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Session 3A: Watershed Management II

Kentucky Water Resources Research Institute, University of Kentucky

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Salinization and Alkalinization of Kentucky Lake: A Result of Human Activity?

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Increased salinization and alkalinization of lakes and reservoirs over the past several decades are well documented for the World's northern regions and are related largely to human activity, particularly the ever-increasing use of road salts. Water quality of Kentucky Lake, the terminal hydroelectric impoundment on the Tennessee River system, has been monitored for a number of water quality parameters since 1988. Trend analyses of variables associated with salinity (chloride and alkalinity) have increased significantly over the past three decades. Cl has increased from 6 mg/L to 10 mg/L, and alkalinity, even though seasonally variable, has increased from 50 mg $CaCO_3$/L to 60 mg/L since 1988. Ca ion concentrations, measured since 2012, doubled from <12 mg/L to over 30 mg/L in 2017 and then decreased to 12-15 mg/L in 2018 and 2019.

The largest source of Ca and Cl ions is likely related to increases in road-salt runoff. Because of the size of the Tennessee River basin (105,870 km^2), determining sources of Ca and Cl remains difficult, but the six Kentucky counties surrounding Kentucky Lake have experienced a 100% increased use of de-icing Cl and Ca brine since 2002. Increasing agricultural liming and wet deposition may be adding to increases in Ca and Cl. Zebra mussels were rare in Kentucky Lake until 2017 when a massive bloom occurred corresponding with high Ca levels. Once the Ca levels dropped below 21 mg/L in 2018, zebra mussels all but disappeared. Reasons for the Ca decrease remain unknown but appear directly related to human activities. The potential long-term effects of increased salinization and alkalinization on the lake ecosystem and the development of conditions favorable for species shifts, such as zebra mussels, are expected to become more apparent as long-term monitoring continues. Data will aid in understanding the long-term patterns of Ca and Cl and their effects on reservoir ecology and biology and will help inform reservoir management protocols in the 21st century.

Tools for Wetlands Assessment and Prioritization: Assets in Abating Nonpoint Source Pollution

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Wetlands are known to provide valuable ecosystem services, including water storage, streamflow and groundwater stabilization, carbon storage, recreation, wildlife habitat, and pollution absorption and remediation. The ability of wetlands to help regulate water quantity issues as well as store and potentially treat pollutants in watersheds make them valuable nature based solutions for nonpoint source pollution abatement (NPS) at a watershed scale. The ability of wetlands to abate NPS is dependent on factors affecting wetland function and watershed organizations often lack access to localized tools that can help them efficiently estimate the health of their wetlands and prioritize potential actions.

Kentucky has lost approximately 81% of its original 1.5-million wetland acres. In order to assess the extent and quality of the state's remaining wetlands, the Kentucky Division of Water (KDOW), in collaboration with other state, federal and university partners collectively known as the Technical Work Group (USFS, KDFWR, USFWS, NRCS, USEPA, KDNR, USACE, KSNPC, KDOW, and EKU), developed the Kentucky Wetlands Rapid Assessment Method (KY WRAM). Metrics of the KY WRAM include size and distribution, buffers and intensity of surrounding land use, hydrology, habitat alteration and habitat reference comparison, special wetlands, and vegetation, interspersion, and habitat features. Although originally created to be used in Clean Water Act Section 401 and 404 permitting decisions, the KY WRAM could be a valuable tool for watershed organizations to assess the health of their wetlands. Additionally, the Kentucky Division of Water also developed the Wetlands Prioritization Tool (WPT) to assist groups in prioritizing wetlands for restoration and protection. The WPT is an Excel model that incorporates KY WRAM data into the decision making process. The tool allows five choices of ecosystem services: general, flood flow alteration, sediment retention, water quality/nutrient removal, and wildlife diversity and abundance. These services were appraised in light of three categories: social significance, effectiveness, and opportunity. The ability to incorporate wetland data and priorities in watershed management could be valuable for groups aiming to increase water health by decreasing NPS in their watershed.

The KY WRAM and WPT have the potential to help watershed groups understand the health of their wetlands and prioritize wetland restoration and protection. This may increase the ability of these organizations, and their associated watersheds, to abate NPS. This presentation will focus on the potential of these tools to be used in projects aiming to reduce NPS at a watershed scale.

Monitoring McConnell Springs Stormwater Quality Wetland Pond and Gainesway Pond Retrofit: 2010-2021

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It has been 12 years since the completion of the McConnell Springs Stormwater Quality Wetland Pond and the Gainesway Pond Retrofit projects by the Lexington-Fayette Urban County Government (LFUCG). The McConnell Springs stormwater project, consisting of a pre-treatment gross debris trap, three settling forebays, a 0.2 acre deep-pool pond, and a 0.5 acre shallow marsh/littoral shelf area, was completed in December 2009. In spring 2009, LFUCG remediated Gainesway Pond at Centre Parkway as part of the Gainesway Retention Basin Water Quality and Environmental Education Project, which consisted of constructed wetlands, aquatic plantings, aeration, and upstream biofiltration/gross debris traps. The purposes of these facilities were to reduce non-point source pollution entering neighboring streams, as a public demonstration of the benefits that natural environments provide to water volume control and quality, and provide the community with environmental educational opportunities. Both of these projects were funded in part through a §319(h) grant provided by the U.S. Environmental Protection Agency and administered by the Kentucky Division of Water.

During the last 11 years, LFUCG Division of Water Quality has been monitoring water quality and determining the effectiveness of pollutant reduction by the two stormwater projects. Five sampling sites were tested at McConnell Springs, sites M1-M3 were located in the pre-treatment and forebay cells and sites M4-M5 were located in the main pond. Five sampling sites were also tested for Gainesway Pond: upstream, mid-stream, wetland area, Pond A, and Pond B (i.e., GP1-GP5). A total of 64 sampling events have been conducted at McConnell Springs and 60 sampling events at Gainesway Pond. On-site measurements included: temperature, pH, dissolved oxygen (DO), conductivity, and total dissolved solids (TDS). Samples also were collected for testing at the laboratory and the additional analysis included: alkalinity, hardness, CBOD5, total suspended solids (TSS), total ammonia, nitrate, nitrite, orthophosphates, total phosphorus, bacterial enumeration, and total metal concentrations. Bacterial enumeration of fecal coliforms, *E. coli*, and total coliforms were conducted using the IDEXX Colilert-18 and Quanti-Tray/2000 method. Metals in water samples from McConnell Springs were analyzed in 2010, 2013, 2014 and 2017 and from Gainesway Pond in 2013, 2014 and 2017.

Water quality parameters in the McConnell Springs stormwater structure were elevated in the 2010-2012 period, however, average concentrations decreased and stabilized as the system became established. Although average dissolved oxygen levels at the stormwater structure were reduced, DO did increase through the facility, with downstream sites M4-M5 having the highest DO. Alkalinity levels averaged 55-64 mg/L and hardness averaged 47-84 mg/L for 2013-2021. Total suspended solids were observed decreasing over time. As expected, highest levels of TSS and TDS were detected in the forebays and decreased in the pond. Average ammonia, nitrate, nitrite, total phosphorous, and orthophosphate concentrations for 2010-2021 decreased at sites M4-M5. Reductions in bacterial counts at sites M4-M5 also were observed in 2010-2021. Levels of *E. coli* peaked in June 25, 2014, however, both fecal coliforms and *E. coli* counts have decreased. Of the 30 metals tested in 2010, the concentrations of Al, Cu, Fe, Ni, S and Zn decreased through the stormwater facility. With the exception of sulfur, all detectable metal concentrations decreased in 2013, 2014, and 2017. Metals not detected in 2013 included Ag, Cd, Ni, and Zn.

At the Gainesway Pond stormwater structure the lowest DO levels were observed at the wetland site (GP3), but increased in the downstream ponds (GP4-GP5) in part due to the addition of an aeration fountain and underwater bubbler. Total alkalinity has remained stable since 2013 with average concentrations of 185-208 mg/L. Whereas, hardness has been decreasing over time, with lower concentrations observed in 2018-2021. Conductivity, alkalinity, and hardness concentrations decreased at sites GP4-GP5. As expected, average TSS concentrations were highest in the wetland area and downstream ponds. Yearly averaged TSS levels were elevated in 2015 (mainly at GP3), but the concentrations have decreased in subsequent years. Ammonia and total phosphorous concentrations were elevated in February 19, 2014, but have decreased over time. Increased total phosphorous and orthophosphate concentrations were detected in the downstream ponds. Levels for nitrate and nitrite peaked in 2010, decreased in 2011, and have since remained fairly constant. Both fecal coliforms and *E. coli* yearly average counts have decreased during the 11 years of monitoring. Bacterial counts were generally largest at upstream sites and decreased in the ponds. Metals not detected in 2013 included Ag, Cd, and Zn. Concentrations for Fe, Mg, Mn, Ni, K, and S were highest at GP3.

Since their completion, and based on 11 years of monitoring data, the stormwater structures have improved incoming water and are performing efficiently. Consistent results are being obtained as the systems have stabilized over time. Reductions of several pollutants were observed at both facilities. Of interest were the reductions in bacterial counts over time, and decreased water metal concentrations through the systems. These reductions aid in decreasing urban stormwater impacts on neighboring streams. LFUCG will continue to monitor water quality in these projects. In particular, close monitoring of ammonia, total phosphorous and bacterial counts which can have detrimental impacts to the stormwater structures and receiving waters. In addition to improvements in water quality, both stormwater structures have provided the community with educational opportunities and have enhanced these public recreational areas.