The Effects of Prescribed Fire on Wetland Habitats in the Eastern United States.

Wetland habitats are vital for a variety of reasons. Not only do wetlands provide habitat for many different forms of life, but also, they offer protection against floods and provide water quality maintenance (USDOI, 1984). The US Department of Forestry defines a wetland by three components or features: hydrophytic vegetation, hydric soils, and water being within several centimeters of the soil surface for a part of the year." There are several different types of wetlands which can include coastal and inland (EPA). The USDOI (1984) reported that prior to the 1960's, the value of wetlands was not fully understood, instead they were filled to make room for housing projects, industrial facilities, and a place to dump landfill items. Today wetlands are recognized for the many values and functions that they provide, including benefits to fish and terrestrial wildlife that inhabit them, improvement of environmental quality (water filtration and storage), and socioeconomic benefits to humans (US DOI, 1984).

The wetland habitat allows for a large multitude of species of many different types of organisms that inhabit them. For example, a wetland habitat allows amphibians to complete their life cycles on land and in water and waterfowl use wetlands during migration periods. One of the tools that can help a wetland maintain these functions is the use of prescribed burning. As with any type of habitat, prescribed burning can be beneficial for aiding that environment in improving growth and restoring nutrients.

The USDA Forest Service (1984) reported that prescribed burning is a tool used to manage the land by reducing the buildup of hazardous fuels, minimizing spread of pests and insects, and promoting the growth of trees, wildflowers, and other plants. The US Forest Service (1984) reported that after the decades of fire exclusion it led to habitats that were not suitable for

continued growth. Trees become overcrowded, leaf litter builds up increasing flammability and plant species that rely on fire can no longer survive. Fire-dependent species in wetland environments rely on fire for a portion of their life stages.

Goals of prescribed burning, historically, have, included promoting growth of fire tolerant species and reducing the buildup of flammable materials, fuel load, to prevent large wildfires. Prescribed fires are different from wildfires in that they are controlled, severity is minimized and planned with specific goals set.

Wetlands differ in how burns are carried out, but the premise remains the same. Burning wetlands allows native grasses to be maintained and to improve the growth of those grasses as well as controlling invasive species. Prescribed fire in wetland habitats also removes dead organic layers that contribute to the fuel load.

Another benefit of wetland prescribed burning is the remobilization of nutrients; the leaching of nutrients in the soil or to the air. Venne and Frederick (2013) reported that fire in wetlands has been shown to remobilize nutrients, alter plant cover, structure and composition, promote new vegetative growth with enhanced nutritional content and can influence aquatic bird use of the wetland landscape.

Battle and Golladay (2003) reported that fires were historically caused naturally by lightning strikes and by Native Americans who also used them as a management tool during the spring and summer months. In present day, prescribed fires in wetlands are done on a seasonal rotation that best fits the need of the wetland.

In the southeastern United States, Battle and Gollday (2003) reported that fire is critical to the continued growth of the long leaf pine wire grass (*Pinus palustris).* The long leaf pine-wiregrass species burns on a time span of about every, one to three years. Battle and Golladay

(2003) reported that long leaf pine wire grass relies on fire for the management of the species. Fire helps the species release important nutrients. Martin (2009) reported that bi-yearly burns of long leaf pine wire grass allows light to penetrate the understory and lends toward the continued growth of several diverse plant species. The study completed by Battle and Golladay (2003) showed that prescribed burns do have an impact on the water quality of the wetlands in southwestern Georgia. The most likely cause for this was due to the soil being burned which lead to runoff during rain events which caused changes in the water chemistry of the wetland. Prescribed burns in wetlands alter water chemistry as well as the soil content.

Another impact of prescribed burns is the releasing of nutrients into the water. Battle and Golladay (2003) reported that when a fire occurs in a wetland ecosystem the nutrients that are released have a shorter distance to reach the water. Another aspect of their study looked at rainfall amounts and the impact it had on nutrients in the water. It was found that after a significant rainfall event the levels of sediment were higher in the water of the wetland. High levels of sediment in any body of water, along with wetlands can cause detrimental effects to that habitat. Sediment fills in the stream reducing important sources of oxygen for the organisms that inhabit the wetland or stream. The loss of microorganisms in a stream or wetland will impact other organisms in the food chain because a major link has been disrupted in the food chain. Bishop and Haas (2005) reported that, "increases in sediment can also adversely affect water quality. Bedload sediments can fill spaces between gravel and rocks where fish and other aquatic biota lay eggs and forage for nutrients."

In wetlands smoldering after a prescribed burn is a common occurrence. Watts and Schmidt (2015) reported that smoldering in wetland habitats can occur for days or even months

after a prescribed burn to the accumulation of organic soils in the wetland. Organic soils come from decades of buildup from decayed plant matter. This buildup of organic matter is perfect fuel for a fire. A particular type of organic soil known as peat continues to smolder in a wetland post burn. Smoldering is of concern in wetlands due to the ability of combustion to other fuels in the wetland potentially causing another unexpected fire. This could lead to issues due to the unplanned nature of the fire such as reduced visibility from smoke and negatively impacting plant species which are adapted to resist certain levels of fire and heat. Watts and Schmidt (2015) reported that smoldering fires also burn layers of soil in wetlands that can affect the morphology of the wetland. The smoldering of excess soil layers in wetlands has impacts for the future of the wetland.

Wetlands have slow decomposition rates; Lugo (1995) reported that large number of organic materials builds up in wetlands over decades. Prescribed burning helps the wetland ecosystem rid the habitat of these organic materials and reduces the amount of combustible fuels in the wetland habitat. Wetlands are habitats that are highly adaptable to stress. Lugo (1995) stated that wetlands are habitats that can appropriately deal with stress and it is seen through characteristics such as reduced number of plant species diversity and the prevalence of variety in age of plant species.

Prescribed burning is a stressor introduced on the wetland environment but has been shown to have few negative impacts on the ecosystem as a whole.

Organisms and native grasses that are found in wetlands respond positively to prescribed burning and are not put under any stress when burned. Prescribed burning in wetland habitats also helps to reduce invasive species.

In Virginia, a number of wetland-dependent herbs and grasses are also dependent on fire. Cat tails (*Typha latifolia*), rice cutgrass (*Leersia oryzoides*), and fowl manna grass (*Glyceria striata*) benefit from prescribed burning. These burns also help remove invasive species such as reed canary grass (*Phalaris arundinacea)*, rough stalk bluegrass (*Poa trivialis*) and joint head arthraxon (*Digitaria hispida)*. These are just a few examples of plant species that can be found in freshwater wetlands in northern Virginia. (Manner, 2008) In wetland habitats, hydrophytic vegetation allows plants to survive in heavily saturated soils. "For example, some plants such as Spartina, have hollow tissues that allow them to transport oxygen down to their roots." (Brady and Weil, 2002)

Soils in wetlands, by definition are exposed to periods of saturation. This prevents oxygen from penetrating down into the soil causing soil that has reduced oxygen or no (anoxic) oxygen (Brady and Weil 2002). Battle and Golladay (2003) studied "results indicated that burned soil had elevated pH, alkalinity, DOC, NH4-N and soluble reactive phosphorus compared to unburned soil…. Overall our results suggest that the linkage of fire and water quality of wetlands is through fire's effects on soils rather than vegetation (Battle and Golladay, 2003). Prescribed fire in wetlands can change the composition of plant material and can release important nutrients. Prescribed fire adjacent to wetlands can also impact wetlands through the drainage of water into the wetlands thereby indirectly impacting the wetland ecosystem (Battle and Golladay, 2003).

The wetland fauna is diverse, and taxonomic groups respond differently to fire. A variety of birds, fish, reptiles, mammals, and amphibians rely on a wetland for survival. The wetland provides many aspects that make it a desirable place for many forms of life to live. De-Szalay and Resh (1997) reported that aquatic invertebrates respond positively to a prescribed burn, often post-burn invertebrates increase in weight due to increased food availability and a change in the

climate of the wetland. In coastal wetlands fish and shellfish are crucial to wetlands. In freshwater wetlands some species of fish are wetland dependent meaning the fish spends their entire lifecycle in the wetland. (USDOI, 1984) Waterfowl and other bird species depend on the wetland as a stopping point during migration and are used as breeding and wintering grounds for a number of these species. Waterfowl use wetlands for nesting and as protection from predators. Block and Conner (2016) reported that when a prescribed burn occurs waterfowl are attracted due to the vegetation that had been reduced. After a prescribed burn water fowl also gain easier access to seeds and other nutrients.

The US DOI (1984) reported that wetlands also provide habitat for other wildlife such as American alligators (*Alligator mississippiensis*), frogs, and American beavers (*Castor canadensis*). In both coastal and freshwater wetlands, "fur bearing" animals such as beavers (*Castor canadensis*), otters (*Lutra Canadensis*) and mink (*Neovison vison*) can be found.

Another important species to wetlands is snakes. The (USDOI, 1984) reported that species of water snakes are found to be the most abundant in wetlands but other species such as cottonmouth (*Agkistrodon piscivorus*), and garter snakes (*Thamnophis*) can be found in some wetlands. The above listed species are valuable to the life cycle of wetlands. Without these species the wetland habitat would not be viable for other species.

Amphibians make up the greatest type of species that are found in a wetland. Salamanders and frogs are the two main amphibians that can be found in freshwater wetlands. Like all animals these amphibians have a response to prescribed fire that occurs in wetlands. Russell and Van Lear (2017) reported that amphibians have a different response to fire due to the permeability of their skin. Amphibians are more vulnerable to fires in wetlands due to "their moist and permeable skin and eggs of amphibians increase their vulnerability to heat and

microhabitat drying." Most vertebrates respond to fire by running away from the fire or by burying under the soil. Most amphibians do not have this advantage but have developed adaptations to responding to fire.

Russell and Van Lear (2017) reported that frogs have been observed in plumes of smoke directly after a fire. Western Fence Lizards, (*Sceloporus occidentalis*) was also observed "selectively using burned and charred branches for perching." In the same study, box turtles (Terrapene *carolina*) and eastern mud turtles (*Kinosternon subrubrum*) adapted to fire by burrowing into the soil.

Amphibians that can move such as lizards and snakes were observed leaving areas that were burning. Of the data available on herpetofauna response to prescribed burning, Russell and Van Lear (2017) reported that the Eastern Glass Lizard (*Ophisaurus ventralis)* suffered the highest mortality rate as a result of fire in a wetland. Means and Campbell (1981) recorded 15 dead eastern glass lizards and 4 live eastern glass lizards directly after a prescribed burn. There was little explanation as to why the lizards did not escape the prescribed fire other than the possibility of fire intensity and the season in which the wetland was burned. A high intensity fire could lend to the possibility that the eastern glass lizard was unable to escape the burn.

Bishop and Haas (2005) studied flatwoods salamanders that are found in ephemeral wetlands and noticed a decline in species. These salamanders inhabit wetlands of the Southern United States. Bishop and Haas (2005) predicted that forest management activities as well as the "degradation and loss of habitat from development, agriculture and silviculture, modification of breeding, and fire suppression" led to the decline of this species (Bishop, Haas 2005). The results of the study discussed that, "no long-term monitoring datasets exist and capturing individuals is

difficult" for understanding how prescribed fire impacts the federally threatened Flatwoods Salamanders.

Another impact that prescribed fires have on Flatwood Salamanders in wetlands is that of the firebreak impacting adult salamanders' eggs. These salamanders deposit their eggs on land. The area created by the fire break becomes suitable area for eggs to be laid. Larval amphibians may also face complications due to being trapped in one of these depressions and being unable to complete their life cycle. Bishop and Haas (2005) reported that in a wetland if fires only burn on the outer edge benefits for larval salamanders will be seen such as increased growth in the understory, increased water temperature from the fire and increased levels of dissolved oxygen due to the breakdown of plant materials.

Wetlands which are burned on a consistent interval are suitable for reproduction of Flatwood salamanders. Gorman and Haas (2013) reported that prescribed burning also reduces canopy cover over wetlands, which allows for photosynthesis to take place leading to increased development of flatwood salamander larvae. Reproductive success for these salamanders all depends on the season and rainfall amounts for that season. Large amounts of rainfall fill in the depressions and fire plow lines that salamanders use to lay eggs.

Fire is an important management tool for growth and species reduction in many ecosystems. Fire has historically been a tool used by Native Americans to control land and direct game in order to be hunted. Wetland habitats are burned for a variety of reasons including reducing or removing invasive plant species, promoting growth of native grasses and herbs and reducing organic fuel material buildup. Periodic prescribed burns in wetlands reduces future fire intensity by burning away highly flammable organic material.

Plant and animal species respond to fire in a variety of ways. Most native grasses rely on fire to control growth. Amphibians and reptiles have developed ways to respond to the fire through adaptations or by escaping the burn. Several turtle species burrow under the soil to escape the fire. Waterfowl reap the benefits of a prescribed burn by using the exposed cover for breeding grounds and for foraging. A study of salamanders was analyzed and found that the prescribed fire had little to no negative implications for mature salamanders but could potentially have an impact on larval stage salamanders.

Prescribed fire was thought to have an impact on water chemistry in wetlands due to runoff and the leaching of nutrients out of the soil after a burn. In Southwestern Georgia a study was carried out to better understand the relationship between long leaf pine wire grass and how a prescribed burn is crucial for its continued growth. The study analyzed water chemistry impacts from the burn and found negative impacts on water chemistry from the burn.

Unlike prescribed burns in most other habitats, the water is very close to the burn site in a wetland. Possible water contamination is imminent; therefore, it is important to understand the effects of different chemicals being leached out of the soil. Nitrogen and phosphorus were among the highest chemical compounds found in the soil at wetlands. The smoldering of soil in a wetland is of high concern due to its ability to smolder for days or months after a burn. This could cause combustion of neighboring grasses which could lead another unplanned fire. This could cause complications with smoke and visibility in neighboring areas. Wetlands smolder due to the organic peat layer that builds up over decades. This layer of decayed grasses and plant matter is highly flammable. It is important to do a prescribed burn on a wetland habitat frequently so that the buildup of highly flammable fuels does not lead to a highly intense fire as

the result of lightning strike. It is important to take steps ahead of time to reduce negative fire complications in the future.

Another negative impact from prescribed burning in wetlands is sediment buildup in the water from erosion and runoff. This buildup of sediment greatly reduces oxygen in the stream and can lead to a loss of microorganisms. The loss of microorganisms will have negative implications up the food chain.

Wetlands are a highly diverse habitat that are home to a variety of life forms. Prescribed burns are possible to carry out in a wetland and are carried out in a frequent rotation to promote growth and life among the wetland. While some negative aspects of burning have been discussed, overall prescribed burns are crucial to the continued functioning of a wetland. Without a prescribed burn decayed plant material will continue to build up and would lead to a very high intense fire. A high intensity fire would have more negative implications on the wetland habitat then a prescribed burn.

References:

Battle J., Golladay S., (2003). Prescribed Fire's Impact on Water Quality of Depressional Wetlands in Southwestern Georgia. *The American Midland Naturalist*, 150(1), 15-25.

Bishop D., Haas C. (2005). Burning Trends and Potential Negative Effects of Suppressing Wetland Fires on Flatwoods Salamanders. *Natural Areas*, 25(3), 290-294.

Conner L., Block W. Effects of Prescribed Fire on Wildlife and Wildlife Habitat in Selected Ecosystems of North America. Available from: https://www.fs.fed.us/rm/pubs_journals/2016/rmrs_2016_block_w001.pdf

Manner M., Bingol G., Wolinski J. (2008). Common Wetland Plants of Northern Virginia's Piedmont A Field Guide. *The Piedmont Environmental Council*

McKee K. Grace J. Effects of Prescribed Burning on Marsh-Elevation Change and the Risk of Wetland Loss. Available from: https://pubs.usgs.gov/of/2012/1031/OFR12-1031.pdf

National Wetlands Inventory (1984) Wetlands of the United States: Current Status and Recent Reports

Prescribed Fire. (n.d.). Retrieved from https://www.fs.usda.gov/managing-land/prescribed-fire

Russell K., Van Lear D., Guynn D., (1999). Prescribed Fire Effects on Herpetofauna: Review and Management Implications. *Wildlife Society Bulletin*, 27(2), 374-384.

Watts A., Schmidt C., McLaughlin D., and Kaplan D. (2015) Hydrologic Implications of Smoldering Fires in Wetland Landscapes. *Freshwater Science*, 34(4): 1394-1405.

What is a Wetland? (2018, June 12). Retrieved from https://www.epa.gov/wetlands/what-wetland

White, J.R., Gardner L. (2008). The Short-Term Effects of Prescribed Burning on Biomass Removal and the Release of Nitrogen and Phosphorus in a Treatment Wetland. *Journal of Environmental Quality*, 37, 2386-2391.

Venne L., Trexler J., Frederick P. (2016). Prescribed burn creates pulsed effects on a wetland aquatic community. *Hydrobiologia*, 771(1), 281-295.