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Diversity in Vegetation, Macroinvertebrates, Soil Type, and Hydrology can Explain Success of Restoration Efforts of Wetlands in the Ninepipe Area on the Flathead Indian Reservation

Introduction

Wetland Restoration is returning degraded wetlands to naturally functioning condition. Wetland restoration is important because healthy wetland ensures healthy watersheds. Thus the quality of our water would continually be threatened and part of the natural heritage comes from wetlands, without restoration all would be lost. Over the past 200 years the nation's wetlands have vanished at an alarming rate. More than half of the nation's wetlands have been overcome by agriculture and development. (Kentula, 1999)

Ninepipe National Wildlife Refuge was establishes in 1921 as a breeding ground for native birds. The size of the area includes 2,062 acres of lands and wetlands devoted to wild life.

Wetland come equipped with water, hydric soils, and hydrophytes (aquatic plants). There are several types of wetlands, including marsh, bogs, and swamp. Wetlands or estuaries act as nurseries for invertebrates, birds, plants, and many other organisms. Wetlands are also important in bird migrations. For example the Cheyenne Bottoms in Kansas, is 41,000 acres wetland is said to be the largest wetland in the interior United States. Kansas claims that 45 percent of shorebirds in the United States stop at the marsh. At least 320 species of birds have been recorded there, including numerous Whooping Cranes *Grus americana* and thousands of Sandhill Cranes *Grus canadensis*. (Harvey, 1930) Wetland restoration is important because wetlands are being filled for farming, and or highway building, Oil rigging and various other industrial uses.

Vegetation in wetland is easily adapted to change. Wetlands are known to change throughout the year. These changes are brought about through changes in climate and or seasons. Wetland plants are beneficial because they soak up water that would otherwise cause lakes and rivers to flood. The plants slow the flow of water in the vernal ponds. Plants also decrease bank erosion. Lastly, plants filter excess nutrients, sediments and pollutants out of the water. Main vegetation that will be found is Cat tail *Typha latifolia* and Bulrush *Cyperaceae*. Other organisms that aid in explaining the health and stability of wetlands are aquatic macroinvertebrates. Macroinvertebrates are simply understood as, small organisms that do not have a backbone. Some common macroinvertebrates found in wetlands are: dragonfly nymph, worms, snails, beetles, leeches, mayflies, caddisflies, and small crustaceans. Macroinvertebrates are useful indicators of the health or condition of wetlands and other water bodies. They respond to many kinds of pollution, including chemical pollution and physical disturbance to the landscape around the site, wetland structure, and hydrology. (Helgen, 2002) The macroinvertebrates sampled for this projected will be from vegetation (emerged), Macroinvertebrates submerged in soil, and lastly benthic macroinvertebrates.

Soil properties and type is an important aspect when restoring a wetland. Soil type will explain the types of vegetation that will occur in the wetlands. A soil survey should be done to determine levels of nutrients in the soil. Depending on what the land was used for there will be different amounts of nutrients available in the soil. Hydrology of the wetlands is important for organisms such as birds and macroinvertebrates. If the wetland is highly turbid the abundance of invertebrate species would be low. The same nutrients available in the soil can also be found in the water of wetlands. There are special adapted plants that have the ability to thrive in wetlands. These plants provide shelter and food for various other organisms that live in the wetlands. If hydrology parameters are not uniform there would not be a refuge these organisms.

The importance of this research project is to understanding wetland restoration and how a wide diversity of vegetation, macroinvertebrates, soil type and hydrology can explain the success of the wetland restoration. The time of the wetland restoration will also be taken into account in this research project.

The objectives of this study are first, aquatic macroinvertebrates vary with wetland size, vegetation, and water depth. Second, the relative abundance of aquatic macroinvertebrates and hydrophytes will vary with wetland habitats. Wetland habitats will be distinguished by high diversity in macroinvertebrates, vegetation, soil type, and hydrology parameters lastly, examining soil nutrients between wetlands to see the use of the land prior to restoration. Was the land used for crops or cattle grazing? What is the limiting nutrient in the soil from wetland to wetland?

I hypothesize I will find a higher species diversity in macroinvertebrates in wetlands with a higher diversity in vegetation. Second hypothesis is that the abundance of macroinvertebrates and vegetation will vary with water quality and depth in wetlands sampled. Third hypothesis is the soil types will not change among sites because of agricultural usage of the lands prior to restoration. My null hypothesis is that there will be no change in diversity or abundance of macroinvertebrates depending on water quality, depth, and vegetation. Second null hypothesis is there will be no change in diversity or abundance of macroinvertebrate and vegetation depending upon soil types.

Materials and Methods

This research was done in the Ninepipe wetland area on the Flathead Indian Reservation in Montana. The wetlands sampled for this study included Herak, Sandmarks, Fish Hatchery rd, Crow, Johnson 80, and Duck Haven. Each individual wetland was sampled on the north, south, east, and west sides of the wetland. The site will include a 5meter transect going from the bank into the water. At each transects the depth of the water will be measure beginning at (4ft), (8ft), (12ft) and end (16ft). At every 4ft along the transect vegetation will be observed. Vegetation observation is done by observing plants from 1 meter out on both the right and left sides of transects. During that same time I will also take in account the aquatic insects. Using YSI I will measure water quality parameters in the center of the transect (8ft). Parameters include pH, conductivity, dissolved oxygen and water temperature. Next, a core samples will be taken from under the water to collect soil invertebrates. The core samples will be taken from the beginning and middle of the transect using a homemade corer made out of PVC piping. The core will be place in the bottom of the wetland down 10cm. Next collection of macroinvertebrates will be done by using a d-net up and down transects to gather more macroinvertebrates for this study. Last collection I will make is taking a soil sample from 1meter away from where transects begins. Materials needed for this research project include YSI, D-net, corer, soil sampler, GPS, containers, meter stick, measuring tape, squeeze water bottle, sifting trays, and waders.

Results

A linear regression was done comparing vegetation richness and macroinvertebrates richness from the six wetlands that were sampled. An alpha value of 0.1 was chosen. The statistical test showed a p-value 0.375482858 and F-ratio of 0.9926578561. (Figure 1) Another linear regression was done comparing vegetation richness and water quality. The water quality parameters included pH, dissolved oxygen, temperature, and conductivity. An alpha value of 0.1 was chosen. P-value for this test was P-value 0.3804453729 and an F-ratio 1.7731219220. (Figure 2) Followed by another linear regression was done comparing the relationship of macroinvertebrates and water quality parameters. An alpha value of 0.1 was chosen. The p-value for this test was P-value 0.1279738010 and an F-ratio 6.9744292951. (Figure 3) An analysis of variance was done comparing macroinvertebrate richness and concentration of nitrogen in the soil. An alpha value of 0.1 was chosen. The analysis showed a p-value of p-value 0.0446126734 and an F-ratio 8.3456790123. Lastly, a principal component analysis was done with data shown in (Table 1). After running a PCA statistical test, the data was organized in a Hierarchical cluster. The soil nutrient levels are shown in (Table 2). In (figure 4) the water depths are shown in a bar graph and are measured in inch.

Discussion

In the end there was not a connection with the richness of invertebrates and richness in vegetation. The reason behind that could be the small number of sampling sites. Since water quality and soil survey showed little variation amongst the sites it is difficult to come to the conclusion that Restoration efforts have been successful or not. There was also no relationship with water quality and abundance of invertebrates and vegetation. There was significance between the relationship of soil nitrogen and invertebrate richness. This could be explained by those wetlands had more of a complex environment. Complex meaning the environment is more suitable to sustain life. Greater percentage of nitrogen in the soil offers excess nitrogen to the vegetation which in return feeds and houses the aquatic insects.

All six wetlands were different, but not different enough to conclude success of restoration in wetlands in the Ninepipes refuge area. The six wetlands that was samples included Herak, Sandsmark, Fish Hatchery rd, Crow, Johnson 80, and Duck Haven. All of the wetlands are in a protected area either manages by the Flat Head Indian Reservation, Fish and Wildlife, or the state of Montana. Herak wetlands is a shallow wetlands dominated primarily by cat tails. Sandsmark wetland was the richest wetland that was sampled in this project. Particular restoration dates was not given, therefore the concise date of restorations is unknown. If one was looking at data I gathered sandmark would be the best restored wetland. This is because it had the highest species richness in macroinvertebrates and in vegetation. Soil survey and water quality tests should little differences amongst sites. Fish Hatchery rd wetlands resembled recent cattle grazing also the wetland resembled a pond. The water became deeper sooner than all the other wetlands that were sampled. Crow wetland was shallow and primarily dominated by bulrush and invasive plants such as bull thistle. Johnson 80 wetland is a well-established wetland with and average diversity in vegetation and macroinvertebrates. Lastly, Duck Haven wetland is shallow and primarily dominated by grasses and a small percentage of cat tails.

Conclusion

All in all the wetlands sampled from the Ninepipes Refuge showed diversity amongst themselves. The differences were minute in that the changes did not show significance between the variables that were tested. Since soil samples and water quality showed little difference also, I can conclude my study cannot be provided as evidence of success in the wetland restorations in Ninepipes Refuge area in Montana.

To have a more stable explanation of restoration in the Ninepipes refuge area more wetlands are needed to be sampled.

Future Studies

In the future I would like to build on this project adding more wetlands site. In adding wetlands the realism of proving success in restoration efforts would be better supported. With the small number of wetlands I examined it was hard to come to a straight and concise conclusion on the restoration of the wetlands in the Ninepipes refuge area. Along with more sample sites I would also extend the length of transects from 5m to 10m. Extending transects will insure a higher diversity in aquatic macroinvertebrates. I would also sample macroinvertebrate by using emergent traps.

Acknowledgements

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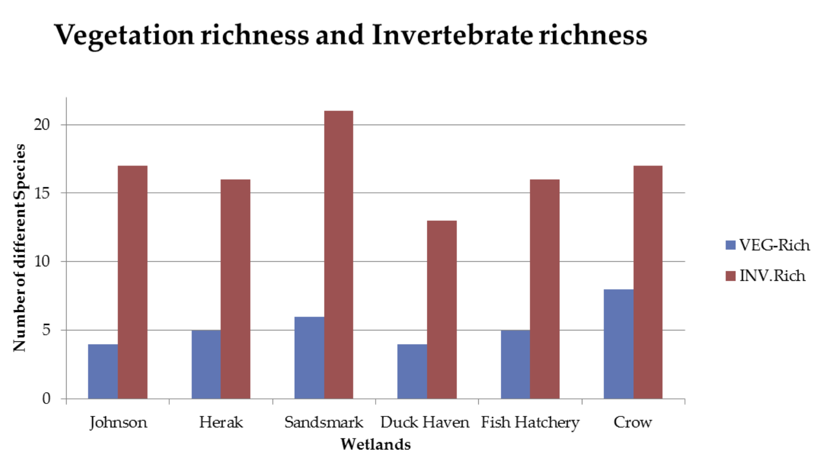

Figure 1- Linear regression done on Vegetation richness and Macroinvertebrate richness collected and observed from all six wetlands that were sampled in the Ninepipes refuges.(P-value 0.375482858 and F-ratio 0.9926578561)

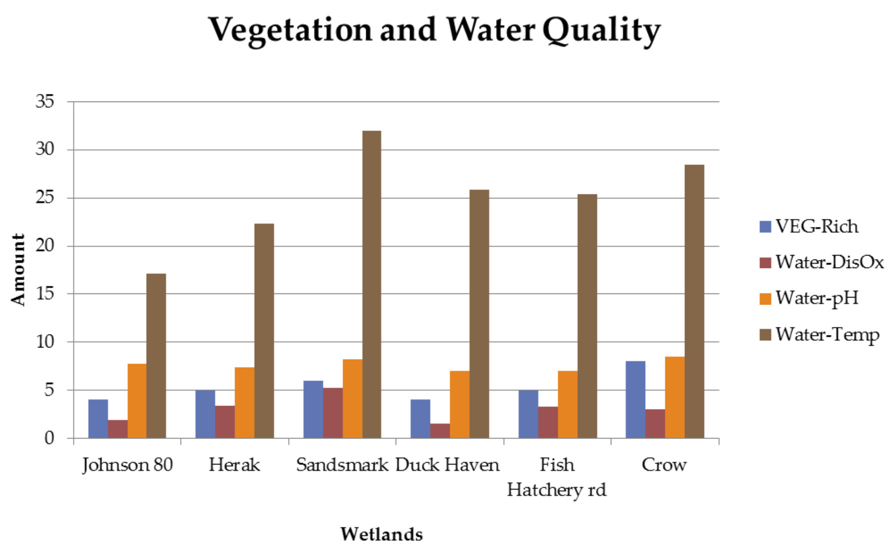

Figure 2- Linear regression showing relationship between vegetation observed and water quality tested from all six of the wetlands found in the Ninepipes refuge area. (P-value 0.3804453729 and F-ratio 1.7731219220)

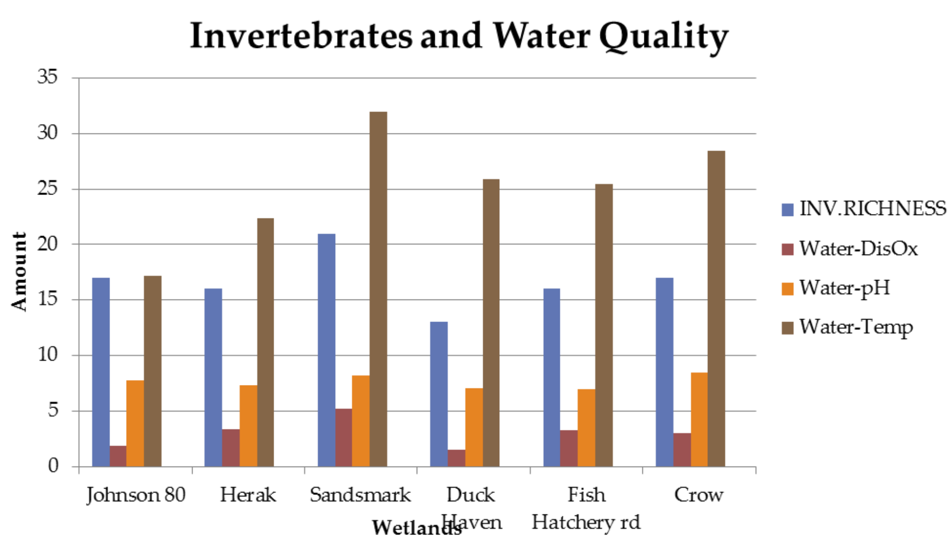

Figure 3- Linear Regression showing the relationship between water quality and macroinvertebrates in wetlands in the Ninepipes refuge. (P-value 0.1279738010 F-ratio 6.9744292951)

Table 1- Data used in the PCA analysis

Wetlands	VEG-PropCatT	VEG-PropBulr	VEG-PropGrasse	VEG-PropForbs	INV.RICHN	WD-4ft-CV	WD-8ft-CV	Water-DO	Water-pH	Water-Temp

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JOHNSON 80	0.079	0.062	0.098	0.0921	17	0.2247	0.8235	1.875	7.725	17.15
Herak	0.128	0.115	0.19	0.065	16	0.8883	0.61215	3.3825	7.3325	22.325
Sandsmark	0.176	0.09	0.075	0.1	21	0.38717	0.674	5.2075	8.205	32
Duck Haven	0.0625	0	0.257	0	13	0.35294	0.3679	1.5425	7.025	25.85
Fish Hatcher RD	0.335	0	0.339	0.025	16	0.4615	0.136	3.27	7	25.425
Crow	0.0375	0.478	0.064	0.145	17	1.2	0.2721	3.01	8.4575	28.475

Table 2- Soil nutrients that was tested on soil samples that was taken from all six wetlands sites in the Ninepipes Refuge.

Soil-nitrogen	Soil-phospho	Soil-potassium	Soil-pH
low	Medium	low	Slightly acidic
low	Medium	low	Slightly acidic
mild	mild	mild	Slightly acidic
low	Mild	mild	Neutral
low	Medium	low	Neutral
low	Mild	low	Slightly acidic

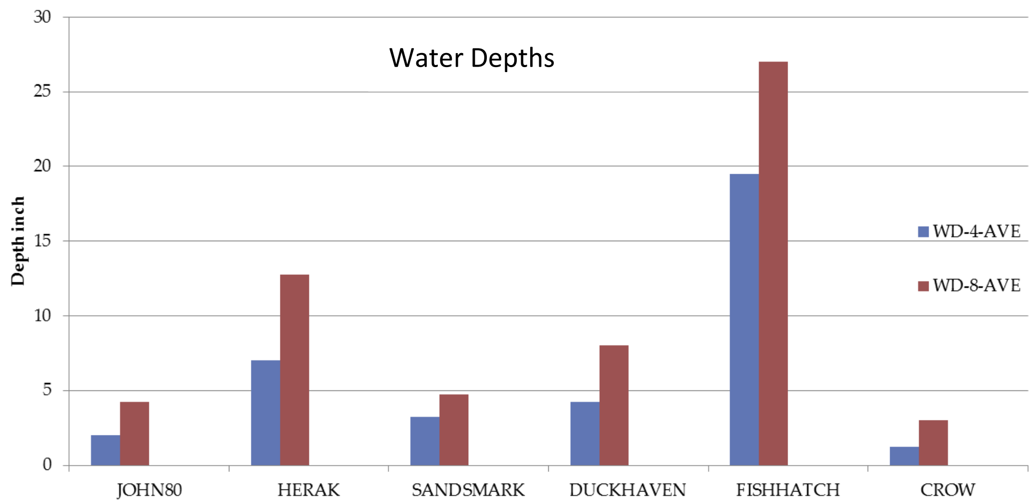

Figure 4- Water depths of each wetland sampled in the Ninepipes refuge

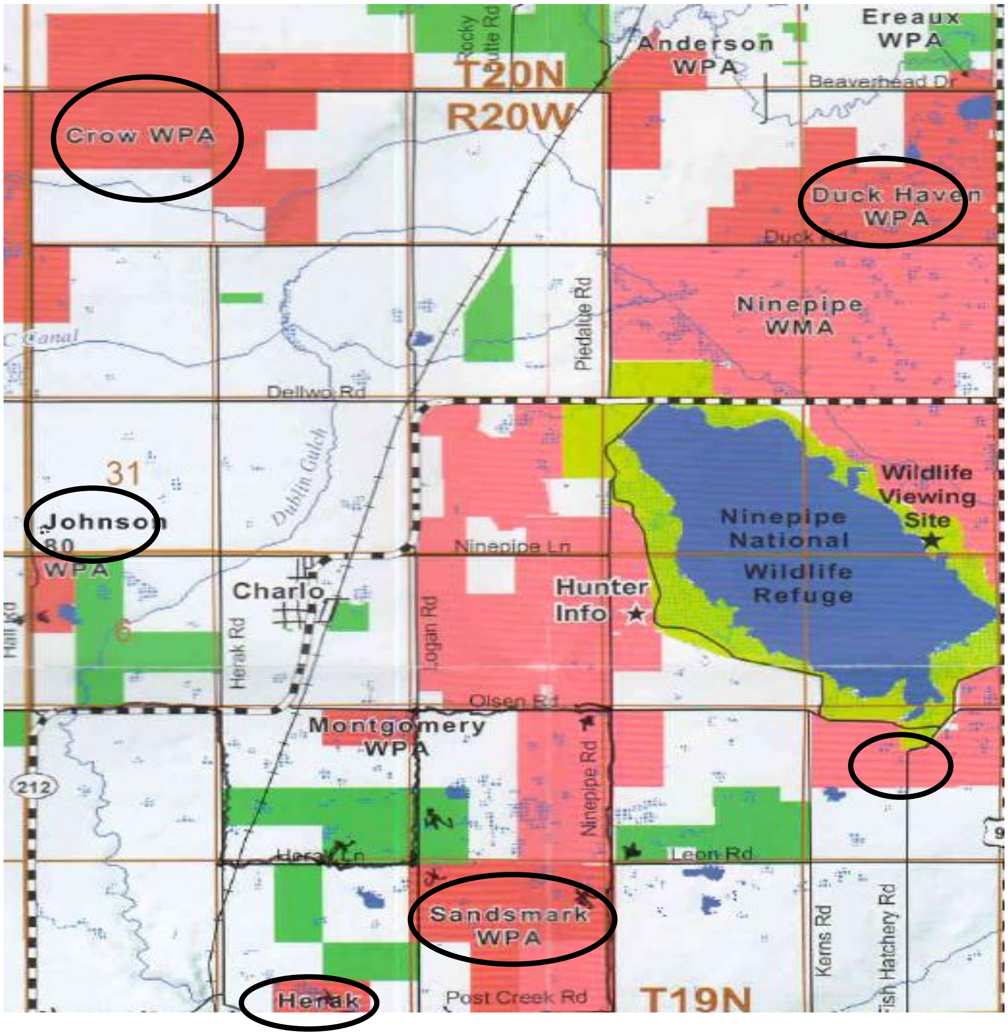

Figure 5- Map of Ninepipes region where the wetlands was sampled.