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REGIONAL REPORT: MIDWEST

EXECUTIVE SUMMARY

The Midwest Region consists of Illinois, Missouri, Indiana, Michigan, Wisconsin, Minnesota, Iowa, and Ohio.

The Midwest is called “The Corn Belt” and “The Steel Belt” for good reason: agriculture and manufacturing dominate the region’s economy. Approximately 70% of the land in this region is dedicated to agricultural activities. Corn and soy are the dominant crops by far, used for human and wildlife consumption and in biofuel production. As a region, the Midwest emits 25% of the United States’ carbon dioxide—equivalent to a whopping 5% of the entire world’s carbon dioxide—an immensely disproportionate amount when compared to the region’s population. This high regional emissions rate can be attributed to the area’s dependency on carbon-intensive coal for generation of electricity as well as, to a lesser extent, emissions from extensive agricultural production and methane release from livestock.

At first glance, it might seem that crops would benefit from the longer growing seasons and increased carbon dioxide levels that accompany greenhouse gas accumulation in the atmosphere. However, studies show that corn yields will likely decrease due to a shorter development window. Even if plants are projected to increase yields due to higher carbon dioxide levels, such as soy, a net negative result is predicted due to more frequent extreme weather events including unpredictable freeze damage and heat waves. Plants better suited for new climates will need to be researched, cultivated, and adjusted.

These issues are not restricted to plants; people in the Midwest are also negatively affected by heat waves, which exacerbate already existing air quality issues in urban areas. Over 20 million people in the region live with air quality that does not meet national standards. Particulate matter, pollen, and ozone all contribute to make breathing difficult, and are only expected to increase with increasing temperatures, humidity, and industrial emissions.

The Great Lakes are a major feature of the Midwest, supporting recreational and commercial fisheries activities. The health of this aquatic ecosystem is at great risk from both fertilizer runoff and invasive species. The Midwest has been colonized by over 180 invasive water species including zebra mussels, Asian carp, and sea lamprey. These invasives entered the Great Lakes via fishing and shipping industries, and fishermen must now clean their boats when traveling between bodies of water to prevent the further spread of invasives in this already fragile system.

Regional Overview

NATURAL FEATURES

The Midwest United States is home to sixty five million people and covers the region from the Appalachian Mountains to the Great Plains. It shares a border with Canada and is made up of eight states, Illinois, Missouri, Indiana, Michigan, Wisconsin, Minnesota, Iowa, and Ohio. As geographic features, it contains four of the five great lakes, Lake Superior, Lake Michigan, Lake Huron, and Lake Erie, and serves as headwaters for the country's biggest river, the Mississippi. The Midwest is known for its nutrient-rich soil and flat expanses, making it extremely arable. Likewise, thousands of lakes and streams cut through valleys and hills, providing for vibrant, diverse ecosystems. Among these are the biome classifications: grassy plains, mesic forest, rivers and lakes, woodlands, prairie and savannah.

With this diverse array of ecosystems, there is quite a range of supported species. In the more mountainous regions to the north, the common large animals to find are: White tail deer, elk, moose, wolves, coyotes, black bears, and foxes. The north is also home to many bird species, namely the osprey, bald eagle, short-eared owl, woodpeckers, herons, cranes, and wild fowl. Further south, in Missouri it's common to find many of the large mammals mentioned above, but also rabbits, beavers, opossums, minks, rattlesnakes and groundhogs. There are over 300 species of fish in the midwest, but the most common are the catfish, shovelnose sturgeon, bowfin, bigmouth buffalo, and many types of darter and sculpin. In addition it is common to find turtles, frogs and many types of amphibians. There is a lot of concern about threatened species in the Midwest, there are ninety-seven species currently on the threatened or endangered list. Of those, some of the most notable are the grey wolf, the canadian lynx, the sturgeon, and the whooping crane.

Climactically, the Midwest varies strongly with the season. During the summers, temperature can rise above 100°F, and in the winter can drop well below freezing. From November until March it snows, but in the late spring and early summer it rains, a lot, semi-frequently reaching 4.22 inches/day. This degree of precipitation is great for growing crops but also sets the stage for severe weather events. Floods, tornados and blizzards are regular to the Midwest, but they still manage to cause billions of dollars in damages each year. In 2013, a catastrophic ice storm swept through the Midwest, claiming the lives of twenty seven, leaving millions without power, and costing an estimated 3.2 billion dollars. In 2011, a tornado touched down in Joplin, Missouri that destroyed 25% of the cities buildings, claimed over 100 lives, and cost the city approximately 2 billion in damages. Scientists agree that these severe weather events are exacerbated by rising temperature in the region overall, which has increased 0.12°C per decade for the period 1950- 2010, and 0.26C per decade for the period 1979-2010”.

In the context of this report, it is important to understand the geologic history of the Midwest in order to gain insight for mitigating the environmental issues we encounter today. By looking at geochemistry and tectonic history of the Midwest, geologists have been able to

put together a sketch of what it would have looked like in the Paleozoic era, between 500-240 million years ago. The Midwest existed under a shallow tropical ocean, and was geographically much closer to the equator. Relatively small island clusters were scattered throughout, which were host to marshes and carbon-rich tropical jungles. This is responsible for the coal deposits we find today. During this period heavy sedimentation took place on the ocean floor, laying the foundation for limestone formations we see today, a contributing factor to the nutrient-rich soil of the Midwest today. During the next major ice age, the Pleistocene, glaciers reached as far south as Kentucky, shrouding the Midwest with an icy veil. The biggest glaciers bored long, finger-like scars into the landscape, which evolved into the plethora of lakes and streams we see today. The bulk of the glaciers merely shaved off the surface of the limestone, creating vast, even expanses with glacial moraine deposits at the edges. As the glaciers receded the land was lifted and gave the form the midwest carries today, enormous rolling planes with more mountainous regions as you travel north.

AGRICULTURE

The Midwest is called “The Corn Belt” and “The Steel Belt” for a reason: agriculture and manufacturing dominate the region’s economy. Together the eight Midwestern states accounted for 18.1% of overall U.S. GDP in 2013.¹ In 2012, agriculture contributed 7.5% of the eight Midwest states’ economy (nationally, agriculture contributed 1.3% of U.S. GDP in 2013).² Among the Midwestern states, agriculture contributes the most in Iowa – a whopping 25.7% of Iowa’s economy (see Table 1).³

The “Corn Belt” states – Illinois, Indiana, Iowa, Minnesota, Missouri, and Ohio – are major corn, soy, and hog producers. Indeed, Iowa and Illinois are the top two U.S. producers of both corn and soy, while Iowa is the top producer of hogs. Minnesota is also the nation’s top turkey and sugarbeet producer. Wisconsin, Minnesota, and Iowa provide major contributions to oats production. Wisconsin, Minnesota, and Michigan comprise the “Dairy Belt,” and are major dairy producing states (Wisconsin is

Table 1.
Agriculture share of Midwest economy, 2012

State	Agriculture share of state's economy
Illinois	3.3%
Indiana	5.1%
Iowa	25.7%
Michigan	2.7%
Minnesota	9.4%
Missouri	5.2%
Ohio	2.6%
Wisconsin	6.0%
Total	7.5%

Mercier, Stephanie. *Employing Agriculture*. Chicago: Chicago Council on Global Affairs, 2014.

¹ “Widespread but Slower Growth in 2013,” Bureau of Economic Analysis, 11 June 2014, http://www.bea.gov/newsreleases/regional/gdp_state/2014/pdf/gsp0614.pdf.

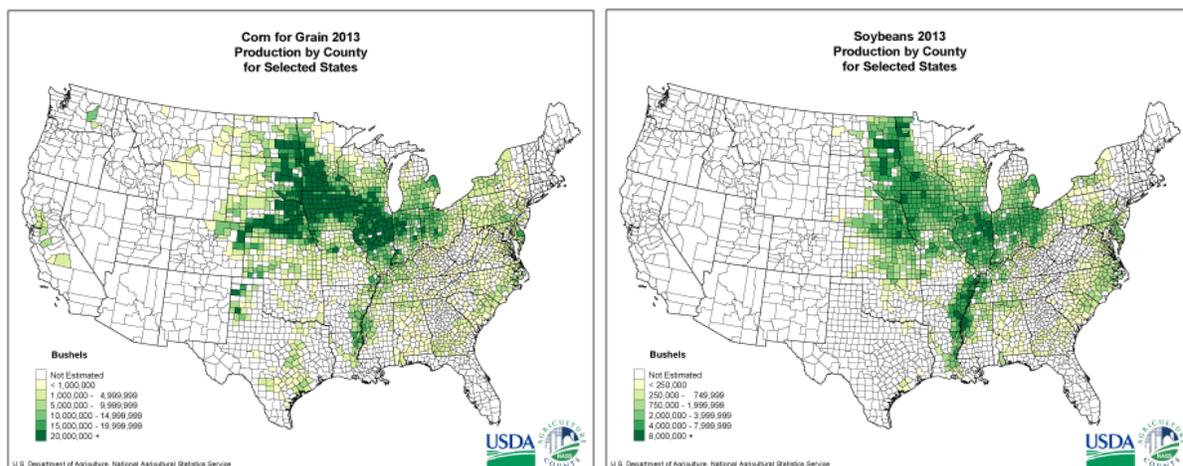
² “Agriculture, value added (%),” *The World Bank*, 2014, <http://data.worldbank.org/indicator/NV.AGR.TOTL.ZS>.

³ Stephanie Mercier, *Employing Agriculture: How the Midwest Farm and Food Sector Relies on Immigrant Labor* (Chicago: The Chicago Council on Global Affairs, 2014), http://www.thechicagocouncil.org/sites/default/files/Midwest_Ag_final.pdf.

the second-largest dairy producing state behind California). For most Midwest states, specialty crops like fruits and vegetables contribute a small fraction of overall agricultural output. Minnesota and Wisconsin provide the exceptions: Midwest is the country's top producer of sugarbeets for sugar, while Wisconsin is the fourth largest vegetable producer.⁴

Figure 1. Corn and soybean (2013). The Midwest's "Corn Belt" states—Illinois, Indiana, Iowa, Minnesota, Missouri, and Ohio—are the United States' primary corn and soybean-producing region. Sugarbeets are produced primarily in Minnesota and North Dakota.

Source: "Charts and Maps." *National Agricultural Statistics Service*, USDA, n.d., http://www.nass.usda.gov/Charts_and_Maps/Crops_County/.



Such large agricultural output has significantly affected the Midwest's landscape. Figure 2 shows the distribution of land use in the Midwest region. Cropland and pasture (yellow and orange) dominate the landscape, aside from urban pockets and the forested regions of Upper Michigan and northern Minnesota. These relatively untouched northern areas house a substantial eco-tourism industry, contributing a large amount to Michigan's economy in particular.

⁴ Jerry Hatfield, "Agriculture in the Midwest," in *U.S. National Climate Assessment Midwest Technical Input Report* (GLISA, 2012), http://glisa.umich.edu/media/files/NCA/MTIT_Agriculture.pdf.

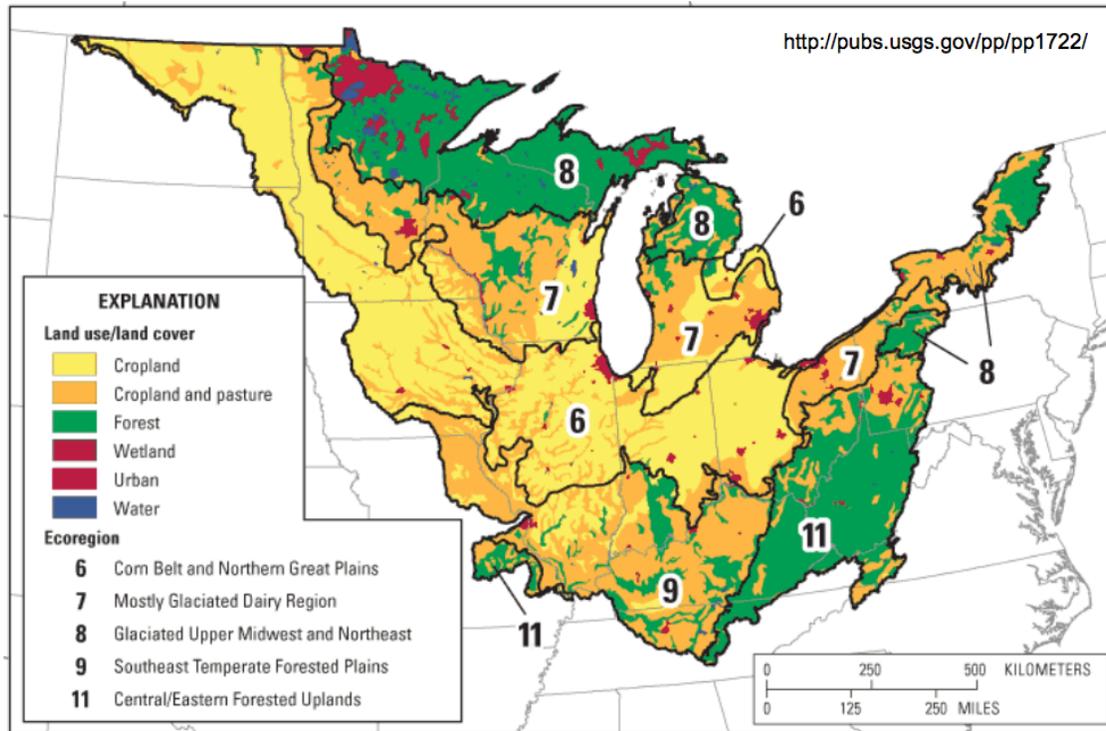


Figure 2. Land use and land cover in the Midwest.

Source: Dale Robertson, et. al., “Nutrient Concentrations and Their Relations to the Biotic Integrity of Wadeable Streams in Wisconsin,” *USGS*, 14 Oct. 2006, <http://pubs.usgs.gov/pp/pp1722/#N1006D>.

DEMOGRAPHICS

The Midwest’s clear rural-urban division in the economy also manifests demographically. Racially, the region is about 79% white – the highest of any U.S. region. The Native American population is concentrated in northern Wisconsin, Minnesota, and Michigan. In rural agricultural areas, by contrast, the population is in general mostly white. Black and Asian minorities are concentrated in large metropolitan areas like Chicago, Detroit, Minneapolis-St. Paul, and St.

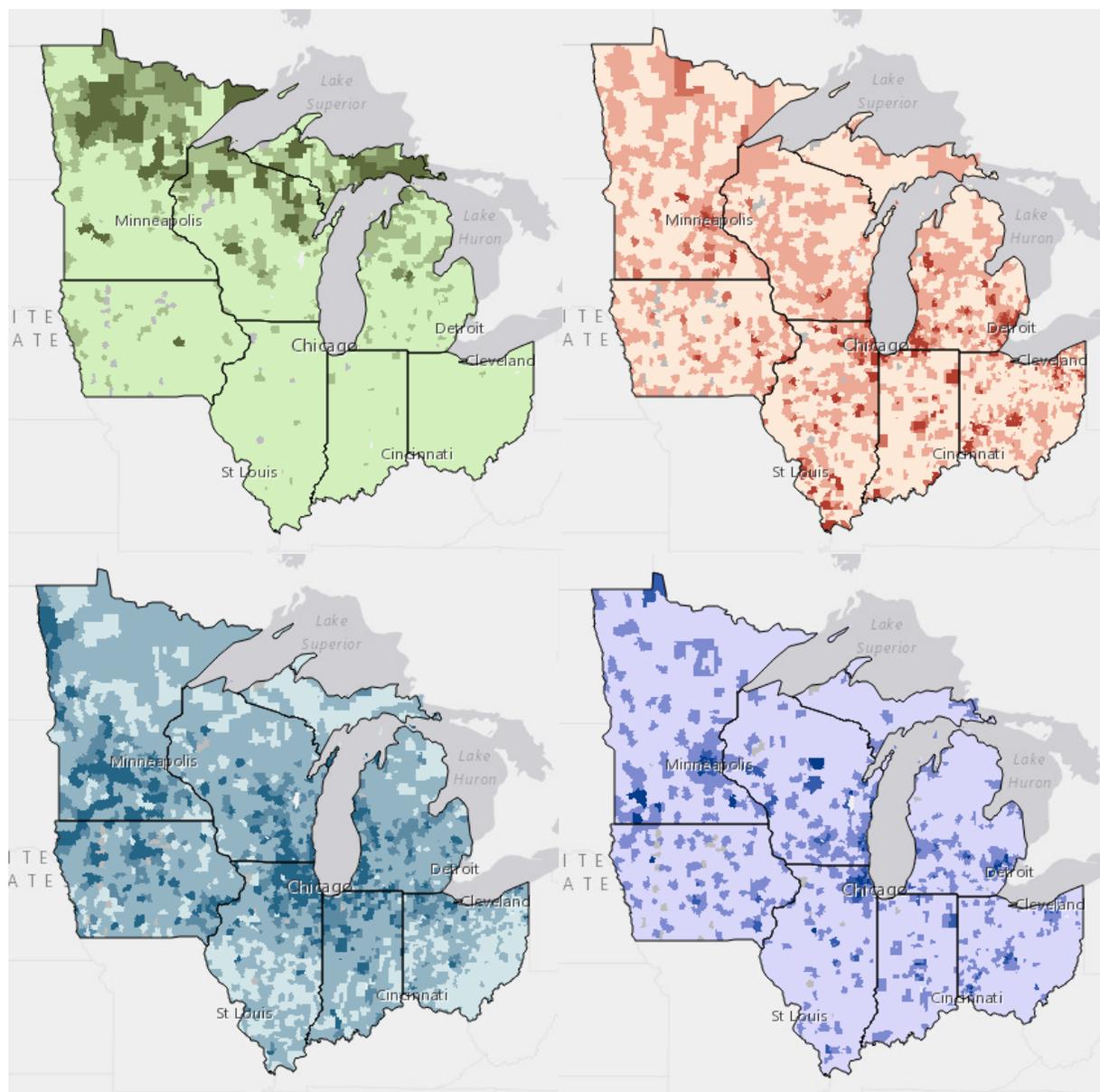


Figure 3. (Clockwise from top left) American Indian, Black, Asian, and Hispanic population density in Midwest states except Missouri, 2011-12. Colors represent (from lightest to darkest) 0-1%, 2-5%, 6-10%, and 11-100% of population. Note that Black, Asian, and Hispanics populations are centered around urban areas, while American Indians live mainly in the northern part of the Midwest.

Source: "Historic District-Level Ethnicity," *EDMaps*, RELMidwest.org, 2012, <http://www.relmidwest.org/edmaps>.

Louis, while the Hispanic population is more spread out, although still centered in the major urban areas.⁵

⁵ "Historic District-Level Ethnicity," *EDMaps*, RELMidwest.org, 2012, <http://www.relmidwest.org/edmaps>.

Among the Hispanic demographic are approximately 57,000 immigrant workers that contribute to the region's 1 million-strong agriculture labor force. The Midwest's unique agricultural needs – including the need for year-round rather than seasonal attention to crops and livestock – has in many cases forced migrant workers into the margins of immigration and labor policy and oversight.⁶ In Iowa, for example, migrant workers have been cheated of wages and steered into substandard housing.⁷ This problem likely extends throughout the Midwest, while the share of unauthorized migrant workers in Midwestern agriculture continues to grow.

In 2012, poverty rates in the Midwest fell near the national average of 15.9%. Indiana, Michigan, and Ohio reported rates above the average, while the remaining five states fell below. Overall, poverty rates in the Midwest trended below the extremely poor Southeast and Southwest.⁸

Rates of population change in the Midwest vary throughout the region. In agricultural counties, populations generally rose in the “Dairy Belt” parts of Minnesota, Wisconsin, and Michigan from 2000 to 2010. In contrast, populations fell in much of the “Corn Belt” over the same time period. Populations also fell in the less-developed north of Minnesota, Wisconsin, and Michigan. Meanwhile, metropolitan areas in general experienced high growth rates from 2000 to 2010, with Detroit, MI, and the center of Chicago, IL, as notable exceptions.⁹ Overall, although the population of the Midwest is growing, the Midwest's share of U.S. population has fallen steadily in the last 15 years.¹⁰

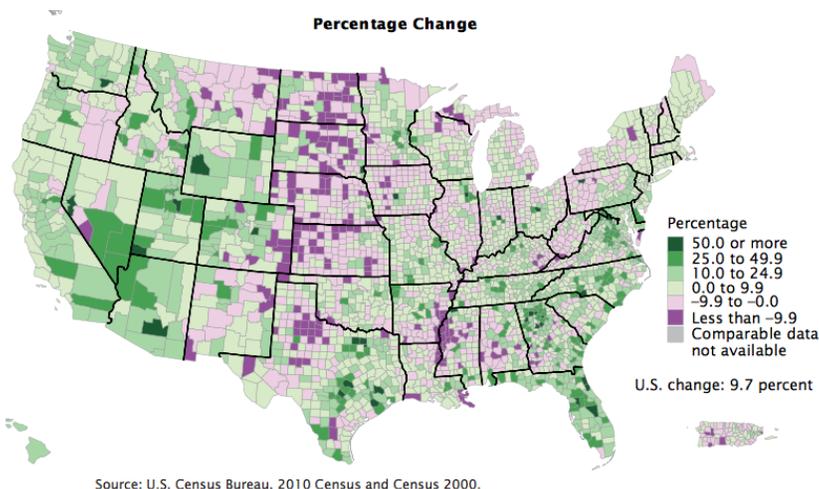


Figure 4. U.S. population change 2000-2010.

⁶ Mercier, *Employing Agriculture*.

⁷ Lauren Mills, “Poor Housing, Wage Cheats Still Plague Midwest Migrant Farm Workers,” *IowaWatch.org*, 30 Dec. 2013, <http://iowawatch.org/2013/12/30/poor-housing-wage-hassles-still-plague-midwest-migrant-farm-workers/>.

⁸ Tim Anderson, “Poverty rates, income inequality up in most Midwestern states,” *CSGMidwest*, Oct. 2012, <http://www.csgmidwest.org/policyresearch/1012incometrends.aspx>.

⁹ Paul Mackun and Steven Wilson, *Population Distribution and Change: 2000 to 2010*, 2010 Census Briefs (U.S. Census Bureau, 2011), <https://www.census.gov/prod/cen2010/briefs/c2010br-01.pdf>.

¹⁰ https://www.census.gov/popclock/data_tables.php?component=growth.

Impacts of Global Change: The Science

POPULATION CHANGE

With a newfound urgency to power a growing world population while also mitigating climate change, scientists are pursuing new forms of alternative energy. In the Midwest, with its predisposition for agriculture, biofuels caught particular scientific interest as having high potential. One study showed an increased likelihood of success for using cellulosic feedstock crops (in lay terms, crops that are not used to feed humans or livestock) to create biofuel in the Midwest (Wilhelm et al, 2010). This would allow fuel to be made from agricultural products without limiting human consumption of goods like corn and soybeans which are commonly used today to create energy in the form of ethanol and soybean biofuel. Additionally, research suggests that this new sort of cellulosic biofuel could help mitigate greenhouse gas emissions (Gelfand et al, 2012). With a way to create energy while decreasing climate-change-causing pollutants and avoiding wasting food products, feedstock biofuels in the Midwest may become a more prominent part of the economy.

Increasing population means not only an increase in energy demands, but also a need to house additional people. Residential land use has been in flux in the Midwest, and density of housing has been increasing in urban areas dramatically. In the 60 years leading up to 2000, the Midwest has added 14 million more houses, leading to a 146% increase in housing units which have for the most part been built within cities (Rayburn & Schulte, 2009). Suburban and rural areas have seen increased sprawl with varying levels of habitat loss and fragmentation resulting. Suburban sprawl tends to affect one small area strongly, while rural sprawl takes over larger, more “wild” lands with less of an intense impact (Radeloff et al, 2005). Together, urbanization, suburban sprawl, and rural sprawl are fundamentally altering the Midwestern landscape to the detriment of many ecosystems.

Agricultural demands on the Midwest continue to increase as more people in the region, country, and world need to be fed. Scientists have noted a persistent, rapid move towards increased corn and soybean production in recent years. Unfortunately, because farms already cover much of the Midwest’s fertile lands, this increased production forces farmers to use less productive lands with high propensity for erosion and increased susceptibility for drought (Wright and Wimberly, 2003). This has led to a 530,000 hectare - over 2000 square miles - decrease in grass-dominated lands across the Midwestern cornbelt (Wright and Wimberly, 2003). In some areas, this move to marginal farm lands may have caused significantly higher than average erosion rates in combination with the stronger storms that accompany climate change. In parts of Iowa, storms swept away 12 times more soil than the average erosion rate for the state, causing a loss of 64 tons of soil per acre of farmland (Cox et al, 2010). The scientific literature suggests that the recent increase in food demand has not been an altogether positive experience for the ecosystems of the Midwest.

POLLUTION

Pollution is one of the Midwest's most impactful environmental problems. As a region, the Midwest emits 25% of the United States' carbon dioxide and a whopping 5% of the entire world's carbon dioxide, a disproportionate amount when you consider the size of the population (World Research Institute, 2007; See Table 1 and Table 2). This high regional emissions rate can be attributed to the area's dependency on carbon-intensive coal for generation of electricity as well as, to a lesser extent, emissions from extensive agricultural production and methane release from livestock. Fortunately, even with coal as the backbone for energy in the Midwest, emissions from 1990-2003 temporarily declined, giving hope for reduced greenhouse gas release; however, with the Midwest's predicted shift towards additional biofuel crops and impending increased weather variation, scientists cannot predict whether this emissions decline will continue (World Research Institute, 2007). On the agricultural side, studies have found that farms - particularly corn farms - in the Midwest more frequently emit nitrous oxide than methane gas (World Research Institute, 2007). The EPA states that nitrous oxide's warming potential outweighs carbon dioxide's by about 300-fold and methane's by 12-fold, which makes this common agricultural gas pollutant a threat to Midwestern and world climate.

While greenhouse gases threaten the climate, other aspects of pollution directly threaten human health, particularly through water contamination. Patz et al (2008) found that, with the extreme precipitation events forecasted to be a result of climate change, sewer flooding has been and will continue to be a problem in the Midwest. Sewer systems cannot contain all of the water introduced from heavy rainstorms, causing the rain and sewage mixture to overflow from the systems into the streets and into drinking water sources, posing a severe threat to human health and recreation sites (Patz et al, 2008). Additionally, an increase in biofuel crops will also lead to water problems through increases in nitrate nitrogen fertilizer runoff, which can enter potable water and contaminate it further (Wu & Liu, 2012). With these pollutants jeopardizing access to clean drinking water and greenhouse gas pollutants imperiling the future climate, the Midwest has no deficiency of serious pollution problems to face in this era of global change.

BIODIVERSITY LOSS

Urbanization poses challenges to a variety of species in the Midwest because of habitat reduction and direct urban impacts on individual organisms' survival. Radeloff et al (2005) writes of the dangers of urban sprawl and its potential to fragment animal habitats. This fragmentation causes a reduced flow of genetic diversity and decreases species' abilities to quickly adapt to environmental forces, including the effects of climate change. Without a capacity to quickly adapt, species could face endangerment or even extinction. Animal die-offs can also be caused by other hallmarks of cities, such as roads. Studies report a loss of tens of millions of moths and butterflies in just one week in Illinois due to collisions

with cars driving through cities (McKenna & McKenna, 2001). Half a million of those killed were monarch butterflies, iconic species that have experienced extreme declines in recent decades. Research suggests that a higher number of cars on the roads and higher speed limits increases mortality in these species (McKenna & McKenna, 2001). Habitat fragmentation and high-traffic roads in cities brings new threats to species of the Midwest, from megafauna to insects.

Agriculture, too, has been a culprit in the decline of biodiversity in the Midwest. Since the onset of intensive agriculture, half of all Illinois bumble bee species have gone locally extinct or decreased population size substantially (Grixti et al, 2009). Additionally, with more corn and soybeans for being grown in monocultures to be used as biofuels, scientists have noticed a decrease in bird species richness by 7-65% in a fifth of the Midwest (Meehan et al, 2010). The loss of bee and bird pollinators jeopardizes plant growth - both agricultural and natural - in the region.

Biodiversity problems can also arise when a certain species is overabundant rather than underabundant. In the Midwest and across much of the temperate United States, deer overpopulation threatens various plant and animal species as well as ecosystem health and the services they provide. For example, deer overgrazing on tree seedlings halts the regeneration of forests, preventing the benefits that forests give such as erosion prevention, flood protection, soil maintenance, and more (Côté et al, 2004). As climate change causes more severe weather, the lack of forest ecosystem services because of deer overgrazing will be felt more strongly. Hunting regulations may loosen in response to this overpopulation and the problems it sparks.

Finally, climate change presents a threat to species survival. Although all species will experience the effects of climate change as the Midwest warms, aquatic species inhabiting cool and cold bodies of water will be most strongly impacted (Hall, 2012). Shallow-water species in particular will struggle since their habitats will be easily warmed and therefore altered dramatically. As a whole, all species across the area will face increased survival challenges as climate change adds to other stressors such as urbanization, human-wildlife conflicts, industry, pollution, and more (Hall, 2012). The combination of multiple factors will be the real threat to biodiversity.

CLIMATE DISRUPTION

The vast majority of scientific studies on climate disruption in the Midwest deal with its effects on agriculture. The Midwest as a whole will likely see more precipitation and more intense precipitation overall, less precipitation in the fall, and more frost-free days throughout the year (Rogovska and Cruse, 2011). Together, these changes have already led to increased erosion of farmlands, increased use of chemical pesticides on crops, and favorable conditions for the pests that plague farms in the Midwest (Rogovska and Cruse, 2011). None of these outcomes benefit the farmers or the general public; increased pesticide usage can contaminate sources of drinking water, and more erosion and pests

cause farmers to rely even more heavily on pesticides and chemical fertilizers to make up for crop loss due to pests, starting a positive feedback loop.

Additionally, the crops themselves are sensitive to environmental change. Although increased carbon dioxide concentrations can improve crop yield by providing more fuel for the plants' photosynthesis, high levels of CO₂ cannot sufficiently outweigh the negative effect of rising temperature on crop yields in the Midwest (Ruiz-Vera et al, 2013). Other threats to crop yields include higher corn sensitivity to drought conditions, longer growing seasons with high maximum temperatures, a more variable climate, and increased water stress (Lobell et al, 2014; Southworth et al, 2000; Haskett et al, 2000). Together, these results of climate disruption in turn disrupt the Midwest by ruining crop yields necessary to feed the region and to provide its farmers with a sufficient source of income.

INVASIVES & DISEASES

The Midwest has been colonized by 139 invasive water species in the Great Lakes alone over the past 200 years, with about a third of those species entering in the last three decades (Mills et al, 1993). Hypothesized means of arrival include direct human introduction, introduction via boats, and other unintended means of relocating the species. Although less than 10% of the introduced species of the Great Lakes have a recorded effect on the ecosystem, this is likely a product more due to a lack of research and an inability to know how the species introduced before modern times affected the lakes than due to the low impact of most invasive species (Mills et al, 1993). Great Lakes invaders pose a threat to fisheries, tourism, and recreation in one of the hallmarks of the Midwestern region.

Introduced terrestrial plant species, including buckthorn and honeysuckle, are known for overpowering forests and neighborhoods of the Midwest. According to a recent study by Vernon et al (2014), areas inhabited with buckthorn in the Midwest had significantly fewer white-tailed deer present and significantly more coyotes and Virginia opossums present than areas without buckthorn (Vernon et al, 2014). With these sorts of results, scientists conclude that buckthorn is affecting native species distributions, either by attracting or repulsing them. Regardless as to the reason, this invasive species alters the ecosystem and the other organisms living there. Honeysuckle, too, seems to cause habitat redistribution in native species. A study in Ohio observed that in areas with more honeysuckle plants, there was increased American robin predation; decreased plant cover, tree seedling concentration, and species richness; and a decrease in fitness of native plants (Rich, 2000). Together, invasive plants like the buckthorn and honeysuckle force fundamental shifts in native ecosystem balances and species interactions.

Impacts of Global Change: Popular Media

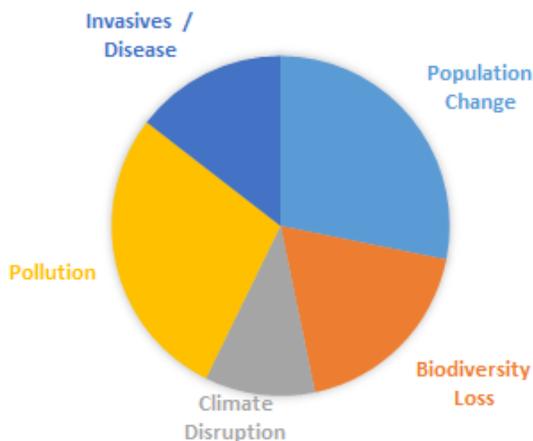
OVERVIEW

This class demonstrated the importance of the media and human perspectives in global change communication and action. Currently, there is a disconnect between scientific research, policy makers, and the general public, which makes preventing and mitigating the impacts of global change rather difficult. Coordination among these groups is imperative, and the media plays a critical role in relaying information between these groups. We will dive deeper into each aspect of global change highlight how each is portrayed in the media.

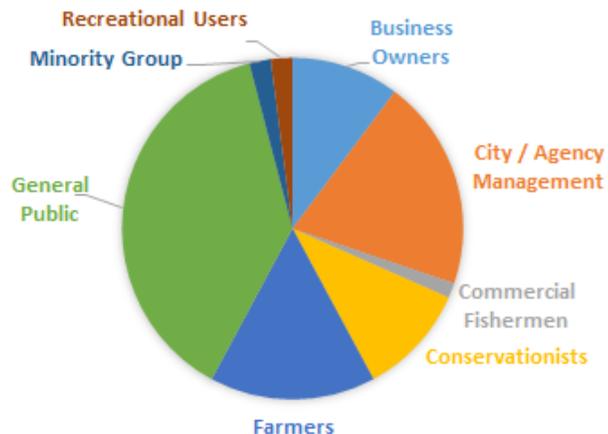
Overall, global change is a difficult topic to discuss in the Midwest. The media chooses to report on things that are widely accepted, like changes in biodiversity and invasive species. In this regard, I do think the media is succeeding in environmental communication and education. Most news sources are doing an incredible job of presenting these aspects of global change in a non-partisan, honest, and inspiring manner. However, much improvement is needed when discussing other aspects of global change, particularly climate change and pollution.

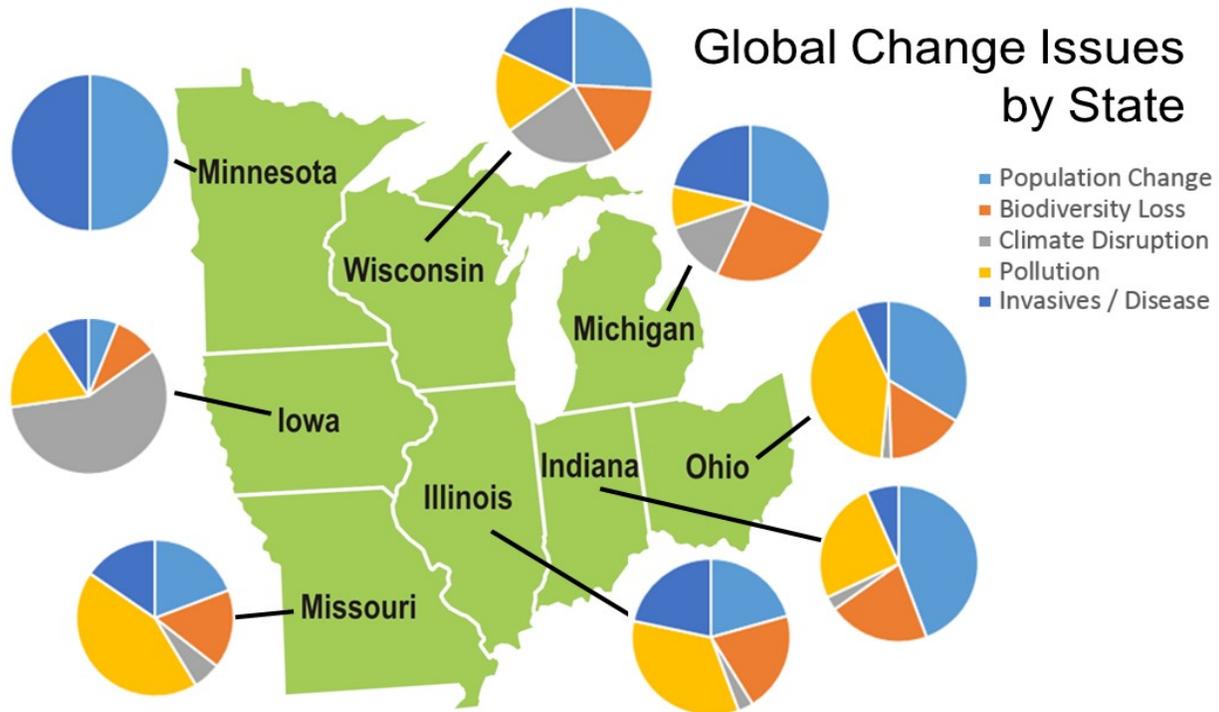
The current environmental communication rhetoric places too much blame on the general public, the farmer, the rancher, or the fisherman in regards to these issues. Thus, the actors don't feel compelled to participate in solutions because they view this dialogue as an attack. In the upcoming years, it will be imperative to critically think about the manner in which we discuss and educate the general public about global change in regions that are otherwise less progressive. I do think there is hope for success, and the media will play a critical role in this journey to address the impacts of global change.

MIDWEST ARTICLES BY ISSUE



MIDWEST ARTICLES BY STAKEHOLDER





POLLUTION

The agricultural industry is the main culprit for nitrogen and phosphorous pollution that is contaminating water, soil, and ecology in the Midwest. Limited science education cultivates misunderstanding among farmers about how fertilizers should be applied, and thus leads to excessive application of these chemicals. More education about the effects of fertilizers and pollutants for the people who use them is imperative if the Midwest hopes to clean up its act. An article from Tech Times quoted a soil scientist from Madison, Wisconsin saying, "We've changed nitrogen and phosphorus cycles vastly more than any other element, "(The increase) is on the order of 200 to 300 percent. In contrast, carbon has only been increased 10 to 20 percent and look at all the uproar that has caused in the climate." (1)

Similarly, trash is polluting the Great Lakes at unprecedented levels. A NPR reported captured a local Wisconsinite admitting that it is "a bigger problem than we initially had thought." More education is needed to prevent the impacts of trash, toxic waste, and agricultural pollution in the Midwest.

CLIMATE DISRUPTION

After years of living in the Midwest, hearing others' perspective, and doing research from this class, it is becoming more apparent that "climate change" is a difficult idea for many Midwesterners to consider. A news article quoted a Wisconsin farmer proclaiming "First thing about climate change: Don't talk about climate change." (2) Often, people too easily relate climate change to immediate weather events. How could climate change possibly be occurring if yesterday was cold or if a huge snowstorm just occurred? This type of debate ensues when discussing climate change in cold, Midwestern climates.

A "see it to believe it" seems to overshadow scientific evidence of global change. However, climate disruption is certainly worth considering, as the effects on agricultural production will have a major impact on the Midwest. All eight states' economies depend heavily on agriculture. Changes in precipitation, increases in flooding events, and other extreme weather events will likely be detrimental to the agriculture industry.

Similar to other aspects of global change, the misunderstanding about climate change stems from a lack of knowledge about how the Earth works. An article from Michigan State University quoted a student saying, "How can we tell if these things being reported about global warming are true?" (3) Science programs in the Midwest don't stack up to those in many other regions, especially when it comes to earth and environmental science.

Finally, the Midwest is notorious for lacking progressive climate policy. Many policymakers refuse to acknowledge it, and some won't even discuss it. Wisconsin's governor Scott Walker just banned government workers from saying the words "climate change" at work. In a news article about the ban, one government worker stated "Having been on this board for close to 30 years, I've never seen such nonsense, we've reached the point now where we're going to try to gag employees from talking about issues. In this case, climate change." (4) Rather than climate change being an environmental issue based in science and requiring policy solutions, it is a taboo phrase that only certain political affiliations are permitted to use. Drastic changes are needed in environmental science communication and education to promote what climate change truly is, a pressing component of global change.

POPULATION CHANGE

A severe impact of population change in the Midwest is its effect on land use. Conversions from one land cover type to another are common, and land use changes like intensification are also stressing environmental resources.

If you've ever been to Chicago or Milwaukee, you might have heard of people discussing Chica-waukee. These two large cities used to be distinct, but sprawl has now virtually connected the two via many large suburbs. Suburban lifestyles have a particularly destructive effect on the environment, as they often require lots of commuting, large

homes, and massive energy consumption. Much of the Midwest's prairies and forests were converted for urban sprawl in the past 100 years. An article about Detroit's increasing apartment demand demonstrated this stating, "Detroit's numbers are a testament to the renewed interest in living in or close to downtowns, especially by young professionals looking for an urban, walkable environment." (5) The expansion of these industries is also a huge driver of land cover change, as it is relatively cheap and easy to convert the flat, fertile prairies, forests, and grasslands into productive croplands and pine plantations.

The Midwestern economy is largely supported by agriculture and raw materials industries like paper production while the demand for these products is also high. This leads to rapid conversion of land for these resource intensive uses. However, not all hope is lost. Advances in technology are already promoting agricultural intensification; so more food can be grown on the same amount of land. An article about vertical farming in Michigan stated "We face a very interesting challenge of feeding an ever-increasing world population when the land available for production will likely shrink. We have to have new and creative ways to produce the food to feed our people." (6)

BIODIVERSITY LOSS

Biodiversity is a hot topic in the Midwest, as many states are dependent on animal related industries like hunting, fishing, and tourism. Protecting species so people may enjoy them in a variety of methods is a virtue that the Midwest holds near and dear. However, the Midwest's most critical species are succumbing to the effects of global change, and the media does not shy away from such topics in this region.

The wolf has always been a controversial species in the Midwest. In the early 1900's, the species was nearly entirely eradicated from the area through culling and incentives. More recently, the gray wolf population was re-established in Wisconsin, Michigan, and Minnesota, although the species transitions from endangered to delisted status annually. Many stakeholders like ranchers and hunters dislike the species. Some farmers, including owners of cranberry bogs, love wolves because they keep deer populations in check, as deer eat cranberries. Some deer hunters also want to keep the wolves protected, as wolves help to create a healthier deer population overall.

Although many perceive hunting and fishing to be environmentally destructive, in most cases hunting and fishing improve ecosystem health in the Midwest. Deer hunting helps to keep the massively imbalanced deer population in check (which otherwise leads to agricultural browsing and car accidents.) A University of Wisconsin-Madison news article quoted an ecologically minded hunter stating, "First, deer are overabundant relative to the long-term carrying capacity of their habitat. In the absence of other predators, human predators play a crucial ecological role. I want to be part of that." (7) Similarly, the revenue generated from hunting and fishing tags, taxes, and permits virtually all goes to conservation efforts, which these states would be hurting immensely without.

Moose are another charismatic megafauna native to the northern Midwest states. Michigan had one of the only thriving populations of moose in the continental United States until recently. Studies from the Michigan Department of Natural Resources show imminent decline. One Michigan native stated, "It might not happen in our lifetime, or our children's, but we have to face the possibility that there might not be a wild moose population in Michigan." (8)

INVASIVES & DISEASES

Unlike climate change, many Midwesterners welcome the idea that invasive species present a threat to the ecology and economy of their states. The effects of invasive species and disease are difficult to ignore, thus making the "see it to believe it" mantra applicable in this situation.

The Midwest is suffering immensely from aquatic invasives, which are brought into the Great Lakes through the fishing and shipping industries. However, there are many education efforts to involve citizens and industries with mitigation and prevention efforts to reduce the impacts of these species in the Midwest. Fishermen in particular are highly encouraged (if not required) to clean their boats when traveling between bodies of water. Nearly all fishermen have adopted this practice. An article by the University of Michigan promoted an advertisement for the practice that read, "Simply washing boating and other watercraft equipment before arriving and after departing can prevent the spread of aquatic invasive species. Your local organization can promote boater education by bringing the Mobile Boat Wash to their community!" (9)

A new app, being tested in Wisconsin, allows users to track the existence and spread of invasive species. The goal is to remove the invasives before they reach native, wild lands. The article states, "A lot of these are favorite getaway spots and just special places in the landscape. If we can keep invasives out of there, that's important. Every acre we protect from invasion is one more place that we'll have invasive-free and we won't have to bear that cost down the road." (10) Recreationalists like hunters and fishers, as well as those in related industries, can more easily understand and see the effects of invasive species. I conclude that they are thus more responsive and willing to act on the issues.

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