The Biofuels Explosion: Is Green Energy Good for Wildlife?

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Ever since President Bush uttered the biofuels buzzword "switchgrass" in his State of the Union Address in January, there has been plenty of talk about biofuels. But what exactly are biofuels? And could their increased production impact wildlife? These are some of the questions those interested in wildlife management and conservation are beginning to ask.

Biofuels are liquid fuels produced from biomass (renewable organic material), which are usually used for transportation fuel. Biomass includes materials such as forestry residues, agricultural crops and residues, wood, animal and livestock wastes, and municipal wastes. Various types of biomass are currently converted into biofuels such as ethanol and biodiesel. In addition to their use in producing transportation fuels, biomass crops can also be used to produce electricity and for other industrial uses. About 150 power plants in this country are currently fueled by biomass and over 350 use a combination of biomass and traditional fossil fuels.

Biofuels such as biodiesel and bioethanol are becoming more common in this country, and worldwide, especially as oil and natural gas prices continue to rise. Biodiesel is a fuel derived from vegetable oils, animal fats, or recycled greases. It can be used as a transportation fuel in pure form, but is more commonly used as an additive to petroleum-based diesel fuel. In this country, most is made from soybean or canola oil, although it can also be derived from recycled cooking oils. Bioethanol is an alcohol made by fermenting the sugars in various types of biomass, usually sugar and starch crops. In the United States, most bioethanol comes from corn, while in Brazil the main biomass crop is sugarcane. Research into how to produce bioethanol from cellulosic biomass, such as agricultural residues, forestry wastes, or crops grown expressly for use as biomass is ongoing; the current process is not able to produce commercially viable amounts of bioethanol.

Bioethanol is used primarily as a fuel additive, which reduces air pollution and prevents early ignition. It can also be used in various blends with gasoline, up to 100% pure ethanol. Most of the bioethanol produced today comes from the Midwest, where the majority of our corn is grown. Today, 99% of bioethanol consumed in the United States is in a blend of 10% ethanol and 90% gasoline called E10; the remaining 1% is blended with 15% gasoline (E85) or used in pure form as an alternative fuel. While E10 is commonly used in traditional vehicles, higher concentrations of bioethanol require specially designed vehicles.

At the beginning of 2006, our domestic ethanol production capacity was about 4.4 billion gallons per year; this could grow to 6.3 billion gallons per year by the end of 2006. Approximately 95% of the United States' bioethanol production comes from corn. In fact, it is estimated that 2.15 billion bushels of corn will be used to make ethanol this year—that is about one fifth of the country's corn production. Iowa alone has more than 2-dozen ethanol refineries, with more under construction.

In Brazil, a world leader in bioethanol production, ethanol is made from sugar cane. There, bioethanol has displaced 44% of gasoline, and no longer needs government subsidies to be competitive with petroleum-based fuels. In fact, thanks to their biofuels production, Brazil soon will be independent of foreign oil.

As noted above, bioethanol can also be made from cellulosic biomass, such as prairie grasses, agricultural residues, wheat straw, and woody biomass crops. This requires a different process than fermenting ethanol from corn, either enzymatic hydrolysis or synthesis gas fermentation. Called cellulosic ethanol, ethanol produced by these processes often is seen as environmentally preferable to corn ethanol due to its lower greenhouse gas emissions and higher energy balance. In his State of Union Address, the President espoused the goal of making cellulosic ethanol "practical and competitive within 6 years." Here in the United States, switchgrass (*Panicum virgatum*) has been identified as the most promising source of biomass for cellulosic ethanol. It provides more biomass per unit area than many other species, making it an ideal crop for biofuels production. Native to the North American tallgrass prairie, switchgrass is a fast-growing perennial grass that needs limited fertilizer and can grow in marginal areas. In addition, it can be harvested once or twice a year and can be harvested soon after establishment.

Biodiesel, corn and cellulosic ethanol, and other forms of biomass have different environmental impacts that must be considered in evaluating their potential as a viable alternative energy source. Many of these will depend on what land is used to grow the biomass crop—was it formerly used for traditional row crops, in the Conservation Reserve

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Program (see below), or in a natural state? While switching from growing row crops to producing biomass crops may provide environmental benefits such as decreased erosion and increased wildlife habitat, putting new land into production, even for biomass crops, can have negative effects. While they often require less fertilizer and irrigation than do traditional row crops, biomass crops still require some management and harvesting either once or twice a year. Loss of habitat to biofuels production certainly has the potential to impact native wildlife species.

Two other key concerns are the emissions produced by each type through production and consumption and how efficiently each type of biomass can be converted into energy, called its energy balance. Many studies have examined the energy balance of biofuels. A recent study by the National Academy of Sciences found that ethanol from corn generates 25% more energy than is required to produce it, whereas soy biodiesel generates 93% more. And, whereas ethanol from corn emits 12% less greenhouse gas than gasoline, biodiesel from soybeans emits only one third as much greenhouse gas as does ethanol. As noted above, the production and use of cellulosic ethanol often results in fewer greenhouse gas emissions and produces more energy per unit of input. For example, a recent literature review by the Natural Resources Defense Council and Climate Solutions compared the energy ratio of corn and cellulosic ethanol. The energy ratio is the ratio of energy contained in one unit of ethanol to the energy consumed during its production. Several studies have shown corn ethanol to have an energy ratio of 1.29:1.65, while cellulosic ethanol has ratios of 4.4:6.61, depending on the biomass used and the method used to produce it.

Corn ethanol's low energy balance and high emissions, as compared to some types of cellulosic ethanol and biodiesel, can be explained by the high investment in fossil fuels used to plant, tend, and harvest the corn and to convert it into ethanol. This also requires high inputs of fertilizers and water; production of 1 gallon of ethanol can require more than 3 gallons of water. For example, officials in Illinois were surprised recently to learn that a proposed ethanol plant in their state would use 300 gallons of water each year to produce 100 gallons of corn ethanol. While many industries use large amounts of water in production, there is still concern that increased corn ethanol capacity will add additional strain to already overtaxed water systems in some parts of the country.

Increases in the production of biomass crops for use as biofuels or other types of alternative energy could have significant impacts on wildlife. Depending on the type of biomass used, the increased production of biomass could force conversion of idle land that provides habitat to wildlife, increase habitat fragmentation, or reduce the crop residues available to wildlife for food and cover.

The wildlife effects of growing traditional row crops such as corn are relatively well known. The most significant effect of increased corn ethanol would be the additional land that would have to be converted to agricultural use, and the increased erosion and fertilizer use that goes along with agricultural production. Increasing our ethanol production through the use of corn could produce negative effects on wildlife, the magnitude of which will depend on the scale of production and whether the land used for this increased production was formerly idle, in a natural state, or planted in other row crops.

Switchgrass or other grasses used for biomass production could provide grassland bird habitat that has been decreasing in recent years. These grasses could provide benefits similar to the Conservation Reserve Program; by removing land from traditional row crop production, there is the potential for reduced erosion and increased wildlife habitat. However, the benefits will likely depend on how intensely the grass is managed. Increased fertilization means higher, denser growth, which is less beneficial to some species, and increased herbicide use reduces the growth of forbs that could lead to fewer nesting opportunities for some species. Of course, other species will benefit from these conditions.

The frequency and timing of mowing or harvesting is perhaps the most important factor to consider when weighing the wildlife effects of switchgrass. When grown as a biomass crop, it is generally harvested either once or twice a year. If switchgrass is harvested in the autumn, after the breeding season for grassland birds, it minimizes the effect of harvesting on these species and leaves time for regrowth before the next nesting season. However, harvesting in autumn or winter can reduce winter cover for some species. Several studies have shown that following harvest, there is a shift in bird species composition from a community dominated by birds that prefer tall grass to those that thrive in shorter grass. One way to ensure that switchgrass production benefits as many species as possible and does not harm grassland birds, especially species of management concern, is strip harvesting. Leaving some fields or areas of fields unharvested each year provides habitat for both species that prefer vegetation of short to moderate height and low to moderate density and those that prefer a tall, dense vegetation structure. Such a system provides habitat for a greater diversity of birds than if all the switchgrass was harvested each year. Of course, local preexisting conditions also should be considered. If most of the idle grassland habitat in the area is tallgrass, then harvesting switchgrass annually for biofuel production can increase the area's diversity.

Another consideration is whether to plant a switchgrass monoculture or use a variety of grasses and other vegetation. While a mixture of vegetation types likely would provide better wildlife habitat, the technology has not yet developed to allow the processing of a mixture of different grass species or vegetation types into bioethanol. Of course, cellulosic ethanol production is still in its infancy, and the possibility of using diverse vegetation stands instead of monocultures deserves further exploration as research continues.

In addition to various grasses, woody biomass can be used to produce cellulosic ethanol. Woody biomass consists of trees and woody plants grown on plantations as a biomass crop as well as trees and tree parts that are byproducts of ecological restoration, hazardous fuel reduction treatment activities, or other forestry activities. The removal of woody biomass for ecological restoration or hazardous fuels reduction usually will benefit wildlife by improving habitat. Plantations that grow short-rotation woody crops such as poplar and cottonwood (*Populus* spp.), willow (*Salix* spp.), or sycamore (*Plantanus* spp.) may provide some benefits to wildlife, although not to the extent of a natural landscape. They can also provide other environmental benefits, since these crops can grow on highly erodible or marginal agricultural lands, and they can provide water quality and soil stabilization benefits.

These plantations may provide habitat benefits to birds and small mammals similar to or somewhat greater than agricultural row crops, but less than natural ecosystems. Like switchgrass fields, plantations will provide wildlife benefits if they replace agricultural lands, which generally provide less diverse wildlife habitat. However, these plantations do tend to have a simplified vegetation structure, making them less suitable habitat for many small mammal species. These plantations do not function as true forestland within the ecosystem; species dependent on such habitat will be unlikely to use the plantations. The benefits to wildlife can be increased by planting in larger blocks that provide more extensive habitat and reduce habitat fragmentation.

Crop residues also can be used to produce bioethanol. Crop residues, the nonedible plant parts left in the field after harvest, such as corn stover, can be collected and used to produce cellulosic ethanol. However, removal of these residues from the fields can have several impacts, such as reduced soil fertility and moisture and increased erosion. In addition, many wildlife species depend on crop residues for food and cover. Ground-feeding birds such as sharp-tailed grouse, pheasants, mourning doves, and turkey benefit in particular. With modern farming practices, about 5% of the crop may be left in the field, providing an important food source for many wildlife species.

The wildlife impacts and other environmental effects of increasing biofuels production clearly depend on the type of biomass used. In the current political climate, it seems likely, perhaps even unavoidable, that biofuels production will increase. The issue then becomes what policies should be in place to support or encourage this increased production.

Many are already looking to the Farm Bill's conservation programs or energy title (see below) as a natural way to encourage biomass production. The Conservation Reserve Program (CRP), established by the 1985 Farm Bill, pays farmers for leaving land idle. The going rate averages about US$50/acre. Thirty-five million acres of highly erodible lands are currently enrolled in the program. Originally created to halt erosion, the program also provides myriad benefits to wildlife. Some groups fear that farmers could pull their land out of CRP and put it back into production, not for traditional row crops but for biofuel production. It has also been suggested that the CRP program be amended to allow production of biomass crops on these lands, since many are planted with prairie grasses anyway. However, use of CRP lands for biomass production could harm wildlife if harvesting is not coordinated with breeding and nesting seasons or if it does not take into account the need to provide cover for over-wintering animals. Changes in vegetation structure brought about by the harvest also could affect breeding bird abundance and nesting success. While overall bird abundance may not change, certain species may be more prevalent in nonharvested CRP land versus biomass cropland.

The 2002 Farm Bill was the first to contain an energy title. Its provisions include a procurement preference for bio-based products, bio-refinery development grants, and a granting program for biomass research and development. For the reauthorization, a new Farm Bill program, an energy reserve, also has been proposed. Such an idea may hold some promise, but it also could draw farmers out of CRP. Such a program has the potential to harm or benefit wildlife, depending on its requirements and on-the-ground effects.

Once the biomass crops are grown, a number of incentives are in place to support their conversion into biofuels. For the past 20 years, a number of tax credits and subsidies have been in place for corn ethanol production, and recent legislation has included many provisions intended to support increased biofuels production. In October 2004, President Bush signed the American Jobs Creation Act of 2004, which included a provision regarding the Volumetric Ethanol Excise Tax Credit (VEETC), as well as other biofuels provisions. The VEETC provides a $0.51-per-gallon excise tax credit for each gallon of ethanol blended with gasoline. The American Jobs Creation Act extended this tax credit through 31 December 2010. The Energy Policy Act of 2005 also contains many renewable fuels provisions. One requires that the amount of renewable fuels, such as ethanol, blended with gasoline increase from 4 billion gallons nationwide in 2006 to 7.5 billion gallons in 2012. The Act also extends the biodiesel tax credit through 2008; with this credit, fuel blenders receive a 1-cent credit per gallon per percent of agricultural-based biodiesel blend. In addition, there are incentives to encourage the production of cellulosic biofuels, with a goal of being able to produce a billion gallons annually by 2015. Government funding and subsidies likely will drive much of the developments in biofuels and biomass energy. Some research programs have already begun to look at the effect of biofuels production on wildlife, such as the Chariton Valley Project in Iowa, but this and similar work must continue to ensure that any increase in biofuels provides not only green energy but also wildlife benefits.

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