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Rate of *Myrica pensylvanica* (bayberry) expansion in grassland at Gateway National Recreation Area, New York

Garry F. Rogers, John M. Robertson, William D. Solecki and Mary K. Vint[1]

Department of Geography, Columbia University, New York, NY 10027

ROGERS, G. F., J. M. ROBERTSON, W. D. SOLECKI AND M. K. VINT (Geography Dept., Columbia Univ., New York, NY 10027). Rate of *Myrica pensylvanica* (bayberry) expansion in grassland at Gateway National Recreation Area, New York. Bull. Torrey Bot. Club 212: 74–78.—Using comparisons of aerial photograph and field measurements of 55 clones, we determined the rate of expansion of bayberry in *Andropogon scoparius* grassland in the natural area portion of the Floyd Bennett Field unit of Gateway National Recreation Area. We found that between 1980 and 1984 the average annual rate of bayberry cover increase was 4.08%. We discuss bayberry's role in future vegetation change at Floyd Bennett Field, and point out the possible threat to continued change posed by expansion of fire–prone and fire–tolerant *Phragmites australis*.

Key words: *Andropogon scoparius*; bayberry; Floyd Bennett Field, New York; little bluestem; *Myrica pensylvanica*; rate of shrub expansion in grassland; succession.

In the natural area portion of Floyd Bennett Field, Gateway National Recreation Area, New York, bayberry (*Myrica pensylvanica* Loisel.), a clonal perennial shrub, is expanding into adjacent grasslands dominated by little bluestem (*Andropogon scoparius*). Bayberry invasion of grassland has been reported in other studies (Benson 1978, Blizzard 1931, Morris *et al.* 1974), but the rate of invasion has not been measured. In this study, we measured the rate of expansion of bayberry clones growing in grasslands occurring on the human–built land surfaces of Floyd Bennett Field.

The mechanism whereby bayberry replaces little bluestem appears to be competitive suppression of the grass as shade intensifies and litter accumulates beneath emerging shoots on the periphery of clones (Collins and Quinn 1982). The mostly deciduous habit of bayberry permits easy detection of clone boundaries. A distinct decrease in albedo (fraction of incident sunlight that is reflected) occurs during winter as grass on clone margins is covered by bayberry litter. Aerial photographs taken during the winter, therefore, clearly indicate the boundaries of bayberry clones. In our study we use this difference in albedo to measure the rates of horizontal expansion of individual clones by comparing field measurements of clone sizes with measurements made on aerial photographs taken 4 yr earlier.

Study Area. Floyd Bennett Field is a broad peninsula, about 546 ha in size, located on the west side of Jamaica Bay on the southwest corner of Long Island, New York. An historic airport built on land created between 1900 and 1920 by burying previous wetlands with urban rubble and dredged fill (Englebright 1975, Friedberg *et al.* 1980), Floyd Bennett Field has had only limited military and civilian use since the 1930's. After management by the National Park Service began in 1973, use was further curtailed. Our study area is the portion of the Field that has been designated as a "natural area" by the Park Service (U.S. National Park Service 1983). This area has been left largely undisturbed since its formation except for narrow zones that

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were mown along runways and around a few scattered buildings and munitions bunkers.

Vegetation of the study area has been mapped and described by Grady (1984), Friedberg *et al.* (1980), and Rogers, Solecki and Vint (1984). It consists of four layers, including a sparse moss/lichen carpet, a layer of forbs and grasses reaching about 1.5 m, a shrub layer reaching about 5 m, and a sparse upper layer of young trees (Fig. 1). The vegetation is composed of many species, but is dominated by only a few. Dense, almost pure stands of bayberry and the reed *Phragmites australis* cover about 50% of the area, and grasslands dominated by little bluestem cover about 25%. Vegetation dominated by *Artemisia vulgaris, Rhus copallinum*, Rosaceae shrubs, and mixed species groups account for the remainder of the area. Common tree species include: *Prunus serotina, Ailanthus altissima, Morus* spp., *Elaeagnus* spp., and *Populus grandidentata*. Of these, *P. serotina*, often found growing on the margins or interiors of bayberry clones (Fig. 1), is the most abundant.

Methods. To obtain the rate of grassland replacement by bayberry we selected clones for measurement that were surrounded by grassland, and rejected those that were bounded by airport runways and other potential barriers. We also rejected clones with irregular shapes, clones damaged by fire, and clones smaller than about 4 m on either axis, as the latter could not be measured accurately on the aerial photographs. None of the clones we studied appeared to be experiencing stem mortality in their centers, and except for occasional tree saplings or *Phragmites* shoots, none were being invaded by other species. The 55 clones we selected which met these criteria include approximately 40% of all such clones in the study area. The position of each of the measured clones is recorded on aerial photographs on file at Gateway National Recreation Area, Floyd Bennett Field, Brooklyn, New York 11234.

We measured the major and minor axis of each clone using the outer margin of the litter layer to define clone boundaries, and we calculated clone area using the standard formula for the area of an ellipse.

Fig. 1. The foreground of this scene is dominated by little bluestem, the midground by bayberry, and the tallest plant, upper center of the scene, is a *Prunus serotina* sapling growing in a bayberry clone. The bayberry clone shown here was not included in our sample (Rogers negative 125/14, 14 May 1984).

The clones in our sample were relatively symmetrical and elliptical, and we feel that the ellipse formula accounts for most of the variation in area due to boundary irregularities. Standard photogrammetric techniques (Paine 1981) were used to measure the clone axes on large scale (1:2400) enlargements of aerial photographs (see Rogers and Brest 1983) taken 19 March 1980, and field measurements of the same dimensions were made on 24 March 1984. Change in area was measured by subtracting the 1980 area from the 1984 area. Change in area was then divided by 1980 area to obtain the total rate of change, and the annual rate of change from 1980 to 1984 was calculated using the formula for compound interest.

To determine how representative the 1980–1984 rate of change was, we compared it to the rate of change between 1970 and 1980. Using the compound interest formula, we calculated the total area of bayberry in 1970 by applying the 1980–1984 rate to the total area of bayberry on the 1980 aerial photograph, and we compared the result to the actual bayberry area measured on a 28 May 1970 aerial photograph. We used total bayberry area rather than individual clone area for this test because most of the clones in our sample were too small in 1970 to be accurately measured. In calculating total area of bayberry in 1970 and 1980 we found that in several places on the aerial photographs transitions between bayberry and other vegetation were not clear, and boundaries had to be estimated. This problem was more serious on the 1970 photograph, apparently because leaf emergence in other de-

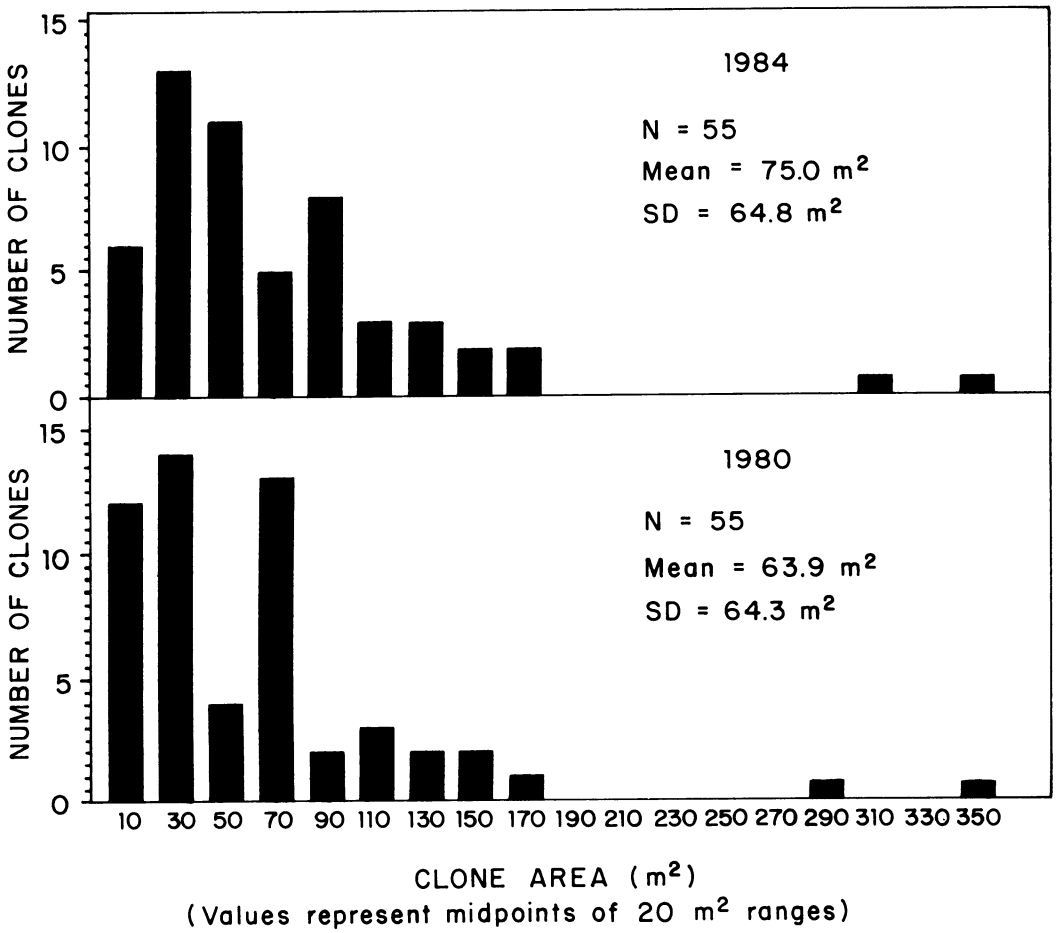

Fig. 2. Areas (m^2) of bayberry clones included in the study.

ciduous species obscured bayberry boundaries.

Results and Discussion. The areas of the clones we measured were logarithmically distributed (Fig. 2), and appeared to represent the middle of the distribution of areas of all clones and patches of bayberry in the study area. We believe that a reduction occurs in the expansion rate as clones increase in area, because we found that percent increase in area was negatively related to logarithms of 1980 area (simple correlation = −.75).

We found that mean percent increase in clone size was 40% (SE = 7%), and total increase in area of the sample was 610 m^2. The sample included about 1% (3516 m^2) of the total 1980 area of bayberry. Thus, from 1980 to 1984 the total area of the sample increased 17%, or about 4.08% per year. When we used this rate to calculate 1970 total area and compared the result with total area on the 1970 photograph, we found that expansion between 1980 and 1984 was slower than from 1970 to 1980. The calculated 1970 area, 19 ha, is 36% greater than the actual area, 14 ha, estimated from the 1970 photographs. We believe that the difference is due to contact with barriers, replacement of bayberry by reeds, and slower growth rate of large clones included in the total area estimates.

Bayberry may play a central role in the development of vegetation at Floyd Bennett Field. It is one of only a few species that invades little bluestem grassland (Blizzard 1931), and because it improves soil moisture conditions (Blizzard 1931, Morris *et al.* 1974) and increases nitrogen availability (Collins and Quinn 1982), it may facilitate (see Connell and Slatyer 1977) the invasion of forest species. The seral replacement of bayberry by *Prunus serotina* described by Blizzard (1931) is occurring at Floyd Bennett Field (Fig. 1), and one small island (about 1000 m^2) of *P. serotina* with closed canopy is present (Rogers, Solecki, and Vint 1984). Considering that the site is less than 80 yr old, it appears that vegetation change may be occurring more rapidly than in similar circumstances elsewhere (Blizzard 1931, Stalter 1981). Although future change may be slowed because of the stability of little bluestem and bayberry (cf, Niering and Goodwin 1974; Stalter 1981), inhibition as defined by Connell and Slatyer (1977) does not appear to be occurring at Floyd Bennett Field.

The continuation of vegetation changes leading to forest in the study area may be prevented at some sites by the invasion of the fire–tolerant and fire–prone species *Phragmites australis*. Changes wrought by invasion of fire–prone species can be relatively permanent (e.g., Rogers 1982; Zedler, Gautier, and McMaster 1983). Portions of the extensive stands of *Phragmites* at Floyd Bennett Field are burned yearly by accidental human–caused fires. The growth of *Phragmites* during the first year following fire equals or exceeds the growth of unburned plants (Hartig 1984, Haslam 1971, Van der Toorn and Mook 1982). The burned bayberry clones we observed, however, were only partially recovered one year after burning. Because of this apparent differential tolerance of fire, we hypothesize that *Phragmites* will replace bayberry if fire occurs in those portions of the Floyd Bennett Field natural area where the two species grow together.

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