FINAL REPORT

A CHRONOLOGY OF POST LOGGING PLANT SUCCESSION IN CANAAN VALLEY THROUGH THE DEVELOPMENT OF A SERIES OF VEGETATION MAPS FROM 1945 TO PRESENT

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INTRODUCTION

The Canaan Valley ecosystem is one of the most intensively studied areas in the eastern United States. This interest has been high because: (1) it is one of the largest and best examples of inland freshwater wetland ecosystems in the eastern United States and (2) its extant flora and fauna together represent an exceptional example of a refugium from a biota of a prior climatic period. The values of the biota and wetland habitats of Canaan were verified with the establishment of the Canaan Valley National Wildlife Refuge in 1994.

Some of the largest and most important studies and reports on the Canaan Valley watershed were by Allard and Leonard (1952), Goudy et al. (1969), Fortney (1975), Vogelmann (1978), U.S. Fish and Wildlife Service (1979), Stout (1992), and Michael (1993). Among the principal features documented by these studies is the fact that the vegetation and habitats of the valley, while generally typical of high altitude ecosystems in the central Appalachian Mountains region, are unique with respect to plant successional dynamics, the juxtaposition of upland and wetland habitats vegetation types, and the effects to the ecosystem by anthropocentric activities, including logging, fires, and farming.

Brooks (1957) considered the original red spruce forest to have been one of the best developed in the entire eastern United States, with 80,000 to 100,000 board feet of lumber cut from some areas in the valley, with most of the logging in Canaan and adjacent areas occurring between 1900 and 1920. Following the logging era, much of the valley and surrounding areas repeatedly burned, creating a distinctive pyric vegetation association of aspen (*Populus tremuloides* and *P. grandidentata*) in many areas, which persisted for several decades. Also following the logging era, portions of the valley were converted to crop and grazing land that caused further disturbance. In more recent years (1970s to present) large areas in the southern end of the valley were converted to second home developments and intensive recreational areas (e.g., Timberline and Canaan Valley State Park). Ironically, resident populations of beaver and deer increased dramatically, further impacting the natural vegetation.

Even with these past perturbations and land use practices, the valley's vegetation has made a remarkable recovery, re-capturing a high degree of naturalness in composition and structure. Unfortunately, a record of this recovery is only partially documented through the recent studies by Fortney, Stout, and Michael. The vegetation patterns and species composition of plant communities were described the most thoroughly by Fortney in his 1975 vegetation study of the Valley in which a vegetation map was developed and successional patterns were detailed. But even with this study and others, the overall knowledge of the real time successional processes and trends are poorly understood because of the lack of detailed documentation between the end of the logging era in the 1920s and the 1970s. Recent observations by this researcher (unpublished) suggest that the plant communities, particularly in wetlands and in

nonforested upland habitats, have continued to change since the first successional models for the Valley's vegetation were developed by Fortney.

With the intense pressure from recreation-related development in the southern end of the valley and with the establishment of the Canaan Valley National Wildlife Refuge, it is important to better understand vegetation successional trends in both the valley's upland and wetland habitats. A series of maps showing the stages of successional patterns at timed intervals, as completed in this study, should provide invaluable baseline information useful in the development of management plans and as a reference base for present and future research efforts in the valley.

PROJECT OBJECTIVES AND HISTORY

The principal goals of this project were to:

1. Produce a series of GIS-based maps that present a historical picture of the development of upland, wetland, and aquatic land cover in the post logging era.
2. Provide information on the location of wetland habitats based on the occurrence of wetland plant species.
3. Update the occurrence of beaver ponds and other aquatic habitats.
4. Develop a new plant succession paradigm for the Canaan Valley watershed.

The project was initiated in the fall of 1995. At that time, sources for aerial photographs were identified. Preliminary ground truthing activities were conducted in the valley along with a review of the literature pertinent to the project. In early 1996, required equipment, GIS software, and software training were procured. During the 1996 growing season, extensive field observations were conducted throughout the valley to document the occurrences of vegetation cover types and aquatic and wetland habitats. Land cover mapping within Canaan Valley State Park was also initiated at this time; however, the principal mapping activities began during the summer of 1996. Additional ground truthing activities were conducted during the spring and summer of 1997 to further verify vegetation types and aquatic habitats.

The project initially included the preparation of a series of four maps at approximately 20-year intervals. The first three maps, corresponding to the 1930s, 1950s, and 1970s, were to be based on U. S. Department of Agriculture (USDA) black and white aerial photography, with the most current map, 1990s, based on recent color aerial photography (1989) available through the U. S. Fish and Wildlife Service (FWS). Unfortunately, the aerial photography for the 1930s, which had been on file at the National Resource and Conservation Service office in Parsons, WV, was damaged

during the flood of 1985 and had been discarded. Searches of at the National Archival Centers in Beltsville, MD, and in Provo, Utah, failed to locate archived sources. Therefore, it was not possible to prepare the 1934 map. Black and white aerial photography was, however, available for 1945 through a combination of two sources, the West Virginia University Extension Service Office in Parsons and the Monongahela National Forest Headquarters in Elkins, WV. The intervals were, accordingly, 30 and 27 years. It would have been useful to have had photography recorded closer to the end of the logging era in the early 1920s; however, the three years selected well document the vegetation development patterns and the location and diversity of wetland and aquatic habitats within the watershed.

PROJECT SETTING

The Canaan Valley watershed is an elongated, canoe-shaped valley located high in the Allegheny Mountains in the northeastern section of Tucker County, West Virginia (39° 05' N latitude and 79° 25' W longitude). It has an elevation range of 3160 ft (1,006 m) at the point of egress of the Blackwater River in the northwestern portion of the valley, to 4,308 ft (1,372 m) on Bald Knob of Cabin Mountain in the southeastern section. The valley is delineated by four mountains: Brown Mountain which, more or less, forms the northern boundary; Canaan Mountain which defines the western edge, Cabin Mountain, the prominent mountain on the eastern side, which separates Canaan from the Dolly Sods region, and the smallest of the four mountain, Middle Mountain, which forms the southern terminus (Figure 1). The Canaan Watershed and contiguous upland areas are covered by the Davis, Mount Storm Lake, Blackwater Falls, and Blackbird Knob, WV, USGS 7.5 minute topographic quadrangle maps.

An ecologically distinguishing feature of Canaan is the extent of the wetlands on the valley floor (Fortney 1975). The total area of fresh water wetlands in the watershed has been estimated by Fortney (1975) and Michael (1992) to be in excess of 7,000 acres, making Canaan one of the largest inland freshwater wetland areas in the mid-eastern section of the United States. The wetlands, which once supported extensive coniferous forests, now support extensive open bogs, wet meadows, marshes, and swamps.

Canaan Valley has suffered the same fate as many areas in the Allegheny Mountains—its original forest was destroyed by logging and fire (Allard and Leonard 1952). The valley was, however, distinguished from other areas in this region by its original magnificent virgin forest. The forest, before its almost complete destruction, was probably the best representation of a red spruce (*Picea rubens*) forest in the entire eastern United States, and possibly even the world, as described by Allard and

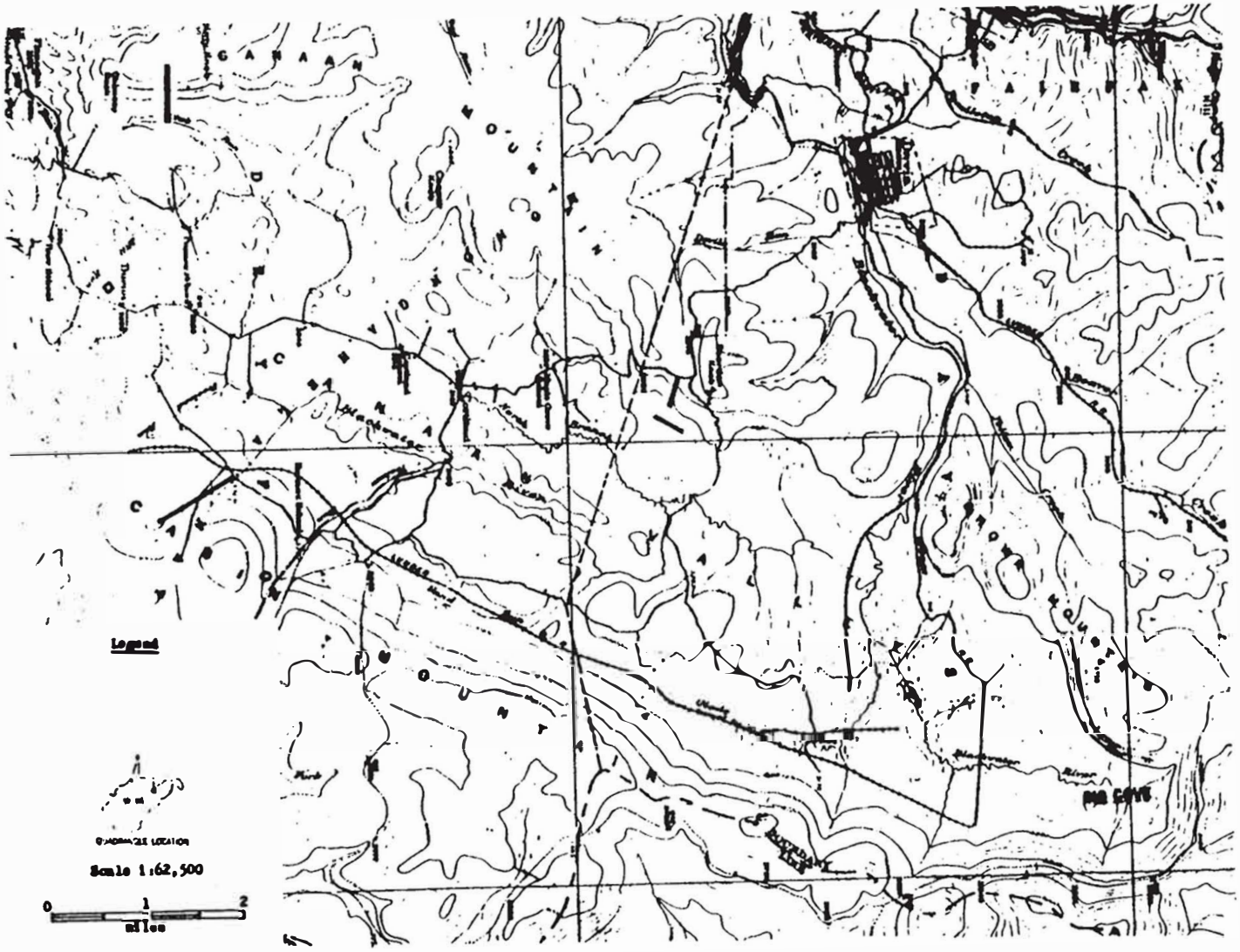

Figure 1. Topographic map of the Canaan Valley, WV, water shed and adjacent areas. (From U.S. Geol. Survey, 1919.)

Leonard (1952) and Brooks (1957). Today, the valley's vegetation is chiefly forb and grass-dominated meadows and northern hardwood forests, with red spruce forests now restricted to relatively small areas on the crests of the surrounding mountains, in protected coves and on lower mountain slopes, and in scattered mixed conifer and hardwood forests in or near wetlands on the valley floor.

The original forests in the Canaan Valley and contiguous areas were essentially clear-cut between the late 1890s and the early 1920s. During the logging era and for a decade following, fires, some intentionally set and others of accidental origin, repeatedly burned the once humus rich upland soils and the peaty wetlands. Severe wind and water erosion of the top soil added to the degradation of the natural habitats, particularly on the uplands sites. In some areas, including the Canaan Heights area between Canaan Valley and Davis, extensive areas of exposed boulders and generally thin soils developed, which even today, nearly 100 years later, cannot support a large forest.

Following this period of extreme perturbation, the vegetation was largely allowed to develop naturally, except where farming activities were initiated. Today, most of the mountain sides are dominated by hardwood species, and the bottomlands are forb and grass-dominated where drainage is good. Where drainage is poor there is a extraordinary diversity of wetlands, aquatic habitats, and plant communities. Wetlands along streams and rivers feature grass and sedge dominated meadows and dense thickets of speckled alder (*Alnus rugosa*) and pipestem (*Spiraea alba*); peatlands behind active flood plains of the valley's streams and rivers have developed into moss and shrub dominated bogs. The Canaan Valley flora, as a whole, is an assemblage of species existing as remnants of the original flora, species that have migrated into the valley since the destruction of the red spruce forest, and species that have been introduced through human activity.

The key distinguishing characteristic of the Canaan flora is its large number of species with distinctly northern ranges that are at or near their southernmost edge of their range (Fortney 1975). It is commonly accepted that the cool climate of Canaan has made it a "refugium" for many northern plant species that migrated southward during the time of the Pleistocene glaciation and were left behind as the glaciers receded (Core 1966). The occurrence and persistence of such a large representation of northern species in a mid-latitude region is due, in part, to the past and present climatic and micro-climatic conditions. Because of its high elevation, Canaan's climate is cool temperate. Because Canaan is a high mountain valley, it is subject to the frost pocket phenomena, in which on cool, clear nights cold air from the surrounding mountains moves down the valley slopes and pools on the valley floor often producing unseasonable low temperatures. As a result, frost is frequently reported for the valley in June and August (Fortney 1975).

METHODS

The process for producing the three GIS maps was completed in six separate tasks:

1. Acquiring aerial photography and EPIC GIS files
2. Scanning and converting photography to digital images
3. Developing vegetation, wetland, and aquatic classification systems
4. Conducting ground truthing activities
5. Preparing a GIS file for each target year
6. Preparing final report

Acquiring Aerial Photography, EPIC GIS Files, and Other Mapping Resources

Sources for the aerial photography for the three target years were:

1. For 1945--USDA black and white prints on file at the West Virginia University Extension Service office in Parsons, WV, and the US Forest Service office in Elkins, WV; photograph was flown August 1945 (leaf on); scale = 1:20000
2. For 1969--USDA black and white prints in the principal investigator's personal files; photography was flown September 1969 (leaf on); scale = 1:20000
3. For 1989--US Fish and Wildlife Service (FWS) full color prints on file at the FWS office in Elkins, WV; photograph was flown October 1989 (leaf on); scale = 1:9600

The 1997 map is an updated and modified version of the land cover GIS map prepared by the U.S. Environmental Protection Agency's Environmental Photographic Interpretation Center (EPIC) in Warrenton, VA, which was based on April 1991 color aerial photography (leaf off). The 1975 map is a revised version of a vegetation map prepared by Fortney (1975) that was originally based on USDA 1969 photography. The 1945 map is an original file developed from the 1945 photography.

Scanning and Converting Photography to Georeferenced Digital Images

Each aerial photograph was scanned using an Hewlett Packard ScanJet IIcx to generate a TIFF file. The TIFF files were imported into TNTmipps GIS software as raster files. The 1969 and 1989 photography was available in flight lines that were in stereo coverage. Only about one half of the 1945 coverage was in stereo. The existing 1975 vegetation map was scanned and imported into the GIS system as a raster file. It was later converted to a vector file, georeferenced and corrected for distortions by warping with TNTmipps software.

Using TNTmipps, each digital photograph was georeferenced by finding common landmarks on the EPIC, land cover, road, and stream GIS maps. The warping function on TNTmipps was used to compensate for distortions on the outer sections of the images. Generally, though, mapping activities were confined to the center most portions of the photographs.

Developing Vegetation, Wetland, and Aquatic Classification Systems

To be consistent with the EPIC maps for Canaan Valley, the basic land cover classification system for the 1945, 1975, 1997 map series is based on the systems used by EPIC. This includes the land cover classifications of wetland and deepwater habitats developed by Cowardin (1979) and the hierarchical classification designed by EPA and EPIC (Table 1).

Added to these classification systems were two fields--a designation of each wetland mapping area (polygon) as having organic or mineral soil and the dominant plant species in terms of apparent ground cover as interpreted from aerial photographs and from subjective visual observations made during field verification activities. Supporting data for these vegetation types are based on description of the vegetation of the valley by Fortney (1975), Stout (1991), Rentch and Fortney (1997), and unpublished data by the principal investigator. Because the most detailed interpretation of the vegetation could be completed for the most current aerial photographs (1989 color, leaf on), the basic vegetation classification units were developed first for the 1997 map. Because fewer vegetation signatures were interpretable on the photography used for the 1975 and 1945 maps, some fields used for the 1997 map were not necessarily identified as specific categories on the other maps. Examples of this include graminoid palustrine communities, where such types as bluejoint and haircap moss communities were not used on one or both the 1975 and 1945 maps (Tables 5, 6, and 7).

Ground Truthing Activities

To verify the signatures that were difficult to interpret on the aerial photographs, ground truthing activities were conducted within the Canaan Valley watershed in areas for which the principal investigator had authorization to visit, e.g., Canaan Valley State Park, Canaan Valley National Wildlife Refuge, and habitats visible from public roads. For other areas, verification was accomplished by comparing signatures of known areas. Ground truthing was conducted during the 1996 growing season and the spring and early summer period of 1997.

Table 1. The 1991 EPA classification of land cover (wetlands, uplands, and deepwater habitats) used in the EPIC maps for Canaan Valley, West Virginia[1] and fields used in the 1945, 1975, and 1979 Canaan valley maps for land cover (LCODES), water regimes, wetland or upland habitat (WETCODE), soils and special modifiers.

PALUSTRINE

PML1 - Moss
PEM1 - Emergent, Persistent
PSS1 - Scrub/Shrub, Broad-Leaved Deciduous
PSS3 - Scrub/Shrub, Broad-Leaved Evergreen
PSS4 - Scrub/Shrub, Needle-Leaved Evergreen
PSS5 - Scrub/Shrub, Dead
PFO1 - Forested, Broad-Leaved Deciduous
PFO4 - Forested, Needle-Leaved Evergreen
PFO5 - Forested, Dead
PUB - Unconsolidated Bottom
PUS - Unconsolidated Shore

RIVERINE

R2UB - Lower Perennial, Unconsolidated Bottom
R3RB - Upper Perennial, Rock Bottom
R4SB - Intermittent. Streambed

LACUSTRINE

L1UB - Limnetic, Unconsolidated Bottom

UPLANDS

UAA - Artificial/Anthropogenic Cover
UUV - Unvegetated
UHU - Herbaceous Cover
USS1 - Scrub/Shrub, Broad-Leaved Deciduous
USS3 - Scrub/Shrub, Broad-Leaved Evergreen
USS4 - Scrub/Shrub, Needle-Leaved Evergreen
USS8 - Scrub/Shrub, Mixed
UFO1 - Forested, Broad-Leaved Deciduous
UFO4 - Forested, Needle-Leaved Evergreen
UFO8 - Forested, Mixed

WATER REGIMES--NON-TIDAL

A	Temporarily Flooded
B	Saturated
C	Seasonally Flooded/well Drained
E	Seasonally Flooded Saturated
F	Semipermanently Flooded
G	Intermittently Exposed
H	Permanently Flooded
J	Intermittently Flooded
K	Artificially Flooded
W	Intermittently Flooded/temporary
Y	Saturated/semipermanent/seasonal
Z	Intermittently Exposed/permanent
U	Unknown

WETCODE

W	Wetland
U	Upland

SPECIAL MODIFIERS

f - farming
b -beaver

[1] NOTES: Land cover classification was prepared by the U.S. Environmental Protection Agency's Environmental Photographic Interpretation Center (EPIC) in Warrenton, Virginia.

Land cover and road data were digitized from 1:12,000 aerial photography using an Analytical Stereoplotter. The date of the photography was April 19, 1991.

Land cover classifications of wetlands and deepwater habitats are based on the Cowardin et al. system (U.S. Fish and Wildlife Service). Land cover classifications of uplands follows the hierarchical structure of the wetlands and deepwater habitats classifications and were designed by EPA/EPIC.

DESCRIPTION OF VEGETATION MAPPING UNITS

The following sections provide a general description of the vegetation classification units used on the three maps. They are organized as either upland or palustrine types (i.e., upland or wetland types). The principle criteria for determining classification types is based on the apparent dominant species as determined from aerial photography, the 1975 study by the author, and ground truthing activities conducted during the preparation of the 1997 map. The types are further summarized in Tables 5, 6, and 7).

Uplands Types

1. **Aster-Goldenrod-Fern Forb Meadow (MX_GF)**--This type occurs throughout the Canaan Valley watershed. The largest expanses are in fields at the bases of the surrounding mountains and on the Pocono ridge in the center of the valley. This type develops in old field type habitats that were once grazed or in row crop production. The dominant species varies, but most frequently it is an add mixture of rough-leaf goldenrod (*Solidago rugosa*), flat-toped white aster (*Aster umbellatus*), bracken fern (*Pteridium aquilinum*), and grass-leaved goldenrod (*Solidago graminifolia*). Among the common variations within this type are bracken fern dominated meadows (which often occur on the Pocono Ridge), and on more moist sites, flat-topped white and grass-leaved asters which can occur together or as single dominants. Associated species include mountain oat-grass(*Danthonia compressa*) field hawkweed (*Hieracium pratense*), dew berry (*Rubus hispidus*) meadow buttercup (*Ranunculus acris*), deertongue grass (*Panicum clandestinum*) and sheep sorrel (*Rumex acetosella*). Near the forest edges hay-scented fern (*Dennstaedtia punctilobula*), New York fern (*Thelypteris noveboracensis*), and various species of clubmoss (*Lycopodium* spp,) are common, often occurring in large colonies. This type also grades into the graminoid meadow type discussed below.

2. **Graminoid Meadow (GRAM_N; GRAM_D)**--Two subtypes are recognized. First is the graminoid meadow with a predominance of introduced grasses. This type is principally in the southern end of the valley in agricultural meadows or in meadows that were recently abandoned. The second type is a graminoid meadow with a combination of different native graminoid species, mountain oat-grass, red top (*Agrostis alba*), and deertongue grass. Other important graminoids which may occur locally on more moist soils include sweet vernal grass (*Anthoxanthum ordoratum*) and velvet grass (*Holcus lanatus*). Mountain oat-grass is mostly associated with relatively recently disturbed sites throughout the valley floor and in meadows on the mountain ridges, particularly on the wind-swept crests of Cabin Mountain. Meadows, some resembling grass balds, occur in broken segments practically the entire length of the mountain. These areas were mostly open in 1945 photos, but are now restricted to sites exposed to

severe wind and icing (Rentch and Fortney 1997). Associated with poverty grass are hay-scented fern, *Carex flexuosa*, and rough-leaf goldenrod. These areas often have scattered colonies of blueberry (*Vaccinium* spp.) and patches of hardwoods frequently dominated by American beech (*Fagus grandifolia*).

3. **Mountain Oat-Grass Meadow (GRS_P)–**This type occurs throughout the valley, particularly in open disturbed areas, e.g., old fields and roadsides. Mountain oat-grass is the dominant grass, with many species common in graminoid and mixed grass-forb types frequent associated species.
4. **Hawthorn Thicket Tall Shrub Thicket (HAW)**--This type occurs throughout the valley, most commonly in the southern end where there has been sustained cattle grazing in the post logging era. Two species of hawthorns have been reported for the valley, *Crataegus punctata* and *Crataegus macrocarpa* (Fortney 1975).

5. **Glade St. John's-wort Low Shrub Thicket (GL_SJ)**--Areas dominated by glade St. John's-wort *(Hypericum densiflorum*) occur commonly throughout the valley floor. This species, however, is most commonly associated with wetland habitats, as further described below, but it often occurs in dense stands in abandoned, moderately-well drained fields, and frequently in transition areas between upland and wetland sites.

6. **Spiraea Tall Shrub Thickets (SPIREA)**--Spirea or pipestem *(Spiraea alba)* is most common in wetlands, but it occasionally occurs in moderately well-drained abandoned fields, and like the glade St. John's-wort, it often occurs in the transition areas between upland and wetland habitats.

7. **Heath Thickets (HEATH)**--This type is restricted to the thin-soiled, wind-blown areas on the crests of the surrounding mountains. This type was once much more common, as reflected by the 1945 map, but has been replaced in many areas by northern hardwood forests and shrubby communities with added mixtures of shrubs and hardwood trees. The principal species are great laurel (*Rhododendron maxima*), mountain laurel (*Calmia latifolia*), Allegheny menzesia (*Menzesia pilosa*), and several species of blueberry, including late low blueberry (*Vaccinium vacillans*) and early low (*V. angustifolium*).

8. **Blueberry Low Shrub Thicket (BLU_B)**--This vegetation type occurs in two habitats types in the valley--bogs and old fields. In the latter case, it occurs in old fields with internal soil drainage restrictions, e.g., claypans, and where the surface of the substrate is strongly undulating, with late low blueberry and velvetleaf blueberry (*Vaccinium myrtilloides*) occurring in the low areas. Haircap moss (*Polytrichum* spp.) is often associated with this habitat.
9. **Bigtoothed Aspen Groves (ASP_B)**--Following the logging era, bigtoothed aspen was a principal vegetation type on the upland areas, occurring in circular

colonies, as reflected in the 1945 map. Although still a common species, the present number of groves are markedly lower throughout the valley. Bigtooth aspen is an early invader tree of disturbed sites, particularly those that have been burned. The importance of the species is likely to continue to decrease; however, the recent and current logging operations on the mountainsides in the valley may open new seed beds for the species to colonize.

10. **Quaking Aspen Groves (ASP_Q)**--This clone forming species is mostly restricted to wetland sites, but it is occasionally found on uplands. Like bigtooth aspen, it is an early invader of disturbed open sites and is also favored by fire.

11. **Mixed Shrub-Hardwood Thicket (MX_ST)**--This type is best described as a transitional community with a prominent layer composed of an add mixture of northern hardwood species, including red maple (*Acer rubrum*) and wild black cherry (*Prunus serotina*), service berry (*Amelanchier arborea*), and fire cherry (*P. penslyvanica*) and various shrubs, including mountain holly (*Ilex montana*) and wild raisin (*Viburnum cassinoides*). In the southern end of the valley, black locust (*Robinia pseudo-acacia*) may also be present. Occurring as transition mixtures, this type is not only variable in species composition, but also is relatively short lived. But as long as upland areas are abandoned, this transitional type community will continue to develop. This type was considerably more extensive in 1945 than today.

12. **Northern Hardwood Forest (NHW)**--The northern hardwood type is the most extensive forest type in the watershed, covering most of the mountain sides of Canaan, Brown, and Cabin Mountains and most of the Pocono Ridge in the center of the valley. It is characterized by a mixture of sugar maple (*Acer saccharum*), American beech, wild black cherry , and yellow birch (*Betula allegheniensis)*. Other important canopy species include red maple, basswood (*Tilia americana*), and white ash (*Fraxinus americana*).

13. **Northern Hardwood Transitional Forest (NHW_T)**--This type is basically a northern hardwood forest in species composition, but in structure it differs in that it has a broken or more open canopy layer. These apparently transitional stands, occur mostly between old fields and closed canopy northern hardwood forests. They may occupy a narrow or broad area. Characteristically, they occur near the base of mountains and hills throughout the valley. This type is particularly apparent on the 1975 and 1997 maps. The fact that it is mostly located at the base of the surrounding mountain slopes and at the base of slopes associated with the Pocono Ridge may mean that this persistent type may be linked to areas of cold air accumulation, i.e., frost pockets. Another factor that may be important is the heavy deer browsing that occurs in edge areas, limiting recruitment of hardwood species.

14. **Northern Hardwood-Hemlock Forest (NHW_H)**--This is basically a northern hardwoods forest with a variable component of eastern hemlock. It occurs in coves and sheltered slopes near the bases of mountains, particularly on Canaan Mountain.

15. **Red Spruce-Yellow Birch Forest (RSYB)**--Chiefly a transitional forest community, the red spruce-yellow birch forest occurs on the upper slopes of the surrounding mountains, mostly on northwestern to northeastern aspects. Varying mixtures of other hardwood tree species are intermixed.

16. **Red Spruce Forest (RS)**--Once the dominant canopy species in Canaan Valley, this evergreen conifer is now mostly restricted to small stands at the crests on the surrounding mountains where they occur in sheltered areas and on north-facing slopes. A few small stands occur on lower slopes in coves; most were not large enough to delineate on any of the maps.

17. **Balsam Fir Forest (BAL_F)**--Balsam fir (*Abies balsamea*) occurs as a single dominant species in a few isolated stands both on wetland and upland sites. Most stands are within Canaan Valley State Park in the southern end and in Big Cove in the northern end of the valley. Also, these are typically young stands with dbh measurements averaging under 20 cm.

18. **Pine Plantations (PP)**--In the southern end of the valley, there are several pine plantings of scotts pine and red pine. Most are in view of State Route 32.

Palustrine (Wetlands) Types

1. **Mixed Graminoid-Forb Wet Meadow (MX_GF)**--This type is highly variable. It is an add mixture or a combination of several common graminoid and forb species that occur in wetlands throughout the valley on a variety of mineral soils and under different hydrologic regimes. They may occur in large expanses near streams and rivers or in abandoned fields with seasonally high watertables, or they may occur as fringe meadows between uplands and shrub or forested wetlands. All type are combined here because they could not be consistently delineated on the aerial photographs. Generally, forbs are more important on drier sites. The most frequently occurring graminoid species include *Glyceria grandis, Calamagrostis canadensis,* rice cutgrass (*Leerzia oryzoides*), *Agrostic alba, Carex folliculata, C. stricta, C. scoparia, C. lurida, C. vulpinoidea, Scirpus atrovirons, S. atrocinctus, and* common rush (*Juncus effusus*). Dominant forbs include bog goldenrod (*Solidago uliginosa*), cinnamon fern (*Osmunda cinnamomea*, dew berry (*Rubus hispidus*), stiff marsh bedstraw (*Galium obtusum*), and arrowleaf tearthumb (*Polygonum sagittatum*). Graminoid-forb meadows appear to have increased since 1945 because of intense beaver activity along streams and rivers and the abandonment of agriculture meadows.

2. **Graminoid Wet Meadow (GRAM)**--This type is similar to the graminoid-forb meadows but there is a clear dominance of one or more graminoid species. A further distinguishing feature is graminoid meadows develop under wetter hydrologic regimes than the mixed graminoid-forb type. They are also often associated with disturbed habitats along streams where overbank flooding is frequent.

   Wet meadows are often dominated by bluejoint grass and/or a combination of sedges, grasses, forbs. The exact species composition of wet meadows could not be accurately interpreted from the aerial photos, particularly on the 1945 and 1969 black and white photos. In many cases, the dominant vegetation is cited as graminoid (GRAM), indicating that it is a combination of graminoid species. Individual species, e.g. common rush, are cited when they could be reliably interpreted from the photos.

3. **Common Rush Wet Meadow (COM_R)**--A variation of the graminoid wet meadow type, common rush meadows are dominated by common rush. These sites appear to correlate with recent disturbances, particularly along streams; common rush is also a frequent dominant emergent species in bogs with a haircap moss-dominated ground-cover.

4. **Bluejoint Grass Wet Meadow (GRS_B)**--Bluejoint grass typically dominates meadows along streams where there is frequent overbank flow. Associate species are ones found in mixed graminoid-forb wet meadows.

5. **Carex Wet Meadow (CAREX)**--This type, which occurs frequently through the valley, is a variation of the graminoid meadow type. The most frequently occurring *Carex* are *C. scoparia*, *C. stricta*, *C. vulpinoidea*, and *C. folliculata*. Associate species are those cited in other wet meadow types.

6. **Cattail Marsh (CAT_T)**--This type is frequently associated with old beaver pond sites and wet meadows created by restricted drainage behind stream side levees. Broad-leaved cattail (*Typha latifolia*) communities may also have varying mixtures of burreed (*Sparganium americanum)*. The latter species occasionally occurs in slow-flowing streams throughout the valley.

7. **Bogs (MOSS, MOS_S and MOS_P)**--Although highly variable in emergent species, all bogs (cold peatlands) in the Canaan Valley watershed have a nearly continuous groundcover of sphagnum moss (*Sphagnum* spp.) or hair-cap moss (*Polytrichum* spp.). There is basically a continuous variation in the proportion of sphagnum to haircap moss forming the ground cover. Generally, sphagnum occurs as the predominant ground cover in bogs with persistently high water tables during the growing season. Under such hydrologic regimes graminoids are often the dominant emergent species. Bogs with haircap moss as the

dominant ground cover have lower water tables during the summer, dropping up to 0.5 m below the surface during the growing season. The emergent layers in haircap moss dominated bogs are highly variable. They range from a few scattered species to dense stands of several species. On the three maps, all bogs are labeled under the PLTCODE as PML1, with soils always cited as organic. The dominant plants (DOM_SPEC) may be either of the mosses (MOSS, MOS_P OR MOS_S), *Carex* spp. (Carex), *Viburnum* spp. (VIBUR), or *Vaccinium* spp. (BLU_B). The most common creeping species is dew berry, but since the botanical study by Fortney (1975), large cranberry (*Vaccinium oxycoccus*) has become more common, based on field observations made during this study. The most important graminoid species are *Carex rostrata*, *Carex stricta*, common rush and cottongrass (*Eriophorum virginicum*). Important forb species are bog goldenrod, tea berry (*Gautheria procumbens*), cinnamon fern, and vervain thoroughwort (*Eupatorium pilosum*). Common shrubs are velvetleaf blueberry, black chokeberry (*Pyrus melanocarpa*), wild raisin (*Viburnum cassinoides*), smooth arrowwood wild holly (*Nemopanthus mucronata*). Where there is a predominance of haircap moss and significant shrub invasion, hummocks are common, creating an undulating ground cover of mosses.

8. **Blueberry Low Shrub Thickets and Viburnum Tall Shrub Thickets (BLU_B/VIBUR)**--Both of these types may occur on mineral soil, but they are typically in bogs. Both blueberry and viburnum species often occur together as co-dominants, but they also occur, particularly in the large bogs in the northern part of the valley, as distinct singly dominant species. The most common blueberry species are velvetleaf blueberry and early low blueberry (*Vaccinium angustifolium*). The principal viburnums are wild raisin and smooth arrowwood (*Viburnum recgnitum*). Associated shrubs include black chokeberry and black alder (*Nemopanthus mucronata*). Haircap moss forms the prominent ground cover in shrub-dominated bogs. Dew berry is typically a common creeper.

9. **Mixed Shrub-Hardwoods Thickets (MX_ST)**--This is a loosely associated admixture of shrubby hardwood tree species and shrub species. Commonly occurring shrubs include wild raisin, blueberries, and willows (*Salix* spp.). Tree species include red maple, black cherry, and quaking aspen. It mostly occurs on wet mineral soils. This type represents and immature, transitional plant community.

10. **Glade St. John's-wort Low Shrub Thicket (GL_SJ)**--This densely growing shrub typically has a broad ecological amplitude, occurring in both upland and wetland sites, but it is most common in wetlands. St. John's-wort thickets occur on mineral soils along streams that remain saturated throughout most of the growing season and are subject to frequent overbank flooding. Thickets also

develop in poorly drained abandoned fields with saturated hydrologic regimes. In both conditions, it can form dense thickets with low species diversity. The most extensive thickets occur in abandoned agricultural fields in the southern end of the valley and in old fields near the Little Blackwater River at the base of Cabin Mountain.

11. **Spirea Tall Shrub Thickets (SPREA)**--Pipestem thickets are, doubtless, the most dense shrub-dominated communities in the valley. They are best developed on active flood plain, often interspersed among speckled alder (*Alnus rugosa*) thickets. They also frequently develop in abandoned meadows with poorly drained (saturated) soils . Pipestem thickets, because they are typically dense and nearly impenetrable for humans, have extremely low species diversity. The most extensively developed thickets occur in the southern end of the valley, where pipestem has invaded many poorly drained abandoned meadowlands. The area occupied by pipestem has more than quadrupled since 1945, largely as a result of the abandonment of agriculturally land in the southern end.

12. **Speckled Alder Tall Shrub Thickets (SP_AL)**--Speckled alder forms extensive shrub thickets along most stream and river segments on the valley floor. A consistent aspect of the alder thickets is that they occur and persist only where overbank flooding occurs, more or less, on an annual frequency. In addition to flooding, the water table in alder thickets is usually at or near the surface of the substrate for most of the growing season. Associated shrub species include pipestem, glade St. John's-wort, and arrowwood (*Viburnum recognitum*). Alder thickets are some of the most diverse plant communities in the valley.

13. **Mixed Hardwood Forest (HRD_W)**--This type is mostly restricted to terrace land associated with the channel of the lower Blackwater River in the north central section of the valley. These forests, which are typically dominated by wild black cherry, yellow birch, and red maple, often have well-drained substrates except during high intermittent flows. Hemlock and red spruce are occasional components. These are basically northern hardwood forests without beech and sugar maple.

14. **Quaking Aspen Groves (ASP_Q)**--Quaking aspen is a strongly colonial species, forming more or less circular groves through underground rootstock development. They commonly develop in open areas with mineral soil and saturated hydrologic regimes. Many aspen groves occur in old field type habitats (areas presumed to be pastureland at one time). Like bigleaf aspen, this species is also favored by fire. The most extensive growths of quaking aspen occur along the North Branch of the Blackwater River and areas adjacent to the Little Blackwater River and Glade Run. Quaking aspen groves, however, are frequent throughout the valley. They may be associated with pipestem and

alder thickets. Since 1975, the area covered by quaking aspen has decreased. Field observations made during this study suggest that the decline is a combination of low recruitment and a decline (death) of the oldest groves. The lack of recent fires may also be a factor.

15. **Red Spruce (RS)**--Forested wetlands where red spruce is the single dominant canopy species are rare. In most cases, these stands were too small to delineate.

16. **Spruce-Fir-Hemlock Swamp Forest (SFH)**--This wetland forest type represents a relatively small portion of the current vegetative cover in the valley. A major portion of this type and the subtype described below in which red maple and yellow birch are components, has been destroyed by beaver activities. This is particularly apparent within Canaan Valley State Park and in Big Cove by comparing the 1945 and 1975 maps with the 1997 map. Other associated canopy species include wild black cherry and mountain ash (*Pyrus americana*). Generally, species diversity is low in this community.

17. **Spruce-Fir-Hemlock-Maple-Birch Swamp Forest (SFHMB)**--This type is considered here as a subtype of the spruce-fir-hemlock community described above because of its hardwood component of red maple and yellow birch. It generally occurs in association with the SFH type, but appears to develop under slightly drier conditions, with a lower watertable during the growing season. Wild black cherry and mountain ash are also occasional canopy species.

18. **Aquatic Beds**--Aquatic habitats in the valley are largely restricted to beaver ponds and streams and rivers. The oldest beaver ponds frequently have a fringe emergent vegetation of cattail, woolgrass (*Scirpus* spp.), or burreed. Where flood plain pools and beaver pond edges become shallow or lack standing water throughout the growing season, a few wetland or aquatic plants may invade. They include rice cutgrass, marsh purslane (*Ludwigia palustris*), larger water starwort (*Callitriche heterophylla*), and floating pondweed (*Potamogeton epihydrus*). These sites are typically small (less than 1/20 hectare) and were not mapped.

AREA CHANGES IN LAND COVER AND VEGETATION TYPES BETWEEN 1945 AND 1997

The surface areas by land cover types for 1945, 1975, and 1997 are summarized in Tables 2, 3, and 4, and the surface areas by dominant species for 1945, 1975, and 1997 are summarized in Table 5, 6, and 7.

For upland cover classes and plant communities, there are several obvious trends of either increasing or decreasing areas. Between 1945 and 1997, the area in broad-leaved deciduous forest (UFO1) increased from 4,730 ha to 6,104 ha, an expansion of 22.5%. The area covered by red spruce also increased, from 13 ha to 116 ha, nearly an 800% enlargement. The mixed forest type (UFO8), which is chiefly northern hardwood-red spruce, decreased by 3,569 ha. The increased importance of northern hardwood forest communities is evidence of the success of hardwood species since the logging era. Correspondingly, the decline of the mixed conifer-hardwood type is, doubtless, related to the success northern hardwoods species appear to have over red spruce in upland habitats.

The level of encroachment of northern hardwood transitional community type (NHW_T) into old field-type habitats does not appear to follow the trend of other hardwood communities. This ecotonal community, which is typically a transitional type generally occupying an area between old fields and northern hardwood forests, is characterized as having scattered individual trees and a broken canopy. The northern hardwood transition type increased between 1945 and 1975, expanding from 639 ha to 1,254 ha. By 1997, however, its area had decreased to 289 ha. The decrease is probably related, in part, to the maturation of this temporary northern hardwood community and a decrease in the rate of its encroachment into old field habitats. Another factor contributing to this decline is the extensive clearing of forested areas in the southern portion of the valley to create open recreational lands. This type is further discussed below in the section covering plant succession.

Aspen communities, both quaking and bigtooth, displayed a similar developmental pattern. There was minimal coverage for each in 1945, 3 ha and 6 ha, respectively. In 1997, quaking totaled 293 ha, while bigtooth totaled 84 ha. By 1997, quaking had declined to 61 ha and bigtooth to 1 ha. Ground truthing revealed limited recruitment for both aspens, and for each a decline in healthy aspen groves. It should be noted that in 1997 the area covered by bigtooth aspen was probably somewhat larger that reported here, because aspen groves surrounded by northern hardwood communities were difficult to identify using aerial photographs.

As expected, there was a decrease in the importance of shrub-dominated communities. The most notable decline was by heath, a decrease from 638 ha to 86 ha. The overall loss of shrub cover, doubtless, relates to the replacement of this type by hardwood tree species.

The area of upland habitats dominated by grasses and forbs remained relatively stable between 1945 and 1997. This is apparently related to the balance between areas cleared for various purposes and areas replaced by shrub and tree dominated communities.

Several palustrine types also exhibited significant changes. The area covered by pipestem expanded from 85 ha to 432 ha, an increase of over 400%. Similarly, the area cover by glade St. John's wort increased by nearly 860%, from 90 ha to 863 ha. The increase of these two species can be attributed to the abandonment of agricultural

lands throughout the valley since 1945 and beaver activity along the water courses. As facultative wetland plants, some of the success of these species relates to their ability to invade upland meadows as well as poorly drained bottomlands. This is especially true for glade St. John's wort.

Conversely, grass and forb-dominated wet meadows (PEM1) exhibited a marked decline. Between 1945 and 1997, the area occupied by wet meadows decreased from 1,680 ha to 795 ha. Many wet meadows were replaced by pipestem, St. John's wort, quaking aspen, or speckled alder communities. However, speckled alder showed a decline between 1975 and 1997, decreasing from 646 ha to 542 ha. A similar pattern was recognizable for wetland forest communities dominated by conifers; these types increased from 217 ha to 387 ha between 1945 and 1975, followed by a decrease of 135 ha by 1997. The land cover and the juxtaposition of wetland plant communities and habitats along watercourses have been and continue to be strongly influenced by beaver activity. As the beaver population in the valley has increased, so did the impact to the vegetation.

There appeared to be some expansion of peatlands or bogs in the valley since 1975. During ground truthing activities related to the preparation of the1997 map, numerous areas were found where sphagnum and haircap mosses had developed or expanded since 1975. In many cases, these areas were too small to delineate on the map. A comparison of peat accumulation was not made since historical data peat depth were unavailable. The most significant change to bogs was the invasion of shrub species–mostly blueberries (*Vaccinium* spp.) and black chokeberry. In a few bogs in the central and northern portions of the valley, *Vibumum* spp. and wild holley were dominant or existed as co-dominants with blueberries and black chokeberry.

VEGETATIONAL PATTERNS AND SUCCESSIONAL TRENDS

The distribution patterns of plant communities in any area are the product of successional changes throughout time. Vegetational patterns and successional changes both reflect the impact of environmental patterns and interacting biotic factors.

Table 2. Area of cover classes in Canaan Valley in 1945 using the US Fish and Wildlife Service wetland classification system (Cowardin et al. 1979).[1, 2, 3]

COVER CODE	COVER CLASS NAME	AREA (ha)	AREA (acres)	Rel. Area (%)
L1UB	Limnetic	0	0	0
PEM1	Moss	1,680	4,150	12
PFO1	Forested, broad-leaved deciduous	65	161	0.46
PFO4	Forested, needle-leaved evergreen	178	441	1.27
PFO5	Forested, dead	0	0	0
PFO8	Forested, mixed	39	96	0.28
PML1	Moss	665	1,640	4.73
PSS1	Scrub/shrub, broad-leaved deciduous	780	1,930	5.55
PSS3	Scrub/shrub, broad-leaved evergreen	0	0	0
PSS4	Scrub/shrub, needle-leaved evergreen	15	36	0.1
PSS5	Scrub/shrub, dead	0	0	0
PUB	Unconsolidated bottom	24	58	0.17
PUS	Unconsolidated shore	0	0	0
R2UB	Lower perennial, unconsolidated bottom	34	83	0.24
R3RB	Upper perennial, unconsolidated bottom	0	0	0
R4SB	Intermittent, streambed	0	0	0
UAA	Artificial cover	0	0	0
UFO1	Forested, broad-leaved deciduous	4,730	11,700	33.6
UFO4	Forested, needle-leaved evergreen	13	32	0.09
UFO8	Forested, mixed	187	462	1.33
UHU	Herbaceous cover	4,220	10,400	30
USS1	Scrub/shrub, broad-leaved deciduous	1,090	2,700	7.77
USS3	Scrub/shrub, broad-leaved evergreen	279	689	1.99
USS4	Scrub/shrub, needle-leaved evergreen	34	84	0.24
USS8	Scrub/shrub, mixed	0	0	0
UUV	Unvegetated	21	51	0.15
UNKNOWN		0	0	0
TOTAL		14,100	34,700	100

1 Cover codes beginning with P indicate palustrine types
2 Cover codes beginning with U indicate upland types
3 Cover codes beginning with R indicate riverine types

Table 3. Area of cover classes in Canaan Valley in 1975 using the US Fish and Wildlife Service wetland classification system (Cowardin et al. 1979).[1, 2, 3]

COVER CODE	COVER CLASS NAME	AREA (ha)	AREA (acres)	Rel. Area (%)
L1UB	Limnetic	0	0	0.00
PEM1	Moss	270	668	1.91
PFO1	Forested, broad-leaved deciduous	355	877	2.51
PFO4	Forested, needle-leaved evergreen	216	534	1.53
PFO5	Forested, dead	0	0	0.00
PFO8	Forested, mixed	171	422	1.20
PML1	Moss	722	1,785	5.10
PSS1	Scrub/shrub, broad-leaved deciduous	1,008	2,490	7.11
PSS3	Scrub/shrub, broad-leaved evergreen	0	0	0.00
PSS4	Scrub/shrub, needle-leaved evergreen	0	0	0.00
PSS5	Scrub/shrub, dead	0	0	0.00
PUB	Unconsolidated bottom	35	87	0.25
PUS	Unconsolidated shore	0	0	0.00
R2UB	Lower perennial, unconsolidated	32	78	0.22
R3RB	Upper perennial, unconsolidated	7	18	0.05
R4SB	Intermittent, streambed	0	0	0.00
UAA	Artificial cover	0	0	0.00
UFO1	Forested, broad-leaved deciduous	6,892	17,029	48.62
UFO4	Forested, needle-leaved evergreen	354	874	2.49
UFO8	Forested, mixed	291	718	2.05
UHU	Herbaceous cover	3,428	8,470	24.18
USS1	Scrub/shrub, broad-leaved deciduous	325	803	2.29
USS3	Scrub/shrub, broad-leaved evergreen	59	145	0.41
USS4	Scrub/shrub, needle-leaved evergreen	0	0	0.00
USS8	Scrub/shrub, mixed	0	0	0.00
UUV	Unvegetated	10	26	0.07
UNKNOWN		0	0	0.00
TOTAL		14,174	35,024	100.00

1 Cover codes beginning with P indicate palustrine types
2 Cover codes beginning with U indicate upland types
3 Cover codes beginning with R indicate riverine types

Table 4. Area of cover classes in Canaan Valley in 1997 using the US Fish and Wildlife Service wetland classification system (Cowardin et al. 1979).[1, 2, 3]

COVER CODE	COVER CLASS NAME	AREA (ha)	AREA (acres)	Rel. Area (%)
L1UB	Limnetic	27	66	0.19
PEM1	Moss	795	1,966	5.68
PFO1	Forested, broad-leaved deciduous	336	831	2.40
PFO4	Forested, needle-leaved evergreen	188	465	1.35
PFO5	Forested, dead	2	5	0.01
PFO8	Forested, mixed	62	153	0.44
PML1	Moss	230	568	1.64
PSS1	Scrub/shrub, broad-leaved deciduous	1,881	4,647	13.44
PSS3	Scrub/shrub, broad-leaved evergreen	1	3	0.01
PSS4	Scrub/shrub, needle-leaved	8	21	0.06
PSS5	Scrub/shrub, dead	10	26	0.07
PUB	Unconsolidated bottom	69	170	0.49
PUS	Unconsolidated shore	0	0	0.00
R2UB	Lower perennial, unconsolidated	27	66	0.19
R3RB	Upper perennial, unconsolidated	15	36	0.10
R4SB	Intermittent, streambed	0	1	0.00
UAA	Artificial cover	171	422	1.22
UFO1	Forested, broad-leaved deciduous	6,104	15,083	43.62
UFO4	Forested, needle-leaved evergreen	116	287	0.83
UFO8	Forested, mixed	651	1,607	4.65
UHU	Herbaceous cover	2,400	5,930	17.15
USS1	Scrub/shrub, broad-leaved deciduous	837	2,069	5.98
USS3	Scrub/shrub, broad-leaved evergreen	50	122	0.35
USS4	Scrub/shrub, needle-leaved	2	4	0.01
USS8	Scrub/shrub, mixed	1	1	0.00
UUV	Unvegetated	11	28	0.08
UNKNOWN		0	0	0.00
TOTAL		13,993	34,576	100.00

1 Cover codes beginning with P indicate palustrine types
2 Cover codes beginning with U indicate upland types
3 Cover codes beginning with R indicate riverine types

Table 5. Area of vegetation cover classes in Canaan Valley for 1945 using dominant pieces to typify plant cover.

PLANT CODE	COMMON NAME	AREA (ha)	AREA (acres)	Rel. Area (%)
ASP_B	Bigtoothed aspen	6	15	0.04
ASP_Q	Quaking aspen	3	7	0.02
BAL_F	Balsam fir	0	0	0.00
BLU_B	Blueberry	0	0	0.00
CAREX	Carex (sedge)	35	87	0.25
CAT_T	Broad-leaved cattail	0	0	0.00
COM_R	Common rush	0	0	0.00
GL_SJ	Glade St. John's wort	90	222	0.64
GRAM	Graminoid	237	585	1.68
GRAM_D	Introducedated grass	757	1,870	5.38
GRAM_N	Native grass	144	355	1.02
GRS_B	Bluejoint grass	0	0	0.00
GRS_P	Poverty grass	0	0	0.00
HAW	Hawthorn	0	0	0.00
HEATH	Heath	638	1,576	4.54
HRD_W	Hardwoods	371	917	2.64
MOS	Moss	637	1,574	4.53
MOS_H	Haircap moss	0	0	0.00
MOS_S	Sphagnum moss	37	91	0.26
MX_GF	Mixed grasses and forbs	4,765	11,774	33.90
MX_ST	Mixed shrub thicket	510	1,259	3.63
NHW	Northern hardwoods	3,957	9,777	28.15
NHW_H	Northern hardwoods and hemlock	0	0	0.00
NHW_S	Northern hardwoods and spruce	192	475	1.37
NHW_T	Northern hardwoods transition	639	1,579	4.55
PP	Pine plantation	1	2	0.00
RS	Red spruce	46	114	0.33
RS_YB	Red spruce and yellow birch	0	0	0.00
SFH	Spruce, fir, and hemlock	165	409	1.18
SFHMB	Spruce, fir, hemlock, maple, birch	59	146	0.42
SPREA	Pipestem	85	211	0.61
SP_AL	Speckled alder	604	1,492	4.30
VIBUR	Viburnum	0	0	0.00
UNVEGETATED		21	51	0.15
RIVERINE		34	83	0.24
LAKE		0	0	0.00
UNKNOWN		23	56	0.16
TOTAL		14,054	34,727	100.00

Table 6. Area of vegetation cover classes in Canaan Valley for 1975, using dominant species to typify plant cover.

PLANT CODE	COMMON NAME	AREA (ha)	AREA (acres)	Rel. Area
ASP_B	Bigtoothed aspen	84	208	0.59
ASP_Q	Quaking aspen	293	725	2.07
BAL_F	Balsam fir	0	0	0.00
BLU_B	Blueberry	102	252	0.72
CAREX	Carex (sedge)	0	1	0.00
CAT_T	Broad-leaved cattail	3	8	0.02
COM_R	Common rush	0	0	0.00
GL_SJ	Glade St. John's wort	117	290	0.83
GRAM	Graminoid	242	597	1.70
GRAM_D	Introduced grass	1,285	3,176	9.07
GRAM_N	Native grass	19	46	0.13
GRS_B	Bluejoint grass	29	72	0.21
GRS_P	Poverty grass	0	0	0.00
HAW	Hawthorn	50	125	0.36
HEATH	Heath	59	145	0.41
HRD_W	Hardwoods	17	42	0.12
MOS	Moss	11	26	0.07
MOS_H	Haircap moss	451	1,113	3.18
MOS_S	Sphagnum moss	101	250	0.71
MX_GF	Mixed grasses and forbs	2,130	5,263	15.03
MX_ST	Mixed shrub thicket	171	423	1.21
NHW	Northern hardwoods	5,586	13,803	39.41
NHW_H	Northern hardwoods and hemlock	192	475	1.35
NHW_S	Northern hardwoods and spruce	116	286	0.82
NHW_T	Northern hardwoods transition	1,254	3,099	8.85
PP	Pine plantation	0	0	0.00
RS	Red spruce	358	885	2.53
RS_YB	Red spruce and yellow birch	0	0	0.00
SFH	Spruce, fir, and hemlock	212	523	1.49
SFHMB	Spruce, fir, hemlock, maple, birch	171	422	1.20
SPREA	Pipestem	293	723	2.07
SP_AL	Speckled alder	646	1,596	4.56
VIBUR	Viburnum	98	242	0.69
UNVEGETATED		10	26	0.07
RIVERINE		39	96	0.27
LAKE		0	0	0.00
UNKNOWN		35	87	0.25
TOTAL		14,174	35,024	100.00

Table 7. Area of vegetation cover classes in Canaan Valley for 1997, using dominant species to typify plant cover.

PLANT CODE	COMMON NAME	AREA (ha)	AREA (acres)	Rel. Area (%)
ASP_B	Bigtoothed aspen	1	4	0.01
ASP_Q	Quaking aspen	61	151	0.44
BAL_F	Balsam fir	1	2	0.01
BLU_B	Blueberry	169	417	1.21
CAREX	Carex (sedge)	133	329	0.95
CAT_T	Broad-leaved cattail	25	63	0.18
COM_R	Common rush	28	70	0.20
GL_SJ	Glade St. John's wort	863	2,133	6.17
GRAM	Graminoid	226	558	1.61
GRAM_D	Introduced grass	1,004	2,482	7.18
GRAM_N	Native grass	31	78	0.22
GRS_B	Bluejoint grass	70	173	0.50
GRS_P	Poverty grass	21	53	0.15
HAW	Hawthorn	83	205	0.59
HEATH	Heath	86	213	0.62
HRD_W	Hardwoods	458	1,131	3.27
MOS	Moss	0	0	0.00
MOS_H	Haircap moss	316	781	2.26
MOS_S	Sphagnum moss	52	128	0.37
MX_GF	Mixed grasses and forbs	1,761	4,351	12.58
MX_ST	Mixed shrub thicket	308	761	2.20
NHW	Northern hardwoods	5,807	14,348	41.50
NHW_H	Northern hardwoods and hemlock	55	136	0.39
NHW_S	Northern hardwoods and spruce	435	1,076	3.11
NHW_T	Northern hardwoods transition	289	713	2.06
PP	Pine plantation	15	37	0.11
RS	Red spruce	116	287	0.83
RS_YB	Red spruce and yellow birch	168	415	1.20
SFH	Spruce, fir, and hemlock	177	437	1.26
SFHMB	Spruce, fir, hemlock, maple, birch	65	161	0.47
SPREA	Pipestem	432	1,067	3.09
SP_AL	Speckled alder	542	1,339	3.87
VIBUR	Viburnum	42	104	0.30
UNVEGETATED		11	28	0.08
RIVERINE		42	103	0.30
LAKE		27	66	0.19
UNKNOWN		71	175	0.51
TOTAL		13,993	34,576	100.00

The present vegetation patterns in the Canaan Valley watershed, as well as adjacent upland areas, differ markedly from the comparatively homogeneous vegetation pattern which existed before the destruction of the original forest (Fortney 1975). Prevailing in the valley today is a complex and diverse mixture of developmental herbaceous, shrub, and tree dominated communities, as well as transient plant aggregations. These vegetative cover types are distributed in a more or less predictable pattern over the landscape. This heterogeneous pattern has developed in response to complex environmental patterns in the area and to past and present disturbances. The most important disturbances, historically, have been logging, fire, farming, and beaver activities. The fact that so many of the vegetation types in the Valley represent early successional stages indicates the magnitude and the relatively recent occurrence of many of these disturbances.

The homogeneous nature of the original red spruce forest covering the Canaan Valley watershed and adjacent areas was probably partly a reflection of the tolerance of red spruce to a wide range of environmental conditions and partly a reflection of the somewhat uniform nature of edaphic conditions. The deep, organic surface layer which characterized the soils of the original spruce forest was doubtless a major factor in maintaining mesic conditions in the former forest. Following the destruction of the vegetative cover and the organic layer by logging, fire, and erosional forces, variations in edaphic conditions became much more pronounced and many new and varied habitats developed. The present habitats are much more sharply delineated by the distribution of individual species and vegetation types than the habitats that existed in the pre-logging era. At the same time, the current conditions within Canaan reflect, as a whole, a naturally recovering ecosystem, reestablishing relative stability through natural processes.

Edaphic conditions, specifically soil hydrologic conditions, together with current and past disturbances, appear to be the most important factors determining successional trends, and, therefore, the vegetational patterns in Canaan Valley. Other factors, including micro climate, topography, geology, and slope inclination and aspect, are doubtless important; but their impact seems to be more subtle. The fact that the valley floor is underlaid by Greenbrier Limestone appears to have minimal impact on the vegetation. Most of the limestone is covered by alluvium and therefore, does not have an extensive surface exposure, except in a few areas in the southern end of the valley. However, to clearly evaluate the level of influence the limestone has on vegetation patterns and species distributions, additional studies will be necessary to correlate individual species occurrences with bedrock and edaphic conditions.

The following description of vegetational patterns and specific successional trends are presented as two general physiographic categories, upland areas and palustrine habitats. Summary diagrams depicting the major secondary successional trends within Canaan Valley on upland areas are shown in Figures 2 and 3 and on palustrine wetland areas in Figures 4 and 5.

Uplands

The current spatial distribution of upland communities in Canaan Valley reflects chiefly the impact of past land use practices, mainly farming and logging. Following the logging era, a large portion of the somewhat poorly drained to well-drained land on the valley floor was converted into agricultural use. Most of this land was utilized as open pastureland, but some areas were used for row crops. The steep slopes of the surrounding mountains not suitable for cultivation were allowed to undergo natural reforestation. The northern hardwoods forest communities which prevail today, including those on the surrounding slopes and on the Pocono Ridge, were apparently not the initial tree cover to develop on the barren, burned-over areas. A pyric type forest, dominated by a loose association of fire cherry, bigtooth aspen, and quaking aspen, was first to develop (Allard and Leonard 1952). These species were likely unimportant and greatly suppressed components of the original dense spruce forest. It was not until the original forest was cut and much of the organic soil destroyed that favorable habitats were created for the development of the aspen-fire cherry association.

Only small remnants of the original aspen-fire cherry association exist today, as most of this forest has been replaced by the dense shade-producing, long-lived northern hardwoods forests. All that remains of many bigtooth aspen groves on the mountain slopes surrounding Canaan Valley are dead snags and fallen logs. Other groves have been completely surrounded by hardwoods and are in declining growth states. Like bigtooth aspen, the fire cherry component of the pyric forest has been reduced to occasional trees interspersed in hardwood forests and to adventives along roadsides and in old fields. This was generally the situation in 1975, and was found to be even more so in 1997.

As previously noted, most of the agricultural land was utilized as pastureland rather than for row crops. The successional trends of natural reforestation following abandonment of pastureland appear to be greatly affected by the intensity of past grazing pressures and soil-moisture conditions. The development of low and tall shrub communities in abandoned pastureland is limited to areas having moderately well-drained to somewhat poorly drained soils. On well-drained sites, shrub series rarely develop and the forb dominated stages are replaced by a pre-northern hardwood association, often dominated by a combination red maple, black cherry, and American beech. Other hardwood species are only occasionally present.

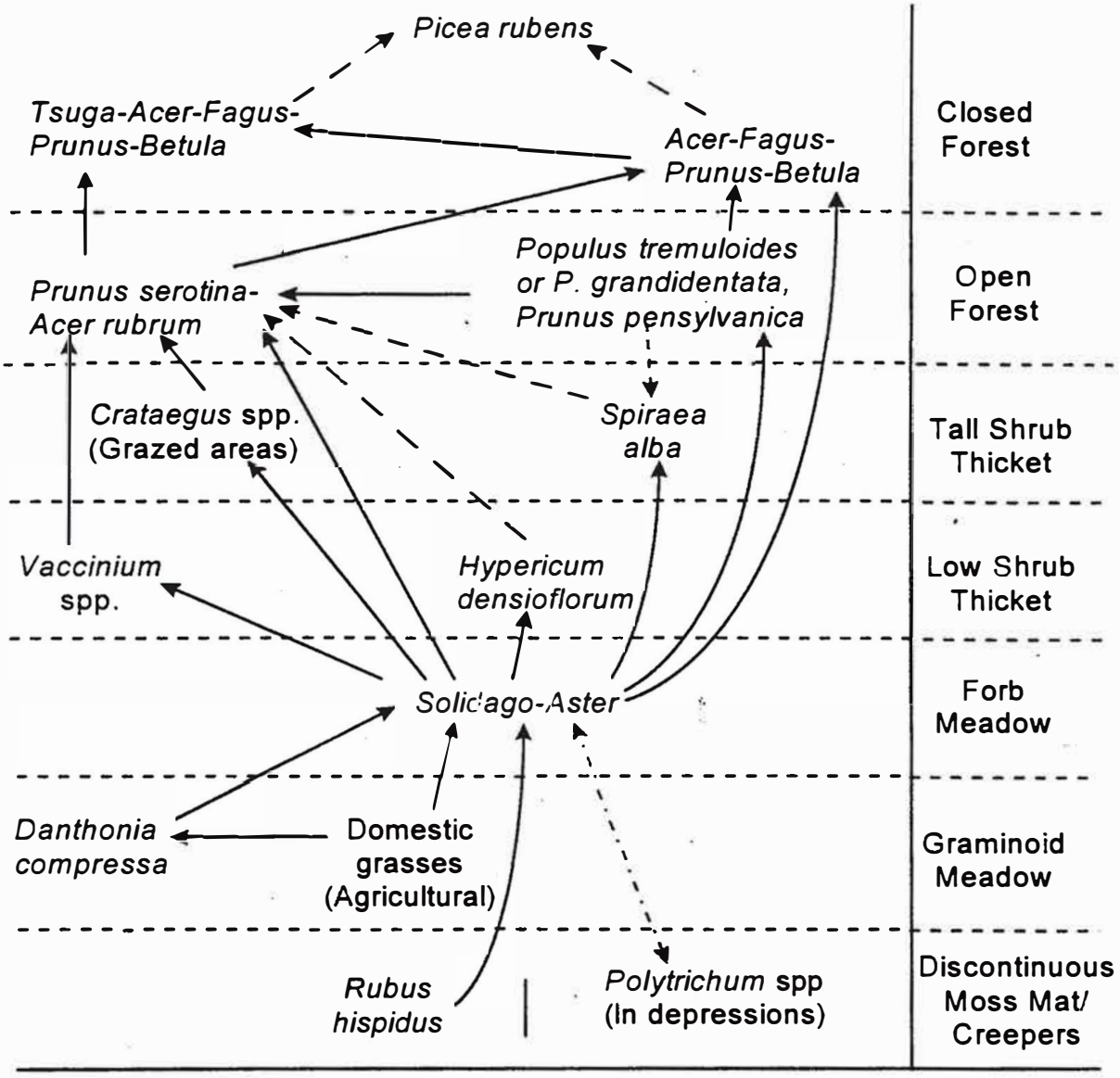

Figure 3. Secondary plant succession on well-drained to moderately well-drained sites in Canaan Valley, WV. Solid lines indicate apparent successional sequences, broken lines indicate probable sequences, and mixed lines indicate possible inverted sequence. Physiognomy and dominant life-forms are shown for each stage. Open forest stage may be scattered individuals or groves of hardwoods.

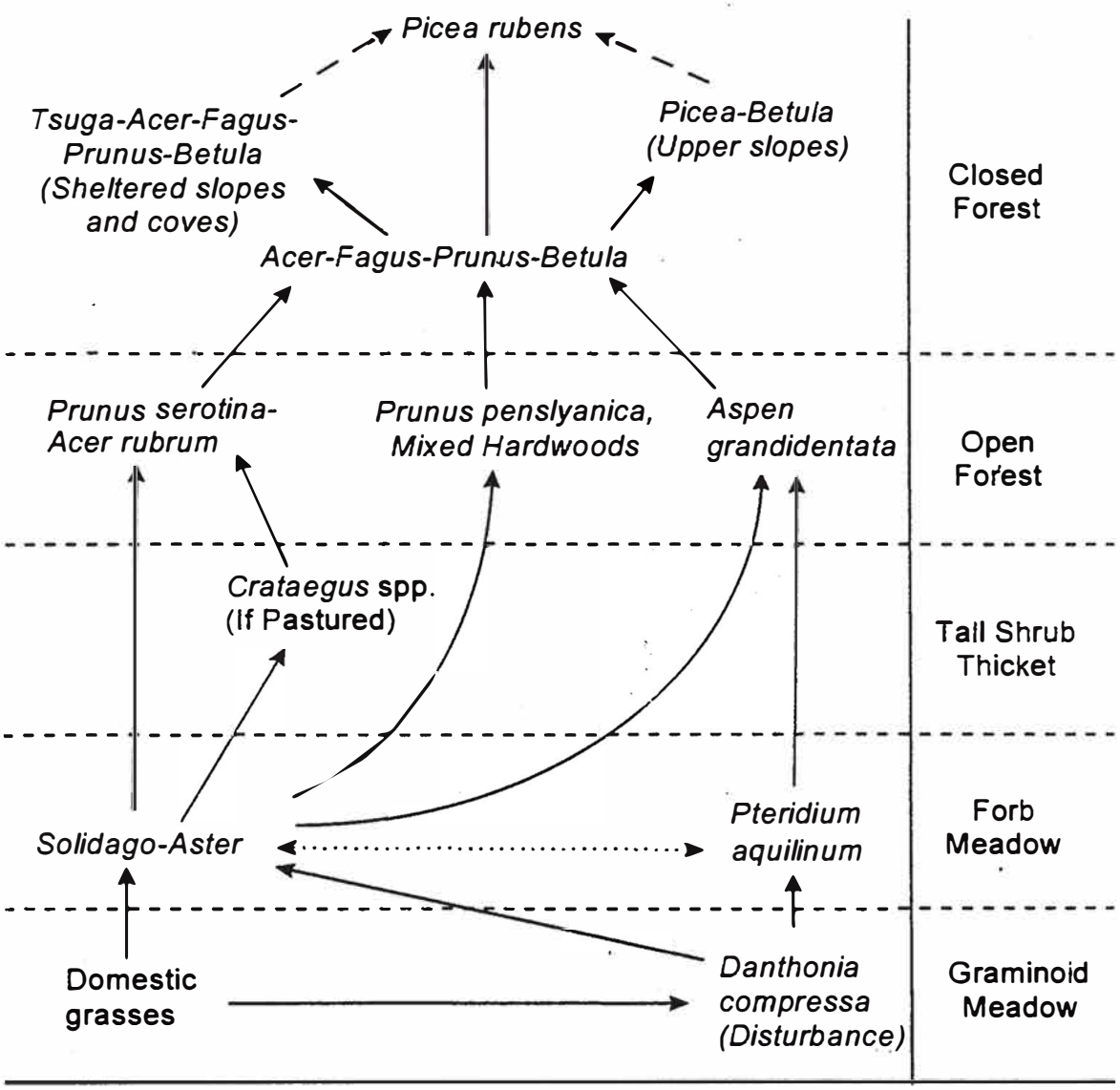

Figure 2. Secondary plant succession on well-drained to moderately well-drained sites in Canaan Valley, WV. Solid lines indicate apparent successional sequences and broken lines indicate probable sequences. A comma used to separate species or group of species indicates a loose association. Physiognomy and dominant life-forms are shown for each stage. Open forest stage may be scattered individuals or groves of hardwoods.

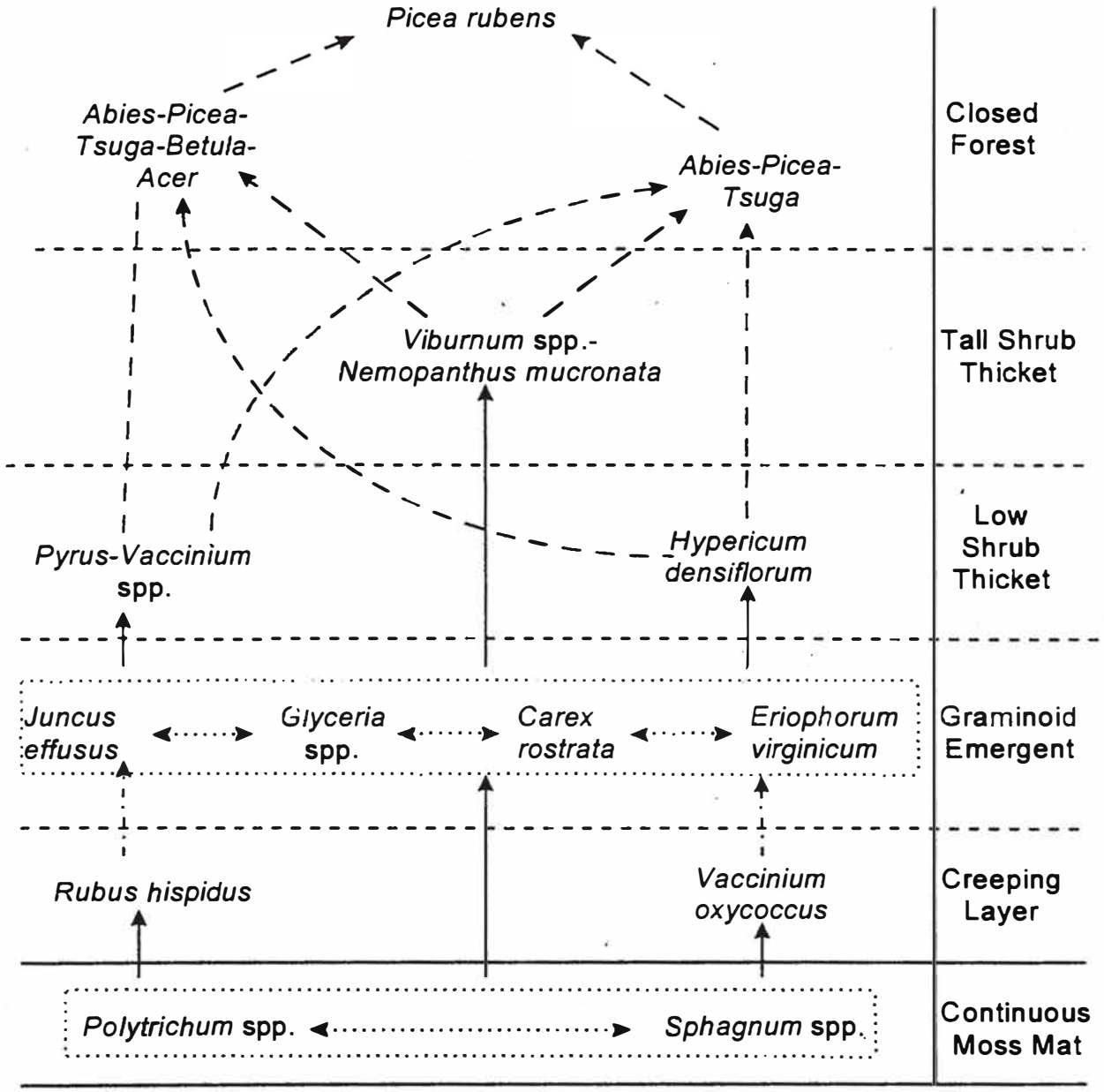

Figure 5. Secondary plant succession on wet organic soils in Canaan Valley, WV. Solid lines indicate apparent successional sequences, broken lines indicate probable sequences, dotted lines indicate a gradation may occur between two communities, and mixed lines indicate possible inverted sequence. Physiognomy and dominant life-forms are shown for each stage.

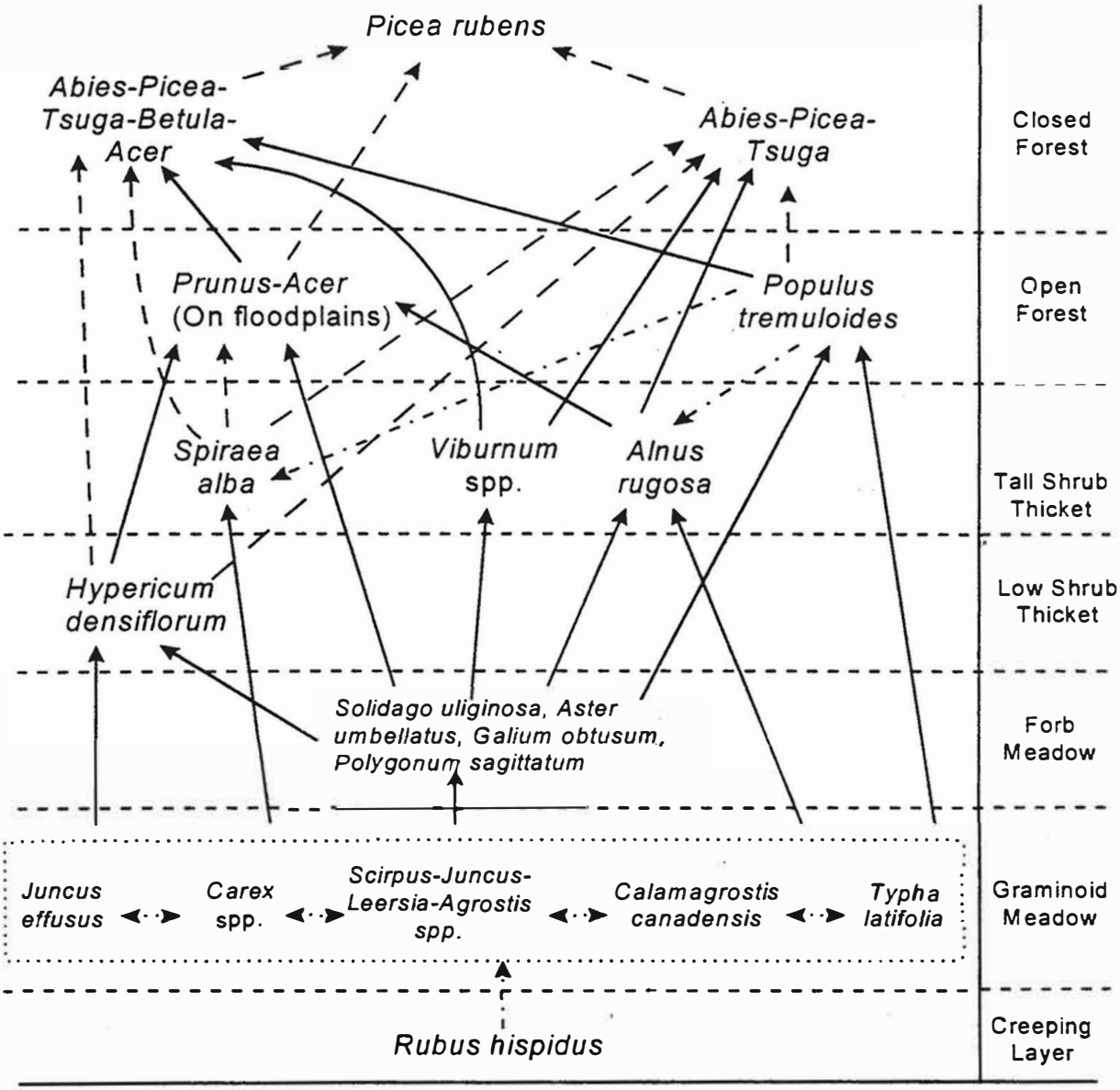

Figure 4. Secondary plant succession on wet mineral soils in Canaan Valley, WV. Solid lines indicate apparent successional sequences, broken lines indicate uncertain sequences, dotted lines indicate a gradation may occur between two communities, and mixed lines indicate a possible inverted sequence. A comma between species means any combination is possible; a hyphen means regularly occurs together. Physiognomy and dominant life-forms are shown for each stage.

Grazing, in general, results in the reduction in the population of the most palatable species and an increase in the proportion of less palatable species (Daubenmire, 1968). Evidence for the effects of this selective pressure induced by grazing is best exemplified in Canaan Valley by the success of hawthorn (*Crataegus* spp.) populations. Dense to moderately dense stands of hawthorn occur mainly where there has been sustained heavy grazing pressure.

Less dramatic has been the increased abundance of such forbs as thistles, everlastings, and goldenrods in response to selective foraging. Since 1975, the deer populations in the watershed have been high, with ostensible impacts, including browse lines. Preliminary observation in 1997 indicated that sustained heavy deer browsing may be causing a decrease in the species diversity in some areas as deer feed on the most palatable species. Deer browsing may also be influencing the rate of old field succession in the valley as well. Most old fields with well-drained soil that were mapped in 1975 remain open in 1997, with limited shrub or tree invasion.

The pattern of secondary plant succession on bare mineral soils on upland sites is similar to succession for abandoned pastureland once a graminoid stage is reached. Observations of successional trends on bare soil around gas well sites and on roadsides indicated that the pioneer stage is an aggregation of scattered, noncompeting species, including polytrichum moss, mountain oat-grass, red top, lichens, and various forbs. On most sites the trend following the influx of pioneers is for graminoid components to become increasingly important. Mountain oat-grass becomes dominant on most sites, although in localized areas red top stands may develop.

The present northern hardwoods forest type has to be considered as a subclimax community in view of the original red spruce forest which existed here before the logging era. It is evident from comparisons made between the USDA black and white 1945 and 1969 aerial photos and the 1989 color photos, plus ground truthing efforts in 1996 and 1997, that the amount of area invaded by hardwood communities has increased markedly since 1945, especially on the surrounding mountain slopes and on the Pocono Ridge in the center of the valley. On-site observations of hardwood stands suggest that the northern hardwood forest type will be a relatively long-lived successional stage because of the high reproductive potential of its canopy dominates and the paucity of red spruce pioneers. Even though Canaan Valley and adjacent upland areas were in the past, and may still be, macro climatically and topoclimatically suited to support a red spruce forests, the displacement of the northern hardwood community by a red spruce community on the uplands will take hundreds and perhaps thousands of years, if such displacement ever occurs. However, there is evidence that browsing pressure from deer may be reducing recruitment of hardwood species (Fortney unpublished data).

The fact that a red spruce forest has not regenerated on most upland sites since the original forest was devastated by lumbering and fire appears related to two main factors: first, unsuitable substrate for seedling survival and second, competition with

already established hardwood species. According to Fowells (1945) adequate moisture is the chief factor controlling red spruce regeneration; further, natural reproduction of red spruce is dependent upon factors determining seedling survival rather than on requirements for germination. The re-establishment of a red spruce forest in Canaan Valley may, therefore, depend, at least in part, upon the redevelopment of a moist soil substrate with deep humus and litter to nurture red spruce seedlings. However, even with optimum edaphic conditions, the heavy shade-producing hardwood forests which currently prevail in the valley may have a dominating effect. Fowells (1965) concluded that competition for red spruce pioneers comes chiefly from heavy shade-producing hardwoods, like beech and maple, and that although understory trees of red spruce will live in dense shade for many years, "they require nearly full light for best development." Since 1945, the red spruce stands on the surrounding mountain rims of Canaan Valley have shown some evidence of encroachment into hardwood stands lower on the slopes, but this advancement has been quite localized, probably in stands in which canopy closure had not occurred.

The ecotonal, transitional vegetation types which have developed in some areas between old fields and hardwood forests may also be related to past grazing pressures by cattle and present grazing pressures from deer. Characteristic of such ecotones are scattered groves of hardwood tree species; including black cherry, beech, and sugar maple; and the peninsular extensions of northern hardwood stands into the fields. This pattern is particularly common at the base of Cabin Mountain and on the Pocono Ridge in the center of the Valley.

The re-establishment of forested communities in the wetland areas of the valley in which red spruce is one of three or four major canopy species, however, is apparently successful in areas which have not been repeatedly disturbed by agricultural practices or by beaver activity (cutting and flooding). Conifer and conifer-hardwood swamp forests have developed in which red spruce is a co-dominant in varying proportions with balsam fir, hemlock, red maple, and yellow birch; but only locally is red spruce the dominant member in any forested stand in palustrine habitats.

It is important to mention that Allard and Leonard (1952) noted that oak (*Quercus* spp.), hickories (*Carya* spp.), cucumber tree (*Magnolia accuminata*), tuliptree (*Liriodendron tulipifera*), sassafras (*Sassafras albidum*), and black locust are entirely lacking in the valley. With the exception of the hickories, all of these trees were found by Fortney in 1975 and persist in 1997. Although infrequent throughout, the tuliptree and the cucumber tree are locally abundant on some moist slopes of Canaan Mountain and on Middle Ridge between Club Run and the Canaan Valley State Park golf course road. Apparently, Allard and Leonard did not make extensive observations in this part of the valley, since many large trees of red oak (*Quercus rubra*) and white oak (*Q. alba*) are present in the extreme southern end of the valley. Black locust and sassafras continue to be minor species in the valley, represented only by small stands in abandoned fields in southern sections.

The forest tree species listed by Allard and Leonard (1952) as absent in Canaan Valley are common components of many mixed hardwood forests at lower elevations in Tucker County. The infrequent occurrence or absence of many species is undoubtedly related to such limiting factors as unusually low temperatures and migration barriers imposed by the surrounding mountains. For instance, the restriction of some species to the southern end of the valley is probably related to their entry through the low gaps between Canaan Mountain and Middle Mountain and between Cabin Mountain and Middle Mountain. Many of the hardwoods noted as being restricted chiefly to the southern end of the valley are found in abundance on the south-facing slopes of the Red Creek drainage basin which adjoins these gaps.

Shrub-dominated communities on the upper slopes of Cabin, Brown, and Canaan Mountains have progressively declined in area since 1945. Once widespread, communities in which various heaths, mountain holly, mountain ash, fire cherry, and add mixtures of various hardwood species are now restricted chiefly to sites with poor soils or to areas frequently exposed to severe weather conditions. Many of these types are associated with the open, grass bald type communities that occur on upper slopes, particularly on Cabin Mountain.

The persistence of grass balds on the windswept Cabin Mountain has been evaluated by Fortney (1975) and by Rentch and Fortney (1997). Early descriptions of the Canaan Valley-Dolly Sods region in the 1700s include references to grassy areas on mountaintops. Bald Knob near the southern most extent of Cabin Mountain was one of these naturally open, grassy meadows. Grass balds in the southern Appalachian Mountains, similar in appearance to those on Cabin Mountain, have been studied by many researchers, including Mark (1958) and Wells (1961). These authors and others have speculated that the cause of origin and maintenance of these treeless areas can be either natural or the result of human impacts. Among the natural factors which have been mentioned are climatic, edaphic, biotic, and pyric forces. Rentch and Fortney (1997) compared the vegetation of the grass balds in West Virginia, including the one on Bald Knob and others farther north on Cabin Mountain, to those in the southern Appalachians. The West Virginia balds, while they appear to have many similarities in their physical site characteristics and the appearance of their vegetation, have several noticeable distinctions. Although many of the same genera are shared by balds in both regions, their species compositions are dissimilar, and unlike the West Virginia balds, the southern Appalachian balds are not restricted to occurring only on west and southwest-facing slopes that are repeatedly exposed to damaging ice, snow, and wind. The meadows that persisted on Cabin Mountain since the logging era and studied by Fortney (1975) and Rentch and Fortney (1997), show some change during this 22 year period. Mountain oat-grass is not as dominant as it was in 1975; and there appears to be increased shrub invasion by blueberries. However, invasion by hardwood species is still limited.

Bottomlands (Palustrine)

The vegetation in palustrine habitats in Canaan is much more varied than that in the upland areas in respect to distributional patterns and diversity of vegetation types. This is mainly a reflection of the greater variety of habitat types, principally variations in edaphic conditions and hydrologic regimes.

The distribution of vegetation types in palustrine areas often correlates closely with the distribution of soil types, and in some instances, the boundary of a community corresponds closely to the limits of a soil type on which it occurs. This is best exemplified by polytrichum and sphagnum moss bogs, which are confined to Muck and Peat and Blago soils and which are delimited by the extent to which the organic substrate is developed. However, such communities as pipestem thickets, glade St. John's-wort thickets, and quaking aspen groves occur on a wide range of edaphic conditions, from moderately well-drained to very poorly drained soils. The distribution of these communities is more closely correlated with the availability of recently disturbed non-forested habitats rather than with the distribution of specific soil types.

While the extent and frequency of quaking aspen groves have decreased since 1975, they remain an important plant community on poorly drained mineral soils on the valley floor. Many of the extant quaking aspen groves, however, are in states of decline, with the old, larger trees in the center of the colonies dead or dying. Many are being invaded by speckled alder and pipestem. Like bigtooth aspen, quaking aspen requires disturbance to become established. Generally, there have been few disturbances in recent years that would open good seed beds for quaking aspen; certainly, wild fires have been few.

On-site observations of pipestem and glade St. John's-wort thickets suggest that these communities will be rather long-lived non-forested seres. Trees were observed by Fortney in 1975 to occur only very rarely in these communities. Observation made during ground truthing work for the current study indicate that these stands may be more temporal than originally projected in 1975. Such thickets appear to persist by virtue of their dense growth, with the heavy shade-producing overstory preventing the establishment of tree species in the thickets. Some stands sampled by Fortney in the 1970s and re-examined during this study appeared to have lost some of their vigor , with scattered dead or dying individuals plants. However, the rate and direction of change is not obvious at this time.

Additional plant communities, speckled alder thickets and graminoid-dominated wet meadow such as bluejoint grass meadows, appear to persist as seres as result of external physical factors. Such communities appear to develop and are maintained as a result of frequent overbank flow from nearby streams.

Another important factor influencing the development and distribution of vegetation types on floodplains of most steams in the valley is the disturbances

resulting from beaver activities. Beavers were native to Canaan Valley but were extirpated in the early 1900s. They were reintroduced into the area in the 1930's. Since this time their population has increased dramatically. The current extent to which wet meadow communities are developed is directly related to the damming actions of beavers. Wherever the soils of thickets and swamp forests are partially inundated or waterlogged by beaver ponds, retrograde succession to wet graminoid-dominated meadows occur, or where completely inundated, the whole process of primary succession starts anew with aquatic communities. Many mixed conifer-hardwood forests and conifer forests along Glade Run, Mill Run, Little Blackwater River, and Blackwater River have been eliminated as a result inundation from beaver ponds. This was the conclusion by Fortney in 1975. Many additional stands have been flooded and destroyed since 1975. Following persistent inundation, forests may be destroyed in a relatively short period of time. Swank (1949) reported that the length of time to "water-kill" hemlock, red maple, red spruce, and yellow birch is from one to two years for speckled alder, two to four years, and for balsam fir one to three years. If the present population of beavers in Canaan Valley is not greatly reduced in the near future, a larger proportion of the swamp forests will be destroyed, as many new beaver dams will be constructed and will result in the flooding of more swamp forests. Further, repeated beaver activity is preventing the reestablishment of these forest types. Conifer and mixed conifer-hardwood forests are the only communities occurring on the valley floor today which resemble the original red spruce forest.

One of the most diverse and complex vegetation patterns in the valley occurs on wet terrace lands located near the boundary of the wetlands with the bases of the surrounding mountain slopes. Here surface and subsurface drainage systems carrying water down the mountain slopes, forming on the valley floor a general pattern of parallel streams and wetlands alternating with somewhat better drained alluvial fans or terraces. The plant communities in these areas, which include bogs, marshes, and old fields, are aligned in a similar pattern, with their major dimensions perpendicular to the axes of the adjoining mountains; similar vegetation patterns are found commonly through the Valley along the many interfaces of uplands with wetlands.

Bogs, which are cold peatlands, are a major palustrine habitat type in the valley. The total area of bog habitat in Canaan, about 1000 ha, is larger than the combined area of all the other bogs in West Virginia.

Dacknowski (1921) considered two classes of bogs based on their origin: 1) land-laid peat deposits, developing on moist flat land under conditions of raising or fluctuating water levels and 2) water-laid peat deposits, developing in depressions occupied by standing water. Except for a few small bogs which have formed in long-lived beaver ponds, the bogs in Canaan Valley seem to be land-laid bogs, developing behind the natural levees that have been deposited along the mainstem of the Blackwater River and its major tributaries in the northern section. The largest bogs are behind levees along the Blackwater and Little Blackwater Rivers.

There is ample evidence to suggest that bog forests (forested wetlands with peat substrates) were the pre-logging vegetation cover of the present open bog areas. This is confirmed by the presence of persistent stumps and logs in many bogs today and the persistence of peat deposits. Current peat deposits are up to about four meters deep in a bog near the confluent of the Blackwater and Little Blackwater Rivers.

The current vegetative cover of bogs is diverse in terms of the dominant species. Bogs with persistently high watertables generally have sphagnum moss as the predominant ground cover, with such graminoid species as cottongrass and *Juncus acuminatus*, and common rush as important emergents. Bogs with a water table that drops below the surface during much of the growing season will characteristically have haircap moss as the predominant ground cover and more forb species, e.g., tea berry, vervain thoroughwort, and cinnamon fern. Many such bogs will also have a well developed shrub layer that includes black chokeberry, velvet-leaf blueberry, black alder, wild raisin, and a wide spreading creeping layer of creeper dew berry (*Rubus hispidus*), snowberry (*Gaultheria hispidula*) and large cranberry. These species can occur in varying combinations or in near monotypic communities. There are several bogs or sections of bogs in the northern end of the valley where shrub invasion is significant.

Tree invasion in bogs is rare. Fortney reported few trees in bogs in 1975; there was little change in 1997. Those that were observed, which included red maple, balsam fir, and red spruce, had stunted growth forms and generally appeared stressed. Forest invasion in the bogs in Canaan, therefore, appears to be a slow process, even though a forested community existed there less than a 100 years ago. It is likely that the present herbaceous and shrub-dominated vegetation will be a long term plant cover. The fact is that after nearly 100 years of succession, virtually no tree invasion has occurred. One reason for this may be that the overall water level in bogs during the growing season may have been higher since the forest cover was removed and evapotranporation rates lowered. Another factor may be nutrient availability. Nutrient availability in bogs is generally low (Smith 1996). The bog forests were essentially clear-cut and a large portion of the nutrients base supporting these forests was probably substantially removed with the timber. Therefore, there may not be the required nutrient availability needed to support a high standing crop of a mature red spruce forest.

There is some evidence of small changes in species composition since 1975. In the 1997 field work in Canaan, many new stands of large cranberry and sundew (*Drosera rotundifolia*) were observed. Previously, these species were very infrequently observed.

Another change is the pervasiveness of dew berry in a variety of habitats, from peat bogs to upland old fields. This species has increased in frequency and importance in several areas. It has long been a characteristic member of the creeping layer in bogs. Since 1975, its importance appears to have increased in graminoid-forb meadows and in some speckled alder thickets, along with its frequency in forb-

dominated old fields. As shown in Figures 3, 4 and 5, it appears in a variety of vegetation types.

Other changes in the vegetation of emergent palustrine wetlands have been tracked since the 1945 aerial photos were flown. A significant and dynamic emergent species in bogs is the sedge *Carex rostrata*, which characteristically grows in circular colonies. Though underground rhizome growth, this species can spread quickly throughout a bog. Since 1945, numerous new colonies have developed. In some cases, two or more colonies appear to have merged or grown together to form extensive stands. Colonies, which can exceed 50 m in diameter, can also disappear within 20 years. Another sedge, *Carex stricta*, which occurs frequently on mineral substrates on floodplains, is a less frequently colonizer in bogs.

Palustrine wet meadows appear to be the most rapidly changeable wetland communities in the valley. Depending on the hydrologic regime and the degree of physical disturbance from beaver activity and overbank flow, these communities may quickly appear or disappear. They are often invaded by speckled alder or pipestem or by a combination of both shrubs.

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