Diatom paleoecology reveals anthropogenically driven changes at Jackson Lake (Wyoming)

John Dilworth[a], Jefferey Stone[b], Michael McGlue[a], Kevin Yeager[a], Ryan Thigpen[a]

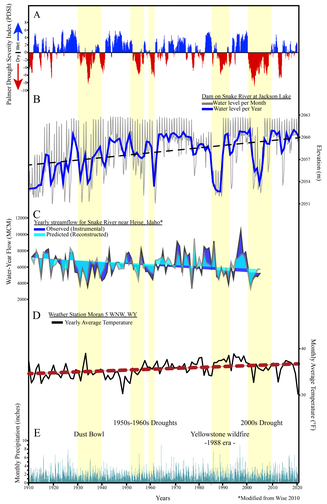
[a] University of Kentucky, 121 Washington Ave Lexington, KY 40508 [b] Indiana State University, 600 Chestnut St - Science 159 Terre Haute IN 47809

Abstract

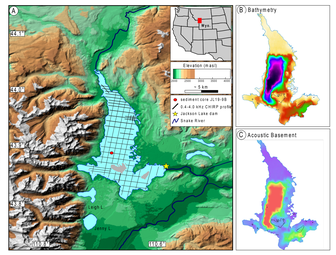
Jackson Lake, located in northwestern Wyoming, is the largest piedmont lake in Grand Teton National Park and is a crucial reservoir for the upper Snake River Valley. Damming of the lake's outlet from 1908-1916 resulted in a ~12 m increase in lake level elevation, drastically changing lake surface area and morphology by flooding marginal environments. To investigate paleolimnological changes associated with dam installation, we compiled regional hydroclimate data, and developed new diatom assemblage and geochemical data on a well-dated deepwater sediment core. The core spans the termination of the Little Ice Age (LIA) and extends to the present day (~1650-2019 CE). Diatom assemblages prior to dam installation are characterized by high relative abundances of planktonic species indicative of low nutrient availability, perhaps due to a single, short-lived season of partial water column mixing. Following dam construction, diatom assemblages transitioned to dominance by planktonic species commonly associated with nutrient-rich waters. The diatom flora suggest that since emplacement of the dam, the lake's nutrient concentrations have increased, likely a result of the change in lake-level elevation and a possible reduction in nutrient loss at the outlet, which has been restricted due to dam emplacement. Geochemical indices obtained from the lake's sediments, show an increase in nutrient concentrations and organic matter content post dam emplacement, supporting the interpretations of the diatom paleoecology. Changes in Jackson Lakes, paleoecology and geochemistry has occurred as a direct result of the anthropogenic modification to the lake's outlet resulting in lake conditions changing dramatically from post LIA conditions to present day.

1 Site characterization

Hydroclimate data



Site location



- Jackson Lake is located in Grand Teton National Park and is the largest of the piedmont lakes.
- Short core was recovered in ~130 m of water from the deepest depocenter (red dot).
- Jackson Lake Dam is located on the southeastern outlet of Jackson Lake (yellow star).

- Interpretation of the climatic and hydrologic data is that the Snake River discharge and Jackson Lake water level have been closely linked.
- Jackson Lake level appears therefore to be tied to fluctuations in precipitation, evaporation, and discharge of the Snake River.
- Natural drawdowns associated with regional drought conditions are likely exaggerated in the lake level curve as the resevor is tapped to support aggricultural activities in the greater Snake River basin.

Reference:
*Wise, E.K., 2010, Tree ring record of streamflow and drought in the upper Snake River: Water Resources Research, v. 46, doi:10.1029/2010WR009282.

2 Age model

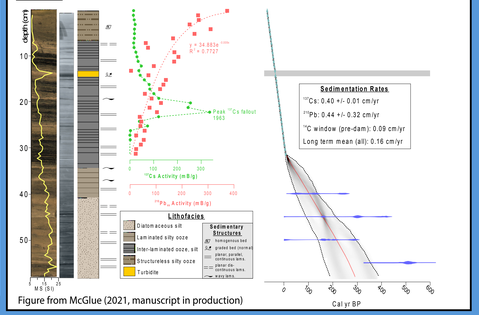
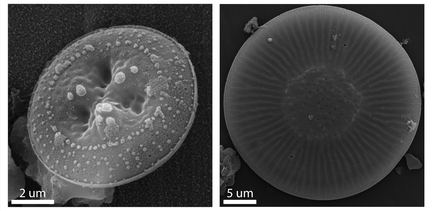


Figure from McGlue (2021, manuscript in production)

3 *Lindavia* and *Sephanodiscus* characteristics



L. ocellata *L. intermedia*

Diatoms: *Lindavia* and ***Stephanodiscus***

Lindavia

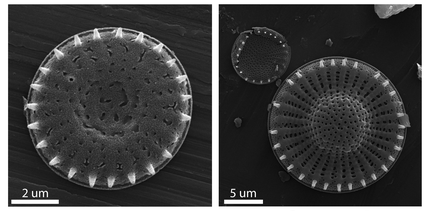
-Dominates in poorer nutrient conditions

-Common in the pre-dam period

Stephanodiscus

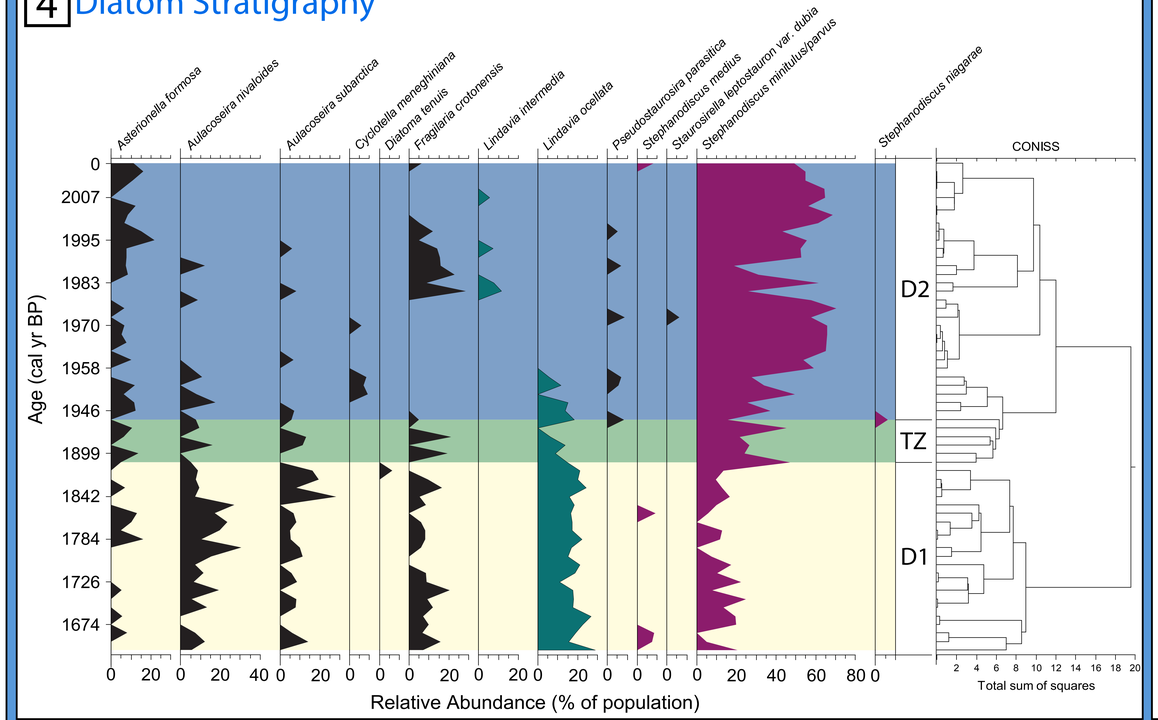
-Dominates in richer nutrient conditions

-Dominates in the post dam period

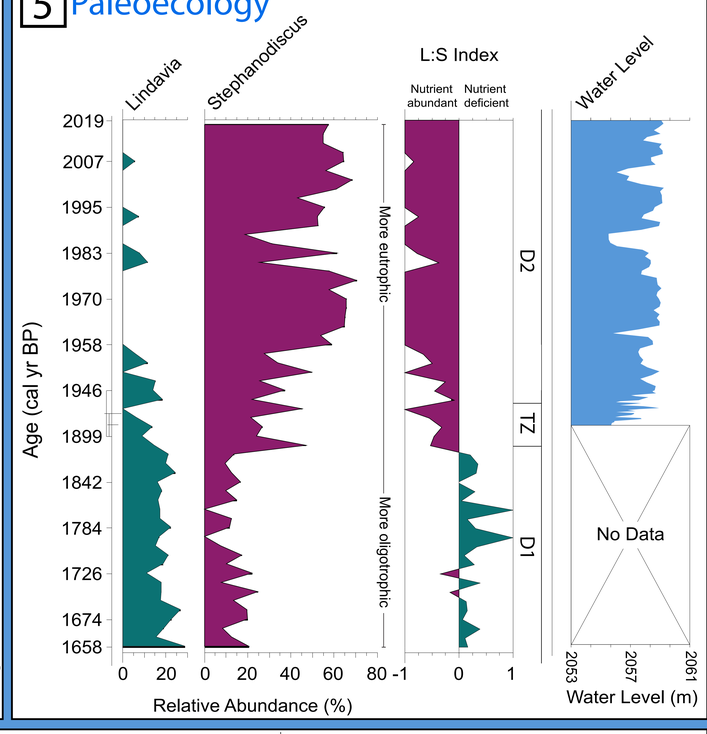


S. rugosa *S. cf. medius*

4 Diatom Stratigraphy



5 Paleoecology



Discussion

-D1: Abundance of *Lindavia* species suggest the lake was generally nutrient deficient. Settlement was minimal during this time. The division captures the end of the Little Ice Age.

-TZ: Succession of *Lindavia* to *Stephanodiscus* as dominate species. Suggests nutrient conditions are becoming more eutrophic. Completion of Jackson Lake dam 1916.

-D2: Dominance of *Stephanodiscus* species in the diatom assemblage. Suggest lake conditions are more eutrophic than conditions from D1.

Conclusions

-The paleoecology is representative of diatom flora from the end of the Little Ice Age and the transition into the modern era.

-Diatom flora suggests more nutrient deficient conditions prior to ~1916 CE and more eutrophic conditions post 1916 CE.

-The emplacement of the Jackson lake dam has resulted in Jackson Lake experiencing a eutrophic shift within the oligotrophic state.

Future work

-Sampling from shallower depocenters should enable a benthic diatom signal that is presently not present in the deeper core record.

-Collection and analysis of diatom assemblages from longer core will help establish lake conditions from earlier in the Little Ice Age and better demonstrate how the paleoecology has evolved into the modern era.

Acknowledgements

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