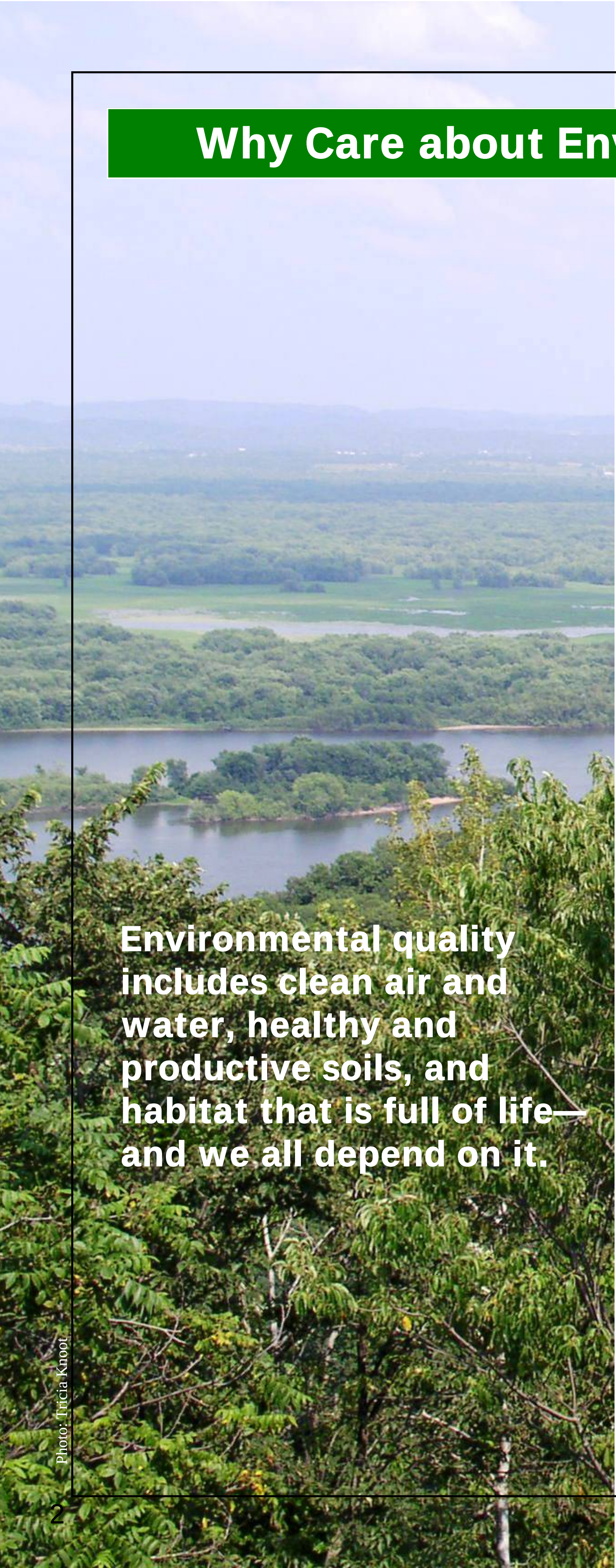
A Targeted Conservation Approach for Improving Environmental Quality

Multiple Benefits and Expanded Opportunities

Why Care about Environmental Quality?

Among our most basic needs are clean air and water to breathe and 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 are also safer, more attractive places for people to live and recreate.

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 while recreating outdoors. According to the 2006 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation, more than 87 million Americans watch wildlife, fish, or hunt, and they spent $120 billion on those activities in that year. For some small communities, the tourism dollars generated by these activities can be significant.



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

Photo: Tricia Knoot

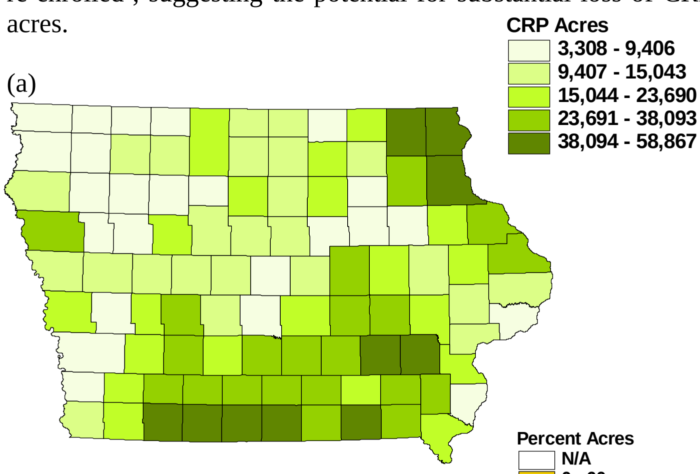
Yet, right now we are in challenging times for environmental quality. While a boon for the agricultural economy, the recent higher prices for crops such as corn, soybeans, and wheat have steepened the cost of, and need for, conserving environmental quality.

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 would have otherwise been in pasture, hay, or enrolled in conservation programs (*see below*). 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 accompanying 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.

Below: (a) Acres enrolled in the Conservation Reserve Program's (CRP) general signup, and (b) percent of these acres participating in CRP's reenrollment and extension (REX) program[1]. As of October 2007, there were almost 2 million acres of CRP in Iowa (72.4% in the general sign up). 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[2], suggesting the potential for substantial loss of CRP acres.

(a)



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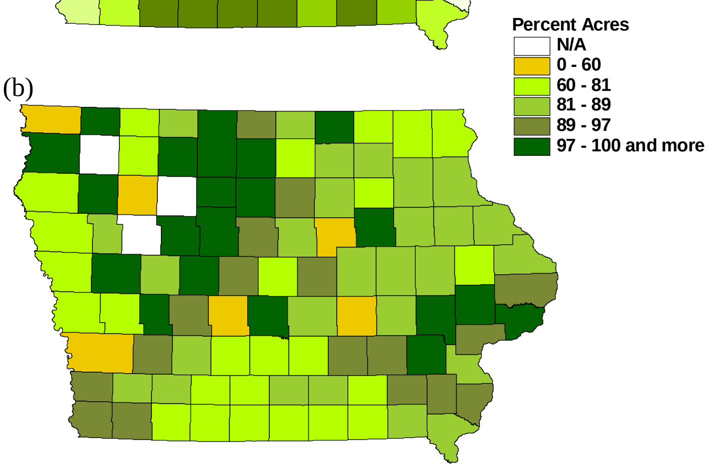
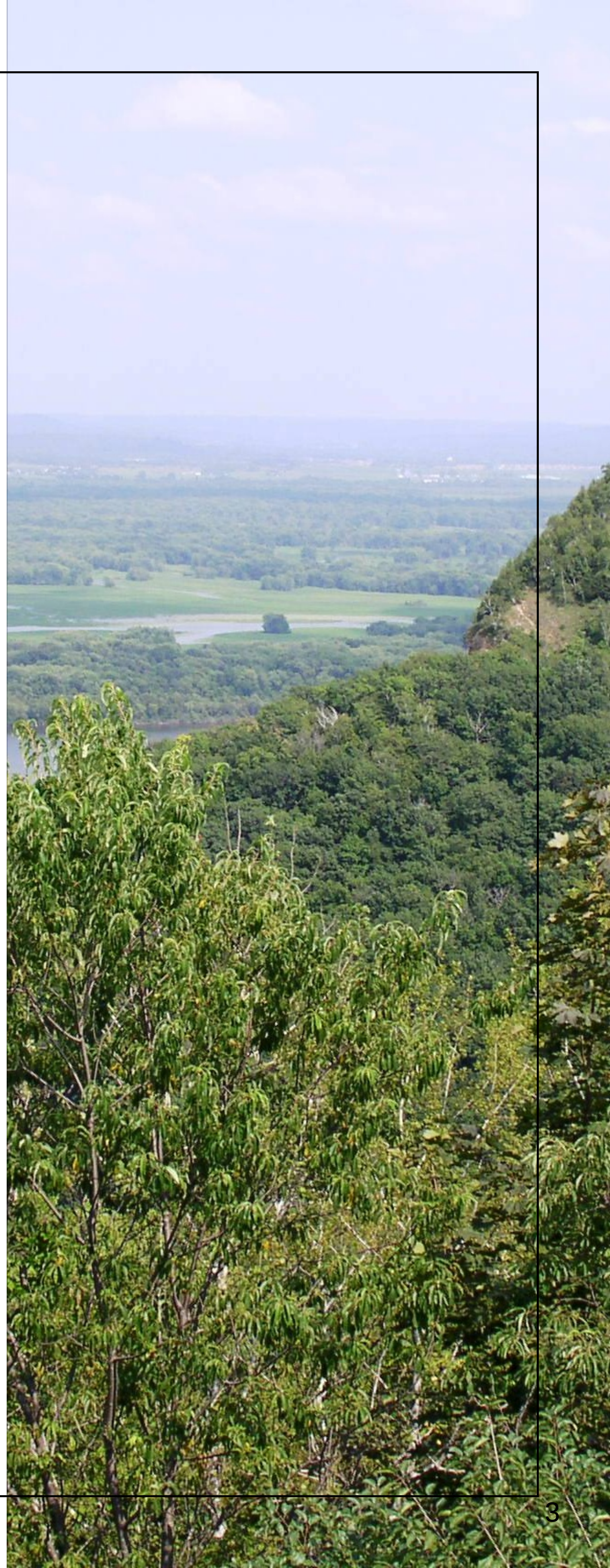




Targeted Approaches & Expanded Opportunities

Photo: Tricia Knoot

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 a small change in the overall agricultural production[3]. 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 our prime farmlands or would require that very little prime farm land 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 on-line, 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 (*Box 1*). 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 afford the opportunity to engage in emerging carbon markets, since the below-ground portions of these plants are substantial and remain on site as the above-ground 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 adjacent page provides specific examples of economic benefits to be obtained in conjunction with targeted conservation practices.

The remainder of this brochure 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.

Box 1. Perennials Contributing to Farm Production

Switchgrass near Lake Rathbun, IA— Switchgrass, a native of Iowa's tallgrass prairie, is being grown on marginal farmlands 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 that "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 make those trips replanting." In test burns associated with the Chariton Valley Biomass Project[4], switchgrass produced 19,600 megawatt/hours of energy—enough electricity to power nearly 1,900 average sized homes for a year. **<<JN: how much from how many>>**

Photo: John Sellers

Agroforestry near Wapello, IA—Windbreaks, shelterbelts, and riparian buffers are often touted for their soil, water, wildlife, and aesthetic benefits; however, they can also be designed to produce marketable crops. Red Fern Farm near Wapello, IA has developed a profitable comprehensive agroforestry system[5]. The system is based on nut-bearing trees such as black walnuts, Chinese chestnuts, hickories, and pecans. 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.**<<HA: pic>>**


Photo: Nebraska Forest Service

Hybrid Poplar near Roland, IA—Trees could also 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[6]! Trees can furthermore 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 comprise a component of the riparian buffer system along Bear Creek, near Roland, IA. While they were planted so their roots could assist in protecting water quality (stabilize streambank, filter nutrients, etc.) 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[7]. Someday they could be harvested for their biomass, and if done properly, regrow from an established root system.


Photo: Lisa Schulte

Targeting for Air Quality

Photo simulation: Gary Bentrup

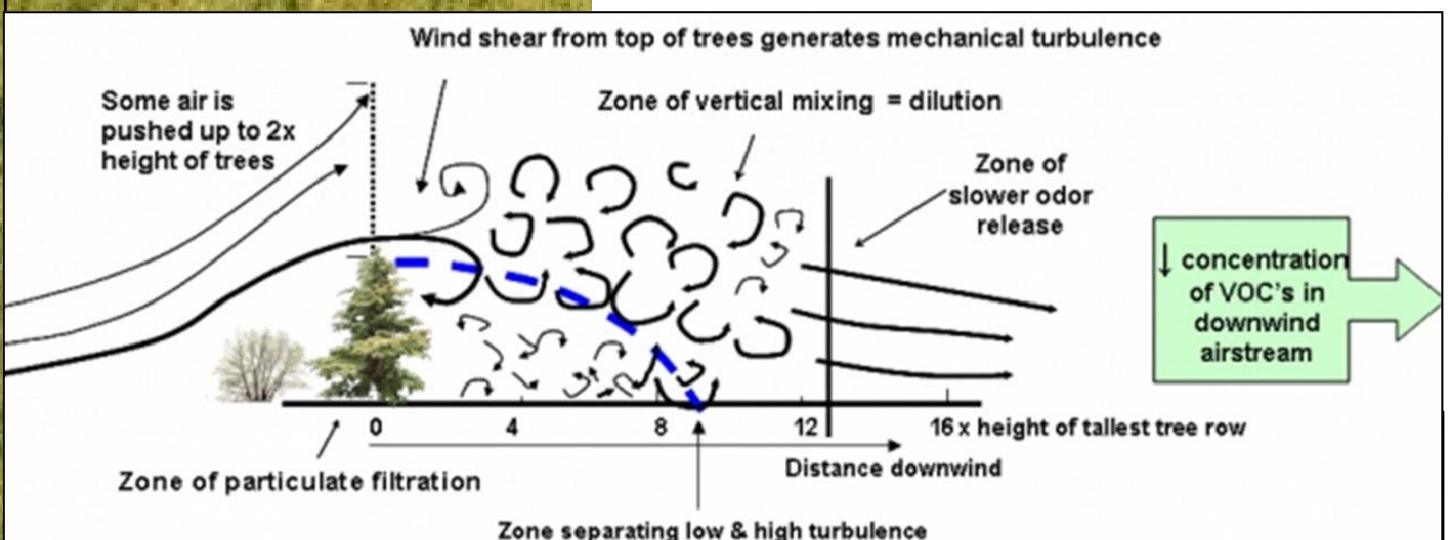
Vegetative buffers are a targeted approach for capturing airborne particulates and reducing odor transport from livestock production facilities.

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 raise contentions that are socially damaging to rural communities and are under varying degrees of regulation or regulatory review.

Building type, facility management, animal diet, and climate affect the amount of potential odor constituents generated at production facilities. Local environmental conditions, especially wind speed and direction, vegetative cover, and topography determine the amount of odor constituents 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 rowcrops, leaving much of the landscape is devoid of vegetation through the winter and spring. As the landscape has become relatively devoid of any significant vegetation barriers, the highly concentrated odor, ammonia, and dust emissions from livestock production facilities is able to travel unimpeded into contact with people.

Vegetative buffers around livestock production facilities add physical and ecological complexity back into these simplified landscapes right where it is needed most (*see next page*)[8]. Perennial trees and shrubs are among the most efficient natural filtering structures because of their large overall surface area, and do their work in many ways (*Box 2*).



Above: Diagram displays generalized shelterbelt odor mitigation dynamics featuring increased turbulence, vertical air mixing and articulate/odor filtration.

Right: Photo simulation, showing the visual impacts of installing a confined animal system and a vegetative buffer ,over time. Credit: George Malone.

Box 2. How do vegetative buffers do their work?

Single or multiple rows of trees near livestock production facilities incrementally reduce odor, ammonia, and particle transport through multiple mechanisms, both physical and social[8].

1. The swaying of tree branches (i.e., mechanical turbulence) vertically mixes the atmosphere, enhancing the dilution and dispersion of odor and particulates.
2. Leaves and stems directly intercept and trap odor, ammonia, and particulates. The waxy cuticles surrounding leaves posses a chemical affinity for "lipophilic" substances; dust, ammonia, and other nitrogen-based chemicals are adsorbed onto the leaf surface. Plants additionally have the capacity to absorb aerial ammonia through stomata and other physiological pathways.
3. By reducing wind speeds, trees capture gravitational fallout of odor-carrying particulates from air (*see previous page*).
4. Trees soften people's psychological response to odor by improving the aesthetics surrounding confinement facilities.
5. Because vegetation buffers are highly visible and socially acceptable, producer-community relations improve as community members recognize producer efforts to lessen impacts on air quality.

It's 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 assist in achieving all of these goals at a modest cost. For more information: **http://www.nrem.iastate.edu/old/research/veb/index.html**.

Targeting for Water Quality & Quantity

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

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 a major source of nutrients (mainly nitrates) 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 rowcrop 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, most of these practices have been applied randomly to the landscape through voluntary participation by farmers. However, 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[9]. 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 below ground pathways, there is a need to reduce the nitrate concentrations of soil water 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 (*Box 3*), which retains the nitrogen in biomass. Nitrate export can also 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-of-field practices that could be used to reduce nitrate export include nitrate-removal wetlands (*Box 3*)[10,11]. These wetlands should be targeted to areas where tile line exits can be routed.

ft: Fully established riparian buffer containing a mixture of asses, shrubs, and trees. Credit: ISU NREM.

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 (*see previous page*). Buffer systems are most effective and provide the greatest benefit when installed in areas where they can intercept and slow surface runoff[11]. 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 water is concentrating and running off the landscape[11]. Furthermore, buffers should be designed and sized for the amount of surface runoff they receive.

Stream banks have largely been neglected for conservation practice application, but may be the major source of sediment and phosphorus pollution in streams[12]. 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 for to effect timing of stream discharge volumes and thereby reduce stream bank erosion. Conservation practices that can be applied to stabilize stream banks include bioengineering techniques, which use a combination of plants and hard engineering materials (e.g., rock, broken concrete). Alternatively—if peak flows can be attenuated—streams can be more easily stabilized using well-defined restoration techniques (for more information: **www.nrcs.usda.gov/technical/stream_restoration**). It is also important to recognize that accumulation of historical sediment in our river valleys influence stream bank 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 and prioritized 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[13]. 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 considering water transport throughout whole watersheds, from upland areas to streams.

Box 3. Perennial Practices for Improving Water Quality & Quantity

Winter rye cover crop in corn filed; early spring. Photo: Jeremy Singer, USDA ARS.

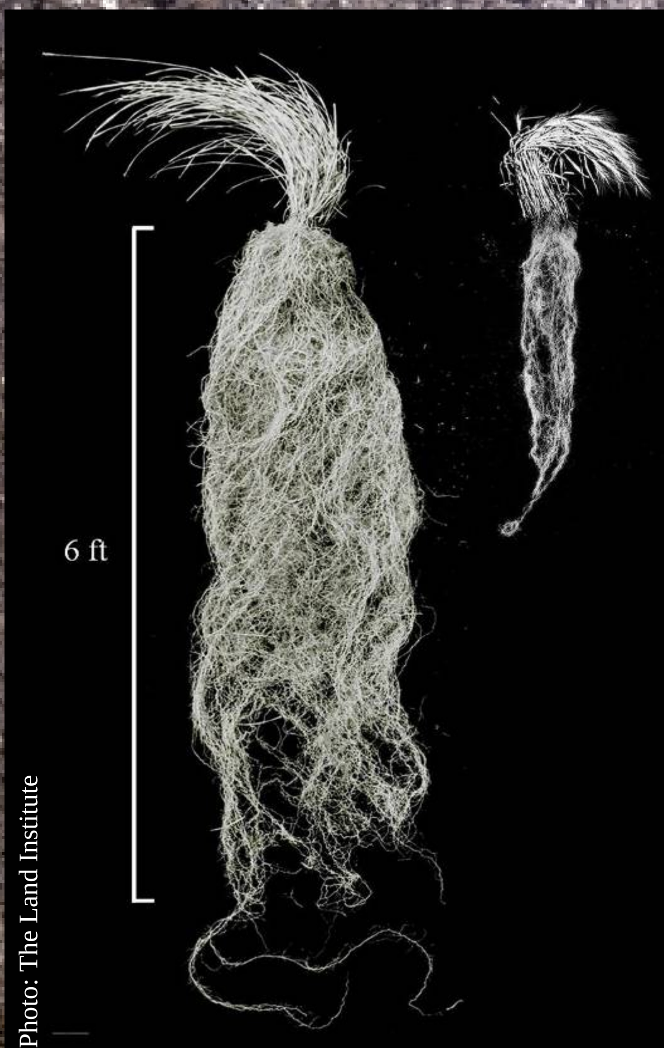
Reconstructed wetland placed at the end of a small tile line. Photo: ISU NREM.

Grassed waterways and contour buffers. Photo: NRCS

Stream bank stabilization with bioengineering. Photo: ISU NREM.

Targeting for Soil Quality & Carbon Sequestration

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



Above: Perennials, such as big bluestem (left), have well-developed root systems compared to annuals, such as intermediate wheatgrass (right). They, in turn, support greater amounts of biological activity, which is so important to maintaining and enhancing soil quality.

Photo: NRCS

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[14].

Soil quality is strongly affected by a soil's organic matter content and its biological characteristics. **Organic matter** enhances water and nutrient-holding capacity, improves soil structure, sequesters atmospheric carbon dioxide, and—when managed carefully—can reduce 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[15].

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 cropland. Similar patterns have been found for trees and shrubs used as riparian buffers, as compared with adjacent cropland (*see next page*). 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 left*). Cover crops that protect soil from erosion can also provide "food" for soil microbes and stimulate microbial activity[16].

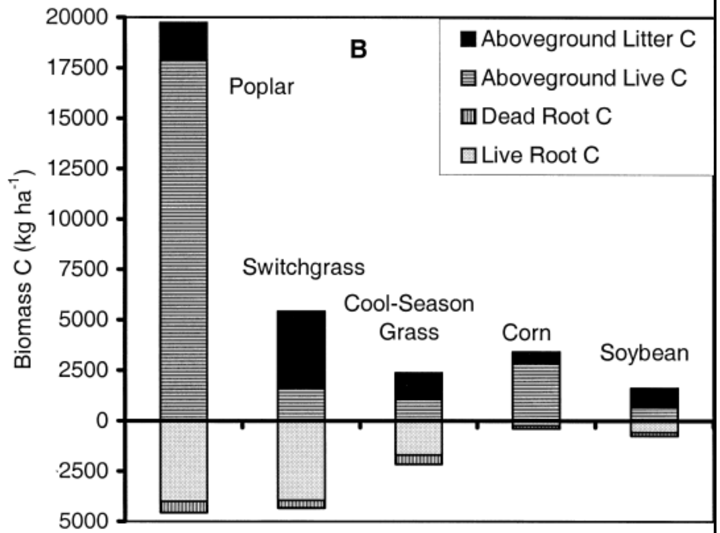
Erosion, intensive tillage, and cropping practices that fail to provide regular additions of organic matter reduce soil organic matter and lead to soil compaction, loss of fertility, and decreased water infiltration and storage capacity. Conversely, protecting soil from erosion, reducing or eliminating 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 farmlands, low in organic matter, tend to be most responsive to practices directed at improving soil quality. Within fields, ridges and hillslopes particularly 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, potentially off-setting **greenhouse gases** produced by other agricultural activities[17]. Globally, agriculture contributes approximately 20% of the annual increase in the greenhouse gases, which includes about 18% of carbon dioxide, 50% of methane, and greater than 20% of nitrous oxide emissions[18]. Methane, produced with enteric fermentation by ruminant livestock and through manure management, has about 23 times the strength of carbon dioxide in impacting 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 CO_2.

Compared to annual crops, perennials take up and store greater amounts of carbon dioxide in their plant bodies—especially roots (*see previous page*)—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[17]. Scientists estimate that establishing perennial grasslands can increase soil organic carbon content to levels similar to native unplowed, prairie within 55-75 years[19]. Converting large areas to non-crop perennial plants may be cost-prohibitive on prime farmlands. 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 off-set lost opportunity costs.

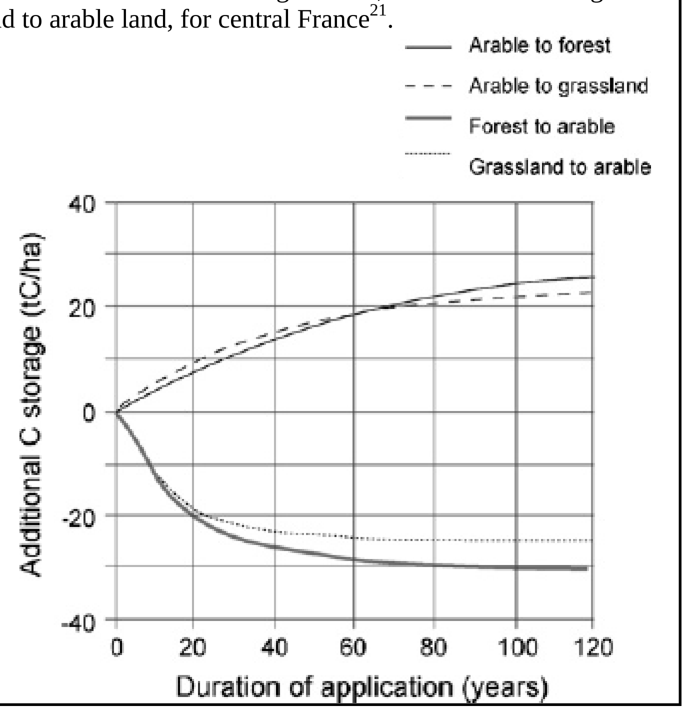
Once perennial plants are established, it's important to recognize that accumulation rates are generally rapid during the early years after adopting a practice, but these rates eventually taper off over time (*see right*). Once soil carbon reaches equilibrium, conservation of the stored soil carbon requires 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.



Above: Distribution of carbon in aboveground and belowground plant components in riparian buffers and adjacent crop fields along Bear Creek in central Iowa[20].

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

Below: 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[21].



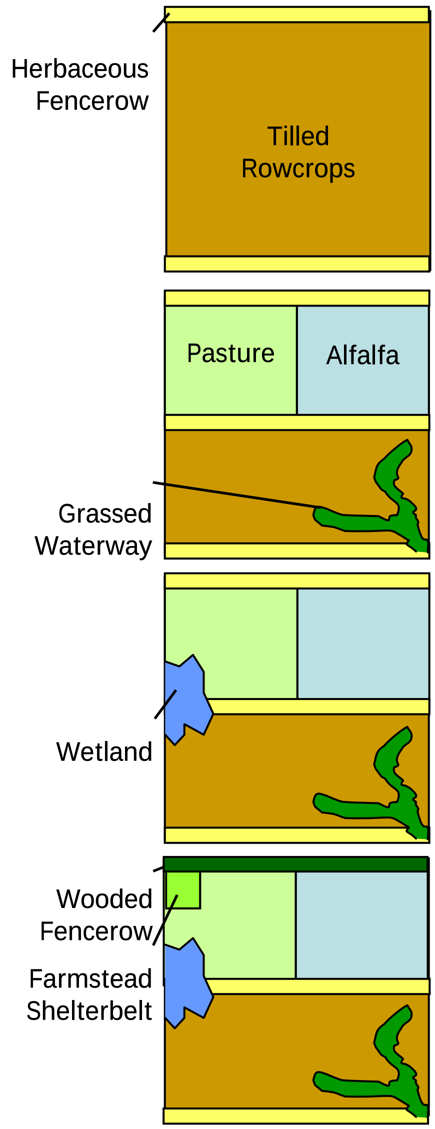
Targeting for Habitat Quality

Photo: Maged Nosshi

"Wildlife-related recreation rejuvenates our spirit, connects us with nature and gets us outside pursuing healthy activities," according to H. Dale Hall, Director of the U.S. Fish and Wildlife Service.

Humans are the one species with the ability to make air and water clean 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 the loss of life.

Quality habitat supports a diverse array of plants and animals, which are beneficial to us and our environment. The links between farmland **biodiversity** and vegetation cover—both the amount and the arrangement—is exemplified for breeding birds in the scenarios below[22].



Scenario 1
You could maximally find 18 species of birds nesting in a quarter section (160 ac) of row-cropped farmland with grassy field borders.

Scenario 2
Add some vegetation diversity, in the form of a pasture, an alfalfa field, and a grassed waterway, and 26 species of birds could be found nesting there.

Scenario 3
Add a wetland, and 52 species of birds could be found nesting there.

Scenario 4
Add woody vegetation—a wooded fencerow and a farmstead shelterbelt—and maximal breeding bird diversity jumps to 93 species.

However, such humanized ecosystems do not provide habitat for the multitude of native species[23], which 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 (*Box 4*). Targeting efforts can encourage these type of practices as appropriate for local environmental conditions and area conservation priorities.

Box 4. 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 U.S. The once abundant tallgrass prairie, savanna, and wetland ecosystems now cover less than 1%, 1%, and 4% of their respective historic ranges[24,25]. Where they exist, remnant patches of native vegetation comprise 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 are generally considered "big enough," although some species require much larger areas of contiguous habitat[26].
- **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 are also attributed to the negative effects from conventional farm practices, such as larger field sizes and greater inputs of fertilizer, herbicides, and pesticides[27]. 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.

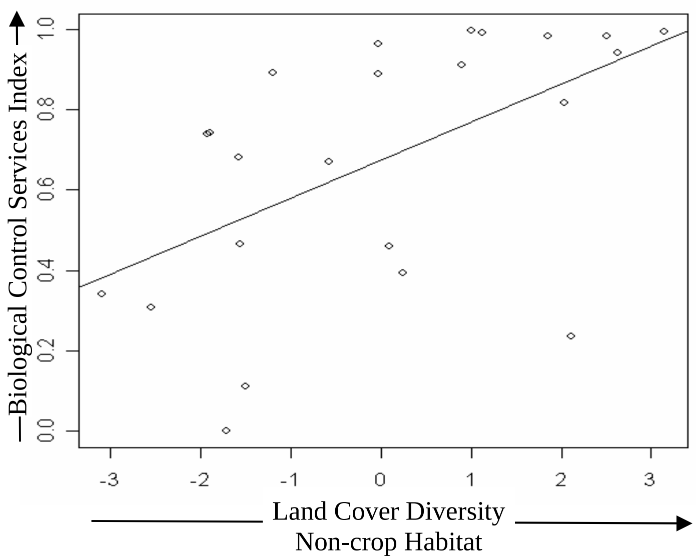
Targeting for Biological Control & Pollination

Photo: Wayne Ohnesorg

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** services. It is now recognized that portions of the landscape need to be planted to 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[28]. 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 make a living in other portions of the year, specifically food resources both before and after pests are present and shelter essential for surviving the winter. By providing perennial habitat, the abundance of predators can be maintained, and contribute to fewer or lower levels of pest outbreaks.



For example, this graph shows the level of biological control of the soybean aphid is higher in landscapes with a higher diversity of land cover and greater extents of non-crop habitats. This study was conducted during 2005 and 2006 across 22 soybean fields within Iowa, Michigan, Minnesota, and Wisconsin[28].

Although insect-pollinated crops do not dominate midwestern agricultural landscapes, pollinators like 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. These insects are furthermore essential for the survival of many of our native plants. As honeybees and their wild counterparts suffer from multiple stresses, like colony collapse disorder (CCD), tracheal mite, etc., 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[29]. 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[30,31]:

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 lifecycle. 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 the improvement of ecosystem services.

Golden alexanders (*Zizia aurea*) provides nectar and pollen for beneficial insects early in the growing season, with flowers that bloom in May and June. By providing these resources early in the growing season, predators of the soybean aphid like *Orius insidious* 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 in sidiosus*, as well as several species of parasitoid wasps that attack a variety of insect pests.

Blue lobelia (*Lobelia siphilitca*) is highly attractive to bees providing nectar throughout the later part of the summer.

Photos: Wayne Ohnesorg

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

Thus, there is the potential to improve crop production and environmental quality through conservation practices that incorporate native plants. For more information on the role that beneficial insects can play in agricultural landscapes and how their impact can be improved with native plants visit: **http://nativeplants.msu.edu**.

How Do We Get There?

Historical soil and water conservation practices such as conservation tillage, grass waterways, field borders, contour buffers and 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 augment the breadth of benefits that conservation can and does provide.

The first step of 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 fence lines and link up efforts, so as to achieve the intended benefit(s)—something existing conservation programs, such as CRP, fails to do. Yet, neither air nor water, beneficial wildlife nor pests pay attention to fence lines. 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 historic tall grass 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 substantially reduced[10]. 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 the stream.

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[32], 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 not have yet been conceived or designed. For example, an experiment is currently being conducted at Neal Smith National Wildlife Refuge to test the impact of strategically placing narrow strips of native prairie within row-cropped watersheds. Another emerging technology for improving water quality is the use of a subsurface drainage bioreactor where a portion of the drainage water is routed through a woodchip trench that promotes denitrification.

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

Photo: NRCS

On the economic side, we need **creative policies** that account for and foster the public benefits discussed here. These could include more targeted use of current conservation funding or cost-share dollars to assist with the expense of implementing a new practice or transitioning to an alternative crop. Policies could also fund green payments, which pay land owners and/or operators for putting land in a conservation practice much like the CRP but expanded, rather than commodity subsidies (*Box 5*); in other words, a farm program based on land stewardship instead of crop price supports.

We need **markets for other outputs** of agricultural landscapes. While hunting licenses, agroforestry, and emerging carbon markets provide some economic opportunities,

transitioning to biorefineries that use cellulosic feedstocks will be a critical step towards realizing a clean and secure food and energy future.

Cellulose-based bioenergy would allow prime farm lands 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 could reward farmers for protecting and purifying air and water, and for providing wildlife habitat.


Photo: NRCS

Box 5. 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 ~66% of current CRP lands and 24% of current croplands in the state, totaling less than 7 million acres. Given these statistics, consider the following scenario:

> *If we assume continued high crop prices in the neighborhood of $5/bushel for corn and $12/bushel for soybeans, 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%, would cost around $230 million—<u>less than the average annual conservation payments at present.</u>*

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/ac is the approximate average of the following projections. For corn, using a yield of 170 bu/ac (trend for 2010), a price of $5, and costs of $475/acre (USDA forecast for 2009) leads to net returns of $375/acre. For soybeans, using a yield of 49 bu/ac (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 not so concentrated.

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

Photo: Lisa Schulte

While the 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 are also efficient in that several objectives can be achieved at once. For example, native perennial cover can be targeted to where it can simultaneously attenuate water flows for reduced 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 further be alleviated if we look to conservation practices that also provide economic benefits. Conservation and production benefits can be jointly produced 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 can also be in the form of enhancing the quality of certain crops—reductions in wind erosion and wind-borne particulates have been shown to positively impact both the yield and quality of certain orchard fruits[33]. Yield increases may also 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 are both likely to become commodity markets in the very near future. Grazing on conservation lands can be a win-win if implemented in an environmentally-sensitive manner[34].

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 conservation targeting provides a way forward to act creatively and cooperatively in accomplishing 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 opportunity is now.

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