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A Choose-and-Cut Pine and Fir Christmas Tree Case Study

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Introduction

Choose-and-cut Christmas tree farms are often operated on a part-time basis as a family activity. Because various family members may be involved, it is difficult to record and place a value on the time and costs required to establish, maintain, and finally market the trees over the life cycle of the plantation. Recording time and expenses becomes even more complex once additional plantings are established each spring and previous plantings become partially harvested.

In 1996 the authors purchased a small tract of land which adjoined an already established plantation. Because this was a separate and distant tract, we decided to keep accurate records in an attempt to make long-term decisions based upon facts. As a result we can report the following case study of the time requirements to establish, maintain, and harvest a 1.6-acre pine and fir plantation over an eight-year time period. Projections for year nine are provided. (Cassens (2002) published an earlier report on the same plantation.) Details on cultural activities, performance of different varieties of Scotch pine and different fir species, sales, and an estimate of production costs are included.

Cassens Trees was established in 1978 near Lafayette, Indiana. In 1986 the operation began to expand; and during the last ten years, about 15-20 acres have been maintained in Christmas tree plantations. Most trees are sold on a choose-and-cut basis, but some wholesale trees are also sold. All planting, herbicide application, mowing, shearing, and tree coloring are done by the owner, Daniel Cassens. Harvesting and sales are conducted with the help of other family members. The times reported here are for activities done on the 1.68 acre site only. Time spent on locating vendors, ordering supplies, advertising, record keeping, Web site development and maintenance, filing tax returns, attending professional meetings, and other "learning" activities are not included. The hours reported here should be considered minimal. They likely would be increased for inexperienced operators who are still learning basic procedures.

Seedlings and Mortality

Table 1 shows the species and variety of seedlings planted in the spring of 1996 as well as the number, height, age, and mortality. The seedlings were all stock items, except the Berkeley variety of Scotch pine that is a hybrid. Spacing was 6 x 9 feet.

First year mortality for the seedlings was variable; for some varieties of Scotch pine, mortality was excessive – over 10 percent. The high mortality for just two of the pine varieties, as compared to the others, indicates the problem likely originated at the nursery or during shipping. The mortality for the Douglas and Canaan fir seedlings was high, in the 17 to 19 percent range, but tolerable based on the potential value of these species.

Mortality for the Fraser fir seedlings ranged even higher, from 29 to 39 percent. No irrigation was used. Other plantations of Fraser fir have had better survival rates than this, and some have been worse. Although mortality is high,

Table 1. Species and variety, number, height, age, and percent mortality for seedlings planted in year 1 or 1996.

	Number	Height (inches)	Age (years)	Mortality [1] (percent)
Scotch Pine				
Breckland	135	6-12	2-0	49
Knieviey	200	6-12	2-0	24
Improved Pike Lake	150	12-15	2-0	10
Berkeley	100	9-14	1-2	1
Douglas-fir				
Lincoln	45	8-14	2-0	18
Deep Mountain	47	6-12	2-1	17
Canaan Fir	78	8-16	Plug +1+1	19
Fraser Fir				
Source 1	45	12-15	3-2	29
Source 2	41	9-15	3-2	39

[1] at end of first year

the number is again tolerable given the potential value compared to Scotch pine. We replaced dead seedlings the following spring.

Time Requirements

Cultural Activities

Of all the cultural activities (Table 2), mowing consumed the most hours (59 hours). We used a Ford 1600 tractor (23-horsepower) and a five foot rotary mower.

Shearing was the second most time consuming activity (57 hours) and was performed by hand with serrated knives. This is the most important cultural activity particularly for Scotch pine, as it is the shaping of the tree that makes the tree marketable. Initially, both the Douglas fir and true fir species were sheared with a knife in a fashion similar to Scotch pine. Toward the end of the cycle information on proper shearing was obtained and these procedures were used to the extent still possible (Sundback 2002a and b).

Scotch pine required the most time to culture, due to shearing. Our records indicate that shearing Scotch pine becomes a more time consuming activity as the plantation matures; whereas, fir trees take much less care.

Planting was the third most time consuming activity (32 hours). The initial planting was done by hand and required 20.5 hours, but subsequent replanting required an additional 11.5 hours. Herbicide application was the fourth most time consuming activity (31.5 hours). Herbicides were applied at least once a year to the fir trees and for the first 5 years to the Scotch pine. These applications were done with the same Ford 1600 and a PTO driven 60 gallon sprayer. Some spot application for poison ivy was also performed. Toward the end of the rotation, some insect problems began to develop. Scale was noted on some of the Scotch pine in 2001. Application of an insecticide was made in the spring of 2002 and the problem was controlled. At about the same time a spider mite infestation developed on the Canaan fir. It likely hurt the sales of these trees in 2002, due to the mottled brown color. The infestation was treated in the late spring of 2003, and some improvement in color was noted.

Table 2. Time in hours required for selected activities by year for a 1.68 acre choose-and-cut planting.

	Year									
	1996	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004[1]**	**Total**
Purchase Property	9.5									9.5
Site Preparation	13.0									13.0
Planting	20.5	9	1.5	1						32
Herbicide Application	3	6	7	2	4	3.5	2	2	2	31.5
Mowing	7.5	7	7	7	9.5	7.5	7.5	4	2	59
Deer Control	4	7		3.5	1.5					16
Fert. of Firs			2		1.5	1.5	1.5	4	4	14.5
Basal Pruning and Staking			8							8
Shearing			6	8	10	17	8	4	4	57
Applying Colorant					2	8	4	1	1	16
Pricing and Tagging					1	8	4	2	2	17
Pine Shoot Beetle						3	1			4
Insect Control							4	4		8
Wholesale Sales						1				1
Harvest Wholesale Trees						9	13	2		24
Choose and Cut Sales						80	20	10	10	120
Subtotal								405.5		
Total	57.5	29.0	31.5	21.5	29.5	138.5	65.0	33.0	25.0	430.5

[1] Anticipated

The remaining cultural activities of deer control, fertilization of the fir trees, basal pruning, and staking consumed 38.5 man-hours. Another 22.5 man-hours were invested in the purchase of the property and initial site preparation.

Tree Size and Marketability

Nearly all of the Scotch pine in this planting were marketable in seven years. Estimates in 2001 indicated that three percent of the Berkeley variety, five percent of the Improved Pike Lake, nine percent of the Breckland, and 18 percent of the Knievey were not marketable. The Knievey subsequently developed into saleable trees. By the end of 2003, 574 or 98 percent of the 585 trees planted were either selected by choose-and-cut customers or sold wholesale. Six to 13 percent of the Douglas-fir and Fraser fir appeared not marketable in 2001. Only one percent of the Canaan firs appeared to be culls. By the end of 2003, or after eight years, 80 of the 256, or 31 percent, of the fir trees had been sold. It now appears that 75 percent of the remaining trees will eventually be marketed.

A three-year time period to completely cut any particular pine planting is assumed. Most of the trees were removed as choose-and-cut trees during the first two years of harvest. These sales will be continued during the third year. The remaining salable trees, many of which will need to be shortened due to crooked trunks, are harvested one row at a time and sold as fresh cut trees at our farm or as wholesale trees. The fir trees have taken longer to develop.

Figure 1 shows the percent of all Scotch pine trees by variety and height class after six years. Comparison of the size distribution (Figure 1 and 2) and the mortality information (Table 1) demonstrates the importance of choosing the correct variety of Scotch pine. The Breckland variety would appear much better had it not experienced a 42 percent mortality rate. These remaining trees were replaced with other Scotch pine varieties and were included in Figure 1.

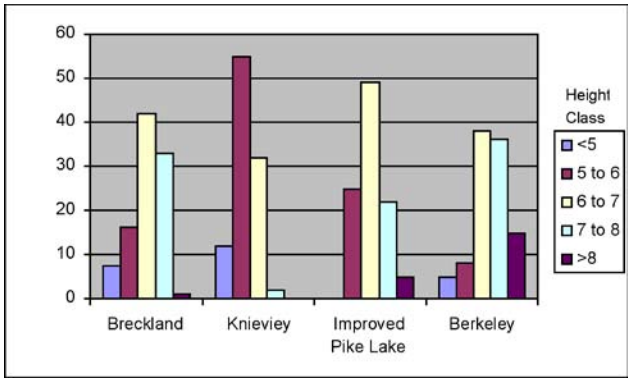

Figure 1. Percent of Scotch pine trees by variety and height class in feet after six years of growth.

Figure 2. Smaller Knieviey (first four trees in center row) as compared to Improved Pike Lake variety at the end of the row.

Figure 3 shows the percent of trees by height class for Douglas-fir, Fraser and Canaan fir after six years of growth and before any harvesting occurred. With the possible exception of about one-half of the Canaan Fir, the trees were still in a submerchantable size class. Important difference in height growth are apparent, however.

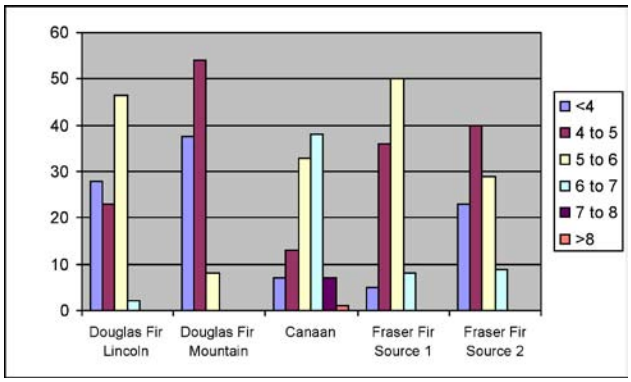

Figure 3. Percent of Douglas fir and true fir trees by height class in feet after six years of growth and before any harvesting occurred.

Figure 4. Deep Mountain Douglas-fir (first row on right) and Douglas-fir Lincoln variety (second row from right) and Canaan fir (third row from right) after six years of growth. Fraser fir are in the background.

Figure 5. Deep Mountain Douglas-fir (first row on right) and Douglas-fir Lincoln variety (second row from right) and Canaan fir (third row from right) after seven years of growth. Fraser fir are in the background.

Figure 6. Deep Mountain Douglas-fir (first row on right) and Douglas-fir Lincoln variety (second row from right) and Canaan fir (third row from right) after eight years of growth. Fraser fir are in the background.

The Lincoln variety of Douglas-fir has 48.5 percent of the trees in the greater than five-foot height class as compared to only eight percent for the Deep Mountain variety (Figure 4).

Finally, the Canaan fir produced more height growth than either source of Fraser fir or Douglas-fir (Figure 4, 5, and 6). Canaan fir and Douglas-fir tended to be a better quality than the Fraser fir. Seventy-nine percent of the Canaan fir trees were taller than five feet after six years. Figure 7 and 8 shows Canaan fir after seven and eight years of growth. Some of the better and taller trees had been removed by choose-and-cut customers.

Figure 7. Canaan fir after seven years of growth. For the tree on the left, note the openness at the bottom which is probably due to inadequate fertilization.

Figure 8. Canaan fir after eight years of growth.

When this plantation was established in 1996, we had very little technical information on the production of Douglas-fir and true fir species. Another adjacent plantation of Fraser-fir established earlier had done very well without the application of the many cultural practices now recommended for this species. One objective for the 1996 plantation was to compare the performance of two varieties of Douglas-fir, Canaan fir, and two different sources of Fraser-fir. Some very important differences are reported, and the plantation was somewhat successful. In general, the quality of the Douglas-fir is good. The Canaan fir out grew the Fraser fir and the quality of many was acceptable. The Fraser-fir grew at a slower rate and had lower quality. The trees were planted on a well-drained soil, which is particularly important for Fraser-fir.

Soil Factors

The important factors which were not known at the time the plantation was established included soil pH and fertilization levels. Soil tests for the fir planting were done in 1998 and again in 2003. Some fertilization of the fir planting had been done. A soil test of the area planted to Scotch pine was also done in 2003. This area had not been fertilized since the pine plantation was established. Based on this limited information, the P, K, Mg, and Ca were all low for the fir species recommendations given by Spectrum Analytic, Inc. (no date). Thus, the fir trees in this plantation were not adequately fertilized from the date of establishment. Over the years, some N, P, and K were applied to the fir species. The 2003 soil analysis showed the pH to be 5.3, which is appropriate for Fraser fir and a little low for Canaan, a nearly adequate level of P, excessive K, but the site is deficient in Mg and Ca. Although attempts were made to fertilize these trees based on the general recommendation that "fir trees need fertilizer", deficiencies still remained in P and probably N. The author was not aware that Mg and Ca were also deficient and important. Had the proper fertilization program been developed early in the plantation, this could have been a good crop of trees and the rotation cycle probably shortened. With the fir species, it is important that pH, macronutrients, and micronutrients be evaluated and adjusted as recommended by a competent agronomist familiar with the appropriate tree species. Due to varying requirements, species should not be mixed in the same block. The state soil testing laboratories this author was dealing with in the past did not have this expertise.

Costs

Cultural costs through 2003 or for eight years are given in Table 3. The total cost for eight years is $1,499, with the cost of the seedlings being the single largest expense followed by equipment for deer control and herbicides. Only the fir trees were fertilized; and had current recommendations been followed, this number would be substantially larger. Estimated cultural costs to carry the fir trees forward for another year are $87. The estimated cost of herbicide is $25; fertilizer is $50; and taxes are $12.

Equipment costs are provided in Table 4. A 23-horsepower Ford tractor is used with a PTO sprayer for herbicide and colorant application and for mowing with a rotary machine. In addition, a fertilizer spreader is necessary for broadcasting the nutrients needed for proper fir management. The total equipment costs for eight years are estimated at $1,035. Another $90 for herbicide application, mowing, applying colorant and fertilizer will be required to carry the fir trees forward for one more year.

Finally, sales costs of $1,080.50 are itemized in Table 5. Tree colorant is required for the Scotch pine but not for the Fraser fir. Some of the Douglas-fir are colored; it is probably advantageous to color this species. Using 2003 costs, $105 in sales costs are required to carry the fir trees forward for another year. Table 6 provides a summary of costs. Over the course of eight years, $3,614 was expended, or about $452 per year. For the 1.68 acre plantation, the cost per acre would be $2,157. To carry the

Table 3. Estimated cultural costs for materials and taxes in dollars for eight years

Item			Total for Eight Years
Soil Tests			$ 80.00
Seedlings			
Douglas-fir, 2-1, $.70 each @ 92 trees	70.00		
Fraser fir, 3-2, $1.50 each @86 trees	150.00		
Canaan fir, plug +2, $1.16 each @78 trees	116.00		
Scotch pine, 2-0, $34/hundred @585 trees	204.00		
		Total	$540.00
Herbicide $25/year			200.00
Insecticide			125.00
Fertilizer for Fir			100.00
Shearing Knives			
Cost 2 @ $30.00			60.00
Sharpening 2 @ $4.00 each for 6 years			48.00
Electric fence for deer control			250.00
Taxes $12/year			96.00
		Total	$1,499.00

Table 4. Equipment costs in dollars for eight years

Tractor with sprayer for herbicide application: 29.5 hours @ $10/hr	$295.00
Tractor for mowing with rotary mower: 57 hours @ $10/hr	570.00
Tractor with sprayer for applying colorant: 14 hours @ $10/hr	140.00
Tractor with broadcast applicator: 3 hours @$10/hr.	30.00
	$1,035.00

[1] Tractor was on site for 110 hours during sale times to power shaker but not included. Most operators would run an electric shaker.

Table 5. Sales costs in dollars for eight years

Tree Colorant $15/gal @ 50 trees	100 trees in 2000		$ 30.00	
	525 trees in 2001		157.50	
	250 trees in 2002		75.00	
	60 trees in 2003		18.00	
		Total	280.50	
				280.50
Tree Baler				250.00
Netting (netting used in 2001 - $50; netting used in 2002 - $50) netting used in 2003 - $20				120.00
Tree Shaker $1000 new - $100/year for 2 years and $40 for 1 year				240.00
Tree Boring Machine $800 new - $80/year for 2 years and $30 for 1 year				190.00
		Total		$1,080.50

Table 6. Summary of costs ($)	
Cultural	$1,499
Equipment	1,035
Sales	1,080
Total	$3,614

established and remaining fir trees for another year, the estimated cost is $282.

Marketing

Several activities lead up to and are involved in the final sale and harvesting of the trees. In total, these activities consume about one-half of all the time required (Table 2) to establish and maintain the plantation from the first year to harvest.

Typically, in a choose-and-cut operation, colorant is applied to many more of the pine trees than are eventually sold. However, judging from customer response and comments, the time and expense are well justified.

A price tag is placed in each tree that is for sale. This procedure allows a premium to be charged for the trees with exceptional quality, an average price for an average tree, and a discounted price for lower quality trees. The system also tells the customer exactly what the tree will cost before cutting. It improves efficiency and accountability at the time of payment. Because the tree is already priced, there is no need for measurement and discussion. The bottom half of the tag is simply retained for accounting records.

Four hours were spent working with the state entomologist in inspecting for the pine shoot beetle (which was negative) and obtaining a permit to ship the trees from a quarantined county to a non-quarantined county.

Finally, the amount of time required for selling is very dependent on the operation. This location opens on Friday after Thanksgiving and the following three weekends from 9 a.m. to 5 p.m.

Services provided, upon request, include field assistance, free tree shaking to remove dead needles, tree baling ($2 fee), drilling holes for trees for special tree-stands ($2 fee), and assistance in loading when requested.

Depending on volume of sales, one experienced person might manage this small plantation, but two people could be used, particularly at the busier times of the day and under good weather conditions.

With just one person in place for the eight days of sales, 80 hours are required. Nearly all of the trees sold at the Delphi location came from this plantation in 2001. The amount of time charged to this plantation was reduced during subsequent years as more trees came from other nearby plantations. Conducting sales has now become the most time consuming activity for this plantation (Table 2).

Sales

Table 7 summarizes sales information by year, species, and type of sale. Due to a shortage of small trees in adjacent plantations, we chose to begin marketing in year five. Just 20 of the larger trees were sold for $20 each.

In 2001, or after six years of growth, nearly all of the choose-and-cut trees priced at $25 or more were sold. The wholesale prices are approximately one half of the choose-and-cut value. Thus, including the small number of trees sold in 2000, $6,520 in gross income for the Scotch pine was received for 324 trees. Of the remaining trees, many were in the $20 price category and less than six feet tall. At this time, about eight percent of the total Scotch pine in the plantation were estimated to be culls and unsalable.

In 2002, 53 Scotch pine were sold for $1,250 as choose-and-cut trees while 142 were sold wholesale for $1,475. Only 55 Scotch pine remained in 2003, which brought a return of $1,107.

In 2001, 19 of the fir trees were sold for an average price of $47. In 2002, 22 fir trees were sold at an average value of $57.50 and in 2003, 39 more fir trees were sold for $59.62 each.

Table 7. Realized and estimated revenue of Scotch pine and fir by year and sales method.					
1	**Species**	**Type of Sale**	**Number of Trees Sold**	**Average Price** ($)	**Total Revenue** ($)
2000	Scotch pine	Choose-and-Cut	20	20.00	400
2001	Scotch pine	Choose-and-Cut	207	24.40	5,050
	Scotch pine	Wholesale	97	11.03	1,070
	Fir	Choose-and-Cut	19	47.37	900
				TOTAL	7,420
2002	Scotch pine	Choose-and-Cut	53	23.58	1,250
	Scotch pine	Wholesale	142	10.39	1,475
	Fir	Choose-and-Cut	22	57.50	1,265
				TOTAL	3,990
2003	Scotch pine	Choose-and-Cut	28	28.39	795
	Scotch pine	Wholesale	27	11.57	312
	Fir	Choose-and-Cut	39	59.62	2,325
				TOTAL	3,432
				SUBTOTAL	$14,842
2004[1]	Douglas-fir	Choose-and-Cut	79 59[2]	55.00	3,245
	Canaan fir	Choose-and-Cut	42 31[2]	58.00	1,798
	Fraser fir	Choose-and-Cut	62 47[2]	46.00	2,162
				SUBTOTAL	7,205
				GRAND TOTAL	$22,047

[1] Anticipated
[2] 75% of Remaining Trees

Due to a spider mite infestation, the 2002 sales were probably reduced. Given the current local demand for choose-and-cut fir trees, very few are sold for less than $40.

Table 8 provides gross and net revenue value and net revenue generated per hour of labor for this plantation at the end of eight years. Considering all of the trees which have been sold either as choose-and-cut or as wholesale trees at the end of eight years, $11,228 of net revenue has been received. This is $27.68 per hour of labor. If 75 percent or 137 of the remaining 183 fir trees are sold at average choose-and-cut prices in year nine, the net income becomes $18,151 or $42.16 per hour of labor. If all of the trees had been sold as choose-and-cut trees and if the remaining 137 fir trees are sold, the net income would be $21,776 or $50.58 per hour. This is probably the maximum value which could be generated. Conversely, if all of the trees were sold wholesale the revenue received would be about $8,186 or $22.46 per hour.

The gross income at the end of nine years should be about $22,047. The net income after subtracting all out-of-pocket expenses of $3,896 ($3,614 for actual expenses for eight years plus $282 estimated expenses for year nine) and the cost of 430.50 hours of labor at $10 per hour is $13,846 or $8,654 per acre. On a nine year cycle the return would be $962 per acre per year. The cost (value) of the land has not been considered.

Table 8. Gross revenue, net revenue, and net revenue per hour by cutting option.			
Cutting Option	**Gross Value $**	**Net Value $**	**$/Hour**
Choose-and-Cut/ Wholesale Through 2003 [1]	14,842	11,228	$27.68
Choose-and-Cut/ Wholesale Through 2004 [2, 3]	22,047	18,151	42.16
Choose-and-Cut Only, Through 2004 [2]	25,672	21,776	50.58
Wholesale Only, Through 2004 [4]	12,082	8,186	22.46

[1] Based on 405.5 hours
[2] Based on 430.5 hours
[3] Anticipated
[4] Based on 364.5 hours due to reduction in sales hours and pricing and tagging (Table 2)

For all choose-and-cut options the retail price was applied to wholesale trees. For wholesale, prices applied to retail trees. The value of choose-and-cut fir were divided in half.

Adjacent fields rent for $100 to $120 per acre. This small tract in itself is not suitable for traditional row crop production.

Note that closer spacing than our 6 x 9 feet would have increased the number of trees and the net income per acre.

Summary and Discussion

This report discusses time required for the production and sale of trees on a 1.68 acre choose-and-cut Christmas tree plantation. Actual income and costs for an eight year period and estimates for the ninth year are included.

For this plantation, the total time requirement over a nine year period is about 430.5 hours. Shearing accounted for 13 percent, and mowing accounted for 14 percent of the total time. Herbicide application and planting also consumed substantial amounts of time.

However, sales and marketing activities consumed the most time. Simply being on site to sell the trees during the first year required 80 hours or nearly 26 percent of the total time investment for the first six years. This time commitment also comes between the Thanksgiving and Christmas holiday season when families are particularly busy.

The study demonstrated distinct differences in survival, quality, and growth rate by variety in Scotch pine and Douglas-fir. Canaan fir grew faster and was more uniform than the Fraser fir.

The total value of all trees sold from 2000 to 2003 was $14,842. The expected revenue from the remaining fir trees is $7,205. Most of the Scotch pine were sold by the end of the seventh year. By the end of the eighth year 80 fir trees had been sold as choose-and-cut trees. One hundred and eighty three fir trees remain and it is estimated that 75 percent of these are marketable with an expected revenue of $7,205.

The Scotch pine, with the exception of a mortality problem in some varieties, developed

as expected. The quality of the Canaan and Fraser fir trees would probably have improved with proper fertilization. A mite problem also developed and went undetected in the Canaan fir during 2002.

The most important point to remember is the trees have no value until they are sold, and the window for sales opportunities is very short. A marketing plan must be developed and it must work. Just because the trees are available does not mean that they will all sell.

Since there will be no revenues for six years, the owner will need to absorb all costs in the interim. The final outcome can be influenced by any disease and insect problems which develop.

Finally, consumers' preferences can also change in the time frame required. The fir trees in this study were planted just as their popularity was increasing. These few trees (approximately 250) are projected to generate almost as much income as over twice (585 trees) the number of Scotch pine.

We are encouraged by the information and will continue to keep detailed records. It will allow us to make sound decisions such as the appropriate seed sources, species, and so on.

The tree farm has provided income for which our family is solely responsible. It has allowed us to attain a certain feeling of independence and security beyond a regular full-time job. However, the success of such an operation is also closely tied to a "love of trees," enjoyment of the type of work, and dedication.

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Spectrum Analytic Inc. No Date. Fertilizing Christmas Trees, Box 639, Washington Court House, Ohio 43160. www.spectrumanalytic.com

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forestry & natural resources
OUTDOOR RECREATION

Pathways for People

Trail Design to Minimize Environmental Damage and Enhance User Enjoyment

Wendy Hultsman, Asst. Professor of Forestry, and John Hultsman, Asst. Professor of Recreation and Parks

Trails can add considerably to the enjoyment people experience in outdoor recreation areas. Developed for a variety of activities, including hiking, biking, horseback riding, cross-country skiing, snowmobiling, interpretation and off-road vehicle riding, trails can be used to challenge, to teach or simply to provide recreation for a broad spectrum of users. For trails to encourage these activities and achieve these purposes, however, requires advance planning and careful design.

Individuals who design and plan trails have a dual responsibility. They must design for both environmental protection and use. Trails must be easy for resource managers to protect and maintain and, at the same time, be easy for people to use and enjoy.

There are a number of information sources available which deal with trail construction and upkeep, covering such diverse topics as surfacing materials, trail standards, signing methods and periodic maintenance (see "References"). However, there are two other, equally important considerations often ignored during trail development: trail design to minimize damage and to enhance enjoyment.

Designing to Minimize Damage

Trails are a valuable recreational resource which must be protected, and the most critical time to consider their protection or maintenance is during the planning and building phases, when problems can be prevented. If a trail is inadequately designed with respect to maintenance, it will not only require costly upkeep but will also provide a poor experience for users. The most prevalent forms of damage and therefore the ones to be most aware of during the design phase are damage caused by water and damage caused by vandalism.

Minimizing Water Damage

Level Terrain. When trails are located on primarily level terrain, water tends to pool on the trail tread. Building the trail surface slightly above grade allows water to move off the trail. Although this technique does increase initial construction costs, it decreases later maintenance expenses required to cope with pooled water and also provides a more convenient pathway for users during wet periods. A less expensive technique involves center crowning the trail so water moves to the sides rather than pooling on the trail surface (Figure 1). With either of these techniques, drainage escape channels, or "gutters," along the edges of the trail should be provided for runoff water.

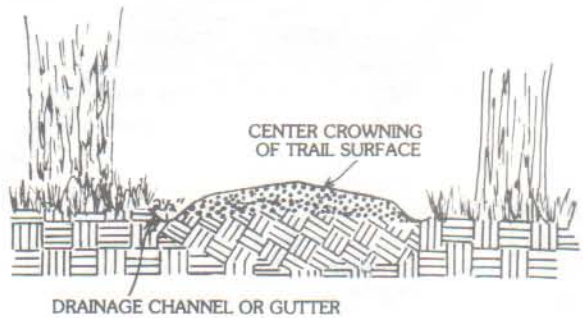

Figure 1. Center crowning of the trail surface allows water to move to the sides of the trail.

Hilly Terrain. Erosion caused by water movement is a major concern when trails are built in hilly terrain. Most such damage is caused by design and construction errors which allow water to build up volume and velocity. The key to reducing erosion created by water is to move the water off the trail surface as quickly as possible. One method to accomplish this is to outslope, that is, to build the uphill edge of the trail at a slightly higher elevation (2-3%) than the downhill edge (Figure 2). This encourages water to flow perpendicular to, rather than along, the trail surface, thus directing the flow off the trail before erosion can occur.

One of the most common methods for redirecting the downhill flow of water over trail surfaces is through the installation of water bars (Figure 3). This

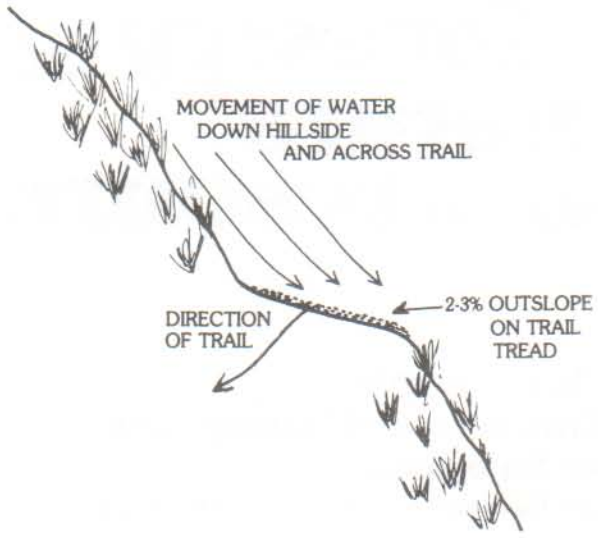

Figure 2. Section of a trail showing outsloped trail tread.

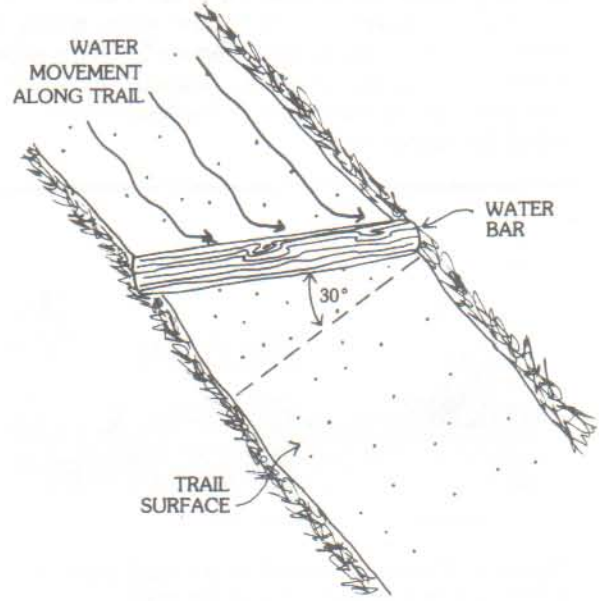

Figure 3. Water bars are used to redirect water off a trail surface.

involves placing sections of logs 4-6 inches in diameter across the trail surface at a 30° angle. The bars are placed at critical intervals to channel water off the surface of the trail. Water bars should be anchored firmly in place, with the uphill edge exposed to interrupt runoff and the downhill edge flush with the trail surface to permit users to step over them easily. Often, sections of logs, known as stabilizer bars, are also placed along the downhill side of trails to serve as retaining walls. However, stabilizer bars should be avoided in almost all situations, because the portion of these bars above the trail surface serves as a lip, encouraging water to remain on the trail where it can erode the tread.

A third method of minimizing the damage caused by water volume and velocity is through the use of grade dips (Figure 4). This technique works well on slow, steadily climbing trails. Short sections of trail, about 4-6 feet long, are designed at a grade opposite to the prevailing trail surface. These grade dips prevent water from building up downhill speed. The trail should be outsloped more at the point of the grade dip to provide a chance for the water to be channeled off the trail.

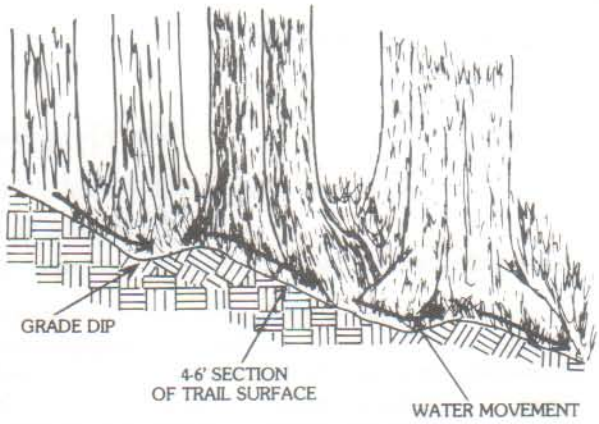

Figure 4. Grade dips work well on slow, steadily climbing trails.

Another method for protecting sloping trails from damage caused by water is armor plating. This involves placing a short section of reinforcing material (flat tiles or large stones) perpendicular to the trail surface wherever the trail crosses major drainages. This channels the water from the uphill side of the trail, across the trail surface, and down the continuation of the drainage. It is generally better to avoid placing culvert pipes under trails, since these tend to clog with leaf litter. Water then backs up and flows across the unprotected surface of the trail.

Finally, switchbacks, or hairpin-like turns, are frequently used on trails when the climbing grade is excessive (Figure 5). However, if the topography is steep enough for switchbacks to be necessary, then any type of trail construction will probably have an

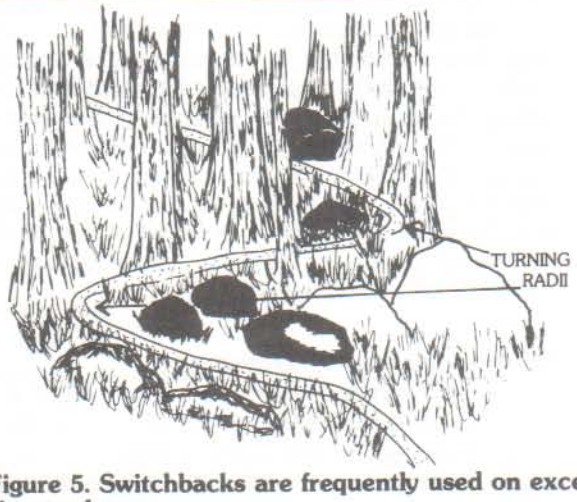

Figure 5. Switchbacks are frequently used on excessive grades.

erosive effect on the terrain. Thus, alternative trail alignments should be considered instead of using multiple switchbacks to cope with severe elevation changes. If inclusion of a switchback cannot be avoided, a 4 foot minimum turning radius is required for walking trails and an 8 foot minimum radius should be allowed for multipurpose or motorized use trails.

Minimizing Vandalism

Careful design can reduce the damage to trails caused by thoughtless users or vandals. For example, it is common along trails to see graffiti carved into smooth-barked trees such as American Beech. This problem can be reduced during the planning stage of trail development by two methods. First, the trail should be routed away from such trees as often as possible. Second, understory vegetation between the trail and these trees should be encouraged, and brush may be piled between the tree and the point on the trail nearest to it. While it is probably not possible to prevent users from leaving the trail to vandalize a tree, they can be subtly discouraged by measures making it difficult for them to leave the trail without an effort.

Combining incompatible trail uses can also lead to vandalism, as well as diminish the experience users have on a trail. Some trail functions, such as environmental or historical interpretation and hiking, should be kept segregated from each other. The moods you want to create on each of these trails is different. Compared to hikers, for instance, interpretive trail users seek a slower pace, more conducive to learning and observation than to vigorous exercise. Mixing these moods can lead to problems for users and management.

Another area of concern is vandalism of trail signs. Often, this type of vandalism is performed by people other than trail users. For instance, it is not uncommon for restless young people to cruise through parking lots looking for ways to release energy. A great deal of vandalism can be prevented by placing the signs designating the trail head out of sight of these parking lots, so they are not visible from passing cars. The beginning of the trail can be made obvious by opening the vegetation somewhat, and all necessary signing can be placed inside the trail head, but out of sight of the parking lot. With this technique, individuals who want to use the trail for its intended purpose will be able to determine where the trail starts, while those just passing through the area will not have any targets for vandalism. Similarly, most vandalism on trails seems to occur within the first 500 feet of a trail entrance. Placing expensive facilities, such as benches, beyond this zone should also reduce damage.

At times, damage to signs along trail sides may result from unintentional misuse. Given human nature, people may reach out and shake a sign post, just to see how secure it is. This behavior can be discouraged by placing signs just beyond arm's reach, although this will require using somewhat larger lettering on the signs in the interest of legibility and user convenience.

Designing to Enhance Enjoyment

It's not enough to design an easy-to-maintain trail or to design a beautiful trail winding through a scenic natural environment. A genuinely successful trail also requires that consideration be given to how the trail will be experienced by users. Designers can anticipate and thus enhance that experience by employing the techniques of design psychology.

The aim of design psychology is to use subtle planning and construction techniques to enhance the experience of trail users. The techniques should be unobtrusive enough to avoid calling attention to themselves. For example, a trail experience should convey a feeling of being in a natural environment, away from the intrusive influences of large numbers of other people. Toward this end, trails should be designed to reduce encounters with other users.

Loop Design

In addition to minimizing encounters with other users, loop trails avoid the need for users to backtrack. Backtracking can be monotonous for users, and it also doubles wear on the trail surface.

Loops permit users to "design their own experience" by providing alternative routes of varying length. A loop several miles long with cutovers, or internal connectors (Figure 6), provides trail options which might vary in travel time from 20 minutes to all day. Additionally, this design permits all users to end their experience where they began.

Figure 6. Loops with crossovers provide many options for trail users.

Curvilinear Design

Another method of reducing trail encounters is to use curvilinear design. This eliminates long tangents, which can create a boring experience, from line of sight and replaces them with gentle curves beckoning users to explore the next turn. However, caution must be exercised when designing motorized or bicycle trails. Although curves do present the users of these trails with varying degrees of challenge, the curves should not be designed so tightly that the trail becomes dangerous.

Curves should also be avoided where pedestrian trails cross a motorized pathway. These junctions should always be made at right angles to assure proper sight distance from all directions (Figure 7). Vegetation should also be thinned more heavily as a trail approaches an intersection. Safety is an important management concern when motorized trails cross other trails and when any trail crosses a roadway.

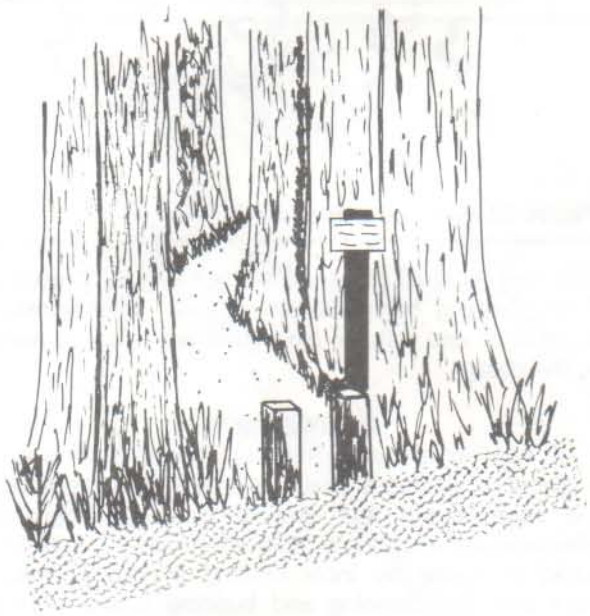

Figure 7. Trails crossing roadways should be at right angles to assure proper sight distance.

Using Vegetation

Even in areas of small acreage, it is possible to reduce encounters with other users. This can often be accomplished by taking advantage of existing vegetative cover. By leaving existing understory screening intact, it may be possible to have parts of a loop fairly close together, yet invisible from each other during some seasons of the year. Understory vegetation can also separate trails with differing purposes and users. For example, with proper vegetative screening, an interpretive songbird walk might be located near a segment of a hike and bike trail. Without the screening, the moods and behavior of the interpretive trails users and the hike and bike trail users would probably clash.

Deciduous trees and shrubs, however, will not provide dense screening from mid-fall to late spring. Thus, it is good practice to design trails during this period so planners can determine how much physical distance is needed between parallel sections of trails.

Using Topography

When a ridge system is part of the area being planned, the trail can be designed to circle the ridge. This approach reduces the encounters trail users will have by letting the ridge top separate parallel sections of trail. This practice affords a greater variety of scenery and allows any necessary gains in elevation to be made more gradually than climbing immediately to the ridge top. This technique should not be used, however, on longer trails where the severity of the slope of the ridge system precludes erosion-resistant cutovers or connectors.

Entries and Exits

Entranceways should be inviting and should encourage use. Thus, trails should not begin with a steep climb. Once into a loop trail, most climbs should be located where they can be traversed during the first half of the trail, before users tire. When the overstory vegetation at the trail entrance grows into the pattern of a tunnel, as in Figure 8, the results can have a negative psychological effect on trail users. The trail then becomes a darkened, uninviting place lacking in appeal. Variety in vegetative cover—mixing openings with vegetation—provides a

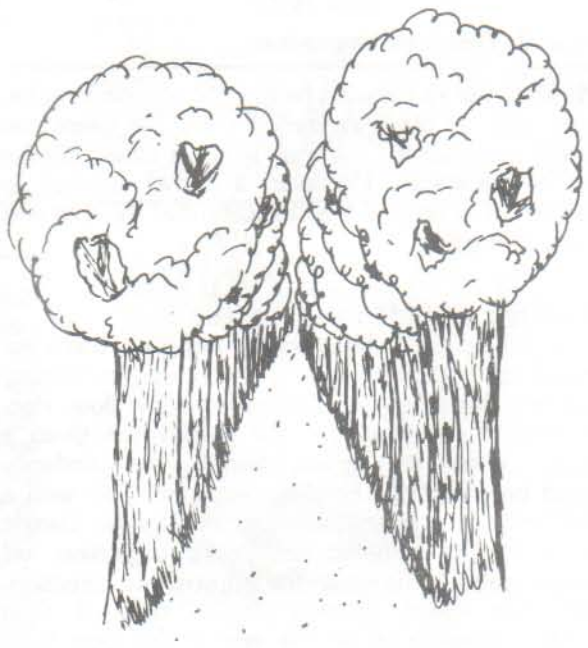

Figure 8. Overstory Tunnel Effect.

more appealing, interesting and secure environment for the trail user.

Whenever possible, a single entry/exit should be used for trail heads. This increases management's ability to control use of the trail. A single entry/exit also decreases user disorientation, since people exit the trail at the same point they entered it. As users approach the entry/exit point to begin the trail, design psychology can be used to focus their vision on the trail head. By creating an inverted "V" in the vegetation at the trail head (Figure 9), the user's vision is moved from a wide focal point into the narrower trail entrance. Coupled with this technique, the width of the trail tread can be reduced to draw users visually into the trail.

A single entry/exit will aid trail users in knowing where they are once they complete the trail. However, the final destination or reference point should not be visible from the trail until users reach the trail exit. This ensures that users will not leave the trail surface, taking shortcuts across and possibly damaging the natural environment.

At times, a single entry/exit is not feasible, due to existing terrain or other constraints. In these instances, the exit should be in sight of a parking lot, picnic area or other reference point the users can identify upon leaving the trail. In some cases, signing may be necessary. However, if a trail appears to need better signing, it may indicate that the trail was poorly designed.

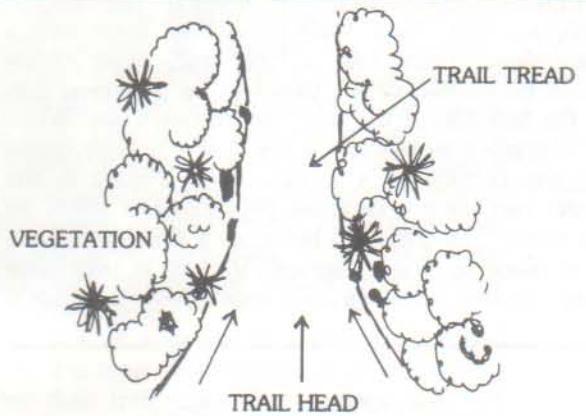

Figure 9. Trail head vegetation.

Directing Circulation Patterns

On a loop trail with a single entry/exit, there are several methods available to decrease uncertainty regarding the direction of intended traffic flow. People tend to move toward the right when given a choice. When the terrain permits, this tendency should be reinforced by designing loop trails with a right-hand, or counterclockwise, traffic flow. Gentle curves to the right at the trail's beginning will prompt users to move in the appropriate direction. With their vision focused to the right, it then becomes possible to tie the end of the loop back into the trail without making it appear as an alternative direction to follow. A reverse curve, in which an angle greater than 90° is used to tie the exit back to the trail, reinforces this effect. Note in Figure 10 that when the trail end might be visible from the trail head, physical objects, such as stones and vegetation, can be used to create a psychological blockade. Trail planning becomes much easier when existing vegetation and natural landforms are used to assist in the design.

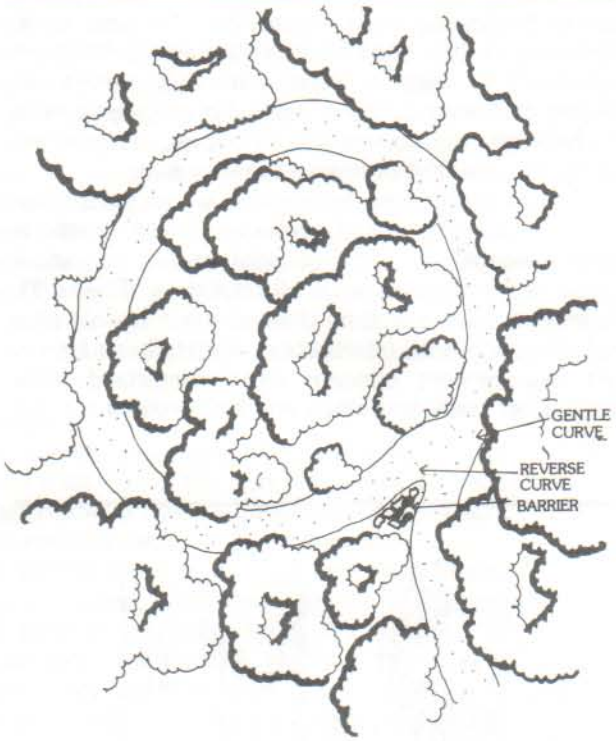

Figure 10. Reverse curve with barrier.

Summary

A number of design methods are compatible with a resource planner's dual responsibility of protecting the environment and enhancing user enjoyment. Maintenance efforts are most effective when used to avoid problems by incorporating preventive measures into the planning and building stages of trail development. Subtle techniques of design psychology can create positive experiences for users without intruding at a conscious level and destroying the "natural mood" sought on trails. With these methods, both new trails and old ones can be made to reduce problems and expenses for management personnel as well as offer a more enjoyable experience for trail users.

References

- Department of Natural Resources, "Indiana Trails Construction and Maintenance Manual." Division of Outdoor Recreation, Streams and Trails Section.
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forestry & natural resources

WOODLAND MANAGEMENT

Woodland Wildlife Management

by Brian K. Miller, Extension Wildlife Specialist

Introduction

Land management for any purpose requires planning, time, labor, and money. An efficient and cost-effective way to manage a parcel of forest land for wildlife habitat and/or recreational objectives is through timber management. Timber management occurs in three stages: regeneration, intermediate treatments, and harvests. When preplanned, all stages can create desirable habitat components.

A number of standard practices can be employed to routinely integrate wildlife management with intermediate treatments and normal forest management operations (Table 1). These suggested management practices provide valuable wildlife habitat while serving useful timber or land management functions such as soil erosion control or seedling regeneration.

Table 1. General management practices that can benefit wildlife.

General practice	Wildlife benefits	Timber mangement considerations
Protect woodlot from livestock grazing.	Provides increased mast availability, greater browse availability, and thicker stem density for cover.	Prevents soil compaction. Improves vigor and growth rates of trees. Provides greater regeneration and species diversity. Reduces decay and defects intimber.
Allow shrubs, vines, blackberries, etc. to develop along woods edge (or plant them).	Provides food and cover for wildlife. Provides early successional habitat required by many species. Provides highly productive habitat (many species live at woodland edge since they require more than one habitat type).	Gradual edge reduces wind and drying effects in woods. Timber quality is poor along forest edge; therefore, vines and undesirable species have less economic effect.
Allow felled trees to remain along edge of woodlot.	Provides cover. Produces insect souces for wildlife.	Saves time and labor cost to remove. Returns nutrients to the soil.
Plant conifers in small blocks (less than 2 acres) of up to 10% of the area. Most efficient when established on nonforested erodible areas. One to two rows of shrubs which provide wildlife foods (dogwood, highbush cranberry, crabapple, Washington hawthorn, [redacted] redbud, etc.) can be planted adjacent to conifer plantation.	Provides cover during harsh weather. Provides nesting habitat for songbirds. Provides food for wildlife.	Provides tree species diversity. Prevents soil erosion.

Management Plan

Overview

In some cases, management may be as simple as providing protection against grazing, insects, fire, and diseases. In others, more intensive management may involve frequent cuttings and intermediate treatments which substantially alter the forest character and provide new habitat conditions favoring certain wildlife species.

Habitat components that can be created include open water, permanent openings or old fields, conifers, crop fields or food plots, shrubs or early successional habitat, fruit bearing trees, beech stands, oak stands, or den sites. Concentrate on creating some of these components when managing your woodlot. Other practices, such as leaving buffer strips of unbroken forest along streams and roads, provides a contiguous habitat. This allows travel corridors for crossing property lines. It links your property with other important wildlife habitats in surrounding areas.

Wildlife management can be facilitated by using sound timber management to provide a diversity of habitats over the entire landscape. Many timber management practices such as timber stand improvement (TSI) or commercial harvests often favor a diversity of trees capable of providing food and shelter for wildlife. Due to the relatively small size of most privately owned forested tracts, few owners have the luxury of managing timber stands which accommodate all the needs of hawks, deer, or wild turkey. Consideration must be given to the habitat components available in adjoining stands, the wildlife and timber species most suited to a given site, and the habitat needs most limited for the primary wildlife species to be featured on the property.

Conduct an inventory of the property and identify current plant and animal species. Look for unique geologic features (springs, spring seeps, caves, outcrops, streams, potholes, wetlands, etc.) or vegetative features (den trees, desirable fruit producing species, snags) which should be protected or enhanced. Developing recommendations that satisfy the landowner's various objectives and stand conditions requires a thorough management plan.

Regeneration

Regeneration cuts are designed to encourage seedlings and saplings to grow in the understory or in newly created openings. Young trees will be the crop trees of the future.

Encourage this regeneration by using harvest methods such as shelterwood cutting, regeneration cutting, single tree selection, or group selection cutting which allows light to reach the understory and reduce competition from undesirable species. These practices also may be followed by controlled burns, herbicide treatments, and planting of certain seedling species to get the desired results.

Some species of songbirds that migrate to the tropics in winter, certain warblers, vireos, tanagers, and thrushes (also called "neotropical migrant songbirds") may require large units of forest habitat containing a limited amount of non-forest edge. Current research suggests nesting in close proximity (300 meters) to non-forest edges may be detrimental to some woodland songbirds due to higher concentrations of predators and nest parasites.

There are two types of edges; forest and non-forest edges. A non-forest edge is a distinct break between forests and non-forest covertypes such as agricultural fields, subdivisions, urban areas, and pastures. A forest edge is created when a regeneration cut or group selection cut is made. Tornadoes, high winds, and fire are natural forest edge creators. The edge is only evident for a short time (5-15 years), and then disappears as the regenerating trees grow larger. This type of disturbance provides a variety of

Forest edge

Non-forest edge

trees in the forest of different ages, tree heights, and densities, which are needed to provide nesting, foraging, and gleaning areas for various wildlife species. In fact, nearly 70 percent of the 260 wildlife species occurring in the central hardwood forest require successional stages of a forest less than 40 years old to meet at least part of their habitat requirement.

In some areas, especially near municipalities and in farming areas, the landscape has been fragmented by development and agriculture, leaving small, sometimes isolated woodlots. This situation is common in northern and central Indiana. In hilly, less arable areas, particularly in south-central Indiana, land that was previously farmed has reverted to forest cover, thus creating a more continuous forest canopy and a less fragmented landscape than in the first half of the 1900's.

It may be advantageous to manage a portion of the forest landscape in a way that minimizes non-forest edges for the wildlife species sensitive to this type of edge. Since this practice often requires large tracts of land, this may be accomplished most practically on public lands, corporate ownerships, or where several private landowners cooperate to accomplish a common management objective.

Intermediate Treatments

Intermediate treatments are a series of procedures designed to produce a stand of desired size and species composition. Most intermediate treatments are referred to by foresters as "timber stand improvement" (TSI). TSI can be accomplished through cull tree removal, precommercial thinning, commercial thinning, and vine removal. Most intermediate treatments provide products, including fence posts, firewood, lumber, pulpwood, pallet material, or specialty items, which can be used on the property or sold.

Cull Tree Removal

Cull tree removal eliminates diseased, poorly formed, or undesirable trees from the stand. Uncommon species, den trees, well-formed trees, and vigorously growing trees should be favored for both timber and wildlife management. **Decisions made during the culling process will be some of the most critical ones you make concerning wildlife on your forested lands.** Some tradeoffs have to be made between timber and wildlife interests, particularly when considering cavity trees (or den trees) and snags .

Cavity Trees and Snags

Cavity trees are living trees which have internal cavities. These cavities are created by injury, disease, woodpeckers, or loss of large limbs. The best cavity trees have healthy crowns, a cavity protected from rain, and may provide multiple benefits, including multiple dens and mast production, or contain woodpecker nests on large dead limbs. Because of the long time period required to produce a cavity tree, both existing and potential cavity trees with healthy crowns should be retained through any rotation to provide adequate den sites while a new stand is developing. Actively used cavities can be identified by smoothly worn entrance holes (bird nest), fresh gnawing around the entrance (mammal den), or observation of wildlife use. These should be retained, and additional trees with cavity potential may be left to achieve your objective. Cavities usually occur in tree crowns and may affect less than 20 percent of the total board foot volume.

Cavity tree

Snag

However, the retention of living cavity trees without timber value occupies growing space that could be devoted to a crop tree. But with careful selection, the best cavity trees only take a small proportion of the available growing space in the stand. Many rough cull and rotten cull trees are not good "den trees" for wildlife and may be removed from the stand.

Snags are dead trees at least 10 feet tall and at least 6 inches DBH (Diameter Breast High). They provide perches for singing, hunting, foraging, resting, and roosting, as well as foraging sites for insect-eating birds and mammals. In addition, woodpeckers, Northern flicker, Carolina chickadees, and black-capped chickadees can excavate cavities in these trees. Snags provide many of the benefits of cavity trees, such as shelter, areas for roosting, hiding, and nesting. In addition, secondary cavity users, which include many species of birds, mammals, reptiles, and amphibians, will also use these trees. Evenly distributed snags and cavity trees are needed in each habitat type (Figures 1 and 2).

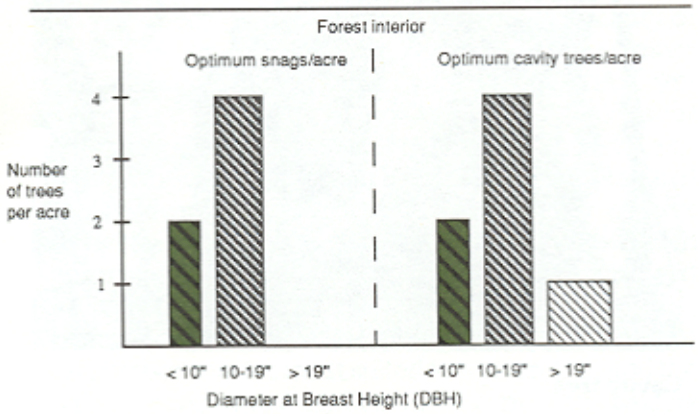


Figure 1. Proportions of snags and cavity trees per acre in each DBH class for forest interiors.

Over 50 wildlife species use the cavities found in snags or living trees for shelter. Many species of cavity users have specific preferences for living or dead trees, while others will use both. Due to the variation in size of these animals (Barred owl needs 20" DBH minimum, Carolina chickadee needs 4" DBH minimum), cavities of varying diameters are needed to accommodate them. In addition, these cavity using wildlife species may have specific preferences for heavily forested, semi-open, open, bottomland hardwood, or riparian habitats.

Since living cavity trees are more scarce than dead trees, they should be given preference when choosing trees to meet cavity objectives. Snag trees result from natural mortality and TSI operations. Thus, when selecting trees to remain as cavity trees, select species with long life spans (favor white oak species over black oak species) that attain large diameters. Also, choose trees with healthy crowns that are likely to remain in the stand for a long time. If a sufficient number of existing cavity trees are not available, select large trees which show cavity potential. Overmature trees or trees with woodpecker holes, physical damage, fungal infections, dead portions, or trees stressed by mechanical damage or disease are all good candidates. When deadening trees to create snags, only deaden trees larger than 19 inches DBH after your requirements for living trees in that size class have been met.

Approximately 90 wildlife species in the central hardwoods region depend on cavity trees and snags for food and shelter. In order to accommodate the needs of the widest variety of wildlife species, a mixture of cavity and snag trees of the proper sizes (Figures 1 and 2) should be left in each stand. For best

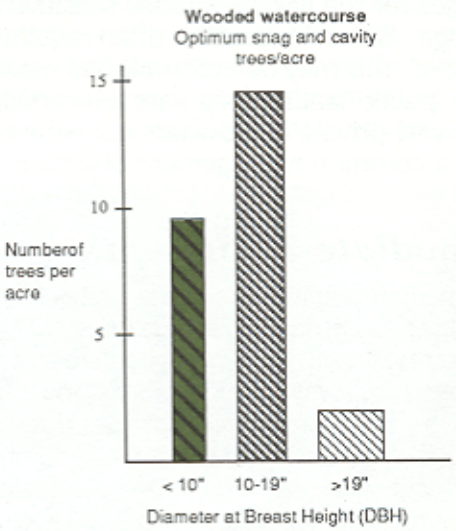


Figure 2. Proportions of snags and cavity trees per acre in each DBH class for wooded watercourse areas.*

* Because less harvest activity is recommended adjacent to water courses, a distinction is not made between snags and cavity trees. It is not necessary to deaden valuable cavity trees to achieve a given number of snags.

results, these structures should occur in both openings and mature forests. The retention of snags has little effect on the growth of desirable trees. In fact, leaving these trees in the stand saves time and money often spent on removal. In addition, the insect eating bird and mammal species these snags attract play a role in controlling insect pests in your woods. In forest interiors, the retention of six snags and seven cavity trees per acre of the proper sizes is ideal. Wooded watercourses provide an important type of habitat to a more diverse set of species. Therefore,

the optimum number of snags and cavity trees is higher—twenty-five snags and/or cavity trees per acre[1].

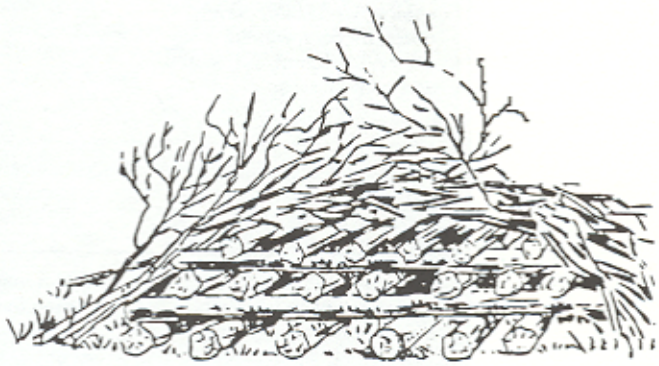
When a tree marked for removal is not needed for firewood, fenceposts, or marketable products, girdling the tree with a chainsaw and injecting the trunk with herbicide will remove the tree from competition with neighboring crop trees, save labor and time, and create snags. Avoiding deep girdling allows snags to stand longer. After the tree falls, it may serve as a drumming log for ruffed grouse. In addition, the decaying wood may provide habitat for over 65 wildlife species including salamanders, snakes, song birds, and small mammals. A fallen tree returns nutrients to the soil as it decays.

Steps in girdling a tree

Productive, mast-producing trees such as beech, oak, hickory, walnut, cherry, or maple, should be left in areas where production of this fruit is limited. In many cases, the same tree serves dual purposes. For example, one tree can serve as a cavity tree and mast producer, a timber tree and mast producer, or a timber and cavity tree.

Thinning

Thinning is designed to remove trees from an overstocked stand to allow more room for the desirable "crop trees" to grow, and reduce competition with the crop trees which already have crowns in the overstory. Forest stands benefit from a precommercial thinning when they are 20 to 50 years old. In some cases, a second commercial thinning may be recommended before the stand reaches maturity. The thinning process allows the remaining trees to maintain a rapid growth rate, and may provide some valuable products. Removed trees can provide firewood, fenceposts, small sawlogs, and other marketable products. The resulting tree tops and brush (slash) can be piled along edges, or other areas receiving heavy wildlife use, to provide cover. Piling brush on stumps, rock piles, or logs creates a space for wildlife underneath. In areas where deer use is heavy, thinnings during the winter may reduce browsing on desired seedlings by producing ample palatable browse at ground level from the resulting slash. A mixture of hard mast trees (oak, hickory, beech), soft mast trees (cherry, black gum, ash, sassafras, tulip poplar, and maple), and mast producing shrubs and small trees (dogwood, hazelnut, ironwood, and viburnum) should be available in every stand. A variety of white and red oak species should be selected in order to maintain more consistent acorn production from year to year.



Proper brush pile construction

When thinning sapling stands, maintaining less than 50 percent canopy closure can be accomplished through wide spacing (greater than 10 x 10 feet) between selected crop trees. This practice encourages rapid tree crown development and a diverse understory development. Thinnings scheduled at 10 year intervals will continue to promote understory development. These thinnings can also be used to release the crowns of selected mast and den trees through the poletimber and sawtimber stages. This practice maintains valuable wildlife trees and provides improved browse and herbaceous plants around trees already selected for wildlife (see Table 2 on page 6).

Harvest

There are many wildlife recommendations that can be incorporated into the harvest procedures to improve wildlife values (see Table 3 on page 7). With the exception of some songbirds, which may be sensitive to edge (discussed earlier in the text), most wildlife species found in the central hardwood forest

[1] Missouri Department of Conservation and U.S. Forest Service. 1985. Management of Snags and Cavity Trees in Missouri. Habitat Management Series No. 2.

Table 2. Timber Stand Improvement practices that can benefit wildlife.

TSI practice	Wildlife benefits	Timber management considerations
Retention of cavity trees can be concentrated within 50' of woods' edge (where timber value is lowest), or in wetland area, or adjacent to stream (where timber harvest is difficult or not recommended for water quality concerns).	Provides den and nest sites for wildlife.	Some cavity trees also may be timber trees. Provides a diverse bird and mammal population important to the ecology of the forest (i.e., squirrels distribute seeds; woodpeckers eat harmful insects, etc.).
Girdle nonmarketable trees which must be culled from the stand. Inject with herbicide instead of removing and leave existing dead trees or snags.	Creates snags which provide food sources for insect eating birds such as woodpeckers, nuthatches, etc. Creates perches for hawks.	Saves time and labor cost over removal . Reduces damage caused by felling cull trees.
Encourage mix of mast producing trees (red oak species, white oak species, beech, hickory, walnut, cherry, blackgum, ash, maple, and tulip poplar).	Provides food for wildlife.	Provides seed source for future tree regeneration. Many mast-producing trees are valuable timber- producing species--oak, cherry, walnut, hickory, maple, and ash. Diversity protects against insect and disease infestations that can destroy single tree species (i.e., Chestnut blight, Dutch elm disease).
Perform no TSI or management on inoperable sites (areas where logging equipment cannot reach).	Provides mature trees for species requiring this cover type.	Saves time and labor cost in areas providing no economic return.

require openings, edges, or early successional stages of forested habitat to fulfill a portion of their habitat requirements. An efficient way to manage for these species is to create their desired habitat component as a result of a commercial harvest. This makes the cost of the practice affordable, and provides an economic return to the landowner.

Uneven-aged Management: Small Forest Parcels

Uneven-aged management is a good strategy for small acreages, or areas that are to be maintained for aesthetic quality in a continuous forest canopy. Uneven-aged management also provides a steady, periodic economic return. Single-tree selection (individual trees selected for cutting) results in stands dominated by shade tolerant species such as American beech and sugar maple. This practice is most appropriate for wildlife species such as the wood thrush, box turtle, worm-eating warbler, and broad-winged hawk who do not require openings or shade intolerant mast producing tree species. Den sites for cavity nesting species requiring mature stands with canopy closure greater than 70% (barred owls and white-breasted nuthatches) and snags supplying food for insect eaters (downy woodpecker, red-bellied woodpecker, and Carolina chickadee) should remain when selecting trees for harvest. Additional trees can be provided by TSI considerations.

In order to provide mast-producing trees and shrubs within the stand, managers often combine group tree selection with single tree selection within the same forest. If this is not possible, food and structure diversity can be provided for wildlife by planting fruit producing trees and shrubs along woodlot edges and edges of log landings. Keeping the forest canopy open over logging roads (daylighting) to stimulate shrub production is another way to provide these needs. Supplemental food can be provided in food plots located along woodland edges, in log landings, or by leaving some waste grain or standing grain in adjacent fields.

Regeneration Openings

Regeneration openings are created in the forest canopy to stimulate regeneration of shade intolerant mast-producing tree species, such as oak, tulip poplar, cherry, ash, etc. In small forest ownerships, this

Table 3. Harvest practices that can benefit wildlife.

Harvest practice	Wildlife benefits	Timber management considerations
Design regeneration and group selection openings with irregular boundaries when possible.	Provides browse, nesting, food, and escape cover. Increases habitat interspersion.	Regenerates shade-intolerant species (oak, tulip poplar, ash, cherry, walnut). These are cost effective harvest strategies.
With strip cuts, clear-cut timber in strips 60-300' wide, spaced 600-900' apart. Position cuts to run perpendicular to the slope.	Provides continuous supply of ample browse, food, nesting, and escape cover. Ensures availability of plants and earthworms with varying moisture conditions.	Regenerates shade-intolerant species. Provides regular economic return through pulpwod sales.
Remove 60 percent of overstory around spring seeps. Optimum when most remaining trees are mast producers. Insure that all slash is removed from seep area.	Provides food around spring seep areas which do not freeze and provide water and accessible mast all winter.	Provides areas for seed production. Growth can be concentratedon valuable timber trees.
Perform TSI and harvest operations in late fall or winter when possible.	Causes least disturbance to wildlife. Provides browse during most critical period of the year. Increases sprouting which results in excellent cover.	Increases stump sprouting of many species. Causes less soil compaction and erosion.
Make brush piles near edge of woodlot or logging road.	Provides cover for mammals and ground-dwelling birds near areas of greatest activity.	Concentrates brush in areas producing the poorest timber, thus allowing greater freedom of movement for maintenance and seedling regeneration in high quality areas.
Seed permanent logging deck and/or logging road with grass-legume mixture or encourage native herbaceous species on nonerodible sites. Openings can also be created on utility rights-of-way, poorly stocked stands or regeneration failures (maintain 5-10% of unit) in openings.	Provides insects for wildlife food, nesting cover, and forage for consumption. Provides travel lanes and links wildlife openings.	Prevents soil erosion. Maintained roads can be used for hiking, horseback riding, cross-country skiing, and woods access for maintenance. Maintains logging deck in permanent condition for future harvest operations.

is most commonly accomplished through group selection cuts which are usually 1/2 acre in size or greater. A dense growth of tree seedlings and other woody plants will flourish in these openings. Many of the species found there, such as dogwood, serviceberry, raspberry, and viburnums, provide a diverse food source for wildlife species, and a shrubby understory structure preferred by many bird and mammal species (summer tanager, indigo bunting, cooper's hawk, sharp-shinned hawk, and rabbit). In 5 to 15 years these early successional plants will be dominated by mast producers, eventually providing acorns, cherries, and walnuts. Since these openings are constantly changing, subsequent cuts should be planned every 10 to 20 years to create a diverse forest with well-distributed, small, even-aged tree groups of various ages and species.

Regeneration opening

The production of mast can be enhanced during future thinning operations in these openings. Leaving den, snag, and mast trees along the borders of group selection cuts, openings, roads, and stream corridors places these important trees in areas of high wildlife use and reduces conflicts with timber production.

Excessive slash may be removed in regeneration openings through firewood cutting or controlled burning to permit free movement of ground foraging birds such as woodcock, wild turkey, and grouse. It also enhances the regeneration response. If visibility is obstructed in all directions at ground level, or it is difficult to walk through the opening, some slash should be removed. However, in areas where deer browse is heavy, dense slash will restrict deer access and permit sprouting and growth of seedlings.

Semi-Permanent Openings

If managing for a diversity of wildlife species, at least 5 percent of the management area should be in herbaceous or grass/forb openings. This requirement can usually be met by maintaining logging roads, log landings, and portions of adjacent fields to herbaceous cover suitable to wildlife. If additional openings are required, herbaceous cover can be established in regeneration cuts or group selection openings. When possible, openings should be irregularly shaped and 1-10 acres in size.

Semi-permanent opening

The log roads and skid trails connecting these openings improve access to wildlife and provide access for maintenance. Openings placed on poor sites , including southeast exposures, narrow ridges, poor soils, or frost pockets will last longer and cost less to maintain, but they are less productive. Such openings provide roost cover and singing sites for woodcock; insects for grouse and turkey broods; forage for deer, rabbits and other herbivores; nest sites for songbirds; and seeds for food for many wildlife species.

Insects are a primary food for many young birds including wild turkey and ruffed grouse chicks. Insect production can be 25 times higher in clearings than in adjacent forest undergrowth. Insects can be enhanced by incorporating legumes or forbs in the seed mixture for these sites.

Openings seeded with agronomic forages should be maintained by periodic mowing to control encroachment of woody and unwanted vegetative species. Once a good stand is established, mowing should be kept to a minimum (it may not be required every year) and conducted after the nesting season is complete (August 15). Mowing as early as possible after this date will allow for some regrowth before dormancy, providing some cover during the winter months. Native plant communities can be maintained by mowing after August 15 every one to three years. A mix of agronomic forages and native plant communities on your property will provide high-quality forage early in the growing season and seeds, cover, and forage later in the year.

Firewood Cutting

Cutting timber for firewood is a common practice in uneven-aged management. If cutting firewood is a management objective, either for additional income or for personal use, concentrate firewood cutting to within 25 to 50 feet of the logging road, or within 30 feet of the woodland edge. Small trees or shrubs with wildlife value can remain. This practice creates browse, fruit production, cover, and insect production in the most beneficial locations. At the same time, these practices provide easy access to firewood and require minimal loading time.

Even-aged Management: Large Forest Parcels

Even-aged management ultimately results in a complete overstory removal (regeneration cuts) which creates openings and favors future mast trees for the wildlife species mentioned above. If you do not wish to cut an entire stand, cutting 2 to 10 acre patches every 10 to 20 years periodically increases browse, creates habitat for wildlife species requiring early hardwood successional stages and still provides areas for regeneration of shade intolerant tree species.

Regeneration cuts create areas abundant in herbaceous growth and young woody stems which provide preferred food for deer and most other herbivores (rabbits, voles, and woodchucks). The resulting dense vertical cover provides the needed feeding habitat, protective cover, and nest sites for woodcock, ruffed grouse, yellow-breasted chat, indigo bunting, brown thrasher, blue-winged warbler, and many other species. As these young stands

regenerate and begin to mature, they go through a period (25-40 years old) where herbaceous forage, browse, and cover for species like woodcock and grouse are no longer available and hard-mast production has not yet begun. During this period, several required wildlife habitat components are not present in this stand. However, these required components can be provided in adjacent stands. Through proper planning, the landscape as a whole can fulfill all the necessary habitat requirements for wildlife. However, there are a few practices that can be used in regeneration cuts and final shelterwood harvests to increase their wildlife value over the entire life of the stand.

Large forest regeneration openings can be further enhanced for wildlife use by retaining snags and mast producing trees within the opening. Retaining some mast producing trees in this area will increase potential food for wildlife during the first 40 years as the young regenerating trees reach mast production age. Individual trees left in an opening are subject to windthrow, lightning, dieback, and disease. Therefore, leaving trees in small groups or clumps increases the life expectancy of each tree and provides irregular boundaries around the opening. This is needed and most practical in large clearcuts (20-40 acres) that cover an extensive portion (>50%) of the forest. Any live trees which are selected to remain should be sturdy and not susceptible to wind throw, and be capable of responding to increased light (usually 6-12" in diameter with a good crown). Leaving small clumps of trees (two 1/6 acre clumps or one 1/3 acre clump per five acres) on points, rocky ledges, wet areas or inoperable sites, increases harvesting efficiency and creates the least interference with regeneration objectives. These clumps should contain snags, cavity trees, and a mix of hard mast and soft mast trees. Snags are important in regeneration openings. When isolated snags are left, one or two adjacent live trees should be retained with them when possible. Where natural snags are limited, unmerchantable trees can be girdled and left standing, thus reducing operation costs and time.

Generally, the management of 5- to 20-acre irregularly shaped timber stands, some of which are harvested every 10 years over an 80 to 100 year rotation, will result in a mixed timber stand of different ages. The well-dispersed stands of timber in early successional stages will benefit most forest wildlife species (Figure 3). Under the above recommendations, 40% of the timber in commercial production will favor pioneer wildlife species (eg. white-tailed deer, ruffed grouse, blue-winged warbler) by providing stands less than 40 years old on a 100 year rotation. On an 80 year rotation, 50% will be in this cover type.

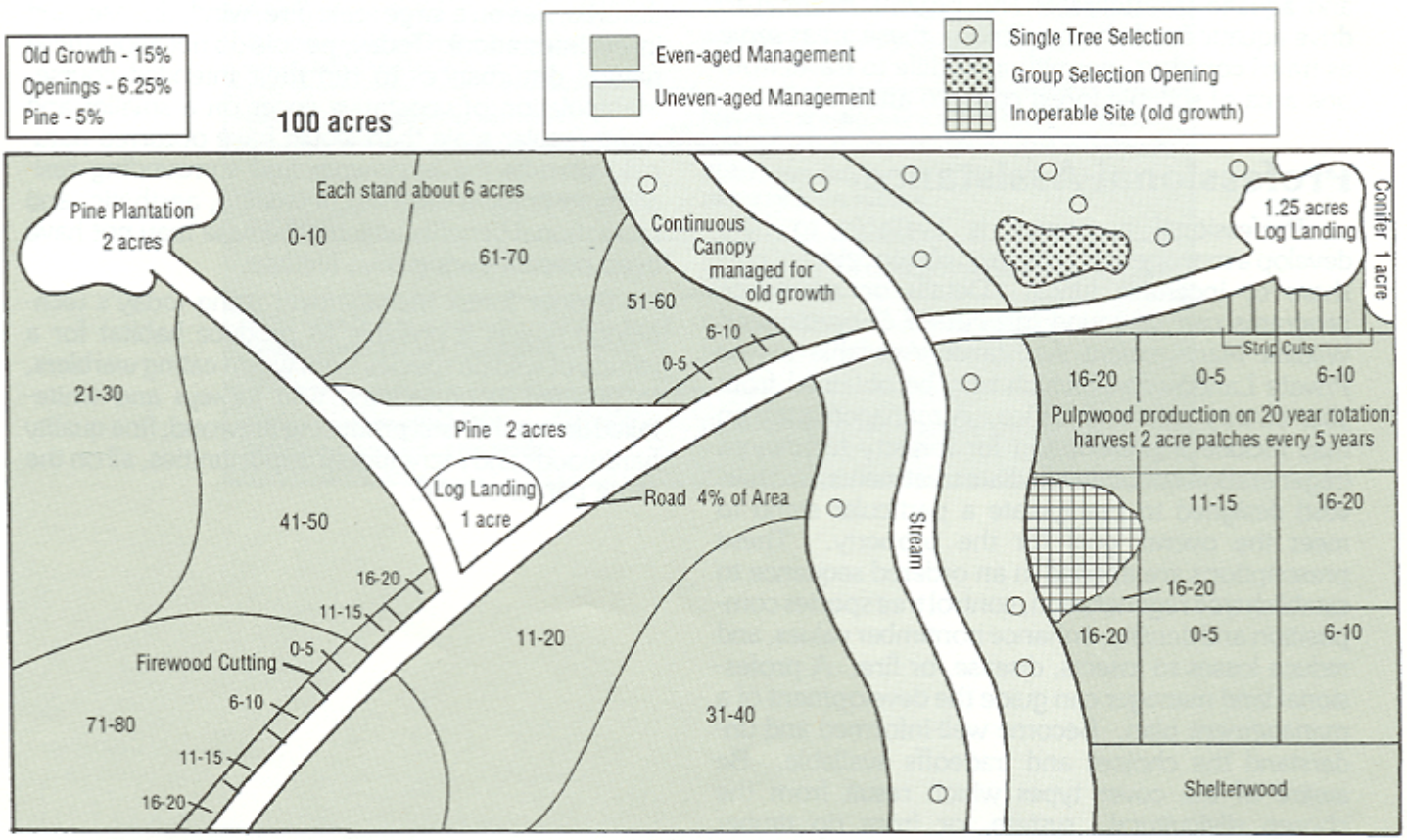


Figure 3. Example of various management options interspersed on one property (numbers represent ages of cuts in years)

Intense management for early successional wildlife species (eg. American woodcock, ruffed grouse, and chestnut-sided warbler) can be obtained on selected parcels by shortening stand rotations to 20 to 40 years. Small stands of two to five acres should be cut at five year intervals to maintain an even distribution of five year age classes. Maximum interspersion is created when cuts are made in a checkerboard pattern. This type of management fits well with commercial production of hardwood pulpwood, firewood, or specialty products.

Stream Habitats

Special attention must be paid to areas along streams when conducting even-aged management techniques. A good recommendation for wildlife management is to use single tree selection in wooded areas within 150 to 200 feet of a stream. These areas can be managed for older aged trees and provide a continuous canopy for edge sensitive wildlife species. Group selection and shelterwood cutting may be used to enhance production of shade-intolerant species where providing a continuous canopy is not an objective. Live cavity trees are very important due to the diversity of cavity-using wildlife species in this habitat type. These buffer strips along streams also provide streambank stability, filter sediment from erosion, provide shade and cover for fish and aquatic invertebrates and organic material to drive aquatic food chains. Finally, these areas serve as travel corridors, permitting wildlife to travel from one area of suitable forest cover to another.

Professional Assistance

Professional assistance is available to help develop a management plan and obtain relevant cost share or incentive funds. Details on assistance programs can be found in FNR-87 "Forestry and Wildlife Management Assistance Available to the Private Landowner," which may be obtained from your county extension office. A management plan may include a prescription for forestry techniques (regeneration cuts, intermediate treatments, and harvest) designed to manipulate a particular stand to meet the overall goal for the property. These prescriptions are applied in an ordered sequence to establish tree regeneration, control tree species composition and density, enhance nontimber values, and reduce losses to insects, disease, or fire. A professional land manager can guide the development of a management plan. Become well-informed and understand the choices and tradeoffs available. Be aware of the cover types which result from the chosen silvicultural system, or from no timber management at all.

Wildlife Management in Addition to Timber Management

Additional measures can be taken to enhance wildlife in a forest which may not enhance timber production (Table 4). Some of these practices may involve input costs. Therefore, the extent to which these are practiced depends on the budget and management objectives of the landowner.

Most of the practices recommended in this publication are general management strategies and will benefit a broad array of wildlife species. To intensify management for a particular wildlife species, contact your Indiana Department of Natural Resources, District Wildlife Biologists for specific recommendations for your property.

Conclusion

Past mass removal of forest tracts left Indiana with extremely fragmented woodlands. Many remaining woodlands have not been managed for long-term objectives such as sustained timber production or wildlife habitat. This deprives landowners of forest-related opportunities. Natural processes have been managing forests for centuries using natural disturbances on a large scale (fire, wind, disease, and insect infestation). Today, people do not allow these natural disturbances to run their intended course. Manipulation of vegetative cover on a smaller and more regular scale than would have occurred naturally permits the landowner and surrounding residents to enjoy a diversity of wildlife, aesthetic, and recreational benefits which otherwise may not have been present during their lifetime.

Proper forest management using today's technology makes it possible to produce habitat for a variety of wildlife species from worm eating warblers, to pileated woodpeckers, wild turkeys and white-tailed deer, while still producing firewood, fine quality hardwoods and recreational opportunities, all on the same parcel of land.

Table 4. Wildlife habitat improvement in addition to timber management.

Management practice	Comments
Plant small food plots containing a variety of foods or leave a small portion of adjacent field crops unharvested.	Provides food where natural supplies are limited or during deep snow and late winter when natural supplies are unaccessable.
Encourage fruit trees - release old existing ones. Plant new ones around edge, in odd areas, etc. where enough light exists.	Provides food where natural supplies are limited or during deep snow and late winter when natural supplies are unsuccessful.
Plant or encourage shrubs on woodlot edge. Favor trees or shrubs with high wildlife food value, especially heavy fruit producers like autumn olive, Russian olive, dogwood, hawthorn, crabapple, and high-bush cranberry.	Provides cover and nesting habitat as well as food.
Erect nest boxes for cavity nesting species (eg. wood duck, squirrel, Northern flicker, barred owl, Northern screech owl, Northern saw-whet owl, raccoon, pileated woodpecker) where natural dens are deficient.	This is a good option if retention of a sufficient number of cavities is inconsistent with timber management objectives.
Save and encourage beech trees for nut production and den trees.	Beech nuts are a preferred food. These trees can provide two needs at once.
Plant adjacent areas not suited for farming to trees, shrubs and permanent cover crops.	Prevents soil erosion and provides needed wildlife habitat (may also be most efficient use of site).
Establish and maintain openings in or adjacent to woods.	Provides required habitat component for a majority of forest wildlife species.
Plant grass-legume strips along woods' edge.	Provides nesting area for ground-nesting species close to "escape cover."
Cut low wildlife value or cull trees along woods edge and let lie.	Provides cover and good mix of vegetation.
Leave den and potential den trees.	Important to many cavity users--bird and mammal.
Leave strip of undisturbed vegetation adjacent to streams, wetlands, ponds, rivers, and lakes.	Water, especially if moving, provides an activity center for many species.
Protect all wetlands in or near woodlands.	Wetlands are the most productive of habitat types.
Plant open or odd areas with conifers in small clumps not to exceed 10 percent of forest area.	Provides winter protection as well as roosting and nesting cover for many species.
Encourage moderate to dense understory throughout portions of the woods.	Especially important in attracting songbirds.

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Suggested Publications

FNR-86 The Economics of Timber Stand Improvement

FNR-87 Forestry and Wildlife Management Assistance Available to Indiana Landowners: Providers, Organizations, and Programs

FNR-88 Forestry and Water Quality: Pollution Control Practices

FNR-89 Criteria for Evaluating Forestry Activities in Relation to Water Quality Management

FNR-94 Wildlife Field Notes: The Fox Squirrel and the Gray Squirrel

FNR-95 Wildlife Field Notes: Den Boxes for Squirrels

FNR-96 Wildlife Field Notes: How Vines Provide Wildlife with Food and Cover

FNR-97 Wildlife Field Notes: Mast, An Important Wildlife Food Source

FNR-101 Timber Harvesting and Logging Practices for Private Woodlands

FNR-111 Marketing Timber

FNR-125 Managing Forest and Wildlife Resources: An Integrated Approach

FNR-138 Tips on How to Get the Most from Your Timber Harvest

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Purdue University
Forestry and Natural Resources

Assessing Your Land's Potential for Wildlife

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Many landowners are interested in attracting wildlife to their property for a variety of reasons that may include hunting, fishing, hiking, bird watching, or photography. However, the majority of landowners are unsure how to approach this problem. Any venture will likely fail without a proper plan that considers a variety of factors, many of which are not obvious at first glance. This paper outlines the basic decision-making process landowners must go through prior to initiating management practices to make their property more attractive to wildlife.

All properties provide habitat for some wildlife species, but in most cases, the quality of that habitat can be improved. In some cases, the habitat is not desirable to the species you want; and in other cases, the species you want to attract is not appropriate for the property. There are numerous options of where and how to create a particular wildlife feature, and which option(s) you choose depend upon other management objectives for your property. All wildlife species have the same four basic requirements – food, water, shelter, and space. However, each species requires different kinds and combinations of food or shelter, which often vary in time and space. In addition, many wildlife species (e.g., deer, songbirds, or wild turkeys) may only use your property to fulfill a portion of their life requirements.

For example, there are some basic wildlife management recommendations that can be followed on every forest property (see Table 1). However, a wildlife management plan for a specific species or group of species must be tailored to each property. This plan must take into consideration the landowner's objectives, existing habitats and natural features on the property, property size, wildlife species present in your area, and habitats and natural features on surrounding properties.

A tailored plan requires the assistance of a professional wildlife biologist. In Indiana, there are 22 state wildlife management biologists available to assist private landowners. You can locate the wildlife management biologist nearest to you by contacting the Indiana Department of Natural Resources (IDNR), Division of Fish and Wildlife or county extension educator. Your state district forester, Natural Resources Conservation Service (NRCS) wildlife biologist or resource conservationist, or a private wildlife consultant certified by The Wildlife Society can also assist you (see FNR-87). However, your job doesn't end there. When the professional arrives, you will be asked several questions. If you are prepared to answer these questions and understand the basic principles outlined in this paper, your resulting management plan will best reflect your wishes.

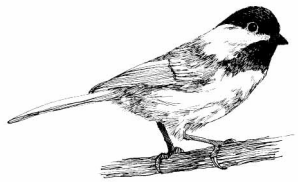
The professional will come equipped with the knowledge of relative wildlife populations in your area. Popular game species such as ruffed grouse, wild turkey, bobwhite quail, or ring-necked pheasants occur in portions of Indiana. If a resident population does not occur in your area or if there are no natural corridors for the animals to move from existing populations to your property, then the best management in the world won't do you any good.

Conversely, if a population of your desired species occurs in the area, they will utilize your property if the proper habitat exists.

Question #1

The first question you will be asked is "What are your management objectives for your property?" Potential answers may include timber production, recreation (such as hunting, fishing, camping, bird watching, hiking, mountain biking, mushroom hunting, etc.), wildlife habitat, long-term investment, source of steady income production, or any combination of these. Your answer and the priority you place on each objective will determine what, where, and how much wildlife habitat management can occur on your property. For example, if timber management is your primary objective, any wildlife management practices initiated (i.e., improving fruit or nut [mast] production, creating early successional vegetation, creating brush piles) will be incidental to timber harvest and Timber Stand Improvement (TSI). An example of a tradeoff would be removing valuable den trees or mast-producing trees to create growing space for valuable crop trees. However, if providing wildlife habitat and timber management are both objectives, timber harvesting and TSI procedures can be used to create and enhance wildlife habitat while producing some income (see Tables 2 and 3). For example, log landings and skid trails can be seeded to desirable cover to create areas for species that utilize forest openings for nesting and feeding. Logging roads can be widened to create more dispersion and early successional habitat. Valuable den or mast-producing trees may be left specifically for wildlife. Specific cutting techniques (single tree selection, group selection, regeneration cut, or seed tree cuts) may be used to create a desired habitat condition (see FNR-102). If wildlife habitat is the primary objective for hunting or bird-watching purposes, then additional practices such as erecting nest boxes, planting food plots, planting specific trees or shrubs, and wetland restoration, enhancement, or creation may be considered (Table 4).

One thing to remember is that wildlife habitat often looks "wild". Good wildlife habitat can look rough and may be considered poor management by neighbors who are used to mowing fallow fields and odd areas. However, these "rough" areas provide the undisturbed cover essential to many species of wildlife to survive or reproduce. Therefore, it may be a good idea to discuss your plan with your neighbors prior to carrying it out.



Finally, give the biologist some indication of your long-term ownership objectives. Do you plan to own the land for a very long time, or are you planning to sell in the near future? Will the land be passed on to children or sold? If the property changes ownership, what will they most likely do with the property? While these questions may seem too personal or too long range to be practical, it is important that you at least give them some consideration. Wildlife management is often a very long-range endeavor. Tree and shrub plantings or regeneration from a timber harvest may take 15 to 50 years or longer to reach its desired condition. This is difficult for many people to grasp since we usually plan our activities by the day, week or month. Also, management that is implemented may positively or negatively affect future property values. For example, a windbreak or pond might increase property values. In some rural agricultural areas, conversion of cropland to trees or wetlands may decrease property values, while these practices may increase property values in suburban areas by creating more aesthetically pleasing sites for development. Therefore, it is important to consider these long-term issues to ensure that management decisions made today will be compatible with your plans for tomorrow.

Question #2

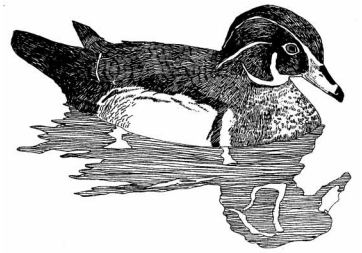
If managing for wildlife is determined to be one of your objectives, the next question is "Which species or group of species do you want to encourage?" You may wish to manage:

- for the greatest diversity of wildlife species

- for one or more specific game species for hunting
- for one or more nongame species for bird watching, photography, etc., or
- for wildlife populations from which you can derive income from allowing others to hunt, fish, bird watch, or trap on your property.

In addition, you may wish to manage your land to minimize damage from a specific species, or to maximize the harvestable surplus of deer or turkeys.

The answer will give the biologist a specific goal to achieve. You should note that there will often be tradeoffs when managing for a particular species. By changing the habitat to benefit a single or group of species, you will most likely reduce the habitat suitability for another or group of species.



At this point, the biologist will determine if the desired species exists on the property and at what level. This can be done be an assessment of tracks, observations, nests, and evidence of browsing or feeding. A more detailed census can also be conducted employing scientific survey techniques, although this is generally outside the bounds of services provided by state or federal biologists. If the target species has a home range larger than your property and your property only fulfills part of their life requirements (as would be the case for deer, turkeys, ducks, or migratory songbirds), then the biologist will determine which habitat components are amply provided on neighboring properties, which components are most limiting to the target species, and which of these limiting components can be most easily provided on your property given its natural features (soil type, topography, land use, hydrology) and your management objectives. These are the components that would then be featured in a management plan.

If the target species has a home range that is small and the animal spends most or all of its life on your property (e.g., quail, rabbits, squirrels, pheasants, or grouse), then the biologist will assess which required habitat features currently exist and what improvements can be made to these features. In addition, the biologist will try to create all of the animal's requirements (food, water, and shelter) in as small a space as possible. The more of these conditions that can be created, the greater the likelihood that you will see the population increase (Figure 1).

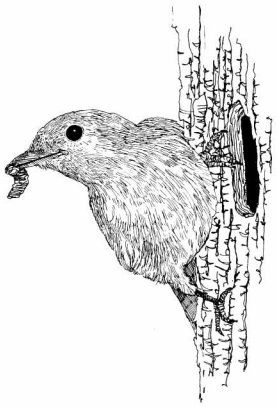
The biologist will probably come armed with an array of aerial photos, topographic maps, and soil maps for your property. If you already have some of these materials, tell the biologist beforehand and bring them to your meeting. These tools illustrate the natural features and key wildlife habitat components on your property in relation to surrounding properties. The biologist can then determine which components are in short supply and assist in determining the most advantageous placement for additional features. The soil maps give a biologist a good indication of what plants, management practices, and wildlife species the land will support. For example, a wetland could be restored on hydric (wetland) soils, a water impoundment could be constructed on clay soils (but might not be possible on sands), or substitutions might have to be made in species selected for nesting or food plots to be compatible with the soils present.

You can assist the biologist at this point by being prepared to provide the management history of your property if you know it. Information on past logging, grazing, or cropping practices (including pesticide applications) as well as future plans for these and other practices can affect management decisions. Tiling history, tile line location, location of underground utilities, and plans to maintain or improve tile drainage will influence what plant species may grow there and will limit management options to those conducive with your future plans. If you plan to work with any other natural resource professional, such as a NRCS conservationist or a forester, invite that person to meet with you and the biologist. If you already have plans prepared by these other professionals, bring them with you. This will ensure that

any wildlife recommendation will be compatible with the overall management of your property. Be prepared to point out marginal cropland acreage, areas providing management problems (e.g., areas that are hard to access, those that are often too wet to farm, or lands that are highly erodible) or areas that are hard to maintain (ditch and stream banks, steep slopes, or irregular field edges). Often, these are places where wildlife management practices can be concentrated.

Question #3

The final question will be "How much money and time do you wish to spend in managing for your target wildlife species?" Be prepared to give the biologist an indication of what equipment you own or have access to use (bulldozer, backhoe, grass drill, sprayer, etc.). It is also helpful to know if a neighbor might be hired to provide this service. Decide how much money you are willing to spend for management on your property and how much time you have for management and maintenance. The answer to these questions will determine how much actual management will be accomplished.



There are several points to consider that might help your time and dollars go a little further. First, a number of state and federal programs provide cost-share payments, leases or easements, or incentive payments for certain wildlife management practices. These programs vary by county and will change over time. Consult your wildlife professional, NRCS office, Farm Service Agency (FSA) office, district forester, or county Extension office to determine what programs or assistance may be available in your area to accomplish the desired management goals. Second, several private organizations, such as Quail Unlimited, the Ruffed Grouse Society, Pheasants Forever, the National Wild Turkey Federation, Ducks Unlimited, and Waterfowl USA, offer equipment rentals, labor assistance, free seed, or possibly cost-share assistance for various management practices. Finally, some landowners even develop agreements with hunters where seed and/or labor towards wildlife management practices is provided in return for hunting rights. Often, these hunters who have permission to be on your land can help you monitor your land and reduce problems with trespassers.

It is important to remember that most land-management practices take time to develop. You can't have an instant forest or prairie. The practices you establish will continue to mature and change over time. This is a dynamic process, and each stage provides a unique niche for some wildlife species. With proper management, you can maximize the benefit of these niches for wildlife. If a biologist's recommendations seem too ambitious, remember that you can accomplish some of these things in stages; and in some cases it may be desirable to do so. Also, you have to take the good with the bad. For example, when you create wetlands and habitat for fish, you will also get fish predators such as great blue herons. Management that favors upland game will also favor their associated predators such as foxes and hawks. Most management practices will usually favor deer. While deer are desirable to many landowners, too many deer can create damage problems and can be inconsistent with certain management objectives such as orchards, new tree plantings, nursery operations, vegetable crops, or, in some situations, row crop production. All of these species are an integral part of the natural environment and are essential for a healthy ecosystem. A biologist can minimize some damage potential by the design and placement of certain habitat features. In addition, fences, repellants, and exclusion devices can be used when the need arises. Contact the USDA-Wildlife Services at 1-800-893-4116 for information on damage control techniques available to you. This once again illustrates the need for you to carefully consider your objectives and communicate those objectives to the biologist.

Summary

Managing for wildlife on your property can be a fun and rewarding experience, but it will also require some work from you. If wildlife management is not

your primary objective, some level of management is usually consistent with many other potential objectives. Due to the complexity of natural systems, the advice of a professional wildlife biologist is instrumental in assessing your land's potential for wildlife and determining the proper course of action to realize this potential. There are a lot of options and tradeoffs in developing any plan. If you carefully consider the three questions discussed above *prior* to contacting a wildlife biologist, then you will be prepared to be an active participant in this process. If you work as an active partner with your wildlife biologist, you will be assured of developing a plan that meets all of your expectations now and in the future.

Additional Information

A large amount of species-specific wildlife management information is available for your use. For additional information on assistance with conservation planning, cost-share opportunites, and wildlife incentive programs, contact your county Extension office; IDNR, Division of Fish & Wildlife (317) 232-4080; U.S. Fish & Wildlife Service (812) 334-4261; local USDA Service center; or visit www.agriculture.purdue.edu/fnr/.

Acknowledgments

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Related Publications and Technical References

Vist www.agcom.purdue.edu/agcom/Pubs/ to view and download the Purdue Cooperative Extension Service publications found below and more, or call 1-888-EXT-INFO (398-4636) for ordering information.

FNR 36, Planting Forest Trees and Shrubs
FNR 38, Tree Windbreaks for Farms and Homes
FNR 87, Forestry and Wildlife Management Assistance Available to Indiana Landowners
FNR 102, Woodland Wildlife Management
FNR 134, Planting Hardwood Seedlings
FNR 135, Weed Control for Tree and Shrub Seedlings
FNR 172, Conserving Endangered Species on Private Lands
FNR 173, Snakes of Indiana
FNR 188W, Warm Season Grasses, What's All the Fuss?
FNR 189W, Windbreaks for Farms and Wildlife
FNR 192W, Enhancing Your Farm for Northern Bobwhite Quail

Web Sites of Interest

IDNR, Division of Fish and Wildlife
www.state.in.us/dnr/fishwild/index2.htm

Purdue University, Department of Forestry & Natural Resources
www.agriculture.purdue.edu/fnr/

Purdue University Cooperative Extension Service
www.ces.purdue.edu

USDA, Natural Resources Conservation Service
www.nrcs.usda.gov

USDA-NRCS. Wildlife Habitat Management Institute Leaflets.
www.ms.nrcs.usda.gov/whmi/technotes.htm

USDA-NRCS. *Indiana NRCS Technical Guides*
www.in.nrcs.usda.gov/planningandtechnology/FOTG/section4/section4.htm

USDA, Farm Service Agency
www.fsa.usda.gov

U.S. Fish and Wildlife Service
www.fws.gov

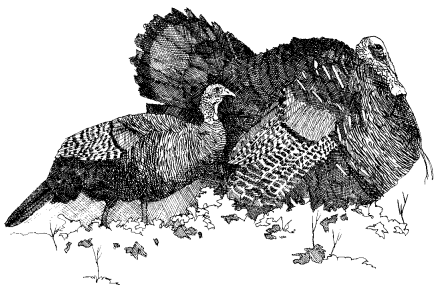

Table 1. General management practices that can benefit wildlife.

General practice	Wildlife benefits	Timber management considerations
Protect woodlot from livestock grazing.	Provides increased mast availability, thicker stem density for cover, and a more diverse understory.	Prevents soil compaction, improves vigor and growth rates of trees; provides greater regeneration and species diversity; reduces decay and defects in timber.
Allow shrubs, vines, blackberries, etc. to develop along woods edges (or plant them).	Provides food and cover for wildlife; provides early successional habitat required by many species; provides highly productive habitat (many species live at woodland edge since they require more than one habitat).	Gradual edge reduces wind and drying effects in woods; timber quality is poor along forest edge; therefore, vines and undesirable species have less economic effect.
Allow felled trees to remain along the edge of woodlot.	Provides cover; produces insect sources for wildlife.	Saves time and labor cost to remove; returns nutrients to the soil.
Plant conifers in small blocks (less than 2 acres) of up to 10% of the area – most efficient when established on nonforested, erodible areas; one to two rows of shrubs which provide wildlife foods (dogwood, highbush cranberry, crabapple, hawthorn, redbud, etc.) can be planted adjacent to conifer stand.	Provides cover during harsh weather; provides nesting and roosting habitat for songbirds, owls and hawks; provides food for wildlife.	Provides tree species diversity; prevents soil erosion.

Table 2. Timber Stand Improvement (TSI) practices that can benefit wildlife.

TSI practice	Wildlife benefits	Timber management considerations
Retention of cavity trees can be concentrated within 50' of woods' edge (where timber value is lowest), or in wetland areas, or adjacent to streams (where timber harvest is difficult or not recommended for water quality concerns).	Provides den and nest sites for wildlife.	Some cavity trees also may be timber trees; provides a diverse bird and mammal population important to the ecology of the forest (i.e., squirrels distribute seeds; woodpeckers eat harmful insects, etc.).
Girdle nonmarketable trees that must be culled from the stand. Inject with herbicide instead of removing and leave existing dead trees or snags.	Create snags that provide food sources for insect-eating birds such as woodpeckers, nuthatches, etc.; creates perches for hawks; creates small openings when done in groups for early successional species.	Saves time and labor cost over removal; reduces damage caused by felling cull trees.
Encourage mix of mast producing trees (red oak species, white oak species, beech, hickory, walnut, cherry, blackgum, ash, maple, and tulip poplar).	Provides food for wildlife.	Provides seed source for future tree regeneration; many mast-producing trees are valuable timber species – oak, cherry, walnut, hickory, maple, and ash; diversity protects against insect and disease infestations that can destroy single tree species (i.e., Chestnut blight, Dutch elm disease).
Perform no TSI or management on inoperable sites (areas where logging equipment cannot reach).	Provides mature trees for species requiring this cover type.	Saves time and labor cost in areas providing no economic return.

Table 3. Harvest practices that can benefit wildlife.

Harvest practice	Wildlife benefits	Timber management considerations
Design regeneration and group selection openings with irregular boundaries when possible.	Provides browse, nesting, food, and escape cover; increases habitat interspersion.	Regenerates shade-intolerant species (oak[1], tulip poplar, ash, cherry, walnut); these harvest strategies are cost-effective. [1] Advanced regeneration required for oak species
For strip cuts, clear-cut timber in strips 60'-300' wide, spaced 600'-900' apart; position cuts to run perpendicular to the slope.	Provides continuous supply of ample browse, food, nesting, and escape cover; ensures availability of plants and earthworms with varying moisture conditions.	Regenerates shade-intolerant species; may provide economic return through pulpwood sales.
Remove 60% of overstory around spring seeps - optimum when most remaining trees are mast producers; insure that all slash is removed from seep area.	Provides food around spring seep areas that do not freeze and provide water and accessible mast all winter.	Provides areas for seed production; growth can be concentrated on valuable timber trees.

Table 3. Continued.

Harvest practice	Wildlife benefits	Timber management considerations
Perform TSI and harvest operations in late fall or winter when possible.	Causes least disturbance to wildlife; provides browse during most critical period of the year; increases sprouting, resulting in excellent cover.	Increases stump sprouting of many species, causes less soil compaction and erosion.
Make brush piles near edge of woodlot or logging road.	Provides cover for mammals and ground-dwelling birds near areas of greatest activity.	Concentrates brush in areas producing the poorest timber, thus allowing greater freedom of movement for maintenance and seedling regeneration in high quality areas.
Seed permanent logging deck and/or logging road with grass-legume mixture or encourage native herbaceous species on nonerodible sites; openings can also be created on utility rights-of-way, poorly stocked stands or regeneration failures (maintain 5-10% of unit in openings).	Provides insects for wildlife food, nesting cover, and forage for consumption (esp. for turkeys and grouse); provides travel lanes and connects wildlife openings.	Prevents soil erosion; maintained roads can be used for hiking, cross-country skiing, and woods access for maintenance; maintains logging deck in permanent condition for future harvest operations.

Table 4. Wildlife habitat improvement techniques in addition to timber management.

Management practice	Comments
Plant small food plots containing a variety of foods, or leave a small portion of adjacent field crops unharvested.	Provides food where natural supplies are limited or during deep snow and late winter when natural supplies are inaccessible.
Encourage fruit trees – release old existing ones. Plant new trees around edge, in odd areas, etc. where enough light exists.	Provides food where natural supplies are limited or during deep snow and late winter when natural supplies are unsuccessful.
Plant or encourage shrubs on woodlot edge. Favor trees or shrubs with high wildlife value, especially heavy fruit producers like dogwood, hawthorn, crabapple, and high-bush cranberry.	Provides food, cover, and nesting habitat.
Erect nest boxes for cavity nesting species (e.g., wood duck, squirrels, woodpeckers, owls, and raccoon) where natural cavities are deficient.	This is a good option if retention of a sufficient number of cavities is inconsistent with timber management objectives. Nest boxes usually need annual maintenance to remain productive.
Save and encourage beech trees for nut production and den trees.	Beechnuts are a preferred food. Mature beech trees readily form natural cavities.
Plant adjacent areas not suited for farming to trees, shrubs, and permanent cover crops.	Prevents soil erosion and provides needed wildlife habitat (may also be most efficient use of site).
Establish and maintain openings in or adjacent to woods.	Provides required habitat component for many forest wildlife species.

Table 4. Continued.

Management practice	Comments
Plant grass-legume strips along woods' edge.	Provides nesting area for ground-nesting species close to "escape cover."
Cut low wildlife value or cull trees along woods edge and let lie.	Provides cover and optimizes area of low timber value for wildlife.
Leave den and potential den trees.	Important to many cavity users – bird and mammal.
Leave strip (≥100-ft wide) of undisturbed vegetation adjacent to streams, wetlands, ponds, rivers, and lakes.	Water, especially if moving, is an activity center for many species. Adjacent uplands often provide nesting and feeding areas for many species of wetland wildlife.
Protect all wetlands in or near woodlands.	Wetlands are the most productive of all habitat types. Forested wetlands provide important amphibian breeding habitat.
Encourage moderate to dense understory throughout portions of the woods.	Especially important in attracting songbirds.
Strip disk dense perennial vegetation.	Creates early successional herbaceous cover critical to quail and several other species of ground-nesting wildlife.
Replace fescue or other grass monocultures with diverse cool-season or native warm-season grass/forb plantings.	Creates structural diversity in grassland habitats that support a wide array of bird and mammal species.

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FNR-193-W

Purdue University
Forestry and Natural Resources
Wildlife Management

The Basics of Managing Wildlife on Agricultural Lands

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Introduction

All wildlife species require four basic components: food, cover, water, and space. The proper types, amounts, and arrangement of these requirements vary among species. Species utilize an area if supplied with the right types, sufficient amounts, and proper arrangement of these components at correct times of the year. Properties that have an insufficient arrangement or quantity of any one of these necessities will not support a given wildlife species. The quality of food, water, and cover can also influence the survival and productivity of wildlife – higher quality habitat will support a higher density of animals. Decide what types of wildlife you want to attract, determine which of their basic four requirements could be improved on your property, and then develop a plan to provide these requirements.

Once you decide what species or group of species you wish to manage, you need to identify the food, water, cover, and space requirements for those species. Identify the amount and arrangement of each of these on your property; determine which requirement is limiting, and determine the best way to supply the limiting requirement. For example, you may have decided to manage for wild turkey on your property. You learn that good turkey habitat is comprised of an approximate 50/50 mix of mature oak-hickory forest stands with early successional openings and croplands. Forest openings and other early-successional habitats that contain herbaceous (non-woody) plants are important brood cover for turkeys. These areas supply an abundance of insects, the primary food of turkey poults, and provide habitat where turkey poults can feed in close proximity to cover. However, your property lacks quality herbaceous areas. Therefore, the first step in attracting turkeys to your property would be to provide this habitat either by establishing permanent forest openings or other herbaceous cover on areas adjacent to your woods.

Many times, a species that you are interested in attracting to your property is abundant in areas around your land but rarely if ever uses your property. This is often the case for wild turkeys. Releasing birds on your land is not the best way to increase the population. Wildlife released on your land rarely survives long and will not stay on your land if the habitat is unsuitable. Rather, you should provide proper amounts of food, cover, and water on your property that may be of limited supply in the environment. If you build it, they will come. Many state and federal programs offering technical and cost-share assistance exist to assist you in establishing wildlife habitat on your land. This publication summarizes some of the most common wildlife habitat practices available through federal and state programs, and helps direct you to sources of additional information.

Where Do I Begin?

Any wildlife management plan for a specific species or group of species must be tailored to each property. This plan must take into consideration the landowner's objectives, existing habitats, natural features on the property, property size, wildlife species present in your area, and habitats and natural features on surrounding properties. Fortunately, there is help available. In Indiana, there are 22 state wildlife management biologists (district wildlife biologists) available to assist private landowners. You can locate the wildlife management biologist nearest to you by contacting the Indiana Department of Natural Resources (IDNR), Division of Fish and Wildlife or your county Extension Educator. Your state district forester, Natural Resources Conservation Service (NRCS) wildlife biologist or resource conservationist, or a private wildlife consultant certified by The Wildlife Society can also assist you. Many of these agencies offer cost-share assistance that can make these practices listed below more attractive and affordable. For a complete list and description of forestry and wildlife assistance available to private landowners, see *FNR-87*.

The natural resources professional will ask several questions that will assist in the design of a management plan for your property. Common questions are: 1) What are your goals and objectives for your property? 2) What species or group of species do you wish to encourage? 3) How much time and money are you willing to spend? By being prepared to answer these questions before the initial meeting with a natural resources professional, your wildlife management plan will best reflect your wishes and will be

compatible with all of your short- and long-term goals. See *FNR-175-W* for more information about assessing your land's potential for wildlife.

Farm Bill programs such as the Conservation Reserve Program (CRP) (see *FNR-157*), the Wetlands Reserve Program (WRP) (see *FNR-158*), the Environmental Quality Incentives Program (EQIP) (see *FNR-169*), and the Wildlife Habitat Incentives Program (WHIP) (see *FNR-168*) offer up to 50-100 percent cost-share incentives for the establishment of a variety of land management practices. The primary purpose of many of these conservation practices is to reduce soil erosion and improve water quality. However, they can also be established and maintained in a manner that will maximize their benefit to wildlife while meeting soil and water conservation goals.

Cost-share assistance programs often make wildlife management practices affordable. In many cases, dedicating marginal farmland to wildlife management practices can actually improve the per acre net return. See *FNR-162* to learn more.

Grassed Waterways

Agricultural fields commonly contain natural swales and depressions that concentrate water flow after storm events. Rather than planting row crops, plant grassed waterways on these highly erodible areas. By reducing the rate of surface water flow, grassed waterways can reduce soil erosion and thereby improve water quality. However, grassed waterways can also provide valuable wildlife habitat if you do the following:

1. Avoid planting fescue, a cool-season grass, if wildlife habitat is a priority. If fescue must be planted, a low-endophyte fescue (Johnstone, Fawn, Kenhy, Forager vars.) should be used. Fescue endophyte is a fungus that grows between the cells of a tall fescue plant. High-endophyte fescue (Ky31 var.) has been found to reduce litter sizes in some species such as rabbits.
2. Plant a combination of grasses (Kentucky bluegrass, orchardgrass, perennial ryegrass, redtop, switchgrass, or timothy) with clover, annual lespedeza (southern Indiana only), or partridge pea.
3. Establish filter strips (see below) on each side of the waterway.
4. Minimize or eliminate disturbance (mowing, machine traffic, grazing, etc.) during the nesting season. Repeated mowing during the growing season prior to establishment is necessary for establishment of cool-season grasses and control of weeds. Once established, mow the grassed waterway in a 2 to 3 year rotation so that only 1/2 to 1/3 of it is mowed in a given year. This will maintain the integrity of the waterway while providing some winter cover and early-spring nesting habitat for wildlife. Mow cool-season grass no shorter than 6 inches and native warm-season grass no shorter than 10 inches.

Filter Strips / Buffer Strips

Filter strips are strips of vegetation placed adjacent to streams and watercourses that reduce the amount of nutrients and sediments entering the water from surface runoff and erosion. Grasses, trees, and shrubs are acceptable cover types for this practice. Use all three cover types to enhance wildlife diversity. Filter strips can be enhanced for wildlife by completing one or more of the following steps.

1. The grass species planted depends upon the site conditions, the grade of the slope, and the amount of sediment and contaminants in the runoff. If the slope is relatively steep and/or if the filter strip incurs a high sediment and/or contaminant load, then mixes of sod forming grasses (e.g., switchgrass, redtop, orchardgrass, timothy, or smooth brome) planted at high densities may be necessary. Avoid planting fescue when possible (see grassed waterways above).
2. However, if these conditions are not present, or you wish to further enhance a filter strip for wildlife with additional width, then plant grass mixtures at lower densities or consider selecting other grass mixtures that benefit wildlife such as native warm-season bunch grasses (see Table 1, page 10). Non-profit conservation groups such as *Pheasants Forever* and *Quail Unlimited* may donate grass seed, provide warm-season grass drills, and in some cases, provide planting assistance for specific projects. For more information about warm-season grasses, see *FNR-188-W*.
3. Adding forbs (non-woody plants other than grass, i.e., wildflowers and legumes; See Table 2, page 11 and Table 3, page 12) to grass plantings will enhance its value to most wildlife species. Forbs provide a source of food and structure that attracts insects, while grasses are an excellent source of cover. Bunch grasses are grasses that do not form a sod. Thus, they provide spaces for wildlife to move through (i.e., orchard grass, native warm-season grasses), making them particularly valuable for winter and brood cover.
4. If management of wildlife is your goal, you should plant grass mixtures at a rate of 3.75 to 4.5 PLS (Pure Live Seed; See Box 1, page 3) for warm-season grasses, 5 to 10 PLS for cool-season grasses, and 0.5 to 1.5 PLS for forbs if lower planting rates do not impact the function of the filter strip. In general, the greater number of species you select for your planting, the greater potential benefit that planting has for wildlife. However, you should adjust your planting rates so you do not exceed

Box 1

Most seeding rates are listed in pounds of seed per acre. These rates can be unreliable for some species since they do not take into account the viability (germination rate) of the seed. Also, plants such as native warm-season grasses and some forbs tend to be chaffy, or have a large amount of seed hulls mixed with the viable seed. Thus, it is extremely important that you calculate the pure live seed (PLS) for these species to avoid paying for unviable materials or underestimating your planting rates.

% PLS = percent pure seed x (% germination + % dormant seed)

Example - The tag from a bag of seed would have the following information.

% Pure Seed	96.75	% Germination	75
% Other Crop	.10	% Dormant (Hard)	10
% Inert Matter	2.35	% Total Germ.	85
% Weed Seed	.80	Noxious Weeds	432

The percent PLS for the above seed would be 82%

% PLS = .9675 x (.75 + .10)

% PLS = .9675 x .85 = 82%

Thus, only 82 of the 100 pounds of bulk seed purchased can germinate and produce the desired crop.

To determine the amount of bulk seed required, locate the % PLS of the seed to be planted in the left column and the desired PLS planting rate in the top row.

	Desired pounds PLS per acre									
% Purity	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
20	5	10	15	20	25	30	35	40	45	50
30	3	7	10	13	17	20	23	27	30	33
40	3	5	8	10	13	15	18	20	23	25
45	2	4	7	9	11	13	16	18	20	22
50	2	4	6	8	10	12	14	16	18	20
55	2	4	5	7	9	11	13	15	16	18
60	2	3	5	7	8	10	12	13	15	17
65	2	3	5	6	8	9	11	12	14	15
70	1	3	4	6	7	9	10	11	13	14
75	1	3	4	5	7	8	9	11	12	13
80	1	3	4	5	6	8	9	10	12	13
85	1	2	4	5	6	7	8	9	11	12
90	1	2	3	4	6	7	8	9	10	11
95	1	2	3	4	6	6	7	8	9	11

the PLS guidelines for either warm-season or cool-season grass mixes. This is important because mixtures for wildlife are planted at relatively lower rates to allow for the growth of forbs and the movement of animals such as bobwhite quail. See *FNR-192-W* for more information about bobwhite quail management in Indiana.

5. Left unmanaged, woody vegetation eventually invades a grass planting. Maintain grass plots by mowing (cool-season grasses) and burning (warm-season grasses). Repeated mowing during the growing season prior to establishment may be necessary for establishment of cool-season grasses and control of weeds. Only mow in years when it is needed. Mowing is only needed to suppress noxious weeds and woody growth. Burning helps to encourage the growth of warm-season grasses and discourage invasion by woody plants. Depending upon the soil fertility and climate, you should mow or burn every 1 to 4 years. Rather than mowing or burning all of your plantings in the same year, mow or burn on a rotational basis. Always leave some cover undisturbed.

For example, if you have a field >10 acres, consider mowing 1/3 each year (Figure 1). This provides a diversity of growth stages in the same field (1/3 is 1 year old, 1/3 is 2 years old, and 1/3 is 3 years old), and reduces the amount of mowing you need to do in any given year. Mow cool-season grass no shorter than 6 inches and native warm-season grass no shorter than 10 inches.

5. The minimum width of the filter strip depends upon the percent slope of the drainage area above the filter strip. However to benefit wildlife, you should plant filter strips as wide as possible. The old adage of bigger is better applies here. Many wildlife species utilize filter strips for nesting, cover, and travel ways. Filter strips need to be wide enough to allow nesting animals a chance to hide from predators that travel the edges of these areas. Filter strips 66 feet wide or greater on each side of the waterway provide good cover for wildlife, while meeting the setback requirement on the atrizine label.

6. Select shrub species suited to your soil type that also provide food and nesting habitat for wildlife (see Table 4, pages 13-16). The state nursery provides a selection of shrubs for this purpose. Placing one row of shrubs closest to the stream helps stabilize the stream bank while providing a setback for the first row of trees. This is a concern to landowners along watercourses with heavy scour erosion. In these situations, trees that are set back from the stream edge are less likely to fall into the stream in later years; however, they are still close enough to provide shade to the stream. The minimum spacing for planting shrubs is 6' by 6'. Design plantings with irregular edges when possible. Before purchasing your seedlings, contact your county NRCS office or drainage board for any restrictions on tree or shrub plantings near regulated drains.

7. Select tree species that provide food and/or cover for wildlife (see Table 5, pages 17-22). For example, many native tree species adapted to soil conditions along streams are excellent wildlife trees. A tree planting containing many species provides a diversity of food and structure. Thus, it becomes more valuable for wildlife than a planting that only contains one or two tree species. Planting a variety of tree species also minimizes the chance of incurring a high mortality rate due to environmental variability because it can be difficult to predict which tree species competes best on a given site.

   Oaks are a very important food source for many wildlife species. When selecting oak species, select a variety of both white and red oak group species. The acorns of trees in the white oak group mature in one year, while acorns of trees in the red oak group mature in two years. Therefore, every autumn trees in the red oak group have small immature acorns on the current year's growth and mature acorns on previous year's growth. Species in the red oak group can provide an acorn crop in years with a late spring freeze that might have destroyed that year's white oak (and next year's red oak) acorn crop. A ratio of about 2:1 to 3:1 red oaks to white oaks is recommended to prevent a total mast failure of your plantings in a given year while maximizing your total annual mast production.

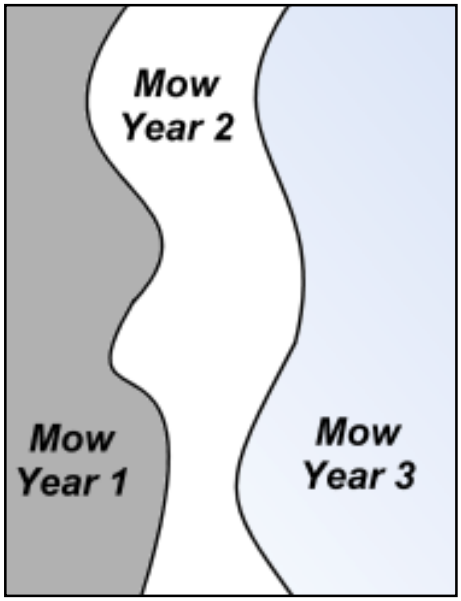

Figure 1. Rotational mowing of a grass planting. *Mowing is conducted only to maintain the area in a grass/forb mixture, not for aesthetic purposes. Note the irregular shape of each management unit.*

Depending on your goals, the spacing of trees in plantings will vary. Wildlife plantings are usually spaced at 400 to 500 trees per acre; however, if you are planting in a bottomland, or you are interested in managing your tree planting for timber, you may have to plant as many as 900 trees per acre. If you plan to purchase trees from the state nursery, call the Vallonia nursery at (812) 358-3621, or the Jasper-Pulaski nursery at (219) 843-4827, or order online from the IDNR, Division of Forestry Web site *www.state.in.us/dnr/index.html*.

The deadline for ordering trees from the state nursery is in October of each year and seedlings are available the following March. Your District Forester or Consulting Forester can assist you with tree planting and maintenance. A consulting forester may be needed to plant large areas requiring machine planting. See *FNR-134* and *FNR-135* for more information about tree planting.

Wetland Restoration and Enhancement

Wetland benefits and values include storm water storage, ground water recharge, nutrient recycling, sediment filtering, and wildlife habitat. Over 87 percent of Indiana's wetlands have been degraded or destroyed. Wetland restoration aims to restore drained or degraded wetlands to the point that soils, hydrology, vegetation, and biological habitats are returned to their natural condition or as close as possible. You should obtain the required local, state, and federal permits before beginning any wetland restoration project (see *FNR-171* for more information). Often, blocking drainage tile or installing a basic water control structure (wetland video) can restore a wetland. The USFWS (812-334-4261) can provide technical and financial assistance at little or no cost to you for many wetland restoration projects. Also, contact your county NRCS office or see *FNR-87*. The following guidelines can make a wetland more beneficial to wildlife.

Design

Different types of wetlands attract different communities of wildlife. Therefore, your wetland should reflect your management goals. For example, if you would like to manage for waterfowl, then a wetland with a 50/50 mix of open water and aquatic emergent plants is ideal. The water depth for dabbling ducks (mallards, teal, wood duck, etc.) should not exceed 18 inches and should include depths <12inches. Generally, aquatic emergent plants grow in shallow areas less than 18inches in depth. They are important because these plants provide food and cover for many species of wildlife such as waterfowl, reptiles, amphibians, and the invertebrates they depend on for food. Deep-water areas provide habitat for diving ducks and many fish species. They are important to migrating (waterfowl, water birds) and overwintering (fish) wildlife. Predators of mosquitoes require deeper water refuges (usually > 8 feet that won't dry out easily. Many birds, frogs, fish, and insects (dragonflies, damselflies, water striders, backswimmers, and diving beetles), all natural enemies of mosquitoes, inhabit wetlands having these characteristics (IDNR undated; also see *FNR-69*).

Managing wetlands for fish populations is not compatible for all management goals. For example, fish management is compatible with waterfowl management, but not for amphibian species since fish are one of their primary predators. Also, having fish in a wetland will not necessarily enhance wildlife use of the wetland. It is important to discuss your goals and possible tradeoffs of design options with the professionals overseeing your wetland restoration project.

The best rule to follow when designing your wetland is more diversity equals more wildlife. Therefore, increasing the size, the diversity of water depths, and the number of plant species maximizes its value for wildlife. Cole et al. (1996) recommended the following design considerations.

- Install water control structures. They can be used to more accurately control water levels, and to allow for drawdowns to control or enhance wetland vegetation.
- Larger wetlands generally support more diverse plant and wildlife communities. Wetlands ranging in size from 0.5 to 5.0 acres can be expected to support a reasonably diverse wildlife community.
- Irregular shapes promote more structural diversity in and around the wetland basin. Coves, peninsulas, islands, and rough shorelines provide more habitat types.
- Gentle slopes (1:10) result in exposed mudflats and a diversity of emergent plants. These areas are used by many bird, amphibian, and reptile species. Plan for a high diversity of slopes with a higher percentage of gentle slopes.
- Providing variety of depths results in a diversity of plant communities, and subsequently, wildlife. Emergent plants favor depths less than 18 inches and are favorite habitats of dabbling ducks, herons, and frogs. Submergent and floating plants prefer water depths 18 to 48 inches. Depths greater than 6 feet provide permanent water. However, wildlife tends to be much more diverse and abundant in wetlands that are dominated by shallow (<3 feet) water.

If you are working in wetland soils or participate in farm programs, there are a few regulations or permits that may apply. See *FNR-171* for details or contact your county NRCS office.

Plant Establishment

Most wetlands do not require planting. Once wetland hydrology is restored, wetland vegetation become established naturally from seeds already present in the soil, bird droppings, wind dispersal, and seeds caught in the fur and feathers of wildlife that utilize the wetland. Many landowners simply let nature take its course and do not introduce plants into a wetland. However, when you allow wetland plants to naturally establish themselves, you do not choose the species composition. If invasive exotic species (purple loosestrife, reed canary grass, common reed) or aggressive native species (cattail) overrun the site, then it may be necessary to supplement natural plant colonization with nursery stock. Selection of plants depends upon the hydrology and soil conditions of the site. Plant stock can be purchased from private nurseries or transplanted from other wetlands (see Appendix A, pages 24-36 for potential sources). Damage from Canada geese may be a problem when establishing wetland plants in this manner. For more information about preventing Canada goose damage, see *FNR-FAQ-8-W*.

Buffer Strips

Establish an undisturbed grass/forb buffer strip around the wetland (see filterstrip section above). A strip 66 to 99 feet in width provides excellent nesting cover for waterfowl, and it reduces bank erosion (especially before the wetland is completely vegetated) and chemical and nutrient runoff. Because Canada geese are attracted to open water surrounded by very short vegetation, an unmowed strip of native grasses and forbs around your wetland may also reduce your risk to damage from unnaturally large groups of Canada geese. It provides nesting cover for many birds and other wetland species. To maximize nesting potential for ground nesting ducks (e.g., mallards and teal), establish buffer areas >3 to 4 times the wetlands.

Special Features

One or a group of small islands in the center of a wetland provides ideal nesting habitat for many species of waterfowl. Unless your wetland is large (2 acres or more), islands will attract primarily Canada geese rather than ducks. Also, if your wetland is >1/4 acre, you can place wood duck nest boxes, goose tubs, or brush islands for nesting waterfowl in your wetlands (plans can be attained from your District Wildlife Biologist or County Extension Office, also see *NCR-338, Shelves, Houses, and Feeders for Birds and Mammals* and *FNR-129, Canada Geese in the Mississippi Flyway*).

Conservation Cover

Conservation cover is the establishment and maintenance of a perennial vegetation cover to protect soil and water resources on land retired from agricultural production. Conservation cover is an eligible practice for many cost-share programs including CRP and WHIP.

The species and arrangement you select depend upon your management goals. In general, planting few plants or mixtures in large blocks has minimal value to most wildlife species (Figure 2). However, some species of wildlife (e.g., bobolink and upland sandpipers) require large blocks of grassland. You can maximize benefits to most wildlife species by planting many small blocks or strips of a variety of species and/or habitat types (Figure 3). This increases the amount of edge (transitional areas among two or more habitat types) in the planting, and they provide habitat to the largest diversity of wildlife.

Other than noxious weeds, any plant cover can be established and maintained. Native plants adapted to the site conditions like those listed in Tables 1-6, pages 10-23, benefit wildlife. A mixture of plant species and habitat types such as grassland, old-field/brushland, and forestland provide escape, nesting, and foraging cover for a wide variety of wildlife species. You should select plants that meet the basic requirements of the wildlife species you wish to attract. Your NRCS Representative or District Wildlife Biologist can assist you in selecting the best species for your property. The size of your plantings also varies depending upon the species you wish to attract. A common shortfall in the majority of wildlife plantings by landowners is the lack of proper maintenance. Once your planting is established, it requires some form of disturbance (mowing, burning, thinning, disking, etc.) every 1 to 5 years to maintain its composition and structure (see Maintenance Provisions).

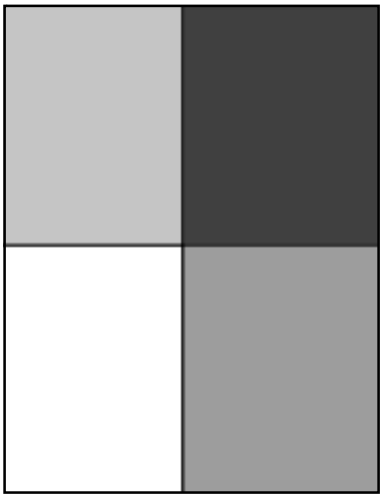

Figure 2. Planting arrangements with low diversity and edge.

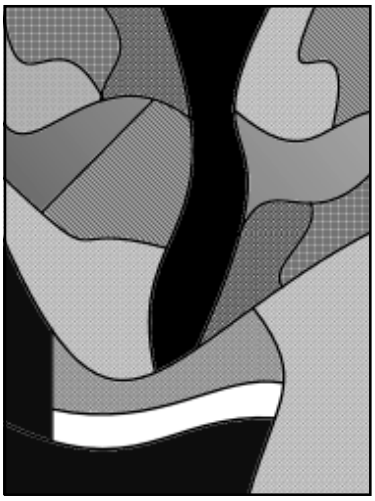

Figure 3. Planting arrangements with high diversity and edge.

Pasture and Hay Planting / Management

Converting fescue pastures or hayfields into warm-season grasses or a mix of warm-season grasses and forbs provide nesting, brood, and winter cover for many species of game and non-game birds. Warm-season grasses provide quality forage in July and August when cool-season grasses have shut eMwn.

Another benefit of warm-season grasses is that they can vastly improve the organic matter throughout the soil profile. Cool-season grasses have a shallow-root system, usually no more than 18 inches. Warm-season grasses have very deep root systems that can reach depths of 10 feet or more.

Burning a field planted to warm-season grasses reduces competition from weeds and woody plants while stimulating growth of the warm-season grasses. You should plant small blocks (1 to 2 acres) of warm-season grasses divided by firebreaks at least twice the height of your planting. Firebreaks can be planted to cool-season grass mixes, legumes, or winter wheat. Contact your local NRCS office for more information about burning warm-season grass plantings.

Cool-season hayfields can be attractive nesting habitat for some species of grassland birds (e.g., bobolink) although the

timing and frequency of mowing during the nesting season often results in high losses. Establishing undisturbed grassland cover near hayfields can henp draw broods away from nesting in hayfields and minimize nest losses.

Food Plots

Food plots are an important component to many wildlife management plans. The selection of plants (Table 6a and Table 6b, page 23 for species selection and planting rates) for your food plot depends upon the species you are managing for, the amount of annual snow fall, and the types, amounts, and arrangement of food and cover on your property. Many plants such as soybeans, millets, wheat, rye, and buckwheat provide an excellent source of food. However, they tend to lodge and get buried in the snow and then rot, making them an unreliable food source in late winter or early spring. You can plant mixtures of these species with plants that do not readily lodge, such as corn and grain sorghum. While grazing of food plots is generally not recommended, you should note that grain sorghum can be poisonous to livestock after frost or drought.

Just as for any agricultural crop, seedbed preparation and correct fertilization is essential for the successful establishment of any food plot. However, high yields are not the goal of food plots, so herbicides should be used sparingly and only when necessary to produce a crop. Weedy food plots often provide secondary benefits to wildlife, including cover and insect food.

After you determine the species of plants for your food plot, determine the size and location of the food plot. In general, food plots should be about 1/4 to 1 acre in size. Planting larger food plots is not recommended since wildlife tend to use primarily the outer edge of plantings close to cover rather than the interior. The amount of value gained by planting larger food plots usually does not justify its cost. However, larger food plots (blocks of 3 to 10 acres) are justified in areas that receive large amounts of blowing snow as found in the Northern Plains. These food plots require a cover component; otherwise, the food is buried by the snow.

Whenever possible, locate food plots adjacent to adequate cover on the windward side (see *FNR-189-W*). In Indiana, the prevailing winter wind is from the northwest. If this is not possible, plant corridors of cover between food plots and winter cover. Corridors should be at least 50 feet in width and include at least three rows of shrubs and two rows of trees. You can also construct brush piles adjacent to the food plot. A minimum of six or more brush piles should be located around each food plot. See *http://www.conservation.state.mo.us/landown/benefit/* for more information about brush pile construction. Typically, one food plot per 40 acres of farmland or forestland is a minimum and should not exceed 5 percent of the total acreage.

Rather than replanting the same food plot every year, allow old food plots to stand 3 to 4 years prior to replanting. The resulting habitat will provide nesting cover and insect foraging habitat that will benefit ground nesting bird species like bobwhite quail.

Maintenance Provisions

Habitat maintenance is just as important as establishing good wildlife habitat, yet it is frequently overlooked. Would you plant a new lawn and not mow, water, or fertilize it? The same is true for other habitats. Without proper maintenance, plantings may lose their vigor, become overrun by invasive species, or convert to a less desirable stage of development.

The timing and methods you select depend upon the long-term management objectives for your property. However, some common maintenance provisions are briefly described below. In general, all maintenance is done on a rotational basis. This promotes a diversity of habitat types and provides food and cover during the winter and early spring.

Disking - Disking breaks up grass plantings that have become too overgrown. Many species of wildlife such as quail require habitat that they can walk through, but it still provides overhead cover. Infrequent disking promotes annual food plants and a mix of grasses, forbs, and shrubs. Disk strips 3 to 4 inches deep and about 10 to 20 feet wide. Disk strips on a 4- to 5-year rotation from January to March.

Burning - Prescribed burning of native warm-season grasses removes excess litter (which can limit wildlife movements), stimulates new and vigorous growth, and prevents excessive woody growth. Divide your planting into small units (<5 acres) with firebreaks. Fire breaks, which are typically bare ground, cool-season grass/legume mix, small grains, or existing roads, should be at least 20 feet in width. Burn the units on a 3-year rotation, burning 1/3 of the total area each year. See Appendix B, page 23 for a list of private consultants that provide prescribed fire assistance.

Mowing - Mowing cannot be used as a substitute for disking or burning. It does not remove old growth and litter like burning or disking. Repeated mowing creates a grass-dominated system that lacks woody shrubs, vines, and bare ground. A mixture of these habitat components is important to a variety of wildlife. For example, research has demonstrated that the majority of quail nests are built at the base of brambles, sumac, sassafras, and other woody plants on sites that contain about 30 percent bare ground.

Mowing can be a substitute for disking on highly erodible slopes or burning on areas near buildings, or to control tree invasion on a spot-basis. Mow these areas on a 4- to 5-year rotation in August, mowing 1/5 of the units each year. This maintains the area in a mix of grasses, forbs, and shrubs; but it prevents tree invasion.

Endangered Species

Many landowners are concerned about endangered and threatened (listed) species. In most cases, the presence of listed species does directly impact the landowners. Several programs exist to assist private landowners in their efforts to manage for listed species. For example, Safe Harbor Agreements allow private and other non-federal landowners to manage their land in a way that restores, enhances, or maintains habitat for rare plants and animals while still meeting other management goals – all without incurring additional land-use restrictions. See *FNR-172* for more information about endangered species, Safe Harbor Agreements, and more.

Nuisance Wildlife

Occasionally, wildlife management practices attract unwanted species, leading to problems for landowners. For example, increased deer populations can inhibit the growth of food plots or tree and shrub plantings (see *FNR-136* for suggestions on how to minimize this type of damage), or nuisance Canada geese (see *FNR-FAQ-8-W*) can damage plantings for wildlife, winter wheat, or landscaping around the home.

Properly planned management can still encourage wanted wildlife species while minimizing nuisance wildlife problems. Strategies vary on a case-by-case basis. However, successful plans include taking steps to prevent damage *before* the damage occurs, monitoring for signs of new damage, and minimizing further damage through a combination of approved techniques. You will rarely be able to eliminate nuisance wildlife, and minimizing nuisance wildlife is an ongoing process. For information on managing nuisance wildlife problems, contact the USDA Wildlife Services/IDNR wildlife conflicts hotline at 1-800-893-4116. If you have a nuisance wildlife problem, you will find that many of the nuisance animals are regulated and protected by federal, state, and/or local regulations. For more information about rules and regulations in Indiana, see *FNR-FAQ-16-W*.

Who Do I Call?

"What kinds of assistance are available to me, and from whom?" "Is there money available to help me?" "Where do I go to get help with my wildlife resource problems?" These are questions frequently asked by Indiana landowners. The answer to these questions can be quite complicated because programs that assist landowners are implemented by a number of public and private organizations. The best place to start for answers to your questions is with your county Cooperative Extension Service Educator. For more information about forestry and wildlife assistance available to Indiana landowners, see *FNR-87*. Your county Educator will assist you in contacting the appropriate person and/or agency administering the assistance programs best suited to your needs. The address and phone number for your county's Cooperative Extension Service Office can be found in the telephone directory under "County Government Office," or they may be listed in the white pages under the name of your county. You can also call 1-888-EXT-INFO.

NRCS, along with FSA, provides leadership for Farm Bill programs. Contact your local USDA Service Center for more information. They will assist you with determining the eligibility of your land, the development of a conservation plan, and the application process. In addition, they can put you in touch with your District Forester or District Wildlife Biologist. They will provide assistance in developing more detailed management plans and in selecting cost-share and incentive programs that can make wildlife management on your property more attractive and affordable.

References

Cole, A. C., T. L. Serfass, M. C. Brittingham, and R. P. Brooks. 1996. *Managing your restored wetland*. Pennsylvania State University, Cooperative Extension Service, University Park, PA.

IDNR, Division of Fish and Wildlife. *Did you know?... Healthy wetlands devour*

Mosquitoes. Indiana Wetlands Conservation Plan Fact Sheet.

INPAWS. *Landscaping with Plants Native to Indiana*. Indiana Native Plant and Wildflower Society.

Pitts, D. E. and B. McGuire. 1999. *Wildlife Management for Missouri Landowners*, 2nd edition. Missouri Department of Conservation.

USDA. 2000. *Upland wildlife habitat management*. NRCS Conservation Practice Standard 645.

USDA-NRCS. NRCS - Wildlife Habitat Management Institute Leaflets. (*www.ms.nrcs.usda.gov/whmi/technotes.htm*).

Additional Information

For additional information on assistance with conservation planning, cost-share opportunities, and wildlife incentive programs, see the following publications available from your county Extension office, online at *www.agriculture.purdue.edu/fnr/* and click on "extension," or order by contacting Agricultural Communication Media Distribution Center, Purdue University, 1187 SERV Building, West Lafayette, IN 47907-1187, Toll Free: 1-888-EXT-INFO, Local: (765) 494-6794; Fax: (765)-496-1540.

A list of companies that sell plants native to Indiana is provided in Appendix A, pages 19-22. A list of companies

who are licensed to conduct prescribed fires on private lands in Indiana is provided in Appendix B, page 23.

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Related Publications

Visit *www.agcom.purdue.edu/agcom/Pubs/* to view and download the Purdue Cooperative Extension Service publications found below and more, or call 1-888-EXT-INFO (398-4636) for ordering information.

FNR-69	Fish kills in Indiana: their causes and prevention.
FNR-87	Forestry and wildlife management assistance available to Indiana landowners: *providers, organizations, and programs.*
FNR-102	Woodland wildlife management.
FNR-134	Planting hardwood seedlings.
FNR-135	Weed control for tree and shrub seedlings.
FNR-136	Electric fences for preventing browse damage by white-tailed deer.
FNR-141	Wildlife, the other agriculture crop.
FNR-157	New CRP provisions provide good return on marginal acres while providing wildlife habitat.
FNR-158	The wetlands reserve program.
FNR-168	The Wildlife Habitat Incentives Program (WHIP) Provides technical assistance and funds to improve wildlife habitat.
FNR-169	EQIP: Opportunities for wildlife management on your land.
FNR-171	Wetland, regulations, and you: what every Indiana farmer needs to know.
FNR-172	Conserving endangered species on private land.
FNR-173	Snakes of Indiana.
FNR-175W	Assessing your land's potential for wildlife.
FNR-188W	Warm-season grasses: why all the fuss?
FNR-189W	Windbreaks for farms and wildlife.
FNR-192W	Enhancing your farm for northern bobwhite quail.
FNR-FAQ-8W	Urban Canada goose management.
FNR-FAQ-16W	Animal damage management – rules and regulations in Indiana.

IDNR. Wildlife habitat cost share project. Indiana Dept. of Natural Resources, Division of Fish and Wildlife, Indianapolis, IN. (317-232-4080)

IDNR. Classified wildlife habitat act. Indiana Dept. of Natural Resources, Division of Fish and Wildlife, Indianapolis, IN. (317-232-4080)

USFWS. Restoring wetlands for wildlife in Indiana. United States Fish and Wildlife Service, Dept. of the Interior. (812-334-4261)

Web Sites of Interest

IDNR, Division of Fish and Wildlife
www.state.in.us/dnr/fishwild/index2.htm

Purdue University, Department of Forestry & Natural Resources
www.agriculture.purdue.edu/fnr/

Purdue University Cooperative Extension Service
www.ces.purdue.edu

USDA, Natural Resources Conservation Service
www.nrcs.usda.gov

USDA-NRCS. *Wildlife Habitat Management Institute Leaflets*
www.ms.nrcs.usda.gov/whmi/technotes.htm

USDA-NRCS. *Indiana NRCS Technical Guides*
www.in.nrcs.usda.gov/planningandtechnology/FOTG/section4/section4.htm

USDA, Farm Service Agency
www.fsa.usda.gov

U.S. Fish and Wildlife Service
www.fws.gov

Table 1. Examples of native warm-season grass, legume, and forb species mixes (Adapted from NRCS Practice Standard 645, Upland Wildlife Habitat Management). Note: these mixes and planting rates may not be appropriate for some conservation practices.

Species	PLS rates per acre		Species	PLS rates per acre	
	Wildlife	Vegetative		Wildlife	Vegetative
QU Mix IA[1]					
Big Bluestem			[2] Big Bluestem	0.75	1
Indiangrass			Indiangrass	0.75	1
Little Bluestem	4.5	6.5	Little Bluestem	1.75	2.5
Sideoats Grama			Sideoats Grama	1	1.5
Switchgrass			Annual Lespedeza	2	1
Wildflower Mix					
QU Mix IB[1]					
Big Bluestem			[2] Little Bluestem	2.5	4
Indiangrass			Indiangrass	0.75	1
Little Bluestem	4.25	6.25	Sideoats Grama	0.75	1
Sideoats Grama			Annual Lespedeza	2	2
Switchgrass					
Wildflower Mix					
QU Mix II[1]					
Big Bluestem			[2] Switchgrass	1.75	2
Indiangrass	4.25	6.25	Big Bluestem	1	2
Little Bluestem			Indiangrass	0.5	1
			Annual Lespedeza	2	2
QU Mix III[1]					
Little Bluestem			[2] Big Bluestem	1	1.5
Indiangrass	3.75	5.75	Indiangrass	1.5	2
Sideoats Grama			Little Bluestem	1	0.5
Wildflower Mix			Sideoats Grama	0.5	0.5
			Annual Lespedeza	2	2

[1] Quail Unlimited Premixed Mixtures; rates are for entire mixtures.
[2] Mix can be used on poorly drained sites.
Note: 2-8 oz of any single, or a combination of forb species listed in Table 2 can be added to any of the above mixtures for added wildlife or aesthetic benefits, or substituted for annual lespedeza.

Table 2. Selected species of forbs beneficial to wildlife (Adapted from Upland Wildlife Habitat Management, NRCS Practice Standard 645, and Landscaping with Plants Native to Indiana, *Indiana Native Plant and Wildflower Society***).**

Blue False Indigo	*Baptisia australis*	Blue	May-June
Blue-Stemmed Goldenrod	*Solidago caesia*	Yellow	August-October
Butterfly Weed	*Asclepias tuberosa*	Orange	June-September
Button Blazing Star	*Liatris aspera*	Purple	August-September
Cardinal Flower	*Lobelia cardinalis*	Red	July-September
Culver's Root	*Veronicastrum virginicum*	White	June-September
Dense Blazing Star	*Liatris spicata*	Purple	July-September
Rosinweed	*Silphium integrifolium*	Yellow	July-September
Gray Goldenrod	*Solidago nemoralis*	Yellow	July-November
Gray-Headed Coneflower	*Ratibida pinnata*	Yellow	June-September
Illinois Bundleflower	*Desmanthus illinoensis*	White	June-August
New England Aster	*Aster novae-angliae*	Purple	August-October
Partridge Pea	*Cassia fasciculata*	Yellow	July-September
Prairie Dock	*Silphium terebinthinaceum*	Yellow	August-October
Purple Coneflower	*Echinacea purpurea*	Purple	June-October
Queen-of-the-Prairie	*Filipendula rubra*	Pink	June-August
Royal Catchfly	*Silene regia*	Red	June-August
Saw-Toothed Sunflower	*Helianthus grosseserratus*	Yellow	July-October
Short's Aster	*Aster shortii*	Lavender	August-October
Smooth Aster	*Aster laevis*	Blue	August-October
Spotted Joe-Pye-Weed	*Eupatorium maculatum*	Pink	July-September
Stiff Goldenrod	*Solidago rigida*	Yellow	August-October
Summer Phlox	*Phlox paniculata*	Purple	July-October
Sunflower Heliopsis	*Heliopsis spp.*	Yellow	July-September
Tall Coreopsis	*Coreopsis tripteris*	Yellow	July-October
Violet Lespedeza	*Lespedeza violacea*	Purple	July-September
Virginia Mountain Mint	*Pycnanthemum virginianum*	White	July-September
Wild Bergamot	*Monarda fistulosa*	Lavender	July-August

Table 3. Selected mixes of cool-season grasses, legumes, and forbs (Adapted from NRCS Practice Standard 645 Upland Wildlife Habitat Management).

[1,2]	Orchardgrass	2	6	[4] Redtop	1	2
	Timothy	1	2	Timothy	1	2
	Annual Lespedeza	2	4	Alsike Clover	1	2
	Ladino Clover	0.25	0.25	Birdsfoot Trefoil	2	4
[1]	Redtop	1	2	[1] Redtop	1	2
	Orchardgrass	2	6	Kentucky Bluegrass	1	3
	Annual Lespedeza	2	4	Annual Lespedeza	2	4
	Ladino Clover	0.25	0.25	Ladino Clover	0.25	0.25
[1]	Redtop	1	2	[1] Orchardgrass	1	6
	Timothy	1	2	Timothy	1	2
	Red Clover	1	2	Red Clover	1	2
	Annual Lespedeza	2	4	Ladino Clover	0.25	0.25
				Annual Lespedeza	2	4
	Orchardgrass	2	6	[3] Smooth Bromegrass	5	10
	Timothy	1	2	Timothy	1	2
	Alfalfa	3	6	Ladino Clover	0.25	0.25
	Ladino Clover	0.25	0.25	Birdsfoot Trefoil	2	4
[3]	Smooth Bromegrass	5	10	Orchardgrass	2	6
	Alfalfa	3	6	Timothy	1	2
	Ladino Clover	0.25	0.25	Red Clover	1	2
	Birdsfoot Trefoil	2	4	Sweet Clover	1.5	3
[4]	Timothy	1	2	Timothy	1	2
	Smooth Bromegrass	5	10	Kentucky Bluegrass	1	3
	Alsike Clover	0.5	1	Annual Lespedeza	2	4
	Birdsfoot Trefoil	2	4	Red Clover	1	2
[1]	Timothy	1	2	Orchardgrass	2	6
	Kentucky Bluegrass	1	3	Timothy	1	2
	Annual Lespedeza	2	4	Ladino Clover	0.25	0.25
	Birdsfoot Trefoil	2	4	Birdsfoot Trefoil	2	4

[1] Better suited for southern Indiana
[2] Can by used on dry sites
[3] Better suited for northern Indiana
[4] Can be used on wet sites

Table 4. Selected shrub species (Adapted from NRCS Pra2ctice Standard 645, Upland Wildlife Habitat Management)

Species	[1]Soil Moisture Tolerance	Average Mature Height (ft.)	Wildlife Benefits	General Comments
Alternate-Leaf Dogwood (Cornus alternifolia)	SPD-WD	18	Fruit eaten by birds. Twigs browsed by deer and rabbits.	Blue-black fruit with red stems. Leaves not opposite.
American Plum (*Prunus americana*)	MWD-ED	30	Fruit eaten by birds and mammals. Recommended for quail.	Fruit is a reddish drupe.
Arrowwood (*Viburnum dentatum*)	MWD-WD	9	Fruit eaten by songbirds.	Drupe blue-black, 1/4" long.
Black Chokeberry (*Aronia melanocarpa*)	SPD-WD	10	Fruit eaten by songbirds.	Fruit dark purple, 1/3" long.
Blackhaw (*Viburnum prunifolium*)	MWD-WD	20	Fruit eaten by songbirds, quail, and fox.	Drupe dark blue, 1/2" long.
Bladdernut (*Staphylea trifolia*)	SPD-WD	10		3 lobed, papery capsule.
Buttonbush (*Cephalanthus occidentalis*)	VPD-WD	5	Seeds eaten by waterfowl. Beneficial structure for many amphibians.	Round nutlets; best on wet sites. Wilted leaves may be toxic to livestock.
Chokecherry (*Aronia melanocarpa*)	SPD-WD	18	Fruit eaten by songbirds, grouse, fox, and rabbit.	Dark purple, 1/3" long fruits persistent through winter; grows in a wide variety of site conditions.
Coralberry (*Symphoricarpos orbiculatus*)	MWD-WD	5	Fruit eaten by songbirds, grouse, and quail.	Coral to purple fruits persistent through winter.
Devil's Walkingstick (*Aralia spinosa*)	SPD-MWD	20	Fruit eaten by songbirds and some mammals.	Stout stems with spines; showy white flowers produce a black drupe. Wildlife value relatively low.

[1] Listed in order from driest to wettest soils: ED = Excessively Drained; WD = Well Drained; MWD = Moderately Well Drained; SPD = Moderately Poorly Drained; PD = Poorly Drained; VPD = Very Poorly Drained

Species	[1]Soil Moisture Tolerance	Average Mature Height (ft.)	Wildlife Benefits	General Comments
Eastern Wahoo (*Euonymus atropurpureus*)	SPD-WD	12		Four-lobed red capsule, sometimes with winged stem.
Elderberry (*Sambuscus canadensis*)	VPD-WD	9	Fruit eaten by many birds in summer including pheasant, dove, and turkey. Plant contains hydrocyanic acid. Recommended for quail.	Showy, flat clusters of white flowers followed by dark fruits. High wildlife value.
Flowering Dogwood (*Cornus florida*)	MWD-WD	30	Fruit eaten by quail, songbirds, turkey, and some small mammals.	Glossy red drupes ripen in late fall and are available through fall. Attractive white flowers in the spring.
Gray Dogwood (*Cornus racemosa*)	SPD-WD	8	Fruit eaten by quail, songbirds, turkey, raccoon, and fox.	Red pedicles in winter, white drupe.
Hazel Alder (*Alnus serrulata*)	VPD-WD	18	Bud and catkin eaten by grouse, seeds eaten by some songbirds.	Grows best in wet to moist soils. Long lenticles on the stem.
Hazelnut (*Corylus americana*)	MWD-WD	15	Small nut and catkin eaten by squirrels, deer, grouse, quail, and pheasant. Good cover and nesting sites.	Often forms large colonies. Grows well on woods borders and fencerows.
Highbush Cranberry (*Viburnum trilobum*)	VPD-WD	9	Fruit eaten by grouse, pheasant, and songbirds.	Clusters of red fruits.
Indigobush (*Amorpha fruticosa*)	VPD-WD	10	Legume, fixes Nitrogen in soil.	Small pods with 1-2 seeds, flowers purple spikes.
Leadplant (*Amorpha canescens*)	WD-ED	3	Legume, fixes Nitrogen in soil.	Small erect prairie shrub with purple flowers.
Nannyberry (*Viburnum lentago*)	SPD-WD	18	Fruit eaten by songbirds, game birds, and fox.	Dark blue fruits similar to raisins.
New Jersey Tea (*Ceanothus americanus*)	WD-ED	3	Quail and wild turkey eat the 3-celled capsule that matures in the fall.	Prairie plant with white flower in dense heads. Leaves were used for tea in 19th Century.

[1] Listed in order from driest to wettest soils: ED = Excessively Drained; WD = Well Drained; MWD = Moderately Well Drained; SPD = Moderately Poorly Drained; PD = Poorly Drained; VPD = Very Poorly Drained

Table 4. Continued

Species	[1]Soil Moisture Tolerance	Average Mature Height (ft.)	Wildlife Benefits	General Comments
Ninebark (*Physocarpus opulifolius*)	VPD-WD	10	Some cover value for songbirds.	White to pinkish flowers followed by small, dry fruits that persist through winter.
Pawpaw (*Asimina triloba*)	SPD-WD	20	Fruit eaten by opossum, squirrels, raccoon, and fox.	Large leaves, prefers deep, moist soils.
Prairie Crab (*Malus ioensis*)	PD-WD	30		Small fruit, showy flowers.
Prickly Ash (*Zanthoxylum americanum*)	SPD-WD	9		Dense growth with prickly leafstalks. Small reddish-brown pods.
Red Osier Dogwood (*Cornus stolonifera*)	VPD-WD	10	Fruit eaten by songbirds, grouse, and quail. Twigs browsed by deer and rabbits.	Red stem, white drupe; attractive winter plant.
Redbud (Cercis canadensis)	MW-WD	30	Seeds eaten by a few songbirds.	A legume, pod 2-3" long, pink flowers, heart-shaped leaves.
Rough-Leaved Dogwood (*Cornus drummondii*)	PD-WD	18	Fruit eaten by songbirds, grouse, quail, turkey, and pheasant. Browsed some by rabbits and deer.	White drupes.
Serviceberry (*Amelanchier spp.*)	MW-WD	30	Recommended for quail.	White flowers bloom in April. Dark red fruit ripens in early summer.
Shining Sumac (*Rhus copalina*)	MW-ED	8	Fruit eaten by some songbirds, quail, dove, and pheasant. Twigs sometimes browsed.	Clusters of red, fuzzy fruits ripen in fall and remain available through the winter.
Shrubby St. Johnswort (*Hypericum prolificum*)	SPD-WD	6		Bright yellow flowers, 3-chambered capsule.
Silky Dogwood (*Cornus amomum*)	VPD-WD	10	Sometimes browsed by rabbits and deer. Fruit eaten by quail, songbirds, turkey, raccoon, and fox.	Bluish fruit, prefers moist soils and partial shade.

[1] Listed in order from driest to wettest soils: ED = Excessively Drained; WD = Well Drained; MWD = Moderately Well Drained; SPD = Moderately Poorly Drained; PD = Poorly Drained; VPD = Very Poorly Drained

Species	[1]Soil Moisture Tolerance	Average Mature Height (ft.)	Wildlife Benefits	General Comments
Smooth Sumac (*Rhus glabra*)	MWD-ED	12	Twigs and fruit sometimes eaten by songbirds, quail, dove, and pheasant. Recommended for quail.	Clusters of red, fuzzy fruits ripen in fall and remain available through the winter.
Spicebush (*Lindera benzoin*)	VPD-WD	9	Twigs and fruit eaten by songbirds, deer, rabbit, opossum, quail, and grouse.	Often forms large colonies. Red fruit.
Spirea (*Spirea alba, S. tomentosa*)	VPD-WD	4	Bud eaten by grouse, twigs browsed by deer and rabbit.	Pink flowers. Also called meadowsweet or hardack.
Staghorn Sumac (*Rhus typhina*)	MWD-ED	15	Fruit sometimes eaten by songbirds, quail, dove, and pheasant. Twigs sometimes browsed by rabbits and deer.	Clusters of red, fuzzy fruits ripen in fall and remain available through the winter. Tolerant of dry, infertile soils.
Washington Hawthorn (*Crataegus phaenopyrum*)	SPD-ED	30	Fruit eaten by deer, fox, rabbit, grouse, pheasant, and songbirds. Excellent nesting cover for songbirds.	Red fruit ripens in the fall and is persistent into the winter. Dense branching with heavy foliage. Twigs armed with thorns.
Wild Blackberry (*Rubus allegheniensis*)	MWD-WD	5	Fruit eaten by songbirds, game birds, and many mammals. Excellent cover for birds and mammals.	Excellent summer food source for wide variety of wildlife. Upright, arching structure forms dense, thorny thickets.
Wild Raspberry (*Rubus occidentalis*)	MWD-WD	5	Fruit eaten by songbirds, game birds, and many mammals. Excellent cover for birds and mammals.	Excellent summer food source for wide variety of wildlife. Upright, arching structure forms dense, thorny thickets.
Wild Sweet Crabapple (*Malus coronaria*)	SPD-ED	30	Fruit eaten by fox, raccoon, and upland game birds.	Yellow-green edible fruit with highly fragrant flowers.
Winterberry (*Ilex verticillata*)	VPD-SPD	10		Erect structure with small greenish white flowers and bright red berries that persist through winter. Dioecious; require male and female plants for propagation.
Witch-Hazel (*Hamamelis virginiana*)	SPD-WD	18	Seeds, buds, and twigs eaten by deer, rabbit, quail, and pheasant.	Pale yellow flowers followed by pods with seeds available fall to winter.

[1] Listed in order from driest to wettest soils: ED = Excessively Drained; WD = Well Drained; MWD = Moderately Well Drained; SPD = Moderately Poorly Drained; PD = Poorly Drained; VPD = Very Poorly Drained

Table 5. Selected tree species (Adapted from NRCS Practice Standard 645, Upland Wildlife Habitat Management)

Species	[1] Soil Moisture Tolerance	Wildlife Benefits	General Comments
American Beech (*Fagus grandifolia*)	WD	High wildlife value. The small, triangular nuts are highly preferred and eaten by wood ducks, ruffed grouse, squirrels, chipmunks, and some songbirds. The tendency for mature trees to form cavities in the trunk make it valuable cover for raccoons, squirrels and chipmunks.	Common, medium sized tree of moist, well-drained soils. Easily recognized by its smooth, gray bark.
American Hornbeam (*Carpinus caroliniana*)	W, WD	Seeds and catkins eaten by songbirds and squirrels.	Shrub or small tree in the birch family. Also called musclewood due to the smooth gray, striated bark. Common in floodplains.
American Sycamore (*Platanus occidentalis*)	W, WD	Minimal food value to wildlife. However, forms an important structural component of bottomlands and floodplains.	One of our largest trees capable of heights over 100 feet.
Ash, Green (*Fraxinus pennsylvanica*)	W, WD	Seeds eaten by squirrels, quail, and songbirds.	Medium sized tree. Common component of swamps and floodplains.
Ash, Pumpkin (*Fraxinus tomentosa*)	W		Large tree of swamps and floodplains. Range limited to southern Indiana.
Ash, White (*Fraxinus americana*)	WD		Common tree of upland forests. Forms a large straight bole with interlacing bark as it matures.
Baldcypress (*Taxodium distichum*)	W, WD	Seeds are occassionally eaten by waterfowl. Also serves as perching areas for songbirds and wading birds.	One of two deciduous conifer trees native to Indiana. Extremely flood tolerant.
Birch, River (*Betula nigra*)	W, WD	Stands serve as important cover for riparian dwelling mammals.	Small to medium sized tree of floodplains. Attractive cinnamon colored, exfoliating bark.
Blackgum (*Nyssa sylvatica*)	A	Fruit eaten by songbirds, turkeys, and pileated woodpeckers.	Medium sized tree. Thrives in upland and wetland conditions. Foliage turns an attractive red color in fall.

[1] W = Wet; WD = Well Drained; D = Dry; A = All

Species	[1] Soil Moisture Tolerance	Wildlife Benefits	General Comments
Black Cherry (*Prunus serotina*)	WD	Fruit eaten by many species songbirds, ruffed grouse, and pheasant.	Valuable timber species. Produces attractive white flowers and edible fruits.
Black Walnut (*Juglans nigra*)	WD	Nuts eaten by squirrels.	Medium sized tree typical of central hardwood forests. Valuable timber species.
Butternut (*Juglans cinerea*)	WD	Nuts eaten by squirrels.	A rare, medium sized tree with gray interlacing bark. Produces an oblong fruit similar to that of the black walnut.
Catalpa (*Catalpa speciosa*)	WD		Medium sized tree with large, heart-shaped leaves and elongated seed pods.
Cottonwood, Eastern (*Populus deltoides*)	A	Twigs and bark eaten by deer and beavers. Buds and catkins eaten by ruffed grouse.	Large tree typical of riverbanks. The triangle-shaped leaves, that flutter in the wind, give this tree its name.
Cottonwood, Swamp (*Populus heterophylla*)	W, WD		Similar to the eastern cottonwood, but more southern in distribution. The leaves are egg-shaped with a white tone on the undersides.
Hackberry (*Celtis occidentalis*)	W, WD	Fruits are sparingly consumed by songbirds, including cedar waxwings, mockingbirds, and robins through the winter.	Small to medium sized tree of calcareous soils and floodplains. The fruits are similar to dates in taste, but contain a large seed.
Hawthorn, cockspur (*Crataegus crus-galli*)	W, WD	Fruits are an important food source for many species of songbirds and ruffed grouse.	Large shrubs or small trees that usually bear stout spines. Attractive white flowers are followed by small, apple-like fruits. Common in disturbed woodlands that have been pastured by livestock.
Hawthorn, Washington (*Crataegus phaenopyrum*)	W, WD		
Hawthorn, Green (*Crataegus virdis*)	W, WD		
Hickory, Bitternut (*Carya cordiformis*)	WD	Hickory nuts are a very important food source for squirrels. The nuts are also eaten in some quantity by wood ducks and wild turkeys.	Medium sized tree of moist woodlands. Winter buds are sulfur yellow.
Hickory, Mockernut (*Carya tomentosa*)	WD, D		Small to medium sized hickory. Its name is derived from the relatively small size of the sweet kernel.

[1] W = Wet; WD = Well Drained; D = Dry; A = All

Table 5. Continued

Species	[1] Soil Moisture Tolerance	Wildlife Benefits	General Comments
Hickory, Pignut (*Carya glabra*)	WD, D	Hickory nuts are a very important food source for squirrels. The nuts are also eaten in some quantity by wood ducks and wild turkeys.	Medium sized tree of well-drained soils. The common name is derived from the better taste of the nut.
Hickory, Shagbark (*Carya ovata*)	WD		Medium sized tree typical of well-drained soils throughout Indiana.
Hickory, Shellbark (*Carya laciniosa*)	W, WD		Similar to shagbark hickory, but found on poorer soils.
Kentucky Coffeetree (*Gymnocladus dioicus*)	WD	Fruits relished by squirrels, opossum, raccoon, and songbirds.	Uncommon, medium sized tree with gray, scaly bark. Fruit is a thick, brown pod with inedible green pulp surrounding the seeds.
Maple, Black (*Acer nigrum*)	WD	Samaras are widely consumed by birds and squirrels. New growth is browsed by deer.	Medium sized tree very similar to sugar maple, but is usually found in more moist soils. The leaves tend to be mostly 3-lobed and somewhat pubescent.
Maple, Red (*Acer rubrum*)	W, WD		Common, medium sized tree of wet soils, but is also found in dry, upland conditions. Leaves turn an attractive scarlet red in fall. Flowers early in the spring.
Maple, Silver (*Acer saccharinum*)	W, WD		Very fast-growing, medium sized tree of floodplains and poorly drained soils. Small flowers appear very early in the spring.
Maple, Sugar (*Acer saccharum*)	WD		Very common, medium sized tree of well-drained woodlands. Important timber species and also yields maple syrup.
Northern White-Cedar (*Thuja occidentalis*)	A	Foliage often browsed by deer in late winter as an emergency food source.	Medium sized evergreen tree. Planted as an ornamental or part of a windbreak or shelterbelt.

[1] W = Wet; WD = Well Drained; D = Dry; A = All

Species	[1] Soil Moisture Tolerance	Wildlife Benefits	General Comments
Hickory, Pignut (*Carya glabra*)	WD, D	Hickory nuts are a very important food source for squirrels. The nuts are also eaten in some quantity by wood ducks and wild turkeys.	Medium sized tree of well-drained soils. The common name is derived from the better taste of the nut.
Hickory, Shagbark (*Carya ovata*)	WD		Medium sized tree typical of well-drained soils throughout Indiana.
Hickory, Shellbark (*Carya laciniosa*)	W, WD		Similar to shagbark hickory, but found on poorer soils.
Kentucky Coffeetree (*Gymnocladus dioicus*)	WD	Fruits relished by squirrels, opossum, raccoon, and songbirds.	Uncommon, medium sized tree with gray, scaly bark. Fruit is a thick, brown pod with inedible green pulp surrounding the seeds.
Maple, Black (*Acer nigrum*)	WD	Samaras are widely consumed by birds and squirrels. New growth is browsed by deer.	Medium sized tree very similar to sugar maple, but is usually found in more moist soils. The leaves tend to be mostly 3-lobed and somewhat pubescent.
Maple, Red (*Acer rubrum*)	W, WD		Common, medium sized tree of wet soils, but is also found in dry, upland conditions. Leaves turn an attractive scarlet red in fall. Flowers early in the spring.
Maple, Silver (*Acer saccharinum*)	W, WD		Very fast-growing, medium sized tree of floodplains and poorly drained soils. Small flowers appear very early in the spring.
Maple, Sugar (*Acer saccharum*)	WD		Very common, medium sized tree of well-drained woodlands. Important timber species and also yields maple syrup.
Northern White-Cedar (*Thuja occidentalis*)	A	Foliage often browsed by deer in late winter as an emergency food source.	Medium sized evergreen tree. Planted as an ornamental or part of a windbreak or shelterbelt.

[1] W = Wet; WD = Well Drained; D = Dry; A = All

Table 5. Continued

Species	[1] Soil Moisture Tolerance	Wildlife Benefits	General Comments
Oak, Bur (*Quercus macrocarpa*)	A	Acorns of oaks constitute perhaps the most important food source for a wide variety of wildlife including wild turkeys, woodpeckers, squirrels, and deer. Small acorns (pin oak) are also eaten by pheasants and waterfowl.	Medium to large sized tree. Typically found in mesic woodlands and along floodplains. Very drought and fire tolerant. Stout branches and large acorns with fringed caps are easy to identify.
Oak, Black (*Quercus velutina*)	WD, D		Medium sized tree of well-drained soils. Very similar to red oak in appearance; however, the leaves of black oak have pubescent undersides.
Oak, Cherrybark (*Quercus pagoda*)	W, WD		Large tree of bottomlands and well-drained soils. In Indiana, found only in the extreme southwestern part of the state.
Oak, Chinkapin (*Quercus muehlenbergii*)	WD		Small to medium sized tree of calcareous soils and well-drained bottomlands. Bark is scaly with a yellow cast.
Oak, Pin (*Quercus palustris*)	W, WD		Common medium sized oak of poorly drained soils and floodplains. Acorns are relatively small. Branches typically grow at right angles to the trunk.
Oak, Northern Red (*Quercus rubra*)	WD		Common medium to large sized tree of mesic woodlands. Bark is blocky at the base of old trees while the upper portion of the trunk is streaked with flat ridges.
Oak, Scarlet (*Quercus coccinea*)	WD		Medium sized tree of dry ridges. Leaves turn a brilliant scarlet color in autumn.
Oak, Shingle (*Quercus imbricaria*)	WD		Small to medium sized tree of mesic woodlands. Unlobed leaves remain on tree through winter.
Oak, Shumard (*Quercus shumardii*)	W, WD		Large sized tree of well-drained soils and bottomlands. Closely resembles northern red oak, but is usually found in bottomland areas.

[1] W = Wet; WD = Well Drained; D = Dry; A = All

Species	[1] Soil Moisture Tolerance	Wildlife Benefits	General Comments
Oak, Swamp Chestnut (*Quercus michauxii*)	W, WD	Acorns of oaks constitute perhaps the most important food source for a wide variety of wildlife including wild turkeys, woodpeckers, squirrels, and deer. Small acorns (pin oak) are also eaten by pheasants and waterfowl.	Medium to large sized tree of poorly-drained soils. Bark is very similar in appearance to that of white oak, but the coarsely serrated margins of its leaves are distinct.
Oak, Swamp White (*Quercus bicolor*)	W, WD		Medium sized tree of poorly-drained soils. The leaves are dark and shiny above, and dull and white on the undersides.
Persimmon (*Diospyros virginiana*)	WD	Large fruit are readily eaten by raccoons, fox, some songbirds, and deer. The twigs and buds are browsed by deer.	Small to medium sized tree found in bottomlands and old fields. The orange fruit is edible by humans when ripe.
Pine, Eastern White (*Pinus strobus*)	WD	In general, pines make excellent winter cover and roosting trees for many species of birds. Seeds eaten by a wide variety of birds, squirrels and small mammals.	Large tree capable of attaining heights of over 200 feet in ideal conditions. Needles grow in groups (fascicles) of five. In Indiana, native to west-central part of the state.
Pine, Virginia (*Pinus virginiana*)	WD, D	In general, pines make excellent winter cover and roosting trees for many species of birds. Seeds eaten by a wide variety of birds, squirrels and small mammals.	Small sized tree. Needles grow in groups (fascicles) of two. Cones bear sharp prickles.
Serviceberry (*Amelanchier arborea*)	WD	Purplish fruits rapidly consumed by many species of birds. Recommended for quail.	Small, uncommon tree or large shrub of well-drained woodlands. White flowers bloom in April. Fruit ripens in early summer.
Sweetgum (*Liquidambar styraciflua*)	W, WD	Seeds consumed by "northern" finches in winter.	Large tree common in bottomlands of southern Indiana. Leaves are palmately, five-lobed. Fruit is a prickly ball with multiple seed capsules.

[1] W = Wet; WD = Well Drained; D = Dry; A = All

Table 5. Continued

Species	[1] Soil Moisture Tolerance	Wildlife Benefits	General Comments
Tamarack (*Larix larcina*)	W, WD		Small to medium sized tree found in northern Indiana bogs and swamps. The only deciduous member of the pine family found in Indiana. Small cones grown upright along twigs.
Tuliptree (*Liriodendron tulipifera*)	WD	Moderate significance to wildlife overall. Value is that some of the seeds persist in the cones through winter. Seeds eaten by songbirds and squirrels.	Common, large sized tree of the magnolia family. Boles are typically very straight and free of branches for 2/3 the height of the tree. Fruits are upright, aggregates of samaras ("cones"), which remain on the twig through winter.
Willow, Black (*Salix nigra*)	W	Buds, catkins, and tender twigs eaten by ruffed grouse. Bark and wood readily consumed by beaver.	Medium sized tree common along rivers and in wet soils. Narrow, elongate leaves are light green with persistent stipules.

[1] W = Wet; WD = Well Drained; D = Dry; A = All

Table 6a. Annual food plots planting rates (Adapted from NRCS Practice Standard 645, Upland Wildlife Habitat Management)

Species	Single Species (lbs. per acre)	Multiple Species[1] (lbs. per acre)	Wildlife Species Benefited
Milo	15	4	Deer, quail, wild turkey, pheasant, dove, songbirds
Corn	10	4	Deer, quail, wild turkey, pheasant, squirrels
Grain Sorghum	12	4	Deer, quail, wild turkey, pheasant, dove, songbirds
White Proso Millet	15	4	Quail, wild turkey, pheasant, dove, songbirds
German/Pearl Millet	10	2	Deer, quail, wild turkey, pheasant, dove, songbirds
Oats	50	10	Deer, quail, wild turkey, pheasant, songbirds
Sunflowers	6	2	Deer, quail, wild turkey, pheasant, dove, songbirds
Cowpeas	20	5	Deer, quail, wild turkey, pheasant, dove
Soybeans	45	8	Deer, quail, wild turkey, pheasant
Partridge Pea	10	2	Quail, wild turkey, pheasant
Buckwheat	40	8	Deer, quail, wild turkey, pheasant, songbirds
Wheat	50	10	Deer, quail, wild turkey, pheasant, dove, songbirds

[1] Total mix not to exceed 20 lbs. per acre.

Table 6b. Perennial green browse food plot planting rates (Adapted from NRCS Practice Standard 645, Upland Wildlife Habitat Management)

Species[2]	Single Species (lbs. per acre)	Wildlife Species Benefited
Alfalfa	15	Deer, quail, wild turkey, pheasant
Alsike Clover	6	Deer, quail, wild turkey, pheasant
Ladino Clover	5	Deer, quail, wild turkey, pheasant
Red Clover	10	Deer, quail, wild turkey, pheasant

[2] These are usually mixed with a thin stand of cool-season grass or inter-seeded into an existing stand of cool-season grass.

Appendix A

Sources for seeds and plants native to Indiana. Note: This appendix is not an inclusive list of all companies that sell plants native to Indiana. This list is provided as a service only and inclusion of any company should not be interpreted as an endorsement by Purdue University or the quality of service they provide. (Adapted from Landscaping with Plants Native to Indiana, Indiana Native Plant and Wildflower Society.)

Company	Address	City	State	Zip	Phone	Web
Agrecol Corporation	1984 Berlin Rd.	Sun Prairie	WI	53590	(608) 825-9765	
AgVenture D&M Seeds	Box 102	Kentland	IN	47951	(800) 933-0259	
Altum's Horticultural Center	11335 N. Michigan Rd.	Zionsville	IN	46077	(317) 733-4769	
Applewood Seed Co.	5380 Vivian	Arvada	CO	80002	(303) 431-7333	www.applewoodseed.com
Arrowhead Alpines	P.O. Box 857	Fowlerville	MI	48836	(517) 223-8750	
Beineke's Nursery	513 Sharon Rd.	West Lafayette	IN	47906	(765) 463-2994	
Berg-Warner Nursery	P.O. Box 259	Lizton	IN	46149	(317) 994-5487	www.berg-warner.com
C.M. Hobbs & Sons, Inc.	P.O. Box 31227	Indianapolis	IN	46321	(317) 247-4478	
Central Indiana Supply Co. (CISCO)	3610 Shelby At.	Indianapolis	IN	46227	(800) 888-2986	
Cherryhill Aquatics, Inc.	2627 N. County Line Rd.	Sunbury	OH	43074	(740) 965-2798	www.cherryhillaquatics.com
Crystal Palace Perennials	P.O. Box 154	St. John	IN	46373	(219) 374-9419	www.crystalpalace perennial.com
Country Road Greenhouses, Inc.[1]	19561 E. Twombly	Rochelle	IL	61068	(815) 384-3311	www.prairieplugs.com
CRM Ecosystems, Inc.	9738 Overland Rd.	Mt. Horeb	WI	53572	(608) 437-5245	
Designs on Nature	202 Lincolnway East	Mishawaka	IN	46544	(574) 256-2242	
Earthly Goods Ltd.	P.O. Box 614	New Albany	IN	47150	(812) 944-2903	www.earthlygoods.com
Edge of the Prairie Wildflowers	1861 Oak Hill Rd.	Crawfordsville	IN	47933	(765) 362-0915	
Enders Greenhouse	104 Enders Dr.	Cherry Valley	IL	61016	(815) 332-5255	
Flick Brothers Seed Co.	1764 NW 50 P.O. Box 128	Kingsville	MO	64061	(866) 328-0494	www.seedguys.com
Genesis Nursery[1]	23200 Hurd Rd.	Tampico	IL	61283	(815) 438-2220	
Hamilton Seeds	16786 Brown Rd.	Elk Creek	MO	65464	(417) 967-2190	www.hamiltonseed.com
Heartland Restoration Services, Inc.	349 Airport North Office Park	Fort Wayne	IN	46825	(260) 489-8511	
Hartmann's Plant Company	P.O. Box 100	Lacota	MI	49063	(616) 253-4281	www.hartmannsplant company.com
Hoham, Smith, & Co.	104 Walnut P.O. Box 710	Auburn	IN	46706	(888) 262-2214	

[1] Wholesale Only

Appendix A. Continued

Company	Address	City	State	Zip	Phone	Web
IDNR State Tree Nurseries	Jasper-Pulaski Nursery 15508 West 700 North	Medaryville	IN	47957	(219) 843-4827	www.state.in.us/dnr/forestry/index.html
IDNR State Tree Nurseries	Vallonia Nursery 2782 West 540 South	Vallonia	IN	47281	(812) 358-3621	www.state.in.us/dnr/forestry/index.html
Ion Exchange	1878 Old Mission Dr.	Harpers Ferry	IA	52146	(800) 291-2143	www.ionxchange.com
J&J Transplant Aquatic Nursery	W 4980 County Road W P.O. Box 227	Wild Rose	WI	54984	(715) 256-0059	www.tranzplant.com
J.F. New & Assoc., Inc.	708 Roosevelt Rd.	Walkerton	IN	46574	(574) 586-2412	www.jfnew.com
Lafayette Home Nursery, Inc.	R.R. 1, Box 1A	Lafayette	IL	61449	(309) 995-3311	
Mark M. Holeman, Inc.	7871 Hague Rd.	Indianapolis	IN	46256	(317) 849-3120	
Marshland Transplant Aquatic Nursery	P.O. Box 1	Berlin	WI	54923	(920) 361-4200	
Mary's Plant Farm	2410 Lanes Mill Rd.	Hamilton	OH	45013	(513) 894-0022	www.Marysplantfarm.com
Missouri Wildflowers Nursery	9814 Pleasant Hill Rd.	Jefferson City	MO	65109	(572) 496-3492	
Munchkin Nursery & Garden	323 Woodside Dr., N.W.	Depauw	IN	47115	(812) 633-4858	www.munchkinnursery.com
Native Plant Nursery	P.O. Box 7841	Ann Arbor	MI	84107	(734) 677-3260	www.nativeplant.com
Oikos Tree Crops	P.O. Box 19425	Kalamazoo	MI	49019	(616) 624-6233	
Osenbaugh Grass Seeds	R.R. 1, Box 44	Lucas	IA	50151	(800) 582-2788	
Prairie Moon Nursery	R.R. #3, Box 163	Winona	MN	55987	(507) 452-1362	www.prairiemoon nursery.com
Prairie Nursery	P.O. Box 306	Westfield	WI	53964	(608) 296-3679	www.prairienursery.com
Shooting Star Nursery	444 Bates Rd.	Frankfort	KY	40601	(502) 223-1679	www.shootingstar nursery.com
Sharp Brothers Seed Co.	396 SW Davis St. – LaDue	Clinton	MO	64735	(660) 885-7551	
Spence Restoration Nursery[1]	2220 E. Fuson Rd. P.O. Box 546	Muncie	IN	47308	(765) 286-7154	www.spencenursery.com
Springcreek Landscaping and Nursery	1860 North 525 East	Logansport	IN	46947	(574) 722-1128	
Sylvan Gardens	4003 Sylvan Ct.	Floyd Knobs	IN	47119	(812) 923-8132	
Taylor Creek Restoration Nurseries	17921 Smith Rd.	Broadhead	WI	53520	(608) 897-8641	www.appliedeco.com
Vans Pines Nursery, Inc.	14731 Baldwin St.	West Olive	MI	49460	(616) 399-1620	www.vanspines nursery.com
Wetlands Nursery, Inc.	P.O. Box 14553	Saginaw	MI	48601	(989) 752-3492	
Wildlife Nurseries, Inc.	P.O. Box 2724	Oshkosh	WI	54903	(920) 231-3780	
Woods' Edge Farm	532 Stanek Rd.	Muscoda	WI	53573	(608) 739-3527	www.woodsedgefarm.com

[1] Wholesale Only

Appendix A. Continued

	Consulting Services	**Herbaceous Species**	Wildlife Seed Mixes	Cool Season Grasses	Warm Season Grasses	Clovers	Legumes	Grains	Lespedezas	**Woody Species**	Fruit Trees	Shrubs	Deciduous Trees, bare root seedlings	Deciduous Trees, container stock	Coniferous Trees, bare root seedlings	Coniferous Trees, container stock	**Wildflowers & Ferns**	Wildflowers, plants/plugs	Wildflower Seed	Ferns	**Wetland Plants**	Aquatic Plants	Herbaceous Emergent Plants	Shrubs	Trees	Grasses, Sedges, Rushes	Wetland Seed Mixes
Agrecol Corporation	✓	✓	✓	✓	✓		✓										✓	✓	✓		✓					✓	✓
AgVenture D&M Seeds	✓	✓	✓	✓	✓	✓	✓	✓	✓								✓		✓								
Altum's Horticultural Center	✓	✓	✓	✓			✓			✓		✓		✓		✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	
Applewood Seed Co.	✓	✓		✓	✓		✓										✓		✓		✓						✓
Arrowhead Alpines		✓							✓	✓		✓		✓		✓	✓	✓		✓	✓			✓	✓	✓	
Beineke's Nursery	✓									✓		✓	✓	✓	✓	✓											
Berg-Warner Nursery, Inc.	✓									✓		✓		✓		✓											
C. M. Hobbs & Sons, Inc.										✓		✓		✓		✓					✓			✓	✓	✓	
Central Indiana Supply Co., Inc.		✓	✓	✓	✓	✓	✓	✓	✓								✓		✓								
Cherryhill Aquatics, Inc.	✓																				✓	✓	✓			✓	
Crystal Palace Perennials	✓	✓		✓	✓					✓	✓						✓	✓		✓	✓	✓	✓	✓		✓	
Country Road Greenhouses, Inc.[1]	✓	✓			✓		✓		✓								✓	✓			✓		✓			✓	
CRM Ecosystems, Inc.	✓	✓	✓	✓	✓	✓	✓		✓								✓	✓	✓		✓		✓	✓	✓		✓
Designs on Nature	✓		✓		✓		✓		✓	✓		✓	✓				✓	✓	✓		✓		✓	✓	✓		✓
Earthly Goods Ltd.	✓	✓	✓		✓												✓		✓								
Edge of the Prairie Wildflowers	✓	✓	✓		✓												✓	✓	✓								
Enders Greenhouse	✓									✓		✓	✓				✓	✓		✓	✓		✓	✓	✓	✓	
Flick Brothers Seed Co.	✓	✓	✓	✓	✓	✓	✓		✓								✓	✓	✓		✓						✓
Genesis Nursery[1]		✓	✓		✓												✓	✓	✓		✓	✓	✓			✓	
Hamilton Seeds		✓	✓	✓	✓		✓		✓	✓		✓		✓		✓	✓	✓	✓		✓	✓	✓			✓	
Hartmann's Plant Company	✓									✓	✓	✓					✓	✓			✓		✓	✓			
Heartland Restoration Services, Inc.	✓	✓	✓	✓	✓		✓		✓								✓		✓		✓						✓
Hoham, Smith, & Co.		✓	✓	✓	✓	✓	✓										✓		✓		✓						✓
IDNR State Tree Nurseries										✓	✓	✓	✓		✓						✓			✓	✓		

[1] Wholesale Only

Appendix A. Continued

	Consulting Services	**Herbaceous Species**	Wildlife Seed Mixes	Cool Season Grasses	Warm Season Grasses	Clovers	Legumes	Grains	Lespedezas	**Woody Species**	Fruit Trees	Shrubs	Deciduous Trees, bare root seedlings	Deciduous Trees, container stock	Coniferous Trees, bare root seedlings	Coniferous Trees, container stock	**Wildflowers & Ferns**	Wildflowers, plants/plugs	Wildflower Seed	Ferns	**Wetland Plants**	Aquatic Plants	Herbaceous Emergent Plants	Shrubs	Trees	Grasses, Sedges, Rushes	Wetland Seed Mixes
Ion Exchange		✓	✓	✓	✓				✓	✓		✓					✓	✓	✓		✓	✓	✓			✓	✓
J & J Transplant Aquatic Nursery	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
J. F. New & Associates, Inc.	✓	✓	✓		✓		✓		✓	✓		✓	✓				✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Lafayette Home Nursery, Inc.	✓	✓	✓	✓	✓	✓	✓		✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Mark H. Holeman, Inc.	✓									✓	✓	✓		✓		✓	✓	✓		✓	✓		✓	✓		✓	
Marshland Transplant Aquatic Nursery	✓	✓	✓		✓		✓			✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Mary's Plant Farm		✓			✓				✓	✓	✓			✓		✓	✓	✓	✓	✓							
Missouri Wildflowers Nursery		✓	✓	✓	✓		✓		✓	✓		✓		✓			✓	✓	✓		✓	✓	✓	✓		✓	
Munchkin Nursery & Garden																	✓	✓	✓	✓							
The Native Plant Nursery	✓	✓	✓	✓	✓		✓		✓	✓		✓		✓			✓	✓	✓		✓		✓	✓		✓	✓
Oikos Tree Crops										✓	✓	✓	✓								✓			✓	✓		
Osenbaugh Grass Seeds	✓	✓	✓	✓	✓	✓		✓	✓								✓		✓		✓						✓
Prairie Moon Nursery		✓		✓	✓		✓		✓	✓		✓	✓				✓	✓	✓	✓	✓					✓	✓
Prairie Nursery	✓	✓	✓		✓												✓	✓	✓								
Shooting Star Nursery		✓	✓		✓					✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Sharp Brothers Seed Company		✓	✓	✓	✓	✓	✓		✓								✓		✓		✓						✓
Spence Restoration Nursery[1]		✓	✓		✓					✓		✓					✓	✓	✓		✓	✓	✓	✓	✓	✓	✓
Springcreek Landscaping & Nursery	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Sylvan Gardens	✓																✓	✓	✓								
Taylor Creek Restoration Nurseries	✓	✓	✓	✓	✓		✓	✓	✓	✓		✓					✓	✓	✓	✓	✓	✓	✓	✓		✓	✓
Vans Pines Nursery, Inc.							✓			✓	✓	✓	✓		✓												
Wetlands Nursery, Inc.	✓																				✓	✓	✓	✓		✓	✓
Wildlife Nurseries, Inc.		✓	✓	✓	✓	✓	✓	✓	✓								✓		✓	✓	✓	✓	✓	✓		✓	✓
Woods' Edge Farm										✓		✓					✓	✓	✓	✓							

[1] Wholesale Only

Appendix B

List of consultants that perform prescribed fire assistance in Indiana (updated 4/2002). Note: This list is provided as a service only and inclusion of any company or name should not be interpreted as an endorsement by Purdue University or the quality of service they provide.

Stewart Turner, Consultant Forester
8464 S. 950 E.
Upland, Indiana 46989
Phone: 765-998-1161
Fax: 765-998-7549
Email: stove@netusa1.net

Heartland Restoration Services Inc.
14921 Hand Road
Ft. Wayne, IN 46818
Phone: 219-489-8511
Fax: 219-489-8607

J.F. New & Associates
708 Roosevelt Rd.
Walkerton, IN 56574
Phone: 219-586-3400
Fax: 219-586-3446
Email: dnew@jfnew.com
Web: http://www.jfnew.com

David Howell
(only for Quail Unlimited Members)
Regional Director
Quail Unlimited
10364 S. 950 E.
Stendal, Indiana 47585
Phone: 812-536-2272
Fax: 812-536-2272
Email: dhowell@psci.net

Haubry Forestry Consulting
912 North Drive
Seymour, Indiana 47274
Phone: 812-523-1960
Email: rhaubry@hsonline.net
Web: http://www.haubryforestry.com/home.htm

David Borneman
Borneman Consulting
1123 Mixtwood Street
Ann Arbor, MI 48103
Phone: 734-994-3475
Email: davidborneman@yahoo.com

Planting and Care of Fine Hardwood Seedlings

Hardwood Tree Improvement and Regeneration Center
North Central Research Station
USDA Forest Service
Department of Forestry and Natural Resources
Purdue University

Designing Hardwood Tree Plantings for Wildlife

Brian J. MacGowan,
Department of Forestry and Natural Resources, Purdue University

Woody plants can be of value to many wildlife species. The species of tree or shrub, or the location, size, and shape of planting can all have an impact on wildlife. The purpose of this paper is to discuss the benefits of trees and shrubs for wildlife and how to design tree and shrub plantings for wildlife. Some of the practices may conflict with other management goals and may have to be modified for individual priorities.

Trees and Shrubs for Wildlife

The species you select for a tree planting should depend on the growing conditions of the site and the wildlife species that you want to manage. Talk to a professional forester to help you select the tree species best suited for your growing conditions. A professional biologist, such as a Department of Natural Resources District Biologist (www.in.gov/dnr/fishwild/huntguide1/wbiolo.htm), can assist you with planning a tree planting for wildlife.

There is no specific formula for developing wildlife habitat. For example, acorns are eaten by a wide variety of wildlife species including tree squirrels, pheasants, wild turkey, and deer. However, planting oaks does not guarantee you will observe these species. But you will find that an increased variety of tree and shrub species will increase the types of food available at different times of the year, and the number of foraging and nesting niches. Improved forage and nesting niches increases wildlife use.

Each tree and shrub species is susceptible to specific diseases and pests and can endure varying degrees of environmental stress. By planting a diversity of trees and shrubs, one can minimize the probability that the entire wildlife planting would be destroyed as a result of prolonged drought, flooding, or disease and pest outbreaks.

Shrubs can be planted as part of a fencerow or travel lane; they can be combined with other conservation plantings, or they can be established along the edges of tree plantings. Many species of shrubs are of value to wildlife (Table 1). The fruit or nuts from shrubs such as dogwoods (*Cornus* spp.) and viburnums (*Viburnum* spp.) are an important food source. Soft (berries and fruit) and hard (nuts) mast produced by various tree species is a valuable

food source for wildlife (Table 2). Shrubs can be particularly important because several species of wildlife, especially songbirds, prefer to feed or nest on or near the ground. Shrubs also provide good protective cover for these types of wildlife. Pines and other softwoods provide limited food, but are an excellent source of winter and roosting cover, and they can provide important foraging substrate for insectivorous birds, especially migrating warblers. Tree plantings can benefit wildlife in many ways, particularly when combined with other conservation practices, or as a connection or corridor between patches of existing habitat.

The age of a tree planting is an important consideration for wildlife. Young tree plantings are of greatest value to early-successional wildlife that requires thick brushy cover. These include cottontail rabbit (*Sylvilagus floridanus*), woodcock (*Scolopax minor*), and numerous songbirds. Although trees typically do not produce a significant amount of mast until 20+ years of age, young tree plantings can serve as important resting and insect foraging areas for migrating songbirds.

Plantings for Wildlife

Location

Tree and shrub plantings can be useful in connecting patches of forested areas. Planting corridors of trees, shrubs, or both between woodlots can

provide travel lanes for terrestrial wildlife. Hard and soft mast-producing species can provide additional food benefits to a travel corridor. The width of the corridor should be as wide as possible; a minimum of 50 to 100 feet is best. Narrow corridors are still used by some wildlife, but these do not necessarily benefit them because predators and their prey both use these travel corridors. Predators moving through narrow corridors of habitat can efficiently find their prey that has taken up residence there. Wildlife corridors can be composed of one of the following:

- At least three rows of shrubs, one row of a soft mast tree species, and one row of a hard mast tree species. (Mast is the fruit or nuts produced by certain tree species.)
- When shrubs are a limiting habitat factor, create a shrubs-only corridor consisting of a minimum of five rows of shrubs. The tallest species should be located in center rows.
- When winter cover is a limiting habitat factor, create a corridor consisting of three rows of pine, one row of a hard mast tree species, and one row of shrubs.

See Table 1 for shrub species valuable to wildlife and Table 2 for tree species valuable to wildlife.

Shrub plantings on the edge of existing woodlots can improve habitat for edge species of wildlife. (Edge species are wildlife that thrives along areas where the edge of one habitat type meets the edge of one or more of another habitat type.) Plant one to four rows of shrubs along the boundary between a woodlot and a field.

Spacing

Plant spacing should depend on your goals and the surrounding habitat conditions. Some tree plantings for wildlife are established at 20 x 20 ft spacing. Wider spacing will delay crown closure and allow sunlight penetration for a longer period of time. The planting will have a diversity of annual and perennial forbs interspersed among the trees that will benefit some species of wildlife. A spacing of 9 x 9 ft or 10 x 8 ft is typical and is a good compromise between the needs of wildlife and timber production (Payne and Bryant 1994). If wide-spacing planting conflicts with other goals, establish the tree planting adjacent to early-successional habitats that provide similar structure such as weedy areas, old fields, or grass plantings. Skip rows throughout the planting to encourage herbaceous and shrub mixes within the tree planting (Payne and Bryant 1994).

A wider spacing does not benefit all species of wildlife. Decrease spacing in all areas of the planting to establish thick winter cover (or escape cover), if this type of cover is lacking elsewhere on the property. There are no definitive answers when it comes to spacing. Cost, existing and surrounding habitat, wildlife goals, and timber goals should all influence spacing decisions. Consult a professional forester, wildlife biologist, or county Extension educator for more information.

Maintenance

Herbicide treatment is required for optimal establishment and growth of tree plantings in most situations. Minimize or eliminate mowing around tree plantings. The timing of maintenance depends on the density and type of competing vegetation. Grasses, forbs, shrubs, and vines that grow in the planting will enhance its value for wildlife.

Many landowners are interested in obtaining timber from tree plantings. Often this requires grapevine control, but grapevines are a good soft mast source, nesting, and foraging habitat for wildlife. If grapevine control is necessary to meet timber goals, limit it to crop trees and leave vines on non-crop trees and along the edges of the tree planting.

If thinning of tree plantings is necessary for timber production, girdle the non-crop trees rather than remove them. Standing dead trees (snags) are beneficial to many species of wildlife such as woodpeckers, chickadees, and tree squirrels.

Size and Shape of Plantings

Many species of wildlife prefer habitat with a high amount of edge, that is, areas where two or more distinct habitat types meet. Edge habitats are valuable to wildlife because the plant community is often more diverse along edges, and more

than one habitat requirement for wildlife species is close together. Typically, trees and shrubs are planted in linear rows and square or rectangular blocks. This design does not maximize edge habitat. Irregular plantings that incorporate curves will be more valuable to wildlife. Abrupt edges are of lesser value to wildlife than edges with a transition zone or buffer.

Variety

Plant diversity is important for wildlife, both in structure and composition. Multi-layered vegetation will attract more wildlife species than monocultures. Tree plantings that incorporate shrub borders will provide additional food and cover values for wildlife. Various mast-producing

Table 1. *Selected shrub species valuable to wildlife*[1]

Common Name (Scientific Name)	Soil Drainage Class Suitability[2]	Ave. Mature Height (ft.)	Wildlife Information
American Plum (*Prunus americana*)	MWD - ED	30	Fruit eaten by songbirds. Recommended for quail and turkey.
Arrowwood (*Vibrunum dentatum*)	MWD - WD	9	Fruit eaten by songbirds.
Ash, Prickly (*Xanthoxylum americanum*)	SPD - WD	9	
Bayberry, Northern (*Myrica pensylvanica*)	MWD - ED	2 - 8	Fruit and seeds eaten by songbirds. Low, brushy stature provides concealment for ground-dwelling wildlife.
Blackhaw (*Viburnum prunifolium*)	MWD - WD	20	Fruit eaten by songbirds, quail, fox, and turkey.
Bladdernut (*Staphylea trifolia*)	SPD - WD	10	
Chokecherry (*Prunus virginiana*)	SPD - WD	18	Fruit eaten by songbirds.
Chokeberry, Black (*Aronia melanocarpa*)	SPD - WD	10	Fruit eaten by songbirds. Recommended for turkey.
Coralberry (*Symphoricarpos orbiculatus*)	MWD - WD	5	Fruit eaten by songbirds, quail, and ruffed grouse.
Crabapple, Flowering (*Malus* spp.)	SPD - WD	8 - 20	Fruit eaten by birds, deer, and small mammals.
Devils Walking Stick (*Aralia spinosa*)	SPD - MWD	20	Fruit eaten by birds.
Dogwood, Alternate Leaf (*Cornus alternifolia*)	SPD - WD	18	Fruit eaten by birds. Twigs browsed by deer and rabbits.
Dogwood, Flowering (*Cornus florida*)	MWD - WD	30	Recommended for quail and turkey.
Dogwood, Gray (*Cornus racemosa*)	SPD - WD	8	Fruit eaten by pheasant, turkey, and grouse.
Dogwood, Red Osier (*Cornus sericea*)	VPD - WD	10	Fruit eaten by songbirds, grouse, quail, and turkey. Twigs browsed by deer and rabbits.
Dogwood, Rough Leaved (*Cornus drummondii*)	PD - WD	18	Fruit eaten by songbirds, grouse, quail, turkey, and pheasant. Twigs browsed by rabbits and deer.
Dogwood, Silky (*Cornus amomum*)	VPD - WD	10	Sometimes browsed by rabbits and deer.
Eastern Wahoo (*Euonymus atropurpureus*)	SPD - WD	12	Fruit eaten by birds.
Elderberry (*Sambucus canadensis*)	VPD - WD	9	Fruit eaten by many birds including pheasant and dove. Recommended for quail and turkey.
Hazel Alder (*Alnus serrulata*)	VPD - WD	18	Deer browse on the twigs.

Table 1 continued on next page.

Table 1 continued from previous page.

Common Name (Scientific Name)	Soil Drainage Class Suitability[2]	Ave. Mature Height (ft.)	Wildlife Information
Hazelnut (*Corylus americana*)	MWD - WD	15	Small nut eaten by squirrel, deer, jays, grouse, and pheasant. Recommended for quail and turkey.
Highbush Cranberry (*Viburnum trilobum*)	VPD - WD	9	Fruit eaten by grouse, pheasant, and songbirds. Recommended for turkey.
Indigobush (*Amorpha fruticosa*)	VPD - WD	6	
Leadplant (*Amorpha canescens*)	WD - ED	3	
Nannyberry (*Viburnum lentago*)	SPD - WD	18	Fruit eaten by songbirds. Recommended for turkey.
New Jersey Tea (*Ceanothus americanus*)	WD - ED	3	Quail and wild turkey eat the three-celled capsule.
Ninebark (*Physocarpus opulifolius*)	VPD - WD	10	Fruit are small dry bladders. Recommended for turkey.
Pawpaw (*Asimina triloba*)	SPD - WD	20	Fruit eaten by opossum, squirrels, raccoon, and fox.
Prairie Crab (*Malus ioensis*)	PD - WD	30	Fruit eaten by opossum, squirrel, raccoon, and fox. Recommended for turkey.
Redbud (*Cercis canadensis*)	MWD - WD	30	Seeds eaten by a few songbirds.
Shrubby St. Johnswort (*Hypericum prolificum*)	SPD - WD	6	
Spicebush (*Lindera benzoin*)	VPD - WD	9	Twigs and fruit eaten by songbirds, grouse, rabbit, opossum, quail, and deer. Recommended for turkey.
Spirea (*Spiraea alba*) (*Spirea tomentosa*)	VPD - WD	4	Buds eaten by ruffed grouse. Twigs browsed by deer and rabbits.
Sumac, Shining (*Rhus copallina*)	MWD - ED	8	Fruit eaten by songbirds, quail, dove, and pheasant. Recommended for turkey.
Sumac, Smooth (*Rhus glabra*)	MWD - ED	12	Twigs and fruit eaten by songbirds, pheasant, and dove. Recommended for quail and turkey.
Sumac, Staghorn (*Rhus typhina*)	MWD - ED	15	Fruit eaten by songbirds, quail, dove, and pheasant. Twigs browsed by rabbits and deer. Good for turkey.
Wild Blackberry (*Rubus allegheniensis*)	MWD - ED	5	Provides cover and food for birds and mammals. Recommended for quail and turkey.
Wild Black Raspberry (*Rubus occidentalis*)	MWD - WD	5	
Wild Sweet Crabapple (*Malus coronaria*)	SPD - ED	30	Recommended for quail and turkey.
Willow, Prairie (*Salix humilis*)	PD - SPD	13	Use where prairie requires woody vegetation for the targeted species, such as perches for dickcissels.
Winterberry (*Ilex verticillata*)	VPD - WD	15	Buds and twigs browsed by deer and rabbits.
Witch-hazel (*Hamamelis virginiana*)	SPD - WD	18	Seeds, buds, and twigs eaten by deer, rabbit, quail, and pheasant.

[1] Adapted from USDA-NRCS Conservation Practice Standard 645, Upland Wildlife Habitat Management, Indiana NRCS Field Office Technical Guide.

[2] Key for soil drainage class suitability: ED = excessively drained; WD = well drained; MWD = moderately well drained; SPD = somewhat poorly drained; PD = poorly drained; and VPD = very poorly drained.

Table 2. *Selected tree species valuable to wildlife*[1]

Common Name (Scientific Name)	Soil Drainage Class Suitability[2]	Ave. Mature Height (ft.)	Wildlife Information
Pine/Softwoods			
Baldcypress *(Taxodium distichum)*	VPD - WD	80	Waterfowl occasionally consume seeds. Trees also serve as perching areas for song and wading birds.
Cedar, Eastern Red *(Juniperus virginiana)*	SPD - ED	45	Berries consumed by songbirds. Recommended for turkey.
Cedar, Northern White *(Thuja occidentalis)*	PD - WD	40	Foliage often browsed by deer in late winter as an emergency food source. Recommended for turkey.
Hemlock, Eastern *(Tsuga canadensis)*	SPD - WD	70	The dense low foliage of young plants makes good winter cover for grouse, turkey, deer, and other wildlife. Excellent nesting habitat. Small winged seeds fed on by chickadees, pine siskins, crossbills, and red squirrels; twigs browsed by deer and rabbits.
Pine, Eastern White *(Pinus strobus)*	MWD - WD	90	Pines make excellent roosting trees for many species of birds. Seeds are eaten by a wide variety of birds, squirrels, and mice. Recommended for turkey.
Pine, Jack *(Pinus banksiana)*	WD - ED	40	Pines make excellent roosting trees for many species of birds. Seeds are eaten by a wide variety of birds, squirrels, and mice. Recommended for turkey.
Pine, Virginia *(Pinus virginiana)*	MWD - ED	40	
Non-Mast Producing Species			
Aspen, Bigtooth *(Populus grandidentata)*	MWD - WD	70	Twigs and bark consumed by deer and beavers. Buds and catkins eaten by ruffed grouse.
Cottonwood, Eastern *(Populus deltoides)*	PD - ED	90	Recommended for turkey.
Sycamore, American *(Platanus occidentalis)*	PD - WD	90	Sycamore has low food value to wildlife; however, this species forms an important structural component of bottomlands and floodplains.
Soft Mast Producing Species			
Ash, Green *(Fraxinus pennsylvanica)*	VPD - WD	60	Seeds eaten by squirrels, quail, and songbirds.
Ash, White *(Fraxinus americana)*	MWD - WD	70	Seeds eaten by squirrels, quail, and songbirds. Recommended for turkey.
Birch, River *(Betula nigra)*	VPD - WD	50	Stands of birch serve as important cover for riparian dwelling animals.
Cherry, Black *(Prunus serotina)*	MWD - WD	70	Familiar fruits eaten by many species of songbirds, ruffed grouse, and pheasant. Recommended for turkey.
Gum, Black *(Nyssa sylvatica)*	PD - WD	60	Fruits consumed by songbirds and pileated woodpeckers. Recommended for turkey.
Hackberry *(Celtis occidentalis)*	SPD - WD	50	Fruits sparingly eaten by songbirds, including cedar waxwings and robins during winter. Recommended for turkey.
Hawthorn, Cockspur *(Crataegus crusgalli)*	ED - SPD	30	Fruits are important winter food source for many songbirds including ruffed grouse. Fruit eaten by deer, fox, rabbit, pheasant, and turkey. Excellent nesting habitat for songbirds.
Hawthorn, Green *(Crataegus viridis)*	ED - SPD	30	
Hawthorn, Washington *(Crataegus phaenopyrum)*	ED - SPD	30	
Kentucky Coffeetree *(Gymnocladus dioicus)*	SPD - WD	50	Fruits relished by squirrels, opossum, raccoon, and songbirds.

Table 2 continued on next page.

Table 2 continued from previous page.

Common Name (Scientific Name)	Soil Drainage Class Suitability[2]	Ave. Mature Height (ft.)	Wildlife Information
Maple, Black *(Acer nigrum)*	MWD - WD	70	Samaras are widely consumed by birds and squirrels. Browsed by deer. Recommended for turkey.
Maple, Red *(Acer rubrum)*	VPD - WD	70	
Maple, Silver *(Acer saccharinum)*	VPD - WD	80	
Maple, Sugar *(Acer saccharum)*	MWD - WD	70	
Persimmon *(Diospyros virginiana)*	MWD - WD	50	Raccoons as well as some songbirds readily consume large berries.
Sassafras *(Sassafras albidum)*	ED - SPD	40	Browsed by deer, rabbits, beaver, fox squirrel, and woodchuck. Fruit eaten by raccoons, squirrels, woodchucks, and many songbirds. Recommended for quail.
Serviceberry *(Amelanchier arborea)*	MWD - WD	30	Purplish fruits rapidly consumed by birds. Recommended for turkey.
Sweetgum *(Liquidambar styraciflua)*	PD - WD	85	Seeds consumed by finches in winter.
Tuliptree *(Liriodendron tulipifera)*	MWD - WD	90	Seeds eaten by songbirds, squirrels, quail, and turkey.
Hard Mast Producing Species			
Beech, American *(Fagus grandifolia)*	MWD - WD	75	Nuts consumed by deer and squirrels. Recommended for turkey.
Buckeye, Ohio *(Aesculus glabra)*	SPD - WD	60	Nuts sparingly consumed by eastern fox squirrels.
Butternut *(Juglans cinerea)*	MWD - WD	50	Elliptical nuts consumed by squirrels.
Hickory, Bitternut *(Carya cordiformis)*	SPD - WD	50	The nuts of these species constitute an important food source for squirrels and wood ducks. Recommended for turkey.
Hickory, Mockernut *(Carya tomentosa)*	ED - MWD	50	The nuts of these species constitute an important food source for squirrels and wood ducks Recommended for turkey.
Hickory, Pignut *(Carya glabra)*	WD - ED	50	
Hickory, Shagbark *(Carya ovata)*	MWD - WD	70	The loose shaggy bark makes excellent bat roosting sites. Recommended for turkey.
Oak, Black *(Quercus velutina)*	MWD - ED	60	Acorns from oaks are perhaps the most important food source for a variety of wildlife including woodpeckers, squirrels, and deer. Recommended for turkey.
Oak, Bur *(Quercus macrocarpa)*	PD - ED	80	
Oak, Cherrybark *(Quercus pagoda)*	SPD - WD	75	
Oak, Chinquapin *(Quercus muhlenbergii)*	MWD - ED	60	
Oak, Pin *(Quercus palustris)*	VPD - WD	75	The smaller pin oak acorns are particularly favored by wood ducks.
Oak, Red *(Quercus rubra)*	MWD - WD	80	

Table 2 continued on next page.

Table 2 continued from previous page.

Common Name (Scientific Name)	Soil Drainage Class Suitability[2]	Ave. Mature Height (ft.)	Wildlife Information
Oak, Scarlet *(Quercus coccinea)*	MWD - ED	70	Acorns from oaks are perhaps the most important food source for a variety of wildlife including woodpeckers, squirrels, and deer. Recommended for turkey.
Oak, Shingle *(Quercus imbricaria)*	SPD - WD	50	
Oak, Shumard *(Quercus shumardii)*	SPD - WD	75	
Oak, Swamp Chestnut *(Quercus michauxii)*	SPD - WD	70	
Oak, Swamp White *(Quercus bicolor)*	VPD - WD	70	
Oak, White *(Quercus alba)*	MWD - WD	90	
Pecan *(Carya illinoensis)*	SPD - WD	120	Ellipsoid nuts readily consumed by a variety of wildlife.
Walnut, Black *(Juglans nigra)*	MWD - WD	80	Nuts consumed by squirrels.

[1] Adapted from USDA-NRCS Conservation Practice Standard 645, Upland Wildlife Habitat Management, Indiana NRCS Field Office Technical Guide.

[2] Key for soil drainage class suitability: ED = excessively drained; WD = well drained; MWD = moderately well drained; SPD = somewhat poorly drained; PD = poorly drained; and VPD = very poorly drained.

species produce food at different times throughout the growing season. Planting adjacent blocks in different years will provide added structural diversity.

Summary

Tree and shrub plantings can be beneficial to wildlife. The amount of value depends on a variety of factors and includes not only the specific characteristics of the planting, but the type and quality of surrounding habitat and the habitat requirements of wildlife species. Following the guidelines presented in this paper will enhance plantings for wildlife. However, every situation is unique. Thus, there is no substitute for consulting with a professional wildlife biologist (www.in.gov/dnr/fishwild/huntguide1/wbiolo.htm).

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Wildlife Brush Piles

Conservation Practice Job Sheet - Indiana 645

WHAT IS A BRUSH PILE?

The term "brush pile" describes a mound or heap of woody vegetative material constructed to furnish additional wildlife cover. Brush piles can be fashioned in many different ways to meet various cover needs for particular wildlife species.

Mark Bennett, IDNR Division of Fish & Wildlife

Loosely formed brush piles can provide nesting habitat, resting areas, concealment, and protection from predators. Brush piles that are relatively open at ground level, but tightly compacted above, can provide good protective cover against harsh weather conditions. Densely packed piles of logs, rocks, or boulders can provide den sites for additional species of wildlife.

Constructing brush piles on your land can provide cover for ground-nesting birds (such as quail), many songbirds, rabbits, and other small mammals. Landowners should determine what cover types are needed and specifically design brush piles to meet those needs.

PLANNING CONSIDERATIONS

- Place brush piles near wildlife food sources. Good locations include: along forest roads and edges; in woodland openings; along field edges and corners; and beside streams and wetlands. Isolated piles are not likely to be well-used.
- Brush piles can be developed in woodland habitats with the material left from timber harvesting, woodland edge development, forest stand improvement, forest opening development, or firewood cutting.
- Several strategically placed medium-size piles (roughly 10 feet in diameter and 6 feet high) are better than one large one.
- Plant native vines such as Bittersweet, wild grape, or Virginia Creeper as an attractive cover for the brush pile; border with wildflowers; or screen with shrubs. Shrubs can provide additional food and cover.
- Keep brush piles away from houses and lawns to avoid problems with nuisance wildlife.
- Brush piles are flammable. Keep them away from buildings.
- Consider requesting technical assistance from an NRCS, IDNR, or U.S. Fish and Wildlife Service biologist through your local SWCD Office.

BRUSH PILES FOR NESTING, RESTING AND ESCAPE COVER

Predators such as owls, hawks, foxes, coyotes, and domestic pets, can significantly impact rabbit and quail populations when thick, brushy cover is lacking or not well distributed. The well-planned creation and placement of brush piles can often supplement naturally occurring escape cover for these and other wildlife species.

A loosely formed brush pile will encourage plant growth by allowing sunlight penetration. The tangled network of dead branches will eventually be intertwined by a thin to moderately dense stand of grasses and forbs. The end result is excellent resting and escape cover. These same types of brush piles may also be used as nesting sites by songbirds such as the White-throated Sparrow, Song Sparrow, Fox Sparrow, and Brown Thrasher.

The key to forming this type of habitat is to lightly pile branches in such a fashion so that plenty of sunlight reaches the ground. The branches can be sparingly piled in a teepee-type fashion or laid against an elevated object, such as a tree stump or fallen log. Discarded Christmas trees (without the tinsel) can be used

Dan McGuckin. IDNR Division of Fish & Wildlife

in a similar manner. The resulting combination of overhead woody cover mixed with a grass and forb groundcover provides a secure hiding and resting site.

An old, discarded section of woven wire fencing, rolled up to an inner diameter of 1½ to 2 feet and laid on its side, will afford rabbits considerable protection from predators and at the same time allow grasses and forbs to grow up through the openings. Brush piles fashioned in this way take on the characteristics of the "old briar patch" that rabbits find attractive.

Another alternative is to elevate a discarded wooden pallet approximately 8 to 12 inches above ground. Sunlight penetrating through the slats will allow grasses and forbs to grow and provide additional cover.

Placement

Rabbits and quail rarely stray far from good protective cover. This often limits the use of large open spaces that might otherwise serve as important nesting and feeding habitat. By placing brush piles along the edge or scattered throughout large open areas, rabbits and quail are more likely to utilize all available habitat.

General Recommendations

- Good locations to place brush piles include:
  - ⇨ Adjacent to edges of gullies, woodlands, and pastures or hay fields
  - ⇨ Within shrub thickets, fencerows or shelterbelts
  - ⇨ In field corners or other odd areas
- For edge habitats, such as along a woodland, fence row, or gully, one brush pile every 200 to 300 feet will provide adequate cover and travel lanes between food sources.
- In abandoned fields and other early successional habitat, create at least two piles per acre.
- On properties with little natural cover, create three or four brush piles per acre.
- Avoid the bottoms of drainage ways and low spots where standing water or flooding will reduce the usefulness of brush pile for upland wildlife species.

Living Shelters

A brush pile will last longer if constructed of living materials. In addition to providing cover and protection, living brush piles made from partially cut hardwood trees can supply buds, twigs, leaves, and seeds for animals to eat. Red cedar or locust trees can be used as well.

To make a living brush pile, find several (three to five) small hardwood saplings (4 to 8 inches in diameter) located within a few feet from one another. Cut each tree halfway through the trunk about 12 to 18 inches above the ground. Place the cuts on the outside, away from the other trees in the group. Fold the treetop over towards the other trees in the group so it rests on the ground or on top of the other half-cut trees. Since the tree is not cut all the way through, the tree will stay alive for some time. Pile limbs and brush to reduce any large entrances, particularly near the folded trunks. Avoid covering the tops of the cut trees so they will continue to grow.

BRUSH PILES FOR HARSH WEATHER COVER

Brush piles can help ground dwelling wildlife escape the effects of harsh weather (bitterly cold or extremely hot), snow, and ice. A well-constructed, properly maintained, brush pile can supplement natural cover for 10 to 15 years.

Generally, brush piles of this type should range between 10 to 15 feet in diameter, and 5 to 8 feet in height. The most common design is built using logs (arranged in a tic-tac-toe pattern) for the foundation and covered with brush. Start with the largest material on the bottom to provide hiding space under the pile. Shallow depressions can also be dug before beginning the brush pile to provide more space.

Foundation

Use the largest available materials when constructing the foundation. Logs at least 6 to 10 inches in diameter and 10 to 15 feet in length are recommended. The larger materials at the bottom keep the smaller limbs off the ground, helping to prevent decay.

Start construction by laying logs parallel and 6 to 12 inches apart. Next, place a second layer of logs on top of, and perpendicular to, the first layer (again about 6 to 12 inches apart - see Figure 1). Large, flat rocks can be substituted for the second layer of logs. Repeat this process one or two more times to complete the final tiers. The intent is to make a pyramid-type structure that has a hollow core. Note that old and discarded fence posts can also serve this purpose.

Figure 1

Many other options for building brush pile foundations are possible depending upon the materials available.

- A tree stump that is still in place can create an adequate foundation. Place several logs (6 to 10 inches in diameter and 5 to 6 feet long) on top of the stump so that the logs are radiating out from the center (see Figure 2).

Figure 2

- Discarded wooden pallets can also make a suitable base. Pallets should be arranged in 4-6 layers (and elevated from the ground using concrete blocks, stones, etc., if available) to form the foundation.
- Small rock piles can be substituted as foundation material. Create rock piles approximately 12 inches apart with each pile about 10 inches high and 12 inches across. Stagger the piles so that they are capable of supporting the next layer of limbs (see Figure 3).

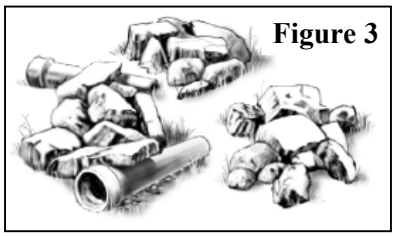


Figure 3

- Consider utilizing old clay tile, 6 to 8 inches in diameter, to create small wildlife tunnels within the foundation.

Brush Covering

Once completed, cover the foundation with larger branches and limbs, placing the smallest stock on top. The cover can consist of small limbs, saplings, old Christmas trees, stumps, or loose brush. Use leaves or pine boughs as a cap if available.

Ideally, the foundation should be covered with 2 to 4 feet of brush. Larger brush piles provide more security for wildlife and will receive more use than smaller piles. Leave openings (6 to 12 inches in width) in the sides at several places for easy wildlife access. Add to the brush pile as new brushy material is available. The older brush will settle as it decays, and new cover must be added as time passes.

When properly constructed, harsh weather brush piles will contain an easily accessible labyrinth of tunnels and cavities at ground level and at the same time provide good overhead shelter from harsh weather. Once again, brush piles should be established throughout the management area to meet wildlife needs.

OTHER CONSTRUCTION OPTIONS

A simple pile of logs, wood slabs, large rocks or boulders can be very attractive to amphibians, reptiles and small mammals, especially when located near or within woodland habitats. Piles of rotting logs or wood slabs not only provide shelter, produce an abundance of food items, but also maintain the moist conditions required by woodland amphibians.

Rock Piles

Amphibians and reptiles such as frogs, lizards, salamanders and snakes will benefit from rock piles. Besides providing shelter and basking areas, the rocks absorb heat during the day and radiate warmth at night.

Rock piles should start with the largest rocks (or boulders) on the bottom of the stack to create hiding places between rocks. Broken slabs of concrete can also be used for the foundation by arranging them loosely to form tunnels and cavities. Digging depressions under large flat rocks can create temporary pools for breeding frogs and salamanders (see Figure 4).

General Recommendations

- Build a mound of rocks and stones of different shapes and sizes, arranging the rock pile in a way that creates openings for shelter.
- Place pieces of chimney tile, old clay field tile or lengths of pipe at the base for entrances and tunnels.
- Add flat rocks on top for amphibians and reptiles.

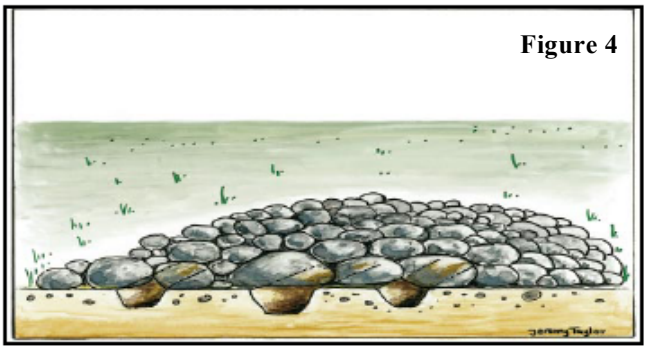


Figure 4

SPECIFICATIONS

Materials that contain toxic substances (i.e. pressure treated lumber/posts, creosote railroad ties, lead painted surfaces, tires, etc.) shall not be used. These substances can cause wildlife mortality either through contact, consumption, or inhalation.

Site-specific requirements will be listed on the attached specification sheet. Specifications are prepared in accordance with the FOTG Standard 645-*Upland Wildlife Habitat/Management*.

OPERATION AND MAINTENANCE

1. Brush piles are not permanent structures. Rot and decay are a normal process of brush piles. As brush piles rot, more insects are attracted, providing additional food for birds and other wildlife. The piles should be inspected yearly to see if the state of decay is such that additional brush is needed, or if a new brush pile should be constructed.
2. Fertilizer can be applied to *living* brush piles to encourage other plant growth and to help the half-cut trees stay alive. Scatter about 5 pounds of 12-12-12 fertilizer (or equivalent) on each living brush pile in March or April.

Acknowledgements:
Fig. 1-3: *Wildlife Management for Missouri Landowners* (3rd Ed).
Fig. 4: *Outdoor California*, CA Department of Fish & Game.

Wildlife Brush Pile - Specifications Sheet

NAME: _____ FIELD NUMBER: _____
COUNTY: _____ DATE: _____
TRACT NUMBER: _____ ASSISTED BY: _____
CONCURRENCE OF IDNR DISTRICT BIOLOGIST (recommended): _____

Specific Recommendations

Purpose of Brush Pile: _____

Species to be benefited: _____

Number and spacing of Brush Piles: _____

Preparation: _____

Lime/Fertilizer Recommendations (if necessary): _____

Additional Operation and Maintenance: _____

_____
_____
_____
_____
_____
_____

Site/Sketch Map

November 2002

Strip Disking and Other Valuable Bobwhite Quail Management Techniques

The bobwhite quail (northern bobwhite, *Colinus virginianus*), is one of the most exciting game birds in the Southeast. A covey rise of 12 or more birds in front of a dog's nose has increased the heart rates of thousands of bobwhite hunters over the decades that man has enjoyed this sport.

For the past several decades, though, bobwhite numbers have been declining, and for the last 10 years, population declines have been as much as 7 percent per year in certain places. Changing land use practices and habitat conditions (food and cover problems) account for most of the downward trend in bobwhite numbers, but other factors, such as predation, disease, and environmental toxicants may play significant roles. In parts of the South, where bobwhites have been managed intensively, bird populations have remained stable, which indicates the bobwhite quail can be managed successfully if you use proper techniques to create essential habitats.

Habitat Requirements

In the southeastern United States, bobwhite are closely tied to early successional plant communities. Early successional plants are the annual weeds, grasses, and shrubs that develop in the first several years after some kind of disturbance. The disturbance may be a disking, fire, cultivation or fallowing, or such.

Bobwhites have specific habitat requirements that vary seasonally according to environmental and biological processes. Various stages of the agricultural/fallow/idle old-field cycle meet different seasonal habitat needs of bobwhites. For example, they nest in idle native grasslands (broomsedge field), raise their broods in weedy areas, and use low shrubby cover for protection from predators and weather. Habitat

Mississippi State University Extension Service

management programs for bobwhites should create and maintain each of these plant communities that meet specific seasonal habitat needs. In the past, bobwhite were an accidental byproduct of forest and agricultural management practices. However, in modern landscapes, restoration of bobwhtie populations requires intentional management.

Habitat Management

Planned periodic disturbance is the key to creating and maintaining bobwhite habitat. Because of the long growing season, fertile soils, and abundant rainfall in the Southeast, undisturbed agricultural lands can rapidly develop into dense young forests not suitable for bobwhites. Management practices that are beneficial for bobwhites generally involve setting back plant succession to very early stages, similar to those found in fields one or two years after cultivation. In the South, habitats, whether open fields or wooded areas, that are allowed to grow up longer than three to four years without some type of soil or vegetative disturbance quickly grow out of good bobwhite habitat.

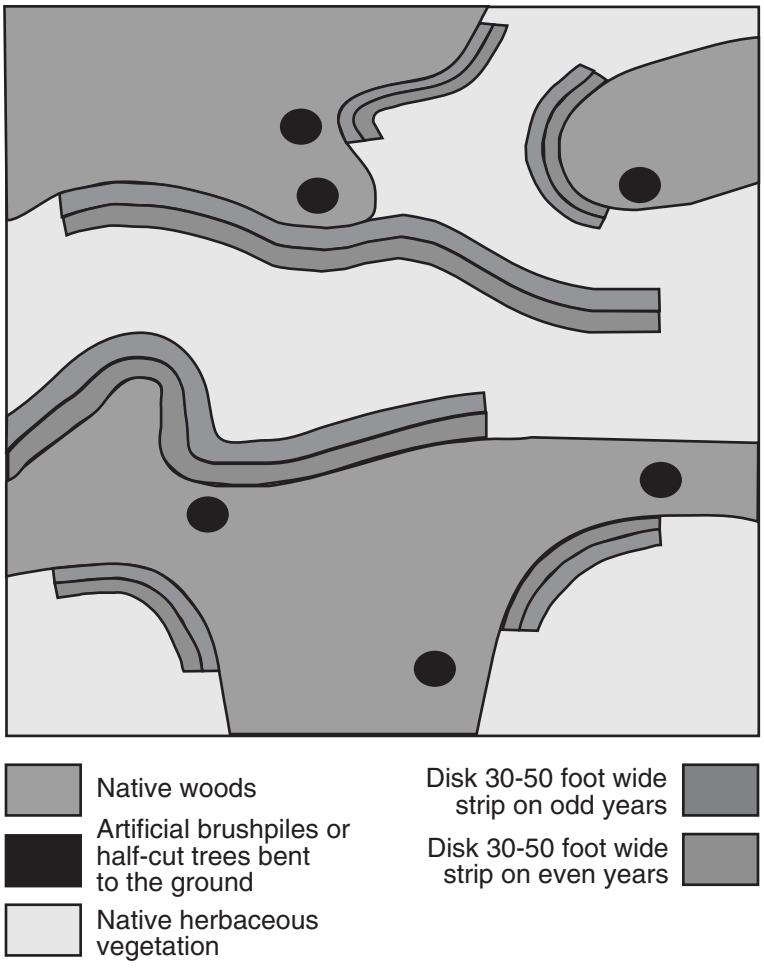
Typically, management practices for open fields include prescribed burning annually or every two years, bush-hogging, disking, planting agricultural crops, and protecting some areas that grow up into brushy escape cover. For wooded areas, the same management practices apply, but concentrating on opening up or daylighting canopies by selective thinning or clearcut timber harvests (to encourage understory plant growth) is important. Prescribed burning on a one- or two-year rotation is critical in pine forests for controlling the leaf and needle litter layer and hardwood understory and for promoting growth of legumes.

Bobwhite thrive in complex landscapes that resemble a patchwork of small crop fields, old fields, grasslands, and brush. Mixing different habitat types (nesting, broodrearing, feeding, or escape cover) close by is a must. Small patches of various habitat types, such as brushy fence rows and ditch banks, should be left within cropland or old-field areas. Small woodlots should be bordered by transition zones of brushy cover that gradually fades into an opening or field. Artificial brush piles or windrows can be placed in large fields to break them into smaller units and increase habitat diversity. The goal is to crate a patchwork of types, well interspersed. This interspersion of patch types increases the proportion of the landscape bobwhites can use.

Strip Disking

Although bobwhite populations have declined, many landowners in the Southeast have significant opportunities to create habitat and restore populations. Hundreds of thousands of acres of old fields and young forests may provide excellent bobwhite habitat. But many of these habitats are in poor shape for bobwhites because they have grown up into thickets of less desirable grasses and brush that are too dense for birds to use. Many don't have a desirable plant mix.

Bobwhites like to have their feet touch bare ground because this makes it easy for them to feed on seeds and insects. The key to bobwhite management



is a balance between a mix of bare ground that lets bobwhites feed and travel freely and vegetation that provides food, nesting habitat, and protection from predators.

Thick sod or dense vegetation that hinders bobwhite feeding can be renovated in old-field habitats with a tractor and disk. The technique simply involves disking strips through a field or open woods in the fall or spring. These strips should be 30 to 50 feet wide and separated by undisked strips of 60 to 100 feet. Disked strips should be as long as possible and should follow the contour of the land to prevent erosion. The undisked areas will provide nesting habitat, while the adjacent disked areas that later grow up into succulent forbs and legumes will provide habitat that is rich in insects and seeds.

Strip disking should be thought of as a rest/rotation system. After a year has passed, disk the previously undisked areas and let the previously disked areas grow for up to two years. This system develops a mix of vegetation that is zero to one, one to two, and two to three years old. Do not let areas get older than three years.

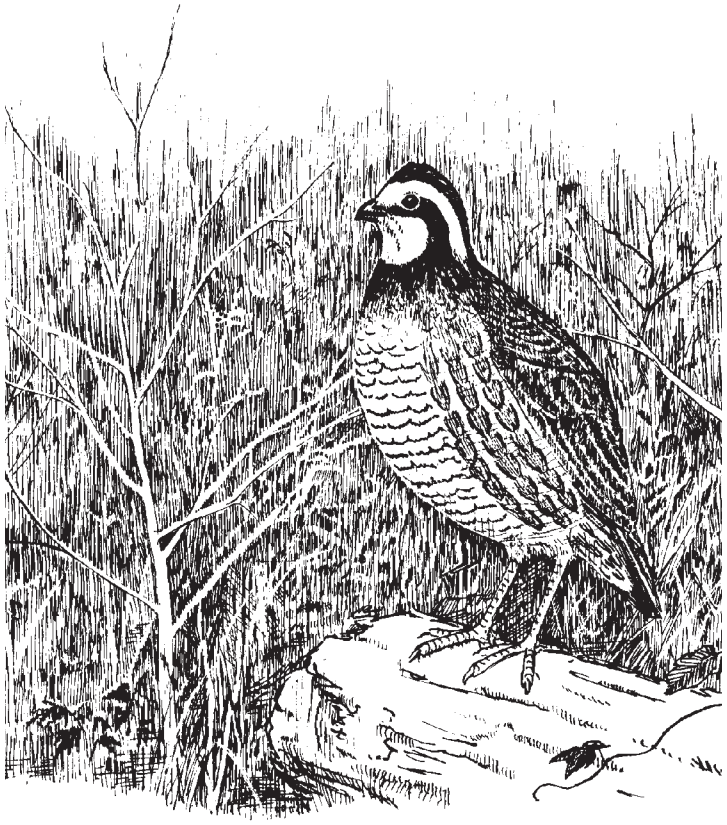
Strip disking enhances habitat quality in a number of ways, including releasing grass-bound fields, reducing litter accumulation, creating bare ground, stimulating germination of desirable seed-producing plants, and increasing insect populations by as much as four times. It will maintain nesting cover and produce adjacent brood habitat on a scale that will positively impact bobwhite populations. It will provide more insects and plenty of natural seeds at a much lower cost than planting food plots, although planting some of the strips to grains or legumes will further enhance habitat quality by providing additional winter food resources.

Although planting winter food resources is an important management tool and can enhance local habitat quality, vegetation succession management is the single most important aspect of bobwhite habitat management in the Southeast. Strip disking is an efficient and cost-effective vegetation management tool and should be broadly implemented to enhance bobwhite habitat quality.

As an example of successful strip disking, one Mississippi landowner kept records between 1987 and 1991 that show an increase in covey numbers from 16 to more than 100 partly because of switching to this management technique. Although not a cure-all for bobwhite quail, strip disking can be a valuable management technique that may help return the bobwhite to good population numbers.

Conservation Reserve Program

Strip-disking is an approved management practice on grass fields enrolled in the Conservation Reserve Program (CRP). In fact, the USDA-Farm Services Agency will cost-share (50 percent) strip-disking on CRP as a mid-contract management practice. To qualify for this cost-share CRP contract, you must visit your USDA Service Center (USDA-FSA/NRCS office) and request that your CRP conservation plan of operation (CPO) be modified to permit strip-disking. For further information, see the USDA-FSA Mid-Contract Management Guidelines and USDA jobsheets MS-CRP-05 and MS-ECS-645-09.



INDIANA DIVISION OF FISH&WILDLIFE

Tree and Shrub Coverts

Tree and shrub coverts are thickets that provide shelter and food for a variety of wildlife species. A well-designed covert will provide food sources, nesting sites, and protection from snow, ice, and predators. A covert planting can be part of a reforestation plan, used to stabilize a stream bank, or used to address an erosion problem. The planting can provide other benefits to the landowner such as a sight and sound barrier, or windbreak.

How important are these thickets to wildlife? A study in Missouri found that wintering quail coveys were usually located within 70 feet of brushy vegetation at all times. Examples of wildlife species that will benefit from this type of habitat component are quail, rabbits, pheasants, and turkeys. Most resident and migratory songbirds will also use these areas.

Three possible techniques are available to produce a tree and shrub covert for wildlife. The first is natural regeneration (see Natural Revegetation Habitat Management Fact Sheet). In some situations, an area can be allowed to naturally grow into a thicket. If the site has seed sources available, and a lack of competing vegetation, a thicket will develop over time. The advantage of this technique is the low cost. The disadvantages are no control of the plant species that grow, and a longer time period to achieve the desired results.

The second technique is to enhance an existing thicket. This could be done by cutting down larger trees and allowing understory species to increase in size and number, or by planting trees and shrubs in and around the existing thicket to increase the size or the plant diversity.

The third technique is to “start from scratch” by designing and planting the covert on open ground. The layout of your property, your goals, and the existing vegetation will determine which technique will produce the best results.

Planning

Creating a plan for your property is the critical first step. A soil map (available from your local Natural Resource Conservation Service office) or aerial photograph is a good base on which to start sketching a plan. In addition, you will need to consider the

HABITAT MANAGEMENT FACT SHEET

following questions: (1) What species of wildlife do I want to benefit? (2) What species of wildlife are in the area? (3) Where is adequate winter and escape cover lacking? (4) What other purposes do I want to accomplish? (5) What are the site characteristics (soil type, slope, moisture, existing vegetation, etc.) of my property? (6) How does my property fit in with the surrounding landscape? (8) Are there small, odd areas on my property, such as wetlands, sink holes, small ravines, or field corners that can be enhanced with coverts? (7) What type of trees and shrubs should I plant, and (8) How will the planting and maintenance be done?

In general, tree and shrub coverts should be 1/8 to 1/4 acre in size and at least 50 feet wide. Coverts that are too small or too narrow will not protect wildlife from predators or harsh weather. Also, many wildlife species will not stray far from protective cover. In large, open areas, coverts should be located no farther than 200 yards apart and will provide the greatest benefit if connected by habitat corridors (see Wildlife Corridors Habitat Management Fact Sheet).

Tree and shrub coverts are thickets that provide food and cover. Therefore, the ideal covert should consist of a dense planting of a variety of trees, shrubs and evergreens. The more species of trees and shrubs planted, the greater the benefits will be to wildlife. Most shrub seedlings should be planted no more than 3 to 4 feet apart, with tree and evergreen seedlings planted no more than 5 to 6 feet apart. Seedlings should be randomly mixed during planting, however taller shrubs should be mixed with taller shrubs, and shorter shrubs should be mixed with shorter shrubs. Seedlings of shorter species should be planted on the outside edges so enough sunlight is received.

Planting

In most cases, tree and shrub seedlings are planted as soon as possible after the ground thaws in the spring. The site must be prepared for the seedlings by controlling existing vegetation. Tillage and/or herbicide will probably be required unless seedlings are to be planted in a field that was cropped the previous year. (In that situation, check on herbicides that were used on the crop field to see if any carry-over could injure the seedlings.) Generally, fertilizing is not recommended because it tends to encourage the competing vegetation to grow more rapidly, thus hindering seedling growth.

Small projects (500 seedlings or less) are usually planted by hand using a planting bar or garden spade. Larger projects are usually planted by using a tree planter, pulled behind a tractor. Some Soil and Water Conservation Districts have tree planters available for rent. Most Consulting Foresters also provide custom planting, herbicide, and maintenance services on a fee basis. For some tree and shrub species, direct seeding (planting tree and shrub seeds instead of seedlings) by broadcasting or use of a grain drill is also an option - the main benefits are lower costs and less labor in large plantings or creating a thicker seedling density when desired (See Direct Seeding Habitat Management Fact Sheet).

Helpful information on how to plant seedlings is included in the Indiana Department of Natural Resources Tree Seedling Order Form. This form is available from the Division of Forestry each September to order seedlings for the following spring's planting. The order form can be obtained over the internet at the following location: www.state.in.us/dnr/forestry. Try to order as much stock as you can from the state tree nursery, and "fill in" as needed from other nurseries. This will help keep project costs down. When ordering seedlings, it's a good idea to order 5% more seedlings than needed to provide replacements for damaged or inferior stock.

Maintenance

As with most wildlife habitat development projects, maintenance is an important element that needs to be considered. In most situations, competing vegetation will likely need to be controlled during the first 2 - 3 growing seasons. Mulching, mowing, or herbicide treatment may be needed if seedlings begin to get smothered by weeds or grasses. If competing vegetation is going to be controlled by mowing, it is a good idea to mark the individual seedlings or, at least, the ends of the planting rows with

biodegradable flagging material. This will greatly reduce the accidental mowing of seedlings and aid in locating seedlings to assess their growth. Non-biodegradable flagging should not be used because it will constrict seedling growth at the point of attachment and ultimately lead to weakened trunk development. The objective of covert creation is to provide thick, woody cover with an understory of weeds, grasses, briars and brambles for additional protective cover at ground level. Therefore, once seedlings have become firmly established, usually after the second or third year, weed control should be discontinued.

If the planting occurs in a high deer-density area, it is sometimes best not to control the competing vegetation. Although this technique will result in slower seedling growth, a tall weed canopy can reduce the likelihood of deer finding individual seedlings. Maintaining hunting pressure throughout the deer season will also help. Rodents may also cause severe damage by girdling the base of the seedlings. In this situation, consideration should be given to erecting raptor perches in the immediate vicinity to encourage their presence and focus their prey-foraging activities on the impacted area. Appropriate fencing should be erected if the planted area is accessible to livestock or horses.

Long-term maintenance also needs to be considered. Coverts will eventually grow to the point at which the thicket starts to thin out. Larger trees will shade out the understory, and smaller trees and shrubs may get too large to provide the thick cover necessary for wildlife. Some cutting of larger trees may be needed to increase sunlight penetration and, thus, increase the growth of understory plants. The cut trees can be used for brush piles or firewood. Once cut, most hardwood trees and deciduous shrubs will re-sprout around the stump. The resulting basal sprouts, if allowed to grow, will help rejuvenate and thicken the covert without additional planting needs. Conifers, on the other hand, will not re-sprout and may need to be replaced. You may also need to cut out “invading” species to maintain the diversity of the planting.

A top quality tree and shrub covert will have fruit and nut-bearing trees and shrubs, conifers for shelter, and a mixture of vines, briars, weeds, and other wildlife-friendly plants. The covert is an important component that will provide for the habitat needs of many wildlife species, and fit in well with your overall plan. For assistance with the design, establishment, or maintenance of tree and shrub coverts, contact your District Wildlife Biologist.

Selected Native Conifers with Value to Wildlife				
Species	**Scientific Name**	**Wildlife Benefit**	**Sun**	**Soil Moisture**
Bald Cypress	*Taxodium distichum*	shelter/seeds	partial/full	moist/wet
Cedar, Eastern Red	*Juniperus virginiana*	shelter/ fruit	partial/full	all
Cedar, Northern White	*Thuja occidentalis*	shelter/fruit	partial/full	moist
Hemlock, Eastern	*Tsuga canadensis*	shelter/seeds	all	moist/wet
Pine, Eastern White	*Pinus strobus*	shelter/seeds	full	well drained/moist
Pine, Jack	*Pinus banksiana*	shelter/seeds	full	all
Pine, Virginia	*Pinus virginiana*	shelter/seeds	full	all

Selected Native Shrubs (Over 15') with Value to Wildlife				
Shrub Species	**Scientific Name**	**Wildlife Benefit**	**Sun**	**Soil Moisture**
Blackhaw	*Viburnum prunifolium*	fall fruit	all	well-drained
Dogwood, Flowering	*Cornus florida*	fall fruit	full/partial	well-drained
Dogwood, Rough Leaved	*Cornus drummondii*	summer fruit	full/partial	well-drained/moist/wet
Cherry, Choke	*Prunus virginiana*	summer fruit	all	dry/well-drained/moist
Nannyberry	*Viburnum lentago*	winter fruit	all	dry/well-drained/moist
Redbud	*Cercis canadensis*	nectar/seeds	full/partial	well-drained/dry
Serviceberry	*Amelanchier arborea*	summer fruit	all	moist/wet
Sumac, Shining (Dwarf)	*Rhus copallina*	winter fruit	full/partial	dry/well-drained/moist
Sumac, Staghorn	*Rhus typhina*	winter fruit	full/partial	dry/well-drained/moist

Selected Native Shrubs (under 15') with Value to Wildlife				
Shrub Species	**Scientific Name**	**Wildlife Benefit**	**Sun**	**Soil Moisture**
Arrowwood	*Viburnum dentatum*	winter fruit	partial/full	dry/well-drained/moist
Buttonbush	*Cephalanthus occidentalis*	nectar/seeds	full/partial	well-drained/wet
Chokeberry, Black	*Aronia melanocarpa*	winter fruit	full	well-drained
Dogwood, Gray	*Cornus racemosa*	fall fruit	full/partial	well-drained/moist
Dogwood, Red-Osier	*Cornus stolonifera*	fall fruit	all	moist/wet
Dogwood, Silky	*Cornus amomum*	summer fruit	full/partial	well-drained/wet
Elderberry	*Sambucus canadensis*	summer fruit	partial/full	well-drained/moist/wet
Hazelnut	*Corylus americana*	nut	full/partial	well-drained/moist/wet
Ninebark	*Physocarpus opulifolius*	summer fruit	partial/full	well-drained/wet
Plum, Wild	*Prunus americana*	summer fruit	full/partial	dry/well-drained/moist
Spicebush	*Lindera benzoin*	nectar/fall fruit	partial/full	well-drained/moist/wet
Sumac, Smooth	*Rhus glabra*	winter fruit	full/partial	dry/well-drained/moist
Winterberry	*Ilex verticillata*	fall fruit	all	moist/wet

Selected Native Trees with Value to Wildlife				
Species	**Scientific Name**	**Wildlife Benefit**	**Sun**	**Soil Moisture**
Ash, Green	*Fraxinus pennsylvanica*	fall seed	full	well-drained/moist
Ash, White	*Fraxinus americana*	fall seed	full	well-drained/moist
Beech, American	*Fagus grandifolia*	nut	full	moist
Birch, River	*Betula nigra*	nectar	full	well-drained/wet
Blackgum	*Nyssa sylvatica*	fruit	partial/full	all
Cherry, Black	*Prunus serotina*	summer fruit	full	well-drained
Hickory, Shellbark	*Carya laciniosa*	nut	full	well-drained/moist/wet
Hickory, Shagbark	*Carya ovata*	nut	partial/full	well-drained/wet
Hackberry	*Celtis occidentalis*	winter fruit	partial/full	all
Oak, Black	*Quercus velutina*	nut	full	dry/well-drained
Oak, Bur	*Quercus macrocarpa*	nut	full	dry/well-drained
Oak, Chinquapin	*Quercus muehlenbergii*	nut	full	dry/well-drained
Oak, Pin	*Quercus palustris*	nut	full	well-drained/wet
Oak, Red	*Quercus rubra*	nut	full	well-drained/moist
Oak, Scarlet	*Quercus coccinea*	nut	full	dry/well-drained
Oak, Swamp Chestnut	*Quercus michauxii*	nut	full	well-drained/moist/wet
Oak, Swamp White	*Quercus bicolor*	nut	full	well-drained/wet
Oak, White	*Quercus alba*	nut	full	well-drained/moist
Pecan	*Carya illinoensis*	nut	full	well-drained/moist/wet
Persimmon	*Diospyros virginiana*	fruit	full	well-drained
Sweetgum, American	*Liquidambar styraciflua*	seed	full	well-drained/wet
Sycamore, American	*Platanus occidentalis*	seeds	full	well-drained/wet
Tuliptree	*Liriodendron tulipifera*	nectar/summer seed	full	well-drained/moist
Walnut, Black	*Juglans nigra*	nut	full	well-drained

Related *Habitat Management Fact Sheets*:

Natural Revegetation
Direct Seeding
Woodland Edge Enhancement
Wildlife Corridors

Prepared by the Indiana Department of Natural Resources, Division of Fish and Wildlife. For up-to-date information concerning the Indiana Division of Fish and Wildlife, or for information on the location of your District Wildlife Biologist, visit our website at www.state.in.us/dnr/fishwild/index2.htm
January 2002

INDIANA DIVISION OF
FISH&WILDLIFE

Fescue Eradication

HABITAT MANAGEMENT FACT SHEET

Tall fescue (*Festuca arundinacea*) is an exotic, cool-season grass that begins growing early in the year when temperatures are too cold for most other plants to grow. This fact, combined with its ability to form a dense, low-growing mat, which covers the seed bed and prevents other seeds from germinating, allows fescue to quickly establish dominancy. In addition, tall fescue is fairly drought and flood tolerant, grows well on acidic and low fertility soils, and compares somewhat favorably with other cool-season grasses in forage quality. These characteristics, combined with its ability to control erosion and withstand heavy traffic, made KY 31 tall fescue attractive to livestock producers, erosion control specialists, and landscapers. In Indiana, over 1 million acres of pastures, hay fields, field borders, utility right-of-ways, and roadsides have been seeded to tall fescue. Although primarily grown in the southern third of Indiana, tall fescue occurs to some degree in almost every county.

Unfortunately, these same characteristics have also made tall fescue one of the greatest enemies of maintaining quality wildlife habitat. It is an aggressive, sod-forming grass that creates a thick, matted condition which severely limits the movement and foraging ability of ground-nesting and ground-feeding wildlife. Tall fescue is also allelopathic. This means it produces compounds that adversely affect the growth or germination of surrounding plants, thus suppressing the establishment of other plants, which are more beneficial to wildlife. As a result, a solid stand (monoculture) of fescue often results. This reduces the ability of wildlife to select a diverse and nutritious diet, and its matting nature leaves little in the way for wildlife concealment against avian predators. The absence of structural and plant diversity within a fescue stand limits its potential to provide quality nesting and foraging habitat for most wildlife species. Fescue also tends to flatten under the weight of snow, reducing its ability to provide protective winter cover, and once established in an area, tall fescue can be tough to completely eradicate.

Another quality of tall fescue that has proven detrimental, is the fact that most tall fescue stands have become infected with the endophytic fungus, *Acermonium coenophialium*, that lives within the plant's intercellular spaces. The fungus produces alkaloids that are toxic

to many plants and animals and causes fescue toxicosis in cattle, horses, and sheep. The symptoms of this infection include nervousness, rough hair coat, elevated body temperature, reduced weight gain, decreased milk production, and lowered birth rates. It has been estimated that the livestock industry loses $500 million a year from fescue toxicosis. One farmer said "It is our main feed and our main problem". Wildlife, including deer, rabbits, quail, and some small mammals and songbirds are also known to be adversely effected by the fungus and exhibit many of the same symptoms. Past studies have shown that rabbits and quail, feeding solely on infected fescue and its seed, exhibit high mortality rates within two weeks.

Eradication of tall fescue, where ever possible, greatly improves the opportunity to provide diverse grasslands capable of supporting more robust and healthier wildlife populations. The two methods most frequently used to eradicate tall fescue are the use of herbicides and/or conventional tillage. In choosing a method, consideration should be given to the availability of equipment, potential for soil erosion, the type of vegetation to be re-seeded, and cost.

Use of Herbicides

The use of herbicides for fescue eradication is usually the best choice because it can be adapted to any site. It is strongly recommended for use on highly erosive soils and slopes where soil disturbance (plowing or disking) may cause or exacerbate erosion problems. Another advantage is that only one pass with spraying equipment is needed in most situations. If the landowner does not have the equipment or the time to do the spraying, most farm supply stores provide custom spraying services. Another option is to hire the services of a nearby farmer.

To make the most efficient use of the herbicides and obtain the best results, spraying should be conducted when the fescue is actively growing (March - April or September - October) and approximately 6 to12 inches in height. Prior to herbicide treatment, the fescue should be mowed, grazed, or burned and allowed to re-grow to a height of 6-12 inches. This will reduce the amount of non-target residue (dead, leafy material) and ensure the maximum exposure of new growth to herbicide contact. If prescribed burning is going to be used, make sure a comprehensive burn plan is developed, and if necessary, seek professional assistance in conducting the burn.

Sites Scheduled for Cool-Season Grass and Legume Establishment

For sites scheduled to be re-seeded to a cool-season grass/legume mixture, two applications of glyphosate *(RoundUp®, RoundUp Ultra®* or equivalent) are recommended (Fall and Spring). Glyphosate is a broad spectrum, systemic herbicide that does not provide residual (post-application) effects, therefore, it will not harm cool-season grasses, legumes, or forbs that are seeded after the fescue has been eliminated. A Fall application mixture of 1 quart/acre of glyphosate, 6-7 ounces of a nonionic surfactant, plus ammonium sulfate (17 pounds per 100 gallons of water) will control about 95 % of the existing tall fescue stand. However, this treatment alone will not provide any residual control of late germinating weeds or grasses, and some fescue re-infestation will likely result from the current year's seed production unless fescue seed heads were mowed prior to maturity (late May - early June). A similar, follow-up treatment in the Spring will probably be necessary. Allow any remaining fescue grass or seed to germinate and grow approximately 6 inches in height and then spray. Wait 7 days after application before preparing the seedbed or sowing seed. **Note:** Although a single Spring application of a similar tank mixture, using glyphosate at the rate of 2 quarts/acre can be used to eliminate fescue, this method only provides adequate control. Fescue regrowth and late-germinating fescue seed will quickly invade newly seeded sites and likely result in the need for additional fescue control.

Sites Scheduled for Warm-Season Grass and Forb Establishment

For sites scheduled to be re-seeded to a warm-season grass/forb mixture, the method described above for eliminating fescue for cool-season grass establishment (using glyphosate), may also be used. Another option is to use imidazoline (*Plateau®* or equivalent), alone or in combination with glyphosate. Imidazoline is a broad spectrum herbicide that provides residual control for up to 8 weeks, depending on

the application rate. Most warm season grasses and many forbs (wildflowers) are tolerant to this herbicide, however, cool season grasses and most broad-leafed annuals are not tolerant. The residual effects of imidazoline suppress the growth of most broadleaves and cool-season grasses, thus allowing warm season grasses and forbs to become established more quickly.

The preferred method is to apply imidazoline at the rate of 4 ounces, along with 2 quarts of glyphosate, plus 1 quart of methylated soybean oil (MSO) per acre in the Spring when the fescue is actively growing. This mixture will control 95 % of the tall fescue and will control late-germinating grasses and weeds for up to 6 weeks. The low rate of imidazoline will also allow a greater diversity of tolerant forbs to become established.

Imidazoline can also be used alone at the rate of 8-12 ounces, plus 1 quart MSO per acre in the Spring to effectively kill fescue. At this rate, residual control of weeds and grasses may extend up to 8 weeks, however, most forbs will be intolerant. The high rate of imidazoline should not be used if a large component of the new seeding consists of switchgrass, eastern gamagrass, sideoats grama, or wildflowers. Severe injury, poor stand development, or stunted growth of these plants will occur.

Methods for Controlling Tall Fescue with Herbicides[1]

Chemicals/Methods	Timing	Site Can Be Seeded To:		Comments
		Cool Season Grasses	Warm Season Grasses	
Glyphosate[2] (1 quart/acre) Nonionic Surfactant (6-7 ounces) Ammonium Sulfate (17 lbs./100 gallons of spray) 10 gallons of water/acre	Fall and Spring	Yes	Yes	Both Fall and Spring application needed. Will control 95 % of fescue. Apply with flat fan nozzles at 30-40 p.s.i. when fescue is 6-12 inches and actively growing. Wait at least 7 days after Spring treatment to prepare seedbed or plant.
Glyphosate (2 quarts/acre) Nonionic Surfactant (6-7 ounces) Ammonium Sulfate (17 lbs./100 gallons of spray) 10 gallons of water/acre	Spring	Yes	Yes	Fescue control will be adequate (50-90 %). Re-infestation from seed will occur. Apply with flat fan nozzles at 30-40 p.s.i. when fescue is 6 inches and actively growing.
Glyphosate (2 quarts/acre) Imidazoline[3] (4 ounces/acre) Methylated Seed Oil (2 pints/acre)	Spring or Fall	No	Yes	Up to 6 weeks residual control. Do not plant cool-season grasses during residual time period. Some wildflowers not tolerant.
Imidazoline (8-12 ounces/acre) Methylated Seed Oil (2 pints/acre)	Spring or Fall	No	Yes	Up to 8 weeks residual control. Do not plant cool-season grasses during residual time period. Most wildflowers will not be tolerant.

[1] The use of trade names does not constitute an endorsement of specific products. Contact local farm supply stores for availability of equivalent herbicides. Always consult and follow herbicide label directions and precautions.
[2] Glyphosate is the active ingredient in *RoundUp®*, *RoundUp Ultra®* or equivalent brand.
[3] Imidazoline is the active ingredient in *Plateau®* or equivalent brand.

Conventional Tillage

Although tall fescue is difficult to eradicate without using herbicides, conventional tillage equipment can be used to suppress tall fescue. It is best adapted for use on non-erosive sites. The most effective method is to plow the sod in the fall and allow the fescue rhizomes to remain exposed to freezing conditions throughout the

winter months. As soon as the soil can be worked in the spring, disk down the plowed sod and allow it to green-up with whatever germinates. Disk the field again to kill off the vegetation, being careful to only disturb the first 2-3 inches of the soil. Deep disking will only bring more fescue seed up into the germination zone. Allow the field to green-up one more time, then shallow disk to kill the competition.

At this point, the site can be left fallow to encourage annual weed growth, planted to a grain food plot, or seeded to a cool-season grass/legume mixture. Another option is to plant a dense stand of wheat, oats, or millet to further suppress the germination of any remaining fescue seed. If the site is going to be seeded to warm season grasses, repeat the green-up/shallow disking method at least one more time to further reduce weed competition.

If the conventional tillage method is employed on sloping sites, care should be taken to keep erosion to a minimum. Perform all tillage practices on the contour and alternate tilled areas with unplowed buffer strips. Once the tilled areas have been adequately vegetated, the remaining buffer strips can be converted using the same process.

Tall fescue is an extremely competitive, exotic, cool-season grass that is very difficult to completely eradicate. It is not always practical or necessary to eliminate all fescue. Rather, the goal should be to keep most of it suppressed so that other more beneficial and diverse vegetation types are available to support the needs of wildlife. Once a site has been renovated, frequent mowing, deep tillage, or fall burning should be avoided. These practices will tend to accelerate fescue re-infestation.

Related *Habitat Management Fact Sheets*:

Warm Season Grass Establishment
Cool Season Grass Establishment
Natural Revegetation
Woodland Edge Enhancement
Grain Food Plots
Legume Food Plots
Legume Interseeding
Wildflowers

Prepared by the Indiana Department of Natural Resources, Division of Fish and Wildlife. For up-to-date information concerning the Indiana Division of Fish and Wildlife, or for information on the location of your District Wildlife Biologist, visit our website at www.state.in.us/dnr/fishwild/index2.htm
March 2002

INDIANA DIVISION OF
FISH&WILDLIFE

Bobwhite Quail

WILDLIFE MANAGEMENT FACT SHEET

LIFE HISTORY

Bobwhite quail in Indiana typically begin nesting in May. Both the male and female pick a site and build the nest together. Most often, the nest is built in a grassy or weedy site that contains scattered shrubs or briars, and is located within 75 feet from bare or nearly bare ground, such as pastures, crop fields, and paved, gravel or dirt roadways. Using dead grass or weedy vegetation from the previous year's growing season, the nest is built within a saucer-shaped depression. A dome of overhanging vegetation is frequently fashioned over a portion of the nest.

After the nest has been completed, the female begins egg laying, usually laying one a day. A typical clutch contains 12 to 15 small, white eggs. Once the clutch has been completed, the hen begins incubating. Incubation is typically done by the hen, but the male may also perform this task. Twenty-three days later, the eggs hatch within minutes of one another. Most quail eggs hatch by mid-July, but adverse weather during May and June may delay the peak hatch to late July or even early August. If the hen disappears, the male will often raise and care for the brood. It is not uncommon to find quail still nesting in early September.

Nest desertions resulting from predation, drought or heavy rains are common, but quail will often attempt to re-nest. With each subsequent nesting attempt, fewer eggs are produced. Nest success varies from site to site and from year to year, however, only 25% of all nesting attempts are usually successful. Recent research has shown that in good habitat, second broods are more common than once believed.

As soon as the young quail have hatched and dried, they are led away from the nest to begin feeding. Insects are a very important food item at this time. Insects have a high protein content, a necessity for rapid chick growth and development. Between early morning and late afternoon feeding periods, time is spent dusting, preening and resting in areas with protective overhead cover (loafing cover). As nightfall approaches, a roosting area is selected in sparse grassy or weedy vegetation.

With the approach of fall, seeds become an important dietary item, and quail begin seeking areas of heavier cover and higher seed production. At this time, known as the "fall shuffle", quail gather in larger groups, mix and eventually reorganize into smaller groups of 10 to 16 birds. During periods of snow, roosting habits change, and thicker overhead cover

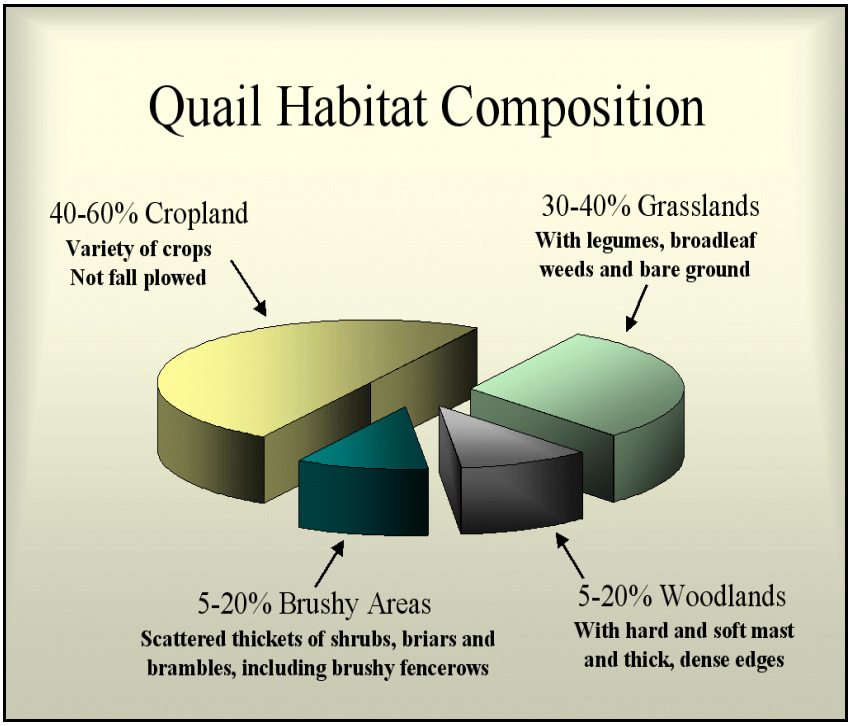
in the form of shrubs, brambles, and thick woody cover is sought.

The covey remains together until spring, then birds begin pairing off in preparation for the nesting season. By spring, the population has reached its lowest level. Up to 80 percent of the fall quail population will have perished, and few hens will live long enough to reproduce. Rarely does a quail in the wild live for more than 14 months.

MANAGEMENT

Since nothing can be done to stop droughts, heavy snowfalls, cold temperatures and heavy rainfalls, the major goal of quail management should be to reduce the detrimental effects of intensive land use and natural plant succession.

Quail need food, nesting cover and winter cover to maintain a population. At some point during the year, the lack of one or more of these habitats will limit quail populations. By improving the deficient habitat, the population can increase until some other factor becomes limiting. In essence, improving an area for quail becomes a step-by-step process of eliminating those factors which limit production and survival.



In general, quail are most prevalent in areas consisting of 40-60% cropland, 30-40% grassland, 5-20% woodland, and 5-20% brushy areas. However, the extent to which quail are abundant is more dependant on the interspersion (mixing) of these cover types, as well as the condition of each cover type. For example, a large block of cropland, adjacent to other large blocks of grassland, woodland, and shrubland, would not be as favorable as having many small crop fields intermixed with numerous small grasslands, woodlands, and shrubby areas. Additionally, crop fields that have been fall plowed have limited value to quail. Woodlands lacking thick woody perimeters do not provide adequate escape and winter cover, and grasslands composed of thick stands of tall fescue provide little, if any, nesting or brood-rearing cover. Quail become most abundant where cropland, woodland, grassland and brushland are well mixed and each component is maintained in a condition that meets the quail's daily and seasonal needs.

NESTING COVER

Good quail nesting cover can best be described as an area of scattered shrubs and brambles interspersed with moderately dense stands of weeds and grassy vegetation with access to nearby bare or nearly bare ground. Unmown grassy or weedy fencerows, woodland edges, roadsides and the edges of idle fields are good examples of areas that can be good nesting cover because of their proximity to bare ground.

Nesting sites must contain dead grassy materials for nest construction. This means an area that has been disked or burned must remain undisturbed for at least one growing season to provide proper nesting materials. A second undisturbed growing season is necessary to ensure a successful hatch. Ideal nesting sites contain about 20 to 30 percent bare ground distributed evenly throughout the vegetation. Studies have shown that more than half of all quail nests are built at the base of brambles, poison ivy, trumpet creeper or other woody plants such as elm, sassafras, persimmon and sumac.

Many types of course-stemmed grasses such as tall fescue and reed canarygrass are not suitable as nesting habitat due to their dense, sod-forming characteristics. These grasses provide inferior nesting cover and produce little, if any, foods. The best way to provide good quality nesting cover is to eradicate the existing sod grasses, using appropriate herbicides, and allow native forbs and grassy vegetation to seed in naturally or plant the site to a light mixture of native grasses, legumes and forbs.

Good quail nesting cover can best be described as an area of scattered shrubs and brambles interspersed with moderately dense stands of weeds and grassy vegetation

During the first growing season after disturbance and continuing through the third year, the area usually will be invaded by ragweeds, daisy fleabane, annual lespedezas, foxtails, beggarweeds, panic grasses and crab grasses. This early successional stage is most important for seed and insect production and brood-rearing habitat. Over the next six years, perennial forbs (goldenrods, milkweeds, yarrows, asters, plantains and ironweeds), grasses (broomsedge and bluegrass) and woody shrubs and brambles begin to predominate. During this successional stage, nesting cover is at its best. The rate at which these stages progress is dependent on site fertility and will determine how long an area remains in good nesting cover. Once woody vegetation begins shading out the preferred native nesting grasses and forbs, or when ground cover becomes too thick and matted, the area must be rejuvenated by disturbance (prescribed burning, disking, or herbicide treatments).

Preferred nesting conditions are commonly found in idle fields, such as those enrolled in the Conservation Reserve Program. However, most nests will tend to be placed within the perimeter of such fields since the interior portions are typically too far removed from bare or nearly bare ground. By applying strip disking, strip herbicide applications, or prescribed burning at intervals throughout the interior portion of an idle field, both nesting conditions and brood rearing habitat can be improved. Strip disking, strip herbicide spraying, and prescribed burning are approved practices for use on Conservation Reserve Program lands, however, the landowner must first make sure his Conservation Plan has been properly amended and approved by the local USDA offices prior to initiating these practices.

Mowing is extremely detrimental to nesting cover as well as nesting quail. An Illinois study determined that mowing accounted for more than 83 percent of the nest failures attributed to farming practices. Since quail prefer nesting cover between 8 and 20 inches high, mowing potential nesting areas in the spring, prior to nest building, may make these areas less attractive and may actually cause birds to seek nesting cover elsewhere. Mowing during the nesting season causes nest abandonment, nest destruction, mortality of the nesting hen, or mortality of the young. If mowing must be done to control noxious weeds, raise the mower blade as high as possible so that only the seed heads are removed. Use of a flushing bar may also help reduce mortality of nesting hens.

Landowners are encouraged to delay mowing until after August 1. By then, most nesting has been completed and chicks are capable of flight. Where fields must be mowed to control brush, a

rotational system of maintenance ensures that some of the nesting cover will be undisturbed each year. Mow no more than one-third of the area in any one year, and leave a mowed height of at least 8 inches to provide adequate winter cover. Frequent mowing is also detrimental to the maintenance of nesting habitat because it encourages grasses to form a thick sod, thereby reducing the amount of bare ground and the diversity of native forbs and legumes.

FOOD

Although quail eat a variety of foods, almost 80 percent of their diet consists of seeds from annual plants. High on the list of annuals are common weeds such as ragweeds and foxtails, and some of our most common grain crops: corn, soybeans, wheat and sorghum. Various legumes including annual lespedezas, beggarweeds (sticktights), and partridge pea are especially attractive. Another 15 percent of the quail's diet consists of seeds from woody plants. The remainder of the diet is a mixture of green vegetation and insects including beetles, weevils, aphids, crickets and grasshoppers. Insects are eaten in small quantities by adult bobwhites, but comprise the bulk of food items consumed by growing chicks. During late winter and early spring, green vegetation becomes a key food item and improves the overall physical condition of the birds, resulting in improved nesting success.

Quail are ground-feeding birds. Seeds of annual plants must be readily visible on the bare ground or be in a light ground litter that can easily be moved about by scratching. Quail feeding areas are often in semi-bare soils beneath a canopy of standing vegetation such as weeds, small grains, or sparse grass and legume mixtures. Once feeding areas become overrun with perennial weeds, usually in four or five years, the amount and variety of quality quail foods decrease. Grass and perennial weeds tend to become too thickly matted and inhibit quail movement. If such areas are to continue to provide high-quality foods, they must be disked, burned, treated with appropriate herbicides, or replanted to encourage a new crop of annuals.

Naturally occurring woody or herbaceous plants that hold their fruits or seeds until early spring should be encouraged along field borders, fencerows and woodlots.

Snowfall that remains on the ground for extended periods of time can lead to starvation because most quail foods are seeds and waste grains that have fallen to the ground prior to snow accumulation. Food plots that stand above the snow can be extremely important, especially in northern Indiana. Sorghum, corn, wheat or soybean food plots, one-eighth to one-quarter acre in size should be planted adjacent to good winter cover. The plots will be best utilized if they are long and narrow (20 to 50 feet wide). As with any crop, proper applications of fertilizer and lime will improve plant growth and seed production. During periods of heavy snowfall, knock down some of the standing plants to provide additional feeding opportunities.

Naturally occurring woody or herbaceous plants that hold their fruits or seeds until early spring should be encouraged along field borders, fencerows and woodlots. They serve as emergency food sources during periods of deep or enduring snows. Black locust, redbud, sumac, native roses (Pasture, Prairie, Swamp, or Virginia rose), blackhaw, nannyberry, maple-leaved viburnum, poison ivy and Virginia creeper are good sources of emergency food and are common throughout most of Indiana. Other woody plants that provide important seasonal foods include sassafras, dogwoods, wild plum, blackberries, raspberries, grapes, ashes and oaks.

WINTER COVER

Quail are primarily a warm climate bird, and populations in the northern half of Indiana often fluctuate wildly in response to the duration of snow cover and freezing temperatures. During years with mild winters and favorable nesting conditions, populations increase, but when faced with several lasting snowfalls and cold temperatures, populations drop rapidly. Snowfalls of more than three inches that remain for at least 60 days can seriously reduce quail numbers.

The main goal of winter cover management should be to maintain thick, brushy cover capable of providing emergency food items close to other traditional food resources. Thick woodland edges, shrubby fencerows, thickets, tall herbaceous weedy growth and clumps of evergreens provide good winter cover. These areas are even better if they contain a low ground cover of trumpet creeper, Virginia creeper, poison ivy, native roses, or wild grapes.

Winter cover is often in the form of woody stems that will eventually grow into large trees. As trees grow, they shade out the underlying thickets and shrubs and no longer provide winter cover. Larger saplings that shade out underlying dense cover should be cleared. Tree and sapling stems should be collected and piled loosely to form brushpiles for additional winter cover. Emphasis should be placed on piling brush loosely so that grasses, forbs, and vines grow up through and around the dead branches.

Where winter cover is lacking, shrubby or young woody growth should be encouraged. Native trees and shrubs resulting from natural succession are usually the best cover because they offer familiar foods as well as cover. Establish winter cover and adjoining food plots where the chances of drifting snow are reduced. In areas where drifting snow is a problem, establish a windbreak of evergreens 20 feet to the windward side of food and cover plots.

Maintain woodland edges in dense shrubby growth

Woodland edges can be good winter habitat if the perimeter contains areas of dense shrubby growth. Woodland edges that abruptly change from tall mature trees to open ground lack the brushy edge needed for winter cover. By selectively removing or girdling large trees within the perimeter of the woodland, thick brushy growth, plus blackberry and raspberry brambles, are encouraged. Trees that are removed through this process can be sold as firewood or saw timber and the tops made into brushpiles.

Tree-lined fencerows can also serve as winter habitat, if areas of thick brushy cover are maintained. Where fencerows have grown into tall mature trees, quail habitat can be rejuvenated by alternately felling or girdling groups of trees along the length of the fence line. This will result in portions of the fencerow developing into young brushy growth, immediately adjacent to sections having mature trees (providing soft and hard mast) in an alternating fashion. To maintain this condition, periodical removal of the maturer trees of the fencerow will be necessary. Again, trees that are removed through this process can be sold as firewood or saw timber and the tops made into brushpiles.

ARRANGEMENT

The secret to successful quail management is the proper arrangement and maintenance of all habitat components. Quail become most abundant where cropland, woodland, grassland and brushland are well mixed and each component is maintained in the proper condition. The more these habitats are mixed together, the more "edge" is created and the greater the possibility for higher quail numbers.

BENEFICIAL MANAGEMENT PRACTICES FOR BOBWHITE QUAIL

1. **Create grassy or weedy field borders around crop fields.** Leaving a border of native herbaceous cover around fields will increase nesting and brood rearing cover with minimal impact on crop production. As little as 10 feet will benefit quail, but where possible, 20 to 50 feet is a better field border width. To develop field borders simply leave a strip of fallow ground around each field. Annual plants will soon begin to appear, followed quickly by native grasses, such as bluegrass, crabgrass, and broomsedge. If erosion is a concern, seed the area lightly with winter wheat, spring oats, or a mix of clovers. Field borders will need to be disturbed on a regular basis to prevent woody encroachment. Instead of disturbing the entire field border every three or four years, disk one-fourth to one-third of the border every year on a rotational basis. This practice can be incorporated with routine ground preparation work in the Spring or Fall. Fall disking tends to encourage hard-seeded weeds such as ragweed and partridge pea and help control Johnsongrass. Spring disking will encourage annual grasses such as foxtails.

Grassy and weedy field borders provide nesting and brood rearing habitat for quail

2. **Maintain idle areas in beneficial grasses, legumes and forbs.** High quality nesting cover is very important in maintaining abundant quail populations. If idle areas currently contain good nesting cover, then maintain the stand in good condition. If not, plant idle areas to a light seeding mixture of native (warm season) grasses or thin-stemmed cool season grasses such as timothy, redtop, bluegrass, or Virginia wild rye.
3. **Convert areas planted to tall fescue to more beneficial grasses, legumes and forbs.** Tall fescue is a very aggressive sod-forming grass. It will reduce plant stand diversity and cover bare soil areas in a very short time span. Plant stand diversity and associated bare ground are important to quail. Treating fescue with herbicide is your best bet for creating better quail habitat.
4. **Create brushy areas for escape, loafing, and winter cover.** Create brushy cover along woodland edges using woodland edge enhancement practices. Maintain fencerows in a combination of brushy and weedy growth, with scattered mature trees to provide emergency winter foods. Plant tree and shrub corridors or coverts where brushy cover is lacking, or set aside areas and allow natural succession to run its course.
5. **Routinely apply strip disking, strip spraying, or prescribed burning to idle grasslands**. Over time, grassland habitats become too thick. The amount of bare ground interspersed within the stand disappears, and the litter layer (the accumulation of dead vegetation laying on top of the ground) becomes too thick for quail to scratch for fallen seeds.
6. **Reduce and delay mowing.** Mowing of idle areas such as field borders, ditch banks, roadsides,

and grass waterways prior to or during the nesting season is very detrimental. Delay mowing until after August 1st. Where mowing is necessary, use it judiciously. Spot mow only those areas that are a problem, or use rotational mowing to leave undisturbed nesting and roosting areas. Mow no more than one-third of the area in any one year, and mow no shorter than 8 inches to allow adequate regrowth prior to winter. When mowing large areas or cutting hay, mow from the inside and work toward the outside. This will push quail broods to the safety of the field edge instead of trapping them in the center of a shrinking patch of cover.

7. **Place grain food plots adjacent to good winter cover.** Energy conservation is very critical for quail during winter months. The farther quail must move to secure food, the greater amount of energy they have to expend. If food plots are to be established on the eastward or southward sides of winter cover, leave 10 to 20 feet between the food plots and winter cover. This will serve as a snow trap and allow blowing snowfall to accumulate prior to reaching the food plots.

Place grain food plots adjacent to good winter cover

Related *Habitat Management Fact Sheets*:

Fescue Eradication
Warm Season Grass Establishment
Cool Season Grass Establishment
Woodland Edge Enhancement
Tree and Shrub Corridors
Tree and Shrub Coverts
Strip Disking
Strip Spraying
Natural Revegetation
Prescribed Burning
Warm Season Grass Maintenance
Brush Pile Construction
Legume Food Plots
Grain Food Plots
Legume Interseeding

Prepared by the Indiana Department of Natural Resources, Division of Fish and Wildlife. For up-to-date information concerning the Indiana Division of Fish and Wildlife, or for information on the location of your District Wildlife Biologist, visit our website at www.state.in.us/dnr/fishwild/index2.htm
May 2003

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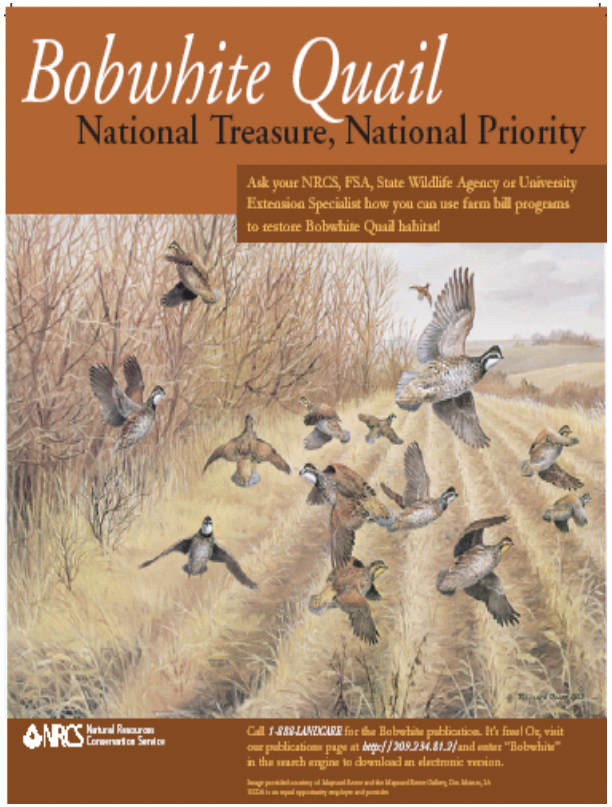

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Quail Habitat Incentives Program

To help improve quail population numbers, the Indiana Division of Fish and Wildlife has designated priority areas throughout southern Indiana to focus on quail habitat management. The Division will offer eligible landowners within the priority areas a variety of incentive payments to encourage the development and maintenance of quality quail habitat.

Quail were once abundant across southern Indiana with peak populations occurring in the late 1960's and early 1970's. At that time there was upwards of 4 million acres of Hoosier farmland idled in USDA land retirement programs. These programs provided an important source of herbaceous cover that remained undisturbed during most nesting and brood-rearing seasons and allowed our quail population to flourish.

Unfortunately, the amount of ground in USDA land retirement programs has declined by more than 90 percent (only slightly more than 250,000 acres remain), and the amount of brushy cover that traditionally served as the primary fall and winter headquarters for quail coveys is declining as well.

How To Apply

Interested landowners should consult the accompanying map and priority area descriptions to determine if they are eligible for the quail habitat incentives program. Eligible landowners should then contact the appropriate priority area biologist listed on the back of this brochure to discuss quail habitat management on their property. The biologist will prepare a management plan for each acceptable parcel and determine the total amount of incentive payments the landowner may be eligible to receive.

To be eligible for the incentive payments, the priority area biologist must approve the habitat practice or practice enrollment prior to implementation. Eligible habitat practices and enrollments are listed on the adjacent panel.

Excluding the one-time incentive payments for enrolling in eligible CRP practices and CRP mid-contract management, total monetary assistance from the Division of Fish and Wildlife will not exceed 90 % of the cost of the practice. No payments will be made until the work has been completed and inspected by the priority area biologist or their designated representative.

Eligible Practices and Payments

CRP Enrollment

Individuals enrolling in specific Regular or Continuous CRP practices are eligible for a one-time signing incentive of up to 120 % of the average soil rental rate. This incentive payment is in addition to any signing incentive payments provided by USDA.

CRP Mid-Contract Management

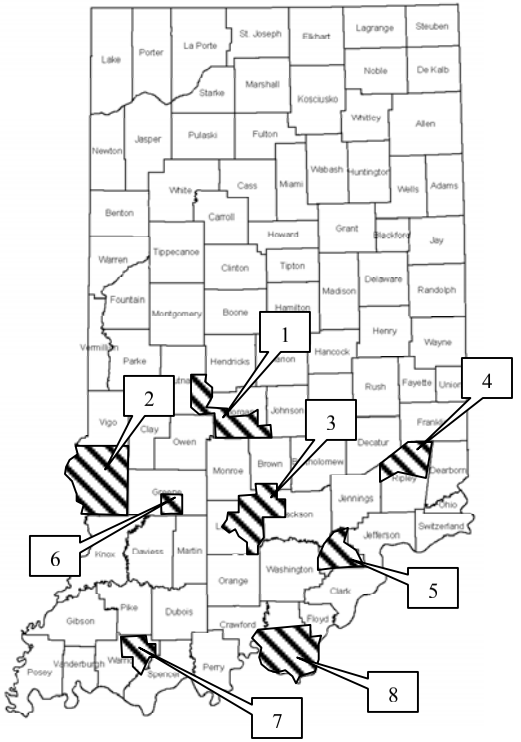
Individuals voluntarily enrolling existing CRP (prior to Sign-up 26) into mid-contract management activities are eligible for an incentive payment not to exceed $16/acre for light disking, $10/acre for legume interseeding, $27/acre for strip spraying, and $20/acre for prescribed burning. This incentive payment is in addition to any cost-share provided by USDA.

Habitat Practices Not Related to CRP

(Maximum payments per practice)

- Establishment of native grasses - $175/acre
- Establishment of cool season grasses - $90/acre
- Fescue Eradication -$30/acre
- Establishment of shrubs - $400/acre
- Strip discing - $30/acre
- Legume interseeding - $40/acre
- Chemical application - $30/acre
- Control burning - $40/acre
- Woodland edge feathering - $20/hour
- Fencerow rehabilitation - $20/hour
- Grain food plots - $50/acre

Quail Habitat Priority Areas



Priority Area Descriptions

Priority Area #1
Putnam County – Only Marion, Jefferson, and Cloverdale (East of US 231) Townships.
Morgan County – Only Ashland, Ray, Baker, Jefferson, Washington, and Jackson Townships.

Priority Area #2
Sullivan County – Entire County.

Priority Area #3
Lawrence County – Only Pleasant Run, Shawswick, Bono, and Guthrie Townships.
Jackson County – Only Salt Creek and Owen Twp.

Priority Area #4
Ripley County – North of US 50.

Priority Area #5
Scott County – Entire County.

Priority Area #6
Greene County – Only Taylor Township.

Priority Area #7
Warrick County – Only Lane, Owen, Pigeon, and Skelton Twp.

Priority Area #8
Harrison County – South of I-64.

HABITAT MANAGEMENT FOR BOBWHITES:

A BASIC GUIDE FOR THE LAND MANAGER

Habitat Needs of Bobwhite Quail

In his book "Beef, Brush and Bobwhites - Quail Management in Cattle Country", Fred Guthery has an opening two paragraphs which rather sums up how the quail manager must look at habitat. He says:

> "Imagine you're 6 inches tall, weigh 6 ounces and would rather walk than fly. Your view of the world would change. A knee-high shrub would become a small tree, a dense stand of bluestem would become an impassible jungle, a 1-mile jog would telescope into a half marathon.
>
> You're beginning to see through the eyes of a bobwhite. These are delicate, immobile birds that require a variety of habitats. They're largely concerned with living space from ground level to a height of about 3 feet on areas no larger than 20 city blocks. Therefore, managers must create crazy-quilt patterns of cover on small areas; "patches" in the quilt must fulfill seasonal and annual cover needs"

The preferred habitat of bobwhites is a mixture of grassland, cropland, brushy areas and woodland interspersed to provide abundant areas of "edge" - those margins where two or more cover types come together. Grasslands are utilized mainly for nesting cover and brooding, cropland for feeding and dusting, and brushy areas, thickets and woodlands for escape cover, loafing and winter protection. The bobwhite is dependent upon "edges" where it can move quickly from nest to feeding areas, from food supply to escape cover; where changing from one activity to another is but a matter of a quick walk or flight of a few seconds duration. The greater the interspersion of type combinations, the greater the amount of edge and bobwhite quail.

Characteristics of Specific Cover Needs

Nesting Cover

Bobwhites construct their nest on the ground, typically in the protection of a clump of grass that they can walk to and yet provides some overhead protection. The nest bowl is made from dry vegetation from the previous year's growth. About 80% of quail nests are found within 20 to 25 feet of an edge where habitat types change and which serves as a travel lane for the birds. Most nests are built in a grass clump from 6" to 18" tall. Native prairie grasses with their clump-type growth form are ideal nest cover. Prairie grass sites with a clump density of no more than one 12" diameter clump per 4 sq. ft. (2' X 2' area) are the best. This allows for sufficient nesting clumps (about 10,000 per acre) and is thin enough to allow the birds to walk through the cover. Even much thinner nesting cover allows for plenty of nesting clumps and easier travel. In Texas, biologists consider about 250 nesting clumps per acre (or 1 clump per 13' X 13' size area) to be about the minimum.

Brood Cover

The greatest mortality of quail occurs in the first four weeks after hatch. This is a critical period which often determines whether the fall population will be a bumper crop or less than desired.

Quail chicks have only a few requirements but these are a must! Chicks need freedom of movement at ground level, overhead concealment and a diverse assortment of green plants or plant parts within pecking height - which for a baby quail is only about two inches. The ground cover must be very open with only 30% to 50% vegetative coverage. This means that as much as 70% can be bare ground. The low-growing greens attract insects such as beetles, grasshoppers, leafhoppers, ants and other invertebrates which compose almost

the entire diet of quail up to three weeks of age. Recently burned prairie units are ideal as are old field sites, weedy strips, legume plantings and small grain and legume mixes. The brood cover must be near (within 100 yards) of midday loafing coverts which is typically woody cover thickets or stands of taller dense weeds.

Loafing Cover and Winter Protection

Bobwhites require some type of shrubby/woody cover for loafing, headquarters sites, and protection from winter snow and winds. These areas provide a safe, comfortable resting site between morning and evening feeding periods. They will utilize tall grasses and weed patches but prefer woody plants. Many of these sites become what are known as "covey headquarters" which are those select sites around which a covey will center its daily activities. A covey may have several headquarters within its home range that it uses from time to time depending upon the weather and available food. Loafing and headquarters sites may be as small as 100 sq. ft. but ideally are at least 400 sq. ft. or more. Larger, denser sites are required for protection during extremely cold winter weather. No less than 5% nor more than 25% of a covey home range should be in woody cover that is 3' to 6' tall.

Covey headquarters and loafing sites are easily made by protecting existing thickets from fire or grazing, felling a tree covered with grape or greenbrier vines or planting small thickets to low growing shrubby species such as American plum, black berry, fragrant sumac, tartarian honeysuckle, Bessy cherry, Nanking cherry, or dogwood.

Winter Food

Bobwhites will utilize numerous kinds of seeds, grains and berries to satisfy their food requirements. Studies have shown that over 1,000 different plants are included in the diet. However there are a relatively few that are of the most importance.

To the manager wanting to maximize quail populations knowing which seeds provide the most energy to quail is of utmost importance. Raising or encouraging those plants for winter food supply which provide a low calorie food source is not only wasteful but can actually be detrimental to the quail. Quail food habits are almost as much a matter of availability as they are selectivity. Therefore if a low quality seed is in abundance the birds will utilize it. On poor feed quail will not be as fat and not be able to withstand severe winter weather, hens will enter the breeding season in poorer condition, lay fewer eggs and experience more physiological stress.

The seeds which contain 80% or more of the energy required to maintain a quail in winter are (in decreasing order of importance):

Food Item	**% of Requirement**
Giant ragweed	99.2
Western ragweed	89.1
Corn	88.7
Soybean	86.7
Sorghum	85.1
Sunflower	83.8
Osage orange	81.6
Dogwood	81.2

Having several of the above seeds available to quail within their home range would offer some degree of insurance against crop failure.

In most plans we will try to maintain one food plot (or feeder station where plots are not feasible) per 40 acres at the maximum density to one per 160 acres at the minimum density. The plots need not be more than 2-3 acres and in fact several smaller plots with better distribution would be better. The exception would be those fields managed for doves where larger fields are needed to attract the birds.

Description of Selected Habitat Management Techniques

A few management techniques will be of the most importance in developing quail habitat. These include controlled burning, disking, mowing, planting of food plots, legume seeding, shrub and shelterbelt planting, and 1/2 cutting. A short discussion of each of these is presented here to better understand each.

Controlled Burning

Fire is one of the most important quail habitat management tools in our area. Burning performs several vital functions including removing accumulated litter, stimulating new growth and controlling excessive woody invasion. Native rangelands that are burned periodically have a wider diversity of plants beneficial to quail than unburned prairies. Also quail utilization of burned prairies will be greater than on unburned prairies for four reasons: 1) The litter has been removed from the ground level which aids in bird movement, 2) Burned units attract a greater density and diversity of insects which are critical to quail chicks, 3) Seed production is greater on burned prairies and 4) The ability of birds to feed on those seeds is improved.

Burn when there is a 5-15 mph wind, preferably in the stable atmosphere of one day after a storm front has moved through and when the humidity is above 40%. Remember that the wind tends to increase in speed throughout the day and generally decreases toward evening.

For best wildlife response burn in small units. On any area of 40-60 acres or larger burn only 1/3 of the unit annually. Use fire breaks that are maintained by disking or fall mowing. Burning only 1/3 of the unit annually allows a portion of the area to be in ideal nesting cover, a portion that is good nesting and fair brooding and an area that regrows to ideal brooding sites.

If control of excessive woody plants is the objective of the burn then a "hot" fire is best. This is one which, after the backfires are secure, is set to travel with the wind and generate a lot of heat as it consumes the litter. "Cool" fires are most often used by wildlife managers. These are generally fires set to back into the wind or where the line of fire is parallel with the wind. Cool fires are easier to control and do a good job of leaving some woody cover intact. Cool late afternoon and nighttime burns are very good. The purpose is not generally to completely sweep the entire area black with a fire but rather to enhance the "crazy quilt" pattern. Nighttime fires set when the wind is decreasing and humidity rising tend to go out in some spots and burn through the heavier cover creating a patchwork design.

Disking and Mowing

The disk is another relatively inexpensive and effective tool available to the quail manager. Too often quail populations are perennially low in an area simply because birds are not able to move from one habitat to another. Quail must be able to walk between their food, cover and water needs and if the vegetation is too thick to allow this or there are inadequate travel lanes then the potential population density of quail will be reduced.

Disking also does a couple other beneficial things for quail. If a disked area is allowed to regrow into the annual weeds and grasses that normally invade disturbed soil then there will be additional areas for chicks to catch insects and a winter food supply in the weed seeds. Also the bare soil areas are needed by quail for dusting sites so the birds can rid themselves of external parasites.

Normally the strips are disked deep enough to thoroughly disturb the soil and kill existing vegetation. About 3" to 4" depth is enough. The strips can be in various widths depending upon the equipment used,

however, about 10' to 15' is about the minimum. Strips up to 10 yards wide are fine as long as they are allowed to revegetate to annual weeds and grasses.

In some places disking will be impossible due to the erosion that might occur on the strip or because of shallow, rocky soils. In either of these instances mowing can be used as the alternative.

Areas mowed as travel lanes should be cut as short as possible and preferably in the fall. With successive years of fall mowing a carpet of Kentucky bluegrass tends to invade these strips which offers green winter browse for quail, rabbits and other animals. Also a mowed strip covered with bluegrass is a more effective fire break. Mowed strips should also be at least 15' wide. Mowing should be considered only a substitute for disking where disking is not possible since a mowed strip does not possess many of the beneficial attributes described above for the disked strip.

Food Plots

Food plots can vary greatly in size but generally from 1/4 acre to 2 acres is sufficient for bobwhites. On areas where there may be severe competition with other animals, especially deer, the larger food plots will be needed. Where no deer problems are likely to occur then the smaller ones are sufficient. On larger food plots or even portions of crop fields managers plant only 1/2 to 1/3 of the plot annually and allow the remaining portion to grow into summer annuals in the idle years.

Care must be taken that quail are always able to walk through the food plot to gather seeds. If the plot is planted too thick or becomes choked with weedy grasses then quail use and food plot effectiveness will be reduced. Use the following seeding rates for the various food plot crops:

Crop	**Lbs. per acre**
Milo (with planter)	4 to 5
Milo (broadcast)	6 to 8
Soybeans (with planter)	30 to 40
Soybeans (broadcast)	50 to 80
Corn (with planter)	12 to 15
Corn (broadcast)	not recommended
Sunflowers (with planter)	3 to 4
Sunflowers (broadcast)	4 to 8
Egyptian wheat (planted)	4 to 5
Egyptian wheat (broadcast)	6 to 10
Proso millet	20 to 30

Some additional food plot crops that have worked well for quail are: buckwheat, sorghum Sudan grass, Rox orange cane, peredovic sunflower, WGF sorghum, bobwhite soybeans (a reseeding variety of field soybeans), various peas and cowpeas. All of these should provide high energy winter foods.

Soil samples should be taken for any quail food plot area to determine the fertility and recommended fertilizer rates. Follow the recommended rates for producing a medium milo or corn crop.

Allowing some "weeds" to grow in the food plot is not necessarily bad however a thick mat of annual grasses such as crabgrass or foxtail will hinder the quails ability to forage for seed. At least 1 cultivation is usually needed to get the grain seed plants off to a good start ahead of the weeds and grasses.

Legume Seeding

The seeding of disked strips with wheat or oats and a legume crop is recommended. Legumes are important to the hen in spring when she is gaining physiological condition for nesting. Green legumes also attract a diverse array of insects beneficial to quail chicks.

The legumes most often used by the quail manager are: Korean lespedeza, ladino clover, white clover, red clover, and subterranean clover. All of these can be broadcast seeded in late winter onto bare soil or drilled.

Any strips disked as a fire break or disked as a travel lane for quail or even portions of some of the larger food plots can and should be planted to a legume crop or a small grain and legume mixture.

Half Cutting and Shrub Planting

In many areas the amount of woody cover at "quail level" is deficient or essentially non-existent. Where there are trees that can be used a lot of half cuttings can be made.

Half cutting of trees means cutting a tree 1/2 to 2/3 of the way through leaving a hinge of bark attached so that the tree falls over yet remains alive. Essentially this creates a living brush pile. This is particularly useful in making covey headquarters. The effect is enhanced if trees can be found which have a vine such as river grape or greenbrier attached which will then proceed to cover the entire brush pile. Several trees in one site, half cut so that they fall onto each other making a brush pile of from 20 to 50 feet, across are particularly effective.

In places where there is no woody cover existing that can be halfcut or protected with disking the manager may have to replant some small shrub thickets. The best shrubs for our area are: American plum, fragrant sumac, autumn olive, red cedar, dogwood, blackberry, multiflora rose, granjeno (spiny hackberry), lote bush (chaparral), black brush, Texas persimmon, and lime prickly ash. Where no native shrubs exist at a site where a thicket is needed then we have little choice but to plant. Any planting will have to be protected from fire and grazing for at least several years until it is well established. All of the shrubs we plant for these purposes are bare root seedlings. Plantings are made at any time from mid-March to mid-May; however, the earlier the better. Site preparation is very important to the survival of seedlings. Any vegetation that will compete with the seedling's moisture or nutrients should be killed. If the planting site is currently in cultivation, disking once or twice may be adequate to kill existing competition and prepare a mellow soil. If it is in grass sod then you must plow the area to be planted. Allow the plowed site to mellow over winter and disk again in the spring to prepare the soil.

Spacing of plants is important. Between row spacing can be dictated by the equipment used to cultivate (or disk) between the rows however the rows or shrubs should be no closer than 8' nor more than 12'. Spacing within the rows should be 10' for red cedar and 5' for shrubs.

Care after planting is also very important. The thickets must be protected from livestock. They must also be kept weed and grass free at least for the first year or two by cultivation and/or hoeing or mulching.

Prepared by Roger Wells, National Habitat Coordinator, Quail Unlimited, Inc., 868 Road 290, Americus, KS 66835, 316-443-5834

Featuring a revised habitat appraisal tool – pages 13-14

Missouri
Bobwhite Quail

HABITAT APPRAISAL GUIDE

Assessing your farm's potential for bobwhites

Published by University of Missouri Extension MP902

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CONTENTS

BOBWHITE QUAIL HABITAT APPRAISAL GUIDE

Northern bobwhite quail *(Colinus virginianus)* have long been a favorite of landowners and hunting enthusiasts across Missouri. Besides being a desirable wildlife species for recreational hunting, bobwhite quail also play an important role within forest, grassland and agricultural ecosystems.

Quail eat plant and weed seeds and consume a variety of insects. They also serve as prey for many predators. Because of their role in the food chain, quail are an important indicator of ecosystem health. The species is representative of a community of wildlife that requires early-successional habitats.

More specifically, bobwhites prefer habitats that have recently been disturbed. The resulting plant community includes grasses and legumes, a wide variety of broadleaf plants, annual weeds, and brushy cover, all closely interspersed across the farm.

Bobwhites are found throughout Missouri. However, their population level at any given time is directly related to land use patterns, management practices and weather. Historically, quail populations have increased and declined as a result of natural factors, as well as the land use and management activities of humans. Early land-use practices and farming methods, such as sharecropping and the use of fire, created a patchwork of small fields that provided ideal quail habitats.

Over the past 30 years, bobwhite quail populations have significantly declined across Missouri. Modern farming tends to use more intensive cultivation practices, makes use of herbicides and insecticides to a greater degree and requires larger equipment. These advanced farming methods have encouraged the removal of edges and field borders, resulting in larger field sizes. Pastures have also been planted to monocultures of grasses such as tall fescue. Tall fescue tends to grow aggressively, and this further reduces the overall habitat quality for bobwhites in many areas.

On many farms, weedy and brushy fence lines, field borders and draws have become dominated by smooth brome, tall fescue and mature trees. Large expanses of woodlands made up of trees with closed canopies do not provide suitable habitat for bobwhite quail.

Your property may have the potential to provide better habitat, but the quality will vary from poor to excellent depending on many land-use factors. Habitat is also influenced by annual disturbances such as disking, prescribed fire, grazing, row cropping and timber harvests.

As a landowner, you have a great opportunity to improve bobwhite quail habitat on your property. By understanding the habitat needs for bobwhites, you can begin to identify the habitat components that may be missing on your farm, as well as appraise the quality of the habitat that may already present. Once this has been accomplished, you can apply the appropriate management practices to improve the habitat for bobwhite quail on your property.

Figure 1. Evaluating your farm's potential for bobwhites is the first step to improve quail habitat.

ASSESSING QUAIL HABITAT

This appraisal guide provides a process for you to evaluate the suitability of a particular area of land (such as cropland, pasture, grassland or forest) on your farm for bobwhite quail. It is designed so that you can inventory and analyze existing habitat conditions (see Figure 1). The guide also serves as a tool to help you identify the habitat requirements that are in the shortest supply (called *limiting factors*) that potentially limit quail numbers on your property.

Identifying these limiting factors is an important step in determining the appropriate management alternatives that need to be implemented to improve the *carrying capacity*, or the capability of the habitat to support a population of bobwhite quail. In addition, the appraisal guide will assist you in evaluating your chances of success and help you decide whether additional investment in bobwhite quail management is needed.

Managing for bobwhite quail can require a significant amount of time and financial commitment. You will find that there are often land-use trade-offs involved that need to be considered as habitat management decisions are made. To succeed with your

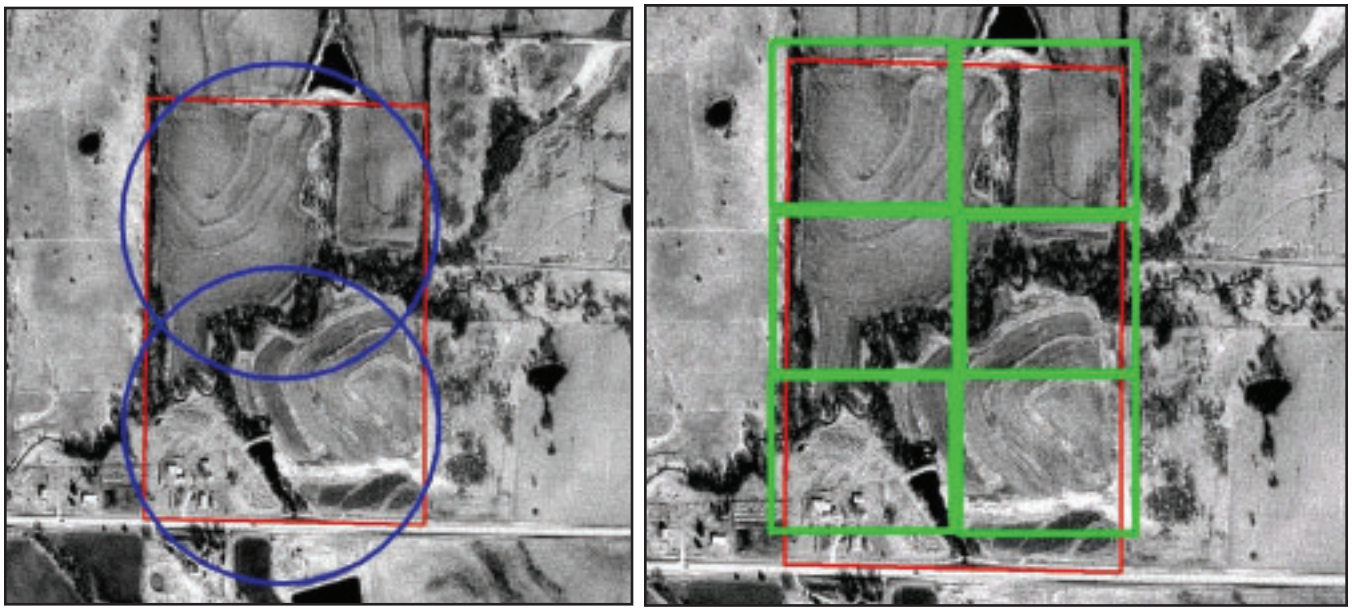


Figure 2a (left) and 2b. Landowners interested in improving habitats for bobwhite quail can make initial management decisions based on a chosen conceptual home range size. Aerial maps can be used to outline and assess these areas on your farm.

habitat management goals, it is important to understand that bobwhites need different habitat types throughout the year. Bobwhites require early-successional plant communities dominated by herbaceous vegetation (such as grasses, annual weeds and legumes), interspersed with grain crops, brushy cover and open stands of timber.

DETERMINING YOUR FARM'S POTENTIAL FOR BOBWHITES

Bobwhite quail typically restrict daily activities to a home range that varies in size depending on the kind, amount, condition and interspersion of required habitat components. All habitat requirements for the bobwhite quail must be found within this area, referred to as the home range.

The size and shape of this area are determined by the limits of how far the animal can travel and the overall quality of the habitat that exists within the home range.

Home ranges for bobwhite quail are not marked by permanent boundaries, nor are they the same from one year or season to the next. Because of this, research has suggested that landowners interested in improving their farm for bobwhite quail make initial management decisions on the basis of the species' conceptual home range and the desired intensity of management. The *conceptual home range* is the area selected by the landowner for bobwhite quail management. This process allows you to arbitrarily set boundaries around the limits of movement for the bobwhite. This also allows you to work on one home range at a time to improve quail habitat. In theory, you should be able to produce at least one covey for each conceptual home range if all limiting factors are addressed.

Identifying conceptual home range areas (see Figures 2a and 2b) is an important first step as you begin to appraise and evaluate the habitat quality for bobwhites on your farm. Working with a conceptual home range of less than 15 acres may not be cost-effective. Likewise, working with a conceptual home range larger than 80 acres does not provide adequate habitat conditions that are in close proximity to one another. In other words, one covey per 15 acres is about as good as you can practically manage quail habitat, and one covey per 80 acres is about as large as you can stretch out the habitat conditions. The quality of habitat within a conceptual home range is determined by the condition of the habitat components within the specified area.

Bobwhite quail use all plant successional stages of vegetation, from recently disturbed openland to mature forest. However, bobwhites are primarily a species requiring edge habitats and early- to mid-stages of plant succession. Excellent seed producers and indicators of early-successional habitats attractive to bobwhites are ragweeds (*Ambrosia* spp.), pigweeds (*Amaranthus* spp.), foxtail grasses (*Setaria* spp.), panic grasses (*Panicum* spp.), tick trefoils (*Desmodium* spp.) and smartweeds (*Polygonum* spp.). Habitat quality generally declines as perennials and woody plants replace shade-intolerant annuals and clump grasses. However, patches of woody

plants and shrubs provide valuable protective cover.

In general terms, ideal bobwhite quail habitat should be made up of the following:

- about 50 percent of the area in annual weeds, legumes, and minimum or no-till row crops
- about 30 percent of the area in grasses
- about 20 percent of the area in shrubby, brushy cover

Note: Addressing the limiting factors on your property may not immediately restore a population of quail. If you have a small property surrounded by large areas of fescue, mature forest or row crops, quail populations may be slow to increase. This will tend to reduce all habitat ratings.

IMPROVING HABITAT FOR BOBWHITES

One goal for managing habitats for bobwhites is to make each square foot of a management area, or home range, usable throughout the year. Habitat is usable if it fits the habits and physical needs of the bird. Providing habitats that are usable simply means creating and managing cover to which bobwhites are adapted.

Cover types need to be mixed together, or interspersed, throughout the home range. The proper arrangement of these habitat patches (food and cover) is important because of the bobwhite's relative low mobility and the need for open, bare ground conditions. Bobwhite quail spend a great deal of time walking, feeding, loafing and roosting directly on mineral soil. Their daily movements are often restricted to a home range size of 20 to 40 acres. Depending on the season, bobwhites may indeed roam over a larger area. However, research indicates that a covey seldom uses an area larger than 100 acres in size. Keep in mind that the size of the home range is directly dependent on the quality and quantity of habitat, which can vary throughout the year.

Under certain conditions, bobwhites concentrate their activity around food and cover patches that are less than 50 feet apart. Recent research has found that bobwhite quail seldom travel more than 70 feet from woody escape cover during the winter. This demonstrates the importance of having brushy cover close to available foods during the winter months.

As mentioned earlier, size of the bobwhite's home range varies according to the quality and quantity of habitat within a particular area. Although it is common for individual birds to move further distances during fall and spring, the habitat components necessary for a covey of quail must be met within their home range.

The average bobwhite population density on intensively managed areas is about one covey per 15 acres. In the Midwest, the carrying capacity of the habitat for quail rarely exceeds one bird per acre under the best habitat conditions. During the fall (when populations are typically at their highest), the average covey is made up of about 10 to 12 birds.

Using the habitat appraisal tool

The habitat appraisal tool located at the end of this guide outlines the process for evaluating the quantity and quality of habitats and for identifying the limiting factors that may exist on your farm. The values represent the general quality of the habitat and identify the factors that limit the bobwhite quail population within the selected conceptual home range.

The appraisal tool allows you to select the rating that best describes the existing land use and cover conditions. Steps four through seven outline the habitat appraisal process and help you record ratings of your farm.

The following procedures describe the method to inventory existing habitat conditions and calculate the limiting factor values. It is suggested that the appraisal be conducted during the growing season, particularly as the habitat evaluation will be based on the kinds, amounts, condition and arrangement of the plant community. However, habitat can be evaluated year-round as long as the user pictures growing season conditions.

Procedures for habitat appraisal

The following steps outline the procedures for conducting habitat appraisal.

Step 1. Determine goals and objectives. First, determine goals for your property and the intensity of management you are willing to commit to. You may ask yourself several questions to determine the goals and objectives for your property, such as the following:

- Do you wish to intensively manage your property for bobwhite quail?
- Is the bobwhite a secondary species of concern, after white-tailed deer or a combination of other wildlife species?
- Do you wish to integrate bobwhite quail management practices with ongoing agricultural production?

Step 2. Estimate time and cost. Next, determine the practicality of managing for bobwhite quail on

your property and the amount of time and money you are willing to invest. For example, if a large percentage of your property and the surrounding area is dominated by tall fescue pastures, mature forest land, or large crop fields, a greater time and financial commitment will be required to make necessary habitat improvements for bobwhite quail.

Step 3. Select the best locations for assessing habitat. Select locations on your farm that have the greatest potential for improving bobwhite quail habitat. It is best to select areas that represent a *conceptual home range* for bobwhite quail on your property. The size of the home range will be predetermined, based on the intensity of management you wish to employ and your desired population goals.

For example, you may set a goal of having one covey per 15 acres, one covey per 40 acres, etc., on your property. It is important to realize that the smaller the home range, the more intensive the management becomes.

Conceptual home ranges that you select may be square, rectangular, triangular, or any other shape that is practical to appraise and manage (see Figures 2a and 2b). The conceptual home range may consist of one field, or more often will cross field or land use and cover boundaries.

Several home ranges may also be superimposed over the entire farm or area of interest. Any portion of your property may be appraised by evaluating one or more of these conceptual home ranges. The remainder of the farm does not have to be appraised at all, or may be appraised by evaluating the habitat for another species.

Step 4. Examine habitat within the conceptual home ranges. In this step, examine the habitat found within the selected home ranges. It is important to ensure that all required habitat components are present. If any component is missing, record a "0" value as that component's quantity requirement rating on the evaluation tool.

This means that the habitat is unsuitable for bobwhite quail unless that habitat component is provided. Some requirements may be filled by more than one component. For example, herbaceous plants (annual weeds, grasses or legumes) may fulfill both food and brood habitat requirements.

Ratings: Ratings for the various habitat criteria range from 0 (poor) to 10 (excellent). Each habitat criteria has one to three variables, and each variable has different levels of management that can be evaluated and applied.

Step 5. Evaluate the condition of required habitat components. Next, evaluate the habitat components by matching habitat conditions with the ratings for the various requirements. These are also listed on the evaluation tool. Specific instructions are contained in the next section and on the appraisal tool.

Step 6. Determine the limiting factor value for each habitat component. Based on your assessment and rating of the various habitat criteria you can identify the requirement that has the lowest value for each of the habitat components necessary for bobwhite quail within each home range.

Habitat component limiting factor value = the requirement with lowest rating value for each habitat component

Step 7. Develop a wildlife management plan. Finally, assess the habitat requirements that are limited or missing, and develop a management plan that addresses bobwhite quail habitat needs.

HABITAT REQUIREMENTS

The following section provides a brief summary of the food and cover requirements for bobwhite quail. These include nesting cover, brood-rearing cover, protective and escape cover and important foods. In addition, the criteria for each of the cover requirements are described in more detail.

Nesting cover

Bobwhites begin nesting in Missouri after covey break-up occurs in April. However, most nesting will begin in May with peak hatching in mid-June with a smaller peak in July. Either perennial or annual warm- and cool-season grasses from the previous season provide nesting cover for early season nesting (Figure 3).

Nesting cover typically consists of grasses at least boot-high or around 12 inches to conceal quail. Small clumps of grass with last year's grass residue present are preferred. Nesting cover should be open clumps of grass, which can conceal the nest site, near open ground to allow chick movement after hatching. Radio-tagged birds in a north Missouri study chose nest sites with an average of under 10 percent grass composition, while an Iowa study found nests that had an average grass composition of 69 percent at the nest location. Nesting cover should be heavily disturbed once every two or three years. This promotes growth of legumes and weedy vegetation and helps create open ground conditions.

Grasses must also be located in close proximity to

brood-rearing habitat. Most nests are located 50 to 70 feet from an opening or edge. Dense vegetation and thick litter on the soil surface restrict the movement of small chicks and inhibit foraging. Thus, disturbance on a two- to four-year cycle is necessary to maintain nesting cover. As the time since disturbance increases beyond three years, litter accumulates, grasses become too dense, and quality of nesting declines.

The following criteria, outlined on the evaluation tool, are necessary for quail nesting cover:

1. Nesting cover quantity within the home range. Nesting cover is defined as an open grassy area where the plant community includes the following:

- warm-season bunch grasses such as big and little bluestem, broomsedge, indiangrass, switchgrass, sideoats grama, or others that are a height of at least 12 inches at maturity
- other cool-season perennial grasses, provided that the grass stand has been recently disturbed (at least once out of the last three years by light disking or burning).
- low-growing woody cover such as poison ivy and blackberry, with sparse ground cover and nearby herbaceous material.

The same areas that provide food or brood habitat may serve as nesting cover. At least 30 percent of the habitat within the bobwhite's home range should be composed of grassy/herbaceous vegetation. When the optimal home range size is being considered (15 acres), at least 4.5 acres (or 30 percent of the area) should be composed of grassy/herbaceous vegetation for optimal nesting cover.

2. Nesting cover height. Cover height depends on management practices such as grazing, mowing or prescribed burning. Nesting cover conditions occur where at least 12 inches of grass stubble height remains. Land that is hayed typically does not have the residual cover necessary to initiate a nest.

Figure 3. Bobwhite prefer to nest in clumps of grasses from the previous year's growth.

3. Distance to edge. Quail nest research in Missouri has shown that quail prefer to nest within 50 feet of an edge. Similar research in Iowa showed a preference for nesting within 75 feet of edge. Edge is, generally considered, the boundary between another habitat type, such as nesting cover and a cropfield, coveyheadquarters, pasture or woodland. The more edge created within nesting cover, the more opportunity will be presented for quail nesting. Strip disking, patch burning, food plots or development of coveyheadquarters areas are some examples of how to create edge within nesting cover. When considering nesting cover that has been broken up by strips of crops, disking or food plots, use the average distance from the center of each nesting cover strip to edge. Nesting habitat provided in strips such as field borders must be wide enough to prevent a predator from easily finding birds or nests. Nesting strips should not be less than 30 feet wide. The wider the field border or nesting strip, the better the chances of a quail nest producing a brood of birds with the optimum width being around 150 feet.

Some of the best nesting cover existed in Conservation Reserve Program fields, which were planted to a mixture of orchardgrass and annual lespedeza. During planting, the seed was broadcast and the lighter grass seed did not fly as far as the lespedeza seed. The resulting fields were narrow strips of lespedeza alternating with narrow strips of orchardgrass. Likewise, radio-tagged quail on conservation areas in northern Missouri chose nest sites, which were characterized by widely scattered clumps of grass, surrounded by weeds and blackberry vines, instead of sites with a solid stand of grasses.

Brood rearing cover

Brood rearing cover can be different from the cover used for nesting or it can be one in the same. Broodrearing cover is characterized by a plant community made up of legumes and annual weeds. These habitats are typically found in areas that have been left fallow one to two years after a soil disturbance (see Figure 4). Insects are the most important food item for nesting hens and quail chicks. A fallow crop field (such as corn or grain sorghum) that has been planted the previous year is a good example of this type of habitat. The annual weeds in such fields provide an abundance of insects needed for rapid chick development and are often used by broods as feeding areas.

Figure 4. Fallow crop fields, annual weeds, and legumes provide excellent brood-rearing habitat.

Figure 5. Annual weeds provide an abundance of insects needed for quail chicks.

Only minimum- or no-till crops contain enough insects, ants and spiders to sustain a quail chick. Tilled crops with heavy use of herbicides do not provide enough food to sustain a brood of quail chicks. Tilled crops or food plots should have little herbicide used in order to promote weedy plant growth to attract insects for the quail chicks. In addition, research has shown that disked plots planted to millet, wheat and legumes such as red clover and lespedeza provide quality brood rearing cover. Some legumes such as red clover or ladino clover can be planted too thick, which provides little opportunity for quail chick use. Areas that have been burned also promote this type of patchy vegetative cover that attracts insects. These areas are often called bugging grounds. Good brood habitat consists of plants that provide overhead cover that conceals bobwhites from predators, while remaining relatively open at ground level for easy chick movement (see Figure 5).

The following criteria, also listed on the evaluation tool, are important for brood habitat:

1. Quantity of brood habitat within the home range. Brood habitat is defined as any area that provides food and cover for the survival of quail chicks during the time of brood rearing (May 15-September 15). About 40 percent of the bobwhite's home range should consist of brood habitat (legumes, annual weeds, fallow fields, minimum or no-till crop fields). When the optimal home range size is being considered (15 acres), at least 6 acres (or 40 percent of the area) should be composed of brood habitat.

The same areas that provide either food or nesting cover may also qualify for brood habitat.

2. Percent bare ground. Open conditions at the soil surface are critical for optimal brood rearing habitat. At least 25 to 50 percent of the area should consist of bare ground conditions at the soil surface. Fields with less than 5 percent bare ground typically have vegetation that is too thick for broods to use.

3. Screening cover. Screening cover is defined as the overhead canopy of herbaceous plants (approximately 6 inches in height) which provides protection for quail chicks during their foraging activity.

Protective and escape cover

Protective (escape) cover is used by bobwhites throughout the year and is necessary for eluding predators such as hawks, owls, foxes, and house cats (Figure 6). Stands of overgrown shrubby cover, as well as stands of grass and weedy areas open at ground level, are also typically used. Protective cover must persist throughout the year, especially during cold weather when thermal protection is needed, and during the summer for protection from heat and sun.

The lack of escape cover is often identified as a limiting factor on many farms in Missouri. Escape cover should be available in patches that are at least 30 feet by 50 feet in size. It is also extremely important that food sources be available that are adjacent to protective cover.

Escape cover typically should not have a canopy

Figure 6. Protective cover helps bobwhites escape hawks, owls, foxes, cats and other predators.

of larger trees over it, because quail prefer not to have their flight path blocked and to flush up through several layers of canopy. In native plant communities such as savannas, woodlands or glades, which may have a ground layer of shrubs, grasses and forbs, the overhead canopy of trees is acceptable to quail. This is because the tree canopy is usually high enough to allow quail to flush and fly between the shrubby layer and the overhead tree canopy. Woodlands or savannas, that are not properly managed, may develop a midstory canopy of smaller trees over time, which will block the quail's flight path and make the area unusable for quail again.

Areas that provide protective cover are called **covey headquarters** because coveys of quail spend a large part of the day loafing in this type of habitat. The following criteria, also listed on the evaluation tool, can be considered when measuring or improving covey headquarters:

1. Quantity of covey headquarters within the home range. Covey headquarters consist of woody shrubs/low-growing stemmy trees (3 to 12 feet tall) or other cover types such as downed trees that are dense enough to form a canopy (Figure 7). This provides protection from the elements and predators. These areas must also be open beneath the canopy to permit quail movement. A minimum size for a covey headquarters should be approximately 1500 sq. ft., or 30 feet by 50 feet.

The distribution of these habitat types across the farm is extremely important. Research conducted during winter months in Missouri found that the average distance between known quail locations and woody cover was only 70 feet. In other words, the usable space in a particular field or area consists of a relatively narrow band next to woody cover.

Two critical factors that need to be determined include the size of a particular field and the amount of shrubby cover in close proximity to the area. Consider an area about the size of a football field (300 feet in length and 160 feet wide). The entire field is theoretically usable if both sidelines are lined with shrubby cover. If the field is substantially larger, there may be areas in the middle that are more than 70 feet from shrubby cover. This space would be unusable by bobwhites. Placing a covey headquarters in this unusable space increases the carrying capacity of the habitat for bobwhite quail. A guideline measurement for spacing between covey headquarters is about 150 feet.

In general, 10 to 20 percent of the bobwhite's home range should be made up of brushy or shrubby cover. With a conceptual home range size of 15 acres, three acres (or 20 percent of the area) of shrubby habitat need to be available to optimize the protective cover within the area. Covey headquarters should be distributed throughout the home range (as described earlier) to improve habitat conditions.

Figure 7. A covey headquarters area consists of patches of woody shrubs that provide overhead cover and open access at ground level.

2. Covey headquarters composition. Covey headquarters should be composed of trees and shrubs with low canopies (3 to 12 feet tall), shrub thickets, briars and bramble thickets are all examples. Edge-feathering and downed tree structures are also examples of covey headquarters.

Low-growing shrubs such as plums, blackberries, sumacs, sassafras, false indigo, shrub lespedezas, young pine plantations, dogwoods and buckbrush provide valuable protective cover that can be used throughout the year.

These types of cover provide the best protection because they are persistent over a number of years. Covey headquarters of tall weeds are not persistent unless steps are taken to maintain the weed patch from year-to-year.

Protective cover should also offer overhead protection, completely concealing quail from aerial predators, but relatively open at ground level to permit quail movement underneath.

Trees that have blown down or structures made from downed trees may be included only if the structures provide overhead protection and the ground cover beneath the canopy is sparse. Dense brush piles generally are not suitable covey headquarters because they are too thick and usually are not open beneath the canopy.

3. Density of the covey headquarters. Canopy closure should be measured by selecting a representative area of protective cover (the covey headquarters). This may be a single low-growing tree or shrub, but is usually characterized by a thicket or clump of shrubs. The minimum size of a covey headquarters is 1500 sq. ft. (at least 30 feet wide). Canopy closure at 3 feet in height is important, as this is the level that will provide adequate protection from predators or inclement winter weather. Shrubs that do not reach at least 3

Figure 8. Seeds from annual weeds, legumes, grasses, shrubs, trees and crops, along with insects, provide foods for quail.

feet in height are used little by quail. Canopy higher than 12 feet adds little value for covey headquarters. Record the combination of covey headquarters size and canopy closure that yields the highest possible rating value.

Imagine a volleyball thrown into the top of a covey headquarters. The ball should hit several branches and fall within the covey headquarters. If the canopy is too thick, the ball will roll off and away from the headquarters. If the canopy is too thin, the chances of the volleyball hitting a shrub are low.

Foods for bobwhites

The diet of adult bobwhite quail consists of insects, seeds and fruits of annual weeds, legumes, grasses, shrubs, trees and cultivated crops (see Figure 8). Seeds are eaten throughout the year, but are heavily used during the fall and winter. Insects are high in protein and are eaten during the spring, summer and fall. Because of quail chicks' high dietary protein requirement, insects are their primary food item during their first few weeks of life. For purposes of habitat appraisal, only food plants are considered, assuming that the more diverse the plant life within the home range, the more insects as well as seeds and plant parts will be available year-round for quail foods.

The following criteria can be used to evaluate the capability of the habitat to provide food sources.

1. Measure food quantity. Fall and winter quail foods primarily consist of the seeds from a wide variety of plants (see the box). These food plants also attract insects that are beneficial for quail. Several criteria that should be considered when examining the habitat's potential to provide food for quail are categorized as follows:

Common quail foods

Acorns	Panic grasses
Agricultural crops	Partridge pea
Bedstraws	Paspalums
Beggar ticks	Perennial lespedezas
Black locust	Pigweeds
Blackberries	Pine seeds
Cinquefoil	Poison Ivy
Clovers	Ragweeds
Cowpeas	Sedges
Crabgrass	Sheep sorrel
Crotons	Smartweeds
Dandelion	Sprangletops
Dogwoods	Spurges
Dropseeds	Strawberry
Foxtails	Sumacs
Grapes	Sunflowers
Johnsongrass	Tick trefoils
Korean lespedeza	Wild beans
Lambsquarters	Wild geranium
Milk peas	Wood sorrel
Millets	Yellow nutgrass

Insects are also an important food item for quail. However, for purposes of habitat appraisal, only food plants are considered.

- *Very abundant:* If 100 paces were taken in a representative portion of the plant community, 50 percent of the steps would strike an important quail food plant.
- *Abundant*: If 100 paces were taken in a representative portion of the plant community, 30 percent to 50 percent of the steps would strike an important food plant.
- *Moderately abundant*: If 100 paces were taken in a representative portion of the plant community, 10 percent to 30 percent of the steps would strike an important food plant.
- *Sparse*: If 100 paces were taken in a representative portion of the plant community, less than 10 percent of the steps would strike an important quail food plant.

A single adult bobwhite quail consumes an average of 0.05 pound of food per day. A covey of 14 birds would consume 0.70 pound of food per day. Enough food must be available during the fall to last through the winter until the critical month of March. This means that about 130 pounds of food (0.70 lb per covey per day x 182 days = 127 lb) needs to be produced and available during this period.

Generally, this amount of food can easily be pro-

duced if native food sources are available. This can also be accomplished within a quarter-acre crop field or food plot if soil fertility and weather conditions are ideal or by idling a portion of a food plot to allow annual weed growth. However, this area would need to be larger if high populations of white-tailed deer are present.

At least 50 percent of the bobwhite's home range should be made up of habitats that provide food sources. By applying 50 percent to the optimum bobwhite quail home range size (15 acres) it can be determined that 7.5 acres of the area that provides available sources of food would be needed to optimize the bobwhite's food requirements throughout the year.

The same areas that provide either nesting cover or brood habitat may also qualify as habitat that provides food, assuming that the criteria for each requirement are met.

2. Food diversity. The major food groupings for bobwhites include annual weeds, legumes, grasses, grains and woody vegetation. Food plants are represented in this criterion when it is easy to observe their presence. More than 300 different food plants have been found in the diets of bobwhite quail in Missouri.

3. Food accessibility. Bobwhites secure most of their food on the ground or from the layer of leaves and stems on the soil surface. If seeds are to be found by quail, they must be seen on bare ground or in litter that is sparse and can be easily moved. If seeds drop on a thick mat of stems and leaves, they will fall to the bottom and become inaccessible. At least 50 percent of the area being evaluated should consist of bare ground conditions.

The following categories can be used to define plant litter conditions:

- *Light plant litter*: 50 percent or more bare ground in food areas.
- *Moderate plant litter:* 30-50 percent bare ground in food areas.
- *Heavy plant litter:* 10-30 percent bare ground in plants areas.
- *Very heavy plant litter:* 10 percent or less bare ground in food areas. The area selected for estimating food accessibility should fall within the same boundaries and locations that produce the majority of the potential food sources.

Arrangement of habitat components

Bobwhites are an edge species that require a mix of grasses and herbaceous cover, agricultural crops, and brushy cover all closely arranged together. You can use aerial photographs to help evaluate the arrangement of habitats on your property. These can be obtained from your nearest USDA NRCS Service Center or from the University of Missouri CARES Web site at *www.cares.missouri.edu*.

The optimum arrangement of habitats, as outlined in the appraisal tool, includes the following:

- 30 to 40 percent grassland or early-successional stage forest (dominated by grasses and annual weeds) in 5- to 20-acre patches
- 40 to 60 percent early-successional grassland (high annual and perennial weed and legume component) or cultivated crop fields in 1- to 5-acre patches
- 5 to 20 percent brushy (shrubs or tree sprouts) cover in small patches

Woodland or forest habitat components are unnecessary if shrubs are present. The ranges above can be used to construct ratings for the various habitat requirement quantities.

Water requirements for bobwhites

Surface water is not essential for bobwhites, although it may be used if provided. Water needs are usually met by seeds, succulent herbaceous plants, insects, dew and snow. Surface water, such as ponds and streams, produces microhabitats that can provide green, succulent vegetation and insects during dry or unfavorable weather conditions.

APPLY HABITAT APPRAISAL TO YOUR FARM

To optimize quail habitat on your farm, you must address the lowest limiting factor score(s) under each habitat component in every conceptual home range.

The habitat appraisal process serves as a tool to help identify the habitat components that are in the shortest supply and will potentially limit quail numbers on your farm. The system for appraising habitat is used by matching the criteria ratings with the nearest match of existing land use and cover conditions, and calculating the necessary values for determining the habitat quality.

The evaluation tool (pages 13-14) describes a method for inventorying existing habitat conditions, rating the habitat element criteria and calculating the habitat quality and limiting factor values. As the appraisal system is based primarily on the kinds, amounts, condition and arrangement of plants, it is suggested that the inventory be performed during the growing season. However, habitat can be evaluated year-round as long as one pictures growing season conditions.

Ratings for the various habitat criteria range from 1 (poor) to 10 (excellent). The number of ratings per criterion depend on the number of variables that can be practically measured and levels of management that can be practically applied. A scoring sample is located on page 15 of this guide.

Information obtained from the habitat appraisal provides a basis for developing a wildlife management plan for your property. The habitat appraisal will also provide a tool for making management decisions that benefit bobwhite quail, and will help you to enhance habitat to address current limiting factors.

Additional Information

For more information on managing your farm for bobwhite quail, contact a natural resource or wildlife professional with the Missouri Department of Conservation (MDC), USDA Natural Resources Conservation Service (NRCS) or University of Missouri Extension. Refer to the following publications and resources for additional information.

Publications

On the edge - A guide to managing land for bobwhite quail - published by the Missouri Department of Conservation.

Wildlife Management for Missouri Landowners, 3rd edition - published by the Missouri Department of Conservation.

Covey headquarters Quarterly Newsletter, cooperatively developed by the MDC, NRCS and University of Missouri Extension.

Ecology of northern bobwhite quail in Missouri. MU publication G9431, University of Missouri Extension.

Habitat management practices for bobwhite quail. MU publication G9432, University of Missouri Extension.

Useful Web sites

mdc.mo.gov/ (Missouri Department of Conservation)
coveyheadquarters.com/ (The Covey Headquarters)
muextension.missouri.edu/ (University of Missouri Extension)
www.nrcs.usda.gov (Natural Resources Conservation Service)
qu.org/ (Quail Unlimited)
quailforever.org/ (Quail Forever)
ttrs.org/ (Tall Timbers Research Station)

Bobwhite Quail Habitat Appraisal Tool

Name_____ **Date**_____ **Planner**_____

Land management goal: 1 covey per ___ acres (optimum home range is 15 acres) Size of evaluation area: _____acres

Habitat components, listed below, are the elements needed for survival and propagation of the species. For BWQ, these components include (A) Nesting Cover, (B) Brood Habitat, (C) Covey Headquarters, (D) Food, and (E) Arrangement of Habitats.

Scoring Instructions - Descriptions for quail habitat components are listed below. Under each description, find the rating or explanation that best matches the habitat being appraised on your farm. Then locate the corresponding score (the bold number in front of the explanation) and write it on the chart to the right. Two columns are provided for existing and planned conditions. These scores will be used to determine limiting factors at the end of this form. The charts allow for up to four habitats to be appraised on this form.

(Additional forms can be printed online at *extension.missouri.edu/explore/miscpubs/mp0902.htm*.)

A. Nesting Cover - Herbaceous cover consisting of bunch grasses with forbs and low-growing shrubby cover with last year's grass growth available before or during nesting season (May 1 to Sept. 15).

Nesting cover quantity - Percentage of home range dominated by preferred cover.
- **10** 30% or more
- **8** 20% to 30%
- **6** 10% to 20%
- **4** 1% to 10% or open stands at ground level fescue/brome
- **0** None present (if 0, skip to Brood Habitat)

Average nesting cover height - The condition of nesting cover vegetation (previous year's growth) during the nesting season, with residue available for use May 1.
- **10** Greater than 8 inches
- **8** 6 to 8 inches
- **4** 4 to 6 inches
- **2** Less than 4 inches

Distance to edge - Distance from center of nesting cover to an edge.
- **10** 50 to 75 feet
- **6** 25 to 50 feet or 75 to 150 feet
- **2** less than 25 feet or more than150 feet

B. Brood Habitat - Herbaceous plants and bare ground that consists of new growth of forbs/weeds, annuals, minimum or no-till crops in each home range, needed from May 15 to Sept. 15.

Brood habitat quantity - Percent of the home range dominated by forbs/weeds annuals or crop cover.
- **10** 40% or more forbs/legumes, annuals or minimum/no-till crops
- **8** 30% to 40% forbs/legumes, annuals or minimum/no-till crops
- **6** 20% to 30% forbs/legumes, annuals or minimum/no-till crops
- **4** 10% to 20% forbs/legumes, annuals or minimum/no-till crops
- **2** 1% to 10% forbs/legumes, annuals or minimum/no-till crops
- **0** No preferred cover, or conventional tilled crops (if 0, skip to Covey Headquarters)

Percent bare ground - Openness throughout brood habitat area (below 6")
- **10** 25% to 50%
- **5** 5% to 25%, or 50% to 75%
- **0** Less than 5% or more than 75%: 0 (if 0 skip to Covey Headquarters)

Screening cover - Brood habitat canopy cover above foraging broods (at least 6 inches high)
- **10** 50% or more
- **8** 30% to 50%
- **6** 10% to 30%
- **2** 1% to 10%
- **0** No herbaceous cover above height 6 inches

C. Covey Headquarters - Woody shrubs, low-growing stemmy trees, down tree structures, feathered edge. Headquarters at a minimum should be 30 feet wide by 50 feet long, or 1,500 square feet.

Covey headquarters quantity - Amount of covey headquarters in each home range.
- **10** 10% to 25% of home range
- **8** 5% to 10% of home range
- **6** 1% to 5% of home range
- **2** Less than 1% or more than 25% of home range
- **0** No covey headquarters within the home range: 0 (If 0, then skip to next page)

Covey headquarters composition - Quality of the plant community.
- **10** Woody shrubs and low-growing stemmy trees, upright growth habitat and little ground litter
- **6** Down tree structures, tangled vines, blackberry thickets, feathered edge, little ground litter
- **2** Larger trees without extensive low growing stems, or non-upright shrubs
- **0** Headquarters with closed/rank ground vegetation or overhead tree canopy

Covey headquarters density - Canopy closure or canopy cover provided by plant structure.
- **10** 60% to 80% canopy at 3 to 12 feet high
- **8** 40% to 60% canopy at 3 to12 feet high
- **6** 20% to 40% canopy at 3 to 12 feet high
- **2** Less than 20% canopy at 3 to 12 feet high
- **0** Canopy less than 3 feet high or more than 12 feet high or canopy more than 80%

	Existing	Planned	
A. Nesting cover quantity			
1.			
2.			
3.			
4.			
A. Average nesting cover height			
1.			
2.			
3.			
4.			
A. Distance to edge			
1.			
2.			
3.			
4.			
B. Brood habitat quantity			
1.			
2.			
3.			
4.			
B. Percent bare ground			
1.			
2.			
3.			
4.			
B. Screening cover			
1.			
2.			
3.			
4.			
C. Covey headquarters quantity			
1.			
2.			
3.			
4.			
C. Covey headquarters composition			
1.			
2.			
3.			
4.			
C. Covey headquarters density			
1.			
2.			
3.			
4.			

D. Food - Seeds of grain crops and/or naturally occurring herbaceous or woody plants.

Food quantity - Percentage of the home range that provides food plants for quail.

10 50% or more
8 30% to 50%
6 10% to 30%
4 1% to 10%
0 No food plants in home range: 0 (if 0, skip to Arrangement of Habitats)

Food diversity - How many food groups are present in home range (forbs/legumes/grasses/grains/woody)?

10 4 or more food groups
7 3 groups
5 2 groups
2 1 group

Food accessibility - Percent of bare ground in food areas. (Food availability depends on bare ground.)

10 50% or more
7 30% to 50%
5 10% to 30%
2 Less than 10% bare ground

	Existing	Planned	
1.			Food quantity
2.			
3.			
4.			
1.			Food diversity
2.			
3.			
4.			
1.			Food accessibility
2.			
3.			
4.			

E. Arrangement of Habitats: the spatial arrangement and mix of herbaceous and shrubby cover is an important consideration in determining the quality of the habitat components, including nesting and brood-rearing cover , protective escape cover and food.

Rating criteria for arrangement of habitats
Do nesting cover, brood cover, covey headquarters and food occur within 150 feet of each other in one or more places within the home range?

10...yes
5...within 660 feet
0...no

Distance to covey headquarters. What proportion of the home range is within 150 feet of a covey headquarters?

10..... >80%
8.....>60 to 79%
6.....>40 to 59%
4.....>20 to 39%
0..... <20%

1.			Arrangement of habitats
2.			
3.			
4.			
1.			Distance to headquarters
2.			
3.			
4.			

Limiting factors for bobwhite quail

Enter the value of the lowest-scored habitat description for each habitat component, for existing and planned conditions. (Each chart allows space to total the scores of the four ranges recorded previously.)

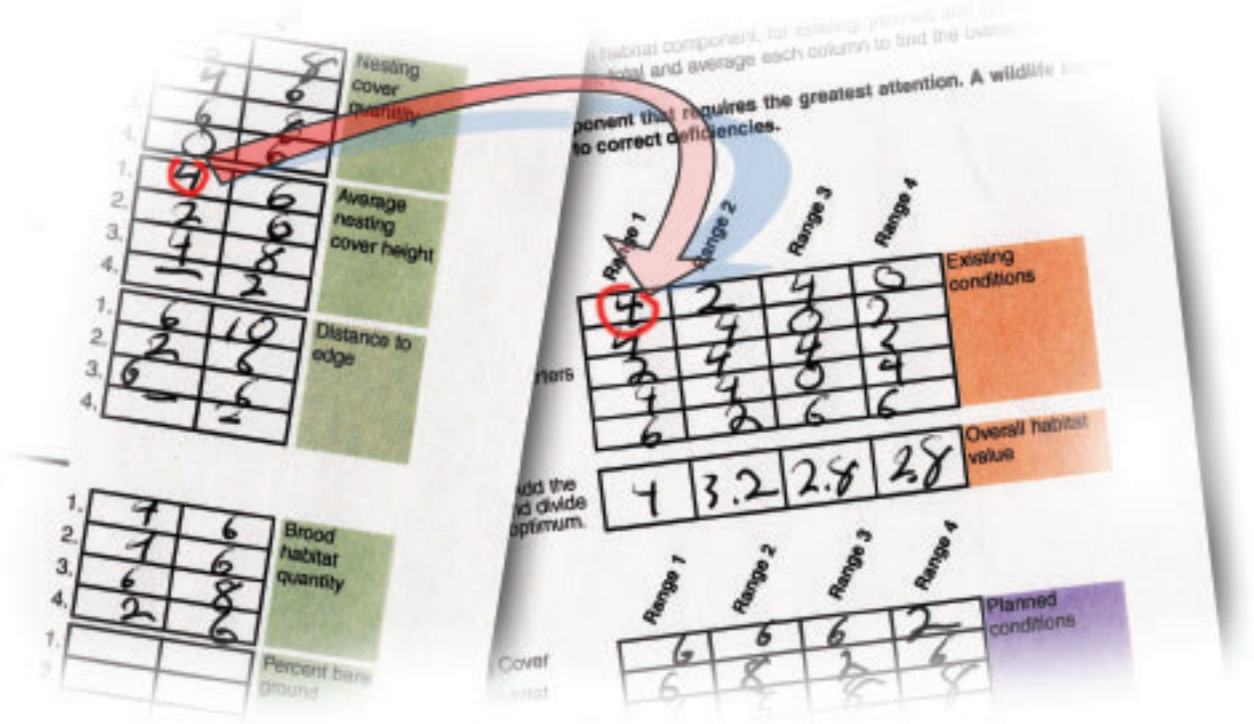
The lowest limiting factor value equals the habitat component that requires the greatest attention. A wildlife biologist can help you interpret habitat scores, and a management plan can be created to correct deficiencies.

	Range 1	Range 2	Range 3	Range 4	
A. Nesting Cover					**Existing conditions**
B. Brood Habitat					
C. Covey Headquarters					
D. Food					
E. Habitat Arrangement					

	Range 1	Range 2	Range 3	Range 4	
A. Nesting Cover					**Planned conditions**
B. Brood Habitat					
C. Covey Headquarters					
D. Food					
E. Habitat Arrangement					

Sample Habitat Scoring

In this example use of the habitat appraisal tool, the "existing condition" score for habitat component A, "average nesting cover height" in range 1 was determined to be 4 (4 to 6 inches in height). This rating represents the lowest "existing condition" score when compared with the other "existing condition" scores within habitat component A. Therefore "average nesting cover height" would be designated as a limiting factor for the "nesting cover" habitat components (A) in range 1. As the lowest value, this score (4) would be recorded in the "limiting factors" table on page 14. Additional scores for the various habitat components (brood habitat, covey headquarters, food, habitat arrangement) found within each conceptual home range would be recorded and an overall habitat value for each "range" would be determined.



This guide was collaboratively developed by University of Missouri Extension, the Missouri Department of Conservation and the USDA Natural Resources Conservation Service and has been adapted from the Oklahoma Cooperative Extension Service publication Circular E-904, *Habitat Appraisal Guide for Bobwhite Quail.*

Tips for Success

As you conduct bobwhite quail habitat appraisal on your property ...

- ❑ Using the appraisal guide can help identify the level of quail management you wish to conduct, determined by the number of coveys you wish to produce.
- ❑ Use an aerial photo to determine the size and shape of the conceptual home range for quail on your property. A home range can be circular or square, crossing fields and habitat types.
- ❑ The conceptual home range should be between 15 and 80 acres.
- ❑ Your goal is to manage the habitat within each home range so that it will support one covey.
- ❑ Your goal is to provide all the habitat requirements in proportion within each home range that you have identified.
- ❑ Get out in the field and conduct a thorough examination of the entire home range to determine the limiting factors related to nesting, brood-rearing, and protective cover, foods and habitat arrangement.
- ❑ The appraisal will help you identify the limiting factors on your property.
- ❑ The optimal time to complete the appraisal is between May and August, but an appraisal can be conducted any time of year.
- ❑ Conduct the appraisal each year, and develop a plan to help monitor the success of your efforts.

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