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COMMON BARN-OWL POPULATION DECLINE IN OHIO AND THE RELATIONSHIP TO AGRICULTURAL TRENDS

By Bruce A. Colvin

The Common Barn-Owl (*Tyto alba pratincola*) is a species of open country (Stewart 1952a) characteristically found near grasslands. The barn-owl is known for a close association with man and agriculture because it often is observed roosting or nesting on farmsteads. Population changes have been occurring in North America over the past 30 years (Stewart 1980); drastic declines have been noted in midwestern states (Tate 1981).

In Ohio, both the barn-owl population and agriculture have varied greatly over the past 100 years. Originally, the barn-owl probably was absent or extremely rare in Ohio (Bales 1909); it was first documented there by Wheaton (1861). Trautman (1940) stated that the forested conditions of pioneer times were not suited to the barn-owl, but that the species increased greatly with the clearing of the country. By the 1920s and 1930s, the species was well established in Ohio (Earl 1934). However, since the 1930s, the barn-owl population in Ohio has declined, and the barn-owl again is considered to be rare (Smith et al. 1973). In 1982 only 2 nesting pairs of barn-owls were recorded: 1 by the Ohio Division of Wildlife (D. Case, pers. comm.) and 1 by Peterjohn (1982).

Several factors have been suggested as possible contributors to changes in barn-owl populations, including shooting, winter mortality, pesticides, nest site loss, and prey cycles (Stewart 1952b, Henny 1969, Klass et al. 1978, Petersen 1979, Stewart 1980). I contend, however, that availability of foraging habitat (i.e., selected prey resources) should be considered as a crucial limiting factor on barn-owl populations.

Barn-owls forage upon small mammals of particular size (Marti 1974, Colvin 1984). Microtines are the dominant prey in midwestern states (Errington 1932, Wallace 1948, Phillips 1951, Dexter 1978), and these rodents, or similar-sized prey, also prevail in barn-owl diets in other regions of the United States (Pearson and Pearson 1947, Boyd and Shriner 1954, Parmalee 1954, Maser and Brodie 1966, Smith et al. 1972, Marti 1973). Microtine rodents found in grassland habitats are taken selectively by barn-owls over alternative prey, and the availability of microtine populations has been related to the number and distribution of barn-owl nests observed in an area, as well as to annual productivity (Colvin 1984). In addition, radio-tracking of barn-owls has shown that owls intercept grass habitats more often than by chance alone and that owls commonly range 2 km from nest sites to forage in grassland habitats inhabited by voles; some birds regularly hunt over 3 km from their nest sites (Colvin 1984, Hegdal and Blaskiewicz 1984). From 1979-1982, I documented 33 barn-owl nestings in Ohio, and all were in areas with grassland or wet meadow habitats.

Emlen (1966) suggested that the extent to which predators tend to pass by potential food items may be used to evaluate the role of food in the population limitation of a predator species. Thus, one might predict, given highly restrictive, stereotyped, and selective foraging behavior, that availability of particular prey resources would in fact limit barn-owl populations. In order to test this prediction, barn-owl population trends in twentieth century Ohio and agricultural practices that affect the availability of grassland foraging habitat (i.e., vole habitat) were compared. Declines in grassland habitats would be expected to result in decines in barn-owl populations.

METHODS

Common Barn-Owl observations made on Christmas Bird Counts in Ohio (1907–1983) were examined, and those observations made over a 50-year period (1931–1980) were compared to several agricultural variables for the same period. The number of owls observed and the number of bird-watcher parties (i.e., groups) were tabulated from annual Christmas Count reports (Bird Lore 1907–1940, Audubon Magazine 1941–1946, Audubon Field Notes 1947–1970, American Birds 1971–1981). The owl data then were grouped into 5-year blocks (total no. owls obs./total no. parties in a 5-year period) to compensate for yearly inconsistencies, such as variations in weather or observer expertise (Arbib 1967, Falk 1979). The number of owls observed/party was used as the population index rather than owls observed/party-hour. Because barn-owls are highly nocturnal and typically are observed by bird watchers at specific and accessible roost sites (e.g., barns, silos, abandoned buildings), I believe that observations of them on Christmas Bird Counts in Ohio are usually a result of checking previously known roost sites rather than random encounters.

The agricultural variables, chosen on the basis of major crops and/or their likely association with grassland availability, included: numbers of sheep, milk cows, horses/mules, and beef cattle; hectares of corn, hay, and soybeans; and numbers of farms and farm acreage. Agriculture data, reported as annual estimates, were provided by the Ohio Crop Reporting Service (U.S. Dept. Agr., Statistical Reporting Service, Columbus, Ohio). Agriculture data were grouped into the same 5-year blocks as the owl data, and an annual mean was calculated for each agricultural variable for each 5-year period (e.g., mean ha soybeans/year 1951–1955). A correlation matrix, using the ten 5-year periods (1931–1935 through 1976–1980), showed that the agricultural variables were highly intercorrelated. Thus, I used principal component analysis (PCA) to summarize this interrelatedness (Thorndike 1978, SAS 1982). The resulting Ohio agricultural trend was interpreted from factor loadings, which represented the correlation between the original variables and the new component. A correlation coefficient then was calculated between the principal component generated by PCA and barn-owl population trends for the same time period (1931–1980). Numbers of horses/

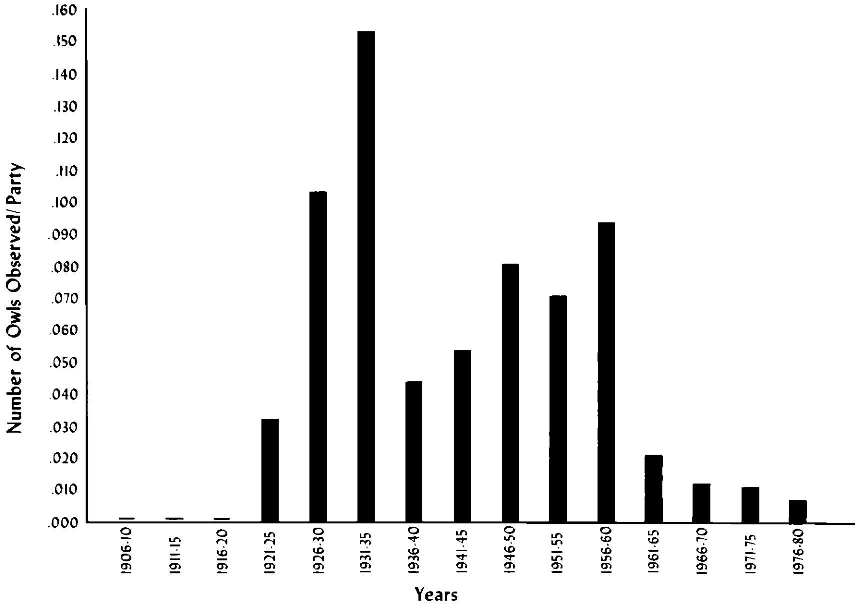

FIGURE 1. Common Barn-Owl population trends in Ohio summarized from Audubon Christmas Count data. Results from counts 1906–1980 are shown; the first barn-owl observed on a Christmas Bird Count was 1921.

mules were not used in the multivariate analysis because data only were available for 1931–1960.

RESULTS

Christmas Bird Counts from 1930 through 1980 illustrated the Common Barn-Owl population decline in Ohio (Fig. 1). The decline probably was even more drastic than shown from these data because of a "rare bird effect," meaning increased eagerness by bird watchers to list the owl. The peak in the Ohio barn-owl population was 1931–1935 (index value = .153); the population index was .007 for 1976–1980. In 1981, the index value was .002 (1 owl observed, 503 parties); no barn-owls were observed on the 1982 Ohio Count (543 parties); and in 1983, the index value was again .002 (1 owl observed, 537 parties).

Since the 1930s, agriculture in Ohio showed declines in sheep and milk industries, numbers of horses and mules on farms, and hay production (Figs. 2, 3). Declines in numbers of farms and farm acreage also occurred (Fig. 4). The trend represented by these variables could be described as replacement of grass-associated agriculture by row-crop (i.e., grain-related) farming on a reduced total acreage of farmland.

The first principal component represented the correlated changes in Ohio agricultural practices (Table 1). Seven of 8 agricultural variables were highly correlated with this component, whereas corn was corre-

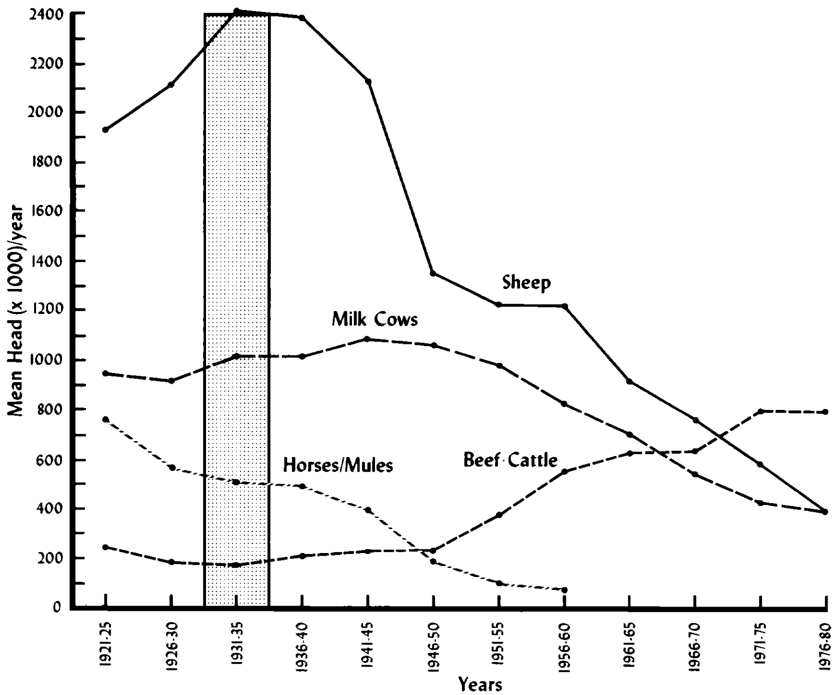

FIGURE 2. Sheep, milk cows, horses/mules, and beef cattle in Ohio, 1921–1980, as estimated by the Ohio Crop Reporting Service. Number of horses and mules was not estimated after 1960. Shaded portion represents the peak in the Ohio barn-owl population.

lated with component 2. Component 1 accounted for 83.6% of the total variation in the agricultural variables. Soybeans and beef cattle loaded negatively in component 1, while the other 5 variables loaded positively. Thus, component 1 clearly represented replacement of grass-associated agriculture by row-crop (i.e., grain-related) farming on a reduced amount of total farmland. Common Barn-Owl population indices were highly correlated with this agricultural change ($r = .7324$, $P = .016$).

The 2 agricultural variables that might best reflect changes in available grassland habitat are hay and soybean production. Soybean acreage first surpassed hay acreage in 1961–1965 (Fig. 3), and since then the barn-owl population in Ohio has been in a major decline without suggestion of recovery (Fig. 1).

DISCUSSION

Laub et al. (1979) described changing land use in Ohio and stated that the increasing trend of wildlife which associate with open lands probably continued into the 1930s, when Ohio's forest acreage stopped declining. Sitterely (1976) also discussed the changes in Ohio land use

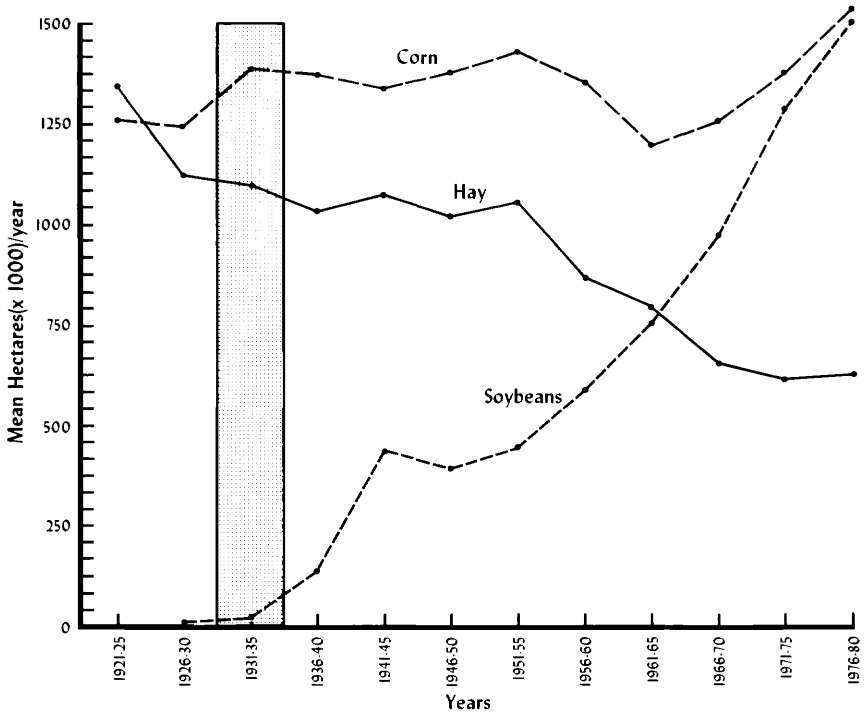

FIGURE 3. Corn, hay, and soybean production in Ohio, 1921–1980, as estimated by the Ohio Crop Reporting Service. Shaded portion represents the peak in the Ohio barn-owl population.

and stated that, until the 1940s, there were 6 different crop rotations generally used in Ohio; and all consisted of 1–2 years of meadow. He also noted that it was rare if less than 25% of a farmer's cropland was in meadow (20% in northwest Ohio). Farming was intensified in the early 1940s, grain crops emphasized, crop fields enlarged, and brushy fencerows and idle areas eliminated (Laub et al. 1979). The need for pasture declined because of decline in sheep and dairy industries and feedlot use for beef cattle. Mechanized farming replaced a need for horses and mules; by 1960, numbers of horses and mules on farms had dropped so low that the Ohio Crop Reporting Service no longer estimated their numbers (H. Carter, pers. comm.).

By the 1950s, crop rotations that included meadow were being replaced by 2-year rotations of corn and soybeans because of the use of commercial fertilizers (Laub et al. 1979). Acreage of row crops increased, in particular soybeans from 12,500 ha harvested in 1930 to 1,522,000 ha harvested in 1980. Sitterely (1976) explained that currently many farmers maintain 100% of their cropland in intertilled crops; farm machinery now greatly reduces labor costs associated with

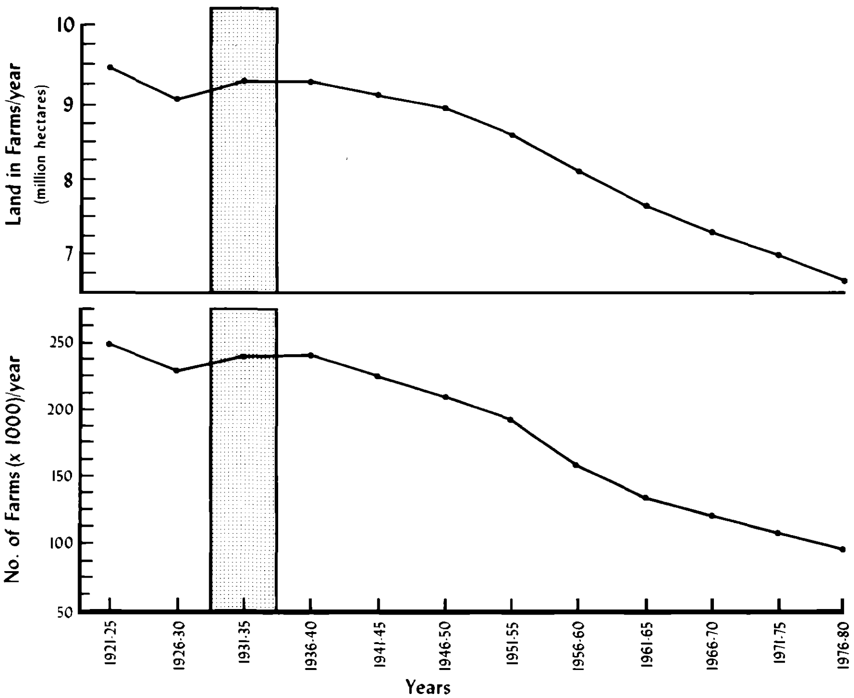

FIGURE 4. Land in farms and number of farms in Ohio, 1921–1980, as recorded by the Ohio Crop Reporting Service. Shaded portion represents the peak in the Ohio barn-owl population.

intertilled crops, and no-till planters make it possible to grow more corn and less meadow in hilly portions of the state where soil erosion can be a problem. Farm acreage and number of farms have declined in twentieth century Ohio; those farms which remain are larger and more efficiently managed (Laub et al. 1979). These agricultural trends observed in Ohio would be expected to cause a decrease in Common Barn-Owl numbers.

Certainly, small mammals such as house mouse (*Mus musculus*), white-footed mouse (*Peromyscus leucopus*), and short-tailed shrew (*Blarina brevicauda*) that are found in a wide variety of habitats still would have been available in large numbers to owls as this transition from grass-associated agriculture to intensive row-crop farming occurred. However, availability of the selected prey, meadow vole (*Microtus pennsylvanicus*), would have become limited with the major reduction in available grassland (i.e., vole) habitats.

Although foraging habitat (i.e., particular prey) availability does influence barn-owl populations, and given that the agricultural variables examined showed a strong association with barn-owl population trends, suggestive of cause and effect and reasonably interpreted as such, other

TABLE 1. Results of principal component analysis using 8 agricultural variables (Ohio, 1931–1980).

Variables	Factor loadings
Number sheep	0.940
Number cows	0.974
Number beef cattle	−0.987
Ha corn	−0.083
Ha hay	0.975
Ha soybeans	−0.971
Ha farmland	0.992
Number farms	0.999
Eigenvalue	6.688
Variance explained by component 1	83.6%

variables also may have played a role in barn-owl population changes. For example, the availability of nest sites also may be a limiting factor (Marti et al. 1979). However, in contrast to selective behavior for foraging habitat, barn-owls are relatively opportunistic in terms of nest sites and may readily use tree cavities or a variety of man-made structures (e.g., barns, silos, chimneys, water towers, abandoned houses) when appropriate foraging habitat and prey are available (Colvin et al. 1985). This opportunistic use of nest sites is not surprising given the limited longevity of natural nest sites (e.g., tree cavities, holes in cut-banks). For example, in New Jersey, out of 44 different nest trees identified, 32% of the trees or their nest cavities were lost permanently; and 18% of the nest cavities were lost for at least 1 year over a 4-year period (Colvin 1984).

Inspection of man-made structures (or nest boxes) alone for nesting or roosting owls is a highly-biased procedure for finding or evaluating barn-owl nesting and likely has often resulted in disproportionate emphasis on their use by owls. Natural nest sites (i.e., tree cavities) and non-farmstead roost sites can be difficult to find, especially given the nocturnal and relatively secretive habits of the barn-owl.

Nest boxes on farmsteads provide places to look for barn-owls and, when used, should not be interpreted as evidence that owls just started nesting in an area. For example, intensive searches for barn-owl nest sites were made at a New Jersey study area (approx. 1150 km^2) over a 5-year period and, out of 237 nestings (or attempts) among 94 nest sites, 72% of all non-nest-box nestings were in trees and 28% were in man-made structures (66% and 34%, respectively, before nest boxes were installed). Even these proportions of nests in man-made structures, particularly the first year, should be considered biased high, because principal search efforts focused on structures. Also, although 30% of all nestings were in nest boxes the first year that boxes were available, and 69% after 4 years, there was no increase observed in the total number of nests within the study area, simply a shift of the nesting population into the boxes (Colvin 1984). Of the tree nest sites, 34% were actually in towns that immediately bordered agricultural areas with microtine habitats. In addition, radio-tracking repeatedly showed frequent use of woodlots by owls for daytime roosting, and roost sites regularly could be as far as 4–5 km from a farmstead nest site (Hegdal and Blaskiewicz 1984). (Hegdal and I made similar observations when radio-tracking 2 adult and 1 fledgling barn-owl in Ohio in 1981).

Many historic barn-owl nest sites can be found in Ohio today. For example, nest boxes for barn-owls have been available in northwest Ohio since the 1940s and 1950s; and although commonly used, particularly in the mid 1950s, their use steadily declined (L. Van Camp, pers. comm.). From 1941–1974, Van Camp documented 132 Common Barn-Owl nestings (banded 633 owls) in northwest Ohio, and almost all were in nest boxes. The last nest box used was in 1974, even though many of the boxes still are available. Also, no nesting has been observed in 15 nest boxes that were erected and available for the past 3 nesting seasons in some of the historic barn-owl areas of northwest Ohio (M. Shieldcastle, pers. comm.). Van Camp (pers. comm.) also noted the change from grass-associated agriculture to intensive row-crop farming in his northwest Ohio study area.

Natural nest sites would have been available to barn-owls in nineteenth century Ohio, but it was not until forests were cleared and grass-associated agriculture expanded in the late nineteenth and early twentieth centuries that barn-owls extended their range into Ohio. Although natural nest sites (i.e., tree cavities) and a variety of man-made structures generally still are available in Ohio, the barn-owl population has not persisted well. Yet, in some situations today, nest sites, and particularly secure nest sites, may not be available where grasslands remain with adequate microtine populations to support barn-owl nesting.

Winter weather may influence barn-owl populations. The barn-owl in the United States is more of a southern species (Wallace 1948), and winter mortalities in Ohio and other portions of its northern range have been described (Stewart 1952a,b). Johnson (1974) found that the insulating quality of barn-owl feathering was lower than expected for a bird that size and suggested that the use of man-made structures by barn-owls for roosting may act to supplement plumage in heat retention. Some fluctuations observed in the barn-owl population in Ohio (Fig. 1) likely are a result of years with extreme winter conditions of cold and/or snow cover.

Pesticides, however, probably have not played a major role in barn-owl population changes. Organochlorine pesticides are thought not to have had the severe effect on barn-owls that has occurred with various other raptor species (Henny 1972, Mendenhall et al. 1983). Barn-owls consume largely small mammal prey from grasslands, rather than from woodlands or crop fields, and therefore would have been less subject to contamination from organochlorine insecticides than those raptors which interact largely with insect, bird, or aquatic food chains and habitats of high pesticide use.

Because barn-owls take large numbers of rodent prey and may nest on farmsteads, it has been hypothesized that rodenticide use on farmsteads has affected maintenance of barn-owl populations. However, investigations have shown that the potential for secondary poisoning of barn-owls from such rodenticide use is low and should not impact on maintenance of stable barn-owl populations (Colvin 1984, Hegdal and Blaskiewicz 1984). While there is a regional-specific (i.e., Midwest) population decline of the barn-owl, in other parts of the United States its populations continue to be relatively stable and even expanding (Stewart 1980), and this would not be predicted if current widespread pesticide use was a principal cause of barn-owl population decline.

The importance of appropriate prey resources to barn-owl population maintenance is centered in the life-history strategy of the species. Natural selection has favored a life history that maximizes productivity and energy investment in reproduction. Unlike most birds of prey that generally have K-selected traits (i.e., small brood size, long maturation time, long-lived), the barn-owl has *r*-selected traits that include large brood size, more than one brood per year possible, nesting in almost any month possible, and short maturation time (Colvin 1984). The *r*-selected nature of the barn-owl coincides with an *r*-selected prey population (e.g., microtines) and apparently allows barn-owl populations to quickly increase in number if adequate foraging habitat and selected prey are available (e.g., original spread into Ohio). I believe this life-history strategy has been favored because of an oscillating prey population (Garsd and Howard 1981) combined with potentially high juvenile mortality and relatively short adult life in barn-owls (Stewart 1952a, Henny 1969, Colvin 1984). The negative effect that winter conditions have on barn-owls in the northern portion of their North American range (e.g., Ohio) would appear to further limit barn-owl population growth and accentuate selection for high *r*. The high level of energy (i.e., vole) resources required to support this reproductive strategy might be deduced from examination of pellet material at nest sites. For example, based on pellet analysis and varying numbers of young at 16 barn-owl nest sites (6 Ohio, 10 New Jersey), I roughly estimate that 600 voles (approximately 76% of total diet biomass) could be consumed by a brood of 6 young from hatching through fledging (10 weeks of age).

Petersen (1979) in Wisconsin, Lerg and Maley (1980) in Michigan, and Colvin (1982) in Ohio all have cited the importance of minimizing habitat loss to maintaining barn-owl populations. Management of barn-owl populations typically focuses on the effectiveness of nest boxes (Marti et al. 1979, Colvin 1983) in providing secure nest sites, and even winter roost sites; however, such programs must consider the effect that selected prey resources and available grassland foraging habitat have had on changes in barn-owl populations. Barn-owl management in Ohio presently includes placement of nest boxes within proximity (1–3 km) of grassland (e.g., dairy areas), marsh, or wet meadow habitats and efforts are being made to maintain and preserve grassland (vole) habitat, in part, as barn-owl foraging habitat. Because of the nocturnal and secretive habits of the barn-owl, however, it will continue to be difficult to assess actual population levels. I project that the Ohio population will continue to be limited and localized only to areas with appropriate foraging habitat, given current trends in agriculture.

SUMMARY

Agricultural changes in Ohio over the past 50 years have resulted in less favorable Common Barn-Owl habitat (i.e., grasslands); and, as expected, a relationship does exist between several agricultural variables that reflect the availability of grasslands and barn-owl population decline. Just as a developing agriculture originally facilitated spread of the barn-owl into Ohio, a changing agriculture appears to subsequently have forced its decline. The intensifiction of farming in the 1950s and 1960s had negative effects on many different raptor species through pesticide use (e.g., DDT); however, intensification of farming practices and the general decline in farm acreage in Ohio appear to have affected barn-owl populations principally through loss of foraging habitat (i.e., grasslands). The importance of particular prey populations (i.e., energy resources) needed to maintain the high level of productivity in the barn-owl should be considered when interpreting population changes and considering species management.

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