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A MANAGEMENT PLAN FOR A SWAMP FOREST BASED ON VEGETATION ANALYSIS

INTRODUCTION

Many natural areas in Wisconsin have been preserved by the state legislature, acting through the Scientific Areas Preservation Council, and by public and private organizations such as the Nature Conservancy. The Field Station's beech-maple woods and Cedarburg Bog are good examples. Once a natural area has been preserved, decisions must be made about how to maintain or manage it. Management is defined as any activity directed toward maintaining a given condition in plant and/or animal populations and/or habitats in accordance with the conservation plan for an area (Leopold, et. al., 1963). Since many biological communities are constantly changing due to the processes of ecological succession, the desirable features for which natural areas have been preserved may disappear, unless some form of active management is utilized. During 1975 and 1976, I made a thorough study of a tamarack-swamp hardwood forest at the Riveredge Nature Center and proposed a management plan based on that study (Swartz, 1977).

DESCRIPTION OF STUDY AREA

The Riveredge Nature Center is located in Ozaukee County, northeast of Newburg and eight miles east of West Bend. The Center, over 250 acres, was founded in 1968 and is both a natural sanctuary and a non-profit organization dedicated to helping everyone understand and appreciate his environment. One of the goals of Riveredge is to provide an optimum number of different plant and animal communities for educational and scientific purposes. A management plan for any part of the sanctuary should emphasize the maintenance of these communities.

The study site was a tamarack-swamp hardwood forest located in the "wilderness" area of the Center. The soils of the study area belong to the Houghton-Adrian Association, poorly drained organic soils with a high permanent water table (USDA, 1970). Aerial photos taken in 1937, 1941, 1957 and 1971 indicated that part of the forest had been cleared at one time, but now the entire area appears heavily wooded.

METHODS

Nested quadrats, located randomly in the specified area, were used to sample the three major vegetation strata. The quadrat size for the tree stratum, consisting of woody stems over 1 in (2.5cm) dbh, was 15m x 6.66m. The shrub and seedling stratum consisted of woody plants under 1 in dbh and the quadrat size was 4m x 1m. A quadrat size of 2m x 0.5m was used to sample the groundlayer stratum. Each species of non-woody plant was identified, listed and the number of stems was recorded. The same procedure was followed for the shrub, seedling and tree strata. The diameter at breast height (4.5 ft.) was recorded for all trees. The quadrat data were analyzed for relationships of groups by a similarity index procedure, as described by Mueller-Dombois and Ellenberg (1974).

Sampling data for tree species are summarized in Tables 1 and 2, where density refers to numbers of individuals of each species in the sample, frequency refers to the number of quadrats in which each species occurs, and dominance is measured as the total basal area (cross sectional area of the trunk at breast height, approximately 1.5m above the ground) of each species. These values are summed and expressed as relative density, relative frequency, and relative dominance, which give these parameters for each species as a percentage of the total for all species. Where relative density greatly exceeds relative dominance the species is present mostly as small trees but relatively numerous, while higher relative dominance values indicate fewer but larger trees of that species, e.g., *Acer* spp. versus *Larix*. Importance value is the sum of relative values for density, frequency, and dominance divided by three to give a relative importance of each species in the forest based on all three parameters. Dominance and importance values were not calculated for seedlings (Table 2), since they were not measured for size of individuals.

RESULTS AND DISCUSSION

Vegetation composition

The species composition of this swamp forest is an indication of the varied past history of the stand. Two of the most important tree species (Table 1), tamarack *(Larix laricina)* and white cedar *(Thuja occidentalis)*, are coniferous species that are characteristic of northern lowland forest in Wisconsin (Curtis, 1959). Paper birch *(Betula paprifera)*, which has the highest importance value in this stand, is often found in the first stage of secondary succession in the northern forests. The three other major tree species, American elm *(Ulmus americana)*, red maple *(Acer rubrum)* and black ash *(Fraxinus nigra)* are often

found together in the northern wet-mesic forest. Christensen (1959) divided the northern lowland forest into three groups, tamarack-spruce bogs, cedar and black ash swamps and hardwood swamps. This stand shows an affinity to the second group, with the broadleaf species beginning to invade as the swamp succession proceeds.

The progression that is occuring is evident when the data from the seedling stratum are analyzed (Table 2). Only three tree species of major importance in the tree stratum occur in the seedling stratum. Those species, red maple, black ash and American elm, are more intermediate successional species than tamarack or paper birch and can become established in the understory. Basswood *(Tilia americana)* and sugar maple *(Acer saccharum)* make up much of the seedling layer, an indication that portions of the stand are becoming more mesic.

The shrub component indicates a relationship to both shrub carr and alder thicket. Species characteristic of shrub carr, such as red osier dogwood *(Cornus stonlonifera)*, common elderberry *(Sambucus canadensis)*, red raspberry *(Rubus strigosus)* and nannyberry *(Viburnum lentago)* were abundant and alder *(Alnus rugosa)* was concentrated along the stream (Figure 1). The presence of both shrub carr and alder thicket species suggests that at one time the tamarack swamps must have been larger. Both these communities invade tamarack swamps that have been disturbed by logging, burning or cutting and annual mowing (Curtis, 1959). Other shrub species found helped relate the stand to the northern wet-mesic forest. These included dwarf blackberry *(Rubus pubescens)*, which was the most frequent and most dense of all woody ground-layer plants, winterberry *(Ilex verticillata)* and smooth gooseberry *(Ribes hirtellum)*.

Many of the plants in the herbaceous layer are species of wet communities. Some show an affinity with the shrub carr–alder thicket stage of succession, such as late goldenrod *(Solidago gigantea)* and rough bedstraw *Galium asprellum)*. Other species such as Jack-in-the-Pulpit *(Arisaema triphyllum)*, marsh blue violet *(Viola cucullata)* and skullcap *(Scutellaria lateriflora)* are related to southern wet-mesic and wet forests. Finally, many species are those that are found in the northern forests. These include Canada mayflower *(Maianthemum canadense)*, goldthread *(Coptis trifolia)*, naked miterwort *(Mitella nuda)*, water avens *(Geum rivale)*, blue-bead lily *(Clintonia borealis)* and starflower *Trientalis borealis)*. The occurence of these groundlayer species in association with the dominant tree species leads to the conclusion that part of the stand is a relict community.

Similarity Index Analysis

Six similarity groups were determined by the procedure of Mueller-Dombois and Ellenberg (1974). Groups 5 and 6 were combined for purposes of description because differences were slight. Each group was characterized by the common species of trees or shrubs. Figure 1 is a composite map showing the location of each group.

Group 1 Shrub Carr

This area is similar to a shrub carr, but elements of the southern wet-mesic forest are invading. This habitat is very important to the hydrology of the entire sanctuary, since it acts as a huge sponge. The structural diversity, including tall herbs, shrubs and low trees, provides a variety of nesting sites. This community

TABLE 2: Summary of Seedling Data

Species	Frequency	Density (stems/acre)	Relative Frequency	Relative Density
	%	%	%	%
Acer rubrum	33.33	796.30	17.65	19.32
Acer saccharum	16.67	462.96	8.83	11.23
Betula papyrifera	3.70	111.11	1.96	2.70
Carpinus caroliniana	7.41	259.26	3.92	6.29
Fagus grandiflora	3.70	37.04	1.96	0.90
Fraxinus nigra	29.63	511.11	15.69	12.40
Fraxinus pennsylvanica	12.96	425.92	6.86	10.33
Ostrya virginiana	12.96	129.63	6.86	3.14
Populus tremuloides	3.70	203.70	1.96	4.94
Prunus serotina	5.56	74.07	2.94	1.80
Quercus bicolor	7.41	93.59	3.92	2.25
Salix spp.	3.70	203.70	1.96	4.94
Thuja occidentalis	7.41	166.67	3.92	4.04
Tilia americana	18.52	296.30	9.80	7.19
Ulmus americana	22.22	796.30	11.76	8.54
TOTALS:		4122.21	99.99	100.01

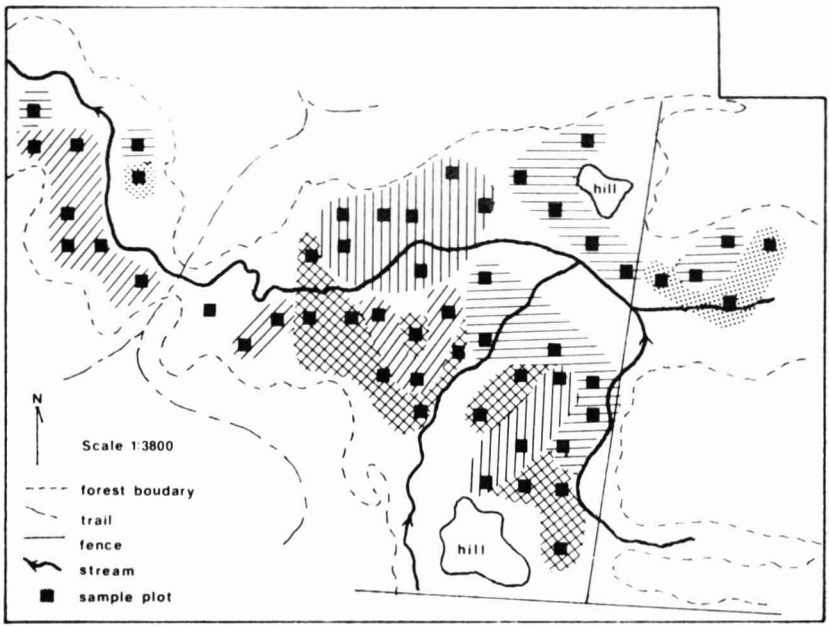

Fig. 1. Composite Map of Community Types and Management Proposals

Community Type		Management Proposed
Shrub Carr		Maintain shrub carr; retard swamp forest invasion
Alder Thicket--Black Ash Forest		Community restoration Experimental tamarack regeneration
Cedar Swamp--Black Ash Forest		Community restoration
Birch–Tamarack Forest		Maintain tamarack forest by removal of vegetation Allow succession to proceed
Northern Wet-Mesic Forest		Community restoration

type is particularly valuable since past draining and ditching have reduced the area to a minimum among preserved places.

Group 2 Alder Thicket–Black Ash Forest

This area resembles stream-edge alder thickets and a dense, even aged black ash forest. Forty years ago, this area was not heavily wooded and it seems likely that alder thickets grew up after initial disturbances and were later invaded by black ash. The remnant of the alder thicket gives special value to this area because it is relatively rare south of the tension zone. The dense underbrush of this area provides good winter roosting and cover and the many berry bearing shrubs provide a winter food source for wildlife.

Group 3 Cedar Swamp–Black Ash Forest

White cedar is the most conspicuous species in this section. When the affinity with ground layer species such as dwarf blackberry and Canada mayflower is considered, this community represents a late successional stage in the evolution of northern lowland forests, comparing favorably with the stands in the 800-1700 ordination segment described by Christensen (1959). The area has high winter wildlife value and could become a potential winter "yard" for white-tailed deer *(Odocoileus virginianus)*.

Group 4 Birch–Tamarack Forest

This area is characterized by a high density of tamaracks. Ages of some of the tamaracks, measured from core samples, ranged from 26 to 70 years. Several small tamaracks, 1-2 inches dbh were counted, but no tamarack seedlings were observed. Apparently, some tamaracks remained after the initial disturbance. These residual trees reproduced and grew successfully, but as conditions became less favorable, tamarack reproduction ceased. Paper birch is abundant, most likely regenerating as sprouts after the disturbance.

Group 5 Northern Wet-Mesic Forest

This portion of the stand had the aspect of a more mature forest, with few saplings and a sparse shrub layer. The largest paper birches were found here and yellow birch *(Betula lutea)* sampled in this area. In the herbaceous layer, goldthread, starflower and blue-bead lily were found only here. The composition resembles that of the 1800-2300 segment of Christensen's ordination (Christensen, 1959), representing a later stage in the conifer swamp succession.

MANAGEMENT PLAN

The management plan that I proposed was directed toward one of the goals of the Riveredge Nature Center: to maintain the greatest possible number of different plant and animal communities within a small area. Different management techniques are suggested for each of the five community groups that I defined. Restoration of the biotic community seems particularly appropriate for some of these areas. Zimmerman (1974) suggests that restoration has two elements: 1) introduction of currently missing species, those poorly or slowly dispersed; and 2) selection or creation of self-maintaining local conditions which

favor the survival and propagation of appropriate plants and animals. The composite map of Figure 1 also shows management techniques suggested for each group.

Management of Shrub Carr

Preservation of the shrub carr community as a transition between sedge meadow and swamp forest is the objective here. The invasion of swamp forest species, such as green ash *(Fraxinus pennsylvanica)* and willows *(Salix spp.)* should be controlled either by cutting or burning. Burning should be done in small sections so as to retain winter cover for birds and mammals and survival of necessary invertebrates.

Management of Alder Thicket–Black Ash Forest

Here, retention of the alder thicket aspect is a primary management objective. Removal of some of the black ash will be necessary, but many of the ground layer species important in the alder thicket like wild mint *(Mentha arvense)* and turtlehead *(Chelone glabra)* are already present and ground layer restoration does not appear necessary.

Parts of this area could be managed for experimental community restoration, such as tamarack regeneration and fen restoration. This type of management would involve clearing of shrubs and control of light and water levels.

Management of Cedar Swamp–Black Ash Forest

Retention of the cedar swamp stage of the northern lowland forest succession is the primary management objective. The area should be checked periodically for excessive damage from deer browse. Community restoration would involve planting such tree and shrub species as balsam fir *(Abies balsamea)*, yew *(Taxus canadensis)*, and red elderberry *(Sambucus canadensis)*. All new plantings must be protected from animal browse until well established.

Management of Birch–Tamarack Forest

A primary management aim for this area is its retention as a tamarack-birch woods. It is desirable to show the development of pioneer species after a disturbance for teaching purposes and it is also desirable to retain sources of winter food, such as tamarack cones and paper birch buds, for wildlife habitat. To do this, active management, such as controlling sunlight and water levels, is necessary. Brush and trees should be selectively cleared, again taking care not to destroy too much winter cover or too many roosting sites at one time.

Management of the Northern Wet-Mesic Forest

Community restoration is the key to management in this area. The community restoration must be done carefully with these things in mind: 1) restoration plantings must be done in small units; 2) selection will be necessary to include species that can be readily obtained and planted with reasonable success; and 3) care must be taken to protect new planting from animal damage.

These management recommendations for the five communities fall into two categories: 1) removal of vegetation to alter the rate and/or direction of

succession; 2) restoration of missing species to alter the composition of selected areas. These recommendations can help the Riveredge Nature Center to achieve the greatest possible number of different communities. One benefit from these recommendations is an increase in educational opportunities that can be offered. Also there is a chance for people to become involved in the management projects and in this way, they may more truly appreciate the native vegetation and the virgin remnants.

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