MINNESOTA GUIDE

to

FOREST GAME HABITAT IMPROVEMENT

INNESOTA DEPARTMENT OF CONSERVATION
Division of Game and Fish

Technical Bulletin No. 10

FORESTS AND WILDLIFE — A PERSPECTIVE

- **The wealth of forest lands is not measured in trees alone. The forest is a reservoir of many natural resources all of which must be managed to provide optimum use and values. The goal should be management for multiple use.**

- **In Minnesota the supply and production of pulpwood at present is much greater than the demand. Extensive acreages of mature or over-mature aspen and some other species are likely to go unharvested. This loss in timber values will also result in a loss in wildlife values.**

- **There is an increasing demand for wildlife—for observation and photography as well as for hunting.**

- **This increasing demand for wildlife-based recreation makes necessary greater emphasis on management practices that benefit wildlife on all forest lands.**

- **As the amount of non-forested land that is available for production of wildlife decreases, intensive habitat management to benefit wildlife will be more and more needed on forest lands. This, with proper land-use planning, can be an integral part of forest management.**

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A MINNESOTA GUIDE

to

FOREST GAME HABITAT IMPROVEMENT

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MARGIN INDEX TO PRINCIPAL SECTIONS

To use bend book and follow margin index to pages with black edge marking.

TABLE OF CONTENTS

FIGURES

INTRODUCTION

This publication attempts to summarize present available information on forest game habitat and its management, especially as it relates to northern Minnesota. Emphasis is placed on the applied aspects of forest game management. In Minnesota, as elsewhere, the forests and associated wildlife habitat vary greatly as do the many factors affecting the welfare and abundance of forest game. Therefore, the information presented should be used as the title indicates as a "guide" for field operations and not applied "cookbook" fashion. There are no exact recipes or formulas for raising forest game and to a great part selection of best management practices is a matter of judgment by the forester and game manager. Such judgment decisions, however, must be based on best available information and used together with knowledge of local conditions and game populations. If this is done, forest game habitat and populations will certainly benefit. It can be expected that the recommendations presented will be revised and improved as additional knowledge is accumulated.

This Guide has been written with two general purposes in mind:

First—to guide and encourage both public and private forest managers in the use of practices designed to sustain ample numbers of forest game animals and other wildlife, both for hunting and esthetic enjoyment, and to show how both timber and game management can be part of an integrated and mutually beneficial program.

Second — to inform sportsmen, game managers, foresters and other interested persons as to what can be done to prevent deterioration of wildlife habitat in our northern forests. This deterioration can come either from natural changes, especially plant succession, or as a result of timber management that is designed to produce timber and pulpwood alone.

The author gratefully acknowledges the assistance of Regional Game Manager Milton Stenlund, who initiated the work on this publication. Appreciation for critical review and helpful comments is extended to Lester Magnus, U. S. Forest Service; Walter Petraborg, Minnesota Division of Game and Fish; and several Foresters of the Minnesota Division of Lands and Forestry. The author is also grateful to Dr. John B. Moyle for aid in editing and preparing the manuscript for publication.

INTEGRATED MANAGEMENT OF TIMBER AND WILDLIFE

There are two approaches to improving habitat for forest game. The approach that has often been used has game habitat or hunting improvement as its primary objective. This includes such activities as deer browse cutting, food and cover planting, or development of trails and wildlife openings. The second approach, and potentially the most important, provides forest game habitat improvement indirectly through modification of practices used primarily for timber management.

Projects that have game management as their primary objective can usually affect relatively small areas because land management agencies seldom have the funds to carry out large programs of this type. The second approach, that of combining timber and game management, has much greater possibilities and can be of great value to forest wildlife. It requires that management of forest lands be planned to take potential wildlife benefits into consideration. Often such integrated planning requires some modification of timber management; but this is usually a matter of location and timing of operations and is not likely to entail large additional operating costs. However, where extra costs are involved, these are certainly justifiable under the concept of management of our forest lands for multiple use.

This coordinated and integrated approach is especially effective because:

1. Timber management operations can and often do change forest cover types and by this affect quality of wildlife habitat.

2. Benefits to wildlife from timber management operations can be provided over much larger areas than they can be by special game habitat improvement projects.

3. This approach has the advantage of economy since it can be largely a by-product of timber and pulp production.

4. It can be an integral part of an even larger planned approach for obtaining other public benefits from forest lands.

There are many ways in which forest and game management can be integrated . Some of the practices which are recommended and which will be discussed elsewhere in this Guide are:

1. Scatter small timber sales.

2. Spread cuttings on large sale areas over several years.

3. Preserve uncut plots and travel lanes for wild animals in large clear-cuttings.
4. Use selective cutting to open the canopy of dense forests.
5. Maintain adequate cover in deer winter concentration areas.
6. Plan cutting program to retain mature male aspen for ruffed grouse and mast-producing oaks for deer and bear.
7. Plan winter cuttings so food for deer is provided when and where needed.
8. Recycle aspen by non-commercial means when demand for fiber is not sufficient to secure harvest before deterioration of stand and subsequent conversion to balsam fir. Aspen stands of several ages in fairly close proximity are desirable.
9. In stand conversion preserve buffer strips of original type between planted area and other timber.
10. Preserve and maintain existing small openings.
11. Reserve openings in larger plantations.
12. Break large planted areas with natural cover strips.

To guide the reader and make the information included more readily available, outline summaries are provided at the beginning of the longer sections. There are essentially expansions of the Table of Contents The reader's attention is also called to the printed tab system on the back cover by which the major sections and subjects can be easily located.

TIMBER HARVEST AND WILDLIFE

OUTLINE SUMMARY

Benefits that can be obtained from coordination of timber cutting practices with wildlife habitat management are:

1. Increased food supply for wildlife.
2. Redistribution of deer so that those in winter shelter areas have better food supplies.
3. Creation of openings and edges.
4. Perpetuation of aspen stands of types most beneficial to ruffed grouse.

Operational procedures especially beneficial to wildlife are:

1. Winter logging.
2. Scattered small timber sales.
3. Short term cutting cycles.
4. Sequential sales.
5. Combined even-age and selective timber management.

Operations procedures that can result in loss of wildlife values are:

1. Underharvest of timber.
2. Rock-raking that eliminates browse regeneration.
3. Planting that eliminates openings and forest type and age diversity.
4. Chemical sprays that eliminate wildlife food plants.

VALUES OF TIMBER CUTTING TO WILDLIFE

The two principal game species of Minnesota's forested area, the white-tailed deer and the ruffed grouse, are most abundant in brushy habitat that is largely young deciduous trees and shrubs and in which there are numerous small openings with grasses and forbs. Such conditions represent the early stages in forest development. In time, these brushy habitats become stands of tall timber with little shrub growth. In many instances, such con-

ditions favor the invasion of trees characteristic of a later stage of plant succession. In much of northern Minnesota this later stage is the spruce-fir climax which is not as favorable to deer and grouse as the stages which precede it.

Fire prevention and suppression, developing maturity of the forest, and forest conversion to species less useful to wildlife through forest management practices all reduce the capability of the forest land to produce game (10,28,60)*. Timber harvest is now the principal means whereby plant succession is set back to the stages more useful to game over extensive areas of forest land. Adequate and proper timber cutting is therefore all-important in forest game management.

Timber cutting affects both food and shelter of forest game. Whether the results of cutting are beneficial or otherwise depends upon the species cut, the amount and extent of the cut, and the size and location of cuttings in relation to other, especially adjacent, cover types.

The following review summarizes studies and field experiences in Minnesota and elsewhere on the effects and importance of timber cutting as related to wildlife management. Recommendations are made on the basis of demonstrated value and reasonable inference.

EFFECTS OF TIMBER CUTTING ON THE FOOD SUPPLY OF DEER

Providing additional winter browse

Logging operations carried out in winter can provide large amounts of deer browse. In Michigan browse made available to deer by clear-cutting of an all-aged mature northern white cedar stand produced enough browse to carry 11 deer per acre for 100 days of winter (63). A lower cutting intensity produced smaller, but still impressive, amounts of food. In Wisconsin a study of the amount of browse provided by felling trees of different species and sizes showed that a moderately dense stand of second-growth hardwood-hemlock (approximately 90 sq. feet basal area hardwoods and 10 sq. ft. b. a. hemlock) could provide about 2340 pounds of browse per acre when clear-cut (59).

In another study of nutrient value and acceptability of browse from three species of hardwoods felled at monthly intervals throughout the year it was found that nutrient content differed little but deer preferred to browse twigs from freshly cut trees with leaves or trees cut after leaf-fall (2).

*Numbers in parentheses are citations to references given in the bibliography.

If browse is being supplied by winter logging, it is especially desirable that cutting be continued beyond the critical winter period. This prevents deer that have been attracted to the cutting from being left without food at a time when other foods may not be available. It is also desirable that slash be cut and placed so that all tops are available to deer (33).

Stimulating browse production

In addition to providing winter food, cutting promotes regrowth by sprouting and suckering and this increases the future food supply. In a study of the regrowth of deer browse in a Virginia forest, as related to different cutting intensities and the age of trees cut, it was found that even the lightest cut made (30 percent of the stand) increased production of browse from 10 pounds per acre (on uncut areas) to 31 pounds per acre one year after cutting (50).

In the Black Hills it was found that production of grasses, forbs, and shrubs increased as basal area and crown density of the pine overstory and the amount of forest litter decreased (49).

Increased deer use of logged areas is generally recognized. This has been documented by track and pellet counts, and by strip census on two 1000-acre tracts in the New York Adirondacks. An area that had been commercially clear-cut had greater deer use than a similar uncut area (37).

A Michigan study showed an increase in hunter take and better physical condition of deer taken from cutover portions of a 28-square-mile study area (7).

EFFECTS OF TIMBER CUTTING ON COVER FOR DEER AND GROUSE

The effect of timber cutting on winter shelter and cover for deer depends on the local situation. If conifer cover is scarce and is found only as isolated conifer stands several miles apart, every effort should be made to preserve or increase such cover. If, as is the case generally in northeastern Minnesota, conifers form a large proportion of the total forest cover, cutting them at current rates will still allow generally adequate shelter. In fact, sufficient winter shelter for deer is usually insured by forest management practices designed to maintain a sustained yield of conifers. Unfortunately, such areas may not have adequate food.

Logging in coniferous types also provides an opportunity for manipulation of the distribution of deer. Large cuttings in extensive coniferous stands

can discourage deer use of the specific areas and force them to use other areas where cover is closer to a good food supply. Deer can be provided with an adequate wintering situation by strip cutting of conifers where there is both sufficient cover and browse improvement potential. Fifty percent crown closure in mixed coniferous swamps appears to provide minimum conditions under which deer will yard for shelter (64).

A northern Michigan study of cutting in mixed conifer swamp surrounded by northern hardwoods showed strip cutting to be best. Here the cutting pattern left uncut strips of excellent cover adjacent to abundant browse. Because of deep snow in Michigan it was concluded that the clear-cut strips in the cutting pattern should not exceed 75 feet in width. In Minnesota, because of less snowfall, strips might well be 100 feet wide. Clear-cut strips could be improved for deer use by leaving timbered cross strips at intervals for travel lanes when snow is deep (36).

Clear cutting of strips oriented in an east-west direction is recommended by the North Central Forest Experiment Station for best tree regeneration. Such orientation also provides several benefits for ruffed grouse. The open strips hold deeper snow for roosting—a winter survival factor in Minnesota (25). Also the snow along the south-facing edges of such strips melts early and provides green feed for grouse prior to egg laying.

A deer management proposal made to the Great Lakes Deer Group points out that preservation of small isolated patches of coniferous cover in hardwoods allows use of such range considerably longer in winter than if it were of hardwoods alone. Deer use such scattered patches of conifer cover when the weather is less severe. The value of patches of conifers for deer cover should be taken in account when the forester is marking the stand for cutting. The management plan should indicate stands which contain small patches of conifers that should be left (33).

Forest openings

Timber cutting, especially clear-cutting, can produce forest openings that add desirable diversity to cover types (38). The value of these openings varies with the specific cover type and species cut. Openings in upland forest are of greater value to deer and grouse than are openings in lowland forest. How long such openings will benefit wildlife depends upon subsequent land management practices and the site condition. Openings can be expected to last longest where reforestation is by natural regeneration. Maintenance of herbaceous or grassy cover in some cleared openings is desirable for wildlife.

Timber Harvest

During the past two decades many openings in northern Minnesota have been reforested both by tree planting and natural encroachment of timber. The effects of this will be considered in greater detail in the discussion of reforestation.

Timber cutting and ruffed grouse

In general, timber cutting benefits ruffed grouse if it maintains the aspen stage of plant succession and retards plant succession toward the spruce-fir and maple-basswood climax types. Cutting should be planned to provide a good distribution of various aspen age-classes throughout the forest. The role of aspen in the habitat of ruffed grouse has been delienated by Gullion as follows (26):

Throughout the primary ruffed grouse range in Minnesota today, aspen, or "popple" appears to be the most important plant contributing to their year-long welfare. During most winters and springs the flower buds of the male aspen are the important source of food. Most male grouse select drumming logs within sight of a clone of male aspen, and hens, after being mated, evidently seek a suitable clone of male aspen as a site for their nests (the female aspen is no more important than any other hardwood).

Although hazel, birch and ironwood catkins are sometimes heavily used for winter food, it seems essential to preserve an adequate supply of mature aspen throughout much of this species' range in Minnesota. The abundance of grouse on each 40 acres is quite closely related to the quantity and quality of food available to them on that "forty". Territorial behavior among these birds is such that there may be an excess of food in one small area, but the resident birds will not allow other grouse to utilize it—so an equitable distribution of satisfactory food resources throughout the habitat is preferable.

Most wintertime feeding is done in aspen over 30 years of age, indicating a need for rotational cutting to assure a continual renewal of the stand. Clear-cutting of blocks as small as 5 acres may be most desirable, as shown in Figure 1. This provides a continuous rotation in small enough areas to accommodate a maximum density of grouse, and will provide the most efficient interspersion of new forest openings, dense sapling stands, pole stage stands for nesting cover, and mature trees for winter food.

Work in the Cloquet Study Area (26a) by Gullion has resulted in the following concept of the roles of different age classes of aspen in the habitat of ruffed grouse:

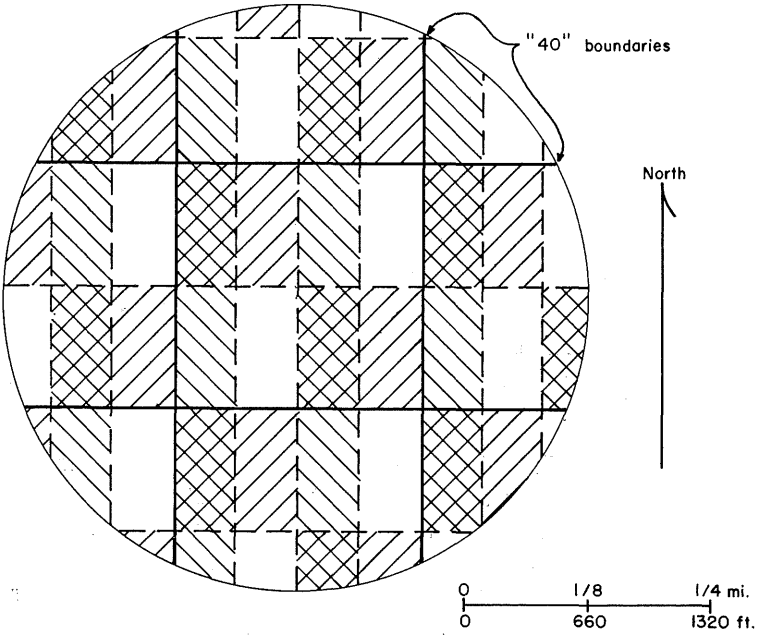


Figure 1. Idealized cutting program for aspen stands to benefit ruffed grouse. Each cutting block shown here is 5-acres in size (330 x 660 feet). If larger areas need to be cut for economic reasons, they should be longer, in north-south alignment, but not wider. It would probably be advisable to leave scattered clumps of birch and/or ironwood within the clear-cut area, but the presence of other tree species decreases the value of the habitat for these birds and will suppress aspen regeneration. Whenever possible cutting programs should be planned to favor male aspen clones in preference to female clones.

1. The newly regenerating stand, following fire or cutting, provides a transitory opening for a year or two as sucker growth commences but soon closes in to provide the stem densities (perhaps as high as 8,000 to 10,000 stems per acre) which are the best cover for broods. This is especially true if the site is one which would become an alder swale in a more mature forest, *i.e.,* a low, moist site where fire has reduced the amount of ground litter.

2. At the age of about 10 to 12 years the developing aspen stand has reached a height of 20 to 30 feet and the stand has thinned to perhaps 3,000 to 5,000 stems per acre. At this density the aspen stand becomes habitable on a year-long basis by adult grouse, and males will move in and successfully establish drumming activity centers—but only if some older aspen is nearby to provide them with their essential winter food resources.

3. At 20 to 30 years the 40- to 50-foot tall pole-stage aspen stand becomes too open, at densities of about 1,000 to 2,500 stems per acre, and the stand loses its quality as year-long habitat. But this age stand has opened up enough to provide the best quality nesting cover for hens, and such a stand will continue to be good nesting cover for another 20 to 30 years, until it starts falling apart from old age. It seems probable that an occasional fire through this aged stand would enhance the quality of the habitat by reducing the accumulation of ground litter resulting from natural thinning.

4. The flower buds of the male aspen commence providing an essential winter food resource for grouse when the trees reach an age of about 30 years. They will continue to provide this resource until the trees either die of old age, are killed by fire, or are cut for their fiber.

If these aspen are not cut or killed under conditions which favor aspen regeneration, they will die without regenerating at an age of about 60 to 80 years on most sites, and the clonal stock will be lost permanently. Aspen stands very rarely develop from seedlings under present-day forest conditions. Most of the stands now present in Minnesota's forests are the product of vegetative regeneration from long established clones which were periodically killed by fire in earlier times.

In considering the four age classes of aspen and their role in serving ruffed grouse populations, it is important to note that each of these classes must be present within the normal mobility range of these birds if maximum densities are to be realized. This means that an adequate diversity of mosaic of aspen age classes must be available on each 40 acres of range to provide the best quality of ruffed grouse habitat.

To prevent an irreversible loss of habitable grouse coverts on extensive areas of forest land we recommend that, wherever spruce-fir or maple-basswood types threaten to exclude aspen as part of the stand composition, efforts be made to convert parts of such stands to the aspen stage of succession. This can be done by clear-cutting or burning to remove all of the canopy and induce sucker sprouting from the remaining aspen roots.

OPERATIONAL PROCEDURES BENEFICIAL TO WILDLIFE

There are a number of forest management operational procedures that are especially beneficial to wildlife. The most important of these are:

1. *Winter logging* — We have already emphasized the desirability of winter cutting because it provides supplemental deer browse during the most critical period of the year.
2. *Scattered small timber sales* — Although it may not be the most efficient timber management, dispersal of cutting sites is essential for greatest benefit to the deer herd. Ideally there should be a cutover area that is less than five years old no more than two miles from any point in the deer range.
3. *Short term cutting cycles* — Short term forest rotation for pulp production maintains a larger proportion of the range in the young-tree, open-canopy stage most favorable to deer browse production. This approach can also lead to a distribution (scattering) of cutting sites.
4. *Sequential arrangement of sales around deer yards* — Timber sales on perimeters of winter deer concentration areas should be scheduled to provide a sequence of cut areas on which there will be improved browse conditions. This is preferable to a single complete cut around a wintering yard followed by years of no cutting.
5. *Even-age vs. selection silviculture* — Even-age management is a system by which clear-cutting establishes trees of different ages in separate blocks. In selective cutting management only trees of a certain age (or species) are removed from a tract of forest, resulting in a mixed stand of large, medium and small trees. Each of these management approaches has a place in developing and maintaining conditions that benefit wildlife.

The wildlife value of even-age stand management is dependent upon clear cutting of many small blocks. Selective cutting, if it opens the canopy in a fairly regular pattern, may provide habitat diversity over larger areas in a shorter period of time. Clear-cuttings should be kept as small as practical to avoid the likelihood of large even-age stands developing in the future (3). Generally, a large block of any even-age class is less desirable than a selectively-cut block of the same size. But, when it is possible to establish many small blocks of various even-age classes within such an area, more and better food and cover is provided for deer (64).

Timber Harvest

It has been suggested that owners of small tracts (80-90 acres) can produce best wildlife habitat by cutting to develop a series of even-age units on three-fourths of their land and by selectively cutting on the remaining one-fourth of the units (52,53).

LOSS OF WILDLIFE BENEFITS

Greatest benefit of timber harvest to wildlife habitat is not obtained when only a small portion of the forest is logged each year. Ideally the annual desirable cut for timber production should be made. On a state-wide basis in Minnesota this annual desirable cut exceeds the actual cut by over 2.4 million cords, the potential harvest being 2½ times the current yearly cut (60).

Optimum cutting of various forest types for best wildlife habitat improvement varies and must be determined on a local basis. In general, however, it is not likely that the optimum will be achieved at any level less than the desirable cut as established for silvicultural purposes. There can be exceptions such as in areas where conifer cover is deficient and where there is a large age gap between mature conifers and plantations. In such cases, forest management to benefit game might preclude cutting of mature conifers, despite timber losses, until the plantations are mature enough to furnish winter shelter for deer.

Much of the value of logging for wildlife habitat improvement can be lost if intensive silviculture follows cutting. Situations vary but generally rock-raking followed by planting and herbicide releasing of plantations tend to greatly diminish the aid that timber harvest can give to deer and grouse. The benefits of logging to wildlife, except for browse supplied to deer from the cut trees, must be judged on the basis of the proportion of the cutover area that will be subsequently subjected to intensive reforestation practices. The relationship of these practices to maintenance of wildlife habitat are considered in the section on reforestation.

TIMBER STAND IMPROVEMENT AND WILDLIFE

OUTINE SUMMARY

Stand improvement cuts can benefit game by:

1. Providing supplemental winter deer browse.
2. Stimulating shrub and sprout growth.

Beneficial practices are:

1. Locating timber stand improvement (TSI) where it will benefit game as well as timber production.
2. Preservation of some mature male aspen in every 40-acre tract.
3. Preservation of cover values, where needed, by maintaining 50 percent canopy closure and providing wind protection by not pruning stand edges.
4. Preservation of den and food-producing trees.
5. Prevention of conversion of aspen stands to balsam fir by non-commercial regeneration if harvest cannot be secured before deterioration.

DISCUSSION

Timber stand improvement (TSI) refers to all cuttings, that are not a part of a major harvest felling, made during the life of a forest stand to improve the stand composition, condition, or rate of growth (46).

Cuttings made for deer browse production rather than timber management are best made in stands of low market value. Here thinnings can be greater than normal TSI to be most productive of future browse. Intensive work of this type for the benefit of deer is considered in the section on special methods of habitat improvement.

Opening dense stands by thinning or release cutting for the benefit of tree growth can provide supplementary deer food and may also increase game food production in the period before the canopy closes again. Real benefits to wildlife can be obtained if the location and manner in which this practice is carried out are keyed to the needs of wildlife as well as to the objectives of silviculture.

Lack of funds usually limits the number of sites on which a forester is able to make non-commercial improvement cuts. Since selections must be made, it is suggested that—if timber site values are anywhere near equal—the improvement cuts be made adjacent to known winter deer concentration areas, or adjacent to cover or topography that has deer shelter potential.

There are three principal aspects to coordination of timber stand improvement work with wildlife habitat enhancement. The first is that cuttings be timed, located, and distributed so they will benefit deer as well as timber production.

The second involves preservation of certain plant species and forms for the benefit of wildlife. This is especially important because removal of competing growth is the objective of TSI work. Precautions to be taken are as follows:

1. Do not remove all aspen by TSI. Maintain several clones of mature male aspen in every 40-acre tract for the benefit of ruffed grouse.
2. Preserve shelter value of conifer cover for deer in areas where it is scarce. This can be accomplished by not pruning stand perimeters and by not reducing canopy closure below 50 percent.
3. Preserve a good distribution of game-food producing trees, fruit or mast, in every 40-acre tract of forest.
4. Preserve enough den trees to meet wildlife needs.

The third aspect involves coordination of timber stand improvement and wildlife needs in the hardwood type. Hardwood sites adjacent to winter deer shelter are recommended for improvement cuts because of the supplemental browse that will usually be provided. In many instances such sites are also best for hardwood production and would have priority in a hardwood management program. However, the present poor market for hardwoods often does not permit good management by means of commercial cuttings.

Non-commercial improvement cuts could serve the interests of both forestry and game management if properly located. Several studies of the mutual benefits of this kind of action have been made. One detailed quantitative study was of the amount of browse provided by felling and thinning trees of different species and sizes. The cutting of all competing trees within a five foot radius of selected crop trees (about 100 per/acre at 20 by 20 feet) in a sapling-sized (one to five inches d.b.h.) stand of northern hardwoods produced fresh browse in the range of 26.3 to 46.2 pounds per square foot

of basal area. On a per acre basis, when 418 northern hardwood or aspen trees were felled in thinning, the per acre volume of fresh browse was 372 pounds (59).

An intermediate cutting to increase deer production and improve small game food and cover is currently in use on the Allegheny National Forest. The method was tested for its yield of woody deer browse in 40-60 year-old hardwoods. Felling all stems except crop trees produced a total of 141,000 twigs of browse per acre in the first year. The crop trees preserved represented about 80 square feet of basal area per acre.

Such cuttings have a multiple-use value when they are used in large tracts of pole timber where regeneration clear-cuttings will not be made for many years. Individual areas which produce good browse for as little as three years will be valuable. Then a series of cuttings succeeding over a period of time can sustain a deer population until timber sales can be made. In this way the land unit remains more productive until a better balance of age classes evolves (31).

For either forestry or game management alone, the cost of such action might not be justified. However, in view of the multiple benefits, a cooperative program between the two interests should be seriously considered.

REFORESTATION AND WILDLIFE

OUTLINE SUMMARY

1. Avoid development of large area mono-types.
2. Maintain interspersion of natural stands different from plantations.
3. Create wildlife openings by establishing clover-seeded firebreaks on the area cleared for site conversion.
4. Regenerate aspen stands by non-commercial means to maintain the type when demand for fiber is lacking.
5. Coordinate site preparation, planting, and release practices in a reforestation treatment pattern that creates diversity and produces additional food.
6. Plan plantations to benefit game as well as timber production.

REFORESTATION BY STAND (OR SITE) CONVERSION FOR NON-COMMERCIAL TIMBER

Definition. The term "stand conversion" as used here applies to the practice of changing the composition of the forest by removal of unmerchantable species such as white birch, off-site aspen or conifers that are of little value and replacement of them by artificial planting of trees having greater current or potential demand.

Effects Upon Wildlife Habitat. Stand conversion, as here defined has potential for either benefiting or damaging wildlife habitat depending upon what is removed, what is planted and how the operation is related to adjacent forest types. Conversion of some sites to conifers can benefit wildlife if carried out in extensive deciduous stands. On the other hand, conversion to conifers can be detrimental to wildlife if most of the general area is already in conifers and preservation or expansion of shrub areas would benefit game production. Conversion by planting on sites with non-commercial timber has an advantage over reforestation by planting commercially-cut sites because there is greater likelihood that the forest manager can choose locations that will produce both wildlife and timber benefits. This approach, however, produces no immediate economic returns such as are obtained from sites where commercial timber has been cut before replanting is done.

Recommendations. The following practices of benefit to wildlife are recommended if stand conversion is desirable and feasible from a silvicultural standpoint.

1. Avoid conversion on large areas where one undesirable forest monotype will be replaced by another.
2. Maintain interspersion of cover types by making conversions in small blocks or strips with natural stands between plantations. This will benefit wildlife and reduce the danger of widespread crown fires in conifer plantations (30,44).
3. Create wildlife openings by planting clover on maintained firebreaks in the area cleared for site conversion.
4. If maintenance of openings is not feasible, reserve a buffer strip for natural regeneration, one to three chains wide, between planted area and natural stand.
5. Plant several species of conifers on conversion sites to produce diversity of cover that is desirable for game.

REFORESTATION BY NATURAL FOREST REGENERATION

Definition. The term regeneration is here used as meaning natural forest renewal. It includes natural renewal of a stand by seeding, sprouting or suckering from rhizomes.

Effects upon wildlife. Under many forest conditions, the natural renewal of a timber stand, as an aftermath of logging or burning, results in considerable diversity in age, form and species of tree reproduction and associated plants. This is favorable to wildlife.

Recycling of aspen is especially beneficial. In Minnesota large areas of brush and open land that once benefited deer and other wildlife have disappeared. They have been replaced by stands of closed-canopy, pole-size timber that have less wildlife value. Many such stands of aspen and northern hardwood are not being harvested because of lack of a market. Without logging to return these stands to a stage more beneficial to wildlife, they will be of little value to deer and grouse for years to come. A timber loss will also occur, especially in aspen stands where balsam fir is taking over as the aspen matures and dies. There are both silvicultural and wildlife benefits to be obtained from regeneration of such stands.

A stand of aspen for which there is no demand at present could be clear-cut as a cooperative forestry and game management practice to insure the presence of an aspen stand 30 to 50 years hence to meet future demands for wood or fiber. This would also create an abundance of sprouts for deer browse during the first five years after cutting. Where such stands are adjacent to deer wintering areas winter cuttings should be made in sequence to insure a continuous browse supply. Such cuttings should be made upon the joint recommendation of forester and game manager and should be designed to meet local needs for wildlife habitat that are not met by commercial cutting of aspen or hardwood. The total special recycling cuts and commercial cuttings would not exceed the "desirable annual cut" taking into account any existing accumulation from previous undercutting. Such recycling of aspen stands should be of sufficient value to justify special financial support by both game management and forestry agencies.

REFORESTATION BY PLANTING OF LOGGED SITES OR CLEARINGS

Definition. The term reforestation as used here refers to artificial planting or seeding when used to establish a stand of trees—especially on sites where there has been commercial logging or plantings made, in existing forest openings and clearings.

Effects upon wildlife. Reforestation is an important goal of silviculture. However, as a long-range operation, it is often detrimental to wildlife. This is because reforestation, which often emphasizes planting of conifers, adds an additional impetus to the natural ecological trends which are causing the forest habitat to become less favorable for game in northern Minnesota. Reforestation by planting would be less detrimental if timber cuttings, currently so vital to maintaining deer and grouse habitat, were more numerous and more generally distributed. As has already been noted, where logging is done, reforestation by planting often reduces the effectiveness of logging for improving wildlife habitat.

The principal effects of reforestation, as here defined, upon wildlife are: (1) wildlife makes little use of the large plantations, and (2) usable wildlife habitat is lost when existing forest openings are planted.

There has long been concern over the effect of large plantations upon wildlife. Studies of 62 plantations of pure and mixed species in New York State showed that distribution and abundance of wildlife was influenced by size of the plantation, nature of edge produced, size and abundance of

openings, and management practices used. It was concluded that the diameter of a plantation was of little importance as long as it contained openings and was planned so that wildlife could use adjacent cover (59). An intensive study of a 256-acre pine and spruce plantation in New York indicates that grouse used the outer 330 feet of the plantation only where other good habitat adjoined it. It was found that the interior of large, solid plantations that have reached the closed canopy stage are little used by most game animals. This study also indicated that where game is an important consideration, large plantations of conifers should be interspersed with openings, brush and/or hardwood areas and that conifer units within the plantation should not be larger than 7 to 8 acres (4).

The importance of preserving forest openings is stressed by findings in six National Forests in northeastern United States which emphasize the importance of legumes, grasses and forbs in the diet of deer (57). In Wisconsin it has been found that areas with few openings have fewer deer than other areas with more openings. This study also showed that small (less than 5 acres) and narrow (less than 5 chains) openings are used more intensively by deer than larger or wider openings (42).

The United States Forest Service recognizes the value of many small clearings scattered throughout the forest. They state: "Every effort should be made to maintain old fields as wildlife openings. The best portion of larger fields should be selected and improved for wildlife use, leaving the remainder to natural succession or reforestation by planting. Artificially created openings may be made where needed to give good distribution of wildlife openings" (62).

Since 1959 the Forestry and Fish and Game Divisions of the Minnesota Conservation Department have had a cooperative agreement on the reforestation of openings entitled "A Guide to the Reforestation of Natural and Man-made Openings". The recommendations of that guide have been revised and incorporated into this publication.

Recommendations. Plantations made in natural and man-made forest openings require consideration of wildlife needs if forest land is to be managed for both timber and game. Some considerations are:

1. Rock-raking — Bulldozing stumps, rocks, sprouts, and ground cover into windrows in preparation for planting can eliminate much of the shrub and sprout growth that would develop with natural stand regeneration.

2. Planting — When cutover areas are completely planted, especially if planted to produce a type similar to that surrounding the cut area, the potential for development of diversity in cover type and form is lost. The possibility for development of grassy forest openings is also largely lost when a logged area is fully replanted.

3. Herbicide releasing — Spraying herbicide over conifer plantations to eliminate the competition of shrubs and hardwood sprouts benefits the growth of the planted conifers but eliminates much of the benefit wildlife could derive from forest cutting.

It is suggested that the foregoing practices be used only on part of any cut-over area and used in ways that will tend to establish openings and improve deer browse. A suggested pattern of treatment for an aspen or hardwood area for benefiting wildlife is shown in Figure 2.

If the cut-over area depicted in Figure 2 were a 40-acre block, about 30 acres might be planted and the remaining 10 acres left to natural forest regeneration. Herbicide spraying to release the plantation in later years could be extended into the unplanted area and the uncut woodland for a short distance. This pattern of treatment would produce a diversity of cover types and edges. With several sprayings there is a good possibility that grassy openings would develop in the center and on the left edge of the plantation.

It has been found in Wisconsin that well sodded openings in some red pine plantations are used very heavily by deer indicating that the combination of pine and opening may be very valuable summer habitat (43). Over-spraying into the area outside the plantation would promote additional sprout growth and might divert browsing from the planted trees (57).

4. Planting in clearings — There are also desirable management measures that relate to the proportion of a clearing — natural or man-made — that should be left unplanted. Some general recommendations are:

   a. *Planting in openings of five acres or less* — In an area where there are many small openings forming a patchy forest, some, but not all of the openings may be planted. Small openings in extensive aspen or hardwood areas where conifer cover is lacking should be retained. Here conifer cover can be provided by conversion of part of the deciduous stand.

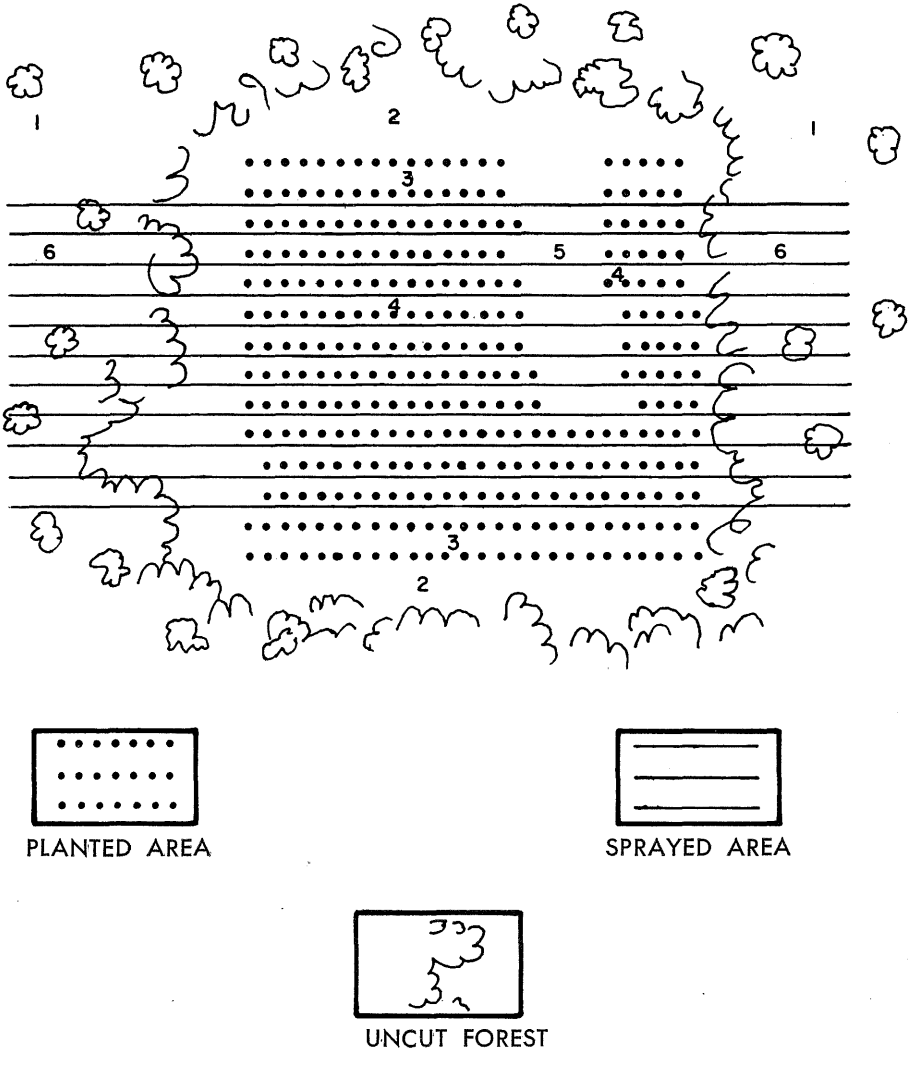


Figure 2. Idealized pattern for forest opening created by cutting for production of both timber and game. This treatment results in six different areas: (1) uncut woodland, (2) unplanted cut-over, (3) planted cut-over, (4) planted and sprayed cut-over, (5) unplanted but sprayed cut-over, and (6) uncut but sprayed woodland.

b. *Planting in openings of 5 to 10 acres adjacent to road* — Although such openings are sometimes used for illegal deer shining, the esthetic value of pleasant meadows interspersed in an otherwise solid wall of timber is considerable. At least half of such an opening, up to three acres, should be left open adjacent to the road. The remaining area to the rear could be planted. On the larger openings an unplanted strip about one chain wide along the perimeter would further enhance wildlife habitat values. See Figure 3.

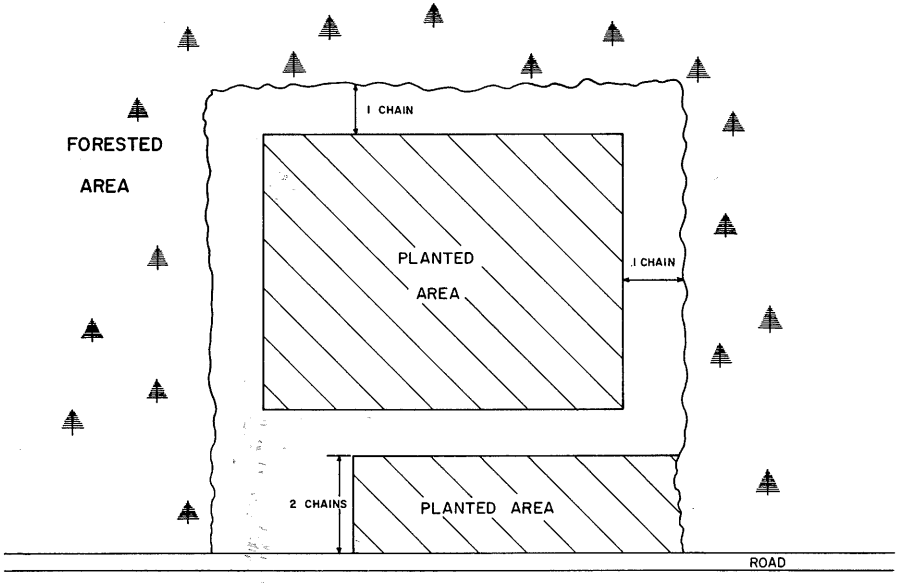


Figure 3. Suggested planting pattern for 10-acre forest opening adjacent to a road.

c. *Planting in openings of 5 to 10 acres not adjacent to a road* — If these are planted, leave an unplanted strip about one chain wide around the edges of the plantation. In a 10-acre clearing this strip would occupy about 3.5 acres. See Figure 4.

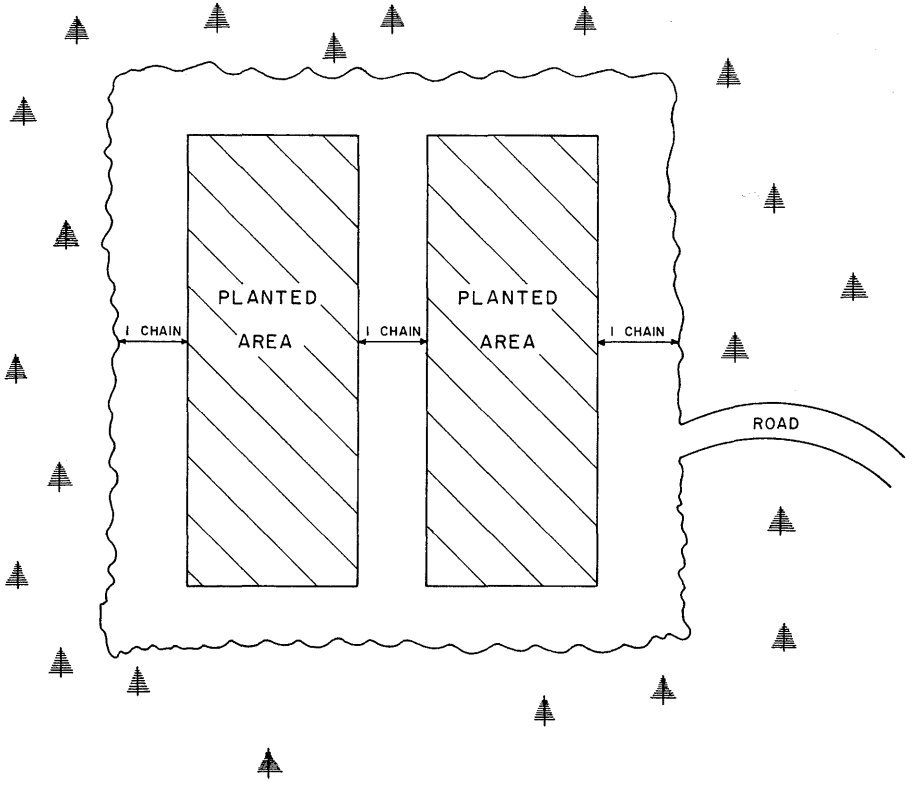


Figure 4. Suggested planting pattern for a 10-acre forest opening not adjacent to a road.

d. *Planting openings of 10 acres or more* — Plant as indicated in Figures 5 and 6. If a road runs alongside or through the area, preserve some openings along the road. Do not plant an unbroken strip because there is considerable recreational value in seeing wildlife.

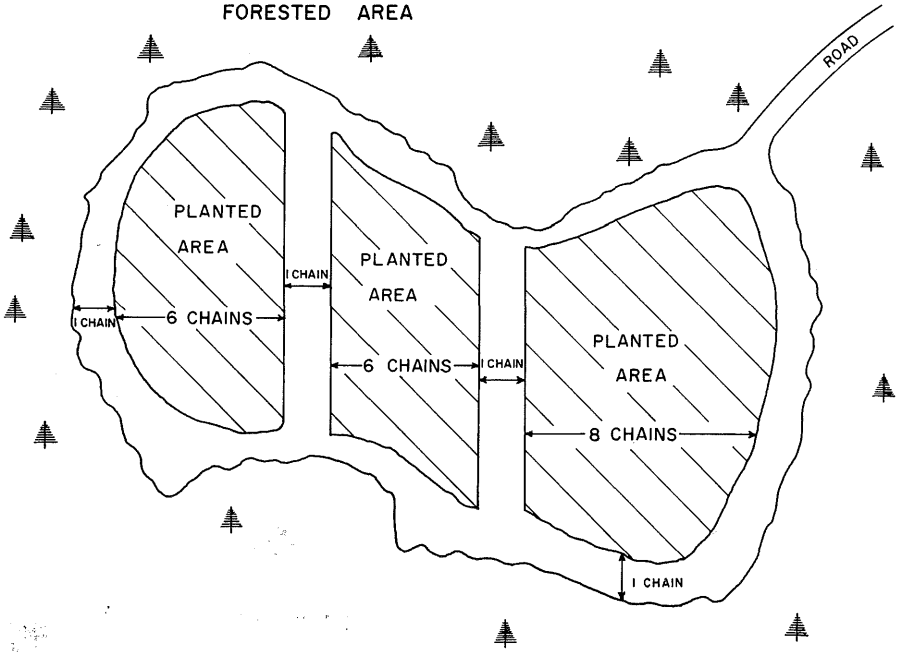


Figure 5. Suggested planting pattern for forest openings larger than 10 acres.

Figure 6. Suggested planting pattern for long narrow opening planted conifers.

e. *Planting of logging roads, landings, building and mill sites* — Those smaller than five acres should not be planted. Where over five acres, the recommendations given above should be followed.

f. *Openings in large deforested areas* — In large deforested areas where remaining forest stands are small and scattered, larger plantations may be made if numerous small openings or frequent open strips about one chain wide are left.

g. *Sharptail grouse and prairie chicken area* — In areas where there are sharp-tailed grouse or prairie chicken, the area game manager should be consulted when laying out planting programs.

h. *Buffer strips along roads* — Do not extend land-clearing operations to public roads. Reserve a buffer strip of timber or preserve natural openings to provide esthetic values.

INTEGRATED MANAGEMENT BY FOREST TYPE

OUTLINE SUMMARY

1. Aspen—Preserve aspen stands from conversion to balsam fir. This is the key to maintaining good forest game habitat in Minnesota.
2. Mixed conifer swamp — Develop even-age blocks (or strips) of good cover adjacent to blocks (or strips) of good deer browse.
3. Spruce-fir (upland) — Maintain 50 percent canopy adjacent to good browse areas. Clear-cut all species where spruce-fir is an understory in good quality aspen.
4. Northern white cedar — Plan cutting for late winter to provide most benefit to deer.
5. Hardwood types — Preserve den and mast trees. Recycle by non-commercial cutting.
6. Jack pine — Maintain a good distribution of stands and age classes.
7. Red and white pine — Plan plantations to provide interspersion of other forest types.
8. Black spruce — Limited wildlife use; requires no coordination with timber management.

ASPEN

The aspen (popple) stands of Minnesota make up the most important timber type determining future status of deer and grouse populations. Depending on management of them in the near future, our aspen lands can either be of great value for maintaining game or of little value to wildlife. This is because:

1. Aspen covers 5,451,000 acres or nearly one-third of the commercial forest land in Minnesota (24).
2. Aspen is the forest type that most often provides adequate deer browse, either from young aspen or from shrubs and trees associated with older aspen stands (42).
3. Natural forest succession is converting many aspen stands to balsam fir (10,28), a forest type that generally provides much less deer

browse and grouse habitat. Such a stage in vegetational change is shown in Figure 7.

Figure 7. Advanced stage of natural conversion of aspen to balsam fir. This natural process of plant succession is reducing the carrying capacity of the deer range over much of northern Minnesota.

4. Clear-cutting of aspen stands, including the understory of balsam fir, results in profuse aspen sprouting. This provides abundant deer browse and regeneration of the aspen stand (22,67).

5. Hardwood types — Preserve den and mast trees. Recycle by non-produced from their roots. Under such conditions, these sprouts are over-topped by other vegetation and die because of their intolerance to shading (23).

6. Timber cutting, at current rates (24,60), does not remove enough mature aspen to provide the desirable regeneration of aspen for either timber management or wildlife.

RECOMMENDATIONS FOR ASPEN LAND MANAGEMENT

1. Maintain medium and better sites in aspen production by commercial cutting that removes non-merchantable material as well as that which is merchantable (46).

2. Recycle aspen with non-commercial cuttings when demand for wood is not sufficient to secure harvest before deterioration. Herbicides may be used if there are no conifers to survive and shade out aspen regeneration. The combination of herbicide and fire offers possibilities under such conditions. Under present forest conditions in Minnesota, the recycling of aspen stands provides a tremendous opportunity for integration of timber and game management. Both forests and wildlife can gain much from concerted and expanded work of this nature.
3. Limit stand conversion by planting to poor aspen sites and select those on which there can be coordination with wildlife requirements of a locality.
4. Make numerous, well distributed, small cuttings each year. Deer will not fully utilize cuttings larger than 40 acres (23) and the value of aspen sprouts as deer browse is limited to the first three to five years (22).

   The following table will be useful in determining the total area of initial aspen cuttings per square mile required to meet the needs of the estimated deer population (23):

Population of deer	Recommended area to be cut
11 to 20 deer per square mile	20 acres or more per square mile
21 to 30 deer per square mile	40 acres or more per square mile
31 to 40 deer per square mile	100 acres or more per square mile
41 to 50 deer per square mile	200 acres or more per square mile

   At most places in Minnesota a 20- to 40-acre cut per square mile of forested area, once every three to five years, is adequate.
5. Whenever possible, priority should be given to cutting aspen adjacent to known or potential deer yarding areas.
6. Mark and preserve several clones of mature male aspen in each 40-acre tract of forest for the benefit of ruffed grouse (25).

MIXED CONIFER SWAMP

Much of the work on habitat manipulation of this forest type has been done in the Upper Peninsula of Michigan. Some work has also been done in Maine, especially as related to shelter preferences of deer.

Application of findings from these studies to Minnesota requires consideration of (1) the differences and similarities in deer habits and habitat in these three states, and (2) differences in objectives, methods, and means for deer management.

In the Upper Peninsula of Michigan the mixed conifer swamp stands contain much northern white cedar, whereas in Minnesota swamps cedar is less common. Here black spruce, balsam fir and tamarack often predominate.

Shelter preferences of deer in the three states seem to be somewhat dissimilar. On the basis of work in northern Michigan it has been concluded that forests composed predominantly of spruce and balsam often make mediocre deeryards and ought to be managed primarily for pulpwood (64). In Minnesota, on the other hand, both upland and lowland balsam stands are recognized as important wintering areas. In a Maine study of deer-bed sites tree preferences were recorded. It was found that cedar was definitely less preferred as shelter than spruce, fir, or hemlock (21). It was also found in Maine studies that, contrary to the impressions of many observers, cedar stands generally are much less important to deer than spruce-fir stands with their associated species (including cedar) (19).

It appears, therefore, that Minnesota conditions are more like those reported for Maine than for the Upper Peninsula of Michigan. Regeneration of cedar and manipulation of deer distribution to achieve it within the mixed conifer swamp type does not have the importance to Minnesota deeryard management that it has in Michigan. However, the Michigan evaluation of the effects of various methods of timber cutting upon the quality of deer shelter and related food conditions and carrying capacity are applicable to the mixed conifer swamp type in Minnesota.

RECOMMENDATIONS FOR MIXED CONIFER SWAMP MANAGEMENT

1. By clear-cuttings establish a series of narrow (66 to 100 feet wide) strips or small blocks (2 chains square) that will provide an approximation of a checkerboard of various even-age classes. This procedure provides the following:

    a. Even-age uncut blocks that provide better protection for deer from severe winds, bitter cold, and hinderance from snow than will drafty, semi-open mixed-aged stands (64).

b. Alternating clear-cut blocks or strips will provide browse adjacent to good cover (36).

c. The possibility of invasion of cut areas by alder is reduced by not clear cutting of an entire area (5,48).

2. Where uneven-age management (selective cutting) of swamp conifers is desirable from a silvicultural standpoint, maintain at least 50 percent crown closure for winter shelter of deer.

SPRUCE-FIR (UPLAND)

This type will generally contain less cedar—usually none—but more aspen than the foregoing. In many cases this type is the result of natural succession from aspen to spruce-fir and in the future there is likely to be much of this type on forest land previously dominated by aspen. Already, as a result of this natural change in northeastern Minnesota, adequate winter cover for deer is now quite generally distributed and deer are less concentrated in yarding areas than formerly. This condition has some advantages in mild winters when deer are free to range but serves little purpose when deer movement is restricted because there is often a shortage of browse in this cover type. When food is scarce there is little value in having the deer scattered. Deer can suffer as much from malnutrition in small groups as they can when concentrated in yarding areas.

RECOMMENDATIONS FOR UPLAND SPRUCE-FIR MANAGEMENT

1. Block or strip clear-cuts as discussed under Swamp Conifers should be tried for long-range management in this type of deer habitat.

2. Uneven-age management by selective cutting is generally recommended by the Minnesota Division of Lands and Forestry for this type. This method, with a cutting cycle of 30 years or less, is designed to reduce natural mortality of trees and to keep the stand in a thrifty condition. Although there are no studies of deer browse production in spruce-fir so managed, field observations show that this approach benefits shrub growth whenever the canopy is opened. On small areas this effect is slight and temporary but if considerable acreages were selectively cut or small patches are cut annually, the cumulative effect can be of substantial benefit to deer.

3. To provide benefits for wildlife, uncut plots and travel lanes of dense conifers should be provided. These provide protection from wind and permit better utilization of the sprout growth in large heavily-cut areas.
4. For mixed stands the following recommendation of the Minnesota Division of Lands and Forestry will also benefit game. "In stands containing high quality aspen or other hardwood sawlog or veneer material, over a dense balsam-fir understory of merchantable size, the area should be completely clearcut to induce suckering so as to favor the aspen or hardwood trees . . ."

NORTHERN WHITE CEDAR

The recommendations for Michigan deeryard management cited under Swamp Conifers can be applied in Minnesota wherever cedar occurs in nearly pure stands of 200 acres or more. Because Minnesota deer are more closely harvested and represent less of a threat to cedar reproduction, the size of the clear-cut blocks can be reduced from the Michigan standard of 40 acres to as little as 10 acres. Exceptions should be made where there are unusually heavy winter deer concentrations, approximating Michigan conditions, i.e. where all regeneration above the snow is so heavily browsed by deer that it is killed or badly mutilated.

In Maine (20) little or no cutting of softwoods in coniferous deeryards within a size range of five to 125 acres is recommended. For Michigan (64) it has been concluded that, "yards (cedar) smaller than 200 acres probably cannot be managed by designated age classes because individual units would be too small to regulate deer activity efficiently. Instead, a practical solution would be to methodically clearcut the entire stand at age 60 to 80 years, thereby forcing the herd elsewhere during the critical restocking stage."

Since the problem of cedar regeneration in Minnesota involves deer less and because Minnesota deer are not as dependent upon cedar for cover as they once were, it is recommended that the practices of sustained yield forestry take precedence for this species. When sales are made, however, cutting should be planned for late winter when the large amounts of nutritious browse produced will provide the most benefit for deer (63).

HARDWOOD TYPES — NORTHERN UPLAND AND SWAMP

The current market for hardwoods is small and possibilities for multiple-use management based on timber harvest are few. The modified selection system of managing hardwoods recommended by the Minnesota Division of Lands and Forestry (46) may produce small forest openings and the recommended series of partial cuts to be made at relatively short intervals (8 to 15 years) should induce additional browse growth. The greatest problem is finding a market for enough of the hardwoods to encourage cutting. This does not apply, however, to farmland woodlots which should be managed on an intensive basis for both wood and wildlife.

Whenever hardwoods are cut, enough den trees should be reserved to meet the needs of wildlife even though they may be cull trees.

When logging is done in oak country, enough trees should be reserved to meet the mast requirement of wildlife. It has been suggested that at least 15 oaks, averaging 14 inches d.b.h., are necessary per acre (52). Michigan's formula for managing oak for game includes the following:

1. Insure a continuing supply of 40-80 year old, vigorous, full-crowned oaks.
2. Leave ten oaks per acre within 1.2 miles of deeryards—the total acreage to be equivalent to the number of deer in the yard, or equal to the size of the yard.
3. Farther than ½ mile from deeryards, leave five oaks per acre—the total acreage to be twice the number of deer using the range.
4. When possible leave a ratio of three red oaks to one white (bur oak in Minnesota) near deeryards and two red oaks to one white in summer range.
5. When practical, leave oaks in higher elevations and cut those on lower sites to reduce chance of frost damage to acorn production.

In lieu of greatly expanded hardwood harvests the best possibilities for silvicultural management and wildlife enhancement in this type lie in non-commercial cuts as discussed under the sections of this publication on value of timber cutting to wildlife and on aspen land management.

JACK PINE

Jack pine is the most abundant of the pines found in Minnesota. The jack pine forest type covers nearly twice as many acres of commercial forest land as red and white pine combined (60).

Jack pine is generally rated, along with aspen, as second or medium preference deer food. The young trees are heavily browsed wherever there is a large number of deer. Studies of the effects of browsing upon jack pine reproduction have shown that this species can withstand up to 80 percent removal of annual growth and still survive (6). Recent studies of the digestibility of various deer foods indicate that jack pine may be somewhat superior to aspen as a sole browse for deer (61).

Jack pine does not intercept as much snowfall as most of the other conifers and therefore does not provide as good winter shelter. Dense young stands, however, can give wind protection and in winters of light snowfall may permit deer to remain in areas having better food supplies. A New York study reports a better growth of shrubs and herbaceous plants under jack pine than under other conifers because of greater light penetration (56). Observations in Minnesota indicate that this value is limited to the older and more lightly stocked stands and cannot be regarded as an attribute of all jack pine stands.

It appears that the jack pine type can be a valuable component of deer habitat if there is a good distribution of stands and of age classes throughout the range.

Cutting practices that favor the maintenance of this type and the development of a balanced distribution of age classes are recommended.

RED AND WHITE PINE

Red and white pine of merchantable age, occupy such a small part of the forest in Minnesota that there is currently no need to consider coordination of their harvest with game management needs. The relationship of pine plantations to wildlife is considered in the chapter on reforestation.

BLACK SPRUCE

Wildlife use of the black spruce type is quite limited and sustained yield timber management needs no modification to enhance wildlife values.

USE OF FIRE

Because of the special position that fire holds in the minds of all people, the aspects of its use that can benefit wildlife are treated separately in this section. These are, in part, practices that can be integrated with timber management and in part practices that can be applied directly to benefit wildlife.

The destructive effects of fire upon life, property and timber have long over-shadowed the constructive role that fire has had and can have in both forest and game management. Fire can be a most useful tool.

Fire releases fertilizers for a short period of years whereas cutting does not. Fire removes ground litter and slash which are obstacles to deer and grouse. Fire stimulates the growth of certain small trees and shrubs such as cherries, birch, Juneberries, dogwood, blueberries, raspberries and many kinds of herbaceous plants. Cutting alone will not do this. It is well known that certain forest trees, especially aspen and jack pine are "fire types". Some recommendations regarding use of fire are:

1. Burn logging slash.
2. Use fire to recycle aspen when commercial harvest cannot be obtained.
3. Burn selected 10-20 acre areas adjacent to deer yards.
4. Burn at intervals to create or maintain forest openings.
5. Classify areas as to fire suppression importance.

It is not within the scope of this publication to consider all the aspects of fire ecology. For a review of pertinent literature the reader is referred to Ahlgren and Ahlgren (1). However, because fire has so long been viewed as a great enemy to both forests and wildlife, it is necessary to discuss the relationship between fire and these natural resources.

There are a number of misconceptions that have caused the public and some early conservation leaders to develop an abhorrence to any fire in the woods. One of these is the common and long-held opinion that, until the white man came and started fires, the northern forest areas had remained, century after century, covered by magnificent pine forests and that this pine is the "natural" timber type. Investigation has shown this idea to be false. The pines that existed when lumbering began were here as a result of previous fires that started from natural causes or were set, accidentally or deliberately, by Indians. The Indian made use of fire for land-clearing, hunting assistance, and insect relief (12). If it had not been for the fires that burned

100 to 200 years earlier the lumbermen would have found spruce and fir instead of the great pine stands. The large red or "Norway" pine at Itasca Park date from fires that swept the area in the 1790's.

An investigator of the role of fire in Wisconsin forests came to the conclusion that: "Forest fires have, in the past five centuries, burned through 95 percent of the virgin forest of Wisconsin. The terms 'virgin' and 'primeval', therefore, in their application to the old forests of this region, are rather meaningless from an ecological point of view, for practically all 'virgin' stands are really successfully rehabilitated burned-over areas" (41).

Burned-over areas will regenerate to pine or aspen depending upon a number of factors, the details of which are beyond the scope of this discussion. However, the primary factor that prevented pines from becoming established again after the great lumbering operations was repeated land-clearing fires set by the early settlers. Burning of slash after logging was common practice but it was the repeated fires started by settlers to clear land for crops and livestock that prevented the re-establishment of fire-sensitive conifers (32).

Another misconception that is widely held is that forest preservation by protection from fire is automatically wildlife preservation. There is great sentimental appeal in the depiction of forest fire as a destroyer of wildlife but there is little basis in fact (11,40). Although fire may kill some animals, the general and longer term effect is creation of conditions which favor game animals and usually make it possible for a given area to support a larger wildlife population.

Fire can provide several silvicultural benefits such as reduced cost of site preparation, better vigor and greater survival of seedlings planted on a burn area, and lower planting costs. Burning also increases direct seeding possibilities because often all ground cover and duff is burned and mineral soil is exposed.

From a game management viewpoint fire produces results that logging alone cannot. The ash from a fire makes additional plant nutrients available for a few years and these can significantly increase the protein content of plants growing in the burn area. It has been found that deer which fed exclusively on four browse species that grew on both burned and unburned plots ingested from 10 to 26 percent more protein per calory of food eaten when the plants taken came from the burned area (13). Fire also removes ground litter and slash which are obstacles to use of an area by grouse and deer (25,33). Fire stimulates growth of a number of species of plants such

as the cherries, Juneberries, and certain forbs that are associated with fire-type forest trees (29,65).

The controlled use of fire for management of game has been an established practice for over 30 years in southeastern United States (58). It has been used to improve game and livestock ranges in parts of the West. As long ago as 1949 leaders in wildlife management were advocating the use of fire to improve habitat in these northern states as well (39). But, except in Michigan (29) little use has been made of this effective and economical tool in the north-central region.

Fire can be useful and may even be necessary for the conservation of some of our natural resources. Over-emphasis of the destructive aspects of fire without regard to its true role in the development of forests and wildlife habitat has made difficult land management practices which require controlled burning. There is a need to educate the public as to the value of planned controlled burning.

Forest management agencies are making use of fire to an increasing extent—more so in some parts of the country than in others. Some cooperative work with wildlife management agencies to determine the effect of burns upon vegetation has been carried out (9). However, we are a long way from the degree of coordination and use of fire that will have any important general impact upon wildlife habitat.

Forest management literature is replete with studies of the silvicultural use of fire. These works have timber management objectives quite separate from wildlife considerations but they may portend a more general acceptance of the use of fire in wildlife habitat improvement.

RECOMMENDATIONS FOR USE OF FIRE

The following general recommendations for the use of fire are made with the objective of producing the same kinds of favorable wildlife responses that have been achieved by wildfire, while at the same time safeguarding scenic, timber and cultural values.

1. Burn logging slash. This will result in improved seed-beds, remove obstacles to deer and grouse use, and make the cut-over areas more accessible to hunters.

2. Use fire to recycle aspen where stands are deteriorating and will be converting to balsam-fir due to a lack of commercial cutting. This will insure a stand of aspen 30 to 40 years hence and will provide abundant deer browse during the first five years after burning.

3. Use small, 10-20 acre, fires as a direct means of improving browse conditions in aspen stands adjacent to deer winter concentration areas. It has been demonstrated that fire during the dormant season will be followed by a great abundance of vigorous shrub and hardwood tree sprouting (9).

4. Use repeated fires in small areas to create and maintain openings in the forest.

5. Classify areas as to fire suppression importance. In some areas it could be more economical and of greater eventual benefit to the forest as well as wildlife, to let some accidental fires burn as long as they are within previously well-prepared boundaries and control lines.

Controlled burning techniques differ from place to place and a discussion of the details is not within the scope of this publication. We would, however, like to pass along the words of two persons with fire-use experience—words which we hope will serve to counter some common objections to the use of fire even when its values are recognized.

Jenkins in Michigan, where considerable burning for wildlife habitat improvement has been done, says, "Controlled burnings should not be looked upon as a dangerous experiment. Hundreds of accidental fires in different kinds of cover and in hazardous weather conditions are controlled every year by men without the advantage of warning or previous ground preparation. Certainly, these men can control fire on an area when it is adequately firelined beforehand and the fire set at their own discretion according to weather conditions" (29).

Buckman comments on the uncertain occurrence of suitable fire weather thus: "This obstacle is perhaps more serious for silvicultural uses than for such purposes as improvement of wildlife habitat or hazard reduction because many silvicultural applications require removal of heavy fuels including humus, or elimination or severe setback to competing vegetation" (8).

Weather limitations are one of the large obstacles to silvicultural burning; but, for wildlife benefits—where a severe burn is usually unnecessary or undesirable—advantage can be taken of the more dependable burning weather that occurs in springtime. Spring fires benefit deer habitat because they are more likely to foster heavy sprout growth. Spring burning should be done before ruffed grouse begin nesting.

SPECIAL PRACTICES FOR IMPROVEMENT OF FOREST GAME HABITAT

OUTLINE SUMMARY

Special practices carried out for the direct benefit of game habitat or hunting can be applied to key areas by agencies that manage large areas of land. They lend themselves well to use by owners of small acreages, can best meet specific, critical needs, and can be used to attract wildlife to a particular area. In general these practices are:

1. Creation of openings and trails in the forest.
2. Improvement of deer browse production.
3. Thinning and ground-clearing to benefit wildlife.
4. Release or planting of fruit-producing trees or shrubs.
5. Establishment of evergreen cover in extensive stands of aspen or hardwoods.

DISCUSSION

The practices recommended in this Section are intensive management practices primarily intended to benefit ruffed grouse and white-tailed deer on small key or critical areas. Agencies which manage large tracts of land should determine the location of such key or critical areas where intensive work can be expected to benefit wildlife on a larger surrounding area. In the case of the small-tract owner it is a matter of determining which particular practice might be applied to his unit of land with the greatest likelihood of increasing its attractiveness to wildlife.

Agencies that manage land on a large scale have considerable freedom in the use of intensive game management practices because they are not confined to working within the limits of a small acreage. The owner of a small, 40 to 160 acre, tract of woodland must analyze his particular situation to determine what aspect of game habitat can be improved by work upon his own land. He must also consider what the adjacent lands either supply or lack.

The primary objective of habitat management is to increase the game "carrying capacity" of a unit of land. To achieve this the land manager should ascertain the particular food and cover requirements of each animal.

If all the requirements are met within smaller units of area, the total area represented by these smaller units will have a greater carrying capacity than if each unit of area supplies only part of the animals' requirements. For game having a small home range, such as ruffed grouse, the small-tract owner can often provide all the requirements necessary. With wide-ranging game, such as deer, it is unlikely that an individual landowner will be able to manage enough land intensively to increase the population appreciably on his own land. If his land is within or adjacent to a deer winter concentration area, he may contribute materially to the survival of local deer during severe winters by making enough cuttings to improve the browse situation. Generally, however, the small-tract owner will be restricted to the secondary objective of habitat management to provide sites that attract animals during the hunting season. This will make possible the harvest of animals that are otherwise too widespread to be hunted effectively. Some practices are also of value for attracting wildlife at times of the year other than the hunting season. This will benefit photographers or others who enjoy seeing wildlife.

Several plans for incorporating the management of timber with that of game on small tracts have been presented in recent literature (52,53). Landowners may wish to defray the cost of game habitat improvement by selling the timber they cut but this is not always possible at present because of the over-supply of timber and transportation costs in many localities. Landowners who wish to manage their timber for a sustained yield as well as for wildlife should consult the foregoing sections of this manual and their local forest management agency.

CREATION OF OPENINGS AND TRAILS IN THE FOREST

Herbaceous plants form an important part of the diet of both deer and ruffed grouse (25,42,57). Dense stands of timber shade out such ground vegetation. The high food production value of openings compared to timbered areas has been demonstrated (27). Any attempts to increase or sustain the game population should include the creation of open areas that will be sunlit and productive of grasses and herbs. Natural openings that are already established should be preserved and maintained. Trails also serve this purpose if their edges are cut back to allow enough sunshine on the shrubs and ground cover. Seeding of trails and roadways with clover also serves to draw ruffed grouse out of timber to where the hunter can find them more easily. This poses no threat of overshooting because only a small proportion of the total grouse population moves far enough to encounter such trails.

1. *Openings*

Forest openings need not be large. Openings smaller than five acres in size and narrower than 330 feet in width have been found to be used more intensively by deer than larger openings in a Wisconsin study (43). It has been recommended that for the benefit of ruffed grouse 10 percent of the managed areas remain in open land (3). A Wisconsin authority says, "Five or six small open fields of one-half to one acre planted to legumes, mixed with an 80-acre wooded matrix would provide ideal interspersion for grouse" (15). This combination would be nearly ideal for deer as well. Some precautions are in order, however. Evidence compiled from several years of study of grouse survival at the Cloquet Forest Research Center suggests that it is inadvisable to establish openings in stands of large conifers. Here an opening may serve as an "ecological trap" for grouse by giving raptors an advantage over the grouse (25).

There are various means for creating and maintaining openings—cutting, bulldozing, chemical sprays, and fire. Removal of trees by cutting is the simplest method. All trees should be removed from the area selected. The area should be one without significant numbers of berry or mast producing trees and shrubs. In a study of such an operation in Pennslyvania it was found that root suckers and stump sprouts eventually convert the openings to sapling stands (51). By the seventh year after cutting, the openings were losing the herb and other ground-layer vegetation because of shading. At such a time herbicide might be used to set back the sapling growth. If the openings made by cutting are bulldozed clear of stumps they will maintain themselves longer. They will also produce more herbaceous plants and grass because the soil was disturbed. Experiments in using plant-killing chemicals to create openings have shown that this is an effective method only if used repeatedly or if the chemical used is a soil sterilant. Use of the latter, however, might also prevent the growth of desirable plants. Most means of developing openings create a considerable mass of dead timber. This should be dozed into a pile and burned. Pushing it to the perimeter creates a barrier to animal travel and provides a favorable approach cover for predators. Fire is the most economical way of making forest openings and its use is discussed in the section on use of fire.

2. *Trails*

Much that has been said about forest openings also applies to walking trails. Trails provide improved habitat for game and make it more likely that the desirable harvest of game animals will be achieved.

A good place for a trail to accomplish these goals is across southerly-facing slopes just above a lowland brush (alder or willow) area. A trail thus located will make an opening in the tree canopy that often will:

1. Provide dusting sites for ruffed grouse adjacent to the dense lowland cover that is used by adult grouse during their annual summer molt period.
2. Encourage an edge growth of herbaceous plants and food-producing shrubs adjacent to the cover type (alder swales) that constitutes the most satisfactory grouse brood range.
3. Provide open sites where grouse can sun themselves and be protected from the wind when the weather turns cold in late fall.
4. Provide an opening where snow will accumulate more deeply and which will have no obstructions for the birds when they plunge from full flight to make a snow burrow roost.
5. Insure early availability of green plants in spring by exposing a south slope to the sun.

Such a trail will also allow the hunter to flush grouse coveys before the fall dispersal or as singles seeking a home range of their own. Because grouse remain in the lowland alder habitat until frosts have killed the ground vegetation and the alder leaves before moving to upland sites, a trail along the edge between these seasonal habitats offers the hunter a particularly good opportunity of finding grouse—especially if the trail is sufficiently wide in parts to encourage berry-producing shrubs. Such a trail is also more likely to be productive of woodcock than a ridge trail and will provide a natural route for deer travel.

Seasonal or abandoned logging roads are good examples of woods trails which lend themselves to this type of development.

INCREASING DEER BROWSE PRODUCTION

Improved browse conditions are provided when shrubs are released from tree competition and when there is growth of stump sprouts, root suckers, and seedlings. When the ground is disturbed there is also an invasion by other kinds of plants present in the area. Such improvement occurs on large tracts that have been logged. Small scale timber harvests on privately-owned tracts will have similar benefits.

Where land ownership is in such small tracts as to make a cutting program impractical or where markets for wood are lacking other approaches can be used to improve deer browse. Intensive work will be most useful when applied to critical deer winter concentration areas.

The objective is to provide an adequate number of succulent shoots and sprouts of the desirable browse species within the reach of deer. There are three situations under which it is desirable to improve browse. The first is where hardwood browse species have been so intensively browsed that they now provide relatively little food for deer. The second is where, because of fewer deer in the area over a few years, the shrubs have 'escaped' from the deer and their succulent tips are now growing higher than deer can reach. Both of these conditions can be remedied by cutting the plant off near the ground or otherwise killing the top growth so that new sprouts from the root are induced. The third situation and the most important one for our deer herd is that progress of much of our forest to a climax stage is causing over-all shrub density to decrease. If there are not enough browse-producing shrubs present, pruning alone will not compensate for this deficiency. Removal of trees is the only action that will be of benefit. Opening the canopy to allow sunlight will encourage the growth and spread of shrubs. Additional young tree growth also may provide browse.

To benefit areas of significant size bulldozing, burning or herbicide spraying are necessary. This should be done on many small areas well distributed across the deer range. For the small-tract owner or when individual shrubs within a deer concentration area must be treated, cutting by hand has the advantage of inducing better regrowth and makes the cut tops immediately available to deer (34). Cuttings or bulldozing should be done in winter whenever possible so that deer may utilize the tips at a time when the need is greatest.

The Minnesota Plan for Emergency Winter Care of Deer (47) contains the following general instructions for deer yard improvement projects:

The cutting of natural browse for emergency winter deer feeding has proven to be the most efficient and economical method for supplying nutritious foods for deer in the shortest period of time. Such cutting of natural browse which provides food for immediate use by deer also stimulates sproutings from the stumps, thus improving food conditions in future years.

The recommended approaches and procedures are:

1. Locate and map areas where deer concentrate during severe winters. These areas can be upland or lowland sites, but will usually contain both hardwoods and coniferous trees. Yarding areas in Minnesota are of three general types:
   a. White cedar swamps. These are the best known and traditional "deer yards". Some have been so heavily browsed in the past that they now provide little in the way of available preferred foods. In these areas cutting of cull cedar and some cutting of brush

can be done, but stress should be placed on cutting along the upland edge of the yard where hardwoods can provide food near the cover. Cuttings can be made in and around the perimeter of this type of yard outward for a distance of 100 yards. Cull trees are those which are deformed, crooked, or rotted and which will not provide commercial timber.

b. Upland yarding areas. These consist of rather dense stands of balsam or other conifers which provide cover and also have enough hardwoods mixed in or along the edges to provide food. The classic example of this type yard is the Jonvik Deer Yard near Lutsen on the North Shore. In this type of yard cuttings of hardwoods should be made in and along the edge of the conifer cover. Balsam is of greater value for cover than for food.

c. Lowland yarding areas other than cedar. Balsam lowlands provide cover and some food for deer. Cull hardwoods and birch can be cut and brush cut within and around the perimeter of such areas for a distance of 100 yards.

2. Determine land ownership on areas where cutting is to be done. Secure permission in writing from public agency or private landowner to cut on specified tracts. Include in the agreement the species size, and amount and description of unmerchantable material to cut.

3. Cut deer browse species as follows:

a. White cedar. Prune some branches from commercial quality trees and cut occasional cull trees which are crooked, hollow, or rotted. It must be kept in mind that white cedar, once cut, seldom regenerates itself.

b. Brushy plants. For the brushy species listed below cut all stems on which there is no usable deer browse from ground level up to a height of five feet. These stems are usually one inch or more in diameter at ground level. Stems should be cut as near the ground as possible or at snow level. The tops should be completely felled so that they are available to feeding deer. It may also be necessary to cut off some branches from the felled tops to bring them within the reach of deer. Species to be cut in this manner are mountain maple, red osier dogwood and other dogwoods, willow, elderberry, and sumac.

c. Browse trees. For the following species thin out heavy stands or multiple stems by cutting unmerchantable cull trees first. Species to be cut are white birch, red maple, sugar maple, aspen, oak, basswood, and ash.

Special Practices

Do not cut cull conifers other than white cedar and do not cut tag alder or hazel. Alder and hazel are the most common brush species but alder is a starvation food and hazel is rated only as a fair food.

The three following plates (Figures 8, 9, and 10) illustrate recommended cutting methods.

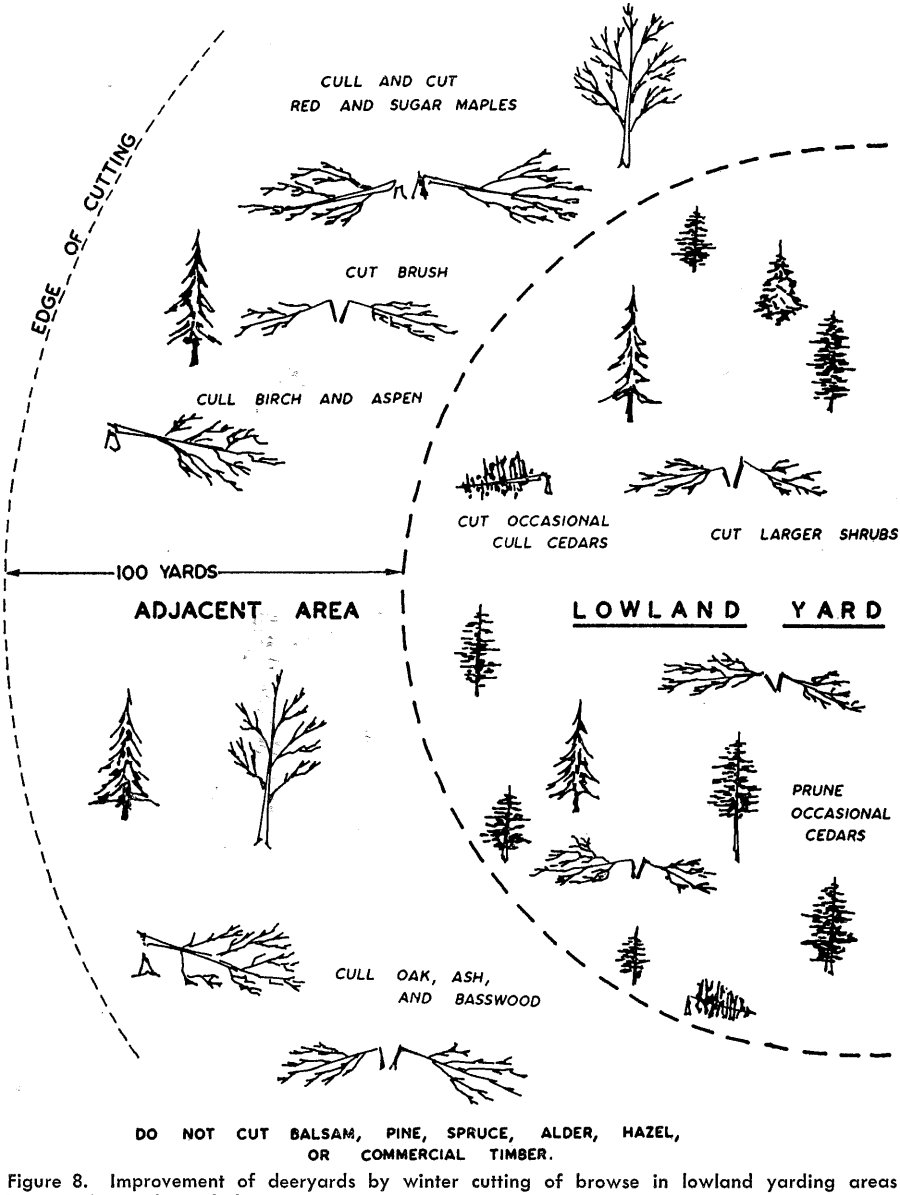


Figure 8. Improvement of deeryards by winter cutting of browse in lowland yarding areas having white cedar or balsam cover.

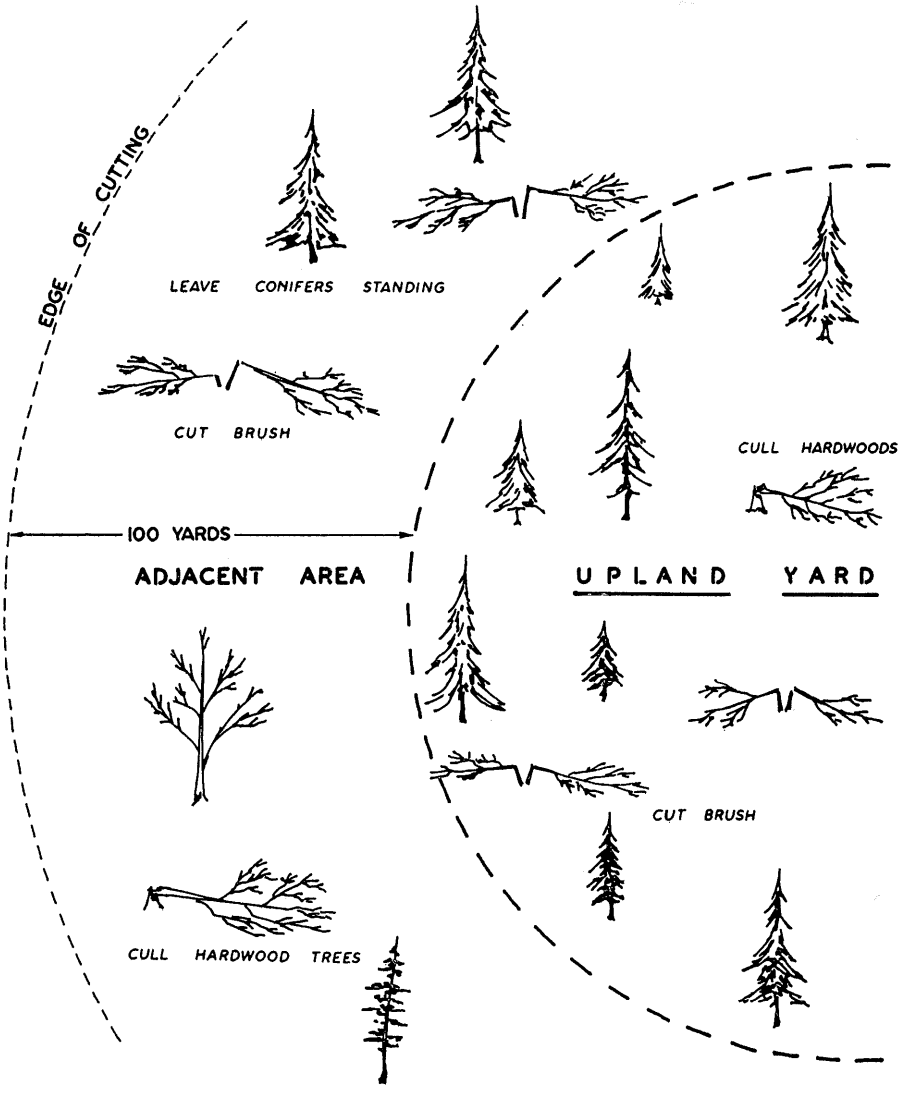
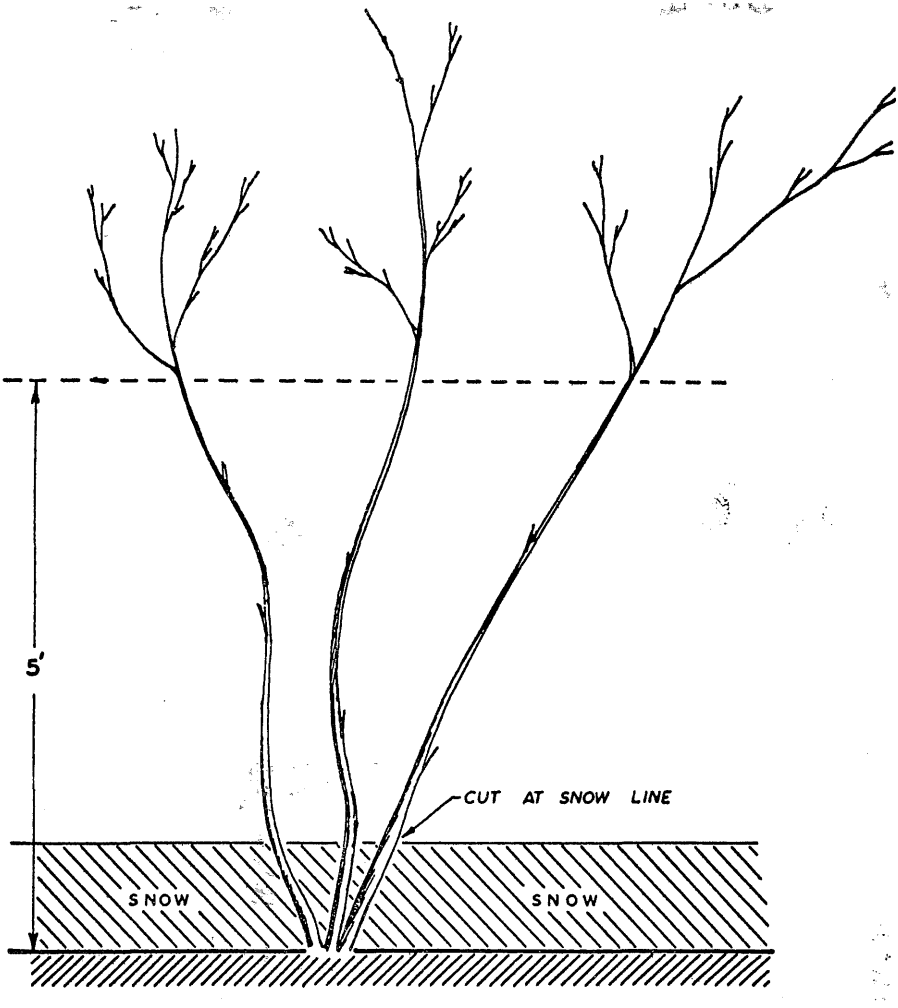


Figure 9. Improvement of deeryards by winter cutting browse in upland yarding areas of balsam, spruce or pine.



FOR SHRUBS WITH FEW, IF ANY, BRANCHES UTILIZABLE AS BROWSE UP TO FIVE FEET, CUT AT SNOW LINE. THE STUMPS WILL PROVIDE A NEW GROWTH OF BROWSE NEXT YEAR.

Figure 10. Winter cutting of mountain maple, elderberry, dogwood, sumac and willows for deer browse.

THINNING, CLEARING, AND DEBRIS REDUCTION TO ATTRACT WILDLIFE

The term "thinning and clearing" as used here has a somewhat different meaning than it usually has. We are here referring not to removals which induce sprout growth or improve timber stands but to a reduction of tree density and litter on the forest floor for the physical benefit of the animals themselves.

Work at the Cloquet Research Center has shown that grouse avoid cut-over areas where slashing has been left and prefer wooded tracts where the ground is less cluttered. It is thought that the accumulation of litter on the forest floor resulting from natural pruning, fallen trees, and logging debris produces hazards and impediments to movement of both young and old grouse. For centuries grouse have benefited from wildfire that cleaned up forest litter periodically. The wide-scale absence of fire has become important only during recent years. Park-like requirements for nesting are evident in the selection of nest sites by hens that offer effective surveillance over the terrain for a radius of 50 to 60 feet (25).

Brush piles, slashing, and other accumulations of litter also create opportunities for ambush by predators. To minimize losses by predators an effort should be made to keep cut-over areas clear of the usual debris. Prescribed burning to remove slash promises to be an important means of maintaining the best quality ruffed grouse habitat.

Although clearing up forest tangles chiefly benefits ruffed grouse, it is apparent from general observation as well as several deer behavior investigations that it is also of value to deer. A Maine investigation of deer shelter preferences points out that deer tend to seek parts of a forest stand where the canopy is closed and where natural pruning of lower branches allows easy travel and good visibility (17). A Wisconsin recommendation for browse cutting warns against producing an extensive dense tangle. Deer seldom utilize browse in the center of heavy growths and cutting of long narrow strips is suggested as a pattern to obtain greatest utilization (33).

It may appear that the habitat requirements just listed for grouse and deer are in conflict with previous recommendations for increasing the density of browse-producing shrubs and they are when applied to large areas. However, in good habitat—either natural or managed—the areas of forest density and openness are small and complement each other. The degree of their interspersion is a measure of habitat quality. The key to habitat improvement is proper distribution of required components throughout the animal's range.

Special Practices

The following recommendations are made to the holders of small acreages and to land management agencies that desire to carry out intensive habitat improvement.

1. Pile and burn slashings and accumulated woodland litter from numerous well distributed small areas to provide favorable grouse nest sites—keeping in mind the bird's preference for sites in proximity to mature aspen trees (25). Cuttings that have been made to provide supplemental winter deer browse can be burned in spring after utilization by deer is complete.
2. Avoid creating extensive tangles of either cuttings or sprout growth by confining management work to long narrow strips well distributed throughout the area.
3. Cut away lower branches from south sides of dense, low-growing spruce and other conifers wherever clumps of these species are surrounded by good quantities of deer browse shrubs such as mountain maple, red-osier dogwood, and Juneberry. This will make the trees more satisfactory winter shelter and will enable utilization of the adjacent food supply that might otherwise be unavailable.

It has been shown by work in Wisconsin that light grazing by cattle or sheep can increase the number of ruffed grouse inhabiting an area. The study reports that the ecological effect of light grazing seems to favor grouse for the following reasons: Light grazing on young aspen stands (3-5" d.b.h.) opens up numerous trails which provide dusting spots, succulent greens (e.g. clover, plantain, dandelions) and seems to encourage the growth of some berry shrubs such as dogwood, blackberry, and raspberry. It is believed that the bare ground resulting from the trampling of the stock provides the necessary seedbed for these shrubs. Furthermore the cow manure attracts insects and thereby may help the young chicks with this necessary part of their spring diet. This study was conducted on two areas, one of 60 acres, the other of 80 acres. The woodland was primarily aspen intermixed with alder, northern hardwoods and jack pine. It was grazed at the rate of 7 to 9 heifers per 40 acres. Aspen was recommended as the best type for the use of controlled grazing since the 1 to 6 foot shrub layer is usually more prevalent. Pasturing northern hardwoods and scrub oak was not recommended since the shrub cover in these types is already too sparse (15).

The foregoing suggestion does not apply to farm woodlots; often these are already overgrazed to the detriment of both wildlife and tree production. The use of grazing to enhance ruffed grouse habitat should be limited to heavily wooded areas where fields and clearings are scarce.

RELEASE OR PLANTING OF FRUIT-PRODUCING TREES AND SHRUBS

Clearing away competing and shading trees from around berry bushes and trees so they may get sunlight and set fruit is better than planting to improve this aspect of wildlife habitat.

On the other hand, such desirable plants are not always present and may not appear even after conditions have been established to favor them. Work in pole-timber hardwood stands has shown that canopy removal will release suppressed plants in the ground layer; but, if certain plants are absent from a site at the time of cutting, they may not appear afterward. In such cases artificial planting may be the only means of getting some species started.

Planting of berry-producing shrubs has its place but success at it has often been poor. The State of New York appears to have done the most work in this aspect of game habitat improvement. An investigation of some experimental plantings made in the early 1940's found a possible potential only for nannyberry, high-bush cranberry and persistent-fruited hawthorne (55). Another study investigated the value of seed-source plantings. These are plantings established to provide a source of seed for species of plants not normally found in some forest types. The seed-source plantings are made in especially prepared sites adjacent to logged or otherwise disturbed areas where new growth has an opportunity to become established. The plantings are made with the expectation of natural distribution of the seed from them into larger disturbed areas by birds and mammals. In theory this is a good method of increasing the distribution of desirable plants. In practice the work carried out in New York was not successful. However, it was found that many non-native species were planted and that heavy deer browsing was a problem (66).

In another experiment to provide winter food for wildlife attempts were made to establish certain crab apple, apple, pear, and hawthorn cultivars by grafting them to wild apple or hawthorn trees and by planting a few that could be purchased as small trees. Grafting by top-working proved to be the most practical method on the basis of cost, ease of establishment, rapid fruiting and freedom from wildlife damage. The small orchard type planting of purchased crab apples grew very poorly, and were subject to excessive animal damage (54).

Fortunately, berry-producing shrubs do not appear to be essential to the welfare of any game species in northern Minnesota. Planting of these shrubs

would have little value except as a method of attracting grouse to certain locations; thereby making hunting easier (26).

Planting berry bushes to attract grouse in fall has considerable appeal, however. One effective way to make the planting is to plant in long, zig-zag rows in a clearing about 20 yards from native woodland cover. The plants below are native species whose fruit is retained on the tree well into the winter or even spring if not eaten. They are hardy and will fruit if planted in the proper locations.

1. Highbush cranberry *(Viburnum trilobum)*

   This species does best on moist sites. It prefers sun, but will stand moderate shade.

2. Hawthorn or thornapple *(Crataegus* spp.)

   There are many species in this genus adapted to various site conditions. Some species retain their fruit into winter much better than others and these should be sought when looking for planting stock. In northern Minnesota the hawthorn is most commonly present along streams and lakeshores. This may be the result primarily of the effectiveness of water as a dispersal agent for the rather heavy fruit; and the thornapple certainly prospers in these well-watered locations. Such locations are also better exposed to sunlight than the forest interior.

3. Mountain ash *(Sorbus* spp.)

   This small native tree grows throughout much of northern Minnesota and is especially conspicuous along the rocky slopes near Lake Superior. It will probably do well everywhere but on sand. It appears to tolerate a fair amount of shade.

4. Smooth sumac *(Rhus glabra)*

   This attractive shrub prefers dry sites and requires full sun. It will die out if shaded.

The amount of shrubbery that the owner of a small tract might plant is not enough to really attract deer to the premises although deer passing through may browse heavily on certain species. Land management agencies might consider planting browse species on the perimeters of conifer plantations if they are not present in good quantity. It would be desirable to have planting stock of mountain maple and red-osier dogwood available for this purpose.

It is important not to put too much stress on planting—working with vegetation already present is far a surer, quicker, and less expensive way of

making the land produce more grouse (3). The owner of a small tract can accomplish the most toward berry production if he will seek out these shrubs where they grow naturally and clear away the competing vegetation from around them. The time to locate these native plants is in July and August when the presence of fruit makes them more conspicuous. In shade, however, most plants will set little or no fruit, so leaf and stem characteristics learned from those in sunny locations will have to be used to locate and improve those growing in dense woods.

Trails leading from one group of these released fruit-procedures to another can serve as convenient and possibly the most productive means of hunting a piece of woodland.

Recent research at the Cloquet Forest Center has shown the vital importance of the male aspen (popple) tree in the ecology of ruffed grouse (25). To get the most out of his land for the benefit of grouse the landowner should maintain these trees as per recommendations in the sections on Values of Timber Cutting and on Aspen management.

The planting and culture of fruit and browse producing shrubs as described here is practical only where intensive wildlife management is planned. It lends itself best to private management on small tracts or to intensive management on demonstration areas.

ESTABLISHMENT OF EVERGREEN COVER IN EXTENSIVE STANDS OF ASPEN OR HARDWOODS

Recommendations for achieving wildlife habitat improvement from conifer plantings on a large scale are given in the section of this publication which deals with reforestation and wildlife.

Recommendations in this section are directed to the owner of a small (40-160 acre) tract who wishes to enhance the game production on his unit of land. Conifer plantings should not be made without careful consideration as to whether they are necessary and will actually aid wildlife in the area.

Because grouse management is the small tract owner's greatest potential the recommendations from the Cloquet Research Station are particularly applicable. The long-term study of grouse survival there has resulted in a recommendation against the planting of conifers for the purpose of producing ruffed grouse cover. Pines are especially undesirable since in about 20 years they will provide ambush cover for the hawks and owls which are the primary predators of these grouse. Although balsam fir and spruce seem

to be less hazardous than pines, grouse survival where they are present is lower that in pure hardwood stands (26).

If deer habitat improvement is a goal, the following possibilities of conifer plantations should be considered:

1. Evergreen cover is of special benefit to deer only in the wintertime. If there is a fair amount of heavy evergreen cover within a half-mile of a particular tract, an additional planting is not necessary for providing winter cover for deer.
2. If the nearest good conifer cover does not supply adequate food—that is, if browse shrubs are scarce and/or overbrowsed or cedar is above reach of deer—conifer plantings may improve the deer carrying capacity.
    a. The best possibility is provided by sites where there is a shrubby growth of the preferred browse either as open brushland or as an understory to the smaller pole-size aspen. Here aspen can be cut to provide abundant sprouts if the browse shrubs should become scarce by the time the conifer cover provides shelter for deer. Sites with dense thickets of young aspen already too tall for browse or sites with large mature aspen are less desirable for evergreen cover plantings because of the uncertainty as to food production. Birch-maple or other northern hardwood types are relatively poor sites for conifer cover development because the shrub layer is usually sparse. An exception is where maple predominates and could be cut repeatedly to provide stump sprouts or where the entire growth is so open that good quantities of browse shrubs are likely to remain after conifer cover develops. The shrub growth adjacent to evergreen cover plantings must be of species that are useful as deer browse. Alders are of no value, and hazel and willows are only fair. The shrubby maples, dogwoods, Juneberries, cherries and sumac provide preferred food.
    b. Getting deer to utilize a food supply by providing cover first requires that the deer are able to reach the food. Deer are not likely to use an isolated patch of cover when there is deep snow. To be effective, the conifer planting must be within one-fourth mile of good existing cover. Ideally, 3 or 4 plantings should be made on each 40-acre tract.
    c. Plantings should be about an acre in size (about 200 x 200 feet). Smaller plantings are likely to be filled with drifting snow. A six

by six foot tree spacing should be used. Plantations of pine should be surrounded by several rows of spruce spaced to develop dense lower branching and thereby provide better wind protection.

d. Conifer plantings should not fill in forest openings—plant only part of larger clearings or clear new areas.

Transplants of large wild spruce and balsam have been made to shorten the time until the trees provide adequate shelter (35). These transplants were successful but the method is too expensive to use under the usual circumstances.

A plantation is not likely to be successful unless the ground is properly prepared and the young trees are released from competition. Concentrated deer and rabbit populations can add to the problems of survival for a small plantation (14).

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