Assessment of Macroinvertebrate Health and Agricultural Chemical Exposure on Waterfowl Production Areas in Nebraska's Rainwater Basin Wetland Management District

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Introduction

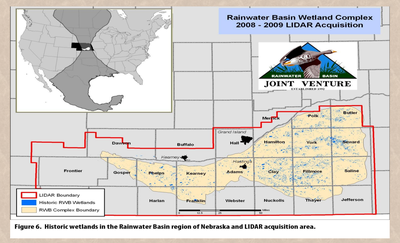


Figure 6. Historic wetlands in the Rainwater Basin region of Nebraska and LIDAR acquisition area.

The Rainwater Basin (RWB) in south-central Nebraska is among the most threatened wetland ecosystems in the United States. Less than 10 percent of the original pre-settlement wetland area currently remains. Furthermore, remaining wetlands exist in a landscape dominated by agriculture, and as a result, siltation and poor water quality are continual problems.

Despite wetland loss and degradation the RWB continues to provide essential habitat for migratory birds. An estimated five to nine million ducks and several hundred thousand geese use this area every spring. Aquatic macroinvertebrates are an essential food item for many migratory birds and are also important in maintaining the aquatic health of RWB wetlands.

Agricultural runoff includes nutrients, elemental contaminants, and pesticides. In other studies agricultural runoff into wetlands has been associated with decreased invertebrate abundance, species density, and richness, dominance by few nutrient tolerant taxa, and loss of endemic and characteristic species.

The effects of surrounding land use and agriculture runoff on aquatic macroinvertebrate communities in RWB wetlands is largely unknown. The purpose of the study was to evaluate the presence of buffers on aquatic macroinvertebrates in the Rainwater Basin. We hypothesized that aquatic macroinvertebrates in wetland sites are exposed to varying concentrations of agricultural chemicals in runoff and that exposure is related to changes in population and community indices including abundance and diversity.

Methods

Twelve wetland sites, six "buffered" and six "non-buffered," were chosen among Waterfowl Production Areas throughout the Rainwater Basin. Buffered sites had a consistent vegetative buffer of at least 25 meters from agricultural land whereas non-buffered sites received agricultural runoff directly via culverts and drainage ditches.

Sites were sampled for macroinvertebrates and water quality bi-weekly from April to August, 2007-2009 (23 total occasions). Water quality parameters included temperature, dissolved oxygen, specific conductivity, pH, chlorophyll *a*, turbidity, nitrogen, phosphorus, heavy metals, and atrazine. However, only results for turbidity and nutrients are presented here. Macroinvertebrates were collected with a D-Frame net by taking 4 sweeps per site per occasion. Passive Hester-Dendy traps were also placed into the wetland and sampled bi-weekly. Macroinvertebrates were preserved in 50% ethyl alcohol and identified to genus in lab. Differences between buffered and non-buffered sites among years were analyzed by a MANOVA ($P \leq 0.05$).

Simpson's and Shannon's diversity indices were used to compare invertebrate communities among buffered and non-buffered sites. The Simpson's diversity index indicates the number of taxa present and the relative evenness of each taxa. The Shannon diversity index indicates the number of different taxa and taxa richness among sites. A student t-test was used to test for significant differences in taxa diversity and water quality parameters between buffered and non-buffered sites.

Results

A total of 38,467 macroinvertebrates representing 69 genera were collected. Approximately 58 percent more invertebrate specimens and 40 percent more genera was observed in buffered wetland sites. Abundance per taxa was significantly greater on buffered sites than non-buffered sites for Diptera (Flies), Coleoptera (Beetles), Anisoptera (Dragonflies), Zygoptera (Damselflies), and Ephemeroptera (Mayflies).

Shannon's diversity was significantly greater in buffered wetlands (t-test, P=0.04). Simpson's evenness was not significantly different among buffered wetlands (t-test, P=0.07).

Figure 1

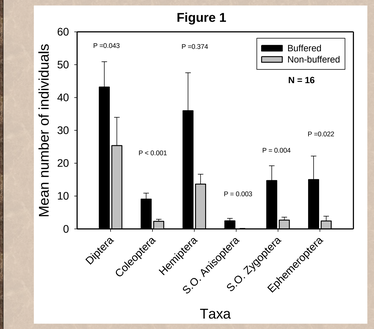


Figure 2

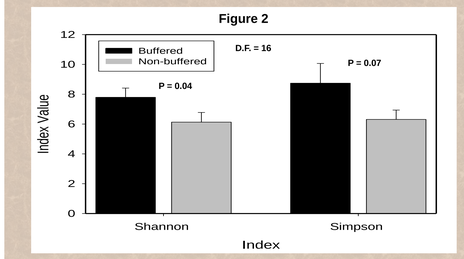
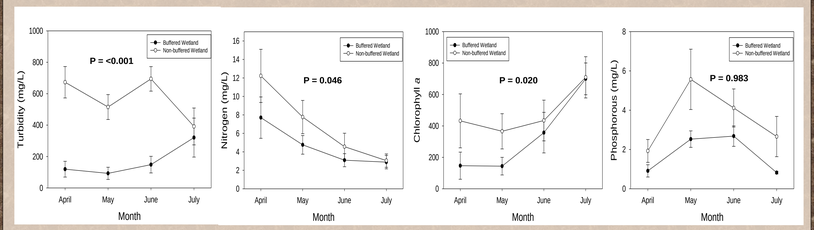


Figure 1: Mean (±S.E.) number of macroinvertebrates sampled in buffered and non buffered wetlands (N=16). Individual orders and sub-orders were analyzed by wetland condition in a Student t-test.

Figure 2: Mean (±S.E.) Shannon-Weiner and Simpson diversity indices of macroinvertebrate genera collected from buffered and non-buffered wetlands in a Student t-test.

Results

Buffered wetland sites had significantly lower turbidity, nitrogen, and chlorophyll a in non-buffered wetlands. Furthermore, significantly high concentrations of phosphorus (P = 0.050) were also collected during the month of May in non-buffered wetlands though significance was not detected across all years.



Figures: Mean (±S.E.) of turbidity, nitrogen, chlorophyll a, and phosphorus by month for buffered and non-buffered wetlands of the Rainwater Basin across all years (2007-2009) (N = 16).

Discussion

Of the 12 sampled locations, the 6 non-buffered sites appear to be affected by agricultural chemical exposure. Agricultural chemical exposure to these sites include runoff from corn and soybean row crops and discharges from concentrated animal feeding operations. Our data suggest that these outside land practices have a negative effect on macroinvertebrate diversity and abundance. Use of vegetative buffers to filter surface runoff can reduce pollutant inputs and improve macroinvertebrate biodiversity at wetland sites. Outside literature supports the institution of vegetative buffers as a method to protect water resources and macroinvertebrate populations (Davis and Bidwell 2008, Muscutt et al. 1993, Osborne and Kovacic 1993, USDA 1991). Evaluation of pesticide exposure is ongoing but preliminary results further support the benefits of vegetative buffers. The finalized study report will provide land and program managers with the information they need to develop water quality improvement strategies for select WPAs. Study results are also valuable for the development of Integrated Pest Management Plans and Pesticide Use Proposals.

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