Effects of Changing Salinity on Microbialite Associated Production

Melody Lindsay
Montana State University
Boyd Geobiology Lab
Microbialites

Archean - 3.5 billion years old

Modern Day

Allwood et al., 2006

Reid et al., 2000
Modern microbialites are present all over the world -
Highbourne Cay, Bahamas
Shark Bay, Australia
Pavilion Lake, Canada
Salda Golu, Turkey
Lake Tanganyika, Tanzania/DRC

...and a few other places.

Largest extent of modern microbialites present in Great Salt Lake
Microbialites in GSL

Adapted from Lindsay et al., 2016
Mapping data from Colman et al., 2002, Eardley, 1938
Importance of Microbialites in GSL

Artemia and Ephydra

GSL Bird Populations
 >200 species of birds
 Supports 7.5 million birds annually
 Part of the Western Hemisphere Shorebird Reserve Network

Adapted from Wurtsbaugh et al., 2011

Ron Dudley

Artemia - Brine Shrimp

Ephydra - Brine Flies

GSL Microbialite Periphyton

GSL Lake Phytoplankton

>200 species of birds
Supports 7.5 million birds annually
Part of the Western Hemisphere Shorebird Reserve Network

Wurtsbaugh et al., 2011
Microbialite (periphyton) chlorophyll levels are ~9x that of lake phytoplankton

Microbialites estimated to contribute ~30% of the productivity that phytoplankton contribute (Wurtsbaugh et al., 2011)

Microbialite and associated planktonic communities are similar

Provide substrate for brine fly pupae to attach

Adapted from Lindsay et al., 2016 combined with unpublished data
Microbialite Response to an Anthropogenic Salinity Gradient

Lindsay et al., 2016
Effect of Salinity on Microbialites

SA microbialite  NA microbialite

Lindsay et al., 2016
Effects of Salinity on Microbialite Communities

Lower biomass and lack of photosynthetic primary producers in the NA, likely due to restraints caused by increased salinity
With increasing salinity, how/at what point do microbialites biologically change from: 

? 

?
Guiding Questions

What effects will a change in salinity have on microbialite communities and production?

Decreased biomass?
Changes in the community composition?
Decreased primary productivity?
Decreased secondary productivity?
Microbialite Sampling
Methods

Microcosm based approach - 8 weeks incubation
Salinities ranging from 8% to 30%
Microcosms included:
  50 mL filtered lake water (salinity adjusted)
  10 g crushed microbialites
  0.5 g Artemia eggs
Guiding Questions

What effects will a change in salinity have on microbialite communities and production?

Decreased biomass?
Changes in the community composition?
Decreased primary productivity?
Decreased secondary productivity?
Genomic Analyses - Methods

DNA-based approach

Two Main Goals:

Quantification

Sequencing and Identification
Effects on Microbialite Biomass Quantity
Effects on Community Composition
Guiding Questions

What effects will a change in salinity have on microbialite communities and production?

- Decreased biomass?
- Changes in the community composition?
- Decreased primary productivity?
- Decreased secondary productivity?
Effects on Primary Productivity - Methods

Add $^{14}$C labeled CO$_2$ to microcosm subsamples
 Track how much CO$_2$ is incorporated into biomass
 Proxy for rates of primary production

10 mL slurry from each microcosm in triplicate vials

Add $^{14}$C-CO$_2$, Incubate

Collect biomass on filter

Analyze for incorporation of radioactive $^{14}$C into biomass
Effects on Primary Productivity

The graph shows the effects of salinity on primary productivity. The x-axis represents different salinity levels (% Salinity) ranging from 8 to 30. The y-axis represents the primary productivity in n mole C g dm^{-1} hr^{-1}. The graph indicates that primary productivity decreases as salinity increases from 8% to 15%, and remains relatively constant from 15% to 20%. Beyond 20%, primary productivity decreases with increasing salinity to 25% and 30%. The graph includes error bars indicating variability or uncertainty in the measurements.
Guiding Questions

What effects will a change in salinity have on microbialite communities and production?

- Decreased biomass?
- Changes in the community composition?
- Decreased primary productivity?
- Decreased secondary productivity?
Potential Downstream Effects on *Artemia*
Conclusions

Communities responded to the salinity change with increased biomass at 8% and 10% salinity, but with decreased biomass at 20%, 25%, and 30%.

No significant change in total community composition observed thus far - still working on investigating changes attributable to individual species.

Major decreases in primary productivity were observed at salinities > 15%.

Hatch rates of *Artemia* were highest at 8% and 10% salinity, but *Artemia* were capable of surviving in microcosms up to 20% salinity.
Acknowledgments

Montana State University
Boyd Geobiology Lab
Eric Boyd
Rachel Johnston
John Dore
Dan Colman
Max Amenabar
Saroj Poudel
Eric Dunham
Libby Fones

Colorado School of Mines
John Spear

Westminster College
Great Salt Lake Institute
Bonnie Baxter
Jaimi Butler

Utah Geological Survey
Mike Vanden Berg

Funding

FRIENDS of
Great Salt Lake
Doyle W. Stephens
Scholarship

NASA Earth and Space

All Uncredited Photos:
Eric Boyd, Melody
Lindsay
Questions?
melody.lindsay@msu.montana.edu

Boyd Lab Website:
http://agweb.msu.montana.edu/geoboydology/

intense microbialite observation