

# Remote Evaluation of Vegetative Best Management Practices

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## Introduction

Non-Point Source (NPS) pollution is the greatest threat to our nation's waterways and Best Management Practices (BMPs) are the most effective tool to mitigate NPS pollution. In Indiana long-term monitoring of BMPs after installation is dependant on landowners rather than trained professionals. Making certain BMPs are properly functioning, however, is critical to ensure BMP effectiveness. The major hurdles to a systematic assessment of BMPs include travel time to and from BMPs, time required to inspect BMPs, lack of properly trained personnel, difficulty in gaining access to private lands, and lack of consistent guidelines to determine BMP condition.

We set out to create a method of BMP evaluation using aerial images and ArcGIS. We also hope to help standardize how BMP condition is determined. Collaborating with the Indiana Department of Environmental Management, the NRCS, Purdue University, the Indiana Association of SWCD's, as well as several chapters of Pheasants Forever, we created and tested our remote assessment of BMPs.



## Results

We had undergraduates in a remote sensing class assess vegetation density and erosion to determine the intercoder reliability. The results demonstrate our remote assessment of BMPs is consistent from one coder to the next. Overall the reliability for our criteria were good or better (Table 1). We discovered that the majority of students in the remote sensing class had not had a soils course. This suggests that reliability will be higher for experienced inspectors. For the remaining criteria, intercoder reliability was determined by comparing the scores from two researchers.

The condition of BMPs were determined by the lead author. Table 2 displays the results from the remote evaluation. In general, the BMPs fare well after installation. The median scores were acceptable or higher for all BMPs, with the exception of riparian buffers and grassed waterways.

The remote evaluation of vegetative BMPs shows promise as a means of reducing and prioritizing the in situ inspection of BMPs.

Criteria	Krippendorff's Alpha	Average Pairwise Agreement	Interpretation
Remaining Area	0.968	98.3%	Near perfect*
Vegetation Density	0.602	84.4%	Good
Signs of Erosion	0.571	79.4%	Fair
Mounding	0.814	87.9%	Near perfect*
Waterway Shape	0.761	84.8%	Substantial*

\* Due to the more complicated nature of this criteria, it was evaluated by two researchers

BMP Type	Ave Score	Med Score	Interpretation	stand dev	Number	Ave Age
Conservation Cover	2.49	3	Acceptable to Excellent	1.25	198	2.41
Field Border	2.42	2.67	Acceptable	0.73	56	2.38
Filter Strip	1.97	2.33	Acceptable	1.05	193	7.14
Grassed Waterways	1.43	1	Unacceptable	0.32	26	5.90
Pasture	1.75	2	Unacceptable to Acceptable	0.46	39	7.46
Hayland Planting	1.71	2	Unacceptable to Acceptable	0.28	15	7.91
Riparian Buffer	1.65	1	Unacceptable	0.34	21	4.85
Tree Planting	2.27	2.67	Acceptable	0.55	34	3.17
Wetland	2.93	3	Acceptable to Excellent	0.35	9	4.71



## Methods

We performed field inspections of BMPs along side BMP experts from across the Midwest and hosted a day long workshop with a panel of BMP experts from the NRCS, Purdue Extension, and Pheasants Forever to identify common criteria for determining BMP condition. We also performed an extensive literature review to ensure our criteria we consistent with the literature. For most vegetative BMPs the criteria for this assessment were remaining area, vegetative cover, and signs of erosion within the BMP. Scoring grassed waterways also included a proxy for shape and signs of mounding. We then developed a scoring system to apply these criteria to aerial photos. The aerial images we used are from 2005, and have a resolution of 6" to 12". To validate our method, we recruited students from a remote sensing class at Purdue University to measure intercoder reliability of two of our criteria. For the remaining criteria, we compared results from two of our researchers to determine intercoder reliability. For the remaining area of a BMP and vegetative cover we were able to create a quantitative evaluation scale. We could not identify a quantitative approach for erosion, mounding or waterway shape. For these criteria, BMP assessment will depend on the experience of the evaluator. Each criteria is scored as unacceptable, acceptable, and excellent. If any criterion is unacceptable, the overall score for that BMP will also be unacceptable. Otherwise the criteria are averaged for an overall score, which also ranges from unacceptable to excellent.

### Remaining Area



The percentage of BMP remaining is determined using the following formula:

$$(\text{digitized area} / \text{installed area}) * 100$$

For BMPs with a minimum width, we also measured BMP width.

Width	Area	Score
95-100%	95-100%	Excellent
Min to 95%	80%-95%	Acceptable
Below Min	<80%	Unacceptable

### Vegetative Cover



Using Matlab, we created a dot grid matrix with at least 199 dots for each BMP. The result gives us the percent cover +/- 5%

Percent Cover	BMP Score
91%-100%	Excellent
81%-90%	Acceptable
<81%	Unacceptable

### Erosion/ Gullies



The score for this criterion is based on the evaluator's judgment. Much like a field evaluation, this qualitative scoring depends on the experience of the evaluator. Like the other criteria, it is scored as excellent, acceptable, and unacceptable.

### Mounding and Shape



Mounding decreases the amount of water that enters the waterway and shape is important for safe transport of water within the waterway. This is a qualitative scoring based on the evaluator's judgment and experience. Scores range from unacceptable to excellent