Summary Report:
Recovery Potential Screening of Kansas Watersheds
in Support of Nutrient Management

INTRODUCTION

The US Environmental Protection Agency's (EPA's) Total Maximum Daily Loads (TMDL) Program, in cooperation with state water quality programs, released a long-term TMDL Vision document in December 2013. Part of the TMDL Vision involves increasing states' identification of priority watersheds for restoration and protection efforts over a several-year time frame, and better linkage of TMDLs to these priorities. Previously, a 2011 Office of Water policy memorandum on nutrients had also recommended systematic watershed analysis, comparison and priority setting to obtain better results.

EPA's TMDL program has provided watershed data, comparative assessment tools and state technical assistance for the past ten years through the Recovery Potential Screening (RPS) approach and tools (see Attachment 1). In support of state requests for assistance in nutrient-related prioritization, the TMDL program has partnered with several states, including Kansas, to jointly carry out RPS assessments and develop results to help states consider their watershed nutrient management options systematically with consistent data. These RPS assessments were designed to address primary nutrient-related issues identified by each state using state-specific indicators and data relevant for watershed comparison. This report summarizes the approach and findings of the Kansas project completed from 2015 to 2017, and identifies multiple additional products (e.g., RPS Tools and data files) that were developed along with this overview document.

Background

Recovery Potential Screening (RPS) is a systematic, comparative method for identifying differences among watersheds that may influence their relative likelihood to be successfully restored or protected. The RPS approach involves identifying a group of watersheds to be compared and a specific purpose for comparison, selecting appropriate indicators in three categories (Ecological, Stressor, Social), calculating index values for the watersheds, and applying the results in strategic planning and prioritization. EPA developed RPS to provide state water programs and other planners with a systematic, user-customizable, flexible tool that could help them compare watershed differences in terms of key environmental and social factors affecting prospects for prioritization and restoration success in a designated geographic area of interest. The RPS Tool is a custom-coded Excel spreadsheet that performs all RPS calculations and generates RPS outputs (rank-ordered index tables, graphs and maps). It was developed in 2010 to help users calculate Ecological, Stressor, Social, and Recovery Potential Integrated index scores for comparing up to thousands of watersheds in a desktop environment using widely available and familiar software. EPA's RPS Tools are embedded with indicator data and available for all states and territories.

Kansas Department of Health and Environment (KDHE) requested assistance from EPA in 2014 to further the State's efforts in prioritizing watersheds for nutrient TMDL development and nonpoint source watershed planning. An RPS assessment project has been jointly undertaken by EPA's TMDL program, Tetra Tech (EPA contractor), and KDHE. Forty-six (HUC8) and 241 (HUC12) base, ecological, stressor, and social indicators were measured from national and state data sources and compiled in a Kansas statewide RPS tool (Excel file). The assessment findings and most figures in this document are generated by the Kansas RPS Tool.

APPROACH

As a starting point, each state RPS nutrient project was designed to apply recommendations from the EPA Office of Water 2011 nutrient policy memorandum, which reads in part:

> *Prioritize watersheds on a statewide basis for nitrogen and phosphorus loading reductions*
>
> *A. Use best available information to estimate Nitrogen (N) and Phosphorus (P) loadings delivered to rivers, streams, lakes, reservoirs, etc. in all major watersheds across the state on a Hydrologic Unit Code (HUC) 8 watershed scale or smaller watershed (or a comparable basis.)*
>
> *B. Identify major watersheds that individually or collectively account for a substantial portion of loads (e .g. 80 percent) delivered from urban and/or agriculture sources to waters in a state or directly delivered to multi-jurisdictional waters.*
>
> *C. Within each major watershed that has been identified as accounting for the substantial portion of the load, identify targeted/priority sub-watersheds on a HUC 12 or similar scale to implement targeted N and P load reduction activities. Prioritization of sub-watersheds should reflect an evaluation of receiving water problems, public and private drinking water supply impacts, N and P loadings, opportunity to address high-risk N and P problems, or other related factors.*

The two-stage approach implicit in the text above fits well with the RPS Tool, which easily supports comparing HUC8s in an initial targeting stage and then focuses on screening and comparing HUC12s in a second, implementation-oriented stage, as illustrated in Figure 1. All of the RPS nutrient projects utilize the same general two stage approach (HUC8 or similar larger-scale unit in Stage 1, HUC12 in Stage2), while encouraging state-specific customization of the approach in identifying stage 1 Scenarios, establishing state approaches for priority watershed identification, and selection and weighting of the most nutrient-relevant indicators for use in both stages. In this project, the data sources and indicators compiled in the RPS tool, the selections of indicators, choice of demonstration watersheds, and weighting of indicators in the nutrient-related screening runs all took place collaboratively among KDHE, EPA and its contractor. Nevertheless, this technical project's findings and outputs are not meant to represent decisions or policies of KDHE, EPA, or any other entity.

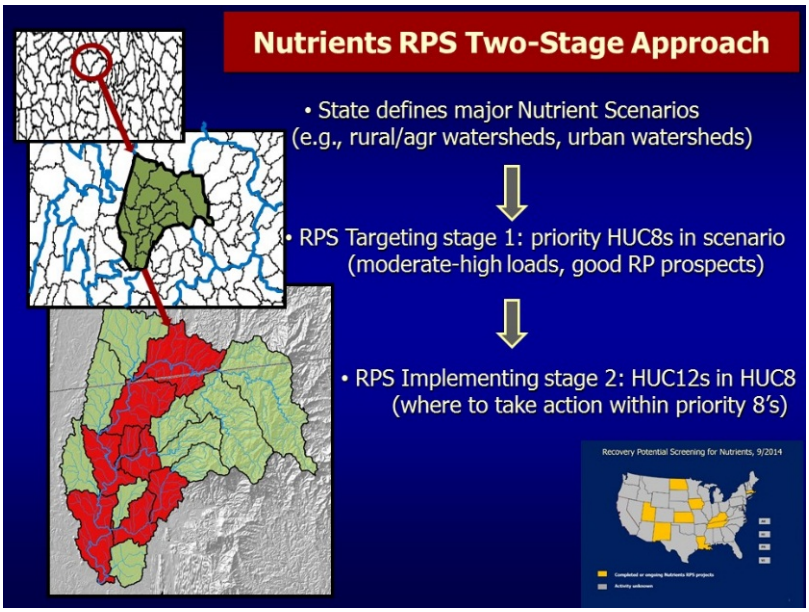


Figure 1. Two-stage conceptual approach utilized in RPS projects for supporting state nutrient management

Stage 1 Methodology: Defining and Analyzing Nutrient Scenarios

The RPS Tool is most effective in comparing groups of watersheds that have something in common, such as generally similar landscapes, nutrient sources, impacts and possible management options; for this reason, Stage 1 begins by engaging the state in defining specific types or groups of watersheds with something in common regarding their primary nutrient management challenges. The term "Scenario" is used here to describe these sets of shared characteristics that provide a basis for groups of similar watersheds to be compared and contrasted with one another effectively. Nutrient management challenges in any given state can be complex and involve multiple Scenarios. Breaking down a large group of watersheds statewide into smaller, more similar groups and focusing on Scenarios most relevant to each group enables a narrower focus on nutrient issues and possible solutions.

For Kansas, three Stage 1 Scenarios of interest were initially selected during a series of conference calls between EPA, KDHE, and Tetra Tech:

- **Scenario 1 – Nutrient TMDLs --** Watersheds where nutrients directly impact public water supplies or downstream waters for nutrient TMDL development
- **Scenario 2 – Nonpoint Sources --** Watersheds with opportunities to significantly reduce nonpoint source nutrient loads
- **Scenario 3 – Point Sources --** Watersheds for nutrient TMDL development and restoration that are significantly influenced by NPDES permitted dischargers

Each of these Scenarios are assessed in Stage 1 at a HUC8 watershed scale (Figure 2); continued evaluation occurs in Stage 2 at the smaller, HUC12 subwatershed scale within selected individual HUC8s.

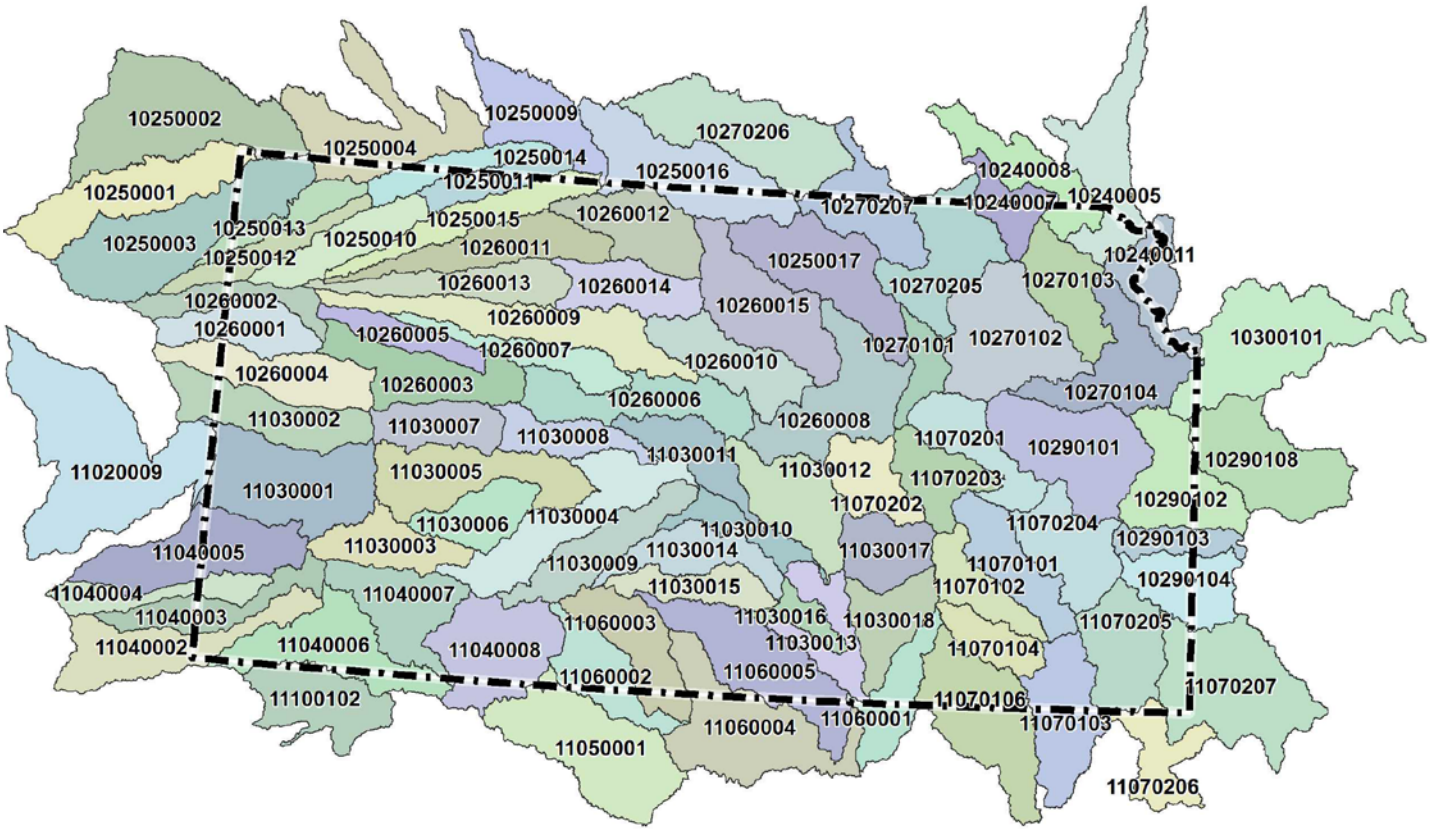


Figure 2. Kansas HUC8 watersheds

Selection of Stage 1 Indicators

Watersheds within each Scenario are compared to one another with Scenario-specific indicator selections since each Scenario differs in nutrient source types and exposure pathways. Indicators for Stage 1 need only to be sufficient for generally comparing watersheds across the state, identifying which watersheds to include in each Scenario, and revealing major differences in condition and estimated nutrient loading magnitude. Using the RPS Tool, Scenario-specific selections of recovery potential indicators are used to compare Kansas HUC8 watersheds within each Scenario.

Interpreting the Stage 1 Screening Results

Several products are produced by the RPS Tool through the screening runs for each Scenario. Each watershed in a Scenario screening run receives an Ecological, Stressor, and Social index score and rank. There is also an aggregate Recovery Potential Integrated (RPI) score and rank for each watershed. Ecological, stressor, and social index values have a range from 0 to 100. They are each calculated by summing weight-adjusted, normalized indicator values, dividing by the total weight, and multiplying by 100. RPI Scores are calculated as: [Ecological Index + Social Index + (100 - Stressor Index)] / 3, and also range from 0 to 100. All four indices are equally important primary products of RPS screening, and

the RPI score as an integrated score should not detract from use of the other three indices when they each provide unique insights on watershed comparisons.

Among the Ecological, Social and RPI index values, a higher score implies a watershed may be better suited for restoration. A higher Stressor Index score means higher stressors and thus implies lower relative recovery potential. In the case of rank order, all four indices (ecological, stressor, social and RPI) are rank ordered so that #1 is always the 'best' rank (i.e., best-suited for recovery).

Although screening data can be exported to GIS for more complex map development, simple maps illustrating the watersheds in the screening run are also generated within the RPS Tool. These maps can be customized to display a range of values as color gradients for the watersheds based on any single index or indicator.

Bubble plots are also produced for each screening run. At a glance, these provide a visual tool for comparing the relative values of ecological, stressor and social indices across all watersheds in the screening run. Individual watersheds can be labeled or color coded by any single indicator or index for specific display purposes. The bubble plots position watersheds relative to axes representing the median stressor and ecological scores for every screening run. These axes split the plots into four quadrants. For example, watersheds in the upper left quadrant have high ecological scores and low stressor scores. The size of the symbol indicates the social score.

The scores of any watershed in a screening run provide relative information for supporting the discussion on recovery potential and nutrient management strategies and alternatives. Whereas screening results make no claim of predicting the actual recovery potential or protection outlook for a watershed (e.g., a restorable/unrestorable threshold), considering watersheds' relative scores may help guide restoration decisions or actions by revealing either better candidates for recovery, or watersheds that would require much more effort than others. The most common approach to applying RPS results in Stage 1 is to focus on those watersheds that have moderate to high pollutant loading or other impact, but still score well on ecological or social indexes related to better recovery prospects.

STAGE 1 ANALYSIS AND RESULTS

Although the three Scenarios represent distinctly different settings of how nutrient issues affect Kansas watersheds, the Scenarios are not mutually exclusive. An individual watershed may in fact be included in all three Scenarios if it has the appropriate qualifying characteristics. In such a case, that watershed may be part of multiple strategic planning approaches tailored to each Scenario's traits and needs. Many of Kansas' 90 HUC8s are included in more than one of the three Scenarios. Scenario 1 includes 71 HUC8s and Scenario 3 includes 57 of the State's 90 HUC8s. Scenario 2 includes every HUC8 in the state. In all Scenarios, different sets of indicators specific to the Scenario, its nutrient sources and impacts are used in the screenings, and small numbers of high-scoring HUC8s per Scenario are identified from the analysis.

Scenario 1 – Nutrient TMDLs -- Watersheds where nutrients may directly impact public water supplies or downstream waters for nutrient TMDL development

Watersheds in this Scenario either have nutrient impairments and/or have a public drinking water supply that is potentially impacted by nutrients. KDHE has indicated that generally the State's nutrient impairments are primarily driven by phosphorus loading, therefore stressors in these watersheds include wastewater discharges, population, and phosphorus yield. Watersheds with nutrient impairments or potential public water supply effects include 71 of 90 HUC8 watersheds in the state.

Scenario 1-specific indicators are provided in Table 11; Attachment 2 includes indicator descriptions. Ecological indicators focus on watershed and stream assimilative capacity measured as flow and biotic integrity. Stressor indicators primarily represent nutrient sources. Social indicators focus on watersheds that serve as public water supplies and consider the distance to the state boundary. A copy of the RPS Tool populated with this Scenario's screening results is among project deliverables, and the primary findings are summarized below.

*Table 1. Stage 1 RPS indicator selections and weights (wt) for screening and comparing HUC8 watersheds for Scenario 1. See Attachment 2 for indicator definitions. Those indicators with a * are derived from state-specific datasets.*

Ecological Indicators	**wt**	**Stressor Indicators**	**wt**	**Social Indicators**	**wt**
% natural cover in watershed (N-Index2)	1	% agriculture (2006) in watershed	1	Nutrient TMDL count	1
% natural cover in hydrologically connected zone (N-Index2)	1	% urban (2006) in watershed	1	Distance to outlet of the state inverse*	1
National Fish Habitat Partnership Habitat Condition Index	1	% population growth in watershed (2000-2010)*	1	Total public drinking water system (PWS) project score*	1
Flow (cfs) generated in watershed*	1	Phosphorus yield (SPARROW incremental)	1	Critical watershed class score*	1
IBI Indicator (weighted average IBI score)*	1	Median TP concentration for streams in watershed*	1		
		% watershed streamlength 303d-listed nutrients	1		
		% watershed waterbody area 303d-listed nutrients	1		

Recovery Potential Integrated (RPI) scores for Scenario 1 are displayed in map form in Figure 3, showing the relative geographic distribution of the Scenario. Higher ranking watersheds are found in the southern and eastern parts of the state; the highest ranking watersheds include Neosho Headwaters (11070201), Kaw Lake (11060001), and Fall (11070102). These and other high ranking watersheds also correspond with the Flint Hills ecoregion (Figure 4), which notably contains the largest remaining intact tallgrass prairie in the Great Plains:

- Lower Walnut River (11030018)
- Kaw Lake (11060001)
- Upper Verdigris (11070101)
- Fall (11070102)
- Elk (11070104)
- Caney (11070106)
- Neosho Headwaters (11070201)
- Lower Cottonwood (11070203)

Although these areas are ecologically higher-scoring, there are also nutrient impairments in all of the watersheds with the exception of Upper Verdigris and Fall (Figure *5*), although both of these watersheds are part of a public drinking water system project area.

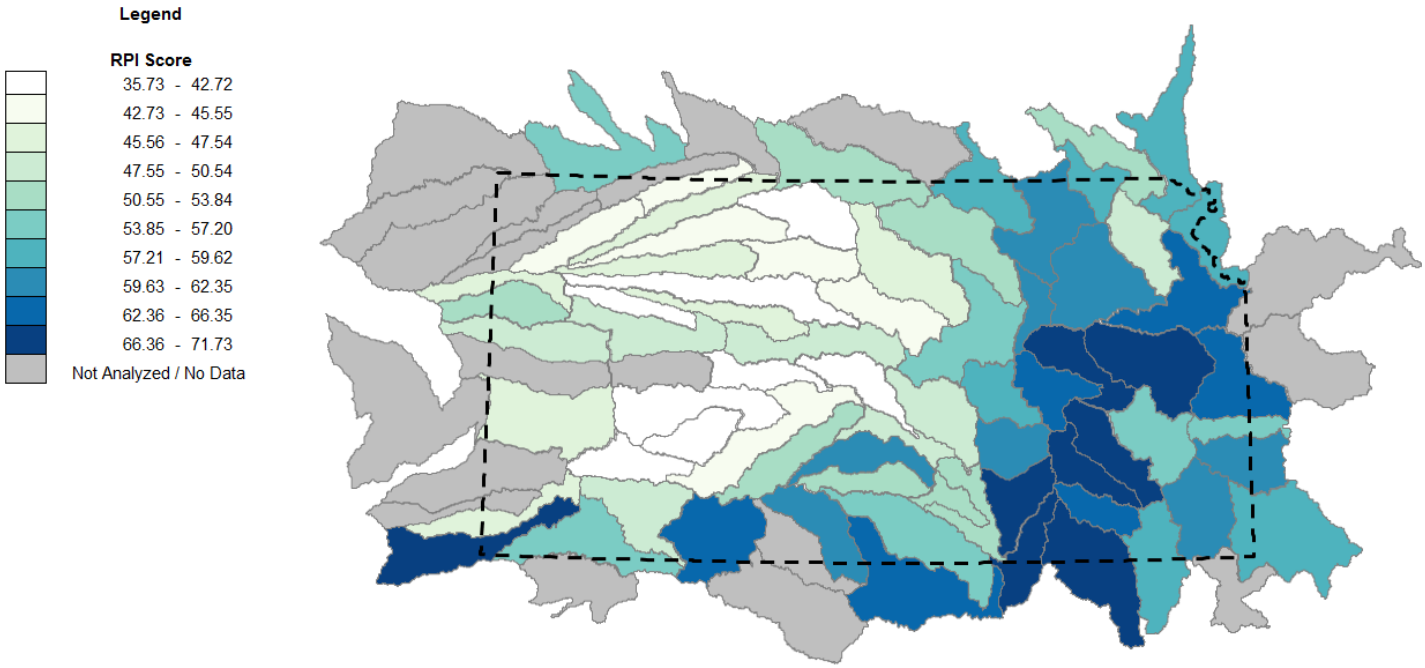


Figure 3. Scenario 1 watershed ranking by RPI score (darker blue implies better for restoration)

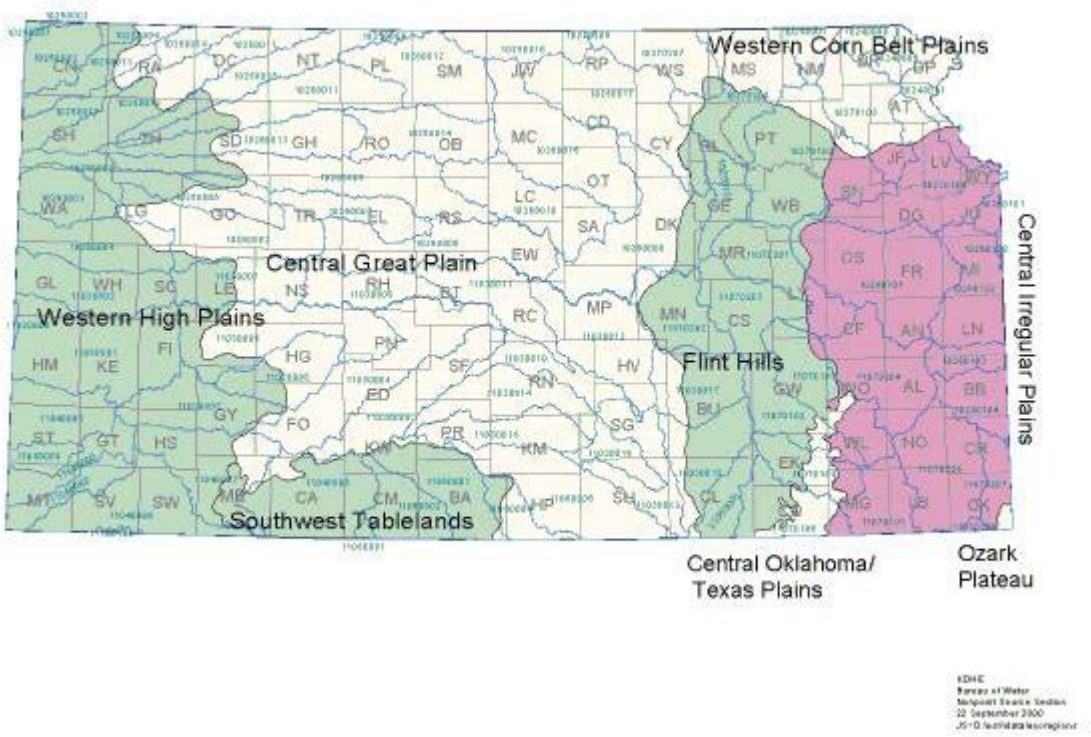


Figure 4. Kansas ecoregions

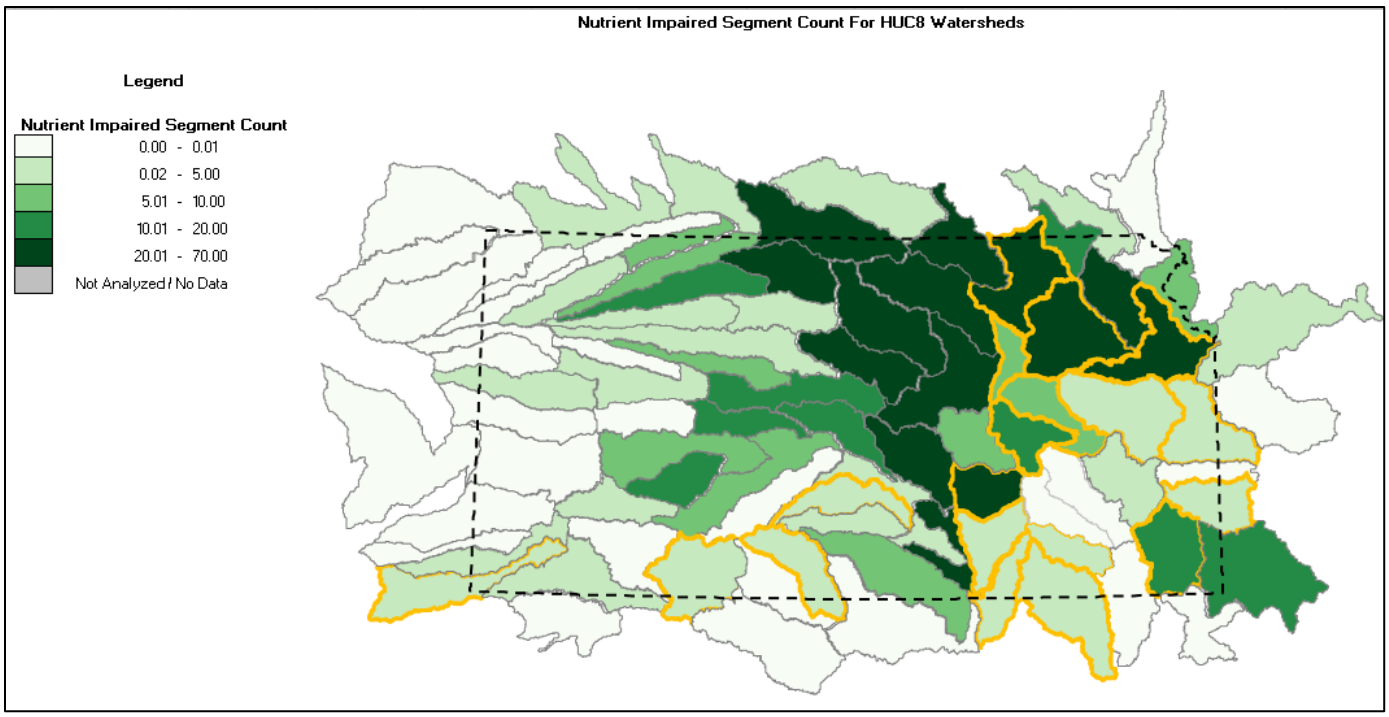


Figure 5. Number of nutrient impairments per HUC8. Yellow-outlined HUCs have nutrient impaired segment counts but also scored among the top three deciles of RPI score; darker green HUCs with yellow outlines may be good candidates for addressing significant nutrient impairments in watersheds with relatively better recovery prospects.

The bubble plot in Figure 6 displays the relative value differences among HUC8 watersheds in Ecological, Stressor and Social Index scores by each bubble's size and position on the graph, also showing how these compare to Scenario medians (the horizontal and vertical median lines). The highest ranked watersheds based on the RPI Score are labeled below in Figure 6; the majority of these watersheds have lower than average phosphorus concentrations, higher Ecological Index scores, and lower Stressor Index scores. Because all of these watersheds contain nutrient impairments or are part of a public drinking water system project area, higher ranked watersheds are good candidates for nutrient management and restoration (e.g., Neosho Headwaters, Kaw Lake, Fall, Upper Marias Des Cygnes, and Lower Walnut River). Their recovery potential may be greater than those watersheds with higher levels of stressors (e.g., Middle Neosho, Lower Marias Des Cygnes, Lower Kansas, Kansas).

The bubble plot also identifies Lower Big Blue and Upper Cimarron-Liberal as having high instream phosphorus concentrations. These watersheds plot in the upper right quadrant (dark green) where higher-than-median ecological and stressor scores are found together, and this may indicate threatened but functional watersheds where efforts could be placed to reduce further degradation.

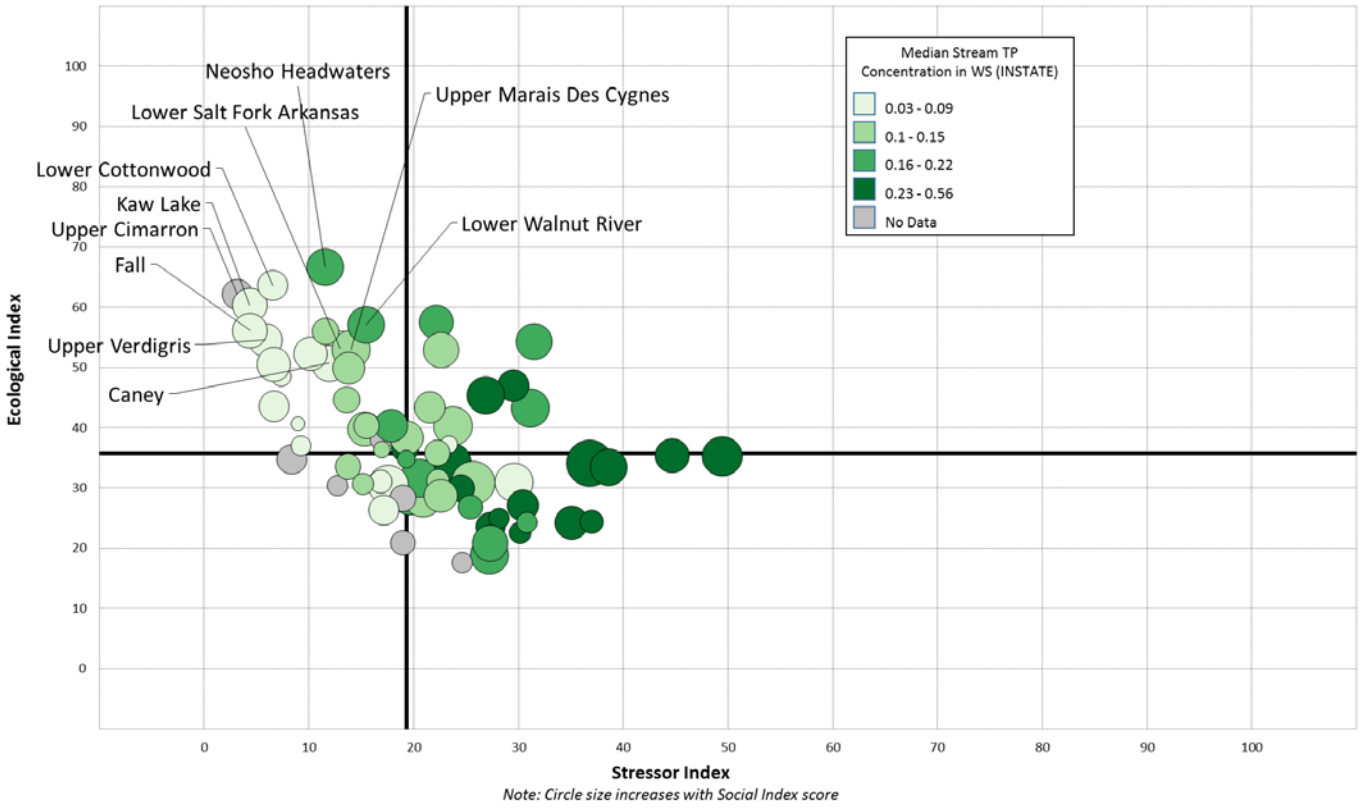


Figure 6. Bubble plot for Kansas Scenario 1 watersheds color-sorted by median phosphorus concentration; watersheds that rank in the top 10 by RPI score are labeled. Axes are set to median Ecological Index and Stressor Index scores.

Maps of Ecological and Stressor index scores for Scenario 1 are displayed in Figure 7 and Figure 8. The Ecological Index map shows that high Ecological Index scores are mostly found in the eastern part of the state, which corresponds to watersheds with higher amounts of natural areas and tend to be located in and near the Flint Hills ecoregion (Figure 4). Lower Stressor Index scores are also found in the southeastern part of the state, also corresponding with the Flint Hills ecoregion. HUC8s with higher Stressor Index scores correspond to developed areas in the northeast near Kansas City and Topeka and in the south central near Wichita. Note that color intensity of these different indices is always 'the darker blue the better.'

Table3 contains Ecological, Stressor, Social, and RPI scores for all HUC8 watersheds, in order of descending RPI score and color-coded by quartile per RPI score. This tabular format is another option for presentation of Stage 1 results that can be used to compare and contrast HUC8 watersheds. In interpreting this table, preferred HUC8 watersheds for nutrient management do not necessarily have to be those with the highest RPI scores but instead could consider one or more of the component index scores. For example, a watershed such as the Upper Walnut River (11030017) with poor Stressor Index scores may be a good restoration priority candidate because of high its Ecological Index score and moderate Social Index score; this would not be revealed by examining the RPI score alone.

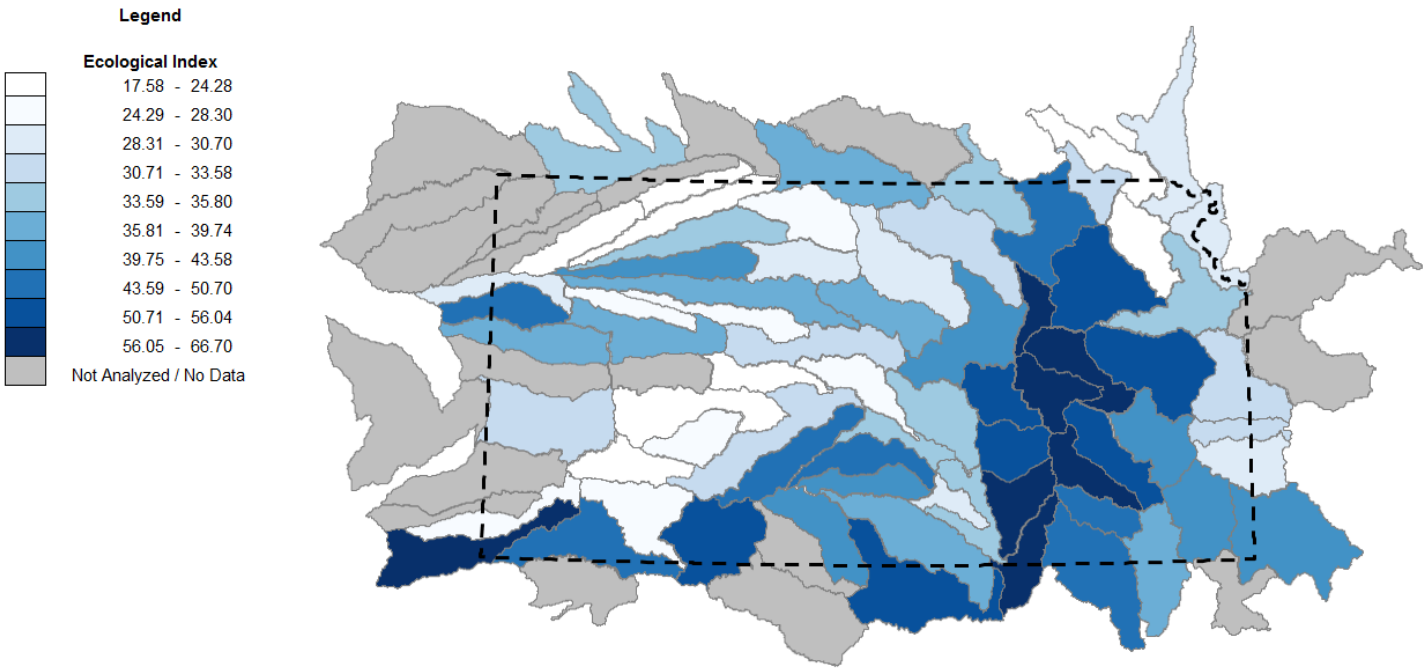


Figure 7. Ecological ranking (darker blue implies better for restoration)

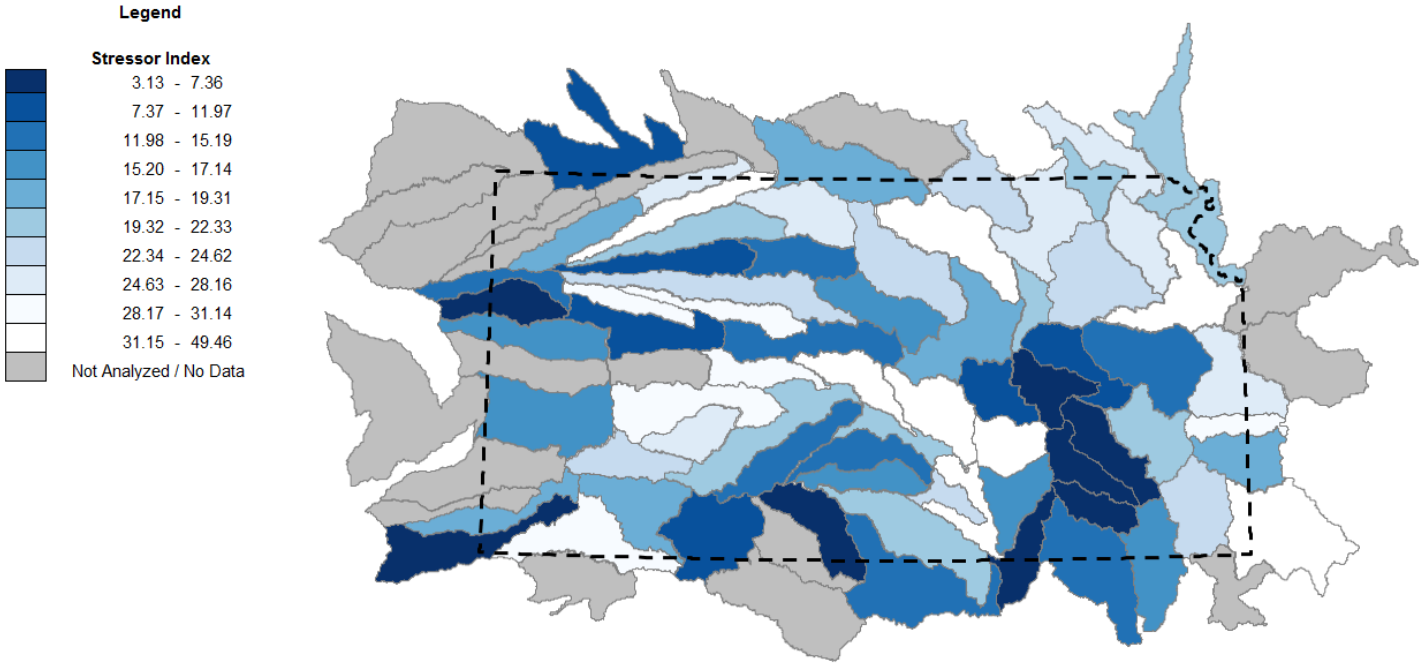


Figure 8. Stressor ranking (darker blue implies better for restoration)

Table 3. Index and RPI scores for Scenario 1. HUC8 watersheds are ordered by RPI score. Cells in each column are shaded by quartile according to rank for each of the four indices (black = 76 -100th percentile; dark gray = 51-75th percentile; light gray = 26-50th percentile; white = 0-25th percentile).

Watershed ID	Watershed Name	Ecological Index	Ecological Rank	Stressor Index	Stressor Rank	Social Index	Social Rank	RPI Score	RPI Rank
11070201	Neosho Headwaters	66.70	1	11.54	13	60.03	18	71.73	1
11060001	Kaw Lake	60.34	4	4.36	2	54.10	24	70.03	2
11070102	Fall	56.12	7	4.37	3	54.20	23	68.65	3
10290101	Upper Marais Des Cygnes	53.04	12	14.03	21	65.57	9	68.19	4
11030018	Lower Walnut River	57.12	6	15.47	24	61.40	16	67.68	5
11070101	Upper Verdigris	54.54	9	5.86	4	51.43	27	66.71	6
11040002	Upper Cimarron	62.18	3	3.13	1	40.37	41	66.47	7
11070106	Caney	50.70	15	11.97	15	60.33	17	66.35	8
11070203	Lower Cottonwood	63.64	2	6.53	5	41.10	40	66.07	9
11060004	Lower Salt Fork Arkansas	53.16	11	13.00	17	55.23	22	65.13	10
11070104	Elk	50.52	16	6.64	6	50.87	29	64.92	11
10270104	Lower Kansas, Kansas	34.12	42	36.77	67	96.77	1	64.71	12
11040008	Upper Cimarron-Bluff	52.30	14	10.17	12	49.83	32	63.99	13
10290102	Lower Marais Des Cygnes	30.86	49	25.67	52	85.77	2	63.65	14
10270102	Middle Kansas	52.84	13	22.61	45	56.83	21	62.35	15
10270101	Upper Kansas	57.52	5	22.16	41	50.47	31	61.94	16
11070205	Middle Neosho	40.26	28	23.76	48	68.48	6	61.66	17
10290104	Marmaton	30.50	51	17.57	30	71.53	4	61.49	18
11030014	North Fork Ninnescah	49.94	17	13.80	20	46.47	35	60.87	19
10270205	Lower Big Blue	45.36	20	26.90	53	64.00	12	60.82	20
11030017	Upper Walnut River	54.30	10	31.49	65	58.23	19	60.35	21
11060003	Medicine Lodge	43.58	22	6.67	7	41.97	39	59.63	22
10240007	South Fork Big Nemaha	31.64	45	20.51	38	66.78	7	59.30	23
11070207	Spring	43.24	24	31.14	64	65.53	10	59.21	24
11070103	Middle Verdigris	39.74	29	15.31	23	52.97	25	59.13	25
10240011	Independence-Sugar	28.46	56	20.89	39	69.55	5	59.04	26
11070202	Upper Cottonwood	56.04	8	11.56	14	32.10	47	58.86	27
10270207	Lower Little Blue	34.26	41	23.67	47	62.85	13	57.81	28
10240005	Tarkio-Wolf	28.66	55	19.63	37	62.58	14	57.20	29
10260008	Lower Smoky Hill	40.30	27	17.86	31	48.80	34	57.08	30
11060005	Chikaskia	38.34	30	19.31	35	51.10	28	56.71	31
10290103	Little Osage	30.98	48	29.59	59	65.50	11	55.63	32
10250004	Upper Republican	34.73	40	8.37	9	39.23	43	55.20	33
11070204	Upper Neosho	43.38	23	21.53	40	43.13	38	54.99	34
11040006	Upper Cimarron-Liberal	47.00	19	29.49	58	44.97	36	54.16	35
11030009	Rattlesnake	44.64	21	13.60	18	30.47	49	53.84	36
10260001	Smoky Hill Headwaters	48.54	18	7.36	8	17.33	65	52.84	37
11030013	Middle Arkansas-Slate	35.24	38	49.46	71	72.70	3	52.83	38
10240008	Big Nemaha	18.88	70	27.26	54	65.58	8	52.40	39
10250017	Lower Republican	33.44	44	38.61	69	61.70	15	52.18	40
11030016	Ninnescah	28.68	54	22.59	44	49.23	33	51.78	41
11030015	South Fork Ninnescah	40.34	26	15.49	25	29.63	51	51.50	42

Watershed ID	Watershed Name	Ecological Index	Ecological Rank	Stressor Index	Stressor Rank	Social Index	Social Rank	RPI Score	RPI Rank
10250016	Middle Republican	36.62	34	19.16	34	34.17	45	50.54	43
10270103	Delaware	20.84	69	27.31	56	57.38	20	50.30	44
10260006	Middle Smoky Hill	33.58	43	13.73	19	30.03	50	49.96	45
11040007	Crooked	26.34	60	17.14	29	40.33	42	49.84	46
10260003	Upper Smoky Hill	37.02	33	9.26	11	17.33	65	48.36	47
11030012	Little Arkansas	35.34	37	44.67	70	52.85	26	47.84	48
10260004	Ladder	38.08	31	16.88	27	21.63	58	47.61	49
11030010	Gar-Peace	35.80	36	22.24	42	29.07	52	47.54	50
10260007	Big	27.14	58	30.41	61	44.93	37	47.22	51
10260013	Upper South Fork Solomon	40.64	25	8.93	10	8.53	71	46.75	52
11040003	North Fork Cimarron	28.30	57	18.95	32	30.70	48	46.68	53
10250015	Prairie Dog	24.18	65	35.04	66	50.60	30	46.58	54
10260015	Solomon	29.94	53	24.49	49	32.77	46	46.07	55
11030001	Middle Arkansas-Lake McKinney	31.08	47	16.86	26	23.67	56	45.96	56
10260002	North Fork Smoky Hill	30.36	52	12.73	16	19.03	63	45.55	57
10260014	Lower South Fork Solomon	30.70	50	15.19	22	20.28	60	45.26	58
10250011	Lower Sappa	23.52	66	27.30	55	38.70	44	44.97	59
11030004	Coon-Pickerel	31.20	46	22.33	43	23.00	57	43.96	60
10260010	Lower Saline	36.34	35	16.94	28	12.07	69	43.82	61
10260011	Upper North Fork Solomon	34.82	39	19.31	35	13.98	67	43.16	62
10250010	Upper Sappa	20.90	68	18.98	33	27.03	53	42.98	63
11030006	Buckner	26.82	59	25.43	51	26.77	54	42.72	64
10260009	Upper Saline	37.20	32	23.36	46	13.73	68	42.53	65
10260012	Lower North Fork Solomon	24.94	62	28.16	57	19.10	61	38.63	66
11030005	Pawnee	22.58	67	30.16	60	21.20	59	37.87	67
11030003	Arkansas-Dodge City	17.58	71	24.62	50	19.07	62	37.34	68
11030011	Cow	24.40	63	37.00	68	24.30	55	37.23	69
11030008	Lower Walnut Creek	24.28	64	30.81	63	18.13	64	37.20	70
10260005	Hackberry	26.10	61	30.51	62	11.63	70	35.74	71

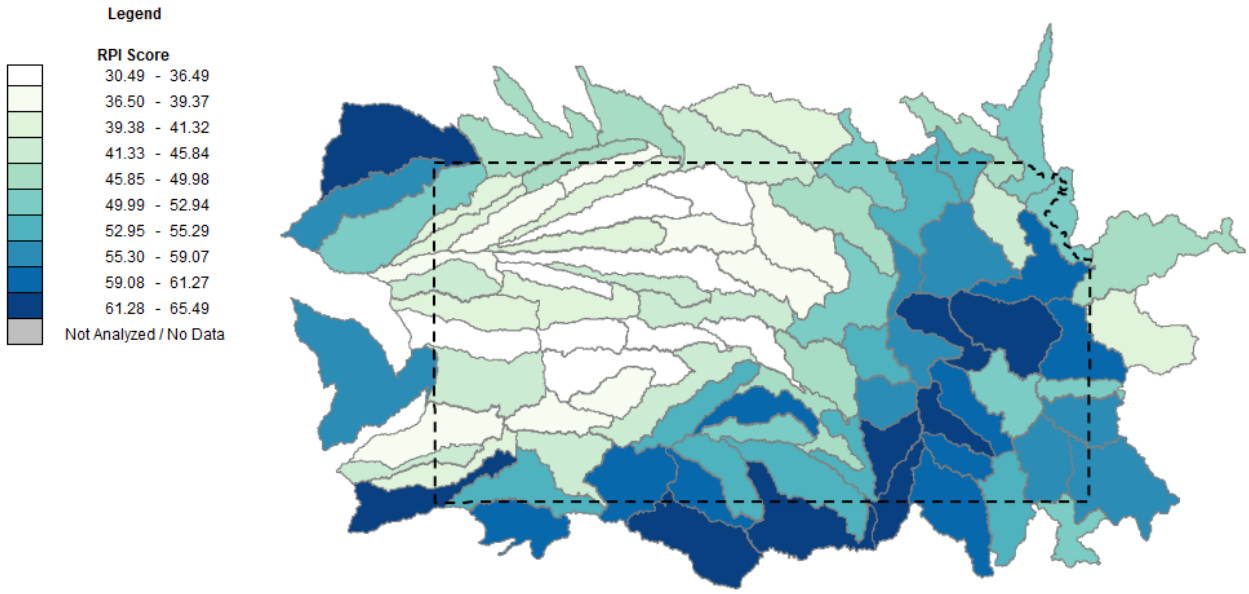
Scenario 2 – Nonpoint Sources – Watersheds with opportunities to significantly reduce nonpoint source nutrient loads

This Scenario includes HUC8 watersheds that are of higher interest for nonpoint source nutrient management efforts. The analysis will screen and compare nonpoint source-impacted HUC8 watersheds that could be targeted for phosphorus reductions from nonpoint sources. Agricultural land uses, animal agriculture activities, erosion, and septic systems are potential stressors in these watersheds. All of Kansas' HUC8 watersheds are screened for this Scenario. Scenario-specific indicators are provided in Table 2; Attachment 2 includes indicator descriptions.

*Table 2. Stage 1 RPS indicator selections and weights (wt) for screening and comparing HUC8 watersheds for Scenario 2. See Attachment 2 for indicator definitions. Those indicators with a * are derived from state-specific datasets.*

Ecological Indicators	wt	Stressor Indicators	wt	Social Indicators	wt
% natural cover in watershed (N-Index2)	1	% agriculture (2006) in watershed	1	Nutrient TMDL count	1
% natural cover in hydrologically connected zone (N-Index2)	1	Number of dams in watershed	1	Distance to outlet of the state inverse*	1
National Fish Habitat Partnership Habitat Condition Index	1	Watershed mean soil erodibility	1	Total public drinking water system (PWS) project score*	1
Flow (cfs) generated in watershed*	1	Hydrologically connected zone mean soil erodibility	1	Critical watershed class score*	1
IBI Indicator (weighted average IBI score)*	1	Phosphorus yield (SPARROW incremental)	1		
		Median TP concentration for streams in watershed*	1		
		% watershed streamlength 303d-listed nutrients	1		
		% watershed waterbody area 303d-listed nutrients	1		

RPI scores for Scenario 2 are displayed in map format in Figure 9. North Fork Republican (10250002), Neosho Headwaters (11070201), Lower Cimarron-Eagle Chief (11050001), Upper Cimarron (11040002), and Lower Salt Fork Arkansas (11060004) HUC8 watersheds are the highest ranked watersheds for recovery potential based on RPI score. Distribution of the higher-scoring Scenario 2 watersheds around the state roughly resembles that of Scenario 1, despite their different themes and indicators selected.



The bubble plot for Scenario 2 (Figure 10) reflects the relative value differences among HUC8 watersheds in Ecological, Stressor and Social index scores by each bubble's size and position on the graph, also showing how these compare to region-wide Ecological and Stressor index medians (the horizontal and vertical median lines respectively). Figure 11 color sorts the bubble plot to show number of nutrient impairments in each watershed. Four of the top ten highest RPI ranked watersheds do not have any identified nutrient impairments (North Fork Republican, Lower Cimarron-Eagle Chief, Fall, and Lower Salt Fork Arkansas); these may be of less interest for nutrient management, but could be candidates for protection strategies. Maps of Ecological and Stressor Index scores for Scenario 2 are displayed in Figure 12 and Figure 13. HUC8 watersheds with high Ecological Index scores are in the east-central part of the state; low Stressor Index scores are found in the southern part of the state.

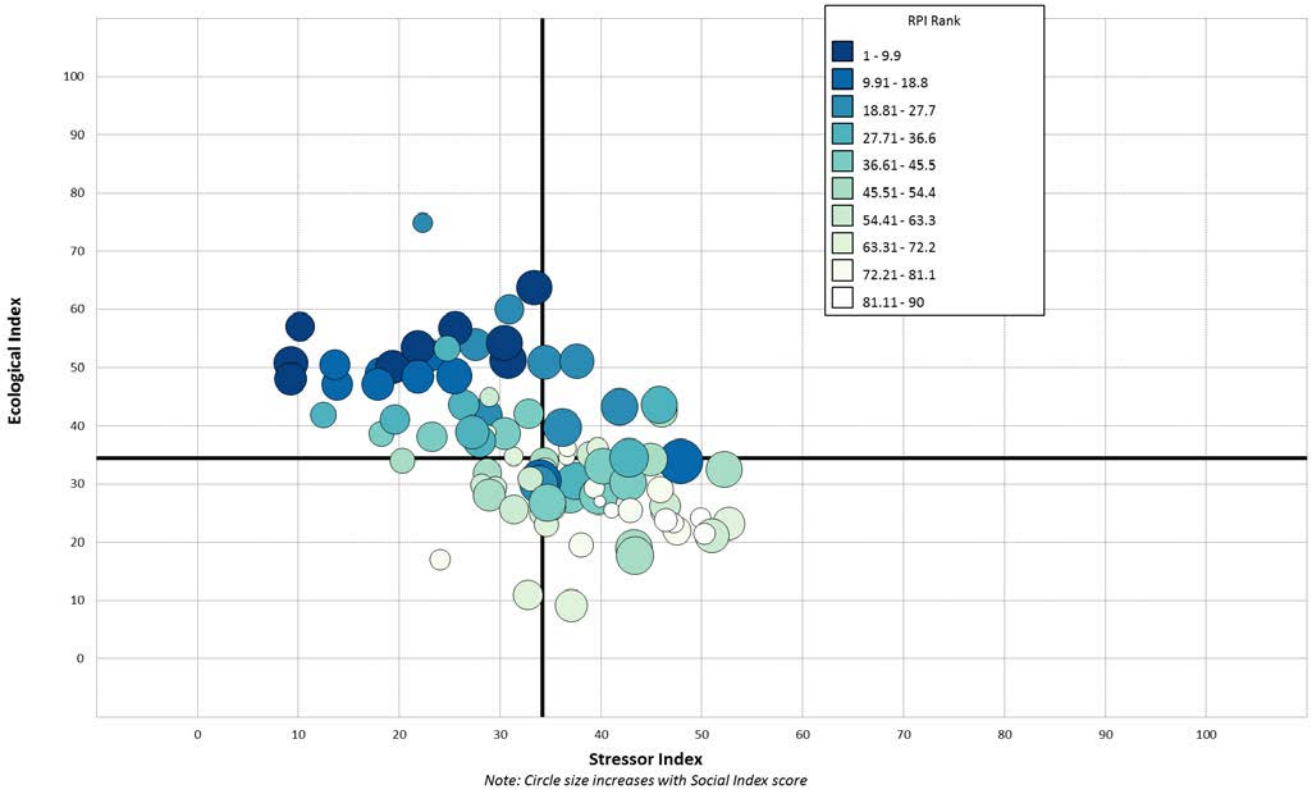


Figure 10.Bubble plot for Scenario 2 HUC8 watersheds color-coded by RPI rank. Axes are set to median Ecological and Stressor Index scores.

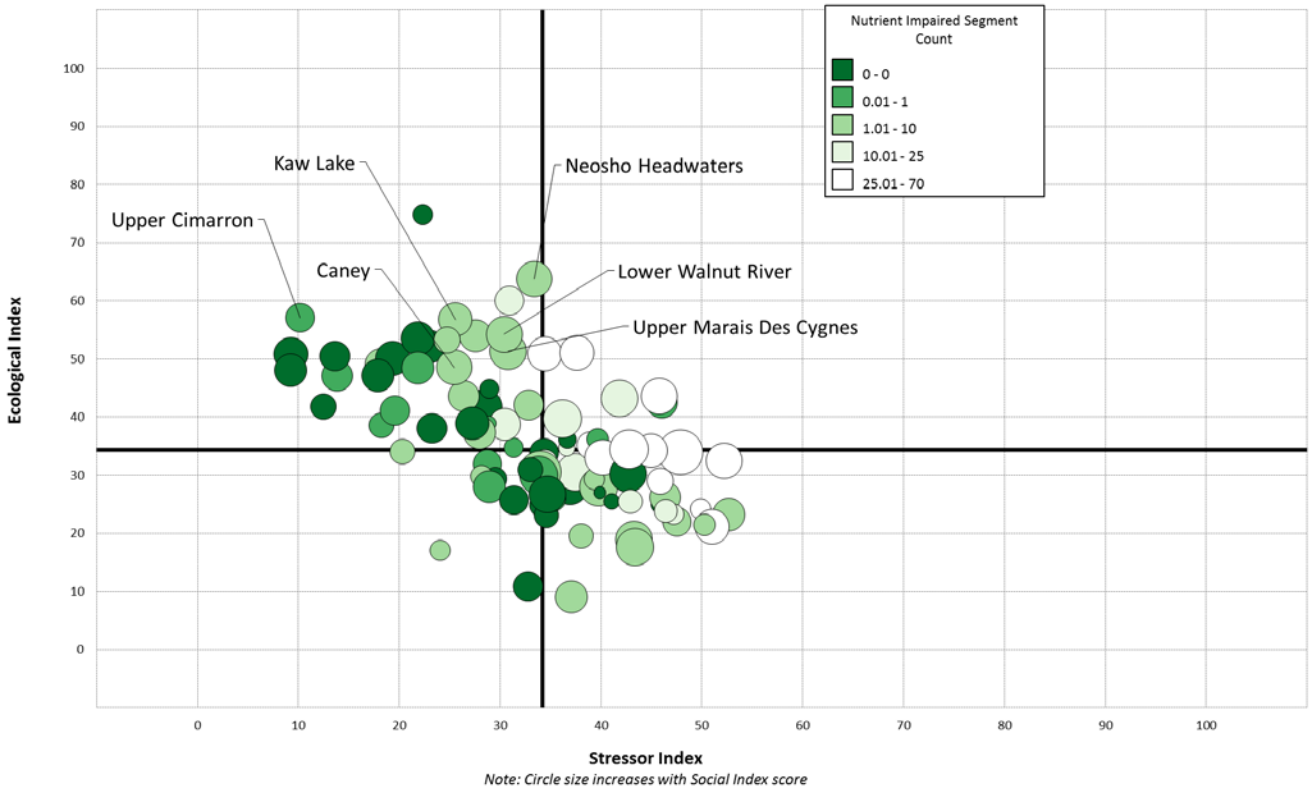


Figure 11.Bubble plot for Scenario 2 HUC8 watersheds. This plot color-sorts the watersheds by number of nutrient impairments; labeled watersheds have top ranking RPI scores and at least some nutrient impairments. Axes are set to median Ecological and Stressor Index scores.

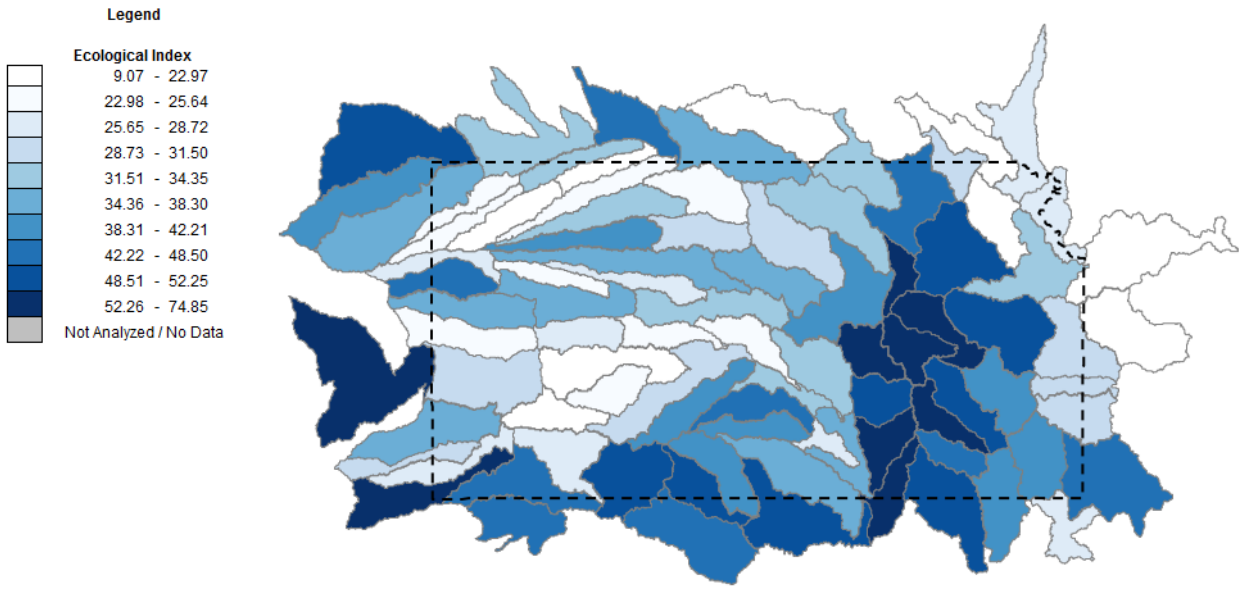


Figure 12. Scenario 2 Ecological Index (darker blue implies better for restoration)

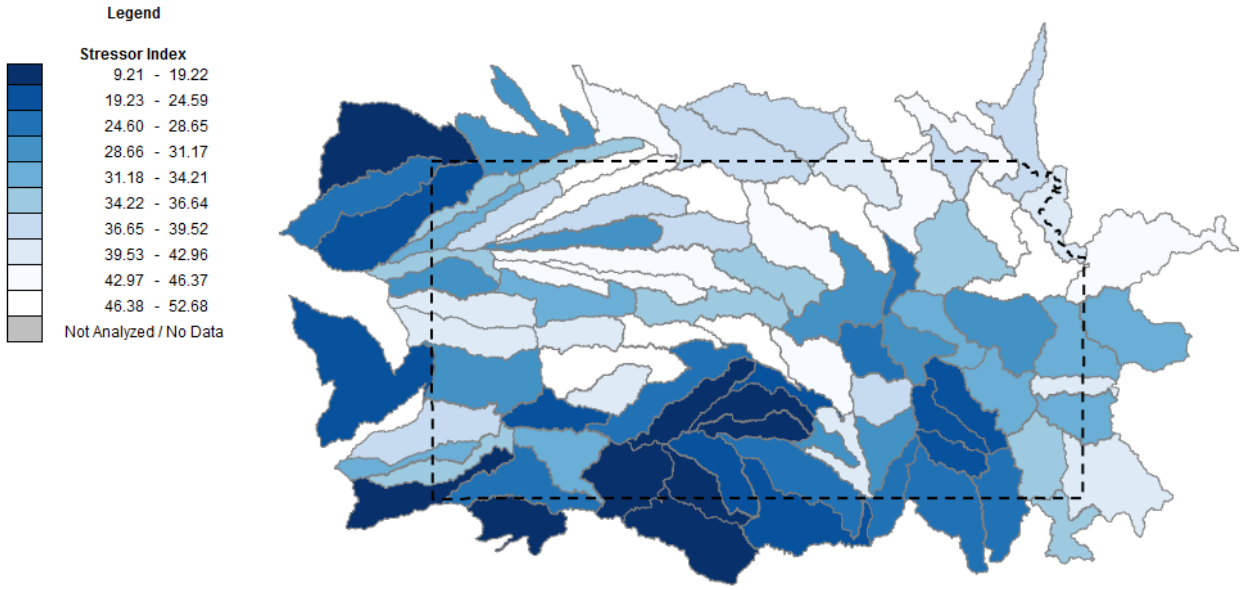


Figure 13. Scenario 2 Stressor Index (darker blue implies better for restoration)

Table 3 contains Ecological, Stressor, Social, and RPI scores for Scenario 2, in order of descending RPI score and color-coded by quartile per RPI score. This tabular format is another option for presentation of Stage 1 results that can be used to compare and identify HUC8 watersheds for Scenario 2 nutrient management efforts. Of interest, Lower Kansas, Kansas has a much higher Stressor Index score, however it also ranks very high for Social Index, which generates an overall high RPI. Conversely, Upper Arkansas-John Martin Reservoir is ranked highest for Ecological Index and has a good Stressor Index score, however a very low Social Index score moderates the overall RPI ranking for this watershed (ranked 24 out of 90).

Table 3. Index and RPI scores for Scenario 2. HUC8 watersheds are ordered by RPI score. Cells in each column are shaded by quartile according to rank for each of the four indices (black = 76 -100th percentile; dark gray = 51-75th percentile; light gray = 26-50th percentile; white = 0-25th percentile).

Watershed ID	Watershed Name	Ecological Index	Ecological Rank	Stressor Index	Stressor Rank	Social Index	Social Rank	RPI Score	RPI Rank
		Higher Index is Better		Lower Index is Better		Higher Index is Better		Higher Score is Better	
10250002	North Fork Republican	50.80	14	9.26	2	54.90	26	65.48	1
11070201	Neosho Headwaters	63.74	2	33.40	42	60.10	21	63.48	2
11050001	Lower Cimarron-Eagle Chief	48.08	20	9.21	1	51.03	35	63.30	3
11040002	Upper Cimarron	57.06	4	10.16	3	40.93	53	62.61	4
11060004	Lower Salt Fork Arkansas	50.12	16	19.33	10	55.77	25	62.19	5
10290101	Upper Marais Des Cygnes	51.32	11	30.79	35	65.93	9	62.16	6
11070102	Fall	53.52	8	21.84	13	54.37	27	62.02	7
11060001	Kaw Lake	56.80	5	25.56	21	54.33	28	61.85	8
11030018	Lower Walnut River	54.22	6	30.43	33	61.57	18	61.79	9
11070106	Caney	48.56	18	25.48	20	60.57	20	61.22	10
10270104	Lower Kansas, Kansas	33.92	48	47.88	85	96.90	1	60.98	11
10290102	Lower Marais Des Cygnes	30.52	56	33.99	44	85.80	2	60.78	12
11040008	Upper Cimarron-Bluff	49.00	17	18.20	8	50.57	39	60.46	13
11070101	Upper Verdigris	52.14	10	22.98	16	51.80	31	60.32	14
11060002	Upper Salt Fork Arkansas	50.50	15	13.60	5	43.87	46	60.26	15
11030014	North Fork Ninnescah	47.10	22	13.86	6	46.90	43	60.05	16
11100102	Middle Beaver	47.17	21	17.90	7	50.63	37	59.97	17
11070104	Elk	48.48	19	21.85	14	51.17	34	59.27	18
10270101	Upper Kansas	53.98	7	27.56	24	50.63	37	59.02	19
10250001	Arikaree	41.74	30	28.43	27	60.70	19	58.01	20
10270102	Middle Kansas	50.90	13	34.41	48	57.00	24	57.83	21
11070205	Middle Neosho	39.70	32	36.19	53	68.90	6	57.47	22
11030017	Upper Walnut River	51.08	12	37.61	59	58.63	22	57.36	23
11020009	Upper Arkansas-John Martin Reservoir	74.85	1	22.36	15	18.97	80	57.15	24
11070203	Lower Cottonwood	60.02	3	30.90	36	41.10	52	56.74	25
10290104	Marmaton	29.92	59	33.85	43	71.75	4	55.94	26
11070207	Spring	43.22	26	41.86	69	65.70	12	55.69	27
11070103	Middle Verdigris	38.90	34	27.24	23	53.70	29	55.12	28
11030013	Middle Arkansas-Slate	34.48	45	42.78	71	72.97	3	54.89	29
11060003	Medicine Lodge	41.10	31	19.56	11	42.87	49	54.80	30
11040006	Upper Cimarron-Liberal	43.60	25	26.40	22	45.87	44	54.36	31
10270205	Lower Big Blue	43.62	24	45.76	77	64.10	14	53.99	32
11070202	Upper Cottonwood	53.24	9	24.73	19	32.67	59	53.73	33
11060005	Chikaskia	37.34	38	27.95	25	51.77	32	53.72	34
11030009	Rattlesnake	41.82	29	12.50	4	31.37	61	53.56	35
10240007	South Fork Big Nemaha	30.52	56	37.45	58	66.88	8	53.32	36
10250003	South Fork Republican	38.10	37	23.25	17	43.23	48	52.69	37
10240011	Independence-Sugar	27.96	66	39.78	65	69.75	5	52.65	38
11070206	Lake O' The Cherokees	26.78	69	34.69	51	65.77	10	52.62	39

Watershed ID	Watershed Name	Ecological Index	Ecological Rank	Stressor Index	Stressor Rank	Social Index	Social Rank	RPI Score	RPI Rank
		Higher Index is Better		Lower Index is Better		Higher Index is Better		Higher Score is Better	
10260008	Lower Smoky Hill	38.72	35	30.46	34	49.50	41	52.59	40
10270207	Lower Little Blue	33.06	51	40.20	67	62.88	15	51.91	41
10240005	Tarkio-Wolf	28.02	65	36.95	56	62.85	16	51.31	42
10290103	Little Osage	30.26	58	42.71	70	65.67	13	51.07	43
11070204	Upper Neosho	42.08	28	32.85	40	43.43	47	50.89	44
11030015	South Fork Ninnescah	38.60	36	18.23	9	30.67	62	50.35	45
11030016	Ninnescah	28.06	64	28.95	31	49.73	40	49.61	46
11030010	Gar-Peace	34.04	47	20.34	12	30.13	64	47.95	47
10250009	Harlan County Reservoir	42.50	27	46.03	80	47.35	42	47.94	48
10250004	Upper Republican	31.88	54	28.74	28	40.20	54	47.78	49
11030012	Little Arkansas	34.22	46	44.98	76	53.45	30	47.57	50
10300101	Lower Missouri-Crooked	17.64	87	43.38	75	68.20	7	47.49	51
10250017	Lower Republican	32.50	52	52.21	89	62.03	17	47.44	52
10240008	Big Nemaha	18.94	86	43.29	74	65.73	11	47.13	53
10250014	Beaver	33.88	49	34.36	47	39.20	56	46.24	54
11040007	Crooked	25.68	72	31.39	38	41.40	51	45.23	55
10260001	Smoky Hill Headwaters	44.88	23	28.93	30	17.80	82	44.59	56
10250016	Middle Republican	35.10	42	38.95	61	34.67	57	43.61	57
10260006	Middle Smoky Hill	32.28	53	34.41	48	30.58	63	42.81	58
10270103	Delaware	21.12	84	51.00	88	57.43	23	42.52	59
11040004	Sand Arroyo	30.93	55	33.00	41	28.90	66	42.28	60
11030004	Coon-Pickerel	29.84	60	28.15	26	23.90	72	41.86	61
10260007	Big	26.20	70	46.36	81	45.03	45	41.62	62
11030001	Middle Arkansas-Lake McKinney	29.38	61	29.51	32	24.53	71	41.47	63
10270206	Upper Little Blue	9.08	90	37.04	57	50.90	36	40.98	64
11040003	North Fork Cimarron	26.03	71	35.24	52	31.60	60	40.79	65
10250015	Prairie Dog	23.20	80	52.68	90	51.48	33	40.67	66
10260003	Upper Smoky Hill	34.74	43	31.35	37	17.88	81	40.42	67
10290108	South Grand	10.88	89	32.79	39	42.47	50	40.19	68
10260013	Upper South Fork Solomon	38.94	33	28.90	29	9.67	89	39.90	69
10250012	South Fork Beaver	24.88	76	34.16	45	28.30	67	39.67	70
10260004	Ladder	36.18	39	39.67	64	22.03	74	39.51	71
10250013	Little Beaver	23.08	81	34.59	50	30.00	65	39.50	72
10260015	Solomon	29.00	63	45.86	79	33.53	58	38.89	73
11040005	Bear	36.17	40	36.67	55	15.40	83	38.30	74
10250011	Lower Sappa	22.00	82	47.53	84	39.70	55	38.06	75
11030003	Arkansas-Dodge City	17.06	88	24.04	18	20.10	76	37.71	76
10260002	North Fork Smoky Hill	27.76	67	34.26	46	19.50	78	37.67	77
10260010	Lower Saline	34.64	44	36.61	54	13.10	86	37.04	78
10260014	Lower South Fork Solomon	29.32	62	39.35	62	20.90	75	36.96	79
11030006	Buckner	25.50	73	42.91	72	27.63	69	36.74	80

Watershed ID	Watershed Name	Ecological Index	Ecological Rank	Stressor Index	Stressor Rank	Social Index	Social Rank	RPI Score	RPI Rank
		Higher Index is Better		Lower Index is Better		Higher Index is Better		Higher Score is Better	
10250010	Upper Sappa	19.53	85	38.04	60	28.07	68	36.52	81
10260011	Upper North Fork Solomon	33.50	50	39.45	63	14.65	85	36.23	82
10260009	Upper Saline	35.30	41	43.16	73	14.70	84	35.61	83
11030011	Cow	23.80	78	46.44	82	25.43	70	34.27	84
11030002	Whitewoman	25.48	74	41.09	68	11.87	88	32.09	85
11030008	Lower Walnut Creek	23.28	79	47.21	83	19.33	79	31.80	86
11030007	Upper Walnut Creek	27.00	68	39.89	66	7.40	90	31.50	87
10260012	Lower North Fork Solomon	24.18	77	49.88	86	19.78	77	31.36	88
11030005	Pawnee	21.50	83	50.28	87	22.17	73	31.13	89
10260005	Hackberry	24.94	75	45.76	77	12.30	87	30.49	90

Delaware and Little Arkansas are of particular interest to the State, thus a summary of the rankings for these watersheds is provided in Table 4. Both of these watersheds have high levels of stressors, but also rank very well in the Social Index. Little Arkansas ranks much better than Delaware for Ecological Index. Figure 14 shows where on the bubble plot these watersheds plot.

Table 4. Rankings for two watersheds of interest in Kansas

Watershed ID	Watershed Name	Ecological Index	Ecological Rank	Stressor Index	Stressor Rank	Social Index	Social Rank	RPI Score	RPI Rank
		Higher Index is Better		Lower Index is Better		Higher Index is Better		Higher Score is Better	
11030012	Little Arkansas	34.22	46	44.98	76	53.45	30	47.57	50
10270103	Delaware	21.12	84	51.00	88	57.43	23	42.52	59

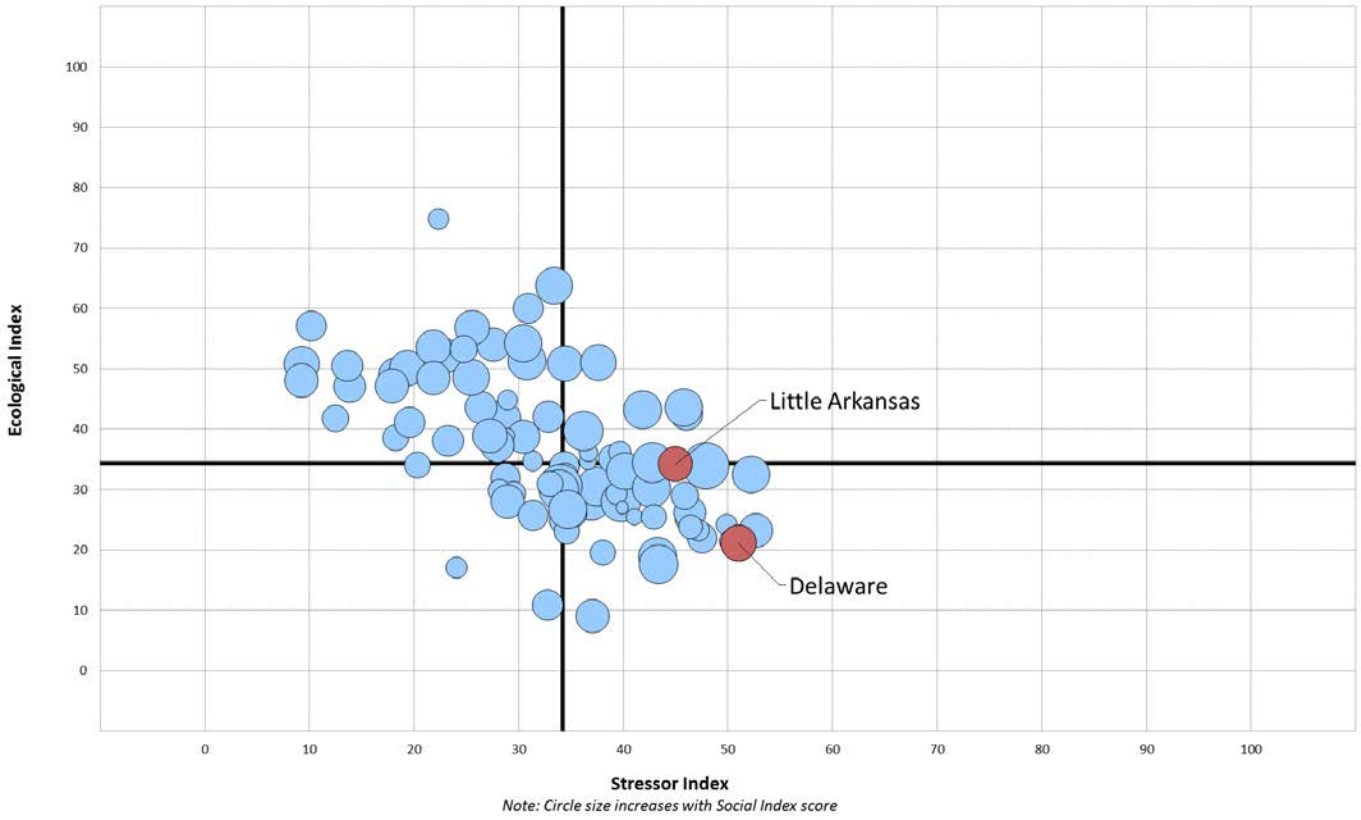


Figure 14. Bubble plot for Scenario 2 HUC8 watersheds. This plot highlights the location of Little Arkansas and Delaware watersheds. Axes are set to median Ecological and Stressor Index scores

<u>Scenario 3 – Point Sources – Watersheds for nutrient TMDL development and restoration that are significantly influenced by NPDES permitted dischargers</u>

Watersheds in this Scenario contain point sources (wastewater, stormwater, or animal feeding operations) and are screened and compared for targeted nutrient TMDL development and restoration. These watersheds include wastewater facilities discharging greater than 0.5 million gallons per day (MGD), at least one regulated MS4, and/or contain at least 23 animal feeding operations (the statewide median number of animal feeding operations per HUC8). A copy of the RPS Tool populated with this Scenario's screening results is among project deliverables.

The goal of this analysis is to rank watersheds that are impacted by moderate to high point source loadings. In this case, the focus is on phosphorus reduction. The following 57 of Kansas' 90 HUC8 watersheds are part of this Scenario:

- Tarkio-Wolf
- South Fork Big Nemaha
- Big Nemaha
- Independence-Sugar
- Prairie Dog
- Lower Republican
- Ladder
- Middle Smoky Hill
- Big
- Lower Smoky Hill
- Upper Saline
- Lower Saline
- Delaware
- Lower Kansas, Kansas
- Lower Big Blue
- Lower Little Blue
- Upper Marais Des Cygnes
- Lower Marais Des Cygnes
- Marmaton
- Lower Missouri-Crooked
- Middle Arkansas-Lake McKinney
- Whitewoman
- Arkansas-Dodge City
- Coon-Pickerel
- Pawnee
- North Fork Ninnescah
- South Fork Ninnescah
- Ninnescah
- Upper Walnut River
- Lower Walnut River
- North Fork Cimarron
- Upper Cimarron-Liberal
- Crooked
- Kaw Lake
- Chikaskia
- Upper Verdigris
- Middle Verdigris

- Upper North Fork Solomon
- Lower North Fork Solomon
- Upper South Fork Solomon
- Lower South Fork Solomon
- Solomon
- Upper Kansas
- Middle Kansas
- Buckner
- Lower Walnut Creek
- Rattlesnake
- Gar-Peace
- Cow
- Little Arkansas
- Middle Arkansas-Slate
- Neosho Headwaters
- Upper Cottonwood
- Lower Cottonwood
- Upper Neosho
- Middle Neosho
- Spring

Scenario-specific indictors are provided in Table 5; Attachment 2 includes indicator descriptions. Ecological indicators focus on the assimilative capacity of the watershed represented by higher average flows and the presence of biota that indicate good water quality. Stressor indicators focus on urban area, population growth indicating increases in wastewater loads, wastewater discharges, and watershed nutrient loads. Social indicators focus on regulated areas such as MS4s.

*Table 5. Stage 1 RPS indicator selections and weights for screening and comparing HUC8 watersheds for Scenario 3. See Attachment 2 for indicator definitions. Those indicators with a * are derived from state-specific datasets*

Ecological Indicators	**wt**	**Stressor Indicators**	**wt**	**Social Indicators**	**wt**
% natural cover in watershed (N-Index2)	1	% urban (2006) in hydrologically connected zone	1	Nutrient TMDL count	1
% natural cover in hydrologically connected zone (N-Index2)	1	% urban (2006) in watershed	1	% MS4 in watershed*	1
National Fish Habitat Partnership Habitat Condition Index	1	Count of animal feeding operations in watershed*	1		
Flow (cfs) generated in watershed*	1	% population growth in watershed (2000-2010)*	1		
IBI Indicator (weighted average IBI score)*	1	Phosphorus yield (SPARROW incremental)	1		
		Cumulative design flow discharge in MGD of major and mid minor plants in watershed*	1		
		% watershed streamlength 303d-listed nutrients			
		% watershed waterbody area 303d-listed nutrients			

RPI scores for Scenario 3 are displayed in map format in Figure 15. RPI scores are a composite of scores for the Ecological, Stressor, and Social Indices based on the Scenario's indicator selection and weighting. The highest ranking watersheds include Neosho Headwaters (11070201), Upper Marais Des Cygnes (10290101), Upper Verdigris (11070101), Middle Neosho (11070205) and Lower Walnut River (11030018).

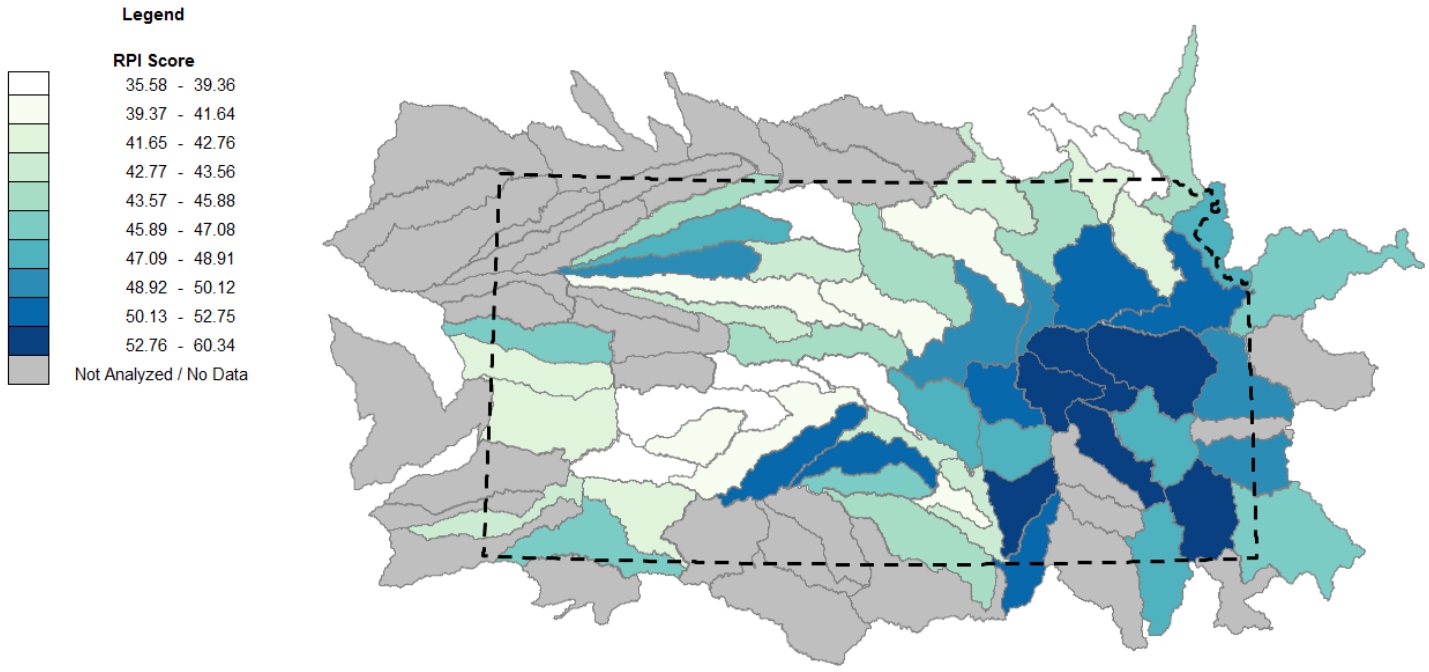


Figure 15. Scenario 3 RPI scores (darker blue implies better for restoration)

The bubble plot in Figure 16 displays the relative value differences among HUC8 watersheds in Ecological, Stressor and Social Index scores by each bubble's size and position on the graph, also showing how these compare to medians (the horizontal and vertical median lines). Further, this figure presents the highest RPI-scoring watersheds in the state. It is unusual to see very good and very poor index scores occurring in the same watershed, but that is evident in several cases. Notably, one of the highest Social Index watersheds also has one of the poorest Stressor Index scores (Lower Kansas, Kansas). Figure 17 sorts all of the Scenario 3 watersheds by median total phosphorus concentration. Of the highest overall ranking watersheds, Lower Kansas, Kansas has a very high median concentration of phosphorus and is ranked the second highest for Social Index. Despite scoring poorly on the Stressor Index, watersheds with mixed traits often deserve consideration for management efforts because their more positive ecological setting or social context may enable more progress in loading reduction than other watersheds that may have scored poorly on all indices.

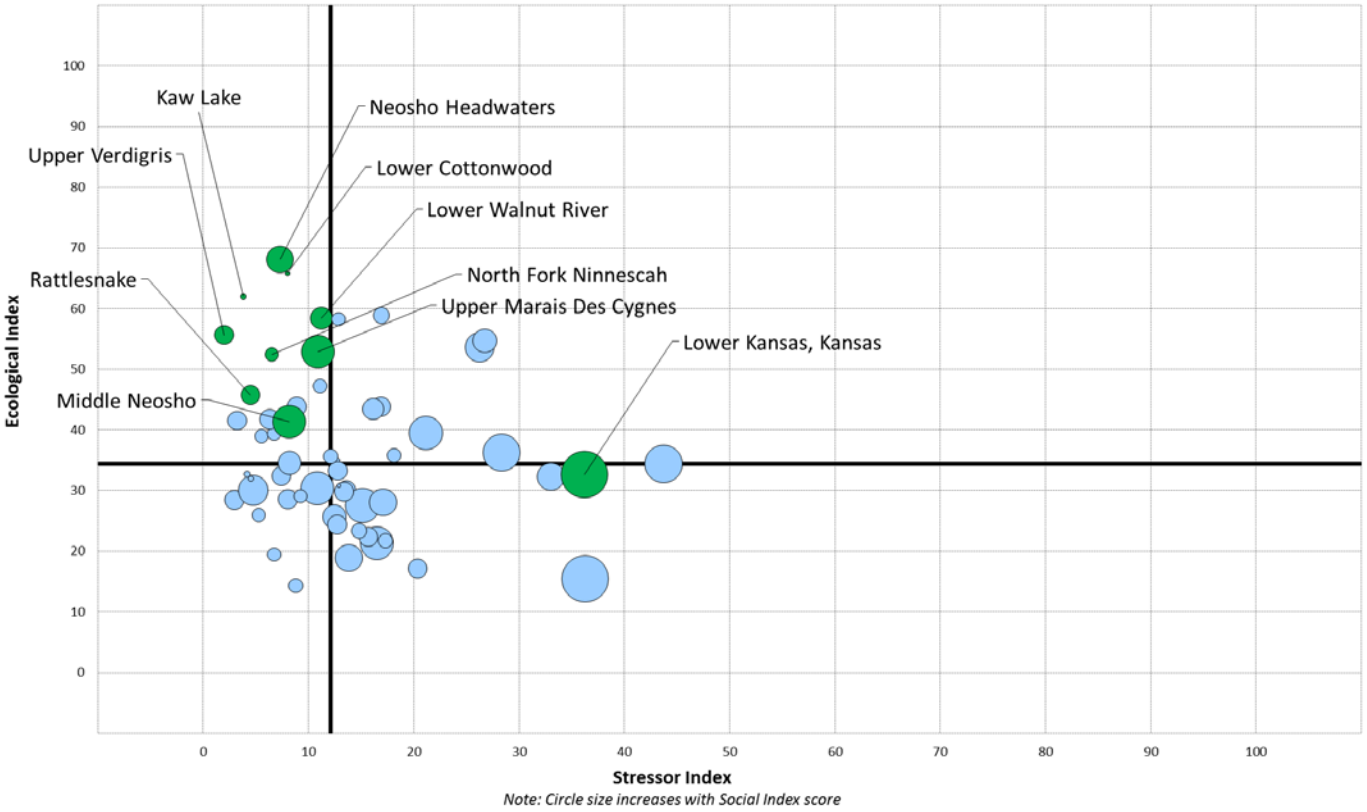


Figure 16. Bubble plot for Scenario 3 watersheds. This plot highlights the top 10 watersheds based on RPI scores (green bubbles with labels). Axes are set to median Ecological and Stressor Index scores.

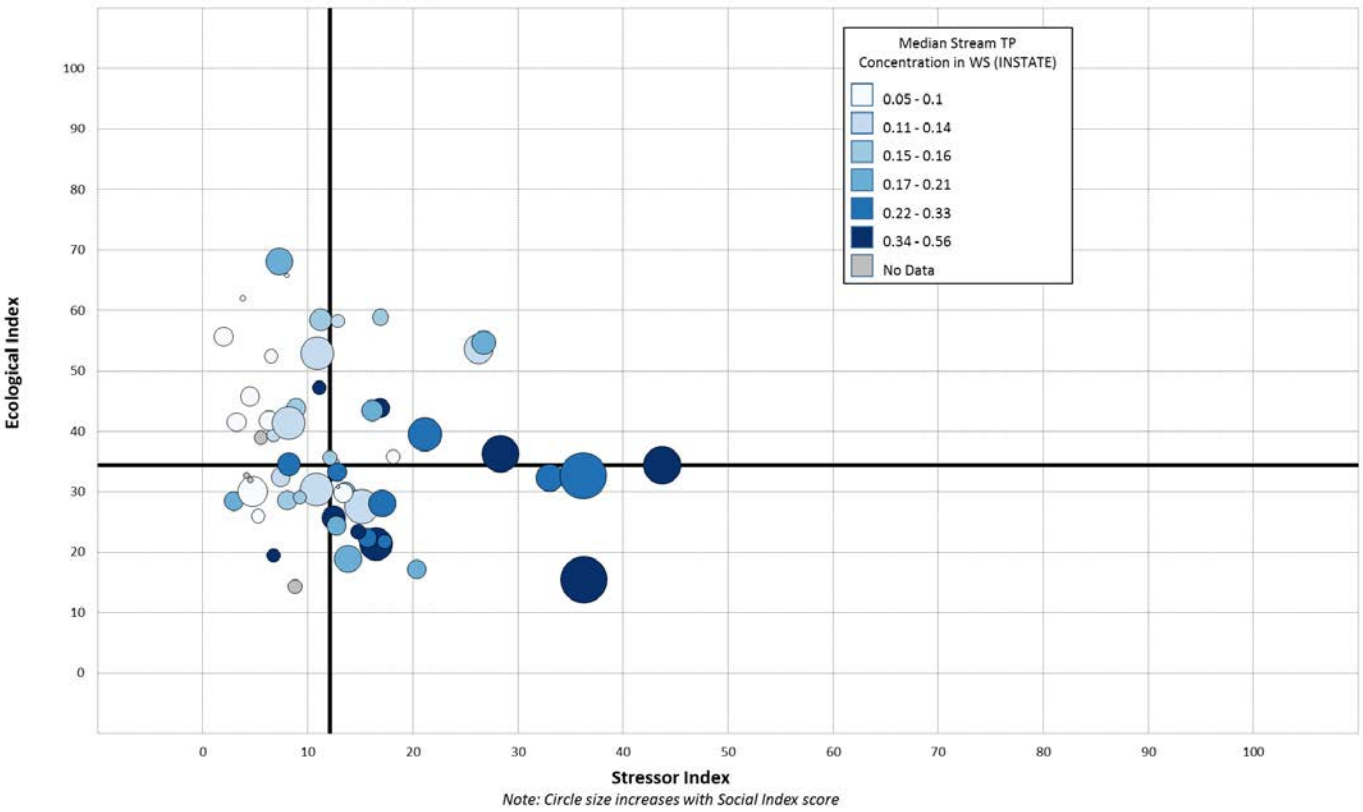


Figure 17. Bubble plot for Scenario 3 watersheds with color-coding based on median total phosphorus concentration in watershed

Maps of Ecological and Stressor Index scores for Scenario 3 are displayed in Figure 18 and Figure 19. HUC8 watersheds with high Ecological Index scores are focused in the eastern part of the State; watersheds with high Stressor Index scores are found in the central and northeastern part of the state. A series of maps showing select single indicator values are also provided (Figure 20, Figure 21, and Figure 22). Viewing indicators individually in map or bubble plot form is easily done in the RPS Tool without changing the screening parameters, and images of these single indicator maps or plots can be saved for later use. Upper Kansas (10270101) presents an interesting example of a watershed that has a moderate overall RPI ranking (ranked 16 out of 57), but with a very high Ecological Index score and a very high Stressor Index score. This watershed tends to stand out in the indicator specific maps, showing a very high percentage of natural cover and a high percentage of population growth.

Table 6 contains Ecological, Stressor, Social, and RPI scores for Scenario 3, in order of descending RPI score and color-coded by quartile per RPI score. This tabular format is another option for presentation of Stage 1 results that can be used to compare and identify HUC8 watersheds for Scenario 3 nutrient management efforts. The tabular format is especially effective at revealing where HUCs with otherwise 'middle of the pack' overall scores may have very positive Ecological or Social Index scores, and where otherwise high scoring HUCs may have very poor Stressor or other index scores that may present a greater challenge.

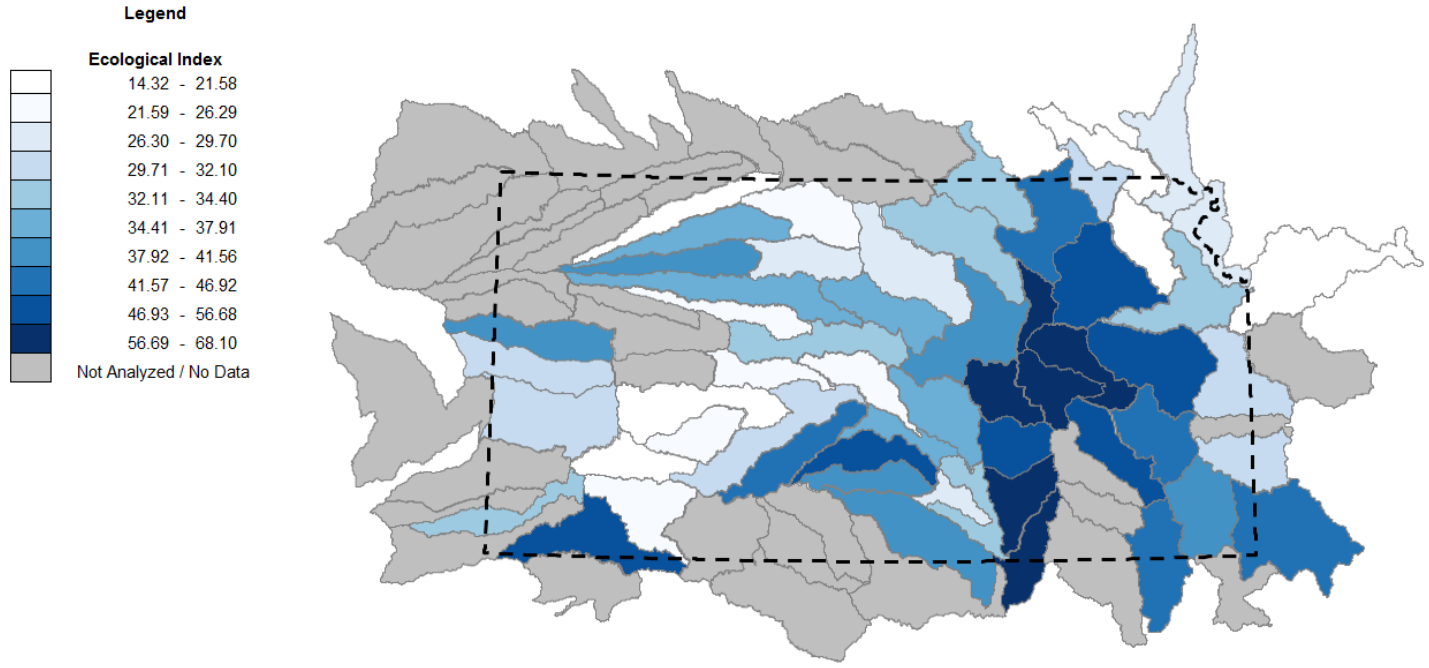


Figure 18. Scenario 3 Ecological Index (darker blue implies better for restoration)

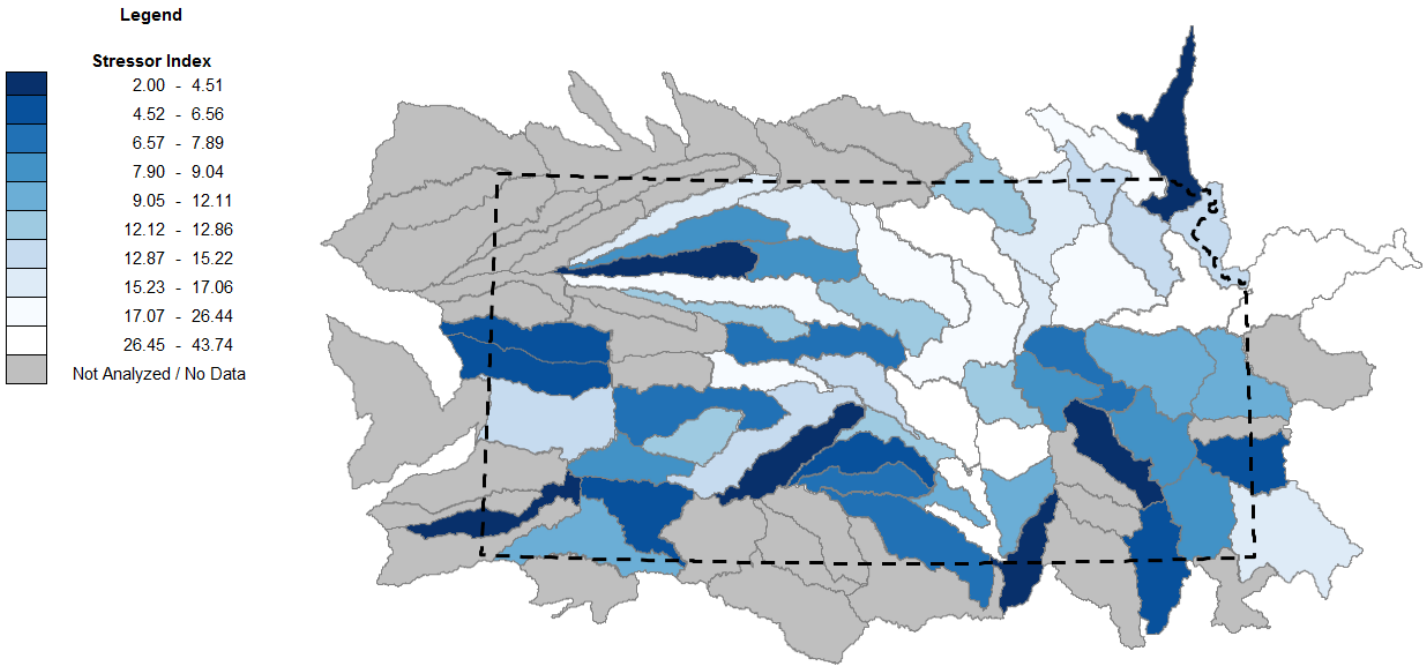
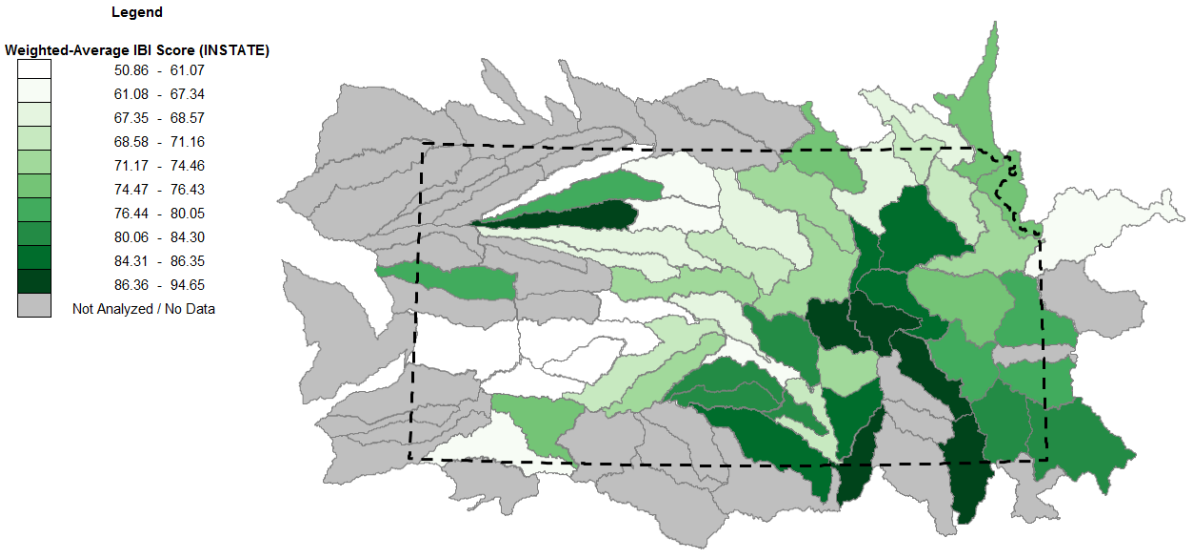


Figure 19. Scenario 3 Stressor Index (darker blue implies better for restoration)



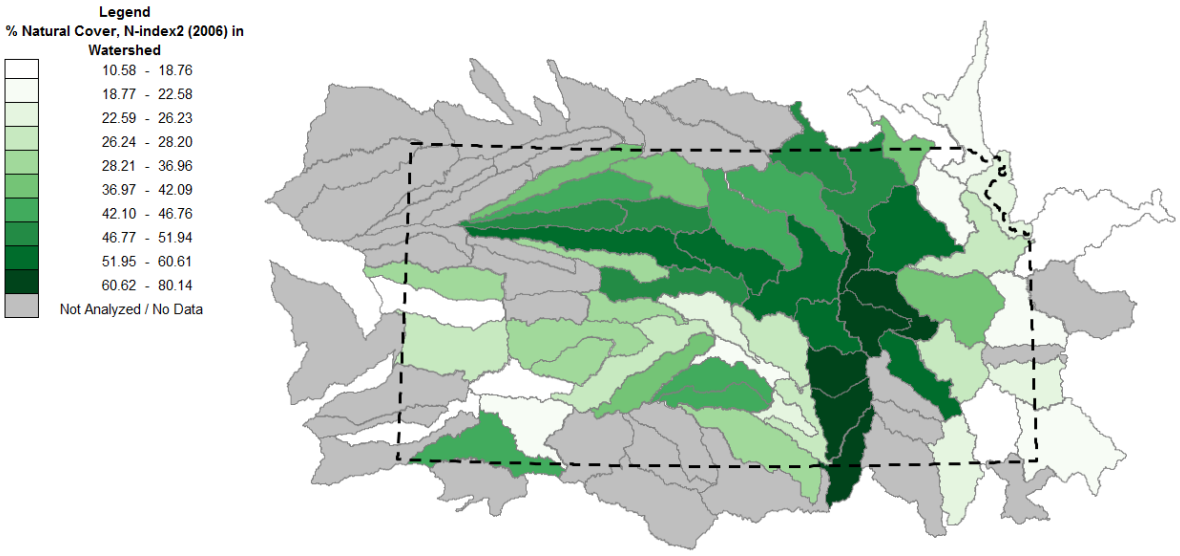
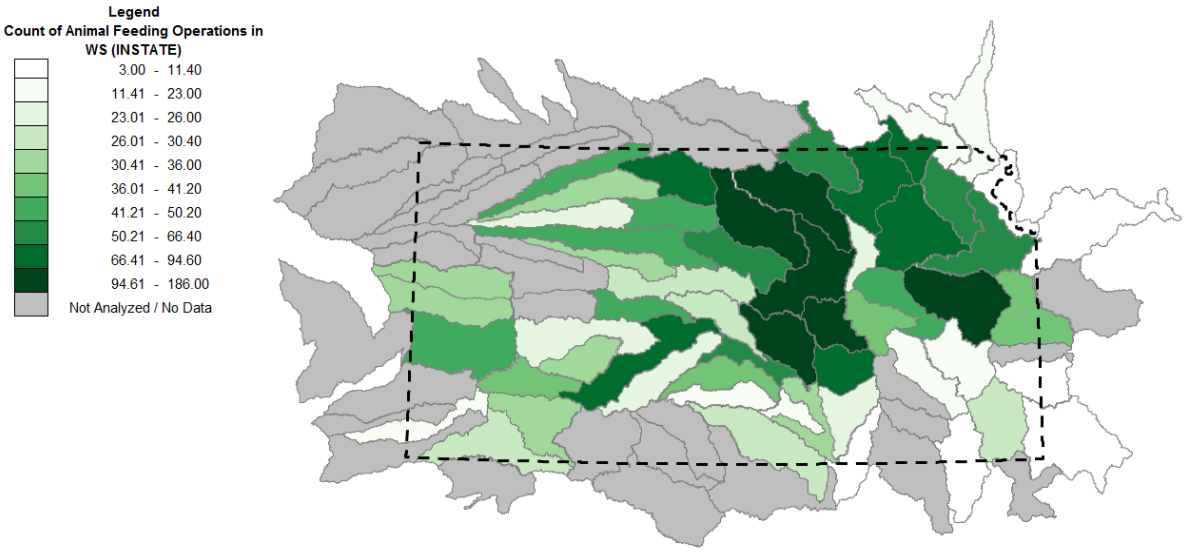
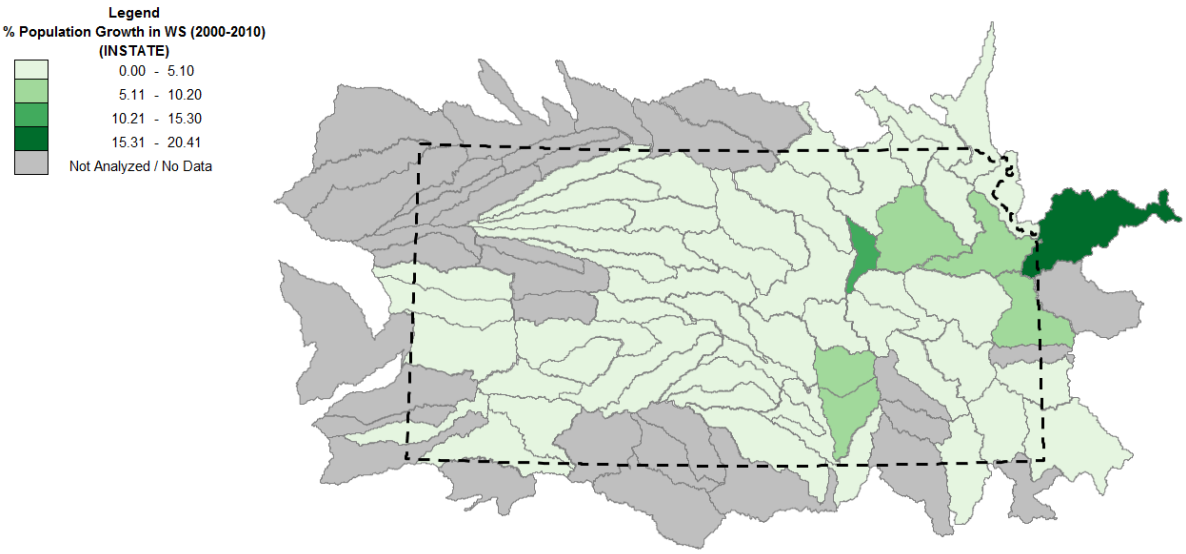


Figure 20. Select ecological indicators (IBI and natural cover)





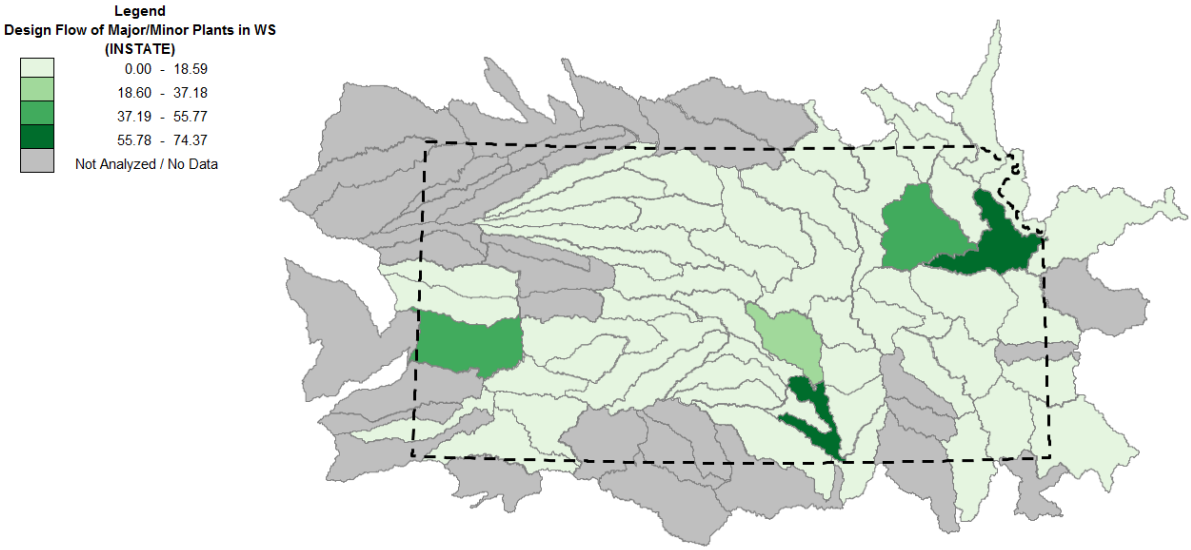


Figure 21. Select stressor indicators (count of animal feeding operations, population growth, and wastewater flows)

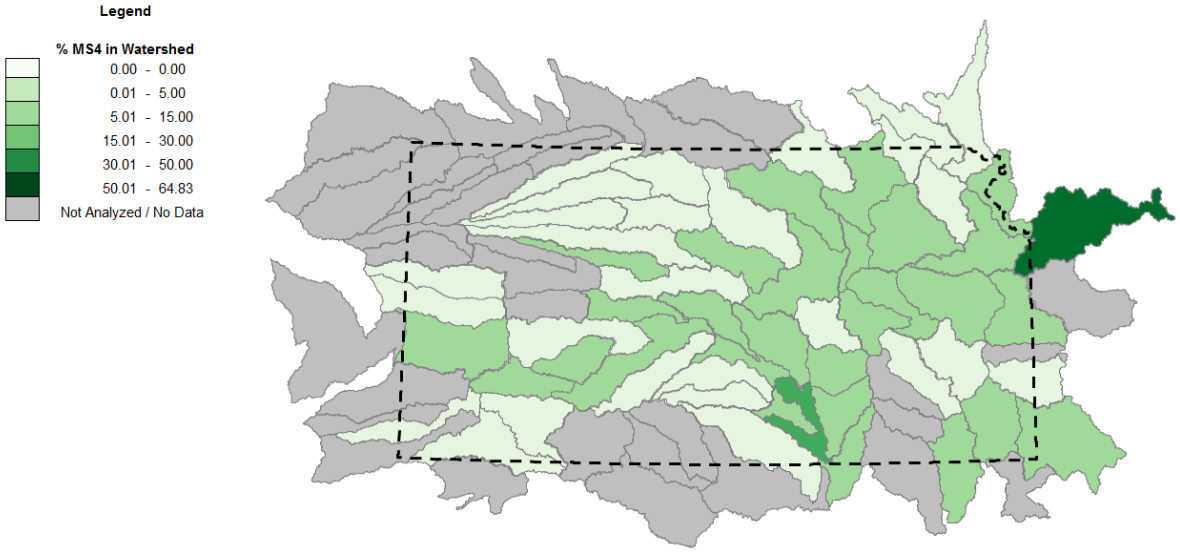


Figure 22. Select social indicator (% MS4)

Table 6. Index and RPI scores for Scenario 3. HUC8 watersheds are ordered by RPI score. Cells in each column are shaded by quartile according to rank for each of the four indices (black = 76 -100th percentile; dark gray = 51-75th percentile; light gray = 26-50th percentile; white = 0-25th percentile).

Watershed ID	Watershed Name	Ecological Index	Ecological Rank	Stressor Index	Stressor Rank	Social Index	Social Rank	RPI Score	RPI Rank
11070201	Neosho Headwaters	68.10	1	7.30	16	20.20	13	60.33	1
10290101	Upper Marais Des Cygnes	52.92	10	10.90	26	30.25	9	57.42	2
11070205	Middle Neosho	41.32	19	8.18	20	30.50	7	54.55	3
11070101	Upper Verdigris	55.64	7	2.00	1	10.00	26	54.55	4
11030018	Lower Walnut River	58.44	5	11.21	28	13.45	20	53.56	5
11070203	Lower Cottonwood	65.80	2	8.00	18	0.55	53	52.78	6
11060001	Kaw Lake	62.02	3	3.81	4	0.00	55	52.74	7
10270104	Lower Kansas, Kansas	32.64	32	36.20	55	59.80	2	52.08	8
11030009	Rattlesnake	45.74	13	4.49	6	10.00	26	50.42	9
11030014	North Fork Ninnescah	52.40	11	6.51	12	5.00	43	50.30	10
10270102	Middle Kansas	53.62	9	26.24	51	23.15	12	50.18	11
11070202	Upper Cottonwood	58.24	6	12.85	34	5.00	43	50.13	12

Watershed ID	Watershed Name	Ecological Index	Ecological Rank	Stressor Index	Stressor Rank	Social Index	Social Rank	RPI Score	RPI Rank
10290104	Marmaton	30.06	39	4.75	8	25.00	11	50.10	13
10290102	Lower Marais Des Cygnes	30.38	37	10.85	25	30.30	8	49.94	14
10260008	Lower Smoky Hill	39.50	21	21.16	50	30.60	6	49.65	15
10270101	Upper Kansas	58.88	4	16.93	45	6.95	37	49.64	16
10260013	Upper South Fork Solomon	41.52	18	3.24	3	10.00	26	49.43	17
11070103	Middle Verdigris	41.72	17	6.34	11	10.95	22	48.78	18
11030012	Little Arkansas	36.28	24	28.33	53	37.60	4	48.52	19
10240011	Independence-Sugar	27.60	45	15.10	40	32.50	5	48.33	20
11070204	Upper Neosho	43.80	15	8.90	23	10.00	26	48.30	21
11030017	Upper Walnut River	54.70	8	26.74	52	15.70	17	47.89	22
10260011	Upper North Fork Solomon	34.54	28	8.20	21	15.00	19	47.11	23
11040006	Upper Cimarron-Liberal	47.22	12	11.11	27	5.00	43	47.04	24
11070207	Spring	43.44	16	16.15	42	12.15	21	46.48	25
10300101	Lower Missouri-Crooked	15.48	56	36.25	56	60.00	1	46.41	26
11030015	South Fork Ninnescah	41.04	20	6.96	15	5.00	43	46.36	27
10260004	Ladder	39.00	23	5.53	10	5.00	43	46.16	28
11060005	Chikaskia	39.38	22	6.75	14	5.00	43	45.88	29
10270205	Lower Big Blue	43.84	14	16.90	44	10.40	23	45.78	30
10240005	Tarkio-Wolf	28.44	43	2.95	2	10.00	26	45.16	31
10260006	Middle Smoky Hill	32.40	33	7.43	17	10.00	26	44.99	32
10250015	Prairie Dog	21.34	52	16.51	43	30.00	10	44.94	33
10260015	Solomon	28.04	44	17.09	46	20.00	15	43.65	34
10260014	Lower South Fork Solomon	28.56	42	8.05	19	10.00	26	43.50	35
10270207	Lower Little Blue	33.28	30	12.80	33	10.00	26	43.49	36
11030013	Middle Arkansas-Slate	34.40	29	43.74	57	39.65	3	43.44	37
11030010	Gar-Peace	35.66	26	12.11	29	5.95	39	43.17	38
10260007	Big	25.70	47	12.46	30	15.70	17	42.98	39
11040003	North Fork Cimarron	32.68	31	4.19	5	0.00	55	42.83	40
11030002	Whitewoman	31.98	35	4.53	7	0.00	55	42.48	41
11030001	Middle Arkansas-Lake McKinney	29.86	40	13.39	36	10.30	24	42.26	42
10240007	South Fork Big Nemaha	30.08	38	13.60	37	10.00	26	42.16	43
11040007	Crooked	25.96	46	5.26	9	5.00	43	41.90	44
10270103	Delaware	18.86	54	13.83	38	20.00	15	41.68	45
11030016	Ninnescah	29.08	41	9.25	24	5.05	42	41.63	46
10260010	Lower Saline	34.94	27	12.78	32	0.60	52	40.92	47
10260009	Upper Saline	35.84	25	18.13	48	5.00	43	40.91	48
11030006	Buckner	24.34	48	12.70	31	10.25	25	40.63	49
10250017	Lower Republican	32.30	34	33.01	54	20.15	14	39.81	50
11030004	Coon-Pickerel	30.84	36	12.86	35	0.35	54	39.44	51
11030005	Pawnee	19.46	53	6.74	13	5.00	43	39.24	52
10260012	Lower North Fork Solomon	22.38	50	15.69	41	10.00	26	38.90	53
11030011	Cow	23.36	49	14.81	39	6.05	38	38.20	54
11030003	Arkansas-Dodge City	14.32	57	8.79	22	5.40	41	36.98	55
11030008	Lower Walnut Creek	21.74	51	17.33	47	5.65	40	36.69	56
10240008	Big Nemaha	17.14	55	20.38	49	10.00	26	35.59	57

STAGE 2 ANALYSIS AND RESULTS

As described in the Approach section of this report, the Stage 2 analysis compares HUC12 subwatersheds to one another for the purpose of identifying priority HUC12s for actions to reduce nutrient loads. A much more extensive array of RPS indicators is available at the HUC12 scale (compared to HUC8), enabling specific targeting of indicators relevant to the implementation of nutrient management activities.

Stage 2 indicators and weights were selected by EPA and used in the Stage 2 screenings carried out by EPA. The three Stage 2 scenarios formulated by EPA and KDHE were:

- Scenario 1 – HUC12s that are candidates for nutrient TMDL development where nutrients may impact public water supplies;
- Scenario 2 – HUC12s with opportunities to significantly reduce nonpoint source nutrient loads;
- Scenario 3 – HUC12s that are candidates for nutrient TMDL development that are significantly influenced by NPDES permitted dischargers.

Stage 2 screenings were completed for HUC12s within a single HUC8 (Lower Big Blue) for scenario 1 and statewide for all HUC12s in scenarios 2 and 3. The Stage 2 screening results are briefly summarized below. As with the Stage 1 screenings, a separate copy of the RPS Tool for each of the demonstration scenarios has been archived for delivery to KDHE with other products.

Results of Stage 2-Scenario 1

Scenario 1 focused on evaluating HUC12 subwatersheds within a single HUC8 that are: (a) candidates for nutrient TMDL development *and*; (b) have public drinking water supplies that are potentially impacted by nutrients. To begin the analysis, EPA reviewed characteristics of HUC8s that contain nutrient impairments and drinking water supplies. Stage 1 analysis found that 71 of 90 HUC8s in Kansas have nutrient impairments and drinking water supplies. These 71 HUC8s vary in the number of nutrient impairment listings, the size of public water systems, and relative HUC8 condition. Together, EPA and KDHE determined that the Lower Big Blue watershed (Figure 1) was the best candidate for demonstrating Scenario 1. The Lower Big Blue watershed is a known priority for drinking water supplies and has over 20 nutrient impairment listings.

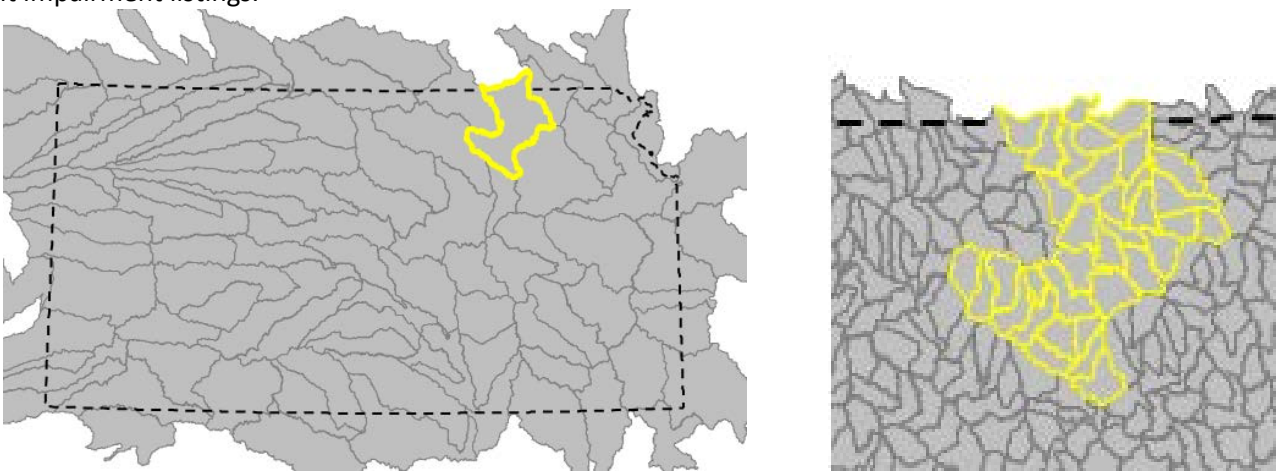


Figure 23. Map of Kansas HUC8s with the Lower Big Blue HUC8 highlighted (left) and HUC12s within the Lower Big Blue HUC8 (right).

The Lower Big Blue watershed contains 35 HUC12s that were compared in two screenings that separately focused on agricultural and urban sources of nutrients. Indicators selections for the two screenings are listed in Table 1 (indicator descriptions can be found in Attachment 1). Both screenings use the same ecological and social indicators but differ in the stressor indicators selected to reflect agricultural versus urban nutrient sources.

Table 7. Indicator selections for the Stage 2-Scenario 1 screenings.

Ecological Indicators	Stressor Indicators (Agricultural)	Stressor Indicators (Urban)	Social Indicators
PHWA Watershed Health Index, State (2016)	% Agriculture in WS (2011)	% Urban in RZ (2011)	USDA Conservation Reserve Program Area in WS
PHWA Watershed Health Index, ER (2016)	% Cultivated Crops in RZ (2011)	% Urban Change in WS (2001-11)	% Streamlength Assessed (2015)
	% Pasture/Hay in RZ (2011)	% Developed, Open Space in WS (2011)	Nonpoint Control Projects Count
	Agricultural Water Demand in WS	% Developed, Medium Intensity in RZ (2011)	Nutrients Nonpoint Control Projects Presence
	Manure Application in WS	% Developed, Low Intensity in RZ (2011)	Critical Watershed Class Score (Instate)
	Synthetic N Fertilizer Application in WS	% Waters Near >= 5% Impervious Cover (2011)	Count (2011-2014) Conservation Practices (Instate)
	303(d)-Listed Segments Count (2015)	Population Density in RZ	303(d) Vision Restoration Priority 2017
	% Streamlength 303(d)-Listed Nutrients (2015)	303(d)-Listed Segments Count (2015)	WRAPS 2018 Priority for Cropland
	Number of Animals (USDA County) in WS (Instate)	Segment-Cause Impairment Combinations Count (2015)	WRAPS 2018 Priority for Livestock
	Count of Animal Feeding Operations in WS (Instate)	Nutrients 303(d)-Listed Segments Count (2015)	WRAPS 2018 Priority for Steambank
		% Streamlength 303(d)-Listed Nutrients (2015)	WRAPS 2018 Priority Sum
		Number of Septic Systems in WS (INSTATE)	

Bubble plots displaying Ecological, Stressor, and Social index scores for the Scenario 1 agricultural and urban screenings are displayed in Figure 2. The RPS Tool is able to generate two separate bubble plots for any screening: a "subset" version and a "statewide" version. The subset version displays index scores exactly as calculated with user-supplied screening settings (watersheds, indicators, and weights). The statewide version displays scores that are based on the same indicators and weights but considers all watersheds in the state for index score calculation. The statewide bubble plot provides a broader context for evaluating the screening results so that users can understand how the highest and lowest index scores for their selected watersheds compare to statewide values.

Figure 2 displays both the subset and statewide bubble plots for the agricultural and urban screenings. Key observations include:

- In the statewide bubble plots, HUC12s are generally condensed within a smaller range of index scores compared to the subset plots. This is a typical result. Index scores in the statewide plots consider a larger group of HUC12s with a wider range of indicator values, which serve as the basis of index scoring. Relative differences among HUC12s in indicator values are, therefore, less pronounced in the statewide plots.
- In the statewide bubble plots, the HUC12s selected for screening have Ecological Index scores that extend above and below the horizontal axis. Since the horizontal axis is set to the statewide median Ecological Index score, this points to a wide variety of ecological conditions within the Lower Big Blue HUC12s above and below what is typical for the state.
- Similarly, Stressor Index scores in the statewide bubble plot for the agricultural screening extend across both sides of the vertical axis (the statewide median Stressor Index). This indicates a wide range of stressor exposure within the Lower Big Blue HUC12s.
- The median Stressor Index (vertical axis) for the urban screening is near zero in the statewide bubble plot. This commonly occurs when the stressor indicators selected for a screening measure attributes that are relatively uncommon across the entire state and cluster at zero or near-zero values. In this case, the finding of a near-zero Stressor Index for the urban screening reflects the rural setting of most Kansas HUC12s.
- In both the agricultural and urban scenarios, Social Index scores vary widely among the subset of watersheds selected for screening (i.e., a wide range of bubble sizes is apparent). The statewide and subset plots do not show major differences in Social Index scores, indicating that social indicator values in the watershed subsets are representative of statewide conditions.

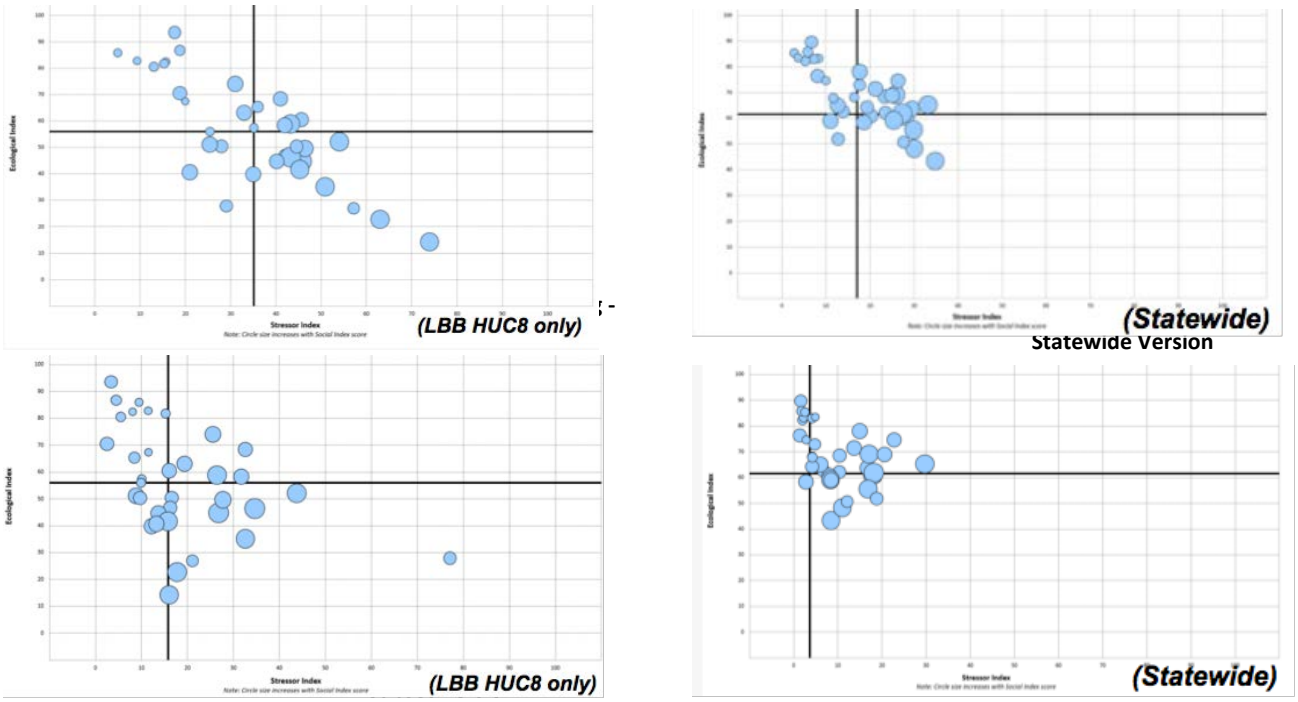


Figure 24. Bubble plots for Stage 2-Scenario 1 screenings. For each screening, a "subset" version and a "statewide" version of the bubble plot are displayed.

The agricultural and urban RPS screenings were used to evaluate potential priority HUC12s in the Lower Big Blue watershed for TMDL development and implementation. The evaluation of potential priorities was organized around the following questions:

1. Which HUC12s have programmatic attributes that support nutrient TMDL development?
    a. Not fully supporting domestic water supply designated uses
    b. 303(d) listed for nutrients
    c. Limited presence of existing nutrient TMDLs
    d. Prior designation as a priority by the Kansas Watershed Restoration and Protection Strategy (WRAPS) program or Kansas 303(d) program
2. How do index scores compare among potential priority HUC12s for nutrient TMDL development?
3. What nutrient management actions might be needed in potential priority HUC12s?

Which HUC12s have programmatic attributes that support nutrient TMDL development?
Question 1 focuses on identifying HUC12s with attributes relevant to 303(d) and other clean water programs that support their designation as priorities for nutrient TMDL development. These attributes include: (a) the presence of waters that are not supporting designated uses for domestic water supply; (b) the presence of waters that are 303(d) listed for nutrients; (c) limited presence of existing nutrient TMDLs; (d) and the presence of waters that were previously designated as a WRAPS or 303(d) program priority. These four factors indicate that nutrient TMDLs are needed, that drinking water supplies may be at risk from excess nutrient loading, and that support for prioritization has been previously established.

Question 1 was evaluated using indicator data presented on the "HUC12 Data" tab of the RPS Tool (Table 2). Out of 35 total HUC12s in the Lower Big Blue watershed, 12 were not fully supporting their domestic water supply designated uses, 22 had nutrient 303(d) listings, 2 had existing nutrient TMDLS, and 23 were state-defined WRAPS or 303(d) priority waters. Eight HUC12s combined all four attributes:

- Alcove Spring-Big Blue River (102702050502)
- Cedar Creek-Big Blue River (102702050705)
- Cedar Creek-Black Vermillion River (102702050405)
- Corndodger Creek-Black Vermillion River (102702050406)
- Deer Creek-Big Blue River (102702050204)
- Irish Creek (102702050305)
- Outlet North Fork Black Vermillion River (102702050302)
- Outlet Robidoux Creek (102702050403)

These eight HUC12s are of particular interest for this scenario and are highlighted in the following discussion of additional screening questions.

Table 8. HUC12s in the Lower Big Blue watershed with information on domestic water supply designated use attainment, nutrient impairments, nutrient TMDLs, and 303(d) program or WRAPS priority designations.

Name HUC12 Watershed	Not Attaining Drinking Water Supply Designated Use	Nutrient Impaired Segment Count	Nutrient TMDL Count	2017 303(d) Vision Priority Flag	Count of 2018 WRAPS Priorities
Deer Creek-Big Blue River	X	4	0	X	4
Outlet North Fork Black Vermillion River	X	2	0	X	3
Irish Creek	X	2	0	X	1
Outlet Robidoux Creek	X	4	0	X	3
Cedar Creek-Black Vermillion River	X	5	0	X	1
Corndodger Creek-Black Vermillion River	X	1	0	X	1
Alcove Spring-Big Blue River	X	5	0	X	1
Carter Creek-West Fancy Creek	X	0	0		0
Deadman Creek-West Fancy Creek	X	0	0		0
North Fork Fancy Creek-West Fancy Creek	X	0	0		0
Otter Creek-Fancy Creek	X	0	0		0
Cedar Creek-Big Blue River	X	3	0	X	1
Mission Creek		2	0	X	1
Big Blue River		1	0	X	1
North Elm Creek-Big Blue River		4	0	X	4
Headwaters Horseshoe Creek		2	0	X	1
Outlet Horseshoe Creek		4	0	X	1
Headwaters North Fork Black Vermillion River		1	0	X	3
Town of Centralia-Black Vermillion River		2	1	X	1
Town of Vermillion-Black Vermillion River		1	0	X	1
Little Timber Creek-Black Vermillion River		7	0	X	3
Headwaters Robidoux Creek		1	0	X	3
Snipe Creek		0	0		2
Clear Fork		2	0	X	1
Marysville Country Club Dam-Spring Creek		3	0	X	3
Elm Creek-Big Blue River		4	0	X	1
Bluff Creek		0	0		0
Game Fork-Big Blue River		0	0	X	1
Swede Creek-Tuttle Creek Lake		0	0		0
North Otter Creek		0	0		0
Walnut Creek-Fancy Creek		0	0		0
Booth Creek-Tuttle Creek Lake		0	0		0
Mill Creek-Tuttle Creek Lake		0	0		0
Big Blue River-Tuttle Creek Lake		0	0		0
Tuttle Creek Dam		1	1		0

How do index scores compare among potential priority HUC12s for nutrient TMDL development?
Question 2 can be evaluated with bubble plots displaying RPS screening results by reviewing the position of the eight HUC12s identified from question 1. Figure 3 displays bubble plots for the agricultural and urban screenings with labels added to the eight HUC12s of interest.

In both screenings, the eight HUC12s of interest cover a wide range of Ecological and Stressor Index scores. Four of these (Alcove Spring-Big Blue River; Cedar Creek-Black Vermillion River; Irish Creek; Outlet Robidoux Creek) have above-median Ecological Index scores and also have Stressor Index scores that are near or above the median for the screening. These four HUC12s could be prioritized for nutrient TMDL development because they appear to have moderate levels of agricultural and urban stressors, but still maintain positive ecological traits that can facilitate improvement in aquatic ecosystems within the HUC12 and might lead to full restoration .

Conversely, HUC12s with higher Stressor Index scores but lower Ecological Index scores (e.g., Outlet North Fork Black Vermillion River, Deer Creek-Big Blue River, Cedar Creek-Big Blue River) may be of greater interest for efforts targeting HUC12s with the highest nutrient loads to reduce downstream impacts.

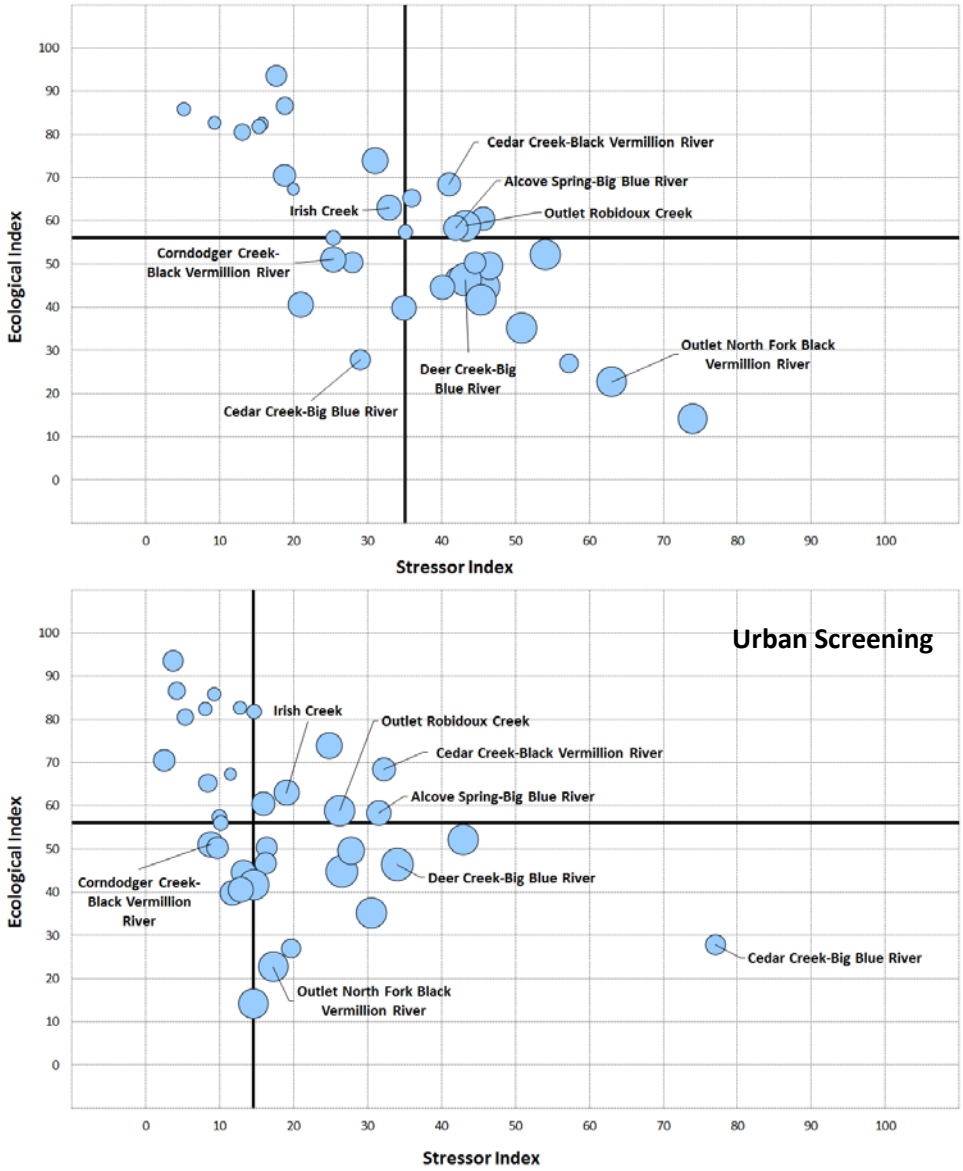


Figure 25. Bubble plots for the Stage 2-Scenario 1 screenings. The labeled HUC12s are potential priorities for nutrient TMDL development because they contain waters that are not supporting domestic water supply designated uses, waters that are 303(d) listed for nutrients, and waters previously designated as a WRAPS or 303(d) program priority.

What nutrient management actions might be needed in potential priority HUC12s?

Although the RPS Tool is primarily a screening-level resource for comparing relative conditions within a group of watersheds, it can also be used for initial evaluations of specific water quality restoration needs in one or more watersheds. Figure 4 displays bubble plots for the agricultural screening with bubbles shaded according to three indicators that are relevant to nutrient reduction planning:

(a) *Percentage of the HUC12 with cultivated crops in the riparian zone* (defined as the 100-meter buffer around surface waters). Figure 4a shows that potential priority HUC12s have between 5% and 9% of their area covered by cultivated crops in the riparian zone, equating to approximately 1,250 acres to 3,700 acres of riparian zone in the HUC12s of interest. These HUC12s appear to have sufficient crop cover in their riparian zone to benefit from efforts to promote the establishment and expansion of vegetated buffers to filter agricultural runoff.

(b) *Average rate of synthetic nitrogen fertilizer application in the HUC12*. In Figure 4b, five of the potential priority HUC12s appear to have moderate to high rates of synthetic fertilizer application compared to other HUC12s (Alcove Spring-Big Blue River, Cedar Creek-Black Vermillion River, Deer Creek-Big Blue River, Outlet North Fork Black Vermillion River, and Outlet Robidoux Creek). Annual application rates for the five HUC12s range from 36 to 58 kilograms of nitrogen per hectare, all of which are above the statewide average of approximately 26 kilograms of nitrogen per hectare. These five HUC12s may therefore be good candidates to implement programs that aim to reduce over-application of fertilizers on agricultural lands.

(c) *The number of animal feeding operations (AFOs) in the HUC12*. Figure 4c displays AFO counts in each HUC12 in the Lower Big Blue watershed. All of the potential priorities for TMDL development have at least one AFO, with the highest count (6 AFOs) in the Outlet North Fork Black Vermillion River and the Cedar Creek-Big Blue River HUC12s. Efforts to encourage best practices for animal manure management may help to reduce nutrient loading in these HUC12s.

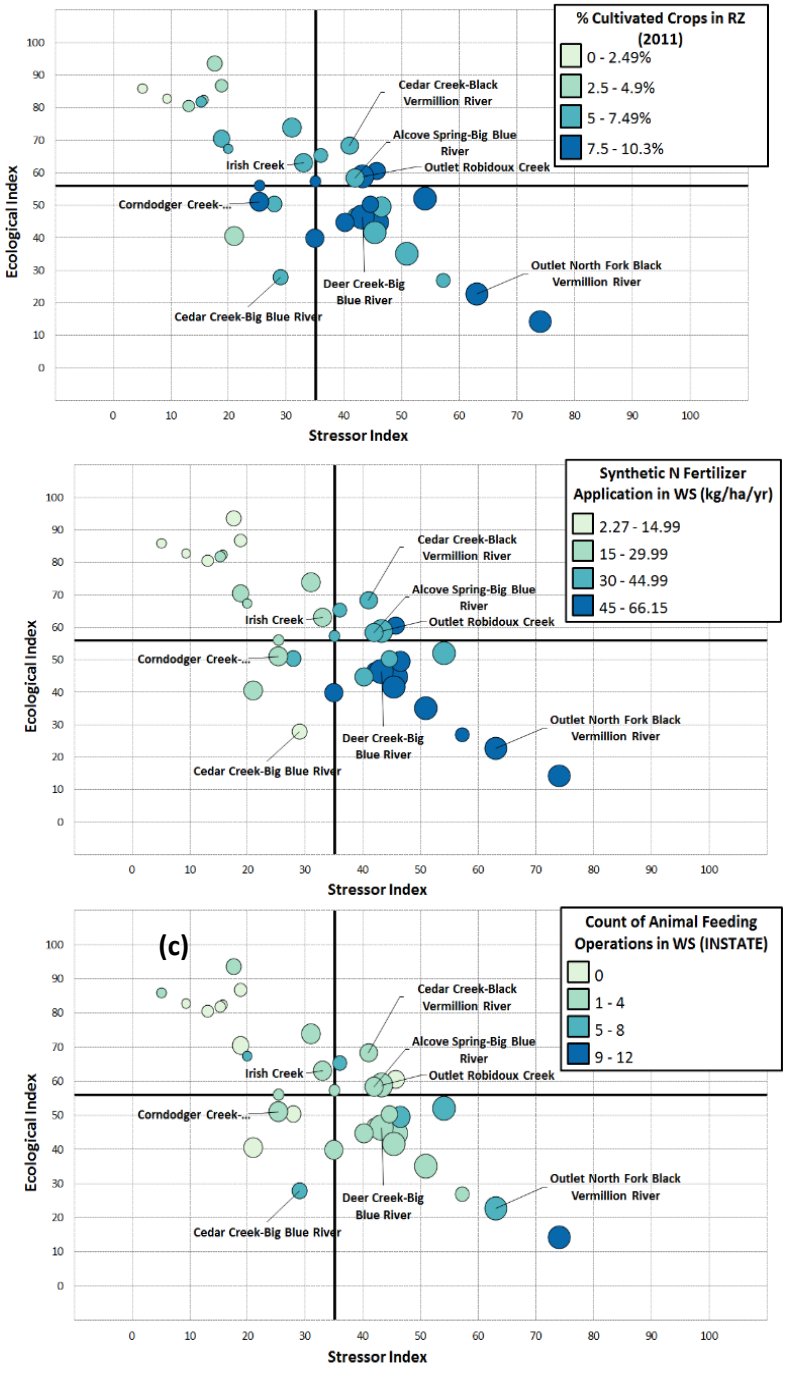


Figure 26. Bubble plots for the Stage 2-Scenario 1 agricultural screening with labels applied to potential priority HUC12s for nutrient TMDL development. The bubbles in each plot are shaded according to different indicators of agricultural nutrient sources.

A similar review can be completed for the urban screening. Figure 5 displays bubble plots for the urban screening with bubbles shaded according to three indicators that are relevant to management of urban nutrient sources:

(a) *Percent of the HUC12 with urban cover in the riparian zone* (defined as the 100-meter buffer around surface waters). Figure 5a shows that most of the priority HUC12s have less than 1% of their area classified as urban land cover in the riparian zone. The exceptions are the Deer Creek-Big Blue River HUC12 (1.2%) and the Cedar Creek-Big Blue River HUC12 (4.2%). Results suggest that the Cedar Creek-Big Blue River HUC12 may be a prime candidate to significantly benefit from efforts to promote the establishment and expansion of vegetated buffers to filter urban runoff.

(b) *Percent impervious cover in the HUC12*. Figure 5b also reflects the limited extent of urban development in the Lower Big Blue watershed, as only the Deer Creek-Big Blue River HUC12 (1.4%) and the Cedar Creek-Big Blue River HUC12 (4.7%) have impervious cover percentages greater than 1%. This reinforces the designation of the Cedar Creek-Big Blue River HUC12 as a better candidate for actions to reduce nutrient loading from urban lands, such as the installation of retention basins, rain gardens, and other stormwater best management practices (BMPs).

(c) *Number of septic systems in the HUC12*. Figure 5c displays septic system counts for each HUC12 in the Lower Big Blue watershed. All of the potential priorities for TMDL development have some septic systems present, however, the Deer Creek-Big Blue River HUC12 and Cedar Creek-Big Blue River HUC12 again stand out with 196 and 886 septic systems, respectively. These two HUC12s appear to be best-suited for efforts to inventory and upgrade septic systems and expand centralized sewer services.

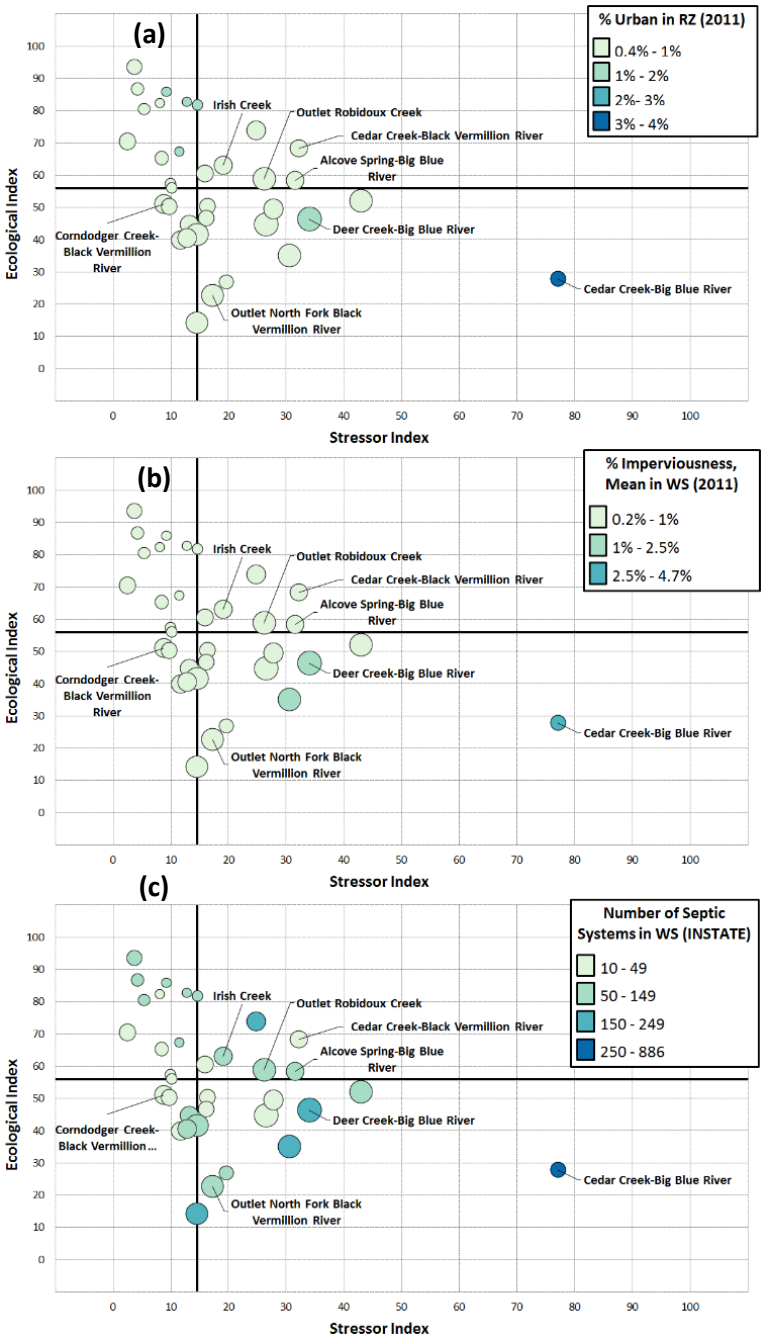


Figure 27. Bubble plots for the Stage 2-Scenario 1 urban screening with labels applied to potential priority HUC12s for nutrient TMDL development. The bubbles in each plot are shaded according to different indicators of urban nutrient sources.

Results of Stage 2-Scenario 2

Scenario 2 consisted of an exploratory analysis of HUC12 subwatersheds across the state to evaluate opportunities to reduce nutrient loading from nonpoint source pollution. The analysis focused on HUC12s that were already identified as priorities through the Kansas Watershed Restoration and Protection Strategy (WRAPS) framework. Included in the Kansas RPS tool are social indicators that describe whether each HUC12 in the state has been designated as a high, medium, or low priority under the WRAPS program in different categories (e.g., urban stormwater, cropland, streambank erosion, TMDL development). For each category, indicators are scored as 1.0 for high priority, 0.67 for medium priority, and 0.33 for low priority within the RPS tool. As of March 2018, a total of 340 HUC12s in Kansas were assigned WRAPS priority status in at least one category. Figure 6 illustrates the sum of WRAPS priority scores in each HUC12. The HUC12s with the highest WRAPS priority totals are shaded dark blue in Figure 6 and were designated as high priority in at least three categories. These HUC12s generally cluster in the eastern portion of the state.

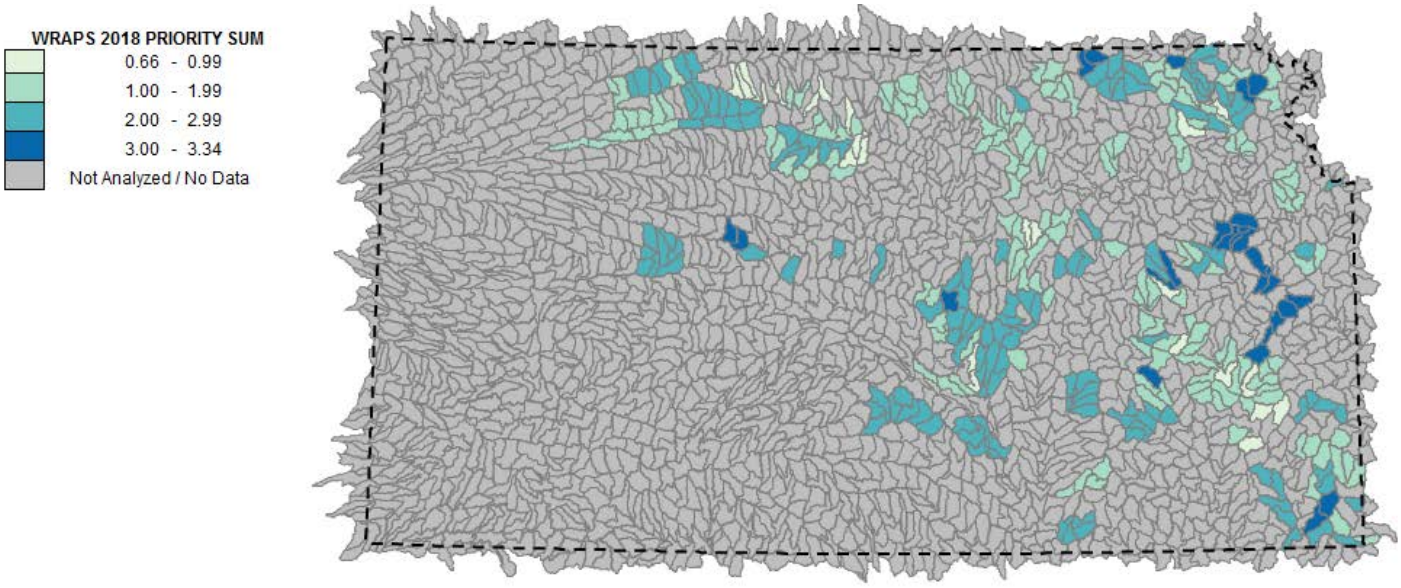


Figure 28. Sum of WRAPS priority scores for Kansas HUC12s. Summed values reflect the total of individual priority scores for various categories (e.g., urban stormwater, cropland, streambank erosion, TMDL development).

The exploratory analysis completed for scenario 2 did not include a formal RPS screening run. Instead, indicator data for HUC12s with WRAPS priorities were reviewed using the RPS tool's mapping functionality. The scenario 2 analysis was organized around the following questions for HUC12s with WRAPS priorities:

1. Which HUC12s contain nutrient impaired waters?
2. In which HUC12s are urban and agricultural nonpoint sources of nutrients prevalent?
3. What additional impairments are present in the HUC12s?
4. Which HUC12s might be considered for actions to protect water quality from future degradation?

Which HUC12s contain nutrient impaired waters?

Of the 340 HUC12s with WRAPS priority status, 178 contain at least one nutrient impaired waterbody segment. Figure 7 displays the extent of nutrient impairments in each HUC12. Impairment extent is mapped as the number of waterbody segments with nutrient impairments (top), the percentage of HUC12 streamlength with nutrient impairments (middle), and the percentage of HUC12 lake or reservoir area with nutrient impairments (bottom). The maps show a wide range in the extent of nutrient impairment within the HUC12s. For example the percentage of impaired streamlength ranges from 1% to 91% in HUC12s with at least one nutrient impaired segment. This variety offers planners an opportunity to determine whether nonpoint source management resources should be directed towards HUC12s with widespread issues versus HUC12s with isolated nutrient impairments.

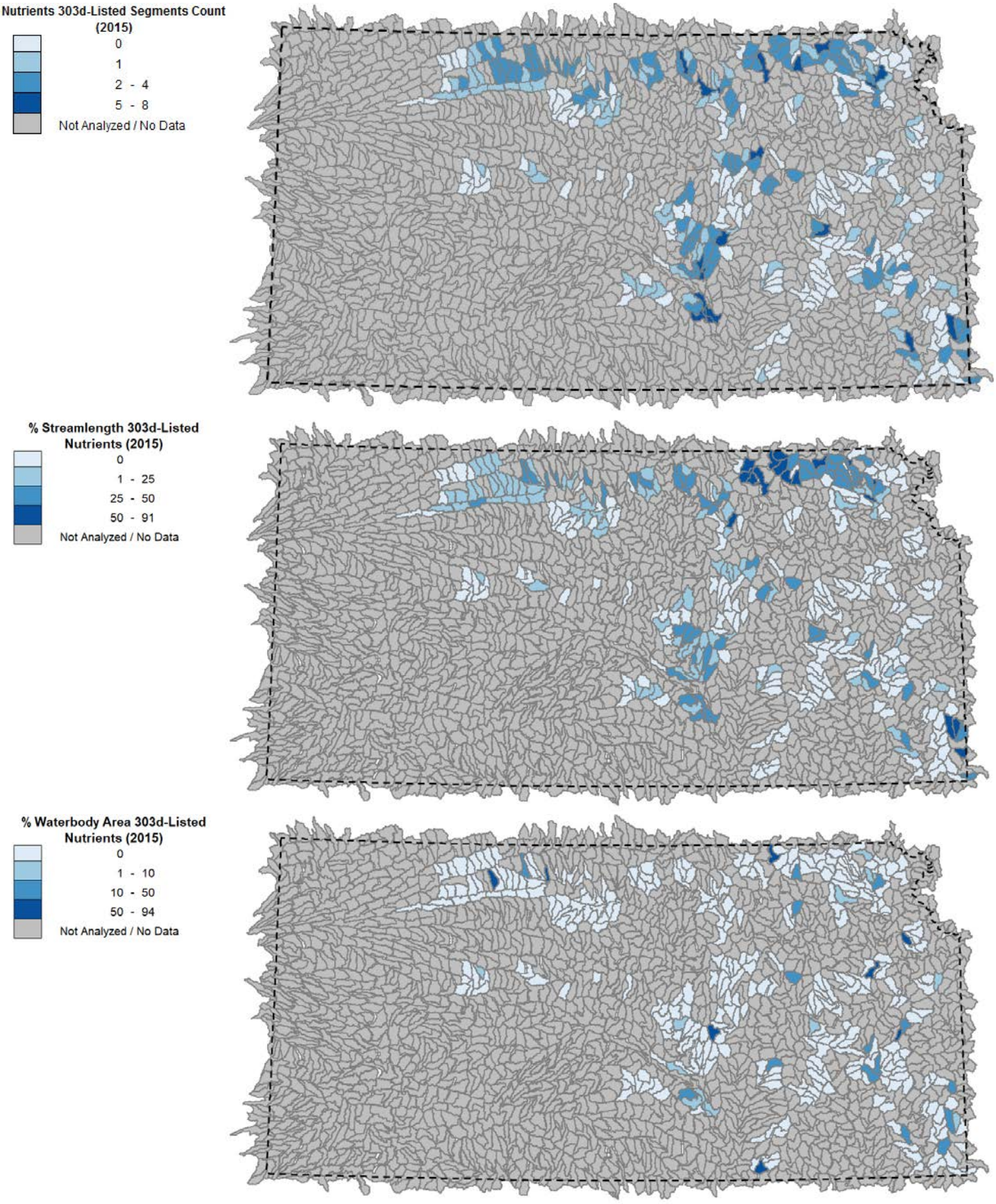


Figure 29. Nutrient impaired waters in HUC12s with WRAPS priority status. Impairments are mapped as: the count of waterbody segments with nutrient impairments (top), the percentage of streamlength with nutrient impairments (middle), and the percentage of waterbody area with nutrient impairments (bottom).

In which HUC12s are urban and agricultural nonpoint sources of nutrients prevalent?
Watershed priorities can be further refined by identifying likely sources of nutrients within HUC12s. Figure 8 through Figure 10 display indicators of the potential for nonpoint source pollution from urban stormwater and agricultural runoff. Figure 8 shows that most HUC12s with WRAPS priorities have a relatively low amount of impervious cover (less than 5% of the HUC12). While urban stormwater issues may be present these HUC12s, they are likely to be site- or reach-specific and not prevalent throughout the HUC12 area. Three HUC12s in the vicinity of Wichita (Cadillac Lake-Cowskin Creek; Wichita Floodway; Wichita VC Floodway-Arkansas River) have more than 10% impervious cover and are at greater risk for widespread urban stormwater pollution.

The percentage of cropland in each HUC12 is mapped in Figure 9. Reflective of Kansas' character as an important agricultural state, a large number of HUC12s have cropland cover across at least 50% of their area. While this group of HUC12s could be considered priorities for implementing agricultural BMPs, a review of additional indicators can pinpoint watersheds in greater need of specific management actions. For example, Figure 10 shows estimated annual rates of phosphorus application to cropland from chemical fertilizer. HUC12s in Figure 10 are shaded according to their percentile rank for phosphorus application. Those within the top ten percentile (highest phosphorus application; shaded dark blue) are concentrated in the northeast and east-central part of the state. These HUC12s could be higher priorities for BMPs that reduce nutrient concentrations in agricultural runoff or outreach efforts to producers on preventing over-application of fertilizer.

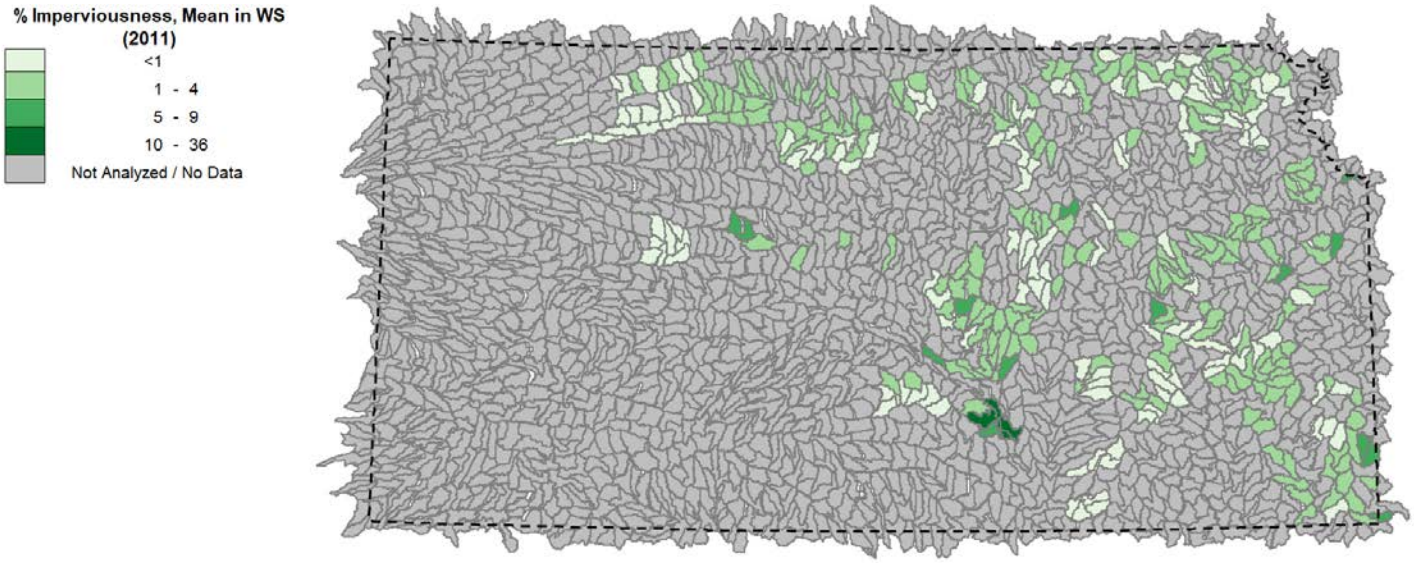


Figure 30. Percentage of impervious cover in HUC12s with WRAPS priority status.

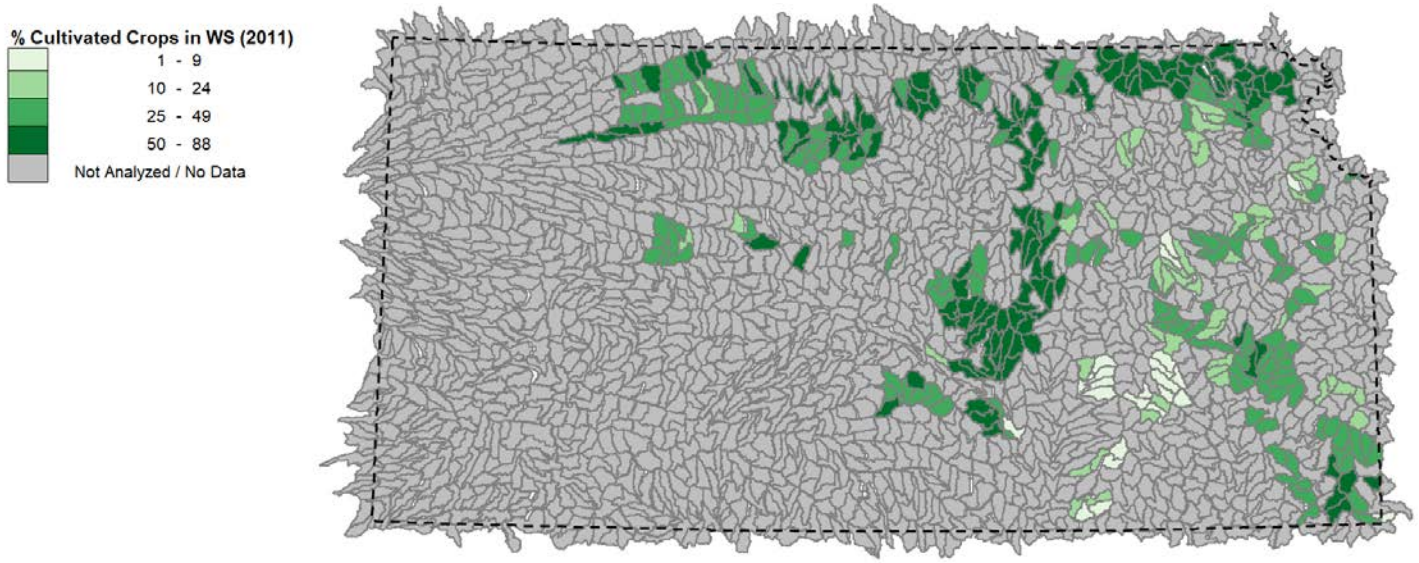


Figure 31. Percentage of cultivated cropland in HUC12s with WRAPS priority status.

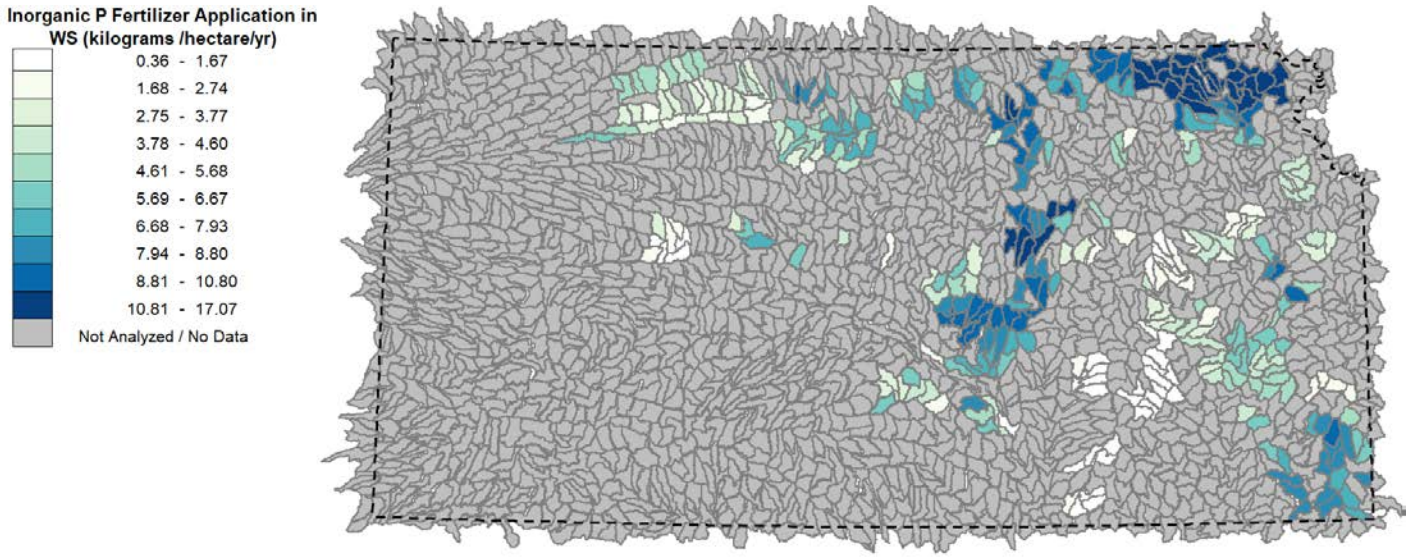


Figure 32. Estimated rates of agricultural phosphorus application from chemical fertilizer in HUC12s with WRAPS priority status.

What additional impairments are present in the HUC12s?

The goals of a nonpoint source management plan could include restoration of degraded biological communities or de-listing of impaired waterbody segments. To achieve such goals, an understanding of the complete group of pollutants of concern within a watershed is needed. The Kansas 303(d) list of impaired waters serves as a resource for identifying pollutants of concern that are causing designated use impairments. Figure 11 displays the number of impairment causes within each HUC12 as reported on the Kansas 303(d) list. Impairment causes can include nutrients, pathogens, temperature, metals, pesticides, salinity, sediment, impaired biota, etc. Figure 11 can be compared with the number of nutrient impaired segments (Figure 7; top) to identify HUC12s in which nutrients are the only cause of impairment (i.e., HUC12s with one cause of impairment and at least one nutrient-impaired segment). These HUC12s might be priorities for nonpoint source management because they could be de-listed with reduced nutrient loading and their biological communities may show greater recovery following nutrient reductions relative to ecosystems that are subject to excess levels of metals, pesticides, etc.

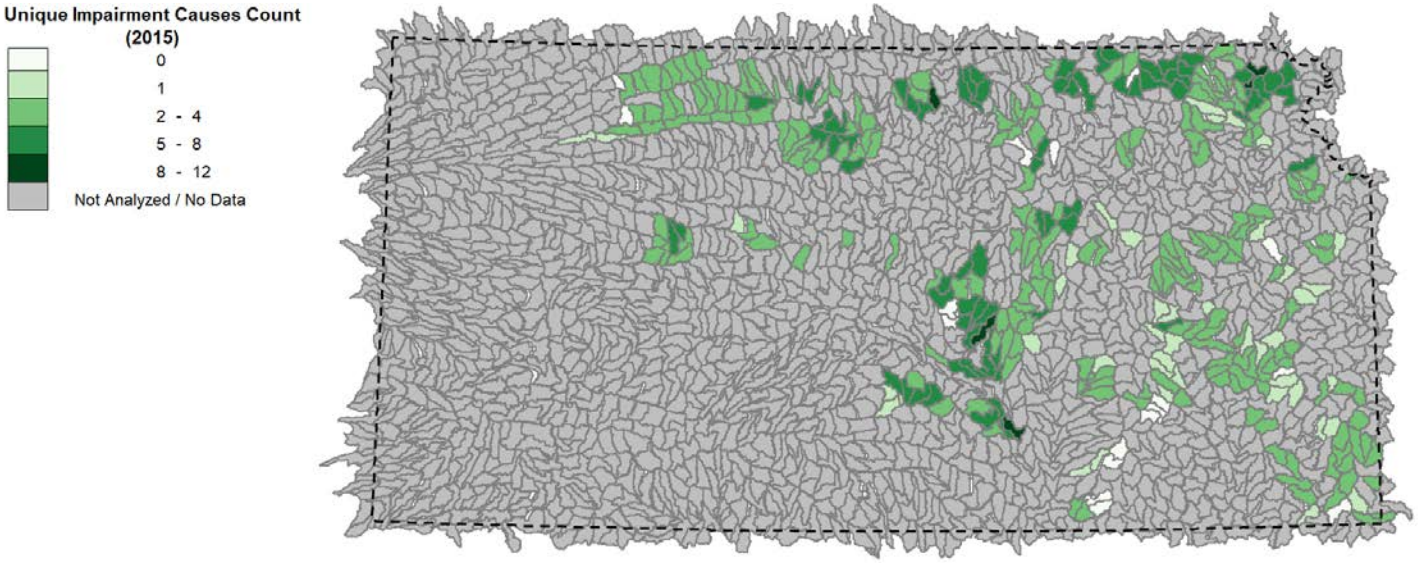


Figure 33. Number of impairment causes reported on the Kansas 303(d) list in HUC12s with WRAPS priority status.

Which HUC12s might be considered for actions to protect water quality from future degradation?

Although degraded watersheds with water quality impairments are often the focus of nonpoint source management resources, proactive actions in unimpaired watersheds can prevent future impairments and avoid the need for costly restoration measures. Activities to prevent or minimize pollutant loading from future development can also be paired with restoration actions in impaired watersheds to support long-term water quality protection. For example, restoration of degraded riparian buffers can be paired with easement acquisition to ensure long-term protection of the restored buffers. One indicator in the RPS tool that can guide the prioritization of watersheds for protection is the Preliminary Healthy Watersheds Assessment (PHWA) statewide Watershed Health Index (https://www.epa.gov/hwp/download-2017-preliminary-healthy-watersheds-assessments). This indicator scores HUC12s according to their potential for supporting healthy, functioning aquatic ecosystems by combing subindices of landscape, hydrologic, geomorphology, habitat, water quality, and biological condition. Figure 12 maps Watershed Health Index scores as a percentile relative to all other HUC12s in the state. HUC12s in the top ten percentile could be prioritized for protection since they are most likely to support functioning aquatic ecosystems. HUC12s in the second grouping (75th-89th percentile) could also be prioritized for protection since they may be more vulnerable to degradation from future increases in pollutant loading.

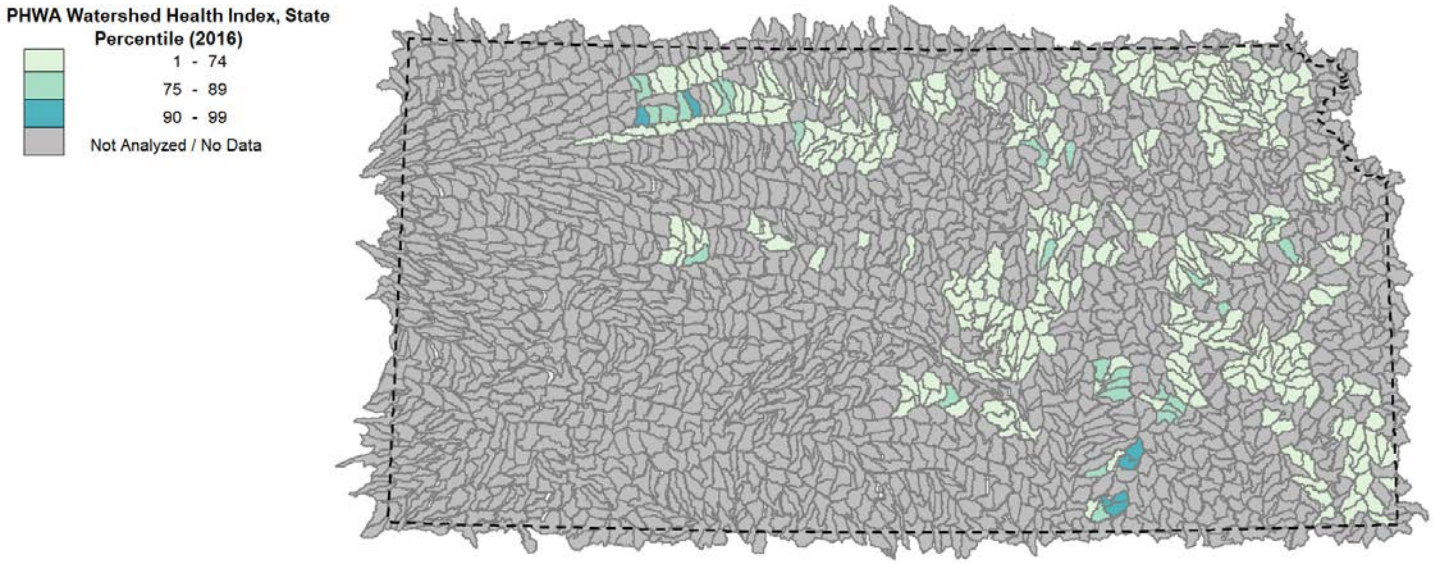


Figure 34. Watershed Health Index scores for HUC12s with WRAPS priority status. HUC12s are divided into three groups for mapping based on Watershed Health Index scores: top ten percentile, 75th to 89th percentile, and below 75th percentile.

Results of Stage 2-Scenario 3

Scenario 3 investigated HUC12s that are suitable for nutrient TMDL development and may be significantly influenced by NPDES permitted dischargers. The exploratory analysis completed for scenario 3 did not include a formal RPS screening run. Instead, this scenario demonstrates the "subset" function of the RPS tool. The subset function allows the user to define a condition or combination of conditions based on indicators in the tool to select a group of watersheds. In order to identify an initial group of HUC12s that could be suitable for TMDL development and affected by point source loading from NPDES permitted dischargers, the following subset conditions were applied:

- 303(d)-Listed Segments Count greater than zero; and
- NPDES Permit Count greater than zero.

The above query creates a subset of 276 HUC12s statewide that could be candidates for nutrient TMDL development. Figure 7 displays a map of these 276 HUC12s shaded by the number of waterbody segments that are listed as impaired due to nutrients. Additional subset conditions could be further applied to identify HUC12s that may require less complex TMDLs and show greater reductions in nutrient concentrations with improved point source management. Example subset conditions could include:

- The "Headwater HUC12 Flag" or "Upstream HUC Count" indicators could be used to focus on headwater HUC12s or those with relatively few additional upstream HUC12s. This group is less likely to be subject to nutrient pollution from sources beyond their upstream boundary. The HUC12s could also require lower-complexity TMDLs if additional upstream sources are insignificant;
- The "Watershed Unique 303(d)-Listed Causes Count" indicator to identify HUC12s with relatively few causes of impairment reported on the state 303(d) list. In addition to nutrients, impairment causes could include pathogens, temperature, metals, pesticides, salinity, sediment, etc. HUC12s with a lower number of impairment causes may also require lower-complexity TMDLs.

Other subset conditions could be further applied to identify HUC12s with aquatic ecosystems that may be more responsive to recovery with reduced nutrient loads. For example, the PHWA Watershed Health Index could be used to identify HUC12s that received higher watershed health scores under the EPA Preliminary Watershed Health Assessment.

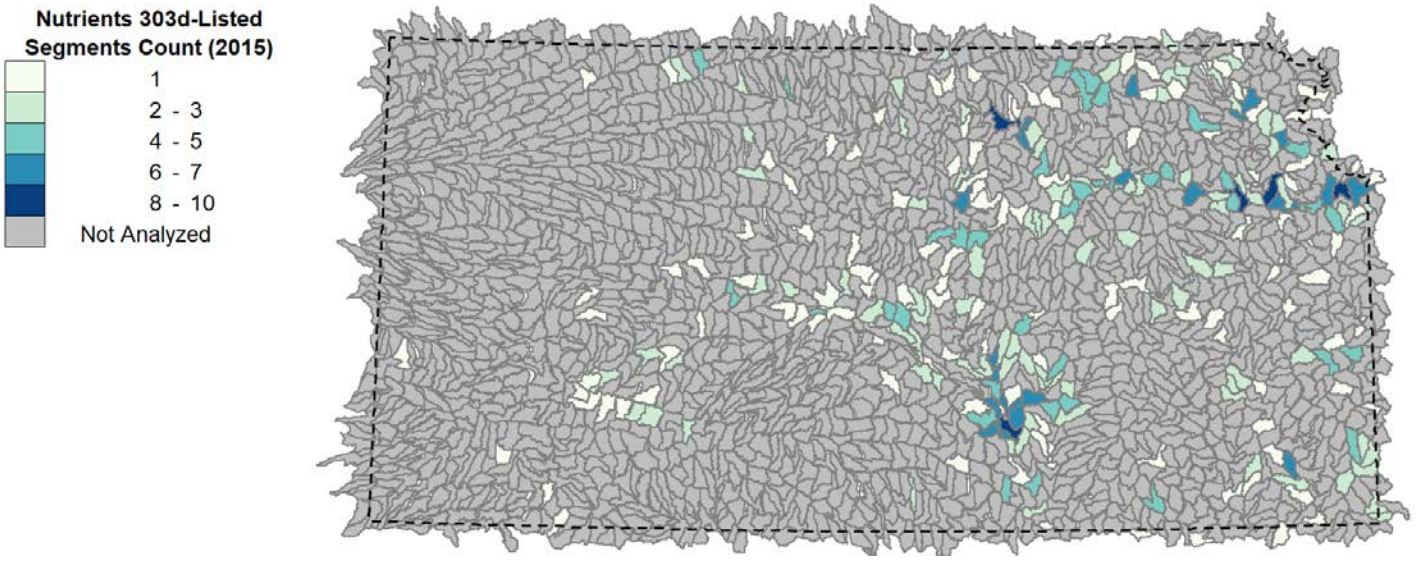


Figure 35. HUC12s that contain 303(d) listed waters with nutrient impairments and NPDES-permitted dischargers.

SUMMARY AND RECOMMENDATIONS

This document summarizes the usage of Recovery Potential Screening (RPS) to compare watersheds at two scales (HUC8 and HUC12) for purposes of informing possible watershed management options and priorities for nutrient management. Utilizing georeferenced data provided primarily by KDHE, EPA and additional sources, this project compiled indicators (base, ecological, stressor and social) at one or both watershed scales that were used to screen and compare watersheds in a two-stage process. In the first stage, Kansas's HUC8s were screened with two separately developed sets of indicators selected to identify and rank watersheds. Based on these first stage screenings and other criteria, one watershed was selected as a demonstration HUC8 for further analysis in the second stage (Little Arkansas).

Stage two screening was performed on the demonstration HUC8 that scored and compared HUC12s using a more detailed sets of indicators that drew from HUC12-scale metrics. Whereas the purpose of Stage 1 was to compare and recognize like groups of watersheds at the larger scale, Stage 2's purpose was to examine and reveal potential opportunities for nutrient management action at the more localized HUC12 scale. As a demonstration of how the RPS Tool could be applied to support decision-making (rather than a true analysis of priority watersheds), no priorities among HUC12s were selected in this project but numerous alternatives and analytical techniques were presented. Products include this summary report, a master RPS Tool file, and separate screening files that archived the results from the Stage 1 and Stage 2 screenings. Opportunities for KDHE and other users from this point forward may include:

Become adept at RPS Tool desktop use. Despite the extensive amount of data stored within the RPS Tool and the wide variety of comparisons among watersheds that these data can support, the RPS Tool is actually a fairly simple spreadsheet tool. This tool allows for simple but useful forms of spatial data analysis, systematic comparisons among watersheds, and a variety of visualization tools – on users' own desktops. A wide circle of users will be able to perform quick 'what-if' screenings to compare watersheds and gain insights on what may be worth a greater investment of time and effort with more technical analytical tools.

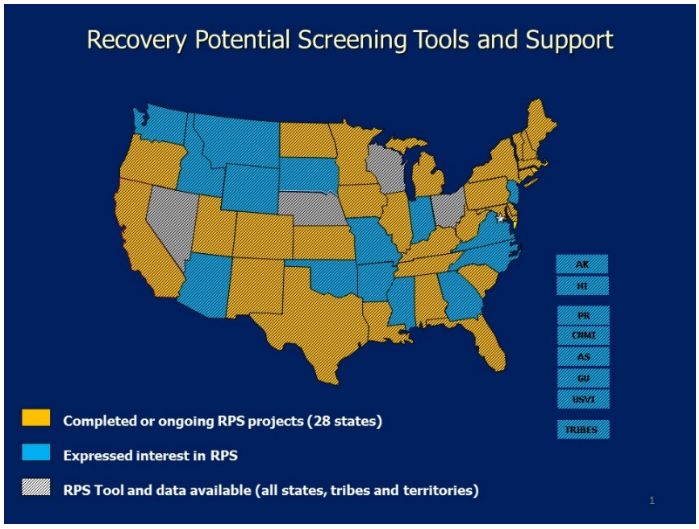
Apply the RPS Tool to other screening topics. Although this effort focused on a nutrients application of RPS, the Kansas dataset could support numerous other screening themes and purposes that can be explored in long-term restoration and protection priority setting. Other screening applications might include sediment, metals, pathogens, or any other prominent cause of impairment. Or in contrast, screenings might focus on a valued resource/use such as watersheds with coldwater fisheries, or drinking water sources, or major outdoor recreational sites. The RPS Tool might be used to develop a first-cut identification of healthy watersheds for protection, or rank likely eligibility for specific types of pollution control incentives. With both the TMDL Program and the Non-Point Source Control Program promoting watershed priority-setting, the range of opportunities is extensive.

Refine the available data and selection of indicators. Even within this nutrient application of RPS, opportunities exist to add more relevant data or refine previous screenings as new insights are gained. The RPS Tool is structured to accept additional indicator data from a user that can be incorporated into future screenings. New data does not need to be available statewide, and a local user may still use the tool after adding data for a limited set of their local subwatersheds. Further, previous analyses can be refined by structured group processes to assign consensus weights to indicators, or by correlation analyses designed to narrow down indicator selections and better differentiate between watersheds. For example, expanding Kansas' available HUC8 indicators and re-screening could allow for considering nutrient delivery to the Gulf of Mexico.

Galvanize state/local restoration and protection dialogue and partnering. RPS offers a mechanism for state-local collaboration. Features of the RPS Tool, such as the option to add new or updated indicator data or the ability to quickly adjust screening settings, allow an analysis to be tailored to reflect the environmental and social settings of a specific locale. Watershed groups, academic researchers and local governments can provide data or other refinements to develop a customized watershed screening within the versatile RPS Tool. Further, if local organizations do engage with KDHE and enhance their RPS Tool copies, they may provide valuable dialogue on addressing local as well as statewide interests in watershed priority-setting and improved nutrient management.

ATTACHMENT 1

RECOVERY POTENTIAL SCREENING: SUMMARY



- Recovery Potential Screening (RPS) is a systematic, comparative method for identifying differences among watersheds that may influence their relative likelihood to be successfully restored or protected. The EPA Office of Wetlands, Oceans and Watersheds (OWOW) created RPS jointly with the EPA Office of Research and Development (ORD) in 2004 to help states and others use limited restoration resources wisely, with an easy to use tool that is customizable for any geographic area of interest and a variety of comparison and prioritization purposes.

- The main programmatic basis for RPS includes the TMDL Program (e.g., prioritized schedule for listed waters; where best to implement TMDLs; Integrated Reporting of Priority waters under the TMDL Vision) and the Nonpoint Source Program (e.g., annual program strategies; prioritization to aid project funding decisions; collaboration with Healthy Watersheds), but several other affiliations also exist.

- Since 2005, several hundred RPS indicators have been incrementally compiled through literature review, identifying states' indicator needs and preferences, and collaboration with others (ORD EnviroAtlas, Region 4 Watershed Index). Most have been applied in a series of statewide RPS projects. In 2009, an RPS paper was published in the refereed journal *Environmental Management*. The one-stop RPS Website hosts a library of indicators, RPS tools, case studies and step by step RPS instructions.

- As of 2017, RPS projects and statewide databases have been either initiated or completed in 28 states (see figure). Approximately that many additional states have expressed interest in RPS usage, but limited EPA resources have not yet been able to support all requests.

- The RPS Tool is key to RPS' ease of use, widespread applicability and speed. This tool is an Excel spreadsheet that contains all watershed indicators, auto-calculates key indices, and generates rank-ordered tables, bubble plot graphics and maps that can be user-customized. Any novice Excel user can become fluent in using the RPS Tool.

- Statewide RPS Tools and data are available for each of the states and territories. These generally contain 285 indicators measured for every HUC12, and enable customizable desktop screening, rank ordering, graphics plotting and mapping without advanced software or training. Individual, state-specific RPS Tools were distributed in 2014, 2016, and 2017 and are publicly available online.

- RPS is playing/may soon play a pivotal role in each of the following:
  - Prioritizing watersheds for nutrient management (projects in 9 states)
  - Identifying state priority watersheds for TMDL Vision/Integrated Reporting 2016-2022
  - Improving state/local interactions in states with RPS projects
  - Enabling Tribes to screen and compare their watersheds for purposes similar to states
  - Helping the Healthy Watersheds program by providing a national Preliminary Healthy Watersheds Assessment (PHWA; https://www.epa.gov/hwp/download-2017-preliminary-healthy-watersheds-assessments)
  - Jointly (OW and EPA Region 4) creating the Watershed Index Online (WSIO) interactive tool (https://www.epa.gov/wsio/download-and-use-wsio-tool)

- Contact: Miranda Chien-Hale, WB/WRAPD/OWOW at chien-hale.miranda@epa.gov or 202-566-0401.

ATTACHMENT 2

KANSAS STAGE 1 (HUC8) SCENARIO INDICATOR DESCRIPTIONS

Green denotes ecological indicators, red are stressor indicators, and blue are social indicators. All Kansas-specific indicators are denoted with (INSTATE).

HUC8 INDICATOR	DESCRIPTION
Weighted-Average IBI Score (INSTATE)	The area-weighted average Index of Biological Integrity (IBI) score for each HUC8, derived from HUC12 data provided by the state of Kansas. IBI scores are based on data from 1994-2014. Source data used was received via personal communication with Andrew Lyon (State of Kansas) in April 2015. "(INSTATE)" denotes that the indicator was only calculated for HUC areas within Kansas state boundaries.
Flow (cfs) Generated in Watershed (INSTATE)	Flow in cubic feet per second (cfs) generated within the HUC8. HUC8 scale data was provided by the state of Kansas. Source data used was received via personal communication with Tom Stiles (State of Kansas) in May 2015. "(INSTATE)" denotes that the indicator was only calculated for HUC areas within Kansas state boundaries.
Habitat Condition Index WS (2015)	Mean Habitat Condition Index (HCI) score for the HUC12 from the National Fish Habitat Partnership (NFHP) 2015 National Assessment. Scores range from 1 (high likelihood of aquatic habitat degradation) to 5 (low likelihood of aquatic habitat degradation) based on land use, population density, roads, dams, mines, and point-source pollution sites. Source data were NFHP 2015 National Assessment Local Catchment HCI scores for NHDPlus Version 1 catchments (acquired via personal communication with NFHP in March 2016). NHDPlus Version 1 catchments are local drainage area delineations for surface water features in the NHDPlus Version 1 database. Catchment HCI scores were aggregated to HUC12 scores by calculating the area-weighted mean of HCI scores for catchments that intersect the HUC12. See http://ecosystems.usgs.gov/fishhabitat/nfhap_download.jsp for more information on the NFHP National Assessment.
% N-Index2 in WS (2011) (% natural cover in the watershed)	Percent of the HUC12 classified as natural land cover (excluding barren land) by the 2011 CDL-NLCD Hybrid Land Cover dataset. Natural land cover classes in the N-Index2 include forest, wetlands, shrubland, and grassland; codes 141 through 143, 152, 171, 190, and 195 in the 2011 CDL-NLCD Hybrid Land Cover dataset. Equation used: N-Index2 Area / HUC12 Area * 100. (See also 2011 CDL-NLCD Hybrid Land Cover glossary definition).
% N-Index2 in HCZ (2011) (% natural cover in the HCZ)	Percent of the HUC12 that is in the Hydrologically Connected Zone (HCZ) and classified as natural land cover (excluding barren land) by the 2011 CDL-NLCD Hybrid Land Cover dataset. Natural land cover classes in the N-Index2 include forest, wetlands, shrubland, and grassland; codes 141 through 143, 152, 171, 190, and 195 in the 2011 CDL-NLCD Hybrid Land Cover dataset. Equation used: Area of N-Index2 in HCZ / HUC12 Area * 100. (See also 2011 CDL-NLCD Hybrid Land Cover and Hydrologically Connected Zone glossary definitions).
% Urban in WS (2011)	Percent of the HUC12 classified as urban cover by the 2011 CDL-NLCD Hybrid Land Cover dataset. Urban cover classes include 'Developed, Open Space' (code 121), 'Developed, Low Intensity' (code 122), 'Developed, Medium Intensity' (code 123), 'Developed, High Intensity' (code 124) in the 2011 CDL-NLCD Hybrid Land Cover dataset. Calculated as urban area divided by HUC12 area, multiplied by 100. (See also 2011 CDL-NLCD Hybrid Land Cover glossary definition).
% Urban in HCZ (2011)	Percent of the HUC12 that is in the Hydrologically Connected Zone and classified as urban cover by the 2011 CDL-NLCD Hybrid Land Cover dataset. Urban cover classes include 'Developed, Open Space' (code 121), 'Developed, Low Intensity' (code 122), 'Developed, Medium Intensity' (code 123), 'Developed, High Intensity' (code 124) in the 2011 CDL-NLCD Hybrid Land Cover dataset. Calculated as urban area in the Hydrologically Connected Zone divided by HUC12 area, multiplied by 100. (See also 2011 CDL-NLCD Hybrid Land Cover and Hydrologically Connected Zone glossary definitions).
% Agriculture in WS (2011)	Percent of the HUC12 classified as agriculture cover by the 2011 CDL-NLCD Hybrid Land Cover dataset. Agriculture cover classes includes cropland and pasture; codes 1 through 92, 181, 182, and 204 through 254 in the 2011 CDL-NLCD Hybrid Land Cover dataset. Calculated as

	agriculture area in the HUC12 divided by HUC12 area, multiplied by 100. (See also 2011 CDL-NLCD Hybrid Land Cover glossary definition).
Count of Animal Feeding Operations in WS (INSTATE)	The count of Animal Feeding Operations in the watershed, within the state of Kansas. HUC8 indicator data was derived from HUC12 data provided by the state of Kansas. Source data used was received via personal communication with Tom Stiles (State of Kansas) in May 2015. "(INSTATE)" denotes that the indicator was only calculated for HUC areas within Kansas state boundaries.
Median Stream TP Concentration in WS (INSTATE)	The median total phosphorus concentration within the watershed, within the state of Kansas. HUC8 scale total phosphorus concentration data was provided by the state of Kansas. Source data used was received via personal communication with Tom Stiles (State of Kansas) in May 2015. "(INSTATE)" denotes that the indicator was only calculated for HUC areas within Kansas state boundaries.
Design Flow of Major/Minor Plants in WS (INSTATE)	The total discharge from the sum of all design flow discharges from "Mid Major" and "Major" NPDES permitted dischargers with a design flow greater than 0.5 Million Gallons per Day (MGD) within each HUC8, within the state. HUC8 scale NPDES data was provided by the state of Kansas. Source data used was received via personal communication with Tom Stiles (State of Kansas) in May 2015. "(INSTATE)" denotes that the indicator was only calculated for HUC areas within Kansas state boundaries.
% Population Growth in WS (2000-2010) (INSTATE)	The percent of population growth in watershed (2000 – 2010) based on census data (positive values only). County scale data was processed using a weighted average according to county size. Watersheds with negative growth were changed to no growth (zero change). Source data used were the Intercensal Estimates of Resident Population for Counties: April 1, 2000 to July 1, 2010 (https://www.census.gov/popest/data/intercensal/county/CO-EST00INT-01.html). "(INSTATE)" denotes that the indicator was only calculated for HUC areas within Kansas state boundaries.
SPARROW Predicted Incremental P Yield	Incremental total phosphorus yield from HUC8 predicted by SPARROW water quality model.
% Streamlength 303d-Listed Nutrients (2015)	Percent of streamlength in the HUC12 listed as impaired due to nutrient-related causes and requiring a TMDL under Section 303(d) of the Clean Water Act. Source data for calculating the length of stream features that are 303(d) listed was the EPA Office of Water 303(d) Listed Waters geospatial dataset. Only includes the length of stream features with "Nutrients", "Organic Enrichment/Oxygen Depletion", "Algal Growth", or "Noxious Aquatic Plants" listed as a parent cause of impairment. The denominator used for percentage calculations (total streamlength) is the length of NHDPlus2 NHD Snapshot stream features plus any additional custom-added streams in the 303(d) Listed Waters dataset. (See also 303(d) Listed Waters and NHD Snapshot glossary definitions).
% Waterbody Area 303d-Listed Nutrients (2015)	Percent of the area of lakes, estuaries, and other areal water features in the HUC12 listed as impaired due to nutrient-related causes and requiring a TMDL under Section 303(d) of the Clean Water Act. Source data for calculating the area of waterbody features that are 303(d) listed was the EPA Office of Water 303(d) Listed Waters geospatial dataset. Only includes area of waterbodies with "Nutrients", "Organic Enrichment/Oxygen Depletion", "Algal Growth", or "Noxious Aquatic Plants" listed as a parent cause of impairment. The denominator used for percentage calculations is the area of NHDPlus2 NHD Snapshot waterbodies in the HUC12 plus any additional custom-mapped waterbodies in the 303(d) Listed Waters dataset. (See also 303(d) Listed Waters and NHD Snapshot glossary definitions).
Soil Erodibility, Mean in WS	Average soil erodibility (K) factor in the HUC12. Source data was a 100-meter resolution grid of soil map units and attributes in the Natural Resources Conservation Service (NRCS) Soil Survey Geographic (STATSGO2) database, acquired from the US Geological Survey in July 2013. Calculated as the mean of soil erodibility values in the HUC12.
Soil Erodibility, Mean in HCZ	Average soil erodibility (K) factor in the Hydrologically Connected Zone (HCZ) of the HUC12. Source data was a 100-meter resolution grid of soil map units and attributes in the Natural Resources Conservation Service (NRCS) Soil Survey Geographic (STATSGO2) database, acquired from the US Geological Survey in July 2013. Calculated as the mean of soil erodibility values in the Hydrologically Connected Zone of the HUC12. (See also Hydrologically Connected Zone glossary definition).

HUC8_Number of dams WS	Number of dams within each HUC provided by EnviroAtlas that uses the National Inventory of Dams maintained by the US Army Corps of Engineers.
Segments with Nutrient TMDLs Count (2015)	Count of surface water segments with a nutrient-related TMDL in the HUC12. Calculated as the number of unique state-assigned surface water segment IDs in the HUC12 from the EPA Office of Water TMDL Waters geospatial dataset with "Nutrients", "Organic Enrichment/Oxygen Depletion", "Algal Growth", or "Noxious Aquatic Plants" listed as a parent TMDL pollutant. (See also TMDL Waters glossary definition).
Critical Watershed Class Score (INSTATE)	Mean watershed priority value on a scale from one to five, from lowest priority (1) to highest priority (5). HUC8 and HUC12 scale data was provided by Jaime Gaggero (state of Kansas) in April 2015. "(INSTATE)" denotes that the indicator was only calculated for HUC areas within Kansas state boundaries.
% MS4 in Watershed	Percent of the HUC12 that is in Municipal Separate Storm Sewer Systems (MS4s). An MS4 is a drainage system that collects and conveys stormwater from developed lands. Includes MS4s that are regulated under the EPA National Pollutant Discharge Elimination System (NPDES) stormwater program; non-regulated MS4s are not counted. Source data was a geospatial dataset of MS4 boundaries developed circa-2010 by EPA Office of Waste Management (acquired via personal communication). The MS4 boundary dataset was created from a list of regulated MS4s, jurisdictional boundaries for municipalities and counties with regulated MS4s, and urbanized area boundaries from the US Census Bureau. Equation used: MS4 Area / HUC12 Area * 100.
Distance to Outlet of the State Inverse (INSTATE)	A spatial analysis was performed using a 30-meter resolution DEM to estimate average flow lengths from each HUC8 outlet to the receiving HUC8 intersecting the state boundary. Outlet HUC8s were scored as 10. A Jenks Method to identify natural statistical breaks was used to rank those HUC-8 watersheds not already identified as outlet HUC-8s, with scores ranging from 9 to 1. "(INSTATE)" denotes that the indicator was only calculated for HUC areas within Kansas state boundaries.
Public Drinking Water System (PWS) Score (INSTATE)	The total project score applied to the watershed contained within a Public Water Supply (PWS) reservoir project area, as scored under the State Interest Priority Scoring Tool (SIPS). SIPS considers 4 major metrics: percent of Water Assurance District population served, total population to be served that participates in a Water Assurance District, the volume of reservoir water that is in the Kansas Water Marketing Program, and number of interstate watersheds draining to a PWS outside of state boundaries. "(INSTATE)" denotes that the indicator was only calculated for HUC areas within Kansas state boundaries.

Attachment 3: Kansas Stage 2 (HUC12) Screening Indicator Descriptions

Green denotes ecological indicators, red are stressor indicators, and blue are social indicators. All Kansas-specific indicators are denoted with (INSTATE). These indicators are based on data that end at the state-line, therefore watersheds were clipped to the state line and all metrics were calculated based on this area.

HUC12 INDICATOR	DESCRIPTION
Watershed Health Index (Statewide)	The statewide Watershed Health Index score for the HUC12 from the 2016 EPA Preliminary Healthy Watersheds Assessment (PHWA). The Watershed Health Index is an integrated measure of watershed condition that combines Landscape Condition, Hydrologic, Geomorphology, Habitat, Water Quality, and Biological Condition Sub-Index scores. Higher scores correspond to greater potential for a watershed to have the structure and function in place to support healthy aquatic ecosystems. Source data were statewide Watershed Health Index scores for HUC12s developed as part of the 2016 EPA Preliminary Healthy Watersheds Assessment (February 8, 2017 version). NOTE: PHWA scores/percentiles are not suitable for comparing HUC12s that occur in different states to one another. Scoring of a given HUC12 reflects its condition relative to all other HUC12s within the same state only.
Watershed Health Index (Ecoregional)	The ecoregional Watershed Health Index score for the HUC12 from the 2016 EPA Preliminary Healthy Watersheds Assessment (PHWA). The Watershed Health Index is an integrated measure of watershed condition that combines Landscape Condition, Hydrologic, Geomorphology, Habitat, Water Quality, and Biological Condition Sub-Index scores. Higher scores correspond to greater potential for a watershed to have the structure and function in place to support healthy aquatic ecosystems. Source data were ecoregional Watershed Health Index scores for HUC12s developed as part of the 2016 EPA Preliminary Healthy Watersheds Assessment (February 8, 2017 version). NOTE: PHWA scores/percentiles are not suitable for comparing HUC12s that occur in different ecoregions to one another. Scoring of a given HUC12 reflects its condition relative to all other HUC12s within the same ecoregion only.
Soil Stability, Mean in HCZ	Mean soil stability in the Hydrologically Connected Zone (HCZ) of the HUC12. Soil stability is the inverse of soil erodibility. Source data was a 100-meter resolution grid of soil map units and attributes in the Natural Resources Conservation Service (NRCS) Soil Survey Geographic (STATSGO2) database, acquired from the US Geological Survey in July 2013. Mean soil erodibility in the HCZ was calculated as the average of erodibility grid values in the HCZ per HUC12. Mean soil stability was calculated as 1 - Mean soil erodibility. (See also Hydrologically Connected Zone glossary definition).
% Urban in WS (2011)	Percent of the HUC12 classified as urban cover by the 2011 CDL-NLCD Hybrid Land Cover dataset. Urban cover classes include 'Developed, Open Space' (code 121), 'Developed, Low Intensity' (code 122), 'Developed, Medium Intensity' (code 123), 'Developed, High Intensity' (code 124) in the 2011 CDL-NLCD Hybrid Land Cover dataset. Calculated as urban area divided by HUC12 area, multiplied by 100. (See also 2011 CDL-NLCD Hybrid Land Cover glossary definition).
% Agriculture in WS (2011)	Percent of the HUC12 classified as agriculture cover by the 2011 CDL-NLCD Hybrid Land Cover dataset. Agriculture cover classes includes cropland and pasture; codes 1 through 92, 181, 182, and 204 through 254 in the 2011 CDL-NLCD Hybrid Land Cover dataset. Calculated as agriculture area in the HUC12 divided by HUC12 area, multiplied by 100. (See also 2011 CDL-NLCD Hybrid Land Cover glossary definition).
% Agriculture in HCZ (2011)	Percent of the HUC12 that is in the Hydrologically Connected Zone and classified as agriculture cover by the 2011 CDL-NLCD Hybrid Land Cover dataset. Agriculture cover classes include cropland and pasture; codes 1 through 92, 181, 182, and 204 through 254 in the 2011 CDL-NLCD Hybrid Land Cover dataset. Calculated as agriculture area in the Hydrologically Connected Zone divided by HUC12 area, multiplied by 100. (See also 2011 CDL-NLCD Hybrid Land Cover and Hydrologically Connected Zone glossary definitions).
% Streamlength 303d-Listed Nutrients (2015)	Percent of streamlength in the HUC12 listed as impaired due to nutrient-related causes and requiring a TMDL under Section 303(d) of the Clean Water Act. Source data for calculating the length of stream features that are 303(d) listed was the EPA Office of Water 303(d) Listed Waters geospatial dataset. Only includes the length of stream features with "Nutrients", "Organic Enrichment/Oxygen Depletion", "Algal Growth", or "Noxious Aquatic Plants" listed as

HUC12 INDICATOR	DESCRIPTION
	a parent cause of impairment. The denominator used for percentage calculations (total streamlength) is the length of NHDPlus2 NHD Snapshot stream features plus any additional custom-added streams in the 303(d) Listed Waters dataset. (See also 303(d) Listed Waters and NHD Snapshot glossary definitions).
% Waterbody Area 303d-Listed Nutrients (2015)	Percent of the area of lakes, estuaries, and other areal water features in the HUC12 listed as impaired due to nutrient-related causes and requiring a TMDL under Section 303(d) of the Clean Water Act. Source data for calculating the area of waterbody features that are 303(d) listed was the EPA Office of Water 303(d) Listed Waters geospatial dataset. Only includes area of waterbodies with "Nutrients", "Organic Enrichment/Oxygen Depletion", "Algal Growth", or "Noxious Aquatic Plants" listed as a parent cause of impairment. The denominator used for percentage calculations is the area of NHDPlus2 NHD Snapshot waterbodies in the HUC12 plus any additional custom-mapped waterbodies in the 303(d) Listed Waters dataset. (See also 303(d) Listed Waters and NHD Snapshot glossary definitions).
Number of Animals (USDA County) in WS (INSTATE)	The total number of animal units within each watershed, within the state. Animal unit data was derived using a county size weighted average of the USDA Census of Agriculture 2012 county-scale data. "(INSTATE)" denotes that the indicator was only calculated for HUC areas within Kansas state boundaries.
Number of Septic Systems in WS (INSTATE)	The total number of septic systems within each watershed, within the state. HUC12 septic system data was obtained from the EPA STEPL model input database (http://it.tetratech-ffx.com/steplweb/models$docs.htm). "(INSTATE)" denotes that the indicator was only calculated for HUC areas within Kansas state boundaries.
Segments with Nutrient TMDLs Count (2015)	Count of surface water segments with a nutrient-related TMDL in the HUC12. Calculated as the number of unique state-assigned surface water segment IDs in the HUC12 from the EPA Office of Water TMDL Waters geospatial dataset with "Nutrients", "Organic Enrichment/Oxygen Depletion", "Algal Growth", or "Noxious Aquatic Plants" listed as a parent TMDL pollutant. (See also TMDL Waters glossary definition).
Critical Watershed Class Score (INSTATE)	Mean watershed priority value on a scale from one to five, from lowest priority (1) to highest priority (5). HUC8 and HUC12 scale data was provided by Jaime Gaggero (state of Kansas) in April 2015. "(INSTATE)" denotes that the indicator was only calculated for HUC areas within Kansas state boundaries.
Count (2011-2014) Conservation Practices (INSTATE)	The count of conservation practices funded by NRCS, the Kansas Department of Agriculture Division of Conservation (Conservation Districts), and Kansas 319 program - Watershed Restoration And Protection Strategy (WRAPS) within the HUC12 over the 2011-2014 time period. Source data was provided by Andrew Lyon (state of Kansas) in April 2015. "(INSTATE)" denotes that the indicator was only calculated for HUC areas within Kansas state boundaries.

Attachment 4: Kansas RPS Tool file names and contents

The following are RPS Tool files completed during this project and delivered to Kansas for statewide and watershed-specific use. Except for KS RPS-Scoring-Tool-052416_BASE, all these files contain archived results for each geographic area and Scenario as named. Other than differences in their screening results, these files are otherwise identical to the master file.

RPS Tool File Name	Content
KS RPS-Scoring-Tool-052416_BASE	Kansas RPS Tool with all HUC8 and HUC12 data, no screening content saved (master copy for all new screening statewide or on HUC subsets)
KS RPS-Scoring-Tool-052416_SCENARIO1	Kansas RPS Tool with screening results for Scenario 1
KS RPS-Scoring-Tool-052416_SCENARIO2	Kansas RPS Tool with screening results for Scenario 2
KS RPS-Scoring-Tool-052416_SCENARIO3	Kansas RPS Tool with screening results for Scenario 3
KS RPS-Scoring-Tool-052416_LittleArkansas	Kansas RPS Tool with Stage 2 results for HUC12 screening of Little Arkansas HUC8