Midwest and Great Plains Assessment Models

Data Summary

Prepared for the North Atlantic Landscape Conservation Cooperative (NALCC) Assessment Project
04-12-2013

Introduction

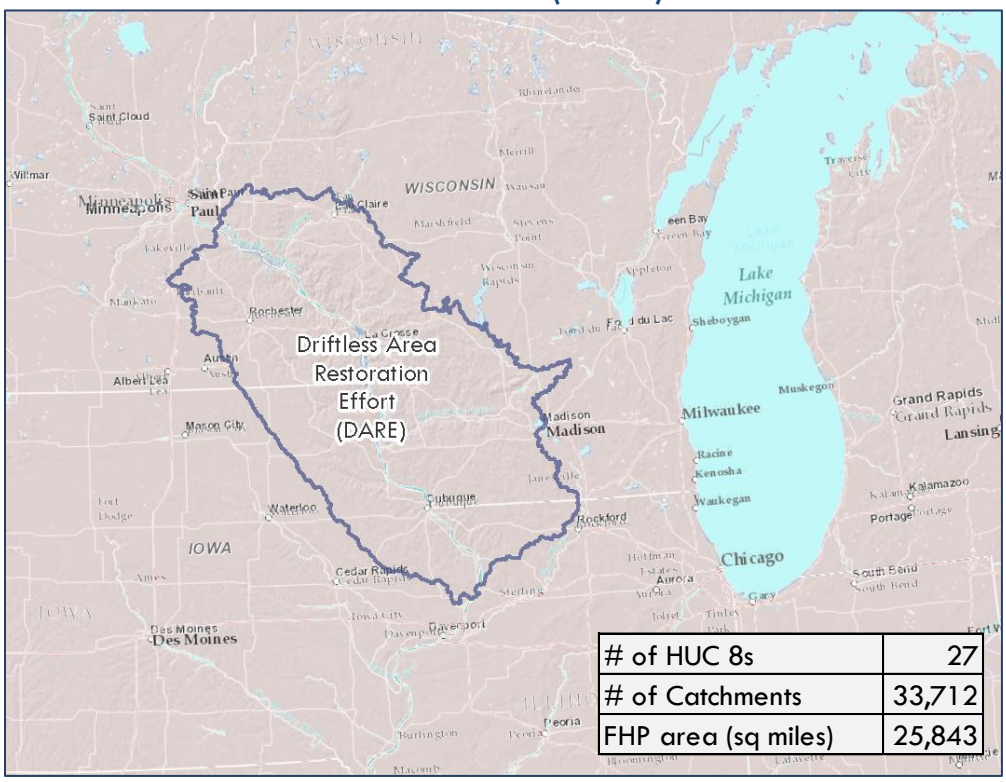
Downstream Strategies was contracted by the United States Fish & Wildlife Service (USFWS) to create a spatially explicit data analysis and modeling system for assessing fish habitat condition across the Midwest and Great Plains based on a range of metrics. The data and tools developed as part of the project will be applicable to watersheds, streams, rivers and lakes. The outcomes are utilized to conduct fish habitat condition assessments based on a range of stakeholder specified metrics and modeling endpoints that will help determine the natural drivers of aquatic conditions as well as the major stressors at various spatial scales in specific Fish Habitat Partnership (FHP) regions.

The data provided by the FHPs for use in the modeling process can be broken down into two categories: response variables and predictor variables. The response variables are typically instream measures of condition, including biological measures such as species abundance, presence, or richness, or instream physicochemical measures, such as pH, conductivity, or physical habitat measures or scores. Each FHP provided 5 to 7 individual response variables for use in the assessment. Each response variable represents a separate model and assessment. The predictor variables are typically measures of land use or land cover derived from a GIS, such as percent impervious surface area or road crossing density. Although the response variable is always measured at the same local scale (i.e., individual sample site on a stream), the predictor variables are compiled at multiple scales, including the local scale (i.e., single 1:100k NHD stream catchment), the network scale (i.e., all upstream catchments and the local catchment), or the regional scale (e.g., ecoregion). The process then employs a statistical modeling approach, called boosted regression trees (BRT), to relate the instream response variable to the landscape-based predictor variables. This process results in a series of quantitative outcomes, including predictions of expected current conditions to all catchments in the FHP (on the scale of the response), measures of the accuracy of those predictions, a quantification of each predictor variable's relative influence on the predictions (i.e., variable importance),

The BRT model output includes a list of the predictor variables used in the model ordered and scored by their relative importance. This relative importance values are based on the number of trees in which they were included in within the BRT model. The modeling ouput combined with the "post-modeling" creates indices of anthropogenic stress and natural habitat quality. These indices are derived directly from the measures of variable influence and their functional relationships with the response. Specifically, each predictor variable in the statistical model is extracted, along with its importance value and functional plot, to generate an individual "metric" for use in calculating a "cumulative" index of stress or natural quality. The individual predictors that are anthropogenic in nature (e.g., impervious surface cover) are used to generate anthropogenic stress metrics and the anthropogenic stress index, whereas predictors that are of "natural" origin (e.g., bedrock geology) are used to generate natural quality metrics and the natural quality index.

The top five anthropogenic and top five natural variables from each model for each FHP and a regional model are summarized in this brief. This summary pinpoints only those variables that were most important in structuring the responses for each model. Across all models, each variable is tabulated for the number of times it is occurs as one of the most influential (top 5 of each category). This analysis presents the relative usefulness of the most important variables in structuring regional- and fhp-scale model responses. In addition to the tables for each FHP, a master summary table shows the distributions of the variables across every model created for the Midwest, Great Plains, and the regional model.

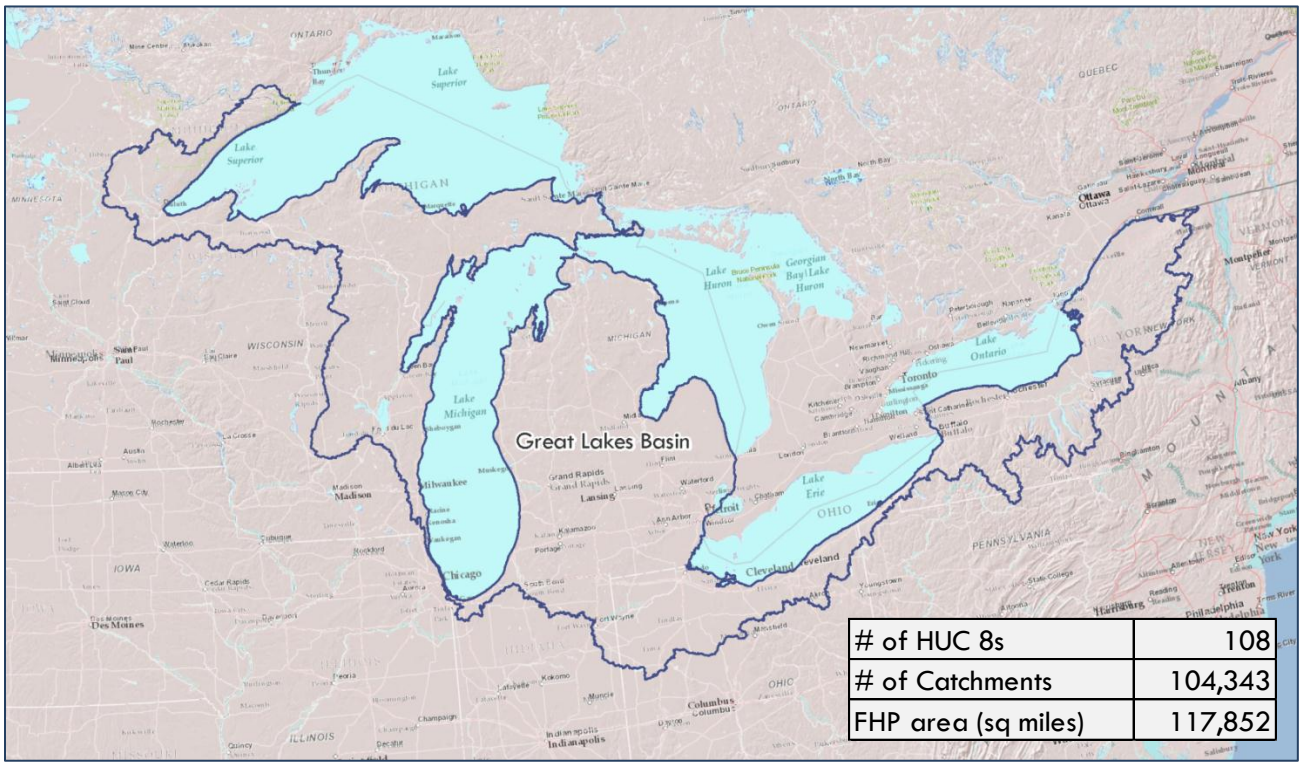
Driftless Area Restoration Effort (DARE)



# of HUC 8s	27
# of Catchments	33,712
FHP area (sq miles)	25,843

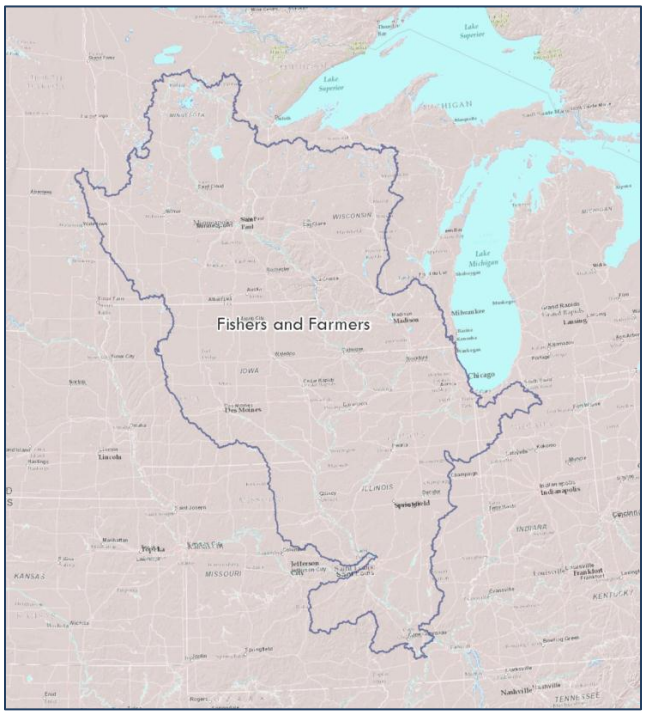
DARE	Variable	Data Source	Brook Trout	Brown Trout	Smallmouth Bass	Cottus	Longnose Dace	Total
Anthropogenic	local forest cover	NLCD 2006	X	X	X			III
	network cattle density	NFHP network_disturbance_variables.dbf	X	X	X	X	X	IIIII
	network forest cover	NLCD 2006	X	X	X		X	IIII
	network grassland cover	NLCD 2006	X	X	X	X	X	IIIII
	network impervious cover	NLCD 2001 Impervious Surface Area	X					I
	network pasture cover	NLCD 2006		X		X		II
	network percent forest cover	NLCD 2006				X		I
	network rowcrop cover	NLCD 2006				X		I
	network surface water use	NFHP network_disturbance_variables.dbf			X			I
	network wetland cover	NWI and GAP wetlands, NLCD					X	I
Natural	mean annual air temperature	NHD Plus	X	X	X	X	X	IIIII
	mean annual precipitation	NHD Plus	X	X	X	X		IIII
	minimum catchment elevation	NHD Plus			X	X	X	III
	network carbonate bedrock geology cover	USGS state geologic maps for Midwest		X		X		II
	network drainage area	NHD Plus	X	X	X		X	IIII
	network mean baseflow index	USGS	X	X		X	X	IIII
	network sandstone bedrock geology cover	USGS state geologic maps for Midwest			X			I
	slope of the catchment flowline	NHD Plus	X				X	II

Great Lakes Basin



GLB	Variable	Data Source	Brook Trout	Cold Water Species	Lithophilic Species Richness	Walleye	Large River Species	Total
Anthropogenic	local agriculture land cover	Great Lakes land cover (2001)		X				I
	local developed land cover	Great Lakes land cover (2001)			X	X		II
	local forest cover	NLCD 2006	X	X		X		III
	local groundwater use	NFHP local_disturbance_variables.dbf	X					I
	network cattle density	NFHP network_disturbance_variables.dbf	X			X	X	III
	network density of dams	NFHP network_disturbance_variables.dbf	X		X		X	III
	network groundwater use	NFHP network_disturbance_variables.dbf		X	X		X	III
	network mine density	NFHP local_disturbance_variables.dbf				X	X	II
	network surface water use	NFHP network_disturbance_variables.dbf		X	X			II
	network wetland cover	NWI and GAP wetlands, NLCD	X	X	X	X	X	IIIII
Natural	mean annual air temperature	NHD Plus	X	X	X		X	IIII
	mean annual precipitation	NHD Plus		X		X		II
	minimum catchment elevation	NHD Plus	X	X	X		X	IIII
	modeled stream temperature	GLB FHP	X	X	X	X	X	IIIII
	network drainage area	NHD Plus			X	X	X	III
	network high infiltration soil group	NRCS STATSGO	X		X	X		III
	network very slow infiltration soil group	NRCS STATSGO		X				I
	slope of the catchment flowline	NHD Plus	X			X		II

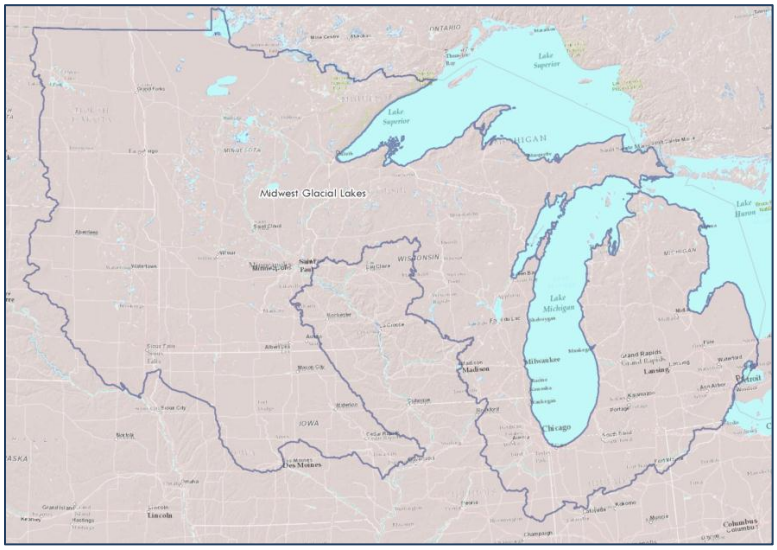
Fishers and Farmers



# of HUC 8s	140
# of Catchments	180,823
FHP area (sq miles)	189,913

Fishers and Farmers	Variable	Data Source	Blacknose Shiner	Golden Shiner	Smallmouth Bass	Brook Silverside	Species Richness	Total
Anthropogenic	local road crossing density	NFHP local_disturbance_variables.dbf				X		I
	network cattle density	NFHP network_disturbance_variables.dbf			X	X	X	III
	network density of road crossings	NFHP network_disturbance_variables.dbf	X			X		II
	network grassland cover	NLCD 2006					X	I
	network groundwater use	NFHP network_disturbance_variables.dbf	X	X			X	III
	network impervious cover	NLCD 2001 Impervious Surface Area	X	X				II
	network percent grassland cover	NLCD 2006				X		I
	network percent pasture cover	NLCD 2006			X			I
	network percent rowcrop cover	NLCD 2006		X	X		X	III
	network percent wetland	NLCD 2006	X	X	X	X		IIII
	network surface water use	NFHP network_disturbance_variables.dbf	X					I
	percentage stream corridor agriculture	Fishers Farmers FHP		X	X		X	III
Natural	Level III Ecoregion	USEPA	X	X	X	X	X	IIIII
	local recharge rate	USGS					X	I
	local soil erodibility	NRCS STATSGO	X	X	X	X		IIII
	mean annual air temperature	NHD Plus	X	X	X	X	X	IIIII
	network drainage area	NHD Plus		X	X	X	X	IIII
	network recharge rate	USGS	X	X	X			III
	network soil erodibility	NRCS STATSGO	X			X		II
	slope of the catchment flowline	NHD Plus					X	I

Midwest Glacial Lakes



# of HUC 8s	210
# of Lakesheds	72,903
FHP area (sq miles)	270,566

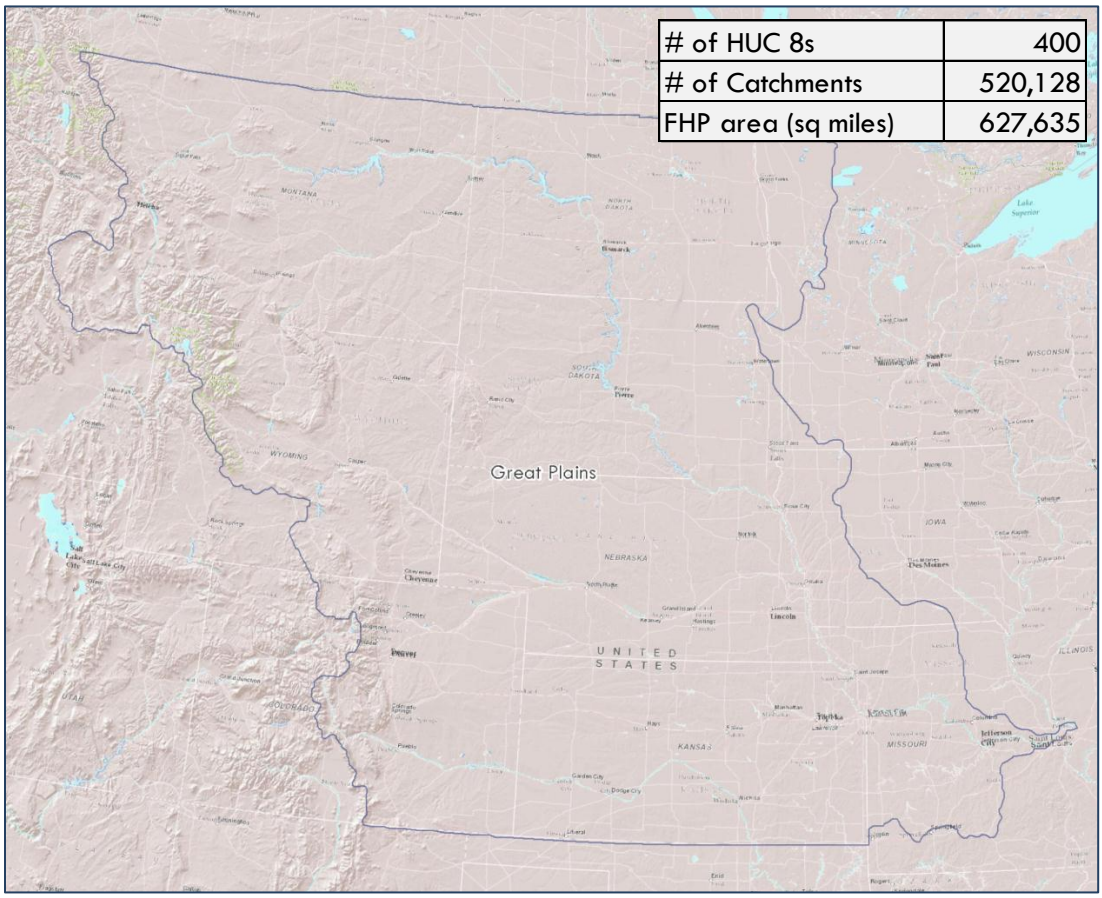
MGLP	Variable	Data Source	Coldwater Index	Northern Pike	Walleye	Bluegill	Water Quality	Total
Anthropogenic	lakeshed mean sulfate deposition rate	NADP		X	X	X	X	IIII
	lakeshed percentage of "fair" land stewardship	GAP Analysis Project	X					I
	lakeshed average population density change	Census, some data provided by MGLP	X	X	X	X	X	IIIII
	lakeshed percentage of "good" land stewardship	GAP Analysis Project				X		I
	lakeshed percentage of "best" land stewardship	GAP Analysis Project	X	X				II
	local percentage of developed land cover	NLCD 2001	X					I
	network percent developed	NLCD 2006				X	X	II
	network percent grassland cover	NLCD 2006			X			I
	network percent pasture cover	NLCD 2006		X	X		X	III
	network percent rowcrop cover	NLCD 2006					X	I
	network percent wetland	NLCD 2006	X		X	X		III
	network wetland cover	NWI and GAP wetlands, NLCD		X				I
Natural	average slope of local catchment	MGLP FHP	X			X	X	III
	lake shoreline development index	Hydrostats table provided by MGLP			X			I
	lakeshed percentage of soil hydrologic group 4	NRCS STATSGO		X				I
	lakeshed mean soil available water capacity	NRCS STATSGO		X			X	II
	lakeshed mean sulfate deposition rate	NADP			X			I
	local average July temperature	PRISM				X	X	II
	Log10 transformation of lake area	GIS computation (DS)	X			X		II
	Log10 transformation of lake area in acres	GIS computation (DS)	X	X	X		X	IIII
	mean annual precipitation	NHD Plus	X	X	X	X		IIII
	network mean baseflow index	USGS	X	X	X	X	X	IIIII

Ohio River Basin and Southeast Aquatic Resource Partnership

# of HUC 8s	152
# of Catchments	226,923
FHP area (sq miles)	203,828

ORB/SARP	Variable	Data Source	Small Streams Signature Fish Index	Modified Index of Centers of Diversity	Smallmouth Bass	Redhorse	Percent Intolerant Fish	Great Rivers Species	Intolerant Mussels	Total
Anthropogenic	local groundwater use	NFHP local_disturbance_variables.dbf			X					I
	local impervious surface cover	NLCD 2006						X	X	II
	local riparian disturbance	NLCD (provided by SARP staff)						X		I
	network cattle density	NFHP network_disturbance_variables.dbf	X	X	X	X	X			IIIII
	network density of dams	NFHP network_disturbance_variables.dbf			X	X			X	III
	network density of road crossings	NFHP network_disturbance_variables.dbf				X			X	II
	network density of Superfund sites	NFHP network_disturbance_variables.dbf				X		X		II
	network forest cover	NLCD 2006			X		X		X	III
	network impervious cover	NLCD 2001 Impervious Surface Area	X	X			X			III
	network pasture cover	NLCD 2006	X	X			X	X		IIII
	network riparian disturbance	NLCD (provided by SARP staff)	X							I
	network rowcrop cover	NLCD 2006		X						I
	network surface water use	NFHP network_disturbance_variables.dbf			X	X	X	X	X	IIIII
	network wetland cover	NWI and GAP wetlands, NLCD	X	X	X	X				IIII
Natural	Level III Ecoregion	USEPA	X	X	X	X	X			IIIII
	mean annual air temperature	NHD Plus	X	X	X	X		X		IIIII
	mean annual precipitation	NHD Plus					X		X	II
	minimum catchment elevation	NHD Plus			X	X		X		III
	network alluvium cover	USGS surficial geology of the US							X	I
	network carbonate bedrock geology co	USGS state geologic maps for Midwest						X		I
	network drainage area	NHD Plus	X	X	X	X	X	X	X	IIIIIII
	network mean baseflow index	USGS	X	X			X		X	IIII
	network moderate infiltration soil group	NRCS STATSGO						X		I
	network slow infiltration soil group	NRCS STATSGO	X							I
	network shale bedrock	USGS state geologic maps for Great Plains							X	I
	slope of the catchment flowline	NHD Plus		X			X			II

Great Plains



# of HUC 8s	400
# of Catchments	520,128
FHP area (sq miles)	627,635

GP	Variable	Data Source	Darter Guild	Madtom Guild	Northern Headwaters Guild	Southern Headwaters Guild	Turbid River Guild	Total
Anthropogenic	local forest cover	NLCD 2006		X	X	X		III
	local groundwater use	NFHP local_disturbance_variables.dbf	X					I
	network cattle density	NFHP network_disturbance_variables.dbf	X	X	X	X	X	IIIII
	network groundwater use	NFHP network_disturbance_variables.dbf					X	I
	network percent pasture cover	NLCD 2006	X					I
	network percent rowcrop cover	NLCD 2006	X					I
	network rowcrop cover	NLCD 2006		X	X	X	X	IIII
	network scrub cover	NLCD 2006					X	I
	network surface water use	NFHP network_disturbance_variables.dbf	X	X	X	X		IIII
Natural	mean annual air temperature	NHD Plus	X	X	X	X		IIII
	mean annual precipitation	NHD Plus	X			X	X	III
	network drainage area	NHD Plus	X	X	X	X	X	IIIII
	network high infiltration soil group	NRCS STATSGO		X	X			II
	network mean baseflow index	USGS		X	X	X	X	IIII
	network moderate infiltration soil group	NRCS STATSGO	X					I
	network slow infiltration soil group	NRCS STATSGO				X		I
	network very slow infiltration soil group	NRCS STATSGO					X	I
	network shale bedrock	USGS state geologic maps for Great Plains		X	X		X	III
	network sand/shale - clastic bedrock surficial	USGS state geologic maps for Great Plains					X	I
	slope of the catchment flowline	NHD Plus	X	X	X	X		IIII

Regional Assessment

Map

# of HUC 8s	n/a
# of Catchments	641,615
FHP area (sq miles)	663,586

Regional Assessment	Variable	Data Source	Coldwater	Coolwater	Warmwater	Total
Anthropogenic	catchment road density	NFHP local_disturbance_variables.dbf		X		I
	network groundwater use	NFHP network_disturbance_variables.dbf	X			I
	network impervious cover	NLCD 2001 Impervious Surface Area	X	X	X	III
	network percent agriculture	NLCD 2006	X	X	X	III
	network surface water use	NFHP network_disturbance_variables.dbf	X			I
	network TRI density	NFHP network_disturbance_variables.dbf		X	X	II
Natural	catchment percent wetland	NWI and GAP wetlands, NLCD		X		I
	mean annual air temperature	NHD Plus	X	X	X	III
	mean annual precipitation	NHD Plus	X			I
	minimum catchment elevation	NHD Plus	X	X	X	III
	network drainage area	NHD Plus		X	X	II
	network mean baseflow index	USGS	X			I
	network recharge rate	USGS			X	I
	network percent shrub/scrub	NLCD 2006			X	I
	slope of the catchment flowline	NHD Plus	X	X		II

Summary Table

Summary	Variable	Data Source	DARE	FF	ORB/SARP	GLB	MGLP	GP	Regional Assessment	Total
Anthropogenic	catchment road density	NFHP local_disturbance_variables.dbf							X	I
	lakeshed mean sulfate deposition rate	NADP					X			IIII
	lakeshed percentage of "fair" land stewardship	GAP Analysis Project					X			I
	lakeshed average population density change	Census, some data provided by MGLP					X			IIIII
	lakeshed percentage of "good" land stewardship	GAP Analysis Project					X			I
	lakeshed percentage of "best" land stewardship	GAP Analysis Project					X			II
	local agriculture land cover	Great Lakes land cover (2001)				X				I
	local developed land cover	Great Lakes land cover (2001)				X				II
	local percentage of developed land cover	NLCD 2001					X			I
	local forest cover	NLCD 2006	X			X		X		IIIIIIII
	local groundwater use	NFHP local_disturbance_variables.dbf			X	X		X		III
	local impervious surface cover	NLCD 2006			X					II
	local road crossing density	NFHP local_disturbance_variables.dbf		X						I
	local riparian disturbance	NLCD (provided by SARP staff)			X					I
	local wetland cover	NWI and GAP wetlands	X							I
	network cattle density	NFHP network_disturbance_variables.dbf	X	X	X	X		X		IIIIIIIIIIIIIIIIIII
	network density of dams	NFHP network_disturbance_variables.dbf			X	X				IIIIII
	network density of road crossings	NFHP network_disturbance_variables.dbf		X	X					IIII
	network density of Superfund sites	NFHP network_disturbance_variables.dbf			X					II
	network forest cover	NLCD 2006	X		X					IIIIIII
	network grassland cover	NLCD 2006	X	X						IIIIII
	network groundwater use	NFHP network_disturbance_variables.dbf		X		X		X	X	IIIIIIII
	network impervious cover	NLCD 2001 Impervious Surface Area	X	X	X				X	IIIIIIII
	network mine density	NFHP local_disturbance_variables.dbf				X				II
	network pasture cover	NLCD 2006	X		X					IIIIII
	network percent agriculture	NLCD 2006							X	III
	network percent developed	NLCD 2006					X			II
	network percent forest cover	NLCD 2006	X							I
	network percent grassland cover	NLCD 2006		X			X			II
	network percent pasture cover	NLCD 2006		X			X	X		IIIII
	network percent rowcrop cover	NLCD 2006		X			X	X		IIIII
	network percent wetland	NLCD 2006		X			X			IIIIIII
	network riparian disturbance	NLCD (provided by SARP staff)			X					I
	network rowcrop cover	NLCD 2006	X		X			X		IIIIII
	network scrub cover	NLCD 2006						X		I
	network surface water use	NFHP network_disturbance_variables.dbf	X	X	X	X		X	X	IIIIIIIIIIIII
	network TRI density	NFHP network_disturbance_variables.dbf							X	II
	network wetland cover	NWI and GAP wetlands, NLCD	X		X	X	X			IIIIIIIIII
	percentage stream corridor agriculture	Fishers Farmers FHP		X						III
Biophysical	average slope of local catchment	MGLP FHP					X			III
	catchment percent wetland	NWI and GAP wetlands, NLCD							X	I
	lake shoreline development index	Hydrostats table provided by MGLP					X			I
	lakeshed percentage of soil hydrologic group 4	NRCS STATSGO					X			I
	lakeshed mean soil available water capacity	NRCS STATSGO					X			II
	lakeshed mean sulfate deposition rate	NADP					X			I
	Level III Ecoregion	USEPA		X	X					IIIIIIIII
	local average July temperature	PRISM					X			II
	local recharge rate	USGS		X						I
	local soil erodibility	NRCS STATSGO		X						IIII
	Log10 transformation of lake area	GIS computation (DS)					X			II
	Log10 transformation of lake area in acres	GIS computation (DS)					X			IIII
	mean annual air temperature	NHD Plus	X	X	X	X		X	X	IIIIIIIIIIIIIIIIIIIIIIII
	mean annual precipitation	NHD Plus	X		X	X	X	X	X	IIIIIIIIIIIIIII
	minimum catchment elevation	NHD Plus	X		X	X			X	IIIIIIIIIII
	modeled stream temperature	GLB FHP				X				IIIII
	network alluvium cover	USGS surficial geology of the US			X					I
	network carbonate bedrock geology cover	USGS state geologic maps for Midwest	X		X					III
	network drainage area	NHD Plus	X	X	X	X		X	X	IIIIIIIIIIIIIIIIIIIIIII
	network high infiltration soil group	NRCS STATSGO				X		X		IIIII
	network mean baseflow index	USGS	X		X		X	X	X	IIIIIIIIIIIIIII
	network moderate infiltration soil group	NRCS STATSGO			X			X		II
	network slow infiltration soil group	NRCS STATSGO			X			X		II
	network very slow infiltration soil group	NRCS STATSGO				X		X		II
	network recharge rate	USGS		X					X	IIII
	network sandstone bedrock geology cover	USGS state geologic maps for Midwest	X							I
	network shale bedrock	USGS state geologic maps for Great Plains			X			X		IIII
	network sand/shale - clastic bedrock surficial	USGS state geologic maps for Great Plains						X		I
	network percent shrub/scrub	NLCD 2006							X	I
	network soil erodibility	NRCS STATSGO		X						II
	slope of the catchment flowline	NHD Plus	X	X	X	X		X	X	IIIIIIIIIII