National Park Service
U.S. Department of the Interior
Grand Canyon National Park

Efficacy of humpback chub translocations and invasive trout control in Grand Canyon tributaries, 2012-2018

Brian Healy, Robert Schelly, Emily Omana Smith, Charles Yackulic, Melissa Trammell, Rebecca Koller, Keegan Evans, Mary Conner, Mark McKinstry, Kirk Young, Phaedra Budy

Joe Tomelleri Illustrations

Acknowledgments

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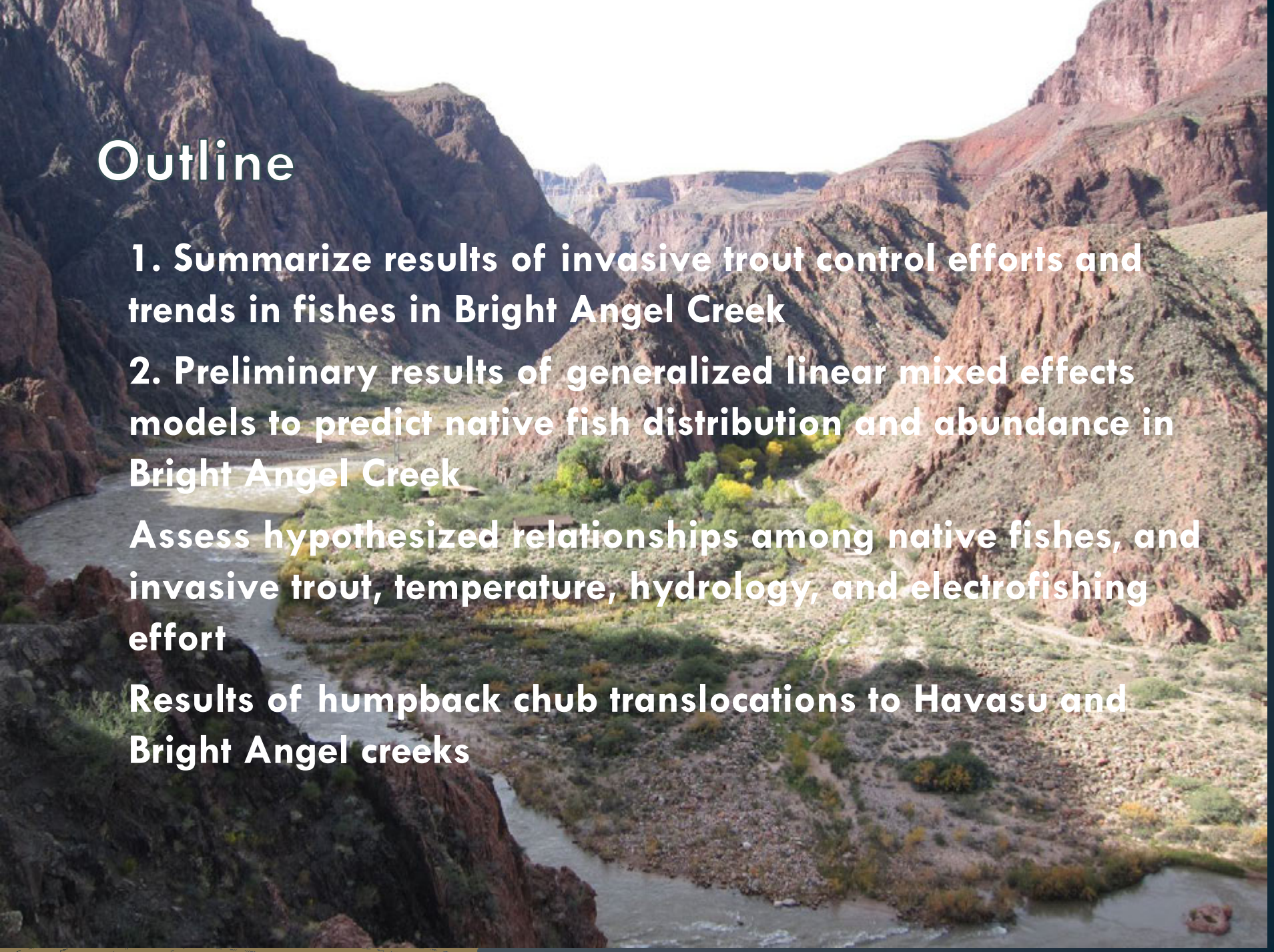
Reclamation (non-AMP funds)
National Park Service
Grand Canyon Conservancy
Arthur L. & Elaine V. Johnson Foundation Center for Colorado River Studies – Utah State US Geological Survey, Utah Cooperative Fish and Wildlife Unit (In Kind)
Utah State University-Ecology Center/Watershed Sciences National Park Foundation/Albright-Wirth Grant

Conservation Measures – Humpback Chub

- Glen Canyon Dam Operations Biological Opinion:
  - Control of nonnative fish (rainbow and brown trout)
  - Translocations to Grand Canyon tributaries
- Objective: assess efficacy of conservation measures



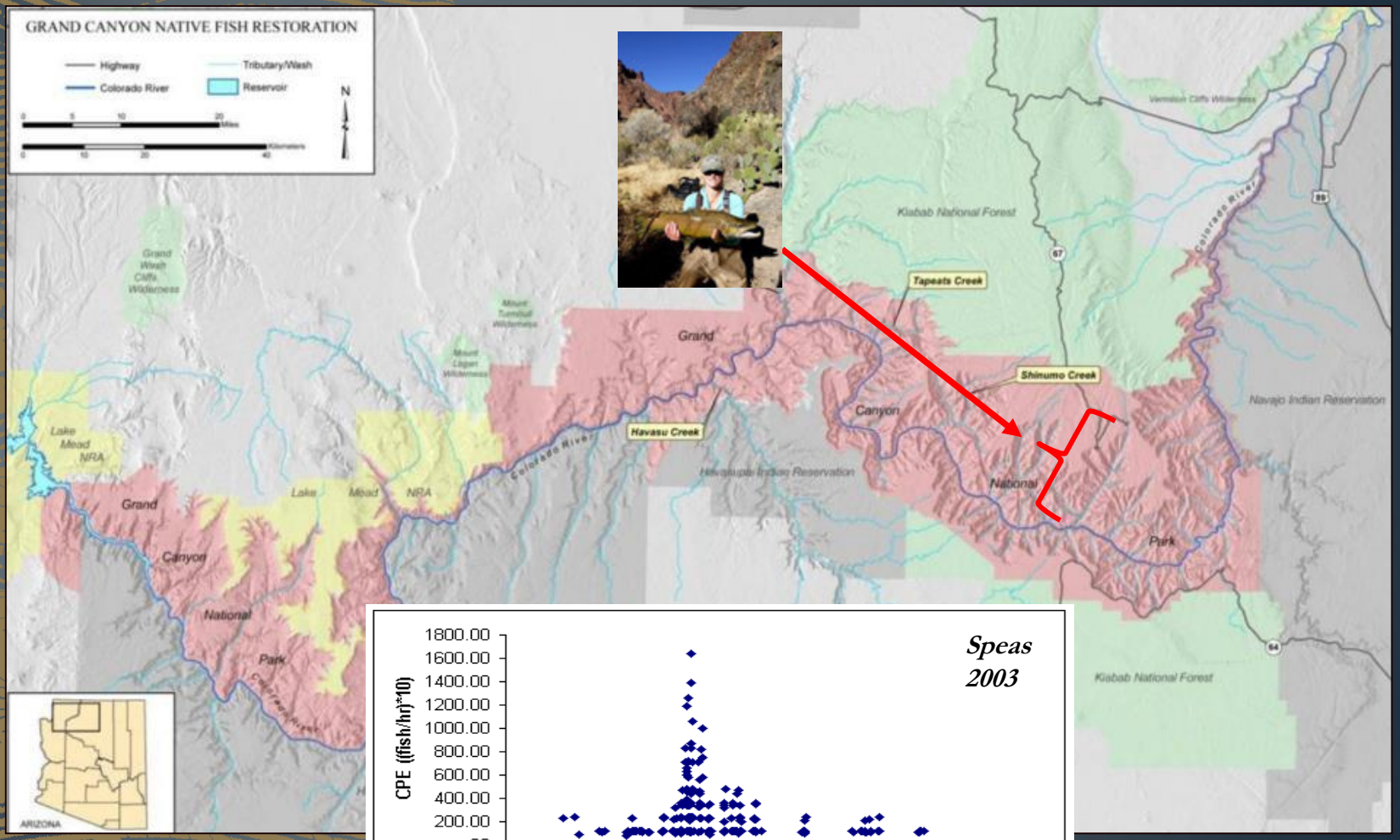
Outline

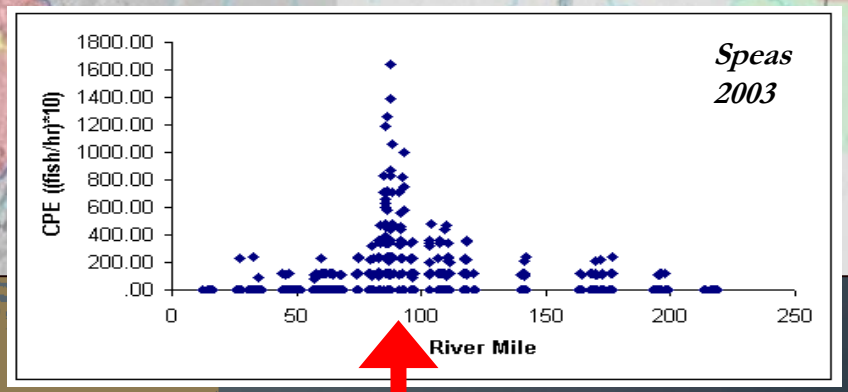
1. Summarize results of invasive trout control efforts and trends in fishes in Bright Angel Creek
2. Preliminary results of generalized linear mixed effects models to predict native fish distribution and abundance in Bright Angel Creek

Assess hypothesized relationships among native fishes, and invasive trout, temperature, hydrology, and electrofishing effort

Results of humpback chub translocations to Havasu and Bright Angel creeks

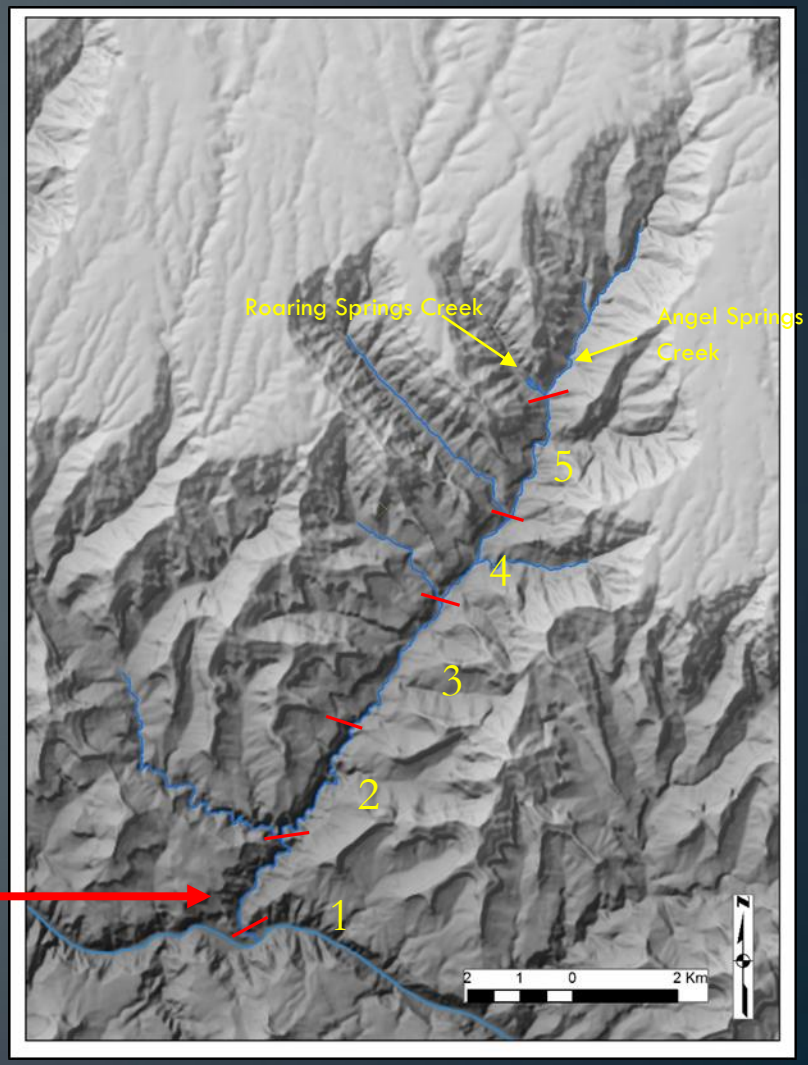
Study Area – Bright Angel Creek





Bright Angel Creek Inflow

Methods

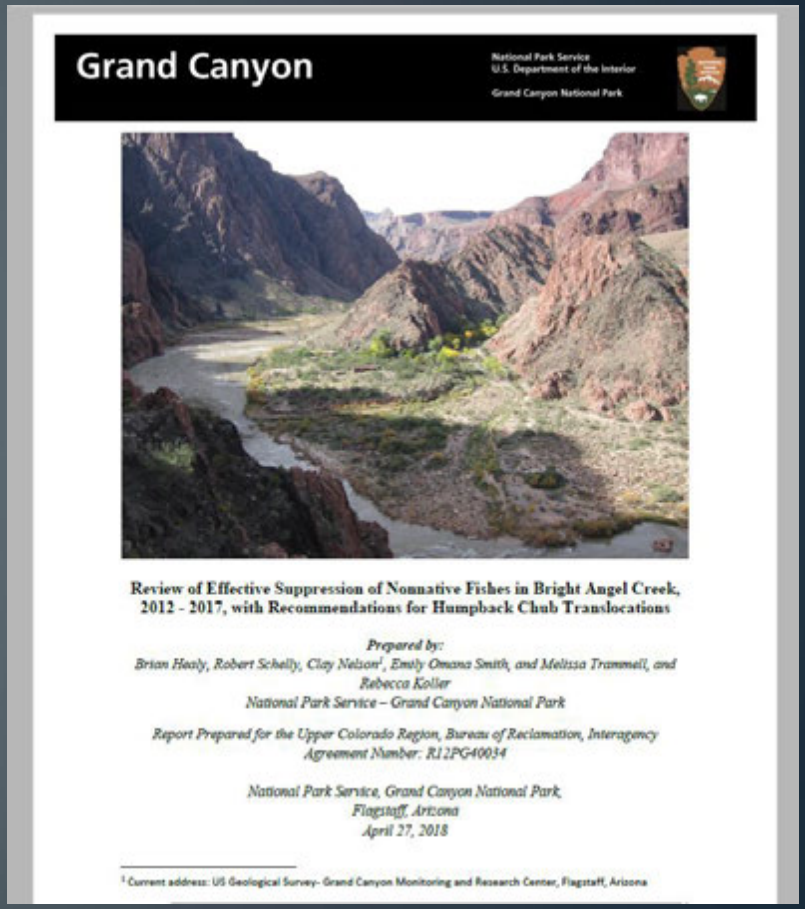


Peer-review comments (2018):

Changes based on peer-review:

- *"Continue trout control to avoid a potential for a compensatory response, …redistribute trout suppression efforts to "hotspots" …, and/or target areas of high YOY trout abundance. "*

- Two-pass depletion, with targeted single-pass electrofishing at "hot spots"



Grand Canyon

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Review of Effective Suppression of Nonnative Fishes in Bright Angel Creek, 2012 - 2017, with Recommendations for Humpback Chub Translocations

Prepared by:
Brian Healy, Robert Schelly, Clay Nelson[1], Emily Omana Smith, and Melissa Trammell, and Rebecca Koller
National Park Service – Grand Canyon National Park

Report Prepared for the Upper Colorado Region, Bureau of Reclamation, Interagency Agreement Number: R12PG40034

National Park Service, Grand Canyon National Park, Flagstaff, Arizona
April 27, 2018

[1] Current address: US Geological Survey- Grand Canyon Monitoring and Research Center, Flagstaff, Arizona

Bright Angel Creek: trends

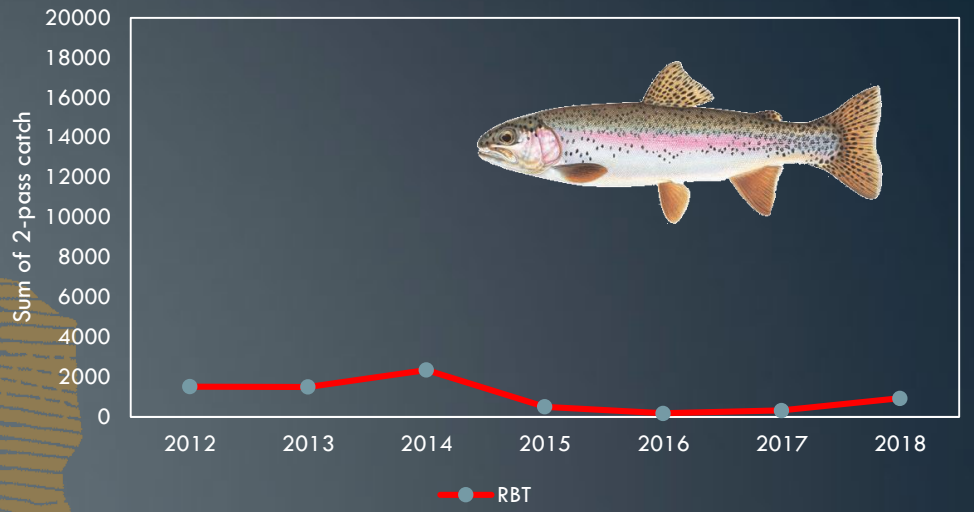
Rainbow trout

- Increase in 2018

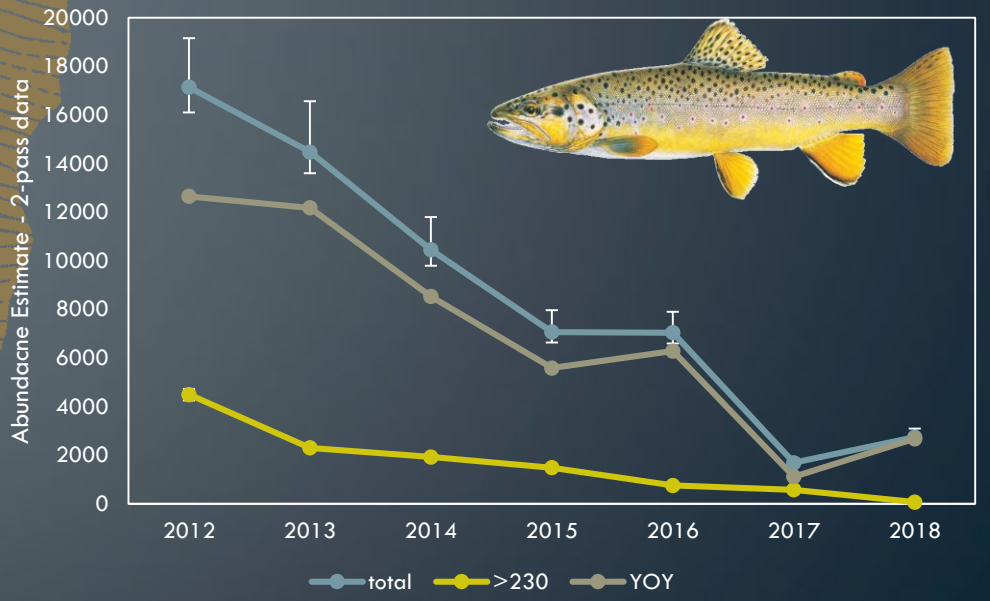
Brown trout

- Strong BNT year class in 2018
- 2018 BNT abundance = 84% decline since 2012 (>90% through 2017)

Rainbow trout: total catch- 2-pass



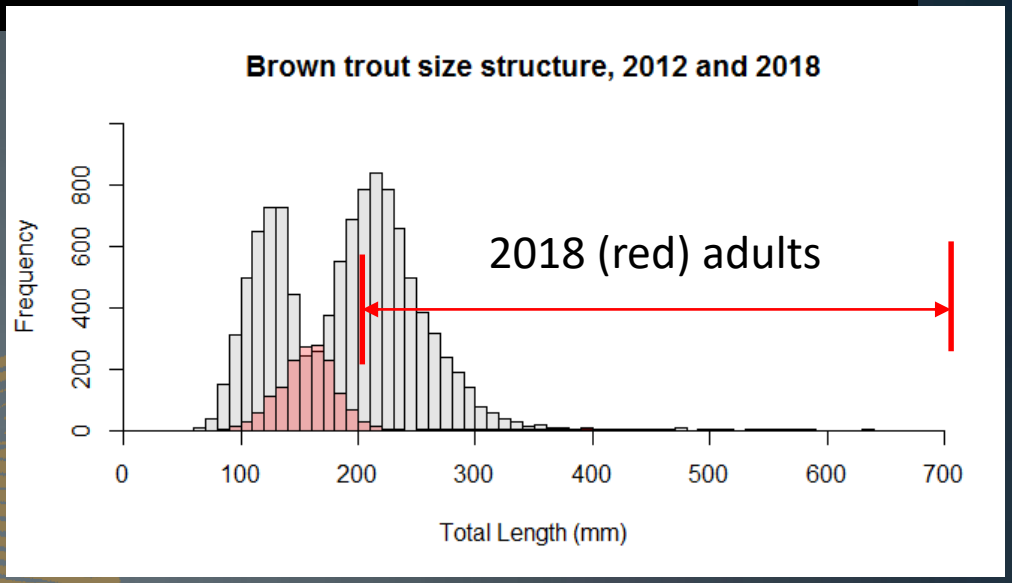
Bright Angel Creek: total, young-of-year, adult abundance



Bright Angel Creek: trends

Brown trout:

- Very few adult/spawning BNT remaining
- Shift in size structure since 2012



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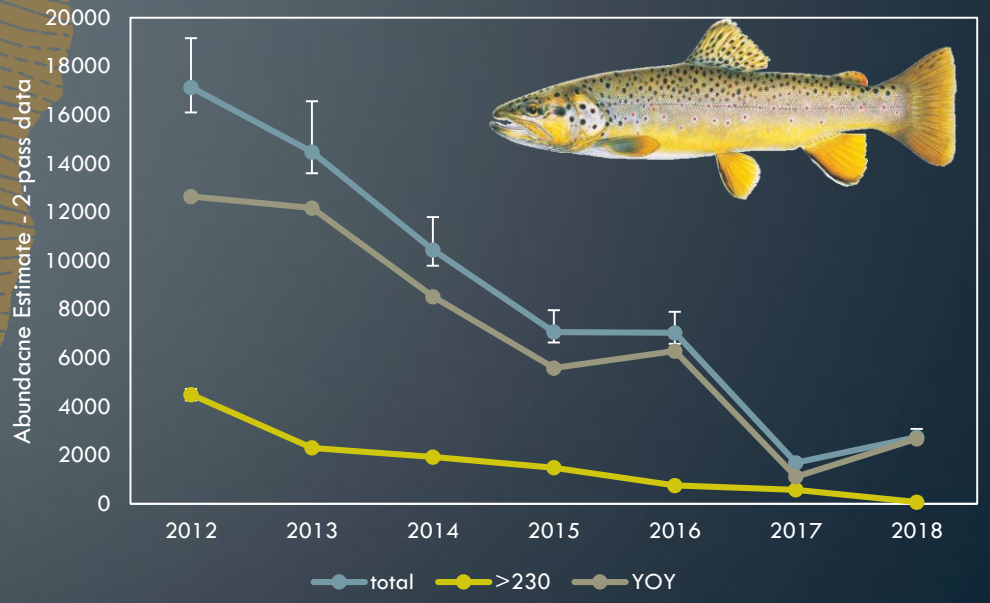

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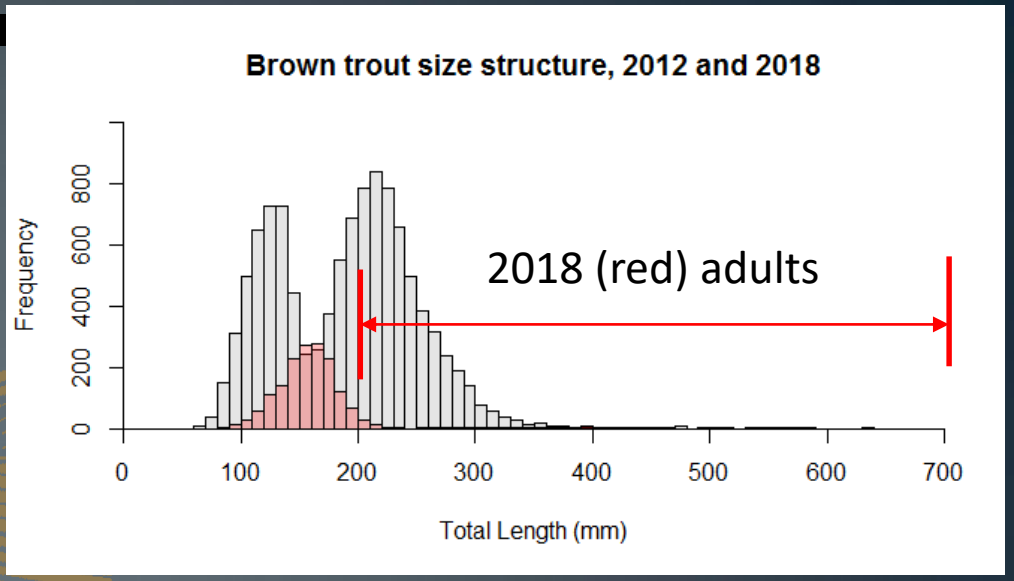
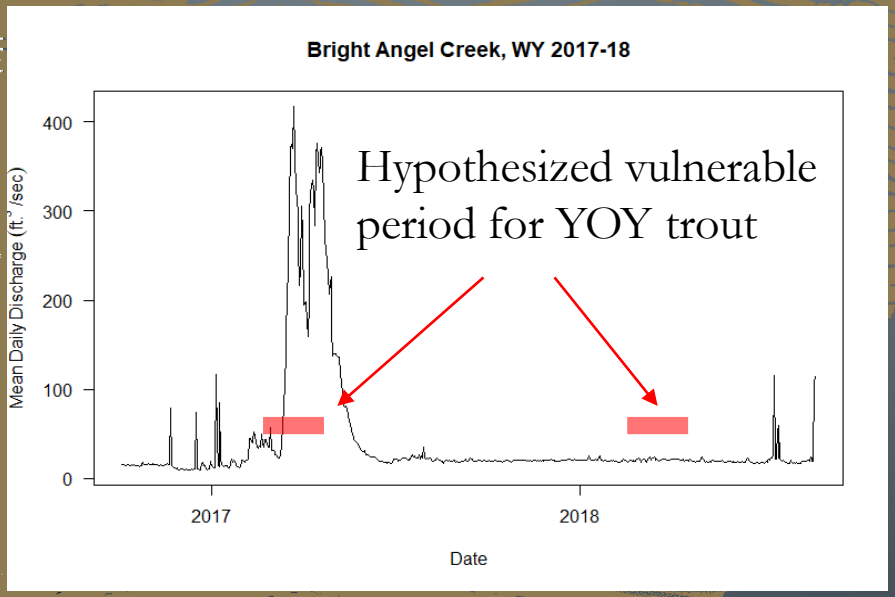
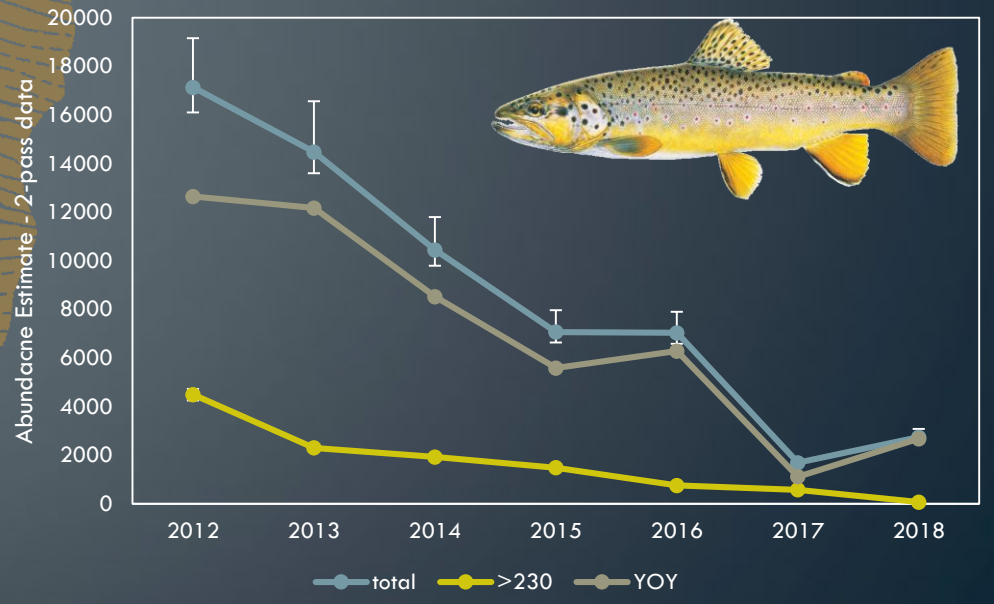




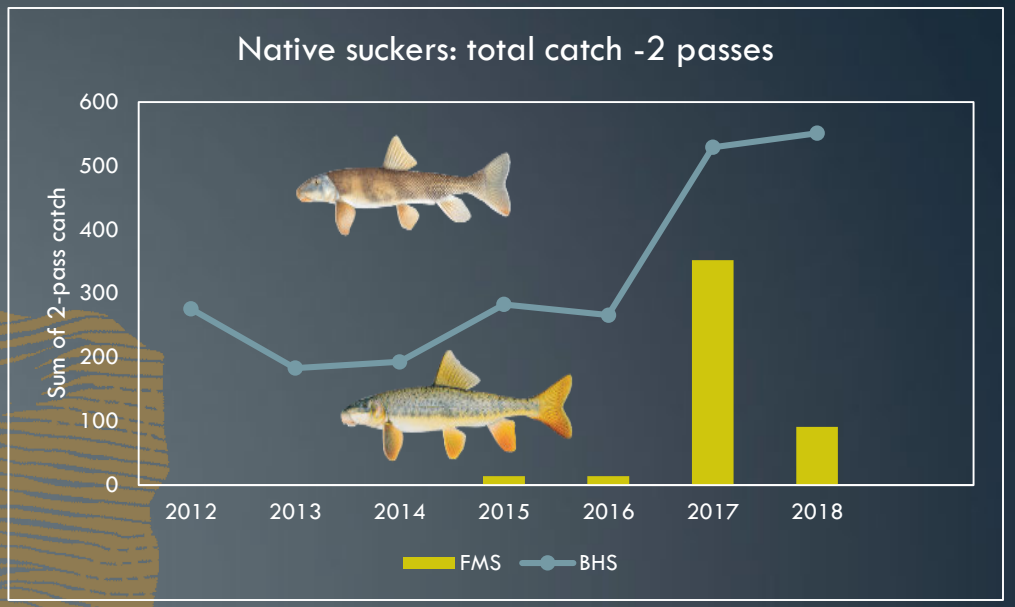
Bright Angel Creek: total, young-of-year, adult abundance

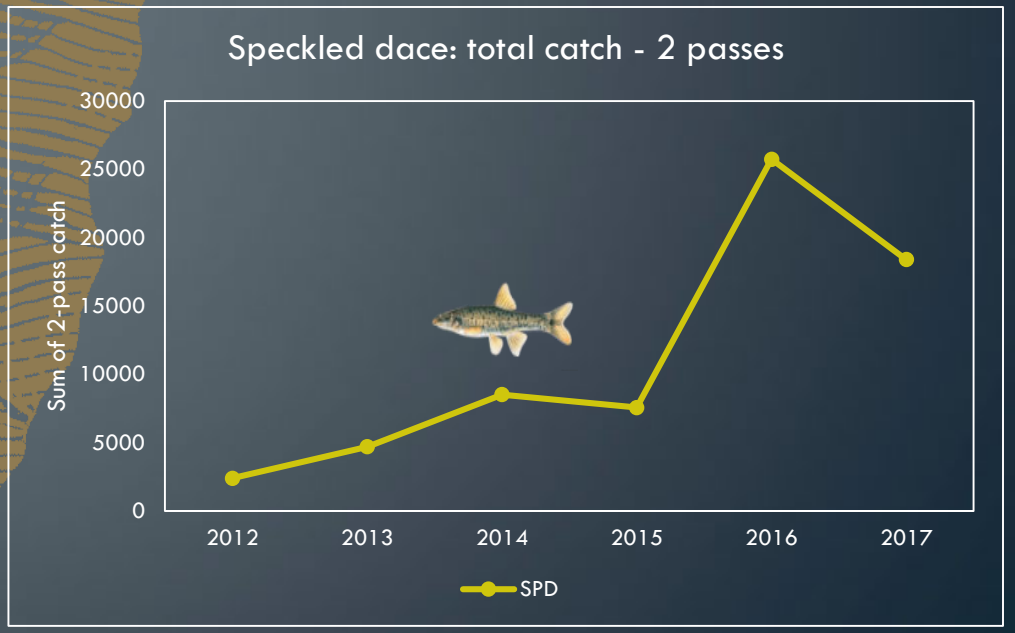


Bright Angel Creek: trends

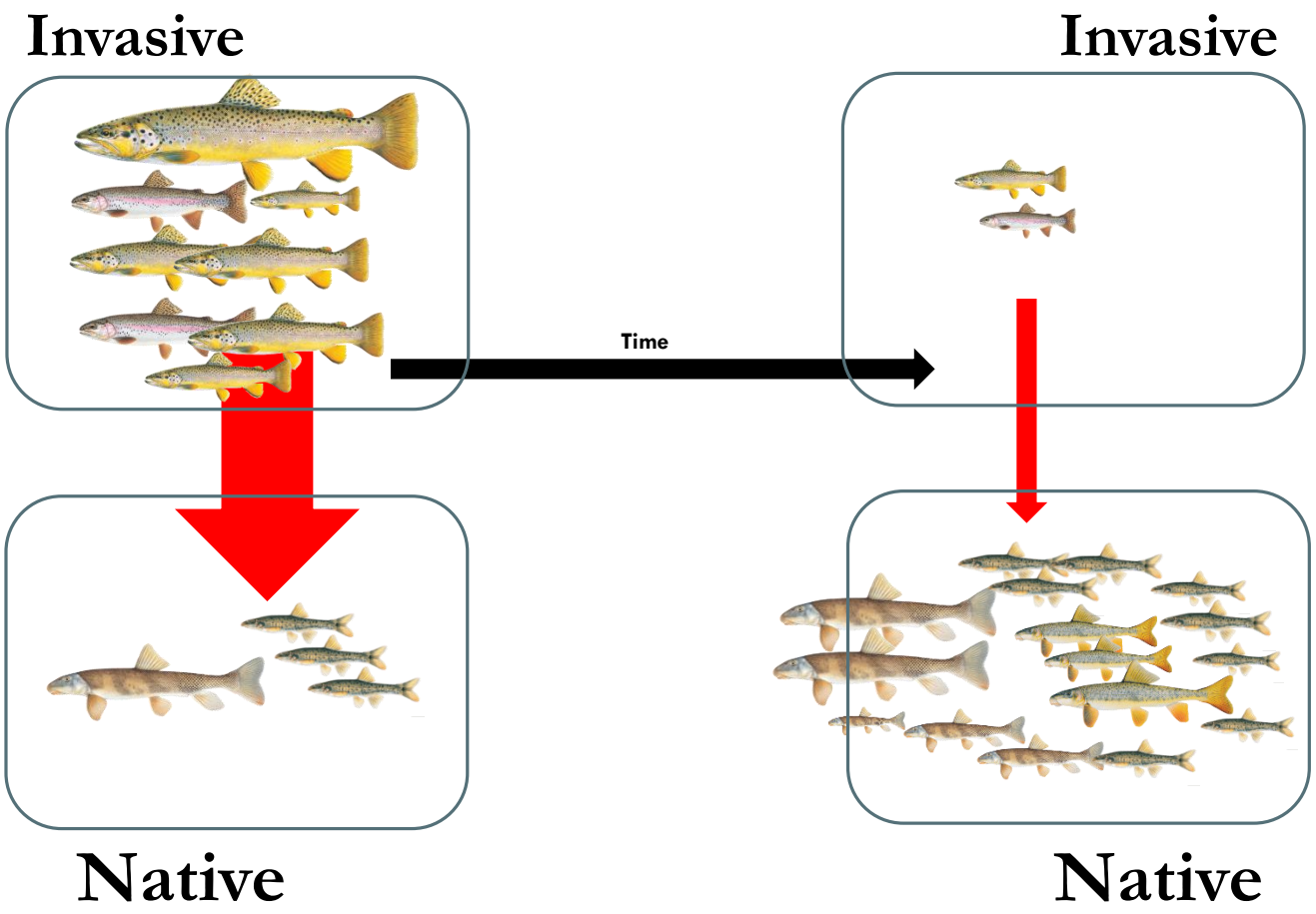
Native fishes

- Creek-wide abundance
- Sum of 2-electrofishing passes (preliminary)
- Declines in catch in 2017-2018



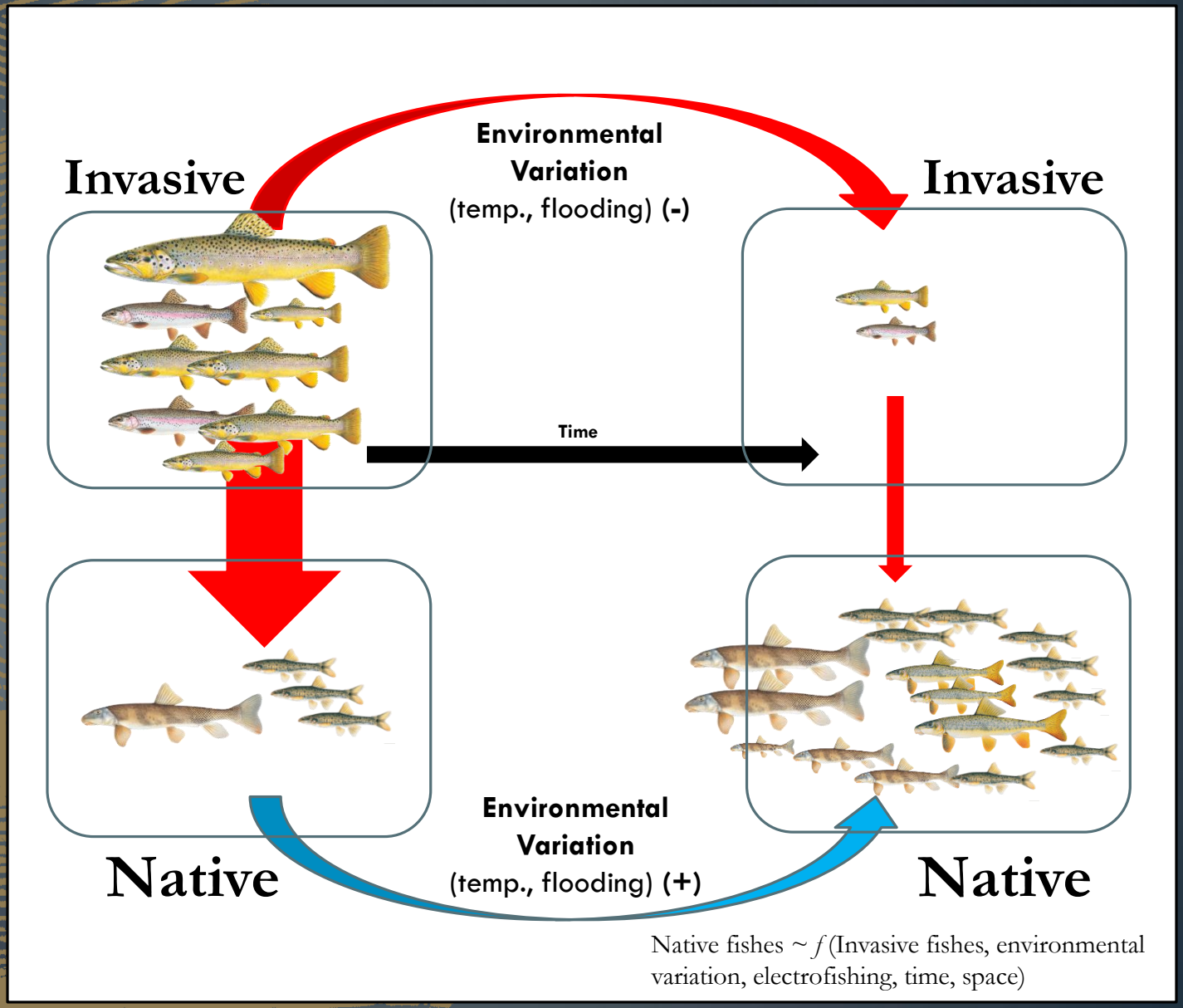


Drivers of native fish abundance and distribution



Native fishes ~ *f* (Invasive fishes, environmental variation, electrofishing, time, space)

Drivers of native fish abundance and distribution



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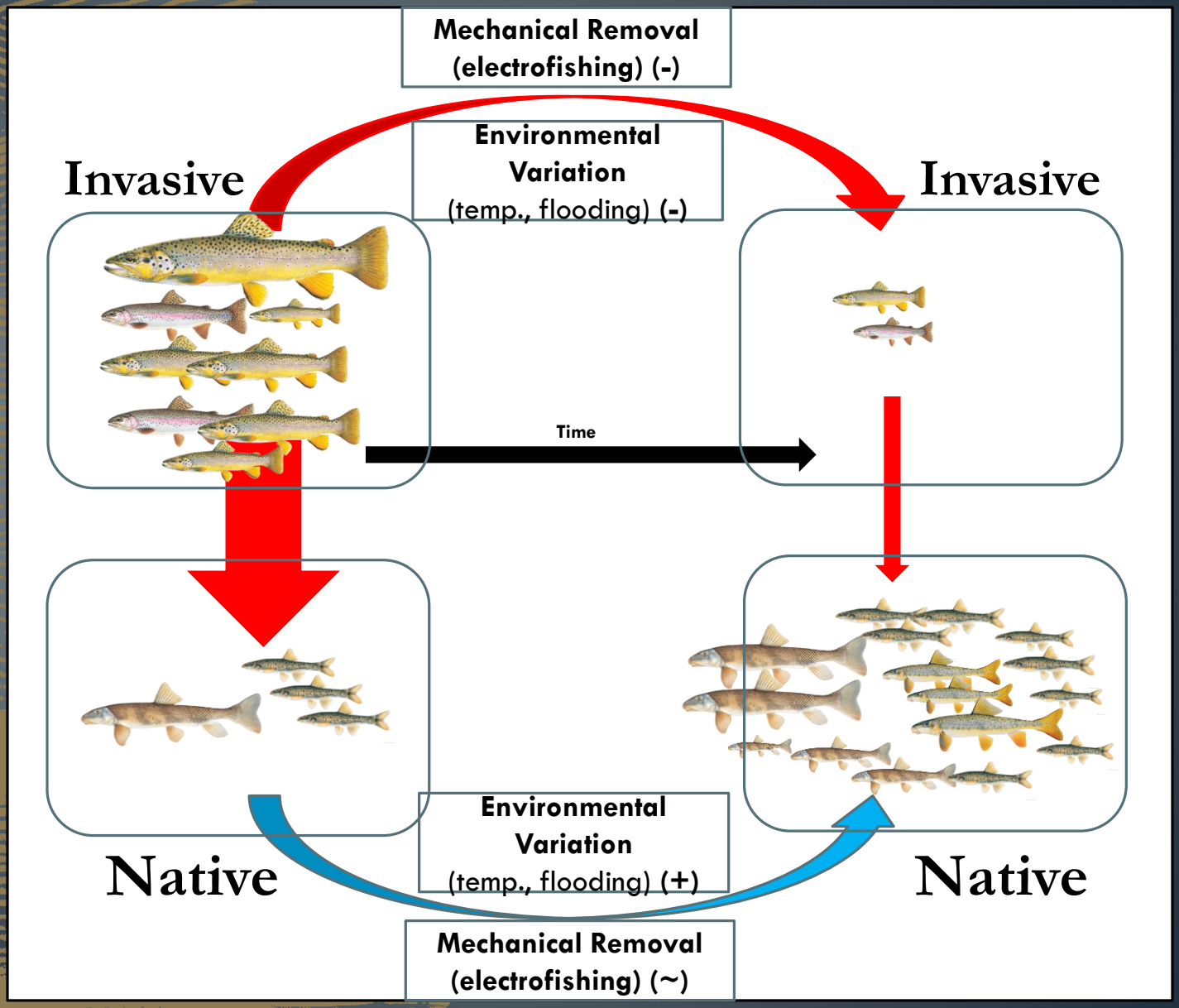
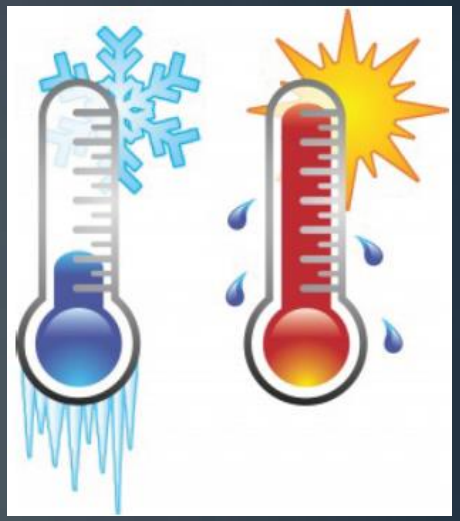
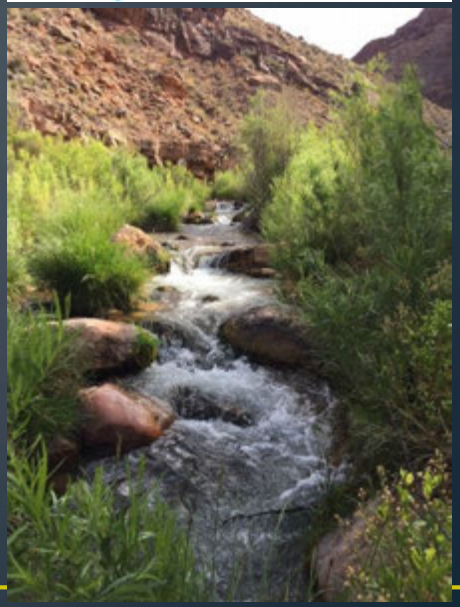


Methods – Data Analysis

- Objective: predict distribution and abundance of native fish
- Analytical approach:
  - Hypothesized drivers:
    - Flow, spatial-thermal, trout, electrofishing effort, interactions
  - Generalized linear mixed-effects models
    - Probability of occurrence of native fish, and abundance components
  - Random effects:
    - Year – random intercept
    - Reach - Random intercept and slope
  - Model Evaluation – lowest BIC

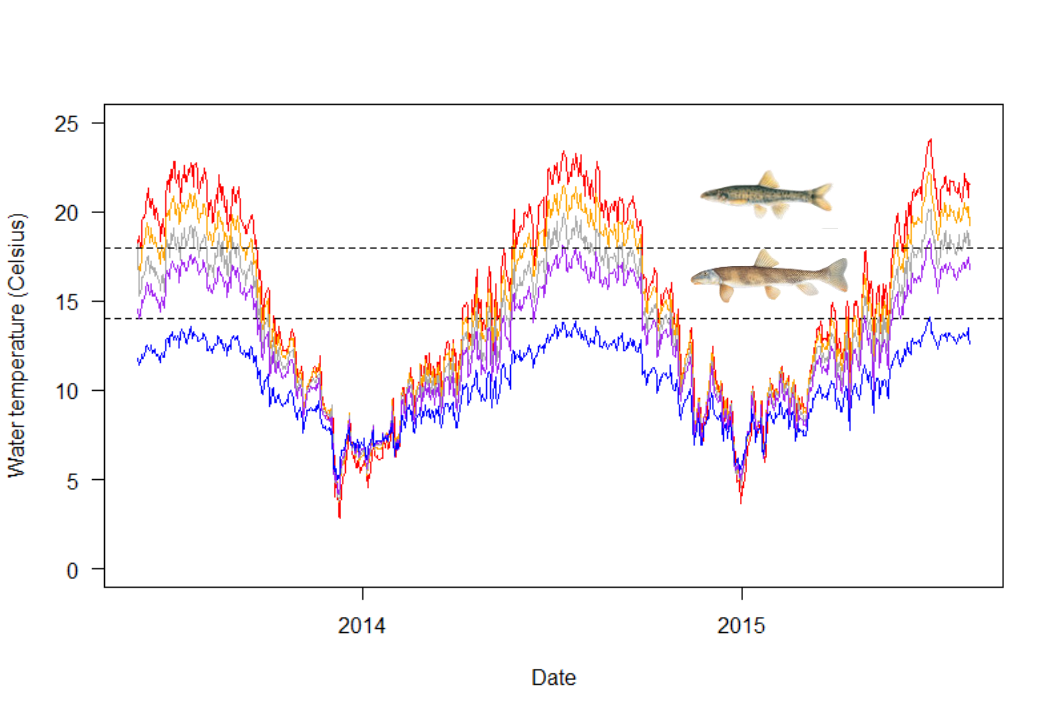


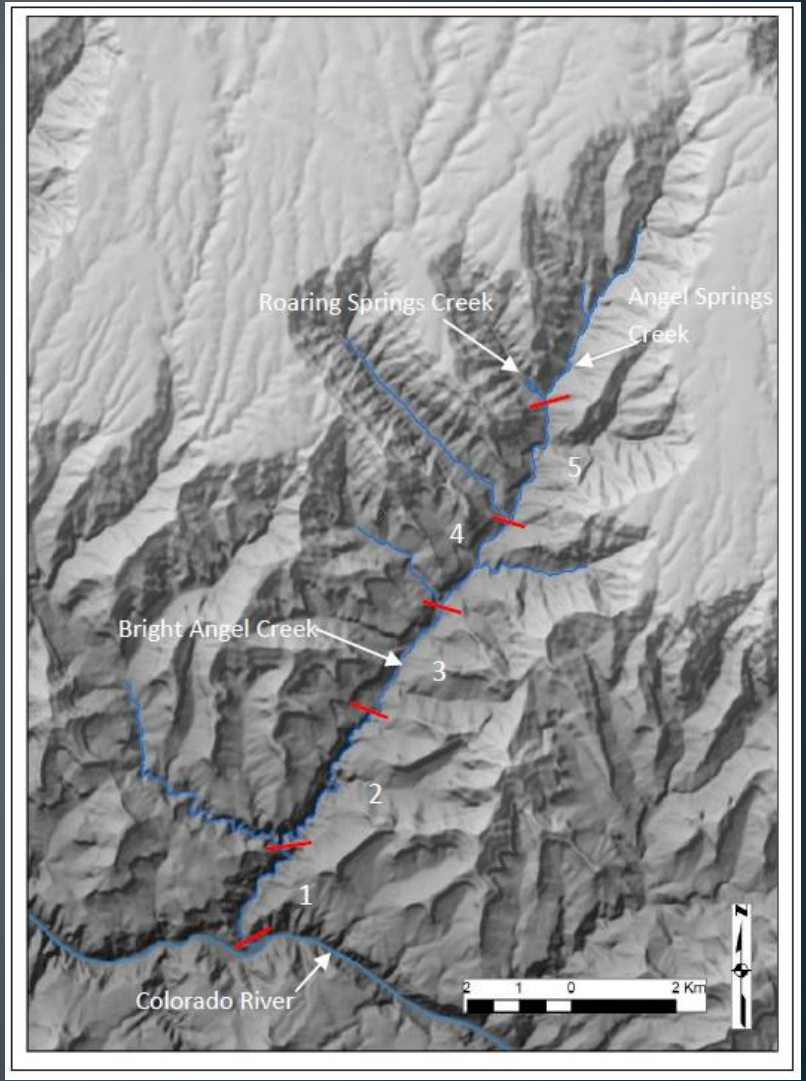


Methods – Data Analysis

"Spatial-thermal" variable:

- Bair et al. (*in press*)
  - *Temperature predicted by distance from source*

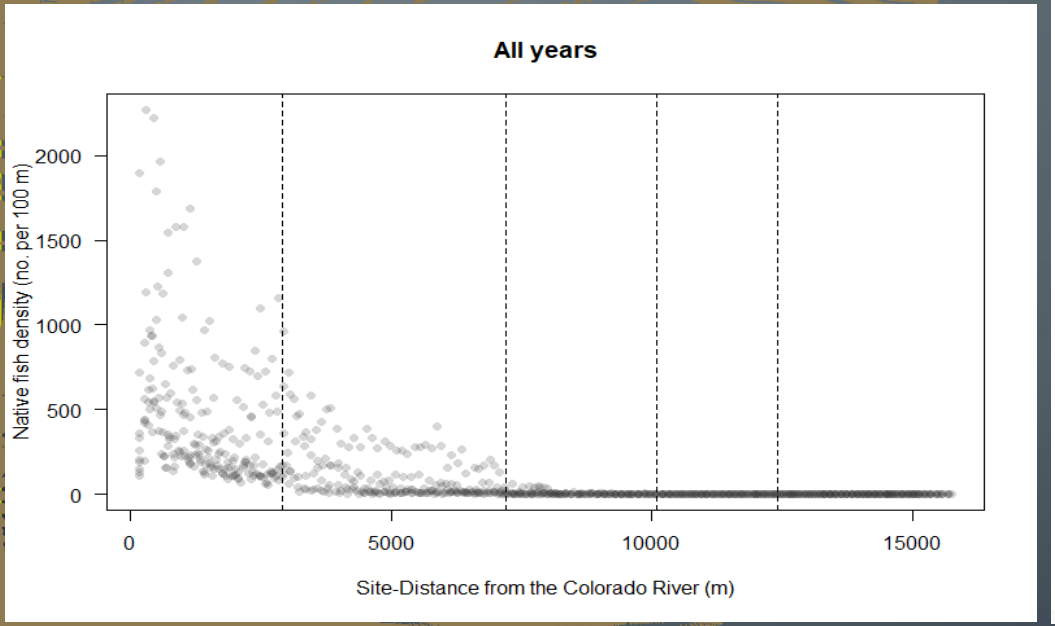


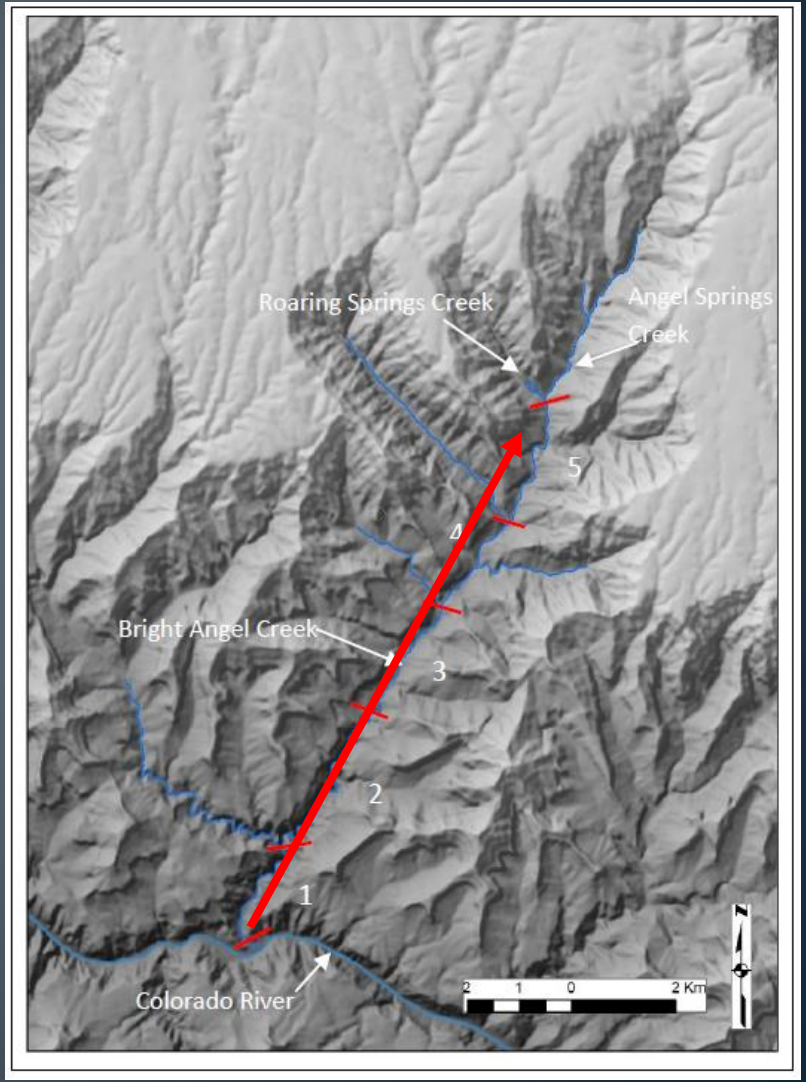


Methods – Data Analysis

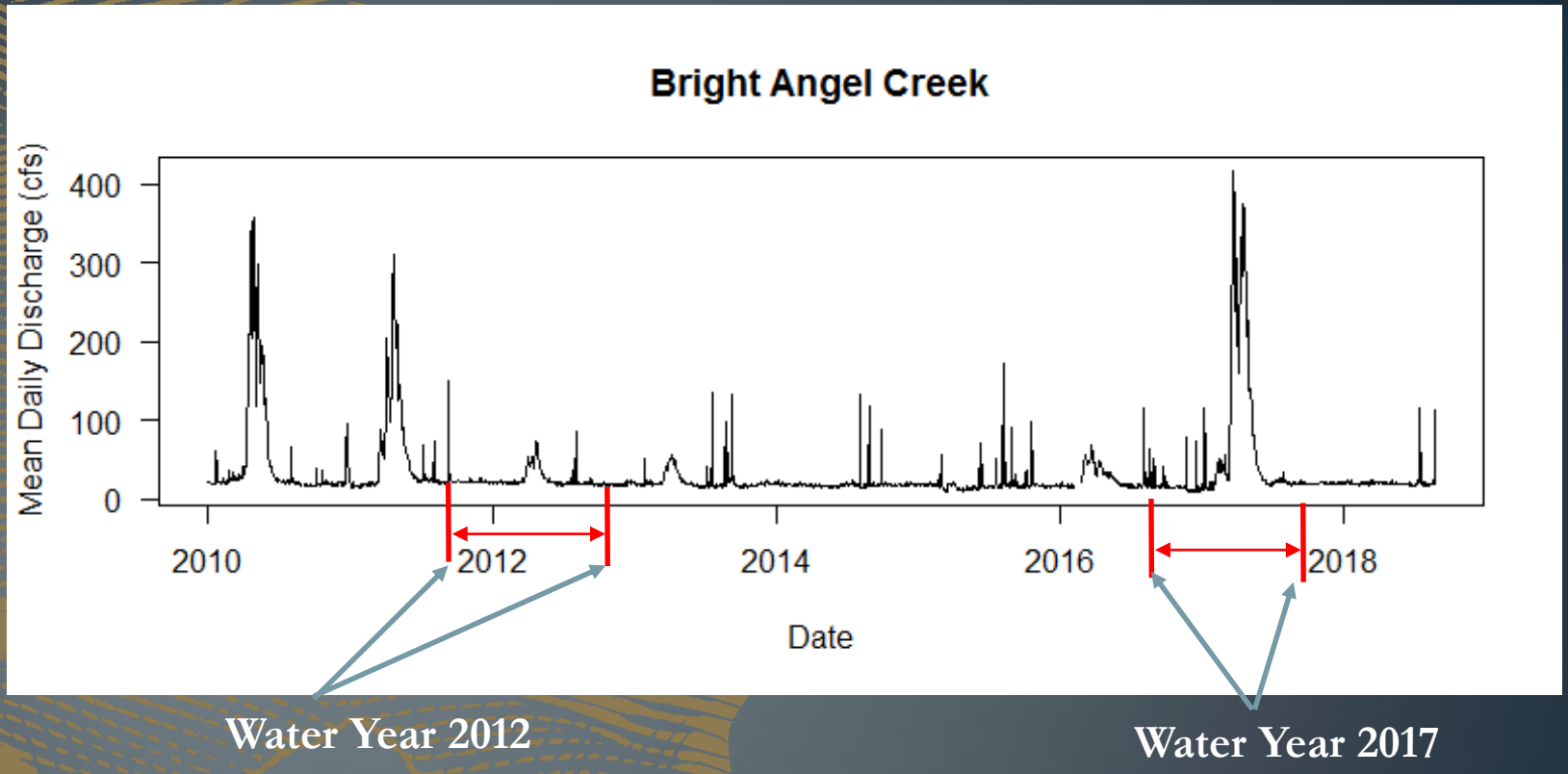
"Spatial-thermal" variable:

- Proxy for temperature
- Assigned sites a "distance from the Colorado River"





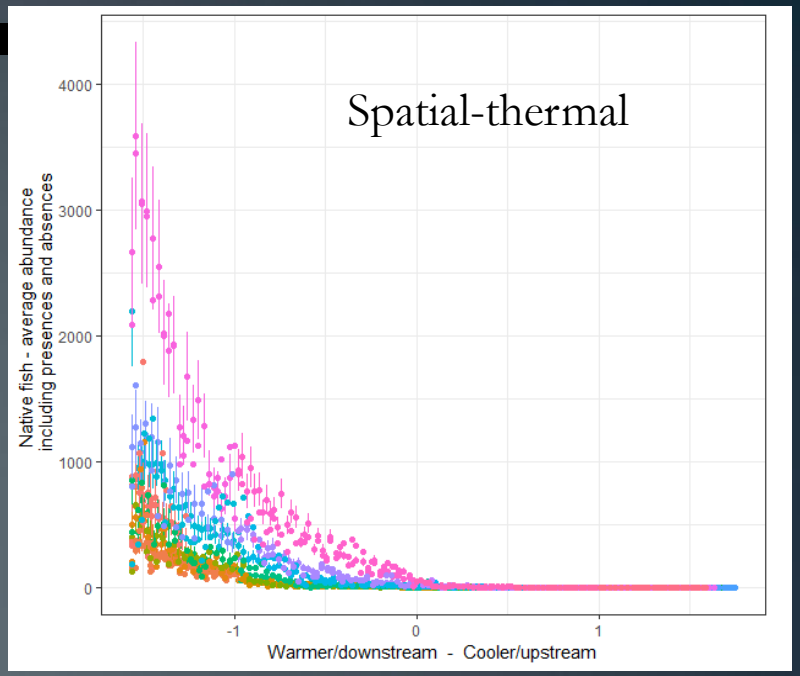
Flow variables

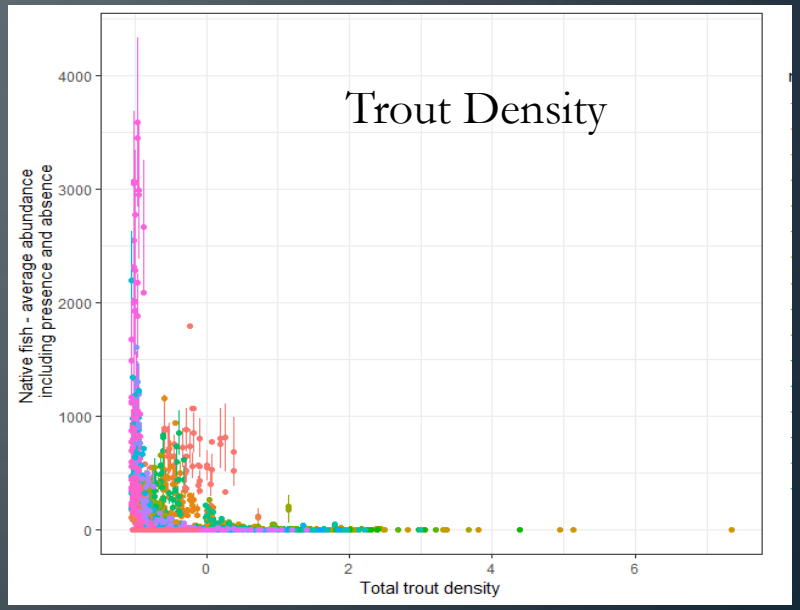


- Variation in flow variability
  - Captured in flow metrics – Spring and monsoon season flow variability/flood magnitude
  - Annual time step (years very different)

Results

- Top Model:
  - Native Fish (aggregated) abundance ~
    - *Spatial-thermal (-)*
    - *Trout density (-)*
    - *Spring flooding index (+)*
  - Native Fish (aggregated) prob. of occurrence ~
    - *Spatial-thermal (-)*
    - *Monsoon flooding index (+)*
  - *Electrofishing <u>not</u> a strong predictor of native fish counts*





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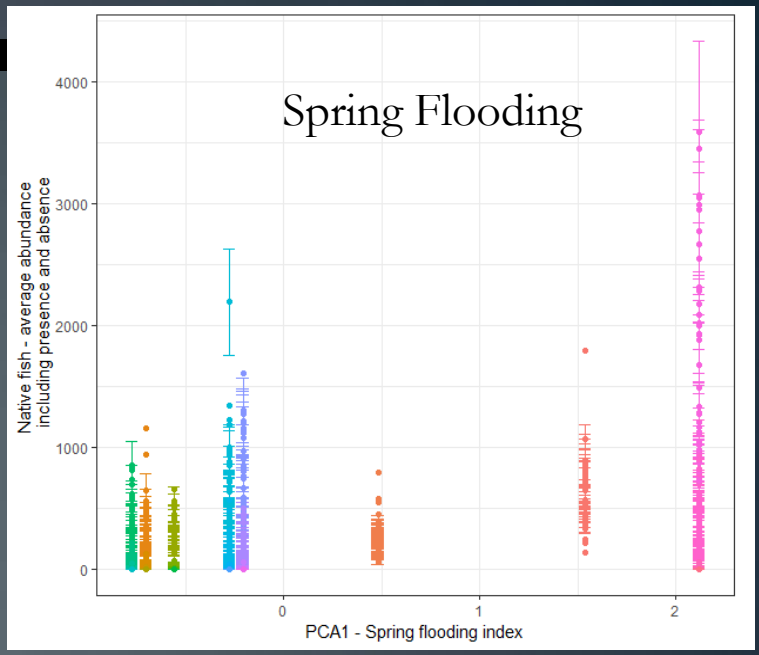
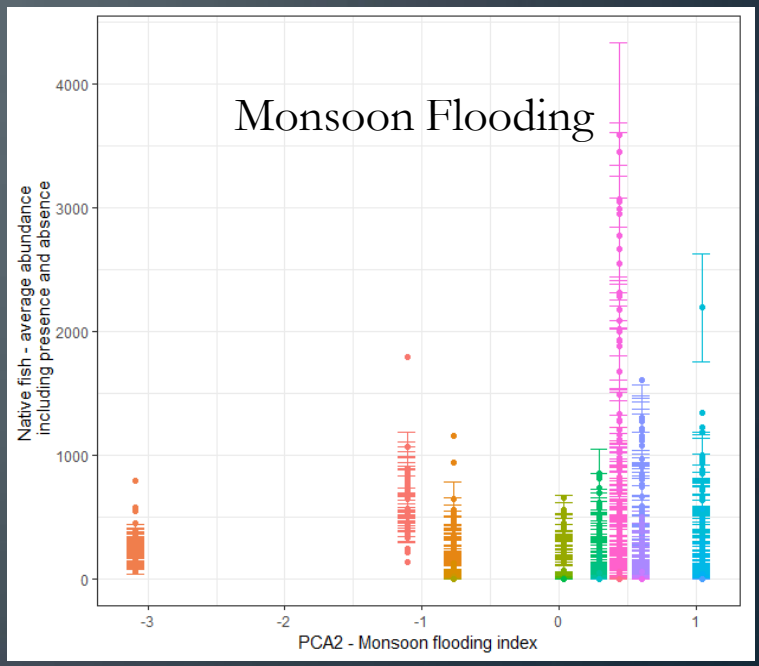




Summary – Bright Angel Creek

- Brown trout abundance remains 84% below baseline levels
- Native fishes have increased and expanded upstream with declines in trout
- Temperature, trout, and flows predict native fish abundance
- Drought in winter-spring 2018 could explain small native fish and large trout cohorts
- Effects of reductions in invasive trout likely outweigh any negative effects of electrofishing to individuals

Humpback Chub translocations

Illustration by Joseph Tomelleri

Photo by George Andjreko, AZ Game & Fish

Humpback Chub in Grand Canyon

- Largest Population
- Little Colorado River – Center of the Humpback Chub Universe:
  - Sole Spawning Location = Risk of Extirpation

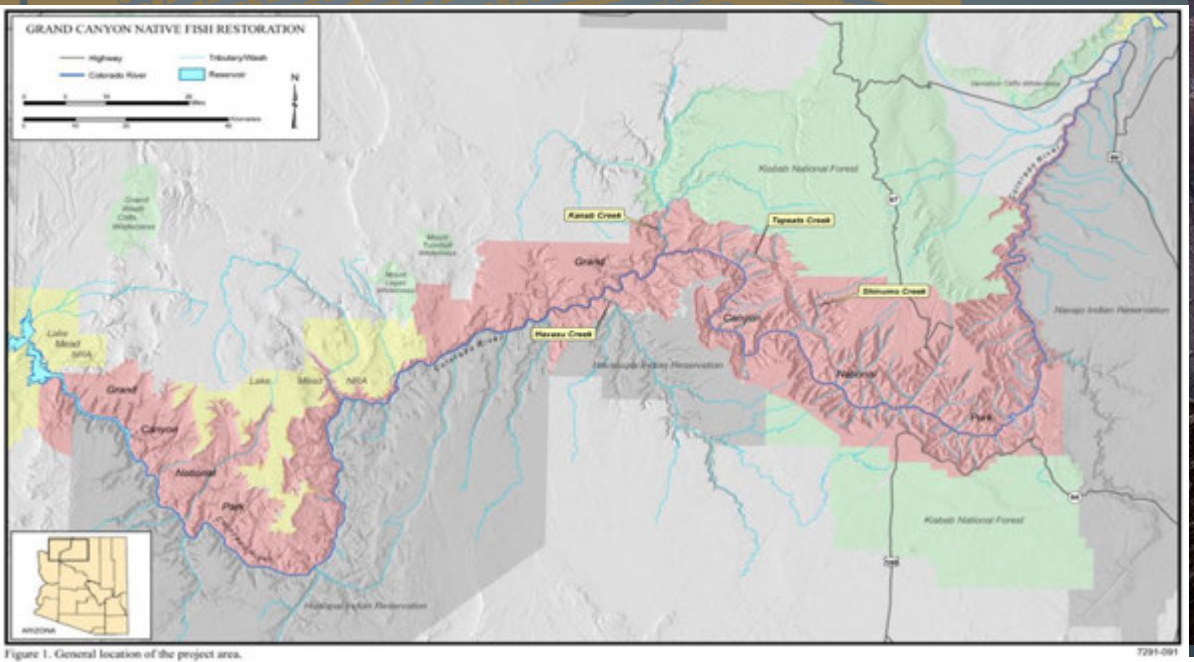
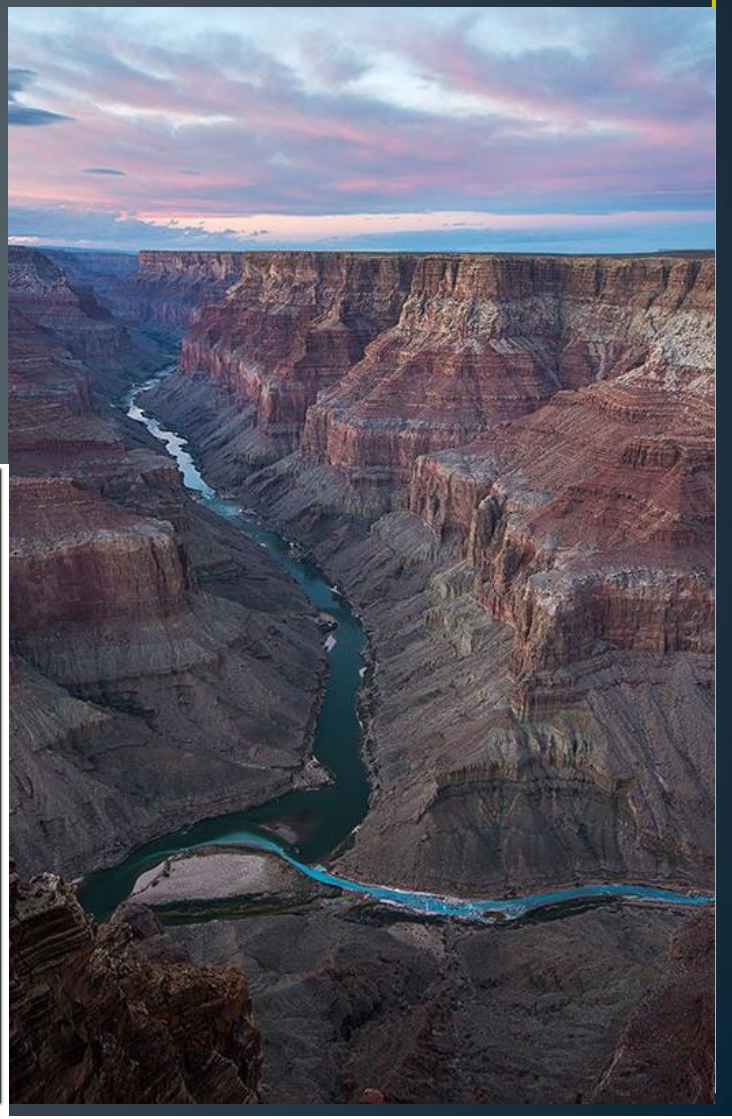


Figure 1. General location of the project area.

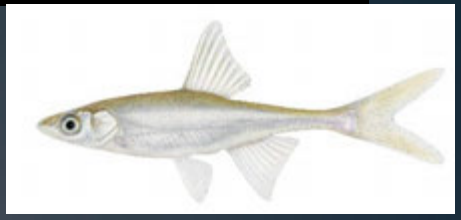


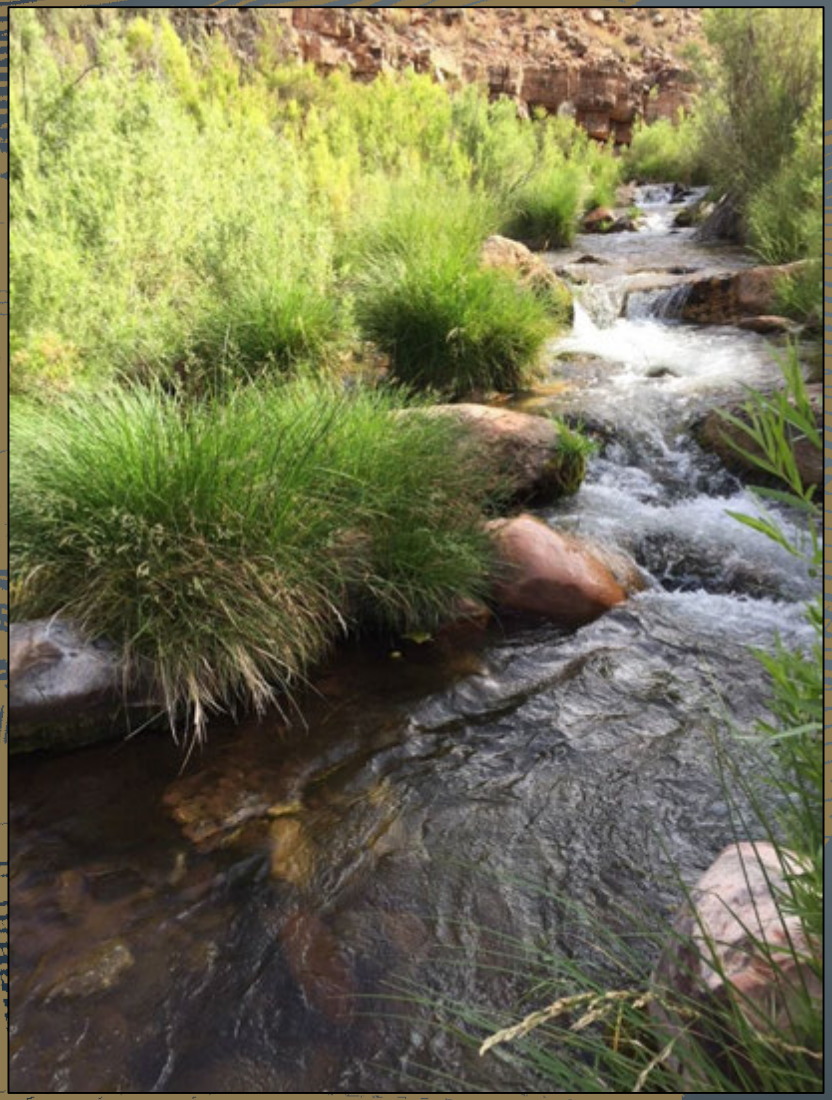
Little Colorado River Collections

Hatchery Rearing

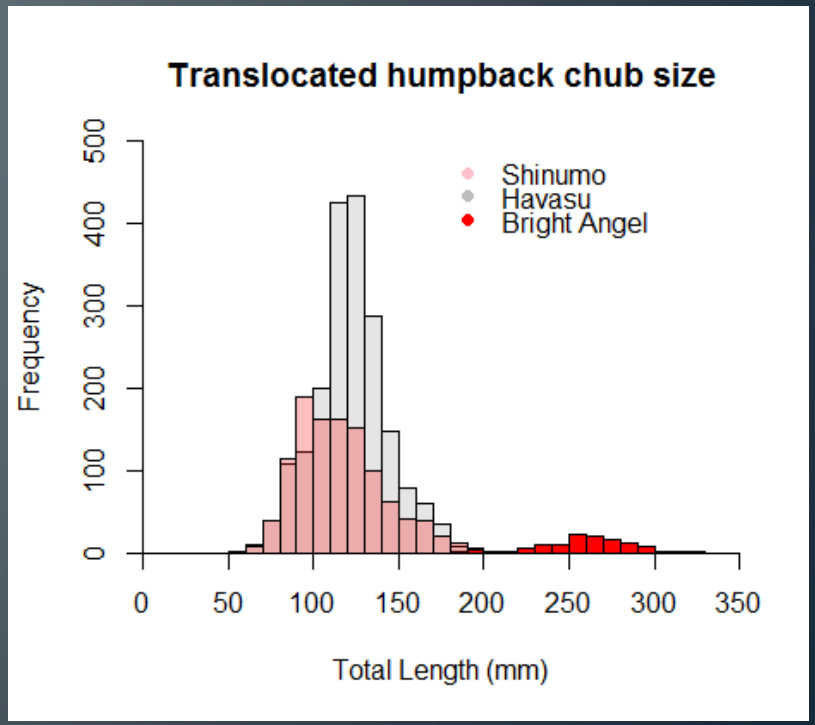
- Parasite & disease treatment
- Flow training
- Pit tagging
- Weight & length measurements

Translocations 2009-2018





Shinumo ~ 1,102 fish, 2009-2013
Havasu ~ 1,956 fish, 2011-2016
Bright Angel ~ 116 fish, 2018



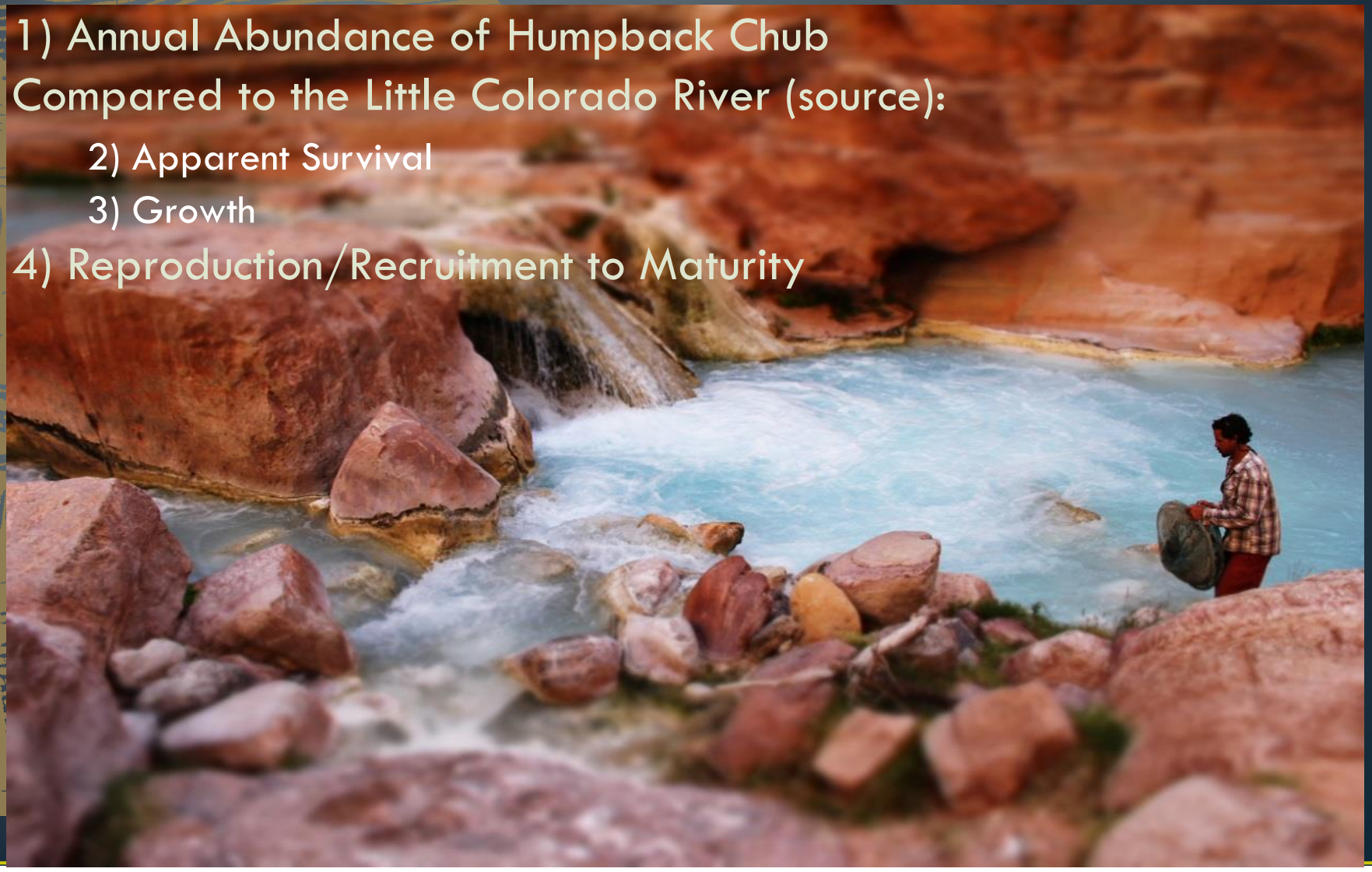
Monitoring Metrics

1) Annual Abundance of Humpback Chub Compared to the Little Colorado River (source):

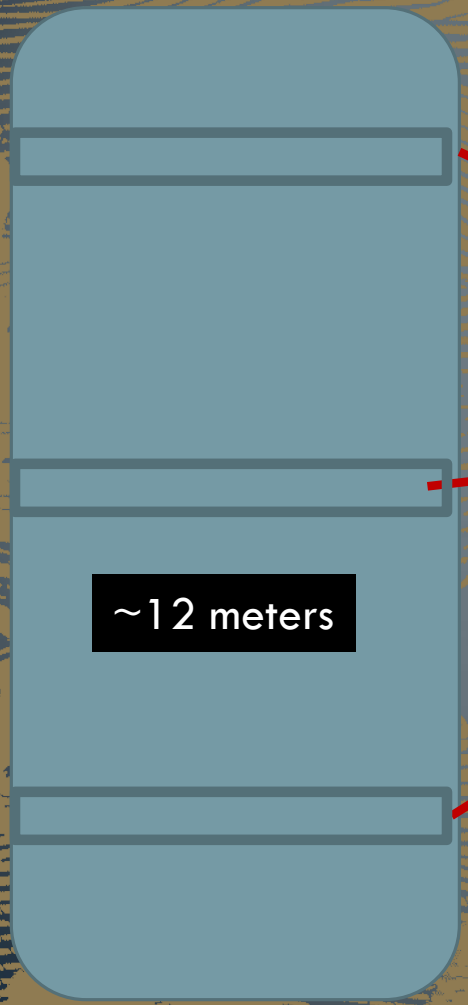
2) Apparent Survival

3) Growth

4) Reproduction/Recruitment to Maturity



PIT tag Antenna Array



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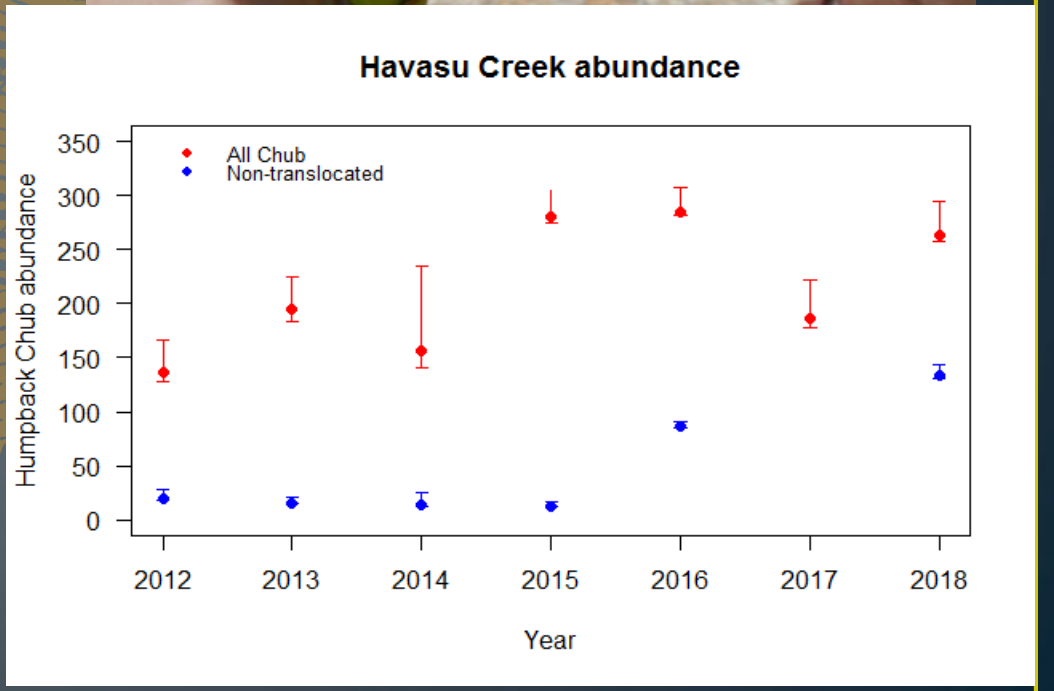
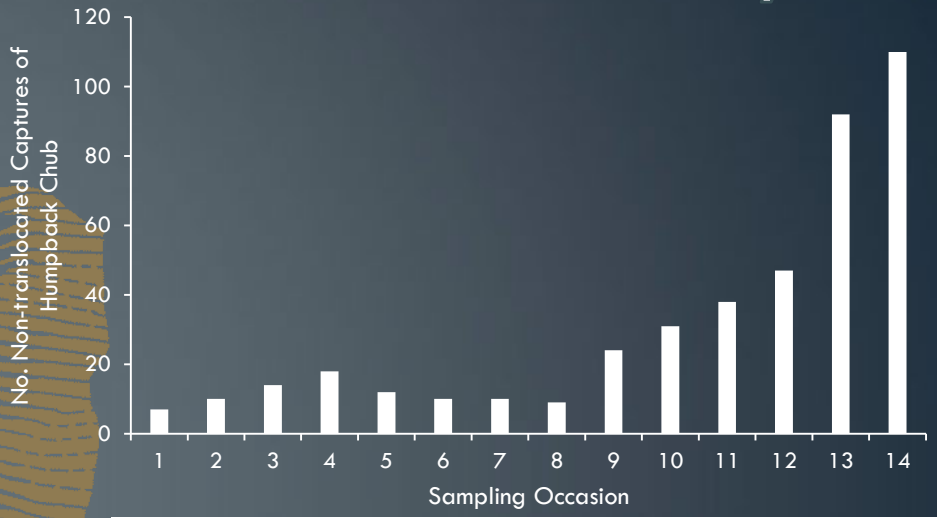
Havasu: Abundance

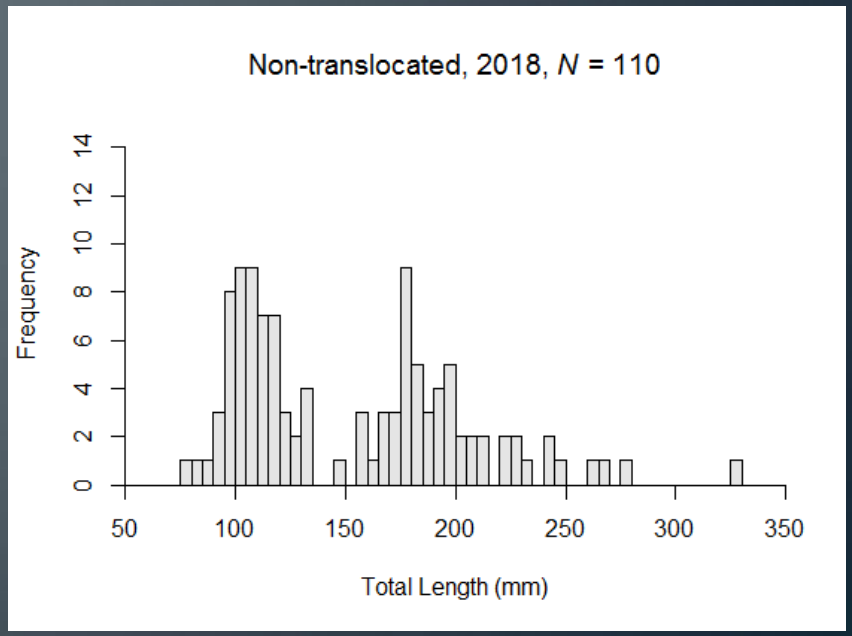
- Population estimate ~ 300
- Non-translocated/fish produced *in situ* catch continues to increase
- ~50% of abundance estimate in May, 2018



Havasu: Reproduction & Recruitment to Maturity

- Continued recruitment
- 2018 – Increases in catch of fish produced in Havasu Creek
- Multiple age-classes present

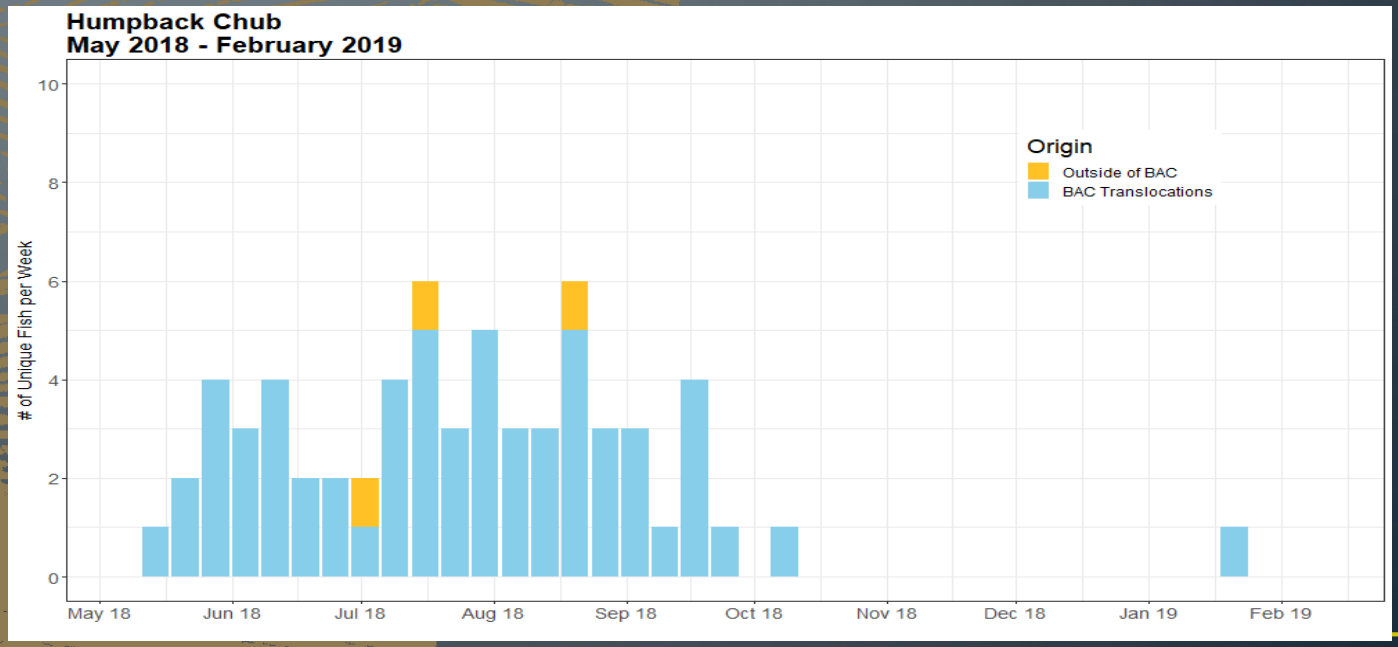




√ Reproduction and Recruitment

Bright Angel Creek – Antenna Highlights

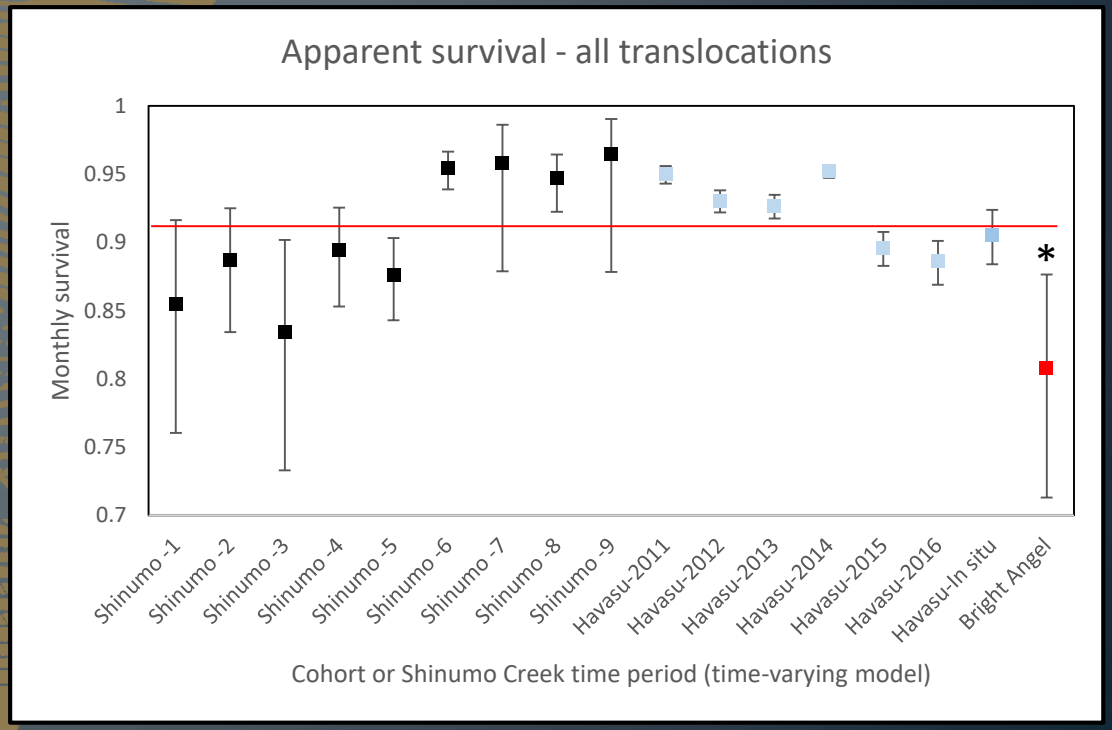
- May, 2018, released 116 adult humpback chub (mean TL =257 mm)
- Detected 29 individual translocated humpback chub (May – February)
- 2 HBC tagged in the Colorado River – RM 80 and 100
- 2 Brown trout tagged at -3 and -4 mile above Lee's Ferry (90+ miles upstream)



Humpback chub translocations

Bright Angel Creek:

- Antenna data and captures (fall hoop-netting + e-fishing)
- Preliminary apparent survival ~80%; estimate will change with additional data



*BAC - Preliminary estimate

Summary/Next Steps - Translocations

- Havasu Creek represents a second reproducing population in Grand Canyon
- Next steps: Spring 2019, larval collection for Bright Angel translocation #2 (2020)
- Continued monitoring/trout suppression - Bright Angel
- Monitoring and potential augmentation - Havasu Creek.

Questions?

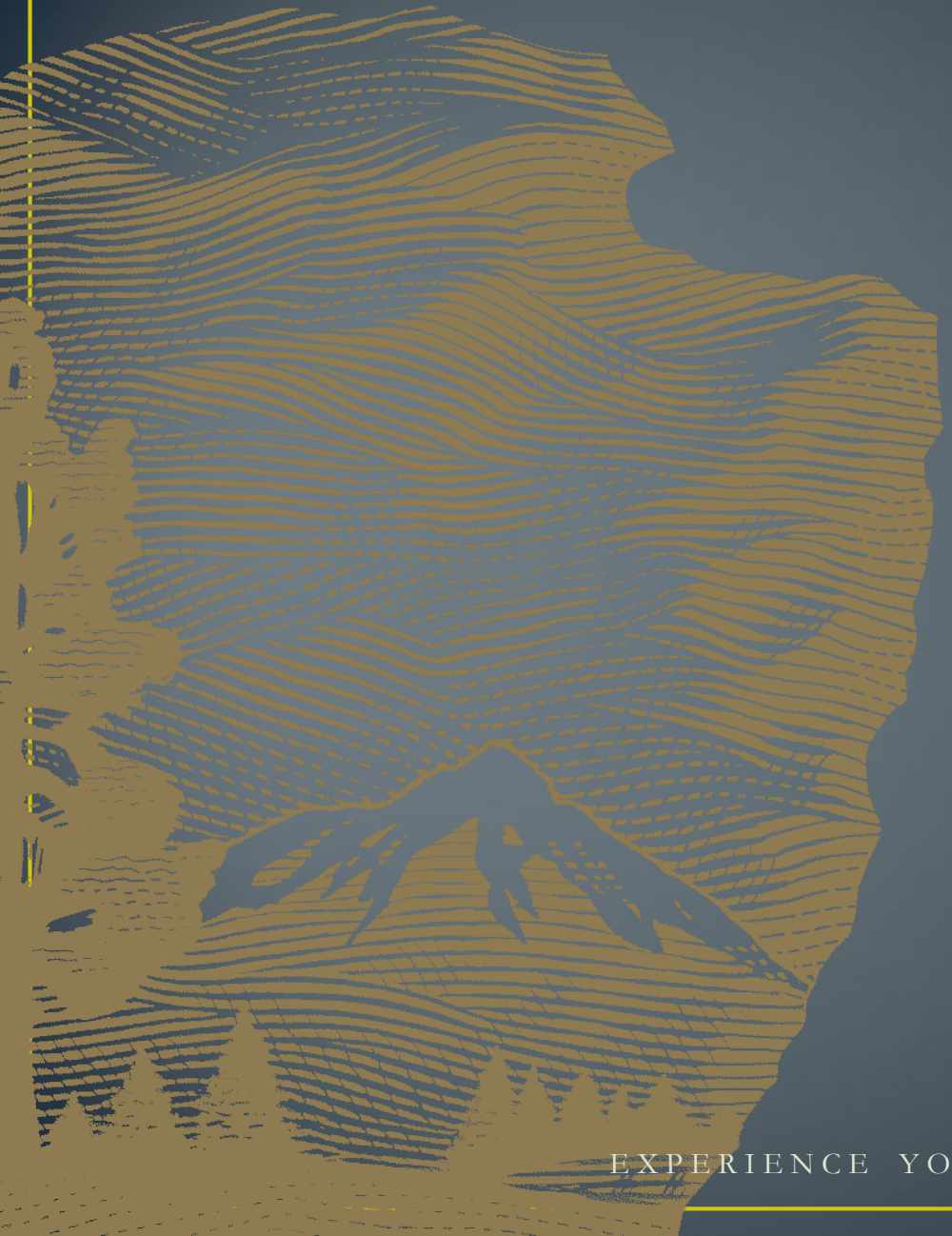
Products

Annual Reports (2): translocations and nonnative Fish Control

Trip reports (all trips)

Manuscripts in preparation:

- Establishment of an endangered humpback chub population through experimental translocations (*to be submitted to North American Journal of Fisheries Management*)
- Native fish recovery across environmental gradients following invasive trout control in a Grand Canyon tributary(*to be submitted to Canadian Journal of Fisheries and Aquatic Sciences*)



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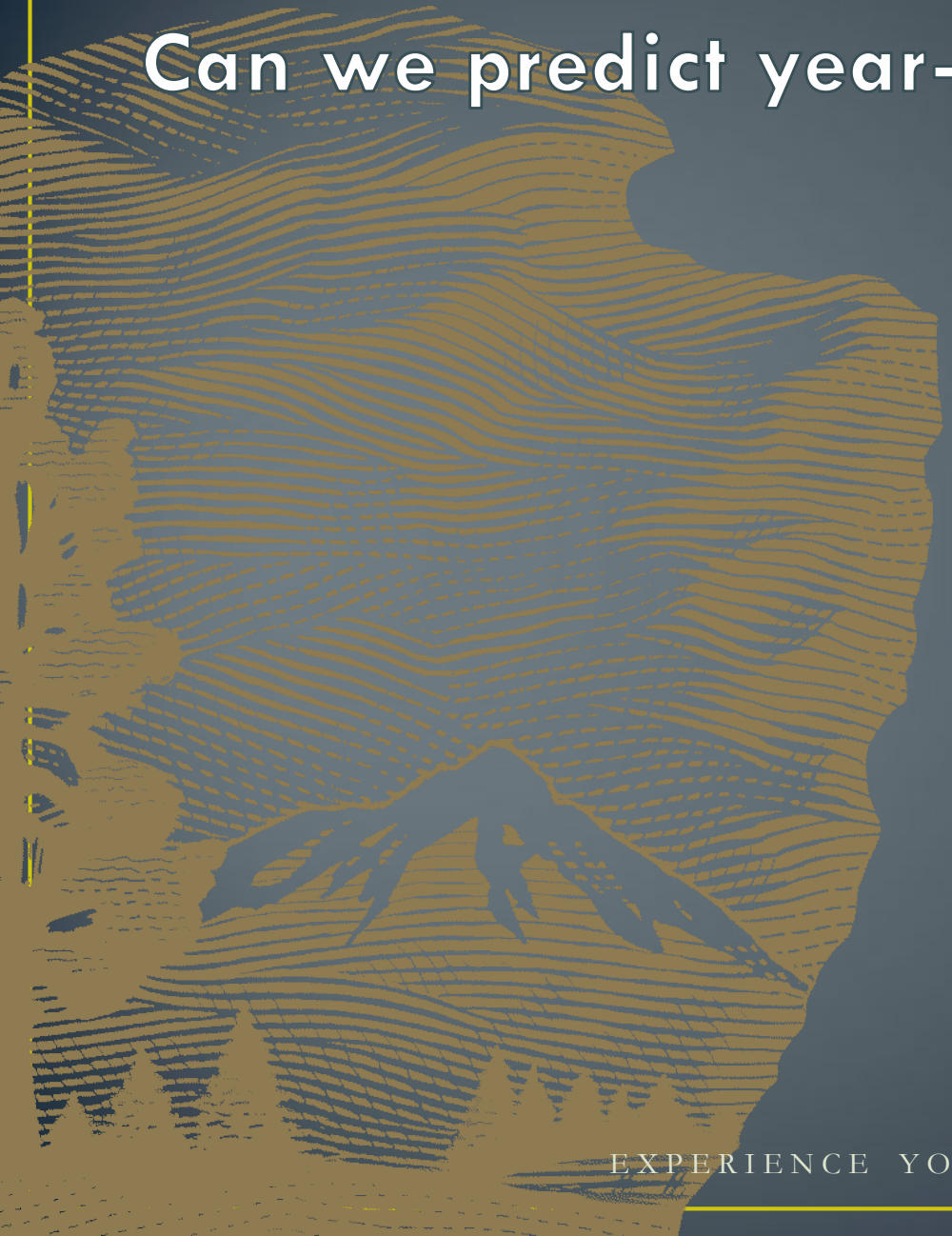
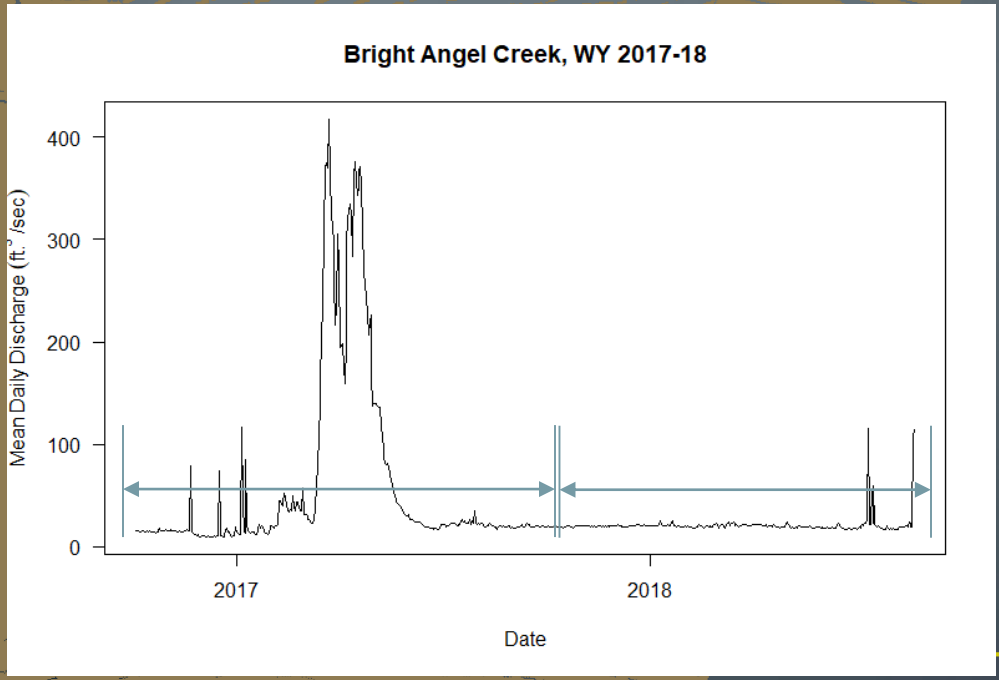
Can we predict year-class strength?



Can we predict year-class strength?

- Water years:

2017 and 2018



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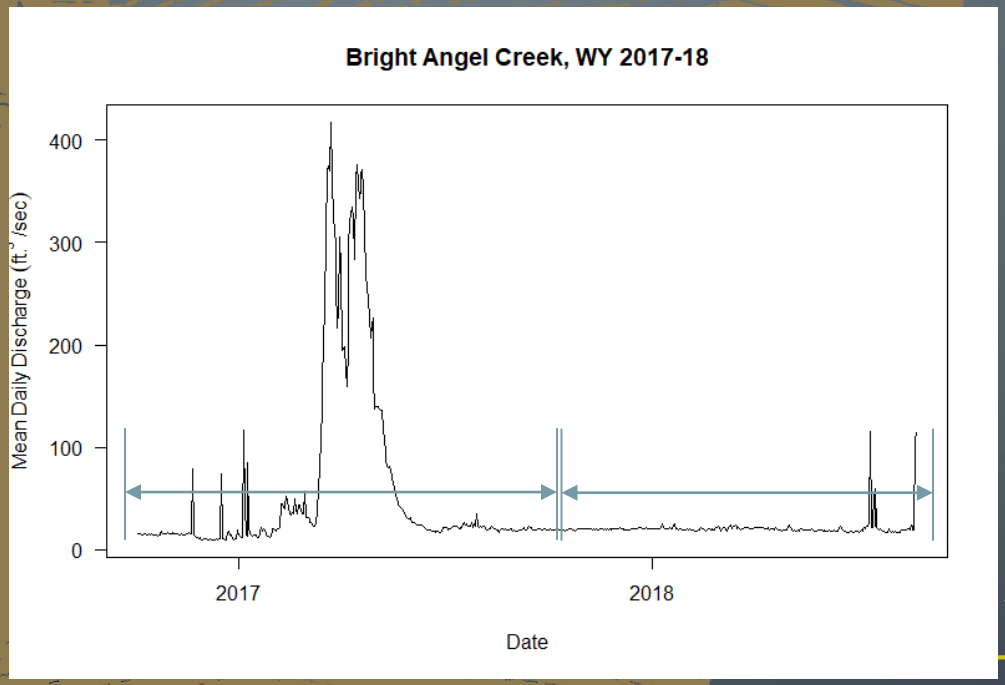
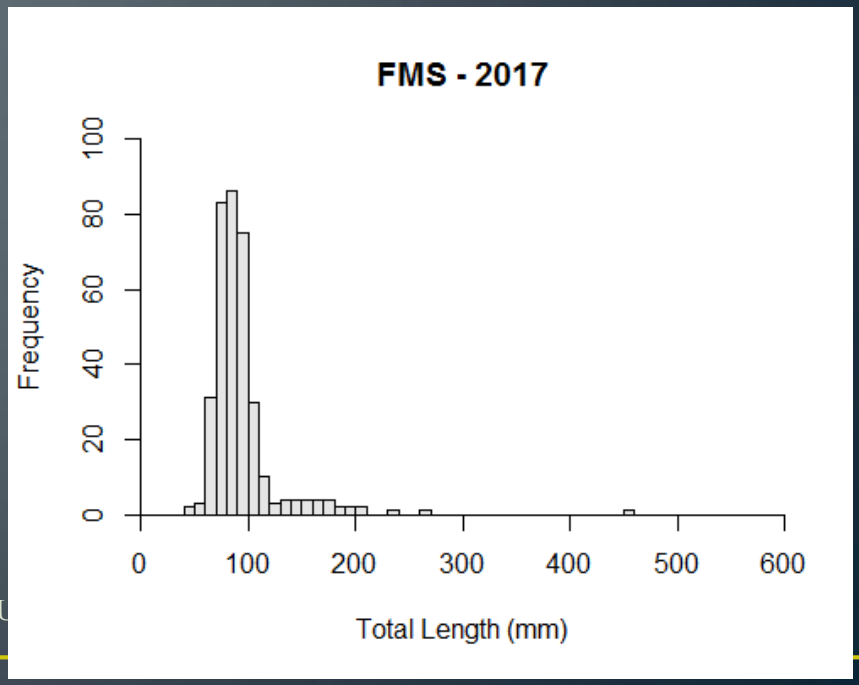
  2017 and 2018





Can we predict year-class strength?

- Water years:
  2017 and 2018