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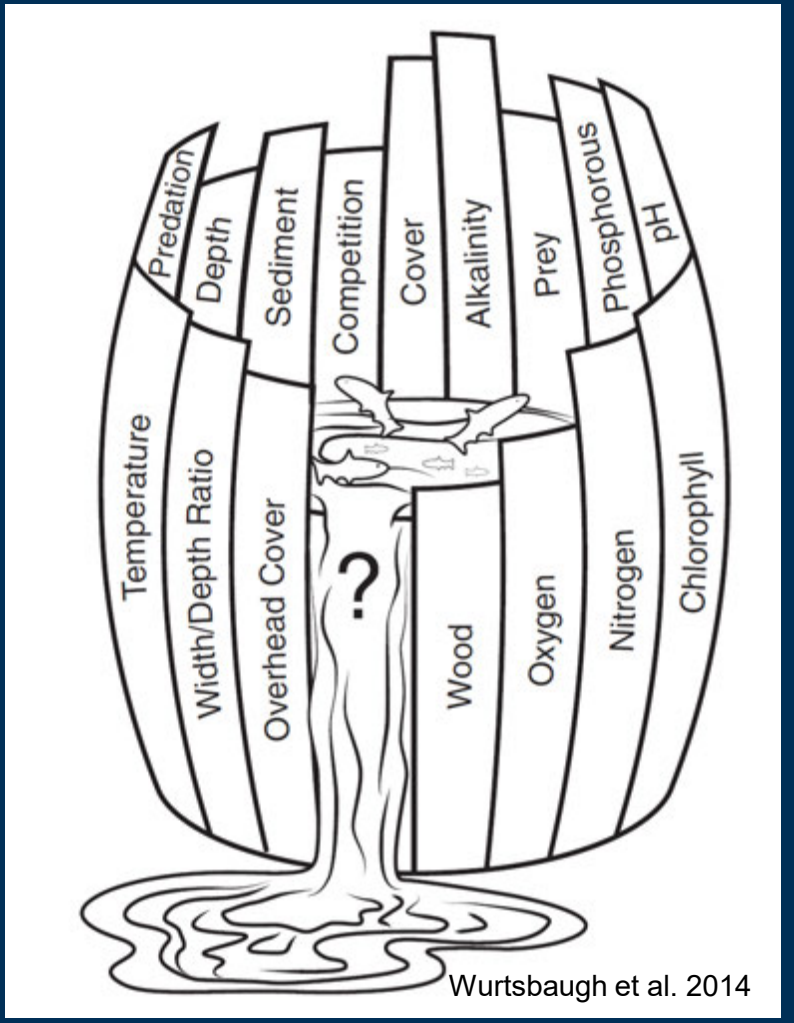
science for a changing world

Predictions, populations, and energetic constraints

Project elements: Projects E – I data
- E.2 Ecosystem modelling ($50K)
- H.2 RBT recruitment and BNT modelling ($7K)
- (G.1 HBC population modelling)
- (J.2 Decision science)

Resource Goals: Humpback Chub, Natural Processes, Other Native Fish, Rainbow trout, Nonnative Invasive Species

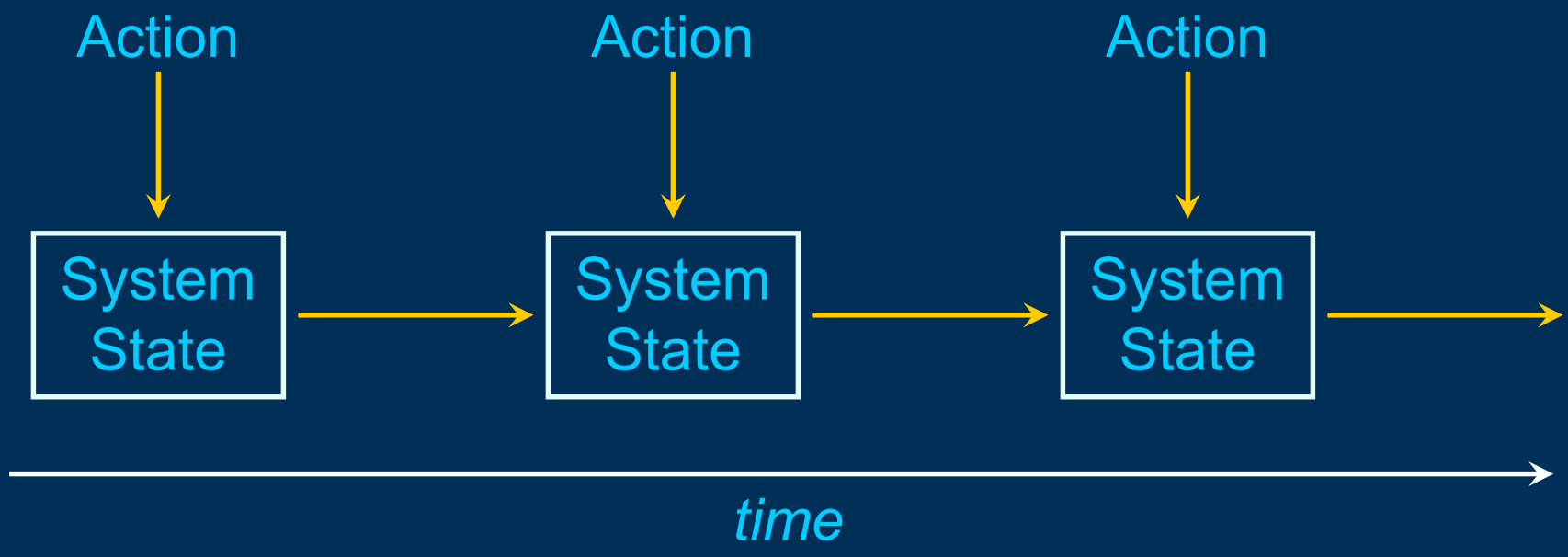
Annual Reporting
January 13, 2020



Wurtsbaugh et al. 2014

U.S. Department of the Interior
U.S. Geological Survey

Science needs to improve predictions to be useful.
Process understanding (arrows)
State-dependent decisions (boxes)*



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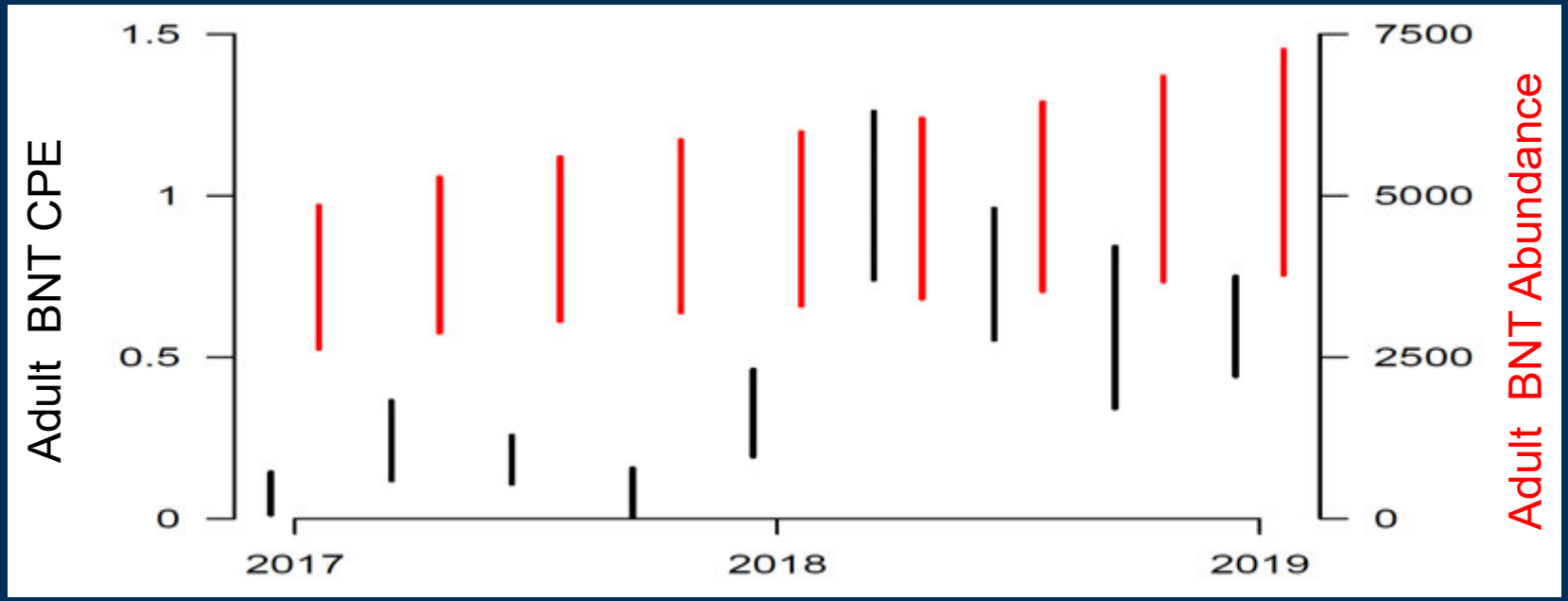
Prediction, models and management

"An approximate answer to the right question is worth a great deal more than a precise answer to the wrong question.“ - Tukey



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Preliminary data, do not cite

Prediction, models and management, cont.

- Very few ecological questions are definitely answered with single studies.
  - Biomedical studies –75-90% of published, preclinical results can be reproduced
  - Even worse when a single study with replication equal to 1 or 2

- But statistical significance shouldn't be basis for management decisions (Trends)

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A working example of Adaptive management: Mid-Continent Mallard Harvest

- Initiated 1995
- 4 distinct hypotheses
- Abundance estimated by aerial survey
- Model weights updated: comparison of estimate with predictions

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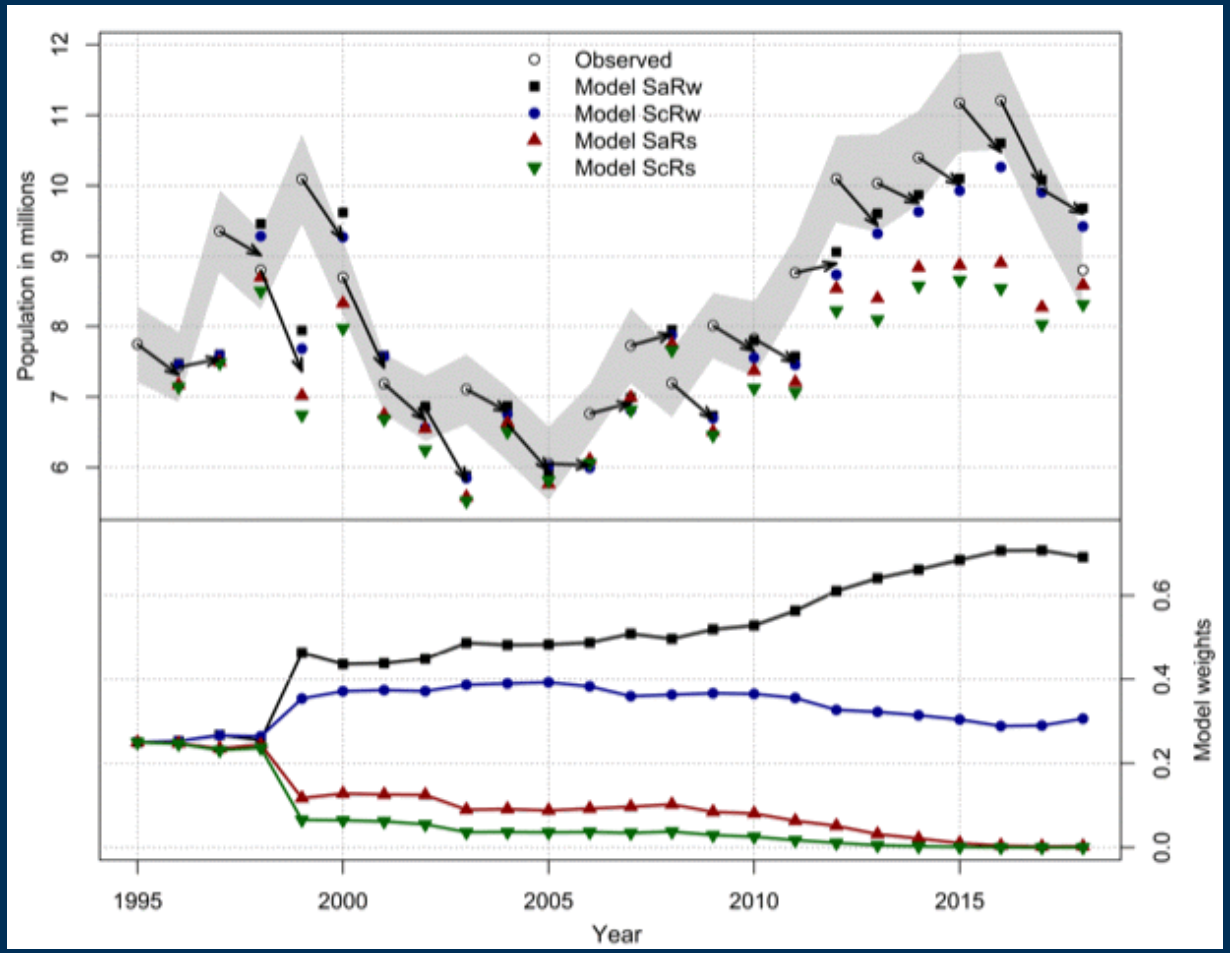
Mid-Continental Mallard Harvest has been informed by 4 models for over 20 years with model weights updated over time to reflect learning from data



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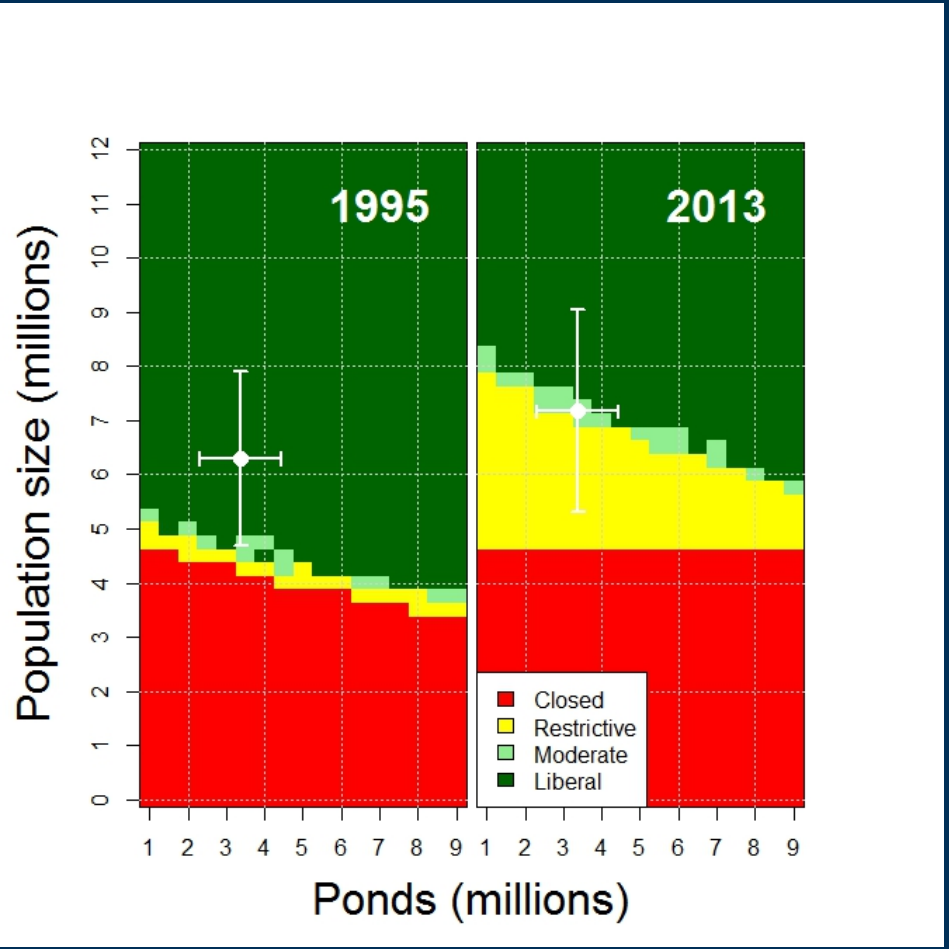
Nichols et al., 2019

Harvest policy has been updated adaptively with differences in model weights



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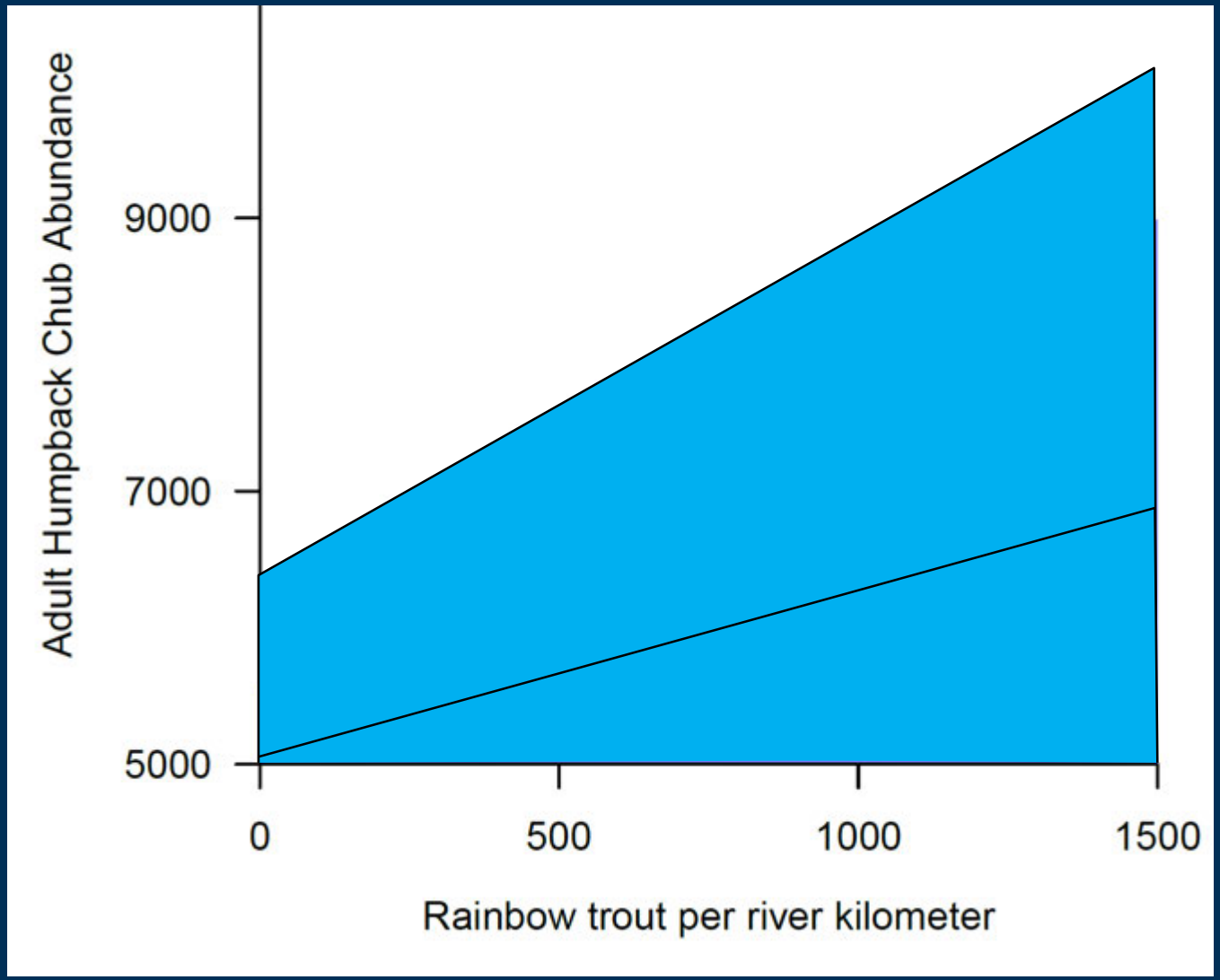
Nichols et al., 2019

We have been working to develop similar approaches for updating decision rules with monitoring results



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Adapted from Donovan et al., 2019; Yackulic et al., 2019

Outline

- Brown trout update
- Energetic constraints
  - Rainbow trout recruitment models
  - Native fish near Little Colorado River
  - Energetics/recruitment of Flannelmouth sucker in western Grand Canyon

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BNT integrated model

- Uses mark-recap data from USGS and catch from AZGF
- Expected lambda had ~50% probability of being greater than 1 (Runge et al., 2018)
- Last year showed N for adults sensitive to priors because of lack of mark-recap data
- Allowed to collect mark-recap data in 2019

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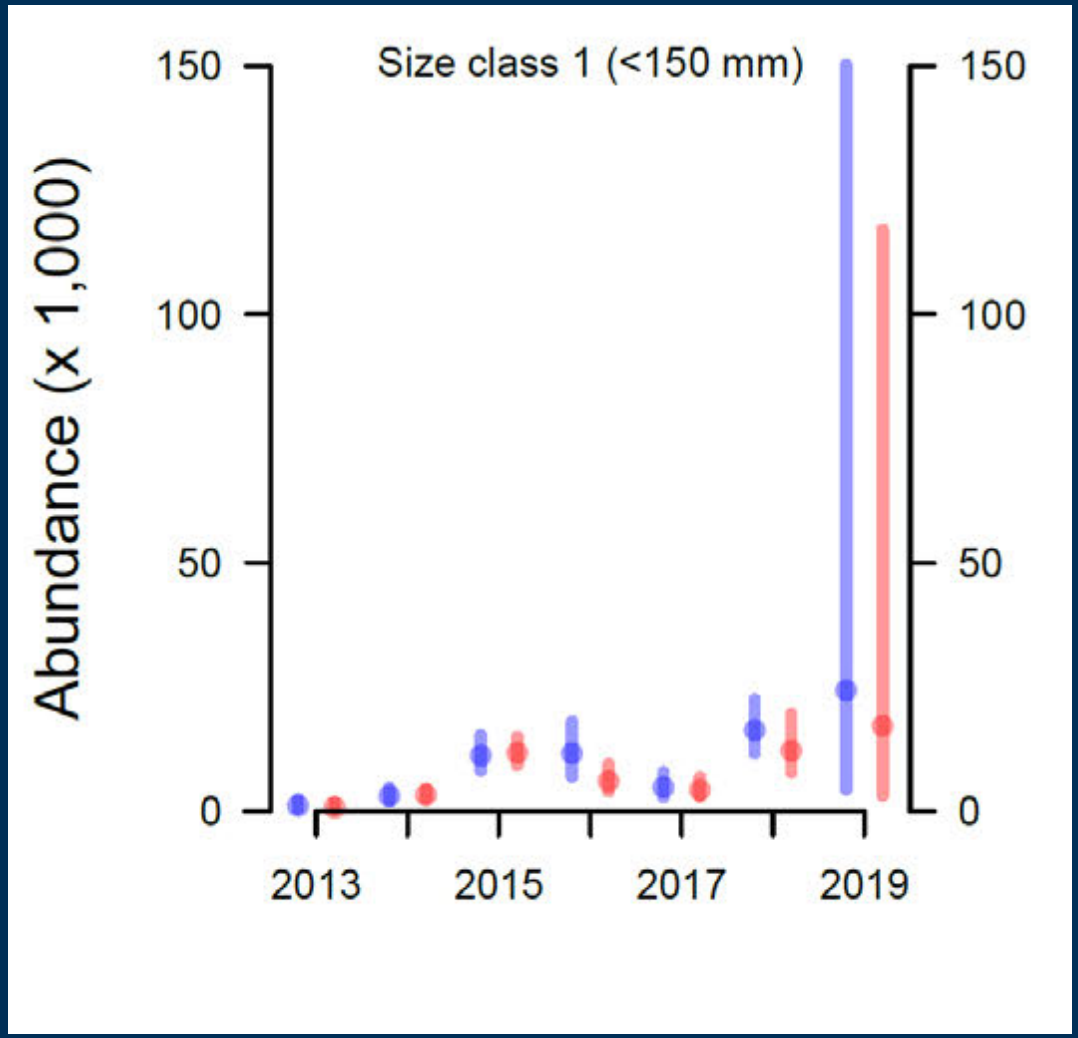
With a little more mark-recap, models with different priors are starting to estimate similar abundances.



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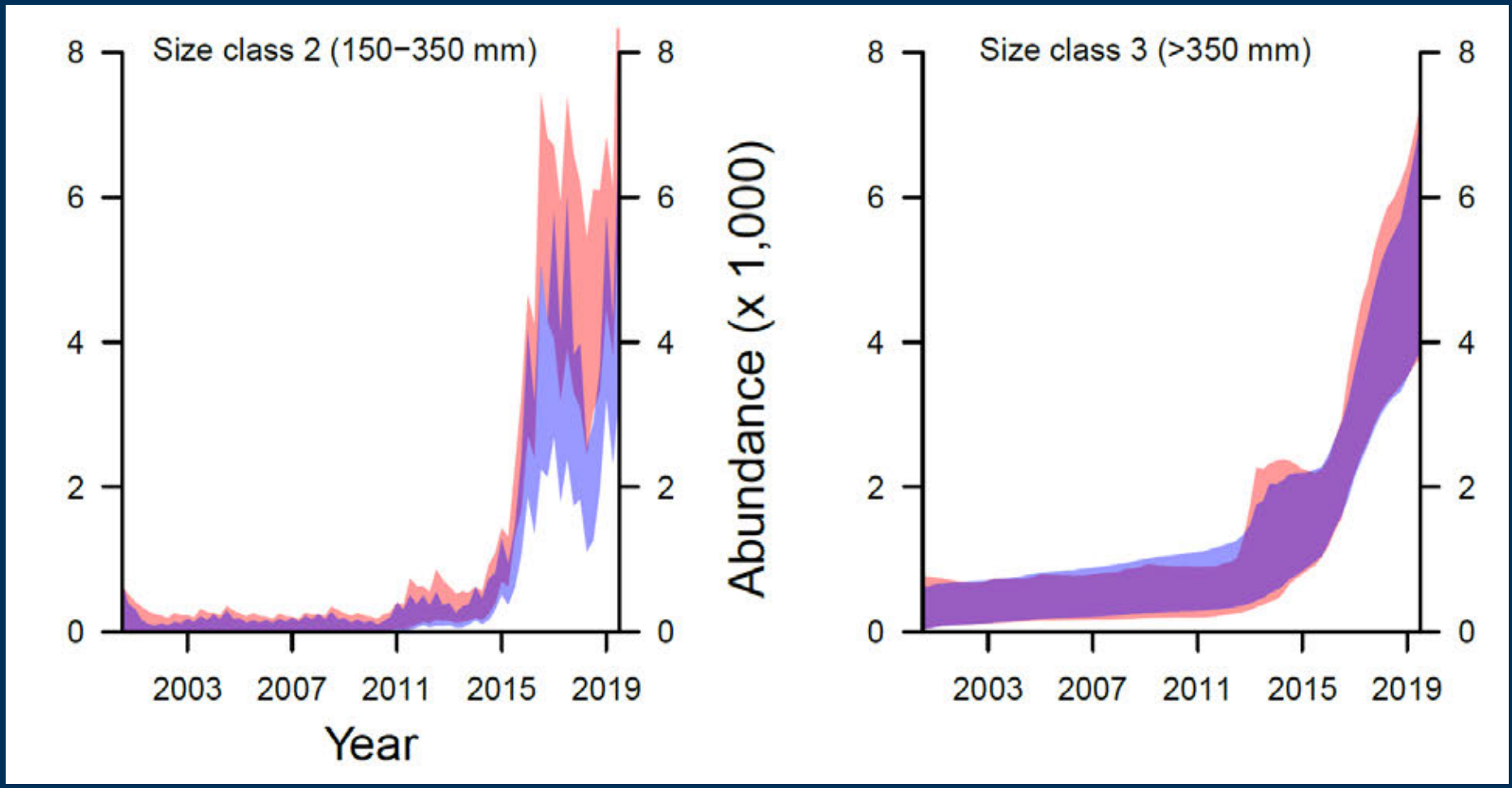
Abundance estimates for larger size classes are more similar now between models with different priors (red and blue represent different priors on survival)



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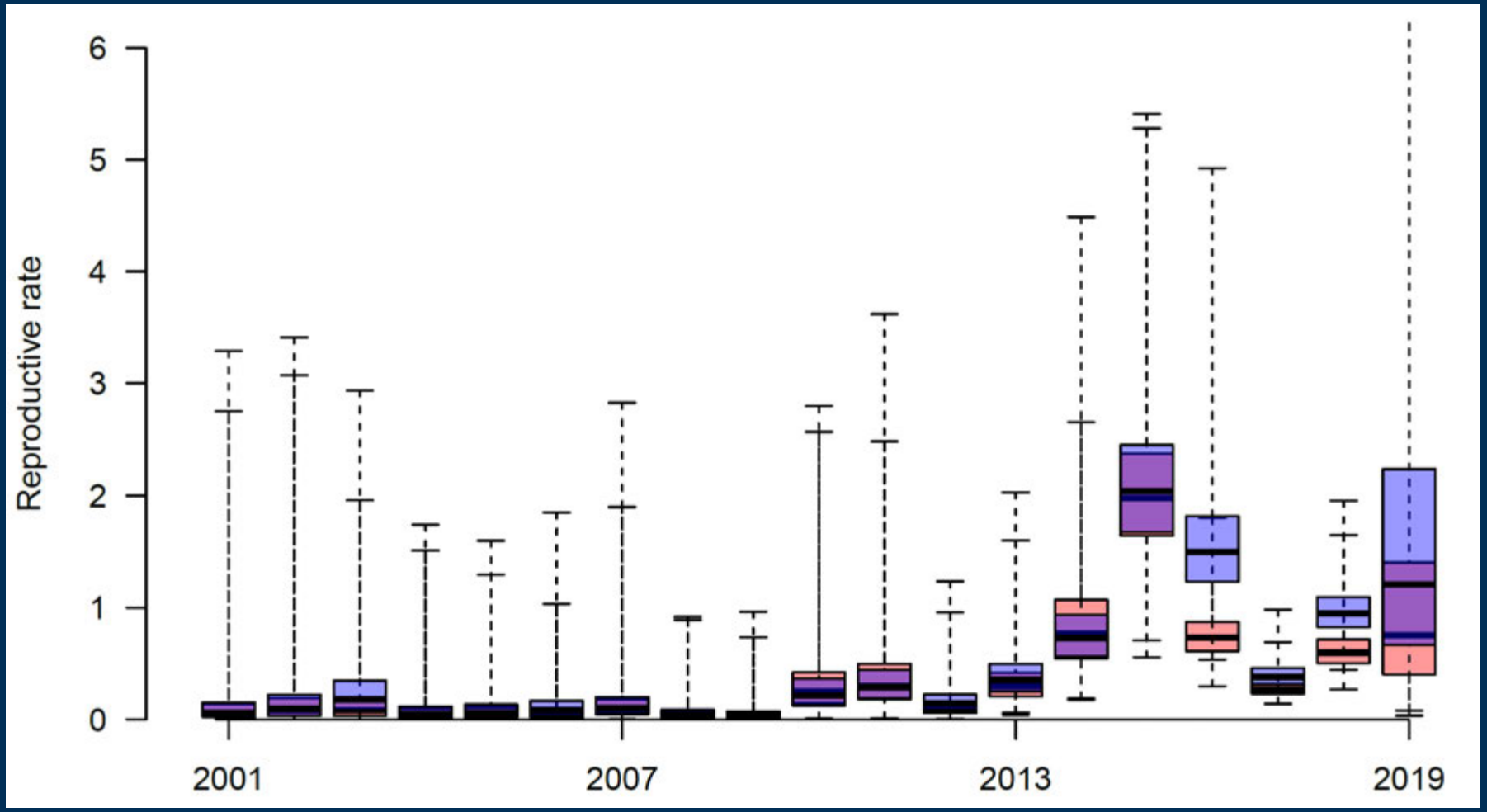
But models still disagree a little regarding magnitude and timing of reproduction



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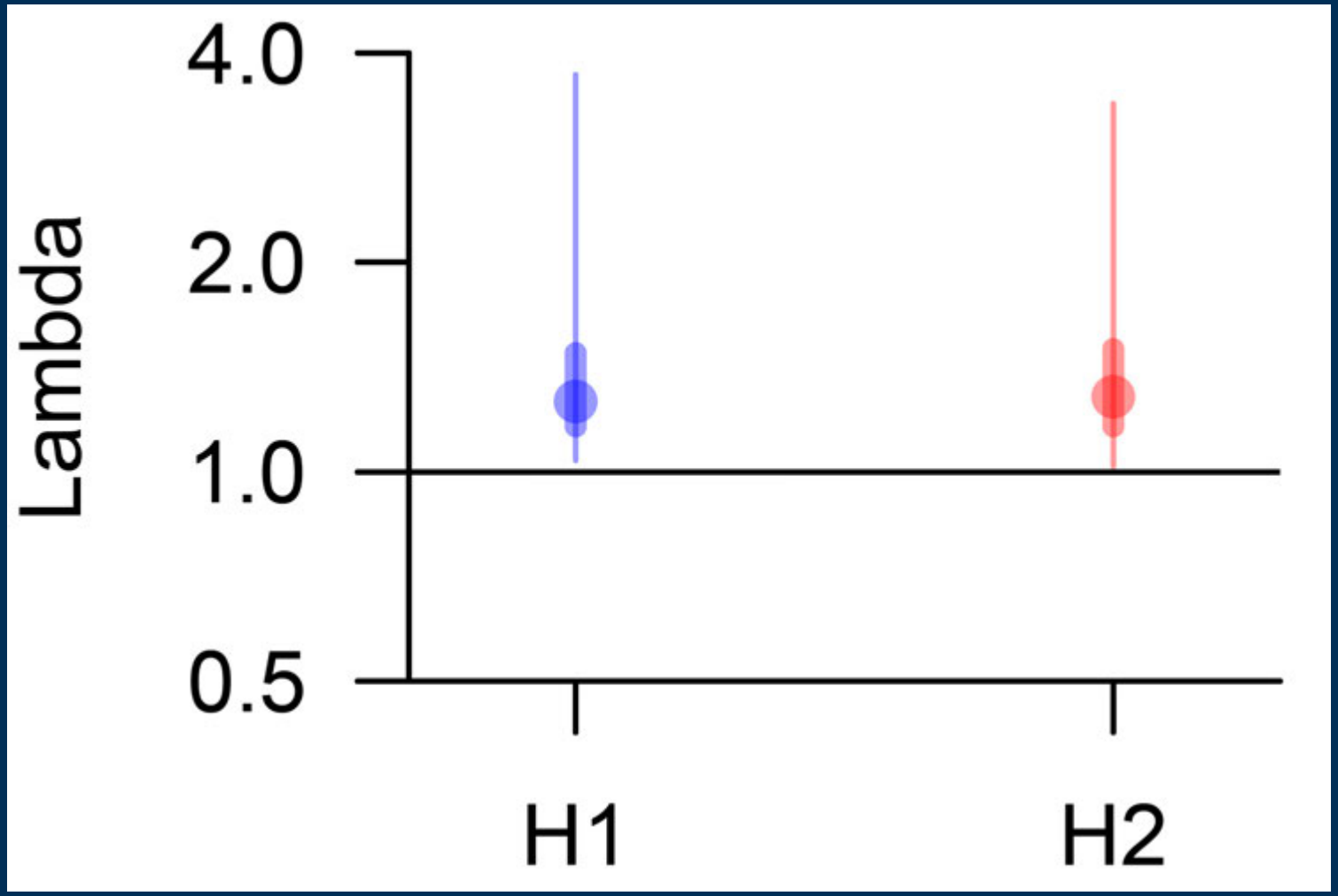
There is no doubt population growth will continue if things don't change



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Outline, cont.

- Brown trout update

- Energetic constraints
  - Flannelmouth sucker in western Grand Canyon
  - Rainbow trout recruitment models
  - Humpback chub condition

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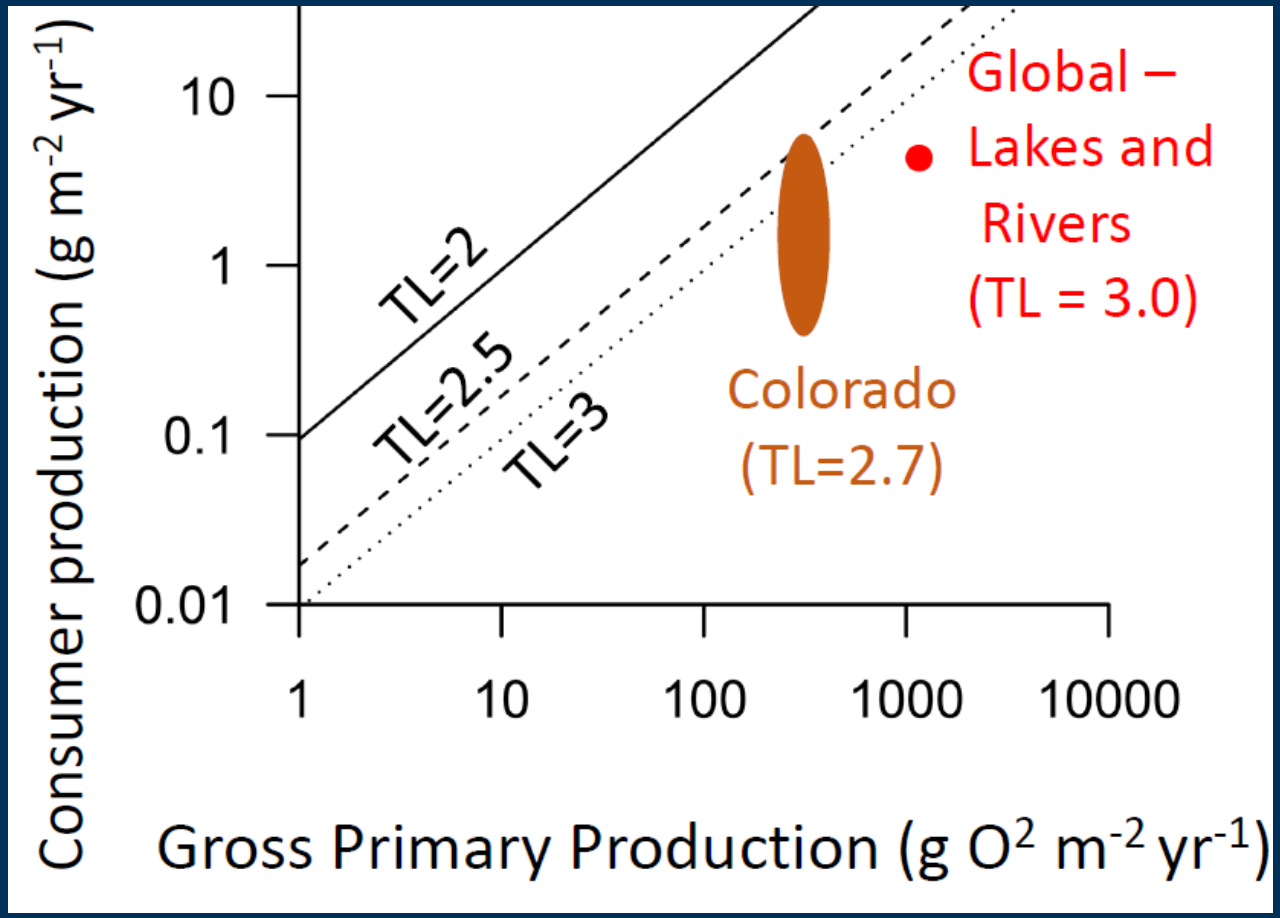
Primary production and the transfer of energy through food webs constrain fish production.



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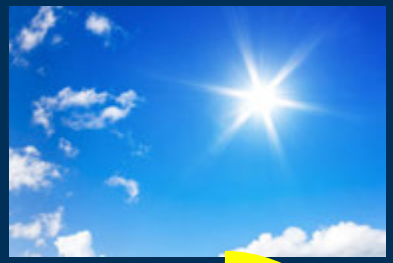
Ruegg et al., in review; Preliminary data, do not cite

Conceptual model



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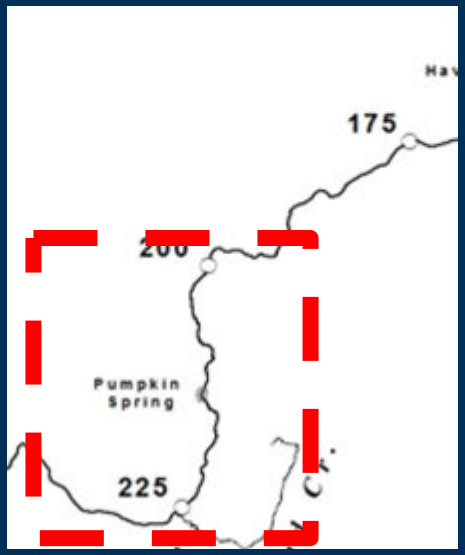
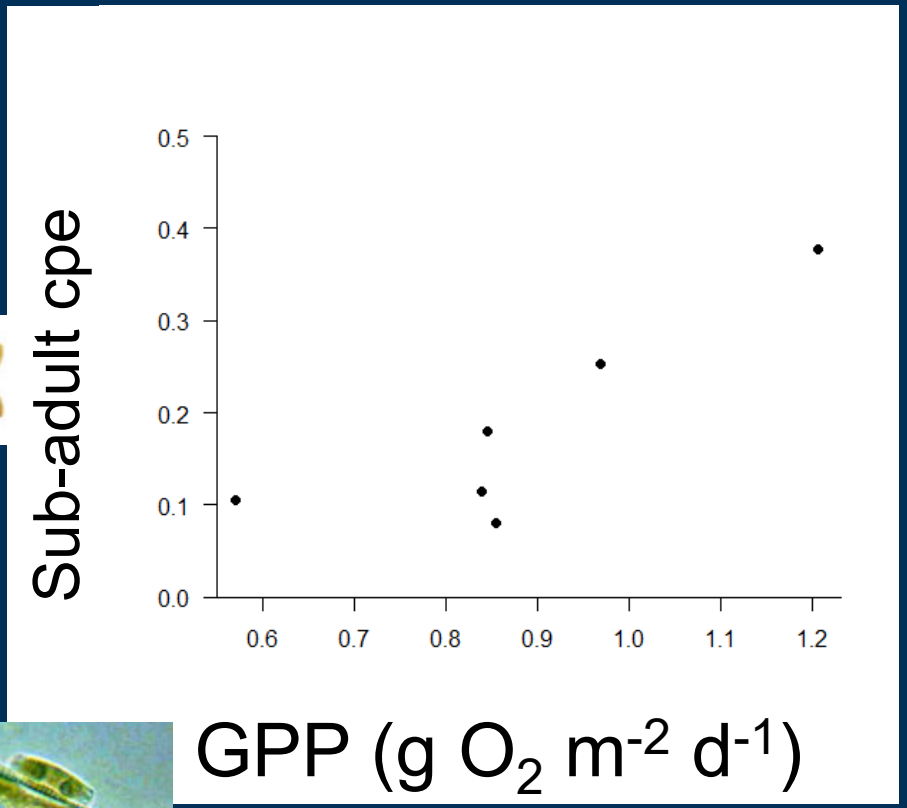
How changes in energetic constraints will effect vital rates will depend on life history / metabolism, but should be most clear in species that dominate consumption in a local community.





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Preliminary data, do not cite

Unclear what drives GPP in western Grand Canyon, but we previously (a priori) hypothesized that phosphorous in Dam releases may be limiting energy (and thus fish) in Lees Ferry and near the Little Colorado River.

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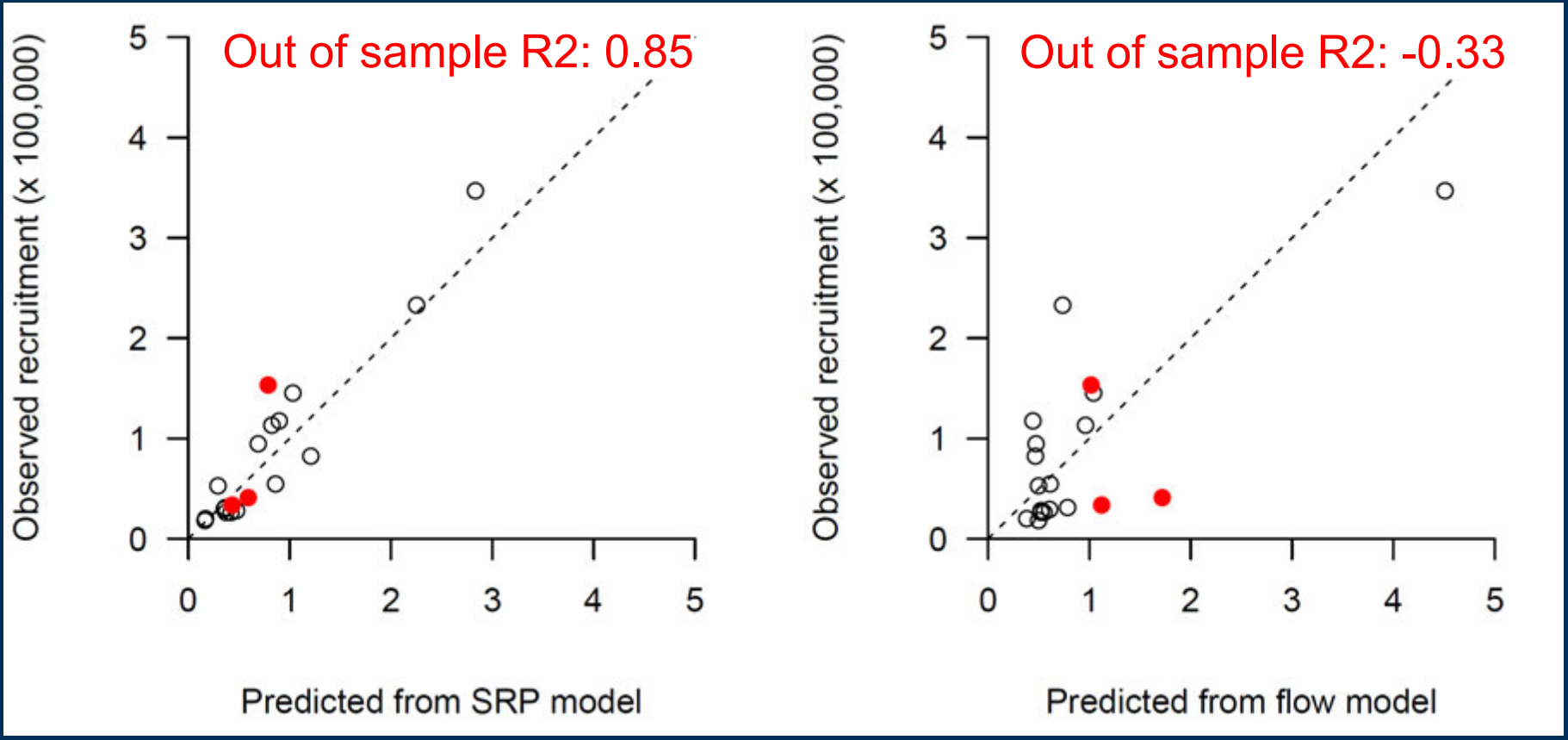
Rainbow trout recruitment models fit for 2017 annual reporting meeting



Model using SRP and existing rainbow trout population size as covariates previously outperformed model used in LTEMP EIS.

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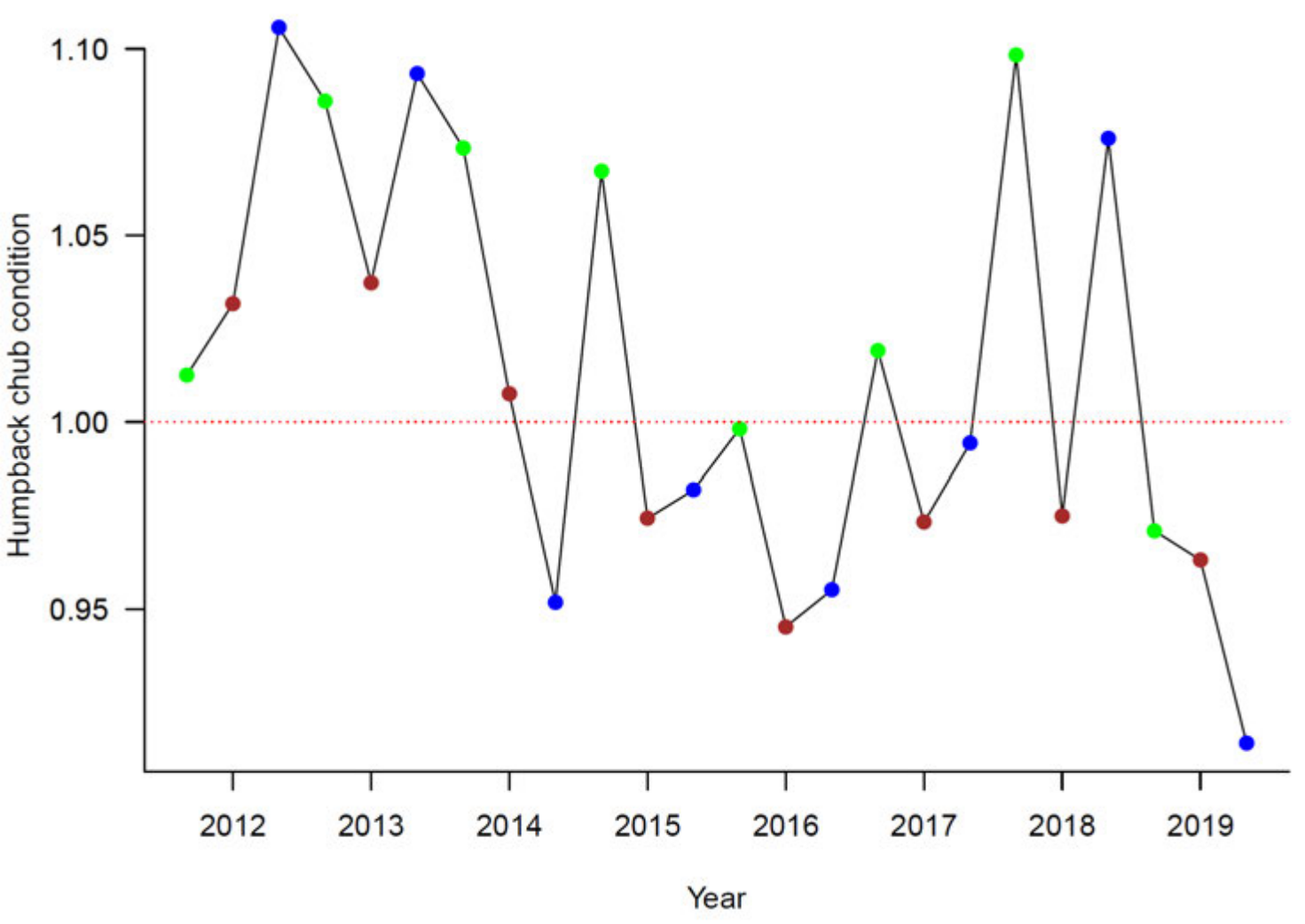
Near the LCR, the picture is less definitive.



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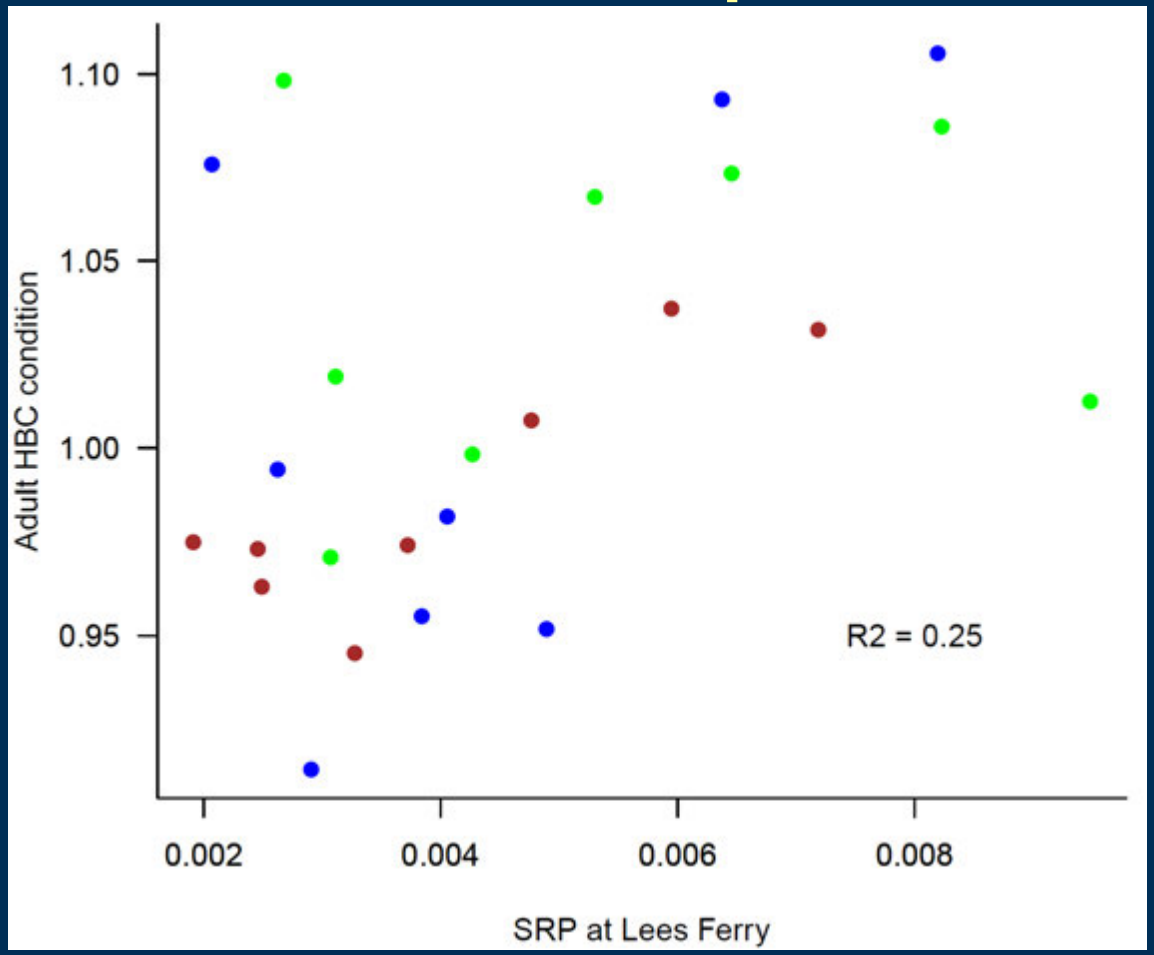
Correlation between SRP and chub condition has not been as close in recent years, but SRP measured far upstream.



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Take homes

- Predicting the actual quantity of interest (not a proxy) with uncertainty should be the goal of applied science.

- Brown trout are likely to continue to increase in the short term.

- Energetic constraints exist for fish populations in all parts of the canyon, and phosphorous is strongly linked to rainbow trout and more weakly linked to humpback chub.

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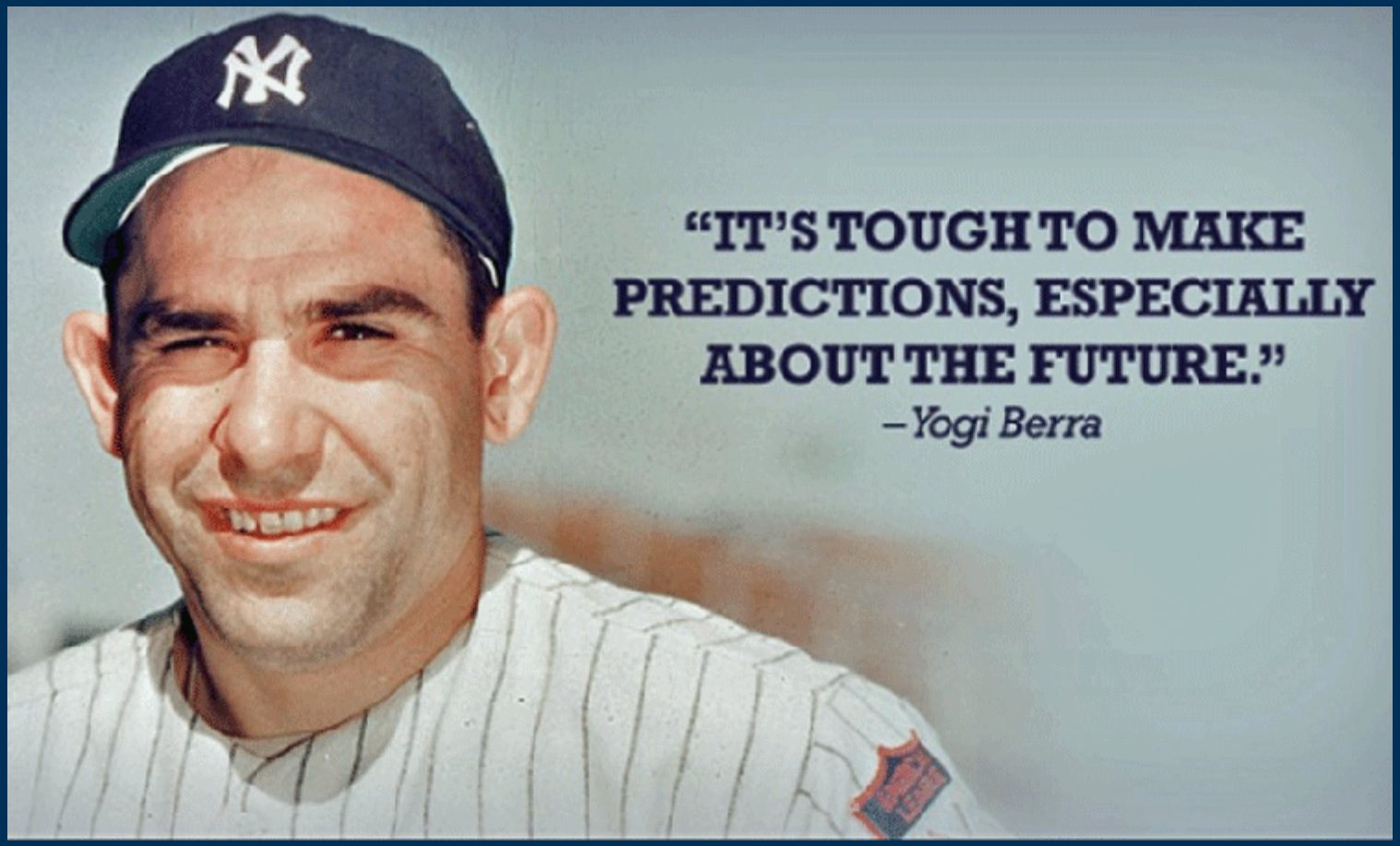
Thank you for your attention!



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