Roads, Water, and Wetlands: Effects of Highway Construction on Wetland Viability

Natasha Chenot
Pawnee Nation of Oklahoma
Haskell Indian Nations University

Introduction

Wetlands are highly sensitive to disturbances associated with highway construction. Construction activities (e.g. clearing, placement of fill, and paving) are likely to result in immediate loss of natural vegetation, fluctuations in surface water levels, and changes in soil and water chemistry. Wetland highway crossings may also disrupt hydrological connectivity, fundamentally changing the functions of affected wetlands (Frissel 2014, 12). However, few studies have examined the during-and-after effects of highway construction on wetland viability. At the Wakarusa Wetlands, northeast Kansas, a four-lane highway was built from May 2014 to June 2016 across the northern part of the area. This summer, data collected during two time periods at four sites is used to assess the during-and-after effects of highway construction on the water chemistry of the Wakarusa Wetlands.

History of the Wakarusa Wetlands

The Wakarusa Wetlands are located in Douglas County, Kansas. Located in the Wakarusa River Valley of northeast Kansas, the wetlands were formed approximately 12,000 years ago during the last ice age (Haines 1995, 1). Due to extensive human modification, the Wakarusa Wetlands has shrunk from an original size of 18,000 acres^2 to a mere 640 acres^2 at present. Still, the wetlands is a biologically diverse place, home to more than 400 species of plants, 265 bird species, and 30 mammal species (Johnson and Larsen 2017, 81).

Figure 1. Haskell students at the Haskell Farm. Author unknown, ca. 1920

Figure 2. Snowy egrets (*Egretta thula*) at the Wakarusa Wetlands. (Photo courtesy of Jay Johnson).

Year	Wakarusa Wetland Timeline
Pre-history	Wakarusa River Valley occupied and used by various tribes including the Kanza.
1883	The Bureau of Indian Affairs (BIA) purchases sections of the Wakarusa Wetlands to establish Haskell Institute, an off-reservation boarding school for Native children.
1887	Haskell Institute implements a farming program. Student labor is used to drain and farm sections of the wetlands (known locally as the Haskell Farm).
1953-1968	BIA transfers over 70% of Haskell's original acreage to the City of Lawrence, Douglas County, and the University of Kansas. Baker University acquires the Haskell Farm (approx. 572 acres).
1968-1990s	Baker University restores the Haskell Farm into functioning wetlands.
1985-2012	Discussions begin about the construction of a four-lane highway (the South Lawrence Trafficway, or SLT) through the former Haskell Farm. Over the next 26 years, tribal communities and environmentalists challenge the SLT on the grounds that it would be detrimental to the Wakarusa Wetlands, and to the historical and cultural legacy of Haskell.
2012	Construction of the SLT is approved in May.
2016	SLT opens for traffic in November.

Figure 3. Wakarusa Wetlands timeline. (Data from Larsen and Johnson 2017).

Methods

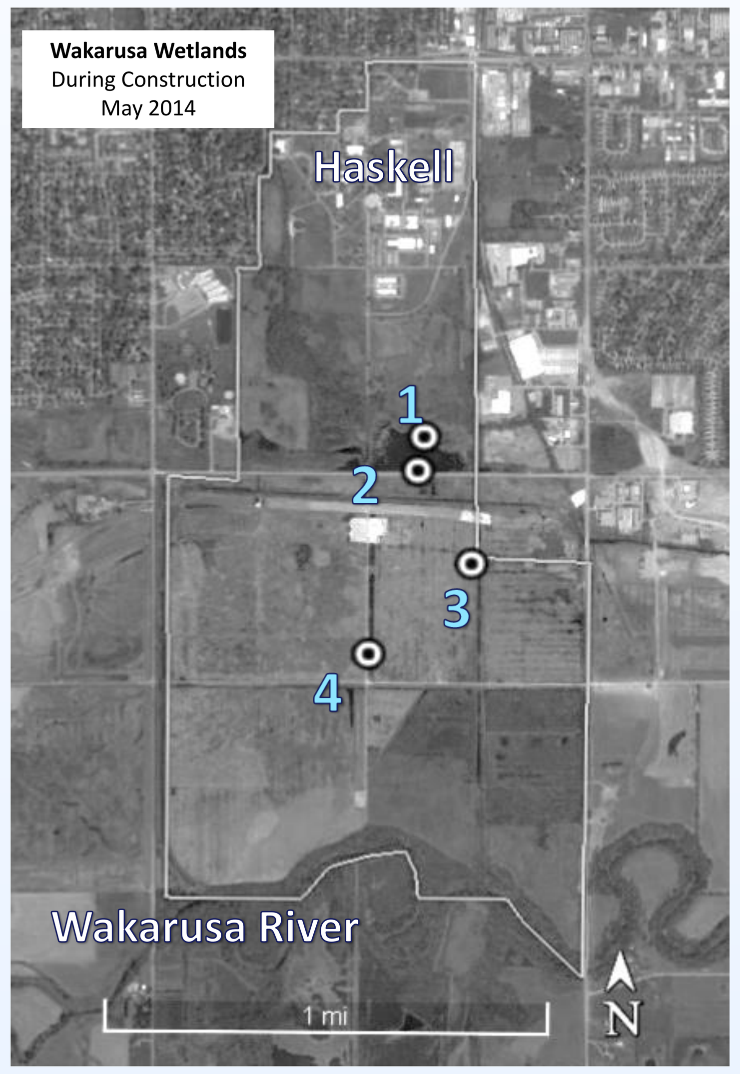

Figure 4. Map of the Wakarusa Wetlands (during construction) with sample sites (1-4). Sites 1 and 2 were sampled on 2 May 2018; sites 3 and 4 were sampled on 3 May 2018. Map data: Google Earth, Digital Globe. Image date May 2014.

- Garmin GPS was used to locate sites sampled in May 2014 at the start of SLT construction
- Water chemistry data were collected from all 4 sites on 3 July 2018
- Samples were filtered on-site using 0.45 µm nylon syringe filters into dry, acid-rinsed 2 x 60 mL bottles
- 1 bottle was acidified with 3 drops of nitric acid for later alkalinity titration. All samples were placed in a closed ice chest for transport
- Conductivity, pH, temperature, and dissolved oxygen were measured on-site using YSI PRO portable meter by following standard methods
- Within one hour of collection, all samples were tested for turbidity using LaMotte GREEN Program Water Monitoring testing module 5887

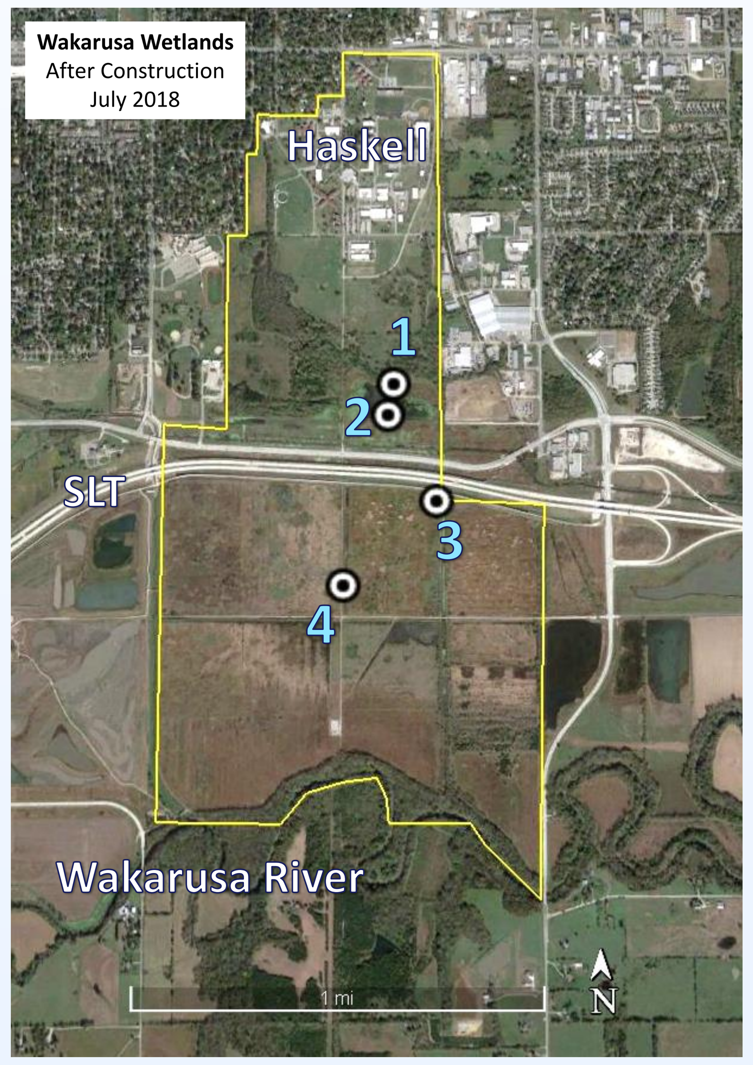

Figure 5. Map of the Wakarusa Wetlands (post-construction) with water sample sites (1-4). All sites were sampled on 3 July 2018. The historic boundary of the Haskell Farm is outlined in yellow. Map data: Google Earth, Digital Globe. Image date 3 July 2017.

Wetland Water Chemistry: During and After Construction

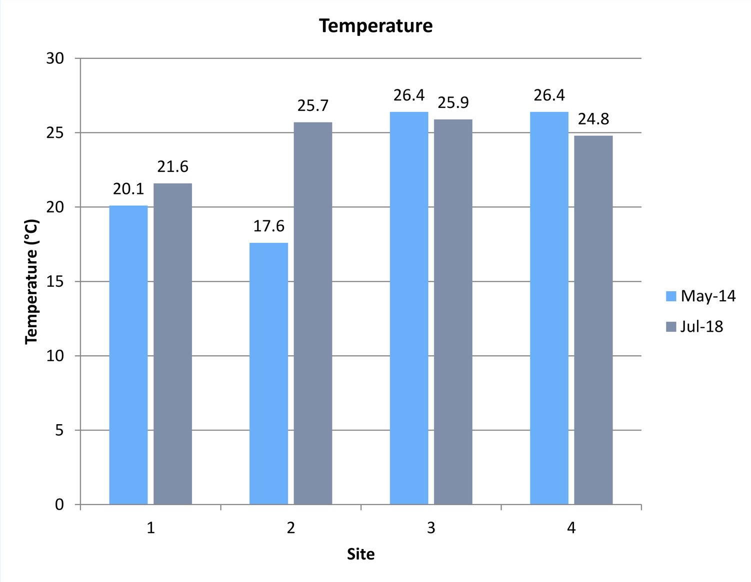

Figure 6. Water temperature of the 4 sample sites during construction (May 2014) and after construction (June 2018).

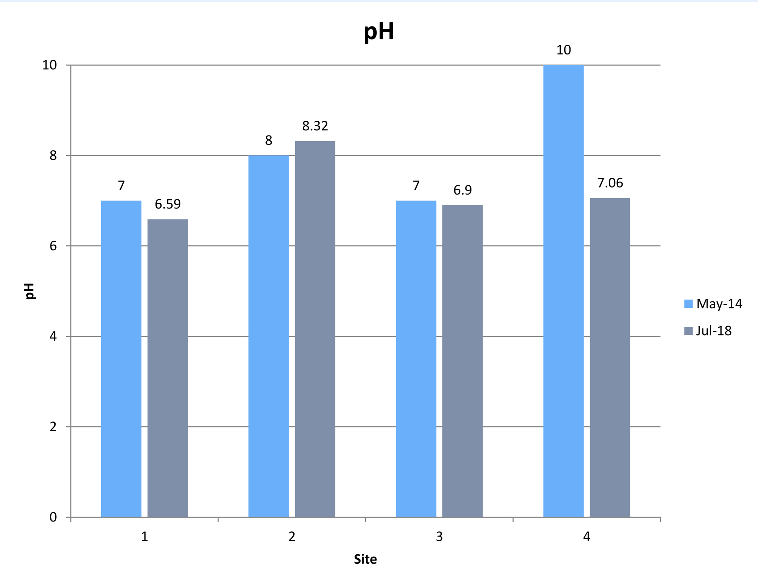

Figure 7. pH of the 4 sample sites during construction (May 2014) and after construction (June 2018).

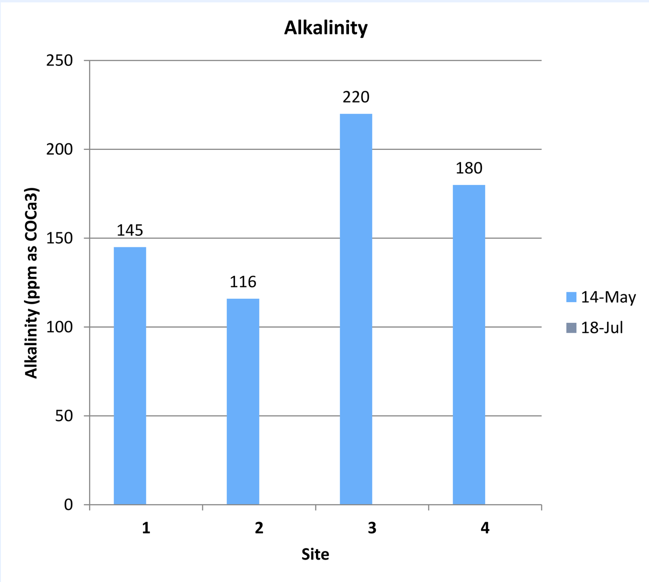

Figure 8. Alkalinity of the 4 sample sites during construction (May 2014). Results from alkalinity titrations from 2018 samples are forthcoming.

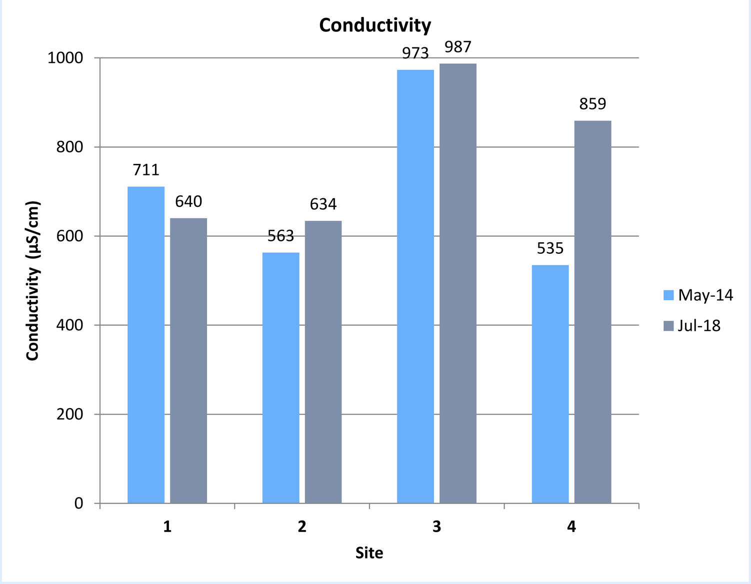

Figure 9. Conductivity of the 4 sample sites during construction (May 2014) and after construction (June 2018).

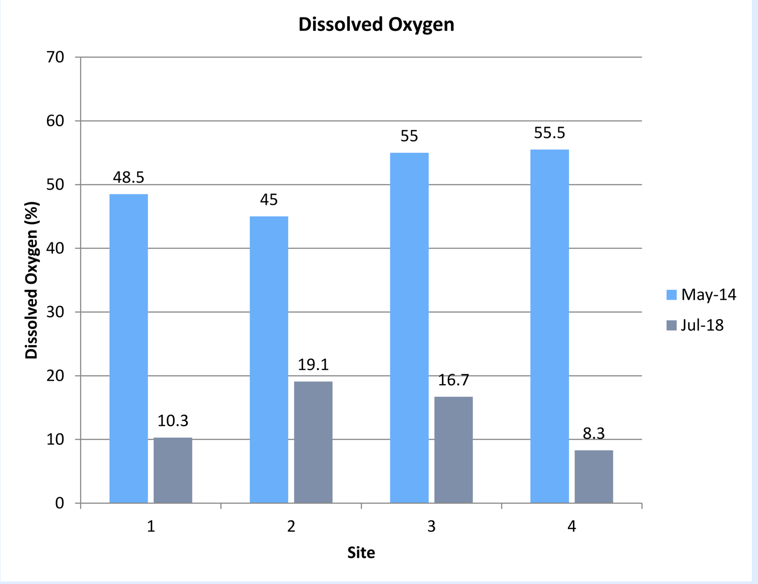

Figure 10. Dissolved oxygen of the 4 sample sites during construction (May 2014) and after construction (June 2018).

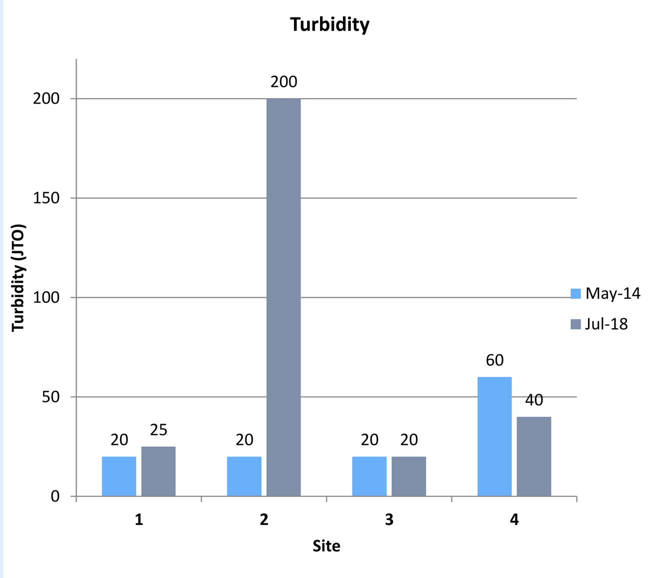

Figure 11. Turbidity of the 4 sample sites during construction (May 2014) and after construction (June 2018).

Discussion

Dissolved oxygen (DO)

- 2018 site levels were lower than 2014 levels, which may be resulted from highway impacts. Highway construction can impound wetlands and disrupt existing hydrology (Frissel 2016, 11). Disrupted water circulation may lead to lower DO levels
- Excessive algae growth can also lead to lower DO levels. Algae was visibly detected at all sites in 2018. Algal growth may also be influenced by inputs of nitrogen and phosphorus pollution from highway runoff
- Low DO levels can lead to morality of aquatic life

Turbidity

- Significantly increased at Site 2 after construction. Ground disturbance by roads generally increases erosion. Erosion was present at Site 2, which is located at the edge of a relocated roadbed
- High sediment loads can alter wetland functions that depend on the normal slow flow of ground and surface water (NCSU, n.d.)

Temperature

- 2018 levels were consistent with 2014, with the exception of Site 2. This may be resulted from the soil loss and sedimentation due to erosion along the relocated roadbed. Sediment particles raise water temperature by absorbing the sun's heat. Warmer temperatures can lead to eutrophication (NCSU, n.d.)

Conductivity and pH

- 2018 levels were consistent with 2014 levels

Figure 12. Collecting samples in the Wakarusa Wetlands. Photo by N. Chenot. Image date 3 July 2018.

Conclusions

The goal of this study was to examine how the construction of a highway alters the water chemistry of adjacent wetlands. Immediate results from water quality tests suggest that disturbance from highway construction to date has had an impact on turbidity and dissolved oxygen content in the Wakarusa Wetlands. Based on my literature review, I expect to see definite departures from 2014 water quality parameters as the SLT remains in operation. Continued monitoring at the sample sites will allow a longer-term view of the effects of highway construction on wetland water chemistry. In addition, SLT construction did not provide for the installation of water crossings, such as culverts and other structures, between the northern and southern parts of the wetlands. Thus, future research activities may include the (re)mapping and monitoring of wetland hydrology.

References

Frissel, Christopher A. 2014. "Foreseeable Environmental Impact of Potential Road and Pipeline Development on Water Quality and Freshwater Fishery Resources of Bristol Bay, Alaska." Anchorage: University of Alaska.

Haines, Charles E. 1995. "Haskell Wetlands Native American Ethnohistory: Wetlands Delineation and Assessment and Impact on Haskell's Science Programs." Lawrence: Haskell Indian Nations University.

Johnson, Jay T., and Soren C. Larsen. 2017. *Being Together in Place*. Minneapolis: University of Minnesota Press

North Carolina State University (NCSU) Water Quality Group. n.d. "Wetland Loss and Degradation." http://www.water.ncsu.edu/watershedss/info/wetlands/wetloss.html (accessed June 19, 2018).

Acknowledgments

I would like to thank the Haskell Environmental Research Studies Institute (HERS), EPSCoR, the National Science Foundation (NSF), Haskell Indian Nations University, and the University of Kansas. I would also like to acknowledge Cheyenne Sun Eagle, Josh Meisel, and Drs. Jay Johnson, Charles Haines, and Daniel Wildcat. This project was supported by NSF Grant Number 0078563.

Contact: tashamgc@gmail.com