Benefits of long-term data for adaptation planning

Or: What can long-term data tell us that we wouldn’t otherwise know?

Date: January 22, 2020
Presented to: MN Climate Change Adaptation Conference
Presenter: Lucinda Johnson
Many Possible Response Patterns to Climate Stress
(& Potential Analytical Approaches)

- Simple Linear Regression
- Piecewise Linear Regression
- Logistic Regression
- Quantile Regression
- Piecewise Quantile Regression

$B =$ Biological Condition Breakpoint
$T =$ Environmental Threshold

From: J. Ciborowski
Lessons Learned

• 2007: Millions of data records (over 4000 lakes in the database), but overall, little overlap among data sets, e.g., only 27 lakes with both long term fish and water chemistry data. Heinz Stefan (UMN)

• 2013: “Long-term, consistent data sets are sorely needed to detect robust trends.” Lucinda Johnson (NRRI) Talk 3/27/13 to DNR Fisheries Managers
Linear & Nonlinear Trends…
historic and future

- Climate
- Climate Change Responses: examples
  - Ice Out
  - Water Temperature
  - Water Chemistry
  - Fish Species traits
  - Fish Species Distributions
Northern MN is warming more and faster than southern MN.
Summer Temperatures: Lake Superior

From: Austin and Colman, 2006.

Water temperatures are rising faster than air temperatures due to reduced ice cover.
Ice out dates are earlier and the rate of ice loss is accelerating.

Trend = 1.4 days / decade
Since 1950's (n = 71)

Staples, et al. in prep.
Some water quality variables are more responsive than others to changing temperature regimes.

(“Hot” = > 2 S.D. mean annual temp; “Cold” = < 2 S.D. mean annual temp)

Blumenfeld et al., unpublished data.
Some fish are more robust & adaptive than others to changing temperature regimes.

K. Schneider, 2010
Models

- Predictive Models:
  - Lake temperature
  - Stream temperature
  - Brook Trout presence / absence
  - Cold water fish habitat

- Can be used for hind casting as well as forecasting

- Co-located data are powerful
Temperature: 427 sites 
1996 - 2009

Brook Trout: 371 sites 

Co-located fish + temperature 

\[ n = 79 \]

within 1km distance and no tributary between sites.

From: Johnson, et al. 2013
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• 2019: “Over 450 Minnesota lakes now have fish and water quality data; many of these also have plant surveys as well.” Jacquelyn Bacigalupi, (DNR)
Despite Minnesota Being a Data-Rich State, Data Gaps in Aquatic Response Studies Still Persist:

1. Groundwater maps throughout state
2. Full coverage of detailed soil maps
3. Detailed surficial geology maps
4. Depth to bedrock
5. Bedrock fracture patterns
6. Hydrologic models of groundwater flow
Thank You

Speaker Name(s)
Title
Contact Information

NRRI Duluth
(218) 788-2694
5013 Miller Trunk Hwy, Duluth, MN 55811

NRRI Coleraine
(218) 667-4201
One Gayley Avenue, Coleraine, MN 55722

nrriinfo@d.umn.edu // www.nrri.umn.edu