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HABITAT DEVELOPMENT FOR BOBWHITE QUAIL ON PRIVATE LANDS IN WISCONSIN

ABSTRACT

The habitat development project for bobwhite quail had two objectives: (1) to double premanagement quail densities and stabilize population fluctuations, and (2) to develop incentive programs for wildlife management on private lands. Two management tools were selected to accomplish these objectives: (1) habitat restoration, and (2) supplemental winter feeding. Habitat restoration and winter feeding were implemented on the 60-mile^2 (155-km^2) Marshall Area while winter feeding was the only technique tested on the 63-mile^2 (163-km^2) Buena Vista Area. Trends in wildlife populations were monitored on the management areas and a 49-mile^2 (111-km^2) control area.

Habitat restoration activities were implemented on 100 properties between 1975 and 1980. Over 465,000 shrubs and conifers were planted to create 32.2 miles (51.8 km) of new or improved hedge, 6.5 miles (10.4 km) of enhanced riparian corridor, 11.5 miles (18.5 km) of improved woodland edge and 191 plots. The plots totaled 196 acres (79.3 ha) and varied from a clump of spruce covering 1,352 ft^2 (126 m^2) to a 6.7-acre (2.7-ha) unit with conifers, shrubs, brush piles, nesting cover, and food patches of legumes and sorghums. Sorghum food patches were planted on 75 plots; 13 of these sites had legume patches as an auxiliary food source for early winter. Sorghum patches averaged 8,283 ft^2 (770 m^2) while the smaller legume patches were about 1,950 ft^2 (181 m^2). Brush piles were located at 26 plots with food patches, and 24 plots with only shrubs and conifers. An additional 80 brush piles were located along linear cover developments. The typical brush pile was 20 by 29 by 10 ft high (6.1 by 8.8 by 3.0 m high). The 3-row hedge of mixed shrubs and conifers was the predominant linear cover development (16.1 miles) installed on the Marshall Area. Autumn olive, wild grape, ninebark, silky dogwood, gray dogwood, and nannyberry were the principal shrubs planted; white spruce was the predominant conifer. Sorghum plots were composed of mixed grain and silage varieties; legume patches employed a lespedeza, crownvetch, or trefoil. The cost of installing habitat improvements on the typical property was $1,610.

Weather during the 1975-76, 1979-80, and 1980-81 winters was relatively mild, hence supplemental feeding was not practiced. January 1977 was extremely cold and winter feeding was initiated on the Marshall and Buena Vista areas. Three-hundred-eleven landowners were contacted and 81 coveys located; 55 required supplemental feeding. The landowners distributed 1,890 lb (857 kg) of meal and 150 lb (68 kg) of feed was placed in food patches where the availability of sorghum seed was low. The supplemental feeding program cost $1,738 and proved to be an excellent public relations tool, but of uncertain value to quail. Adverse weather prevailed during the 1977-78 and 1978-79 winters, but supplemental feeding was limited to augmenting food supplies at the sorghum patches.

Surveys were initiated and programed through 1990 to monitor the impacts of management on bobwhite quail, cottontail rabbits, white-tailed deer, great horned owls, barred owls, red tailed hawks, songbirds, and mammalian predators. Premanagement quail population densities were 3.6 whistling males/mile^2 during the breeding season and 1.6 coveys/mile^2 during fall.

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PERSPECTIVE

The management of habitat on private lands is increasingly important for the welfare of wildlife associated with agricultural land uses. This need is particularly germane for the bobwhite quail whose populations occur almost exclusively on private property. Cooperation between the professional resource manager and the landowner is a prerequisite to improved land management in the private sector. Financial incentives and technical assistance must be offered to the land managers who hold the key to the welfare of an important component of Wisconsin's wildlife resources. This interim report presents the experience and implications of an intensive project designed to assist property owners with improving wildlife habitat on their farms.

Program Objectives

The objectives for the management program were two-fold: (1) to double premanagement quail densities and maintain stable populations; and (2) to develop incentive programs for wildlife management on private lands. To accomplish these objectives, two management tools were employed: (1) habitat development, and (2) supplemental winter feeding. Habitat development was directed at improving cover and food availability for quail during the winter months. Supplemental feeding was carried out during very severe winters to reduce the degree of year-to-year fluctuations in population numbers.

Previous research in Wisconsin has demonstrated that the long-term decline in quail abundance was a result of habitat deterioration, principally the loss of hedgerow cover, while short-term population fluctuations were mainly a function of adverse winter weather (Kabat and Thompson 1963:64, 73). The assumptions in this experimental management program were that habitat restoration activities would improve the carrying capacity of the land for quail and that supplemental feeding would mitigate losses during harsh winters.

Management Areas

Habitat restoration was employed on a 60-section area — the Marshall Area — in Richland County (Fig. 1). This management area possessed better-than-average quail densities for Wisconsin and carried a history of conservation-minded landowners. It was here that the greatest return in quail production could be expected for the least amount of management effort.

The Marshall Area included all of Marshall township and 12 sections each of Sylvan and Rockbridge townships (Fig. 2). Topography of the area is rather abrupt with a complex of narrow valleys and broad ridges. Found within the management area are portions of both the upper Mill Creek and the Pine River watersheds. Land use is characteristic of southwest Wisconsin's driftless area (Table 1).

Supplemental winter feeding was employed on the Marshall Area and was the only management tool used on a 63-section area — the Buena Vista Area. This management area included most of Buena Vista and portions of Orion, Richland, and Ithaca townships (Fig. 1). Broad valleys and broad ridges characterize this area which includes the lower portions of the Pine River and Bear Creek watersheds. The 3,000-acre Pine River Public Hunting Grounds is located along the western edge of this management area.

Long-term changes in wildlife populations and land use were monitored regionally. However, changes in certain land use parameters were followed on a control area. A 49-section area encompassing Willow township was designated as the control area because of its proximity to the Marshall Area, and its similarity in topography, land use, and quail population.

TABLE 1. *Land use on the Marshall Area.**

Land Use	Area (%)	
Cropland		43
Corn	16	
Hay	22	
Small grains	4	
Miscellaneous	1	
Pastureland		18
Woodland		27
Pastured	4	
Non-pastured	23	
Idle land		9
Miscellaneous		3

*Composite of 3 sources: 1980 Wisconsin Agricultural Statistics, 1974 Land Use Analysis for Southwestern Wisconsin, and 1968 Wisconsin Forest Resource Statistics.

Bobwhite Quail

A spectacular increase in quail during the mid-1800's coincided with the rapid expansion of agriculture across the state (Kabat and Thompson 1963). Pioneer farming practices provided ample brushy cover on property lines, woodland edges, internal fencelines, and erosion strips plus an abundance of waste grains for winter food. Spring burning was also a common agricultural activity in wetlands and woodlots.

In the early to mid-1900's, the grazing of woodlands and creek bottoms resulted in the loss of cover and more efficient harvesting equipment reduced the availability of waste grains. Also, more intensive use of herbicide on croplands most certainly decreased the availability of weed seeds on both the cultivated fields and adjoining fencelines and roadsides.

The loss of hedge cover became apparent during the late 1800's, but was more dramatic during the mid-1900's. At the Prairie du Sac Study Area, Kabat and Thompson (1963:65) estimated a 90% loss of hedgerows between the mid-1800's and mid-1900's. The long-term loss of brushy cover caused a decline in quail abundance. Despite the drastic loss of hedgerows, Kabat and Thompson considered food supplies to be adequate during the early 1900's, perhaps due to the availability of waste grains.

Short-term population fluctuations of Wisconsin quail were influenced by a complex of factors of which winter weather appeared dominant (Kabat and Thompson 1963:24, 73). Winter losses fluctuated directly with the number of months of snow cover exceeding 3 inches and ranged from 4 to 80% at the Prairie du Sac Area.

Bobwhite quail were hunted in Wisconsin from 1932 to 1962 with the exception of 5 years (1936-40). After 1962, quail hunting was not permitted until 1973 when a 14-day season in 6 southwestern counties was allowed. Reopening of the hunting season was approved by the Natural Resources Board with the stipulation that a quail management program be initiated. That directive, in part, provided the impetus for this project.

FIGURE 1. *Wisconsin quail range and location of Richland County management areas.*

Premanagement quail density on the Marshall Area was about 1.5 coveys/mile^2 based principally on landowner questionnaire surveys. Kabat and Thompson (1963) suggested that 1 mile of hedge/450 acres of land would support roughly 2 coveys/mile^2. A mapping of habitat components of recognized value to quail on the Marshall Area in 1978 revealed 1 mile of brushy fenceline/492 acres (Table 2; 6,887 ft/mile^2). Based on the availability of hedgerow cover (i.e., brushy fencelines), the Marshall Area exhibited a quail population predicted by Kabat and Thompson (1963).

People

A 1972 prehunting season census of quail involving public input revealed that Richland County might be a good site for a management program. Inquiries requesting recent observations of quail were sent statewide to DNR field personnel, Conservation Congress members, conservation clubs, and rural mail carriers. Many responses, some with personal notes, were received from Richland County residents. The respondents demonstrated a genuine interest in the welfare of bobwhite quail.

A willingness to cooperate with a habitat development program was indicated by other resource agency personnel in the county. Prior to embarking on the project, program objectives were discussed with the Soil Conservation Service District Conservationist, the Agricultural Stabilization and Conservation Service Executive Director, the University of Wisconsin Agricultural Extension Specialist, and the Department of Natural Resources County Forester. Presentations were also made to the Richland County Soil and Water Conservation District Board of Supervisors. All groups and individuals were supportive; the stage was set for an interdisciplinary endeavor.

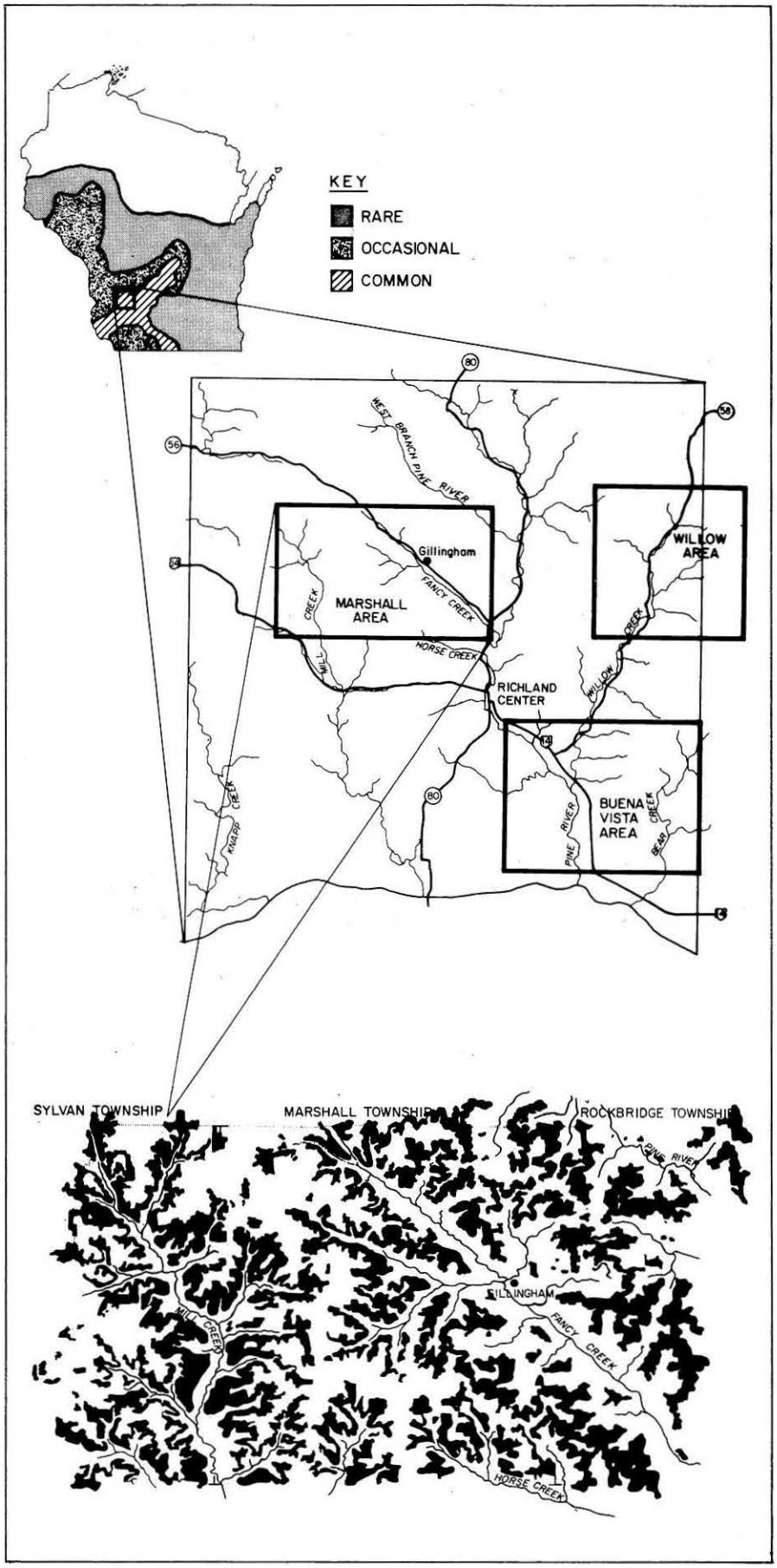

FIGURE 2. *Marshall Area.*

TABLE 2. *Presence of habitat components of value to quail on the Marshall Area, 1978.*

Habitat Component	Amount ($\bar{x}$/mile^2) No.	Size (acres)	Length (ft)	
Conifer clumps*	2.4	4.3		
Thickets*	4.6	0.6		
Brushy woodlands**,[1]	6.8	23.9		
Herbaceous plots**,[2]	8.6	47.5		
Drainage[3]				2,912
Trees			790	
Brush			1,624	
Herbaceous			498	
Fenceline[3]				14,968
Trees			1,595	
Brush			6,887	
Herbaceous			6,486	
Woodland edge[3]				12,806
Brush			9,923	
Herbaceous			2,883	

*Minimum size 500 ft^2.
**Minimum size 5,000 ft^2.
[1]Vegetation qualifications: < 25% trees, < 50% herbaceous, > 25% brush.
[2]Vegetation qualifications: > 75% grass and/or forbs.
[3]Minimum width 8 ft (excluding water for riparian cover), minimum length 100 ft.

HABITAT DEVELOPMENT

Habitat development was undertaken systematically; 26 management units of contiguous, physiographically similar habitats were defined on the 60-section area (Fig. 3). Key habitat components were identified from aerial photos and collated with quail sightings obtained from landowner questionnaire surveys. Traditional and potential wintering sites for quail were identified and prescriptions written to improve food, cover, and dispersal features. The management concept was to provide an even distribution of secure wintering sites connected by a network of continuous hedge, thereby facilitating year-round access.

Habitat restoration activities were initiated in 1975 in the northwest quarter of the Marshall Area, moved to the northeast region in 1976, the southwest sector in 1977, large projects in the southwest and southeast in 1978, and area-wide priority projects in 1979 and 1980. The management units were initially prioritized for habitat development based on the physical features of the land and potentials for a continuous web of hedgerows encompassing at least 3-4 wintering sites.

ASSESSING LANDOWNER SUPPORT

A preliminary appraisal of landowner interest in a high priority unit was obtained by contacting individuals who controlled the most critical elements of the unit plan. If: (1) access to the property was permitted for field reconnaissance, and (2) general interest in the program was demonstrated, property owners were approached with a farm plan showing their portion of the management unit complex. The landowner's ideas were solicited and incorporated into a tentative plan from which a final farm plan was developed. Although the bobwhite quail was the primary target species for this project, the promotional strategy was to feature the total wildlife benefits offered by the habitat developments.

Sites for winter plots and hedge were selected to mesh with good agronomic farm management. Shrubs, trees, and food plots were established in a pattern that was aesthetically pleasing as well as functional for wildlife.

If the landowner chose to adopt the habitat recommendations, a contractual agreement was consummated wherein he/she pledged 10 years of protection to improvements established by the Department of Natural Resources (Append. I). Essentially the landowners' contribution was the land taken out of production or otherwise devoted to wildlife enhancement and the DNR's contribution was the plant materials, planting labor, and wildlife habitat management advice.

OBTAINING LANDOWNER COOPERATION

Contracts were made with 117 landowners to solicit participation in hab-

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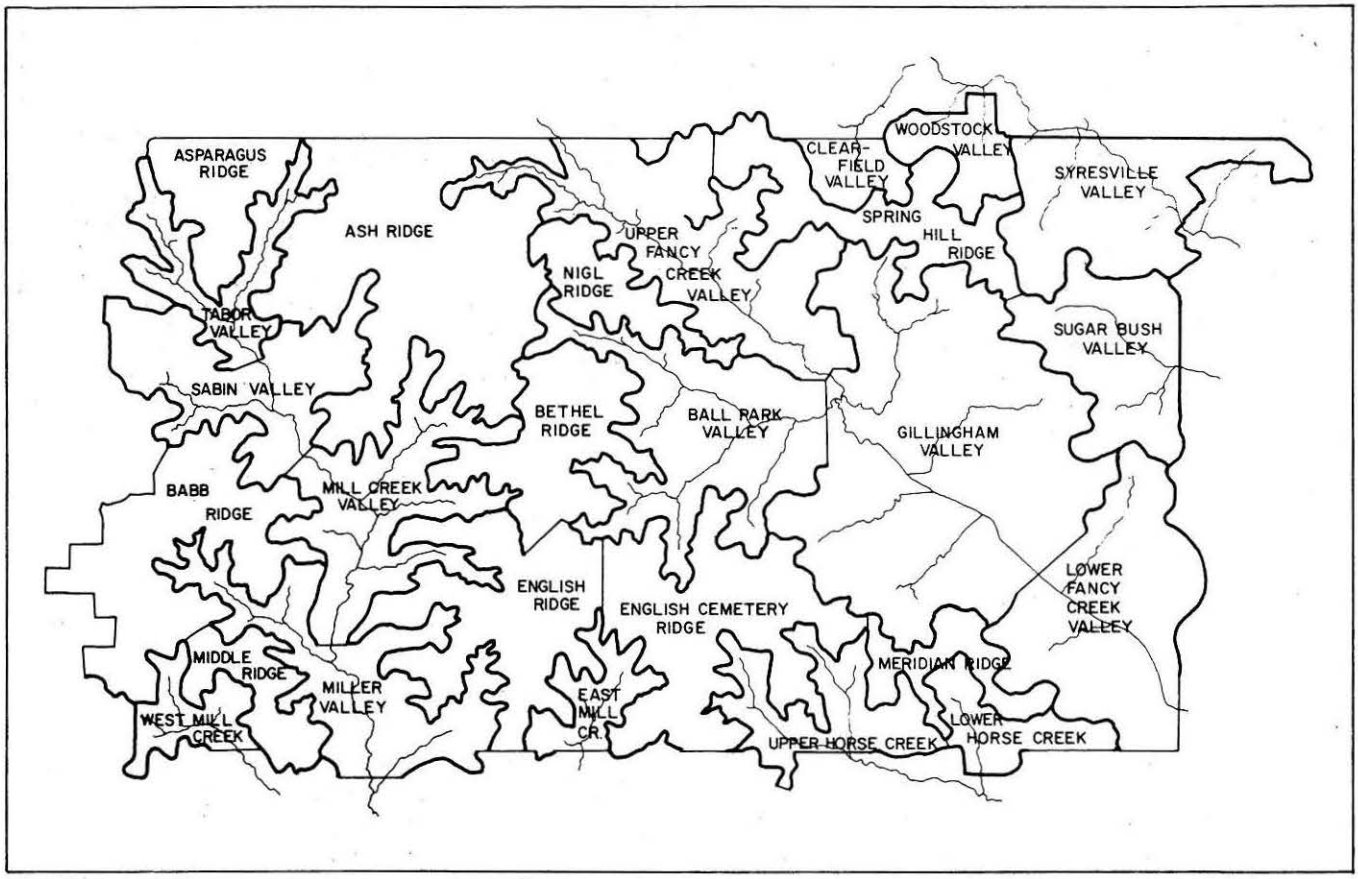


FIGURE 3. *Management units in the Marshall Area.*

itat development activities; 100 landowners (85%) ultimately participated in the program. Among the 17 nonparticipants, 10 property owners tentatively accepted a habitat development plan, but extenuating circumstances precluded involvement in the project (Table 3). Only 2 individuals refused to sign the agreement, so this obstacle to participation was not of great consequence. Five landowners who asked their attorneys to review the agreement ultimately signed the contract. Two landowners did not accept the habitat development plan because they felt they did enough for wildlife without DNR help (Table 3). Agricultural land use on these parcels was, in fact, less intensive than on surrounding farms. Our intention, on these properties, was to install food plots and to improve plant species composition in existing hedge.

There were 317 property owners on the Marshall Area and 228 (72%) were residents. Among the participants in habitat development activities, 56% were residents (Table 4). Although absentee owners were favored in program participation it was not intentional.

HABITAT COMPONENTS RESTORED

Habitat developments were classified as either a hedge, riparian corridor, woodland edge, or plot. Shrubs and conifers were planted in rows or intermittently, contingent upon the space available and the quality of existing cover. Plantings up to 4 rows in width were considered linear or edge developments; plantings of 5 rows or more were classified as plots. Shrub rows were spaced 6-8 ft apart and conifer rows 8-10 ft apart. A 3-row hedge composed of 1 shrub row and 2 conifer rows required a strip 28-34 ft wide.

Habitat developments characterized by continuous rows of shrubs and/or conifers were termed "new" plantings while intermittently planted linear or edge cover were termed "improved". Most new hedges were established adjoining fencelines or similar linear features and varying levels of remnant woody vegetation were present. Selective cutting was used to: (1) remove undesirable woody plants, (2) regenerate aging stands of desirable shrubs, and (3) facilitate close passage to fencelines with planting equipment. The brush was windrowed or placed in piles. Landowners may have benefitted from tree or tall shrub removal by improved yields from adjacent crops.

Riparian corridors most often retained a modest component of woody cover and the plantings were used to: (1) provide a more contiguous cover strip, (2) improve the vegetative composition, or (3) protect the watershed. Whereas hedges were most often straight-edged to reduce interference with farm machinery and of minimum width, riparian corridors were irregularly edged and of variable width.

HABITAT DEVELOPMENT ACCOMPLISHMENTS

Shrubs and Conifers

Between 1975 and 1980, 324,445 shrubs and 140,920 conifers were planted creating 50.3 miles of linear cover or edge and 191 plots. Twelve varieties of shrubs (321,070 stems)

TABLE 3. *Circumstances surrounding non-participation in habitat development activities by 17 Marshall Area landowners.*

Accepted habitat development plan *but* . . .
- would not sign the agreements (2 cases).
- did not get ASCS cost-shared fence built.
- did not get ASCS cost-shared fence approved.
- hunting license violation disrupted negotiations.
- family problems disrupted negotiations.
- sale of property disrupted negotiations (3 cases).
- land renter anti-DNR, threatened to destroy plantings.

Accepted part of habitat development plan *but* . . .
- not enough opportunity remaining to justify planting.

Did not accept habitat development plan *because* . . .
- did enough for wildlife without DNR help (2 cases).
- partners could not agree on the level of participation.
- plan was not presented due to a death in the family.
- bad DNR press at the time of negotiations.
- DNR policy regarding purchase of out-of-state license by an absentee landowner.

TABLE 4. *Residency of landowners and program participants on the Marshall Area.*

Residency	All Landowners	Participating Landowners
Marshall Area	228 (72%)*	56 (56%)*
Richland Center	14 (4%)	5 (5%)
Elsewhere in Wisconsin	23 (7%)	13 (13%)
Illinois	45 (14%)	24 (24%)
Elsewhere in the U.S.**	7 (2%)	2 (2%)
Total	317	100

*Percent of total.
**Rochester, N.Y.; Golden, Colo.; Fairbanks, Alaska; Jeffersontown, Ky.; Oklahoma City, Okla.; Highlands, Ind.; Dever, Iowa.

TABLE 5. *Shrubs and conifers planted on the Marshall Area, 1975-80.*

DNR Shrubs	Stems	SCS Shrubs*	Stems	DNR Conifers	Stems
Ninebark	60,755	Cardinal autumn olive	50	White spruce	111,990
Autumn olive	85,010	Mich 777 autumn olive	725	Norway spruce	250
Gray dogwood	21,750	Cornelian cherry dogwood	25	White cedar	16,805
Red-osier dogwood	13,500	Silky dogwood	100	Red cedar	500
Silky dogwood	27,300	Midwest Manchurian crabapple	200	White pine	5,875
Nannyberry	20,475	Radiant crabapple	150	Red pine	5,500
Highbush cranberry	16,450	Zumi crabapple	175		
Hazel	9,730	Sargents crabapple	325		
Hawthorn	500	Pink lady euonymus	225		
Wild plum	500	Amur maple	100		
Wild grape	59,500	Chinquapin	25		
Bittersweet	5,600	Amur privet	275		
		Rem-red amur honeysuckle	50		
		Firethorn	150		
		Silver buffaloberry	500		
		Blackhaw	100		
		Washington hawthorn	200		
Total 12 Species	321,070	17 Species	3,375	6 Species	140,920

*Rose Lake Nursery, Mich.

TABLE 6. *Annual allotments of shrubs and conifers planted and replanted on the Marshall Area.*

	Shrubs			Conifers		
Year	Planted	Replanted	Total	Planted	Replanted	Total
1975	41,900		41,900	9,650		9,650
1976	51,730	600	52,330	19,190	150	19,340
1977	53,970	16,440	70,410	26,800	8,130	34,930
1978	79,225	500	79,725	31,515	6,725	38,240
1979	43,575	4,275	47,850	20,350	2,325	22,675
1980	26,475	5,755	32,230	10,685	5,400	16,085
Total	296,875	27,570	324,445	118,190	22,730	140,920

TABLE 7. *Shrub and conifer composition of habitat developments installed on the Marshall Area, 1975-80.*

	Habitat Development (linear ft)		
Shrub/Conifer Composition	Hedge	Riparian Corridor	Woodland Edge
Shrubs only	12,636		6,344
Conifers only	30,240	6,814	26,330
Shrubs and conifers	127,310	27,508	28,148
Total	170,186	34,322	60,822

Selective cutting was employed to prepare sites for shrub/tree planting; occasionally secondary benefits were derived such as streambank improvement. (left)

The typical new hedge was about 30 ft wide and composed of 2 rows of conifers and one row of shrubs. (above)

were provided by the DNR nurseries; 17 varieties of shrubs (3,375 stems) were secured from the Soil Conservation Service nursery at Rose Lake, Michigan (Table 5). Autumn olive, wild grape, ninebark, silky dogwood, gray dogwood, and nannyberry were the principal shrubs planted on the Marshall Area (Scientific names in Append. II). All conifers were provided by DNR nurseries. White spruce was the predominant species planted.

Replanting of shrubs and conifers was required in most years to replace habitat developments that were accidently destroyed by farming operations or were experiencing poor survival due to environmental conditions (Table 6). In 1976, droughty conditions prevailed during the planting period and poor plant survival necessitated a 35% replanting effort in 1977. Survival was poorest among white spruce, white cedar, and wild grape and best among nannyberry and ninebark. A very cold, snow-free winter in 1976-77 contributed to the loss of white spruce following the drought.

Shrubs and conifers were planted as mixed shrubs, mixed conifers, or mixed shrubs and conifers. The stands of mixed shrubs and conifers comprised 69% of the linear habitat developments (Table 7); plantings composed exclusively of shrubs or conifers were principally 1- to 2-row hedge or woodland edge. Mixed shrubs and conifers were used most frequently (83%) in the improvement of linear cover types and woodland edge.

Pure conifer stands were utilized more frequently than pure shrub developments. Among 1- or 2-row plantings, 62% of the woodland edge and 57% of the hedge employed only conifers.

Linear Cover and Edge

Linear cover occurring as hedge totalled 32.2 miles of which 27.8 miles (86%) were new cover (Table 8). The 3-row planting predominated among new hedge. Over 16 miles of 3-row hedge were developed and 98% was composed of mixed shrubs and conifers. Six and a half miles of riparian corridor were enhanced, of which 74% represented improvement of existing cover. Eleven and a half miles of woodland edge were enhanced; the 1- and 2-row plantings were utilized most commonly.

All linear habitat developments were divided into segments and classified according to: (1) the number of rows of shrubs and conifers planted, (2) the plant composition, i.e., shrubs only, conifers only, or shrubs and conifers, (3) the adjoining land use, (4) the orientation or facing direction, and (5) the habitat type, i.e., hedge, riparian corridor, or woodland edge. The classification system provided a basis for inventorying the habitat developments and structuring wildlife and vegetational evaluations.

The diversity of foods and cover found in conjunction with row-crop agriculture attracts bobwhite quail; large tracts of idle land or pasture are rarely utilized by quail. Whenever possible, habitat developments were established within an area of active grain cropping. Sixty-eight percent of the hedge, 76% of the riparian corridor, and 68% of the woodland edge undergoing development adjoined cropland (Table 9). Only 17% of the hedge and 6% of the riparian corridor were developed where the adjoining cover on both sides was idle. These situations provided opportunities for breeding territories and nesting sites because they were not far removed from cropland.

The most highly valued hedge was the type with cropland on both sides. The 2-row hedge was most prevalent among this class of hedge with 2.2 miles created; the 3-row (1.6 mile) and improved hedge (1.3 mile) were also important. Predictably, landowners were less willing to devote a wide strip of this choice farmland to wildlife.

North-south and east-west orientations of hedge and riparian corridor were similarly represented among habitat developments (Table 10). This situation reflected a good distribution of linear habitat developments on the landscape and a firm basis for

TABLE 8. *Habitat developments installed on the Marshall Area, 1975-80.*

Shrub/Conifer Planting	Habitat Development (linear ft) Hedge		Riparian Corridor		Woodland Edge	
New cover: 1-row	12,090	(27.8 miles)	2,522	(1.7 miles)	14,106	(8.6 miles)
2-row	32,522		3,226		25,056	
3-row	86,465		3,068		4,752	
4-row	15,656				1,638	
Existing cover improved	23,453		25,506		15,270	
Total	170,186	(32.2 miles)	34,322	(6.5 miles)	60,822	(11.5 miles)

TABLE 9. *Land use adjoining habitat developments installed on the Marshall Area, 1975-80.*

Adjoining Land Use	Habitat Development (linear ft) Hedge		Riparian Corridor		Woodland Edge	
Crop/crop	34,798	(68%)	9,776	(76%)	1,456*	(68%)
Crop/pasture	15,322		4,342		39,684**	
Crop/idle	53,277		6,526			
Crop/road	12,216		5,460			
Pasture/pasture	1,248		390			
Pasture/idle	7,722		2,602		1,456**	
Pasture/road	1,170					
Idle/idle	29,184		1,898		17,082**	
Idle/road	15,249		3,328		1,144**	

*Woodland was pastured.
**Woodland was not pastured.

TABLE 10. *Orientation of habitat developments installed on the Marshall Area, 1975-80.*

Orientation	Habitat Development (linear ft) Hedge	Riparian Corridor	Woodland Edge
North-South	90,775	15,732	
East-West	79,411	18,590	
Facing: North			12,532
South			14,664
East			15,802
West			17,824

documenting vegetational development and wildlife use. A cursory evaluation of snow build-up in established hedges in 1978-79 revealed a 3-fold greater accumulation in east-west vs. north-south hedgerows. The cover value of hedge and riparian corridor diminished as snow depth increased.

The exposures of developed woodland edges were similarly divided among the cardinal directions, affording a good opportunity for the evaluation of vegetational development and wildlife use (Table 10). Greater wildlife use during the winter months would be expected on the south-, east-, and west-facing edges which comprised 79% of the woodland developments.

Kabat and Thompson (1963:97) recommended 1 mile of hedge (12 ft wide)/450 acres of land to sustain a quail population of about 1 bird/20 acres in fall. Intensive habitat development in 6 management units — Syresville, Woodstock, Spring Hill, Clearfield, Gillingham, and Sugar Bush (6,560 acres) — added 1 mile of hedge/633 acres to the landscape. Adding the unimproved hedge in this block to the computation yields a total of 1 mile of hedge/306 acres. Since the unimproved hedge qualified under the criteria established by Kabat and Thompson (1963:97-98), the goal for hedge cover set forth by these investigators was attained on a portion of the Marshall Area.

Riparian corridor and woodland edge serve essentially the same function as hedge, i.e., secure travel access plus loafing, roosting, and nesting sites. When improved and unimproved riparian corridor and woodland edge were added to the hedge cover, a total of 1 mile of travel access/88 acres was computed for the management block. As a point of reference, consider that a cover strip around each 40-acre unit in the block would yield 1 mile of strip/64 acres.

Plots and Food Patches

One hundred ninety-one plots totalling 196 acres were established on the Marshall Area. Seventy-eight plots were designed to accommodate sorghum food patches, and 75 had test patches planted to evaluate site characteristics (Table 11). The sorghum patches averaged 8,283 ft^2 and ranged between 1,805 and 18,240 ft^2. The remaining 113 plots were composed of shrubs, conifers, unmanaged herbaceous vegetation, and occasionally brush piles and were designed as intermediate winter cover areas, breeding season territories, and nesting sites. These plots totalled 72 acres and averaged 0.6 acres in size. Plots with food patches averaged 1.6 acres. Brush piles were constructed on 26 plots with food patches and 24 with only shrubs and conifers. Thirteen of the 78 plots with sorghum patches also had legume patches to serve as an auxiliary food source in early winter. The legume patches averaged 1,950 ft^2.

A preferred pattern for aligning food and cover components in a winter unit complex is shown in Figure 4. The

TABLE 11. *Ages of sorghum food plots planted on the Marshall Area, 1975-80.*

No. Years Planted	No. Sorghum Plots
1	21
2	12
3	17
4	13
5	9
6	3
Total	75

Sorghum food plots averaged slightly less than 1/4 acre and were often established in retired cropland or pasture.

Silage and grain sorghums were planted in alternate rows to enhance plant growth and maturity and to create a diverse cover.

Conifers and shrubs were planted adjoining sorghum food plots to provide escape cover for wildlife and shelter for the plot from drifting snow. (above)

The sorghum stalks partially collapse in fall, lowering the seed heads and forming a canopy of cover. (right)

Establishment of food plots involved 3 steps: (1) preparing the seed bed with a rotovator (far left), (2) planting with a grain drill (middle), and (3) applying herbicide with a mist blower (left).

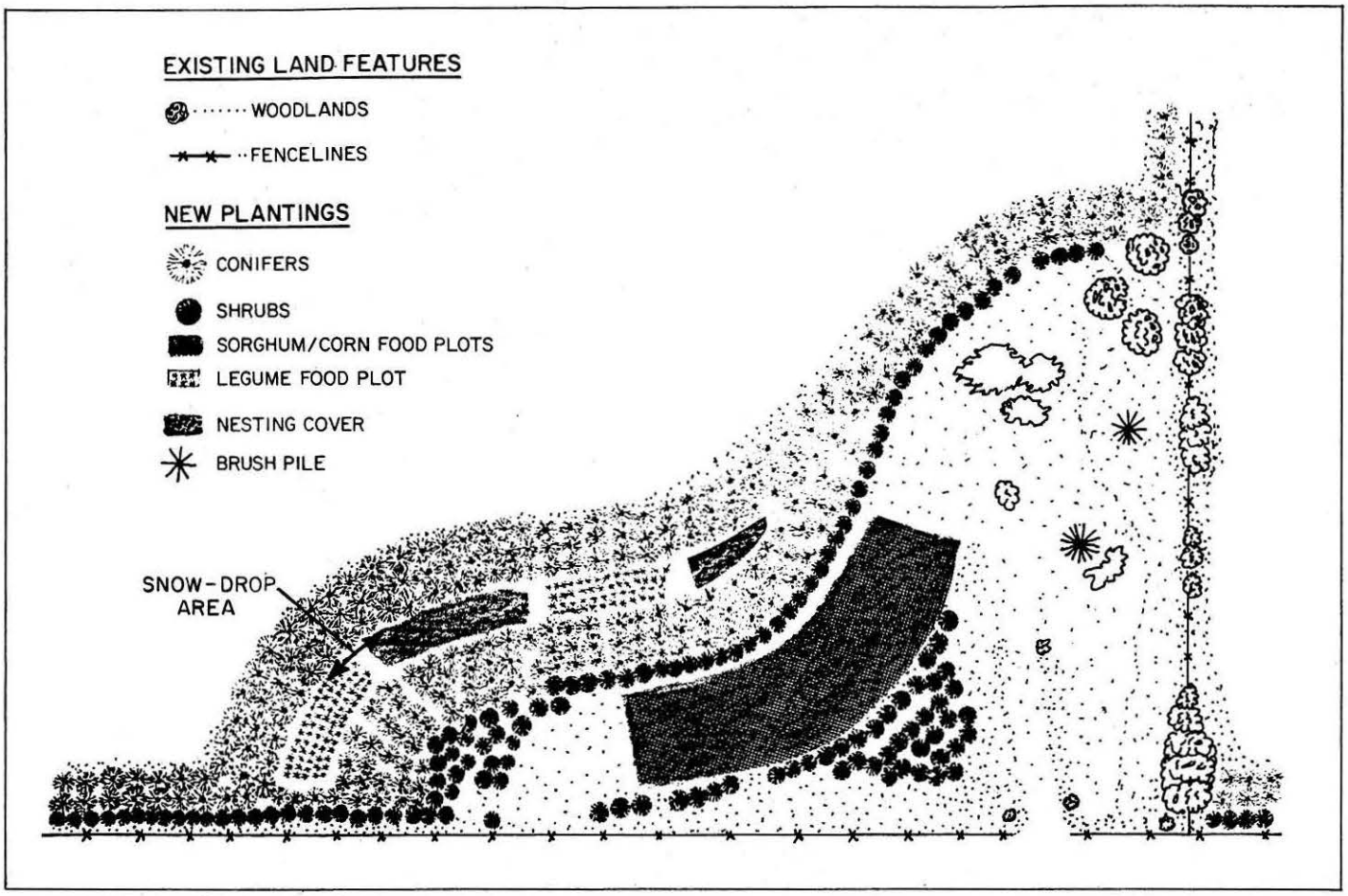


FIGURE 4. *Ideal winter food and cover plot*

TABLE 12. *Sorghum food patches planted on the Marshall Area.*

Year	Patches* Planted	Size (ft²) Mean	Range	Varieties
1975	12	8,048	1,975-14,600	Unk S/S**
1976	26	7,163	2,075-18,240	NK 145[1]
1977	36	7,637	2,052-18,240	NK 145
1978	50	7,946	1,805-16,500	NK 145, MM 52[2] Titan E[3], Bug Off E[3]
1979	46	9,063	1,805-18,240	NK145, MM 52
1980	43	9,123	1,805-18,240	NK 145, MM 52, Trudan 8[4], P 944[5]
Total	75			
Mean		8,283		

*Total of 75 food patches planted, some replanted annually for all 6 years (Table 11).
**A sorghum-sudan hybrid of unknown origin.
[1]Northrup King 145.
[2]Mini Milo 52 (Northrup King).
[3]Asgrow hybrids.
[4]Trudan 8 (Northrup King).
[5]Pioneer 944.

"snow-drop" area* was incorporated in 6 plot developments to minimize the accumulation of drifting snow in the sorghum patch. The degree of compaction of vegetation and therefore its suitability for nesting cover will be monitored in the years ahead. The brome grass/forb complex, currently prevalent in most snow-drop areas, will be replaced with switchgrass or another plant of similar resistance to snow compaction if the cover becomes unsuitable for nesting quail.

The sorghums NK 145 (Northrup King silage sorghum hybrid) and MM 52 (Northrup King grain sorghum hybrid) were the standards for evaluating site characteristics and new sorghum varieties. NK 145 has been recommended for food plots since sorghum varieties were tested at the Waterloo Wildlife Area in the 1960's (Woehler 1982). MM 52 was recommended by Northrup King as a companion sorghum for NK 145 to prevent flattening of the silage sorghum and to provide a seed source at 2-3 ft.

The sorghums were planted using a

*Open area between the conifer plantings in which herbaceous cover may be planted.

grain drill with every other opening plugged. The seedbox was partitioned and the openings paired so 2 rows of each variety were planted. Characteristically the NK 145 reached a height of 7-8 ft and the MM 52, 2-3 ft. As the silage sorghum collapsed in the fall, it would intertwine and come to rest against the grain sorghum. Variable growth and weed competition within the food patches yielded a diverse food and cover combination.

The standability and related stalk rigidity of NK 145 has deteriorated markedly in recent years. Concommitently Northrup King has decided to remove the hybrid from the market. Considering these factors, 4 sorghum hybrids were tested with NK 145 and MM 52 as standards beginning in 1978 (Table 12). The Asgrow varieties Titan E and Bug Off E show promise and will be tested further.

Thirty-seven legume patches were planted to evaluate 8 varieties (Table 13). Among the 4 lespedezas, a fair to poor catch was experienced with "wooly", "daurica", and "prostrate" while "natob" failed to establish. A portion of the natob seed received from Hillcrest Farms was planted at the DNR's Wilson Nursery, and it was developing well at the time of writing. Seed from the nursery stock will be used for future legume plantings on the Marshall Area. Emerald crownvetch and Mackinaw birdsfoot trefoil established consistently well on the 9 patches devoted to these legumes. Bobwhite soybean and "sesbania" failed to catch on 9 small patches selected to test these varieties.

Peredovick sunflowers did well on 3 plots that were formerly test sites for sorghum and moderately well in 58 sorghum patches where the seed was scattered on the ground ahead of the grain drill. Since sunflowers are sensitive to Atrazine, the variable success in establishment depended on herbicide levels in the soil. Sunflowers received heavy songbird use in fall.

Switchgrass/legume combinations were successfully established on a new roadside that adjoined a shrub/conifer plot. The seeding will ultimately provide a fall feeding site and potential nesting area as well.

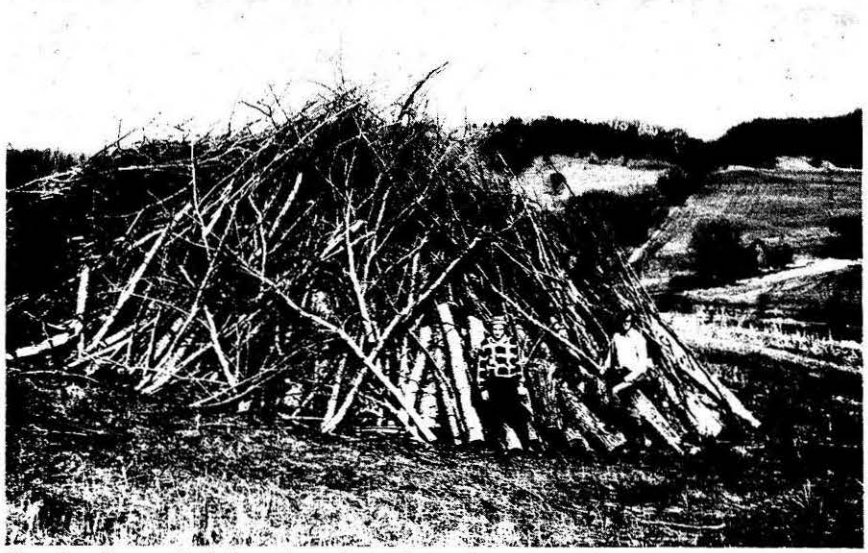
TABLE 13. *Legume and sunflower plantings on the Marshall Area.*

Variety	No. of Plots and Total Area (ft²)				
	1975	1976	1977	1978	1979
Bobwhite soybean*	3 (2,500)	6 (3,665)[3]			
Sesbania*	1 (1,100)				
Emerald crownvetch**				6 (9,581)	
Wooly lespedeza**				6 (12,547)	
Daurica lespedeza**				4 (7,224)	
Prostrate lespedeza**				4 (9,400)[4]	
Natob lespedeza[1]				2 (1,945)	
Wooly/daurica mix				1 (7,540)	
Wooly/trefoil mix					1 (1,680)
Mackinaw birdsfoot trefoil**				3 (5,560)[5]	
Peredovick sunflower[2]			3 (15,282)[6]		

*Received from the USDA, Soil Conservation Service Nursery at Elsberry, Mo.
**Received from the USDA, Soil Conservation Service Nursery at Rose Lake, Mich.
[1]Received from Hillcrest Farms, Box 129, Route 3, Martinsburg, W. Va.
[2]Received from the Illinois Department of Conservation.
[3]Soybeans were planted adjoining sorghum in the same patch.
[4]Including 1 plot (2,520 ft²) with switchgrass.
[5]Including 1 plot (720 ft²) with switchgrass.
[6]Sunflower seed was was also scattered on the sorghum patches in 1978 and 1979.

Brush Piles

Selective tree and brush removal or "tree-limbing" to allow close passage to fencelines with planting equipment was employed on about 40% of the linear habitat developments. One-hundred-thirty brush piles were constructed along travel lanes or within plots between 1975 and 1980. Most



Brush piles varied from hut-shaped stacks composed of small prickly ash and sumac (above) to large piles over 20 ft in diameter and composed of large boxelder and willow (below).

TABLE 14. *Compaction of brush piles constructed on the Marshall Area.*

Constructed	Measured	Intervals (years)	No. Piles	Compaction (%)
1976 winter-summer	1977 summer	1	30	20
1976 winter-summer	1980 summer	4	30	49*
1977 winter	1980 summer	3	72	34**

*Assuming a first year compaction rate of 20% for this cohort of brush piles, the additional 29% average reduction in brush pile height over 3 years yields a mean annual compaction of about 10%.

**Presuming a first year compaction rate of 20% for this cohort of brush piles, the additional 14% average reduction in brush pile height over 2 years yields a mean annual compaction of 7%.

TABLE 15. *Fencing constructed to protect new plantings.**

	Rods of Fence (No. of Properties)			
Year	DNR	Landowner/ ASCS	Landowner	Total
1975	200 (5)**			200 (5)
1976	371 (8)**	88 (1)	58 (1)	517 (10)
1977			120 (2)	120 (2)
1978	215 (6)			215 (6)
Total	786 (18)	88 (1)	178 (3)	1,052 (22)

*No fencing was constructed in 1979 and 1980.

**125 rods of fence in 1975 and 175 rods in 1976 were constructed on 1 property principally for trout stream protection.

brush piles were hut-shaped and composed of elm, box elder, prickly ash, and staghorn sumac. The sumac was cut to regenerate aging stands. The typical brush pile was 20 by 29 by 10 ft high; the piles varied from 5 by 11 by 3 ft high to 22 by 77 by 13 ft high. On 2 properties, the cuttings were windrowed and piled to a height of 6 ft. The lengths of these windrowed segments were 354 and 276 ft. Brush piles compacted roughly 20% in the first year following construction and an average of about 8% each year thereafter (Table 14).

Fencing

Fences were constructed to protect new plantings on 22 properties between 1975 and 1978 (Table 15). The DNR provided equipment and labor for 786 rods of the 1,052 rods of fence built. About 300 rods of DNR fence was constructed by Fish Management to protect trout water. CETA crews cut black locust for fence posts, salvaged barbed wire from state properties, and built 486 rods of protective fencing. Fencing costs were minimal because the black locust trees and the barbed wire were removed from nearby wildlife areas as prescribed vegetation management and hunting grounds maintenance practices. Also some of the black locust posts were provided by volunteers clearing trees from a scientific area.

ASCS cost-sharing was used to establish 88 rods of critical fencing that not only protected new plantings, including a food plot, but also secured an important feeder stream for Fancy Creek. ASCS cost-sharing was requested for 2 additional projects; funding was denied in 1 case and granted in the other. However, the landowner receiving funding failed to build the fence in the required contract period.

DOCUMENTATION OF HABITAT DEVELOPMENT

Photo stations and vegetation measurement sites were established to document changes in the structure and plant composition of habitat developments. Photo stations were of 2 types: (1) a strategic point was selected to photograph a portion of the development, and (2) a random point was identified along a linear development where a density board was placed for a photograph taken perpendicular to the long axis (Fig. 5). To date, 239 photo stations have been established and photography is planned through 1990. Photographs are taken in all seasons and at 3- to 5-year intervals on a rotational basis.

Plant composition and relative abundance were recorded at 75 sites on 25 segments to quantitatively document weed encroachment and the growth of newly planted shrubs and conifers. These segments were selected to represent the predominant linear habitat components established in 6 management units. Each segment falls within a transect used for the songbird survey. The 3 sampling sites/segment were located at quarter points, i.e., the transect length was divided by 4 and the points set at 1/4 intervals from either end. An 18-inch stake, with an identification tab, was driven into the ground along the fenceline to facilitate relocation of the quarter point.

A density board was placed atop the ground level stake and the vegetational obstruction of the squares judged from 50 ft. The species of plants interrupting the view of the 12-inch-wide board were recorded for 3 24-inch vertical tiers. A subjective appraisal of the relative dominance of up to 9 plant species was recorded for each tier. The hedge width, measured from the stake to the outermost extension of new plantings or the cropping edge, was also recorded.

The vegetation measurement sites were established in 1978 and scheduled for evaluation in 4-year increments through 1990. In 1980, 14 segments (42 sites) were visited to obtain a preliminary assessment of vegetational changes. Among the 43 forbs, 8 grasses, 17 naturally occurring woody plants, and 9 planted varieties of shrubs and conifers found in both years, the grasses were dominant among lower tier plants. Between 1978 and 1980, the frequency of occurrence for planted shrubs and conifers increased as did most other woody plants including prickly ash — a most undesirable shrub (Table 16).

USE OF CHEMICALS IN HABITAT DEVELOPMENT ACTIVITIES

The use of chemicals in conjunction with habitat development activities was minimized. Only 8% of the stumps resulting from selective cutting were treated with herbicides to prevent regrowth. Tordon (picloram), Ammate X-NI, Krenite, and Roundup showed the most promise; tests will continue on selected sites to develop application specifications for landowners interested in using the herbicides.

Simazine was employed to control grassy-herbaceous competition on 84% of all shrub and conifer plantings at an application rate of about 4 lb/acre. No adverse affects of the chemical were noted on the planted stock including autumn olive which was reputed to be the most sensitive. Approximately 2.5 miles of linear cover or edge and 17.3 acres of plots on 5 properties were not treated with herbicides because the landowners objected to the use of chemicals. These

TABLE 16. *Changes in relative dominance of planted stock and important naturally occurring species on restored hedge as determined by density board measurements in 1978 and 1980.**

Plant	Importance Value** 1978	1980
New plantings:		
Conifers[1]	47	134
Shrubs[2]	71	109
Grasses:		
Brome grass	203	220
Timothy grass	142	78
Quackgrass	91	25
Bluegrass	81	86
Forbs:		
Wild carrot	121	75
Goldenrod	92	90
Burdock	36	22
Sweet clover	29	35
Aster	24	15
Alfalfa	24	16
Ground cherry	25	5
Hog peanut	24	6
Woody:		
Poison ivy	81	68
Woodbine	67	85
Staghorn sumac	50	53
Choke-cherry	41	49
Prickly ash	38	61
Blackberry	33	39
Black raspberry	25	16

*Combined results from 42 sampling stations on 14 segments of hedge; among the 43 forbs, 8 grasses, and 26 woody plants tallied in both years only the more prominent species in each category were included in the table.

**Within the lower tier of the density board (Fig. 5), the plants were ranked on a scale of 9 to 1 with 9 awarded to the most prevalent species. The ranks of individual species were totalled for the 42 sampling stations; the maximum importance value for all stations combined would be 378 (9 × 42).

[1]Includes white spruce and white cedar.

[2]Includes ninebark, autumn olive, wild grape, highbush cranberry, hazel, nannyberry, and red-osier dogwood.

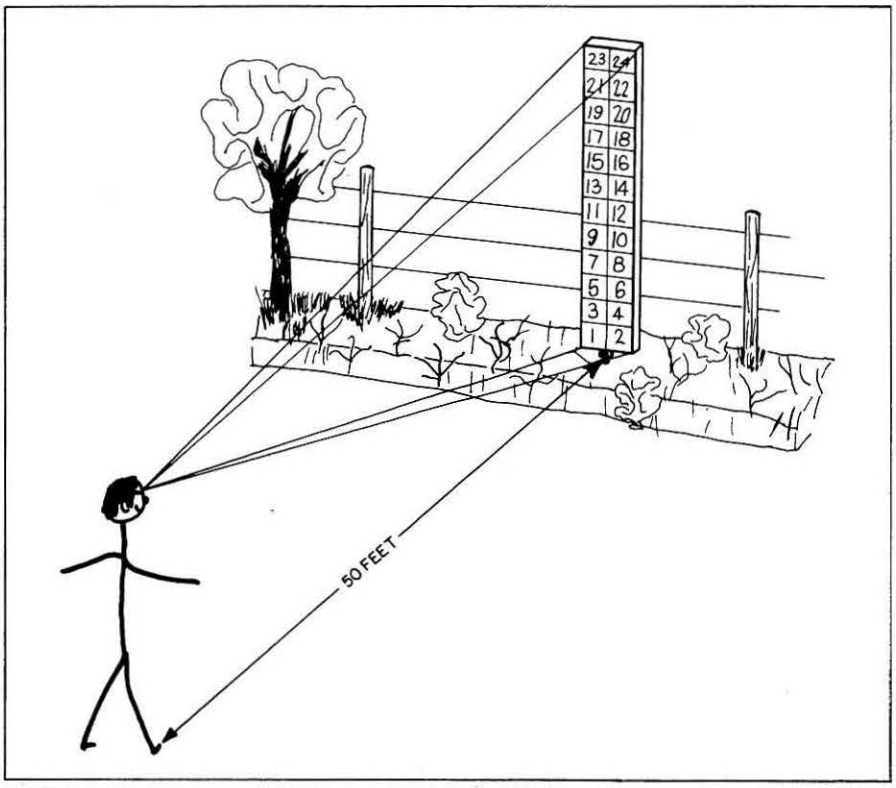


FIGURE 5. *Placement of the vegetation density board relative to the observer.*

new plantings were slower to establish but experienced comparable survival based on subjective evaluations.

Atrazine was applied to all sorghum patches except 2 where the landowners objected to the use of herbicides. At one of these sites we tried unsuccessfully for 2 years to establish a respectable food plot; at the other site, herbicide-free farming practices yielded a very good sorghum patch. Atrazine was applied with a mist blower (Stiehl) at 3 lb/acre. Thirteen sorghum patches were not treated with a herbicide in 1980, and Atrazine carry-over proved insufficient to control weedy species. The plots were treated with Atrazine 80 W at 3 lb/acre in 1979.

The invasion of undesirable woody species, principally prickly ash and black locust, has hindered the development of new plantings. Selective herbicide treatment may be required to attain satisfactory establishment of the shrubs and conifers. Chemical treatments will be arranged individually with the landowners.

INTENSITY OF PARTICIPATION IN THE HABITAT DEVELOPMENT PROGRAM

Involvement in habitat development activities among program participants varied from a small plot enhanced with fewer than 100 shrubs and conifers to 2 large complexes of 8-11 plots and 2-3 miles of linear cover created by the addition of several thousand shrubs and conifers (Table 17). The typical property received 3,250 shrubs and 1,400 conifers to develop 0.5 mile of linear cover or edge and 2 plots, 1 with a sorghum patch. The level of participation appeared dependent on a variety of factors including:

- The intensity of land use which was often related to the residency of the owner(s), i.e., absentee owners usually practiced less intensive farming.
- The farm size, i.e., large holdings, offered more opportunities for wildlife habitat development.
- The compatibility of the landowner's long-range land use plan and the wildlife habitat management unit needs.
- Agreement between landowners and land renters regarding the intensity of land use.
- Agreement between partners, including the husband/wife partnership, regarding farm management.
- Interpersonal relationships between the DNR staff and the participants, i.e., personality compatibility.
- Our perception of landowner willingness to participate.
- The landowner's perception of total benefits and long-term gains.
- The landowner's interest in wildlife relative to other products of the land.

EXTENT OF HABITAT DEVELOPMENT AMONG MANAGEMENT UNITS

The extent of habitat development on the 26 management units varied from extensive to no activity (Table

TABLE 17. *Range of involvement by participants in habitat development activities as depicted by 4 examples, 2 each on the range extremes.*

Participant	Plots (acres, no.) Food	Plots (acres, no.) No Food*	Habitat Development (linear ft) Hedge	Riparian Corridor	Woodland Edge	Shrubs	Conifers
Low involvement							
A**		0.4 (1)				50	25
B[1]			500			122	250
High involvement							
C	12.1 (3)	9.2 (8)	10,556	5,644	4,498	15,360	7,675
D[2]	3.3 (5)	0.6 (3)	13,636	1,326	4,082	33,190	13,440

*Plots without sorghum patches.

**The landowner was reluctant to participate in a DNR project, but agreed to have a small, roadside plot enhanced with shrubs and conifers. The plot connected with a large complex on the adjoining property.

[1]The property owner was asked to permit establishment of a critical hedge linking 2 large developments and may have become more involved given the opportunity.

[2]The comparatively large allocation of shrubs and conifers resulted from an extensive replant requirement.

TABLE 18. *Assessment of habitat development on 26 management units within the 60-section Marshall Area.*

Extent of Habitat Development	Management Units: Ridge	Valley	
Extensive	Spring Hill English Ridge Babb Ridge	Syresville Gillingham Sugar Bush	Woodstock Clearfield Lower Fancy Creek
Moderate	Asparagus Ash Ridge English Ridge Cemetery	Upper Fancy Creek Mill Creek	Sabin Ball Park
Little	Bethel Nigl	West Mill Creek East Mill Creek	Upper Horse Creek Miller Creek
None	Middle Ridge Meridian	Tabor	Lower Horse Creek

18, Fig. 6). Some units offered little opportunity for habitat restoration based on topography, land use, or landowner attitudes. Although no landowner requesting participation in the program was denied, habitat improvement was not encouraged in units lacking potential for at least 3-4 wintering sites and 2-3 miles of hedge.

Extensive habitat development was undertaken in 9 management units (Table 18). Seven adjoining units—Spring Hill, Clearfield, Woodstock, Syresville, Gillingham, Sugar Bush, and Lower Fancy Creek—comprise the *Eastern Sector* and encompass nearly 1/3 of the Marshall Area (Fig. 7). The English Ridge and Babb Ridge units are disjunct, but in association with the Sabin unit are termed the *Western Sector*. Land use was more intensive and quail abundance generally poorer in the Western Sector. Documentation of wildlife response to habitat restoration activities will be undertaken principally within the 2 sectors; this report focuses special attention on these units.

Extensive Development

Eastern Sector. The desired level of habitat improvement and the pattern of habitat components were most fully attained in the Spring Hill Unit (Table 19, Fig. 8b). All 10 landowners in the unit participated in the habitat restoration project which created 7 sorghum patches linked by 5.1 miles of hedge and woodland edge. Spring Hill habitat developments were connected with improvements in the Clearfield and Woodstock units thus magnifying the significance of this complex (Fig. 8b). Prior to development, 4-9 quail coveys occupied this area. Our goal is to sustain 8-10 coveys on the 3-unit complex at full development.

Landowner participation in habitat development activities was also exceptional (9 of 13 ownerships) in the Syresville Unit. Actually, only 1 of the 4 nonparticipants was formally contacted regarding habitat restoration, and he agreed to implement the farm plan without our assistance. Six food plots were linked by 2.4 miles of linear cover and woodland edge in this valley unit (Fig. 9b). Although the continuity of linear cover was not equal to Spring Hill, the full potential of the unit, considering the constraints of land use, was realized. Five to 10 quail coveys were reported in the unit prior to habitat development; 8-11 coveys are expected to occupy the area at full development if the 2 future food plots are established (Fig. 9b).

Across a heavily wooded ridge to the south of Syresville is another improved valley unit—Sugar Bush (Fig. 10). Land use was intensive with a history of heavy pasturing. However, 5 property owners were interested in improving their lands for wildlife and 6 sorghum patches plus a mile of linear cover were created. Four of the food patches were adequately linked by linear cover (4 southerly plots, Fig. 10b); the 2 northerly plots in this complex received immediate use by quail. Despite the narrowness of these valleys, the 4-patch complex should eventually harbor 3-4 coveys. The 2 disjunct food patches in the northern region of this unit were located in traditional quail wintering areas and both received immediate use. Heavy use of this area for cattle pasture precluded the establishment of connecting hedge. Two future food plot sites are planned for Sugar

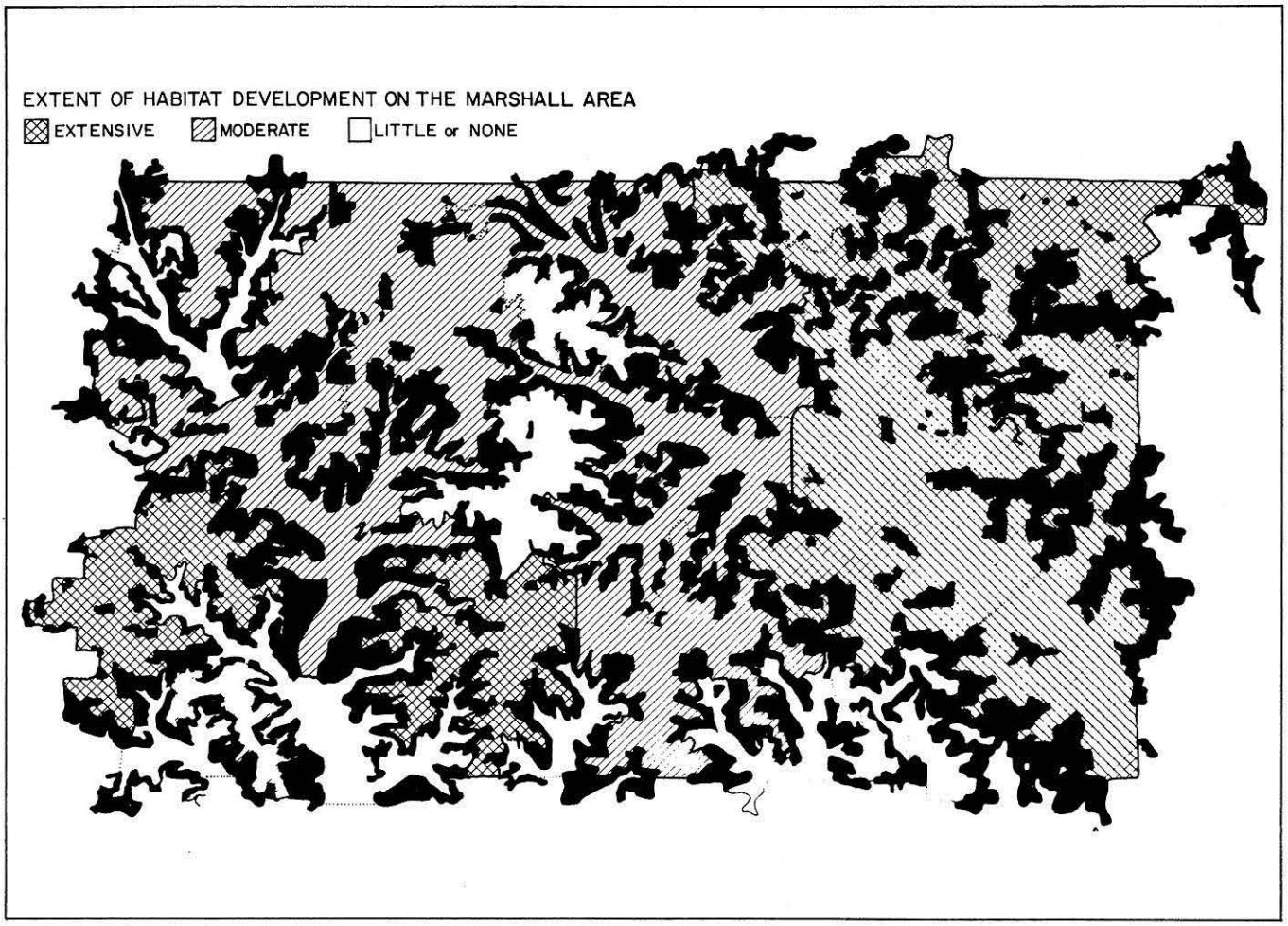


FIGURE 6. *Extent of habitat development on the Marshall Area.*

Bush (Fig. 10b). One will be located in a long-standing winter use area for quail (northerly plot) and the other will replace a smaller plot located nearby.

The Gillingham Management Unit is the largest on the Marshall Area and only the northeastern section was included in the "Eastern Sector" (Fig. 7). Substantial development occurred in 2 areas of the unit with 1 complex containing 6 closely spaced food plots and extensive hedge development (Fig. 11b). A spacing of about 1/2 mile between food plots was characteristic of most developments; a separation of only 1/4 mile or less was tested in this Gillingham complex. The objective of the test was to evaluate the saturation level of habitat improvements respective to quail abundance. Traditionally, 1-2 quail coveys occupied this valley; our goal is to sustain 4-6 coveys on this 1.1 mile^2 area. The northerly complex in the Gillingham Unit was developed, in part, with the intention of ultimately connecting it with the intensively developed southerly complex. Farm plans were prepared for the key parcels in the intervening space but problems arose in the negotiations and habitat restoration activities were not implemented. Habitat development plans were prepared for properties A, B, and D (Fig. 15). Property C would have provided the final link in the system. At least 1 sorghum plot would have been located on Property C or D to satisfy the needs of a traditional covey. A second food plot on the south portion of property B would have likely served a new covey.

The Lower Fancy Creek Unit ranks among the finest examples of a continuous network of linear cover (Fig. 12b). Three well-sited sorghum plots and 1 future food plot were located within the network which included 6.0 miles of hedge, riparian corridor, and woodland edge (Table 19). Thirteen cover plots were also scattered within the complex and 7 of the sites could accommodate an alternate food patch. Quail were abundant in this valley unit with 12-20 whistling males located in the summer and 3-5 coveys found in the winter. Ample nesting cover combined with the new habitat improvements gives this unit exceptional potential for sustaining a stable, high density quail population. Three landowners control virtually all of the developments; therefore, the loss of just one cooperator would be of considerable consequence.

Western Sector. Babb Ridge (upper portion) had a history of intensive land use—principally heavy pasturing—and the availability of wildlife habitat was negligible (Fig. 13a). Quail were infrequently observed in the unit and an area of traditional covey use was not found. The potential for a 3- to 4-fold increase in quail abundance is possible with the addition of 4 sorghum plots and 2.6 miles of new hedge and improved woodland edge (Table 19). The food patches were paired in 2 nearby complexes of circuitous travel lanes (Fig. 13b). These developments are found on 1 ownership and a change in attitude or transfer of the property could have serious consequences. The landowner also controls property in the Sabin and Mill Creek units including an additional 3 food plots and 2.3 miles of linear cover and woodland edge.

The English Ridge Unit had favorable land use for quail prior to management, and habitat development activities were designed to improve existing hedge and the availabil-

TABLE 19. *Accomplishments in 7 management units receiving extensive habitat development.**

Management Unit	No. Properties	No. Plots Food**	No. Plots No food	Linear Cover and Edge: Hedge (ft)	Riparian Corridor (ft)	Woodland Edge (ft)	Total (miles)
Eastern Sector							
Spring Hill	10	7	12	17,344		9,508	5.1
Syresville	9	6	9	9,276	2,860	286	2.4
Sugar Bush	5	6	6	4,732	1,118		1.1
Gillingham	10	6	14	17,006	2,964	10,476	5.8
Lower Fancy Creek	4	3	13	17,732	6,008	7,826	6.0
Western Sector							
Babb Ridge	1	4	2	10,100		3,744	2.6
English Ridge	7	6	3	13,869		1,508	2.9

*Excludes Clearfield and Woodstock management units which also had extensive habitat development (Table 18).
**"Food" refers to plots with sorghum patches.

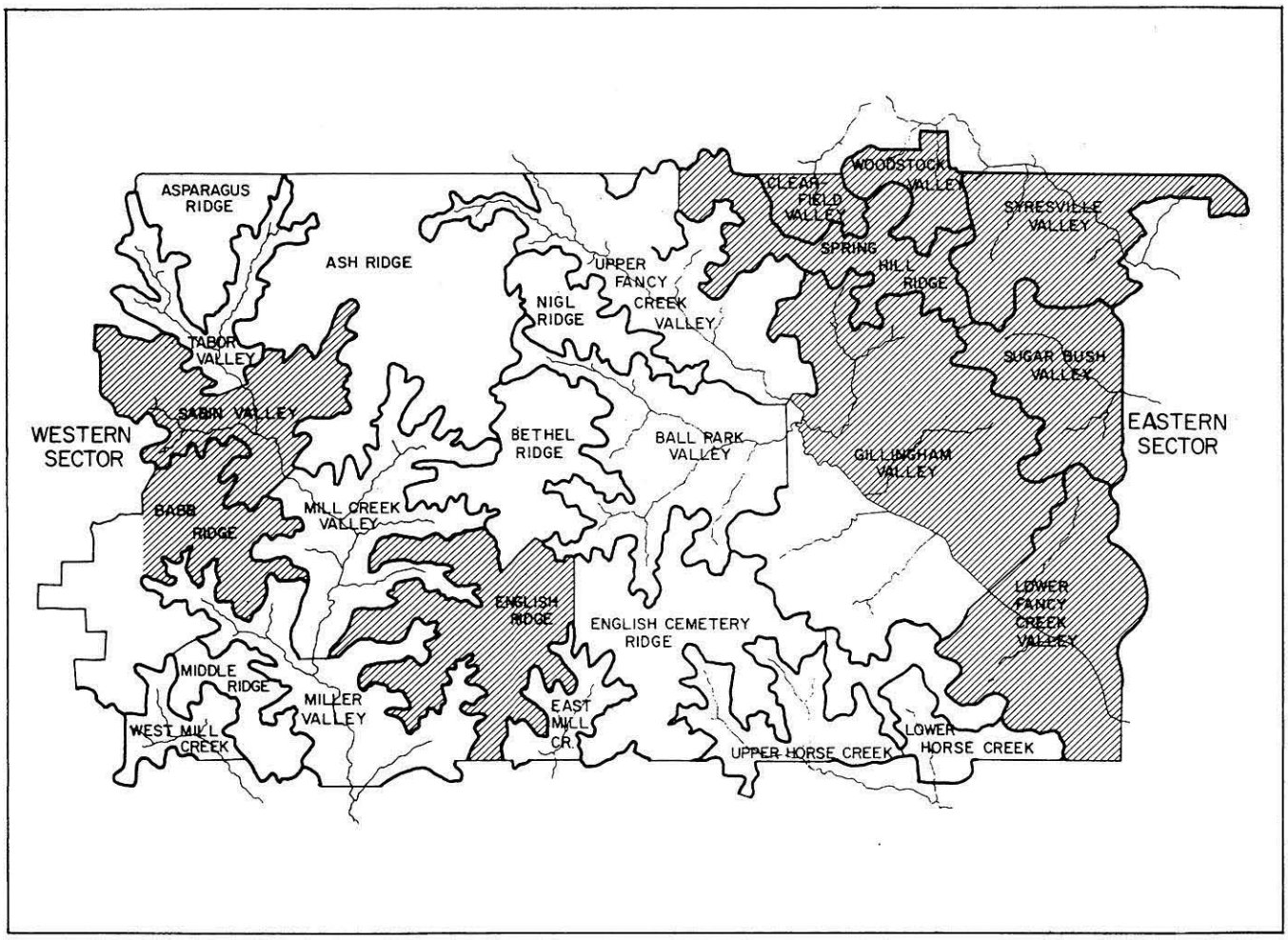


FIGURE 7. *Eastern and Western sectors (shaded areas) of the Marshall Area.*

ity of winter food (Fig. 14a). Six food and cover plots were designated although only 5 were active at the time of this writing (Fig. 14b). Hedge development was very good; however, key parcels were not obtained to make the unit exceptional (Fig. 16). Habitat developments on properties C and F would have provided important links in the established system. Weaknesses in communications between the landowners and quail project personnel with time constraints on lengthy negotiations precluded participation of these properties in habitat restoration activities. Habitat improvements on properties A, D, and E would have provided nice additions to the unit, but landowners declined participation for some of the reasons indicated in Table 3.

The food and cover plot on property B fits most perfectly our model for configuration, slope, and critical components (Fig. 4). The farm has traditionally harbored 1-2 large coveys and the sorghum patch has served 1-2 coveys since its establishment in 1976. Thirty-two quail were flushed from the food patch on 1 January 1979, during a winter when weather conditions were particularly harsh. Within each management unit there were 1 or 2 key parcels that were secured first to provide a core for development. Property B served that purpose in the habitat development activities for English Ridge.

Habitat restoration on Property G occurred primarily in the adjoining Miller Unit; however, a food patch and 2 hedge segments were established in English Ridge (Fig. 16). This property owner provided 2 retired hayfields of about 6 acres each for nesting cover experiments. Since the availability of suitable nesting cover was not thought to be a critical need for quail, testing was limited to switchgrass establishment trials and discing of grassy cover to encourage forbs. The switchgrass failed to establish. The discing of the grassy cover resulted in a more diverse nesting cover, and future testing of this technique may be appropriate. Prior to habitat improvement activities, 2-4 quail coveys occupied the English Ridge Unit. Our goal is to sustain 6-8 coveys if all 6 food plots (Fig. 14b) can be kept active.

Little Development

Among the management units with "little" habitat development, the Miller Unit had a complex with 2 sorghum patches and 1.1 miles of hedge and the Bethel, Nigl, West Mill Creek, and Upper Horse Creek units had 1 food plot each and a modest complement of hedge. All of the sorghum patches except the 1 in West Mill Creek have received use by a quail covey. A major renovation of riparian corridor, through selective cutting, was undertaken in the Upper Horse Creek Unit. Six brush piles averaging 21 by 24 by 10 ft high were constructed along 1,900 ft of creek bottomland.

Moderate Development

"Moderate" habitat development was accomplished on 7 management units (Table 18). The Ball Park Unit had 6 sorghum patches, but only 3 were linked by hedge. Two of the food patches had documented quail use; however, 3 of the remaining plots have a high potential for future use. Eight brush piles were constructed during the development of 1.5 miles of linear cover within the 3-food-patch complex. Two additional food patch sites were offered by landowners in the Ball Park Unit and one has sufficient existing cover to merit planting in the future. The second site had very little associated cover and no potential for shrub and conifer development due to pasturing practices.

Five wintering sites with sorghum patches were established in the Upper Fancy Creek Unit. Two of the food patches were linked by 1.2 miles of improved riparian corridor; an equal complement of hedge cover in the Ash Ridge Unit adjoined this complex. Two or three quail coveys reaching 28 birds in one winter have made use of these upper valley habitat improvements. Among the remaining 3 wintering sites, 2 had small (4,000 ft^2) food patches which were located in marginally suitable cover situations. These sites may be abandoned in favor of other, as yet undesignated, sites with more potential.

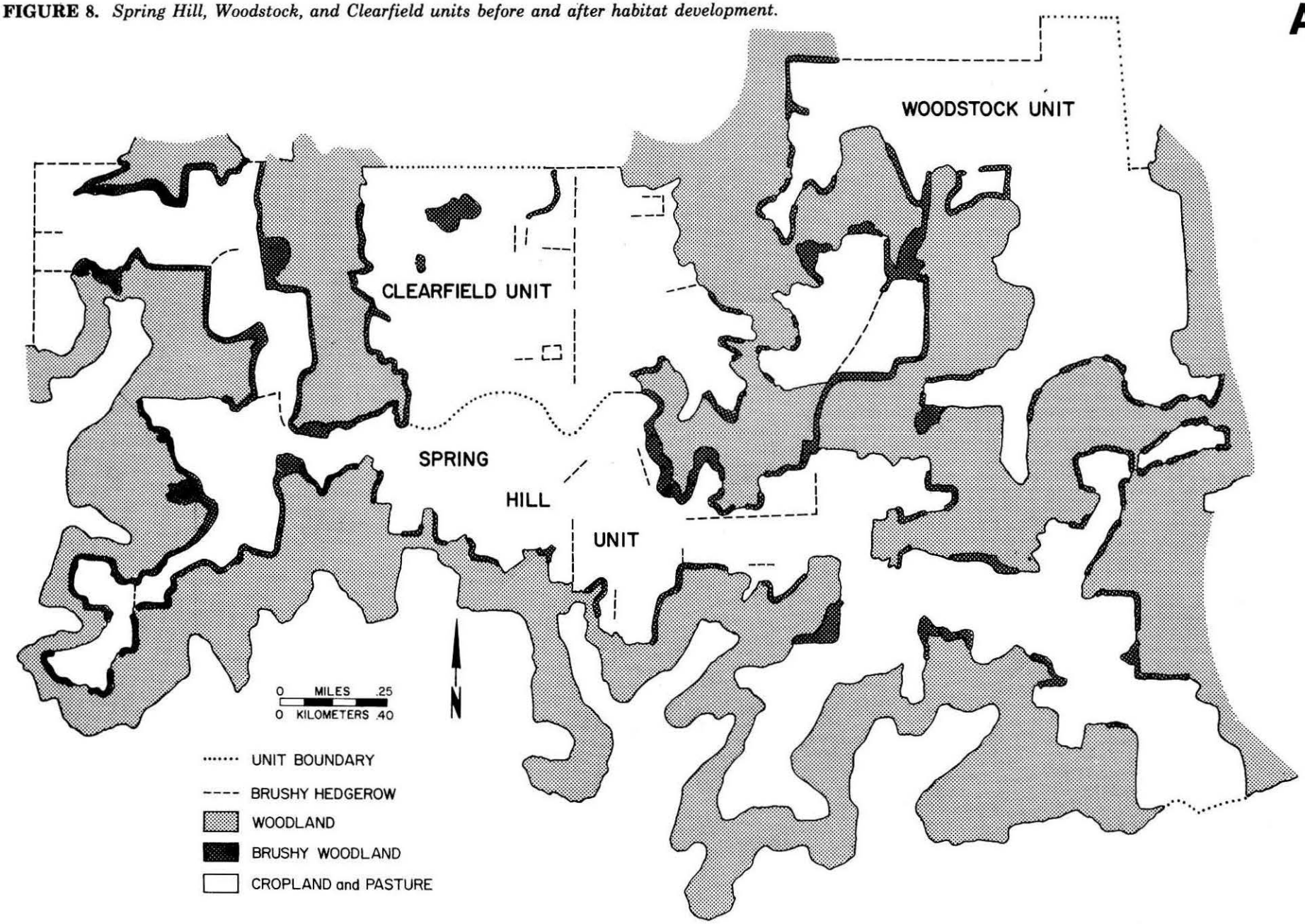
The Mill Creek Unit also had moderate habitat development with 4 designated wintering sites and 2.2 miles of improved riparian corridor or hedge. Seven brush piles were created by selective cutting in this broad valley complex. Two or three quail coveys made use of this unit during the early stages of habitat restoration.

Three wintering sites were established in the English Ridge Cemetery Unit and 2 were linked by 1.6 miles of improved linear cover or edge. The remaining wintering site was established in an ideal location and suitably linked to developments in the Upper Horse Creek Unit. The complex with 2 food plots has harbored 2 quail coveys since development began but the other site has not yet properly developed to attract a covey.

Two wintering sites each were located in the Sabin and Ash Ridge Units. One of the sorghum patches in the Sabin Unit was associated with 1.1 miles of improved riparian corridor and another food patch site should be identified within this complex. Quail use was documented in both sorghum plots in Sabin and 1 of the Ash Ridge plots. Only 1 sorghum plot was planted in the Asparagus Unit, but 2 additional sites of fair potential were identified. The lone food plot was located within an open woodland that was enhanced by the addition of shrubs, conifers, switchgrass, and brush piles. Despite only fair success in establishing sorghum on this site, the food patch received regular quail use.

Noteworthy habitat improvements were installed in the management units with moderate development. Overall, the continuity of linear cover did not attain the level prevalent in the extensively developed units but variations in the management strategy were tested and subsequent evaluations must be made. The documentation of wildlife response to habitat improvements will be most intensive in the Eastern and Western sectors. Nonetheless, periodic evaluations will be made in the management units not included in these sectors. Particular attention will be given to special developments like the woodlot improvement project in the Asparagus Unit.

FIGURE 8. *Spring Hill, Woodstock, and Clearfield units before and after habitat development.*



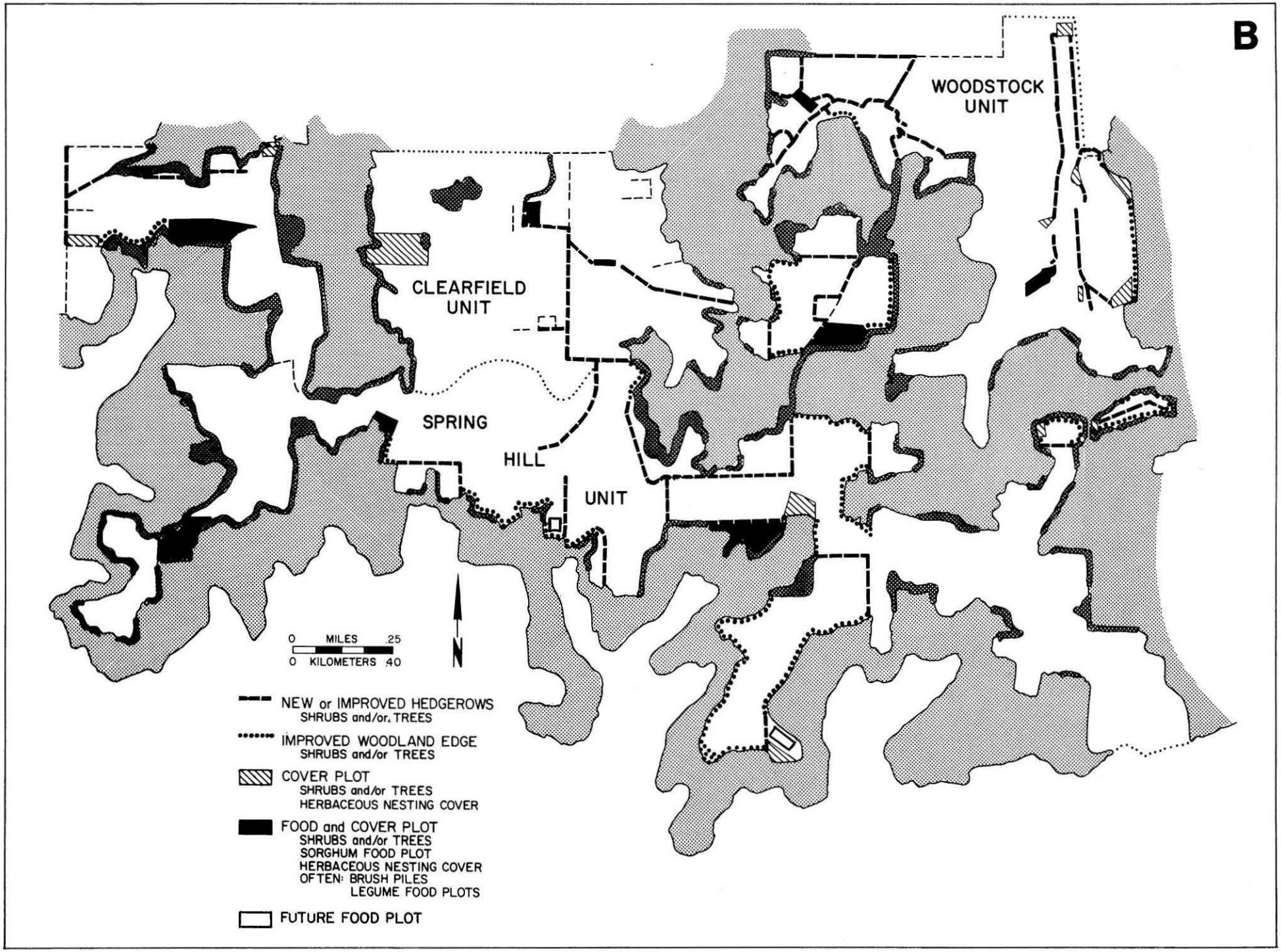
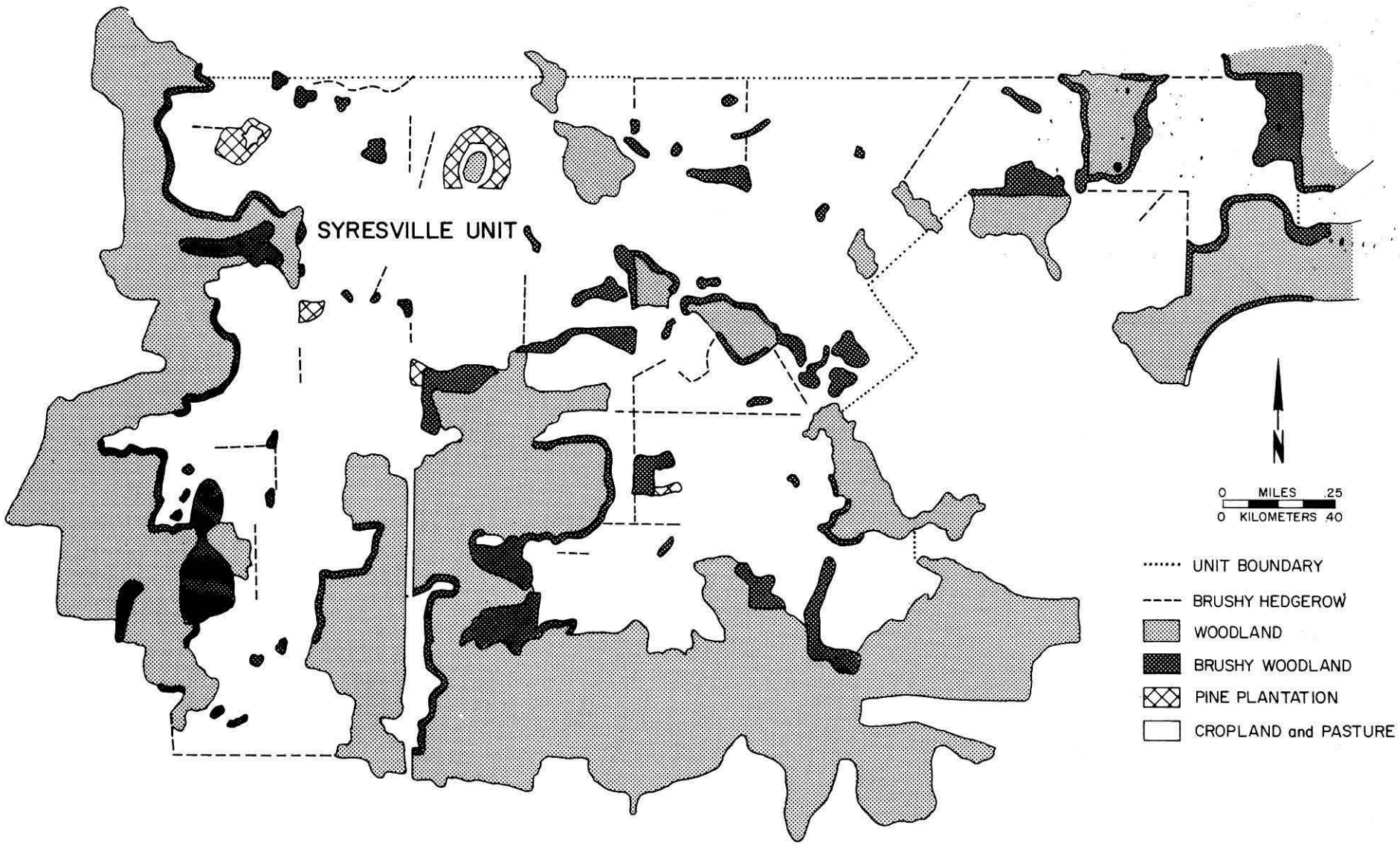
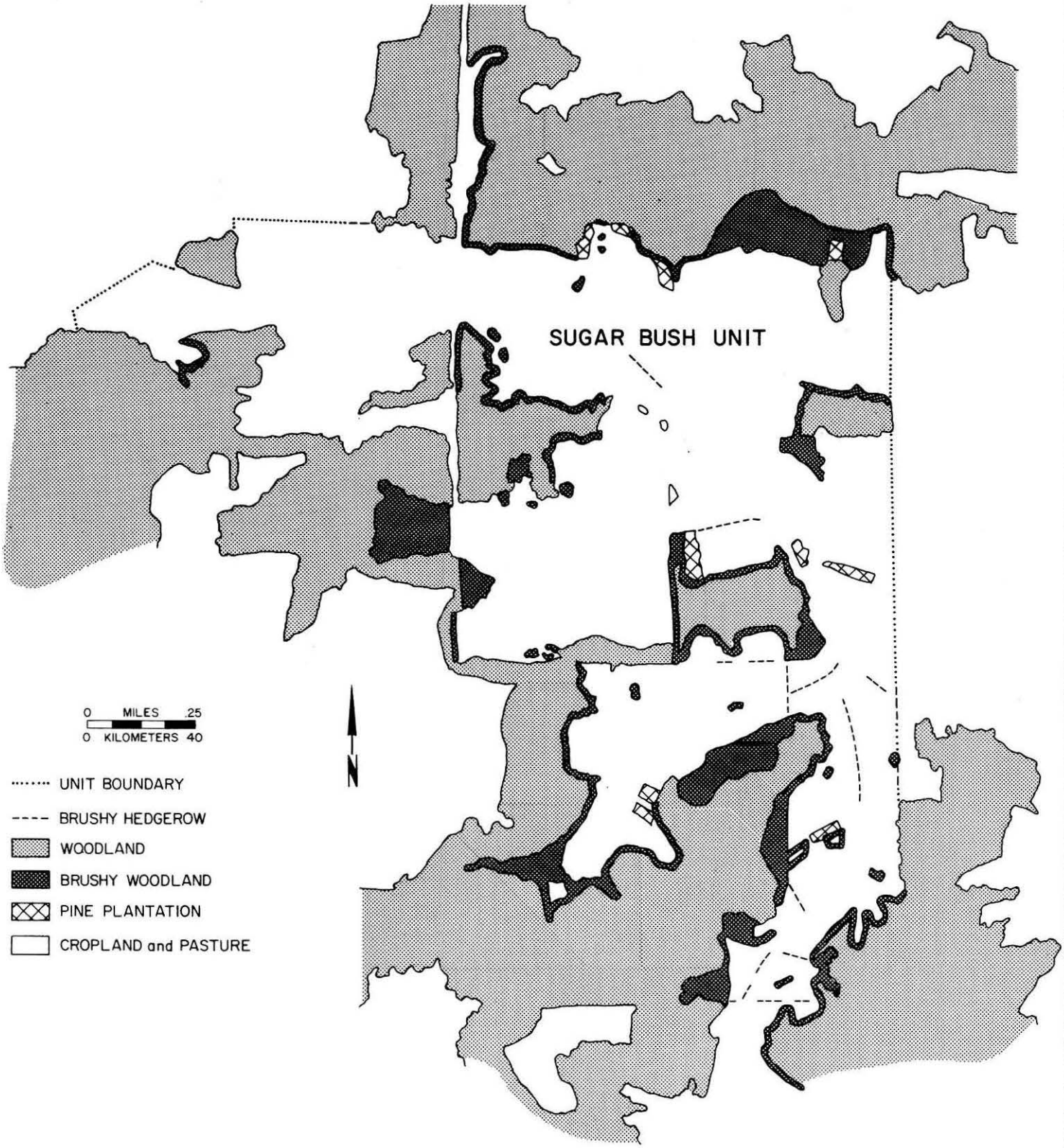

B
WOODSTOCK UNIT
CLEARFIELD UNIT
SPRING HILL UNIT
0 MILES .25
0 KILOMETERS .40
N
NEW or IMPROVED HEDGEROWS
SHRUBS and/or TREES
IMPROVED WOODLAND EDGE
SHRUBS and/or TREES
COVER PLOT
SHRUBS and/or TREES
HERBACEOUS NESTING COVER
FOOD and COVER PLOT
SHRUBS and/or TREES
SORGHUM FOOD PLOT
HERBACEOUS NESTING COVER
OFTEN: BRUSH PILES
LEGUME FOOD PLOTS
FUTURE FOOD PLOT

FIGURE 9. *Syresville Unit before and after habitat development.*




B
SYRESVILLE UNIT
N
0 MILES .25
0 KILOMETERS .40
NEW or IMPROVED HEDGEROWS
SHRUBS and/or TREES
IMPROVED WOODLAND EDGE
SHRUBS and/or TREES
COVER PLOT
SHRUBS and/or TREES
HERBACEOUS NESTING COVER
FOOD and COVER PLOT
SHRUBS and or TREES
SORGHUM FOOD PLOT
HERBACEOUS NESTING COVER
OFTEN: BRUSH PILES
LEGUME FOOD PLOTS
FUTURE FOOD PLOT

FIGURE 10. *Sugar Bush Unit before and after habitat development.*



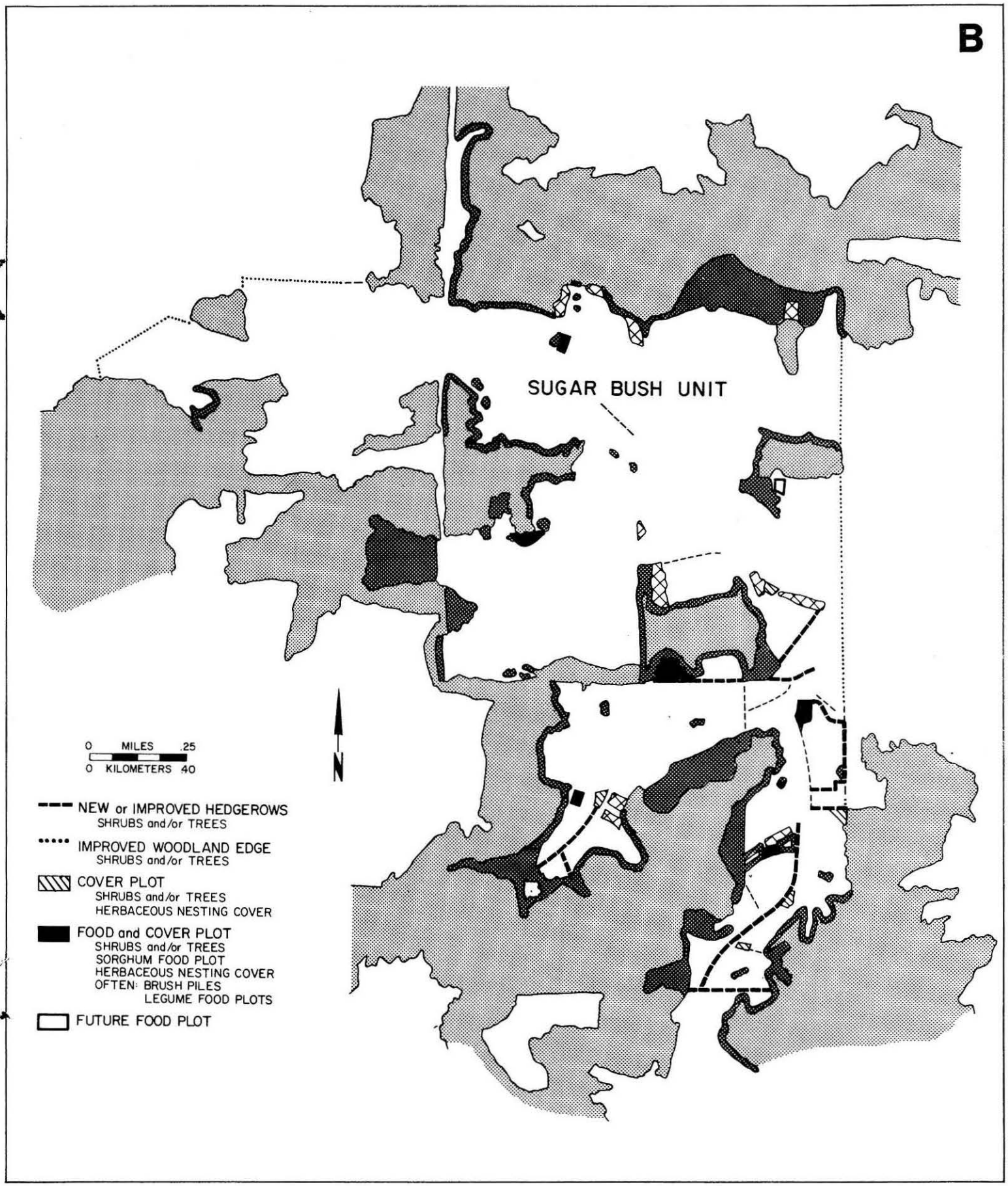
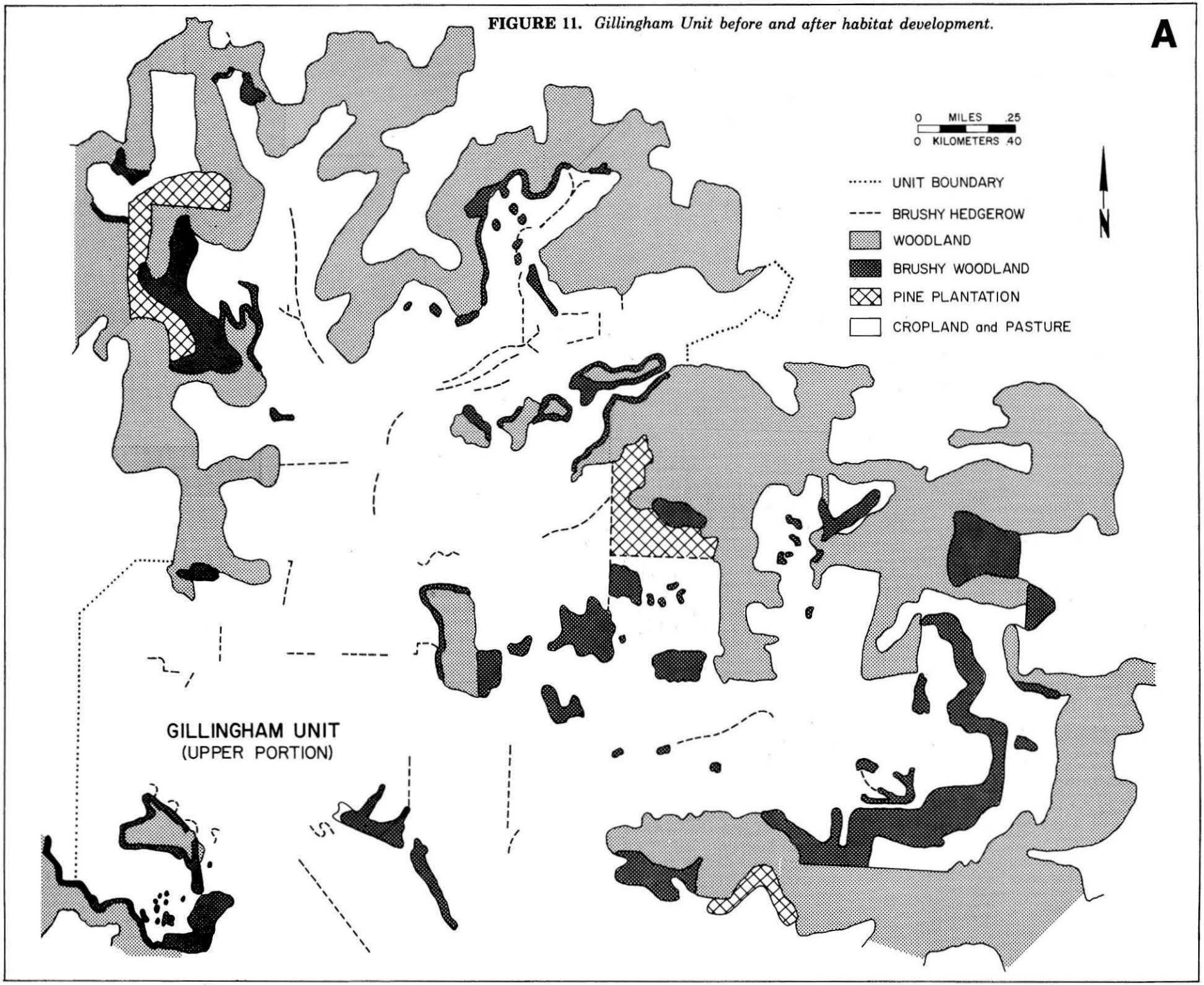

B
SUGAR BUSH UNIT
0 MILES .25
0 KILOMETERS .40
N
NEW or IMPROVED HEDGEROWS
SHRUBS and/or TREES
IMPROVED WOODLAND EDGE
SHRUBS and/or TREES
COVER PLOT
SHRUBS and/or TREES
HERBACEOUS NESTING COVER
FOOD and COVER PLOT
SHRUBS and/or TREES
SORGHUM FOOD PLOT
HERBACEOUS NESTING COVER
OFTEN: BRUSH PILES
LEGUME FOOD PLOTS
FUTURE FOOD PLOT

FIGURE 11. *Gillingham Unit before and after habitat development.*



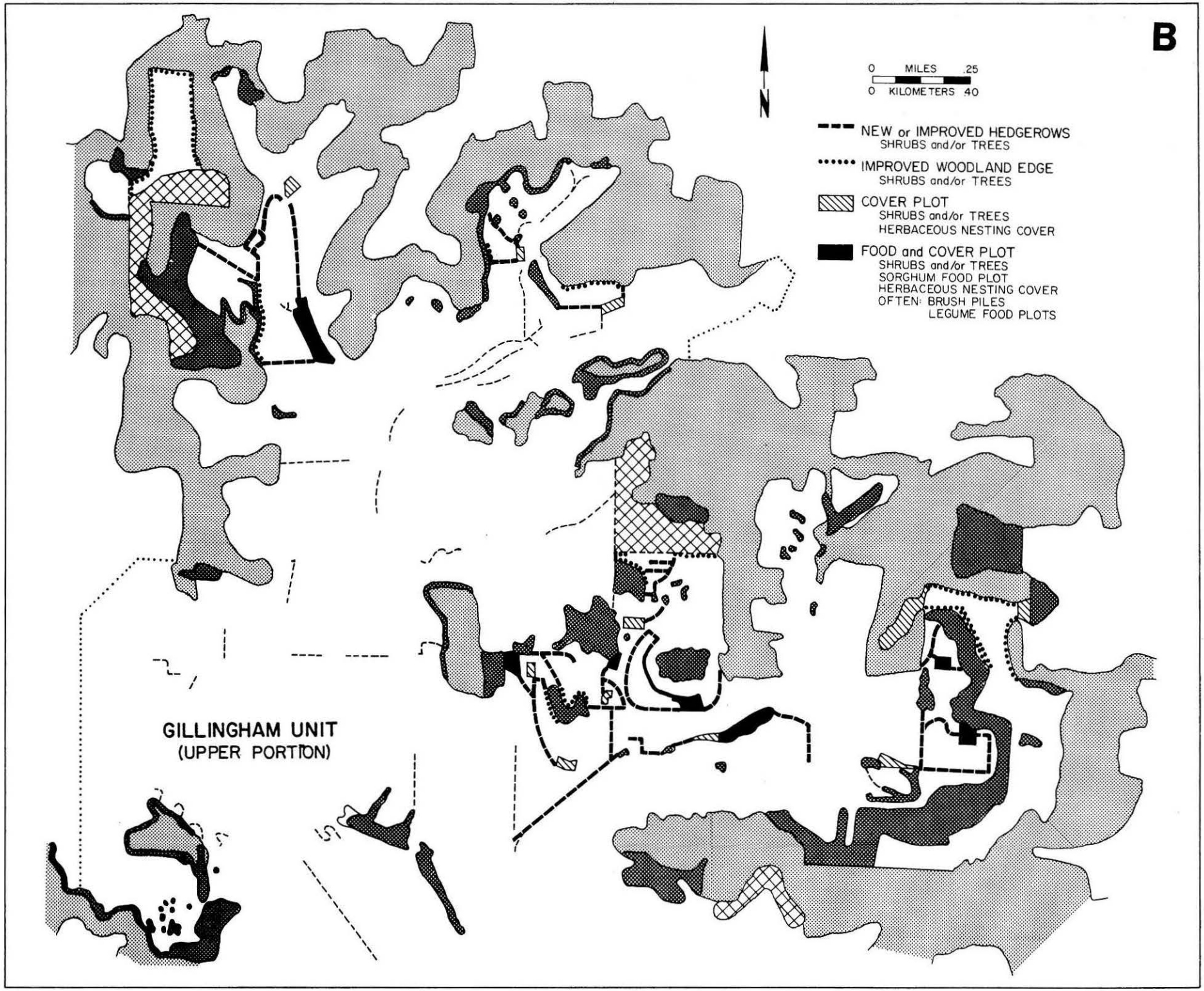
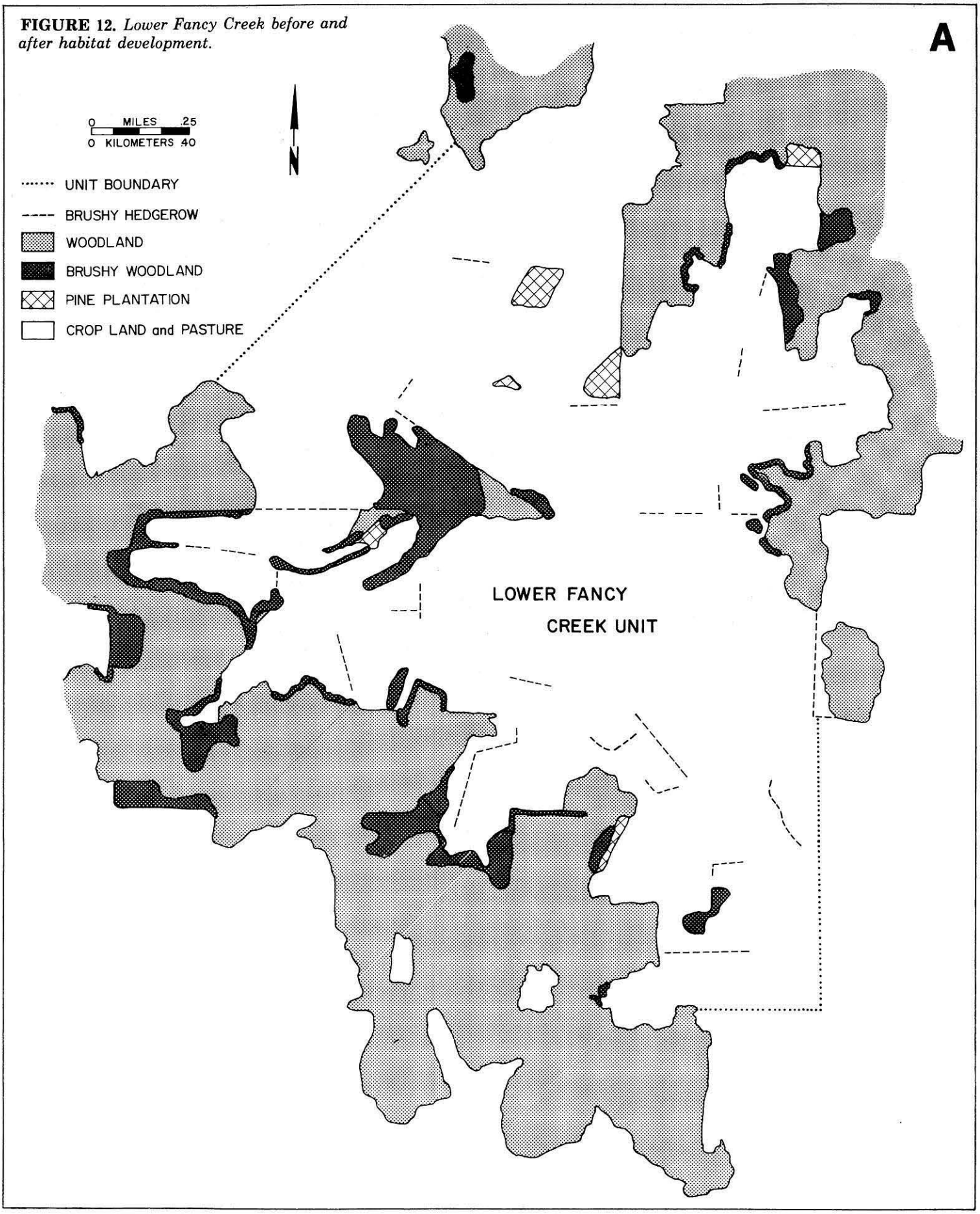
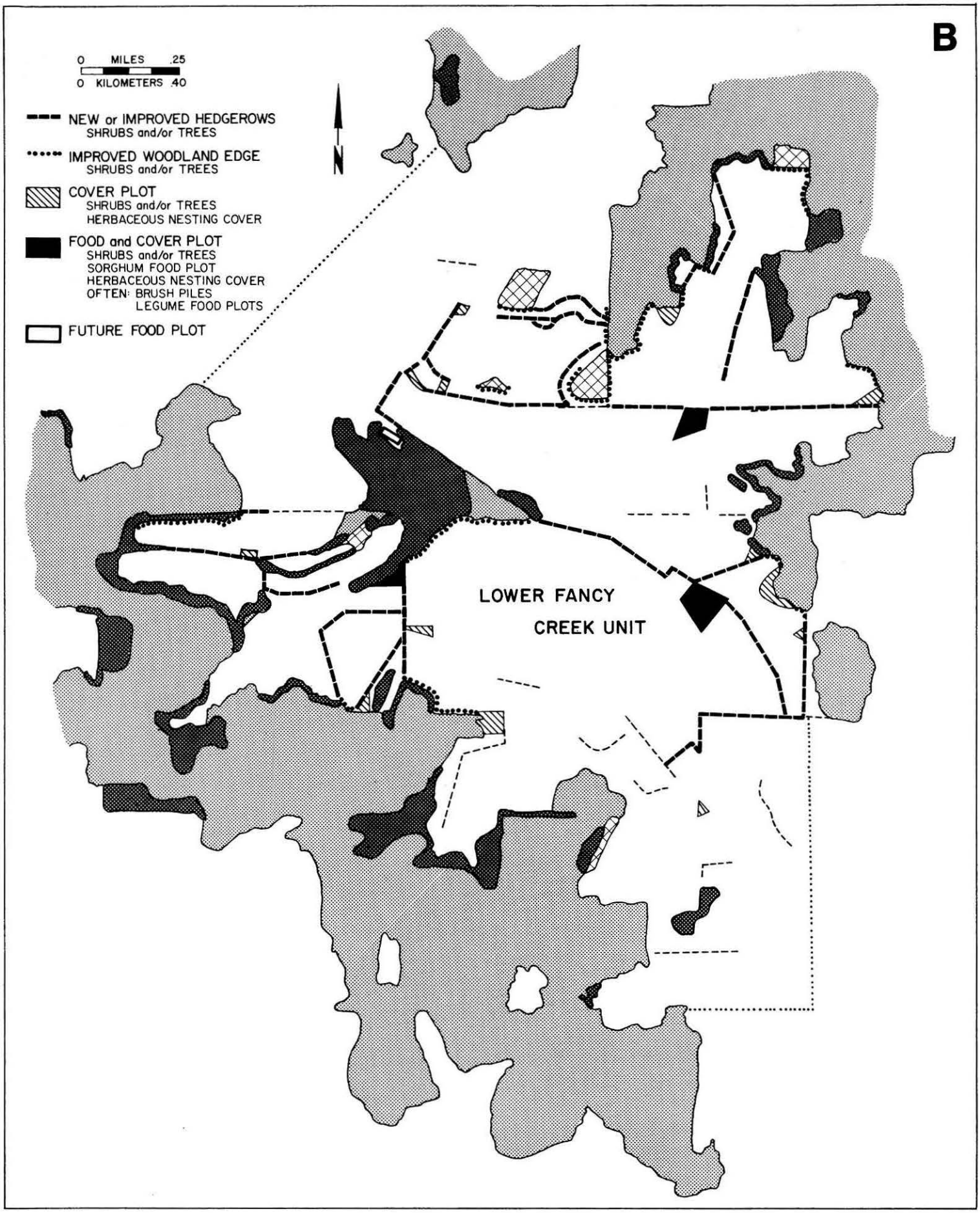

B
0 MILES .25
0 KILOMETERS .40
NEW or IMPROVED HEDGEROWS
SHRUBS and/or TREES
IMPROVED WOODLAND EDGE
SHRUBS and/or TREES
COVER PLOT
SHRUBS and/or TREES
HERBACEOUS NESTING COVER
FOOD and COVER PLOT
SHRUBS and/or TREES
SORGHUM FOOD PLOT
HERBACEOUS NESTING COVER
OFTEN: BRUSH PILES
LEGUME FOOD PLOTS
GILLINGHAM UNIT
(UPPER PORTION)

FIGURE 12. *Lower Fancy Creek before and after habitat development.*




B
0 MILES .25
0 KILOMETERS .40
NEW or IMPROVED HEDGEROWS
SHRUBS and/or TREES
IMPROVED WOODLAND EDGE
SHRUBS and/or TREES
COVER PLOT
SHRUBS and/or TREES
HERBACEOUS NESTING COVER
FOOD and COVER PLOT
SHRUBS and/or TREES
SORGHUM FOOD PLOT
HERBACEOUS NESTING COVER
OFTEN: BRUSH PILES
LEGUME FOOD PLOTS
FUTURE FOOD PLOT
N
LOWER FANCY
CREEK UNIT

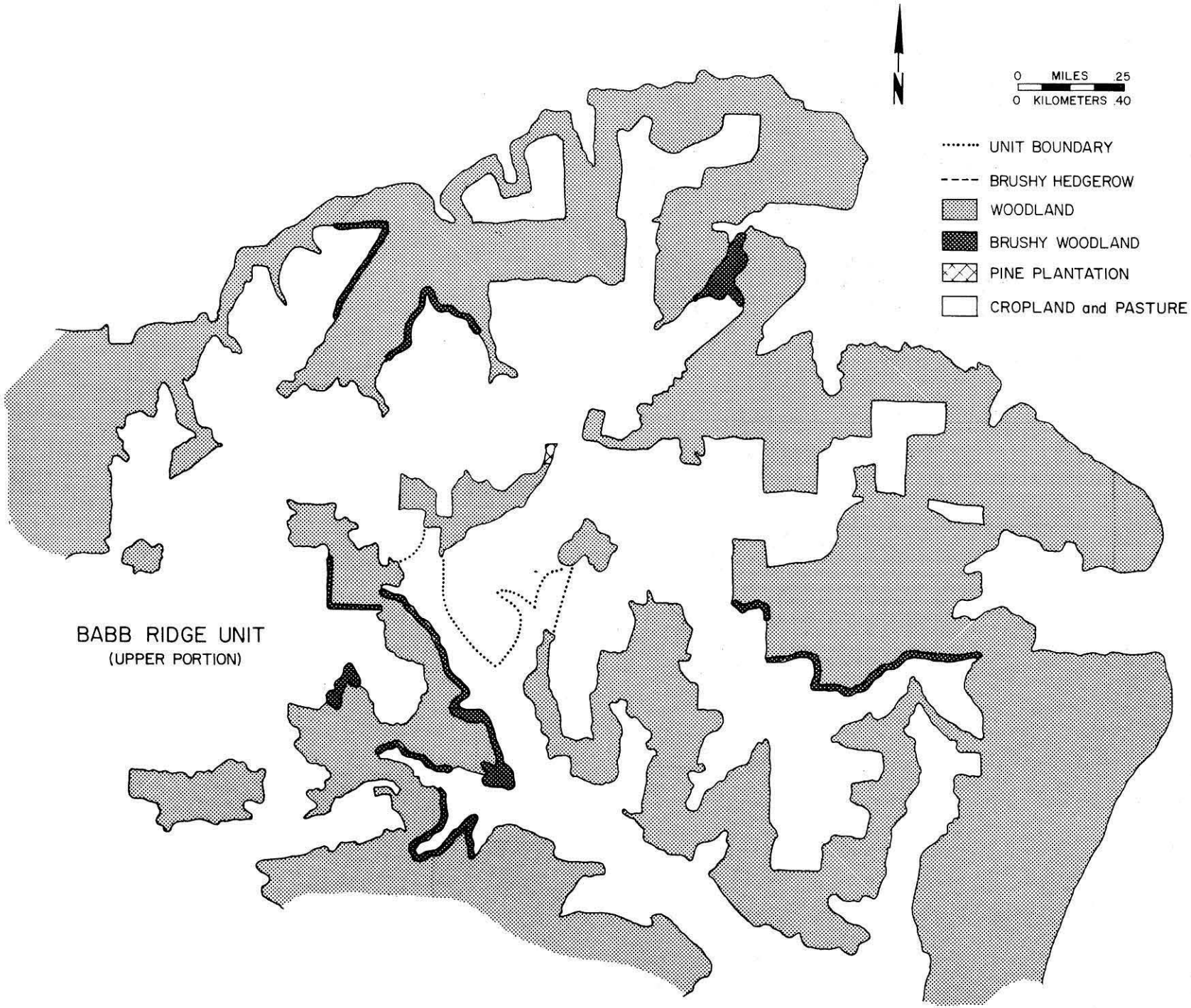
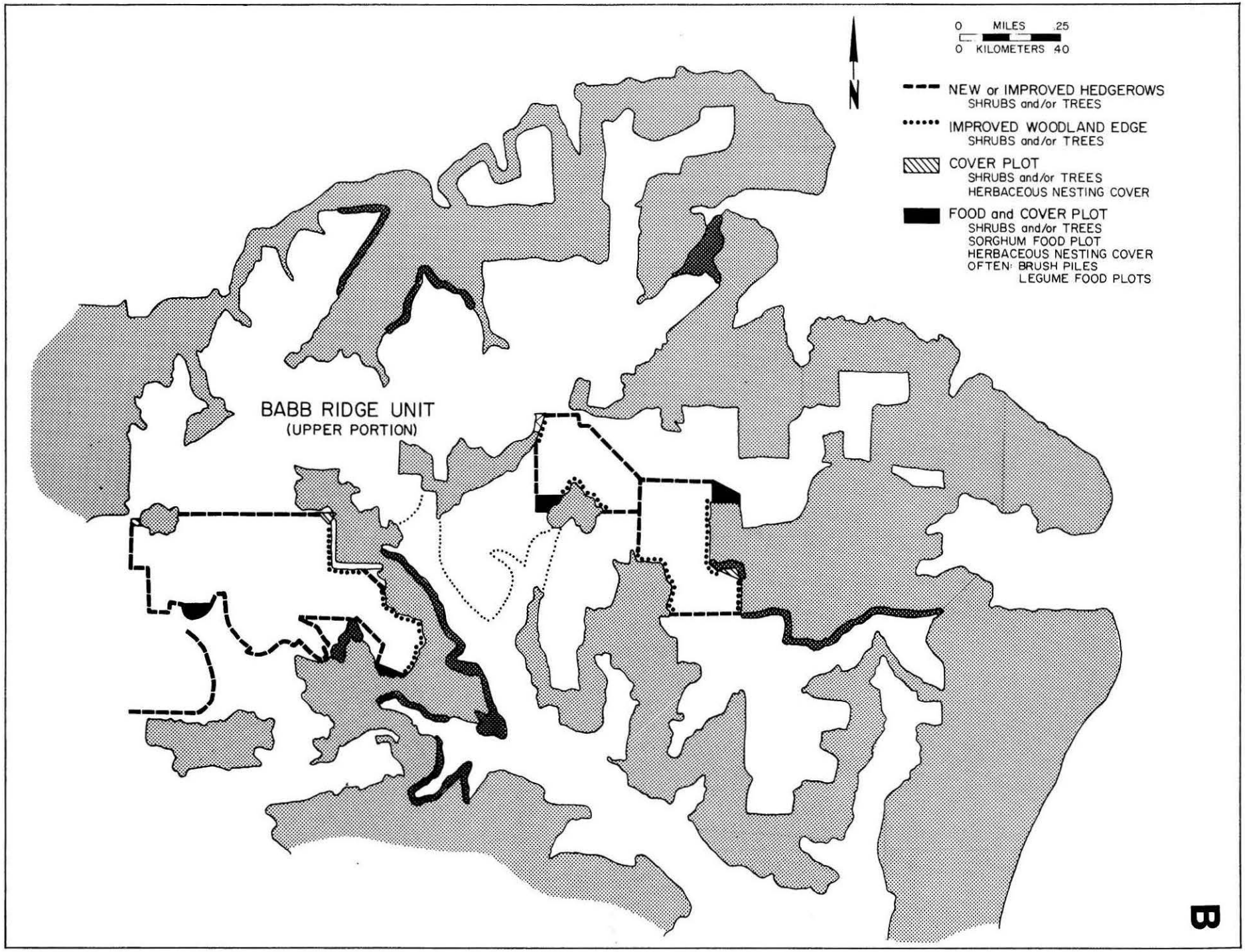


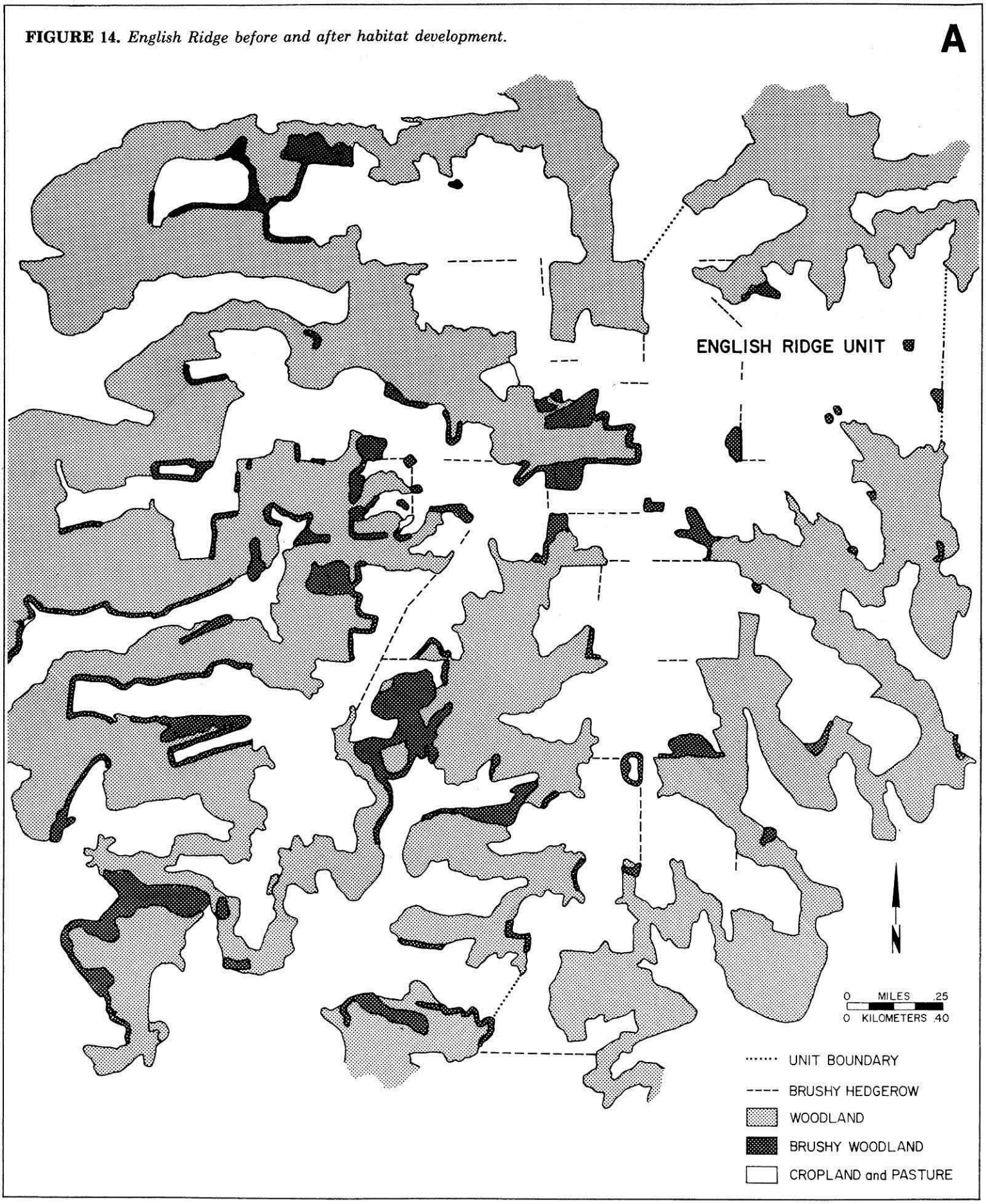
FIGURE 13. *Babb Ridge before and after habitat development.*

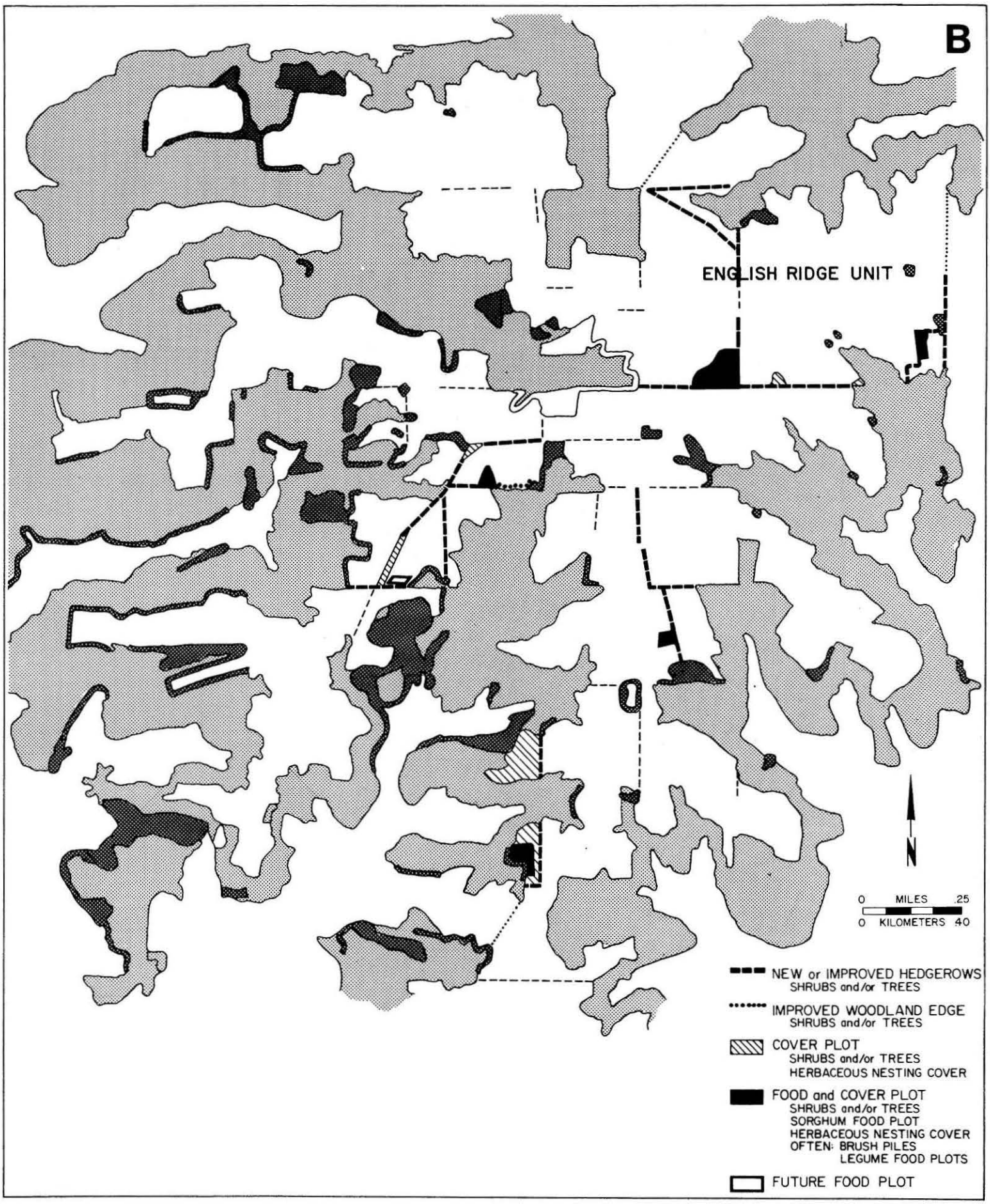
A


0 MILES .25
0 KILOMETERS .40
N
NEW or IMPROVED HEDGEROWS
SHRUBS and/or TREES
IMPROVED WOODLAND EDGE
SHRUBS and/or TREES
COVER PLOT
SHRUBS and/or TREES
HERBACEOUS NESTING COVER
FOOD and COVER PLOT
SHRUBS and/or TREES
SORGHUM FOOD PLOT
HERBACEOUS NESTING COVER
OFTEN: BRUSH PILES
LEGUME FOOD PLOTS
BABB RIDGE UNIT
(UPPER PORTION)

B

FIGURE 14. *English Ridge before and after habitat development.*




B
ENGLISH RIDGE UNIT
N
0 MILES .25
0 KILOMETERS .40
NEW or IMPROVED HEDGEROWS
SHRUBS and/or TREES
IMPROVED WOODLAND EDGE
SHRUBS and/or TREES
COVER PLOT
SHRUBS and/or TREES
HERBACEOUS NESTING COVER
FOOD and COVER PLOT
SHRUBS and/or TREES
SORGHUM FOOD PLOT
HERBACEOUS NESTING COVER
OFTEN: BRUSH PILES
LEGUME FOOD PLOTS
FUTURE FOOD PLOT

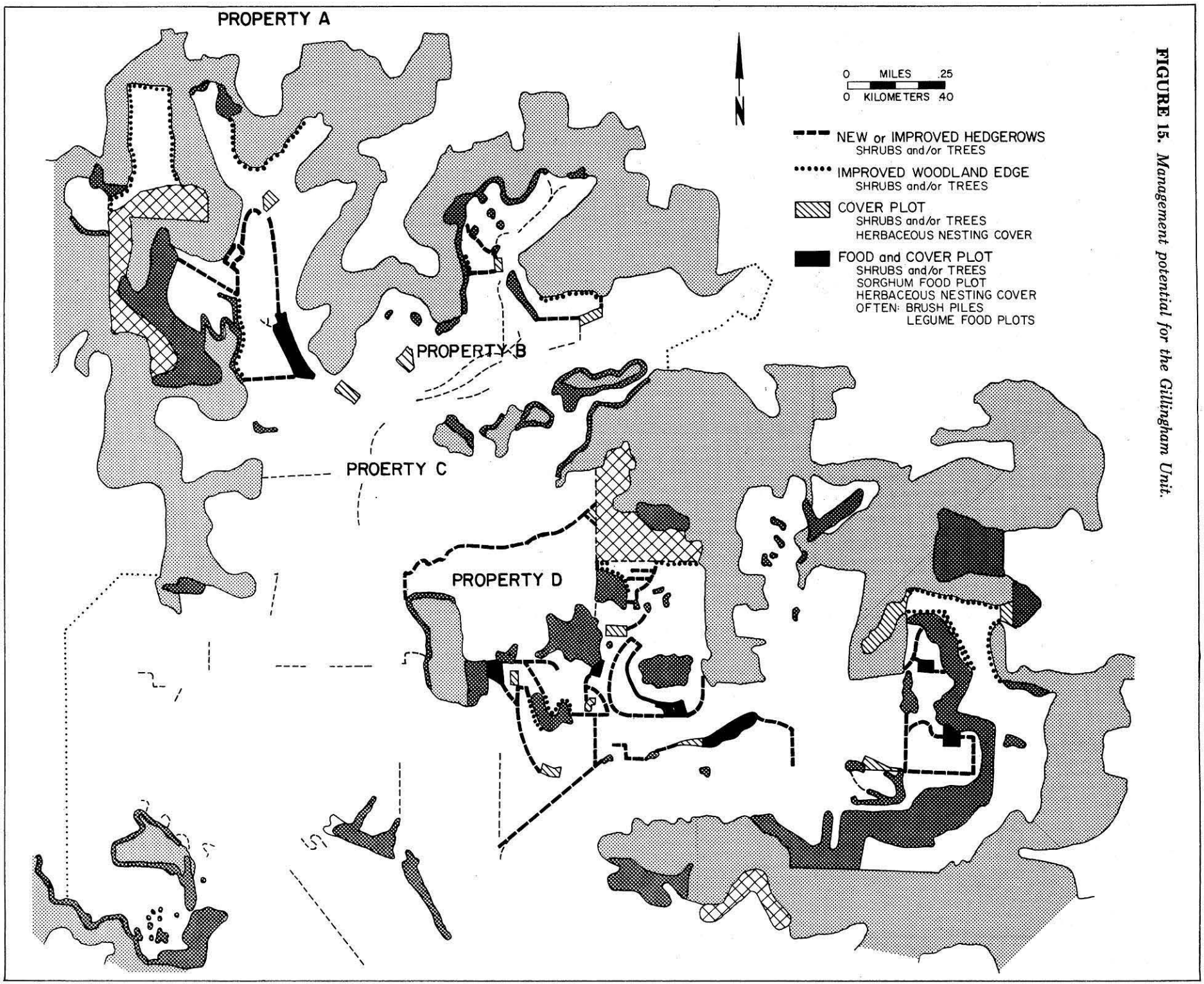


FIGURE 15. *Management potential for the Gillingham Unit.*

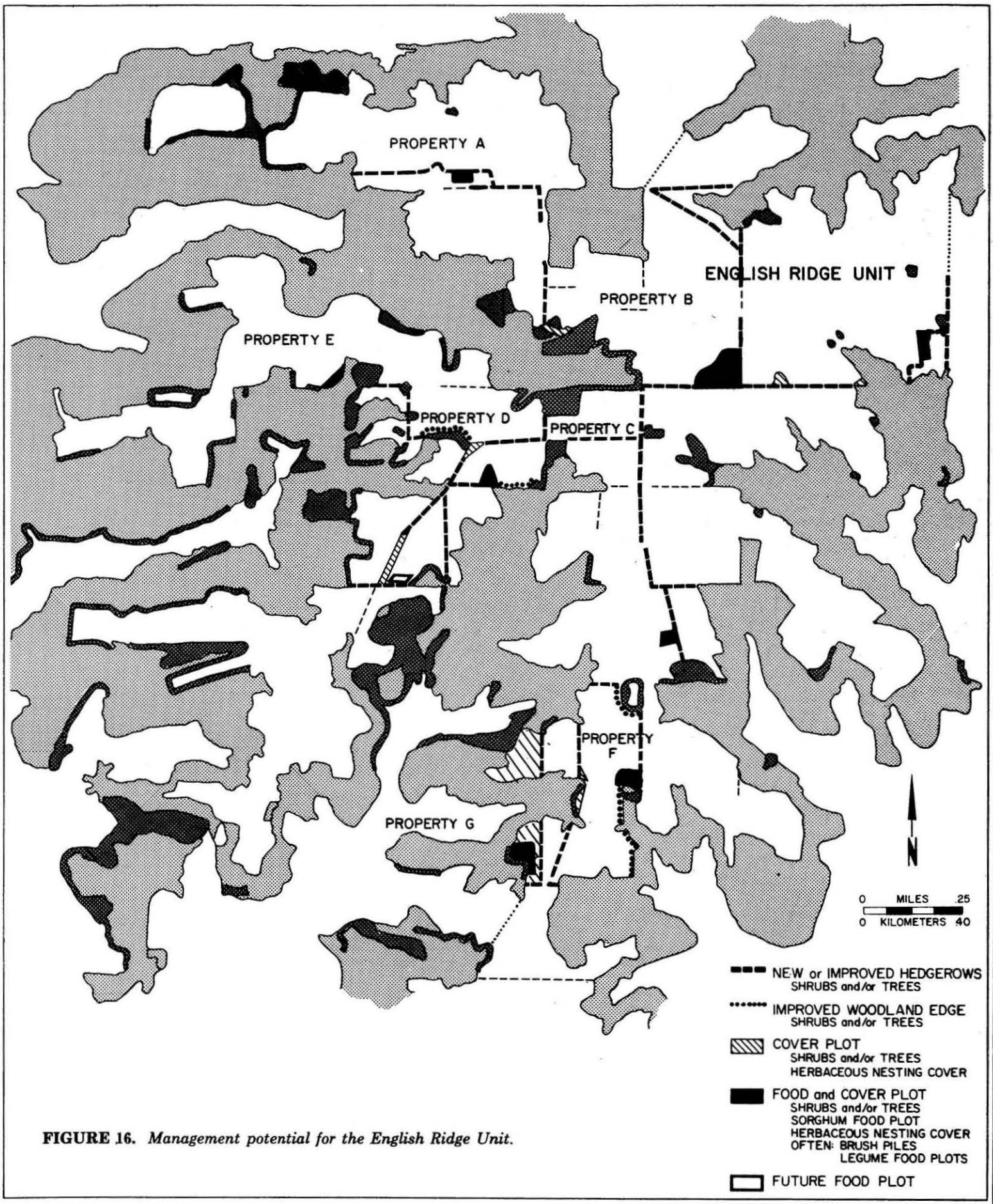


FIGURE 16. *Management potential for the English Ridge Unit.*

COSTS FOR HABITAT DEVELOPMENT

Installation of wildlife habitat developments on a typical property cost $1,610 (Table 20). About $176 was expended for labor, equipment, and materials to plan habitat improvements and negotiate an agreement with the landowner. Planting costs were $1,415, with cover developments costing about $1,330 and a food patch, $85.

The cost for smaller projects was about $250, while the larger projects cost over $5,000. These cost figures for habitat restoration do not include: (1) expenditures for contacts made with nonparticipants, (2) incidental field reconnaissance, (3) special plant materials testing, (4) general land use mapping, or (5) wildlife surveys. The cost figures provide a fair estimate of the investment on a typical property for the planning and implementation of habitat developments excluding chargebacks for other program costs.

Habitat improvment activities depended heavily on work experience programs (CETA, CAP, WIN) for field work and work study programs (Internships) for landowner contacts. DNR costs for habitat development were minimized by the use of low-cost labor, but the project provided a training opportunity for 45 nonstaff personnel. Work crews varied from 2-3 persons year-round to 10-15 individuals for 2-3 weeks in the summer. The crews also assisted with DNR forestry activities and SCS functions in Richland County.

Equipment for habitat improvement activities was most often provided by Wildlife Management, Dodgeville Area. Occasionally equipment was rented from implement dealers or management area farmers when DNR equipment was not available or was more expensive to operate.

STATUS OF HABITAT DEVELOPMENTS

An assessment of plant survival and the accidental or deliberate destruction of food and cover developments was made in summer 1980. Rank herbaceous vegetation concealed newly planted stock making a plant-by-plant appraisal for survival extremely time-consuming. Therefore, roughly 50% of the apparent skips in a shrub or conifer row were closely inspected to determine if the new stock was alive and vigorous under the herbaceous cover. Recommendations for chemical or mechanical treatment of competing vegetation and suggestions for replanting of shrubs and conifers were made. Arrangements for a cooperative implementation of these recommendations was negotiated with the landowners in 1981.

The 1980 assessment revealed a survival of shrubs and conifers of 69% and 61%, respectively, on segments not accidentally or deliberately destroyed. These estimates reflect the 1980 status of the plantings with the varying levels of replanting and the differing ages of plant materials.

Approximately 0.7 mile of hedge and 2 plots were completely destroyed. An additional 3.2 miles of linear cover and 1.1 miles of woodland edge were partially eliminated. Most of these plantings were destroyed by careless use of farm machinery or poorly attended cattle. Less than 20% of these losses of new plantings could be considered malicious.

TABLE 20. *Cost of installing wildlife habitat developments on a typical property.*

Activity	Costs ($) Labor[10]	Travel/ Equipment[11]	Materials[12]	Total	
Announcing program*	5.00		4.00	9.00	$176 Planning
Management unit planning**	10.00	20.00		30.00	
Initial solicitation of interest[1]	10.00	10.00		20.00	
Reconnaissance of property[2]	30.00			30.00	
Presentation of wildlife habitat plan[3]	35.00	10.00	2.00	47.00	
Negotiations and agreement signing[4]	20.00	10.00	10.00	40.00	
Pre-planting site preparation[5]	550.00	40.00		590.00	$1,415 Planting
Shrub and conifer allocation[6]	40.00			40.00	
Shrub and conifer planting[7]	310.00	90.00	300.00[13]	700.00	
Food patch planting[8]	40.00	15.00	30.00	85.00	
Post-planting evaluations[9]	10.00	10.00		20.00	
Total	1,060.00	205.00	346.00	1,610.00	

*Preparation and distribution of newsletters and form letters.

**Regional planning activities that must be concluded before individual habitat development plans can be drawn by property.

[1]The first personal contact made with the landowner to judge interest in: (1) incorporating wildlife habitat practices into farm management, (2) this particular program and its benefits. and (3) depth of involvement considering short- and long-range farm plans.

[2]On-site inspection of the property to augment aerial photo interpretation and to evaluate potentials for fitting the property into the regional plan.

[3]Preparing and presenting a preliminary wildlife habitat development plan to the landowner.

[4]Incorporating the landowner's ideas/modifications; often requires a walk over the property with the owner(s) and renter(s) to fully explain the proposed developments. This step must conclude with the landowner signing the agreement or, technically, the process should not continue. The landowner receives a packet of materials.

[5]Selective cutting and fencing as required plus site evaluation for special planting procedures.

[6]Site characteristics are evaluated and a blending of shrub and conifer species is made to match the site.

[7]Actual planting of stock by machine and hand.

[8]The activities surrounding establishment of a food plot.

[9]An evaluation of plant survival and replanting needs plus discussions with the landowner regarding protection and maintenance of the plantings.

[10]All labor $5.00/hour since salaries ranged from $2.20/hour (Interns, CETA, CAP, LTE) to $9.50/hour (Project Leaders). No administrative costs were included.

[11]Travel included mileage and lodging costs; equipment costs included tractor and truck charges.

[12]All items given to the landowner.

[13]Shrubs $45.00/1,000 stems at 3,250 stems/property, conifers $120.00/1,000 stems at 1,400 stems/property.

SUPPLEMENTAL WINTER FEEDING

A supply of 6,000 lb of meal was placed in storage at the Poynette Game Farm in November 1974. The meal included 5,500 lb of shelled corn and 500 lb of wheat. Approximately 100 lb of meal is required for each covey during a severe winter; therefore the reserve food supply would serve 60 coveys.

Weather during the 1975-76, 1979-80, and 1980-81 winters was relatively mild, hence supplemental feeding was not required. However, January 1977 was extremely cold, placing heavy energy demands on wildlife. On 29 January, emergency winter feeding was initiated on the Marshall and Buena Vista areas.

Three-hundred-eleven landowners were contacted and 81 coveys located; 55 required supplemental feeding. The meal was placed in 30-lb bags and distributed to cooperating landowners by 5 2-person DNR crews. Forty-seven landowners, 23 on the Marshall Area, and 24 on the Buena Vista, received 1,890 lb of meal, and 150 lb of feed was placed in food patches where the availability of sorghum seed was low. The feeding program cost $1,738 including expenditures for mileage ($219), labor ($1,265), feed ($102), and preparation ($152).

Winter feeding was a very positive program from the viewpoint of public relations. The landowners were pleased to participate in a wildlife project with potential immediate gains. Furthermore, the supplemental feed was distributed on a weekend, unintentionally bolstering the image of DNR employees. A weekend delivery was planned so more people would be at home with presumably more time to devote to this endeavor.

Only 60% of the cooperators were successful in locating their covey and in setting up a functional feeder. As a result, 23% of the quail coveys were fed. Kabat and Thompson (1963:99) stated that a feeding program must reach 25% of the coveys to reduce mortality from the severe range (70% loss) to the moderate range (50% loss). Although a goal of feeding 25% of the coveys was nearly attained, questions regarding the merit of this effort surfaced. Most of the coveys located by the landowners were associated with farmsteads or manure-spread fields and were probably not as much in need of supplemental food as the more remote coveys. Secondly, the feeding program was initiated relatively late in the winter and the coveys with inadequate food supplies may have already disappeared. Although many of the landowners were willing to assist with the feeding project, they lacked a full appreciation of the time required to search for coveys not observed since the previous fall and then to set up a functional feeder.

The breeding season count of whistling males in the summer of 1977 revealed a density comparable to summer 1976 for the Marshall Area (Table 22). Since the fall 1976 population on the Marshall Area was greater than the 1975 density, the quail population experienced poorer overwinter survival during 1976-77 than 1975-76, as expected. The regional whistling counts for 1977 revealed a comparable or slightly improved breeding density rel-

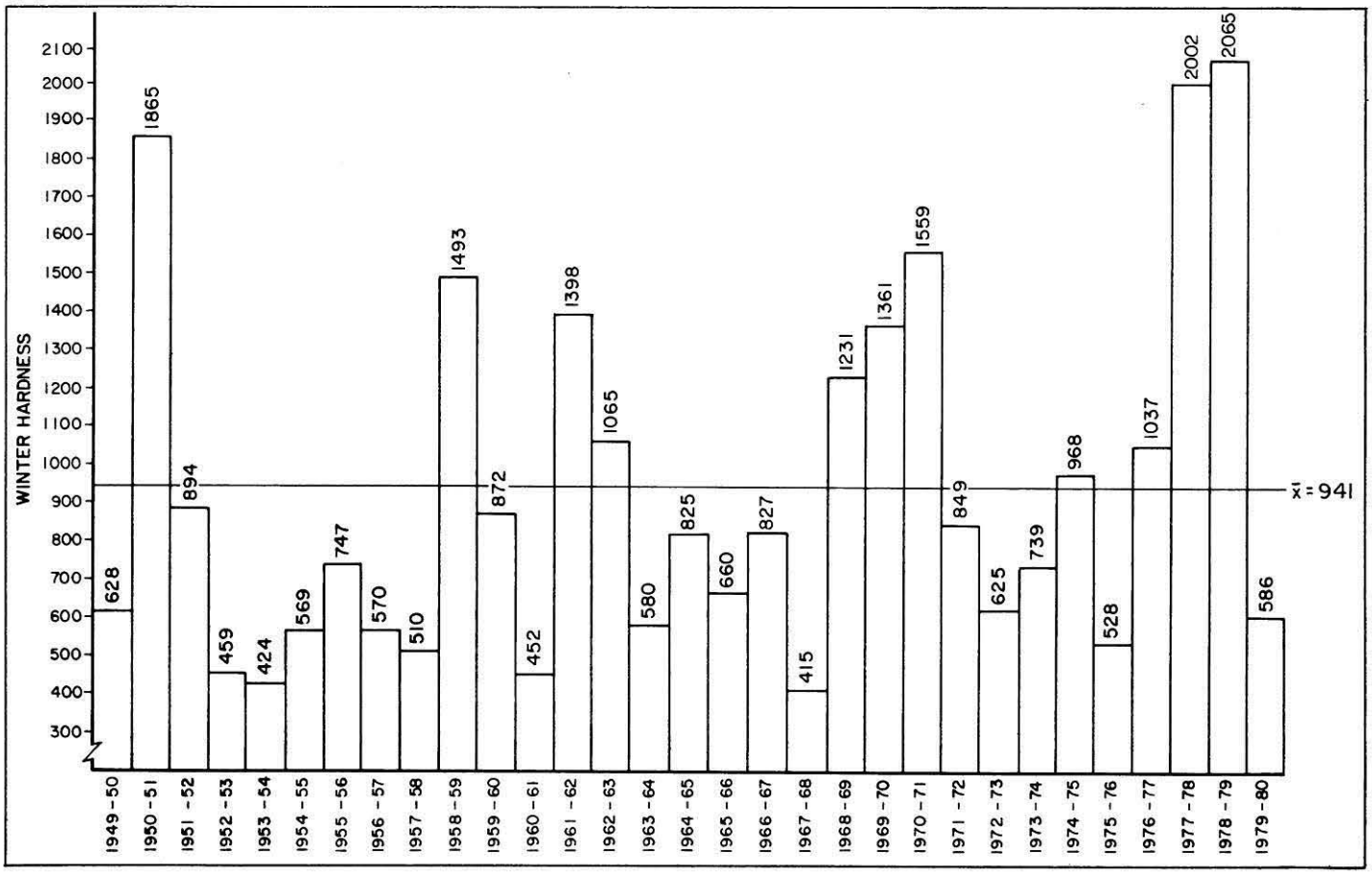


FIGURE 17. *Winter weather hardness (southwest Wisconsin stations: Darlington, Viroqua).*

ative to 1976, suggesting no differential mortality rates between the fed and unfed populations. Unfortunately, breeding season counts are unreliable indicators of localized increases in overwinter survival because the spring dispersal of birds masks these effects.

The supply of meal in storage at the Poynette Game Farm was not replenished following supplemental feeding in the winter 1976-77. Instead an arrangement was made to use pheasant feed as needed and to restore the supply prior to spring. Supplemental feeding was not employed during the 1977-78 winter despite adverse weather. The unusual pattern of snowfall and the irregular distribution of unpicked corn caused unpredictable movement of quail coveys, thus making location and feeding impractical.

Heavy snowfall and cold temperatures characterized the winter of 1978-79 which ranked the most severe on a winter hardness scale kept since 1950 (Fig. 17). A graduate research project to study the winter ecology of quail was underway on the Marshall Area. Considerable time was expended by investigator Robert Ramharter and a CETA crew searching for quail coveys as winter conditions became progressively worse. The situation was similar to the previous winter when the coveys could not be located. Since some of the missing coveys in the 1977-78 winter were eventually located in the spring, it became apparent that the habits of these birds made them very difficult to locate in midwinter when adverse conditions prevailed. Obviously, we cannot predict the adversity of winter weather in the fall and thereby monitor quail coveys continually into the winter period when they have to be fed. How does one institute an effective winter feeding program? One answer may lie in the habitat development program.

The complex of winter food-cover plots and connecting hedge is designed to make the movement of quail coveys more predictable. As the harvest of crops begins in the fall, the landscape becomes more barren of protective cover. The hedges should become prominent areas for quail roosting, loafing, and dispersal activities. As snow covers the crop residues, the coveys should gradually shift to the strategically located food patches. Presumably the food and cover requirements will be met at the winter plots in most years. Under extreme winter conditions when food patches become covered with snow or depleted in seed, the coveys using the sites can be conveniently located for supplemental feeding. If only 3/4 of the 78 food patches on the Marshall Area are established and 3/4 of these harbored a quail covey, about 1/3 of the management area population (120 coveys) would be served.

Snowfence shelters with cracked corn were placed in 17 food patches during the 1978-79 winter to augment dwindling food supplies. The feeders received regular use and 1 food patch served 27 quail. Evidence of predation was found near 3 of the winter food-cover plots; the impact of predation on quail and other wildlife concentrating at the feeding sites was unknown. Our assumption was that the superior food and cover relationships and the distribution of alternative protective sites on the landscape would offset the impact of increased predation at some sites. Theoretically, selective predator control could be practiced more effectively in a system where the movements and habitat use of prey species are somewhat predictable.

In some years, a substantial share of the corn crop remains unharvested (as in 1977-78 when a wet fall prevailed). Presumably some of these unpicked fields would adjoin developed hedge or a plot. The desirable food and cover arrangement brought about by these circumstances would provide a bonus for wintering wildlife. The habitat use patterns for quail and associated species would be less predictable, perhaps, but the risk of excessive mortality and the impact of predation would be less important also. The forthcoming evaluation phase will reveal how well quail conform to the hypotheses underlying the habitat development activities and the potential for tailoring a supplemental feeding program to quail movement within a habitat complex.

DOCUMENTATION OF WILDLIFE POPULATION RESPONSES

Surveys were initiated and programed through 1990 to monitor the impacts of management on bobwhite quail, cottontail rabbits, white-tailed deer, great horned owls, barred owls, red-tailed hawks, songbirds, and various mammalian predators including red and gray foxes. Predator populations are being monitored because changes in their abundance could cloud an evaluation of the impact of habitat improvements on quail. This report will briefly describe the survey procedure and present the baseline data.

BOBWHITE QUAIL

A quail whistling survey was begun in 1948 to measure trends in the breeding density of southwest Wisconsin populations. The number of quail heard whistling for 2 minutes at each of 20 stations, a mile apart along a prescribed transect, was tallied. In 1975, 28 transects were distributed in 23 counties in the Wisconsin quail range. By 1980, only 18 routes in 17 counties (Fig. 18) were surveyed due to budget cutbacks. Similar transects were established on the Marshall, Buena Vista, and Willow areas to obtain counts for comparison with the regional routes.

Triangulation counts of whistling males were used on the Marshall Area to augment the 20-station transects in estimating breeding density. Eight transects covering nearly all roads on the Marshall Area were traversed from opposing ends with 1/4 to 1/2-mile stops (sufficient to yield 100% coverage) between 5:00 and 7:00 a.m. (D.S.T.) on calm (< 7 mph wind) mornings. The transects were run 3 times between 1 June and 5 July. Six cross-country routes covering roadless areas were walked at least twice during the same period. A composite map showing the locations of whistling quail was prepared for each season. The triangulation count was labor intensive (102 worker-hours) but more sensitive to local changes in abundance than the 20-station count.

Counts from the 20-station route which traversed the Marshall Area showed poor agreement with the triangulation counts (Fig. 19); however, population trends from the triangulation counts agreed closely with those suggested by the rangewide survey

ative to 1976, suggesting no differential mortality rates between the fed and unfed populations. Unfortunately, breeding season counts are unreliable indicators of localized increases in overwinter survival because the spring dispersal of birds masks these effects.

The supply of meal in storage at the Poynette Game Farm was not replenished following supplemental feeding in the winter 1976-77. Instead an arrangement was made to use pheasant feed as needed and to restore the supply prior to spring. Supplemental feeding was not employed during the 1977-78 winter despite adverse weather. The unusual pattern of snowfall and the irregular distribution of unpicked corn caused unpredictable movement of quail coveys, thus making location and feeding impractical.

Heavy snowfall and cold temperatures characterized the winter of 1978-79 which ranked the most severe on a winter hardness scale kept since 1950 (Fig. 17). A graduate research project to study the winter ecology of quail was underway on the Marshall Area. Considerable time was expended by investigator Robert Ramharter and a CETA crew searching for quail coveys as winter conditions became progressively worse. The situation was similar to the previous winter when the coveys could not be located. Since some of the missing coveys in the 1977-78 winter were eventually located in the spring, it became apparent that the habits of these birds made them very difficult to locate in midwinter when adverse conditions prevailed. Obviously, we cannot predict the adversity of winter weather in the fall and thereby monitor quail coveys continually into the winter period when they have to be fed. How does one institute an effective winter feeding program? One answer may lie in the habitat development program.

The complex of winter food-cover plots and connecting hedge is designed to make the movement of quail coveys more predictable. As the harvest of crops begins in the fall, the landscape becomes more barren of protective cover. The hedges should become prominent areas for quail roosting, loafing, and dispersal activities. As snow covers the crop residues, the coveys should gradually shift to the strategically located food patches. Presumably the food and cover requirements will be met at the winter plots in most years. Under extreme winter conditions when food patches become covered with snow or depleted in seed, the coveys using the sites can be conveniently located for supplemental feeding. If only 3/4 of the 78 food patches on the Marshall Area are established and 3/4 of these harbored a quail covey, about 1/3 of the management area population (120 coveys) would be served.

Snowfence shelters with cracked corn were placed in 17 food patches during the 1978-79 winter to augment dwindling food supplies. The feeders received regular use and 1 food patch served 27 quail. Evidence of predation was found near 3 of the winter food-cover plots; the impact of predation on quail and other wildlife concentrating at the feeding sites was unknown. Our assumption was that the superior food and cover relationships and the distribution of alternative protective sites on the landscape would offset the impact of increased predation at some sites. Theoretically, selective predator control could be practiced more effectively in a system where the movements and habitat use of prey species are somewhat predictable.

In some years, a substantial share of the corn crop remains unharvested (as in 1977-78 when a wet fall prevailed). Presumably some of these unpicked fields would adjoin developed hedge or a plot. The desirable food and cover arrangement brought about by these circumstances would provide a bonus for wintering wildlife. The habitat use patterns for quail and associated species would be less predictable, perhaps, but the risk of excessive mortality and the impact of predation would be less important also. The forthcoming evaluation phase will reveal how well quail conform to the hypotheses underlying the habitat development activities and the potential for tailoring a supplemental feeding program to quail movement within a habitat complex.

DOCUMENTATION OF WILDLIFE POPULATION RESPONSES

Surveys were initiated and programed through 1990 to monitor the impacts of management on bobwhite quail, cottontail rabbits, white-tailed deer, great horned owls, barred owls, red-tailed hawks, songbirds, and various mammalian predators including red and gray foxes. Predator populations are being monitored because changes in their abundance could cloud an evaluation of the impact of habitat improvements on quail. This report will briefly describe the survey procedure and present the baseline data.

BOBWHITE QUAIL

A quail whistling survey was begun in 1948 to measure trends in the breeding density of southwest Wisconsin populations. The number of quail heard whistling for 2 minutes at each of 20 stations, a mile apart along a prescribed transect, was tallied. In 1975, 28 transects were distributed in 23 counties in the Wisconsin quail range. By 1980, only 18 routes in 17 counties (Fig. 18) were surveyed due to budget cutbacks. Similar transects were established on the Marshall, Buena Vista, and Willow areas to obtain counts for comparison with the regional routes.

Triangulation counts of whistling males were used on the Marshall Area to augment the 20-station transects in estimating breeding density. Eight transects covering nearly all roads on the Marshall Area were traversed from opposing ends with 1/4 to 1/2-mile stops (sufficient to yield 100% coverage) between 5:00 and 7:00 a.m. (D.S.T.) on calm (< 7 mph wind) mornings. The transects were run 3 times between 1 June and 5 July. Six cross-country routes covering roadless areas were walked at least twice during the same period. A composite map showing the locations of whistling quail was prepared for each season. The triangulation count was labor intensive (102 worker-hours) but more sensitive to local changes in abundance than the 20-station count.

Counts from the 20-station route which traversed the Marshall Area showed poor agreement with the triangulation counts (Fig. 19); however, population trends from the triangulation counts agreed closely with those suggested by the rangewide survey

(Fig. 20). The dramatic recovery of quail populations on the Marshall Area relative to rangewide populations between 1979 and 1980 may be the first indication of benefits from habitat improvement activities.

A questionnaire to landowners on the Marshall Area requesting quail observations was combined with sightings reported by other cooperators to estimate winter populations. The locations and sizes of coveys on the management area were recorded. The questionnaire data were collected by mail in 1975, by telephone in 1976, and by personal interview in 1977 and 1980. Budgetary constraints precluded questionnaire surveys in 1978 and 1979; in fact, only the Eastern and Western sectors were surveyed in 1980. The personal interview was labor intensive (63 worker-hours in 1980) but provided the most reliable and usable information.

A survey of quail hunting on the Marshall Area in 1975 revealed that about 5% of the fall population was harvested. Most of these birds were taken incidental to ruffed grouse hunting. Interest in quail hunting appeared to be increasing; hunters interviewed in the field and landowers responding to the questionnaire indicated an interest in hunting quail if they became more abundant.

Since future data collection will occur primarily in the Eastern and Western sectors, baseline information is provided for these areas (Table 21) as well as the entire Marshall Area (Table 22 and 23).

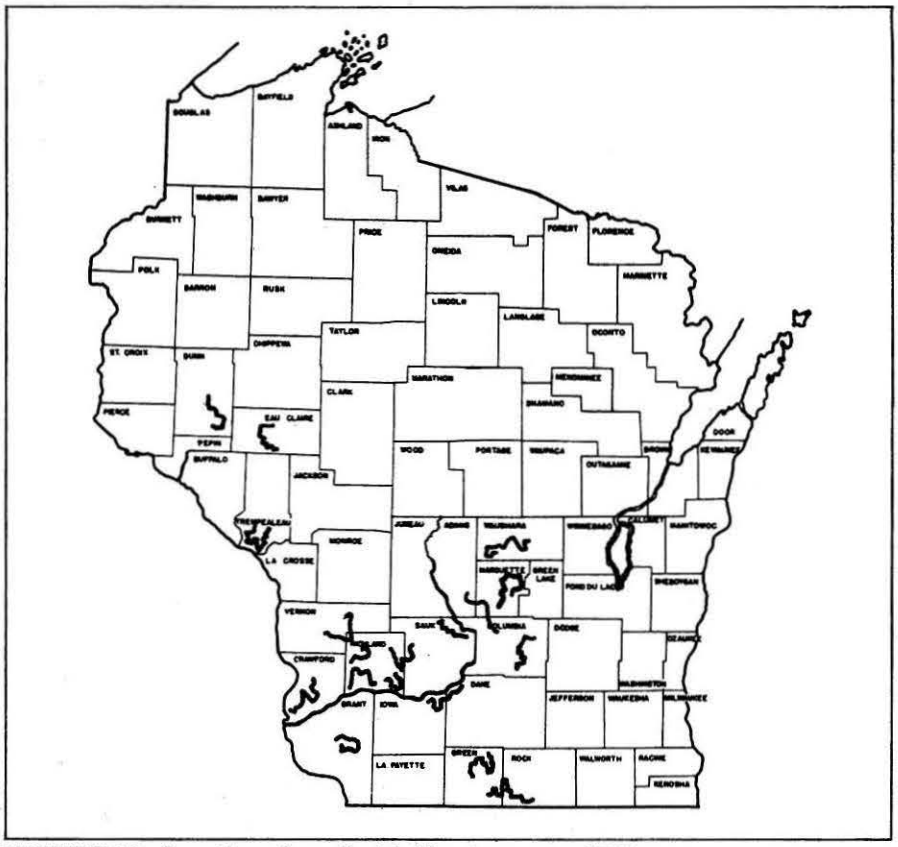


FIGURE 18. *Location of quail whistling transects, 1980.*

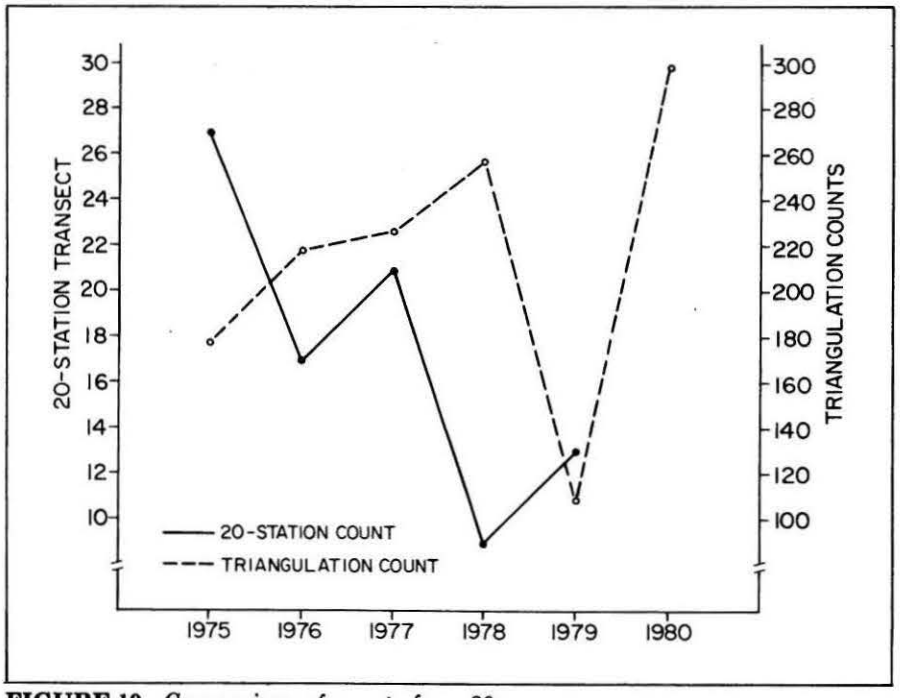


FIGURE 19. *Comparison of counts from 20-station transects and from triangulation.*

SONGBIRDS

The songbird survey has two primary objectives: (1) to determine the changes in species composition and abundance of passeriformes, piciformes, apodiformes, cuculiformes, columbiformes, galliformes, and falconiformes resulting from the conversion of primarily herbaceous hedge to mostly woody hedge, and (2) to identify the hedge structure (plant composition and width) and site (orientation and topography) that yield the maximum species diversity with a balance of preferred bird species. Changes in: (1) total number of birds, (2) total number of species, and (3) composition of bird species will be determined from comparisons of annual surveys run between 1977 and 1990.

Along 7 transects, totaling 9.7 miles (Fig. 21), a walking observer tallies birds sighted or heard during 2 breeding season counts (May, June) and 1 winter count (December, January). The transect corridor is 98 ft wide and centered on the newly planted hedge.

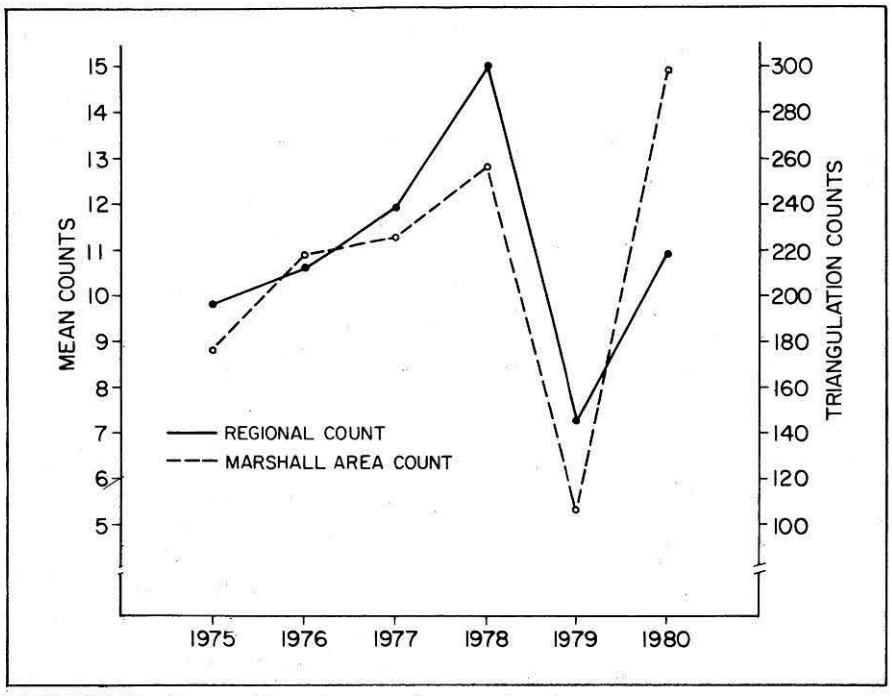


FIGURE 20. *Comparison of counts from regional surveys and from triangulation.*

FIGURE 21. *Location of songbird transects.*

TABLE 21. *Quail counts on the Eastern and Western sectors combined.*

Year	Triangulation Count Whistling Quail	Covey Count Fall/Winter*
1975	98	37
1976	118	49
1977	127	58
1978	129	
1979	52	
1980	142	41

*No survey in fall 1978 and 1979.

The counts generate 1,000-2,000 individual observations/year. The observations are catalogued by transect segments.

A computer storage system was developed to assemble the songbird data for future analysis. Bird observation by segments will be grouped in various combinations to ascertain the hedge structures and sites that produce the best species diversity and balance of birds. Changes in species composition and abundance of birds resulting from the conversion of herbaceous hedge will be accomplished by comparing sets of data from early years with later years. Weather information and changes in the vegetational composition of restored hedgerows will be catalogued with corresponding bird observations to provide a basis for interpreting the findings.

Data from the first counts each summer, 1977-79, and the winter counts, 1977-78 and 1978-79, are provided in Table 24 as an indication of the baseline information being collected. The most prominent species in the breeding season survey were the red-winged blackbird, song sparrow, field sparrow, bobolink, and eastern meadowlark. The bobwhite quail was among the more common species reported in the 1977 summer count and 1977-78 winter survey.

RAPTORS

A 70-mile transect covering portions of the 2 management areas and the control area was established to obtain an index to hawk and owl abundance (Fig. 22). The route was driven by 2 observers on 3 days during the period of snow cover; hawks observed within 1/4 mile of the road were tallied. The same route was driven during the nocturnal hours (usually 8:30 p.m. to 2:30 a.m.) in January to survey great horned owls and in March to census barred owls. A recorded owl call was played in the following sequence: listen 30 sec, play call 15 sec, listen 30 sec, play call 10 sec, listen 30 sec. The total number of owls heard during the prescribed time period was tallied for the entire transect.

The results for the 3 areas were pooled for this presentation of baseline data for the hawk count. An average of 17.0 red-tailed hawks and 2.3 rough-legged hawks were observed/year during the initial 7 years of this survey (Table 25). Red-tailed hawks were observed at a mean rate of 0.25 individuals/mile during the period on all areas combined, on the Buena Vista and Willow areas combined, and on the Marshall Area. Counts of horned owls were also combined for the 3 areas and

TABLE 22. *Counts of whistling quail on 26 management units within the Marshall Area.*

Management Unit	Composite Count of Whistling Quail					
	1975	1976	1977	1978	1979	1980
Spring Hill	11	10	3	12	8	19
Clearfield	3	6	5	3	2	7
Woodstock	1	0	0	0	0	0
Syresville	15	27	26	14	4	8
Sugar Bush	7	9	9	12	8	7
Gillingham	34	33	37	40	14	43
L. Fancy Creek	4	12	20	22	9	27
Babb Ridge	7	5	6	8	1	6
English Ridge	8	14	14	13	6	21
Sabin	8	2	7	5	0	4
Asparagus	6	1	3	2	1	6
Ash Ridge	12	23	27	35	21	47
Nigl	5	10	9	2	1	5
English Ridge Cem.	12	15	8	16	17	23
U. Fancy Creek	17	10	10	19	4	17
Ball Park	7	17	16	17	1	12
Mill Creek	3	5	3	1	1	14
Bethel	8	12	9	13	8	14
W. Mill Creek	0	0	1	0	0	1
E. Mill Creek	1	1	1	2	0	2
U. Horse Creek	0	2	0	4	1	6
Miller Creek	4	6	10	10	2	6
Middle Ridge	0	0	0	0	0	0
Meridian	0	0	0	0	0	0
Tabor	3	0	3	3	0	2
L. Horse Creek	0	0	0	1	0	0
Total	176	219	225	256	109	297

TABLE 23. *Counts of quail coveys on 26 management units within the Marshall Area.*

Management Unit	Counts of Quail Coveys Fall-winter*			
	1975-76	1976-77	1977-78	1980-81**
Spring Hill	2	3	3	4
Clearfield	1	1	2	0
Woodstock	0	1	0	2
Syresville	8	11	8	5
Sugar Bush	3	8	6	5
Gillingham	13	13	22	8
L. Fancy Creek	4	0	8	6
Babb Ridge	0	0	0	0
English Ridge	2	8	8	5
Sabin	4	4	1	6
Asparagus	0	2	3	
Ash Ridge	6	5	20	
Nigl	2	3	2	
English Ridge Cem.	1	1	7	
U. Fancy Creek	4	4	8	
Ball Park	2	7	14	
Mill Creek	3	3	2	
Bethel	4	4	5	
W. Mill Creek	1	2	0	
E. Mill Creek	0	1	1	
U. Horse Creek	1	1	2	
Miller Creek	4	7	2	
Middle Ridge	2	0	1	
Meridian	0	0	0	
Tabor	1	0	2	
L. Horse Creek	0	0	1	
Total	68	89	128	

*Counts obtained from landowners' questionnaires and field searches during the period 1 September to 1 March.
**Only the Eastern and Western Sectors were surveyed in 1980-81.

TABLE 24. *Counts of songbirds heard or sighted along 7 transects (total 9.7 miles) following new or improved hedgerows on the Marshall Area.*

Parameter	Summer*			Winter	
	1977	1978	1979	1977-78	1978-79
No. species obs.	40	52	52	17	18
Total obs.	466	714	576	152	77
Diversity index**	2.30	2.86	3.05	2.28	2.57
Prominent species[1] (obs.)	RW Black (226)	RW Black (268)	RW Black (194)	Snow Bunt (50)	Cardinal (11)
	Fld Spar (39)	Bobolink (29)	Song Spar (33)	N Junco (35)	Dn Wdpkr (9)
	Song Spar (29)	E Mead (29)	Catbird (25)	Bobwhite (9)	Chickadee (8)
	Bobolink (14)	Fld Spar (28)	E Mead (23)	Tr Spar (8)	Tr Spar (8)
	Bobwhite (12)	Bh Cowbd (24)	Goldfinch (21)	Goldfinch (8)	Rb Wdpkr (8)
	Br Thrash (12)	Song Spar (24)	Blue Jay (18)	Dn Wdpkr (7)	Blue Jay (6)
	Grackle (12)	Catbird (23)	Robin (17)	Chickadee (5)	Hr Wdpkr (5)
	Goldfinch (11)	Robin (22)	Grackle (15)	R Grouse (5)	Crow (5)
	Catbird (11)	N Oriole (19)	Bobolink (14)	Blue Jay (4)	N Junco (4)
	Tr Spar (10)	Goldfinch (19)	Bh Cowbd (14)	Cardinal (4)	Hse Spar (3)

*Data from first count (of 2) in 1978 and 1979 and only count in 1977.
**Shannon-Weaver diversity index.
[1]Abbreviation of species name developed for computer tabulation.

TABLE 25. *Counts of hawks observed along a 70-mile route traversing the Marshall, Buena Vista, and Willow areas.*

Winter Period	Mean No. Hawks Observed on 3 Counts*					Survey Dates
	Redtail	Roughleg	Unk. Buteo	Kestrel	Accipiter	
1974-75	25.7	7.3	4.0	4.7	0.3	14 Jan, 4 Mar, 8 Apr
1975-76	12.0	2.7	3.0	3.3	0	23 Jan, 13 Feb, 11 Mar
1976-77	13.7	1.3	3.3	1.0	0.3	7 Jan, 2 Feb, 18 Feb
1977-78	21.3	3.0	2.3	0.3	0	31 Jan, 17 Feb, 20 Feb
1978-79	16.0	1.3	1.0	2.3	0.3	11 Jan, 19 Feb, 14 Mar
1979-80	22.0	0	1.0	1.0	0	29 Jan, 11 Mar
1980-81	8.7	0.3	0.7	1.3	0	13 Jan, 19 Feb
Avg.	17.0	2.3	2.2	2.0	0.1	

* Only 2 surveys conducted in 1979-80 and 1980-81.

Table 26 presents the composite results for 2 surveys annually except for 1980. Preliminary findings suggest a declining horned owl population.

TABLE 26. *Counts of great horned owls heard along a 70-mile route traversing the Marshall, Buena Vista, and Willow areas.*

Year	Owls Heard*	Survey Dates
1977	32	9 Feb, 16 Feb
1978	37	16 Jan, 24 Jan, 8 Feb **
1979	24	8 Feb, 27 Feb[1]
1981	13	13 Jan, 18 Jan, 29 Jan**

*Composite count from 2 surveys.
**Only 2 areas were surveyed per night, therefore 3 nights were required to complete 2 surveys per area.
[1]Count from 1 survey each of the Buena Vista and Willow areas and 2 surveys of the Marshall Area.

MAMMALS

Winter track-count surveys were initiated to measure trends in fox and cottontail rabbit abundance. Tracks of deer, squirrel, dog, cat, skunk, raccoon, weasel, and mink were also recorded. The transects were established in 8 randomly selected sections within each management area and in 6 sections of the control area (total of 22 routes, Fig. 23). The transects, which run diagonally between section corners, were walked when tracks on the snow blanket from the previous night's activity could be distinguised from older sign.

All routes were surveyed in 1974-75 and 1977-78, whereas only 6 transects were run in 1975-76 and 3 in 1976-77. No survey was conducted in 1978-79 because of budgetary constraints, and unsuitable tracking conditions precluded surveys in 1979-80 and 1980-81. Since future comparisons will examine trends in fox and rabbit abundance between the Marshall Area where habitat restoration was applied and the other 2 areas, baseline population data for these species are provided (Table 27). Preliminary results suggest comparable fox abundance between the Marshall Area and unmanaged habitat areas; however, rabbit numbers may be greater on the unmanaged areas during these early habitat development years.

TABLE 27. *A comparison of fox and cottontail rabbit counts on the Marshall Area vs. the Buena Vista and Willow areas combined.*

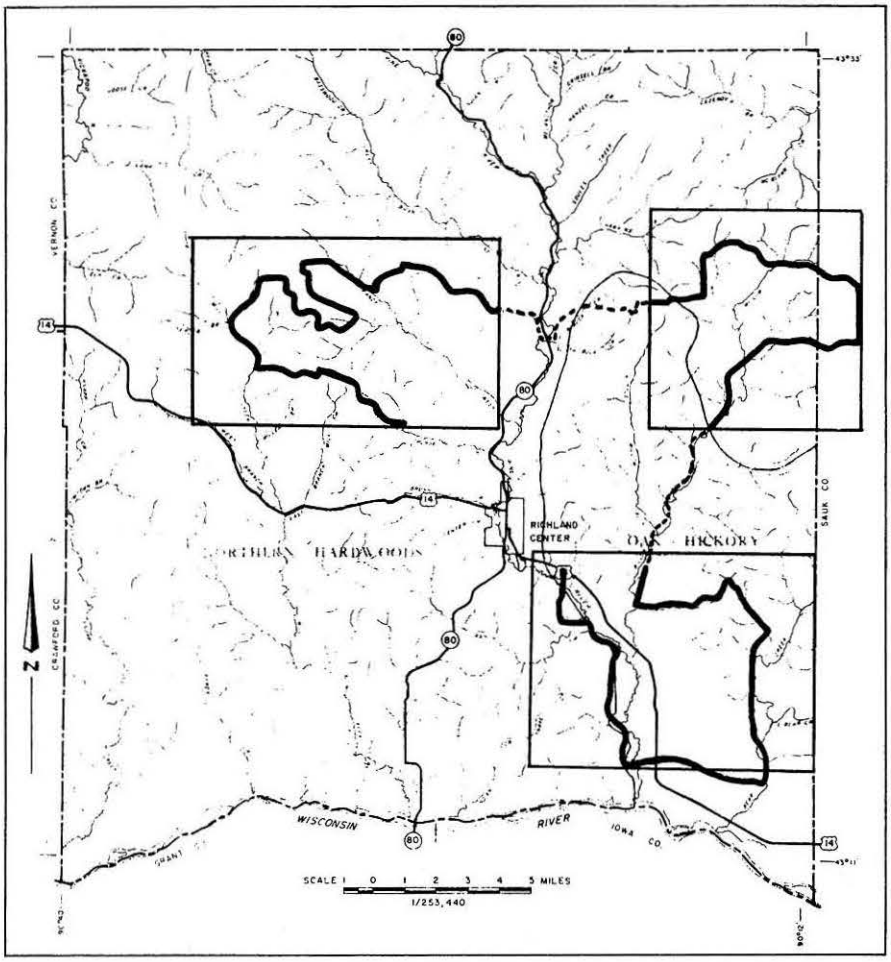
Winter Period	Mean No.Fox/Transect Mile		Mean No. Rabbits/Transect Mile	
	Marshall	Buena Vista/ Willow	Marshall	Buena Vista/ Willow
1974-75	1.1	0.9	2.3	7.9
1975-76	1.5		1.0	
1976-77	1.8		3.8	
1977-78	0.7	1.7	5.9	4.9
Mean	1.1	1.1	3.4	6.4

WILDLIFE USE OF FOOD PATCHES

Wildlife use of the food plots was documented irregularly because of variable snow conditions and time and travel limitations. Most plots were vis-

ited once in the fall to assess the vegetative characteristics of the plant materials and at least once in winter to evaluate these aspects plus wildlife use. These limited observations suggest increasing winter use of sorghum plots by quail and fox; use by rabbits, deer, and small birds was high in all years.

Quail use was documented at 14 of 43 sorghum plots established in 1980 and has been reported for 35 of 75 winter sites under development. In 1980, 2 food plots had 2 coveys using the site—1 plot had 40 birds, 20 in each covey, the other plot had 27 birds, 15 and 12 in each covey. Less than 1/4 of the food plots had fox use in the initial 2 years, whereas more than half the plots had fox sign in the latter 2 years. During the severe 1978-79 winter, 91% of the sorghum plots had evidence of fox use. Fox use was documented at all but 2 sorghum plots used by quail in 1980. Over 90% of the sorghum plots were used by small birds in all years; likewise, around 70% of these plots were frequented by cottontail rabbits. Deer visited 1/2 to 3/4 of the sorghum plots, but the intensity of their feeding varied considerably. Perhaps 1/4 of all plots frequented by deer were used to the extent where most of the seed was consumed by winter's end.



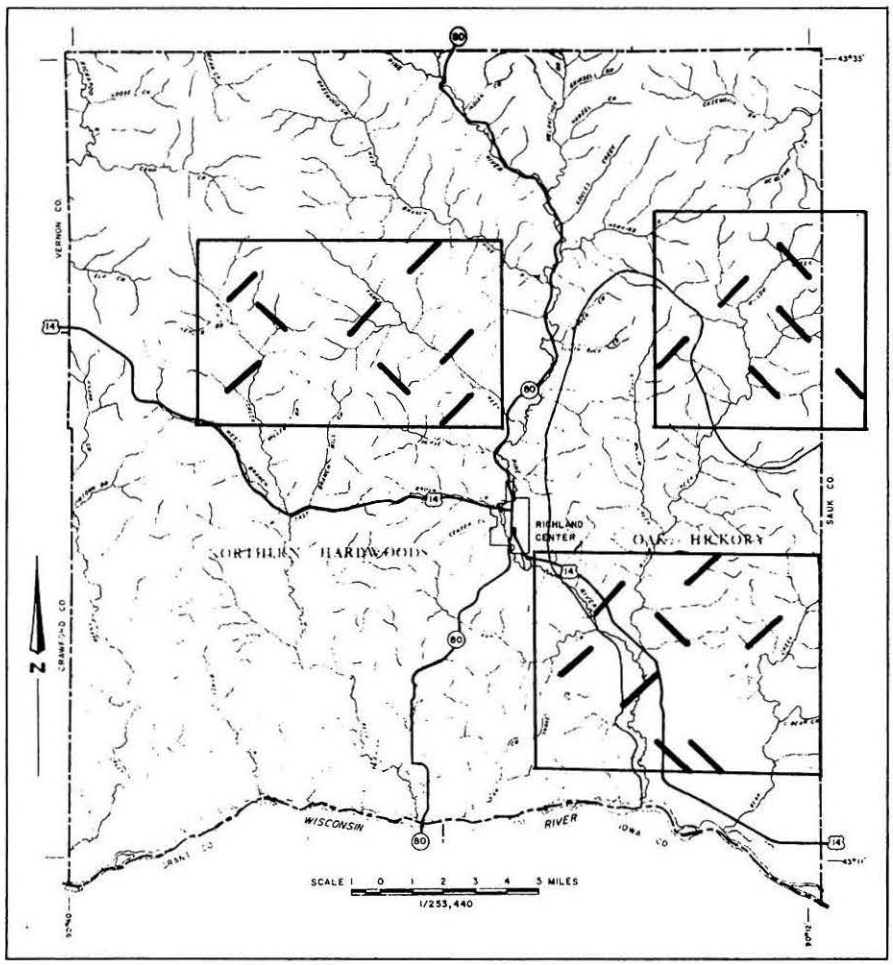


FIGURE 22. *A 70-mile transect for hawk and owl surveys. (above)*

FIGURE 23. *Twenty-two randomly selected winter track-count transects. (below)*

IMPLICATIONS AND RECOMMENDATIONS

Of the two objectives established for the quail management program—(1) double quail densities, and (2) develop incentive programs—only the latter objective can be critically evaluated at this writing. At the onset of this project Richland County resource managers suggested that 50% participation by solicited landowners would be an optimistic goal. Our success in gaining 85% cooperation among property owners contacted for habitat development reflected an adequate incentive program and an effective delivery system. The key elements in this program that contributed to its success were: (1) personal contact, (2) early support by community leaders, (3) flexibility, (4) interpersonal cooperation, (5) DNR administrative support, and (6) an acceptable agreement.

KEY ELEMENTS OF SUCCESS IN LANDOWNER INVOLVEMENT

Personal contact was likely the most important factor in attaining a high level of cooperation in habitat improvement activities. Three to four visits with the landowner were required on the typical property to introduce the project and to negotiate a satisfactory farm plan. Conversations were important for: (1) gaining an appreciation of the landowners' objectives for the property, (2) understanding the economic, cultural, and ecological constraints that impinged on our cooperative management of the land, (3) appraising the interrelationships in the community by identifying leaders, followers, and divergents, and (4) developing a relaxed communications relationship with the landowners. We had to first determine and then adjust to, personal wishes regarding private times (religious holidays, unusual work shifts), the use of chemicals, and the consumptive and nonconsumptive use of wildlife resources.

Too little time was available to share with some landowners who had so much to offer us intellectually and culturally. One of our early cooperators not only expended considerable personal funds in a joint effort to improve wildlife habitat on their property, but allowed our use of their barn for storage and rented a tractor to us substantially below commercial rates. Occasionally we used their tools, and too rarely, joined the couple for coffee to offer our thanks.

Most of the initial landowner contacts were made by summer interns. We gave them 1-2 weeks of program orientation and then the responsibility for making the initial landowner contact. Subsequent visits usually involved a project leader; the agreement signing often required a project leader to serve as the notary. Most landowners were aware of the program prior to visitation by the intern, since each received a newsletter and discussions of the program were frequent at local gathering places.

Although no formal assessment of the cooperating landowners' attitudes regarding resource problems and DNR action was undertaken, the attitude patterns described for Richland County residents by Karbon and Trent (1977) likely apply. In their study, the citizens ranked diminishing game habitat and hunting and fishing regulations collectively as the most important resource problem in Richland County. This issue ranked above such concerns as municipal and private sewage treatment, lake and stream pollution, farmland conversion, and recreational facilities. DNR staff serving Richland County viewed lake and stream pollution as the most pressing problem, with wildlife habitat and regulations of secondary concern. The county residents considered trespass, vandalism, and hunting and fishing violations collectively a serious issue, ranking it 7th among 19 resource management problems. DNR personnel ranked this issue 12th. Many (38%) Richland County citizens felt the DNR was doing a better job in recent years and that positive attitude, no doubt, contributed to the success of the quail project.

At least 5 of the 100 cooperators on habitat improvement activities, including 1 of our most prominent cooperators, had very strong opposition to other DNR programs. In fact, DNR action on other issues resulted in the loss of 4 properties and tense relationships with 6 landowners after habitat development was initiated. In the latter 6 cases, immediate personal contacts restored confidence in the DNR's quail project and clarified, somewhat, the other issues.

Early support by community leaders was another important factor in attaining a high level of cooperation in habitat improvement activities. Initially, the key cooperators were contacted without regard for their social status. We had limited knowledge of who the community leaders were and the potential they held for promoting our program. The presentations made to the county board and the local resource agents were favorably received, and we therefore anticipated their cooperation. We presumed that questions regarding the program that were referred to these individuals would be suitably answered.

Cooperators for habitat development activities were solicited based on the potential of their farms for enhancement of food and cover for quail and other wildlife. Later, it became apparent that conversations between neighbors at social functions or at community gathering places were important in spreading the news of a "good" DNR project. We had, in fact, developed a good rapport with individuals whose opinions were viewed favorably in the community. Rumors regarding DNR's motives, legal control, or whatever were dispelled by knowledgeable community leaders who defended the project. The answers for questions raised by the landowners were available *in* the community, i.e., from neighbors and community leaders. Combined with newsletters and periodic contacts with key individuals by the project staff, this communication system prevented anti-project feelings from developing.

The key word in the approach used to solicit cooperators for habitat improvement activities was flexibility. Except for the signed agreement required to initiate habitat development, each arrangement with a cooperator followed a unique channel. Negotiations allowed for flexibility including: (1) how much habitat improvement was feasible (some landowners wanted more plantings than we could justify), (2) who would plant the shrubs and conifers, (3) would chemicals or "organic" farming practices be employed, (4) who would purchase the fencing materials, (5) who would build the fence, (6) when would planting be undertaken (some landowners wanted to help, others wanted to oversee planting operations), and (7) what permission was required to enter property for planting or evaluations. Even the agreement was modified to satisfy individual concerns. Clarification of intent was requested by 7 cooperators so a qualifying statement was written on the agreement to the satisfaction of

both parties. Our assumption was that a program that emphasizes flexibility may require more time during the negotiation process, but the level of cooperation will be greater and more sustained.

Also important in the success of this habitat development project were the interpersonal cooperation among the project staff (including county resource personnel) and the support received from the DNR administration. The changing of personnel was a constant threat to the stability of the quail project, yet this obstacle did not significantly alter its ultimate success. Fifteen individuals including 5 wildlife managers, 4 interns, 3 foresters, 2 LTE's, and 1 researcher, served on the field staff (excludes LTE's and Work Experience personnel solely responsible for planting and brushing) for varying terms during the 6 years of habitat development. New personnel had to learn the management strategies, concepts and constraints, and the landowners to effectively participate in field activities. Gaining this knowledge required time—time that slowed progress in obtaining new cooperators for habitat development. However, new personnel brought new perspectives, a much valued commodity in a developing project.

DNR administrative support was evident at critical times during the life of this project. Within the constraints of our budgetary process, shifts in monies were made to accommodate needs generated by public interest in the project. These shifts reflected a dedication toward the quail project relative to other important endeavors, and a realization of the importance of habitat development on private lands.

Five key elements associated with the success of this project should be considered in future endeavors to improve wildlife habitat on private lands:

1. *Personal contacts* with landowners should be employed to solicit cooperation with habitat restoration activities. Five hours of visitation and property review should be budgeted per landowner to plan habitat improvements and to consummate a cooperative working agreement. Introductory letters and newsletters should be used to advise landowners regarding the project's objectives, personnel, and accomplishments.

2. Field staffs should remain cognizant of the *individual perceptions and needs* of landowners and the application of habitat improvement practices should remain *flexible* to accommodate these differences.

3. A project leader should be assigned to supervise field activities as a sole responsibility, and landowner contacts should be shared with technicians, interns, and LTE's. An *interdisciplinary* staff (wildlife manager, fish manager, forester, warden, and researcher as appropriate) should be assembled to review plans and cooperatively engage in field activities.

4. *Key community leaders* and *county resource managers* should be involved in the planning and implementation of habitat development projects.

5. A *simple agreement* should be developed that protects the DNR's investment of public monies, yet provides flexibility in resource management for the landowners.

RECOMMENDATIONS FOR HABITAT DEVELOPMENT

Future projects to develop hedge cover should consider the following planting guidelines:

- Use mixed plantings of conifers and shrubs for hedge developments and match plant tolerances with site characteristics (Table 28).
- Preferred conifer and shrub species for hedge developments include:

White cedar	Hazel
White pine	Highbush cranberry
White spruce	Nannyberry
Autumn olive	Ninebark
Bittersweet	Red-osier dogwood
Gray dogwood	

(Autumn olive is an exotic.)

- Plant 1-0 shrubs, 2-4 stems/hole with 3-5 ft between holes; plant conifer transplants 1 stem/hole with 6-8 ft separation. Space shrub rows 6 ft apart and conifer rows 8 ft apart. This dense stocking of plant materials will provide a contiguous ground-level cover in 8-12 years. The conifers will require selective thinning at 10-15 years.
- A 3-row hedge composed of 2 conifer rows and 1 shrub row will provide a suitable 25-ft-wide cover strip.

TABLE 28. *Characteristics of shrubs from state nurseries that were planted on the Marshall Area, 1975-80.*

	Site Requirements*			Wildlife Value**		
Shrub	Soil	Sun[2]	Moisture	Food	Cover	Principal Contribution[1]
Ninebark	Sandy-loamy	S-ps	Dry-moist	V. good	Good	Wide site tolerence, high transplant survival, winter food
Autumn olive	Sandy-loamy	S	Dry	Good	Good	Tolerates infertile sites, high transplant survival, colorful foliage and fruit
Gray dogwood	Loamy	S-ps	Dry-wet	Excellent	Fair	Shade tolerant, fall food
Red-osier dogwood	Loamy-alluvial	S	Moist-wet	Fair	Good	Colorful stems and fruits, good transplant survival
Silky dogwood	Loamy-alluvial	S-ps	Moist-wet	Fair	Good	Adapted to wet sites
Nannyberry	Loamy	S-ps	Moist	Good	Fair	Good transplant survival
Highbush cranberry	Loamy	S-ps	Moist	Good	Good	Fall food for wildlife and man, colorful foliage and fruit
Hazel	Loamy	S-ps	Dry-moist	Good	V. good	Thicket former, squirrel food
Hawthorn	Sandy-loamy	S	Dry-moist	Fair	Fair	Songbird nest cover
Wild plum	Loamy	S	Dry-moist	Good	Fair	Colorful flowers, thicket former
Wild grape	Loamy	S-ps	Moist	Good	Poor	Vine, fall food
Bittersweet	Sandy-loamy	S	Dry-moist	V. good	Fair	Winter food, colorful fall foliage and fruit

*Site requirements within the regime present on the Marshall Area.
**Value of the shrub to wildlife species using a hedge, particularly ground-dwelling animals.
[1]Principal contribution of the shrub to the plant composition used in hedge development.
[2]S - full sun, ps - partial sun.

Future projects to develop wintering sites for farm wildlife species should be patterned after the model depicted in Figure 4 and consider these planting guidelines:

- In rolling topography, a field with southern exposure and 1/2 to 1 1/2 acres of tillable land (with acceptable soil erosion quotient) should be chosen. At least 1/2 acre of additional land will be required for the development of protective cover.

- Conifers—white spruce, or spruce-pine-cedar mixes—should be planted on the west and north sides of the food plots(s) in 2 parallel units with an intervening snow-drop area. These units should be at least 4 conifer rows wide.

- Mixed shrubs, brush piles, and managed nesting cover are desirable additional options for the winter plot.

- Sorghum, sorghum/corn, or corn food plots should be 1/4 to 1 acre in size. Sorghum is preferred over corn where deer are common. Grain and silage sorghums should be planted together at 10-12 lb/acre. If a grain drill is used to plant the sorghums, alternate tubes should be plugged and the open tubes paired with the same grain. Cardboard dividers can be used in the drill box to separate the seed. If a corn planter is used to establish the sorghums, 2 overlapping trips should be made over the field to obtain a 12- to 15-inch row spacing. Northrup King sorghums NK 145 (silage) and MM 52 (grain) are currently recommended for wildlife food plots.

- Legume food plots should be 1/8-5/8 acre and utilize perennial varieties. Lespedezas are preferred and testing is underway to produce a winter-hardy variety for Wisconsin conditions.

- Recommendations for the proper spacing of winter plots on the landscape will have to await future evaluations on the Marshall Area. Spacing of about 1/2 mile was standard on the quail project although spacing varied between 1/8 and 3/4 mile.

Future habitat development projects in the agricultural sector of Wisconsin should involve management units of 4-10 farms (400-2,000 acres). Many landowners appreciate an opportunity to work cooperatively with a small group of neighbors to collectively develop a wildlife habitat complex. This cooperative arrangement concentrates habitat improvements, thus optimizing the value of food and cover requirements. It should be recognized that the "cooperatives" may also choose to control utilization of the wildlife resource.

LITERATURE CITED

KABAT, C. AND D. R. THOMPSON
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APPENDIX I.
Agreement developed for the Richland County quail project.

State of Wisconsin
Department of Natural Resource
Box 7921
Madison, Wisconsin 53707

WILDLIFE RESEARCH AGREEMENT
Form 8100-49 Rev. 10-76

This agreement is voluntarily entered into by and between _____of _____, hereinafter referred to as "Landowner", and the State of Wisconsin Department of Natural Resources, hereinafter referred to as "Department", for good and valuable consideration as described further herein under the following terms and conditions:

1. The Landowner owns the following described property, contained within a designated Department research or experimental wildlife management area, which shall be known as the "project area":

2. The Landowner and Department agree that within the above-described project area boundaries, the Department may establish an experimental program consisting of the following management efforts:

   a. The Department shall furnish, and place on the project area, trees, shrubs, seeds and fencing materials required to establish the experimental program in accordance with the farm plan and without charge to the Landowner.

   b. The Landowner shall allow trees, shrubs and miscellaneous fencing materials placed on the project area by or with the supervision of the Department to remain in place for a minimum of ten years from the date of signature of the Landowner on this agreement. The Department retains the right to remove fencing materials supplied by it at any time. The need for foodpatch seeds and plantings will be reviewed annually.

   c. The Landowner agrees to take ordinary precautions against damage to said materials placed on his/her property caused by fire, grazing, chemicals, farm machinery or other activity under Landowner's control.

   d. The Department shall be permitted access to enter the project area of the Landowner to evaluate the results of the experimental management practices.

3. The Landowner agrees to consider all Department recommendations regarding allowable harvests of bobwhite quail by hunting on or in the project area.

4. The Landowner shall not sell the right to hunt bobwhite quail within the boundaries of the project area.

5. Violation of any term or condition contained herein shall make the Landowner liable for the cost of the trees and shrubs as of the date of planting, provided by the Department.

6. This agreement is entered into pursuant to and under the authority of Section 23.09(2)(h), Wisconsin Statutes, and may be terminated upon ten (10) days written notice to the Landowner.

7. This agreement may be amended upon mutual consent of the parties in writing.

8. This agreement shall run with the land constituting the project area for a period of 10 years from the date of signature of the Landowner of this agreement.

STATE OF WISCONSIN)
_____COUNTY) ss.

Personally came before me this _____ day of _____, A.D., 19_____, of the Department of Natural Resources to me known to be the person who executed the foregoing instrument, and to me known to be such employe and agent of said Department of Natural Resources, and acknowledges that he/she executed the foregoing instrument as such person as an agreement of said Department of Natural Resources by its authority.

STATE OF WISCONSIN
DEPARTMENT OF NATURAL RESOURCES
For the Secretary

By _____

(NOTARY SEAL)

_____
Notary Public,_____County, WI
My Commission Expires _____

IN WITNESS WHEREOF, the Said _____has caused these presents to be signed at _____,_____, this_____day of _____, A.D., 19_____.

Signed and Sealed in the Presence of:

_____ By _____
Landowner

_____ By _____
Landowner

STATE OF WISCONSIN)
_____COUNTY) ss.

The foregoing instrument was acknowledged before me this _____ day of _____, A.D., 19 _____ by _____.

_____

(NOTARY SEAL)

Notary Public_____,
My Commission Expires (is permanent)
(_____)

This instrument was drafted by the
Department of Natural Resources

APPENDIX II.
Scientific names of plants and animals cited.

Plants

Alfalfa	*Medicago sativa*
Amur maple	*Acer ginnala*
Amur privet	*Ligustrum amurense*
Aster	*Aster* spp.
Autumn olive	*Elaeagnus umbellata*
Bittersweet	*Celastrus scandens*
Blackberry	*Rubus* spp.
Blackhaw	*Viburnum prunifolium*
Black locust	*Robinia pseudoacacia*
Black raspberry	*Rubus occidentalis*
Bluegrass	*Poa* spp.
Bobwhite soybean	*Glycine* spp.
Boxelder	*Acer negundo*
Brome grass	*Bromus inermis*
Burdock	*Arctium minus*
Chinquapin	*Castanea pumila*
Choke-cherry	*Prunus virginiana*
Corn	*Zea mays*
Cornelian cherry dogwood	*Cornus mas*
Crabapple	*Pyrus* spp.
Daurica lespedeza	*Lespedeza daurica*
Elm	*Ulmus americana*
Emerald crownvetch	*Coronilla varia*
Firethorn	*Pyracantha coccinea*
Goldenrod	*Solidago* spp.
Gray dogwood	*Cornus racemosa*
Ground cherry	*Physalis* spp.
Hazel	*Corylus americana*
Highbush cranberry	*Viburnum trilobum*
Hog peanut	*Amphicarpa bracteata*
Mackinaw birdsfoot trefoil	*Lotus corniculatus*
Nannyberry	*Viburnum lentago*
Natob lespedeza	*Lespedeza bicolor natob*
Ninebark	*Physocarpus opulifolius*
Norway spruce	*Picea abies*
Peredovick sunflower	*Helianthus* spp.
Pink lady euonymus	*Euonymus bungeanus*
Poison ivy	*Toxicodendron radicans*
Prickly ash	*Zanthoxylum americanum*
Prostrate lespedeza	*Lespedeza daurica schimidai*
Quackgrass	*Agropyron repens*
Red cedar	*Juniperus virginiana*
Red pine	*Pinus resinosa*
Red-osier dogwood	*Cornus stolonifera*
Rem-red amur honeysuckle	*Lonicera maackii*
Sesbania	*Sesbania* spp.
Silky dogwood	*Cornus amomum*
Silver buffaloberry	*Shepherdia argentea*
Sorghum	*Sorghum* spp.
Staghorn sumac	*Rhus typhina*
Sweet clover	*Melilotus* spp.
Switchgrass	*Panicum virgatum*
Timothy grass	*Phleum pratense*
Washington hawthorn	*Crataegus phaenopyrum*
Wheat	*Triticum aestivum*
White cedar	*Thuja occidentalis*
White pine	*Pinus strobus*
White spruce	*Picea glauca*
Wild carrot	*Daucus carota*
Wild grape	*Vitis riparia*
Wild plum	*Prunus americana*
Willow	*Salix* spp.
Woodbine	*Parthenocissus quinquefolia*
Wooly lespedeza	*Lespedeza tomentosa*

Animals

Barred owl	*Strix varia*
Blue jay	*Cyanocitta cristata*
Bobolink	*Dolichonyx oryzivorus*
Bobwhite quail	*Colinus virginianus*
Brown thrasher	*Toxostoma rufum*
Brown-headed cowbird	*Molothrus ater*
Cardinal	*Cardinalis cardinalis*
Cat	*Felis domestica*
Catbird	*Dumetella carolinensis*
Chickadee	*Parus atricapillus*
Cottontail rabbit	*Sylvilagus floridanus*
Crow	*Corvus brachyrhynchos*
Dog	*Canis familiaris*
Downy woodpecker	*Dendrocopos pubescens*
Eastern meadowlark	*Sturnella magna*
Field sparrow	*Spizella pusilla*
Goldfinch	*Spinus tristis*
Grackle	*Quiscalus quiscula*
Grasshopper sparrow	*Ammodramus savannarum*
Gray fox	*Urocyon cinereoargenteus*
Great horned owl	*Bubo virginianus*
Hairy woodpecker	*Dendrocopos villosus*
House sparrow	*Passer domesticus*
Kestrel	*Falco sparverius*
Mink	*Mustela vison*
Northern junco	*Junco hyemalis*
Northern oriole	*Icterus glabula*
Pheasant	*Phasianus colchicus*
Raccoon	*Procyon lotor*
Red fox	*Vulpes fulva*
Red-bellied woodpecker	*Centurus carolinus*
Red-tailed hawk	*Buteo jamaicensis*
Red-winged blackbird	*Agelaius phoeniceus*
Robin	*Turdus migratorius*
Rough-legged hawk	*Buteo lagopus*
Ruffed grouse	*Bonasa umbellus*
Skunk	*Mephitis mephitis*
Snow bunting	*Plectrophenax nivalis*
Song sparrow	*Melospiza melodia*
Squirrel	*Sciurus* spp.
Tree sparrow	*Spizella arborea*
Weasel	*Mustela frenata*
White-tailed deer	*Odocoileus virginianus*

TECHNICAL BULLETINS (1977-82)

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Copies of the above publications and a complete list of all technical bulletins in the series are available from the Bureau of Research, Department of Natural Resources, Box 7921, Madison, WI 53707.

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