DETERMINING GROUNDWATER FLOW AND RECHARGE RATES IN THE WETLANDS AT FISH LAKE ENVIRONMENTAL EDUCATION CENTER, LAPEER COUNTY, MICHIGAN

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Abstract

Wetlands are hydrologic-dependent, intricate ecosystems that offer vital ecological services. Understanding the functionality of these ecosystems and their interactions with the surrounding environment is crucial for conservation efforts. The Fish Lake Environmental Education Center near Lapeer, Michigan is dominated by glacial topography and contains a kettle lake (Fish Lake) and several wetlands, including a large bog and multiple kettles in the northern region of the property. In the spring, snowmelt and precipitation form ephemeral ponds called vernal pools in the kettles. A combination of groundwater and precipitation sources each of the kettles in varying amounts, while the bog is primarily sustained by precipitation. A previous study conducted in the southern portion of the site indicated that groundwater is flowing southeastward toward the lake. Groundwater flow direction on the northern portion of the site was undetermined. The purpose of this research was to assess the flow of groundwater in the northern wetlands and to determine the rate surface water recharges groundwater in the vernal pools.

Shallow groundwater and surface water sampling took place monthly or biweekly from April 2023 to September 2024. Sample collection using a disposable bailer occurred in monitoring wells with depths ranging from 8 to 12 feet below the ground surface. Pressure transducers in several wells continuously record water levels. Field data collection included manual water level measurements, electrical conductivity, pH, and temperature. Hand auguring allowed for the collection of soil samples in the kettles. In laboratory analysis, water samples were tested for nitrite, nitrate, sulfate, phosphorus, iron, and turbidity. Permeameter testing determined soil hydraulic conductivity values in order to estimate recharge. With the calculated well elevations and other data, it can be inferred that groundwater initially flows towards the bog then as it infiltrates deeper into the ground it flows towards the lake. The data also suggest that each kettle functions differently in terms of recharge and groundwater interactions. This project supports other research conducted at Fish Lake and will be added to a digital field guide.

Introduction

- **Site**: EMU Fish Lake Environmental Education Center located North of Lapeer Michigan (Fig. 1).
- The property contains a large bog and multiple kettles (Fig. 2).
- Recent research determined the relative contribution of precipitation and groundwater within the wetlands (Allen, 2024).
- A study concluded that groundwater flow was southeast from the pond toward the lake (Hollon, 1995). Groundwater flow north of the lake is unknown.

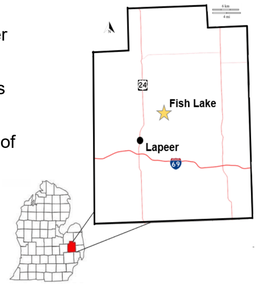

Figure 1: Map of Michigan highlighting Lapper County. Star represents location of Fish Lake.

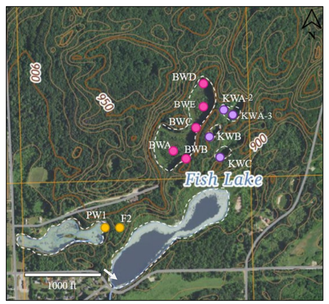

Figure 2: Aerial Map of Fish Lake. Purple circles represent wells in the kettles. Magenta circles represent wells in the bog. Yellow circles represent wells near the lake. The white arrow represents direction of groundwater flow.

- The purpose of this project is to determine groundwater flow and assess the recharge rate within the wetlands north of the lake.
- This is part of a larger study with EMU Biology and GIS programs.

Bog Wells | Kettle Wells | Lake Wells

Methods

- Using a hand auger, collected soil samples at various depths in all kettle locations to analyze using a falling head permeameter (Fig.3)
- Collected shallow groundwater and surface water samples for field and laboratory analysis (Fig.4)
- Used pressure transducers to collect water level measurements in 15-minute intervals for selected wells

Figure 3: Conducting Falling-Head permeameter test

Field Data:
- pH, electrical conductivity, water level, and temperature

Lab Data:
- Nitrate, nitrite, phosphorous, iron, sulfate, and turbidity

Equipment used:
- Oakton PC 450 pH/cond/temp meter, Hach DR 900 portable colorimeter, Hach 2100Q portable turbidimeter, Solinst 3001 LT Levelogger Edge M5

Figure 4: Measuring water level

Results

- Approximately 10 cm (~4 in) of rain fell on July 29, 2023
- Figure 5 shows a sharp rapid increase in water level in KWA and KWB
- Other wells also experience an increase but at a smaller magnitude

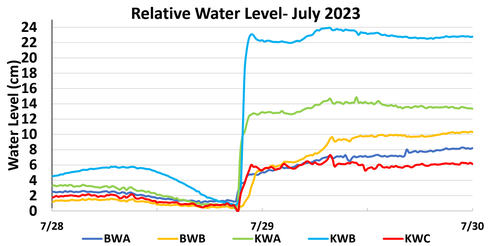

Figure 5: The water level changes in the Bog and Kettle wells after a large rain event in July 2023

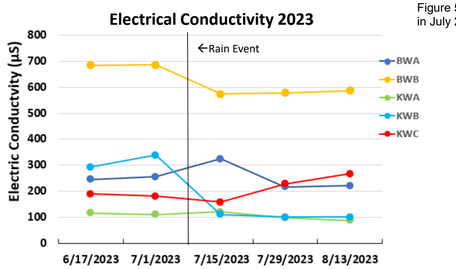

Figure 6: Electric conductivity values from June 16th to August 13th 2023

After the rain event shown by the vertical line on Figure 6:
- KWB and BWB saw decreases in their electrical conductivity
- KWA electrical conductivity remained constant
- The electrical conductivity of KWC increased throughout the 2023 rain event

- During July 10-11, 2024, approximately 14 cm (~5.5 in) of rain fell as an effect of Hurricane Beryl
- Fig. 7 shows a rapid increase in all the well water levels with KWB displaying the greatest increase

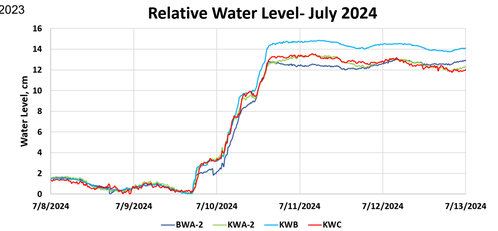

Figure 7: The water level changes in the bog and kettle wells after a large rain event in July 2024

Discussion

- 2024 precipitation values are substantially higher than 2023.
- When the vernal pools were present, kettle well water levels were above the land surface in 2024, indicating groundwater levels that intersected the land surface (Fig.8).
- The kettle vernal pools persisted throughout summer 2024 (Fig. 9) unlike previous years.
- The change in electrical conductivity and groundwater levels after rain events suggest Kettle B has greatest recharge overall.
- Kettle B had greater recharge in July 2023 when dry vs. in July 2024 when it still contained ~60 cm of standing water (Fig. 9).

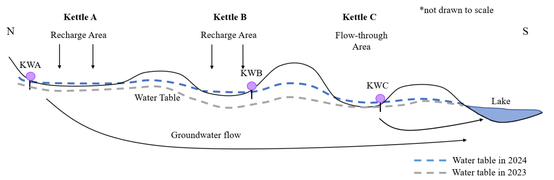

Figure 8: Conceptual model showing the change in water table elevation in the Fish Lake kettles from 2023 to 2024

Figure 9: Kettle B and well KWB (foreground) with vernal pool, August 2024

Limitations

- Lack of elevation data for KWB and KWC limits the ability to assess groundwater flow between kettles
- Equipment malfunction limited the ability to collect BWB-2 water level in 2024

Conclusions

- The changes in water levels, water chemistry, and recharge varied between 2023 and 2024 due to precipitation and relative water table position.
- Kettles A and B function as recharge areas while Kettle C is a flow-through area (Fig. 8)
- Electric conductivity and groundwater levels are useful indicators of recharge in the wetlands at Fish Lake

Future work

- Measure vertical groundwater gradient in the kettles by installing monitoring well nests in the center of the kettles to observe recharge after storm events.
- Survey all well elevations to assess groundwater flow between them.
- Characterize the groundwater interactions between north and south lobes of the bog by installing monitoring wells for observation of water level flux and nutrient concentrations.

References

Allen, R.C., 2024. Identifying nutrient dynamics and relative groundwater contribution in wetlands at Fish Lake Environmental Center, Lapeer MI. Senior Thesis, Eastern Michigan University. https://commons.emich.edu/honors/827

James-Hollon, D.A., 1995. Hydrogeology of Fish Lake, Lapeer County, Michigan. Thesis (M.S.), Eastern Michigan University.

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