Examining Striped Bass Environment-Recruitment Relationships With Quantile Regression

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Goals

MARYLAND DEPARTMENT OF NATURAL RESOURCES

Verification:

Can we explain patterns in the YOY Index with knowledge from studies and external data?

Planning:

What can we expect recruitment to look like under changing environmental conditions?

Past studies

What influences Striped Bass recruitment?

Spring freshwater discharge

Controls larval transport to and retention in the estuary turbidity maximum where high concentrations of larval fish and zooplankton prey overlap (North and Houde 2001,2003; Martino and Houde, 2010)

Past studies

What influences Striped Bass recruitment?

Winter temperatures

Controls the size and timing of the spring peak of copepods (Millette et al., 2020).

Winter dinoflagellate blooms increase copepod nauplii survival (Millette et al., 2015).

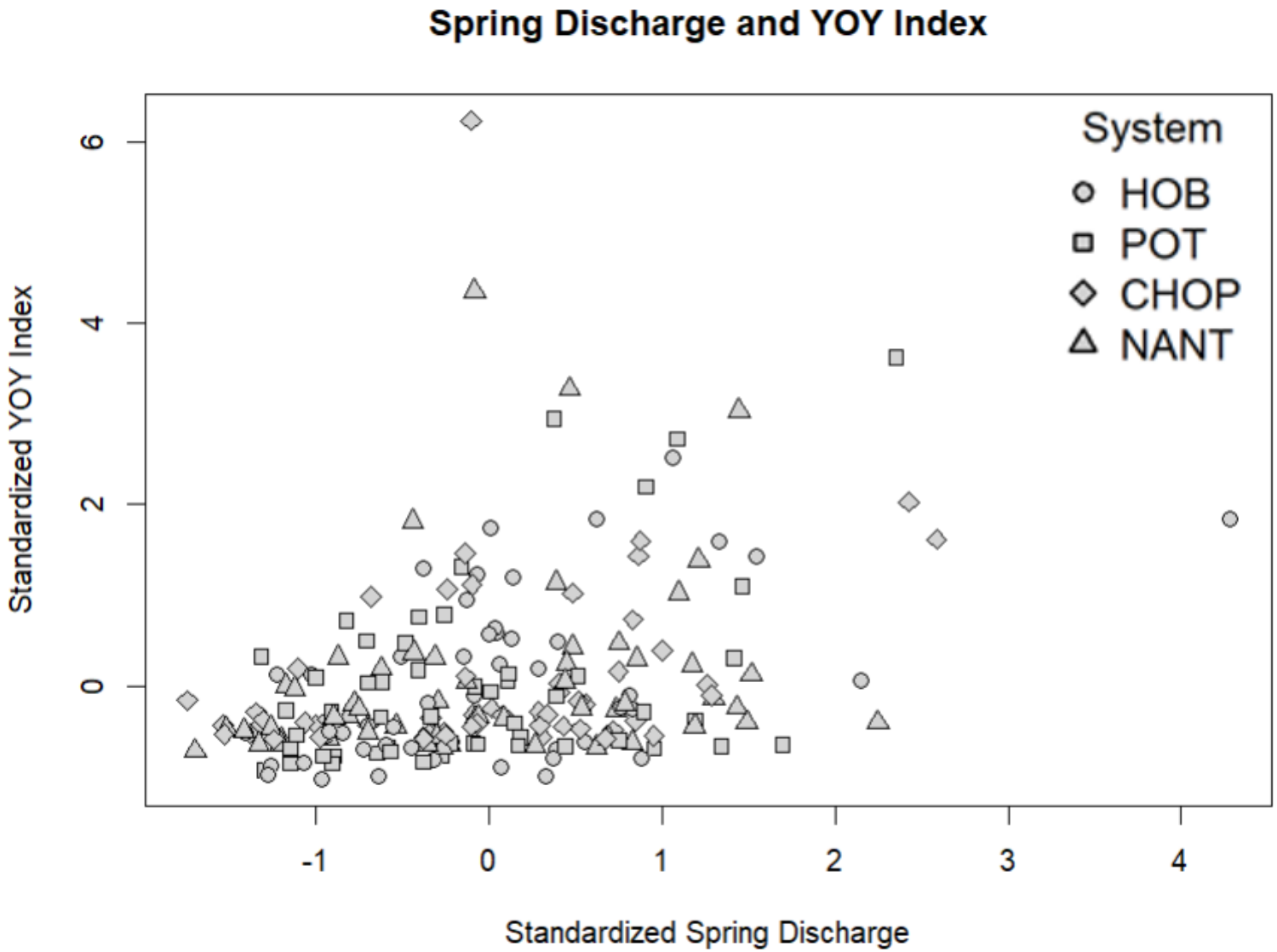
Past studies

What influences Striped Bass recruitment?

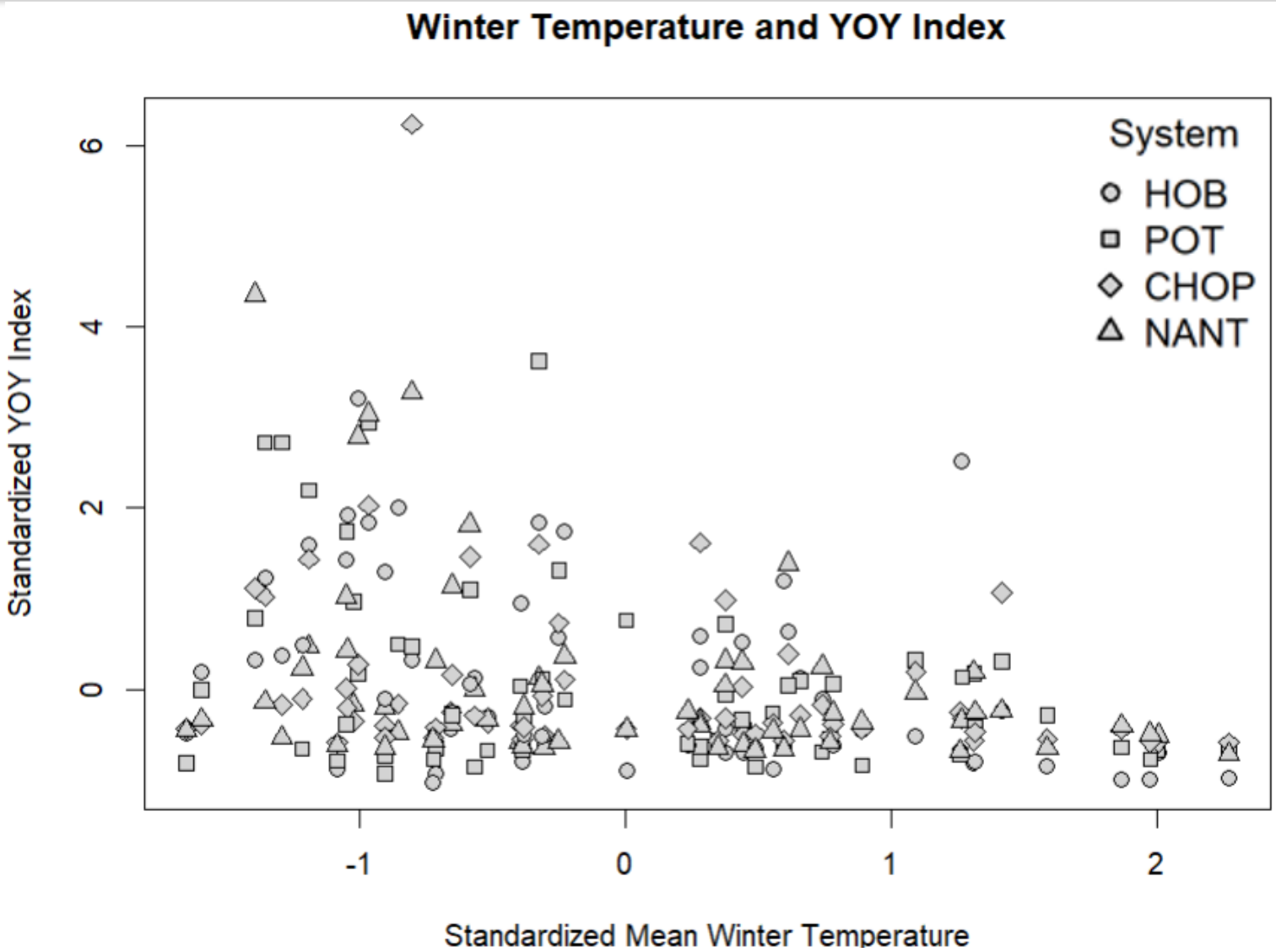
Many other interacting factors that are known, unknown, or unmeasured!

Spawning stock, age diversity, spawning phenology, contaminants, extreme events (e.g. cold snaps), ecological interactions (e.g. predation, density dependence, etc…)

Spring Discharge



Winter Temperature



Quantile Regression

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FRONTIERS IN ECOLOGY and the ENVIRONMENT

Review

A gentle introduction to quantile regression for ecologists

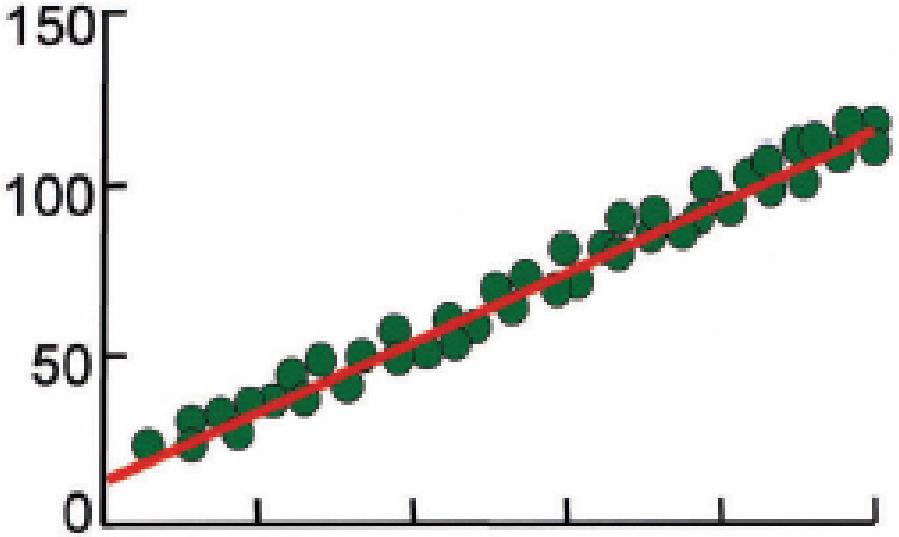
Brian S. Cade, Barry R. Noon

First published: 01 October 2003 | https://doi.org/10.1890/1540-9295(2003)001[0412:AGITQR]2.0.CO;2 | Citations: 1,404

Limiting Factors

Sprengel-Liebig Law of the Minimum

The response of an organism is proportional to the most limiting resource.



Cade & Noon, 2003

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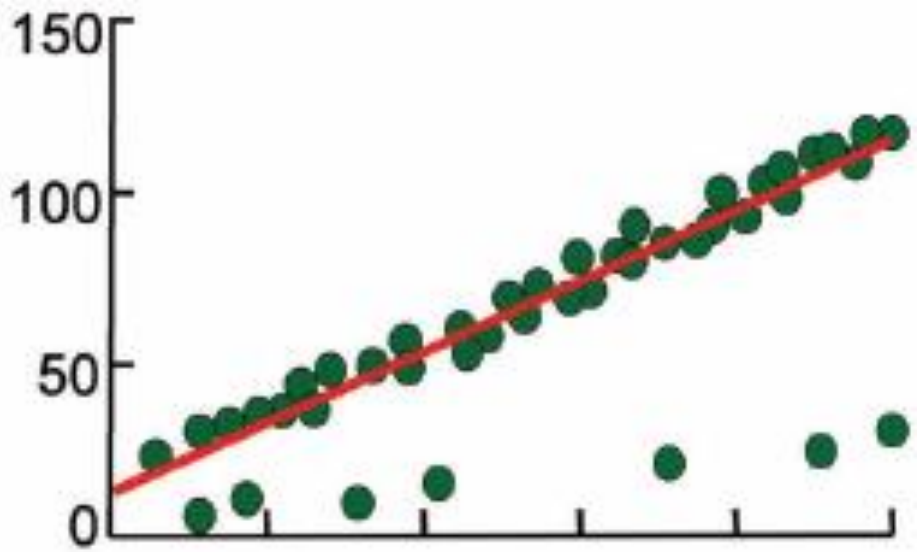

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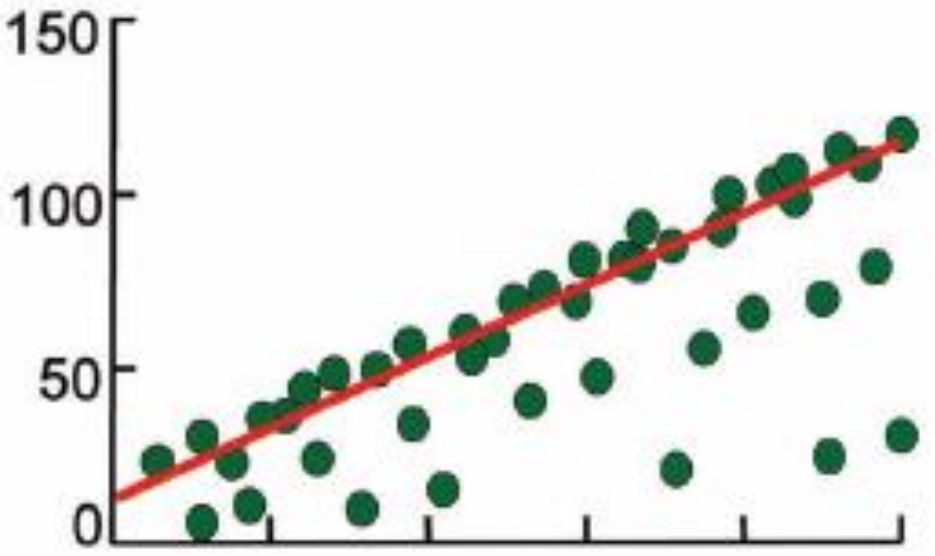

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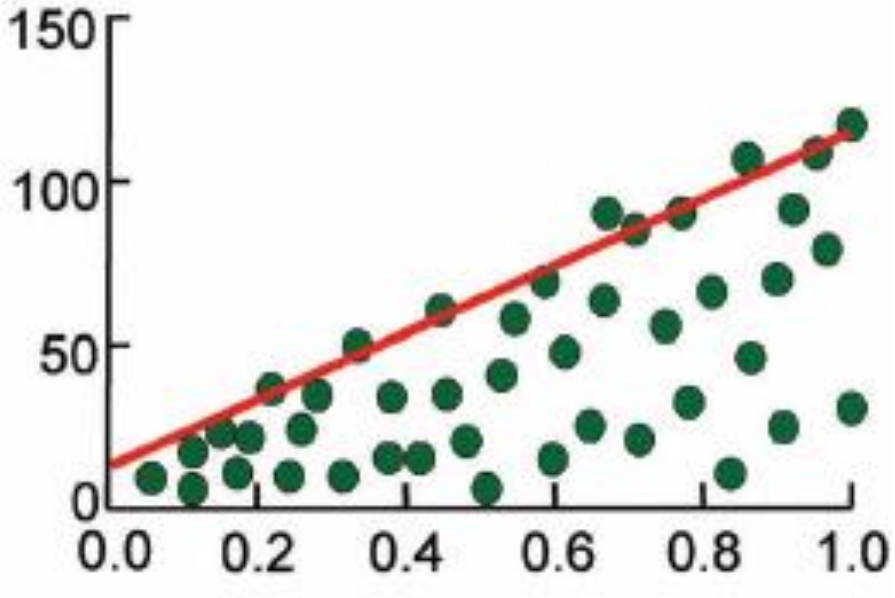

Cade & Noon, 2003

Quantile Regression

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Least-squares regression

The conditional mean is the solution to minimizing the sum of squared residuals.

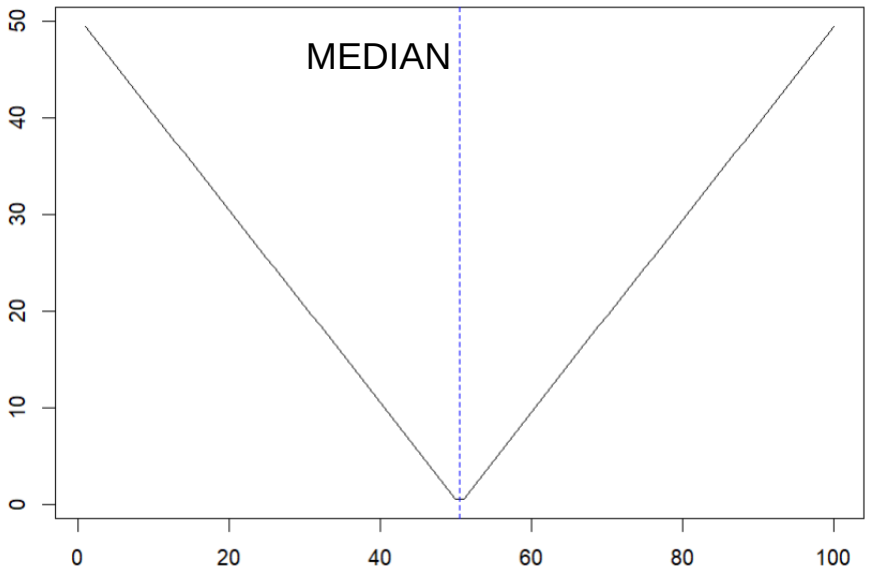
Quantile Regression

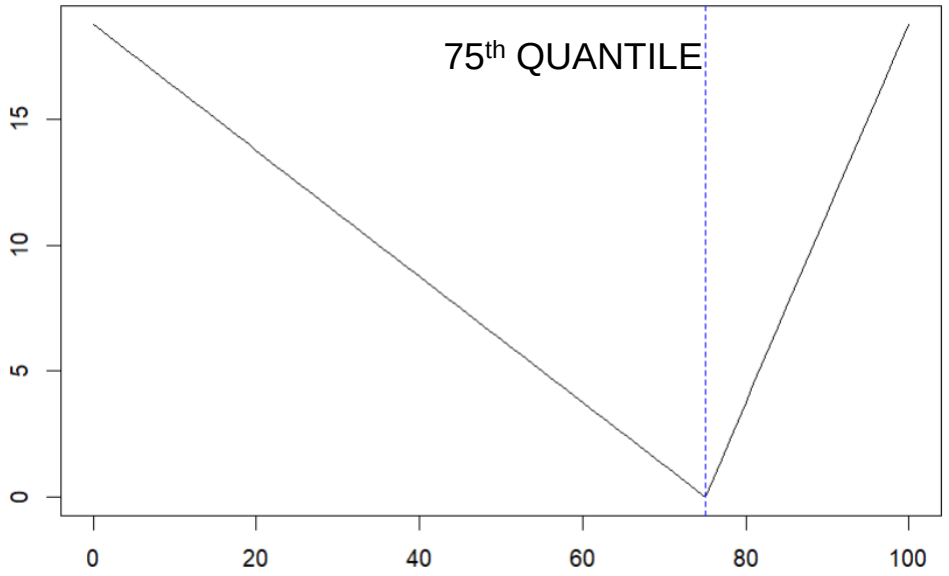
The conditional median is the solution to minimizing absolute residuals.

Koenker, R., & Hallock, K. F. (2001). Quantile regression. *Journal of economic perspectives*, *15*(4), 143-156.

Quantile Regression

The conditional n^{th} quantile (τ) is the solution to minimizing the *asymmetrically weighted* absolute residuals.





Quantile Regression

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Benefits of quantile regression:

- Few distributional assumptions
- Robust to outliers
- **Model full conditional distribution**
- **Model upper limit of the response (e.g. 90th conditional quantile)**

Quantile Regression

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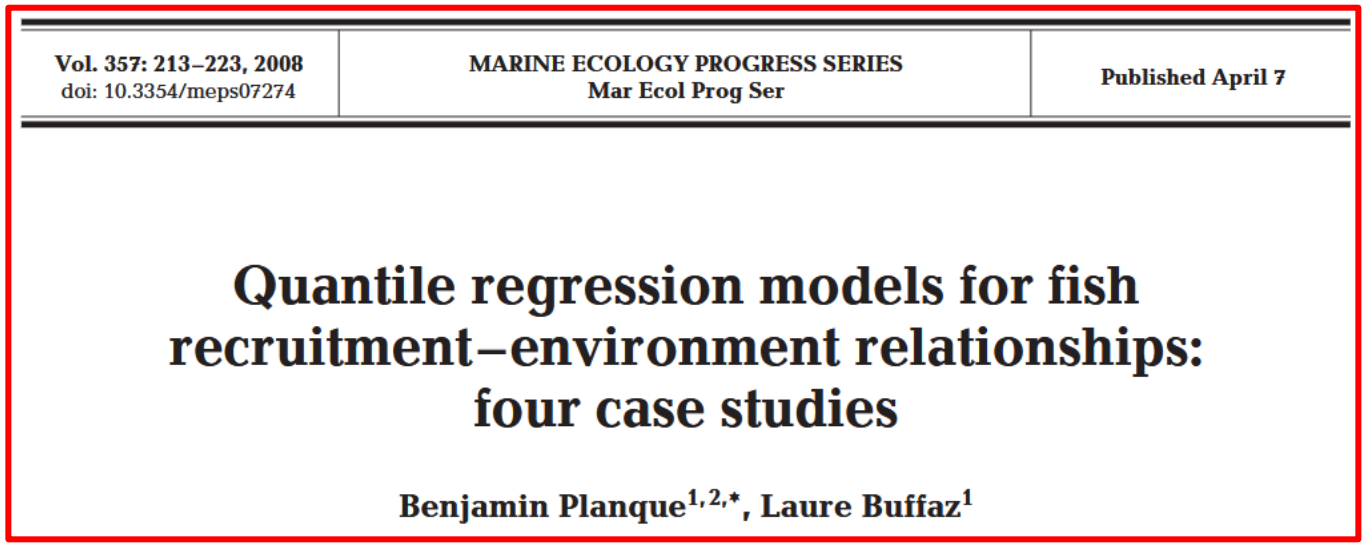
Significance of quantile regressions

- Phase randomization (10,000X)
- Generate an empirical distribution of slopes from randomized data.



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doi: 10.3354/meps07274

MARINE ECOLOGY PROGRESS SERIES
Mar Ecol Prog Ser

Published April 7

Quantile regression models for fish recruitment–environment relationships: four case studies

Benjamin Planque[1,2,*], Laure Buffaz[1]

Timeseries

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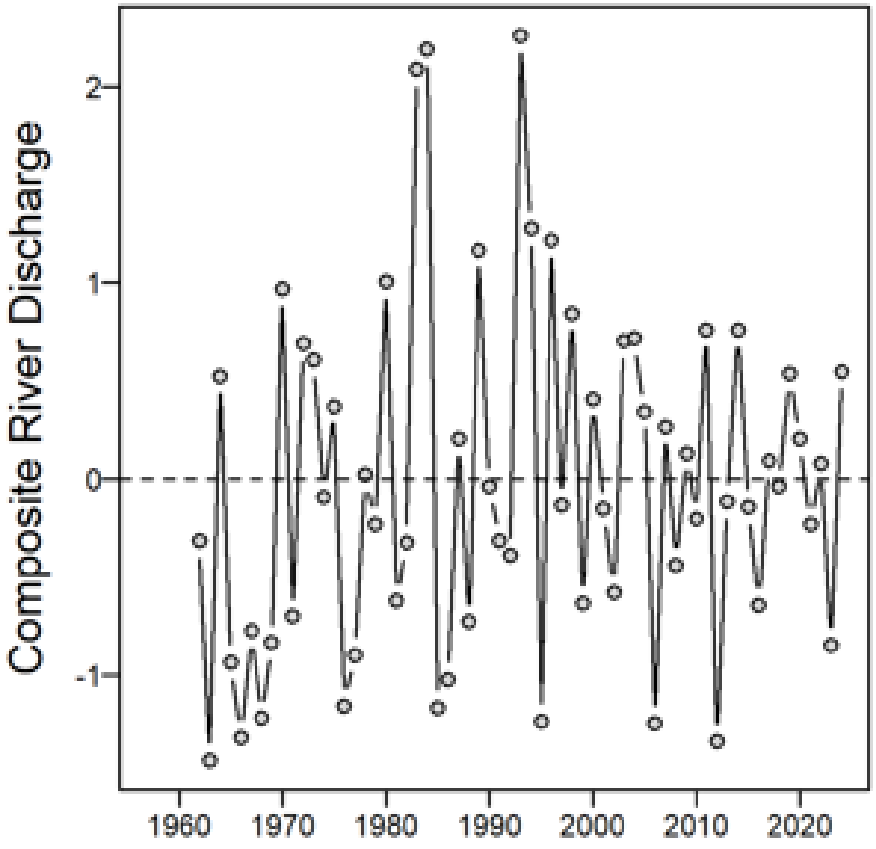
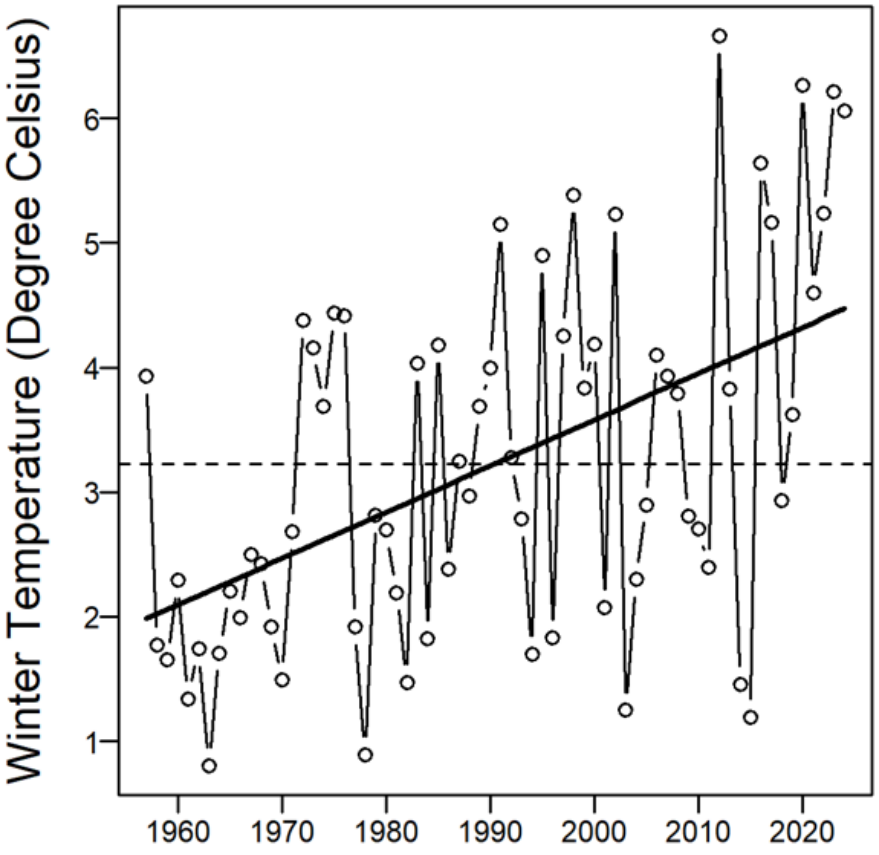
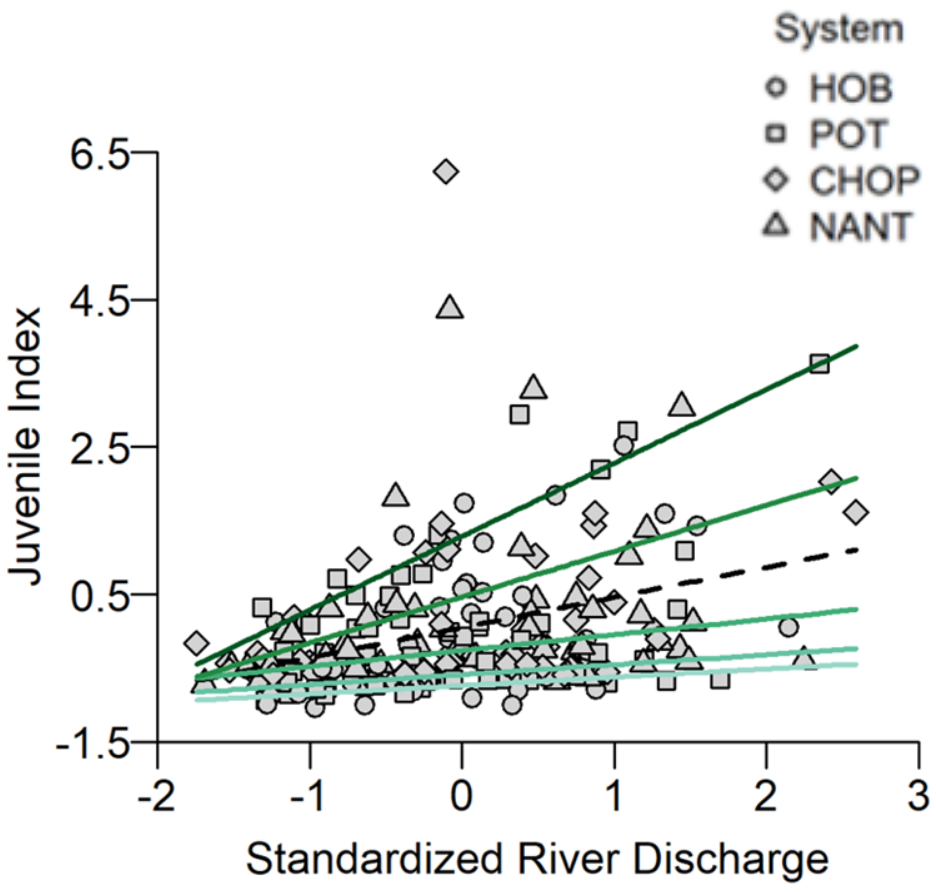
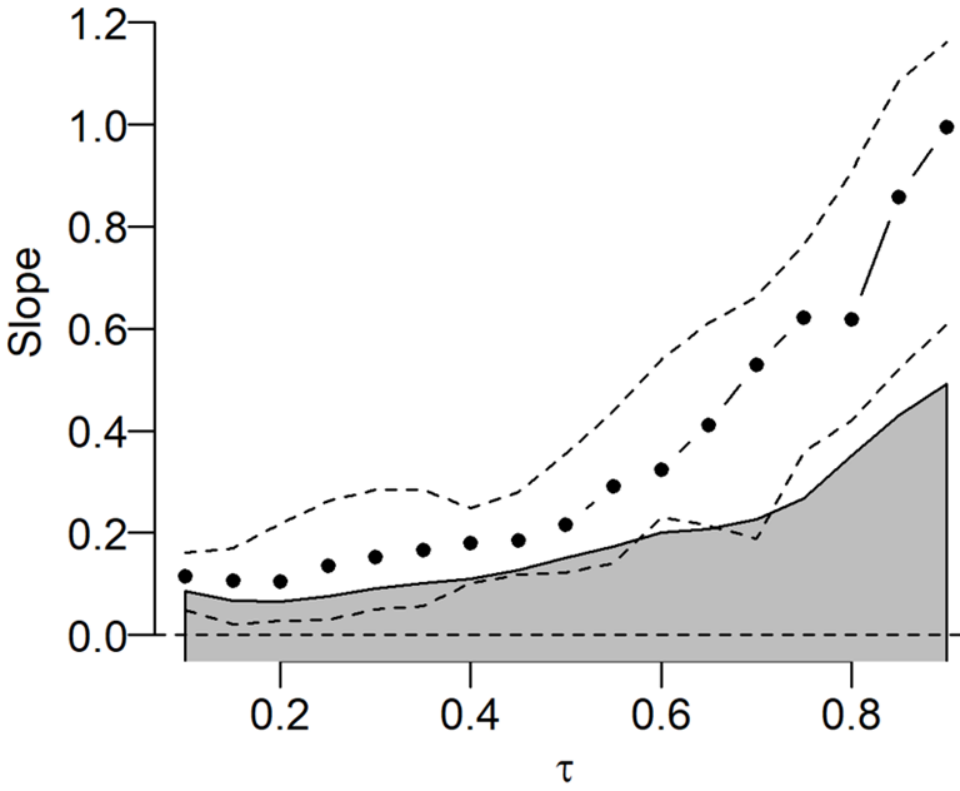




Spring Discharge





Winter Temperature

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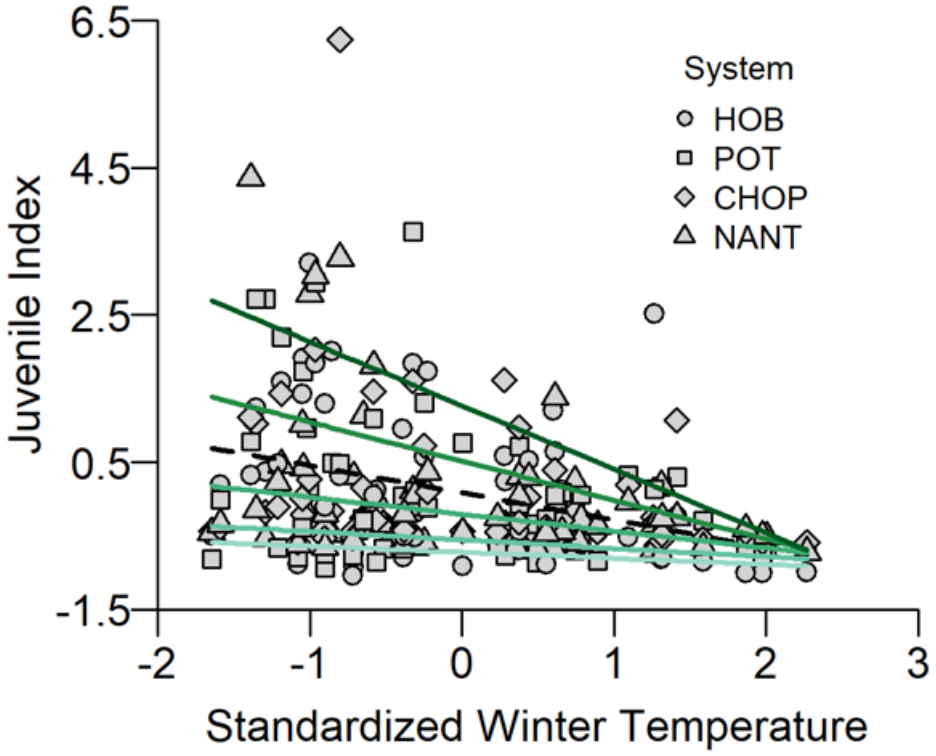
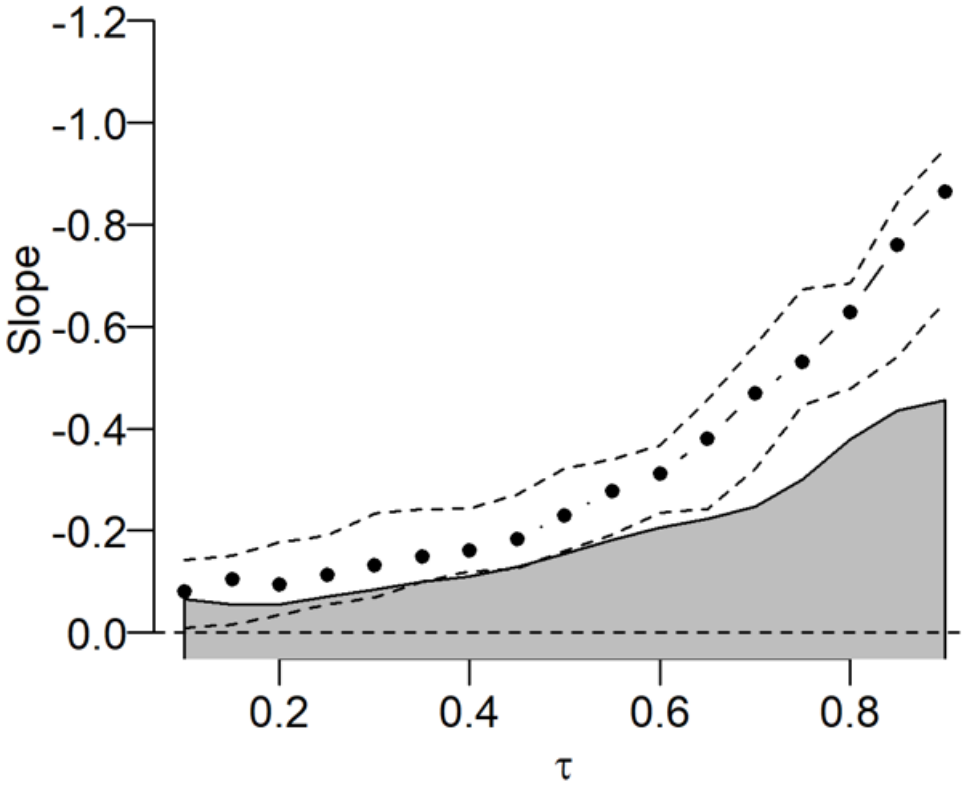
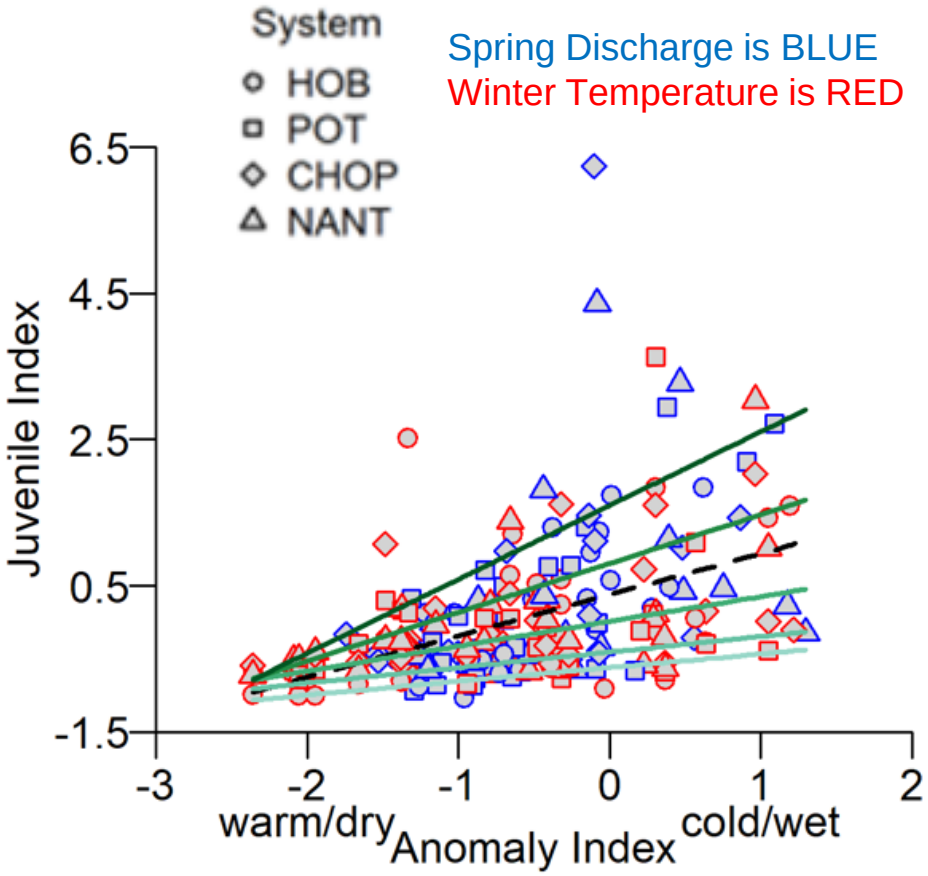
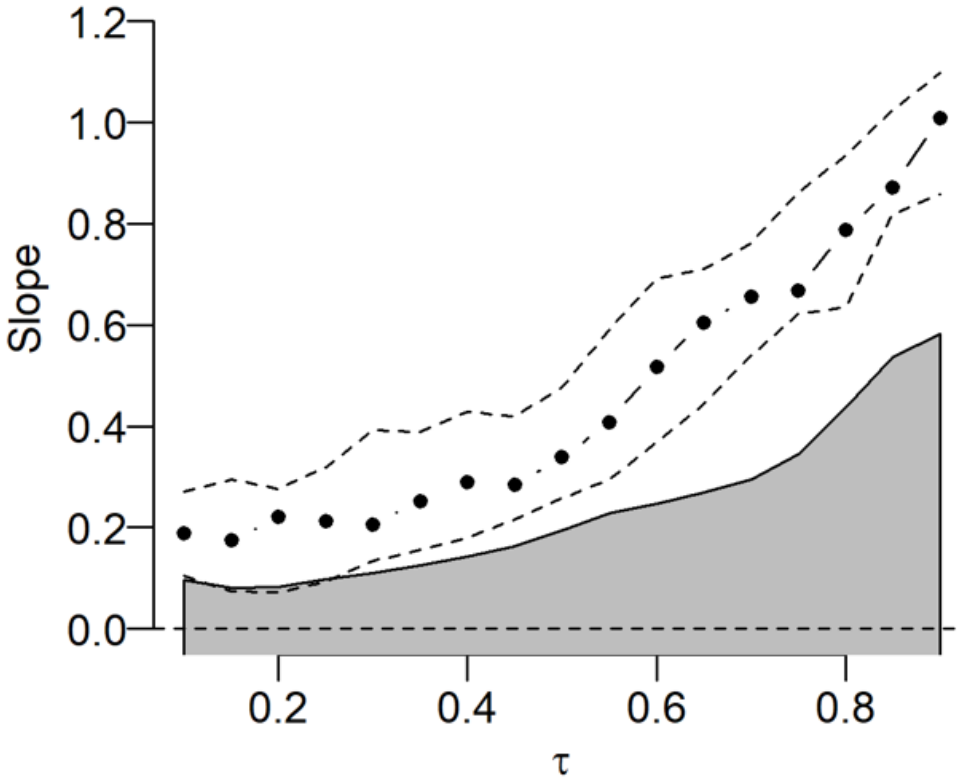


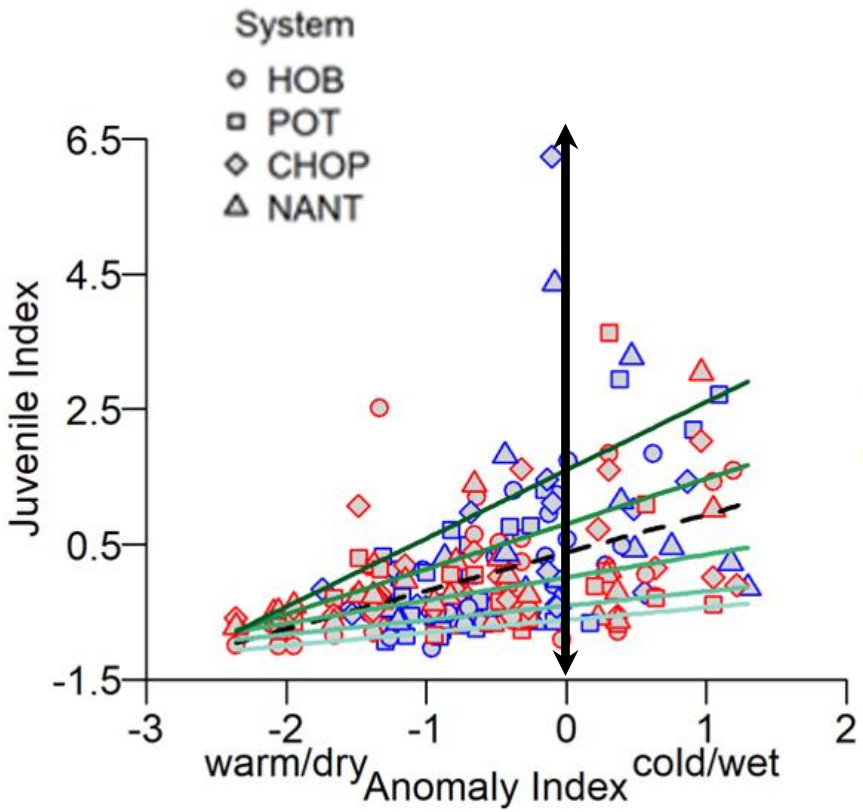


Anomaly Index

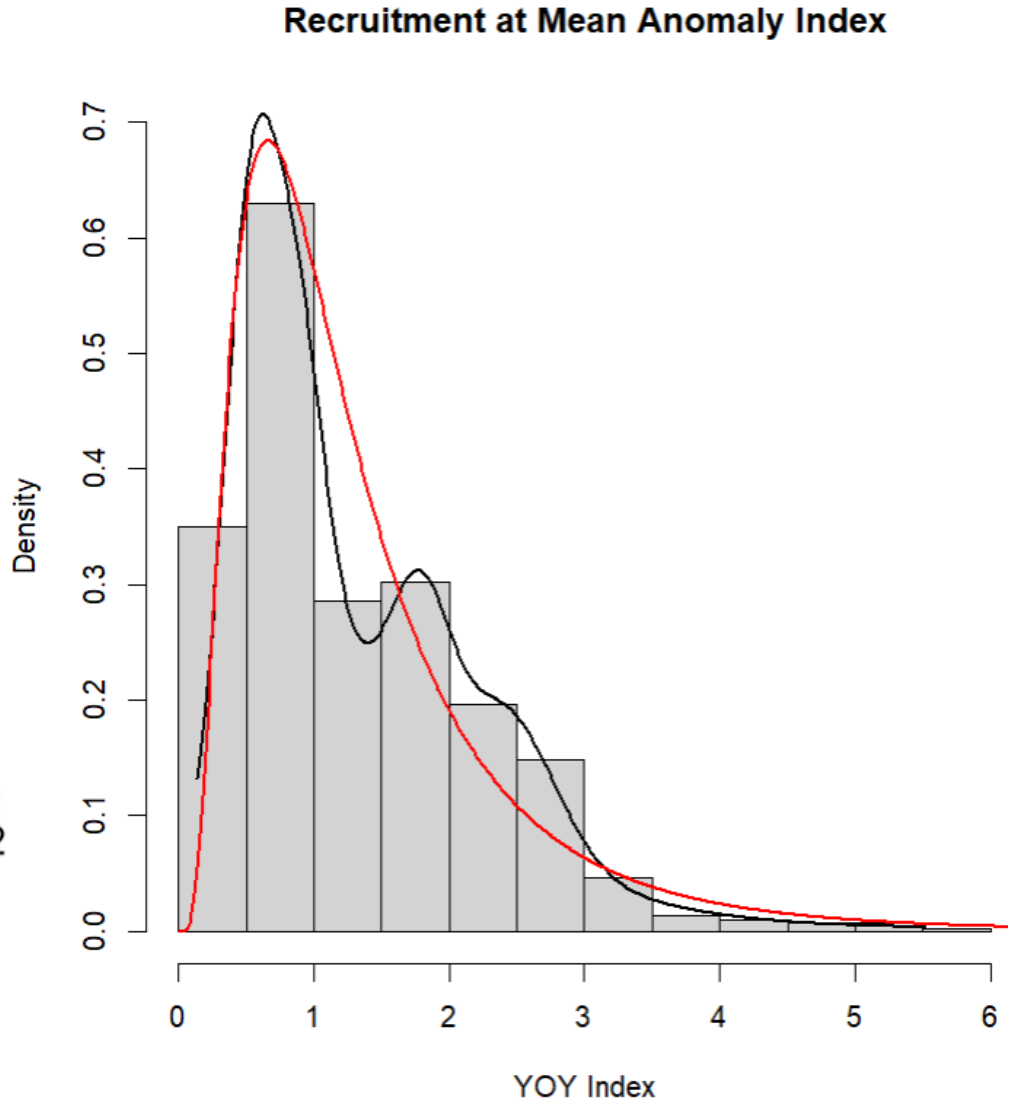




Recruitment Performance



Spring Discharge is BLUE
Winter Temperature is RED



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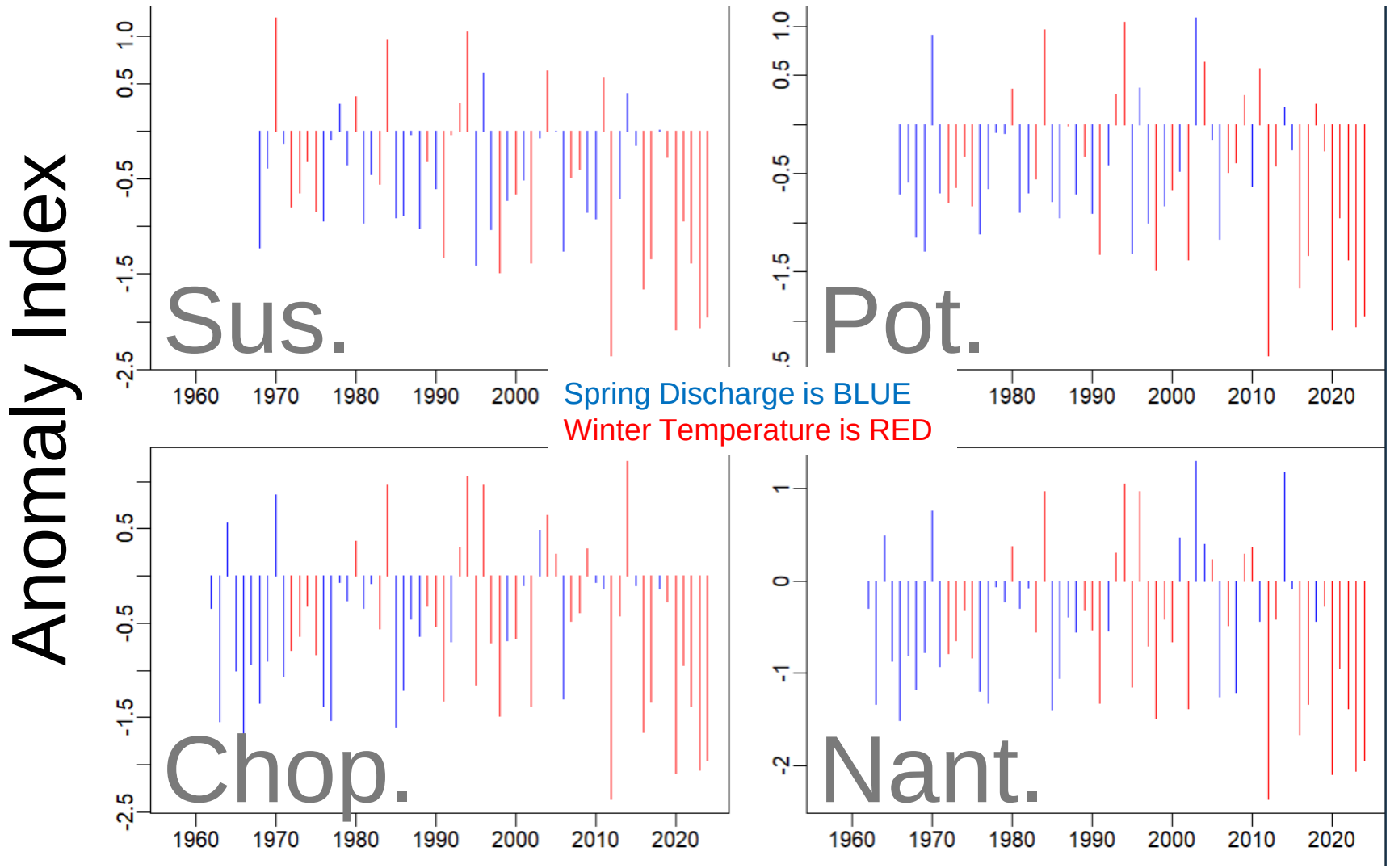

Recruitment Performance

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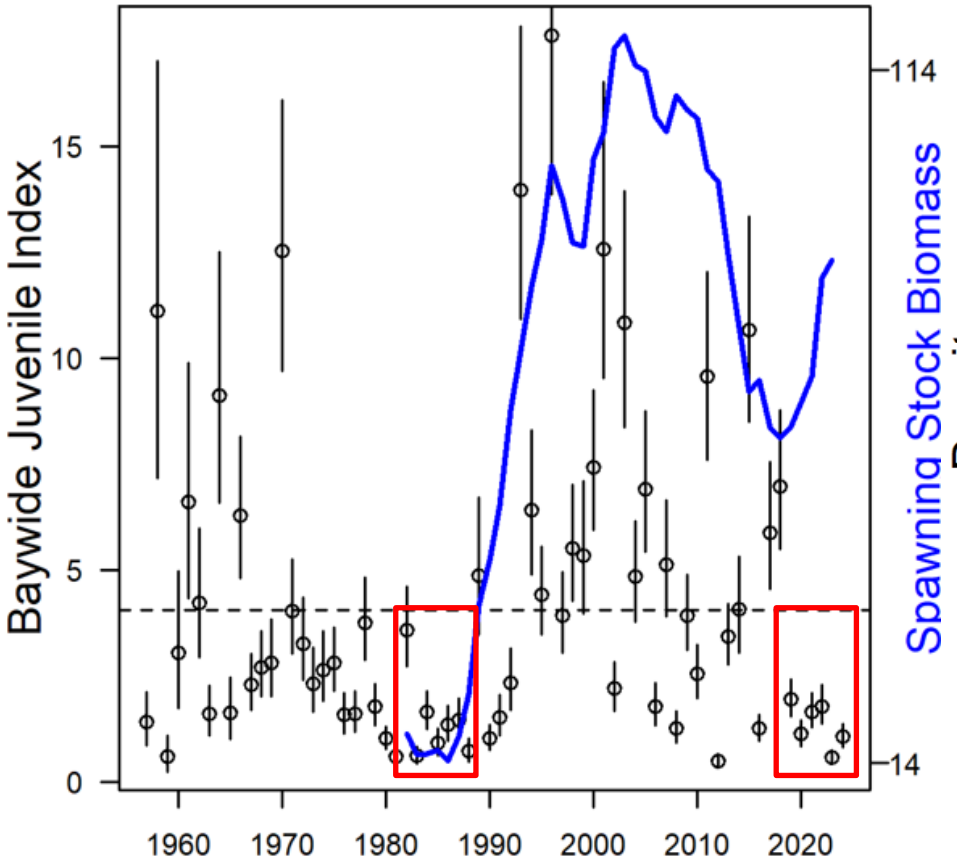

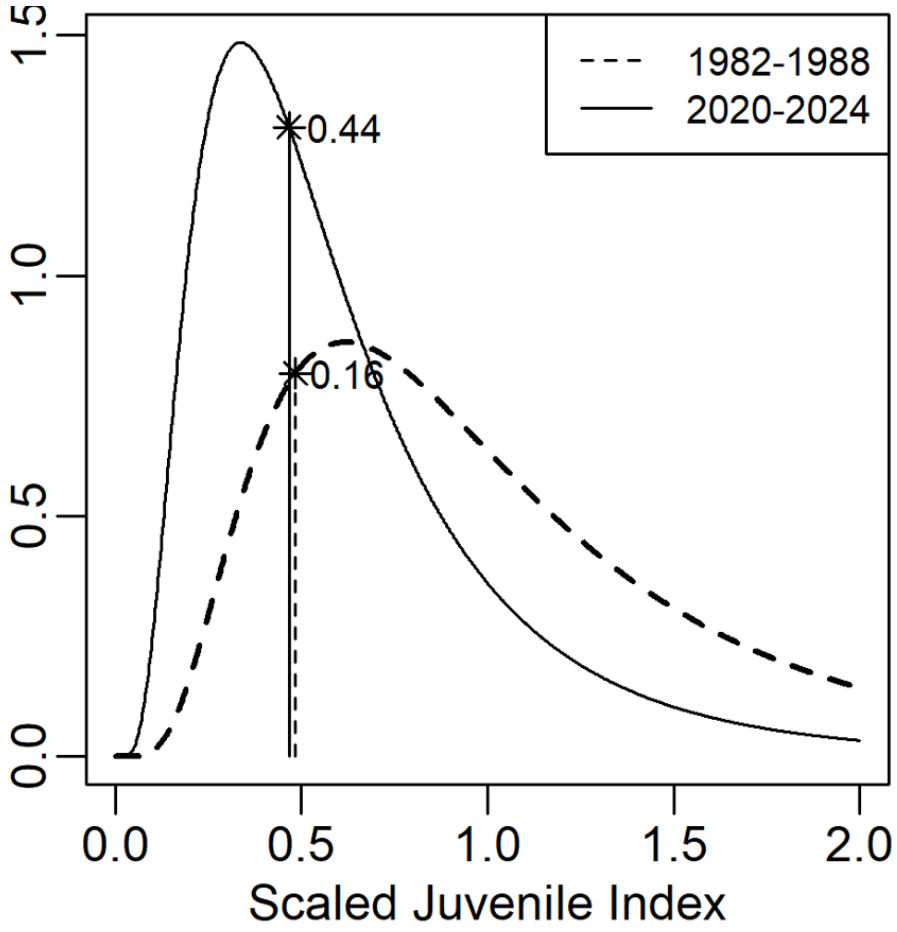

Planning for warmer winters

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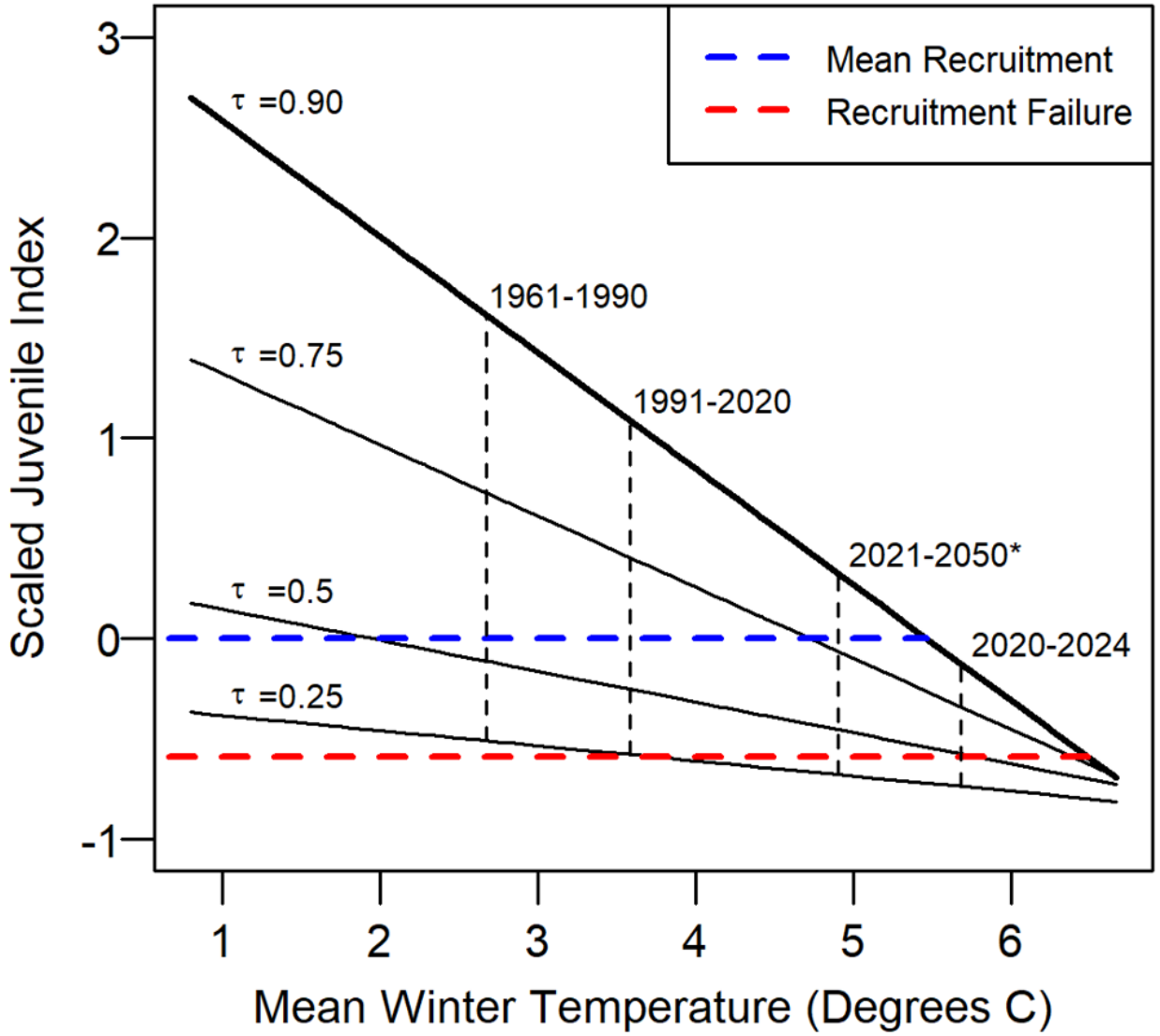

Conclusions

- Quantile regression can approximate recruitment potential.
- Winter temperature and spring freshwater discharge are both limiting factors.
- Recruitment performance suggests recent poor recruitment is due to warm winters.
- If warming trend continues, recruitment will be increasingly constrained.