Ecosystem Health and Sustainable Agriculture

Rural Development and Land Use

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The Rural Landscape

History of Land Use in the Great Lakes Region

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Ecosystems, biotic communities and social systems evolve and change in response to a variety of natural and anthropogenic pressures and constraints. This complicates the pursuits of sustainability, sustainable rural communities, species diversity and ecosystem processes. According to Ostrom (2009), understanding ecosystem dynamics and how a desired resource will respond to different management practices is an important component to establishing sustainable socio-economic systems. Sustainable management of common property natural resources tends to occur where the resource users are familiar with the resource, its dynamics and its limits; and where rules against overuse are clearly stated and enforced; and use is readily monitored. In the past these conditions have most frequently been achieved in managing resources at a relatively small scale. As remote sensing allows for large scale monitoring, sustainable landscape management can become more common. This chapter provides a brief overview of the long term co-evolution of the humans and the landscape in The Great Lakes region of the US. Much of what took place in the 19th and 20th centuries demonstrates unsustainable land use, which may serve as a cautionary tale, indicating mistakes that ought not be repeated. Various problems associated with unsustainable land use have been recognized and some corrective measures have been implemented. The longer term history may provide an understanding of the context within which local sustainable resource management efforts must operate to move the larger system closer to sustainability.

Great Lakes Region Prehistory

After the Recent Glaciation
The topography of the Great Lakes region was formed by repeated cycles of glacial advance and retreat over the last million years. The most recent glaciers reached its maximum extent about 20,000 years ago and extended south of the Basin. There is evidence of human activity in the region that is 13,000 years old (Walters and Stafford, 2007). At that time, glaciers and tundra covered the northern portions of the Great Lakes Basin. Between 10,000 and 12,000 years ago, 35 genera of large mammals went extinct in North America, including mastodons, mammoths and horses. The causes of this extinction event are uncertain, but may include climate change, extraterrestrial impact, and human hunting pressure (Faith and Surovell, 2009).
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After the glaciers retreated, and the climate warmed, forests eventually dominated most of the landscape, with boreal forests in the north, deciduous hardwood forests in the south, and mixed conifer-deciduous forests in between. There were, however, significant climatic shifts over the last 10,000 years which caused shifts in the patterns of vegetation (Davis et al. 2000). Based on pollen evidence, precipitation generally increased during the last 8,000 years which has increased the proportion of mesic trees, such as sugar maple and beech. Increased precipitation probably also increased the areas of wet prairie, wetlands, numerous inland lakes that were found to be common in the Basin in the 19th century when systematic surveys were completed.

The First Settlers – Native Americans

Native Americans’ use of fire also influenced aspects of the vegetation and wildlife in some areas, most notably to the south and west of the Basin, in Illinois, where frequent fires, some of which were likely of human origin, maintained prairie and savannah landscapes where rainfall was sufficient for hardwood forest. Native Americans probably had some influence on the composition and structure of the forest as well, through fire, selective tree removal, and gathering activities that enhanced seed dispersal, but the extent and significance of that influence is not well known (Williams, 2000).

Early Native Americans made use of the landscape through hunting, fishing and gathering plants for consumption and other uses. Wild rice (four species in the genus Zizania) was an important food source that was gathered in some regions of the basin. In the southern regions deer, bison, elk, turkeys were commonly hunted. In the north, moose, bear, caribou, geese and beaver, were more important game animals (Tanner et al., 1987). The lakes and its tributaries provided both avenues of transportation as well as an abundant source of fish (Bogue, 2000). Tools were made out of stone, bone and wood. Trees were harvested for fuel, shelter and other uses such as canoes building. The lifestyle appears to have been largely nomadic or semi-nomadic to take advantage of resources available in different locales during different seasons.

In the last 2,000 years cultivation of domesticated crops became an increasingly important aspect of Native American life in the southern portions of the Great Lakes Basin. Evidence for plant domestication in eastern North America, including the land that is now Illinois, is about 4,000 years old (Smith, 1989). In the Mississippi River Basin, 7,000 year old archeological evidence indicates that humans began to occupy river flood plains continuously during the summer months. This occupation caused disturbances to the flood plain environment that appear to have favored certain weedy invader plants, such as curcubita, goosefoot, sumpweed and sunflower, which have edible seeds. At some undetermined date, humans apparently began to intentionally cultivate these plants, and by about 3,000 years ago evidence of domesticated varieties is apparent from physiological differences between the cultivated varieties and their wild relatives.

Maize was probably introduced into North America from Central America about 1,700 years ago, but it remained a relatively minor crop until about 800 years ago when the common bean was also introduced. At that time, cultivation of maize-bean-squash complex became widespread in eastern North America, including the southern
portion of the Great Lakes Basin. During the Medieval Warm Epoch (approximately 950 to 1250 AD) both wild and domesticated species could be found much further north than their present ranges.

With the expansion of maize and bean cultivation into North America, the cultivation of indigenously domesticated plants, such as goosefoot and sunflower, decreased. Nonetheless, there was still a great variety of domesticated crops grown in Native American fields, such as tobacco, peppers, cotton, amaranth, sunflower, and Jerusalem artichoke (Smith, 1992). Additionally, different varieties of maize with different cob shapes and sizes appeared in different regions. Early European explorers recorded the existence of short- and long-season maize varieties, indicating a sophisticated knowledge of crop breeding and husbandry (Tanner et al., 1987).

Native American population densities in the Great Lakes region seem to have been low and the human impact on the landscape, although uncertain, was also probably relatively small. One possible explanation for the low impact is the absence of large domesticated animals used as beasts of burden like horses or oxen in Europe. The primary source of power of Native Americans appears to have been human muscle and open fires. Additionally, the short growing season and the low productivity of the crop varieties probably limited human population density. In southeastern North America and Mexico, with longer growing seasons, higher population densities and permanent settlements were established, probably with greater environmental impact.

**The European Colonization**

The arrival of Europeans to the Americas and their release of domesticated pigs in the late 15th and early 16th Centuries introduced diseases that drastically reduced Native American populations throughout the Americas (Mann, 2005). In Hernando Desoto’s 1539 brutal incursion across southeastern North America, he encountered “thickly settled with great towns” along the Mississippi River. One hundred and fifty years later, Renee-Robert Cavelier, Sieur de la Salle, found these areas largely abandoned (Mann, 2005).

Besides diseases to which the Americans had little or no immunological resistance, Europeans introduced horses and firearms (Holder, 1970), which many Native Americans adopted for hunting and war fighting, thereby changing the nature of their interactions with the environment and with other people. The initial European interest in the Great Lakes Region largely focused on the fur trade. Native Americans traded animal pelts in exchange for European products, such as firearms. In their enthusiasm for such products, the Iroquois people of the eastern Great Lakes region depleted the beaver population in their territory as early as 1641 (Tanner et al., 1987). Competition over beaver trapping and the fur trade contributed to a long period of hostilities between the Iroquois and the neighboring Huron people.

**European Encroachment and Landscape Transformation**

During the 1700s, much of central North America, including the Great Lakes, was officially designated as Native American territory, and many of the eastern Native Americans migrated into the Great Lakes region. This increased the population and competition and conflict over resources. There was also some westward migration of Europeans into Native American territory, most notably Finish forest dwellers, who had emigrated from forested areas of Finland, where hunting, trapping and gathering wild foods had been viable livelihoods (Warren, 1994). The British Isles and much of continental Europe had long been deforested and immigrants from those places were unfamiliar with hunting or clearing forest. In the westward expansion of European settlement in North America, Finnish immigrants often provided the first clearing. The Finnish frontier immigrants would build a simple living structure and clear a small patch of forest for growing crops, but would subsist to a large degree from hunting, gathering and trapping. As the neighboring population increased, hunting and gathering success would decline, prompting the frontier woodsmen to sell their land, move further westward, and repeat the cycle of setting up a homestead and pursuing their frontier lifestyle. Although the Finns came with skills and attitudes that were well suited to frontier living, they were unfamiliar with the American flora and fauna. In many areas, they learned about local plants and animals from Native
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Americans with whom they enjoyed good relations and intermarried.

Before moving further west, the frontier woodsmen often sold their land to people who had less interest in and/or skills for living primarily by hunting and gathering. The buyers were more typically people who had traditional farming skills learned in the eastern states or in Europe, and they bought the land to pursue that livelihood. These farmers generally cleared larger areas for crops than the frontier woodsmen had, built more permanent structures, kept livestock and produced a little marketable surplus if there was access to a market (Cochrane, 1993).

Relationships between Native Americans and European-descended immigrants ranged from friendly to hostile. Some Native Americans readily adopted the practices of the European immigrants such as the use of log cabins, with glazed windows and fenced yards (Tanner et al., 1987). But as more Europeans encroached upon Indian lands in the early 1800s and cut down forests, the forest wildlife became more scarce and Native American hunting and gathering became increasingly difficult (Perlin, 2005). Through a series of treaties, forcible removal, and armed skirmishes, most of the Indian lands in the Great Lakes region were taken over by the US government in the 1800s, and then made available to European immigrants by various means: sale, auction or legislation (e.g., the Homestead Act of 1861).

In 1825 the Erie Canal was completed which provided a transportation link from the Great Lakes to the Hudson River and the Atlantic coast. This opened the Great Lakes region to more extensive immigration and commercial development, most notably in the abundant fish provided by the lakes (Bogue, 2000). Initially, settlement in the region occurred largely near the lakes and along the river corridors. After 1830, railroad networks were constructed and connected the interior landscape to urban markets, and consumed vast quantities of wood (Perlin, 2005). Between 1830 and 1900, several million immigrants arrived in the region and most of the land that was suitable for agriculture was converted from forest or prairie to cropland. As the southern forests disappeared, the northern forests were aggressively harvested for wood for the expanding population, railroads, steam ships, iron smelters and other commercial activities (Bogue, 2000; Cronon, 1991; Perlin, 2005). Large areas of old-grown coniferous forest were cut down and the tree trunks removed. The remaining slash was left behind, occasionally contributing to damaging wildfires.

The extensive logging and lumber milling practices had several negative impacts on the Great Lakes fishery. Tree removal led to greater erosion and sedimentation of streams and rivers which served as spawning beds for many fish species. Additionally, in some places logs were transported to saw mills by floating them down streams and rivers, which could also degrade habitat. Finally, sawing the logs into boards and useful wood products produced large quantities of saw dust and waste wood, which were often dumped into rivers or coastal waters of the Great Lakes further degrading the quality of the habitat for fish (Bogue, 2000).

Concern over destructive logging practices was expressed as early as 1867 in a document prepared for the Wisconsin legislature titled “Report on the Disastrous Effects of the Destruction of Forest Trees Now Going on so Rapidly in the State of Wisconsin.” Similar deforestation occurred throughout the US and criticism of the practices became more vocal during the course of the 19th century. The American Association for the Advancement of Science recommended the creation of protected forest reserves on federal lands and in 1891 President Benjamin Harrison complied by stopping timber sales on federal lands (Perlin, 2005). This provided the basis of the National Forest System in the US. The US Forest Service
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was created in 1905 to manage the forests for multiple uses, including production of wood as well as recreation and environmental conservation.

Pioneer Farming in the Great Lakes Region

Many of the early immigrant farmers to the Great Lakes region brought relatively simple tools that they had used in the East: wagon, plow, harrow, axe, rake, scythe, fork and shovel (Bogue, 1963). These early pioneers gravitated toward forested areas, which provided wood for housing, fencing and fuel, in part because they were familiar with clearing and farming woodlands. Although they may have had some experience with natural meadows, their wooden or iron faced plows were not suited to either cutting into the thick prairie sod or for working the fine textured soils.

In the 1820s and 30s farmers, blacksmiths and other innovators introduced various modifications to the plow that provided a sharper and stronger cutting edge (share) and smoother surfaces so that soil did not stick to either the plow share or the moldboard. John Deere’s steel plows reportedly became a standard for excellence in the 1850’s, but Deere was neither the inventor nor the only manufacturer of steel plows. Deere’s primary contribution to the plow lie in manufacturing a large number of high quality plows at an affordable price (Bogue, 1963).

Even with improved plows, the initial breaking of the thick prairie sod required large teams of draft animals. After the prairie sod was first broken, the soil was surprisingly productive. Without applying fertilizer or manures, without even paying much attention to weeds, farmers would harvest yields that were equal to or greater than yields which east coast farmers had struggled for. The prairie soil and vegetation had accumulated plant nutrients and organic matter during the previous six to ten thousand years after the retreat of the glaciers. When the prairie sod was broken and the soil cultivated, these nutrients were released as the plant material and organic matter decomposed. In 1890, the Illinois Agricultural Experiment Station in Urbana reported only a minimal crop response to manures or commercial fertilizers applied to soils that had been used for continuous maize production for 15 years, and that this small response was not sufficient to justify the investment in fertilizer (Bogue, 1963). A smaller flush of nutrient availability occurred when woodland soils were brought under cultivation.
The settlers planted a mixture of crops and raised livestock both for home consumption and for the market. Crops included wheat, maize, oats, barley, rye, flax, potatoes, vegetables, and fruit (Bogue, 1963). Although pioneer farms were much more diversified than today’s more specialized farms, maize was grown on a large portion of crop land acres because it gave high and reliable yields and the mature crop could stand in the field all winter without spoilage or much loss to wildlife. However, maize’s low price per bushel did not justify transporting it very far and consequently much of it was fed livestock on or near the farm where it had been grown. Thus, by 1860, the Midwest (including the southern portions of the Great Lakes Basin) was becoming the nation’s livestock and feed grain producer, complementing the agricultural and industrial specializations occurring in other US regions (Cochrane, 1993).

A considerable quantity of wheat was grown because it brought a much higher price per bushel than maize. This rendered it a more attractive export crop, but yields were lower and much less certain than maize (Bogue, 1963).

Horses and mules were used for draft power, and a large portion of the oats that farmers grew was fed to their horses, with the remainder sold for human consumption. Land that was too wet to cultivate was initially used for livestock grazing. Through the 1870s, there was apparently a considerable quantity of communal grazing land as evidenced by occasional newspaper stories and editorials about settlers attempting to claim such land for private ownership (Bogue, 1963).

Many rural communities were settled by people of one particular ethnic or religious heritage. Amish families congregated together as their part of their religious practice emphasizing harmonious relationships with their fellow believers and avoiding dependency on nonbelievers. Some groups of families migrated from Germany as a group and established a new community in the US (Salamon, 1992). Others migrated individually and gravitated toward towns settled by people of similar ethnic heritage. To varying degrees, community relations and farming decisions reflected a continuation of some of the traditional attitudes and practices that had been common in Europe. Some of these traditions continued through much of the 20th century. After interviewing farm families in the 1980s, Salamon (1992) reported that many German descended farmers were oriented toward intergenerational continuation of the family farm and supporting their local community. These farmers tended to avoid taking on debt, and preferred to intensify their operations with livestock production. They also preferred to live close to town and were active in their church. At the appropriate time, the farm would be passed on to the next generation. In contrast, English-descended farmers approached farming as a business, and were more willing to take on debt in pursuit of higher economic return. Their farms were larger and less diversified. They were less likely to be active in community affairs or to want their children to take over the family farm or to enter farming as a livelihood.

Wetland Drainage

In the 1800s, large areas of land in and near the Great Lakes Basin were wetlands. Both Native Americans and early European settlers tended to avoid these areas in part because of the difficulty they presented to travel as well as the presence of mosquitoes and malaria. In 1850, the US government gave more than 26 million hectares of federally owned marsh and swampland to the states on the
condition that money from the sale of the land to private
individuals would be used to drain the land and render it
more productive. Ohio, Michigan, Illinois received over
2 million hectares of this federal land. These states en-
acted laws to allow the formation of drainage districts
that would organize multiple land owners in drainage
projects (Bogue, 2000). In Illinois, much of the land was
purchased by absentee owners, speculators and land bar-
ons, who in turn, leased the land to tenants, or sold it at a
profit (Bogue, 1951). Large areas of wetlands were also
being drained in Ontario.

There was experimentation with land drainage tech-
niques between 1850 and 1880. Installation of clay pipes
or “tiles” about one meter deep in the soil was a desired
technique, but initially too expensive for all except a few
of the wealthiest land owners. Open ditches were a com-
mon approach to drainage when the cost of tile drainage
was too high. But the impediments to draining large tracts
of land were as much social as they were economic or
technical. The most efficient path for draining water from
one farmer’s land might cross the fields of neighboring
farmers. Obtaining the necessary cooperation among
landowners was the work of the drainage districts.

Wetland soils tend to have even greater accumulations
of organic matter and stored nutrients than prairie soils.
Once drained, these soils are highly productive cropland
and thus there has long been a strong economic incentive
for farmers to install drainage tiles. Additionally, drain-
age reduced mosquito habitat and the prevalence of ma-
laria, while also reducing habitat for birds and amphib-
ians. In the 19th and early 20th century many miles of clay
tiles were installed using hand labor. By mid 20th century
the process had been mechanized and plastic tubing has
replaced clay tiles.

As the wet prairies were drained, and common graz-
ing areas enclosed, livestock raisers found that the native
grasses, such a big bluestem, did not survive or produce
well under the drier conditions and more intensive graz-
ing. They found imported bluegrass and timothy grass
were more suitable than the native grasses for barnyards
and forage (Bogue 1963). By 1900, cultivated crops and
pastures of introduced forages replaced all but a few rem-
nants of the native vegetation that once covered Illinois
(Iverson, 1988) and other states in the Great Lakes re-

From Farming to Manufacturing

At the same time that people were migrating into the Great
Lakes region in the early 1800s, New Englanders were
developing a distinctive system of manufacturing that
emphasized mass production, low cost, and interchange-
ability of parts (Sawyer, 1954). This system took many
years to develop and depended in part on the development
of precision machine tools (Roe, 1916). It also involved
significant investment of public and private funds. One of
the key contributors to this development was Eli Whitney,
who received many contracts from the US government
to produce military hardware. While he was developing
new machine tools to produce parts that would be suf-
ciently uniform to allow interchangeability, he did not
always complete his contracts. In effect, these contracts
were fore-runners of government research and develop-
ment grants, although they were not intended as such.

Manufacturers in the US created many products, some
of which were used on farms to increase labor productivi-
ty in harvesting, planting and cultivating fields. Advances in textile manufacturing equipment increased the demand for cotton. Manufacturing also created a demand for labor and an increasing percentage of the population would find employment in the manufacturing sector and decreasing percentage in agricultural production. In 1800, approximately 75% of the US population was directly engaged in agricultural production. In 1850, this had fallen to less than 60% and by 1900, less than 40% of the population was engaged in agricultural production (Rasmussen, 1960). As farms became increasingly mechanized, one family could farm more acres. Between 1900 and 1950, the average farm in Illinois increased from about 50 to 60 hectares ha in area. In 1990, it had jumped to 140 hectares and farms became more specialized in a smaller number of products such as corn and soybean. A similar trend toward larger farms occurred in other states but with somewhat different patterns of specialization. Wisconsin and Minnesota, for instance, have greater specialization in dairy production.

Increasing Influence of Science and Technology

By the 1890s, the native fertility of the cultivated soils was beginning to be exhausted. Some farmers began to notice declining crop yields that could be reversed by applications of manures, rock phosphate, lime, and rotations that included nitrogen fixing legumes. Around 1900, a rotation of maize-oats-clover became common in Illinois. The US Department of Agriculture, under the guidance of Secretary James Wilson between 1897 and 1912, increased its emphasis of scientific research in such areas as genetics, pathology, soils, chemistry and statistics. Wilson also influenced the Department’s growing regulatory function with the passage of the Food and Drug Act of 1906.

In the 20th century, three major technological innovations further transformed agricultural land use in the Great Lakes Region: the use of the internal combustion engine to replace draft animals; the introduction of hybrid maize, and the use of industrially manufactured nitrogen fertilizers. Steam engines had replaced some animal power in the latter half of the 19th century, particularly for harvesting and threshing grain. However, the use of steam power never approached the use of animal power on farms in the US (Wik, 1953). Steam engines were extremely heavy, and required a great deal of fuel and water. Sparks from the engine exhaust could ignite a dry field waiting to be harvested. The weight of the engines is reported to have collapsed some bridges, and in some such incidents, the expensive engine was not recoverable. After 1910, internal combustion engines and liquid fuels became more readily available, and tractors began to displace the use of both steam power and draft animals. Draft animals, particularly horses, persisted on farms longer than steam engines and were still a common sight on Illinois farms in 1950. With the elimination of draft animals, however, land that had been used to grow their feed and forage was devoted to other purposes, such as the production of maize and soybean for hog, beef and dairy production. This led to farms becoming more dependent on a supply of fossil fuel rather than relying on internally produced feed and forage for draft power.

In the 1920s scientific research conducted by the US Department of Agriculture and the Land Grant Colleges began to produce practical results, particularly in the development of higher yielding varieties of hybrid maize. At first, farmers were either too poor and/or too skeptical to purchase and plant much of the new seed. But when economic conditions improved in the mid to late 1930s, nearly all maize grown in the region was hybrid varieties which provided higher yields per unit area and ushered in a new era of crop breeding.

The availability of inexpensive nitrogen fertilizers after about 1960 reduced the need for applying animal manures, or rotating grain crops with legumes to maintain soil fertility. Many farmers with the highly productive soils, particularly those in the “Corn Belt” south of the Great Lakes, found they could earn greater returns on investment by specializing in maize and soybean rather than with livestock. After 1960, much of the Corn Belt land that had been planted to hay for livestock forage was brought into a maize-soybean rotation. Much of this land is tile drained, and the combination of tile drainage, nitrogen fertilizer on maize and high soil organic matter soils contributed to high nitrate concentrations in drainage water, which is a drinking water hazard and a contributor to algae production in coastal marine waters.
The Great Depression, Dust Bowl and Expanded Government Programs

The combined crises of the Great Depression and the Dust Bowl of the early 1930s led to significant changes in government policies in conservation and economic assistance. The dust storms of the “dirty 30’s” were the consequence of several factors. The years 1930-1934 were years of below average rainfall for much of the US, including portions of the Great Lakes region. The topsoil dried out and became susceptible to wind erosion where there was little or no vegetative cover, such as in cultivated fields. The worst wind erosion occurred on south western plains: Oklahoma, New Mexico, Texas, and Kansas, where above average rainfall in the 1920s had encouraged expansion of cultivation and wheat production (Worster, 1979). The wind-blown soil that appeared in Washington, DC and elsewhere during this period may have helped convince politicians to support the legislation that provided funds for technical and financial assistance for rural areas and farmers.

In addition to establishing soil conservation programs, described below, a variety of farm income stabilization programs were initiated by US Congress in the 1930s, some of which continue to the present day in modified form. These programs include crop insurance, price supports, loan programs and land set-aside programs. Although these programs benefit farmers in the short term, by providing subsidies that reduced the risks of economic losses from agricultural production, these programs helped attract financial investments in high tech agriculture (Strange, 1988). Over the decades, this contributed to production surpluses and regional specialization. Some critics have described this as a production treadmill with much of the net benefit being captured by land owners, equipment manufacturers, agrochemical suppliers, food processors and consumers rather than farmers who increasingly rent land from absentee owners. Since the 1930s, the numbers of farmers has declined dramatically.

A primary reason for low farm product prices was the excess supply in relation to the demand. This was partly a result of abundant land and improved production methods. To address the problem of excess production, the Cropland Adjustment Act of 1934 was the first of many subsequent land set-aside programs in which farmers removed portions of their land from production in return for either direct payments or for price guarantees. A farmer might be required to plant an annual crop, such as oats or
barley, for soil conservation, but would not be permitted to sell any product from the land that was set aside from production. At times when the US Department of Agriculture officials anticipated periods of sustain surpluses and low commodity prices, set-aside programs were established for multiple years. For example, the Conservation Reserve programs of 1956-1969 provided funding to participating farmers to establish perennial vegetation for multiple years. These programs of long-term set aside were probably more beneficial to wildlife, such as pheasants, than annual set-aside programs (Edwards, 1994). However, when high commodity prices returned in the 1970s, the perennial vegetation was replaced with annual crops which reduced numbers of pheasants and rabbits.

The agricultural legislation of 1930s also created the Soil Conservation Service (SCS), which was renamed the Natural Resources Conservation Service (NRCS) in 1995. The SCS provided and the NRCS continues to provide technical assistance to farmers adopting soil and water conservation practices. In 1934, the SCS estimated that more than half of the nation’s land was moderately or severely eroded (Schwab et al., 1993). More scientifically based soil erosion surveys have been conducted as part of the Natural Resource Inventory starting in 1977. In 1982, 25% of US cropland and nearly 40% of cropland in the Corn Belt was eroding at rates believed to be damaging to the long term productive capacity of the soils (National Research Council, 1986). In 1985 the Conservation Reserve Program (CRP) was initiated in which the US federal government paid an annual fee to land owners who took highly erodible land out of crop production. By 1992, erosion rates had declined considerably largely due to the CRP and the use of conservation tillage (Kellogg et al, 1994). In recent years erosion rates have continued to decline as conservation tillage and no-till have become more commonly practiced (US Dept. of Agriculture, 2009).

Despite reductions of soil erosion, the impacts of agricultural runoff on water quality continue to be a concern, due to sediment, nutrients and pesticides. A later version of CRP targeted cropland adjacent to streams for conversion to perennial vegetation in order to filter runoff and thereby buffer the receiving streams. The connection between reduced erosion from cropland and surface water quality is complicated, however. In some settings, a reduction in erosion from cropland has been linked with improved water quality. In other settings the improvement in water clarity has permitted the formation of algal blooms because of high concentrations of phosphorus in runoff. In yet other areas, there has been little or no discernible effect of soil conservation on water quality. Trimble and Lund (1982) examined the connection between soil conservation measures and sediment transport in the Coon Creek in southwestern Wisconsin, and reported that cropland erosion rates and sediment deposition rates in the stream valley declined dramatically after 1940 due to the implementation of soil conservation measures. However,
high rates of sediment deposition in the stream valley during the preceding seven decades left a legacy of sediment supply that will influence sediment transport in the stream for many decades into the future. We still have much to learn about the art of managing cropland in ways that protect or restore the aquatic ecosystems that receive agricultural runoff.

**Population Rebound in Rural Areas**

Depending on how “rural” is defined, between 18% and 36% of the population in the Great Lakes States could be classified as rural in 2000; and between 65% and 95% of the land area could be classified as rural (Cromartie and Bucholtz, 2007). For most of the 20th century, rural counties and communities have been losing population to urban and suburban areas. This has partly been a consequence of reduced demand for labor in farming, forestry
and mining, and increased demand for labor in the manufacturing and service sectors. With many rural people migrating to urban areas for education and employment, a considerable number of rural schools and businesses have closed, thus forcing the remaining residents to commute longer distances for services, and to become less connected to their local community. It becomes difficult to attract educated professionals, such as doctors and dentists, to areas with declining populations and services. However, starting in the 1970s, there is evidence of a revival of many rural communities in the US and in the Great Lakes Region (Johnson, 1999). It appears to be driven by several factors such as urban residents seeking a rural quality of life that includes neighborliness and environmental amenities. These new rural residents include people raising young children, retirees and new immigrants to the US (Salamon, 2003). Several rural areas in the Great Lakes region offer environmental amenities as well as recreational opportunities and have been able to generate jobs and income from tourism (Johnson, 1999).

While the new rural residents are often initially welcomed by the long-time residents, there are also sometimes conflicts, particularly over environmental amenities. For example, the long-time residents tend to be accustomed to odors produced by local livestock facilities, while the new comers may find the odors offensive and seek to impose limits on the odor producing activities. Similar conflicts may also arise over forestry or mining activities that threaten recreation, wildlife or scenic views.

In recent decades an increasing number of conservation and ecological restoration activities have been initiated, partly driven by the information acquired from nearly a century of formal ecological science. Both private and federal agencies have engaged in a process to promote sustainable forestry practices. Remaining wetland areas have been given a modest degree of legal protection, and wetland and prairie restoration activities are enjoying an increasing amount of private, federal and state funding. Since 1972, the US and Canada have engaged in a process of ecological monitoring and restoration of the Great Lakes through the Great Lakes Water Quality Agreement. Although this Agreement focuses on the Lakes, the connection between land use and the lakes is recognized. Although it will likely take many decades to recover from the extensive changes that have occurred since 1800s, it is hoped that an adaptive process of discovery, education, and restoration will bring about positive changes for the people and landscape of the Great Lakes region.

Summary and Conclusions

The landscape of the Great Lakes region has been altered by natural factors and human activities. European settlement since 1800 has caused significant and rapid conversion of forest, prairie and wetland to agriculture. This process was initially driven by individuals seeking to provide for their families, but over time became a complex industrial, and governmental system. The environmental and social problems caused by these changes were recognized by a few during the 19th century, but there was insufficient capability to restrict destructive uses or plan more constructive land uses. Efforts to address the problems were often implemented only after the problem resulted in a crisis, such as large forest fires or the Dust Bowl. While some progress has been made in protecting forests and conserving soils, considerably more work can be done to improve the sustainability of rural communities and design landscapes that provide habitat for native species as well as healthy livelihoods for rural residents. Finer scale analysis than presented here is needed to guide local restoration and compatible rural development activities. At the scale of the Great Lakes Basin, state and national and institutions are needed to provide a framework for understanding the socio-ecological system, and developing policies and practices that enhance local sustainability and discourage unsustainable activities.
Chapter 4

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