

AUGLAIZE RIVER WATERSHED SUMMARY

The Auglaize River watershed is located in northwest Ohio in portions of Allen, Auglaize, Defiance, Hancock, Hardin, Henry, Mercer, Paulding, Putnam, Shelby and Van Wert counties, as well as small portions of Adams and Allen counties in Indiana. 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.



Model results estimated that ~15% of the Auglaize watershed contributes phosphorus outputs that range from 1.71 to 2.33 lbs/acre to the Auglaize River on an annual basis.

The Auglaize 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 some BMPs helps nutrient loads reach the Great Lakes Water Quality Agreement 40% reduction goal in some Hydrologic Unit Code (HUC)-12 subwatersheds. Combining the implementation of several BMPs in a HUC-12 provides greater nutrient reduction across the entire Auglaize watershed.***
- ***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 Auglaize watershed.

- ***Sixty-one HUC-12 subwatersheds are in the Auglaize watershed.***
- ***No approved NPS-IS plans exist in the Ohio portion of the Auglaize watershed (as of June 2019), though nineteen are in development. No WMPs exist in the Indiana portion of the Auglaize watershed, though one is slated for development in late 2019.***
- ***Of those plans in development, four are listed among the top ten highest contributing HUC-12s.***

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 Auglaize River watershed, as well as in Lake Erie.

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Auglaize River Watershed Background

The Auglaize Watershed (Hydrologic Unit Code 8 (HUC-8) = 04100007, area = 1,671 sq. mi (1,069,303 acre)) is located in northwest Ohio in portions of Allen, Auglaize, Defiance, Hancock, Hardin, Henry, Mercer, Paulding, Putnam, Shelby and Van Wert counties, as well as small portions of Adams and Allen counties in Indiana. The Auglaize River is the largest river in this watershed (113 miles), flowing northerly to meet the Maumee River at the city of Defiance. Major tributaries to the Auglaize include the Ottawa River, Jennings Creek, the Little Auglaize River, Prairie Creek, Flatrock Creek, Blue Creek and Powell Creek.

The watershed extends across two Major Land Resource Areas (defined by the Natural Resource Conservation Service (NRCS)), and is almost entirely flat-lying, with ~86% of the land having an average slope of 2% or less. Surficial deposits include till, glaciolacustrine sediments and outwash over shale, limestone and dolomite bedrock. Cities and villages within the Auglaize watershed include: Defiance, Cecil, Paulding, Continental, Oakwood, Melrose, Latty, Payne, Dupont, Cloverdale, Grover Hill, Haviland, Scott, Monroeville, Convoy, Ottoville, Kalida, Columbus Grove, Fort Jennings, Middle Point, Van Wert, Ohio City, Delphos, Cairo, Beaverdam, Adam, Lafayette, Lima, Harrod, Wapakoneta, Spencerville, Cridersville, Fort Shawnee, Buckland, Elgin and Elida. Historically, the watershed was densely wooded, and the northern portion was covered by a vast wetland system known as The Great Black Swamp.

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 5,000 HRUs throughout the Auglaize 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 Auglaize River and its tributaries are simulated by considering realistic physical processes.

Auglaize 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)

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and USGS National Hydrography Dataset (NHD). These data were used to delineate the Auglaize 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).

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. Ninety-three NPDES permits were located in the Auglaize River watershed, at the time this model was prepared (January, 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 US EPA 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. The Ohio EPA has grouped the MS4-permitted entities into two categories (Phase 1 or Phase 2) based upon population and amount of combined sewers within the community. Two Phase 2 MS4 communities exist within the Auglaize Watershed: Lima and Defiance.

Confined animal feeding operations (CAFOs) are considered point source pollutants due to their production of animal waste. Two CAFOs with NPDES permits are operating in the Auglaize River Watershed (Ohio EPA, 2019

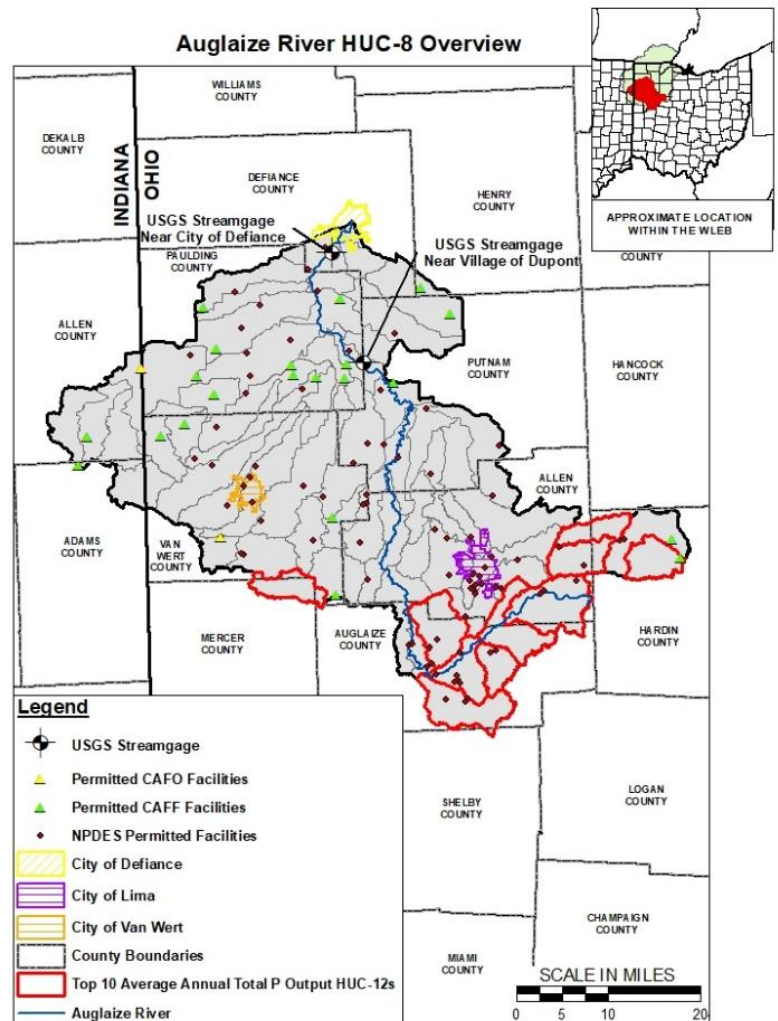


Figure 1: Auglaize River HUC-8 streamgages, point sources and priority HUC-12s.

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and IDEM, 2016). Listings provided by the Ohio Department of Agriculture and Indiana Department of Environmental Management denoted 20 Ohio-permitted and two Indiana-permitted facilities throughout the watershed (ODA, 2019 and IDEM, 2016). According to published estimates in 2009, 227 livestock operations of varying sizes were in the watershed, generating enough waste to supply 20 percent of the total phosphorus needed to fertilize crops in the watershed (NRCS, 2009). However, the watershed was large enough to receive this waste, if distributed properly.

Nutrients, Sediments, and Flow Observed Data

The SWAT model was calibrated for a three-year period (2014-2016) with the observed nutrients (phosphorus and nitrogen), total suspended solids and flow data from USGS monitoring station (Station No. 04191500) in the Auglaize River near Defiance (Figure 1).

Auglaize 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 Auglaize 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) |
| 4100007 01 02 | Blackhoof Creek | 10,438.82 | 2.33 | 0.14 |
| 4100007 01 05 | Dry Run-Auglaize River | 15,514.92 | 2.09 | 0.14 |
| 4100007 06 01 | Kyle Prairie Creek | 12,187.74 | 2.05 | 0.20 |
| 4100007 01 04 | Pusheta Creek | 22,187.16 | 1.95 | 0.14 |
| 4100007 02 01 | Two Mile Creek | 20,307.22 | 1.93 | 0.17 |
| 4100007 03 03 | Little Hog Creek* | 14,232.81 | 1.90 | 0.11 |
| 4100007 01 03 | Wrestle Creek-Auglaize River | 19,128.10 | 1.86 | 0.13 |
| 4100007 03 01 | Upper Hog Creek* | 13,881.50 | 1.78 | 0.21 |
| 4100007 01 01 | Headwaters Auglaize River | 27,148.47 | 1.72 | 0.14 |
| 4100007 03 04 | Lower Hog Creek* | 10,318.13 | 1.71 | 0.12 |

* Nonpoint Source Implementation Strategy under development

Recommendations

As outlined in the previous section, the Auglaize River SWAT Model shows the ten HUC-12 watersheds that have the highest potential to contribute the largest loading of Total P within the Auglaize watershed. ***In order to make progress towards the goal of a 40% reduction in nutrient loadings coming from the Auglaize 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 Auglaize River watershed are listed in Table 2.

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TABLE 2: Stakeholders Located or Working in the Auglaize HUC-8

| Organization Name | Type of Organization |
|--|-------------------------------|
| Ottawa River Coalition | Non-governmental 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 |
| Conservation Action Project | Non-governmental Organization |
| Colleges and Universities (National Center for Water Quality Research (NCWQR) at Heidelberg University, Ohio Northern University, The Ohio State University at Lima) | Higher Education Institution |
| Soil and Water Conservation Districts (Ohio: Allen, Auglaize, Defiance, Hancock, Hardin, Henry, Mercer, Paulding, Putnam, Shelby and Van Wert; Indiana: Allen and Adams) | Government |
| Boards of County Commissioners (Ohio: Allen, Auglaize, Defiance, Hancock, Hardin, Henry, Mercer, Paulding, Putnam, Shelby and Van Wert; Indiana: Allen and Adams) | Government |
| Cities and Towns (Defiance, Cecil, Paulding, Continental, Oakwood, Melrose, Latty, Payne, Dupont, Cloverdale, Grover Hill, Haviland, Scott, Monroeville, Convoy, Ottoville, Kalida, Columbus Grove, Fort Jennings, Middle Point, Van Wert, Ohio City, Delphos, Cairo, Beaverdam, Adam, Lafayette, Lima, Harrod, Wapakoneta, Spencerville, Cridersville, Fort Shawnee, Buckland, Elgin and Elida) | Government |
| Townships (Auglaize, Jackson, Shawnee, Perry, Duchoquet, American, Bath, Amanda, Spencer, Liberty, Marion, Ridge, York, Pleasant, Tully, Harrison, Hoaglin, Monterey, Latty, Blue Creek, Benton, Paulding, Washington, Brown and Crane) | 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). ***The need for the preparation of approved nine element plans in the Auglaize River watershed is evident in the fact that of its 61 constituent HUC-12s, none have approved plans in Ohio or Indiana. Nineteen NPS-IS plans are undergoing development in Ohio, as of June 2019, most of which are funded through planning grants. Of those under development, four are within the top ten nutrient contributing HUC-12s. Plan development for the Auglaize watershed in Indiana is slated for late 2019. Once the plans 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 Auglaize SWAT model also includes scenarios of agricultural BMPs that would reduce the loading of Total P coming from the Auglaize 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

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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 Auglaize 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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