USGS
science for a changing world

Brown trout population modeling

H.2 RBT recruitment and BNT modelling ($7K)

Using data collected by AZGF and TRGD as part of project H

Thanks to Josh Korman, Laura Tennant, Jan Boyer and Michael Yard

Resource Goals: Invasive Species

Annual Reporting
January 21, 2021

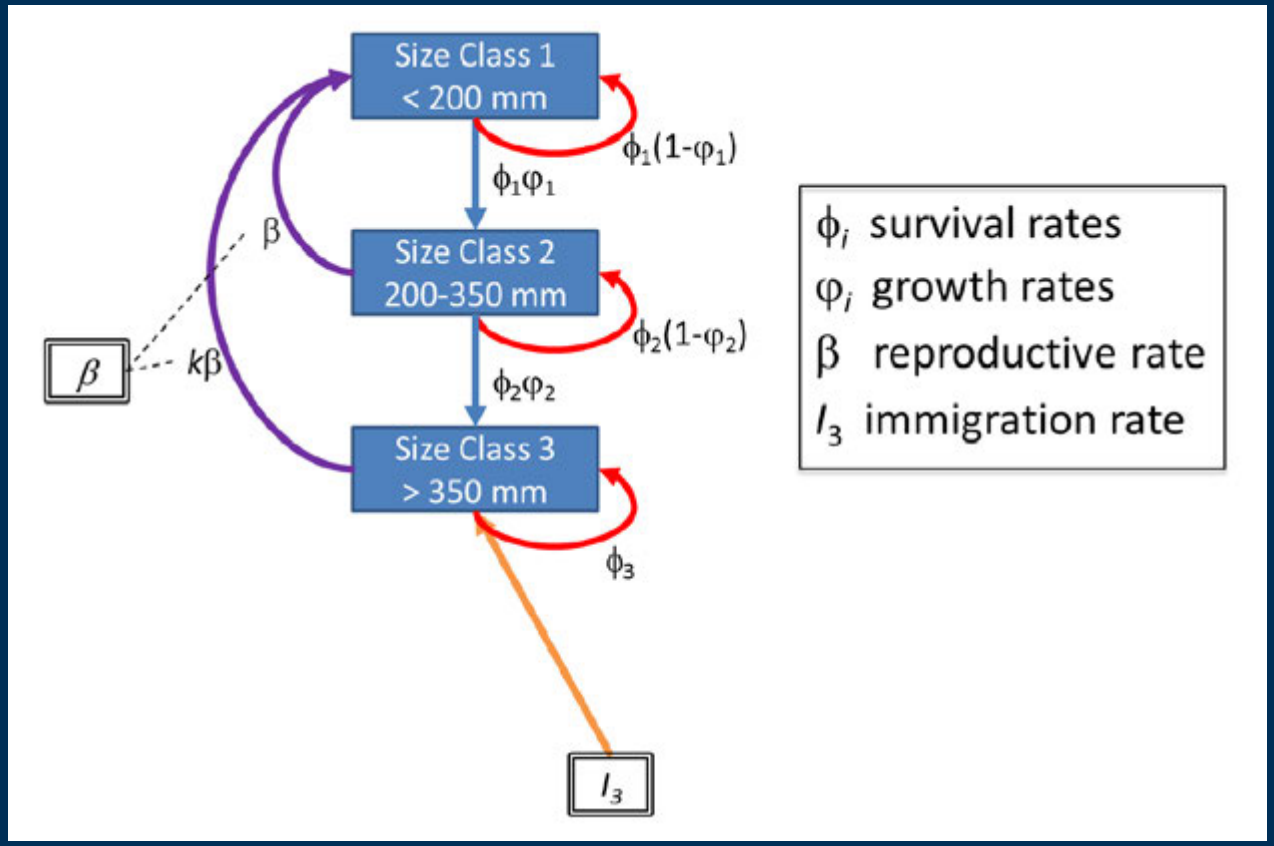
U.S. Department of the Interior
U.S. Geological Survey

Outline

- Brown trout continue to increase.
- The competitive interference hypothesis for recruitment may have legs.
- Evidence for another immigration event coincident with 2018 fall high flow event.
- Influence of data reduction for BNT model.
- Rainbow trout recruitment model update.

USGS

Basic modelling framework



- Fit to cpe data (2000 – present) and mark-recapture data (2012-present)
- 1 mark-recapture site (2012-2016), 3 sites (2017-2020), 2 sites (FY21)…
- Gap in mark-recapture data when culling required.

USGS

Modelling assumptions

- Seasonal time step.
- Size and seasonal variation in growth and survival (but not among years).
- Survival informed by a Lorenzen relationship.
- Capture probability allowed to vary by trip and size class (random effect).
- Immigration for large adults allowed to vary for each interval (random effect).
- Recruitment varies between years (random effect).

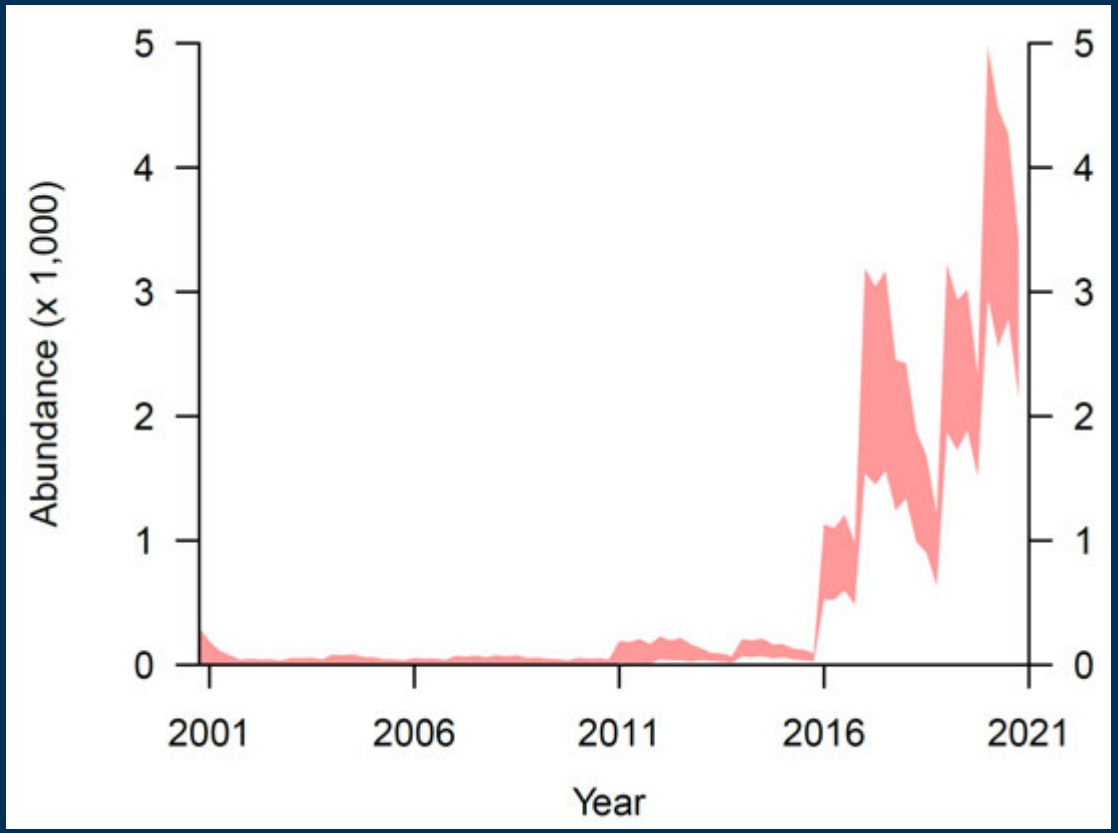
USGS

Somewhat good news: Abundance of largest brown trout stable over last ~2 years.

(Preliminary, do not cite)

USGS

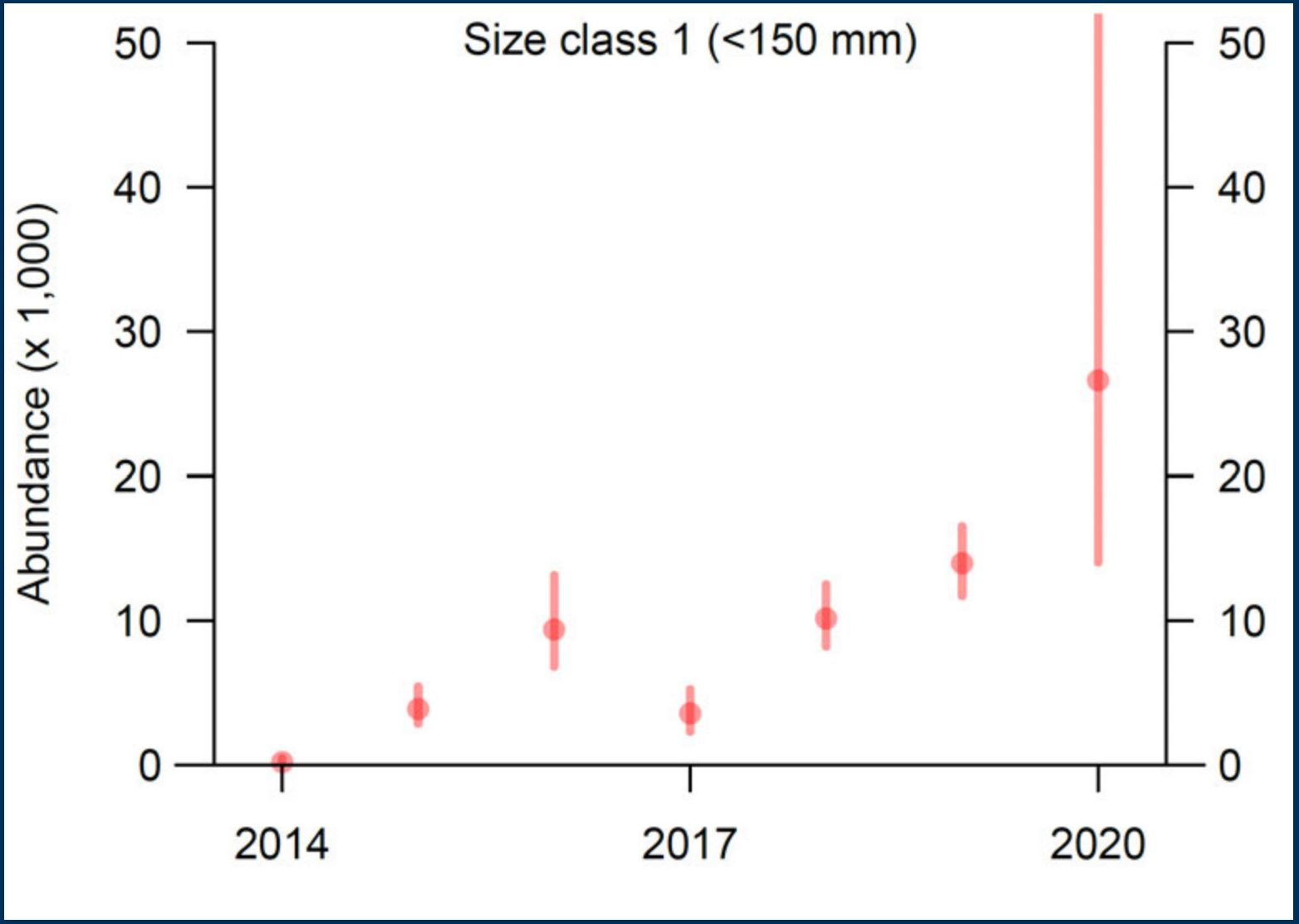
But increasing abundance of size class 2 (150 – 350 mm) brown trout.



USGS

(Preliminary, do not cite)

And recruitment keeps trending upwards (these are fall estimates).



(Preliminary, do not cite)

USGS

So, what is driving year to year variation in recruitment?

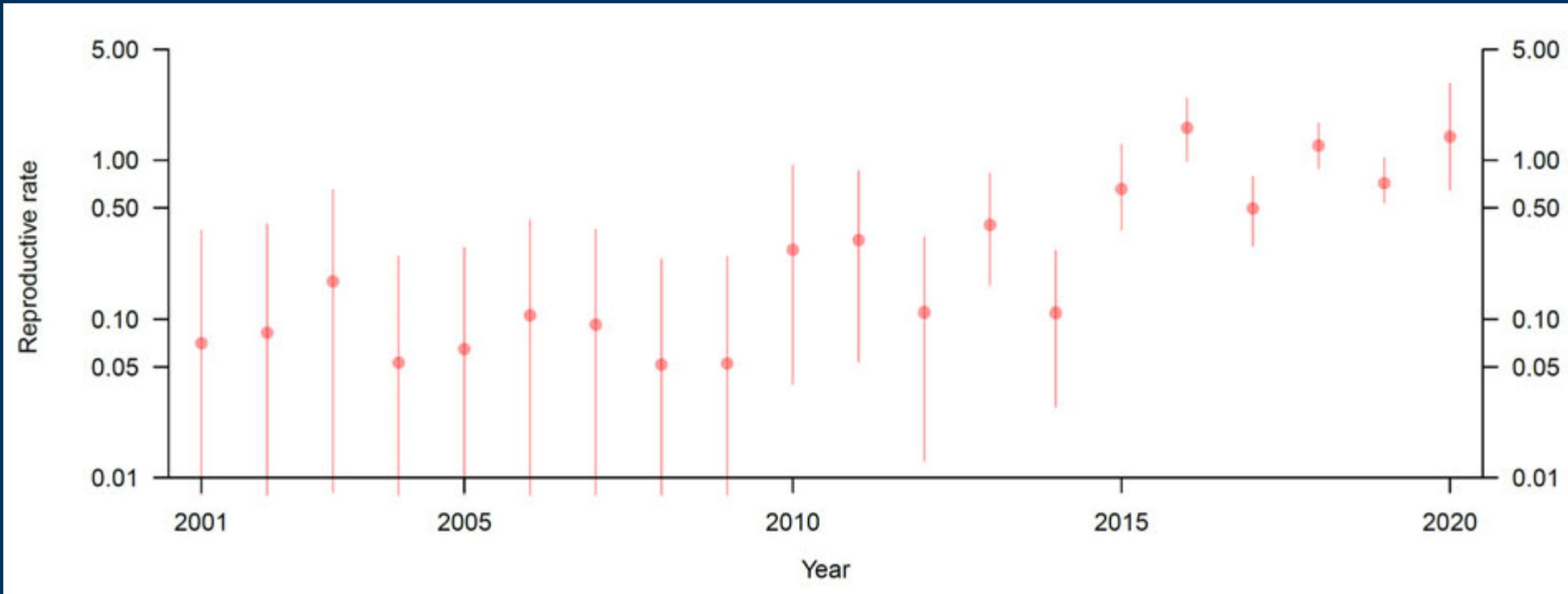
- Allee
- Temperature
- High flow experiments
- Spawner interference

https://youtu.be/sUcpTQcTvMg?t=36

USGS

(Runge et al., 2018)

Reproductive rate: Number of brown trout in the fall per small adult in preceding winter (x4 for large adults)



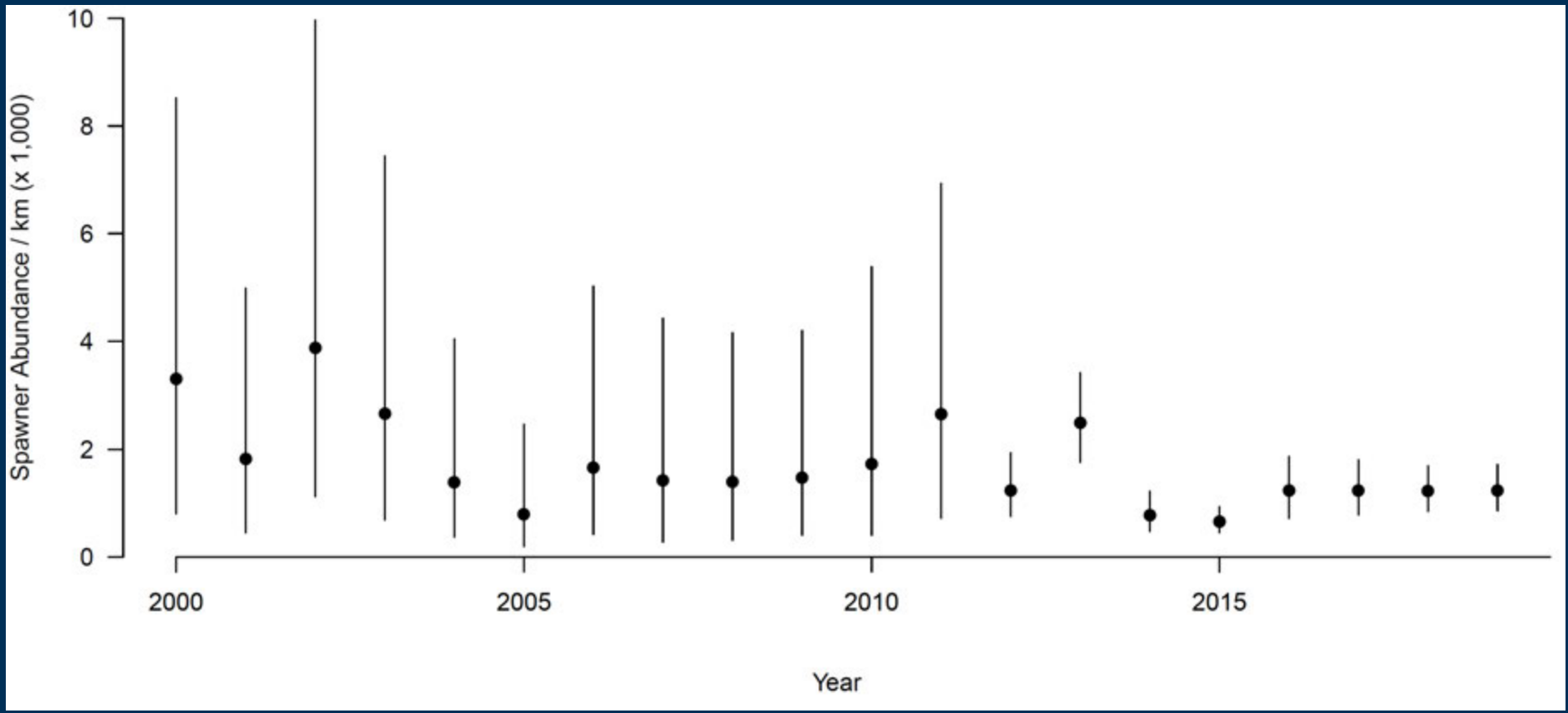
USGS

Quantifying RBT spawner abundance

- Not necessarily correlated with RBT total abundance.
- Not necessarily correlated with RBT recruitment.
- Recall showed relationship between condition factor and maturity.

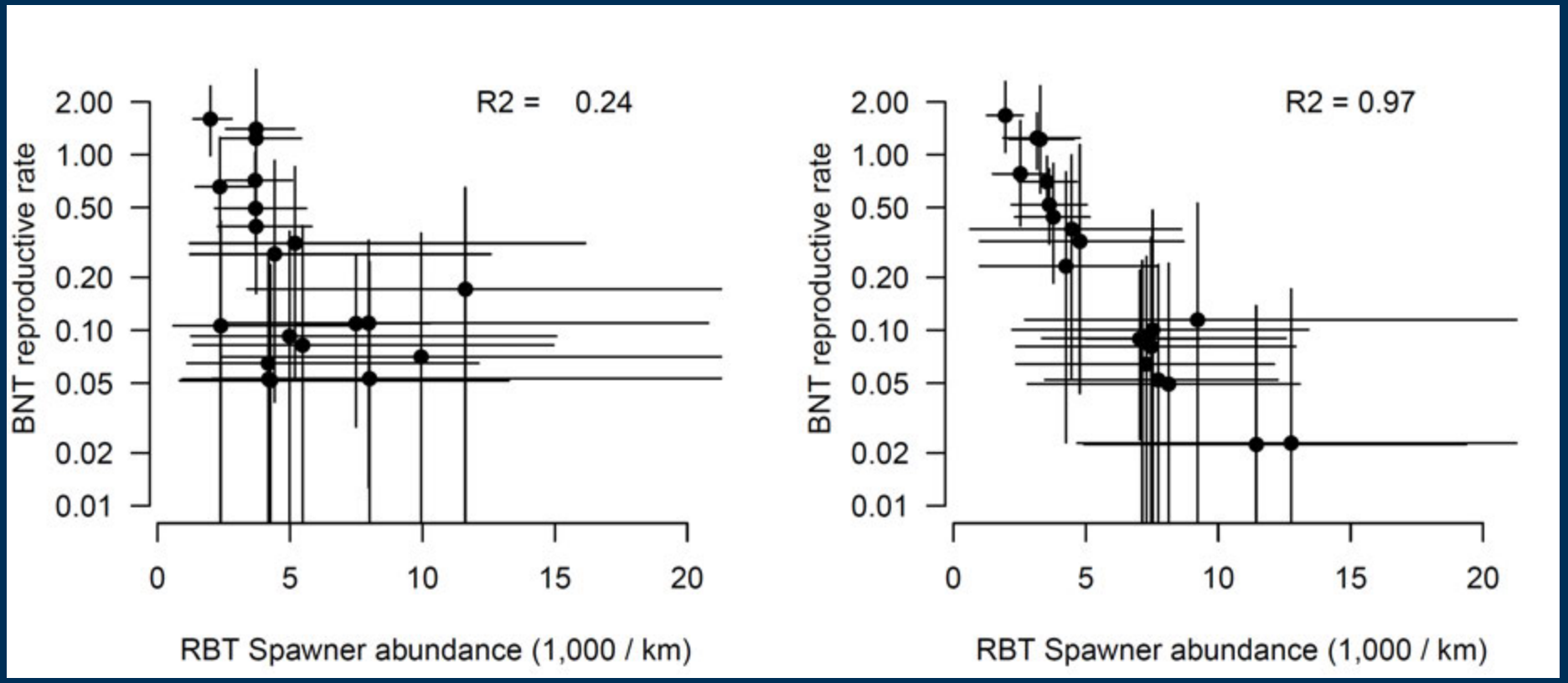
USGS

Our best guess of spawner N as of right now, courtesy of Josh, based on integrating cpe and mark recap data.



USGS

Moderate to strong negative correlation depending on how you analyze the relationship.



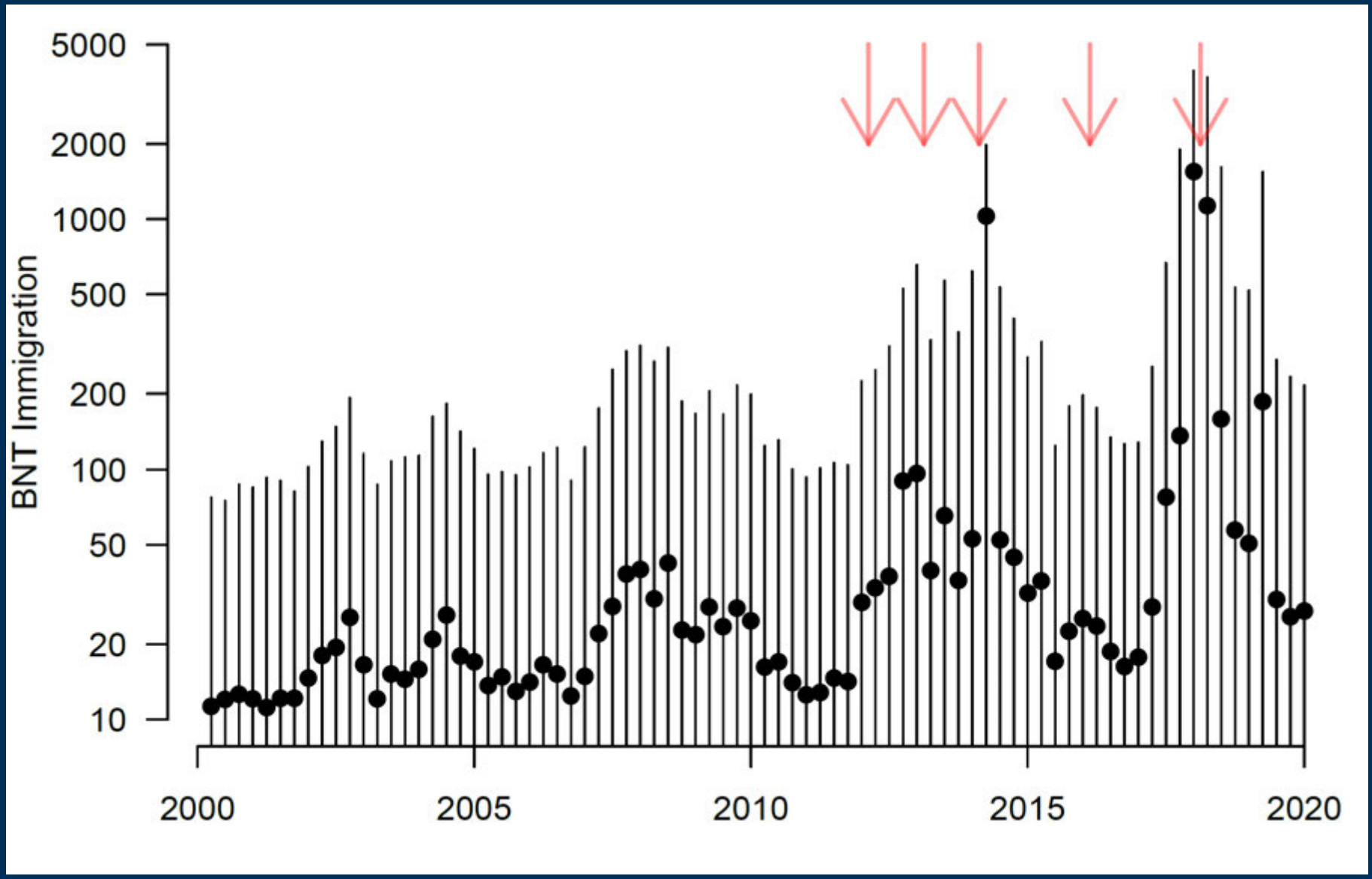
USGS

What about immigration?

- We have known for a while that there was a large immigration event coincident with 2014 fall HFE, but other competing hypotheses (see Runge et al., 2018).

- Now there is some indication of a second immigration event coincident with 2018 fall HFE.

USGS


BNT Immigration
5000
2000
1000
500
200
100
50
20
10
2000
2005
2010
2015
2020

USGS

A brief history

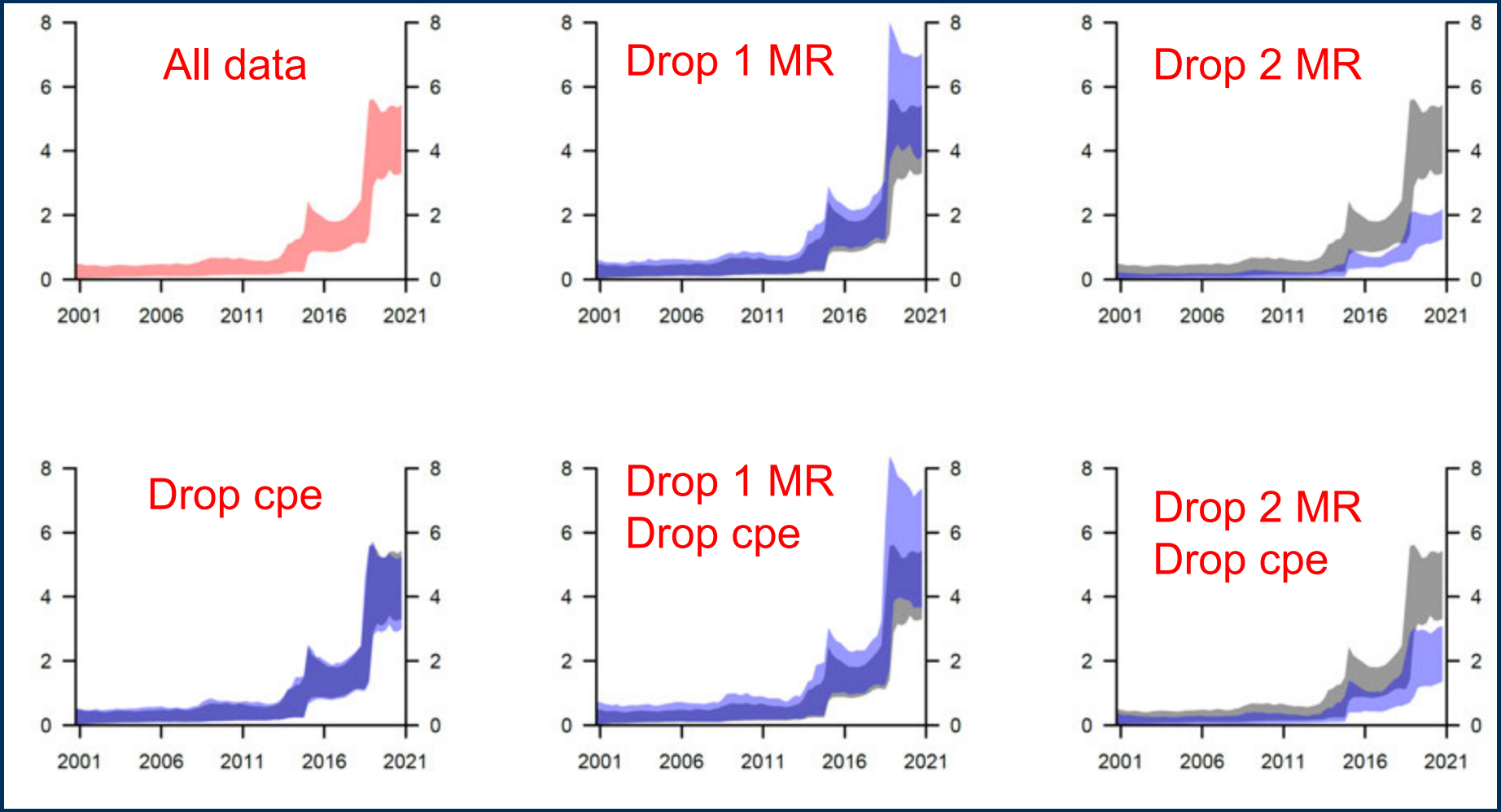
- TWG / GCMRC leadership proposed to eliminate two mark-recapture sites and maintain cpe monitoring over other monitoring designs for brown trout.

- TWG requested biologists meet to integrate cpe and mark-recapture and find a way to monitor two sites.

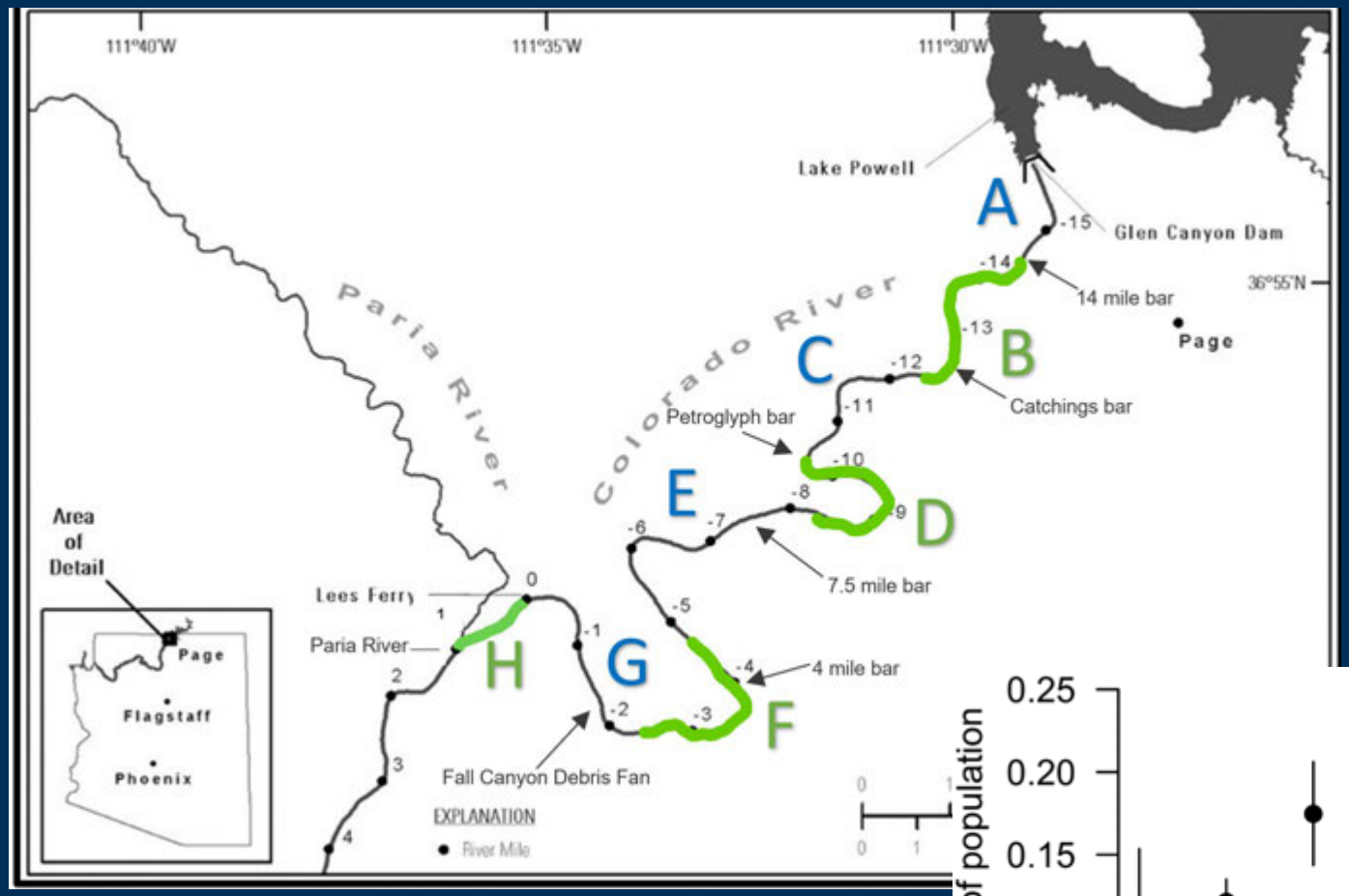
- Two meetings, not a ton of progress/concessions. Some discussion of need for pseudo-power analysis were effects of different designs on brown trout model output are considered.

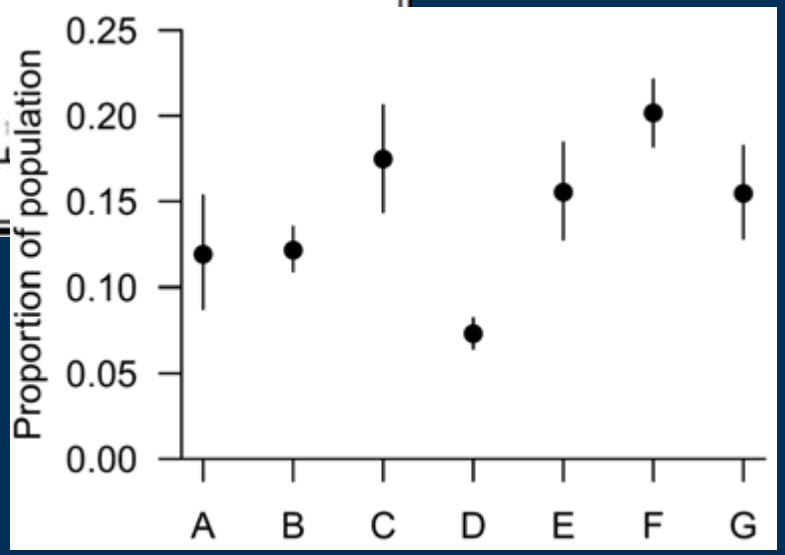
USGS

There are some potential issues.



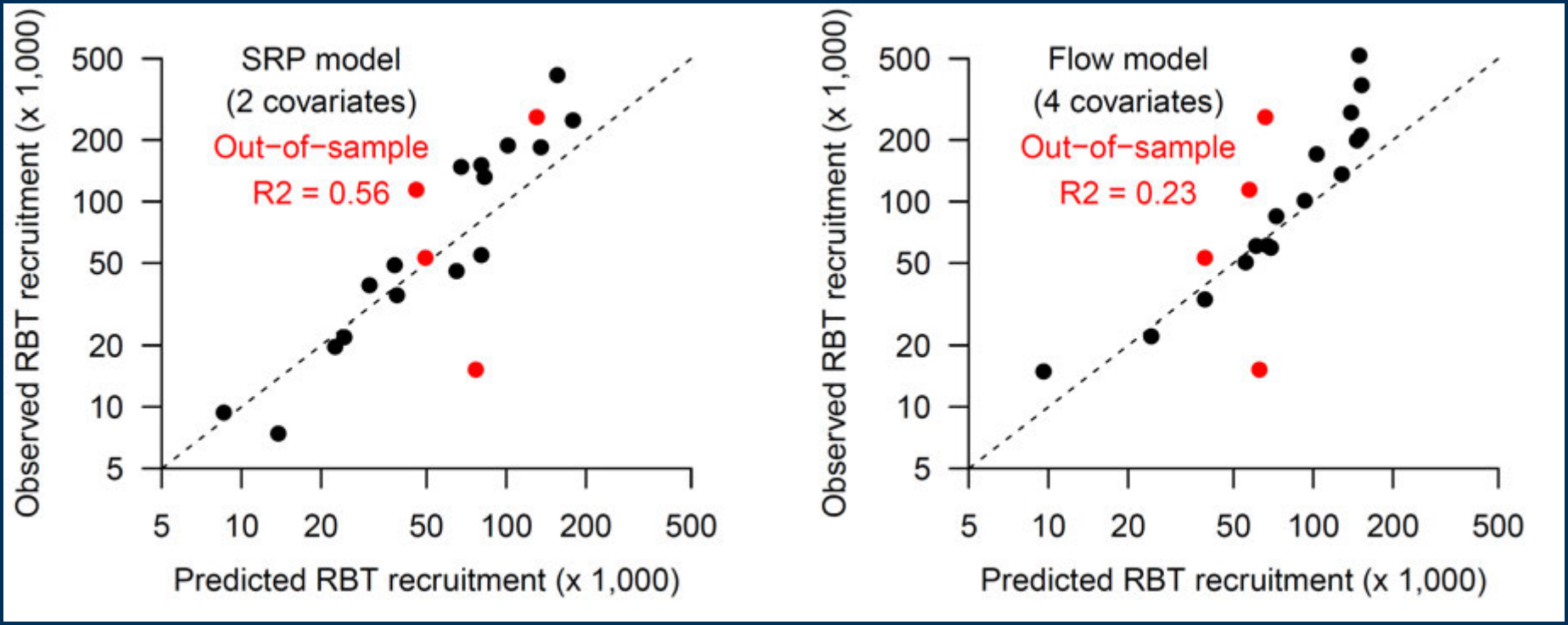
USGS


111°40'W
111°35'W
111°30'W
Lake Powell
Glen Canyon Dam
14 mile bar
36°55'N
Page
Catchings bar
Petroglyph bar
7.5 mile bar
4 mile bar
Fall Canyon Debris Fan
Lees Ferry
Paria River
Colorado River
Area of Detail
Flagstaff
Phoenix
EXPLANATION
River Mile
A
B
C
D
E
F
G
H
-15
-14
-13
-12
-11
-10
-9
-8
-7
-6
-5
-4
-3
-2
-1
0
1
2
3
4

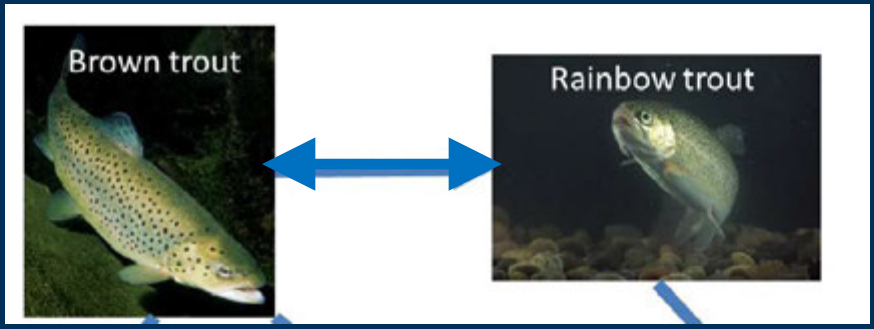

Proportion of population
0.25
0.20
0.15
0.10
0.05
0.00
A
B
C
D
E
F
G

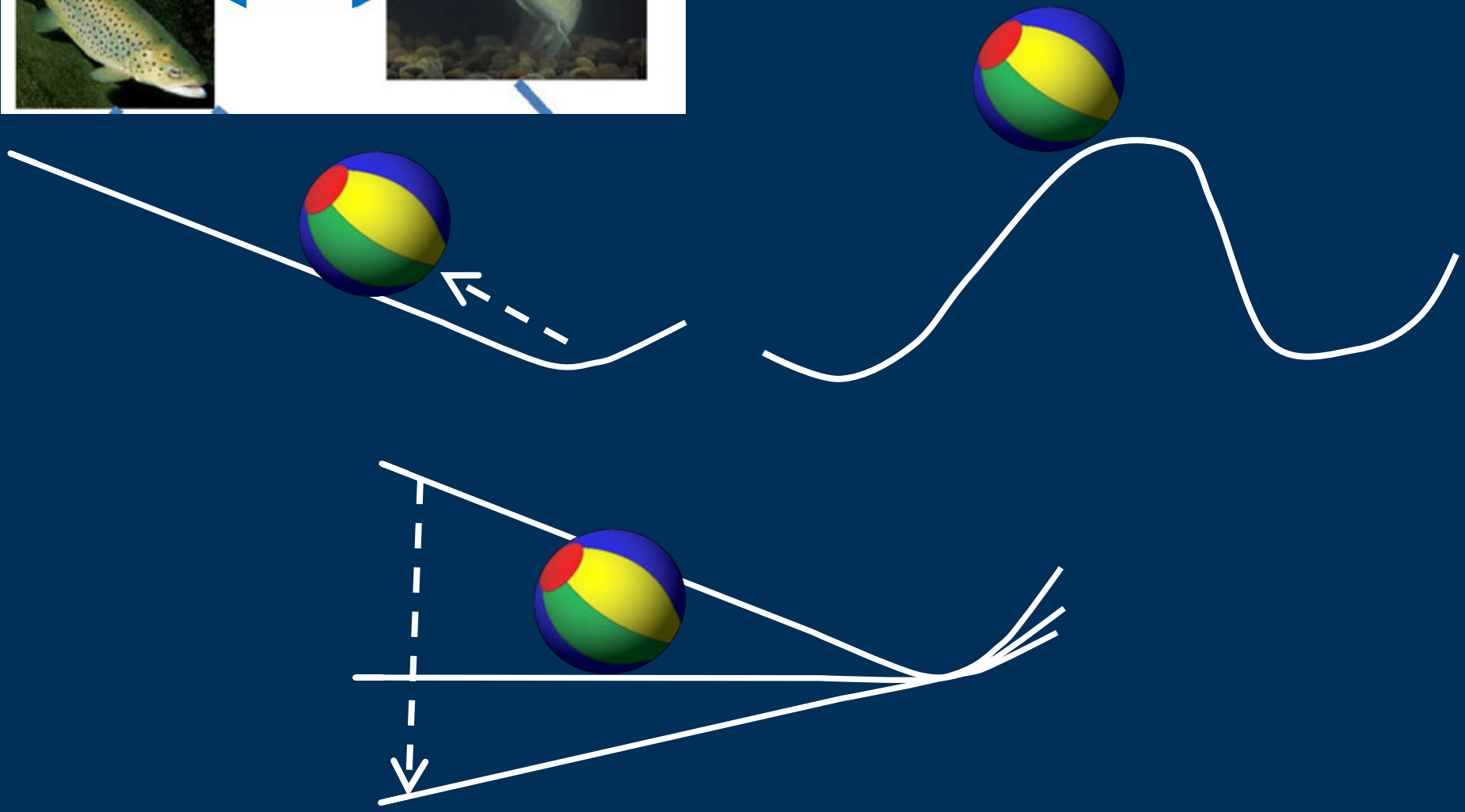
USGS

For the most part, brown trout piscivory does not appear to be affecting RBT recruitment yet.



USGS





USGS


Questions
cyackulic@usgs.gov