

An aerial photograph showing a dark, winding river or stream cutting through a dense, vibrant green forest. The trees are thick and cover the majority of the landscape, with the river meandering through them.

# **A Targeted Conservation Approach for Improving Environmental Quality**

**Multiple Benefits  
and Expanded  
Opportunities**

**IOWA STATE UNIVERSITY**  
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File: Environmental Quality 1



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# Why Care about Environmental Quality?



**Environmental quality includes clean air and water, healthy and productive soils, and habitat that is full of life—and we all depend on it.**



Among our most basic needs are clean air to breathe and clean water to drink. The cleaner these resources are in the natural environment, the less we have to spend on purifying them in our homes and municipalities. Clean environments also are safer, more attractive places for people to live, work, and play.

We all want to live in places we perceive to be healthful. Whether we are locals out for an afternoon or tourists visiting from far away, we prefer to swim, fish, canoe, and picnic around clean lakes and streams with sufficient levels of water. Many people also hope to see wildlife. According to the 2006 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation, more than 87 million Americans watch wildlife, fish, or hunt, spending \$120 billion on those activities. For some small communities, the tourism dollars generated by these activities can be significant.





**Yet, right now we are in challenging times for environmental quality.** While a boon for the agricultural economy, the recent higher prices for crops such as corn, soybean, and wheat have increased the cost of, and need for, conserving environmental quality.

In their attempts to meet production demands, farmers are under pressure to intensify production on existing cropland or plant row crops on marginal lands that otherwise would have been in pasture, hay, or enrolled in conservation programs (see *fig. 1*). This pressure to intensify production comes not only in the form of demand for the products, but also from increasing land values and rental rates that accompany the higher value of commodity crops. Thus, farmers must increase yields in attempts to meet their own rising costs.

All of these circumstances conspire to make the price of conservation more expensive and shrink the conservation land base.

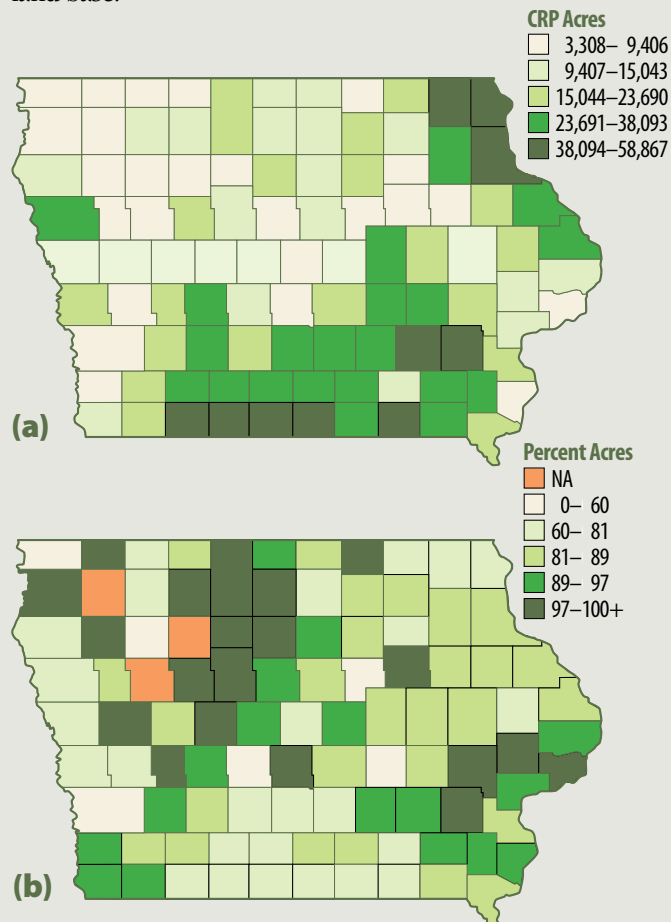


Fig. 1. (a) Acres enrolled in the Conservation Reserve Program's (CRP) general signup, and (b) percent of the 2007 eligible acres participating in CRP's re-enrollment and extension (REX) program. As of October 2007, there were almost 2 million acres of CRP in Iowa (72.4% in the general signup). Overall, 1.2 million acres were due to expire between 2007 and 2010 and were, therefore, eligible for REX. Only 66.9% of the acres have been extended or have re-enrolled, suggesting the potential for substantial loss of CRP acres.





# Targeted Approaches and Expanded Opportunities



**Targeting is touted  
as a way to do more  
conservation with less—  
less land and fewer  
resources.**

Not all portions of agricultural landscapes are equally suited to protecting or enhancing environmental quality. If conservation practices were targeted—or strategically deployed in portions of the landscape where they would have the most impact—it is expected that large improvements in environmental quality could be realized while causing only a small change in overall agricultural production. Because much of the land targeted would be marginal for producing commodity crops like corn and soybean, such a conservation approach either does not compete with agriculture for prime farmland or requires that very little prime farmland be taken out of production.

In addition to fueling higher corn and soybean prices, the emerging bioeconomy offers the potential for conservation to help pay for itself. Although industrial-scale facilities are not yet online, ethanol plants that use cellulosic feedstocks may offer comparative benefits over corn grain-based ethanol plants, suggesting cellulosic plants will be a part of the future of the bioenergy industry. Cellulosic crops such as winter triticale, switchgrass, native prairie, and fast-growing trees could better sustain our soil and water resources than row crops. Perennial plants such as switchgrass and fast-growing trees also accumulate and store substantial biomass in their roots, which helps improve soil quality and mitigate climate change.

Further economic opportunities exist (see *Perennials contribute to farm production*). Conservation practices that provide year-round cover provide important habitat for plant and animal diversity. Hunting leases can be sold where wildlife is abundant. Perennial crops, such as switchgrass and trees, provide the opportunity to engage in emerging carbon markets, since the belowground portions of these plants are substantial and remain after the aboveground portions are harvested. Agroforestry niche products including medicinal and culinary herbs, ornamental stems, mushrooms, and even fruit (berries, apples, etc.) can be part of these practices.

The remainder of this publication summarizes the need to consider targeted approaches for improving the environmental benefits related to clean air and water, productive soils, diverse wildlife and plant habitat, and biological controls for crop protection. We also discuss how targeting could work.





### **Perennials contribute to farm production.**

**Switchgrass near Lake Rathbun, Iowa**—Switchgrass, a native of Iowa's tallgrass prairie, is being grown on marginal farmland within the Lake Rathbun watershed. The switchgrass stabilizes soil, improves soil quality, sequesters carbon, and provides a cellulosic feedstock for bioenergy production. In comparison to annual crops, it requires fewer fertilizer and herbicide inputs. One producer states, "From a farmer's perspective, this is a wonderful crop to work with. It's indigenous, and when you get it in, it keeps coming back; you don't have to make those trips replanting." In test burns associated with the Chariton Valley Biomass Project, 15,647 tons of switchgrass produced 19,607 megawatt/hours of energy—enough electricity to power nearly 1,900 average-sized homes for a year.



**Agroforestry near Wapello, Iowa**—Windbreaks, shelterbelts, and riparian buffers often are touted for their soil, water, wildlife, and aesthetic benefits; however, they also can be designed to produce marketable crops. Red Fern Farm near Wapello has developed a profitable comprehensive agroforestry system. The system is based on nut-bearing trees such as black walnut, Chinese chestnut, hickory, and pecan. To further enhance the economic value of this land, either medicinal herbs—including ginseng, goldenseal, and purple coneflowers—are grown or livestock are grazed in the understory.



**Hybrid Poplar near Roland, Iowa**—Trees also could be grown as a biomass crop for bioenergy production. Trees offer numerous advantages as a biomass feedstock, including very high energy output-to-input ratios—up to 55:1. Furthermore, trees can be grown on a variety of soils and slopes and be grown right up until the time they are needed for energy production. For example, hybrid poplar trees are a component of the riparian buffer system along Bear Creek, near Roland. They were planted so their roots could help protect water quality by stabilizing the streambank and filtering nutrients. However, these poplars also provide a windbreak and a visual break in an otherwise open landscape, supply habitat for a multitude of species—including 55 species of birds—and sequester large amounts of carbon in their roots. Someday they could be harvested for their biomass and, if done properly, regrow from an established root system.

# Air Quality

One of the most significant and persistent environmental concerns in agriculture is associated with the predominant method of raising livestock in the U.S. Midwest: confinement-based animal systems. Air movement of odor, ammonia, and dust from animal production and manure storage facilities raises contentions that are socially damaging to rural communities and is under varying degrees of regulation or regulatory review.

Building type, facility management, animal diet, and climate affect the amount of odor that could be generated at production facilities. Local environmental conditions, especially wind speed and direction, vegetative cover, and topography, determine the amount of odor transported from production facilities.

A key factor contributing to rural air quality problems is that—over the last half century or so—the Iowa landscape has been converted to fairly homogeneous agricultural uses. As field sizes have increased, perennial vegetation once occupying fencerows has disappeared. Land that was once devoted to grazing, hay, and small grains has been converted to row crops, leaving much of the landscape devoid of vegetation through the winter and spring. As the landscape has lost significant vegetation

**Vegetative buffers are a targeted approach for capturing airborne particulates and reducing odor transport from livestock production facilities.**

barriers, the highly concentrated odor, ammonia, and dust emissions from livestock production facilities are able to travel unimpeded into contact with people.

**Perennial vegetative buffers** around livestock production facilities add physical and ecological complexity back into these simplified landscapes right where it is needed most (see *figs. 2 and 3*). Trees and shrubs are among the most efficient natural filtering structures because of their large overall surface area. They do their work in many ways (see *How do vegetative buffers do their work?*).

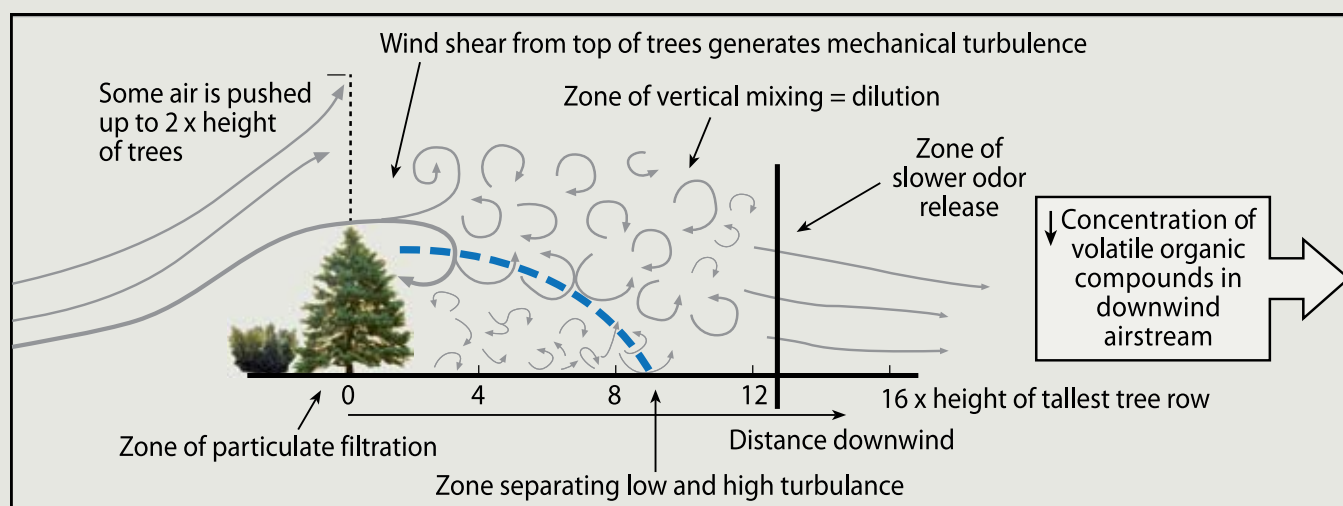


Fig. 2. Diagram displays generalized shelterbelt odor mitigation dynamics featuring increased turbulence, vertical air mixing, and particulate/odor filtration.



### How do vegetative buffers do their work?

Single or multiple rows of trees near livestock production facilities reduce the impacts of odor, ammonia, and airborne particulates through multiple mechanisms, both physical and social.

- The swaying of tree branches (i.e., mechanical turbulence) vertically mixes the atmosphere, enhancing the dilution and dispersion of odor and particulates.
- Leaves and stems directly intercept and trap odor and particulates. Dust, ammonia, and other nitrogen-based chemicals stick to the waxy cuticle covering leaf surfaces and are thus removed from the passing air. Additionally, plants have the ability to absorb ammonia through stomata—microscopic openings in the leaf surface for gas exchange—and other pathways.
- By reducing wind speeds, trees capture gravitational fallout of odor-carrying particulates from air (see *fig. 2*).
- Trees soften people's psychological response to odor by improving the aesthetics surrounding confinement facilities.
- Because vegetative buffers are highly visible and socially acceptable, producer-community relations improve as community members recognize producer efforts to lessen impacts on air quality.

It is important to many state economies that livestock production flourishes but only in a manner that respects the environment and the humans living in it. Adding a vegetative buffer around a livestock production facility can help achieve all of these goals at a modest cost. For more information, visit [www.nrem.iastate.edu/old/research/veb/index.html](http://www.nrem.iastate.edu/old/research/veb/index.html).



Planned facility site



Building, Year 1 planting (3- to 4-year-old red cedar stock)



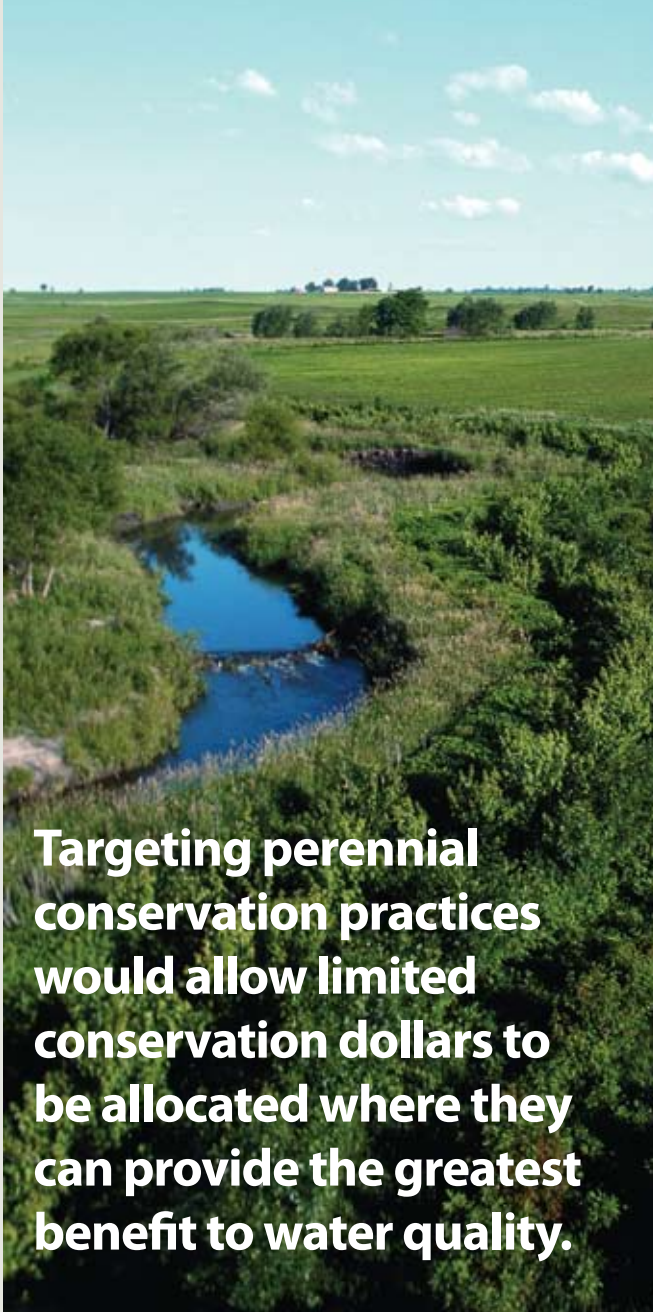
Year 5



Years 10–15

Fig. 3. Photo simulation, showing the visual impacts of installing a confined animal system and a vegetative buffer, over time. Source: Bud Malone, University of Delaware.

# Water Quality and Quantity



**Targeting perennial conservation practices would allow limited conservation dollars to be allocated where they can provide the greatest benefit to water quality.**

Fig. 4. Fully established riparian buffer containing a mixture of grasses, shrubs, and trees.

The transport of nutrients, sediment, and herbicides from agricultural lands to downstream water bodies is of concern both locally and regionally. Iowa and the rest of the Midwestern Corn Belt have been implicated as major sources of nutrients (mainly nitrate-nitrogen and phosphorous) contributing to hypoxia in the Gulf of Mexico. Historically, much of the Midwest was covered by perennial tallgrass prairie and wetlands, but most of this land has been cleared, tile-drained, and converted to row-

crop agriculture. This conversion has increased water flow and the associated transport of agricultural pollutants to downstream water bodies.

Many conservation practices have been shown to reduce the impacts of agriculture on water quality. To date, these practices have been applied through voluntary participation by farmers and without watershed-scale planning to fully realize their potential water quality benefits. Since not all agricultural areas contribute equally to degrading water quality, **there is a need to target the implementation of conservation practices** to portions of the landscape that contribute the most pollutants. The following factors need to be considered when targeting for water quality protection:

- the type and sources of pollution,
- the hydrologic pathway by which the pollutant is transported, and
- the extent to which the pollutant load needs to be reduced in the stream.

In areas where tiling is common, a primary pollutant of concern is **nitrate**. Since nitrate predominantly moves out of the agroecosystem through belowground pathways, there is a need to reduce the nitrate concentrations of soil and water exiting tile lines. Appropriate in-field management to reduce nitrate concentrations may include nutrient management and/or cover cropping to maintain year-round vegetation cover (see *Perennial practices improve water quality and quantity*), which retains the nitrogen in biomass. Nitrate export also can be reduced through tile line designs that balance crop production and environmental practices and also through drainage practices that manage or control the outflow of drainage water during certain times of the year, particularly during the summer and winter months. Edge-of-field practices that could be used to reduce nitrate export include nitrate-removal wetlands (see *Perennial practices improve water quality and quantity*). These wetlands should be targeted to areas where tile line exits can be routed.

In areas where surface **runoff** is a concern, both in-field and edge-of-field practices should be considered. In-field management could include residue management, contour buffers, and/or grassed waterways with the goal of minimizing surface runoff and associated pollutant loss.



Edge-of-field practices might include installation of grass and/or riparian buffer systems. Buffer systems are most effective and provide the greatest benefit when installed in areas where they can intercept and slow surface runoff. Since it is unlikely that surface runoff will be uniform across a field edge or from one field to the next, buffers need to be installed where overland flows are most likely to be delivered from the landscape to streams. Furthermore, buffers should be designed and sized for the amount of surface runoff they receive. For more information, visit [www.buffer.forestry.iastate.edu](http://www.buffer.forestry.iastate.edu).

Streambanks largely have been neglected for conservation practice application but may be the major source of sediment and phosphorus pollution in streams. Bank erosion is often the result of the timing and quantity of runoff. Upland conservation practices that simply keep soil and nutrients in place, but do not slow water and allow it to infiltrate, may do little to affect timing of stream discharge volumes and thereby reduce streambank erosion. Conservation practices that can stabilize streambanks include bioengineering techniques that use a combination of plants and hard engineering materials (e.g., rock, broken concrete). Alternatively—if peak flows can be reduced—streams can be stabilized more easily using well-defined restoration techniques (for more information, visit [www.nrcs.usda.gov/technical/stream\\_restoration](http://www.nrcs.usda.gov/technical/stream_restoration)). It also is important to recognize that accumulation of sediment in our river valleys influences streambank heights and channel meandering in many watersheds.

While methods to slow and reduce water flow should be considered throughout watersheds, conservation practices do not have the same water quality benefit everywhere—implementation should be targeted to portions of the landscape where practices can have the greatest benefit. In doing so, practices should be designed appropriately given the water pathway (i.e., subsurface, overland) and amount of flow they receive. In some cases, it may be appropriate to modify the path of water movement to enhance the effectiveness of conservation practices—for example, by routing tile lines and drainage to constructed wetlands at key locations.

Water quality and quantity goals are most likely to be achieved if conservation practices are designed and implemented as part of a system that considers water transport throughout entire watersheds, from upland areas to streams.

## Perennial practices improve water quality and quantity.



Winter rye cover crop in corn field—early spring.



Reconstructed wetland placed at the end of a small tile line.



Grassed waterways and contour buffers.



Streambank stabilization with bioengineering.

# Soil Quality and Carbon Sequestration

**Perennial vegetation tends to increase soil organic matter and biological activity relative to annual crops.**

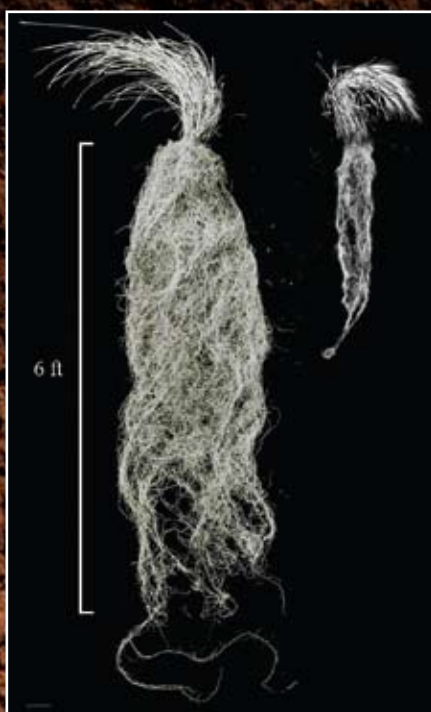


Fig. 5. Perennials, such as big bluestem (left), have well-developed root systems compared to annuals, such as new wheat (right). They, in turn, support greater amounts of biological activity, which is so important to maintaining and enhancing soil quality. Source: The Land Institute.

Many conservation practices have beneficial effects on **soil quality**—a soil's capacity to sustain plant and animal productivity, maintain or enhance water and air quality, and support human health and habitation.

Soil quality is strongly affected by a soil's organic matter content and its biological characteristics. **Organic matter** enhances the soil's capacity to hold water and nutrients, improves soil structure, sequesters atmospheric carbon dioxide, and—when managed carefully—reduces the severity and costs of droughts, floods, and diseases. Animals and microbes living in the soil affect its structure, susceptibility to erosion, and water relations; they also play a central role in organic matter decomposition and the cycling of nutrients necessary for crop growth, and can protect crops from certain pests and diseases.

Studies conducted in the northern Great Plains and the Corn Belt found that soil organic matter levels were greater under switchgrass and other perennial warm-season native grasses than under cultivated annual crops. Similar patterns have been found for trees and shrubs used as riparian buffers, as compared with adjacent cropland (see fig. 6). The inclusion of perennial crops, such as forage grasses and legumes, within sequences of annual crops promotes the maintenance of soil organic matter, improves soil structure, and can increase the biomass and metabolic activity of soil microbial communities (see fig. 5). Cover crops that protect soil from erosion also can provide “food” for soil microbes and stimulate microbial activity.

Erosion, intensive tillage, and cropping practices that fail to provide regular additions of organic matter reduce soil organic matter and lead to soil compaction, loss of fertility, and decreased water infiltration and storage capacity. Conversely, protecting soil from erosion; reducing or eliminating tillage; and supplying adequate amounts of crop residues, manures, and other organic matter amendments can rebuild soil organic matter and improve soil quality.

Given that enhancing soil quality is beneficial throughout agricultural landscapes, where should it be targeted? Over landscapes, degraded farmland that is low in organic matter tends to be most responsive to practices directed at improving soil quality. Within fields, ridges and hillslopes show the benefits of practices that increase soil organic matter and, hence, nutrient and water retention.



Enhancing soil organic matter is also a form of **carbon sequestration** and is a good conservation practice for our global atmosphere because it may offset **greenhouse gases** produced by other agricultural activities. Globally, agriculture contributes approximately 20 percent of the annual increase in greenhouse gases, which includes about 18 percent carbon dioxide, 50 percent methane, and greater than 20 percent nitrous oxide emissions. Methane, produced with intestinal fermentation by ruminant livestock and through manure management, has about 23 times the strength of carbon dioxide in affecting global warming. Nitrous oxide is produced by bacteria in response to soil cultivation, the application of nitrogen fertilizers, and manure management, and has nearly 300 times the strength of carbon dioxide.

Compared to annual crops, perennials take up and store greater amounts of carbon dioxide in their plant bodies—especially roots (see fig. 6)—and contribute fresh plant material to the soil. Sequestering carbon in the soil is especially important because the soil comprises the largest terrestrial pool of carbon on earth: 2,500 gigatons, or 3.3 times more carbon than stored in the atmosphere and 4.5 times more carbon than stored in biological organisms. Scientists estimate that establishing perennial grasslands can increase soil organic carbon content to levels similar to native, unplowed prairie within 55–75 years. Converting large areas to non-crop perennial plants may be cost-prohibitive on prime farmland. In this case, a promising alternative may be to **incorporate carbon-sequestering perennials in marginal portions of the landscape** where they can provide additional benefits (e.g., water quality, habitat, soil quality) and potentially be harvested for biomass to offset lost opportunity costs.

Once perennial plants are established, it is important to recognize that accumulation rates are generally rapid during the early years after adopting a practice, but these rates eventually taper off over time (see fig. 7). Once soil carbon reaches equilibrium, conservation of the stored soil carbon requires maintenance. Abandoning or significantly changing these management practices on these lands can result in rapid release of the stored carbon back to the atmosphere. The current trend of taking CRP land out of conservation and putting it back into annual crops threatens agriculture's contribution to carbon sequestration and climate change mitigation achieved over past decades, since large amounts of stored carbon are released back to the atmosphere.

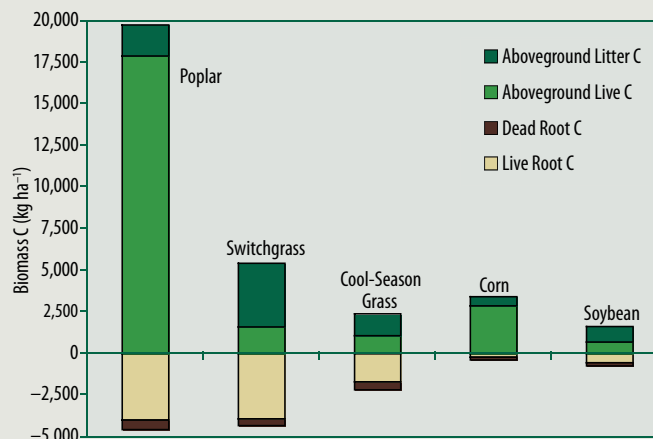


Fig. 6. Distribution of carbon in aboveground and belowground plant components in riparian buffers and adjacent crop fields along Bear Creek in central Iowa. Source: Tufekcioglu et al. 2003.

**Incorporating perennial plants into agricultural landscapes represents one of the most effective means of minimizing the negative impacts of agriculture on climate change.**

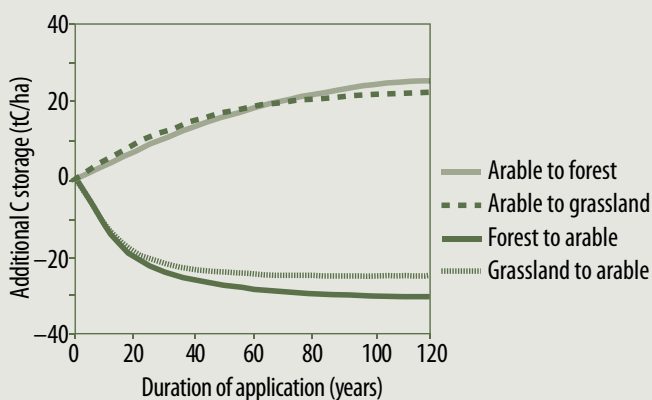


Fig. 7. Change in the amount of soil carbon following conversion from arable land to forest or grassland, and from forest or grassland to arable land, for central France. Source: Seguin et al. 2007.

# Habitat Quality



**“Wildlife-related recreation rejuvenates our spirit, connects us with nature, and gets us outside pursuing healthy activities.”**

—H. Dale Hall, Director  
U.S. Fish and Wildlife Service

We humans are the only species with the ability to clean up the air and water for ourselves. Most creatures have to make do with what is around them, which, depending on its quality, can lead to poor health or even death.

Quality habitat supports a diverse array of plants and animals that are beneficial to us and our environment. The links between farmland **biodiversity** and vegetation cover—both the amount and the arrangement—are shown for breeding birds in the scenarios in figure 8.

However, such humanized ecosystems do not provide habitat for the multitude of native species that need greater care and attention to survive and thrive in today’s world. The quality, amount, and arrangement of native habitats (e.g., prairie, savanna, wetland) are key to their livelihood.

While nitty-gritty habitat assessments require lots of detailed information and weeks of work, some general guidelines do exist (see *How can we promote habitat quality in agricultural landscapes?*). These guidelines can encourage these type of practices as appropriate for local environmental conditions and area conservation priorities.

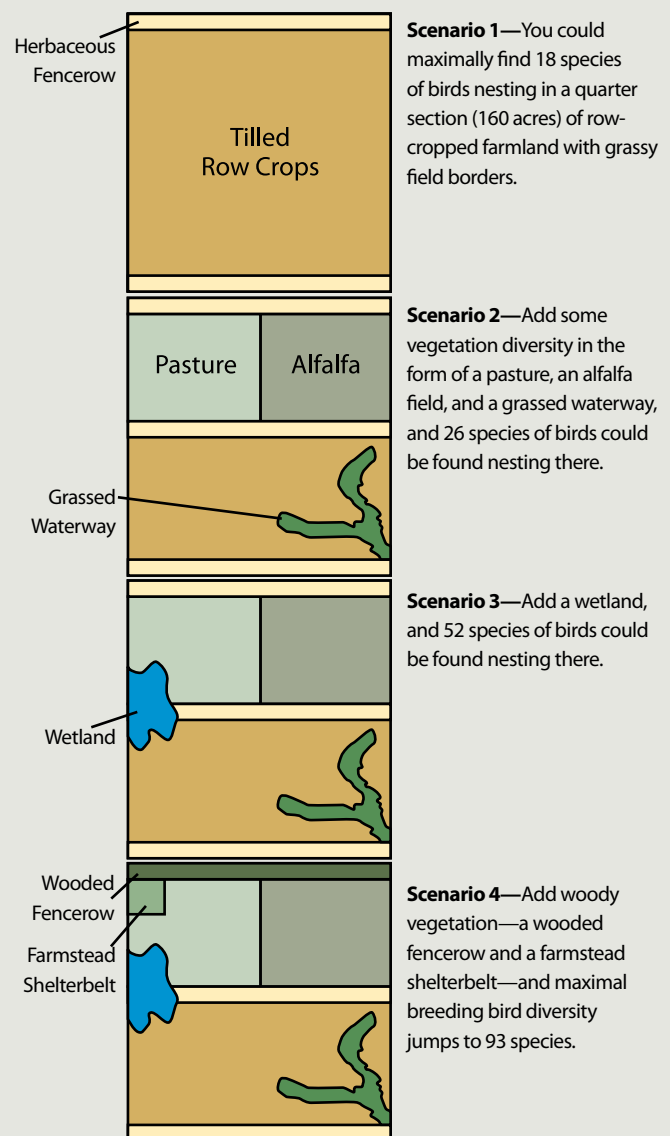


Fig. 8. Four agricultural landscape scenarios and the maximum number of associated breeding bird species. Each illustration represents a quarter section (160 acres). Source: Best et al. 1995.





## How can we promote habitat quality in agricultural landscapes?

- **Protect native ecosystems where they remain.** Iowa, and the Corn Belt generally, retain the lowest percentage of native ecosystems in the United States. The once abundant tallgrass prairie, savanna, and wetland ecosystems now cover less than 1 percent, 1 percent, and 4 percent of their respective historical ranges. Where they exist, remnant patches of native vegetation are important reservoirs of biodiversity and may contain biotic and structural legacies important for understanding how these ecosystems work and how they can be restored. Indeed, the contribution of these areas to habitat provision, biodiversity conservation, and the maintenance of key ecological processes is likely far in excess of that expected based on their size.
- **Create and maintain some large, contiguous patches of native vegetation.** Large patches of grassland, wetland, savanna, and forest serve critical habitat functions for species that exhibit area sensitivity. These species can't exist in small patches either because the available resources are too few or because small patches are prone to disturbance, such as the overspray of pesticides or human foot traffic. Several species of grassland and forest songbirds exhibit well known area sensitivities. Bigger patches, such as those greater than 250 acres, generally are considered "big enough," although some species require much larger areas of contiguous habitat.
- **Increasing the amount and diversity of perennial and natural cover types provides better habitat.** Most species benefit from the cover provided by perennial plants, and especially if there is variation within it. For example, prairie plantings that incorporate many different plant species provide better habitat than plantings that just use a few species. The more closely the prairie planting resembles large remnant patches of native prairie, the better. Yet, even if the number of species used is fairly low, you can increase the quality of the habitat by planting species that exhibit different growth forms (e.g., tall grasses, short grasses, forbs, and shrubs).
- **Infield management and land care also matter.** Birds, bats, and nocturnal insects tend to be more abundant in organically grown in comparison to conventional crop fields. These differences are partially due to hedgerows, cover crops, and perennial grasses incorporated onto organic farms, but they also are attributed to the negative effects from conventional farm practices, such as larger field sizes and greater inputs of fertilizer, herbicides, and pesticides. Regardless of whether the agriculture is conventional or organic, a greater amount of tilling and passes has a negative impact. In general, the greater crop diversity and less disturbance within agricultural fields, the better the habitat is for native species.



A few species that would benefit from the conservation practices outlined above include the (clockwise from upper left) Henslow's sparrow (*Ammodramus henslowii*), grasshopper sparrow (*Ammodramus savannarum*; nest), compass plant (*Silphium laciniatum*), mallard (*Anas platyrhynchos*), downy gentian (*Gentiana puberulenta*), rattlesnake master (*Eryngium yuccifolium*), red-eared slider (*Trachemys scripta*), Hine's emerald dragonfly (*Somatochlora hineana*), and greater prairie chicken (*Tympanuchus cupido*).

# Biological Control and Pollination



**Conservation can provide habitat for more than just the highly visible wildlife but also for the many small insects that are essential for pest suppression and pollination.**



Insects are the dominant life form on the planet and provide services essential for agriculture, including pest suppression and crop pollination. It is now recognized that portions of the landscape need to be planted and maintained in natural habitat to garner high levels of these positive services.

Research conducted in Iowa shows that, as the area of non-cropped land surrounding commodity crops increases, there is a decrease in soybean aphid abundance due to greater mortality from insect predators like ladybeetles. Insects that feed on or parasitize insect pests provide biological control, limiting the occurrence and severity of pest outbreaks. While food for ladybeetles and other insect predators is plentiful during insect pest outbreaks, natural habitat provides the key resources these insects need to survive during other times of the year, specifically food resources both before and after pests are present and shelter essential for overwintering. By providing perennial habitat, predator populations can be maintained and will contribute to fewer or lower levels of pest outbreaks.

For example, figure 9 shows the level of biological control of the soybean aphid is higher in landscapes with a higher diversity of land cover and greater extent of non-crop habitats. This study was conducted during 2005 and 2006 across 22 soybean fields within Iowa, Michigan, Minnesota, and Wisconsin.

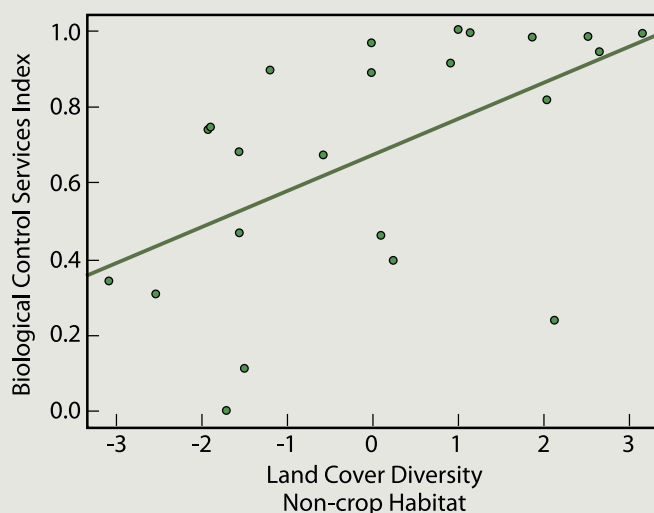


Fig. 9. The relationship between biocontrol, land cover diversity, and non-crop cover in the Midwest. Source: Gardiner et al. 2008.



Although insect-pollinated crops do not dominate Midwestern agricultural landscapes, pollinators such as bees and butterflies are necessary for the production of many of the fruit and vegetable crops grown on small farms and in gardens across the state. Furthermore, these insects are essential for the survival of many of our native plants. As honey bees and their wild counterparts suffer from multiple stresses, such as colony collapse disorder (CCD) and tracheal mite, there is an increasing need to provide refuges in the form of natural habitat for these species.

These beneficial insects—both predators and pollinators—benefit from conservation practices that provide habitat for their survival. Optimal habitat for beneficial insects must include floral resources (i.e., nectar and pollen) and alternative prey throughout the growing season—not just when crops and their associated pests are present.

A growing body of research is revealing that many of Iowa's native plants, by providing food resources and appropriate habitat for insect predators and pollinators, can increase their abundance. Here are a few examples of native plants that are highly attractive to one or both groups of beneficial insects:

#### **Prairie coneflower**

(*Echinacea* spp.) and other flowering plants provide nectar, a necessary food source for many insects, like this painted lady butterfly, to complete their life cycle. By selecting



plants that provide these resources when crop plants are not available and are attractive to beneficial insects, there is a greater opportunity for improving ecosystem services.



#### **Golden alexanders**

(*Zizia aurea*) provide nectar and pollen for beneficial insects early in the growing season, with flowers that bloom in May and June. By providing these resources early, predators of the soy-

bean aphid like minute pirate bug (*Orius insidiosus*) have a food source before the pest arrives.

#### **Canada anemone**

(*Anemone canadensis*) also blooms early in the season and is an attractive source of nectar for *Orius insidiosus*, as well as several species of parasitoid wasps that attack a variety of insect pests.



#### **Blue lobelia** (*Lobelia siphilitica*)

is highly attractive to bees and provides nectar throughout the later part of the summer.



Several species of milkweeds, like this **butterfly milkweed** (*Asclepias tuberosa*), can be highly attractive sources of nectar for honey bees, native bees, and insect predators.



Crop production and environmental quality can be improved by using conservation practices that incorporate native plants. For more information on the role of beneficial insects in agricultural landscapes, visit [www.nativeplants.msu.edu](http://www.nativeplants.msu.edu).



## How Do We Get There?



**Targeting requires that we adopt a landscape view and think creatively about conservation policy and practices.**

**H**istorical soil and water conservation practices, such as conservation tillage, grass waterways, field borders, contour buffers, riparian buffers, and filters, are widely acknowledged as beneficial and will continue to play a major role in future, targeted approaches. Given changing agricultural markets, pressure on the environment, and societal values, however, we need to expand the breadth of benefits that conservation provides.

The first step in expanding the conservation toolbox is to adopt a **landscape view**. Specifically, we need to look for those areas where conservation practices can achieve the biggest bang for the buck—then focus funding and effort there. We also need to look over fencelines and link up efforts to achieve the intended benefit(s)—something that existing conservation programs, such as CRP, fail to do. Neither air nor water, beneficial wildlife nor pests pay attention to fencelines. For this reason, obtaining the ecosystem services that our society depends on requires some level of coordination.

Incorporating **native plants** into our conservation practices, such as those found within historical tallgrass prairie, savanna, and riparian forest ecosystems, will provide habitat for a wider array of species—beyond simply the huntable wildlife focused on in the past—and help to conserve our native biodiversity. Native plants provide habitat for insect predators that perform biocontrol, pollinators, and watchable birds and butterflies. Additionally, the structure of native plants often provides enhanced conservation of water, soil, and carbon storage.

We need to place **constructed wetlands** at the end of tile lines. When wetlands are sited such that they intercept a large proportion of the total drainage, annual nitrate exports can be reduced substantially. In tiled landscapes, the majority of nitrate is exported through tile drainage, so it is important that wetlands are targeted to intercept this water before it enters streams.

The use of **cover crops** should be expanded. In addition to reducing soil erosion, cover crops can add organic matter, minimize nutrient runoff and leaching, suppress weeds and insect pests, and potentially be harvested for forage or biomass.

We also need to **develop and test new practices**—the practices that might best achieve targeted conservation may still be on the horizon. For example, an experiment currently conducted at Neal Smith National Wildlife Refuge in Iowa tests the impact of strategically placed native prairie strips within row-cropped watersheds for the purposes of water purification, erosion control, habitat provision, and biocontrol of pest populations. Another emerging technology for improving water quality is the subsurface drainage bioreactor, which is basically a trench filled with woodchips. Nitrogen removal from drainage water can be substantial when the water is routed through a bioreactor.



On the economic side, we need **creative policies** that account for and foster the public benefits discussed here. These could include improvement of existing conservation programs, more targeted use of current conservation funding, or cost-share dollars to assist with the expense of implementing a new practice or making a transition to an alternative crop. Policies also could fund green payments, which pay land owners and/or operators for putting land in a conservation practice much like the Conservation Reserve Program (CRP). Rather than providing commodity subsidies, a farm program could be based on land stewardship instead of crop price supports. (See *How could a targeted approach to conservation work in practice?*)

We need **markets for other outputs** of agricultural landscapes. While hunting leases, agroforestry, and emerging carbon markets provide some economic opportunities, making the transition to biorefineries that use cellulosic feedstocks will be a critical step toward realizing a clean and secure food and energy future. Cellulose-based bioenergy would allow prime farmland to be devoted to food and feed production, while marginal lands could produce biofuel feedstocks in tandem with conservation benefits. We also need markets that reward farmers for protecting and purifying air and water, and for providing wildlife habitat.



### How could a targeted approach to conservation work in practice?

Since 2002, direct commodity payments in Iowa have averaged \$511 million annually while conservation payments have averaged \$242 million annually. Highly erodible lands—those that would be subject to targeted conservation for water and soil quality—comprise approximately 66 percent of current CRP land and 24 percent of current cropland in the state, totaling less than 7 million acres. Given these statistics, consider the following scenario:

If we assume continued high crop prices around \$5/bushel for corn and \$12/bushel for soybean, net returns from production could average around \$325/acre\* from these lands. Retiring a portion of the highly erodible acres through targeting mechanisms, say 10 percent, would cost around \$230 million—less than the average annual conservation payments at present.

Note that this is a high cost estimate, since targeted erodible lands are likely to be less productive than average and net production returns from them would be lower than the \$325/acre average. Under such a scenario, targeted conservation is more than affordable.

\*\$325/acre is the approximate average of the following projections. For corn, using a yield of 170 bu/acre (trend for 2010), a price of \$5, and costs of \$475/acre (USDA forecast for 2009) leads to net returns of \$375/acre. For soybean, using a yield of 49 bu/acre (1980–2006 trend for 2010), a price of \$12, and costs of \$310/acre (USDA forecast) leads to net returns of \$278/acre.

## A Final Point



**While targeting focuses conservation resources on small, key portions of the agricultural landscape, the environmental benefits it provides are more widespread.**



**We all benefit from clean air and water, healthy and productive soils, abundant wildlife, and the other benefits that targeted conservation provides.**

While current high crop prices are creating a tension between agricultural production and environmental quality, it doesn't have to be so. By using targeted approaches to conservation, we could obtain greater benefits using fewer resources and a smaller land base. Targeted approaches also are efficient in that several objectives can be achieved at once. For example, native perennial cover can be targeted to where it can simultaneously reduce water flows to minimize flooding, provide critical habitat for wildlife and beneficial insects, and enhance soil quality and carbon storage. However, working to achieve all of these benefits at once requires a landscape view.

The tension between agricultural production and the environment can be alleviated further if we look to conservation practices that also provide economic benefits. Conservation and production benefits can be created jointly with many perennial systems and can be surprisingly tangible for today's producers. Direct economic benefits may be associated with reduced input costs for one or more goods. For example, practices that reduce in-field erosion tend to increase nutrient retention and enhance soil organic carbon, which is key to long-term soil fertility. Direct benefits also can be in the form of enhancing the quality of certain crops—reductions in wind erosion and windborne particulates have been shown to positively affect both the yield and quality of certain orchard fruits. Yield increases also may be seen in mainstream Iowa crops such as corn in locations prone to drought and wind erosion. Overall, there are existing and emerging market opportunities—ranging from niche to mainstream—for farmers who manage perennial systems. On small-to-medium scales, ornamental stems, nut crops, pine straw, mushrooms, and hunting leases show strong signs of viability. On larger scales, cellulosic biomass and carbon both are likely to become commodity markets in the very near future. Grazing on conservation lands also can be win-win if implemented in an environmentally sensitive manner.

We have many opportunities to adapt conservation to today's economy and, in the process, realize the full value of preserving our resources for future generations. The concept of targeted conservation provides a way forward, acting creatively and cooperatively to accomplish this goal. We call for a renewal of our conservation ethic, supported by action based on new, targeted approaches to planning and implementation. The time to take advantage of the opportunities is now.



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