M.L. 2019 Project Abstract
For the Period Ending June 30, 2022

PROJECT TITLE: Mapping Unprofitable Cropland for Water and Wildlife
PROJECT MANAGER: Jason Ulrich
AFFILIATION: Science Museum of Minnesota – St. Croix Watershed Research Station
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FUNDING SOURCE: Environment and Natural Resources Trust Fund
LEGAL CITATION: M.L. 2019, First Special Session, Chp. 4, Art. 2, Sec. 2, Subd. 04n as extended by M.L. 2021, First Special Session, Chp. 6, Art. 6, Sec. 2, Subd. 18

APPROPRIATION AMOUNT: $100,000
AMOUNT SPENT: $98,440
AMOUNT REMAINING: $1,560

Sound bite of Project Outcomes and Results
This project mapped an estimated 550,000 acres of unprofitable cropland in southern Minnesota. It was then estimated that converting 20% of these acres could significantly improve stream health and wildlife habitat.

Overall Project Outcome and Results

Despite investing millions of dollars on agricultural conservation, the health of southern Minnesota's streams and rivers has not improved demonstrably. At the same time, increases in agricultural cropland have resulted in dramatic declines in grassland habitat critical for migratory birds, butterflies and pollinators. An approach for improving both stream health and wildlife habitat lies replacing portions of southern Minnesota's agricultural land with prairie and wetlands. However, most cropland is profitable and thus too costly for a farmer to take out of production. But what about parts of crop fields that often too wet or too dry to turn a profit, could these be replaced with prairie or wetlands more economically? This project set out to answer the following questions: 1. How much corn and soybean cropland in southern Minnesota is unprofitable? 2. What are the environmental benefits of converting portions of this unprofitable cropland to prairie or wetlands? Our project used county agricultural financial data and detailed soil maps to pinpoint an estimated 550,000 acres of unprofitable cropland in a 40-county region of southern Minnesota. Next, the project estimated the improvement to streams and wildlife habitat if the most unprofitable of these acres located next to streams (114,000 acres) were converted to prairie or wetlands. The results suggest that targeting unprofitable croplands in this way would significantly improve stream health and wildlife habitat in southern Minnesota, and provide a good bang for the buck. The project outcomes are intended to be useful for the public and policy-makers to understand the amount and distribution of unprofitable cropland in southern Minnesota and its great potential for improving environmental health in an economical way.

Project Results Use and Dissemination
The project content was presented at several Science Museum member events over Zoom. And in October 2022, the work will be presented at the MN Water Resources Conference, a premier venue for this type of research.

The results of this project including the GIS files and attached fact sheet will be linked from this Science Museum website when our new web portal is up and running fall of 2022. Interested visitors will be able to download the GIS files and conduct their own analyses based upon those in the study. Announcements about these deliverables and about the key points and highlights of the project will be shared on the Science Museum's social media accounts in fall 2022.

Environment and Natural Resources Trust Fund (ENRTF)
M.L. 2019 ENRTF Work Plan - Final Report

Today's Date: July 31, 2022

Final Report

Project Completion Date: June 30, 2022

PROJECT TITLE: Mapping Unprofitable Cropland for Water and Wildlife

Project Manager: Jason Ulrich

Organization: Science Museum of Minnesota

College/Department/Division: St. Croix Watershed Research Station

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Location: Agricultural areas in the southern 1/3 of Minnesota; includes all of Southwest and Southeast regions, and portions of the Central region (Chippewa, Kandiyohi, McCleod, Meeker, Nicollet, Renville, Sibley Counties) and Metro region (Carver, Dakota, Scott, Wright Counties).

Total Project Budget: $100,000

Amount Spent: $98,440

Balance: $1,560

Legal Citation: M.L. 2019, First Special Session, Chp. 4, Art. 2, Sec. 2, Subd. 04n as extended by M.L. 2021, First Special Session, Chp. 6, Art. 6, Sec. 2, Subd. 18

Appropriation Language: $100,000 the first year is from the trust fund to the Science Museum of Minnesota for the St. Croix Watershed Research Station to conduct the first statewide analysis that maps the extent of Minnesota's unprofitable cropland and estimates both the water-quality and habitat benefits of converting these lands to perennial crops and vegetation. This appropriation is available until June 30, 2021, by which time the project must be completed and final products delivered.

M.L. 2021, First Special Session, Chp. 6, Art. 6, Sec. 2, Subd. 18. ENVIRONMENT AND NATURAL RESOURCES TRUST FUND; EXTENSIONS. [to June 30, 2022]

I. PROJECT STATEMENT:

What is the statewide potential of converting unprofitable cropland to perennial vegetation? Could this approach be the silver bullet for improving Minnesota's water-quality and habitats?

- **Our current conservation approaches have not met Minnesota's water-quality or habitat goals.**

  Despite investing millions of dollars in best management practices, water-quality has not improved demonstrably. At the same time, increases in corn and soybean acres and changes in agricultural practices have resulted in dramatic declines in grassland habitat critical for migratory birds and pollinators.

- **Perennial vegetation is a very effective way to improve water-quality and habitat but is too expensive.**

  It has been estimated that meeting our water-quality goals using existing best management practices will cost over a billion dollars per year. However, despite this investment, habitat will not be significantly improved. Alternatively, perennial vegetation -- defined here as either perennial cash-crops (such as alfalfa), or permanent vegetation (such as wetlands or restored prairie) -- is a very effective means of improving both water-quality and habitat but thus far has been economically impractical because it requires taking profitable cropland out of production.

- **It is estimated that at least 1 million acres of Minnesota's cropland is unprofitable.**

  Based on Midwestern studies, it is likely that 1 million acres or more of cropland in Minnesota has been unprofitable (i.e., lost farmers money) in some or all of the last 5 years. Moreover, in 2017, Minnesota's cropland was unprofitable on approximately of 2/3 of its 8 million total corn acres.

- **Targeting unprofitable cropland is the cheapest way to increase perennial vegetation in Minnesota.**

  Prioritizing unprofitable cropland for perennial vegetation makes sense because this land costs the least to take out of production and can even increase whole farm profits. These unprofitable areas are generally very wet or very dry portions of otherwise profitable fields. This concept of targeting unprofitable land is not new, and in fact, organizations such as Pheasants Forever are currently implementing it on a number of demonstration farms in Minnesota.

- **However, we do not know the statewide extent of unprofitable cropland in Minnesota, nor the water-quality and habitat benefits of converting some or all of it to perennial vegetation.**

  Presently, there is no information on the probable statewide locations and extent of unprofitable cropland, and the cumulative water-quality and habitat benefits from converting some or all of these areas to perennial vegetation. If the extent of unprofitable cropland as well as the water-quality and habitat benefits from converting these areas are significant, targeting unprofitable cropland needs to become a major focus of water and wildlife management and policy efforts.

Our project will conduct the first analysis in Minnesota to map the probable extent of unprofitable croplands, and quantify both the water-quality and habitat benefits of converting these areas to perennial vegetation. The project's study area will be composed of agricultural areas in the southern one-third of Minnesota.

II. OVERALL PROJECT STATUS UPDATES:

First Update January 31, 2020

With approximately 20% of the total funds spent thus far, the project has been progressing on schedule. Activities have been focused around data collection related to Activity 1 Outcome 1. At present, data collection related to calculation of sub-field scale (i.e., sections within fields) input costs, yields and resulting profitability are nearly complete. Further detail is presented under Activity 1.

Second Update June 30, 2020

No substantive work was completed for the project between January 31, 2020 and March 23, 2020, when Science Museum staff were laid-off due to Covid-19 until November 2020.

Third Update January 31, 2021

Staff on this project returned to work from Covid-19 layoff on November 2, 2020. Since then, no substantive work has been completed. Work related to the project will resume in the late-winter/spring 2021.

Project extended to June 30, 2022 by LCCMR 6/30/21 as a result of M.L. 2021, First Special Session, Chp. 6, Art. 6, Sec. 2, Subd. 18, legislative extension criteria being met.

Fourth Update June 30, 2021:

Work completed in this period is associated with Activity 1, Outcomes 1 and 2. Data compilation has been completed which enabled first (prototype) versions of GIS input costs and yield maps to be developed. Importantly, searches for farmers willing to share sub-field scale yield to validate the study-area wide profitability analyses have resulted in at least one farmer committing to participating in the project at this time.

Fifth Update January 31, 2022:

Overall, work completed in the last 6+ months is associated with all remaining work items from both Activities 1 and 2. Provisional mapping results of estimated unprofitability have been completed. Preliminary modeling work to assess the water quality and habitat benefits of different perennial scenarios (i.e., retirement/re-purposing of marginal or unprofitable land) has been completed for the six HUC-12 watersheds. The last tasks to finish entail validating the profitability estimation approach and results with involvement from a select group of farmers as well as preparing reports and other Dissemination deliverables.

Also, we have requested amendment of the Dissemination section of the workplan to omit presentation of project results at five or more venues; this change reflects two difficulties related to covid-19: (1) Project progress was slowed because of covid-19 layoffs and furloughs at the Science Museum; consequently, presentable results will only be available in the 1-2 months prior to the project completion date, and (2) because of continued covid-19 restrictions, there are far fewer venues/opportunities to present the project results. We propose amending the Dissemination in the following ways:

(1) The Science Museum will sponsor opportunities to present the results live to members and the general public.
(2) The Science Museum will create social media content in the form of produced videos that will present and summarize results. These videos will be shared across social media sites representing environmental and farming audiences.
(3) An oral presentation will be given at the MN Water Resources Conference in October 2022; this is the premier local/regional venue for this project's content.

Note: Budget balance remaining $53,353 is the same as reported in the last project update, and reflects that the Science Museum has not invoiced for any further funds as of yet although project activities have continued.

Overall Project Outcomes and Results

Despite investing millions of dollars on agricultural conservation, the health of southern Minnesota's streams and rivers has not improved demonstrably. At the same time, increases in agricultural cropland have resulted in dramatic declines in grassland habitat critical for migratory birds, butterflies and pollinators. An approach for improving both stream health and wildlife habitat lies replacing portions of southern Minnesota's agricultural land with prairie and wetlands. However, most cropland is profitable and thus too costly for a farmer to take out of production. But what about parts of crop fields that often too wet or too dry to turn a profit, could these be replaced with prairie or wetlands more economically? This project set out to answer the following questions: 1. How much corn and soybean cropland in southern Minnesota is unprofitable? 2. What are the environmental benefits of converting portions of this unprofitable cropland to prairie or wetlands? Our project used county agricultural financial data and detailed soil maps to pinpoint an estimated 550,000 acres of unprofitable cropland in a 40-county region of southern Minnesota. Next, the project estimated the improvement to streams and wildlife habitat if the most unprofitable of these acres located next to streams (114,000 acres) were converted to prairie or wetlands. The results suggest that targeting unprofitable croplands in this way would significantly improve stream health and wildlife habitat in southern Minnesota, and provide a good bang for the buck. The project outcomes are intended to be useful for the public and policy-makers to understand the amount and distribution of unprofitable cropland in southern Minnesota and its great potential for improving environmental health in an economical way.

III. PROJECT ACTIVITIES AND OUTCOMES:

ACTIVITY 1 Title: Estimate the probable extent of unprofitable croplands in Minnesota.

Description: We propose building upon previous work of researchers at Iowa State (*Subfield profitability analysis reveals an economic case for cropland diversification,* Brandes et al. 2016) to estimate at a sub-field scale the profitability of row-crop agriculture in the study area during the last 5 years; this period will reflect representative fluctuations in commodity prices, input costs, and climate. The probable extent of unprofitable croplands will be determined using a GIS (geographic information systems) approach that utilizes soils, topography, cropping history, crop prices, input costs, and crop yield data. An important and unique component of our approach will be to also evaluate the size, position and shape of the estimated unprofitable areas to ensure that conversion of these areas is practical given current farming practices, equipment sizing, etc. These profitability estimates will be validated using precision-based farm profit data from the ongoing LCCMR Pheasants Forever *Growing Green Together* project.

ACTIVITY 1 ENRTF BUDGET: $ 50,000

Outcome	Completion Date
1. Compile GIS, input cost, pricing and yield data necessary for profitability analyses.	January 31, 2020
2. Generate and validate GIS maps of the probable extent of unprofitable croplands.	June 30, 2020

First Update January 31, 2020

At present, data collection is nearly complete. Foremost, a large collection of county-level corn and soybean input cost data for the study area has been assembled from the University of Minnesota's FINBIN website (https://finbin.umn.edu/) categorized by crop type (corn or soybean) and ownership type (owned or rented). A custom R program was written to process and aggregate approximately 200 separate data files. This data will be matched with county-level USDA NASS (National Agricultural Statistics Service) corn and soybean yield data that was retrieved, along with sub-field soils data to create field-scale yield/profitability estimates for the 43 counties in the study area. In addition, high-resolution LiDAR elevation data for these 43 counties has been retrieved and organized in an ArcGIS file geodatabase; this data will assist in contextualizing the sub-field soils data in terms of soil moisture and potential drain tile extent, and will also be used in Activity 2 in preparation for the SWAT modeling.

Second Update June 30, 2020

No substantive work was completed for the project between January 31, 2020 and March 23, 2020, when Science Museum staff were laid-off due to Covid-19 until November 2020.

Third Update January 31, 2021

Staff on this project returned to work from Covid-19 layoff on November 2, 2020. Since then, no substantive work has been completed. Work related to the project will resume in the late-winter/spring 2021.

Fourth Update June 30, 2021:

Activity 1 work completed includes tasks associated with Outcomes 1 and 2. Data compilation has been completed which enabled first (prototype) versions of GIS input costs and yield maps to be developed. Importantly, searches for farmers willing to share sub-field scale yield to validate the study-area wide profitability analyses have resulted in at least one farmer committing to participating in the project at this time.

Fifth Update January 31, 2022:

Activity 1 is mostly complete at this point: Provisional mapping results across the study area of estimated input costs, yields, and unprofitability have been completed and compiled in a GIS database. The last tasks to finish entail validating the profitability estimation approach and results with involvement from a select group of farmers; efforts to procure farmer field data are wrapping up at present.

<u>Activity 1 Final Reporting</u>

Summary

The first of the project's two Activities entailed estimating the potential extent of unprofitable corn/soybean cropland in a 40-county area in southern Minnesota from 2011-2020. This study area totaled 16,131,000 acres with 10,517,000 acres of cropland, comprising 153,000 corn/soybean fields (See Figure 1). Profitability was calculated at a sub-field scale based on (1) the estimated crop productivities of soil types within each field, (2) maps showing which crop was grown in each field each year (corn, soybeans or other), (3) annual county crop yields from the US Department of Agriculture, and (4) annual financial data for a sample of farmers from each county provided by the University of Minnesota. Using these data, input costs, crop yields, revenue and net profit were computed for each corn/soybean field in the study area. Unprofitable fields were defined as having a net profit/return-on-investment (ROI) of -10% or less over the period 2011-2020 (i.e., total 10 year revenue was at least 10% less than total 10 year costs). Using this -10% threshold, approximately 550,000 acres (or 5% of the 40-county cropland area) were estimated to be unprofitable. Counties on the eastern side of the study area generally exhibited more unprofitable cropland than the west and central counties (See Figures 5 and 6). While subject to assumptions and uncertainties, these estimations suggest an appreciable fraction of corn and soybean cropland in southern Minnesota was marginal (broke-even) or unprofitable in the last decade.

Approach

The project approach, as it pertains to estimation of crop yields and profitability, most closely follows the work done in the State of Iowa over the last decade exploring potential for profitable energy crop production in the place of marginal or unprofitable corn and/or soybean land (Bonner et al., 2014; Brandes et al., 2016; Brandes, McNunn, et al., 2018; Brandes, Plastina, et al., 2018). These studies utilized available sub-field scale GIS datasets of soil productivity and county-scale surveys of annual yields and input costs to estimate the annual sub-field extent of corn and soybean cropland that could achieve higher net profits if bioenergy crops (e.g., switchgrass) were planted instead. Our project differs in that (1) we did not consider economics – or conversion to a cash crop such as switchgrass or alfalfa -- in the placement of our perennial vegetation options (prairie filter strips and restored wetland), and (2) we estimated water quality and habitat benefits of unprofitable land conversions (See Activity 2).

Methods

Yields and Profitability

Yield and total acres planted and harvested per-crop, per-county, per-year where downloaded from the NASS data server for 2011-2020 (USDA National Agricultural Statistics Service, 2022). Financial data came from the FINBIN data downloaded from the University of Minnesota's Center for Farm Financial Management (University of Minnesota, 2022). The FINBIN database stores anonymous farm financial data from voluntary contributors that use the FINPACK farm financial software. FINBIN data was retrieved by crop (corn or soybean) and tenure (owned or rented) from 2011-2020. Financial data analyzed included all costs (direct, overhead, labor, land rent, crop insurance premiums, etc.) and payments (crop sale revenue, government payments, crop insurance payments, etc.). All data was imported in R software for analysis (R Core Team, 2020).

Individual field PLS field boundaries were assumed representative of a "farm" for purposes of estimating farm ROI (return on investment). GIS field boundaries and their annual crop designations were provided as part of the ACPF Core Database (Tomer et al., 2015). The approach takes NASS reported yield averages for each county/crop/year and disaggregates them to individual sub field soil polygons using Crop Productivity Index (CPI) soil parameter (from gSSURGO soil database). The CPI ranges from 0-100 and is an indicator of potential, maximal crop productivity for given soil under optimal growing conditions (climatic, agronomic, adequate drainage, etc.; however, CPI does not consider if the soil were to be irrigated). A CPI is 0 indicates extremely low potential for crops; 100 is the most optimal. Thus, the CPI is used as a scaling factor to modify the annual county yield average (for each year and crop) for each sub field soil polygon based on the county-wide distribution on CPIs, such that the area-weighted average of all CPI-scaled yields equals the reported yield average for each county/crop/year. As such, the approach is assumes the CPI scales linearly with yield; it also assumes that CPI and the county-reported yields are the only factors influencing yields in any given field-soil polygon.

The methodology for calculating yields and profitability at the sub field level was as follows:

1. ACPF field boundary polygons for the study area were intersected with sub-field scale SSURGO polygons using ArcGIS Pro 3.0. This resulted in each field having multiple soil polygons, each with a crop productivity index (CPI). Field-soil polygon tabular data were imported into R software for further analysis.

2. In R: Field-soil polygons data, including whether corn or soybeans were planted there each year 2011-2020, were joined with the NASS county yield data and FINBIN financial data by county, crop (corn or soybeans only), and year.

3. Solved for the CPI coefficient for each county/crop/year combination: $CountyCropYear\ CPI\ coeff = CountyCropYear\ Yield\ \div \sum_{i=1}^{100} [\![(FieldSoilPolygon\ CPI_i\ \times FieldSoilPolygon\ area_i\ \div TotalCountySoilPolygon\ area_i\ ]\!])$

4. Calculated predicted yield associated with each county/crop/year CPI by multiplying each CPI x CPI coeff.

5. Calculated gross production revenue by multiplying county/crop/year yields by county/crop/year crop prices. Subtract FINBIN county/crop/year total operating expenses from gross production revenue to predict a profit/loss, profit/loss margin (i.e., ROI) for each county/crop/CPI/year.

6. Joined result data to field-soil polygon data and export to ArcGIS Pro 3.0 and join to field-soil polygon layer.

Estimations of subfield-level yields and expenses rely on the following assumptions:

- CPI and yield have a linear relationship for each county/crop/year (i.e., regardless of year-to-year climate variability, landscape position, proximity to streams, crop agronomics, etc.).

- Average FINBIN county/crop/year expenses reported by a relative small sample size of farmers (generally representing ~2-5% of the county corn or soybean area) are representative of the entire county/crop/year farmer population.

- County/crop/year FINBIN expenses are the same for every field per-crop, per-year, per-acre regardless of yield and soil CPI.

Note of change from original proposal: we originally proposed getting sub-field yield and profitability data from a small group (<10) of farmer partners to check our yield and profitability predictions against. However, covid-19 made developing these potential (and already challenging) collaborations with farmers largely unsuccessful. On the other hand, had we received this validation data, given the variability of sub-field profitability across the whole of the study area, it would not have likely impacted the project results or conclusions; to do so, would have required potentially 100's of farmer partners.

Results and Discussion

We estimated yields and profitability/ROI (return on investment) for all corn and/or soybean fields in the 40-county study area for each year 2011-2020. Figure 1 shows the 10,517,000 acres of corn/soybean cropland in the study area. During this period, 57% of corn/soybean fields were planted with corn. (Note: Non-field areas along the Iowa border are the result of ACPF data for the study area being queried by HUC-12 watersheds that terminate within the border of Minnesota. The gaps represent the headwaters of HUC-12 watersheds that terminate within Iowa; these areas were not analyzed in the study.)

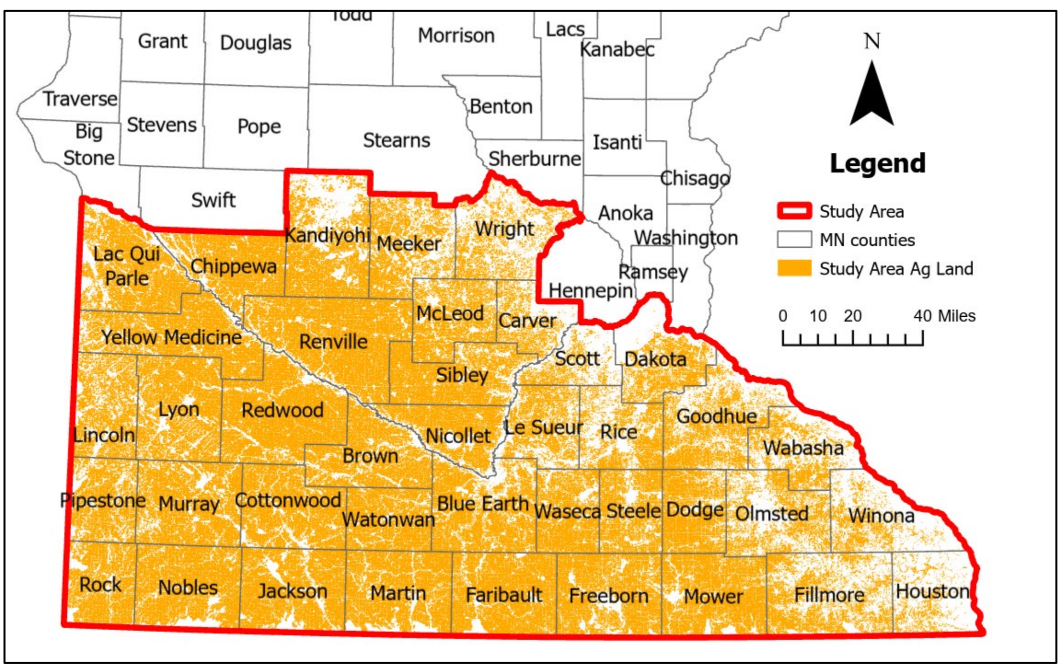

Figure 1. Extent of corn/soybean croplands in study area 2011-2020

Yield, cost, revenue estimates were generated for the 1,890,000 soil polygons comprising the 153,000 corn/soybean fields in the study area. Figure 2 shows the annual area-weighted mean yields and crop prices for the 40-county study area generated by our methodology (note: because this approach is based upon data from NASS and FINBIN, these numbers are assumed to match the actual reported numbers for this region of Minnesota.). Comparing the first half to the second half of the study period, both corn and soybean yields generally increased, while prices declined from their pronounced highs in 2011-2013 ($6.59 and $13.69 per bushel in 2012, respectively) but gradually increased by the end of the period reaching $4.10 and $10.55 per bushel, respectively (note: reported prices at the time of this writing [August 2022] were approximately $7.50 and $14.50 per bushel, respectively).

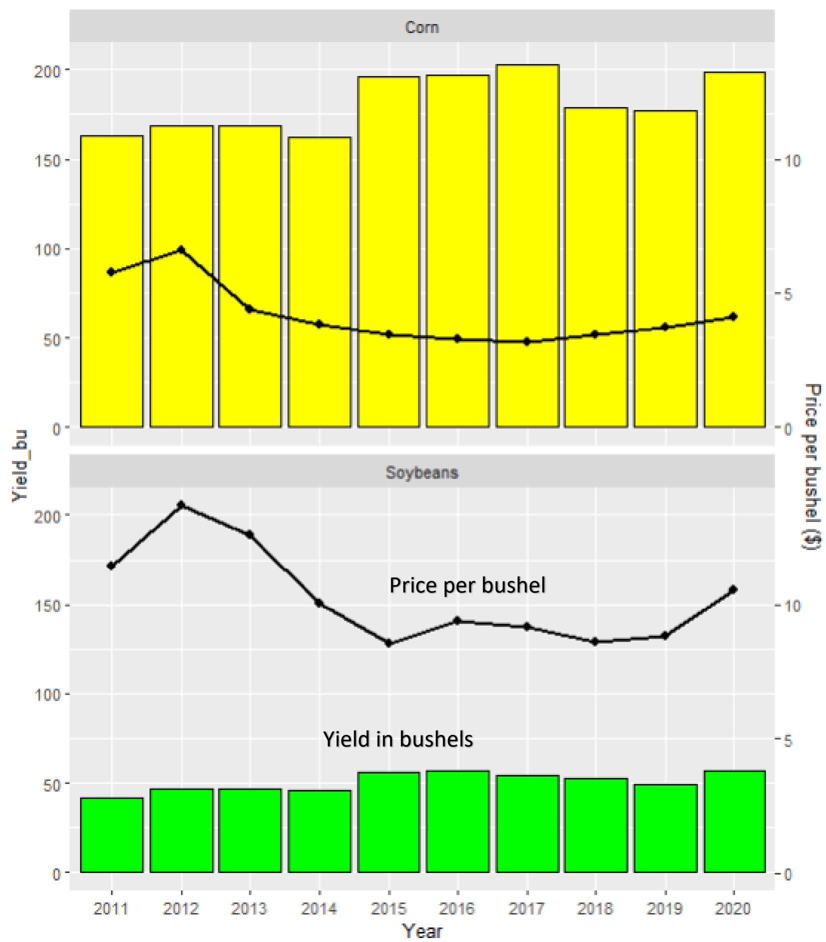

Figure 2. Annual yields and price per bushel for corn and soybeans in the study area 2011-2020.

Estimations of profitability are presented in Figures 3, 4, 5, and 6. As a general indicator, study area wide averages predict low to negative corn ROIs from 2014-2019, and ROIs above 20% for soybeans 9 out of 10 years (Figure 3). ROI frequency distributions (histograms), cumulative through for all years in the study period (i.e., 10-year cumulative revenue minus 10-yr cumulative expenses; Figure 4), follow a somewhat normal distribution for soybeans with rented land showing wider variation. However, corn ROI distributions exhibit a bimodal shape with the first mode (for both owned and rented) near to well less than zero ROI, suggesting corn profitability is less-assured/more-risky – given the same climate and site conditions – than soybeans (area-weighted mean CPIs for corn and soybeans over the 10-year study period were both ~ 88); reasons for corn's ROI distribution were not investigated in this study.

Area-averaged ROIs range from 13% (rented corn and soybean land) to 43% (owned soybean). Figure 5 shows the spatial distribution of 10-year ROIs less than or equal to -10% (comprising approximately 550,000 acres, or about 5% of the total corn/soybean acres) with concentrations discernible in the central, north, northeast and southeast regions of the study area. Figure 6 expresses this same data as a percent of all county corn/soybean land in production. Eighteen of the 40 counties are estimated to be unprofitable (using -10% as a threshold) on approximately 6 to 28% of land in production; the remainder being unprofitable on 1 to 5%. While subject to assumptions and uncertainties, these estimations suggest a significant fraction of soybean and (especially) corn cropland underperforming when analyzed cumulatively across 2011-2020.

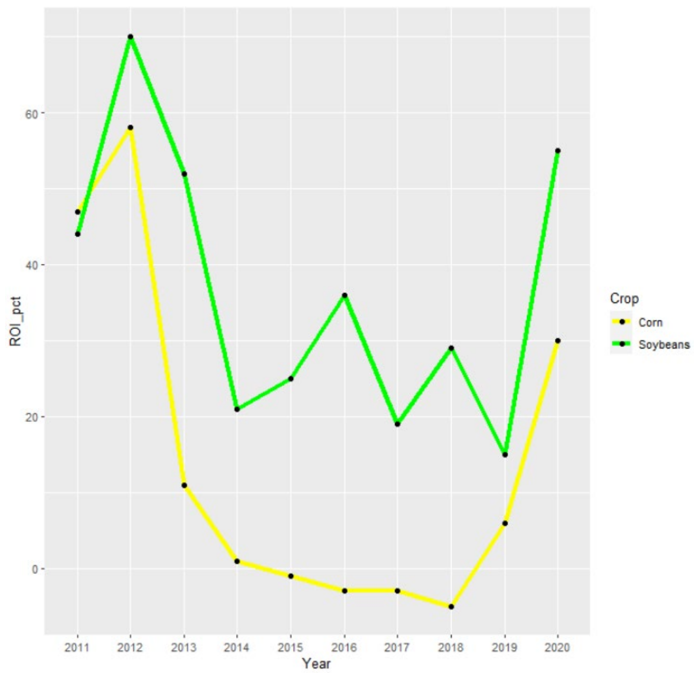

Figure 3. Area-weighted average ROI percentage estimates by year across all (owned) corn and soybean fields in the 40-county study area. Note negative ROI estimates for corn 2015-2018.

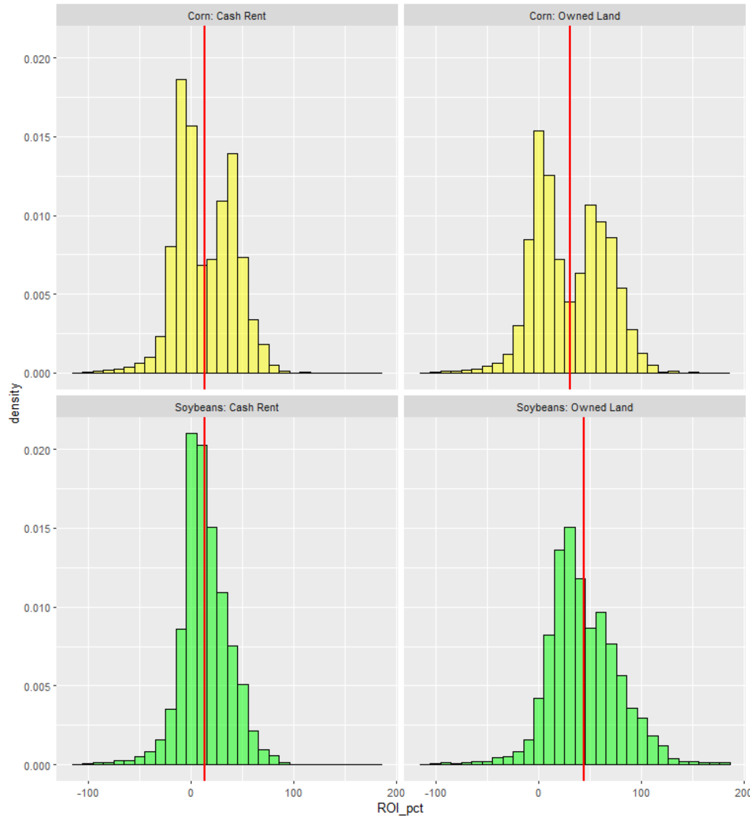

Figure 4. Distribution of predicted rented & owned corn/soybean profitability (expressed as percent return-on-investment – ROI) cumulative across all years (2011-2020) in the 40-county study area. Predicted variability is greater for corn as evidenced by bimodal distributions. Vertical red lines are the area-weighted mean ROI percentages: Corn: Cash Rent = 13.2%; Corn: Owned Land = 30.5%; Soybeans: Cash Rent = 13.5%; Soybeans: Owned Land = 43.7%

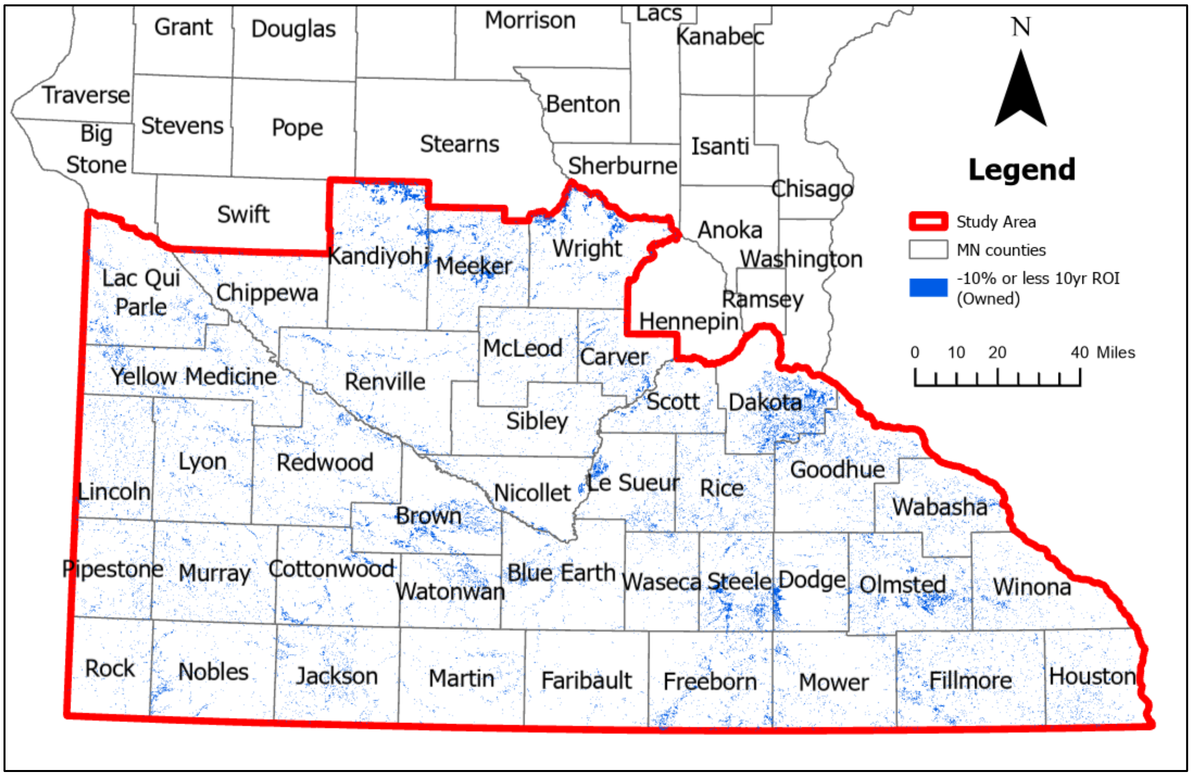

Figure 5. Distribution of estimated unprofitable corn/soybean land with a predicted 10-year cumulative ROI less than or equal -10% (total of 550,000 acres).

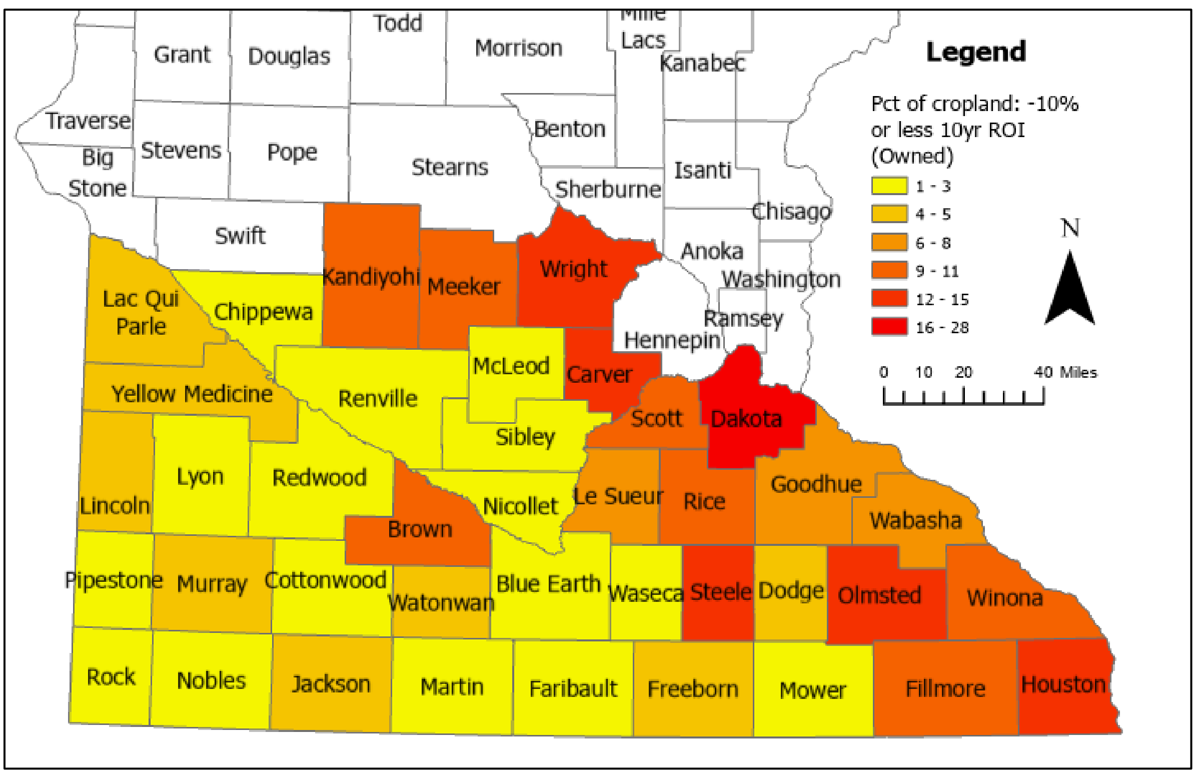

Figure 6. Estimated unprofitable cropland as a percent of each county's corn/soybean cropland using a 10-year cumulative ROI less than or equal -10% (total of 550,000 acres).

ACTIVITY 2 Title: Quantify water-quality and habitat benefits of converting unprofitable cropland to perennial vegetation.

Description: We propose quantifying the water-quality benefits of repurposing unprofitable croplands in the study area by predicting and comparing nutrient and sediment loads under row-crops and three perennial vegetation scenarios (alfalfa, prairie, wetland vegetation) using the GIS based hydrologic, water-quality and agronomic model SWAT. Our approach entails selecting 6-8 regionally representative subwatersheds (e.g., USGS HUC-12) distributed across the study area in which to model scenarios. Model results will be validated using existing field scale monitoring sites and current literature. In addition, we will utilize existing models, data and analyses from efforts such as TMDL, WRAPS and One Water, One Plan projects whenever possible. The results from modeling these representative subwatersheds will be scaled up to entire study area thereby providing water-quality benefits from the field-scale up to the watershed-scales consistent with established water-quality goals. Habitat benefits will be determined by applying an existing scoring system based on habitat size, geometry, vegetation type and hydrologic regime.

The resulting maps of water and habitat benefits will be intersected with the mapped extent of unprofitable land from Activity 1 to create maps of croplands that present the most cost-effective opportunities for conversion to perennial vegetation. These deliverables are intended for watershed and conservation managers and will also be summarized in fact sheets describing watershed scale and statewide benefits, and presented to watershed management organizations, state agencies and at state agricultural and water resources conferences.

ACTIVITY 2 ENRTF BUDGET: $ 50,000

Outcome	Completion Date
1. Construct and validate models predicting water-quality benefits.	January 31, 2021
2. Apply habitat scoring system and estimate habitat benefits.	January 31, 2021
3. Create maps and datasets with areas of highest cost-effective conversion opportunities.	June 30, 2021
4. Create and disseminate fact-sheets and presentations.	June 30, 2021
5. Create manuscript for submittal to peer-reviewed journal	June 30, 2021

First Update January 31, 2020
No work done on tasks related to this Activity yet.

Second Update June 30, 2020

No substantive work was completed for the project between January 31, 2020 and March 23, 2020, when Science Museum staff were laid-off due to Covid-19 until November 2020.

Third Update January 31, 2021

Staff on this project returned to work from Covid-19 layoff on November 2, 2020. Since then, no substantive work has been completed. Work related to the project will resume in the late-winter/spring 2021.

Fourth Update June 30, 2021:

No work done on tasks related to this Activity yet.

Fifth Update January 31, 2022:

Work during this period entailed design and development of the modeling framework to predict the water quality benefits of perennial vegetation scenarios. The SWAT modeling step has been supplemented with results from existing one-watershed/one-plan modeling efforts (using the GIS based model PTMapp) with consultation with results from MPCA's HSPF models available for the study area. Preliminary modeling work to assess the water quality and habitat benefits of different perennial scenarios (i.e., retirement/re-purposing of marginal or unprofitable land) has been completed for the six HUC-12 watersheds.

Activity 2 Final Reporting

Summary

Activity 2 was designed to take the outcomes from Activity 1 – locations of 550,000 potentially unprofitable corn/soybean acres (using a -10% ROI threshold) in southern Minnesota – and estimate the water quality and habitat benefits of a scenario converting a portion of these acres to perennial vegetation. The scenario selected 114,000 acres meeting the following criteria: (1) an estimated cumulative 10-year ROI% percentage of -33% or lower, and (2) located within 250 meters of impaired streams (streams designated as polluted by the Minnesota Pollution Control Agency); thus, these criteria selected optimal areas that were potentially the most unprofitable and the most polluting. The environmental benefits of these proposed acres were estimated using models assuming the areas were converted to prairie or restored wetlands. Average estimated reductions of sediment and total phosphorus (the primary water quality pollutants in southern Minnesota streams/rivers) across watersheds in the study area were 5% and 3%, respectively. Average estimated habitat improvement of these potential conversions, assuming a goal of 5% of each watershed in perennial vegetation, were 15%. Thus, for the cost of converting about 1% of the cropland in the study area (114,000 acres out of 10,517,000 acres) the resulting benefits were a combined 8% improvement in sediment and total phosphorus pollution and a 15% improvement in wildlife habitat.

Approach for Environmental Benefits Estimation

Activity 2 demonstrated the potential water quality and habitat benefits of converting estimated locations of unprofitable cropland (UPCL) from Activity 1. However, instead of simulating benefits for the estimated 550,000 acres of UPCL (-10% or less 10-year ROI) across the entire study area, we selected a more stream-focused and conservative scenario, targeting UPCL locations within a 250 meter riparian buffer of 867 MPCA impaired reaches (as of 2022) in the study area. Stream reaches were selected if impaired for one or more of the following: TSS, turbidity, dissolved oxygen, excess nutrients, or fish/invertebrate health. These types of impairments are wide-spread in Minnesota and in the study area, and are primarily caused by non-point source export of cropland sediment and phosphorus into streams adjacent to agricultural fields – the closer an agricultural field to the stream the higher the pollution delivery potential.

Further, within the 250 meter stream buffer zone, UPCL was defined as any subfield-soil polygon >= 1 acre with a 10-year cumulative predicted ROI percentage (profit/loss margin) less than or equal to -33% on owned-land (i.e., cumulatively over 10 years, the field-soil polygon lost 33% or greater of the farmer's predicted investment/input costs.). The intent of this owned-land/-33% threshold was to conservatively select croplands that are significantly unprofitable – far below marginal – to create the most realistic, least-improbable scenarios for conversion to perennials from a farming economics perspective. An overarching project assumption is that the average farmer will hold on to their farmland and keep it in production regardless of if certain fractions of fields are often unprofitable; we also assume here that the average farmer *knows* which parts of their fields are unprofitable. Given this, and coupled with large uncertainties in the expense data available, our ROI thresholds for designating unprofitable land are conservative.

Designated unprofitable areas hereafter are referred to as potential perennial areas (PPAs). Habitat was not considered as a selection criterion for PPAs as -- relative to improving stream water quality -- location of perennial vegetation habitat is not as important as the amount and quality. The scenario criteria resulted in 24,400 PPAs comprising 114,000 acres across 548 impaired HUC-12 watersheds (i.e., HUC-12s where at least one impaired stream was present). Weighted mean CPI and ROI% across these UPCL acres were 29.6 and –53%, respectively (See Figure 7). PPA acreage is most pronounced in the north, northeast and southeast regions of the study area with notable concentrations in the Cannon, Cottonwood, Des Moines, North Fork Crow, Root and Zumbro River HUC-8 watersheds. It should be noted that unprofitable areas are often either high/dry or low/wet; however, since this demonstration scenario focused on riparian areas of streams, PPA conditions were predominantly caused by high wetness. (Another important cause of yield/profitability decline are the "headlands" or "turnrows" of fields where repeated passes by farm equipment tend to compact the soil (Sunoj et al., 2021); however, these areas were not investigated in this study due to a lack of any data available to identify and map them.)

Note of change from original proposal: We originally proposed a PPA selection process that would take into account assumed farmer preferences in shape, size and field location. We feel the project benefited from focusing locations of PPAs in the 250 meter riparian corridor rather than anywhere in the watershed, where discriminating on the basis of shape, size and field location may have been a greater differentiator. And given this is an exploratory study with inherent uncertainties, this type of analysis would have been of questionable accuracy and benefit. Recent research on farmer field shape preferences is presented in Griffel et al. (2020).

A second change from the original proposal omitted alfalfa as a third perennial scenario. As the project progressed, alfalfa became more problematic as a perennial conversion scenario because it ideally also necessitates a discussion of economics (i.e., federal (beneficial) control of alfalfa's market/profitability/risk is not provided for like that of corn or soybeans) in a way that non-crop/non-harvestable prairie and wetlands do not. In addition, for alfalfa to convey maximal habitat benefits, growing season cuttings have to be constrained to retain alfalfa's flowering stages. Last, given its water quality value would be mostly indistinct from prairie in our modeling methodology, we chose to eliminate it as perennial scenario.

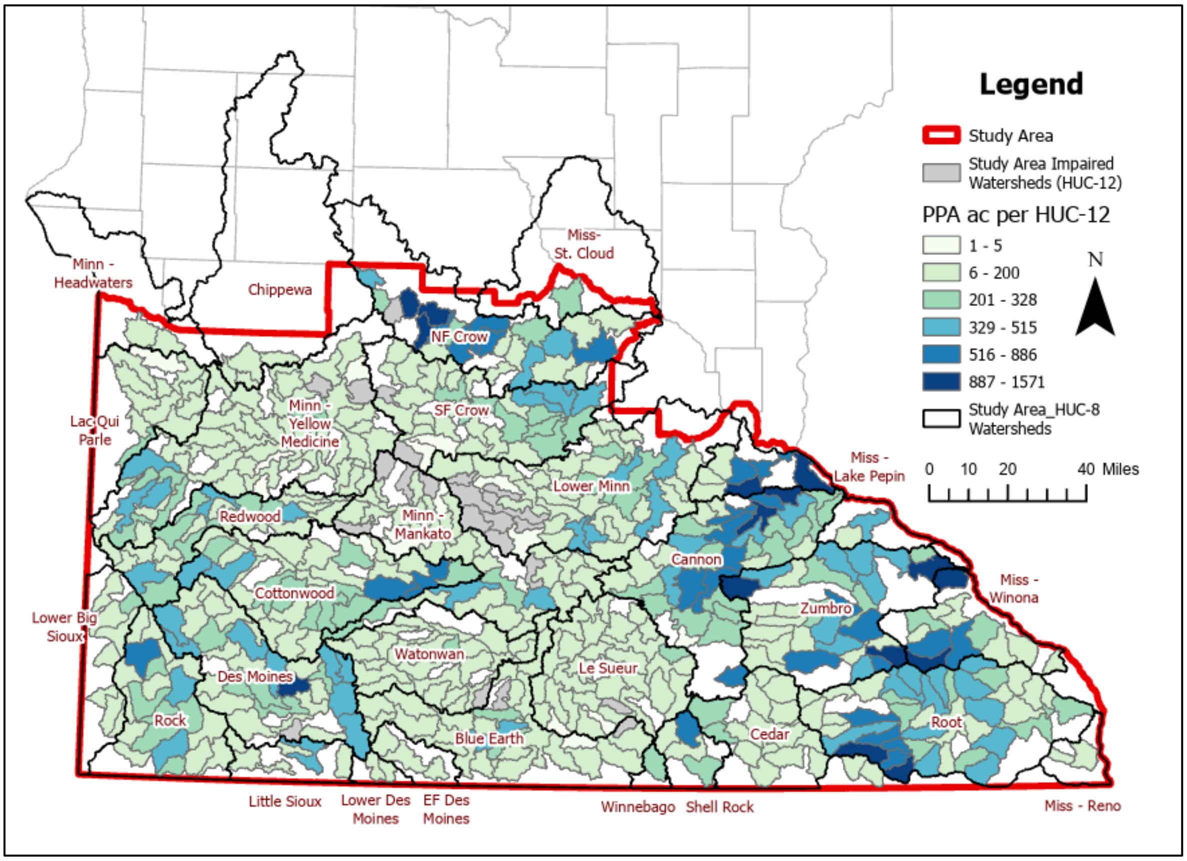

Figure 7. Amount of PPA (potential perennial areas) acres in each of 548 HUC-12 watersheds containing at least one MPCA-impaired stream reach; PPA area totals 114,000 acres. Gray HUC-12s indicate those with no PPA area (i.e., no unprofitable cropland predicted to be present using a 10-year threshold ROI of -50% on owned-land). Abbreviations: Minn = Minnesota River, Miss = Mississippi River; EF, NF, SF = East Fork, North Fork, South Fork, respectively.

Water Quality Benefits Modeling

Estimating the water quality benefits for PPAs went through several iterations over the course of the project. The SWAT hydrologic and water quality model was originally proposed for this purpose because it is ideal for watershed-scale simulations of agricultural areas, taking into account daily variations in weather, crop growth, drainage practices, etc. SWAT modeling of UPCL conversion to prairie/wetland was to be performed on 6-8 HUC-12 watersheds (comprising a very small percentage of the total study area), with these results scaled up to the entire study area using a GIS/statistical approach. However, as the project progressed, we alternatively chose to GIS based approach to model water quality benefits at the *subfield* scale (i.e., soil polygon scale; rather than *watershed*-scale) consistent with the scale of predicted UPCLs delineated in Activity 1; therefore, this change enabled explicit spatial analysis of UPCLs, their locations in each field, upstream drainage area to each, and proximities to impaired streams; whereas SWAT simulations treat such spatial characteristics only implicitly. In addition, the alternative approach enabled the entire study area to be modeled with the same specificity (avoiding the need to scale up model results from the relatively small area modeled with SWAT).

PPAs were modeled to estimate their potential to reduce stream pollutant loads as either (1) prairie filter strips or (2) restored wetland, both via two complementary mechanisms:

<u>Source reduction</u>: Loads originating from the (formerly corn/soybean) PPAs will now be substantially reduced due to the perennial cover (and storage, in case of a wetland) and discontinued fertilizer application and tillage.

Trapping: Runoff and water quality pollutants from corn/soybean portions of the field that flow over the PPA will be intercepted and significantly reduced.

See Figure 8 for example of PPAs and associated drainage areas. Effectiveness of the PPA scenarios was assessed as the cumulative pollutant reduction percentage in each HUC-12 containing at least one impaired reach. To estimate the HUC-12 pollutant budgets for this process, we used the USGS SPARROW model for the Upper Mississippi watershed (Robertson & Saad, 2019). The SPARROW model uses a complex regression scheme to predict pollutant loads/yields at intra-HUC-12 watershed scale, which was used to estimate loads originating from each PPA and its upstream drainage area. To estimate the pollutant reduction effects of the PPAs we used a GIS-based modeling approach using best management practice (BMP) effectiveness/reduction fractions published as part of BWSR's PTMapp model (Kronholm, 2020; Minnesota Board of Soil and Water Resources (BWSR), 2016) using BMP design standards from NRCS (NRCS - MN, 2017).

The integrated WQ modeling approach used the following workflow:

1. LiDAR 3 meter resolution DEMs for study area were resampled to 9 meter resolution and mosaicked to perform GIS operations more efficiently across the entire study area (using ArcGIS Pro 3.0).

2. SPARROW (intra-HUC-12) catchments (containing the pollutant loads/yields) were intersected with the 867 impaired reaches.

3. Upstream drainage areas for each PPA were delineated with extents limited by the containing SPARROW catchment boundaries (this prevented unrealistically large drainage areas).

4. Any PPA that intersected the restorable wetlands index (RWI; NRRI - UMD, 2019) or the enhanced National Wetlands Inventory (NWI) was assumed to be compatible with a wetland restoration.

5. Resulting PPA and drainage area loads or each HUC-12 were calculated by using the containing SPARROW catchment yields with reductions estimated by applying the PTMapp BMP effectiveness fractions (for source reduction + filter strips or restored wetland).

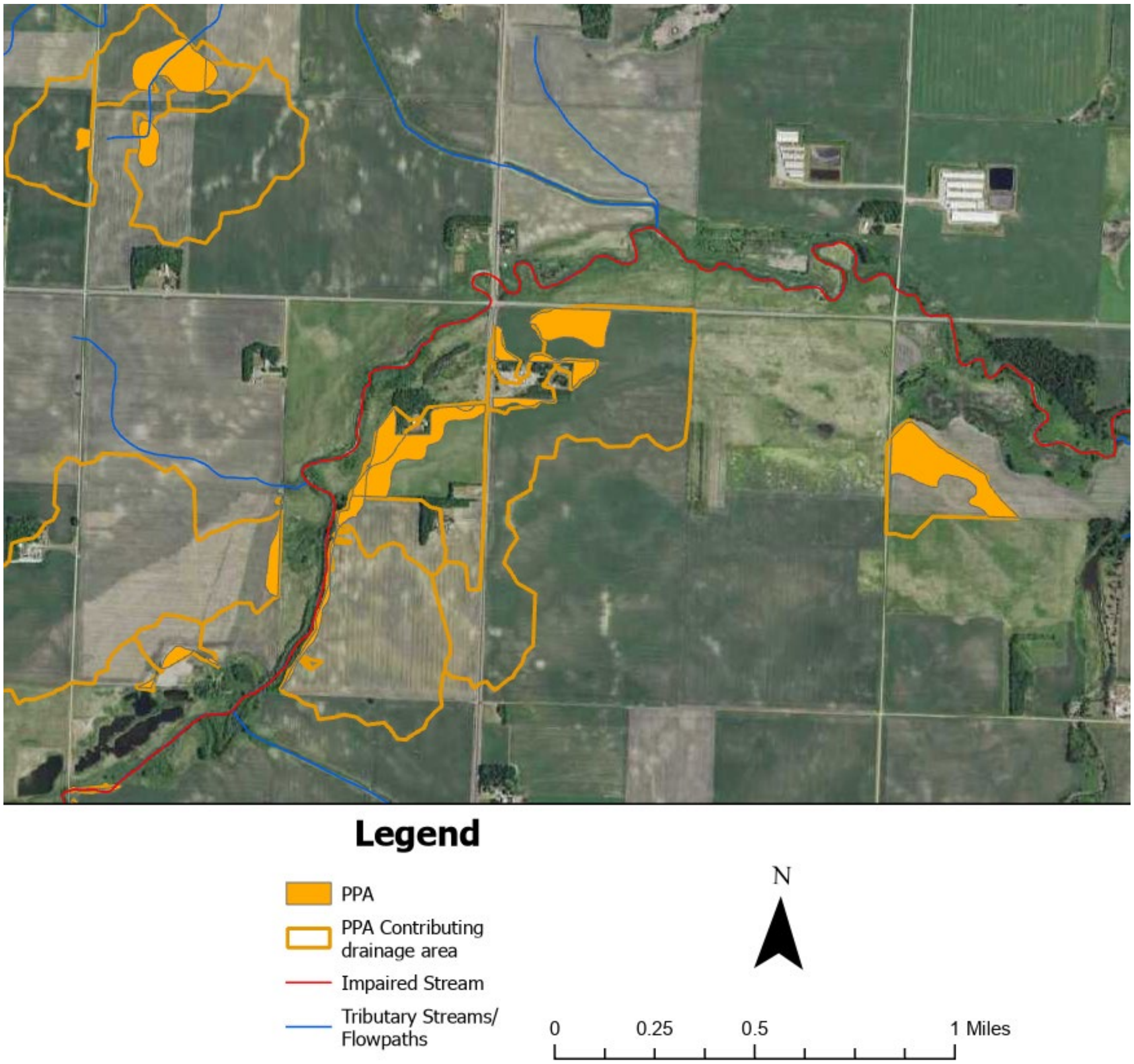

Figure 8. Example of PPAs and associated contributing drainage areas near impaired Spring Creek, Minnesota River – Yellow Medicine HUC-8 watershed.

Habitat Scoring

Frequently, when perennial cropping systems are being promoted the water quality benefits are given primary, if not sole, consideration. However, from a natural resource perspective and value to the public, the benefits of these cropping systems as potential wildlife habitat are often of equal importance. What is lacking in many water quality modeling efforts is an easy way to calculate a habitat value of the crops and management practices implemented. We developed a method for generating a "habitat score" based on vegetation type, acreage, and other ecological factors to apply to the HUC-12 watersheds of impaired reaches in this project.

Scenario habitat benefits were defined using a normalized habitat score specifically developed for the project. Calculating the normalized habitat score for each converted area entailed first calculating a raw habitat score and then dividing it by the raw habitat score given to an area whose size, species composition and management are presumed to be of optimal habitat quality. In our watershed example, optimal habitat quality was defined as an area composed of 5% of each watershed area covered with undisturbed, diverse prairie. For example, a habitat score of "25" means the cumulative PPA perennial crops in a HUC-12 are 25% equivalent to putting 5%

of the watershed in high quality, diverse prairie. This 5% number is arbitrary (and impractical) but allows a relative, comparable score to be calculated.

The habitat score is not based on benefits to any particular fauna, but rather founded in the premise that size, floristic diversity and minimal disturbance are basic attributes of good habitat.

$$HS = \sum(Area_i \times C_i \times D_i \times M_i) \times 100 / WA$$

HS = the combined Habitat Score for PPAs added to each HUC-12 watershed.
Area = the total acreage of each PPA (i)
WA = HUC-12 watershed area

C_i, D_i and M_i are modifiers related to floristic diversity and management of the perennial crop:

C_i is a modifier for the configuration of how the perennial crop is implemented. For example,
- C_i for 200 foot buffers = 0.85
- C_i for 80 acre fields = 1.0
- C_i for 40-foot-wide strips/waterways = 0.75
- C_i for whole field implementation such as inter-row cover crops = 1.0

D_i is the modifier for floristic diversity of the crop or cropping system:
- D_i for grass monocultures = 0.75
- D_i for mixed grass planting = 0.9
- D_i for single species forb crop (e.g., alfalfa or camelina) = 0.8
- D_i for multiple species of forb = 0.9
- D_i for mixed plantings (forbs + grasses, e.g., prairie) = 1.0

M_i is the modifier related to how the crop is managed:
- M_i for undisturbed = 1.0
- M_i for fall harvest = 0.9
- M_i for harvest during nesting season = 0.5
- M_i for termination in the spring (e.g. for rye inter-row cover crop) = 0.1
- M_i for low intensity grazing = 0.7
- M_i for high intensity grazing = 0.6

This habitat score provides a simple, quantitative and comparative measure of the potential wildlife benefits of the perennial crops/vegetation added to a watershed. While the specifics of what is good habitat can be somewhat nebulous, the appreciation that there is a continuum of habitat value ranging from annually plowed fields, to seasonally harvested perennial vegetation, to blocks of undisturbed, highly diverse grasslands is almost obvious---the essence of which is captured by the habitat score.

It should be noted that, as proposed, the project's habitat scoring was intended to differentiate habitat quality across a relatively diverse set of PPA landscape conditions; however, with the final project focus on riparian areas of streams, prairie filter strips and restored wetlands, the habitat score is most differentiated by total watershed PPA area rather than the three score modifiers outlined above.

Results and Discussion

The water quality and habitat benefits of converting PPAs (i.e., areas with 10-year cumulative ROIs of -33% or less) to restored prairie or wetland are presented in Figure 9 and Figure 10. Water quality benefits are summarized as the sum of modeled sediment and total phosphorus (TP) reduction percentages per HUC-12. Habitat benefits are a function of the HUC-12 PPA habitat score normalized by the habitat score of 5% of the HUC-12 watershed being in high quality prairie; the resulting score is the percent equivalence of the HUC-12 PPA habitat to the idealized HUC-12 habitat score.

Water quality reduction percentage sums in Figure 9 consist of approximately 0.6 sediment/0.4 TP based on the set ratio between effectiveness fractions from Kronholm (2020) -- i.e., a 10% PPA sediment + TP reduction would comprise a 6% sediment reduction and 4% TP reduction. Overall, spatial distribution and variability of results for water quality and habitat are very similar to the areal distribution and variability of PPAs (Figure 7) per HUC-12, with the most pronounced reductions are seen in the northern, northeast and southeast regions of the study area (This similarity is due to habitat scores and water quality effectiveness being mainly a function of total PPA area, and total PPA area + total PPA drainage area, respectively.). The area-weighted mean sediment and TP reduction percentages across the 548 impaired HUC-watersheds were 5.2% and 3.4%, respectively; however, the upper 10% of HUC-12s had means of 19% and 13% for sediment and TP, respectively.

An estimate of cost-effectiveness can be calculated assuming that PPA land values are linearly correlated with CPI (i.e., the lower the CPI, the lower the asking price). Multiplying each PPA's acres by its CPI provides a hypothetical, relative land value; dividing the sediment + TP reduction percentages by this product yields an estimate of reduction percentage per hypothetical unit land value (Figure 11). Unlike the spatial similarities between PPA area and water quality effectiveness, highest cost-effectiveness is estimated be in the central region of the study area; this is a function of PPAs in this region predicted to occur on croplands with lower CPIs when compared to the rest of the study area.

HUC-12 habitat scores follow the distribution of PPA acres as discussed above. Area-weighted mean habitat scores were 33 (i.e., 33% equivalent to 5% of HUC-12 area covered in high quality prairie) with the upper 10% mean of 64. Although the "5% high quality prairie equivalence" standard is an arbitrary benchmark, the potential habitat benefits associated with this PPA scenario are not insignificant.

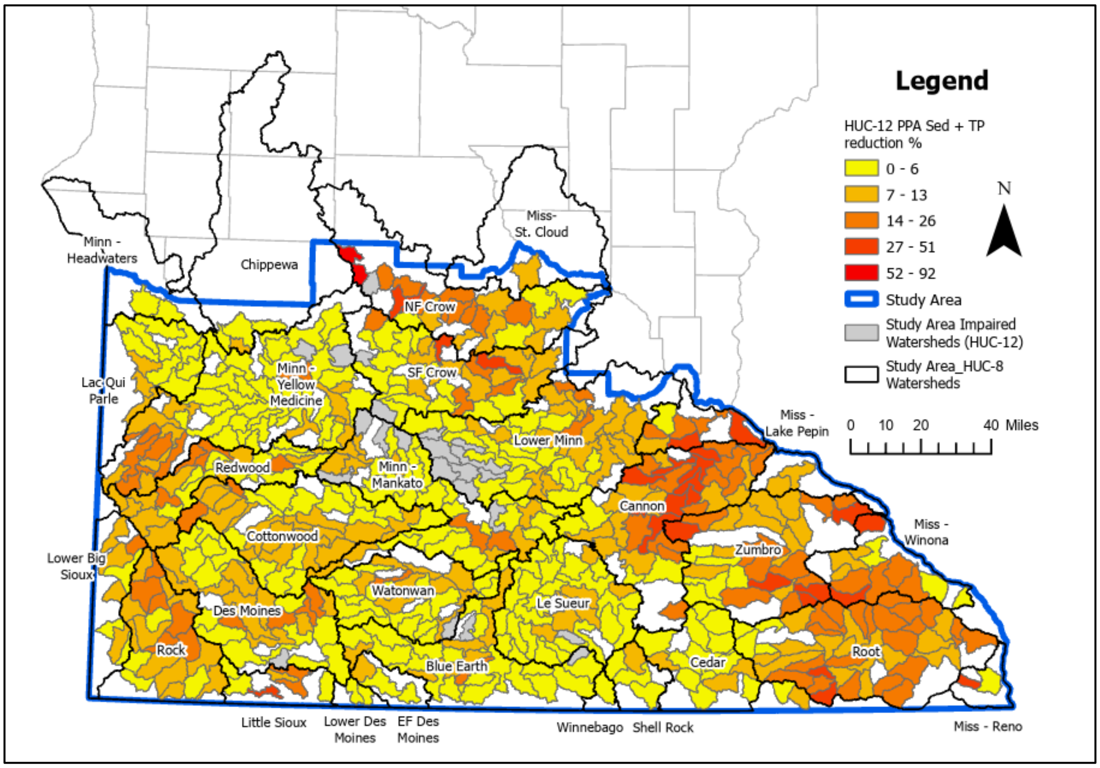

Figure 9. Water quality effectiveness: estimated sediment + TP reduction percentages for PPAs in each study area HUC-12 watershed (total PPA area = 114,000 acres).

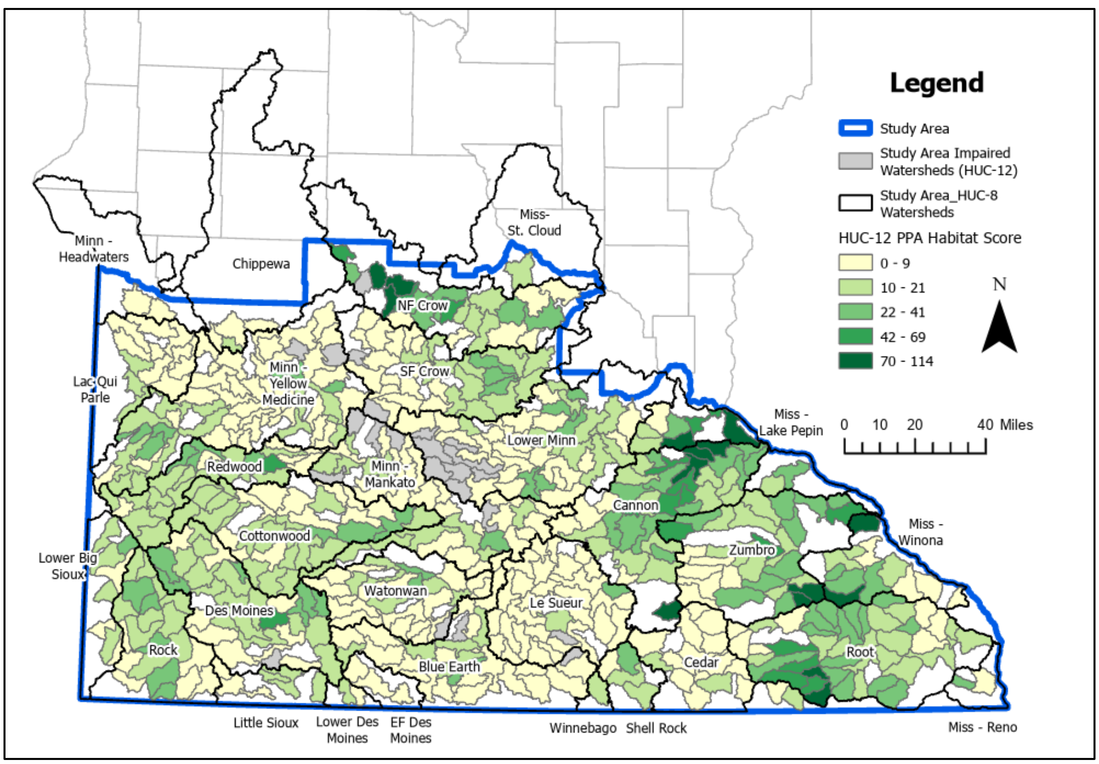

Figure 10. Habitat scores for PPAs in each study area HUC-12 watershed (total PPA area = 114,000 acres).

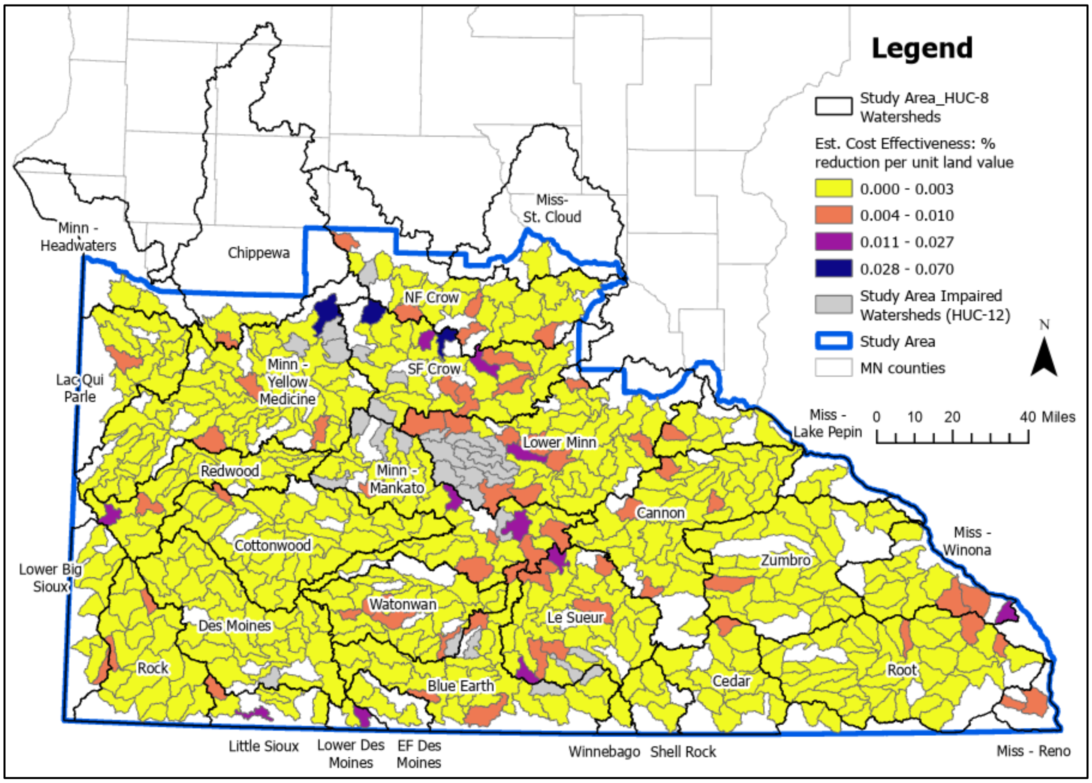

Figure 11. Estimated cost-effectiveness: HUC-12 PPA sediment + TP reductions per hypothetical unit land value. Hypothetical land values are based on the CPI of each PPA.

Overall Project Conclusions

The objective of this project was an exploratory analysis of (1) the estimated locations of unprofitable corn and soybean farmland across a broad swath of southern Minnesota's agricultural watersheds, and (2) the estimated water quality and habitat benefits from converting what was estimated to be the most unprofitable of these croplands to perennial vegetation (prairie filter strips or restored wetlands). Coupling water quality and habitat benefits together into a single conservation framework is potentially more cost-effective than pursuing them separately. Further, it allows greater potential for coalition building amongst often siloed citizen, nonprofit and governmental stakeholders groups that can aid politically and financially.

Several studies have quantified unprofitable land extent in Iowa 2010-2016 and the associated environmental benefits of converting these lands to perennial vegetation (Brandes et al., 2016; Brandes, Plastina, et al., 2018; Kreig et al., 2021), while similar studies in Minnesota are not known to the authors to have been published. A report conducted by Minnesota's Board of Water and Soil Resources (BWSR, 2018) estimated the extent of unprofitable (marginal) corn/soybean land in six HUC-8 watersheds in Minnesota, and used HSPF models to estimate the water quality benefits of conversion to a suite of perennial cash and forage crops (The report is also an excellent primer on the agricultural economic realities of corn/soybeans in Minnesota vs. perennial cash crops.). Other research has evaluated prairie filter strips in corn/soybean fields within Iowa highlighting their effectiveness for water quality and habitat (Luther et al., 2021; Schulte et al., 2017).

Unprofitable cropland, conservatively defined here as a cumulative 10-year ROI% percentage of -10% or lower on owned-land from 2011-2020, was mapped at a subfield scale, and was estimated to occur on at least 550,000 acres (approximately 5%) of the 10,517,000 acres in corn/soybean production within the 40-county study area (16,131,000 acres total); this estimate is considered conservative because it did not take into account the unknown amount and locations of rented-land, on which input costs will be significantly higher on average.

A demonstration of the environmental benefits of converting unprofitable land to prairie filter strips or restored wetland was conducted on 114,000 acres (of the 550,000 acres; 1% of the total corn/soybean area) with a cumulative 10-year ROI% percentage of -33% or lower, and located within 250 meters of 867 MPCA-designated impaired stream reaches. Estimated water quality benefits from taking these areas out of production, as well as from their functioning as filter strips/wetlands for trapping sediment and phosphorus from their contributing drainage areas, were modeled using a GIS based approach. Benefits were evaluated in the study area's 548 impaired HUC-12 watersheds. Average sediment and TP reduction percentages across the watersheds were 5.2% and 3.4%, respectively; the upper 10% of watersheds had average reductions of 19% and 13% for sediment and TP, respectively. The Minnesota Pollution Control Agency (MPCA) has set reduction goals of 50% for stream sediment and 45% for phosphorus for southern Minnesota's watersheds (MPCA, 2014, 2015). While the reductions associated with this demonstration (i.e., more or less unprofitable cropland scenarios could have been evaluated for benefits as well) fall far short of MPCA goals, a combined sediment and TP reduction of 8% at the cost of 1% of the total cropland suggests a reasonable cost-effectiveness. Habitat benefits of adding 114,000 acres of prairie/wetlands across the study area were estimated to be 15% equivalent to prairie covering 5% of the study area suggesting a similar cost-effectiveness.

The intent of this project was to provide a foundation for further discussion and research on the policy implications of utilizing this approach for more intensive conservation efforts. The current programs available to interested landowners to convert cropland are easement-type programs such as RIM, CREP and CRP (MN Board of Water, Soil Resources, 2022b, 2022a; USDA, 2020). The programs are very effective, target marginal/unprofitable land, and prioritize placement in priority areas for water quality and habitat; however, they are under-funded relative to the scale of southern Minnesota's acute water quality and habitat issues. Therefore, it is the authors' hope that this analysis of estimated unprofitable croplands and their potential environmental benefits across the predominant agricultural area in Minnesota will foster new ideas to cost-effectively expand funding for easement programs in Minnesota.

Acknowledgements

Dr. David James of Iowa State for providing all ACPF data for the study area. Tony Thompson, owner/operator of Willow Lake Farm, Windom, MN for project advocacy and knowledge sharing of farming practices and operations. We would also like to acknowledge LCCMR staff for their help and advice in seeing this project through to its conclusion.

IV. DISSEMINATION:

Description: Results from this project will be summarized in a final report, a concise four-page fact sheet and digital (GIS) maps. These materials will be made available on the following website: https://www.smm.org/scwrs. The fact sheet will illustrate the concept of the project and will highlight cost-effective locations within the study area for converting unprofitable land to perennial vegetation and their water-quality and habitat benefits. In addition, the concept, objectives and results of the project will be presented ~~orally at over five venues~~ throughout the State over the duration of the project. Venues will include professional conferences and statewide meeting to audiences of state and federal natural resource managers, policy makers, non-profit advocacy groups, and agricultural producers.

The Minnesota Environment and Natural Resources Trust Fund (ENRTF) will be acknowledged through use of the trust fund logo or attribution language on project print and electronic media, publications, signage, and other communications per the ENRTF Acknowledgement Guidelines.

First Update January 31, 2020
No work done on tasks related to this Activity yet.

Second Update June 30, 2020

No substantive work was completed for the project between January 31, 2020 and March 23, 2020, when Science Museum staff were laid-off due to Covid-19 until November 2020.

Third Update January 31, 2021

Staff on this project returned to work from Covid-19 layoff on November 2, 2020. Since then, no substantive work has been completed. Work related to the project will resume in the late-winter/spring 2021.

Fourth Update June 30, 2021:
No work done on tasks related to this Activity yet.

Fifth Update January 31, 2022:
No substantive work has been completed on Dissemination work items from Activity 2; work on these items will commence in the starting April. Also, an amendment to change the nature of the proposed Dissemination activities (see struck-out text above in the Description) was presented in the Overall Project Updates section above.

Final Report Summary

The cancellation of the typical conferences (without a Zoom option) for this type of project due to covid-19 in 2020-2021 greatly limited the opportunities to share the project goals and results. In addition, the project was suspended during covid-19 because Science Museum staff were furloughed for almost 9 months – this set the project progress timelines back considerably preventing presentable results to be ready until near the end of the project. However, the project content was presented at several Science Museum member events over Zoom. And in October 2022, the work will be presented at the MN water resources conference, a premier venue for this type of project.

The results of this project including the GIS files and attached fact sheet will be linked from this Science Museum website when our new web portal is up and running fall of 2022. Interested visitors will be able to download the GIS files and conduct their own analyses based upon those in the study. Announcements about these deliverables and about the key points and highlights of the project will be shared on the Science Museum's social media accounts also in fall 2022.

Note of change from original proposal: The last outcome in Activity 2 was to complete a draft manuscript for submittal to a peer reviewed journal by the end of the project. Given other issues with covid-19 effects on timelines, we were not able to do this. However, a manuscript will be written and submitted in early 2023, after which it will be shared on social media and the above website.

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V. ADDITIONAL BUDGET INFORMATION:

A. Personnel and Capital Expenditures

Explanation of Capital Expenditures Greater Than $5,000: NA

Explanation of Use of Classified Staff: NA

Total Number of Full-time Equivalents (FTE) Directly Funded with this ENRTF Appropriation:

Enter Total Estimated Personnel Hours for entire duration of project: 2,662	Divide total personnel hours by 2,080 hours in 1 yr = TOTAL FTE: 1.28

Total Number of Full-time Equivalents (FTE) Estimated to Be Funded through Contracts with this ENRTF Appropriation:

Enter Total Estimated Contract Personnel Hours for entire duration of project: 0	Divide total contract hours by 2,080 hours in 1 yr = TOTAL FTE: 0

VI. PROJECT PARTNERS:

A. Partners outside of project manager's organization receiving ENRTF funding: NA

B. Partners outside of project manager's organization NOT receiving ENRTF funding: NA

VII. LONG-TERM- IMPLEMENTATION AND FUNDING:

This project is the first of its kind in Minnesota to analyze the extent of unprofitable cropland and the potential water-quality and habitat benefits of converting this land to perennial vegetation at a large scale. Therefore, it has the potential to be an exceptionally effective and economically practical approach for significantly improving the quality of Minnesota's waters and grassland habitats. Results of this project are intended to be of immediate value to restoration projects such as BWSR One Watershed, One Plan, and can serve as a model for all of the Midwest's agricultural regions.

VIII. REPORTING REQUIREMENTS:

- Project status update reports will be submitted January 31 and June 30 each year of the project
- A final report and associated products will be submitted between June 30 and August 15, 2022

IX. SEE ADDITIONAL WORK PLAN COMPONENTS:

A. Budget Spreadsheet
B. Visual Component or Map
C. Parcel List Spreadsheet: NA
D. Acquisition, Easements, and Restoration Requirements: NA
E. Research Addendum

Attachment A:
Environment and Natural Resources Trust Fund
M.L. 2019 Budget Spreadsheet - Final
Legal Citation: M.L. 2019, First Special Session, Chp. 4, Art. 2, Sec. 2, Subd. 04n
Project Manager: Jason Ulrich
Project Title: ENRTF ID: 100-BH - Mapping Unprofitable Cropland for Water and Wildlife
Organization: Science Museum of Minnesota, St. Croix Watershed Research Station
Project Budget: $100,000
Project Length and Completion Date: 3 years, June 30, 2022
Today's Date: August 15, 2022

ENVIRONMENT AND NATURAL RESOURCES TRUST FUND BUDGET	Budget	Amount Spent	Balance
BUDGET ITEM			
Personnel (Wages and Benefits)	$ 98,440	$ 98,440	$ -
Ulrich, Assistant Scientist, Science Museum of MN: Project coordination, estimating extent of unprofitable cropland, quantifying water quality benefits, watershed modeling: 43% FTE for 2 years; Salary =70%, Benefits=30% ($64,867)			
Schottler, Senior Scientist, Science Museum of MN: Calculate habitat scores, cost effectiveness analysis: 21% FTE for 2 years; Salary =70%, Benefits=30% ($33,573)			
Equipment/Tools/Supplies			
Printing Supplies, modeling software licenses	$ 500	$ -	$ 500
Travel expenses in Minnesota			
Travel to present and disseminate results (2000 miles x $0.53/mile = $1060)	$ 1,060	$ -	$ 1,060
Other			
	$ -	$ -	$ -
COLUMN TOTAL	$ 100,000	$ 98,440	$ 1,560

OTHER FUNDS CONTRIBUTED TO THE PROJECT	Status (secured or pending)	Budget	Spent	Balance
Non-State:		$ -	$ -	$ -
State:		$ -	$ -	$ -
In kind: Support services from Science Museum of Minnesota: 40.83% of direct costs	Secured	$ 40,830	$ 40,830	$ -

PAST AND CURRENT ENRTF APPROPRIATIONS	Amount legally obligated but not yet spent	Budget	Spent	Balance
Current appropriation:		$ -	$ -	$ -
ENRTF M.L. 2018, Chp. 214, Art. 4, Sec. 02, Subd. 08c. Develop Market-Based Alternatives for Perennial Crops to Benefit Water Quality and Wildlife.	$ 150,000	$ 150,000	$ 150,000	$ -
Past appropriations:		$ -	$ -	$ -
ENRTF M.L. 2016, Chp. 186, Sec. 2, Subd. 08c. Establishment of permanent habitat strips with row crops.	$ 78,261	$ 179,000	$ 179,000	$ -
ENRTF M.L. 2014, Chp. 226, Sec. 2, Subd. 03g. Watershed-Scale Monitoring of Long-Term Best Management Practices	$ -	$ 900,000	$ 900,000	$ -