

Wetland Environment Teams Educational Companion Guide

October 2016
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Preface

This guide is intended to explain *why* we are collecting the data we're collecting and how they fit into a bigger picture. If you are unsure of the purpose of one of our survey questions, you can refer to its corresponding section in this guide.

Background

Wetlands are an important component of our watersheds. They provide plant and animal habitat, recreation space, flood protection, groundwater recharge, and improvements to water quality. Wetlands are also an extremely unique ecosystem in Montana, covering just 1% of the state. However, society has only recently begun to value wetlands. Until recently, wetlands were regarded as “waste areas” and people were incentivized to drain, fill, farm, or develop them. As a result, over half of the wetlands in the continental U.S. have been destroyed, including more than 25% of Montana's. In addition, wetlands are also highly sensitive to changes in the surrounding landscape. Wetland ecological communities can be strongly impacted by changes in the timing, quantity, and quality of water that they receive.

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. These rapid changes are expected to continue and are likely to stress 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, there is a lack of information on the extent, condition, and function of local wetlands. Wetland Environment Teams was created to monitor the effects of these changes on wetlands by annually assessing wetland condition and function across a broad sample of wetlands in Gallatin County. **Condition** refers to a wetland's ecological health and is indicated by factors such as invasive species, water quality, hydrologic patterns, and human-caused disturbances. **Function** refers to a wetland's ability to provide ecosystem services such as flood attenuation and water filtration.

Our goal is to generate information that improves our understanding of the impacts of rapid development on wetlands in Gallatin County and guides future management. Specifically, we seek to answer the following questions:

- What are the land uses surrounding our wetlands?
- How are changes in land use affecting our wetlands?
- Where are the high-quality, minimally-disturbed wetlands in Gallatin County?
- What are the threats to these high-quality wetlands?
- What are our tools for maintaining these high quality wetlands?

Additionally, we aim to share this information with the various public and private wetland owners and managers help inform decisions concerning wetland management. Finally, by recruiting and training citizen scientists for this effort, we will increase public awareness of wetlands and empower people to play an active and direct role in managing their natural resources.

Understanding The Survey

In this section, the purposes for most of our survey questions are explained.

Site Photos

Annual photo documentation is an excellent way to document major changes in a wetland's hydrology (flooding regime) and plant community over time. Additionally, photos are much easier to understand and interesting to look at than charts of data. These photos will be one of the most compelling outreach tool that this project produces.

Classification

The U.S. Fish and Wildlife Service's classification of wetlands types is referred to as "Cowardin water regimes" after the classification's lead author. A wetland's Cowardin water regime describes how long it is flooded during throughout the year. A permanent change in a wetland's Cowardin water regime would indicate drastic and consequential changes in the wetland's hydrology.

Patch Types and Diagram

Tracking major changes in the structure of a wetland could indicate changes to its hydrology and condition.

Condition Assessment

This section evaluates the wetland's ecological "health" or integrity. There are several components to this section that are described below.

Disturbances

The disturbances listed here have the potential to impact a wetland's health in a variety of ways. Tracking the extent of these disturbances will allow us to find correlations between them and changes in a wetland's condition and function. We assess disturbances outside of the 40m assessment area because wetlands are impacted by disturbances in the landscape around them. Below are some of the potential impacts of some of the more common disturbances found in our surveys:

- Roads: sediment and oil runoff, wildlife barrier
- Agricultural fields: sediment, pesticide, and fertilizer runoff
- Recreation or human visitation: soil compaction, spread of invasive species, disturbance of nesting wildlife

- Ditches and berms: block and redirect flow of water across a landscape
- Culverts: channelize flow and concentrate it in one spot, thereby flooding some areas and depriving others of water
- Impoundment of flowing water: floods transitional and temporary wetlands, creates fish habitat (bad for amphibians)

Buffers

The more native vegetation surrounding a wetland, the less likely it will be impacted by the above disturbances. Buffers help prevent sediment and invasive plants from entering a wetland and provide more wildlife habitat. Buffered wetlands may be more resilient to change over time.

Native Vegetation, Noxious Weeds, and Aggressive Grasses

Native plant communities are much more biodiverse than those dominated by a handful of noxious weeds and aggressive grasses. Because of their higher biodiversity, they also have a more complex structure and therefore provide habitat for more species. Native plants are drastically more useful to native wildlife because they have coevolved with them. For example, native plants support much larger and diverse insect communities, which are a foundational food source.



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A hairstreak butterfly sips nectar from Stiff Goldenrod.

Plant Litter

The accumulation of litter and/or woody debris is integral to a variety of wetland functions, such as surface water storage, percolation and groundwater recharge, nutrient cycling, and support of wetland plants. Intact litter layers and/or woody debris provide areas for primary production and decomposition that are important to maintaining functioning food chains. They nurture fungi essential to the growth of rooted wetland plants. They support soil microbes and other detritivores that comprise the base of the food web in many wetlands. The abundance of litter and/or woody debris on the substrate surface can significantly influence overall species diversity and food web structure. Fallen debris serves as cover for macroinvertebrates, amphibians, rodents, and even small birds. Litter is the precursor to detritus, which is a dominant source of energy for most wetland ecosystems.



Sedges growing from a healthy layer of plant litter.

Structural Complexity

The more complex the physical structure of a wetland is, the more habitat niches it provides, and therefore the more species it can host.



A mix of shrubby and herbaceous increase structural diversity in this West Yellowstone wetland.

Soil Integrity

Bare, disturbed soils often indicate anthropogenic (human-caused) disturbance and are prone to colonization by noxious weeds and aggressive grasses.

Water Quality

Large algal blooms often indicate excess nutrients from fertilizer runoff. These algal blooms can decimate aquatic wildlife by depleting the water's oxygen content as millions of algal cells die and decompose.

Turbid, or cloudy, water indicates excessive sediment runoff. High turbidity can smother fish nests, clog fish gills, and prevent some aquatic species from locating their food.

An oily sheen on the surface of water that doesn't leave a hole if you poke it is a sign of petroleum pollution. While chemical pollution is harmful to all wildlife, amphibians are particularly sensitive because they absorb chemicals through their skin and eggs.

Input, Output, Connectivity, and Hydroperiod

The timing, quantity, quality, and duration of waters that reach a wetland play an extremely large role in determining what plants and animals will live in a wetland. Assessing the extent of human alteration in a wetland's hydrology helps explain other signs of degradation.

Function Assessment

This section evaluates the wetland's ability to provide services that benefit society. There are several components to this section that are described below.

Wildlife Habitat

Wetlands provide habitat for many species of birds, fish, amphibians, insects, and plants that live only in wetlands. All amphibians in Montana need a source of water to lay their eggs in, and many species can only successfully breed in water uninhabited by fish, which eat their eggs and young. Ephemeral wetlands (wetlands that flood in spring and dry up in summer) do not support fish and are essential for amphibian survival. Wetlands are also crucial habitat for waterfowl, which in turn support the duck- hunting and watching industries. Millions of migratory shorebirds also depend on wetlands as a source of food during their biannual journeys between the northern and southern hemispheres.



Northern Harrier chicks in a cattail wetland in Blackbird Fishing Access.

Fish Habitat

The slow, shallow water and dense aquatic vegetation of wetlands provide excellent habitat for young fish to grow. Young fish are extremely vulnerable to a wide variety of predators. The bodies of young fish are also poorly-suited to navigate flowing water. In addition, wetlands provide an abundance of small aquatic invertebrates that are ideal food for tiny fish. Structural cover and shade (to keep water cool) are two beneficial aspects of fish habitat that we assess in our surveys. Structural cover provides areas for fish to rest, hide from predators, and find insect prey. Shade is ideal for many fish species because dissolved oxygen content decreases as water

temperature increases. We also look for hanging culverts because they prevent fish from accessing upstream waters. The Cowardin water regime is also used to calculate a fish habitat score, with more permanent water creating higher scores.



Recently-hatched fish hiding in the vegetation of a shallow wetland at Cherry River Fishing Access.

Flood Attenuation

Wetlands in flood zones can protect property by reducing the frequency and severity of floods. Wetlands slow floodwaters by allowing them to spread out over a large area and creating friction with their dense vegetation. Shrubby, woody plants slow floodwaters more effectively than herbaceous ones. Wetlands also absorb and store large amounts of water, slowly releasing them throughout the summer. During the growing season, plants also take up water and release it to the atmosphere through their leaves. As a result, floodwaters are not only slower, but lower when they leave a wetland. Wetlands with restricted outlets do a better job of blocking and slowing floodwaters.

Water Storage

Wetlands capture water during periods of high precipitation or snowmelt. These flooded areas provide a valuable resource for wildlife and people. By slowly releasing this water throughout the summer, wetlands provide a source of water during the driest parts of the year. The greater the portion of a wetland that floods and the more frequently it does so, the more water it has the potential to store.

Sediment/Nutrient/Toxicant Retention and Storage

Wetlands have an amazing ability to filter these pollutants out of the water that passes through them. When water stagnates, the sediment suspended in it settles at the bottom. Because

wetlands are places where water naturally slows, sediment settles at their bottoms. The plant and microorganism communities of wetlands have an amazing ability to convert nutrients and toxic chemicals to less harmful forms and bury them. As a result, the water that flows out of wetlands (and often into streams and rivers) is much cleaner than it would be without wetlands.

Excess nitrogen and phosphorous from runoff fertilizer creates algal blooms that can decimate aquatic wildlife by depleting the water's oxygen content as millions of algae cells die and decompose. In aerobic (oxygenated) wetlands, organic nitrogen may mineralize to ammonium, which plants and microbes can utilize, adsorb to negatively charged particles (e.g. clay), or diffuse to the surface. As ammonia diffuses to the surface, the bacteria *Nitrosomonas* can oxidize it to nitrite. The bacteria *Nitrobacter* oxidizes nitrite to nitrate. This process is called nitrification. Plants or microorganisms can assimilate nitrate, or anaerobic bacteria may reduce nitrate to gaseous nitrogen (N_2) when nitrate diffuses into anoxic (oxygen depleted) water. The gaseous nitrogen volatilizes and the nitrogen is eliminated as a water pollutant.



An extreme algal bloom. Photo by Richard Litts/Tenmile Lakes Basin Partnership.

Phosphorus removal from sediment in wetlands occurs through use of phosphorus by plants and soil microbes; adsorption by aluminum and iron oxides and hydroxides; precipitation of aluminum, iron, and calcium phosphates; and burial of phosphorus adsorbed to sediments or

organic matter. Dissolved phosphorus is processed by wetland soil microorganisms, plants, and geochemical mechanisms. Microbial removal of phosphorus from wetland soil or water is rapid and highly efficient; however, following cell death, the phosphorus is released again. Similarly, for plants, litter decomposition causes a release of phosphorus. However, burial of litter in peat can provide long-term removal of phosphorus. Wetlands along rivers have a high capacity for phosphorus adsorption because as clay is deposited in the floodplain, aluminum (Al) and iron (Fe) in the clay accumulate as well. Thus, floodplains tend to be important sites for phosphorus removal from the water column.

Wetlands can remove metals from surface and ground water as a result of the presence of clays, humic materials (peats), aluminum, iron, and/or calcium. Metals entering wetlands bind to the negatively ionized surface of clay particles, precipitate as inorganic compounds (includes metal oxides, hydroxides, and carbonates controlled by system pH), complex with humic materials, and adsorb or occlude to precipitated hydrous oxides. Iron hydroxides are particularly important in retaining metals in salt marshes. Wetlands remove more metals from slow flowing water since there is more time for chemical processes to occur before the water moves out of the wetland. Burial in the wetland substrate will keep bound metals immobilized.

In our surveys, we assess a wetland's ability to remove pollutants by looking at the extent of vegetation, evidence of standing water, and whether the site has a restricted or unrestricted outlet. Generally, a wetland's ability to uptake nutrients and toxicants and filter sediment increases with the density of its vegetation. Standing water in wetlands is indicative of sites that allow sediments to settle out and facilitate nutrient/toxicant uptake by increasing contact time with vegetation, soil, and microbes. Sites with no outlets or restricted outlets retain water longer than sites with unrestricted outlets.

Shoreline Stabilization

Wetlands or wetland plants often grow along the edges of flowing bodies of water. The deep, dense roots of these plants (such as willows, sedges, and rushes) help hold banks in place in the face of rushing water. When the banks of flowing bodies of water lose their natural vegetation they are prone to erosion and increased turbidity.



Willows and sedges stabilize a stream leading into Hebgen Lake.

Production Export/Food Chain Support

This question assesses the extent to which the site generates food for aquatic and terrestrial organisms and exports it outside the site's boundaries. In order to provide food for aquatic invertebrates, a site needs to contain standing water. In order to export the food, there needs to be a water outlet. A site's productivity is correlated to its amount of vegetation. Analysis of this question also incorporates answers to the wildlife and fish habitat questions.

Groundwater Discharge/Recharge

By allowing water to slow down, wetlands allow water percolate back into the groundwater, thereby increasing our supply of water for drinking and irrigation. The indicators in this question are signs that groundwater discharge and/or recharge may be occurring.



Groundwater bubbles from a spring in a wetland along Taylor Fork Road south of Big Sky.

Uniqueness Rating

This field assesses how unique and irreplaceable the wetland is. Fens, warm springs, and mature forested wetlands are very difficult or impossible to replicate at mitigation sites. More structurally-diverse wetlands also score higher in this field.

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