USDA FOREST SERVICE RESEARCH NOTE NE-186
1974

Northeastern Forest Experiment Station

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SOME EFFECTS OF FOREST PRESERVATION

Abstract.—Long-term preservation (no cutting) of a deciduous forest stand in New Hampshire is leading toward stable populations of beech, sugar maple, striped maple, mountain maple, and hobblebush, coupled with a decline or complete disappearance of other woody species. The humus has stabilized at a depth no greater than that of cut stands. Nitrate discharge in the streams is higher than what is normally found in uncut stands, possibly because of stability in standing crop and humus.

The acceleration in nutrient losses from a small watershed in New Hampshire that was devegetated and then chemically treated to prevent regrowth has been described by Bormann et al. *(1968)*. Pierce et al. *(1970)* suggested that such losses can degrade the soil so that tree growth will be impaired or that only nondemanding species will grow. Recent work *(Pierce et al. 1972)* indicates that a moderate acceleration in nutrient discharge occurs after normal clearcutting operations in forest stands in the mountains of New England.

Because of these results, as well as aesthetic and recreational considerations, the clearcutting of timber stands has become a national issue. Opponents of clearcutting demand some alternative method of managing timber stands in certain locations. Basically, only two other approaches exist: (1) partial cutting in one form or another, and (2) no cutting (forest preservation). Both alternatives are being proposed for certain areas. However, before any alternative is accepted, information should be obtained about long-term effects on vegetation, soil, and water.

Our way to gain an insight into the possible effects of a no-cutting policy is to examine the characteristics of the few remaining so-called virgin forests—forests that have followed natural successional trends because they have seldom, if ever, been heavily damaged by logging or natural catastrophe.

The Study

In the summer of 1972, I studied a portion of The Bowl, a 206-ha Research Natural Area in the White Mountains of New Hampshire. The Bowl lies about 17 miles (27 km) due east of the Hubbard Brook Experimental Forest. The study was limited to an 18-ha stand typed as typical beech-birch-maple. This stand, to our knowledge, has never been logged and thus has developed naturally for many decades. The aspect is east to northeast. Elevation ranges from about 580 to 640 m above sea level. The soil is Berkshire, a podzol, a well-drained fine sandy loam.

Eleven plot locations were established well within the stand borders. (Other plots, not reported on here, were established near the transition between hardwoods and spruce-fir at the upper elevations of the study area.) At each location, the species and the diameter above the root collar (above root swell) were recorded for all trees 100 mm and larger on a 1/10-ha plot, all woody stems 10 to 99 mm on a 1/100-ha plot, and all woody stems of 1-year-old and up to 9 mm on four 1/10,000-ha plots.

One stem per species on the smaller plots and two stems per species on the large plot were aged (above root collar) either by counting terminal bud scars in the field (small stems) or by ring-counting a section or increment boring in the laboratory. Ten humus-depth measurements (H layer, excluding L and F layers) were made per plot location, using a sharp tube sampler.

Water samples were taken every 2 weeks during the growing season for NO_3^- analysis by an Orion NO_3^- probe (operated by Wayne C. Martin at the Hubbard Brook Experimental Forest). Samples were taken in three small permanent brooks that drain through the study area. A few samples also were taken in the Wonalancet River, which drains both the Natural Area and the eastern portion of the geologic bowl, which contains nonvirgin forest.

For each species, a linear or second-degree regression of age over diameter was run. Standard errors of the mean for the major species were less than 8 years; R^2 values were about 0.8, except for a 0.5 for sugar maple. From these relationships, all measured trees were classified into 20-year age groups and all shrubs were classified into 5-year age groups.

Results and Discussion

Survival curves for tree species in New England follow a steeply descending (negative exponential) form (*Marquis 1967*, *Leak 1969*, and *Leak et al. 1969*); mortality of small or young stems is high. Only four tree species

Figure 1.—Number of trees/ha (common logarithms) over midpoints of age classes for species with stationary age distributions.

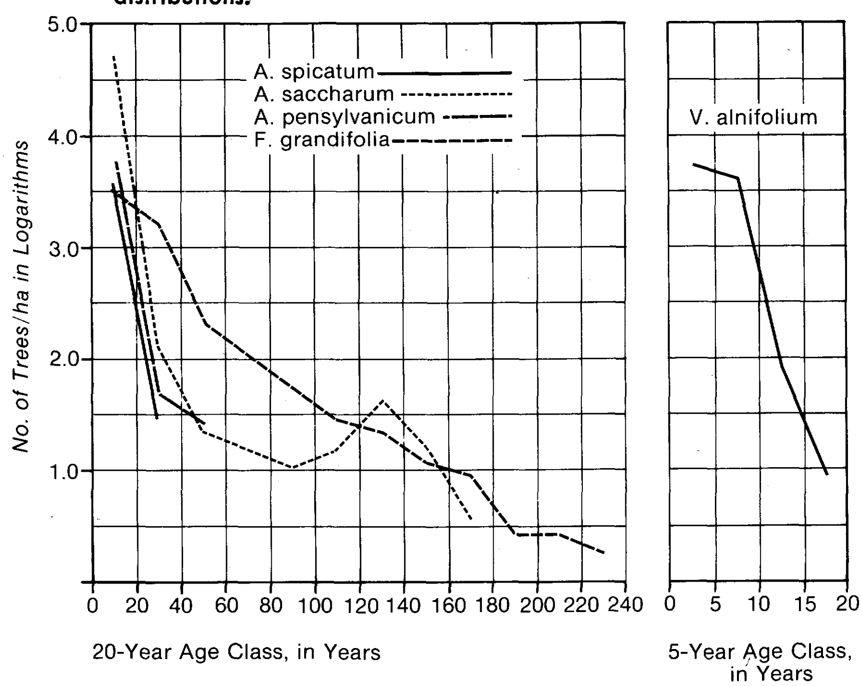
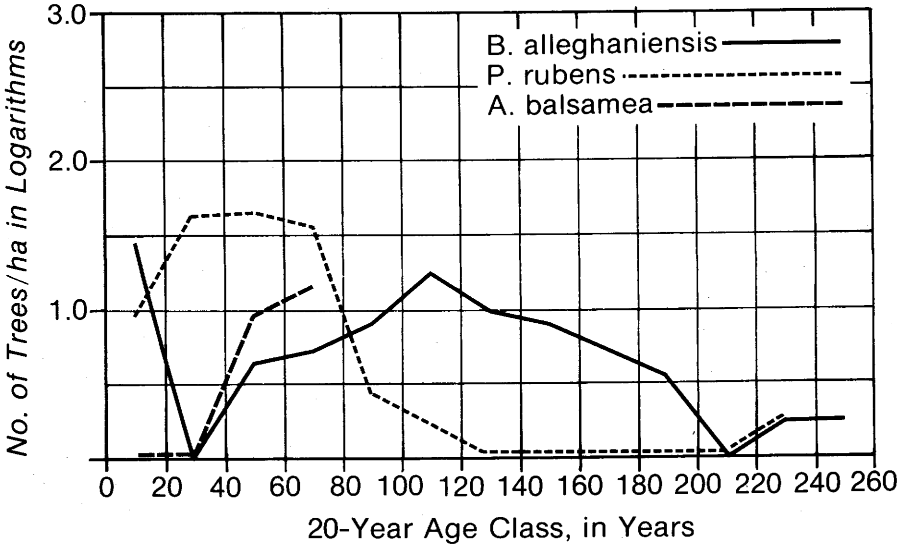


Figure 2.—Number of trees/ha (common logarithms) over midpoints of age classes for species with nonstationary (declining) distributions.



and one shrub found in The Bowl had the steeply descending age distributions characteristic of reasonably stationary populations: beech (*Fagus grandifolia* Ehrh.), sugar maple (*Acer saccharum* Marsh.), striped maple (*A. pensylvanicum* L.), mountain maple (*A. spicatum* Lam.), and hobblebush (*Viburnum alnifolium* Marsh.) (fig. 1). These species seem to be permanent and abundant residents of the study area.

Three species had somewhat bell-shaped age structures typical of declining populations: yellow birch (*Betula alleghaniensis* Britton), red spruce (*Picea rubens* Sarg.), and balsam fir (*Abies balsamea* (L.) Mill.) (fig. 2). Although these species—especially yellow birch—were abundant in certain age classes, the age structure indicates that all must decline appreciably in the future, unless regeneration rates markedly increase—an unlikely possibility.

Three tree species and one shrub were present in very limited numbers: red maple (*Acer rubrum* L.), one tree tallied on a plot near the transition between hardwoods and spruce-fir; eastern hemlock (*Tsuga canadensis* (L.) Carr.), an occasional large tree observed off the plots; pin cherry (*Prunus pensylvanica* L.), three to four trees along the trail at the upper edge of the study area, apparently the result of the 1938 hurricane; and red elder (*Sambucus pubens Michx.*), one stem tallied on a transition plot.

Two local tree species were not found: paper birch (*Betula papyrifera* Marsh.) and white ash (*Fraxinus americana* L.). Several white ash can be seen along the trail into The Bowl. Paper birch is very common in disturbed areas near the study area and at about the same elevation. A number of large dead paper birch were found in the spruce-fir zone just above the study area. Either these two species were prevented from entering the study area by the heavy stand of vegetation present, or—a more likely explanation—these species were present at some time in the past but could not survive because of their high requirement for sunlight.

Humus depths averaged between about 20 and 50 mm, depending upon the slope of the land (Humus depth (mm) $= 60.8 - .946 \times$ slope %). The maximum single measurement was 101 mm. The average depths are less than those reported for several cut stands on comparable well-drained soils on the Bartlett Experimental Forest, New Hampshire *(Hart 1961)*. Apparently, humus in The Bowl study area has reached its maximum depth.

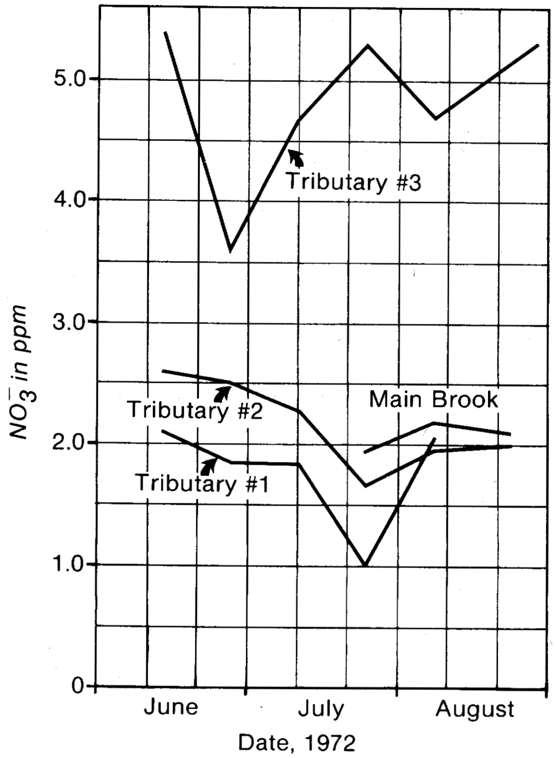
Conclusions

As in most virgin forests, it can be assumed that the standing crop remains about constant—the total biomass produced is offset by the large quantity that dies in the form of dead leaves, twigs, stems, and roots. Because the humus depth apparently is not increasing, I hypothesized that nutrient discharge into the stream must be higher in The Bowl stand than in younger stands that are either increasing in standing crop or humus depth. NO_3^- content in the water samples was high (fig. 3), between 1 and 5 ppm, depending upon sampling date and location.

Uncut controls at Hubbard Brook and elsewhere in the White Mountains usually produce less than 1 ppm of NO_3^- during the summer—often they produce only a trace *(Bormann et al. 1968)*. The highest discharge for an uncut sampling site that I know of is one (Dartmouth Outing Club), reported by Pierce et al. *(1972)*, which produced between 1 and 3 ppm during the summer; we do not know anything about stand and humus conditions on this site.

Preservation of beech-birch-maple stands leads toward a very restricted species composition that could work either for or against the use objective for the stand. It is well known that disturbance of such stands broadens the species composition to include both early- and late-successional species. Contrary to common belief, the humus, which is the major nutrient capital in podzol soils, is no deeper in the virgin beech-birch-maple study area than in disturbed stands. Stability in both humus and biomass may help explain the accelerated nitrate discharge observed in this virgin stand as compared to younger, more vigorous stands. This aspect of nutrient budgeting should be examined in depth by those with the necessary facilities.

Figure 3.—NO_3^- (ppm) in three tributaries and the main stream of The Bowl during the 1972 growing season.



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MANUSCRIPT RECEIVED FOR PUBLICATION 16 NOVEMBER 1973