Management of Snags and Den Trees in Missouri —
A Process
Russ Titus

ABSTRACT. — The Missouri Department of Conservation and Mark Twain National Forest have been reviewing and refining standards and guides for managing wildlife habitat. An important part of this effort has been to more clearly define the biological basis for dens and snags and to develop management guidelines. A committee was assigned to review available literature on 89 species of birds, mammals, amphibians and reptiles known to require snags and/or den trees to meet their life history requisites in Missouri. Data on these species such as territory size, maximum populations/100 acres, and den tree characteristics such as diameter at breast height, cavity height, and number of dens per acre required for maximum populations were compiled. The species were then segregated by their use of broad habitat types which were identified as Forest Interior, Semi-open/Open Land, and Wooded Watercourses, referred to as Land Use Patterns (LUPS). Biological requirements were established for each major land use pattern and management techniques recommended for even-age and uneven-age silvicultural systems.

INTRODUCTION

Missouri is in the Middle Mississippi Valley. The land area is 69,674 square miles with 448 being water surface (Steyermark 1963). Elevations range from 230 feet in the southeast to over 1,700 feet in the Ozark Plateau.

Thom and Wilson (1980) classified six major natural divisions in Missouri based on geological history, soils, bedrock geology, topography, plant and animal distribution, presettlement vegetation and other factors. These divisions and man's influence depict the diversity of conditions in Missouri which influence the availability of snags and den trees. These natural divisions represent 1) the influence of big rivers which created lowland and riparian habitats; 2) the Ozark uplands which are a highly dissected peneplain, heavily forested with oak-hickory and oak-pine types and, 3) the plains of west and north Missouri, glaciated north of the Missouri River, and which once represented 18,474 square miles of tall grass prairie (Schroeder 1981).

Man's influence has greatly altered the forested portions of the prairie and the forested region itself. This activity has had an adverse impact on wildlife species requiring snags and den trees (McComb 1982). Once native to Missouri, the ivory-billed and red-cockaded woodpeckers are extinct or extirpated. These species succumbed to such activities as excessive forest type conversion, unregulated clear-cutting, tree-length skidding, high fuelwood utilization and removal of defective trees. These activities all influence the quality and quantity of snags and den trees.

Biologists in Missouri recently embarked on a joint effort between the Mark Twain National Forest and the Missouri Department of Conservation to review species requirements for snags and den trees, evaluate current management practices and their potential impacts on these species and to recommend management techniques compatible with a variety of management practices.
BIOLOGICAL REQUIREMENTS

Procedure

A list of birds, mammals, reptiles and amphibians requiring snags and den trees was compiled showing that 89 species of wildlife in Missouri require these special habitat characteristics (Schwartz and Schwartz 1959, Conner and Adkisson 1974, Hardin and Evans 1977, Johnson 1977, Brawn 1979, Evans and Conner 1979, DeGraff et al. 1980). Habitat characteristics were compiled and tabled for all species.

The procedure used to define biological requirements was as follows:

1. The list of species was segregated by primary excavators or secondary cavity users.
2. Species were then organized by their preference for broad habitat types. Habitats were based on land use patterns (forest interior, open and semi-open lands, and wooded water courses) which are defined later in the text.
3. Species within land use patterns were further segregated by the size class of tree required to meet their needs. The size classes are greater than 19" dbh, 10-19" dbh and less than 10" dbh.
4. Data on species using each size class were analysed to determine the number of dens and/or snags required per acre. Territory size, maximum population per 100 acres, minimum dens or nest trees required per pair were some of the criteria used to obtain this quantity.
5. The number of snags and/or den trees required per acre for all species at high population levels were summed for each size class of den tree or snag for each land use pattern. Table 1 illustrates these results.

Forest Interior Habitats

Management recommendations for the forest interior land use pattern are based on the biological needs of eight primary excavators and 22 secondary cavity users. These species display a proclivity for contiguous forest cover but will probably exist at low population levels in parts of the state with little forest cover. Best opportunities to manage for these species at high population levels exist in the heavier forested areas. Objectives for snags and den trees are shown in Table 2.

<table>
<thead>
<tr>
<th>Diameter Class</th>
<th>Forest Interior</th>
<th>Semi-open And Open</th>
<th>Wooded Water-Courses</th>
</tr>
</thead>
<tbody>
<tr>
<td>DBH (inches)</td>
<td>Dens 1</td>
<td>Dens 1</td>
<td>Dens 1</td>
</tr>
<tr>
<td>Greater Than 19&quot;</td>
<td>1</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>10&quot; - 19&quot;</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Less Than 10&quot;</td>
<td>2</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>

Animal needs are in den trees because snag creation by deadening trees is not generally recommended in these land use patterns.

<table>
<thead>
<tr>
<th>Diameter Class</th>
<th>Forest Interior</th>
<th>Percent of Optimum</th>
</tr>
</thead>
<tbody>
<tr>
<td>DBH (inches)</td>
<td>Snags 1</td>
<td>Dens 90%</td>
</tr>
<tr>
<td>Greater Than 19&quot;</td>
<td>0</td>
<td>1.0</td>
</tr>
<tr>
<td>10&quot; - 19&quot;</td>
<td>4</td>
<td>4.0</td>
</tr>
<tr>
<td>Less Than 10&quot;</td>
<td>2</td>
<td>2.0</td>
</tr>
</tbody>
</table>

Snag and den tree requirements are similar because many species would use either live or dead trees and the number of species requiring live den trees approximated the number of species requiring dead trees. Minimum was chosen as half of optimum management with intermediate levels displayed.

Although snag management was integrated with den tree management, it should be emphasized that trees are predominant in the forest interior, therefore, snag objectives should be relatively easy to achieve with the exception of larger diameter trees. Because snags are provided by natural or man induced mortality and do not need the protection den trees require, we can strive for more even distribution and the optimum level of management.

This information is available from the author at Box 509, Rolla, Missouri 65401.
Management guidelines to achieve these goals are:

1. Manage for optimum snag objectives, but do not compromise den tree objectives.
2. Distribution of snags should be even across the landscape (Bull et al. 1980).
3. Management should favor tree species which are relatively rot resistant and long lived.
4. Snag objectives for trees greater than 19" dbh should be met only if there are surplus trees in this diameter class.

Semi-open and Open Habitats

Four primary excavators and 21 secondary users show habitat preferences for snags and den trees in the semi-open and open land use patterns (Schwartz and Schwartz 1959, Conner and Adkisson 1974, Hardin and Evans 1977, Johnson 1977, Brawn 1979, Evans and Conner 1979, DeGraff et al 1980.) In this habitat trees may be more critical than in the forest interior.

<table>
<thead>
<tr>
<th>DBH Class</th>
<th>Optimum No./Ac.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Greater than 19&quot;</td>
<td>3</td>
</tr>
<tr>
<td>10&quot; - 19&quot;</td>
<td>4</td>
</tr>
<tr>
<td>Less than 10&quot;</td>
<td>3</td>
</tr>
</tbody>
</table>

Most species did not show a preference for den trees or snags in this habitat type. Because live trees may be critical in these conditions, recommendations are that den tree management take precedence over snag management.

In the semi-open and open land patterns, the objectives for snags and den trees can only apply to those acres which can provide enough trees. If a stand has 10 or more trees per acre, it should qualify as having the potential to provide den trees through time.

Two conditions will exist which may influence the manager's objectives for snags and/or den trees. These are stands not productive for commercial timber (noncommercial forest lands) with site index less than 40, and stands of commercial timber (commercial forest land) with site index greater than 40.

When a stand is classified as noncommercial, and has less than 40 square feet of basal area in timber, the value of trees as dens or potential dens warrants management at or near the optimum level. If there is greater than 40 square feet basal area of trees, the optimum level of management can be utilized; however, snag objectives may be met by induced mortality or by natural mortality. Snags on these lands should be selected from surplus stems above den tree objectives. Snag management should never compromise den tree objectives.

When stands are classified commercial forest land and are to be managed for forest products as well as wildlife habitat, the management level for den trees may be reduced below optimum, but should not be lower than 50% of optimum. Species selected for reserve den trees or potential den trees should be selected following guidelines that recommend 7 long lived species which attain large diameters.

When basal area exceeds 40 square feet and the decision is made to sacrifice living trees to provide snags, then protect the best den trees and deaden the residual. Spacing of snags should be distributed throughout each stand. (Bull et al. 1980).

Wooded Watercourses

Wooded watercourses are a scarce and disappearing habitat. They occur on alluvial flood plains and benches of streams which have very productive soils for timber as well as agricultural crops.

Wooded watercourses are the least predominant and the highest in quality when compared to other broad habitats. They provide critical habitat for eight of ten primary excavators found in Missouri. Twenty-seven secondary cavity users also utilize cavities in wooded watercourses, eight which find their life requisites only along wooded watercourses.

The species' requirements for snags and den trees in wooded watercourses did not vary greatly between wooded watercourses not within 200 feet of permanent water (lowland hardwoods) and wooded watercourses within 200 feet of permanent water (riparian). Riparian and flood plain hardwoods were separated from lowland hardwood primarily to facilitate multi-resource management. There was no evidence of a preference for snags over den trees, so requirements are given as den trees. These requirements are shown below:

<table>
<thead>
<tr>
<th>DBH Class</th>
<th>Optimum Den Trees/Ac.</th>
<th>Minimum Recommended Dens/Ac.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Greater than 19&quot;</td>
<td>2+</td>
<td>1</td>
</tr>
<tr>
<td>10&quot; - 19&quot;</td>
<td>14+</td>
<td>7</td>
</tr>
<tr>
<td>Less than 10&quot;</td>
<td>9+</td>
<td>4</td>
</tr>
</tbody>
</table>

6 Species information is available from the author at Box 509, Rolla, MO 65401.

7 Species information is available from the author at Box 509, Rolla, MO 65401.
Snags in the riparian and flood plain hardwoods zones should be managed by natural mortality only. Because of the physiological characteristics of the tree species occurring there (softer wood and shorter life expectancy than upland hardwoods), snag requirements should not be a limiting factor.

DETERMINING OBJECTIVES

The biological requirements presented above provide the basis for establishing agency or landowner objectives. Other multi-resource objectives may require objectives below the optimum. Objectives can be established by:

1. Determining the appropriate set of guides from the land use pattern key.
2. The silvicultural system used.
3. The role of old growth.
4. The specific objectives in relationship to optimum.

Land Use Patterns

To determine appropriate species and biological standards it was necessary to define major land use patterns in Missouri. The committee identified three major patterns (forest interior, semi-open and open) based on habitat preferences of the species. Three additional combinations (forest inclusion in semi-open and open, and semi-open inclusion in forest interior) were also identified. Descriptions of these land use patterns are:

- **Forest Interior**: Greater than 70% of a 5,000 acre evaluation area in contiguous forest cover. (fig. 1)

- **Semi-open**: 70-20% forested of a 5,000 acre evaluation area (fig. 2).

- **Open**: Less than 20% forested. (fig. 2).

- **Forest Interior Inclusion in Semi-open or Open Land Use Pattern**: A block of contiguous forest cover qualifies to be managed for forest interior species in a semi-open or open land use pattern if it is at least 1,000 acres managed by an even-age system or 500 acres managed by an uneven-age system. (fig. 2)

- **Semi-open Inclusion in Forest Interior Land Use Pattern**: When 20% of relatively contiguous semi-openland exists in a forest interior land use pattern. (fig. 1)

Later in the process the committee decided that recommendations for semi-open and open land use patterns were so similar that they should be combined.

These land use patterns further help the land manager decide what species and guides should be emphasized by the use of a dichotomous key. This key was designed using the land use patterns and their combinations as well as the wooded watercourses which may occur within any land use pattern. This key should also standardize the interpretation of snag and den tree objectives as they are applied.
Major silviculture systems implemented in the United States are clear-cutting, seed-tree, shelterwood, single-tree selection, and group selection. Clear-cutting, seed-tree, and shelterwood systems generate stands of trees of the same age. This system is called even-age management (EAM). Single-tree selection and group selection produce and maintain stands of trees of several age groups. This system is called uneven-aged management (UAM) (Society of American Foresters with Cooperation of the Wildlife Society 1981). Both the even-age and uneven-age systems are used in Missouri, the size of ownership and landowner objectives will determine which system is most suitable. The system selected will influence the techniques and practices necessary to meet den tree and snag objectives (the number and size/acre).

**Old Growth**

Past land management on Missouri's public lands has attempted to accommodate the needs of species requiring old growth or potential old growth. This paper illustrates that adequate numbers of dens and snags cannot be provided from a limited amount of old growth. Although the number of snags and dens within these stands are, or will be high, their existence is clumped on the landscape causing very dispersed distribution. Advantages of using old growth management are that these stands can be identified, designated, and protected from harvest, while the rest of a management unit may then be treated with little or no regard for snags and den tree management.

The amount and quality of old growth can make an important contribution to meeting den tree and snag objectives. However, the emphasis on old growth varies among landowners and agencies and old growth alone may not meet den tree and snag requirements.

**Management Techniques**

Management for snag and den tree objectives should be met over large (approximately 1,000 acres) areas. Opportunities to reach these objectives will vary greatly according to the characteristics of stands involved. Site potential, topography and especially dominant size class of the stands in the evaluation area will influence the manager's capability to achieve objectives. Administrative objectives will also influence the intensity of den tree and snag management. Because these variables exist we have suggested a variety of techniques and recommendations to assist managers with their objectives.

Achieving den tree objectives under present stand conditions in Missouri may be difficult. Limited inventories on lands managed by the Missouri Department of Conservation and the U.S.D.A. Forest Service show den tree densities presently range from one to eight per acre, usually three to five per acre. These are generally in the 10-19 inch DBH size class, the large den trees (greater than 19 inches dbh) are scarce. If the manager was to set top priority on cavity users, the optimum system would be not to cut any trees, but designate the tract as old growth or potential old growth. This paper illustrates that adequate numbers of dens and snags cannot be provided from a limited amount of old growth. Although the number of snags and dens within these stands are, or will be high, their existence is clumped on the landscape causing very dispersed distribution. Advantages of using old growth management are that these stands can be identified, designated, and protected from harvest, while the rest of a management unit may then be treated with little or no regard for snags and den tree management.

There are three prescriptions common to even-age management, 1) clear-cut, 2) intermediate thinning; and 3) leave. To achieve den tree objectives for a tract of land the manager will need to meet objectives on a per acre average by stand. If the stand prescription is to leave or be designated as old growth then little concern should be given to the preservation of the den tree component. When treatments are prescribed, methods will vary with the type of treatment and stand age.

**Even-age Management**

There are three prescriptions common to even-age management, 1) clear-cut, 2) intermediate thinning; and 3) leave. To achieve den tree objectives for a tract of land the manager will need to meet objectives on a per acre average by stand. If the stand prescription is to leave or be designated as old growth then little concern should be given to the preservation of the den tree component. When treatments are prescribed, methods will vary with the type of treatment and stand age.
Clear-cut Prescription (Regeneration)

When a stand is clear-cut its contribution to den tree and snags will be negligible for at least 50 years unless trees are designated to remain. In the regeneration stand two techniques may be applied either singly or in combination; individual den trees may be left or the clump technique may be used. Either technique or combination may be utilized, but seldom can optimum objectives be achieved through time, primarily because there is limited knowledge of den tree survival or how many need to be left to meet objectives after natural mortality.

The manager should consider the clump technique when the aspect of a stand will expose leave trees to high winds. Generally, protected drainages, coves, and north and east slopes should be the best locations for both individual trees or clumps. Strive to leave trees with long life expectancies when the choice is available i.e., the white oak group should be selected over the black oak group.

Individual Tree Selection: Snag and den tree objectives can be met by selecting individual trees to reserve as den trees or to be deadened as snags. This technique can be utilized in all silvicultural management systems, but does have associated disadvantages as well as some definite advantages. Biological disadvantages associated with trees selected to remain in clear-cuts are:

1. Individual den trees grown in a forest stand have relatively small root systems which do not anchor the tree well enough when left in a new opening with associated high winds. These trees are vulnerable to windthrow.

2. Added stress of winds and lightning may cause breakage of tops and boles.

3. The drastic change of micro-climates can cause top dieback and tree mortality.

Some management disadvantages also present themselves:

1. Accounting for individual trees to ensure that objectives are being met poses some administrative difficulties, especially when several crews are marking reserve trees.

2. Protecting these reserve trees during post sale activities presents a problem i.e., cordwood and firewood operations, natural regeneration work and precommercial and commercial treatments of young stands.

Advantages of the single tree selection tend to be for the animal species rather than administrative. These advantages are:

1. An actual count can be made (either in regenerated stands or intermediate treatments) which helps the manager know when his snag and den tree objectives are being met.

2. An even distribution of snags and den trees can be achieved because an attempt is being made to leave them as they occur on the landscape. This may reduce intra- and inter-species competition for dens. (Bull et al. 1980)

When the individual tree selection method is used, select species with long life expectancies. These trees should be selected in protected locations when possible i.e., side slopes and drainages. When regenerations are located on the more exposed sites of the landscape, the manager may want to utilize the clump method of leaving reserve den trees.

The Clump Method: To ensure that den trees and large diameter snags are available in stands 10-50 years after a regeneration cut will require a different management technique. The manager can choose one or more large existing dens and reserve a portion of the stand surrounding them to protect them during the post clear cut stage. Some shortcomings are associated with this technique if used unilaterally to meet den tree objectives. The distribution of dens is not even on the landscape and meeting den tree objectives is difficult because den trees plus shelter trees take up a large amount of the area.

The committee elected to count shelter trees as potential den trees and snags. Advantages associated with this method are:

1. It would reduce or eliminate many of the stresses associated with isolated trees, providing for longer wildlife utilization.

2. Clumps can be excluded during sale layout and kept intact and trackable through successive treatments.

3. Trees left as protection for dens would provide a source of potential large dens and snags in young (10-50 year old) stands.

Based on stocking charts by Ashley (1980), the optimum7 live dens by recommended size classes, occupies 7% of each acre; however, it is more desirable to leave a clump large enough to be distinguishable during management activities and yet provide distribution on the landscape. The following selection and spacing criteria are based on ranges of pertinent wildlife species. For each five acres of opening the specified clump size is needed to meet den requirements. The clump should contain one or more larger (greater than 10 inches) dens per 1/3 acre of clump. As management intensity is decreased

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8 Den tree spacing guides are available from the author at Box 509, Rolla, MO 65401.
The number of den trees reserved depends upon the management goal. The lowland hardwoods of Missouri are primarily along big river drainages while the riparian habitat may exist along all streams.

10 Den tree spacing guides are available from the author at Box 509, Rolla, MO 65401.
Although most lowlands have been cleared of forest to produce agricultural crops, some lowland hardwoods remain and are managed for waterfowl mast and/or forest products. Management for other resources could soon eliminate existing and potential den trees favoring the younger fast growing individuals, i.e., pin oak, which bear highest yields of mast during the ages of 25-80 years (Fowells 1965).

Lowland Hardwoods—(Wooded, Not Within 200 feet of Permanent Water) A high density of den trees is necessary to meet the requirements of cavity users in the lowland hardwoods. Two methods can be utilized to meet these objectives:

1. Attempt to achieve an even distribution of snags.
2. Attempt to leave snags which are relatively rot resistant.
3. When excessive den trees exist they make excellent snags.

Snag management in the lowland hardwoods depends on the existing density of den trees and the level of their management. If managers choose to supplement den trees with snags they should follow these guidelines:

1. Attempt to achieve an even distribution of snags.
2. Attempt to leave snags which are relatively rot resistant.
3. When excessive den trees exist they make excellent snags.

Riparian--(Wooded, Within 200 feet of Permanent Water). The objectives for riparian habitats are the same as for lowland hardwoods; however, the habitat should be managed to maximize opportunities to host species requiring cavities. There should be very little closely managed timber cutting in the 100-200 feet zone along stream banks.

If individual trees are managed or removed because they are of high economic value, their removal should not compromise the integrity of the habitat or the quality of the stream. This habitat would lend itself to old growth classification.

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LITERATURE CITED


