubus flagellaris* Willd.		shrub	1
Rosaceae	*Rubus hispidus* L.		subshrub	1
Rosaceae	*Rubus idaeus* ssp. *strigosus* (Michx.) Focke		forb	1
Rosaceae	*Rubus occidentalis* L.		shrub	1

(Appendix I continued on next page)

Appendix I (continued)

Family	NRCS species with naming authority	Haines (2011), new name and change in family if applicable	Growth form	Native
Rosaceae	*Rubus pensilvanicus* Poir.		shrub	1
Rosaceae	*Rubus pubescens* Raf.		subshrub	1
Rosaceae	*Sorbus americana* Marsh.		tree	1
Rosaceae	*Spiraea alba* Du Roi var. *latifolia*		shrub	1
Rosaceae	*Spiraea tomentosa* L.		shrub	1
Rubiaceae	*Cephalanthus occidentalis* L.		shrub	1
Rubiaceae	*Galium asprellum* Michx.		forb	1
Rubiaceae	*Galium palustre* L.		forb	1
Rubiaceae	*Galium trifidum* L.		forb	1
Rubiaceae	*Galium triflorum* Michx.		forb	1
Rubiaceae	*Houstonia caerulea* L.		forb	1
Rubiaceae	*Mitchella repens* L.		subshrub	1
Salicaceae	*Populus balsamifera* L.	*Populus balsamifera* L. ssp. *balsamifera*	tree	1
Salicaceae	*Populus grandidentata* Michx.		tree	1
Salicaceae	*Populus tremuloides* Michx.		tree	1
Salicaceae	*Salix bebbiana* Sarg.		shrub	1
Salicaceae	*Salix discolor* Muhl.		shrub	1
Salicaceae	*Salix eriocephala* Michx.	*Salix eriocephala* Michx. ssp. *eriocephala* var. *eriocephala*	shrub	1
Salicaceae	*Salix lucida* Muhl.	*Salix lucida* Muhl. ssp. *lucida*	shrub	1
Salicaceae	*Salix pedicellaris* Pursh		shrub	1
Salicaceae	*Salix sericea* Marsh.		shrub	1
Sapindaceae	*Acer pensylvanicum* L.		tree	1
Sapindaceae	*Acer platanoides* L.**		tree	
Sapindaceae	*Acer rubrum* L.		tree	1
Sapindaceae	*Acer saccharinum* L.		tree	1
Sapindaceae	*Acer saccharum* Marsh.	*Acer saccharum* Marsh. var. *saccharum*	tree	1
Sapindaceae	*Acer spicatum* Lam.		tree	1
Saxifragaceae	*Mitella nuda* L.		forb	1
Saxifragaceae	*Tiarella cordifolia* L.	*Tiarella cordifolia* L. var. *cordifolia*	forb	1
Scrophulariaceae	*Chelone glabra* L.	(→ Plantaginaceae)	forb	1
Scrophulariaceae	*Gratiola neglecta* Torr.	(→ Plantaginaceae)	forb	1
Scrophulariaceae	*Linaria vulgaris* Mill.**	(→ Plantaginaceae)	forb	
Scrophulariaceae	*Melampyrum lineare* Desr.	(→ Orobanchaceae)	forb	1

(Appendix I continued on next page)

Appendix I (continued)

Family	NRCS species with naming authority	Haines (2011), new name and change in family if applicable	Growth form	Native
Scrophulariaceae	*Veronica officinalis* L.*	(→ Plantaginaceae)	forb	
Scrophulariaceae	*Veronica serpyllifolia* L.*	(→ Plantaginaceae)	forb	
Solanaceae	*Solanum dulcamara* L.**		vine	
Sparganiaceae	*Sparganium*		herb	1
Taxaceae	*Taxus canadensis* Marsh.		shrub	1
Thelypteridaceae	*Phegopteris connectilis* (Michx.) Watt		fern	1
Thelypteridaceae	*Thelypteris noveboracensis* (L.) Nieuwl.	*Parathelypteris noveboracensis* (L.) Ching	fern	1
Thelypteridaceae	*Thelypteris palustris* Schott var. *pubescens* (Lawson) Fern.	*Thelypteris palustris* Schott var. *pubescens* (G. Lawson) Fern.	fern	1
Thelypteridaceae	*Thelypteris simulata* (Davenport) Nieuwl.	*Parathelypteris simulata* (Davenport) Holttum	fern	1
Thymelaeaceae	*Dirca palustris* L.		shrub	1
Tiliaceae	*Tilia americana* L.	(→ Malvaceae)	tree	1
Ulmaceae	*Ulmus americana* L.		tree	1
Valerianaceae	*Valeriana officinalis* L.**	(→ Caprifoliaceae)	forb	
Violaceae	*Viola blanda* Willd.		forb	1
Violaceae	*Viola cucullata* Ait.		forb	1
Violaceae	*Viola pubescens* Aiton		forb	1
Violaceae	*Viola renifolia* A. Gray		forb	1
Viscaceae	*Arceuthobium pusillum* Peck		forb	1
Vitaceae	*Parthenocissus quinquefolia* (L.) Planch.		vine	1

APPENDIX II.

Number of species per plant family, and growth form of vascular plants of the Penobscot Experimental Forest, Bradley, Maine. This summary follows the NRCS database, not Haines (2011) (see Appendix I), and includes some of the unresolved genera.

	Growth form							
Family	fern	graminoid	herb	shrub	subshrub	tree	vine	Total
Alismataceae			1					1
Anacardiaceae				1	1			2
Apiaceae			2					2
Aquifoliaceae				2				2
Araceae			2					2
Araliaceae				2	2			4
Asteraceae			31					31
Balsaminaceae			1					1
Berberidaceae				1				1
Betulaceae				3		4		7
Brassicaceae			1					1
Callitrichaceae			1					1
Campanulaceae			1					1
Caprifoliaceae				13	1			14
Caryophyllaceae			1					1
Celastraceae				1			1	2
Clusiaceae			1					1
Convolvulaceae			1					1
Cornaceae				4	1			5
Crassulaceae			2					2
Cucurbitaceae							1	1
Cupressaceae				1		1		2
Cyperaceae		26						26
Dennstaedtiaceae	2							2
Dryopteridaceae	10							10
Equisetaceae	2							2
Ericaceae				11	3			14
Euphorbiaceae			1					1
Fabaceae			5					5
Fagaceae						2		2

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Appendix II (continued)

Family	Growth form							Total
	fern	graminoid	herb	shrub	subshrub	tree	vine	
Geraniaceae			1					1
Grossulariaceae				2				2
Hamamelidaceae				1				1
Iridaceae			1					1
Juncaceae		5						5
Lamiaceae			6					6
Liliaceae			9					9
Lycopodiaceae	4							4
Lythraceae			1					1
Monotropaceae			1					1
Myricaceae				2				2
Oleaceae						3		3
Onagraceae			8					8
Orchidaceae			4					4
Osmundaceae	3							3
Oxalidaceae			3					3
Pinaceae						9		9
Poaceae		13						13
Polygalaceae			2					2
Polygonaceae			4				1	5
Primulaceae			3					3
Pyrolaceae			4					4
Ranunculaceae			8				1	9
Rhamnaceae				3				3
Rosaceae			6	15	2	8		31
Rubiaceae			5	1	1			7
Salicaceae				6		3		9
Sapindaceae						6		6
Saxifragaceae			2					2
Scrophulariaceae			6					6
Solanaceae							1	1
Sparganiaceae			1					1
Taxaceae				1				1

(Appendix II continued on next page)

Appendix II (continued)

Family	Growth form							Total
	fern	graminoid	herb	shrub	subshrub	tree	vine	
Thelypteridaceae	4							4
Thymeliaceae				1				1
Tiliaceae						1		1
Ulmaceae						1		1
Valerianaceae			1					1
Violaceae			4					4
Viscaceae			1					1
Vitaceae							1	1
Grand total	25	44	132	71	11	38	6	327

APPENDIX III.

(a) Some vascular plant taxa that have been proposed for inclusion by various researchers, but are omitted from the list. These taxa may lack appropriate habitat at the PEF or be out of known range. Unavailability of voucher specimens prevents their listing.

Asplenium sp.

Cystopteris sp.

Krigia virginica

Lactuca sativa

Pyrola chlorantha

Rosa johannensis

(b) Unresolved genera, some of which probably duplicate species already listed in Appendix I. During field work, plant material might have lacked flowers or fruits and could not be resolved below genus level, yet the genus is represented already by known species or subspecies in Appendix I.

Agrostis sp.
Amelanchier sp.
Aster sp.
Betula sp.
Bidens sp.
Carex sp.
Circaea sp.
Cornus sp.
Crataegus sp.
Danthonia sp.
Dryopteris sp.
Epilobium sp.
Equisetum sp.
Fraxinus sp.
Galium sp.
Geum sp.
Hieracium sp.
Hypericum sp.
Ilex sp.
Lonicera sp.
Luzula sp.
Lycopodium sp.
Oxalis sp.
Picea sp.
Poa sp.
Polygala sp.
Populus sp.
Potentilla sp.
Prenanthes sp.
Prunus sp.
Pyrola sp.
Ranunculus sp.
Ribes sp.
Rosa sp.
Rubus sp.
Salix sp.
Silene sp.
Solidago sp.
Sorbus sp.
Sparganium sp.
Thelypteris sp.
Trifolium sp.
Trillium sp.
Vaccinium sp.
Viola sp.

APPENDIX IV.

Provisional list of lichens of the Penobscot Experimental Forest, Bradley, Maine. Nomenclature follows Esslinger (2011).

Lichens	Macrolichen	Crustose lichen
Bryoria furcellata (Fr.) Brodo & D. Hawksw.	1	
Bryoria nadvornikiana (Gyelnik) Brodo & D. Hawksw.	1	
Caloplaca sp.		1
Candelariella sp.	1	
Cetrelia olivetorum (Nyl.) W.L. Culb. & C.F. Culb.	1	
Cladina sp.	1	
Cladonia chlorophaea group	1	
Cladonia coniocraea (Flörke) Sprengel	1	
Cladonia fimbriata (L.) Fr.	1	
Cladonia furcata (Hudson) Schrader	1	
Cladonia squamosa Hoffm.	1	
Cladonia sp.	1	
Cladonia spp. (*squamulose*)	1	
Collema subflaccidum Degel.	1	
Evernia mesomorpha Nyl.	1	
Flavoparmelia caperata (L.) Ach.	1	
Hypogymnia physodes (L.) Nyl.	1	
Lecanora sp.		1
Lepraria sp.		1
Leptogium corticola (Taylor) Tuck.	1	
Leptogium cyanescens (Rabenh.) Körber	1	
Leptogium saturninum (Dickson) Nyl.	1	
Lobaria pulmonaria (L.) Hoffm.	1	
Lobaria quercizans Michaux	1	
Melanelia halei (Ahti) Essl.	1	
Melanelia subaurifera (Nyl.) Essl.	1	
Myelochroa galbina (Ach.) Elix & Hale	1	
Nephroma parile (Ach.) Ach.	1	
Parmelia squarrosa Hale	1	
Parmelia sulcata Taylor	1	
Parmeliopsis ambigua (Wulfen) Nyl.	1	
Parmeliopsis hyperopta (Ach.) Arnold	1	
Peltigera canina (L.) Willd.	1	
Peltigera horizontalis (Hudson) Baumg.	1	
Peltigera polydactylon (Necker) Hoffm.	1	
Peltigera praetextata (Flörke ex Sommerf.) Zopf	1	
Peltigera rufescens (Weiss) Humb.	1	
Peltigera cf. *membranacea* (Ach.) Nyl.	1	

(Appendix IV continued on next page)

Appendix IV (continued)

Lichens	Macrolichen	Crustose lichen
Peltigera aphthosa (L.) Willd. or *leucophlebia* (Nyl.) Gyelnik	1	
Phaeophyscia pusilloides (Zahlbr.) Essl.	1	
Phaeophyscia rubropulchra (Degel.) Essl.	1	
Physcia millegrana Degel.	1	
Physconia detersa (Nyl.) Poelt	1	
Platismatia glauca (L.) W.L. Culb. & C.F. Culb.	1	
Platismatia tuckermanii (Oakes) W.L. Culb. & C.F. Culb.	1	
Punctelia rudecta (Ach.) Krog	1	
Pyxine sorediata (Ach.) Mont.	1	
Ramalina americana Hale	1	
Ramalina dilacerata (Hoffm.) Hoffm.	1	
Ramalina intermedia (Delise ex Nyl.) Nyl.	1	
Tuckermannopsis ciliaris (Ach.) Gyelnik grp.	1	
Usnea filipendula Stirton	1	
Usnea lapponica Vainio	1	
Usnea merrillii Motyka	1	
Usnea mutabilis Stirt.	1	
Usnea strigosa subsp. *strigosa*	1	
Usnea subfloridana Stirton	1	
Usnocetraria oakesiana (Tuck.) M.J. Lai & C.J. Wei	1	
Verrucaria sp.	1	
Vulpicida pinastri (Scop.) J.-E. Mattsson & M.J. Lai	1	
Xanthoparmelia conspersa (Ehrh. ex Ach.) Hale	1	
Xanthoparmelia tasmanica (Hooker f. & Taylor) Hale/*angustiphylla* (Gyelnik) Hale	1	
Total	59	3

APPENDIX V.

Provisional list of bryophytes at the Penobscot Experimental Forest, including 9 liverworts and 40 mosses. Nomenclature for liverworts follows Crosby and Magill (2005, 2006) and Stotler and Crandall-Stotler (1977). Nomenclature for mosses follows Allen (2005), except for pleurocarpous mosses (Crosby et al. 1999).

Bryophytes
Liverworts
Bazzania trilobata (L.) S. Gray var. *trilobata*
Frullania bolanderi Austin
Frullania tamarisci (L.) Dum. subsp. *asagrayana* (Mont.) Hatt.
Nowellia curvifolia (Dicks.) Mitt.
Pellia epiphylla (L.) Corda
Ptilidium ciliare (L.) Hampe
Ptilidium pulcherrimum (G. Web.) Hampe
Radula complanata (L.) Dum.
Scapania nemorosa (L.) Dum.
Mosses
Anomodon attenuatus (Hedwig) Hübener
Atrichum oerstedianum (C. Müller) Mitten
Atrichum sp.
Brachythecium cf. *laetum* (Brid.) B.S.G.
Brachythecium erythrorhizon W.P. Schimper in B.S.G.
Bryhnia novae-angliae (Sullivant & Lesquereux) Grout
Climacium dendroides (Hedwig) Weber & D. Mohr
Dicranum spp.
Dicranum montanum Hedwig
Dicranum polysetum Swartz
Dicranum scoparium Hedwig
Drepanocladus aduncus (Hedwig) Warnstorf
Hedwigia ciliata (Hedwig) Palisot de Beauvois
Homalia trichomanoides (Hedwig) W.P. Schimper in B.S.G.
Hylocomium splendens (Hedwig) W.P. Schimper in B.S.G.
Hypnum imponens Hedwig
Isopterygiopsis muelleriana (W.P. Schimper) Iwatsuki
Leucobryum glaucum (Hedwig) Ångström in Fries
Leucodon andrewsianus (H. Crum & L.E. Anderson) W.D. Reese & L.E. Anderson
Mnium hornum Hedwig
Neckera pennata Hedwig
Othodicranum flagellare (Hedw.) Loeske
Pleurozium schreberi (Willdenow ex Bridel) Mitten
Polytrichum sp.
Polytrichum commune Hedwig
Polytrichum ohioense Ren. & Card.

(Appendix V continued on next page)

Appendix V (continued)

Bryophytes
Mosses (continued)
Ptilium crista-castrensis (Hedwig) De Notaris
Rhizomnium appalachianum
Rhytidiadelphus triquetrus (Hedwig) Warnstorf
Sphagnum affine Renauld & Cardot
Sphagnum capillifolium (Ehrhart) Hedwig
Sphagnum fimbriatum Wils.
Sphagnum girgensohnii Russ.
Sphagnum palustre L.
Sphagnum squarrosum Crome
Sphagnum wulfianum Girg.
Tetraphis pellucida Milde.
Thuidium delicatulum (Hedw.) Schimp.
Ulota crispa (Hedw.) Brid.
Warnstorfia fluitans (Hedw.) Loeske

APPENDIX VI.

Comparison of species richness in the checklist of taxa for Penobscot Experimental Forest, Bradley, Maine, with that of some other land bases in Maine. Numbers are approximate and do not reflect some recent additions and name changes.

Land base	Number of hectares	Number of vascular plant taxa	Number of nonnative taxa (percentage of total known)	Number of lichen species reported	Number of liverwort species reported	Number of moss species reported
Maine, entire state	9,164,673	2,103	634 (30%)	(ca. 700)	147	(ca. 430)
Penobscot Experimental Forest, Bradley	1,618	344	45 (15%)	59	9	40
Massabesic Experimental Forest, Alfred and Lyman, York County	1,497	464	43 (9%)	Not reported	Not reported	Not reported
Great Pond Mountain Wildlands, Orland, Hancock County	1,700	400+	40 (10%)	12	5	14
Acadia National Park, Bar Harbor, Hancock County	14,648	1,135	284 (25%)	379, of which 198 are crustose	11+	51+