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Island biogeography in Southeastern Wisconsin: a progress report.

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ISLAND BIOGEOGRAPHY IN SOUTHEASTERN WISCONSIN

A progress report

Ecosystems develop as a result of interactions between the biotic and abiotic components in the environment. Natural systems are diverse and stable when interactions between the community and the supersystem are in balance. Change or perturbation in the supersystem will effect a commensurate change in the natural subsystems. Urbanization results in the remaining natural systems becoming isolated within the urban system—a supersystem quite unlike that which gave rise to the natural system. As a result, the natural subsystem must change in the way in which it interacts with its new supersystem to reach equilibrium. A mechanism for such change in natural systems is succession. Successional patterns as a result of urban influences may be quite different than those expected under natural conditions.

In order to evaluate these successional patterns, it is necessary to first assess the forest biotic communities when they are embedded and isolated from each other in a non-forest matrix. Crowell (1975) and others, point out that any discontinuous habitat becomes an island. In this context, isolated forested woodlots, embedded in the "agro-urban" matrix, are islands. This study attempts to explain how these forest islands function as a regional forest ecosystem. It will also examine the effects of urbanization on these wildland island communities. Principles useful in management, planning, and maintenance of forest ecosystems in metropolitan areas should emerge. The immediate importance of this basic information is clear, as Kolata (1974) stated, ". . . the realization that national parks can be treated as islands has enabled researchers to predict the rate that species in national parks will become extinct, to predict the number of species that will eventually survive, to describe the type of species most likely to survive, and to specify park designs that will minimize extinctions."

While Diamond (1973), Kolata (1974) and Crowell (1975) refer to terrestrial islands in terms of large national parklands, our study and others (Foreman, 1975; Tramer and Suhrweir, 1975) applies the same basic concepts to much smaller county parks and rural woodlots. The island hypotheses were first proposed by MacArthur and Wilson (1967) in a book on theories of island biogeography. Their studies suggest that: 1. The species diversity of a given island is usually directly related to the area of the island. In addition, area is correlated with environmental diversity which exerts a more direct effect on species numbers. A corollary is the notion that there is a limit to the number of species which now persist on a given island. 2. Island species diversity decreases with distance from the colonizing source. Thus, the number of species should increase with area more rapidly on distant islands, and should decrease more rapidly with distance on small islands. Other basic, but no less important concepts include: 3. When species immigration and extinction rates are equal, a biotic equilibrium is reached. 4. Dispersal along island chains shows a loss in both species diversity and higher taxa. However, relative diversity may increase in the species that succeed in dispersal as a result of competitive replacement in the restrictive island habitats. 5. Islands can significantly contribute to biotic exchange–if they are capable of supporting a population of the species in the first place. Although not yet demonstrated empirically, a final concept is suggested: 6. A "stepping stone" between two source regions, will increase the biotic exchange between them: but the original ratio of exchange should remain unaltered. If a second "stepping stone" appears after the first has been colonized, the source region closest to the two islands will be favored in exchange.

Kolata (1974) further acknowledges MacArthur and Wilson's (1967) theory that when new islands are formed, or isolated, the number of species on that island should decrease approximately at an exponential rate until a new equilibrium is obtained. At what rate has the Metropolitan Milwaukee regional ecosystem lost species?

The University of Wisconsin–Milwaukee, in cooperation with the Oak Ridge National Laboratory, Rutgers University and the University of Wisconsin–Madison are exploring the role of natural island communities in urban and urban-rural matrices.

Specific objectives of our study are: 1. To determine the significant effects of the regional pattern of forest and non-forest land use upon local forest ecosystems (the forest islands). 2. To evaluate the role of local forest ecosystem units in the functioning of the regional ecosystem. 3. To provide insights useful for regional landscape planning and resource management.

Oak Ridge National Laboratory will develop computer models of seed dispersal. A forest island computer simulation has been developed at The University of Wisconsin–Madison and the comprehensive Wisconsin and New Jersey test (control) areas will be monitored.

Forest islands are being studied in southeastern Wisconsin and in New Jersey where work began in 1973.

Our intensive field studies as well as data from older UWM studies on distribution and composition of plant communities and of birds and mammals will provide the basic information. Species diversity and changes in species composition are being studied in producers (trees, shrubs and herbs), consumers (birds and small mammals), and some decomposers (fungi).

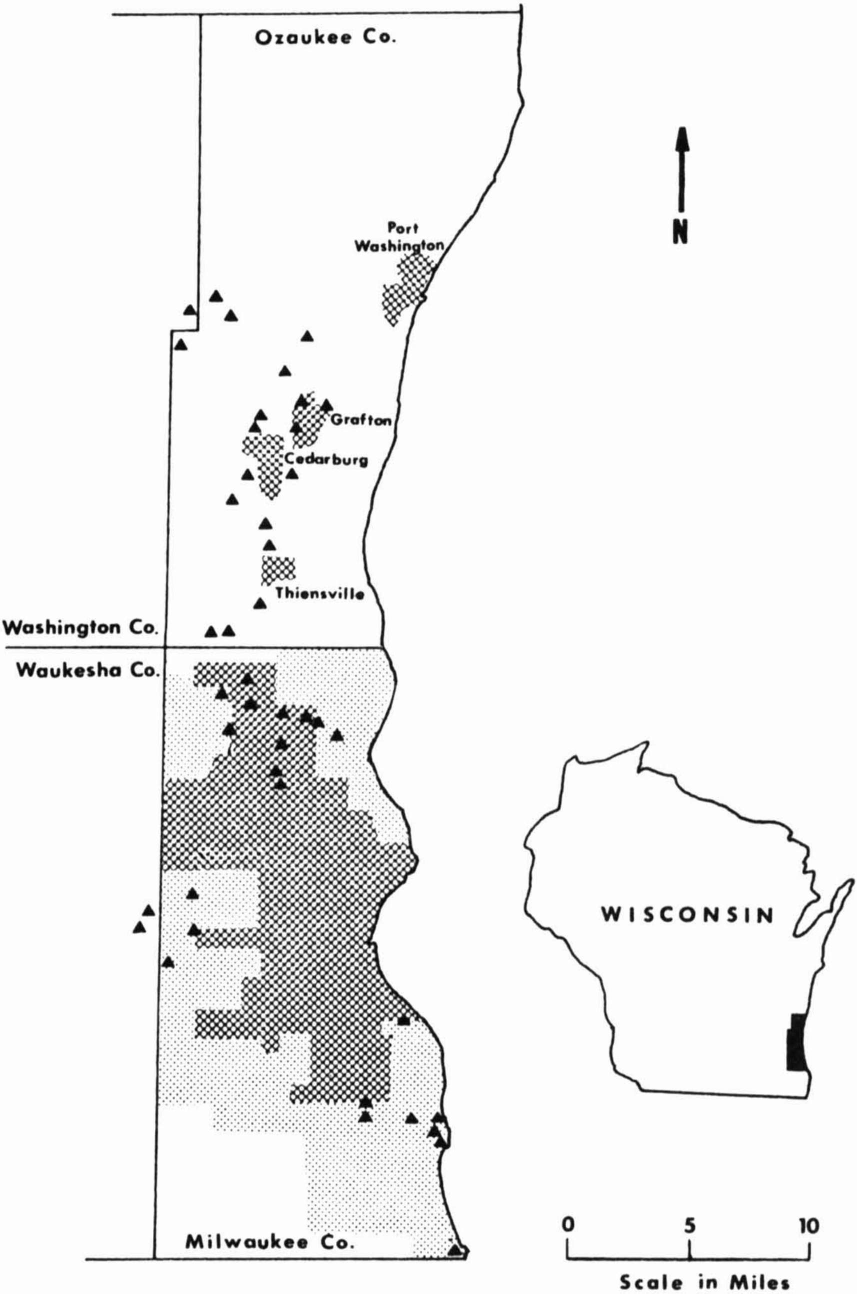

Fig. 1. Map of the study area indicating the location of the 43 forested island woodlots in the metropolitan Milwaukee area.

STUDY AREA

Lying within the Milwaukee Metropolitan region of southeastern Wisconsin, the study area includes all of Milwaukee County, the southern half of Ozaukee County and extreme eastern Waukesha and Washington Counties, approximately 325 mi^2 (Fig. 1).

This region appeared especially suitable for the study since topography, soils and climate are relatively uniform; and forests include many widely dispersed woodlots within an urban and agricultural matrix. In addition, the area is compatible with the urban ecological research mission of the University.

The vegetation unit selected for study was the southern-mesic and the southern dry-mesic forest types described by Curtis (1959). These types have several advantages: 1) they represent the dominant upland vegetation type for the region today, as well as in pre-settlement times, and they are regional successional end-points 2) their baseline and modal characteristics have been described (Curtis, 1959), 3) they provide a 20-year follow-up of Whitford and Salamun's (1954) regional study and 4) they have a specific faunal aggregation that is characteristic.

Climatic conditions conducive to the maintenance of upland southern-mesic forests were important in the physical location of the sites. North-south climatic bands parallel Lake Michigan in Ozaukee and Milwaukee Counties. Similarly, the topography has a general north-south orientation. Environmental trends coupled with the need to test effects of urbanization on the biota of forested island communities suggested use of urban to rural transects. Two specific north-south climatic-topographic corridors were established. A south transect lies between St. Francis, at the north, to Oak Creek, at the south within 1½ miles of Lake Michigan. The north transect lies between McGovern Park, in the City of Milwaukee, and the UW–Milwaukee Field Station in the town of Saukville, Ozaukee County. It is generally bounded on the east by the Milwaukee River and the west by the western Ozaukee Co. line. The transects traverse urban, suburban and rural areas to permit appropriate comparisons. The urban matrix includes built up residential areas, and parks as well as industrial sections. The major urban portion of the transects cross areas of single and multi-family dwellings with yards and street trees.

METHODS

Islands chosen included a variety of sizes and shapes. To date, 43 islands, ranging in size from 0.08 to 20 ha, have been sampled. Replicates of different sized islands were examined within each zone along the gradient from city to country.

Selection was based on several criteria: 1) The island must be isolated from other islands with no direct connections by fencerows, streamways, or other corridors. Each island is, thus surrounded by a matrix of urban or agricultural land. 2) The island must support southern-mesic forest and repesent a remnant of original upland vegetation. Virtually all stands remaining in the region display some disturbance. To be sure the southern mesic forest was indicated, only stands which contained sugar maple, whether in mixture with beech, oak or other species, were chosen. 3) The island must have existed as a discrete unit long enough to have developed a mature forest edge. 4) The forest island must have a well-developed shrub and ground layers.

The vegetation of each island was sampled using the stratified-random line-strip method (modified from Lindsey, 1955). Sampling began May 29 and 43 stands were completed by October 13. Ground, shrub, understory and canopy layers were sampled simultaneously using a series of nested plots (Fig. 2).

Mammals were censused using live traps, supplemented by visual sighting of tracks, scats, burrows and other indicators of presence. Each site was sampled for four days and nights along two transects running across the long and short axis of the woodlot. A variety of trap sizes was used to sample mammals present.

Bird populations were sampled using visual and auditory contacts along transect lines 30 meters apart (Emlen, 1971).

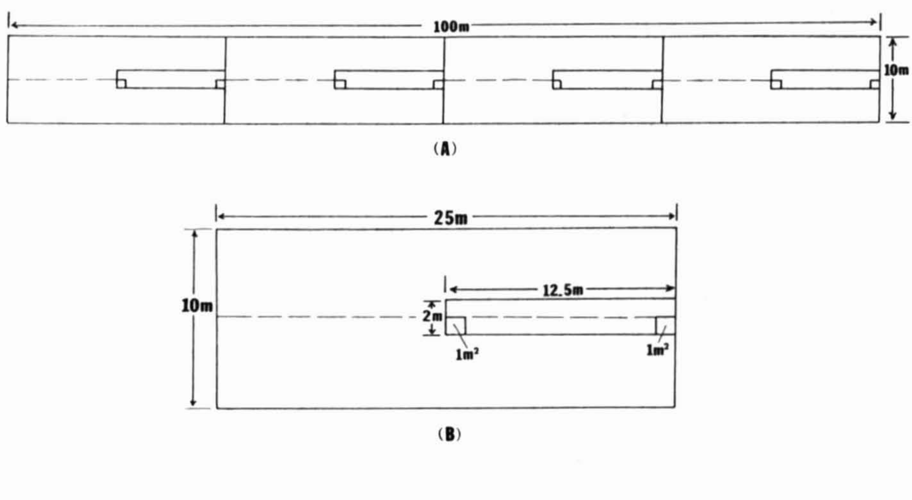

Fig. 2. (A) Diagram of a line-strip, four plots in length, showing the arrangements of the nested plots. (B) Trees were sampled in the 10 x 25 m plots, shrubs in the 2 x 12.5 m plots and ground layer vegetation in the $1m^2$ plots.

DISCUSSION

Field work is still in progress and much of the data have yet to be analyzed in detail. A discussion of the results is being limited to "trends" which appear to be developing as work progresses.

1. Diversity in vegetation appears to increase with urbanization.
2. Similarly, a trend has developed for greater mammalian diversity within urban islands and large, distant rural islands, with lower density in the urban/rural ecotonal islands.
3. A relationship appears to be developing, at the urban-rural interface, between size of the island, species composition, and possibly abundance. However, the generally smaller urban islands tend to show a maximization of habitat use by small mammals.
4. There seems to be a direct relationship between the absence of certain tree species, specifically red oak and shagbark hickory, and the absence or low relative abundance of squirrels.
5. Bird diversity appears to increase with an increase in forest island size.
6. In general, an increase in human usage is associated with increased bird diversity.
7. Chokecherry *(Prunus virginiana)* is the dominant species of the shrub layer. Along the urban to rural gradient, the contribution of chokecherry generally decreases.
8. Red elm and American elm appear to have increased survivorship in the rural areas in contrast to the city.
9. American ash seems to have equal success reproducing in urban and rural sites. However, sugar maple appears to be less successful in urban sites. This may suggest the replacement of sugar maple by American ash in the urban sites over time.
10. The European immigrant orchid, helleborine *(Epipactis latifolia)* appears to have become a successful component of the southern mesic forest.

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