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HABITAT MANAGEMENT FOR NORTHERN BOBWHITES IN WISCONSIN: A LONG-TERM ASSESSMENT

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ABSTRACT

An experimental habitat management program was initiated to improve the carrying capacity for northern bobwhites (*Colinus virginianus*) on private lands by the Wisconsin Department of Natural Resources (WDNR) in 1974. During 1975–80, extensive habitat restoration was undertaken on a 60-mi^2 (155-km^2) study area in Richland County to restore hedge row cover, improve riparian corridors and woodlot edges, and construct plots of food and shelter to function as wintering sites for bobwhites. Previous investigations in Wisconsin have documented that the long-term decline of bobwhites was the result of habitat deterioration, principally hedgerow cover. Elsewhere, continuous declines in bobwhite abundance suggest a re-evaluation of the validity of time-honored habitat management practices is in order. Therefore, it seemed appropriate to test the impact of extensive attempts at habitat restoration, especially the development of hedgerows, on one small treatment area in the northern fringe of the geographic range of the northern bobwhite. After 10–15 years of growth, only 25% of the planted hedges were found to be effective for wintering bobwhites (i.e., closed canopies and producing fruits). Planted hedgerow cover suffered from poor survival due to deer browsing, competition from other surrounding vegetation, and changes in property owners and attitudes as farms were sold. Linear brushy cover was measured in 1990 and compared to similar estimates from 1978. During the 12-year span, brushy linear cover, including project hedges, decreased by 41% (5,995 to 3,545 yards/square mile; 2,531 to 1,497 meters/square kilometer). In addition, managed winter food resources after 1980 were reduced by half compared to earlier efforts. Through 1991, bobwhite population trends on the treatment area did not differ from statewide trends, indicating that extensive habitat restoration work had no discernible impact with respect to reversing population declines. Over 60% of the annual variability in bobwhite abundance in Richland County is related to the severity of winters. Despite these results, we still cannot discount the value of managing for hedgerows in Wisconsin. Achievements of this project include: (1) developing a bobwhite management strategy on a landscape scale, (2) gaining a high level of landowner cooperation, and (3) implementing an extensive amount of habitat restoration on private agricultural lands at minimal costs. The major problem with our overall approach is that such habitat restoration work requires continuous attention and maintenance over time to maintain effectiveness. Landowners, while highly cooperative, are not interested in protecting or maintaining habitat improvements for wildlife unless they have a vested stake in the project (i.e., a sense of "ownership"). Habitat restoration on private agricultural lands necessitates first working to change landowner attitudes towards wildlife, with the development of private lands habitat programs as a secondary concern. The outlook for northern bobwhites in the northern fringe of their range is not bright. Northern bobwhite populations will not recover unless they become a by-product of the contemporary agricultural landscape. Unfortunately, this is not the case in Wisconsin and it is unlikely to change in the foreseeable future.

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INTRODUCTION

Effective habitat management techniques for northern bobwhites have been known for more than 50 years (Stoddard 1931) yet throughout their range, declining bobwhite abundance (Droege and Sauer 1990, Brennan 1991, Church et al. 1993) has been attributed to reduced habitat quantity and quality (Sorrow and Webb 1982, Brennan 1991, Church and Taylor 1992). Such a relationship is a paradox only if viewed from a 1930 perspective. Brennan (1991) presented a strong case for re-examining habitat management for northern bobwhites. He suggested that traditional habitat management prescriptions were designed for landscapes that were very different from the ones today. This opinion is reinforced when land managers consistently fail to restore bobwhite abundance with time-honored habitat practices. While some problems can be attributed to a lack of familiarity with the concepts outlined by Stoddard (1931) and Rosene (1969), there is little question that the intensification of agricultural and fiber management practices have undoubtedly altered habitat for northern bobwhites, and in turn, negatively impacted bobwhite numbers for >6 decades.

Historically, northern bobwhites in Wisconsin were numerous throughout much of the southern half of the state. During 1846–54, bobwhites became so numerous that it "ceased to be a sport to shoot them"—they were used in place of pigeons for trap-

shooting and it was common to flush 3 coveys for every 10 acres (4 hectares) of land within the city of Milwaukee (Schorger 1946:81–82). Schorger (1946) noted that this extraordinarily high bobwhite abundance was due to a favorable ratio of agricultural lands set within a wild prairie landscape, combined with a series of exceedingly mild winters. Such bobwhite abundance has never been observed in Wisconsin since this time.

From a high during the mid-1850's, bobwhite numbers steadily declined through 1962. This decline was directly correlated with the loss of hedgerow cover. Kabat and Thompson (1963) documented a 90% loss in hedgerow cover on their Prairie du Sac Study Area between the mid-1800's and the mid-1900's. They found bobwhite numbers averaged 23 birds per mile (14 birds per kilometer) of hedgerow cover when hedge cover exceeded 1 mile per 450 acres (1 kilometer per 113 hectares) of land. When the amount of hedge declined to 1 mile per 650 acres (1 kilometer per 164 hectares) of land (a 45% loss), bobwhites disappeared altogether (Kabat and Thompson 1963:61). Surprisingly, while Kabat and Thompson noted precipitous hedgerow losses, they believed food supplies from waste grains were adequate during the early 1900's. The hunting season was closed from 1963–72 because of concern for low bobwhite numbers, and there was some effort to place the northern bobwhite on the songbird list, essentially de-listing the bobwhite as a game species. The bobwhite season was re-opened in 1973 with the departmental (Wisconsin Department of Natural Resources) mandate for the initiation of a bobwhite management program. This mandate also initiated the habitat management study for northern bobwhites on private lands (Dumke 1982). The experimental habitat study focused on improving cover and food availability for bobwhites during the winter months. Implementing this strategy suggested that habitat restoration would increase the carrying capacity for bobwhite on the study area (Dumke 1982). Winter months appeared to be the time of concern as short-term population fluctuations of Wisconsin bobwhites are influenced by a complex set of factors where winter weather appeared dominant (Kabat and Thompson 1963). Dumke (1982) reported on the early phases of this study, outlining the approaches used on this private lands program involving habitat developments during 1975–80, evaluations in dealing with landowners, and preliminary results. This paper reports on the long-term evaluation of the habitat restoration efforts, and offers suggestions and ideas regarding northern bobwhite management in the northern fringe of their range.

Background from the Earlier Work

A synopsis of the experimental habitat development work is presented to provide an understanding for the Quail Management Project (QMP) as it developed. For more detailed information, see Dumke (1982). A 60-mi^2 (155-km^2) study area, the Marshall Management Area (MMA), in Richland County was

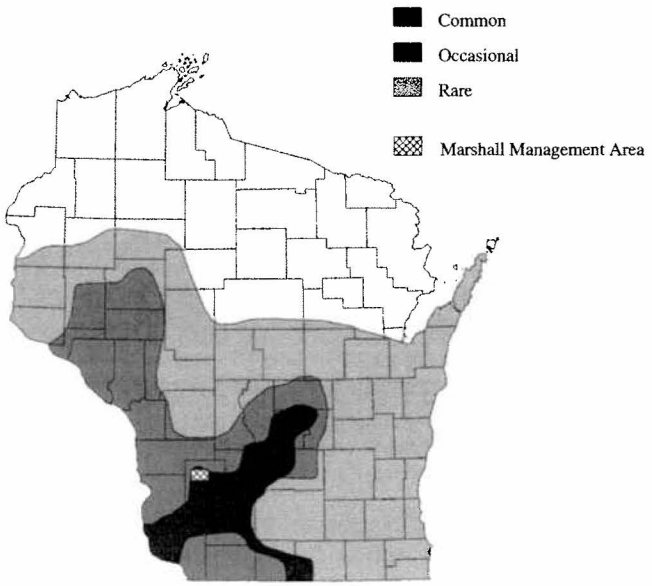

Fig. 1. Wisconsin northern bobwhite range and location of Marshall Management Area.

selected because it contained better-than-average northern bobwhite densities for Wisconsin and had a history of conservation-minded landowners (Figure 1). A 1972 preseason bobwhite survey indicated that Richland County residents had a genuine interest in the welfare of the northern bobwhite in Wisconsin. The topography of this region is rather rugged with a complex of narrow valleys and broad ridges. Land use was typical of southwest Wisconsin's driftless area (Table 1). Cropland was confined to the valley floors or ridge tops and the side slopes were mostly forest and pasture. The QMP was an interagency effort with active involvement from the USDA Soil Conservation Service (now know as the Natural Resources Conservation Service) District Conservationist, the Agricultural Stabilization & Conservation Service (now the Farm Service Agency) Executive Director, the University of Wisconsin Extension Specialist, and the Wisconsin Department of Natural Resources County Forester. A QMP Newsletter was developed and sent to all landowners on the MMA informing them of the project and its progress, basic bobwhite biology, and relevant resource issues.

The Marshall Management Area was divided into 26 management units of contiguous, physiographically similar habitats. Critical habitat components were identified from aerial photographs and collated with bobwhite sightings collected from landowner questionnaires (Figure 2). Both traditional and potential wintering sites were identified for bobwhites. Habitat prescriptions were written to improve food, cover, and dispersal elements of the habitat. The management concept was to provide a matrix of secure wintering sites that were connected by a series of continuous hedge, thereby promoting year-round use by bobwhites (see Guthery [1997] regarding the high value of year-round use of space for bobwhite). Some management units offered little opportunity for habitat restoration

Table 1. Land use in Richland County, Wisconsin 1977–92.[a]

Land use (area in mi²)	1978 Area (%)	1982 Area (%)	1987 Area (%)	1992 Area (%)
Cropland[b]	261 (53)	247 (53)	241 (53)	227 (54)
Corn	61 (12)	68 (15)	56 (12)	59 (14)
Hay	130 (26)	129 (28)	139 (31)	107 (25)
Oats	13 (3)	9 (2)	9 (2)	5 (1)
Idle Cropland	15 (3)	6 (1)	18 (4)	19 (5)
Pastureland[b]	56 (11)	46 (10)	40 (9)	49 (12)
Woodland[b]	161 (33)	156 (33)	155 (34)	134 (32)
Pastured woodland	100 (20)	99 (21)	85 (19)	65 (15)
Woodland not pastured	62 (13)	57 (12)	71 (16)	69 (16)
Number of farms	1,345	1,234	1,165	1,094
Average farm size (in acres)	236	242	250	248

[a] Data compiled from U.S. Department of Commerce, Bureau of the Census, 1982, 1992.
[b] Percents calculated from acres of land in farms.
[c] Percent land in farms based on total land in Richland County.

due to topography, land use, or landowner attitudes. As a result, habitat improvement was not promoted in units lacking potential for at least 3–4 wintering sites and 2–3 miles (3.2–4.8 kilometers) of fencerow hedge. Extensive habitat restoration was undertaken in 9 management units, 7 units received moderate work, 6 had little development, and the remaining 4 units received no development. From 317 property owners on the MMA, 117 landowners were initially selected to be contacted and 100 became cooperators, an 85% success rate. Seventy-two percent, or 228 of the 317 landowners, were residents, whereas only 54 of the 100 cooperators lived on the area.

Landowners controlling the most critical elements within the habitat plans for each unit were initially contacted to ascertain interest in program participation. If a field reconnaissance of their property verified initial interpretations, and landowner interest in the bobwhite program was demonstrated, a farm plan was developed. Whereas such plans focused on bobwhites, a comprehensive wildlife package was promoted as an additional incentive for participation. Desires and ideas of the property owners were incorporated into the farm plan and if agreed upon, a 10-year contract was signed, pledging the landowners' protection of the habitat improvements. The landowners' contribution was to take land out of production, whereas the WDNR's contribution was the planting materials, planting labor, and wildlife management advice.

During 1975–80, >465,000 shrubs and conifers were planted to create 32.2 miles (51.8 kilometers) of

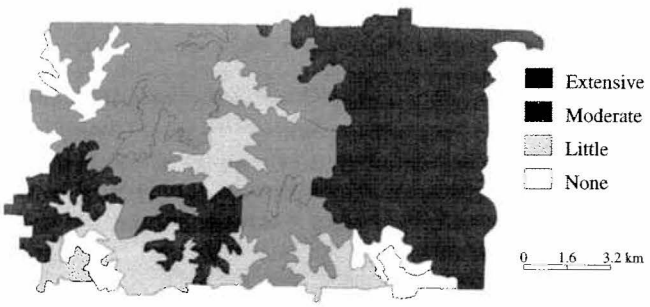

Fig. 2. Delineation of Marshall Management Area management units and intensity of habitat management undertaken.

new or improved hedge, 6.5 miles (10.4 kilometers) of enhanced riparian corridors, 11.5 miles (18.5 kilometers) of improved woodland edge, and 191 plots of combined food and cover (i.e., sites with >4 rows of shrubs and conifers, often associated with sorghum and/or legume food patches). Plots were created to serve as activity centers for wintering bobwhites; they totaled 196 acres (79 hectares) and varied from a clump of spruce covering 1,350 square feet (126 square meters) to a 6.7 acre (2.7 hectare) plot with conifers, shrubs, brush piles, nesting cover, and food patches of legumes and sorghum. In addition, 130 brush piles were constructed from selectively removed trees and shrubs along areas where linear cover was developed and within plots (26 brush piles were placed in plots with food, 24 in shrub and conifer plots). The typical brush pile was 20 by 29 feet, and approximately 10 feet high (6x9x3 meters). Sorghum food patches were planted on 75 plots; 13 of these had legume patches as an auxiliary food source for early winter. Sorghum food patches averaged 8,283 square feet (770 square meters), while the mean legume plots was 1,950 square feet (181 square meters). The 3-row hedge of mixed shrubs and conifers was the predominate linear cover development installed on the MMA. Autumn olive (*Elaeagnus umbellata*),wild grape (*Vitis riparia*), ninebark (*Physocarpus opulifolius*), silky dogwood (*Cornus amomum*), gray dogwood (*Cornus racemosa*), and nannyberry (*Viburnum lentago*) were the principal shrubs planted; white spruce (*Picea glauca*) was the predominate conifer. Overall, 29 species of shrubs and 6 species of conifers were planted. Sorghum food plots were seeded to mixed grain and forage varieties (*Sorghum* spp.); legume patches consisted of lespedeza (*Lespedeza* spp.), crownvetch (*Coronilla varia*), or trefoil (*Lotus* spp.).

The cost of installing habitat improvements on a typical cooperating farm was $1,610, and ranged from $250 to >$5,000. These costs included seed and tree/shrub stock, labor, and the planning and implementation of habitat developments and associated salaries, excluding costs for wildlife surveys, incidental field reconnaissance, and general land use mapping. Overall costs were kept low with extensive use of Federal work experience programs (Comprehensive Employ-

ment Training Act, Community Action Program, WIN) for field work, and work study programs (e.g., internships) for landowner contacts. Wisconsin Department of Natural Resources equipment, or rentals from local implement dealers or farmers were used throughout the program.

Landowners did not participate in the QMP with equal involvement. Intensity of program participation varied with a number of factors: (1) intensity of land use was often related to the residency of the landowner (absentee landowners usually practiced less aggressive farming), (2) farm size (larger holdings offered greater opportunities), (3) compatibility of the landowner's long-range land use plan to wildlife habitat management needs, (4) agreement between the landowner and land renters regarding the intensity of land use, (5) agreement between owning partners regarding farm management, (6) interpersonal relationships between Department staff and participants (personality compatibility), (7) our perception of landowner willingness to participate, (8) the landowner's perception of total benefits and long-term gains, and (9) the landowner's interest in wildlife relative to other products of the land. In general, planned habitat restoration was largely accomplished on properties identified as potential cooperators.

Monitoring Efforts

Changes in northern bobwhite populations were documented on the Marshall Management Area and statewide. Both triangulation counts and 20-station transects of whistling males were conducted on the Marshall area, whereas regional surveys relied on transects only, following established procedures (Kabat and Thompson 1963, Dumke 1982). Triangulated counts of whistling males were taken from all suitable roads during 1 June to 5 July, three times annually. Population trends on the QMP were compared to regional trends to assess the success of habitat restoration efforts.

A Winter Severity Index (WSI) was used to objectively measure winter weather conditions. Seasonal values were calculated from minimum monthly temperature and daily snow depths during the period from December 1 through March 31 (Gates 1971, Dumke 1986). The winter severity index is more strongly influenced by snow depth than it is by minimum temperatures, and is reflective of earlier findings that Wisconsin bobwhite can often survive low winter temperatures as long as snow cover does not hamper their ability to find adequate food resources (Leopold 1931, Errington and Hamerstrom 1936, Kabat and Thompson 1963).

Hedges were monitored every 4–6 years to quantify growth and development, as well as plant survival. We visually judged growth and development, whereas survival was documented along measured intervals on randomly selected hedgerows (Woehler 1984, 1985). Wildlife use of food patches was monitored by periodic visits. A fall visit to subjectively evaluate the vegetation characteristics and seed production was followed by at least one winter visit to ascertain wildlife use.

SHORT-TERM RESPONSES

Habitat Changes

Changes on the landscape were dramatic. For example, on 6 intensive management units (a total of 6,560 acres, 2,656 hectares), 1 mile of new hedge was added for every 633 acres (1 kilometer for every 159 hectares) of landscape. Combined with existing hedge deemed adequate to serve bobwhite, the total of fencerow hedge then equaled 1 mile per 306 acres (1 kilometer per 77 hectares). If improved riparian corridors and woodlot edges also function as hedges (i.e., secure travel lanes, roosting and nesting sites), then total improved and unimproved edge cover was 1 mile per 88 acres (1 kilometer per 22 hectares) without adjusting for planting losses and growth problems. Kabat and Thompson (1963) estimated that 1 mile of hedge was needed for every 450 acres of land (1 kilometer per 113 hectares) to sustain a fall population of 1 bobwhite per 20 acres (8 hectares); they suggested this amount of hedge as a desirable management goal for bobwhite in Wisconsin. It was apparent that on some sites (i.e., intensive management units), habitat restoration efforts made monumental strides in changing habitat structure on a landscape scale.

It was routine to replace lost shrubs and conifers during the 6 years of habitat restoration. Over 50,000 shrubs and conifers were planted to replace losses due to adverse environmental conditions or accidental farming operations during 1975–80. A 1980 assessment of planting losses indicated a 31% mortality in shrubs and a 39% loss in conifers. After 1980, cooperators were offered free replacement shrubs and conifers if they would plant them. The restoration aspect of the bobwhite project was completed by then and the Department could no longer provide free labor. An average of 20,800 shrub and conifer replacement seedlings were provided to willing landowners during 1983–85. The number of seedlings actually planted as replacements for lost shrubs and conifers is unknown.

During the 1980 evaluation, severe competition from herbaceous and woody vegetation was observed from successional plant growth among the small shrubs and conifer seedlings. Negotiations with landowners were conducted to ask for their assistance in chemical or mechanical weed control. Cooperation among landowners was mixed. Survival and growth of individual species were highly variable. Site differences, year of planting, presence of competition, and quality of planting stock all contributed to the overall condition of the hedgerow. Autumn olive and ninebark developed better cover than all other shrub species, although autumn olive has an undesirable tendency to spread. Six-to-8 year old plantings of highbush cranberry (*Viburnum trilobum*), ninebark, and autumn olive produced fruit (Woehler 1984).

In Wisconsin, most cover development takes time to grow and become effective, therefore an evaluation

of the habitat restoration was not believed possible until after 1990. Hedges were not considered "effective" until their growth forms overlapped, when planted shrubs and conifers formed a continuous overhead layer of protective cover (Woehler 1985, 1986). Since planted conifers were spaced 8 to 10 feet (2.4–3.0 meters) apart, it was anticipated that 8–10 years of growth was required before hedges became effective for bobwhite.

Effective Implementation with Cooperating Landowners

Whereas any judgement of the planted edges required more time, an evaluation of the techniques used to gain landowner cooperation, however, could be made. An 85% success rate in gaining cooperators reflected an adequate incentive program and an effective delivery system. The high level of landowner participation exceeded all expectations. Factors that contributed to this success rate included: (1) personal contacts, (2) early support by community leaders, (3) flexibility, (4) interpersonal cooperation, (5) administrative support from the Wisconsin Department of Natural Resources, and (6) an acceptable agreement. Of these factors, personal contacts and early support by community leaders were considered the most important. Three to 4 visits with the landowner were typically required to introduce the project and to negotiate a satisfactory farm plan. Listening to the landowner's objectives for the property, understanding their economic, cultural, and ecological constraints, and developing a sense of trust all played a role in the evolving relationship. Even issues such as chemical use during restoration work or a landowner's interest in northern bobwhite as a game species were considered. At least 5 cooperators held very strong opposition to other Department programs, and tense relations developed with another 6 cooperators due to other Department activities, yet these obstacles were overcome. Personal contacts built a close, working relationship and, when needed, restored trust.

A second factor contributing to the high level of cooperation was the active support of key landowners, the agricultural community leaders. As cooperators, these landowners were instrumental in spreading the "word" regarding the bobwhite project, and were able to address questions from other landowners and defend the project. Questions or concerns from landowners could be answered within the community, and when combined with occasional personal contacts by bobwhite project personnel and the Newsletter, little anti-project behavior developed.

Also, a major key to our success in soliciting landowners was flexibility. Every landowner and habitat plan was unique. Negotiations with cooperators included issues such as how much to plant, would the landowner play a role in planting the shrubs and conifers, would chemicals be used, would fences be installed to protect the plantings and who would build them, and even if it was necessary to gain permission to enter the property for evaluations. Such negotiations took longer to complete, but the resulting level of cooperation and its longevity more than compensated for the time spent negotiating.

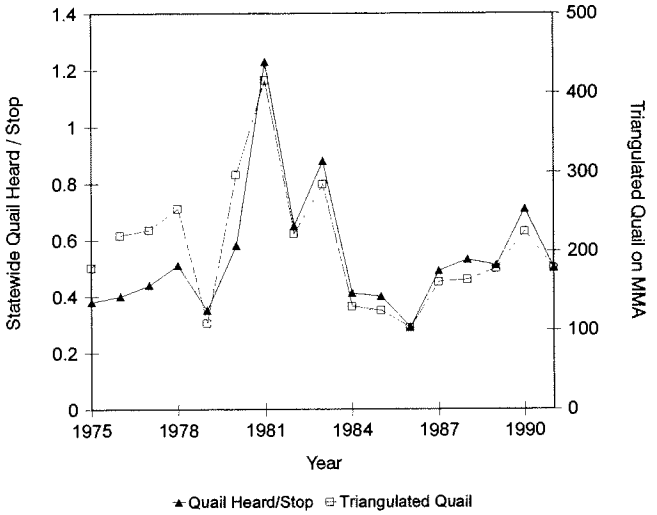

Fig. 3. Relationship of triangulated bobwhites from the treatment area to statewide transects used as controls, 1975–91.

Based on our preliminary experience from the bobwhite project, similar future efforts to improve bobwhite or other farmland wildlife species on private agricultural lands should include: (1) personal contacts to solicit landowner interest and negotiate an agreement: anticipate 5 hours per landowner contact, but inform the landowner with personal letters and a Newsletter about the project before the meeting; (2) agency personnel need to remain cognizant of the perceptions and needs of the individual landowner, and strive to remain flexible to accommodate any differences; (3) an interagency field staff needs to be involved to optimize efficiency, although a single project leader is essential; (4) key community leaders and county resource managers should be involved in the planning and implementation of the habitat development project; and (5) a simple agreement should be developed that protects the sponsoring agency's investment, yet provides flexibility in management for the landowners.

LONG-TERM RESULTS

Changes in Bobwhite Abundance

There was a strong correlation between the bobwhite counted on the Marshall Management Area and the bobwhite heard per stop on statewide transects ($n = 17$, $r = 0.86$, $P < 0.001$), indicating that the Bobwhite Management Project had no detectable impact on bobwhite densities (Figure 3). Statewide, routes were similar in their individual trends, suggesting a uniformity in factor(s) affecting bobwhites throughout Wisconsin. When winter severity was compared to triangulated bobwhite numbers on the Marshall area (Figure 4), the results suggested that over 60% of the annual variability in study area bobwhite numbers was due to winter weather conditions ($r^2 = 0.61$, $P < 0.01$).

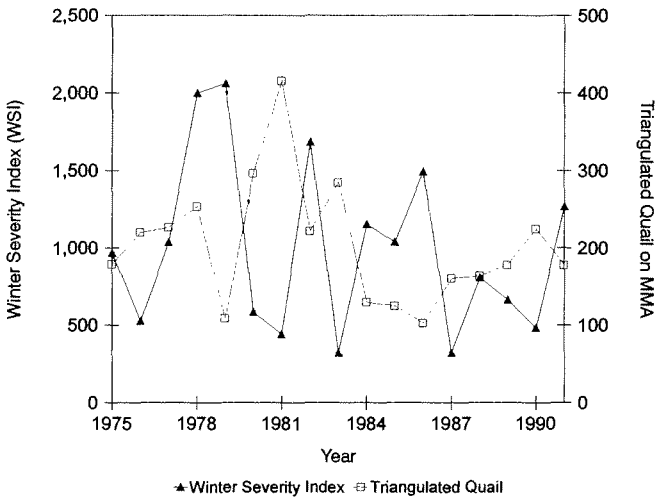

Fig. 4. Relationship of triangulated bobwhites from the Marshall Management Area to winter severity indices, 1975–91.

The impact of winter weather on spring bobwhite numbers came as no surprise. Past research on bobwhites in Wisconsin confirms the importance of winter conditions on subsequent spring numbers (Leopold 1931, Errington 1933, Errington and Hamerstrom 1936, Kabat and Thompson 1963). Kabat and Thompson (1963) documented that "normal" winter mortality for bobwhites varied from 37 to 77% of the fall population dependent upon winter severity, primarily snow depth. However, a stronger effect was expected on the Marshall area. Kabat and Thompson (1963) found that adequate food supplies through the 1950's enhanced weights and survival. Dumke (1984) suggested, however, that intensification of farming practices had drastically changed the availability of winter food stocks for bobwhites during the 1960's and early 1970's. Inadequate food resources should have resulted in an even stronger relationship between winter weather and spring bobwhite abundance. There are two factors present on the Marshall area that may have played a mitigating role: (1) the use of woodlands for pasture has declined between 1978 and 1992 (Table 1), offering additional wintering habitat (35% drop over 14 years), and (2) the practice of spreading barnyard manure remains common, offering a reliable source of winter food. Statewide, bobwhite transects for 1960–95 have suggested a declining trend (Dhuey 1997), implying factors effecting bobwhite trends in Richland County may be operating throughout Wisconsin, although BBS results from 1966–1996 show a stable trend for northern bobwhites in Wisconsin (Sauer et al. 1997).

Contributing Factors to the Poor Habitat Response

A number of factors are believed to be responsible for the lack of response by bobwhites to the extensive habitat restoration efforts. Most important was the survival and performance of hedges and other edge developments. The 1980 planting evaluation revealed substantial mortality, in spite of efforts to replant lost shrubs and conifers. In addition, the high density of white-tailed deer (*Odocoileus virginianus*) caused severe browsing damage on shrubs and conifers during 1975–85. Overwintering deer densities in Richland County were estimated at 19 to 26 animals per square mile (7.3 to 10.0 deer per square kilometer) of range, although the management goal was 15 deer per square mile (5.8 deer per square kilometer) of range (Wisconsin Department Natural Resources 1994). A sample of 14.6 miles (23.5 kilometers) of hedge examined in November 1983 and 1984 found that 39% of all shrub hedgerows suffered severe damage from browsing deer. Deer damage to planted shrubs was sufficient to cause mortality if browsing continued unabated (Woehler 1984).

An evaluation of linear brushy edge was made during 1990 to document changes since 1978. This evaluation was based on the original field maps and techniques employed by Dumke (1982). A sample of 5 management units, or 27% of the entire study area, was examined. All brushy edges along fencerows, drainages (riparian), and woodlot edges were tallied (Table 2); such types were believed to function as hedges as described by Kabat and Thompson (1963). These 3 types of linear brushy edge averaged 3.41 miles per square mile (2.53 kilometers per square kilometer) in 1978. By 1990, the same 3 types declined to 1.76 miles per square mile (1.31 kilometers per square kilometer), a 48% loss over a period of 12 years. Annual rate of loss was 4% per year. The existence of bobwhite project hedges (0.26 miles per

Table 2. Presence of habitat components of value to bobwhite on the Marshall Area, 1978–90.[a]

Cover type	1978	1990	Difference	Percent change
Area (acres/mi²)				
Cropland	182.3	155.9	−26.4	−15.0
Conservation Reserve Program	—	25.2	—	—
Thickets[b]	0.9	1.3	0.4	44.0
Conifer clumps	3.4	6.3	2.9	85.0
Herbaceous cover	59.4	40.9	−18.5	−31.0
Brushy woodlands	32.1	49.3	17.2	53.0
Linear cover (yards/mi²)				
Herbaceous drainage[c]	176.0	616.0	440.0	250.0
Tree drainage	451.0	946.0	495.0	110.0
Herbaceous fencerow	2189.0	1617.0	−572.0	−26.0
Tree fencerow	605.0	770.0	165.0	27.0
Herbaceous woodlot edge	891.0	891.0	—	—
Brushy drainage	693.0	528.0	−165.0	−24.0
Brushy fencerow	1914.0	1199.0	−715.0	−37.0
Brushy woodlot edge	3388.0	1364.0	−2024.0	−60.0
Quail Management Program hedges[d]	—	454.0	—	—
All brushy edge	5995.0	3545.0	−2450.0	−41.0

[a] Compiled from a 16-mi² sample of the 60-mi² study area; sampled 5 of 26 management units, 3 intensively managed, 2 moderately manipulated units.
[b] Thickets defined as small areas of brush in herbaceous cover, pastures, cropland, or sites along a fenceline that are wider than the rest of the hedge. All thickets were a minimum of 500 ft².
[c] Only measured as herbaceous drainage when not pastured.
[d] Over 1815 yards/mi² of hedge originally planted during 1975–1980, 25%, or 454 yards/mi² judged effective after 12 years.

square mile, 0.19 kilometers per square kilometer) kept the amount of brushy edge to a respectable figure (2.01 miles per square mile, 1.50 kilometers per square kilometer). Only 25% of the original project hedge was judged effective (25% of the 1.03 miles per square mile, 0.77 meters per square kilometer planted). The net loss of brushy edge cover was 1.39 miles per square mile (1.03 kilometers per square kilometer) over the 12-year time span (41% loss; 3.4% per year).

These changes can be described another way. Kabat and Thompson (1963) call for 1.42 miles of hedge per square mile (1.05 kilometers per square kilometer) as a management goal in Wisconsin. When the amount of hedge declined to 1.00 miles per square mile (0.74 kilometers per square kilometer) of land, bobwhites ceased to exist. Brushy linear edge on the MMA in 1978 was 3.41 miles per square mile compared to 2.01 miles per square mile in 1990 including project hedge. Whereas brushy linear edge is still in excess of the established management goal, the rate of decline is a cause of great concern. If the rate continues as such, the future existence of bobwhites in Richland County is in question within the foreseeable future.

Severe competition without periodic chemical or mechanical control of surrounding herbaceous and undesirable woody vegetation continued to be a problem. It was believed that once the plantings became established and became taller than surrounding vegetation, such competition would be of minor consequence. Conifers planted along woodlot edges varied in height from 2 to 10 feet (0.6–3.0 meters), reflecting differences in soil fertility, soil moisture, and competition that seriously impaired their growth and development. Even with extensive cutting and weed control, it was doubtful that these plantings would ever have any favorable influence on bobwhites (Woehler 1985,1986). Woehler (1985, 1986) felt that the variability in conifer growth, fragmentation of the conifer edge due to plant losses, and excessive competition from surrounding vegetation would not allow the conifer woodlot edge to develop as intended.

The Conservation Reserve Program (CRP) represented 16% of the cropland, but only 4% of the total land area. Subjectively, it appeared that the CRP tended to be clustered in certain areas and in some small drainages where cropland was less than ideal. In such small valleys with heavy CRP enrollment, calling male bobwhites were seldom detected within 2–3 years after retirement. The addition of CRP during the habitat restoration program may have compromised our efforts to improve habitat conditions for bobwhites on some portions of the Marshall area. Elsewhere, CRP has not been associated with improved bobwhite habitat conditions, and has been implicated in declining bobwhite abundance (King and Savidge 1995, Harr 1996). Bobwhites require semi-open areas with exposed ground and herbaceous vegetation for nesting (Stoddard 1931, Rosene 1969). They avoid fields with heavy, dense cover (Roseberry and Klimstra 1984). Over 86% of the CRP established in Richland County was cool-season grass-legume mixtures, predominately smooth brome (*Bromus inermis*) and alfalfa (*Medicago sativa*). After 3–4 years, the alfalfa was essentially gone, which left a monotypic stand of smooth brome. Smooth brome is a sod-forming grass (Carlson and Newell 1985). Without periodic disturbance such as fire, it will become dense with little or no bare ground. Over time, it will develop a thick layer of grass litter unsuitable for bobwhites (King and Savidge 1995).

Building brush piles and planting sorghum food patches were two habitat practices that were thought to provide immediate positive habitat changes for bobwhites on the Marshall area. Unfortunately, these practices had limited benefits for bobwhites. Sorghum plots are annual undertakings, whereas brush piles compacted and lost their usefulness to bobwhites over time. Brush piles compacted approximately 20% the first year and nearly 8% per year thereafter. Without periodic restoration, the brush piles would be reduced to nearly 40% of their original size in 10 years and be of little value to bobwhites. Brushy linear edge was designed to provide safe travel lanes for bobwhites. Winter movements and home ranges of bobwhites in Wisconsin are small (typically <0.25 mile radius) even during the best of times (Errington and Hamerstrom 1936, Kabat and Thompson 1963). Unless a covey was within 0.25 miles (0.4 kilometers) of a food plot or brush pile, its use was unlikely. The winter covey density on the Marshall area during 1975–1979 was only 1.6 coveys per square mile (0.6 coveys per square kilometer), suggesting that there were large areas (presumably much of which was restored habitat) without wintering bobwhites.

Throughout the intensive phase of habitat restoration in 1975–80, 75 sorghum food plots were annually seeded. Thirteen legume patches were planted near selected sorghum plots to provide an auxiliary food source. From 1984 to 1990, planted winter bobwhite food resources were: 12 to 19 sorghum plots, 18 perennial Natob lespedeza plots, and 2–3 corn parcels purchased from cooperating landowners. This reduction of food plots was due to fiscal and personnel constraints. It reduced the number of managed food plots by half compared to earlier efforts. By 1991, the Department stopped planting sorghum plots and purchasing of corn parcels all together. Periodic checks of food plots in 1984–90 to ascertain use by wintering bobwhites were disappointing. Bobwhite visits of the sorghum plots varied annually from 0 to 30%, and only a single covey of bobwhites visited a Natob lespedeza patch during a single winter over the 7-year period. A variety of wintering songbirds did, however, extensively use these food plots. Over 75% of the corn parcels were used, although they were originally purchased because of the existence of a nearby covey of bobwhites. In addition, the lespedeza was susceptible to top growth die-backs during cold weather, and the resulting growth form and seed production were poor. Natob seed was also invariably gone by the end of December.

Changes in Observed Farms and Farming Patterns

While CRP increased, and grazing of woodlots decreased in Richland County, other, more subtle land-

Table 3. Agricultural chemicals used on Richland County farms, 1978–90.[a]

Chemicals used (acres treated)[b]	1978	1982	1987	1992
Cropland fertilizer	65,638	65,708	71,069	70,288
Pastureland fertilizer	1,951	2,334	1,424	2,392
Insecticides on hay & crops	25,379	21,349	21,944	17,794
Herbicides on pastures & crops	33,017	31,997	31,980	33,449

[a] Data from U.S. Department of Commerce, Bureau of the Census, 1982, 1992.
[b] Total harvested cropland: ~126,000 acres, pastured cropland: ~30,000 acres, and total harvest cropland and hay: ~200,000 acres.

scape and bobwhite habitat changes were noted. The number of farms as a whole, and the amount of land in farms, decreased in Richland County, although farm size remained relatively unchanged (Table 1). The increase in the amount of non-farm lands is believed to be due to urbanization. The number of bobwhite project cooperators declined by about 4% per year, reflecting changes in farm ownership. By 1996, only 39 of the original 100 cooperators remained, and 2 of these had destroyed bobwhite project plantings. New landowners received the QMP Newsletter until 1991 when it was discontinued. No systematic efforts at personal contacts were made to promote the bobwhite project. As a result, some excellent bobwhite habitat improvements were destroyed by grazing or other farming activities. However, this project was not designed to continue indefinitely. As agency personnel slowly shifted their attention to other duties, it was hoped that the inherent attributes of the habitat improvements would encourage landowners to maintain them. This apparently did not always happen.

Changes in corn harvesting methods also had negative impacts on bobwhite habitat. During the 1950's, it was still common to find corn shocks in Richland County. Over the last decade, however, picker-sheller harvesters became common place, and the shelled corn is stored in sealed bins. This makes it unavailable to any wildlife. Corn stalks previously left in the fields as organic matter are now chopped and blown into large stacks, hauled out of the fields and fed to dry stock or beef cattle. The resulting corn fields have virtually no waste corn nor shelter, and offer very little, if any, benefits to wintering bobwhites. Between half to three-quarters of all corn fields used as grain are now treated in this fashion. Soybeans are not common on the Marshall area (<2% of harvested cropland) and, therefore, corn is believed to be the most important agricultural grain available to wintering bobwhites. This trend is likely to continue and it is difficult to see how wintering bobwhites can derive any benefits from corn fields.

Changes in agricultural chemicals used in Richland County were examined using data from the Census of Agriculture (U.S. Department of Commerce 1983, 1994; Table 3). During 1978–92, use of fertilizers and herbicides on crops and pastures changed very little, although there was a decline (30% drop) in the use of insecticides on hay and crops. Whereas the effect of agricultural chemicals on bobwhites in Wisconsin is unknown, the decreased use of insecticides in Richland County does not appear to be a source of concern (Sotherton et al. 1993).

Lessons Learned from the Bobwhite Management Project

Whereas the results of the intensive bobwhite habitat management efforts on the MMA did not produce the desired outcome, there are lessons that can be gleaned from our efforts. First and foremost is the original assumption that lack of hedges limits bobwhite abundance in Wisconsin cannot be answered from our efforts, yet there is also no compelling reason to discount this belief. Only 25% of all managed hedge row cover was judged effective for bobwhites by 1990, certainly far less than what was hoped. This was not a fair test of the hedge row habitat prescription developed by Kabat and Thompson (1963) and implemented by Dumke (1982).

However, the approach used by Dumke (1982) to develop a bobwhite habitat management strategy on a landscape scale, gain landowner cooperation, implement extensive habitat restoration on the land at minimal costs, and maintain this effort over time (albeit a short period of time) was remarkably successful. Habitat management designed for individual farms can be beneficial to bobwhites residing on that farm, but will hardly benefit bobwhites on a regional or landscape scale. The 85% level of cooperation among landowners exceeded all expectations. Whereas one might say that this high level of cooperation was only achieved because the Department essentially did all the planning, provided all the planting stock, and did all the work may be true, this level of participation was much higher than anticipated at the beginning of the project.

If there was a major flaw in our overall approach, it was that restored bobwhite habitat on private agricultural lands requires continuous attention and maintenance over time to remain effective. Some sorghum food plots and most brush piles were used immediately by bobwhites, but they need frequent, continuous management to maintain their usefulness. Sorghum plots need to be planted annually, while brush piles need to be restored every 3–5 years. Shrub and conifer hedges take 10–15 years to become effective for bobwhites, but attention must be made to replace lost plants or provide protection from farming operations (accidental or otherwise) if the resulting hedge is to make a contribution. Competition from surrounding vegetation must also be controlled by mechanical or chemical means. Landowners on the Marshall area were essentially required to provide little of their own resources to this project, consequently, we feel that they possessed little desire to make sure these developments were protected or maintained over time. Had the Marshall area landowners invested some of their time or resources into this project, the level of initial participation would have been lower, but those participating

may have had a stronger commitment. Habitat management projects on private lands typically have shown better long-term results when the property owners develop a vested interest in the program (Deknatel 1979, Applegate 1981).

Where does this leave us with respect to bobwhite habitat management in Wisconsin and elsewhere in the northern fringe of their range? Edminister (1954) suggested that bobwhite habitat management on the northern fringe of their range is ineffective because winter weather overwhelms any habitat change or improvements. With restricted resource agency funding, the use of any dollars for bobwhite habitat management would appear to be a waste of financial resources. However, in Wisconsin, we are also on the northern edge of ring-necked pheasant (*Phasianus colchicus*) and on the southern fringe of ruffed grouse (*Bonasa umbellus*) range, yet these two species enjoy great popularity, high agency interest, and extensive habitat management programs. Management dollars are frequently tied to harvest levels, in which case, it would be difficult to secure substantial funding for bobwhite management in Wisconsin.

Any habitat management program for bobwhites in the northern fringe of their range requires careful planning and implementing. Bobwhites are a by-product of the agricultural land use and, therefore, require effective cooperation with private landowners if we have any hope of making an impact. Madsen (1981) suggested the widespread failure of most private land wildlife programs has resulted from concentrating on implementation, rather than first working to obtain a favorable attitude among the potential participants. Personal contacts and support from community leaders greatly influenced landowners attitudes towards bobwhites and state agencies. Also, recent approaches using geographic information systems (GIS) to map suitable habitat on a statewide basis have greatly improved our ability to identify where habitat management dollars can be most effectively used (Donovan et al. 1987, Mladenoff et al. 1995, Deelen 1996). Dumke (1982) originally examined the treatment area from a landscape-scale viewpoint, delineated critical bobwhite habitat and deficiencies, and then mapped out a treatment plan. Such an approach mirrors using GIS and a habitat suitability model to manage bobwhite habitat in today's world.

Perhaps the greatest lesson to be gleaned from this experimental management effort is that it was a classic example of what Walters and Holling (1990) describe as "passive adaptive" management. Past research indicated that hedgerow cover was the factor limiting bobwhites in Wisconsin, and that the other critical habitat components were essentially in place. We assumed that simply adding hedgerows would reverse the long-standing stagnation of bobwhite abundance. When years of hedgerow work failed to produce the anticipated results, we struggled for answers. Walters and Holling (1990) suggest that passive adaptive management not only fails to lead to sound conclusions, but often confounds or clouds existing policy, leaving the researchers with few, if any alternatives. They suggested that an "active adaptive" experimental approach, involving the developing and testing for a variety of alternative hypotheses, would have produced better results. An active approach can be costly and complex in monitoring, but so is spending 15 plus years on a single hypothesis, only to find few definitive answers.

MANAGEMENT RECOMMENDATIONS AND IMPLICATIONS

Brennan (1993), Capel et al. (1993) and others are developing strategic plans that attempt to deal with two issues related to bobwhite habitat in the agricultural sector: (1) general habitat loss and strategies for habitat development and improvement, and (2) agricultural programs and policies. Efforts must continue to develop and enhance this strategic plan into a working document. In Wisconsin, intensive grazing systems and rotational grassland dairy farming are new techniques that are receiving great interest. Their potential for altering bobwhite habitat is unknown, but merits study. Also, the 1996 federal farm bill (Federal Agriculture Improvement and Reform Act) offers wildlife more opportunities through the existence of some new rules: the Wildlife Habitat Improvement Program (WHIP) and the Environmental Quality Incentives Program (EQIP). Even on new CRP lands, part of the annual payment will include a maintenance fee allowing light disking of established cover to promote growth of annuals, prescribed burning to remove litter and expose more bare ground, and the establishment of food plots. Some less desirable cool-season grasses (e.g., tall fescue, *Festuca arundinacea*) will receive a zero wildlife multiplier in calculating the overall environmental index, severely reducing the chances that such cover will receive a minimum entrance score. Such activities will benefit bobwhites. Fortunately, mandatory mowing of CRP no longer happens.

Private land management is now being recognized as an integral part of the wildlife program in Wisconsin and elsewhere. With adequate resources, opportunities for economic incentives and technical advice to private landowners can be enhanced. Every landowner is different in the way they approach their land and what attributes they are seeking to gain. Any private lands management program must therefore be aware of these differences and offer a variety of options and a continuum of opportunities that allow the property owner to pick the program that best fits their needs. At the same time, we must also work to change the attitudes of landowners towards bobwhite and other farm wildlife. The property owner must have an interest in wildlife and be willing to invest his resources if bobwhite habitat management is to be a success. Whereas much bobwhite habitat has been lost or severely fragmented in the last several decades, there are still opportunities to restore habitat for this important upland game bird in the Upper Midwest.

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