Vegetation Dynamics

Sammy L. King, Marianne K. Burke, Terry J. Antrobus, and Sarah Billups[1]

A disturbance can be defined as "any relatively discrete event in time that disrupts ecosystem, community, or population structure and changes resources, substrate availability, or the physical environment" (Pickett and White 1985). Vegetation dynamics are a function of the temporal and spatial patterns of the disturbance regime. Natural disturbance regimes support the highest biological diversity; therefore, forest management practices that most closely mimic natural disturbances are expected to sustain the highest biological diversity within a given area (Denslow 1980). In southern forested wetlands, flooding is the dominant disturbance factor, thus plant species are usually distributed along a growing-season flood gradient (Franz and Bazzaz 1977).

Flooding is not, however, the sole factor affecting vegetation dynamics within these systems. Light availability can constrain regeneration of wetland plants (Brinson 1990). In general, plant species can be divided into light generalists, low-light specialists, and high-light specialists based upon their habitat requirements (Menges and Waller 1983). As a result, the frequency, size, and distribution of canopy disturbances can alter forest structure and composition because they affect the amount and quality of light available to plants (Streng and others 1989). Understanding the relationship between light availability and forest structure and composition is important to restoring and managing wetland ecosystems because forest structure and composition are correlated with wetland functions such as wildlife habitat and water quality (Dickson and Noble 1978). To date, no studies have been conducted on canopy disturbance patterns and their influence on plant regeneration in southern bottomland hardwood ecosystems.

Photo by Marianne Burke

Canopy gaps can influence ground vegetation through changes in light regime.

This study had two objectives: (1) to characterize and compare annual canopy disturbance rates in bottomland hardwood ecosystems in the Coosawhatchie River and Cache River floodplain forests, and (2) to determine the influence of canopy gaps and associated changes in light level on ground vegetation at the Coosawhatchie Site.

To determine annual canopy disturbance rates, we conducted complete censuses of a 119-ha section of the Coosawhatchie study area during May 1996 and May 1997. These results were compared with censuses of a 103-ha section of the Cache River study site completed during June 1995 and October 1996. All canopy gaps formed during the previous year were identified based upon the presence of leaves, the amount of soil on the roots, and other diagnostic characteristics.

A pole was placed in the center of each restricted gap, i.e., the actual area of the opening in the canopy projected onto the ground surface (Runckle 1981). The d.b.h. and species of trees forming the boundary of the expanded gap were determined, i.e., the area defined by the boles of the trees whose canopy defines the actual canopy opening (Runckle 1981). To determine the area and configuration of the restricted and expanded gaps, the distance and azimuth from the plot center pole to the edge of the restricted gap ($\geq$ 6 azimuths [0, 60, 120, 180, 240, 300]) and to the boundary trees were recorded and the gap area was calculated.

At the Coosawhatchie site, ground vegetation was inventoried in two habitats: nongap habitat in permanent ground vegetation plots described in Burke and others (2000a) and in gap habitat in plots established at gap centers during the summer of 1997 (fig. 2.5). In each plot the density and percent cover of each species of tree seedling, grass, and forb were determined, and species richness and the Shannon-Weiner diversity index were calculated. In addition, elevation was determined and light regimes, expressed as percent of incident light, were characterized. Relative density and cover were analyzed for each individual species and for groups of tree seedlings, grasses, and forbs. The effect of light and elevation served as covariates, while

[1] Ecologist, U.S. Geological Survey, Biological Resources Division, National Wetlands Research Center, Lafayette, LA; Research Ecologist, USDA Forest Service, Southern Research Station, Center for Forested Wetland Research, Charleston, SC; Biologist, U.S. Geological Survey, Biological Resources Division, National Wetlands Research Center, Lafayette, LA; and Graduate Student Intern, Biology Department, University of Charleston, Charleston, SC, respectively.

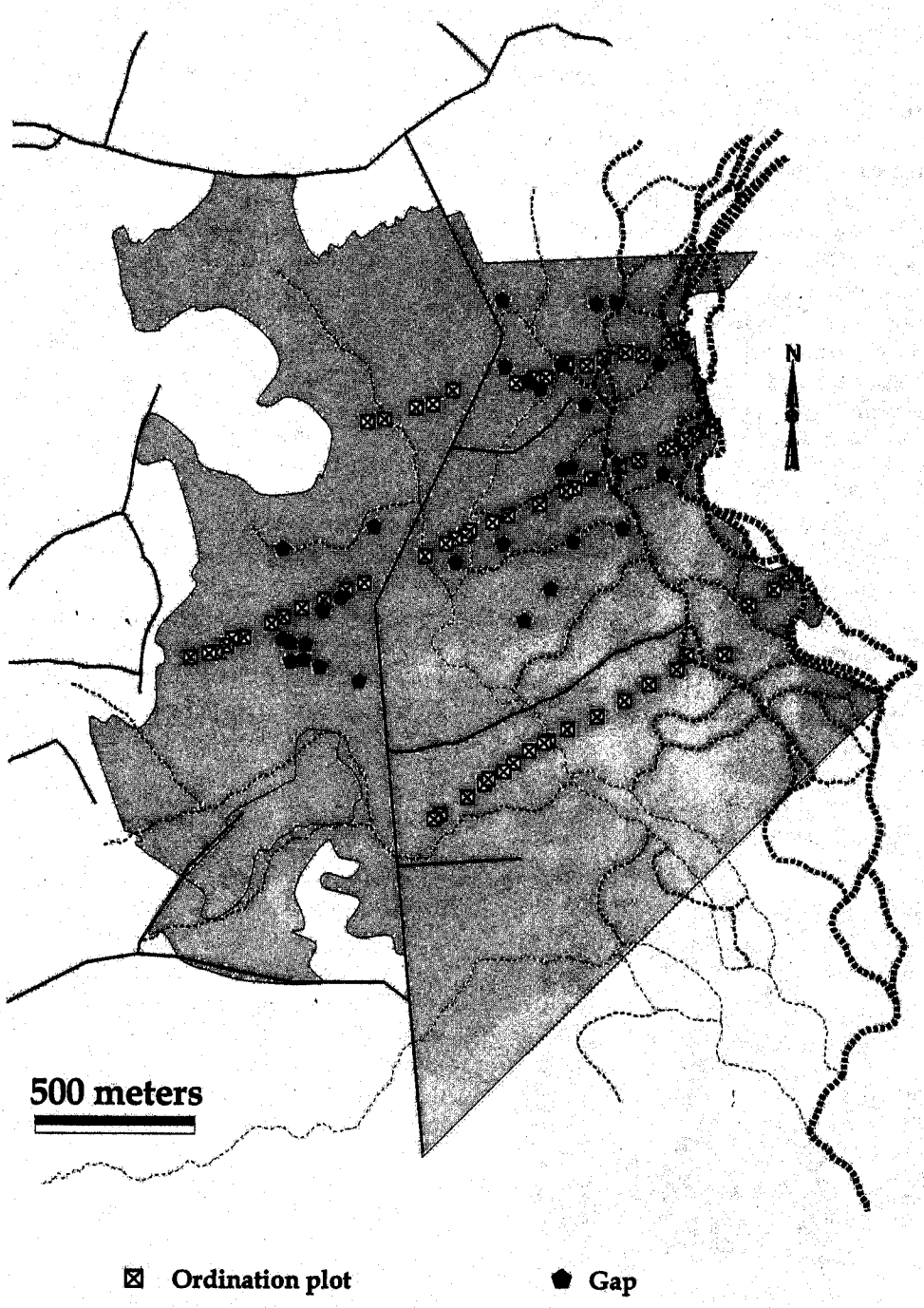

Figure 2.5—Locations of ordination plots and canopy gaps from the first census of the Coosawhatchie Bottomland Ecosystem Study site.

species richness, Shannon-Weiner diversity, and relative density and cover of trees, forbs, and grasses served as response variables.

A total of eight newly formed gaps were located on the Coosawhatchie site in May 1996. The mean gap size was 216.1 m^2 with a median gap size of 187.8 m^2; 0.02 percent of the total study site area was located within newly formed canopy gaps. The results from the Coosawhatchie site differed markedly from previous studies and from the Cache River study. At the Cache site, 47 newly formed canopy gaps were located in 1995 and 43 in 1996, and the mean size of the gaps was 366.4 m^2 and 234.3 m^2, respectively. The total area within newly formed gaps at the Cache site encompassed 1.3 percent of the study area. Previous studies estimated the gap formation rate at 0.5 to 1.3 percent of the area (Quinghong and Hytteborn 1991, Runckle 1985, Van der Meer and Bongers 1996).

Although these canopy gap dynamics results are preliminary, the data suggest that the Cache River site approximates the standard for percentage of forest canopy consisting of newly formed canopy gaps (1 to 3 percent: Pickett and White 1985). The much lower rate of disturbance at the Coosawhatchie site may be related to stand structure, age, soils, flooding, or a temporal anomaly. The Coosawhatchie site was logged as recently as 1950, and the site is affected by hurricanes more often than the Cache River site—the eye of Hurricane Gracie passed within 20 miles of the site in 1961.

The analysis of ground vegetation indicated an effect of gaps: tree seedlings were relatively more important in the nongap habitat, and grass was more important in the gap habitat ($p < 0.05$); but there was an elevation x habitat interaction for relative cover of tree seedlings ($p = 0.08$) and relative cover of grass ($p = 0.04$). There was also an elevation x habitat interaction for species richness (0.06), with more species occurring higher in the elevational gradient ($p = 0.02$) and in the nongap habitat ($p = 0.05$). Surprisingly, the light environment did not differ significantly between habitats; hence, light did not significantly affect any response variable. These findings suggest that the gaps were small enough to prevent significant changes in light regime, and that something besides elevation or light level is influencing the ground vegetation composition on the Coosawhatchie Bottomland Ecosystem Study site. Although the rate of canopy disturbance is low at the Coosawhatchie site, and gap formation may only subtly change the light regime at the forest floor, ground vegetation appears to respond to gap formation with lower relative cover of tree seedlings, greater relative cover of grasses, and lower species richness.