EML formatted metadata for the dataset on Dryad titled:

Soranno_MI_LULC

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Publication: Soranno, PA, KS Cheruvelil, T Wagner, KE Webster, and MT Bremigan. 2015. Effects of land use on lake nutrients: The importance of scale, hydrologic connectivity, and region. PLoSONE. https://doi.org/10.1371/journal.pone.0135454

General Metadata	
Title	**Soranno_MI_LULC.csv**
Abstract	We compiled lake water quality and land use/land cover (LULC) data on Michigan lakes. We broadly define lakes to include both lakes and reservoirs. MSU's Remote Sensing and GIS Outreach and Services (RS/GIS) staff conducted all landscape analyses that have been incorporated into this database. At RS/GIS, Justin Booth and Sarah Acmoody were the analysts creating the landscape portions of the database. Lakes were selected that had historical water quality data collected from ~ 1975-1985 by the Michigan Department of Environmental Quality. The lakes were further selected based on whether they had lake depth associated with them, lake classifications, and other metrics. All lakes that the MI-DEQ sampled only were > 20 ha and had public access.
Keywords	Lake nutrients, water quality, landscape limnology, watershed, land use
Usage Rights	This dataset is publicly available through Dryad
Funding	Michigan Department of Environmental Quality; Michigan Department of Natural Resources-Fisheries Division; USGS-Water Quality Grants Program; MSU Agricultural Experiment Station Disciplinary Research Grant
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Organization	Michigan State University
Geographic Metadata	*These are the underlying data used to create lake catchments for lakes in this dataset.*
Geographic Description	Lake and landscape data were collected for inland lakes throughout Michigan
Bounding Coordinates	Michigan, US
Lake polygons	USGS 1:24,000 NHD water bodies; and Michigan Geographic Framework lake polygons
Watershed boundaries	1:24,000 watershed boundary datasets (WBD). Subwatershed hydrologic unit boundaries created by the NRCS
Hydrography	USGS NHD flowlines, high and medium resolution (depending on availability)
Topography	USGS National Elevation Dataset (NED); 30 m raster elevation model
Land use/Land cover	Michigan Resources Information System (MIRIS) 1978 land use/land cover; Michigan Department of Natural Resources. The data were reclassified into 9 categories (see attributes below). http://www.mcgi.state.mi.us/mgdl/?rel=thext&action=thmname&cid=5&cat=Land+Cover%2FUse+MIRIS+1978
Catchment delineation	Remote Sensing and Geographic Information Systems (RS/GIS) at Michigan State University delineated catchments for each lake that, when applicable, included all upstream streams and lakes (referred to as 'network catchments'). Lake catchments were delineated to include the land that drains into upstream connected lakes and streams draining into a given 'focal' lake. We used digital elevation models (30 m resolution) and 1:24,000 stream data, where available. When high resolution stream data were not available, we used 1:100,000 resolution data. The high resolution stream data were available and used for ~68% of the lake catchment delineations. To delineate lake catchments, existing watershed boundaries for rivers were used in the initial catchment delineation step and to constrain the catchment delineation process using the 1:24,000 Watershed Boundary Dataset (WBD; http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/technical/?cid=nrcs143_021630 , USDA Natural Resources Conservation Service).

	For all lakes, we defined the catchment as land draining directly to the lake, and land draining to inflow streams for DRST and DRST-LK lakes. For drainage lakes that had inflowing streams, but no upstream lakes (DRST), the catchment included all upstream stream catchments. For drainage lakes that had inflowing streams and upstream lakes connected through stream connections (DRST-LK), the catchment only included the stream catchments up until the next upstream lake (defined as a water body > 10 ha). For DRST-LK lakes, we also calculated a network catchment, which we defined as the combined catchments of all upstream connected streams and lakes. For this class of lakes, we calculated LULC within the network catchment to represent an additional spatial extent. Based on each lake's catchment, we calculated equidistant zones around the lake that were constrained to be within the catchment boundaries. We examined a range of extents from the lake shoreline (100, 250, 500, 1000, and 1500 m). These zones are nested within each other such that the area of land within smaller zones is included in the measurement for the larger zones. For all drainage lakes (DRST and DRST-LK), we also calculated another spatial extent that we compared to the other zones, which was a single equidistant zone around the connected upstream streams within the lake's local catchment. For this zone, we chose one extent width (100 m) based on past studies on streams.
Temporal Metadata	
Temporal Description	Lakes were sampled during the summer stratification period, July to September
Begin	1978
End	1983

Methods Metadata	
General Sampling Design	**Historical STORET water quality database in MI: 1978-1983.** These data were originally obtained from an Access database from Jim Breck (MI-DNR) in ~2000 whereby he converted the database from STORET format to a more usable format. The lakes were sampled a single time from 1978 to ~1984 by the MI-DEQ. For lakes that were sampled more than once in the summer, we randomly chose one sample date; for lakes that were sampled more than once during the decade, we chose the most recent year. We chose this time period because the dates overlap with the best land use coverage available for the state based on aerial photographs (MIRIS land use/cover database for Michigan). The epilimnion of each lake was sampled on a single date during summer stratification (July, August, or September) for: alkalinity, water color, Secchi disk depth, total nitrogen, total phosphorus, chloride, and chlorophyll *a*. Note that total phosphorus data from < 1978 should be deleted due to laboratory minimum detection problems as pointed out by Howard Wandell (the lab could not detect phosphorus < 20 ug/L).
Laboratory Analysis	Standard limnological lab methods were used
Spatial Analysis	LULC were quantified within several spatial extents for each lake
Study Extent	Michigan
Quality Control	The lake nutrient data came from a state agency that followed EPA quality assurance and quality control protocols. In addition, we identified outlier water chemistry values that may have come from erroneous measurements.

Data Table Metadata	
File Name	Soranno_MI_LULC.csv
Case Sensitive	No
Number of Records	347
Orientation	The data are arranged with major variables in columns and individual lakes as rows

Attribute name	**Label**	**Definition**	**Units**	**Type**
NEW_KEY_CODE	new keycode	Lake unique identifier developed for Michigan lakes. The first two digits are the alphabetical list of counties in Michigan. The second group of numbers are from the Humphreys and Green book that is the list of lakes in each county. The MI-DNR-Fisheries Division has maintained this code.		text
Lake_Name	lake name	Lake name with spaces		text
LATITUDE	lake latitude	Lake latitude, usually of the center of the lake	degrees	numeric
LONGITUDE	lake longitude	Lake longitude, usually of the center of the lake	degrees	numeric
EDU	ecological drainage unit	The region that the lake is located in based on the Ecological Drainage Unit regionalization framework: Higgins, J. V., M. T. Bryer, M. L. Khoury, and T. W. Fitzhugh. 2005. A freshwater classification approach for biodiversity conservation planning. Conservation Biology 19:432–445. For the codes and the region names, see table below.		numeric

DR_COD2	lake class	The class of the lake used in this analysis, which is based on aggregating measures of landscape position described below in LP and described in the table below; categories are: ISOL, DRST, DRSTLK		categorical
LP	lake landscape position	Landscape position as measured by a modified version of 'lake hydrology' described in Martin et al. 2006, and shown below in a table. Martin, S.L. and P.A. Soranno. 2006. Defining lake landscape position: relationships to hydrologic connectivity and landscape features. Limnology and Oceanography. 51: 801-814.		
AVGD_M	lake depth, average	Average depth of the lake	meters	numeric
MAXD_M	lake depth, maximum	Maximum depth of the lake	meters	numeric
TP	total phosphorus	total phosphorus in a surface sample taken in the summer between 1978 and 1985	ug/L	numeric
ALK	alkalinity	alkalinity in a surface sample taken in the summer between 1978 and 1985	ug/L	numeric
SEC	secchi depth	secchi depth taken in the summer between 1978 and 1985	meters	numeric
CHLRD	chloride	chloride in a surface sample taken in the summer between 1978 and 1985	mg/L	numeric
CHLA	chlorophyll a	chlorophyll a in a surface sample taken in the summer between 1978 and 1985	ug/L	numeric
COLOR	water color, true	true water color in a surface sample taken in the summer between 1978 and 1985	Pt-Co	numeric
NITRATE	nitrate	nitrate in a surface sample taken in the summer between 1978 and 1985	ug/L	numeric
TN	total nitrogen	total nitrogen in a surface sample taken in the summer between 1978 and 1985	ug/L	numeric

LK_AREA_HA	lake area	surface area of the lake from GIS coverage obtained from the NHD dataset	ha	numeric
LCL_AREA_HA	local catchment area	the area of the local lake catchment	ha	numeric
NET_AREA_HA	network catchment area	the area of the network lake catchment, which is calculated only for lakes with upstream lakes. The value is null otherwise.	ha	numeric
UPDIST_NET	upstream connected streams in network catchment	the length of upstream connected streams to a given lake in the network catchment, which is calculated only for lakes with upstream lakes. The value is null otherwise.	km	numeric
UPDIST_LCL	upstream connected streams in local catchment	the length of upstream connected streams to a given lake in the local catchment	km	numeric
URB_A	urban_A	the percent of urban land in A (the 100m equidistant lake buffer)	%	numeric
AGR_A	agriculture_A	the percent of agriculture land in A (the 100m equidistant lake buffer)	%	numeric
FOC_A	forest, coniferous_A	the percent of coniferous forest in A (the 100m equidistant lake buffer)	%	numeric
FOD_A	forest, deciduous_A	the percent of deciduous forest in A (the 100m equidistant lake buffer)	%	numeric
FOR_A	forest, total_A	the percent of total forest in A (the 100m equidistant lake buffer)	%	numeric
WAT_A	water _A	the percent of water in A (the 100m equidistant lake buffer)	%	numeric
WEF_A	wetland, forested_A	the percent of forested wetlands in A (the 100m equidistant lake buffer)	%	numeric
WEE_A	wetland, emergent_A	the percent of emergent wetlands in A (the 100m equidistant lake buffer)	%	numeric
WET_A	wetland, total_A	the percent of total wetland in A (the 100m equidistant lake buffer)	%	numeric
URB_B	urban_B	the percent of urban land in B (the 250m equidistant lake buffer)	%	numeric

AGR_B	agriculture_B	the percent of agriculture land in B (the 250m equidistant lake buffer)	%	numeric
FOC_B	forest, coniferous_B	the percent of coniferous forest in B (the 250m equidistant lake buffer)	%	numeric
FOD_B	forest, deciduous_B	the percent of deciduous forest in B (the 250m equidistant lake buffer)	%	numeric
FOR_B	forest, total_B	the percent of total forest in B (the 250m equidistant lake buffer)	%	numeric
WAT_B	water _B	the percent of water in B (the 250m equidistant lake buffer)	%	numeric
WEF_B	wetland, forested_B	the percent of forested wetlands in B (the 250m equidistant lake buffer)	%	numeric
WEE_B	wetland, emergent_B	the percent of emergent wetlands in B (the 250m equidistant lake buffer)	%	numeric
WET_B	wetland, total_B	the percent of total wetland in B (the 250m equidistant lake buffer)	%	numeric
URB_C	urban_C	the percent of urban land in C (the 500m equidistant lake buffer)	%	numeric
AGR_C	agriculture_C	the percent of agriculture land in C (the 500m equidistant lake buffer)	%	numeric
FOC_C	forest, coniferous_C	the percent of coniferous forest in C (the 500m equidistant lake buffer)	%	numeric
FOD_C	forest, deciduous_C	the percent of deciduous forest in C (the 500m equidistant lake buffer)	%	numeric
FOR_C	forest, total_C	the percent of total forest in C (the 500m equidistant lake buffer)	%	numeric
WAT_C	water _C	the percent of water in C (the 500m equidistant lake buffer)	%	numeric
WEF_C	wetland, forested_C	the percent of forested wetlands in C (the 500m equidistant lake buffer)	%	numeric
WEE_C	wetland, emergent_C	the percent of emergent wetlands in C (the 500m equidistant lake buffer)	%	numeric
WET_C	wetland, total_C	the percent of total wetland in C (the 500m	%	numeric

		equidistant lake buffer)		
URB_D	urban_D	the percent of urban land in D (the 1000m equidistant lake buffer)	%	numeric
AGR_D	agriculture_D	the percent of agriculture land in D (the 1000m equidistant lake buffer)	%	numeric
FOC_D	forest, coniferous_D	the percent of coniferous forest in D (the 1000m equidistant lake buffer)	%	numeric
FOD_D	forest, deciduous_D	the percent of deciduous forest in D (the 1000m equidistant lake buffer)	%	numeric
FOR_D	forest, total_D	the percent of total forest in D (the 1000m equidistant lake buffer)	%	numeric
WAT_D	water _D	the percent of water in D (the 1000m equidistant lake buffer)	%	numeric
WEF_D	wetland, forested_D	the percent of forested wetlands in D (the 1000m equidistant lake buffer)	%	numeric
WEE_D	wetland, emergent_D	the percent of emergent wetlands in D (the 1000m equidistant lake buffer)	%	numeric
WET_D	wetland, total_D	the percent of total wetland in D (the 1000m equidistant lake buffer)	%	numeric
URB_E	urban_E	the percent of urban land in E (the 1500m equidistant lake buffer)	%	numeric
AGR_E	agriculture_E	the percent of agriculture land in E (the 1500m equidistant lake buffer)	%	numeric
FOC_E	forest, coniferous_E	the percent of coniferous forest in E (the 1500m equidistant lake buffer)	%	numeric
FOD_E	forest, deciduous_E	the percent of deciduous forest in E (the 1500m equidistant lake buffer)	%	numeric
FOR_E	forest, total_E	the percent of total forest in E (the 1500m equidistant lake buffer)	%	numeric
WAT_E	water _E	the percent of water in E (the 1500m equidistant lake buffer)	%	numeric
WEF_E	wetland, forested_E	the percent of forested wetlands in E (the 1500m equidistant lake buffer)	%	numeric

WEE_E	wetland, emergent_E	the percent of emergent wetlands in E (the 1500m equidistant lake buffer)	%	numeric
WET_E	wetland, total_E	the percent of total wetland in E (the 1500m equidistant lake buffer)	%	numeric
URB_F	urban_F	the percent of urban land in F (the local catchment area)	%	numeric
AGR_F	agriculture_F	the percent of agriculture land in F (the local catchment area)	%	numeric
FOC_F	forest, coniferous_F	the percent of coniferous forest in F (the local catchment area)	%	numeric
FOD_F	forest, deciduous_F	the percent of deciduous forest in F (the local catchment area)	%	numeric
FOR_F	forest, total_F	the percent of total forest in F (the local catchment area)	%	numeric
WAT_F	water _F	the percent of water in F (the local catchment area)	%	numeric
WEF_F	wetland, forested_F	the percent of forested wetlands in F (the local catchment area)	%	numeric
WEE_F	wetland, emergent_F	the percent of emergent wetlands in F (the local catchment area)	%	numeric
WET_F	wetland, total_F	the percent of total wetland in F (the local catchment area)	%	numeric
URB_G	urban_G	the percent of urban land in G (the 100m stream buffer in the local catchment area)	%	numeric
AGR_G	agriculture_G	the percent of agriculture land in G (the 100m stream buffer in the local catchment area)	%	numeric
FOC_G	forest, coniferous_G	the percent of coniferous forest in G (the 100m stream buffer in the local catchment area)	%	numeric
FOD_G	forest, deciduous_G	the percent of deciduous forest in G (the 100m stream buffer in the local catchment area)	%	numeric

FOR_G	forest, total_G	the percent of total forest in G (the 100m stream buffer in the local catchment area)	%	numeric
WAT_G	water _G	the percent of water in G (the 100m stream buffer in the local catchment area)	%	numeric
WEF_G	wetland, forested_G	the percent of forested wetlands in G (the 100m stream buffer in the local catchment area)	%	numeric
WEE_G	wetland, emergent_G	the percent of emergent wetlands in G (the 100m stream buffer in the local catchment area)	%	numeric
WET_G	wetland, total_G	the percent of total wetland in G (the 100m stream buffer in the local catchment area)	%	numeric
URB_H	urban_H	the percent of urban land in H (the network catchment)	%	numeric
AGR_H	agriculture_H	the percent of agriculture land in H (the network catchment)	%	numeric
FOC_H	forest, coniferous_H	the percent of coniferous forest in H (the network catchment)	%	numeric
FOD_H	forest, deciduous_H	the percent of deciduous forest in H (the network catchment)	%	numeric
FOR_H	forest, total_H	the percent of total forest in H (the network catchment)	%	numeric
WAT_H	water _H	the percent of water in H (the network catchment)	%	numeric
WEF_H	wetland, forested_H	the percent of forested wetlands in H (the network catchment)	%	numeric
WEE_H	wetland, emergent_H	the percent of emergent wetlands in H (the network catchment)	%	numeric
WET_H	wetland, total_H	the percent of total wetland in H (the network catchment)	%	numeric

Lake landscape position & lake classification categories and definitions

Lake Hydrology category	LP	DR_COD2	River Connections	Lake Connections
Seepage (S)	S	ISOL	none	None
Headwater (H)	H	ISOL	one or more downstream ONLY	None or downstream only
Inflow-Outflow (IO)	IO	DRST	one or more upstream AND one or more downstream	None
Inflow-Headwater (IH)	IH	DRST	one or more upstream AND one or more downstream	None or downstream only
Flow-through (F)	F	DRSTLK	one or more upstream AND one or more downstream	Upstream AND downstream
Terminal (T)	T	DRSTLK	one or more upstream and possibly downstream	Upstream only

Codes for the EDU regionalization

EDU CODE	Description
3	SLM, Southeast Lake Michigan
4	SGB, Saginaw Bay
5	NLM, Northern Lake Michigan
6	WUP, Western Upper Peninsula
7	EUP, Eastern Upper Peninsula
8	CUP, Central Upper Peninsula
16	SMP, SE Michigan interlobate and lake plain