



2017

# PLOWPRINT





Since the 1980s, public awareness of the destruction of rainforests around the world has grown exponentially. The continuing loss of these precious ecosystems has captured our collective imaginations in ways that many other habitats have not. Variations on "save the rain forest" are a mantra that can be seen on bumper stickers, t-shirts, and billboards around the world. This visibility can be attributed to an abundance of some of the world's most charismatic wildlife, intriguing geographic locations, and effective marketing by some of the world's largest conservation organizations. However, there is another vital, yet vastly underappreciated, biome that is being lost at a similar pace without the fanfare, but of no less importance.

Temperate grasslands are threatened worldwide, due to their ability to provide food and fuel for a growing human population. Converting these grasslands impairs their ability to offer other services, such as providing habitat for wildlife, storing carbon, stabilizing the soil, connecting migration corridors and filtering and retaining water for communities in this region and downstream. It is their dual role in providing for human communities and wildlife that makes the conservation of these grasslands so critical.

<sup>1</sup> Intact habitat, as defined by the Plowprint analysis, includes those lands that were not in annual crops as of 2008 (in the US) or 2009 (Canada) and have not been converted to annual crops between 2008/9 and 2016 (or the most recent year of data), and are also not classified as developed, barren or open water as of 2011 (the most recent data available for these categories). Intact habitat may include: Lands that were converted and planted back to grass prior to 2008/9 (through conservation programs such as CRP or other private land management decisions); Lands that have not been converted since 2008/9 but are not in native cover; Lands that have a mix of native and non-native vegetation and are managed to a variety of standards; Lands that have pristine, native cover.

# THREAT

Grasslands are converted for a number of purposes, including cropland expansion, urban development, and energy exploration and development. The focus of the Plowprint Report is to document the extent and impact of conversion of grassland to cropland, which is by far the largest contributor.

# FOCUS

This year's Plowprint Report is also focused on the impacts of grassland conversion on water resources and the actions we can take to slow grassland loss. From 2015-2016, World Wildlife Fund (WWF) estimates that approximately 2.5 million acres of grasslands were lost to crop production across the Great Plains. This loss affects bird species and other wildlife that breed in the region. It also leads to increased soil erosion, which impairs water quality for communities downstream.

# PURPOSE

The purpose of the Plowprint is to identify remaining intact habitat<sup>1</sup> across the Great Plains region of the US and Canada. WWF does this by tracking cumulative loss of grassland to cropland over time. WWF is estimating cumulative loss because the conversion of intact grasslands represents a significant ecological loss that cannot easily be recovered. Intact grasslands hold hundreds, if not thousands, of years' worth of organic matter that gives the land an exceptional ability to store and filter water, stabilize the soil, sequester carbon and support diverse life above and below ground. The first time it's plowed, the land loses much of its capacity to provide these valuable ecosystem services. WWF is dedicated to eliminating grasslands loss in the Northern Great Plains by 2030 to ensure a vibrant future for the communities and species across the region, and for those who depend on these grasslands each day without realizing it.

## THE BIG PICTURE

# 2.5 MILLION ACRES LOST

From 2015-2016 approximately 2.5 million acres were lost to crop production across the Great Plains.



Six songbird species are only found in the Great Plains. Populations of these species have each declined by 65-94% since they were first counted in the 1960s. The most threatened birds include the Sprague's pipit, chestnut-collared longspur, McCown's longspur, Baird's sparrow, lark bunting and Cassin's sparrow. The loss of habitats—via conversion of grasslands to crops and other threats—negatively impacts grassland birds.

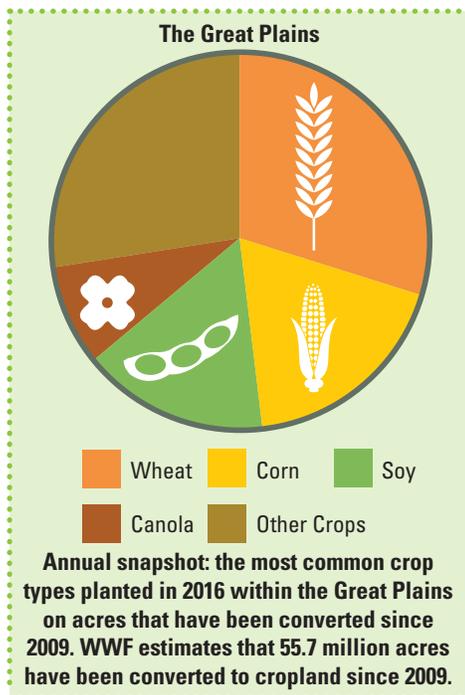
Protecting threatened grasslands  
**WILL SAVE** the same amount  
of water that's used by

# 11.6 MILLION Four-Person Homes Annually



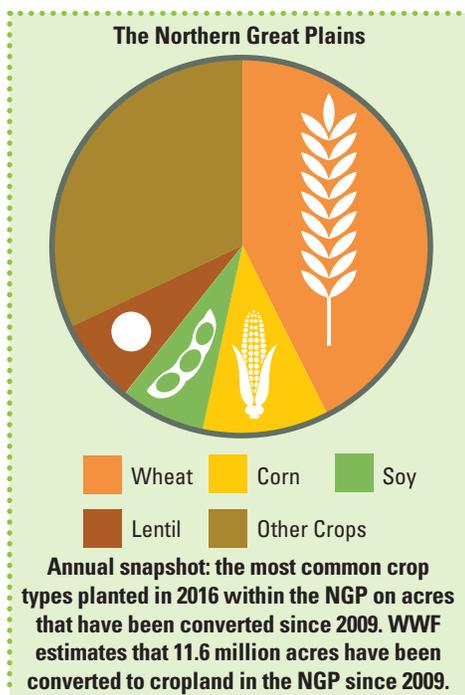
The geographic focus of this report is on the Great Plains (GP; excluding Mexico), as defined by the Commission for Environmental Cooperation, and the Northern Great Plains (NGP), as defined by WWF. WWF focuses on the GP because it represents the vast majority of the remaining intact grasslands in North America and it provides comparison to the NGP ecoregion, which WWF prioritizes because of the significant conservation values it provides.

In the following sections, WWF shows estimates of the amount of converted acres that were planted to common crops in 2016. WWF acknowledges that many of these crops are grown in rotation with each other and that “breakout” crops (i.e., those that are planted after initial conversion) vary depending on price and growing conditions.



### Great Plains Overview

- In 2016, the rate of loss of grassland to cropland decreased in the GP region, as compared to 2015, with the annual loss rate dropping from 1.00% in 2015 to 0.69% in 2016. This still amounts to 2.5 million acres of grassland lost to conversion for growing crops, as compared with 3.7 million acres in 2015. In total, approximately 8% of the GP has been plowed for crops just since 2009. Overall, approximately 54% of the Great Plains is still intact grassland.
- Of the conversion to cropland that has occurred since 2009, wheat (30%), corn (18%), soy (16%), and canola (8%) are the most common crops grown on these lands in 2016. The remaining 28% of the cropland in the Plowprint is planted to lentils, sorghum, barley, peas, oats, dry beans, sunflowers, flaxseed and other crops<sup>2</sup>. Areas with high rates of conversion within the GP (but outside the NGP; see Map on page 5) include northern Missouri, eastern Colorado, the Gulf Coast and the Prairie Parklands in Canada.
- Conversion of grassland and other natural vegetation to cropland is not necessarily permanent and many farmers do choose to return or rotate cropland back to grasslands and wetlands, which, for this report, is referred to as “perennial cover.” Please see the Methodology and Technical Data section on pages 8-10 of this report for more information on lands rotating back into perennial cover.

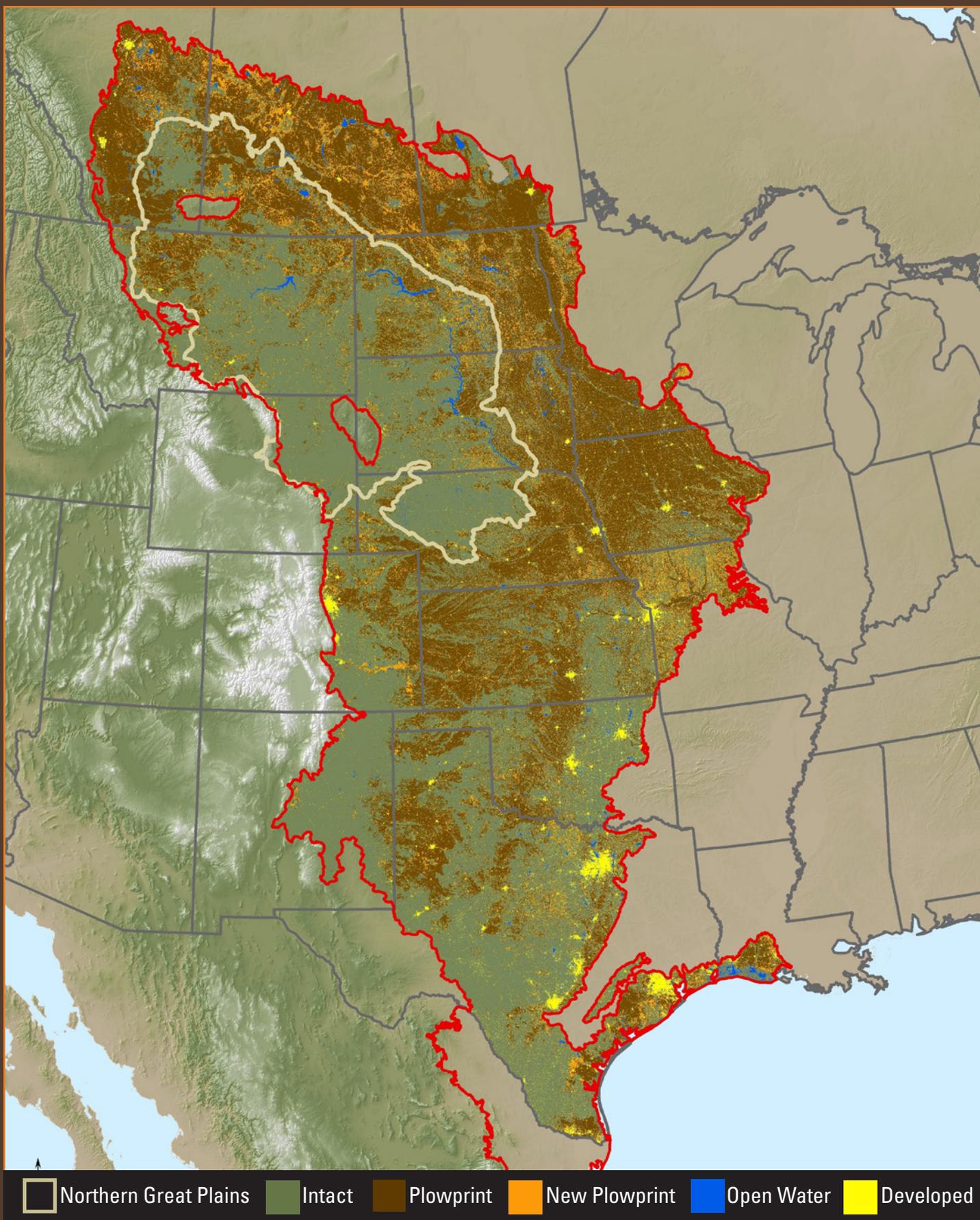


### Northern Great Plains Overview

- Over 700,000 acres of grassland were lost to cropland in the Northern Great Plains in 2016. Similar to the GP region, this represents a decrease in the annual loss rate to 0.55%, as compared to 0.75% in 2015.
- Wheat (43%), corn (11%), soy (7%) and lentils (7%) represent the primary crops grown in 2016 on acres that have been converted to cropland since 2009. Wheat is much more prevalent in the NGP than in the larger GP region, while corn and soy are less common in the NGP than in the broader region, due to the suitability of soils and climate. The remaining Plowprint is planted to peas, barley, sunflower, canola, oats, sorghum, flaxseed, dry beans and other crops<sup>3</sup>. Areas with high rates of conversion within the NGP were similar to 2015, with areas in Saskatchewan and Alberta, as well as the Prairie Pothole Region in the US, losing the most grass.

<sup>2,3</sup> Other crops include: millet, sugarbeets, safflower, mustard, rye, potatoes, triticale, buckwheat, vetch, camelina, speltz, grapes, turnips, radishes, onions, aquaculture and other fruits, vegetables, herbs, and small grains.

## 2017 Plowprint: Intact Grasslands, Plowprint, and New Plowprint in 2016



Map of intact grasslands, Plowprint (lands that have been planted to crops beginning in 2009) and the new addition to the Plowprint in 2016 (lands that were plowed in 2016) in the Great Plains<sup>4</sup>.

# Special Focus: Water



The Northern Great Plains form a large part of the Missouri River Basin (MORB), which is the “life zone” of the larger Mississippi River Basin. WWF calls the MORB the life zone because it is made up of largely intact grasslands, which help to infiltrate precipitation and reduce downstream flooding, filter nutrients (such as nitrogen and phosphorus), store carbon, recharge groundwater, reduce erosion and provide wildlife habitat. The NGP provide these important ecosystem services to communities along the Missouri River, including those that depend on the river for drinking water (such as Great Falls, Bismarck, Omaha, Kansas City and St. Louis), as well as downstream communities.

In 2016, Limnotech, in partnership with WWF, estimated the potential downstream water quality impacts of avoiding future conversion of intact grasslands to cropland in the MORB<sup>5</sup>. To do this, Limnotech used a hydrological model known as the Soil and Water Assessment Tool (SWAT) to predict the amount of surface runoff, sediment and nutrient (nitrogen and phosphorus) loading from changing land cover for two scenarios: 1) the current baseline conditions as estimated by the Plowprint in 2015 (see page 4)<sup>6</sup> and 2)

the predicted future conversion of all suitable grassland to cropland<sup>7</sup>. WWF included the following variables in the model: slope, climate, soils, land cover and agricultural management (i.e., representative crop rotations, planting dates, tillage operations, fertilizer applications and irrigation schedules from USDA data). If we compare estimated sediment and nutrient losses, we can understand the benefit of keeping those grasslands intact.

We estimated that conserving grasslands that are predicted to be lost could save 1.7 trillion gallons of water, or about 4% of the total flow volume of the MORB<sup>8</sup>. This is equivalent to the water 11.6 million four-person US households use annually, or 1/3 of the volume of Utah's Great Salt Lake. We would also save 46 million tons of sediment annually (about 9% of the total sediment in the MORB) by keeping the grass intact, which is equivalent to the weight of 127 Empire State Buildings. We would save significant amounts of nitrogen and phosphorus as well: 87 million pounds of phosphorus (about 17% of the total for the MORB) and 427 million pounds of nitrogen (about 22% of the total for the MORB) annually.

<sup>4</sup> Because the Plowprint has a spatial resolution of 56 meters, the pixels that were plowed in 2016 are challenging to see at the scale of the Great Plains. Thus, WWF aggregated the smaller pixels into a resolution of 1 kilometer, while maintaining the percentage of the larger cell that was new Plowprint. To display the data, WWF experimented with different thresholds of cropland composition within each 1 km pixel and selected a threshold of 1%. Thus, for each aggregated pixel, 1% of the pixels had to be new Plowprint to qualify. This threshold allowed the pixels to be clearly visible at the Great Plains scale and reflect the hotspots of new conversion. <sup>5</sup> Flynn, A.M. et al. (2017). Quantifying the environmental benefits of conserving grassland. *Journal of Management and Sustainability* 7(2): 65-77 <sup>6</sup> Gage, A. M., Olimb, S. K., & Nelson, J. (2016). Plowprint: Tracking cumulative expansion to target grassland conservation. *Great Plains Research*, 26, 107-116. <https://doi.org/10.1353/gpr.2016.0019> <sup>7</sup> Smith, J.T. et al. (2016). Reducing cultivation risk for at-risk species: predicting outcomes of conservation easements for sage-grouse. *Biological Conservation*, 201, 10-16. <https://doi.org/10.1016/j.biocon.2016.06.006> <sup>8</sup> This represents only the surface runoff fraction of the total flow volume.

Why does WWF care? In addition to supporting wild-life and communities in the Northern Great Plains, these intact grasslands provide clear benefits to downstream communities and water users. This research highlights the importance of maintaining intact, natural systems for improving water quality and increasing water quantity in the Missouri River Basin. Maintaining grasslands reduces downstream flooding events by regulating runoff, as well. Protecting natural systems is one important way to ensure high-quality water supplies are available for future generations.

The impacts of nitrogen and phosphorus pollution on aquatic resources are wide-ranging, including increased algal blooms, decreased water quality for human consumption, decreased quality of habitat for aquatic species, and decreased oxygen availability for fish and other species. Nutrient pollution is directly linked to hypoxia, or dead zones, in the Gulf of Mexico.



### Water-Associated Birds

Twenty species of water-associated birds are of conservation concern in the NGP. These include species dependent on rivers, marshes, lakes and large ponds. Relatively unique species such as the Long-billed Curlew, Marbled Godwit, Wilson's Phalarope, and Franklin's Gull nest in and around wetlands in the region. These species are affected by the conversion of grasslands as they depend on the local hydrology of grasslands to maintain wetlands for feeding and nesting. As landscapes shift from grassland to cropland, water levels can fluctuate more as water processes such as surface runoff, infiltration, and water table depth are altered. The Franklin's Gull, like several other water birds, makes a nest of floating vegetation and requires relatively stable water levels in marshes. Large water fluctuations can result in colonies of Franklin's Gulls abandoning breeding areas, reducing production of young.

Beyond marshes and ponds, many more grassland species depend on the ribbons of riparian forests and shrublands restricted by the amount of available water in low lying areas within the grasslands. Moreover, these ribbons are tendrils of life for grassland birds that depend on them during different times of their annual cycle. Upland gamebirds can use riparian forests as roosting and feeding sites in the winter and their young depend on such areas for feeding when food in grasslands becomes scarce in late summer.

### Plowprint Methodology

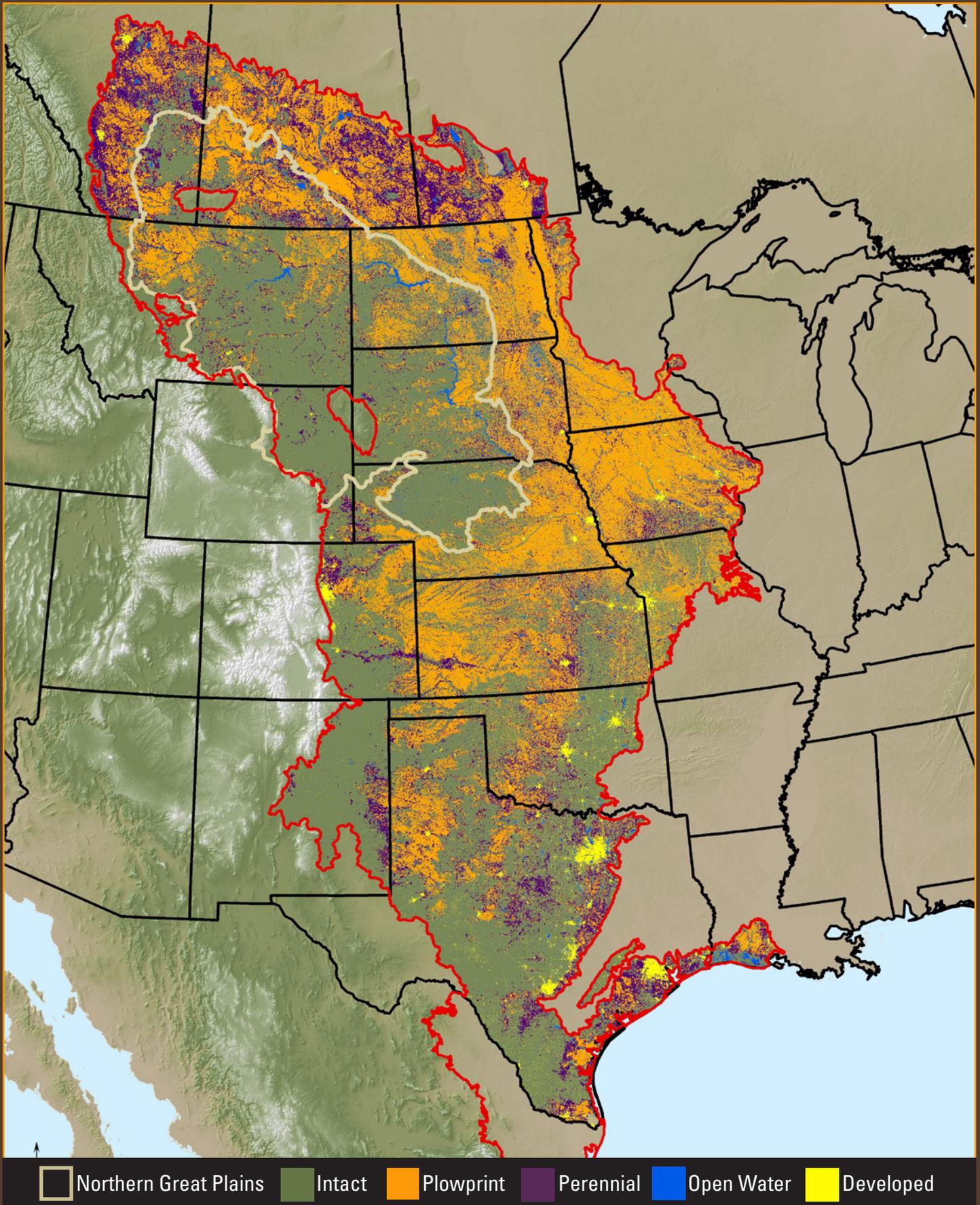
WWF is tracking cumulative or gross—as opposed to net—initial conversion between 2008/9 and 2016, the most recent year of data. In other words, if an acre of intact grass was converted for crop production but returned back to grass during this period, it is still counted in the Plowprint. To do this, WWF uses the USDA National Agricultural Statistics Service Cropland Data Layer for 2008-2016 in the U.S. and the Agriculture and Agri-Food Canada Annual Crop Inventory from 2009-2016<sup>9</sup>. Other studies look at net conversion<sup>10,11</sup>; in those studies, land is not counted as converted if it was planted back into grass or if it returned naturally. WWF monitors gross conversion because the first conversion of intact grasslands represents a significant ecological loss that can't be easily recovered. The first time it's plowed, the habitat is degraded and the land loses much of its capacity to provide valuable ecosystem services. Farmers and ranchers can use crops and livestock as tools to rebuild that soil and restore diverse plant life, but it can take a long period of time to do so—longer than the period covered by the Plowprint.

### Perennial Cover

Conversion of grassland to cropland is not necessarily permanent, and cropland can rotate back into grass cover through restoration or abandonment. Land that has gone back to grass cover, regardless of its quality, is referred to as “perennial cover” in the Plowprint analysis. Within the Cropland Data Layer, grassland, wetland, shrubland, forest, hay and barren lands are included in the perennial cover. Lands that were tilled and then planted back to alfalfa are also included as perennial cover. Some of these lands may be diverse grasslands, whereas others may be temporarily abandoned fields of low-quality habitat. Our primary concern about quality is that these areas have been converted in the recent past, impacting their ability to sequester carbon, prevent erosion and facilitate the infiltration of water until newly reestablished vegetation has developed mature root systems. Initial plow-up has significant, long-term environmental impacts, particularly when diverse and/or native stands of grassland are lost. Restoration and rotations into perennial cover, while important, are not always enough to address these losses, particularly with regard to conserving biological diversity<sup>12</sup>. However, these grasslands can provide conservation value in a broader, land-use management context.

<sup>9</sup> For noncropland cover types: In the US, WWF uses the National Land Cover Dataset from 2011. In Canada, WWF uses the Land Cover Data from 2000. <sup>10</sup> Wright, C. K., & Wimberly, M. C. (2013). Recent land use change in the Western Corn Belt threatens grasslands and wetlands. *Proceedings of the National Academy of Sciences*, 110, 4134-4139. <https://doi.org/10.1073/pnas.1215404110> <sup>11</sup> Lark, T. J., Salmon, J. M., & Gibbs, H. K. (2015). Cropland expansion outpaces agricultural and biofuel policies in the United States. *Environmental Research Letters*, 10, 044003. <https://doi.org/10.1088/1748-9326/10/4/044003> <sup>12</sup> Sala, O. E., and J. M. Paruelo. 1997. Ecosystem services in grasslands. Pages 237-252 in G. C. Daily, editor. *Nature's Services: Societal Dependence on Natural Ecosystems*. Island Press, Washington, D.C.

## 2017 Plowprint: Active vs. Perennial Plowprint in the Great Plains



Map of active vs perennial Plowprint in the Great Plains. Active Plowprint refers to pixels that were in cropland in 2016. Perennial Plowprint refers to pixels that were planted in perennial cover in 2016. Taken together, these two categories represent the Plowprint as a whole<sup>13</sup>.

Of the land that has been added to the Plowprint since 2009, our analysis shows that roughly half is currently in perennial cover. Perennial cover remains relatively constant from 2015-2016 in the Great Plains, but has increased slightly in the NGP. However, these are likely overestimates, based on work completed on error rates and bias in the Cropland Data Layer, which WWF used to develop the Plowprint<sup>14</sup>. Still, WWF acknowledges the value of these lands in potentially helping to increase infiltration, protect water quality, reduce erosion and provide wildlife habitat. While stopping the loss of intact grasslands is important, WWF also aims to increase the amount of grasslands in perennial cover in order to restore these important areas and increase the ecosystem services that they provide. WWF advocates that landowners and land managers choose to restore these lands to high-quality mixes of native grasses.

### **Error rates/bias**

As with any data product derived from satellite imagery, there is error in classification of the Cropland Data

Layer. The U.S. Department of Agriculture provides error rates for each crop type annually, and accuracies vary widely, depending on the geographic location, crop type and year. Given these error rates, the Plowprint analysis aggregates crop types to distinguish cropland from non-cropland with greater accuracy. In addition, for many of the most common crops grown throughout the study region, accuracy is in the 80-90% range across much of the geography. Thus, WWF feels confident in identifying cropland versus non-cropland and highlighting the major crop types grown in these areas. However, as discussed previously with respect to perennial cover, WWF is conservative in its approach and likely overestimating the amount of the Plowprint that has reverted back to some type of perennial cover. Wright et al. (2017)<sup>15</sup> suggest that reversions of cropland to non-cropland could be overpredicted by about 125% or 2.25 times as often as they actually occur. Interpretation of the quantity and spatial location of the Plowprint that has gone back into perennial cover in this analysis therefore calls for some caution.



**The Great Plains is home to hundreds of native pollinator species. 1 out of 4 species of bumble bee – vital members of this community due to the range of plants that they visit – are at risk of extinction.**

**Habitat loss is playing a major role in their decline.**

### WWF Engages:

- **Policy Makers** at the federal, state and local levels to better protect and restore grasslands by fostering solutions for working agricultural lands that improve wildlife habitat, protect air and water quality and enhance soil health. This includes expanding incentive-based conservation programs for farmers and ranchers, easing inter-generational transition for producers and encouraging farm policy that supports improved conservation outcomes.
- **Producers and Supply Chains** to integrate and incentivize improved stewardship and conservation of grassland in food and energy production. We recognize that most of our grasslands are also working lands, and that well-designed grazing management systems are good for business and can also support biodiversity and ecological function. In the face of changing climate and pressure to convert grasslands to cropland, this is especially important.
- **Companies** on sustainable sourcing commitments and programs that protect sensitive habitats, including grasslands, and reward advances in production efficiency.

### WWF Supported Actions and Programs:

- Spotlighting agricultural producers and companies that prioritize sustainable production and commit to responsible sourcing.
- Encouraging support for an effective conservation title in the 2018 Farm Bill, such as:
  - o Increased funding for conservation programs, with no cuts to one at the expense of another, such as:
    - Conservation Reserve Program (CRP) to help fund the retirement of marginal land to grassland for habitat and to build soils;
    - Regional Conservation Partnership Program (RCPP) to encourage conservation partnerships that are coordinated, leveraged and well-funded;

- Environmental Quality Incentives Program (EQIP) and Conservation Stewardship Program (CSP) to provide assistance to landowners seeking to improve conservation outcomes on working lands;
  - Agricultural Conservation Easement Program (ACEP) to permanently protect grassland from development, subdivision and conversion.
  - o A strong Sodsaver provision that eliminates insurance subsidies when native grasslands are plowed under to produce crops.
  - o Enhanced Natural Resources and Conservation Service (NRCS) Technical Assistance funding so that farmers and ranchers are afforded the technical expertise necessary to access farm programs and improve conservation outcomes.
  - o Funding for the Beginning Farmer and Rancher Development Program to assist ranching families with transitions to the next generation and to assist with bringing new ranchers into opportunities for mentoring.
- Educating WWF members and others about the importance of grassland conservation and encouraging them to share their passion with neighbors, friends and other WWF members.

WWF is committed to securing the future of grassland systems in North America with a focus on the Northern Great Plains. Slowing conversion of these areas to other uses depends on recognizing the many values that grasslands provide for people, their communities, and wildlife. It will take a multi-dimensional approach, in concert with producers and industry, to sustain these valuable systems for the benefit of future generations.

For additional information visit:  
[www.Plowprint.org](http://www.Plowprint.org)

<sup>13</sup> WWF used a similar technique to display the perennial cover within the 2016 Plowprint. First, WWF identified Plowprint pixels as “perennial” or “active cropland” using the current (2016) Cropland Data Layer. Perennial cover includes grassland, wetlands, shrubland, forests and other non-cultivated land cover types. Pixels of perennial Plowprint were aggregated to one kilometer and WWF systematically tested the composition threshold to identify the value that increased visibility while maintaining the integrity of the underlying data. A 15% threshold was used to create the map shown.

<sup>14-15</sup> Wright, C.K. et al. 2017. Recent grassland losses are concentrated around U.S. ethanol refineries. *Environmental Research Letters* 12(4): 044001.



together possible

**Front Cover:** Grassland birds such as the McCown's Longspur have declined as much as 80% since the 1960s due to the plow-up of grasslands for cropland and other forms of development.

Image © Donald M. Jones / Minden Pictures



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