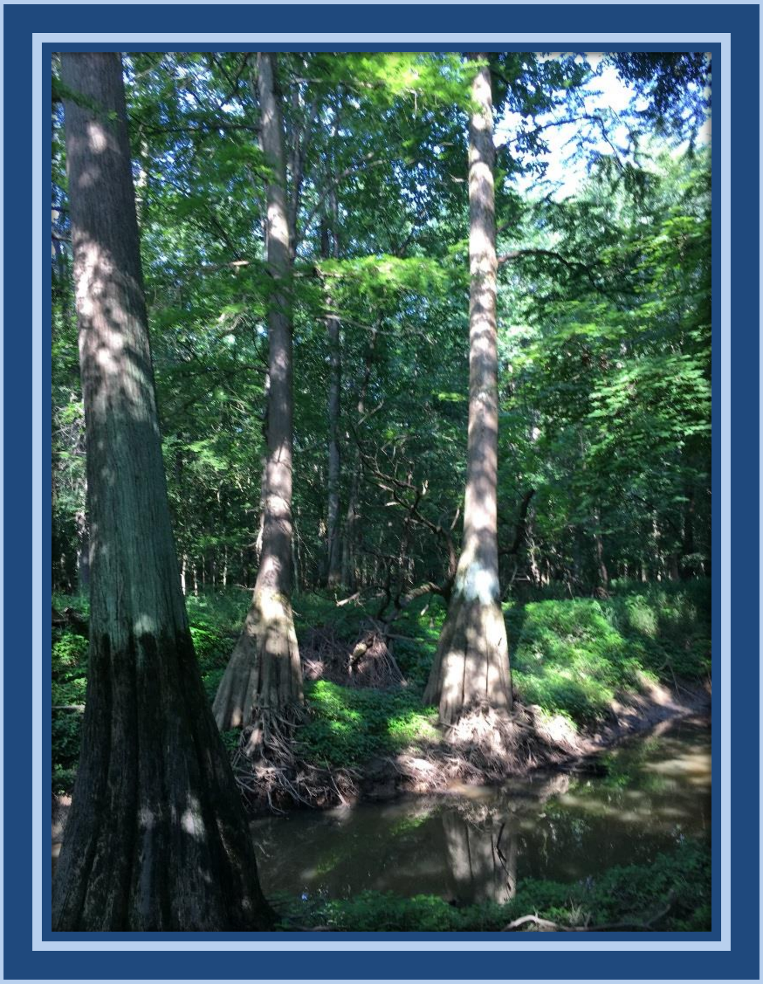
The Wetland Prioritization Tool:

A method to prioritize wetlands for restoration and protection



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Abbreviations

CWA	Clean Water Act
HGM class	Hydrogeomorphic wetland classification
KDOW	Kentucky Division of Water
KY-WRAM	Kentucky Wetlands Rapid Assessment Method
NRCS	Natural Resources Conservation Service
NWCA	National Wetland Condition Assessment
NWI	National Wetland Inventory
PEM	Palustrine Emergent
PFO	Palustrine Forested
PSS	Palustrine Scrub Shrub
RPT	Recovery Potential Screening Tool
USACE	US Army Corps of Engineers
USFWS	US Fish and Wildlife Service
WPT	Wetlands Prioritization Tool

Introduction

Wetlands are unique habitats that perform processes that are beneficial for people and wildlife, such as protecting and improving water quality, storing floodwaters, recharging groundwater, and providing food and habitat for numerous plant and animal species (Mitsch and Gosselink, 2007). Therefore, wetland protection is of critical importance throughout the United States, especially in Kentucky which is one of the top states in the nation for percent of wetland loss, with ~81% lost as of the late 1980s (Dahl 1990). Wetland loss and disturbance have continued to reduce the amount of natural wetland area remaining in Kentucky (Dahl, 2006). According to the Louisville District of the US Army Corps of Engineers (USACE), over 218 acres of wetland loss have been permitted by the Clean Water Act (CWA) § 404 program alone from 2013 to 2018 (Pam Loeffler, personal communication). This does not include wetland loss permitted by the Memphis and Nashville Districts, which regulate areas of Kentucky that have the highest concentrations of wetlands.

The quality of Kentucky wetlands is of concern as well. As shown in Table 1, of the 364 wetlands across the Commonwealth that the Kentucky Division of Water (KDOW) has assessed with the Kentucky Wetland Rapid Assessment Method (KY-WRAM), a large portion have lost significant hydrologic and habitat functions, and a majority had an unhealthy coverage of invasive species. Although there was some targeted assessments, a significant proportion of these wetlands were chosen with a random site-selection by rotating major watershed basins, somewhat representing the conditions of wetlands across the state. The results also include KY-WRAM assessments from the 2016 National Wetland Condition Assessment (NWCA), which was a probability sample for the entire state with selections made by wetland density. This resulted in 43 of the 48 wetlands being in the western part of the state. The greatest density of wetlands are in the western part of the state, but they differ substantially in size and character from the rest of the state. These two samples showed more than half had hydrologic regimes modified enough so as to have lost significant function, between 10 and 20% did not have intact or near optimal habitat functions, and, more than a quarter had over 5% coverage of highly-invasive species. At the same time, these wetlands commonly occurred in watersheds that contain water-dependent species that are of state concern, or are federally threatened or endangered. Over a quarter of the wetlands were considered to have high ecological value as defined by the Kentucky State Nature Preserves Commission (KDOW, 2014).

In addition to habitat loss, the loss of wetlands removes valuable ecosystem services to surrounding populations. While most research has focused on coastal wetlands, studies suggest that wetlands, as green infrastructure, can be as effective at mitigating flood losses as built infrastructure (Hubbart et al, 2011; Reguero et al, 2018). Wetlands provide other, often overlapping, ecosystem services: sediment retention, water quality improvement, and carbon sequestration to name a few. The value of these services does not necessarily correlate with general wetland quality in that the service provided may be important even when the quality is low. For instance, proximity to populations or other landscape features can determine how valuable that service is to a community. A flood occurring in a remote area does not have the same economic impact as one occurring in an urban area, which argues for considering the ecosystems services a wetland provides along with its quality when considering decisions regarding mitigation or protection.

Table 1. General quality of Kentucky's wetlands as found by assessments from 2011 through 2017.

Wetland quality in Kentucky					
Quality Indicator	Threshold	All (n=364)		NWCA* sites (n=48)	
		count	percent	count	percent
Hydrologic Function[1]	Functioning	140	38	15	31
	Loss of Function	224	62	33	69
Habitat Function[2]	Functioning	286	79	43	90
	Loss of Function	78	21	5	10
Invasive Species > 5%	Yes	218	60	13	27
	No	146	40	35	73
Special Wetlands[3]	Yes	296	81	38	21
	No	68	19	10	79
High Ecological Value[4]	Yes	100	27	13	35
	No	264	73	35	73

*NWCA sites were chosen by a random process based on wetland density, and therefore should be representative of the quality of wetlands within the state as a whole. However, 43 of the 48 sites were in the western part of the state, reflecting the greater density of wetlands in that part of the state.
[1]Loss of function defined as score of < 7 on KY-WRAM metric 3d.
[2]Loss of function defined as score of < 3 on KY-WRAM metric 4b.
[3]Special wetland is any wetland described in KY-WRAM metric 5a.
[4]High Ecological Value as defined by any wetland defined in KY-WRAM metric 5b.

While the KY-WRAM has value as a rapid wetland assessment method in itself, it was originally created to assist CWA § 401 and 404 regulatory decisions. Currently, wetland impacts in Kentucky are typically mitigated at a 2:1 ratio based solely on acreage. This ratio does not take into account the quality or type of wetland impacted nor the ecosystem services that it provides. Because of severe historic wetland loss, and, more recently, recognition of the services wetlands provide, it is prudent that we protect wetlands from further degradation and loss, especially ones that provide essential services to populations. When impacts cannot be avoided, the ability to scale mitigation ratios based on quality and function is essential and requires an assessment of condition and function.

While KY-WRAM has been successful in assessing condition, it has yet to be incorporated into the decision making process. At this time, the KDOW is working with USACE to implement and adopt the KY-WRAM. If adopted, the newly developed Wetlands Prioritization Tool (WPT) will allow KDOW to take the step of using data gathered by KY-WRAM and incorporate it into decision making processes. The WPT can be used not only for § 401 and 404 regulatory decisions, but also for organizations seeking to gain the best return on investment for their efforts to protect or restore wetlands. This tool can be used to inform local government or non-governmental organizations where best to put grant money from the Kentucky Nonpoint Source Pollution Control Program to address nonpoint source pollution in watershed-based plans (Section 319(h) of the Clean Water Act grants).

The WPT is a modification of the Recovery Potential Screening Tool. The RPT objectively scores each watershed based on user-selected social, ecological, and stressor metrics and then ranks each watershed (EPA, 2016). The WPT differs from the RPT in that it compares individual wetlands instead of watersheds, and while the RPT allows users to choose which metrics to input, the WPT calculates scores for each wetland using all of the metrics in the KY-WRAM. While all metrics are used, the weighting of metrics are adjusted based on the ecosystem service of interest, as selected by the user.

The RPT assigns metrics into one of three classes: ecological, stressor, and social metrics. While these three classes are likely appropriate for ranking wetlands for protection, potential mitigation sites need additional consideration. According to the Wetlands Evaluation Technique (Adamus et al, 1987), wetlands are evaluated by three characteristics: social significance, effectiveness, and opportunity. Social significance is the value that humans place on the wetland. Here, economic valuation is an objective measure of these metrics. Effectiveness reflects the services that the wetland currently provides. An example might be that a wetland removes (or retains) a ton of sediment a year from reaching a particular waterway. In contrast, opportunity is the potential the wetland has at full capacity. That same wetland, if between a construction development and stream, might have the opportunity to remove 5 tons of sediment a year. The opportunity category, then, reflects characteristics of the land surrounding the wetland, while effectiveness reflects the characteristics within the wetland. A review of the literature to determine the wetland characteristics that impact the various ecosystem services informed the weighting for the effectiveness and opportunity categories.

Tool Development

Metric Classification and Weighting

Overview

The tool allows 5 choices of ecosystem services:

- General
- Flood Flow Alteration
- Sediment Retention
- Water Quality/Nutrient Removal
- Wildlife Diversity and Abundance

These services were further appraised in light of three categories: social significance, effectiveness, and opportunity. The literature was consulted in determining which KY-WRAM metrics reflect the effectiveness and opportunity to impact the ecosystem service chosen by the model. A decision was made to weight the social significance category by use of economic valuation, while the other categories were based on giving more or less weight to individual KY-WRAM metrics. Because the social significance category is the same for all ecosystem services, it will be discussed as a whole, while the effectiveness and opportunity categories will be discussed for each of the ecosystem services separately.

The discussion of each ecosystem service includes the characteristics of a wetland that influence that ecosystem service, the source for that information, and the KY-WRAM metrics that reflect those characteristics. The ecosystem service denoted as 'General' is the unmodified KY-WRAM score. The assessment was designed to reflect overall wetland quality without emphasizing any particular ecosystem service. Weighting for each ecosystem service began with the KY-WRAM point values and were adjusted up or down depending on how or if that metric impacted the ecosystem service under consideration. Table 2 gives the literature sources for the characteristics that impact each service, while Table 3 details the metrics that influence each ecosystem service.

For the effectiveness and opportunity categories, each metric score is normalized to a scale from 0 to 1 by dividing by the maximum score for that metric. For the social significance category, the economic valuation is also normalized and used to compute the social significance score. Metrics are multiplied by a weight to reflect the influence they have on each ecosystem service. The process to determine these weights is discussed in the Calibration Process section. Weights may be modified by narrative metrics as described in the narrative for each ecosystem service. A weighted score for each metric was calculated with the formula:

$$WeightedMetricScore = NormalizedMetricScore \times \left(\frac{N(y) * Soc + Eff + Opp}{3}\right)$$

Equation 1. Weighted metric calculation.

N(y) = normalized economic valuation (see Equation 3)
Soc = Social Significance weight
Eff = Effectiveness weight
Opp = Opportunity weight

The weighted metrics are summed to determine a total score. The weight was adjusted for each metric – category combination until the result rankings reflect what is expected by best professional judgment. The calculation to determine the social significance weight is discussed below.

Table 2. Literature sources for weighting of metrics.

Sources for influences on ecosystem services	
Ecosystem Service	**Source**
Water Quality / Nutrient Removal	Fisher & Acreman, 2004
Sediment Removal	Gilbert et al, 2006
Flood Flow Alteration	Carter, 1997; Acreman & Holden, 2013
Wildlife Diversity and Abundance	Zedler & Kercher, 2005

Table 3. Metrics that influence ecosystem services.

Influences and metrics that impact ecosystem services			
Effectiveness		**Opportunity**	
Main influences	**KY-WRAM metrics that reflect main influence**	**Main influences**	**KY-WRAM metrics that reflect main influence**
Flood Flow Alteration			
Wetland size	1a. Wetland size	Wetland size	1a. Wetland size
Available storage capacity	3c. Duration of inundation/saturation (inverse)	Hydrology	3b. Hydrological connectivity
	3d. Alterations to natural hydrologic regime		3d. Alterations to natural hydrologic regime
Wetland type	Narrative: HGM class	Wetland type	Narrative: HGM class
Vegetation type	Narrative: PFO/PSS/PEM		
Sediment Removal			
Wetland size	1a. Wetland size	Landscape position	3b. Hydrological connectivity
Hydraulic retention time	3c. Duration of inundation/saturation	Surrounding buffer	2a. Average buffer width (inverse)
	3d. Alterations to natural hydrologic regime		2b. Intensity of surrounding land use (inverse)
Vegetation structure	6d. Horizontal interspersion	Overland flow into the wetland	3d. Alterations to natural hydrologic regime
Wetland type	Narrative: HGM class	Wetland type	Narrative: HGM class
Nutrient Removal / Water Quality			
Wetland size	1a. Wetland size	Landscape position	3b. Hydrological connectivity
Hydraulic retention time	3c. Duration of inundation/saturation	Surrounding buffer	2a. Average buffer width (inverse)
	3d. Alterations to natural hydrologic regime		2b. Intensity of surrounding land use (inverse)
Fluctuating water table height	3a. Input of water from an outside source	Overland flow into the wetland	3d. Alterations to natural hydrologic regime
	3c. Duration of inundation/saturation		
Sediment oxygen/redox (water logging)	Narrative: PFO/PSS/PEM		
Actual wetland type (riparian more efficient than depressional/flat)	3a. Input of water from an outside source		
	3c. Duration of inundation/saturation (inverse)		
Vegetation processes	6d. Horizontal interspersion		
Wildlife Diversity and Abundance			
Wetland size	1a. Wetland size	Connection to other natural areas	2a. Average buffer width around the wetland's perimeter
Habitat Alteration	4b. Habitat alteration (intermediate disturbance hypothesis)		2b. Intensity of surrounding land use within 1,000 ft of the wetland
Habitat heterogeneity	6a. Wetland vegetation components		2c. Connectivity to other natural areas
	6b. Open water, mudflat, and aquatic bed habitats		
	6c. Coverage of highly-invasive plant species		
	6d. Horizontal interspersion		
	6e. Microtopographic features		
Hydrologic connectivity	3b. Hydrological connectivity		
	3d. Alterations to natural hydrologic regime		
Special wetlands	5a. Regulatory protection /critical habitat		
	5b. High ecological value / ranked communities		
	5c. Low-quality wetland		

Social Significance

Brander et al (2006) conducted a meta-analysis to generate a multivariate equation for the economic valuation of wetlands for various ecosystem services. Patton et al (2012) used this further to apply to four fish and wildlife wetland refuges to determine economic values. Following this approach, the contingent valuation method (CVM) was used to estimate the economic value of a given ecosystem service for an assessed wetland. Variables included in the regression for all ecosystem services include the size of the wetland, latitude, percent palustrine emergent (PEM), percent palustrine forested (PFO), GDP per capita, and population. Latitude reflects the global nature of the valuation. Size and vegetation type give information about the wetland, and GDP and population specify how important the wetland will be to people.

In addition to giving a final score and rank, the results table also provides the results of the economic valuation. Brander et al's equation calculates the value in 1995 dollars. For the WPT, we further translate the valuation to 2015 US dollars using the Bureau of Labor Statistic's Consumer Price Index Inflation Calculator (no date). Valuation is given as both the annual 2015 US $/acre value as well as the annual total value based on the size of the wetland ($US\ \$\ /\ acre * wetland\ size\ in\ acres$).

$$\boldsymbol{a} = (\boldsymbol{ln}(\boldsymbol{hectares\ of\ wetland}) * (-\mathbf{0.11})) + (|\boldsymbol{latitude}| * \mathbf{0.03}) + \left(\boldsymbol{latitude}^{\mathbf{2}} * (-\mathbf{0.0007})\right) + \left(\%\boldsymbol{PEM} * (-\mathbf{1.46})\right) + (\%\boldsymbol{PFO} * \mathbf{0.86}) + (\boldsymbol{lnGDPpercapita} * \mathbf{1.16}) + (\boldsymbol{lnPopDensity} * \mathbf{0.47}) - \mathbf{6.98}$$

b = Σ

Flood Flow	or	Sediment Retention	or	Water Quality	or	Wildlife Habitat
1.49 for CVM 0.14 for flood control 0.63 for water quality		1.49 for CVM 0.63 for water quality		1.49 for CVM 0.63 for water quality		1.49 for CVM -0.03 for habitat & nursery 0. 6 for biodiversity

$$\boldsymbol{x} = \boldsymbol{a} + \boldsymbol{b}$$

$$\mathbf{2015}\ \boldsymbol{US}\,\$/\boldsymbol{acre} = \frac{\boldsymbol{e^{x}}}{\mathbf{2.47105381}} \times \frac{\mathbf{1.56}\ (\mathbf{2015}\ \boldsymbol{US}\ \$)}{\mathbf{1}\ (\mathbf{1995}\ \boldsymbol{US}\ \$)} = \boldsymbol{y}$$

Equation 2. Economic valuation of ecosystem services.

$$\boldsymbol{N}(\boldsymbol{y}) = \frac{(\boldsymbol{y} - \boldsymbol{Min})}{\frac{(\boldsymbol{Max} - \boldsymbol{Min})}{\mathbf{25}}} \times \mathbf{0.01} + \mathbf{0.75}$$

Equation 3. Normalization of economic valuation from 0.75 - 1 for the wetlands in the model run.

Min – Minimum per acre or total valuation amount for wetlands in the model run
Max – Maximum per acre or total valuation amount for wetlands in the model run

The actual social significance score is derived from Equation 2. The goal was to convert the dollar amount into a social significance score commensurate with other KY-WRAM category scores. However, the economic valuation process produces output more varied than the KY-WRAM scoring. Therefore, for each run of the tool, the per acre and total wetland valuation scores are normalized on a 0.75 to 1 scale (Equation 3), and this value is multiplied by the weight and normalized KY-WRAM score. By normalizing the dollar amount to 0.75 to 1 scale, the impact of the variability found in the economic valuation is dampened. The valuation per acre is used for all metrics except for wetland size (metric 1a). For this metric, the total valuation for the wetland was used.

The social significance scores exhibit more variability than the effectiveness and opportunity scores due to the economic valuation's heavy dependence on the percent forested and emergent in calculating the value per acre. The percent forested has a positive multiplier of 0.86, while the percent emergent has a multiplier of -1.46. These multipliers give markedly higher valuations to forested wetlands compared to emergent wetlands. While the economic valuation equation always returns higher values for forested wetlands above emergent, we wanted to recognize that some emergent wetlands will impact flood flow and can provide effective services. For this reason, an exception was incorporated into the valuation in calculating the social significance score for the ecosystem service flood flow alteration and the metric, High Ecological Value / Ranked Communities (5b). If the percent emergent was 50 or greater and the high ecological value community was of an emergent type, then a multiplier of 10 was applied to the weight. This brought the social significance score into the same range as that of forested wetlands for that high ecological value community.

Effectiveness and Opportunity

The effectiveness of a wetland reflects whether the conditions of the wetland are conducive to the ecosystem service under consideration. In contrast, opportunity scores indicate whether the surrounding area has conditions that support the need for that particular ecosystem service. Examples of opportunity are the delivery of surface water, anthropogenic sources of sediment or nutrients, or wildlife corridors in the area surrounding the wetland. Weighting for each metric begins with the point value assigned by the KY-WRAM, and then is adjusted up or down depending on the influence of that metric on the ecosystem service under consideration.

General

The choice of 'General' for ecosystem service represents overall wetland quality. This choice returns the KY-WRAM score with the difference that no maximum scores are recognized for metrics 5 and 6. The KY-WRAM was developed to represent overall wetland quality for the purpose of evaluating wetland ecosystem health as part of the Water Quality Certification program in conjunction with the U.S. Army Corps of Engineers' Section 404 program (Scott, 2009). Because no ecosystem service is emphasized, no economic valuation is undertaken. Equation 1 is modified such that the Social Significance weight is 0 and the divisor is 2 instead of 3. The social significance of the wetland is represented only in the inherent weighting of the assessment.

Flood Flow Alteration

According to Acreman and Holden (2013), the major factors mitigating flood flow, are type of wetland, size, connectivity, saturation of soil, and type of vegetation. Weighting for metrics was determined by the gradation of factors as shown in Table 4, with higher scores given to factors that contribute to greater attenuation of flood waters.

Table 4. Factors and relative degree of influence of flood flow attenuation according to Acreman & Holden (2013).

Influence	Greatest Attenuation	⟵	⟶		Least Attenuation
Vegetation	PFO	>	PSS	>	PEM
HGM Class	Riverine	>	Depressional Flat Lacustrine	>	Slope
Saturation / Inundation	Seasonally Inundated / Saturated	>	Regularly Inundated / Saturated	>	Permanently Inundated / Saturated

The effectiveness weight for metric 3a, *Input from an Outside Source*, vary according to HGM class. Depressional, Flat, and Lacustrine classes are given the weight shown in the weighting table. Riverine wetlands are more effective in attenuating flood flows so a multiplier is applied to the default weight. In addition, vegetation, particularly forested, increases roughness and slows flood flow; so the multiplier is modified by vegetation type with the formula:

$$Riverine\ Multiplier\ for\ Effectiveness = 1.5 + \left(\frac{\%PSS * 0.25}{100} + \frac{\%PFO * 0.5}{100}\right)$$

Equation 4. Determination of multiplier for vegetation influences.

For the HGM class of Slope, the weight shown in the table is multiplied by 0.5, as Slope wetlands can be sources of flood water instead of sinks (Acreman & Holden, 2013).

For the impacts of saturation and inundation on flood attenuation, a wetland that is not permanently inundated has the ability to hold more water in flood conditions than wetlands with permanently inundated or saturated soils (Acreman & Holden, 2013). Metric 3c, *Duration of Inundation/Saturation*, reflects these conditions with higher point values given to wetlands that are more frequently inundated or saturated. In order to better reflect opportunity and effectiveness in attenuating flood waters, the point value is "flipped" by subtracting the normalized value from 1.1. The maximum normalized value is 1; subtracting from 1 might result in a divide by 0 error, so the normalized value is subtracted from 1.1 to obtain the "flipped" value. This method rewards drier wetlands as having more potential to attenuate flood flow.

Sediment Retention and Removal

The retention of particulate matter by wetlands is strictly a physical process (Brinson et al, 1998). Particularly for the case of riverine wetlands, particulate matter is carried on the current, and with overbank flow, the slowing of flow from an increase in cross-sectional area and roughness allows the sediment to drop out. Burial or re-suspension may occur, depending on the hydrology of a particular wetland.

The effectiveness weighting for this ecosystem service emphasizes the physical processes that influence sedimentation. Effectiveness weights are increased for *duration of inundation/saturation*, *alterations to hydrologic regime*, and a higher degree of *horizontal interspersion*. For opportunity, more weight is given for a landscape position that places the wetland between a sediment source and a waterway, a smaller surrounding buffer, and an unaltered hydrologic regime. In addition to increasing the weight for landscape position, the HGM class also influences that weight for opportunity as shown in Table 5, because each wetland has a differing profile of input source, and therefore sediment input.

Table 5. Impact of narrative metrics on weighting of opportunity category for Sediment Retention and Removal.

Influence	**Greatest Retention**	⟵		⟶	**Least Retention**
HGM Class	Riverine Lacustrine	>	Depressional	>	Slope Flat
Multiplier	**2**		**1**		**0.5**

Water Quality / Nutrient Removal

Nutrient removal and improved water quality are implemented by both physical and chemical processes. Physical removal occurs when nutrients, metals, and other contaminants sorb onto particulate matter and co-occurs with sediment retention. The chemical process involves removal through transformation of the chemical to another form that renders the chemical less available to biological systems. These chemical reactions frequently occur at the border between oxidizing and reducing conditions. As such, water-logged conditions with increased surface area from roots and stems of plants provide favorable conditions for these reactions. Table 6 illustrates the range of the conditions that influence these conditions. The duration of inundation metric awards points favoring water-logged conditions, so the weighting of that metric was further modified by adding to the weight based on vegetation as shown in Equation 5.

Table 6. Metrics that influence chemical reactions for water quality improvement.

Influence	Greatest Impact ⟵		⟶		Least Impact
Vegetation	PEM	>	PSS	>	PFO
Saturation / Inundation	Permanently Inundated / Saturated	>	Regularly Inundated / Saturated	>	Seasonally Inundated / Saturated

$$Duration\ of\ Inundation\ Multiplier\ for\ Effectiveness = 2 + \left(\frac{\%PEM * 0.75}{100} + \frac{\%PSS * 0.50}{100} + \frac{\%PFO * 0.25}{100}\right)$$

Equation 5. Duration of inundation multiplier for Effectiveness.

The literature suggests that particular classes of wetlands may be efficient at removing one nutrient while at the same time being a source for another (Fisher & Acreman, 2004). Because of a lack of a clear association between the type of wetland and its efficiency in improving water quality, HGM class was not incorporated into the weighting for nutrient removal.

Wildlife Diversity and Abundance

According to Zedler and Kercher (2005), habitat area and heterogeneity are main factors in wildlife diversity. In addition, flow regime and connectivity of smaller wetlands can also be important for driving diversity. The presence of invasive species has a strong dampening effect on diversity. For effectiveness, weighting of metrics focused on increasing the weight of metrics that reflect heterogeneity of habitat. Weighting was also modified for habitat alteration. While habitat alteration typically reduces wetland quality, it often increases the heterogeneity of habitat and may create additional niches in the wetland (intermediate disturbance hypothesis). Therefore, the default weight in Table 9 is altered according to the following:

Table 7. Multiplier applied to the effectiveness category weighting of the Habitat Alteration metric (4b) based on the intermediate disturbance hypothesis.

Score Range	Low	Mid-Range	High
Score	1 - 3	4 - 7	8 - 9
Multiplier	0.5	2	1

Opportunity emphasized the weighting for metric 2, examining the buffer around the wetland and its connectivity to other natural areas.

Scoring for Potential Mitigation Sites

One potential use for the WPT is to rank potential mitigation sites in order to determine the most effective location for delivery of an ecosystem service. A procedure, therefore, must be in place to create KY-WRAM scores for restoration of defunct wetlands. Individual metrics of KY-WRAM were characterized as either geospatial or descriptive. The geospatial metrics were those based on the characteristics of the size and location/landscape position of the potential mitigation site. Geospatial metrics can be determined by a site visit and/or aerial imagery. Descriptive metrics are those that reflect the condition of the wetland and cannot be determined by conditions that exist before the mitigation activity. A contrived score forecasting the condition that may be attained after the mitigation activity is inserted. These generic scores were derived from the mean metric scores from a previous performance curves study of mitigation sites in Kentucky (internal report). The mean mitigation site age at assessment for the performance curves study was 7 years with an age range of 1 – 18 years. The total sample size was 22. As more wetlands are assessed with KY-WRAM, these values will be updated. Table 8 lists KY-WRAM metric type and contrived scores of descriptive metrics.

Table 8. Metric scores for potential mitigation sites are determined by site characteristics or given a mean score based on analysis of assessed mitigation sites.

Scoring for potential mitigation sites		
Geospatial metrics (based on site characteristics)	**Descriptive metrics (based on mean of mitigation sites)**	**contrived score**
1a. Wetland size	3d. Alterations to natural hydrologic regime	3.8
1b. Wetland scarcity	4a. Substrate / soil disturbance	2.3
2a. Average buffer width around the wetland's perimeter	4b. Habitat alteration	2.7
2b. Intensity of surrounding land use within 1,000 ft of the wetland	4c. Habitat reference comparison	2.9
2c. Connectivity to other natural areas	5a. Regulatory protection / critical habitat	6.4
3a. Input of water from an outside source	5b. High ecological value / ranked communities	0.0
3b. Hydrological connectivity	5c. Low-quality wetland	0.0
3c. Duration of inundation/saturation	6a. Wetland vegetation components	4.1
	6b. Open water, mudflat, and aquatic bed habitats	2.1
	6c. Coverage of highly-invasive plant species	-0.3
	6d. Horizontal interspersion	2.2
	6e1. Hummocks / tussocks / tree mounds	2.1
	6e2. Large woody debris	0.4
	6e3. Large snags	0.3
	6e4. Amphibian breeding/nursery habitat	1.5

The Wetlands Prioritization Tool

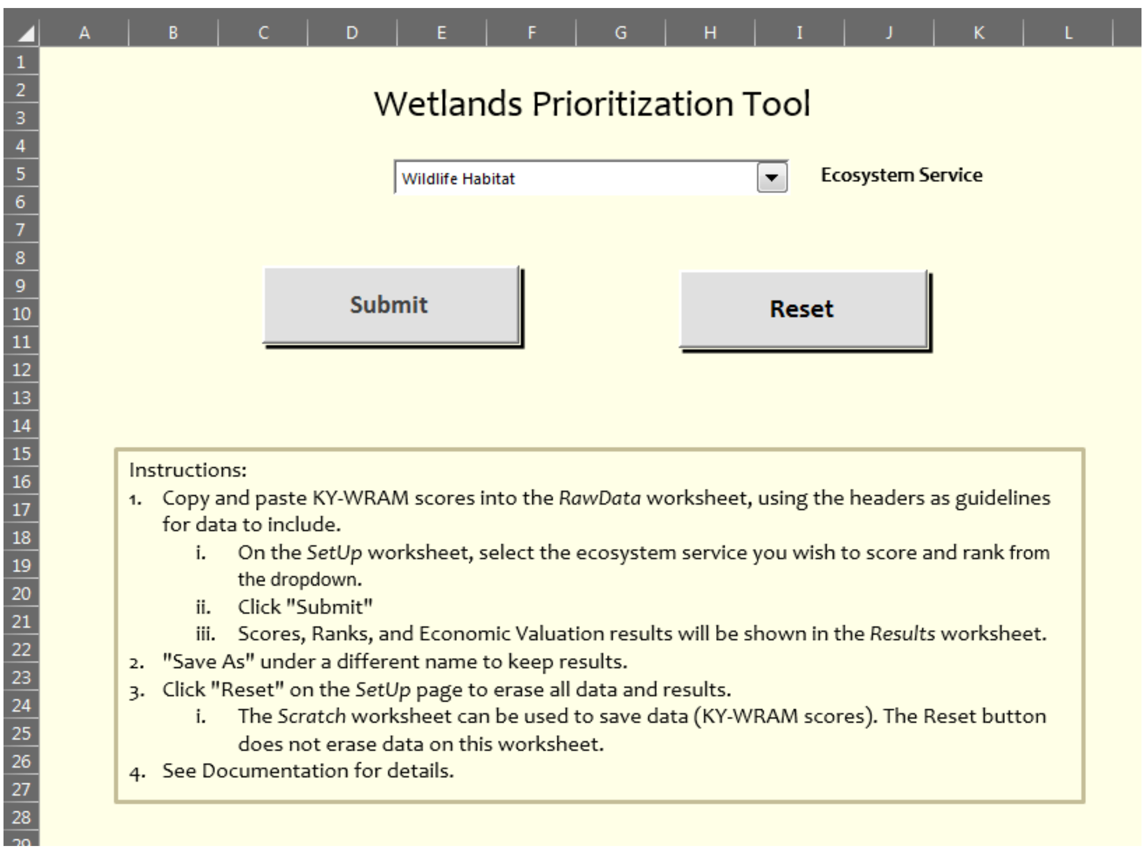
The finished tool is a macro-enabled Excel file. It consists of 5 worksheets.

- SetUp
- RawData
- Results
- Weight
- Scratch

Set Up

The SetUp worksheet (Figure 1) is the launch page for choosing the ecosystem service and running the model. It includes instructions on where to put KY-WRAM data and how to make your selections and run the tool. The *Submit* button runs the model, while the *Reset* button clears the Results and RawData worksheets.

Figure 1. The SetUp worksheet.



Raw Data

The KY-WRAM data under consideration are copied into this sheet (Figure 2) according to the template in the header row.

Figure 2. The RawData worksheet (showing only a few columns) is where the KY-WRAM data are copied and pasted into the WPT.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	
1	**wetland_ID**	**assessment_date**	**County**	**PctPEM**	**PctPSS**	**PctPFO**	**SizeAcres**	**HGM Class**	**k_1a**	**k_1b**	**k_1_tot**	**k_2a**	**k_2b**	**k_2c**	**k_2_tot**	**k_3a**	**k_3b**	**k_3c**	**k_3d**	**k_**
2	WPT_GP_1	10/5/2016	Boone	100	0	0	0.4	Depressional	2.0	3.0	5.0	0.0	3.0	0.0	3.0	2.0	4.0	3.5	3.0	
3	WPT_GP_18	10/5/2016	Boone	100	0	0	0.12	Depressional	1.0	3.0	4.0	4.0	3.0	4.0	11.0	2.0	2.0	3.0	3.0	
4	WPT_GP_19	10/5/2016	Boone	100	0	0	0.97	Riverine	2.0	3.0	5.0	3.0	1.0	0.0	4.0	10.0	4.0	4.0	5.0	
5	WPT_GP_20	10/5/2016	Boone	0	100	0	0.2	Riverine	1.0	3.0	4.0	3.0	1.0	0.0	4.0	6.0	4.0	2.0	1.0	
6	WPT_GP_2	10/14/2016	Boone	10	0	15	0.53	Riverine	2.0	3.0	5.0	3.0	2.0	2.0	7.0	6.0	2.0	3.5	9.0	
7	WPT_GP_6	10/14/2016	Boone	100	0	0	0.026	Riverine	0.0	3.0	3.0	3.0	2.0	0.0	5.0	6.0	2.0	2.0	3.0	
8	WPT_GP_7	10/14/2016	Boone	0	67	0	0.23	Riverine	1.0	3.0	4.0	3.0	2.0	2.0	7.0	6.0	4.0	3.0	8.0	
9	WPT_GP_10	10/17/2016	Boone	0	0	100	0.97	Riverine	2.0	3.0	5.0	3.0	2.0	2.0	7.0	6.0	4.0	3.0	5.0	
10	WPT_GP_12	10/14/2016	Boone	70	0	30	0.235	Depressional	1.0	3.0	4.0	3.0	2.0	2.0	7.0	6.0	4.0	1.0	1.0	
11	WPT_GP_13	10/17/2016	Boone	100	0	0	0.6	Depressional	2.0	3.0	5.0	2.0	1.0	0.0	3.0	6.0	4.0	3.0	1.0	
12	WPT_GP_17	10/17/2016	Boone	0	100	0	0.532	Riverine	2.0	3.0	5.0	3.0	3.0	0.0	6.0	6.0	4.0	3.0	5.0	

Table 9. Weights for ecosystem services and social significance, effectiveness, and opportunity categories.

	Flood flow alteration			Sediment retention			Nutrient removal			Wildlife			General		
	SocSigWt	EffectWt	OppWt	SocSigWt	EffectWt	OppWt	SocSigWt	EffectWt	OppWt	SocSigWt	EffectWt	OppWt	SocSigWt	EffectWt	OppWt
k_1a	6	14	14	6	10	6	6	10	6	6	9	6	-	6	6
k_1b	3	3	3	3	3	3	3	3	3	3	3	3	-	3	3
k_2a	4	4	4	4	4	6	4	4	6	4	6	6	-	4	4
k_2b	4	4	4	4	4	8	4	4	4	4	6	6	-	4	4
k_2c	4	4	4	4	4	4	4	4	4	4	7	7	-	4	4
k_3a	10	18	18	10	10	10	10	15	10	10	5	5	-	10	10
k_3b	6	6	8	6	6	8	6	6	8	6	8	7	-	6	6
k_3c	4	10	4	4	8	4	4	8	4	4	1	1	-	4	4
k_3d	9	14	14	9	5	14	9	5	5	9	11	9	-	9	9
k_4a	4	2	2	4	4	4	4	4	4	4	4	4	-	4	4
k_4b	9	5	5	9	9	9	9	9	9	9	9	9	-	9	9
k_4c	7	5	5	7	5	5	7	5	5	7	7	7	-	7	7
k_5a	10	10	10	10	5	5	10	5	5	15	12	10	-	10	10
k_5b	10	10	10	10	5	5	10	5	5	15	12	10	-	10	10
k_5c	10	10	10	10	0	0	10	0	0	10	12	10	-	10	10
k_6a_f	3	3	3	3	3	3	3	3	3	3	5	3	-	3	3
k_6a_s	3	3	3	3	3	3	3	3	3	3	5	3	-	3	3
k_6a_e	3	3	3	3	3	3	3	3	3	3	5	3	-	3	3
k_6b	3	3	3	3	3	3	3	3	3	3	5	3	-	3	3
k_6c	5	2	2	5	5	5	5	5	5	5	7	5	-	5	5
k_6d	5	3	3	5	7	5	5	7	5	5	7	5	-	5	5
k_6e_1	3	3	3	3	5	5	3	5	5	3	4	3	-	3	3
k_6e_2	3	3	3	3	5	5	3	5	5	3	4	3	-	3	3
k_6e_3	3	2	2	3	3	3	3	3	3	3	4	3	-	3	3
k_6e_4	3	1	1	3	3	3	3	3	3	3	4	3	-	3	3
	Relative Value for Metric/Category Combination														

Weight

The Weight worksheet (Table 9) shows users what the weighting factors are for all ecosystem services and the social significance, effectiveness, and opportunity categories. Values were set during the iterative calibration process and cannot be altered by the user. As discussed previously in the Metric Classification and Weighting section, some categories and metrics have these basic weights modified in the coding of the model depending on narrative metrics.

Scratch

The Scratch worksheet is for the user's convenience. The reset function on the SetUp sheet erases the KY-WRAM scores in the RawData worksheet. The data for various wetlands can be kept on this page, and copied and pasted into the RawData worksheet after resetting the model from the SetUp page.

Results

The Results worksheet contains the final output of the tool (Figure 3). Output notes the ecosystem service under consideration, the results of the economic valuation (both per acre and total values of the annual ecosystem service), the three category scores, the total score and a ranking of the total score in comparison to all of the wetlands considered in the model run. An explanatory box is provided to emphasize that the economic valuation does not reflect the value of the property, but the annual value of the service provided by the wetland.

Figure 3. The Results worksheet of the WPT.

Wildlife Habitat Site	per Acre Valuation*	Total Valuation*	Social Score	Effectiveness Score	Opportunity Score	Total Score	Rank
WPT_UT4	$1,144	$38,029	53.3	75.0	62.9	63.7	3
WPT_UT_6	$3,880	$22,507	49.4	57.1	44.7	50.4	9
WPT_UT10	$2,286	$40,434	49.6	66.0	52.4	56.0	7
WPT_UT13	$2,796	$36,806	51.7	66.4	53.2	57.1	6
WPT_UT_18	$3,891	$4,669	83.5	96.6	82.8	87.6	1
WPT_UT3	$4,443	$12,262	61.7	73.8	60.6	65.3	2
DOW001	$1,557	$38	31.7	49.8	42.5	41.3	12
DOW002	$588	$1	27.8	49.7	42.0	39.8	14
DOW003	$1,830	$2	33.2	52.6	44.3	43.4	10
DOW004	$1,475	$26	38.8	62.2	51.5	50.8	8
DOW006	$1,253	$11	29.3	51.6	42.8	41.2	13
DOW007	$1,804	$48	49.7	73.9	64.3	62.6	4
DOW008	$587	$21	14.3	23.8	22.5	20.2	18
DOW011	$729	$5	46.3	74.7	66.0	62.3	5
DOW012	$1,802	$87	32.3	49.8	42.5	41.6	11
DOW013	$1,830	$3	28.2	41.5	38.3	36.0	16
DOW014	$2,891	$138	27.9	36.9	34.5	33.1	17
DOW015	$2,122	$92	28.9	42.6	37.5	36.3	15

* Per acre and total valuations are an estimate of the annual monetary benefit provided by the chosen ecosystem service in 2015 US$.
* Economic valuation is based on the contingent valuation method.
* The valuation does not reflect, in any way, the value of the property on which the wetland resides.

Evaluation and Calibration of the Tool

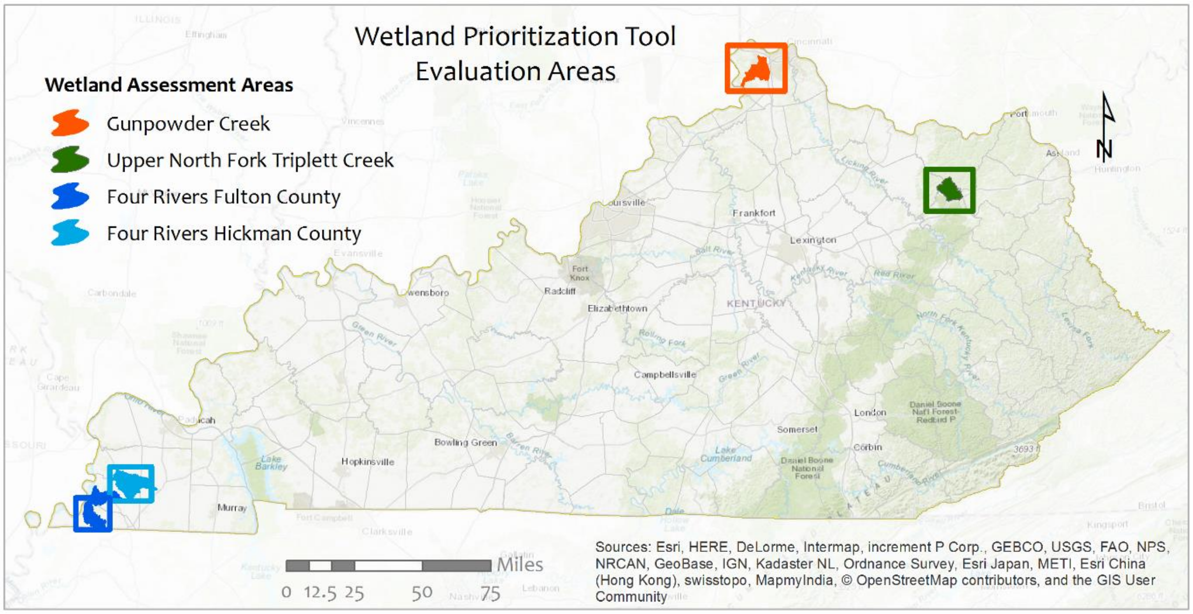
Site Selection

The tool was evaluated by collecting KY-WRAM data from three areas within the state representing different land use and ecoregions. Wetlands in Kentucky can vary dramatically in both size and character. In the eastern part of the state, most wetlands are small ridgetop wetlands. In far western Kentucky, wetlands may be thousands of acres, and can be cypress tupelo swamps. Assessment areas were chosen for evaluation in the same manner the finished tool was to be implemented. Stakeholders were consulted in determining possible assessment areas.

1) Gunpowder Creek Watershed Planning in Boone County is located in the Interior Plateau ecoregion and represents an area with rapid suburbanization with significant wetland loss and degradation. The watershed planning committee is led by the Boone County Conservation District and works to address nonpoint source pollution impacts and to protect the water resources of the watershed. Sites were assessed during the summer of 2016. Eleven assessments were conducted for Gunpowder Creek.
2) Upper North Fork Triplett Creek Watershed in Rowan County is in the Western Allegheny Plateau ecoregion. This is a mountainous region characterized by small ridgetop wetlands as well as riverine wetlands in the valley, most of which have been modified and have lost function to the point of devolving into floodplain areas that lack wetland habitat. Six sites were assessed by this project. In addition, 12 sites in the same watershed were assessed for another project in 2015. These earlier assessments were included in evaluation of the model for this watershed.
3) The Four Rivers region is found in western Kentucky. Wetlands in the far western part of the state are substantially different in nature than the rest of the state. They can be large, often 1000s of acres; and frequently cypress and tupelo swamps are found here. These assessments were the result of discussions with partner organizations. The Nature Conservancy and the Natural Resources Conservation Service (NRCS) Wetlands Reserve Program both strive to protect wetlands by either purchasing land, or putting land into easements to prevent any future development or farming. Both expressed a desire to be able to determine the best investments for their limited dollars. They proposed that we assess 'protected lands' to determine how the tool functions and for insight into determining characteristics to look for as ideal candidates for preservation. The Mississippi Alluvial Plain ecoregion, primarily in Fulton County, and the Mississippi Valley Loess Plains ecoregion, with wetlands in Obion Creek Wildlife Management Area and Obion Creek State Nature Preserve in Hickman County were chosen as areas for assessment. The sites were in the Obion Creek Wildlife Management Area, Obion Creek State Nature Preserve, and NRCS Wetland Reserve Program easement sites, either established or in the application process. Sites were assessed in 2017. A total of 14 sites were assessed.

Potential wetlands were identified with the National Wetland Inventory (NWI) dataset (USFWS, 2017), with additional inputs from other organizations such as the National Forest Service. The initial goal was to conduct assessments on all wetlands within chosen watersheds. With limited time and resources, the strategy to assess all wetlands was revised to be a random draw of wetlands, with the goal of assessing a minimum of 10 wetlands within a watershed. In addition, with loss of wetlands in many areas, the limitation to a single watershed was expanded to a more general area. General areas for the evaluations are shown in Figure 4. Specific sites for evaluation wetlands are found in Appendix A.

Figure 4. Evaluation areas represent various land use and physiographic areas in Kentucky.



Potential validation sites were scouted to determine if they were a wetland or potential wetland restoration site; ownership was determined and permission for access to the site was sought from landowners. If permission was not granted, the site was removed from consideration. Sites were also removed from consideration if the site was inaccessible due to the necessity to cross deep streams or other hazardous conditions. Area and HGM class of evaluated sites is shown in Table 10.

Table 10. General characteristics of evaluation wetlands.

Evaluation Area	Area (acres)*			HGM Class (count)	
	Min	Mean	Max	Riverine	Depressional
Gunpowder Creek	0.026	0.438	0.97	7	4
Upper North Fork Triplett Creek	0.001	4	33	6	12
Four Rivers Fulton County	50	50	50	7	0
Four Rivers Hickman County	50	50	50	7	0

*The KY-WRAM assesses a maximum of 50 acres per wetland, even if the wetland is larger.

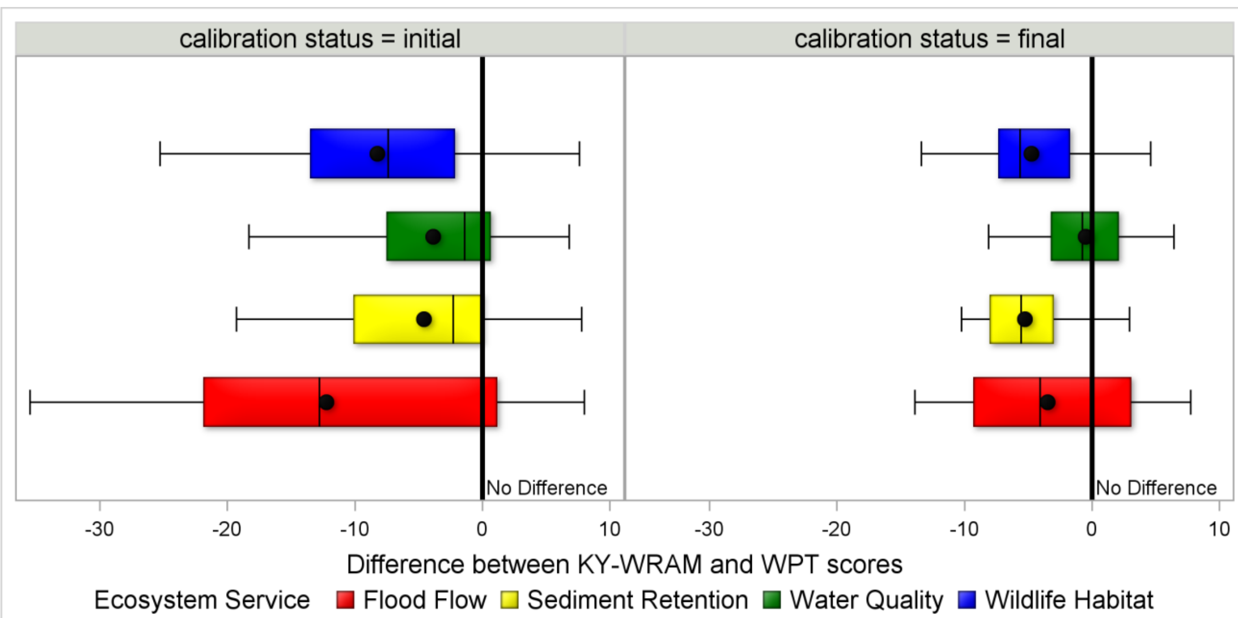
Calibration Process

After an initial adjustment of weights based on Table 3, the WPT was run for each ecosystem service and assessment area separately. Results were assessed, and the weighting of metrics was adjusted in an iterative process until the model results reflected the differences between the wetlands across ecosystem services and assessment areas according to the best professional judgment of the program coordinator. The final weights resulting from this iterative process are shown in Table 9.

Calibration Results

In calibrating the model, we strove to have the category and total scores for each ecosystem service be in the same range as the KY-WRAM scores (ranging from 1 - ~100), meaning, the ecosystem service will emphasize different metrics, but the final scores should be pushing up or down the KY-WRAM score, rather than give a dissimilar result. Figure 5 shows that the iterative calibration process, comparing the initial weighting of the tool compared with the final weighting, moved the final WPT scores closer to the range of KY-WRAM scores. WPT scores tended to be higher than KY-WRAM scores for all ecosystem services. The initial weighting had WPT mean scores diverging from the KY-WRAM scores by as much as 12 points for Flood Flow Attenuation, with a maximum difference of 35 points; whereas the final calibration had a mean difference of 3.5 points and a maximum difference of 13 points.

Figure 5. The iterative calibration process moved the WPT scores closer to the KY-WRAM scores.



The move up or down reflects the better or worse ability of the particular wetland to provide a given ecosystem service, as opposed to the general quality of the wetland. Figure 6 plots the WPT category and total scores against the KY-WRAM scores. A one-to-one match is not the ideal, in that some metrics are emphasized over others, but a similar range was found. Some patterns are found in these graphs. For all ecosystem services, the social significance category plots lower and shows more variability than the other categories. The variability found in the economic valuation was dampened by normalizing that factor on a 0.75 to 1.0 scale. This did improve the range of the category but it still reflects more variability in this category. With the exception of sediment retention, the effectiveness category tends to score higher than the opportunity category. This effect is more marked in higher scoring wetlands and most pronounced in the wildlife habitat ecosystem service.

Figure 6. WPT category and total score compared to KY-WRAM score.

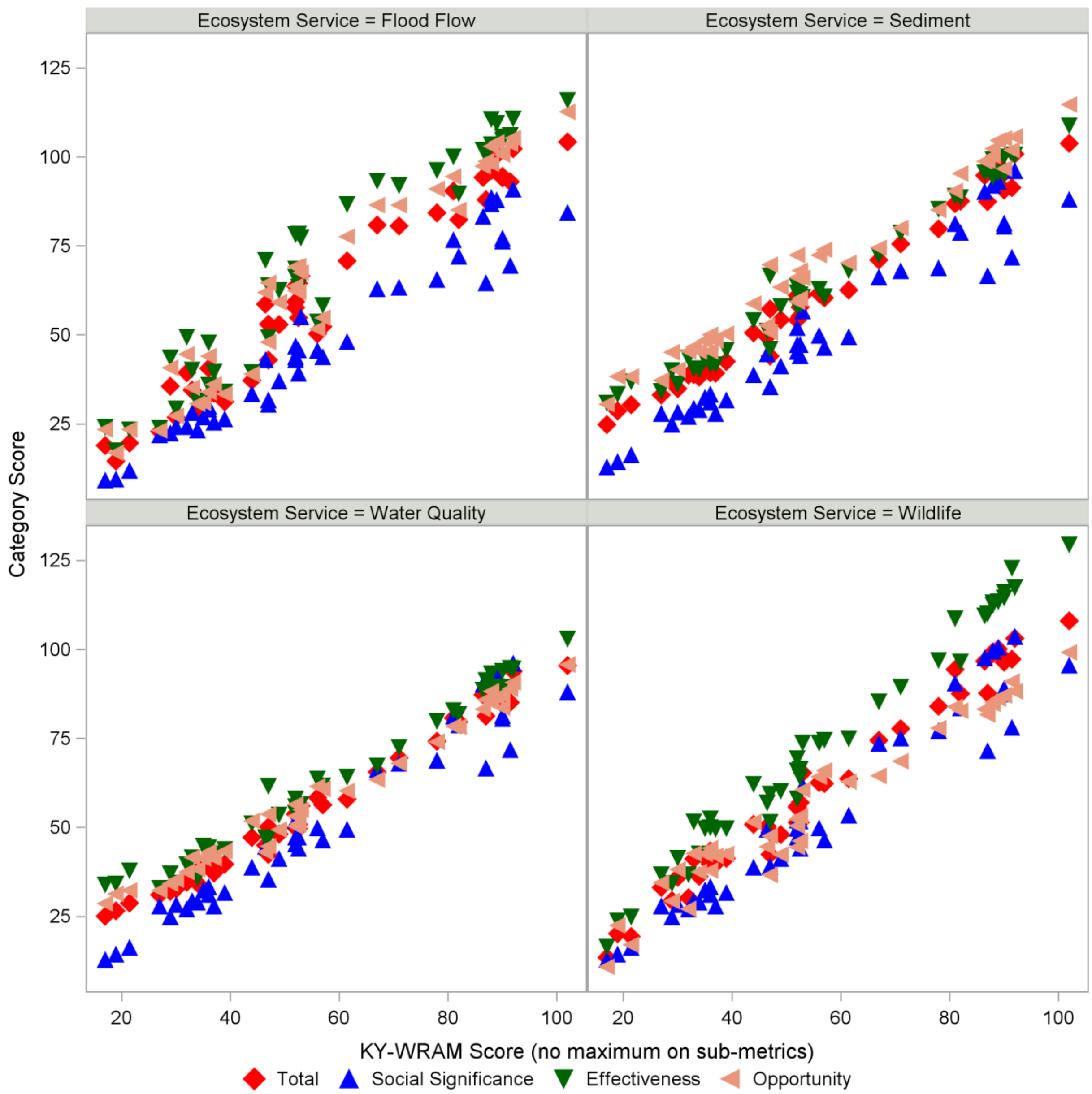
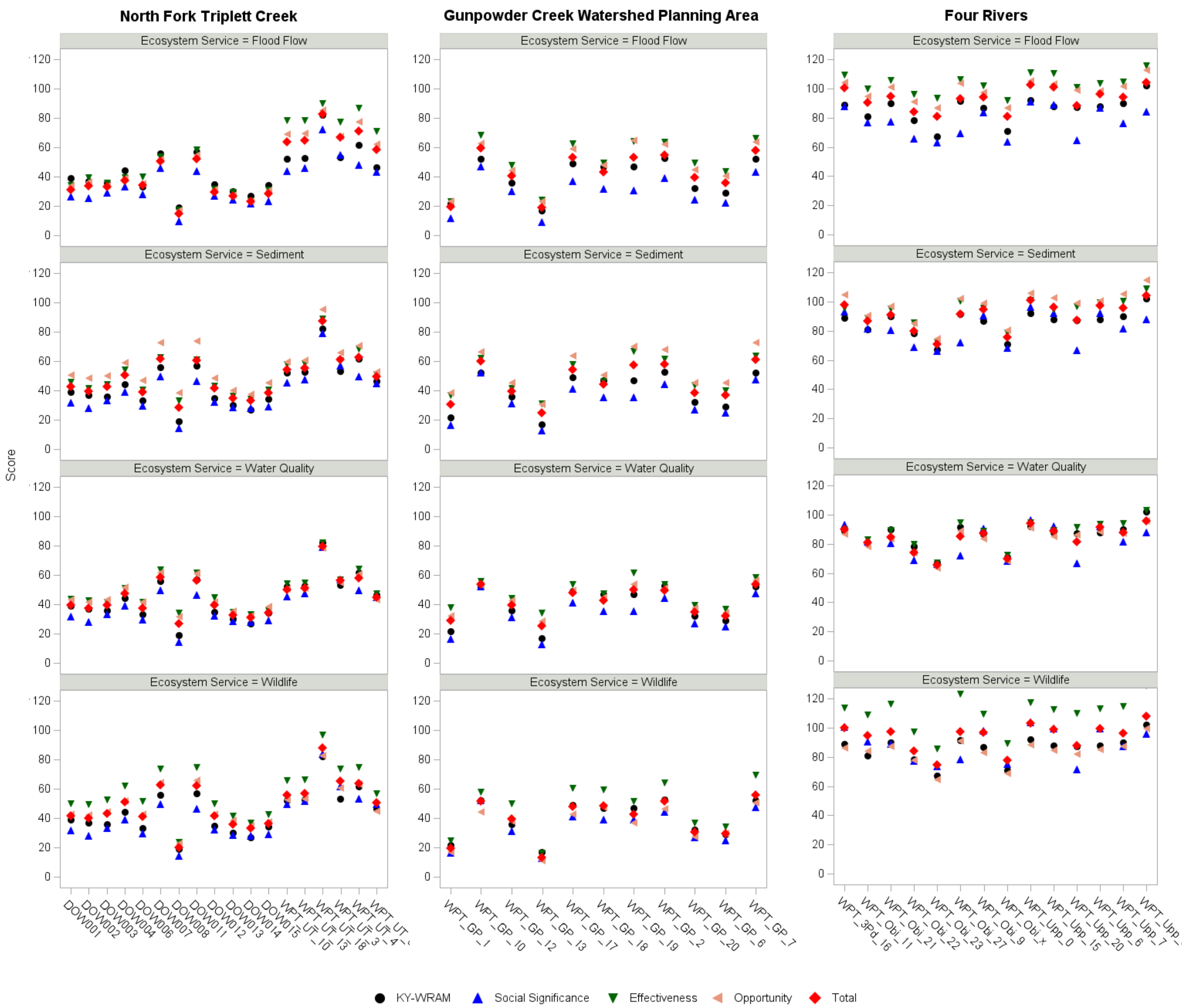


Figure 7 shows the individual category and total scores of the WPT for each validation site. The plots demonstrate that the scores track with the KY-WRAM score, but do push up or down depending on wetland characteristics. In particular, the North Fork Triplett Creek sites demonstrate this for flood flow attenuation (top left cell). The six sites with the prefix 'WPT' are all riverine sites, while the sites with the prefix 'DOW' are depressional ridgetop sites. For the riverine sites, the effectiveness and opportunity scores are pushed above the KY-WRAM score pulling up the WPT total score. In contrast, the ridgetop wetlands have effectiveness and opportunity scores near or below the KY-WRAM score, with the total score lower than the KY-WRAM score. This shows the desired pushing of scores up or down from the general score of the KY-WRAM.

Figure 7. Breakdown of category and total scores for each validation wetland.



Discussion

Important Factors for Mitigation and Protection

An expected outcome from this project was a better understanding of the factors that are important in planning wetlands protection or mitigation projects.

In general, wetlands in the western part of state score higher than other parts of the state because they are larger. While only one metric addresses size, function can also be impacted by size. Wetlands in the far western part of the state (the Jackson Purchase) are riverine and many are within the floodplains of the Ohio and Mississippi Rivers. The hydrology of these immense waterways can overwhelm any man-made hydrologic manipulation when floodwaters rise. In the rest of the state, with the exception of some wetlands in the Ohio River floodplain, wetlands are further removed from the magnitude of hydrologic impact of these major arteries. With lesser flows, these wetlands may have more loss of function from a similar hydrologic alteration.

In working through each ecosystem service, it became apparent that the narrative information was important in determining impact. The narrative information includes the HGM classification and the NWI classification, which uses vegetation classes as defined by Cowardin et al, 1979. The KY-WRAM does not give a point value to this information; therefore, it was necessary to incorporate this information into the coding of the model as opposed to making an adjustment to the weight table. Without including the narrative rating in the coding, the delineation between a slope wetland as a potential source of floodwaters, from a riverine wetland which efficiently stores floodwaters would not be possible. These basic classification differences are not captured in the scoring of the KY-WRAM.

One difficulty with developing the weights was that some of the metrics are comprised of several smaller metrics summed together (see Appendix B: Kentucky Wetland Rapid Assessment Method). This made it difficult to precisely target some factors that influence effectiveness or opportunity. For example, **3b. Hydrological Connectivity** is comprised of *100-year floodplain or abutting smaller stream/creek*, *Between a Stream/Lake/Pond and Human Land Use*, and *Wetland Complex*. Each of these are worth 2 points, but only the summed score (maximum of 6 points) is reported. Weighting of *Between a Stream/Lake/Pond and Human Land Use* for emphasis in the opportunity category cannot be precisely targeted since the score is combined with others. At this time, an application is under development for collecting electronic KY-WRAM data in the field. This application will automate data entry and have the added benefit of keeping these sub-metrics separate. When the application is complete, the model will be updated to more precisely target factors that impact ecosystem services.

Interpreting Results

The Results page of the tool gives dollar values for each wetland. This value represents the per-acre or total value provided by the ecosystem service each year. While the dollar value does give more information to the user, it is possible that the amount may be misinterpreted as representing the value of the property the wetland sits upon. The decision to include or not include the valuation results have been debated as some fear that the regulated community will see the dollar value and believe that they have been overcharged for their mitigation activities. The decision was made to leave in the economic valuation, but to emphasize, by means of a text box, that the valuation gives an annual value for the ecosystem service provided, and not the value of the property.

The social significance score is computed using the normalized economic value. For most metrics, the value per acre is used, but for the size metric, the total wetland value is used. When this total value is normalized, the dollar difference between a half acre wetland and a 50 acre wetland essentially renders the smaller wetland irrelevant. If the smaller wetland is pristine compared to the larger one, this scoring difference may seem as though the calibration is off; however, in assessing ecosystem function, more services will be delivered by the larger wetland even though it may be less efficient at delivering those services. In normal use, the tool would be used to determine the best use of mitigation or preservation dollars. For most cases, particularly compensatory mitigation plans, comparison of sites of vastly different sizes would be contrary to the objectives of the project. In all cases except for the General ecosystem service, it should be remembered that all scores are relative to the wetlands being compared, not absolute scores.

All models are estimates of how a system operates. In constructing a model, the challenge is to include enough variables to adequately represent the system without including so many variables that collecting the data to run the model becomes untenable. A weakness of this tool is that the economic valuation equation was overly broad in that it was derived from a meta-analysis that spanned studies from across the globe. Because of the wide variation of wetland types and locations, the values produced are generic and not as specific to Kentucky's wetlands as a valuation that was more focused. One example of this broadness can be seen in the equations for Water Quality/Nutrient Removal and Sediment Retention. They are identical for both services. Sediment removal is a strictly physical process, while nutrient removal and water quality improvement take place through the physical process of sorption to sediment as well as the chemical process of transformation to a less available form. As reflected in Table 9, certain metrics in the KY-WRAM impact the chemical processes of nutrient removal and water quality. The economic valuation is a broader measure and fails to account for chemical processes while the WPT does reflect these processes. Because of the generic nature of the valuation, total scores and ranks should be considered as better indicators of ecosystem service function than the economic valuation when evaluating wetlands for potential projects.

Moving toward Integration of the WPT into Decision Making

At this time, KDOW issues § 401 Certification, leaving mitigation decisions to the USACE. Kentucky is covered by the Louisville, Nashville, and Memphis USACE districts; each having a slightly different means of determining the mitigation ratio for a project. The default ratio for all districts is 2:1, but this ratio may go up or down depending on the type of wetland and the district. KY-WRAM has not yet been integrated into the permitting and certification process, but is being considered for that purpose. The WPT is a way to objectively consider the quality and services a wetland provides instead of just looking at acreage and HGM class. With use, the WPT will be used to introduce the concept of considering quality and ecosystem services as part of the justification for choosing a mitigation project. While no regulatory requirement for use of the tool is planned, its introduction and use will lend credibility to decisions. The WPT, as additional information, can be used to inform this process, with the results being able to justify a given ratio. Over time, instead of justifying what has already been decided, the tool may shift toward being used in the decision making process.

Interest in the tool has already been shown from organizations that focus on preservation and restoration. The tool objectively compares wetlands for the functions that the wetlands provides and can help organizations and agencies determine how best to spend scarce dollars.

Conclusion

Beyond the project period, the successful implementation of the WPT by partner organizations will result in an increased quality and quantity of wetlands by providing a means to determine which wetland projects will provide the best return of ecosystem services for the investment provided. The tool illustrates that wetlands are naturally variable and perform different functions. In considering the various ecosystem services, the tool highlights that a wetland may be better at performing one function than another, thus broadening the understanding of wetland functions. The WPT is also a means to communicate to non-scientists the various functions a wetland performs.

Acknowledgments

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Appendix A: Assessment Sites

Figure 8. Gunpowder Creek assessed wetlands.

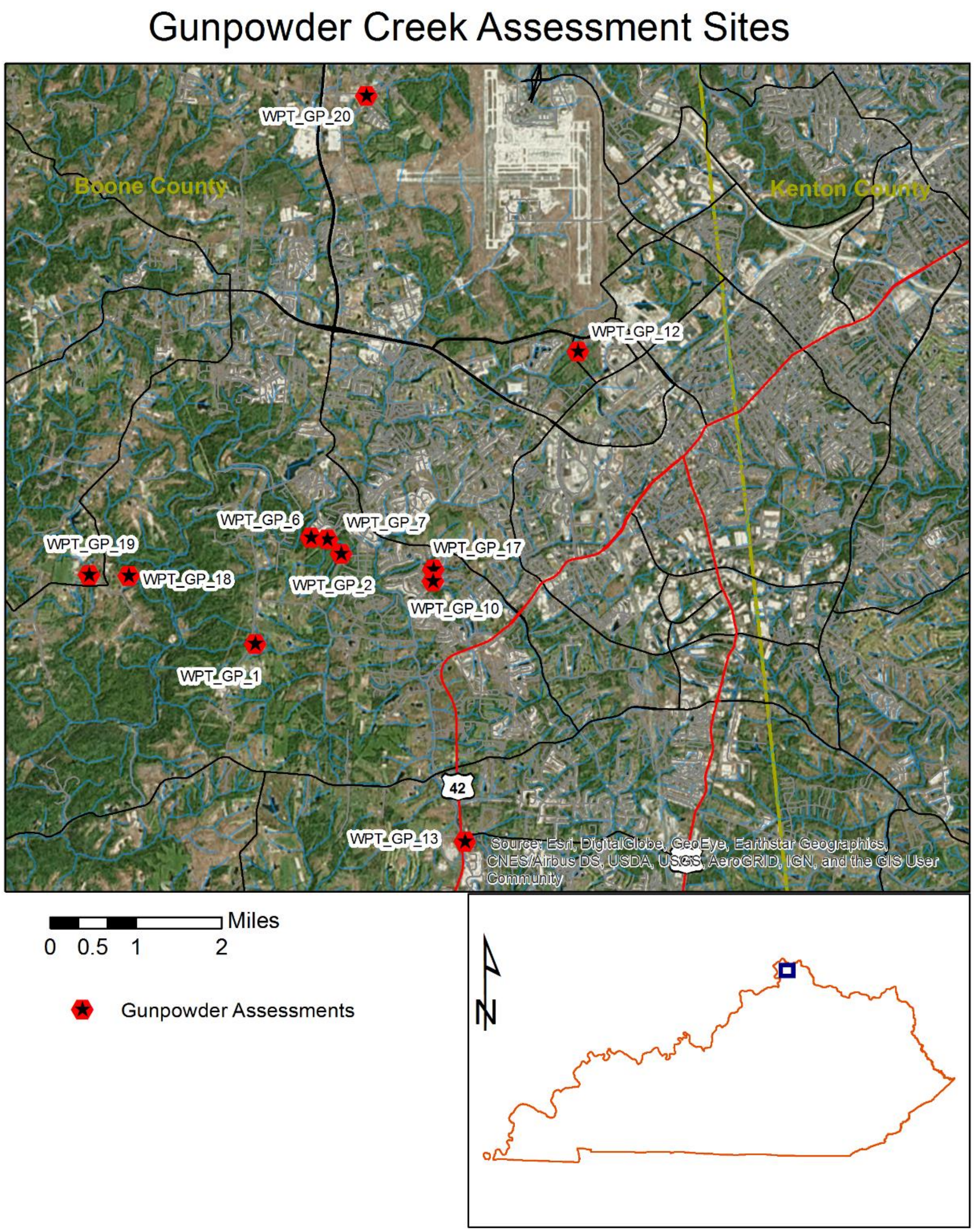


Figure 9. Upper North Fork Triplett Creek wetland sites.

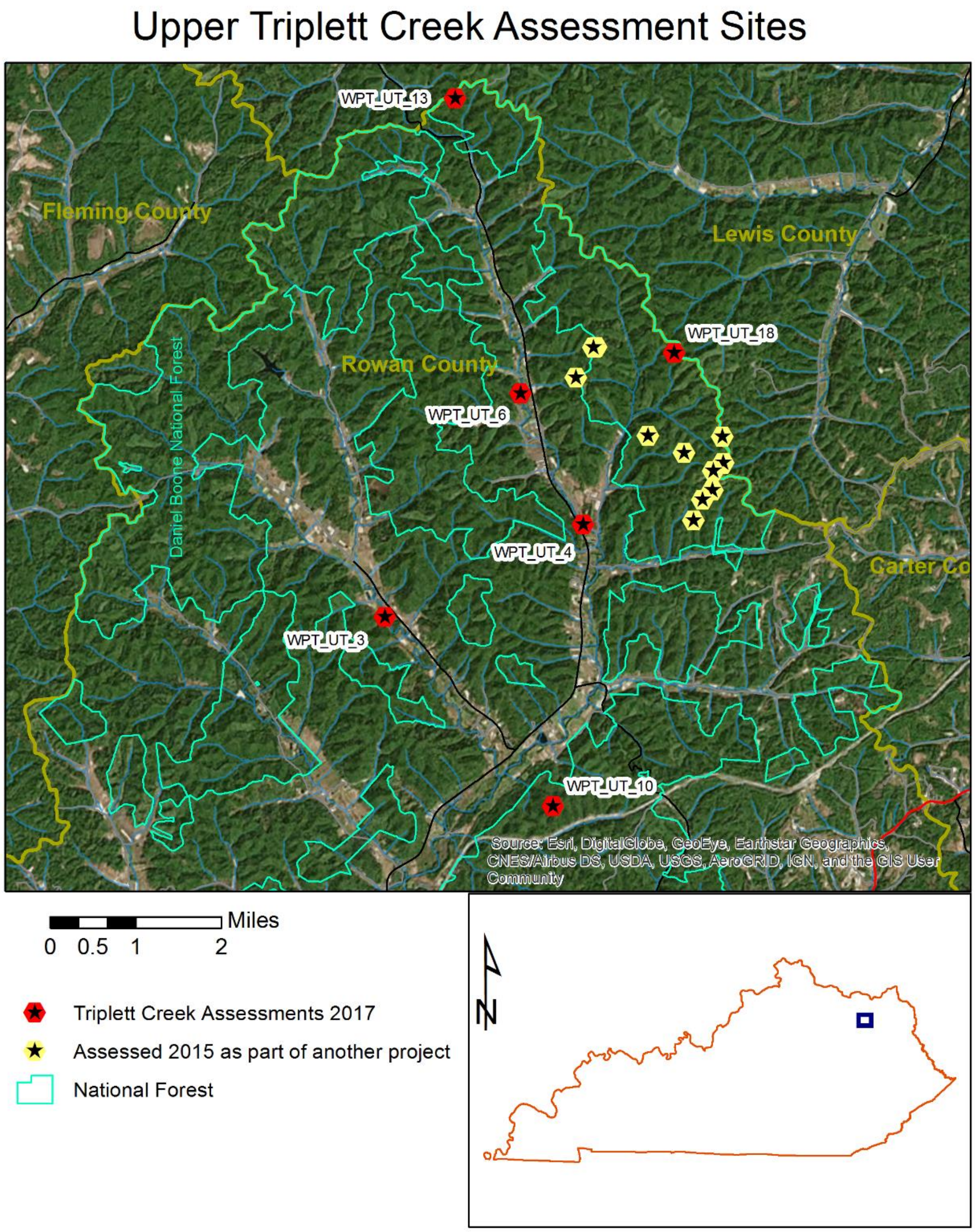


Figure 10. Four Rivers / Fulton County wetland sites.

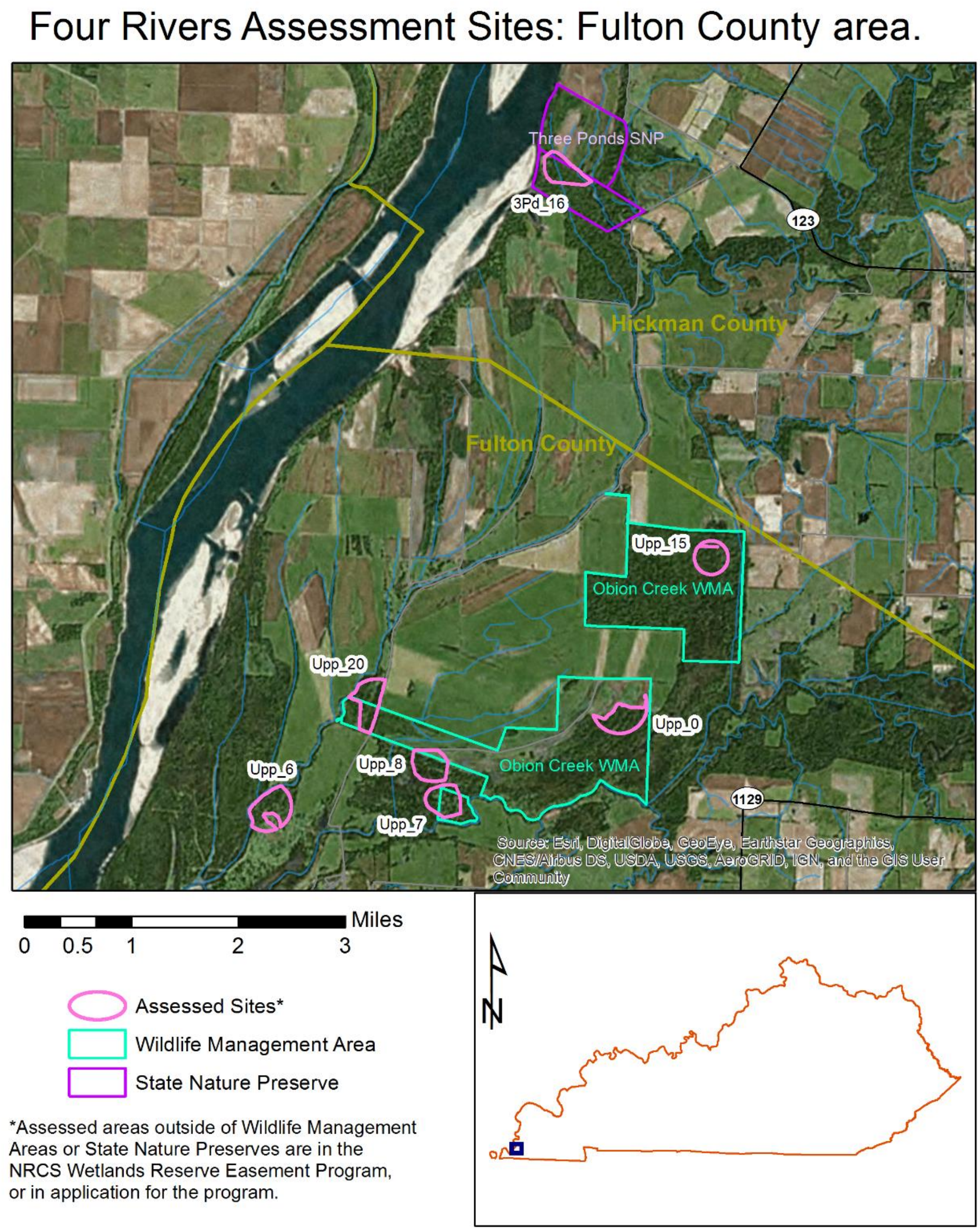
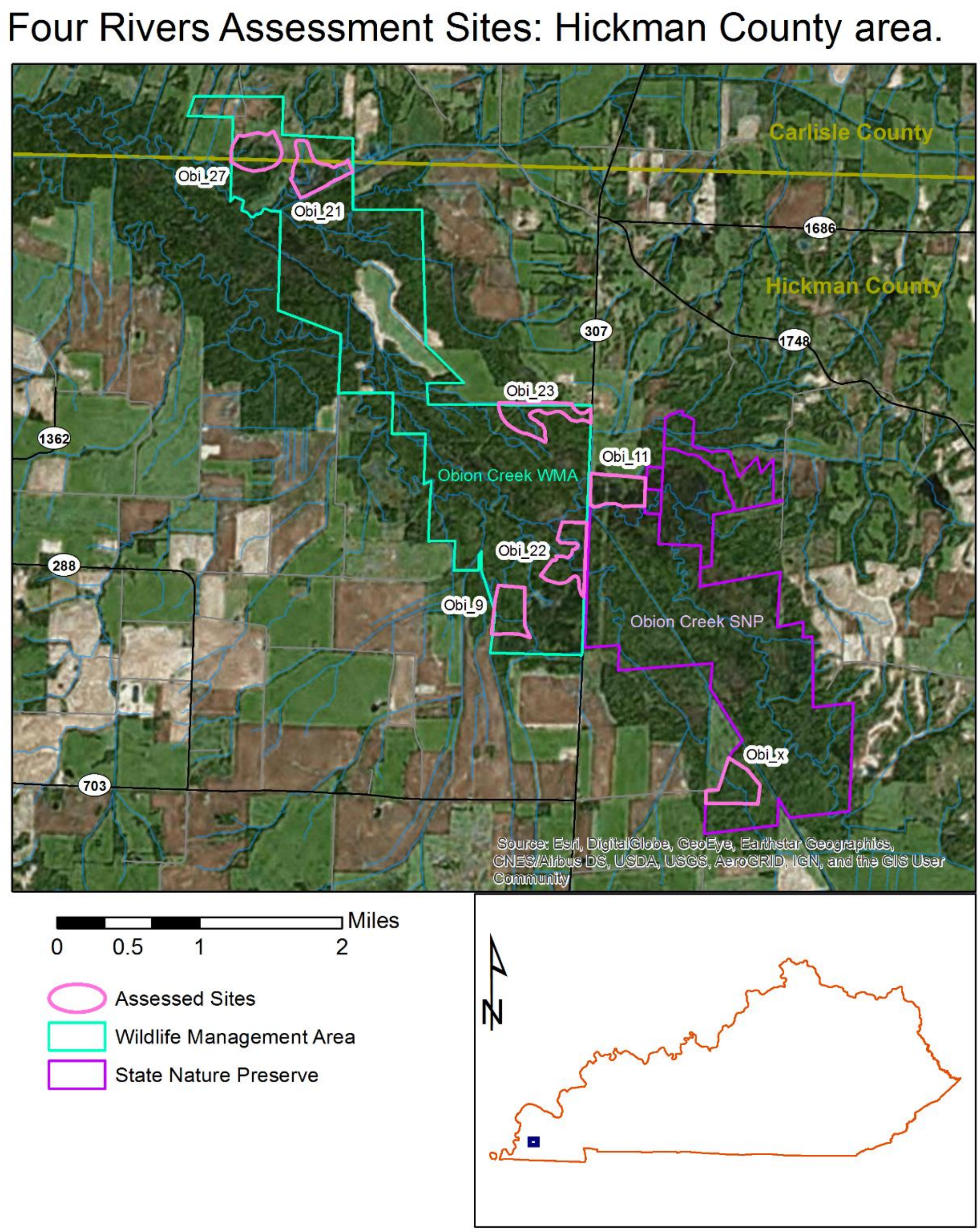


Figure 11. Four Rivers / Hickman County wetland sites.



Appendix B: Kentucky Wetland Rapid Assessment Method

KY-WRAM Rating Form Version 3.0	# Kentucky Wetland Rapid Assessment Method (KY-WRAM) Kentucky Division of Water

Instructions:

The Kentucky Wetland Rapid Assessment Method is intended for use as a tool for functional assessment. The method supplements, but does not replace information used in the existing regulatory process for wetlands, such as delineation. It is intended for use on all types of wetland in Kentucky. This is a rapid assessment method with combined field and office prep time (GIS) of no more than 8 hours. This method does not replace quantitative assessments such as Indices of Biotic Integrity.

The Rater is *STRONGLY URGED* to read the Guidance Manual for using the Kentucky Wetland Rapid Assessment Method (KY-WRAM) for further elaboration and discussion of the questions below prior to using the rating forms. It is *VERY IMPORTANT* to properly and thoroughly answer each of the questions in the KY-WRAM in order to properly categorize a wetland. To *properly* answer all the questions, the boundaries of the wetland being assessed must be correctly identified. Refer to the Scoring Boundary section in the Guidance Manual for a discussion of how to determine the "scoring boundaries." In some instances, the scoring boundaries may differ from the "jurisdictional boundaries."

The KY-WRAM was developed by a Technical Working Group of state and federal agencies and Eastern Kentucky University. This method is modeled off of the Ohio Rapid Assessment Method (ORAM) with modifications influenced by North Carolina and Michigan's wetland rapid assessment methods.

The total score has been shown to be consistent year round; however, the ideal timeframe for use of this method is during the plant growing season when plant species can be reliably identified. It should be noted that the individual metrics may be scored differently between the seasons because certain metrics are easier to evaluate during the growing season (e.g., highly-invasive plant species coverage, special wetlands, vegetation components) and non-growing season (e.g., substrate/soil disturbance, hydrology).

Although the form may be filled out in a linear manner it is expected that the Rater will make note of wetland characteristics throughout the entire field evaluation. For example, alterations to the hydrology, substrate, or habitat, plant species encountered, and the amount of microtopography features present. This is an important step in evaluating the method properly.

Background Information

Name of wetland:	Evaluator name:
Date of evaluation:	Phone number:
Lat/Long coordinates: (decimal degrees)	Email:
County:	Evaluator affiliation and address:
USACE/WQC Project ID:	
Precipitation within the last 48 hours? Circle: Yes No	

Attachments: Complete and check (√) each box

- ☐ Attach map of wetland location. Use county road map or USGS 7.5 minute topographic map with location indicated.
- ☐ Attach color photographs of wetland including landscape shot of entire wetland (if possible), vegetation components, habitat types, hydrologic features, and other relevant site features.
- ☐ Attach prints of satellite imagery used for buffer and connectivity metrics. This should include multiple prints at appropriate scales. Prints should include labeled marks of the following: site location, Wetland Assessment Area, plant communities within the wetland, streams, 100 year floodplains, ponds, patches of open water, relevant upland features, and location of modification to wetland. Also include north arrow and scale of each print.

Wetland Sketch (include north arrow, hydrologic features, plant communities and other habitat features)

Actual Wetland Size (indicate units):

Wetland Type (indicate NWI & HGM classifications):

Background Information (continued)

Narrative Discussion: List any additional site information or features that may be relevant to evaluation of the wetland. See Guidance Manual for the types of information that should be included here. Scoring comments should be placed on page 13.

Narrative Rating

1. U.S. Fish and Wildlife Service (USFWS) Critical Habitat

- Is any part of the wetland located within the same HUC-12 watershed designated as Critical Habitat? (see Narrative Discussion) ☐ Yes ☐ No
- Does any federal (G1/G2) or state-listed T/E plant or animal species (S or S2) occur within the wetland's HUC-12 watershed? (see Narrative Discussion) ☐ Yes ☐ No
- Does any S3 (state species of concern) species occur within the wetland's HUC-12 watershed? (see Narrative Discussion) ☐ Yes ☐ No

2. Rare Wetland Community Type

- Does the wetland include a KSNPC rare wetland community? ☐ Yes ☐ No
- If YES, list the community type, the size of the rare community, and the percent of the wetland area.

3. Scenic, Recreational, and Cultural Value

- Does the wetland have scenic, recreational, or cultural value? (see Narrative Discussion) ☐ Yes ☐ No

Comments:

Site:	Rater(s):	Date:

Metric 1. Wetland Size and Distribution – Maximum 9 points.

1a. Wetland Size – Maximum 6 points. Using GIS, estimate the size of the wetland (i.e., Wetland Assessment Area). **Select one size class.**			**Score**
Sources/assumptions for size estimate (list): **Actual Wetland Size Estimate:** ________ acres **Wetland area proposed to be impacted:** ________ %	≥ 50 acres	**6 pts**	
	25 acres to <50 acres	**5 pts**	
	10 acres to <25 acres	**4 pts**	
	3 acres to <10 acres	**3 pts**	
	0.3 acre to <3 acres	**2 pts**	
	0.1 to 0.3 acre	**1 pts**	
	< 0.1 acre	**0 pts**	

1b. Wetland Scarcity – Maximum 3 points. Use USFWS National Wetlands Inventory (NWI) maps, aerial imagery, and other information to estimate percentage of wetland area remaining within a 2-mile radius from the wetland's center (use ArcGIS or by visual estimate). For this submetric, areas of open water within lakes, streams, rivers, and ponds (PUBX), etc. should be excluded. **Select the most appropriate category below.**		**Score**
0 to 5% of surrounding 2-mile radius is wetland	**3 pts**	
6 to 20% of surrounding 2-mile radius is wetland	**2 pts**	
>20% of surrounding 2-mile radius is wetland	**1 pt**	

Metric 1 Total: add 1a & 1b **(9 points max.)**	

Wetland Size Estimate + Metric to English Conversion							
acres	hectare	$feet^2$	ft on side	$yard^2$	yd on side	m^2	m on side
50	20.2	2,177,983	1,476	241,998	492	202,000	449
25	10.1	1,088,992	1,044	120,999	348	101,000	318
10	4.1	435,596	660	48,340	220	41,000	203
3	1.2	130,679	362	14,520	121	12,000	110
0.3	0.12	13,067	114	1,452	38	1,200	35
0.1	0.04	4,356	66	484	22	400	20

Site:	Rater(s):	Date:

Metric 2. Buffers and Intensity of Surrounding Land Use – Maximum 12 points.
**Use color maps for all metric 2 sub-metrics.

2a. Average Buffer Width around the Wetland's Perimeter – Maximum 4 points.

Draw the cardinal and ordinal lines from the centroid of the wetland and calculate average buffer width. Select only one score.

Buffers Include:	Non-Buffers Include:		
☐ shrubland, forest of any age, natural grassland, natural rock outcrops and cobble bars ☐ abandoned row crop field (vegetated & naturalizing) ☐ hay field (non-row crop) ☐ lightly managed forest (selectively logged) ☐ lightly managed parkland ☐ other wetland, lake, or river ☐ Single-track dirt roads (non-motorized vehicle trails that are not sources of sediment)	☐ lawns, golf courses, manicured parkland ☐ residential, commercial, industrial ☐ roadways (including shoulders), parking lots ☐ railroad tracks/beds ☐ active agriculture: row crop field ☐ conservation tillage, grazed pasture, utility right-of ways ☐ clear-cutting or heavily managed forest, mining, construction activity ☐ gravel or double-track dirt roads (includes ATV trails)		**Score**
Wide Buffer Width: 150 feet around the perimeter		**4 pts**	
Medium Buffer Width: 75 to <150 feet around the perimeter		**3 pts**	
Narrow Buffer Width: 25 to <75 feet around the perimeter		**2 pts**	
Very Narrow Buffer Width: 0 (no buffer) to <25 feet around the perimeter		**0 pts**	

2b. Intensity of Surrounding Land Use within 1,000 feet of the Wetland – Maximum 4 points.

If a land use type in not listed, use the examples below to determine the category. Write in additional land use types here and indicate the land use category you assigned:

Land Use Category	Estimate the percent coverage comprised by each of the four categories of land use below. Sum the points from all dominant land use categories (i.e., dominant is ≥25% total per category) and then average the score.				
	Land Use Types:		Estimate % of each category **here** ↓		**Score**
Very Low:	☐ mature growth forest	☐ other wetland, lake, stream, river		**4 pts**	
Low:	☐ shrubland/young forest ☐ hay field (non-row crop) ☐ lightly managed parkland	☐ old field ☐ single track and two track dirt roads ☐ one-lane paved road		**2 pts**	
Moderately High:	☐ residential & lawns ☐ manicured parkland ☐ golf course ☐ grazed pasture ☐ utility right-of-way	☐ conservation tillage ☐ recent logging and clear-cut (<5 years) ☐ two-lane road ☐ railroad ☐ man-made lake		**1 pts**	
High:	☐ commercial, industrial ☐ high-density residential ☐ heavily grazed pasture ☐ row crop field	☐ multi-lane paved roadway ☐ construction activity ☐ parking lot ☐ hazardous areas (mining, landfills, brownfields, etc.)		**0 pts**	
			Round to the nearest 0.5		

2c. Connectivity to Other Natural Areas – Maximum 4 points.

Use GIS with field adjustment if necessary. Evaluate the wetland's connectivity to habitat patches in the greater landscape either contiguously or via a corridor (≥ 30 ft wide) of natural vegetation. Habitat patches and corridors must be natural terrestrial habitat (i.e., shrubland, forest, natural rock outcrops, cobble bars, wetlands, and etc.). Large streams and rivers, roads, and "non-natural" habitat such as grassland are barriers that end patches and corridors.

Connected at:	**Circle all categories that apply but report only the highest point value**		**Score**
Up to 2500 ft. (can be more)	>50% of area is patch	**4 pts**	
	<50% of area is patch *(minimum patch size requirement = 10 acres)*	**2 pts**	
Up to 1000 ft.	>25% of area is patch	**2 pts**	
	<25% of area is patch	**0 pts**	

Metric 2 Total: add 2a – 2c **(12 points max.)**	**Sub-total:**

Site:	Rater(s):	Date:

Metric 3. Hydrology – Maximum of 29 points.

3a. Input of Water From an Outside Source – Maximum 10 points. Select all that apply.		Score
Surface Water: Inundation from a lake, pond, or stream overbank flow at least yearly (in a typical year)	**4 pts**	
Groundwater: Score only if you observe direct evidence of groundwater (e.g. including, but not limited to, a spring or seep)	**4 pts**	
Precipitation: All wetlands receive some portion of their hydrological budget from this	**2 pt**	

3b. Hydrological Connectivity – Maximum 6 points. Select all that apply.		Score
100-Year Floodplain or abutting a smaller stream/creek. As defined in FEMA maps or NRCS alluvial soil maps if FEMA maps are unavailable.	**2 pts**	
Between a Stream/Lake/Pond and Human Land Use. The wetland is located between a surface waterbody and any human land use, such that run-off from the adjacent land use could flow through the wetland before it discharges into the surface waterbody.	**2 pts**	
Wetland Complex. The wetland is part of a large scale (10+ acres) complex of *other* wetlands within 2500' of the assessment area boundary, with small areas of unmanicured/undeveloped vegetated uplands in between.	**2 pts**	

3c. Duration of Inundation/Saturation – Maximum 4 points. Select the option(s) below that best describe(s) the dominant hydrologic characteristic of the wetland. "Dominant" is defined as comprising at least 25% of the wetland area. If separate areas have distinctly different hydrologic characteristics, select all that apply and average the points. Use US ACE hydrology indicators for assistance. Use NRCS growing season criteria to determine the growing season length for the county the wetland is in. If the wetland is in the NWI database, the Rater may consult the hydrology modifiers listed in the Classification Code for assistance.			Score
Semi- to Permanently Inundated/ Saturated	(75 – 100% of growing season)	**4 pts**	
Regularly Inundated/ Saturated	(25 – 75% of growing season)	**3 pts**	
Seasonally Inundated	(12.5 – 25% of growing season)	**2 pts**	
Seasonally Saturated in the Upper 12 Inches of Soil	(12.5 – 25% of growing season)	**1 pt**	

3d. Alterations to Natural Hydrologic Regime – Maximum 9 points.
Evaluate the intactness of the natural hydrologic regime of the wetland. Check all forms of observed hydrologic alteration(s) that are potentially influencing the wetland (e.g. alteration may be outside of the wetland). Keep in mind that some alternations do not need to be actively maintained to have permanent negative effects.

A hydrologic alteration may also impact the Substrate/Soil (submetric 4a) and/or Habitat (submetric 4b).

Low	High	Alteration	Low	High	Alteration
☐	☐	ditch(es) in or near the wetland	☐	☐	stormwater inputs (addition of water)
☐	☐	tile(s) in or near the wetland	☐	☐	non-stormwater discharge(s)
☐	☐	dike(s) in or near the wetland	☐	☐	road bed(s)/RR grades(s) in or near the wetland
☐	☐	weir(s) in or near the wetland	☐	☐	dredging activities in or near the wetland
☐	☐	stream channelization	☐	☐	filling/grading activities in or near the wetland
☐	☐	other(s) (specify)	****only consider anthropogenic alterations (e.g. exclude beaver activity)**		

Select an option below that best describes the extent of wetland hydrology alteration. You may select **adjoining** options and average the points when appropriate.		Score
No Hydrologic Alterations Apparent	**9 pts**	
The wetland hydrology appears to have been altered, but the wetland was resilient to alterations and the functions are intact or near optimal level.	**7 pts**	
The wetland hydrology was altered but appears to retain some degree of functions.	**3 pts**	
Alterations are severely impacting the hydrology of the wetland.	**1 pt**	

Metric 3 Total: add 3a – 3d **(29 points max.)**	**Subtotal**

Site:	Rater(s):	Date:

Metric 4. Habitat Alteration and Habitat Structure Development – Maximum 20 Points.

*** A substrate or habitat disturbance may also negatively impact hydrology (Submetric 3d) and substrate/habitat (Submetric 4a/4b).*

4a. Substrate/Soil Disturbance – Maximum 4 points.

Evaluate whether a physical disturbance has occurred to the soil and surface substrates of the wetland. Check all possible forms of observed substrate/soil disturbances **within the wetland** below.

Low	High	Alteration	Low	High	Alteration	Low	High	Alteration
☐	☐	filling	☐	☐	human-induced erosion or exposure	☐	☐	plowing, disking
☐	☐	grading	☐	☐	human-induced sedimentation or burial	☐	☐	intensive grazing (hooves)
☐	☐	logging	☐	☐	dredging (includes excavating)	☐	☐	off-road vehicle use
☐	☐	construction	☐	☐	vehicle use	☐	☐	other(s) (specify)

Select an option below that best describes the extent of wetland soil alteration. You may select **adjoining** options and average the points when appropriate.		**Score**
No Substrate or Soil Disturbance Apparent	**4 pts**	
The wetland substrate or soil appears to have been altered, but the wetland was resilient to alterations	**3 pts**	
The wetland substrate or soil was altered but was somewhat resilient to alterations	**2 pts**	
The wetland substrate or soil was altered and was not resilient to alterations	**1 pt**	

4b. Habitat Alteration – Maximum 9 points.

Evaluate the intactness of the natural habitat and check all possible observed habitat alterations **within the wetland** below.

Utilize aerial photography and field evidence to determine if any habitat alteration has occurred. Determine the approximate pre-disturbance extent of vertical and horizontal habitat attributes (e.g., large woody debris, plant species diversity, hummocks, patchiness, niche diversity, etc.). Disregard changes attributable to wetland community succession or other natural processes.

Low	High	Alteration	Low	High	Alteration	Low	High	Alteration
☐	☐	barriers (e.g. road bed(s)/RR grades(s))	☐	☐	large woody debris (LWD) removal	☐	☐	sedimentation
☐	☐	tree plantation	☐	☐	grazing	☐	☐	dredging
☐	☐	selective cutting	☐	☐	rutting	☐	☐	filling/grading
☐	☐	clearcutting	☐	☐	Herbicide or chemical treatment	☐	☐	plowing/disking/farming
☐	☐	mowing or shrub removal	☐	☐	nutrient enrichment, e.g., nuisance algae	☐	☐	other(s) (specify)

Select an option below that best describes the extent of wetland habitat alteration. You may select **adjoining** options and average the points when appropriate.		**Score**
No Habitat Alterations Apparent	**9 pts**	
The wetland habitat appears to have been altered, but the wetland was resilient to alterations and the functions are intact or near optimal level	**7 pts**	
The wetland habitat was altered but appears to retain some degree of functions	**3 pts**	
The alterations are severely limiting habitat function of the wetland	**1 pt**	

4c. Habitat Reference Comparison – Maximum 7 points.

Determine an overall qualitative rating of the wetland habitat quality in comparison to the best of its type remaining (i.e., any ecologically and/or hydrogeomorphically similar wetland habitat). Do **not** consider the best example for an area (i.e., compare, for example, emergent riverine wetlands to other emergent riverine wetlands). For instances where there is a clear distinction between wetland areas in terms of habitat structure development, the Rater may double-check non-adjoining options, but justification is required. See Guidance Manual for additional assistance.

Select an option below that best describes the wetland habitat structure development. If unclear which of two options is more appropriate, select **adjoining** options and average the points.			**Score**
Excellent:	Wetland appears to represent the best of its type.	**7 pts**	
Good:	Wetland appears to be a good example of its type	**5 pts**	
Fair:	Wetland appears to be a fair example of its type.	**3 pts**	
Poor:	Wetland is a poor example of its type	**1 pt**	

Metric 4 Total: add 4a – 4c **(20 points max.)**	**Subtotal**

Site:	Rater(s):	Date:

Metric 5: Special Wetlands — Maximum of 10 pts.

Metric 5: Special Wetlands — Maximum of 10 pts.

Check all that apply and score as indicated.

Numbers in brackets **[]** indicate point values.

Provide documentation for each selection (photos, checklists, maps, resource specialist concurrence, data sources, references, etc).

5a. Regulatory Protection / Critical Habitat	**Score**
☐ Known occurrence of federally threatened/endangered species or designated critical habitat within a HUC-12 watershed **[10]**. ☐ Known occurrence of other rare species with state rank S1 ***[10]**, S2 ***[5]**, S3***[3]**; *use higher rank if there are mixed ranks or qualifiers (i.e., S1/S2 [10] and S2/S3 [5)]. Exclude records which are only "historic" (i.e., surveys have documented that the species is no longer there) within HUC-12 watershed.	
5b. High Ecological Value / Ranked Communities (See manual and key for ranked list of communities)	**Score**
☐ Appalachian seep/bog (S1S2) **[8]** ☐ Bottomland marsh (S1S2) **[8]** ☐ Bottomland slough OR Coastal Plain Slough (S2) **[5]** ☐ Calcareous seep/bog (S1) **[10]** ☐ Coastal Plain forested acid seep (S1) **[10]** ☐ Cypress (tupelo) swamp (S1) **[10]** ☐ Sinkhole/depression marsh (S1S2) **[8]** ☐ Sinkhole/depression pond (S2) **[5]** ☐ Wet depression/sinkhole forest (S1S2) **[8]** ☐ Wet bottomland hardwood forest (S2) **[5]** ☐ Wet meadow (S1) **[10]** ☐ Wet prairie (S1) **[10]**	
5c. Low-Quality Wetland **Check all that apply, but maximum score is -10 points:**	**Score**
☐ Wetland is < 1 acre and has >75% cover of invasive plants **[-10]** ☐ Wetland is <1 acre and is nonvegetated mined/excavated land **[-10]** ☐ Wetland is <1 acre and is a constructed stormwater treatment pond **[-10]**	

Metric 5 Total: add 5a – 5c **(10 points max.)***	**Subtotal**

***Score can be negative**

Site:	Rater(s):	Date:

Metric 6. Vegetation, Interspersion, and Habitat Features – Maximum 20 points.

****For each Metric 6 sub-metric, do NOT consider the wetland type being assessed, especially for plant species diversity in 6a.**

6a. Wetland Vegetation Components – Maximum 9 points.

Determine the Qualitative Cover Score of each Vegetation Component. Using the Scoring Table below, start on the left and proceed to the right, until a point value is obtained for each Component. Vegetation Components may exist in overlapping layers, e.g., significant areas of shrub/sapling and/or herbaceous may exist under a forest canopy. Only groups of trees, clusters of shrubs, or dense patches of herbaceous stems may count toward area coverage. Do not include lone trees, shrub/saplings, or sparse patches of herbaceous stems. See Submetric 6c for list of Kentucky's most invasive wetland species. Check the box on the right to indicate how the score was determined for each Vegetation Component (i.e., F, S or H).

Qualitative Cover Scoring Table

Habitat component - *Check all that apply →*					F	S	H
Vegetation Component is **>0.1** acre	>25% of wetland area	Native species dominate the coverage	High native diversity	3 pts			
			Moderate to low native diversity	2 pts			
		Invasive or non-native species dominate the coverage	Moderate to high native diversity	2 pts			
			Low native diversity	1 pt			
	<25% of wetland area	Native species dominate the coverage	Moderate to high native diversity	2 pts			
			Low native diversity	1 pt			
		Invasive or non-native species dominate the coverage	Moderate native diversity	1 pt			
			Low native diversity	0 pts			
Vegetation Component is **<0.1** acre	>25% of wetland area	Native species dominate the coverage	Moderate to high native diversity	2 pts			
			Low native diversity	1 pt			
		Invasive or non-native species dominate the coverage		0 pts			
	<25% of wetland area			0 pts			

Write in "absent" (don't score it a zero) if habitat is not present.

	Score
Forest Overstory Component (F) – **Maximum 3 points**. Qualitative cover score derived from table. Forested wetland areas are characterized by a group of trees at least 3 inches in DBH, regardless of height.	
Shrub/Sapling Component (S) – **Maximum 3 points**. Qualitative cover score derived from table. Shrub/Sapling wetland areas are dominated by clusters of woody plants less than 3 inches in DBH and greater than 3.28 feet in height. Species include true shrubs, young trees, and stunted trees.	
Herbaceous Component (H) – **Maximum 3 points**. Qualitative cover score derived from table. Herbaceous wetland areas are dominated by dense patches of erect, non-woody plants, regardless of size, and woody plants less than 3.28 feet in height. This component includes the robust-stemmed yellow pond lily (*Nuphar advena*) and American lotus (*Nelumbo lutea*). All floating-leaf species (including *Nymphaea* spp.) are **excluded** from the herbaceous component, and are instead included within the open water component (see Submetric 6b).	

6a. Vegetative Components Score	

Subtotal

Site:	**Rater(s):**	**Date:**

6b. Open Water, Mudflat, and Aquatic Bed Habitats – Maximum 3 points.

Open water is an unobstructed, inundated area of water with few or no rooted emergent or non-tree woody plant species. For KY-WRAM, mudflats are considered areas with exposed mud substrate with little to no vegetation. This metric is designed to evaluate habitat for waterfowl, shorebirds, fish, and other wildlife.

This Habitat Component includes combined acreage from any of the following areas:

- **Small ponds (including farm ponds), streams and/or their floodwaters, pools, saturated sandbars, or other natural or constructed waters**
- **Seasonal standing water areas** (e.g., mudflats and dried-down vernal pools) that were inundated long enough during the growing season to support aquatic life. This includes the "understory" below a forest canopy.
- **Aquatic bed areas** (submerged aquatic vegetation). Aquatic bed is dominated by plants growing at or below the surface of the water for most of the growing season in most years. The KY-WRAM includes aquatic bed within the definition of open water, due to the potential difficulty in differentiating the two entities. For the purposes of the KY-WRAM, all floating-leaf aquatic taxa (e.g. water lilies, *Nymphaea* spp.), are included in the definition of aquatic bed (therefore, are included in the definition of open water).
- **100-foot wide strip of open water along a lake or river** (see Wetland Assessment Area guidelines in the *Guidance Manual*). When the Wetland is adjacent to a lake or large river, calculate the acreage of the 100-foot wide open water strip that is included within the Wetland (see KY-WRAM Wetland Assessment Area Boundary Guidelines). Divide the linear feet of shoreline length by 400. For example, if the vegetated portion of the wetland interfaces with 200 linear feet of a lake, then the extent of the lake's open water included within the Wetland would be calculated as: 200/400 = 0.5 acre. Open water ends where water depth is > 6.6 ft; the Rater may use depth charts to establish this, when available.
- **Shallow pools free of dense shrub canopy** (e.g., open area within an inundated shrub swamp).
- **Shallow pools free of densely-packed herbaceous vegetation** (e.g., open area within a marsh or bog).
- The Indicators below are intended to provide guidance to determine if open water was present **when the wetland is currently dry.**
  - If the wetland is currently dry, use the appropriate USACE Wetland Delineation Regional Supplement to determine if indicators of open water are present (appropriate indicators are listed below).
  - One primary indicator OR two secondary indicators must be present to consider presence of open water. In the section indicated below, describe how you used indicators to determine your score.

Surface Water Present? □ **Yes** – How much? Score below □ **No** – Use indicators below, then assign score

Estimate the total coverage. Choose only 1 category.			**Score**
High:	2.5 acres or more	**3 pts**	
Moderate:	1.0 acre to <2.5 acres	**2 pts**	
Low:	0.25 acre to <1.0 acre	**1 pt**	
Virtually Absent:	<0.25 acre	**0 pts**	

Open Water Hydrology Indicators – Information in parentheses represents US ACE Wetland Delineation Regional Supplement Hydrology Indicators that should be consulted for indicators of open water for the purposes of KY-WRAM.

Check indicators present below:

Primary Indicators (must have 1)	**OR →**	**Secondary Indicators (must have 2)**
☐ Surface Water present on aerial imagery (A1)		☐ Sparsely vegetated concave surface (B8)
☐ Water marks (B1)		☐ Drainage patterns (B10)
☐ Inundation Visible of Aerial Imagery (B7)		☐ Moss trim lines (B16)
☐ Algal mat or crust (B4)		☐ Geomorphic position (D2)
☐ Presence of aquatic fauna (B13)		
☐ Presence of true aquatic plants (B14)		

Describe here how indicators were used to determine score:

Subtotal

Site:	Rater(s):	Date:

6c. Coverage of Highly-Invasive Plant Species – Maximum 1 point.
Estimate the combined total coverage of **any** invasive species present in the wetland.

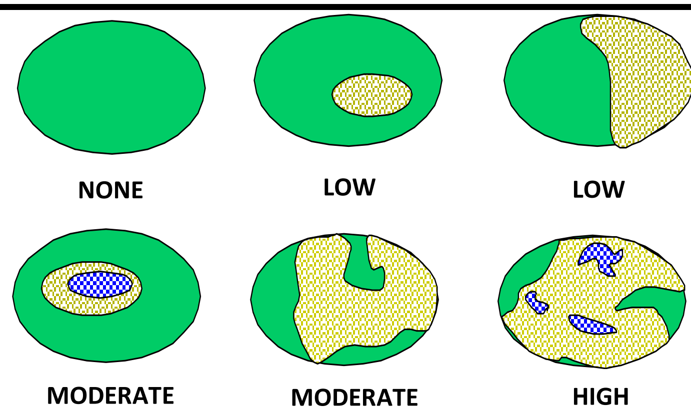
Selected invasive plant species. Remember to include any species found on the KY-EPPC list that is within the assessment area.
(Print the complete KY-EPPC list and take into the field)
*These native invasive plants are being included for the purposes of the KY-WRAM (i.e., everything on the KY-EPPC list are exotics)

- ☐ *Alliaria petiolata* (Garlic Mustard)
- ☐ *Alternanthera philoxeroides* (Alligator Weed)
- ☐ *Conium maculatum* (Poison Hemlock)
- ☐ *Euonymus fortunei* (Winter Creeper)
- ☐ *Lespedeza cuneata, L. bicolor, L. stipulacea, L. striata, L. thunbergii* (non-native *Lespedeza*)
- ☐ *Ligustrum sinense, L. vulgare* (Privet)
- ☐ *Lonicera japonica* (Japanese Honeysuckle)
- ☐ *Lonicera maackii* (Bush Honeysuckle)
- ☐ *Lythrum salicaria* (Purple Loosestrife)
- ☐ *Microstegium vimineum* (Japanese Stilt Grass)
- ☐ *Myriophyllum aquaticum, M. spicatum* (parrotfeather and Eurasion watermilfoil)
- ☐ *Phalaris arundianacea* (Reed Canary Grass)*
- ☐ *Phragmites australis* (Common Reed)
- ☐ *Polygonum cuspidatum* (Japanese knotweed)
- ☐ *Rhamnus cathartica* (Common Buckthorn)
- ☐ *Rosa multiflora* (Multiflora Rose)
- ☐ *Typha ssp.* (Cattail species)*
- ☐ Other(s): specify below

Estimate the total coverage. Choose only 1 category.			**Score**
Virtually Absent:	<1% aerial coverage of invasive species	**1 pt**	
Nearly Absent:	1% to <5% aerial coverage of invasive species	**0 pts**	
Low:	5% to <25% aerial coverage of invasive species	**-1 pt**	
Moderate:	25% to <75% aerial coverage of invasive species	**-3 pts**	
Extensive:	>75% aerial coverage of invasive species	**-5 pts**	

Additional invasive plant species present (list here):

6d. Horizontal (plan view) Interspersion – Maximum 5 points
Evaluate the wetland from a "plan view," i.e., imagine as if you are hovering above the wetland looking down upon it . The figure shows hypothetical wetlands for estimating the amount of habitat interspersion <u>including growing season vegetation communities and open water</u>. Only include open water that is 6.6 feet deep or less and does not include inundated areas below herbaceous and shrub vegetation. If unclear, select **adjoining** options and average the points.



		Score
Wetland has a high degree of interspersion	**5 pts**	
Wetland has a moderate degree of interspersion	**3 pts**	
Wetland has a low degree of interspersion	**1 pt**	
Wetland has no interspersion	**0 pts**	

Subtotal	

Site:	Rater(s):	Date:

6e. Microtopographic Features – Maximum 12 points (i.e., 3 points per feature). Choose only one category for each.				
1. Hummocks/Tussocks/Tree Mounds, e.g., sedge/grass tussocks, decayed nursery logs (remnants of large logs), root tip-up mounds (uprooted trees), etc. Percent coverage is based on total area of the wetland and includes the depressional matrix within any group of raised features.				**Score**
Absent: 0 pt No features present	Low: 1 pt Present but <1% of the area	Moderate: 2 pts 1% to 5% of the area	High: 3 pts >5% of the area	
2. Large Woody Debris (LWD). per log, average width ≥6 inches (e.g., fallen trees and/or large branches, etc.)				**Score**
Virtually Absent: 0 pt < 1 per acre	Low: 1 pt 1 to 5 per acre	Moderate: 2 pts 6 to 10 per acre	High: 3 pts >10 per acre	
3. Large Snags (≥12 inches DBH).				**Score**
Absent: 0 pt No snags present	Low: 1 pt Present but <1 per acre	Moderate: 2 pts 1 to 5 per acre	High: 3 pts >5 per acre	
4. Amphibian Breeding/Nursery Habitat, e.g., temporary pools with standing water of sufficient duration and depth to support frog and/or salamander reproduction. Permanent areas of vegetated standing water along the edges of ponds, lakes, and some streams also serve as amphibian habitat **(see Manual for description of habitat quality)**.				**Score**
Virtually Absent: 0 pt < 5% of the area	Low: 1 pt Present in small amounts (5% to 10% of the area) but of low to moderate quality	Moderate: 2 pts Present in moderate or greater amounts (>10% of the area) but of low to moderate quality **OR** Present in small amounts (5% to 10% of the area) but of highest quality	High: 3 pts Present in moderate or greater amounts (>10% of the area) and of highest quality	
			6e. Microtopographic Features Score	

Metric 6 Total: add 6a – 6e **(20 points max.)**	**Total Score**

KY-WRAM Summary

Narrative Rating	**Circle One**	
Question 1: USFWS Critical Habitat, Federal T/E Species, or State-ranked (S1, S2, or S3) species present?	YES	NO
Question 2: KSNPC Rare Wetland Community Type Present?	YES	NO
Question 3: Wetland has Scenic, Cultural, or Recreational Value?	YES	NO

Quantitative Rating	**Score**	**Maximum**
Metric 1: Wetland Size and Distribution		9
Metric 2: Upland Buffers and Intensity of Surrounding Land Use		12
Metric 3: Hydrology		29
Metric 4: Habitat Alteration and Habitat Structure Development		20
Metric 5: Special Situations		10
Metric 6: Vegetation, Interspersion, and Habitat Features		20
Total Score =		**100 pts. Max.**

Site:	Rater(s):	Date:

Scoring Comments:

HGM definitions:

RIVERINE: Occur in flood plains and riparian corridors in association with stream channels of any flow regime. Dominant water sources are overbank flow or subsurface hydraulic connections.

DEPRESSIONAL: Occur in topographic depressions. Dominant water sources are precipitation, ground water discharge, and water from adjacent uplands. Water moves vertically.

SLOPE: Occur where there is a discharge of ground water to the land surface. Normally occur on sloping land; gradient may be slight to steep. Water does not pool but flows downslope in one direction.

FLAT: Occur most commonly on historic flood plain terraces – where the channel has incised so deeply that it rarely or never floods onto the flood plain. Main source of water is precipitation, and they have poor vertical drainage. They receive no groundwater discharge, which distinguishes them from depressional and slope wetlands.