Temporal Changes and Possible Sources of Dissolved Calcium Levels in Stream, River, and Lake Waters in Western Kentucky

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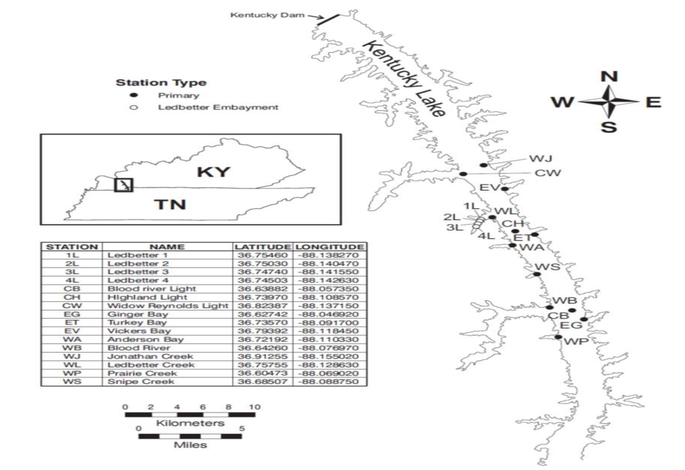
Purpose

- Zebra mussels (*Dreissena polymorpha*) are an invasive species that are indigenous to the Black and Caspian Seas. Zebra mussels spread to other regions and were first discovered in North America in 1988 in the Great Lakes and have since been spreading in major waterways [1,2].
- These mussels are known for being notorious in their "biofouling" capabilities costing the U.S. government billions of dollars in removal from industrial, public water, hydroelectric and nuclear facilities water supply lines [3,4]
- In 2017, high densities of zebra mussels were found on structures and solid substrates throughout the lower portion of the Kentucky Lake. Until this recent discovery of colonization, these mussels were not known to be able to establish colonies in Kentucky Lake and surrounding waterways.
- Earlier studies have correlated population establishment of zebra mussels to the dissolved calcium levels in water with a threshold concentrations of 20-22 mg/L. [2] (Table 1)
- The purpose of this study was to determine if dissolved calcium levels in the lower parts of Kentucky Lake had increased and reached that threshold.



STATION	NAME	LATITUDE	LONGITUDE
1L	Ledbetter 1	36.75460	-88.138270
2L	Ledbetter 2	36.75030	-88.140470
3L	Ledbetter 3	36.74740	-88.141550
4L	Ledbetter 4	36.74503	-88.142630
CB	Blood river Light	36.63882	-88.057350
CH	Highland Light	36.73970	-88.108570
CW	Widow Reynolds Light	36.82387	-88.137150
EG	Ginger Bay	36.62742	-88.046920
ET	Turkey Bay	36.73570	-88.091700
EV	Vickers Bay	36.79392	-88.118450
WA	Anderson Bay	36.72192	-88.110330
WB	Blood River	36.64260	-88.076970
WJ	Jonathan Creek	36.91255	-88.155020
WL	Ledbetter Creek	36.75755	-88.128630
WP	Prairie Creek	36.60473	-88.069020
WS	Snipe Creek	36.68507	-88.088750

Figure 1: Map showing locations of sample site located on Kentucky and tributary streams.

Risk Class	Calcium Concentration
Very low	75th percentile < 12 mg/L
Low	12 mg/L ≤ 75th percentile < 20 mg/L or 75th percentile < 21 mg/L and maximum < 28 mg/L
High	Mean ≥ 28 mg/L and 25th percentile > 12 mg/L
Very High	≥ 15% of sites with Ca < 12 mg/L and ≥ 15% of sites with Ca ≥ 28 mg/L

Table 1: Ecological risk classifications based on calcium concentration sample statistics in US streams and rivers.[2]

METHODS

- Surface and bottom water samples were collected during the Kentucky Lake Monitoring Program (KLMP) sampling Cruises #572-652 conducted during the years 2017 and 2022. (Figure 1)
- Samples were also collected at two sites on the Ohio River and three from Panther Creek. Pre-cleaned (trace metal grade nitric acid and deionized water) I-Chem bottles and high-density polyethylene bottles were used to collect the water samples.
- Samples were filtered with 0.45µm filter. The filtrate was acidified to 0.32 M with trace metal grade nitric acid.
- PerkinElmer PinAAcle 900F Atomic Absorption Spectrometer was used for calcium analysis

RESULTS

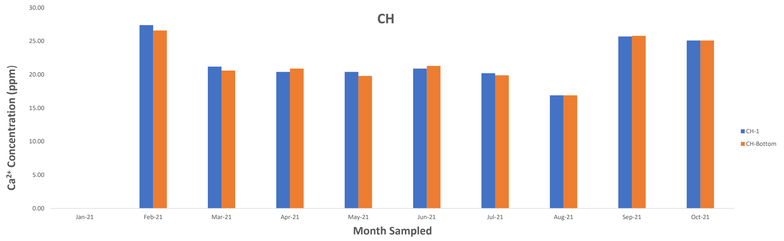


Figure 2: Year 2021 Seasonal variation in calcium levels in water samples from a representative site (Kentucky Lake Channel).

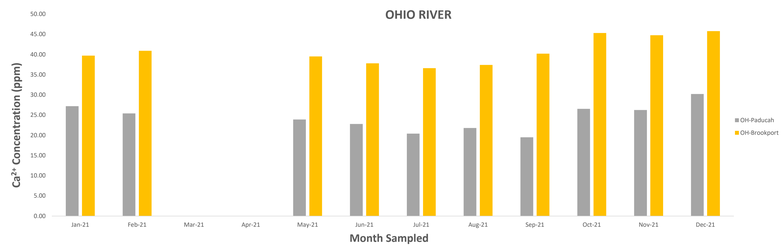


Figure 3: Year 2021 Seasonal variation in calcium concentrations (mg/L) in water samples collected from Ohio River Sites: Brookport and Paducah.

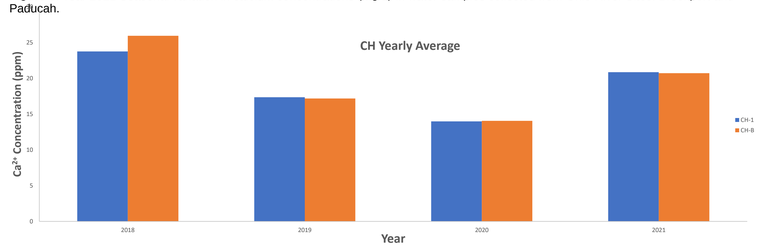


Figure 4: Yearly variation in calcium levels in water samples from a representative site (Kentucky Lake Channel).

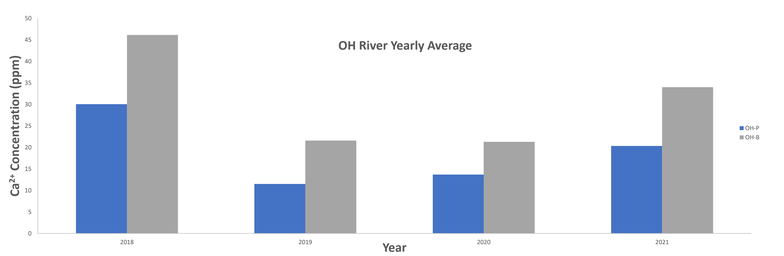


Figure 5: Yearly variation in calcium levels in water samples collected from Ohio River sites: Paducah, KY and Brookport, IL.

CONCLUSIONS

- The results revealed a fluctuating trend in calcium concentrations during the past decade. Particularly, calcium levels gradually/steadily increased in concentration from 2012 to 2018, decreased from 2018 to 2020, and increased again from 2020 to 2021. (Figure 4 and 5)
- Elevated levels are more prominent during winter or early spring months. (Figure 2 and 3)
- Relatively higher concentrations of calcium was found in Ohio River water samples than Kentucky Lake. (Figure 2 and 3)
- Our results give credence to conclude that human activities including road salt application during winter and subsequent runoff due to heavy rain during early spring months contribute to rise in the calcium levels and emergence of zebra mussels in our waters.
- Increasing levels of calcium ions may play a role in the elevated occurrences of zebra mussel colonies in Kentucky Lake.

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