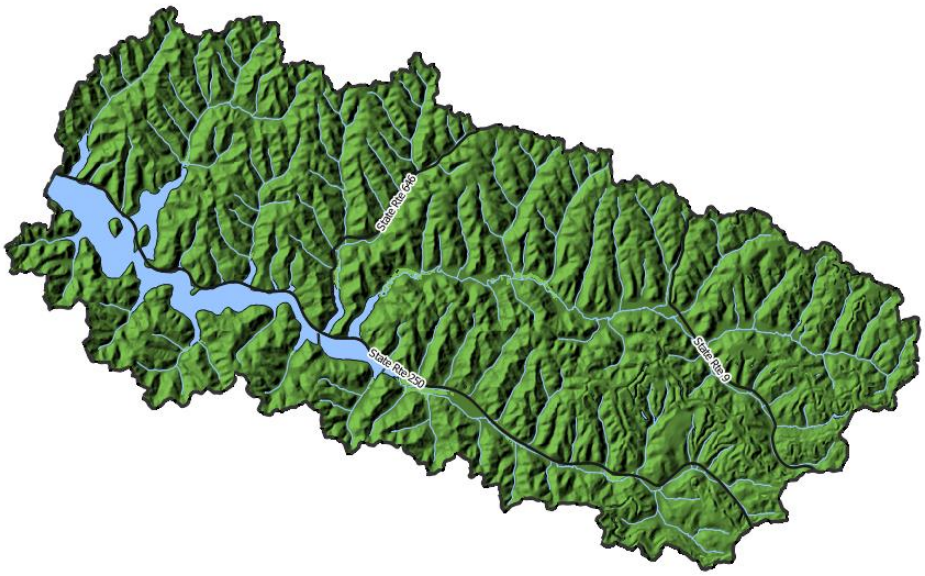
TAPPAN LAKE



9/30/2014

RAPID WATERSHED INVENTORY

Profile Contents

INTRODUCTION

Tappan Lake Watershed makes up 71 square miles in Harrison county, Ohio. The watershed is composed of three 12-digit hydrologic units, Upper Little Stillwater Creek (HUC 050400011503), Clear Fork (HUC 050400011501), and Standingstone Fork (HUC 050400011502). The watershed had a population of 2,216 people as of 2010. The watersheds land use is dominated by the 52 square miles of forest, has 11 square miles of agricultural land, and 4 square miles of urban areas.

Tappan Lake

RAPID WATERSHED INVENTORY

PHYSICAL DESCRIPTION

The area defined in this report as the Tappan Lake Watershed includes three 12-digit hydrologic units, Upper Little Stillwater Creek (HUC 050400011503), Clear Fork (HUC 050400011501), and Standingstone Fork (HUC 050400011502). The headwaters of the watershed are Standingstone Fork and Clear Fork, both of which have numerous unnamed tributaries and flow into the east end of Tappan Lake. In the Upper Little Stillwater Creek hydrologic unit several streams including Beaverdam Run, Eddington Run, Lower Beaverdam Run, Willis Run, and several unnamed streams drain into the lake. The west end of the watershed is located at the dam on Tappan Lake which is maintained by the United States Army Corp of Engineers (USACE).

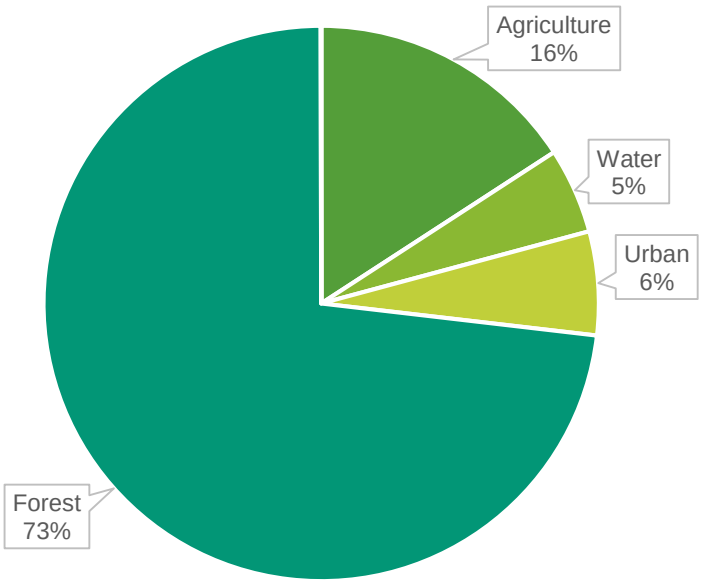


FIGURE 1: Breakdown of land use in Tappan Lake Watershed (ODNR, 2014).

Land use in the Tappan Lake Watershed is 73% forested land and 16% agricultural use (Figures 1 & 2). Minor land uses are urban (6%), water (5%), barren (<0.1%), and scrub/shrub (<0.1%) (ODNR, 2014). Within the agricultural use, 5,471 acres are in pasture or hay and 1,991 acres are in crop production (Fry, 2011). Only 34% percent of the land in the watershed is classified as prime farmland and 88% is classified as highly erodible land (ODNR, 2014). Within the watershed there are 7,260 acres of conservation and recreation lands. Ohio Department of Natural Resources' (ODNR) Harrison State Forest accounts for 1,185 acres of this land, while the rest, including Tappan Lake Park, is owned by Muskingum Watershed Conservancy District.

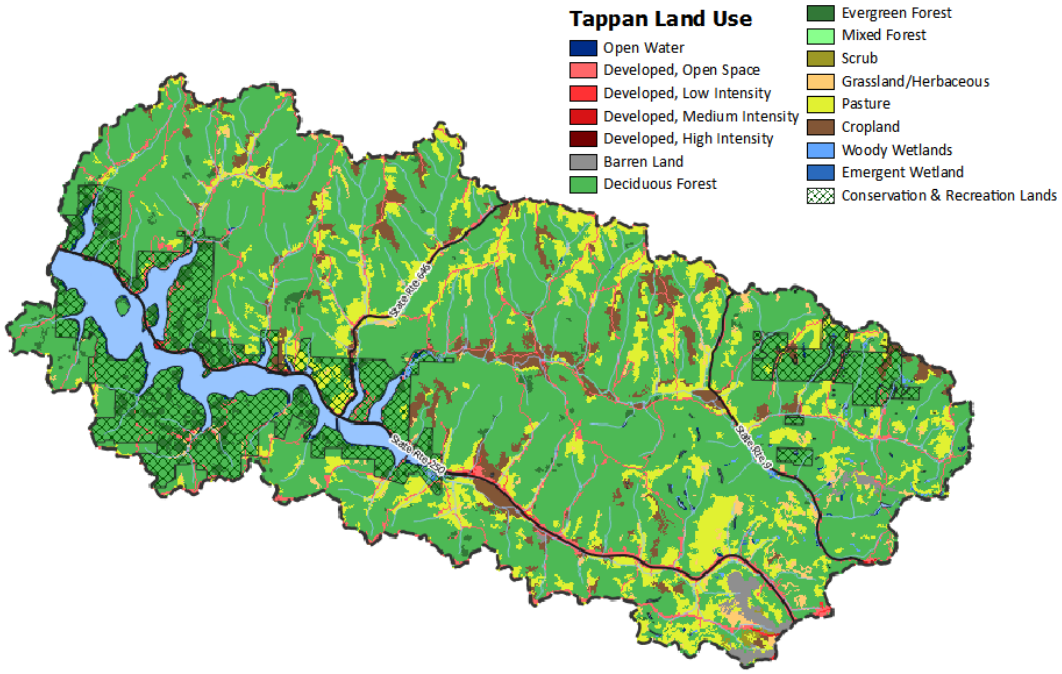


FIGURE 2: Map of land use within Tappan Lake Watershed (Fry, 2011).

Annual precipitation in the watershed is 41 inches, with May, June, and July being the wettest months, receiving 4.5 inches per month. Meanwhile, October, December, January, and February receive 2.5 inches per month (ODNR, 2014). The average annual maximum temperature is 84.5° F and the average annual low temperature is 19° F (ODNR, 2014).

Tappan Lake Watershed is part of the Western Allegany Plateau ecoregion. Most of the Tappan Lake Watershed is located in the Unglaciated Muskingum River Basin ecoregion of the Western Allegany Plateau. This region is defined by hilly terrain with

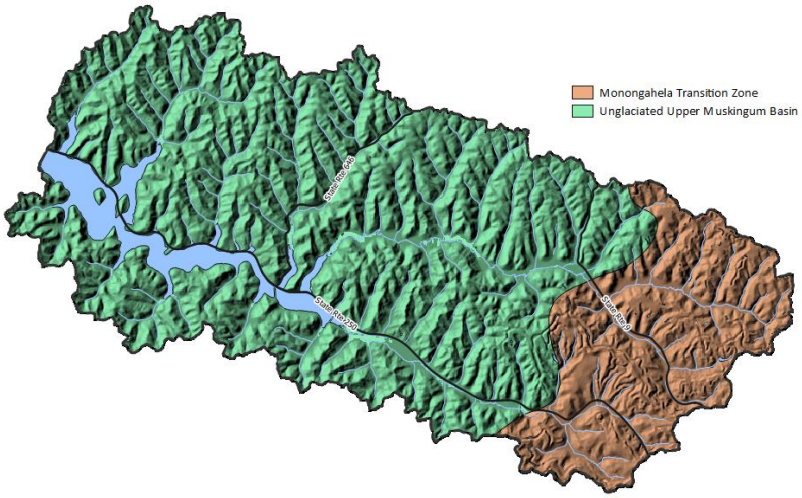


FIGURE 3: Map of ecoregions within Tappan Lake Watershed

extensive forested areas, historically mixed oak and mixed mesophytic forests. Broad, silt filled valleys hold low gradient streams and rivers which are small in comparison to the wide valleys. Agricultural use in the Western Allegany Plateau is focused in these valleys, with dairy, livestock, hay, and row crop operations occurring in the lowlands while the hillsides remain largely forested. The ecoregion has sedimentary bedrock layers and has been mined for coal (US EPA, 1998). The eastern end of the watershed is part of the Monongahela Transition Zone ecoregion of the Western Allegany Plateau. This zone is more degraded by coal mine effluent than the Unglaciated Upper Muskingum Basin. Gas wells, coal mining and reclaimed lands are common as is the associated stream degradation. Other land uses are similar between the two regions (US EPA, 1998).

RESOURCE CONCERNS

TABLE 1: Status of designated used by sub-watershed **(US EPA, 2014)**

	Upper Little Stillwater Creek	Clear Fork	Standingstone Fork
Aquatic Life Use	Impaired	Impaired	Impaired
Human Health Use	Good	Not Assessed	Not Assessed
Public Drinking Water Supply Use	Good	Not Assessed	Not Assessed
Recreational Use	Not Assessed	Not Assessed	Not Assessed

The most recent US Environmental Protection Agency (EPA) Water Quality Assessment Report for the three watersheds lists most uses as not assessed (Table 1). However, aquatic life use was found to be impaired in all three sub-watersheds while human health use (fish consumption) and public drinking water use received good ratings in the Upper Little Stillwater Creek sub-watershed. Ohio Environmental Protection Agency (OEPA) has also noted several watershed impairments in the Tappan Lake watershed (Table 2). Two sites within the Tappan Lake Watershed were assessed during the summer of 2012 and sedimentation/siltation and total dissolved solids were identified as stream impairments.

TABLE 2: Identified impairments and sources within the Tappan Lake Watershed **(OEPA, 2013)**.

STREAM LOCATION	IMPAIRMENT SOURCES	IMPAIRMENTS
Standingstone Fork at Mooreland Road	Coal Mining	Sedimentation/Siltation
	Channelization	Total Dissolved Solids
Clear Fork NW of Cadiz at Lower Clear Fork Road	Coal Mining	Sedimentation/Siltation
		Total Dissolved Solids

Nutrient Enrichment & Algal Blooms

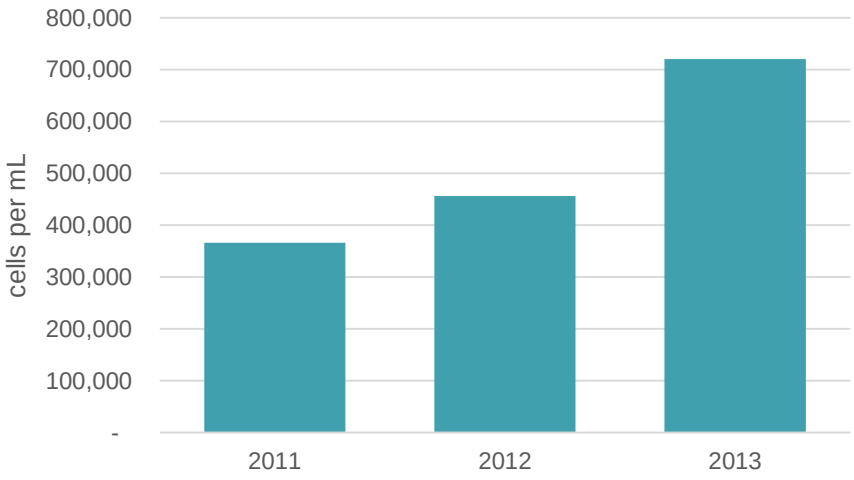


FIGURE 4: Populations of cyanobacteria in Tappan Lake (OLMS, 2013).

One of the primary concerns for the health of the watershed is eutrophication of the streams and Tappan Lake. The concerns have arisen from problems occurring at other locations around the state including Lake Erie and Grand Lake Saint Mary's. Sampling conducted by the Ohio Lake Management Society has found low levels of both microcystin and cylindrospermopsin, two of the major toxins associated with HABs, in Tappan Lake

during the summers of 2011-2013 (OLMS, 2013). The substantial populations of cyanobacteria that cause these blooms has been increasing over this time (Figure 4).

Numerous possible sources of nutrient pollution exist within the watershed. Human waste systems are one source and include poorly functioning or non-functioning septic systems. Additionally, improper storage of animal waste from livestock operations or unsuitable field applications of manure can result in heavy runoff of nutrients. Heavy use of fertilizers also contributes to nutrient pollution and may occur at homes, businesses, parks, and in agricultural field within the watershed.

Oil and Gas Industry

The oil and gas industry has recently grown rapidly in the region. Currently two practices are occurring across the watershed. The first is the drilling of horizontal wells and hydraulic fracturing. There are currently permits issued for 44 wells located at 12 different well pads within the Tappan Lake Watershed for Utica Shale wells. Fourteen wells are currently producing oil and/or gas, 5 others are drilled but not producing, 8 are in the drilling process, and 17 are permitted, but yet to be drilled (ODNR DMRM, 2014). Public concern for these wells include worries about contamination to groundwater supplies, excessive use of surface/groundwater resources for fracking operations, and runoff/erosion from pad sites, particularly during the construction process or an accidental spill. In addition to the new horizontal wells, many conventional oil wells also exist in the region.

The second practice is the construction of pipelines across the watershed and surrounding counties. Currently, the largest water quality concern with pipelines is the disturbance of soil during the construction process and the potential increase in runoff and sedimentation into streams and the lake. The second concern associated with the increasing miles of pipeline across the region is the possibility of future breaks or malfunction in the lines causing gas or oil to release into the air or water supply.

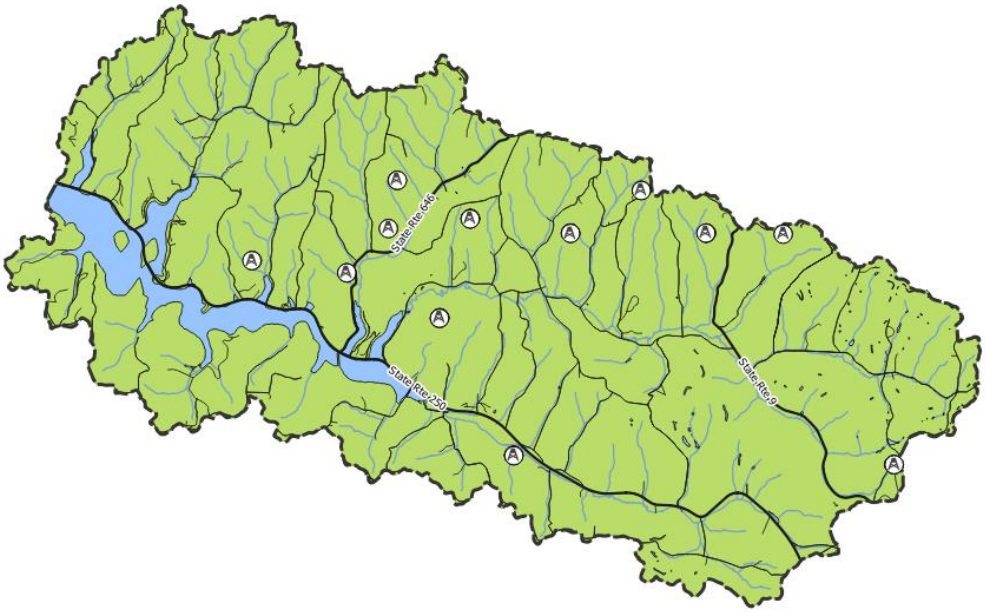


FIGURE 3: Locations of permitted Utica shale well pads in Tappan Lake Watershed (Note: each location has multiple wells at a single pad) (ODNR DMRM, 2014)

Sedimentation

While sedimentation is one portion of the concern surrounding the oil and gas activity in the watershed, it is also a concern for other land uses, primarily agriculture and construction sites. Historically, sedimentation from erosion from cropland, overgrazed pastures, and construction sites has been one of the largest issues within the region (Palone, 1992) and it remains a top priority. Data collected by Ohio Lake Management Society's (OLMS) Citizen Lake Awareness and Monitoring (CLAM) program for Tappan Lake is quite limited with regular monitoring only occurring in the last four years. While it is difficult to determine any major fluctuations due to the limited data, the general trend seems to be a decreasing Secchi depth, suggesting that the lake may be become more turbid over time (Figure 4).

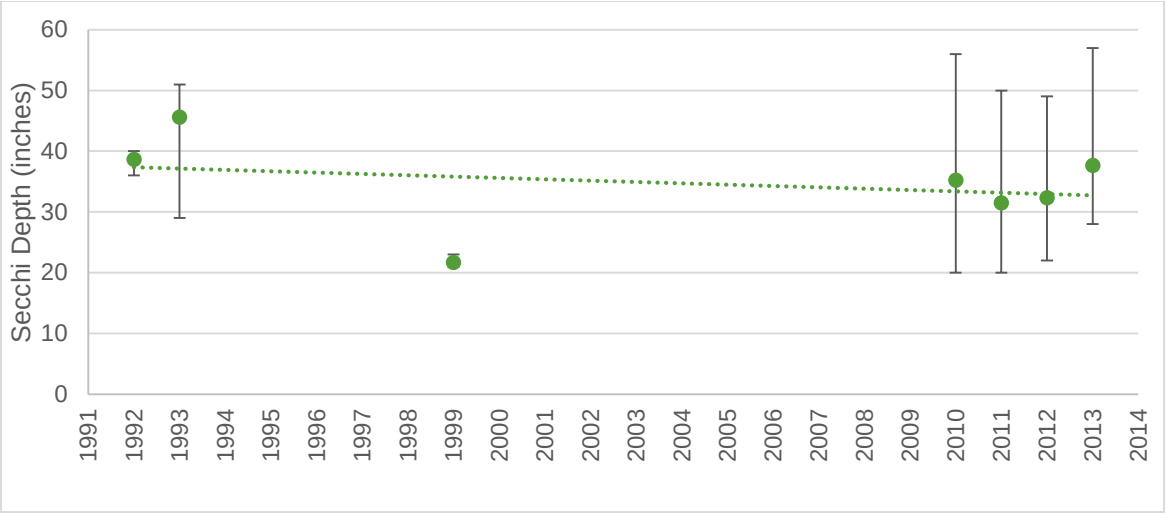


FIGURE 4: Secchi disk measurements from OLMS's CLAM data. Points show average Secchi depth for the year, while error bars represent the highest and lowest recorded Secchi depth that year (OLMS, 2013).

Acid Mine Drainage & Abandoned Mine Lands

Coal mining began in Harrison County in the late 1800's (HERITAGE/HISTORY) and the Tappan Lake Watershed has 95 documented coal permits issued and both surface and underground mining have occurred over a significant portion of the watershed. A documented 5,304 acres have been impacted by coal mining activity (ODNR DMRM, 2009-2012). There is one active coal mine located near the headwaters of Standingstone Fork. Seepage from these mines can increase the acidity of the streams and inputs heavy metals such as iron and aluminum into the water bodies. Conversely, AMD can result in an increased alkalinity when limestone and similar strata exist. Sulfates may also be leached from rock layers containing sulfide minerals (Calhoun, 2012). In 2013 the Ohio Department of Natural Resources (ODNR) Division of Mineral Resources Management (DMRM) conducted a primary assessment of Acid Mine Drainage (AMD) in the Standingstone Fork sub-watershed and did not find any signs of AMD. The two additional sub-watersheds have not been assessed, but many adjacent watersheds have sites impacted by AMD (DMRM).

CENSUS AND SOCIAL DATA

The Tappan Lake Watershed had an estimated total population of 2,216 as of 2010. The community was 99% rural according to 2000 census tract data. A total of 45% of the population was part of the labor force.

STATUS AND HISTORY OF MANAGEMENT EFFORTS

MWCD has several monitoring partnerships in place to gather data on the water quality in Tappan Lake. The MWCD works with the Water Management Section of the Huntington District of the USACE to sample the lake and its main incoming streams and discharge. Additionally, MWCD has worked with the United States Geological Survey to develop predictive models for a system to estimate bacteria levels and issue swim advisories at Tappan Lake beaches. Through 2014 the models will be tested to determine if the system is functional. MWCD also collaborates with OLMS to fund the CLAM volunteer monitoring program. Through the program turbidity, water temperature, and water color are documented. Recent expansion of the program has included sampling nutrients, total suspended solids, chlorophyll α, dissolved oxygen, and HAB.

In 2012 and 2013 OEPA has conducted a biological and water quality study in the Stillwater Creek Watershed, which includes Tappan Lake Watershed. Tappan Lake was sampled 10 times over the two year period. Chemical, fish, and macroinvertebrate sampling were carried out at three stream sites in the Tappan Lake Watershed and two of those sites also had bacteriological sampling conducted and an in-stream data recorder deployed. Fish tissue was sampled from the lake in 2012 and no specific consumption advisories were issued. The data collected from the 2013-2013 OEPA project will be incorporated into the Total Maximum Daily Load report which is scheduled for submission in 2015 (OEPA, 2014).

A 1973 assessment of eutrophic conditions of 20 Ohio lakes was conducted by the United States Environmental Protection Agency (EPA) and included Tappan Lake. Tappan Lake was found to rank sixth in trophic quality among the 20 sampled. The study found that 23% of the phosphorus load was coming from Clear Fork, 20% from Standingstone Fork, 5% from Beaverdam Run, and 44% from other smaller tributaries. An estimated 99% of phosphorus inputs originated from non-point sources (US EPA, 1975).

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