SLIDE 1
Today I am presenting the article "*Dissolved oxygen modeling of effluent-dominated macrophyte-rich Silver bow Creek*." This is an interesting research project because it was a collaborative effort across three types of institutions: 1) a university (Montana Tech), 2) a state government department (Montana Department of Environmental Quality), and 3) a private firm (Carollo Engineers). The research is also very applied, as it serves as an assessment to upgrades made to a wastewater treatment plant in an effluent-impacted system.

I chose this article because of its application of a different model (QUAL2K) that we haven't talked about yet, and its investigation of dissolved oxygen as a metric of water quality. The investigation is looking specifically at how macrophyte density and an upgrade to a wastewater treatment plant affect DO.

Negative associations with excessive BOD include eutrophication, excessive autotroph growth, reduced aquatic communities, dead zones, reduced economic value of land, impacted drinking water

The impacts can be affected on a diurnal scale, when more photosynthesis happens during the day (more CO2 and more acidic) and respiration at night (hypoxic conditions)

This study uses QUAL2K to simulate macrophyte effects before and after WWTP upgrades in an effluent-impacted system. This study also included field work and lab studies to provide inputs to this model and calibration data, but I'll focus mostly on the model component.

SLIDE 2
To assess upgrades, data collection was done in 2015 (pre-upgrade) and 2016 (post-upgrade) – **note that this is a short-term assessment of an evolving and recovering system**

They collected DO, temperature, pH and specific conductivity throughout the reach

Measured constituents were orthophosphate, nitrates, ammonia, total phosphorus, total Kjeldahl nitrogen, alkalinity, inorganic suspended solids, and detritus.

Estimated macrophyte density and sediment composition using field techniques, from which the oxygen produced (est.) could be calculated

Reaeration was calculated using the delta method (empirically relates peak dissolved oxygen values to solar noon and reaeration rates)

SLIDE 3
Field observations are shown for critical low-flow conditions (when water quality is most compromised).

They suggest strong diurnal swings, that intensify downstream (Whiskey to I 15) with increasing macrophyte density. The figure shows pH and DO before and after the WWTP update. In 2015, hypoxic conditions downstream persisted for half the day, which was improved after the upgrades.

Changes in diurnal fluctuations of pH are more prominent in 2016 – the authors associated it with changes in alkalinity that seem to have happened in the natural system between these two years (according to field data), and is not very much impacted by the WWTP.

REMINDER – this is collected data for a short period of time – low flow season

SLIDE 4
QUAL2K was used to model dissolved oxygen dynamics related to macrophytes for the system. This is a one-dimensional **[CE QUAL is 2D]** model simulates nitrification, sediment oxygen demand, photosynthesis, respiration, and reaeration.

Advection-dispersion as mode of transport, and can model at an hourly timescale **[this differs from CE QUAL??]**, allowing for the diurnal investigation. It uses headwater forcing functions to account for temporal changes on an hourly time step. The model starts with a mass balance approach, encompassing many of the values we've looked at in class. Macrophyte processing was represented by sinusoidal loading forcing functions.

SLIDE 5
Modeled DO behavior with and without macrophytes suggests that they play a positive role in increasing DO. This study confirms the important role of macrophytes in aquatic system dynamics, water quality, and biogeochemical cycling. However, the range of DO with the addition of microphytes suggests the possibility for an overabundance to cause hypoxic conditions.

When confirmed outputs for 2015 and 2016 [actual data was put in the model for assessing WWTP upgrade impacts] were applied the concentration of DO increases even more, due to the improvements in the WWTP. This is because the upgrade improved the oxygen sag from ammonia nitrification, increasing overall DO concentrations. This suggests some improvements, though not completely a win, as the resulting DO levels still do not meet state standards.

A future goal of this research is to work macrophytes into QUAL2K as a separate module to extend simulation capacities to better mimic primary production and respiration.