17 Managing Woodlands in Agricultural Environments

Clearing forest land for agriculture is a practice that has been ongoing for millennia. The process initially begins as a landowner enters a forest and clears enough land to meet the needs of a family. But when considering a landscape within which this occurs, the forest is still the matrix condition perforated by agriculture, at least initially. New settlers arrive, or the existing settlers realize that not only can they provide food for themselves but they can also sell excess food to others, so deforestation continues. Eventually, agricultural fields and pastures become the matrix condition with isolated patches of forest, or woodlots, remaining scattered throughout the landscape. If the landowner finds value in the remaining woodlots, then they are maintained, but if not, then they too are cleared and forest is lost until agricultural production is abandoned on that site. Much of New England is forest that was once agricultural fields or pastures, as evidenced by stone walls now criss-crossing a mature forest that has grown up over the past 70–150 years.

Much of the early research into the effects of forest fragmentation on a wide range of species was based on clearing forest land for agriculture until isolated woodlots remain within an agricultural matrix (Robbins et al. 1989, Villard et al. 1999). Hence, we know that many species associated with forests in the eastern United States are adversely affected by conversion to agriculture that leaves remaining woodlands in small patches that are disconnected from one another. The process continues to this day in the temperate and tropical regions of the world. Conversion to agriculture is a very broad sweeping term. What kind of agriculture—grazing, crops, livestock, etc.? Does it make a difference how the forest is converted and for what purpose? Belanger and Grenier (2002) reported changes in eastern Canada that have been documented in many other studies: As the area of land in agriculture increases, the number of woodlots increases but woodlot size decreases. They also reported that fragmentation increased along a gradient from dairy farms to intensive cash-crop agriculture. It would appear that the type of agriculture does influence the landscape structure and quite likely has effects on the species of animals and plants that can remain on the landscape. For some species, such as area-sensitive bird species (e.g., ovenbird), such changes in the configuration of the landscape can lead to regional declines in habitat and populations. For others, such as some bat species, fragmenting forests can lead to higher numbers of individuals (Ethier and Fahrig 2011). The purpose of this chapter is not to revisit the effects of forest fragmentation, but rather to ask what changes may be made to how we manage woodlots and the surrounding agricultural lands to alter habitat quality for selected species.

Management of woodlots in agricultural systems can be challenging, depending on the goals of the landowner. Nearly all woodlots are on private lands, so unless the landowner has another source of income, the land is the economic engine for the owner. Economics plays a large role in decisions (Arnold 1987). Small family farms may be in business to provide sufficient income on an annual basis to meet the collective family needs, which, at the very least, may be subsistence, or in highly productive areas, may include aesthetic and recreational goals. Industrial farms, on the other hand, may be less inclined to retain woodlots since profit margins drive many decisions, but even under these circumstances macroeconomics (world food prices), regulatory considerations (e.g., clean water act), or diversifying the portfolio with multiple uses (e.g., crop production and hunting leases), may result in woodlots being retained or even created on private lands. Alexander (2012) suggested that although the agricultural lands on small farms are intensively managed, small farm owners were more likely to retain woodlands than large farms. Further, the small farms studied by Alexander (2012) provided more jobs and allowed greater public accessibility than industrial farms—two important social benefits. But Alexander's (2012) results may not be applicable to all farm systems. Lovell et al. (2010) reported that larger farms in Vermont had more forest cover arranged in a more complex configuration than small farms, but farmers in that area may have benefited economically from retention of forest lands more than farmers in other areas.

VALUE OF WOODLOTS TO LANDOWNERS

Many landowners do find value in retaining woodlots, and other landowners integrate forests into their agricultural production using an approach called agroforestry (Lawrence et al. 2010). Woodlots provide firewood, a place to hunt, or simply enjoy forest wildlife, protect a wetland that otherwise is unsuitable for crop production, protect a field from wind erosion, or may provide food (e.g., acorns) and shade for livestock.

Farmers in Vermont derived firewood, timber, maple sugar, edible fruits and nuts, and wood crafts from their forest lands—direct economic benefits from woodlot retention (Lovell et al. 2010).

Alternatively, woodlots may also provide habitat for species of animals that can reduce crop yields. Damage to corn and other crops by raccoons (Beasley and Rhodes 2008), squirrels, deer, turkeys, and bears can be exacerbated if forest cover is adjacent to crops. Species that are associated with grasslands may be less abundant near forested edges, and some of these may damage crops (Delattre et al. 2009) while others may be desirable (Ribic et al. 2009). As with all situations involving habitat management, there are tradeoffs. Not all species will be benefited by any one management strategy. Sanderson et al. (2009) found that although farms with a high proportion of grassland and woody edge are likely to provide habitat for many of Poland's farmland bird species, not all are benefited; species-specific management would be needed for species that avoid woodland edges.

EDGE EFFECTS IN AGRICULTURAL SETTINGS

Predation, brood parasitism, and nest destruction are concerns for many species that use forest edges in agricultural landscapes (Donovan et al. 1997). These adverse effects on birds in forest interiors are described in more detail in Chapter 15. Grassland species also can be adversely affected by fragmentation of large expanses of grasslands simply by planting trees. Although tree planting may increase overall bird diversity and abundance in a grassland or agricultural landscape, birds associated with grasslands, including species of conservation concern, may be adversely affected. To reduce these adverse effects on these area-sensitive grassland species, Reino et al. (2009) suggested clustering plantations into fewer larger patches to reduce the proliferation of edges that may have adverse effects on these area-sensitive grassland species.

Habitat Elements in Woodlots

All of the habitat elements described in previous chapters apply to management of woodlots as well. A few elements are particularly vulnerable in agricultural systems, however. If a farmer decides to allow cattle to graze through woodlots, then shrub cover and tree regeneration will be compromised, and the vertical complexity of the woodlot will be simplified. Harvest of trees for firewood or timber will reduce stand density and reduce the likelihood of competition mortality, thereby potentially reducing the number of snags and logs in these woodlots. Hence, these two activities—alone or in combination—may reduce the capacity of a woodlot to support shrub-nesting or browsing species as well as cavity nesters and log-users.

The entire farm operation can also influence how a woodlot functions as habitat. For instance, if invasive species are allowed to colonize from adjacent farm fields and are not controlled, then the species composition of the woodlot can be changed considerably. Although often more of an issue for woodlots in urban areas, the occurrence of non-native plants is frequently higher along woodlot edges in agricultural areas (Brothers and Spingam 1992). Further, birds and mammals inhabiting woodlots disperse seeds from adjacent agricultural areas into woodlots and may further exacerbate invasive species issues, especially where windbreaks and fencerows that contain invasive species are retained (Harvey 2000). These linear features in the landscape provide an avenue for dispersal from woodlot to woodlot. If invasive species are concerns, then farmers will have to be vigilant in controlling unwanted species and encouraging native species. Indeed, farmers, just as any other land manager, need to develop clear goals for their woodlots and manage the woodlot and surrounding landscape to achieve those goals (Haslem and Bennett 2008). For instance, maintaining woodlots to produce veneer oak lumber would likely entail a group selection regeneration system, with subsequent protection of the woodlot from grazing and browsing, to ensure oak regeneration (Kelty et al. 2003). A woodlot managed for maple sugar production might see single-tree selection systems used to focus growth on those trees with large crowns for continued sap production (Kenefic and Nyland 1999).

Fencerows and Shelterbelts

Linear features that are often peculiar to farmlands are windbreaks and fencerows. Fencerows often include shrubs and trees that are the result of either wind dispersal, or—more often—dispersal of seeds by birds and mammals. Birds perch on fences, defecate, and the seeds in the feces germinate. In temperate regions, it is quite common to find fencerows dominated by cherries, roses, blackberries, barberries and other fruit-producing shrubs, usually the direct result of bird-mediated dispersal. Once established, then wind-dispersed seeds can accumulate along these fencerows. Fencerow width is restricted by active farm management, such as plowing, grazing of animals, mowing, or harvest of crops. Nonetheless, fencerows do occupy space that could be used to grow crops; and on large industrial farms, fencerows are often removed to make farming operations more efficient and profitable. In some areas, removal of fencerows, especially large and floristically diverse fencerows, can eliminate habitat for some species of small mammals on farms (Silva and Prince 2008).

Shelterbelts are strips of trees purposefully planted between fields to reduce wind speed across open fields and reduce soil erosion by wind. These strips of trees add structural and compositional complexity to the farm mosaic and are used by many species of vertebrates. They also form forest edges that can have an adverse effect on grassland interior birds (Helzer et al. 1999). Conversely, they can form corridors for potential dispersal of species associated with woody vegetation (Haas 1995). Their use by any one species of animal is largely influenced by the species of trees planted, the shrubs which develop, and the management of the adjacent fields. A dense strip of conifers adjacent to a crop field may be used heavily in the winter as a roost site for over-wintering birds, whereas the same strip planted to deciduous trees may be more heavily used in the summer as a nest site for edge-associated species. Birds were found more likely to use fencerows for nesting in Michigan if they were wide, tall, near old-fields, and contained shrubs (Shalaway 1985). But of course these are the very characteristics that take up additional growing space for crops. Farmers are faced with economic tradeoffs between crop production and habitat when considering shelterbelt and fencerow management.

LOSS OF FORESTS IN INDUSTRIAL AGRICULTURAL SETTINGS

The proliferation of industrial agriculture in meeting the food needs of a growing human population is associated with many environmental concerns (Horrigan et al. 2002). Industrial agriculture treats farms as factories for commodities to be produced as economically as possible, typically over large areas. The rate of forest loss for this purpose is staggering in some parts of the world. In the Brazilian Amazon alone, the rate of forest conversion from 1978 to 2000 ranged from 1.4 to 2 million hectares per year (Lawrence et al. 2001).

Loss of forest land is not simply due to industrial agriculture. Small family farms, which often include a woodlot, already have their lands managed for food production, but the tenure of those lands in the United States is in question due to changes in demographics and costs associated with inheritance taxes that make retaining the farm in the family more difficult. The easy thing for many heirs to do is to sell the family farm to an industrial farm or to a developer who will build homes; so the farm and the woodlot are lost.

The adverse environmental effects of industrial agriculture, including loss of some of the most productive forests in the world, gave rise to more attention to sustainable agricultural systems, and conversion of small farms to housing has led to social changes in the United States. Organic farming, community and urban farms, farmers markets, restaurants specializing in locally grown foods, and gardening grew in popularity over the past few decades, at least partly in response to the environmental concerns associated with industrial agriculture and loss of farmland. But, recently, a new agricultural product has emerged that will likely increase land area in industrial agriculture and perhaps even bring lands that were abandoned in the past back into agricultural production: biofuels. The demand for fuel as well as food and fiber will exert increasing pressure on agricultural lands and increase the likelihood that small farms will be consolidated and that forests will be converted to biofuel production. Ethanol and biodiesel production is increasing; in one year, ethanol production increased by 1 billion gallons and biodiesel production increased from 75 million to 250 million gallons in the United States alone (Altieri 2009). Unless consideration is given to balancing long-term ecological effects of production with increased demands, we can expect to see environmental issues arising from industrial agricultural production of food, fiber, and fuel (Altieri 2009).

FIELD AND FARM MANAGEMENT THAT INFLUENCES WOODLOT FUNCTION

How or whether species of animals will use a woodlot are functions of both the woodlot structure and composition, as well as the types of management activities that occur adjacent to the woodlot. Many species using woodlots also use the surrounding fields as foraging sites. Deer, raccoons, squirrels, quail, and many species of woodland birds and mammals will venture into fields to feed on seeds and insects along woodland edges. The availability of seeds, insects, and other food resources to these species in adjacent fields is influenced by the manner in which the field is managed. It is the juxtaposition of the woodlot and its ability to provide habitat elements with the field that can provide food resources for species able to use the woodlot.

Annual Crop Management

When managing annual crops such as corn, soybeans, wheat, and most other grains that we rely on for our food staples, the fields are typically planted in the spring and harvested in the fall. To prepare the field for planting, the field is often plowed and disked prior to planting so as to create a good seed-bed and also to help to remove competing weeds. Plowing can be done after the crop is harvested in the previous fall, which is when the fields are often less muddy and more likely to allow access to machinery, or in the spring when, following snow-melt, plowing may be delayed due to mud. However, by delaying plowing until spring any waste grain left on the field following harvest remains on the field through the winter and is available to animals living in the adjacent woodlots. Spring plowing, though often more difficult, is preferable if providing food to woodlot-associated species is a goal.

Many farmers are moving toward no-till approaches to soil management. Rather than plowing and disking prior to planting, the next crop is planted through the stubble from the previous year, and either a preemergent herbicide is applied to prevent competition from weeds or some type of mulch is applied (as is most often the case with organic farming). For large farms, use of mulch may be time- and cost-prohibitive so herbicides are typically used, and this may raise concerns about effects on some species, especially amphibians (Relyea 2012). The advantage to this approach is that waste grain again remains on the site for a longer period of time and provides food. Further, the machinery makes fewer passes over the land each year, and the plant material remaining after harvest can decompose on the site, adding an organic layer to the soil.

Grazing Management

When the focus of a farm is production of dairy products, wool, or meat, then, typically, there are both crop management issues (hay and silage for the animals) and grazing area management issues to consider, adjacent to woodlots. Just as forests provide habitat for different species of animals based on its horizontal and vertical structure and composition, grasslands function in a very similar manner. If pastures adjacent to woodlots are grazed continually and at a high intensity, then the structure of the pasture will be simple, homogenous, and dominated by those species of plants that the livestock eats the least. This may be an ideal situation for American robins and killdeer, but not necessarily for other species. Alternatively, if livestock are rotated among pastures and pastures are allowed to recover from grazing pressure, then the structure will be more complex, both vertically as well as (often) horizontally, offering opportunities for use by other species, such as common flickers and accipiter hawks, along woodland edges. Rotational grazing also increases the complexity of the landscape as a whole by providing fields in various stages of recovery.

Several factors can be manipulated to influence the structure and composition of the pastures. Grazing intensity, or the number of livestock per unit area, can be controlled. Historically, this was managed using Animal Unit Months (AUMs), or the forage eaten by a cow and a calf in one month. Pastures with different capacity for net primary production have different allowable AUMs. The frequency with which livestock are rotated from one field to another influences the impact and recovery time on any one field. The type of livestock can also play a role, with sheep, goats, and horses (which have incisors on the upper and lower jaws) more likely to affect roots of plants than cattle (which lack incisors on the upper jaw). Finally, the species of grasses and forbs planted in the pastures can play an important role in determining field structure and composition. If forbs such as clover, alfalfa, and other broad-leafed plants are available, then use of the field by quail may be more likely than if these species were absent. Use of cool-season grasses (species that put on most of their growth in the fall and spring) vs. warm season grasses (species that grow most rapidly in mid-summer) influence the seasonal structure of the pastures.

Managing fields for forage production, by harvesting and storing hay as food for livestock through the winter, presents challenges for some grassland birds and opportunities for species associated with woodlots. When hay is cut prior to July 15 in temperate regions of North America, some grassland birds, such as bobolinks and meadowlarks, may still have young in the nest. Delaying harvest allows these young birds to fledge prior to harvest of hay, and, depending on the types of grasses, can have minimal effects on forage quality (Nocera et al. 2005, 2007).

Land Sparing

Setting aside farmland as fallow for a year or more can provide additional benefits to species in adjacent woodlots (Quinn et al. 2012). The Conservation Reserve Program in the United States was designed to set some farmlands aside for 10–15 years and use other soil conservation practices to reduce the rate of soil erosion from intensively managed regions of the country. By managing farms with a portion set aside to control erosion, maintaining riparian buffers, using a cropping system that reduces or eliminates tillage, and vegetated ditches, the complexity of an otherwise homogenous industrial farm can be enhanced, and the diversity of species that can occur on the farm increases. All of these actions cost money; however, if farmers can see the long-term economic advantages to soil conservation measures while also realizing benefits to various species of wildlife, then they are more likely to continue to manage woodlots, fallow fields, and vegetated waterways.

Since entire textbooks have been written dealing with management of wildlife in agricultural settings, the above management options only scratch the surface of the options that are available and the effects that can be seen on species of animals using adjacent woodlots.

SPECIALTY CROPS AND AGROFORESTRY

Specialty crops, especially woody perennial crops, may be the focus of a farm, or they may be incorporated into other aspects of the farming operation. Incorporation of woody plants into a farm operation, or agroforestry, can provide benefits for some species that associate with both trees and agricultural lands. Johnson and Beck (1988) and Jose (2009) suggested that there are several advantages to employing agroforestry over traditional farming practices, when conservation of biodiversity is a goal:

1. Agroforestry may provide habitat for species that can tolerate disturbance but maintains essential habitat elements.
2. Agroforestry may preserve germplasm of sensitive species that would otherwise be lost.
3. Agroforestry helps to reduce the rates of conversion of natural forests by providing an alternative to traditional agricultural systems that would simply clear the forest.
4. Agroforestry provides connectivity by creating corridors between habitat remnants that may contribute to the integrity of these remnants as functional pieces of a metapopulation.
5. Agroforestry helps conserve biological diversity by providing other ecosystem services, such as erosion control and water recharge, thereby preventing the degradation and loss of surrounding habitat.
6. Agroforestry practices also provide more habitat elements than traditional agriculture by increasing structural and compositional plant diversity on the landscape.

Incorporation of woody crops, windbreaks, fencerows, and riparian buffers offers the only woody habitat for animals in many agriculture-dominated landscapes (Johnson and Beck 1988, Jose 2009). But even retention of individual trees in pastures, field edges, or areas that are of low crop productivity has benefits. DeMars et al. (2010) referred to remnant trees in agricultural settings as keystone features that played a disproportionate role in contributing to biodiversity in farmlands. Retention of existing trees and recruitment of replacement trees should be considered, if farms wish to support as diverse a set of species as possible. However, scattered trees in extensive grasslands may reduce habitat quality for species that require extensive grasslands. These scattered trees may allow predators and brood parasites to more successfully locate nests in the grasslands. Agroforestry has been commonly practiced in some tropical countries, and the benefits of including woody vegetation in tropical farms have been recorded in some areas. Bhaghat et al. (2008) found that more mobile species, such as some species of bats and other mammals, as well as birds, used agroforests while less mobile organisms, such as some species of plants, were less likely to use agroforests. Regardless of tropical or temperate settings, adding trees to otherwise homogenous agricultural settings, even in small amounts, can add significantly to the diversity of animal species that can be supported on the farm (McComb et al. 2005).

ORGANIC VERSUS TRADITIONAL AGRICULTURE

Organic farming has grown in popularity in the past few decades and continues to be an important component of agricultural landscapes, especially in proximity to population centers. Organic farming systems generally support a richer community of plants and animals than conventional systems although that may be dependent on how the traditional farm is managed. Further, the context or the conditions that surround the organic or traditional farm play a significant role in contributing to biodiversity in these agricultural areas (Gomiero et al. 2011). Each species responds to agricultural practices at different spatial scales, so it is the complexity over a landscape, which may be influenced by multiple farmers, that contributes to species observed on any one farm (Gabriel et al. 2010). Consequently, the surrounding landscape may either enhance or reduce the effects of organic farming in supporting higher levels of biodiversity than traditional farming (Smith et al. 2010, Winqvist et al. 2012). In homogeneous landscapes, organic farms can support more species and more individuals of seed-eating birds than conventional farms, but this difference was not detected in more complex landscapes by Dänhardt et al. (2010). Batáry et al. (2010) reported similar results, and suggested that incorporating fencerows and organic farming into otherwise homogenous landscapes could support higher levels of biodiversity than homogenous farms alone.

Why do we see higher levels of biodiversity in homogenous landscapes in which organic farming methods are used? Organic farms tend to be more complex systems than traditional farms, and as such, provide more habitat elements for more species than traditional farms (Norton et al. 2009). Smith et al. (2011) reported positive effects of organic farming on biodiversity in 62 of 82 studies they reviewed and concluded that this was due to factors that tended to increase the complexity of the area:

- Avoidance of pesticides and inorganic fertilizers
- Rotation of crops that include grasses and forbs, and mixed crops
- Raising a variety of crops
- Permanent pastures and fencerows
- Restricted use of manure
- Including a variety of livestock species

But having a high level of biodiversity does not mean that all species would be supported. There will be winners and losers with any management approach. If we wish to support as many species as possible, then we need to begin thinking about how to arrange agricultural landscapes, which include woodlots, fencerows, riparian areas, windbreaks, and organic farms, to best meet the needs for the most species. Thinking about all of these landscape elements as part of a multifunctional landscape may be a promising approach.

MULTIFUNCTIONAL LANDSCAPES

Multifunctional agricultural landscapes attempt to find a balance between maximizing economic, ecological, and social values (Figure 17.1). Imagine a 2000 ha landscape that includes a farm and

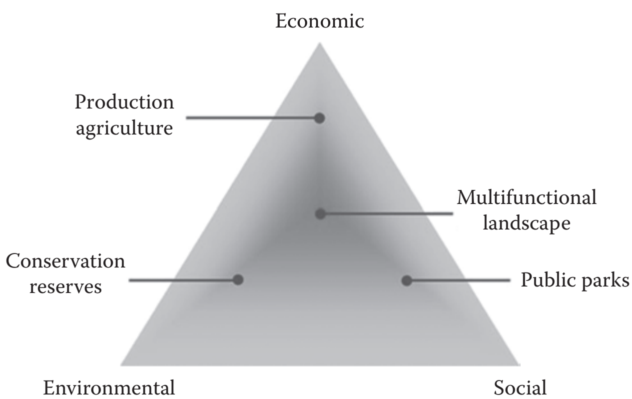

FIGURE 17.1 Conceptual framework for development of multifunctional agricultural landscapes. (From Lovell, S.T., and D.M. Johnston. 2009. *Ecology and Society* 14(1):44. With permission.)

woodlots. In an attempt to meet the needs of the broadest suite of species possible, we would look for the following landscape elements:

- Consolidation of pastures and grasslands to meet the needs for grassland interior species
- Rotational grazing, and fields with cool and warm season grasses, and varying levels of forbs to increase grassland heterogeneity
- Small crop fields managed using no-till or organic farming practices, with fields bordered by fencerows and shelterbelts
- Scattered woodlots of various sizes and in different successional stages, each containing habitat elements important to a suite of species, such as diverse tree and shrubs species, dead wood, and hollow trees
- Fencerows, shelterbelts, and riparian buffer strips connecting with one another and with the woodlots
- An extensive tract of unbroken forest, which is also connected to the fencerows, shelterbelts, and riparian buffers, for forest interior species

Such an approach would view agriculture as a part of an integrated system that extends beyond production of food and fiber to contribute to social and ecological values as well (Renting et al. 2009). But the devil is in the details: How would we best arrange all of these elements in one landscape to achieve multiple goals and meet the needs of as many species as possible? Allocating land-use over space and time must balance economic, social, and ecological goals but when done correctly can achieve desirable results at a fraction of the cost of traditional "manage vs. reserve" binary systems (Reyers et al. 2012). Clearly, forests, woodlots, shelterbelts, and riparian buffers are integral parts of such a system, and they contribute to meeting the habitat needs for many more species than would be present without these features being present.

CERTIFICATION OF AGRICULTURAL LANDS FOR WILDLIFE: THE ROLE OF TREES

Third-party certification of agroforestry and crop farms as sustainable and biodiversity-friendly is a growing trend. Certification has been proposed or implemented for crops such as coffee, rubber, cocoa, and others. Third-party certification will be discussed in more detail in a later chapter, specifically with regard to forest management and effects on biodiversity, but parallel approaches are proposed for agricultural systems as well. For instance, Food Alliance in Oregon is an organization that provides third-party certification for social and environmental responsibility in agriculture (Food Alliance 2012). Food Alliance has developed standards for wildlife habitat conservation on farms that includes continuing education, farm biodiversity plan development, and threat reduction to biodiversity. In addition, it includes many of the habitat elements of forests, as well as the landscape elements described in this chapter, in its assessment of the degree to which a farm is likely to contribute to biodiversity conservation. All in all, seven criteria are identified and rated from 1 (low) to 4 (high). There are many reasons why a farmer may wish to become certified, especially if the crops grown are specialty or high-value crops, in which a biodiversity-friendly certification may lead to a higher demand or market value. But some farmers may simply wish to "do the right thing" as a part of their farm management, because they hold a conservation ethic that they honor, while still turning a profit on the farm.

SUMMARY

Loss of forest land to agriculture to meet demands for food, fiber, and fuel is a significant concern in many parts of the world. But there is increasing awareness that farming need not all be high-impact, high-input, industrial farming. Planned as multifunctional landscapes, farm operations can retain some of the biodiversity present on the site prior to conversion, or recover aspects of biodiversity lost centuries ago. Woodlots and other woody vegetation in agricultural systems can have a disproportionate influence on supporting a diverse assemblage of plants and animals. Incorporation of fencerows, woodlots, windbreaks, riparian buffers, and scattered trees, strategically located in a farmland mosaic, can provide habitat for a richer suite of plants and animals than homogenous farm operations. There are efforts afoot to reward farmers for biodiversity-friendly practices through awards of third-party certification.

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