Project Title: The Effect of Dissolved Oxygen and pH on Wetland Aquatic Invertebrate Diversity
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Background: In the Okanagan Valley of BC over 85% of low elevation wetlands have been destroyed (MOE 2016). Wetlands are one of the most productive ecosystems in the world along with rainforests and coral reefs (Ciruna 2005). They perform critical roles like providing habitat for birds and amphibians, filtering pollution and supplying water in times of drought (Ciruna 2005), particularly important in the arid Okanagan. It is important to identify factors that negatively affect the health of these remaining wetlands.

The health of wetlands can be determined by measuring for aquatic invertebrate diversity (Wray 2006; Adamus 1996). Human activities that add pollution to wetlands, like pesticide use, fertilizer use and animal manure inputs, cause dissolved oxygen (D.O.) and pH levels in the water to rise or fall to abnormal levels (Wray 2006). Water with D.O. levels less than 4 ppm or saturation levels greater than 125% can only support a few, pollution tolerant invertebrate species (CIESE 2016; MOE n.d.). Similarly, very acidic or very alkaline waters are toxic to the majority of aquatic invertebrate species (Camargo et al. 2005).

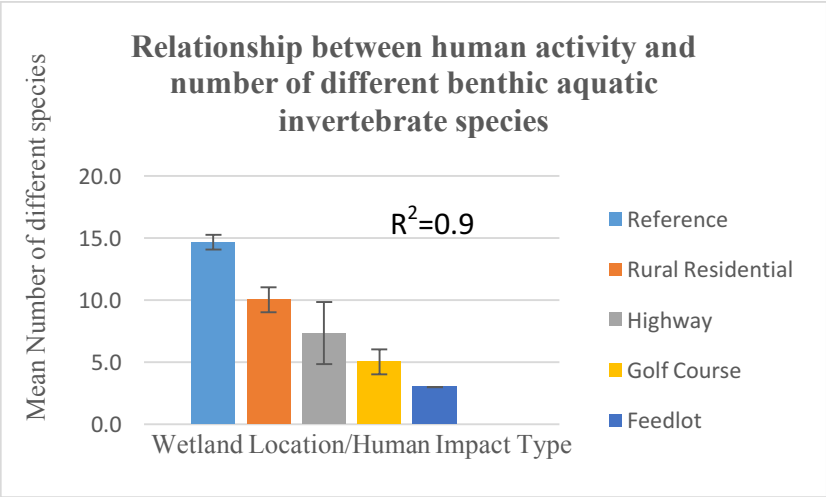
Purpose: The purpose of this experiment is to determine if wetland health, as measured by aquatic invertebrate diversity, is affected by human activities that may affect dissolved oxygen levels and pH levels in the water. The five wetlands tested in this experiment include one in a golf course, one at a feedlot where cattle have free access, one on a rural property, one adjacent to a highway and a non-impacted, reference wetland.

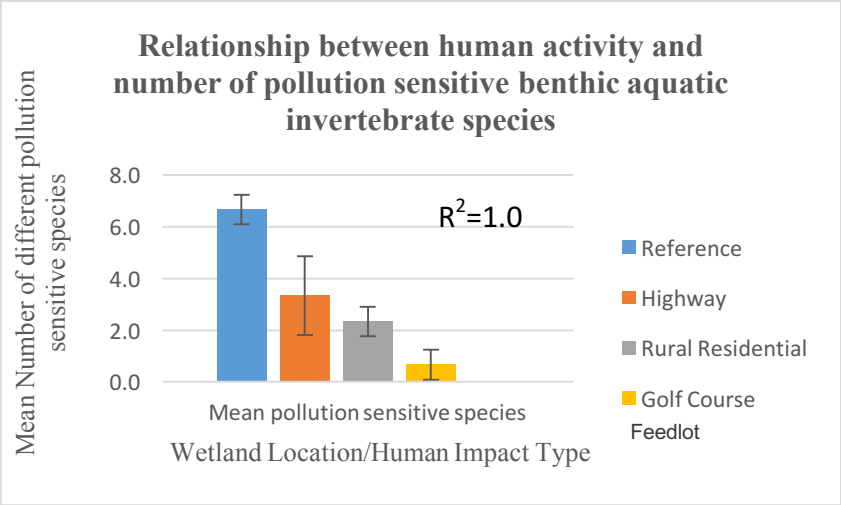
Hypothesis: If human related activity in and around a wetland causes dissolved oxygen levels and pH levels in the water to rise or fall to unusual levels then wetland health goes down as measured by decreasing aquatic invertebrate diversity ($p < 0.05$).

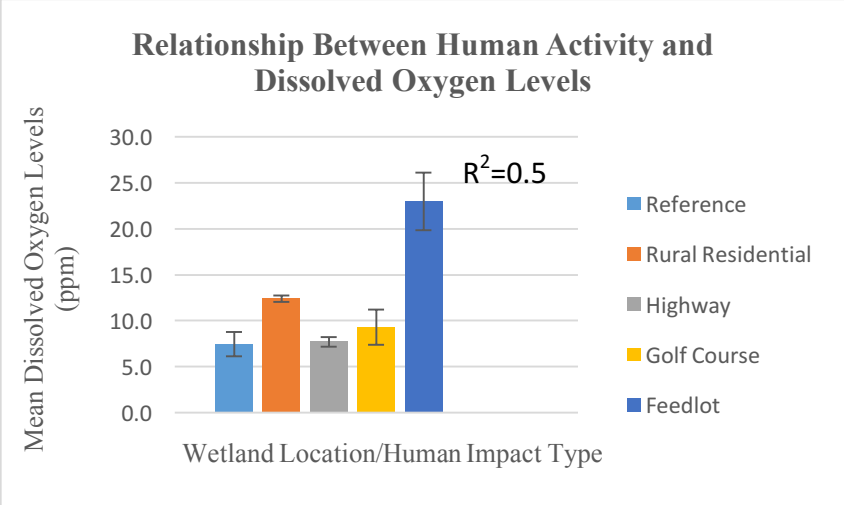
Procedure (materials and methods) at each wetland type:

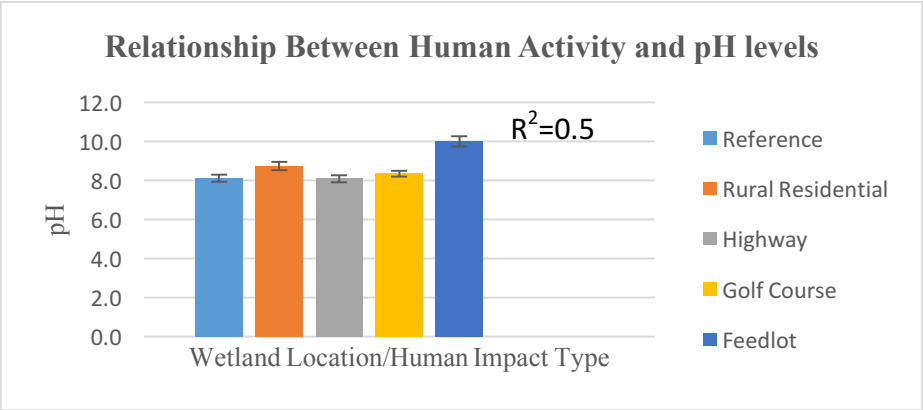
1. Sampled between 12 and 2 PM. First outside temperature was tested with a digital outdoor thermometer, then water temperature using aquatic thermometer and, finally, filled up dish tub and ice cube tray with water from the wetland to hold invertebrate specimens.
2. Chose 4 random locations around wetland with emergent vegetation for sampling.
3. Walked into the wetland between 0.5 and 1 meters and tested for dissolved oxygen levels using a dissolved oxygen meter and pH levels with a pH meter at each of the four test sites.
4. At same 4 locations used a D-net to poke into the emergent vegetation and wetland bottom to disturb benthic aquatic invertebrates using a side-to-side motion to scoop out samples and put into the tub filled with water.
5. Repeated this three times each for the four test sites for a total of 12 samples per wetland.
6. Used a pipette to remove invertebrate species from the tub and put them into different compartments in the ice cube trays to count number of different invertebrate species.
7. Procedure repeated over three sampling periods for each wetland. Sampling period 1: February 16-26, 2016. Sampling period 2: March 23-April 3, 2016. Sampling period 3: April 16-18, 2016.

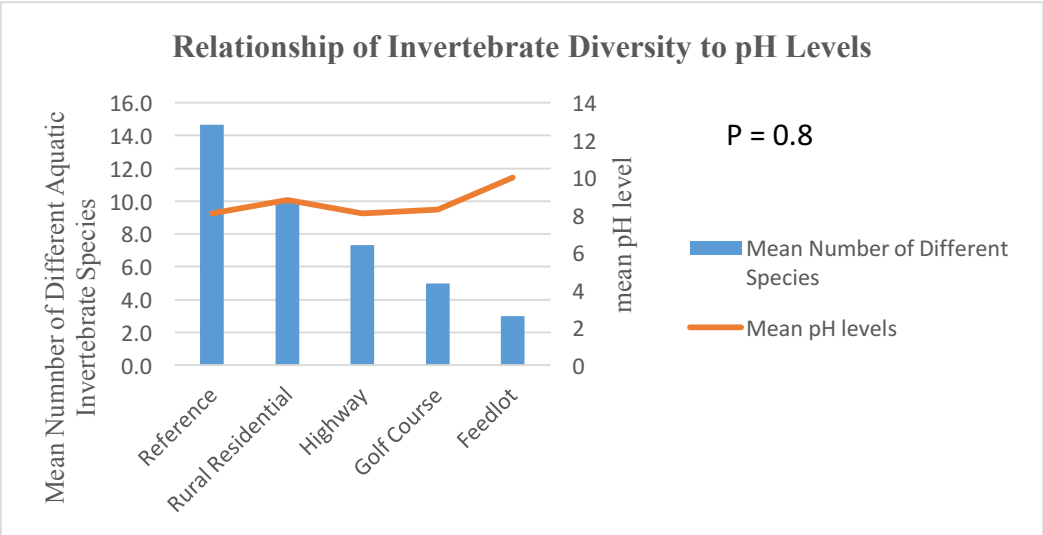
Results:

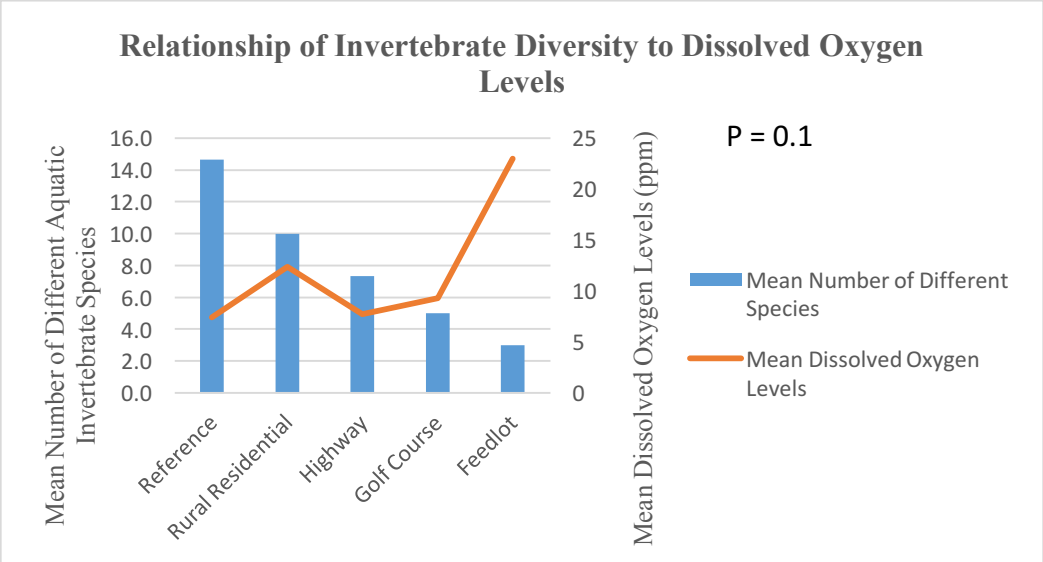

Relationship between human activity and number of different benthic aquatic invertebrate species
Mean Number of different species
20.0
15.0
10.0
5.0
0.0
R2=0.9
Wetland Location/Human Impact Type
Reference
Rural Residential
Highway
Golf Course
Feedlot


Relationship between human activity and number of pollution sensitive benthic aquatic invertebrate species
Mean Number of different pollution sensitive species
8.0
6.0
4.0
2.0
0.0
R2=1.0
Mean pollution sensitive species
Wetland Location/Human Impact Type
Reference
Highway
Rural Residential
Golf Course
Feedlot


Relationship Between Human Activity and Dissolved Oxygen Levels
Mean Dissolved Oxygen Levels (ppm)
30.0
25.0
20.0
15.0
10.0
5.0
0.0
R2=0.5
Wetland Location/Human Impact Type
Reference
Rural Residential
Highway
Golf Course
Feedlot


Relationship Between Human Activity and pH levels
12.0
10.0
8.0
6.0
4.0
2.0
0.0
pH
R^2=0.5
Wetland Location/Human Impact Type
Reference
Rural Residential
Highway
Golf Course
Feedlot


Relationship of Invertebrate Diversity to pH Levels
Mean Numnber of Different Aquatic Invertebrate Species
16.0
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
14
12
10
8
6
4
2
0
mean pH level
P = 0.8
Reference
Rural Residential
Highway
Golf Course
Feedlot
Mean Number of Different Species
Mean pH levels


Relationship of Invertebrate Diversity to Dissolved Oxygen Levels
Mean Number of Different Aquatic Invertebrate Species
16.0
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
25
20
15
10
5
0
Mean Dissolved Oxygen Levels (ppm)
P = 0.1
Reference
Rural Residential
Highway
Golf Course
Feedlot
Mean Number of Different Species
Mean Dissolved Oxygen Levels

Conclusion: Of the five wetlands, the cattle feedlot was the only one with abnormal D.O. levels (supersaturated), the highest pH level and the least mean aquatic invertebrate diversity (in all samples) and was, presumably, the least healthy wetland compared to the reference wetland. On the other hand, the golf course had an average 9.3 ppm D.O and a mean pH of 8.3 which is very good for aquatic life but it had the second least invertebrate diversity and no pollution sensitive species in the second trial.

Therefore, the hypothesis is only partially correct. Although the study demonstrated that increasing human impacts negatively affect aquatic invertebrate diversity (R^2=0.9), the effect of D.O and pH on invertebrate diversity over the five tested wetlands proved insignificant ($p = 0.1$). Other variables must be considered. It was observed that the riparian zone from the water's edge was non-existent in both the golf course and the feedlot. It is also unclear whether herbicides are used around or in the golf course wetland as that information was not given. This is deserving of further investigation.

These results are important for several reasons. They show the negative impacts to wetland health when livestock access and defecate in them. Access should definitely be regulated. The results also show the importance of roadside and rural wetlands in maintaining aquatic invertebrate diversity. Preserving this health should be encouraged. Finally, they demonstrate that wetland health is a complex matter. Many influences should be considered.

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