Final Report: Wetlands Inventory, Enhancement, and Monitoring

Anya Hopple
Intern, Indiana University Office of Sustainability
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Introduction

I conducted an inventory and classification of jurisdictional wetlands on the IUB campus using the 1987 Army Corps of Engineers *Wetland Delineation Manual* and the U.S Fish and Wildlife Service *Classification of Wetland and Deep Water Habitats* (Cowardin et al. 1979). Construction of the Eigenmann/Ashton Parking Expansion will result in loss of stream and riparian habitat, necessitating a permit issued by the Indiana Department of Environmental Management (IDEM) including a mitigation plan to offset the environmental damages. To aid in future planning and construction, IDEM recommended that IUB conduct a detailed inventory of the wetlands on campus, including identification of sites that could be used for future mitigation.

According to the U. S. Army Corps of Engineers Wetland Delineation Manual (1987), prevalence of hydrophytic vegetation, hydric soils, and one primary or two secondary indicators of hydrology signify the presence of a wetland. Hydrology drives wetland plant community and soil development and it is affected by topography, precipitation, groundwater, surface water, and soil types. Field indicators of wetland hydrology are documented and classified through direct visual observation of surface inundation or soil saturation or through indirect evidence such as surface soil cracks, drainage patterns, or crayfish burrows (USACE, 2008).

The 1987 Corps Manual defines hydrophytic vegetation as a plant community whose species diversity is influenced by the permanent or frequent soil saturation or inundation of the area. These communities are also affected by the local weather conditions, regional climate, topography, and natural and man-made disturbances (USACE, 2008). The U. S. Fish and Wildlife Service divides vegetation into five species classes; Obligate Wetland (OBL), Facultative Wet (FACW), Facultative (FAC), Facultative Upland (FACU), and Upland (UPL). Fifty percent or more of the vegetation in the area must be dominated by plant species with indicator statuses of FAC, FACW, or OBL for the site to satisfy the 1987 Corps Manual wetland requirements.

A hydric soil is defined by the National Technical Committee for Hydric Soils (NTCHS) as a soil that has developed anaerobic conditions in the upper part of the rooting zone. Extended periods of soil saturation, flooding, and ponding can result in the formation of these characteristics (USACE, 1987). Inundation of the soil and microbial activity deplete the oxygen levels and cause the chemical and microbial reduction and translocation of several elements, commonly iron and manganese. These biogeochemical processes result in distinctive features that can be used to identify the soil type. Hydric soil field indicators include soil color (chroma value must be two or lower), accumulation of organic matter, and a depleted matrix. A depleted matrix requires that 60% or more of the matrix have a chroma value of two or less and a minimum thickness of 2 inches in the first 6 inches of the soil (USACE, 2008).

Methods

I used topographic maps to determine potential wetland areas on the IUB campus. Ten candidate sites were visited and the three test rule, outlined in the 1987 Corps Manual, was conducted to identify field indicators of wetland hydrology, hydrophytic vegetation, and hydric soils. Identification of one primary or two secondary indicators of wetland hydrology was used to determine the presence of wetland hydrology at a site. A single primary indicator provided substantial evidence of continued or recent hydrologic events and indicated that the soil inundation or saturation of the site occurs. Secondary indicators required support from primary indicators or additional secondary indicators to provide sufficient evidence of continued or recent hydrologic events. The presence of surface water, soil saturation, and sediment and drift deposits are examples of primary field indicators. Drainage patterns, surface soil cracks, and crayfish burrows are examples of secondary field indicators. The field indicators are described in the 1987 Corps Manual and identified through visual observation of the site.

The Dominance Test was used to determine the presence of hydrophytic vegetation at each site. The "50/20 rule" was applied in the Dominance Test to determine the most abundant species across three strata; trees, herbs, and woody vines. Using this procedure, estimates were made of the absolute percent cover of all species in each stratum. The species of each stratum were ranked from most to least abundant. Cumulative coverage of species, selected by decreasing order of coverage, was compiled until it represented at least 50% of the stratum. These species were the dominant species of the stratum. Additionally, any species that alone comprised 20% of the absolute cover of a stratum was a dominant species. The indicator statuses of the dominant species across the strata were identified using the United States Department of Agriculture (USDA) plant database (USDA NRCS, 2009). If 50% or more of the dominant species were classified as OBL, FACW, or FAC then the site satisfied the hydrophytic vegetation requirements of the 1987 Corps Manual.

Descriptions of the soil matrix, redox features and the presence of field indicators of hydric soil were used to confirm the presence or absence of hydric soil (USACE, 2008). A metal soil probe was used to extract a 25 cm soil core sample. The upper, organic portion of the soil was removed and a representative piece taken from the middle. Soil color was determined by referring to the Munsell soil guide (Munsell, 1994). Hydric soils must have a chroma value of two or less. A bluish-gray color often develops in the soil as the soil microbes reduce iron from the ferric form (Fe^{3+}) to the ferrous (Fe^{2+}) form in an anaerobic environment. This feature is called gleying. Ferrous iron is soluble in the soil and is easily transported, forming redox (Fe^{2+}) depletions and redox (Fe^{3+}) concentrations. The Munsell soil guide was also used to determine the color of the redox features. The gleyed appearance of soils and the presence of redox features were important field indicators of hydric soils. If 60% or more of the soil composition had a chroma value of two or less and a minimum thickness of 2 inches in the first 6 inches of a sample, then a depleted matrix was present and the soil satisfied the 1987 Corps Manual hydric soil requirements.

The boundaries of confirmed jurisdictional wetlands were established by identifying the border where hydric soil characteristics end and terrestrial soil characteristics begin. Coordinates were taken at several points along the borders of the wetlands using a Global Positioning System (GPS). The GPS coordinates were incorporated into a Geographical Information System (GIS), which produced a detailed map of IUB campus wetlands (Figure 1) and determined their individual areas (Table 2).

The quality and state (IN) jurisdictional status for each site, that ranks wetlands according to three classes, was established by referring to the IDEM Classification of "Isolated" Wetlands (Elverson *et al*, IDEM). Class I wetlands are significantly disturbed areas of low quality. Class II wetlands are moderately disturbed areas of medium quality. Class III wetlands are areas with little disturbance and high quality and were not present in our inventory.

Results

Of the ten candidate sites, seven sites (1-7) were confirmed as jurisdictional wetlands. Table 1 summarizes the field indicators of hydrology, soils, and vegetation commonly observed throughout these sites. The remaining three sites (8-10) did not pass the three test rule and, therefore, did not meet the wetland requirements described in the 1987 Corps Manual. Water-stained leaves, a primary indicator, and drainage patterns, a secondary indicator, were observed at sites 8 and 10 and indicated that hydrologic processes were present in the area. Site 9 exhibited no indicators of wetland hydrology. The soil sampled at sites 8-10 did not have a chroma value of 2 or less and were characteristic of upland areas. The dominant vegetation consisted of upland species such as *Festuca arundinacea* (tall fescue) and *Dactylis glomerata* (orchardgrass). The locations of these sites are shown in Figure 1 by yellow markers.

Site 1 was an artificial wetland located in the IUB campus arboretum. Surface inundation and soil saturation, both primary indicators of hydrology, were observed at the site. Soil chroma values of 1 and redox features were present in the soil, indicating a depleted matrix. The herbaceous site's vegetation was dominated by *Typha latifolia* (broadleaf cattail) and *Eleocharis acicularis* (needle spikerush) in the herb stratum and *Salix nigra* (black willow) in the tree stratum. All of the dominant species had obligate indicator statuses. It was a very small wetland, with an area of less than 200 m^2.

Site 2 was an herbaceous wetland identified and delineated prior to this inventory (Mertz, 2009). It was located to the north of the Education Building along the Jordan River and had an area of 3,035 m^2.

Site 3 was a forested wetland located south of the IU Auditorium, along the Jordan River. Several primary indicators of wetland hydrology were observed at the site, including surface water, soil saturation, water marks on trees, oxidized rhizospheres on living roots, and the presence of reduced iron. The soil matrix had chroma of 1 and a depleted matrix, redox dark surface, loamy mucky mineral, and depleted dark surface were present throughout the area. The tree stratum was dominated by *Fraxinus pennsylvanica* (FACW) and *Taxodium distichum* (OBL) and the herb stratum was dominated by *Pilea pumila* (FACW). The site has an area of 1,014 m^2.

Table 1. Summary of the field indicators of hydrology, soils, and vegetation observed throughout the jurisdictional IUB campus wetlands.

Hydrology	Soils	Vegetation
		Tree Stratum
*Surface Water, Soil Saturation, Sediment Deposits, Drift Deposits, Water-Stained Leaves, Oxidized Rhizospheres on Living Roots, Presence of Reduced Iron	Gleyed Appearance, Redox Features, Depleted Matrix, Depleted Dark Surface, Redox Dark Surface, Thick Dark Surface, Loamy Mucky Mineral	*Platanus occidentalis* (FACW), *Acer saccharinum* (FACW), *Fraxinus pennsylvanica* (FACW), *Salix nigra* (OBL), *Taxodium distichum* (OBL)
		Herb Stratum
**Drainage Patterns and Crayfish Burrows		*Eleocharis acicularis* (OBL), *Typha latifolia* (OBL), *Leersia oryzoides* (OBL), *Carex comosa* (OBL), *Lysmachia nummularia* (FACW), *Mentha arvensis* (FACW), *Festuca arundinacea* (FACU), *Poa compressa* (FACU)
		Woody Vine Stratum
		Euonymus alatus (FAC)

*Primary indicators of hydrology
**Secondary indicators of hydrology

Site 4 was an extensive herbaceous wetland located to the east of Campus View Apartments. It was delineated in three sections because of its large area, which was calculated to be 8,960 m^2. Primary and secondary indicators of hydrology were observed in each section. Primary indicators included surface inundation, soil saturation, sediment and drift deposits, and water-stained leaves. Secondary indicators identified were drainage patterns and crayfish burrows. Hydric soils were present throughout the site with consistent soil chroma values of 2 or 1 and displayed gleyed and redox features. A depleted matrix and depleted dark surface were observed in each section and a redox dark surface was observed in the northernmost section. The dominant species of the tree stratum, *Platanus occidentalis* (FACW) and *Acer saccharinum* (FACW), were planted throughout the area. The dominant species of the herb stratum were *Festuca arundinacea* (FACU) and *Poa compressa* (FACU).

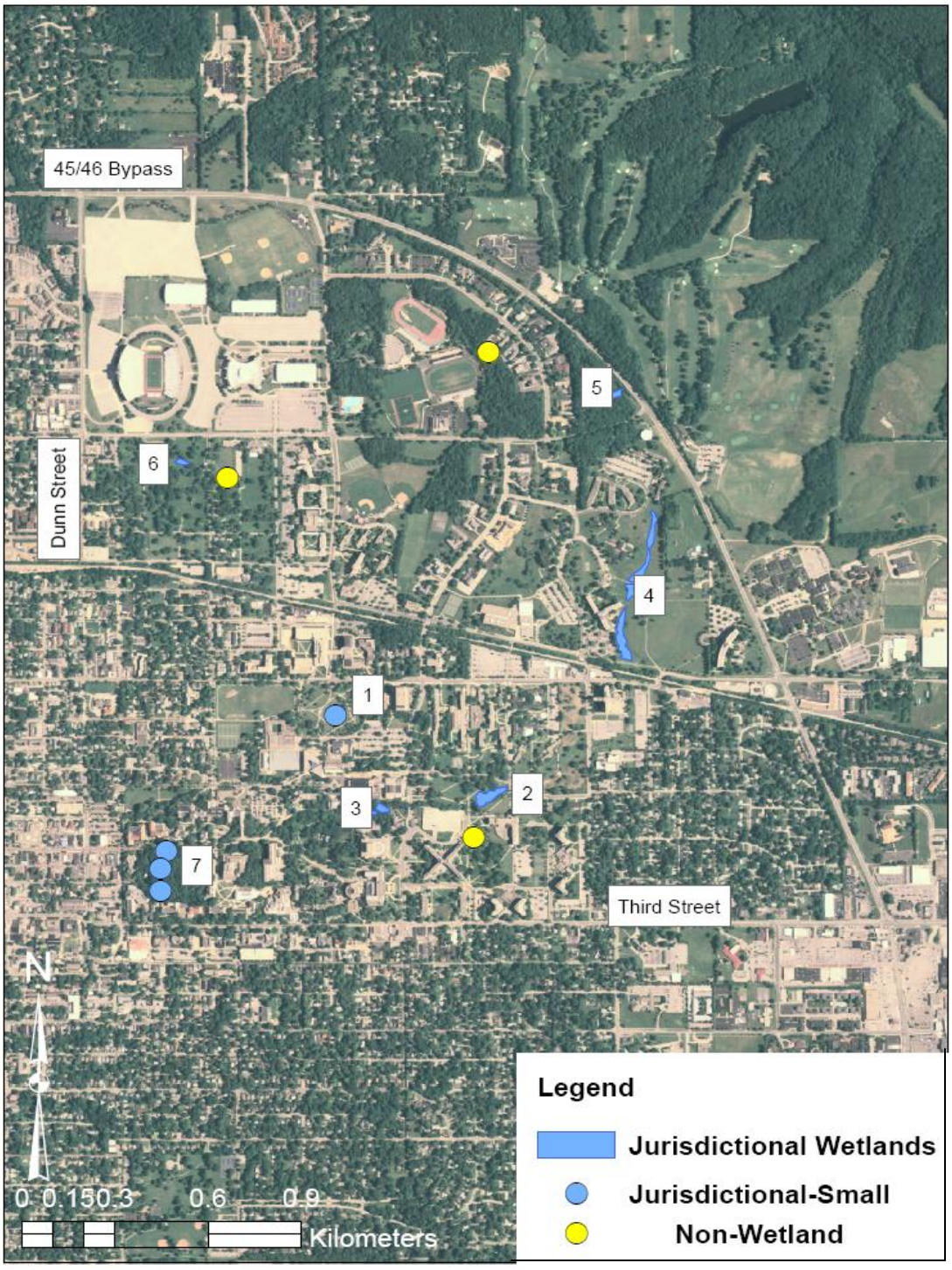

Figure 1. Map of the jurisdictional wetlands on the IUB campus. Seven wetland sites and three non-wetland sites are shown. The wetlands inventory was performed in the Summer of 2009.

This site did not satisfy the hydrophytic vegetation requirements of the 1987 Corps Manual because of the dominant invasive grass species that were introduced from the mowing and management of the site in years past. However, if the site remains unmanaged, the presence of wetland hydrology and hydric soils will enable hydrophytic vegetation to dominate the area.

Site 5 was a forested wetland located west of the intersection of 17th Street and the Bypass. Drift deposits, a primary indicator, and drainage patterns, a secondary indicator, were observed at the site. Hydric soils with chroma values of 2 and 1 that were gleyed and contained redox features were sampled throughout the area. A depleted matrix and redox dark surface were present also. The dominant species of the tree stratum were *Platanus occidentalis* (FACW) and *Fraxinus pennsylvanica* (FACW). The dominant species of the herb stratum was *Leersia oryzoides* (OBL). The site was 882 m^2 in size.

Site 6 was a mowed herbaceous wetland located to the south of the IU Football Stadium. Primary indicators of hydrology that were present at the site, included soil saturation and sediment and drift deposits. The soils sampled had chroma values of 1 and a gleyed appearance. A depleted matrix and loamy mucky mineral matrix, both hydric soil indicators, were observed throughout the site. The natural vegetation of the area was altered from constant mowing to an extent that a hydrophytic vegetation determination was not possible. The area of this site was 588 m^2.

Site 7 consisted of three small wetlands dispersed throughout the lower part of the Dunn Woods. Wetland hydrology indicators identified across these areas included surface inundation, soil saturation, drift deposits, and water-stained leaves and the secondary indicator; drainage patterns. Soils in the area had chroma values of 2 and 1, had a gleyed appearance, and contained redox features. The characteristics of the soil indicated a depleted matrix and other hydric soil features across the sites. The vegetation of the tree stratum was dominated by *Acer rubrum* (FAC) and *Carya ovata* (FACW). The herb stratum was dominated by the invasive woody vine species *Euonymus alatus* (FAC). The area of the three sites was collectively less than 200 m^2.

According to the IDEM Classification of Isolated Wetlands, three of the wetland sites (5-7) were classified as Class I wetlands that were significantly disturbed and of low quality and three of the wetland sites (2-4) were classified as Class II wetlands that were moderately disturbed and of medium quality. Site 1 was artificial and did not qualify for classification under the IDEM Classification of Isolated Wetlands. IDEM requires Class II isolated wetlands to have an acreage of 0.25 of more to receive protection from the agency (Elverson *et al*, IDEM). Sites 2-4 satisfied this criterion. Site 2 was classified as Class II because it had not been mowed for over a year and its anticipated uses included education and research opportunities for undergraduate/graduate students. Site 3 was ranked as a Class II wetland because its features most accurately resemble those of forested wetlands that historically occurred in this region. Site 4 received a Class II classification because of its extensive size and abundance of reduced soils. Mowing has ceased on this site in the past year, which will allow hydrophytic vegetation to gradually dominate the area.

Sites 5-7 were all relatively small wetlands, less that 1,000 m^2, and each contained several anthropogenic alterations that had severely degraded the quality of the site. Site 5 was located near the Bypass and received large amounts of impervious surface run-off from the highway that decreased the water quality of the area. The drainage system of the site was altered from the construction of the Bypass and surrounding university housing developments. The vegetation of Site 6 was constantly mowed to the extent that a hydrophytic vegetation determination was not possible. The soil was disturbed and degraded by fill material dispersed throughout the site. Site 7 was also negatively impacted through the placement of fill and impervious surface run-off that altered the hydrology. The vegetation was dominated by an invasive woody vine species (*Euonymus sp.*) and the area was bisected by pedestrian walk ways. The observed disturbances resulted in the low ranking (Class I) of each area. IDEM requires isolated wetlands that receive a ranking of Class I to be at least 0.5 acres to qualify for protection (Elverson *et al*, IDEM). Sites 5-7 received a Class I exemption because they did not meet the size requirements, i.e. they are too small (<0.5 acres) to qualify. The location, size, and IDEM classification of the IUB jurisdictional wetlands are summarized in Table 2.

Recommendations

Recommendations for future work include two components. The first is to expand the inventory to outer areas of the campus, such as the IU Golf Course, Cyclotron, and the Research and Teaching Preserve. The jurisdictional wetlands inventory conducted this summer was only performed on IUB's central campus. The wetlands identified in the outer properties will likely experience less anthropogenic alterations, resulting in sites that are of higher quality and have more enhancement potential.

The second recommendation is to enhance the medium quality (Class II) wetlands (Sites 2, 3, and 4) delineated in this report. The higher quality of these sites gives them greater enhancement potential. The monitoring and enhancement of these wetland sites will contribute to the sustainability of the campus by supporting ecosystem services, storm-water detention, water quality improvement, and biodiversity and through education and research opportunities for undergraduate/graduate students.

Table 2. Wetland characteristics established from the jurisdictional inventory of the IUB campus wetlands, performed in Summer 2009. The seven sites are located in the central part of IUB's campus.

Wetland Number	Coordinates	Area (m^2)	Vegetation Type	IDEM[1] Classification	Anthropogenic Alterations
1	39.17053° 86.51897°	< 200 (0.05)[2]	Herbaceous	--	Artificial
2	39.16822° 86.51314°	3035 (0.75)	Herbaceous	2	Maintenance/mowing of vegetation, impervious surface run-off, shallow channels
3	39.16772° 86.51763°	1014 (0.25)	Forested	2	Impervious surface run-off, soil disturbed by fill material, walk way and piping bisect area
4	39.17431° 86.50805°	8960 (2.21)	Herbaceous	2	Maintenance/mowing of vegetation, dominated by invasive grass (*Festuca arundinacea*), impervious surface run-off, altered stream hydrology, disturbed by sewer pipe
5	39.18011° 86.50840°	882 (0.22)	Forested	1	Impervious surface run-off, altered drainage
6	39.17816° 86.52470°	588 (0.15)	Herbaceous	1	Maintenance/mowing of vegetation, impervious surface run-off, soil disturbed by fill material
7 (3 Sites)	(1) 39.16526° 86.52555° (2) 39.16644° 86.52533° (3) 39.16592° 86.52553°	Collectively <200 (0.05)	Forested	1	Dominated by invasive woody vine (*Euonymus sp.*), impervious surface run-off, soil disturbed by fill material, walk ways present through area

[1]IDEM: Indiana Department of Environmental Management (http://www.in.gov/idem/)
[2]Acres

Acknowledgements

I would like to thank John Marton and Wes Ket for their assistance in this project. Both John and Wes aided me in developing the skills necessary to identify and delineate wetlands and in learning the benefits gained from their preservation and enhancement. Wes assisted me in determining the wetland boundaries at several of the larger sites and in obtaining the GPS coordinates along the perimeters of the sites. John incorporated the GPS coordinates into a GIS program to develop the map of IUB's jurisdictional wetlands.

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Appendix I: Delineation Data Sheets