Great Lakes Mussel Watch Sites Land-use Characterization and Assessment

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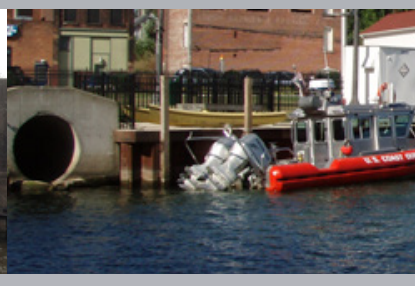

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Executive Summary

This report characterizes the land-use around the Mussel Watch Program (MWP) monitoring sites in the Great Lakes. Land-use is an important parameter in the assessment of the nearshore environment, as contaminant monitoring sites are influenced by point and non-point source pollution, which in turn is a factor of the land-use practices and human activities in the watershed.

Mussel Watch sites are categorized based on the most predominant land-use and classified as Agriculture, Undeveloped, Urban and Low-developed. Additional information on the land-use change from 1992-2006, the presence of major outfalls and the population trend since 1970 for each site is presented through reader friendly maps and graphics.

While this report was written to enhance Mussel Watch Program monitoring objectives in the Great Lakes, the information contained herein may be useful to a variety of sectors including government, academic and private for interpretation of environmental or socioeconomic information.

This report was prepared as a companion document to NOAA Tech Memo NOS NCCOS 180 “Mussel Watch Great Lakes Contaminant Monitoring and Assessment: Phase 1” and more information on Mussel Watch Program and its recent focus on Areas of Concern under the Great Lakes Restoration Initiative is available online and can be found at https://coastalscience.noaa.gov/projects/detail?key=179.

Thank you,

The Great Lakes Mussel Watch Team

1. Introduction

This report characterizes land-use practices and population at 54 water quality-monitoring sites in U.S. waters of the Laurentian Great Lakes. These sites were established by the National Oceanic and Atmospheric Administration (NOAA), Mussel Watch Program (MWP), administered by the National Centers for Coastal Ocean Science (NCCOS) and extend from Duluth, MN on Lake Superior to Massena, NY at the St. Lawrence River. The land-use characterization here is provided to enhance the interpretation of MWP water quality monitoring data and to help attain future monitoring goals and objectives. The MWP began using dreissenid mussels as contaminant indicators in the Great Lakes at seven established sites in 1992. Additional sites were added to the MWP during the 1990s as the invasion and subsequent proliferation of dreissenid species zebra (*Dreissena polymorpha*) and quagga (*Dreissena bugensis*) mussels became more established in the Great Lakes Basin (Lauenstein et al., 1997). With funding from the President's Great Lakes Restoration Initiative (GLRI), 25 new sites were established in U.S. Areas of Concern (AOCs) in 2010 and 2011. This report was prepared as a companion document to NOAA Tech Memo NOS NCCOS 180, "Mussel Watch Great Lakes Contaminant Monitoring and Assessment: Phase 1" (Kimbrough et al., 2014), which provides a basin-wide perspective on contaminant levels.

The influence of land-use practices and anthropogenic activities on coastal water quality is well-documented (Crosbie and Chow-Fraser, 1999; Trebitz et al., 2007; Cvetkovic and Chow-Fraser, 2011). Specifically, land-use change can have measureable impacts at watershed scales in the Great Lakes basin and a profound effect on coastal water quality, and ecosystem impairment (Wolter et al., 2006; Cvetkovic and Chow-Fraser, 2011). Land-use change analysis can be a reasonable predictor of nearshore areas at risk of ecosystem degradation (Depew et al., 2011). As a result, understanding the link between temporal and spatial distributions of contaminants and land-use is needed to effectively manage and mitigate adverse ecological impacts to these ecosystems.

Sites within the Great Lakes which were established and classified by the binational Water Quality Agreement 1987 between Canada and the U.S. as Areas of Concern (AOCs) (Gilbertson, 1999), were added to the MWP sampling schedule in 2009. With the inclusion of AOCs, the MWP overall portfolio of sites within the Great Lakes is more diverse, representing a variety of land uses (urban, agriculture, low-developed, and undeveloped). This is of interest in that these sites are subject to varied levels of land-use practices and human activities, which results in a large pool of sites for characterization and comparison. Though the land uses in Great Lakes watersheds have been extensively characterized, no prior attempt has been done by the MWP to report on the land use around Mussel Watch sites. Understanding land-use practices around Mussel Watch sites is much needed in interpreting contaminant monitoring data and in rendering Mussel Watch dataset more useful to managers and policymakers.

Available benchmarks for contaminant concentrations in dreissenid mussels are scarce, and contaminant measurements from AOCs are mostly interpreted by comparing to long-term MWP reference sites. In this context, characterization of Mussel Watch sites with respect to land-use, will allow to better leverage the existing long-term monitoring data from reference sites as well as to identify the appropriate reference site for a particular study area. Site characterization will also allow broad categorization of sites and help in finding contamination distribution patterns among these categories. This background information can then be utilized in designing future studies.

2. Project Overview

- This report analyzes land-use at 54 Mussel Watch sites across the Great Lakes.
- Emphasis was placed on comparing land-use patterns between 1992 and 2006.
- Boundary layers and overlays within a 10 km radius for each site were used to compare land-use categories.
- Land-use analysis provided an assessment of land-use categories (urban, agriculture, low-developed and undeveloped) within MWP AOC and long-term reference site.

2.1. Study Area Description

The Laurentian Great Lakes constitute the largest freshwater system in the world, with an estimated 21% of the Earth's surface freshwater (about 90% of United States freshwater), covers an area of over 94,250 square miles (Fields, 2005; Sponberg, 2009). It is home to over 35 million people, with nearly 25% of the United States (U.S.) and Canadian population residing within their respective watershed region (Danz et al., 2007; Robertson and Saad, 2011). The region supports numerous economic industries including, agriculture, commercial and sport fisheries (Orr, 1997).

Land-use and land cover within the Great Lakes differs between eco-regions and eco-provinces (Morrice et al., 2008). Land cover predominantly consists of forested areas in the northern and southeastern sections, while agricultural activities are more pronounced in the western and central sections of the basin. Agricultural activities represent 7% of U.S. and 25% of Canadian agricultural production in the Great Lakes (Danz et al., 2007; Shao et al., 2009).

Increased anthropogenic activities within the Great Lakes near-shore zone have led to environmental as well as ecological impairment (Kennish, 1994). Anthropogenic activities in the form of increased land uses and high concentration in new developments (urban and suburban sprawls) have impacted and degraded the near-shore zone and open lake areas of the Great Lakes (GLRI Action Plan, 2010; Neilson et al., 2003).

2.2. Site Description

A total 54 sites, including 34 AOCs and 20 long-term reference sites were characterized and assessed within this report (Table 1; Figure 1). These sites are found in watersheds that represent a variety of land uses. MWP sites are also located in shallow near-shore zones (< 20 feet), and range from approximately 5 to 100 km apart (Lauenstein and Cantillo, 1993; Lauenstein et al., 1997).

A majority of these sites were established away from known 'hotspots' (Lauenstein et al., 1997). Some of these "hotspots" include point source facilities like wastewater treatment facilities and publically owned treatment works (POTW) with known contamination potential. Long-term MWP sites are also located in AOCs as well as outside designated AOCs. Long-term sites located outside AOCs are used as reference sites and also a source for AOC sites comparison.

Table 1. List of MWP AOC and long-term reference sites (REF).

Site Code	Specific Location	Site Type	General Location	Lat	Long
LSLR	St. Louis River	AOC	Lake Superior	46.725670	-92.141000
LSMP	Minnesota Point	AOC	Lake Superior	46.710940	-92.022360
LSTL	Torch Lake	AOC	Lake Superior	47.149600	-88.411500
LSCR	Deer Lake - Carp River	AOC	Lake Superior	46.486050	-87.689300
LSSM	St. Marys River	AOC	Lake Superior	46.286500	-84.211330
LMMQ	Manistique River	AOC	Lake Michigan	45.945780	-86.249700
LMMM	Menominee River	AOC	Lake Michigan	45.096160	-87.591150
GBBS	Bayshore Park	REF	Lake Michigan	44.637000	-87.808167
LMGF	Green Bay-Fox River	AOC	Lake Michigan	44.544520	-88.001200
LMSR	Sheboygan River	AOC	Lake Michigan	43.751600	-87.697300
LMMB	Milwaukee Bay	AOC	Lake Michigan	43.032166	-87.895167
LMWH	Waukegan Harbor	AOC	Lake Michigan	42.362780	-87.811700
LMNC	North Chicago	REF	Lake Michigan	42.304666	-87.827333
LMCB	Calumet Breakwater	AOC	Lake Michigan	41.727166	-87.495000
LMHM	Hammond Marina	AOC	Lake Michigan	41.698650	-87.508250
LMIK	Kalamazoo River	AOC	Lake Michigan	42.654130	-86.206900
LMHB	Holland Breakwater	REF	Lake Michigan	42.773166	-86.215000
LMML	Muskegon Lake	AOC	Lake Michigan	43.218780	-86.305600
LMMU	Muskegon	REF	Lake Michigan	43.228241	-86.346884
LMWL	White Lake	AOC	Lake Michigan	43.375600	-86.426000
TBLL	Leelanau State Park	REF	Lake Michigan	45.205666	-85.536833
LHLB	Lincoln Bay	REF	Lake Huron	45.138310	-83.319700
LHTB	Thunder Bay	REF	Lake Huron	44.922166	-83.413500
TBBR	Black River	REF	Lake Huron	44.816120	-83.298450
LHSR	Saginaw River	AOC	Lake Huron	43.613690	-83.859400
LHEB	Eagle Bay	REF	Lake Huron	44.070580	-82.915800
LHBR	Black River Canal	REF	Lake Huron	43.044333	-82.438667
LCSC	St. Clair River	AOC	Lake Huron	42.880040	-82.469300
LSAB	Anchor Bay	AOC	Lake Huron	42.649166	-82.711000
LCCR	Clinton River	AOC	Lake Huron	42.595180	-82.775100
LMMR	Rouge River	AOC	Lake Erie	42.280180	-83.118300
DRSE	Detroit River	AOC	Lake Erie	42.106900	-83.135500
LESP	Stony Point	REF	Lake Erie	41.958667	-83.233000
LERR	River Raisin	AOC	Lake Erie	41.893283	-83.324800
LEMR	Maumee River	AOC	Lake Erie	41.701416	-83.458716
LERB	Reno Beach	REF	Lake Erie	41.674500	-83.226167
SBPP	Peach Orchard Pt.	REF	Lake Erie	41.659667	-82.825000
LEOW	Old Woman Creek	REF	Lake Erie	41.385000	-82.518667
LELR	Lorain	REF	Lake Erie	41.461167	-82.207000
LEBR	Black River	AOC	Lake Erie	41.474360	-82.181000
LECR	Cuyahoga River	AOC	Lake Erie	41.499410	-81.718780
LEAR	Ashtabula River	AOC	Lake Erie	41.911230	-80.787680
LEAB	Ashtabula	REF	Lake Erie	41.924667	-80.718333
LEPB	Preque Isle Bay	AOC	Lake Erie	42.137766	-80.095250
LEDK	Dunkirk	REF	Lake Erie	42.529167	-79.277667
LEBU	Buffalo River	AOC	Lake Erie	42.880030	-78.891570
NRNF	Niagara River	AOC	Lake Erie	43.046833	-78.892000
LOEC	Eighteenmile Creek	AOC	Lake Ontario	43.338700	-78.718783
LOOC	Olcott	REF	Lake Ontario	43.355333	-78.686667
LORC	Rochester	AOC	Lake Ontario	43.257833	-77.495333
LOOS	Oswego	REF	Lake Ontario	43.452833	-76.550833
LOOR	Oswego River	AOC	Lake Ontario	43.468333	-76.509730
LOCV	Cape Vincent	REF	Lake Ontario	44.144167	-76.324667
LOSL	St. Lawrence River	AOC	Lake Ontario	44.979866	-74.891616

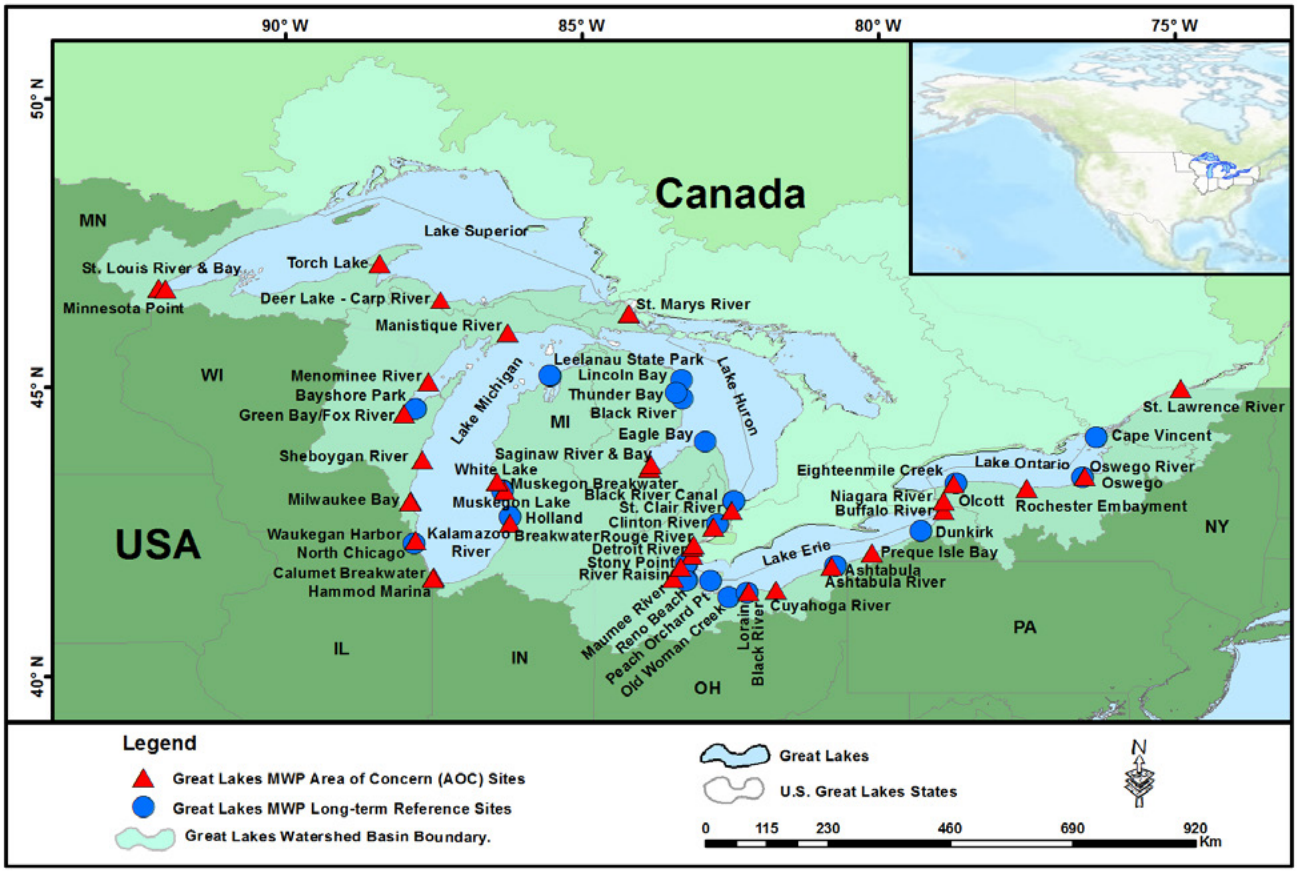


Figure 1. Map depicting Great Lakes MWP AOC and Long-term reference Mussel Watch Sites (inset map shows the Great Lakes basin and its location within the North American region).

Methods

3. Methods

3.1. Data Preparation /Site Assessment Techniques

Land-use data preparation and assessment approach used in this report are described in Edwards et al. (2014) and Maruya et al. (2014). A brief overview is provided here on the classification and assessment techniques used to develop land-use change layers, determine land-use estimates and land-use percentages for MWP sites.

Comparable National Land Cover Database (NLCD) raster layers and base maps (mapped at 30-m x 30-m pixel resolution) covering the entire U.S. portion of the Great Lakes Basin was used in the land-use characterization and assessment of MWP sites. Although other land-use and land cover datasets are available for portions of the Great Lakes region, most of these products are not consistent (e.g., different spatial resolution, temporal scales, extent and time period) across the entire region and also across MWP sites. As such, available NLCD raster layers that were spatially and thematically consistent across the entire Great Lakes Basin and covered three distinct periods (1992, 2001, and 2006) of land-use and land cover were generated from the USGS Multi-resolution Land Characteristics (MRLC) land cover collection (http://www.mrlc.gov/), for the conterminous United States. The NLCD raster layers and base maps were converted into shapefile format for easier geographic information system (GIS) analysis and assessment.

Additional GIS layers and base maps were developed from the U.S. Environmental Protection Agency (U.S.EPA) water quality indicators 303(d) Impaired Waters and 305(b) Assessed Waters, and 1970 – 2010 census block population counts data. Major and minor permitted facilities [Publicly and Non-publicly owned treatment works (POTWs and Non-POTW), wastewater facilities, discharge facilities, water dischargers, and combined sewer overflows (CSO's)] that discharge treated effluent were identified based on the U.S. EPA (Region 2, 3, and 5) National Pollution Discharge Elimination System (NPDES) outfall GIS layers for the Great Lakes region. The U.S.EPA water quality indicator and NPDES outfall GIS layers were used to identify impaired waters and known major and minor NPDES permitted facilities within MWP sites 10 km buffer and their associated watersheds.

For the purpose of this report, population estimates were developed only to address the population dynamics (e.g., population size) and history around MWP monitoring sites. Decennial census population and demographic datasets from 1970 to 2010 were used to generate population information for AOC and long-term reference site locations. Population estimates for MWP sites were generated by creating 10 km buffer polygons to clip and extract population data (e.g., total population counts) at the block-group level from the 1970 to 2010 U.S. Census Bureau (Census Summary File 1 (SF1) Data, Census Summary File 3 (SF3) Data (http://www.census.gov/geo/) and the NOAA Coastal Assessment Framework (CAF) watersheds (Estuarine Drainage Areas (EDAs) and Coastal Drainage Areas (CDAs)) demographic GIS layers and dataset (https://coast.noaa.gov/dataregistry/search/collection).

Digital maps and appropriate orthoimagery datasets [1:12,000-scale or greater from the National Agriculture Imagery Program (NAIP)] (https://gdg.sc.egov.usda.gov) covering the period 2006 to 2013 were used to identify U.S.EPA NPDES major and minor permitted facilities within each site 10 km buffer and watershed.

3.2. Land-use Reclassification

To characterize land uses and land-use change within MWP sites, 10 km buffer polygons were used to clip and extract the NLCD 1992, 2001 and 2006 land-use and land cover data for each site. The NLCD 2001 and 2006 land-use and land cover classification schemes were primarily developed by the MRLC to follow the 1992 NLCD classification scheme (Yang, 2008). However, due to variation in some NLCD land cover classes, slight modification is needed when the NLCD 1992 classification schemes (http://www.mrlc.gov/nlcd92_leg.php) are merged [e.g., low intensity residential (merged to low-developed), commercial/industrial/transportation (merged to low-developed), high intensity residential (merged to urban), small grains (merged to cultivated crops), fallow fields (merged to cultivated crops), recreational grass/park (merged into developed and open space), beach and quarry/strip mine classes (merged to barren land)] with the NLCD 2001 (http://www.mrlc.gov/nlcd01_leg.php) and NLCD 2006 (http://www.mrlc.gov/nlcd06_leg.php) land-use and land cover classification schemes.

With the 1992 NLCD forming the base classification data layer, the NLCD 1992, 2001 and 2006 land-use and land cover classes were remapped, reclassified and then aggregated into a distinct land-use and land cover classification scheme. The reclassification and aggregation resulted in the production of three separate maps, representing the land-use and land cover from 1992 to 2006. For simplification purposes, four generic land-use categories (Agriculture, Low-developed, Undeveloped and Urban) were created from the reclassified NLCD land-use classification schemes. Particular attention was placed on the assignment of land-use groups within the various generic land-use categories. Overall consistency was maintained in

remapping and reclassifying the NLCD 1992, 2001 and 2006 land-use and land cover classification schemes by checking and examining each classification scheme before they were finally aggregated and merged into an assigned land-use category.

The reclassified and aggregated NLCD land-use groups were merged into one of the four land-use categories:

1). Agriculture (Cultivated Crops and Hay/Pasture Agriculture).
2). Low-developed (Developed, Low Intensity, Developed and Open Space).
3). Undeveloped (Open water, Perennial Ice/ Snow, Barren Land, Deciduous Forest, Emergent, Herbaceuous Wetlands, Grassland/ Herbaceous, Evergreen Forest, Sedge/ Herbaceous, Lichens/ Moss, Mixed Forest, Dwarf Scrub, Shrub/Scrub, and Woody Wetlands).
4). Urban (Developed, High Intensity, Developed and Medium Intensity).

3.3. Land-use Estimation

Land-use estimates for individual MWP site were determined via GIS analysis. A series of buffer polygons with radii of 10 km were chosen to characterize and assess land-use and land cover around sites, given that MWP sites range from approximately 5 to 100 km apart and are established at river mouths, outer harbor areas and along shallow, nearshore zones (< 20 ft). As such, these 10 km buffer polygons were overlaid on the NLCD raster base maps to mask and extract land-use and land-use change data contained in each 10 km buffer polygon.

The percent land-use within each site buffer polygon were calculated for ten individual radii (1-10 km) of increasing distance from the 1992, 2001 and 2006 NLCD 10 km buffer land-use polygons. Land-use percentage calculated for the ten individual radii (1-10 km) were normalized to the land area found within the 10 km buffer polygons because most MWP sites either faced open water. As such, areas within the 10 km buffer polygons that were associated with open lake water and other permanent open water bodies (e.g., rivers, bays, estuaries) were excluded and not considered in the normalized land-use categories.

3.4. Statistical Analysis

Land-use percentages developed from the 1992, 2001 and 2006 NLCD 10 km land-use change layers were statistically analyzed to characterize overall land-use within MWP sites as urban, low-developed, agricultural, or undeveloped. A Principal Component Analysis (PCA) and subsequent bi-plots were used to visually identify and group MWP sites that were most similar in their land-use percentage composition. Based on the PCA, sites with similar land-use percentage composition were finally designated to a mutually exclusive land-use category. A discussion on site designation based on the PCA of land-use percentages can be found in Edwards et al. (2014) and Maruya et al. (2014).

To classify MWP sites population estimates, a cluster analysis was performed on the decennial 1970 to 2010 census population data, which were grouped into one of three categories (low, med, and high). Sites with population estimates that grouped below 96,000 people were categorized as low, while sites with population estimates that grouped above 280,000 people were classified as high. Hierarchical clustering was performed using Ward's technique. All statistical analyses were performed using JMP ® statistical software (SAS Institute Inc., Cary, N.C.).

Results

4. Results

In this section, land-use results, the PCA of land-use percentages and population estimates for sites are discussed as a group. The information for individual sites is presented in section 6.

4.1. Site Land-use Designation

The PCA of the land-use percentages found that 57 percent of the variation was explained by PCA1 and 34.5 percent of the variation was explained by PCA 2. PCA bi-plots showed that the sites clustering is oriented around three primary vector directions based on land-use with minute separations of vectors of similar land-use among years (Figure 2).

Although the vectors for urban and low-developed percentages among years had similar orientation and direction with each other, two distinct clusters of sites are identifiable along the first component. Urban sites cluster at the far right, while low-developed sites are clustered to the left of the cluster of urban sites.

For two sites, LEMR – Maumee River and LMGF – Green Bay – Fox River, the PCA bi-plot show these sites clustered among the low-developed sites. However, an evaluation of the land-use percentages depicted that the most predominant land-use category within these sites are agriculture land uses (38% and 36.2%, respectively). Based on the land-use percentages and the fact that these sites had predominant urban and low-developed land-use categories between 2001 and 2006, these sites were designated as low-developed sites. The PCA of the land-use percentages also show that two sites, Holland Breakwater (LMHB) and Peach Orchard Pt. (SBPP) which were predominantly undeveloped and agricultural sites in 1992, were converted to low-developed sites between 1992 and 2006.

Each MWP site was grouped and assigned to one of the four mutually exclusive land-use categories (agriculture, low-developed, undeveloped and urban), based on the distinct land-use clusters that resulted from the PCA of the land-use percentages. See Table 2 for MWP sites land-use categories and corresponding

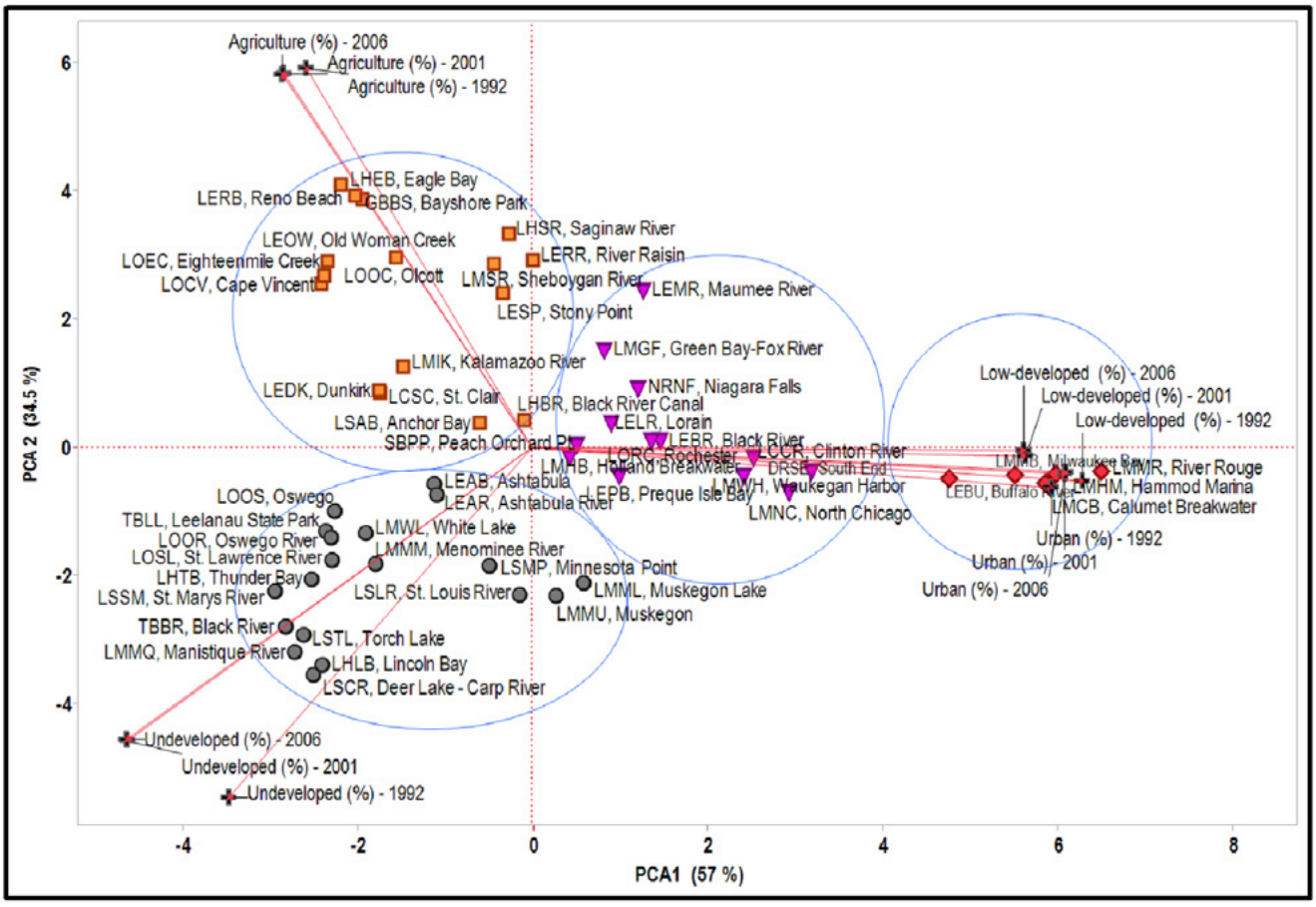


Figure 2. Principal component analysis (PCA) depicting the designation for Agricultural MWP sites (orange closed squares - ■), Low-developed MWP sites (purple closed triangles - ▼), Undeveloped MWP sites (grey closed circles - ●) and Urban MWP sites (red closed diamonds - ♦).

Table 2. List of MWP sites land-use percentages and designation for four mutually exclusive land-use categories (agriculture, low-developed, undeveloped and urban) between 1992 and 2006. PCA was conducted on land-use percentages to obtain appropriate land-use designation for each MWP site.

Specific Location	Land-use Designation	Agriculture			Low-developed			Undeveloped			Urban		
		1992	2001	2006	1992	2001	2006	1992	2001	2006	1992	2001	2006
St. Louis River	Undeveloped	8.2	2.4	2.3	12.6	27.9	28.4	70.3	63.6	62.7	8.9	6.2	6.5
Minnesota Point	Undeveloped	17.5	6.4	6.8	11.8	25.4	23.2	63.0	62.5	64.8	7.8	5.8	5.2
Torch Lake	Undeveloped	11.8	4.9	5.0	1.5	6.1	6.1	85.3	87.6	87.4	1.4	1.4	1.4
Deer Lake - Carp River	Undeveloped	1.3	0.2	0.1	2.1	6.7	7.3	94.8	90.9	90.2	1.8	2.3	2.4
St. Marys River	Undeveloped	19.2	13.5	13.4	0.0	3.3	3.3	80.7	83.2	83.3	0.1	0.0	0.0
Manistique River	Undeveloped	6.8	4.2	3.4	0.9	6.3	5.5	91.5	88.3	90.2	0.9	1.2	0.9
Menominee River	Undeveloped	23.6	11.7	10.7	4.4	13.5	12.1	69.1	70.8	73.6	2.9	4.0	3.5
Bayshore Park	Agriculture	79.5	72.6	68.2	0.7	7.7	10.8	18.7	19.1	19.1	1.0	0.6	2.0
Green Bay-Fox River	Low-developed	48.3	33.1	36.2	18.0	30.5	28.1	24.7	22.5	23.6	9.0	14.0	12.0
Sheboygan River	Agriculture	67.6	53.1	51.3	10.8	18.8	20.3	19.3	18.2	18.1	2.3	9.8	10.3
Milwaukee Bay	Urban	3.2	1.0	1.0	62.2	46.7	48.6	16.8	7.9	8.9	17.7	44.3	41.4
North Chicago	Low-developed	17.5	3.6	3.2	31.3	52.3	53.9	42.6	25.0	23.3	8.5	19.0	19.7
Waukegan Harbor	Low-developed	23.4	8.1	7.0	27.2	46.1	48.2	41.5	27.0	25.1	7.9	18.8	19.7
Calumet Breakwater	Urban	2.1	0.6	0.5	41.2	36.2	36.4	22.4	6.4	6.2	34.3	56.8	56.9
Hammond Marina	Urban	2.0	0.6	0.5	45.0	42.1	42.4	22.5	5.9	5.6	30.5	51.4	51.5
Kalamazoo River	Agriculture	50.5	42.9	42.1	4.2	16.3	16.8	43.1	39.0	39.2	2.2	1.8	1.9
Holland Breakwater	Low-developed	31.5	20.0	19.6	11.7	33.2	33.5	49.6	37.6	37.6	7.2	9.1	9.3
Muskegon Lake	Undeveloped	6.9	0.8	0.8	21.5	34.4	34.5	67.3	54.2	54.0	4.3	10.7	10.8
Muskegon	Undeveloped	5.1	0.7	0.7	21.2	29.7	29.7	69.2	59.0	58.9	4.6	10.5	10.6
White Lake	Undeveloped	22.6	19.2	19.4	5.4	14.5	14.6	71.4	65.3	65.0	0.6	1.0	1.0
Leelanau State Park	Undeveloped	26.1	20.8	20.7	0.4	10.5	10.5	73.2	68.4	68.4	0.4	0.4	0.4
Lincoln Bay	Undeveloped	2.5	1.4	1.4	1.4	7.0	7.1	94.2	87.8	87.6	2.0	3.8	3.8
Thunder Bay	Undeveloped	18.5	14.2	14.1	1.1	7.2	7.2	79.5	77.3	77.3	0.9	1.3	1.3
Black River	Undeveloped	11.7	7.9	7.9	0.0	5.8	5.8	88.3	86.2	86.2	0.0	0.1	0.1
Saginaw River	Agriculture	71.2	57.2	56.6	10.9	21.2	21.8	13.4	13.3	13.0	4.5	8.3	8.6
Eagle Bay	Agriculture	82.6	73.4	73.4	0.5	7.2	7.2	16.8	19.2	19.2	0.1	0.2	0.2
Black River Canal	Agriculture	39.9	27.3	27.2	13.7	24.8	25.1	41.8	38.1	37.7	4.6	9.8	10.0
St Clair River	Agriculture	50.0	38.1	38.0	4.0	12.6	12.9	44.9	46.4	46.1	1.1	2.9	3.1
Clinton River	Agriculture	26.6	10.6	9.8	27.0	39.4	40.3	36.1	24.6	23.4	10.3	25.5	26.5
Anchor Bay	Low-developed	43.5	28.1	27.6	8.7	19.9	20.5	43.9	42.6	42.1	4.0	9.4	9.8
River Rouge	Urban	1.3	0.2	0.2	57.7	25.6	25.5	10.4	2.4	2.4	30.6	71.7	71.9
Detroit River	Low-developed	20.0	7.5	7.2	29.4	35.6	36.0	37.0	20.5	19.8	13.7	36.4	36.9
Stony Point	Agriculture	67.0	45.3	44.8	7.3	25.0	25.2	22.5	22.2	22.1	3.2	7.6	7.9
Raisin River	Agriculture	71.1	49.1	48.6	10.5	27.6	27.9	14.7	15.6	15.5	3.7	7.8	8.1
Maumee River	Low-developed	59.9	40.8	39.7	19.0	31.1	31.8	12.7	11.5	11.3	8.4	16.7	17.2
Reno Beach	Agriculture	83.8	69.4	69.4	0.9	8.7	8.7	14.5	21.3	21.2	0.8	0.6	0.6
Peach Orchard Pt.	Low-developed	46.2	14.1	13.9	8.0	41.9	41.8	42.9	37.0	37.1	2.9	6.9	7.2
Old Woman Creek	Agriculture	69.4	59.4	59.1	2.2	14.8	15.0	27.1	23.9	23.9	1.3	1.9	2.0
Lorain	Low-developed	37.0	22.5	21.7	17.3	37.0	38.3	37.5	32.3	31.4	8.3	8.2	8.6
Black River	Low-developed	33.7	17.1	15.7	19.9	41.8	44.1	36.9	31.4	29.9	9.6	9.6	10.3
Cuyahoga River	Urban	2.7	0.0	0.0	56.2	55.8	56.0	14.0	7.0	6.6	27.1	37.2	37.4
Ashtabula River	Undeveloped	28.1	21.1	21.1	7.2	20.7	21.0	60.7	55.1	54.5	4.1	3.2	3.4
Ashtabula	Undeveloped	29.4	23.2	23.2	7.3	20.2	20.4	59.3	53.5	53.1	3.9	3.1	3.2
Preque Isle Bay	Low-developed	21.5	17.4	16.5	21.8	31.5	33.5	48.1	38.0	36.3	8.7	13.2	13.7
Dunkirk	Agriculture	50.8	38.3	38.4	5.5	12.4	12.6	42.0	47.4	47.0	1.7	2.0	2.0
Buffalo River	Urban	8.1	1.6	1.6	52.1	49.2	49.7	26.4	11.7	11.1	13.4	37.4	37.7
Niagara River	Low-developed	41.0	26.3	25.7	25.7	33.3	34.0	28.1	25.6	25.1	5.2	14.8	15.2
Eighteenmile Creek	Agriculture	76.8	59.3	59.3	1.1	5.6	5.6	21.9	34.8	34.7	0.2	0.4	0.4
Olcott	Agriculture	74.9	56.9	56.9	1.1	5.3	5.3	23.8	37.5	37.4	0.2	0.4	0.4
Rochester	Low-developed	27.3	19.1	18.8	34.4	39.5	40.3	35.4	31.7	30.8	2.9	9.8	10.1
Oswego	Undeveloped	28.7	23.7	23.7	3.5	8.0	8.0	66.7	66.3	66.2	1.0	2.0	2.0
Oswego River	Undeveloped	24.5	19.7	19.7	3.3	7.7	7.7	70.9	70.5	70.4	1.3	2.2	2.2
Cape Vincent	Agriculture	73.1	56.2	56.3	0.8	4.9	4.9	25.7	38.6	38.5	0.5	0.3	0.3
St. Lawrence River	Undeveloped	26.0	13.6	13.5	2.6	8.9	9.0	69.7	76.0	76.0	1.8	1.5	1.5

land-use percentages between 1992 and 2006. Site assignment and designation from the PCA is as follows;
1. Agricultural sites – 16
2. Undeveloped sites – 19
3. Low-developed sites – 13
4. Urban sites – 6 (Figure 3).

4.2. Site Population

Between 1970 and 2010, most of the MWP sites within the Great Lakes experienced a decline in population. In 1970, approximately 9.61 million people resided around MWP monitoring sites, of which 88.1 percent resided around sites that are now considered AOCs and 11.9 percent resided around areas that are now referred to as reference sites. By 2010, the population around MWP sites as a whole, declined from 9.61 million to 7.82 million people, a decrease of -18.6 percent.

From 1970 to 2010, the overall population levels around the eastern Great Lakes monitoring sites (located downstream of Detroit) decreased from 5.28 million to 3.85 million people (-27.2%), whereas the population levels around the western Great Lakes sites (located upstream and west of Detroit) decreased from 4.32 million to 3.97 million people (-8.19%) between the same periods.

The population around all MWP urban monitoring sites (e.g., Buffalo River- LEBU, Milwaukee Bay – LMMB, Calumet Breakwater – LMCB, Hammond Marina – LMHM and Rouge River – LMMR) decreased between 1970 and 2010. The population around urban sites decreased from 5.72 million to 3.78 million people, a decrease of approximately -34.0 percent. Between1970 and 2010, the population levels around AOC sites as a whole, decreased from 8.46 million to 6.59 million people (-22.1%). In contrast, from 1970 and 2010, the population levels around reference sites increased from 1.15 million to 1. 23 million people, an increase of 7.28 percent.

4.3. Outfall Description

Although information on NPDES point source facilities and outfall types are included in this report, they were not compared to either land-use or population information. This information is summarily added to

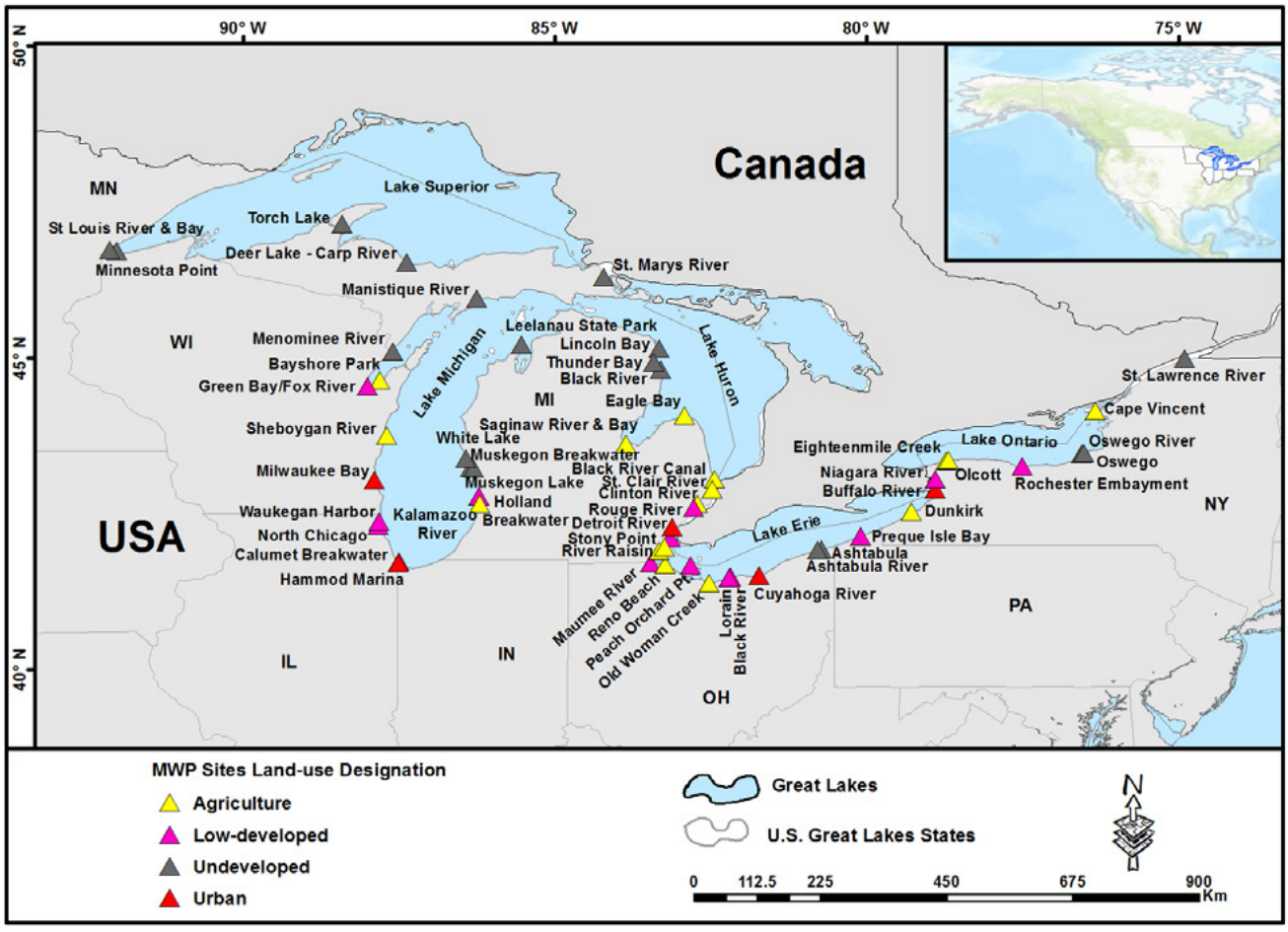


Figure 3. Designated Great Lakes MWP Agricultural, Low-developed, Undeveloped and Urban land-use sites.

identify and illustrate the various locations of permitted point source facilities and outfall types present within the watersheds and 10 km buffer of current MWP sites. Likewise, assessed water quality indicators 303(d) and 305(b) impaired water sources within MWP sites 10 km buffer and associated watersheds are represented to identify those impaired water resources that are closes to AOCs and reference sites.

5. Conclusions and Summary

The information presented within this report provides some understanding of the land cover and land-use change, population dynamics and point source facilities and outfall types within MWP sites and associated watersheds. Although this report contains existing information, the land-use data and maps that were developed from the 1992 to 2006 NLCD raster layers and base maps, orthoimagery datasets, decennial 1970 to 2010 census population data and the U.S. EPA NPDES major and minor permitted facilities, provided a format for characterizing and assessing MWP sites.

Site land-use characterization and assessment findings presented here can be used to address the following:

- Provide a format for broader categorization of sites which helps in the identification of pollution gradients and contaminant patterns among different land-use categories.
- Estimate land-use and land cover fragmentation at different spatial scales (1 - 10 km) within MWP long-term reference and AOC sites in which appropriate datasets can be developed for site land-use change detection and designation.
- A GIS-based approach that can be used to assess and identify land-use tipping points associated with water quality impairment within MWP sites.
- An approach that can be used to summarize and compare land-use information at both site and watershed level.
- Enhance the interpretation of MWP water quality monitoring data within sites that are subject to excessive pollutant loading and changing land uses that may occur as the result of increased anthropogenic activities.

The reclassification and aggregation of the NLCD classification schemes provided a summary of land use and land-use change within MWP sites between 1992 and 2006. The PCA of agricultural, low-developed, undeveloped and urban land-use percentages provided insight on the distinct clustering of land-use groups and the subsequent designation of sites to one of the mutually exclusive land-use categories. The land-use characterization of sites also provided a new insight into the types of land uses and changes that are occurring across MWP sites and the Great Lakes basin.

Decennial census population data between 1970 and 2010 also provided invaluable information on MWP sites demographic characteristic (population size). Population estimates provided insights on the population growth in reference sites, as well as population decline in AOC sites between the same periods.

Pollutant loadings from point and non-point sources (e.g., wastewater treatment and industrial effluent, land fragmentation, urban sprawl, impervious surfaces and stormwater runoff) continue to impair the Great Lakes ecosystems. The U.S.EPA water quality indicator and NPDES outfall GIS layers provides a context in which impaired waters and known major and minor NPDES permitted facilities information can be used to identify possible areas and sources of localized pollutant loading issues within MWP sites.

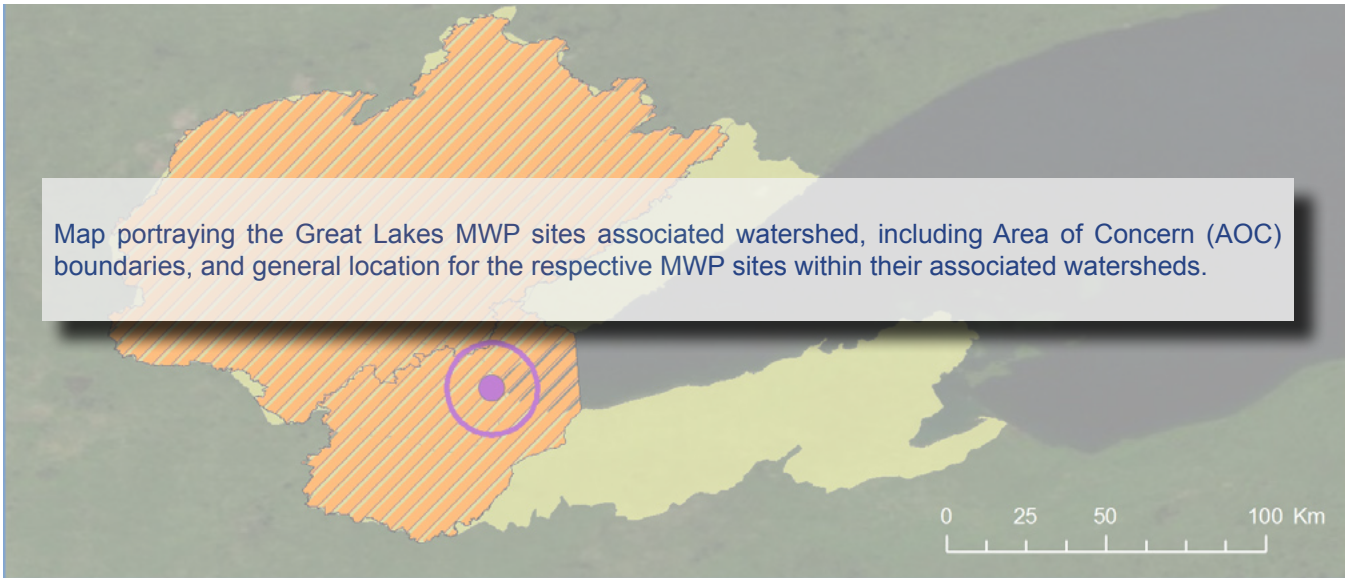
In summary, the information provided in this report can serve as a resource for local as well as regional assessment of land-use within MWP sites. More important, the information provided can also be useful to stakeholders and resource managers in making informed decision in protecting the Great Lakes nearshore resources.

6. Site Characterization

Example:

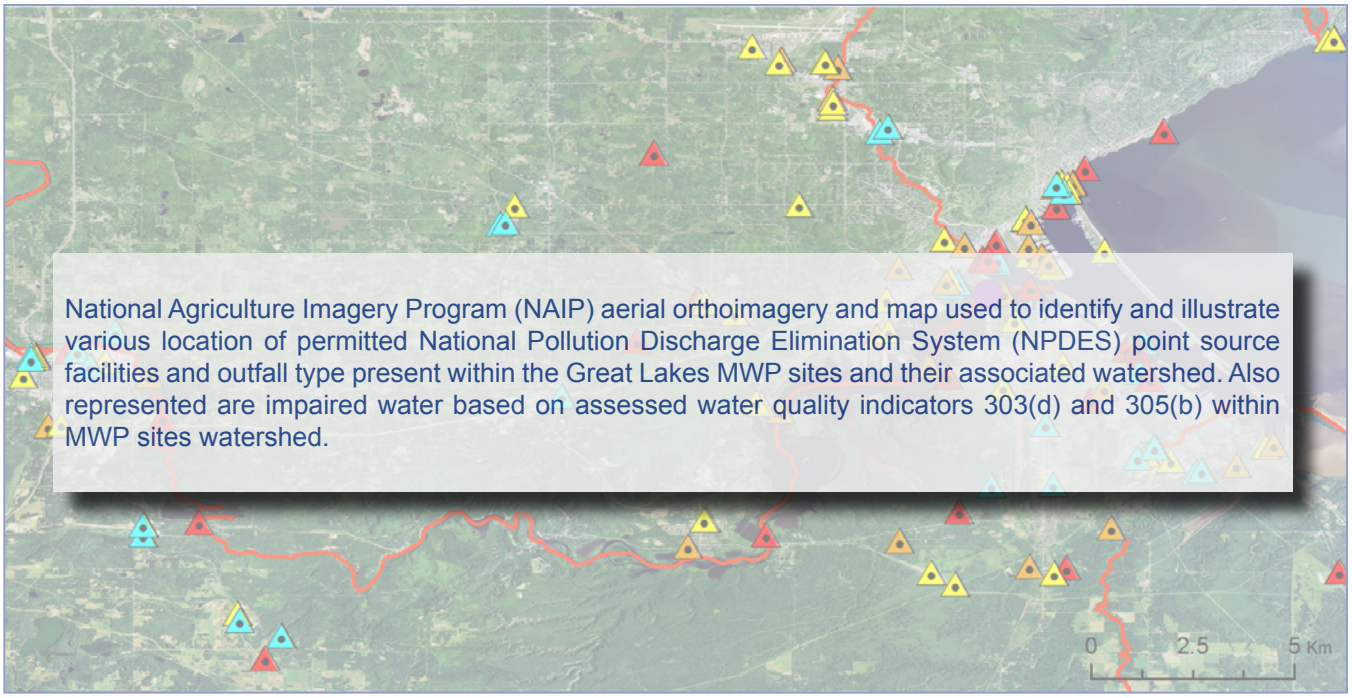
Map depicting the Great Lakes Mussel Watch Program (MWP) site locations. AOCs and reference sites are presented in sequential order by lake region from west to east. Current map is also used to highlight site based on basin wide perspective.

Table providing information on site acronym, site location (latitude and longitude), land-use designation (Urban, low-developed, undeveloped, agriculture), site category (AOC or long-term reference site) and latest 2010 census population count for each Great Lakes MWP site.



Map portraying the Great Lakes MWP sites associated watershed, including Area of Concern (AOC) boundaries, and general location for the respective MWP sites within their associated watersheds.

Spatial delineation: MWP site (●), associated watershed (▭), and AOC boundary (▨) where applicable.



National Agriculture Imagery Program (NAIP) aerial orthoimagery and map used to identify and illustrate various location of permitted National Pollution Discharge Elimination System (NPDES) point source facilities and outfall type present within the Great Lakes MWP sites and their associated watershed. Also represented are impaired water based on assessed water quality indicators 303(d) and 305(b) within MWP sites watershed.

Outfalls: Aerial orthoimagery and map depicting MWP site (●), Impaired and Assessed Waters (▭), and U.S.EPA NPDES major and minor permitted facilities outfall types: POTW (▲), Non-POTW (▲), Wastewater Facilities (▲), Discharge Facilities (▲), Water Dischargers (▲), Combined Sewer Overflows (CSO's) (▲).

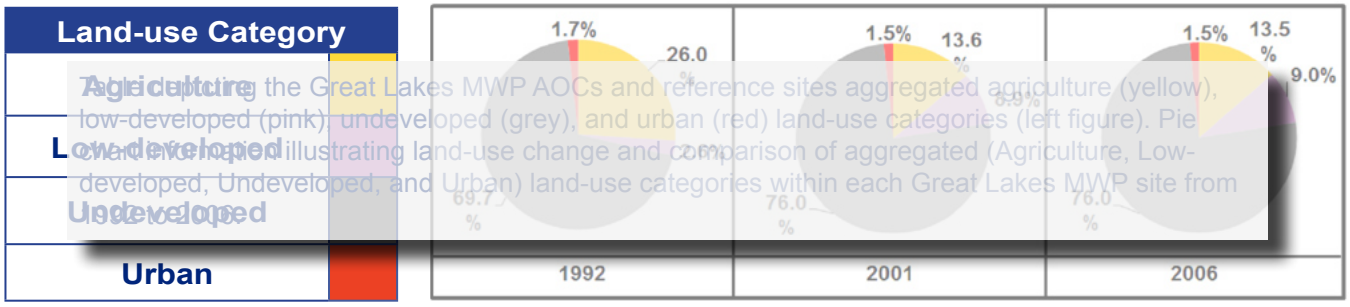
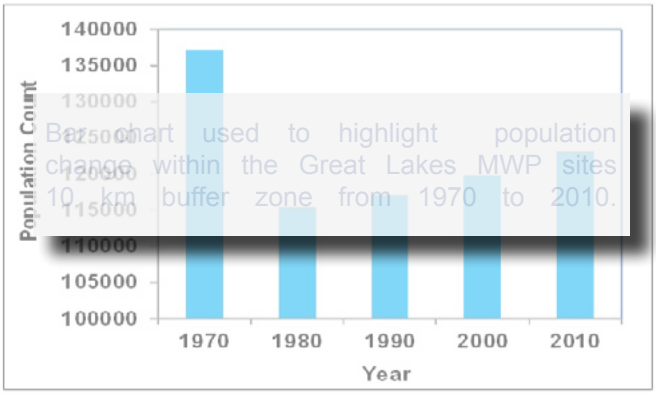


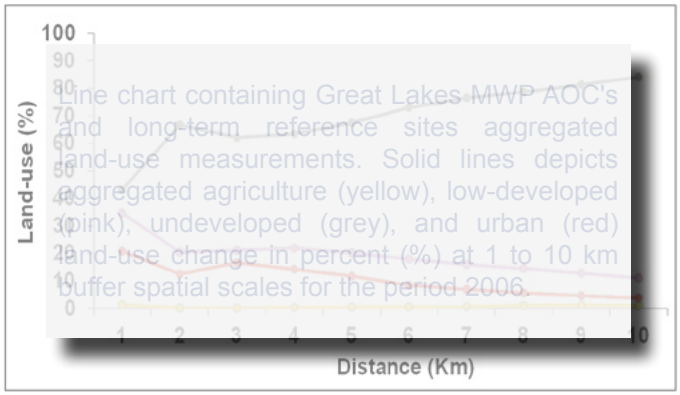
Figure depicting the Great Lakes MWP AOCs and reference sites aggregated agriculture (yellow), low-developed (pink), undeveloped (grey), and urban (red) land-use categories (left figure). Pie chart/s depicting illustrating land-use change and comparison of aggregated (Agriculture, Low-developed, Undeveloped, and Urban) land-use categories within each Great Lakes MWP site from 1992 to 2006.

Legend: 1992 - 2006 National Land Cover Data (NLCD) aggregated hierarchal land-use categories, agriculture, low-developed, undeveloped and urban for Great Lakes Mussel Watch Program (MWP) sites.



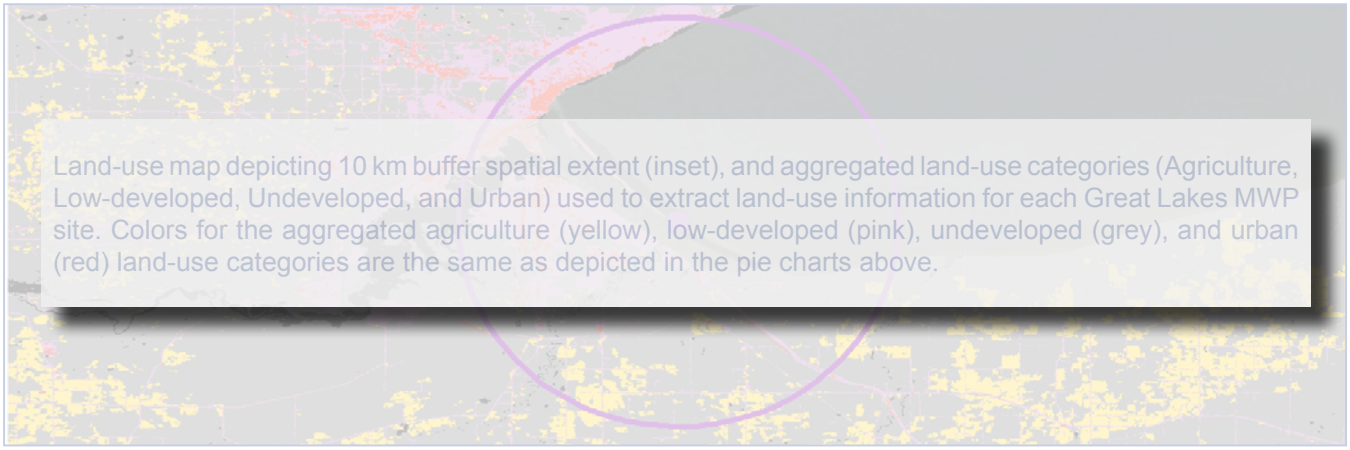
Bar chart used to highlight population change within the Great Lakes MWP sites 10 km buffer zone from 1970 to 2010.

Population barchart: Bar chart depicting population trend within 10 km buffer of MWP site (1970 - 2010).



Line chart containing Great Lakes MWP AOC's and long-term reference sites aggregated land-use measurements. Solid lines depicts aggregated agriculture (yellow), low-developed (pink), undeveloped (grey), and urban (red) land-use change in percent (%) at 1 to 10 km buffer spatial scales for the period 2006.

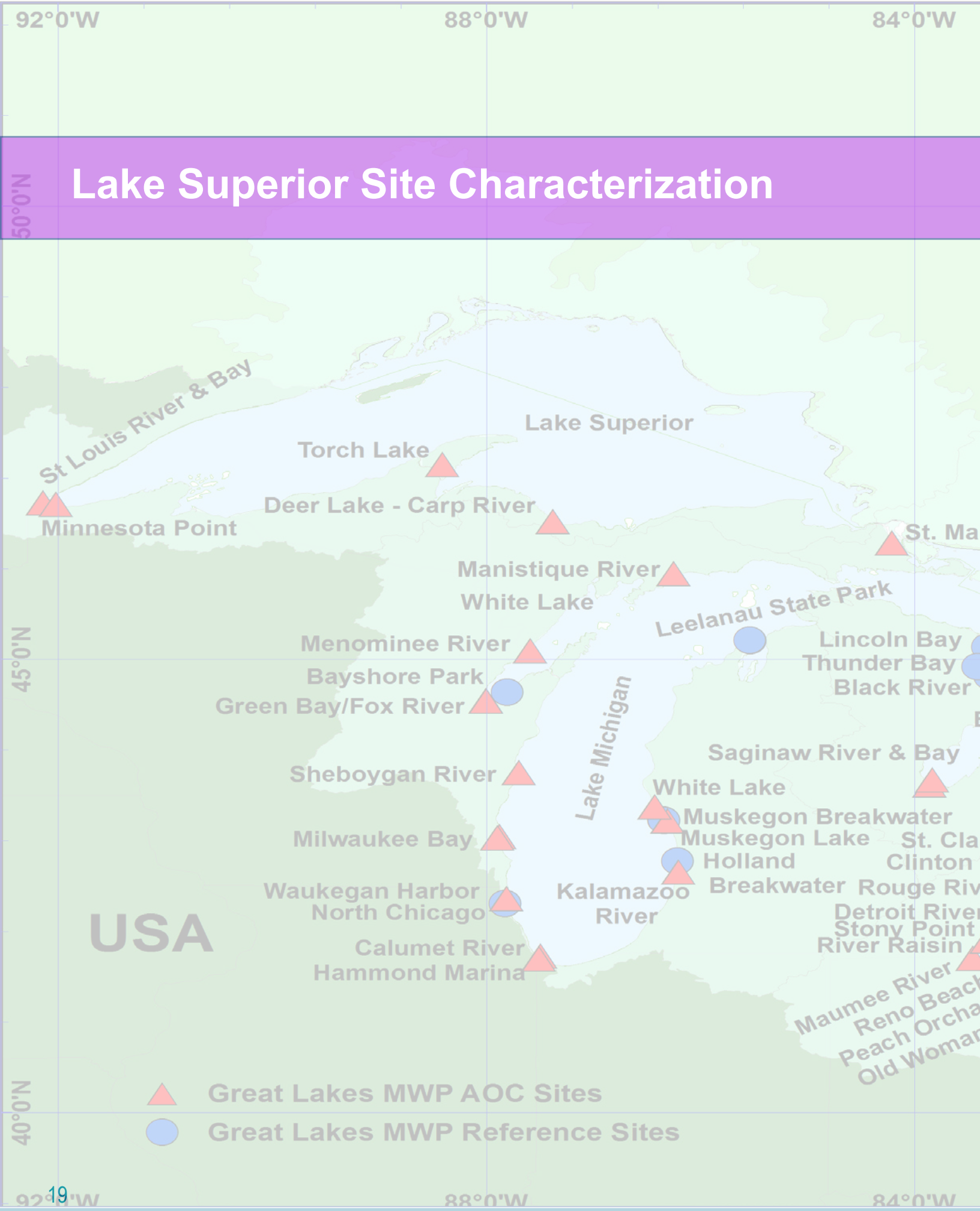
Line chart: MWP site 2006 NLCD land-use categories percentage within a 10 km buffer spatial extent.

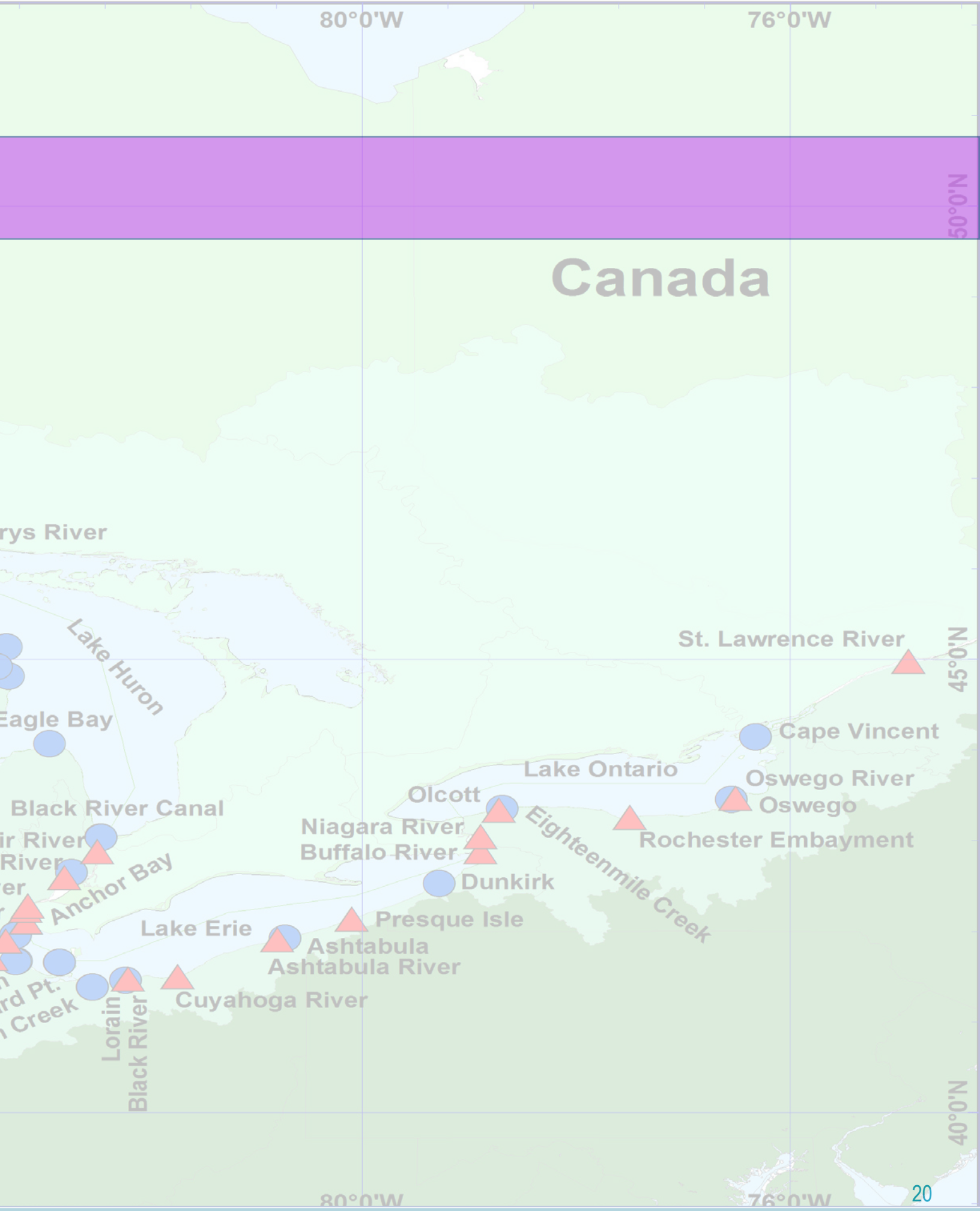


Land-use map depicting 10 km buffer spatial extent (inset), and aggregated land-use categories (Agriculture, Low-developed, Undeveloped, and Urban) used to extract land-use information for each Great Lakes MWP site. Colors for the aggregated agriculture (yellow), low-developed (pink), undeveloped (grey), and urban (red) land-use categories are the same as depicted in the pie charts above.

Land-use categories: MWP site (●) including 10 km buffer (○) and 2006 land-use categories from NLCD.

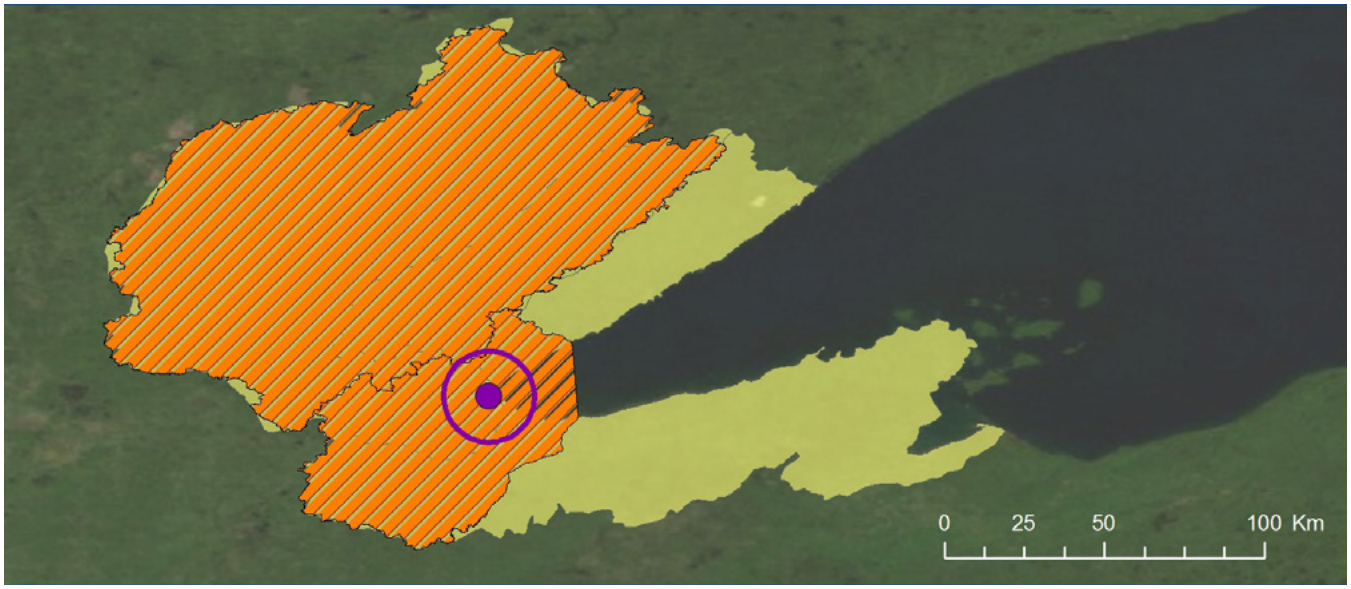
Lake Superior Site Characterization

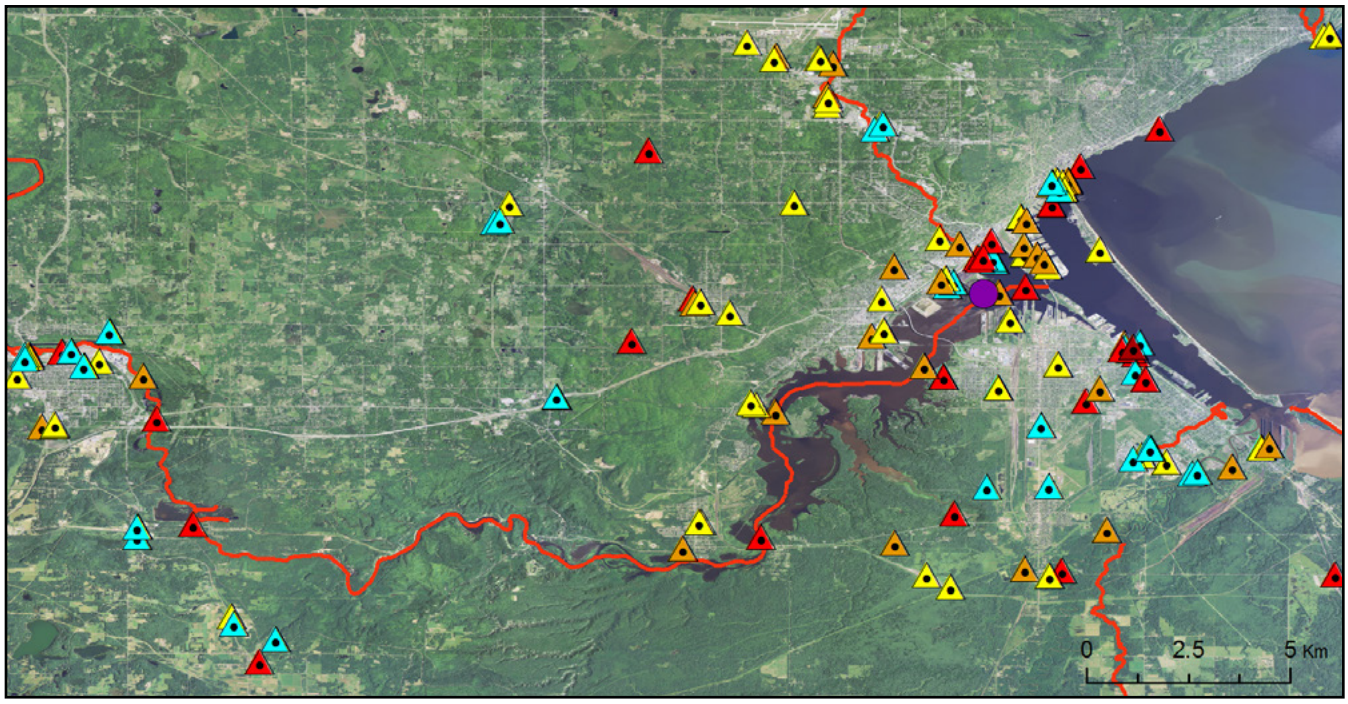


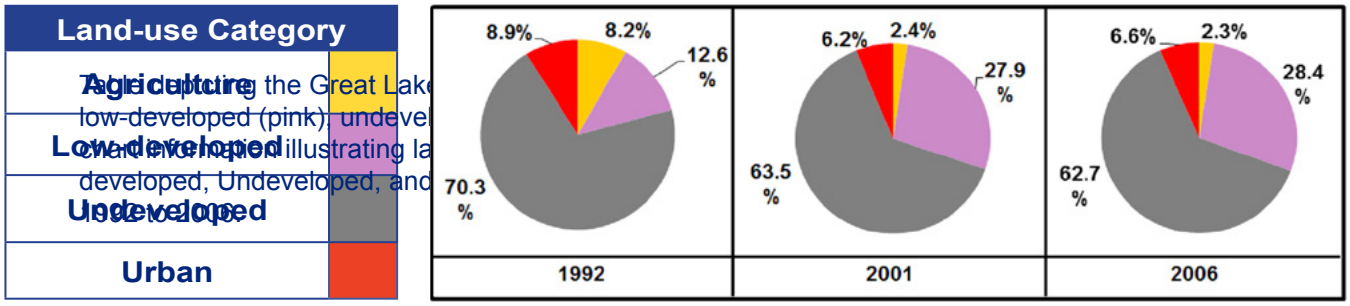

80°0'W
76°0'W
50°0'N
Canada
rys River
Lake Huron
Eagle Bay
St. Lawrence River
45°0'N
Cape Vincent
Lake Ontario
Oswego River
Oswego
Olcott
Black River Canal
Niagara River
Buffalo River
Eighteenmile Creek
Rochester Embayment
Dunkirk
Anchor Bay
Lake Erie
Presque Isle
Ashtabula
Ashtabula River
Cuyahoga River
Lorain
Black River
40°0'N
80°0'W
76°0'W

St. Louis River

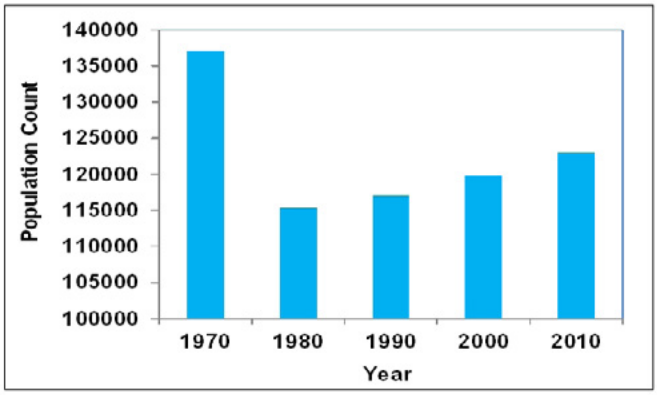
		Med



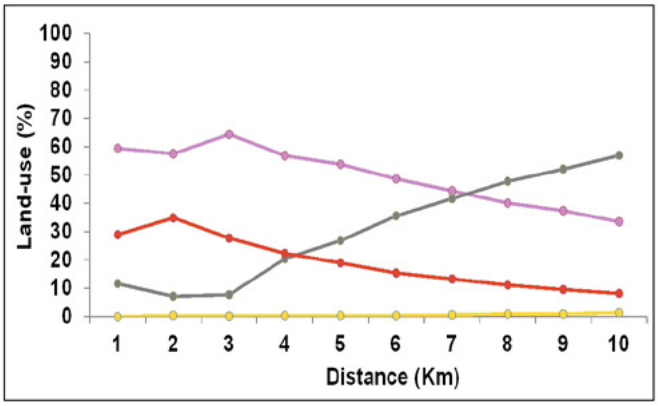




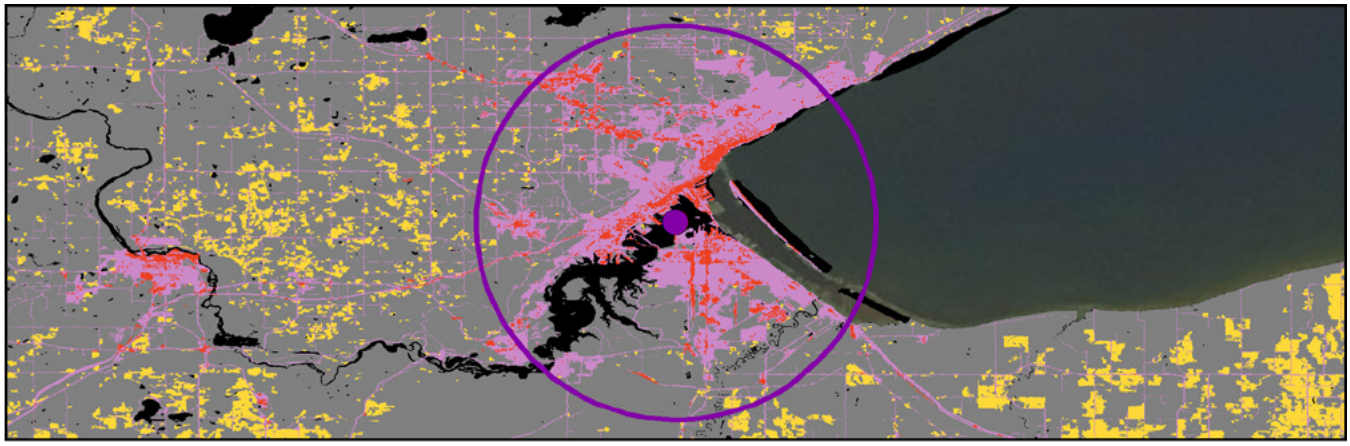
Legend: 1992 - 2006 National Land Cover Data (NLCD) aggregated hierarchal land-use categories, agriculture, low-developed, undeveloped and urban for Great Lakes Mussel Watch Program (MWP) sites.



Population barchart: Bar chart depicting population trend within 10 km buffer of MWP site (1970 - 2010).



Line chart: MWP site 2006 NLCD land-use categories percentage within a 10 km buffer spatial extent.

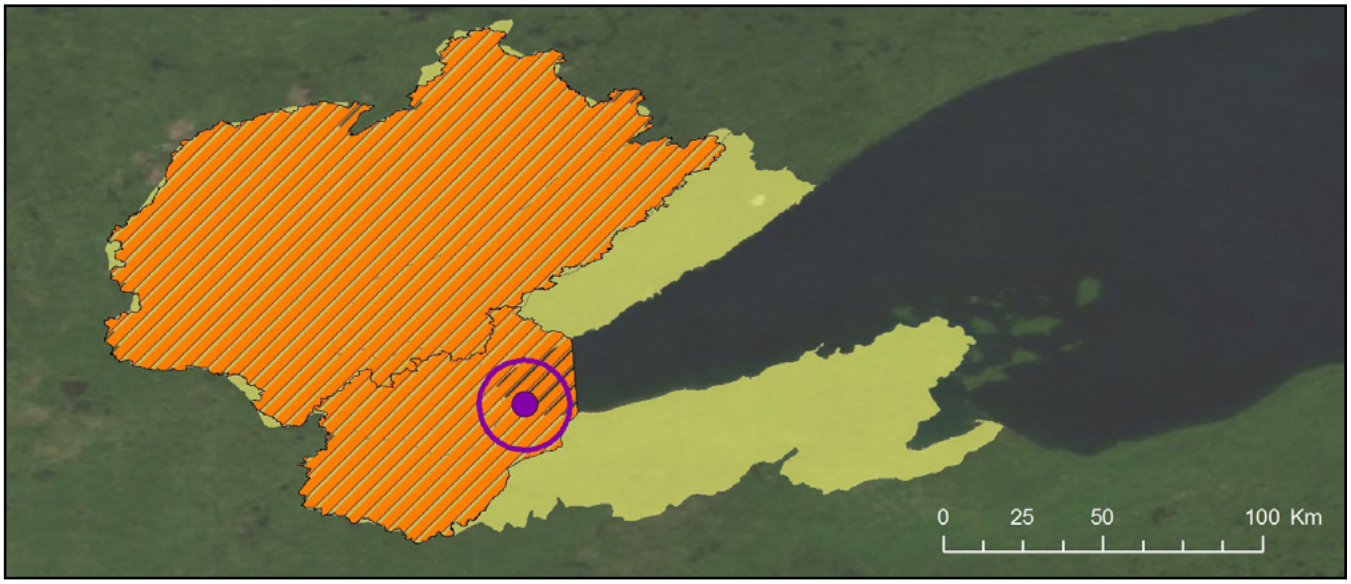


Land-use categories: MWP site (●) including 10 km buffer (○) and 2006 land-use categories from NLCD.

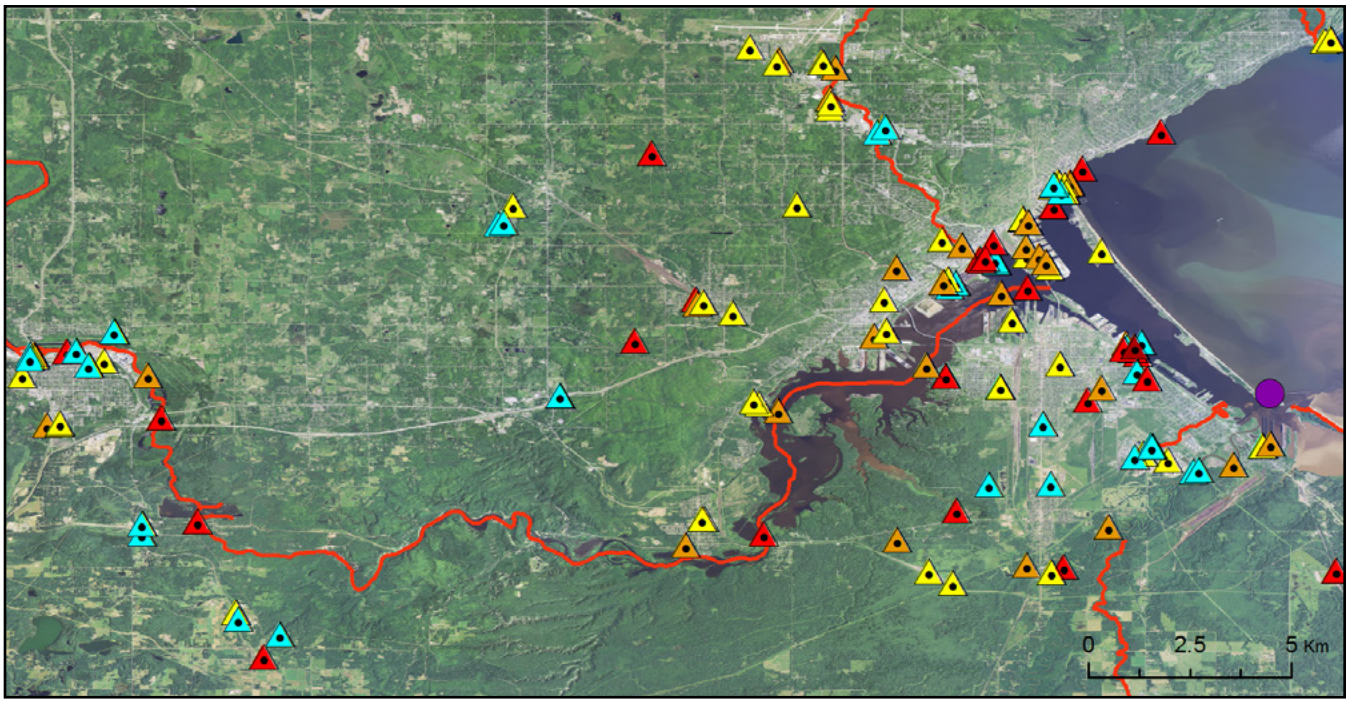
Minnesota Point

Site Acronym	LSMR	
Latitude	46.72587	
Longitude	-92.12236	
State	MN-WI	
Land-use Designation	Undeveloped	
Site Category	MW AOC	
Year Established	2010	
Population 2010	1288	Low

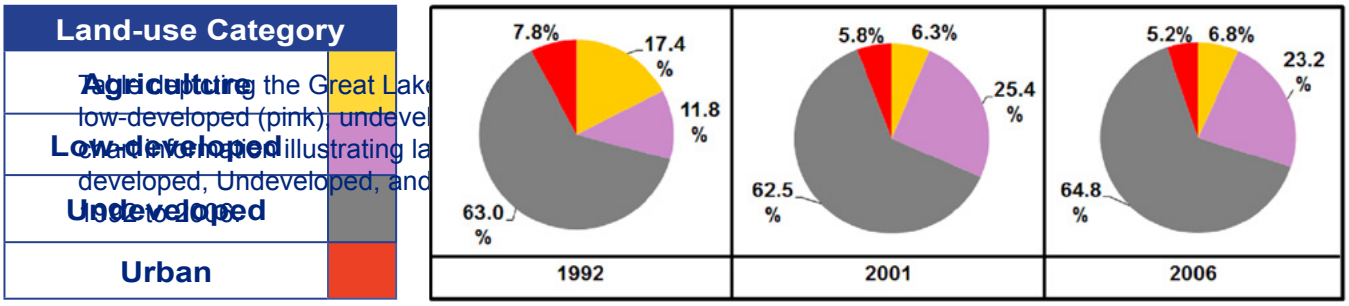
Site location: Basin wide perspective site location.



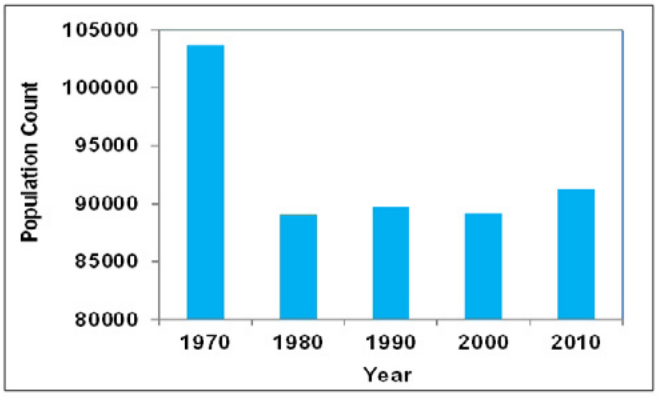
Spatial delineation: MWP site (●), associated watershed (▭), and AOC boundary (▨) where applicable.



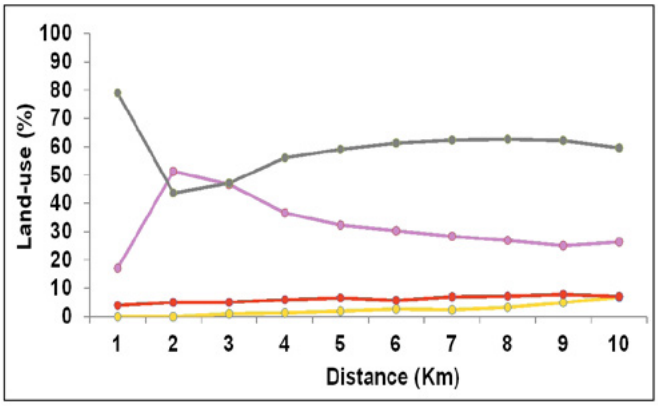
Outfalls: Aerial orthoimagery and map depicting MWP site (●), Impaired and Assessed Waters (▭), and U.S.EPA NPDES major and minor permitted facilities outfall types: POTW (▲), Non-POTW (▲), Wastewater Facilities (▲), Discharge Facilities (▲), Water Dischargers (▲), Combined Sewer Overflows (CSO's) (▲).



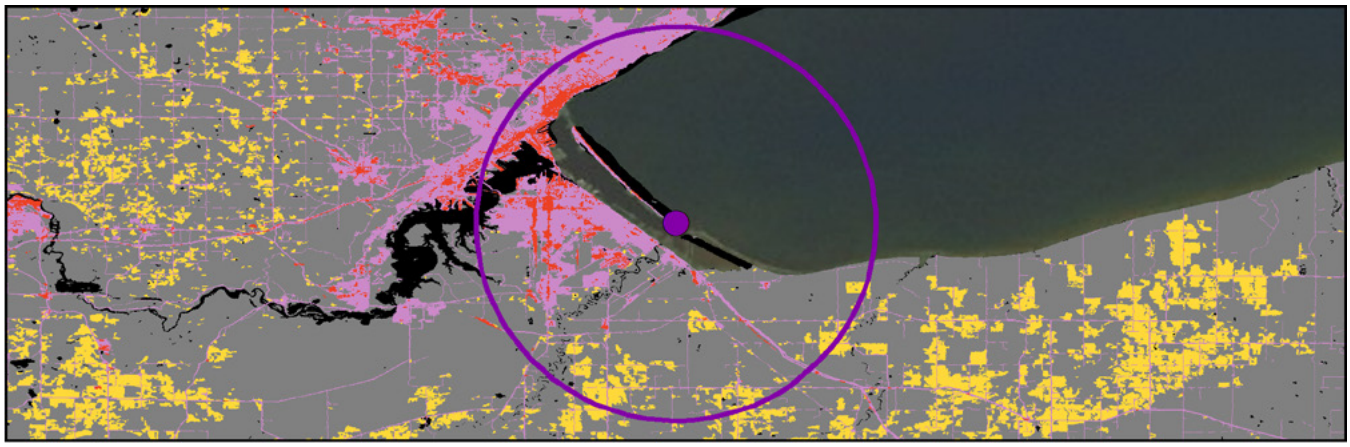
Legend: 1992 - 2006 National Land Cover Data (NLCD) aggregated hierarchal land-use categories, agriculture, low-developed, undeveloped and urban for Great Lakes Mussel Watch Program (MWP) sites.



Population barchart: Bar chart depicting population trend within 10 km buffer of MWP site (1970 - 2010).

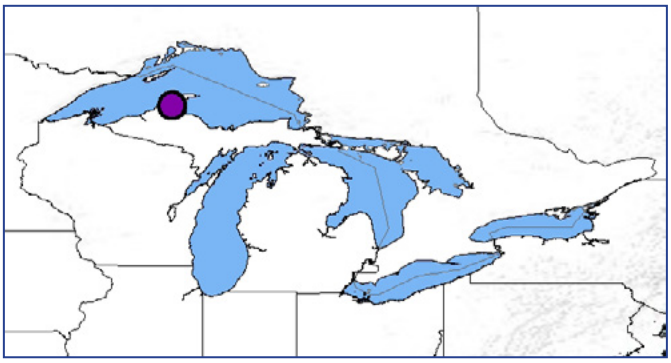


Line chart: MWP site 2006 NLCD land-use categories percentage within a 10 km buffer spatial extent.

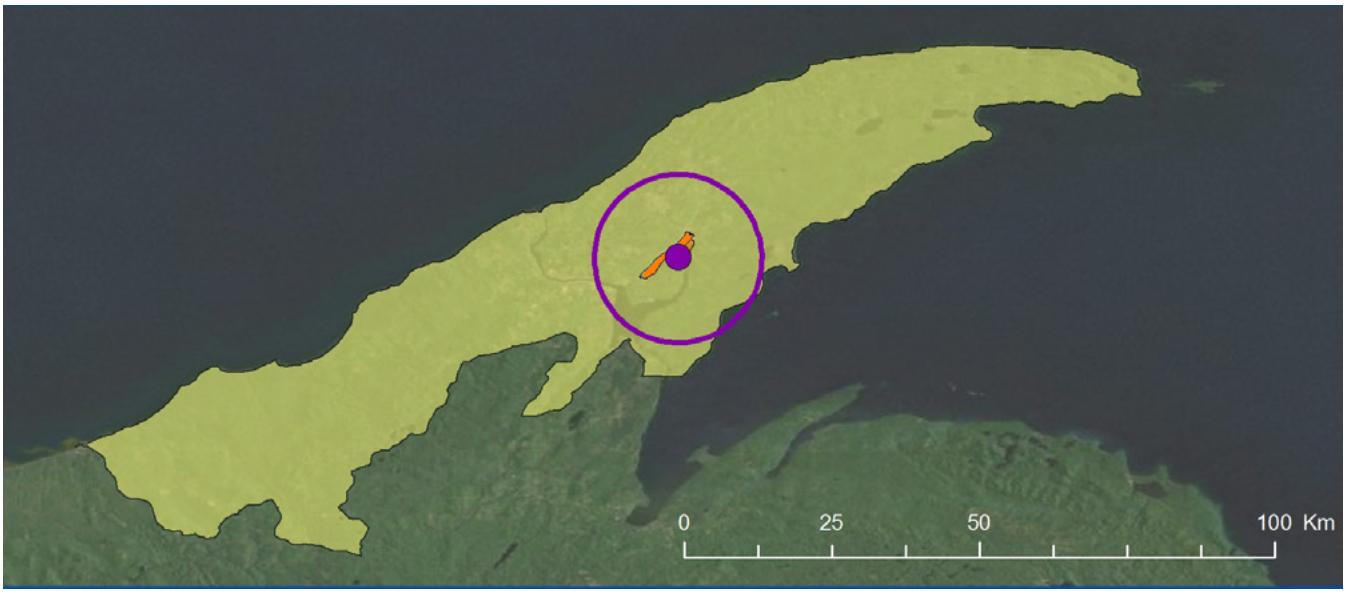


Land-use categories: MWP site (●) including 10 km buffer (○) and 2006 land-use categories from NLCD.

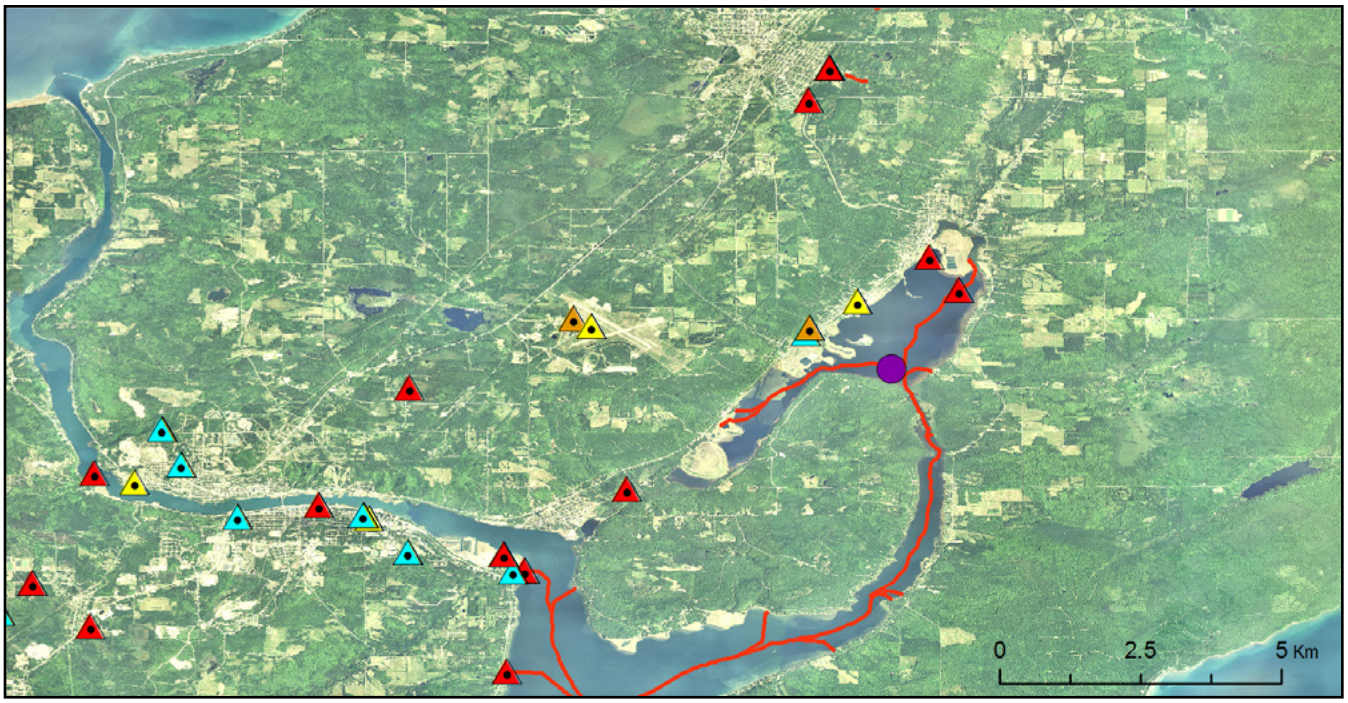
Torch Lake



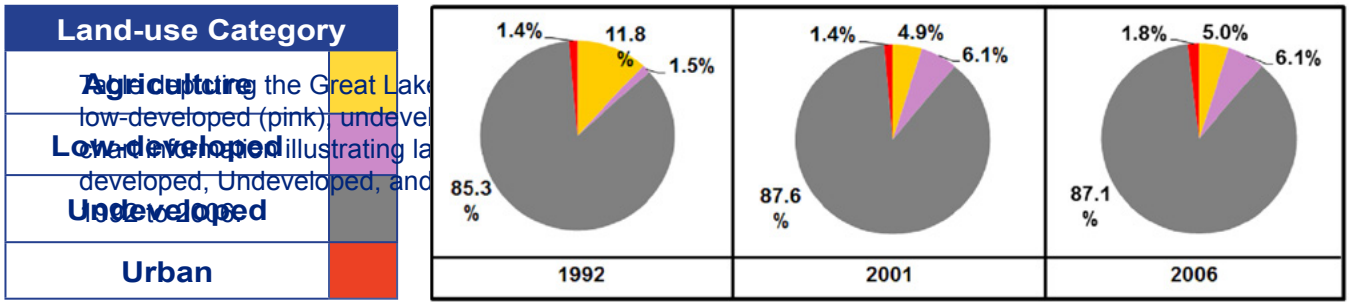
	LSTL	
	47.1496	
	-88.4115	
	MI	
	Undeveloped	
	MW AOC	
	2010	
	18281	Low



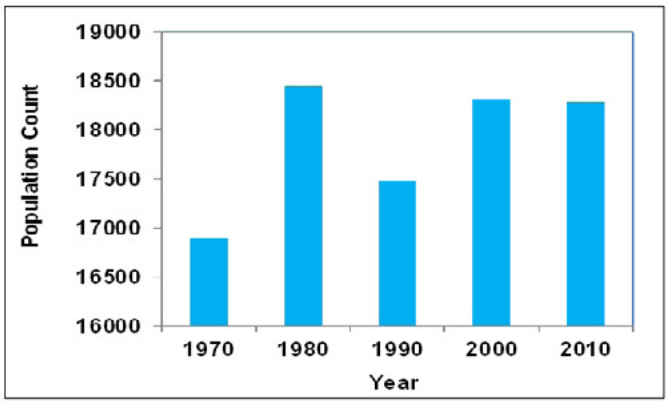
Spatial delineation: MWP site (●), associated watershed (▭), and AOC boundary (///) where applicable.



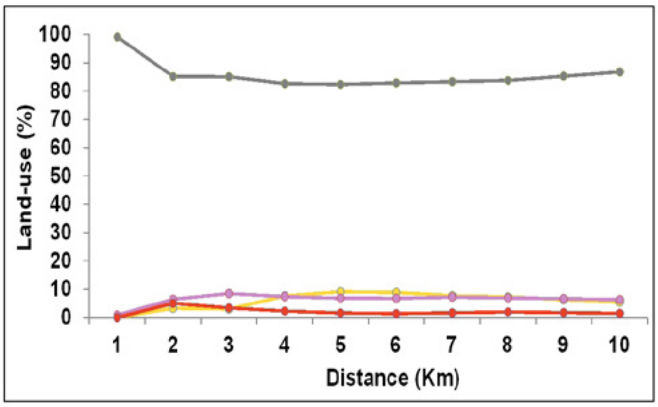
Outfalls: Aerial orthoimagery and map depicting MWP site (●), Impaired and Assessed Waters (▭), and U.S.EPA NPDES major and minor permitted facilities outfall types: POTW (▲), Non-POTW (▲), Wastewater Facilities (▲), Discharge Facilities (▲), Water Dischargers (▲), Combined Sewer Overflows (CSO's) (▲).



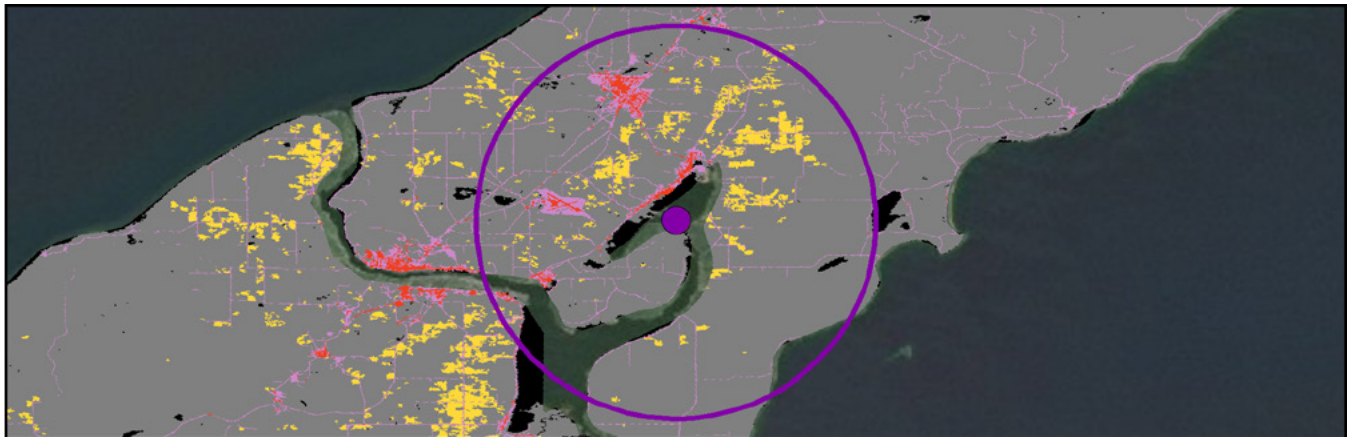
Legend: 1992 - 2006 National Land Cover Data (NLCD) aggregated hierarchal land-use categories, agriculture, low-developed, undeveloped and urban for Great Lakes Mussel Watch Program (MWP) sites.



Population barchart: Bar chart depicting population trend within 10 km buffer of MWP site (1970 - 2010).



Line chart: MWP site 2006 NLCD land-use categories percentage within a 10 km buffer spatial extent.

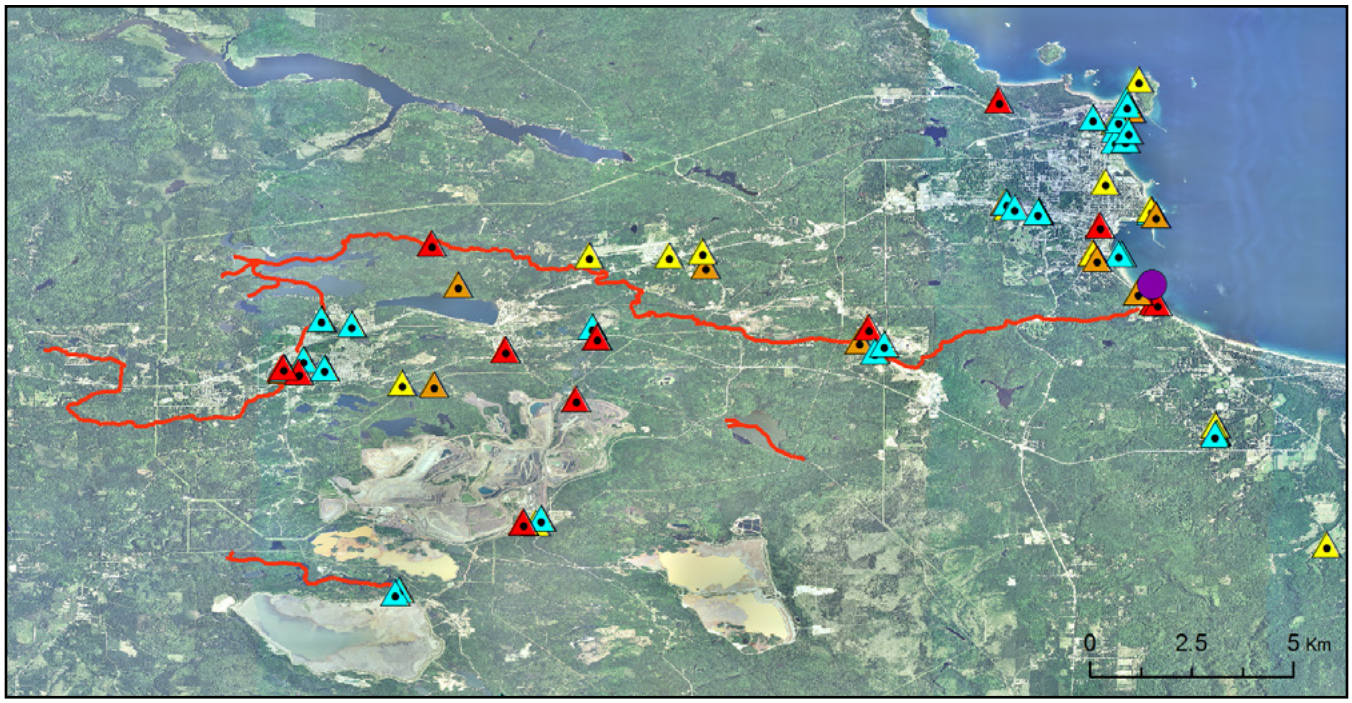


Land-use categories: MWP site (●) including 10 km buffer (○) and 2006 land-use categories from NLCD.

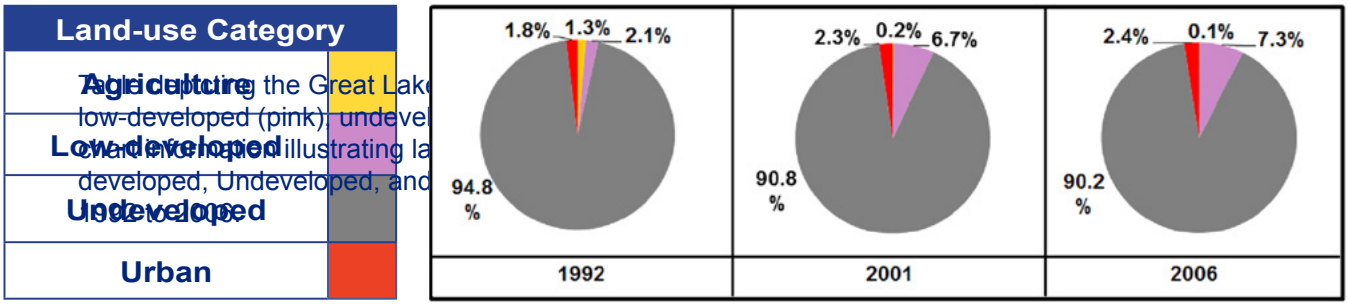
Deer Lake - Carp River

	LSCR	
	46.48605	
	- 87.6893	
	MI	
	Undeveloped	
	MW AOC	
	2010	
	19343	Low

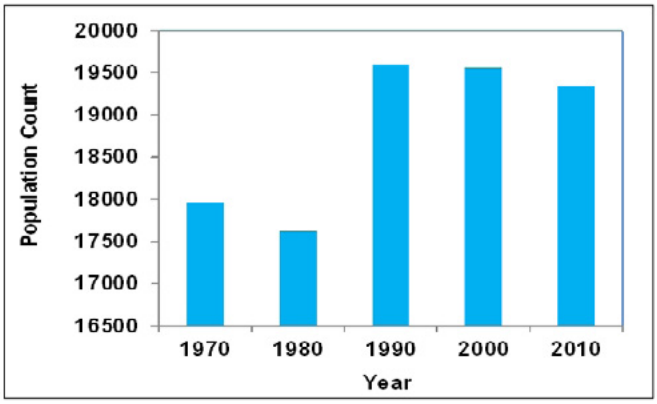
Spatial delineation: MWP site (●), associated watershed (▭), and AOC boundary (///) where applicable.



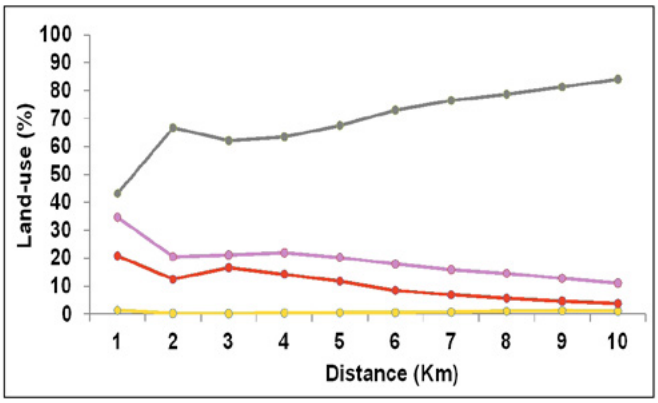
Outfalls: Aerial orthoimagery and map depicting MWP site (●), Impaired and Assessed Waters (▭), and U.S.EPA NPDES major and minor permitted facilities outfall types: POTW (▲), Non-POTW (▲), Wastewater Facilities (▲), Discharge Facilities (▲), Water Dischargers (▲), Combined Sewer Overflows (CSO's) (▲).



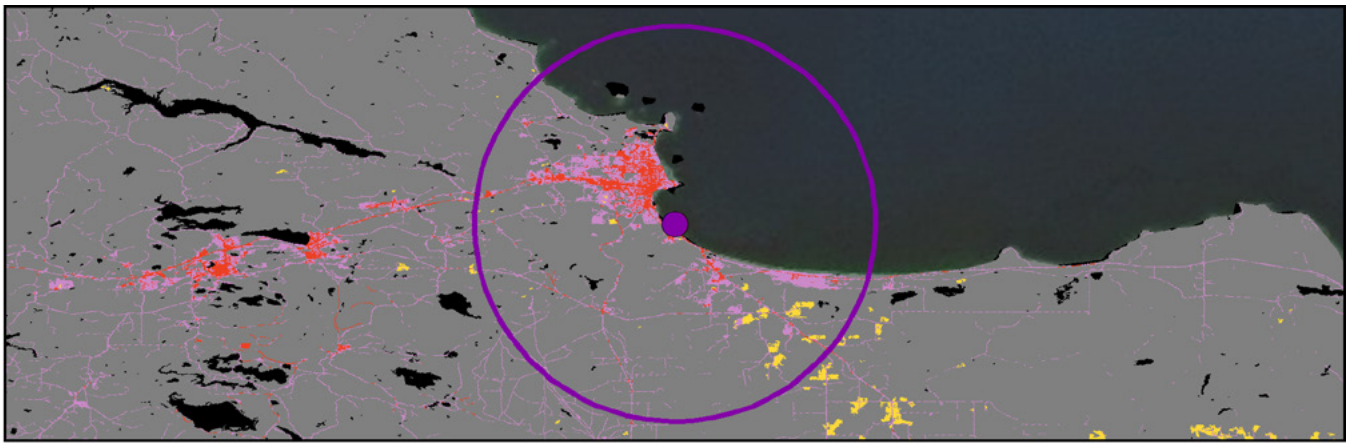
Legend: 1992 - 2006 National Land Cover Data (NLCD) aggregated hierarchal land-use categories, agriculture, low-developed, undeveloped and urban for Great Lakes Mussel Watch Program (MWP) sites.



Population barchart: Bar chart depicting population trend within 10 km buffer of MWP site (1970 - 2010).



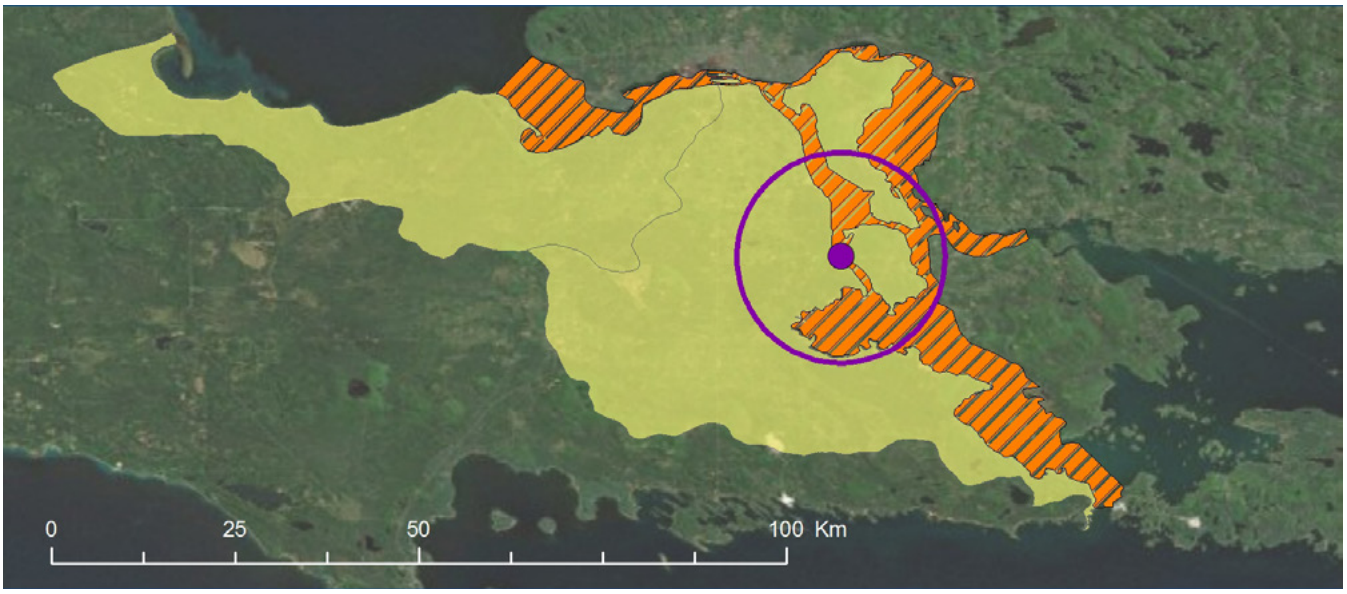
Line chart: MWP site 2006 NLCD land-use categories percentage within a 10 km buffer spatial extent.



Land-use categories: MWP site (●) including 10 km buffer (○) and 2006 land-use categories from NLCD.

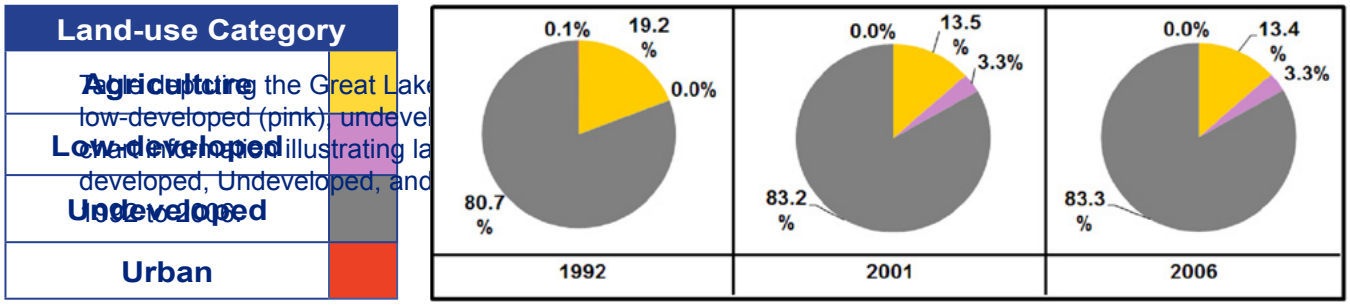
St. Marys River

	LSSM	
	46.2865	
	-84.21133	
	MI	
	Undeveloped	
	MW AOC	
	2010	
	2375	Low



Spatial delineation: MWP site (●), associated watershed (▭), and AOC boundary (///) where applicable.

Outfalls: Aerial orthoimagery and map depicting MWP site (●), Impaired and Assessed Waters (▭), and U.S.EPA NPDES major and minor permitted facilities outfall types: POTW (▲), Non-POTW (▲), Wastewater Facilities (▲), Discharge Facilities (▲), Water Dischargers (▲), Combined Sewer Overflows (CSO's) (▲).



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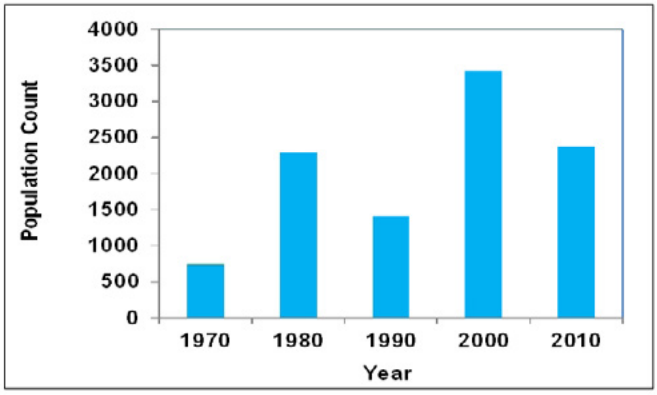
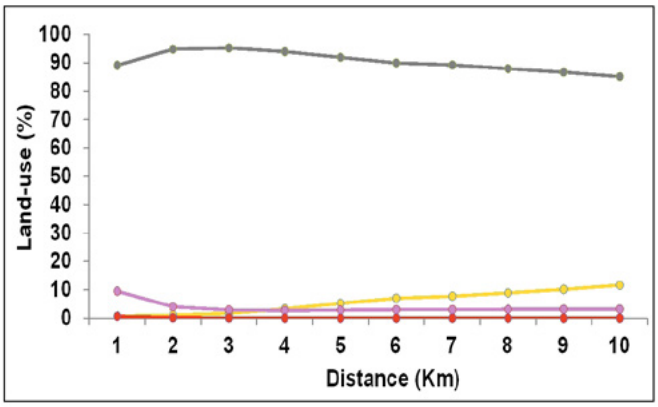
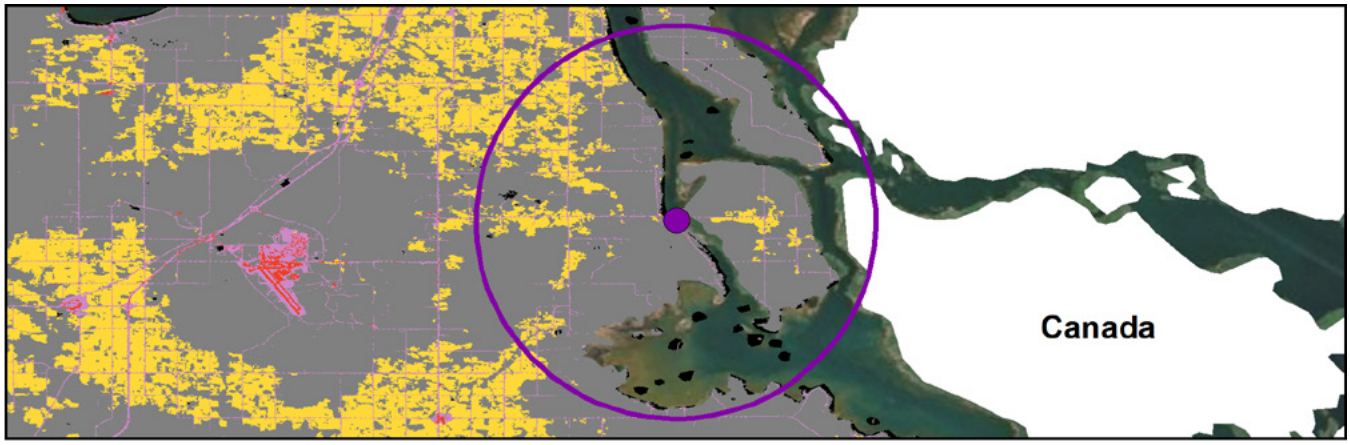


Population barchart: Bar chart depicting population trend within 10 km buffer of MWP site (1970 - 2010).

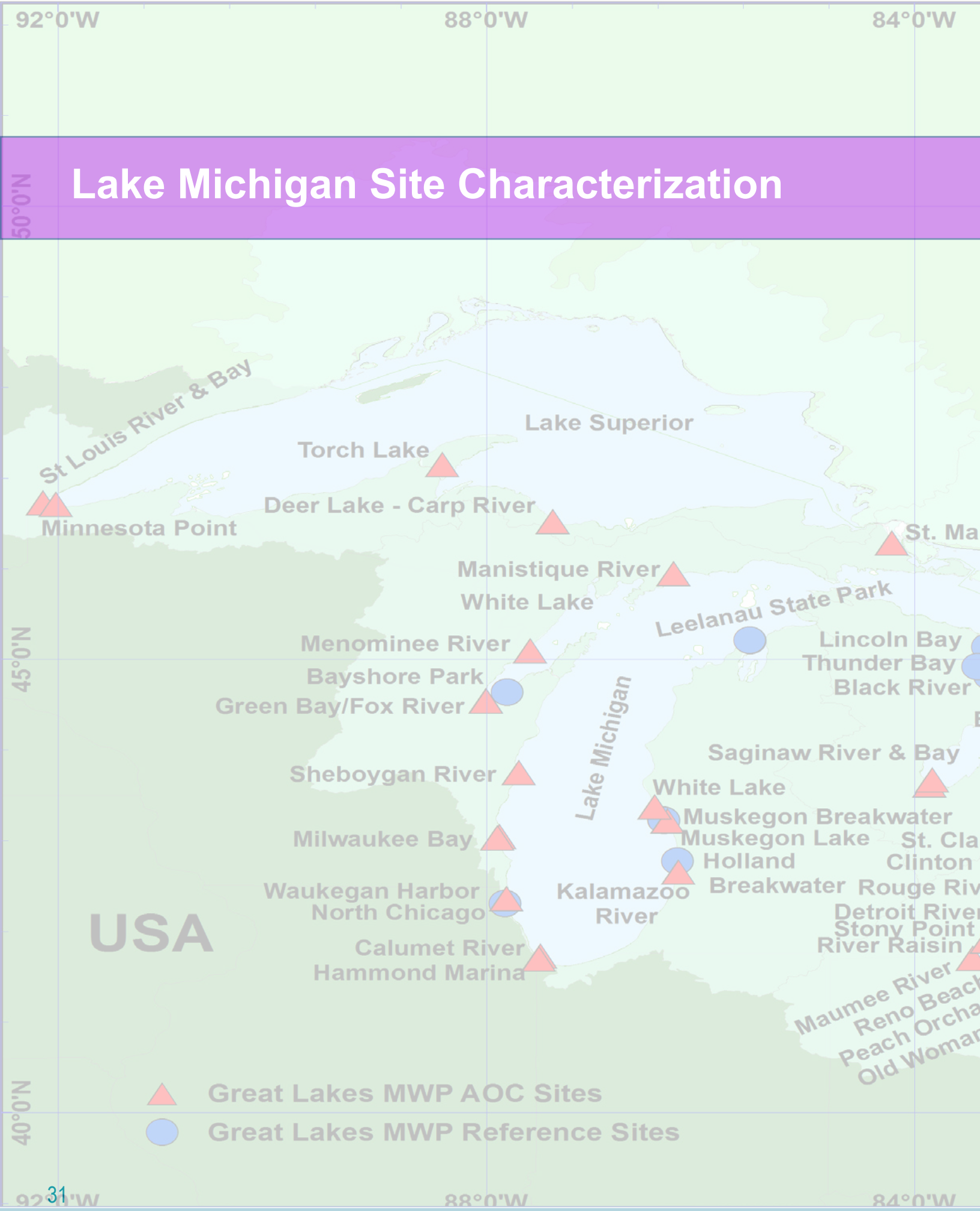


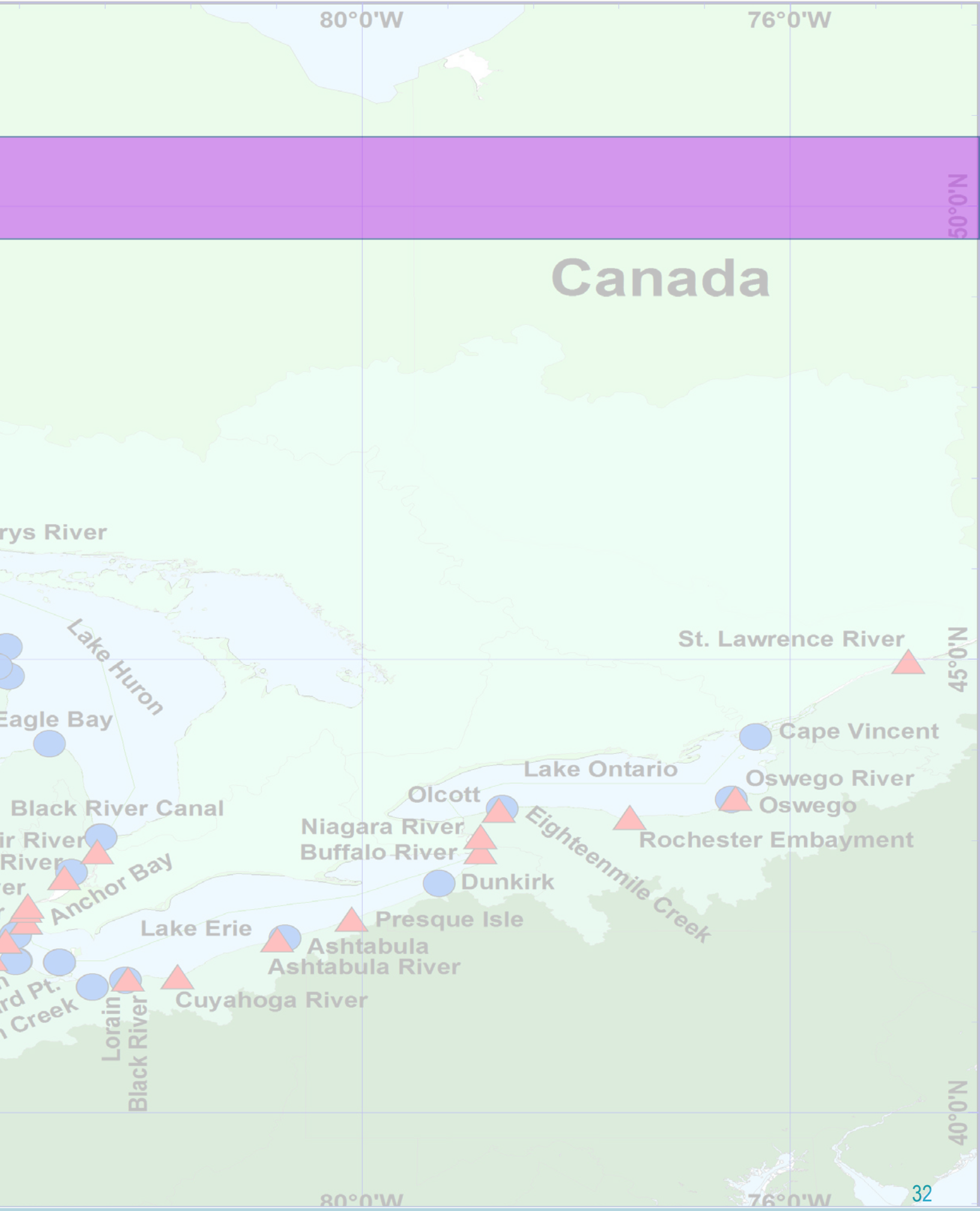
Line chart: MWP site 2006 NLCD land-use categories percentage within a 10 km buffer spatial extent.



Land-use categories: MWP site (●) including 10 km buffer (○) and 2006 land-use categories from NLCD.

Lake Michigan Site Characterization

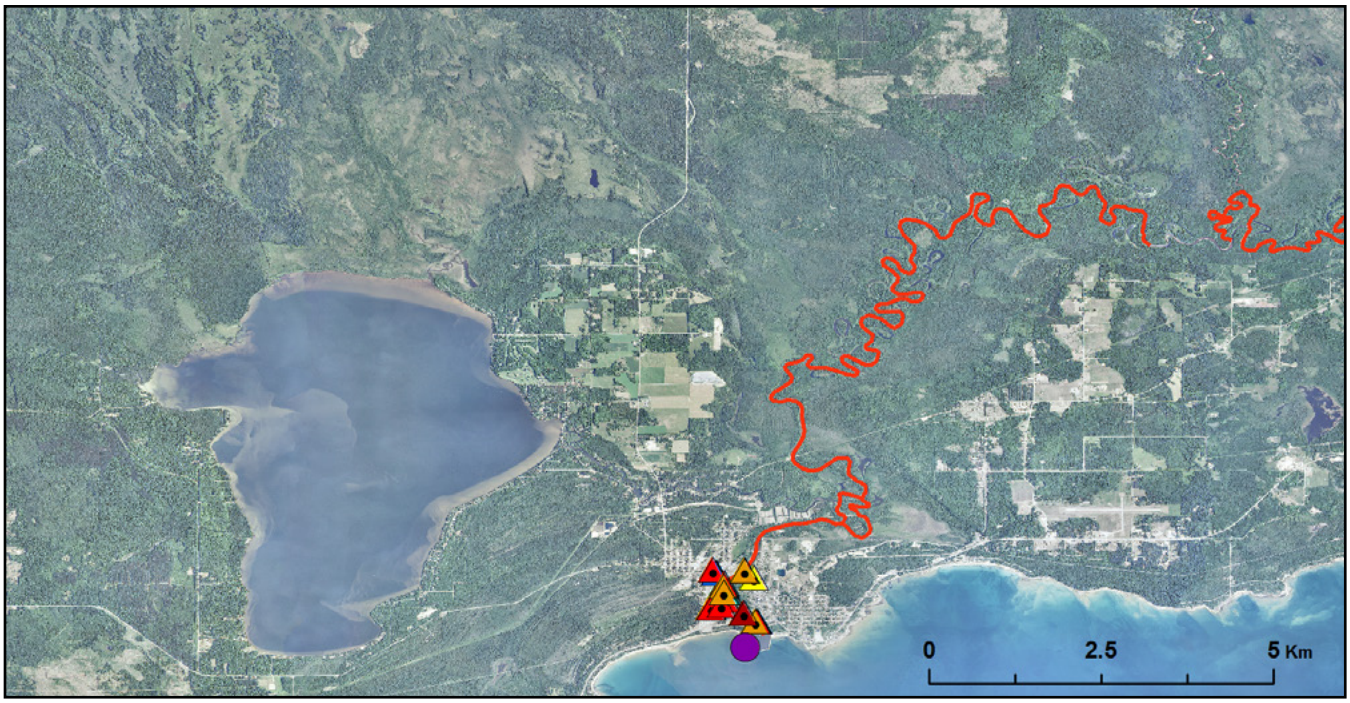



80°0'W
76°0'W
50°0'N
Canada
rys River
Lake Huron
Eagle Bay
St. Lawrence River
45°0'N
Cape Vincent
Lake Ontario
Oswego River
Oswego
Olcott
Black River Canal
Niagara River
Buffalo River
Eighteenmile Creek
Rochester Embayment
Dunkirk
Anchor Bay
Lake Erie
Presque Isle
Ashtabula
Ashtabula River
Cuyahoga River
Lorain
Black River
40°0'N
80°0'W
76°0'W

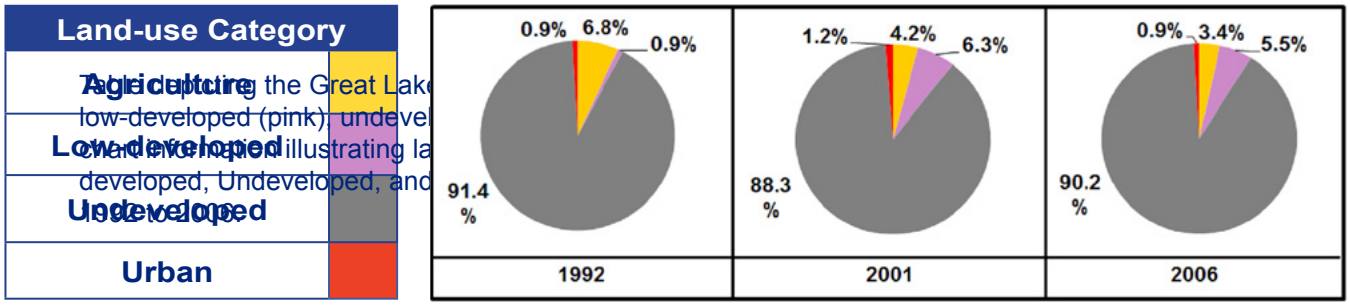
Manistique River

	LMMQ	
	45.94578	
	-86.2497	
	MI	
	Undeveloped	
	MW AOC	
	2010	
	6221	Low

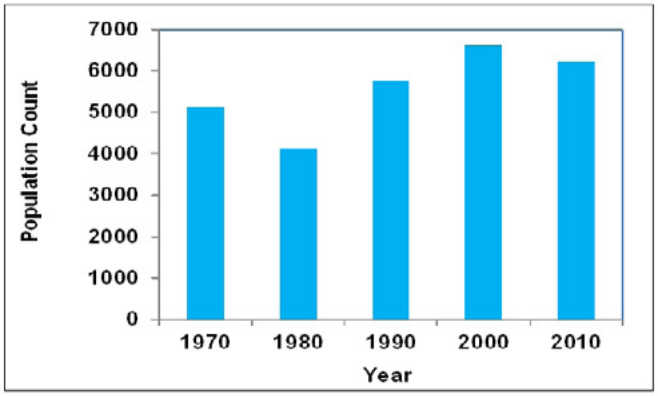
Spatial delineation: MWP site (●), associated watershed (▭), and AOC boundary (///) where applicable.



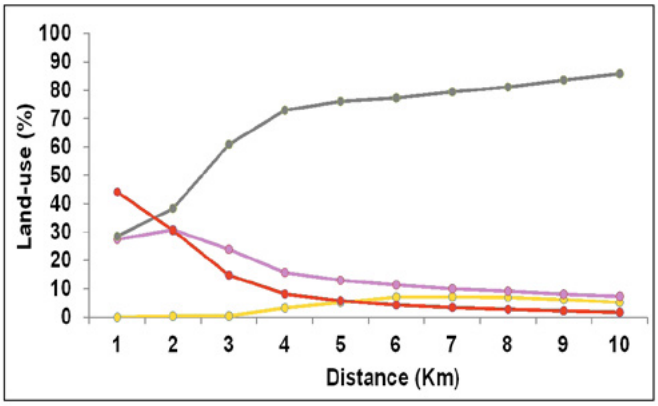
Outfalls: Aerial orthoimagery and map depicting MWP site (●), Impaired and Assessed Waters (▭), and U.S.EPA NPDES major and minor permitted facilities outfall types: POTW (▲), Non-POTW (▲), Wastewater Facilities (▲), Discharge Facilities (▲), Water Dischargers (▲), Combined Sewer Overflows (CSO's) (▲).



Legend: 1992 - 2006 National Land Cover Data (NLCD) aggregated hierarchal land-use categories, agriculture, low-developed, undeveloped and urban for Great Lakes Mussel Watch Program (MWP) sites.



Population barchart: Bar chart depicting population trend within 10 km buffer of MWP site (1970 - 2010).

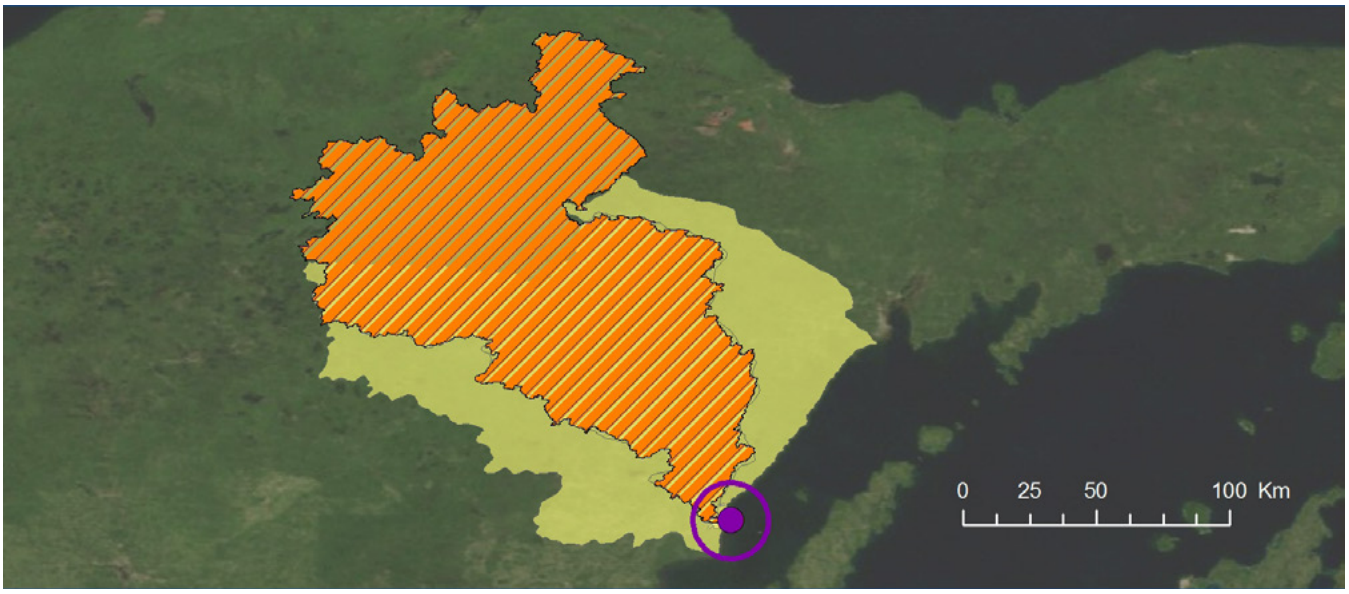


Line chart: MWP site 2006 NLCD land-use categories percentage within a 10 km buffer spatial extent.

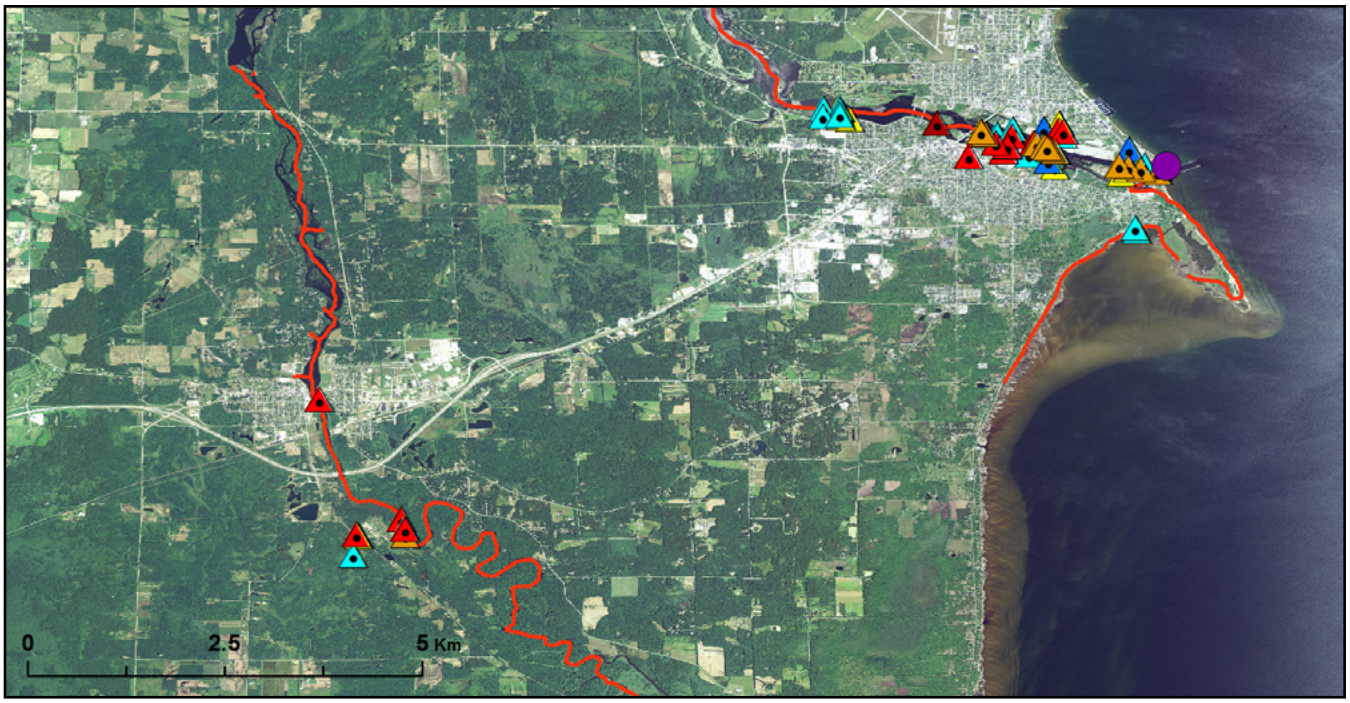
Land-use categories: MWP site (●) including 10 km buffer (○) and 2006 land-use categories from NLCD.

Menominee River

	LMMM	
	45.09616	
	-87.59115	
	MI-WI	
	Undeveloped	
	MW AOC	
	2010	
	14737	Low



Spatial delineation: MWP site (●), associated watershed (▭), and AOC boundary (///) where applicable.



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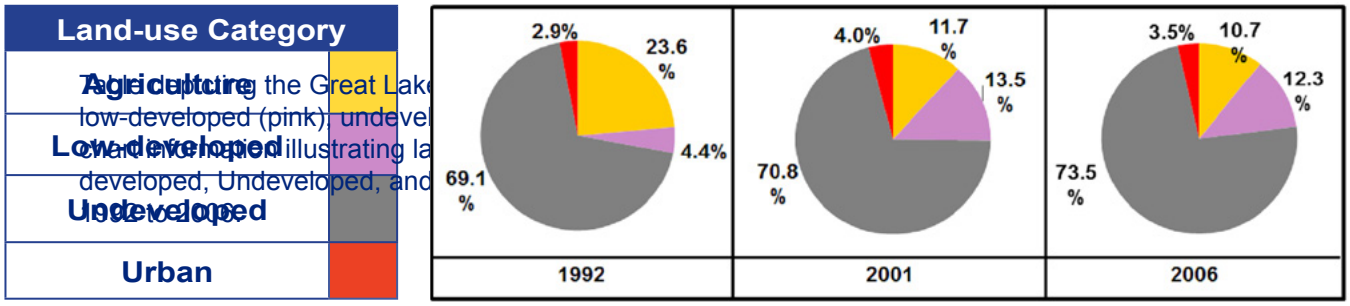

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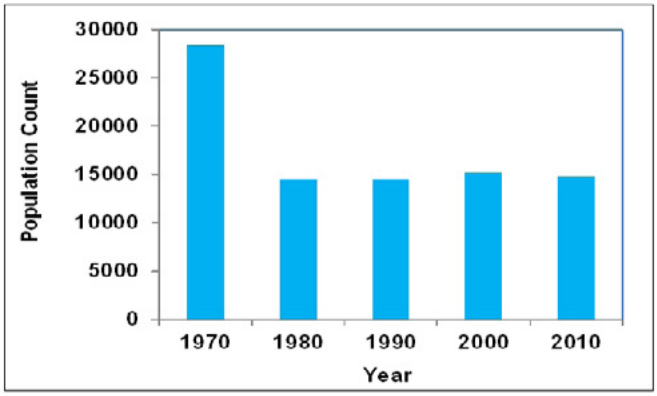

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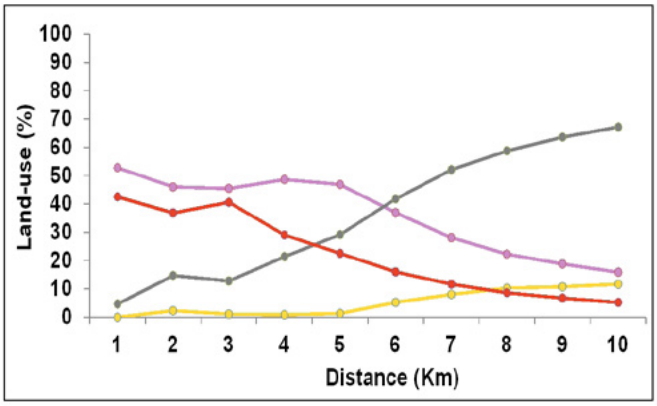
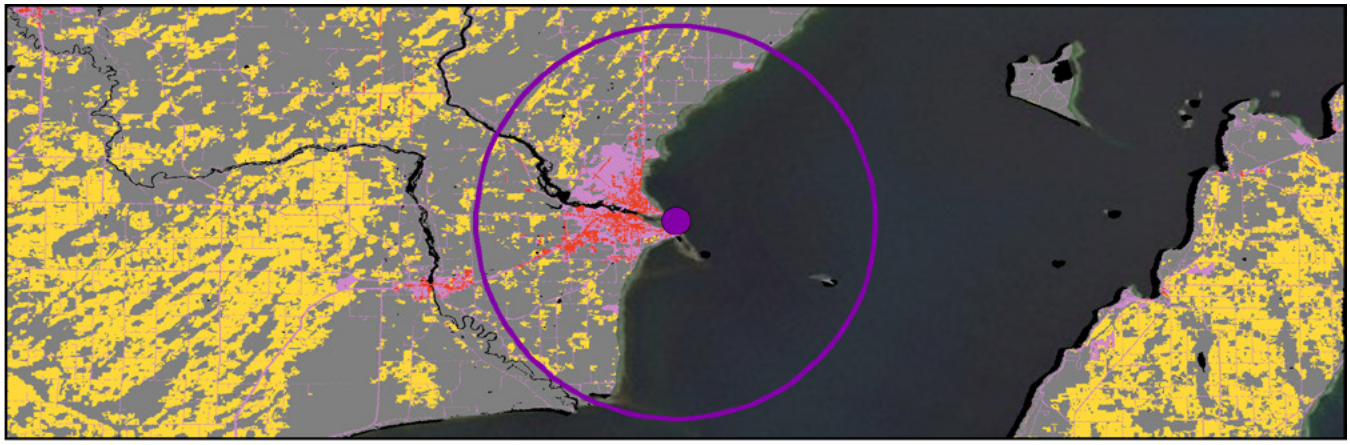


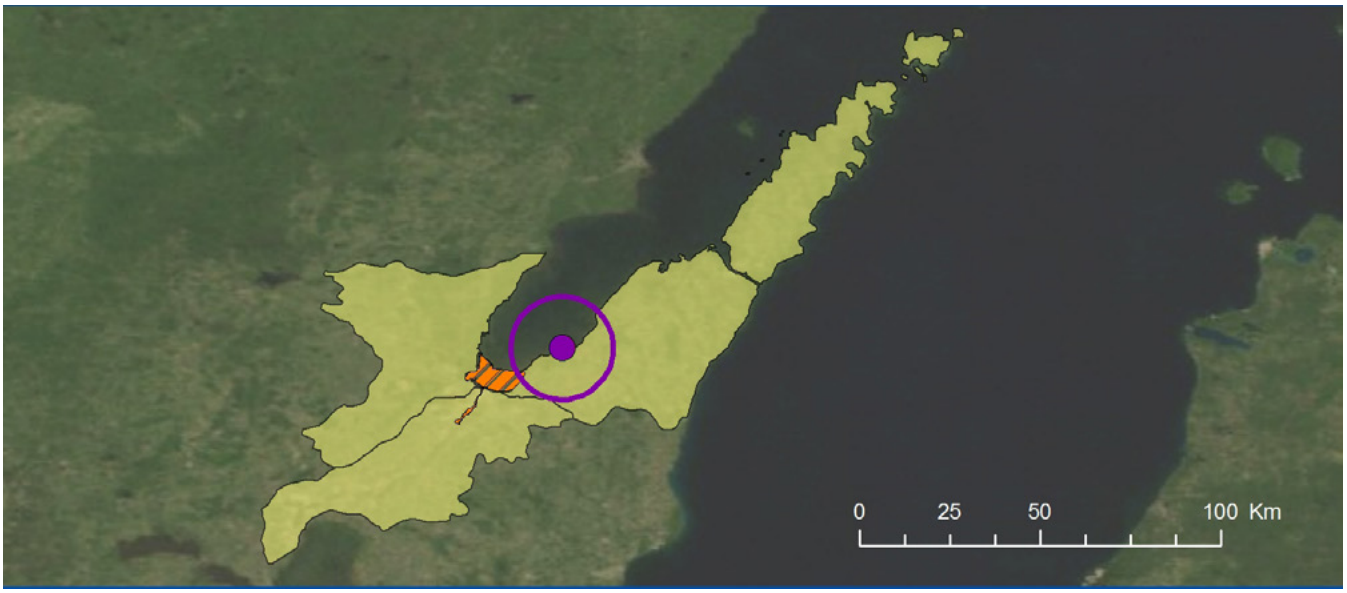
Line chart: MWP site 2006 NLCD land-use categories percentage within a 10 km buffer spatial extent.



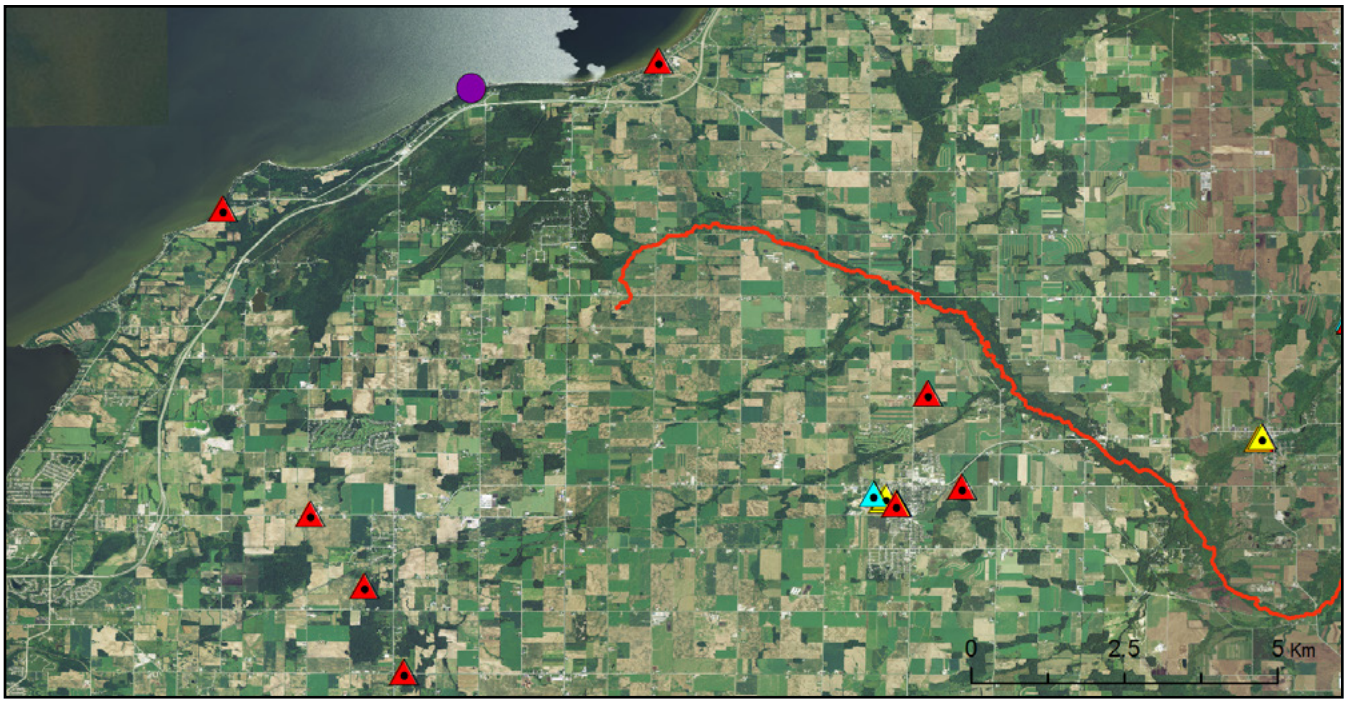
Land-use categories: MWP site (●) including 10 km buffer (○) and 2006 land-use categories from NLCD.

Bayshore Park

	GBBS	
	44.637	
	-87.808167	
	WI	
	Agriculture	
	MW REF	
	1993	
	14471	Low



Spatial delineation: MWP site (●), associated watershed (▭), and AOC boundary (///) where applicable.



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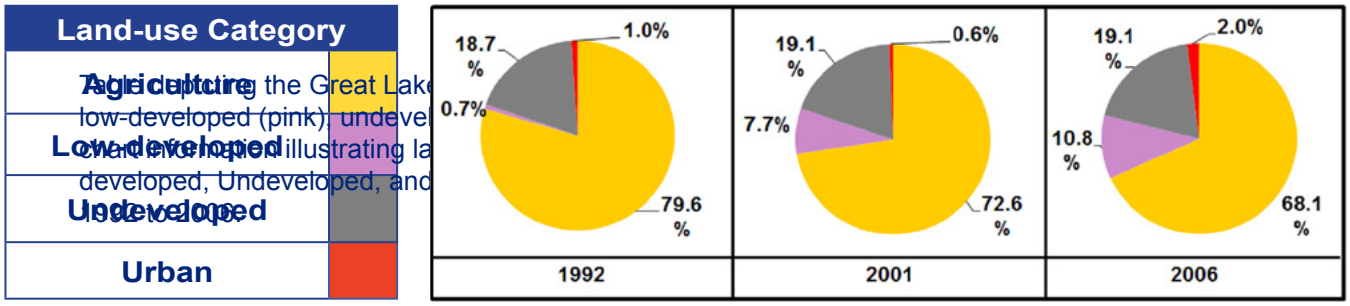

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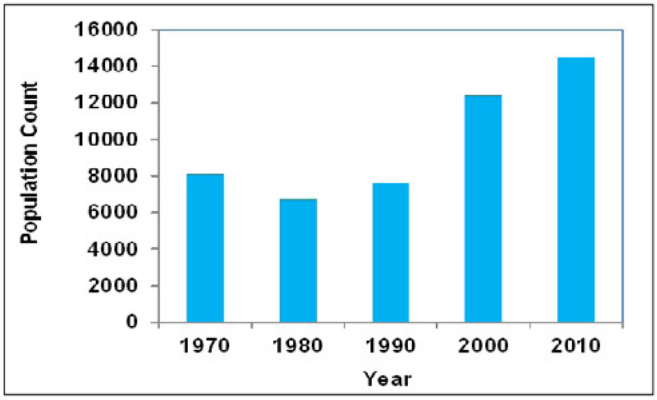

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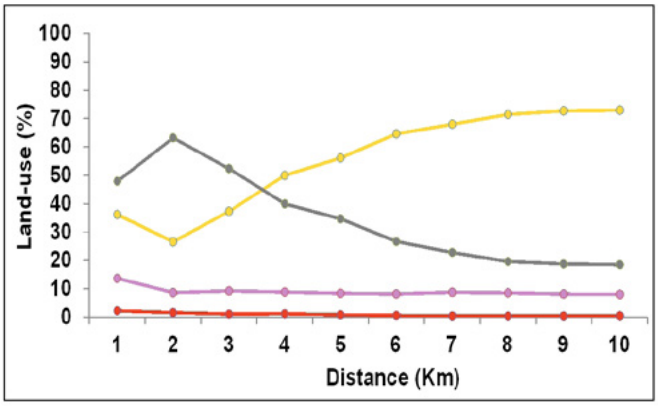
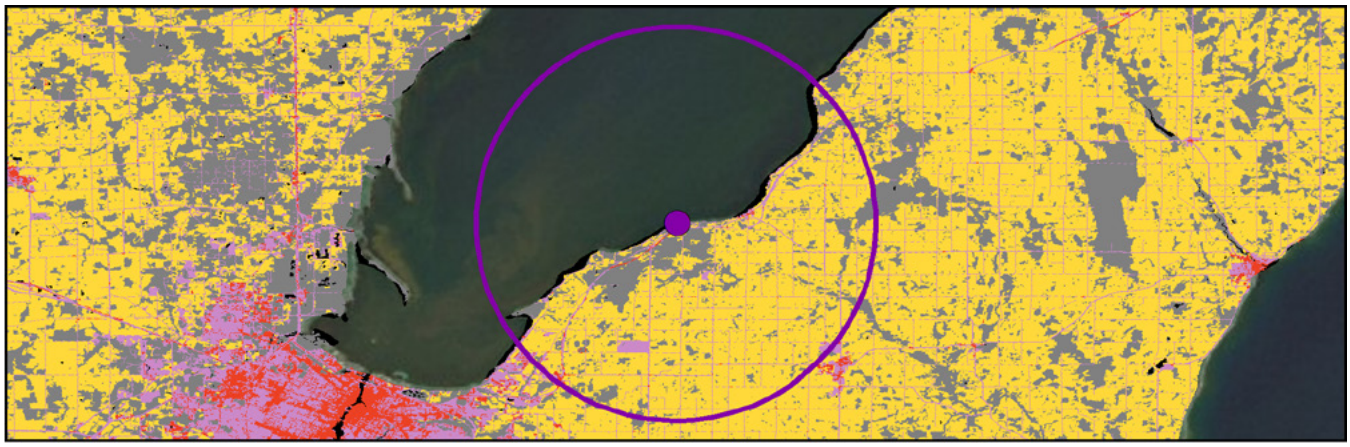


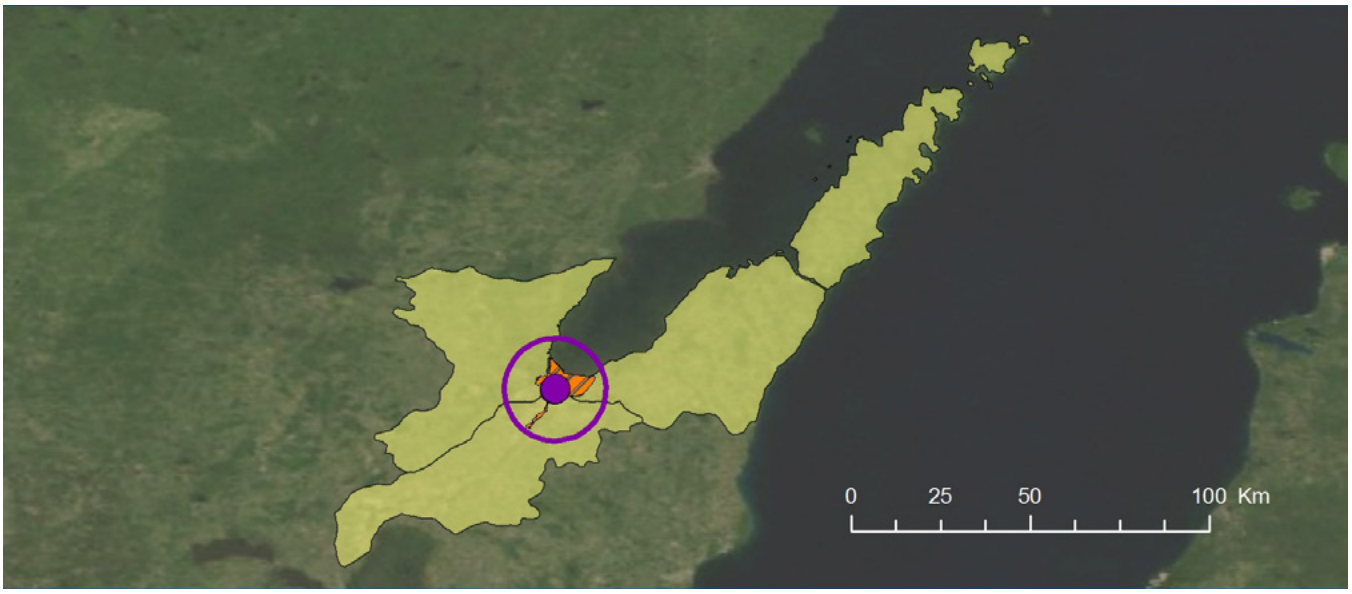
Line chart: MWP site 2006 NLCD land-use categories percentage within a 10 km buffer spatial extent.



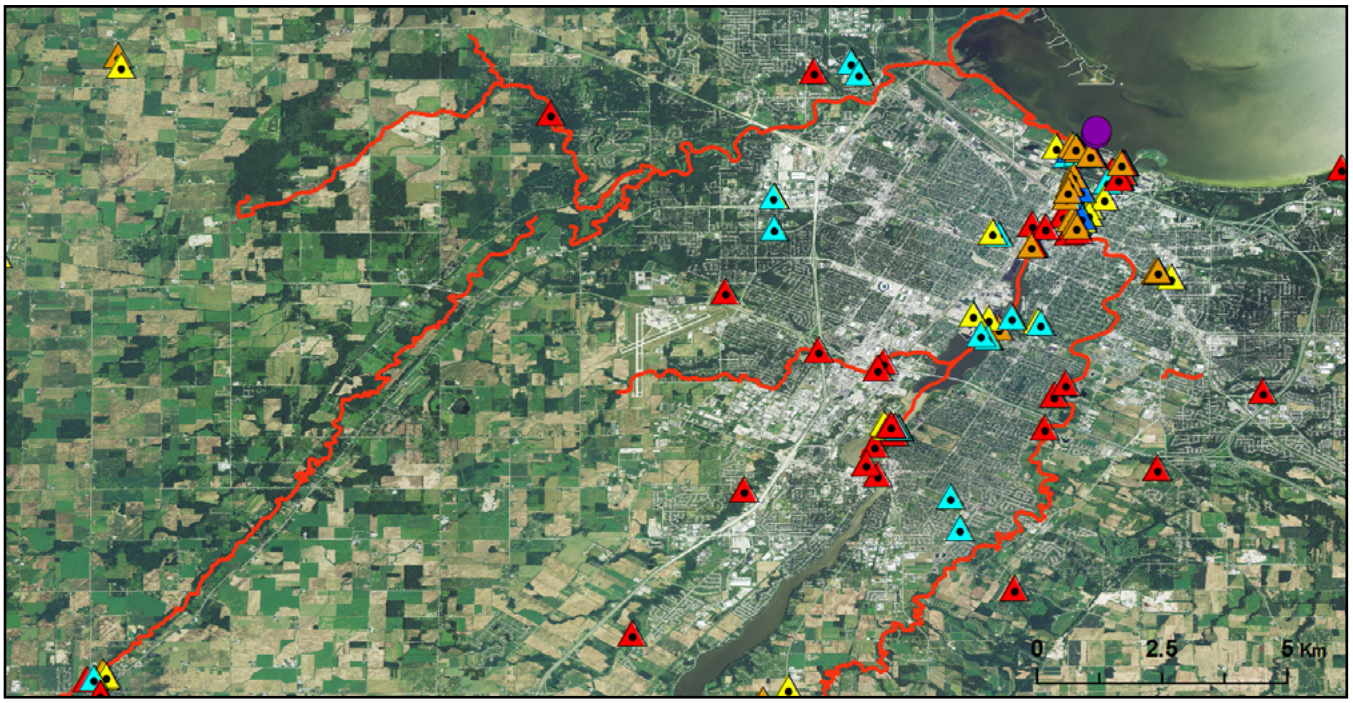
Land-use categories: MWP site (●) including 10 km buffer (○) and 2006 land-use categories from NLCD.

Green Bay - Fox River

	LMGF	
	44.54452	
	-88.0012	
	WI	
	Low-developed	
	MW AOC	
	2010	
	211676	Medium



Spatial delineation: MWP site (●), associated watershed (▭), and AOC boundary (///) where applicable.



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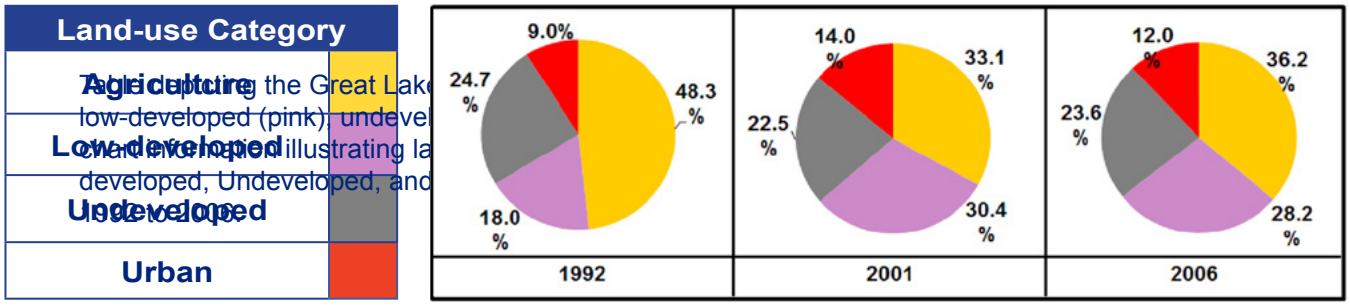

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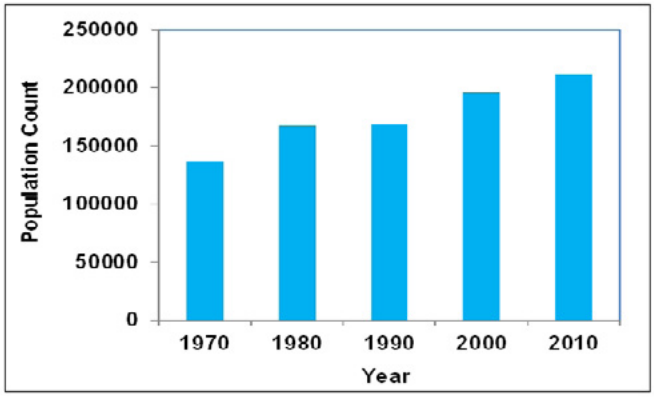

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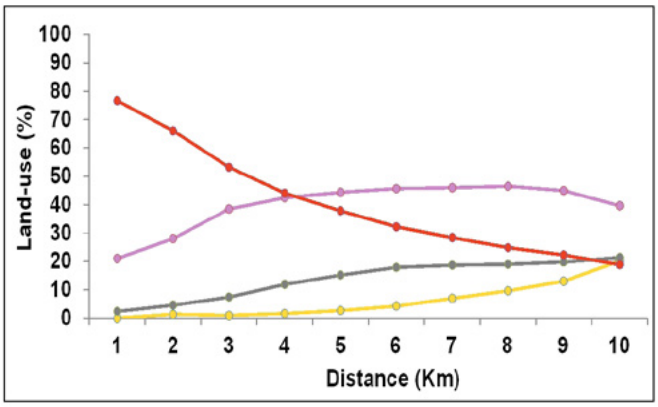

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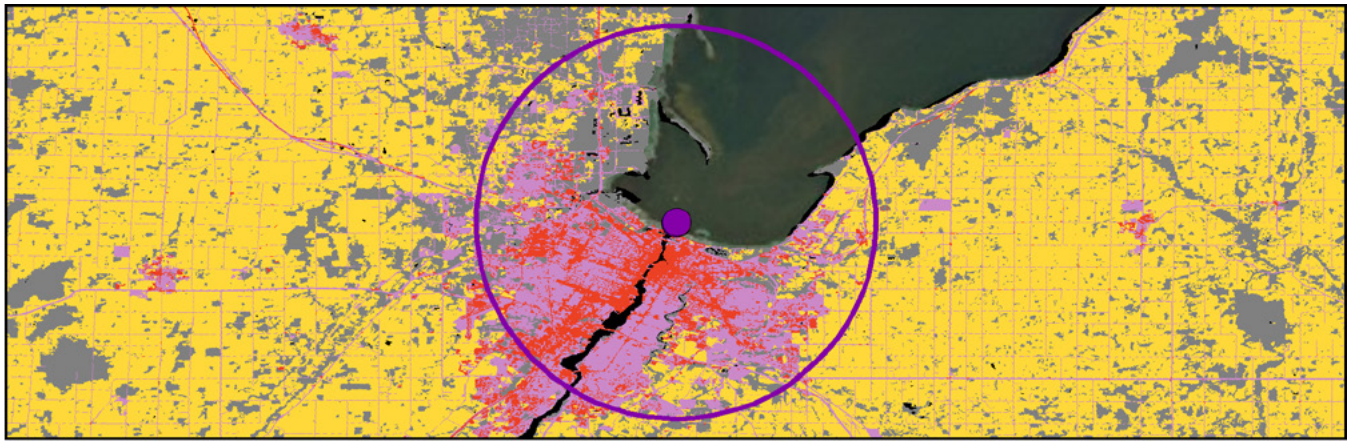
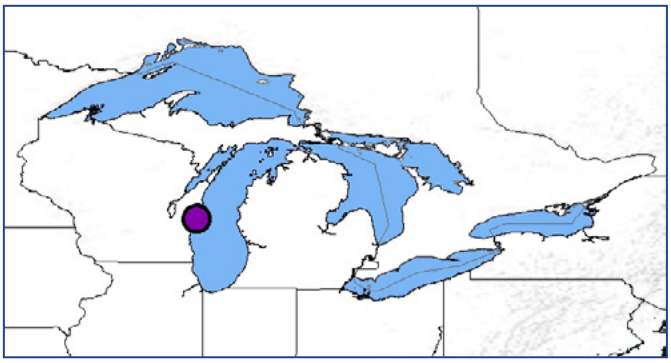
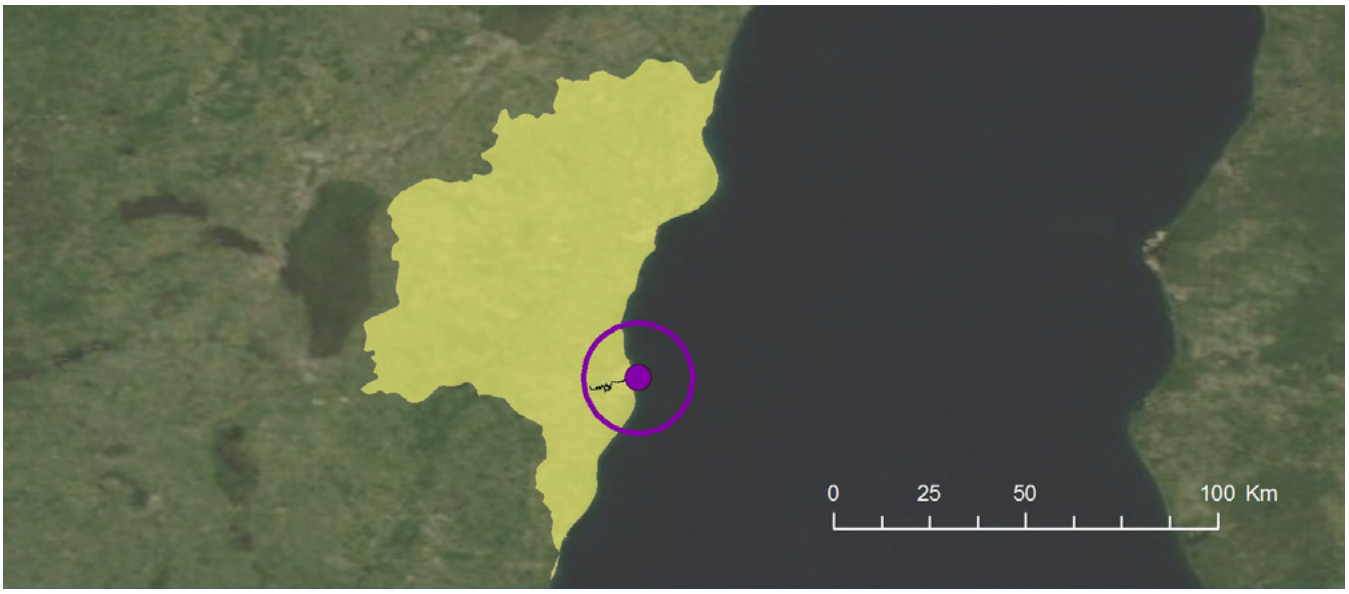


Land-use categories: MWP site (●) including 10 km buffer (○) and 2006 land-use categories from NLCD.

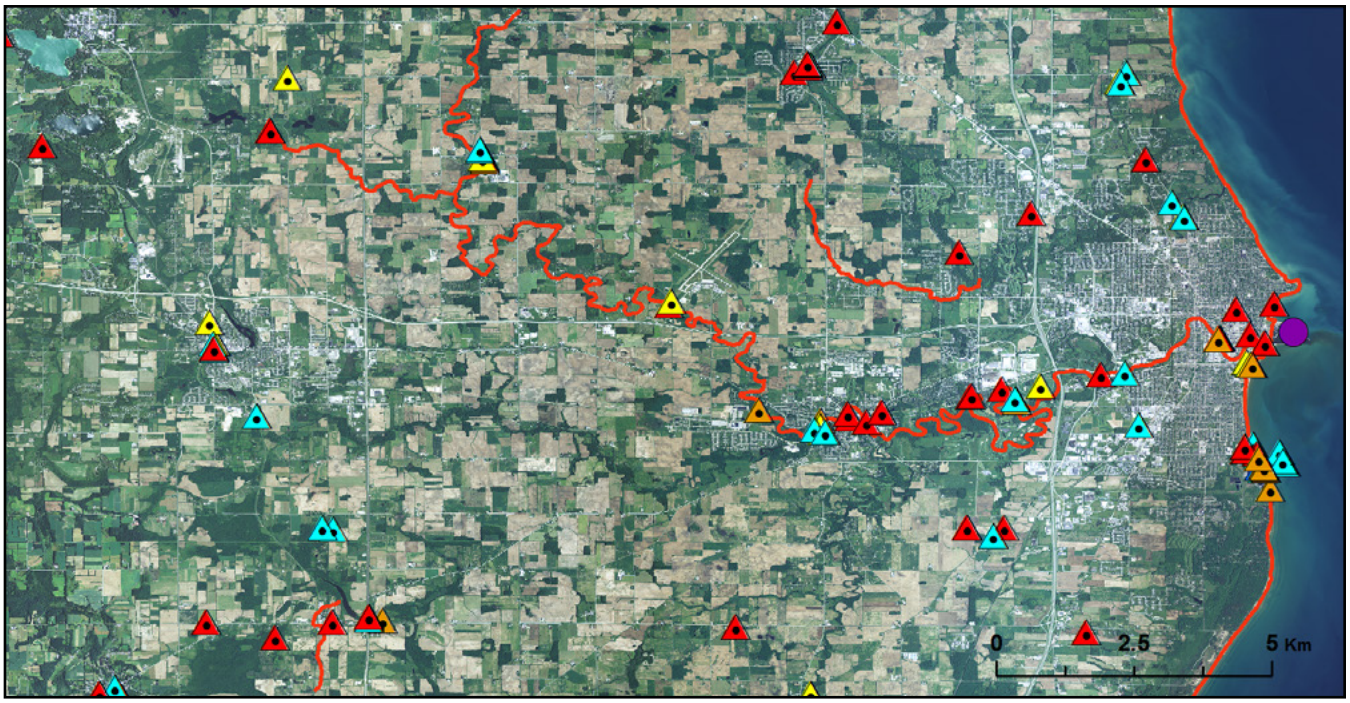
Sheboygan River



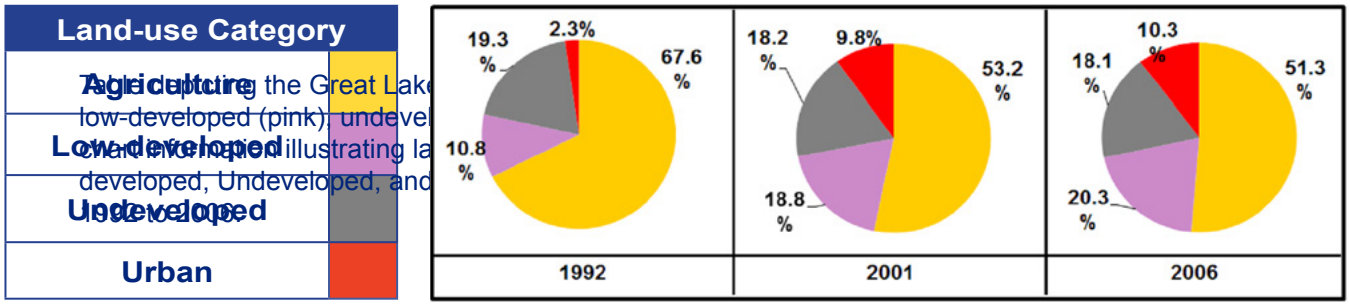
	LMSR	
	43.7516	
	-87.6973	
	WI	
	Agriculture	
	MW AOC	
	2010	
	73357	Low



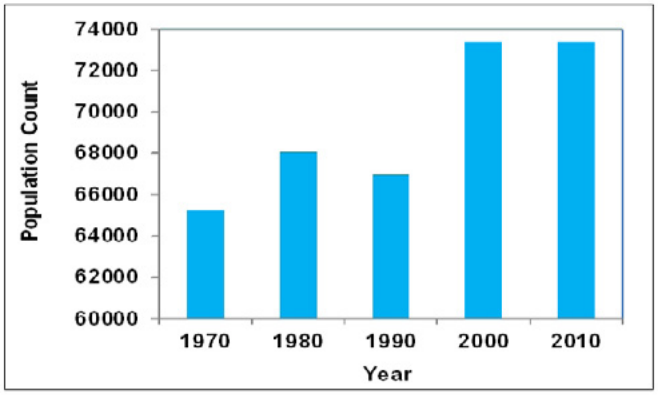
Spatial delineation: MWP site (●), associated watershed (▭), and AOC boundary (///) where applicable.



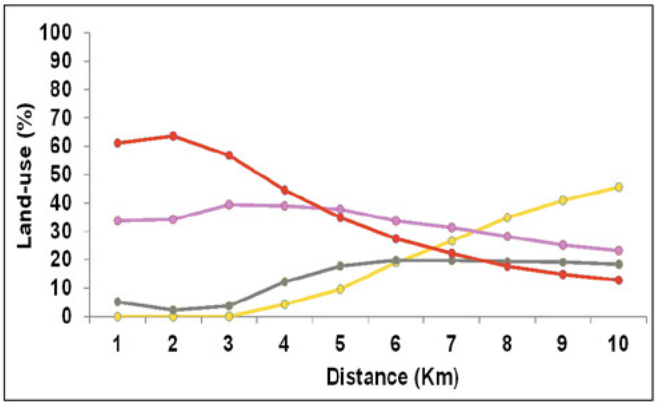
Outfalls: Aerial orthoimagery and map depicting MWP site (●), Impaired and Assessed Waters (▭), and U.S.EPA NPDES major and minor permitted facilities outfall types: POTW (▲), Non-POTW (▲), Wastewater Facilities (▲), Discharge Facilities (▲), Water Dischargers (▲), Combined Sewer Overflows (CSO's) (▲).



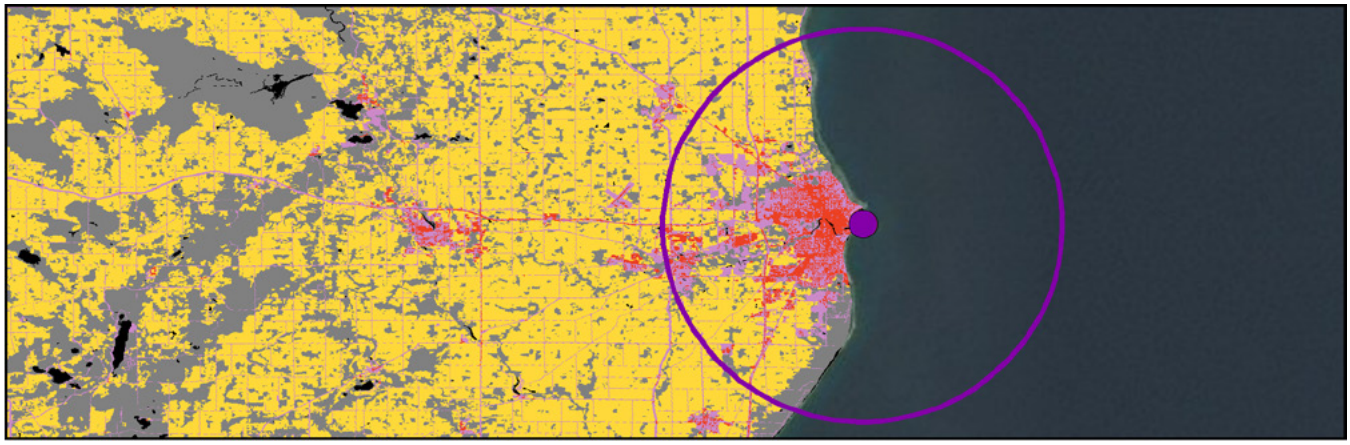
Legend: 1992 - 2006 National Land Cover Data (NLCD) aggregated hierarchal land-use categories, agriculture, low-developed, undeveloped and urban for Great Lakes Mussel Watch Program (MWP) sites.



Population barchart: Bar chart depicting population trend within 10 km buffer of MWP site (1970 - 2010).

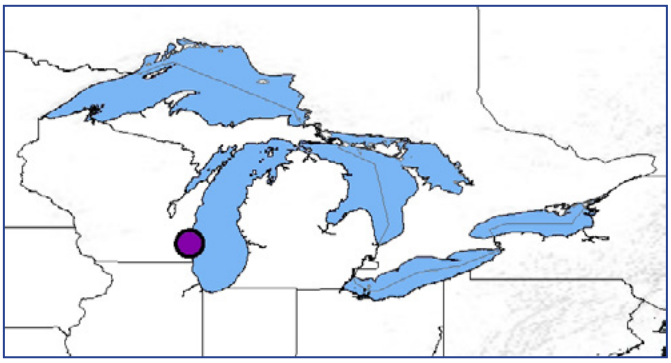


Line chart: MWP site 2006 NLCD land-use categories percentage within a 10 km buffer spatial extent.



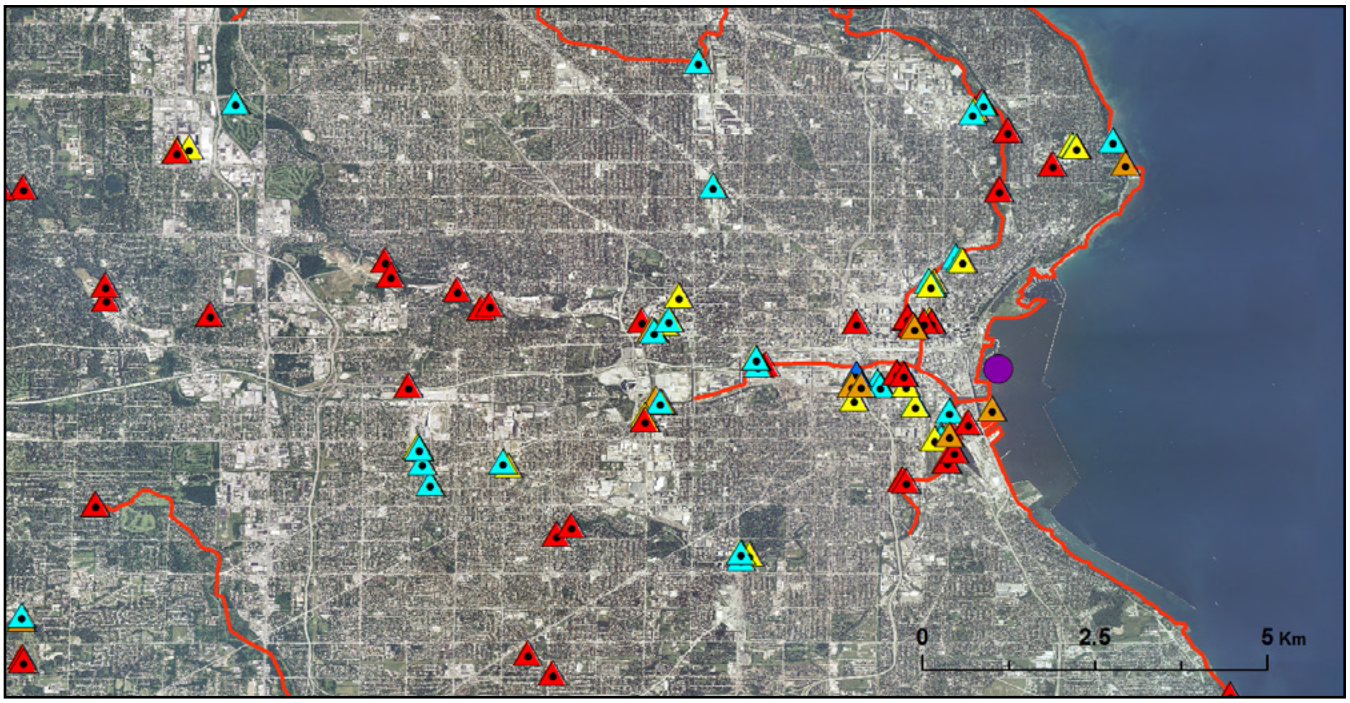
Land-use categories: MWP site (●) including 10 km buffer (○) and 2006 land-use categories from NLCD.

Milwaukee Bay

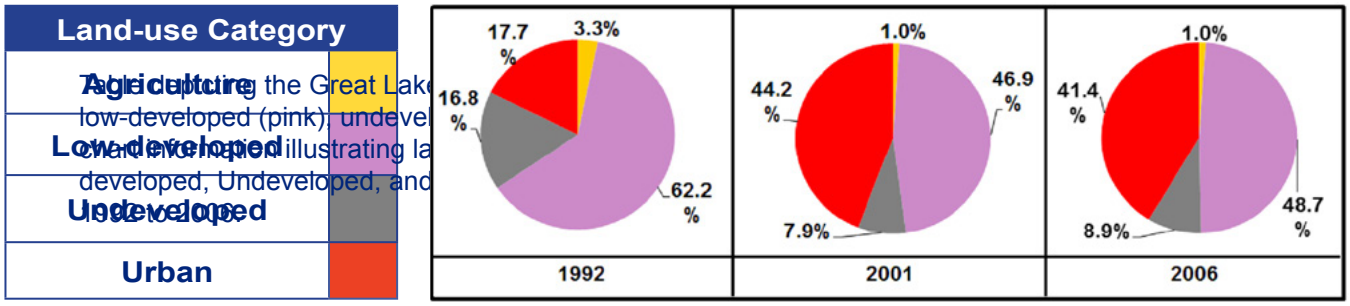


	LMMB	
	43.032166	
	-87.895167	
	WI	
	Urban	
	MW AOC	
	2010	
	774551	High

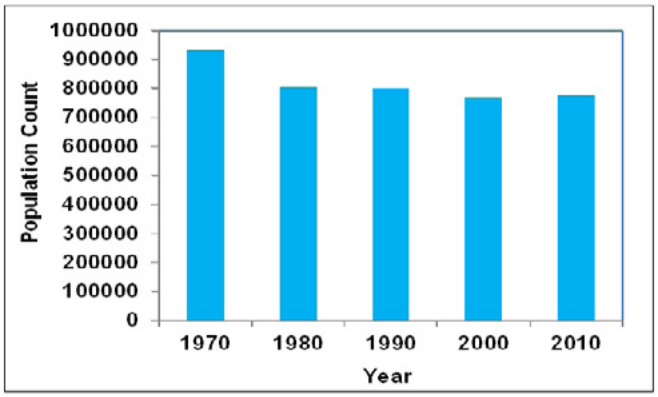
Spatial delineation: MWP site (●), associated watershed (▭), and AOC boundary (///) where applicable.



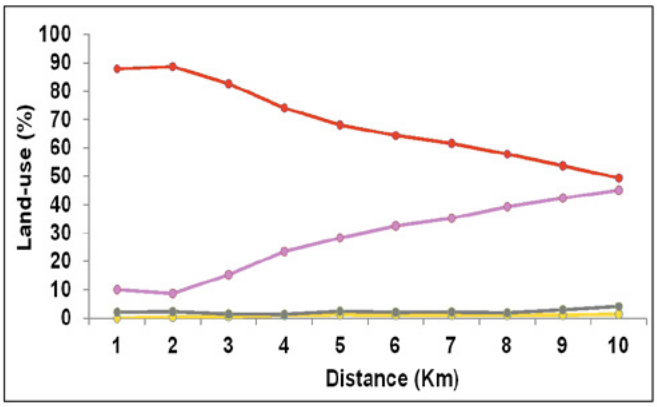
Outfalls: Aerial orthoimagery and map depicting MWP site (●), Impaired and Assessed Waters (▭), and U.S.EPA NPDES major and minor permitted facilities outfall types: POTW (▲), Non-POTW (▲), Wastewater Facilities (▲), Discharge Facilities (▲), Water Dischargers (▲), Combined Sewer Overflows (CSO's) (▲).



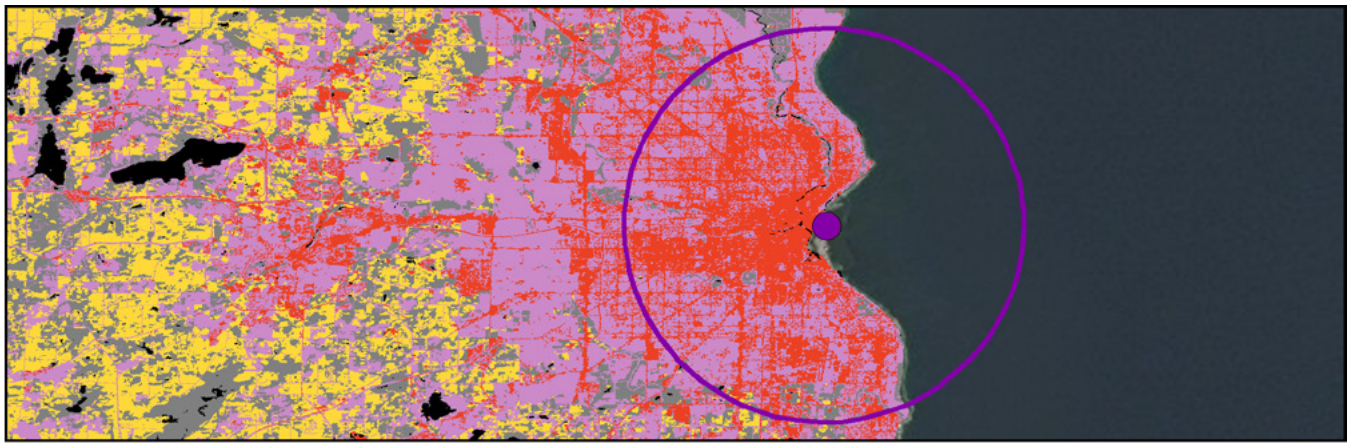
Legend: 1992 - 2006 National Land Cover Data (NLCD) aggregated hierarchal land-use categories, agriculture, low-developed, undeveloped and urban for Great Lakes Mussel Watch Program (MWP) sites.



Population barchart: Bar chart depicting population trend within 10 km buffer of MWP site (1970 - 2010).

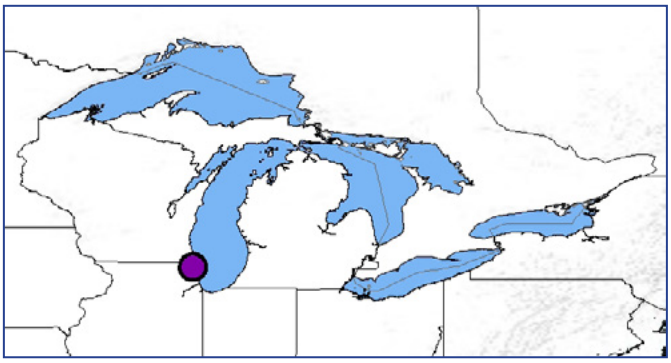


Line chart: MWP site 2006 NLCD land-use categories percentage within a 10 km buffer spatial extent.



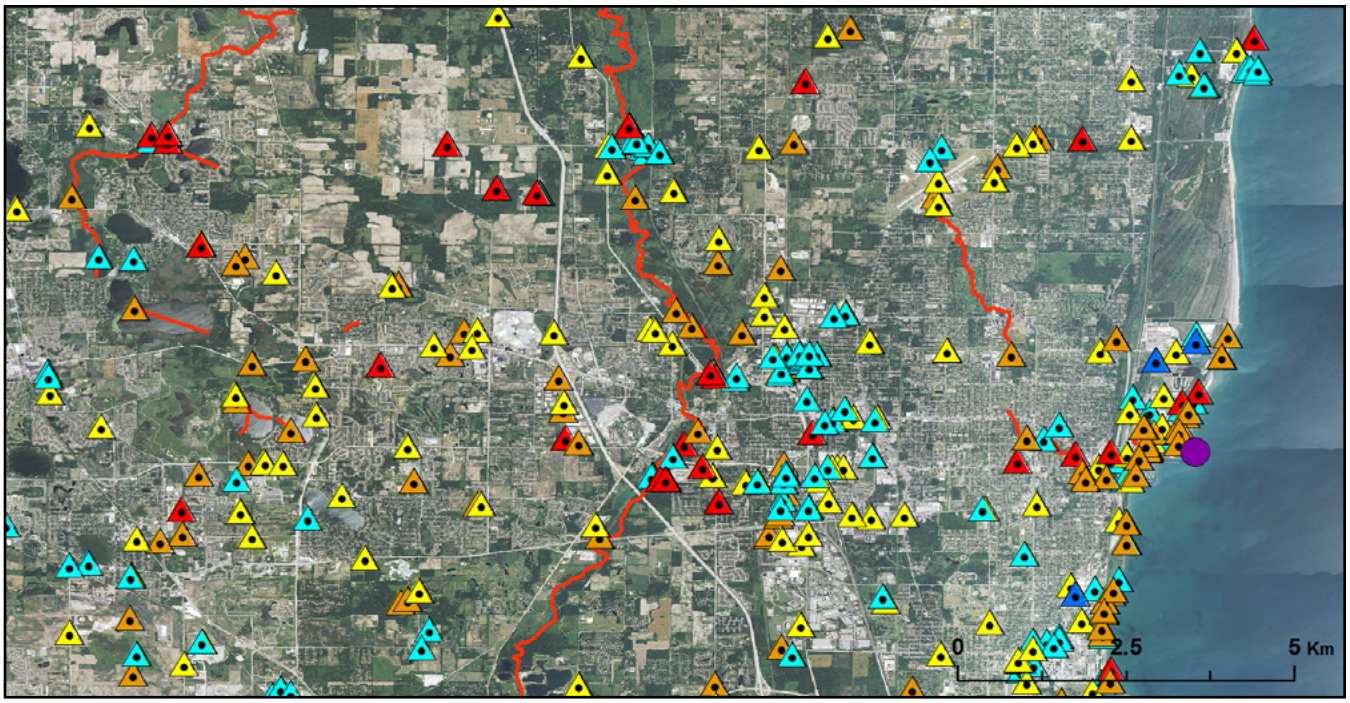
Land-use categories: MWP site (●) including 10 km buffer (○) and 2006 land-use categories from NLCD.

Waukegan Harbor

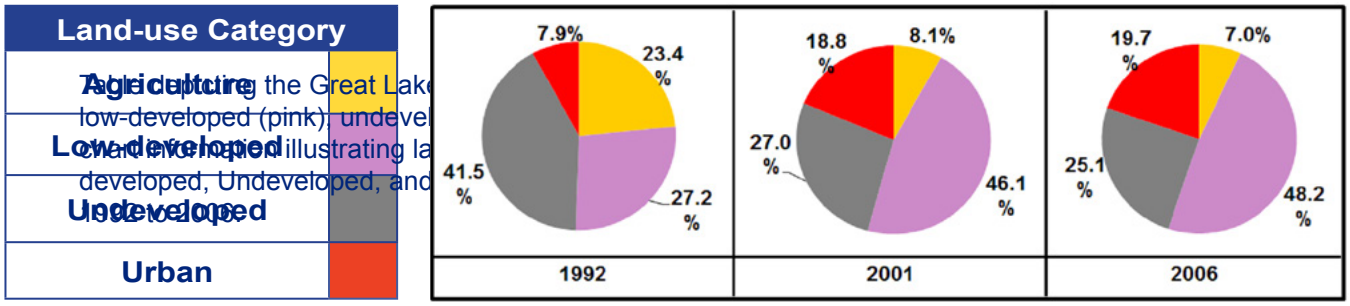


	LMWH	
	42.36278	
	-87.8117	
	IL	
	Low-developed	
	MW AOC	
	2010	
	234800	Medium

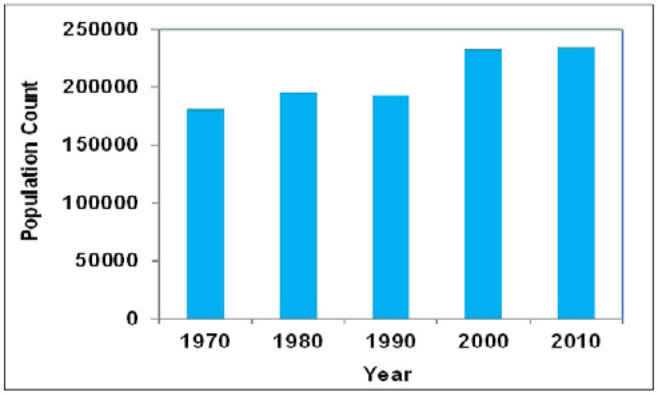
Spatial delineation: MWP site (●), associated watershed (▭), and AOC boundary (///) where applicable.



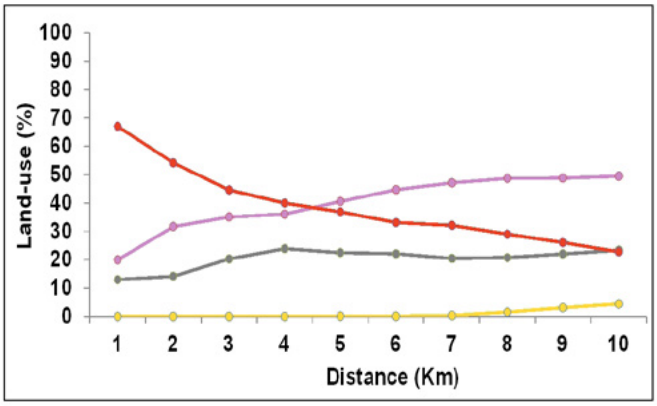
Outfalls: Aerial orthoimagery and map depicting MWP site (●), Impaired and Assessed Waters (▭), and U.S.EPA NPDES major and minor permitted facilities outfall types: POTW (▲), Non-POTW (▲), Wastewater Facilities (▲), Discharge Facilities (▲), Water Dischargers (▲), Combined Sewer Overflows (CSO's) (▲).



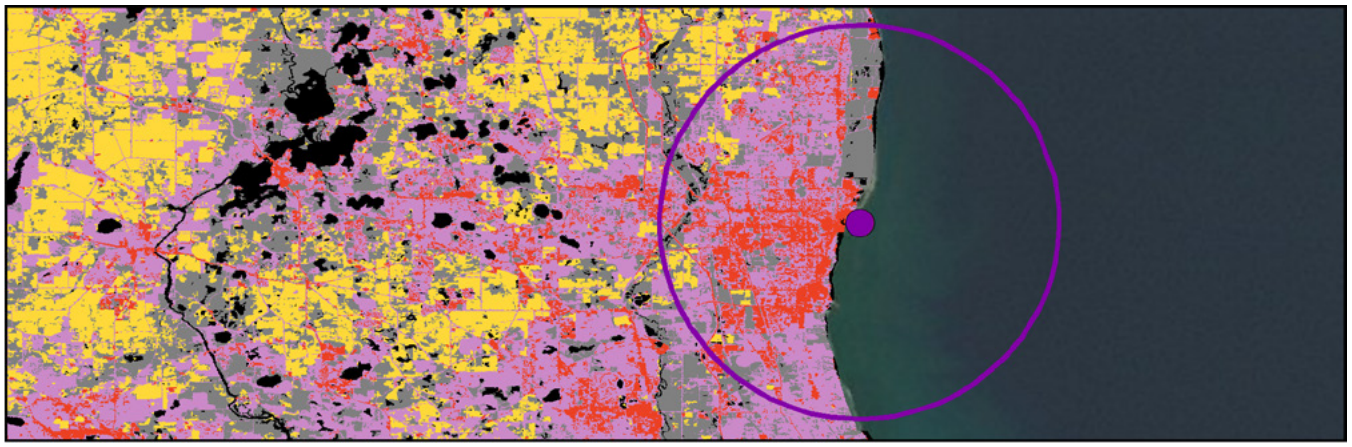
Legend: 1992 - 2006 National Land Cover Data (NLCD) aggregated hierarchal land-use categories, agriculture, low-developed, undeveloped and urban for Great Lakes Mussel Watch Program (MWP) sites.



Population barchart: Bar chart depicting population trend within 10 km buffer of MWP site (1970 - 2010).

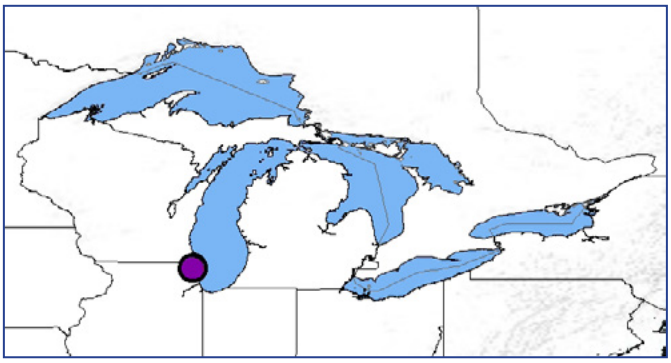


Line chart: MWP site 2006 NLCD land-use categories percentage within a 10 km buffer spatial extent.

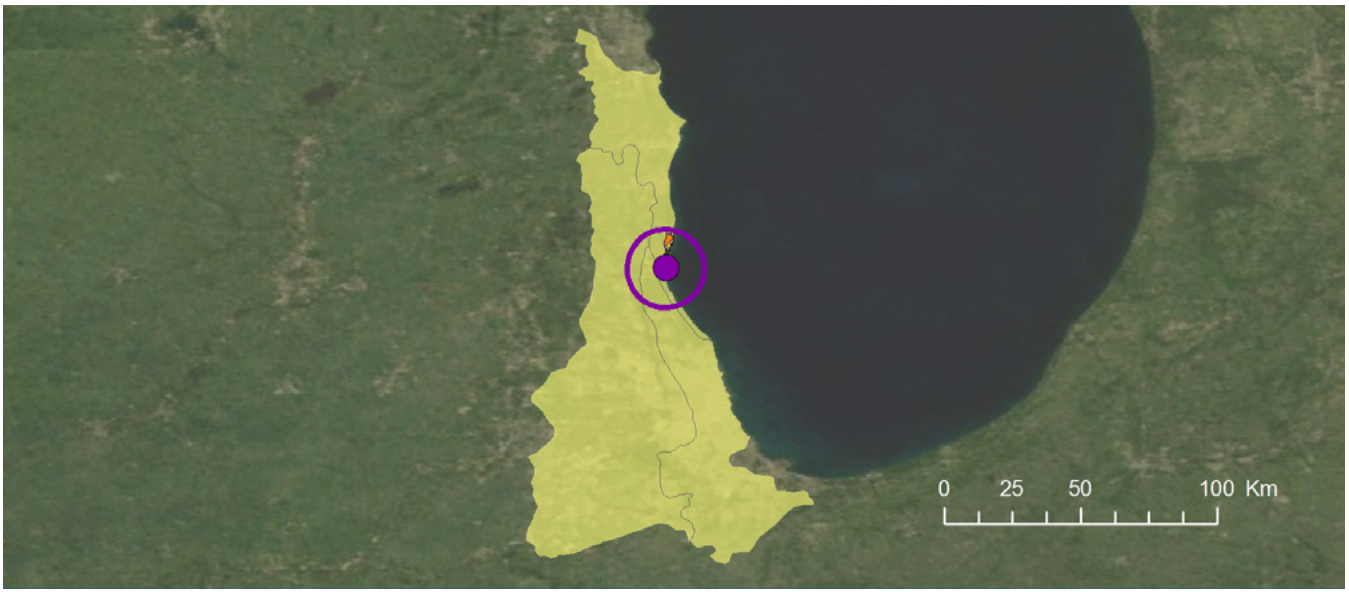


Land-use categories: MWP site (●) including 10 km buffer (○) and 2006 land-use categories from NLCD.

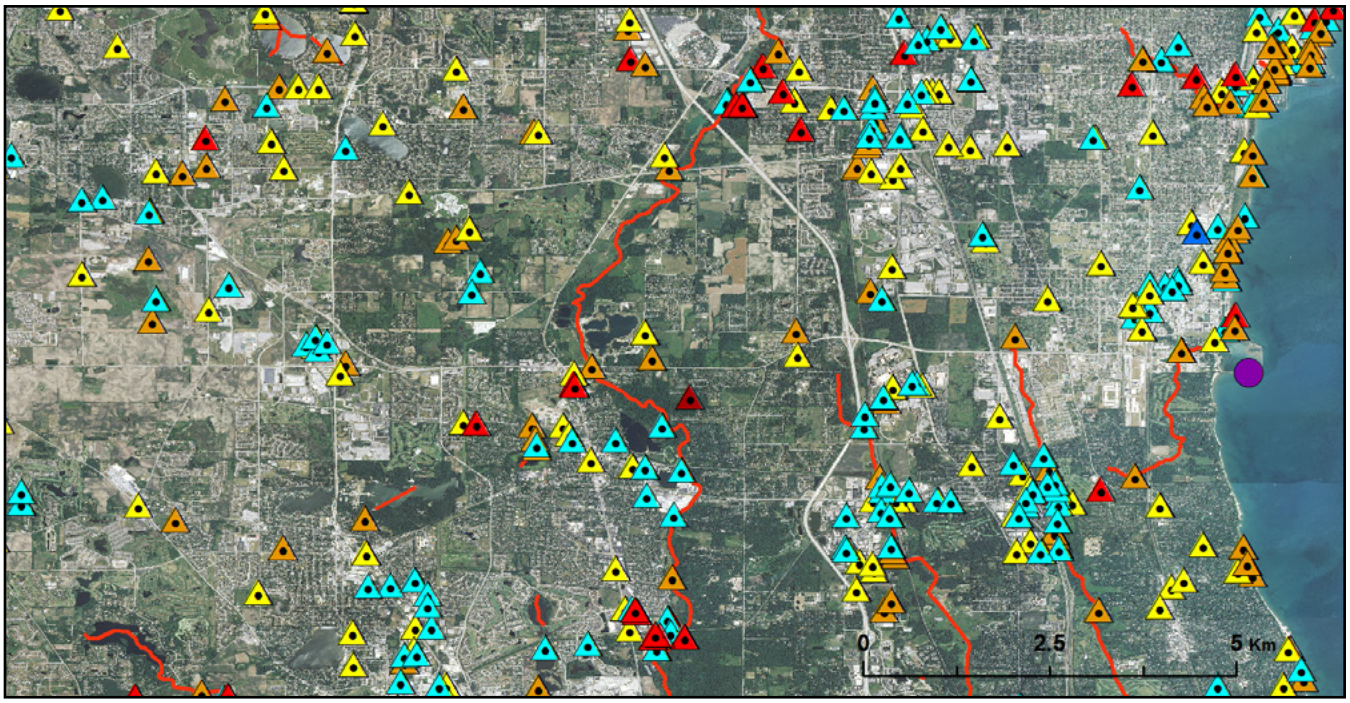
North Chicago



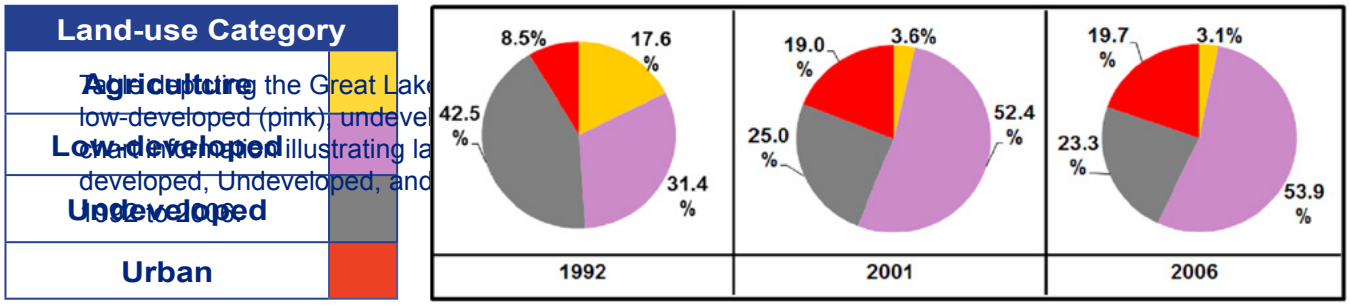
	LMNC	
	42.304666	
	-87.827333	
	IL	
	Low-developed	
	MW REF	
	1993	
	284887	Medium



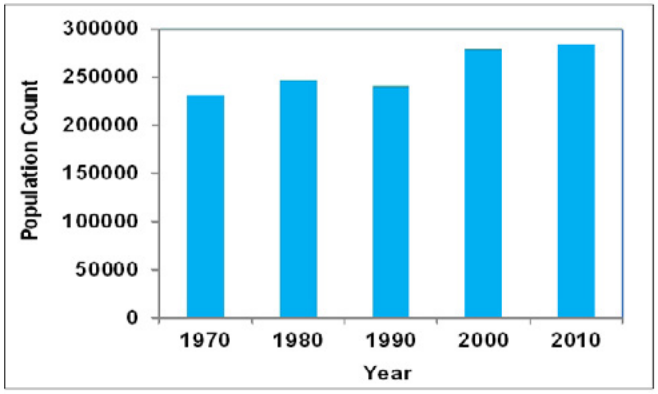
Spatial delineation: MWP site (●), associated watershed (▭), and AOC boundary (///) where applicable.



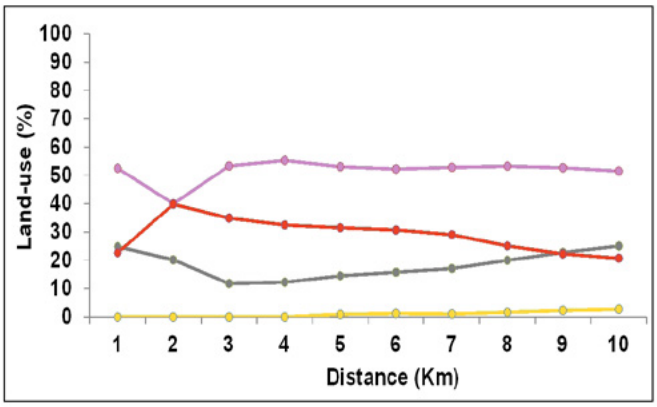
Outfalls: Aerial orthoimagery and map depicting MWP site (●), Impaired and Assessed Waters (▭), and U.S.EPA NPDES major and minor permitted facilities outfall types: POTW (▲), Non-POTW (▲), Wastewater Facilities (▲), Discharge Facilities (▲), Water Dischargers (▲), Combined Sewer Overflows (CSO's) (▲).



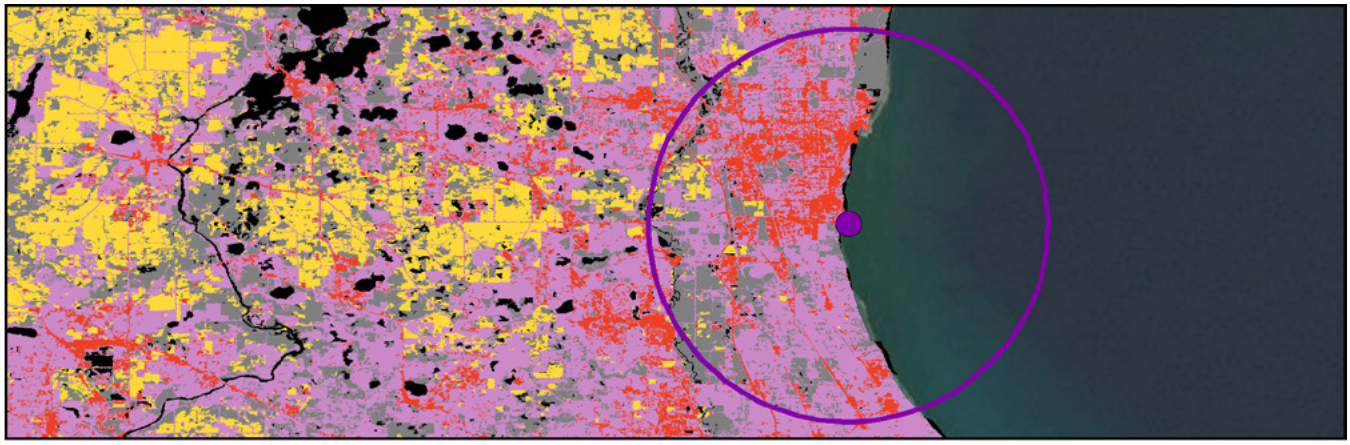
Legend: 1992 - 2006 National Land Cover Data (NLCD) aggregated hierarchal land-use categories, agriculture, low-developed, undeveloped and urban for Great Lakes Mussel Watch Program (MWP) sites.



Population barchart: Bar chart depicting population trend within 10 km buffer of MWP site (1970 - 2010).



Line chart: MWP site 2006 NLCD land-use categories percentage within a 10 km buffer spatial extent.

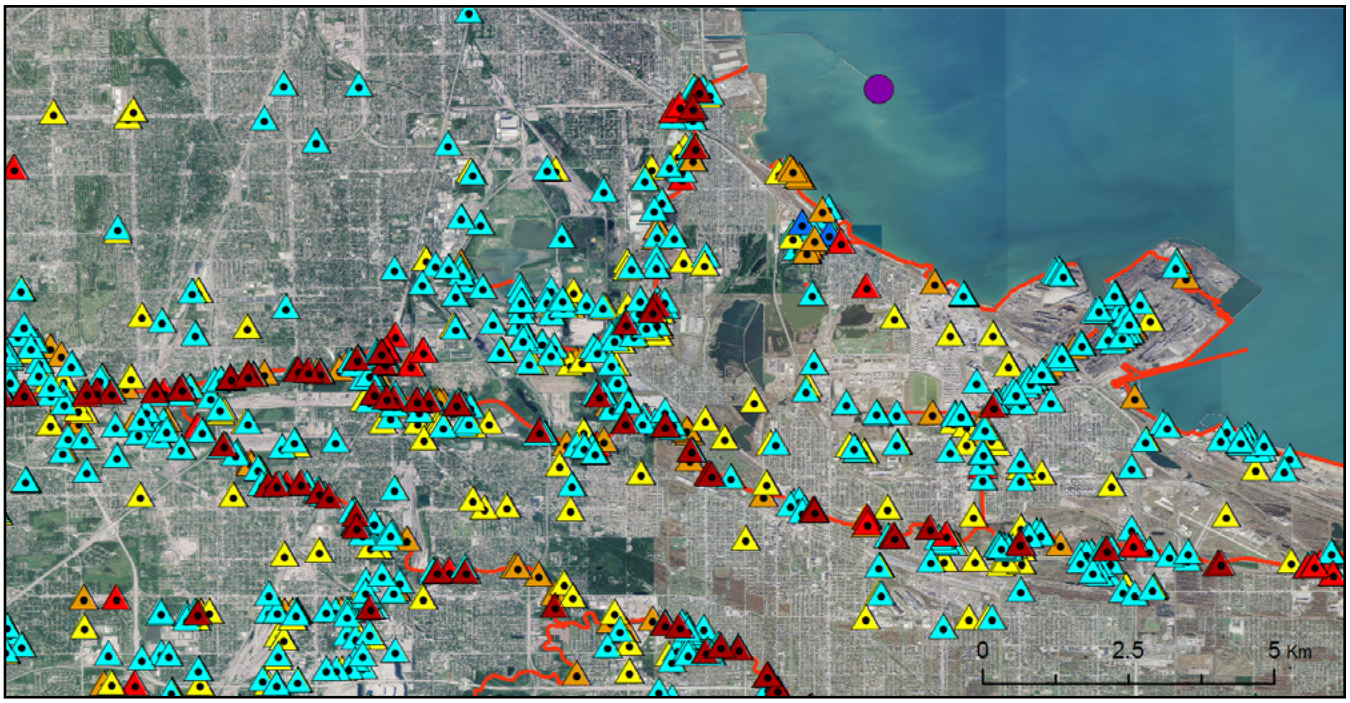


Land-use categories: MWP site (●) including 10 km buffer (○) and 2006 land-use categories from NLCD.

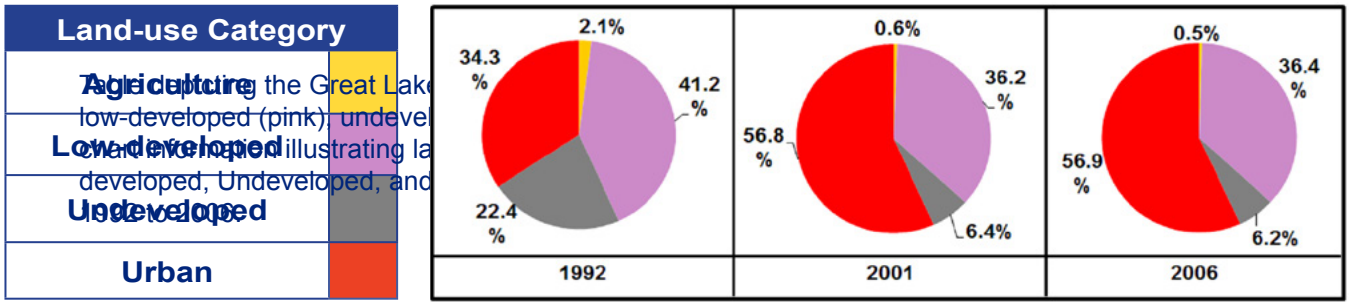
Calumet Breakwater

	LMCB	
	41.727166	
	-87.495	
	IN	
	Urban	
	MW AOC	
	2010	
	534979	High

Spatial delineation: MWP site (●), associated watershed (▭), and AOC boundary (///) where applicable.



Outfalls: Aerial orthoimagery and map depicting MWP site (●), Impaired and Assessed Waters (▭), and U.S.EPA NPDES major and minor permitted facilities outfall types: POTW (▲), Non-POTW (▲), Wastewater Facilities (▲), Discharge Facilities (▲), Water Dischargers (▲), Combined Sewer Overflows (CSO's) (▲).



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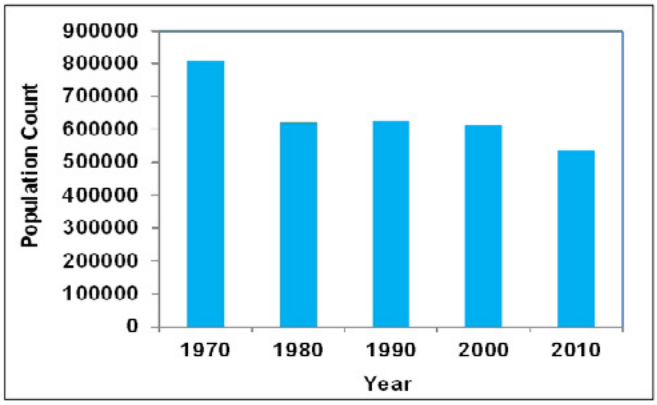
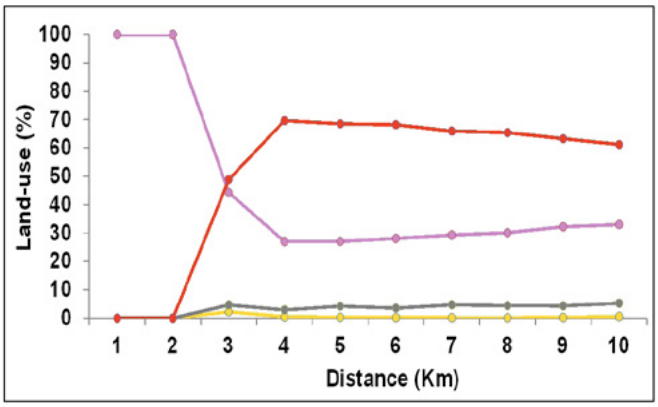


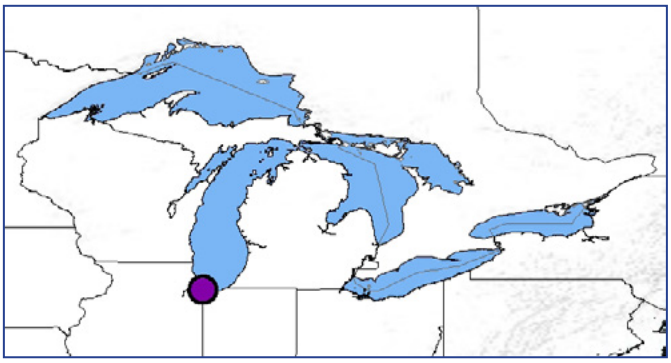
Population barchart: Bar chart depicting population trend within 10 km buffer of MWP site (1970 - 2010).



Line chart: MWP site 2006 NLCD land-use categories percentage within a 10 km buffer spatial extent.

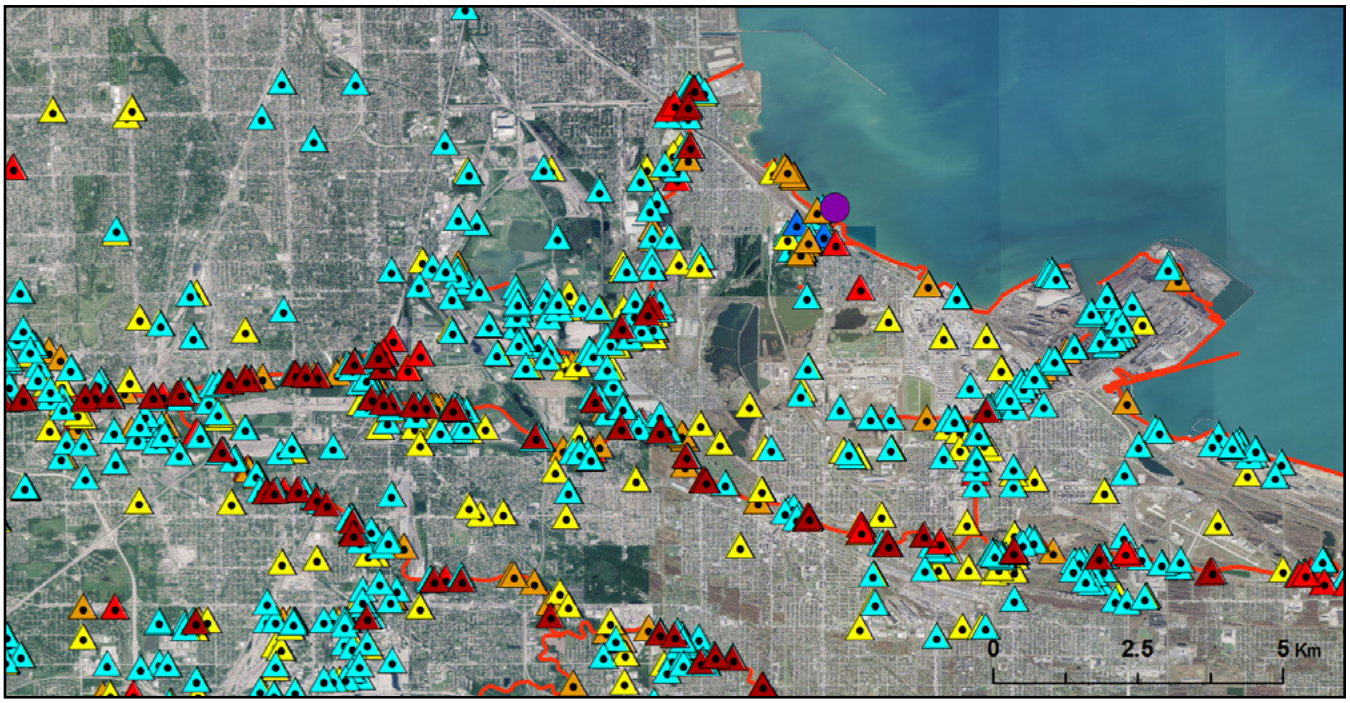
Land-use categories: MWP site (●) including 10 km buffer (○) and 2006 land-use categories from NLCD.

Hammond Marina



	LMHM	
	41.69865	
	-87.50825	
	IN	
	Urban	
	MW AOC	
	2010	
	656289	High

Spatial delineation: MWP site (●), associated watershed (▭), and AOC boundary (///) where applicable.



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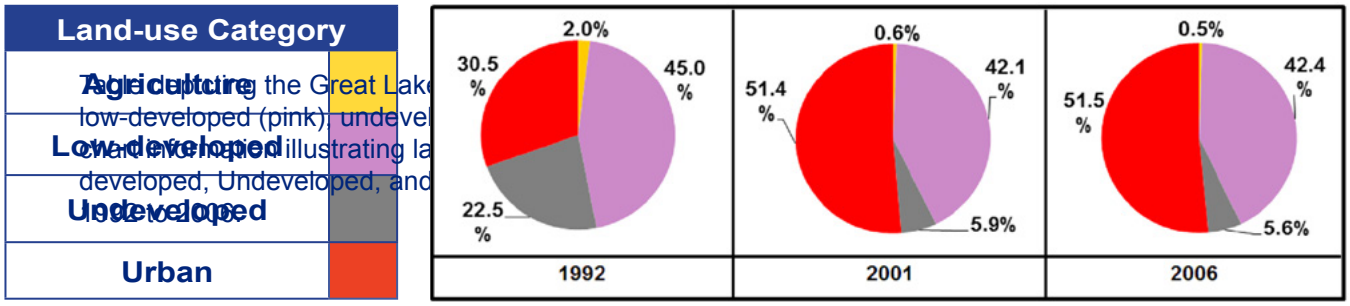

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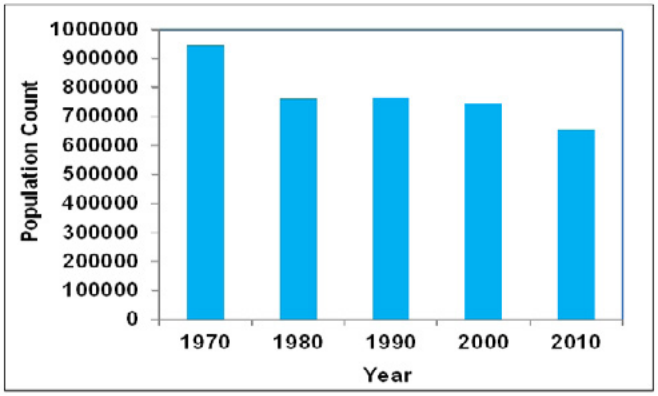

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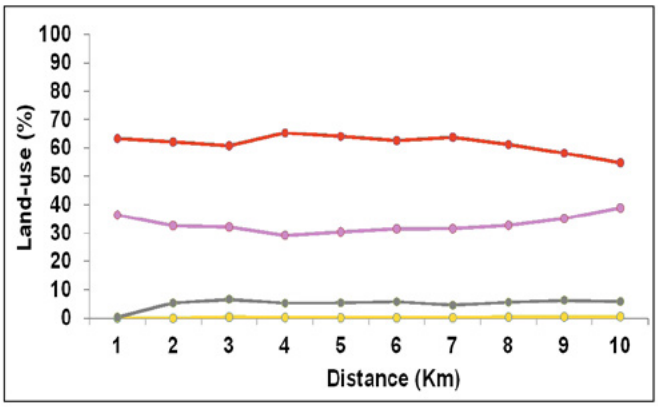
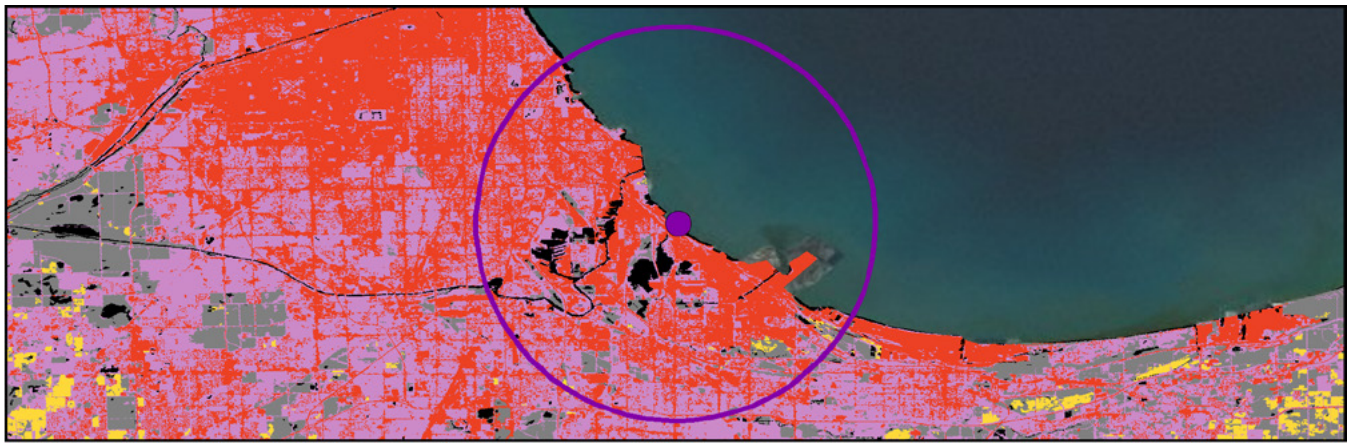
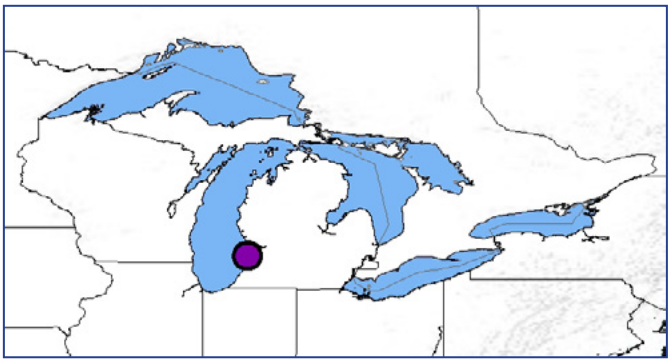


Line chart: MWP site 2006 NLCD land-use categories percentage within a 10 km buffer spatial extent.

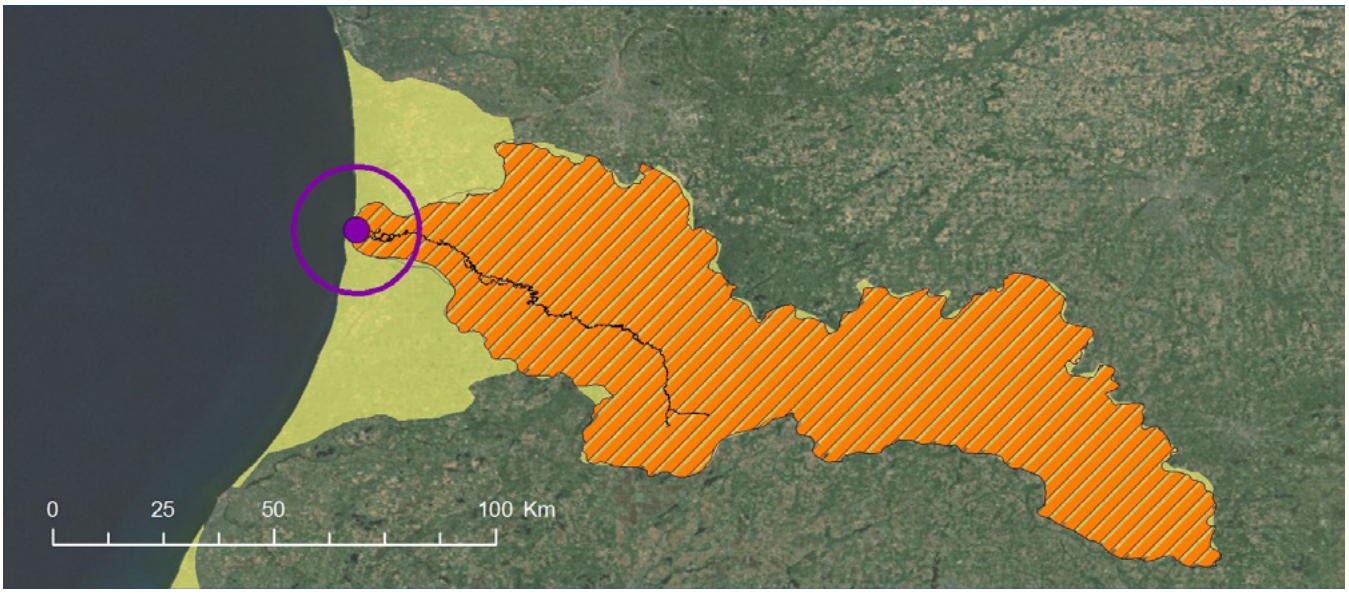


Land-use categories: MWP site (●) including 10 km buffer (○) and 2006 land-use categories from NLCD.

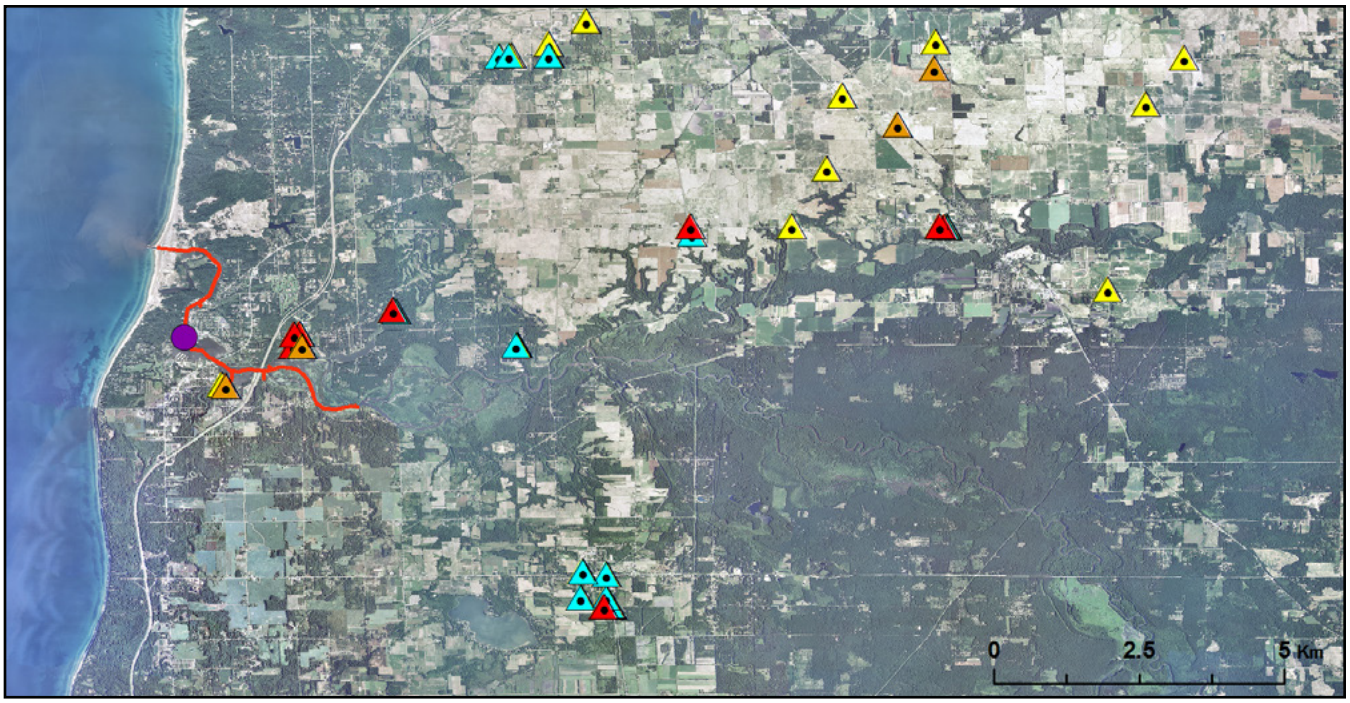
Kalamazoo River



	LMIK	
	42.65413	
	-86.2069	
	MI	
	Agriculture	
	MW AOC	
	2010	
	34724	Low



Spatial delineation: MWP site (●), associated watershed (▭), and AOC boundary (///) where applicable.



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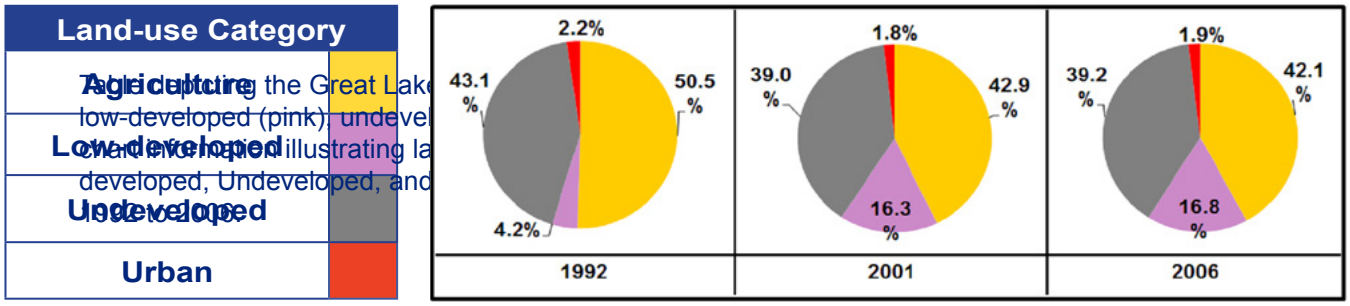

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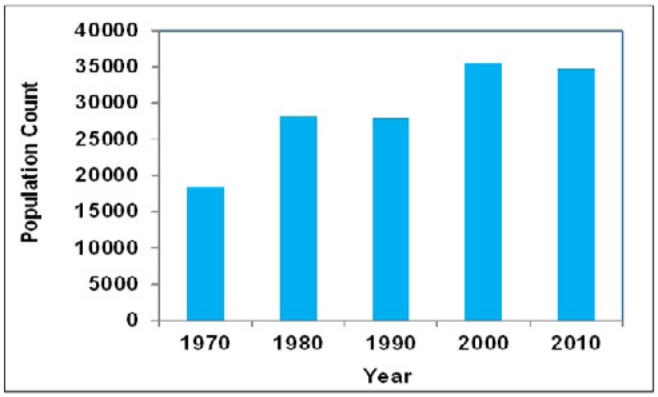
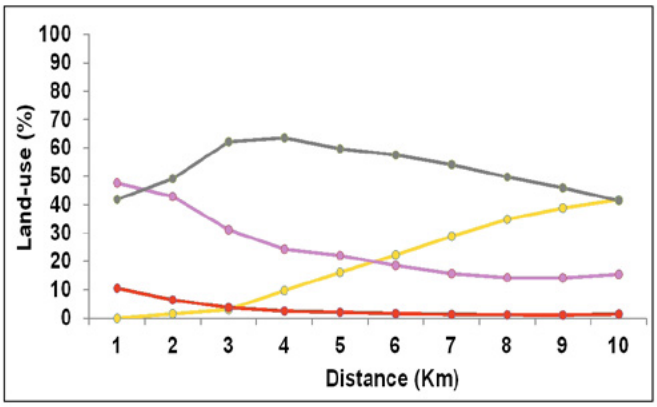
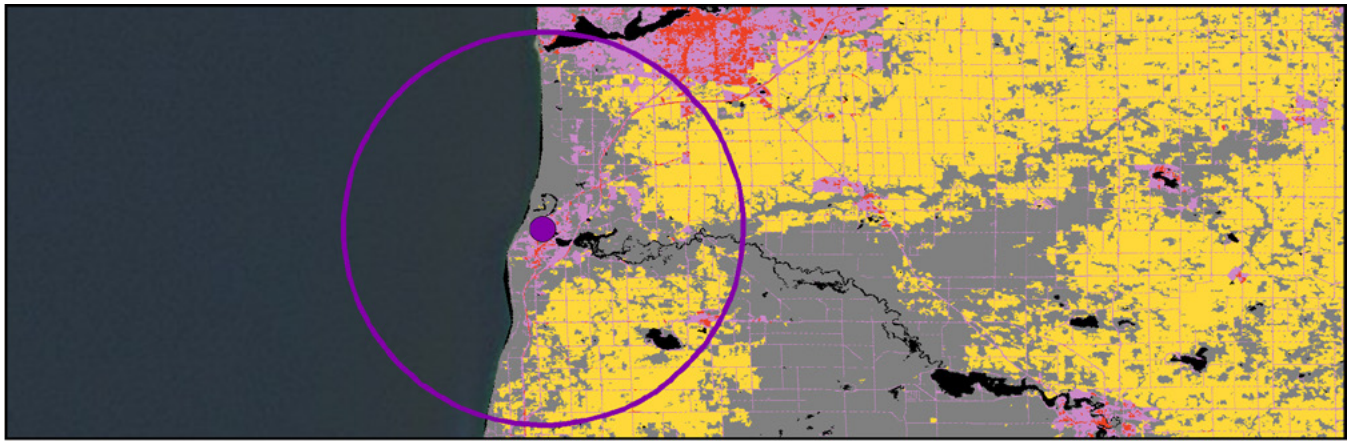


Population barchart: Bar chart depicting population trend within 10 km buffer of MWP site (1970 - 2010).

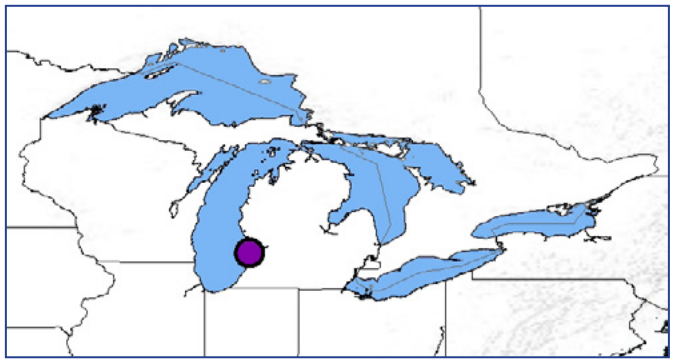


Line chart: MWP site 2006 NLCD land-use categories percentage within a 10 km buffer spatial extent.

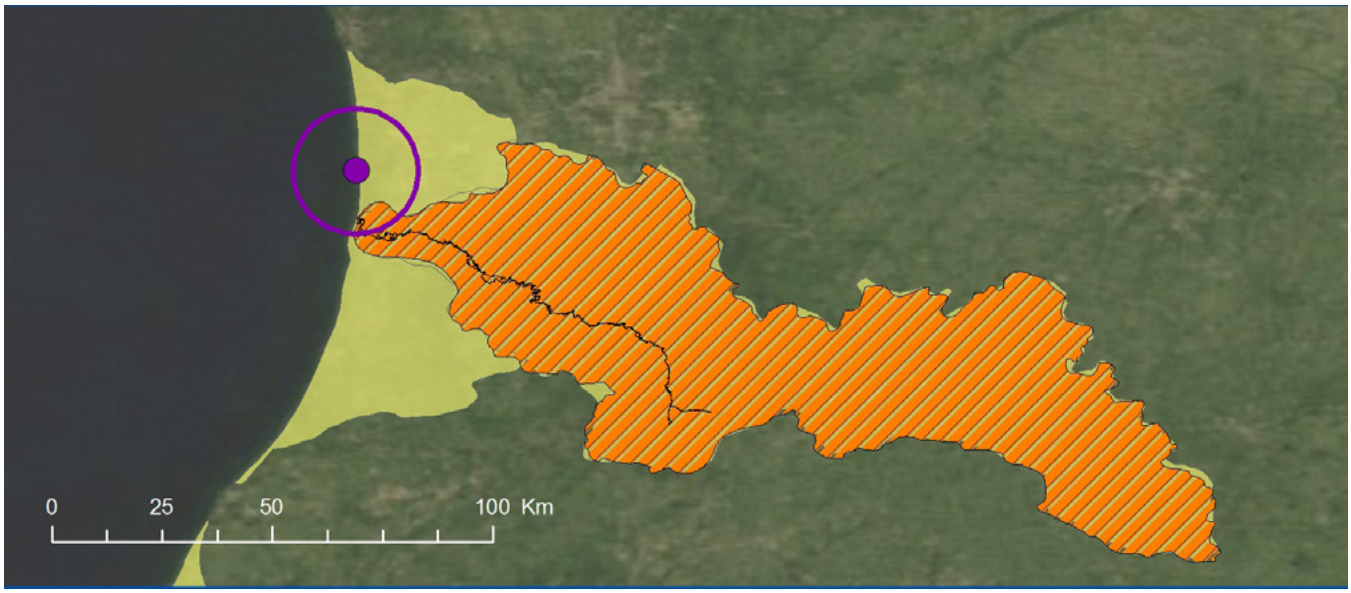


Land-use categories: MWP site (●) including 10 km buffer (○) and 2006 land-use categories from NLCD.

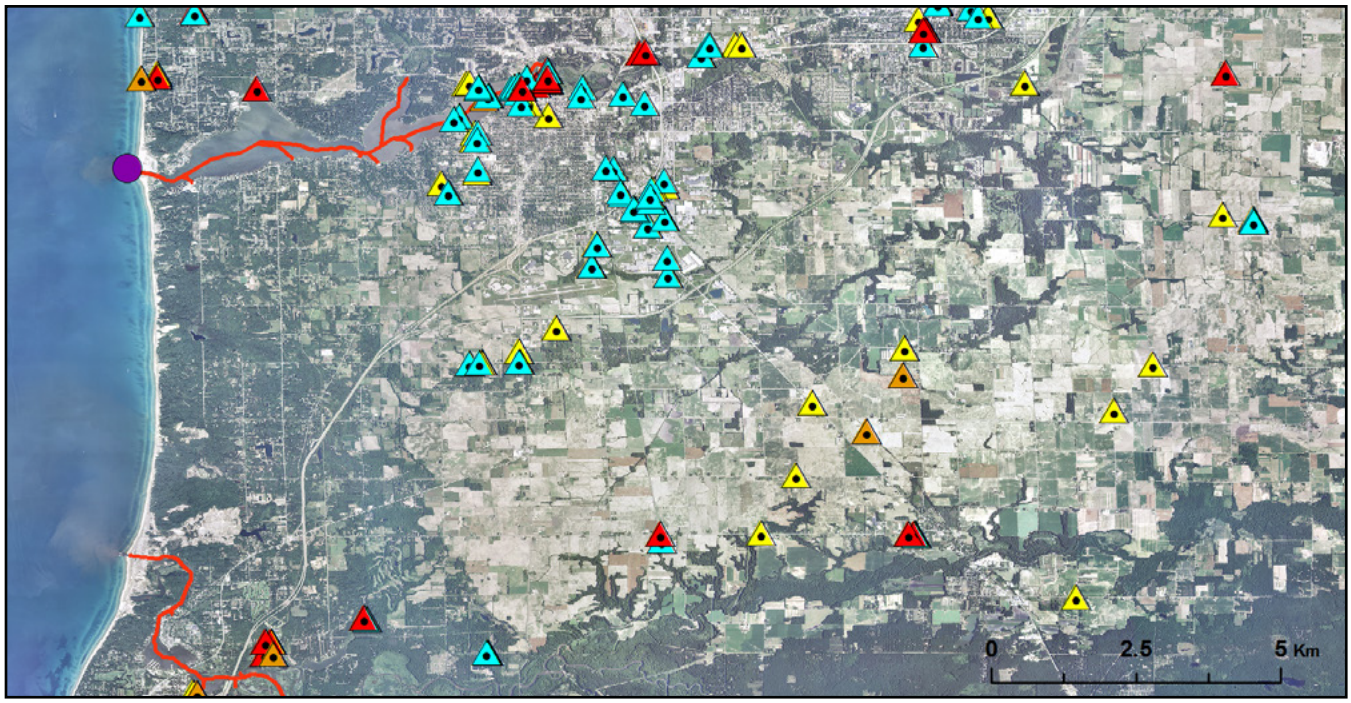
Holland Breakwater



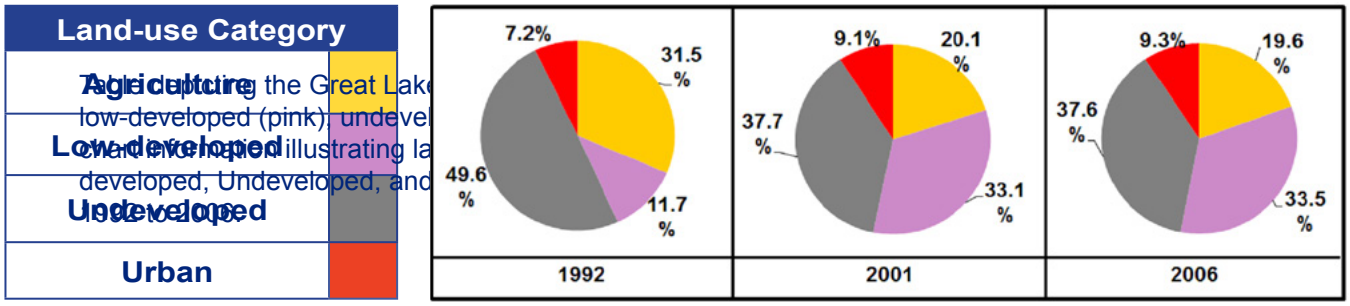
	LMHB	
	42.773166	
	-86.215	
	MI	
	Low-developed	
	MW REF	
	1993	
	85007	Low



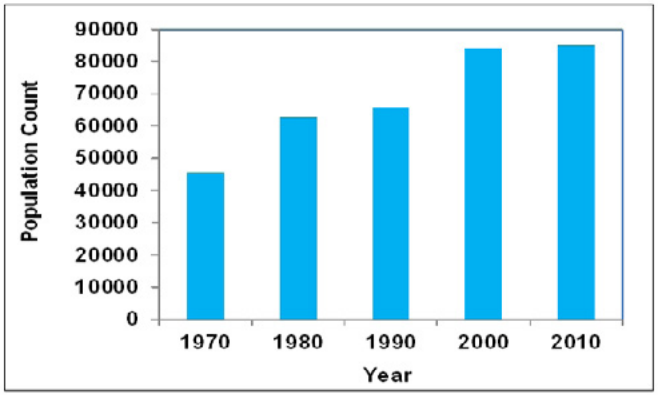
Spatial delineation: MWP site (●), associated watershed (▭), and AOC boundary (///) where applicable.



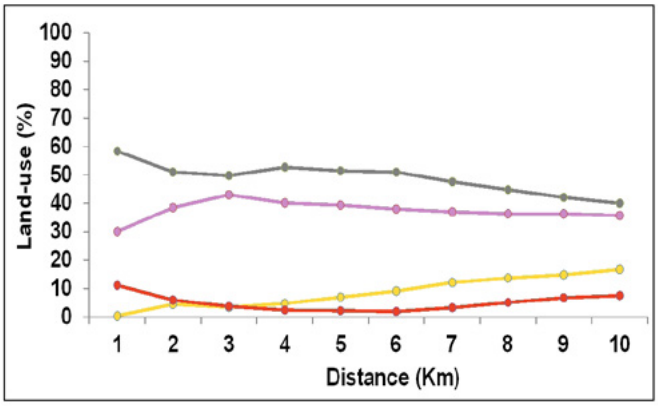
Outfalls: Aerial orthoimagery and map depicting MWP site (●), Impaired and Assessed Waters (▭), and U.S.EPA NPDES major and minor permitted facilities outfall types: POTW (▲), Non-POTW (▲), Wastewater Facilities (▲), Discharge Facilities (▲), Water Dischargers (▲), Combined Sewer Overflows (CSO's) (▲).



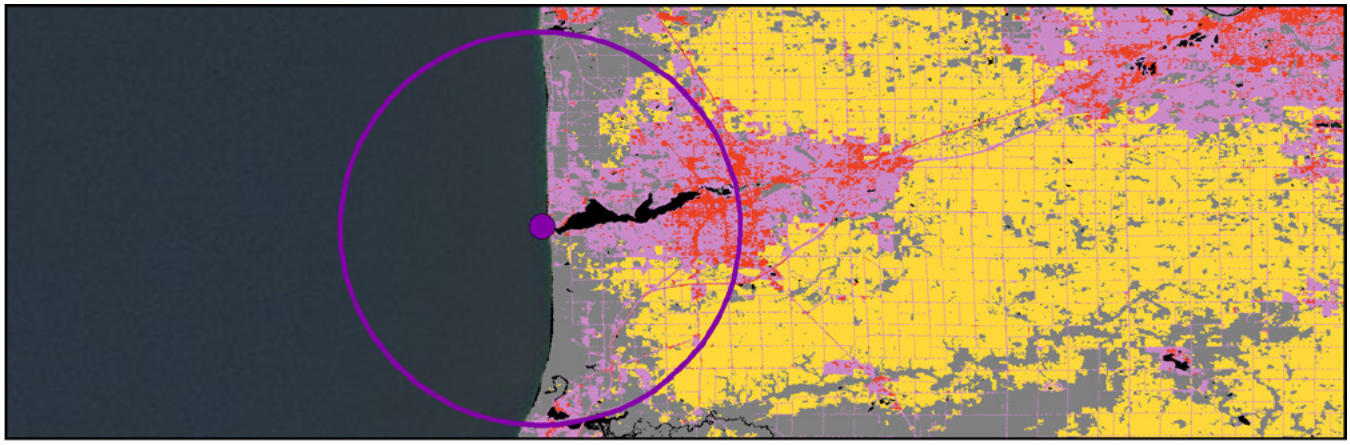
Legend: 1992 - 2006 National Land Cover Data (NLCD) aggregated hierarchal land-use categories, agriculture, low-developed, undeveloped and urban for Great Lakes Mussel Watch Program (MWP) sites.



Population barchart: Bar chart depicting population trend within 10 km buffer of MWP site (1970 - 2010).

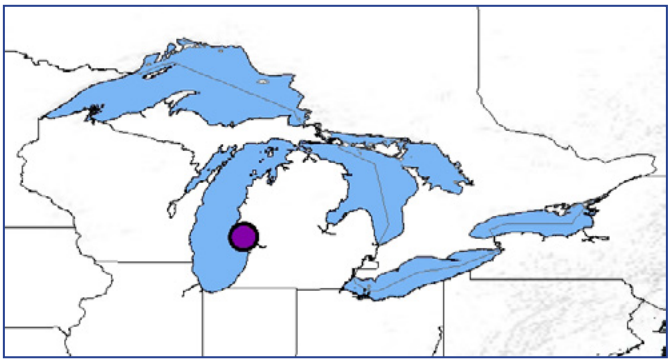


Line chart: MWP site 2006 NLCD land-use categories percentage within a 10 km buffer spatial extent.

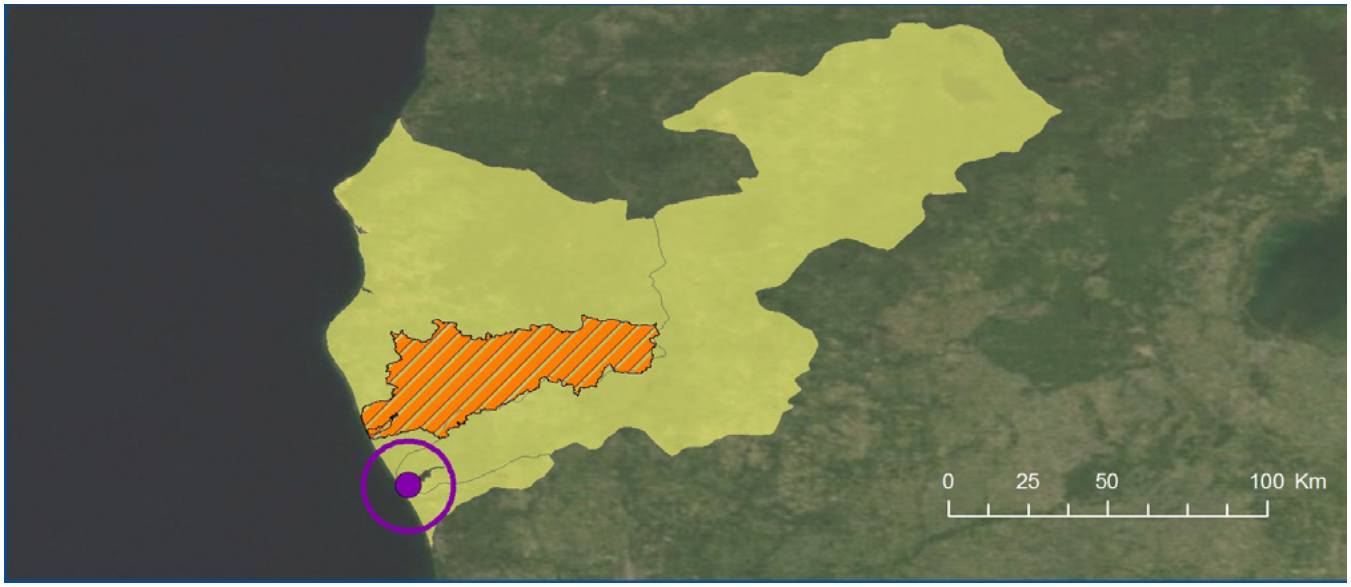


Land-use categories: MWP site (●) including 10 km buffer (○) and 2006 land-use categories from NLCD.

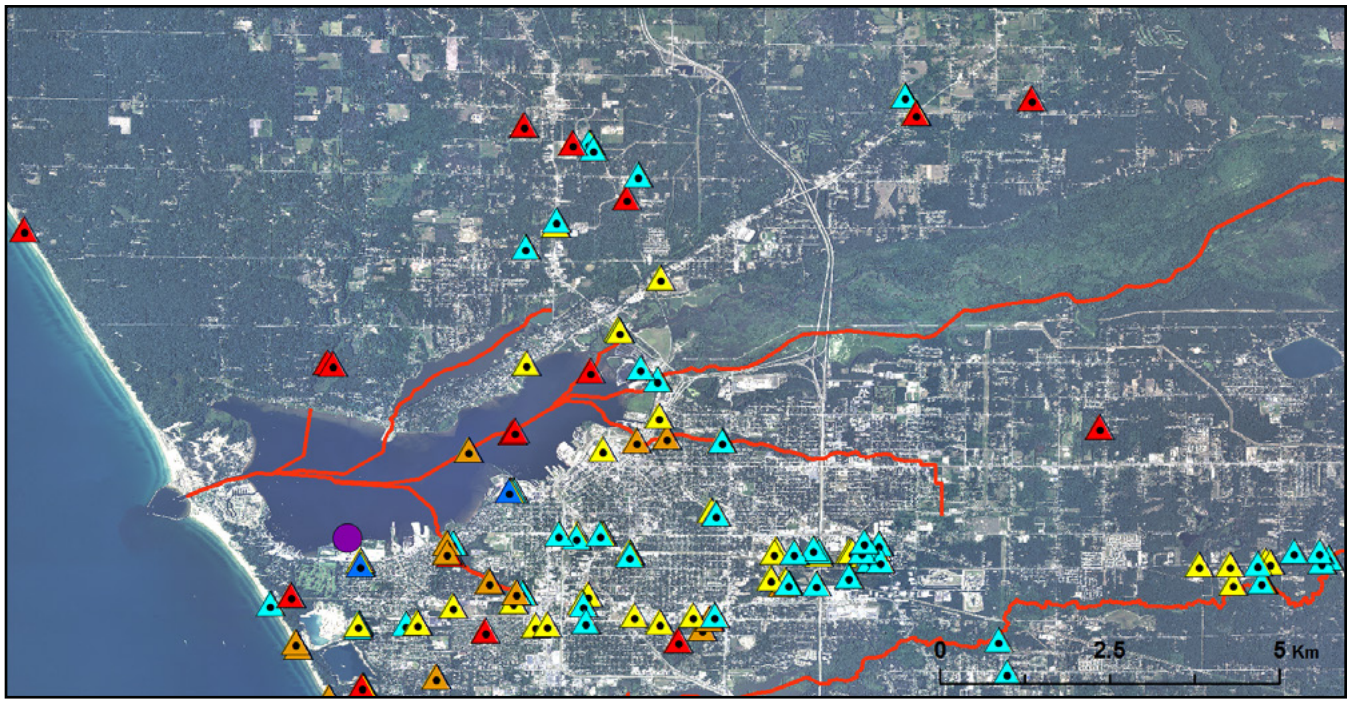
Muskegon Lake



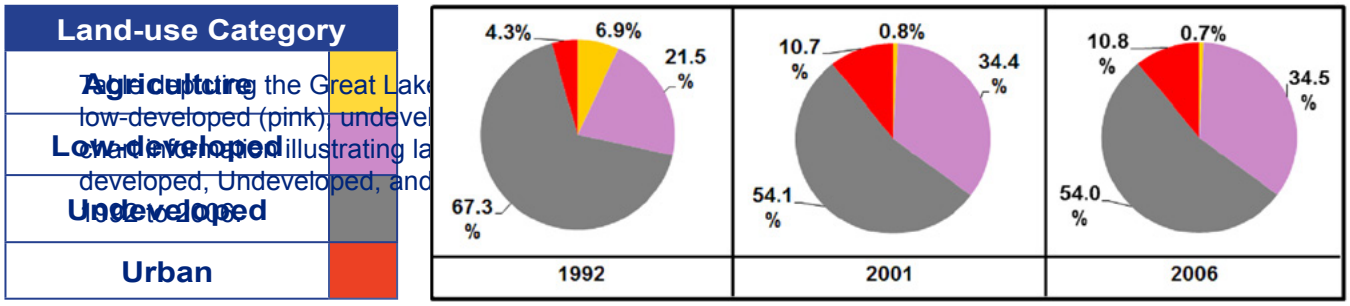
	LMML	
	43.21878	
	-86.3056	
	MI	
	Undeveloped	
	MW AOC	
	2010	
	122079	Low



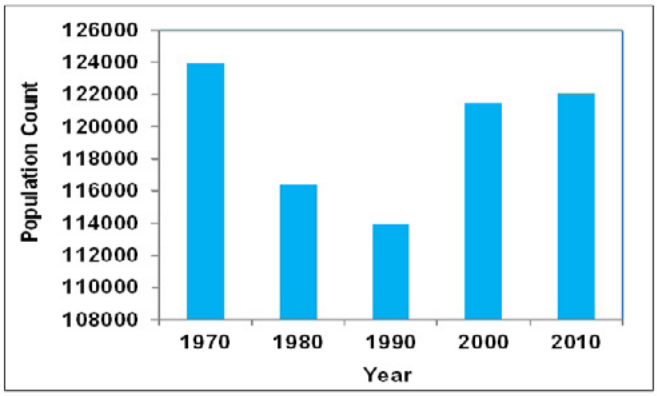
Spatial delineation: MWP site (●), associated watershed (▭), and AOC boundary (///) where applicable.



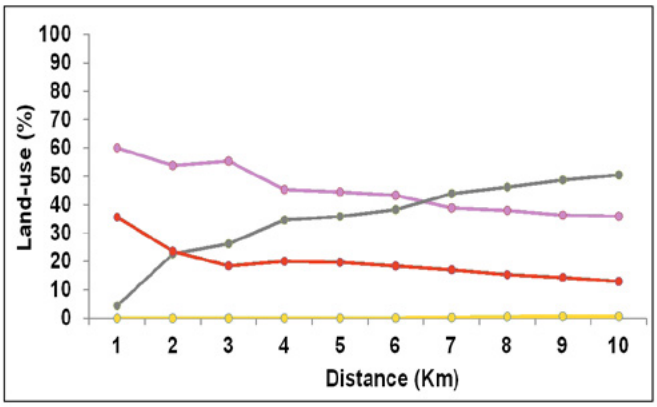
Outfalls: Aerial orthoimagery and map depicting MWP site (●), Impaired and Assessed Waters (▭), and U.S.EPA NPDES major and minor permitted facilities outfall types: POTW (▲), Non-POTW (▲), Wastewater Facilities (▲), Discharge Facilities (▲), Water Dischargers (▲), Combined Sewer Overflows (CSO's) (▲).



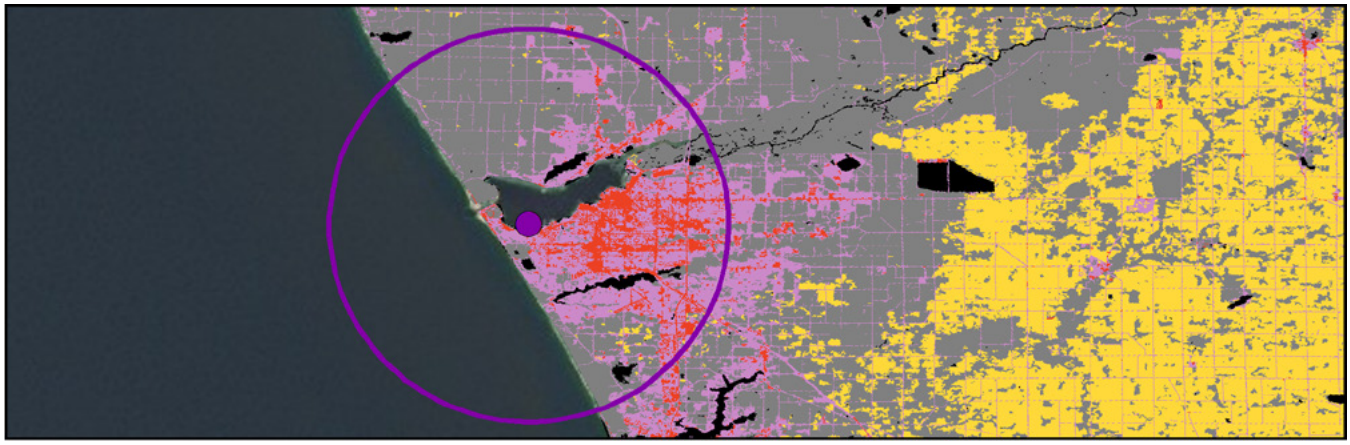
Legend: 1992 - 2006 National Land Cover Data (NLCD) aggregated hierarchal land-use categories, agriculture, low-developed, undeveloped and urban for Great Lakes Mussel Watch Program (MWP) sites.



Population barchart: Bar chart depicting population trend within 10 km buffer of MWP site (1970 - 2010).

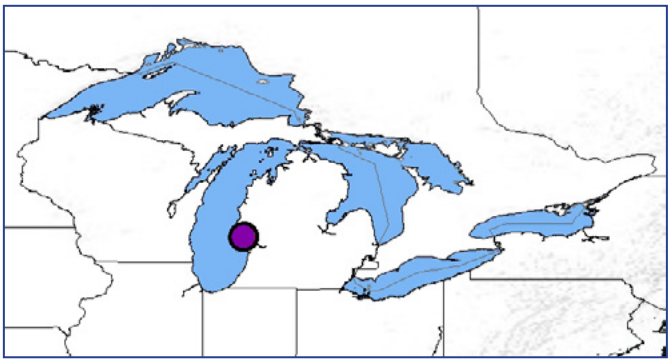


Line chart: MWP site 2006 NLCD land-use categories percentage within a 10 km buffer spatial extent.

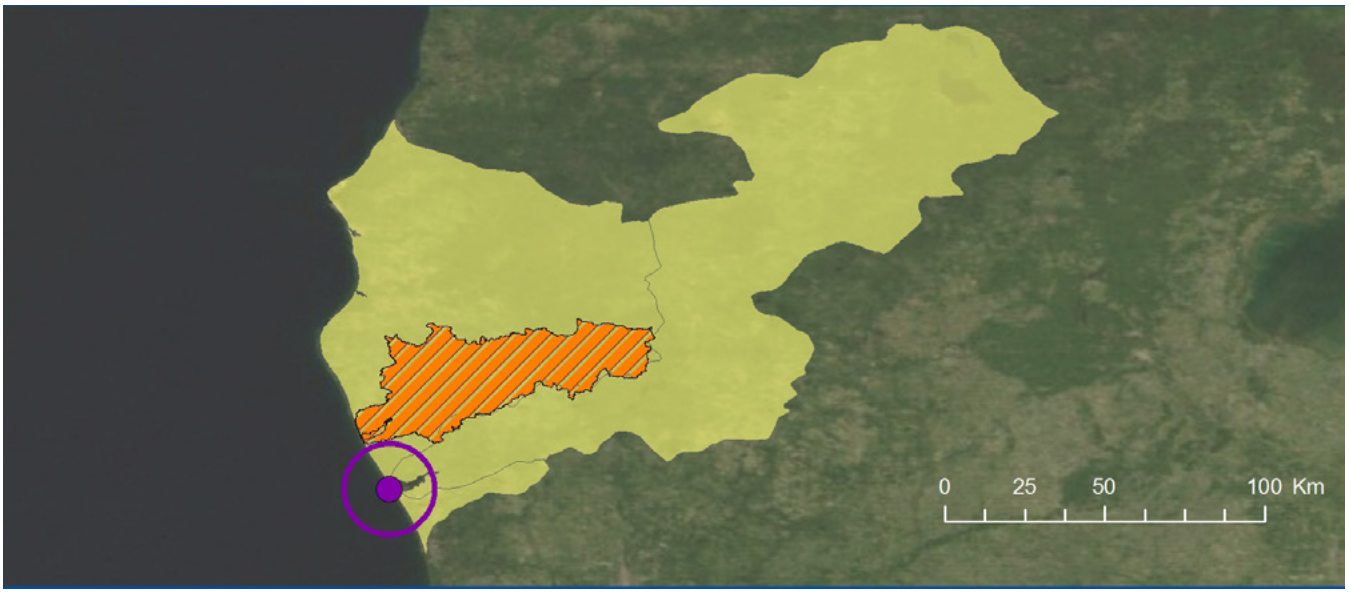


Land-use categories: MWP site (●) including 10 km buffer (○) and 2006 land-use categories from NLCD.

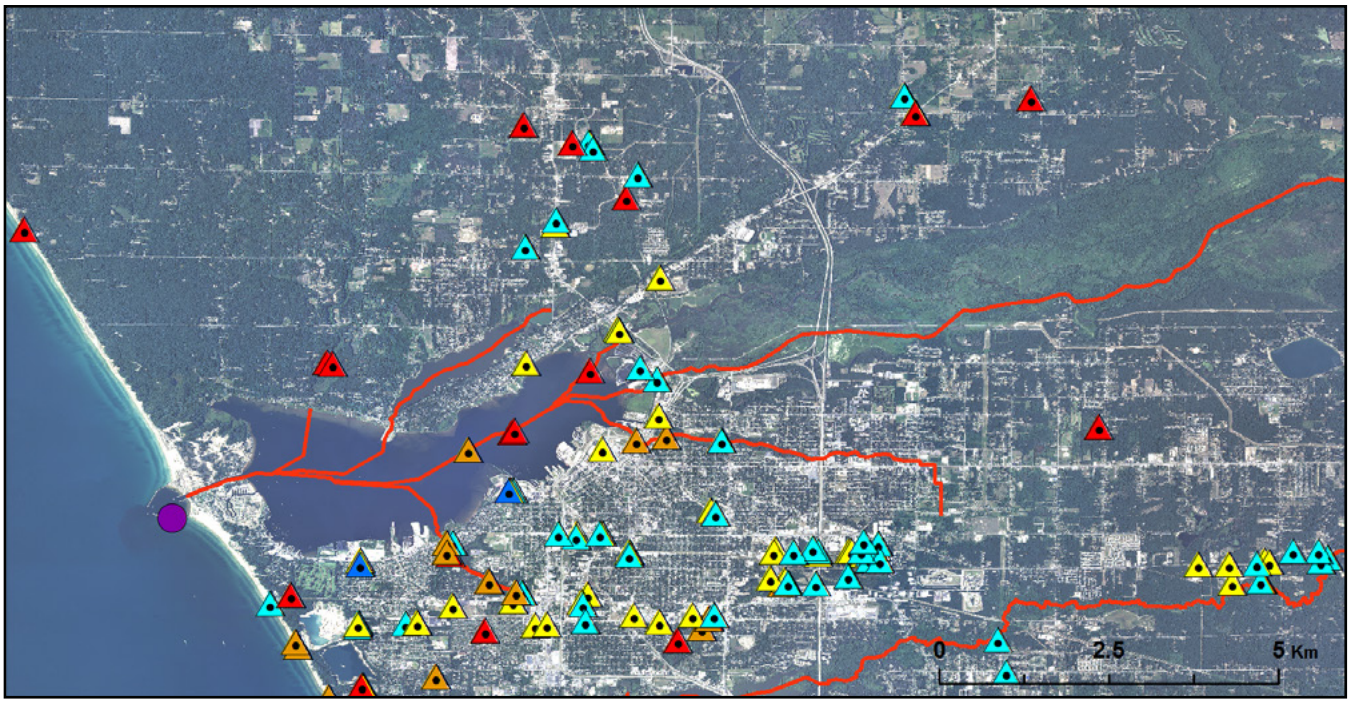
Muskegon



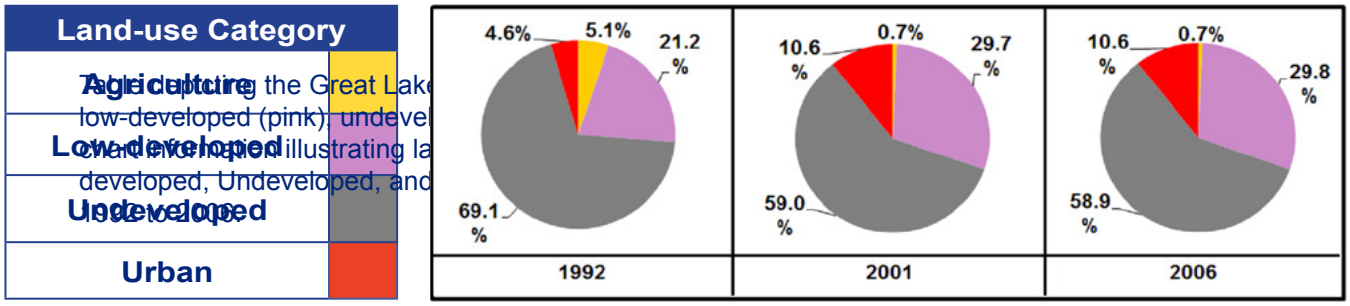
	LMMU	
	43.228241	
	-86.346884	
	MI	
	Undeveloped	
	MW REF	
	1993	
	95622	Low



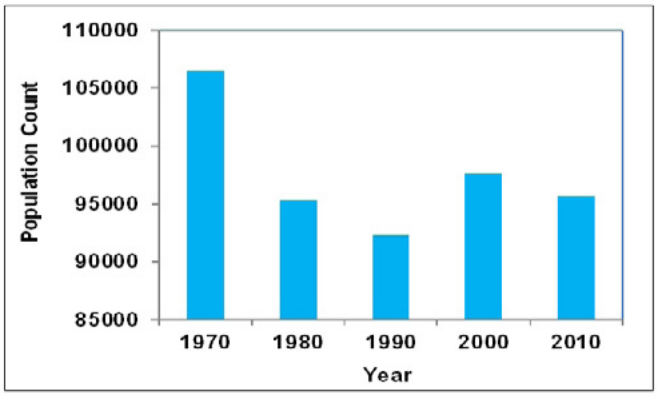
Spatial delineation: MWP site (●), associated watershed (▭), and AOC boundary (///) where applicable.



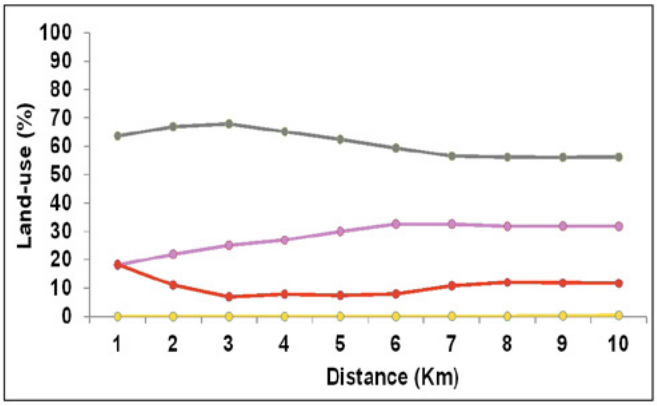
Outfalls: Aerial orthoimagery and map depicting MWP site (●), Impaired and Assessed Waters (▭), and U.S.EPA NPDES major and minor permitted facilities outfall types: POTW (▲), Non-POTW (▲), Wastewater Facilities (▲), Discharge Facilities (▲), Water Dischargers (▲), Combined Sewer Overflows (CSO's) (▲).



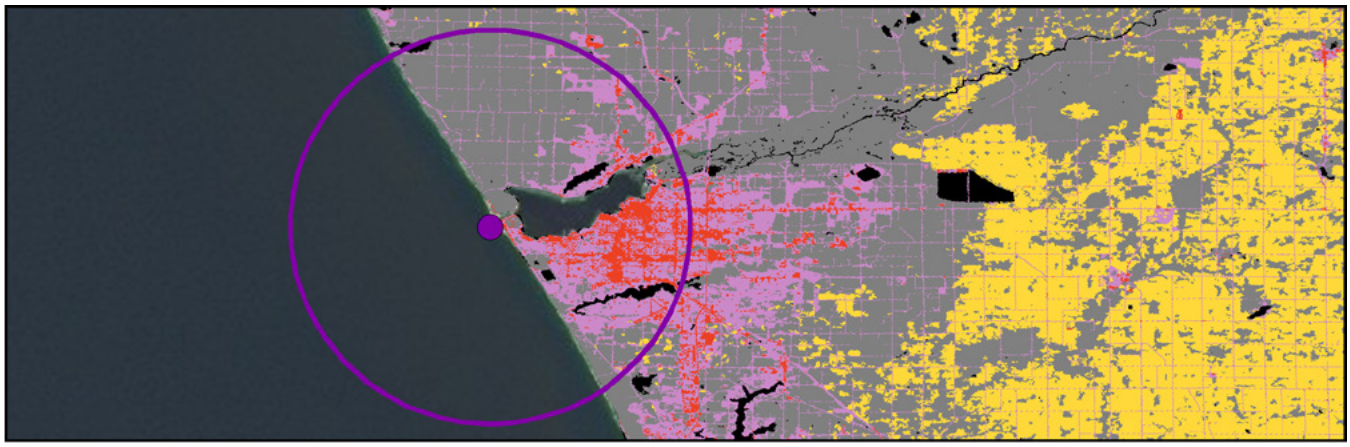
Legend: 1992 - 2006 National Land Cover Data (NLCD) aggregated hierarchal land-use categories, agriculture, low-developed, undeveloped and urban for Great Lakes Mussel Watch Program (MWP) sites.



Population barchart: Bar chart depicting population trend within 10 km buffer of MWP site (1970 - 2010).

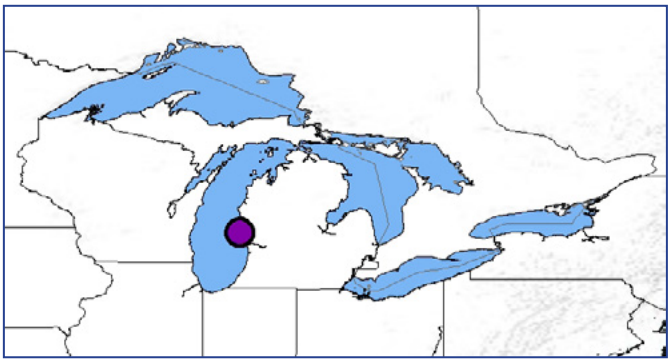


Line chart: MWP site 2006 NLCD land-use categories percentage within a 10 km buffer spatial extent.

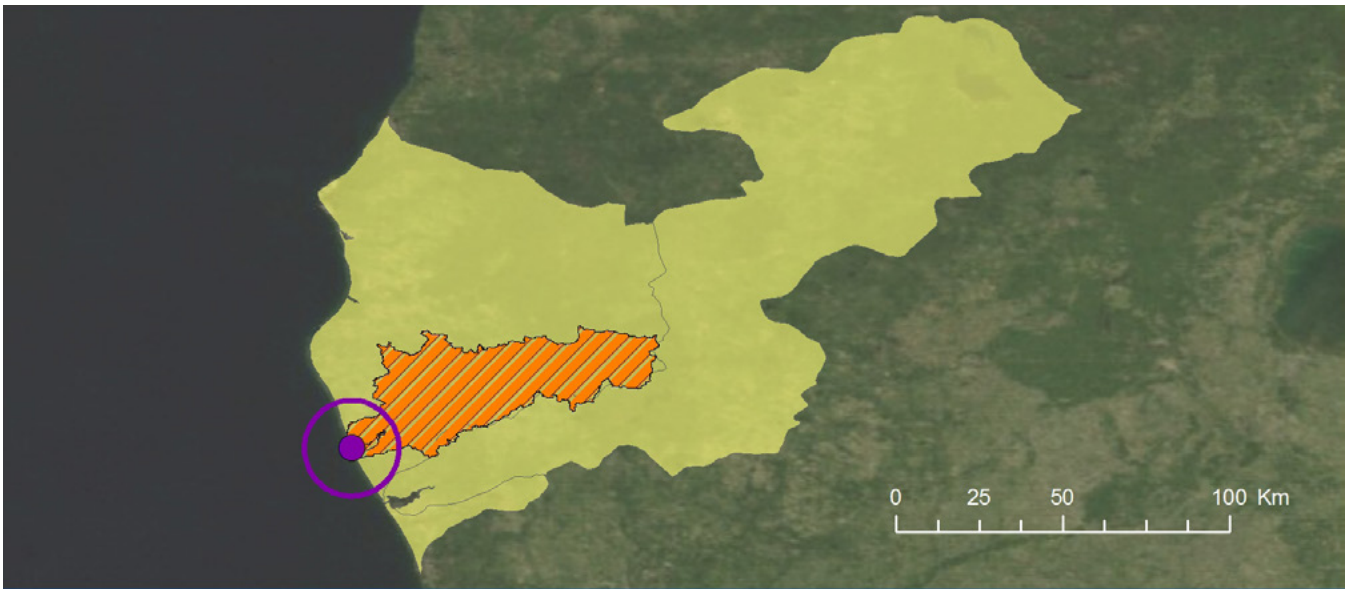


Land-use categories: MWP site (●) including 10 km buffer (○) and 2006 land-use categories from NLCD.

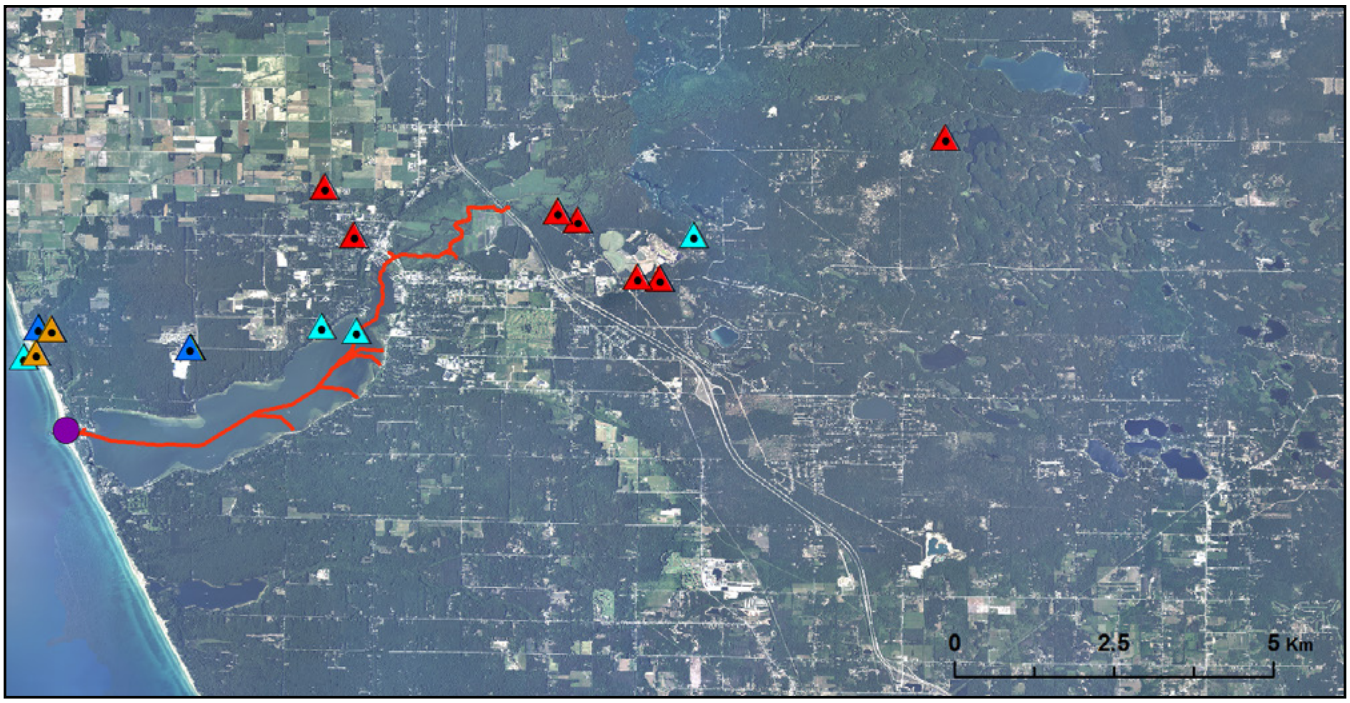
White Lake



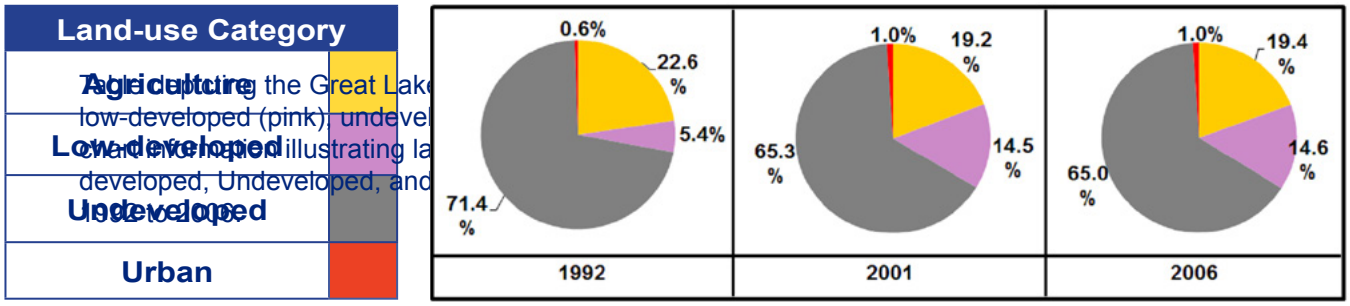
	LMWL	
	43.3756	
	-86.426	
	MI	
	Undeveloped	
	MW AOC	
	2010	
	18394	Low



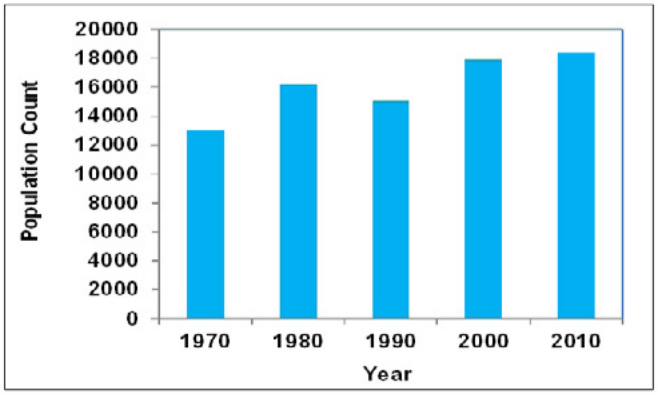
Spatial delineation: MWP site (●), associated watershed (▭), and AOC boundary (///) where applicable.



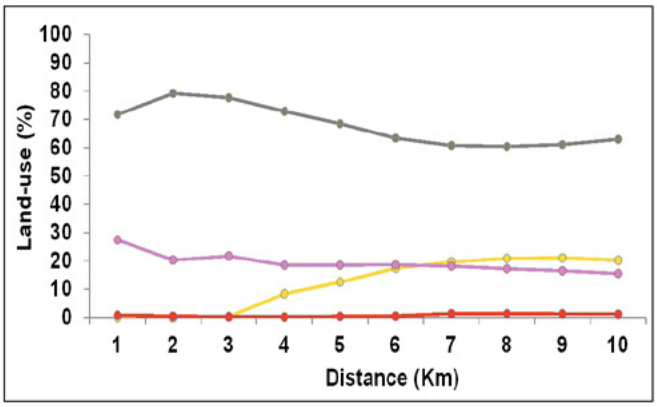
Outfalls: Aerial orthoimagery and map depicting MWP site (●), Impaired and Assessed Waters (▭), and U.S.EPA NPDES major and minor permitted facilities outfall types: POTW (▲), Non-POTW (▲), Wastewater Facilities (▲), Discharge Facilities (▲), Water Dischargers (▲), Combined Sewer Overflows (CSO's) (▲).



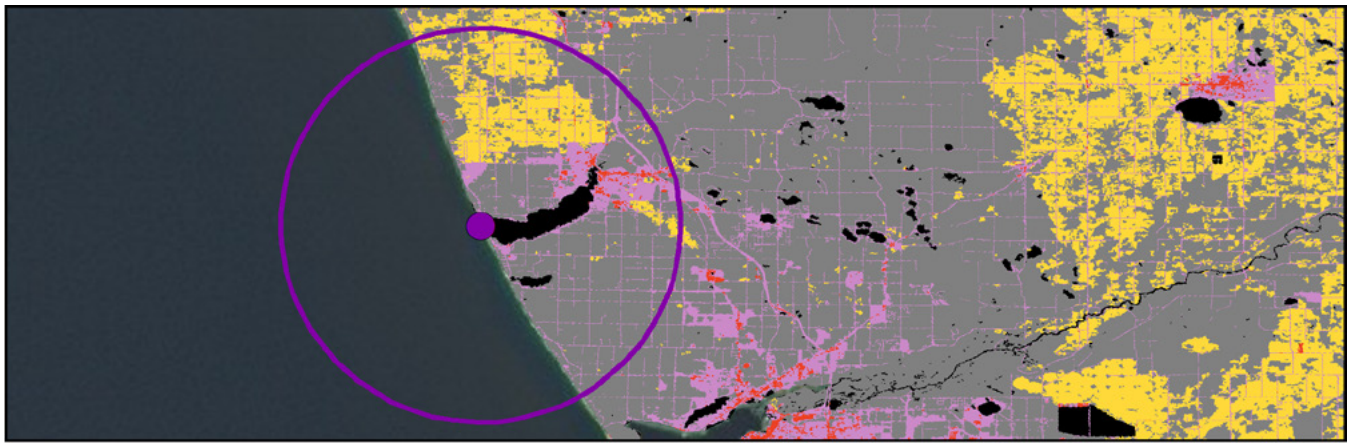
Legend: 1992 - 2006 National Land Cover Data (NLCD) aggregated hierarchal land-use categories, agriculture, low-developed, undeveloped and urban for Great Lakes Mussel Watch Program (MWP) sites.



Population barchart: Bar chart depicting population trend within 10 km buffer of MWP site (1970 - 2010).

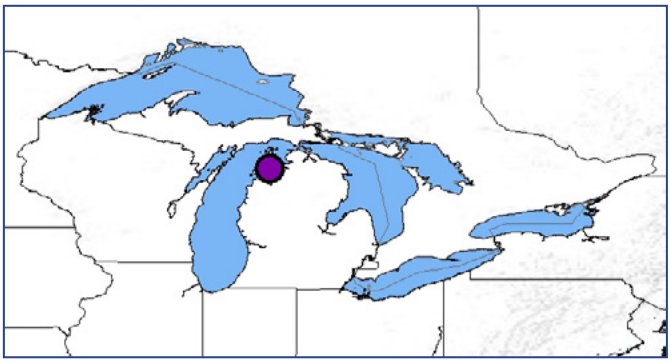


Line chart: MWP site 2006 NLCD land-use categories percentage within a 10 km buffer spatial extent.



Land-use categories: MWP site (●) including 10 km buffer (○) and 2006 land-use categories from NLCD.

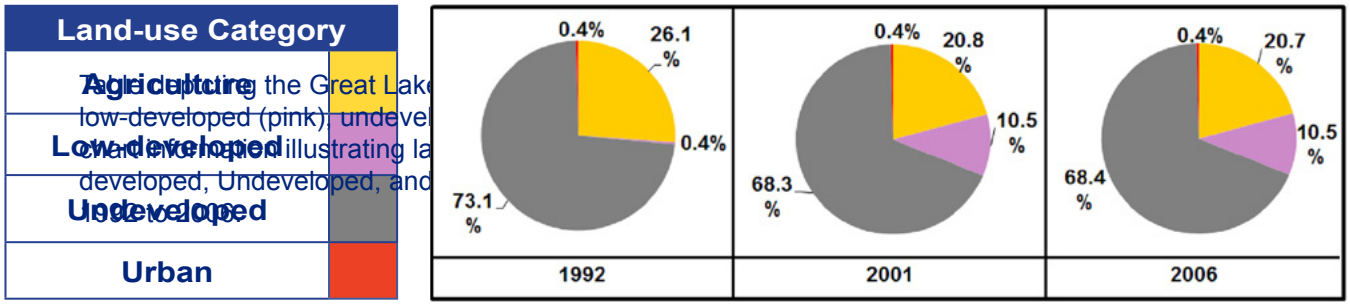
Leelanau State Park



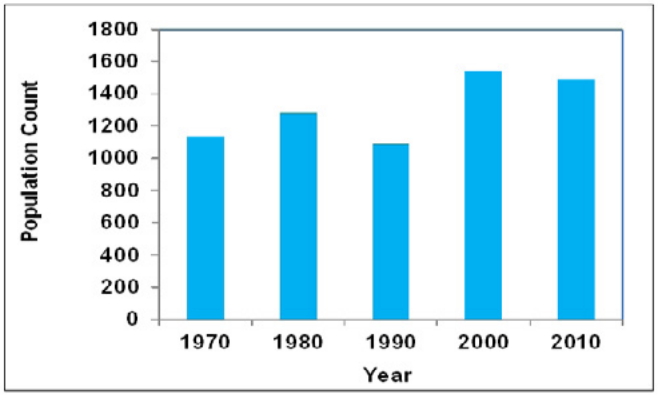
	TBLL	
	45.205666	
	-85.536833	
	MI	
	Undeveloped	
	MW REF	
	1996	
	1488	Low

Spatial delineation: MWP site (●), associated watershed (), and AOC boundary (///) where applicable.

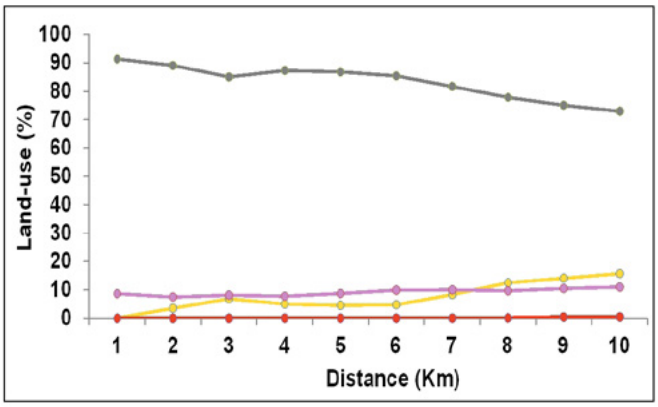
Outfalls: Aerial orthoimagery and map depicting MWP site (●), Impaired and Assessed Waters (), and U.S.EPA NPDES major and minor permitted facilities outfall types: POTW (▲), Non-POTW (▲), Wastewater Facilities (▲), Discharge Facilities (▲), Water Dischargers (▲), Combined Sewer Overflows (CSO's) (▲).



Legend: 1992 - 2006 National Land Cover Data (NLCD) aggregated hierarchal land-use categories, agriculture, low-developed, undeveloped and urban for Great Lakes Mussel Watch Program (MWP) sites.



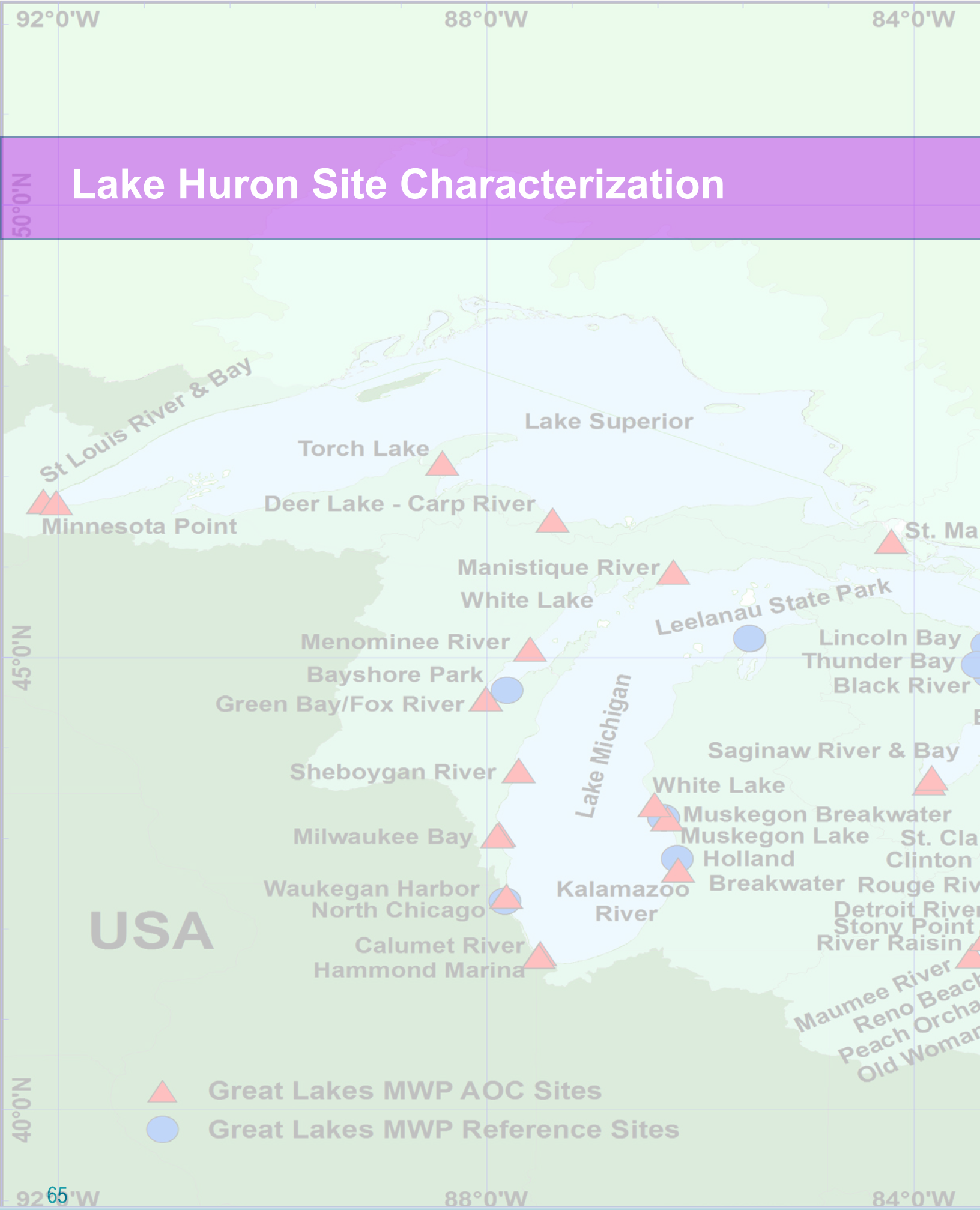
Population barchart: Bar chart depicting population trend within 10 km buffer of MWP site (1970 - 2010).

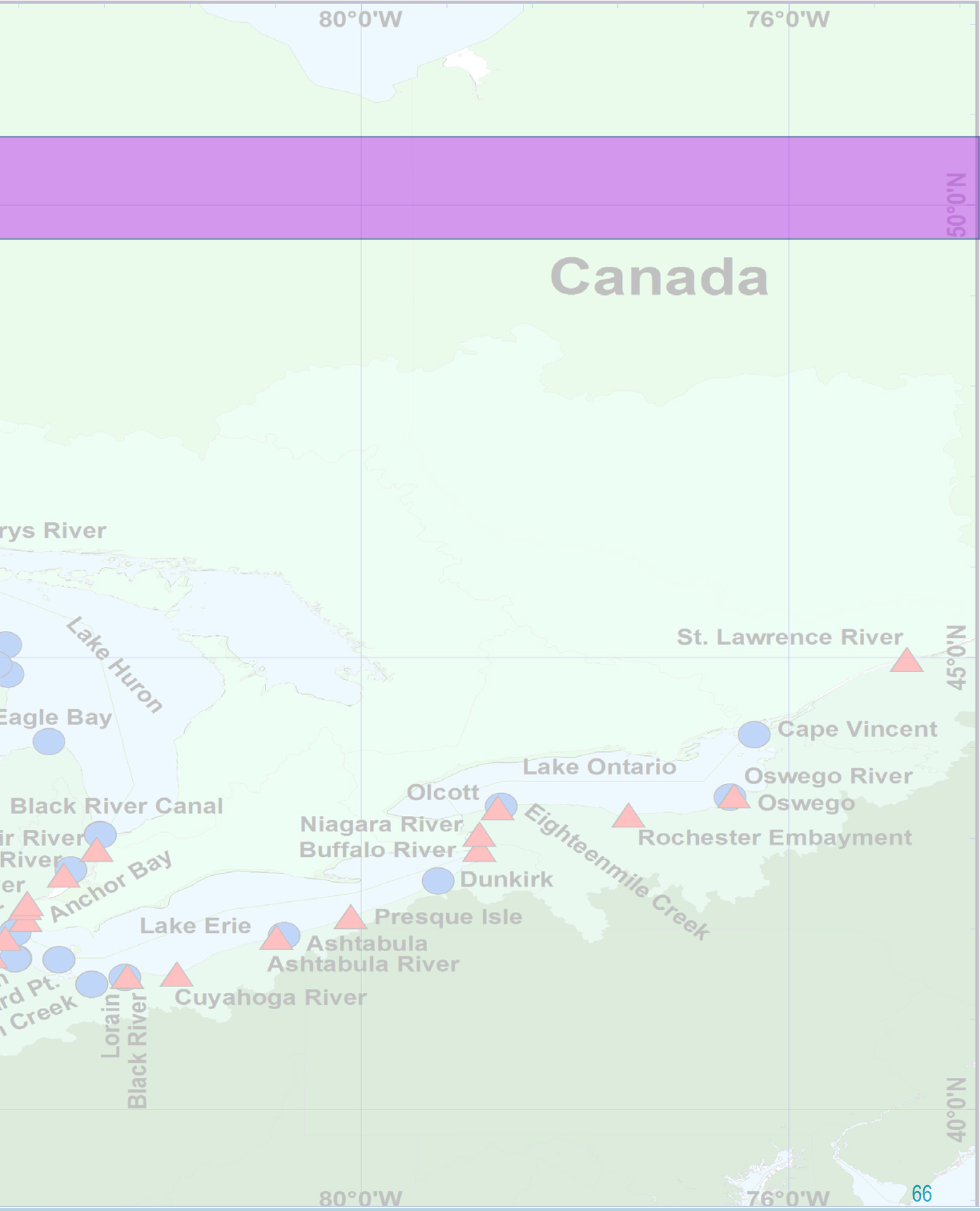


Line chart: MWP site 2006 NLCD land-use categories percentage within a 10 km buffer spatial extent.

Land-use categories: MWP site (●) including 10 km buffer (○) and 2006 land-use categories from NLCD.

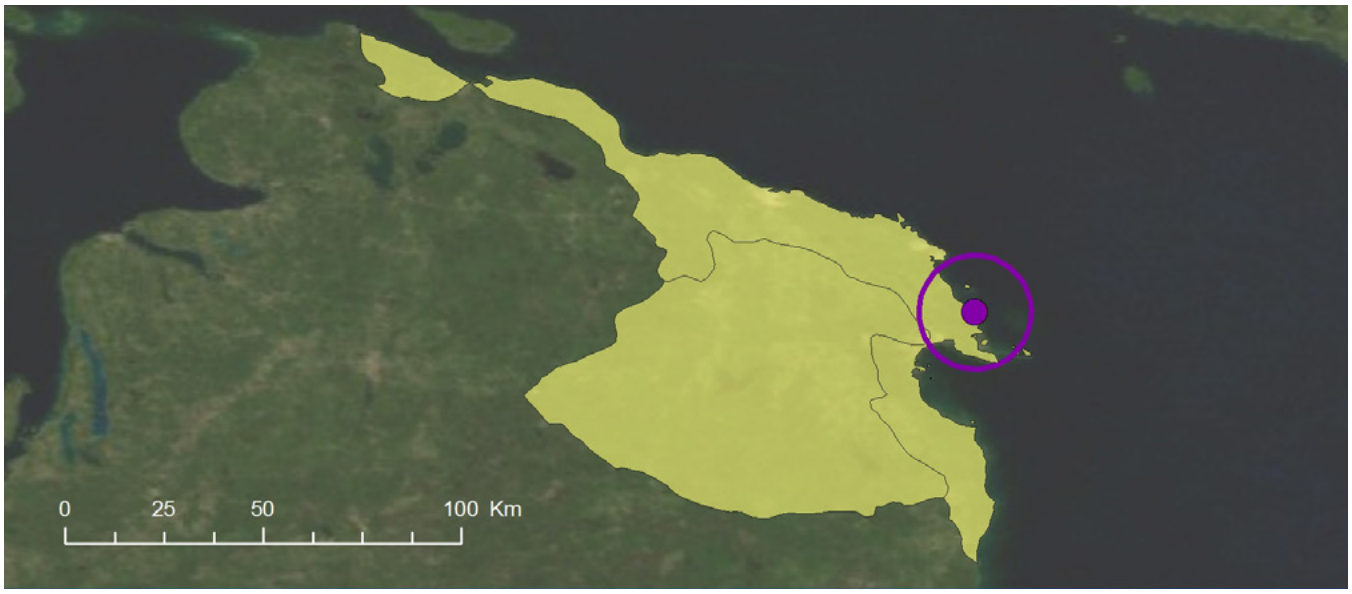
Lake Huron Site Characterization



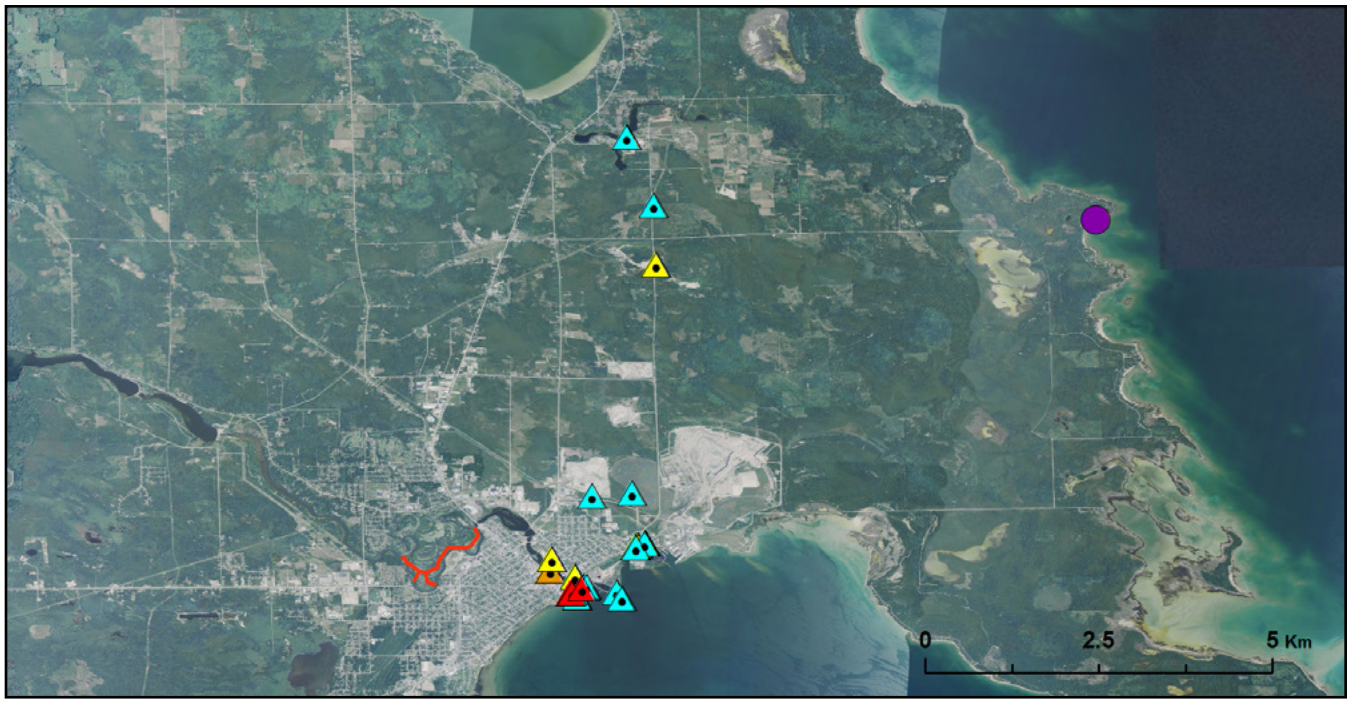

80°0'W
76°0'W
50°0'N
Canada
rys River
Lake Huron
St. Lawrence River
45°0'N
Eagle Bay
Cape Vincent
Lake Ontario
Oswego River
Olcott
Oswego
Black River Canal
Niagara River
Eighteenmile Creek
Rochester Embayment
Buffalo River
Anchor Bay
Dunkirk
Lake Erie
Presque Isle
Ashtabula
Ashtabula River
Cuyahoga River
Lorain
Black River
40°0'N
80°0'W
76°0'W

Lincoln Bay

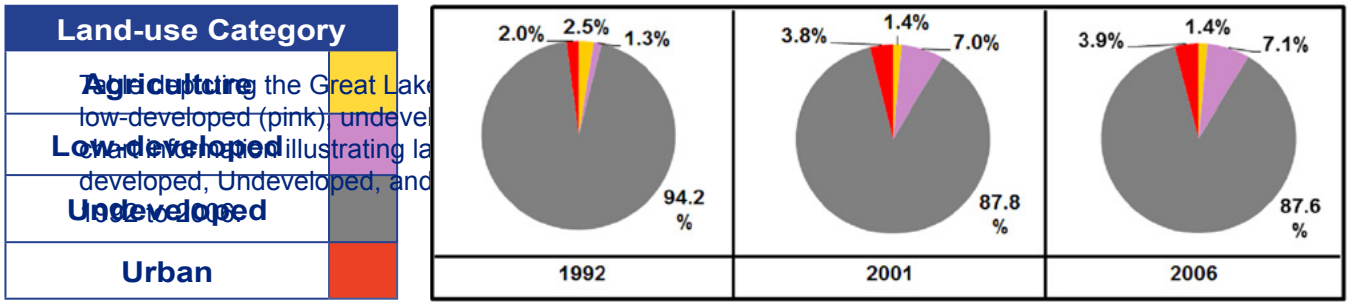
	LHLB	
	45.13831	
	-83.3197	
	MI	
	Undeveloped	
	MW REF	
	2010	
	7978	Low



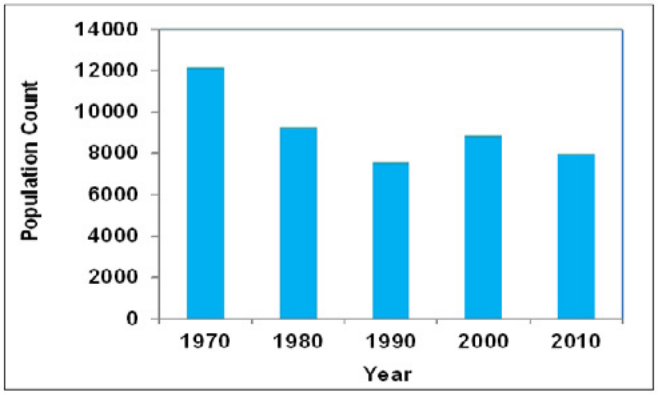
Spatial delineation: MWP site (●), associated watershed (▭), and AOC boundary (///) where applicable.



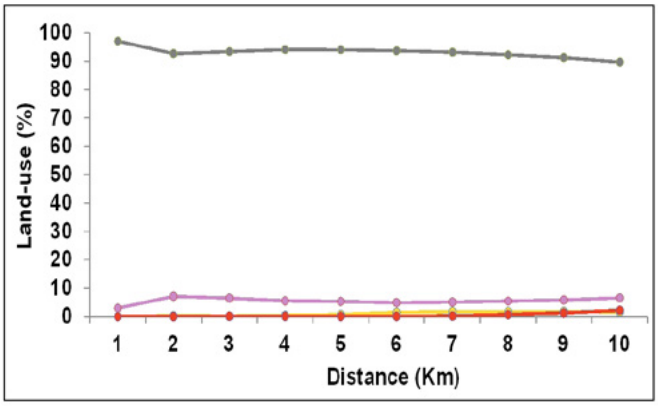
Outfalls: Aerial orthoimagery and map depicting MWP site (●), Impaired and Assessed Waters (▭), and U.S.EPA NPDES major and minor permitted facilities outfall types: POTW (▲), Non-POTW (▲), Wastewater Facilities (▲), Discharge Facilities (▲), Water Dischargers (▲), Combined Sewer Overflows (CSO's) (▲).



Legend: 1992 - 2006 National Land Cover Data (NLCD) aggregated hierarchal land-use categories, agriculture, low-developed, undeveloped and urban for Great Lakes Mussel Watch Program (MWP) sites.



Population barchart: Bar chart depicting population trend within 10 km buffer of MWP site (1970 - 2010).



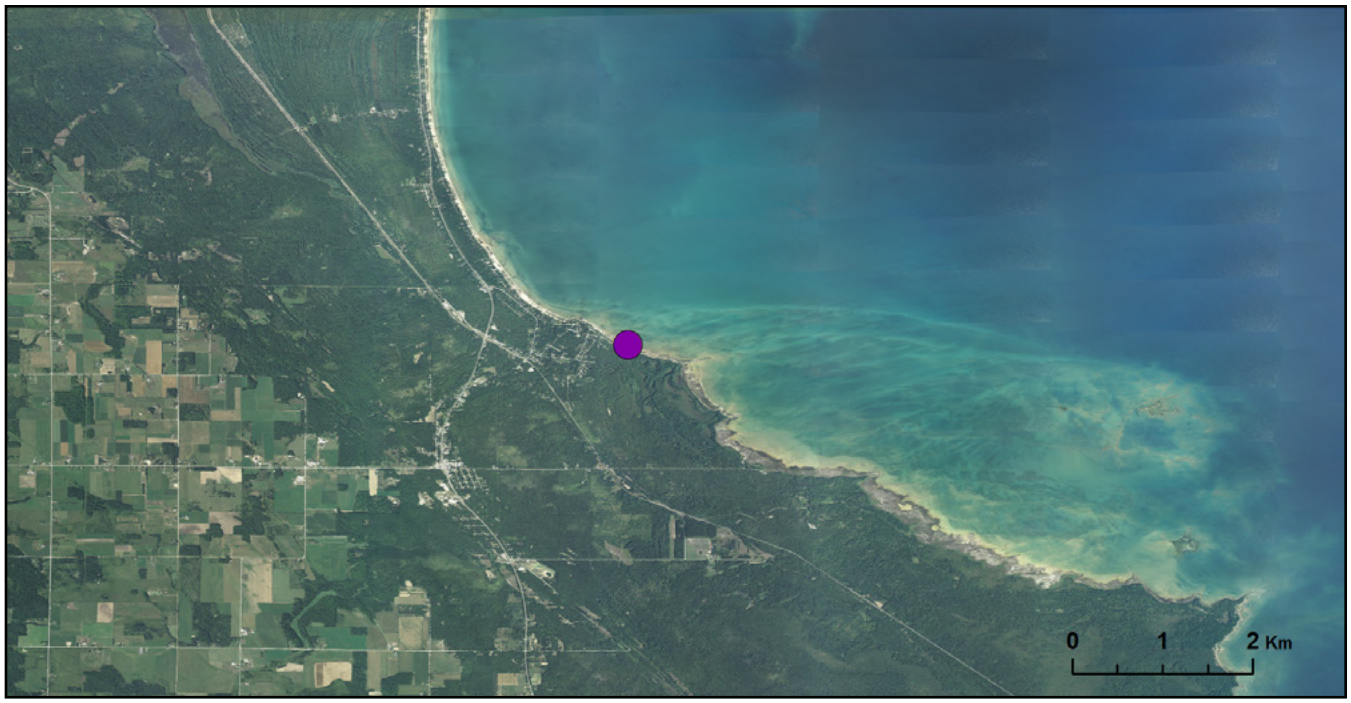
Line chart: MWP site 2006 NLCD land-use categories percentage within a 10 km buffer spatial extent.

Land-use categories: MWP site (●) including 10 km buffer (○) and 2006 land-use categories from NLCD.

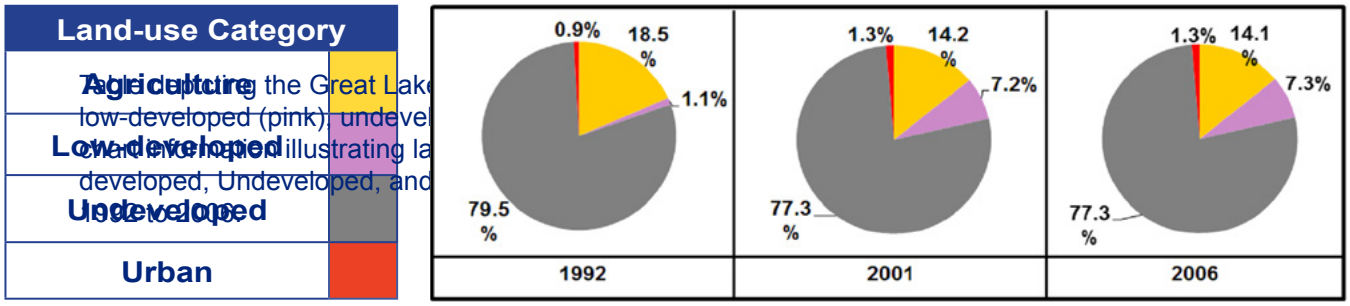
Thunder Bay

	LHTB	
	44.922166	
	-83.4135	
	MI	
	Undeveloped	
	MW REF	
	1996	
	13045	Low

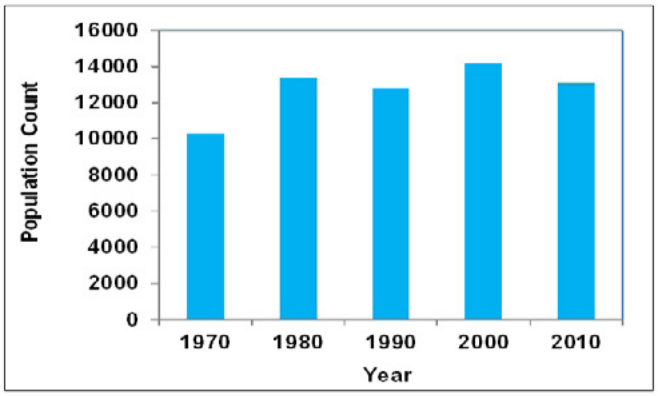
Spatial delineation: MWP site (●), associated watershed (〰), and AOC boundary (///) where applicable.



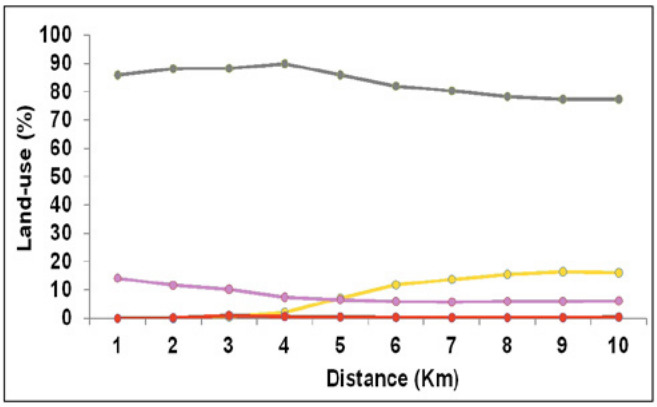
Outfalls: Aerial orthoimagery and map depicting MWP site (●), Impaired and Assessed Waters (〰), and U.S.EPA NPDES major and minor permitted facilities outfall types: POTW (▲), Non-POTW (▲), Wastewater Facilities (▲), Discharge Facilities (▲), Water Dischargers (▲), Combined Sewer Overflows (CSO's) (▲).



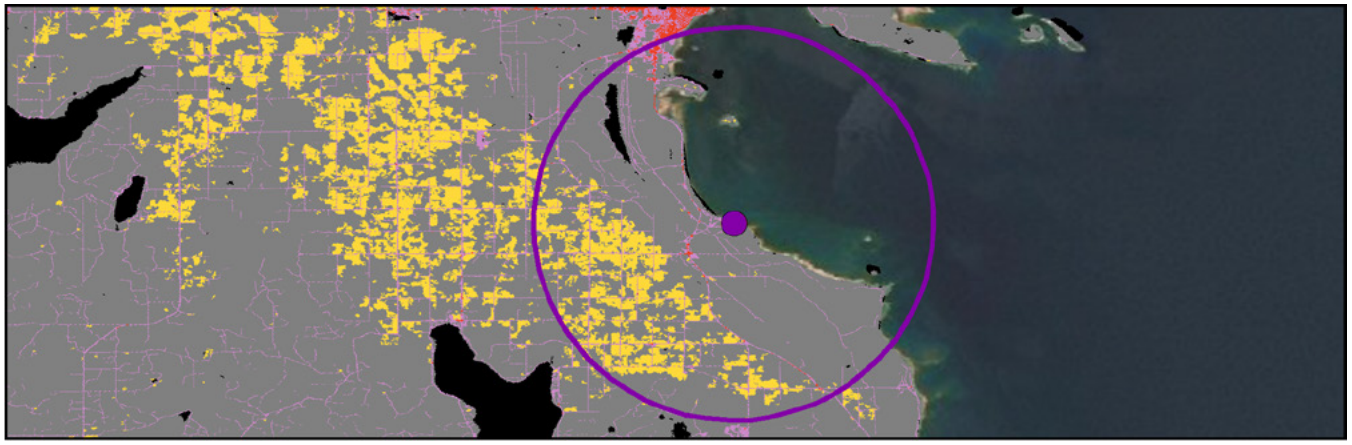
Legend: 1992 - 2006 National Land Cover Data (NLCD) aggregated hierarchal land-use categories, agriculture, low-developed, undeveloped and urban for Great Lakes Mussel Watch Program (MWP) sites.



Population barchart: Bar chart depicting population trend within 10 km buffer of MWP site (1970 - 2010).

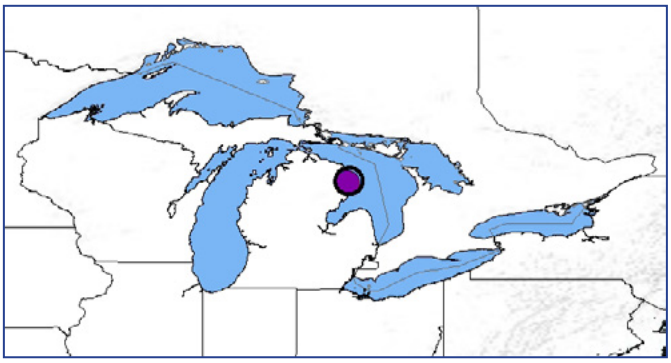


Line chart: MWP site 2006 NLCD land-use categories percentage within a 10 km buffer spatial extent.



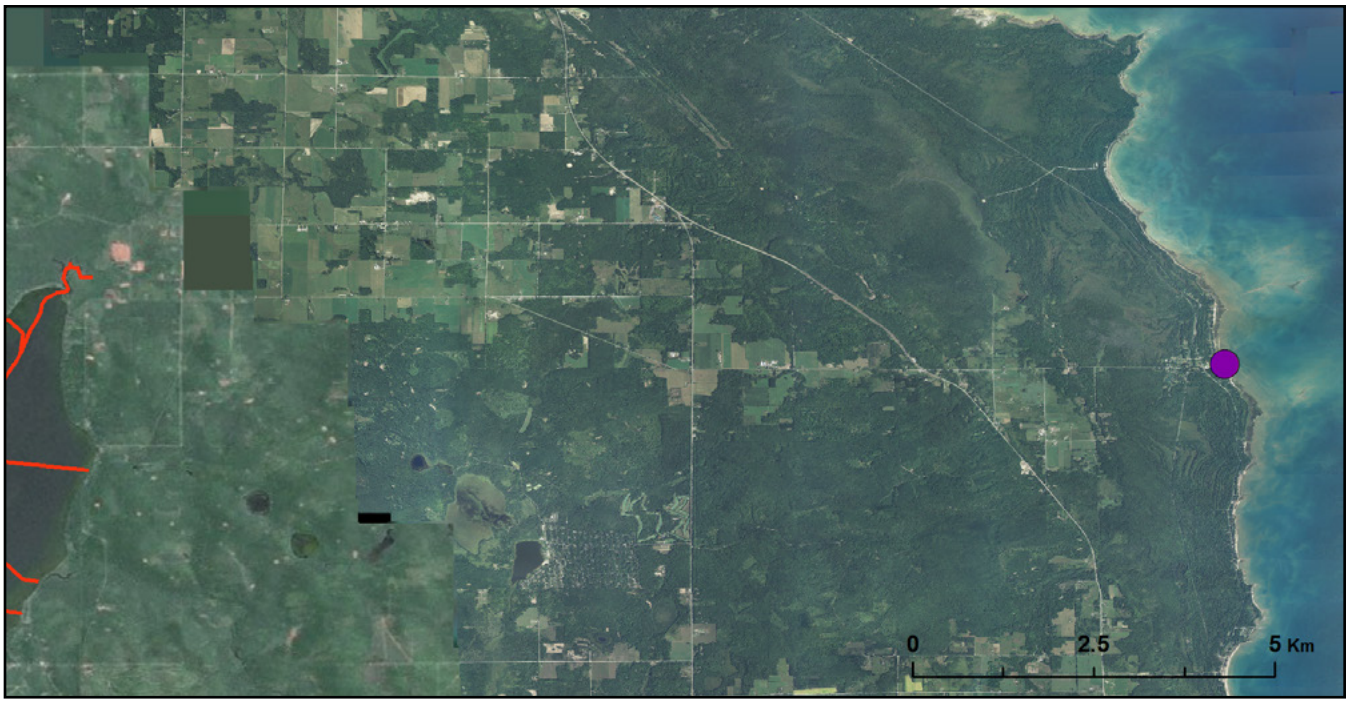
Land-use categories: MWP site (●) including 10 km buffer (○) and 2006 land-use categories from NLCD.

Black River

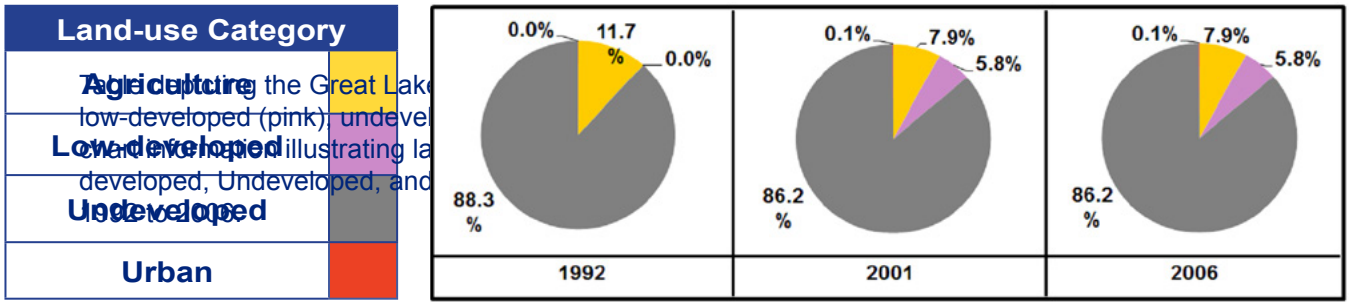


	TBBR	
	44.81612	
	-83.29845	
	MI	
	Undeveloped	
	MW REF	
	2010	
	2198	Low

Spatial delineation: MWP site (●), associated watershed (〰), and AOC boundary (///) where applicable.



Outfalls: Aerial orthoimagery and map depicting MWP site (●), Impaired and Assessed Waters (〰), and U.S.EPA NPDES major and minor permitted facilities outfall types: POTW (▲), Non-POTW (▲), Wastewater Facilities (▲), Discharge Facilities (▲), Water Dischargers (▲), Combined Sewer Overflows (CSO's) (▲).



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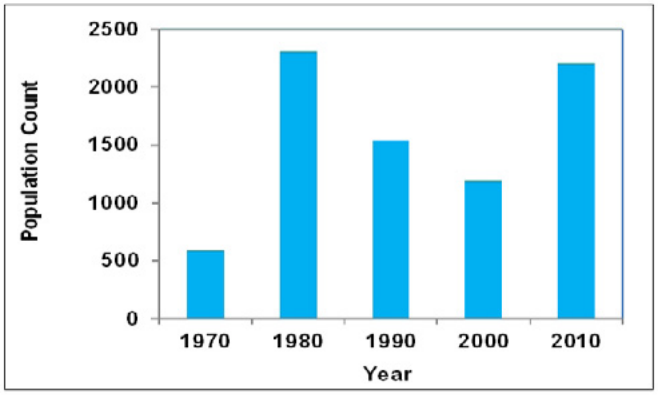
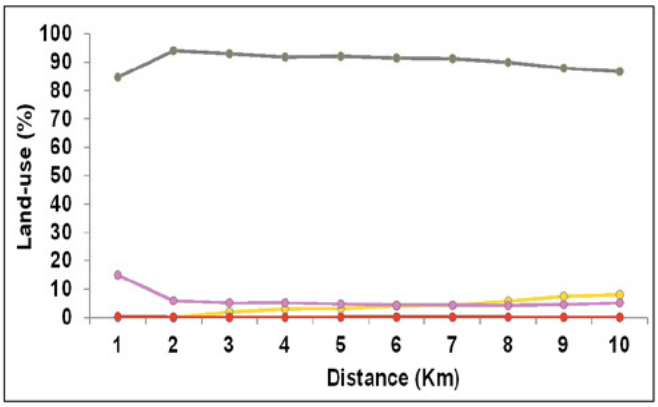
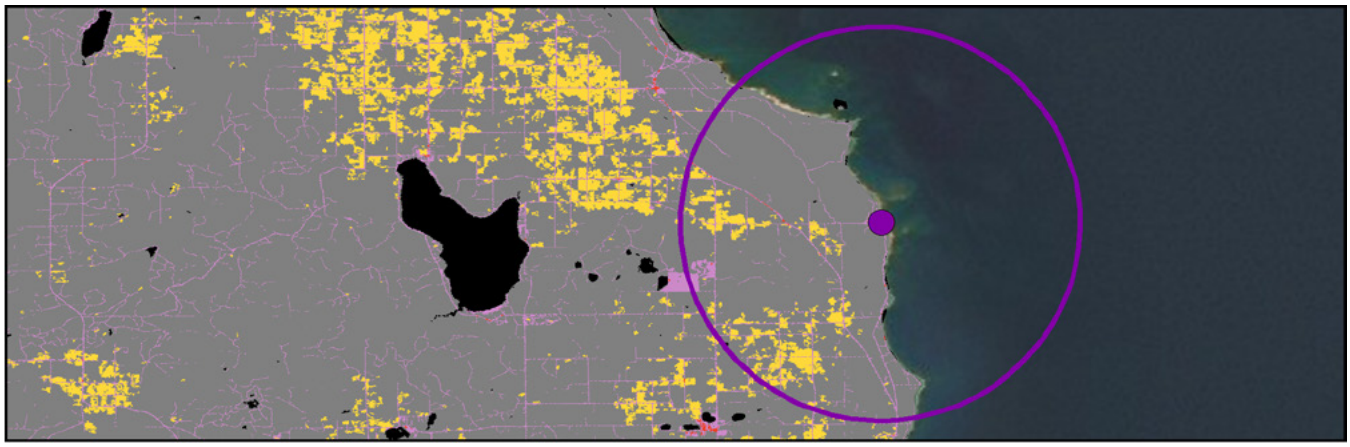


Population barchart: Bar chart depicting population trend within 10 km buffer of MWP site (1970 - 2010).



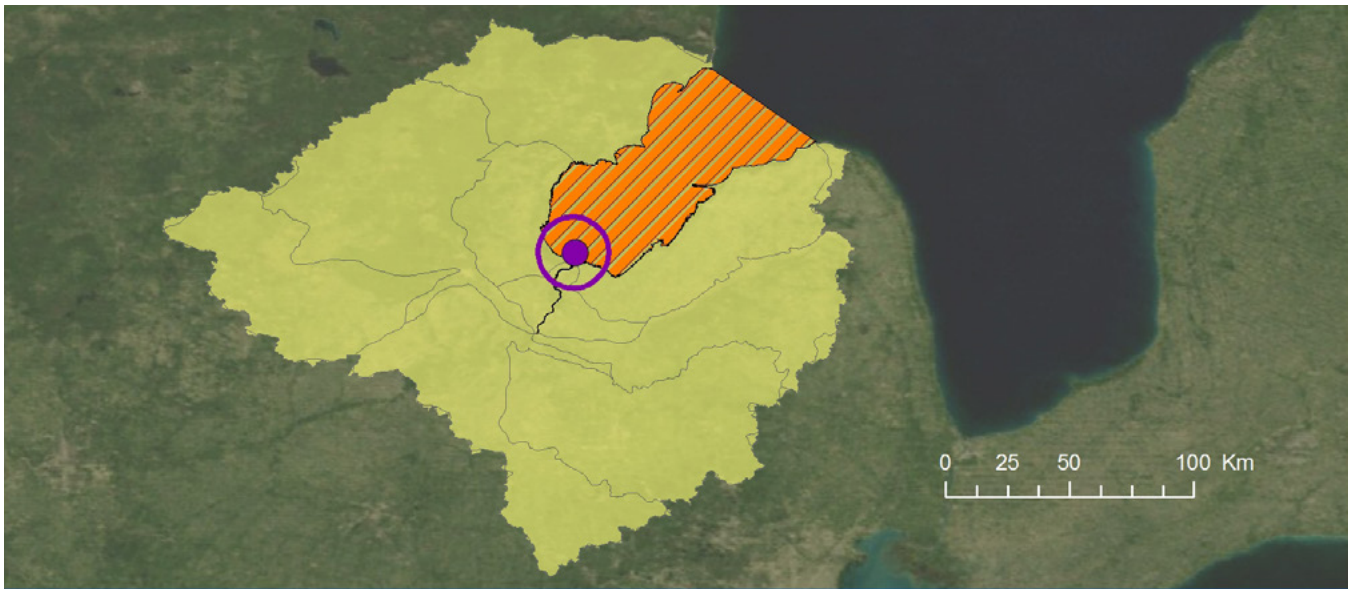
Line chart: MWP site 2006 NLCD land-use categories percentage within a 10 km buffer spatial extent.



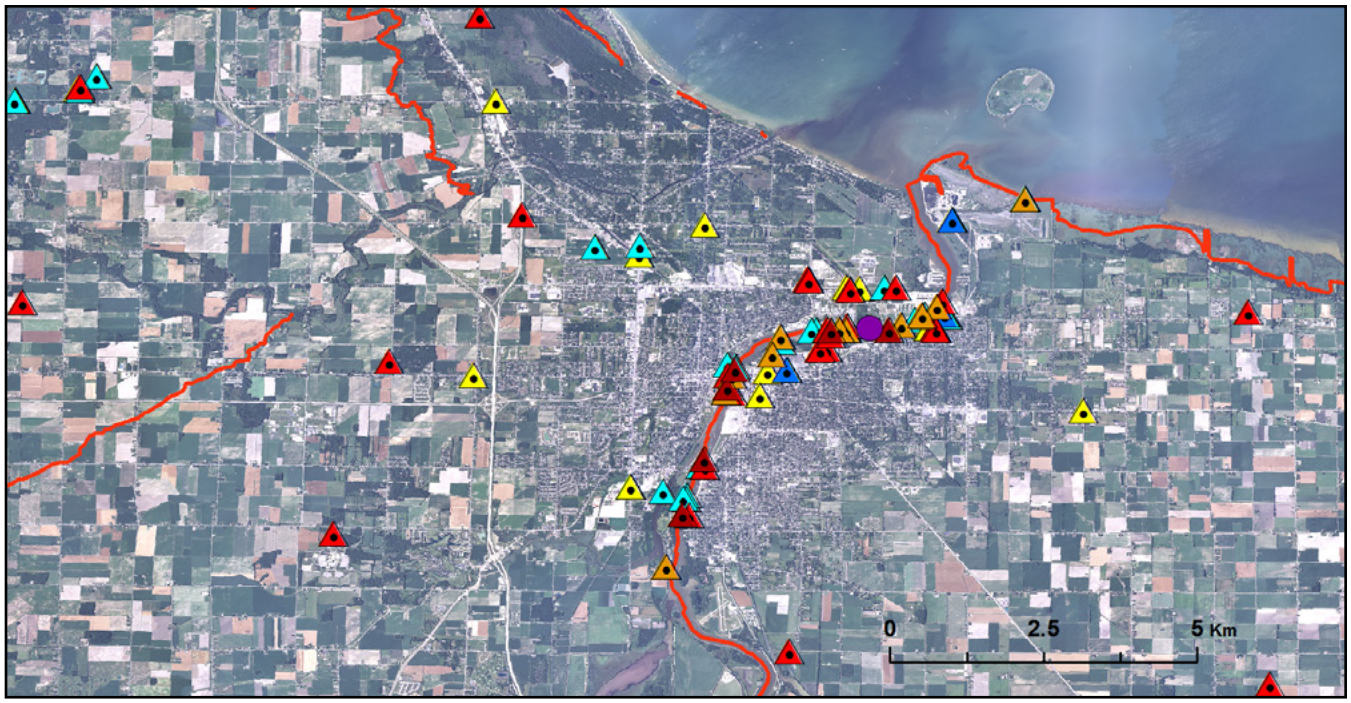
Land-use categories: MWP site (●) including 10 km buffer (○) and 2006 land-use categories from NLCD.

Saginaw River

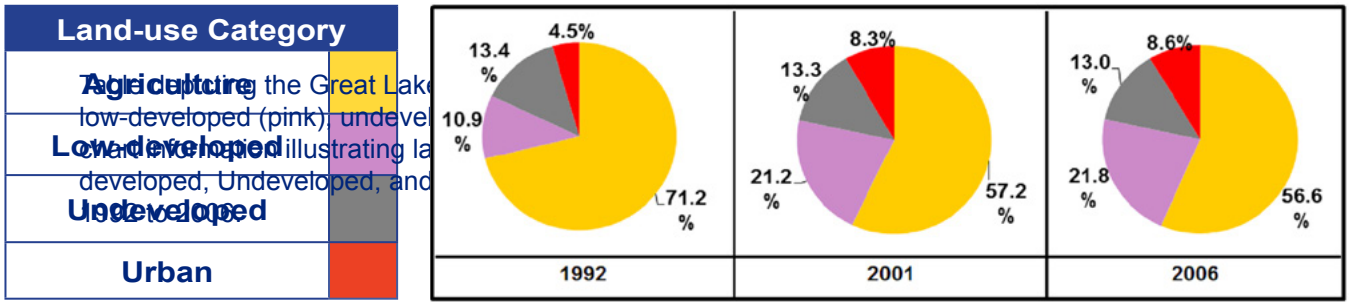
	LHSR	
	43.61369	
	-83.8594	
	MI	
	Agriculture	
	MW AOC	
	2010	
	78140	Low



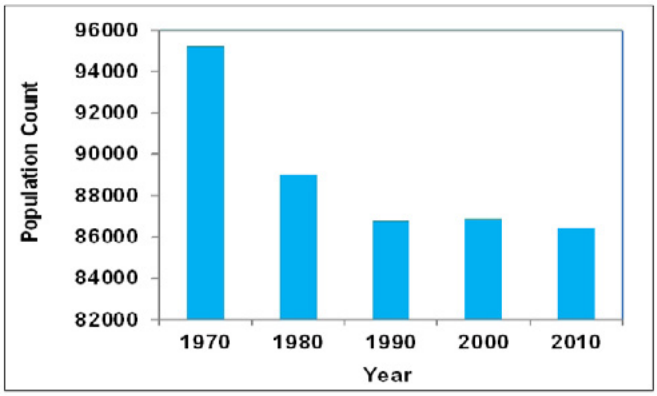
Spatial delineation: MWP site (●), associated watershed (▭), and AOC boundary (///) where applicable.



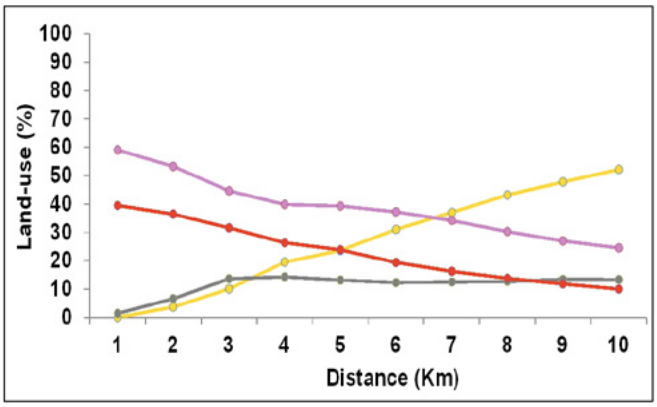
Outfalls: Aerial orthoimagery and map depicting MWP site (●), Impaired and Assessed Waters (▭), and U.S.EPA NPDES major and minor permitted facilities outfall types: POTW (▲), Non-POTW (▲), Wastewater Facilities (▲), Discharge Facilities (▲), Water Dischargers (▲), Combined Sewer Overflows (CSO's) (▲).



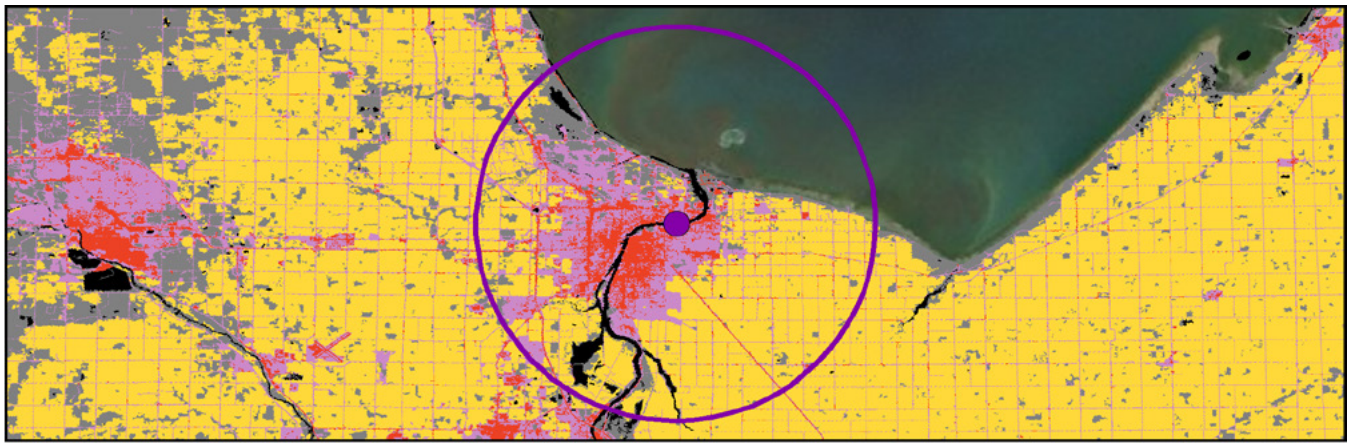
Legend: 1992 - 2006 National Land Cover Data (NLCD) aggregated hierarchal land-use categories, agriculture, low-developed, undeveloped and urban for Great Lakes Mussel Watch Program (MWP) sites.



Population barchart: Bar chart depicting population trend within 10 km buffer of MWP site (1970 - 2010).

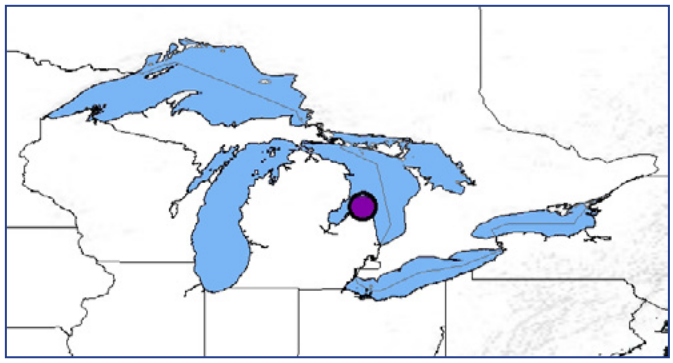


Line chart: MWP site 2006 NLCD land-use categories percentage within a 10 km buffer spatial extent.



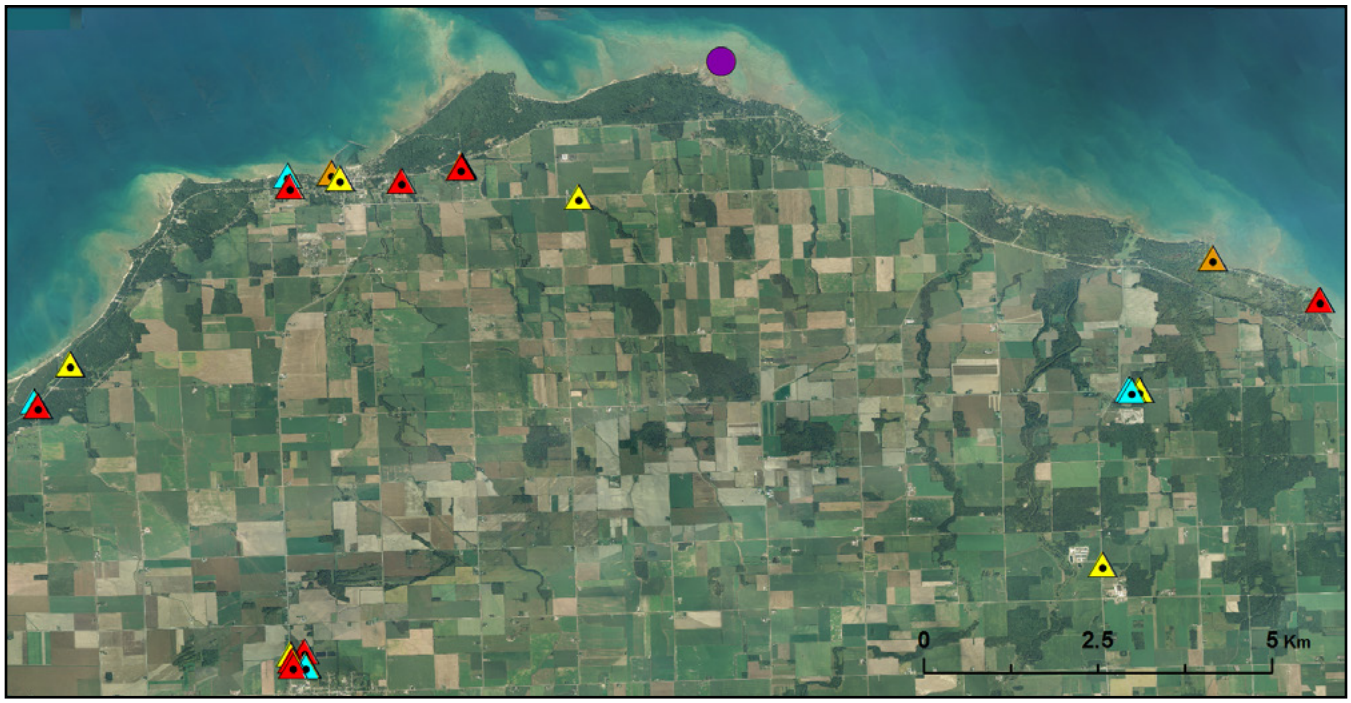
Land-use categories: MWP site (●) including 10 km buffer (○) and 2006 land-use categories from NLCD.

Eagle Bay

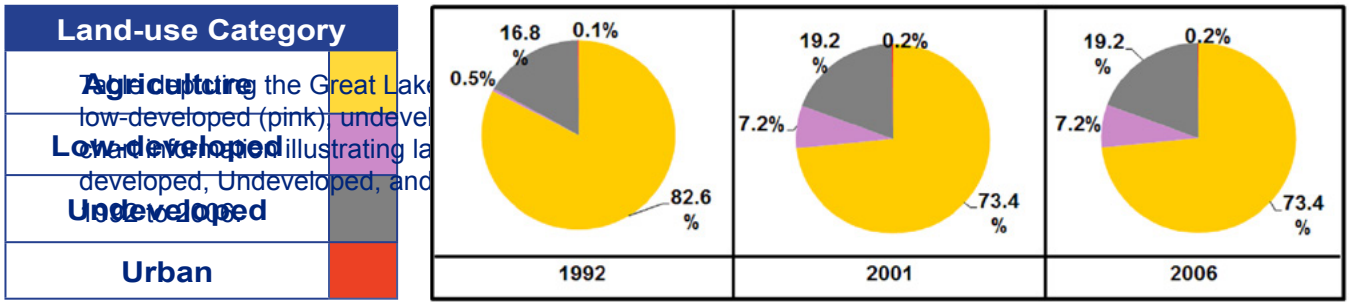


	LHEB	
	44.07058	
	-82.9158	
	MI	
	Agriculture	
	MW REF	
	2010	
	2716	Low

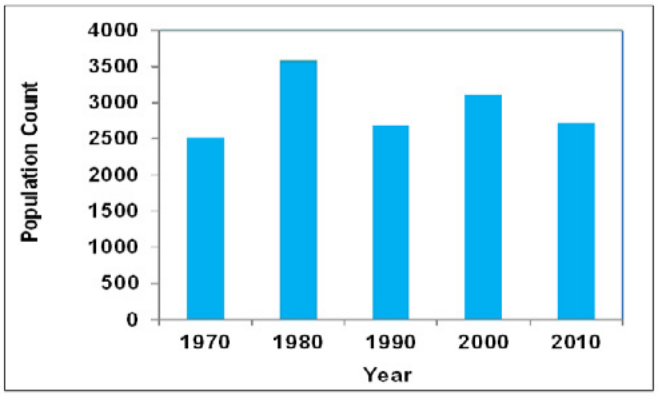
Spatial delineation: MWP site (●), associated watershed (▭), and AOC boundary (///) where applicable.



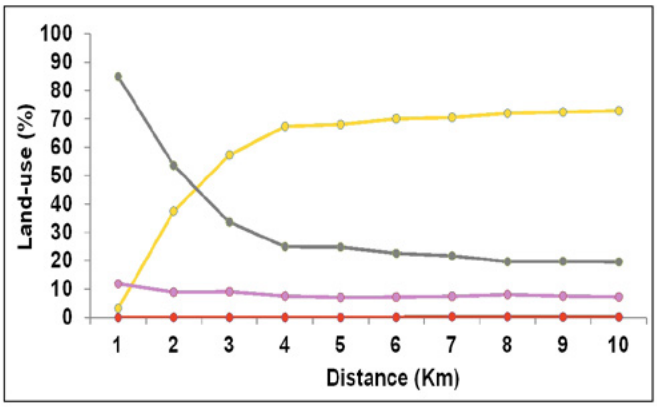
Outfalls: Aerial orthoimagery and map depicting MWP site (●), Impaired and Assessed Waters (▭), and U.S.EPA NPDES major and minor permitted facilities outfall types: POTW (▲), Non-POTW (▲), Wastewater Facilities (▲), Discharge Facilities (▲), Water Dischargers (▲), Combined Sewer Overflows (CSO's) (▲).



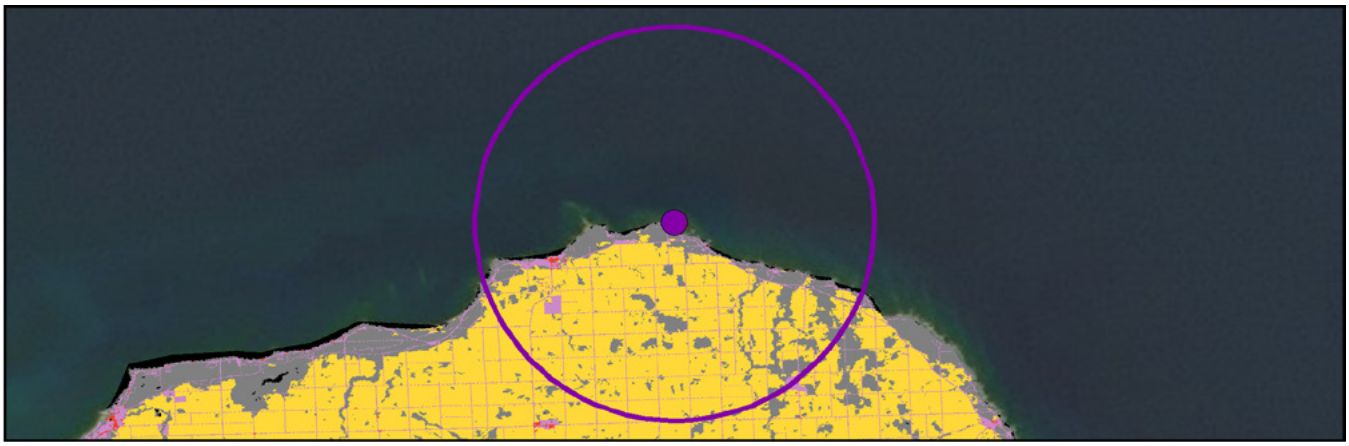
Legend: 1992 - 2006 National Land Cover Data (NLCD) aggregated hierarchal land-use categories, agriculture, low-developed, undeveloped and urban for Great Lakes Mussel Watch Program (MWP) sites.



Population barchart: Bar chart depicting population trend within 10 km buffer of MWP site (1970 - 2010).

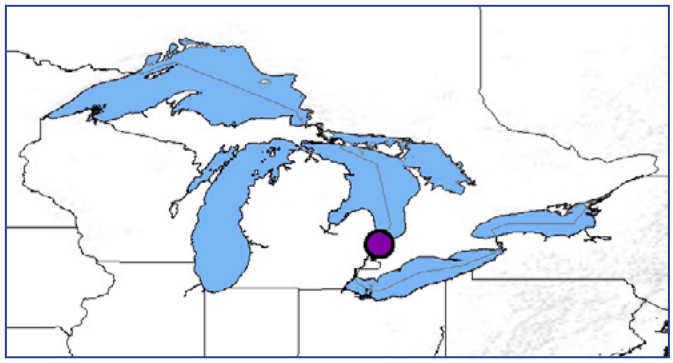


Line chart: MWP site 2006 NLCD land-use categories percentage within a 10 km buffer spatial extent.



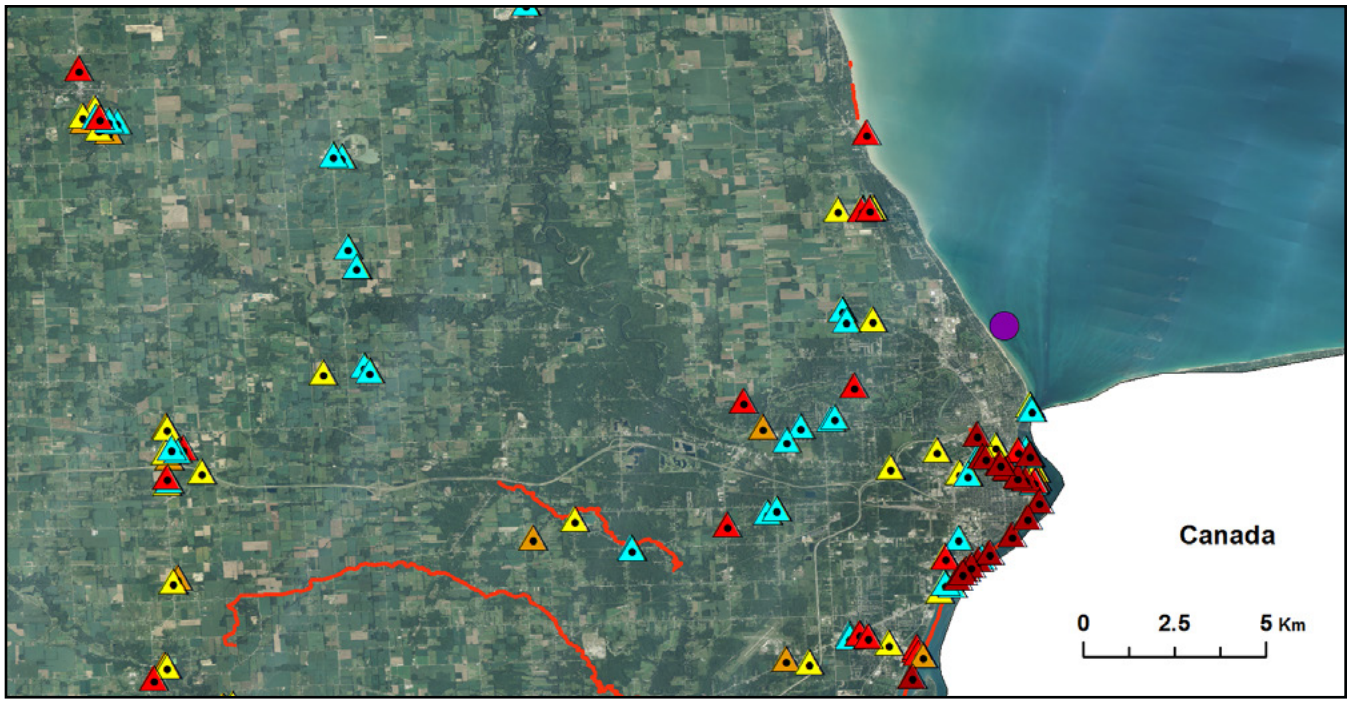
Land-use categories: MWP site (●) including 10 km buffer (○) and 2006 land-use categories from NLCD.

Black River Canal

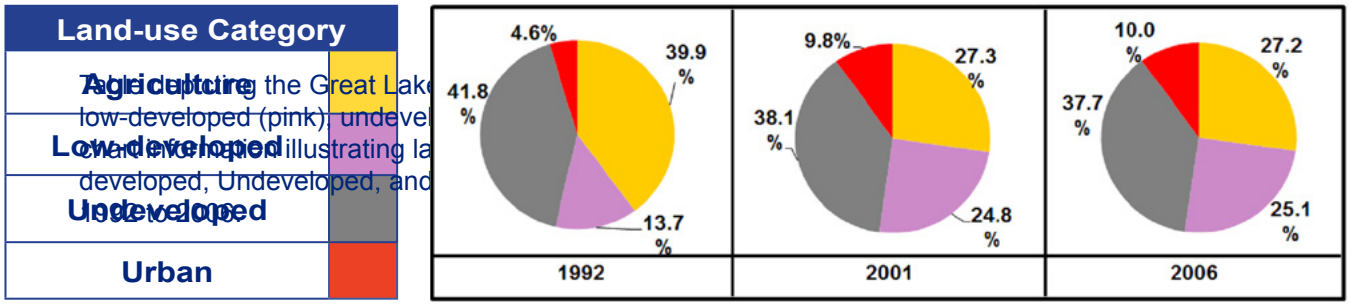


	LHBR	
	43.044333	
	-82.438667	
	MI	
	Agriculture	
	MW REF	
	1992	
	74459	Low

Spatial delineation: MWP site (●), associated watershed (▭), and AOC boundary (///) where applicable.



Outfalls: Aerial orthoimagery and map depicting MWP site (●), Impaired and Assessed Waters (▭), and U.S.EPA NPDES major and minor permitted facilities outfall types: POTW (▲), Non-POTW (▲), Wastewater Facilities (▲), Discharge Facilities (▲), Water Dischargers (▲), Combined Sewer Overflows (CSO's) (▲).



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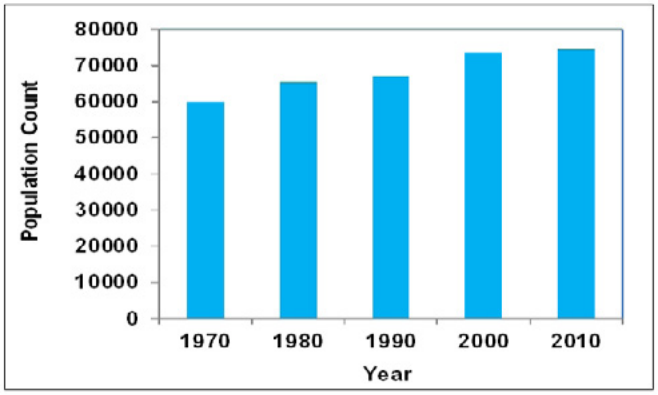
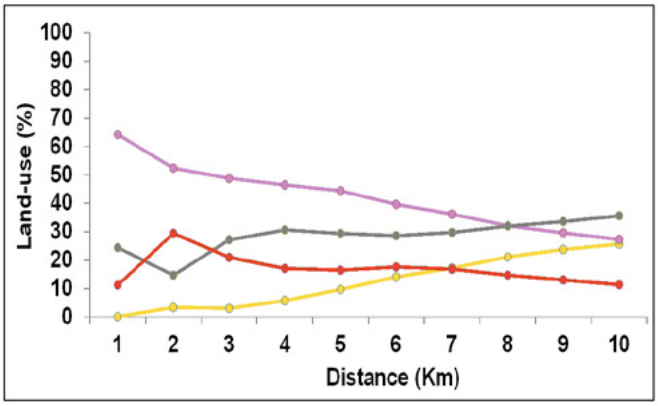
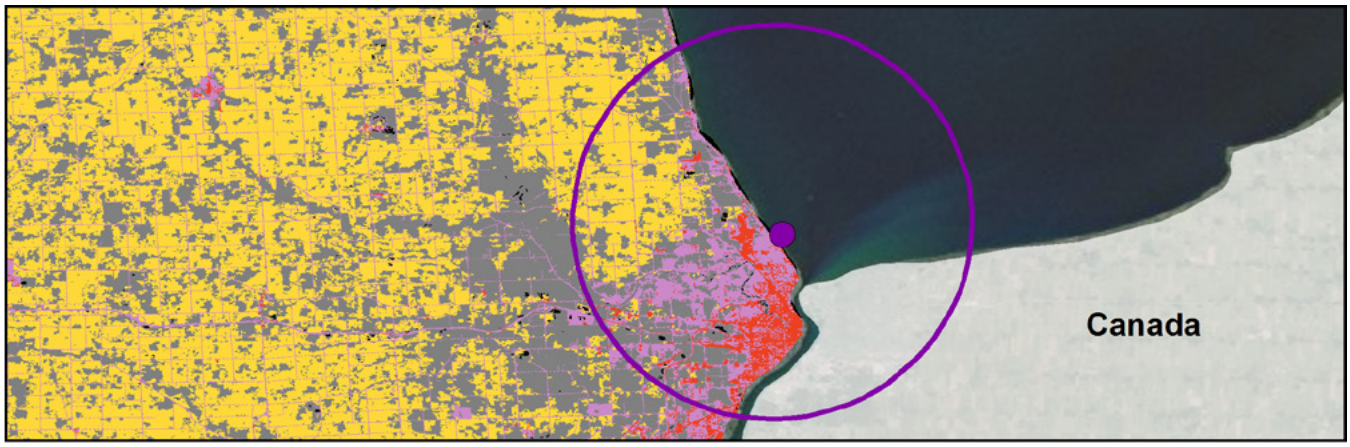


Population barchart: Bar chart depicting population trend within 10 km buffer of MWP site (1970 - 2010).

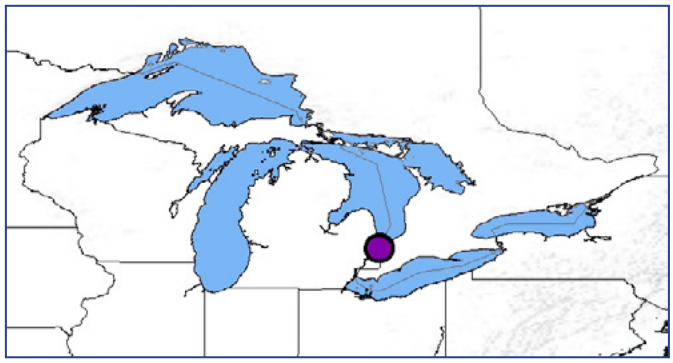


Line chart: MWP site 2006 NLCD land-use categories percentage within a 10 km buffer spatial extent.



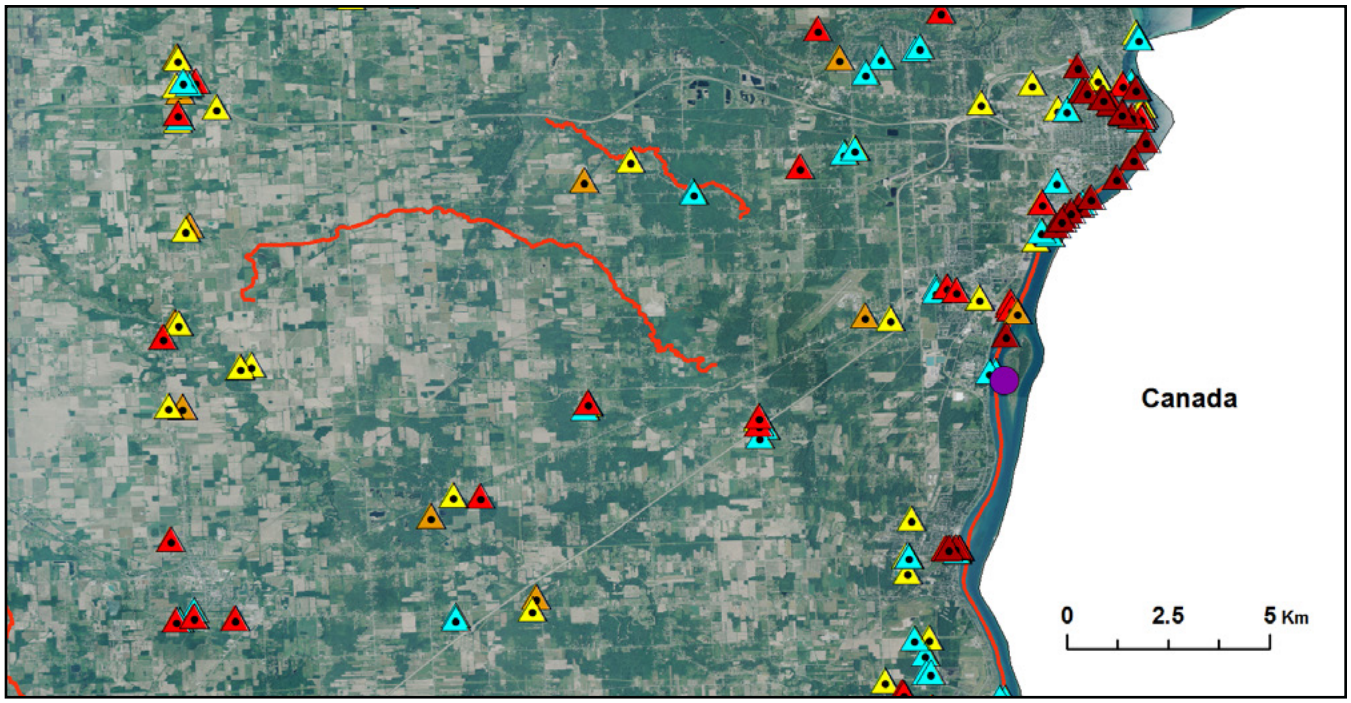
Land-use categories: MWP site (●) including 10 km buffer (○) and 2006 land-use categories from NLCD.

St. Clair River

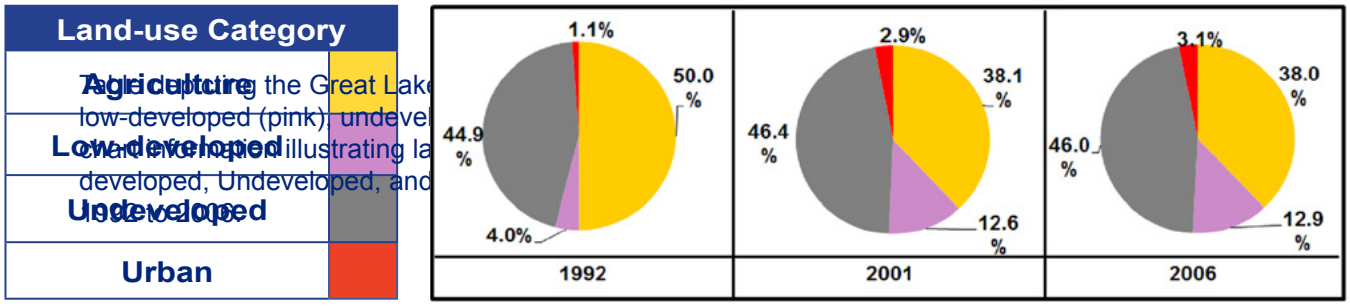


	LCSC	
	42.88004	
	-82.4693	
	MI	
	Agriculture	
	MW AOC	
	2010	
	84121	Low

Spatial delineation: MWP site (●), associated watershed (▭), and AOC boundary (///) where applicable.



Outfalls: Aerial orthoimagery and map depicting MWP site (●), Impaired and Assessed Waters (▭), and U.S.EPA NPDES major and minor permitted facilities outfall types: POTW (▲), Non-POTW (▲), Wastewater Facilities (▲), Discharge Facilities (▲), Water Dischargers (▲), Combined Sewer Overflows (CSO's) (▲).



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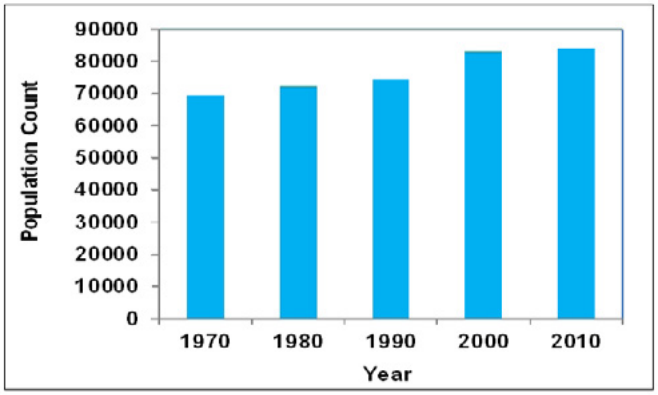

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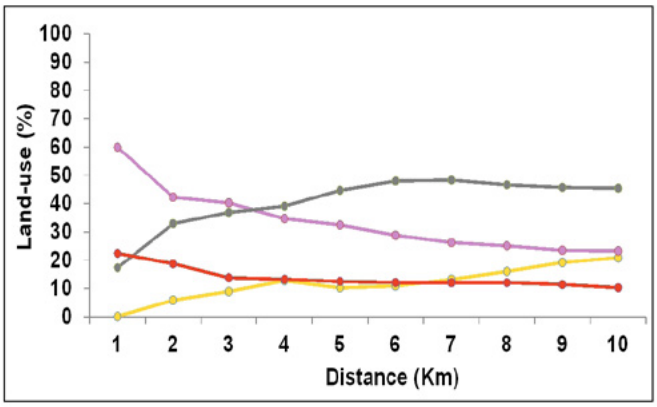
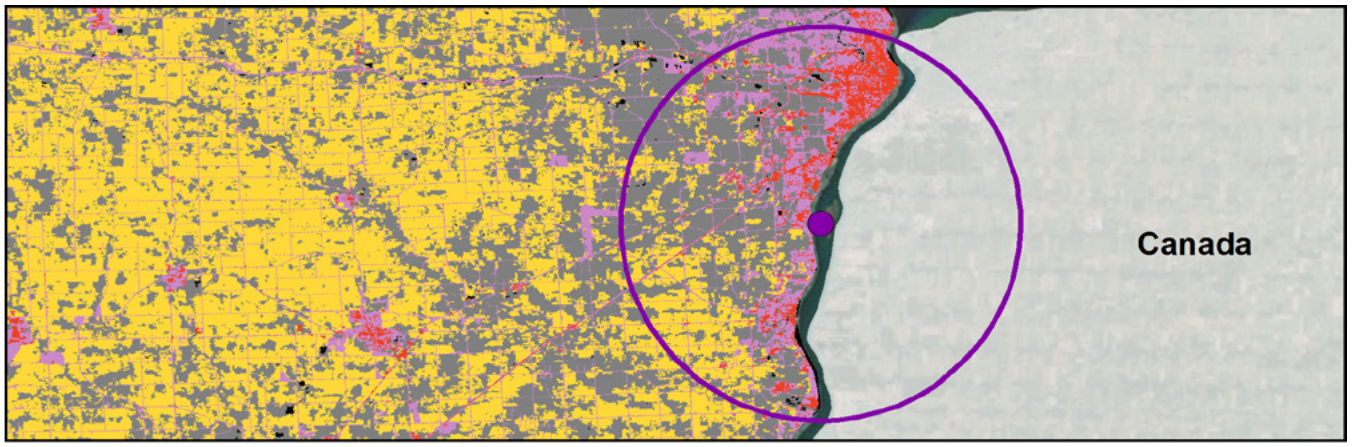
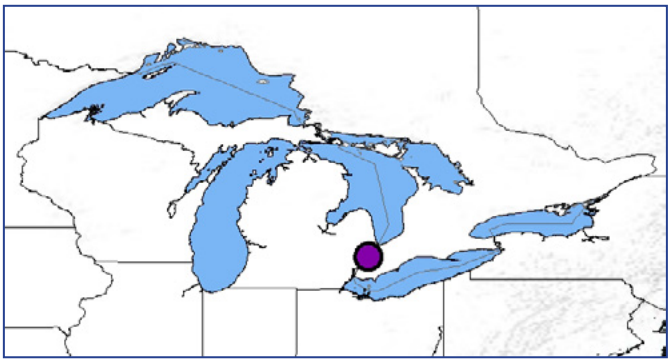


Line chart: MWP site 2006 NLCD land-use categories percentage within a 10 km buffer spatial extent.

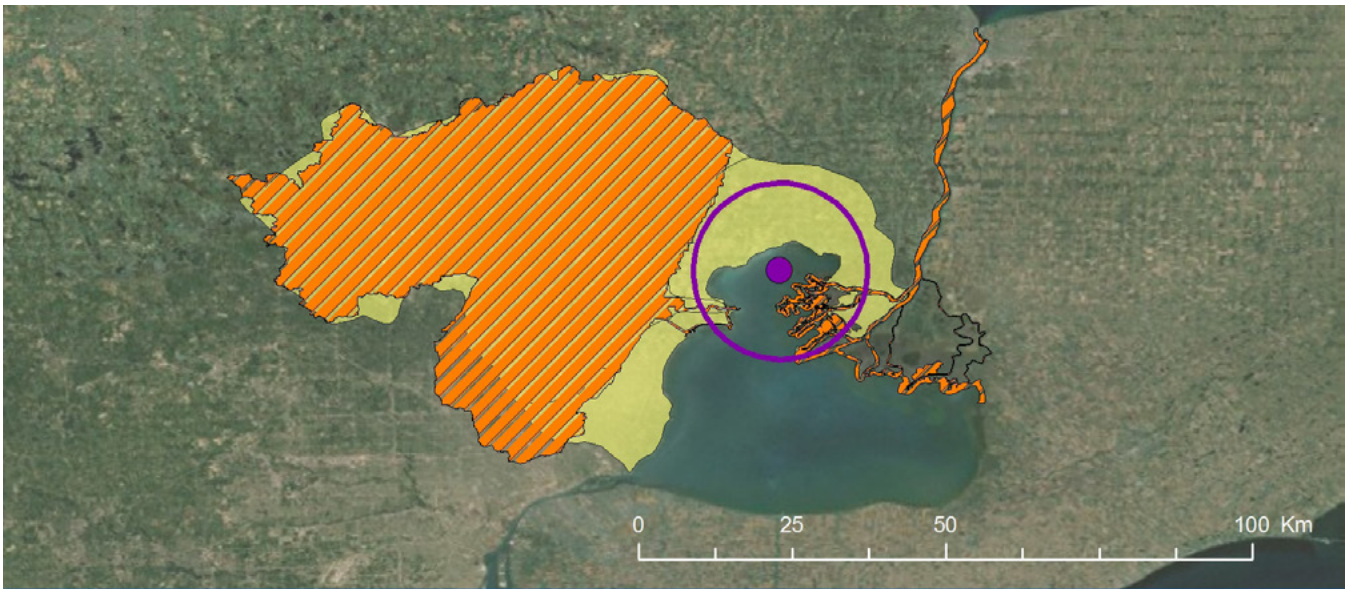


Land-use categories: MWP site (●) including 10 km buffer (○) and 2006 land-use categories from NLCD.

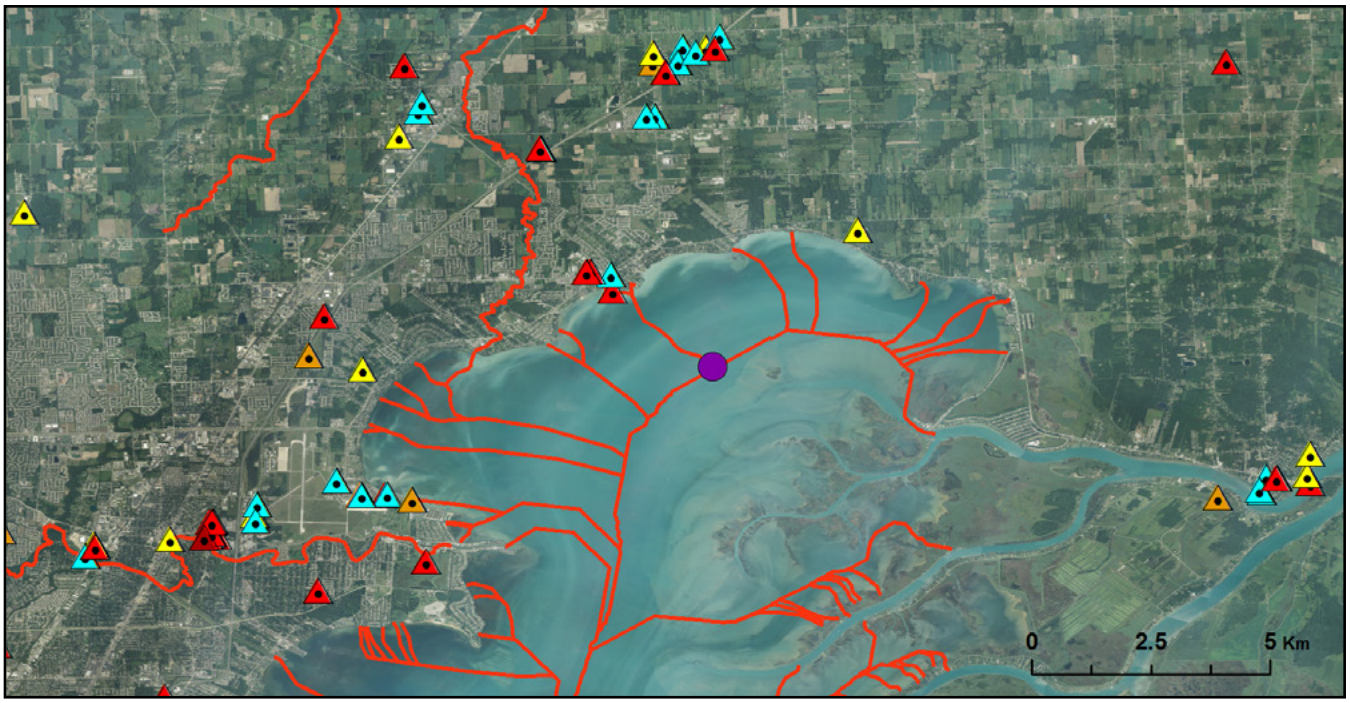
Anchor Bay



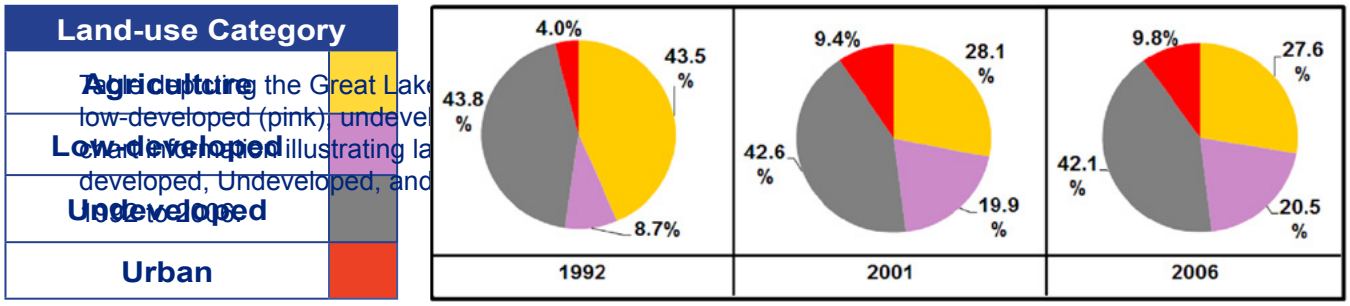
	LSAB	
	42.649166	
	-82.711	
	MI	
	Agriculture	
	MW AOC	
	1992	
	93388	Low



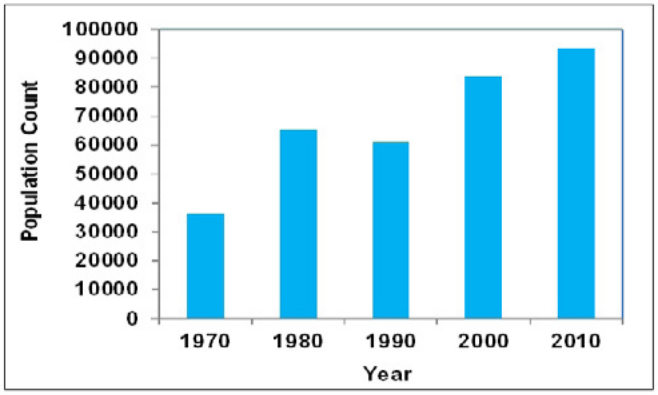
Spatial delineation: MWP site (●), associated watershed (▭), and AOC boundary (///) where applicable.



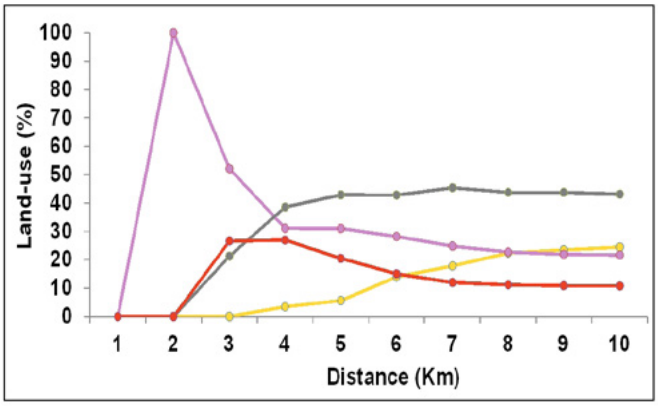
Outfalls: Aerial orthoimagery and map depicting MWP site (●), Impaired and Assessed Waters (▭), and U.S.EPA NPDES major and minor permitted facilities outfall types: POTW (▲), Non-POTW (▲), Wastewater Facilities (▲), Discharge Facilities (▲), Water Dischargers (▲), Combined Sewer Overflows (CSO's) (▲).



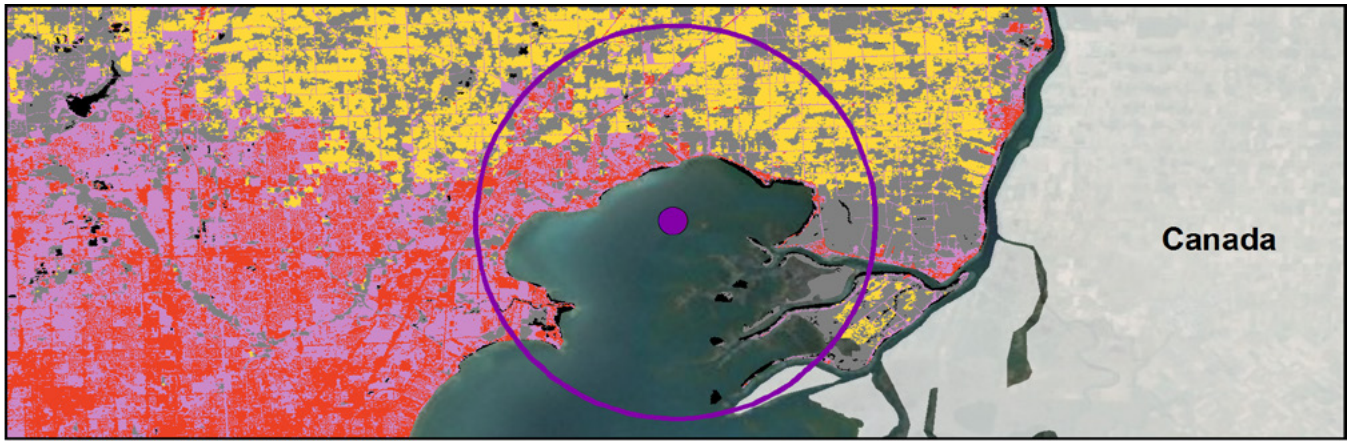
Legend: 1992 - 2006 National Land Cover Data (NLCD) aggregated hierarchal land-use categories, agriculture, low-developed, undeveloped and urban for Great Lakes Mussel Watch Program (MWP) sites.



Population barchart: Bar chart depicting population trend within 10 km buffer of MWP site (1970 - 2010).

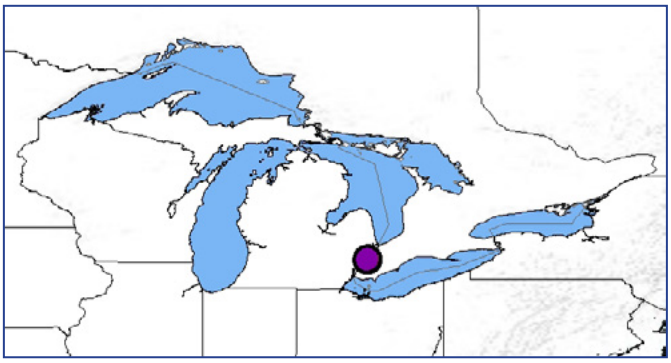


Line chart: MWP site 2006 NLCD land-use categories percentage within a 10 km buffer spatial extent.

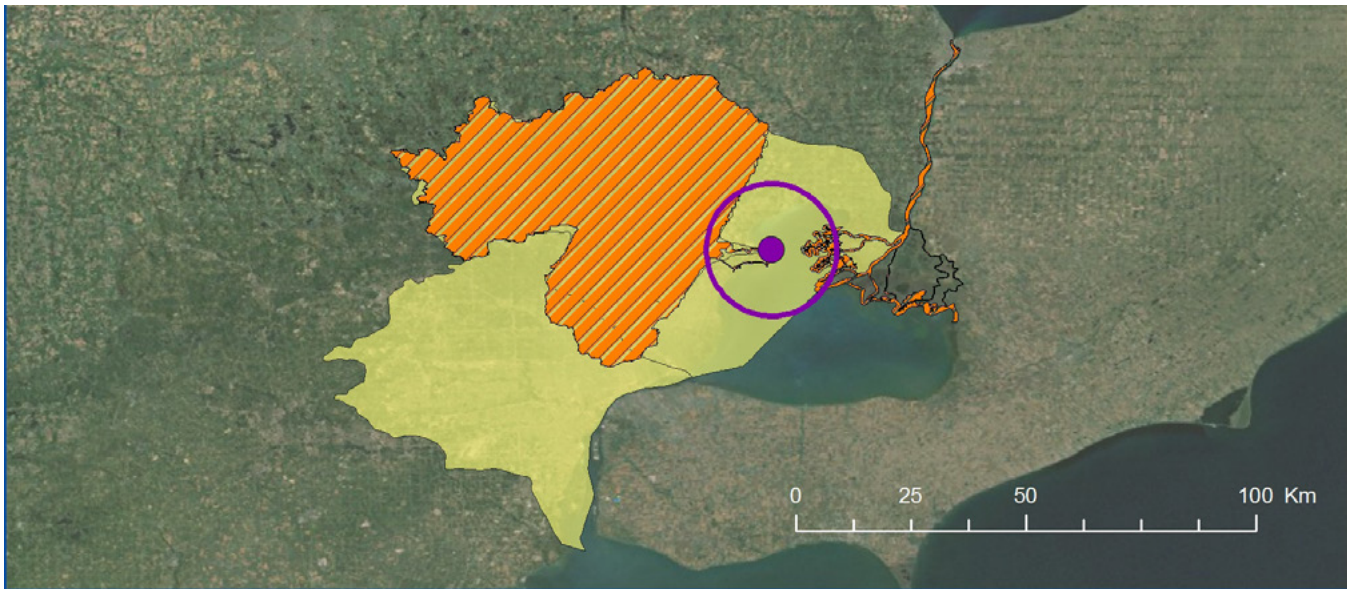


Land-use categories: MWP site (●) including 10 km buffer (○) and 2006 land-use categories from NLCD.

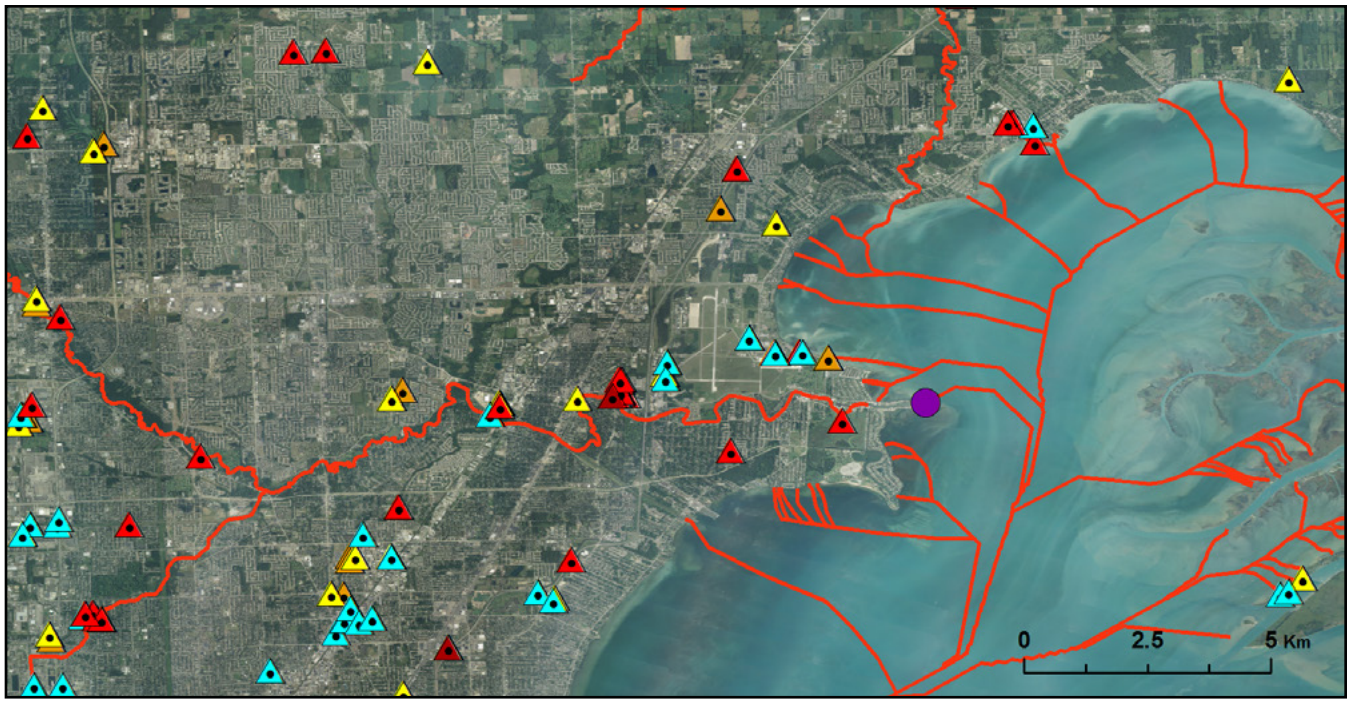
Clinton River



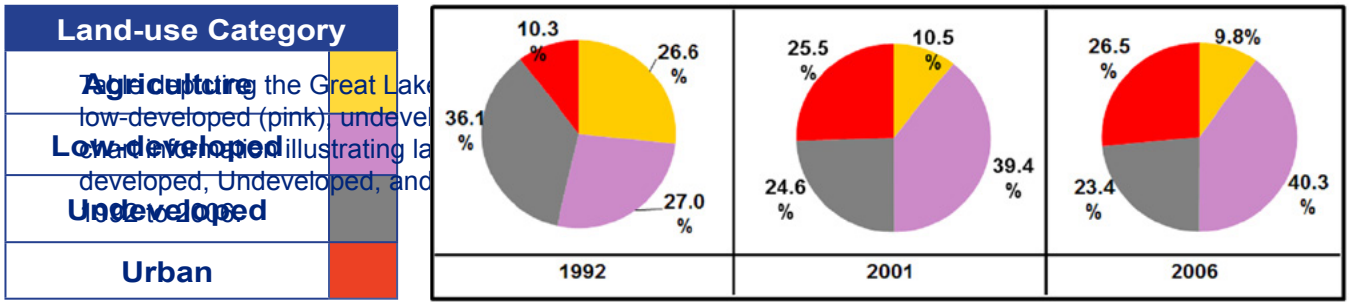
	LCCR	
	42.59518	
	-82.7751	
	MI	
	Low-developed	
	MW AOC	
	2010	
	190461	Medium



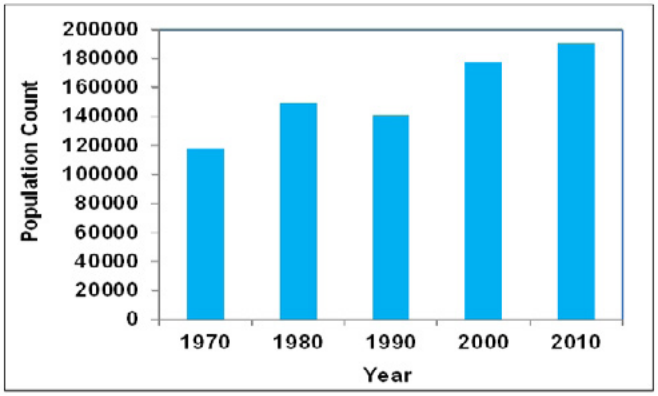
Spatial delineation: MWP site (●), associated watershed (▭), and AOC boundary (///) where applicable.



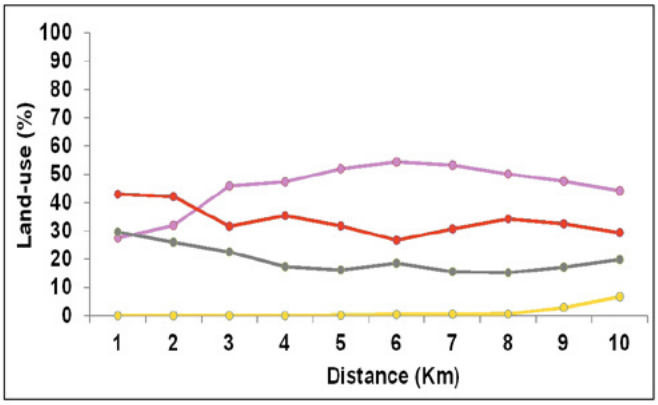
Outfalls: Aerial orthoimagery and map depicting MWP site (●), Impaired and Assessed Waters (▭), and U.S.EPA NPDES major and minor permitted facilities outfall types: POTW (▲), Non-POTW (▲), Wastewater Facilities (▲), Discharge Facilities (▲), Water Dischargers (▲), Combined Sewer Overflows (CSO's) (▲).



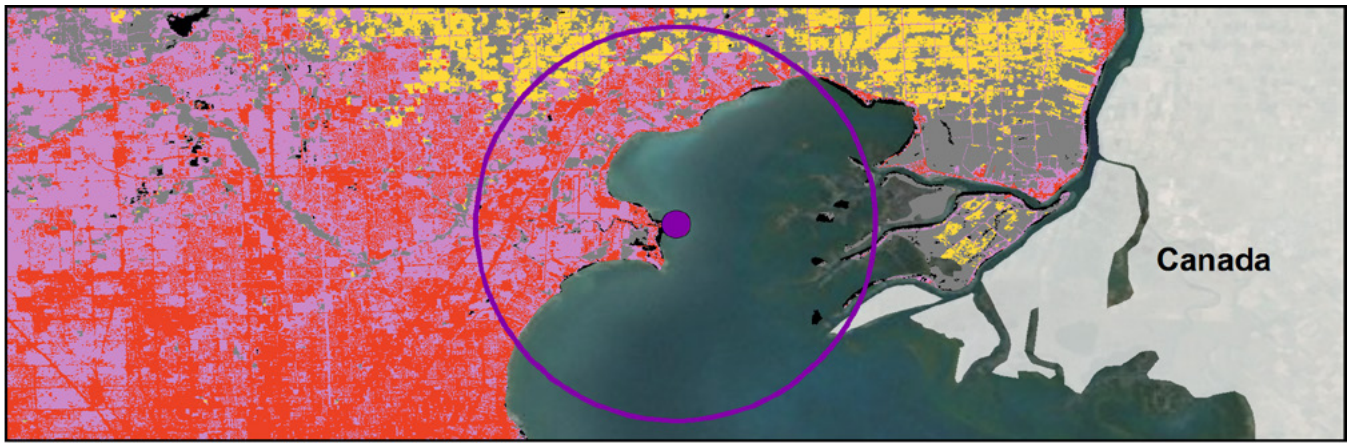
Legend: 1992 - 2006 National Land Cover Data (NLCD) aggregated hierarchal land-use categories, agriculture, low-developed, undeveloped and urban for Great Lakes Mussel Watch Program (MWP) sites.



Population barchart: Bar chart depicting population trend within 10 km buffer of MWP site (1970 - 2010).

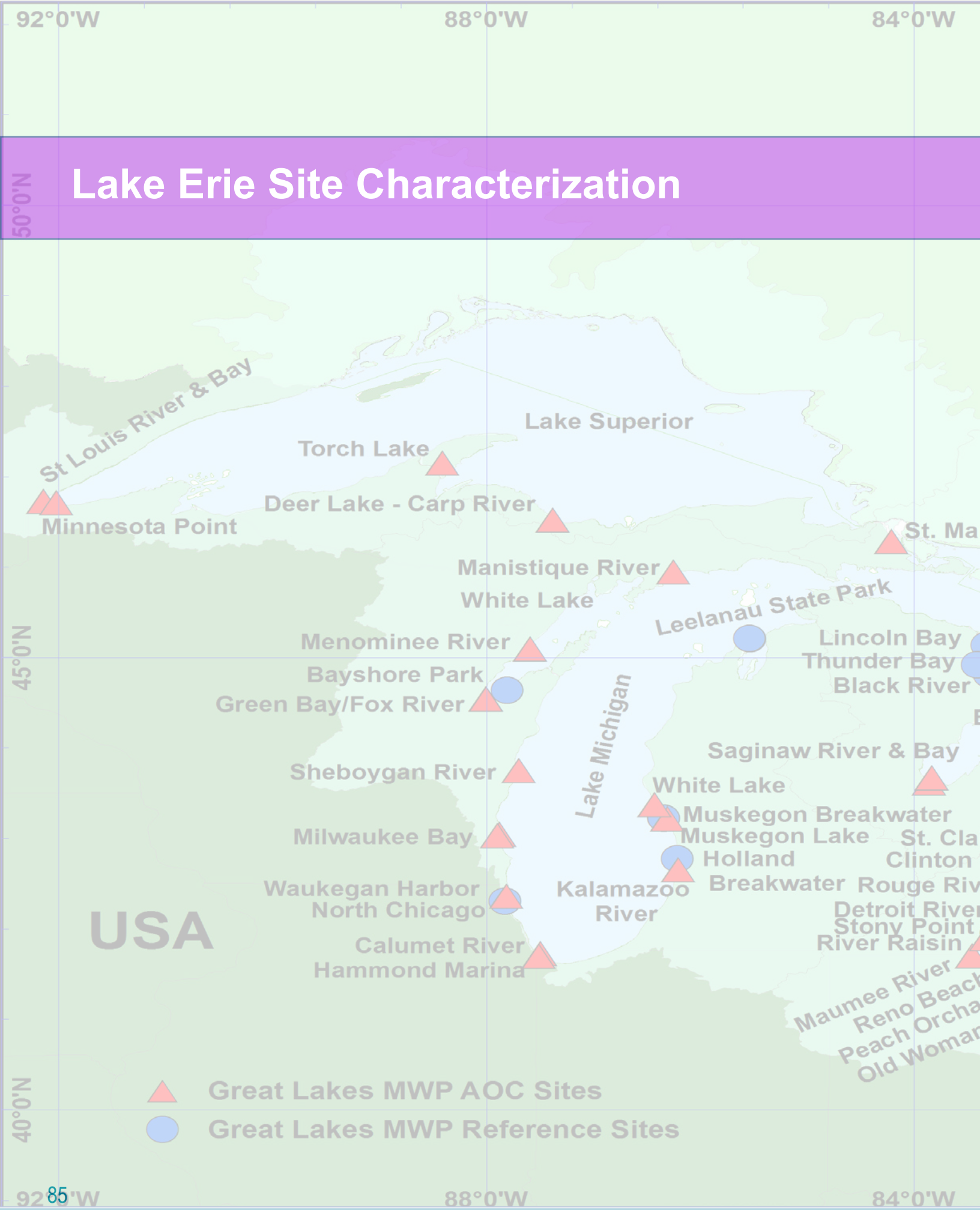


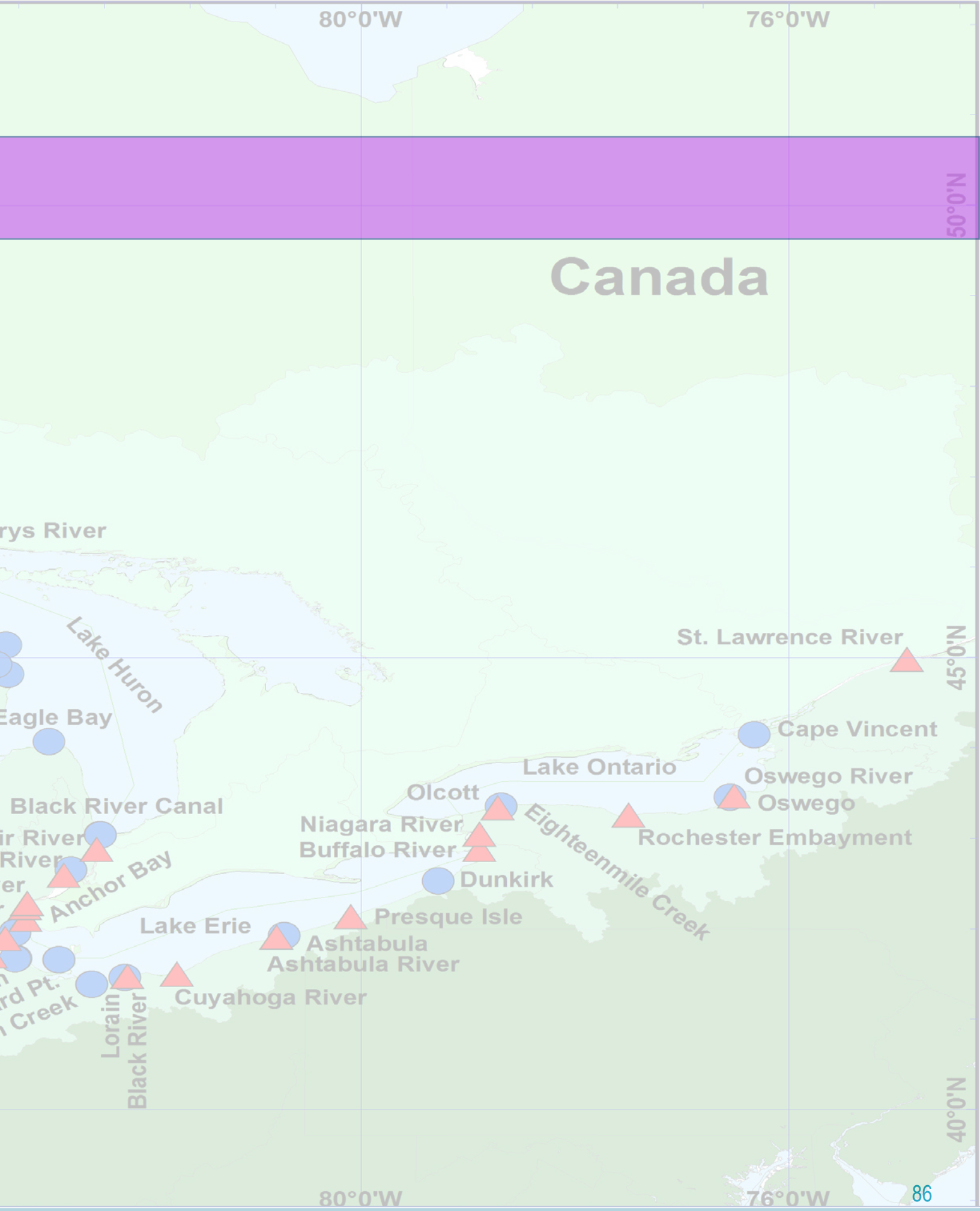
Line chart: MWP site 2006 NLCD land-use categories percentage within a 10 km buffer spatial extent.



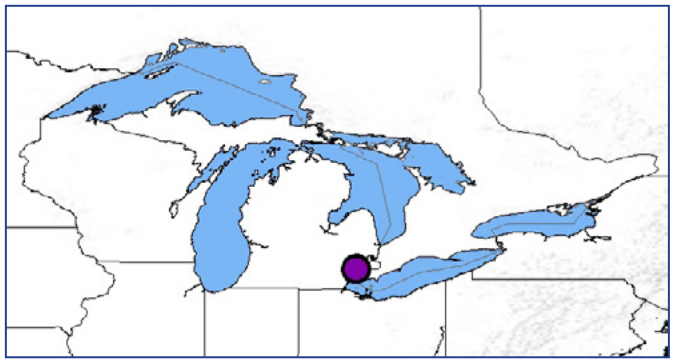
Land-use categories: MWP site (●) including 10 km buffer (○) and 2006 land-use categories from NLCD.

Lake Erie Site Characterization




80°0'W
76°0'W
50°0'N
Canada
rys River
Lake Huron
Eagle Bay
St. Lawrence River
45°0'N
Cape Vincent
Lake Ontario
Oswego River
Oswego
Olcott
Black River Canal
Niagara River
Buffalo River
Eighteenmile Creek
Rochester Embayment
Anchor Bay
Dunkirk
Lake Erie
Presque Isle
Ashtabula
Ashtabula River
Cuyahoga River
Lorain
Black River
40°0'N
80°0'W
76°0'W

Rouge River



	LMMR	
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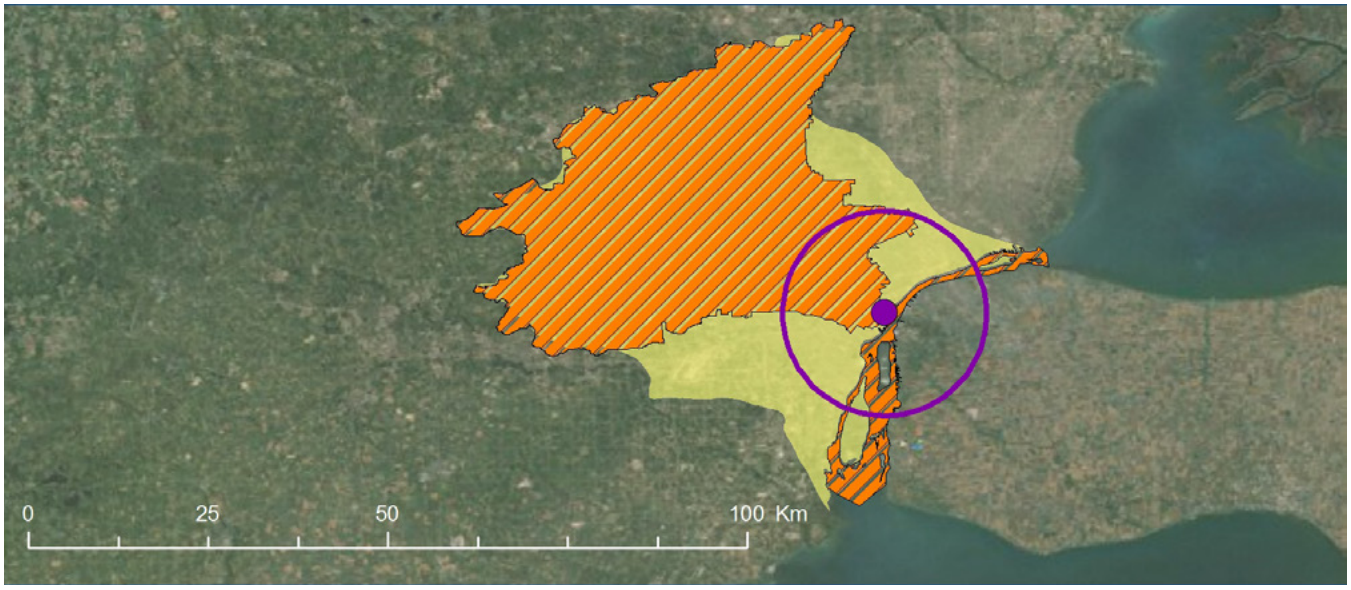
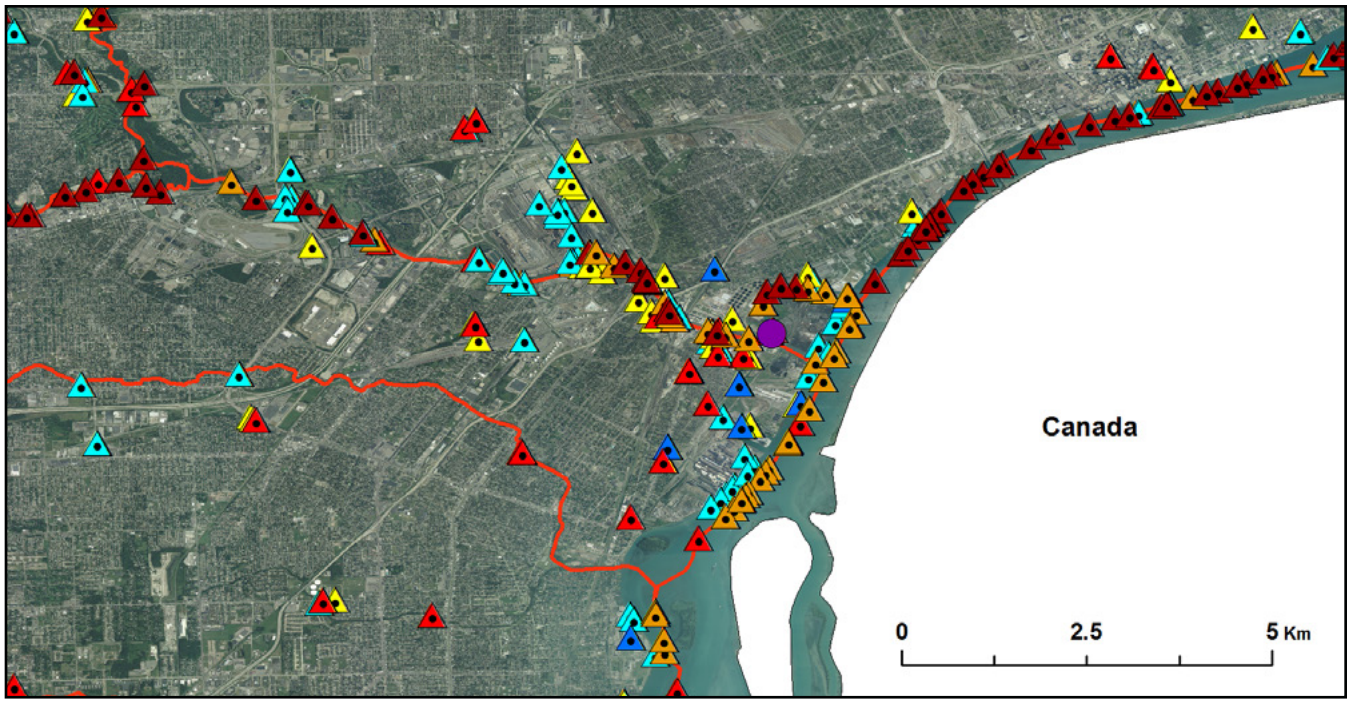
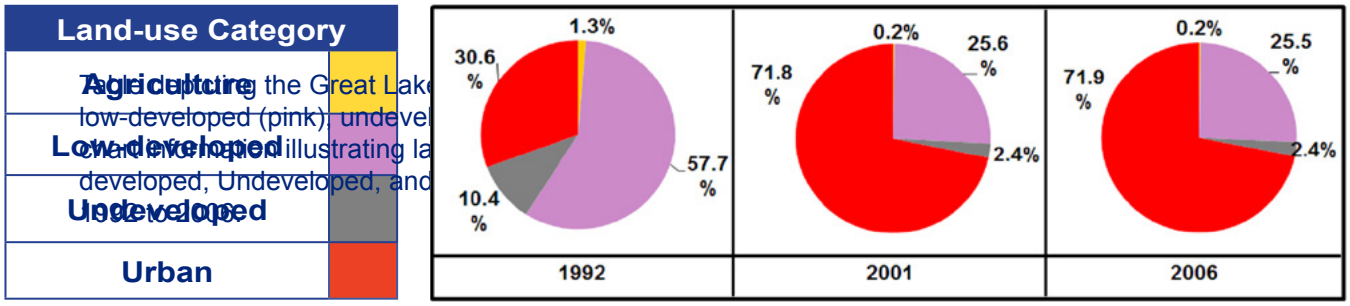
	-83.11807	
	MI	
	Urban	
	MW AOC	
	2010	
	670672	High



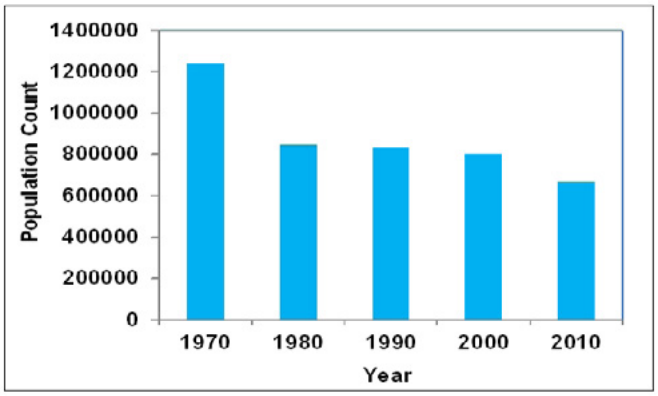
Spatial delineation: MWP site (●), associated watershed (▭), and AOC boundary (▨) where applicable.



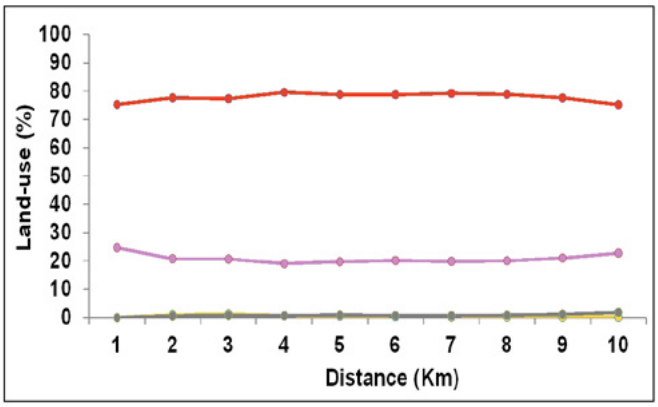
Outfalls: Aerial orthoimagery and map depicting MWP site (●), Impaired and Assessed Waters (▭), and U.S.EPA NPDES major and minor permitted facilities outfall types: POTW (▲), Non-POTW (▲), Wastewater Facilities (▲), Discharge Facilities (▲), Water Dischargers (▲), Combined Sewer Overflows (CSO's) (▲).



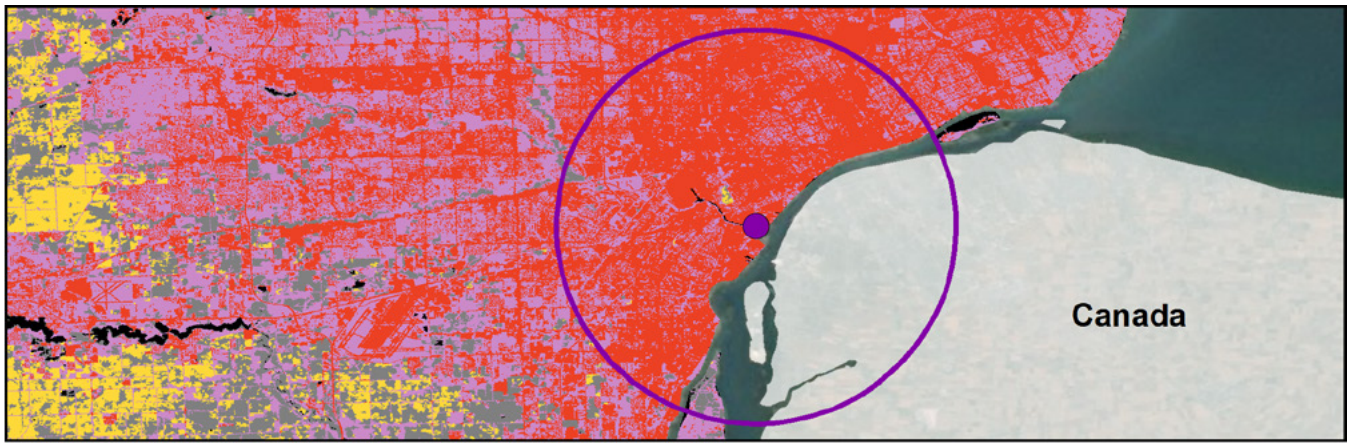
Legend: 1992 - 2006 National Land Cover Data (NLCD) aggregated hierarchal land-use categories, agriculture, low-developed, undeveloped and urban for Great Lakes Mussel Watch Program (MWP) sites.



Population barchart: Bar chart depicting population trend within 10 km buffer of MWP site (1970 - 2010).



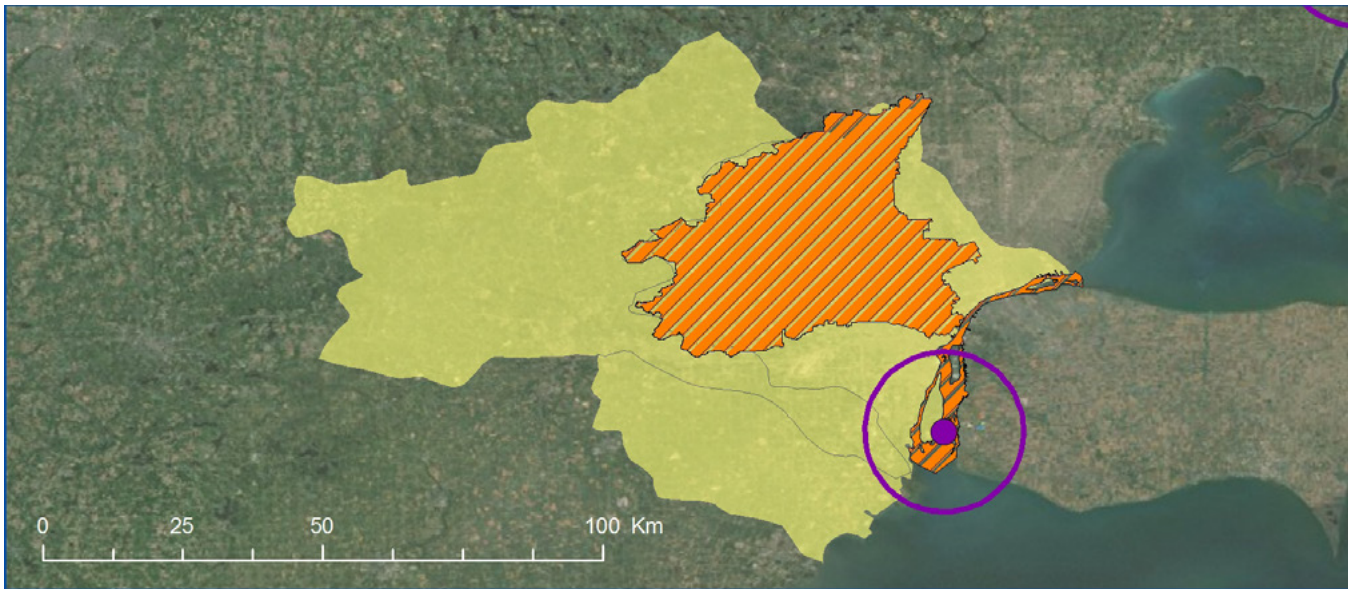
Line chart: MWP site 2006 NLCD land-use categories percentage within a 10 km buffer spatial extent.



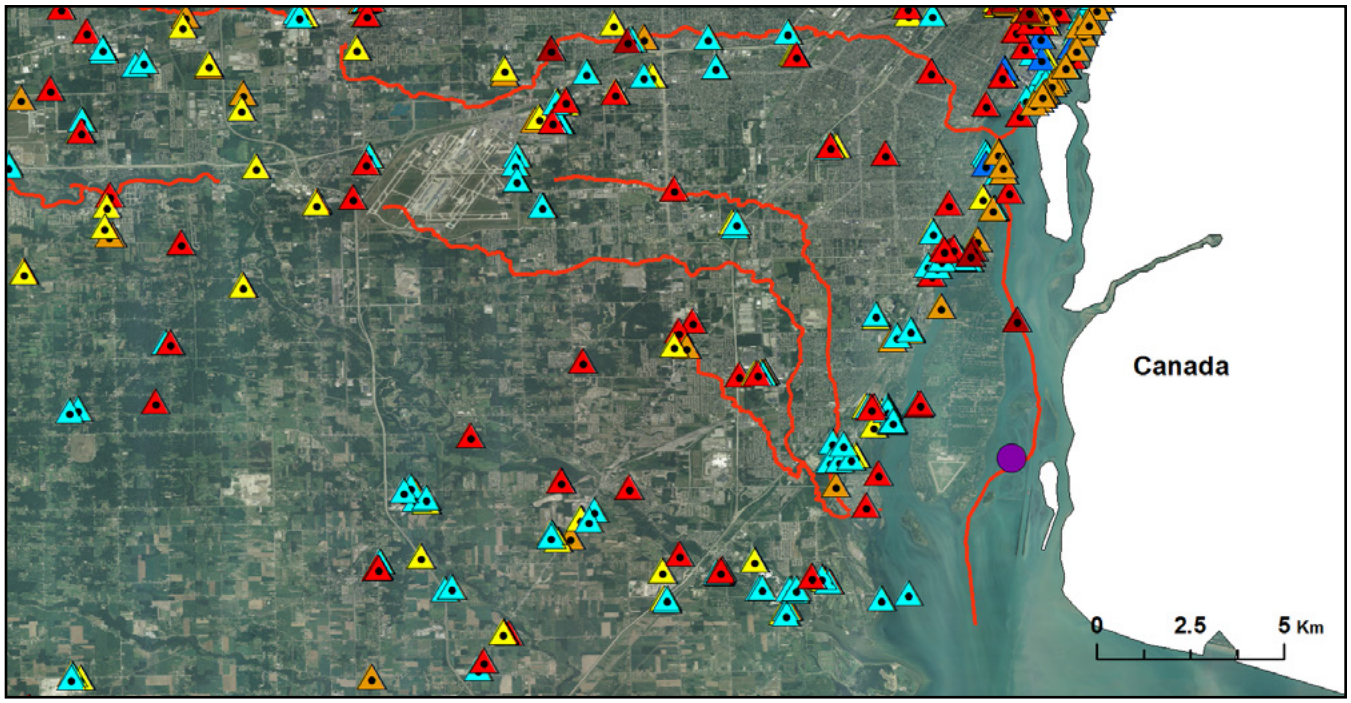
Land-use categories: MWP site (●) including 10 km buffer (○) and 2006 land-use categories from NLCD.

Detroit River

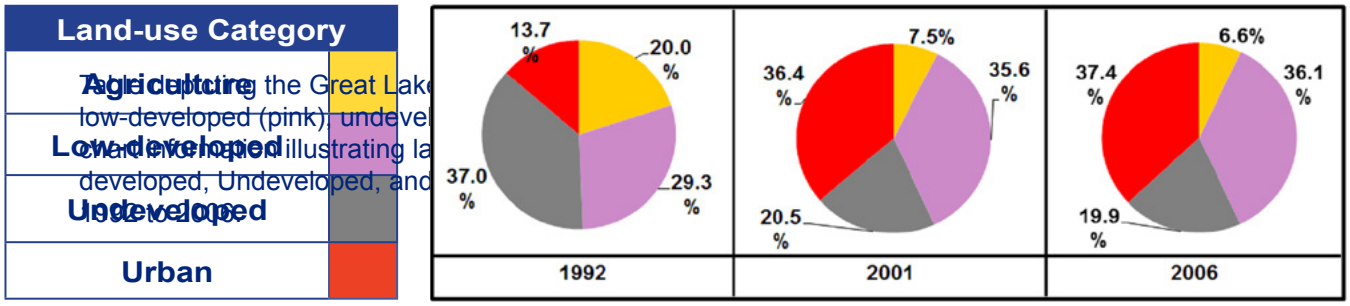
	DRSE	
	42.1069	
	-83.1355	
	MI	
	Low-developed	
	MW AOC	
	2009	
	183049	Medium



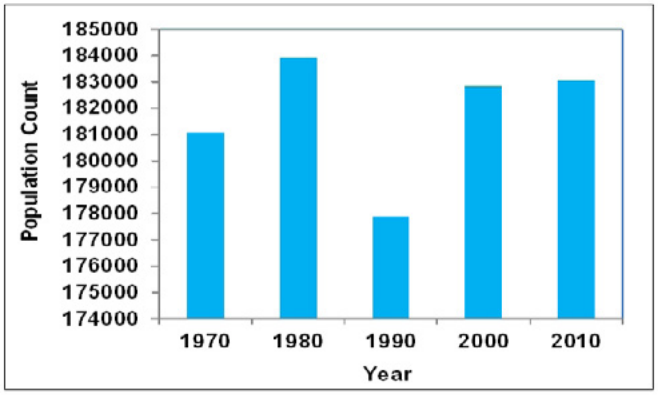
Spatial delineation: MWP site (●), associated watershed (▭), and AOC boundary (///) where applicable.



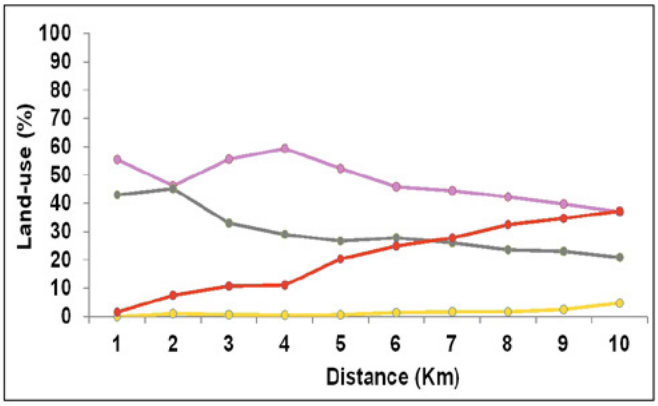
Outfalls: Aerial orthoimagery and map depicting MWP site (●), Impaired and Assessed Waters (▭), and U.S.EPA NPDES major and minor permitted facilities outfall types: POTW (▲), Non-POTW (▲), Wastewater Facilities (▲), Discharge Facilities (▲), Water Dischargers (▲), Combined Sewer Overflows (CSO's) (▲).



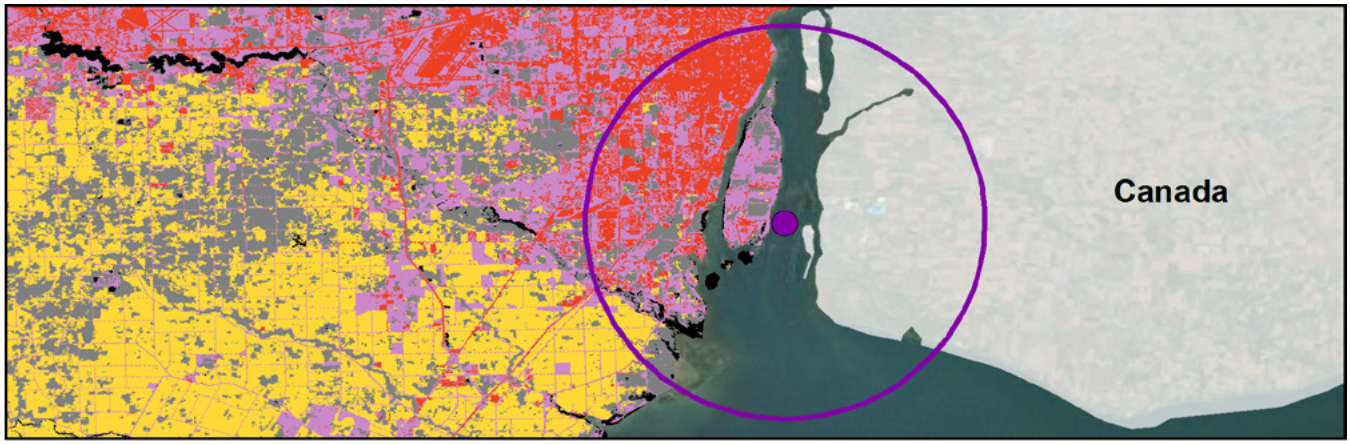
Legend: 1992 - 2006 National Land Cover Data (NLCD) aggregated hierarchal land-use categories, agriculture, low-developed, undeveloped and urban for Great Lakes Mussel Watch Program (MWP) sites.



Population barchart: Bar chart depicting population trend within 10 km buffer of MWP site (1970 - 2010).

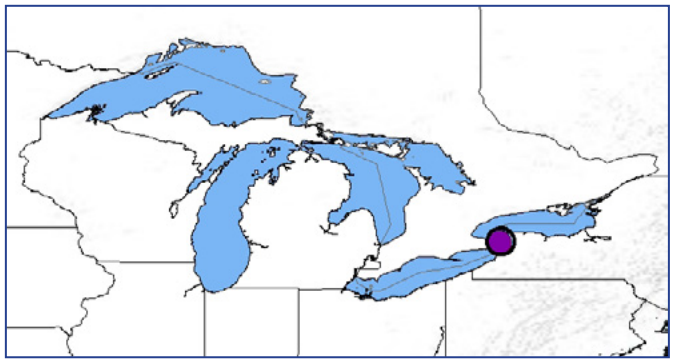


Line chart: MWP site 2006 NLCD land-use categories percentage within a 10 km buffer spatial extent.

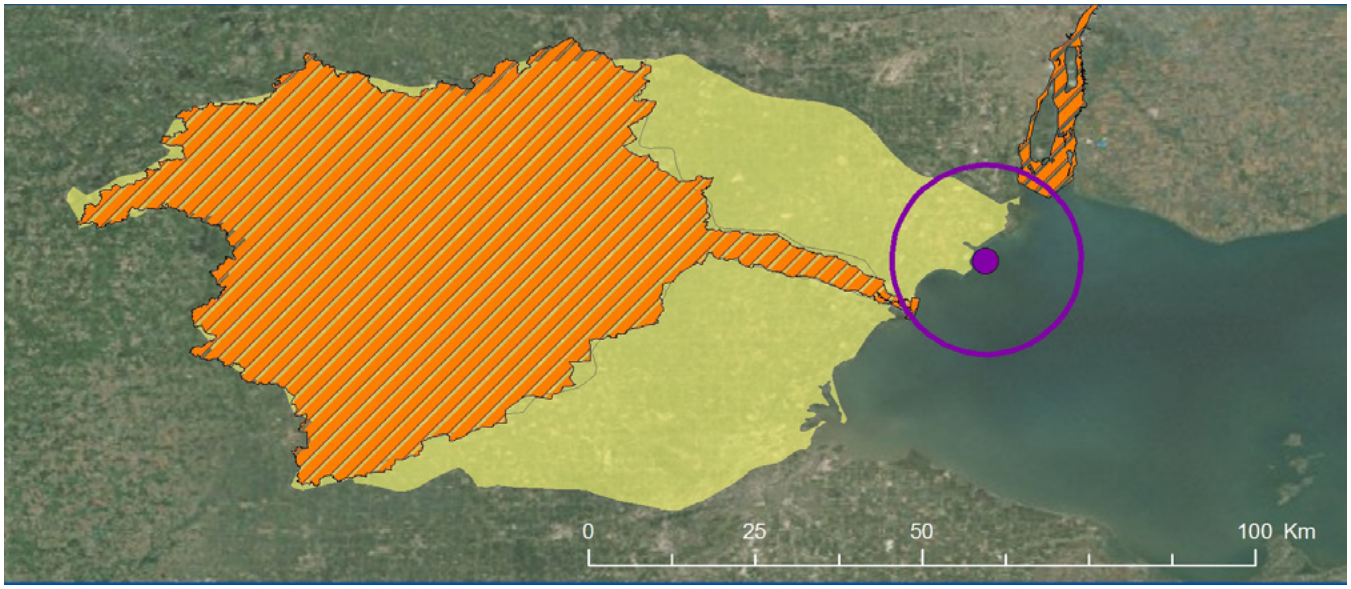


Land-use categories: MWP site (●) including 10 km buffer (○) and 2006 land-use categories from NLCD.

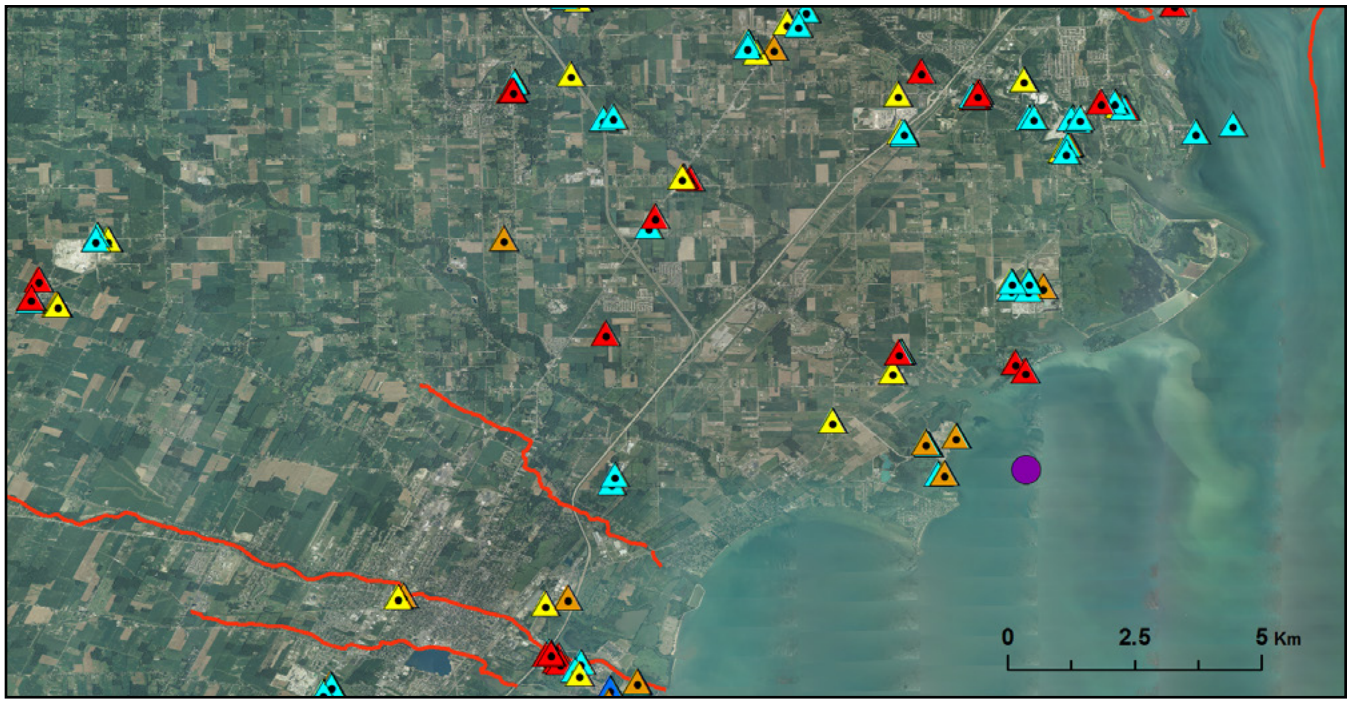
Stony Point



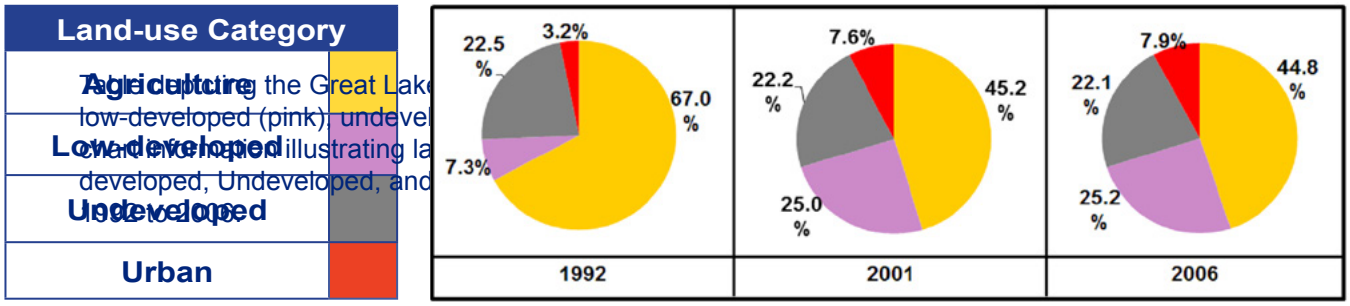
	LESP	
	41.958667	
	-83.233	
	MI	
	Agriculture	
	MW REF	
	1992	
	47573	Low



Spatial delineation: MWP site (●), associated watershed (▭), and AOC boundary (///) where applicable.



Outfalls: Aerial orthoimagery and map depicting MWP site (●), Impaired and Assessed Waters (▭), and U.S.EPA NPDES major and minor permitted facilities outfall types: POTW (▲), Non-POTW (▲), Wastewater Facilities (▲), Discharge Facilities (▲), Water Dischargers (▲), Combined Sewer Overflows (CSO's) (▲).



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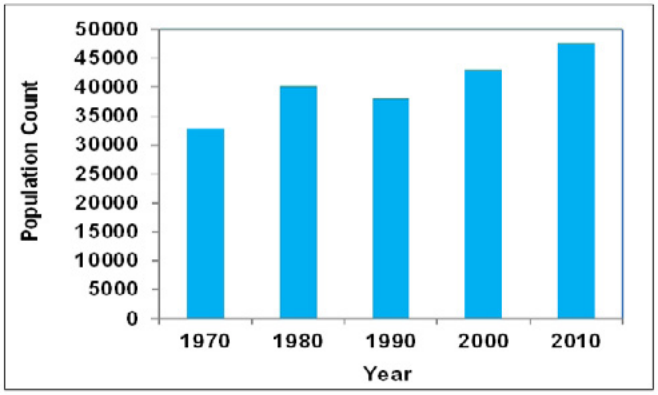
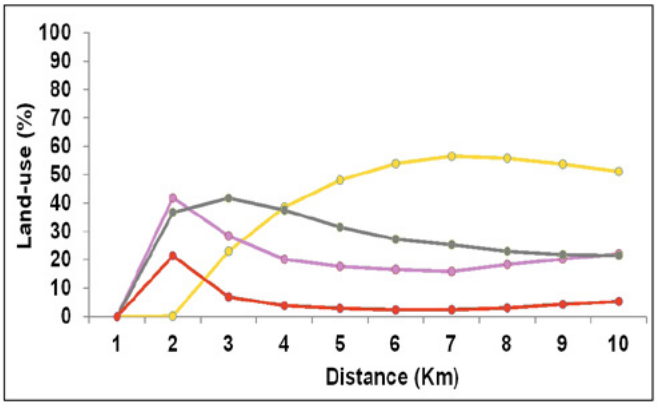


Population barchart: Bar chart depicting population trend within 10 km buffer of MWP site (1970 - 2010).

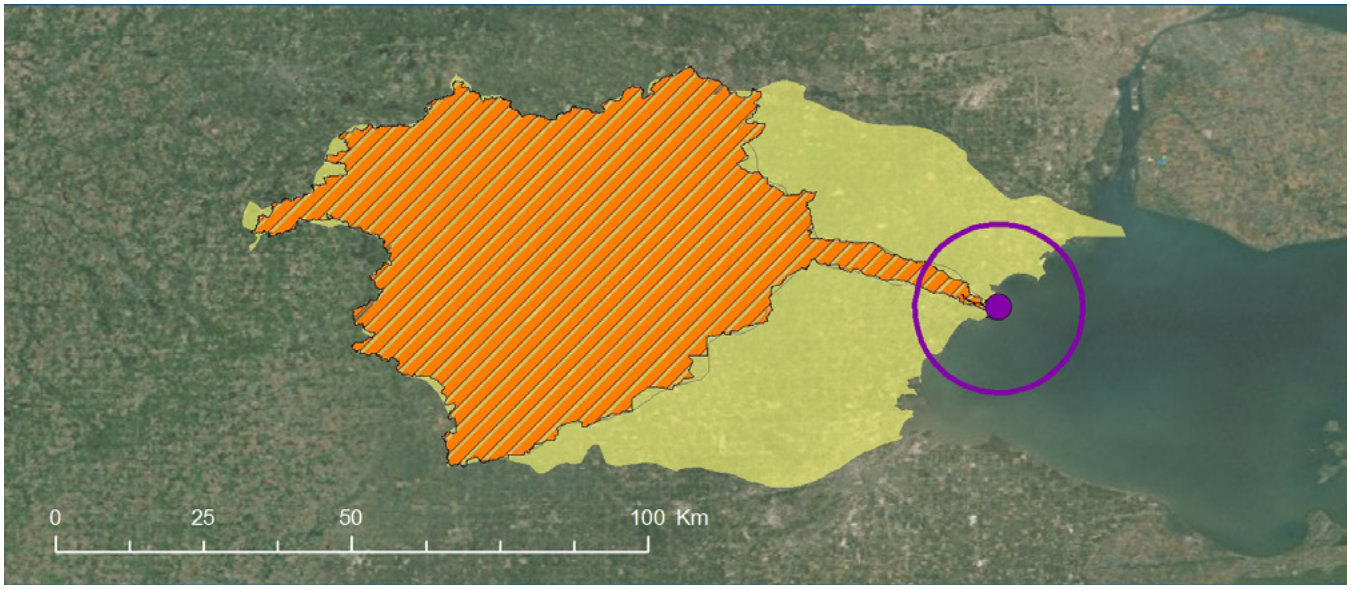


Line chart: MWP site 2006 NLCD land-use categories percentage within a 10 km buffer spatial extent.

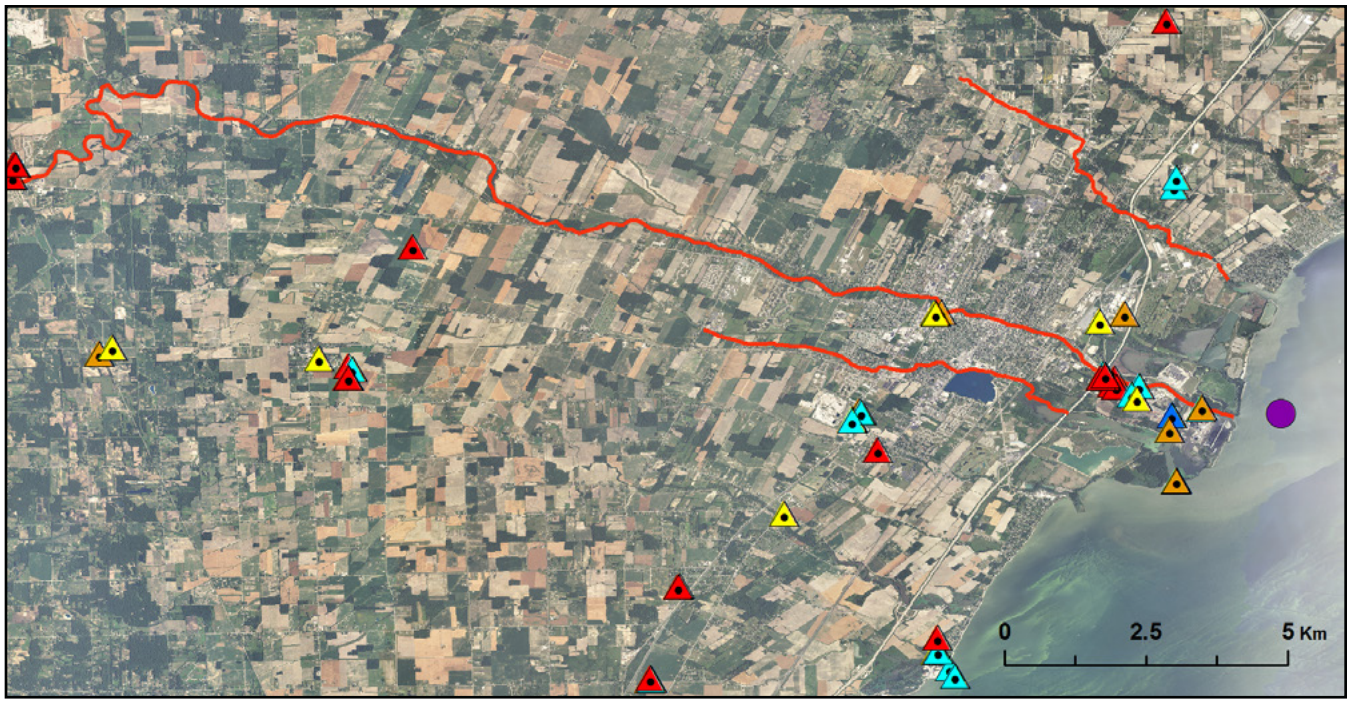
Land-use categories: MWP site (●) including 10 km buffer (○) and 2006 land-use categories from NLCD.

River Raisin

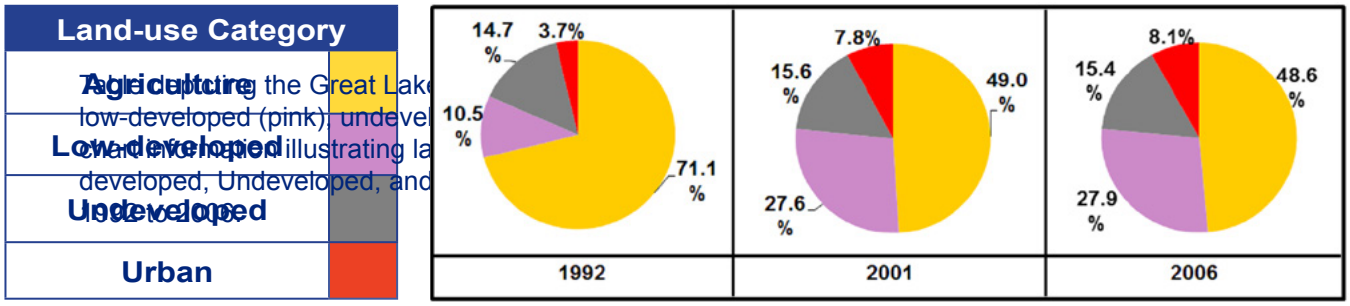
	LERR	
	41.899	
	-83.362	
	MI	
	Agriculture	
	MW AOC	
	2009	
	68051	Low



Spatial delineation: MWP site (●), associated watershed (▭), and AOC boundary (///) where applicable.



Outfalls: Aerial orthoimagery and map depicting MWP site (●), Impaired and Assessed Waters (▭), and U.S.EPA NPDES major and minor permitted facilities outfall types: POTW (▲), Non-POTW (▲), Wastewater Facilities (▲), Discharge Facilities (▲), Water Dischargers (▲), Combined Sewer Overflows (CSO's) (▲).



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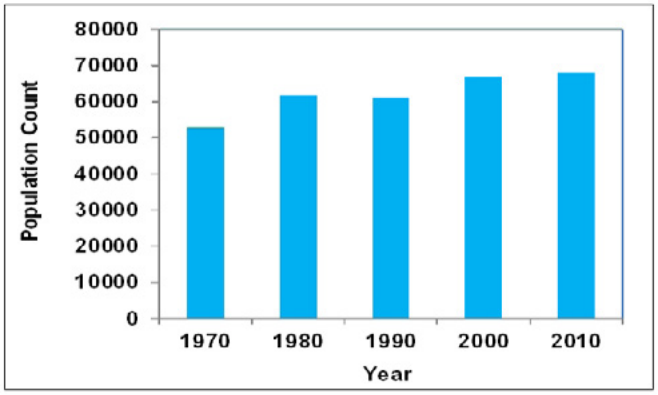
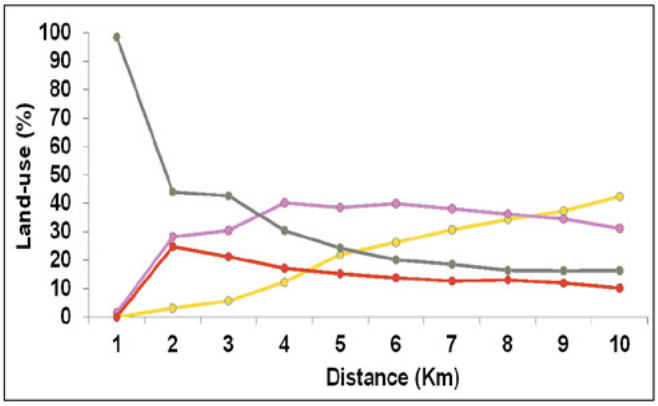
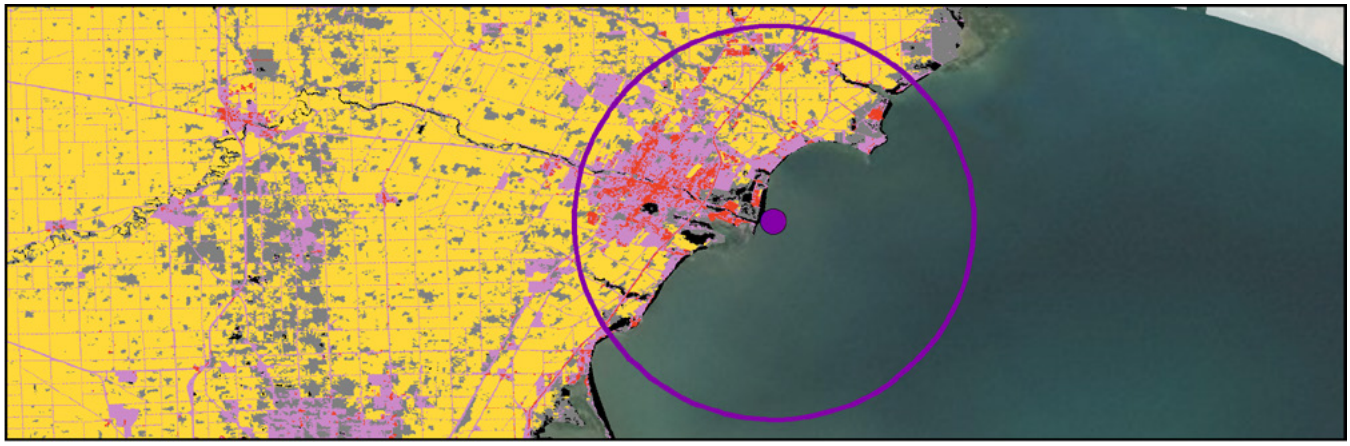


Population barchart: Bar chart depicting population trend within 10 km buffer of MWP site (1970 - 2010).



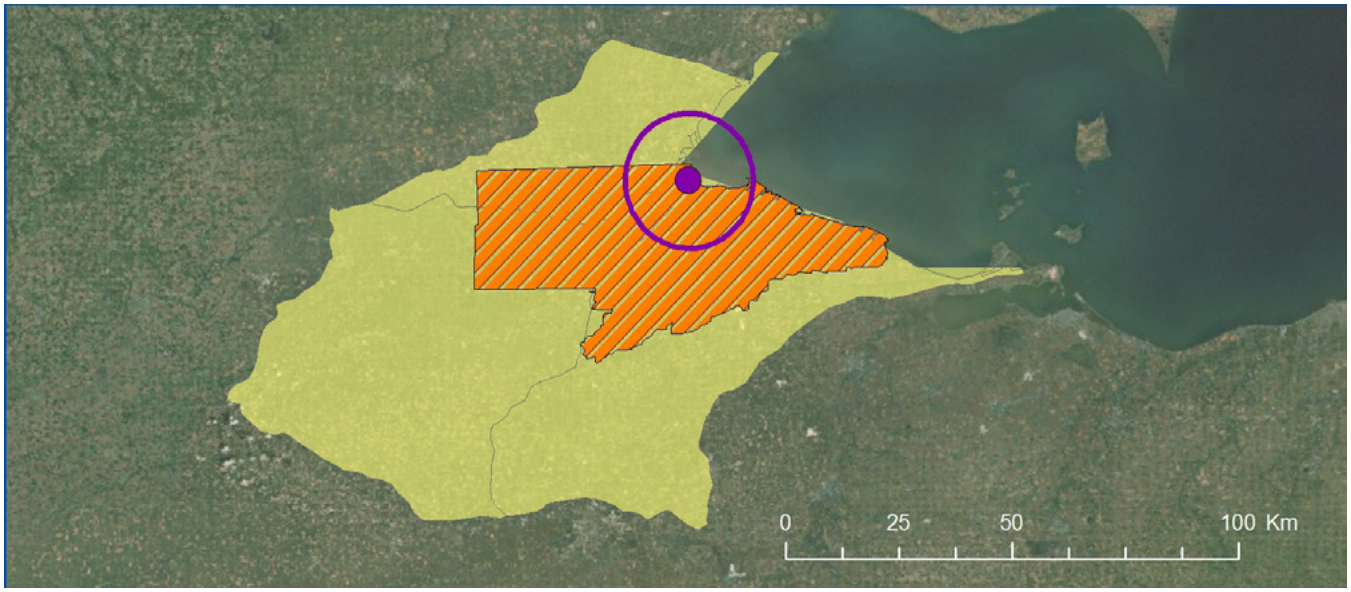
Line chart: MWP site 2006 NLCD land-use categories percentage within a 10 km buffer spatial extent.



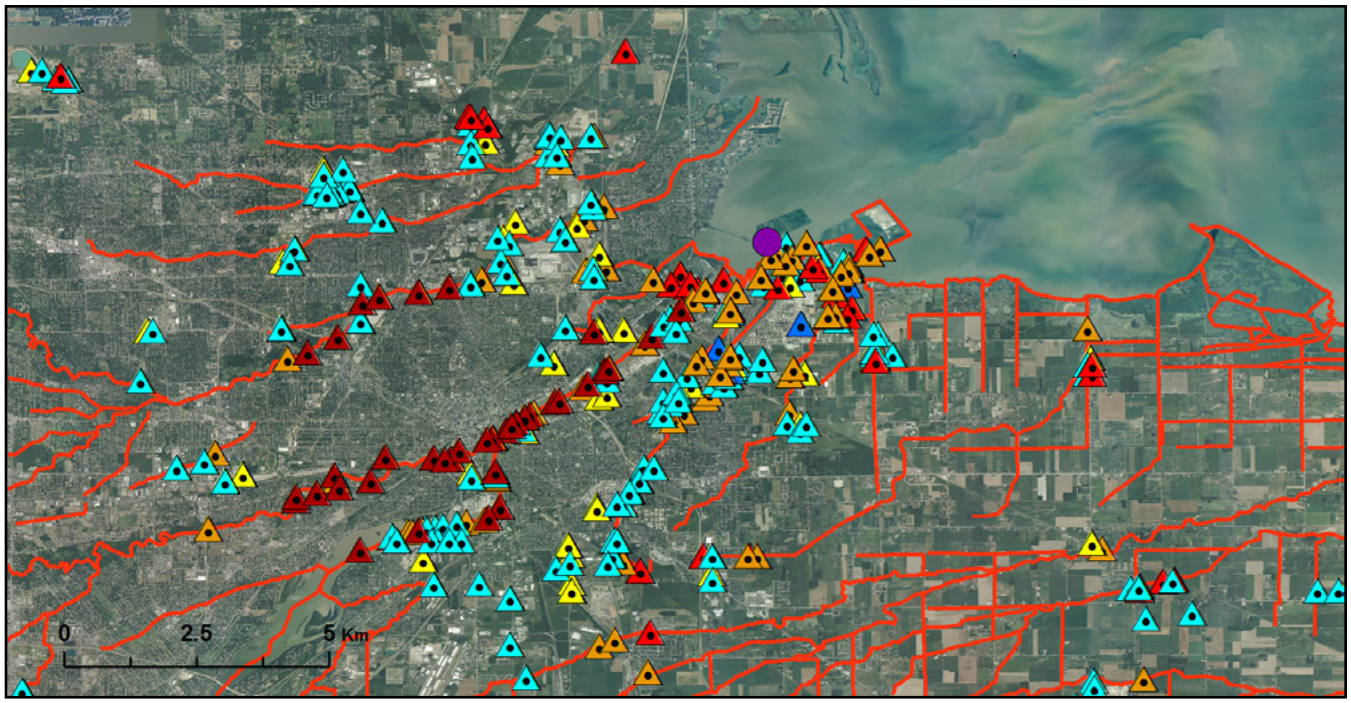
Land-use categories: MWP site (●) including 10 km buffer (○) and 2006 land-use categories from NLCD.

Maumee River

	LEMR
	41.701416
	-83.458716
	OH
	Low-developed
	MW AOC
	2009
	233973 Medium



Spatial delineation: MWP site (●), associated watershed (▭), and AOC boundary (///) where applicable.



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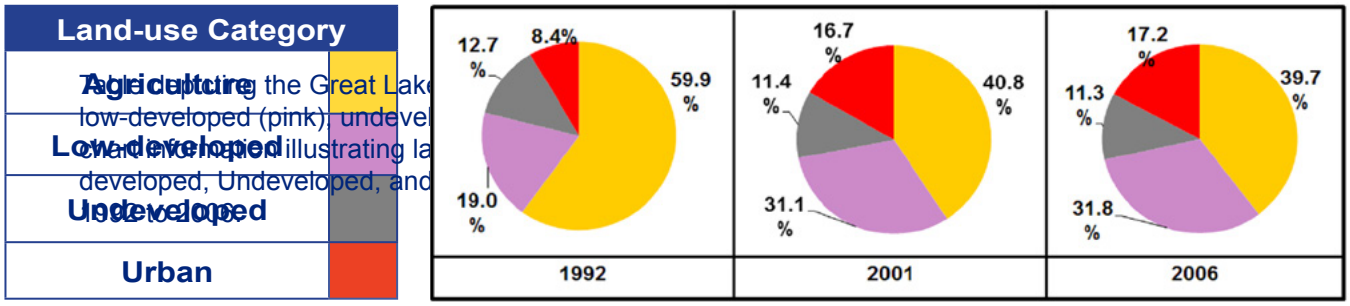

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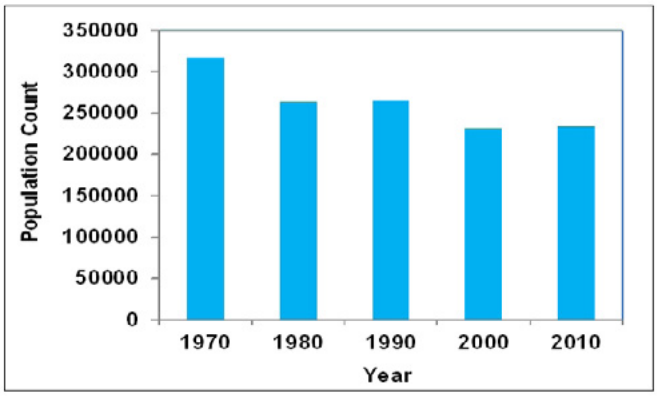

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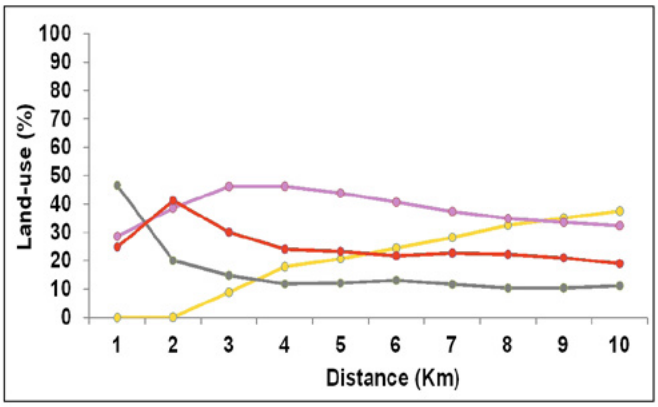
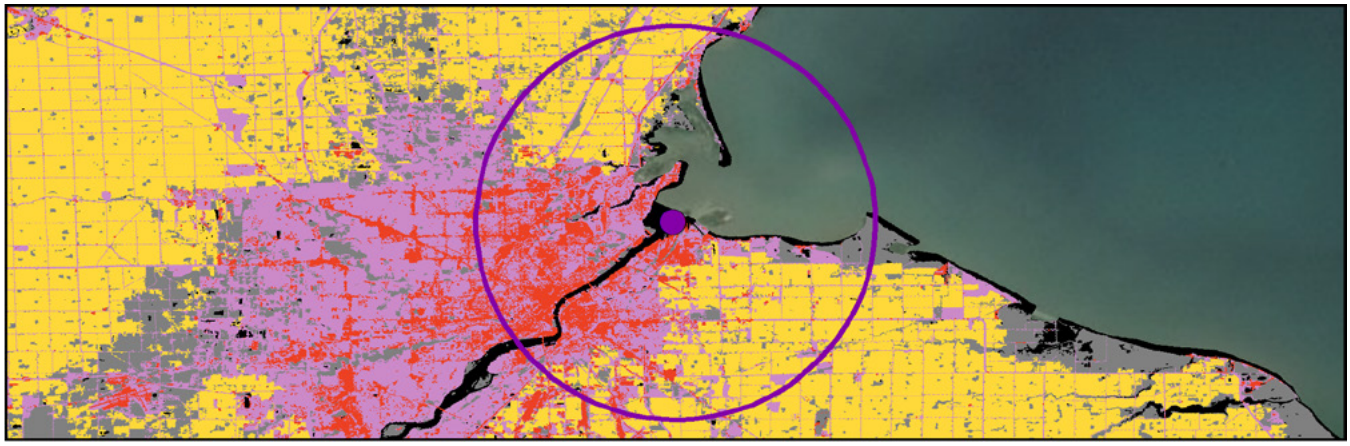
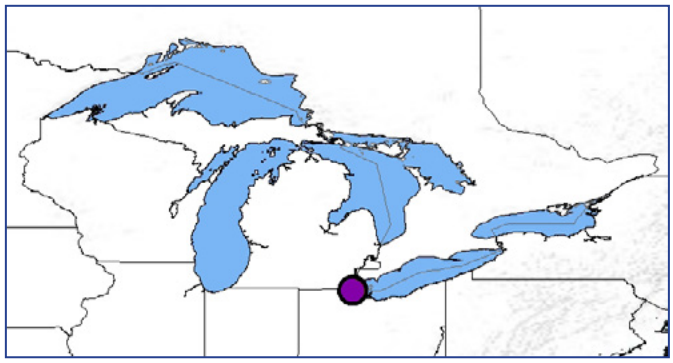


Line chart: MWP site 2006 NLCD land-use categories percentage within a 10 km buffer spatial extent.

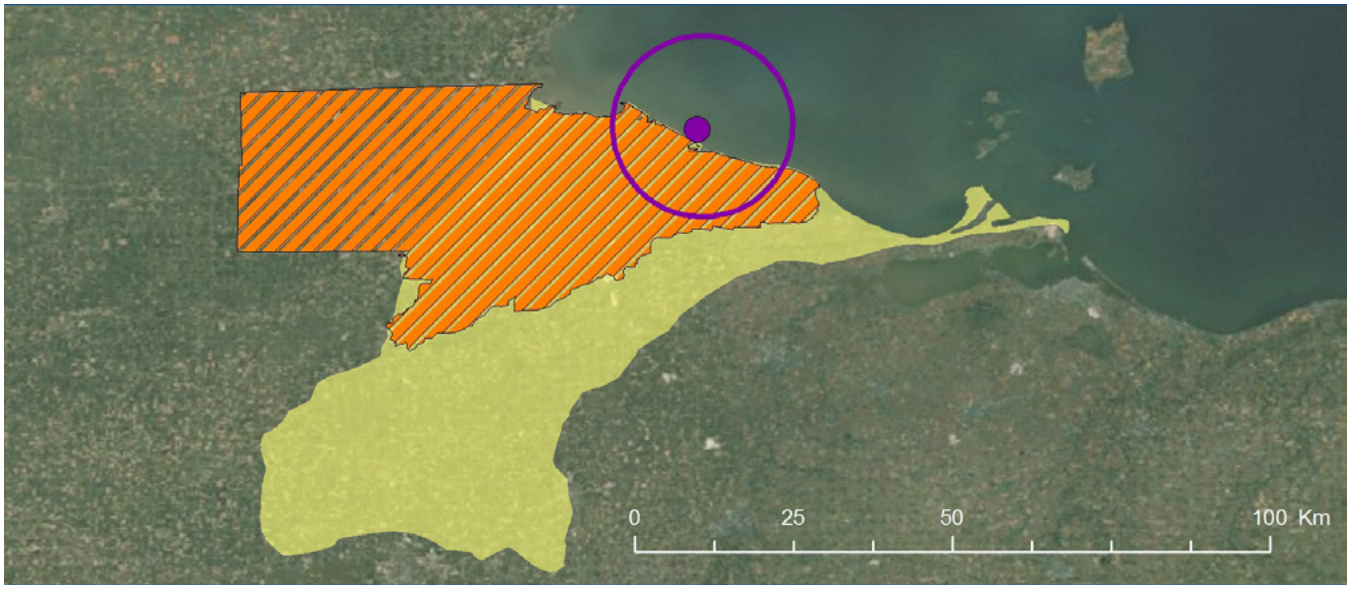


Land-use categories: MWP site (●) including 10 km buffer (○) and 2006 land-use categories from NLCD.

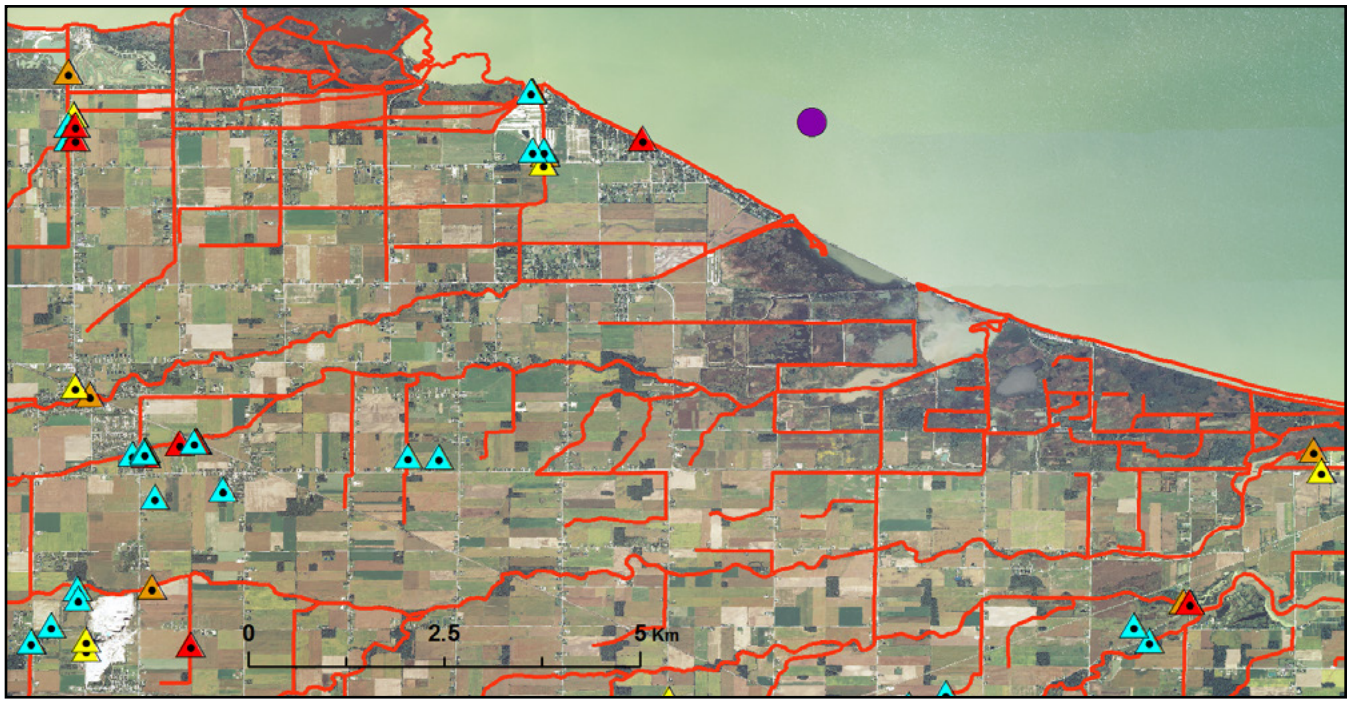
Reno Beach



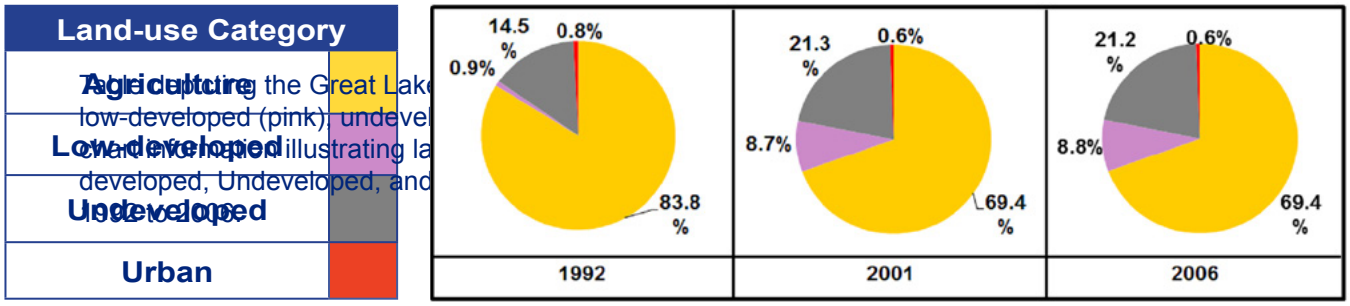
	LERB	
	41.6745	
	-83.226167	
	OH	
	Agriculture	
	MW REF	
	1992	
	8243	Low



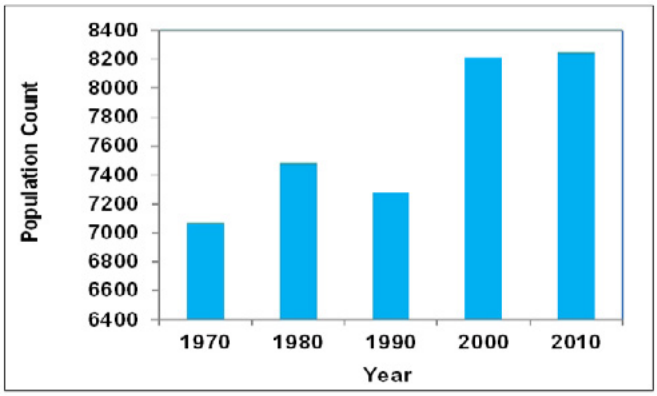
Spatial delineation: MWP site (●), associated watershed (〰), and AOC boundary (///) where applicable.



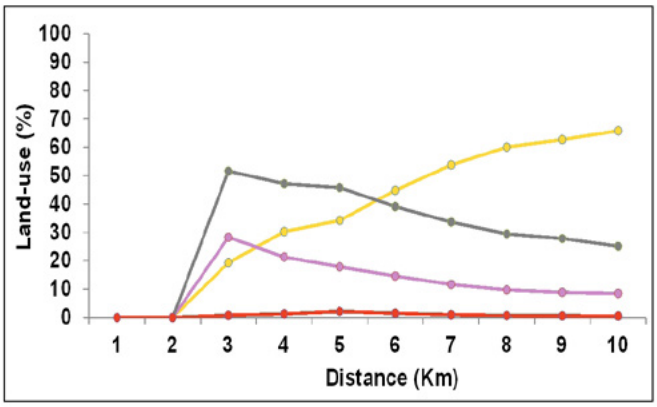
Outfalls: Aerial orthoimagery and map depicting MWP site (●), Impaired and Assessed Waters (〰), and U.S.EPA NPDES major and minor permitted facilities outfall types: POTW (▲), Non-POTW (▲), Wastewater Facilities (▲), Discharge Facilities (▲), Water Dischargers (▲), Combined Sewer Overflows (CSO's) (▲).



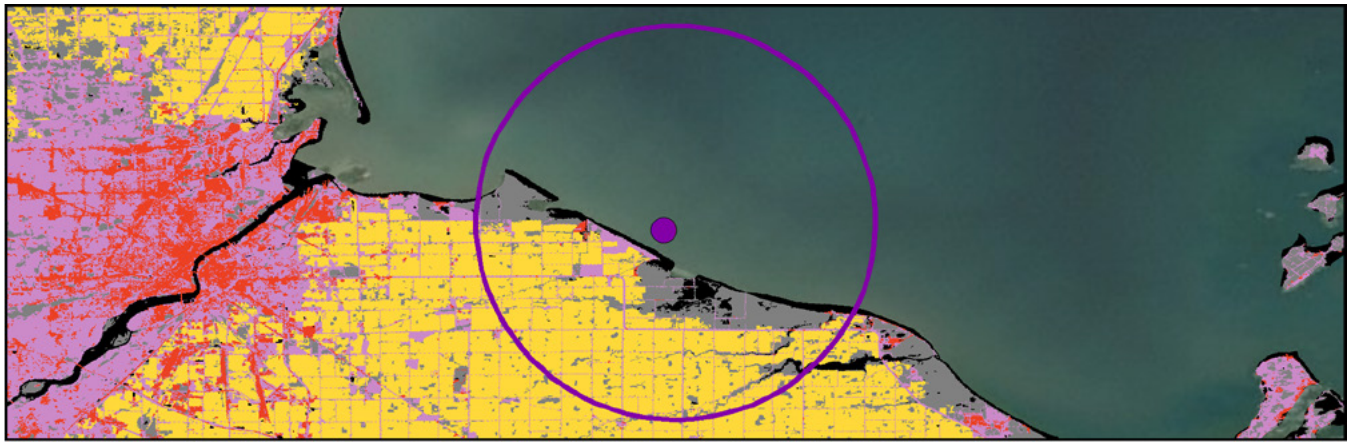
Legend: 1992 - 2006 National Land Cover Data (NLCD) aggregated hierarchal land-use categories, agriculture, low-developed, undeveloped and urban for Great Lakes Mussel Watch Program (MWP) sites.



Population barchart: Bar chart depicting population trend within 10 km buffer of MWP site (1970 - 2010).

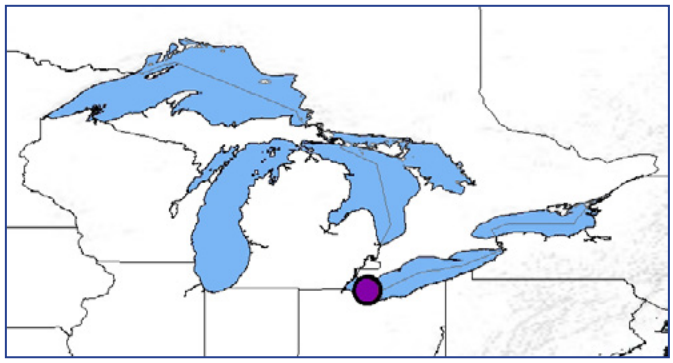


Line chart: MWP site 2006 NLCD land-use categories percentage within a 10 km buffer spatial extent.

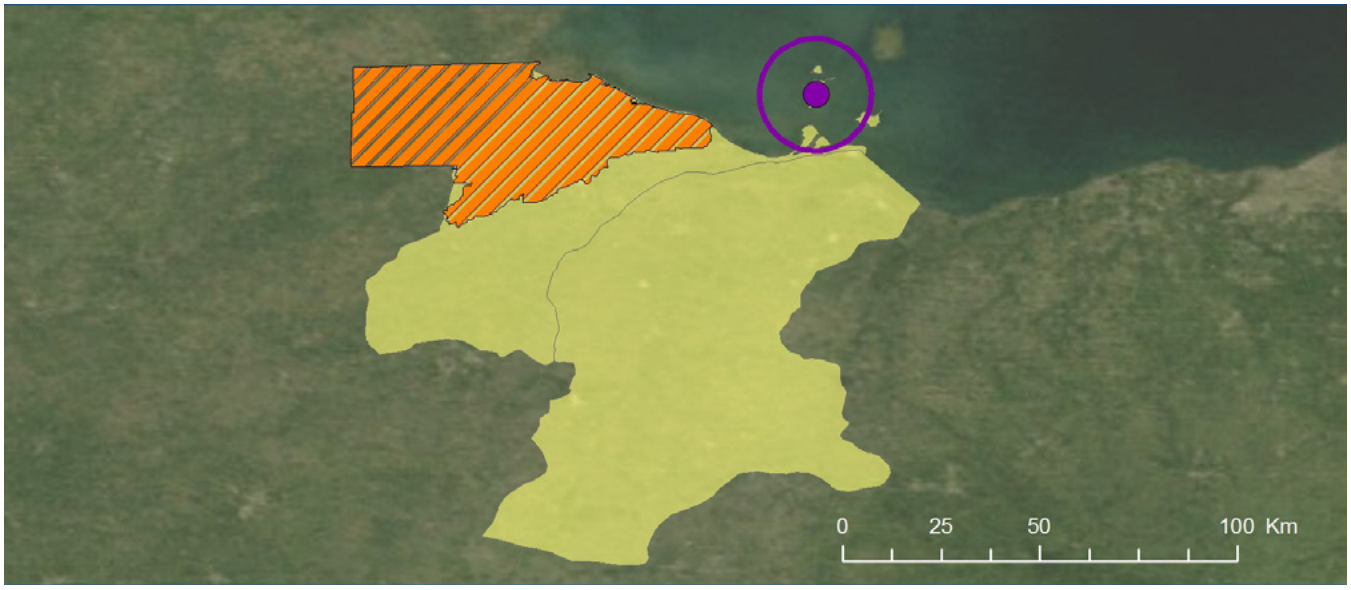


Land-use categories: MWP site (●) including 10 km buffer (○) and 2006 land-use categories from NLCD.

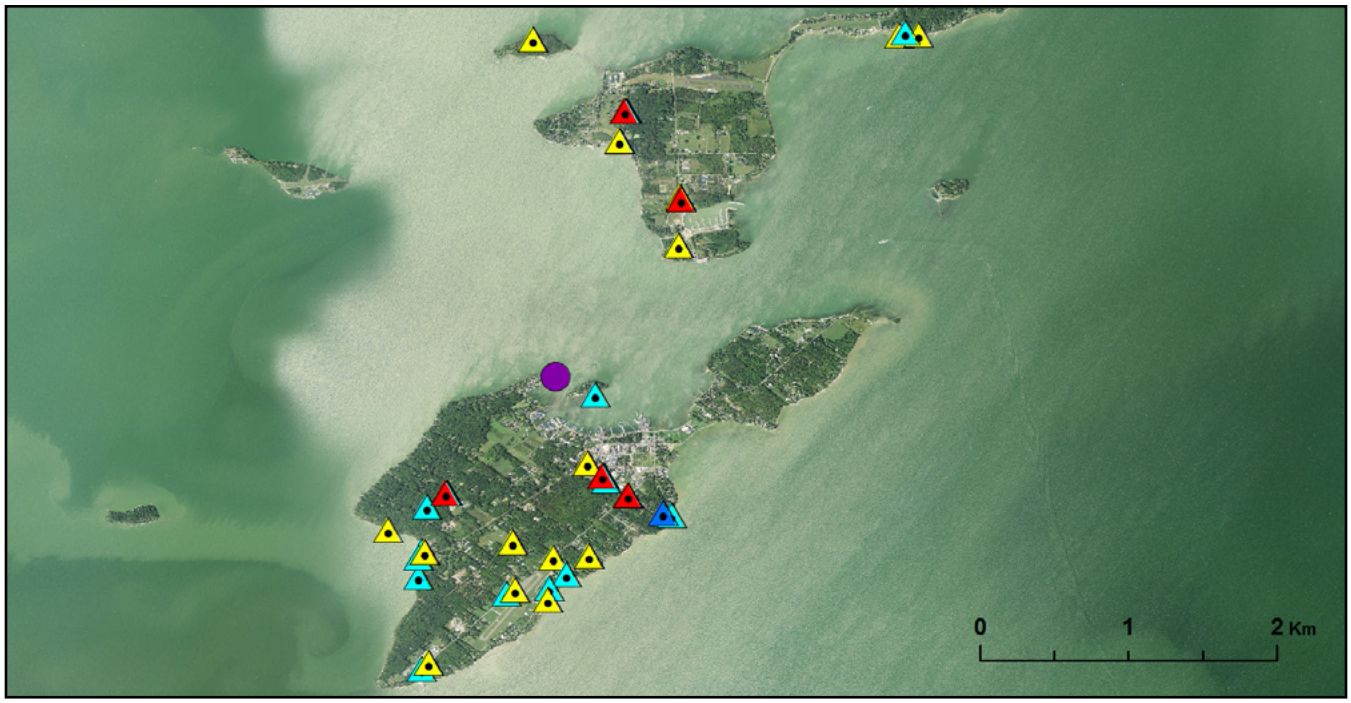
Peach Orchard Pt.



	SBPP	
	41.659667	
	-82.825	
	OH	
	Low-developed	
	MW REF	
	1992	
	8378	Low



Spatial delineation: MWP site (●), associated watershed (▭), and AOC boundary (///) where applicable.



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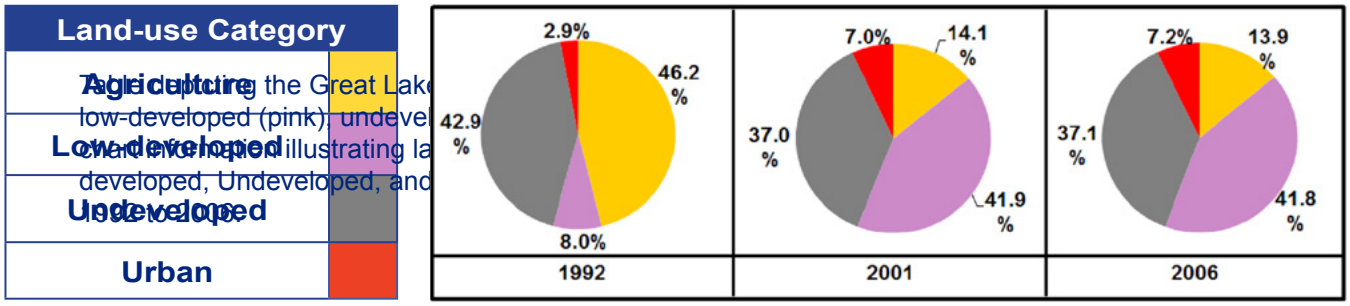

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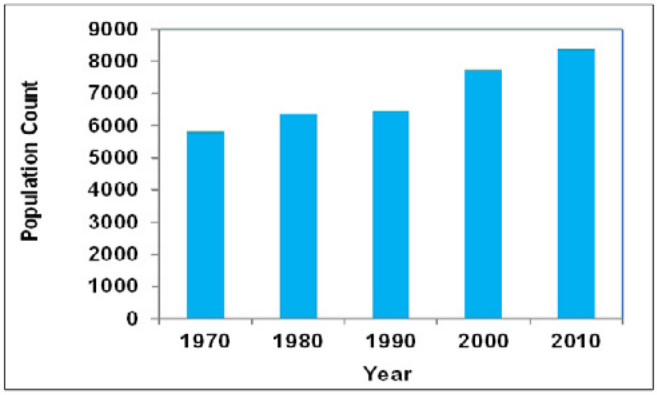

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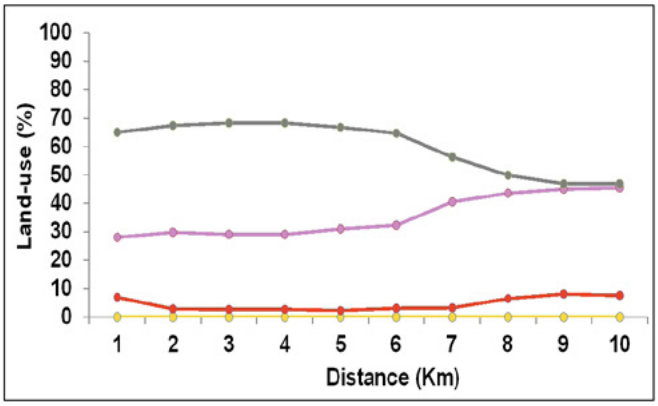

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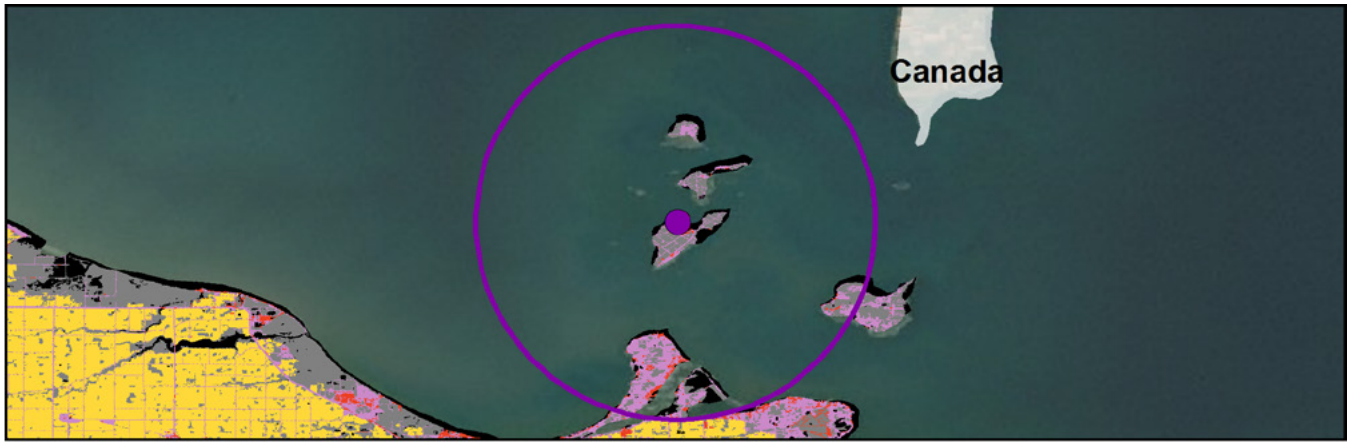
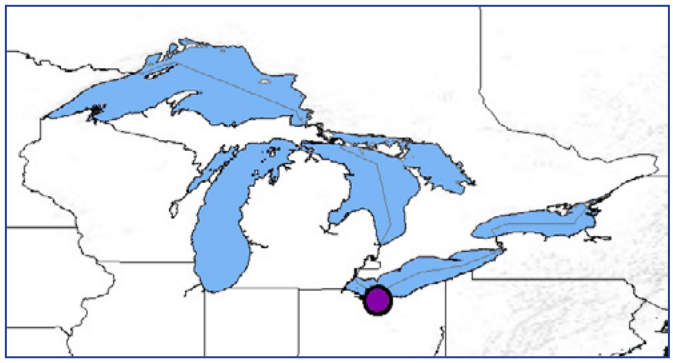
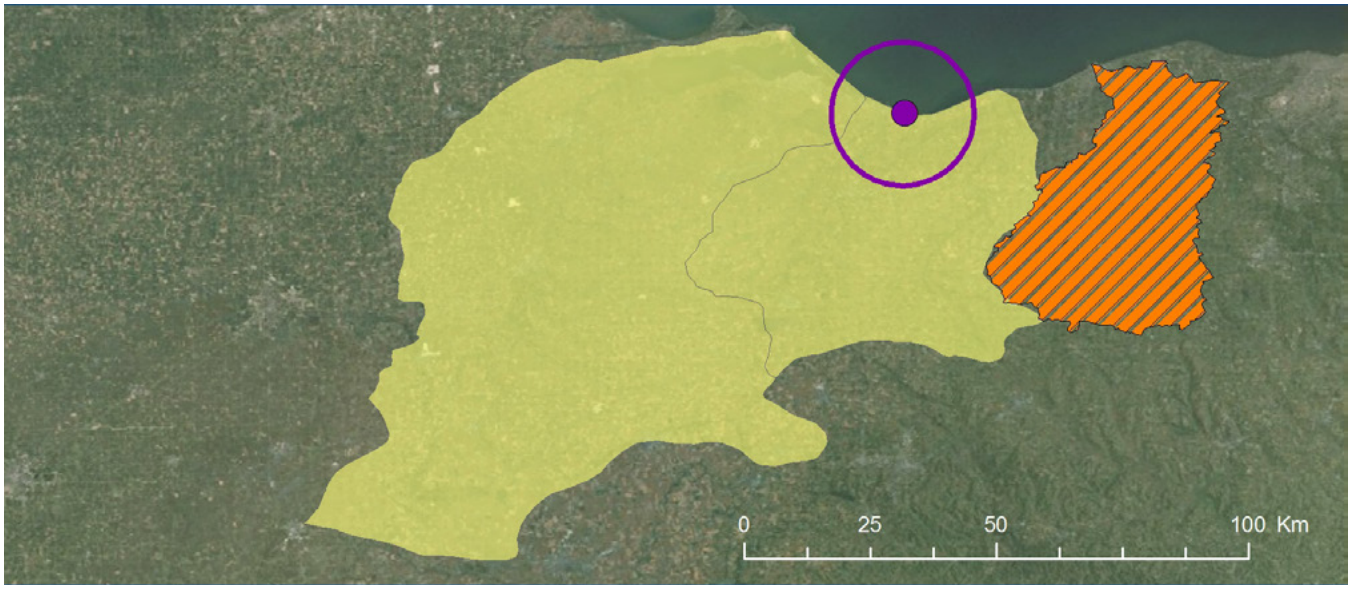


Land-use categories: MWP site (●) including 10 km buffer (○) and 2006 land-use categories from NLCD.

Old Woman Creek



	LEOW	
	41.385	
	-82.518667	
	OH	
	Agriculture	
	MW REF	
	1995	
	33250	Low



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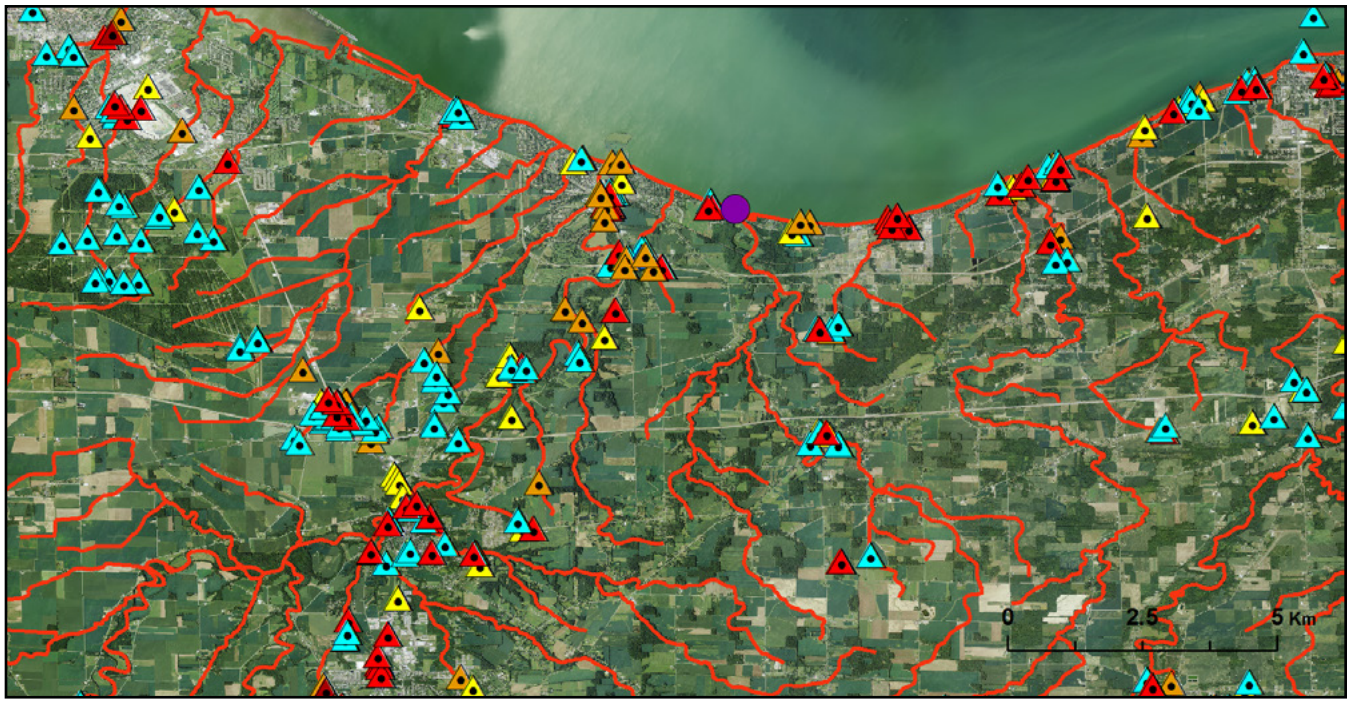

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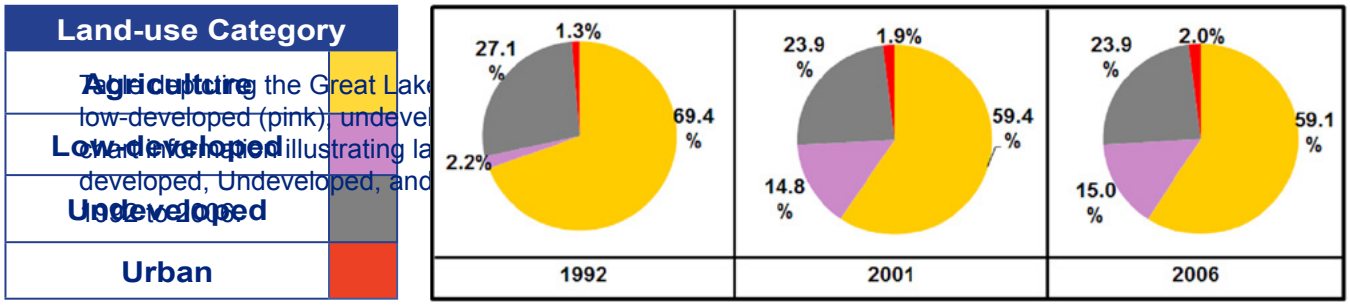

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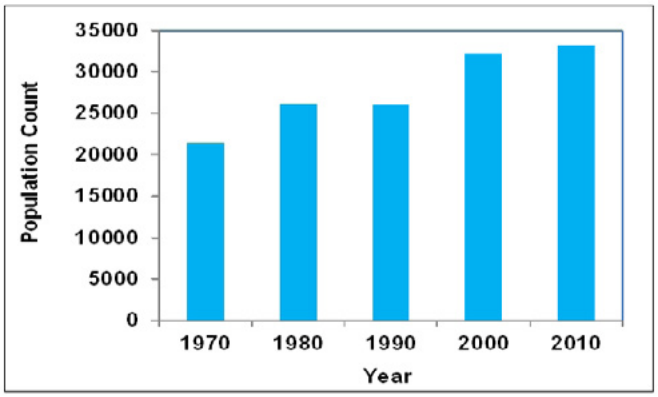
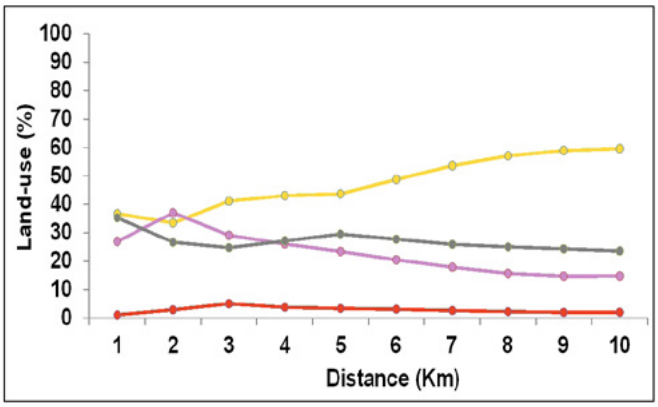


Population barchart: Bar chart depicting population trend within 10 km buffer of MWP site (1970 - 2010).



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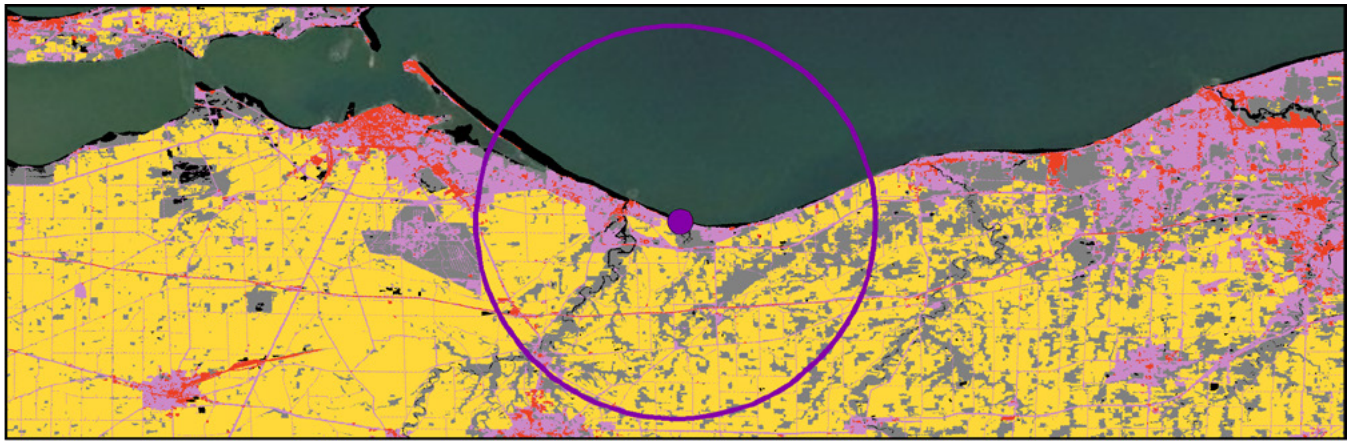
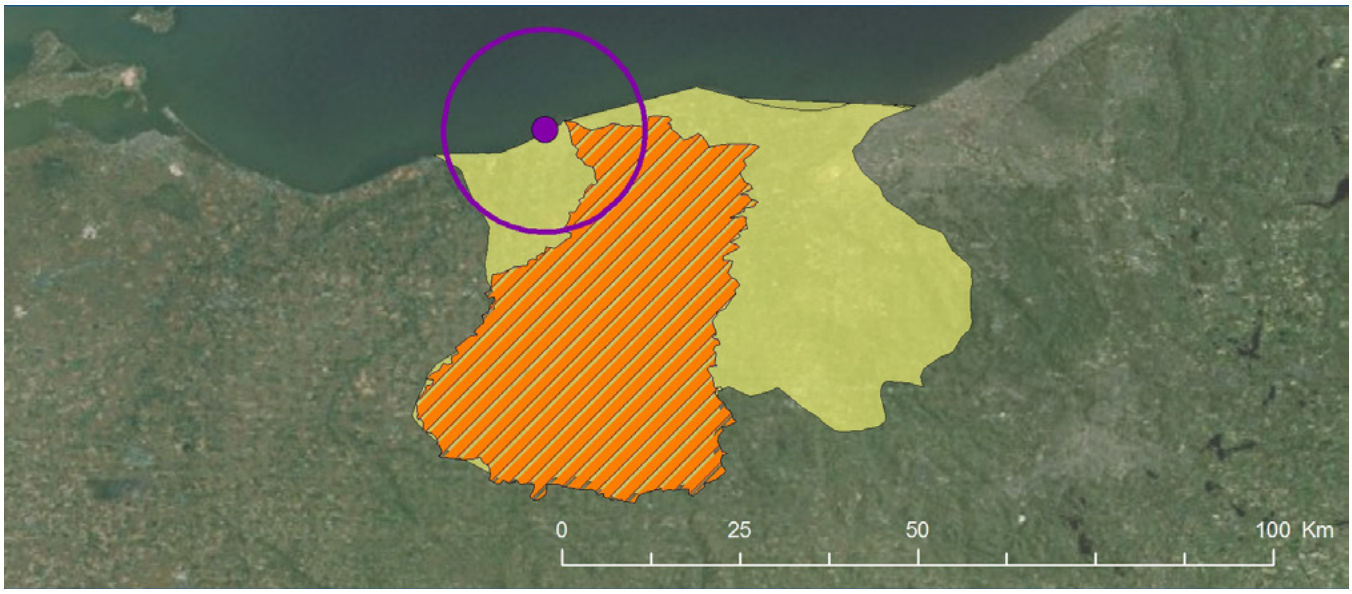


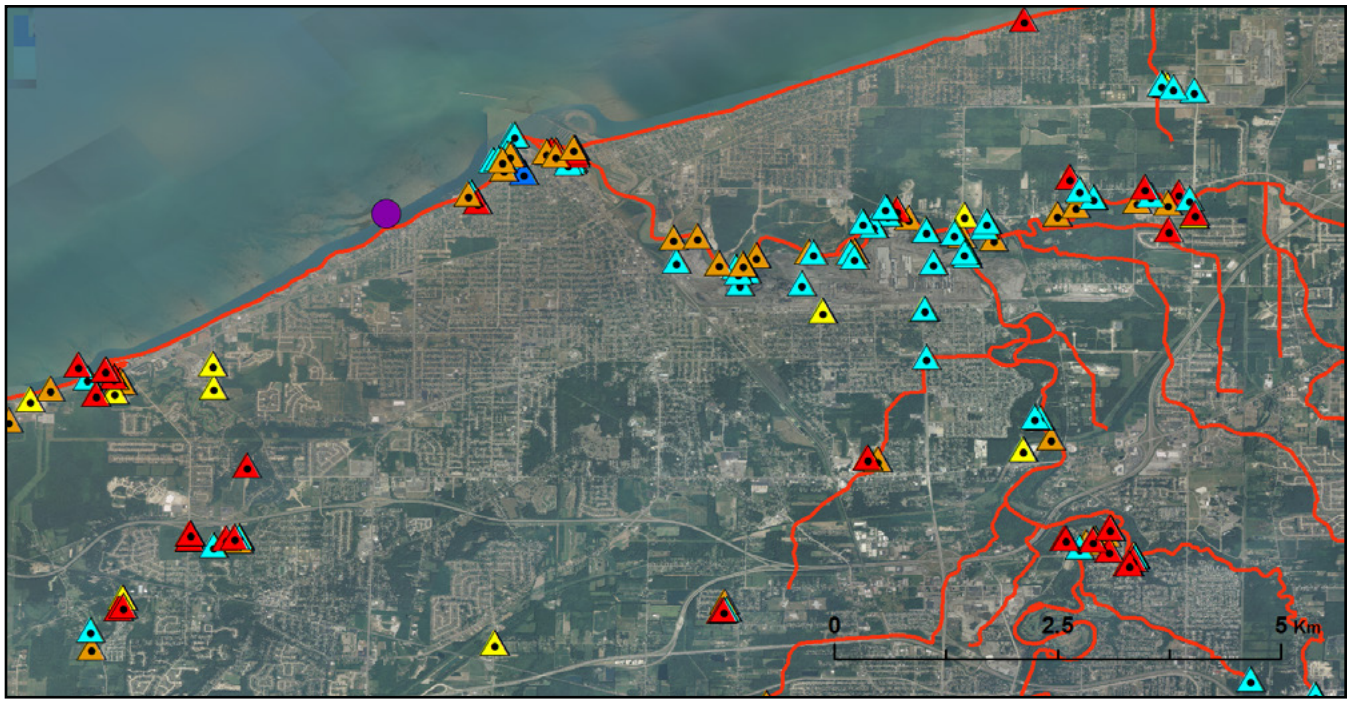
Land-use categories: MWP site (●) including 10 km buffer (○) and 2006 land-use categories from NLCD.

Lorain

	LELR
	41.461167
	-82.207
	OH
	Low-developed
	MW REF
	1994
	147446 Medium



Spatial delineation: MWP site (●), associated watershed (▭), and AOC boundary (///) where applicable.



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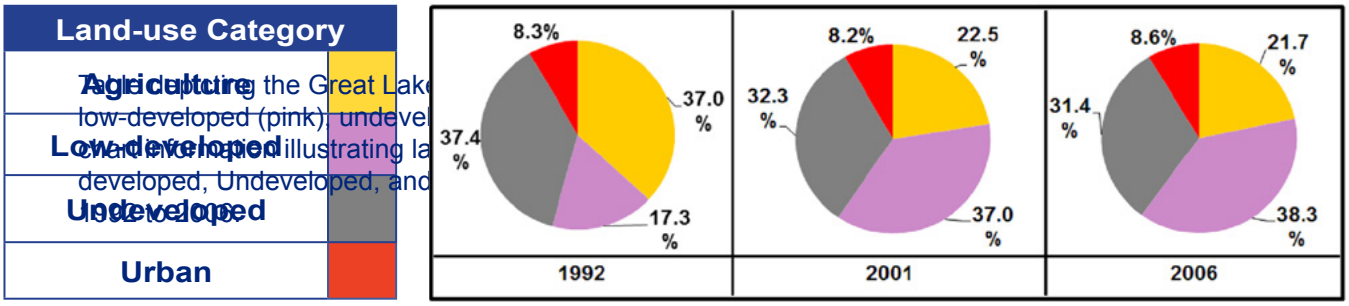

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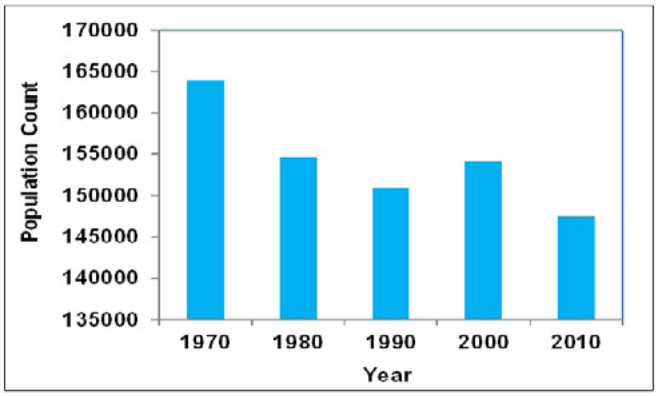

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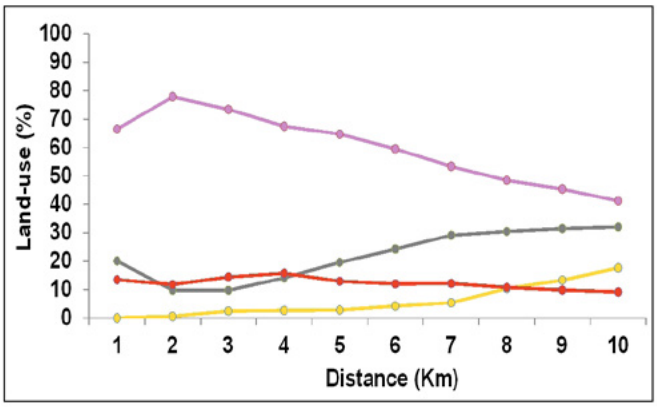

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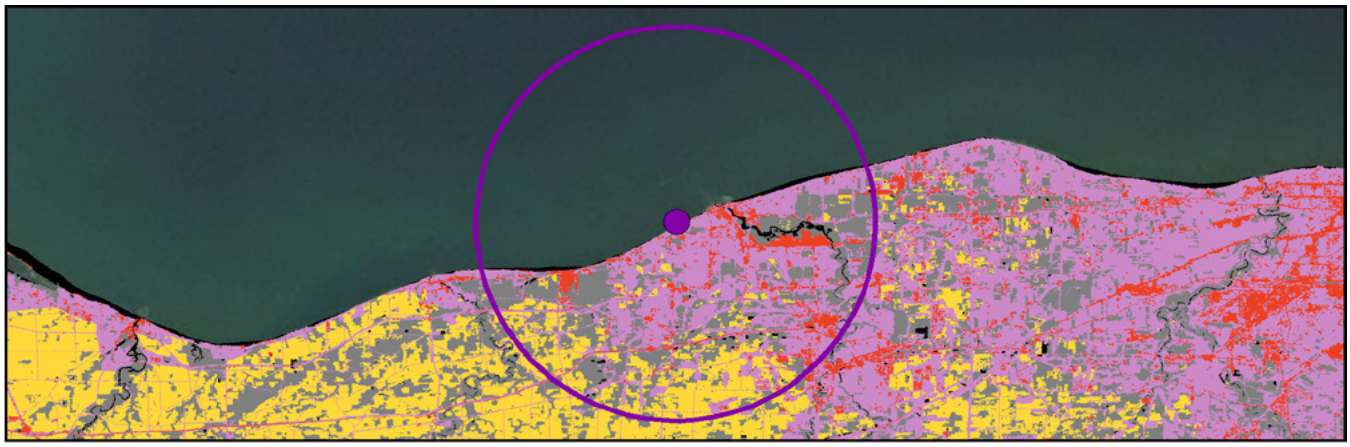
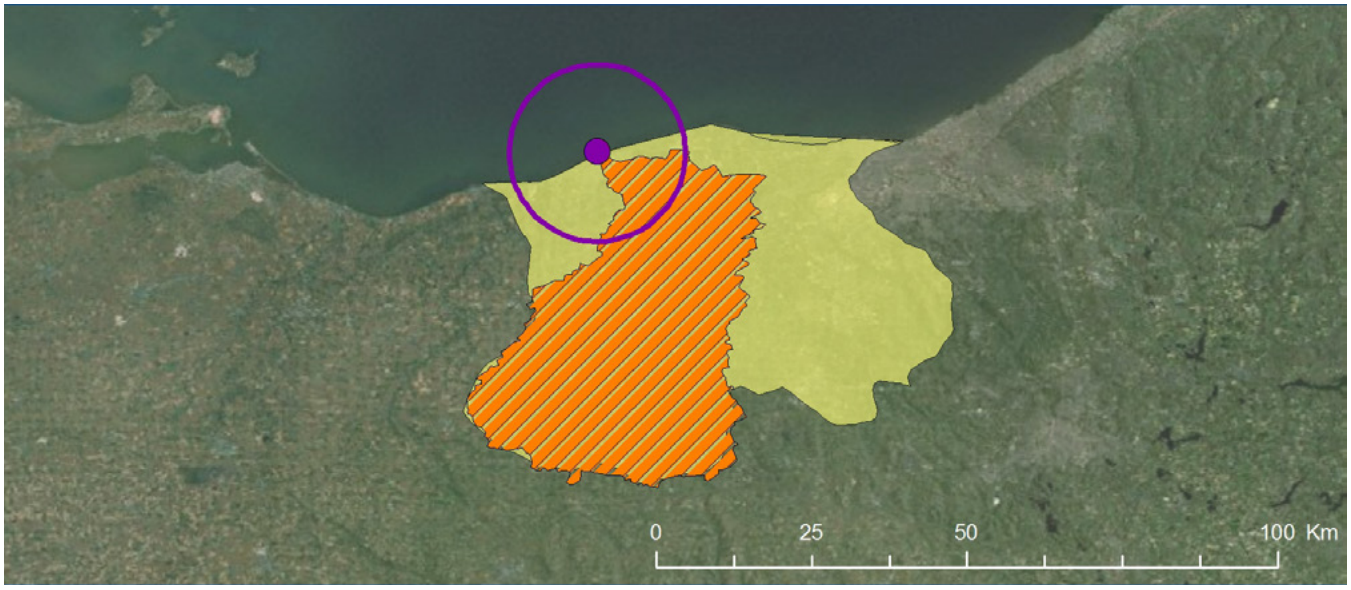


Land-use categories: MWP site (●) including 10 km buffer (○) and 2006 land-use categories from NLCD.

Black River

	LEBR	
	41.47436	
	-82.181	
	OH	
	Low-developed	
	MW AOC	
	2009	
	2198	Low



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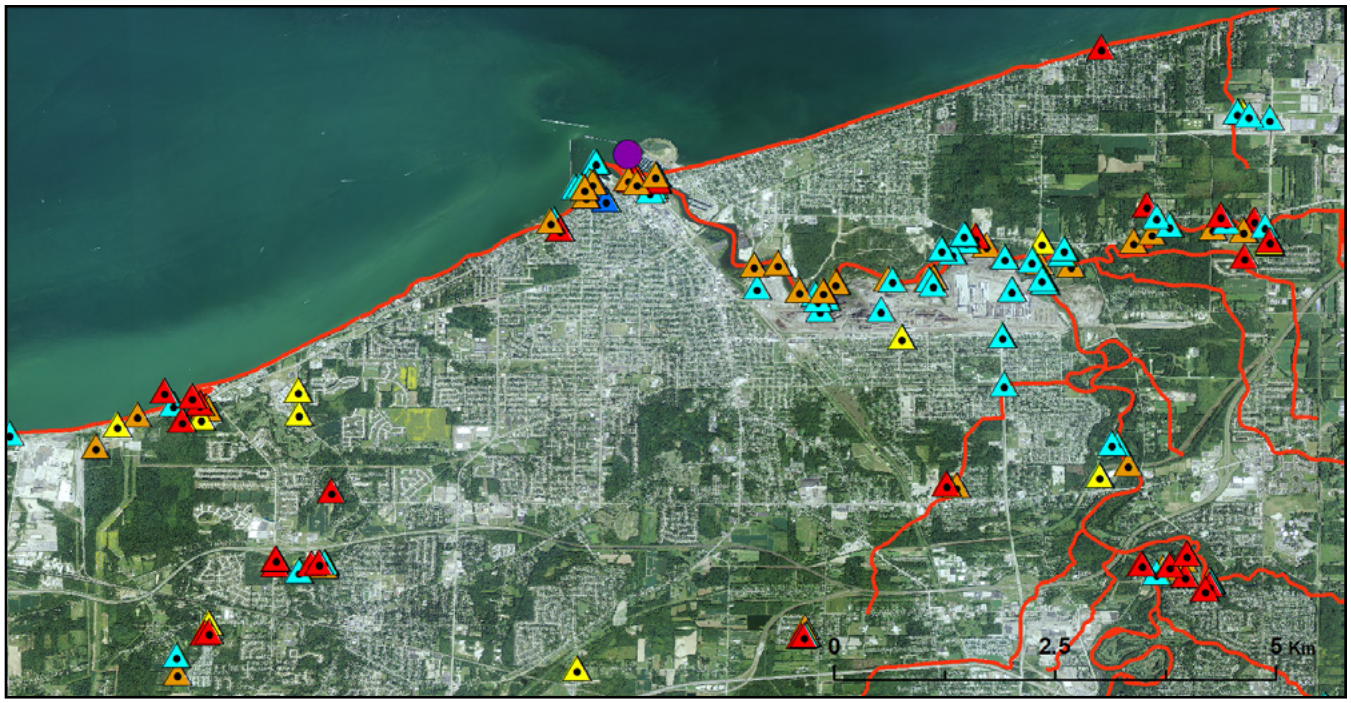

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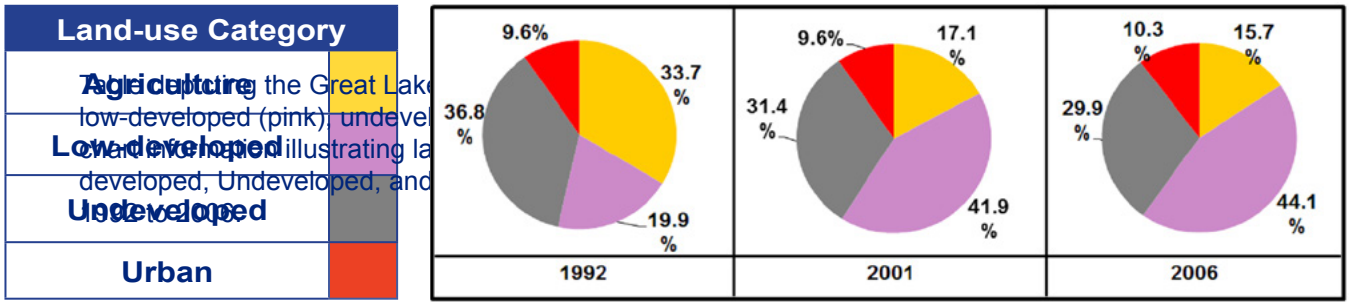

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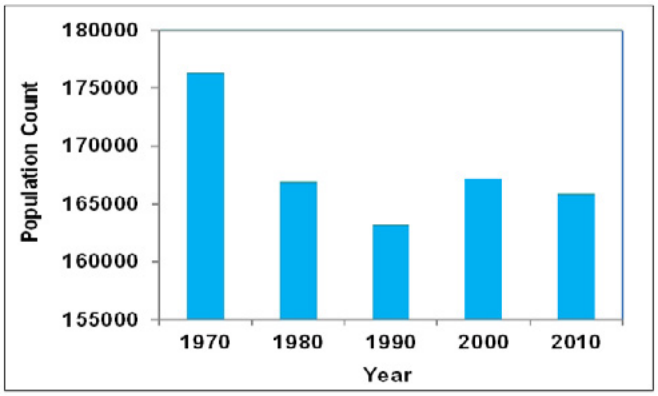

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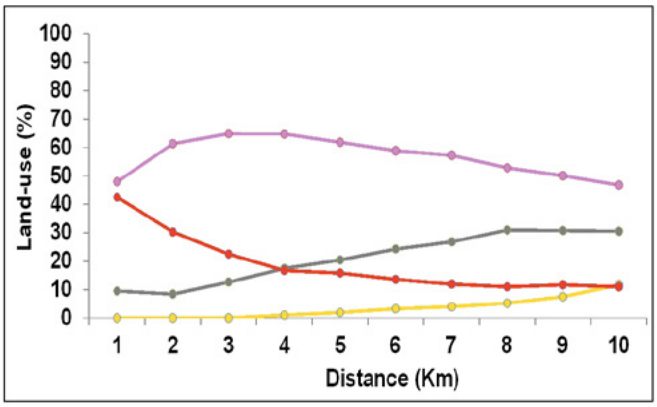

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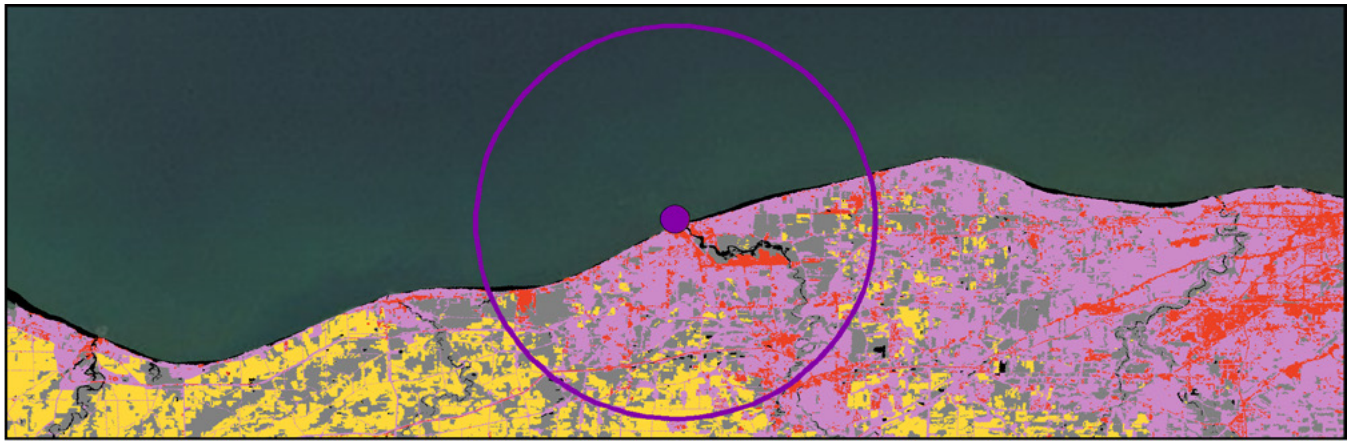
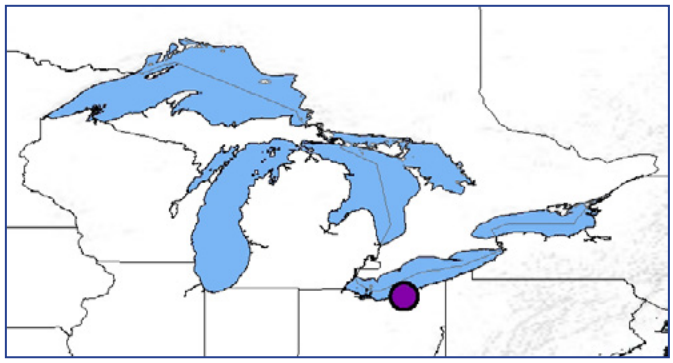
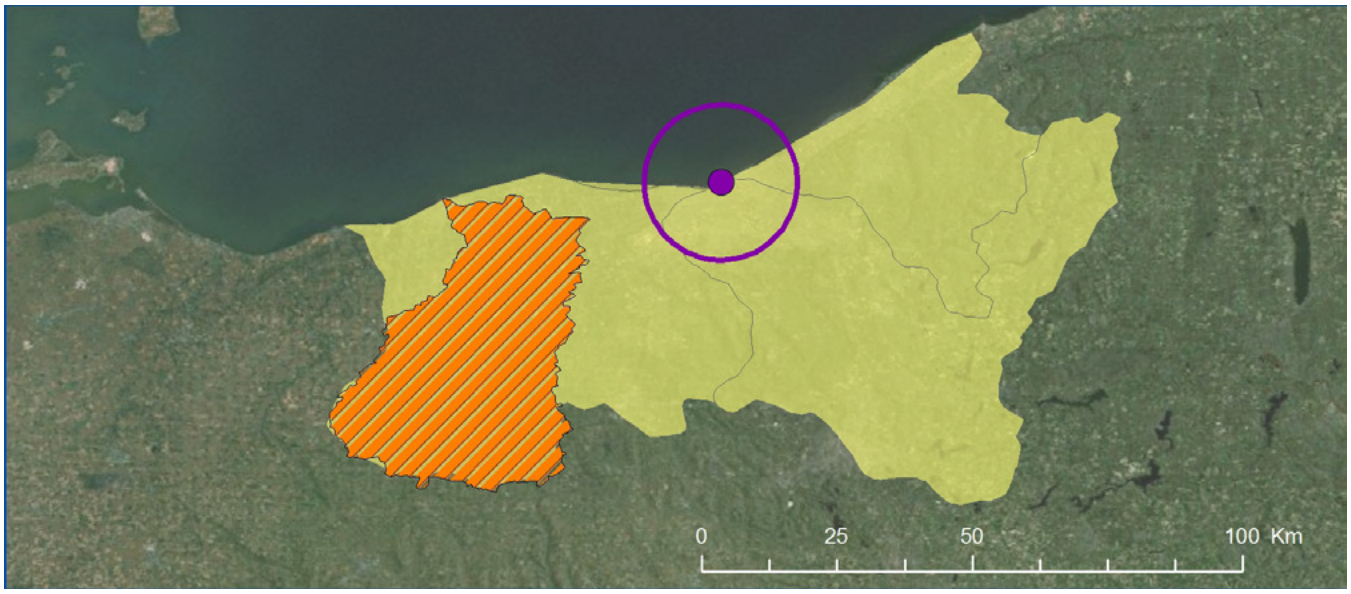


Land-use categories: MWP site (●) including 10 km buffer (○) and 2006 land-use categories from NLCD.

Cuyahoga River



	LECR	
	41.49941	
	-81.71878	
	OH	
	Urban	
	MW AOC	
	2009	
	624379	High



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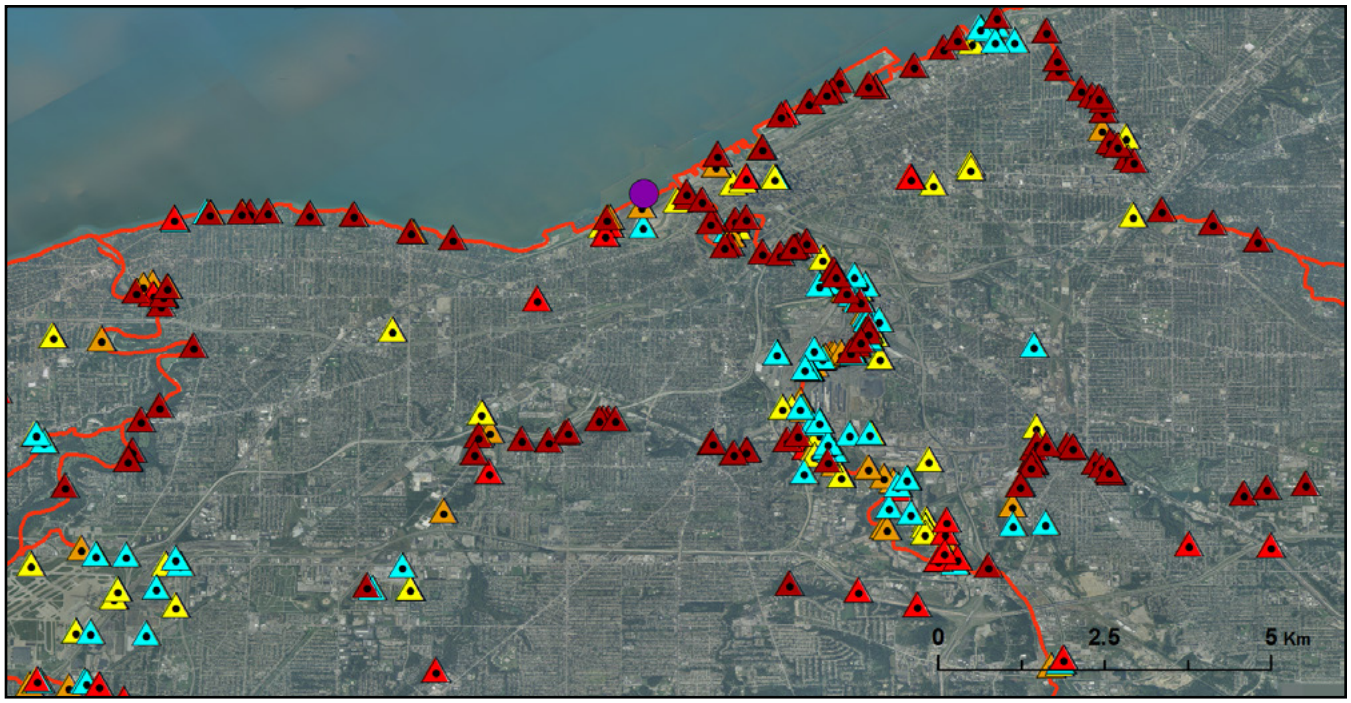

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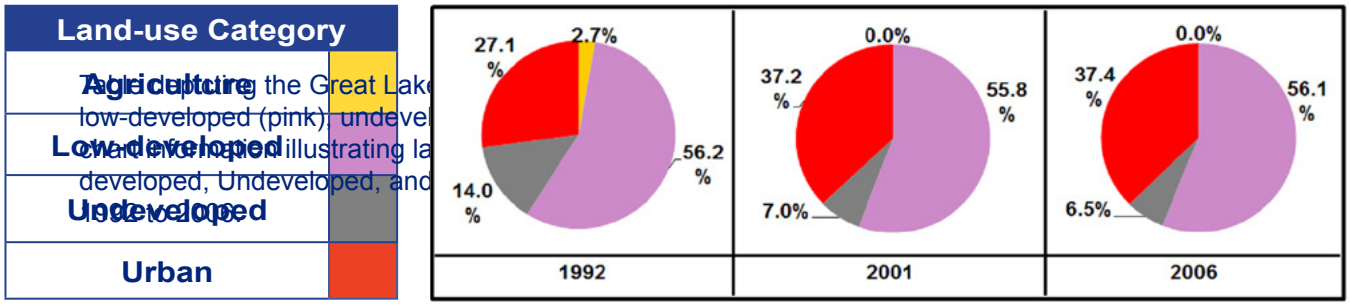

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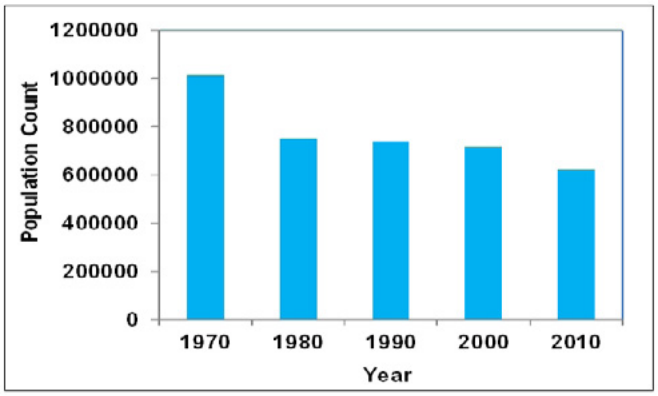

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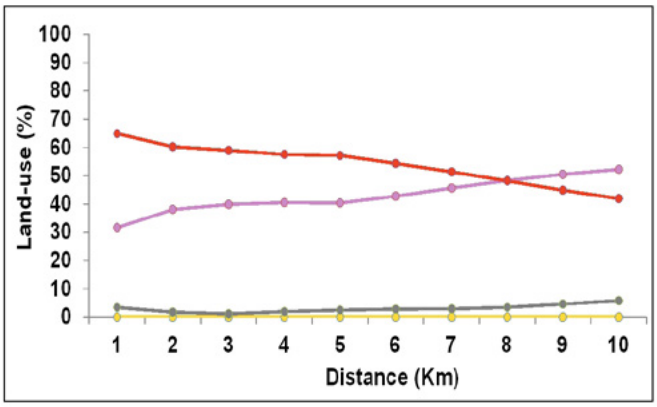

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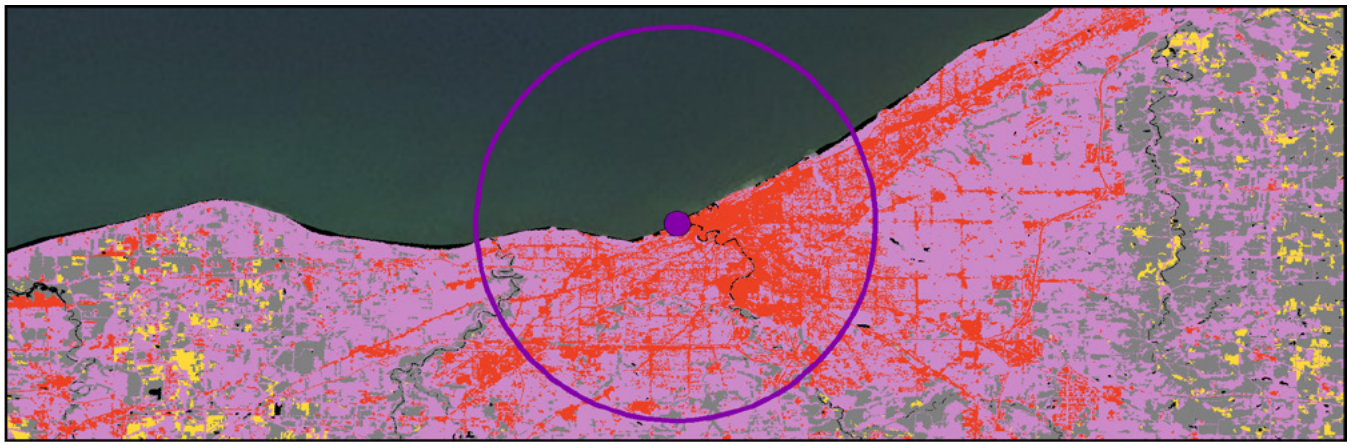
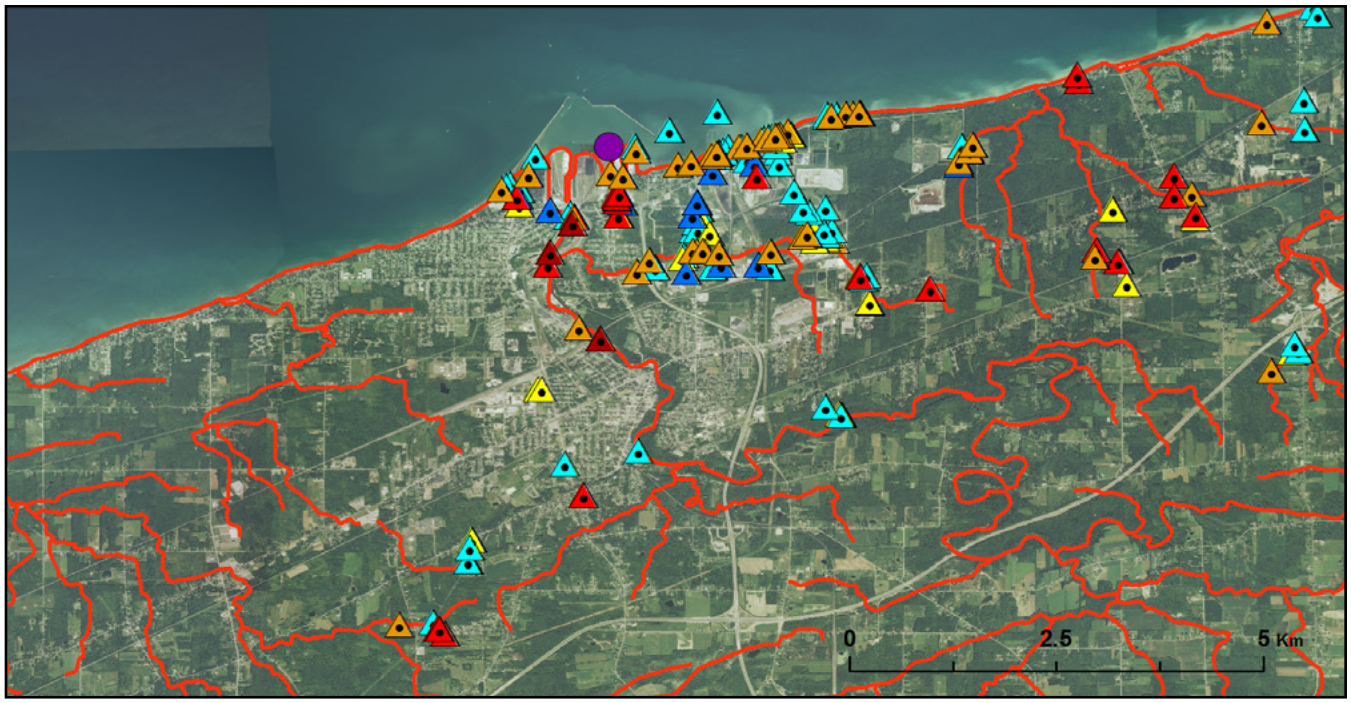


Land-use categories: MWP site (●) including 10 km buffer (○) and 2006 land-use categories from NLCD.

Ashtabula River

	LEAR	
	41.91123	
	-80.78768	
	OH	
	Undeveloped	
	MW AOC	
	2009	
	40513	Low

Spatial delineation: MWP site (●), associated watershed (▭), and AOC boundary (///) where applicable.



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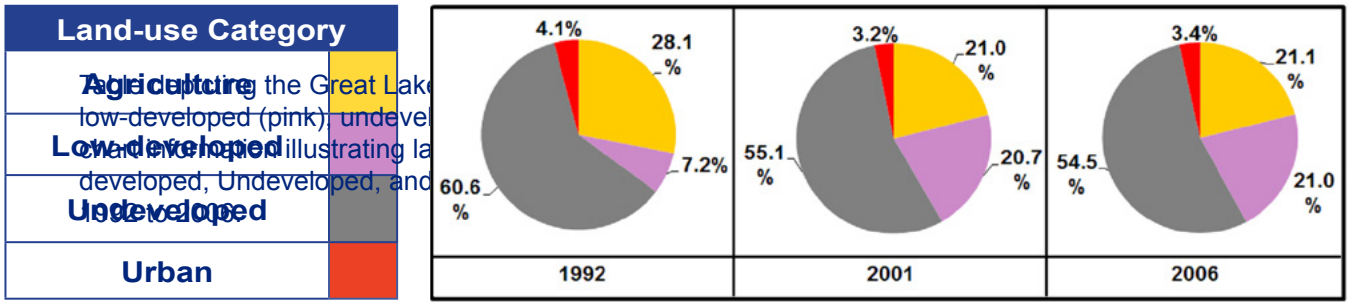

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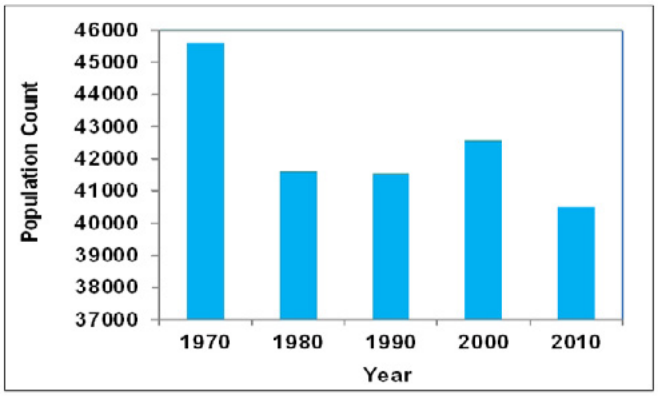

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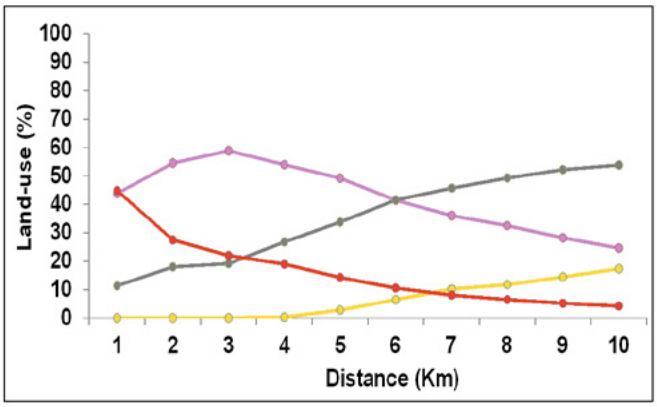
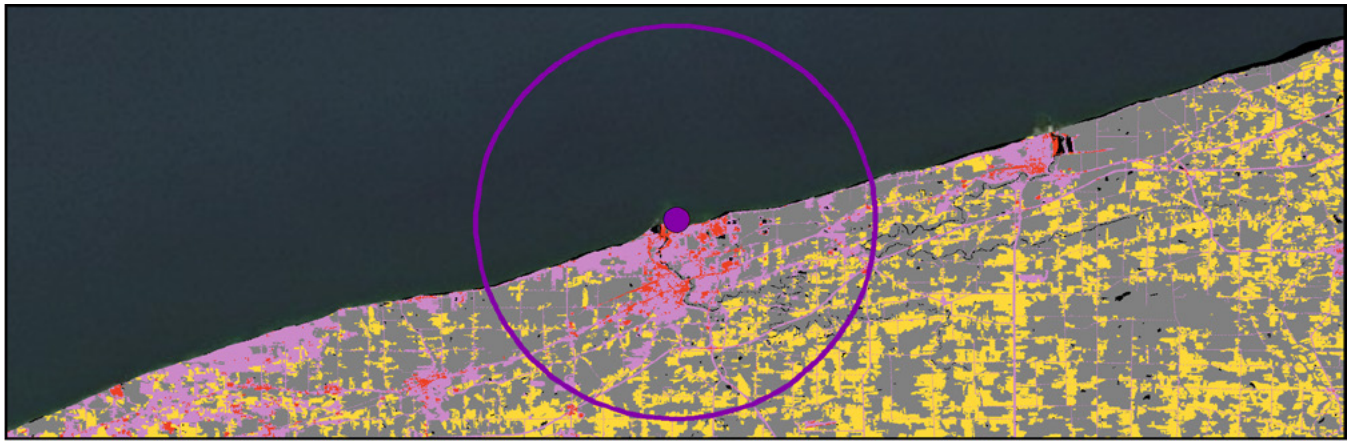


Line chart: MWP site 2006 NLCD land-use categories percentage within a 10 km buffer spatial extent.

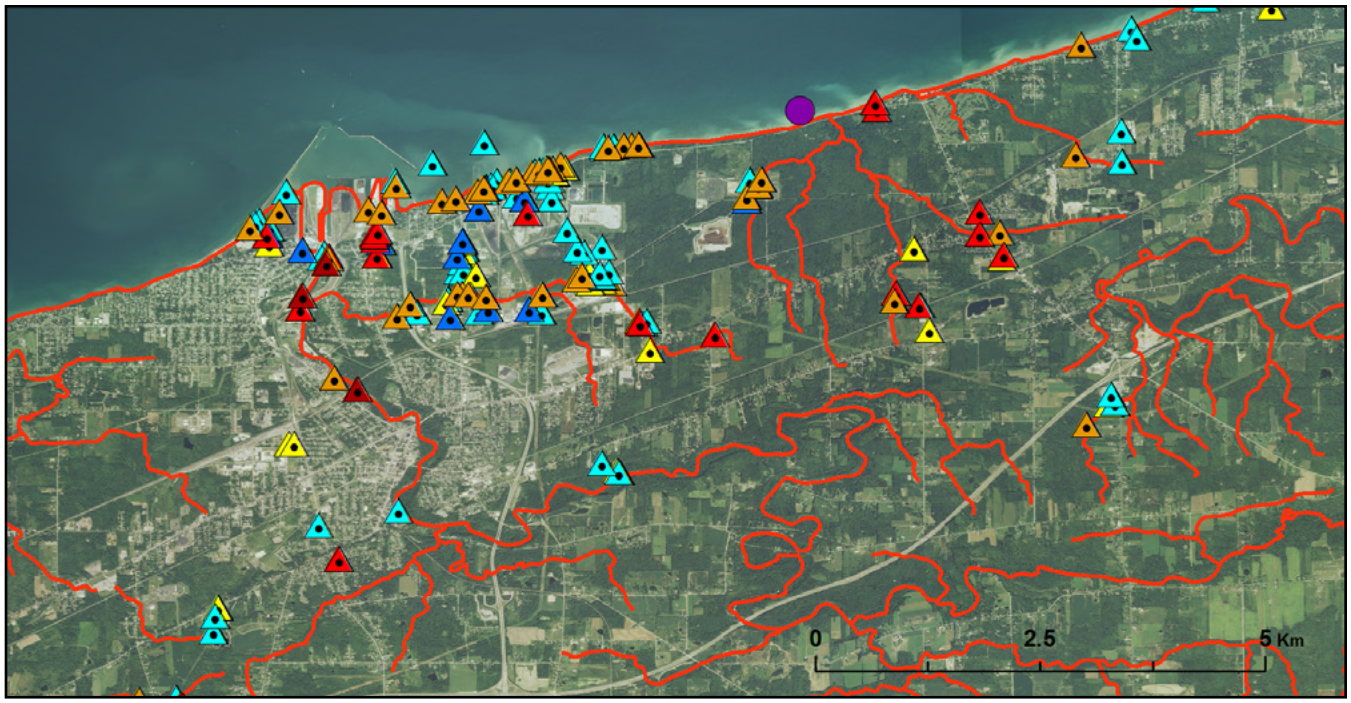


Land-use categories: MWP site (●) including 10 km buffer (○) and 2006 land-use categories from NLCD.

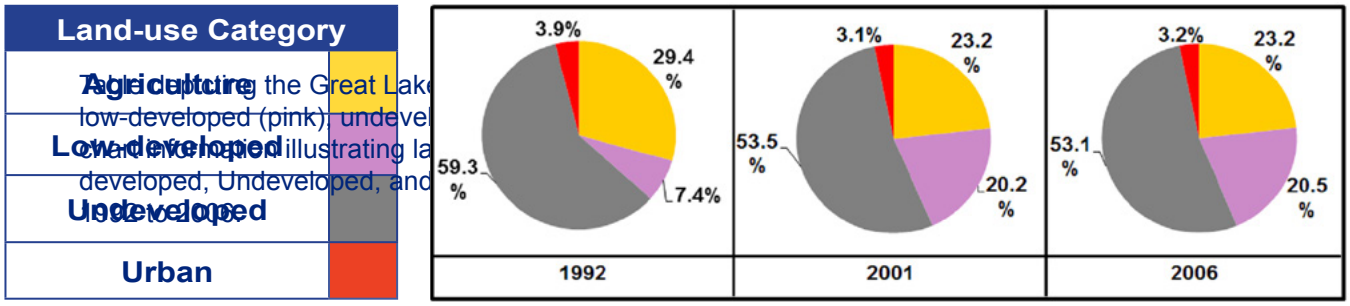
Ashtabula

	LEAB	
	41.924667	
	-80.718333	
	OH	
	Undeveloped	
	MW REF	
	1994	
	42015	Low

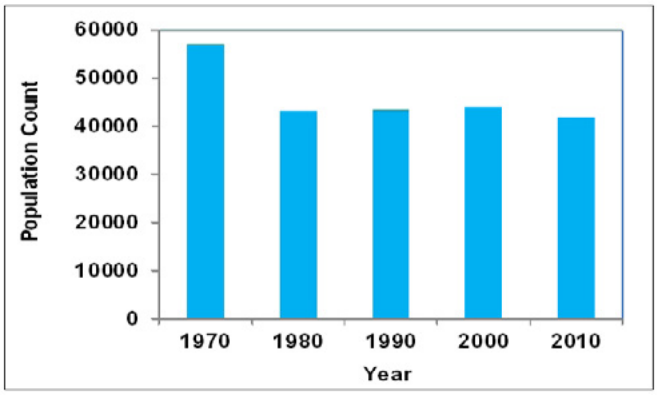
Spatial delineation: MWP site (●), associated watershed (▭), and AOC boundary (///) where applicable.



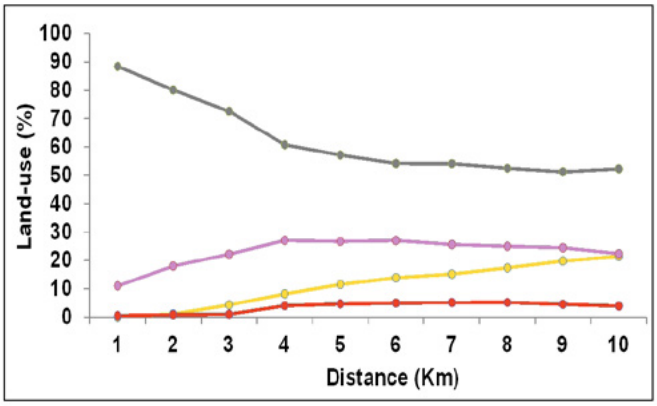
Outfalls: Aerial orthoimagery and map depicting MWP site (●), Impaired and Assessed Waters (▭), and U.S.EPA NPDES major and minor permitted facilities outfall types: POTW (▲), Non-POTW (▲), Wastewater Facilities (▲), Discharge Facilities (▲), Water Dischargers (▲), Combined Sewer Overflows (CSO's) (▲).



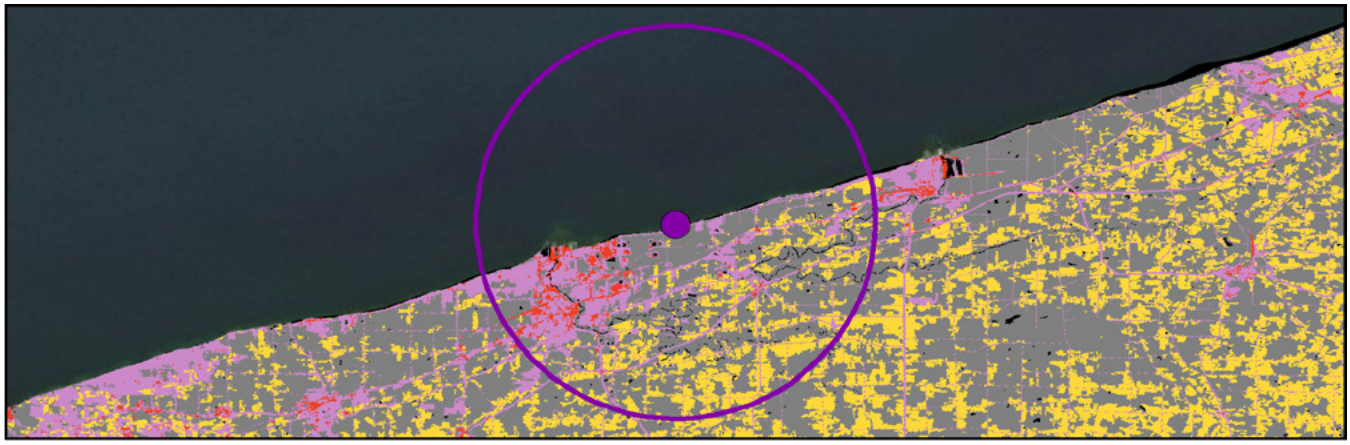
Legend: 1992 - 2006 National Land Cover Data (NLCD) aggregated hierarchal land-use categories, agriculture, low-developed, undeveloped and urban for Great Lakes Mussel Watch Program (MWP) sites.



Population barchart: Bar chart depicting population trend within 10 km buffer of MWP site (1970 - 2010).

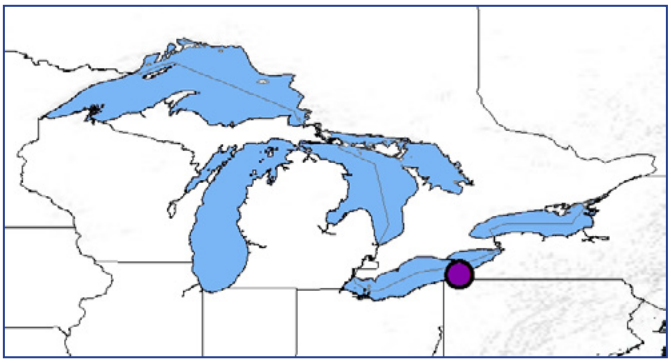


Line chart: MWP site 2006 NLCD land-use categories percentage within a 10 km buffer spatial extent.



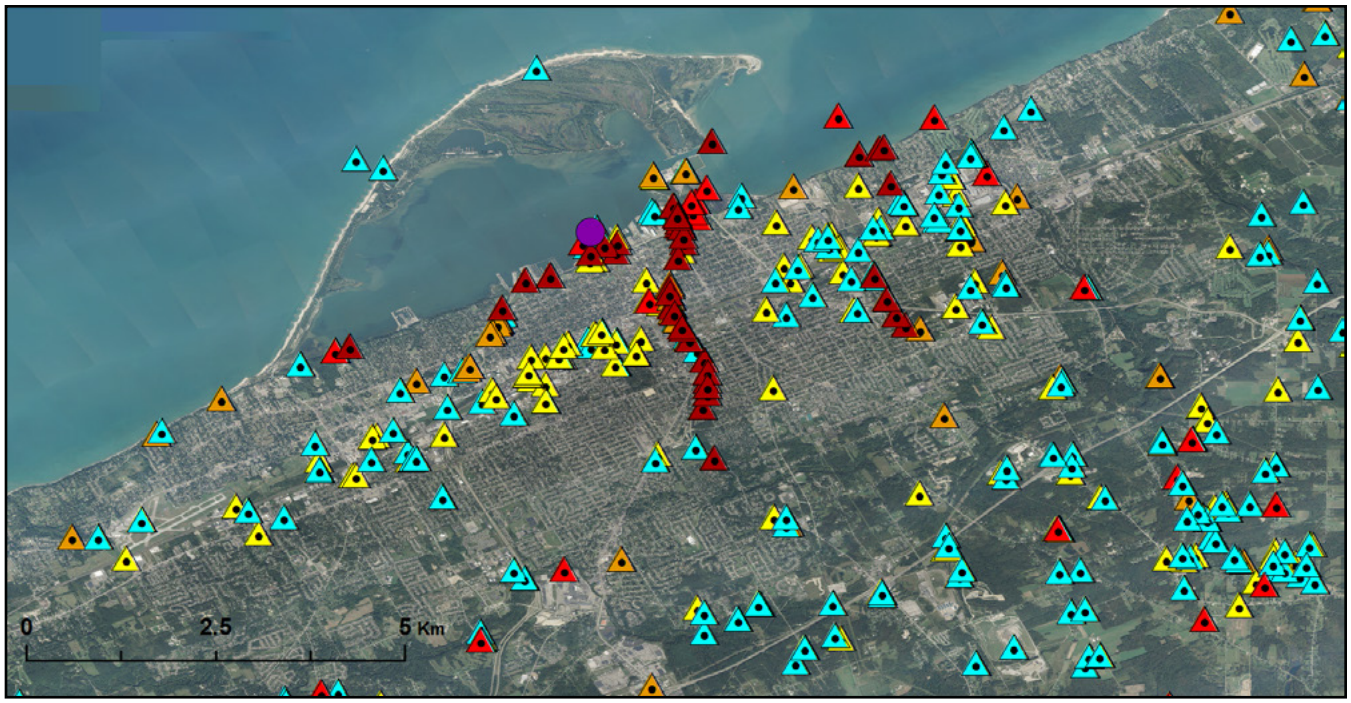
Land-use categories: MWP site (●) including 10 km buffer (○) and 2006 land-use categories from NLCD.

Presque Isle Bay

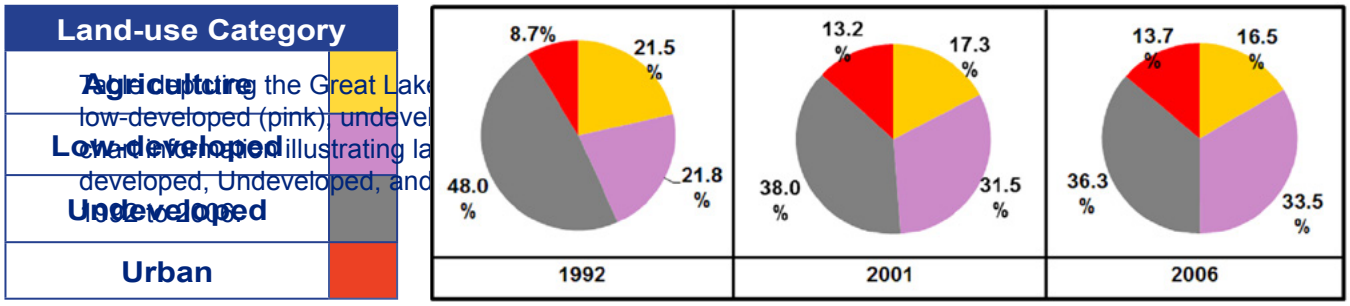


	LEPB
	42.137766
	-80.09525
	PA
	Low-developed
	MW AOC
	2009
	191935 Medium

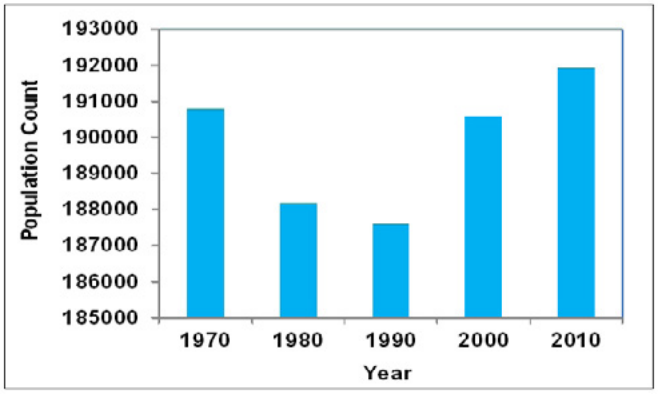
Spatial delineation: MWP site (●), associated watershed (▭), and AOC boundary (///) where applicable.



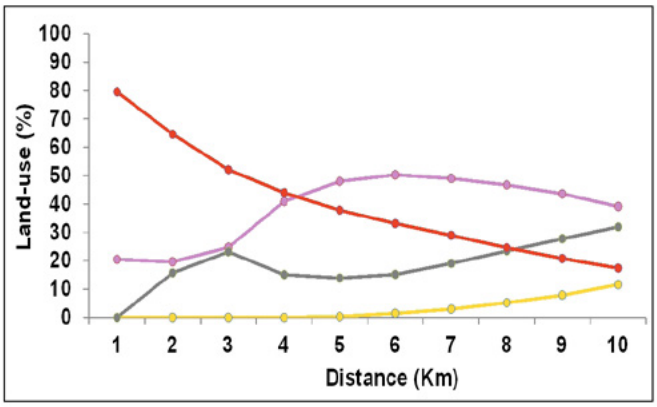
Outfalls: Aerial orthoimagery and map depicting MWP site (●), Impaired and Assessed Waters (▭), and U.S.EPA NPDES major and minor permitted facilities outfall types: POTW (▲), Non-POTW (▲), Wastewater Facilities (▲), Discharge Facilities (▲), Water Dischargers (▲), Combined Sewer Overflows (CSO's) (▲).



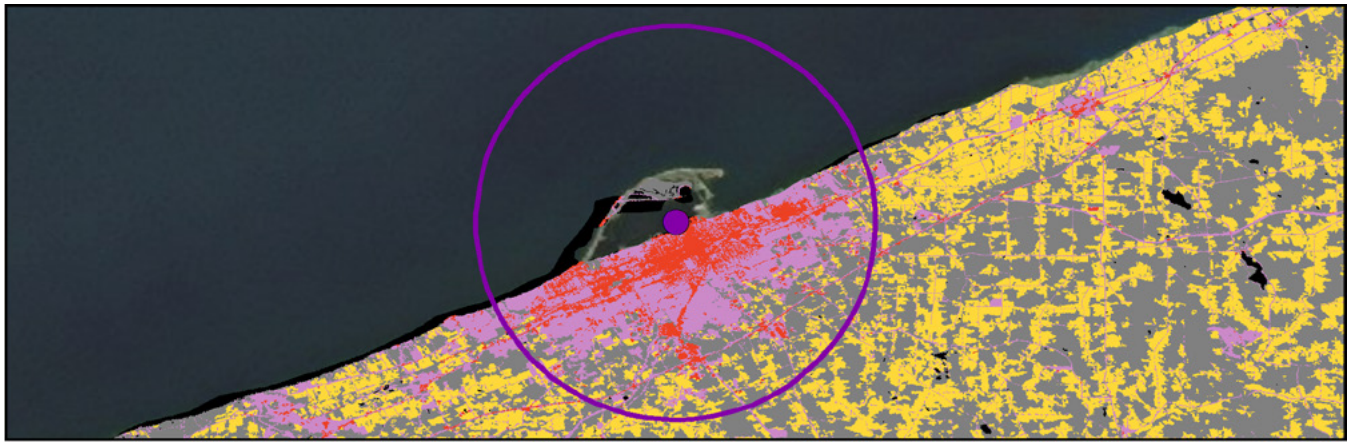
Legend: 1992 - 2006 National Land Cover Data (NLCD) aggregated hierarchal land-use categories, agriculture, low-developed, undeveloped and urban for Great Lakes Mussel Watch Program (MWP) sites.



Population barchart: Bar chart depicting population trend within 10 km buffer of MWP site (1970 - 2010).



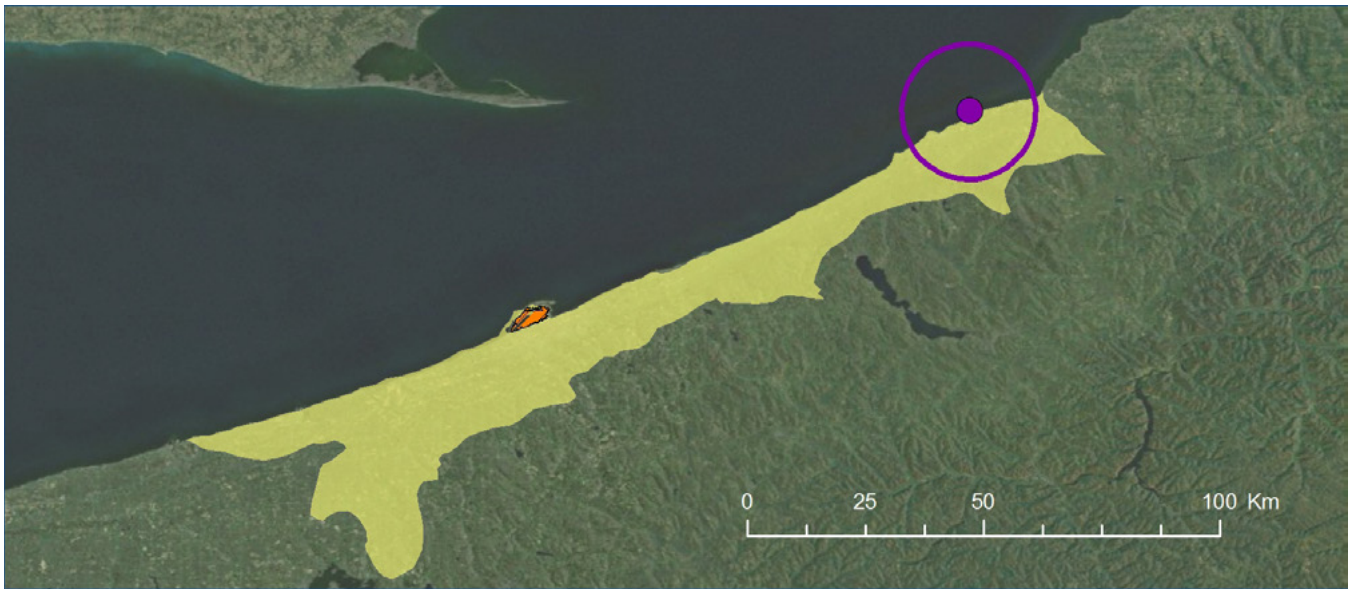
Line chart: MWP site 2006 NLCD land-use categories percentage within a 10 km buffer spatial extent.



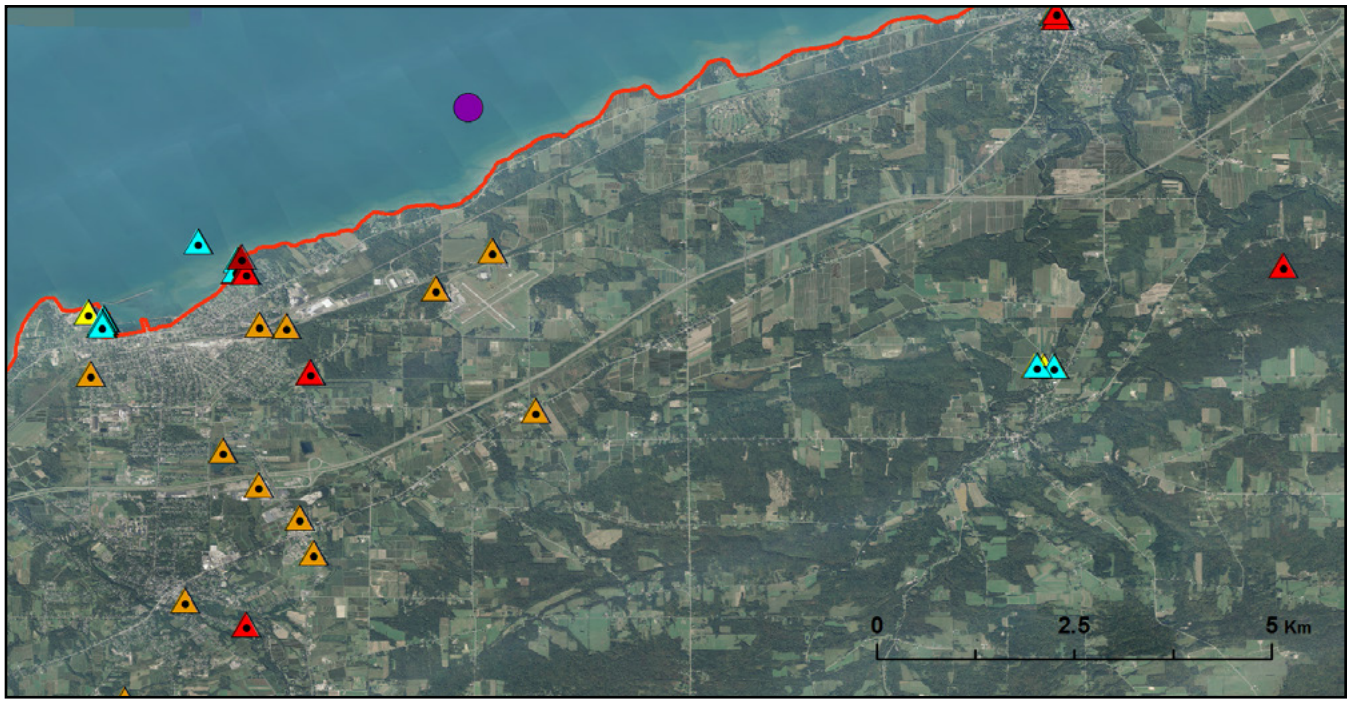
Land-use categories: MWP site (●) including 10 km buffer (○) and 2006 land-use categories from NLCD.

Dunkirk

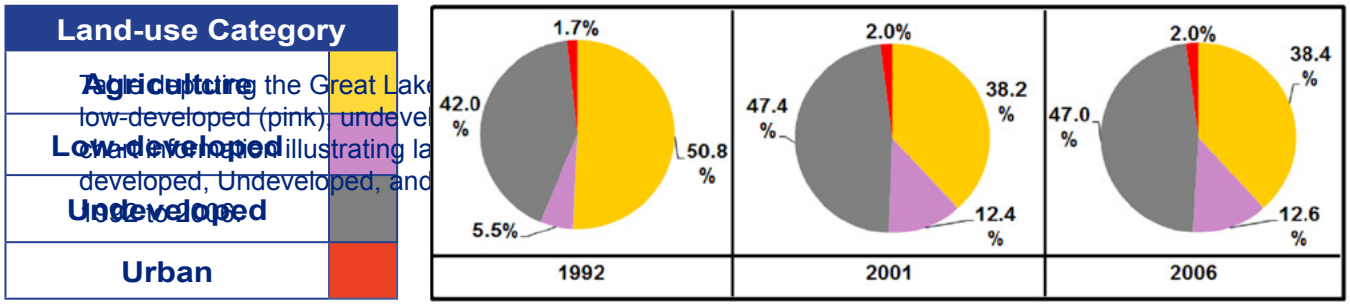
	LEDK	
	42.529167	
	-79.277667	
	NY	
	Agriculture	
	MW REF	
	1994	
	35968	Low



Spatial delineation: MWP site (●), associated watershed (〰), and AOC boundary (///) where applicable.



Outfalls: Aerial orthoimagery and map depicting MWP site (●), Impaired and Assessed Waters (〰), and U.S.EPA NPDES major and minor permitted facilities outfall types: POTW (▲), Non-POTW (▲), Wastewater Facilities (▲), Discharge Facilities (▲), Water Dischargers (▲), Combined Sewer Overflows (CSO's) (▲).



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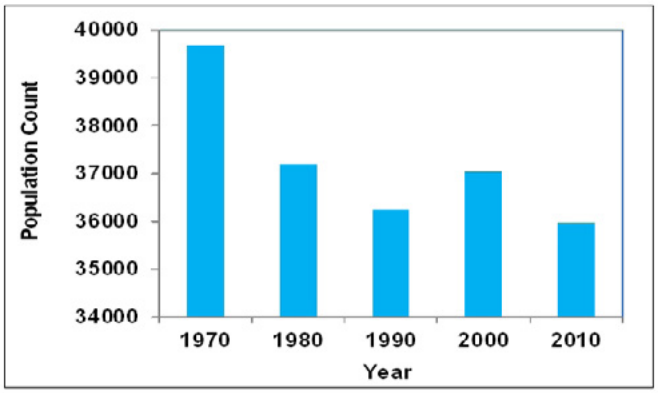
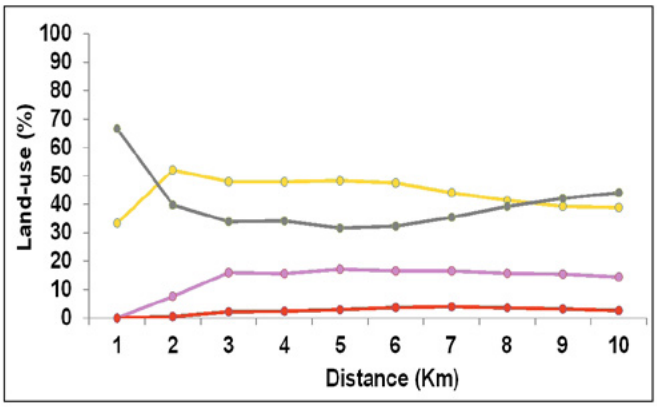
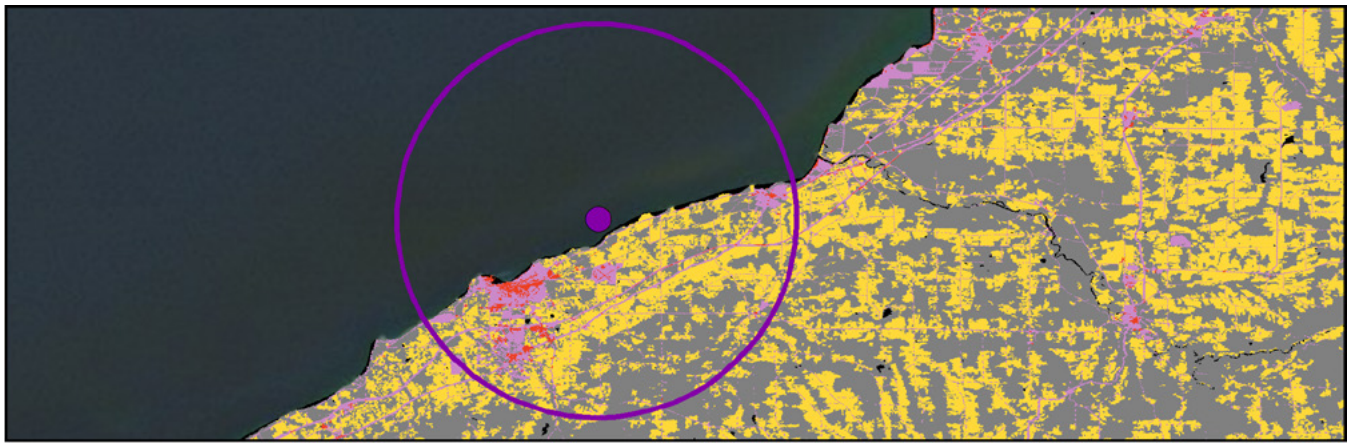


Population barchart: Bar chart depicting population trend within 10 km buffer of MWP site (1970 - 2010).

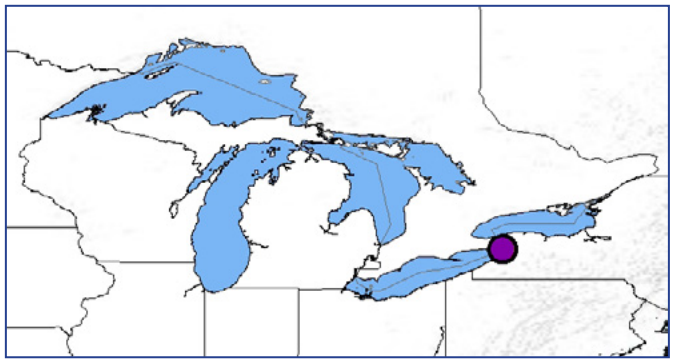


Line chart: MWP site 2006 NLCD land-use categories percentage within a 10 km buffer spatial extent.

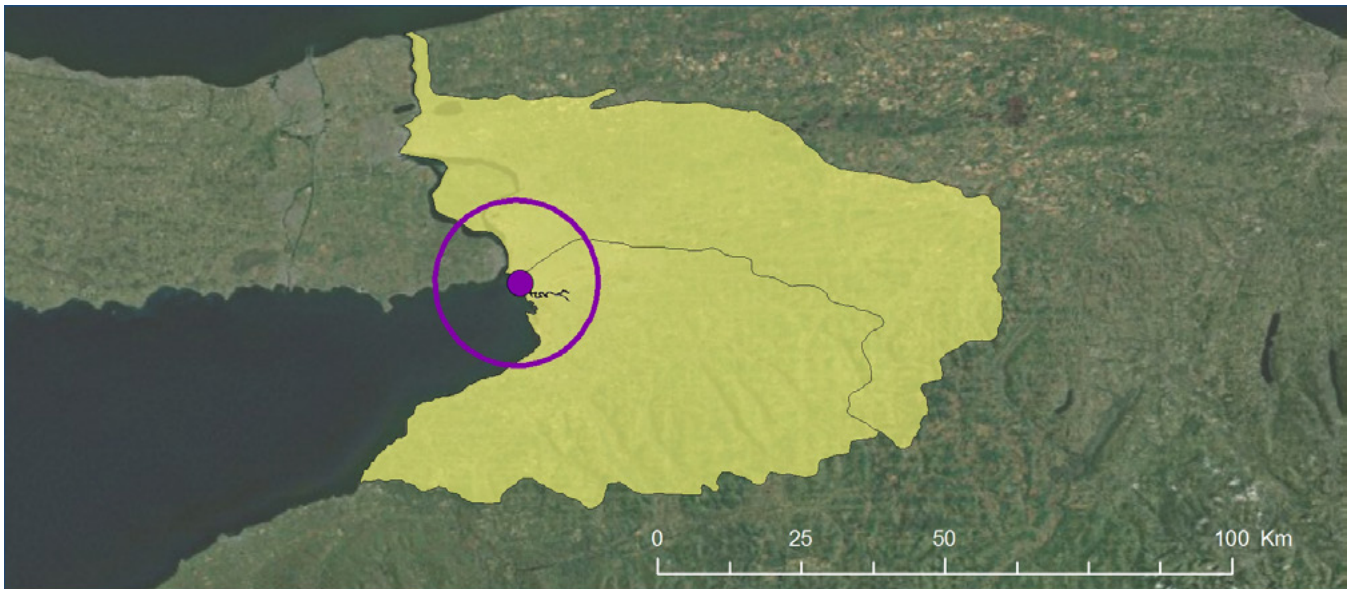


Land-use categories: MWP site (●) including 10 km buffer (○) and 2006 land-use categories from NLCD.

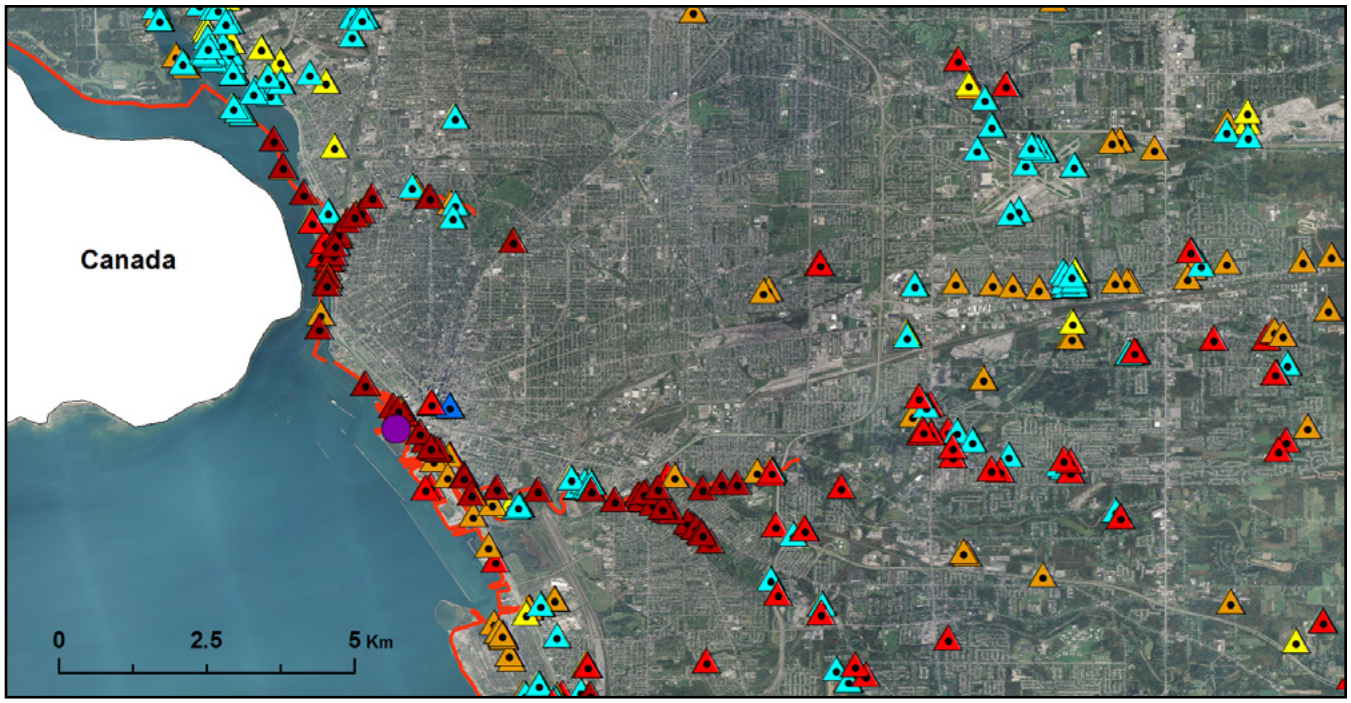
Buffalo River



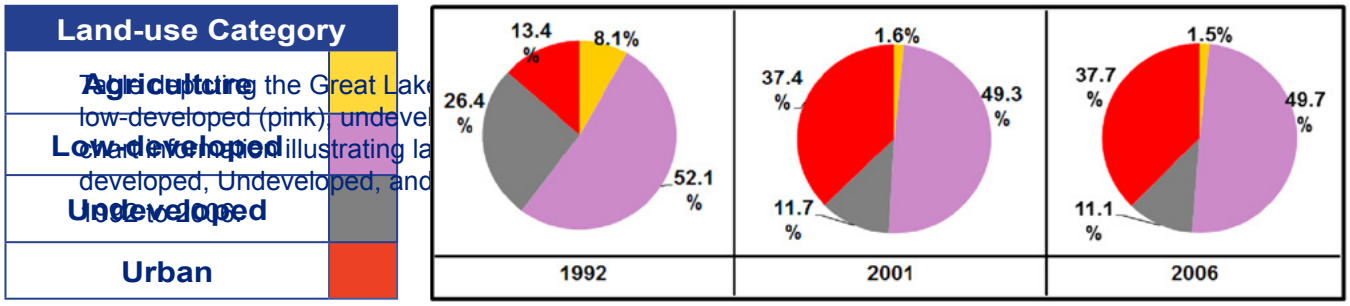
	LEBU	
	42.88003	
	-78.89157	
	NY	
	Urban	
	MW AOC	
	2009	
	516056	High



Spatial delineation: MWP site (●), associated watershed (▭), and AOC boundary (///) where applicable.



Outfalls: Aerial orthoimagery and map depicting MWP site (●), Impaired and Assessed Waters (▭), and U.S.EPA NPDES major and minor permitted facilities outfall types: POTW (▲), Non-POTW (▲), Wastewater Facilities (▲), Discharge Facilities (▲), Water Dischargers (▲), Combined Sewer Overflows (CSO's) (▲).



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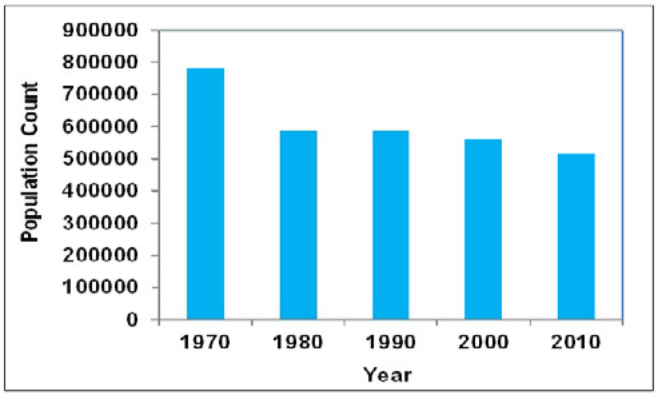
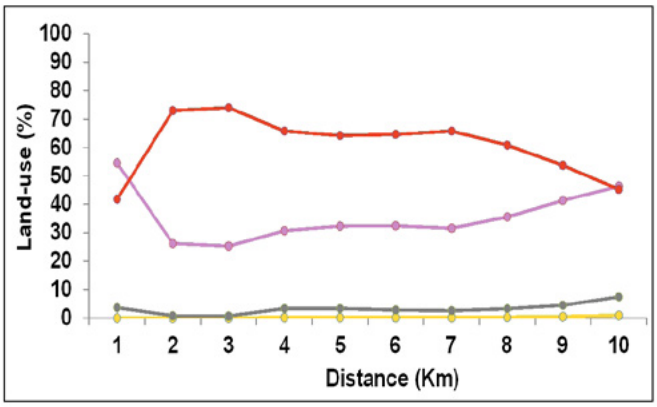
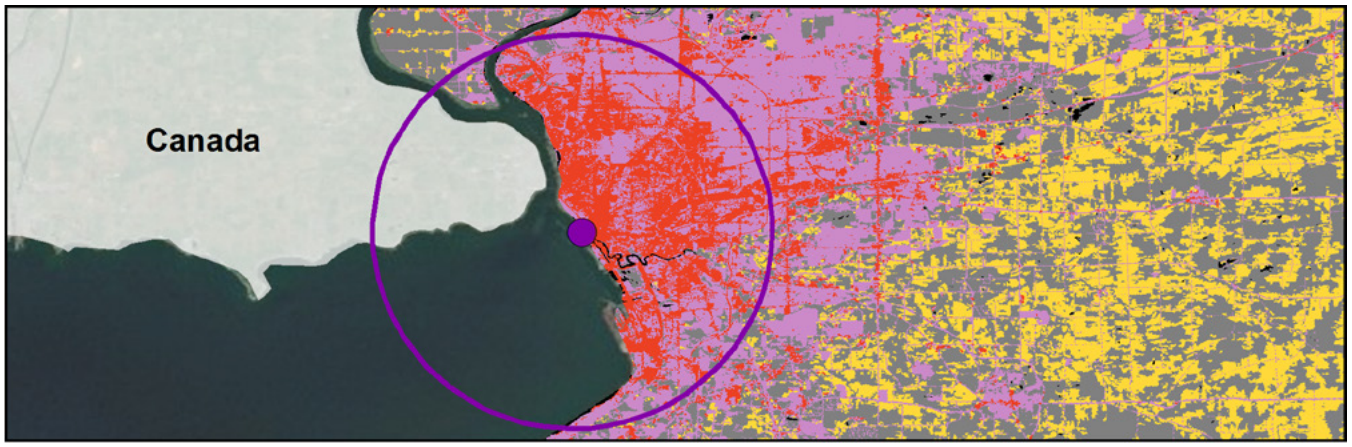


Population barchart: Bar chart depicting population trend within 10 km buffer of MWP site (1970 - 2010).

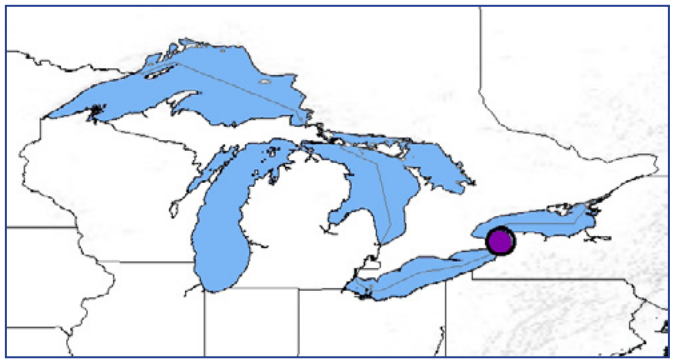


Line chart: MWP site 2006 NLCD land-use categories percentage within a 10 km buffer spatial extent.

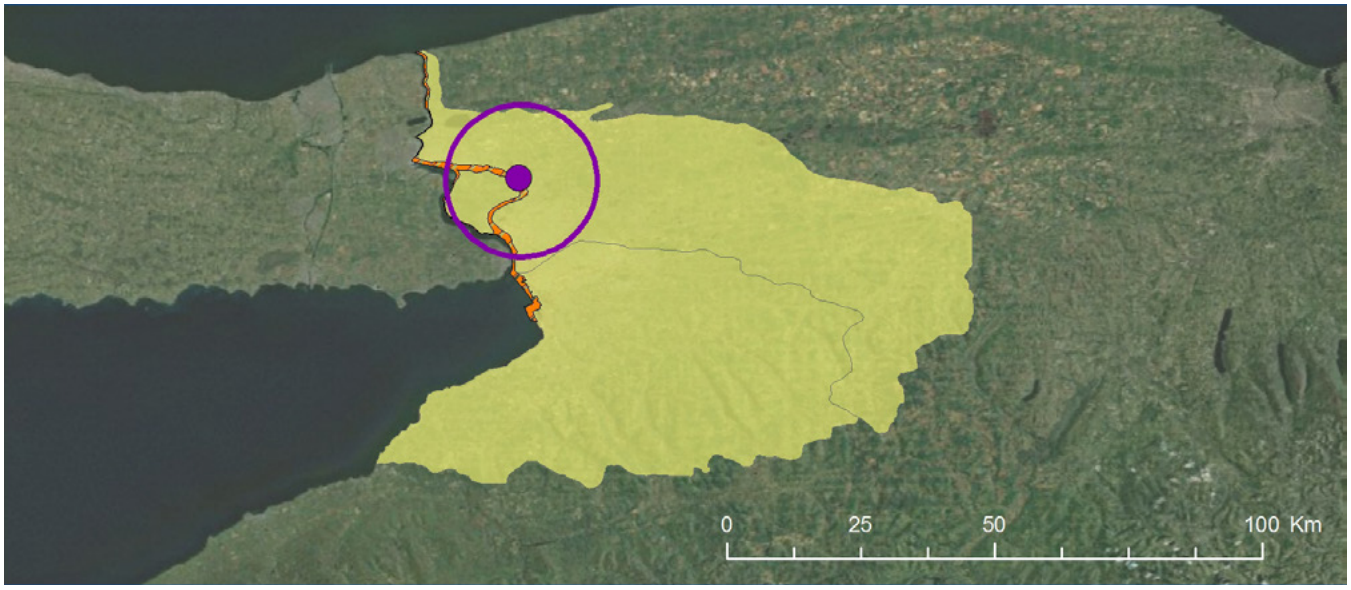


Land-use categories: MWP site (●) including 10 km buffer (○) and 2006 land-use categories from NLCD.

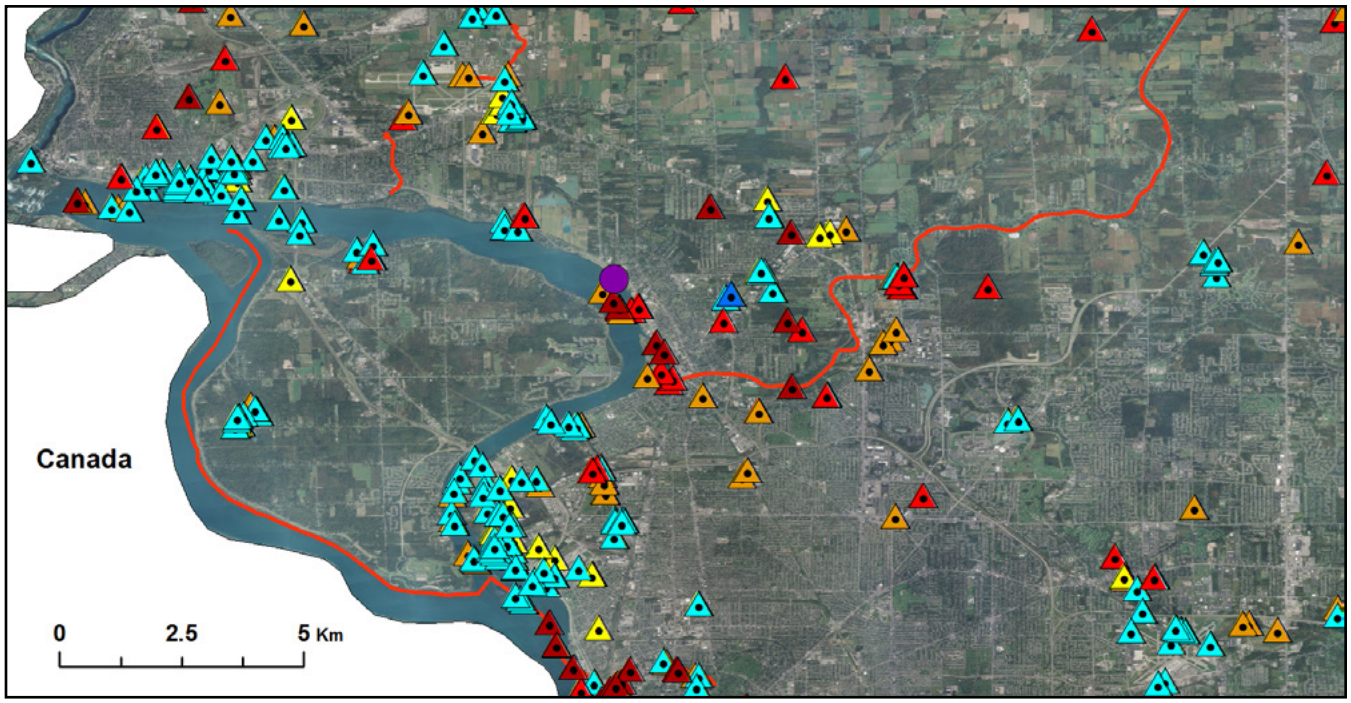
Niagara River



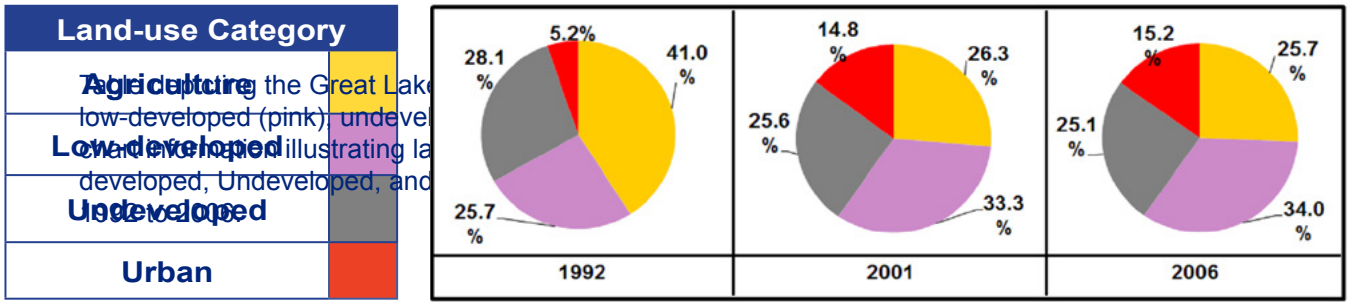
	NRNF	
	43.046833	
	-78.892	
	NY	
	Low-developed	
	MW AOC	
	2009	
	430524	High



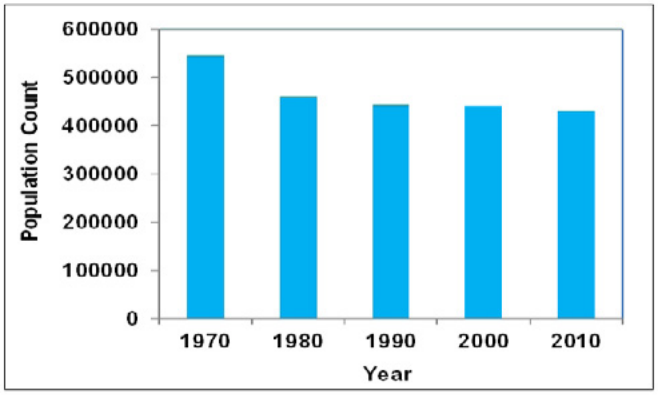
Spatial delineation: MWP site (●), associated watershed (▭), and AOC boundary (///) where applicable.



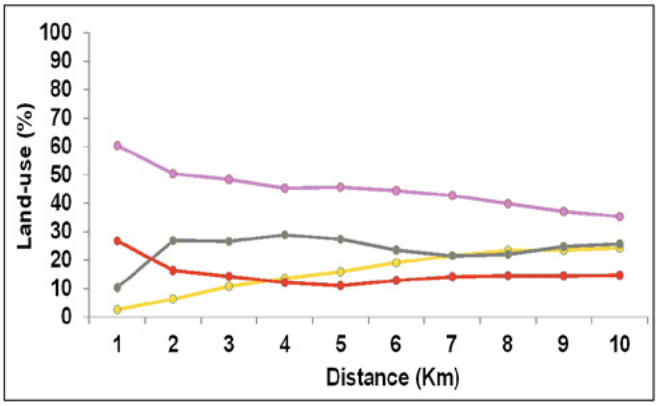
Outfalls: Aerial orthoimagery and map depicting MWP site (●), Impaired and Assessed Waters (▭), and U.S.EPA NPDES major and minor permitted facilities outfall types: POTW (▲), Non-POTW (▲), Wastewater Facilities (▲), Discharge Facilities (▲), Water Dischargers (▲), Combined Sewer Overflows (CSO's) (▲).



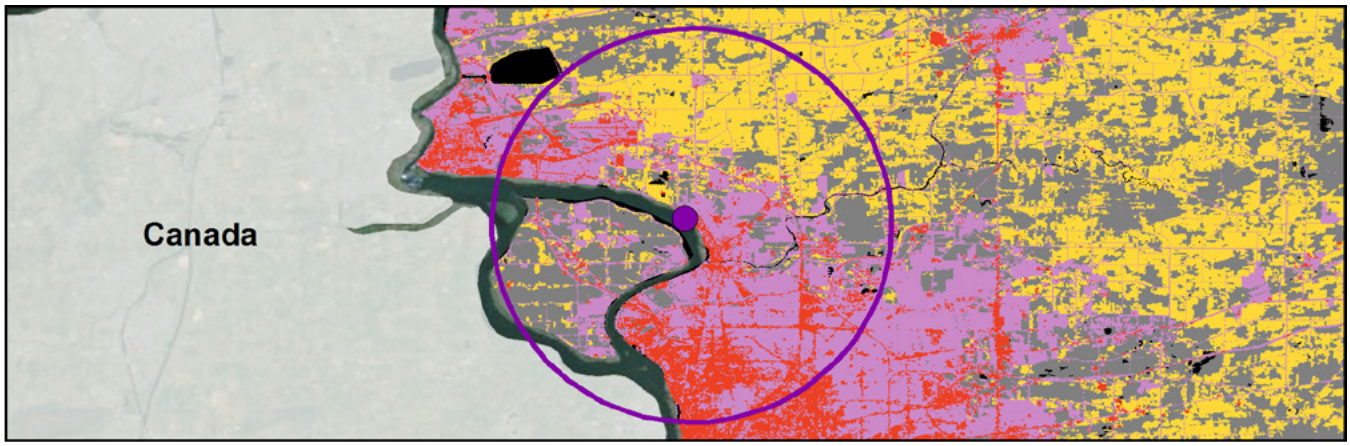
Legend: 1992 - 2006 National Land Cover Data (NLCD) aggregated hierarchal land-use categories, agriculture, low-developed, undeveloped and urban for Great Lakes Mussel Watch Program (MWP) sites.



Population barchart: Bar chart depicting population trend within 10 km buffer of MWP site (1970 - 2010).

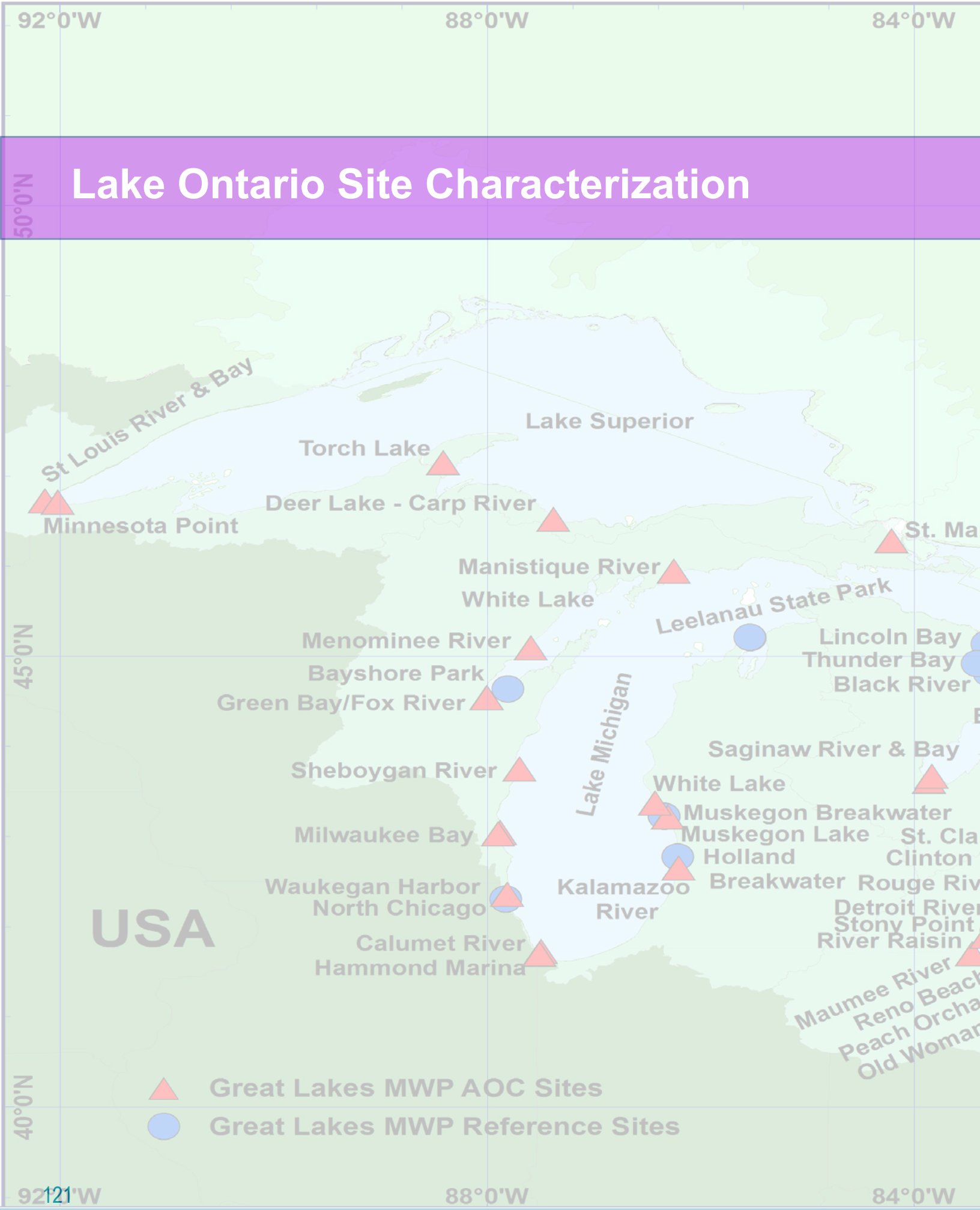


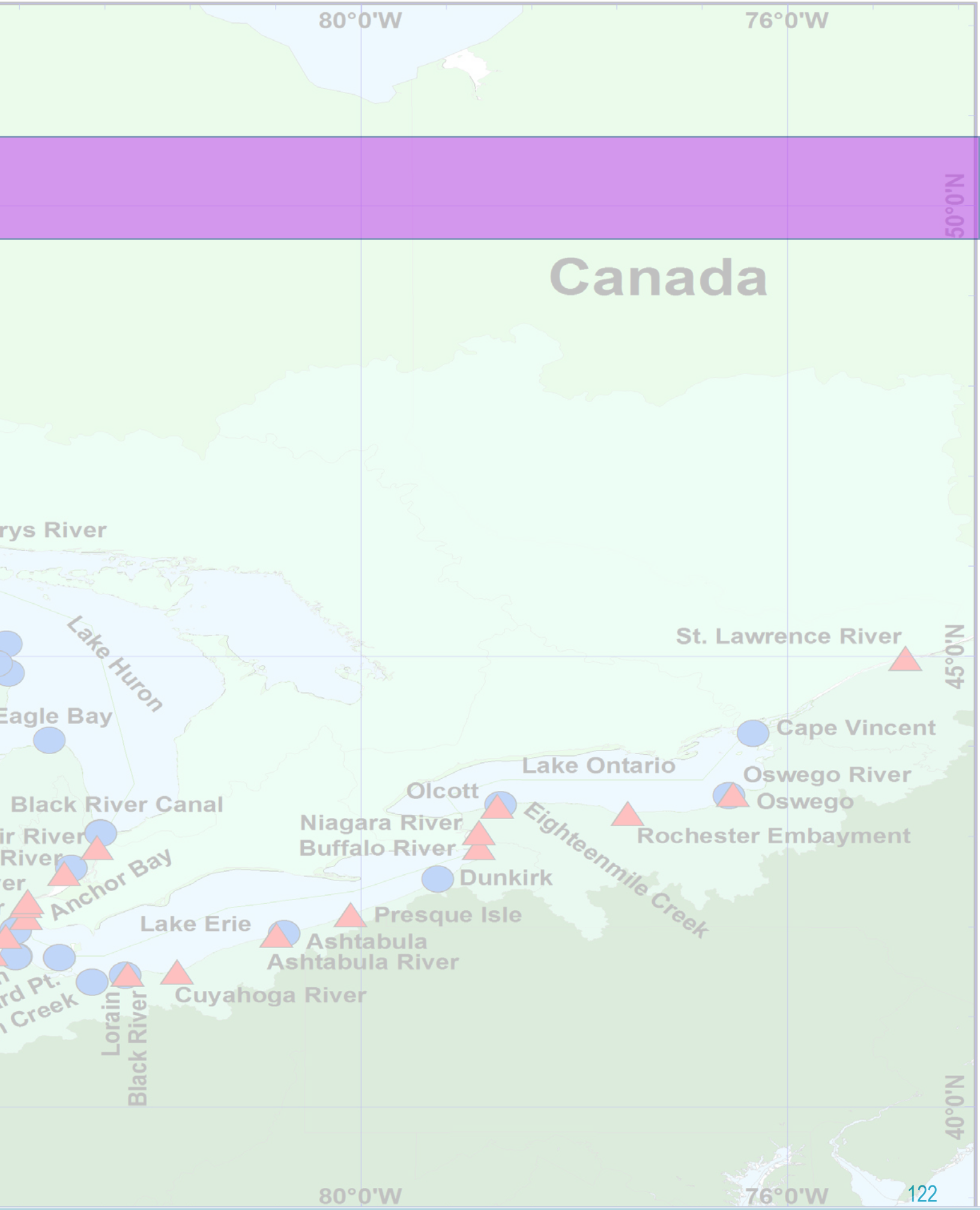
Line chart: MWP site 2006 NLCD land-use categories percentage within a 10 km buffer spatial extent.



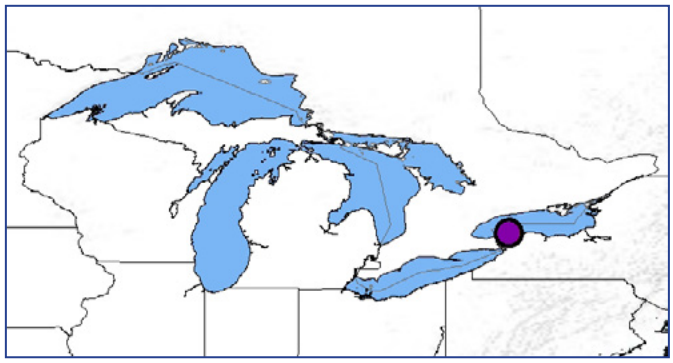
Land-use categories: MWP site (●) including 10 km buffer (○) and 2006 land-use categories from NLCD.

Lake Ontario Site Characterization

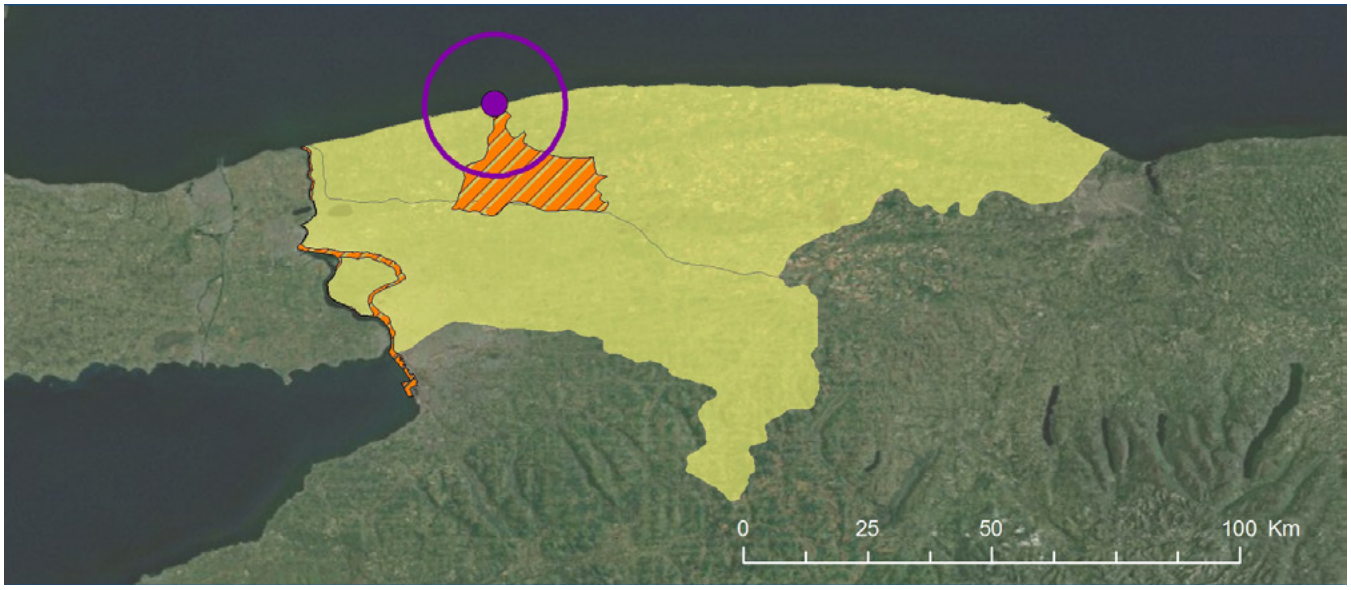



80°0'W
76°0'W
50°0'N
Canada
rys River
Lake Huron
Eagle Bay
St. Lawrence River
45°0'N
Cape Vincent
Lake Ontario
Oswego River
Oswego
Olcott
Black River Canal
Niagara River
Buffalo River
Eighteenmile Creek
Rochester Embayment
Dunkirk
Anchor Bay
Lake Erie
Presque Isle
Ashtabula
Ashtabula River
Cuyahoga River
Lorain
Black River
40°0'N
80°0'W
76°0'W

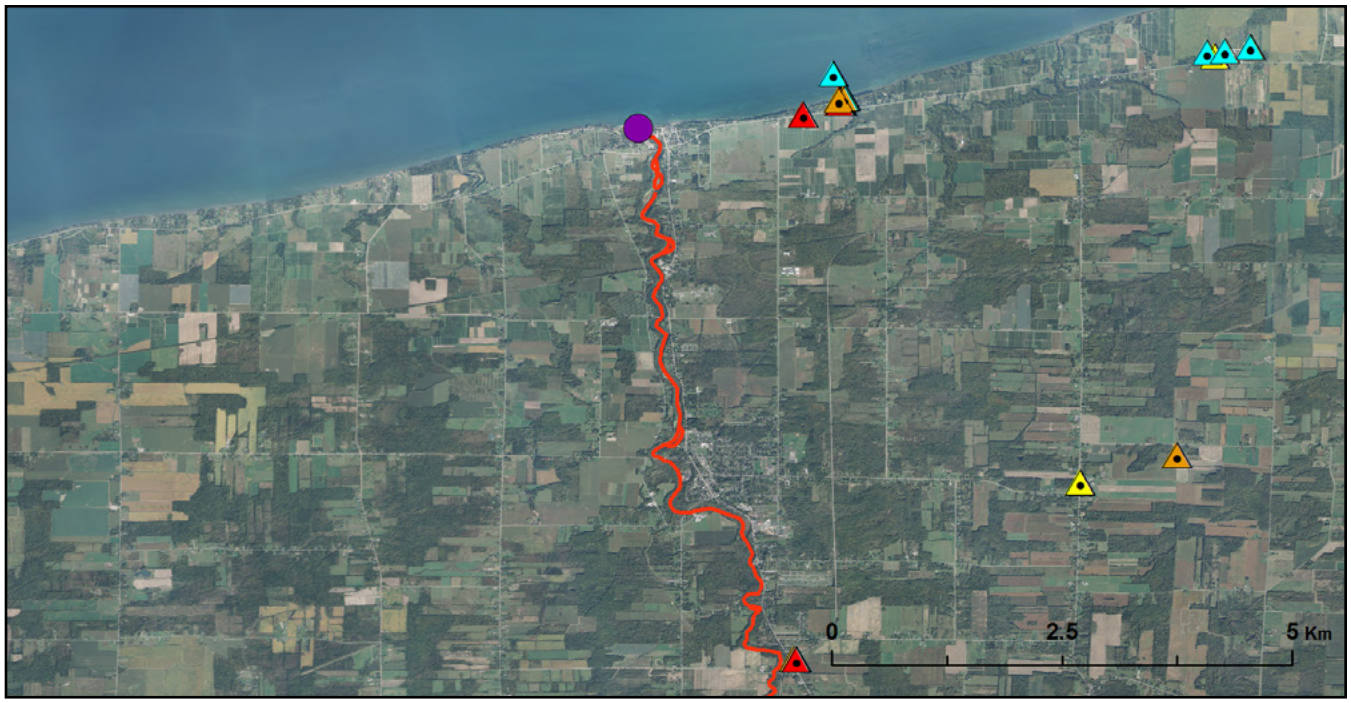
Eighteenmile Creek



	LOEC	
	43.3387	
	-78.718783	
	NY	
	Agriculture	
	MW AOC	
	2009	
	18315	Low



Spatial delineation: MWP site (●), associated watershed (▭), and AOC boundary (///) where applicable.



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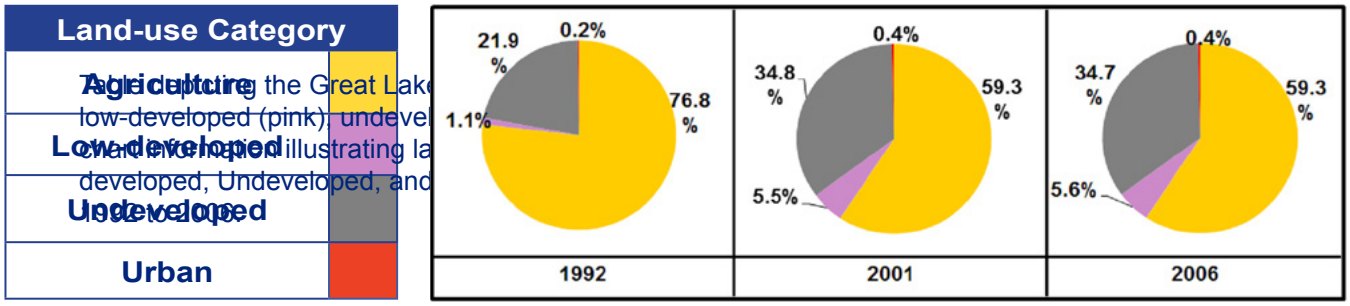
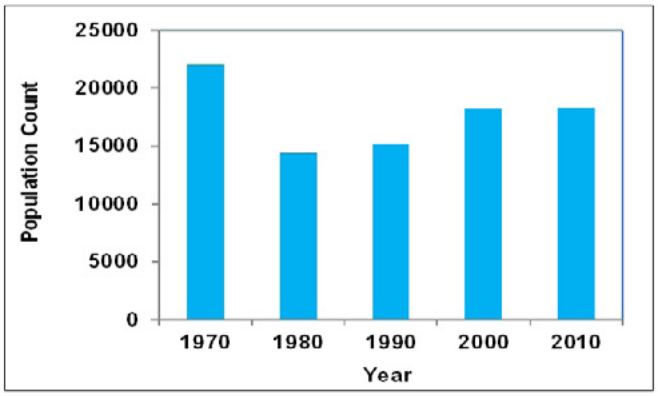


Legend: 1992 - 2006 National Land Cover Data (NLCD) aggregated hierarchal land-use categories, agriculture, low-developed, undeveloped and urban for Great Lakes Mussel Watch Program (MWP) sites.



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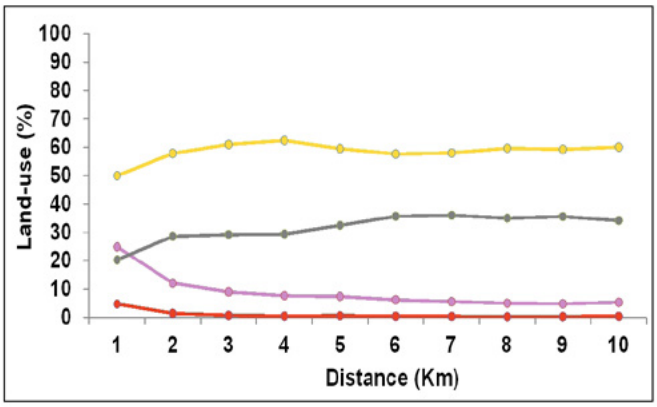
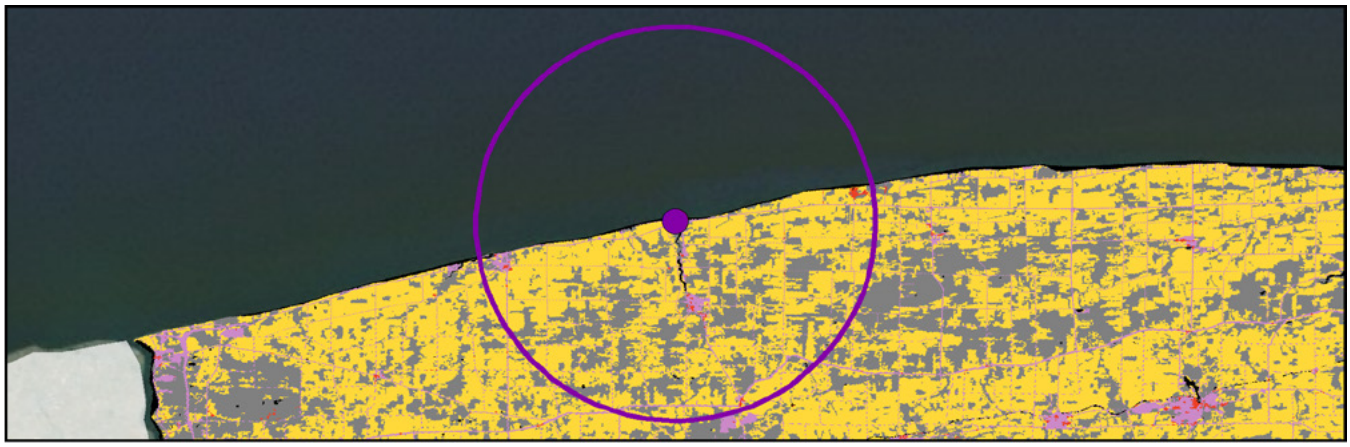
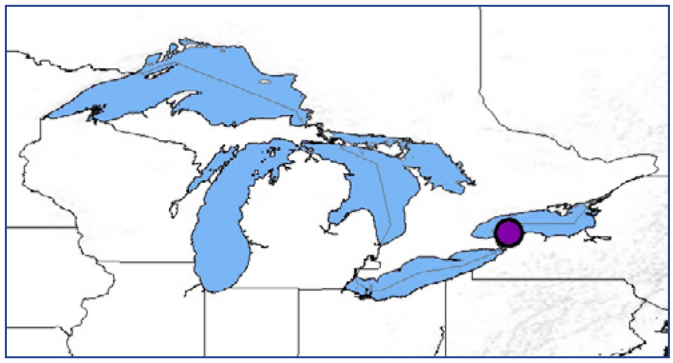


Line chart: MWP site 2006 NLCD land-use categories percentage within a 10 km buffer spatial extent.

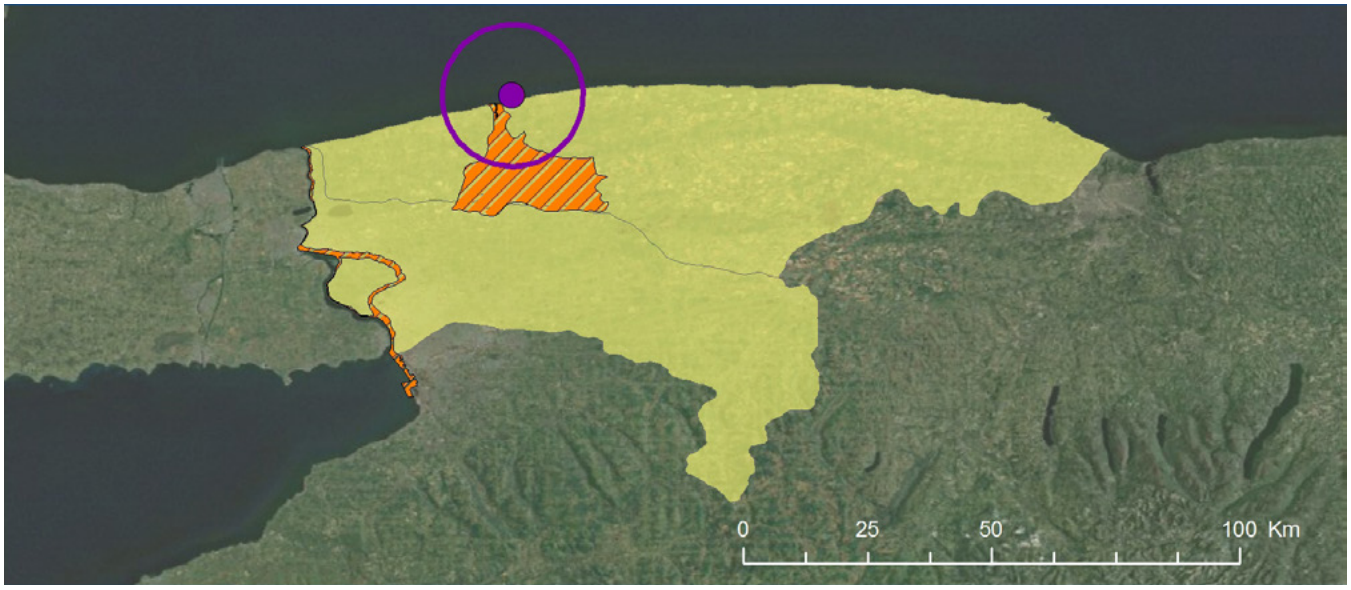


Land-use categories: MWP site (●) including 10 km buffer (○) and 2006 land-use categories from NLCD.

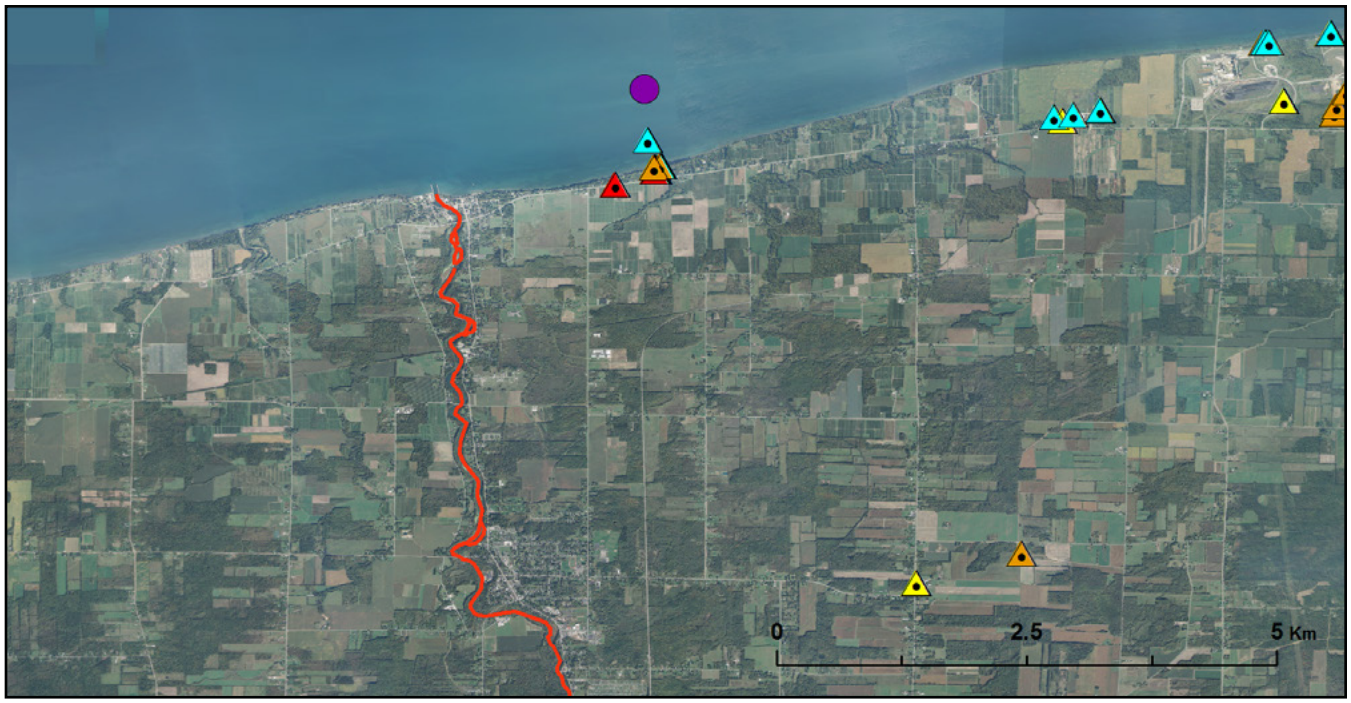
Olcott



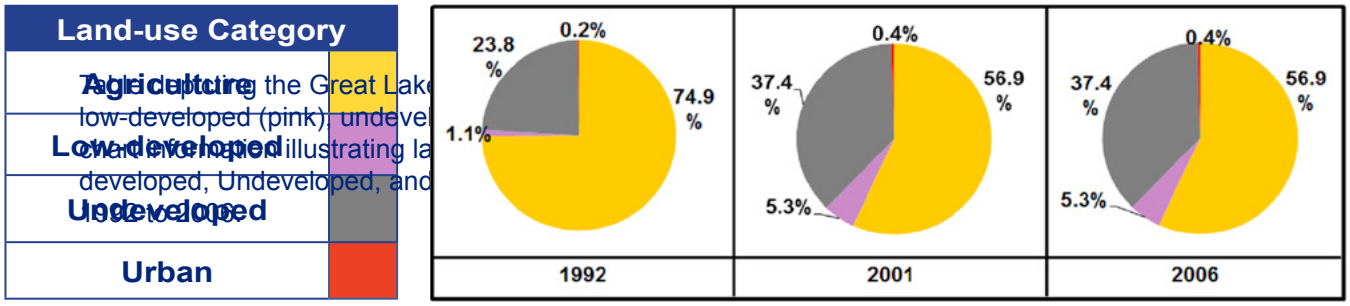
	LOOC	
	43.355333	
	-78.686667	
	NY	
	Agriculture	
	MW REF	
	1994	
	16318	Low



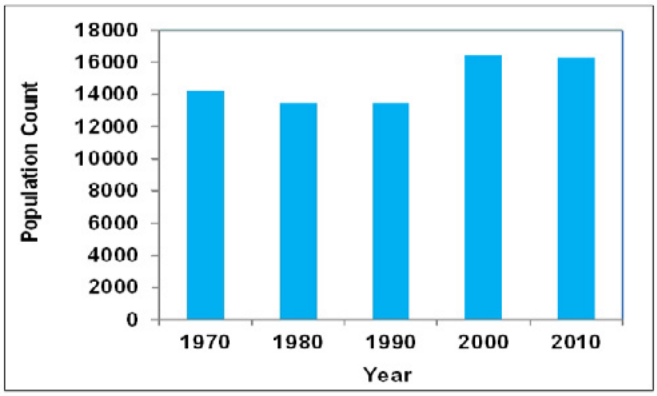
Spatial delineation: MWP site (●), associated watershed (), and AOC boundary (///) where applicable.



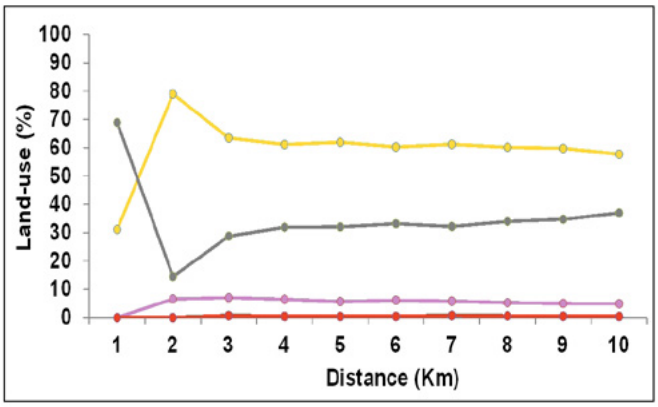
Outfalls: Aerial orthoimagery and map depicting MWP site (●), Impaired and Assessed Waters (), and U.S.EPA NPDES major and minor permitted facilities outfall types: POTW (▲), Non-POTW (▲), Wastewater Facilities (▲), Discharge Facilities (▲), Water Dischargers (▲), Combined Sewer Overflows (CSO's) (▲).



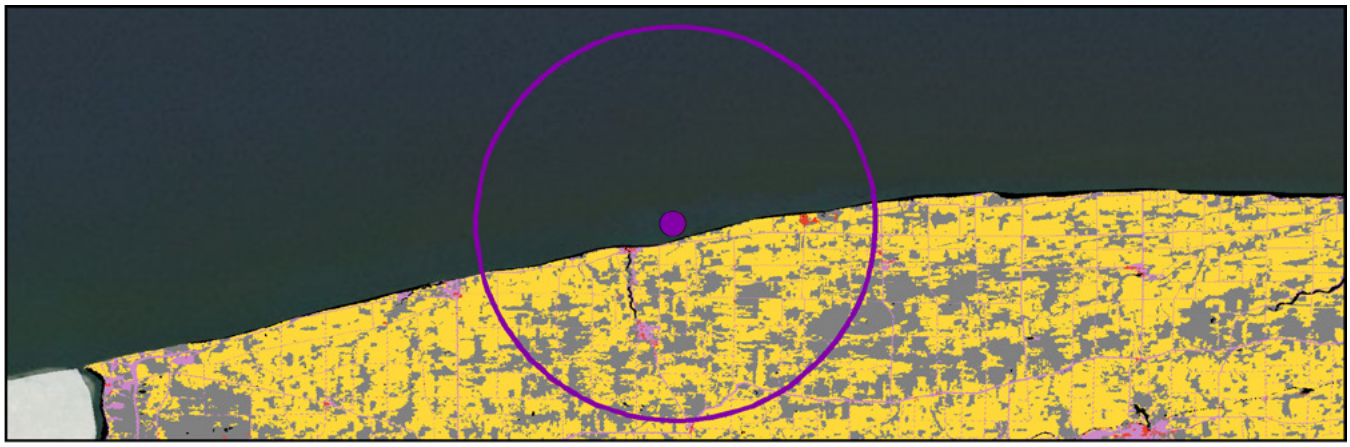
Legend: 1992 - 2006 National Land Cover Data (NLCD) aggregated hierarchal land-use categories, agriculture, low-developed, undeveloped and urban for Great Lakes Mussel Watch Program (MWP) sites.



Population barchart: Bar chart depicting population trend within 10 km buffer of MWP site (1970 - 2010).



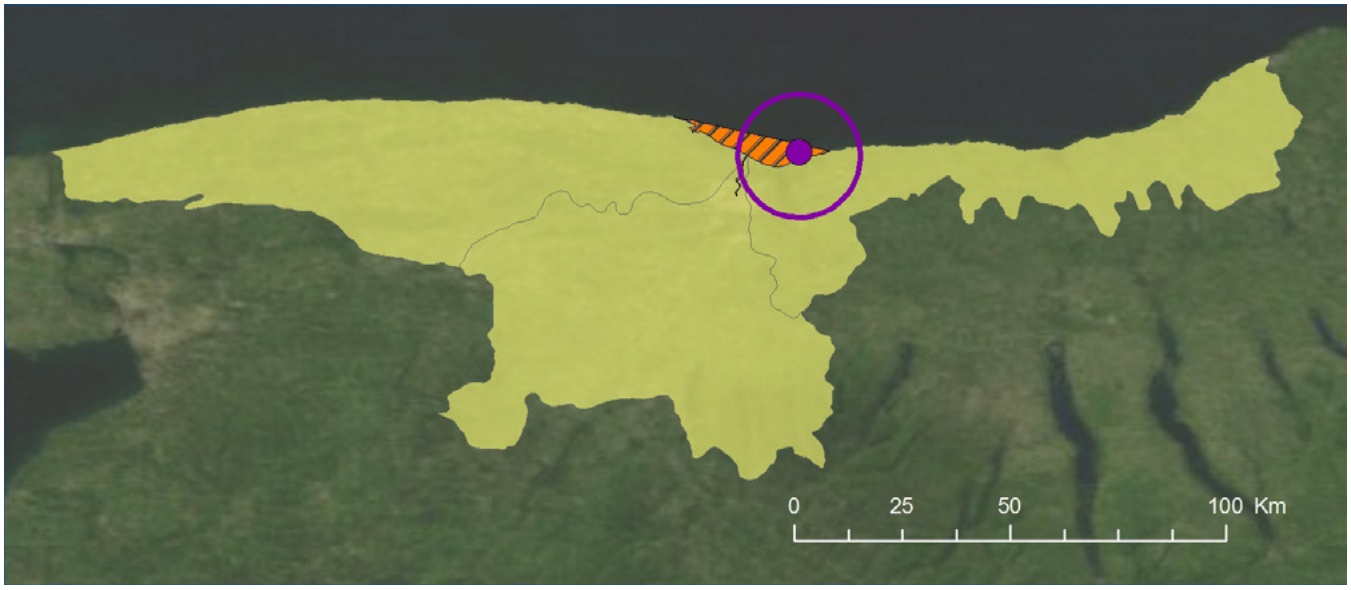
Line chart: MWP site 2006 NLCD land-use categories percentage within a 10 km buffer spatial extent.



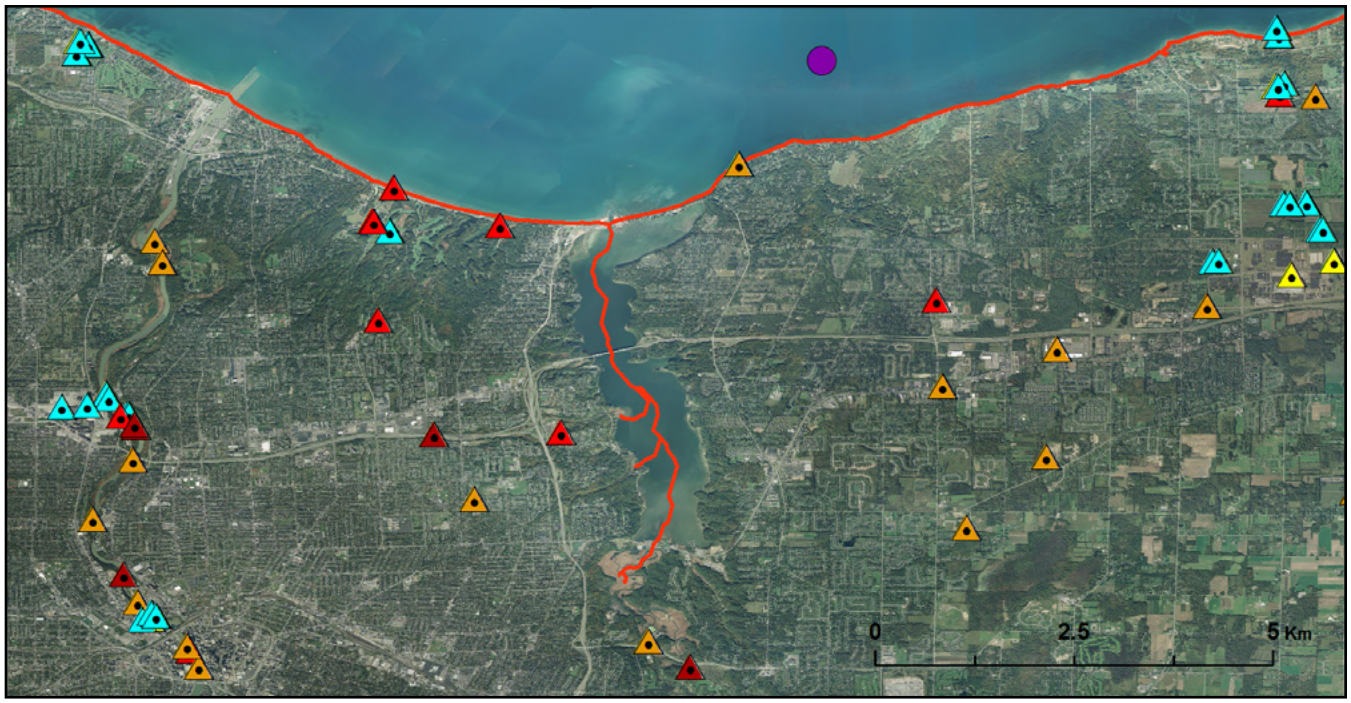
Land-use categories: MWP site (●) including 10 km buffer (○) and 2006 land-use categories from NLCD.

Rochester

	LORC	
	43.257833	
	-77.495333	
	NY	
	Low-developed	
	MW AOC	
	2009	
	265921	Medium



Spatial delineation: MWP site (●), associated watershed (▭), and AOC boundary (///) where applicable.



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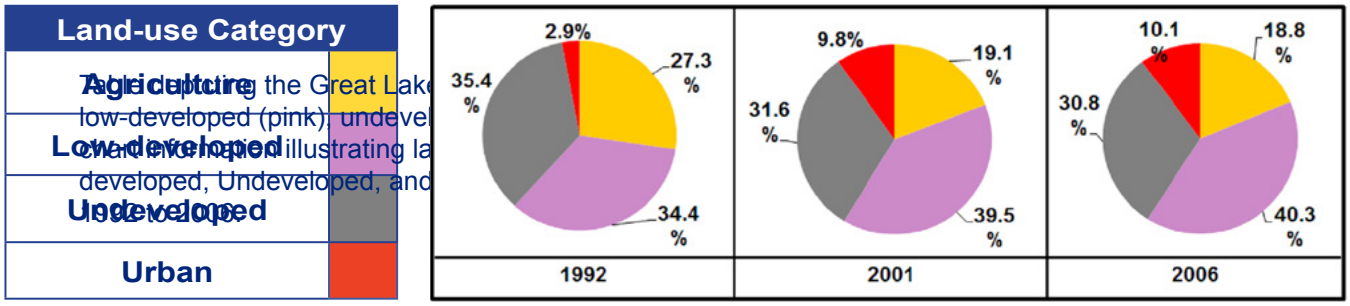

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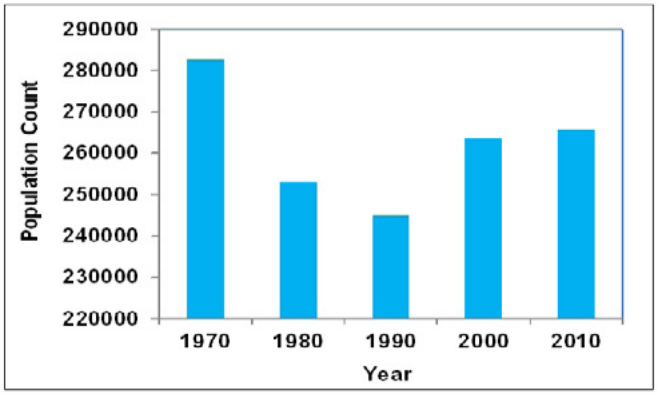
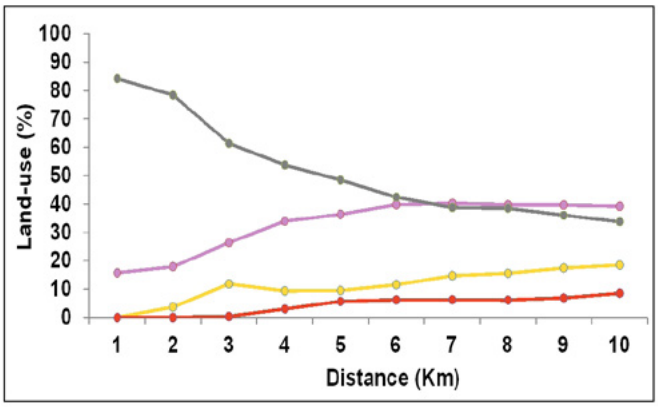
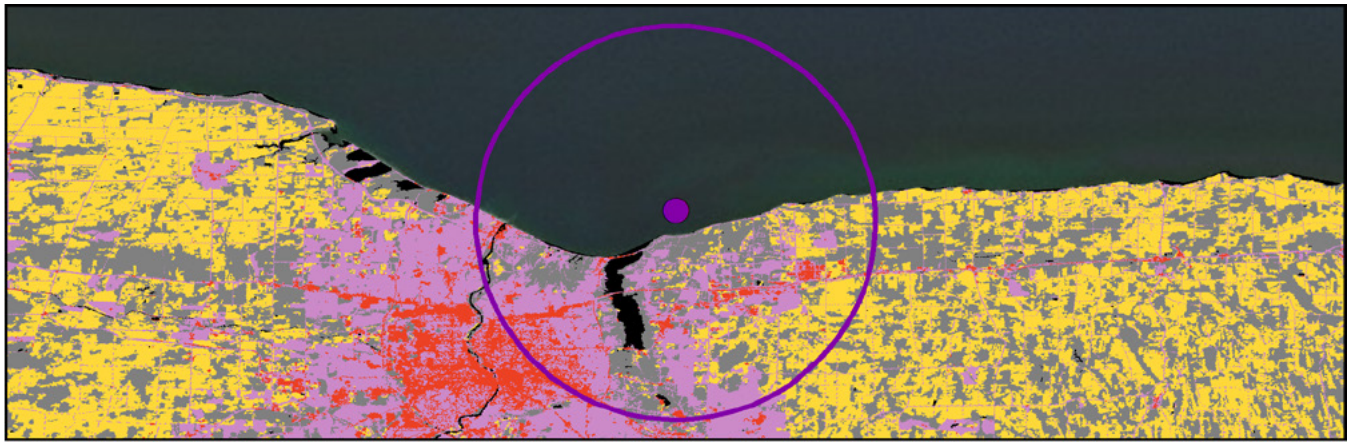


Population barchart: Bar chart depicting population trend within 10 km buffer of MWP site (1970 - 2010).



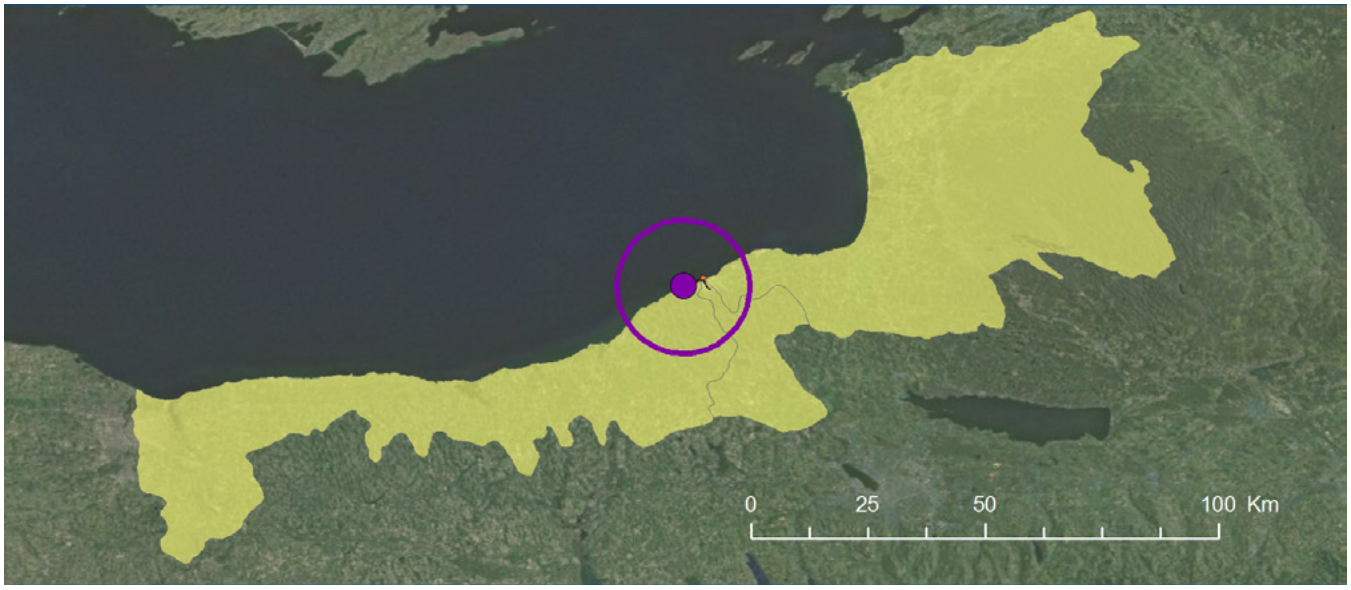
Line chart: MWP site 2006 NLCD land-use categories percentage within a 10 km buffer spatial extent.



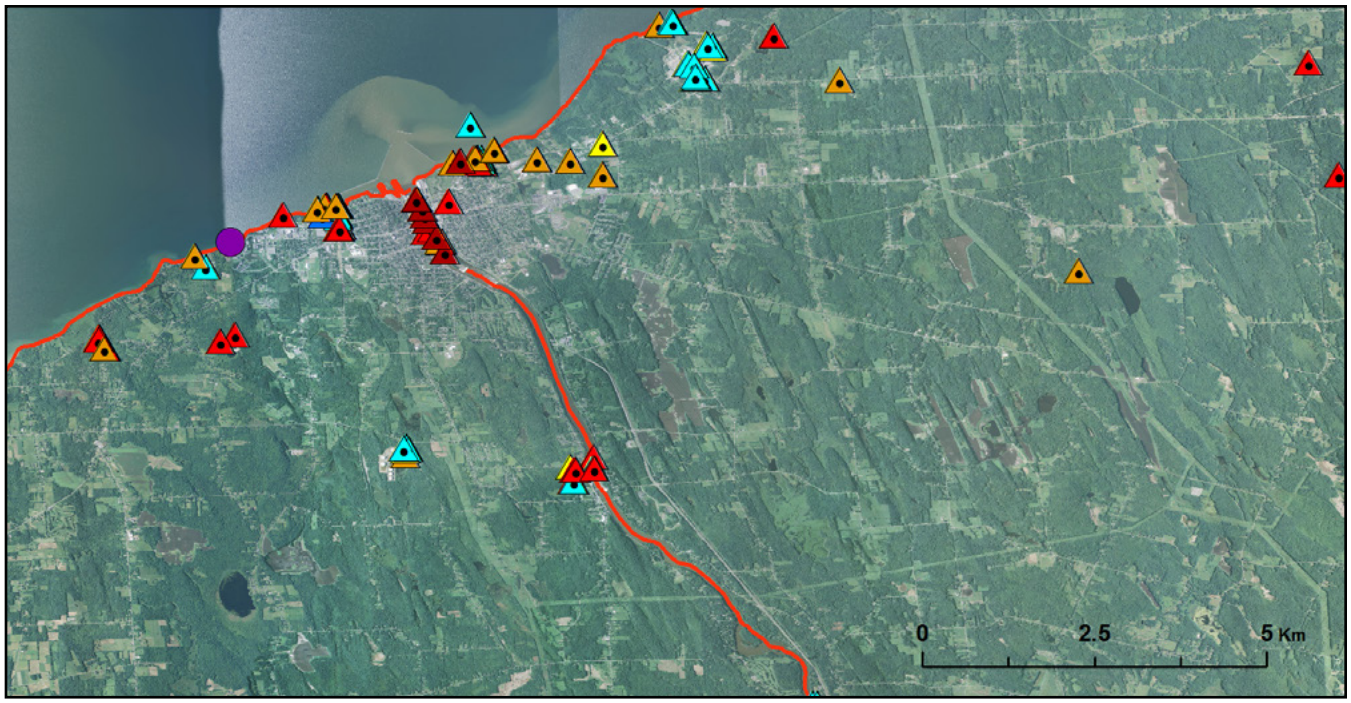
Land-use categories: MWP site (●) including 10 km buffer (○) and 2006 land-use categories from NLCD.

Oswego

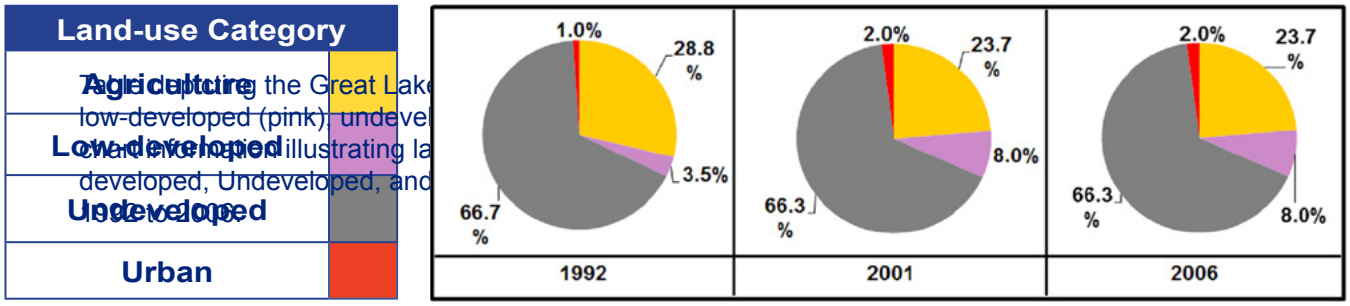
	LOOS	
	43.452833	
	-76.550833	
	NY	
	Undeveloped	
	MW REF	
	1994	
	39907	Low



Spatial delineation: MWP site (●), associated watershed (▭), and AOC boundary (///) where applicable.



Outfalls: Aerial orthoimagery and map depicting MWP site (●), Impaired and Assessed Waters (▭), and U.S.EPA NPDES major and minor permitted facilities outfall types: POTW (▲), Non-POTW (▲), Wastewater Facilities (▲), Discharge Facilities (▲), Water Dischargers (▲), Combined Sewer Overflows (CSO's) (▲).



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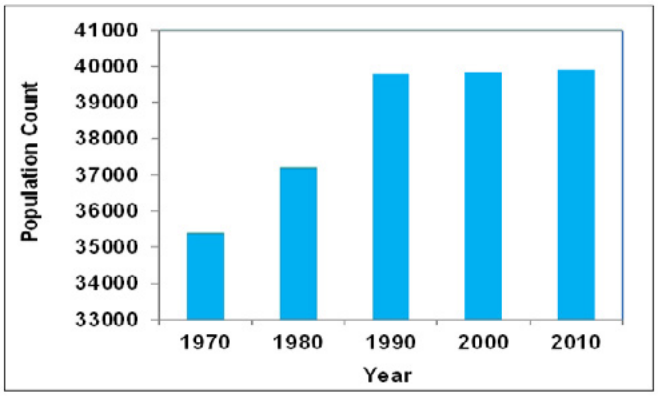
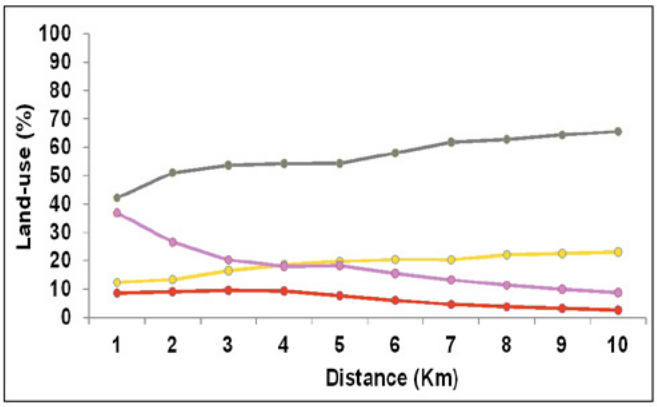
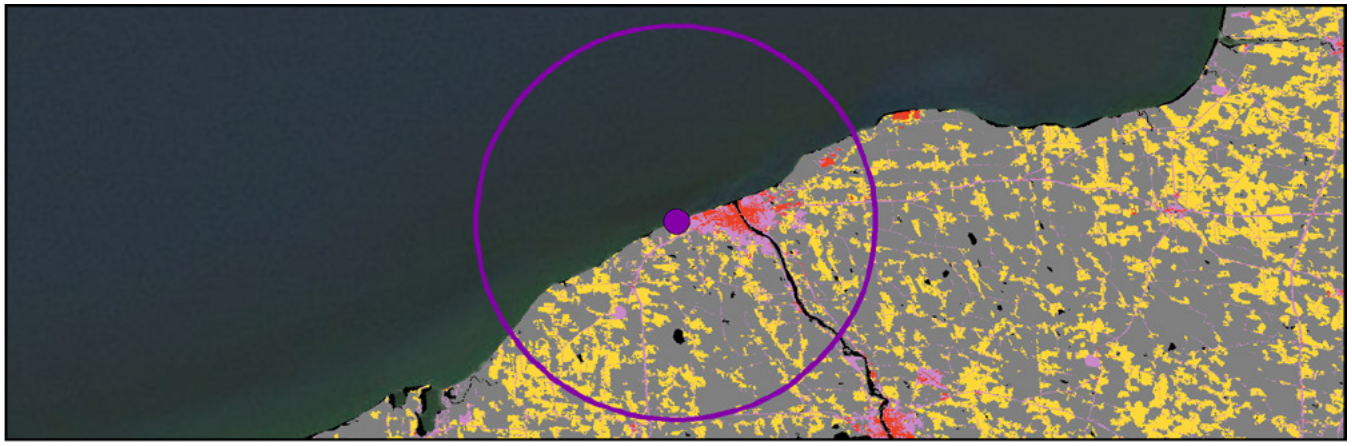


Population barchart: Bar chart depicting population trend within 10 km buffer of MWP site (1970 - 2010).



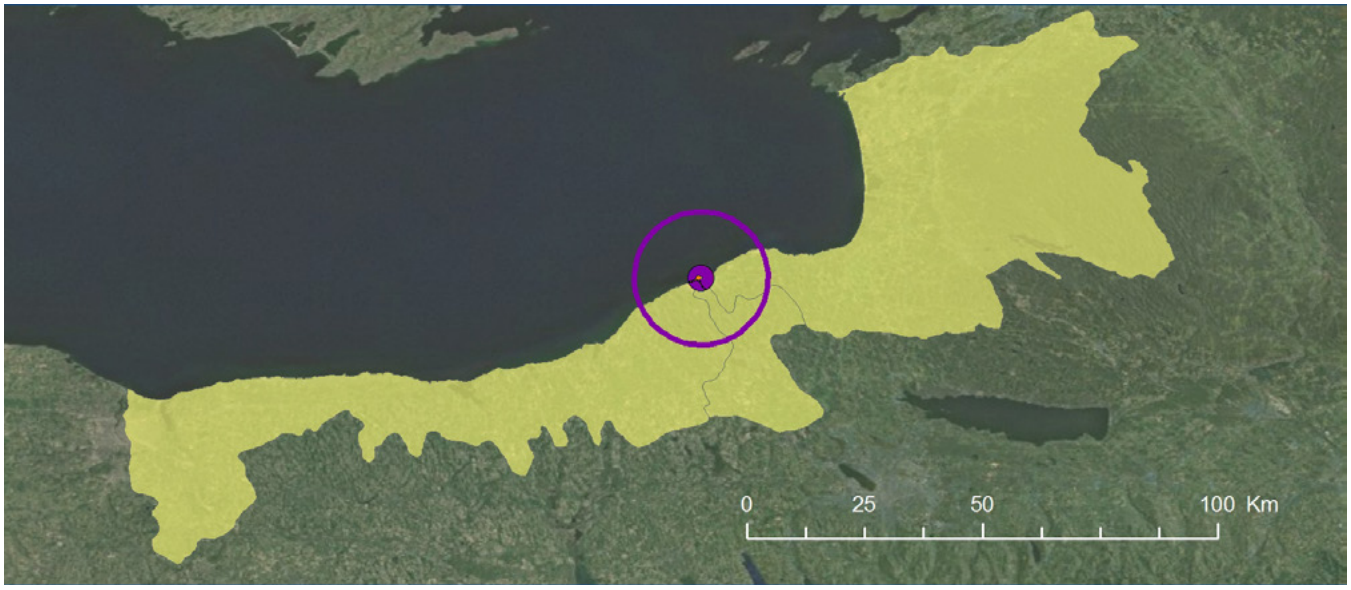
Line chart: MWP site 2006 NLCD land-use categories percentage within a 10 km buffer spatial extent.



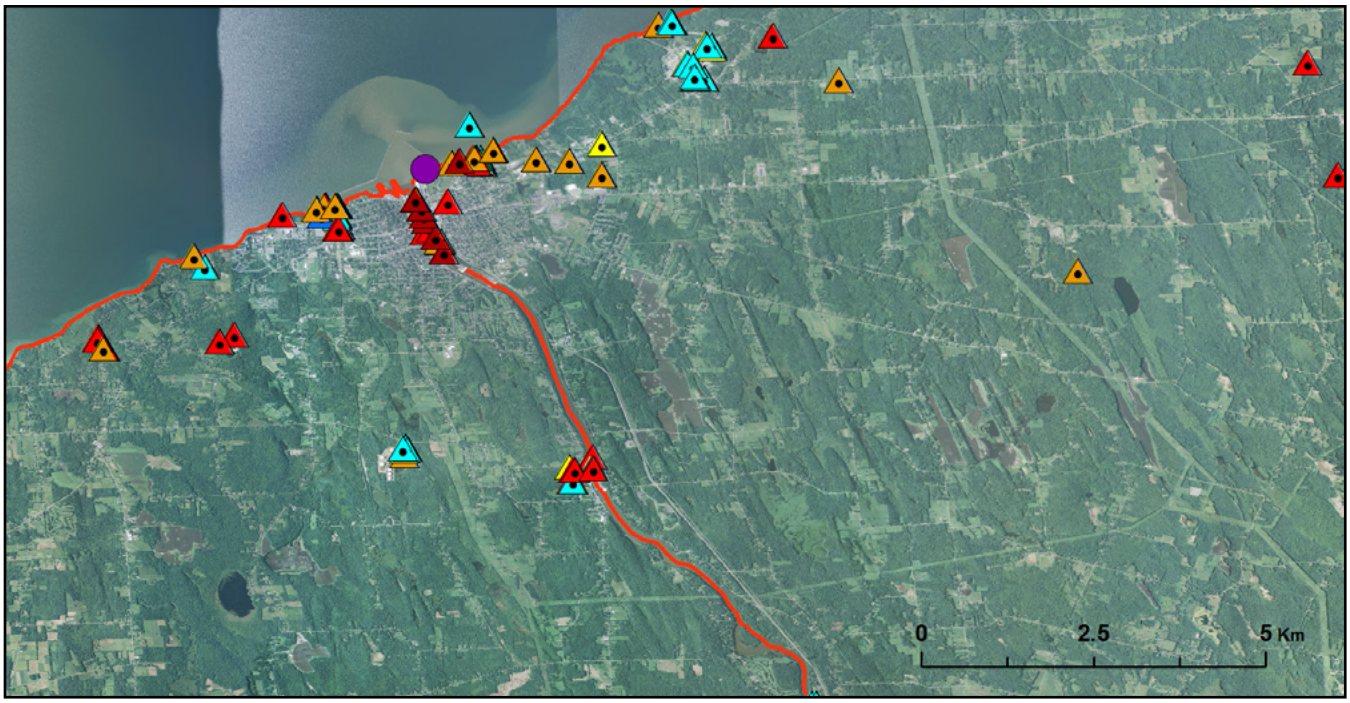
Land-use categories: MWP site (●) including 10 km buffer (○) and 2006 land-use categories from NLCD.

Oswego River

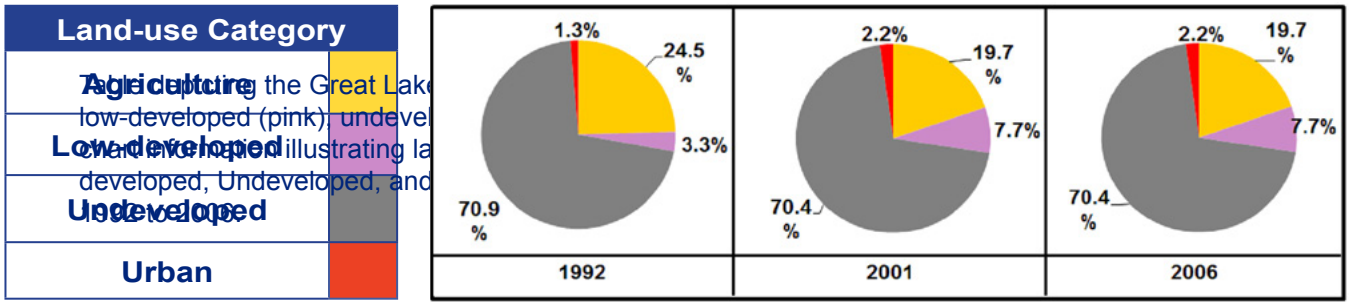
	LOOR	
	43.468333	
	-76.50973	
	NY	
	Undeveloped	
	MW AOC	
	2009	
	40612	Low



Spatial delineation: MWP site (●), associated watershed (▭), and AOC boundary (///) where applicable.



Outfalls: Aerial orthoimagery and map depicting MWP site (●), Impaired and Assessed Waters (▭), and U.S.EPA NPDES major and minor permitted facilities outfall types: POTW (▲), Non-POTW (▲), Wastewater Facilities (▲), Discharge Facilities (▲), Water Dischargers (▲), Combined Sewer Overflows (CSO's) (▲).



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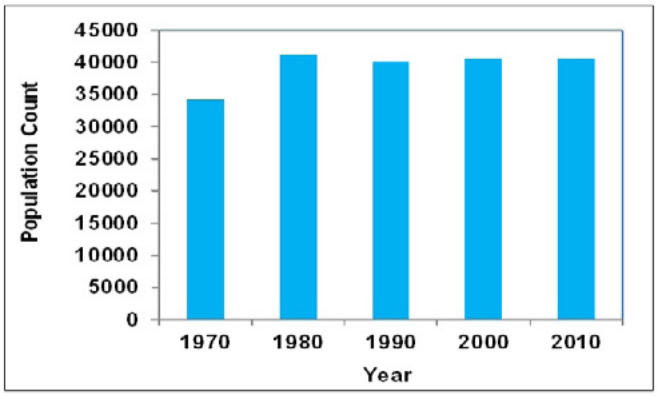

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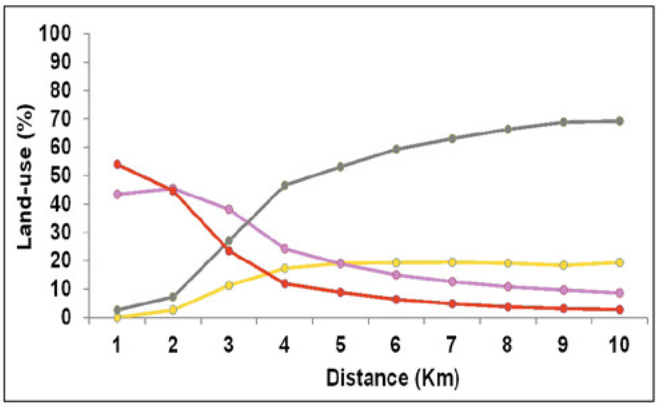
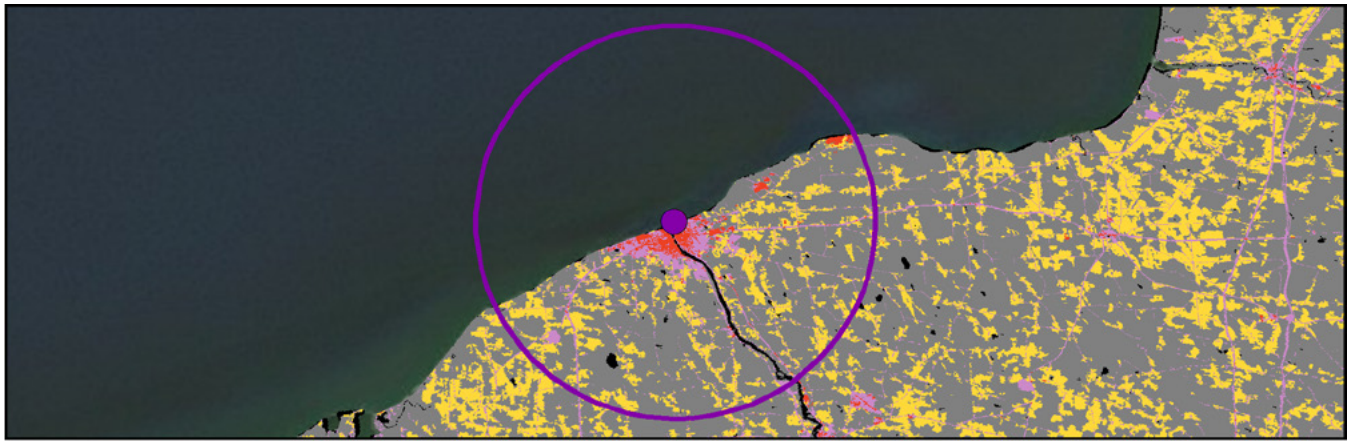


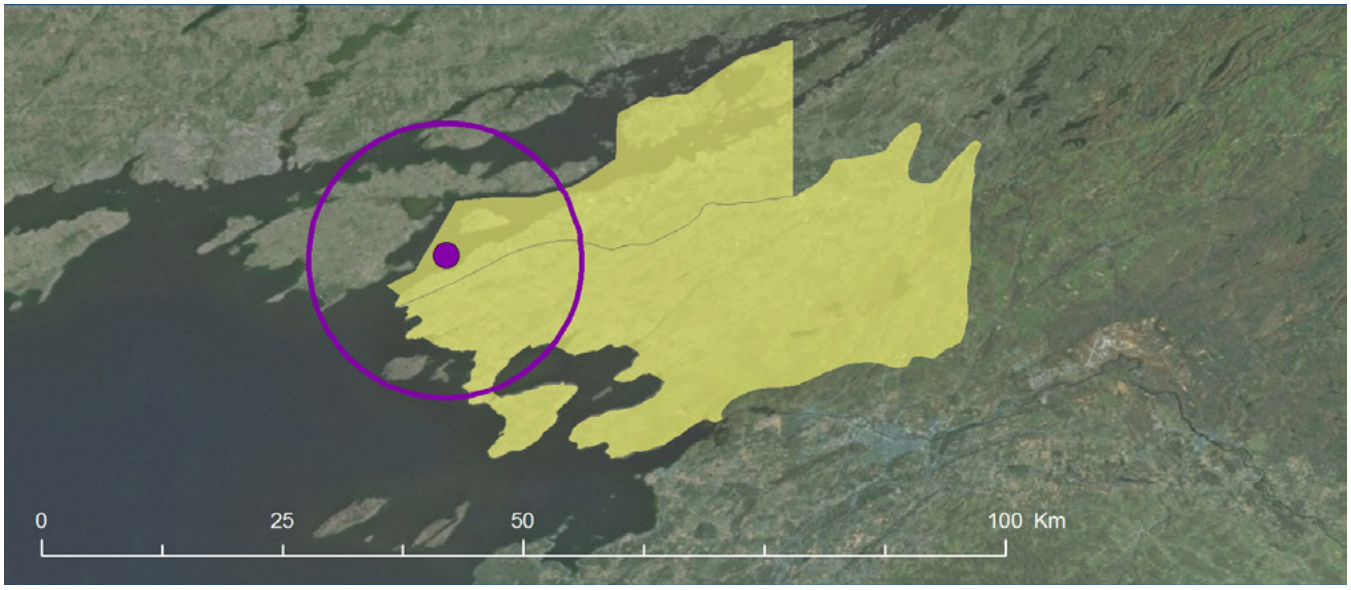
Line chart: MWP site 2006 NLCD land-use categories percentage within a 10 km buffer spatial extent.



Land-use categories: MWP site (●) including 10 km buffer (○) and 2006 land-use categories from NLCD.

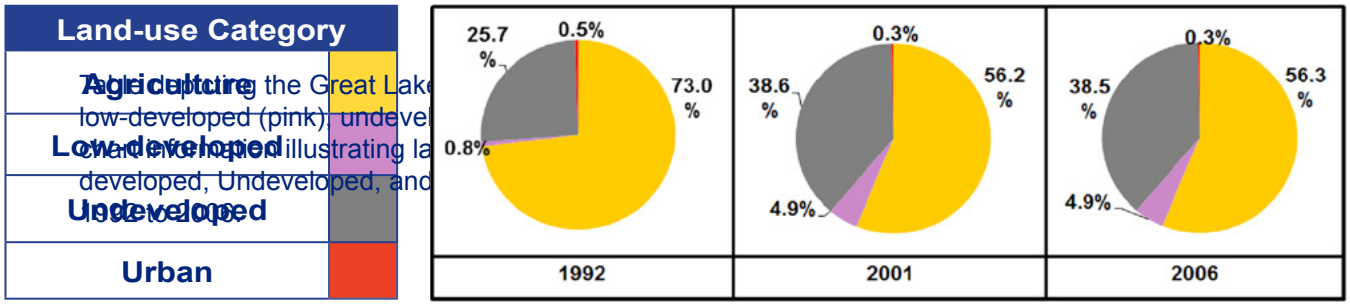
Cape Vincent

	LOCV	
	44.144167	
	-76.324667	
	NY	
	Agriculture	
	MW REF	
	1994	
	3478	Low



Spatial delineation: MWP site (●), associated watershed (▭), and AOC boundary (///) where applicable.

Outfalls: Aerial orthoimagery and map depicting MWP site (●), Impaired and Assessed Waters (▭), and U.S.EPA NPDES major and minor permitted facilities outfall types: POTW (▲), Non-POTW (▲), Wastewater Facilities (▲), Discharge Facilities (▲), Water Dischargers (▲), Combined Sewer Overflows (CSO's) (▲).



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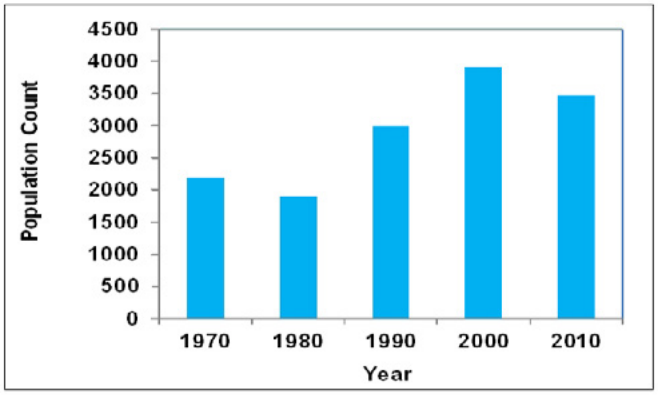
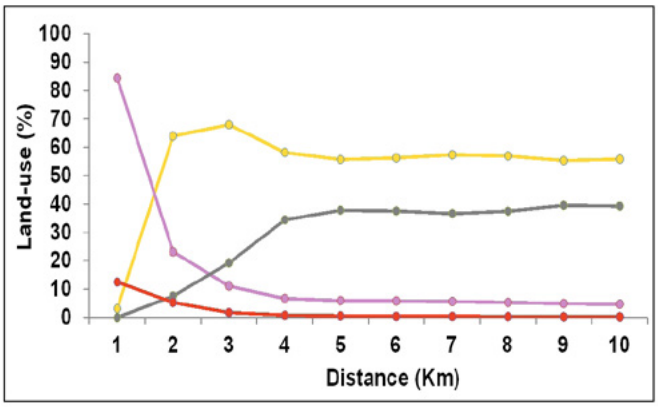
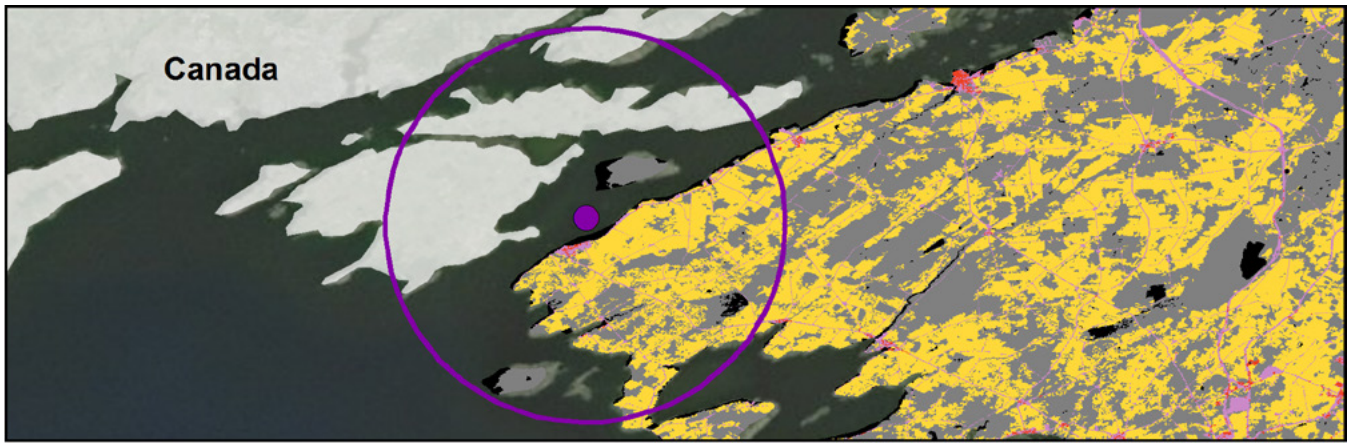


Population barchart: Bar chart depicting population trend within 10 km buffer of MWP site (1970 - 2010).



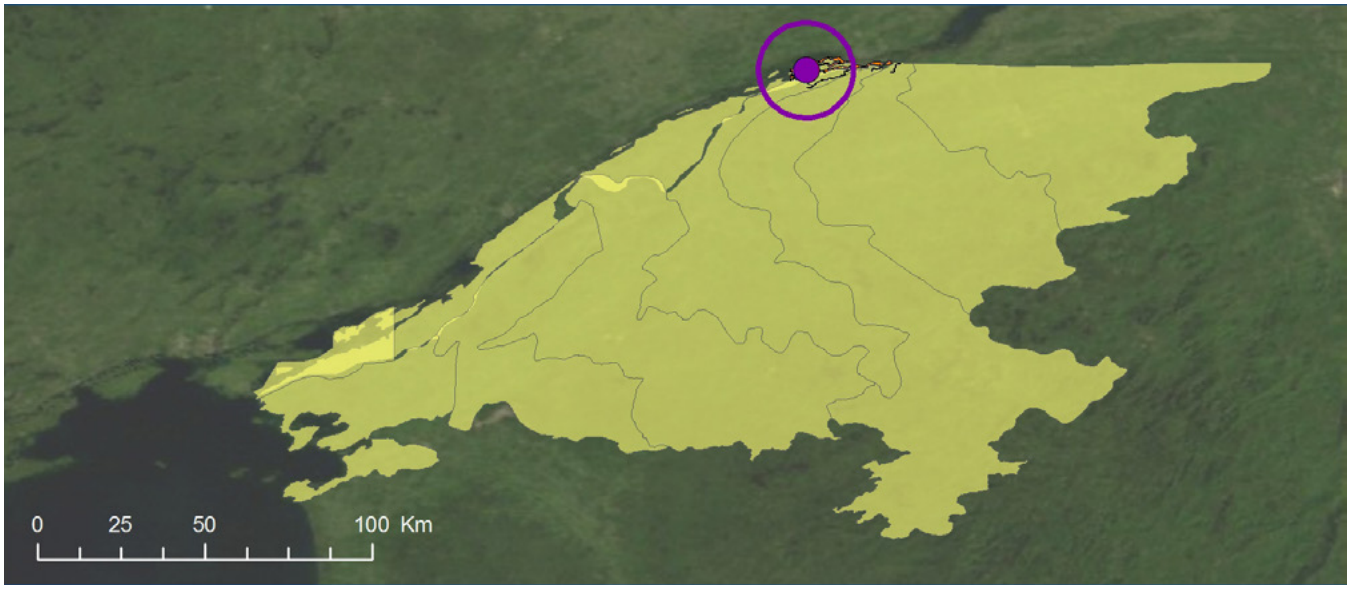
Line chart: MWP site 2006 NLCD land-use categories percentage within a 10 km buffer spatial extent.



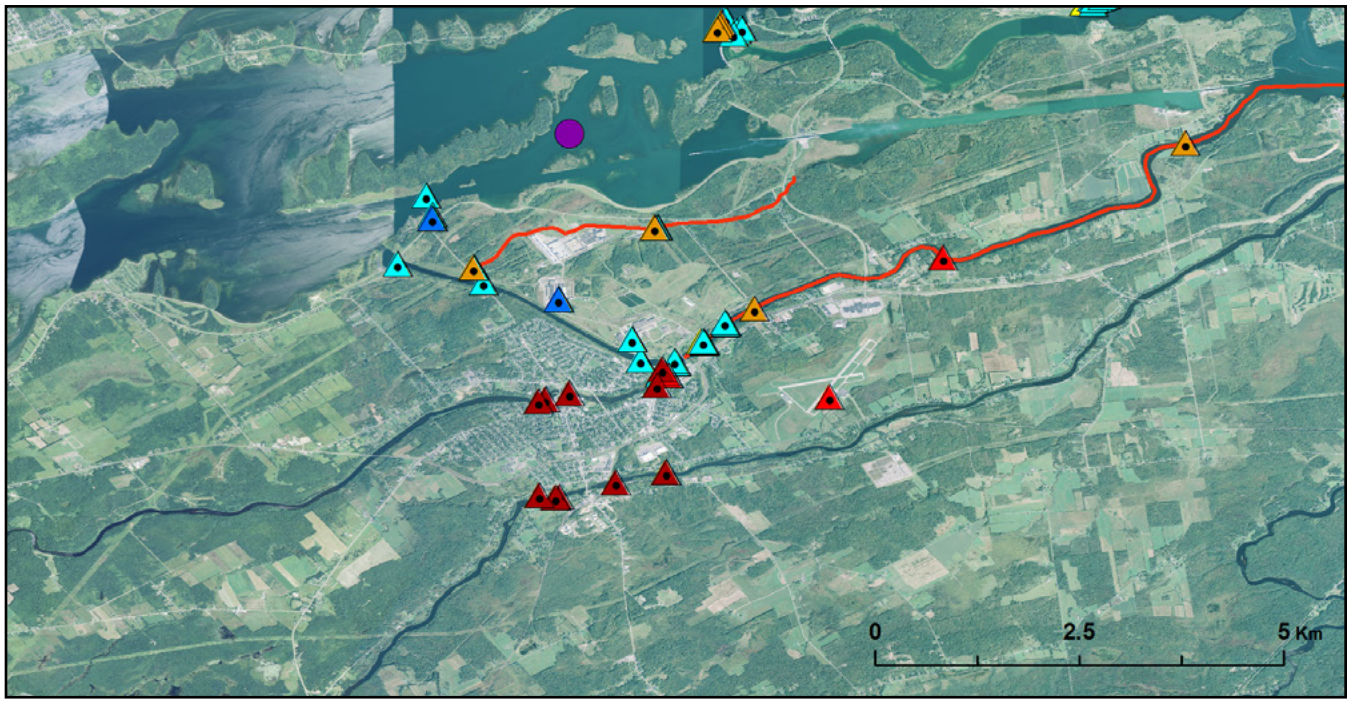
Land-use categories: MWP site (●) including 10 km buffer (○) and 2006 land-use categories from NLCD.

St Lawrence River

	LOSL	
	44.979866	
	-74.891616	
	NY	
	Undeveloped	
	MW AOC	
	2009	
	17871	Low



Spatial delineation: MWP site (●), associated watershed (▭), and AOC boundary (///) where applicable.



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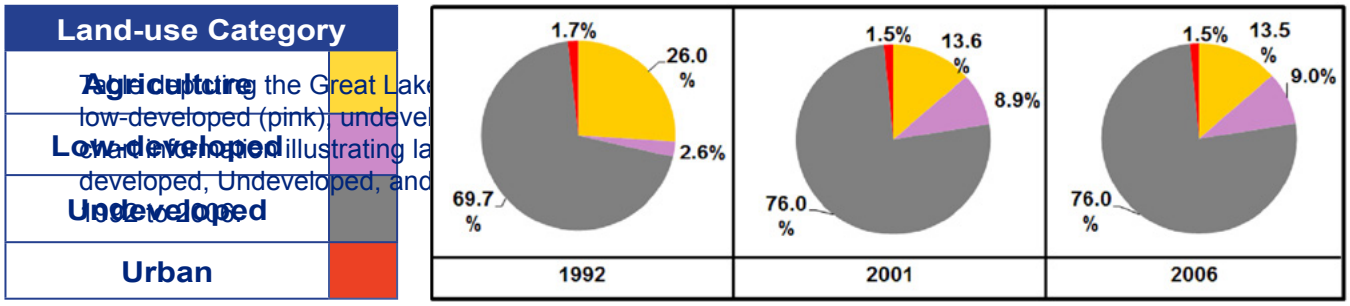

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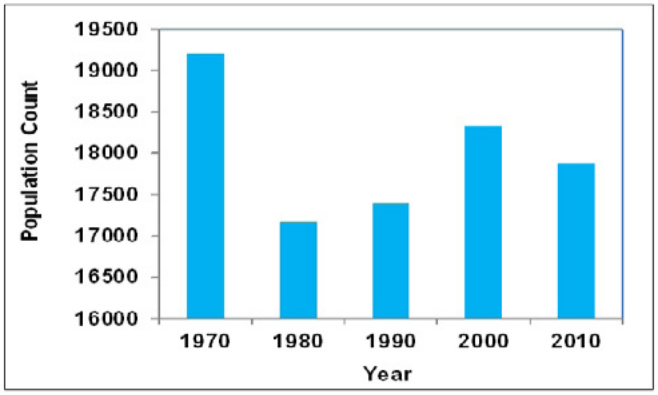

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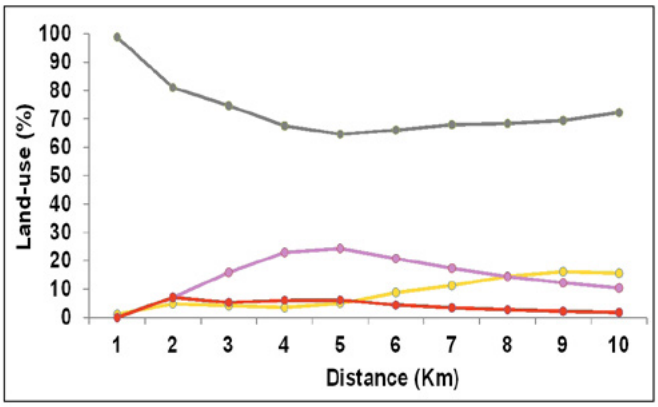

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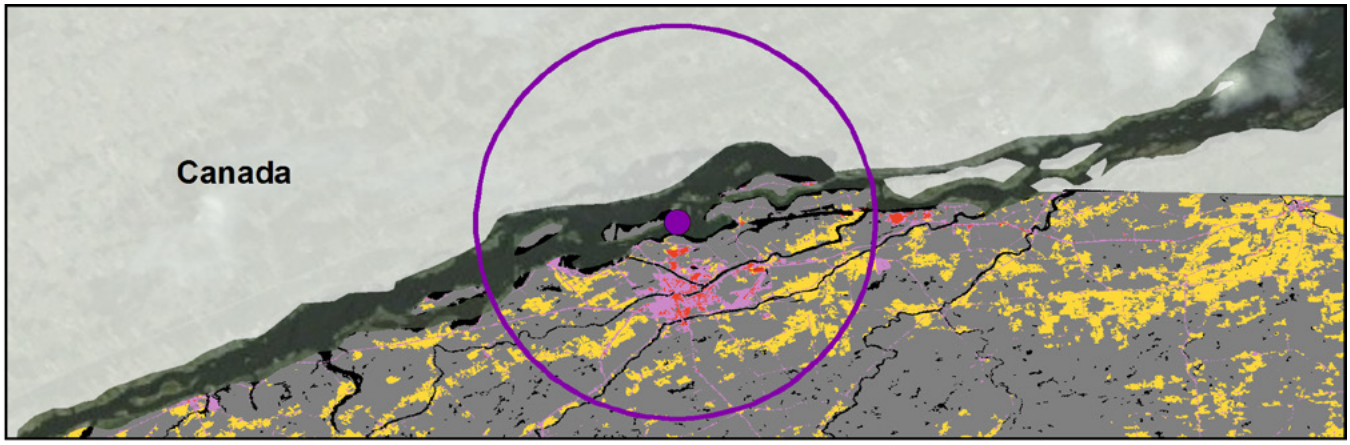

Land-use categories: MWP site (●) including 10 km buffer (○) and 2006 land-use categories from NLCD.

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