CONSERVATION PRACTICE IMPLEMENTATION IN HYPOXIA TASK FORCE MEMBER STATES

2008 to 2020

Abstract

Agricultural conservation practice implementation data from the US Department of Agriculture (USDA) Environmental Quality Incentive Program (EQIP) and the USDA Conservation Stewardship Program (CSP) were compiled for years 2008 through 2020 by the Natural Resources Conservation Service (NRCS). These data were quality controlled and extended to estimate a reasonable life of the practice and presented as cumulative area treated by conservation practices.

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Project Background

As highlighted by the Hypoxia Task Force (HTF) Nonpoint Measures Workgroup, there is a gap in the tools to track agricultural non-point source nutrient loss reductions associated with conservation activities (NPSMWG, 2018). The Conservation Tracking Framework helps fill this gap and implement the Nonpoint Measures Workgroup suggested “key base parameters” to better measure progress toward the HTF goal of reducing nitrogen and phosphorus loads by 2025. Tracking progress toward reduction goals is complex due to the continental scale and scope of non-point source pollution in the Mississippi/Atchafalaya River Basin and the variety of conservation practice tracking and reporting methods used throughout HTF states. The Conservation Tracking Framework was initiated as a public-private partnership between pilot states and SERA-46, a land-grant university committee for nutrient reduction strategy collaboration, members dedicated to quantifying non-point source reductions in the Mississippi/Atchafalaya River Basin.

Conservation Practice Background

A wealth of information is available about conservation practices. Gross data is available for the project pilot states Arkansas and Indiana (as well as all states) through the Natural Resources Conservation Service (NRCS) Resource Conservation Act (RCA) reports (USDA, 2021). Though this information is incredibly useful when trying to understand conservation in each state, these data lack spatial resolution. Additionally, these reports note, “Totals presented here are not comparable to program enrollment acres or contract acres,” since these reports are based on “land unit acreage” rather than treated acreage. However, relative comparisons can be made between years using these data since all federal programs are included (Agricultural Conservation Easement Program (ACEP), Agricultural Water Enhancement Program (AWEP), Conservation Reserve Program (CRP), Conservation Technical Assistance (CTA), Emergency Watershed Protection Program (EWP), Environmental Quality Incentives Program (EQIP), Grassland Reserve Program (GRP), Regional Conservation Partnership Program (RCPP), Watershed Protection and Flood Prevention Program (WFPO), Wetlands Reserve Program (WRP), and Wildlife Habitat Incentive Program (WHIP)). For example, Figure 1 shows a rough breakdown of land unit acres receiving conservation in Illinois. This figure shows 40% of land unit acres being implemented through federal programs are in conservation crop rotation. This type of information is available for all states.

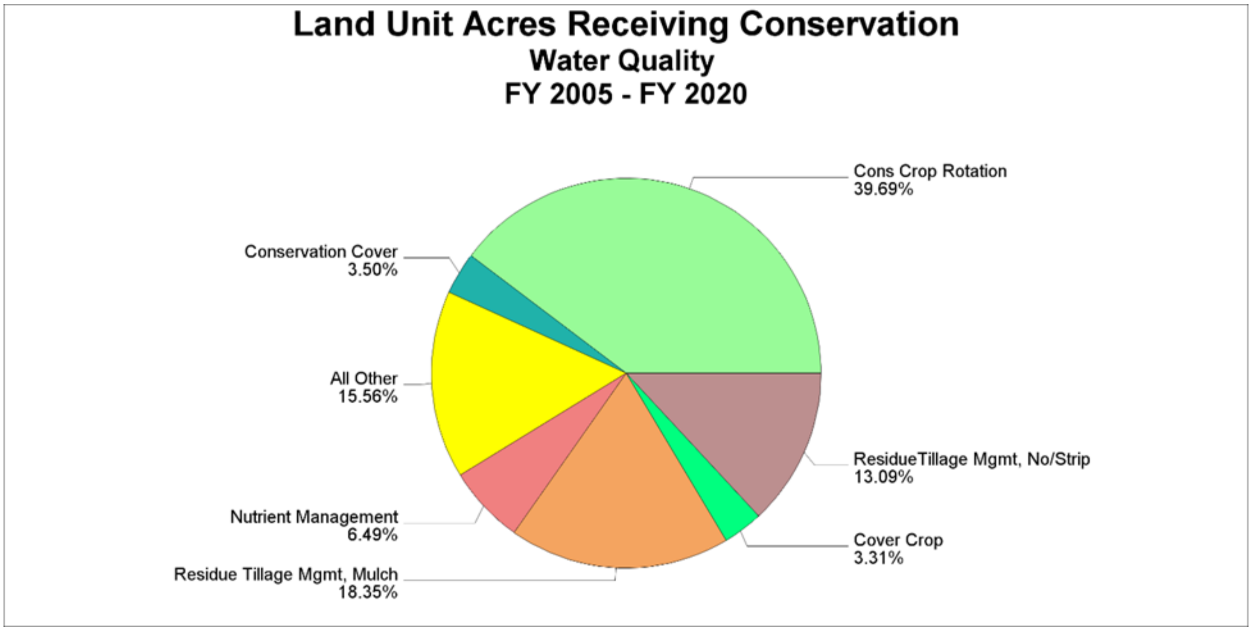


Figure 1. Relative breakdown of land unit acres receiving conservation funding from 2005 to 2020 for Illinois (USDA, 2021). These data include all federal USDA programs.

Data from RCA reports served as a starting place for "converting" conservation practice units from, for example, feet to acres treated. The conversion is a critical step in quantifying water quality benefits to allow direct additions of nitrogen and phosphorus reductions from the various conservation practices. Initial conversions were made using land unit area from the RCA report divided by count (see "Conversions" in the Appendix).

Applying these conversions to available data from the Environmental Quality Incentive Program (EQIP) and the Conservation Stewardship Program (CSP), a visual of conservation practice implementation distribution was developed for the HTF region (Figure 2). Several 8-digit watersheds concentrated along the Mississippi River between Arkansas and Mississippi have had substantial conservation practice implementation between 2008 and 2020.

All Practices - Filtered for Water Quality from 2008 to 2020

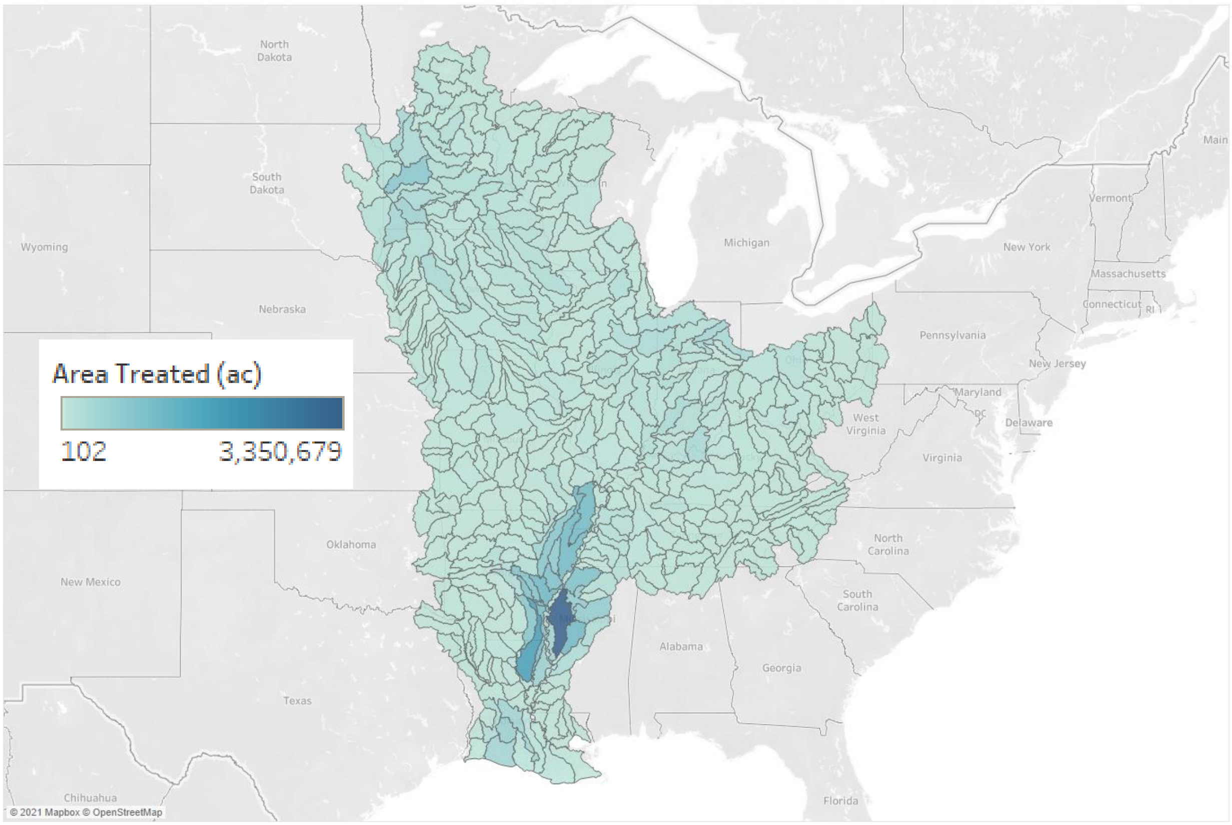
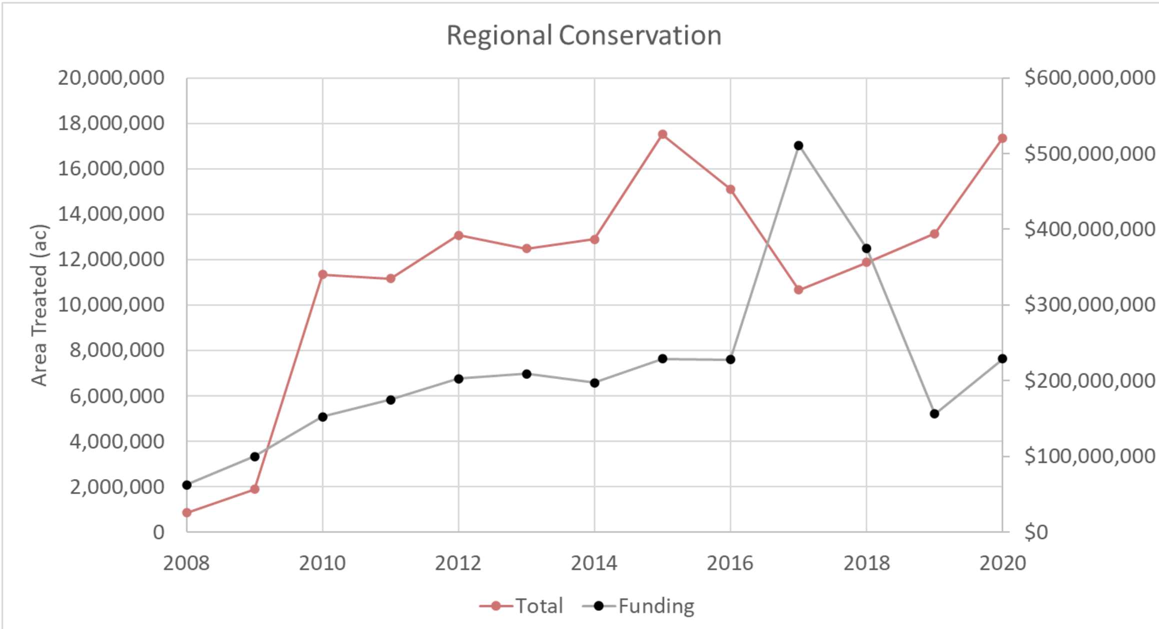


Figure 2. Agricultural conservation practice distribution by 8-digit watershed for HTF region. Data include water quality practices implemented between 2008 and 2020 through the EQIP and CSP programs.

Factoring in practice persistence in the landscape (life) for the region, approximately 17.3 million acres were being treated in HTF states in 2020 (Figure 3a). This is the result of an average $200 million being invested every year (Figure 3a). When restricted to those practices likely providing a water quality benefit, acreage drops slightly to 14.8 million acres in 2020 with an annual average funding level of around $130 million Figure 3b. As these data start from 2008, area treated values are likely low due to data limitations.

a)



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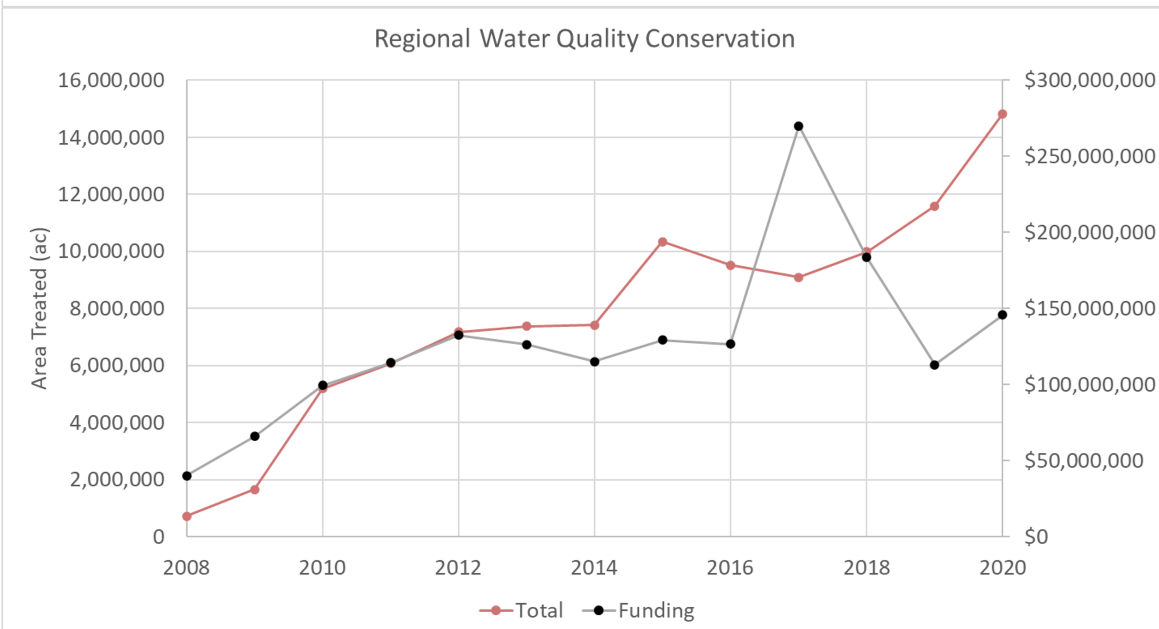

Figure 3. Area treated with annual funding through EQIP and CSP. Area treated factors in practice life. All practices have been included, regardless of impact on water quality.

Nutrient Reduction Efficiencies

The purpose of this step is to assess the nitrogen and phosphorus reduction potentials associated with conservation practices in the database. This was accomplished by entering effectiveness values from models or other tools (e.g., Spreadsheet Tool for Estimating Pollutant Loads (STEPL), Revised Universal Soil Loss Equation (RUSLE), state nutrient reduction strategies) into the framework. These values are used to calculate relative nutrient reductions. For conservation practices without efficiency values in a given state, placeholder values have been entered based on the STEP-L model (Tech, 2011; Tetra Tech Inc., 2018) or values reported by collaborators, where applicable. The intent is to update and add to these values regularly as new research is done and as states update their science assessments, which can be quickly done.

Populating the nutrient reduction tables is easily done in states where a science assessment has been completed; however, not all states have science assessments to draw upon. Note for all sources of available data, there are large gaps in knowledge surrounding many of the conservation practices. In these cases, the nitrogen and phosphorus reduction estimates are set to zero and are not counted towards water quality progress. A list of all efficiency values for the 12 member states of the HTF are listed in the Appendix (Table A- 3 and Table A- 4).

Nutrient Accounting System for Relative Estimates

To transform nutrient reduction efficiencies into mass reductions of nitrogen and phosphorus, an accounting system must be chosen. There are many models currently being used to estimate nitrogen and phosphorus movement to the Gulf of Mexico, however, choices were limited considering the need to have nutrient loss by land use by 8-digit Hydrologic Unit Code (HUC 8) watershed scale. Having this resolution allows areas with relatively more nutrient load to weigh heavier on the final result. Currently, the 2012 version of Spatially Referenced Regressions on Watershed Attributes (SPARROW) (Robertson & Saad, 2019) nutrient model is being used as a common accounting system across the region. A summary of SPARROW loads for the Hypoxia Task Force States is included in Table 1. This can easily be replaced with another model, or several could be used to suit various stakeholders. Additional models for use as the common accounting system will be considered while working with additional states in future efforts.

Table 1. Summary output for the SPARROW model for the Hypoxia Task Force States. Rowcrop nitrogen estimates were made based on a summation of farm fertilizer, manure, atmospheric deposition, nitrogen fixation. Rowcrop phosphorus estimates were made based on a summation of farm fertilizer and manure.

Ranked by State	**Rowcrop N Yield (lbs/ac)**	**Rowcrop P Yield (lbs/ac)**
Arkansas	5.43	1.01
Illinois	16.47	0.93
Indiana	14.62	0.82
Iowa	19.25	1.07
Kentucky	8.03	0.87
Louisiana	3.57	0.64
Minnesota	6.39	0.37
Mississippi	7.55	0.46
Missouri	4.18	0.71
Ohio	13.98	0.57
Tennessee	6.18	0.48
Wisconsin	6.92	0.35

Reduction Estimates (relative)

USDA Programs

In 2020, EQIP and CSP were providing reductions of around 0.14% and 0.06% for P and N, respectively. This is down from the peak in 2015, where there were around 0.19% and 0.10% reductions for P and N, respectively. These estimates are likely low, due to not all individual practices having N and P reduction efficiency estimates. As these are developed for each state, the impact of conservation practices can be further assessed.

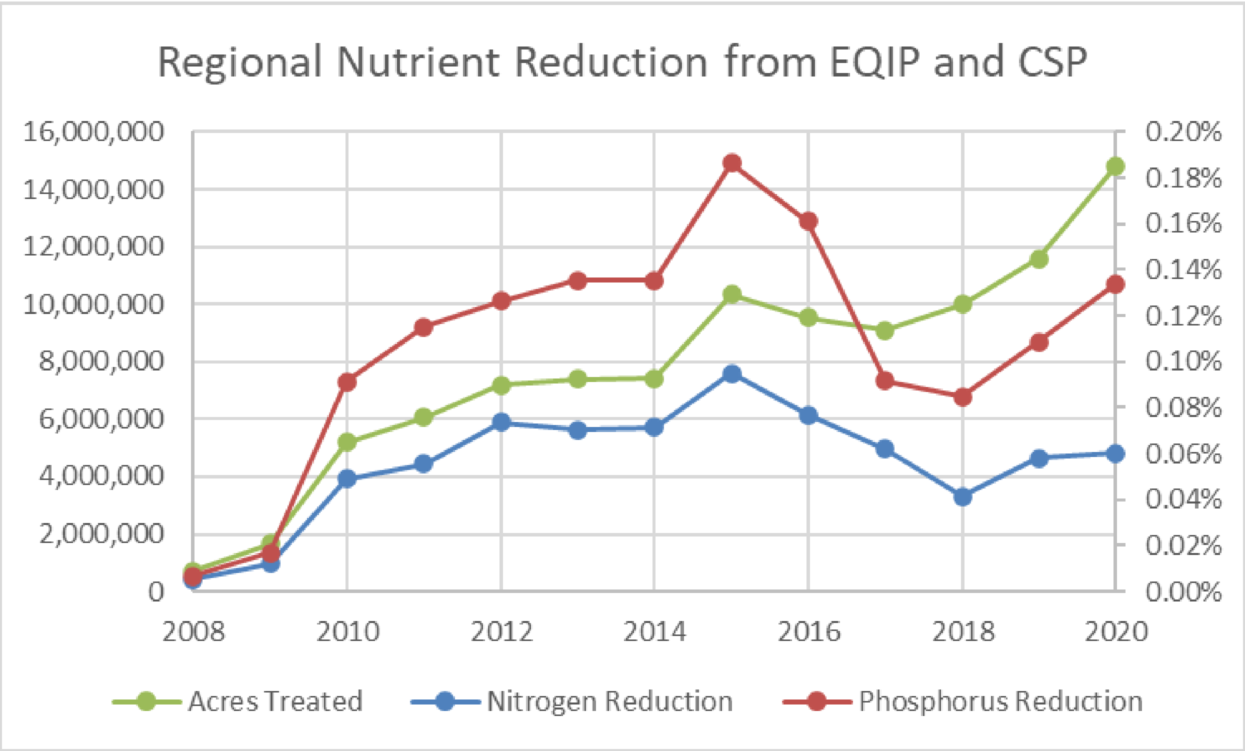

Figure 4. Impact of EQIP and CSP program data between 2008 and 2020 in the HTF region. The EQIP dataset spans 2008 to 2020; the CSP dataset spans 2010 to 2020.

Land Use Change

In addition to conservation practices, nitrogen and phosphorus reductions can be gained through bulk changes in land use. Since the focus is on agriculture, several sources of agricultural land use information were investigated to determine changes since the baseline period (1980 to 1996). The year 1992 was shown by Helmers et al. (2017) as near the 1980 to 1996 baseline average land use in Iowa; however, a new method relating the NASS Agriculture Survey and Cropland Data Layer (CDL) rowcrop estimates has been implemented here. This has helped to overcome the spatial and temporal discrepancies in datasets since the 1980s. Inconsistencies included the Census for Agriculture changing categories in the 1990s, modifications to the procedures to develop the National Land Cover Database (NLCD) starting in 2001, and the Cropland Data Layer (CDL) only available beginning in 1999. Comparing

Agriculture Survey estimates to CDL showed that the survey data for the region was about 1.06 times higher than CDL over the 2008 to 2020 period of overlap (Survey to CDL ratio). Backcasting to the 1980 to 1996 baseline period, Agriculture Survey estimates were reduced by this ratio (state specific) to make these data sources comparable.

With this information, it was possible to estimate the water quality impact of land-use changes since the HTF baseline period (Figure 5). As of 2020, rowcrop land area has increased by about 6 million acres, which will likely result in an increase in both nitrogen (N) and phosphorus (P) losses from the region. Assuming 95% less nutrients are lost from perennial systems, this would result in an increase of P and N by 3% and 1%, respectively over the baseline.

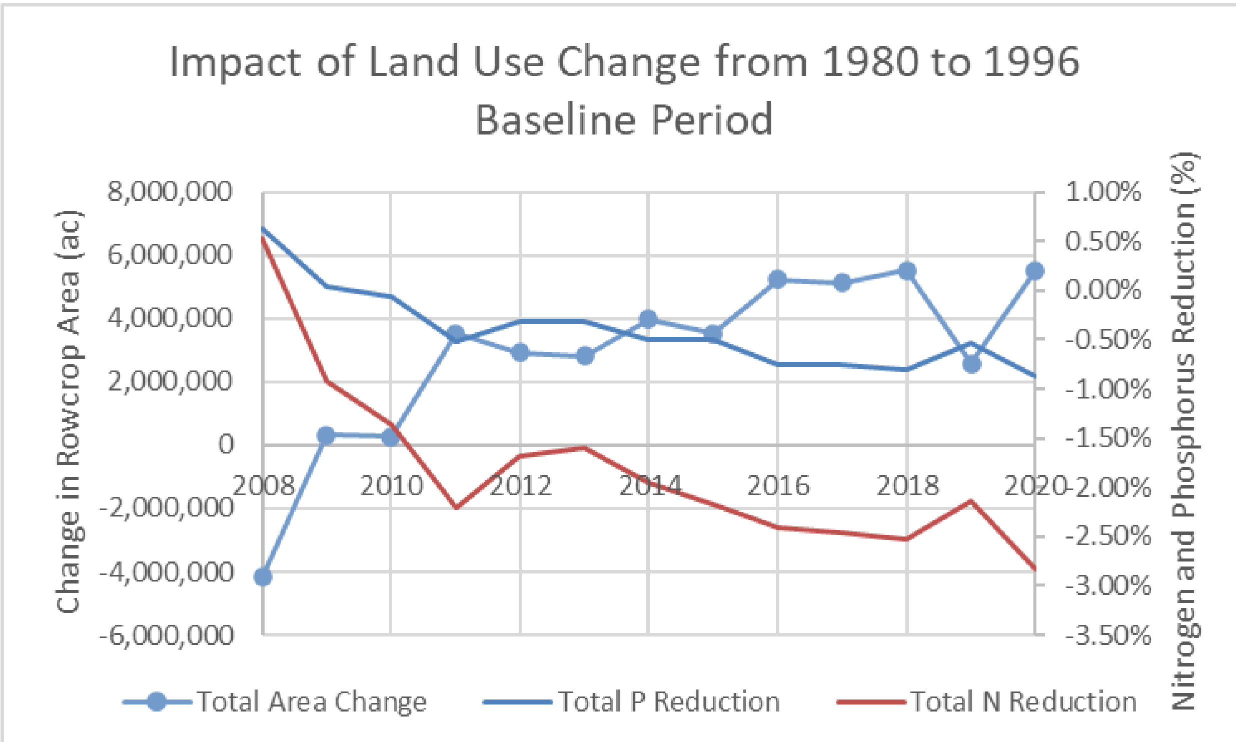

Figure 5. Regional land-use-change estimates based on the Cropland Data Layer and the Agriculture Survey.

Census of Agriculture

The Census of Agriculture has two useful pieces of information for conservation efforts across the country. First, information about tillage has been included since 2012, which allows assessment of the impact of changing tillage practices over time. With the rise of no-till and other reduced tillage approaches increasing in the 1990s, the current tillage estimates should be adjusted by the baseline average. No-till, for example averaged about 6.6% over the baseline period for HUC8 watersheds in the HTF region. These data were backcast using USGS data series 573 (Baker, 2011). Trendlines through the 1989 to 1998 period was used for this backcasting effort. The 2017 Census of Agriculture national estimate for no-till was 39.6%, making the increase 33%. Expanding on this, conservation tillage, assuming to include no-till, ridge till, and mulch till, averaged 51.1% (including “reduced till” to align with the Census of Agriculture) compared to the 2017 census of 70.8%, making an increase of 19.7%.

Assuming a phosphorus loss reduction efficiency of 40%, the uptick in conservation tillage likely is leading to a regional P loss reduction of around 8%.

The same approach can be done with cover crops, though there are no consistent data sources for the baseline period for cover crops. Assuming cover crop acreage was negligible during the baseline period, the 2017 Census of Agriculture can be used to assess impact. Hypoxia Task Force state average cover crop use was 14.1%. Assuming an N and P reduction efficiency of 30%, regional N and P loss reduction of around 4% could be expected.

Overall Story

Combining findings from land-use-change, EQIP and CSP data, and 2017 Census of Agriculture data for tillage and cover crops, N and P have likely been reduced by 1.5% and 3.5%, respectively, as of 2020. Of course, cover crop implementation is likely substantially higher in 2020 than the Census of Agriculture estimates due to recent incentivization of cover crops. These are all rough estimates using generalized reduction efficiencies since not all states have estimates to use. Further, this approach is not accounting for state or local programs or long-lived conservation practices implemented prior to 2008.

References

Baker, N. T. (2011). *Tillage practices in the conterminous United States, 1989–2004—Datasets Aggregated by Watershed*. Retrieved from Reston, VA: https://pubs.usgs.gov/ds/ds573/pdf/dataseries573final.pdf

Helmers, M., Isenhart, T., Christianson, R., Wolter, C., & Lawrence, J. (2017). *Assessment of the Estimated Non-Point Source Nitrogen and Phosphorus Loading from Agricultural Sources from Iowa During the 1980-96 Hypoxia Task Force Baseline Period*. Retrieved from Ames, Iowa: http://www.nutrientstrategy.iastate.edu/sites/default/files/documents/Historic%20Load%20Draft%20Report%20Final%20Edited%20Version.pdf

MDEQ. (1999). *Pollutants Controlled Calculation and Documentation for Section 319 Watersheds Training Manual*. Retrieved from https://www.michigan.gov/documents/deq/wrd-nps-pollutants-controlled_575549_7.pdf

NPSMWG. (2018). *Progress Report on Coordination for Non-Point Source Measures in Hypoxia Task Force States*. Retrieved from https://www.epa.gov/sites/production/files/2018-05/documents/nps_measures_progress_report_1-_may_2018.pdf

R Core Team. (2021). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. Retrieved from https://www.R-project.org/

Robertson, D. M., & Saad, D. A. (2019). *Spatially referenced models of streamflow and nitrogen, phosphorus, and suspended-sediment loads in streams of the midwestern United States* (2019-5114). Retrieved from Reston, VA: http://pubs.er.usgs.gov/publication/sir20195114

Tech, T. (2011). Inc. User's Guide Spreadsheet Tool for the Estimation of Pollutant Load (STEPL); Version 4.1; Tetra Tech. *Inc.: Fairfax, VA, USA*.

Tetra Tech Inc. (2018). *User's Guide Spreadsheet Tool for the Estimation of Pollutant Load (STEPL); Version 4.4*. Retrieved from http://it.tetratech-ffx.com/steplweb/STEPLmain_files/STEPLGuide404.pdf

USDA. (2021). Financial Management Modernization Initiative (FMMI) 2012-2020. Retrieved from https://www.nrcs.usda.gov/Internet/NRCS_RCA/reports/

Appendix

Methods for Conservation Practice Data Quality Control

State and County cleaning

These data were compiled into the standard parameters as defined in the 2018 NPS Measures Workgroup report called "Key Base Parameters." For CSP data in 2016, the HUC 8 watershed was back-filled using county data, which were applied to the HUC8 watershed corresponding to the largest proportion of the county. For example, 55% of Arkansas County, Arkansas is in HUC 8 08020303, so all practices listed for this county are applied to this watershed. This may mis-represent a particular watershed, but the state-wide numbers will be fine. There were also issues with states being listed with a county that the state did not contain. For example, there were 13 instances of Adair County in Arkansas, which is not present. In these cases, the county FIPS identifier was used to overwrite the state name. Also, corrections to the county spelling were made to align across all data and to allow mapping. An example of this was in Mississippi, where the NRCS had listed "DESOTO" county, which was changed to "De Soto" with a space. Other examples included "LAGRANGE" changed to "La Grange" and "STE GENEVIEVE" to "Ste. Genevieve." The common county name list was obtained from https://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/home/?cid=nrcs143_013697. Other small adjustments were made, such as trimming the state or county names to remove spaces at the beginning or end and grouping the programs into generalized categories. For example, "EQIP 2014" was generalized to "EQIP".

For posterity, the county code (FIPS) was filled in for those counties not already having this information. Also, there were three entries for Koochiching County, Minnesota under the EQIP program in 2010 along with 1,189 entries under the CSP program in 2016 that were outside of the Mississippi Watershed. These entries were removed from further analysis.

Practice life

Practice life is listed for some of the conservation practice bundles in the associated factsheets. For example, Grazing Bundle 2 (B000GRZ2) is listed as having a 20-year life. Where this information was available during review of these bundles, the life was added. For other practices, the NRCS has a standard practice life, which can be found here: https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1076947.pdf. These lifespans were added to the CSP and EQIP dataset to help determine persistence in the landscape and track these practices over time. For all other practices where life was not noted, a value of 1-year was added.

Practice name and unit analysis

An analysis of practice names as well as practice units was performed. Practice units were first changed into "common units" by changing disparate entries like "Acres" to "ac" or "No." to "no" or "SQFT" to "sq ft" since these units are the same. Once common units were determined, entries for each unit were counted to determine a "dominant unit." There were 16 practices where the dominant unit represented 90% or less of the total number of entries (**Error! Reference source not found.**). The units for these practices were split between, for example, "sq ft" and "ac" or between "Payment" and "ac" or between "no" and "ac-ft" or between "ft" and "ac", depending on the practice. The main practice, based on count, was practice code 561, Heavy Use Area Protection, where 13,347 entries were entered as "sq ft" and 12,821 were entered as "ac". Practice code "CROP" was split with 4,523 entries as "Payment" and 3,762 entries as "ac".

Table A- 1. NRCS Practices with mixed units. Table represents those where the dominant unit is less than 90% of total entries.

NRCS Practice Code	Dominant Name	Number of Units	Dominant Unit	Percent of Entries as Dominant Unit	Count
561	Heavy Use Area Protection	5	sq ft	50%	26,715
521	Pond Sealing or Lining, Geomembrane or Geosynthetic Clay Liner	2	ac	50%	2
436	Irrigation Reservoir	5	no	50%	531
655	Forest Trails and Landings	2	ft	51%	330
PAST	Pasture Annual Payment	2	ac	51%	2,511
CROP	Cropland Annual Payment	2	Payment	55%	8,285
ANM51	Establish and maintain early successional, natural vegetation in ditches and ditch bank borders	2	ac	57%	7
605	Denitrifying Bioreactor	2	no	60%	15
ENR13	Variable speed motor-drive systems	2	ac	60%	10
570	Stormwater Runoff Control	2	no	67%	66
NIPF	Non-Industrial Private Forest Land Annual Payment	2	ac	77%	1,942
ANM27	Wildlife Friendly Fencing	2	ft	81%	1,268
ANM38	Retrofit watering facility for wildlife escape and	2	no	85%	1,237
386	Field Border	4	ac	87%	1,314
WQT05	Remote monitoring and notification of irrigation p	2	no	88%	180

Unit reconciliation options

Mixed units representing area, such as “sq ft” and “ac” can easily be reconciled, though other mixed units cannot be directly converted. Several options are available:

1) Entries leaving “units” blank could be filled with the dominant unit.
2) Entries not having the dominant unit could be removed and not counted.
3) Entries not having the dominant unit could be “converted” to the dominant unit by using the average of other entries.
    a. The average could be constrained to entries with the same:
        i. County
        ii. State
        iii. Year
    b. Where funding is available, the average $/unit could be used along with the entries funding value to “convert” to the dominant unit. Again average $/unit could be constrained.
4) Entries not having the dominant unit could be assumed mis-entered, and the dominant unit could simply take the place of what was entered.

Option 3b above is likely the best approach since for a given state and year, and the funding ranges are relatively small. This was the approach implemented during the 2021 quality control effort on 2008 to 2020 NRCS data. Alternative methods, besides 3b, could be investigated to determine the extent to which these assumptions impact nutrient reduction estimates.

Unit reconciliation implementation

An example of how option 3b above might be implemented can be found in Arkansas in 2013 with a Grade Stabilization Structure practice (Practice Code 410) entered as 1,328 ft. This is a major outlier when considered by itself since the dominant unit is “no” and just $5,021 was allocated for it. Using the state average $/no for this practice of $2,196, the $5,021 funding level would result in 2.3 units, which would round to 2 structures implemented.

There were 13,975 entries in the 2007/2008 to 2020 EQIP and CSP dataset where units (after sq ft conversion to ac) did not match standard units. Of these, there were 706 entries that did not have funding information or corresponding statewide averages for that year. In other words, the 3b approach resulted in a divide by zero error since there was no average. Evaluating these 706 entries shows there are a total of 40 different practices, though two practices made up more than 60% of these entries. The top two were practice codes ANM27 (34%) and ANM38 (26%) (Wildlife Friendly Fencing and Retrofit watering facility for wildlife escape). These two sets fell under the 2016 CSP year, which NRCS was not able to provide funding estimates for due to how the accounting for CSP was done up to this year. Practice units for all of these were reported as “ac” but it was assumed standard practice units for those CSP practices in 2016, were intended (especially considering the magnitude of the entries (thousands for ANM27, which has standard units of “ft” and single digits for ANM38, which has standard units of “no,” for example). Making this assumption reduced the total entries with misalignments to 200 with one entry missing a date. These 200 were mainly in 2019 and 2020, and units were manually adjusted to match standard units, where the characteristics (i.e., magnitude or presence of decimal points) were consistent. For example, several instances of practice code 516, Livestock Pipeline, were entered as “sq ft” and were between 495 and 3,664 while the standard unit for this practice is “ft” and the 495 to 3,664 range is similar to other livestock pipeline installations entered as “ft”. Once this manual step was completed, there were only four misaligned entries where a determination could not be made. All four of these were practice code ENR13, Variable speed motor-drive systems, which had a mix of “no” and “ac” units. These were under the 2015 and 2016 CSP program and did not have funding data available. Reviewing these manually, it was assumed all four entries were intended to be the “no” unit.

This same approach could be taken for entries exceeding “normal” bounds or “looking” like erroneously entered values. An example of this is in Illinois in 2019, where one entry of cover crops had $2,869 of funding but had listed zero acres implemented. In this case, using the RCPP-EQIP average $/ac of $19.40 for Illinois in 2019, the zero would be replaced with 147.9 acres of cover crops. Many other examples like this are throughout the dataset. To automate this, the software package “R” was used to identify outliers using extended statistics from the boxplot routine (“boxplot.stats()$out”) (R Core Team., 2021). This routine considers outliers to be those values outside the 1st and 3rd quartiles after subtracting or adding 1.5 times the interquartile range. All outliers identified were replace using the average per-unit funding for the state and year for that practice and the total funding for that entry. Where an average per unit was not able to be determined, the outlier value was used. This process was repeated 5 times in an attempt to scrub additional extreme values.

An additional layer of manual scrutiny was added for practices outside “typical” bounds. For example, there were two instances of 2,704 units recorded for grade stabilization structures (PC 410) in Mississippi in 2018 that went in for just $5,303. At that funding level, in that state, in that year, the expected implementation count would be just one structure. A total of nine conservation practices were manually evaluated and generally included looking at those treating unusually high acreages. A more comprehensive screening process may be included in the future.

There were 33 entries without a date associated with implementation. The combined impact of these is likely small, but the date was filled using the highest implementation year for that particular fund code. For example, the “Beginning Farmer” program had 1,217 entries for 2016, which was the highest implementation year so the one entry under the “Beginning Farmer” fund code missing a date was set to 2016. Likewise, the seven entries for the “Big Stone” fund code missing a date were set to 2010, which was the highest implementation year for that fund code.

Practice impact on water quality

In 2017 and 2018 Walton Family Foundation project effort, only data for a subset of around 65 of the 709 unique practice codes appearing in the dataset were included. These practices were evaluated by the original project team and included due to their impact on water quality. This position has been reversed, and now all data are included, though water quality has been listed as a "benefit" for a subset of practices, so estimates of water quality benefits can be made. Creating this subset required "binning" practices into categories for less common practices. An example of this is the CSP practice "ANM14," which includes Riparian forest buffer for terrestrial and aquatic wildlife. This practice was "binned" with the other "Riparian Forest Buffer" practices. Many of the CSP practices have practice codes outside the "standard" practice codes provided by NRCS through their Field Office Technical Guides (https://www.nrcs.usda.gov/wps/portal/nrcs/detailfull/national/technical/cp/ncps/). Other CSP practices include a "base" practice. For example, "E590119Z," which is "Improving nutrient uptake efficiency and reducing risk of nutrient losses to groundwater," has "Nutrient Management" (Practice Codes: 590) as the base. Another example is "E345106X," which is "Reduced tillage to increase soil health and soil organic matter content," has "Residue and Tillage Management, Reduced Till" (Practice Codes: 345) as the base. These practices were grouped with the "base" practice.

Additionally, many "bundles" exist, which require multiple conservation practices to be adopted. An example of a bundle would be the MRBI Bundle #2 – Non-Irrigated Cropland #1, which includes Cover Crop, Residue and Tillage Management, Reduced Till, Nutrient Management, and Pest Management Conservation System (Practice Codes: 340; 345; 590; 595). Three of the four of these practices would impact nutrient losses from a field. There are at least 40 bundles in the dataset.

Future work

In addition to determining the combined impact of bundles, there is also a need to align these conservation practices with the practices highlighted in state nutrient strategies. In some cases, like with cover crop, these practices align well. In other cases, like with tillage practices, states generally track "conservation tillage," which would include reduced till, mulch till, and no-till. Practices including a conversion to a perennial system are also grouped in state strategies. So, general categories like "conservation tillage" or "perennial" can be applied, where appropriate.

Conversions

Table A- 2. Conversion factors to translate native practice units to acres treated. Only practices with conversions different than one are included.

Practice Code	Practice Name	Dominant Unit	Arkansas	Illinois	Indiana	Iowa	Kentucky	Louisiana	Minnesota	Mississippi	Missouri	Ohio	Tennessee	Wisconsin	Notes
313	Waste Storage Facility	no	21.8	19.9	26.0	23.2	19.7	12.8	21.4	23.5	21.2	10.1	22.4	15.3	Values from RCA report (land unit area divided by count)
316	Animal Mortality Facility	no	16.9	25.0	22.2	9.8	9.0	16.4	22.3	24.6	16.7	9.3	19.2	18.6	Values from RCA report (land unit area divided by count)
317	Composting Facility	no	17.4	19.7	18.1	28.6	26.1	9.5	97.4	26.1	17.7	17.5	17.3	17.0	Values from RCA report (land unit area divided by count)
350	Sediment Basin	no	41.6	42.6	65.1	30.8	41.6	41.6	41.6	50.0	40.7	28.2	24.5	21.7	Values from RCA report (land unit area divided by count); The median value was used for states where this practice was not reported; Values were large for MN, KY, and AR, so the median of the other states was used (41.6)
351	Well Decommissioning	no	31.0	22.6	29.9	47.2	6.0	60.2	31.0	43.7	37.5	10.3	31.0	32.0	Values from RCA report (land unit area divided by count); The median value was used for states where this practice was not reported; Values were large for TN, MN and AR, so the median of the other states was used (31)
359	Waste Treatment Lagoon	no	35.4	39.0	52.0	22.0	20.8	11.0	20.8	19.5	38.2	7.0	1.5	19.0	Values from RCA report (land unit area divided by count); The median value was used for states where this practice was not reported
360	Closure of Waste Impoundment	no	14.1	10.8	13.3	9.2	6.2	8.8	17.8	4.0	18.4	9.7	8.1	11.3	Values from RCA report (land unit area divided by count)
362	Diversion	ft	0.0287	0.0563	0.0454	0.0672	0.0279	0.0340	0.0685	0.0703	0.0354	0.0378	0.0586	0.0631	Values from RCA report (land unit area divided by count); However, the numbers were coming up very high, so the "count" was assumed
380	Windbreak/Shelterbelt Establishment	ft	0.0011	0.0011	0.0011	0.0011	0.0011	0.0011	0.0011	0.0011	0.0011	0.0011	0.0011	0.0011	Assume a 50 foot width (after Trevor Laurey)
410	Grade Stabilization Structure	no	75.4	30.0	39.6	32.0	27.1	52.9	66.5	51.9	51.7	16.7	42.4	42.4	Values from RCA report (land unit area divided by count); Iowa uses 32 acres as an average (Iowa's RCA Report is 54)
447	Irrigation System, Tailwater Recovery	no	99.8	90.0	90.0	90.0	90.0	173.2	90.0	80.1	138.0	90.0	55.3	47.4	Values from RCA report (land unit area divided by count); The median value was used for states where this practice was not reported
558	Roof Runoff Structure	no	29.6	23.2	17.1	14.9	9.4	88.0	24.8	17.1	3.0	12.1	18.8	9.3	Values from RCA report (land unit area divided by count); The median value was used for states where this practice was not reported
560	Access Road	ft	0.000320	0.000320	0.000320	0.000320	0.000320	0.000320	0.000320	0.000320	0.000320	0.000320	0.000320	0.000320	Assume a 14 foot width (after Trevor Laurey)
578	Stream Crossing	no	27.0	24.1	27.8	43.2	27.1	49.1	27.0	26.6	50.8	23.0	27.1	40.6	Values from RCA report (land unit area divided by count); The median value was used for states where this practice was not reported; Values were large for MN and AR, so the median of the other states was used (31)
580	Streambank and Shoreline Protection	ft	0.000344	0.000344	0.000344	0.000344	0.000344	0.000344	0.000344	0.000344	0.000344	0.000344	0.000344	0.000344	Assume a 15 foot width (after Trevor Laurey)
587	Structure for Water Control	no	90.0	55.8	74.9	84.4	25.7	83.6	133.5	64.4	48.9	33.4	57.2	30.2	Values from RCA report (land unit area divided by count)
600	Terrace	ft	0.005	0.016	0.040	0.005	0.005	0.005	0.016	0.005	0.005	0.005	0.005	0.005	From Iowa (0.005) or Illinois (0.016)
604	Saturated Buffer	ft	0.038	0.038	0.038	0.038	0.038	0.038	0.038	0.038	0.038	0.038	0.038	0.038	Median value from Jaynes and Isenhart, 2018
605	Denitrifying Bioreactor	no	40.0	40.0	40.0	50.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	Iowa uses 50 acres
629	Waste Treatment	no	7.3	5.0	5.0	13.1	13.1	13.1	20.4	27.7	13.1	8.2	18.0	27.3	Values from RCA report (land unit area divided by count); The median value was used for states where this practice was not reported
634	Manure Transfer	no	38.3	27.3	34.5	26.9	26.0	20.9	20.4	28.5	26.0	14.9	26.0	16.6	Values from RCA report (land unit area divided by count); The median value was used for states where this practice was not reported
635	Vegetated Treatment Area	ac	14.3	14.3	7.3	14.8	14.3	14.3	19.5	553.7	14.3	7.7	14.3	12.7	Values from RCA report (land unit area divided by count); The median value was used for states where this practice was not reported
638	Water and Sediment Control Basin	no	40.0	42.7	48.7	32.0	40.9	43.6	85.8	9.5	47.9	43.6	52.9	35.3	Values from RCA report (land unit area divided by count); The median value was used for states where this practice was not reported; Iowa uses 32 acres as an average
650	Windbreak/Shelterbelt Renovation	ft	0.00115	0.00115	0.00115	0.00115	0.00115	0.00115	0.00115	0.00115	0.00115	0.00115	0.00115	0.00115	Assume a 50 foot width (after Trevor Laurey)
656	Constructed Wetland	ac	101.4	16.9	26.4	1239.0	16.9	16.9	5.0	14.0	41.0	14.9	16.9	5.0	Values from RCA report (land unit area divided by count); The median value was used for states where this practice was not reported; Iowa uses 1,239 acres as the average for their 85 constructed wetlands
658	Wetland Creation	ac	44.8	50.4	26.7	1239.0	92.7	65.5	18.4	246.0	34.7	14.9	13.9	5.7	Values from RCA report (land unit area divided by count); The median value was used for states where this practice was not reported; Iowa uses 1,239 acres as the average for their 85 constructed wetlands
739	Vegetated Subsurface Drain Outlet	ft	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	
378	Pond	no	40.0	42.7	48.7	32.0	40.9	43.6	85.8	9.5	47.9	43.6	52.9	35.3	assume similar to PC638
584	Channel Bed Stabilization	ft	0.00034	0.00034	0.00034	0.00034	0.00034	0.00034	0.00034	0.00034	0.00034	0.00034	0.00034	0.00034	assume similar to PC580
601	Vegetative Barriers	ft	0.00032	0.00032	0.00032	0.00032	0.00032	0.00032	0.00032	0.00032	0.00032	0.00032	0.00032	0.00032	assume similar to PC560
614	Watering Facility	no	7.6	10.3	9.7	19.3	10.9	20.8	10.2	5.7	4.8	9.7	8.7	17.7	Values from RCA report (land unit area divided by count); Practice was not in the water quality section; However, the numbers were coming
ANM14	Riparian forest buffer (ft)	ft	0.00115	0.00115	0.00115	0.00115	0.00115	0.00115	0.00115	0.00115	0.00115	0.00115	0.00115	0.00115	Assume a 50 foot width (after Trevor Laurey)

Nutrient Reduction Efficiencies (N)

Table A- 3. Nitrogen reduction efficiencies as a fraction of 1 – multiply by 100 to convert into a percentage. Values in red are suggested.

Practice Code	Practice Name	Dominant Unit	Arkansas	Illino	Indian	Iowa	Kentuc	Louisia	Minneso	Mississip	Misso	Oh	Tenness	Wiscons	STEPL 4.4 (or other source as noted)
313	Waste Storage Facility	no		0.10			0.10		0.16						
316	Animal Mortality Facility	no					0.01		0.01						
317	Composting Facility	no		0.10											
327	Conservation Cover	ac			0.86										
328	Conservation Crop Rotation	ac			0.15				0.00						
329	Residue and Tillage Management - No-Till	ac	0.10		0.03		0.10								0.25
330	Contour Farming	ac													0.28
340	Cover Crop	ac	0.25	0.30	0.49	0.31	0.25		0.10						0.20
342	Critical Area Planting	ac													0.18
345	Residue and Tillage Management, Mulch Till	ac	0.10		0.08		0.10								0.15
346	Residue and Tillage Management, Ridge Till	ac	0.10				0.10								
359	Waste Treatment Lagoon	no					0.10								
390	Riparian Herbaceous Cover	ac	0.20	0.90											0.34
391	Riparian Forest Buffer	ac	0.30	0.90		0.91	0.30		0.95						0.48
393	Filter Strip	ac		0.90	0.20		0.78								0.53
410	Grade Stabilization Structure	no		0.10					0.10						
447	Irrigation System, Tailwater Recovery	no	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	
472	Access Control	ac	0.10				0.10								0.39
512	Forage and Biomass Planting	ac	0.65	0.65		0.72	0.65								
528	Prescribed Grazing	ac	0.10			0.85									0.41
554	Drainage Water Management	ac				0.33			0.33						0.39
561	Heavy Use Area Protection	ac	0.10	0.10			0.10		0.10						0.18
580	Streambank and Shoreline Protection	ft		0.50					0.50						0.75
590	Nutrient Management	ac	0.10	0.18	0.02	0.06	0.10		0.26						0.15
600	Terrace	ft							0.00						0.25
604	Saturated Buffer	ft				0.50									0.44
605	Denitrifying Bioreactor	no				0.43			0.13						0.45
612	Tree & Shrub Establishment	ac					0.85								
633	Waste Utilization	ac		0.10											
638	Water and Sediment Control Basin	no		0.10	0.17				0.10						
656	Constructed Wetland	ac		0.50		0.52			0.50						0.20
658	Wetland Creation	ac		0.50		0.52	0.50		0.50						0.20
747	Denitrifying Bioreactor	no				0.43			0.13						0.45
AIR02	Nitrogen stabilizers for air emissions control	ac				0.09									
AIR08	Nitrification inhibitors or urease inhibitors	ac				0.09									
AIR09	Nitrification inhibitors or urease inhibitors	ac				0.09									
LR100	Land Retirement	ac				0.85			0.83						0.90
WQL05	Apply nutrients no more than 30 days prior to pla	ac				0.06									
WQL07	Split nitrogen applications 50% after crop/pasture	ac				0.05									
WQL08	Apply split applications of nitrogen based on a pr	ac				0.05									
WQL25	Split applications of nitrogen based on a PSNT	ac				0.05									
386	Field Border	ac	0.00	0.00	0.00	0.85	0.00	0.00	0.83	0.00	0.00	0.00	0.00	0.00	0.90
ANM04	Extend existing filter strips	ac	0.00	0.90	0.20	0.00	0.78	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.53
ANM05	Extend riparian forest buffers	ac	0.30	0.90	0.00	0.91	0.30	0.00	0.95	0.00	0.00	0.00	0.00	0.00	0.48
ANM06	Extend existing riparian herbaceous cover	ac	0.20	0.90	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.34
ANM07	Extend existing field borders	ac	0.00	0.00	0.00	0.85	0.00	0.00	0.83	0.00	0.00	0.00	0.00	0.00	0.90
ANM19	Wildlife corridors	ac	0.00	0.00	0.00	0.85	0.00	0.00	0.83	0.00	0.00	0.00	0.00	0.00	0.90
ANM33	Riparian buffer	ac	0.30	0.90	0.00	0.91	0.30	0.00	0.95	0.00	0.00	0.00	0.00	0.00	0.48
B000CPL1	No-till, cover crop, nutrient management	ac	0.39	0.42	0.51	0.35	0.39	0.00	0.33	0.00	0.00	0.00	0.00	0.00	0.49
B000CPL19	No-till, nutrient management	ac	0.19	0.18	0.05	0.06	0.19	0.00	0.26	0.00	0.00	0.00	0.00	0.00	0.37
B000MRB1	Cover crop, nutrient management	ac	0.33	0.42	0.50	0.35	0.33	0.00	0.33	0.00	0.00	0.00	0.00	0.00	0.32
ENR12	Use of legume cover crops as a nitrogen source	ac	0.08	0.09	0.15	0.09	0.08	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.06
PLT01	Perennial	ac				0.85									
614	Watering Facility	no	0.10	0.25			0.10								
ANM14	Riparian forest buffer (ft)	ft	0.30	0.90	0.00	0.91	0.30	0.00	0.95	0.00	0.00	0.00	0.00	0.00	0.48

Nutrient Reduction Efficiencies (P)

Table A- 4. Phosphorus reduction efficiencies as a fraction of 1 – multiply by 100 to convert into a percentage. Values in red are suggested.

Practice C	Practice Name	Dominant Unit	Arkansas	Illinois	Indiana	Iowa	Kentucky	Louisiana	Minnesota	Mississippi	Missouri	Ohio	Tennessee	Wisconsin	STEPL 4.4 (or other source as noted)
313	Waste Storage Facility	no		0.00			0.15		0.17						
327	Conservation Cover	ac			1.00										
328	Conservation Crop Rotation	ac			0.20				0.00			0.30			
329	Residue and Tillage Management - No-Till	ac	0.20	0.50	0.01	0.90	0.20		0.63			0.69			0.69
330	Contour Farming	ac										0.44			0.40
340	Cover Crop	ac	0.30	0.30	0.62	0.29	0.30		0.29			0.67			0.07
342	Critical Area Planting	ac													0.20
345	Residue and Tillage Management, Mulch Till	ac	0.20	0.50	0.05	0.33	0.20		0.63			0.62			0.36
346	Residue and Tillage Management, Ridge Till	ac	0.20	0.50		0.33	0.20		0.63			0.62			
350	Sediment Basin	no										0.72			
359	Waste Treatment Lagoon	no					0.15								
390	Riparian Herbaceous Cover	ac	0.45	0.50		0.58			0.58						0.44
391	Riparian Forest Buffer	ac	0.45	0.50		0.58	0.45		0.58			0.43			0.47
393	Filter Strip	ac		0.50	0.36		0.76					0.56			0.61
410	Grade Stabilization Structure	no		0.20					0.20						
447	Irrigation System, Tailwater Recovery	no	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	
472	Access Control	ac	0.15				0.15								0.04
484	Mulching	ac		0.50					0.63						
512	Forage and Biomass Planting	ac	0.65	0.65		0.34	0.65								
528	Prescribed Grazing	ac	0.15			0.59									0.23
554	Drainage Water Management	ac										0.01			0.35
561	Heavy Use Area Protection	ac	0.15	0.15			0.15		0.15						0.19
580	Streambank and Shoreline Protection	ft		0.50					0.50						0.75
590	Nutrient Management	ac	0.15		0.04		0.15					0.47			0.45
600	Terrace	ft		0.40		0.77			0.40						0.31
612	Tree & Shrub Establishment	ac					0.75								
629	Waste Treatment	no										0.42			
638	Water and Sediment Control Basin	no		0.20	0.40				0.20						0.52
656	Constructed Wetland	ac		0.00		0.00			0.00			0.72			
658	Wetland Creation	ac		0.00		0.00	0.00		0.00						0.44
AIR01	Injecting or incorporating manure	ac				0.24									
LR100	Land Retirement	ac				0.75			0.56						0.81
WQL09	Apply phosphorus fertilizer below soil surface	ac				0.24									
386	Field Border	ac	0.00	0.00	0.00	0.75	0.00	0.00	0.56	0.00	0.00	0.00	0.00	0.00	0.81
ANM04	Extend existing filter strips	ac	0.00	0.50	0.36	0.00	0.76	0.00	0.00	0.00	0.00	0.56	0.00	0.00	0.61
ANM05	Extend riparian forest buffers	ac	0.45	0.50	0.00	0.58	0.45	0.00	0.58	0.00	0.00	0.43	0.00	0.00	0.47
ANM06	Extend existing riparian herbaceous cover	ac	0.45	0.50	0.00	0.58	0.00	0.00	0.58	0.00	0.00	0.00	0.00	0.00	0.44
ANM07	Extend existing field borders	ac	0.00	0.00	0.00	0.75	0.00	0.00	0.56	0.00	0.00	0.00	0.00	0.00	0.81
ANM19	Wildlife corridors	ac	0.00	0.00	0.00	0.75	0.00	0.00	0.56	0.00	0.00	0.00	0.00	0.00	0.81
ANM33	Riparian buffer	ac	0.45	0.50	0.00	0.58	0.45	0.00	0.58	0.00	0.00	0.43	0.00	0.00	0.47
B000CPL1	No-till, cover crop, nutrient management	ac	0.52	0.65	0.64	0.93	0.52	0.00	0.74	0.00	0.00	0.95	0.00	0.00	0.84
B000CPL1	No-till, nutrient management	ac	0.32	0.50	0.06	0.90	0.32	0.00	0.63	0.00	0.00	0.84	0.00	0.00	0.83
B000MRB1	Cover crop, nutrient management	ac	0.41	0.30	0.64	0.29	0.41	0.00	0.29	0.00	0.00	0.83	0.00	0.00	0.49
ENR12	Use of legume cover crops as a nitrogen source	ac					0.30								
PLT01	Perennial	ac				0.85									
614	Watering Facility	no	0.10	0.25			0.10								
ANM14	Riparian forest buffer (ft)	ft	0.45	0.50	0.00	0.58	0.45	0.00	0.58	0.00	0.00	0.43	0.00	0.00	0.47

Individual State Reductions from USDA EQIP and CSP; Arkansas, Illinois, Indiana, Iowa, Kentucky, Louisiana, Minnesota, Mississippi, Missouri, Ohio, Tennessee, Wisconsin.

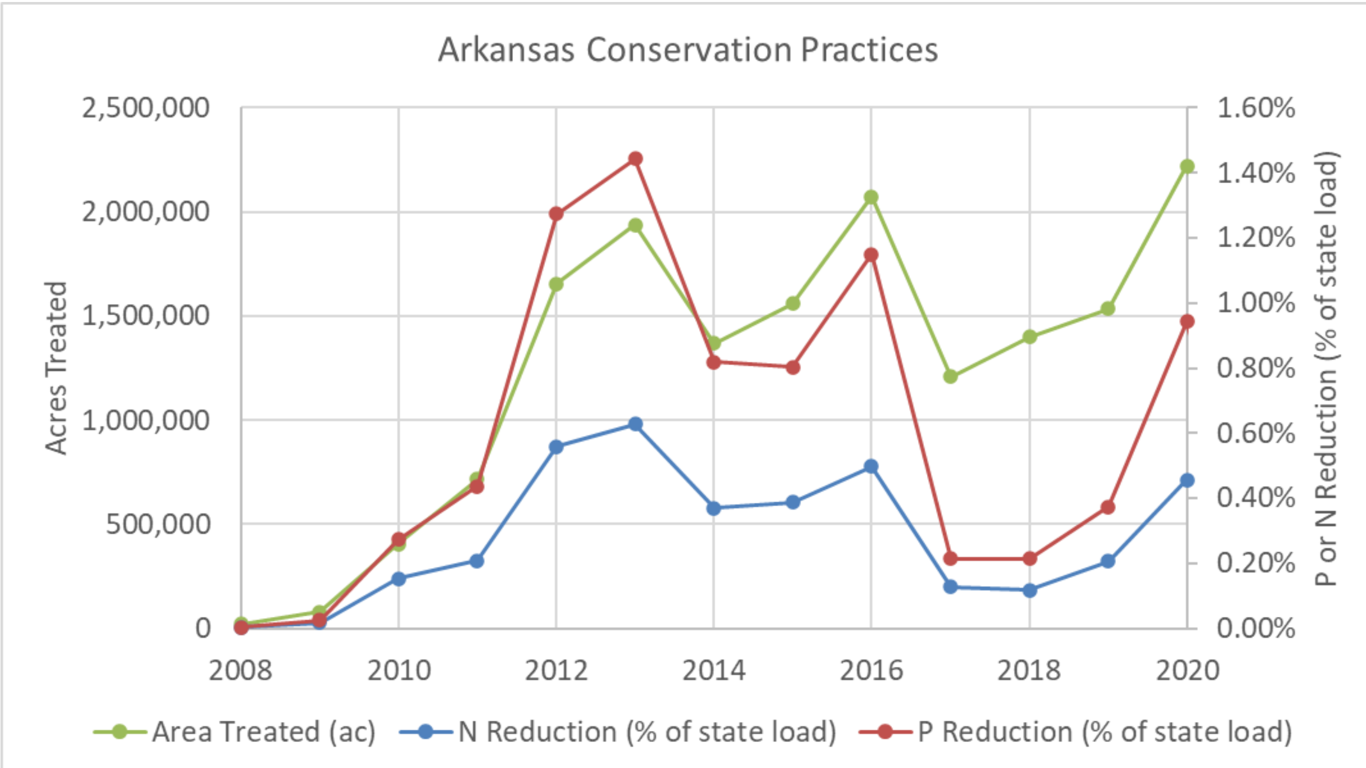

Figure A- 1. Impact of EQIP and CSP conservation practices in Arkansas.

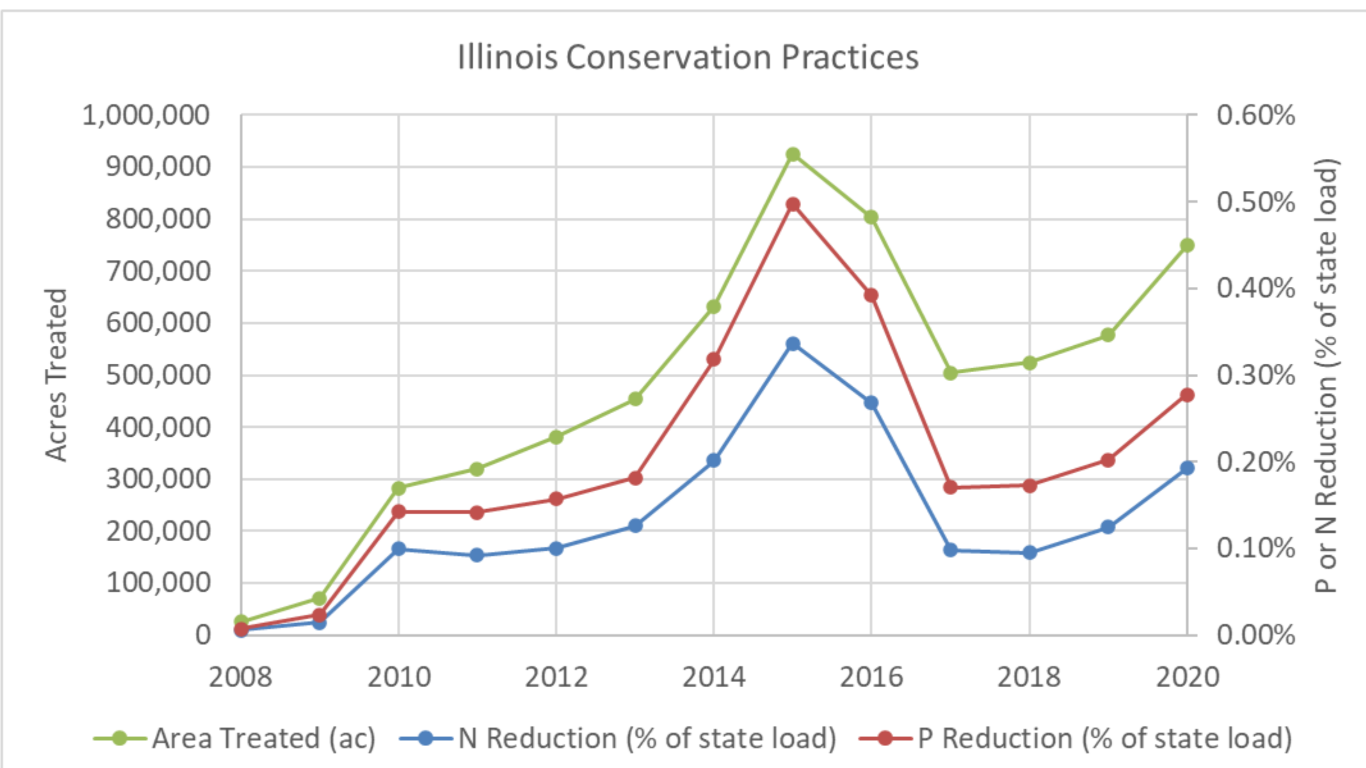

Figure A- 2. Impact of EQIP and CSP conservation practices in Illinois.

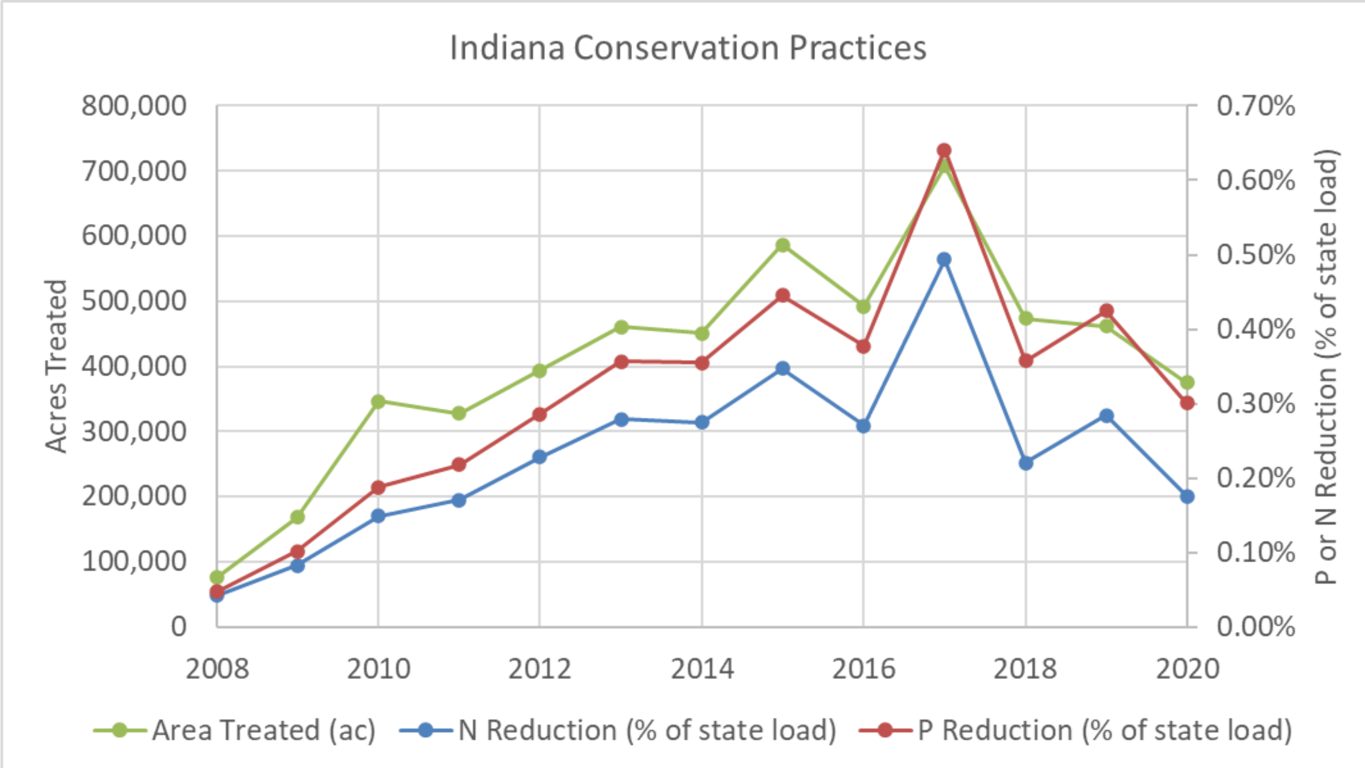

Figure A- 3. Impact of EQIP and CSP conservation practices in Indiana.

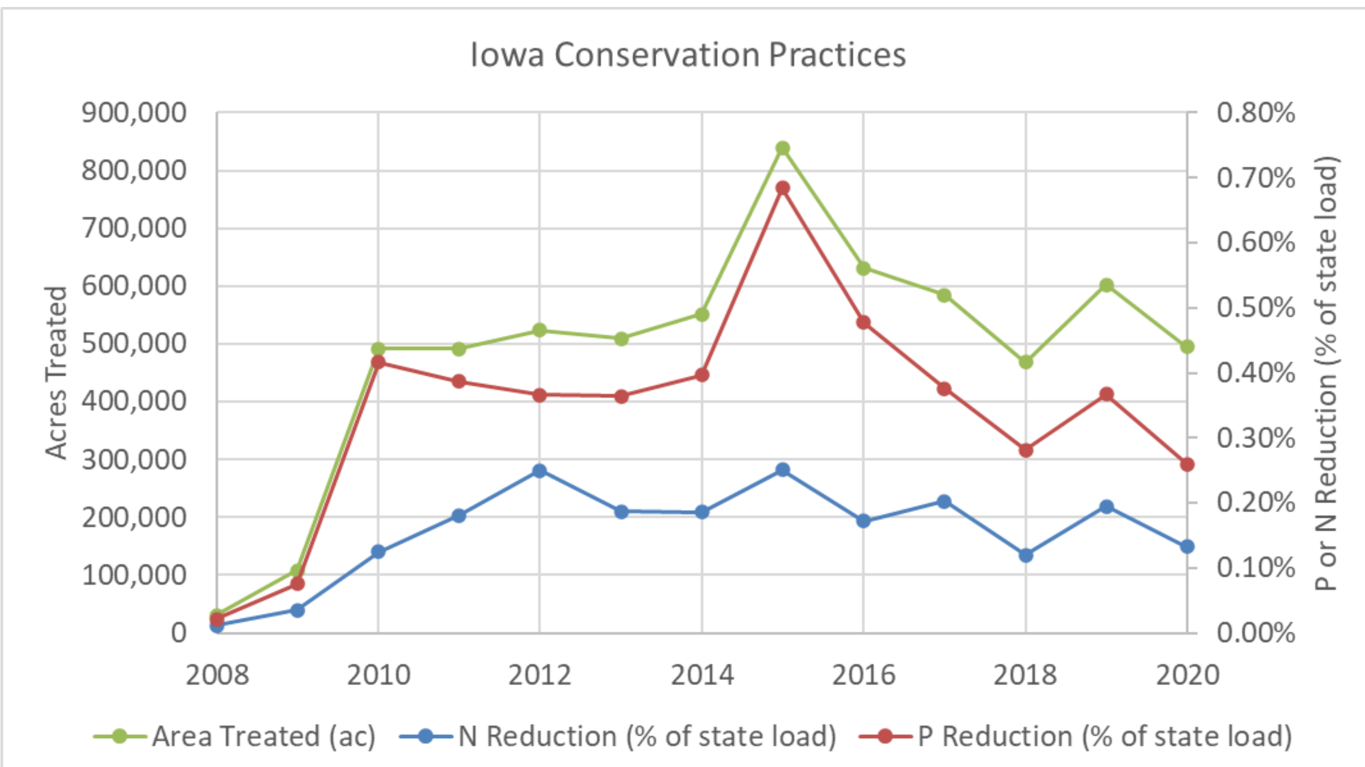

Figure A- 4. Impact of EQIP and CSP conservation practices in Iowa.

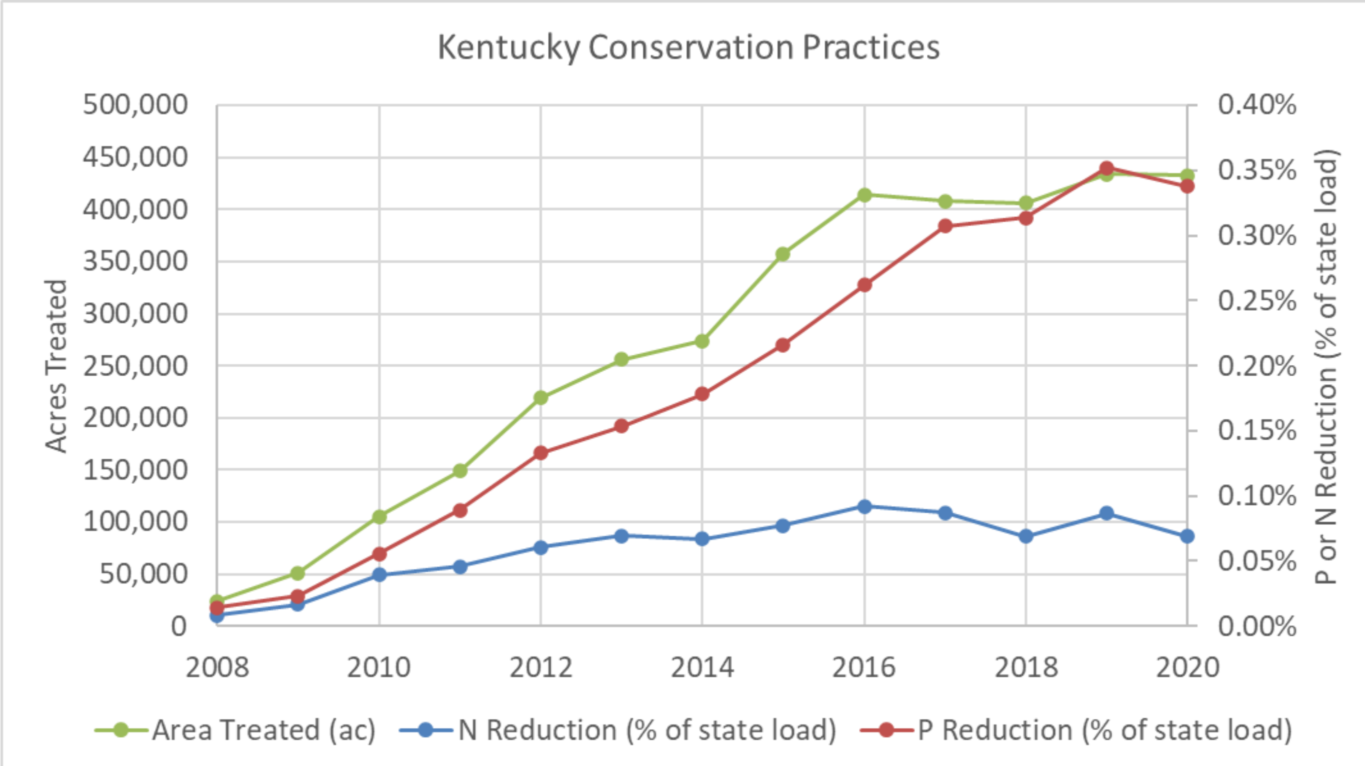

Figure A- 5. Impact of EQIP and CSP conservation practices in Kentucky.

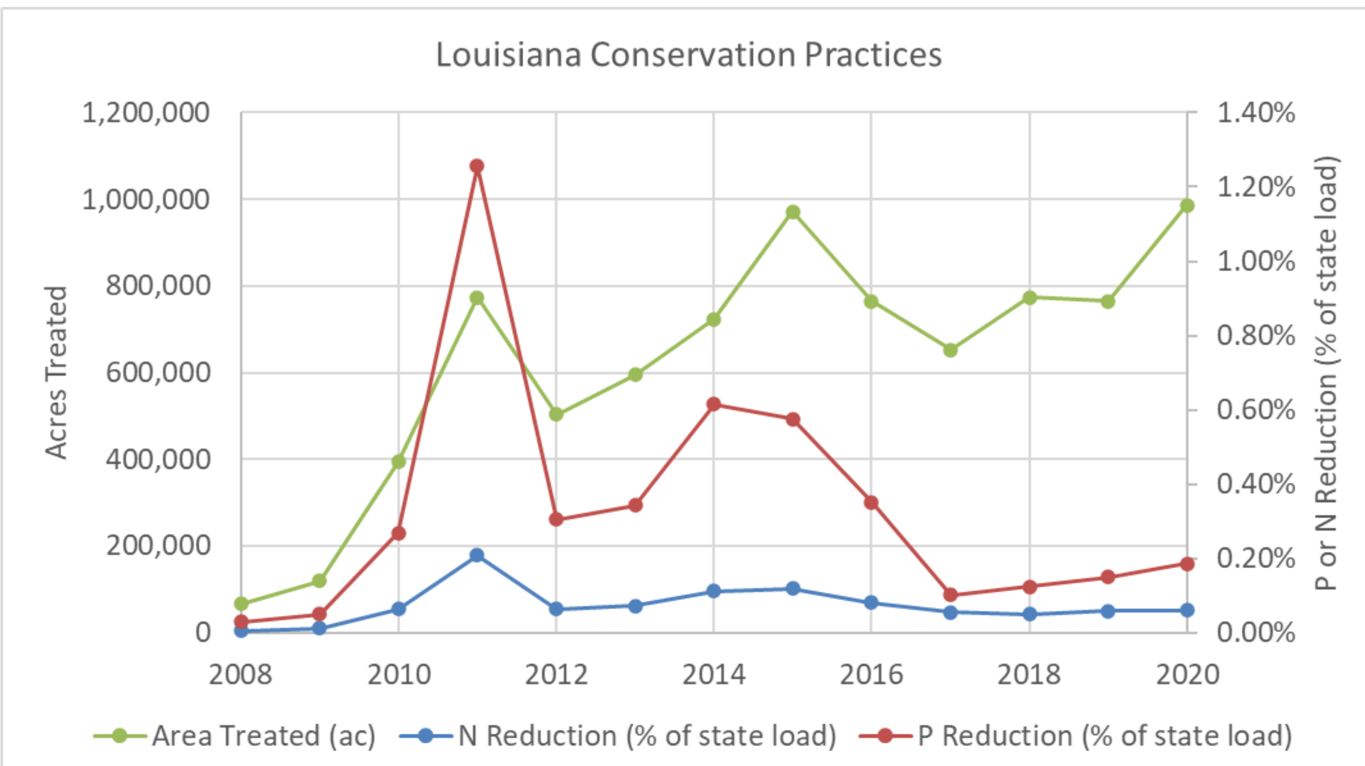

Figure A- 6. Impact of EQIP and CSP conservation practices in Louisiana.

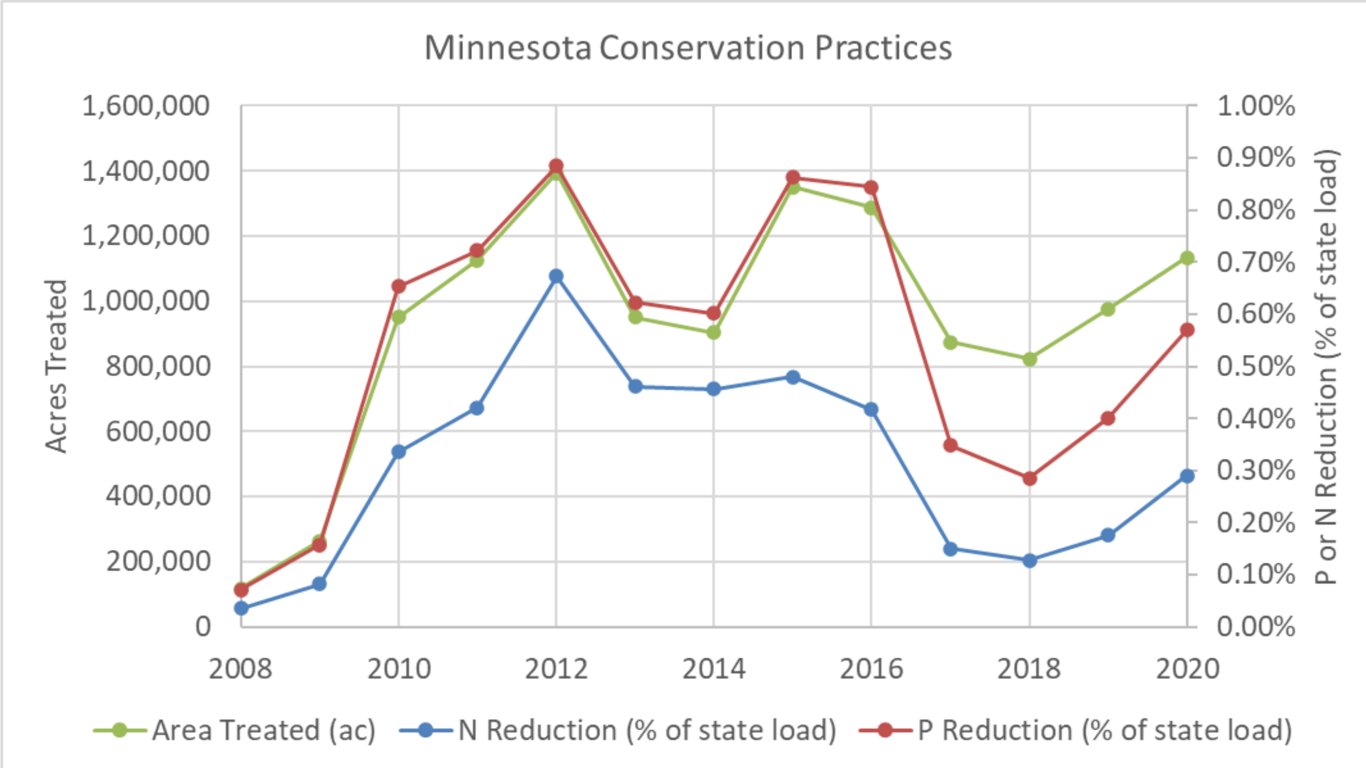

Figure A- 7. Impact of EQIP and CSP conservation practices in Minnesota.

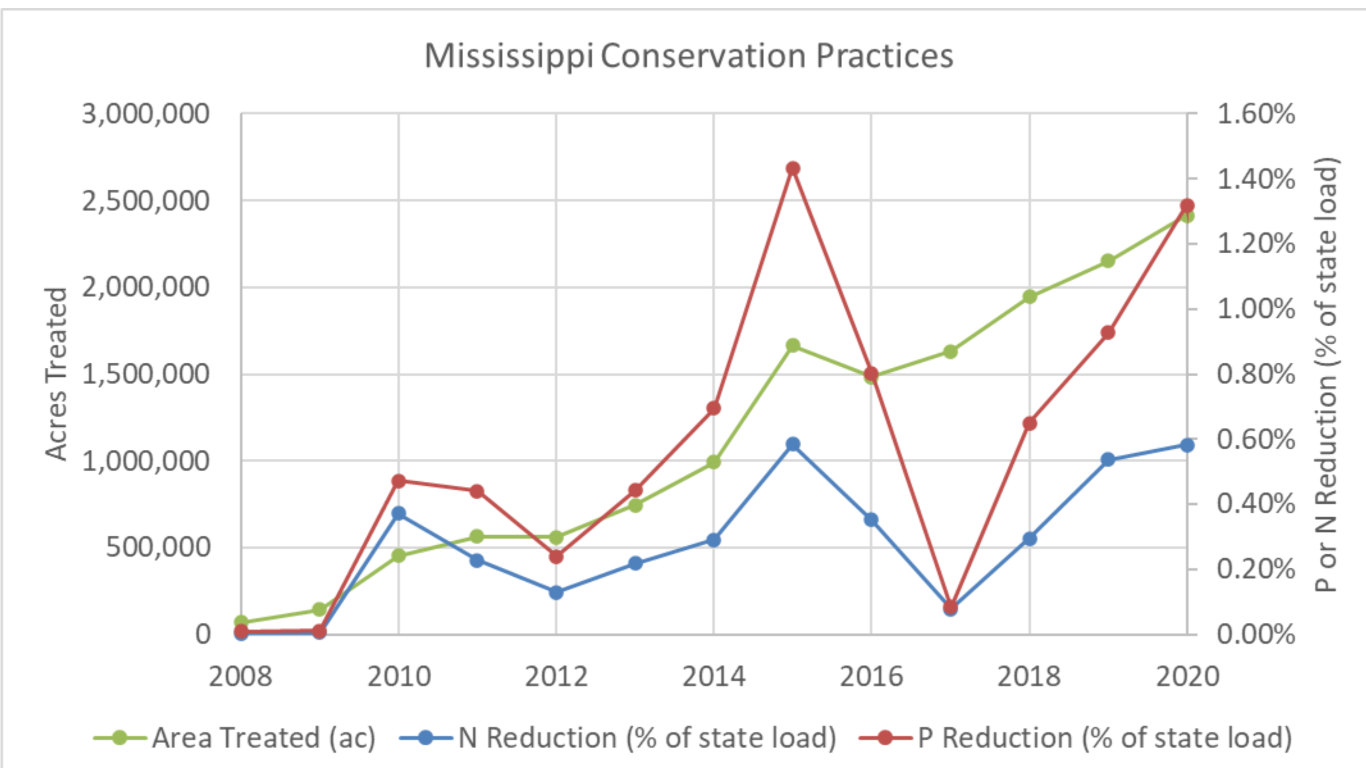

Figure A- 8. Impact of EQIP and CSP conservation practices in Mississippi.

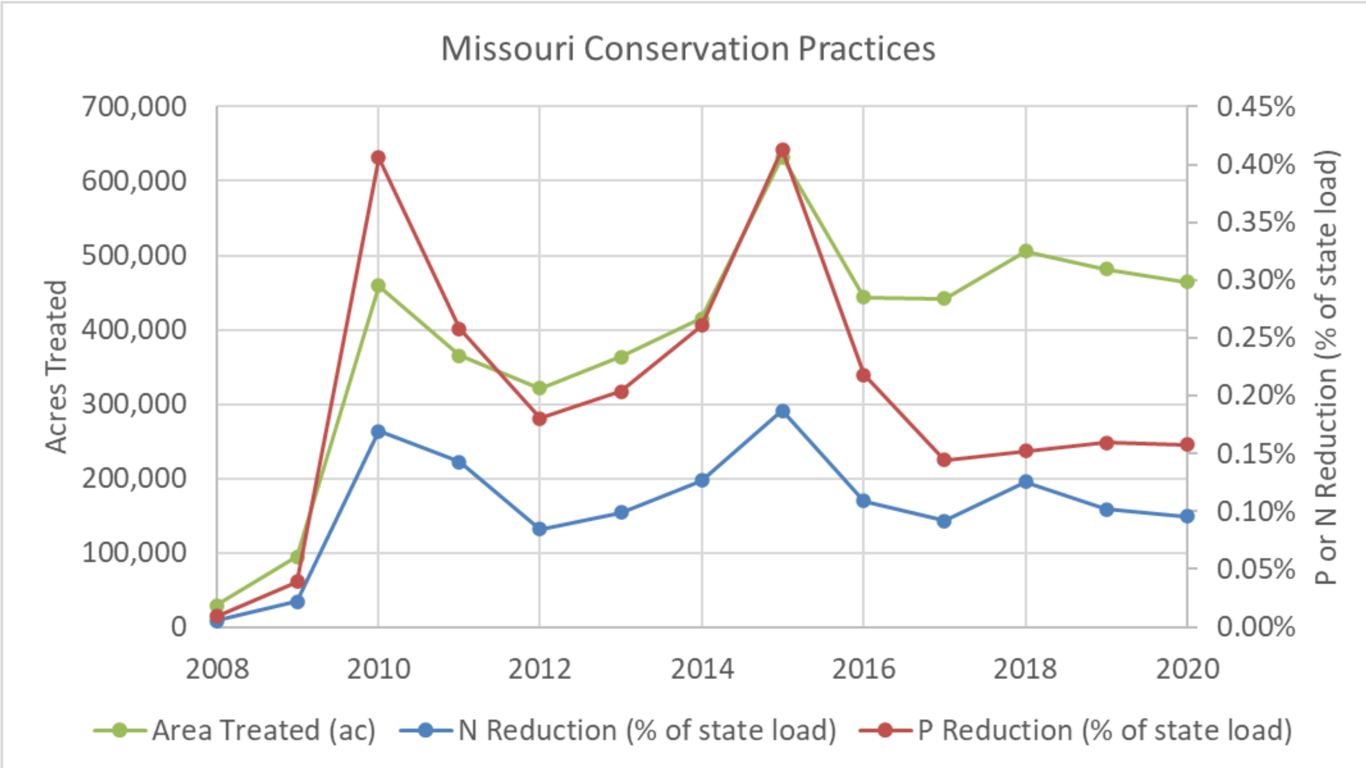

Figure A- 9. Impact of EQIP and CSP conservation practices in Missouri.

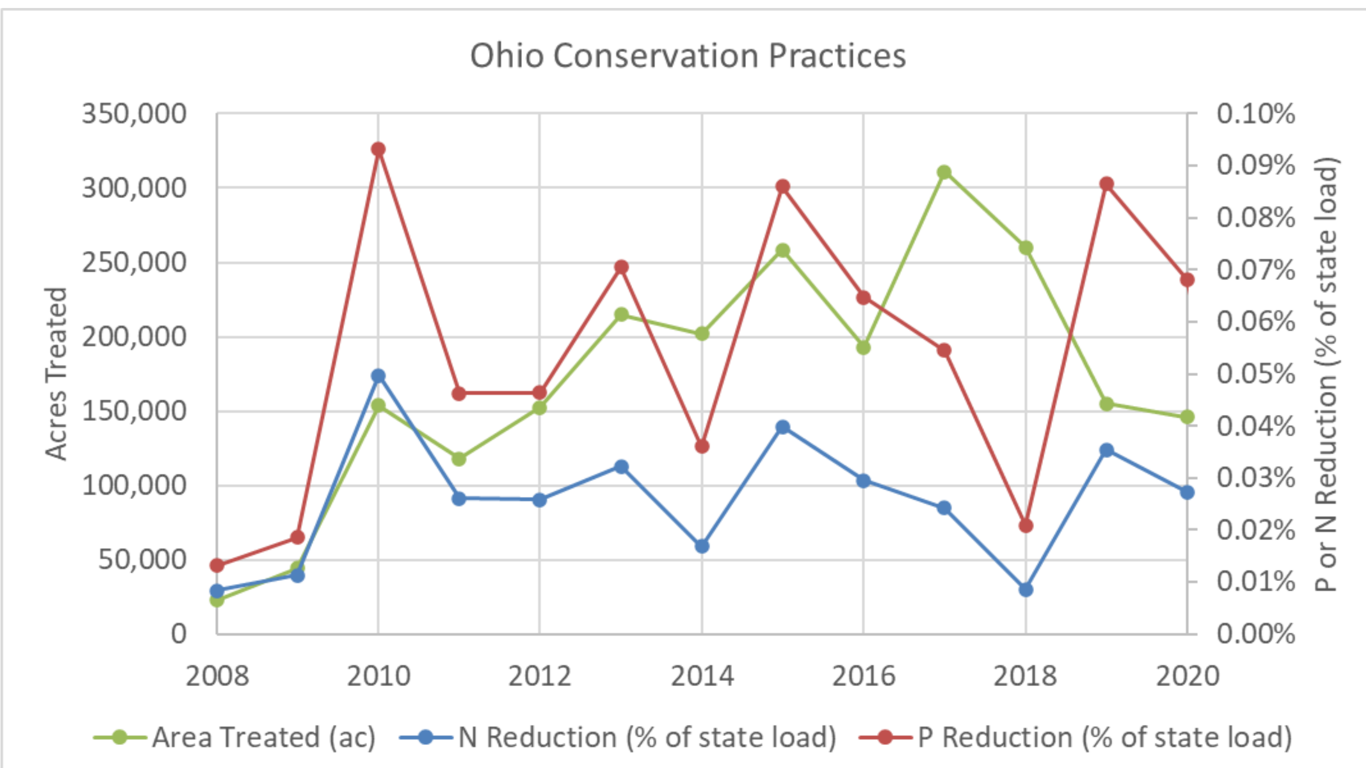

Figure A- 10. Impact of EQIP and CSP conservation practices in Ohio.

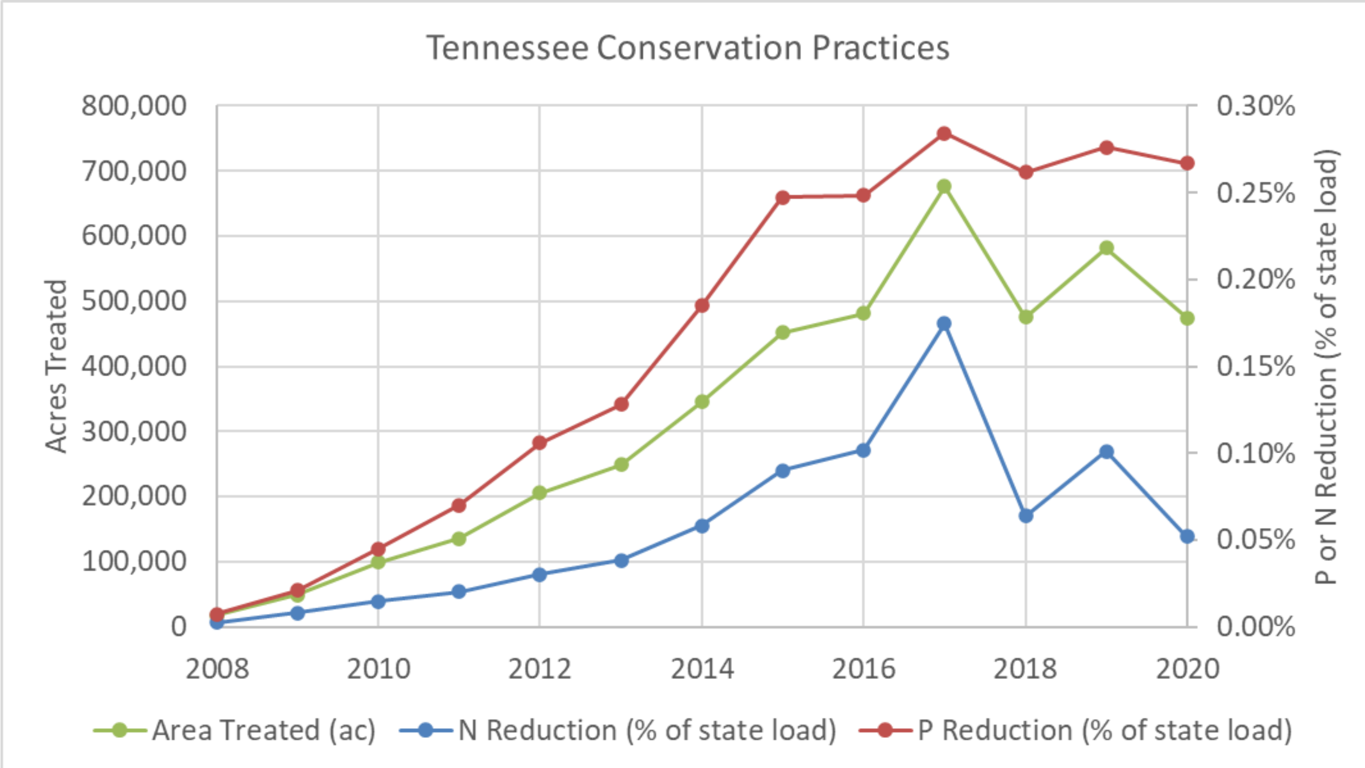

Figure A- 11. Impact of EQIP and CSP conservation practices in Tennessee.

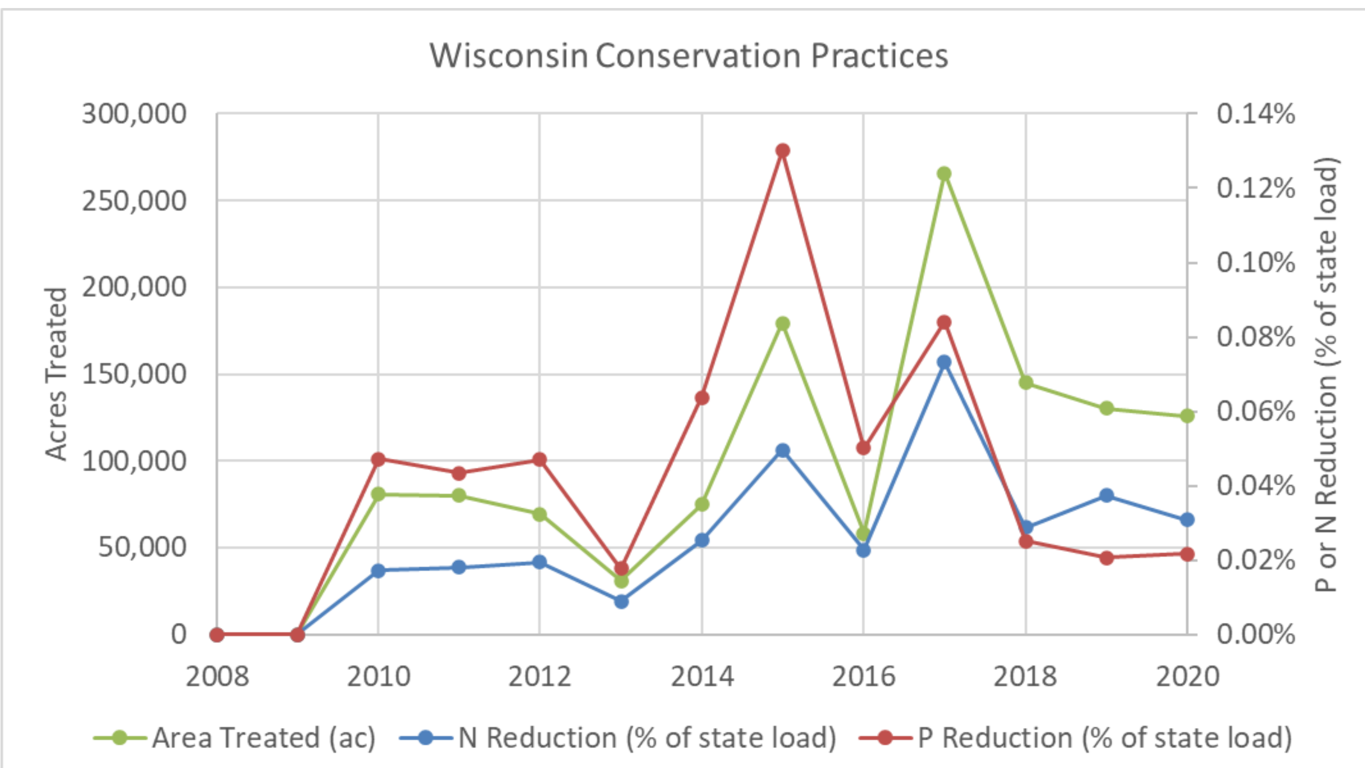

Figure A- 12. Impact of EQIP and CSP conservation practices in Wisconsin.