DRAFT

Southern Appalachian Spruce-Fir Bibliography: September 19, 1987

Adams, H.S., S.L. Stephenson, T.J. Blasing, and D.N. Duvick. 1985. Growth trend declines of spruce and fir in mid-Appalachian supalpine forests. Environmental and Experimental Botany 25: 315-325.

SUBJECT KEYWORDS
tree growth, forest decline

RANGE OF COMMUNITIES
spruce-fir

GEOGRAPHIC SCOPE
Mt. Rogers, West Virginia, Virginia

TYPE OF INFORMATION
quantitative

QUANTITATIVE TOPICS
tree growth & forest decline

Notes for Adams, et al. (1985)

This study examined the decline in growth rates of spruce and fir trees in Virginia and West Virginia, and the possibility that climatic factors were responsible. 258 trees were cored at 10 sites, including Mt. Rogers, and ring widths were measured. When the effect of the normal decline in growth with aging was removed from the data, a clear decline in growth was still evident, becoming steeper around 1965. A predicted growth index derived from regressions of climatic data was subtracted to remove the effect of normal climatic fluctuations. A decline in growth is still visible, beginning at different times in different places. Correlations of growth index with the Palmer drought severity indices varies, being high in the 1960's when severe drought and growth declines corresponded, and being negative in the early 1970's when the drought ended but growth continued to decline. This continued decline suggests ongoing stress. In West Virginia, spruce growth recovered after the drought and began declining again around 1975. Although climate cannot be ruled out because the initial growth decline corresponded to a drought, other factors such as air pollution seem likely causes.

DRAFT

Affeltranger, C.E., and J.D. Ward. 1970. Evaluation of Fraser fir mortality on the Moses Cone Memorial Park, National Park Service, North Carolina. USDA Forest Service, Division of State and Private Forestry, Southeastern Area. Report No. 71-1-8.

SUBJECT KEYWORDS
BWA spread, disease

RANGE OF COMMUNITIES
plantation

GEOGRAPHIC SCOPE
Moses Cone Park

TYPE OF INFORMATION
qualitative

QUANTITATIVE TOPICS

Notes for Affeltranger and Ward (1970)

This report gives results of an evaluation of a Fraser fir plantation in Moses Cone Park on the Blue Ridge Parkway. Many trees were dead or dying in the 60-year-old plantation and other plantings in the park. The survey found a light infestation of balsam woolly adelgid and infection with Fomes annosus root rot. No means of direct control of Fomes exists. The balsam woolly adelgid is deemed a more serious threat and spraying is recommended.

The concept of pathological rotation, the age at which a stand breaks up from disease, is discussed. For balsam fir it has been found to be 60-90 years. This plantation may be reaching its pathological rotation age.

Aldrich, R.C. and A.T. Drooz. 1967. Estimated Fraser fir mortality and balsam woolly aphid infestation trend using aerial color photography. Forest Sci. 13: 300-313.

SUBJECT KEYWORDS
BWA infestation levels, study methods

RANGE OF COMMUNITIES
spruce-fir, northern hardwoods

GEOGRAPHIC SCOPE
Black Mtns.

TYPE OF INFORMATION
quantitative

QUANTITATIVE TOPICS
BWA infestation levels & study methods

Notes for Aldrich and Drooz (1967)

Results of a study testing a method of estimating fir mortality on aerial photographs. The forests (fir, spruce-fir, and spruce-fir-hardwoods) were inititally visually stratified into 5 mortality classes. These were then sampled by systematically located plots on the aerial photos. Dead fir and total spruce and fir were counted. 30 of the photo plots were also located and sampled on the ground with systematically located point samples, measuring tree size and infestation levels as well as total numbers live and dead. The photo estimates were corrected with linear regressions of the relationship between photo and ground measurements.

The photo sampling was repeated in 1960-1963 to estimate the trend in mortality. In 1960 there were 13.9+-.8 trees/acre dead. This increased to 21.3+-1.0 in 1963.

Calculations showed the stratified sample was 3 times as efficient as a simple random sample would have been.

Quantitative data evaluation record for
Aldrich and Drooz (1967)

TOPIC

BWA infestation levels & study methods

METHODS

215 1 acre plots systematically located on aerial photos of the Black Mtns., stratified by 5 classes of infestation. Live spruce and fir, and dead fir, were counted on the photos. 30 photo plots were located on the ground and sampled by point sample methods--10 regularly located points in a 1 acre square. Regressions between ground & photo values used to correct photo counts.

NUMBER OF SAMPLES: 215 PERMANENT PLOTS:

DATA PRESENTED

Plot of a BWA infestation index and fir mortality index for the years 1960-1964, showing trend. Graph comparing adjusted photo estimates with ground measurements of fir mortality. Mean and std. error of fir mortality and total spruce and fir for the 3 forest types in 1960. Mean and std. error of number of dead fir and live spruce & fir, in each of the mortality strata, in each forest type, in 1960. %, mean, and std. error of trees/acre dying each year 1960-1963. Number of photo plots needed to estimate mean mortality within specified limits.

Alexander, W.C. 1970. An avifaunal strip census on Grandfather Mountain. M.A. Thesis, Appalachian State Univ., Boone, NC. 24 pp.

SUBJECT KEYWORDS
vertebrate fauna

RANGE OF COMMUNITIES
general southern Appalachian

GEOGRAPHIC SCOPE
Grandfather Mtn.

TYPE OF INFORMATION
quantitative (no form)

QUANTITATIVE TOPICS

Notes for Alexander (1970)

Nineteen sampling stations were established along a trail up Grandfather Mountain in North Carolina, from 4400-5800 ft. elev. The trail was sampled weekly from April 11, 1969 to Nov. 25, 1969. Five habitat types, including spruce-fir and two transition areas containing red spruce, were defined based on vegetation. Tabulated data included total count of birds by species and habitat type.

Amman, G.D. 1961. Predator introductions for control of the balsam woolly aphid on Mt. Mitchell, North Carolina. USDA, Forest Service, Southeast. Forest Experiment Station, Research Note 153.

SUBJECT KEYWORDS
BWA control, exotic animals

RANGE OF COMMUNITIES
spruce-fir
GEOGRAPHIC SCOPE
Black Mtns.
TYPE OF INFORMATION
quantitative (no form)
QUANTITATIVE TOPICS

Notes for Amman (1961)

Describes initial efforts to establish foreign predatory insects for the control of the balsam woolly adelgid. A table gives the number of each species released on Mt. Mitchell in 1959 and 1960. A total of 6 species from Germany, Australia, and New England was released on Mt. Mitchell at this time. The 2 species introduced in 1959 had completed their life cycles and over-wintered. It was too early to tell about those released in 1960.

Amman, G.D. 1962. Seasonal biology of the Balsam Woolly Aphid on Mt. Mitchell, North Carolina. J. Econ. Entomol. 55: 96-98.

SUBJECT KEYWORDS
BWA life cycle

RANGE OF COMMUNITIES
spruce-fir
GEOGRAPHIC SCOPE
Black Mtns.
TYPE OF INFORMATION
quantitative
QUANTITATIVE TOPICS
BWA life cycle

Notes for Amman (1962)

Describes life history of balsam woolly adelgid on Mt. Mitchell. Egg hatches into 1st-instar nymph, the only mobile stage. Nymph inserts its stylet and enters diapause. Insect overwinters in this stage; in summer diapause lasts 2-8 weeks. On resuming development it goes through 3 nymphal instars and then becomes an adult.

Field samples of plots of bark showed that some adelgids went through 3 generations in a year. 11 out of 51 second generation progeny completed a third generation; the rest stayed in 1st-instar diapause over winter.

Quantitative data evaluation record for
Amman (1962)

TOPIC

BWA life cycle

METHODS

Studied adelgids at Mt. Mitchell. 3x3 in. areas of bark on moderately infested trees surrounded by Tanglefoot to keep out new nymphs. Presence of different life cycle stages observed. Other areas scraped free of adelgids and young adelgids introduced, to distinguish 2nd and 3rd generation. Additional bark samples taken to count numbers of different stages.

NUMBER OF SAMPLES: PERMANENT PLOTS:

DATA PRESENTED

Figure of % of each stage, by week.

Dates of first appearance of eggs of each generation and number of insects completing a third generation are discussed.

Amman, G.D. 1966. Aphidecta obliterata (Coleoptera: Coccinellidae), an introduced predator of the Balsam Woolly Aphid, Chermes piceae (Homoptera: Chermidae), established in North Carolina. J. Econ. Entomol. 59: 506-508.

SUBJECT KEYWORDS
BWA control, exotic animals

RANGE OF COMMUNITIES
spruce-fir
GEOGRAPHIC SCOPE
Black Mtns.
TYPE OF INFORMATION
qualitative
QUANTITATIVE TOPICS

Notes for Amman (1966a)

Describes results of introduction of a European beetle, Aphidecta obliterata, to control the balsam woolly adelgid on Mt. Mitchell. Introduction apparently in 1960. Pupae and adults found in 1962, 63, and 64. They stay in tree crowns and are not visible on the tree boles. No attempts were made to determine their effectiveness in aphid control.

Amman, G.D. 1966. Some new infestations of the Balsam Woolly Aphid in North Carolina, with possible modes of dispersal. J. Econ. Entomol. 59: 508-511.

SUBJECT KEYWORDS
BWA spread

RANGE OF COMMUNITIES
spruce-fir

GEOGRAPHIC SCOPE
Great Smoky Mtns., Roan Mtn., Grandfather Mtn.

TYPE OF INFORMATION
qualitative (some figures)

QUANTITATIVE TOPICS

Notes for Amman (1966b)

Reports on studies of new infestations at Mt. Sterling in the Smokies, Roan Mountain, and Grandfather Mountain. The Mt. Sterling infestation covered 15-30 acres, with >45 dead trees in 1963. One tree had 6 rings of red wood, suggesting it may have been infested before 1958.

The Roan Mountain infestation was first reported in 1962, with additional scattered spots found in 1964. One tree had 6 rings of red wood, suggesting infestation since 1958.

The Grandfather Mountain infestation began in 1959. It presently covers 160 acres but has only killed 30 scattered trees. One tree had 5 red rings, suggesting infestation since 1959.

Scattered infestations at all 3 sites suggests wind dispersal as the mode of invasion.

Amman, G.D. 1967. Effect of minus 29 F on overwintering populations of the Balsam Woolly Aphid in North Carolina. J. Econ. Entomol. 60: 1065-1066.

SUBJECT KEYWORDS
BWA response to environment

RANGE OF COMMUNITIES
spruce-fir

GEOGRAPHIC SCOPE
Black Mtns.

TYPE OF INFORMATION
quantitative

QUANTITATIVE TOPICS
BWA response to environment

Notes for Amman (1967)

In January 1966 a temperature of -29 F was recorded at 6200 ft. on Mt. Mitchell. The overwintering 1st-instar nymph of the balsam woolly adelgid had been found to be killed by temperatures below -30 F. This paper reports results of population surveys done in March at Clingmans peak (6500 ft.) and Commissary Ridge (6200 ft.) to examine the effect of the cold. Five trees at each site were felled and bark samples taken at 5 heights in all cardinal directions. 58% of the nymphs on Commissary Ridge and 50% on Clingmans Peak were dead. This compares with 34% dead in 1964, when the lowest temperature was -16 F.

Quantitative data evaluation record for
Amman (1967)

TOPIC

BWA response to environment

METHODS

In 1964 sampled 10 trees on Commissary Ridge (Mt. Mitchell). Cut 4 1/2 in. bark pieces at 2 1/2, 3 1/2, 4 1/2, and 5 1/2 feet above ground and counted live and dead BWA nymphs in diapause. In 1966 sampled 5 trees each at Clingman's Peak and Commissary Ridge. Cut 1/2 in. bark samples at 1, 5, 10, 15, 20 ft. above ground in 4 cardinal directions. Count live and dead nymphs.

NUMBER OF SAMPLES: 20 PERMANENT PLOTS:

DATA PRESENTED

Table of number of nymphs dead and alive, and % mortality, for each tree, in 1964 and 1966.

Amman, G.D. 1966. A study of the native predators of the Balsam
Woolly Aphid, Chermes piceae Ratz. (Homoptera: Chermidae),
in North Carolina. PhD. Dissertation, Univ. of Michigan.

SUBJECT KEYWORDS
BWA life cycle, BWA response to environment

RANGE OF COMMUNITIES
none
GEOGRAPHIC SCOPE
Black Mtns.
TYPE OF INFORMATION
quantitative (no form)
QUANTITATIVE TOPICS

Notes for Amman (1968a)

This dissertation was not examined, but apparently reports on Balsam Woolly Adelgid studies published in Amman (1968b), Amman (1970b), Amman (1970c), and possibly other papers.

Balsam Woolly Adelgid eggs and recently hatched larvae were subjected to various experimental conditions of temperature and humidity, as well as additional treatments including immersion and periodic dessication.

Results and methods are described in the published papers. Additional data from these studies may also be included here.

Amman, G.D. 1968. Effects of temperature and humidity on development and hatching of eggs of Adelges piceae. Annals Entomol. Soc. America 61: 1606-1611.

SUBJECT KEYWORDS
BWA life cycle, BWA response to environment

RANGE OF COMMUNITIES
none
GEOGRAPHIC SCOPE
Black Mtns.
TYPE OF INFORMATION
quantitative
QUANTITATIVE TOPICS
BWA response to environment

Notes for Amman (1968b)

This study, which was part of the author's dissertation (Amman 1968a), examined the effect of various laboratory temperature and humidity conditions on egg survival, development time, and larval survival of the balsam woolly adelgid. Eggs were subjected to combinations of constant temperature (7-35 C) and 75, 98, and 100% humidity. Other treatments included immersion in water for 2-7 days, periodic dessication, and exposure to outdoor freezing temperatures. The minimum temperature that allowed development and hatching was 5-7 C, but partially developed eggs hatched below 5 C. 100% humidity slowed development but there was little difference between 75 and 98%. Fewer eggs hatched at the extremes of the temperature range. Humidity was important primarily at extreme temperatures. Immersion in water had no effect on hatching. Dessication effect varied with time it occurred and subsequent conditions. Freezing caused little effect until the temperature reached -13 C. Hatched larvae survived longest at low humidity. The optimum conditions, considering both egg and larva, are 75% humidity and 15 C. This occurs on Mt. Mitchell in July and August.

Quantitative data evaluation record for
Amman (1968b)

TOPIC

BWA response to environment

METHODS

Collected overwintering BWA larvae in the field, used their eggs laid in the lab. Subjected 50-egg groups to combinations of constant temperatures (7-35 C) and humidities (75, 98, or 100%). Observed development time of eggs and survival time of hatched larvae. Subjected various sized groups of eggs to immersion in water, periodic dessication, and freezing temperatures.

NUMBER OF SAMPLES: PERMANENT PLOTS:

DATA PRESENTED

Mean and std. dev. of development time at each temperature and humidity combination. Plot of development time vs. temp. at 75% humidity. % hatching at each temp. and humidity combination. % of fresh and partially developed eggs hatching after freezing. Plot of percentage of development each day vs. temperature for 3 humidities. Bar graph of longevity of larvae at different temperatures at 75% and 98% humidity.

Results of dessication and immersion treatments are discussed in the text.

Amman, G.D. 1970. Distribution of redwood caused by the balsam woolly aphid in Fraser fir in North Carolina. USDA, Forest Service, Res. Note SE-135.

SUBJECT KEYWORDS
BWA effect on fir

RANGE OF COMMUNITIES
spruce-fir
GEOGRAPHIC SCOPE
Black Mtns., Roan Mtn.
TYPE OF INFORMATION
quantitative
QUANTITATIVE TOPICS
BWA effect on fir

Notes for Amman (1970a)

This study examined live and dead Fraser firs infested with balsam woolly adelgid. Trees were felled and sectioned to examine distribution of red wood. The height of the first red ring, indicating first infestation, was related to tree height. The number of red rings was related to tree dbh, with larger trees living longer before succumbing. All trees were dead by 6 years after infestation.

Quantitative data evaluation record for
Amman (1970a)

TOPIC

BWA effect on fir

METHODS

Sampled at Mt. Mitchell and Roan Mountain. Felled 12 live infested firs and 15 dead firs and cut sections every 5 feet. Observed height at which first red ring appeared. Did regression of height of first red ring and number of red rings (years of infestation before death) on tree height and dbh.

NUMBER OF SAMPLES: 27 PERMANENT PLOTS:

DATA PRESENTED

Plots, correlation coefficients, and regression equations for height of first red ring vs. tree height and dbh, and number of red rings vs. tree dbh.

Amman, G.D. 1970. Field keys to predators of the Balsam Woolly Aphid in North Carolina. USDA, Forest Service, Res. Note SE-145.

SUBJECT KEYWORDS
BWA control, invertebrate fauna

RANGE OF COMMUNITIES
spruce-fir
GEOGRAPHIC SCOPE
North Carolina
TYPE OF INFORMATION
taxonomic key
QUANTITATIVE TOPICS

Notes for Amman (1970b)

Contains a key to predators of the adelgid--13 insect larvae, 4 mites, and 2 slugs.

Amman, G.D. 1970. Phenomena of Adelges piceae populations (Homoptera: Phylloxeridae) in North Carolina. Ann. Entomol. Soc. Amer. 63: 1727-1734.

SUBJECT KEYWORDS
BWA effect on fir, BWA control, BWA response to environment

RANGE OF COMMUNITIES
spruce-fir
GEOGRAPHIC SCOPE
Black Mtns.
TYPE OF INFORMATION
quantitative
QUANTITATIVE TOPICS
BWA effect on fir & BWA response to environment & BWA control

Notes for Amman (1970c)

This study examined balsam woolly adelgid populations and mortality at Mt. Mitchell. 10 trees were sampled, with bark plugs collected periodically to count populations. Predators were censused on the bark. Host tree condition was the main factor determining adelgid population levels. Trees growing faster before infestation later supported more adelgids than less vigorous trees. Adelgids apparently modify the bark to make it more favorable to higher populations. At the peak of infestation, survival and fertility are positively correlated with number of adelgids present. Later the outer bark dies and adelgids disappear.

The 12 predator species found were tested in the lab for the number of adelgid eggs they could consume. This information was multiplied by numbers found in the field to estimate number eaten in the field. The conclusion was that predation has a negligible effect on adelgid populations.

Weather, probably humidity, appeared to be the most significant factor affecting egg mortality. Cold is not a factor. Wind dispersal removes many crawlers.

Quantitative data evaluation record for
Amman (1970c)

TOPIC
BWA effect on fir & BWA response to environment & BWA contro
METHODS
Sampled 10 trees at Mt. Mitchell. Collected 16 12.7mm bark cores at random from each tree periodically through 2 seasons (3 generations). Counted adelgids present. Cored trees and measured radial growth. Counted predators of adelgids on 15.2 sq. dm areas of bark.
Observed number of adelgid eggs predators could eat in the lab.
NUMBER OF SAMPLES: 10 PERMANENT PLOTS:
DATA PRESENTED
Plots and linear regression of log % neosistens survival vs. present radial growth; of number of adults vs. tree radial growth before infestation; of log number of adults vs. log number of neosistens.
Table of number of individuals in each stage on each tree for each of the 3 generations.
Tables of the relative percentage of the different predator species, the number of eggs consumed by each, and the expected number of eggs eaten in field.

Amman, G.D., and C.F. Speers. 1964. Release of predators of the balsam woolly aphid in North Carolina. USDA, Forest Service, Research Note SE-32.

SUBJECT KEYWORDS
BWA control, exotic animals

RANGE OF COMMUNITIES
spruce-fir
GEOGRAPHIC SCOPE
Black Mtns.
TYPE OF INFORMATION
quantitative (no form)
QUANTITATIVE TOPICS

Notes for Amman and Speers (1964)

Describes results of attempts to control the balsam woolly adelgid by introducing foreign predators. A table gives the number of individuals of each species released. 15 species of insects from Germany, India, and Pakistan were tested in the lab or field in 1961-1963. Three species are listed as having been released in 1956-1960. [Amman (1961) listed 6 species]. Two species released in 1960, Aphidecta obliterata and Laricobius erichsonii, showed promise. They fed on the BWA and had persisted for several years. None of the species released later was recovered again from the site.

Amman, G.D. and C.F. Speers. 1965. Balsam woolly aphid in the southern Appalachians. J. Forestry 64: 18-20.

SUBJECT KEYWORDS
BWA spread, BWA life cycle, BWA effect on fir

RANGE OF COMMUNITIES
spruce-fir
GEOGRAPHIC SCOPE
Southern Appalachians
TYPE OF INFORMATION
qualitative
QUANTITATIVE TOPICS

Notes for Amman and Speers (1965a)

This article is a summary of information on the balsam woolly adelgid at that time. The initial history of infestation in the southern Appalachians is described. BWA had been found in the Black Mtns., Roan Mtn., Grandfather Mtn., and the Great Smoky Mtns. The completion of the Blue Ridge Parkway caused concern that cars could spread BWA to the remaining ranges.

The life history of the BWA, its effect on Fraser fir, and the possibilities of control are discussed. Examination of recently killed trees found 2-5 years were required for the tree to die, with large trees living longer. Benzene hexachloride successfully controls BWA but spraying is limited to Christmas trees and high value areas along roads. Several species of predators were introduced and successfully overwintered, offering some hope for biological control.

Amman, G.D., and C.F. Speers. 1965. Progress in biological control of the balsam woolly aphid in North Carolina. Southern Lumberman 211 (Dec. 15, 1965): 147-149.

SUBJECT KEYWORDS
BWA control, exotic animals

RANGE OF COMMUNITIES
spruce-fir
GEOGRAPHIC SCOPE
Black Mtns.
TYPE OF INFORMATION
qualitative
QUANTITATIVE TOPICS

Notes for Amman and Speers (1965b)

Describes efforts to control the balsam woolly adelgid by introduction of foreign predators in the Black Mountains. 20 species were introduced, beginning in 1959. 3 European species, Laricobius erichsoni, Aphidecta obliterata, and Aphidoltes thompsoni became established after release in 1959 and 1960. Laricobius showed enough promise that a pilot control test was done, with 12,000 beetles released at 1/2 mile intervals in the Black Mountains. Their populations had not increased sufficiently to observe any effect on the BWA. The other introduced species, mostly from India and Pakistan, failed to become established.

Amman, G.D., and C.F. Speers. 1971. Introduction and evaluation of predators from India and Pakistan for control of the balsam woolly aphid (Homoptera:Adelgidae) in North Carolina. Canad. Entomol. 103: 528-533.

SUBJECT KEYWORDS
BWA control, exotic animals

RANGE OF COMMUNITIES
spruce-fir
GEOGRAPHIC SCOPE
Black Mtns.
TYPE OF INFORMATION
qualitative
QUANTITATIVE TOPICS

Notes for Amman and Speers (1971)

Describes results of attempts to introduce predatory insects to control balsam woolly adelgid. 15 species of insects predatory on Adelges and Pineus spp. on spruce and fir in the Himalayas were collected. They were released on Mt. Mitchell in 1961-1965. The names of each and number released are given. Release included free release, free release after allowing time to mate, and placing in cages on infested firs. Attempts were made to collect the insects each year by examining trunks and by beating them out of felled tree crowns, but none of any species were ever recovered. The failure to establish may be due to the climate, which is colder than that in their native habitat, or to their failure to accept Fraser fir as an oviposition site.

Amman, G.D. and R.L. Talerico. 1967. Symptoms of infestation by the Balsam Woolly Aphid displayed by Fraser fir and bracted balsam fir. USDA, Forest Service, Res. Note SE-85.

SUBJECT KEYWORDS
BWA effect on fir

RANGE OF COMMUNITIES
spruce-fir
GEOGRAPHIC SCOPE
Black Mtns., Shenandoah
TYPE OF INFORMATION
qualitative
QUANTITATIVE TOPICS

Notes for Amman and Talerico (1967)

Describes observations of symptoms of balsam woolly adelgid infestation on Fraser fir at Mt. Mitchell and bracted balsam fir at Shenandoah.

Fraser fir is not generally gouted, except in small trees under heavily infested trees. Generally the crown dies from the base upward, in 1-3 years. Infested trees die in 2-6 years, with larger trees taking longer to die. Red wood is induced by even relatively light infestation, and is denser than in other species. No trees survive.

Bracted balsam fir trees are gouted (enlarged buds and nodes). Gouting often kills upper branches, producing a flattopped tree. Stems produce red wood but the trees are not killed. Some trees had 10 consectuive years of red wood; some had been infested 13-18 years before, and survived.

Anderson, L.E. 1979. Geographical relationships of the mosses of the southern Appalachians. In: The Distributional History of the Biota of the Southern Appalachians, Part II. Flora. VPI & SU Research Division Monogr. 2: 101-115.

SUBJECT KEYWORDS
bryophyte flora, floristic affinities

RANGE OF COMMUNITIES
general southern Appalachian
GEOGRAPHIC SCOPE
Southern Appalachians
TYPE OF INFORMATION
qualitative, species list
QUANTITATIVE TOPICS

Notes for Anderson (1970)

This study examined the moss flora of the southern Appalachians from secondary sources, and analysed the distributional characteristics and geographic affinities of the species.

Of 434 moss species, 19 were endemic to the Appalachians and Ozarks, and 8 more were primarily Appalachian. 15 species were disjunct to areas outside the U.S., 2 to SE Asia, 4 to Mexico and SE Asia, 1 to Europe and SE Asia, and the rest widespread in the tropics. 24 species were disjunct to the Coastal Plain. 10 species were disjunct to other areas in the U.S.

Anderson, L.E. and R.H. Zander. 1973. The mosses of the southern Blue Ridge Province and their phytogeographic relations. J. Elisha Mitchell Sci. Soc. 89: 15-60.

SUBJECT KEYWORDS
bryophyte flora, floristic affinities, bryophyte biology

RANGE OF COMMUNITIES
general southern Appalachian
GEOGRAPHIC SCOPE
Southern Appalachians
TYPE OF INFORMATION
qualitative (some figures), species list
QUANTITATIVE TOPICS

Notes for Anderson and Zander (1973)

This study focused most intensely on the gorges of the Blue Ridge escarpment, but includes some information on the region as a whole. An annotated checklist for all moss species, with notes on abundance, habitat, and total range, is given. The species are discussed by different types of distributions.

Of 386 species in the flora, 350 occurred in the Blue Ridge proper, 258 in the Unaka and Smoky Mountains, and 320 in the connecting ranges. 36% of the flora had northern affinities, 24% southern, 19% was generally eastern North American, and 12% was endemic or long-distance disjunct.

Ashe, W.W. 1922. Forest types of the Appalachians and White Mountains. J. Elisha Mitchell Sci. Soc. 37: 183-198.

SUBJECT KEYWORDS
vegetation-environment relationship

RANGE OF COMMUNITIES
general southern Appalachian, general northern Appalachian
GEOGRAPHIC SCOPE
Southern Appalachians, Northeast U.S.
TYPE OF INFORMATION
qualitative
QUANTITATIVE TOPICS

Notes for Ashe (1922)

Discusses the concept of forest site and type, permanence and changes in types, and separation of types. Area considered is the whole Appalachian and White Mountain region.

The types are then listed according to life zone and topographic position.

In the Canadian Life Zone, types include:

Highest crests (>6000 ft.)--red spruce, Alnus viridis, and Rhododendron catawbiense types.

High crests and thin-soiled upper slopes (5500-6000 ft. in NC & TN, 3500 ft. in WV)--red spruce, southern balsam.

Medium slopes--red spruce.

Lower slopes and valleys (4000-5500 ft. in NC & TN, 3000 ft. in WV)--red spruce, red spruce and yellow birch intergrading, red spruce and hemlock intergrading.

Swamps--black spruce and southern balsam.

Ayers, H.B. and W.W. Ashe. 1902. Forests and forest conditions in the southern Appalachians. In: Message from the President of the United States. Senate Document No. 84: 45-59.

SUBJECT KEYWORDS
history, disturbance, logging, fire, conservation, forest condition

RANGE OF COMMUNITIES
general southern Appalachian

GEOGRAPHIC SCOPE
Southern Appalachians

TYPE OF INFORMATION
qualitative (some figures)

QUANTITATIVE TOPICS

Notes for Ayers and Ashe (1902)

This is a report of a federal investigation into forest conditions, considering the question of creating a federal forest reserve. The general types of forest and general forest conditions are described for individual sections of the southern Appalachians. The destructive effects of clearing for agriculture, lumbering, and fire are described.

The forests on the west slope of the Black Mountains are called the densest and wildest in that area. The forests on the east slope of the Black Mountains were lighter and had burned more. In the central interior ridges section, the Balsam Mtns. had the densest forest, with much spruce. The Smokies had the most spruce--20,000 acres.

Ayers, H.B. and W.W. Ashe. 1905. The southern Appalacian forests. U.S. Geological Survey, Prof. Paper 37. Washington, D.C. 291 pp.

SUBJECT KEYWORDS
history, timber statistics, fire, logging, forest condition

RANGE OF COMMUNITIES
general southern Appalachian
GEOGRAPHIC SCOPE
Southern Appalachians
TYPE OF INFORMATION
quantitative
QUANTITATIVE TOPICS
timber statistics

Notes for Ayers and Ashe (1905)

This report is the result of an extensive survey made by U.S. Geological Survey and North Carolina Geological Survey. The entire southern Appalachian region was surveyed, with forests mapped and observations made of composition and condition of the forests. Areas of forest were calculated from the maps and amount of timber and cordwood estimated from area and average amounts per area.

The forests of the region are described by river basin, and broken down into subbasins. The amount of land cleared and wooded, total timber available, relative amounts of each species, nature of the undergrowth and soil, reproduction of trees, severity of fire, and timber marketing conditions are given for each subbasin.

Brief descriptions of the nature, habitat, distribution, and use of each tree species in the region are given.

Quantitative data evaluation record for
Ayers and Ashe (1905)

TOPIC

Timber statistics

METHODS

Survey done of the entire southern Appalachian region, by river basin and smaller watershed. Occurrence of forests was mapped and composition and condition estimated. Area of each type was calculated. Amount of timber available was estimated from area of types and average values for each type.

NUMBER OF SAMPLES: PERMANENT PLOTS:

DATA PRESENTED

Area of cleared, severely burned, and forested land, by river basin. Total and average amounts of timber and small wood by river basin. Percentage of principal timber species in each river basin. Total amount of timber and small wood, and % of principal timber species, in each watershed with the river basins.

Bailey, J.D. 1985. A comprehensive review of the literature on Fraser fir. M.F. Thesis, VPI and SU.

SUBJECT KEYWORDS
general tree characteristics, tree planting, tree reproduction, vegetation sample, BWA effect on fir, fir resistance to BWA
RANGE OF COMMUNITIES
spruce-fir, plantation
GEOGRAPHIC SCOPE
southern Appalachians
TYPE OF INFORMATION
quantitative (no form)
QUANTITATIVE TOPICS

Notes for Bailey (1985)

This thesis is a review of all types of literature regarding Fraser fir. Subjects include morphology, history of the species, distinctness of the species, geographic range, climate, composition of spruce-fir communities, reproduction and growth, various aspects of the balsam woolly adelgid and its interaction with fir, the seed chalcid, damage by leaffooted pine seed bug in plantations, and a number of topics relating to growing Fraser fir for Christmas trees. Data on climate, soils, and community composition are reproduced from several sources.

Balch, R.E. 1952. Studies of the balsam woolly aphid, Adelges piceae (Ratz.) and its effects on balsam fir, Abies balsamea (L.) Mill. Canada Dept. of Agric. Pub. 867.

SUBJECT KEYWORDS
BWA effect on fir, BWA infestation levels, BWA life cycle, BWA spread, BWA response to environment
RANGE OF COMMUNITIES
Northern spruce-fir
GEOGRAPHIC SCOPE
Canada
TYPE OF INFORMATION
quantitative (no form)
QUANTITATIVE TOPICS

Notes for Balch (1952)

Various aspects of balsam woolly adelgid infestation on balsam fir in eastern Canada were investigated. The taxonomy of the genus and history of spread in Canada and New England are given. Detailed descriptions are given of the insect's appearance, development, and habits at different life cycle stages, its method of feeding, population dynamics in an infestation, natural controls on populations, and its effect on balsam fir trees. This early paper is cited by many southern Appalachian studies.

The harmful effects of infestation appear to be caused by insect's saliva. Infestation on twigs causes swelling and inhibition of buds. Eventually the tree dies for lack of new foliage. Stem attack causes abnormal wood with thickened cell walls and abnormal cell shapes, known as rotholz. The wood is similar to "compression wood" produced on the bottom side of branches and produced in response to auxin application. Experiments on conduction of cut wood showed that the rotholz did not conduct water well. They also showed that conduction in fir is done only in youngest few rings. Increased growth is followed by rapid death.

The primary natural controls on BWA populations are resistance of the trees and cold winters.

Barden, L.S. 1978. Regrowth of shrubs in grassy balds of the southern Appalachians after prescribed burning. Castanea 43: 238-246.

SUBJECT KEYWORDS
succession, fire, community maintenance, animal food habits, browsing
RANGE OF COMMUNITIES
high elevation successional
GEOGRAPHIC SCOPE
Balsam Mtns.
TYPE OF INFORMATION
quantitative
QUANTITATIVE TOPICS
succession & browsing

Notes for Barden (1978)

Studied regrowth of shrubs after controlled burning of shrub and herb-dominated successional vegetation. Burning was done to control woody growth on open bald-like lands occurring where spruce-fir forest was destroyed by logging and fire in the early 1900's. Sam Knob, Graveyard Ridge, and Tennent Mtn., which had been burned, respectively, 1, 2, and 3 years before, were sampled. Cover of pre-fire and current shrub crowns was measured in plots, herb cover was measured by line-intercept method, and % of shrub twigs browsed in the previous winter was estimated.

Browsing by deer and rabbits appeared to be a significant factor affecting the recovery of shrubs, but decreased greatly by 3 years after the burn. Heavily browsed species, such as Rhododendron catawbiense, Kalmia latifolia, and Vaccinium constablaei were slower to recover than unbrowsed shrubs such as Pieris floribunda.

To keep the area open, burning would be needed every 10 years, or less if complete killing did not occur. Estimated natural frequency of fires this severe is 100-200 years. Thus, natural fire could not eliminate the shrubs or maintain bald vegetation.

Quantitative data evaluation record for
Barden (1978)

TOPIC

succession & browsing

METHODS

Sampled successional former spruce-fir sites at Sam Knob, Graveyard Ridge, and Tennant Mountain, control burned 1,2, and 3 years previously, in areas where fire had top-killed shrubs. Measured prefire and current shrub canopy radius in 5 m radius plots. Estimated % of twigs browsed in previous winter. Measured herb cover by line-intercept method. Est. dia. of old spruce & fir.

NUMBER OF SAMPLES: PERMANENT PLOTS:

DATA PRESENTED

% cover of herbs of species at each site. Prefire and current % cover of shrubs by species in each site. Estimated spruce and fir basal area before logging. Plot of % of prefire cover recovered by top-killed shrubs of 4 species in the 3 stands. Plot of % of twigs browsed on shrubs of 4 species in the 3 stands.

Barden, L.S. and F.W. Woods. 1973. Characteristics of lightning fires in the southern Appalachians. Tall Timbers Fire Ecol. Conf. Proc. 13: 345-361.

SUBJECT KEYWORDS
fire

RANGE OF COMMUNITIES
general southern Appalachian

GEOGRAPHIC SCOPE
North Carolina, Tennessee

TYPE OF INFORMATION
Quantitative

QUANTITATIVE TOPICS
Fire

Notes for Barden and Woods (1973)

Gives results of a study of 12 years of Park Service and Forest Service fire records for Great Smoky Mountains National Park, Nantahala, Pisgah, and Cherokee National Forests. Number or % distribution of lightning and man-caused fire occurrences were examined by season, elevation, size, severity, and occurrence in pine or hardwood forest.

Most lightning fires occurred in April-August, with 40% in May, the heaviest month. Man-caused fires occurred in March-May and October-December, with more in the spring. The area as a whole averaged 6 lightning fires/year/400,000 ha. The size class distribution of lightning and man-caused fires is similar, with slightly more very large fires being man-caused.

Lightning fires were more common at higher elevations than man-caused fires. Very few fires occurred at high elevation, with only 2 recorded above 1524 m. Apparently none occurred in spruce-fir forests.

Quantitative data evaluation record for
Barden and Woods (1973)

TOPIC

Fire

METHODS

Used fire records for Great Smoky Mountains National Park and Cherokee, Pisgah, and Nantahala National Forests.

NUMBER OF SAMPLES: PERMANENT PLOTS:

DATA PRESENTED

Number of fires in each area. Bar graphs of % distribution of man-caused and lightning fires by month, by size classes of fire, and by elevation zone. Bar graphs of area burned by man-caused and lightning fires by month. Number of fires observed and expected by elevation zone, with chi square test. Bar graphs of number of lightning fires occurring before, during, and after May. Bar graphs of number of lightning fires starting in pine and hardwoods, by elevation zones. Bar graph of % distribution of lightning and man-caused fires by severity class.

Barry, P.J. and H.L. Lambert. 1982. Status and post suppression evaluation of balsam woolly aphid infestations on Roan Mountain, Toecane Ranger District, Pisgah National Forest, NC. USFA Forest Service, Forest Pest Management, Asheville Field Office, Report No. 82-1-22.

SUBJECT KEYWORDS
BWA infestation levels, BWA control

RANGE OF COMMUNITIES
spruce-fir

GEOGRAPHIC SCOPE
Roan Mtn.

TYPE OF INFORMATION
quantitative

QUANTITATIVE TOPICS
BWA infestation levels & BWA control

Notes for Barry and Lambert (1982)

This report gives results of ground surveys for BWA on Roan Mountain in 1981. Post control evaluation in 1979 and 1980 showed that the previous program of spraying every 3 years was not effective, so spraying was increased to every 2 years. The eastern part, along roads and trails from Carver's Gap to Toll House Gap, was sprayed in September 1981. 1/10 acre circular plots, 1-3 chains away from roads or trails at 1/5 mile intervals, were sampled before and after spraying, and in areas not sprayed since 1978 or 1979. Infestations were found only in areas not sprayed since 1978 (Balsam Road and Appalachian Trail-Carver's Gap area). Spraying of the Appalachian Trail-Carver's Gap area in 1981 reduced live eggs by 97%, adults by 43%, and infested trees by 66%.

It was concluded that the spray program is effective and should be continued.

Quantitative data evaluation record for
Barry and Lambert (1982)

TOPIC

BWA infestation levels & BWA control

METHODS

Study in the BWA protection zones established within 200 feet of roads and trails at Roan Mountain. Sampled 42 1/10 acre circular plots, 1-3 chains from road or trail at 1/5 mile intervals. Examined lower 5 feet of trees with magnification for adelgids or eggs. 20 plots in area sprayed in 1981 (Carver's Gap to Toll House Gap) sampled both before and after spraying.

NUMBER OF SAMPLES: 42   PERMANENT PLOTS:

DATA PRESENTED

Total number of plots and trees sampled and % infested, in subdivisions of the treated and untreated areas.

Comparison of number of eggs and adult adelgids on trees in 3 infested plots, before and after spraying. (These were the only infested plots in the 1981 spray area).

Barry, P.J. and T.M. Oprean III. 1979. Evaluation of balsam woolly aphid on Roan Mountain, Toecane Ranger District, Pisgah National Forest, North Carolina, 1979. USDA Forest Service, Southeast Area, State and Private Forestry, Forest Insect & Disease Management Report No. 79-1-12.

SUBJECT KEYWORDS

BWA infestation levels, BWA control

RANGE OF COMMUNITIES

spruce-fir

GEOGRAPHIC SCOPE

Roan Mtn.

TYPE OF INFORMATION

qualitative (some figures), map

QUANTITATIVE TOPICS

Notes for Barry and Oprean (1979)

This report gives results of aerial surveys of 850 acres of spruce-fir and ground surveys of 400 acres in 1978. 52 plots were sampled at 1/10 mile intervals within the protection zones (200 feet from roads and trails) at State Road 1348, Balsam Road, Appalachian Trail, Roan High Bluff trail, and Rhododendron Gardens. Point sample plots based on a BAF of 10 were examined for infestation.

A map is given of previously discovered and newly discovered infestations. New infestations were found south and west of Toll House Gap and in the Rhododendron Gardens. Old infestations occurred below Balsam Road, where most of the firs were dead, and up from Carver's Gap along the Appalachian Trail.

A table is given of stems and acreage treated by mechanical and chemical means, in 1976-1978. Treatment in 1978 covered the Appalachian Trail from Toll House Gap to Carver's Gap, the old hotel site, Toll House Picnic Area, and the Roan High Bluff trail.

The survey found 12% of the plots and only 4% of the trees in the protection boundaries were infested, indicating control was effective.

Becking, R.W. and J.S. Olson. 1978. Remeasurement of permanent vegetation plots in the Great Smoky Mountains National Park, Tennessee, USA, and the implications of climatic change on vegetation. Oak Ridge National Laboratory, Envi. Sci. Div., Publ. 1111. ORNL-TM-6083. 98pp.

SUBJECT KEYWORDS
vegetation sample, climate, tree growth, population dynamics, climatic change, study methods

RANGE OF COMMUNITIES
spruce-fir, beech gap, heath bald

GEOGRAPHIC SCOPE
Great Smoky Mtns.

TYPE OF INFORMATION
quantitative

QUANTITATIVE TOPICS
vegetation sample, climate

Notes for Becking and Olson (1978)

This paper compares 1976 data with data taken by Whittaker and Becking in 1959, but apparently not previously published. It also makes use of, and cites, a number of papers on climate in the mountains. It also gives unpublished data from the 1969 M.S. thesis of L.A. Stephens of Univ. Tenn.-Knoxville.

Based on plot by plot description of vegetation, most spruce-fir has been stable since 1959, with little mortality, except for catastrophic blowdowns on Mt. LeConte.

The paper contains extensive discussion of potential impact of rising global temperatures caused by rising CO_2 levels. It argues that even a 1 degree C rise in average temperature could narrow the spruce-fir zone, possibly eliminating fir.

There is also extensive discussion on the details of establishing and monitoring permanent plots.

Quantitative data evaluation record for
Becking and Olson (1978)

TOPIC

Climate

METHODS

Used data from Stephens (1969) from 4 weather stations in the Great Smoky Mountains.

NUMBER OF SAMPLES: 4   PERMANENT PLOTS:

DATA PRESENTED

Monthly mean, mean max. and mean min. temperatures.
Monthly max. and min. temperatures.
Mean monthly precipitation and predicted soil moisture balance.
Frost free season.

Effect of potential CO_2-induced climate change on elevational zones of climate and vegetation.

Quantitative data evaluation record for
Becking and Olson (1978)

TOPIC

Vegetation sample

METHODS

Used permanent plots established in 1959. (Selection of plots not described). 20 plots total, 7 in spruce-fir, .1 ha (20x50 m). Trees tagged, plots surveyed in. Measured tree dbh, approx. map location in plot. Cored selected trees and measured height.

NUMBER OF SAMPLES: 7   PERMANENT PLOTS: y

DATA PRESENTED

Tree density and basal area per ha, by 10 inch size classes, for 1959 and 1976 data, for live and dead trees.

Location of each site.
General vegetation change since 1959.

Berry, C.R. 1964. Differences in concentrations of surface oxidant between valley and mountaintop conditions in the southern Appalachians. Jour. Air Pollution Control Assoc. 14: 238-239.

SUBJECT KEYWORDS
air pollution

RANGE OF COMMUNITIES
general southern Appalachian
GEOGRAPHIC SCOPE
North Carolina, West Virginia
TYPE OF INFORMATION
quantitative (no form)
QUANTITATIVE TOPICS

Notes for Berry (1964)

This study examined diurnal variation of oxidant concentrations in valley and mountaintop sites. Oxidants were measured using commercial "ozone" recorders. Concentrations were recorded in a valley in Pocahontas Co., WV on June 9-July 6, 1961, on a mountaintop around 5000 ft. near Asheville, NC on June 19-July 10, 1962, and simultaneously on the mountaintop and in a valley near Asheville on July 6-8, 1962. Plots of hourly average concentrations are given.

All records showed strong diurnal variation in concentration. Both valley sites had the highest levels near midday. The mountaintop had the highest levels at night. Diurnal variation may be caused by destruction of oxidants at the ground at night, or by diurnal transport. Multiple recorders are needed to track movement of oxidants to distinguish these possibilities.

Bogle, M.A., and R.R. Turner. 1984. Lead in vegetation, forest floor material, and soils of the spruce-fir zone, Great Smoky Mountains National Park. In: P.S. White (ed). The Southern Appalachian Spruce-Fir Ecosystem: Its Biology and Threats. NPS Research/Resources Man. Rept. SER-71.

SUBJECT KEYWORDS

heavy metal concentrations, air pollution, atmospheric deposition

RANGE OF COMMUNITIES

spruce-fir

GEOGRAPHIC SCOPE

Great Smoky Mtns., Northeast U.S.

TYPE OF INFORMATION

quantitative

QUANTITATIVE TOPICS

heavy metal concentrations

Notes for Bogle and Turner (1984)

This paper discusses results of a 1982 study of lead concentrations in vegetation, litter, and soil of the Great Smoky Mtn. spruce-fir zone. The only other study done in the Smokies had found very high levels.

Samples were taken at Double Springs Gap, Clingmans Dome Road, Mt. Colllins, Mt. LeConte, and Mt. Kephart. Grab samples of tree foliage, wood cores, roots, litter, fermentation, and humus layer, and soil A and B horizon were taken and analysed for lead. Quality insurance procedures are described. Some results are presented here and compared with New England and Europe.

Lead concentrations were generally much lower than those in New England and Europe. Roots contained more lead than wood, which has more than foliage. Older foliage of spruce and fir had more than younger. The 5 sites in the Smokies did not differ. Higher concentration in old foliage and wood of fir show that it accumulates lead. Birch accumulates even more. Within sites lead concentration is higher in more decomposed layers of the forest flood. There is no evidence that lead moves into the mineral soil. This study found much lower lead levels than the earlier study at the same sites, suggesting sample contamination.

Quantitative data evaluation record for
Bogle and Turner (1984)

TOPIC

heavy metal concentrations

METHODS

Sampled at 5 spruce-fir sites in the Smokies. Collected pooled grab samples of old and new spruce and fir foliage, birch foliage, cores of bole wood, roots, litter, fermentation, and humus layers, and mineral soil. Oxidized and dissolved samples, and analysed for Pb by atomic absorption spectrophotometry. Thorough quality assurance measures followed are detailed.

NUMBER OF SAMPLES: PERMANENT PLOTS:

DATA PRESENTED

Mean and standard deviation of Pb concentration in old and new spruce and fir foliage and birch foliage at 3 sites. Mean foliage and forest floor Pb concentration from this study and other studies of sties in the Smokies, New England, and Europe. Mean and standard deviation of Pb concentration in litter, fermentation, and humus layers at Mt. Collins and Double Springs Gap, from this study and previous studies. Bar graph of Pb concentration in the 3 layers at each of the 5 sites.

Bogucki, D.J. 1970. Debris slides and related flood damage associated with the September 1, 1951 cloudburst in the Mt. LeConte-Sugarland Mountain Area, Great Smoky Mountains National Park. PhD. Dissertation, Univ. of Tenn., Knoxville.

SUBJECT KEYWORDS
landslides, geomorphology, climate, hydrology, soil properties, geology

RANGE OF COMMUNITIES
general southern Appalachian

GEOGRAPHIC SCOPE
Great Smoky Mtns.

TYPE OF INFORMATION
quantitative, map

QUANTITATIVE TOPICS
climate & hydrology, soil properties

Notes for Bogucki (1970)

This was an intensive study of the factors associated with the debris slides of Sept. 1, 1951, focusing on the Alum Cave watershed, which had the most damage. Geology (kind of rock, strike, and dip), geomorphology (slope, profile, presence of colluvium and alluvium), soils (pH, K, P, Al, Fe, and clay mineralogy), and vegetation indicators (scarred trees, oriented logs) were examined. Aerial photography was done, slides mapped, and 19 slides surveyed. Weather records and TVA hydrological reports were used to estimate the amount of rainfall and runoff.

The storm dropped possibly 6.5 in. of rain in the watershed with peak discharge on Alum Cave Creek 8-10 feet deep.

A map is given of the 41 slide scars. The size and shape of the scars are described in detail. Slide heads were on slopes around 40 degrees, where slope corresponded to bedrock dip. Regolith apparently slid off of bedrock. Soils were Inceptisols. None of the soils had 2:1 expanding clays.

All slides were in virgin vegetation, with no relation with vegetation type. Although loss of vegetation is often blamed for causing landslides, mature forest increases infiltration and slope weight, which could increase the probability.

Quantitative data evaluation record for
Bogucki (1970)

TOPIC
Climate & hydrology
METHODS
Used weather station data and information on the storm from the U.S. Weather Bureau and TVA. Used estimated stream discharge data from TVA.

NUMBER OF SAMPLES: PERMANENT PLOTS:
DATA PRESENTED
Monthly precipitation at Clingmans Dome and Gatlinburg. Plot of altitudinal precipitation variation from Smallshaw (1953). Storm times and precipitation at various stations in the Smokies on Sept. 1, 1951. Cumulative precipitation curve for that day from Clingmans Dome. Calculated peak discharges for various points on various creeks. Rainfall amount and duration for other major slide-causing storms. Map and table of 100-year storm rainfall amounts. Mean number of thunderstorms in Smokies, and number of days of intense precipitation, by month, 1936-1968.

Quantitative data evaluation record for
Bogucki (1970)

TOPIC
Soil properties
METHODS
Sampled 11 soil pits along 4 slide tracks in Alum Cave watershed. Selection criteria not given. Analysed soil for pH, extractable Fe and Al, K, P, and acidity. Did X-ray diffraction to identify clay minerals.

NUMBER OF SAMPLES: 11 PERMANENT PLOTS:
DATA PRESENTED
Soil pH, K, P, Al, Fe, and acidity, by 10 cm depth intervals, for each of the 11 soil pits. Plots of these data vs. depth for representative well-developed and little-developed soils. Qualitative discussion of clay mineralogy.

Boner, R.R. 1979. Effects of Fraser Fir Death on Population Dynamics in Southern Appalachian Boreal Ecosystems. MS Thesis, Univ. Tenn.-Knoxville.

SUBJECT KEYWORDS
vegetation sample, BWA ecological effects, geomorphology, vegetation-environment relationship
RANGE OF COMMUNITIES
spruce-fir
GEOGRAPHIC SCOPE
Great Smoky Mtns., Black Mtns.
TYPE OF INFORMATION
quantitative
QUANTITATIVE TOPICS
vegetation sample & vegetation-environment relationship, geomorphology

Notes for Boner (1979)

Begins with a general review of literature on climate, geology, flora, and vegetation. Stands were sampled in the Smokies & Black Mtns., representing undisturbed forest and forest at various ages after balsam woolly adelgid attack. Trees, saplings, subsaplings, and ground cover were measured, as well as site topographic factors and stand condition.

Undisturbed stands had overstory density of 354.7 stems/ac with basal area of 205.6 sq. ft./ac above 6000 ft. and 280 stems/ac with basal area of 232 sq. ft./ac below 6000 ft. Infested stands had decreased overstory density and basal area.

Sapling densities in aphid-infested stands were lower 5-10 years after attack, higher 11-20 years after attack. Fir seedlings and Rubus increased with time since attack, while Vaccinium erythrocarpum, Viburnum alnifolium, Oxalis acetosella, and moss cover decreased.

Correlations were done between site and vegetation variables with various results. In undisturbed stands Rubus and Oxalis were positively correlated with drier sites and exposed rock.

Amount of aphid-caused fir death was a good predictor of Rubus and subsapling density.

Quantitative data evaluation record for
Boner (1979)

TOPIC

Geomorphology

METHODS

Stands selected for vegetation sample, on basis of date and amount of balsam woolly adelgid infestation and minimal other disturbance. Randomly located .1 acre circular plots. Observed slope, slope position, form, aspect, % rock exposed.

NUMBER OF SAMPLES: 104 PERMANENT PLOTS:

DATA PRESENTED

Significant (5%) correlation coefficients among elevation, aspect, slope angle, slope form, and surface rock, for disturbed stands, undisturbed stands, and stands greater or less than 6000 feet elev.

Quantitative data evaluation record for
Boner (1979)

TOPIC

Vegetation sample & vegetation-environment relationship

METHODS

Stands selected to represent different dates and amounts of balsam woolly adelgid infestation, and minimal other disturbance. Randomly located .1 acre circular plots, corrected for slope. Measured tree dbh, tallied saplings and shrubs in subplots. Estimated herb cover in subplots. Noted canopy closure and overstory condition, site slope, aspect, position, % rock, etc.

NUMBER OF SAMPLES: 104 PERMANENT PLOTS:

DATA PRESENTED

Overstory density, basal area, sapling and subsapling density, herb layer % cover of disturbed and undisturbed (by BWA) stands. Relative density by diameter size classes & species for undisturbed and different-aged disturbed stands. Correlations among vegetation variables & site variables. Multiple regression of vegetation and site variables.

Bratton, S.P. and P.S. White. In Press. Rare plant sites and recreational: visitation on Mt. LeConte. Proc. Conf. on Social Research in National Parks and Wildland Areas.

SUBJECT KEYWORDS
Rare species, recreation

RANGE OF COMMUNITIES
Spruce-fir, Rock outcrops, Seepage areas
GEOGRAPHIC SCOPE
Great Smoky Mtns.
TYPE OF INFORMATION
Qualitative
QUANTITATIVE TOPICS

Notes for Bratton and White (in press)

This is a short article describing visitor impact on Clifftops/ Mt. LeConte. Annual visitation ca. 30,000. The rocky outcrops (exposed and not under spruce-fir canopy), are a very important site, floristically, as many rare plants occur here. NOTE: publication held up by change in editors.

Bratton, S.P. and P.L. Whittaker. 1977. Great Smoky Mountain National Park: disturbance and visitation on Mt. LeConte. USDI, National Park Service, Southeast Region, Rep. for the Supt. 59 pp.

SUBJECT KEYWORDS
Disturbance, Conservation, Recreation

RANGE OF COMMUNITIES
Spruce-fir, General

GEOGRAPHIC SCOPE
Great Smoky Mtns.

TYPE OF INFORMATION
Quantitative (no form)

QUANTITATIVE TOPICS

Notes for Bratton and Whittaker (1977)

This is an analysis of visitation levels and visitor impacts (hikers and horses) on Mt. LeConte. There is some data om exotic species. NOTE: No vegetation data included on community structure ,composition,etc.

Bratton, S.P., L.L. Stromberg, and M.E. Harmon. 1982. Firewood-gathering impacts in backcountry campsites in Great Smoky Mountains National Park. Environ. Manage. 6: 63-71.

SUBJECT KEYWORDS
disturbance, recreation, nutrient cycles

RANGE OF COMMUNITIES
general southern Appalachian
GEOGRAPHIC SCOPE
Great Smoky Mtns.
TYPE OF INFORMATION
quantitative
QUANTITATIVE TOPICS
disturbance

Notes for Bratton, Stromberg, and Harmon (1982)

This study examined the effect of trampling and firewood-gathering at backcountry shelters and campsites throughout the Smokies. Two of the 8 sampled sites were in spruce-fir forest. Sites were divided into impact classes--site center, transition area, firewood-gathering area, and unused forest control. In each, forest canopy and understory, forest fuels, and soil compaction were sampled.

A tendency toward canopy opening was found in centers of all sites, but was particularly strong in spruce-fir. Canopy basal area and small stems were reduced in the site centers but not in the firewood-gathering areas. Dead stems were reduced in all 3 impact classes, primarily in small size classes.

A carbon cycle model, originally done for tulip poplar forest, was modified to examine the effect of litter and wood removal. Collection of firewood appears to have relatively small effects on nutrient cycling. It may have impacts over 50-70 years in continuously-used sites. Trampling of litter, if the litter is removed from the site, is much more important, seriously depleting soil organic matter.

Quantitative data evaluation record for
Bratton, Stromberg, and Harmon (1982)

TOPIC
disturbance

METHODS
Sampled backcountry shelters and campsites in spruce-fir, cove, and red oak forest. Measured all live and dead stems and stumps in 3-5 50x20 m plots in 4 impact classes. Counted understory and shrub stems in 3 size classes and estimated shrub and herb cover in subplots. Sampled fuels on line transects. Tallied tree scars, stumps, fire pits, and bare ground.

NUMBER OF SAMPLES: 8   PERMANENT PLOTS:

DATA PRESENTED
Average live and dead basal area and density of canopy trees, and understory basal area and density, for each impact class. Density of spruce and fir seedlings and % of understory in each of the 2 spruce-fir sites--Ice Water Spring & Mt. Collins, for each impact class. Cover of each of the 3 understory size classes in each impact class. Plots of stem density vs. size for live and dead stems in each impact class. Plots of depletion of each fuel size class in each impact class. Amount of fuel of each size in each impact class, and % of amount in control plots.

Bratton,S.P.,P.S.White and M.E.Harmon.Disturbance and recovery of plant communities in GSMNP:successional dynamics/naturalness pp. 42-79. in:Hemstrong,M.A. and J.F.Franklin, eds. Successional research and environmental pollutant monitoring assoc.w /Biosphere Reserves. U.S. Nat. Comm. for Man and Biosphere.

SUBJECT KEYWORDS

Conservation, Disturbance, BWA Infestation Levels, Fire, General Succession

RANGE OF COMMUNITIES

General Mountain Vegetation

GEOGRAPHIC SCOPE

Great Smoky Mtns.

TYPE OF INFORMATION

Qualitative

QUANTITATIVE TOPICS

Notes for Bratton, White, and Harmon (1981)

This is a review article on human disturbance (including indirect effects such as the introduction of BWA) in the GSMNP. Logging history is reviewed as well. Whittakers (1956) population distribution for Frasers fir is reproduced. BWA information comes from Hay et.al. (1978). NOTE: No original quantitative data.

Brooks, A.B. 1911. Forestry and Wood Industries. West Virginia Geologic Survey, Vol. 5.

SUBJECT KEYWORDS
history, disturbance, logging, fire, timber statistics, insect damage, air pollution, vegetation patterns
RANGE OF COMMUNITIES
spruce-fir
GEOGRAPHIC SCOPE
West Virginia
TYPE OF INFORMATION
quantitative (no form)
QUANTITATIVE TOPICS

Notes for Brooks (1911)

An extensive review of all aspects of forestry in West Virginia, including kinds of forests, nature of the original forest, species of native woody plants, values of forests, destructive agents, present forest conditions, wood manufacturing industries, and recommendations for future protection. The destruction by logging and fires is described. The list of destructive agents includes not only fire, weather, insects, and fungi, but also smoke and gasses from coke ovens and smelters.

Each county is described in relation to its topography, present forest conditions, original forest conditions, and lumber industry.

Brown, D.M. 1938. The Vegetation of Roan Mountain: An Ecological Study. PhD. Dissertation, Duke University.

SUBJECT KEYWORDS
vegetation sample, succession, community maintenance, ecotones, climate
RANGE OF COMMUNITIES
spruce-fir, grassy bald, heath bald, northern hardwoods
GEOGRAPHIC SCOPE
Roan Mtn.
TYPE OF INFORMATION
Quantitative
QUANTITATIVE TOPICS
Vegetation sample, climate

Notes for Brown (1938)

This study involved intensive phytosociological sampling and observations of the high elevation communities on Roan Mtn. The data and observations are also published in Brown (1941).

Quadrat samples were taken in spruce-fir, beech-maple, alder bald, rhododendron bald, and grassy bald. Two stands of virgin spruce-fir forest were sampled just before logging in 1934. Data are presented on community composition and structure.

The spruce-fir forest was found to be healthy, with trees in 5 different size classes. Spruce and fir trees were invading grassy and rhododendron balds, often advancing as a wedge along the hardwood forest-bald ecotone. Seedlings generally establish in moss or by rocks, but can invade grass clumps. A bed of Polytrichum at the edge of the forest provides a good seedbed.

Diagrams are given of the structure of the ecotones. Conifers with distinctive open-grown form occur back in the spruce-fir forest. Skeletons of open-grown rhododendrons are also found in the forest. The upper 5Ø m of spruce-fir has no trees over 15Ø years old and no dead logs on the ground. It appears that in the last century, 1ØØ acres of grassy bald has become spruce-fir, and 25-5Ø acres of rhododendron has also been invaded.

Quantitative data evaluation record for
Brown (1938)

TOPIC
    Vegetation sample
METHODS
    Sampled stands in all of the high elevation communities on Roan Mountain, including 2 virgin spruce-fir stands. Sampled quadrats of size determined by experiment as described by Cain (1932). Tallied trees by dbh class and strata, tallied shrubs by height class and estimated herb cover class (Braun-Blanquet).

NUMBER OF SAMPLES: PERMANENT PLOTS:
DATA PRESENTED
    The data presented in this dissertation are the same as those presented in Brown (1941).

Quantitative data evaluation record for
Brown (1938)

TOPIC
    Climate
METHODS
    Recording rain guages run by TVA at Cloudland, established Jan. 1935. U.S. Weather Bureau stations were operated at Johnson City, TN and Banner Elk, NC. Camp records kept during field work in the summer of 1934 and 1936.
    Mean monthly temperature of Roan Mtn. was extrapolated from Johnson City and Banner Elk records.
NUMBER OF SAMPLES: PERMANENT PLOTS:
DATA PRESENTED
    Data presented are the same presented in Brown (1941)

Brown, D.M. 1941. Vegetation of Roan Mountain: a phytogeographical and successional study. Ecol. Monogr. 11: 61-97

SUBJECT KEYWORDS
Vegetation sample, community maintenance, succession, ecotones, climate
RANGE OF COMMUNITIES
Spruce-fir, grassy bald, heath bald, northern hardwoods
GEOGRAPHIC SCOPE
Roan Mtn.
TYPE OF INFORMATION
Quantitative
QUANTITATIVE TOPICS
Vegetation sample, climate

Notes for Brown (1941)

This paper reports on detailed studies of phytosociology and observations on succession at Roan Mountain. Plot samples of all strata were taken in spruce-fir, beech-maple (northern hardwoods), shrub and grassy balds. Stands of virgin spruce-fir were sampled just before logging in 1934. Data are presented on the vegetational structure of each community, and on the frequency, density, cover, and basal area of species. Breakdowns of basal area and density by size class are also given.

The virgin spruce-fir was healthy, with trees in a range of size classes. Observations of logged (unburned) areas found initial growth of sedges, followed by invasion of Rubus, Sambucus, and Prunus, and eventual return of conifers.

Grassy bald was being invaded by spruce-fir, rhododendron, and alder. A bed of Polytrichum at the forest edge provides a favorable place for conifer seedlings. Open-grown trees and tree age adjacent to bald suggest that about 100 acres of spruce-fir has invaded bald in the last century. Spruce-fir also invades rhododendron bald, which invades grassy bald. 25-50 acres of rhododendron bald estimated recently invaded by conifers. Dead and shaded shrubs retain evidence of having grown in the open.

Quantitative data evaluation record for
Brown (1941)

TOPIC

Climate

METHODS

Precipitation data taken and observations of cloud cover made at Cloudland on Roan Mtn., during 1935-1937.
Data also used from US Weather Bureau stations at Johnson City, TN and Banner Elk, NC.

NUMBER OF SAMPLES: PERMANENT PLOTS: n

DATA PRESENTED

Plot of mean weekly precipitation on Roan Mountain in 1936, 1937, and 1938. Plot of mean monthly precipitation at Banner Elk and Johnson City. Plot of mean monthly temperatures at Banner Elk and Johnson City, and predicted temperatures for Roan Mountain.

Quantitative data evaluation record for
Brown (1941)

TOPIC

Vegetation sample

METHODS

Sampled various sites on the Roan massif, in spruce-fir, beech-maple (northern hardwoods), grassy bald, rhododendron bald, and alder bald. Plot size was determined by minimum area experiment. Plots were uniformly distributed on a grid in each stand. Trees tallied by dbh class and strata, shrubs tallied by height class, herb cover class (Braun-Blanquet) estimated.

NUMBER OF SAMPLES: PERMANENT PLOTS: ?

DATA PRESENTED

Diagrams of cover class of each stratum in the forest and shrub communities. Frequency of each species in all stands and cover class of each species in bald stands. Frequency distribution of cover classes for each species in each community. Basal area and density of tree spp. in each forest stand. Average relative and absolute basal area for each community. Number and basal area of trees in various size classes, by species for each forest community. Density of woody spp. < 12 ft. tall, by height class, in forest and shrub communities. % of spp. in each frequency class.

Brown, D.M. 1953. Conifer transplants to a grassy bald on Roan Mountain. Ecology 34: 614-617.

SUBJECT KEYWORDS
community maintenance, tree planting

RANGE OF COMMUNITIES
grassy bald

GEOGRAPHIC SCOPE
Roan Mtn.

TYPE OF INFORMATION
Quantitative

QUANTITATIVE TOPICS
tree planting

Notes for Brown (1953)

This article describes results of experiments transplanting spruce and fir seedlings to the open part of Round Bald on Roan Mountain, where they were not naturally invading. 3-5-year-old seedlings, collected in local spruce-fir forest, were transplanted individually and with large blocks of forest soil. Survival curves and height growth data after 12 years are given. No major difference was found between seedlings transplanted directly and those in soil blocks. Plots fenced against grazing showed much better survival and growth. After 12 years, only 1% of the fir and 12% of the spruce survived in the unfenced area. Seedlings protected from wind by a screen had higher survival rates than unprotected seedlings.

This experiment shows that spruce and fir seedlings are capable of growing in the bald. The limiting factor must be in the earlier stages--dispersal, germination, and establishment.

Quantitative data evaluation record for
Brown (1953)

TOPIC

tree planting

METHODS

100 individual spruce and fir seedlings, and seedlings in large blocks of soil, were transplanted from spruce-fir forest into a plot on the summit of Round Bald near Roan Mtn. Part fenced from grazing, part secreened from wind, part unprotected. Survival and height growth of the seedlings were followed over a 12-year period.

NUMBER OF SAMPLES: PERMANENT PLOTS: y

DATA PRESENTED

Survival curves of spruce and fir seedlings in fenced and unfenced plots, and in plots shielded and unshielded from the wind. Numbers surviving in soil blocks. Growth curves for spruce and fir in fenced and unfenced plots. Growth of spruce and fir seedlings in soil blocks.

Busing, R.T. 1985. Gap and Stand Dynamics of a Southern Appalachian Spruce-Fir Forest. Phd. Dissertation. Univ. of Tennessee-Knoxville

SUBJECT KEYWORDS
population dynamics, tree reproduction, gap dynamics, modelling, tree spatial patterns, tree ages
RANGE OF COMMUNITIES
spruce-fir
GEOGRAPHIC SCOPE
Great Smoky Mtns.
TYPE OF INFORMATION
quantitative, mathematical model
QUANTITATIVE TOPICS
gap dynamics, tree ages & population dynamics, modelling, tree spatial patterns

Notes for Busing (1985)

Investigated old-growth spruce-fir forest dynamics in Great Smoky Mountains by field study and computer simulation, focusing on gap dynamics. Trees invading gaps were sampled and related to gap characteristics and gap-making species. Canopy-understory interactions were determined, and a model for species-by-species gap phase replacement probabilites derived.

Advance regeneration of the shade-tolerant spruce and fir is highly successful at capturing gaps. Fir captures most gaps, regardless of gapmaker species. Only a slight tendency toward reciprocal regeneration of spruce and fir was noted. Spruce's longer canopy residence time offsets its poorer gap capture rate and maintains its dominance. Birch and other hardwoods capture enough gaps to remain a minor part of the forest.

A computer model, modified from the FORET model, was constructed for forests such as the sample area. Simulations were run for long-term effects of balsam woolly adelgid infestation, reduced spruce growth rate, and combinations. BWA damage resulted in a spruce-dominated forest. Moderately severe spruce growth decline with fir produced a fir-birch forest. Spruce decline with fir infestation allowed spruce to continue dominance.

Quantitative data evaluation record for
Busing (1985)

TOPIC
modelling

METHODS
Model constructed by modifying FORET model and using field data from this study. Model covered spruce, fir, and 4 hardwood species. Recruitment of seedlings greatly modified to consider location relative to large trees, effect of tree species on seedling species, space competition between seedlings, and relative growth rate of seedling species.

NUMBER OF SAMPLES: PERMANENT PLOTS:

DATA PRESENTED
Table of parameters used in the model.
Plots of simulated total and relative biomass and density for various situations: Normal stand dynamics shown by model. Recovery from logging and initial response to balsam woolly aphid infestation, compared with existing data to validate model. Long term simulations of response to continuous BWA infestation with and without fir regeneration, slight and moderate growth declines in spruce, and combinations of these.

Quantitative data evaluation record for
Busing (1985)

TOPIC
tree ages & population dynamics

METHODS
Site selection same as above. Tree ages determined in .9 m wide strip transects, smaller individuals in .3 m wide strips. Aging done by counting bud scale scars, clipping, or coring at base. Tree and sapling dbh data from 0.1 ha quadrats described above also used.
Calculated life tables based on power function model.

NUMBER OF SAMPLES: 4 PERMANENT PLOTS:

DATA PRESENTED
Size frequency distribution for spruce, fir, yellow birch, mountain maple, mountain ash.
Age frequency distribution for spruce, fir, and birch.
Survivorship curves for spruce and fir.
Life tables for spruce and fir.

Quantitative data evaluation record for
Busing (1985)

TOPIC
    tree spatial patterns
METHODS
    Site selection same as above. Sampled 6 0.1 ha quadrats+subplots. For trees (>12 cm dbh), measured dbh, average crown radius, nearest neighbor dbh and distance. For saplings (2.5-12 cm), measured dbh, height, ave. crown radius, substrate, and health. For seedlings, measured height, crown radius, substrate, health. For saplings and seedlings, measure canopy trees within 5 m.
NUMBER OF SAMPLES: 6   PERMANENT PLOTS: y
DATA PRESENTED
    Frequency distributions of indices of relative influence of canopy spruce vs. fir, spruce vs. birch, and fir vs. birch and Wilcoxon rank-sum tests on indices, for spruce, fir, and birch seedlings and saplings.
    Substrates of seedlings and saplings, by species.
    Values of Morasita's index for 10x10 m subplots. Results of Chi-square test of nearest neighbor frequencies. Scatter diagrams and correlations of distance to nearest neighbor vs. sum of the two circumferences.

Quantitative data evaluation record for
Busing (1985)

TOPIC
    gap dynamics
METHODS
    Sampled a 60 ha area on Mt. Collins, Great Smoky Mountains, 1750-1830m elev., old-growth forest. Sampled 70 canopy gaps selected on random walks. Measured species, dbh, height, crown diameter, substrate, health of 5 tallest trees in each gap.
    Constructed a differential equation model of tree replacement, using species-by-species replacement probabilities.
NUMBER OF SAMPLES: 70   PERMANENT PLOTS:
DATA PRESENTED
    Frequency distribution of gap age and gap size.
    Relative frequency distribution of gap successor species by gap size.
    Number of gaps created by each species captured by each species, and species-by-species replacement probabilities.
    Predicted relative equilibrium canopy composition from differential equation model, and comparison with additional field data from 4 0.1 ha plots.

Cain, S.A. 1930. An ecological study of the heath balds of the Great Smoky Mountains. Butler Univ. Bot. Studies 1: 177-208.

SUBJECT KEYWORDS
community maintenance, vegetation-environment relationships, climate, microclimate, soil temperature, fire, vascular flora
RANGE OF COMMUNITIES
heath bald, spruce-fir
GEOGRAPHIC SCOPE
Great Smoky Mtns.
TYPE OF INFORMATION
quantitative
QUANTITATIVE TOPICS
microclimate

Notes for Cain (1930a)

This study investigated the floristics of heath balds in the Great Smoky Mountains and examined factors potentially determining their distribution. Tables of the occurrence of the heath bald species in other communities and in heath balds of different elevations, and of their Raunkiaer life form and leaf size class, are given. The heath bald species occur in adjacent forest communities. A spruce-fir canopy with dense heath understory often forms a transition between the two communities at high elevation.

One meter quadrats were sampled in middle-elevation heath balds, in 2 different times since last fire, and vegetational data given.

Measurements of evaporation, transpiration, soil and air temperature in high elevation heath bald and adjacent spruce-fir found that heath balds were drier and warmer than spruce-fir, and the shrubs transpired more. Podzol soils were best developed under heath bald.

Important factors in determining heath bald occurrence may be fire, landslide, windthrow, soils, and exposure to extreme weather. Sampled heath balds had burned multiple times.

Quantitative data evaluation record for
Cain (1930a)

TOPIC
microclimate

METHODS
Sampled in heath bald, spruce-fir forest, and transition zone between the two (heath under conifer canopy), at 6500 ft. on Mt. LeConte, and heath bald and adjacent beech gap on Bushy Mountain. Measured evaporation with atmometers. Measured air and soil temperature. Measured transpiration with cobalt chloride method.

NUMBER OF SAMPLES: ? PERMANENT PLOTS:

DATA PRESENTED
Weekly evaporation in the summer of 1928 and 1929 in heath bald, spruce-fir and transition on Mt. LeConte, and in the summer of 1929 in heath bald and beech gap on Bushy Mtn. Cobalt chloride transpiration measurements on Rhododendron catawbiense, 4 in heath bald and 4 in the transition zone. Air and soil temperatures, at various times during the day, on heath bald, in spruce-fir forest, and in the transition zone

Cain, S.A. 1930. The vegetation of the Great Smoky Mountains: An ecological study. PhD. Dissertation, Univ. of Chicago.

SUBJECT KEYWORDS
vegetation-environment relationships, vegetation sample, soil properties, floristic affinities, life-form spectrum
RANGE OF COMMUNITIES
General Southern Appalachian
GEOGRAPHIC SCOPE
Great Smoky Mtns.
TYPE OF INFORMATION
Quantitative (no form), species list
QUANTITATIVE TOPICS

Notes for Cain (1930b)

This dissertation describes studies in the Great Smoky Mountains on the ecology of heath balds, on the relationship of soil pH to vegetation types, and on the floristic affinities of the woody species. Results of these studies are published in Cain (1930), Cain (1931), Cain (1945), and Cain and Miller (1933). Additional data not contained in these papers are also included in the dissertation.

Cain, S.A. 1931. Ecological studies of the vegetation of the Great Smoky Mountains of North Carolina and Tennessee. Bot. Gaz. 91:22-41.

SUBJECT KEYWORDS
soil properties, vegetation-environment relationships

RANGE OF COMMUNITIES
general southern Appalachian
GEOGRAPHIC SCOPE
Great Smoky Mtns.
TYPE OF INFORMATION
quantitative
QUANTITATIVE TOPICS
soil properties

Notes for Cain (1931)

Sampled soils and measured pH for a variety of vegetation associations including spruce-fir, grassy bald, heath bald, and beech orchard. Most acid was high elevation heath bald (pH 3.2 at surface), then spruce-fir (pH 3.6), then grassy bald (4.8).

There is a linear trend of decreasing pH with increasing altitude, although some associations, such as grassy bald, are less acidic than predicted, and others, such as heath bald, are more acidic.

Quantitative data evaluation record for
Cain (1931)

TOPIC

soil properties

METHODS

Sampled in a variety of vegetation types. Collected soil at surface and 6 in. deep at 10-60 sample points per vegetational association. Measured pH. Converted pH values to actual concentrations, averaged by vegetational association, then reconverted to pH.

NUMBER OF SAMPLES: PERMANENT PLOTS:

DATA PRESENTED

Average soil pH by association for surface and subsoil. Plot of average pH vs. altitude.

Cain. S.A. 1935. Ecological studies of the vegetation of the Great Smoky Mountains. II. The quadrat method applied to sampling spruce and fir forest types. Am. Midl. Nat. 16: 566-584.

SUBJECT KEYWORDS
vegetation sample, study methods

RANGE OF COMMUNITIES
spruce-fir
GEOGRAPHIC SCOPE
Great Smoky Mtns.
TYPE OF INFORMATION
quantitative
QUANTITATIVE TOPICS
Vegetation sample

Notes for Cain (1935)

This study investigates quadrat sampling as a replacement for strip cruises and other forest sampling methods. Methods were tested on a spruce forest on Mt. Mingus and a fir forest on Mt. LeConte. Nested quadrats of different sizes were sampled and species-area relations examined to determine minimum size needed. Minimum quadrat area was found to be 200 sq. m for the old spruce and 50 sq. m for the smaller, denser fir. 50 regularly spaced quadrats of minimum area were sampled at each site, to examine effects of quadrat number on basal area measures.

Quantitative data evaluation record for
Cain (1935)

TOPIC

vegetation sample

METHODS

Sampled spruce forest at 5100 ft. on Mt. Mingus and fir forest at 6300 ft. on Mt. LeConte. 10 sets of nested plots, 25-400 sq. meters were located at 40 meter intervals. Tree dbh measured. Species-area curves plotted to determine minimum plot size. 50 minimum-sized plots were then sampled in each stand.

NUMBER OF SAMPLES: 100 PERMANENT PLOTS:

DATA PRESENTED

Diagrams of cover of each stratum in each stand. List of species present in each stratum, including bryophytes and some lichens. Basal area and relative basal area of each tree species. Plots of average % frequency of all species and average number of species/quadrat vs. quadrat size. Table of frequency of tree species in 10 plots of different sizes. Mean, standard deviation, and 95% confidence limit for different numbers of minimum area plots, for dominant trees only, and for all trees, in each stand.

Cain, S.A. 1936. Ecological work in the Great Smoky Mountains region. Castanea 1: 25-32.

SUBJECT KEYWORDS
general research assessment

RANGE OF COMMUNITIES
general southern Appalachian
GEOGRAPHIC SCOPE
Great Smoky Mtns.
TYPE OF INFORMATION
qualitative
QUANTITATIVE TOPICS

Notes for Cain (1936)

This article reviews ecological work published on the Great Smoky Mountains up to that time. Included are vegetation and community studies, biogeographical studies, and works of specific taxonomic groups which include ecological notes.

Cain, S.A. 1937. Botanical trips in connection with the Appalachian Trail Conference--June 25-28, 1937. Castanea 2: 93-97.

SUBJECT KEYWORDS
forest condition, vegetation-environment relationship

RANGE OF COMMUNITIES
spruce-fir, heath bald, bog
GEOGRAPHIC SCOPE
Great Smoky Mtns.
TYPE OF INFORMATION
qualitative
QUANTITATIVE TOPICS

Notes for Cain (1937)

Describes several hikes in the Smokies, with mentions of interesting botanical and vegetational observations.

On Mt. LeConte trail past Alum Cave, he notes heath balds, one with a peat deposit 5 feet deep of coarse fibrous brown peat, giving way to podzolized mineral soil at the bottom.

He mentions that members of the party agreed that heath balds developed from spruce-fir by its deterioration, due largely to edaphic factors.

He describes a steep boggy wet rocky slope at 6000 feet.

On the top was evidence of a cloudburst that dropped 2.74 inches of rain in 45 minutes.

Much of the fir occurred in dense pole stands devoid of undergrowth except for Hylocomium splendens, but with abundant corticolus lichens, mosses, and liverworts.

Cain, S.A. 1940. An interesting behavior of yellow birch in the Great Smoky Mountains. Chicago Naturalist 3: 20-21.

SUBJECT KEYWORDS
    tree reproduction

RANGE OF COMMUNITIES
    spruce-fir, northern hardwoods
GEOGRAPHIC SCOPE
    Great Smoky Mtns.
TYPE OF INFORMATION
    qualitative
QUANTITATIVE TOPICS

Notes for Cain (1940)

This article describes the tendency of yellow birch to establish on logs, eventually becoming adult trees standing on prop roots. This is possible because of the high humidity and low temperatures in the dense forest. The seedlings are believed to suffer less competition on the logs.

On rare occasions, aerial roots from branches of birch trees are observed.

Cain, S.A. 1945. A biological spectrum of the flora of the Great Smoky Mountains National Park. Butler Univ. Bot. Studies 7: 11-24.

SUBJECT KEYWORDS
life-form spectrum

RANGE OF COMMUNITIES
general southern Appalachian
GEOGRAPHIC SCOPE
Great Smoky Mtns.
TYPE OF INFORMATION
quantitative
QUANTITATIVE TOPICS
life-form spectrum

Notes for Cain (1945)

This study examined the Raunkiaer life-form spectrum of the flora of the Smoky Mountains. Number of species and percentage of flora of each life-form were determined, for species occurring above 4500 ft. elev. and for the Smokies as a whole. The pattern was limilar to that of other areas in the eastern U.S. and other similar climates. Hemicryptophytes were the dominant life-form, with phanerophytes and cryptophytes next. The high elevation zone had a higher percentage of hemicryptophyte, phanerophyte, and cryptophyte species and few therophytes.

More detailed analysis was done using frequency and constancy data on cove forests.

Quantitative data evaluation record for
Cain (1945)

TOPIC

life-form spectrum

METHODS

Used floristic list for the Smokies, excluding varieties and escapes. Determined Raunkiaer life-form for each species. Calculated number of species and % of flora of each life-form, for the Smokies, and for above 4500 ft. only.

NUMBER OF SAMPLES: PERMANENT PLOTS:

DATA PRESENTED

Number of species and % of flora of each life-form, for species occurring above 4500 ft. and for the Smokies as a whole. More detailed analysis was done using quantitative field data for a series of cove forests. Data compared to other locations in the E U.S.

Cain, S.A. and J.D.O. Miller. 1933. Leaf structure of Rhododendron catawbiense Michx., grown in Picea-Abies forest and in heath communities. Am. Midl. Nat. 14: 69-82.

SUBJECT KEYWORDS
shrub leaf anatomy

RANGE OF COMMUNITIES
spruce-fir, heath bald
GEOGRAPHIC SCOPE
Great Smoky Mtns.
TYPE OF INFORMATION
quantitative
QUANTITATIVE TOPICS
shrub leaf anatomy

Notes for Cain and Miller (1933)

This study examined the anatomy of Rhododendron catawbiense leaves from adjacent spruce-fir forest and heath bald on Mt. LeConte. Several temperature and evaporation rate measurements confirmed that the heath bald was hotter and drier. Leaves from the heath bald were smaller, often had revolute margins, were more often hairy or scurfy, were darker colored, and had shorter petioles. All cell layers were thicker in the heath bald leaves, with the palisade layer showing the greatest difference. This difference is due both to more layers of cells and to longer cells. The thicknesses of the layers within habitats were quite variable but the differences between habitats were statistically significant. The differences are assumed to be plastic responses to environment, rather than genetic, because of the proximity of the populations.

Quantitative data evaluation record for
Cain and Miller (1933)

TOPIC

shrub leaf anatomy

METHODS

Collected leaves of Rhododendron catawbiense in spruce-fir forest and adjacent heath bald on Mt. LeConte. 32 leaves from heath bald, 32 from forest. Leaves were sectioned and the thickness of the different cell layers measured.

NUMBER OF SAMPLES: PERMANENT PLOTS:

DATA PRESENTED

Average and range of leaf length and width, for leaves from heath bald and forest. Mean, standard deviation, standard error, median, and range for thickness of each leaf cell layer.

Cain, S.A. and A.J. Sharp. 1938. Bryophytic unions of certain forest types of the Great Smoky Mountains. Am. Midl. Nat. 20: 249-301.

SUBJECT KEYWORDS
bryophyte flora, bryophyte communities

RANGE OF COMMUNITIES
spruce-fir, beech gap, cove forest
GEOGRAPHIC SCOPE
Great Smoky Mtns.
TYPE OF INFORMATION
quantitative
QUANTITATIVE TOPICS
bryophyte communities

Notes for Cain and Sharp (1938)

This study examined moss communities in fir, spruce, beech gap, and several kinds of cove forest. Terrestrial, epilithic, epixylic, and corticolous communities were studied separately. Unions and facies were recognized and species cover was sampled in each. Species present in the upper branches of trees were also noted.

Quantitative data evaluation record for
Cain and Sharp (1938)

TOPIC
bryophyte communities

METHODS
Sampled single stands in 6 forest associations: fir, spruce, beech gap, and 3 cove forest types, in the Smokies. Estimated bryophyte cover class in each union and facies in quadrats. On ground, 1 sq. m quadrats with number from species-area study. On rocks, .1 sq. m, 10 of most common communities. On logs, 1 m belt. On trees, 1 m above ground, 5 trees of each dominant sp.

NUMBER OF SAMPLES: PERMANENT PLOTS:

DATA PRESENTED
Cover class by species, for each union and facies in each quadrat, on each substrate, in each forest type. For terrestrial communities, frequency class is also given.

Carey, A.C., E.A. Miller, G.T. Geballe, P.M. Wargo, and T.G. Siccama. 1984. Armillaria mellea and decline of red spruce. Plant Disease. 68: 794-795.

SUBJECT KEYWORDS
disease, forest decline, fungus biology

RANGE OF COMMUNITIES
northern spruce-fir
GEOGRAPHIC SCOPE
New York, Vermont, New Hampshire
TYPE OF INFORMATION
quantitative
QUANTITATIVE TOPICS
disease

Notes for Carey, et al. (1984)

Investigated the extent of infection of red spruce trees with Armillaria mellea, and its relation with elevation and decline. Armillaria attacks the roots of stressed trees.

9 sites with documented decline were sampled in NY, VT, and NH. Spruce-fir, transitional forests, and northern hardwoods with some spruce were sampled with transects along contour. One tree in each of 4 decline classes was examined at intervals of at least 50 m. Roots were excavated and examined for Armillaria to 1 m from the bole.

Infection was correlated with severity of decline within each forest type, but number of infested trees was much lower in the higher spruce-fir forest than in the hardwoods. No healthy trees and only 32% of the recently dead trees were infected in the spruce-fir, compared with 2% of healthy trees and 86% of dead trees in the hardwood forest. Since Armillaria is least common at high elevation where decline is more prevalent, it can only be a secondary factor in the decline. The many severely declining trees without the fungus, even near infected dead trees, indicates the limited distribution of Armillaria.

Quantitative data evaluation record for
Carey, et al. (1984)

TOPIC

disease

METHODS

Sampled 9 sites in NY, VT, and NH with documented forest decline. On transects along the contour, the first recently dead spruce after each 50 m interval was examined, along with the nearest tree in each of 3 other decline classes. All main roots were excavated and examined for Armillaria rhizomorphs and for mycelial fans under the bark, to at least 1 m from the bole.

NUMBER OF SAMPLES: PERMANENT PLOTS:

DATA PRESENTED

Bar graph of % of spruce roots with Arimillaria in each forest type and in each decline class. Bar graph of % of dead and severely declining trees with Armillaria, in each forest type. Some numerical percentages are also given in the text.

Carney, C.B. 1955. Weather and Climate in North Carolina.
North Carolina Agr. Exp. Sta. Bull. 396.

SUBJECT KEYWORDS
climate

RANGE OF COMMUNITIES
general eastern U.S.
GEOGRAPHIC SCOPE
North Carolina
TYPE OF INFORMATION
quantitative
QUANTITATIVE TOPICS
climate

Notes for Carney (1955)

General discussion of weather and climate throughout North Carolina.

Contains general state maps of various climatic variables. Also contains tables of temperature and rainfall data for numerous stations throughout the state, including Mt. Mitchell.

For Mt. Mitchell, mean july temperature is 59.2 F, mean January temp. is 28.7, record high 87, record low -21, total rainfall 71.20 inches. Highest average monthly rainfall is in August (8.94 inches) and July (8.12 inches); lowest is in January (4.68) and February (4.68).

Quantitative data evaluation record for
Carney (1955)

TOPIC

climate

METHODS

Used temperature and rainfall measurements from long-established weather stations.

NUMBER OF SAMPLES: PERMANENT PLOTS:

DATA PRESENTED

Tables of mean January and July temperatures, maximum and minimum temperatures, and monthly rainfall for numerous stations in North Carolina.

Maps of average annual precipitation, average warm season precipitation, average annual, January, and July temperatures, average first and last freeze dates, for all of North Carolina.

Castro, P.K. 1969. A Quantitative Study of the Subalpine Forests of Roan and Bald Mountains in the Southern Appalachians. M.S. Thesis, East Tennessee University.

SUBJECT KEYWORDS
vegetation sample, community maintenance, soil properties

RANGE OF COMMUNITIES
grassy bald, northern hardwoods
GEOGRAPHIC SCOPE
Roan Mtn., Unaka Mtns.
TYPE OF INFORMATION
quantitative
QUANTITATIVE TOPICS
vegetation sample, soil properties

Notes for Castro (1969)

Orchard forest stands surrounding grassy balds were sampled. These forests were northern hardwoods, red oak, or hawthorn.

Several stands at Roan Mtn. contained spruce and fir, which were described as standing 5 feet above the hardwood canopy. Spruce and fir reproduction was also found.

The hardwood forests were aged at an average of 156 years on Bald Mtn. and 247 years on Roan Mtn. A red spruce on Roan had the fastest growth rate of any species. It was 62 years old and 17 inches dbh.

Quantitative data evaluation record for
Castro (1969)

TOPIC

vegetation sample

METHODS

Sites were sampled in all slope aspects and forest types bordering balds at Roan Mtn. and Bald Mtn. Only one site was spruce-fir. Measured canopy basal area by Bitterlich method, with 10 points spaced 75-100 ft. apart on 1-4 transect lines. Measured dbh of 2 trees closest to each point. Counted tree repro. and shrubs in 1/20 acre plots. Estimated importance of herb spp.

NUMBER OF SAMPLES: PERMANENT PLOTS:

DATA PRESENTED

(Only data involving spruce or fir are considered.)
Relative basal area by species by stand. Basal area by elev. by species for one stand N of Round Bald. Average dbh by species by stand. Frequency and presence values for canopy trees by species by stand. Density of tree reproduction, saplings, and shrubs by species by stand. Frequency and presence values for tree reproduction. Estimated average distance between stems of herbs by species by stand. Age and size of spruce trees in stands.

Quantitative data evaluation record for
Castro (1969)

TOPIC

Soil properties

METHODS

Sampled in sites used for vegetation sample. Random samples of soil were taken in each stand. Topsoil, subsoil, and litter depth were measured and soil color and stoniness noted. Composite samples of topsoil were taken and pH measured.

NUMBER OF SAMPLES: PERMANENT PLOTS:

DATA PRESENTED

Topsoil, subsoil, and litter depth, color, series, stoniness estimate, and pH, by stand.

Ciesla, W.M., and W.D. Buchanan. 1962. Biological evaluation of balsam woolly aphid, Roan Mountain Gardens, Toecane District, Pisgah National Forest, North Carolina. USDA, Forest Service, Southeastern Area, State and Private Forestry, Asheville. Field Office Report No. 62-93.

SUBJECT KEYWORDS

BWA spread, BWA control

RANGE OF COMMUNITIES

spruce-fir

GEOGRAPHIC SCOPE

Roan Mtn.

TYPE OF INFORMATION

qualitative (some figures)

QUANTITATIVE TOPICS

Notes for Ciesla and Buchanan (1962)

Describes results of a survey on August 28, 1962, to examine a recently detected suspected BWA infestation (in this area previously believed free of infestation). 5 infested trees were found in a Christmas tree production area above the Balsam Road. It was estimated that the infestation had been present for 2 1/2 years. No additional infestations were found in examining the spruce-fir forest, although numerous firs dead and dying from another cause were noted.

The infested trees and adjacent trees were cut and treated with benzene hexachloride.

Ciesla, W.M., H.L. Lambert, and R.T. Franklin. 1963. The status of the Balsam Woolly Aphid in North Carolina and Tennessee. USDA-Forest Service, Division of State and Private Forestry. Report No. ZONE 1-11-63. (unpub).

SUBJECT KEYWORDS
BWA spread, BWA control, BWA life cycle

RANGE OF COMMUNITIES
spruce-fir
GEOGRAPHIC SCOPE
North Carolina, Tennessee
TYPE OF INFORMATION
map, qualitative
QUANTITATIVE TOPICS

Notes for Ciesla, Lambert, and Franklin (1963)

This report describes the status of balsam woolly adelgid infestations at that time. Aerial surveys were done in May and in mid-late summer, and areas of dead and dying fir were checked for adelgids. Boundaries of the spruce-fir type and adelgid infestation are given on maps for Roan Mtn., Grandfather Mtn., and the Great Smoky Mtns., and each spruce-fir area is discussed. Roan Mtn. had 3 areas of infestation, all on Feeding Ridge. Grandfather Mtn. had 2 areas infested. The Black Mtns. were totally infested. The Great Smoky Mtns. had one area infested, on Mt. Sterling. The Balsam Mtns. had a number of dead trees but the adelgid was not detected.

The life cycle of the adelgid and potential controls are discussed. Cutting of infested trees, use of benzene-hexachloride (BHC) on valuable accessible stands, and continued surveillance are recommended.

Ciesla, W.M., H.L. Lambert, and R.T. Franklin. 1965. Status of the Balsam Woolly Aphid in North Carolina and Tennessee - 1964. USDA Forest Service, Div. State and Private Forestry, Asheville, NC.

SUBJECT KEYWORDS
BWA spread

RANGE OF COMMUNITIES
spruce-fir
GEOGRAPHIC SCOPE
Southern Appalachians
TYPE OF INFORMATION
qualitative (some figures), map
QUANTITATIVE TOPICS

Notes for Ciesla, Lambert, and Franklin (1965)

Aerial surveys were done on all areas of southern Appalachian spruce-fir. Groups of dead and dying trees were ground checked for adelgid infestation.

New infestations were found on Roan Mountain at Haw Orchard Ridge, on Grandfather Mountain, in the Smokies on Cataloochee Mountain, and in a plantation at Moses H. Cone Park near Blowing Rock. Peviously known infestations on Roan Mountain and in the Smokies continued to spread, despite control efforts such as spraying and cutting infested trees. Infestation in the Black Mountains was complete, and no survey was conducted there.

Clarkson, R.B. and D.E. Fairbrothers. 1970. A serological and electrophoretic investigation of eastern North America Abies (Pinaceae). Taxon 19: 720-727.

SUBJECT KEYWORDS
fir taxonomy, fir genetics

RANGE OF COMMUNITIES
spruce-fir
GEOGRAPHIC SCOPE
Eastern U.S.
TYPE OF INFORMATION
quantitative
QUANTITATIVE TOPICS
fir genetics

Notes for Clarkson and Fairbrothers (1970)

This study examined relationships of the 3 fir taxa in the eastern U.S. (balsam, bracted balsam, and Fraser) by their seed proteins. Balsam and bracted balsam fir seeds were collected in West Virginia, and fir seeds obtained from Maine, Michigan, and North Carolina.

Seed protein extracts were compared by disk electrophoresis. Antisera obtained by injecting extracts of the 3 taxa of fir into rabbits were used with the extracts in double diffusion experiments and in measurement of turbidity produced by antibody-antigen reactions. Results of these techniques agreed in finding bracted balsam fir to be more closely related to balsam fir than to Fraser fir, and not to be intermediate between the two.

Quantitative data evaluation record for
Clarkson and Fairbrothers (1970)

TOPIC
    fir genetics
METHODS
    Used balsam, bracted balsam, and Fraser seeds from WV, NC, ME, MI. Obtained antiserum to each from blood of rabbits injected w/ extract of defatted seed meal. Did disk electrophoresis of extracted proteins. Did double diffusion experiments on each taxon against each taxon. Did immunoelectrophoresis. Measured turbidity produced by antigen-antibody reaction.
NUMBER OF SAMPLES: 6   PERMANENT PLOTS: n
DATA PRESENTED
    Results of double diffusion experiments, for antiserum to each fir taxon, preadsorbed by antigen of each fir, and unadsorbed, against antigen of each fir. Serological correspondence values from turbidity measurements for each rabbit for each fir. Average Rp values of bands on electrophoresis. % similarity of electrophoresis results for each pair of fir taxa.

Immunoelectrophoretic experiments did not show differences distinguishing the fir taxa, so are not reported.

Coile, T.S. 1938. Podzol soils in the southern Appalachian Mountains. Soil Sci. Soc. Amer. Proc. 3: 274-279.

SUBJECT KEYWORDS
soil taxonomy

RANGE OF COMMUNITIES
spruce-fir
GEOGRAPHIC SCOPE
Southern Appalachians, West Virginia
TYPE OF INFORMATION
Qualitative
QUANTITATIVE TOPICS

Notes for Coile (1938)

This paper discusses podzol soils that develop under spruce and fir forests. They are best developed in West Virginia, where the parent material is sandstone, and the mountains have broad flat tops. In North Carolina and Tennessee the metamorphic rocks have more bases and the slopes are steeper, resulting in less well-developed podzols.

Podzol soil profiles are described for virgin and cutover spruce forest in West Virginia, and virgin and cutover spruce and fir forest in North Carolina and Tennessee.

Logging and burning has resulted in loss of most of the soil, leaving bare rocks, but this is not believed to be due to erosion. The original soil is believed to have been almost entirely organic, and would have been consumed by the fire. Particularly in West Virginia, the flat mountain tops would not allow much erosion.

Cooley, E.H. 1954. A study of plant distribution patterns at a mid-altitide location in the Great Smoky Mountains National Park. M.S. Thesis, Univ. of Tennessee, Knoxville.

SUBJECT KEYWORDS
vegetation-environment relationship, vegetation sample, tree age, geomorphology, microclimate, soil temperature, climate
RANGE OF COMMUNITIES
cove forest, spruce-fir
GEOGRAPHIC SCOPE
Great Smoky Mtns.
TYPE OF INFORMATION
quantitative
QUANTITATIVE TOPICS
vegetation sample & tree age, climate & microclimate & soil tempe rature

Notes for Cooley (1954)

Studied patterns of evergreen and deciduous forest in an 11 acre area near Alum Cave parking area. The area included a low-elevation island of spruce-fir forest, as well as hemlock and hardwoods. Topography and surface material (alluvium, mantle rock, clay) were mapped in detail, and soil profiles were described. Air and soil temperatures were compared between cove and ridgetop stations. Coves had greater extremes, presumably because of cold air drainage.

Vegetation was sampled in quadrats and transects. 6 vegetational units were recognized from the transect data and mapped. The spruce-fir forest island had the characteristic shrubs and herbs of the higher elevation spruce-fir forests. It occurred on the rockiest, least developed soil. Coring of trees showed it to have invaded a clearing and to have an even-aged structure about 40 years old. Spruce-hemlock-birch forest with rhododendron occurred on weathered bedrock and somewhat on alluvium. The hardwood forests occurred in the cove on deep well-drained alluvium.

Quantitative data evaluation record for
Cooley (1954)

TOPIC

vegetation sample & tree age

METHODS

Studied an 11 acre area near Alum Cave parking area. Measured woody plants > 1 inch dbh in 12 10x10 m quadrats and in 1x10 m segments of line transects in the cove and on the ridge. An unspecified number of spruce, fir, and hemlock trees were cored. The area was divided into 6 stands, based on transect data. These stands were mapped and data for them averaged.

NUMBER OF SAMPLES: PERMANENT PLOTS:

DATA PRESENTED

Bar graphs of number of species in each presence, constancy, and frequency class in the 6 stands, based on the 12 plot samples. Phytograph diagrams of relative basal area, relative density, frequency, and % of reproduction for 8 major species, in each stand. Plots of tree age vs. dbh of spruce, fir, and hemlock, for the spruce-fir island and elsewhere. Maps showing the 6 stands and showing areas of high frequency of different tree species.

Quantitative data evaluation record for
Cooley (1954)

TOPIC

climate & microclimate & soil temperature

METHODS

Used weather station data from Shanks (1954). Used data on soil temperatures from cove and ridge stations at 3200 and 4000 ft., and air temperatures from cove and ridge stations at 3200, 4000, and 5200 ft. It is unclear whether the author took these data or got them from Shanks or elsewhere.

NUMBER OF SAMPLES: PERMANENT PLOTS:

DATA PRESENTED

Plots of temperature, humidity, precipitation, and precip./evaporation index vs. elevation. Plots of average soil temperature by month for cove and ridge stations at 3200, 4000, and 5200 ft., in 1950. Plots of average air temperatures by month for cove and ridge stations at 3200 and 4000 ft., in 1950.

Core, E.L. 1970. The botanical exploration of the southern Appalachians. In P.C. Holt (ed.), The distributional history of the biota of the southern Appalachians. Part II: Flora. Virginia Polytechnic Institute and State Univ., Blacksburg, VA, Research Division Monogr. 2: 1-65.

SUBJECT KEYWORDS
history, early exploration

RANGE OF COMMUNITIES
general southern Appalachian

GEOGRAPHIC SCOPE
Southern Appalachians

TYPE OF INFORMATION
qualitative

QUANTITATIVE TOPICS

Notes for Core (1970)

This article briefly describes the lives and travels of the early botanists who explored in the southern Appalachians, beginning with John Bartram (1699-1777) and ending with Roland Harper (1878-1966).

Cost, N.D. 1974. Forest statistics for the Mountain Region of North Carolina. 1974. USDA Forest Service, Southeast. For. Exp. Sta., Resource Bull. SE-31. 33pp.

SUBJECT KEYWORDS
timber statistics

RANGE OF COMMUNITIES
general southern Appalachian

GEOGRAPHIC SCOPE
North Carolina

TYPE OF INFORMATION
quantitative

QUANTITATIVE TOPICS
timber statistics

Notes for Cost (1974)

This report gives results of the 4th forest inventory in the 21 counties of western North Carolina. Data are based on samples of systematically located plots. Land use is classified and timber statistics are given only for commercial forest land. 4811 acres of commercial spruce-fir occured in Yancey County on National Forest land, 7903 acres in Watauga Co. on private land. (The rest is presumable classified unproductive or reserved). Data given by forest type, in which spruce-fir is distinguishable include number and volume of trees by dbh class, net annual growth, removal, and mortality. No removal of spruce or fir is reported. Sawtimber grew 2421000 cu. ft., growing stock 537000. Mortality was 204000 cu. ft. of growing stock, none for sawtimber.

Statistical reliability of the data is discussed and standard errors given. Although much data is given broken down by county, a warning is given that individual county samples were too small for statistical reliability.

Quantitative data evaluation record for
Cost (1974)

TOPIC
timber statistics

METHODS
Sampled systematically located sites on commercial forest land. Sampled clusters of 10 uniformly distributed points, with variable plot sampled (BAF 37.5 sq. ft./ac) for large trees and fixed radius plots for trees <5 in. dbh. Volume equations were created using intensive measurements from 88 plots. Permanent plots from the previous inventory were resampled to assess change.

NUMBER OF SAMPLES: 561 PERMANENT PLOTS: y

DATA PRESENTED
(Only data in which spruce-fir can be distinguished are noted.) Area of commercial forest land, by county and species, and by ownership and species (spruce & fir together). Number of commercial growing stock trees, by species and dbh class. Volume of commercial forest growing stock, sawtimber, and total live timber, by dbh class and species. Net annual growth, removal, and mortality of growing stock and sawtimber by species.

Crandall, D.L. 1957. Ground patterns of the Spruce-fir area of the Great Smoky Mountains National Park. PhD. Dissertation, Univ. of Tenn.-Knoxville.

SUBJECT KEYWORDS
spruce-fir variation, vegetation sample

RANGE OF COMMUNITIES
spruce-fir, beech gap
GEOGRAPHIC SCOPE
Great Smoky Mtns.
TYPE OF INFORMATION
quantitative (no form)
QUANTITATIVE TOPICS

Notes for Crandall (1957)

This dissertation was not examined but apparently reports on the vegetational study on which Crandall (1958) was based. The study looked at variation within the spruce-fir forests of the Mt. LeConte-Clingmans Dome area, using undergrowth as an indicator of differences in environment. This dissertation presumably gives data from all plots samples, in addition to the representative data presented in Crandall (1958). Additional data not published elsewhere may also be present.

Crandall, D.L. 1958. Ground vegetation patterns of the spruce-fir area of the Great Smoky Mountains National Park. Ecol. Monogr. 28: 337-360.

SUBJECT KEYWORDS
variation within spruce-fir, vegetation sample

RANGE OF COMMUNITIES
spruce-fir, beech gap
GEOGRAPHIC SCOPE
Great Smoky Mtns.
TYPE OF INFORMATION
quantitative
QUANTITATIVE TOPICS
vegetation sample & variation within spruce-fir

Notes for Crandall (1958)

This study looked at variation within the spruce-fir forests of the Mt. LeConte-Clingmans Dome area, using undergrowth as an indicator of differences in environment. 13 site types were recognized under fir, spruce-fir, spruce, spruce-birch, and beech gap canopy. Plot data are given from a representative example of each type, and the altitude, slope, exposure, and substrate ranges are given. Canopy size and reproduction are discussed for each type.

Several types tend to have dense small trees, with many standing dead trees. Density of tree reproduction tends to vary widely between types.

Succession of various kinds is discussed, including succession after fire, after windthrow, and on bare rock. Dense reproduction, particularly of fir, grows up in canopy gaps, forming an even-aged patch. Undergrowth cover may be reduced beneath the dense canopy, but recovers when the canopy matures and opens.

Types under spruce and fir include Oxalis-Hylocomium, Oxalis-Dryopteris, Hylocomium-Vaccinium, Viburnum-Vaccinium-Dryopteris, Senecio (Cacalia) rugelia, Viburnum-Vaccinium-Senecio, Viburnum-Vaccinium-Lycopodium, and Rhododendron.

Quantitative data evaluation record for
Crandall (1958)

TOPIC

vegetation sample & variation within spruce-fir

METHODS

Sampled on Mt. LeConte, Mt. Sterling, Spruce Mtn., and along the Clingmans Dome road. Sampled T-shaped transects, 50 m each way, 10 or 5 m wide for trees, 1 m for shrubs and herbs. Measured trees >1 inch dbh, tallied shrubs by height classes, measured line intercept cover of herbs. Recognized 13 site types under 5 forest types, 8 under spruce or fir-dominated forest.

NUMBER OF SAMPLES: PERMANENT PLOTS:

DATA PRESENTED

Cover of moss, Oxalis, ferns, and herbs, stem density of Vaccinium and Viburnum, basal area, average dbh, elevation range, slope, and exposure range for a representative plot for each site type, and for an open area and a windthrow. Relative density and basal area, frequency, and size classes represented in each site type. % of tree basal area in each diameter class for each tree species in each site type. Number of herbaceous species and cover of common herb species in different altitude ranges.

Crandall, D.L. 1960. Ground vegetation patterns of the spruce-fir area of the Great Smoky Mountains National Park. Virginia J. Sci. 11: 9-18.

SUBJECT KEYWORDS
variation within spruce-fir, vegetation sample

RANGE OF COMMUNITIES
spruce-fir
GEOGRAPHIC SCOPE
Great Smoky Mtns.
TYPE OF INFORMATION
qualitative
QUANTITATIVE TOPICS

Notes for Crandall (1960)

This paper describes variation within the spruce-fir forests of the Mt. LeConte-Clingmans Dome area, using undergrowth as an indicator of differences in environment. The same results, with data, are given in Crandall (1960). The 8 site types that occurred under fir, spruce-fir, or spruce canopy are described with regard to their characteristic species and strata, topographic position, size of canopy, and other characteristics. The 8 types are Oxalis-Hylocomium, Oxalis-Dryopteris, Hylocomium-Vaccinium, Viburnum-Vaccinium-Dryopteris, Senecio (Cacalia rugelia), Viburnum-Vaccinium-Senecio, Viburnum-Vaccinium-Lycopodium, and Rhododendron.

A general list of species characteristic of spruce-fir forests is given.

Culver, D.C. 1981. On using Horn's Markov succession model. Am. Nat. 117: 572-574.

SUBJECT KEYWORDS
modelling, population dynamics, vegetation sample

RANGE OF COMMUNITIES
spruce-fir
GEOGRAPHIC SCOPE
Great Smoky Mtns.
TYPE OF INFORMATION
quantitative
QUANTITATIVE TOPICS
modelling & vegetation sample

Notes for Culver (1981)

This study tested the Markov succession model by comparing equilibrium predictions of canopy composition with observed composition of a virgin spruce-fir forest near Clingmans Dome. Transition probabilities were calculated from the relative number of saplings of each species under the canopy species.

The predicted numbers of canopy trees were not significantly different from those observed.

There were significantly different numbers of spruce and fir saplings under different canopy species.

Quantitative data evaluation record for
Culver (1981)

TOPIC

modelling & vegetation sample

METHODS

Sampled spruce-fir forest in a site near Clingmans Dome. Methods are not given. Measured canopy composition, counted saplings (>1 m tall) beneath each canopy tree, and used these data to estimate transition probabilities. Calculated predicted equilibrium canopy composition by Markov model, and transformed predicted values by longevity of the tree species.

NUMBER OF SAMPLES: PERMANENT PLOTS:

DATA PRESENTED

Transition probability matrix for spruce, fir, and yellow birch.
Observed numbers of canopy trees, untransformed and transformed predicted numbers of canopy trees.
Observed and expected number of saplings of spruce and fir under each species.

Davis, J.H., Jr. 1930. Vegetation of the Black Mountains of North Carolina: An ecological study. J. Elisha Mitchell Sci. Soc. 45: 291-318.

SUBJECT KEYWORDS
vegetation sample, succession, vegetation patterns

RANGE OF COMMUNITIES
general southern Appalachian

GEOGRAPHIC SCOPE
Black Mtns.

TYPE OF INFORMATION
qualitative

QUANTITATIVE TOPICS

Notes for Davis (1930)

Describes the vegetation of the Black Mountains, in qualitative terms, giving lists of the more common species in each community. The description is based on quantitative sampling done for the author's dissertation. 3 major plant communities (or formations) are described: spruce-fir, northern hardwoods, and Appalachian forest. Within the spruce-fir formation, the climax is described as generally dense, with few shrubs or herbs. More open stands with well-developed shrub and herb layers are also described. Small herb-dominated areas are noted. This forest once occupied most of the area above 5500 ft., but most was destroyed by logging. Successional forests in logged areas are also described in detail, with a species list. Progress toward the climax is extremely slow, but these areas do not appear to develop into grassy balds. Instead they become dominated by blackberries and similar species. The northern hardwoods ecotone, orchard forests, grassy balds, heath balds, and lower elevation communities are also described.

DeLapp, J.A., and T.R. Wentworth. 1977. Proposed research natural areas in the southern Appalachians. Research Report to Highlands Biological Station.

SUBJECT KEYWORDS
vegetation sample, soil properties

RANGE OF COMMUNITIES
spruce-fir, low southern Appalachian
GEOGRAPHIC SCOPE
Southern Appalachians
TYPE OF INFORMATION
quantitative
QUANTITATIVE TOPICS
vegetation sample, soil properties

Notes for DeLapp and Wentworth (1977)

Describes 6 proposed research natural areas on Pisgah and Nantahala National Forest, including the Colbert Ridge area in the northeastern Black Mountains. Baseline vegetation data are given, based on 5 .1 ha quadrats in each area. Soil bulk density, % organic matter, and chemistry data are also given. Pictures were also taken in each stand. The Colbert Ridge stands are dominated by spruce (71%), with yellow birch (15%) and fir (7%).

Quantitative data evaluation record for
DeLapp and Wentworth (1977)

TOPIC
vegetation sample

METHODS
Sampled 5 subjectively located .1 ha quadrats in each of 6 areas, including a spruce-fir site in the Black Mountains. Tallied all tree species in 1 inch dbh calsses. Counted shrubs >1 m tall. Estimated cover of herbs and seedlings (<1 m tall) in 25 1 sq. m subplots per quadrat.

NUMBER OF SAMPLES: 5   PERMANENT PLOTS:

DATA PRESENTED
Number of trees in 4 in. dbh classes, by species for each stand. Density of saplings (<3 in. dbh) and trees (>3 in. dbh), total basal area, relative sapling and tree density, relative total basal area, and tree importance value, by species for each stand. Density of shrubs by species for each stand. % frequency, % cover, and relative importance values of seedlings and herbs.

Quantitative data evaluation record for
DeLapp and Wentworth (1977)

TOPIC
Soil properties

METHODS
Collected samples of the A1 horizon in each of the 5 vegetation sample quadrats at each site. Measured bulk density, pH, amounts of P, K, Ca, Mg, Mn, % organic matter, and acidity.

NUMBER OF SAMPLES: 1   PERMANENT PLOTS:

DATA PRESENTED
Range of soil bulk density, pH, % organic matter, acidity, P, K, Ca, Mg, and Mn in each site.

DeSelm, H.R. and R.R. Boner. 1984. Understory changes in spruce-fir during the first 16-20 years following the death of fir. In: P.S. White (ed). The Southern Appalachian Spruce-Fir Ecosystem: Its Biology and Threats. USDI NPS Research/Res. Man. Rep. SER-71.

SUBJECT KEYWORDS
vegetation sample, succession, BWA ecological effects, spruce-fir comparison

RANGE OF COMMUNITIES
spruce-fir

GEOGRAPHIC SCOPE
Great Smoky Mtns., Black Mtns.

TYPE OF INFORMATION
quantitative

QUANTITATIVE TOPICS
vegetation sample & succession

Notes for DeSelm and Boner (1984)

Sampled spruce-fir forests in 1974. Stands chosen to represent varying time since balsam woolly adelgid disturbance, from undisturbed stands in the central Smokies to intermediate times (5-10 years) at Mt. Sterling and the Black Mtns., to long times (11-20 years) in the Black Mtns. While confounded with site differences, these data indicate trends of change after BWA disturbance. The plots in the longest time class suggest hypotheses that can be tested as the shorter-time plots age.

Most species seem to maintain their density over time. Several greatly increased, apparently invading the new openings: Ribes rotundifolium, Rubus canadensis, Rubus idaeus var. canadensis, Sambucus pubens, Vaccinium erythrocarpum, and Viburnum alnifolium. A few, such as yellow birch seedlings and beech, were apparently excluded from the disturbed areas.

Fir reentered the canopy in the 11-20 year class sites, but seedlings had disappeared in these longer intervals.

The data are also contained in Boner (1979).

Quantitative data evaluation record for
DeSelm and Boner (1984)

TOPIC

vegetation sample & succession

METHODS

Sampled (in 1974) 99 stands in the Smoky and Black Mtns. representing varying age since BWA disturbance. Tallied trees and saplings (>2.5 cm dbh) in size classes in .04 ha plots, counted shrub layer stems in 2 .004 ha plots, counted seedlings and estimated herb cover in 8 .0001 ha plots. 6 groups of stands: high & low undist., 5-6, 7-10, 11-15, and 16-20 years since infestation.

NUMBER OF SAMPLES: 99 PERMANENT PLOTS:

DATA PRESENTED

Density and basal area of overstory trees (>12.5 cm dbh), by species, in the 6 groups of stands. Density of saplings (2.5-12.4 cm dbh) stems, by species, for the 6 groups. Density of subsapling stems (<2.5 cm dbh and >.6 m tall). % cover in herb layer.

Data from Boner (1979).

DeVore, J.E. 1972. Fraser fir in the Unicoi Mountains. Castanea 37: 148-149.

SUBJECT KEYWORDS
species range extension

RANGE OF COMMUNITIES
High Southern Appalachian

GEOGRAPHIC SCOPE
Unicoi Mtns.

TYPE OF INFORMATION
qualitative

QUANTITATIVE TOPICS

Notes for DeVore (1972)

Reports discovery in 1971 of 13 trees of Fraser fir on Haw Knob in the Unicoi Mountains. Trees were of varying size, 8-132 inches tall. This occurrence is reported as a range extension. However, Pittillo (1984) states that consultation with Forest Service officials indicated that these trees were planted, despite their uneven-aged appearance.

DeYoung, H.R., P.S. White and H.R. Deselm. 1982. Vegetation of the Southern Appalachians:an indexed bibliography,1805-1982. USDI, National Park Service, Southeast Regional Office, Res. Man. Dept. SER-63. 94 pp.

SUBJECT KEYWORDS
General Vegetation

RANGE OF COMMUNITIES
General Southern Appalachian
GEOGRAPHIC SCOPE
Southern Appalachians
TYPE OF INFORMATION
Bibliography
QUANTITATIVE TOPICS

Notes for DeYoung et. al. (1982)

This report includes ca. 1000 references. Spruce-fir and BWA are in the index. This is the predecessor of the White and Eager bibliography that the current project is based on.

Degelius, G. 1941. Contributions to the lichen flora of North America: II. The lichen flora of the Great Smoky Mountains. Arkiv For Botanik 3Ø(3):1-8Ø.

SUBJECT KEYWORDS
lichen flora, floristic affinities

RANGE OF COMMUNITIES
general southern Appalachian
GEOGRAPHIC SCOPE
Great Smoky Mtns.
TYPE OF INFORMATION
qualitative, species list
QUANTITATIVE TOPICS

Notes for Degelius (1941)

Primarily a listing of lichens collected in a 2-week visit to the Smokies in 1939, with notes on locations and elevations. Lists are given of species in deciduous forest, coniferous (spruce-fir) forest, and both. There is brief discussion of northern, southern, and other floristic elements.

The lichen flora of the Smokies was found to not be particularly rich, probably because of the lack of extensive bare rock. The pure fir forests of the highest elevations were found to support much richer lichen vegetation than the spruce-dominated forests below.

Delcourt, H.R. and P.A. Delcourt. 1984. Late-Quaternary history of the spruce-fir ecosystem in the southern Appalachian Mountain region. In: P.S. White (ed). The Southern Appalachian Spruce-Fir Ecosystem: Its Biology and Threats. USDI NPS Research/Res. Man. Rep. SER-71

SUBJECT KEYWORDS
paleoecology, extent of spruce-fir, climatic change, pollen-vegetation calibrations

RANGE OF COMMUNITIES
spruce-fir

GEOGRAPHIC SCOPE
Southeastern U.S.

TYPE OF INFORMATION
quantitative, map

QUANTITATIVE TOPICS
pollen-vegetation calibrations & paleoecology

Notes for Delcourt and Delcourt (1984)

Reviews the Quaternary history of spruce-fir forests south of the glacial margin in eastern U.S. Calibrations of modern tree dominance from forest inventories with modern pollen samples were used with pollen data from 13 sites scattered throughout the SE U.S. to calculate the importance of spruce and fir in the past. Contour maps are presented of spruce and fir importance at intervals from 18,000 yrs. ago to the present. During the full glacial and late glacial interval, 18,000-12,500 yrs. ago, spruce and fir species occurred in a broad belt from Missouri across Tennessee to the Carolinas, with fir more restricted in latitude than spruce. With climatic warming, they became progressively more restricted to the Appalachians (and migrated north). Fir distribution was dramatically reduced at 12,000-10,000 yrs., while spruce distribution changed more slowly and continuously. The minimum southern distribution occurred 6000 yrs. ago, in the xerothermic period, and since then spruce-fir forests have expanded slightly. Only the southern Appalachians have continuously had spruce-fir forests from the present to 18,000 yrs. ago.

Quantitative data evaluation record for
Delcourt and Delcourt (1984)

TOPIC

pollen-vegetation calibrations & paleoecology

METHODS

Used previously published pollen composition data (by these and other authors) for 13 radiocarbon-dated sites scattered throughout the Southeast. A calibration for relating pollen data to vegetational composition was derived from 1684 modern pollen samples and dominance (growing stock volume) from forest inventories, using geometric mean linear regression. Maps plotted.

NUMBER OF SAMPLES: PERMANENT PLOTS:

DATA PRESENTED

Plots and regression coefficients for the relationship between modern pollen and vegetation. Contour maps of % spruce and fir in the vegetation in the SE U.S., for 18,000, 14,000, 10,000, 6000, 2000 years ago, and at present, based on 13 sites.

Dey, J.P. 1975. The fruticose and foliose lichens of the high mountain areas of the southern Appalachians. PhD. Dissertation, Duke University.

SUBJECT KEYWORDS
lichen flora, lichen taxonomy, floristic affinities, lichen biology
RANGE OF COMMUNITIES
high southern Appalachian
GEOGRAPHIC SCOPE
Southern Appalachians
TYPE OF INFORMATION
qualitative (some figures), taxonomic key
QUANTITATIVE TOPICS

Notes for Dey (1975)

This study is the first comprehensive taxonomic treatment of the fruticose and foliose lichens of the high southern Appalachians. Extensive collecting was done in all of the spruce-fir areas, including areas accessible only by backpacking. Lichen species important in the common communities are listed.

Taxonomic keys to the species and descriptions of each are given, with information on chemical tests, habitats, range, and citation of all specimens. Different kinds of global ranges are discussed, and an appendix lists the species with each kind of range.

Of the 178 species found, 13 are endemic to the southern Appalachians and 31 are disjunct to Mexico or areas outside of North America.

The keys, species descriptions, and some of the biogeographic discussion are published in Dey (1978). This information is also used in Dey (1979).

Dey, J.P. 1978. Fruticose and foliose lichens in the high-mountain areas of the southern Appalachians. The Bryologist 81: 1-93.

SUBJECT KEYWORDS
lichen flora, lichen taxonomy, floristic affinities

RANGE OF COMMUNITIES
high southern Appalachian
GEOGRAPHIC SCOPE
Southern Appalachians
TYPE OF INFORMATION
qualitative, taxonomic key
QUANTITATIVE TOPICS

Notes for Dey (1978)

This paper is primarily a comprehensive taxonomic treatment of the fruticose and foliose lichens, with keys, species descriptions, and chemical color test information. Habitats for lichens and geographic relations of the flora are discussed briefly.

Habitats include spruce-fir forest, fire cherry successional forest, high elevation deciduous forest, beech gap, grassy bald, heath bald, road bank, and rock outcrop. There are 178 species in the high elevation flora. 7 species are narrowly endemic to the Appalachians, 5 are nearly endemic, and 18 are endemic to the Appalachians within their North American range. The flora shows affinities to both northern and southern areas. Lichen distributions show the same patterns as plant distributions but disjunctions are at the species rather than the genus level.

Dey, J.P. 1979. Notes of the fruticose and foliose lichen flora of North Carolina and adjacent mountainous areas. Proc. of the 16th International Phytogeographical Excursion, 1978: Veroff. Geobot. Institut. ETH, Stiftung Rubel, Zurich, 68: 185-205.

SUBJECT KEYWORDS

lichen flora, floristic affinities, lichen biology

RANGE OF COMMUNITIES

general southern Appalachian

GEOGRAPHIC SCOPE

North Carolina, Southern Appalachians

TYPE OF INFORMATION

qualitative

QUANTITATIVE TOPICS

Notes for Dey (1979)

Discusses geographic and habitat distribution of lichen species. Information is primarily derived from Dey (1975). 11 different kinds of species ranges are recognized, and notable species within each are named. 13 species are narrowly endemic to the Appalachian Mtns., and over 26 are disjunct to Mexico, East Asia, or other distant areas. Appalachian-Great Lakes, Appalachian-Ozark, and wider southeastern distributions are also considered.

Species are also discussed by habitats and substrates, with notable species of rock, soil, logs, and trees in the different parts of the region noted.

Dey, J.P. 1984. Lichens of the southern Appalachian mountain spruce-fir zone and some unanswered ecological questions. In: P.S. White (ed). The Southern Appalachian Spruce-Fir Ecosystem: Its Biology and Threats. USDI NPS Research/Res. Man. Rep. SER-71.

SUBJECT KEYWORDS
lichen flora, lichen biology, lichens as biomonitors, floristic affinities

RANGE OF COMMUNITIES
spruce-fir

GEOGRAPHIC SCOPE
Southern Appalachians

TYPE OF INFORMATION
quantitative

QUANTITATIVE TOPICS
lichen flora & lichen biology

Notes for Dey (1984)

The state of current knowledge of southern Appalachian spruce-fir lichens is discussed and the needs for further research considered. The fruticose and foliose lichens have been generally well studied, but little is known about the crustose microlichens. A variety of observations, based on label data in Duke Herbarium, are discussed.

181 species of macrolichens have been collected above 1676 m (5500 ft.). The diversity of macrolichens on fir is much greater than on spruce. Only 12 epiphytic, 2 terricolous & lignicolous, and 1 saxicolous species are strongly restricted to spruce-fir forests. Because most species also occur at low elevation, the isolated mountains cannot be regarded as islands for lichens.

The number of species in each of the 10 high mountain areas is roughly correlated with size of the area, but Grandfather Mtn. and Mt. Pisgah have more than expected and Whitetop has fewer.

Threats to lichens include loss of fir by balsam woolly adelgid and damage by air pollution. Lichens are useful as biomonitors of air pollution, and their use should be investigated in the southern Appalachians. Additional research is also needed on crustose lichens, quantitative abundance, and fir death.

Quantitative data evaluation record for
Dey (1984)

TOPIC

lichen flora & lichen biology

METHODS

Used label data from Duke herbarium and data from other published sources.

NUMBER OF SAMPLES: PERMANENT PLOTS:

DATA PRESENTED

Number of macrolichens collected more than once and once, on fir, spruce, mountain ash, and birch. Number of macrolichen species collected on different substrates in high mountains. Number of macrolichen species in each of the 10 high mountain areas, with size of area and number of vascular species and community types for comparison. Lists of species with 90% or more of high elev. collections from spruce-fir, and from spruce-fir + successional fire cherry communities.

Dickson, R.R. 1959. Some climate-altitude relationships in the southern Appalachian Mountains region. Bull. Amer. Meteorol. Soc. 40: 352-359.

SUBJECT KEYWORDS
meteorologic patterns, climate

RANGE OF COMMUNITIES
general southern Appalachian
GEOGRAPHIC SCOPE
Southern Appalachians
TYPE OF INFORMATION
quantitative
QUANTITATIVE TOPICS
climate & meteorologic patterns

Notes for Dickson (1959)

This study used regressions of climatic data on elevation to derive predictions for climatic variations on a scale intermediate between regional climate and microclimate. Data were used from several weather stations for the period 1931-1952. Mt. Mitchell was the only station over 4000 feet.

Linear regressions were derived for mean temperature for the whole year, January, and July; mean daily temperature range for the year, January, and July; and average growing season length separated for summits and valleys. Summits are warmer than valleys at the same elevation.

Precipitation does not follow linear patterns with elevation. It generally increases with elevation but this is complicated by winds and topographic effects.

Potential evapotranspiration decreases linearly with altitude. At Mt. Mitchell there is a major excess of precipitation over transpiration for every month, with the largest in August and the smallest in May.

Quantitative data evaluation record for
Dickson (1959)

TOPIC

climate & meteorologic patterns

METHODS

Used data on mean temperature for year, January, and July; mean daily temperature ranges for year, January, and July; length of growing season; and annual and monthly precipitation, from established weather stations. Calculated linear regressions of weather data on elevation.

NUMBER OF SAMPLES: PERMANENT PLOTS:

DATA PRESENTED

Plots and linear regression equations for mean annual, January, and July temperatures and temperature ranges vs. elevation.

Plots of linear regression equations for growing season length vs. elevation for summits and valleys.

Plot of annual snowfall vs. elevation.

Plots of potential evapotranspiration by month for 5 stations, including Mt. Mitchell.

Plot of average annual January and July potential evapotranspiration vs. elevation.

Donley, D.E., and R.L. Mitchell. 1939. The relation of rainfall to elevation in the southern Appalachian region. Trans. Amer. Geophys. Union 20: 711-721.

SUBJECT KEYWORDS
climate, meteorologic patterns

RANGE OF COMMUNITIES
general southern Appalachian
GEOGRAPHIC SCOPE
Southern Appalachians
TYPE OF INFORMATION
quantitative
QUANTITATIVE TOPICS
climate & meteorologic patterns

Notes for Donley and Mitchell (1939)

Extends studies of relationship of rainfall and elevation in mountains to the southern Appalachians. Records from 73 TVA, U.S. Weather Bureau, and other rainfall stations above 2500 ft. with continuous records from 1935-1938 were used. Long standing station records showed this period to be typical in rainfall. Stations were divided in 4 zones based on location with respect to moisture source, major ranges, and local topography. For each zone, rainfall vs. elevation was plotted, a line fitted, and slope constant of the line given. There appears to be a linear relationship, but with much scatter.

Quantitative data evaluation record for
Donley and Mitchell (1939)

TOPIC

climate & meteorologic patterns

METHODS

Used data from 73 rainfall stations of TVA, U.S. Weather Bureau, and other agencies, with continuous data from 1935-1938. Divided stations into 4 zones based on relation to source of moisture, major mountain ranges, and local topography. Plotted rainfall vs. elevation for each zone and fitted lines.

NUMBER OF SAMPLES: 73 PERMANENT PLOTS:

DATA PRESENTED

Location and 2-year average annual rainfall for all stations.
Plots of average annual rainfall vs. elevation, for each zone.
Slope constant for linear relation of rainfall with elevation.

Duncan, W.H. 1933. Ecological comparison of leaf structures of Rhododendron punctatum, and the ontogeny of the epidermal scales. Am. Midl. Nat. 14: 83-95.

SUBJECT KEYWORDS
shrub leaf anatomy

RANGE OF COMMUNITIES
spruce-fir, heath bald

GEOGRAPHIC SCOPE
Great Smoky Mtns.

TYPE OF INFORMATION
quantitative

QUANTITATIVE TOPICS
shrub leaf anatomy

Notes for Duncan (1933)

This study examined the anatomy of Rhododendron punctatum (R. minus) leaves from adjacent spruce-fir forest and heath bald on Mt. LeConte. The heath bald is a hotter and drier environment than the forest. Leaves from the heath bald were smaller. Measurement of leaf cell layers found all layers thicker on the heath bald, with the palisade layer showing the greatest difference. The heath bald leaves also had veins closer together. Measurements of diameter of leaf scales were the same for both. Thickness of cell layers varied greatly from one part of the leaf to another, emphasizing the need to take comparative measurements on the same part of the leaf.

Detailed observations of the development of the epidermal scales are also described.

Quantitative data evaluation record for
Duncan (1933)

TOPIC

shrub leaf anatomy

METHODS

Collected leaves of Rhododendron punctatum (R. minus) from spruce-fir forest and adjacent heath bald on Mt. Leconte. Leaves were sectioned and thickness of the cell layers measured.

NUMBER OF SAMPLES: PERMANENT PLOTS:

DATA PRESENTED

Average and range of leaf length and width for leaves from heath bald and forest. Mean, standard deviation, and standard error for thickness of each cell layer, at midvein and leaf margin. Mean length of palisade layer cells, % of total mesophyll that is palisade, and palisade/spongy ratio, for both sites. Mean, standard deviation, and standard error for 30 1st row palisade cells from 10 leaves from each site. Mean, standard deviation, and standard error of distance between veins and scales in 10 leaves from each site. Mean scale diameters.

Eagar, C. 1978. Distribution and Characteristics of Balsam Woolly Aphid Infestations in the Great Smoky Mountains. M.S. Thesis, Univ. of Tennessee, Knoxville.

SUBJECT KEYWORDS
BWA infestation levels, BWA spread

RANGE OF COMMUNITIES
spruce-fir
GEOGRAPHIC SCOPE
Great Smoky Mtns.
TYPE OF INFORMATION
quantitative
QUANTITATIVE TOPICS
BWA infestation levels

Notes for Eagar (1978)

This study examined balsam woolly adelgid infestations in the Smokies in 1976 and 1977, when the adelgid was spreading through the park. Infrared aerial photography was used to divide the spruce-fir area into 11 geographic areas with similar age of infestation and 224 study units. Plot samples in each measured community factors (density of spruce and fir, sum of diameters, mean dbh), environmental factors (slope, aspect, elev., disturbance), and 5 classes of infestation. Canonical correlation was done between the 5 infestation classes and the community and environmental factors. The correlations are used to describe "typical" community and environmental attributes of stands in each infestation class.

Infestations started at low elevation, near the hardwood ecotone, and spread uphill. Infestation became heavy faster on west-facing slopes and in older, more open stands. Dense young fir stands were not infested. Correlations of infestation with slope, disturbance, and amount of spruce are probably the result of correlation of these factors with elevation and geographic area.

Quantitative data evaluation record for
Eagar (1978)

TOPIC

BWA infestation levels

METHODS

In 1976, sampled 224 plots in 11 geographic areas dervied from aerial photos. In 1977 sampled plots on elevational transects. Tallied trees in 10x10 m plots and counted seedlings in subplots. Estimated BWA levels in 2.54 cm squares. Did canonical correlation between infestation classes and environmental variables (slope, aspect, elev., disturbance) and community variables.

NUMBER OF SAMPLES: PERMANENT PLOTS:

DATA PRESENTED

Canonical correlation coefficients between adelgid infestation level classes and environmental + community factors, envi. alone, community alone, for 1976 alone, 1977 alone, both years, and both years on the west side of the park only. Correlations of each variable with the canonical variables. Standard correlation matrix of environmental and community variables.

Infestation and fir mortality are described for each of the 11 geographic areas.

Eagar, C. 1984. Review of the biology and ecology of the balsam woolly aphid in southern Appalachian spruce-fir forests. In: P.S. White (ed). The Southern Appalachian Spruce-Fir Ecosystem: Its Biology and Threats. USDI NPS Research/Res. Man. Rep. SER-71.

SUBJECT KEYWORDS

BWA effect on fir, BWA life cycle, BWA spread, BWA control, fir resistance to BWA

RANGE OF COMMUNITIES

spruce-fir

GEOGRAPHIC SCOPE

Southern Appalachians

TYPE OF INFORMATION

qualitative

QUANTITATIVE TOPICS

Notes for Eagar (1984)

Reviews various aspects of the balsam woolly adelgid, including history of infestation, life cycle and ecology of the insect, controls on populations, effects on fir, and patterns of attack within infestations. The current status and possible future of the Fraser fir forests and BWA are discussed.

The BWA was first found on Mt. Mitchell in 1957, but rapid widespread mortality suggested it had been there much longer. It was found on Mt. Rogers, the last southern Appalachian area to be infested, in 1979, but tree cores showed it had been present there since 1962 without killing the trees

The BWA population consists entirely of parthenogenically reproducing females. Dispersal is primarily by wind. Trees are killed by cellular changes caused by the insect's secretions. The xylem develops short, thick-walled, reddish tracheids with reduced ability to conduct water. The crown gradually dies, apparently from lack of water. Observation by Eagar of tissue from living infested trees at Mt. Rogers found numerous small pockets of dead tissue surrounded by wound periderm, suggesting the hypothesis that these trees were able to seal off the BWA feeding sites without damage to the whole tree.

Fedde, G.F. 1972. Status of imported and native predators of the Balsam Woolly Aphid on Mt. Mitchell, North Carolina. USDA, Forest Service, Res. Note SE-175.

SUBJECT KEYWORDS
bwa control

RANGE OF COMMUNITIES
spruce-fir
GEOGRAPHIC SCOPE
Black Mtns.
TYPE OF INFORMATION
qualitative
QUANTITATIVE TOPICS

Notes for Fedde (1972)

Describes results of the Southeast Forest Experiment Station's releases of predators of balsam woolly adelgid near Mt. Mitchell in 1959 and 1966. 22 species were tried, of which the most promising were Laricobius erichsonii (Coleoptera), Aphidoletes thompsoni (Diptera), Pullus impexus (Coleoptera), and Aphidecta obliterata (Coleoptera).

In 20 sites examined for predators in 1968, 3 native mites were the most common: Allothrombium mitchelli, an unidentified Bdellidae, and Anystis sp. The only introduced predator still present was Laricobius erichsonii, present in less than half of the sites.

At present, aphid levels were low, as most trees were either dead or uninfested.

Conclusion is that there is no good hope of predators controlling the balsam woolly adelgid.

Fedde, G.F. 1973. Cone production in Fraser firs infested by the balsam woolly aphid, Adelges piceae (Homoptera: Phylloxeridae). J. Georgia Entomol. Soc. 8: 127-130.

SUBJECT KEYWORDS
BWA infestation levels, BWA effect on fir

RANGE OF COMMUNITIES
spruce-fir
GEOGRAPHIC SCOPE
Roan Mtn.
TYPE OF INFORMATION
quantitative
QUANTITATIVE TOPICS
BWA infestation levels & BWA effect on fir

Notes for Fedde (1973a)

Study of effect of balsam woolly adelgid infestation on cone production of Fraser fir. 39 firs on Roan Mountain, survivors of a stand of 50, were studied. BWA infestation levels were estimated in plots on lower tree trunks in 1967, 1968, and 1969. Trees were measured and age determined. In 1969, a general seed year, the cone-bearing status of each tree was determined. 82% of the trees, all but the smallest ones, bore cones, despite the infestation. However, the infested trees had cones only in the upper third of the crown, while uninfested trees had cones throughout the crown. Trees were reexamined in 1970 and about 1/2 of the cone-bearing trees had died. There were no significant differences in age, size, growth rate, or infestation levels between surviving and dead trees.

BWA infestation levels peaked in 1968 and declined in 1969, as is typical when the trees' health begins to decline rapidly.

Quantitative data evaluation record for
Fedde (1973a)

TOPIC

BWA infestation levels & BWA effect on fir

METHODS

Sampled 39 firs on Roan Mtn. in an infested stand that initially contained 50. Estimated infestation by counting BWA wax masses in 2 9 sq. in. plots on the lower 6 ft. of each trunk, in 1967-1969. Measured dbh and determined age. Checked for cones in 1969. Checked for mortality in 1970.

NUMBER OF SAMPLES: 39   PERMANENT PLOTS:

DATA PRESENTED

Number of trees, mean and std. error of dbh, age, and number of BWA wax masses/sq. in. in each of the 3 years, for cone-bearing and non-cone-bearing trees.

Fedde, C.F. 1973. Impact of the balsam woolly aphid (Homoptera: Phylloxeridae) on cones and seed produced by infested Fraser fir. Canad. Entomol. 105: 673-680.

SUBJECT KEYWORDS
BWA effect on fir, BWA infestation levels, insect damage, tree reproduction, seed viability and germination
RANGE OF COMMUNITIES
spruce-fir
GEOGRAPHIC SCOPE
Roan Mtn.
TYPE OF INFORMATION
quantitative
QUANTITATIVE TOPICS
seed viability and germination & insect damage

Notes for Fedde (1973b)

Describes physical and viability tests on Fraser fir seed produced by balsam woolly adelgid-infested and uninfested trees. Cones were collected in 1969 from an infested and uninfested sprayed stand on Roan Mountain. Data on tree size, age, and 3 years of infestation levels are given (same data for infested trees is in Fedde (1973a)). Cone length and seed dimensions were measured, and numbers of seeds filled, empty, and infested by chalcids determined both by cutting seeds and by x-raying.

BWA-infested trees had smaller, more brittle cones. Their seeds were significantly smaller and more were empty and chalcid-infested. Germination of seeds from infested trees was 32.5%, compared to 75.5% for uninfested trees. One infested tree, which was dying, produced 100% unfilled seeds.

X-ray examination found many more chalcid-infested seeds than did cutting seeds.

Quantitative data evaluation record for
Fedde (1973b)

TOPIC
seed viability and germination & insect damage

METHODS
Sampled an infested stand on Roan Mtn., for which 3 years of BWA infestation data had been collected (Fedde 1973a). Sampled uninfested sprayed trees 1/4 mile away. Collected cones. Measured cone length, seed length, seed wing length, seed vol., seed wt. Counted number of seeds filled, not filled, and infested with chalcids, both by cutting & X-ray. Tested germination.

NUMBER OF SAMPLES: PERMANENT PLOTS:

DATA PRESENTED
Mean and std. error of cone length, seed length, seed wing length, seed volume, seed wt., number of seeds/g, % of seeds found empty, chalcid-infested, and filled, in cut and x-rayed seeds, and % germination, for uninfested trees, infested trees, and 1 dying infested tree.

Fedde, G.F. 1974. A bark fungus for identifying Fraser fir irreversibly damaged by the balsam woolly aphid, Adelges piceae (Homoptera: Phylloxeridae). J. Georgia Entomol. Soc. 9: 64-68.

SUBJECT KEYWORDS
BWA infestation levels, BWA effect on fir, disease

RANGE OF COMMUNITIES
spruce-fir
GEOGRAPHIC SCOPE
Roan Mtn.
TYPE OF INFORMATION
quantitative
QUANTITATIVE TOPICS
BWA effect on fir & disease

Notes for Fedde (1974)

Observations during the course of other studies suggested that the appearance of fruiting bodies of the bark fungus Lachnellula agassizii on green balsam woolly adelgid-infested firs might be useful as an indicator that they were in poor health and would soon die. This fungus functions as a secondary parasite and saprophyte, invading weakened and dead trees.

To test this idea, firs were studied in the stand on Roan Mtn. previously used by Fedde (1973a, 1973b). 8 green BWA-infested trees with some fruiting bodies of the fungus were found and 8 BWA-infested trees without the fungus were randomly selected for comparison. Dbh, number of years of infestation (redwood rings), and number of BWA adults and eggs were counted. Of the 8 trees with the fungus, 7 died the next year and the other began declining. The trees with the fungus had fewer adelgids present, supporting the idea that they were already declining. They had been infested for fewer years, suggesting that the infestation was more acute on them. There was no difference in size of the trees with and without the fungus.

Quantitative data evaluation record for
Fedde (1974)

TOPIC
BWA effect on fir & disease

METHODS
Studied trees in a stand on Roan Mtn. used in previous studies (Fedde 1973a,b). Found 8 still-healthy, BWA-infested trees, bearing some fruiting bodies of Lachnellula agassizii. Selected 8 random BWA-infested trees without the fungus. Measured dbh of trees. Cored trees and counted number of redwood rings. Counted number of BWA adults and eggs in quadrats on lower trunks.

NUMBER OF SAMPLES: 8   PERMANENT PLOTS:

DATA PRESENTED
Mean and standard deviation of tree dbh, number of years of red-wood, number of BWA adults and egg masses, on trees with and without the fungus, and t-tests of differences.

Feldkamp, S.M. 1984. Revegetation of upper elevation debris slide scars on Mt. LeConte in the Great Smoky Mountains National Park. M.S. Thesis, Univ. of Tennessee, Knoxville.

SUBJECT KEYWORDS
disturbance, landslides, rare species, succession, geomorphology, soil properties
RANGE OF COMMUNITIES
spruce-fir
GEOGRAPHIC SCOPE
Great Smoky Mtns.
TYPE OF INFORMATION
quantitative
QUANTITATIVE TOPICS
succession & soil properties, landslides & geomorphology

Notes for Feldkamp (1984)

A study of landslides above 5600 feet elev. on Mt. LeConte was made in order to describe slide vegetation, to relate the pattern of vegetation to slide topography, and to note the effect of recovery time following a slide on vegetation. 9 landslides, 1 1/2-50 years old, were studied. Based on slope shape, steepness, and profile, each slide was divided into 3 vertical zones (head, erosion transportation, and transportation-gully) and 2 horizontal zones (center and margins). Environmental significance of these zones was discussed. Individual descriptions of landslides were given and a site location map included.

Vegetation and environmental factors were measured in 50x50 cm plots. 7 herb communities were described. ANOVA's were done to determine if different topographic positions within a landslide and different slide age classes resulted in equal means for % area covered by 4 substrate types. Because landslides are a harsh environment, substrate differences rather than larger-scale environmental factors were considered most important in determining vegetational differences between slides. Environmental stress and natural disturbance were discussed in a general sense and in relation to specific rare plants on Mt. LeConte slides.

Quantitative data evaluation record for
Feldkamp (1984)

TOPIC
succession & soil properties

METHODS
Used field data described under landslides. Did ANOVA for plot center soil depth, % bare rock, % bryophyte cover, and % lichen cover with 4 ages, 3 vertical zones, and 2 horizontal zones. Did cluster analysis on plots from 4 slides (1 in each age class).

NUMBER OF SAMPLES: PERMANENT PLOTS:

DATA PRESENTED
Source of variation, degrees of freedom, mean squares, F value, significance at p=.05, .01, .001, for soil depth, % bare rock, % bryophyte cover, % lichen cover. Frequency plus mean and std. dev. of soil depth and % bare rock, for each of the 7 communities indicated by cluster analysis.

Quantitative data evaluation record for
Feldkamp (1984)

TOPIC
landslides & geomorphology

METHODS
Landslides chosen for elev., accessibility, aspect, slope, age. 50x50 cm plots placed 1 m apart in horizontal transects 15 m apart. Estimated dryness, canopy cover class, % rock, bryophyte, and herb cover. Measured soil depth. Counted woody stems. Est. microhabitat category by species, slide horizontal & vertical zone. Slide age, aspect, % slopes, width of zones.

NUMBER OF SAMPLES: 521 PERMANENT PLOTS:

DATA PRESENTED
Age, aspect, mean % slope, width ranges, total number of plots, vascular sp. freq., total number of vascular plants, % of plots with no vascular plants, mean number of vascular taxa/plot, mean and std. dev. of soil depth to obstruction at plot center, % cover/plot by rock, bryophytes, lichens, and vascular plants, for each slide. Mean % bare rock, mean soil depth in plot center and in plant clusters for slide margin and center. Mean and std dev. of soil depth by vascular species. % of total vascular species, frequency, and mean cover in each slide, by life form category.

Fox, J.F. 1977. Alternation and coexistence of tree species. Am. Nat. 111: 69-89.

SUBJECT KEYWORDS
population dynamics, tree reproduction

RANGE OF COMMUNITIES
spruce-fir
GEOGRAPHIC SCOPE
Great Smoky Mtns.
TYPE OF INFORMATION
quantitative
QUANTITATIVE TOPICS
tree reproduction

Notes for Fox (1977)

This study examines the observation that frequently trees reproduce better under trees of other species than under their own species. It addresses the hypothesis that dominant trees provide microhabitats that influence the probability that they will be replaced with a different species, and that tree dynamics are regulated by interactions on the scale of individual trees.

Sampled virgin forests in 5 sites, including spruce-fir forest in the Smokies. Each forest was dominated by 2 principal tree species. The number of saplings of each species under the canopy of each species, and the species of the largest sapling under each tree, were noted. In the Smokies, fir was much more common under spruce, and spruce slightly more common under fir. Size distributions are given of each species under its own species and under the other species. The curves are generally parallel but those under the other species have more saplings in all size classes.

Various mechanisms that could produce this apparent alternation are discussed, as are other mechanisms that could allow coexistence of species.

Quantitative data evaluation record for
Fox (1977)

TOPIC

tree reproduction

METHODS

Sampled virgin forests in the Great Smoky Mountains, in Michigan, Pennsylvania, Florida, and Wyoming. Measured the size of saplings by species under each canopy species. Recorded the species of largest sapling under each canopy tree. Did chi squared tests of association of canopy and sapling species.

NUMBER OF SAMPLES: PERMANENT PLOTS:

DATA PRESENTED

Number of saplings of each species under each canopy species, with results of chi squared test, for each site. Frequency of each species of largest sapling under each canopy species. Plots of size distribution of saplings of each species, under canopy of their own species and the other species.

Frothingham, E.H. 1924. New forests for cut-over and burned spruce lands in the southern Appalachians. USDA, Forest Service, Appalachian Forest Experiment Station, Official Record, December 10, 1924.

SUBJECT KEYWORDS
tree planting, exotic plants

RANGE OF COMMUNITIES
spruce-fir

GEOGRAPHIC SCOPE
Black Mtns.

TYPE OF INFORMATION
quantitative (no form)

QUANTITATIVE TOPICS

Notes for Frothingham (1924)

This manuscript was not examined. The following is an abstract from USDA, Forest Service, 1947, Bibliography of the Appalachian Forest Experiment Station 1921-1946.

Highland spruce and fir areas denuded by logging and fire can be reproduced only through planting. Twenty-eight study plots involving 12 coniferous species were planted on south and east exposures near Mt. Mitchell in North Carolina. These experiments will best determine species and methods for reforestation in the spruce type.

These planting experiments are described in several other publications.

Frothingham, E.H. 1931. Timber growing and logging practice in the southern Applachian region. USDA Tech. Bull. 250. 93 pp.

SUBJECT KEYWORDS
forest condition, forest management, tree reproduction, fire, logging, insect damage, succession

RANGE OF COMMUNITIES
general southern Appalachian

GEOGRAPHIC SCOPE
Southern Appalachians

TYPE OF INFORMATION
qualitative

QUANTITATIVE TOPICS

Notes for Frothingham (1931)

One of a series directed toward forest land owners in 12 principal forest regions of the United States, this paper describes southern Appalachian forest communities, forest utilization and yield, and effects of fire, insects, and disease. Regionally applicable measures for reforestation following both logging and slash fires are outlined. Factors affecting reproduction, growth, and value of timber are discussed. Advice on forest management practices for making full use of the productive capacity of the land center on fire prevention, insect damage prevention, and logging practices.

Information specific to spruce forests includes the mention of Southern pine beetles, in addition to logging and fire, as causes of the destruction of the spruce forest type in the Black and Balsam Mtns. A summary of data on reproduction from a burned and unburned cut-over spruce stand in North Carolina is given. Burned spruce forests are described as often "seized by rhododendron and laurel." Windthrow risk was considered serious if large trees were left exposed by cutting. Planting was recommended for perpetuation of conifers on cut-over and burned spruce lands.

Frothingham, E.H., J.S. Holmes, W.J. Damtoft, E.F. McCarthy, and C.F. Korstian. 1926. A forest type classification for the southern Appalachian Mountains and adjacent plateau and coastal region. J. Forestry 24: 673-684.

SUBJECT KEYWORDS
vegetation patterns, variation within spruce-fir

RANGE OF COMMUNITIES
general Southeastern
GEOGRAPHIC SCOPE
Southeastern U.S.
TYPE OF INFORMATION
qualitative
QUANTITATIVE TOPICS

Notes for Frothingham, et al. (1926)

The dominant species, associates, type variants, successional species, and general elevation and topographic position of 27 forest cover types were described in an effort by the Society of American Foresters to standardize forest cover type names of the Southern Appalachian Mountains and adjacent areas. The spruce-fir type included the standard red spruce-southern balsam (Fraser) fir and the following variants: pure fir (at the highest altitudes), pure spruce, and spruce-yellow birch (transitional to northern hardwoods or hemlock-yellow birch type). Elevation boundaries were 4500 ft. in the southern Appalachian Mountains and 3250 ft. in the Alleghany highlands of West Virginia. Blackberry, raspberry, rhododendron, elder, fire cherry, yellow birch, and other northern hardwoods were listed as successional species following fire and clear cutting of the spruce-fir type.

Fuller, R.D. 1977. Why Does Spruce Not Invade the High Elevation Beech Forests of the Great Smoky Mountains. M.S. Thesis, Univ. of Tennessee, Knoxville.

SUBJECT KEYWORDS
allelopathy, tree reproduction, community maintenance, soil moisture, soil temperature
RANGE OF COMMUNITIES
beech gap, spruce-fir
GEOGRAPHIC SCOPE
Great Smoky Mtns.
TYPE OF INFORMATION
quantitative
QUANTITATIVE TOPICS
allelopathy, soil moisture & soil temperature

Notes for Fuller (1977)

This study examined possible factors preventing spruce seedlings from invading adjacent beech gap communities. Soil temperature and moisture were measured throughout the growing season. The beech gap soil temperature fluctuated widely in the leafless period. The spruce-fir soil was below field capacity more frequently, though soil moisture level never approached the wilting potential. Soil, roots, fragmented and whole leaf litter collected from each community in spring, summer, and fall, were tested for effects on red spruce germination and radicle elongation, using concentrated water extracts, on glass wool. Spruce germination was delayed, but not significantly reduced after 15 days, while radicle growth was reduced. Spruce seeds planted in soil cores with fall litter and placed in growth chambers simulating natural microclimate, showed significantly delayed and reduced germination in the beech gap microclimate.

Factors which may contribute to prevention of spruce invasion of beech gaps include seed predation under beech litter, toxins from beech litter, high temperature variation in spring, inability of radicle to reach moist soil in spring drought, and damping off.

Quantitative data evaluation record for
Fuller (1977)

TOPIC
    allelopathy
METHODS
    Sampled spuce-fir and beech gap litter and top 5 cm of soil, 1.5 km W of Newfound Gap. Watered spruce seeds with water extracts from soil, roots, and litter of each forest. Planted seeds in soil cores with fall litter from each forest, at room temp., in growth chambers with microclimate of each forest, and in fenced and unfenced field plots in each forest.
NUMBER OF SAMPLES: PERMANENT PLOTS:
DATA PRESENTED
    % inhibition of germination and radicle elongation by extracts on seeds in glass wool vs. distilled water. Mean & std. dev. of % germ. in soil cores under fall litter of each type at room temp. Cumulative germ. curves and fate of seeds in soil cores from each forest under microclimate of each. Mean and std. dev. of root & shoot dry wt. of seedlings in summer microclimate of each forest. Fate of seeds and radicle growth in cores from each forest, in each. Fate of seeds planted in plots, after fall, winter, and spring, with and without litter removal and screen exclosures.

Quantitative data evaluation record for
Fuller (1977)

TOPIC
    soil moisture & soil temperature
METHODS
    Sampled in spruce-fir and adjacent beech gap 1.5 km W of Newfound Gap, at 1620 m. Measured soil temperature with temperature probes at 2 cm depth, April-Dec. Collected soil samples at 2 week intervals, March-Nov., and measured % moisture. Measured moisture content of soil at 1/3 bar and 1 bar tension with pressure plate.
NUMBER OF SAMPLES: PERMANENT PLOTS:
DATA PRESENTED
    Plot of 10-day average maximum and minimum soil temperatures in each forest. Plot of soil moisture (% dry weight) for 2-week intervals, with lines for moisture at 1/3 bar (field capacity) and 1 bar.

    Weather station data collected by TVA for 1976 and average for 10 years--precipitation by month and daily temperature range.

Pulling, E.H. 1936. Abies intermedia, the Blue Ridge Fir, a new species. Castanea 1: 91-94.

SUBJECT KEYWORDS
fir taxonomy

RANGE OF COMMUNITIES
spruce-fir
GEOGRAPHIC SCOPE
Shenandoah
TYPE OF INFORMATION
qualitative
QUANTITATIVE TOPICS

Notes for Pulling (1936)

This article reviews the doubts that have been expressed by various botanists about the identity of fir trees in Virginia and West Virginia. Trees on Hawksbill Mountain, Shenandoah National Park, which don't match either Abies balsamea or Abies fraseri are described as a new species: Abies intermedia.

Gant, R.E. 1978. The Role of Allelopathic Interference in the Maintenance of Southern Appalachian Heath Balds. PhD. Dissertation, Univ. of Tennessee, Knoxville.

SUBJECT KEYWORDS
vegetation sample, allelopathy, succession

RANGE OF COMMUNITIES
heath bald
GEOGRAPHIC SCOPE
Balsam Mtns.
TYPE OF INFORMATION
quantitative
QUANTITATIVE TOPICS
vegetation sample, allelopathy

Notes for Gant (1978)

A study was made of potential sources of allelopathic interference in 2 heath balds which straddle a southwest sloping lead on Waterrock Knob in the Plott Balsam Mtns. A vegetation survey was made to quantify the differences between the 2 balds, one of which was dominated by Rhododendron maximum, and the other by R. catawbiense. Field reconnaissance was done to determine site disturbance history. Potential phytotoxins were categorized using paper and gas chromatography on laboratory stock. The samples of potential sources of these phenolic and terpenoid compounds (canopy drip, litterfall, litter, soil, and roots) were collected periodically and analyzed. Bioassays were done on laboratory stock and a series of monthly bioassays was performed on Abies fraseri, Betula lenta, and Tsuga canadensis using filtered canopy drip or leachates. Differences in perceived persistence and response to disturbance of the balds were discussed in a theoretical context with the R. catawbiense being considered climax.

Quantitative data evaluation record for
Gant (1978)

TOPIC
vegetation sample
METHODS
Sampled 2 heath balds on a SW-sloping lead on Waterrock Knob. 2 transects parallel and perpendicular to the ridge along the long axis of each bald. Counted stems >.5 m tall occurring within 1 m of the transect line.

NUMBER OF SAMPLES: PERMANENT PLOTS:
DATA PRESENTED
Density and % of total of Abies fraseri, Betula lenta, Kalmia latifolia, Picea rubens, Prunus serotina, Rhododendron catawbiense, R. maximum, Vaccinium spp. and unidentified, by site and by north and south slope in one site.

Quantitative data evaluation record for
Gant (1978)

TOPIC
allelopathy
METHODS
Sampled 2 heath balds on a SW sloping lead on Waterrock Knob. Collected canopy drip in 3 collectors/slope/site; soil in 5x15 cm cores from 3 1x.15 m plots/site; heath litter in 6 bins/site monthly. Collected large litter in 3 1x5 m plots/site yearly. Collected roots in 5 .5x.5 m soil columns/site. Did bioassays on leachates, chromatography to identify phenolics and terpenoids.
NUMBER OF SAMPLES: PERMANENT PLOTS:
DATA PRESENTED
Presence/absence of various phytotoxins in canopy drip, litter, and soil; bioassay results by species for litter & soil samples; kg/ha of litter components; seeds/ha in litterfall, by month for each site. Weight and % of total for underground organs by size class and depth for each site. Annual total seeds/ha and % total by species by site. Growth of each test species with different known phytotoxin levels (sensitivity test). ANOVA and mean separation for greenhouse and field bioassays. Presence/absence of various phytotoxins in yellow leaves, green lvs., flowers, wood.

Gattinger, A. 1901. The Flora of Tennessee and a Philosophy of Botany. Gospel Advocate Press, Nashville, Tenn.

SUBJECT KEYWORDS
History, vascular taxonomy, conservation

RANGE OF COMMUNITIES
general Southeastern

GEOGRAPHIC SCOPE
Tennessee

TYPE OF INFORMATION
qualitative

QUANTITATIVE TOPICS

Notes for Gattinger (1901)

This book consists primarily of a list of species known in Tennessee at the time, with notes on habitat and blooming times of each. An introduction briefly describes the vegetation of Tennessee. The history of the origins of philosophy and the development of botanical inquiry to the time are described. Arguments are made for the value of forestry and forest protection, and for the creation of a national park or forest reserve in the southern Appalachians.

Gersmehl, P.J. 1973. Pseudo-timberline: the southern Appalachian grassy balds. Arctic and Alpine Res. 5: A137-A138.

SUBJECT KEYWORDS
community maintenance, disturbance

RANGE OF COMMUNITIES
grassy bald

GEOGRAPHIC SCOPE
Southern Appalachians

TYPE OF INFORMATION
qualitative

QUANTITATIVE TOPICS

Notes for Gersmehl (1973)

This article summarizes information and hypotheses regarding the origin and maintenance of grassy balds. The theoretical thermal timberline in the region is 1200 m higher than the highest peak. Wind velocities are often greater in forested gaps and summits than on balds. Postfire succession generally leads to shrubs rather than grassy bald vegetation.

The ecotonal hypothesis suggests that spruce-fir forest was eliminated on some peaks during the Hypsithermal period, when vegetation zones were shifted upward. More recently, when zones shifted back downward, the summits lacked spruce-fir forest but were too high for hardwoods, and became grassy balds. The presence of spruce stands 600 m below their normal lower limit, and hardwood stands 400 m above their normal upper limit suggest it is unlikely that spruce-fir forest would be eliminated by zone shifting. Also, many grassy balds are not on ecotones.

Persistence of balds has been attributed to severe microclimate, but measurements find no difference between places where trees are invading and where they aren't.

The author attributes the persistence of grassy balds to grazing and limited seed dispersal.

Golden, M. S. 1974. Forest vegetation and site relationships in the central portion of the Great Smoky Mountains National Park. Ph.D. Dissertation, University of Tennessee, Knoxville.

SUBJECT KEYWORDS
General vegetation

RANGE OF COMMUNITIES
General Southern Appalachian
GEOGRAPHIC SCOPE
Great Smoky Mtns.
TYPE OF INFORMATION
Quantitative (no form)
QUANTITATIVE TOPICS

Notes for Golden (1974)

266 samples raning from 759 to 1585 m. This is too low for all o f the spruce-fir types to be expressed and only spruce-birch is d escribed. Relative densities in various size classes is used to asses population stability in dominant trees. Soil data were col lected. 19 plots were in the spruce-yellow birch type. Nested p lots were used. Plots were not permanent.

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Golden, M. S. 1981. An integrated multivariate analysis of fore
st communities of the central Great Smoky Mountains. Amer.
Midl. Nat. 106:37-53.

SUBJECT KEYWORDS
General vegetation

RANGE OF COMMUNITIES
General Southern Appalachian
GEOGRAPHIC SCOPE
Great Smoky Mtns.
TYPE OF INFORMATION
Quantitative (no form)
QUANTITATIVE TOPICS

Notes for Golden (1981)

244 stands were reported on here from Golden (1974). Yellow birc
h-spruce was included but the sample is too low for much of the s
pruce-fir zone. Plots were not permanent.

Greenback, D.O. 1970. Climate and ecology of the balsam woolly aphid. Canad. Entomol. 102: 546-578.

SUBJECT KEYWORDS
BWA response to environment

RANGE OF COMMUNITIES
northern spruce-fir
GEOGRAPHIC SCOPE
Northeast U.S.
TYPE OF INFORMATION
quantitative (no form)
QUANTITATIVE TOPICS

Notes for Greenback (1970)

Investigated climatic factors affecting balsam woolly adelgid infestations on balsam fir in the Maritime Provinces. Except for in the southern Appalchians, all infestations are limited to within 100 miles of the coast.

Weather station data were used to make maps and tables of total accumulated summer heat, minimum temperature, and depth of snowfall, the primary climatic factors affecting BWA. The area has 3 climatic zones: maritime, with mild winters; continental, with cold winters and deep snow; and transition, with irregular winters and snowfall.

In the maritime climate BWA attacks both stems and twigs. Populations disperse from the twigs and occur throughout the region. Trees eventually die from twig attack by loss of leaves. In the continental climate populations are limited by cold to the base of trunks below the snow line. Dispersal is limited and infestations are scattered and small. In the transition climate populations build up but are checked by occasional extreme cold.

Experiments were done on freezing point and temperature effects on populations from various places. Populations have not genetically differentiated. None survive temp. < -35 F.

Griffin, N.C.W. 1965. Germination and Early Survival of *Picea rubens* Sargent in Experimental Laboratory and Field Plantings. M.S. Thesis, University of Tennessee, Knoxville.

SUBJECT KEYWORDS
tree reproduction, seed viability and germination, tree growth, tree planting
RANGE OF COMMUNITIES
spruce-fir, oak forest, plantation
GEOGRAPHIC SCOPE
Southern Appalachians
TYPE OF INFORMATION
quantitative
QUANTITATIVE TOPICS
tree growth, seed viability and germination

Notes for Griffin (1965)

This study examined the germination and survival of red spruce seedlings under various conditions. Field plantings were done in plots in the Great Smoky Mountains and in 4 sites outside of the natural range of spruce, in Kentucky, North Carolina, and Georgia. Seeds collected on Roan Mtn., the Balsam Mtns., and the Great Smoky Mtns. had very low numbers viable. Commercial seed from the Adirondacks was also used. Seeds did germinate and survive the first year outside of the natural range of spruce.

Commercial seeds were planted in the laboratory, with experiments done on effect of soil, cold treatment, watering solution, pH, and planting depth. No significant differences were found with cold treatment or with the different substrates. Differences were found between germination and survival in soil from Wayah Bald and Brasstown Bald. Planting depths of 1/4-1/2 inch were found best.

Seedlings were planted at 3 elevations in Great Smoky Mtns. Those at 5000 ft. had the greatest dry weight after one growing season, with 4000 and 6000 ft. close to each other. The greenhouse-grown control plants were the largest.

Quantitative data evaluation record for
Griffin (1965)

TOPIC

tree growth

METHODS

Planted greenhouse seedlings in field plots June 23 at 4000, 5000, and 6000 ft. in Great Smoky Mountains and in the greenhouse. Seedlings harvested on Oct. 3, dried and weighed.

NUMBER OF SAMPLES: PERMANENT PLOTS:

DATA PRESENTED

Mean weight of seedlings in the 3 field plots and greenhouse control.

Quantitative data evaluation record for
Griffin (1965)

TOPIC

seed viability and germination

METHODS

Plots in Smokies (Indian Park Gap) and several sites outside of spruce-fir range. Planted seed from Roan Mtn., Richland Balsam, Smokies, and the Adirondacks. Counted germination & survival every 4 weeks, June-Oct. Greenhouse experiments compared stratified vs. not stratified, different soils, different planting depth, Hoglands solution vs. tap and distilled water, and pH.

NUMBER OF SAMPLES: 50 PERMANENT PLOTS:

DATA PRESENTED

Number of seeds from each seed source germinating and surviving in each site. Germination in 3 sets of seeds in mineral soil, with & without stratification, at .25 and .5 in. planting depth. Germination in 3 sets of seeds at .25 in. depth in sand and moss, with and without stratification. Germination & survival of 3 sets of seeds in soil from Brasstown Bald & Wayah Bald, at 3 planting depths. Germination & survival of 3 sets in sand watered with Hoagland's solution and distilled water, and in moss watered with tap water and distilled water.

Hadley, J.B., and R. Goldsmith. 1963. Geology of the Eastern Great Smoky Mountains, North Carolina and Tennessee. U.S. Geological Survey Prof. Paper 340-B.

SUBJECT KEYWORDS
geology

RANGE OF COMMUNITIES
general southern Appalachian
GEOGRAPHIC SCOPE
Great Smoky Mtns.
TYPE OF INFORMATION
quantitative (no form), map
QUANTITATIVE TOPICS

Notes for Hadley and Goldsmith (1963)

Detailed geologic investigation of the eastern Great Smoky Mountains, extending west to Clingmans Dome and Gatlinburg. Rock units, structures, metamorphism, and surficial conditions are described in detail, and geologic interpretations are made. Various diagrams, tables of chemical and mineral composition, cross sections, and a colored geologic map at a scale of 1:62,500, are given. This work is summarized in King, Neuman, and Hadley (1968).

Haneman, D.M., H.L. Lambert, and D.D. Johnston. 1981. Detection and evaluation of the balsam woolly aphid infestations on Mount Rogers, Virginia, 1980. USDA, Forest Service, Southeastern Area, State and Private Forestry, Atlanta, GA. Rept. No. 81-1-12.

SUBJECT KEYWORDS
BWA spread, BWA infestation levels, BWA effect on fir

RANGE OF COMMUNITIES
spruce-fir

GEOGRAPHIC SCOPE
Mt. Rogers

TYPE OF INFORMATION
quantitative

QUANTITATIVE TOPICS
BWA infestation levels

Notes for Haneman, Lambert, and Johnston (1981)

Gives results of a 1980 survey for balsam woolly adelgid on Mt. Rogers, where it had first been detected in 1979. Traps made of sticky microscope slides were placed on trees and later examined for motile BWA larvae. Of 61 trap plots 2, both within 1/2 mile of a known infestation, had BWA. One had BWA on the lower bole, the other in the middle bole where they could be found only by climbing.

The 47 trees permanently marked in 1979 (Lambert, Morgan, and Johnson 1980) were reexamined and new data on numbers of BWA, crown class, and number of years infested are given. Some trees showed increases in infestation and decline in condition.

18 nodes from known infested trees were examined for evidence of twig infestation, as occurs in balsam fir. None were found.

Quantitative data evaluation record for
Haneman, Lambert, and Johnston (1981)

TOPIC

BWA infestation levels

METHODS

Placed 61 sets of 3 sticky microscope slide traps on Cabin Ridge in 198Ø, and examined for BWA. Trees between the trap trees were examined while setting the traps. Resampled the 47 premanently marked infested fir trees established by Lambert, Morgan, and Johnson (198Ø).

NUMBER OF SAMPLES: PERMANENT PLOTS: Y

DATA PRESENTED

Dbh, age, crown class in 1979 and 198Ø, BWA infestation intensity in 1979 and 198Ø, and number of years infested as of 198Ø, for each of the 47 permanently marked trees.

Hardy, A.V., C.B. Carney, and H.V. Marshall, Jr. 1967. Climate of North Carolina Research Stations. Bull. 433. Ag. Exp. Station, NC State Univ.

SUBJECT KEYWORDS
climate

RANGE OF COMMUNITIES
general southern Appalachian
GEOGRAPHIC SCOPE
North Carolina
TYPE OF INFORMATION
quantitative
QUANTITATIVE TOPICS
climate

Notes for Hardy, Carney, and Marshall (1967)

Contains weather data from the 17 North Carolina Ag. Experiment Stations, including ones at Waynesville, at Fletcher (Henderson Co.), and at Transou (Ashe Co.). These data are apparently from U.S. weather stations. Mean monthly temperature and rainfall are given for each year of data. Missing data values were filled by interpolation. Maximum, minimum, average, and record high and low for temperature and precipitation are given for the period.

Data from these stations is also contained in NOAA (series) and U.S. Weather Bureau (series).

Quantitative data evaluation record for
Hardy, Carney, and Marshall (1967)

TOPIC

Climate

METHODS

Used weather station records for the 17 NC Ag. Res. Stations scattered across the state. Mountain stations are at Waynesville (called Waynesville 1 E), Henderson (called Fletcher 3 W), and Transou. Records at Waynesville were kept since 1894 at one of 3 similar locations. Records at Fletcher were kept since 1955, at Transou since 1946. Missing data were filled in by interpolation.

NUMBER OF SAMPLES: 3   PERMANENT PLOTS: Y

DATA PRESENTED

Mean daily maximum and minimum temperature, monthly mean temp., record high and low temp., mean degree days above 65 F, mean precipitation, record daily precip., mean and record monthly precip., record daily snow and sleet, by month over the period of records. Monthly average temperature and monthly precipitation by month, for each year of records.

Harmon, M.E. 1981. Fire History of the GSMNP, 1940-1979.
USDI,NPS,SE Regional Office,
Res.Man.Rep. SER-46, 39 pp.

SUBJECT KEYWORDS
Fire

RANGE OF COMMUNITIES
General Mountain Vegetation
GEOGRAPHIC SCOPE
Great Smoky Mtns.
TYPE OF INFORMATION
Quantitative (no form)
QUANTITATIVE TOPICS

Notes for Harmon (1981)

This report covers fire records extant in GSMNP Archives and files. This data is summarized in terms of ignition source, site types, fire size and rotation period. Fire is rare in the Spruce-Fir zone.

Harmon, M.E., S.P. Bratton, and P.S. White. 1984. Disturbance and vegetation response in relation to environmental gradients in the Great Smoky Mountains. Vegetatio 55: 129-139.

SUBJECT KEYWORDS
disturbance, fire, disease, vegetation-environment relationship, insect damage, modelling, exotic animals
RANGE OF COMMUNITIES
general southern Appalachian
GEOGRAPHIC SCOPE
Great Smoky Mtns.
TYPE OF INFORMATION
quantitative
QUANTITATIVE TOPICS
disturbance & vegetation-environment relationships

Notes for Harmon, Bratton, and White (1984)

Extends Whittacker's concept of vegetational and environmental gradients to include disturbance. Several types of data are cited to show that disturbance varies along environmental gradients. Fire patterns have changed, from high frequency before the park to low frequency at present. Lightning fires are most likely on dry ridges; man-caused fires on mesic valley sites. Natural fires will not replace anthropogenic fires that established vegetation patterns. Pine forests will probably succeed to oak.

Species differ in sprouting ability, so ability of communities to recover from disturbance also varies along gradients.

Use of a model (Olson 1963) for litter recovery after fire shows a range from 4 years in low mesic sites to 40 years in high dry ridges and greater than 60 years in spruce-fir.

Exotic species invasion varies along gradients also. Pests are concentrated where hosts are common, as in chestnut blight and balsam woolly aphid. Wild boars are more concentrated where mesic herbs occur, being most destructive in beech gaps.

It is difficult to distinguish environmental effects on vegetation from disturbance effects, since they are correlated.

Quantitative data evaluation record for
Harmon, Bratton, and White (1984)

TOPIC

disturbance & vegetation-environment relationship

METHODS

Did plot samples for boar damage. Plots distributed along environmental gradients; locations not given. Estimated percent of surface disturbed.

Used diagrams of species and community distribution from Whittaker (1956) to calculate distribution of sprouting species and pest damage.

NUMBER OF SAMPLES: PERMANENT PLOTS:

DATA PRESENTED

Plots of community attributes on moisture-elevation diagrams:

Percentage of sprouting species in eastern and western Smokies.

Predicted number of years for litter recovery after fire, based on a model by Olson (1963).

Impact of chestnut blight and balasm woolly aphid.

Percent of surface disturbed by boars.

Harper, R.M. 1910. Summer notes on the mountain vegetation of Haywood County, North Carolina. Torreya 10: 53-64.

SUBJECT KEYWORDS
vegetation patterns, grazing

RANGE OF COMMUNITIES
general southern Appalachian

GEOGRAPHIC SCOPE
Balsam Mtns.

TYPE OF INFORMATION
qualitative

QUANTITATIVE TOPICS

Notes for Harper (1910)

This paper describes observations of the vegetation seen on walks in an area including Pisgah Ridge, the East Fork of the Pigeon River, and Cold Mountain.

Cold Mountain, the only place visited above 5500 ft., had open vegetation with uncommon fir and beech-hawthorn thickets on the north slope. Fir was seen to be more common on neighboring summits of the Balsam Mountains. The summit is said to have long been pastured as had most in the region.

Vegetation of lower elevation slopes and peaks, ravines, coves, river bottoms, and wet meadows, is also described.

Harper, R.M. 1947. Preliminary list of southern Appalachian endemics. Castanea 12: 100-112.

SUBJECT KEYWORDS
vascular flora, floristic affinities

RANGE OF COMMUNITIES
general southern Appalachian

GEOGRAPHIC SCOPE
Southern Appalachians

TYPE OF INFORMATION
qualitative, species list

QUANTITATIVE TOPICS

Notes for Harper (1947)

This article presents a list of species confined to the southern Appalachians, defined as extending to the limit of glaciation and including the Cumberland Plateau but not the Great Valley. The list contains 188 species (using nomenclature of Small's 1933 manual), with marks for newly described species with poorly known distributions and for those with slightly broader distribution.

Endemics are most common at higher elevation. The list is only 10% monocots, a fairly low proportion, and contains very few trees.

A later publication, Harper 1948, Castanea 13: 124-127, notes a number of errors in the list and in the text of this article.

Harshberger, J.W. 1903. An ecologic study of the flora of mountainous North Carolina. Bot. Gaz. 36: 241-258; 368-385.

SUBJECT KEYWORDS
floristic affinities, vegetation patterns, climatic change

RANGE OF COMMUNITIES
general southern Appalachian
GEOGRAPHIC SCOPE
Southern Appalachians
TYPE OF INFORMATION
qualitative
QUANTITATIVE TOPICS

Notes for Harshberger (1903)

Describes subjective observations of flora and vegetation of Mt. Mitchell and the surrounding area, with notes on Grandfather and Roan Mountain. Coniferous forest appeared, in the Black Mtns., around 5200 feet, though occasional spruce could be found at 4500 feet. Natural meadows are also described for the Black Mountains, surrounded by spruce-fir. The dwarfed tree-shrub areas on Grandfather Mountain and the balds of Roan Mountain are described.

There is extensive discussion of biogeography, the influence of physiographic changes, climatic changes, and species migration on the flora of the region.

Hart, A.C. 1959. Silvical characteristics of red spruce (Picea rubens). USDA, Forest Service, Northeast Forest Experiment Station. Station Paper No. 124.

SUBJECT KEYWORDS
tree growth, tree reproduction, general tree characteristics

RANGE OF COMMUNITIES
northern spruce-fir
GEOGRAPHIC SCOPE
Northeast U.S.
TYPE OF INFORMATION
quantitative (no form)
QUANTITATIVE TOPICS

Notes for Hart (1959)

This report is a synthesis of literature on silvical characteristics of red spruce, with emphasis on the Northeast. The overall range and the role of red spruce in the southern Appalachians is mentioned briefly. Information is given on associated species in the Northeast, phenology, seed production, development and requirements of seedlings, growth and production of trees, reaction to competition, susceptibility to injury and diseases, and special uses of the trees.

Hay, R.L., C.C. Eagar, and K.D. Johnson. 1976. Status of the balsam woolly aphid in the Great Smoky Mountains National Park--1976. USDI National Park Service, Southeast Region, Research/Res. Man. Rep. 20. 18pp.

SUBJECT KEYWORDS
BWA infestation levels, BWA spread, BWA life cycle, BWA ecological effects
RANGE OF COMMUNITIES
spruce-fir
GEOGRAPHIC SCOPE
Great Smoky Mtns.
TYPE OF INFORMATION
qualitative
QUANTITATIVE TOPICS

Notes for Hay, Eagar, and Johnson (1976)

Outlines various aspects of balsam woolly adelgid biology, including a description of the species, its life cycle, dissemination, and host-insect interactions. Distribution of the BWA and infestation levels in the Great Smoky Mountains are described based on study of 1976 aerial photographs and field reconnaissance. A general pattern of initial infestation development at lower elevations rather than on ridgetops was observed. Specific descriptions of mortality were given for major peaks throughout the Smokies spruce-fir zone. Nearly 100% mortality was reported on Mt. Sterling, the northeasternmost spruce-fir peak in the park. To the south and west, a gradient of decreasing mortality was observed. However, infestations were found throughout the Smokies spruce-fir zone. Speculations and recommendations are presented concerning fir regeneration and fire risk.

Hay, R.L., C.C. Eagar, and K.D. Johnson. 1978. Fraser fir in the Great Smoky Mountains National Park: Its demise by the balsam woolly aphid (Adelges piceae Ratz.). Contract Rept., USDI, National Park Service, SE Reg. Office, Atlanta.

SUBJECT KEYWORDS
BWA infestation levels, BWA spread, BWA response to environment

RANGE OF COMMUNITIES
spruce-fir
GEOGRAPHIC SCOPE
Great Smoky Mtns.
TYPE OF INFORMATION
quantitative
QUANTITATIVE TOPICS
BWA infestation levels & BWA response to environment

Notes for Hay, Eagar, and Johnson (1978)

Gives results of examination of balsam woolly adelgid infestations in the Smokies in 1976 and 1977, when the adelgid was spreading through the park. These data and methods are also contained in Eagar (1978) and Johnson (1977). Infrared aerial photos were used to divide the spruce-fir area into 11 geographic areas by age of infestation and into 224 study units by topography, size, aspect, etc. Community and environmental factors were measured in plots, and measurements or ratings of BWA infestation, tree condition, bark characteristics, age, growth rate, and height were done on 3 randomly selected trees/plot. Canonical correlation was done between stand BWA levels and community and environmental variables. Multiple range tests and chi-square tests were done on individual tree variables between BWA infestation classes.

The survey found BWA present throughout the park's spruce-fir zone. Infestations tended to start at low elevations and were heaviest on large mature trees. Dense young stands, more common at high elev., were the least affected. Bark texture class, crown position, and growth rate had little effect on BWA, but observations suggested smooth bark was harder to attack.

Quantitative data evaluation record for
Hay, Eagar, and Johnson (1978)

TOPIC

BWA infestation levels & BWA response to environment

METHODS

Sampled 6 10x10 m plots in each of 224 stand units defined on aerial photos, and additional plots at elev. intervals on transects. Stands rated for history, slope, aspect, BWA infestation level, and envi. factors. Trees tallied by dbh, rated for health and BWA presence. 3 random trees/plot cored, height measured, and rated for BWA level, crown color, crown position, bark text.

NUMBER OF SAMPLES: PERMANENT PLOTS:

DATA PRESENTED

Canonical correlation coefficients between BWA class and envi. variables, community variables, and both, using data from 1976, 1977, both, and both from the west half only. Correlation of all variables with canonical variables, for each combination of years. Chi-square contingency tests and multiple range tests on tree variables among infestation classes. Relationships between BWA infestation class and tree and environmental data are discussed.

Hesler, L.R. 1936. Notes on southern Appalachian fungi. J. Tenn. Acad. Sci. 11: 107-122.

SUBJECT KEYWORDS
fungus flora, fungus biology

RANGE OF COMMUNITIES
general southern Appalachian
GEOGRAPHIC SCOPE
Southern Appalachians
TYPE OF INFORMATION
qualitative, species list
QUANTITATIVE TOPICS

Notes for Hesler (1936)

Gives a list of fungus specimens collected throughout the region, including some from spruce-fir forests. Notes on location, habitat, and sometimes range and rarity are given. A number of species new for the region are listed.

Hesler, L.R. 1937. Notes on southern Appalachian fungi, II.
J. Tenn. Acad. Sci. 12: 239-254.

SUBJECT KEYWORDS
fungus flora, fungus biology

RANGE OF COMMUNITIES
general southern Appalachian
GEOGRAPHIC SCOPE
Southern Appalachians
TYPE OF INFORMATION
qualitative, species list, supplement
QUANTITATIVE TOPICS

Notes for Hesler (1937)

Gives a list of fungus specimens collected throughout the region, apparently ones that came to light after Hesler (1936), although the dates of specimens overlap. Includes species found in spruce-fir forests. Notes on location, habitat, and sometimes range and rarity are given for each species.

Hoffman, R.L. 1950. Records of Picea in Virginia. Castanea 15: 55-58.

SUBJECT KEYWORDS
extent of spruce-fir

RANGE OF COMMUNITIES
general southern Appalachian

GEOGRAPHIC SCOPE
Virginia

TYPE OF INFORMATION
qualitative

QUANTITATIVE TOPICS

Notes for Hoffman (1950)

This paper lists the locations of known native populations of red spruce in Virginia, with brief descriptions of each. The spruce occurs only in the Mt. Rogers area and in the tier of counties bordering West Virginia. Known plantings are also listed.

Hoffman, H.L., 1959. Boreal forest vascular plants which are also native to the Great Smoky Mountains
Typescript, Univ. of Tennessee, Knoxville

SUBJECT KEYWORDS
Biogeography, floristic affinities, vascular flora

RANGE OF COMMUNITIES
spruce-fir
GEOGRAPHIC SCOPE
Great Smoky Mtns.
TYPE OF INFORMATION
List
QUANTITATIVE TOPICS

Notes for Hoffman (1959)

Typescript list found in the UT herbarium. Supplemented by White and Renfro (1984) in: White,ed. (1984).
Limited usefulness

Hoffman, H.L. 1964. Check list of vascular plants of the Great Smoky Mountains. Castanea 29: 1-45.

SUBJECT KEYWORDS
vascular flora

RANGE OF COMMUNITIES
general southern Appalachian
GEOGRAPHIC SCOPE
Great Smoky Mtns.
TYPE OF INFORMATION
species list
QUANTITATIVE TOPICS

Notes for Hoffman (1964)

This list is based on collections in the Smokies and University of Tennessee-Knoxville herbaria. 126 families, 53 genera, and 1450 species and lower taxa are included in the list.

Hoffman, H.L. 1966. Notes on vascular plant families in the
Great Smoky Mountains. Castanea 31: 301-306.

SUBJECT KEYWORDS
vascular flora

RANGE OF COMMUNITIES
general southern Appalachian
GEOGRAPHIC SCOPE
Great Smoky Mtns.
TYPE OF INFORMATION
quantitative (no form)
QUANTITATIVE TOPICS

Notes for Hoffman (1966a)

This paper discusses various aspects of the vascular flora of the Great Smoky Mountains National Park. There are 126 families, of which 38 have only 1 species; an additional 18 have only one genus. These numbers are compared with published data for other areas in the United States.

Hoffman, H.L. 1966. Supplement to check list, vascular plants, Great Smoky Mountains. Castanea 31: 307-310.

SUBJECT KEYWORDS
vascular flora

RANGE OF COMMUNITIES
general southern Appalachian
GEOGRAPHIC SCOPE
Great Smoky Mtns.
TYPE OF INFORMATION
species list
QUANTITATIVE TOPICS

Notes for Hoffman (1966b)

This list gives corrections to the check list of Hoffman (1964) and gives additional species collected since then.

Holmes, J.S. 1911. Forest Conditions in Western North Carolina. NC Geol. and Econ. Survey Bulletin 23: 1-116.

SUBJECT KEYWORDS
logging, timber statistics, forest management, forest condition, general tree characteristics, tree reproduction, history
RANGE OF COMMUNITIES
general southern Appalachian
GEOGRAPHIC SCOPE
North Carolina
TYPE OF INFORMATION
quantitative
QUANTITATIVE TOPICS
timber statistics

Notes for Holmes (1911)

General report on forest conditions in the North Carolina mountains. Distribution and nature of forest types and of major timber species., forest conditions in each county, and management suggestions for each type are discussed.

A table gives board feet of timber by species in each county. 6 counties have spruce and fir. Spruce-fir forests average 15-25000 feet/acre of both combined, but many stands will yield 40-50000. Average pulp yield is 40-50 cords/acre.

Spruce reaches 80-90 feet tall with a dbh up to 3 feet on N slopes and cove heads. On ridges it may only reach 40-50 feet.

Spruce reproduces best in open forest. In closed forest fir reproduces better. In cut areas, existing seedlings will grow up and new seedlings start. But none regenerate in burned sites.

County reports suggest no logging yet in Swain, Yancey, and Mitchell Counties. Champion Fiber had started logging near Richland Balsam. The spruce-fir forests in Mitchell Co., Grandfather, Roan, and Unaka Mtns., are called scrubby and of little value. A severe fire is mentioned in the Black Mtns. that destroyed 10% of the E slope.

Management suggestion is for light cut, leaving seed trees.

Quantitative data evaluation record for
Holmes (1911)

TOPIC
timber statistics

METHODS
Estimated amount of timber by county in western North Carolina.
Methods not given.

NUMBER OF SAMPLES: PERMANENT PLOTS:

DATA PRESENTED
Board feet in standing trees greater than 10 inches dbh, by county and by species.
Total output of various timber products by county (not by sp.)
Average board feet per acre in different forest types. Area of forested land by county. Potential yield of spruce-fir forests.
Amount of total virgin forest in counties discussed.

Holt, P.C. (ed) 1970. The distributional history of the biota of the southern Appalachians, Part II: Flora. Va. Polytechnic Inst. and State Univ., Res. Div. Monogr. 2.

SUBJECT KEYWORDS
floristic affinities, vascular taxonomy, vascular flora, bryophyte flora
RANGE OF COMMUNITIES
general southern Appalachian
GEOGRAPHIC SCOPE
Southern Appalachians
TYPE OF INFORMATION
qualitative
QUANTITATIVE TOPICS

Notes for Holt (1970)

This volume contains 10 major papers and several shorter ones dealing with floristics, plant biogeography, systematics, and botanical exploration in the region. Several are included in this bibliography: Anderson (1970), Core (1970), and Little (1970).

Hopkins, A.D. 1899. Report on investigations to determine the cause of unhealthy conditions of the spruce and pine from 1880-1893. WV Ag. Exp. Sta. 56: 194-461.

SUBJECT KEYWORDS
insect damage, history, extent of spruce-fir

RANGE OF COMMUNITIES
spruce-fir, pine forest
GEOGRAPHIC SCOPE
West Virginia
TYPE OF INFORMATION
qualitative
QUANTITATIVE TOPICS

Notes for Hopkins (1889)

This report deals primarily with investigations of the death of large areas of spruce and pine timber in 1880-1882 and 1891-1892. The original extent of spruce and the history of its destruction by fire, pasture clearing, logging, and disease are discussed. There were believed to be 1,500,000 acres of spruce in West Virginia before settlement, reduced to 225,000 by 1899.

The death of trees in 1880-1882 was not investigated at the time. Reports of huge number of spruce bark beetles (Polygraphus rufipennis) suggest it as the cause but there is no other evidence for this. It was concluded that natural enemies reduced the numbers of these beetles and that large amounts of logging slash attracted them away from live trees, ending the outbreak.

In 1891 the destructive pine bark beetle (Dendroctonus frontalis), also infesting pines at the time, was found to be killing healthy spruce trees. In 1893 the outbreak suddenly ended, and all stages of the beetles were found dead. A European Clerid predator, imported to combat the bark beetles, was not released until the pests were all dead. Bacterial and fungal disease, combined with a cold winter, were concluded to be the cause of the death of the bark beetles.

Horton, J.H., and L.G. Hotaling. 1981. Floristics of selected heath communities along the southern section of the Blue Ridge Parkway. USDI, National Park Service Research/Res. Man. Report No. 45.

SUBJECT KEYWORDS
vegetation sample, community maintenance, succession

RANGE OF COMMUNITIES
high elevation successional, heath bald, bog
GEOGRAPHIC SCOPE
Craggy Mtns., Balsam Mtns.
TYPE OF INFORMATION
quantitative
QUANTITATIVE TOPICS
vegetation sample

Notes for Horton and Hotaling (1981)

This study provides baseline vegetational data to address future changes in 3 heath-dominated sites along the Blue Ridge Parkway: Craggy Gardens, a heath bald; Graveyard Fields, a severely burned spruce-fir site in the Balsam Mtns.; and Pisgah Campground (Flat Laurel Gap), a bog on Pisgah Ridge. Vegetation was sampled by 3 methods: estimation of Braun-Blanquet cover classes in each site as a whole, nested randomly located quadrats, and by the line intersect method. The sample plots were permanently marked. Data on woody plant cover, density, and frequency are given.

Graveyard Fields was dominated by Rubus sp. and Prunus pensylvanica. Hardwood trees were clearly rapidly invading. spruce was present but was not in any of the samples.

Craggy Gardens was dominated by Rhododendron catawbiense. Yellow birch and mountain ash appeared to be invading.

The Pisgah Campground bog was dominated by Rhododendron maximum, R. catawbiense, and Kalmia latifolia, with no tree invasion.

Quantitative data evaluation record for
Horton and Hotaling (1981)

TOPIC

vegetation sample

METHODS

Sampled shrub dominated communities at Craggy Gardens, Graveyard Fields, and Pisgah Campground. Estimated Braun-Blanquet cover classes in each site. Sampled nested quadrats, 10x10, 4x4, 2x.5m at random distance from a transect line. Measured tree dbh, shrub crown dia., counted woody and herb. indiv. Also sampled by line-intersect method at 2 sites. Cored random pairs of trees.

NUMBER OF SAMPLES: PERMANENT PLOTS: Y

DATA PRESENTED

Dbh and age of each random pair of trees at Graveyard Fields.
Braun-Blanquet cover class of all species for each site.
Absolute and relative density, cover, frequency, plus summed importance value of woody species derived from quadrat samples at each site. Similar data derived from line-intersect samples at Graveyard Fields and Pisgah Campground.
Herb density data are included in the original manuscript in the library at Western Carolina Univ. at Cullowee.

Hudak, J., and R.E. Wells. 1974. Armillaria root rot in aphid-damaged balsam fir in Newfoundland. For. chron. 50: 74-76.

SUBJECT KEYWORDS
BWA effect on fir, disease

RANGE OF COMMUNITIES
northern spruce-fir
GEOGRAPHIC SCOPE
Canada
TYPE OF INFORMATION
quantitative (no form)
QUANTITATIVE TOPICS

Notes for Hudak and Wells (1974)

An investigation of the relationship of balsam woolly adelgid damage and infection by Armillaria mellea root rot in balsam fir in Newfoundland. The current state of BWA was infestation of 6000 sq. miles in Newfoundland, after being introduced in 1949. Estimated mortality in stands infested 10-15 years was 12%.

Six balsam fir stands were sampled. In each, trees along a transect were rated for BWA damage class and roots were examined for evidence of Armillaria. Where found, the fungal mycelia were measured. The % of each BWA class in each stand, and the % of trees infected with Armillaria and size of the mycelia in each BWA class are given. There was a dramatic increase in Armillaria infection with increasing BWA damage, from 2.5% of uninfested trees to 32% of severely damaged trees to 88% of killed trees. It appears that the root rot may be an important factor contributing to mortality of BWA-infested trees.

Jackson, M.D., T.J. Sheets, and C.L. Moffett. 1974. Persistence and movement of BHC in a watershed, Mount Mitchell State Park, North Carolina--1967-72. Pesticides Monitoring Journal 8: 202-208.

SUBJECT KEYWORDS
BWA control, pesticide persistence, animal pesticide levels, water quality
RANGE OF COMMUNITIES
spruce-fir
GEOGRAPHIC SCOPE
Black Mtns.
TYPE OF INFORMATION
quantitative
QUANTITATIVE TOPICS
animal pesticide levels, pesticide persistence, water pollution

Notes for Jackson, Sheets, and Moffett (1974)

This study examined the persistence of benzene-hexachloride (BHC) sprayed on the north side of Mt. Mitchell in 1967. Samples were taken of forest litter, soil, water and sediment in streams draining the sprayed area, and in small mammals.

Initially the litter contained the highest BHC levels--585 ppm one month after spraying. This declined to 27 ppm over the next 5 years. Soil levels increased to a peak of 58 ppm 1.5 years after spraying, and declined to 32 ppm 3.5 years later. The greater weight of the soil, compared to the litter, means the smaller increase in BHC in the soil may account for 50% or more of that lost from the litter. The extended persistence in the soil can be attributed to low microbial activity due to acidity and cool temperatures.

BHC was detectable in stream water only in 2 sample dates, both at times of high flow. Levels in sediment in the stream within the sprayed areas were 3.17 ppm intitially and declined to .49.

BHC levels in animals ranged from 0.6-176 ppm, with no distinction between sprayed and unsprayed areas.

Quantitative data evaluation record for
Jackson, Sheets, and Moffett (1974)

TOPIC

animal pesticide levels

METHODS

Trapped small mammals in and outside of a 13 ha area on the north side of Mt. Mitchell sprayed with 11.2 kg/ha of BHC in 1967. Animals <40 g pooled by species, larger analysed separately. Whole animals, including skin and digestive tract, chopped, dehydrated, extracted with petroleum ether. Alpha, beta, and gamma isomers of BHC determined by gas chromatography.

NUMBER OF SAMPLES: PERMANENT PLOTS:

DATA PRESENTED

Table of % lipid and each BHC isomer in 39 animal samples (all those caught on all sample plots and dates).

Average and range of % recovery of BHC isomers from animal fat standards.

Quantitative data evaluation record for
Jackson, Sheets, and Moffett (1974)

TOPIC

pesticide persistence

METHODS

Sampled in a 13 ha area on the north side of Mt. Mitchell, sprayed with BHC at a rate of 11.2 kg/ha in 1967. Samples taken at various times from just before spraying to 5 years later. In each of 3 plots, 20 grab samples of litter and 2 20-core samples of soil taken. Alpha, beta, and gamma isomers of BHC in extracts were determined by gas chromatography.

NUMBER OF SAMPLES: PERMANENT PLOTS:

DATA PRESENTED

Table of each BHC isomer on 11 sample dates, for litter and soil in each plot.

Average and range of % recovery rates of BHC isomers in soil and water standards.

Quantitative data evaluation record for
Jackson, Sheets, and Moffett (1974)

TOPIC

water pollution

METHODS

Sampled 2 small streams draining a 13 ha area on the north side of Mt. Mitchell, that was sprayed with BHC at a rate of 11.2 kg/ha in 1967. Collected three 3.8 L water samples and 3 sediment samples pooled from 5 grab samples 2-5 cm deep along an 8 m stretch. Alpha, beta, and gamma isomers of BHC in extracts were determined by gas chromatography.

NUMBER OF SAMPLES: PERMANENT PLOTS:

DATA PRESENTED

Table of each BHC isomer in the water on 13 sample dates, and in sediment of 7 sample dates.

Average and range of % recovery rates of BHC in water and sediment standards.

Jacobs, B.F., C.R. Werth, and S.I. Guttman. 1984. Genetic relationships in Abies (fir) of eastern United States: an electrophoretic study.

SUBJECT KEYWORDS
fir taxonomy, fir genetics, intraspecific variation

RANGE OF COMMUNITIES
spruce-fir
GEOGRAPHIC SCOPE
Southern Appalachians, Northeast U.S.
TYPE OF INFORMATION
quantitative
QUANTITATIVE TOPICS
fir genetics

Notes for Jacobs, Werth, and Guttam (1984)

Results of an electrophoretic study on the 3 taxa of eastern fir--Fraser fir, balsam fir, and bracted balsam fir. Samples were taken from 12 populations, including Mt. Mitchell, Clingmans Dome, and Mt. Rogers. 20 genetic loci were examined, of which 13 were polymorphic. Frequencies of alleles were given and genetic distance and similarity calculated. All 12 populations had similar complements of alleles and comparable allele frequencies. The 3 Fraser fir populations were most closely related to the bracted balsam fir populations, with a distance of .03. This group was linked to balsam fir at a distance of .06.

These data support the hypothesis that the 3 taxa were conspecific, with free genetic exchange, during Wisconsinian time, and that bracted balsam fir is intermediate but not of hybrid origin. Because of the long generation time of fir, only 500-600 generations have occurred since the populations were separated.

The cone bract/scale ratio, used to separate the taxa, was found to be variable in the intermediate populations, even on the same tree.

Quantitative data evaluation record for
Jacobs, Werth, and Guttam (1984)

TOPIC

fir genetics

METHODS

Sampled 12 sites, including Mt. Mitchell, Clingmans Dome, Mt. Rogers, Canaan Valley, WV, and Hawksbill Mtn., VA, and sites in New England and PA. Collected cones from 1st 20 trees. Did electrophoresis on ground germinated seeds. Studied the 13 out of 20 genetic loci examined which were polymorphic. Calculated Nei's unbiased genetic distance and Roger's genetic similarity.

NUMBER OF SAMPLES: 12 PERMANENT PLOTS:

DATA PRESENTED

Table of enzyme systems used and number of loci at each. Allele frequencies of the 13 loci for each of the 12 populations. Mean and std. error of number of alleles/locus and % of loci polymorphic in each of the 12 populations. Matrix of Nei's unbiased genetic distance and Roger's genetic similarity between all 12 populations. Dendrogram of relationships based on Nei's distance measure. Matrix of Nei's genetic distance between the 3 recognized taxa of fir.

Jeffers, D.S., and C.F. Korstian. 1925. On the trail of the
vanishing spruce. Sci. Monthly 20: 358-368.

SUBJECT KEYWORDS
conservation, logging, fire, history

RANGE OF COMMUNITIES
spruce-fir
GEOGRAPHIC SCOPE
Southern Appalachians
TYPE OF INFORMATION
qualitative
QUANTITATIVE TOPICS

Notes for Jeffers and Korstian (1925)

Describes the destruction of the southern Appalachian spruce-fir forests by logging and fire, and argues for the application of forestry methods to ensure their regeneration. Numerous pictures of destruction are given. A group of forestry students from Iowa helping foresters from the Appalachian Forest Experiment Station make surveys of regeneration in cutover lands is mentioned.

Jennison, H.M. 1935. Notes on some plants of Tennessee. Rhodora 37: 309-323.

SUBJECT KEYWORDS
rare species, species range extension

RANGE OF COMMUNITIES
general Southeastern
GEOGRAPHIC SCOPE
Tennessee
TYPE OF INFORMATION
qualitative
QUANTITATIVE TOPICS

Notes for Jennison (1935)

Gives notes on recent plant species range extensions throughout Tennessee, including some in spruce-fir forests of the Smokies and Roan Mtn. In addition, the discovery of red spruce in Shady Valley Swamp, a boreal remnant bog on calcareous rocks at 2800 ft. elevation, is noted.

Johnson, K.D. 1977. Balsam Woolly Aphid Infestation of Fraser Fir in the Great Smoky Mountains. M.S. Thesis, Univ. of Tenn., Knoxville.

SUBJECT KEYWORDS
BWA infestation levels, BWA response to environment, BWA effect on fir
RANGE OF COMMUNITIES
spruce-fir
GEOGRAPHIC SCOPE
Great Smoky Mtns.
TYPE OF INFORMATION
quantitative
QUANTITATIVE TOPICS
BWA response to environment & BWA infestation levels

Notes for Johnson (1977)

This study examined factors associated with balsam woolly adelgid infestation in the Great Smoky Mountains. 17 stands, selected over a range of slopes, aspects, and infestation levels, were examined. Tree height, diameter, crown size, bark texture, bark epiphytes, bark thickness, growth rate, crown color, infestation level, and stand slope, aspect, and elevation were sampled.

Tree height and diameter were the factors most significantly associated with infestation levels. Crown color indicated infestation level. There was no apparent relationship between infestation and bark characteristics or age. Large trees appeared to become infested first, but survived longer than smaller trees. Relationship of infestation to site factors was inconclusive.

Quantitative data evaluation record for
Johnson (1977)

TOPIC

BWA response to environment & BWA infestation level

METHODS

Sampled 17 of 224 stand units defined by topography, accessibility, and infestation intensity, selected in advance to represent the range of slope, aspect, and infestation. 6 10x10 m plots/stand unit. Measured height, dbh, width of growth rings, bark thickness, and rated bark texture, epiphyte level, infestation level, crown size and color, for 3 random trees.

NUMBER OF SAMPLES: 17 PERMANENT PLOTS: Y

DATA PRESENTED

Number, mean, and std. error of height and dbh, % of trees in each crown size class, % in each crown color class, by infestation class. Number, height, % in each crown class, and % in each infestation class, by crown color. Mean bark thickness, % in each bark epiphyte and bark texture class, by crown cover class and infestation class. Mean growth rate by age class, infestation class, and crown color class. Mean and std. error of % infestation of plot by Crandall's vegetation site type and slope aspect.

Johnson, K. 198Ø. Fraser Fir and Balsam Woolly Aphid. Summary of Information. Southern Appalachian Research/Resource Management Coop report.

SUBJECT KEYWORDS
bwa control, BWA life cycle

RANGE OF COMMUNITIES
spruce-fir
GEOGRAPHIC SCOPE
Southern Appalachians
TYPE OF INFORMATION
qualitative
QUANTITATIVE TOPICS

Notes for Johnson (198Ø)

This report is a review of the literature and other information relating to balsam woolly adelgid and Fraser fir. It contains extensive discussion on the biology of the adelgid and its effect on Fraser fir and other fir species, control measures for the adelgid, management of infested stands, and policies of the various government agencies managing Fraser fir forests.

Johnson, A.H. and T.G. Siccama. 1983. Acid deposition and forest decline. Envi. Sci. and Tech. 17: 294A-305A.

SUBJECT KEYWORDS
forest decline, disturbance, air pollution, soil properties, tree growth
RANGE OF COMMUNITIES
spruce-fir
GEOGRAPHIC SCOPE
Northeast U.S., Southern Appalachians
TYPE OF INFORMATION
quantitative
QUANTITATIVE TOPICS
forest decline

Notes for Johnson and Siccama (1983)

Discusses the phenomenon of dieback and increased mortality in Appalachian spruce-fir forests. Data obtained from resampling previously sampled plots throughout the region show increased mortality and decline in basal area for northern sites but not for more southerly sites. Reduction is most consistent in red spruce, less so in balsam fir. Mortality occurs over all size classes, vegetation types, and soil types, but is more severe at higher elevations.

Possible natural causes are discussed. Environmental stress seems the only reasonable cause.

Tree rings show sudden decline in growth increment in 1960's in the north. Many have not recovered since. A drought in the 1960's could have triggered the decline, but lack of recovery suggests continued stress or permanent loss of vigor.

SO_2 and O_3 seem unlikely to be the cause of decline. Not enough is known about Al in soils here to suggest Al toxicity. Foliar leaching and direct soil acidification are thought unlikely causes. Trace metals in soil inhibiting micorrhizae are an unstudied possibility. One study did find increased Pb, Cu, and Zn in soil organic matter.

Quantitative data evaluation record for
Johnson and Siccama (1983)

TOPIC

forest decline

METHODS

Resampled previously-sampled plots, according to the original methods used. Sites on Roan Mtn., NC-TN; Mt. Mitchell, NC; Mt. Rogers, VA; Monongahela NF, WV; Shenandoah NP, VA; Catskill Mtns., NY; Whiteface Mtn., NY; Green Mtns., VT; and White Mtns., NH.

NUMBER OF SAMPLES: PERMANENT PLOTS:

DATA PRESENTED

Plot of spruce mortality and % dieback at all sites. Plot of mortality vs. elevation for several sites. Table of change in basal area of spruce, balsam fir, and white birch for North. Plots of frequency and year of appearance of first abnormal ring. Plots of Ca:Al ratio and of Al levels in fine roots vs. elev. Table (from Friedland et al. 1983) showing soil Pb, Cu, Zn, % organic matter, by elevation zone, for 3 years.

Johnson, K.D., H.L. Lambert, and P.J. Barry. 1980. Status and post suppression evaluation of balsam woolly aphid infestations on Roan Mountain, Toecane Ranger District, Pisgah National Forest, NC. USDA Forest Service, SE Area, State & Priv. For., Forest Insect & Disease Man. Rep. No. 80-1-13.

SUBJECT KEYWORDS
BWA infestation levels, BWA control

RANGE OF COMMUNITIES
spruce-fir

GEOGRAPHIC SCOPE
Roan Mtn.

TYPE OF INFORMATION
quantitative

QUANTITATIVE TOPICS
BWA infestation levels

Notes for Johnson, Lambert, and Barry (1980)

This report gives results of ground surveys on Roan Mtn. in July 1979. 44 point sample plots (based on BAF of 10) were established in the 5 protection areas: 1. NC Road 1348, 2. Rhododendron Gardens, 3. FS Road 130, 4. Roan High Bluff, 5. Appalachian Trail. Areas 1 and 2, treated in 1977, had 80% of the plots and 30% of the trees infested. Areas 3 & 4, treated in 1979, had 25% of the plots and 5% of the trees infested, area 5, treated in 1978, had 19% of the plots and 2% of the trees infested.

Low levels in recently treated areas indicate spraying was successful. High levels in areas treated 3 years before indicated the need for continued control. It is recommended that treatment continue, with spraying of areas 1 (90 acres or 18,000 trees) and 2 (50 acres or 10,000 trees).

Quantitative data evaluation record for
Johnson, Lambert, and Barry (1980)

TOPIC
BWA infestation levels

METHODS
Studied the protection zone established on Roan Mtn., within 200 feet of roads and trails. Sampled variable plots (BAF 10) at regular intervals along NC Road 1348 & Rhododendron Gardens (treated 1977), Appalachian Trail (treated 1978), FS Road 130 & Roan High Bluff trail (treated 1979). Tallied species and number of trees, and examined fir for adelgid infestation.

NUMBER OF SAMPLES: 44   PERMANENT PLOTS:

DATA PRESENTED
Total number and % infested trees and infested plots in each of the 5 treatment areas.

King, P.B. 1964. Geology of the central Great Smoky Mountains, Tennessee. U.S. Geological Survey Prof. Paper 340-C

SUBJECT KEYWORDS
geology

RANGE OF COMMUNITIES
general southern Appalachian

GEOGRAPHIC SCOPE
Great Smoky Mtns.

TYPE OF INFORMATION
quantitative (no form), map

QUANTITATIVE TOPICS

Notes for King (1964)

Detailed geologic investigation of the Tennessee side of the central Smokies, extending from just west of Clingmans Dome and Gatlinburg to west of Thunderhead Mountain and Townsend. Rock units, structures, metamorphism, and surficial conditions are described in detail, and geologic interpretations are made. Various diagrams, tables of chemical and mineral composition, cross sections, and colored geologic maps at a scale of 1:24000 are included.

King, P.B., R.B. Neuman, and J.B. Hadley. 1968. Geology of the Great Smoky Mountains National park, Tennessee and North Carolina. U.S. Geological Survey Prof. Paper 587.

SUBJECT KEYWORDS
geology

RANGE OF COMMUNITIES
general southern Appalachian
GEOGRAPHIC SCOPE
Great Smoky Mtns.
TYPE OF INFORMATION
qualitative, map
QUANTITATIVE TOPICS

Notes for King, Neuman, and Hadley (1968)

Explains the current understanding of the bedrock geology of the Great Smoky Mountains National Park and the surrounding area. Each of the rock units and the major structures are described, with a variety of diagrams to show relationships. A colored geologic map at a scale of 1:125,000 is included.

Knight, H.A. and J.P. McClure. 1966. North Carolina's Timber. USDA Forest Service, Southeast. For. Exp. Sta., Res. Bull. SE-5. 47pp.

SUBJECT KEYWORDS
timber statistics

RANGE OF COMMUNITIES
general eastern U.S.
GEOGRAPHIC SCOPE
North Carolina
TYPE OF INFORMATION
quantitative
QUANTITATIVE TOPICS
timber statistics

Notes for Knight and McClure (1966)

This report gives results of the 3rd forest inventory, for the entire state of North Carolina. Data are based on samples of systematically located plots. Most statistics are given only for commercial forest land, which excludes parks and other public land unavailable for cutting. 6300 acres of public and 8400 of private commercial spruce-fir forest were found. There were also 4500 acres of productive reserved land and 1000 acres of unproductive spruce-fir forest.

Data given by forest type or species, so that spruce-fir can be distinguished, include volume, net annual growth, cut, and mortality of growing stock and sawtimber.

Statistical reliability of the data is discussed and standard errors given. Although much data is given broken down by county, a warning is given that individual county samples are too small for statistical reliability.

Quantitative data evaluation record for
Knight and McClure (1966)

TOPIC

Timber statistics

METHODS

Sampled systematically located sites, with supplemental sites chosen to ensure adequate representation of some forest types. Sampled clusters of 10 uniformly distributed plots, sampled by the variable plot method (BAF 37.5 sq. ft./ac) for large trees, with fixed radius plots for trees < 3 in. dbh. Trees tallied, measured, some cored. Volume calculated with volume equations.

NUMBER OF SAMPLES: PERMANENT PLOTS: y

DATA PRESENTED

(Only data in which spruce-fir can be distinguished are noted) Area of commercial forest in public and private ownership, by forest type. Area of noncommercial forest categories by forest type. Volume of growing stock and sawtimber, by dbh class and species (spruce & fir together). Net annual growth, cut, and mortality of sawtimber and growing stock, by species. Number of growing stock and cull trees/acre by forest type.

Komarek, E.V., and R. Komarek. 1938. Mammals of the Great Smoky Mountains. Bull. Chicago Acad. Sci. 5: 137-162.

SUBJECT KEYWORDS
vertebrate fauna, faunistic affinities, vertebrate biology

RANGE OF COMMUNITIES
general southern Appalachian
GEOGRAPHIC SCOPE
Great Smoky Mtns.
TYPE OF INFORMATION
qualitative, species list
QUANTITATIVE TOPICS

Notes for Komarek and Komarek (1938)

Results of a survey done in 1931-1934, around the time of creation of the national park. A list of 48 species found in the park is given, with notes on collection locations, abundance, diet, reproduction, parasites, and measurements as available. Lists are given of species with northern and southern affinities and those with widespread distributions.

Korstian, C.F. 1937. Perpetuation of spruce on cut-over and burned lands in the higher southern Appalachians. Ecol. Monogr. 7: 125-167.

SUBJECT KEYWORDS
disturbance, logging, fire, tree reproduction, tree growth, forest management, vegetation sample
RANGE OF COMMUNITIES
spruce-fir
GEOGRAPHIC SCOPE
Southern Appalachians, West Virginia
TYPE OF INFORMATION
quantitative
QUANTITATIVE TOPICS
vegetation sample, tree reproduction & tree growth

Notes for Korstian (1937)

Widespread logging and fire have destroyed much of the spruce forest. This study looks at virgin, cutover, and burned spruce lands to determine prevailing conditions, reproduction, obstacles to reproduction, and ways to restore or perpetuate spruce forests.

Greatest obstacle to spruce reproduction is drying of soil surface after clearcutting or fire. Fire destroys seed bank and soil organic layer as well as young trees, and allows erosion. Natural spruce-fir forests are not flammable, but opening the canopy allows drying, and slash provides extra fuel.

On best sites, aggressive hardwoods come in after disturbance and limit spruce recovery. Growth rate of young spruce after logging depends on tree condition before logging and whether they remains free of competition.

To allow return of spruce, fire control is essential. Planting spruce and fir seedlings is successful. Selective cutting, leaving 60-70% of original canopy, is best logging method.

Quantitative data evaluation record for
Korstian (1937)

TOPIC
tree reproduction & tree growth

METHODS
Uses seedling growth data from Unaka Mountains in Tennessee and large tree growth data from West Virginia. Methods of collection unknown. Measurements include age of seedlings and height growth for spruce, yellow birch, and fire cherry.

NUMBER OF SAMPLES: PERMANENT PLOTS:

DATA PRESENTED
Graph of seedling growth rates for spruce under different degrees of shading. Graph of growth rates for spruce, yellow birch, and fire cherry seedlings, and fire cherry sprouts.
Tables and graphs of diameter growth rates of spruce by size class, before and after logging, for open and overtopped trees.

Quantitative data evaluation record for
Korstian (1937)

TOPIC
vegetation sample

METHODS
Used data collected by Appalachian Forest Experiment Station for 55 representative areas in NC, TN, VA, and WV. Samples were strips, .5-1 chain wide for large trees, 10-20 feet wide for smaller trees. Tallied trees by species and size class.

NUMBER OF SAMPLES: 55 PERMANENT PLOTS:

DATA PRESENTED
Tables of trees/acre by size class for spruce, fir, and other species, averaged by virgin stands, cutover stands, and cutover and burned stands at various ages after disturbance.
Various figures regarding extent, range, and condition of spruce forests are discussed.
Raw plot data or data averaged by site may be available from the Forest Service.

Korstian, C.F. 1962. The Appalachian Highland Region. In: J.W. Barrett (ed), Regional Silviculture of the United States. pp 178-245.

SUBJECT KEYWORDS
forest management, general tree characteristics, logging

RANGE OF COMMUNITIES
general southern Appalachian
GEOGRAPHIC SCOPE
Southern Appalachians, West Virginia, Virginia
TYPE OF INFORMATION
qualitative
QUANTITATIVE TOPICS

Notes for Korstian (1962)

This chapter covers the southern and central Blue Ridge, Ridge and Valley, Piedmont, and Cumberland Plateau. Each forest type is covered separately, with silvicultural characteristics and methods described.

The section on spruce-fir forest gives the amount of remaining commercial forest lands as 104,000 acres in West Virginia and 14,000 acres in North Carolina, out of 1,000,000 acres originally. The remainder was destroyed by logging and fire. Under government protection some vegetation is returning to most of this area.

Important factors listed to consider in spruce-fir forests are that the stands are generally uneven-aged, that trees are shallow-rooted and subject to windthrow, and that seedlings establish under large trees. Cutting should be single tree or group selection methods, light enough to minimize windthrow. Experiments with planting on cutover burned lands in North Carolina found that 2 release cuttings were necessary to ensure growth. Planting is not recommended if release cutting is not possible.

Kring, J.B. 1965. Vegetational Succession at Craggy Gardens, North Carolina. M.S. Thesis, University of Tennessee, Knoxville.

SUBJECT KEYWORDS
community maintenance, succession

RANGE OF COMMUNITIES
grassy bald, heath bald, northern hardwoods
GEOGRAPHIC SCOPE
Craggy Mtns.
TYPE OF INFORMATION
quantitative (no form)
QUANTITATIVE TOPICS

Notes for Kring (1965)

This study examined succession on the grassy balds, heath balds, and rock outcrops of Craggy Gardens. This area lacks spruce-fir forest, although it contains high altitude areas. Lack of seed source is given as the reason why spruce-fir invasion is not expected. The nearest spruce-fir stand is north of Little Craggy Knob, one mile east of the visitor center.

Lambert, R.S. 1961. Logging on the Little River. East Tenn. Hist. Soc. Pub. 33: 32-42.

SUBJECT KEYWORDS
history, logging

RANGE OF COMMUNITIES
general southern Appalachian
GEOGRAPHIC SCOPE
Great Smoky Mtns.
TYPE OF INFORMATION
qualitative
QUANTITATIVE TOPICS

Notes for Lambert (1961a)

Gives dates, companies involved, economic constraints, methods used, and locations of logging operations within the Little River watershed of Great Smoky Mountains National Park. Overhead cable logging of spruce and hemlock below Clingmans Dome and Silers Bald are mentioned and arrangements between Champion Fibre Co. and the Little River Lumber Co. concerning shipment of spruce pulp are discussed briefly.

Lambert, R.S. 1961. Logging the Great Smokies 1880-1930. Tenn. Hist. Quarterly 20: 350-363.

SUBJECT KEYWORDS
history, logging

RANGE OF COMMUNITIES
general southern Appalachian
GEOGRAPHIC SCOPE
Great Smoky Mtns.
TYPE OF INFORMATION
qualitative
QUANTITATIVE TOPICS

Notes for Lambert (1961b)

Gives a general overview of logging in the Great Smoky Mtns. Explains general methods of pre-1940 timber harvest and certain intricacies of pre-park land ownership. Spruce-fir vegetation is peripheral to the discussion. However, the following points were made. Champion Fibre Co. was a major landowner in the Great Smoky Mountain spruce-fir zone. Because most of that land was held in reserve, the Smokies have much uncut spruce-fir. Spruce was cut by various companies for both lumber and pulpwood with the pulpwood being sold to Champion Fibre Co. The first World War stimulated a short-lived demand for spruce for use in the construction of airplanes.

Lambert, H.L. and W.M. Ciesla. 1965. Status of the Balsam Woolly Aphid in North Carolina and Tennessee. USDA Forest Service, Division of State and Private Forestry report.

SUBJECT KEYWORDS
BWA spread

RANGE OF COMMUNITIES
spruce-fir
GEOGRAPHIC SCOPE
North Carolina, Tennessee
TYPE OF INFORMATION
qualitative (some figures)
QUANTITATIVE TOPICS

Notes for Lambert and Ciesla (1965)

This report describes the status of balsam woolly adelgid infestations at that time, and gives results of aerial surveys in May and in late summer of 1965. Areas of dead and dying fir were ground checked. Aerial dispersal was examined by sticky traps to catch airborne larvae.

No survey was done on the Black Mtns., since infestation was complete there. Several new infestations were found on Roan Mtn. No new infestations were found on Grandfather Mtn. or in the Smoky Mtns., but existing infestations continued to spread. No infestations were found in the Balsam Mtns. or at Unaka Mountains in Tennessee.

Recommendations for reducing the rate of spread include spraying accessible areas of valuable forest, intensive surveillance, and cutting of trees. Infested trees should be cut only in early spring or late fall, when motile forms are uncommon, because cutting can disperse them. Reducing the number of stems in sprayed areas to reduce amount of spray needed is recommended.

Lambert, H.L., and W.M. Ciesla. 1967. Impact of summer cutting on the dispersal of the balsam woolly aphid. J. Econ. Entomol. 60: 613-614.

SUBJECT KEYWORDS
BWA control, BWA spread

RANGE OF COMMUNITIES
spruce-fir
GEOGRAPHIC SCOPE
Roan Mtn.
TYPE OF INFORMATION
quantitative (no form)
QUANTITATIVE TOPICS

Notes for Lambert and Ciesla (1967a)

Cutting of isolated groups of Fraser fir infested with balsam woolly adelgid was recommended by Ciesla, Lambert, and Franklin (1965) as a stopgap measure to control the spread of the infestation. This study examined whether the disturbances caused by cutting infested trees might increase dispersal. A localized infestation of 27 trees on the south slope of Roan Mtn. was used. Traps consisting of sticky microscope slides and screens were placed in and around the stand to capture dispersing BWA before and while the trees were cut. Traps in place for 2 1/2 hours before cutting caught 36 motile nymphs. Traps in place for 2 hours during cutting caught 301. A table of the number caught per square inch of trap at different distances and before and after cutting is given.

Cutting clearly increased the number of dispersing larvae even at 25-50 feet from the cutting boundary. While cutting is still recommended, it should be done in a season when motile nymphs capable of dispersing are not present.

Lambert, H.L., and W.M. Ciesla. 1967. Status of the Balsam Woolly Aphid in the Southern Appalachians - 1966. USDA Forest Service, Division of State and Private Forestry, Southeastern Area. Report No. 67-1-3.

SUBJECT KEYWORDS
bwa spread

RANGE OF COMMUNITIES
spruce-fir
GEOGRAPHIC SCOPE
Southern Appalachians
TYPE OF INFORMATION
qualitative, map
QUANTITATIVE TOPICS

Notes for Lambert and Ciesla (1967b)

This report describes the status of balsam woolly adelgid infestations at that time. Aerial surveys were done in May and in late summer, and areas of dead or dying fir were ground checked. Sticky traps were established, consisting of 18 inch square screens placed in open areas, and microscope slides attached projecting from trees. Areas around traps containing dispersing adelgids were carefully field checked for infestation.

3 new areas of infestation were found on Grandfather Mtn., 4 on Roan Mtn., and 1 in the Great Smokies. Only 2 of these were found by aerial survey; the rest were found by the sticky traps. This was the first time sticky traps were used and the large number of new infestations found is because of improved detection.

Previously known infestations continued to expand. No adelgids were found in the Balsam Mtns. or at Mt. Rogers, but groups of trees dying of unknown cause (not BWA) were found. Maps are given of the known infestations. A table of number of infestations and infested area in each mountain range in 1962-1966 is given.

Lambert, H.L. and J.L. Rauschenberger. 1968. Status of the Balsam Woolly Aphid in the Southern Appalachians. USDA Forest Service, Division of Forest Pest Control, Asheville, NC. Rept. 68-1-17.

SUBJECT KEYWORDS
BWA spread

RANGE OF COMMUNITIES
spruce-fir
GEOGRAPHIC SCOPE
Southern Appalachians
TYPE OF INFORMATION
quantitative, map
QUANTITATIVE TOPICS
BWA spread

Notes for Lambert and Rauschenberger (1968)

Describes results of balsam woolly adelgid surveys in 1967. Aerial surveys and ground checks were conducted on all spruce-fir areas except the Black Mountains, where infestation was complete. The only new infestation spot was on Grandfather Mtn. Previously known infestations on Grandfather, Roan, and the Smoky Mountains continued to expand.

Sticky screen traps were placed to detect airborne adelgids dispersing to new areas. With 400 traps placed, only one area, on Roan Mtn., caught any adelgids.

Maps are given showing infested areas and trap locations in each mountain range.

The rate of spread appears to have slowed this year, over other years since 1962. It may be that the improved detection system has caught up with actual levels, that the observed mortality has an effect, or that weather was unfavorable during dispersal periods this year.

Bark samples were examined to determine mortality at different life stages. Mortality occurred in all stages in all areas. Significance is not known.

Quantitative data evaluation record for
Lambert and Rauschenberger (1968)

TOPIC

BWA spread

METHODS

Aerial search for dead trees done in all spruce-fir areas and infestations mapped. 12x12 in. sticky traps were set in open areas for 15 days in the active dispersal period and trapped adelgids counted. 2 1/2 in. bark samples taken on 20 infested trees in 5 infestations on Roan, Grandfather, and Great Smoky Mountains.

NUMBER OF SAMPLES: PERMANENT PLOTS:

DATA PRESENTED

Maps of infested areas on Grandfather Mtn., Roan Mtn., Black Mtns., the Great Smoky Mtns.

Table and graph of number of infested spots and area infested, by mountain range, for years 1062-1967.

Table of number of live and dead adelgids in each developmental stage, for each of the 5 samples.

Number of adelgids caught on the sticky traps discussed.

Lambert, H.L., S.W. Morgan, and K.D. Johnson. 1980. Detection and evaluation survey of the balsam woolly adelgid infestation on Mt. Rogers--Virginia, 1979. USDA, Forest Service, Southeastern Area, State and Private Forestry, Atlanta, GA. Rept. No. 80-1-7.

SUBJECT KEYWORDS
BWA spread, BWA infestation levels, fir resistance to BWA

RANGE OF COMMUNITIES
spruce-fir

GEOGRAPHIC SCOPE
Mt. Rogers

TYPE OF INFORMATION
quantitative

QUANTITATIVE TOPICS
BWA infestation levels

Notes for Lambert, Morgan, and Johnson (1980)

Gives results of a 1979 survey for balsam woolly adelgid on Mt. Rogers, where it had not been previously detected. The history of BWA in the U.S., its biology, and its effect on firs are reviewed.

Traps made of sticky microscope slides were placed on trees in June 1979. The presence of motile BWA larvae led to the discovery of a 3-acre infestation. A more intensive trapping effort in Sept. 1979 was apparently destroyed by storms, but a second infestation was discovered in setting the traps. Several trees in the first infestation were dead or dying back, but is was not clear whether this was caused by BWA.

47 firs were measured, rated, and permanently marked to follow the future of the infestation. Examination of redwood on disks from 8 trees found evidence of infestations as long as 17 years.

The presence of BWA for as long as 17 years without major damage suggests that the fir trees on Mt. Rogers may have resistance.

Quantitative data evaluation record for
Lambert, Morgan, and Johnson (1980)

TOPIC

BWA infestation levels

METHODS

Placed 53 sticky microscope slide traps at regular intervals along trails at Mt. Rogers, in June 1979, and examined for balsam woolly adelgid after 2 weeks. 47 infested trees were permanently marked, and dbh, age, crown class, % crown dieback, infestation intensity, and number of years infested recorded. Disks cut from 8 infested trees were examined for redwood.

NUMBER OF SAMPLES: PERMANENT PLOTS: Y

DATA PRESENTED

Number of years of redwood in 8 disks from infested trees. Dbh, crown class, age, infestation intensity, and years of infestation for the 47 permanently marked trees.

An additional set of traps in Sept. 1979, which yielded no data, is described. An infestation discovered while setting the traps is discussed.

Lindsay, M.M. and S.P. Bratton. 1979. The vegetation of grassy balds and other high elevation disturbed areas in the Great Smoky Mountains National Park. Bull. Torrey Bot. Club 106: 264-275.

SUBJECT KEYWORDS
succession, disturbance, community maintenance

RANGE OF COMMUNITIES
grassy bald, high elevation successional
GEOGRAPHIC SCOPE
Great Smoky Mtns.
TYPE OF INFORMATION
quantitative (no form)
QUANTITATIVE TOPICS

Notes for Lindsay and Bratton (1979)

Comparison of grassy balds with open areas known to be disturbed. Sampled a variety of high elevation openings, including grassy balds of apparently natural origin, cleared fields, scars from slash fires, roadsides, trail shelter clearings, and pastures. Trees were measured and shrub and herb cover estimated in > 200 plots, but data are not presented here. Principal components ordination was done, and plots of it are presented.

Ordination of woody species data suggests elevation and moisture are the most important factors. For herbs, elevation and disturbance were most important. Continually disturbed areas like pastures and roadsides were similar regardless of elevation. The burned areas fell near the undisturbed forest. They were being invaded by spruce, fir, birch, and mountain ash, and were dominated by Rubus. The grassy balds were intermediate on the ordination. They were dominated by Danthonia compressa, with invaders from the surrounding forest, but did not resemble the burn scars. It is concluded that allowing occasional fire in grassy balds will not maintain them against invasion, as the burned areas are returning to forest. Whatever the origin of grassy balds, their present flora is a result of grazing.

Lindsay, M.M., and S.P. Bratton. 1980. The rate of woody plant invasion on two grassy balds. Castanea 45: 75-87.

SUBJECT KEYWORDS
succession, community maintenance

RANGE OF COMMUNITIES
grassy bald
GEOGRAPHIC SCOPE
Great Smoky Mtns.
TYPE OF INFORMATION
quantitative (no form), map
QUANTITATIVE TOPICS

Notes for Lindsay and Bratton (1980)

Studied Andrews and Gregory Bald in the Great Smoky Mtns. Woody vegetation on each bald was mapped using aerial photography. Plot samples were taken and trees cored. Data are given on the percentage cover of woody plants on the unforested areas. Andrews Bald, which is adjacent to spruce-fir forest, had 1.05 acres, or 13%, covered with invading spruce and fir, with similar amounts of deciduous trees and rhododendron. The spruce-fir forest had also encroached on the N and W edges and had already formed a closed canopy and a forest-like understory. The death of the firs by balsam woolly adelgid halted this invasion. It is suggested that birch, beech, serviceberry, and spruce would cover the bald, but that invasion will be slowed by the loss of fir.

Linzey, D.W. 1984. Distribution and status of the northern flying squirrel and the northern water shrew in the southern Appalachians. In: P.S. White (ed). The Southern Appalachian Spruce-Fir Ecosystem: Its Biology and Threats. NPS Research/Resources Man. Rept. SER-71.

SUBJECT KEYWORDS
rare species, vertebrate biology

RANGE OF COMMUNITIES
spruce-fir

GEOGRAPHIC SCOPE
Great Smoky Mtns., Black Mtns., Whitetop Mtn.

TYPE OF INFORMATION
qualitative

QUANTITATIVE TOPICS

Notes for Linzey (1984)

This paper reviews the status of the northern flying squirrel, Glaucomys sabrinus, and the northern water shrew, Sorex palustris, subspecies in the southern Appalachians, based on a recent status survey. Both species exist in disjunct relict populations in the south. No specimens of the northern flying squirrel have been recorded in the Great SMoky Mtns. since 1958 and at Whitetop since 1966. A study involving placing of nest boxes found the species on Mt. Mitchell for the first record in 31 years. They are threatened by habitat destruction and competition from the southern flying squirrel, Glaucomys volans.

The water shrew was first discovered in the Smokies in 1950. It was trapped on Walker prong in 1965 and at Beech Flats around 4000 feet in 1980.

Linzey, D.W., and A.V. Linzey. 1968. Mammals of the Great Smoky Mountains National park. J. Elisha Mitchell Sci. Soc. 84: 384-414.

SUBJECT KEYWORDS
vertebrate fauna, mammal biology

RANGE OF COMMUNITIES
general southern Appalachian
GEOGRAPHIC SCOPE
Great Smoky Mtns.
TYPE OF INFORMATION
qualitative, species list
QUANTITATIVE TOPICS

Notes for Linzey and Linzey (1968)

Summarized work on mammals throughout the Great Smoky Mountains National Park. Information is based on observations of the authors, earlier literature, and the 28-year journal of Arthur Stupka which recorded his observations and substantiated reports by others. 59 species are known and 6 more are believed extirpated. The species are listed and known information on their distribution (collections and observations), reproduction, hibernation, diet, predation, parasites, pelage, and measurements is given.

Linzey, D.W., and A.V. Linzey. 1973. Notes on food of small mammals from the Great Smoky Mountains, Tennessee-North Carolina. J. Elisha Mitchell Sci. Soc. 89: 6-14.

SUBJECT KEYWORDS
vertebrate biology, animal food habits

RANGE OF COMMUNITIES
general southern Appalachian
GEOGRAPHIC SCOPE
Great Smoky Mtns.
TYPE OF INFORMATION
quantitative
QUANTITATIVE TOPICS
animal food habits

Notes for Linzey and Linzey (1973)

Describes results of a trapping study of 12 species of small mammals over 6 years, at locations throughout the park. Stomachs of trapped animals were examined to determine diet. Detailed breakdown of volume and frequency of food items is given for Sorex fumeus, Blarina brevicauda, Peromyscus maniculatus, P. leucopus, Clethrionomys gapperi, Microtus pinetorum, and Napaeozapus insignis. Comparisons of winter and summer foods of Blarina brevicauda and Peromyscus maniculatus are also given. The other species were too rare to present detailed data, but were discussed in the text. Additional information is given on the elevational range and habitat of each species.

Six species ranged into the spruce-fir zone. Synaptomys cooperi, Clethrionomys gapperi, Microtus pennsylvanicus, Microtus chrotorrhinus, and Peromyscus maniculatus ate vegetation; Microtus pinetorum, Napaeozapus insignis, Clethrionomys gapperi, and Peromyscus maniculatus ate seeds.

Quantitative data evaluation record for
Linzey and Linzey (1973)

TOPIC

animal food habits

METHODS

Small mammals trapped with snap traps set throughout the Great Smoky Mountains National Park. Stomach contents of trapped animals examined.

NUMBER OF SAMPLES: PERMANENT PLOTS:

DATA PRESENTED

Table of % volume and % frequency of categories of food items in Sorex fumeus, Blarina brevicauda, Peromyscus maniculatus P. leucopus, Clethrionomys gapperi, Microtus pinetorum, and Napaeozapus insignis.

Tables comparing winter and summer foods of Blarina brevicauda and Peromyscus maniculatus.

Elevational ranges of all 12 species also given.

Little, E.L., Jr. 1970. Endemic, disjunct, and northern trees in the southern Appalachians. In: P.C. Holt (ed.): The Distributional History of the Biota of the Southern Appalachians. Part II: Flora. Va. Polytech. Inst. and State Univ., Res. Div. Monogr. 2: 249-290.

SUBJECT KEYWORDS
floristic affinities

RANGE OF COMMUNITIES
general southern Appalachian

GEOGRAPHIC SCOPE
Southern Appalachians

TYPE OF INFORMATION
qualitative, map

QUANTITATIVE TOPICS

Notes for Little (1970)

This paper discusses the southern Appalachian tree species (excluding Crataegus) with a variety of distributions, including endemic, centering in the southern Appalachians (nearly endemic), contiguous with larger northern distribution, and disjunct from the north. Relationships to species in the Ohio and Mississippi valleys, the western U.S., Mexico, and east Asia are discussed. Range maps of the western U.S. are given.

The southern Appalachians are relatively poor in endemic trees. Genera and species originating in the ancient land mass have spread beyond the region and are no longer endemic. 10 tree spp. are endemic to the southern Appalachians or slightly beyond. 5 others center there and apparently originated there. Most of the endemic species are old. Abies fraseri is the only young endemic. The flora of the Ozarks is closely related, with 10 characteristically southern Appalachian tree species occurring there. 9 tree genera are disjunct between eastern U.S. and east Asia.

Little, E.L. Jr. 1975. Rare and local conifers in the United States. USDA Forest Service, Conserv. Res. Rep. 19.

SUBJECT KEYWORDS
rare species

RANGE OF COMMUNITIES
general
GEOGRAPHIC SCOPE
U.S.
TYPE OF INFORMATION
qualitative
QUANTITATIVE TOPICS

Notes for Little (1975)

Describes 35 species of rare or local conifer species in the United States, including Fraser fir and Carolina hemlock, with range maps and names of protected areas on public land.

Livingston, D. and C. Mitchell. 1976. Site classification and mapping in the Mt. LeConte growth district. Unpubl. report, Great Smoky Mountains National Park Library, Gatlinburg, TN.

SUBJECT KEYWORDS
vegetation sample, vegetation-environment relationships, soil properties
RANGE OF COMMUNITIES
general southern Appalachian
GEOGRAPHIC SCOPE
Great Smoky Mtns.
TYPE OF INFORMATION
quantitative
QUANTITATIVE TOPICS
vegetation sample, soil properties

Notes for Livingston and Mitchell (1976)

A modification of the Baden-Wurtemberg system of site classification was used in a study area located between 2600 and 6000 feet elevation on the north slopes of Mt. LeConte in the Great Smoky Mountains. Prior to vegetation sampling, 11 site units relatively uniform in vegetation, soils, and topography were classified and mapped, based on aerial photograph interpretation and field reconnaissance. For each site unit, which generally encompassed several non-contiguous areas, vegetation was sampled in 3 subjectively located rectangular plots. Plot size varied according to species diversity and overall area encompassed by the site unit. plot results were summarized and discussed by site unit. A high elevation spruce complex was characterized as the "Subalpine Picea-Betula/Viburnum on north-facing slopes and high elevation draws on imperfectly drained soils" site unit and the "Subalpine and Alpine Abies-Picea/Rhododendron on ridgetops on imperfectly drained, peaty soils" site unit.

Quantitative data evaluation record for
Livingston and Mitchell (1976)

TOPIC
vegetation sample

METHODS
Sampled 11 site units, selected for accessibility and subjectively evaluated representativeness of idealized site conditions. Sampled 3 plots of varying size/stand unit and 5 1x1 m (or 3 5x5 m in dense ericaceous understory) subplots/10x20 m section of plot. Tallied trees >3.5 in. dbh by dbh, counted stems of trees and shrubs <3.5 in., estimated cover class of ground cover.

NUMBER OF SAMPLES: PERMANENT PLOTS:

DATA PRESENTED
Frequency, density, average relative density, and average relative basal area of overstory; frequency, density, and average relative density of understory; frequency and average cover class of understory ericads and ground cover, by species and site unit.

Quantitative data evaluation record for
Livingston and Mitchell (1976)

TOPIC
Soil properties

METHODS
Dug 18 soil pits in the 11 site units used for vegetation sampling. Measured rooting depth, depth to substrate, horizon depth, pH. Rated color, texture, drainage, stoniness, and slope position.

NUMBER OF SAMPLES: PERMANENT PLOTS:

DATA PRESENTED
Summary description by site unit, giving depth, pH, texture, and color.

Lovett, G.M. 1984. Pollutant deposition in mountainous terrain. In: P.S. White (ed). The Southern Appalachian Spruce-Fir Ecosystem: Its Biology and Threats. NPS Research/Resources Man. Rept. SER-71.

SUBJECT KEYWORDS
air pollution, atmospheric deposition

RANGE OF COMMUNITIES
spruce-fir
GEOGRAPHIC SCOPE
Great Smoky Mtns., U.S.
TYPE OF INFORMATION
qualitative
QUANTITATIVE TOPICS

Notes for Lovett (1984)

This paper reviews theoretical considerations regarding pollutant deposition at high elevations and evidence for them. Wet, dry, and gaseous pollutant deposition is expected to increase at high elevation because of higher wind speed, higher humidity, higher rainfall, and more frequent cloud cover, particularly wind-driven clouds. It is alos expected to be increased by coniferous vegetation, because needles are more efficient filters than broad leaves, and because they remain all year. These effects may be offset somewhat by the remote location of most high mountains.

Studies on cloud water deposition and lead accumulation, in various places, support the idea that deposition increases with elevation, but additional data are needed to demonstrate it.

Mathews, R.C., Jr., and A.C. Echternact. 1984. Herpetofauna of the spruce-fir ecosystem in the Southern Appalachian Mountains region, with emphasis on the Great Smoky Mountains National Park. In: P.S. White (ed). NPS Research/Resources Man. Rept. SER-71.

SUBJECT KEYWORDS
vertebrate fauna, vertebrate biology, air pollution, biomass, water pollution, exotic species

RANGE OF COMMUNITIES
spruce-fir

GEOGRAPHIC SCOPE
Great Smoky Mtns.

TYPE OF INFORMATION
quantitative, species list

QUANTITATIVE TOPICS
vertebrate biology & biomass

Notes for Mathews and Echternact (1984)

This paper reviews information on herpetofauna in the Great Smoky Mountains spruce-fir forests. A list of reptile and amphibian species known to occur in spruce-fir forests is given. Only 2 species, the salamanders Desmognanthus imitator and D. wrighti, are truly characteristic of spruce-fir. Plethodon jordani is characteristic in its limited range.

Most work has been done on stream-associated salamanders. Data are given on density and biomass of these salamanders at 3 different elevations (<600 m, 600-1200 m, and >1200m). The density and biomass are low at high elevation. A table is given of partial correlations of salamander biomass, density, and species number, with a number of environmental variables. No single or few variables explains the salamander abundance.

The greatest threats to spruce-fir salamanders are believed to be toxic leachate from roadcuts through the Anakeesta Formation, acid precipitation, balsam woolly adelgid destruction of fir, wild boar rooting and predation, and overcollecting.

Quantitative data evaluation record for
Mathews and Echternact (1984)

TOPIC

vertebrate biology and biomass

METHODS

Used data from Mathews (1984) on number of species, density, and biomass of stream-associated salamanders in 1719 sites, along with data on air temperature, water temperature, stream flow, watershed, substrate type, stream pH, stream order, and slopes (possibly also from Mathews (1984)). Did partial correlations of environmental variables with salamander data.

NUMBER OF SAMPLES: 1719 PERMANENT PLOTS:

DATA PRESENTED

Number of sites in each stream-associated salamander density and biomass class, in 3 elevation classes (<600 m, 600-1200 m, > 1200 m). Partial correlation coefficients of stream associated salamanders species number, density, and biomass with forest type, air temperature, water temperature, stream flow, watershed, logging history, substrate type, stream pH, stream order, terrain slopes, season, and elevation.

McCambridge, W.F., and R.J. Kowal. 1957. Forest insect conditions in the southeast during 1956. Southeast Forest Experiment Station, Station Paper No. 76.

SUBJECT KEYWORDS
BWA spread

RANGE OF COMMUNITIES
General Southeastern
GEOGRAPHIC SCOPE
Southeastern U.S.
TYPE OF INFORMATION
qualitative
QUANTITATIVE TOPICS

Notes for McCambridge and Kowal (1957)

This paper describes outbreaks of a number of insects throughout the Southeast. Brief mention is made of an aphid called Chermes nusslini attacking Fraser firs near Skyland, along the Blue Ridge Parkway in northern Virginia, killing adult trees and deforming saplings.
[This predates the discovery of BWA in the southern Appalachians]

McCord, D. 1968. Herringbone Pattern in Spruce-fir on Devil's Courthouse Ridge. Semester Project for Ecology 450. Typescript ms., Great Smoky Mountains National Park Archives.

SUBJECT KEYWORDS
vegetation sample, logging, soil properties

RANGE OF COMMUNITIES
spruce-fir, high elevation successional

GEOGRAPHIC SCOPE
Great Smoky Mtns.

TYPE OF INFORMATION
quantitative

QUANTITATIVE TOPICS
vegetation sample & soil properties

Notes for McCord (1968)

This study examined an area of logged spruce-fir forest showing a "herringbone pattern" produced by skidding of logs. Strips of fir-dominated forest alternate with open brushy strips where logs were dragged. A transect across an open strip was mapped in detail, and several quadrats were sampled in the forest and openings. Density and basal area of trees and density of lower woody strata are given.

The forest was dominated by a dense stand of fir, with little understory and many dead branches and limbs. The open strips were dominated by briars and sedges. Shrubs were densest at the edge of strips. The most common tree in the open strips was mountain ash, but most individuals were standing dead.

Soil samples found no difference in depth between the forest and open strips. Past disturbance and the difficulty of seedling establishment in the dense sedge were concluded most likely to be responsible for the lack of tree invasion.

Quantitative data evaluation record for
McCord (1968)

TOPIC

vegetation sample & soil properties

METHODS

Sampled an area showing herringbone skidding pattern, on the west slope of Devils Courthouse Ridge below Mt. Buckley in the Smokies. Sampled 3 quadrats each in forest and open strip. Tallied trees, saplings, shrubs, and seedlings in nested plots. Estimated herb cover. Mapped indiv. plants and estimated cover in 8 ft. segments on an 80x8 ft. transect. Took soil depth & pH.

NUMBER OF SAMPLES: 6   PERMANENT PLOTS:

DATA PRESENTED

Absolute and relative density and basal area, and number standing dead, by species, in the 6 quadrats. Density of saplings in 5 size classes and standing dead, seedlings, shrubs, and briar clumps, in 6 quadrats. % cover of total herb, fern, moss, sedge, and litter, for the 6 quadrats and for the transect segments. Map of plants in the transect. Depth and pH of soil in the quadrats.

McCormack, J.F. 1956. Forest statistics for the Mountain Region of North Carolina. 1955. USDA Forest Service, Southeast. For. Exp. Sta., Forest Survey Release No. 46.

SUBJECT KEYWORDS
timber statistics

RANGE OF COMMUNITIES
general southern Appalachian

GEOGRAPHIC SCOPE
North Carolina

TYPE OF INFORMATION
quantitative

QUANTITATIVE TOPICS
timber statistics

Notes for McCormack (1956)

This report gives results of the 2nd forest inventory for the 21 counties of western North Carolina. Data are based on systematically located plots. Land use is classified and timber statistics are given only for commercial forest land.

There were 14200 acres of commercial spruce-fir, 5100 in large sawtimber, 5600 in pole timber, and 3500 in poorly stocked stands.

Data given by species or timber type, so that spruce-fir can be distinguished, include volume by stand size class and tree dbh class, area of commercial forest by % stocking, and average growth rate of growing stock and sawtimber.

Statistical reliability of the data is discussed, and standard errors given. Although much data is given broken down by county, a warning is given that individual county samples are too small for statistical reliability.

Laxton, J. 1931. Pisgah--a forest treasureland. Am. For. 37: 339-342.

SUBJECT KEYWORDS
history, conservation

RANGE OF COMMUNITIES
general southern Appalachian
GEOGRAPHIC SCOPE
Black Mtns., Balsam Mtns., Craggy Mtns., Roan Mtn.
TYPE OF INFORMATION
qualitative
QUANTITATIVE TOPICS

Notes for Laxton (1931)

Describes the history of efforts to establish a forest reserve in the southern Appalachians, leading to the creation of Pisgah National Forest in 1916.

Li, B. 1985. Geographic variation of Fraser fir (Abies Fraseri (Pursh.) Poir.). M.S. Thesis, N.C. State Univ.

SUBJECT KEYWORDS
fir genetics, intraspecific variation, tree growth

RANGE OF COMMUNITIES
spruce-fir, plantation
GEOGRAPHIC SCOPE
Southern Appalachians
TYPE OF INFORMATION
quantitative
QUANTITATIVE TOPICS
tree growth & fir genetics

Notes for Li (1985)

This study examined variation in Fraser fir seedlings grown from seed from different natural populations, with an emphasis on Christmas tree production. Seeds were collected at 150 foot elevation intervals at Richland Balsam, Clingmans Dome, Mt. Mitchell, Roan Mtn., and Mt. Rogers. Seeds were planted in a greenhouse, transferred to nursery beds, and eventually to 3 intermediate to low elevation field trial sites. Seedling total height, number of buds at the terminal node, and root collar were measured. Data were analysed by ANOVA.

Significant differences were found between height growth, with the fastest growth being from lower elevation and more southerly seed sources. The difference was greatest at the lowest elevation planting site. Seeds from Mt. Mitchell high elevations performed differently from other high elevation seed sources, perhaps because planting there altered genetic composition.

Estimates of heritability indicate height growth is under moderate genetic control and root collar diametner is under weak genetic control.

Quantitative data evaluation record for
Li (1985)

TOPIC

tree growth & fir genetics

METHODS

Collected fir seed from 10 trees at each 150 foot elev. interval at Richland Balsam, Clingmans Dome, Mt. Mitchell, Roan Mtn., and Mt. Rogers. Planted seeds in greenhouse in 6 replicates with 5 seedlings/family, transferred to nursery and then to 3 field plantation sites. Measured height and number of lateral buds at each stage. Measured root crown diameter in the field sites.

NUMBER OF SAMPLES: PERMANENT PLOTS:

DATA PRESENTED

Mean total height growth of seedlings from each source site and elevation, at each field planting site. ANOVA of height, bud number, and root collar dia. at each planting site and all sites combined, and in greenhouse and nursery beds. Estimated heritability and std. error, calculated on an individual-tree and a family-mean basis, for greenhouse, nursery, and field height, and for field root crown diameter. Correlation of individual-tree, family-mean, and genotypic height values at different stages.

Quantitative data evaluation record for
McCormack (1956)

TOPIC

timber statistics

METHODS

Sampled systematically located sites throughout western North Carolina. Sampled 1/5 acre plots. Methods not described in detail. Amount of timber cut was estimated from stumps found in plots. Volumes were calculated with volume equations.

NUMBER OF SAMPLES: 1450 PERMANENT PLOTS:

DATA PRESENTED

(Only data in which spruce-fir can be distinguished are noted) Area of commercial forest by stand size class and forest type. Net volume of sawtimber, growing stock, and all timber, by species (spruce & fir together) and stand size class, by species and tree dbh class, and by forest type and stand size class, on commercial forest land. Area of seedling, sapling, and poorly stocked stands by forest type and plantability class. Area of commercial forest and of sawtimber, by % stocking and forest type. Ave. growth of sawtimber & growing stock, by forest type.

McCracken, W.H. 1978. Comparison of forest cover prior to and following disturbance in two areas of the Great Smoky Mountains National Park. M.S. Thesis, Univ. of Tennessee, Knoxville.

SUBJECT KEYWORDS
vegetation sample, disturbance, logging, succession, history

RANGE OF COMMUNITIES
spruce-fir, cove forest
GEOGRAPHIC SCOPE
Great Smoky Mtns., Balsam Mtns.
TYPE OF INFORMATION
quantitative
QUANTITATIVE TOPICS
vegetation sample

Notes for McCracken (1978)

Prelogging forest cover, the nature and intensity of logging, and present forest conditions were investigated for two areas in the Great Smoky Mountains National Park. One area, Cataloochee Balsam, was spruce-fir forest; the other was a cove forest along Middle Prong Little River. The nature of forests before logging and the nature of logging were studied using interviews of people who had been in the area, written records, old photographs, and, at Cataloochee, comparison with nearby unlogged forests. Present conditions were described with plot samples of trees.

Both sites were logged in the 1920's-1930's, using railroads and steam powered overhead skidders. The virgin spruce-fir, and presumably the prelogging forest, was dominated by spruce, with fir and birch. Fir and birch were more important on the ridgetop site than on the slope. Fir dominated the regeneration in both. The logged site did not burn and the high skidding cables caused little damage to remaining trees. The logged forest was dominated by spruce more strongly than the virgin forest. Birch was more important, because of large uncut trees. Basal area was somewhat lower and density somewhat higher in the logged stands.

Quantitative data evaluation record for
McCracken (1978)

TOPIC

vegetation sample

METHODS

Sampled sites for which historical information had been obtained: 1 slope and 1 ridgetop site each in virgin and logged spruce-fir on Cataloochee Balsam, and 6 sites in logged cove forest on Middle Prong of Little River. Measured canopy trees in 1/5 acre plots, subcanopy trees in 1/10 acre plots, counted tree regeneration in 1/1000 acre plots.

NUMBER OF SAMPLES: 8   PERMANENT PLOTS:

DATA PRESENTED

Absolute and relative basal area and density of canopy and subcanopy tree species, and density of tree regeneration, for ridgetop and slope sites in virgin and logged spruce-fir forest, and for 6 logged cove forest sites.

History of disturbance of logged stands and historical information on original forest composition and tree size is given.

McCracken, R.J., R.E. Shanks, and E.E.C. Clebsch. 1962. Soil morphology and genesis at higher elevations of the Great Smoky Mountains. Soil Sci. Soc. Am. Proc. 26: 384-388.

SUBJECT KEYWORDS
soil properties, vegetation-environment relationships

RANGE OF COMMUNITIES
spruce-fir, beech gap, heath bald, grassy bald
GEOGRAPHIC SCOPE
Great Smoky Mtns.
TYPE OF INFORMATION
quantitative
QUANTITATIVE TOPICS
soil properties

Notes for McCracken, Shanks, and Clebsch (1962)

Studied soil profiles in Mt. LeConte-Newfound Gap-Clingman's Dome area. Found Sol Brun Acide sites under spruce-fir, beech gap, and grassy bald, Podzol under heath bald. Described profile and analysed physical and chemical properties.

All sites except grassy bald were extremely acidic, especially at the surface. Grassy balds had much less organic matter in the A horizon, and lower C/N ratio. All sites except heath bald Podzol had decreasing organic matter with depth.

Clay mineralogy on all sites was 40% vermiculite-chlorite intergrade, with some kaolinite and gibbsite. Weathering was extreme in all soils. Bases occurred in appreciable amounts only in the organic A horizon. Fine roots grow in the organic layer with few in mineral layers. This cycling between organic matter and plants is more susceptible to leaching than mineral soil systems and may account for low fertility.

The heath bald Podzol resembles the Leetonia series. Spruce-fir and beech gap soil resemble Ramsey series, and grassy bald resembles Burton. Sol Brun Acide soils are more widespread than Podzols here. Podzols occur only on an extreme site--more coarse texture, more stable, no upslope water.

Quantitative data evaluation record for
McCracken, Shanks, and Clebsch (1962)

TOPIC

soil properties

METHODS

Sampled one site each in spruce-fir forest, beech gap, grassy bald, and heath bald in Smokies. Locations not given. Described soil profile and measured horizons. Analysed for pH, organic carbon, N, free Fe, Ca, K, Na, Mg, exchange acidity, exchangeable Al, and clay minerology.

NUMBER OF SAMPLES: PERMANENT PLOTS:

DATA PRESENTED

Tables by site and by horizon of soil depth, pH, exchange acidity, exchangeable cations, Al, % CA, Mg, K, % organic carbon, % nitrogen, C/N ratio, free Fe_2O_3, % rocks, sand, silt, and clay. Clay mineralogy differences discussed. Soil series and types discussed. Root distribution described.

McDougall, W.B. 1928. Mycorhizas from North Carolina and eastern Tennessee. Am. J. Bot. 15: 141-148.

SUBJECT KEYWORDS
mycorrhizae, fungus biology

RANGE OF COMMUNITIES
general southern Appalachian
GEOGRAPHIC SCOPE
Southern Appalachians
TYPE OF INFORMATION
qualitative
QUANTITATIVE TOPICS

Notes for McDougall (1928)

Describes observations on mycorrhizae collected from various woody species, primarily in Pisgah National Forest. Six collections were made on Fraser fir on Mt. LeConte, under mushrooms of Russula, Spathularia, and Boletus. A species of Russula seems to be most common. One collection was made from red spruce on Mt. LeConte. The collection time in August 1926 was just after the end of a 2-year drought. Local people said no mushrooms had appeared during those 2 years, and the tree roots contained only newly developing mycorrhizae, without old dead ones. The trees did not seem to suffer from the lack of mycorrhizae or from the drought.

McGinnis, J.T. 1958. Forest Litter and Humus Types of East Tennesee. MS Thesis, University of Tennessee-Knoxville.

SUBJECT KEYWORDS
soil properties

RANGE OF COMMUNITIES
general southern Appalachian

GEOGRAPHIC SCOPE
Great Smoky Mtns.

TYPE OF INFORMATION
quantitative

QUANTITATIVE TOPICS
soil properties

Notes for McGinnis (1958)

This study sampled soil and litter layers in a variety of forest types, looking at humus type (mull vs. mor) and soil properties. One virgin spruce-fir stand near Newfound Gap was sampled. Horizons were described and analysed for organic matter, total N, extractable Ca and K, pH, and bulk density. Total weight of organic matter was calculated.

The spruce-fir forest had much more organic matter than the deciduous forests or the pine forests--222,700 lbs./acre. Cation levels were higher in the organic forest floor than in the mineral soil. Ca levels generally decreased with elevation. The C/N ratio in the organic forest floor was higher under coniferous than deciduous forest. Spruce-fir was the only forest type with a mor humus. The upper part was a felty mor, the lower part a greasy mor.

Quantitative data evaluation record for
McGinnis (1958)

TOPIC

Soil properties

METHODS

Sampled 11 sites in different vegetation, one in spruce-fir near Newfound Gap. Sample 5 soil columns 1 dm square, in each site, located randomly but >6 feet from large trees. Described and collected each horizon (only top 10 cm of B horizon). Analysed 2 of the 5 for bulk density, total C, organic matter, total N, Ca, K, and pH.

NUMBER OF SAMPLES: 2   PERMANENT PLOTS:

DATA PRESENTED

Profile descriptions.

Bulk density of each horizon. Pounds/acre of organic matter based on % organic matter and bulk density).

% organic matter, %C, %N, C/N ratio, total Ca, total K for each organic layer (L, F, H).

% organic matter, %C, %N, C/N ratio, available Ca, available K, pH for each mineral horizon.

Quantitative data evaluation record for
McGuire (1983)

TOPIC

soil properties

METHODS

Sample sites selected to represent morphological extremes found in previous study, or randomly. Dug soil pits and sampled all horizons at 7 plots, just spodic horizons at 4 others. Did Bartlett (P absorption) and Holmgren (KOH Al method) field chemical tests for spodic horizon. Did lab analysis of particle size, pH, organic matter, CEC, Ca, Na, Mg, K, acidity, Fe, Al.

NUMBER OF SAMPLES: 11 PERMANENT PLOTS:

DATA PRESENTED

Descriptions of 11 pedons with site characteristics and forest type. Monthly soil temp. readings (at 50 cm) from Unaka & Roan Mtn. Depth, color, sand, silt, clay, texture class, pH, organic matter for each B subhorizon in 11 pedons.

Depth, detailed particle sizes, pH, Ca, Mg, Na, K, extractable acidity, cation exchange capacity for all horizons in 7 pedons.

Al and Fe by both sodium pyrophosphate and sodium dithionite-citrate method for each horizon for 7 pedons.

Comparison of various measures of spodic character for 11 pedons.

McGuire, G.A. 1983. The Classification and Genesis of Soils With Spodic Morphology in the Southern Appalachians. MS Thesis, University of Tennessee-Knoxville.

SUBJECT KEYWORDS
soil properties, soil taxonomy

RANGE OF COMMUNITIES
spruce-fir, heath bald, high elevation successional
GEOGRAPHIC SCOPE
Great Smoky Mtns., Unaka Mtns.
TYPE OF INFORMATION
quantitative
QUANTITATIVE TOPICS
soil properties

Notes for McGuire (1983)

This study supplements limited physical and chemical data on soils with spodic morphology in the southern Appalachians, and examines problems in the current Soil Taxonomy classification of them. 11 pedons were sampled in the Smokies (Clingmans Dome and Enloe Creek) and at Unaka Mountain. 7 had spruce-fir or spruce-hardwood. The rest were heath-dominated, possibly as a result of burning spruce-fir.

Profiles were described and pH, particle size disturbution, extractable bases, and acidity were analysed. Fe & Al were analysed with both sodium pyrophosphate and sodium dithionite-citrate methods. Two field chemical tests for spodic horizon identification were compared. Of the 11 pedons, only 2 met all the present criteria for Spodosols. The most critical criterion was the pyrophosphate Al & Fe/clay ratio. The high clay content of most of the soils reduced it to less than the required 0.2.

Two pedons were classified as Haplorthods, the rest as Dystrochrepts or Haplumbrepts. Proposals were made to change the criteria for Spodosols to include some of these, and to create Spodic subgroups in Inceptisols to include the rest.

Metcalf, Z.P., and B.W. Wells. 1926. North Carolina. Pages 412-418 in V.E. Shelford (ed.), A Naturalist's Guide to the Americas. Ecologial Soc. Am., Baltimore.

SUBJECT KEYWORDS
vegetation patterns, conservation

RANGE OF COMMUNITIES
general Southeastern

GEOGRAPHIC SCOPE
North Carolina

TYPE OF INFORMATION
qualitative

QUANTITATIVE TOPICS

Notes for Metcalf and Wells (1926)

A brief, very general description is given of the vegetation types of the state of North Carolia, giving dominant plant and characteristic animal species. Significant natural areas in the state are described. These include Mt. Mitchell State Park, Roan Mtn., Grandfather Mtn., and the national forests.

The volume contains similar descriptions for each state and country in North and South America, and a series of short articles on the use, values, and management of natural areas. (Descriptions for Tennessee and Virginia do not deal with spruce-fir forests).

Miller, F.H. 1938. Brief narrative descriptions of the vegetative types in the Great Smoky Mountains National Park. Unpublished manuscript, Great Smoky Mountains National Park Archives. 10 pp.

SUBJECT KEYWORDS
vegetation patterns, fire, logging, extent of spruce-fir, vegetation sample
RANGE OF COMMUNITIES
general southern Appalachian
GEOGRAPHIC SCOPE
Great Smoky Mtns.
TYPE OF INFORMATION
quantitative
QUANTITATIVE TOPICS
vegetation sample & vegetation patterns

Notes for Miller (1938)

Vegetation types of a vegetation classification map of Great Smoky Mountains National Park are described. Trees were tallied in plots throughout the park, and height of shrubs and herb layer were recorded in subplots. Slope, aspect, and elevation of each plot was recorded. The types described are grass, cove hardwoods, yellow pine-hardwoods, white pine-hardwoods, hemlock, heath bald, spruce, oak-chestnut, northern hardwoods, blowdown, rock, and burn. Additionally, a cutover boundary is described and age classes and stand conditions are discussed. The spruce type is described as a high elevation community dominated by red spruce and southern balsam (Fraser) fir with consistent variations related to environmental factors and stand history. Old growth is dominated by fir at higher elevations. At lower elevations spruce dominates and is found in nearly pure stands on ridgetops. Old burns and clear cuts are dominated by fire cherry with a spruce and fir understory. Understory shrubs change with stand density and elevation.

Quantitative data evaluation record for
Miller (1938)

TOPIC

vegetation sample & vegetation patterns

METHODS

Sampled 1/5 acre plots, with 1/10 acre subplots for brush and ground cover. Tallied trees >4 in. dbh by dbh class. Recorded average height of dominant trees by species. Divided subplots into 100 rectangles and recorded dominant plant species or ground cover type in each. Tallied average height of ferns, annuals, grasses, and each species of shrub. Mapped vegetation.

NUMBER OF SAMPLES: 1378 PERMANENT PLOTS:

DATA PRESENTED

Vegetation map of Great Smoky Mtns. National Park, indicating vegetation types, cut and burned areas, and age classes of forest. Planimetered estimates of area of each vegetation type. Raw field data for the plot samples are stored in the Great Smoky Mtn. National Park archives.

Minckler, L.S. 1940. Early planting experiments in the spruce-fir type of the Southern Appalachians. J. Forestry 38: 651-654.

SUBJECT KEYWORDS
tree planting, exotic plants

RANGE OF COMMUNITIES
spruce-fir

GEOGRAPHIC SCOPE
Black Mtns.

TYPE OF INFORMATION
quantitative

QUANTITATIVE TOPICS
tree planting

Notes for Minckler (1940a)

Survival class and average annual growth were tabulated for 78 plots, each 100 trees of various species, planted 1923-1931 on cutover and burned spruce-fir forest site in the Black Mtns. A non-statistically based discussion described the superior survival of Abies fraseri and higher survival rates of plantings on east vs. south-facing slopes.

All exotic species planted (Norway spruce, red pine, pitch pine, Scotch pine, northern white cedar, white spruce, Douglas fir, western white pine, European silver fir, Japanese red pine, Japanese larch, European larch, lodgepole pine, Engelmann spruce, sitka spruce, white fir, western white cedar) were present in 1939. However, only Norway spruce and red pine were considered successful along with the native red spruce and Fraser fir.

Quantitative data evaluation record for
Minckler (1940a)

TOPIC
tree planting

METHODS
Sites in the Black Mountains, on S and E-facing slopes. Site selection criteria not given. 78 plots, each consisting of 100 trees, were planted 1923-1931 by Appalachian Forest Experiment Station. Measured mean annual height growth and survival.

NUMBER OF SAMPLES: 78 PERMANENT PLOTS:

DATA PRESENTED
Survival by species for each aspect.
Mean annual height growth by species for each aspect.
The importance of aspect to survival and the superior survival of Fraser fir are discussed.

Minckler, L.S. 1940. Vegetative competition as related to plantation success in the Southern Appalachian spruce type. J. Forestry 38: 68-69.

SUBJECT KEYWORDS
tree planting, exotic plants

RANGE OF COMMUNITIES
spruce-fir
GEOGRAPHIC SCOPE
West Virginia
TYPE OF INFORMATION
quantitative
QUANTITATIVE TOPICS
tree planting

Notes for Minckler (1940b)

Results were presented from a study of competition in plantings of red spruce and red pine in the spruce type of West Virginia. Cover type, occularly estimated cover density, and individual tree condition class and competitive status were recorded for 800 red spruce in 9 plantations and 470 red pines in 4 plantations. A summary tabulation of data by species, competition class, and tree condition was presented. Additionally, average height by species and competition class and percent of thrifty trees by species and cover density class were given. Red spruce in the competition-free category was on the average taller and more thrifty than in other categories. Density, but not species, of associated vegetation was related to competition class. Additionally, sites with a heavy carpet of moss and very little other vegetation were said to be usually associated with poor drainage and plantation failure.

Quantitative data evaluation record for
Minckler (1940b)

TOPIC

tree planting

METHODS

Sampled 800 red spruce and 470 red pines, 2-7 years old, in representative plantations. Determined cover type, estimated cover density, and determined condition and competitive status of each individual.

NUMBER OF SAMPLES: PERMANENT PLOTS:

DATA PRESENTED

Percentage of trees in each competition and condition class, by species. Average height of each species by competition class and percentage of thrifty trees of each species by cover density class are given in the text.

Minckler, L.S. 1941. Preliminary results of experiments in reforestation of cut-over and burned spruce lands in the southern Appalachians. USDA Forest Service, Appalachian Forest Exp. Sta., Tech. Note 47. 5 pp.

SUBJECT KEYWORDS
tree planting, exotic plants

RANGE OF COMMUNITIES
spruce-fir
GEOGRAPHIC SCOPE
West Virginia
TYPE OF INFORMATION
quantitative (no form)
QUANTITATIVE TOPICS

Notes for Minckler (1941)

Regeneration research in plantations initiated in 1923 by the Appalachian Forest Experiment Station on spruce-fir sites in Monongahela and Pisgah National Forests was summarized. Of 20 species planted, only southern balsam (Fraser) fir, red spruce, Norway spruce, and red pine were considered successful. Four problem site types were characterized repsectively by poor drainage, dense herbaceous and shrubby vegetation, dense growth of undesirable hardwoods, and harsh site conditions exacerbated by loss of soil humus following fire. First year results from experiments involving mechanical methods of release, site preparation by broadcast burning, and direct seeding are summarized.

Data from this paper are also contained in Minckler (1938) and Minckler (1941).

Minckler, L.S. 1944. Third-year results of experiments in reforestation of cut-over and burned spruce lands in the southern Appalachians. USDA Forest Service, Appalachian Forest Experiment Station, Tech. Note 60. 10 pp.

SUBJECT KEYWORDS
tree planting, exotic plants

RANGE OF COMMUNITIES
spruce-fir
GEOGRAPHIC SCOPE
West Virginia, North Carolina
TYPE OF INFORMATION
quantitative
QUANTITATIVE TOPICS
tree planting

Notes for Minckler (1944)

In a management oriented presentation, comments were given on the success of various treatments to planted or seeded red spruce, red pine, and Fraser fir in 3 types of problem sites on cutover and burned spruce lands in Monongahela and Pisgah National Forests. The problem sites were described as sites with dense herbaceous and shrubby vegetation, sites with young stands of undesirable, brushy hardwoods, and severe and rocky sites. Treatments involved various forms of site preparation, release through creation of openings in the overstory, use of fertilizer, rooting hormones, mulch, and selected "super" planting stock, and comparison of direct seeding vs. seedling planting. Success was defined as the percentage of trees which were thrifty (i.e., not dead or predicted to die within a year). Results were reported by species in terms of percentage success.

Quantitative data evaluation record for
Minckler (1944)

TOPIC
tree planting
METHODS
Planted red spruce, Fraser fir, and red pine seeds and seedlings in cutover, burned sites with dense shrub and herb growth, undesirable hardwoods, or rocks. Treatments included burning, release by opening overstory, fertilizer, rooting hormones, mulch, and improved planting stock. Examined survival and condition of tree seedlings after 3 years.
NUMBER OF SAMPLES: ? PERMANENT PLOTS: Y
DATA PRESENTED
Percent success by species for direct seeding, planting, release, burning, and eradication of competing roots in sites with dense herb and shrub growth; for release in low, medium, and high density stands of hardwoods; for direct seeding with and without mulch, fertilizer, and added topsoil, on severe rocky sites.

Minckler, L.S. 1945. Reforestation in the spruce type in the southern Appalachians. Journal of Forestry 43: 349-356.

SUBJECT KEYWORDS
tree planting, disturbance, logging, succession

RANGE OF COMMUNITIES
spruce-fir

GEOGRAPHIC SCOPE
Southern Appalachians, West Virginia

TYPE OF INFORMATION
quantitative (no form)

QUANTITATIVE TOPICS

Notes for Minckler (1945)

1,500,000 acres of devastated spruce-fir land in WV, VA, NC, and TN. Hardwood reproduction covers most but only on best sites will it grow to marketable timber. Poor sites should be replanted in spruce. Fires after logging have destroyed reproduction, and little or no seed source remains. In some, but probably no more than 10%, the soil itself has been destroyed, leaving only a rocky surface.

Planting experiments were conducted on three types of problem sites: sites with dense herb and shrub cover, sites with dense bushy young hardwoods, and severe rocky sites. On heavily vegetated sites, some release from competition is needed in first year to allow success. Rocky sites can be successfully seeded in soil pockets.

Recommends testing a combination of burning and grazing to reduce competing vegetation before planting.

Moore, B.J. 1963. A Preliminary Annotated Checklist of the Foliose and Fruticose Lichens of the Great Smoky Mountains National Park. M.S. Thesis, Univ. of Tenn., Knoxville.

SUBJECT KEYWORDS
lichen flora, lichen taxonomy, floristic affinities

RANGE OF COMMUNITIES
general southern Appalachian
GEOGRAPHIC SCOPE
Great Smoky Mtns.
TYPE OF INFORMATION
qualitative, taxonomic key
QUANTITATIVE TOPICS

Notes for Moore (1963)

Contains taxonomic keys and descriptions of 131 species, compiled from other sources. The substrates of the different species are discussed. There is brief discussion of geographic affinities of the species.

Murphy, L.S. 1917. Red spruce: its growth and management. USDA, Dept. Bull. 544. 67 pp.

SUBJECT KEYWORDS
tree growth, tree reproduction, timber statistics, history, general tree characteristics, production, biomass
RANGE OF COMMUNITIES
northern spruce-fir
GEOGRAPHIC SCOPE
Northeast U.S., West Virginia
TYPE OF INFORMATION
quantitative
QUANTITATIVE TOPICS
tree growth & production & timber statistics

Notes for Murphy (1917a)

This bulletin is a review of a variety of information about red spruce trees, forests, and timber. The information is oriented toward the Northeast and West Virginia. At the time, commercial use of spruce in the southern Appalachians had just begun. Results of timber surveys are given, which show that North Carolina produced 1.4% of the nation's spruce and Virginia 4.6%.

The uses of spruce wood, types of spruce forest, the growth form and size of spruce trees, the requirements of spruce reproduction, threats to spruce, and recommended logging practices are described. Tables are given illustrating tree sizes, growth rates, proportions, and stand production in several sites in New England, New York, and West Virginia.

Quantitative data evaluation record for
Murphy (1917a)

TOPIC

tree growth & production & timber statistics

METHODS

Uses data from a variety of sources, for spruce in Maine, New Hampshire, Vermont, New York, and West Virginia.

NUMBER OF SAMPLES: PERMANENT PLOTS:

DATA PRESENTED

Tables of height growth by dbh, in ME, NH, NY, WV. Average dbh of spruce of various ages in ME and average age of trees of various dbh. Yearly increment and years needed to grow 1 inch, for different size trees, on several kinds of sites, in ME, NY, & WV. Cross-sectional area growth in even-aged stands of different age and site quality in VT, NH, & ME. Cubic volume growth by age in NY and ME. Density, basal area, average dbh, ht., timber yield, by age and site quality in even-aged stands in VT, NH, ME. Tables of volume by tree ht. & dbh, by different methods.

Murphy, L.S. 1917. Seeding habits of spruce as a factor in the competition of spruce with its associates. Plant World 20: 87-90.

SUBJECT KEYWORDS
tree reproduction

RANGE OF COMMUNITIES
northern spruce-fir
GEOGRAPHIC SCOPE
Northeast U.S.
TYPE OF INFORMATION
qualitative
QUANTITATIVE TOPICS

Notes for Murphy (1917b)

Discusses observations on seeding behavior of red spruce in New Hampshire and Maine. Spruce has been known to produce abundant seed only at infrequent intervals. In the area observed, the spruce seeded in 1910 and in September of that year spruce seedlings were extremely abundant. In the spring many spruce seedlings were buried beneath hardwood leaves and had died or were in poor health. Those under spruce or fir canopy or otherwise protected from hardwood litter survived. It is concluded that the early dispersal of spruce seed, which results in fall germination, was a significant factor reducing the competitive ability of spruce in relation to associated hardwoods. The effect of hardwood litter is concluded to be on the ability of the seedling's shoot to reach light, rather than on the ability of the root to reach mineral soil.

NOAA (series). Climatological Data. National Oceanic and Atmospheric Administration, U.S. Dept. of Commerce.

SUBJECT KEYWORDS
climate

RANGE OF COMMUNITIES
general
GEOGRAPHIC SCOPE
U.S.
TYPE OF INFORMATION
quantitative
QUANTITATIVE TOPICS
climate

Notes for NOAA (series)

Climatological reports have been issued monthly for each state since 1914. From 1971 to the present they have been issued by NOAA. Before 1971 they were published by the U.S. Weather Bureau. Reports contain daily maximum temperature, minimum temperature, and precipitation, and additional summarized monthly data, including heating and cooling degree days, amount of snow on the ground, etc. They contain evaporation, wind, and soil temperature for a few stations.

Most stations are near towns at low elevations. A few high altitude stations, such as Mt. Mitchell and Grandfather Mtn., are included for part of the time period.

Data from these reports have been used or cited in numerous studies included in this bibliography.

Quantitative data evaluation record for
NOAA (series)

TOPIC

Climate

METHODS

Data from numerous weather stations throughout the country.

NUMBER OF SAMPLES: PERMANENT PLOTS:

DATA PRESENTED

Data vary with age of reports. More recent years contain monthly average max., ave. min., ave. temperature, departure from normal monthly max. and min. temp., heating and cooling degree days, total precipitation, amount of snow on ground, and daily max., min. and percipitation for each of the stations. They also contain evaporation, wind, and soil temperature data for a small number of stations. Older reports have additional data, including hourly precipitation readings at each station.

Nagel, W.P. 1959. Forest Insect Conditions in the Southeast During 1958. USFS Forest Service, SE Forest Experiment Station, Station Paper No. 100.

SUBJECT KEYWORDS
BWA spread

RANGE OF COMMUNITIES
spruce-fir
GEOGRAPHIC SCOPE
Black Mtns.
TYPE OF INFORMATION
quantitative, map
QUANTITATIVE TOPICS
BWA spread

Notes for Nagel (1959a)

General report on infestations of various forest pests in the Southeast.

Balsam woolly adelgid first found inthe fall of 1957. In the spring of 1985 thousands of dying firs were found on 1500 acres of private and national forest land in the Black Mtns. A map is given showing location of infested areas, and a table gives total acreage of spruce-fir, acreage with more than 20% of the firs killed, and estimated number of firs killed, for each land owner.

A special meeting of landowners in the area was called, and it was agreed that pilot tests of insecticides to protect roadside trees should be started.

Aerial surveys and ground examinations of all other spruce-fir areas in North Carolina and Tennessee were conducted and no infestations were found.

Quantitative data evaluation record for
Nagel (1959a)

TOPIC

BWA spread

METHODS

Mapped areas of balsam woolly adelgid infestation and estimated number of dead fir trees. Determined acreage under each ownership.

NUMBER OF SAMPLES: PERMANENT PLOTS:

DATA PRESENTED

Map of infested areas in the Black Mountains.

Acreage of spruce-fir type, acerage with over 20% fir mortality, and number of firs killed, in each ownership.

Aerial surveys of other spruce-fir areas revealed no infestations at this time.

Nagel, W.P.,Status of the balsam woolly aphid in the southeast in 1958 with special reference to infestations on Mt. Mitchell and adjacent lands. USDA, For. Ser. SE. For. Exp. Sta. Rep. 59-1.

SUBJECT KEYWORDS
BWA infestation levels

RANGE OF COMMUNITIES
spruce-fir
GEOGRAPHIC SCOPE
Black Mtns.
TYPE OF INFORMATION
Quantitative (no form)
QUANTITATIVE TOPICS

Notes for Nagel (1959b)

This reference could not be located. It is cited by a number of our other sources as the earliest reference to the discovery of balsam woolly adelgid infestation on Mt. Mitchell.

Nicholas, N.S., and P.S. White. 1985. The effect of balsam woolly aphid infestation on fuel loadings in spruce-fir forests of Great Smoky Mountains National park. NPS Research/Resources Management Rept. SER-71.

SUBJECT KEYWORDS
BWA infestation levels, organic matter distribution, fuel levels

RANGE OF COMMUNITIES
spruce-fir
GEOGRAPHIC SCOPE
Great Smoky Mtns.
TYPE OF INFORMATION
quantitative
QUANTITATIVE TOPICS
fuel levels

Notes for Nicholas and White (1985)

This study examined the effect of balsam woolly adelgid-caused fir mortality on fuel levels in kGreat Smoky Mountains National Park. Fuel levels in spruce-fir forests were sampled in four classes of time since BWA infestation and three elevation classes. Twig and bole volumes were sampled by the planar intersect method, standing live and dead basal area and density by Bitterlich prism. Soil organic layer depths were measured.

Standing dead trees were most prevalent in the 7-17 year and and 3-7 year infestation classes. Highest fuel volumes were in the 3-7 year infestation classes. Stands infested 17-23 years had fuel levels similar to uninfested stands, suggesting rapid decomposition quickly reduces fuel levels. Overall fuel level patterns were related to the original importance of fir in the stand, increasing at higher elevation, despite a trend of decreasing biomass at higher elevation.

Quantitative data evaluation record for
Nicholas and White (1985)

TOPIC

METHODS

NUMBER OF SAMPLES: PERMANENT PLOTS:

DATA PRESENTED

Quantitative data evaluation record for
Nicholas and White (1985)

TOPIC

fuel levels

METHODS

Sampled 3 spruce-fir stands iln each of 3 elevation classes and 4 lengths of BWA infestation (Ø-3, 3-7, 7-17, 17-23 years) in the Great Smoky Mtns. SAmpled dead and down twigs and boles with planar intersect method along transects; measured soil organic layer depth; measured standing live and dead tree density and basal area by Bitterlich prism. Calculated woody fuel volume.

NUMBER OF SAMPLES: PERMANENT PLOTS:

DATA PRESENTED

Mean live and dead stem basal area and density, twig and bole volume/area, mean soil organic layer depth, for each elevation-infestation class. Results of ANOVA for each variable. Table of volume/area of each fuel class for each sample plot.

Nichols, R. 1977. The ecological effects of LeConte Lodge in the Great Smoky Mountains National park. USDI, National Park Service, Upland Field Research lab, Gatlinburg, TN. Report for the Superintendent, Great Smoky Mountains.

SUBJECT KEYWORDS
vegetation sample, disturbance, logging, recreation, BWA spread, exotic plants, water quality, rare species,
RANGE OF COMMUNITIES
spruce-fir
GEOGRAPHIC SCOPE
Great Smoky Mtns.
TYPE OF INFORMATION
quantitative
QUANTITATIVE TOPICS
vegetation sample & disturbance & exotic plants

Notes for Nichols (1977)

Data were collected on the summit of Mt. LeConte in 1976 to obtain base line information on the environmental effects of LeConte Lodge. Vegetation was sampled, daily level of recreation visitation was monitored through use of infrared trail counters and visual counts, black bear activities in the developed area were recorded, reported rare plants were relocated and mapped, land use dating from 1926 and natural disturbance history were investigated, and grab samples of water (from sources in the vicinity of the lodge or the 3 trails approaching it) were obtained for fecal coliform and streptococcus tests. An outline of disturbances associated with the lodge included information on historical levels of use by pack animals on the trails, logging for construction materials and firewood, balsam woolly adelgid (present but no extensive damage in 1976), and windthrow advance adjacent to windthrown areas cleared for firewood. No statistical correlation was attempted between vegetation parameters and historic or human activities around the lodge. However, areal extent was calculated for the various obvious impacts of the lodge operations (e.g. septic field) during the last 20 years.

Quantitative data evaluation record for
Nichols (1977)

TOPIC

vegetation sample & disturbance & exotic plants

METHODS

Sampled 4 80 m and 2 40 m transects in the Mt. LeConte Lodge complex. Recorded erect herb and ground cover at 1 dm intervals. Measured dbh of trees and counted shrubs stems and tree seedlings in 10 1x2 m plots/5x10 transect segment. In outlying disturbances, tallied trees by dbh in 5x10 m plots, counted shrub stems & estimated seedling, herb, & bryophyte cover class in subplots.

NUMBER OF SAMPLES: PERMANENT PLOTS:

DATA PRESENTED

Species list with presence/absence and exotic status in 10 locations. Slope, aspect, and disturbance history of each transect and plot group. Ground cover, herb cover, shrub density, & % frequency, understory and overstory tree absolute & relative basal area, absolute & relative density, by species for transect segments in and out of 50 m radius of lodge complex center. No. & % exotics in ground cover & erect herbs in transects. Herb & tree seedling cover class & freq., shrub stem density & freq., tree absolute and relative basal area and relative density.

Norris, D.H. 1964. Bryoecology of the Appalachian Spruce-Fir Zone. PhD. Dissertation, Univ. of Tenn., Knoxville.

SUBJECT KEYWORDS
bryophyte communities, bryophyte flora, vegetation sample

RANGE OF COMMUNITIES
spruce-fir

GEOGRAPHIC SCOPE
Great Smoky Mtns., New York

TYPE OF INFORMATION
quantitative

QUANTITATIVE TOPICS
bryophyte communities & bryophyte flora, vegetation sample

Notes for Norris (1964)

This study was an intensive examination of the bryophyte communities in Smokies spruce-fir forest. Sampling was primarily in the Mt. LeConte and Clingmans Dome areas. Plots were selected to correspond to Crandall's site types and vascular vegetation was also sampled. Bryophyte cover was estimated in plots on different subhabitats on trees, dead logs, rocks, and the ground. The bryophyte data were classified into 21 unions. The unions are described in detail and data on species cover, frequency of the union, and environments are given for each. A complete floristic list is given. Samples were also taken in the Adirondacks, and the results are compared.

Succession of bryophytes as trees grow, and as logs decay, are discussed.

Data are given on the growth (lbs./acre) of Hylocomium splendens in several different environments.

The Hylocomium splendens union is present in Canada, Europe, and Asia with little species change, suggesting past continuity. It is present in the Smokies where spruce-fir has been destroyed, but is not present beyond the SW limit of spruce-fir forests, suggesting such forests never occurred there.

Quantitative data evaluation record for
Norris (1964)

TOPIC
vegetation sample

METHODS
Sites located throughout Smokies. Sampled 120 plots, located to correspond to Crandall's site types. Trees measured in 100 sq. m quadrats, shrubs counted in 2 10x1 m quadrats, herbs and seedlings in 4 4 sq. dm quadrats.

NUMBER OF SAMPLES: 120 PERMANENT PLOTS:

DATA PRESENTED
Total superior and inferior herb cover. Shrub stem density, tree density and basal area, % fir density and basal area, % of plots on north and east-facing slopes, for each of Crandall's 14 site types.

Quantitative data evaluation record for
Norris (1964)

TOPIC
bryophyte communities & bryophyte flora

METHODS
Sites located in the Smokies. 120 100 sq. m samples blocks. Bryophyte cover estimated in 4 sq. dm plots, on different parts of 10 trees/block, on top and sides of 6 logs or dead trees, on rocks when present, and on the ground. [Hylocomium splendens collected in quadrats?] Data arranged into 21 bryophyte unions that minimized significant associations of species by chi square.

NUMBER OF SAMPLES: 120 PERMANENT PLOTS:

DATA PRESENTED
Frequency, mean cover, and maximum cover by species in each union and habitat. Elevational range, frequency, average and minimum total bryophyte cover for each union.
Mean, max. and min. growth of Hylocomium splendens (lbs./acre) in 3 kinds of lighting, 5 slope aspects, and with and without hardwood litter.

Oosting, H.J. and D.W. Billings. 1951. A comparison of virgin spruce-fir forest in the northern and southern Appalachian system. Ecol. 32: 84-103.

SUBJECT KEYWORDS
vegetation sample, spruce-fir comparison, vascular flora

RANGE OF COMMUNITIES
spruce-fir
GEOGRAPHIC SCOPE
Southern Appalachians, Northeast U.S.
TYPE OF INFORMATION
quantitative
QUANTITATIVE TOPICS
vegetation sample & spruce-fir comparison

Notes for Oosting and Billings (1951)

Northern and southern spruce-fir forests are compared phytosociologically. Groups of species common to both and important only in one or the other are recognized. Community structure is compared. Conclusion is that they are quite similar.

Age and size of trees were found not to be closely related.

Quantitative data evaluation record for
Oosting and Billings (1951)

TOPIC

vegetation sample & spruce-fir comparison

METHODS

Sampled virgin forest sites, 9 in Great Smokies (between Mt. Sterling and Clingman's Dome) and 4 in White Mountains. For each site, sampled 10 quadrats, 10 sq. m for trees, 2 sq. m for other strata, evenly distributed over site.

Measured dbh of trees, counted stems of all woody plants, estimated cover of herbs and bryophytes. Cored trees.

NUMBER OF SAMPLES: 13 PERMANENT PLOTS:

DATA PRESENTED

Species lists for each site.

Cover-stratification diagrams for sample sites.

Discusses comparisons of size and ages of trees and community sturcture between north and south.

Packard, A.S. 1884. Second report on the causes of the destruction of the evergreen and other forest trees in northern New England and New York. Report of the Commissioner of Agriculture for the year 1884.

SUBJECT KEYWORDS
insect damage

RANGE OF COMMUNITIES
general northern Appalachian
GEOGRAPHIC SCOPE
Northeast U.S.
TYPE OF INFORMATION
qualitative
QUANTITATIVE TOPICS

Notes for Packard (1884)

This report describes results of field checking for insect damage in forests of New York and New England. Several insects destructive to spruce are reported.

In the Adirondacks, individual spruce trees amounting to around 10% of the forest had died. They were attacked by a bark beetle, Hylurgops. In northern Maine large areas of spruce had also been killed by bark beetles.

No spruce budworm activity was observed, after infestation in previous years. The reddish-yellow spruce budworm (Stegunoptycha ratzeburgiana) was found to have injured white and black spruce in northern Maine.

Pavlovic, N.B. 1981. An Examiniation of the Seed Rain and Seed Bank for Evidence of Seed Exchange Between a Beech Gap and a Spruce Forest in the Great Smoky Mountains. M.S. Thesis, Univ. of Tenn., Knoxville.

SUBJECT KEYWORDS
community maintenance, seed dispersal, seed bank, ecotones, vegetation sample
RANGE OF COMMUNITIES
spruce-fir, beech gap
GEOGRAPHIC SCOPE
Great Smoky Mtns.
TYPE OF INFORMATION
quantitative
QUANTITATIVE TOPICS
vegetation sample, seed dispersal, seed bank

Notes for Pavlovic (1981)

This study examined the relatively sharp ecotone between beech gap and spruce-fir communities at a site near Newfound Gap (Mingus Lead) in the Smokies. The vegetation was sampled in quadrats and in transects across the ecotone, seed rain was collected with sticky and gravity traps, and seed bank was collected in soil samples and germinated.

The transect samples show the shift between spruce and beech dominance, and between the very different herb layers.

The overall seed rain consisted of 71% birch, 15% Claytonia virginica, 2% beech, and 1% spruce. Spruce and birch seed dispersed into both communities. The log of seed density was correlated with distance and dbh of the 2 nearest upwind trees. Herb dispersal between the communities was limited.

The beech gap had a significantly larger seed bank. Tree and shrub species were scarce in both seed banks, with birch, fir cherry, and elderberry the only woody species. Seed bank species were predominantly early successional species.

Quantitative data evaluation record for
Pavlovic (1981)

TOPIC

seed dispersal

METHODS

Sampled an ecotone area near Mingus Lead in the Smokies. Placed sticky traps (10x20 cm) and gravity traps (32 cm mesh-covered cans) along 5 transects across the ecotone. Traps checked every 2-4 weeks, Sept. 20-Dec. 9, then again in April. 5 directional seed traps also placed. Seeds identified in lab and tested for germination.

NUMBER OF SAMPLES: PERMANENT PLOTS:

DATA PRESENTED

Mean and std. error of number/sq. m and frequency of seeds in each kind of trap, by community and species. Diagram of monthly distribution of seed for all species collected. Plot of log of density of birch seed vs. distance from ecotone. % germination of seed collected, for 3 fall collection dates. Diagram of mean and std. dev. of number of seeds from each direction in directional traps.

Quantitative data evaluation record for
Pavlovic (1981)

TOPIC

seed bank

METHODS

Sampled an ecotone area near Mingus Lead in the Smokies. Collected 25 soil samples at seed trap sites. 10 samples separated into 3 depths. Samples .08 sq. m, 10 cm deep cores. Soil spread out and watered, and germinating seed identified. Seed bank data analysed by ordination, cluster analysis, and discriminant analysis.

NUMBER OF SAMPLES: 25 PERMANENT PLOTS:

DATA PRESENTED

Mean and std. error of density, frequency, and % of total, of seeds germinated, by species, for each community. Species-area curves for seed banks by community. Plot of reciprocal averaging ordination axes of seed bank data. Plot of reciprocal averaging axis 1 vs. distance from ecotone. Cluster analysis dendrograms. Seed density in 3 depth classes, by species, in beech gap sample. Time of emergence by species. Number and % of seeds and asexual plants in samples, by species. Comparison of woody species composition in seed bank, seed rain, and vegetation, by comm.

Quantitative data evaluation record for
Pavlovic (1981)

TOPIC

vegetation sample

METHODS

Sampled an ecotone area near Mingus Lead in the Smokies. 10 randomly located plots in each spruce and beech gap communities, .04 ha for trees > 1 cm, .0004 ha for shrubs. 4 1 sq. m plots for herbs. Also 2 4x100 m transects across the ecotone, sampled in 10 m segments. Tallied trees by dbh, counted shrub stems, estimated herb cover and density in July and May.

NUMBER OF SAMPLES: 20 PERMANENT PLOTS:

DATA PRESENTED

Mean and std. error of density, basal area, and frequency of trees, and density and frequency of shrubs, by community. Herb density, cover, and frequency in May and July, by community. Plot of importance values of species, in overstory and understory, vs. distance along transect. Plot of size distribution of spruce, fir, and birch.

Peine, J.D., C. Pyle, and P.S. White. 1985. Environmental monitoring and baseline data management strategies and the focus of future research in Great Smoky Mountains National Park. NPS Research/Resources Man. Rept. SER-76.

SUBJECT KEYWORDS
data sets

RANGE OF COMMUNITIES
general southern Appalachian
GEOGRAPHIC SCOPE
Great Smoky Mtns.
TYPE OF INFORMATION
qualitative
QUANTITATIVE TOPICS

Notes for Peine, Pyle, and White (1985)

This publication describes monitoring and research data sets which have been collected in Great Smoky Mountains National Park. Each data set is described on a form which gives project name, project number, the dates of data collection, a one-sentence description of the study, a list of parameters measures, equipment used, the principal investigators, any publications resulting from the data, and opportunities for additional use of the data. Many of the data sets are unpublished and need further analysis.

A series of tables gives breakdowns of the kind of baseline data available by watershed within the park. Needs for further baseline data are listed.

Pelton, M.R. 1984. Mammals of the spruce-fir forest in Great Smoky Mountains National Park. In: P.S. White (ed). The Southern Appalachian Spruce-Fir Ecosystem: Its Biology and Threats. NPS Research/Resources Man. Rept. SER-71.

SUBJECT KEYWORDS
vertebrate fauna

RANGE OF COMMUNITIES
spruce-fir
GEOGRAPHIC SCOPE
Great Smoky Mtns.
TYPE OF INFORMATION
qualitative, species list
QUANTITATIVE TOPICS

Notes for Pelton (1984)

This paper reviews information on the mammalian fauna in the spruce-fir forests in the Great Smoky Mtns. A list is given of species occurring in spruce-fir, summarized from Linzey and Linzey (1971), with notes on their elevational range. The spruce-fir forest is relatively unimportant for mammals. No species is restricted to it and only 9 are restricted to high elevations in general. Use by larger mammals is generally only incidental. Food sources for most mammals are scarce in spruce-fir forests.

Little is known about population status of the species most closely associated with spruce-fir forests--Sorex cinerous, Sorex dispar, Microsorex hoyi, Glaucomys sabrinus, and Microtus chrotorrhinus.

Peterson, R.H. 1984. Comments on the fungi of the spruce-fir forest of the southern Appalachian Mountains. In: P.S. White (ed). The Southern Appalachian Spruce-Fir Ecosystem: Its Biology and Threats. USDI NPS Research/Res. Man. Rep. SER-71.

SUBJECT KEYWORDS

fungus flora, mycorrhizae, floristic affinities

RANGE OF COMMUNITIES

spruce-fir

GEOGRAPHIC SCOPE

Southern Appalachians

TYPE OF INFORMATION

qualitative

QUANTITATIVE TOPICS

Notes for Peterson (1984)

Describes the state of knowledge of southern Appalachian spruce-fir fungi. Very little research has been done. Most studies have been taxonomic and have not emphasized specific niches or habitats. A checklist lists 1700 species for the whole Great Smoky Mtns. National Park, a very large number. There is no breakdown by elevation or communities.

Field observations indicate there is a definite northern element that only fruits on the high mountains. Conspicuous decay fungi include Helotium citrinum, Dasyscypha agasizzii, and Pholiota kauffmanii. Common mycorrhizal genera appear to be Russula, Lactarius, Amanita, and Cortinarius.

There is a real need for concerted inventory of species and identification of mycorrhizal associations. Other interesting potential studies include: fungal distribution in beech gaps and grassy balds, the sequence of fungal decay of balsam woolly adelgid-killed firs, and possible effects of acid rain.

Pielke, R.A. 1983. The distribution of spruce in west-central Virginia before lumbering. Castanea 46: 201-216

SUBJECT KEYWORDS
extent of spruce-fir, disturbance, logging

RANGE OF COMMUNITIES
spruce-fir
GEOGRAPHIC SCOPE
Virginia
TYPE OF INFORMATION
qualitative
QUANTITATIVE TOPICS

Notes for Pielke (1983)

Spruce is almost totally absent in west-central Virginia, although high elevations there are as cool and moist as areas in West Virginia with spruce. Weather data from Pielke's paper on weather are used to show this. A mean July temperature of 68 F, around 2500 ft. elev. is taken as the climatic limit of spruce. Historical evidence mentions spruce where it no longer occurs.

Large volumes of spruce were cut before the forests were documented. Species commonly associated with spruce do occur in these areas. Therefore it is suggested that spruce, mixed with northern hardwoods, was once prevalent at high elevations. Solid spruce probably occurred in areas over 4000 feet elev. Logging, fire, and a climatic warming eliminated spruce. With present recovery of soils and climatic cooling, spruce could reestablish, but there are no seed sources.

Pinchot, G., and W.W. Ashe. 1897. Timber Trees and Forests of North Carolina. North Carolina Geological Survey Bulletin No. 6.

SUBJECT KEYWORDS
tree characteristics, tree reproduction, insect damage

RANGE OF COMMUNITIES
general Southeastern
GEOGRAPHIC SCOPE
North Carolina
TYPE OF INFORMATION
qualitative (some figures)
QUANTITATIVE TOPICS

Notes for Pinchot and Ashe (1897)

Contains species-by-species descriptions for all of the major timber trees in North Carolina.

Spruce is described as reaching an average size of 40-50 feet tall, 15-20 inches diameter, but occasionally reaching 100 feet and 4 feet diameter. It seeds only at long intervals, but young growth is common in the forests. Much spruce in Maine and the Adirondacks is destroyed by bark beetles.

Fraser fir is described as averaging under 40 feet tall, 12-15 inches diameter, occasionally reaching 80 feet and 2 feet diameter. It is common on high mountains, does not occur below 4000 feet, and is usually pure but occasionally mixed with spruce. Seedlings are common under trees.

Description given of the forests of North Carolina notes the locations of spruce-fir forest and calls it commercially unimportant at present.

Pittillo, J.D. 1976. Potential natural landmarks of the southern Blue Ridge portion of the Appalachian Ranges Natural Region. USDI, National Park Service, Washington, D.C. 372 pp.

SUBJECT KEYWORDS
conservation, rare species

RANGE OF COMMUNITIES
general southern Appalachian
GEOGRAPHIC SCOPE
Southern Appalachians
TYPE OF INFORMATION
qualitative
QUANTITATIVE TOPICS

Notes for Pittillo (1976)

Contains brief descriptions of potential areas to be included in the National Park Service's National Natural Landmark program. Areas with spruce-fir or related communities include Grandfather Mtn., the Plott Balsam Mtns., Roan Mtn., Shining Rock Wilderness and Graveyard Fields in the Richland Balsam Mtns., Mt. Rogers, and Whitetop.

Pittillo, J.D. 1984. Regional differences of spruce-fir forests of the southern Blue Ridge south of Virginia. In: The Southern Appalachian Spruce-fir Ecosystem: Its Biology and Threats. P.S. White (ed.) NPS Research/Resource Management Report, SER-71.

SUBJECT KEYWORDS
vascular flora, rare species, island biogeography, floristic comparison

RANGE OF COMMUNITIES
spruce-fir, grassy balds, heath balds

GEOGRAPHIC SCOPE
Southern Appalachians

TYPE OF INFORMATION
qualitative

QUANTITATIVE TOPICS

Notes for Pittillo (1984)

Brief discussions of each of the mountain ranges. Literature pertaining to each of the sites is described. Comments are made on some of the species which are characteristic of the range.

Discussion considers the isolated nature of small areas of spruce-fir forest in relation to island biogeographic theory. Each range has unique or restricted species.

Pittillo, J.D., and T.E. Govus. 1978. A manual of important plant habitats of the Blue Ridge Parkway. USDI, National Park Service, Southeast Regional Office, Atlanta, GA.

SUBJECT KEYWORDS
rare species, conservation

RANGE OF COMMUNITIES
general southern Appalachian
GEOGRAPHIC SCOPE
Balsam Mtns., Black Mtns., Craggy Mtns.
TYPE OF INFORMATION
qualitative
QUANTITATIVE TOPICS

Notes for Pittillo and Govus (1978)

Plant occurrences of concern in management throughout the length of the Blue Ridge Parkway are briefly described. These areas include populations of rare species and particularly scenic occurrences of more common species. For each area, several lines of description of significant features, management recommendations, a significance rating, location description, and a map are given.

Spruce-fir areas are included where the parkway crosses the Black, Craggy, Richland Balsam, and Plott Balsam Mountains.

This report is not published, because of the risk of destruction of some of the sites by collection if it becomes public.

Pittillo, J.D. and G.A. Smathers. 1979. Phytogeography of the Balsam Mountains and Pisgah Ridge, Southern Appalachian Mountains. Proceedings of the 16th International Phytogeographic Excursion, 1978: Veroff. Geobot. Institut ETH, Stiftung Rubel, Zurich, 68: 2Ø6-245.

SUBJECT KEYWORDS
vegetation sample, climate, vegetation-environment relationships, vegetation patterns

RANGE OF COMMUNITIES
general southern Appalachian

GEOGRAPHIC SCOPE
Balsam Mtns.

TYPE OF INFORMATION
quantitative

QUANTITATIVE TOPICS
vegetation sample, climate

Notes for Pittillo and Smathers (1979a)

Results of a phytosociological study of general vegetation in the Balsam Mountains, including Pisgah Ridge. The introduction gives detailed information on geology, soils, and climate from other sources. Plant cover by strata was sampled in 1Øx1Ø m plots at elevation intervals and in different communities. Relative cover and frequency data are presented by communities, which include spruce-fir, boulder field, hemlock cove, hardwood cove, etc. Vegetational data from other sources are given for beech gap, heath bald, and successional vegetation on a burned spruce-fir site in the area. Brief discussion is given for each of the communities. A generalized diagram of community patterns on a mountain is given. Elevation is the environmental factor most related to vegetation, and topography also has a strong effect on some communities. Substrate and soil seem to have little effect.

Quantitative data evaluation record for
Pittillo and Smathers (1979a)

TOPIC

vegetation sample

METHODS

Sampled 10x10 m plots located at 92.5 m elev. intervals and in different communities in flat areas. Estimated strata heights and species cover by strata. Calculated relative cover combined for all strata, and relative frequency. Also used data from other sources.

NUMBER OF SAMPLES: PERMANENT PLOTS:

DATA PRESENTED

Relative cover and frequency of trees, shrubs, and herbs, by 8 community types (including spruce-fir). Mean cover, relative cover, and relative frequency of species in beech gap communities, from data by Boufford and Wood (1975). Density, basal area, and frequency of woody species in a heath community at Flat Laurel Gap and successional vegetation (former spruce-fir) at Graveyard Fields, from data by Horton and Gaines (1978). Original field data are available at Western Carolina Univ. archives.

Quantitative data evaluation record for
Pittillo and Smathers (1979a)

TOPIC

climate

METHODS

Used weather station data from TVA and U.S. Dept. of Commerce, and data published in connection with other studies.

NUMBER OF SAMPLES: PERMANENT PLOTS:

DATA PRESENTED

Mean annual temperature (from TVA) and precipitation (from U.S. Dept. of Commerce) from various stations near the Balsam Mtns. Monthly maximum and minimum temperatures for Asheville and Mt. Mitchell, reproduced from Mark (1958) and Schwartzkopf (1974).

Temperature lapse rates with elevation and variations in precipitation are quantitatively discussed.

Pittillo, J.D., and G.A. Smathers. 1979. Vegetational patterns of the Balsam and Great Smoky Mountains of the Southern Appalachians. Proc. Second Conf. on Scientific Research in the National Parks, Nov. 26-30, 1979, San Francisco: NPS and Amer. Inst. of Biol. Sciences: 4: 307-322.

SUBJECT KEYWORDS
vegetation sample, vegetation patterns,

RANGE OF COMMUNITIES
general southern Appalachian

GEOGRAPHIC SCOPE
Balsam Mtns., Great Smoky Mtns.

TYPE OF INFORMATION
quantitative (no form)

QUANTITATIVE TOPICS

Notes for Pittillo and Smathers (1979b)

To provide data for comparison of Balsam Mountain vegetation with that of the Great Smokies (as reported by Whittaker in 1956), 27 10x10 m releve plots were sampled at 97 m elevational intervals along the Blue Ridge Parkway. Data were summarized in Pittillo and Smathers (1979a), and the original data are available from Western Carolina University Archives. A brief description was given of 12 Balsam Mountain vegetation types from floodplain type ascending to high elevation types. Whittaker's (1956) vegetation description with the inclusion of five oak types and three spruce-fir types is contrasted with the two oak types, one spruce-fir type plus rock outcrops, boulderfields, successional, and floodplain types of Pittillo and Smathers. Idealized vegetation diagrams were used to compare the two study areas. 299 plant species are listed as common to both study area or sampled in only one of the areas. Reasons for differences in the vegetation samples of the 2 areas are briefly discussed.

Pratt, J.H. 1905. The Southern Appalachian Forest Reserve.
J. Elisha Mitchell Sci. Soc. 21: 156-164.

SUBJECT KEYWORDS
conservation

RANGE OF COMMUNITIES
general southern Appalachian
GEOGRAPHIC SCOPE
Southern Appalachians
TYPE OF INFORMATION
qualitative
QUANTITATIVE TOPICS

Notes for Pratt (1905)

Argues for the creation of a federal forest reserve in all of the high southern mountains, like those in the West. The primary reason is the destructiveness of commercial lumbering and the threat to water supplies when forests are destroyed.

The diversity of trees in the Southern Appalachians is also discussed.

Pratt, J.H. 1913. Biennial Report of the State Geologist, 1911-1912. NC Geologic and Economic Survey, Raleigh, NC.

SUBJECT KEYWORDS
history, disturbance, fire

RANGE OF COMMUNITIES
general southern Appalachian
GEOGRAPHIC SCOPE
North Carolina
TYPE OF INFORMATION
qualitative
QUANTITATIVE TOPICS

Notes for Pratt (1913)

The report contains a section on forestry in the state of North Carolina. This report contains the results of a survey of the Asheville watershed, with description and recommendations.

Spruce type is reported on Blackstock Knob and Potato Top (Black and Craggy Mountains). It is stated that much of the forest on Potato Top was destroyed by fire years before.

The report recommends establishing fire lines where adjacent land was logged, but says they don't need to go all the way to the ridge top because the upper areas (spruce) are unlikely to burn.

Pratt, J.H. 1915. Biennial Report of the State Geologist, 1913-1914. NC Geologic and Economic Survey, Raleigh, NC.

SUBJECT KEYWORDS
history, disturbance, logging, fire, conservation

RANGE OF COMMUNITIES
general southern Appalachian

GEOGRAPHIC SCOPE
North Carolina

TYPE OF INFORMATION
qualitative (some figures)

QUANTITATIVE TOPICS

Notes for Pratt (1915)

Forestry section of the geologist's report.

General discussion of condition of forests in the state, with particular emphasis on the problems of fire, and specific information on some subjects.

A "very serious" fire was reported on Mt. Mitchell on July 23-26. A description was given of the logged and burned forest on the Black Mountains. Development began 2 years previous and had destroyed much of the spuce-fir forest, to within a mile of the summit. Logging was for lumber and pulp, taking trees down to 4 inches dbh. Repeated fires had already burned the cut lands, extending into uncut lands. The organic soil had been destroyed and erosion had begun.

The ownership of the land and logging company's losses from fire were discussed. The possiblility of the federal government buying the land for national forest was discounted, because of the cost ($30/acre) when the land was last sold.

Pratt, J.H. 1917. Biennial Report of the State Geologist, 1915-1916. NC Geogical and Economic Survey, Raleigh, NC.

SUBJECT KEYWORDS
history, conservation

RANGE OF COMMUNITIES
general southern Appalachian

GEOGRAPHIC SCOPE
Black Mtns., North Carolina

TYPE OF INFORMATION
qualitative (some figures)

QUANTITATIVE TOPICS

Notes for Pratt (1917)

Forestry section of the geologist's report.

Includes text of a variety of laws passed in 1915, including forest fire protection, and authorization of Mt. Mitchell State Park.

Includes information on lands approved and acquired for the national forests, including some in the Black Mountains (but apparently none in spruce-fir). The Black Mountains are noted as having one of the largest, most valuable spruce areas, presently being "operated". In the Smokies, it notes that land acquisition probably can not proceed until the current logging operations finish.

Pyle, C. 1984. Pre-park disturbance in the spruce-fir forests of Great Smoky Mountains National park. In: The Southern Appalachian Spruce-Fir Ecosystem: Its Biology and Threats. P.S. White (ed.) NPS Research/Resource Management Report SER-71.

SUBJECT KEYWORDS
disturbance, logging, fire, extent of spruce-fir

RANGE OF COMMUNITIES
spruce-fir

GEOGRAPHIC SCOPE
Great Smoky Mtns.

TYPE OF INFORMATION
quantitative

QUANTITATIVE TOPICS
extent of spruce-fir

Notes for Pyle (1984)

Major pre-park disturbances were logging and slash fires. Grazing disturbance was limited to grassy balds. Extensive logging of spruce-fir forest began in the early 1900's and continued until park acquisition.

This paper presents new estimates of spruce-fir area in the park before and after logging. Present area is estimated primarily from a vegetation map by Miller, in conjunction with other maps and aerial photos. Prelogging area was estimated by various methods--extrapolation based on elevation, written descriptions of boundaries, timber estimates, and early maps. Spruce-fir area is estimated at 17910 ha before logging, 13370 ha after. The difference represents loss because of failure of spruce to regenerate after fire. The possibility of additional loss of area by spruce failing to regenerate when cut out of mixed spruce-hardwood stands is discussed.

Numerous problems exist in estimation of spruce-fir area. Different sources frequently took different limits of what constitutes spruce-fir--presence of any spruce, any commercial spruce, etc.

Quantitative data evaluation record for
Pyle (1984)

TOPIC

extent of spruce-fir

METHODS

Studied all Great Smokies watersheds with spruce-fir forest, using maps of spruce-fir area, primarily vegetation map by Miller. Estimated post-logging area by dot grid. Estimated prelogging area by estimating boundaries based on written descriptions, elevational extrapolation, and early maps and timber estimates.

NUMBER OF SAMPLES: PERMANENT PLOTS:

DATA PRESENTED

Area and relative area of spruce-fir in various conditions (undisturbed, heavily cut, lightly cut, cut and burned, burned without cutting, and total) by watershed.

Area and relative area of disturbance types by watershed.

Estimates of spruce-fir area from other sources.

Pyle, C. 1985. Vegetation disturbance history of Great Smoky Mountains National Park--An analysis of archival maps and records. National Park Service Research/Resources Management Report. Draft Copy.

SUBJECT KEYWORDS
history, disturbance, logging, grazing, fire

RANGE OF COMMUNITIES
general southern Appalachian

GEOGRAPHIC SCOPE
Great Smoky Mtns.

TYPE OF INFORMATION
quantitative, map

QUANTITATIVE TOPICS
disturbance

Notes for Pyle (1985a)

This report is a parkwide overview of disturbance based on archival records, particularly old maps. Maps are given that show areas of concentrated settlement, corporate logging (at several levels of severity), diffuse disturbance associated with settlement, grazing, fire, and area with no record of disturbance.

No area is completely free of human activities but an area may be high in virgin attributes such as absence of logging, farming, and grazing, presence of old trees, dead snags, etc. The importance of different attributes depends on the purpose.

Estimates of area of virgin forest made by different people are presented. This study estimates less than other--20% of the park. Most of this is in remote areas in the eastern half of the park and is spruce-fir, high elevation hardwoods, and hemlock. Many areas called virgin by others have some big trees but had diffuse disturbance. Such areas are 8% of the park.

Potential applications of this information are discussed, and needs for additional research outlined.

Quantitative data evaluation record for
Pyle (1985a)

TOPIC

disturbance

METHODS

Examined archival records and maps to cover all of Great Smoky Mountains National Park. Transferred mapped information to USGS quad maps and assembled into single parkwide maps. Conflicts between maps were resolved by considering focal scale or by using additional written information.

Area of "virgin" forest measured with dot grid and planimeter.

NUMBER OF SAMPLES: PERMANENT PLOTS:

DATA PRESENTED

Maps of whole park on 8 1/2x11 page, showing areas of concentrated settlement, corporate logging, diffuse disturbance associated with settlement, big trees plus diffuse human activity, suspected diffuse disturbance, herded livestock, severity of corporate logging, several kinds of fire, and areas high in virgin forest attributes.

Table of various other people's estimates of virgin forest area.

Original source maps potentially available at park archives.

Pyle, C. 1985. The type and extent of prepark anthropogenic vegetation disturbance in the Great Smoky Mountains. Manuscript submitted to Castanea.

SUBJECT KEYWORDS
history, disturbance

RANGE OF COMMUNITIES
general southern Appalachian
GEOGRAPHIC SCOPE
Great Smoky Mtns.
TYPE OF INFORMATION
quantitative, map
QUANTITATIVE TOPICS
disturbance

Notes for Pyle (1985b)

The paper is a parkwide study of prepark disturbance, based on archival records and maps. A map is given showing locations of various types of disturbance, and area of different kinds of disturbance is discussed parkwide and by watershed. Corporate logging was most important, affecting 40% of the park--51% of the NC side, 27% of the SC side. Concentrated settlement affected 9% of the park, equally on both sides. Diffuse disturbance around settlements--scattered dwellings, small logging operations, frequent fires, livestock--affected additional areas. Intense fire followed corporate logging on 87% of commercially logged area, 6.9% of the park.

Areas high in virgin attributes (no record of prepark disturbance) occupy 20% of the park. An additional 8% had diffuse disturbance but still have large trees. These estimates are lower than other estimates of virgin forest area.

Spruce-fir forests did not suffer diffuse disturbance associated with settlement, and are either virgin or corporately logged.

Quantitative data evaluation record for
Pyle (1985b)

TOPIC

disturbance

METHODS

Used same data as in Pyle (1985a)--maps of prepark disturbance in the Great Smokies, based on archival records and old maps. Area of different disturbance types was calculated by watershed, using dot grid and planimeter.

NUMBER OF SAMPLES: PERMANENT PLOTS:

DATA PRESENTED

Map of park, on 8 1/2x11 page, showing areas of concentrated settlement, corporate logging, diffuse disturbance, suspected diffuse disturbance, big trees but diffuse disturbance, herded livestock, and areas high in virgin forest attributes.
Table of % concentrated settlement and corporate logging, by watershed.
Percentages of area in the park affected by different disturbance types are discussed.

Pyle, C., and M.P. Schafale. 1985. History of disturbance in spruce-fir forests ofa the SARRMC intensive study sites--Mt. Rogers National Recreation Area, Black Mountains, and Great Smoky Mountains. Report to Southern Appalachian Spruce-Fir Ecosystem Assessment Program. 67 pp.

SUBJECT KEYWORDS

history, disturbance, logging, fire, BWA spread, BWA control, tree planting, forest condition, grazing, extent of spruce-fir

RANGE OF COMMUNITIES

spruce-fir, successional

GEOGRAPHIC SCOPE

Great Smoky Mtns., Black Mountains, Mt. Rogers, Whitetop Mtn.

TYPE OF INFORMATION

qualitative (some figures), map

QUANTITATIVE TOPICS

Notes for Pyle and Schafale (1985)

This study examined the history of disturbance in spruce-fir communities of the Black Mtns., Mt. Rogers, Whitetop, and the Clingmans Dome area of the Great Smoky Mtns. Historical information was derived from published material, written records, historical maps, aerial photos, oral history, and some field examination. Maps of the spruce-fir zone in the three sites are presented, showing areas of logging, fire, blowdown, grazing, and tree planting. The extent of balsam woolly adelgid mortality as of 1985 in the Smokies, BWA infestations on Mt. Rogers, and the BWA protection zone in the Black Mtns. are also shown. Detailed discussion is focuses on the time, progress, nature, and intensity of these disturbances, as well as on efforts to protect the areas. The most severe historic disturbance was commercial logging, coupled with slash fires, in the early 1900's. Most of the area logged and burned no longer supports spruce-fir forest. The destruction of fir by the balsam woolly adelgid has been the major disturbance in recent times in the Smokies and Black Mtns. Other important historical disturbances include blowdown following opening of the tree canopy and, at Mt. Rogers, livestock grazing.

Pyle, C., and M.P. Schafale. 1988. Land use history of three southern Appalachian spruce-fir forest study sites. Journal of Forest History (in press)

SUBJECT KEYWORDS
history, disturbance, logging, fire, grazing, tree planting, forest conditions, extent of spruce-fir
RANGE OF COMMUNITIES
spruce-fir, successional
GEOGRAPHIC SCOPE
Great Smoky Mtns., Mt. Rogers, Whitetop Mtn., Black Mtns.
TYPE OF INFORMATION
qualitative (some figures), map
QUANTITATIVE TOPICS .

Notes for Pyle and Schafale (1988)

This article summarizes early historical information reported in Pyle and Schafale (1985). Historical disturbance was examined in the spruce-fir zone of the Black Mtns., Mt. Rogers, Whitetop Mtn., and the Clingmans Dome area of the Great Smoky Mtns. Historical informkation was derived from published material, written records, historical maps, aerial photos, oral history, and some field examination. Maps are presented showing areas of logging, fire, blowdown, grazing, and tree plantations in the three study areas. The most severe historic disturbance was commercial logging, coupled with slash fires in the early 1900's. Most of the area logged and burned no longer supports spruce-fir forest. Other important disturbances included blowdowns following opening of the tree canopy and, at Mt. Rogers, livestock grazing. The impact of the balsam woolly adelgid is not covered.

Rabenold, K.N. 1984. Birds of Appalachian spruce-fir forests: dynamics of habitat-island communities. In: P.S. White (ed). The Southern Appalachian Spruce-Fir Ecosystem: Its Biology and Threats. NPS Research/Resources Man. Rept. SER-71.

SUBJECT KEYWORDS
vertebrate fauna, island biogeography, vertebrate biology, diversity

RANGE OF COMMUNITIES
spruce-fir, northern spruce-fir

GEOGRAPHIC SCOPE
Great Smoky Mtns., Northeast U.S., Canada

TYPE OF INFORMATION
quantitative, species list

QUANTITATIVE TOPICS
diversity

Notes for Rabenold (1984)

This paper describes the bird fauna of the spruce-fir forest and examines whether it behaves as if the isolated spruce-fir areas were islands. A list of bird species, with density of singing males, is given for Mt. Collins in the Smokies and for a site in Maine. The southern Appalachian bird fauna resembles that of the north more than that of low elevations. It is boreal in character but depauperate compared with northern spruce-fir forests. A plot of Shannon-Weaver diversity of spruce-fir passerine birds shows a gradual increase from southern Appalachians to Maine. Presence of endemic forms of species indicate genetic isolation. Southern spruce-fir areas are not strictly islands though. They are dominated by altitudinally migrating rather than latitudinally migrating species. The fauna may be a result of relict distribution as the southern spruce-fir range shrank in the Pleistocene, or it may result from recolonization after shrinkage in the Xerothermic period. The former is suggested by dominance by effective competitors more than efficient northern colonizers. Detailed study on altitudinal migration of Carolina Juncos found differential & partial migration, best explained as competetion for winter food & breeding opportunities.

Quantitative data evaluation record for
Rabenold (1984)

TOPIC
diversity

METHODS
Calculated Shannon-Weaver diversity index for passerine bird communities in spruce-fir forests at 4 sites ranging from the Great SMoky Mtns. up to Maine, using data from a large number of published sources as well as his own censuses.

NUMBER OF SAMPLES: PERMANENT PLOTS:

DATA PRESENTED
Plot of Shannon-Weaver diversity indices of passerine bird communities at 4 sites, vs. latitude.

Ragenovich, I.R. 1977. Evaluation of Balsam Woolly Aphid on Roan Mountain, Toecane Ranger District, Pisgah National Forest, North Carolina. USDA Forest Service, Division of State and Private Forestry, Southeast Area, Forest Pest Management. Report No. 77-1-6A.

SUBJECT KEYWORDS
BWA infestation levels

RANGE OF COMMUNITIES
spruce-fir

GEOGRAPHIC SCOPE
Roan Mtn.

TYPE OF INFORMATION
qualitative (some figures)

QUANTITATIVE TOPICS

Notes for Ragenovich (1977a)

This report gives results of an intensive survey for balsam woolly adelgid on 14Ø acres on Roan Mountain, along highway 1348 and the Rhododendron Gardens. 8 plots were sampled on each side of the road, using random points within 2ØØ feet of the road and variable plots (BAF 1Ø). Trees were examined for infestation and number of spruce were noted.

3Ø% of the plots had infested trees, all new in the last 2-3 years. Salvage was done in the picnic area in 1975-1976, removing all firs and leaving the forest dominated by spruce. But the rest of the infested area is predominantly fir. Of 14.8 cords/acre, only 1.4 are spruce. 12% of the fir (1.6 cords/acre) is infested.

Chemical control is recommended where practical.

Ragenovich, I.R. 1977. Evaluation of Balsam Woolly Aphid on Roan Mountain, Toecane Ranger District, Pisgah National Forest, North Carolina. USDA Forest Service, Division of State and Private Forestry, Southeast Area, Forest Pest Management. Report No. 78-1-2.

SUBJECT KEYWORDS

BWA infestation levels, BWA control

RANGE OF COMMUNITIES

spruce-fir

GEOGRAPHIC SCOPE

Roan Mtn.

TYPE OF INFORMATION

qualitative (some figures)

QUANTITATIVE TOPICS

Notes for Ragenovich (1977b)

This report gives results of surveys for balsam woolly adelgid on Roan Mountain. Aerial sketchmap survey was done of the whole spruce-fir area, recording areas of dead and dying fir. Ground examination was done along highway 1348, FS Road 130, Balsam Road, the Appalachian Trail, Roan High Bluff Trail, and Rhododendron Gardens. Variable plot (BAF 10) samples were taken on both sides of the road at 1/10 mile intervals (102 total). Number of trees and presence of infestation recorded.

An aerial photo map is given showing the areas of dead fir. 28 out of the 102 plots had infested fir, most along the lower Appalachian Trail and the Balsam Road.

A protection zone within 200 feet of the road has been established. Balsam Road and the Garden were treated in 1976, upper Appalachian Trail in 1974, lower Appalachian Trail in 1971. Highway 1348 is scheduled to be sprayed in 1971. Spraying is recommended for all of these areas to save fir.

A summary table is given of number or stems and acres mechanically and chemically treated. In 1976, 20 acres had fir cut, 138 acres were sprayed. In 1977, 10 acres were cut and 65 acres sprayed.

Ramseur, G.S. 1958. The vascular flora of high mountain communities of the southern Appalachians. PhD. Dissertation, Univ. of North Carolina-Chapel Hill.

SUBJECT KEYWORDS
vascular flora, floristic affinities, geomorphology

RANGE OF COMMUNITIES
spruce-fir, successional, grassy bald, heath bald

GEOGRAPHIC SCOPE
southern Appalachians

TYPE OF INFORMATION
quantitative (no form)

QUANTITATIVE TOPICS

Notes for Ramseur (1958)

This dissertation was not examined but apparently reports on the floristic study on which Ramseur (1960) was based. The study examined all 10 high southern Appalachian mountain areas. Species were collected and floristic lists assembled for each area. Geomorphic information--the number of peaks, miles of ridge, number of areas, and total area above 5500, 6000, and 6500 feet elevation, derived from U.S. Geological Survey maps are probably also included. Additional data of other types may be present.

Ramseur, G.S. 1960. The vascular flora of high mountain communities of the southern Appalachians. J. Elisha Mitchell Sci. Soc. 76: 82-112.

SUBJECT KEYWORDS
vascular flora, floristic comparison, floristic affinities, spruce-fir comparison, geomorphology
RANGE OF COMMUNITIES
spruce-fir, high elevation successional, grassy bald, heath bald
GEOGRAPHIC SCOPE
Southern Appalachians
TYPE OF INFORMATION
quantitative, species list
QUANTITATIVE TOPICS
vascular flora, geomorphology

Notes for Ramseur (1960)

This study examined the plants of all 10 high mountain areas in the southern Appalachians. Spruce-fir, successional fire cherry, grassy bald, and heath bald communities are described. A list of 391 species is presented, with indication which communities and which mountain areas each occurred in. Species occurring in all 10 areas, 9 areas, and 7-8 areas are listed. 14 species occurred in all 10 areas. 127 occurred in only one area, with the Balsam Mtns. having the most. Tables are given showing the number of species in the major plant groupings in each area and in each community. The species with each type of range (southern Appalachian, all Appalachian, generally Northern, generally Southern, etc.) are also listed.

A table is given, showing, for each of the 10 areas, the number of peaks, miles of ridge, number of areas, and area in square miles above 5500, 6000, and 6500 feet. These data were derived from U.S. Geological Survey maps.

Quantitative data evaluation record for
Ramseur (1960)

TOPIC
geomorphology

METHODS
Studied all 10 southern Appalachian high mountain areas. Measured size, length, or number of landscape feature on U.S. Geological Survey maps.

NUMBER OF SAMPLES: PERMANENT PLOTS:

DATA PRESENTED
For each mountain area: number of areas, area in square miles, number of peaks, and miles of ridge above 5500, 6000, and 6500 feet. Highest elevation and percentage of total study area that each area represents. Elevational profiles of each of the high mountain areas.

Quantitative data evaluation record for
Ramseur (1960)

TOPIC
vascular flora

METHODS
Collected and observed in all 10 southern Appalachian high mountain areas. Tallied species by various groupings.

NUMBER OF SAMPLES: PERMANENT PLOTS:

DATA PRESENTED
Number of species of dicots, monocots, gymnosperms, pteridophytes, trees, shrubs, and herbs, in each community and in each of the 10 areas. Number and percentage of species in each geographical distribution category.

List of all species, with the mountain areas and communities each occurred in.

Ramseur, G.S. 1976. Secondary succession in the spruce-fir forest of the GSMNP. USDI, NPS, SE Regional Office, Res. Man. Rep. 7. 35 pp.

SUBJECT KEYWORDS
Succession

RANGE OF COMMUNITIES
spruce-fir, grassy bald, high elevation successional

GEOGRAPHIC SCOPE
Great Smoky Mtns.

TYPE OF INFORMATION
Quantitative (no form)

QUANTITATIVE TOPICS

Notes for Ramseur (1976)

Fixed landmarks were used to locate study trees for future refere nce. Maps of trees included. Sites included grassy balds(1) and fire scars(2). Increment cores, DBH, HT and radius of drip line were taken. Photo points included. Data analysis and discussion are minimal...includes numbers of trees established/decade. "Permanent plots" can be derived from the irregularly shaped area s that were tree mapped. NOTE: Only disturbed sites were sampled, no intact forest.

Rauschenberger, J.L. and H.L. Lambert. 1968. Status of the Balsam Woolly Aphid on Mt. Mitchell State Park, North Carolina - 1968. USDA Forest Service, Division of State and Private Forestry, Southeastern Area. Report No. 69-1-1.

SUBJECT KEYWORDS
BWA control

RANGE OF COMMUNITIES
spruce-fir
GEOGRAPHIC SCOPE
Black Mtns.
TYPE OF INFORMATION
qualitative, map
QUANTITATIVE TOPICS

Notes for Rauschenberger and Lambert (1968a)

This report describes results of surveys in the sprayed protection zone on Mt. Mitchell during June 1968. A map is given of the protection zone. Adelgid propulations were assessed by using traps consisting of sticky microscope slides attached perpendicular to tree trunks. The slides were left out for 1Ø days during the time of peak dispersal. Examinations found no motile nymphs of the adelgid and ground searches found no signs of adelgids.

The recommendation is that no spraying be carried out in the protection zone in 1968 because no active adelgid infestation was found.

Rauschenberger, J.L., and H.L. Lambert. 1968. Status of the Balsam Woolly Aphid on Mount Mitchell State Park. USDA Forest Service, Division of State and Private Forestry, Southeastern Area. Report No. 69-1-27.

SUBJECT KEYWORDS
BWA control, BWA infestation levels

RANGE OF COMMUNITIES
spruce-fir
GEOGRAPHIC SCOPE
Black Mtns.
TYPE OF INFORMATION
qualitative, map
QUANTITATIVE TOPICS

Notes for Rauschenberger and Lambert (1968b)

This report describes results of surveys in the sprayed protection zone at Mt. Mitchell in September and October of 1968. A map is given of the protection zone and sample locations. Adelgid populations were assessed using traps consisting of sticky microscope slides attached perpendicular to tree trunks. 300 slides were left out for 15 days. Examination of the slides found no motile nymphs and ground searches found no signs of adelgids.

The recommendation is that no spraying be done in the protection zone during 1969 because no active adelgid infestation was found.

Rauschenberger, J.L., and H.L. Lambert. 1969. Status of the Balsam Woolly Aphid in the southern Appalachians - 1968. USDA Forest Service, Division of State and Private Forestry, Southeastern Area. Report No. 69-1-29.

SUBJECT KEYWORDS
BWA spread

RANGE OF COMMUNITIES
spruce-fir
GEOGRAPHIC SCOPE
Southern Appalachians
TYPE OF INFORMATION
qualitative, map
QUANTITATIVE TOPICS

Notes for Rauschenberger and Lambert (1969)

This report describes the status of balsam woolly adelgid infestations in the Southern Appalachians at that time. Aerial surveys were done in May and August and suspect areas were ground checked. Sticky traps consisting of 12 inch square screens were placed in open areas. Areas with traps containing motile adelgid nymphs were carefully checked for infestation.

Infestation was detected in the Balsam Mtns. for the first time on Waterrock Knob. Two new infestations were found in the Great Smoky mtns., near Spruce Mtn. and Luftee Knob. No new infestations were found on Grandfather or Roan Mtn. but previous infestations continued to grow in size. Infestation in the Black Mtns. was complete and no survey was conducted there. No adelgids were detected on Mt. Rogers, although several areas of dead trees were detected.

Maps are given of infested areas in each mountain range.

Reed, F.W. 1905. Report on an examination of a forest tract in western North Carolina. USDA, Bureau of Forestry, Bull. No. 60.

SUBJECT KEYWORDS
history, vegetation sample, conservation, timber statistics

RANGE OF COMMUNITIES
general southern Appalachian
GEOGRAPHIC SCOPE
Grandfather Mtn.
TYPE OF INFORMATION
quantitative
QUANTITATIVE TOPICS
vegetation sample

Notes for Reed (1905)

A 16,000 acre tract containing Grandfather Mountain was examined by Reed for the Linville Improvement Company. The company wished to generate income from timber cutting without harming the aesthetic value of the land desired for future resort development.

The forests of the tract were divided into hemlock bottom, chestnut slopes, sugar maple slope, and mountain (spruce-fir) types. Densities of trees by species, in 1 inch dbh classes, are given for each type. The mountain type occurpied 18% of the tract, on top of Grandfather and Grandmother Mtns. It was dominated by spruce and fir, with an understory of rhododendron and ground cover of moss, ferns, and galax. There was plentiful reproduction of spruce and fir. No timber estimates or cutting plans were made for this type because it was in inaccessible places and had been set aside for a park.

Recommendations were made for timber cutting and amounts of timber were estimated for the other 3 types.

Quantitative data evaluation record for
Reed (1905)

TOPIC
vegetation sample

METHODS
Methods were not described. Forests were divided into 4 types.

NUMBER OF SAMPLES: PERMANENT PLOTS:

DATA PRESENTED
Density of trees in 1 inch dbh classes, by species, for each forest type. For the 3 types excluding the mountain (spruce-fir) type, estimates of timber quantity are given.

Rheinhardt, R.D. 1981. The vegetation of the Balsam Mountains of Southwest Virginia. M.S. Thesis, College of William and Mary.

SUBJECT KEYWORDS
vegetation sample, soil properties, climate, diversity, vegetation-environment relationships
RANGE OF COMMUNITIES
general southern Appalachian
GEOGRAPHIC SCOPE
Mt. Rogers, Whitetop Mtn.
TYPE OF INFORMATION
quantitative
QUANTITATIVE TOPICS
vegetation sample, soil properties, climate

Notes for Rheinhardt (1981)

An intensive study of the vegetation of the Mt. Rogers-Whitetop area. Sampling was done in stands not showing evidence of recent disturbance. Tree basal area was sampled by the Bitterlich method. Density of trees, saplings, and herbs, and cover of herbs was estimated in plots. Samples were taken in 4 elevation zones, on the 4 cardinal slope directions, and in other topographic situations. Soils were sampled and chemically analysed. Data analysis included calculation of Shannon diversity measures, polar ordination, and correlations between species values, ordination scores, and soil data. The sample included 10 spruce or fir stands.

Fir dominance was significantly correlated with elevation and with soil Zn and NO3-N. Spruce dominance was significantly negatively correlated with soil K and Mn. The distribution of herb dominance showed little correlation with woody dominance. Available soil moisture measurements were never below 85%, even though the summer of sampling was one of the driest on record.

Quantitative data evaluation record for
Rheinhardt (1981)

TOPIC
climate

METHODS
Used weather station data from Whitetop (TVA--1947-1951) and Troutdale (U.S. Weather Bureau--1938-1951).

NUMBER OF SAMPLES: PERMANENT PLOTS:

DATA PRESENTED
Plot of mean monthly precipitation and monthly mean, minimum, and maximum temperature for Whitetop and Troutdale. Plot of mean monthly wind speed and direction for Whitetop for 1949-1950.

Quantitative data evaluation record for
Rheinhardt (1981)

TOPIC
Soil properties

METHODS
Collected soil in the 21 intensive vegetation sample plots and in 4 additional plots. Also recorded slope, aspect, and elevation. Analysed P, K, Ca, Mg, Mn, Zn, NO3-N, pH, soluble salts, and % organic matter. Measured soil available moisture on 3 separate occasions at each stand, using Bouyoucos soil moisture blocks buried 10 cm deep. Rated soil on amount of pebbles.

NUMBER OF SAMPLES: 25 PERMANENT PLOTS:

DATA PRESENTED
Elevation, slope, aspect, pH, P, K, Ca, Mg, % organic matter, total soluble salts, NO3-N, Zn, Mn, 3 moisture readings, and pebble class, by stand. Significant correlations among soil variables and with vegetation variables.

Quantitative data evaluation record for
Rheinhardt (1981)

TOPIC

vegetation sample

METHODS

Sampled 21 stands in 4 elev. zones on 4 slope aspects, plus sharp ridge, flats, and ravines. Measured tree basal area by Bitterlich method. Counted trees >1Ø cm dbh in 1Ø m radius plots, saplings and tall seedlings (>.5 m high) in 5 m radius plots. Estimated herb cover in 1 sq. m plots. Number of samples determined by spp.-area curve. Sampled 48 stands less intensively.

NUMBER OF SAMPLES: 21 PERMANENT PLOTS:

DATA PRESENTED

Relative basal area, relative density, and importance value, by species for each stand, including 1Ø spruce or fir stands. 3-dimensional plots of polar ordinations done on tree basal area, tree importance value, and herb importance value, labelled with values for important species, and 2-dimensional plots with community types labelled. Shannon-Weaver diversity indices based on several kinds of data. Significant correlations among species importances, ordination axes, and environmental measures.

Rheinhardt, R.D. 1984. Comparative study of composition and distribution patterns of subalpine forests in the Balsam Mountains of southwest Virginia and the Great Smoky Mountains. Bull. Torrey Bot. Club 111: 489-493.

SUBJECT KEYWORDS
vegetation sample, vegetation-environment relationships, spruce-fir comparison
RANGE OF COMMUNITIES
spruce-fir
GEOGRAPHIC SCOPE
Mt. Rogers, Whitetop Mtn., Great Smoky Mtns.
TYPE OF INFORMATION
quantitative
QUANTITATIVE TOPICS
vegetation sample

Notes for Rheinhardt (1984a)

Compares the northern and southern extremes of southern Appalachian spruce-fir, Great Smoky Mountains, Mt. Rogers, and Whitetop, using data from several published and unpublished sources. Tree data collected by different methods were converted to relative basal area. Tables are given comparing mixed spruce-fir stands on Mt. Rogers and in the Smokies, and comparing pure spruce stands on Whitetop and in the Smokies. One difference between the two areas is that Mt. Rogers has only a narrow zone of pure spruce forest. The spruce zone is truncated, with hardwoods extending to a higher elevation than they do in the Smokies. Possible explanations relating to disturbance history or to loss of genotypes during the Xerothermic Period are discussed.

A stand on Mt. LeConte, in which firs have been killed, is compared with spruce stands on Whitetop. The forests appear compositionally similar, except for a more open canopy left by the loss of fir. Possible explanations for the lack of fir on Whitetop are discussed.

The data in this paper are also reported in Rheinhardt (1984b).

Quantitative data evaluation record for
Rheinhardt (1984a)

TOPIC

vegetation sample

METHODS

Used data from published and unpublished studies for the Great Smoky Mountains, Mt. Rogers, and Whitetop. Methods varied and are not described. Data from Cain (1935), Ramseur (1960), Whittaker (1956), Rheinhardt and Ware (1984), Shields (1962), and unpublished 1983 data by Rheinhardt and H.S. Adams. Tree data were converted to relative basal area for comparison.

NUMBER OF SAMPLES: PERMANENT PLOTS:

DATA PRESENTED

Canopy relative basal area by species for 3 spruce-fir stands on Mt. Rogers, and averages of other stands (1 on Mt. Rogers, 3 in Smokies). Canopy relative basal area by species for spruce-dominated stands on Whitetop and in the Smokies. Also for a spruce-fir stand on Mt. LeConte in which all fir had died.

Rheinhardt, R.D. 1984. Comparative study of composition and distribution patterns of subalpine forests in the Balsam Mountains of southwest Virginia. In: P.S. White (ed). The Southern Appalachian Spruce-Fir Ecosystem: Its Biology and Threats. USDI NPS Research/Res. Man. Rep. SER-71.

SUBJECT KEYWORDS
vegetation sample, spruce-fir comparison

RANGE OF COMMUNITIES
spruce-fir

GEOGRAPHIC SCOPE
Mt. Rogers, Whitetop Mtn., Great Smoky Mtns.

TYPE OF INFORMATION
quantitative

QUANTITATIVE TOPICS
vegetation sample

Notes for Rheinhardt (1984b)

Comparison of the northern and southern extremes of the southern Appalachian spruce-fir forests, using data from various published and unpublished sources. Different kinds of data were converted to relative importance values, and elevations were adjusted for latitudinal differences between the two areas.

Mt. Rogers and the Great Smokies forests are similar at equivalent elevations. On both Whitetop and Rogers, spruce does not extend as far down as expected based on the Smokies, even adjusting for latitude. This may be because of disturbance history, or because of loss of genotypes during the xerothermic period.

The spruce forests on Whitetop Mtn. are fairly similar to those where fir has been killed by balsam woolly adelgid, and may indicate the future composition of these forests.

Quantitative data evaluation record for
Rheinhardt (1984b)

TOPIC
vegetation sample
METHODS
Used data from other published and unpublished studies for the Great Smokies, Mt. Rogers, and Whitetop, including Cain (1935), Crandall (1958), Oosting and Billings (1951), Shields (1960), Rheinhardt (1980), and unpublished data of Rheinhardt and Adams (1983). Methods varied and were not described. Climatically equivalent elev. calculated for comparing the 2 areas.
NUMBER OF SAMPLES: PERMANENT PLOTS:
DATA PRESENTED
Relative importance values for trees (calculated from basal area or density data, varying with original data) for 7 stands in the Smokies, 4 on Mt. Rogers, and 2 on Whitetop. Relative importance of herbs (calculated from cover, frequency, or both) for 3 stands on Mt. Rogers, 1 on Whitetop, and 3 in the Smokies.

Rheinhardt, R.D. and S.A. Ware. 1984. The vegetation of the Balsam Mountains of southwestern Virginia: a phytosociological study. Bull. Torrey Bot. Club 111: 287-300.

SUBJECT KEYWORDS
vegetation sample, vegetation-environment relationships, soil properties
RANGE OF COMMUNITIES
general southern Appalachian
GEOGRAPHIC SCOPE
Mt. Rogers, Whitetop Mtn.
TYPE OF INFORMATION
quantitative
QUANTITATIVE TOPICS
vegetation sample, soil properties

Notes for Rheinhardt and Ware (1984)

Correlation analysis among species importance and soil factors showed an unexpected negative correlation between spruce and soil Mg.

The lower limit of spruce is higher here than expected from extrapolating the lower limit in the Smokies adjusted for latitude. Other sites in Virginia have records of spruce where hardwoods now occur. Logging is believed to have destroyed the spruce. However, in those areas spruce is invading hardwood forest; it is not doing so here.

Ordination and correlation of axes with soil was done on hardwood vegetation but spruce-fir forests were excluded.

Quantitative data evaluation record for
Rheinhardt and Ware (1984)

TOPIC

vegetation sample

METHODS

Sampled old-growth forests, with 43 sites selected on open slopes at 4 aspects at 4 elevations, plus on sharp ridges and high elev. flats. Measured basal area by Bitterlich method at 2-6 points/site. Counted stems in 20 10 m radius circular plots. Correlated species values with soil factors. Hardwood forest data ordinated and correlated with soil, but spruce-fir not done.

NUMBER OF SAMPLES: 43 PERMANENT PLOTS:

DATA PRESENTED

Species means of canopy relative basal area and herb cover for each vegetation type (includes spruce-fir and spruce). Some significant correlations between vegetation and soil are presented.

Subcanopy stem density is available from the authors. Tree basal area and herb cover by site are probably also available.

Quantitative data evaluation record for
Rheinhardt and Ware (1984)

TOPIC

soil properties

METHODS

Sampled 43 old-growth forest sites, as described above. Sampled the top 10 cm of soil from points on the vegetation transects, pooled for sites. Measured moisture by Bouyoucos moisture blocks buried at 10 cm, measured 3 times >1 week apart. Analysed pH, P, K, Ca, Mg, Zn, Mn, N, and organic matter. Rated soil rockiness. Correlated soil factors with species values.

NUMBER OF SAMPLES: 43 PERMANENT PLOTS:

DATA PRESENTED

Some significant correlations of soil factors with vegetation factors are presented. Patterns of correlations and soil moisture values are discussed.

Robinson, W.C. 1960. Spruce Knob revisited: A half-century of vegetation change. Castanea 25: 53-61.

SUBJECT KEYWORDS
succession, fire

RANGE OF COMMUNITIES
spruce-fir

GEOGRAPHIC SCOPE
West Virginia

TYPE OF INFORMATION
qualitative

QUANTITATIVE TOPICS

Notes for Robinson (1960)

The author made observations of species growing on the immediate summit area of Spruce Knob, West Virginia, in 1959, for the purpose of comparing them with observations by A.B. Brooks in 1908. The history of Spruce Knob is discussed briefly. Fires occurred in the early 1900's, but no fires have occurred since Forest Service protection in 1921.

Spruce trees have increased greatly in size and abundance in the 51 years, but are still scattered. Red maple has become established. Menziesia pilosa still dominates the summit, and Vaccinium erythrocarpum is still common. Other ericaceous shrubs, including Kalmia latifolia, have disappeared, and Rhododendron roseum and Vaccinium vacillans have become common. 8 new species of herbs have appeared, including 2 exotic species.

Robinson, J.F. 1968. natural variation in Abies of the southern
Appalachian Mountains. M.S. Thesis, Univ. of Tenn., Knoxville. 84 pp.

SUBJECT KEYWORDS
general tree characteristics, intraspecific variation, fir genetics, fir taxonomy

RANGE OF COMMUNITIES
spruce-fir

GEOGRAPHIC SCOPE
Eastern U.S.

TYPE OF INFORMATION
quantitative

QUANTITATIVE TOPICS
general tree characteristics & fir taxonomy

Notes for Robinson (1968)

A study of variation in Abies in the southern Appalachian mountains was made to address the origin of A. balsamea var. phanerolepis, populations intermediate between A. balsamea and A. fraseri. Distribution and taxonomy were reviewed. Study methods were presented in detail. Variation in foliage, seed, and cone characteristics were presented via the results of a nested analysis of variance for predetermined taxonomic groups, stands, trees, and within-tree observations. Hybrid index values were constructed for individual trees in the 3 taxonomic groups on 7 foliage characteristics. Variation patterns were discussed in relation to genetic drift theory, environmental influence, and measurement methods. Because variation was no greater within intermediate fir stands than within Fraser fir stands for 12 of 13 characters analysed, it was concluded that the intermediate fir was not likely to be of hybrid origin.

Quantitative data evaluation record for
Robinson (1968)

TOPIC
general tree characteristics & fir taxonomy

METHODS
Sampled 3-year old branches in upper crown on 10 trees in each of 5 stands of each group. Measured leaf scar dimensions, needle dimensions, number of stomatal rows and hypodermal cells, cone dimensions and bract length, and seed dimensions and color. Did nested ANOVA and calculated % variation explained by each level. Calculated a hybrid index based on 7 characters.

NUMBER OF SAMPLES: PERMANENT PLOTS:

DATA PRESENTED
% of total variance contributed by group, stand, tree, and within trees for all characters measured plus ratios. Plot of mean, std. error, and range of hybrid index values of each stand and of hypodermal cell count, vs. the N-S gradient. Correlation between stand values of needle and cone characters and distance from the northernmost sample. Map of mean stand cone bract and scale length. Plots of no. stomatal rows, prop. of leaf surfaces with stomata, leaf width/thickness, needle shape, leaf scar width, cone length, seed width, seed color, etc. vs. N-S gradient.

Robinson, J.F., and E. Thor. 1969. Natural variation in Abies of the southern Appalachians. For. Sci. 15: 238-245.

SUBJECT KEYWORDS
fir taxonomy, intraspecific variation, fir genetics, general tree characteristics

RANGE OF COMMUNITIES
spruce-fir

GEOGRAPHIC SCOPE
Eastern U.S.

TYPE OF INFORMATION
quantitative

QUANTITATIVE TOPICS
general tree characteristics & fir taxonomy

Notes for Robinson and Thor (1969)

Morphological characteristics of foliage and cones were studied in order to describe and evaluate the relationships among fir population in the southern Appalachians. Three groups of fir were recognized: Fraser, intermediate, and balsam. Five locations per group were sampled. A nested ANOVA was used to analyze the variation contributed by groups, stands, trees, and within-tree observations. Two hybrid indices were constructed using 7 selected foliage characteristics and hypodermal cell counts of stands plotted agaist a north/south gradient. Ranges, standard errors, and variance were discussed with respect to hybrid vs. clinal variation in fir. Because cone bract and scale lengths vary inversely on a north/south gradient, the use of a bract/scale ratio to discriminate between groups was questioned.

Data are apparently from Robinson (1968).

Quantitative data evaluation record for
Robinson and Thor (1969)

TOPIC

general tree characteristics & fir taxonomy

METHODS

Sampled 3-year old branches in upper crown on 10 trees in each of 5 stands of each group. Measured leaf scar dimensions, needle dimensions, number of stomatal rows and hypodermal cells, cone dimensions and bract length, and seed dimensions and color. Did nested ANOVA and calculated % variation explained by each level. Calculated a hybrid index based on 7 characters.

NUMBER OF SAMPLES: PERMANENT PLOTS: N

DATA PRESENTED

% of total variance contributed by group, stand, tree, and within trees for all characters measured, plus ratios. Plot of mean, std. error, and range of hybrid index values of each stand and of hypodermal cell count vs. the N-S gradient. Correlation between stand values of needle and cone characters and distance from the northernmost sample.

Roller, J.H. 1942. Effects of heat and light on red spruce.
Castanea 7: 49-50.

SUBJECT KEYWORDS
disturbance, general tree characteristics

RANGE OF COMMUNITIES
spruce-fir
GEOGRAPHIC SCOPE
Whitetop Mtn.
TYPE OF INFORMATION
qualitative
QUANTITATIVE TOPICS

Notes for Roller (1942)

Describes death of spruce trees adjacent to, and left standing in, a cut area on Whitetop Mountain. Each year more trees died, progressively expanding the opening.

The bark of the trees would die first, on the south side of trees where it was exposed to sun. A thermometer under the bark showed temperatures much higher than the air in winter. Concludes that abnormal temperature changes in bark are responsible for the death of the trees.

Rudolph, W.K. 1963. Concentrations of Gamma-Emmitting Fallout Radionuclides from Picea rubens and Rhododendron maximum of the Great Smoky Mountains. M.S. Thesis, University of Tennessee, Knoxville.

SUBJECT KEYWORDS
atmospheric deposition, radioisotope concentrations

RANGE OF COMMUNITIES
heath bald
GEOGRAPHIC SCOPE
Great Smoky Mtns.
TYPE OF INFORMATION
quantitative
QUANTITATIVE TOPICS
radioisotope concentrations

Notes for Rudolph (1963)

This study measured concentrations of fallout radioisotopes in leaves of spruce, and of rhododendron under spruce canopy and in heath balds, in 1962. Isotopes measured were cerium 144, ruthenium 106, cesium 137, and zirconium 95-niobium 95.

Overstory rhododendron had the greatest concentrations, followed by spruce. Spruce had more in older growth tissue while rhododendron had more in the current year's growth. Concentrations in spruce increased with altitude (and rainfall), while those in rhododendron were erratic.

Quantitative data evaluation record for
Rudolph (1963)

TOPIC

radioisotope concentrations

METHODS

Sampled in heath balds at Chimneys Parking Area, Alum Cave, and Thomas Divide. Collected current year and older stems and leaves from spruce and rhododendron. Recorded gamma ray spectra of ground tissue samples. Computed individual isotope activities by taking the channels around the photopeak characteristic of each element.

NUMBER OF SAMPLES: PERMANENT PLOTS:

DATA PRESENTED

Plot of gamma ray spectrum of old rhododendron leaves at 3200 ft. elev. Tables of concentration of cerium 144, ruthenium 106, cesium 137, and zirconium 95-niobium 95, in stems and leaves of old and new growth of spruce, understory rhododendron, and over-story rhododendron, and various averages.

Russell, N.H. 1953. The beech gaps of the Great Smoky Mountains. Ecol. 34: 366-374.

SUBJECT KEYWORDS
community maintenance, vegetation sample

RANGE OF COMMUNITIES
beech gap, spruce-fir, high elevation successional

GEOGRAPHIC SCOPE
Great Smoky Mtns.

TYPE OF INFORMATION
quantitative (no form)

QUANTITATIVE TOPICS

Notes for Russell (1953)

Studied the isolated beech forests that occur within the elevational range of spruce-fir forests, primarily in south-facing gaps. 14 of these beech gaps, along the Smokies crest from Charlie's Bunion to W of Clingmans dome, and near Mt. LeConte, were sampled. Trees were tallied in 1 inch size classes in 10x10 m plots in 4 sites, and frequency, relative and absolute density, and basal area are given. Herbs were sampled by Braun-Blanquet cover classes in one site. Species lists are given for spruce-fir forest and successional vegetation on burned sites.

The beech gaps had short trees, often only 30 feet tall, and had a richer herbaceous flora. Field observations found them to have more variable temperatures and to have stronger and more constant wind. The author concludes that wind, which the beeches are better able to survive than are spruce, is probably a major factor in the persistence of the beech forests.

Sargent, R.M., 1977. Biology of the Blue Ridge. Highlands
Biol. Foundation, Highlands, NC. 157 pp.

SUBJECT KEYWORDS
General

RANGE OF COMMUNITIES
General Southern Appalachian
GEOGRAPHIC SCOPE
Southern Appalachians
TYPE OF INFORMATION
Bibliography
QUANTITATIVE TOPICS

Notes for Sargent (1977)

5Øth Anniversity of Highlands Biological Station led to this publication. Includes bibliography of work done at HIghlands. Limited usefulness.

Saunders, P.R. 1979. The Vegetational Impact of Human Disturbance on the Spruce-fir Forests of the Southern Appalachian Mountains. PhD. Dissertation, Duke University.

SUBJECT KEYWORDS
disturbance, logging, recreation, vegetation sample, history, extent of spruce-fir, tree growth
RANGE OF COMMUNITIES
spruce-fir
GEOGRAPHIC SCOPE
Southern Appalachians
TYPE OF INFORMATION
quantitative
QUANTITATIVE TOPICS
vegetation sample, extent of spruce-fir, disturbance, tree growth

Notes for Saunders (1979)

This study examined forest management problems in Southern Appalachian spruce-fir forests, focusing on effects of logging, balsam woolly adelgid, and recreation.

The logging and fire history for each area is described briefly. Locations that presently have spruce present are described. The original area, estimated as the area above 1670 m elev. in these sites, was 13857 ha of spruce-fir and 402 ha of spruce only on lower peaks, compared to present values of 6831 and 50 ha respectively.

Vegetation was sampled in sites with various disturbance histories. A stand recently machine-logged after balsam woolly adelgid infestation showed no spruce or fir reproduction, dense shrub growth, and much bare soil. A stand recently mule-logged had good fir reproduction. Stands logged in the 1930's but not burned were similar to virgin stands floristically but had lower basal area and more fir.

Undergrowth in recreation areas was studied by transects. Species were grouped into disturbance response classes. Many species in recreation areas were same as found in natural wind throws but exotic species also occurred in trampled areas.

Quantitative data evaluation record for
Saunders (1979)

TOPIC
vegetation sample

METHODS
Sampled stands with various disturbance history, at sites throughout the southern Appalachians. Tallied dbh of all trees >2.5 cm dbh in 10 random 10x10 m plots. Counted shrub stems, estimated shrub and herb cover in 2x2 m subplots. Resampled Oosting & Billings' Smokies plots and Brown's Roan Mountain plots. Did Bray-Curtis ordination and classification.

NUMBER OF SAMPLES: PERMANENT PLOTS:

DATA PRESENTED
Mean herb cover, shrub and tree reproduction density, and tree basal area, for spruce-fir forest logged in 1930's, recently BWA-infested, recently mule-logged, recently machine-logged, and virgin, and for spruce only forest at Whitetop.
Plots of shrub stem density and tree basal area vs. herb and moss cover in all stands. Size class distribution of spruce, fir, and birch in virgin, second growth, and BWA-infested stands.

Quantitative data evaluation record for
Saunders (1979)

TOPIC
disturbance

METHODS
Sampled several kinds of recreation sites and natural wind falls throughout S. App. spruce-fir. Sampled transects of varying lengths, from center of opening to undisturbed forest. Measured line cover of ground and herb strata at intervals along each transect. Divided areas into bare, disturbed, transition, and forest zones and grouped species into 8 response categories.

NUMBER OF SAMPLES: PERMANENT PLOTS:

DATA PRESENTED
Number of overnight backcountry visitors by month and year at Great Smoky Mountains. Number of visitors in 1973 and 1977 at Shining Rock. Width of disturbance zones in the types of disturbances sampled (backcountry campsites, backcountry shelters, picnic grounds, trails, and natural wind falls. Response class of all species found in the transects.

Quantitative data evaluation record for
Saunders (1979)

TOPIC
tree growth
METHODS
Sampled spruce-fir forests logged in 1930's, recently BWA-infested stands, virgin forest, and recreation sites. Cored trees and measured dbh while sampling vegetation and recreational disturbance. Did linear regression of age on dbh.

NUMBER OF SAMPLES: PERMANENT PLOTS:
DATA PRESENTED
Plot of age vs. dbh, regression lines, and table of regression parameters, for fir and spruce trees.

Quantitative data evaluation record for
Saunders (1979)

TOPIC
extent of spruce-fir
METHODS
Located all areas in the southern Appalachians (excluding WV) with spruce or fir present, including minor amounts of spruce. Measured area above 1670 m in these areas as an estimate of past spruce-fir distribution. Measured present extent of spruce-fir forest on aerial photos.

NUMBER OF SAMPLES: PERMANENT PLOTS:
DATA PRESENTED
Estimated past and present extent of spruce-fir forest and spruce forest.
Percentage of spruce and spruce-fir forest lost.

Saunders, P.F., G.S. Ramseur, and G.A. Smathers. 1981. An ecological investigation of a spruce-fir burn in the Plott Balsam Mountains, North Carolina. USDI, National Park Service, Southeast Regional Office, Res./Resource Manag. Rep. SER-48.

SUBJECT KEYWORDS
    fire, succession, vegetation sample

RANGE OF COMMUNITIES
    spruce-fir

GEOGRAPHIC SCOPE
    Balsam Mtns.

TYPE OF INFORMATION
    quantitative

QUANTITATIVE TOPICS
    vegetation sample

Notes for Saunders, Ramseur, and Smathers (1981)

Vegetation was sampled 25 years following a 1 ha fire on a west facing slope 1 km north of Waterrock Knob on the Blue Ridge Parkway in the Plott Balsam Mtns. Diameter and number of trees and number of stems of smaller plants were sampled. A qualitative discussion focused on comparisons of the study area results with information pertaining to other areas (for which site specific studies were generally not cited). Fire was suggested as a potential cause of vegetational differences between the study area and the other areas discussed.

The same data were used in Saunders, Smathers, and Ramseur (1983).

Quantitative data evaluation record for
Saunders, Ramseur, and Smathers (1981)

TOPIC
vegetation sample

METHODS
Sampled a 1 ha area 1 km N of Waterrock Knob in the Plott Balsam Mtns., 25 years after a fire. Sampled 22 5x5 m plots, at 10 m intervals on 3 transects laid horizontally and vertically across the area. Measured dbh and counted trees > 1 cm dbh. Counted smaller tree, shrub, and herb stems.

NUMBER OF SAMPLES: 22 PERMANENT PLOTS:

DATA PRESENTED
Density, mean dbh, median dbh, basal area, and relative basal area of trees, by species. Density and relative density of tree reproduction, shrubs, and herbs, by species.

Saunders, P.R., G.A. Smathers, and G.S. Ramseur. 1983. Secondary succession of a spruce-fir burn in the Plott Balsam mountains of North Carolina. Castanea 48: 41-47.

SUBJECT KEYWORDS
vegetation sample, fire, succession

RANGE OF COMMUNITIES
spruce-fir, high elevation successional

GEOGRAPHIC SCOPE
Balsam Mtns.

TYPE OF INFORMATION
quantitative

QUANTITATIVE TOPICS
vegetation sample

Notes for Saunders, Smathers, and Ramseur (1983)

This paper describes successional vegetation on a small area that was severely burned by a fire not associated with logging. It is compared to the surrounding area of mature second growth spruce-fir forest.

The site has sparse fir reproduction and almost no spruce. Some species resemble mature forest but others are disturbance species. Combination of severe fire, burned soils, and erosion are believed responsible for shrub dominance and slow recovery.

Quantitative data evaluation record for
Saunders, Smathers, and Ramseur (1983)

TOPIC
vegetation sample

METHODS
Sampled only known example of a small man-caused fire in mature spruce-fir, not associated with logging. Plots (unspecified no.) 10 m apart on 3 transects across horizontal & vertical axes of site, trees 5x5 m, shrubs & herbs 1x1. Measured dbh of trees >1 cm, counted stems of smaller plants. Sampled soil in plots and surrounding area.

NUMBER OF SAMPLES: PERMANENT PLOTS:

DATA PRESENTED
Absolute and relative basal area per ha.
mean and median dbh for trees.
Density of stems of trees, reproduction, shrubs, and herbs.
List of species present on site.
Discussed comparison with nearby mature forest and other sites.
Soil data not presented but potentially available.

Schell, E., J.C. Warden, and P.S. White. 1983. Streptopus amplexifolius (L.) DC. new to Tennessee. Castanea 48: 159.

SUBJECT KEYWORDS
rare species, species range extension

RANGE OF COMMUNITIES
spruce-fir
GEOGRAPHIC SCOPE
Great Smoky Mtns.
TYPE OF INFORMATION
qualitative
QUANTITATIVE TOPICS

Notes for Schell, Warden, and White (1983)

A brief note reporting the discovery of Streptopus amplexifolius on Roan Mountain and near Clingmans Dome in the Great Smoky Mountains.

Schofield, W.B. 1960. The Ecotone Between Spruce-fir and Deciduous Forest in the Great Smoky Mountains. PhD. Dissertation, Duke University, Durham, NC.

SUBJECT KEYWORDS
community maintenance, vegetation sample, ecotones, tree growth, tree reproduction, variation within spruce-fir
RANGE OF COMMUNITIES
spruce-fir, northern hardwoods
GEOGRAPHIC SCOPE
Great Smoky Mtns.
TYPE OF INFORMATION
quantitative
QUANTITATIVE TOPICS
vegetation sample & variation within spruce-fir

Notes for Schofield (1960)

This study examined the spruce-fir--hardwood ecotone near the southwest limit of spruce-fir forest. Transects were run downslope through the elevational limit and along contour through the SW limit. Although the elevational transition appears sharp from a distance, it was found to be gradual and irregular, with a zone of dense rhododendron frequently at the transition. The forests appeared healthy and grew steadily. The latitudinal transition was abrupt. In places, spruce was invading birch forest below or beech gap adjacent. This was generally associated with past selective cutting. Cutting followed by burning limited spruce extension.

Ecotones were divided into 10 types on the basis of aspect, elevation, topography, isolation, and kinds of disturbance. Plots in these types found major differences in amounts of spruce, birch, shrub and herb cover, and tree reproduction. Tree growth rates based on cores are presented and discussed.

The latitudinal ecotone is different from the altitudinal ecotone. It has no evergreen shrub layer. Discussion of ecology of dominant tree species leads to conclusion that competition rather than climate is limiting spruce-fir distribution.

Quantitative data evaluation record for
Schofield (1960)

TOPIC

vegetation sample & variation within spruce-fir

METHODS

Sampled 2 m wide transects, in 20 m segments, from ridgetop down into hardwood forest W of Clingmans Dome and along contour at the SW end of spruce-fir distribution. Measured trees >1 in. dbh, counted shrubs. Estimated herb cover, bryophyte cover, and tree seedlings in 1x1 m plots. Divided plot data into 10 ecotone types, based on exposure, altitude, slope, history, topography.

NUMBER OF SAMPLES: 3? PERMANENT PLOTS:

DATA PRESENTED

Size classes in which each major tree sp. (fir, spruce, birch, beech) is represented in each transect. Plot of relative basal area of the 4 major trees vs. altitude. Relative basal area of all canopy & understory spp. and total basal area, shrub density, herb & bryophyte cover, for each segment of each transect. Diagrams of density, frequency, relative basal area and density of each species in the 10 ecotone types. Diagrams showing total cover in height classes and dbh classes for the 10 ecotone types. Plots of tree growth rate for 5 ecotone types.

Scribner, F.L. 1889. The grasses of Roane Mountain. Bot Gaz. 14: 253-255.

SUBJECT KEYWORDS
vascular flora

RANGE OF COMMUNITIES
grassy bald, spruce-fir

GEOGRAPHIC SCOPE
Roan Mtn.

TYPE OF INFORMATION
qualitative

QUANTITATIVE TOPICS

Notes for Scribner (1889)

Describes grasses found during a July visit at the hotel near the top of Roan Mountain. 15 species are listed, many of which are exotic. Danthonia compressa is the dominant grass on the balds. Several unusual or northern species were noted: Glyceria elongata, Trisetum subspicatum var. molle, and Poa alsodes.

Shanks, R.E. 1952. Checklist of woody plants of Tennessee.
J. Tenn. Acad. Sci. 27: 27-50.

SUBJECT KEYWORDS
Vascular flora

RANGE OF COMMUNITIES
none
GEOGRAPHIC SCOPE
Tennessee
TYPE OF INFORMATION
plant list
QUANTITATIVE TOPICS

Notes for Shanks (1952)

A checklist of plants with information on counties of Tennessee in which they have been found.

Shanks, R.E. 1954. Climates of the Great Smoky Mountains.
Ecology 35: 354-361.

SUBJECT KEYWORDS
climate, meteorologic patterns

RANGE OF COMMUNITIES
general southern Appalachia
GEOGRAPHIC SCOPE
Great Smoky Mtns.
TYPE OF INFORMATION
quantitative
QUANTITATIVE TOPICS
climate

Notes for Shanks (1954a)

Uses weather data from 4 stations ranging from park headquarters to Clingmans Dome, from 1046-1950 m elevation.

Precipitation increased with altitude, but Clingmans Dome had only slightly more than Newfound Gap.

Monthly temperatures were extremely variable. In 1950, January was warmer than April.

Average temperature lapse rate was 2.23 F/1000 feet, less than found in other mountains.

In Thornwaite's 1931 system, the spruce-fir stations fall into the microthermal rain forest category midway between micro/mesothermal boundary and taiga boundary. Taiga spruce-fir is colder and drier. Nearest low altitude equivalent climate is in NE Maine and New Brunswick, 1000 miles to the north. Only in northern New England and in coastal Washington and Oregon is the cool superhumid climate of the Smokies approached.

Quantitative data evaluation record for
Shanks (1954a)

TOPIC
climate
METHODS
Used data from 4 weather stations in the Smokies--park headquarters, Alum Cave parking lot, Newfound Gap, and Clingmans Dome. Stations had recording hygrothermographs and shielded rain guages. Hygrothermograph readings were corrected to daily temperatures.

NUMBER OF SAMPLES: 4 PERMANENT PLOTS:
DATA PRESENTED
Plots of annual percipitation vs. altitude.
Plots of monthly mean temperatures in 1949 and 1950 vs. altitude.
Table of 5-year average, high, and low for monthly mean temperatures at park headquarters.
Values of Thornwaite indices.

Shanks, R.E. 1954. Plotless sampling trials in Appalachian Forest
types. Ecology 35: 237-244.

SUBJECT KEYWORDS
vegetation sample, study methods

RANGE OF COMMUNITIES
spruce-fir, general southern Appalachian
GEOGRAPHIC SCOPE
Great Smoky Mtns.
TYPE OF INFORMATION
quantitative
QUANTITATIVE TOPICS
vegetation sample

Notes for Shanks (1954b)

Comparison of different sampling methods for forests. 1/10 acre plots, 1/40 acre plots, random pairs, and Bitterlich variable plot methods were tested in a previously sampled area. The results of the different methods show very poor agreement. There is also poor agreement with previous studies.

Both random pairs and 1/40 acre plots had badly skewed distributions of means of individual sample basal area values. This is a general problem of small samples.

The variable plot method had a large effective sample size and followed a normal distribution. It is concluded to be good because it is efficient and can be done by a single person.

Samples in other vegetation are also used to the test the methods.

Quantitative data evaluation record for
Shanks (1954b)

TOPIC

vegetation sample

METHODS

Resampled in general area of previous samples by Oosting and Billings (1951) and Cain (1935). Site is 5200-5300 ft., NW from Newfound Gap. Sampled basal area, density, % composition, and frequency, using 1/40 acre circular plot, 1/10 acre circular plot, Bitterlich variable plot, and random pairs methods.

NUMBER OF SAMPLES: PERMANENT PLOTS:

DATA PRESENTED

Basal area, density, % composition, frequency by species, for each of the sample methods, and for the earlier samples.
Standard error of basal area estimate.
Means, medians, 95% confidence limits for the various methods.

Distributions of means and medians of individual samples by the different methods.

Shanks, R.E. 1956. Altitudinal and microclimatic relationships of soil temperature under natural vegetation. Ecology 37: 1-7.

SUBJECT KEYWORDS
soil temperature, microclimate

RANGE OF COMMUNITIES
general southern Appalachian
GEOGRAPHIC SCOPE
Great Smoky Mtns.
TYPE OF INFORMATION
quantitative
QUANTITATIVE TOPICS
soil temperature & microclimate

Notes for Shanks (1956)

This study examined soil temperatures (at 6 in. deep) at varying elevations in the Smokies, in forest stands previously sampled for vegetation. The metal thermometers used were tested against standard thermometers at low elevation and found reliable.

Soil temperatures were generally parallel to weekly and monthly mean air temperatures measured at weather stations. The relationship was strongest during the summer. The agreement is close enough that soil temperature could be used as an estimator of average air temp. at a given elevation, but will be most useful as an index of differences in topographic and altitudinal habitat. Microclimatic variations in individual station readings at the same altitude were substantial. They ranged up to the equivalent of 2000 feet elevation difference. Paired stations, such as spruce-fir and beech gap 60 feet apart showed differences up to 5 degrees F, equivalent to 1000 ft. of altitude.

Quantitative data evaluation record for
Shanks (1956)

TOPIC

soil temperature & microclimate

METHODS

Sampled stands along Newfound Gap and Clingmans Dome roads in the Smokies, used for a previous vegetation study. Measured soil temperature at 6 in. depth with a metal thermometer, in forest stands and near weather stations. Did regressions of data.

NUMBER OF SAMPLES: PERMANENT PLOTS:

DATA PRESENTED

Plots of mean monthly soil and air temp. at the 3 weather stations (one in spruce-fir). Plot and regression of soil temp. vs. mean weekly air temp. for May-Aug. Plot of mean monthly soil temp. and air temp. vs. altitude, for 1946-1950. Table of decrease in soil and air temp. with altitude for each month. Plots of microclimatic departures of individual mean monthly soil temp. from the average temp. vs. altitude line.
Results of tests of the metal thermometers and studies of diurnal soil temp. at low elevation are also reported.

Shanks, R.E. 1958. Floristic regions of Tennessee. J. Tenn. Acad. Sci. 33: 195-210.

SUBJECT KEYWORDS
floristic affinities

RANGE OF COMMUNITIES
general Southeastern

GEOGRAPHIC SCOPE
Tennessee

TYPE OF INFORMATION
qualitative, map

QUANTITATIVE TOPICS

Notes for Shanks (1958)

Based on the coincidence of concentration of a number of woody species and general agreement in their range, floristic regions were delineated on county maps of Tennessee. Dots on the maps were used to represent county records of species from a given floristic region list. Major floristic elements were a southern element, bottomlands, limestone, Cumberland endemics, Appalachian extension, Appalachian, and high mountain. Forty species were listed as characteristic of high mountains. It was noted that the spruce and fir types are restricted to a narrow strip along the North Carolina border in Sevier, Cocke, Unicoi, and Carter Counties.

General discussion centered on the close relationship of major floristic boundaries to major physiographic boundaries with additional smaller floristic areas being related to minor physiographic-edaphic boundaries. Control of floristic boundaries in the Great Smoky Mountains was said to be climatic, stemming from a steep altitudinal gradient, rather than from edaphic factors.

Shanks, R.E. and E.E.C. Clebsch. 1962. Computer programs for the estimation of forest stand weight and mineral pool. Ecology 43: 339-341.

SUBJECT KEYWORDS
dimension analysis, nutrient pools, biomass

RANGE OF COMMUNITIES
spruce-fir
GEOGRAPHIC SCOPE
Great Smoky Mtns.
TYPE OF INFORMATION
quantitative, computer program
QUANTITATIVE TOPICS
dimension analysis & biomass & nutrient pools

Notes for Shanks and Clebsch (1962)

Describes a series of FORTRAN programs to calculate tree weights from regressions of weight of various parts (bole, branches, etc.) on diameter. Tree mineral content was calculated from bole and branch weight and sample concentrations in tissue. Stand values were estimated from stand diameter data.

The calculations are illustrated with data from spruce-fir forests in the Smokies, at 4700-4900 ft. Dry weight was calculated at 289,958 lb./acre, Ca at 484 lb./acre, Mg at 66 lb./acre, K at 198 lb./acre, and P at 43 lb./acre.

Quantitative data evaluation record for
Shanks and Clebsch (1962)

TOPIC

dimension analysis & biomass & nutrient pools

METHODS

Used data from a series of spruce-fir forests in the Smokies. Sample methods not given. Produced a series of FORTRAN programs using regression equations of relations of tree component weights & nutrient concentrations to dbh & height to estimate total stand values of nutrient pools

NUMBER OF SAMPLES: PERMANENT PLOTS:

DATA PRESENTED

Regression equations for total tree, leaf, and branch weight, and Ca, Mg, K, P weights vs. tree dbh, plus scatter diagram of tree and leaf wt. vs. dbh, for spruce forests at 4700-4900 ft. Estimated bole, branch, and needle weight, and mean annual increment for 16 individual spruce trees, calculated from dbh & height using the programs described. Estimated stand dry wt. Ca, Mg, K, and P for spruce, fir, and yellow birch in a stand at 5900 ft., calculated by the programs described.

Shanks, R.E. and J.S. Olson. 1961. First-year breakdown of leaf litter in southern Appalachian forests. Science 134: 194-195.

SUBJECT KEYWORDS
litter breakdown

RANGE OF COMMUNITIES
general southern Appalachian
GEOGRAPHIC SCOPE
Great Smoky Mtns., Ridge-and-Valley
TYPE OF INFORMATION
quantitative
QUANTITATIVE TOPICS
litter breakdown

Notes for Shanks and Olson (1961)

This paper reports first-year results of a long-term study. Leaves of 5 hardwood species (Morus rubra, Acer saccharum, Quercus shumardii, Q. alba, and Fagus grandifolia) were placed in mesh bags in evergreen and deciduous stands at 3 elevations. One site was spruce-fir and beech gap at 1600 m. One set of bags was analysed after 1 year. ANOVA showed significant differences for evergreen vs. deciduous, different altitudes, and species of litter. The difference between evergreen and deciduous was 6%, greater than expected from microclimatic temperature differences. The effect of altitude was linear, with a decrease in weight loss of 2.4%/1000 ft. gained. Mulberry leaves decayed fastest, maple and oaks similar, and beech slowest. Decay was slowest in the spruce-fir stand.

Quantitative data evaluation record for
Shanks and Olson (1961)

TOPIC
litter breakdown

METHODS
Placed mesh bags with 50 g of leaves of 5 species (Morus rubra, Acer saccharum, Quercus alba, Q. shumardii, Fagus grandifolia) on forest floor in 4 randomized blocks in evergreen and deciduous stands at 3 elevations. One site was a spruce-fir - beech gap pair. After 1 year, removed 1 set of bags, dried, removed soil fauna, and analysed contents.

NUMBER OF SAMPLES: 24   PERMANENT PLOTS: Y

DATA PRESENTED
Graphs of % litter remaining after 1 year, by species and stand. Regression and plot of % breakdown of litter vs. altitude. Results of analysis by split plot ANOVA discussed.

Sharp, A.J. 1939. Taxonomic and ecological studies of eastern Tennessee bryophytes. Am. Midl. Nat. 21: 267-354.

SUBJECT KEYWORDS
bryophyte flora, biogeography, taxonomy

RANGE OF COMMUNITIES
General
GEOGRAPHIC SCOPE
Eastern Tennessee
TYPE OF INFORMATION
Qualitative, species list, taxonomic key
QUANTITATIVE TOPICS

Notes for Sharp (1939)

A list of bryophyte species present in eastern Tennessee was assembled from collections at the University of Tennessee herbarium and other institutional and private herbaria. This list is presented, with keys to the species and annotations on counties of occurrence and substrate or habitat.

Environmental factors affecting bryophyte distribution, succession on different substrates, correlation with other vegetation, and geographical affinities are discussed. Lists are given of species with different categories of distribution, and range maps are given for a number of species.

Several species are listed which appear largely restricted to bark of spruce and fir trees: Mylia cuneifolia, Bazzania nudicaulis, Plagiochila tridenticulata, Zygodon viridissimus, and Leptodontium excelsum. Also, Hylocomium splendens was associated with spruce-fir forests and was said to disappear when the trees were cut or blown down.

Sharp, A.J. 1957. Vascular epiphytes in the Great Smoky Mountains. Ecol. 38: 654-655.

SUBJECT KEYWORDS
epiphytes, tree reproduction

RANGE OF COMMUNITIES
spruce-fir, northern hardwoods, cove forest

GEOGRAPHIC SCOPE
Great Smoky Mtns.

TYPE OF INFORMATION
Qualitative (some figures)

QUANTITATIVE TOPICS

Notes for Sharp (1957)

Describes the occurrence of vascular plants growing epiphytically in the mid and high elevations of the Smokies. Gives the frequency and species of occurrences seed along the road from Alum Cave parking lot to Walker Prong (3850-4500 ft.). They included 6 red spruce and 17 Rhododendron maximum, all on yellow birch. Included are 2 photos of young spruce trees growing on yellow birch trees. The occurrence of mature cones on an epiphytic spruce is mentioned.

Shields, A.R. 1962. The Isolated Spruce and Spruce-Fir Forests of Southwestern Virginia, A Biotic Study. PhD. Dissertation, Univ. of Tenn., Knoxville.

SUBJECT KEYWORDS
vegetation sample, tree age, tree growth, vertebrate fauna, history, logging, climate, spruce-fir comparison, bryophyte flora
RANGE OF COMMUNITIES
spruce-fir, northern hardwoods
GEOGRAPHIC SCOPE
Mt. Rogers, Ridge-and-Valley
TYPE OF INFORMATION
quantitative
QUANTITATIVE TOPICS
vegetation sample, climate, vertebrate fauna, tree age & tree gro wth

Notes for Shields (1962)

Results of a study of spruce-fir on Mt. Rogers and Beartown Mtn., Russell Co. VA. Vegetation was sampled, hepatics collected, small mammals and salamanders collected, and nesting birds noted. The introduction contains information on the history of ownership, logging, and fire in the areas. Max. and min. temp. were recorded on Mt. Rogers for 5 months.

The vegetation data, tree basal area, tree and shrub layer density, and herb cover, are reported for spruce-fir, transition, and hardwood (beech-maple) zones, and on Mt. Rogers, for 100 ft. elevation intervals, and for slope aspect. There is a fairly sharp transition between hardwood and conifer, over 100-200 ft. elev. The first list of hepatics for the area is given.

Major logging occurred around 1905 on Mt. Rogers and 1919-1924 on Beartown Mtn., and this affected vegetation distribution. Mt. Rogers shows evidence of recovery, with vigouous fir reproduction, but Beartown mtn. has regenerated spruce only on the upper 300 ft.

In recent cuttings of fir and spruce on Mt. Rogers and Whitetop, stumps were measured and rings counted to determine average growth rate.

Quantitative data evaluation record for
Shields (1962)

TOPIC

vegetation sample

METHODS

On Mt. Rogers, sampled 1/10 ha plots at nonrandom irregular intervals on transects, in hardwood, transition, and spruce-fir zones. Measured tree dbh. Counted tree transgressives and reproduction of shrubs. Estimated herb cover. Similar samples, not on transects, were taken on Beartown Mtn., Russell Co., VA.

NUMBER OF SAMPLES: PERMANENT PLOTS:

DATA PRESENTED

For Mt. Rogers: Tables and bar graphs of absolute and relative canopy tree density and basal area, tree transgressives and reproduction density, shrub density, and woody and herbaceous frequency, each by species and presented separately by vegetation zone, slope aspect, and 100 ft. elevation intervals. Frequency of shrub and herb association by vegetation zone, slope aspect, and elevation interval.

Similar data are presented for Beartown Mountain, but separated only by vegetation zone.

Quantitative data evaluation record for
Shields (1962)

TOPIC

vertebrate fauna

METHODS

Sampled on Mt. Rogers. Trapped small mammals with 50 traps for 1 night in each vegetation zone. Collected salamanders along transects. Noted nesting birds. Birds also counted in regular Christmas bird count.

NUMBER OF SAMPLES: PERMANENT PLOTS:

DATA PRESENTED

List of all mammals reported for Mt. Rogers, by this and 2 previous studies. Number of Clethrionomys gapperi (red-backed mice), Peromyscus maniculatus nubiterrae (white-footed mice) caught in each vegetation zone. Number of salamanders caught, by species, in 100 foot elevation intervals. Number of birds observed on Christmas bird count. List of birds nesting above 4800 ft.

Quantitative data evaluation record for
Shields (1962)

TOPIC

climate

METHODS

Maintained a max-min thermometer on Mt. Rogers crest July 1954-Jan. 1955. Used weather station records from Jefferson, NC and Troutdale, VA and 2-year TVA records from Whitetop.

NUMBER OF SAMPLES: PERMANENT PLOTS:

DATA PRESENTED

Monthly max. min. and difference on Mt. Rogers crest, for July 1954-Jan. 1955. Average annual rainfall and snowfall at Whitetop Mtn., Jefferson, NC, and Troutdale, VA.

Soil and air temperatures were taken at the time of vegetation sampling and may be available from the author.

Quantitative data evaluation record for
Shields (1962)

TOPIC

tree age & tree growth

METHODS

Examined sites of recent logging of spruce and fir on Cabin Ridge near Mt. Rogers in 1958, and spruce on Whitetop in 1956. Measured stump diameter and counted rings.

NUMBER OF SAMPLES: PERMANENT PLOTS:

DATA PRESENTED

Diameter, age, and average radial increment of spruce and fir stumps.

Siggins, H.W. 1933. Distribution and rate of fall of conifer seed. J. Agric. Research 47: 119-128.

SUBJECT KEYWORDS
seed dispersal

RANGE OF COMMUNITIES
general
GEOGRAPHIC SCOPE
U.S.
TYPE OF INFORMATION
quantitative (no form)
QUANTITATIVE TOPICS

Notes for Siggins (1933)

Tested seeds of a large number of conifers, including red spruce and fraser fir. Dropped seeds 160 feet in an elevator shaft and caught them in screens at .1 min. intervals. Seeds were then examined for % good seed and % of total falling in each interval. The variation in fall rate is illustrated with loblolly pine.

Fraser fir averaged 5.1 ft./sec. Red spruce averaged 3.9 ft./sec.

Simpson, M.B., Jr. 1972. Annotated checklist of the birds of Mt. Mitchell State Park, North Carolina. J. Elisha Mitchell Sci. Soc. 88: 244-250.

SUBJECT KEYWORDS
vertebrate fauna

RANGE OF COMMUNITIES
spruce-fir, high elevation successional
GEOGRAPHIC SCOPE
Black Mtns.
TYPE OF INFORMATION
qualitative, species list
QUANTITATIVE TOPICS

Notes for Simpson (1972)

Presents a list of 91 bird species recorded in Mt. Mitchell State park, apparently based on previous work and 500 hours of field work by the author. Notes on season and frequency of observation are given with the list. Early ornithological exploration of the area is reviewed.

Small, J.K. and A.A. Heller. 1892. Flora of western North Carolina and contiguous territory. Mem. Torrey Bot. Club 3: 1-39.

SUBJECT KEYWORDS
vascular flora, early exploration, rare species

RANGE OF COMMUNITIES
general southern Appalachian
GEOGRAPHIC SCOPE
Southern Appalachians
TYPE OF INFORMATION
qualitative, species list
QUANTITATIVE TOPICS

Notes for Small and Heller (1892)

Narrative description of travels and botanical collecting in the southern Appalachians in 1891. Spruce-fir areas visited were Grandfather Mountain and Roan Mountain.

Small, J.K. and A.M. Vail. 1893. Report of the botanical exploration of southwestern Virginia during the season of 1892. Mem. Torrey Bot. Club 4: 93-202.

SUBJECT KEYWORDS
vascular flora, early exploration

RANGE OF COMMUNITIES
general southern Appalachian

GEOGRAPHIC SCOPE
Virginia

TYPE OF INFORMATION
qualitative, species list

QUANTITATIVE TOPICS

Notes for Small and Vail (1893)

Primarily an annotated list of plants collected in southwest Virginia, primarily in the vicinity of Marion, including Whitetop and Mt. Rogers. The list includes vascular plants, bryophytes, lichens, algae, and fungi. It includes the first collection of Fraser fir north of the North Carolina border, on Mt. Rogers. The fir is reported to grow from 5000 feet elev. up to the summit, with large trees. The mountain is described as forested to top and less exposed to storms than the more open peaks of North Carolina.

Smallshaw, J. 1953. Some precipitation-altitude studies of the Tennessee Valley Authority. Trans. Am. Geophys. Union 34: 583-588.

SUBJECT KEYWORDS
meteorologic patterns, climate

RANGE OF COMMUNITIES
General southern Appalachian

GEOGRAPHIC SCOPE
Great Smoky Mtns., Unaka Mtns., Ridge-and-Valley

TYPE OF INFORMATION
quantitative

QUANTITATIVE TOPICS
climate

Notes for Smallshaw (1953)

Three studies are described. Two, on Snake Mountain and Clinch Mtn. (VA) do not involve spruce-fir. They are of interest because they show exceptions to the normal pattern of increasing precipitation at higher elevations. On Snake Mountain (Unaka Mtns. near Rich Mtn. Gap), the sharp ridgetop (elev. 5600 feet) got less rain than lower stations. This was attributed to updraft and carryover of moist air because of the sharp narrow ridge. At Clinch Mountain, updraft combined with wind funnelling through a gap were blamed for similar patterns.

The study in the Smokies, involved weather stations ranging from park headquarters to Clingmans Dome, recording 1946-1950. The same data were used in Shanks (1954). The increase of precipitation with elevation is not linear; it is less steep at higher elevation. Slope of the curve is steeper in the cool season, when rainfall is from cyclonic storms.

Quantitative data evaluation record for
Smallshaw (1953)

TOPIC
climate

METHODS
For Smoky Mounatins study, used data from a series of weather stations along Newfound Gap road and at Clingmans Dome. (Same data used in Shanks (1954).

Other studies were conducted at Snake Mountain (NC-TN, in the Unaka Mountains) and Clinch Mountain (Ridge-and-Valley).

NUMBER OF SAMPLES: PERMANENT PLOTS:

DATA PRESENTED
Plots of precipitation vs. elevation for each year and mean of years, and for averages of October-March and April-September, for the Smokies.

Data are also given for Snake Mountain and Clinch Mountain.

Smith, D.K. 1984. A status report on bryophytes of the southern Appalachian spruce-fir forests. In: P.S. White (ed). The Southern Appalachian Spruce-Fir Ecosystem: Its Biology and Threats. USDI NPS Research/Res. Man. Rep. SER-71.

SUBJECT KEYWORDS
bryophyta flora, rare species

RANGE OF COMMUNITIES
spruce-fir
GEOGRAPHIC SCOPE
Great Smoky Mtns.
TYPE OF INFORMATION
qualitative, species list
QUANTITATIVE TOPICS

Notes for Smith (1984)

Discusses various aspects of the bryophytes in the spruce-fir forests, focusing on the Smokies, where most work has been done. 203 species of bryophytes were found in Smokies spruce-fir. Most are allied to north temperate or boreal zones. Significant rare, endemic, and disjunct species are discussed in detail.

Smith, E.L. and L. Peacock. no date. Natural Features of Mount Mitchell and some of the immediately adjacent areas. Report in files of North Carolina Division of Parks and Recreation, Raleigh, NC.

SUBJECT KEYWORDS
rare species

RANGE OF COMMUNITIES
spruce-fir
GEOGRAPHIC SCOPE
Black Mtns.
TYPE OF INFORMATION
qualitative
QUANTITATIVE TOPICS

Notes for Smith and Peacock (no date)

This report summarizes information in the North Carolina Natural Heritage Program data base for Mt. Mitchell. All plant and animal species considered endangered, threatened, or of special concern in the North Carolina are listed.

Speers, C.F. 1958. The balsam woolly aphid in the southeast.
J. Forestry 56: 515-516.

SUBJECT KEYWORDS
BWA spread

RANGE OF COMMUNITIES
spruce-fir
GEOGRAPHIC SCOPE
Black Mtns.
TYPE OF INFORMATION
qualitative
QUANTITATIVE TOPICS

Notes for Speers (1958)

A brief article reporting the discovery of balsam woolly adelgid on Mt. Mitchell in October of 1957, and its potential for harm to the southern Appalachian firs.

Speers, C.F. 1962. Fraser fir seed collection, stratification, and germination. USDA, Forest Service, Trees Planter's Notes 53: 7-8.

SUBJECT KEYWORDS
Seed viability and germination

RANGE OF COMMUNITIES
Spruce-fir, nursery
GEOGRAPHIC SCOPE
Roan Mtn.
TYPE OF INFORMATION
Quantitative (no form)
QUANTITATIVE TOPICS

Notes for Speers (1962)

Gives results of germination tests on Fraser fir seed collected on Roan Mountain for Christmas tree nurseries. Seeds were collected in 1960 on Aug. 31, Sept. 6, and Sept. 23. Cones were air dried and seeds separated and stored until testing. Germination was tested with and without 60 days of stratification.

Seed collected Aug. 31 had only 18% germination, while those collected Sept. 23, when the seed coat had colored and cone disintegration had started, had up to 66% germination. Germination was quite variable within lots collected at at the same time. There was little difference in germination between stratified and unstratified seeds.

Speers, C.F. 1967. Insect infestation distorts Fraser fir seed tests. USDA, Forest SErvice, Tree Planter's notes 18(1): 19-21.

SUBJECT KEYWORDS
seed viability and germination, insect damage

RANGE OF COMMUNITIES
Spruce-fir

GEOGRAPHIC SCOPE
Roan Mtn.

TYPE OF INFORMATION
Quantitative

QUANTITATIVE TOPICS
Seed viability and germination & insect damage

Notes for Speers (1967)

Gives results of several tests on Fraser fir seed collected on Roan Mountains in 1963-1965. 1963 was a good seed year throughout the range of Fraser fir. Seeds averaged 51% germination and 87% filled. 1964 was a poor seed year. Seeds averaged only 21% germination and 36% filled. Dissection found 29% of the seeds infested with a seed chalcid, Megastigmus specularis. (the biology of this chalcid is described in Speers 1968). In addition to reducing seed viability, the chalcid distorts the tests of moisture content and % filled. In 1965, seeds averaged 78% filled.

Seeds collected in 1965 were sent to 3 different labs and were tested for germination both with and without stratification. There was little difference between the treatments, suggesting that stratification before planting is unnecessary.

Quantitative data evaluation record for
Speers (1967)

TOPIC

seed viability and germination & insect damage

METHODS

Collected Fraser fir seed on Roan Mtn. in 1963-1965. Seeds were tested for % germination, % filled, and number/pound. 1965 seeds were sent to 3 different labs for testing, and were tested with and without stratification. 10 lots of 100 1964 and 1965 seeds were cut and examined for filled vs. empty condition and infestation by seed chalcids.

NUMBER OF SAMPLES: PERMANENT PLOTS:

DATA PRESENTED

Range and average % germination, % filled, and number/lb. of 1963 and 1964 seed crop. Range and average % filled, empty, and chalcid-infested, in 1964 and 1965. Average % germination of stratified and unstratified 1965 seeds after various lengths of time (7-56 days) at each of the 3 labs.

Speers, C.F. 1968. Balsam fir chalcid causes loss of fraser fir seed. USDA, Forest Service, Tree Planters' Notes 19(2): 18-2Ø.

SUBJECT KEYWORDS
seed viability and germination, insect damage

RANGE OF COMMUNITIES
spruce-fir

GEOGRAPHIC SCOPE
Roan Mtn.

TYPE OF INFORMATION
qualitative (some figures)

QUANTITATIVE TOPICS

Notes for Speers (1968)

Fraser fir seeds were discovered to be attacked by a chalcid, Megastigmus specularis, which destroys the embryo and endosperm. In seed collected on Roan Mtn. in 1964, a poor seed year, 29% of the seeds were found infested with this insect. In 1965, a better seed year, 3.5% were infested. This study is described in Speers (1967)

The life history of M. specularis, studied in the Northeast, where it infests balsam fir seeds, is described. Two parasites of the chalcid were also found. Platymesopus sp. was found to have attacked an average of 1% of the chalcids in 1964. A few Tetrastichus sp. were also found.

Springer, M.E. 1984. Soils in the spruce-fir region of the Great Smoky Mountains. In: P.S. White (ed). The Southern Appalachian Spruce-Fir Ecosystem: Its Biology and Threats. NPS Research/Resources Man. Rept. SER-71.

SUBJECT KEYWORDS
soil taxonomy, soil temperature

RANGE OF COMMUNITIES
spruce-fir, northern hardwoods, heath bald
GEOGRAPHIC SCOPE
Great Smoky Mtns.
TYPE OF INFORMATION
qualitative
QUANTITATIVE TOPICS

Notes for Springer (1984)

This paper reviews the literature on soils in the spruce-fir forests of the Great Smoky Mtns., particularly with regard to the occurrence of Spodosols and Inceptisols. Diagrams are given showing the occurrence of Spodosols, Umbrepts, Umbric Dystrochrepts, Dystrochrepts, and Udults, and soil temperature, on the elevation and moisture gradients. At high elevations, on coarse parent material, Spodosols form under spruce-fir and Umbrepts under hardwoods. On medium-textured parent material and on unstable slopes, Spodosols do not form. Under heath vegetation Spodosols form at much lower elevation, and Histosols may also form.

All high elevation soils are low in base saturation and extremely acid, with heath bald the most acidic, hardwoods the least, and spruce-fir intermediate.

Stamper, P.G. 1976. Vegetation of Beech Mountain, North Carolina. M.S. Thesis, Univ. of Tennessee, Knoxville.

SUBJECT KEYWORDS
vegetation patterns, extent of spruce-fir

RANGE OF COMMUNITIES
northern hardwoods, oak forest

GEOGRAPHIC SCOPE
Beech Mtn.

TYPE OF INFORMATION
quantitative (no form)

QUANTITATIVE TOPICS

Notes for Stamper (1976)

This study examined the forests of Beech Mountain in Avery and Watauga counties. There is no spruce-fir forest on Beech Mountain but scattered spruce trees occur in yellow birch, sugar maple, red maple, and beech forests. Local residents reported that there was an extensive spruce stand, logged 30 years before. The spruce is scattered on north and east slopes around 4600-5000 ft. elevation and does not occur higher on the mountain.

Data from vegetation samples in the different hardwoods types include spruce as a minor component.

Stephens, L.A., Jr. 1969. A Comparison of Climatic Elements at Four Elevations in the Great Smoky Mountains. M.S. Thesis, Univ. of Tenn., Knoxville.

SUBJECT KEYWORDS
climate, meteorologic patterns, soil moisture

RANGE OF COMMUNITIES
general southern Appalachian
GEOGRAPHIC SCOPE
Great Smoky Mtns.
TYPE OF INFORMATION
quantitative
QUANTITATIVE TOPICS
climate, soil moisture

Notes for Stephens (1969)

Weather data were collected at 4 stations, including Newfound Gap (5000 ft.) and Forney Ridge (6300 ft.). These same data were used in Shanks (1954), and some are published there. Various means were calculated, and different calculation methods were compared. Soil moisture and evaporation were calculated.

Temperatures increased with altitude at a curvilinear rate, with the rate of change less at high elevation. Humidity and precipitation generally increased with elevation. Vapor pressure deficit decreased with increasing elevation but differences between stations were small.

Total soil moisture balance was always high, exceeding field capacity in every month at the two high elevation stations. However, values calculated from monthly mean data differed from those calculated from daily values. Based on daily data, 36 out of 48 months had a deficit at some time.

Quantitative data evaluation record for
Stephens (1969)

TOPIC

soil moisture

METHODS

Collected weather data at 4 stations in the Smokies, at 1460, 3850, 5000, and 6300 ft. Methods of data collection given in Shanks (1954). Calculated potential evapotranspiration and soil moisture values (based on an arbitrarily assigned field capacity of 12 inches).

NUMBER OF SAMPLES: 4 PERMANENT PLOTS: Y

DATA PRESENTED

Table and plot of monthly mean vapor pressure deficit, by station. Table of calculated annual potential evapotranspiration. Monthly soil moisture content, moisture deficit or surplus, by plot, calculated from monthly and daily means. Max. and min. soil moisture in each, by station by month.

Quantitative data evaluation record for
Stephens (1969)

TOPIC

climate

METHODS

Collected data at 4 stations in the Smokies, at 1460, 3850, 5000, and 6300 ft., including Clingmans Dome and Newfound Gap. Methods are given in Shanks (1954). Obervations on snow and cloud cover. Calculated various means. Calculated mean monthly temp. based on 24 hourly readings/day, on max. and min. of each day, and on 4-hour intervals.

NUMBER OF SAMPLES: 4 PERMANENT PLOTS: Y

DATA PRESENTED

% of days in each cloudiness class, by station and month. Average 1st and last date of 32, 36, and 40 degree temp. at each station. Elevation lapse rate of mean, max., and min. temp. by month for each interval. Mean monthly temp., mean max. and min., absolute max. and min., by month and station. Mean monthly temp. calculated by the 3 different methods. Plot of monthly temp. range by station. Freq. dist. of hourly temp. readings. Mean monthly humidity and freq. dist. of hourly readings. Mean monthly vapor pressure deficit, precip., days with and without precip.

Stephenson, S.L. and H.S. Adams. 1984. The spruce-fir forest on the summit of Mount Rogers in southwestern Virginia. Bull. Torrey Bot. Club 111: 69-75.

SUBJECT KEYWORDS
vegetation sample, soil properties, succession

RANGE OF COMMUNITIES
spruce-fir
GEOGRAPHIC SCOPE
Mt. Rogers
TYPE OF INFORMATION
quantitative
QUANTITATIVE TOPICS
vegetation sample & succession, soil properties

Notes for Stephenson and Adams (1984)

Sampled vegetation and soil in 5 stands near the summit of Mt. Rogers. Trees were measured, saplings and shrubs counted, and herb cover estimated. Representative trees were cored and soil samples were taken and analysed.

Fir domianted the canopy and even more strongly dominated the reproduction. Trees were small, with very few >39 cm dbh. The average age was 76 years for fir, 81 for spruce, with a maximum of 168 for spruce and 123 for fir. Soils were low in nutrients. The soil averaged 56% organic matter and a pH of 3.1.

Comparison with data from Shields (1982) collected in the same area shows a 30% decrease in fir basal area and a 31% increase in spruce basal area. Fir density decreased 38% and spruce density decreased 6%. Mountain ash increased 1100% in basal area.

Quantitative data evaluation record for
Stephenson and Adams (1984)

TOPIC
soil properties

METHODS
Sampled 5 stands, on 4 slope aspects and on ridgetop, on Mt. Rogers. Took 4 soil samples in each stand. Analysed % moisture, % organic matter (loss on ignition), texture, P, Ca, Mg, K, Zn, and N.

NUMBER OF SAMPLES: 20 PERMANENT PLOTS:

DATA PRESENTED
Mean, std. error, and range (over all stands): % gravel, sand, silt, clay, % organic matter, % moisture, Ca, K, Mg, P, Zn, N, total soluble salts, and pH.

Quantitative data evaluation record for
Stephenson and Adams (1984)

TOPIC
vegetation sample & succession

METHODS
Sampled 5 stands, on 4 slopes aspects and ridgetop, on Mt. Rogers. Measured trees > 2.5 cm dbh in 20x50 m plots. Counted saplings and shrubs in 4 5x5 m plots. Counted seedlings and estimated herb cover class, in 10 1x1 m plots. Cored representative trees (45) and measured their heights.

NUMBER OF SAMPLES: 5 PERMANENT PLOTS:

DATA PRESENTED
Slopes, aspect, canopy height, stand age, total basal area, density, number of species, and herb, bryophyte, rock, and dead wood cover for each plot. Absolute and relative basal area and density of canopy species, by species, averaged over stands. Density of seedlings, saplings, and 5 size classes of trees, by species, averaged over stands. Relative cover, relative frequency, % presence of herbs, by species, averaged over stands. Mean basal area of tree species found in this study compared to Shields' (1962) study, showing % change.

Stephenson, S.L. and J.F. Clovis. 1983. Spruce forests of the Alleghany Mountains in central West Virginia. Castanea 48: 1-12.

SUBJECT KEYWORDS
vegetation sample, spruce-fir comparison

RANGE OF COMMUNITIES
northern spruce-fir
GEOGRAPHIC SCOPE
Eastern U.S.
TYPE OF INFORMATION
quantitative
QUANTITATIVE TOPICS
vegetation sample

Notes for Stephenson and Clovis (1983)

This paper provides quantitative data on spruce forests in West Virginia.

The forests in this area are all second growth. The composition of the strata is discussed, along with the range among stands. Spruce dominated 3 of the stands sampled, birch 4, and red maple 1. Presence percentages are compared with those in Oosting and Billings (1951) for the Smokies and the White Mountains. Except for the absence of fir here, the forests are not compositionally different from those to the north or south.

Quantitative data evaluation record for
Stephenson and Clovis (1983)

TOPIC
vegetation sample
METHODS
Sampled 8 sites in conjunction with a study of the Cheat Mountain salamander (Clovis 1979). Sampled 5 random points on each of 4 transects 25 m apart. Took point-quarter sample of trees, estimated cover of saplings and smaller plants, using 2x10 m plots for saplings and shrubs, 1x2 low shrubs and herbs. Cored several representative dominant trees.
NUMBER OF SAMPLES: 8   PERMANENT PLOTS:
DATA PRESENTED
Relative basal area, relative density, relative frequency, and importance value (1/3 sum of dominance, density, and cover) for large (>10 cm) and small (2.5-10 cm) trees, averaged for 8 sites. Relative cover, relative frequency, and importance value for saplings, shrubs, and herbs, averaged over all stands.

Stupka, A. 1964. Trees, shrubs, and woody vines of the Great Smoky Mountains National Park. Univ. of Tenn. Press, Knoxville, Tenn. 186 pp.

SUBJECT KEYWORDS
vascular flora

RANGE OF COMMUNITIES
general southern Appalachian
GEOGRAPHIC SCOPE
Great Smoky Mtns.
TYPE OF INFORMATION
qualitative, taxonomic key
QUANTITATIVE TOPICS

Notes for Stupka (1964)

Primarily a book for identifying woody plants. Keys based on vegetative characters are given. The preface contains a very brief account of early botanical exploration, scientific studies, and logging in the hardwood forests.

Sullivan, J.H., J.D. Pittillo, and G.A. Smathers. 1980. Dispersal and establishment of red spruce and Fraser fir in three bald areas of the southern Appalachinas. USDI National Park Service, Southeast Regional Office, Research/Resource Management Report No. 41.

SUBJECT KEYWORDS

seed dispersal, succession, tree reproduction, vegetation sample, tree age, tree growth, community maintenance

RANGE OF COMMUNITIES

grassy bald, heath bald, spruce-fir

GEOGRAPHIC SCOPE

Balsam Mtns., Craggy Mtns.

TYPE OF INFORMATION

quantitative

QUANTITATIVE TOPICS

seed dispersal, tree age & tree growth, vegetation sample

Notes for Sullivan, Pittillo, and Smathers (1980)

This study focuses on limitations in seed dispersal and establishment as a factor maintaining balds.

Sticky seed traps were placed in 3 sites to collect wind-dispersed seeds. Only one site (Judaculla Fields) caught any spruce or fir seeds, and it only caught 8. Reason may be poor seed year and aphid infestation of surrounding firs. Sites in the Craggy Mountains were too far from seed sources.

Trees that presumably supplied seeds to Judaculla Fields were cored. Average age was 30 for fir, 38 for spruce.

Plots were sampled for species cover and fir seedlings were tested for association with other species. 47% of the plots had fir seedlings, only one had spruce. Fir was only 1.39% of cover. The only significant association was a positive association with Polytrichum, but this may be spurious result of multiple tests. 30% of the fir seedlings were damaged over the winter, a relatively mild winter.

Forests around Judaculla Fields were logged in the 1940's. This may have temporarily slowed the invasion of the bald. Now that trees are maturing, the rate may increase.

Quantitative data evaluation record for
Sullivan, Pittillo, and Smathers (1980)

TOPIC

seed dispersal

METHODS

Studies done in Judaculla Field, (a grassy bald surrounded by spruce-fir), Craggy Dome, and Craggy Flats (heath balds). Sticky seed traps, 1 square meter vertical sheets, sticky on both sides, were set oriented in 2 different directions. 2 sheets at Craggy Dome, 8 at the other sites. Spruce and fir seeds were counted and the direction they had come from noted.

NUMBER OF SAMPLES: 18 PERMANENT PLOTS:

DATA PRESENTED

Direction and species of each spruce and fir seed trapped, for each trap. (8 trapped at Judaculla, none at other sites.)

Quantitative data evaluation record for
Sullivan, Pittillo, and Smathers (1980)

TOPIC

vegetation sample

METHODS

Sampled at Judaculla Field, a grassy bald. Established 5x6 meter quadrats. Sampled 15 alternating 1/2x2 m subplots on each quadrat. Estimated cover of each species. Calculated relative cover and relative frequency. Did chi-square test on 2x2 contingency tables for association of Fraser fir seedlings with other species.

NUMBER OF SAMPLES: 60 PERMANENT PLOTS: Y

DATA PRESENTED

Average relative cover and % frequency for plants in plots. Also presents monthly temperatures for Richland Balsam Mountains, for 1931-1956 (from Pittillo and Smathers) and 1979-80 (unpublished).

Raw data from permanent plots is stored in the Archives at Western Carolina University.

Quantitative data evaluation record for
Sullivan, Pittillo, and Smathers (1980)

TOPIC
tree age & tree growth

METHODS
Study site at Judaculla Field. Sampled spruce and fir trees of reproductive age on the edge of the bald, presumably the seed source for trees invading the bald. Measured dbh and cored trees for age. Calculated average growth rate.

NUMBER OF SAMPLES: 86 PERMANENT PLOTS:

DATA PRESENTED
Range and average of age, dbh, and growth rate, by species.
Raw data for age and dbh.
Diagrams of vegetational structure at bald margins.

TVA (series). Precipitation in Tennessee River Basin. Tennessee Valley Authority, Division of Water Management, Data Services Branch.

SUBJECT KEYWORDS
climate, hydrology

RANGE OF COMMUNITIES
general southern Appalachian
GEOGRAPHIC SCOPE
Southern Appalachians
TYPE OF INFORMATION
quantitative, map
QUANTITATIVE TOPICS
climate & hydrology

Notes for TVA (series)

This series of monthly reports has been issued since 1938. Recent reports have a complete listing of precipitation by day for each of the numerous rain guage stations in the TVA area. None of these stations is in the spruce-fir zone or at high elevation. Ischyet maps show distribution of rainfall in the region. Departures of monthly precipitation over the past 12 months in each of 6 subregions are given. Streamflow at selected stream guages, precipitation and runoff in selected gaged watersheds, and evaporation at several stations are also given.

Quantitative data evaluation record for
TVA (series)

TOPIC

climate & hydrology

METHODS

Used data from a large number of weather stations and stream gauges throughout the TVA region.

NUMBER OF SAMPLES: PERMANENT PLOTS:

DATA PRESENTED

Data are given for each month in a monthly report, dating back to 1938. Precipitation by day at each rain gauge station. Isohyet map of month's rainfall in the Tennessee basin. Rainfall and runoff in selected watersheds. Departures of monthly precip. in 6 subregions of the Tennessee basin from the 85-year mean. Streamflow at selected stream gauges. Evaporation at 4 land-pan stations.

Quantitative data evaluation record for
TVA (series)

TOPIC

Climate & hydrology

METHODS

Used data from a large number of weather stations and stream gauges throughout the TVA region.

NUMBER OF SAMPLES: PERMANENT PLOTS:

DATA PRESENTED

Data are given for each month in a monthly report, dating back to 1938. Precipitation by day at each rain gauge station. Isohyet map of month's rainfall in the Tennessee basin. Rainfall and runoff in selected watersheds. Departures of monthly precip. in 6 subregions of the Tennessee basin from the 85-year mean. Streamflow at selected stream gauges. Evaporation at 4 land-pan stations.

Tanner, J.T. 1963. Mountain temperatures in the southeastern and southwestern United States during late spring and early summer. Journal of Applied Meteorology 2: 473-483.

SUBJECT KEYWORDS
meteorologic patterns, microclimate

RANGE OF COMMUNITIES
general
GEOGRAPHIC SCOPE
Great Smoky Mtns., Southwest U.S.
TYPE OF INFORMATION
quantitative
QUANTITATIVE TOPICS
meteorologic patterns

Notes for Tanner (1963)

Studied the relationship of temperature to altitude in the Great Smoky Mountains and Chiracahua Mtns., in April-July, looking at daily wet-bulb max. and dry-bulb max., min., and average. 4 recorder stations were placed under tree canopy 8 feet above ground in each area. Smokies stations included Newfound Gap and some additional data from Mt. LeConte lodge. Linear regressions were calculated to predict each station's temp. from a U.S. Weather Bureau station. All of the Smokies dry-bulb regressions had slopes significantly <1, indicating that temperature lapse rate depended on temperature. Changes in temperature were less at higher elevation than low. About half of the Smokies regressions were significantly different between July and April-June.

An isotherm map of max. wet and dry-bulb temperatures was drawn for LeConte Creek, using station and supplemental data. On the north-facing slope the temperatures followed elevation, but on the south-facing slope the isotherms were perpendicular to contours and were more related to exposure. Cool temperatures were displaced far downslope immediately adjacent to the creek. This may be due to lack of heating because of dense shade.

Quantitative data evaluation record for
Tanner (1963)

TOPIC
    Meteorologic patterns
METHODS
    Recorded wet and dry-bulb temp. at 4 stations each in the Smokies and in Chiracahua Mtns, AZ, and used weather station records. Took supplemental readings between stations. Calculated linear regressions of each temp. reading (daily max., min., and average dry-bulb, and max. wet-bulb) at each station vs. the U.S. Weather Bureau station. 3 time periods analysed separately if sig. diff.
NUMBER OF SAMPLES: PERMANENT PLOTS:
DATA PRESENTED
    Regression equations for each station vs. reference station, for the 4 temp. readings, for each period that was significantly different. Plots of temp. vs. elev. (derived from regressions) for 10 degree base temp. intervals, for the 4 temp. readings for each site. Isotherm plot of max. daily dry and wet-bulb temp., LeConte Creek valley, based on station and supplemental data. Mean and std. dev. of daily temp. range at each station for each period. Plot of daily course of max. wet and dry bulb temp. at Smokies 3200 ft. station.

Thor, E. 1966. Christmas tree research in Tennessee. Amer.
Christmas Tree Journal 10(3):7-12.

SUBJECT KEYWORDS
tree planting, tree growth

RANGE OF COMMUNITIES
plantation
GEOGRAPHIC SCOPE
Tennessee
TYPE OF INFORMATION
qualitative
QUANTITATIVE TOPICS

Notes for Thor (1966)

Results of ongoing and completed Christmas tree growing and marketing research in Tennessee. Species included in one or more of the studies were Fraser fir, white fir, Norway spruce, blue spruce, white spruce, Douglas-fir, Scotch pine, white pine, Austrian pine, red cedar, and Arizona cypress. Research topics were seed source testing, propagation by cuttings, cultural practices, and consumer preferences. 57 of 675 Fraser fir cuttings from Great Smoky Mountains rooted and it was concluded that other methods of orchard establishment might be more suitable. Differences in rooting ability were discussed. Sod was said to be detrimental to establishment of Fraser fir transplants in abandoned pastures. Nitrogen and potash fertilizers added at the time of planting resulted in decreased survival of Fraser fir. Data were presented on the effects of shearing the leaders of 309 Fraser firs.

Thor, E., and P.E. Barnett. 1974. Taxonomy of Abies in the southern Appalachians: variation in balsam monoterpenes and wood properties. Forest Sci. 20: 32-40.

SUBJECT KEYWORDS
fir taxonomy

RANGE OF COMMUNITIES
spruce-fir
GEOGRAPHIC SCOPE
Southern Appalachians, Northeast U.S.
TYPE OF INFORMATION
quantitative
QUANTITATIVE TOPICS
fir taxonomy

Notes for Thor and Barnett (1974)

Examined the question of the taxonomic relations of balsam fir, Fraser fir, and the intermediate populations. Balsam in bark blisters and cores of wood were collected from 10 trees in each of 5 stands of each taxonomic group. Terpenes in the balsam were identified and measured with gas chromatography. Wood weight before and after organic extraction and length of tracheids were measured. The relative content of the 5 major monoterpenes showed a clinal variation from north to south. A similar pattern was found for wood extractives, which increased northward. Only one terpene varied with season.

The intermediate fir populations were not more variable than others, as would be expected if they were a hybrid group. There was also no sharp break in characteristics between the 3 groups. The 3 groups appear to be remnants of a former continuous cline in characters. The authors propose the recognition of only one species of fir, with 3 varieties.

Quantitative data evaluation record for
Thor and Barnett (1974)

TOPIC
  fir taxonomy
METHODS
  Sampled 5 stands each of balsam fir in PA and NY, Fraser fir in the southern Appalachians, and intermediate fir in WV and VA. Collected balsam from bark blisters and took cores of 10 trees/stand. Identified and measured terpenes by gas chromatography. Measured radial growth for age 10-25 years, specific gravity of wood before and after organic extraction, & length of tracheids.
NUMBER OF SAMPLES: 150 PERMANENT PLOTS:
DATA PRESENTED
  Relative amounts of the 5 major terpenes in each stand. Graph of mean, std. error, and range of alpha-pinene and beta-phellandrene by stands arranged N to S. Variance components of wood measures for taxonomic groups, stands, and trees. Mean and range of stand means of all wood characteristics for the 3 fir groups. Coefficients of variation for the 5 major terpenes and all wood characteristics of the 3 groups. Contour plot of stand mean % alpha-pinene vs. latitude and longitude.

U.S. Weather Bureau (series). Climatological Data.

SUBJECT KEYWORDS
climate

RANGE OF COMMUNITIES
general
GEOGRAPHIC SCOPE
U.S.
TYPE OF INFORMATION
quantitative
QUANTITATIVE TOPICS
climate

Notes for U.S. Weather Bureau (series)

Climatological reports have been issued monthly for each state since 1914. From 1971 to the present they have been issued by NOAA. Before 1971 they were published by the U.S. Weather Bureau. Reports contain daily maximum temperature, minimum temperature, and precipitation, and additional summarized monthly data, including heating and cooling degree days, amount of snow on the ground, etc. They contain evaporation, wind, and soil temperature for a few stations.

Most stations are near towns at low elevations. A few high altitude stations, such as Mt. Mitchell and Grandfather Mtn., are included for part of the time period.

Data from these reports have been used or cited in numerous studies included in this bibliography.

Quantitative data evaluation record for
U.S. Weather Bureau (series)

TOPIC

Climate

METHODS

Data from numerous weather stations throughout the country.

NUMBER OF SAMPLES: PERMANENT PLOTS:

DATA PRESENTED

Data vary with age of reports. More recent years contain monthly average max., ave. min., ave. temperature, departure from normal monthly max. and min. temp., heating and cooling degree days, total precipitation, amount of snow on ground, and daily max., min. and percipitation for each of the stations. They also contain evaporation, wind, and soil temperature data for a small number of stations. Older reports have additional data, including hourly precipitation readings at each station.

USDA, Forest Service. 1947. Bibliography of the Appalachian Forest Experiment Station, 1921-1946. Southeast. For. Exp. Sta., Asheville, NC. 192 pp.

SUBJECT KEYWORDS
bibliography

RANGE OF COMMUNITIES
general Southeastern
GEOGRAPHIC SCOPE
Southeast
TYPE OF INFORMATION
qualitative, bibliography
QUANTITATIVE TOPICS

Notes for USDA, Forest Service (1947)

After the Appalachian Forest Experiment Station was reorganized into the Southeastern Forest Experiment Station on July 1, 1946, a bibliography was prepared covering research done by Appalachian Station personnel or collaborators. References, including abstracts, were grouped into the following categories: fire, forest economics, forest entomology, forest meteorology, forest pathology, forest products, forest regeneration, forest resource and industry statistics, forest soils, general forestry, grazing, instruments and devices, mensuration, silviculture, watershed management, weather damage to forests, and miscellaneous. Also included was a separate list of publications on nava stores done at the Lake City Branch, Florida, under the jurisdiction of the Southern Forest Experiment Station from 1921-1946.

Valentine, D.W. 1984. Forest vegetation in relation to soils and other environmental characteristics in the Black Mountains of North Carolina. M.S. Thesis, Duke University.

SUBJECT KEYWORDS
vegetation sample, vegetation patterns, soil properties, vegetation-environment relationship
RANGE OF COMMUNITIES
general southern Appalachian
GEOGRAPHIC SCOPE
Black Mtns.
TYPE OF INFORMATION
quantitative
QUANTITATIVE TOPICS
vegetation sample & vegetation-environment relationship, soil properties

Notes for Valentine (1984)

This study used several multivariate methods to study the relationship of vegetation and environment in the Black Mountain Research Natural Area in the Middle Creek watershed. Data were taken in 8 subjectively located plots, 5 in spruce-fir, to supplement data collected by Don McLeod on hardwood forests. Overstory and understory trees were tallied by dbh, soils were sampled, and environmental variables measured. Vegetation analysis methods included SAS CLUSTER, TWINSPAN, and DECORANA. Spruce-fir forests were clearly separated from hardwood forests by DECORANA. They were removed and the remaining data ordinated again before further analysis. Rank correlations of axes with soil and other environmental variables were done. The 1st axis was related to soil texture, P, and potential insolation. Direct gradient analyses of species were done using elevation and % sand, % clay, potential insolation, and P. Spruce, fir, and mountain ash were separated from other species by elevation and had a broad range on the other gradients.

Quantitative data evaluation record for
Valentine (1984)

TOPIC

vegetation sample & vegetation-environment relationship

METHODS

Sampled 8 subjectively located plots, 5 in spruce-fir, in the Middle Creek watershed in the Black Mtns. Also used data on hardwood plots from Don McLeod. Tallied overstory and understory trees >5 cm dbh. Did classification (SAS CLUSTER and TWINSPAN) and ordination (DECORANA) on tree data. Correlated with envi. data. Did direct gradient analysis on highly correlated factors.

NUMBER OF SAMPLES: 8 PERMANENT PLOTS:

DATA PRESENTED

Density, basal area, and importance value (% density+%basal area) for overstory, understory, and sum, for each plot. Dendrograms of classification results. Plots, mean, max., min., 25th and 75th percentile of distribution of tree species on direct ordinations using elevation vs. % sand, % clay, potential insolation, and P.

Quantitative data evaluation record for
Valentine (1984)

TOPIC

soil properties

METHODS

Sampled 8 subjectively located plots in the Middle Creek watershed in the Black Mtns. Collected soil at 0-10 cm, 10-20 cm, and >20 cm deep. Also measured soil horizon thickness, % rock cover, topographic position, and potential solar beam insolation index. Measured disturbed bulk density, texture, % organic matter, Ca, K, Mg, pH, total N, and PO4-P. Did Spearman rank correlations.

NUMBER OF SAMPLES: 8 PERMANENT PLOTS:

DATA PRESENTED

Soil pH, Ca, K, Mg, PO4-P, total N, bulk density, % organic matter, % sand, % silt, and % clay for each depth in each plot. Slope, aspect, % rock cover, topographic position index (% of distance between ridgetop and valley), and potential insolation for each plot. Soil horizon thickness in each plot. Correlations among soil and other environmental variables, and with vegetational ordination axes.

Wahlenberg, W.G. 1951. Planting in the southern Appalachian
spruce-fir type. J. For. 49: 569-571.

SUBJECT KEYWORDS
tree planting, forest management, exotic plants

RANGE OF COMMUNITIES
spruce-fir

GEOGRAPHIC SCOPE
Balsam Mtns.

TYPE OF INFORMATION
quantitative

QUANTITATIVE TOPICS
tree planting

Notes for Wahlenberg (1951)

Gives 10 year results of experiments on planting methods. 3rd year results were given in Minckler (1945). Randomized block experimental plots were established in 1940 in cutover land at 5500 ft., in Pisgah National Forest in the Balsam Mtns. 10 treatments, including soil preparation, burning, fertilization, plant hormones, and release after several years, were applied, but the fertilization and hormone treatments were found unsuccessful after 3 years and were not included in this study. Seedlings of red spruce and red pine were planted.

Release from brush competition was the most important factor influencing seedling success. Unreleased spruce (various treatments) averaged 67% survival and 1.6 ft. tall after 10 years, while spruce released in the 1st and 5th year averaged 90% survival and 3 feet tall. Red pine grew faster but had poorer survival. It is concluded that at least 2 release cuttings of brush are needed to insure establishment, and that if funds are not available for cutting, planting should not be done.

Quantitative data evaluation record for
Wahlenberg (1951)

TOPIC
    tree planting
METHODS
    Planting plots were established in the Pigeon River watershed (Balsam Mtns.) in Pisgah National Forest in 1940. 6 randomized blocks, with 10 treatments were established. Treatments included clearing, soil preparation, burning, fertilization, and plant hormones. Seedlings of red spruce and red pine were planted. Survival and growth were measured 10 years later.
NUMBER OF SAMPLES: 6   PERMANENT PLOTS: Y
DATA PRESENTED
    Percentage of planted trees surviving and thrifty in 1950, for 5 treatments (excluding hormone and fertilization treatments). Average height of seedlings in 3rd and 10th year for the 5 treatments.

Ward, D.B. 1962. The first record of Fraser fir. Castanea 27: 78-79.

SUBJECT KEYWORDS
fir taxonomy

RANGE OF COMMUNITIES
spruce-fir
GEOGRAPHIC SCOPE
Southern Appalachians
TYPE OF INFORMATION
qualitative
QUANTITATIVE TOPICS

Notes for Ward (1962)

A brief note suggesting that a specimen described by Thomas Walter in 1788 (and no longer in existence) may have been Fraser fir. This was 26 years before Frederick Pursh's description and naming of the species.

Ward, J.D. 1974. Status of Balsam Woolly Aphid, Adelges piceae (Ratz.) on Roan Mountain, Toecane Ranger District, Pisgah National Forest, N.C., 1974. USDA Forest Service, Division of State and Private Forestry, Southeastern Area. Report No. 75-1-3.

SUBJECT KEYWORDS
BWA infestation levels

RANGE OF COMMUNITIES
spruce-fir

GEOGRAPHIC SCOPE
Roan Mtn.

TYPE OF INFORMATION
quantitative, map

QUANTITATIVE TOPICS
BWA infestation levels

Notes for Ward (1974)

This report gives results of an intensive survey for balsam woolly adelgid on Roan Mtn. The national forest has carried on a vigorous suppression program involving cutting infested trees, spraying, and silvicultural methods.

Aerial photographs were taken in August 1974 and examined for areas of dying trees. Intensive ground survey was done on stands in the protection zones. 60 variable-sized prism plots were tallied and checked for infestation.

Results show a considerable increase in infestation since 1973, with large numbers of new infestations, expansion of existing infestations, and tree mortality. Heavy infestation and mortality occurred near Carvers Gap Picnic Area, with light to heavy infestation along Balsam Road and in the Rhododendron Gardens, and heavy infestation in the lower half of the seed production area.

Quantitative data evaluation record for
Ward (1974)

TOPIC

BWA infestation levels

METHODS

Took aerial photos of most of the spruce-fir area on Roan Mtn. and examined for infestation. Sampled all stands within the protection zones established along roads and in accessible areas. Sampled 60 prism plots at 5-chain intervals. Tallied trees >5" dbh in 2" diameter classes. Examined trees for severity of infestation, including climbing several trees to check crowns.

NUMBER OF SAMPLES: 60 PERMANENT PLOTS:

DATA PRESENTED

Table of area of host type, stems/acre, % fir and spruce in stand, % fir infested, and estimated numbers of fir infested, for each of the 4 protection zones (Carvers Gap Picnic Area, Balsam Road, Rhododendron Gardens, and the seed production area).
Map of infestations throughout Roan Mountain.
Severity of infestation and mortality are discussed.

Ward, J.D., E.T. Wilson, and W.E. McDowell. 1972. Status of the Balsam Woolly Aphid in the Southern Appalachians - 1971. USDA Forest Service, Division of State and Private Forestry, Southeastern Area. Report No. 72-1-21.

SUBJECT KEYWORDS
BWA spread, BWA control

RANGE OF COMMUNITIES
spruce-fir

GEOGRAPHIC SCOPE
Southern Appalachians

TYPE OF INFORMATION
qualitative, map

QUANTITATIVE TOPICS

Notes for Ward, Wilson, and McDowell (1972)

This report describes the status of infestations of that time. Aerial and sticky trap surveys were conducted as in previous years.

Two new infestations were found in the Balsam Mtns. (one in a planting) and 2 on Roan Mtn. Known infestations in these areas and at Grandfather Mtn. and the Great Smoky Mtns. continued to expand. Suppression of infestations in plantations at Moses Cone Memorial Park and in the North Carolina seed nursery at Crossnore were successful. Mt. Rogers is the only major fir area not infested. Several areas of dying trees, primarily fir but some spruce, were found on Mt. Rogers but wood and bark samples failed to reveal any pathogens. Maps are given of the infested areas in each mountain range.

Control measures are discussed. Chemical control on individual trees is the only effective control. 1/8% lindane is recommended, with lime sulfur as an alternative.

Ward, J.D., E.T. Wilson, and W.M. McDowell. 1973. Status of the Balsam Woolly Aphid in the Southern Appalachians - 1972. USDA Forest Service, Division of State and Private Forestry, Southeastern Area. Report 73-1-35.

SUBJECT KEYWORDS
BWA spread

RANGE OF COMMUNITIES
spruce-fir
GEOGRAPHIC SCOPE
Southern Appalachians
TYPE OF INFORMATION
map, qualitative (some figures)
QUANTITATIVE TOPICS

Notes for Ward, Wilson, and McDowell (1973)

This report describes the status of infestations at that time. Aerial surveys and sticky slide traps were conducted in previous years.

New infestations were found at Shining Rock Wilderness in the Balsam Mtns., on Grandfather Mtn., and Roan Mtn. A potential area, not ground-checked, was found near Clingmans Dome in the Smokies. Results of the NC Div. of Forestry trapping at Mt. Mitchell showed a substantial increase inside the protection zone, which was sprayed in 1972 for the first time since 1967.

Severe mortality occurred in older infestations in the Balsam and Great Smoky Mtns. Two new spots of tree mortality on Mt. Rogers were not caused by balsam woolly adelgid, and this area remains free of infestations.

Maps are given of the infested areas in each mountain range.

Weaver, G.T. 1972. Dry Matter and Nutrient Dynamics in Red
Spruce-Fraser Fir and Yellow Birch Ecosystems in the Balsam
Mountains, Western North Carolina. PhD. Dissertation,
University of Tennessee, Knoxville.

SUBJECT KEYWORDS
vegetation sample, biomass, production, nutrient cycles,
nutrient pools, soil properties, precipitation chemistry
RANGE OF COMMUNITIES
spruce-fir, northern hardwoods, high elevation successional
GEOGRAPHIC SCOPE
Balsam Mtns.
TYPE OF INFORMATION
quantitative
QUANTITATIVE TOPICS
biomass & production, vegetation sample, nutrient cycles & nutrie
nt pools, soil properties, precip. chem.

Notes for Weaver (1972)

This study measured net annual primary production and fluxes of Ca, K, Mg, and P in spruce-fir, mature yellow birch in rock-filled coves, and immature yellow birch on burned spruce-fir sites. The sample area was between Wolf Bald and Wesner Bald in the Balsam Mtns. Vegetation was sampled and estimates of biomass obtained by allometric every-tree summation for plants > .5 m tall. The 4 nutrients were analysed in biomass, litter, soil horizons, precipitation, throughfall, and stemflow. Estimates were made of pools of the nutrients in different ecosystem components and of the flux between them.

Dry matter production was 5-10 t/ha/yr and was highest in spruce-fir. Above-ground biomass was 180 t/ha in spruce-fir, 154 in mature birch, 103 in successional birch. In spruce-fir the forest floor was the most important sink of K, Mg, and P, and vegetation the most important for Ca. Order of intensity of nutrient cycling rates was Ca<K<Mg<P. Cycling intensity in spruce-fir was less than mature birch and more than immature birch. Litterfall was the major transfer path for Ca, Mg, and P, but throughfall was equal to litterfall for K.

Quantitative data evaluation record for
Weaver (1972)

TOPIC

nutrient cycles & nutrient pools

METHODS

Used plant tissue from samples. Analysed 600 tissue samples and 275 litter samples for Ca, K, Mg, P. Estimated total amounts of these nutrients and fluxes of them, based on concentrations and estimated biomass, production, and litterfall values.

NUMBER OF SAMPLES: PERMANENT PLOTS:

DATA PRESENTED

Mean and std. error of Ca, K, Mg, and P in tree boles, saplings, and shrubs, by species. Mean and std. error of concentrations in various plant components of spruce, fir, and birch, and other woody species, in herbs by species, and in litterfall. Estimated total amounts of Ca, K, Mg, and P in components of each stratum and in litterfall in spruce-fir, successional birch, and mature birch. Estimated annual accumulation of Ca, K, Mg, and P in components of each stratum of each community.

Quantitative data evaluation record for
Weaver (1972)

TOPIC

vegetation sample

METHODS

Sampled sites selected from a preliminary survey, in spruce-fir, successional birch, and mature birch, in the Balsam Mtns. 40 .04 ha plots for canopy, 20 .09 ha plots for lower strata. Measured dbh of trees >2.54 cm. Measured height, crown dia., and cored 10 trees/plot. Harvested herbs 3 times. Estimated bryophyte biomass in 100 10x10 cm quadrats.

NUMBER OF SAMPLES: 40 PERMANENT PLOTS:

DATA PRESENTED

Importance values, mean and maximum age, of spruce, fir, and birch, tree and shrub stratum density and basal area, and tree bole volume, in each of the 40 plots. Mean and std. dev. of frequency, density, and basal area of trees, tall shrubs, and low shrubs, for spruce-fir and yellow birch ecosystems. Frequency, clipping weight, and relative clipping weight for woody regeneration and herbs, in spruce-fir and yellow birch ecosystems.

Quantitative data evaluation record for
Weaver (1972)

TOPIC
Biomass & production

METHODS
Sampled in spruce-fir, successional birch, and mature birch. Measured woody plants in plots. Harvested herbs 3 times, collected litterfall and large branchfall. Estimated bryophytes in quadrats. Detailed measurements of components of 75 canopy trees and 67 others. Constructed regressions to estimate biomass components components from dia., and prod. from radial increment.

NUMBER OF SAMPLES: 40 PERMANENT PLOTS:

DATA PRESENTED
Estimated tree-tall shrub, sapling-low shrub, woody regeneration, herb, and bryophyte biomass for each plot. Mean and std. dev. of biomass of plant parts in spruce-fir and birch ecosystems. Correlations of biomass and production of plant parts of each stratum and litter in spruce-fir & birch, with various site physical and soil data. Estimated mean and std. dev. of aboveground net primary production of spruce-fir, immature birch, and mature birch. Estimated mean and std. dev. of net assimilation rates & leaf efficiencies. Correlation of net prod. with litter.

Quantitative data evaluation record for
Weaver (1972)

TOPIC
soil properties

METHODS
Sampled soils in 20 of the vegetation sample plots. Collected O1 and O2 horizons in 4 1 sq. dm. quadrats/plot, litter and humus in 5 1 sq. dm. quadrats. Dug 1-2 soil pits per plot, described soil morphology and sampled each horizon. Analysed for bulk density, color, pH, organic matter, particle size, exchangeable Ca, Mg, K, cation exchange capacity, and P, for each horizon.

NUMBER OF SAMPLES: PERMANENT PLOTS:

DATA PRESENTED
Mean and std. dev. of thickness, bulk density, and dry wt. of O1 and O2 horizons in spruce-fir, successional birch, and mature birch, and correlations of dry wt. with various site and stand properties. Mean and std. dev. of organic matter, pH, Ca, K, Mg, P, cation exchange capacity, base saturation, bulk density, and particle size distribution, for spruce-fir and birch. Mean and std. error of pH, Ca, K, Mg, and P in litter, O1, and O2 horizons in spruce-fir and birch. Mean and std. dev. total amount of fine particles, Ca, K, Mg, and P in A1, B1 and Bh horizons of each.

Quantitative data evaluation record for
Weaver (1972)

TOPIC

precip. chem.

METHODS

Collected gross precipitation at 5 locations, 5/23/69-6/6/70. Collected throughfall in 12 stands, placing 4 collectors at random locations each month, collected at 2-week intervals. Collected stemflow on 24 trees, representing various sizes of spruce, fir, and birch. Analysed collected water for Ca, K, Mg, and P.

NUMBER OF SAMPLES: 5   PERMANENT PLOTS:

DATA PRESENTED

Amount of gross precipitation and throughfall, and % stemflow. Mean and std. dev. of % apparent and adjusted interception, for spruce-fir and birch, in June-Nov. and Nov.-June. Mean and range of concentration of Ca, K, Mg, and P in gross precip., in throughfall in each community, and in stemflow in each species. Mean and std. dev. of total amount of Ca, K, Mg, and P in precip. components in each community, June-Nov., Nov.-June and all year. Estimated annual amounts of transfer components of the nutrients between ecosystem compartments in each community.

Weaver, G.T. 1975. The quantity and distribution of four nutrient elements in high elevation forest ecosystems, Balsam Mountains, NC. In: F.G. Howell, J.B. Gentry, and M.H. Smith (eds.) Mineral Cycling in Southeastern Ecosystems. Proceedings of a symposium, ERDA, Tech. Info. Center.

SUBJECT KEYWORDS
nutrient pools, nutrient cycles, soil properties

RANGE OF COMMUNITIES
spruce-fir, northern hardwoods

GEOGRAPHIC SCOPE
Balsam Mtns.

TYPE OF INFORMATION
quantitative

QUANTITATIVE TOPICS
nutrient pools, soil properties

Notes for Weaver (1975)

Measured quantities and distribution patterns of Ca, K, Mg, and P in immature spruce-fir, mature yellow birch, and successional yellow birch ecosystems, located between Wolf Bald and Wesner Bald in the Balsam Mtns. More detailed reporting of methods and results is contained in Weaver (1972). Dry weight estimates for strata of vegetation, forest floor, and soil were made by an every-tree summation method, using data from plot samples and regression equations developed from dimension analysis of trees and shrubs in the area. Nutrient concentrations in plant parts were determined from samples and multiplied by dry weights to determine total pools. Soil and forest floor (O1 & O2 horizons) pools were calculated from sample concentration and bulk density.

Relative amounts of the nutrients in all 3 ecosystems were Ca>K>Mg>P. Only P differed significantly between mature and immature ecosystems. Vegetation was the largest pool for Ca, and forest floor was largest for the others. Distribution of nutrients was not proportional to the distribution of dry matter. Herb layers, including ferns in the spruce-fir and mosses in the mature birch, were important nutrient pools.

Quantitative data evaluation record for
Weaver (1975)

TOPIC

soil properties

METHODS

Sampled immature spruce-fir, mature yellow birch, and successional birch in the Balsam Mtns. Colected forest floor (O1 & O2 horizons) and large litter in plots. Collected soil by horizon in 1-2 pits/vegetation plot. Analysed soil for Ca, K, Mg, and P.

NUMBER OF SAMPLES: 20   PERMANENT PLOTS:

DATA PRESENTED

Mean and std. error of amounts of Ca, Mg, K, and P in forest floor and soil, and % distribution by stratum, for each forest type.

Quantitative data evaluation record for
Weaver (1975)

TOPIC

nutrient pools

METHODS

Sampled 14 immature spruce-fir, 2 mature yellow birch, and 4 successional birch stands in the Balsam Mtns. Measured trees & tall shrubs (>2.5 cm dbh) in .04 ha plots, shrubs & saplings and woody regeneration in subplots. Measured nutrient conc. in sampled plant parts. Estimated nutrient pools from nutrient conc. and dry wt., estimated by every-tree summation of wt. of components.

NUMBER OF SAMPLES: 20   PERMANENT PLOTS:

DATA PRESENTED

Mean and std. error of amounts of Ca, Mg, K, and P in aboveground vegetation, and % distribution by vegetational strata. Mean and std. error of % distribution of nutrients in boles, branches, and foliage of tree + tall shrub stratum.

Weaver, G. T., and H. R. DeSelm. 1973. Biomass distributional p
atterns in adjacent coniferous and deciduous forest ecosyste
ms. P. 413-427 in Proc. of the Working Party on Forest Biom
ass, Univ. of Maine Press.

SUBJECT KEYWORDS
Biomass, Nutrient pools, Production, Soil properties

RANGE OF COMMUNITIES
Spruce-fir, Northern hardwoods

GEOGRAPHIC SCOPE
Balsam Mtns.

TYPE OF INFORMATION
Quantitative (no form)

QUANTITATIVE TOPICS

Notes for Weaver and DeSelm (1973)

This paper presents the results of the biomass study that is described in Weaver's dissertation (Weaver 1972). Sample sites were in successional spruce-fir and yellow birch, and in mature yellow birch forest in the Balsam Mountains. Above-ground woody biomass >.46 m tall was estimated by "every-tree summation", using regression equations on stem diameters. Biomass of lower vegetation, detritis, and soil organic layer was estimated by harvest samples. Total dry matter in each community type varied widely and differences between types were not significant. Importance of compartments was soil>vegetation>forest floor. In spruce-fir forest, 57% of dry matter was in the forest floor, 28% in vegetation, and 14% in the soil. 99% of the vegetation viomass was in trees and shrubs. In contrast, about 75% of the yellow birch community biomass was in the soil, with only 5-10% in the forest floor.

Wells, B.W. 1936. Andrews Bald: The problem of its origin.
Castanea 1: 59-62.

SUBJECT KEYWORDS
community maintenance, ecotones

RANGE OF COMMUNITIES
grassy bald
GEOGRAPHIC SCOPE
Great Smoky Mtns.
TYPE OF INFORMATION
qualitative
QUANTITATIVE TOPICS

Notes for Wells (1936)

This note describes observations of Andrews Bald and considerations of its origin. Andrews Bald was reported present when white settlers came to the area, and it has a thick grass sod, indicating great age. Trees and shrubs are not invading at the time. Any natural force capable of creating the grassy balds would have had sufficient time to create large areas of bald. Fires in spruce-fir forest produce a dense growth of shrubs and fire cherry rather than grassy balds. The author believes that Indians created Andrews Bald and other grassy balds. Once established, the oatgrass sod is able to resist invasion by trees.

White,E., 1939. Plants of the Smoky Mountains. Trans. Ill. Acad. Sci. 32:82-85.

SUBJECT KEYWORDS
Vascular Flora

RANGE OF COMMUNITIES
General Southern Appalachian
GEOGRAPHIC SCOPE
Great Smoky Mtns.
TYPE OF INFORMATION
Qualitative
QUANTITATIVE TOPICS

Notes for White (1939)

Descriptive account of the flora of the Smokies based on limited data

White, P.S. 1982. The flora of the GSMNP: an annotated checklist of the vascular plants and review of previous floristic work. USDI, NPS, SE Regional Office, Res. Man. Rep. SER-55

SUBJECT KEYWORDS
Vascular Flora, Biogeography

RANGE OF COMMUNITIES
General Mountain Vegetation
GEOGRAPHIC SCOPE
Great Smoky Mtns.
TYPE OF INFORMATION
List
QUANTITATIVE TOPICS

Notes for White (1982)

An annotated checklist of ca. 1500 plant taxa for GSMNP. Includes plant geography, abundance and habitats of the plants.

Quantitative data evaluation record for
Zavarin and Snajberk (1972)

TOPIC

fir genetics & intraspecific variation

METHODS

Balsam and fraser fir were sampled throughout their range (5 fraser fir sites with 56 trees, 24 balsam fir sites with 242 trees). Resin was collected and analysed for content of each monoterpene. Primarily nonparametric statistics were used in analysis because on non-normality of data.

NUMBER OF SAMPLES: 56 PERMANENT PLOTS: n

DATA PRESENTED

Median values of terpene levels for each site. Individual tree levels for 3 sites, including Roan Mtn.

Range, first and fourth quartiles, and sum of inter-quartile range for each terpene for Fraser fir and longitudinal groups of balsam fir. Plots of medians of 2 terpenes vs. longitude.

Chi square tests for fit of terpene distributions to normal curve for eastern balsam, western balsam, and fraser fir. Plots for 3.

Results of correlation of terpenes with longitude are discussed.

White, P.S. (ed). 1984. The Southern Appalachian Spruce-Fir Ecosystem: Its Biology and Threats. NPS Research/Resources Man. Rept. SER-71.

SUBJECT KEYWORDS
symposium

RANGE OF COMMUNITIES
spruce-fir
GEOGRAPHIC SCOPE
southern Appalachians
TYPE OF INFORMATION
quantitative (no form)
QUANTITATIVE TOPICS

Notes for White (1984)

This symposium contains contributions covering many diverse aspects of the southern Appalachian spruce-fir ecosystem. The primary emphasis is on the Great Smoky Mountains. Individual papers are entered separately in this bibliography and detailed information is given there.

White, P.S., and C. Eagar. 1984. Bibliography of research on southern Appalachian spruce-fir vegetation. In: P.S. White (ed): The Southern Appalachian Spruce-Fir Ecosystem: Its Biology and Threats. NPS Research/Resources Management Rept. SER-71.

SUBJECT KEYWORDS
bibliography

RANGE OF COMMUNITIES
spruce-fir

GEOGRAPHIC SCOPE
Southern Appalachians

TYPE OF INFORMATION
bibliography

QUANTITATIVE TOPICS

Notes for White and Eagar (1984)

This is an appendix to the symposium on southern Appalachian spruce-fir forests. It is drawn from DeYoung, White, and DeSelm (1982), the bibliographies of papers in the symposium, and the authors' personal files.

White, P.S., and L.A. Renfro. 1984. Vascular plants of southern Appalachian spruce-fir: annotated checklists arranged by geography, habitat, and growth form. In: P.S. White (ed): The Southern Appalachian Spruce-Fir Ecosy stem: Its Biology and Threats. NPS Research/Resources Man. Rept. SER-71.

SUBJECT KEYWORDS

vascular flora, rare species, exotic plants

RANGE OF COMMUNITIES

spruce-fir, bog, heath bald, cliff, northern spruce-fir

GEOGRAPHIC SCOPE

Southern Appalachians

TYPE OF INFORMATION

species list

QUANTITATIVE TOPICS

Notes for White and Renfro (1984)

This is an appendix to the symposium on southern Appalachian spruce-fir forests. It consists of a list of plant species in the Great Smoky Mountains, grouped by type of community and by growth form. Separate lists are given of species found in southern Appalachian high elevation areas but absent in the Smokies, and of northern spruce-fir species not found in the south. Symbols indicating occurrence in northern and southern spruce-fir forests, rare and endemic status, and exotic status are included in the lists.

White, P.S. and B.E. Wofford. 1984. Rare native Tennessee vascular plants in the flora of the GSMNP. J. Tenn. Acad. Sci. 59:61-64.

SUBJECT KEYWORDS
Vascular Flora, Rare species

RANGE OF COMMUNITIES
General Mountain Vegetation

GEOGRAPHIC SCOPE
Great Smoky Mtns.

TYPE OF INFORMATION
Qualitative

QUANTITATIVE TOPICS

Notes for White and Wofford (1984)

A list of plants in Tennessee for which GSMNP represents a signif icant fraction of total state population size. High elevation spe cies are among those disscussed.

White, P.S., M.D. MacKenzie, and R.T. Busing. 1985. A critique on overstory/understory comparisons based on transition probability analysis of an old growth spruce-fir stand in the Appalachians. Vegetatio 64: 37-45.

SUBJECT KEYWORDS
population dynamics, modelling, gap dynamics

RANGE OF COMMUNITIES
spruce-fir
GEOGRAPHIC SCOPE
Great Smoky Mtns.
TYPE OF INFORMATION
quantitative
QUANTITATIVE TOPICS
population dynamics & modelling

Notes for White, MacKenzie, and Busing (1985)

This paper examines the traditional method of evaluating compositional stability in forests by comparing understory to overstory composition. Overstory/understory comparison assumes that relative understory density is sufficient to predict future overstory, that there are no significant canopy/understory species interactions, and that differences in species longevity are unimportant. This study tests models based on this method by comparing their predicted equilibrium canopy composition to that observed in a virgin spruce-fir forest.

The forest, on Mt. Collins, was sampled by variable plot tallies. Reproduction was sampled in nested quadrats beneath each species of canopy tree, at random locations under the canopy, and in gaps. Gaps were analysed and probable successor trees identified, to estimate actual gap capture rates.

14 transition probability models were constructed, based on relative density and relative frequency of reproduction under canopy species in 4 size classes, 2-4 m ht. class in random plots and in gaps, and oberved gap capture rates with and without adjustment for tree life span. Predicted compositions varied widely, with best approximation being model based on gap capture.

Quantitative data evaluation record for
White, MacKenzie, and Busing (1985)

TOPIC

population dynamics & modelling

METHODS

Sampled on Mt. Collins. Tallied tree dbh in 10 variable plots. Tallied regeneration in nested quadrats, 25 under each canopy tree, 25 randomly located under canopy, and 25 in random gaps. 60 gaps analysed and gap maker and successor trees identified. 14 transition probability matrices constructed from various permutations of the data, and used to predict equilibrium canopy.

NUMBER OF SAMPLES: 125 PERMANENT PLOTS:

DATA PRESENTED

Relative density and relative frequency of spruce, fir, and birch in the 4 understory height classes under each canopy species. Rel. density and rel. freq. of tree spp. in size class 4, in gaps and under the canopy. Transition probabilities for the 3 spp., based on gap capture rates. Predicted rel. density and rel. freq. based on freq. and density under each species, in each ht. class. Predicted canopy composition based on gap capture data, adjusted for lifespan and not. Predicted rel. freq. by size class, under each canopy sp., in random plots in gap & forest.

Quantitative data evaluation record for
White, MacKenzie, and Busing (1985)

TOPIC

reproduction and gap dynamics

METHODS

Sampled on Mt. Collins in Great Smoky Mtns. Sampled 60 gaps, measured size and shape, sp., dbh, and age of gap maker; tallied tallest 5 successor trees' height, crown area, and dbh. Sampled vegetation inrandom nested quadrats. Tallied saplings on logs in 5 random transects. Measured extension and crown expansion in gap and understory. Estimated age of canopy entry of gap maker.

NUMBER OF SAMPLES: PERMANENT PLOTS:

DATA PRESENTED

Relative density by species and total density of tree reproduction in 4 ht. classes beneath different canopy species in understory and in gaps. Scatter diagrams of age vs. size of gaps captured by each species. Mean time in suppression, release, and in canopy of each species. Diagram of predicted equilibrium canopy density of each species, based on different models. Diagram of observed density of fir and spruce reproduction by size class, under each species.

Quantitative data evaluation record for
White, MacKenzie, and Busing (1985)

TOPIC
    disturbance
METHODS
    Used aerial photos of the entire Great Smoky Mtns. spruce-fir zone. Estimated distribution and size of disturbance patches <20 years old. Balsam woolly adelgid-killed trees not included. Tallied gaps on 4 random 100 m transects at Mt. Collins. Determined gap maker species. In gaps, tallied saplings crushed by fallen trees. Calculated return interval and recovery time.
NUMBER OF SAMPLES: PERMANENT PLOTS:
DATA PRESENTED
    Table of % of available area affected, return interval, recovery time, and year of last occurrence for several kinds of disturbance, including fire, debris avalanche, windfall, and tree gaps. Table of gap return interval, gap frequency, gaps/ha, and gaps/ha/year, calculated from average tree life span, average time of release, canopy residence, frequency in transects, and photo interpretation.

White, P.S., M.D. MacKenzie, and R.T. Busing. 1985. Natural disturbance and gap phase dynamics in southern Appalachian spruce-fir forests. Canadian Journal of Forest Resources 15: 233-240.

SUBJECT KEYWORDS
disturbance, forest dynamics, reproduction, gap dynamics, fuel loading
RANGE OF COMMUNITIES
spruce-fir
GEOGRAPHIC SCOPE
Great Smoky Mtns.
TYPE OF INFORMATION
quantitative
QUANTITATIVE TOPICS
reproduction & gap dynamics, disturbance, fuel loading

Notes for White, MacKenzie, and Busing (1985)

This paper examines the traditional method of evaluating compositional stability in forests by comparing understory to overstory composition. Overstory/understory comparison assumes that relative understory density is sufficient to predict future overstory, that there are no significant canopy/understory species interactions, and that differences in species longevity are unimportant. This study tests models based on this method by comparing their predicted equilibrium canopy composition to that observed in a virgin spruce-fir forest.

The forest, on Mt. Collins, was sampled by variable plot tallies. Reproduction was sampled in nested quadrats beneath each species of canopy tree, at random locations under the canopy, and in gaps. Gaps were analysed and probable successor trees identified, to estimate actual gap capture rates.

14 transition probability models were constructed, based on relative density and relative frequency of reproduction under canopy species in 4 size classes, 2-4 m ht. class in random plots and in gaps, and oberved gap capture rates with and without adjustment for tree life span. Predicted compositions varied widely, with best approximation being model based on gap capture.

Quantitative data evaluation record for
White, MacKenzie, and Busing (1985)

TOPIC

population dynamics & modelling

METHODS

Sampled on Mt. Collins. Tallied tree dbh in 10 variable plots. Tallied regeneration in nested quadrats, 25 under each canopy tree, 25 randomly located under canopy, and 25 in random gaps. 60 gaps analysed and gap maker and successor trees identified. 14 transition probability matrices constructed from various permutations of the data, and used to predict equilibrium canopy.

NUMBER OF SAMPLES: 125 PERMANENT PLOTS:

DATA PRESENTED

Relative density and relative frequency of spruce, fir, and birch in the 4 understory height classes under each canopy species. Rel. density and rel. freq. of tree spp. in size class 4, in gaps and under the canopy. Transition probabilities for the 3 spp., based on gap capture rates. Predicted rel. density and rel. freq. based on freq. and density under each species, in each ht. class. Predicted canopy composition based on gap capture data, adjusted for lifespan and not. Predicted rel. freq. by size class, under each canopy sp., in random plots in gap & forest.

Quantitative data evaluation record for
White, MacKenzie, and Busing (1985)

TOPIC

reproduction and gap dynamics

METHODS

Sampled on Mt. Collins in Great Smoky Mtns. Sampled 60 gaps, measured size and shape, sp., dbh, and age of gap maker; tallied tallest 5 successor trees' height, crown area, and dbh. Sampled vegetation inrandom nested quadrats. Tallied saplings on logs in 5 random transects. Measured extension and crown expansion in gap and understory. Estimated age of canopy entry of gap maker.

NUMBER OF SAMPLES: PERMANENT PLOTS:

DATA PRESENTED

Relative density by species and total density of tree reproduction in 4 ht. classes beneath different canopy species in understory and in gaps. Scatter diagrams of age vs. size of gaps captured by each species. Mean time in suppression, release, and in canopy of each species. Diagram of predicted equilibrium canopy density of each species, based on different models. Diagram of observed density of fir and spruce reproduction by size class, under each species.

Quantitative data evaluation record for
White, MacKenzie, and Busing (1985)

TOPIC

disturbance

METHODS

Used aerial photos of the entire Great Smoky Mtns. spruce-fir zone. Estimated distribution and size of disturbance patches <20 years old. Balsam woolly adelgid-killed trees not included. Tallied gaps on 4 random 100 m transects at Mt. Collins. Determined gap maker species. In gaps, tallied saplings crushed by fallen trees. Calculated return interval and recovery time.

NUMBER OF SAMPLES: PERMANENT PLOTS:

DATA PRESENTED

Table of % of available area affected, return interval, recovery time, and year of last occurrence for several kinds of disturbance, including fire, debris avalanche, windfall, and tree gaps. Table of gap return interval, gap frequency, gaps/ha, and gaps/ha/year, calculated from average tree life span, average time of release, canopy residence, frequency in transects, and photo interpretation.

White, P.S. R.I. Miller and G.S. Ramseur. 1984. The species-area relationship of the southern Appalachian high peaks: vascular plant richness and rare plant distributions. Castanea 49:47-61.

SUBJECT KEYWORDS
Vascular Flora, Biogeography, Rare species

RANGE OF COMMUNITIES
General Mountain Vegetation
GEOGRAPHIC SCOPE
Southern Appalachians
TYPE OF INFORMATION
Quantitative
QUANTITATIVE TOPICS
Vascular flora

Notes for White, Miller, and Ramseur (1984)

This study examined plant species-area relationships of the 10 Southern Appalachian mountain areas above 5500 ft. elev. Floristic data collected by Ramseur (1960) were updated from more recent herbarium specimens and lists. Mountain areas were characterized by area above 5500 ft. (island size), number of peaks above 5500 ft., maximum elev., distance to nearest range, and presence of grassy balds and well-developed spruce-fir forest. Plants were characterized as far northern, northern, Southern Appalachian endemic, high elevation, low elevation, rare, and meadow species. Correlations were done among these factors.

Species richness was significantly correlated with island size, number of peaks, maximum elevation, and community diversity. Rare plant species numbers were more strongly correlated with area and maximum elevation than were total plant numbers. A log/log plot of total plant species richness vs. island area showed 8 of the areas along a line of slope .28. This steep slope suggests a high degree of insularity, as defined in island biogeographic literature. The 2 additional areas, Mt. Pisgah and Whitetop, had richness disproportionate to their small size. On Mt. Pisgah, this may be a result of more low elevation species.

Quantitative data evaluation record for
White, Miller, and Ramseur (1984)

TOPIC

Vascular flora

METHODS

Studied all 10 Southern Appalachian areas > 5500 ft. elev. Determined vascular plant species present by updating lists from Ramseur (1960), using more recent herbarium specimens and lists. Did correlations among several mountain range characteristics and plant species richness in several categories of geographic distribution, habitat, and rarity.

NUMBER OF SAMPLES: PERMANENT PLOTS: n

DATA PRESENTED

Presence of selected significant species in each range. Number of far northern, northern, and endemic species, meadow species, high elev., low elev., and rare species in each range. Significant correlations among number of species in these categories and mountain range characteristics. Plot of log number of species vs. log island area, for all 10 areas, and for the 8 largest areas.

Whittaker, R.H. 1948. A vegetation analysis of the Great Smoky Mountains. PhD. Dissertation, Univ. of Illinois-Urbana.

SUBJECT KEYWORDS
vegetation sample, vegetation-environment relationships, vegetation patterns, community maintenance
RANGE OF COMMUNITIES
general southern Appalachian
GEOGRAPHIC SCOPE
Great Smoky Mtns.
TYPE OF INFORMATION
quantitative (no form)
QUANTITATIVE TOPICS

Notes for Whittaker (1948)

This dissertation was not examined, but apparently reports on the vegetation study on which Whittaker (1956) was based. This study examined the vegetation patterns in the Great Smoky Mountains, primarily in the Greenbriar, Sugarloaf, and Cades Cove areas. Trees were tallied at points along transects of elevation and topographic moisture gradient. It presumably contains the extensive field sampling data which are summarized in Whittaker (1956). It may contain other additional data and discussion not found in Whittaker (1956).

Whittaker, R.H. 1956. Vegetation of the Great Smoky Mountains.
Ecol. Monogr. 26: 1-80.

SUBJECT KEYWORDS
vegetation sample, vegetation-environment relationships, community maintenance, vegetation patterns
RANGE OF COMMUNITIES
general southern Appalachian
GEOGRAPHIC SCOPE
Great Smoky Mtns.
TYPE OF INFORMATION
quantitative
QUANTITATIVE TOPICS
vegetation sample & vegetation-environment relationships

Notes for Whittaker (1956)

Studied vegetation patterns in the Great Smoky Mnts., primarily in the Greenbriar, Sugarland, and Cades Cove areas. Trees were tallied at points along transects of elevation and topographic position (related to moisture), and at arbitrarily located points which were then grouped into artificial composite transects. Species populations were found to have normal-like curves of distribution along these gradients, with peaks of different species distributed fairly continuously. Communities grade into each other without marked discontinuities. Direct ordination of stands was done on the moisture gradient, using a classification of species into 4 moisture categories.

The vegetation was classified into types, which are described, and important species for all strata named. Diagrams of the general distribution of these community types and tree species on elevational and topographic gradients are given.

A variety of theoretical questions, such as the value of the Association-Unit vs. Individualistic hypotheses, and the relationship of species distributions and genecology, were discussed. More specific local questions, such as the southwestern limit of spruce-fir and the origin of grassy balds, were also discussed.

Quantitative data evaluation record for
Whittaker (1956)

TOPIC
vegetation sample & vegetation-environment relationships

METHODS
Sampled at even intervals of elev. along 6 transects, and at "approximately random" locations along trails. Measured dbh of trees > 1 in. dbh. Estimated cover of lower strata and noted major and minor species. Samples included 50-300 trees. Arranged site samples along artificial composite transects of elev., topo. position, and did direct ordination along moisture gradient.

NUMBER OF SAMPLES: PERMANENT PLOTS:

DATA PRESENTED
Tables and plots of tree density by species along composite transects of topo. position (moisture) at several elevations, and of elev. for several topo. positions. Average density of shrubs and cover of herbs, by stratum, along composite transects to topo. position at 3 elevations in spruce-fir. Plots of distribution of recognized community types on elevation and topo.-moisture gradients. Similar plots of distribution of tree species. The community types are described in the text. Composite stand counts for the community types and field transects are available.

Whittaker, R.H. 1962. Net production relations of shrubs in the Great Smoky Mountains. Ecol. 43: 357-377.

SUBJECT KEYWORDS
 biomass, production, dimension analysis, leaf-production relations
RANGE OF COMMUNITIES
 general southern Appalachian
GEOGRAPHIC SCOPE
 Great Smoky Mtns.
TYPE OF INFORMATION
 quantitative
QUANTITATIVE TOPICS
 biomass & production, leaf-production relations

Notes for Whittaker (1962)

Exploration of problems and means of estimating net production, using shrubs in the Great Smokies. 14 species were sampled in 7 communities, which included spruce-fir forest on Mt. Collins and high elevation heath bald on Mt. LeConte. Production and biomass were estimated for stem wood and bark, branches, current twigs, current leaves, old leaves, and inflorescences of each species. In addition, leaf area and chlorophyll relations to production were estimated for the sepcies. Net production relations are presented for 4 stands, including the heath bald on Mt. LeConte.

In general, in large shrubs, stem and branch growth were each 12-30% of total shoot growth. Current twigs and leaves were generally 33-60% of shoot growth. Evergreen shrubs had 10-16% of their production in old leaves, which increased in weight without increasing in size. Production distribution varies greatly with age and environment.

Conversion factors from clipping (current twigs and lvs.) production to total shoot prod. were generally 1.5-1.8 for small shrubs, 1.9-2.3 for intermediate. Standard errors were 3-6% of the means. They may be an effective way to estimate production.

Quantitative data evaluation record for
Whittaker (1962)

TOPIC

leaf-production relations

METHODS

Sampled 14 shrub spp. in 7 communites, including spruce-fir on Mt. Collins and heath bald at 6600 ft. on Mt. LeConte. Sampled 10 large shoots and 8-15 smaller/species. Collected leaves in late summer. Measured blade length, width, area, weight, thickness, and petiole length, separately for upper and lower leaves. Used biomass and production estimates described above.

NUMBER OF SAMPLES: PERMANENT PLOTS:

DATA PRESENTED

Leaf length, dry wt., area, average number/twig, for upper and lower leaves of each age of each species. % of current twig, dry weight in twig, petiole, and blade thickness, wt./area, amount of chlorophyll, years persistence, % growth in older leaves, shoot production/leaf wt., and shoot prod./blade chlorophyll averaged over upper and lower leaves for large individuals of each species.

Quantitative data evaluation record for
Whittaker (1962)

TOPIC

biomass & production

METHODS

Sampled 14 shrub species in 7 communities, including spruce-fir & heath bald. Collected, measured, and weighed current twigs & lvs., older leaves, fruits and flower parts, branches, and .5 m stem segments. Estimated branch and older leaf growth from plots of wt. vs. age. Est. stem wood growth from cross-sect. increment and total wood dry wt. Used dry wt. for prod. of others.

NUMBER OF SAMPLES: PERMANENT PLOTS:

DATA PRESENTED

For each sp. & size group in each site, % of aboveground prod. in stem wood, stem bark, branches, old lvs., fruits, and current twigs & lvs., total dry wt. prod., current twig prod., #, wt., & prod. of inflorescence parts, % biomass in each component, ave. shoot biomass, biomass accumulation ratio. Comparison of est. & measured stem volume and volume increment. Factors for estimating shoot prod. (+-std. error) from current twig wt., stem growth and shoot prod. from volume increment, shoot prod. from stem growth. Total stand prod. relations for 4 stands.

Whittaker, R.H. 1963. Net production in heath balds and forest heaths in the Great Smoky Mountains. Ecol. 44: 176-182.

SUBJECT KEYWORDS
biomass, production, canopy light absorption, vegetation sample, leaf-production relations
RANGE OF COMMUNITIES
general southern Appalachian
GEOGRAPHIC SCOPE
Great Smoky Mtns.
TYPE OF INFORMATION
quantitative
QUANTITATIVE TOPICS
production & vegetation sample & canopy light absorption

Notes for Whittaker (1963)

Estimated a variety of vegetation measurements for a number of communities with dense heath layers, including a spruce-rhododendron forest and several kinds of heath balds on Mt. LeConte. Measured trees and large shrubs, and clipped herbs and current twigs of shrubs in plots. Measured strata heights and cored trees. Measured cover and light levels at points. Used relations derived elsewhere to estimate shrub production, leaf area, various leaf-production relations, and biomass accumulation ratio for each stand.

The spruce-rhododendron forest had an estimated total shrub shoot production of 202 g/sq. m. The spruce-rhododendron forest was more productive than the heath balds. Because of increased light and decreased leaf life at high elevation, ratios of rhododendron production to leaf area and chlorophyll increased from low elevation forests to high elevation heath balds.

Quantitative data evaluation record for
Whittaker (1963)

TOPIC
production & vegetation sample & canopy light absorption

METHODS
Sampled various communities, including a spruce-rhododendron forest & heath balds on Mt. LeConte. Clipped current twigs of small shrubs and collected herbs in 10 1/2x2 m quadrats. Measured big shrubs and trees, cored and measured ht., in .1-.2 ha quadrats for trees, .01 ha for shrubs. Calculated estimated prod. using conversion factors from Whittaker (1962). Measured light penetr.

NUMBER OF SAMPLES: PERMANENT PLOTS:

DATA PRESENTED
Density, basal area, ba increment, est. vol. incr. of trees & shrubs for each forested stand. Est. vol. incr. by sp. for trees & shrubs in each stand. Shrub and herb clipping wt. by sp. for each stand. Strata heights, strata cover, light strata, clipping wt. of strata, est. total shoot prod., leaf area/ground area, leaf chlorophyll/ground area, shoot prod./leaf blade wt., shoot prod./leaf area, shoot prod./chlorophyll, and biomass accum. ratio for each stand. Plots of log clipping wt. vs. % shrub cov., clipping wt. vs. log light abs., log light abs. vs % shrub cov.

Whittaker, R.H. 1965. Branch dimensions and estimation of branch production. Ecology 46: 365-370.

SUBJECT KEYWORDS
Biomass, production, dimension analysis

RANGE OF COMMUNITIES
general southern Appalachian
GEOGRAPHIC SCOPE
Great Smoky Mtns.
TYPE OF INFORMATION
quantitative
QUANTITATIVE TOPICS
biomass & production

Notes for Whittaker (1965)

Investigated methods for estimating production of shrub branches. Branches include a substantial fraction of biomass in shrubby communities and an even larger fraction of production. A variety of shrub species in a variety of communities was sampled, including Viburnum alnifolium in spruce-fir forest and Rhododendron spp. in high heath balds. Measurements were made of branch weights and dimensions and correlations between the measurements are given. More intensive measurements were made on Rhododendron maximum. There are moderate to strong correlations between branch characters, similar in evergreen and deciduous species, which allow estimation of branch wt. and current twig wt. from measurements such as dia., no. of current twigs, and dry wt./age ratio. There is some evidence of bimodal distribution of values for fast and slow-growing branches.

Branch prod. was estimated by plotting branch wood dry. wt. vs. age, and fitting a curve to the geometric means of wt. at each age. Slopes of the curve give growth factors for estimating current year's growth from branch wt. Intensive analysis of R. maximum compared measured and statistically est. prod. Estimates tend to overestimate branch wt. for non-vigorous branches.

Quantitative data evaluation record for
Whittaker (1965)

TOPIC

biomass & production

METHODS

Sampled branches of 9 shrub spp. in 15 sites, including Viburnum alnifolium in spruce-fir on Mt. LeConte. Measured branch age, basal dia., length, no. current twigs, fruits, older lvs., live & dry wt. of wood, current twigs & lvs., older lvs., and fruit. Est. shrub prod. by plotting branch age vs. wood dry wt. for 10 branches of each size class and fitting curve to means of wt.

NUMBER OF SAMPLES: PERMANENT PLOTS:

DATA PRESENTED

Matrix of correlation coefficients of log-transformed and untransformed branch measurements, combining all deciduous and evergreen spp. Plots of no. branch segments, total wood cross-section area, mean length of annual segments, total wood+bark wt. in annual segments, mean wood radial increment, and total wood cross-sectional increment vs. age for vigorous and non-vigourous Rhododendron maximum branches.

Formula coefficients for different species are given in the text.

Whittaker, R.H. 1966. Forest dimensions and production in the Great Smoky Mountains. Ecology 47: 103-121.

SUBJECT KEYWORDS
biomass, production, dimension analysis, vegetation sample, canopy light absorption

RANGE OF COMMUNITIES
general southern Appalachian

GEOGRAPHIC SCOPE
Great Smoky Mtns.

TYPE OF INFORMATION
quantitative

QUANTITATIVE TOPICS
biomass & production, canopy light absorption

Notes for Whittaker (1966)

This study estimated net production and biomass in climax forests sampled at various places in the Smokies, including 5 spruce-fir forests along Clingmans Dome road and on Mt. LeConte. A variety of stand characteristics was measured, including cover by strata, density, basal area, clipping weight of woody and herb undergrowth, tree growth increment, and light penetration. In addition to data from stands throughout the park, data are given from 5 contiguous .1 ha quadrats in spruce-fir on Mt. Collins, to show the degree of dispersion. For most measurements, the coefficient of variation is < 20%, but shrub cover, light penetration, and parabolic volume vary more widely within the same stand.

Biomass and net production were estimated using clipping weights and forest measurements, combined with some relationships derived from other studies. Estimated volume increments and clipping weights are given by species for each stand (giving a measure of their relative importance in the community). Production of components and total production is given and correlated with elevation, moisture, exposure, and evergreenness.

Quantitative data evaluation record for
Whittaker (1966)

TOPIC

biomass & production

METHODS

Sampled sites in a variety of forest types, primarily in the Smokies, including 5 spruce-fir stands on Mt. Collins, Mingus, and LeConte. Tallied trees and shrubs >1 cm dbh in .1 ha plots. Measured height of all large and some small trees and cored them. Clipped and weighed herbs and current growth on shrub and tree species <1 cm dbh in .5x.2 m plots.

NUMBER OF SAMPLES: 17 PERMANENT PLOTS:

DATA PRESENTED

Stem density, tree and wood basal area, parabolic volume, and estimated volume increment for 5 contiguous spruce-fir stands on Mt. Collins, showing dispersion. Density, basal area, and parabolic volume for trees and shrubs, and estimated volume increment for each stratum, for all sample sites. Estimated volume incr. by sp. for trees & shrubs at all sites. Clipping wt. of woody undergrowth & herbs, by sp. at all sites. Summary of components of biomass & prod. in each site. Multiple correlation of biomass & prod with elev., moisture index, exposure, evergreenness.

Quantitative data evaluation record for
Whittaker (1966)

TOPIC

canopy light absorption

METHODS

Sampled stands in a variety of forest types in the Smokies and elsewhere, including 5 in spruce-fir on Mt. Collins, Mt. Mingus, and Mt. LeConte. Measured light intensity below each stratum with Weston sunlight illuminometer in .1 ha plots used for vegetation sample. Measured cover of plants at 50 points on a tape. Calculated mean light penetration.

NUMBER OF SAMPLES: 17 PERMANENT PLOTS:

DATA PRESENTED

Geometric and arithmetic mean % light penetration through trees, and log light absorption for 5 contiguous stands in spruce-fir forest near Mt. Collins, showing dispersion of measurements. Point coverage of each stratum in these 5 stands. Mean % light penetration to low shrubs, to herbs, and through herbs, for all the sample sites, including 5 spruce-fir. % cover of trees, shrubs, herbs, lichens, and moss, for each stand. Plots and regression equations for log light absorption vs. % cover, tree volume increment, and herb clipping weight vs. log light abs.

Wolfe, J.A. 1967. Forest Soil Characteristics as Influenced by Vegetation and Bedrock in the Spruce-fir Zone of the Great Smoky Mountains. PhD. Dissertation, Univ. of Tennessee, Knoxville.

SUBJECT KEYWORDS
soil properties, variation within spruce-fir, community maintenance
RANGE OF COMMUNITIES
spruce-fir, beech gap
GEOGRAPHIC SCOPE
Great Smoky Mtns.
TYPE OF INFORMATION
quantitative
QUANTITATIVE TOPICS
soil properties

Notes for Wolfe (1967)

This study compared soil properties under spruce-fir forest on sandstone and slate, and under spruce-fir and beech forest with sandstone substrates. Profiles were described and chemical, textural, and mineralogical analysis done.

Soils over sandstone clearly had more sand than slate soils. Slate soils had more organic C and N near the surface and somewhat less translocation of fulvic acid-sesquioxide complexes.

Texture was similar under both forest types, suggesting soil properties were not causing vegetation differences. Spruce-fir soils had much thicker organic layers, lower pH, and higher cation exchange capacity, but slightly lower absolute cation levels and much lower base saturation. Fe, presumably chelated with humic substances, was transported to greater depths under spruce-fir. Both profiles had large amounts of exchangeable Al in mineral soil. The beech litter layer had twice as much Ca as spruce-fir.

Some of the soils were Spodosols but these were rare. On slopes, soil creep and translocation of Fe oxides from above prevented development, and even on ridge crests uprooting of trees destroyed horizons. No albic or spodic horizons in beech.

Quantitative data evaluation record for
Wolfe (1967)

TOPIC

soil properties

METHODS

Sampled sites on Mt. Mingus and Mt. Collins, on slate and sandstone, and paired spruce-fir and beech gap or northern hardwoods stands. Described and sampled several soil profiles at each site. 8 representative samples analysed for pH, CEC, extractable Ca, Mg, K, Na, Mn, total N, exchange H, Al, organic C, free Fe oxides, texture. Identified minerals in each particle size.

NUMBER OF SAMPLES: v PERMANENT PLOTS: n

DATA PRESENTED

Descriptions of 41 profiles from 7 sites. PH of ~ 300 samples from 41 profiles. Extractable Ca, Mg, K, Na, CEC, % N in ~ 100 samples. Free Fe oxides, % organic C, exchangeable H, Al, and acidity for ~ 50 samples. Particle size distribution of ~40 samples. Plots of above plus C/N ratio, % base saturation, texture, and mineralogy of fine sand and silt, for representative profiles on sandstone and slate, with and without A2 horizon development. Plots of above for modal profiles in beech gap and spruce-fir. Levels of cations in 5 litter samples in each.

Zander, R.H. 1980. Spread of Leptodontium viticulosoides (Bryopsida) after balsam woolly aphid infestation of Fraser fir. Bull. Torrey Bot. 107: 7-8.

SUBJECT KEYWORDS
BWA ecological effects, bryophyte biology

RANGE OF COMMUNITIES
spruce-fir
GEOGRAPHIC SCOPE
Balsam Mtns.
TYPE OF INFORMATION
qualitative
QUANTITATIVE TOPICS

Notes for Zander (1980)

Leptodontium viticulosoides (called L. excelsum until recently) is common in Latin American mountains and is disjunct to the high southern Appalachians. It grows on limbs and bark, primarily of Fraser fir, and may be locally abundant. L.E. Anderson in 1951 noted that it was not found in some spruce-fir areas where it might be expected, including Roan Mtn., Mt. Sterling, Waterrock Knob, Jones Knob, and Balsam Cone. In 1976 it was found to be abundant on Waterrock Knob, growing on peeling bark of balsam woolly adelgid-killed Fraser firs. It apparently invaded after the BWA infestation created large amounts of suitable habitat.

Zavarin, E. and K. Snajberk. 1972. Geographical variability of monoterpenes from Abies balsamea and A. fraseri. Phytochemistry 11: 1407-1421.

SUBJECT KEYWORDS
fir taxonomy, fir genetics, intraspecific variation

RANGE OF COMMUNITIES
spruce-fir

GEOGRAPHIC SCOPE
Southern Appalachians, Northeast U.S.

TYPE OF INFORMATION
quantitative

QUANTITATIVE TOPICS
fir genetics & intraspecific variation

Notes for Zavarin and Snajberk (1972)

This study examined variation in amounts of monoterpenes in balsam fir from 24 locations and fraser fir from 5 locations (Mt. Rogers, Roan Mtn., Mt. Mitchell, Richland Balsam, and the Smokies). Major variations were found. For most of the compounds, fraser fir and the western balsam fir were at opposite extremes, with eastern balsam fir intermediate. Longitude was significantly correlated with most terpenes in balsam fir and explained 30-80% of the variation.

Nonparametric variability statistics (quartiles and ranges for individual terpene amounts and sum of interquartile range for all terpenes) show high variability in eastern balsam fir, low in western balsam and fraser fir. This is interpreted to indicate 3 separate gene pools. Fraser fir's genetic diversity is interpreted to have been reduced, probably when climatic warming 8000-4000 years ago reduced the area of southern Appalachian spruce-fir to much less than its present size.

Fraser fir at Mt. Rogers had 2 terpenes different from the rest of the fraser fir, suggesting it might be closer to balsam fir, but it was not significantly different on the basis of all the terpene data.