VEGETATIONAL CHANGES IN A BLACK WILLOW FOREST OVER A 23-YEAR PERIOD

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A second-growth forest on the shore of Lake Texoma was sampled in 1983 to determine changes in vegetation since previous sampling in 1960 and 1964. The tree stratum has followed a normal successional trend from one species in 1964 to 11 species in 1983. Tree basal area and density have decreased since 1960. No successional trend is perceptible in the woody understory and herbaceous strata, both of which may be strongly influenced by year-to-year changes in lake water level.

INTRODUCTION

Penfound (1,2) sampled a black willow forest in 1960 and 1964 on the shore of Lake Texoma in Marshall County. In 1960 the tree canopy consisted entirely of a large number of relatively small black willows (*Salix nigra*: nomenclature follows Waterfall (3)) with a mean diameter of 19 cm. The shrub stratum was fragmentary and the herbaceous stratum was heavy and almost continuous. By 1964 (2) the herbaceous vegetation had been almost completely replaced by small woody vegetation, mostly vines. The site was sampled again in the summer of 1983 to examine the successional changes which have occurred over the 23-year period.

STUDY AREA

The site is located at the middle of the north side of Sec. 7, T8S, R5E, Marshall County, Oklahoma, about 1.6 km west of the University of Oklahoma Biological Station. The area sampled is a second-growth forest of approximately 15 ha which originated about 1945 (1) on the shore of Lake Texoma. The soil is Konawa Fine Sandy Loam (4) on a nearly level area which was formerly a high terrace of the Red River. The site is now in the flood-control pool of Lake Texoma and is sometimes inundated for periods of several days. The area was probably farmland before it was acquired by the federal government in the early 1940's. It is currently being used as an ecological research area.

METHODS

At the center of the site, two transects were laid out 50 m apart in a north-south alignment. Fifteen sampling points were placed along each transect at distances between 20 and 50 m apart, which were obtained from a random numbers table. At each sampling point, trees (defined as woody stems with diameter at 140 cm of 5 cm or larger) were sampled for frequency, density, and basal area with an augmented variable-radius method (5) in which basal area was estimated with a 2-factor metric forester's prism (6) and trees were counted by species in an 18.3-m-diameter circular plot. Woody understory plants having a diameter at 140 cm of less than 5 cm (saplings, tree seedlings, shrubs, and woody vines) were counted by species in a 6.1-m-diameter plot for density and frequency estimates. Percent aerial cover was estimated for herbaceous and small woody plants (by species), litter, and bare ground in a 0.5-m^2 quadrat at each tree point and at an additional 20 randomly distributed points for a total of 50. Numbers of samples were chosen to reduce the standard errors of most variables to less than 20% of the means, based on previous studies.

Field data were used to calculate tree density, tree frequency, tree basal area, frequency, and density of small woody vegetation, relative cover of herbaceous and small woody plant species, litter cover, and bare ground. Importance percentage (the mean of relative density, relative frequency, and relative basal area expressed as a percent) was calculated for each tree species. Shannon-Wiener diversity (7) was calculated from relative density for woody plants.

RESULTS AND DISCUSSION

Table 1 is a comparison of the composition of the tree stratum in 1960 and 1983. In 23 years the stand has gone from a forest composed of only one species (black willow) to one with 11 tree species. Shannon-Wiener diversity of the tree stratum increased from 0 in 1960 to 1.55 in 1983. In 1960 there were

885 trees/ha, with a total basal area of 26.0 m^2/ha (1). There were only 414 trees/ha, with a total basal area of 16.0 m^2/ha in 1983. The decrease in biomass (as indicated by basal area) shown here is not unusual in secondary forest succession (8).

Black willow reproduction in the stand apparently ended sometime before 1960 (1) and the species has been reduced from 885 to 183 trees/ha in the 23-year period. While black willow is still the dominant tree species, it has no seedlings or saplings in the stand and will probably be replaced eventually by other tree species which are already present and reproducing. At the present time, succession seems to be toward a hackberry - persimmon (*Celtis laevigata - Diospyros virginiana*) forest since hackberry and persimmon are second and third in importance in the stand. There are 126 hackberry and 308 persimmon seedlings and saplings/ha and only 67 seedlings and saplings/ha of all other species combined.

Species	Importance percentage	
	1960	1983
Salix nigra	100.0	46.6
Celtis laevigata	0	17.2
Diospyros virginiana	0	15.8
Maclura pomifera	0	6.4
Carya illinoensis	0	3.8
Morus rubra	0	3.7
Gleditsia triacanthos	0	1.8
Ulmus americana	0	1.8
Fraxinus pennsylvanica	0	1.3
Cephalanthus occidentalis	0	0.8
Populus deltoides	0	0.7

TABLE 1. *Changes in tree species importance percentage, 1960-1983. Importance percentage is the mean of relative frequency, relative density, and relative basal area, expressed as a percent.*

It would probably be unwise to attempt to predict the course of tree species succession in the stand beyond the hackberry - persimmon stage for several reasons. It is now recognized that the course of secondary succession is governed by a complex set of conditions, some of which are deterministic and some of which are stochastic (9). Unpredictability for this site is increased by the fact that the flooding regime of a reservoir margin is different from that of a river, with the result that some riparian species may not survive on the site.

There are almost no shrub species on the site and the woody understory is still dominated by vines. The most abundant vines are poison ivy (*Rhus radicans*) with 1690 stems/ha and pepper vine (*Ampelopsis arborea*) with 765 stems/ha. There are small numbers of snailseed (*Cocculus carolinus)*, Virginia creeper (*Parthenocissus quinquefolia*), rattan vine (*Berchemia scandens*), and grape (*Vitis* spp.).

Table 2 is a comparison of relative cover values of herbaceous and small woody plants in 1960, 1964, and 1983. The values given are of relative cover only. Total cover by live understory plants in 1983 was 56%. No total cover values are available for 1960 or 1964. In 1960 the ground cover consisted almost entirely of herbs, while in 1964 it was mostly woody vines (2). In 1983 the herbs were again dominant but some vines were present. The most conspicuous change between 1964 and 1983 was the complete disappearance of blackberry *(Rubus* spp.), which accounted for almost 63% of the small plant cover in 1964. *Teucrium canadense* was the only important non-tree species in 1983 that was not mentioned in 1960 or 1964.

Penfound (2) attributed the disappearance of the herbs between 1960 and 1964 to the desiccation of the soil in the stand caused by low lake levels in 1963 and 1964. The herbaceous species that were important in 1960 and 1983 are more or less hydric, and the stand was inundated for a long period in

Species	Relative cover		
	1960	1964	1983
Polygonum hydropiperoides	6.1	—	28.3
Teucrium canadense	—	—	27.8
Eupatorium serotinum	10.4	tr	10.9
Rhus radicans	—	9.5	8.9
Diodia virginiana	25.3	tr	5.3
Hydrocotyle verticillata	29.4	0	3.2
Ampelopsis arborea	—	8.5	2.0
Panicum hians	8.8	—	0
Rubus spp.	tr	62.9	0
Cephalanthus occidentalis	tr	8.3	tr
Other	20.0	10.6	13.6

TABLE 2. *Changes in relative cover of herbaceous and small woody plants, 1960-1983. A dash means the species was not mentioned and "tr" means the species was present but no quantity was stated. Relative cover for a species is its aerial cover divided by total aerial cover of living plants, expressed as a percent.*

1960 (2) and for several days in May and June of 1983.

No explanation is offered for the disappearance of blackberry, although fire and flood exist as possibilities. The stand has been flooded periodically, and shows evidence of having been burned at least once recently. Reduction in light intensity has probably not occurred, since both density and basal area of trees are lower now than in 1960.

CONCLUSIONS

Since the site was last sampled the tree stratum has followed a normal successional sequence from one species to many species. As might be expected of a site which is periodically flooded, the tree species which have invaded are normally found in bottomland forest. Tree density and basal area have decreased considerably since 1960, apparently because the black willows have died faster than other tree species were able to invade and reproduce. Basal area and density may increase somewhat as the longer-lived tree species become well established. Future tree species succession is not predictable, except that invasion by upland species is unlikely. No successional trend is apparent in the herbaceous and small woody vegetation of the site. It seems likely that, as suggested by Penfound (2), the non-tree vegetation is quite strongly influenced by water levels in Lake Texoma.

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