THE EFFECTIVENESS OF BEST MANAGEMENT PRACTICES ON NON-TIDAL WETLANDS

by

Addison Reid

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Approved:_____
Dr. Jacob L. Bowman, Ph.D.
Professor in charge of the thesis on behalf of the Advisory Committee

Approved:_____
Dr. W. Gregory Shriver, Ph.D.
Committee member from the Department of Entomology and Wildlife Ecology

Approved:_____
Dr. K. Kniel, Ph.D.
Committee member from the Board of Senior Thesis Readers

Approved:_____
Ismat Shah, Ph.D.
Chair of the University Committee on Student and Faculty Honors

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ABSTRACT

Wetlands are important in maintaining a healthy, productive environment. These ecosystems provide humans with services such as water filtration, absorption of nutrients, flood prevention, and habitat to many plants and animals. Wetlands work as filters to protect humans from the impacts of pollution and other heavy metals. Since wetlands are a fundamental part of the ecosystem, monitoring their health is imperative to the life of these habitats. I investigated if three non-tidal wetlands had been restored to original conditions by the implementation of Best Management Practices by Maryland Department of the Environment. The first site (the railroad site) was disturbed by a railroad running adjacent to the wetland, the second site (the rescue squad site) was disturbed by the installation of a gas line, and the third site (the airport site) was disturbed by the installation of a gas line and all terrain vehicle traffic through the site. Using established methods, I surveyed for amphibians once a month from April 2009 to October 2009, I conducted breeding bird surveys three times during June and July 2009, and I surveyed the vegetation at each site during August 2009. I compared the presence of non-native invasive species, bird abundance and richness, and amphibian abundances at each site. Due to the lack of data prior to disturbance, determining the degree of restoration was difficult. Although all sites are still suffering the impacts of the disturbances, the airport site had the greatest degree of restoration compared to the other sites. These results provide an indication of the level

of effort that is needed to protect these ecosystems and return them to their original condition in order to provide habitat and services to the environment.

Chapter 1

INTRODUCTION

Overview

Wetlands are a fundamental component of maintaining a healthy environment and provide many vital functions and values. Functions of wetlands are defined as the "physical, chemical, and biological interactions within wetlands" (NRCS 1996: 1). The basic wetland functions are water storage, filtering sediments and particles, incorporating nutrients back into the food chain, and maintaining biodiversity (NRCS 1996). Each of these functions has a very important value to humans, wildlife and the ecosystem. Values of wetlands are defined as the "characteristics of wetlands that are beneficial to society" (NRCS 1996:1). Wetlands help to prevent flooding by storing water to allow for ground water recharge. The slowing of the water also helps to prevent erosion and enhances the absorption of nutrients by plants and microorganisms (EPA 2001). Filtering of sediments is important for the health of life downstream of the wetland. Reducing sedimentation improves water quality and biodiversity of the waterways. As wetlands decompose organic matter, the nutrients are recycled back into the environment which creates a more productive habitat (NRCS 1996). Organic matter decomposes faster in wetlands and carbon sequestration is greater in wetlands. Wetlands are a vital part of the success of many birds, fish and other wildlife. In the United States, wetlands "support about 5,000 plant species, 190 species of amphibians and a third of all native bird species" (NRCS 1996: 2).

Definition of a wetland

The Army Corps of Engineers defines a wetland as having indicators of hydrophytic vegetation, hydric soils, and wetland hydrology. These indicators are key characteristics used to classify areas as wetlands and to determine the size of a wetland. Hydrophytic vegetation is a "community of macrophytes that occurs in areas where inundation or soil saturation is either permanent or of sufficient frequency and duration to exert a controlling influence on the plant species present" (Environmental Laboratory 1987: 14). Many other components are responsible for the plant community present in a wetland including as climate, soil composition, and land use. Hydrophytic plants are categorized into stratum based on plant height. The stratums consist of trees which are woody plants 6 m or greater in height and 7.6 cm in DBH. Saplings are woody plants 6 m or greater in height and less than 7.6 cm in DBH. Shrubs are woody plants 0.9 to 6 m in height, and herbs are herbaceous plants regardless of size. Finally, woody vines which include all woody vines regardless of height (Environmental Laboratory 31).

Environmental Indicators

Many species such as amphibians and birds can function as an indicator of environmental health and productivity. Species such as plethodontid salamanders that are vulnerable to pollution and disturbance are the first to suffer from lower survival and reproductive rates due to stressors on their habitat (Welsh and Droege 2001). For amphibian species, factors such as moisture content, forest-floor microhabitat, and forest canopy are all components that influence the survival of these individuals. As the canopy layer is lost in forest habitats this causes the reduction in a buffer layer which traps the evapotranspired moisture that maintains the humidity within the forest

(Welsh and Droege 2001). Also, as the amount of trees in the forest decreases, it limits the microhabitats available for these species such as rocky substrates, downed wood and leaf litter (Welsh and Droege 2001). Habitat destruction and alteration have a major impact on amphibian species since these practices often involve the draining or filling of wetlands which serve as prime habitat for many amphibians. With any alteration to a habitat that is near a wetland the hydrodynamics of that area will be altered and ultimately impact the life cycle of the species (Semlitsch 2003).

Birds are a good species to monitor to determine environmental disturbances because of their wide range of habitats that birds occupy for nesting and foraging. Also, birds have a large impact in the food chain because of their various diets and foraging techniques, this allows them to be reliable indicators of changes in the ecosystem (Hausner et al 2003). The effectiveness of an indicator increases if the species is endemic, or range-restricted. If endemic species are present in a particular habitat, then the habitat will support more common bird species that may not be as sensitive to environmental changes. Widespread, common birds are poor indicators of environmental health due to their ability to survive and reproduce in an abundance of habitats and conditions (Larsen et al. 2007). The objective of this study was to determine if three non-tidal wetlands were restored to their previous conditions after disturbances by implementation of Best Management Practices. The use of plant, amphibian and bird compositions at each of the sites has revealed information about the degree of disturbance and the restoration that has been employed.

Goals of Current Work

Best management practices (BMPs) are regulations that are voluntary when doing construction or any form of alteration to a non-tidal wetland site. These

practices should be employed to protect the integrity of the wetland and the species in these habitats. This project sought to determine if wetlands subjected to activities that are believed to be temporary in nature, were in fact restored to their previous conditions by implementation of Best Management Practices. This study employed multiple biotic surveying techniques such as vegetation surveys, bird point counts and amphibian surveys, to evaluate if there had been sufficient restoration to return the sites to original conditions.

Chapter 2

METHODS

Study Area

The three non-tidal wetland sites were located in Garrett County, Maryland. The first site (railroad site) was approximately 1.05 ha located in Loch Lynn Heights east of the Little Youghigany River. This site was disturbed by an active railroad that ran adjacent to this wetland. The railroad site was a mineral soil flat with slope characteristics of a floodplain. It received water from seeps on the west side but it was not easily characterized. Most of the wetland was seasonally saturated except close to the railroad tracks was permanently saturated. The second site (rescue squad site) was also located in Loch Lynn Heights south of Route 135. This site is approximately 0.004 ha. The rescue squad site was disturbed by the installation of a gas line which was located adjacent to the stream that ran through the site. This site was a slope wetland on a floodplain. The dominant source of water was a series of toe-seeps on the north, east and west sides. The secondary source of water was overbank flooding and this site is permanently saturated. The third site (airport site) was located in McHenry, north of Deep Creek Lake and south of the Garrett County Airport. The disturbance at this site was the installation of a gas line and the continuous traffic of all terrain vehicles. This wetland site was a mineral soil flat but it did receive some water from seeps on the east side. The airport site was seasonally saturated and was greater than 1.61 ha. A complete delineation was unable to be conducted at the railroad site because the southern end of the wetland was on property

not accessible to us. An approximation of the size of this site would be at least 2.43 ha. Planted spruce forest is adjacent to this wetland site. All of the sites were located on the Aleghany Plateau.

Figure 1. The railroad site showing the disturbance of the active railroad and the dense vegetation present during September 2009.

Figure 2. Rescue squad site showing the gas line disturbance and the highly traveled highway adjacent to this wetland. This photo was taken in September 2009.

Figure 3. Airport site showing the disturbance caused by all terrain vehicle traffic through the wetland in September 2009.

Hydrophytic Vegetation Sampling

A circular plot with a 9.1 m radius was chosen by assessing if the representative hydrophytic plant community from each stratum were present within the plot. Dominant species were determined by using the 50/20 rule. To determine dominant species, absolute percent coverage was determined for species in each stratum and then the species are ranked from most to least abundant. Percent cover was determined by areal coverage. Total coverage of all species in the stratum was then calculated. Using the ranked list of species abundance, species were selected

until the cumulative coverage exceeded 50 percent of the total absolute coverage for the stratum. Any species that was at least 20 percent of the total absolute percent cover in the stratum was also included in the dominant subset (Environmental Laboratory 23).

Amphibian Sampling

Twenty, 30.5cm x 30.5cm x 5.1cm untreated pine cover boards, each marked with a number for identification, were placed at each site. Boards were place 10m apart in a grid formation. Each month the boards were lifted and scanned for amphibians. If any individuals were present, they were captured and identified. The boards were then returned to the original position and to protect the individuals, amphibians were placed adjacent to the boards.

Figure 4. A photo showing the amphibian cover boards marked with a number for identification that were used over the course of the study to survey for amphibian species at each site.

Bird Point Counts

A survey of the bird species present at each site was conducted on June 9, 24, and July 15 of 2009. The survey on June 24, 2009 was unable to be conducted at the rescue squad site due to road work directly adjacent to the site. The surveys were conducted every two weeks during breeding season. Four counts were done at each site during each visit. Surveys were conducted at the corners of the amphibian cover board transects. A five minute point count was conducted with a one minute acclimation period prior to the start of the count for birds to become accustomed to human presence. Species and abundance were recorded for any birds seen or heard within a 50-meter radius. I recorded flyovers separately because there was no evidence that they were using the habitat for breeding. Surveys were completed at sunrise (approximately 0545) and concluded within 5 hours after the start of the counts. Bird counts were not conducted during heavy rain, fog or high winds.

Chapter 3

RESULTS

Plant Community Composition

Surveys of each of the sites were conducted in August 2009. Only three species was found to be introduced to the area and three species were found to be invasive in Maryland. Reed canarygrass was found at each site in the disturbed area and the undisturbed area of the rescue squad site and the airport site. The plant communities at each site were very different and there was limited overlap in species that occurred at each of the three sites. Also, there was little overlap in the species that were found in the disturbed and undisturbed area at each of the sites. Three of the species observed at the sites were non-native to the area. Norway spruce is non-native species that was planted at the airport site.

Table 1. Classification of vegetation species present at field sites in August 2009. Used to determine the impact of invasive species on disturbed and undisturbed regions of the study sites (USDA NRCS 2010).

Common Name	Species Name	Native	Invasive	Railroad Site		Rescue Squad Site		Airport Site	
				Disturbed	Undisturbed	Disturbed	Undisturbed	Disturbed	Undisturbed
Reed canarygrass	*Phalaris arundinacea*	No	Yes	Yes		Yes	Yes	Yes	Yes
Broadleaf cattail	*Typha latifolia*	Yes	Yes	Yes					
Upright sedge	*Carex stricta*	Yes	No	Yes		Yes			
Woolgrass	*Scirpus cyperinus*	Yes	No	Yes					
Rice cutgrass	*Leersia oryzoides*	Yes	No	Yes			Yes		
Threeleaf goldthread	*Coptis trifolia*	Yes	No	Yes					
Southern arrowwood	*Virburnum recognitum*	Yes	No		Yes		Yes		
Flat-top goldentop	*Euthamia graminifolia*	Yes	No		Yes	Yes			
Wrinkleleaf goldenrod	*Solidago rugosa*	Yes	No		Yes				
Common velvetgrass	*Holcus lanatus*	No	Yes		Yes				

Common Name	Species Name	Native	Invasive	Railroad Site		Rescue Squad Site		Airport Site	
				Disturbed	Undisturbed	Disturbed	Undisturbed	Disturbed	Undisturbed
Sensitive fern	*Onoclea sensibilis*	Yes	No			Yes			
Northern red oak	*Quercus rubra*	Yes	No				Yes		
Black cherry	*Prunus serotina*	Yes	No				Yes		
Oblongfruit serviceberry	*Amelanchier bartramiana*	Yes	No				Yes		
Red maple	*Acer rubrum*	Yes	No				Yes		Yes
Annual fleabane	*Erigeron annuus*	Yes	No				Yes		
Common millet	*Echinoclea walteri*							Yes	
Common rush	*Juncus effuses*	Yes	No					Yes	
Bristly dewberry	*Rubus hispidus*	Yes	No						Yes
Eastern white pine	*Pinus strobus*	Yes	No						Yes
Norway spruce	*Picea abies*	No	No						Yes
Hawthorn	*Crataegus sp.*	Yes							Yes
Common ladyfern	*Athyrium filix-femina*	Yes	No						Yes

Amphibian Species Composition

Amphibian species were found at the airport site in June, September, and October of 2009. The only species found were eastern red-backed salamanders (*Plethodon cinereus*). All of the individuals were found adjacent to the disturbed area of the site. In June, one adult individual was observed, whereas 3 were observed in September and October.

Bird Point Counts

The railroad site had the greatest richness of species followed by the airport site and then finally the rescue squad site. Species of concern are present at each site, also three species of concern breed in range of these sites and they were not observed at any of the sites. Species of concern in this area of Maryland include the black and white warbler, Carolina wren, chimney swift, Eastern towhee, indigo bunting, Northern flicker, scarlet tanager, willow flycatcher, wood thrush, and yellow-throated warbler. The rescue squad site had the lowest richness of birds that are considered of concern in the area and the railroad and airport site both had four species of concern present at the sites. Many of the species found at all three sites were common bird species.

Table 2. Bird species at each site and their abundances (Bull and Farrand 1994). (Bolded species breed in range of sites but were not present (Partners in Flight 2005)).

Species	Common Name	Railroad Site	Rescue Squad Site	Airport Site
Corvus brachyrhynchos	American Crow		3	
Carduelis tristis	American Goldfinch	14	4	1
Falco sparverius	American Kestrel	3		
Turdus migratorius	American Robin	10	1	6
Hirundo rustica	**Barn Swallow**			
Strix varia	**Barred Owl**			
Mniotilta varia	**Black and White Warbler**			
Parus atricapillus	Black-capped Chickadee	1		17
Cyanocitta cristata	Blue Jay		1	10
Polioptila caerulea	Blue-gray Gnatcatcher	1	1	
Thryothorus ludovicianus	**Carolina Wren**			
Bombycilla cedrorum	Cedar Waxwing	1		
Spizella passerine	Chipping Sparrow	1		
Chaetura pelagica	Chimney Swift	1		
Quiscalus quiscula	Common Grackle	8		
Geothlypis trichas	Common Yellowthroat	13	5	5
Junco hyemalis	**Dark-eyed Junco**			
Pipilo erythrophthalmus	Eastern Towhee	2	4	6
Sturnus vulgaris	European Starling	2	3	
Regulus satrapa	Golden-crowned Kinglet			1
Dumetella carolinensis	Gray Catbird	7	2	
Passer domesticus	House Sparrow	2		
Troglodytes aedon	House Wren	5		
Passerina cyanea	Indigo Bunting			1
Dendroica magnolia	Magnolia Warbler			3
Cistothorus palustris	**Marsh Wren**			
Zenaida macroura	Mourning Dove	1		
Cardinalis cardinalis	Northern Cardinal	4	1	
Colaptes auratus	Northern Flicker	1		

Species	Common Name	Railroad Site	Rescue Squad Site	Airport Site
Protonotaria citrea	**Prothonotary Warbler**			
Melanerpes carolinus	**Red-bellied Woodpecker**			
Sitta canadensis	Red-breasted Nuthatch			2
Vireo olivaceus	Red-eyed Vireo	2		
Agelaius phoeniceus	Red-winged Blackbird	3		
Piranga olivacea	Scarlet Tanager			4
	Solitary Vireo	1		2
Melospiza melodia	Song Sparrow	14	10	
Melospiza georgiana	Swamp Sparrow	19		1
Tachycineta bicolor	Tree Swallow			
Baeolophus bicolor	Tufted Titmouse		2	1
Vireo gilvus	**Warbling Vireo**			
Sitta carolinensis	**White-breasted Nuthatch**			
Vireo griseus	**White-eyed Vireo**			
Empidonax traillii	Willow Flycatcher	1		
Hylocichla mustelina	Wood Thrush			3
Dendroica coronate	**Yellow-rumped Warbler**			
Dendroica dominica	**Yellow-throated Warbler**			
Dendroica petechia	Yellow Warbler			1

Chapter 4

DISCUSSION

At the railroad site the presence of a non-native invasive species, reed canarygrass, in a disturbed region of the site demonstrates the idea that the railroad and the subsequent disturbances caused by the alteration have allowed the site to be more susceptible to the invasion of these plant species. As the disturbance to the site caused an increase in nutrient availability there then was an increased chance that other plant species including invasive species would begin using these resources (Moser et al. 2009). Although there was the presence of invasive species at this site, the spread of these species such as reed canarygrass and common velvetgrass from the disturbed area to the undisturbed area is not evident. The lack of colonization of these species in the undisturbed area may demonstrate that this site may have been returned to a relatively undisturbed state before the spread of these plants could occur. Compared to the other sites studied, more invasive species were present in both the disturbed and undisturbed area but it lacked overlap, demonstrating the potential restoration. As with all three sites, no documentation of what plants were present in the area prior to the disturbance was available therefore, there is no way to accurately determine if these plants were introduced to the area because of the disturbance or if they were present before disturbance. The abundance and richness of the bird species at the railroad site was the greatest compared to the other sites. There were many

birds that are not classified as wetland or marsh species and this may have been due to the sites being within close vicinity of both a forested area and an open field. The density of birds in the area demonstrates that this is good nesting and feeding habitat for a large variety of species. Many of the species identified are common species which indicates that this habitat is still disturbed and therefore does not support less common birds that are more vulnerable to alterations to the habitat (Larsen 2007). Species of birds that should have been present at the field sites but were not observed include Barn Swallow (*Hirundo rustica*), Barred Owl (*Strix varia*), Dark-eyed Junco (*Junco hyemalis*), Northern Parula (*Parula Americana*), and White-breasted Nuthatch (*Sitta carolinensis*) (Bull and Farrand 1994). There were no amphibian species found at this site. This was caused by the high density of shrubs and grasses which did not provide the correct soil moisture or microhabitat to support amphibians (Welsh and Droege 2001). Species of reptiles and amphibians that should have been found include Eastern American toad (*Anaxyrus americanus americanus*), spring peeper (*Pseudacris crucifer*), American bullfrog (*Lithobates catebeianus*), Eastern garter snake (*Thamnophis sirtalis sirtalis*) and spotted salamander (*Ambystoma maculatum*) (Constant and Collins 1998).

The rescue squad site had an abundance of the non-native invasive species reed canarygrass present in both the disturbed and undisturbed area of the site. Reed canarygrass was the only invasive species present but it was very prevalent throughout the site which may mean that the area is highly susceptible to the introduction of invasive species. Compared to the other sites, this area had fewer invasive species

than the railroad site but the abundance of the reed canarygrass at this site is greater. Few birds were present at this site during the breeding season. All birds present were at low densities and most of the birds were all common species. One of the factors that could have caused such low densities of birds at this site was the road work that was occurring directly adjacent to the forested area at this site. Compared to the other sites, this area had very few birds and had the lowest richness of species. Considering the closeness in proximity of the railroad site and the airport site, more overlap in species should have been seen but due to the inhospitable conditions for birds to breed there was only the presence of common species. Species of birds that should have been present at this site include Barn Swallow (*Hirundo rustica*), Barred Owl (*Strix varia*), Dark-eyed Junco (*Junco hyemalis*), Northern Parula (*Parula Americana*), and White-breasted Nuthatch (*Sitta carolinensis*) (Bull and Farrand 1994). Habitat assemblages are an important component to study at this site because this is a more effective method of studying the impact of anthropogenic disturbances (Canterbury et al 2000). Since birds at this site are common species and are not very diverse, focusing on quality of habitat would provide a better indication of the impact of the disturbance at this site. No amphibians were found at this site which is probably due to soil moisture and chemical runoff from the highly travel road adjacent to the wetland (Welsh and Droege 2001). Species of amphibians that should have been present at this site include Eastern red-backed salamanders (*Plethodon cinereus*), Northern dusky salamander (*Desmognathus fuscus*), Eastern American toad (*Anaxyrus*

americanus americanus), green frog (*Lithobates clamitans melanota*), and spring peeper (*Pseudacris crucifer*) (Constant and Collins 1994).

The airport site was the least impacted by invasive plant species with only the introduction of reed canarygrass in both the disturbed and undisturbed area of the wetland. This site had the fewest numbers of species that had colonized the disturbed area, which shows that it has not been completely restored to the original condition but it has not been highly impacted by invasive species. The disturbed area at this site was continuously being traveled by ATV vehicles and has yet to be restored to the condition prior to the disturbance of both the traffic and gas line installation. Since this is a planted spruce forest it is has a very different plant community compared to the other sites. The birds present at the airport site were not as diverse as the species found at the railroad site but there were species that are less common. This indicates that the spruce forest and wetland shrubs are less disturbed and provides better habitat for an abundance of bird species. The presence of amphibian species at this site prove that it is the least disturbed compared to the other sites. Although only one amphibian species was found, this demonstrates that the correct moisture and microhabitat to allow for amphibians to thrive were present. Since amphibians are so vulnerable to factors such as habitat alteration and toxins in the water they are indicators of a healthy environment (Welsh and Droege 2001). The Eastern red-back salamanders found in the area were an indication that although the disturbance has not been completely eliminated, the environment is returning to a productive, healthy habitat. Eastern red-backed salamanders are completely terrestrial amphibians and therefore do

not suffer from loss of freshwater wetlands. The airport site site was lacking species that are fully and partially aquatic due to the reduced amount of freshwater wetlands, there has been an average loss of approximately 23,700 ha per year of freshwater wetlands from 1986 to 1997 (Dodd and Smith 2003).

The original objective of this study was to determine if these wetland sites had been restored after a disturbance by the implementation of Best Management Practice. The use of biotic surveying techniques allowed me to determine the quality of restoration of these sites due to the responses of multiple groups of organisms to the change in habitat (Kremen 1992). The introduction of invasive plant species and the limited richness of bird and amphibians prove that these were disturbed ecosystems. If these wetlands are not healthy then they will not provide all of the essential functions needed to improve the environment and provide services for humans. More focus must be placed on the effects that the disturbance had on the ecosystem and the state of the wetland before the disturbance. Without this information, few comparisons can be made to determine the health of the wetland prior to the disturbance and if the Best Management Practices are successfully restoring the ecosystems to the original condition. Having a thorough understanding of wetlands and their health will help to protect these ecosystems for future generations.

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