Establishment of the wetland condition and function monitoring program in the rapidly changing, ecologically significant watersheds of Gallatin County, Montana

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Abstract

Wetlands are an important component of our watersheds. They provide valuable functions and ecosystem services including plant and animal habitat, flood attenuation, groundwater recharge, and improvements to water quality. Wetlands can be affected by natural and anthropogenic disturbance both indirectly and directly. Natural events such as drought, storms, and floods can all impact wetlands; as well as anthropogenic alteration including changes to vegetation, water inputs/outputs, sediment input, and fragmentation.

The land use of Gallatin County, Montana has seen recent large scale changes to both the level and the extent of urban, exurban, and agriculture development. This project has been developed to monitor the effect of these changes on wetlands by annually assessing wetland condition and function across a broad sample of wetlands within Gallatin County. Our annual will provide the community with an understanding of the local trends in wetland health. Additionally, this project's assessment tool, and online application, seek to improve the accessibility of these assessments to volunteers and citizen groups.

The project's assessments are at two levels: landscape and local. Our landscape level assessment of wetlands within Gallatin County indicates that the privately owned wetlands are an important component of the local wetland ownership. These areas represent a critical opportunity to preserve wetland condition and function. Additionally, the land cover in and around wetlands within the landscape, regardless of ownership, has seen a slight increase in disturbance and/or human use since 2010.

Our local level assessments occurred at the wetland level. During the summer of 2015 we established 42 permanent wetland assessment sites. Through these on-the-ground assessments we found that the condition of a majority of wetlands was at a slight or less departure from reference state. Additionally, the function of these wetlands was at a high level. In 2016 we resurveyed all sites, discontinued 16 sites with inadequate wetland habitat, and added 17 new sites for a total of 43. Subsequent annual visits to these 43 permanent assessment areas will allow us to explore an interannual trend of wetland health. In 2016 our Natural Resources Educator generated high community interest in the project and trained 24 volunteer citizen scientists in the field. Additional wetland outreach activities reached over 500 people.

Overview

Background

Over the last several decades Gallatin County has seen extensive land use changes, one of the highest population growth rates of any county in Montana - predicted to grow 36% by 2040-, and an explosion in residential development and economic opportunity. These rapid changes are expected to continue and are likely to contribute to dynamic pressures on the water resources of Gallatin County and downstream users. While several volunteer and government groups are working in the watersheds to monitor the water quality and quantity of riverine systems, a need exists to know more about the extent, condition, and function of wetlands within the watershed and to share this information to inform decision-making.

By monitoring wetland health, this project will establish reference points to track annual and interannual alteration of condition and function. Condition refers to a wetland's ecological integrity (e.g. native and invasive plants, water quality, land use disturbances, etc.) while function refers to its ability to provide ecosystem services (e.g. flood attenuation, water quality improvement, etc.). The locations of monitoring sites were limited to sites with public access and were selected to promote ease of access and efficiency of monitoring. As support for the project and the number of trained technicians/volunteers increases, the opportunity to expand monitoring to additional wetlands will be explored. Both the monitoring tool and the collected data are available through a MSU Extension – Gallatin County website (www.wetlands.msuextension.org, contact brad.bauer@montana.edu for login credentials).

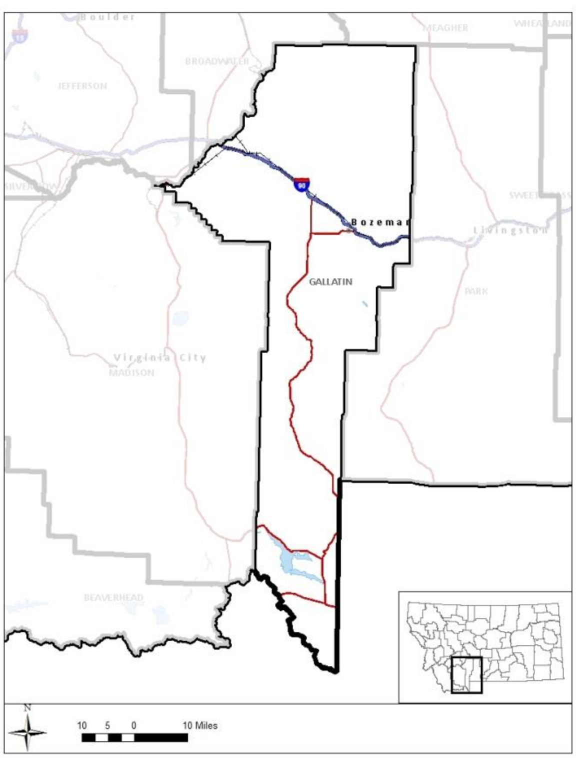

Figure 1: Gallatin County, Montana

Study Area

Our study area is Gallatin County, Montana

(Figure 1). The project area includes four basins: Jefferson River – 10020005, Upper Missouri River - 10030102, Madison River – 10020007, Gallatin River – 10020008 and covers 2,632 square miles (1,684,480 acres). Major towns in the project area include Bozeman, Belgrade, Manhattan, and West Yellowstone. Land use within the project area is primarily agriculture and recreation.

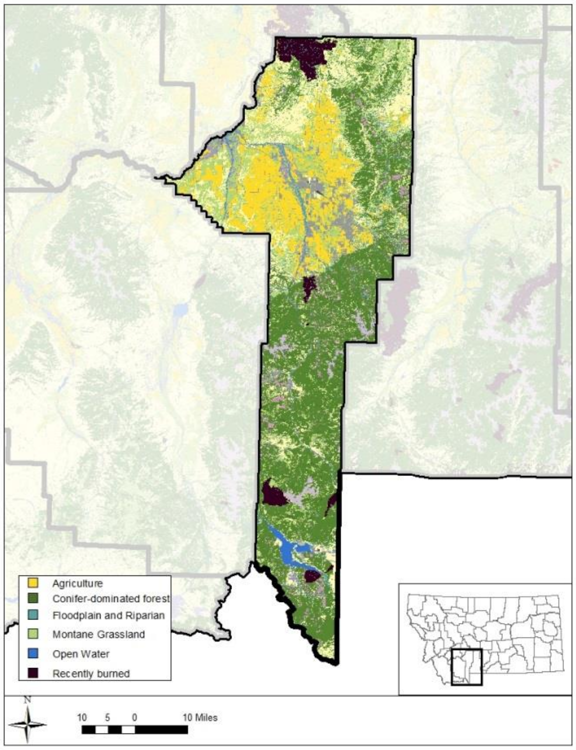

Figure 2: Land cover

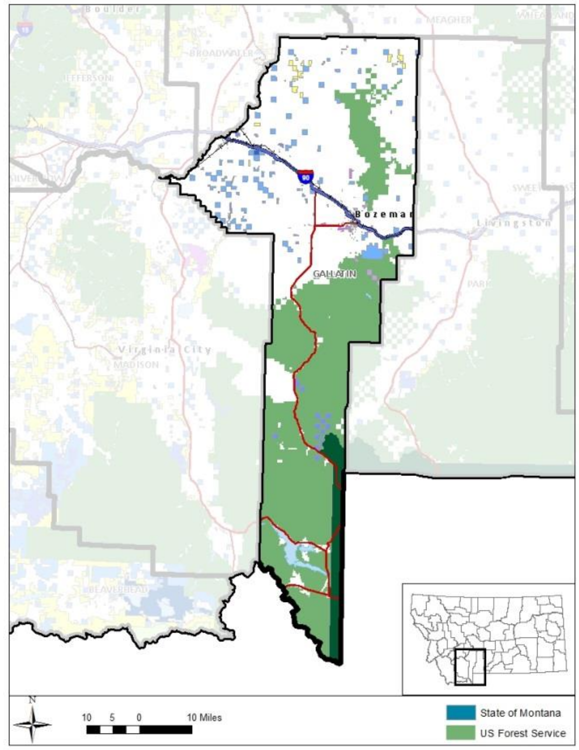

Figure 3: Ownership

Residential and commercial development occurs in and around the major towns (Figure 2). Montane portions of the project area are largely publicly owned, with the U.S. Forest Service being the primary landowner (Figure 3). Private ownership is focused principally in the valleys and lower foothills.

Methods

Level 1-Wetland Landscape Profiling

We assessed wetland health at two levels. Our level 1 analysis was a GIS landscape analyses consisting of: 1) wetland landscape profiles, which used digital wetland mapping to summarize information on wetland abundance, type, extent, and ownership across the watershed; and 2) a landscape characterization of the change of land cover within and surrounding wetlands.

Using digital wetland mapping provided by the Montana Natural Heritage Program (MTNHP) we prepared a landscape level profile of the wetlands within the project area (MTNHP 2014). This GIS-driven analysis was developed to provide a broad characterization of ownership and the degree of recent change in land cover in and around wetlands within the project area.

Within the project area we randomly selected 1000 remotely-sensed points at palustrine wetlands. The ownership of each wetland was derived from Montana Cadastral Database (Montana State Library 2015). Each of the selected points was buffered at 0 m, 100 m, 300 m, and 1000 m. The land cover for each wetland and at each buffer was characterized for 2010 and 2013 using Montana Land Cover to inform local changes to the landscape condition (MTNHP 2010, MTNHP 2013). Land cover data was categorized into three primary bins: Human Use, Recent Disturbance, and Other (Table 1).

Table 1: Land cover categories (bin for analysis) captured for each of the 1000 randomly selected wetlands.

Attribute Value (Bin)	Definition of Attribute Value
Human Land Use (Human Use)	Developed areas in rural or urban settings (including roads), strip mines and gravel pits, and agricultural lands.
Recently Disturbed or Modified (Recent Disturbance)	Recently burned or harvested vegetation, and introduced upland and riparian vegetation.
Sparse and Barren Systems (Other)	Badlands, dunes, and cliffs and canyons, that are characterized by sparse vegetation or are unvegetated. Abiotic substrate features dominant. Vegetation is scattered to nearly absent and generally restricted to areas of concentrated resources (total vegetation cover is typically less than 25% and greater than 0%).
Alpine Systems (Other)	Barren substrate or herbaceous and low shrubby vegetation above mountain timberline.
Forest and Woodland Systems (Other)	All natural forest and woodland systems, with the exclusion of riparian systems.
Shrubland, Steppe and Savanna Systems (Other)	All natural shrub/scrub systems, with the exclusion of alpine and riparian systems. Shrubland: Shrubs generally greater than 0.5m tall with individuals or clumps overlapping to not touching (generally forming

	more than 25% cover, trees generally less than 25% cover). Shrub cover may be less than 25% where it exceeds tree, dwarf-shrub, herb, and nonvascular cover, respectively. Vegetation dominated by woody vines is generally treated in this class. Dwarf shrubland: Low-growing shrubs usually under 0.5 m tall. Individuals or clumps overlapping to not touching (generally forming more than 25% cover, trees and tall shrubs generally less than 25% cover).
Grassland Systems (Other)	All natural herbaceous systems, with the exclusion of alpine and riparian systems. Herbaceous: Herbs (graminoids, forbs, and ferns) dominant (generally forming at least 25% cover; trees, shrubs, and dwarf-shrubs generally with less than 25% cover). Herb cover may be less than 25% where it exceeds tree, shrub, dwarf-shrub, and nonvascular cover, respectively.
Open Water/Wetland and Riparian Systems (Other)	Natural systems located in areas where the soil or substrate is periodically saturated with or covered with water.

Level 2 - On-the-ground Wetland Assessments

Our second level of analysis (level 2) was a field-based assessment. We captured elements of two standard Montana wetland assessment tools to simultaneously assess both wetland condition and wetland function. To capture wetland condition we followed methods outlined in the Montana Ecological Integrity Assessment (EIA) Field Manual (MTNHP 2015). To capture wetland function we followed Functional Assessment (FA) methods outlined in the 2008 Montana Wetland Assessment Methods (MDT 2008).

The EIA metric ratings were integrated to produce overall scores for four attributes: 1) Landscape Context; 2) Biotic Structure and Composition; 3) Physicochemical; and 4) Hydrology. The ratings for these four attributes were combined to produce an overall EIA score (Table 2).

Table 2: Ecological Integrity Assessment metric and ecological attributes measured.

Attribute	Metric
Landscape Context Score	Landscape Connectivity

	Width of Vegetated, Natural Buffer
	Condition of Plants within a 200m Buffer
	Condition of Soil within a 200m Buffer
Vegetation Attribute Score	Relative Cover of Native Plant Species
	Relative Cover of Noxious Weeds
	Relative Cover of Aggressive Graminoids
	Herbaceous Litter/ Woody Debris Accumulation
	Interspersion of Plant Zones
	Woody Species Establishment and Regeneration
	Utilization of Trees and Shrubs
Physiochemical	Soil Surface Integrity
	Water Quality - Algae
	Water Quality - Turbidity
	Water Quality - Sheen
Hydrology	Water Inputs
	Water Outlets
	Hydroperiod
	Surface Water Connectivity

The FA methods were scored across 12 functions (Table 3). The ratings for these 12 functions were combined to produce an overall FA score. Additionally, using the rubric in the 2008 Montana Wetland Assessment Methods guide we were able to convert the FA scores to wetland category 1 through 4 (MDT 2008).

Table 3: Functional Assessment attributes measured.

Functions
Listed/Proposed T&E species Habitat
MT Natural Heritage Program Species Habitat
General Wildlife Habitat
General Fish Habitat
Flood Attenuation

Shore and Long Term Surface Water Storage
Sediment/Nutrient/Toxicant Removal
Sediment/Shoreline Stabilization
Production Export/Food Change Support
Groundwater Discharge/Recharge
Uniqueness
Recreation/Education Potential

Finally, the EIA and FA scores results were combined for each site to capture a simple aggregate assessment score (aggregate score) that was a mean of the EIA and the FA scores.

Initial Site Establishment

Forty-two sites were randomly selected across public ownership. Sites were limited to public ownership to help ensure that sites will be available for future monitoring. These sites will be revisited annually to develop a trend in condition and function.

In 2015 each assessment required approximately two hours to complete. At each sample wetland, we established a 0.5 ha assessment area (AA). Prior to field visits, we created a set of field maps for each targeted sample point. The field maps outline the potential AA boundary and multiple radial buffers around the AA. These buffers are used to assess several of the attributes from both the EIA and the FA component of the assessment.

Once at the target sample point, field team members determined the extent of the AA by pacing and flagging the perimeter. Indicator species (wetland obligate and facilitative wetland) were used to define whether at least 90% of the AA lay within a wetland. The initial establishment of AA in 2015 allowed the AA to be moved to ensure it met this minimum criterion. Subsequent years of sampling efforts will return to the exact site established in 2015 regardless of changes in the site including changes in classification and/or disturbance.

Initial sampling in 2015 captured wetland classification. To capture the natural variability within wetland classes we classified wetlands using Ecological Systems classification (Comer et al. 2003), the USFWS System (aka Corwardin classification system) (Corwardin et al. 1979), and the hydrogeomorphic (HGM) classification system (Hauer et al. 2002).

In addition to the wetland classification, the initial sampling in 2015 also collected standard site variables at each sample location. These included:

- UTM coordinates
- Elevation, slope, and aspect
- Description of onsite and adjacent ecological processes and land use
- Description of general site characteristics and a site drawing
- Water table depth
- Locating directions

Dynamic Data

At least four photos were taken from the AA center at each site. Photos were taken at 90° from each other at the cardinal directions.

The remainder of the monitoring was designed to capture an assessment of disturbances within the AA and a 200 m buffer (Table 4) and the wetland condition and function (Tables 2 and 3).

Table 4: Disturbances assessed within the AA and within a 200 m buffer of the AA.

Transportation Disturbances	**Land Use Disturbances-Development or Recreation**
Paved surfaces (e.g., roads, parking lots)	Domestic or commercial development
Unpaved roads	Intensively managed sports fields, golf courses
Railroads	Recreation or human visitation
Land Use Disturbances-Agriculture	Filling or dumping of sediment or fill
Dryland farming (e.g., wheat, barley, etc.)	Trash or refuse dumping
Open range livestock grazing	**Land Use Disturbances-Resource Extraction**

Horse paddock	Gravel pits, open pit mining
Feedlot	Small scale mining activity or abandoned mines
Irrigated cropland	Abandoned oil/gas wells
Irrigated hay pasture	Oil/gas pump jacks (active)
Irrigation ditches affecting wetland	Injection wells, tank batteries,
Cropland treated with pesticides	collection facilities, or other oil/gas- associated infrastructure
Disturbed fallow lands dominated by exotic species	Intensive logging (50-75% trees of >50cm diameter removed
Haying of native grassland	Selective logging (<50% of trees >50 cm diameter removed)
Fallow fields (no human use in past 10 years)	**Hydrologic Disturbances**
Fields with recent plowing or discing	Upstream spring box
Shelterbelts	Impoundment of flowing water
Fences that impede wildlife	Potential for agricultural runoff
Permanent tree plantation	Potential for urban runoff
Land Use Disturbances-Vegetation Removal/Conversion	Culvert
Chemical vegetation control	Upstream dam
Evidence of intentional burning	Reservoir/stock pond Weir or drop structure
Mechanical vegetation removal	Dredged inlet/outlet channel
Vegetation conversion (e.g., from shrubland to grassland)	Engineered channel (e.g., riprap)
Natural or Environmental Disturbances	Pumps, diversions, or ditches that move water into wetland
Beetle-killed *Pinus* species	Pumps, diversions, or ditches that move water out of wetland
Other diseased conifers	Berms/Dikes/Levees
Evidence of recent fire (<5 years)	

Beaver activity	
Evidence of prolonged drought	
Browsing of woody vegetation by native ungulates	

Results

The data from 2015, the project's first year, were entered into a series of Excel worksheets and related to a GIS attribute table. This GIS table was linked to an online map (http://www.msuextension.org/gallatin/NaturalResourcesWetlandsMap.htm). In 2016 the database was migrated to a website application that calculates the condition, function, and the aggregate score from the values entered during the field assessment. This website application and the resulting calculation will be housed at MSU Extension and will allow the data to be stored in a relational database.

Level 1-Wetland Landscape Profiling

The 1000 randomly selected wetlands were widely distributed across the project area (Figure 4).

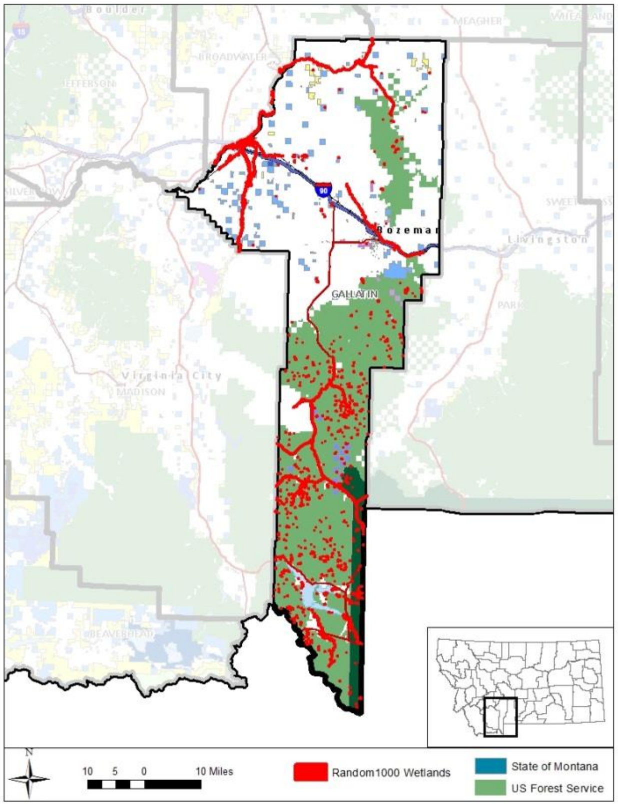

Figure 4: 1000 Random Wetlands for Landscape Profiling

For the 1000 randomly selected wetlands we calculated descriptive statistics across of the selected wetlands and across ownership. Additionally, we calculated acres and descriptive statistics for the selected wetlands based on land cover. Wetlands and other water bodies totaled 78,514 acres within the project area. By class, the majority of the mapped wetlands were palustrine (Table 5).

Table 5: Wetlands by Class in the Project Area

Wetland Class	Percentage of Total Acres
Palustrine	64%
Lacustrine	0%
Riverine	6%
Riparian	30%

The 1000 randomly-selected wetlands captured 4170 acres or approximately 5% of the total wetland acres in the project area. The majority of the wetland acres were in public ownership; however, private ownership contained the greatest amount of wetland acres of any one ownership category (Table 5).

Table 6: Wetland acres in 1000 randomly selected wetlands.

	Across All Ownership	Federal Government	State Government	Local Government	Private
Minimum Acres	0.01	0.01	0.01	0.01	0.01
Maximum Acres	1450.53	281.24	154.29	7.34	1295.84
Mean Acres	4.17	2.06	3.4	1.37	18.8
Total Acres	4170.14	1814.79	394.34	24.62	1936.39
# of Wetlands	1000	879	116	18	103

Land cover was captured for the 1000 randomly selected wetlands across all buffers (0 m, 100 m, 300 m, and 1000 m) the largest land cover was the aggregate category of "Other" (Table7).

Table 7: Land cover at and proximate to the 1000 randomly selected wetlands

No Buffer	**2010 (acres)**	**2013 (acres)**	**Percent Change**
Other	3701	3661	-1%
Human Use	49	87	1%
Recent Disturbance	8	26	0%
100 m buffer	**2010 (acres)**	**2013 (acres)**	**Percent Change**
Other	35577	33259	-3%
Human Use	1423	3228	2%
Recent Disturbance	352	873	1%
300 m buffer	**2010 (acres)**	**2013 (acres)**	**Percent Change**
Other	110421	103607	-3%
Human Use	5144	9610	2%
Recent Disturbance	1901	4251	1%
1000 m buffer	**2010 (acres)**	**2013 (acres)**	**Percent Change**
Other	435900	413048	-2%
Human Use	52859	34521	-2%
Recent Disturbance	10477	20673	1%

Across nearly all buffers, the level of Human Use and Recent Disturbance increased slightly from 2010 to 2013.

Level 2 – On-the-ground Wetland Assessments

The initial 42 assessment sites were located randomly across the county (Figure 5). In 2016, 26 of the original sites were discontinued because they did not meet our site selection criteria. 17 new sites were added, resulting in a total of 43 survey sites. Condition and function scores were calculated for each site using scoring formulas modeled after those used in NHP (2012) and MDT (2008). Additionally, an aggregate score was calculated for each site by averaging the condition and function scores.

Wetland Classification

The majority of our monitoring sites are Western North American Marshes (Figure 6), and Riverine or Depressional HGM Classes (Figure 7). All sites were Palustrine.

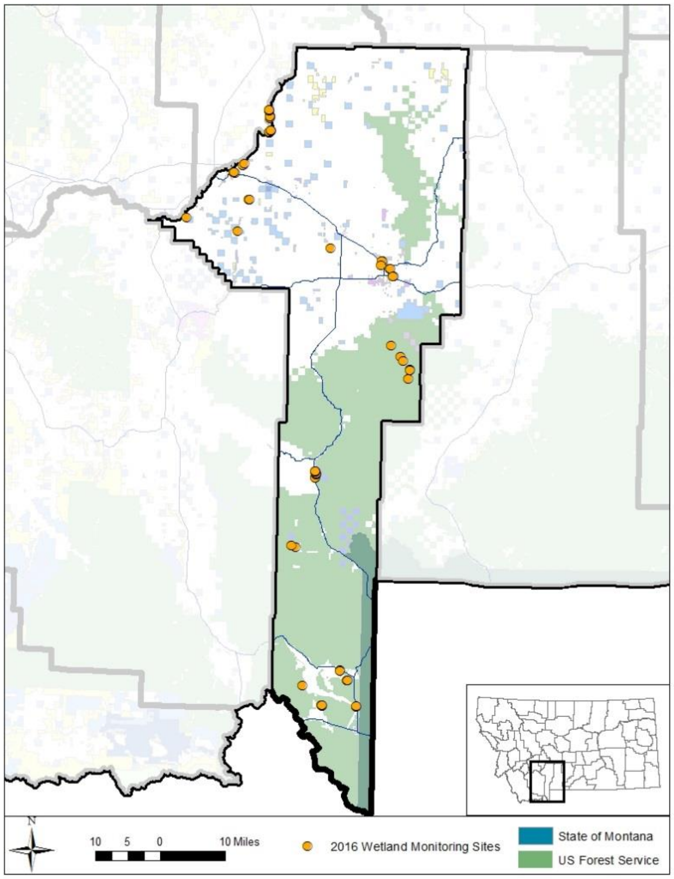

Figure 5. 2016 Wetland Monitoring Sites

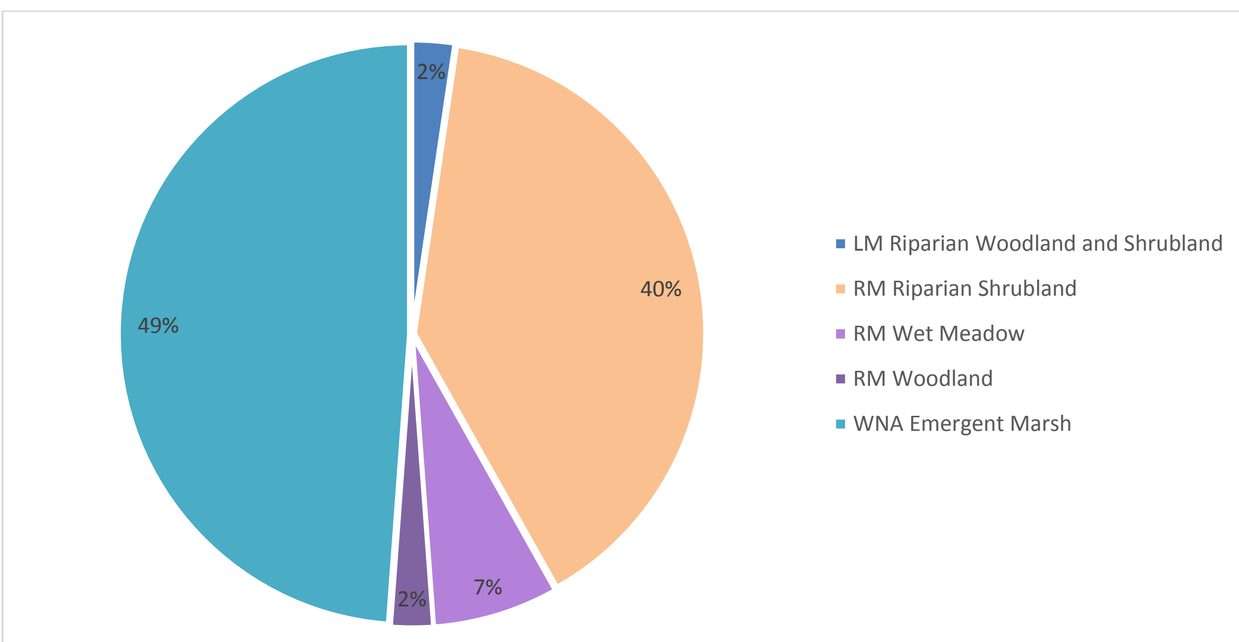

Figure 6: Ecological Systems of sampled wetlands, n = 43

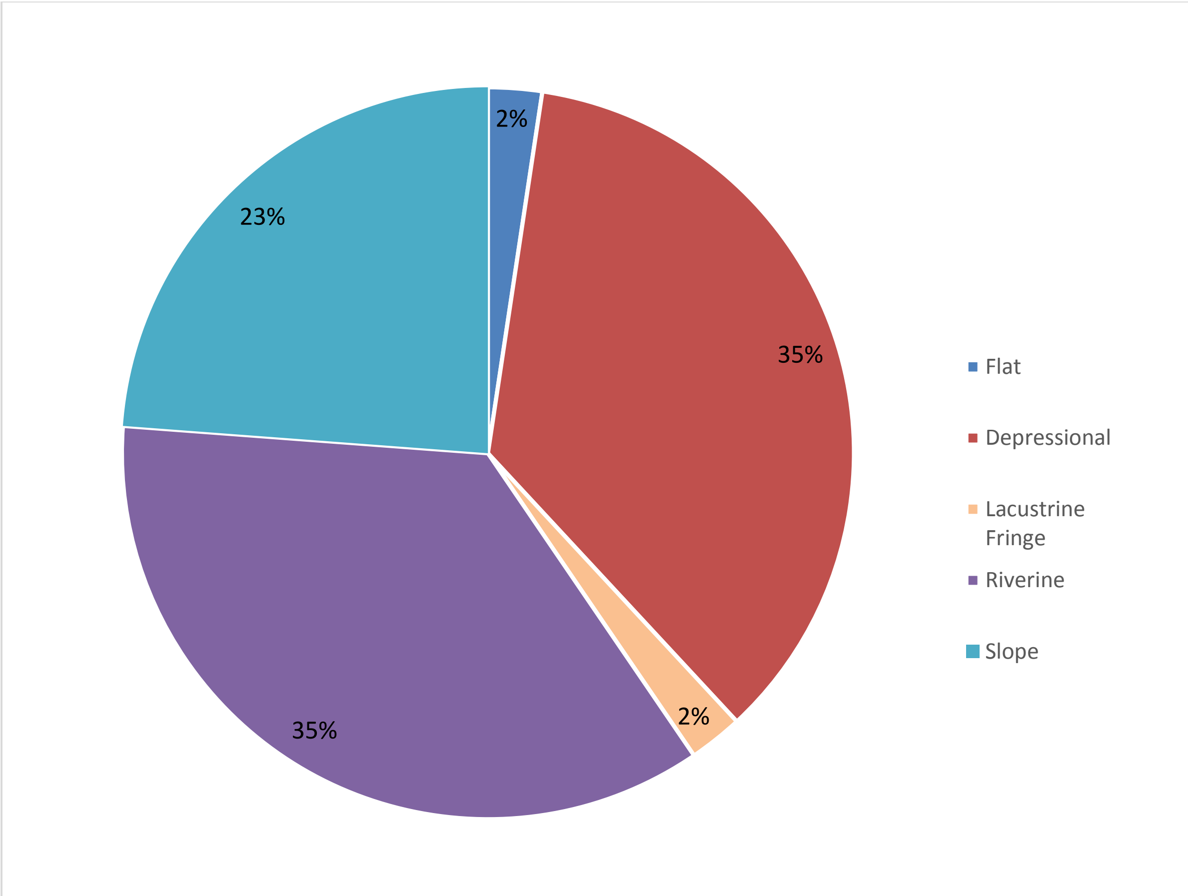

Figure 7: Hydrogeomorphic Class of sampled wetlands, n = 43

An ANOVA was run to test for the affect of the ecological system on the aggregate assessment score. A significant p value of < 0.05 was not calculated for variance between groups ($p = 0.228$, Figure 8).

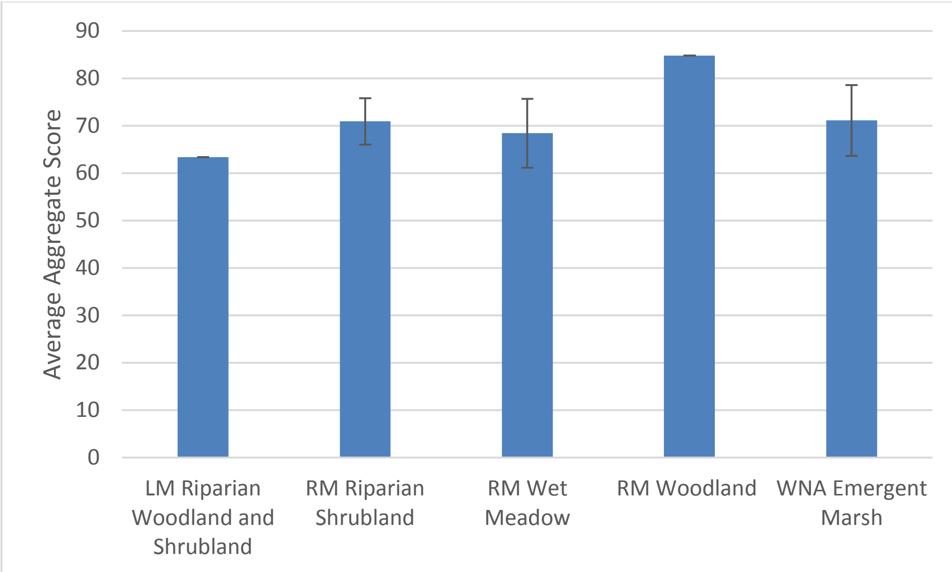

Figure 8: Aggregate assessment score by Ecological System

An ANOVA was run to test for the affect of topographic position on the aggregate assessment score. The p value did not indicate a signficant difference in the variance between groups (p = 0.197, Figure 9).

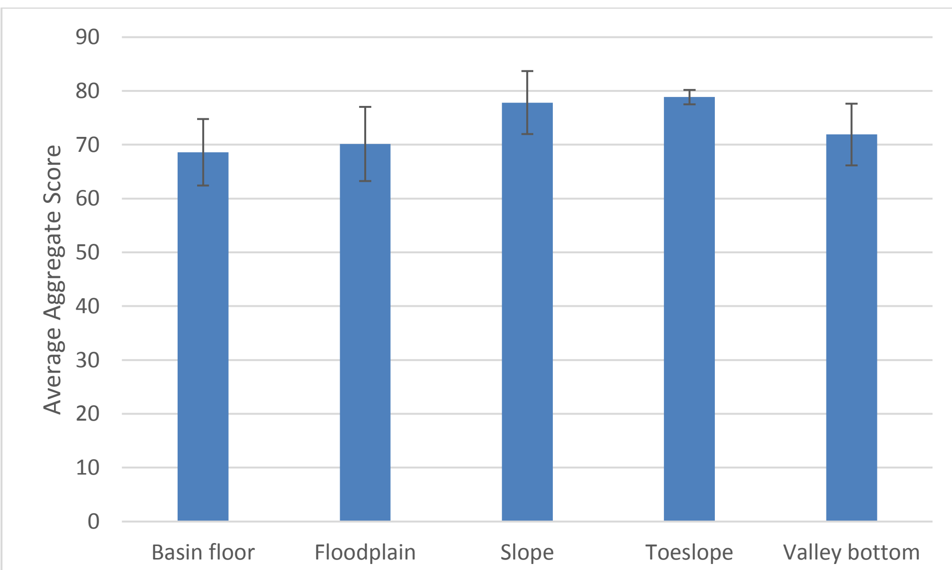

Figure 9: Aggregate assessment score by Topographic Position

An ANOVA was run to test for the affect of hydrogeomopphic class on the aggregate assessment score. The p value did not indicate a signficant difference in the variance between groups (p = 0.194, Figure 11).

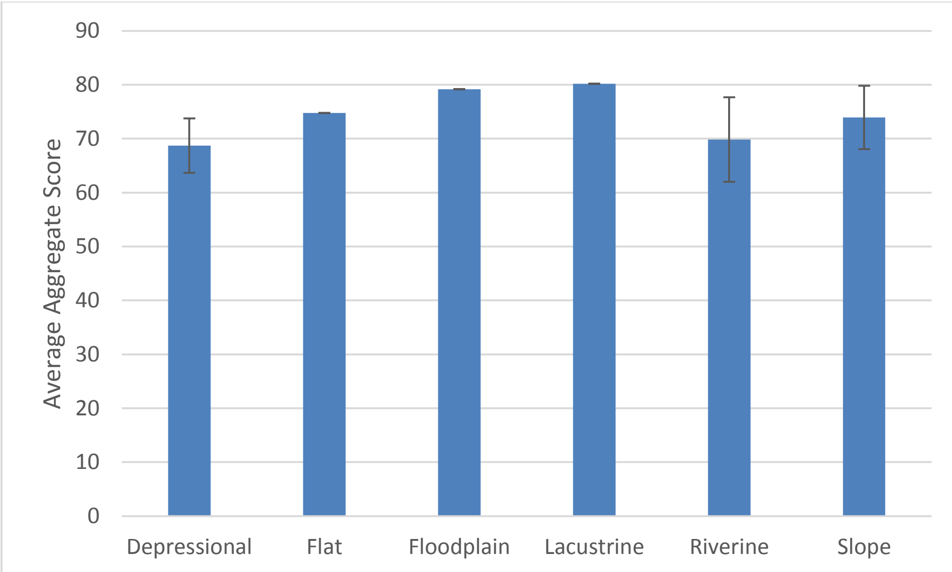

Figure 11: Aggregate assessment score by Hydrogeomorphic Class

The dominant sampled Cowardin water regime is "Seasonal/Intermittent" (Figure 12).

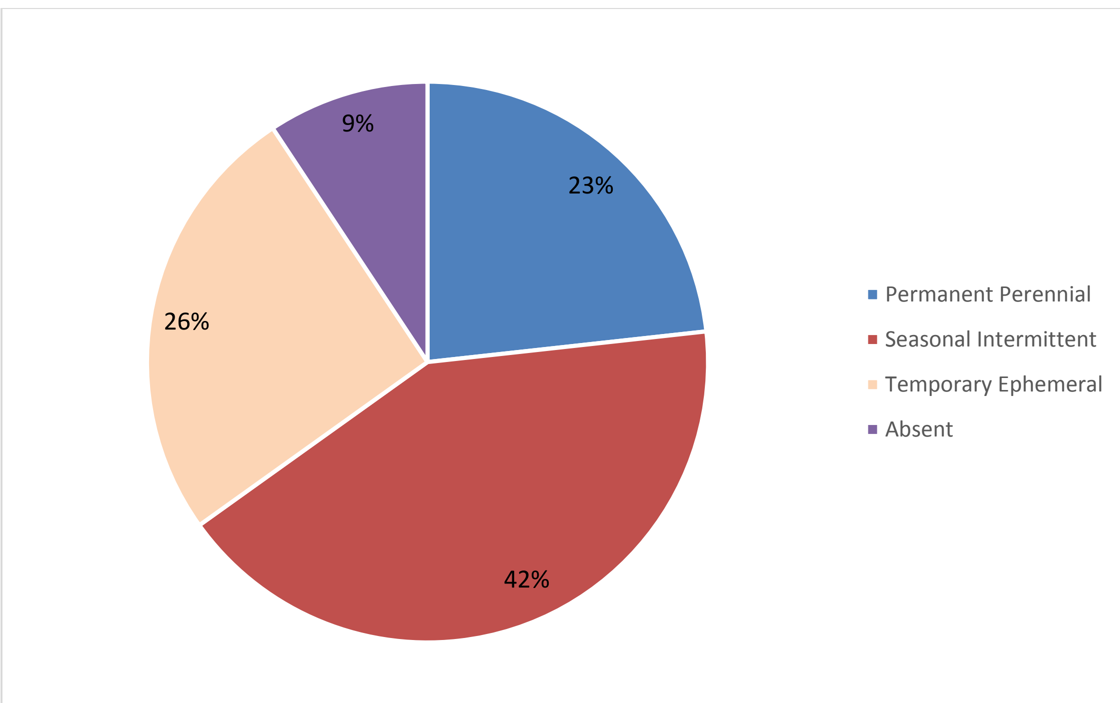

Figure 12: Cowardin water regime of sampled wetlands, n = 43

An ANOVA was run to test for the affect of the Cowardin water regime on the aggregate assessment score. A significant p value of < 0.05 was calculated for variance between groups ($p = 0.020$, Figure 13), indicating that the average aggregate scores between water regimes were statistically significant. The relatively low average aggregate score for sites with a water regime of “absent” was likely due to the fact that these sites were unable to score points in most of the questions in the function section because they required standing water to answer. This is important to note because it suggests that the services wetlands provide may decrease if land use changes diminish water supply to wetlands in Gallatin County.

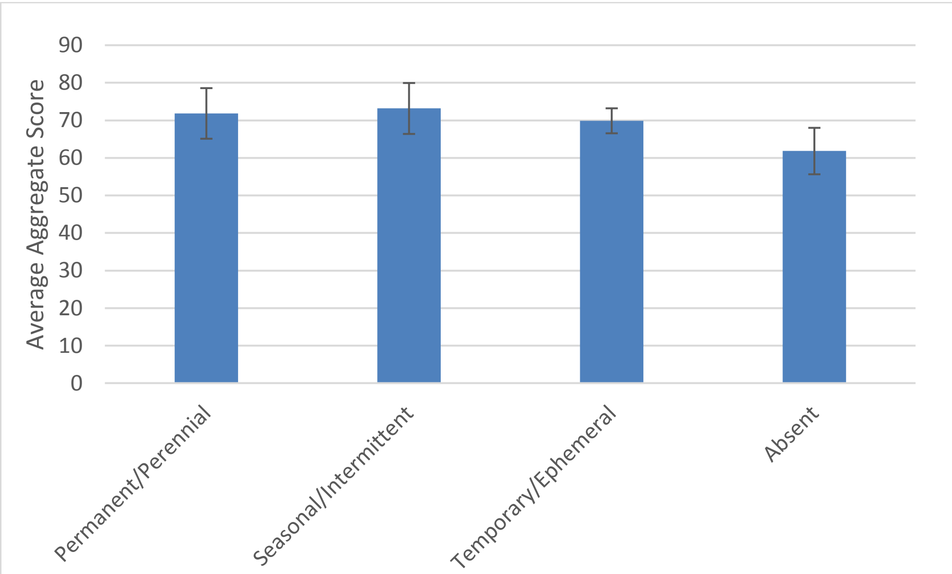

Figure 13: Aggregate assessment score by Water Regime.

Location

All sample sites are on public land (Figure 14, Figure 3), with the US Forest Service being the most common owner.

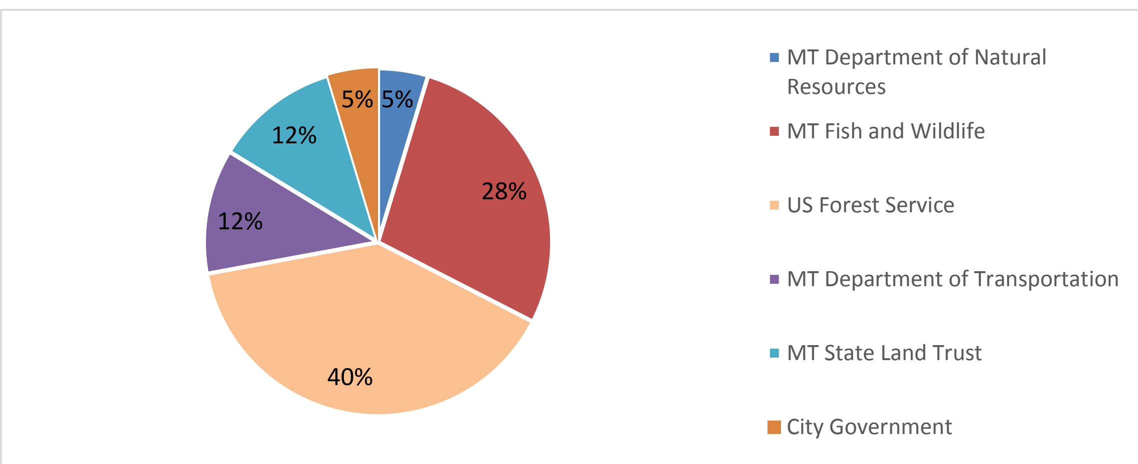

Figure 14: Ownership of sampled wetlands

Dynamic Data – Condition and Function

In 2016 the mean condition score was 74.6% with a standard deviation of 7.6%, n = 43. The majority of monitored sites had a score indicating a moderate departure from reference state in both 2015 and 2016 (Table 8, Figure 15).

Table 8: Departure from reference state, n = 43

Wetland Condition Category	Count
Severe Departure (<70)	10
Moderate Departure (70-79)	22
Slight Departure (80-89)	11
At or Near (90-99)	0

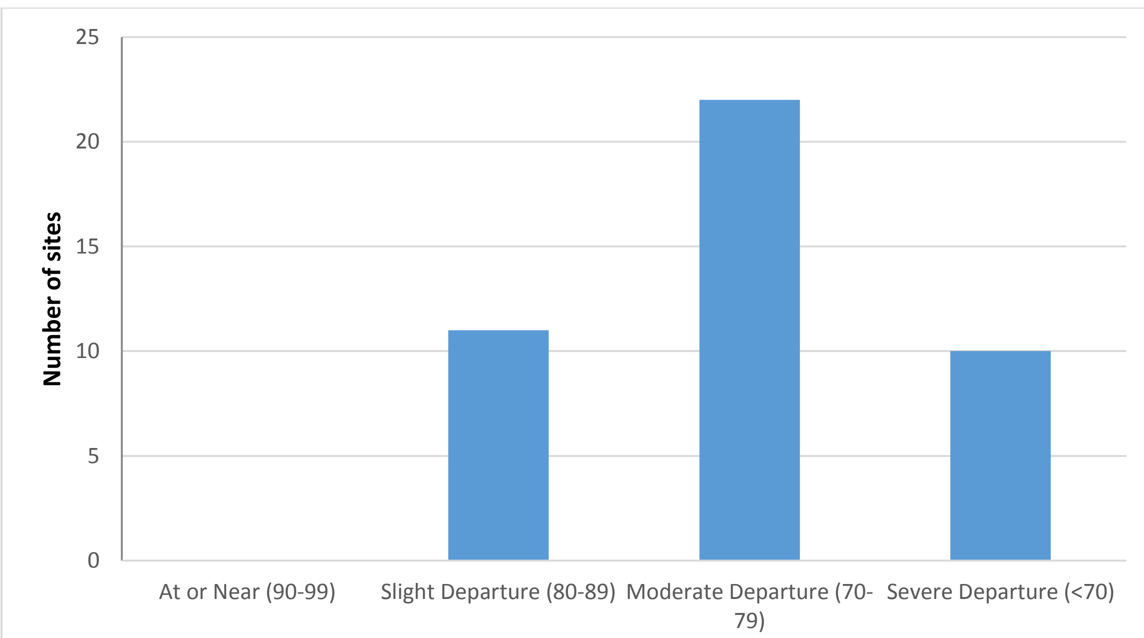

Figure 15: Number of sites in each condition score category, n = 43

The mean function score was 67.3% with standard deviation of 10.2%, n = 43 (Table 9, Figure 16). The majority of sites had a function score between 65-80%.

Table 9: Wetland Function Score

Wetland Function Score	Count
< 65%	19
65 - 80%	21
> 80%	3

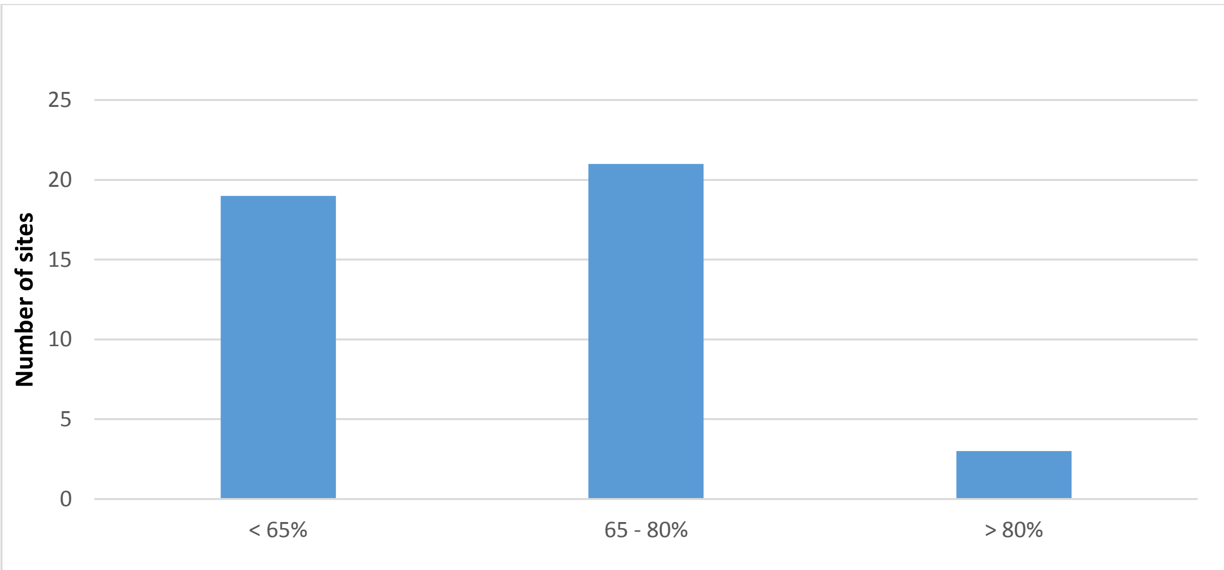

Figure 16: Number of sites in each function score category, n = 43

The majority of monitored sites had a score indicating a category 1 or 2 wetland in 2015 (Table 10, Figure 17). Wetlands are designated category 1 if they contain listed or proposed threatened or endangered species, contain unique habitat, attenuate floodwaters, and/or have a functional score greater than 80. Wetlands are designated category 2 if they contain significant fish or wildlife habitat and/or have a functional score greater than 65. Category 3 wetlands are those that do not meet any of the above requirements.

Table 10: Wetland category based on function score

Wetland Category	Count
1	5
2	27
3	10

	4	0

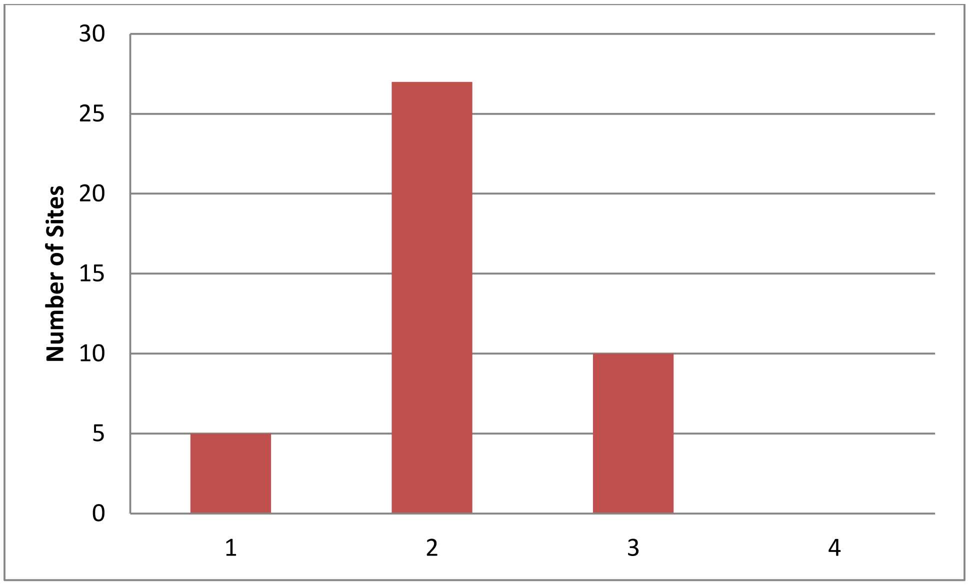

Figure 17: Wetland category based on function, n = 42

The difference between condition and function for each monitored wetland varied widely (Figures 18 and 19), demonstrating the importance of evaluating both.

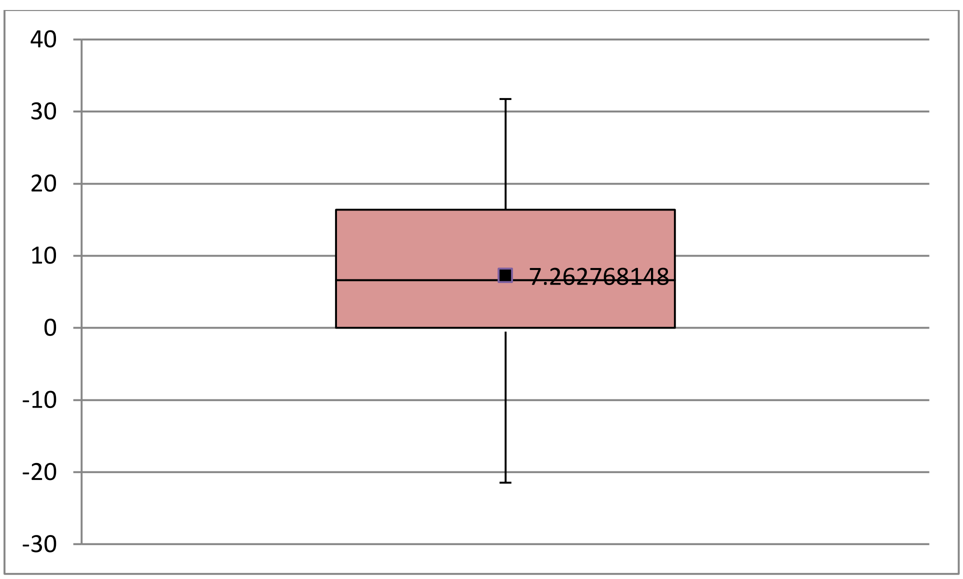

Figure 3: Box plot of the difference between condition and function scores. The mean difference (represented by the black square) was approximately 7.

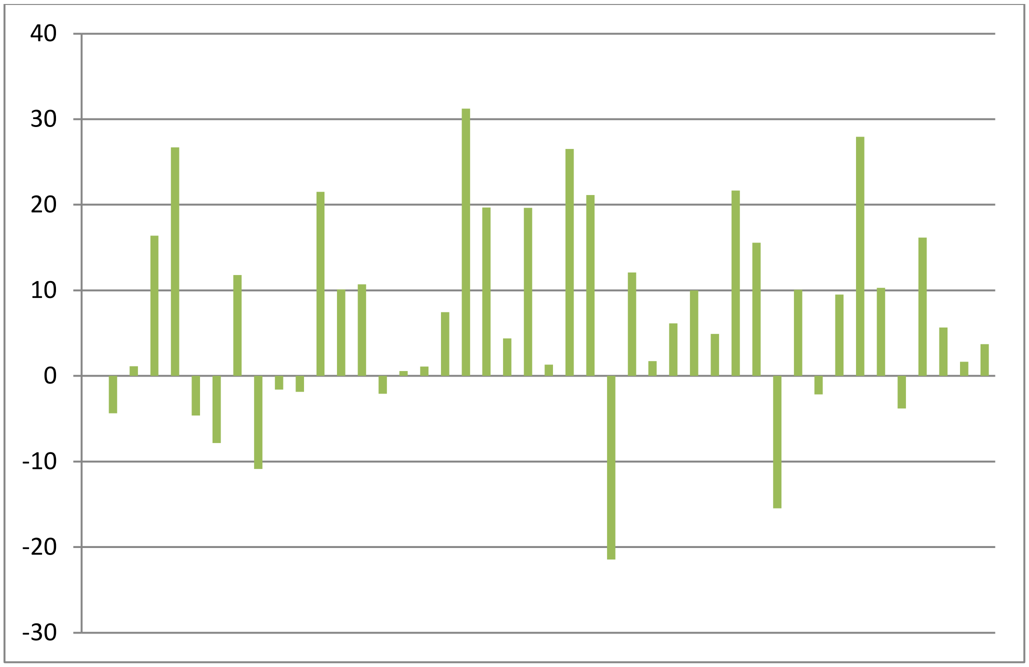

Figure 19: Difference between condition and function scores for each monitored site, n = 43. Each bar represents a site.

The mean aggregate score of condition and function was 80.0 with a standard deviation of 6.8. The majority of sites scored in the top 30 percent of the possible score (Table 11, Figure 20).

Table 11: Aggregate condition and function scores

Aggregate Score	Count
90-100	0
80-89	4
70-79	19
<70	20

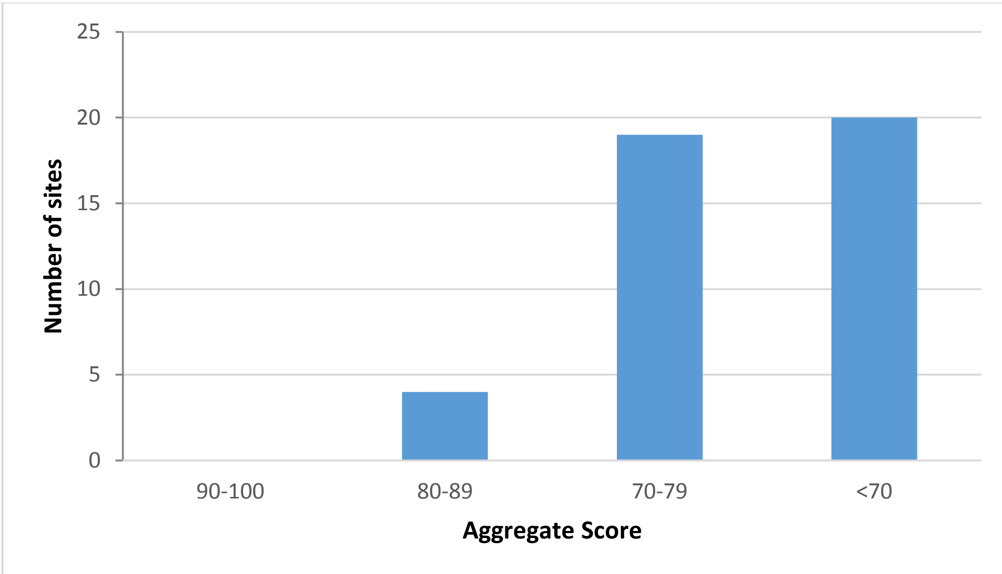

Figure 20. Number of sites in each aggregate score category, n = 43.

Nineteen sites were located within 400m of another site. These clusters were considered wetland "complexes" and we compared these complexes via mean of aggregate scores within a complex (Table 12). We also examined the extent to which aggregate scores for sites within the same complex varied by calculating standard deviation (Table 12). The average standard deviation across complexes was 3.7, indicating that condition and function among sites in the same complex did not vary greatly.

Table 12. Means and standard deviations of aggregate scores within wetland complexes.

Complex	Mean Aggregate Score	Standard Deviation
Clarkston North	62.3	3.1
Clarkston South	68.6	5.3
Missouri Headwaters State Park	69.9	1.1
Blackbird Fishing Access	71.7	3.3
Madison River Road	75.9	3.9
Cherry River Fishing Access	68.3	2.8
Story Mill	63.5	11.3
Bozeman DOT	66.0	2.1
Hyalite Reservoir	68.4	0.5

Dynamic Data - Disturbances

The scope and severity of all disturbances within 200m of a site center point were combined to create an impact score for each site. A combined impact score of 12 indicated no impact from disturbances. A linear regression analysis was performed to determine the effect of impact scores on aggregate scores. 11% of the variance in aggregate scores was explained by the stressor score. (Figure 21).

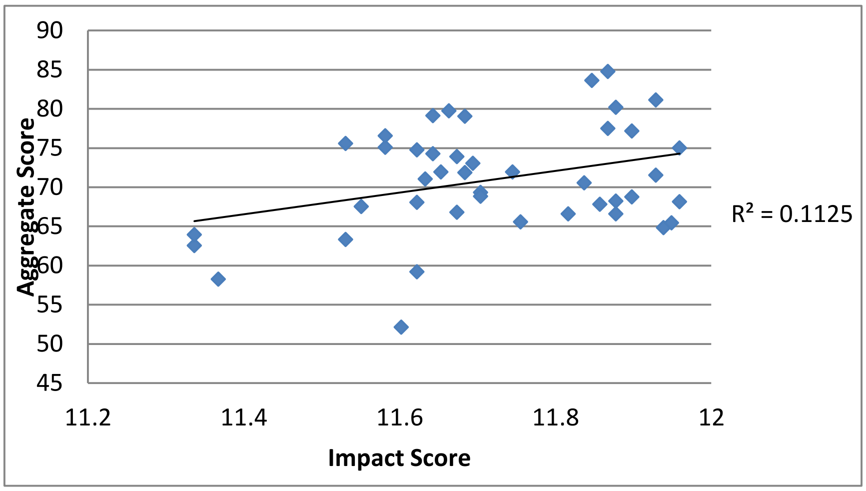

Figure 21: Linear regression of impact score and aggregate score.

Dynamic Data- Inter-annual changes

Four of the surveyed sites were previously surveyed by the Montana Natural Heritage Program in 2010 (MTNHP 2012). Comparing the results of past monitoring provides some context for how wetland condition might have changed since 2010 (Figure 22). Two of these sites were surveyed in 2015 but discontinued from the study in 2016 because they did not meet our site selection criteria. Three out of four of these sites showed slight decreases in condition between 2010-2015/2016

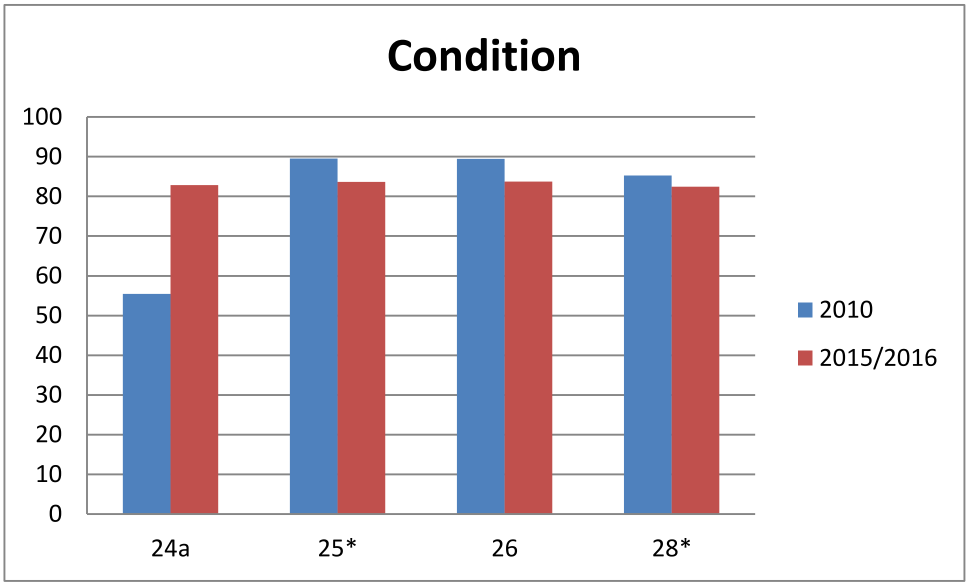

Figure 22. Comparison 2010 condition scores and 2015/2016 scores. *Sites 25 and 28 were not surveyed in 2016.

As this project continues, annual monitoring will provide a greater understanding of long-term changes in condition and function. Of the 26 sites that were surveyed in 2015 and 2016, condition and aggregate scores decreased slightly on average (See Tables 11 and 13 and Figures 23 and 25), while function scores remained constant on average (See Table 12 and Figure 24).

Table 11. Comparison of condition scores between 2015-2016, n = 26

	2015	2016
Minimum	60.74	47.55496
Maximum	85.54	83.75939
Mean	77.02637	74.47627

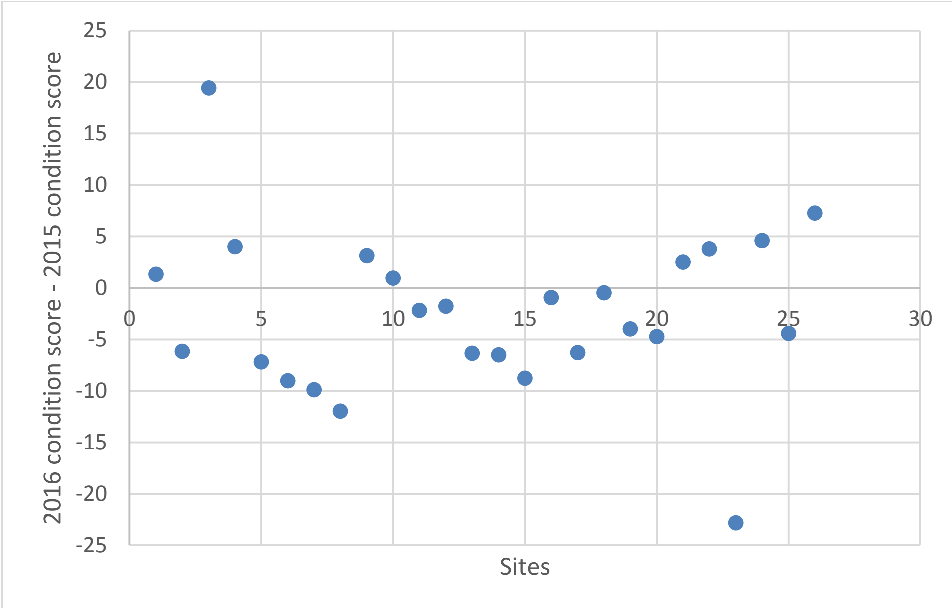

Figure 23. Change in condition scores between 2015-2016. Mean difference was -2.6 and standard deviation 7.7, n = 26. Each point represents a site.

Table 12. Comparison of function scores between 2015-2016, n = 26

	2015	**2016**
Minimum	50	51
Maximum	86.67	85.8333
Mean	68.29462	68.12966

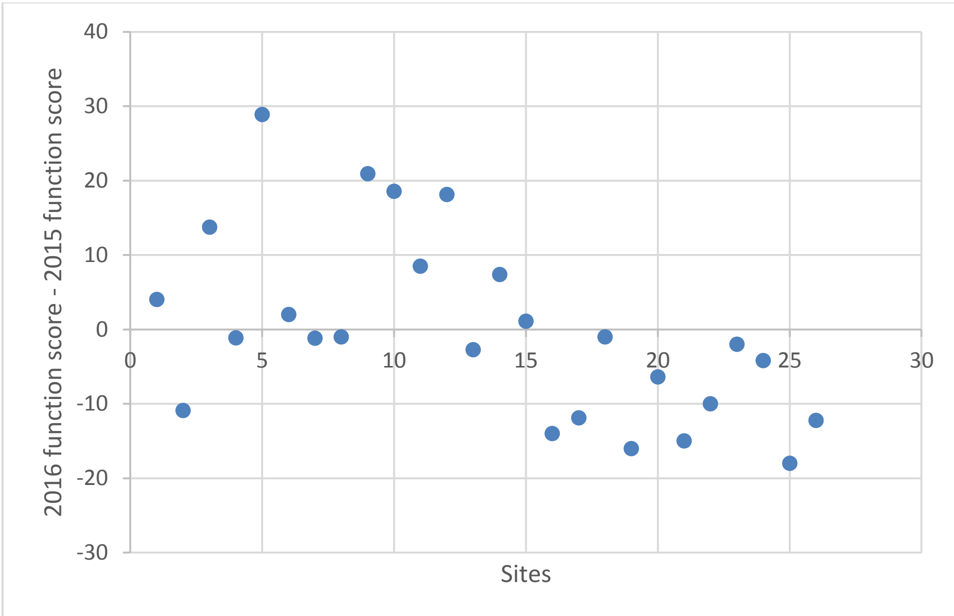

Figure 24. Change in function scores between 2015-2016. Mean difference was -0.2 and standard deviation 12.2, n = 26.

Table 13. Comparison of aggregate scores between 2015-2016, n = 26

	2015	2016
Minimum	55.37	58.27748
Maximum	83.635	84.79634
Mean	72.66068	71.30297

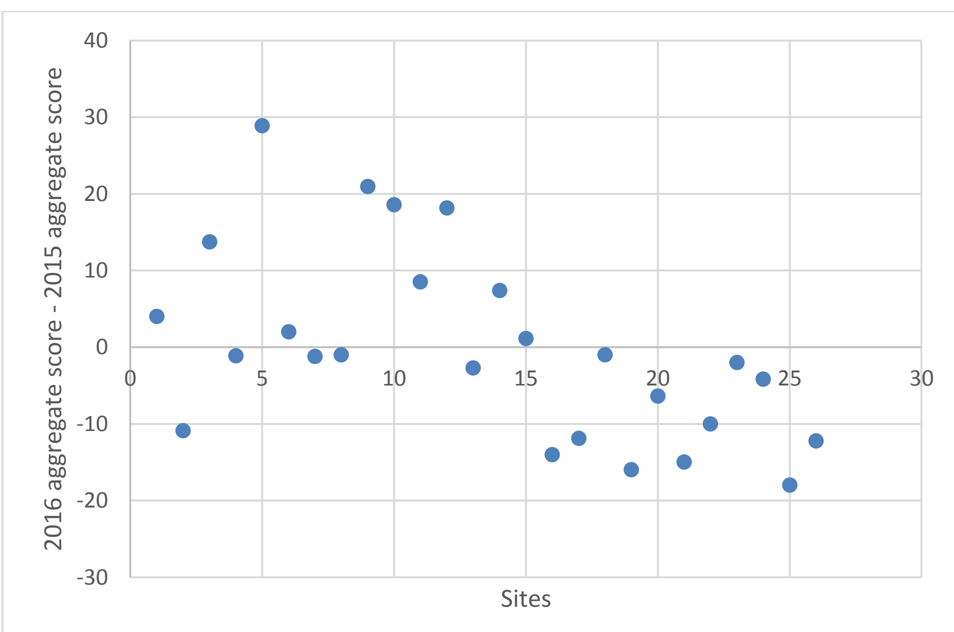

Figure 25. Change in aggregate scores between 2015-2016. Mean difference was -1.4 and standard deviation 7.5, n = 26.

Discussion

Results from our wetland landscape profile indicate that wetlands make up about 5% of Gallatin County. Our level 1 analysis indicates that wetlands are predominantly found at locations with a land cover other than that of human use or recent disturbance. However, a slight increase was observed from 2010 to 2013 in the number of wetland acres found in places with a land cover of human use or recent disturbance. The importance of private ownership to wetland health is underlined by our finding that private ownership contained the greatest amount of wetland acres of any one ownership category within our project area, totaling 46% of wetland cover in Gallatin County. Land cover change continues to be a threat to wetlands and will continued to be assessed through this project.

77% of the wetlands sampled in our level 2 assessments were at a moderate or less departure from reference condition in 2016. 76% of the assessment wetlands were functioning at a category 2 or better in 2015. The assessed score for condition and function for a given wetland were on average widely different, suggesting the value of measuring both condition and function at each assessed wetland. The aggregate assessment scores indicate that 53% of the wetlands were in the top 30% of the possible score in 2016 and that the intra-wetland variation in assessment scores varied widely. The stressors observed within and around the assessment areas appear to have a low impact on the aggregate assessment score.

Condition was monitored for four sites that had been monitored by the Montana Natural Heritage Program in 2010. However, differences in surveyors and a small sample size make these data difficult to draw conclusions from. Many score differences between 2015-2016 were likely caused by refining the protocol and training new surveyors. As monitoring continues over many years, surveyors should become more consistent and persistent trends should emerge.

In summary, all wetlands surveyed have been impacted by human development, but they remain, on average, in relatively good condition. Whether or not they continue to degrade with ongoing development will depend on our ability to act quickly to manage development in a way that ensures the future health and existence of wetlands in Gallatin County.

Additional Products

Wetland Indicator Species Guide	http://www.msuextension.org/gallatin/documents/naturalresourcesdocuments/Wetland%20Indicators.pdf
Web based Map of Results	http://www.msuextension.org/gallatin/NaturalResourcesWetlandsMap.htm
Monitoring Form	http://www.msuextension.org/gallatin/documents/naturalresourcesdocuments/2015DataForm_ForEpaReport.pdf
Wetland Educational Videos	Wetlands Introduction https://youtu.be/l-pRnnCfJoo Water Quality https://youtu.be/DzsN6xAPRRA Water Storage https://youtu.be/BDFz_J0CDUA Fish Production https://youtu.be/ja3TJSD_cI8 Flood Attenuation https://youtu.be/bwuJ0oyKKZc Shoreline Stabilization https://youtu.be/c819a0fthig
Wetland Monitoring Database and Scoring Tool	http://www.wetlands.msuextension.org (contact brad.bauer@montana.edu for login)

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