ST. MARYS RIVER WATERSHED SUMMARY

The St. Marys River watershed is located in northwest Ohio in portions of Auglaize, Mercer, Shelby and Van Wert counties and in eastern Indiana in Adams, Allen and Wells counties. The Soil and Water Assessment Tool (SWAT) was used to estimate this watershed's contribution to nutrient loadings to the Western Basin of Lake Erie (WLEB), as well as simulate estimated nutrient outputs when specific best management practices (BMPs) were implemented.


ST. MARYS RIVER WATERSHED (RED) APPROXIMATE LOCATION WITHIN THE WLEB (GREEN)

Model results estimated that ~33% of the St. Marys watershed contributes phosphorus outputs that range from 1.95 to 3.28 lbs/acre to the St. Marys River on an annual basis. The St. Marys River SWAT model was used to simulate phosphorus outputs if several agricultural BMPs were adopted at a rate of 50% in the areas that have higher Total P contributions. The scenarios modeled were: 1) subsurface application of fertilizer, 2) no-till practices, 3) P-fertilizer application at half the Baseline scenario rate, and 4) a combination of subsurface application of fertilizer, half P-rate application, no-till practices, and use of cover crops.

Analysis of these scenarios shows:

- ***No single BMP provides optimal nutrient reduction everywhere.***
- ***Not every BMP is best-suited for an area, or as a stand-alone BMP.***
- ***Implementation of a combination of several BMPs provides greater nutrient reduction across the entire St. Marys watershed and could achieve the Great Lakes Water Quality Agreement 40% reduction goal in some Hydrologic Unit Code (HUC)-12 subwatersheds.***
- ***For those areas where nutrient reduction goals are not met with single BMP implementation, an adoption rate of greater than 50% or alternative BMPs may be needed.***

State and federal funding is available for nonpoint source pollution reduction projects, but only if a sub-watershed has an approved Nine-Element Plan, also known as a Nonpoint Source Implementation Strategy (NPS-IS) in Ohio or a Watershed Management Plan (WMP) in Indiana. In order to facilitate funding eligibility and fund projects that will make effective progress towards nutrient reduction, the development of NPS-IS plans and WMPs should be prioritized for the highest contributing subwatersheds in the St. Marys watershed.

- ***Thirty-four HUC-12 subwatersheds are in the St. Marys watershed.***
- ***No approved NPS-IS plans exist in the Ohio portion of the St. Marys watershed (as of June 2019), though six are in development. A WMP for the Indiana portion of the St. Marys watershed was written in 2009, but is likely in need of updating.***
- ***Of the top ten highest contributing HUC-12s, three subwatersheds are still in need of plan development.***

These planning efforts, and the subsequent implementation of nutrient reduction projects, are led by local stakeholders who are most knowledgeable of the needs of the watershed, such as county, city, township and village governments, soil and water conservation districts and non-governmental organizations. Collaboration between these stakeholders is essential to the implementation of watershed-scale nutrient reduction efforts that will improve water quality within the St. Marys River watershed, as well as in Lake Erie.

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HUC – 04100004 ST. MARYS RIVER MODEL ANALYSIS AND RECOMMENDATIONS

St. Marys River Watershed Background

The St. Marys Watershed (Hydrologic Unit Code 8 (HUC-8) = 04100004, area = 795 sq. mi (508,618 acre)) is located in northwest Ohio in portions of Auglaize, Mercer, Shelby and Van Wert counties and in eastern Indiana in Adams, Allen and Wells counties. The St. Marys River is the largest river in this watershed (99 miles), flowing from Shelby County in Ohio northwesterly to meet the St. Joseph River in Fort Wayne, Indiana to form the headwaters of the Maumee River. Major tributaries to the St. Marys River include Sixmile Creek, Fourmile Creek, Eightmile Creek, Twelvemile Creek, Yankee Run, Little Black Creek, Duck Creek and Twentyseven Mile Creek.

The watershed spans two Ecoregions: the Eastern Corn Belt Plains (ECBP) and the Huron-Erie Lake Plains (HELP). While the ECBP is dominated by rolling hills and ground moraine, the HELP Ecoregion is characterized as a broad, flat-lying plain composed of extensive lacustrine clays. The St. Marys River flows through deposits of alluvium and glacial outwash. Soils in the watershed are typically poorly-drained, and waterways are typically channelized to efficiently convey drainage throughout a mainly agricultural landscape. Cities, towns and villages within the St. Marys watershed include: Berne, Celina, Decatur, Fort Wayne, Hoagland, Mendon, Monroe, New Bremen, Pleasant Mills, Rockford, St. Marys, Willshire and Yoder.

SWAT Model

The Soil and Water Assessment Tool (SWAT) was developed by the United States Department of Agriculture - Agricultural Research Service (USDA-ARS) "to predict the impact of land management practices on water, sediment and agricultural chemical yields in large complex watersheds with varying soils, land use and management conditions over a long period of time" (Neitsch *et al.*, 2011). The SWAT Model breaks a watershed down into small spatial units called hydrologic response units (HRUs) that contain a unique combination of land use/crop cover, soil properties and slope characteristics. For example, there are over 2,900 HRUs throughout the St. Marys HUC-8. Hydrologic and biologic processes (e.g. precipitation, evaporation, nutrient loss, and plant growth) are modeled in each HRU to increase accuracy and minimize uncertainty. A geographic information system (GIS) interface is used to enter and designate land use, soil, weather, groundwater, water use, management, pond and stream water quality data, and the simulation period (DiLuzio *et al.*, 2002). GIS input files include a digital elevation model (DEM), land use/land cover, soil properties layers and a daily weather database.

SWAT is one of many tools available for assessing watersheds and is regarded as the most versatile and customizable tool available to best achieve real-world scenarios for evaluating best management practices (BMPs) employed within a watershed. It is the most appropriate model to test the effects of BMPs on crop yield and environmental outputs, such as runoff movement, sediment, nutrient and pesticide loadings. These outputs to the St. Marys River and its tributaries are simulated by considering realistic physical processes.

St. Marys River SWAT Model Methodology

Data inputs, include USGS streamgages (active, continuously functioning measuring devices in streams that measure the height of water to calculate average daily streamflow), local weather data, point source nutrient contributors, knowledge of agricultural practices and land management, USDA-NRCS Cropland Data Layer (CDL) and USGS National Hydrography Dataset (NHD). These data were used to delineate the St. Marys River HUC-8 and to estimate its loading contribution into Lake Erie.

SWAT Model Input Data

Non-Point Sources

The crops planted for a certain area (i.e., field, farm, or HRU) in a certain year (2014 to 2017) were taken from the USDA-NRCS CDL, which is the most readily available spatial data set. The crop rotation for an area was then estimated by overlaying the CDLs from these years. Tillage practices were identified using prevailing practice and published reports from the area (NRCS WLEB CEAP report). Example tillage practices in the area include: mainly no tillage on wheat and soybeans and approximately 80% conventional tillage (chisel plow) on corn. Fertilizer and manure rate applications were based on the Tri-State Fertility Guide developed by Michigan State University, The Ohio State University and Purdue University in 1995 and values from the Nutrient Use Geographic Information System (NUGIS) nutrient balance report (IPNI, 2014). Manure production and land applications in the St. Marys watershed are relatively higher than in other portions of the Western Lake Erie Basin (WLEB) (NUGIS, 2014).

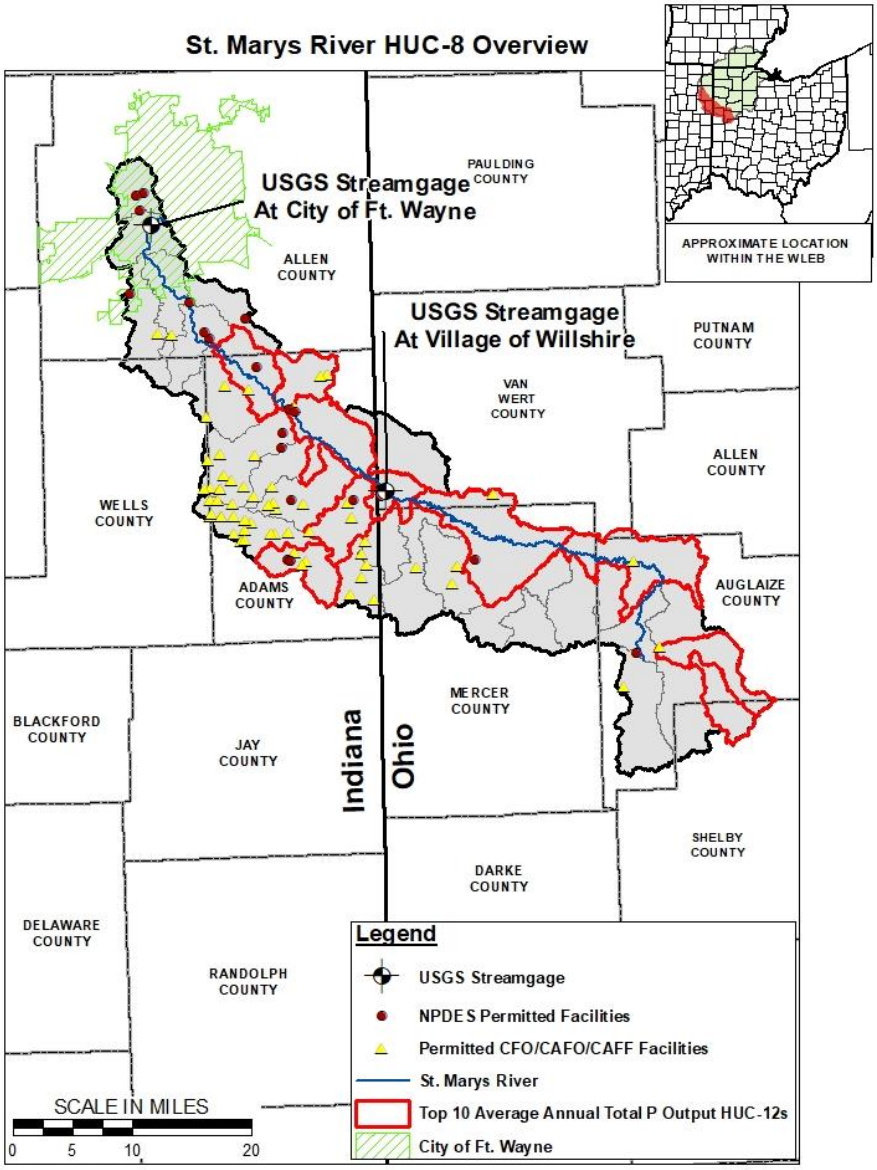

Figure 1: St. Marys River HUC-8 streamgages, point sources and priority HUC-12s.

Point Sources

The National Pollutant Discharge Elimination System (NPDES) permit locations represent point sources that discharge pollutants to waters of the United States. Created in 1972 by the Clean Water Act, the NPDES permit program is authorized to state governments by the US Environmental Protection Agency (EPA) to perform many permitting, administrative, and enforcement aspects of the program. Forty-two NPDES permits were located in the St. Marys River watershed, at the time this model was prepared (July, 2019). Nutrient loading data from each of the permitted locations are included in the SWAT model with data provided from the Ohio EPA Mass Balance Study and Discharge Monitoring Reports (DMRs) submitted to the US EPA's ECHO Database (Figure 1).

Some entities also have Municipal Separate Storm Sewer Systems (MS4) NPDES permits, regulating stormwater runoff using six minimum control measures expected to reduce discharge of pollutants to the receiving waterbody. Three MS4 communities exist within the St. Marys Watershed: Fort Wayne, Celina and Decatur.

Confined animal feeding operations (CAFOs) are considered point source pollutants due to their production of animal waste and are permitted at the federal level once they exceed specific thresholds of numbers of animals. Each state also maintains its own permitting process, threshold limits and naming system (Confined Animal Feeding Facility (CAFF) in Ohio and Confined Feeding Operation (CFO) in Indiana. Listings provided in 2016 from Indiana and 2019 from Ohio denote 62 permitted facilities in the St. Marys watershed.

Nutrients, Sediments, and Flow Observed Data

The SWAT model was calibrated for a three-year period (2014-2016) with the flow data, observed nutrients (phosphorus and nitrogen) and total suspended solids from USGS streamgages near Ft. Wayne, Indiana and Willshire, OH (Figure 1).

St. Marys River SWAT Model Findings

Table 1 lists the HUC-12 watersheds with the ten highest Total Phosphorus (Total P) and Dissolved Reactive Phosphorus (DRP) simulated yields from the St. Marys River SWAT model. These priority watershed locations are outlined in Figure 1.

Table 1: HUC-12 watersheds with highest simulated Total P and DRP yield

HUC-12 Number	HUC-12 Name	Area (acres)	Total P yield (lbs/acre)	DRP yield (lbs/acre)
4100004 05 04	Weber Ditch-St. Marys River**	11,436.12	3.28	0.32
4100004 06 02	Buhlman Ditch-St. Marys River**	15,116.65	3.27	0.26
4100004 05 02	City of Decatur-St. Marys River**	19,762.45	3.22	0.26
4100004 03 05	Yankee Run-St. Marys River*	38,081.37	2.49	0.26
4100004 04 08	Town of Willshire-St. Marys River*	8,585.04	2.48	0.20
4100004 04 08	Blue Creek**	13,517.93	2.28	0.27
4100004 01 03	Muddy Creek	10,542.29	2.17	0.26
4100004 04 05	Gales Ditch**	12,581.15	2.12	0.22
4100004 01 06	East Branch St. Marys River	13,616.44	2.12	0.22
4100004 03 03	Prairie Creek-St. Marys River	27,041.27	1.95	0.22

* Nonpoint Source Implementation Strategy under development

**included in a Watershed Management Plan

Recommendations

As outlined in the previous section, the St. Marys River SWAT Model shows the ten HUC-12 watersheds that have the highest potential to contribute the largest loading of Total P within the St. Marys watershed. ***In order to make progress towards the goal of a 40% reduction in nutrient loadings coming from the St. Marys River watershed, attention should be focused on prioritizing BMP implementation within these HUC-12 watersheds. A key "first step" to implementing BMPs is to identify and coordinate with stakeholders within these HUC-12 watersheds.*** A list of organizational stakeholders working in and around these prioritized HUC-12s in the St. Marys River watershed are listed in Table 2.

Table 2: Stakeholders Located or Working in the St. Marys HUC-8	
Organization Name	**Type of Organization**
Ohio Pheasants Forever	Non-governmental Organization
Black Swamp Conservancy	Non-governmental Organization
The Nature Conservancy	Non-governmental Organization
West Central Ohio Land Conservancy	Non-governmental Organization
Colleges and Universities (Wright State University – Lake Campus)	Higher Education Institution
Soil and Water Conservation Districts (Ohio: Auglaize, Mercer, Shelby and Van Wert; Indiana: Adams, Allen and Wells)	Government
Boards of County Commissioners (Ohio: Auglaize, Mercer, Shelby and Van Wert; Indiana: Adams, Allen and Wells)	Government
Cities, Towns and Villages (Berne, Celina, Decatur, Fort Wayne, Hoagland, Mendon, Monroe, New Bremen, Pleasant Mills, Rockford, St. Marys, Willshire and Yoder)	Government
Townships (Black Creek, Dublin, Hopewell, Jackson, Jefferson, Liberty, Noble, St. Marys, Union, Van Buren, Washington and Willshire)	Government

Implementation of BMPs within the prioritized HUC-12s can be facilitated through the development of Nine Element Plans, called Nonpoint Source-Implementation Strategies (NPS-IS) in Ohio and Watershed Management Plans (WMPs) in Indiana, which are watershed planning documents that include the nine key elements required by the US EPA for nonpoint source pollution projects. Nine Element Plans delineate critical areas in the watershed that affect water quality, outline goals and objectives to attain water quality standards and describe projects meant to reduce impairment from nonpoint source pollution, both within the streams of the HUC-12 (near-field) and Lake Erie (far-field). ***Of the 34 constituent HUC-12s in the St. Marys watershed, approximately half are included in the WMP drafted for the state of Indiana in 2009. Recent planning efforts in the Ohio portion of the watershed are underway, with six NPS-IS plans under development. The estimated Total P outputs are among some of the highest within the WLEB, underscoring the importance of plan updating where needed and new plan development across the watershed as a whole. Once the plans (or updates) are approved, the projects detailed within become eligible and prioritized for nonpoint source funding opportunities through government agencies and other funding sources, thus, reducing costs of implementation and expediting the implementation of projects.***

The St. Marys SWAT model also includes scenarios of agricultural BMPs that would reduce the loading of Total P coming from the St. Marys River watershed. The scenarios are: 1) subsurface application of fertilizer, 2) no-till practices, 3) P-fertilizer application at half the Baseline scenario rate, and 4) a combination of subsurface application of fertilizer, half P-rate application, no-till practices, and use of cover crops. Within the model, these scenarios were implemented to the top 50% of HRUs that have the highest Total P output across the entire HUC-8. This approach includes a realistic adoption rate, and focuses implementation efforts in the areas that could most benefit from those efforts for maximum Total P reduction. ***The selection and implementation of BMPs is a complex process, and no single BMP provides optimal nutrient reduction everywhere. Not every BMP is best-suited for an area, or as a stand-alone BMP, as evidenced by the increase in Total P loads in some HUC-12s with only no-till practices in place. Some BMPs help nutrient loads meet the 40% reduction goal in some HUC-12s, but a combination of BMPs provides greater nutrient reduction across the entire St. Marys watershed.***

For those areas where reduction goals are not met with one specific BMP, an adoption rate of greater than 50% or alternative BMPs may be needed.

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