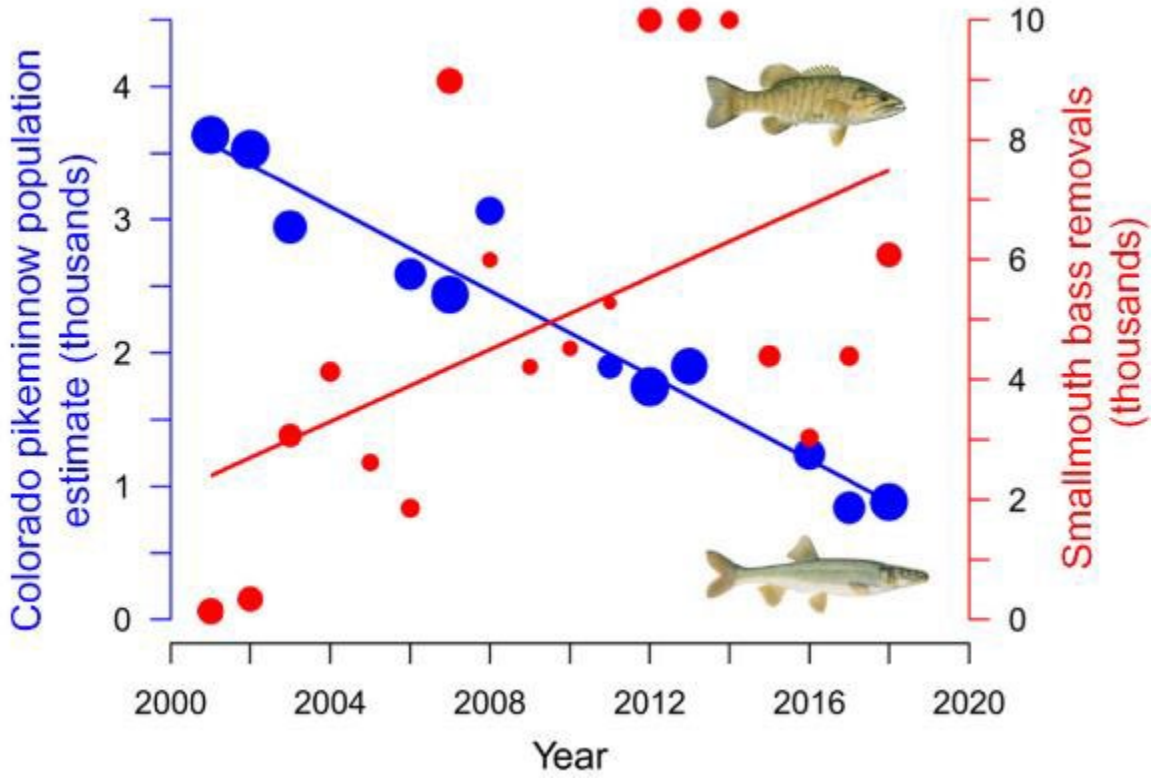
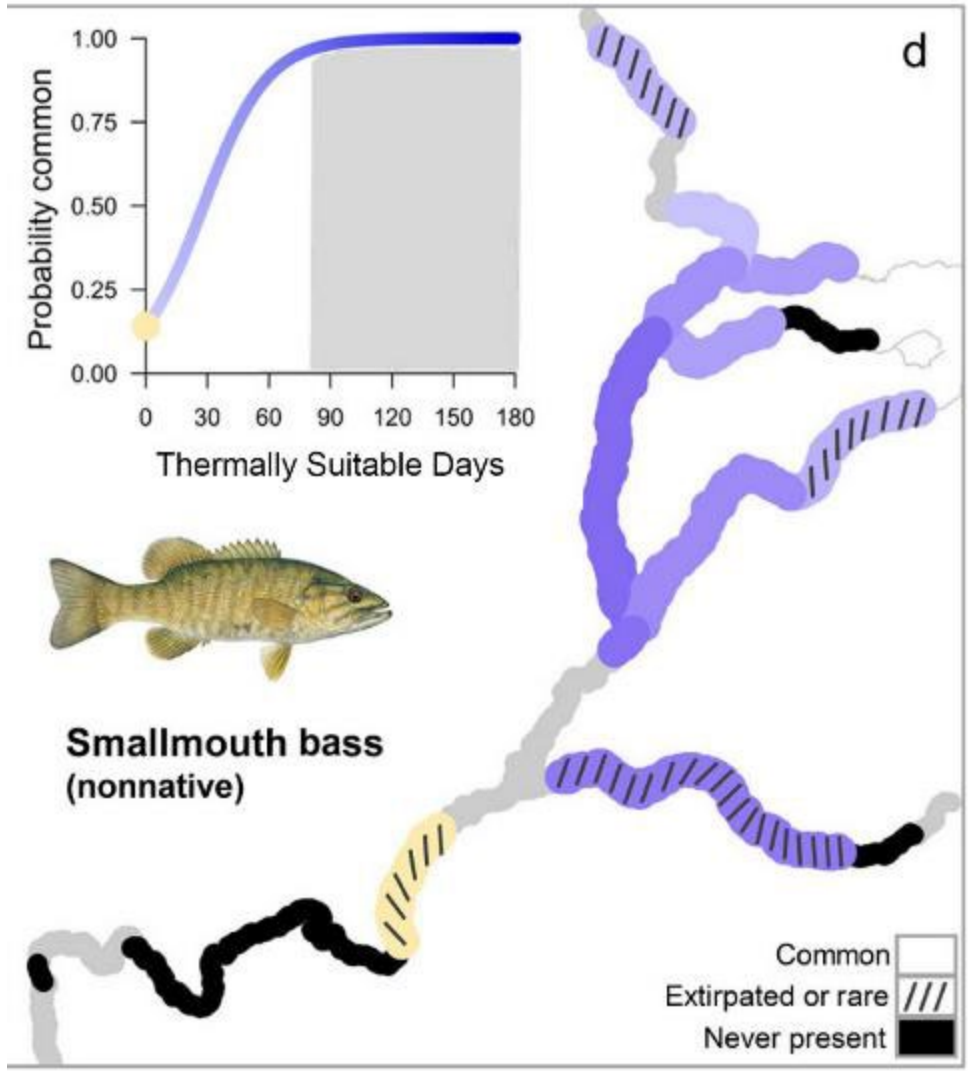
Near-Term Threat of Smallmouth Bass Establishment below Glen Canyon Dam

Charles Yackulic,
US Geological Survey, Southwest Biological Science Center,
Grand Canyon Monitoring Research Center

On behalf of the Smallmouth Bass Task force organized by Kirk Young and including Drew Eppehimer, Jeff Arnold, Lucas Bair, Jan Boyer, Craig Ellsworth, Eric Frye, Sky Hedden, Kerri Pedersen, Pilar Rinker, Scott Rogers, Robert Schelly, Laura Tennant, Melissa Trammell and David Ward.

Where smallmouth bass (*Micropterus dolomieu*) have invaded in the Colorado River basin, they are considered the biggest threat to native fish species.





Dibble et al., 2021
Ecological Applications

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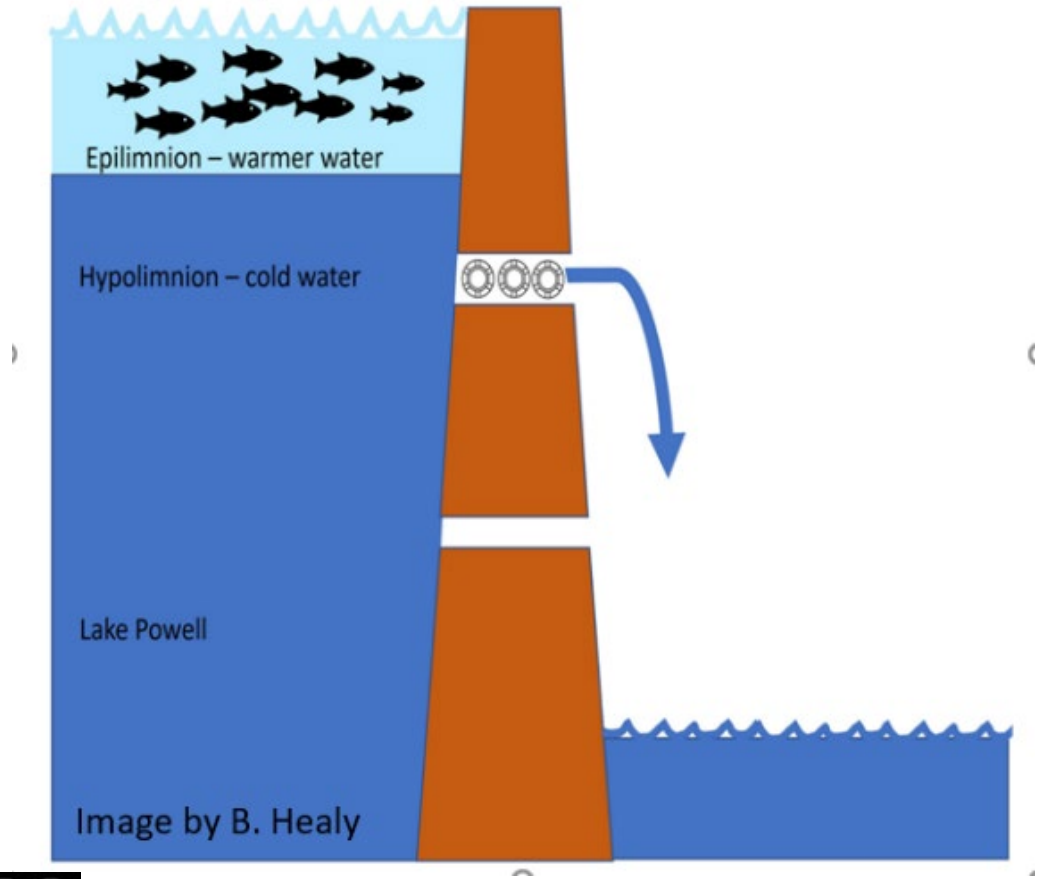
Why aren’t Smallmouth Bass already established in Grand Canyon?

Cold releases from Glen Canyon Dam
Low propagule pressure



Turbidity at the inflow to Lake Mead

Pearce Ferry Rapid – recent barrier

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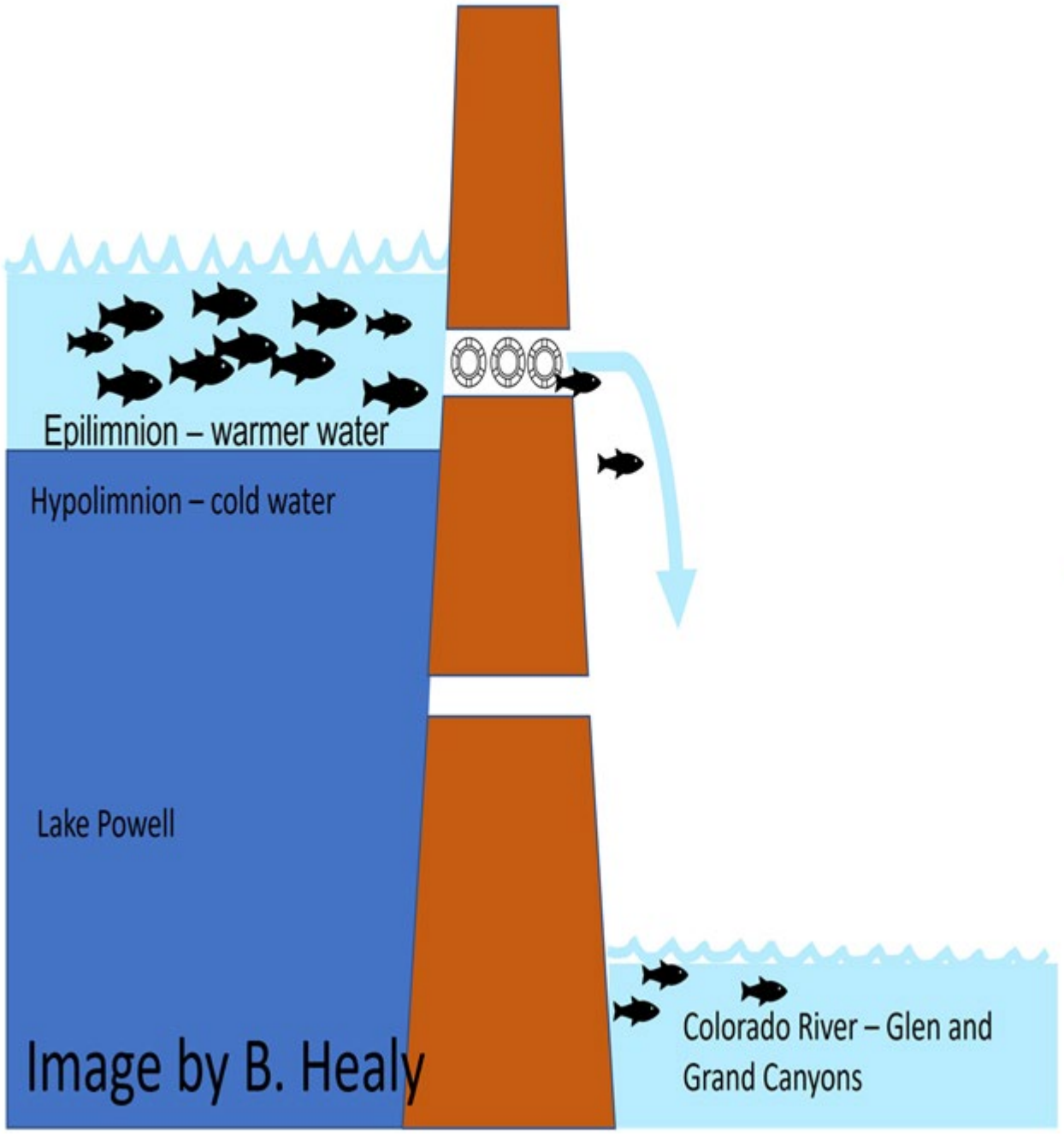
What is changing?

- Lower lake levels likely to increase entrainment; lake surface closer to penstocks

- Release temperatures are becoming warmer and suitable for reproduction and growth at Lees Ferry



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Outline

- How much entrainment is required to establish a population?
- Are conditions suitable for smallmouth bass?
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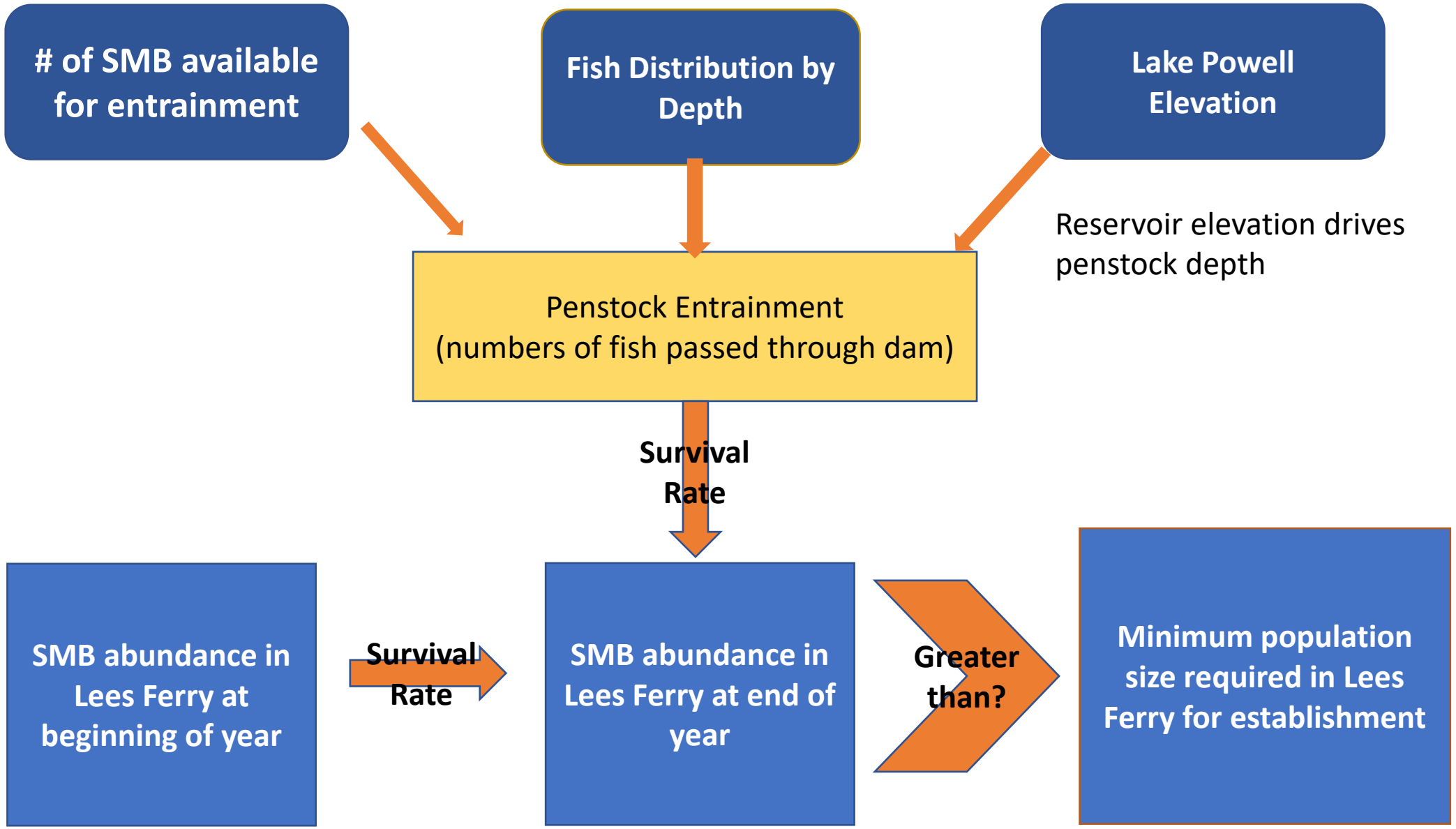
Conceptual Model of Smallmouth Bass (SMB) Entrainment Risk



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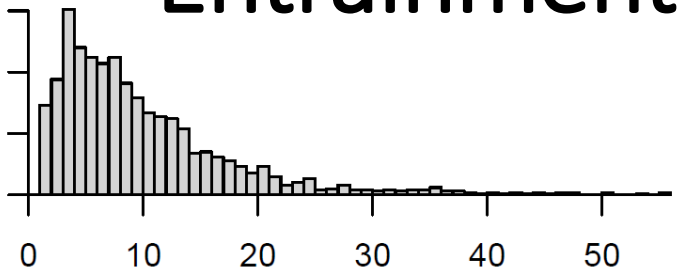
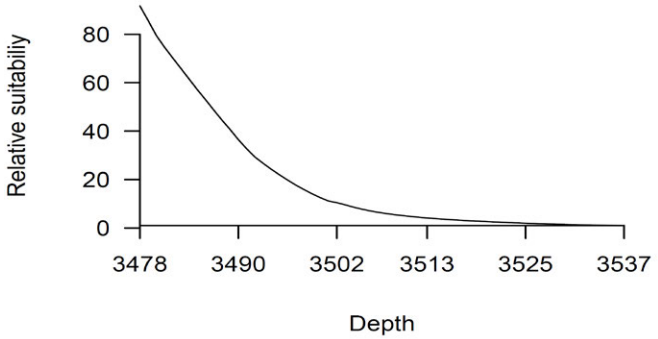
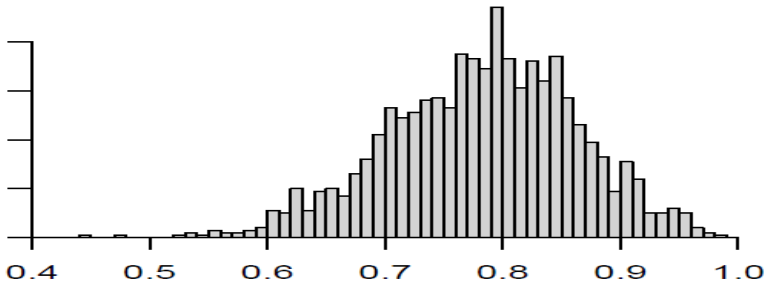
Statistical Model of Entrainment Risk



Size of entrainable population (x 1,000)

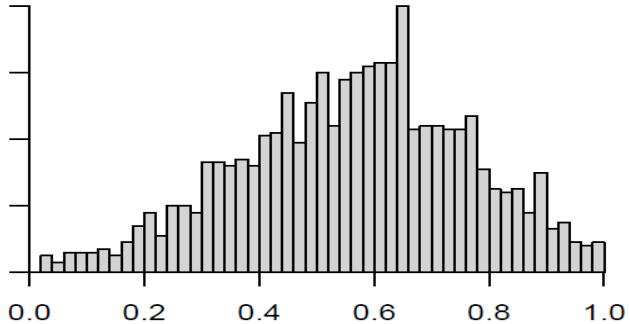


Inflows
Outflows
(Bank Storage, Evaporation)



Annual adult survival

Penstock Entrainment
(numbers of fish passed through dam)



Survival through penstocks

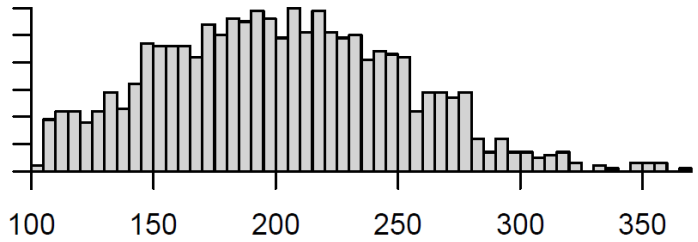
Survival Rate

SMB abundance in Lees Ferry at beginning of year

Survival Rate

SMB abundance in Lees Ferry at end of year

Greater than?



# of spawners required to establish SMB in Lees Ferry

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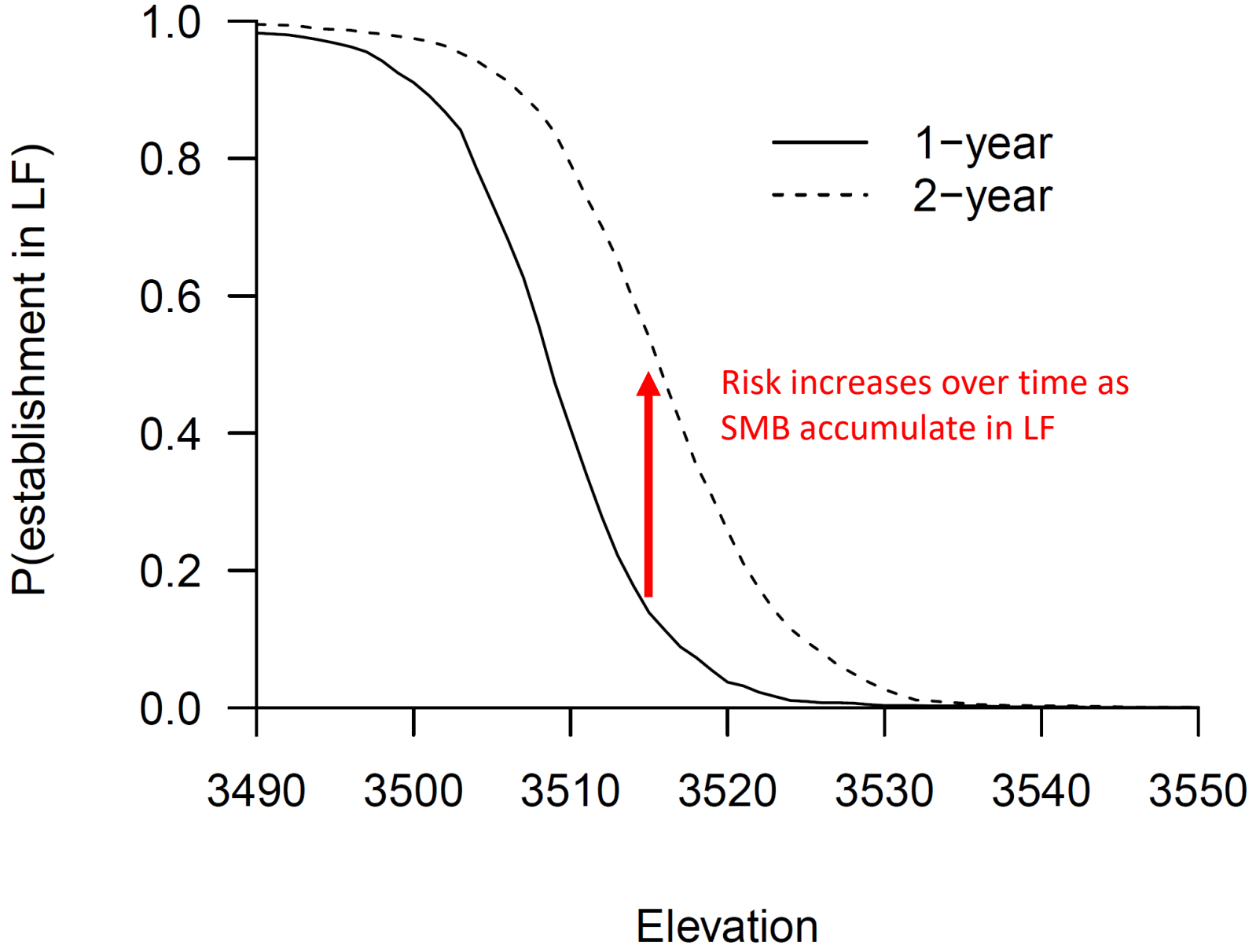
(Preliminary, do not cite)

Entrainment risk if elevation is held constant at a particular value



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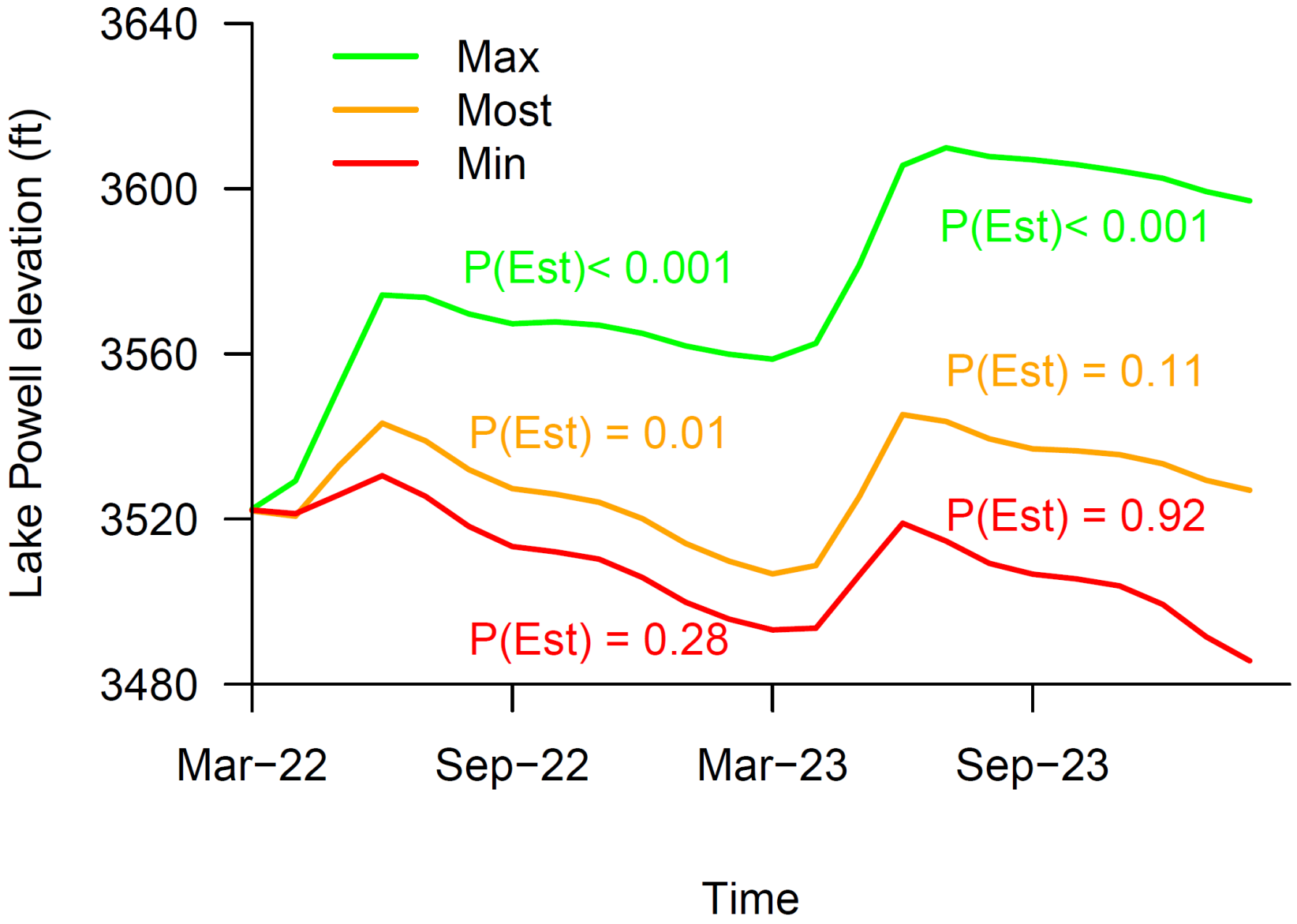
Results based on March 24-month study



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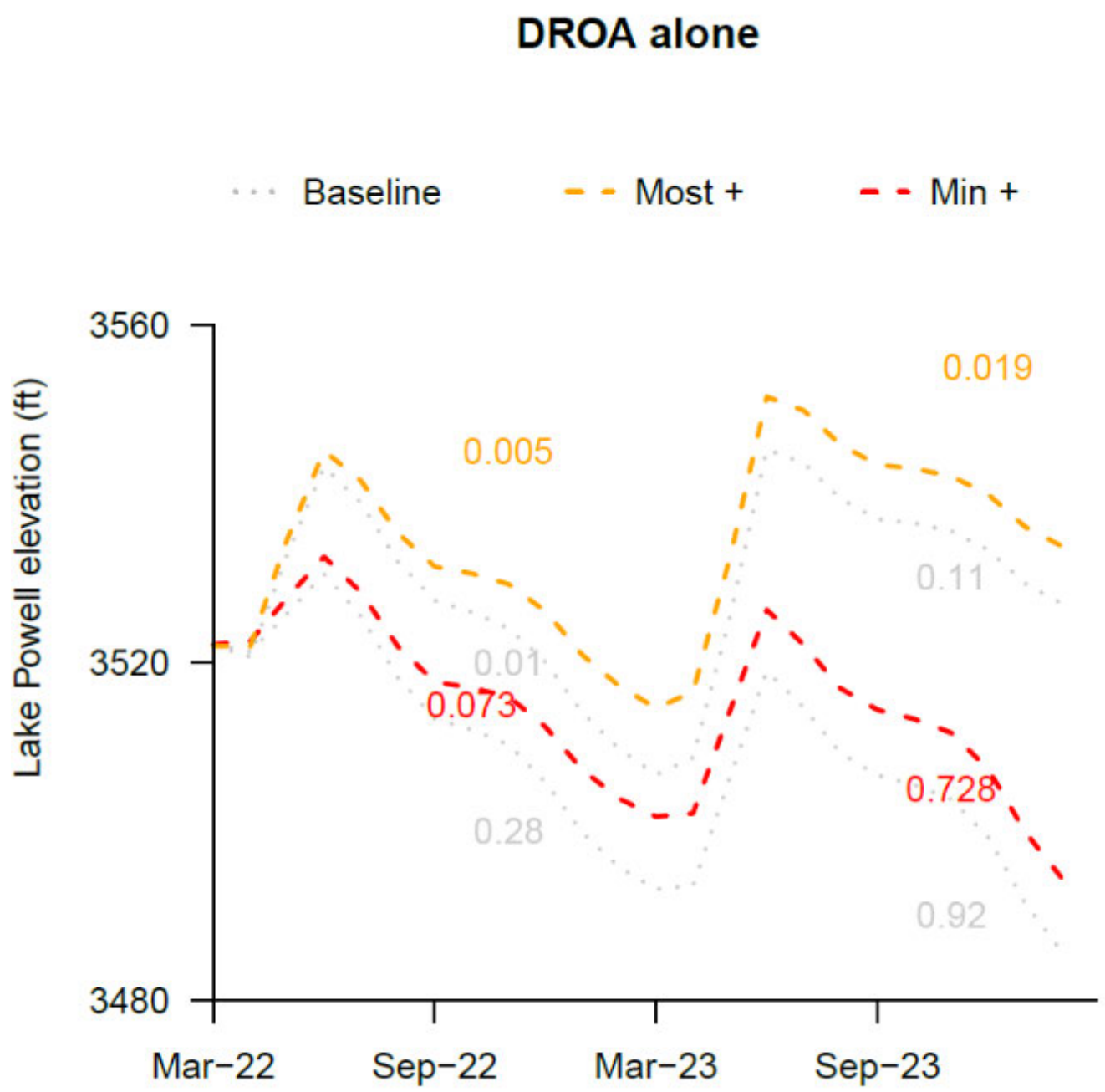
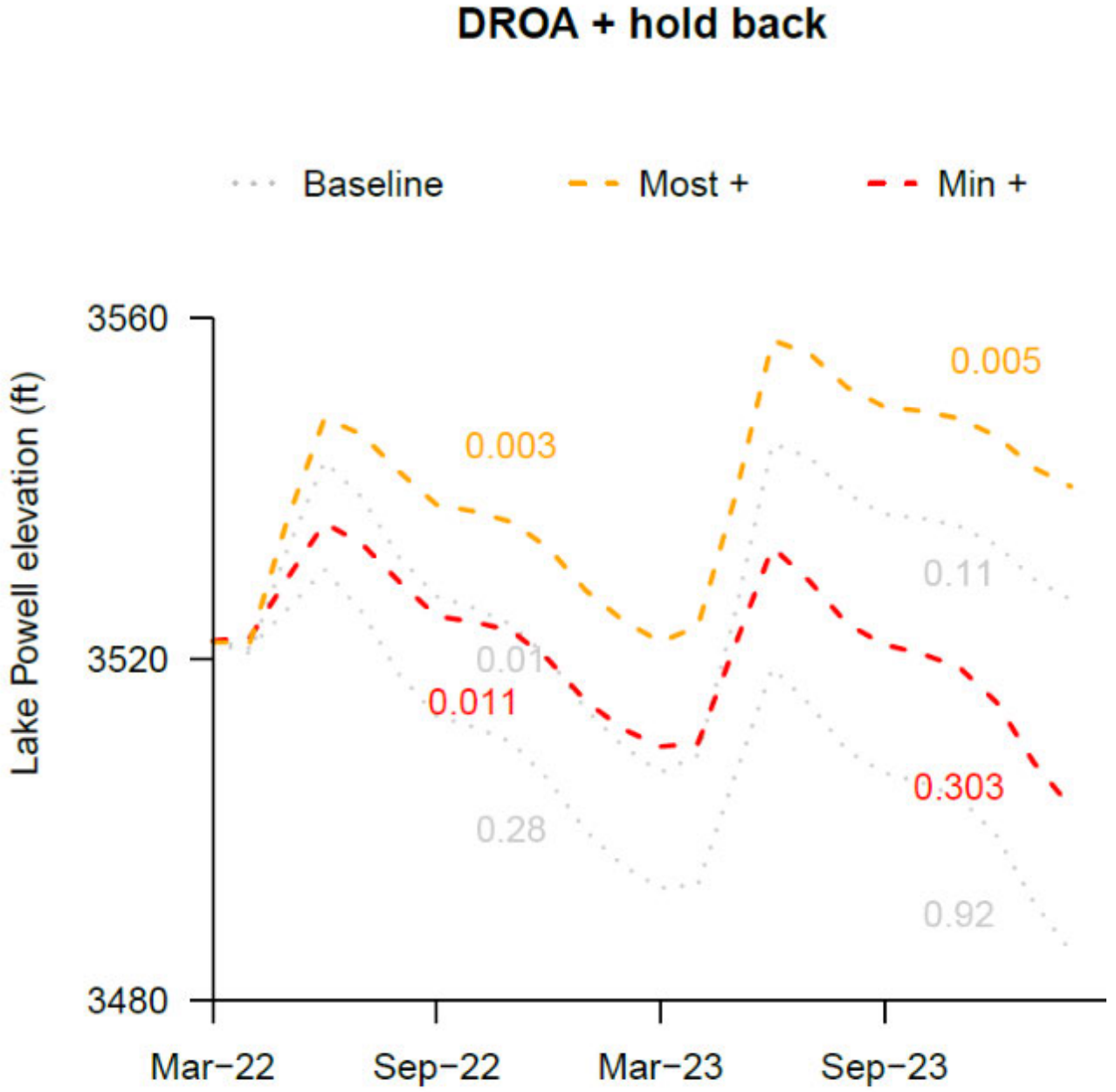
Hypothetical scenario 1



(Preliminary, do not cite)

Hypothetical scenario 2



(Preliminary, do not cite)

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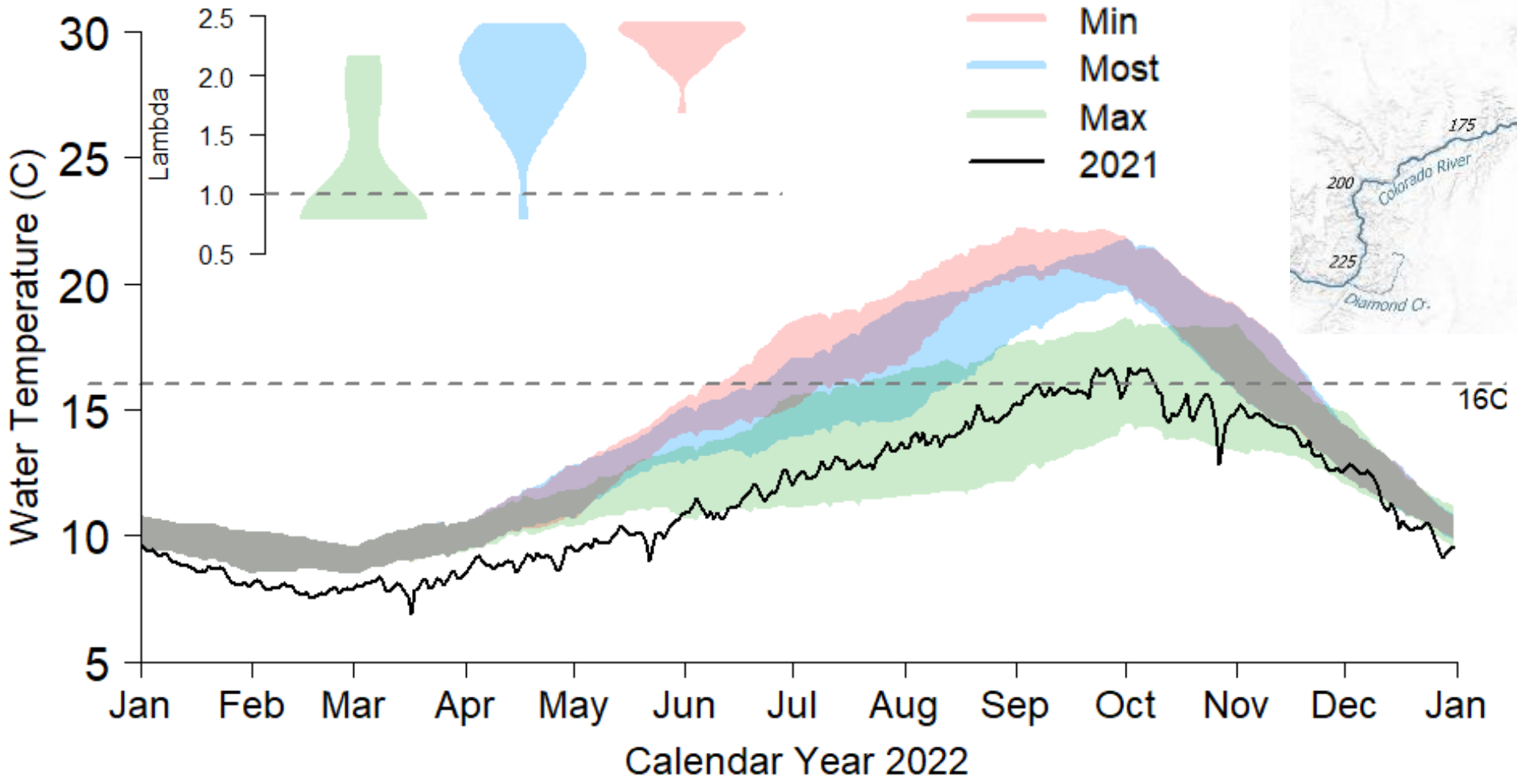
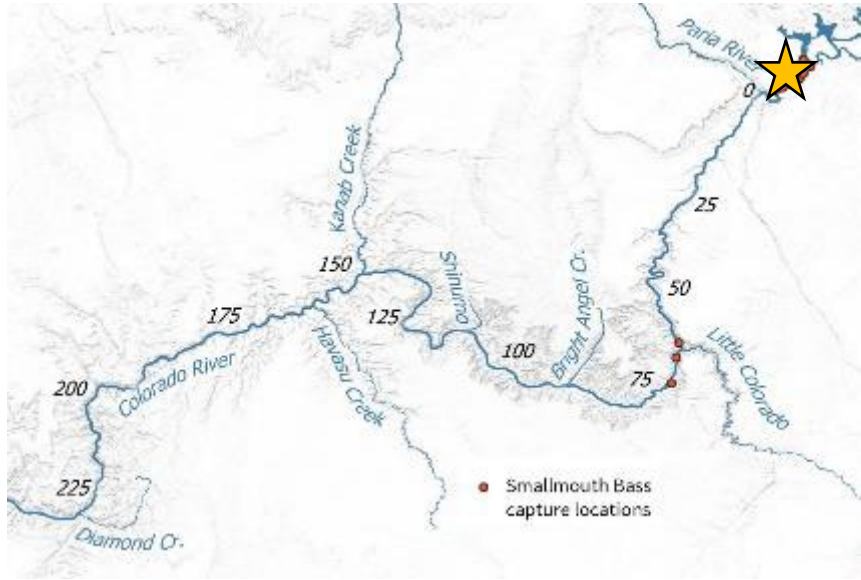
Temperature and SMB Suitability in Lees Ferry





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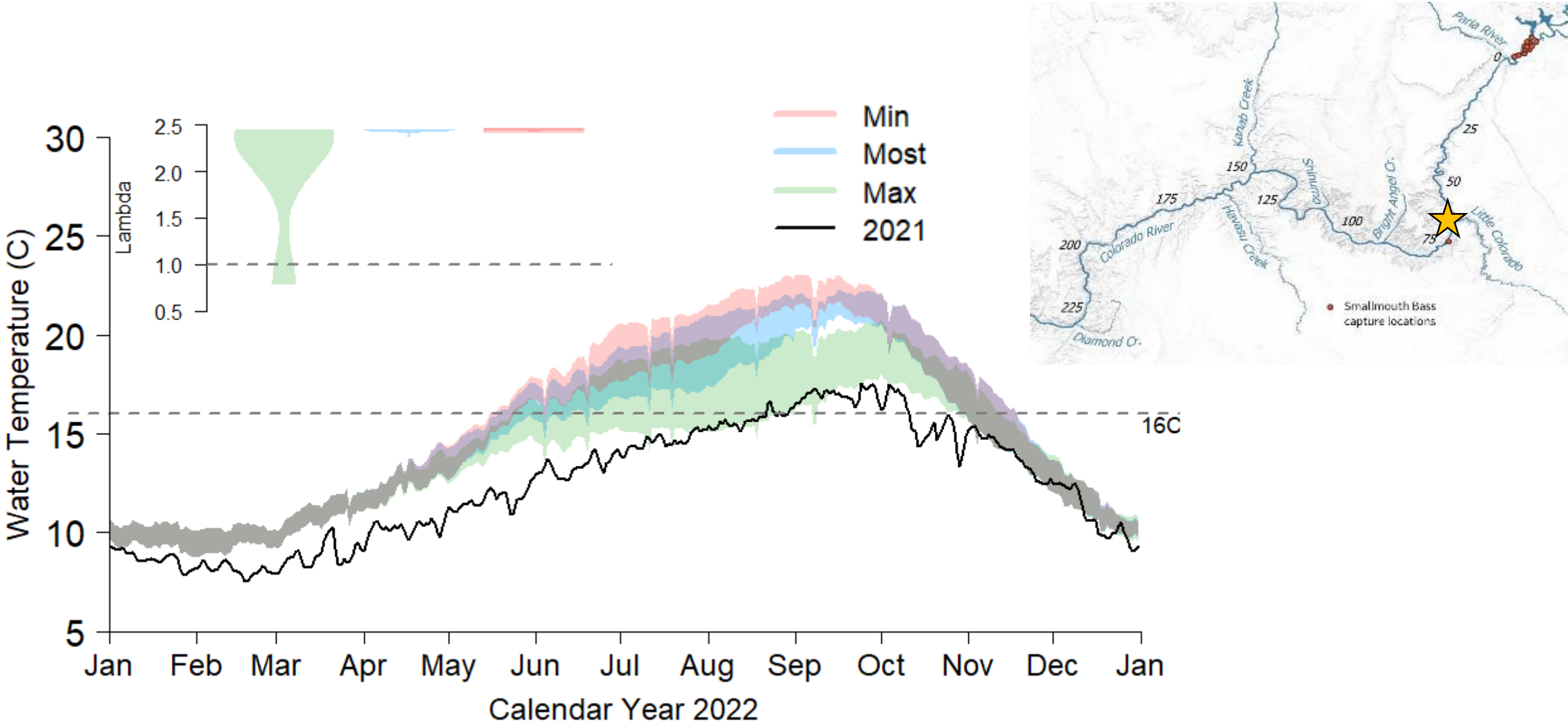
Temperature and SMB Suitability at LCR Reach



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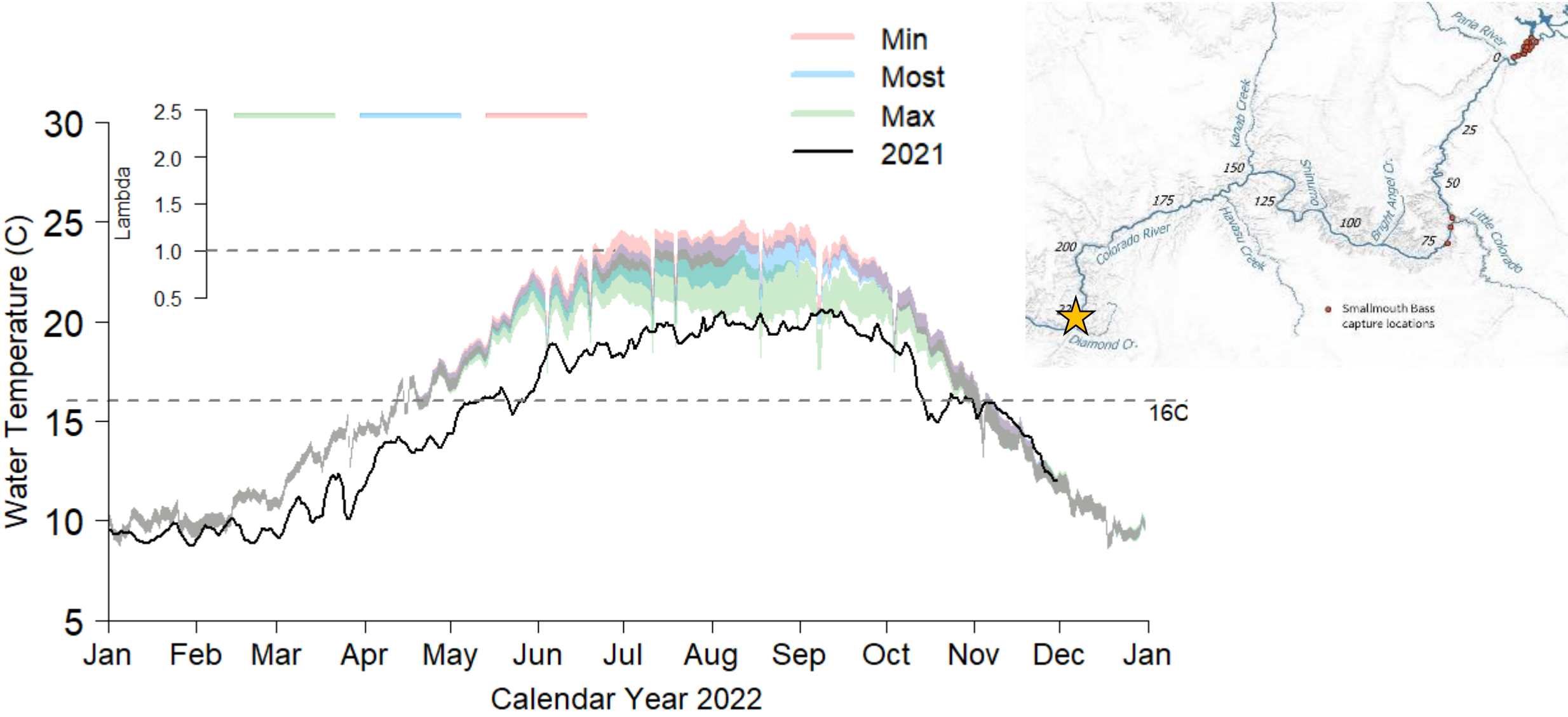
Temperature and SMB Suitability at Diamond Creek Reach



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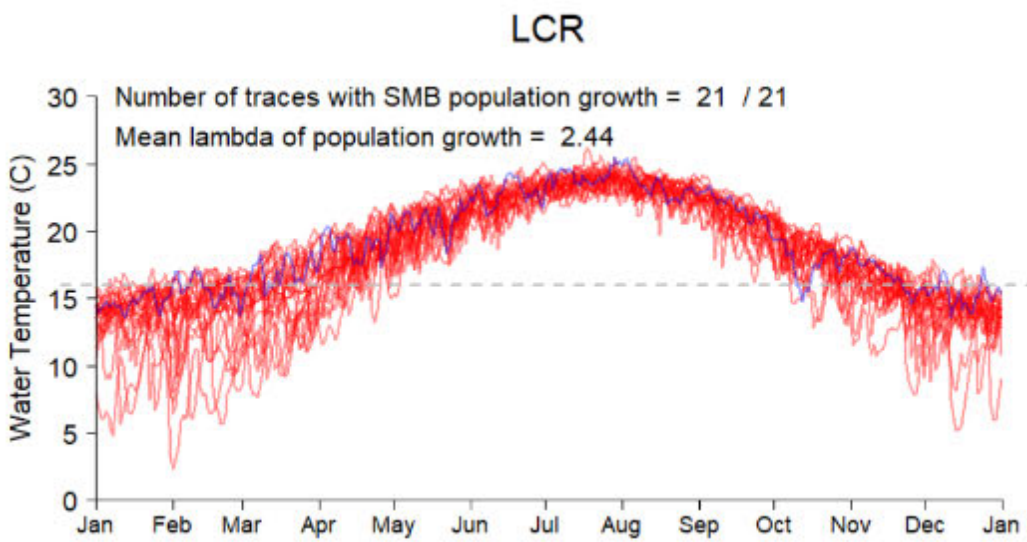
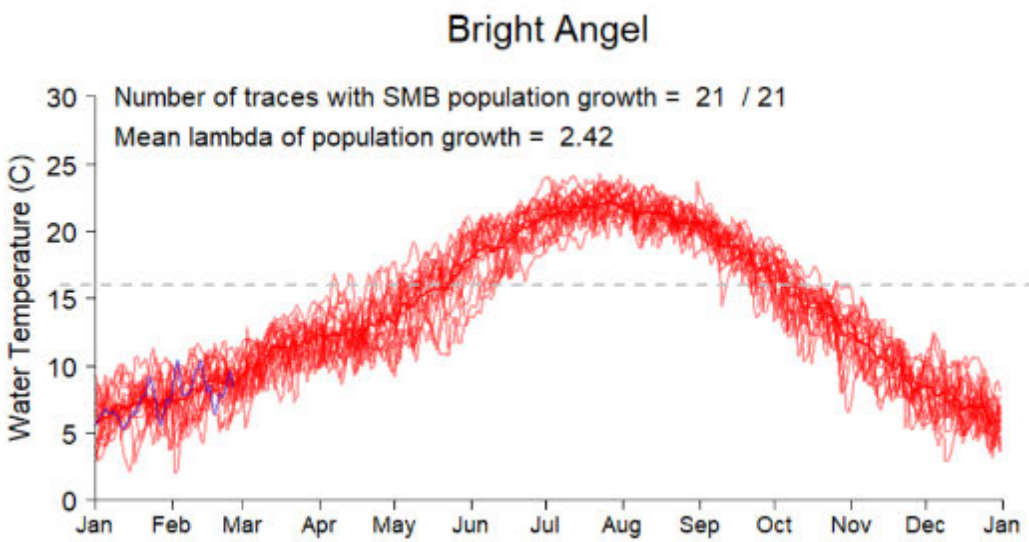
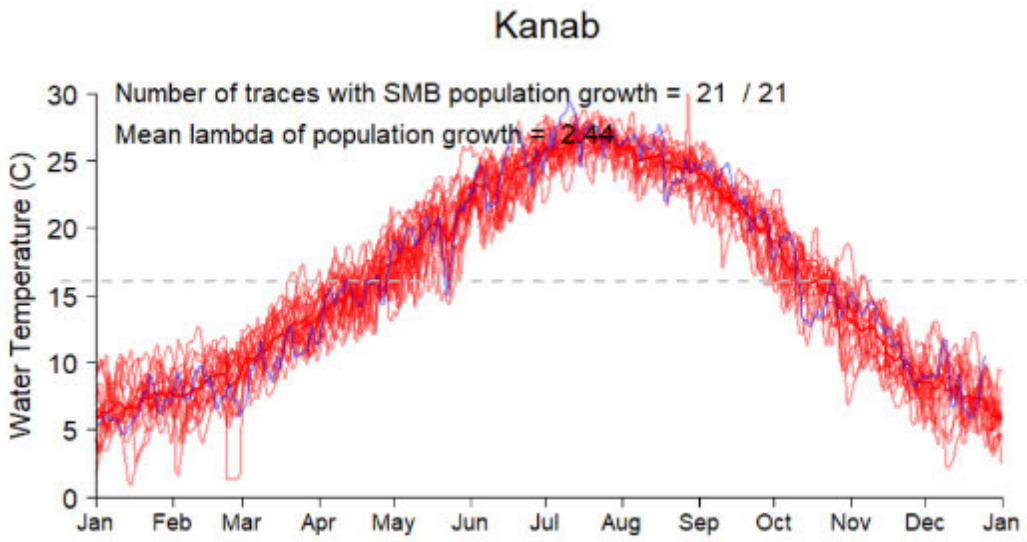
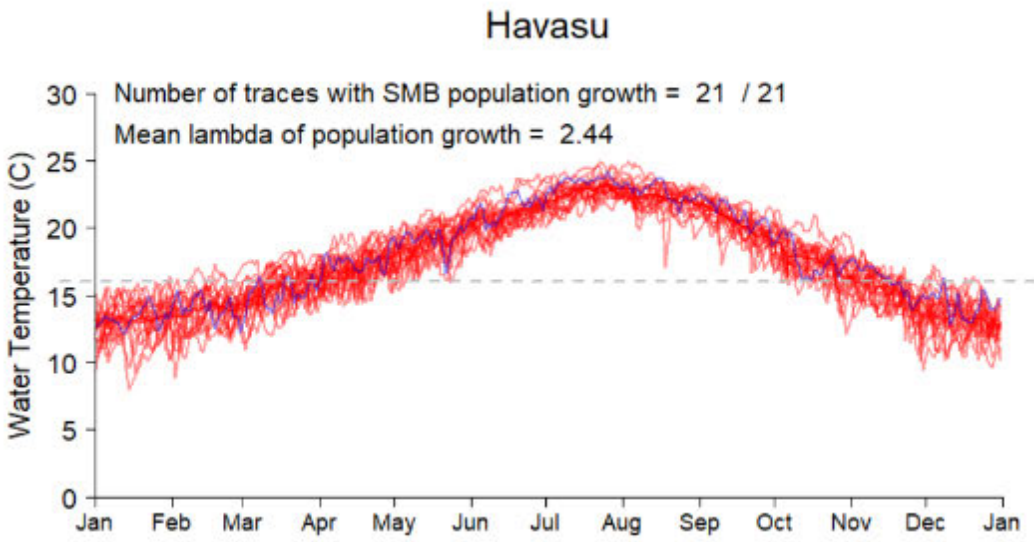
Tributary Thermal Suitability (2000-present)









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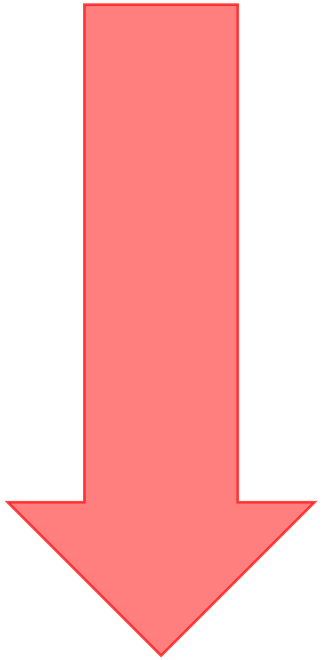
How reversible is a smallmouth bass invasion?

- Scenario 1- Increased SMB population in Lees Ferry or downriver, but not reproducing (not established)
  - Perhaps reversible if action taken quickly
- Scenario 2- Established population in Lees Ferry
  - Perhaps reversible over many years if spawning is disrupted every year
- Scenario 3- Established population(s) downriver of Lees Ferry
  - Extreme changes to dam operations required on a decadal timescale
- Scenario 4- Established populations in tributaries
  - Perhaps reversible with extensive removal and see scenario 3



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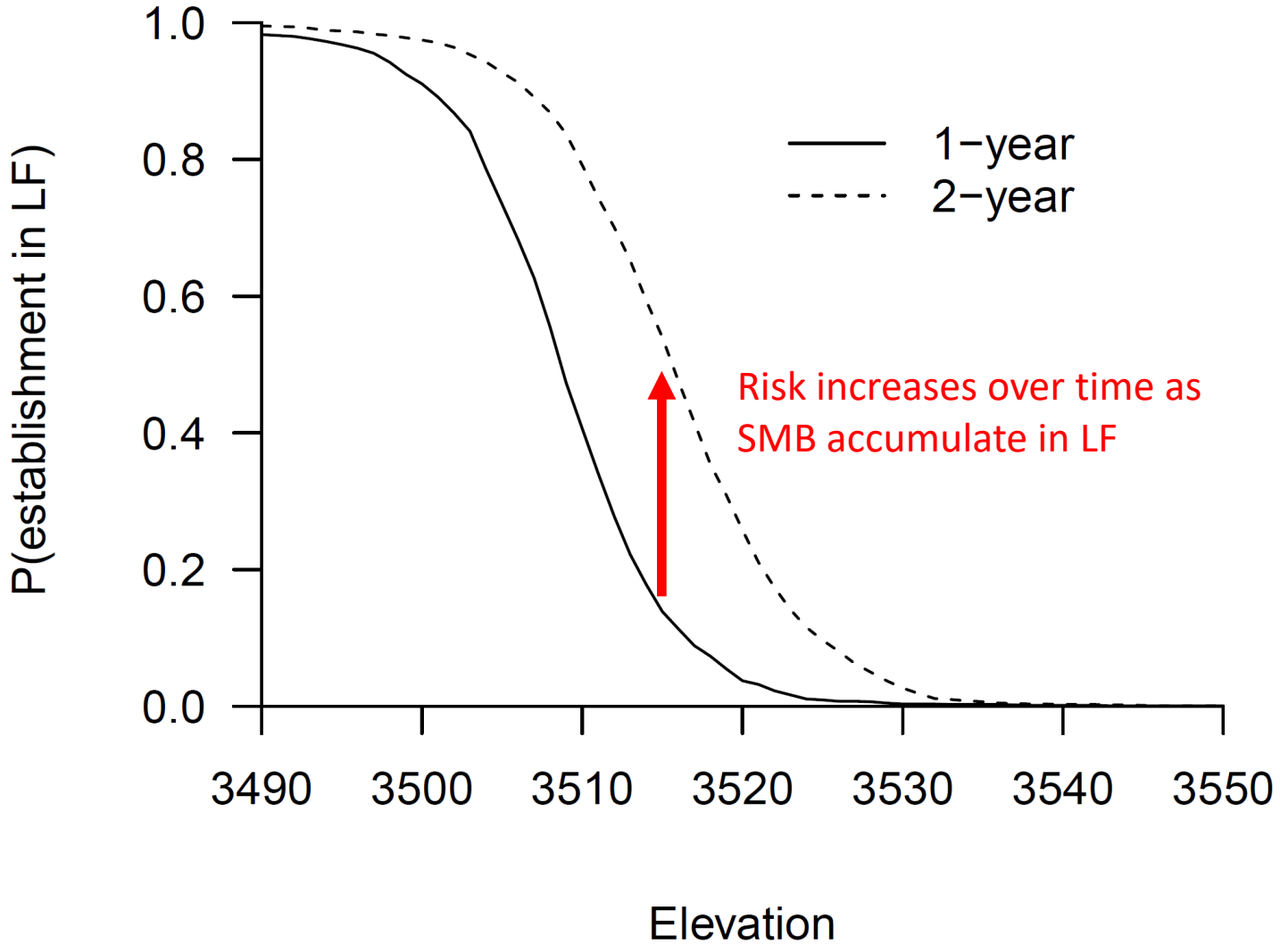
Entrainment relationships with lake elevation



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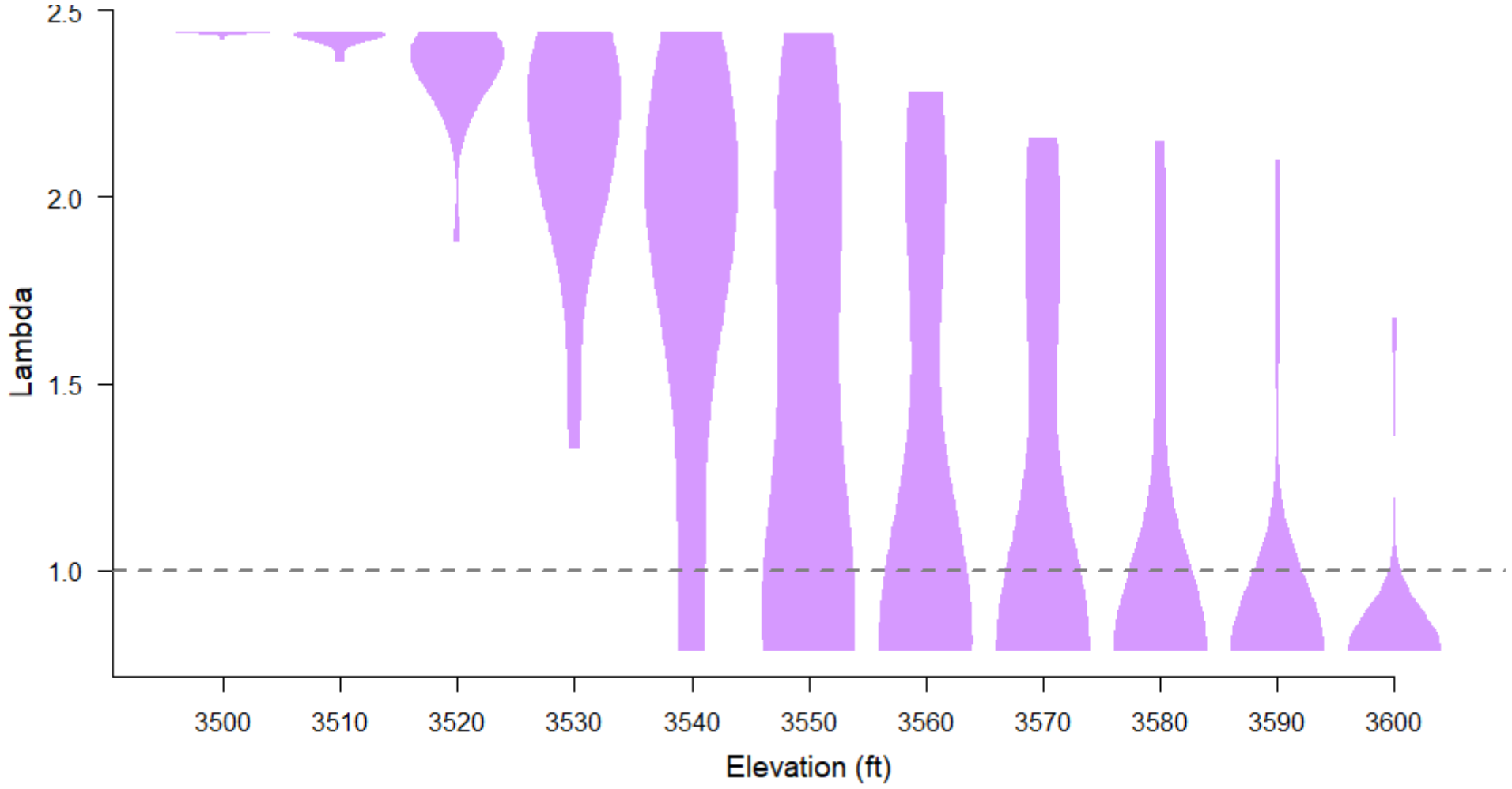
Temperature suitability relationships with lake elevation



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Can Entrainment risk be reduced?

Short term:

Minimize time spent drawing from surface waters

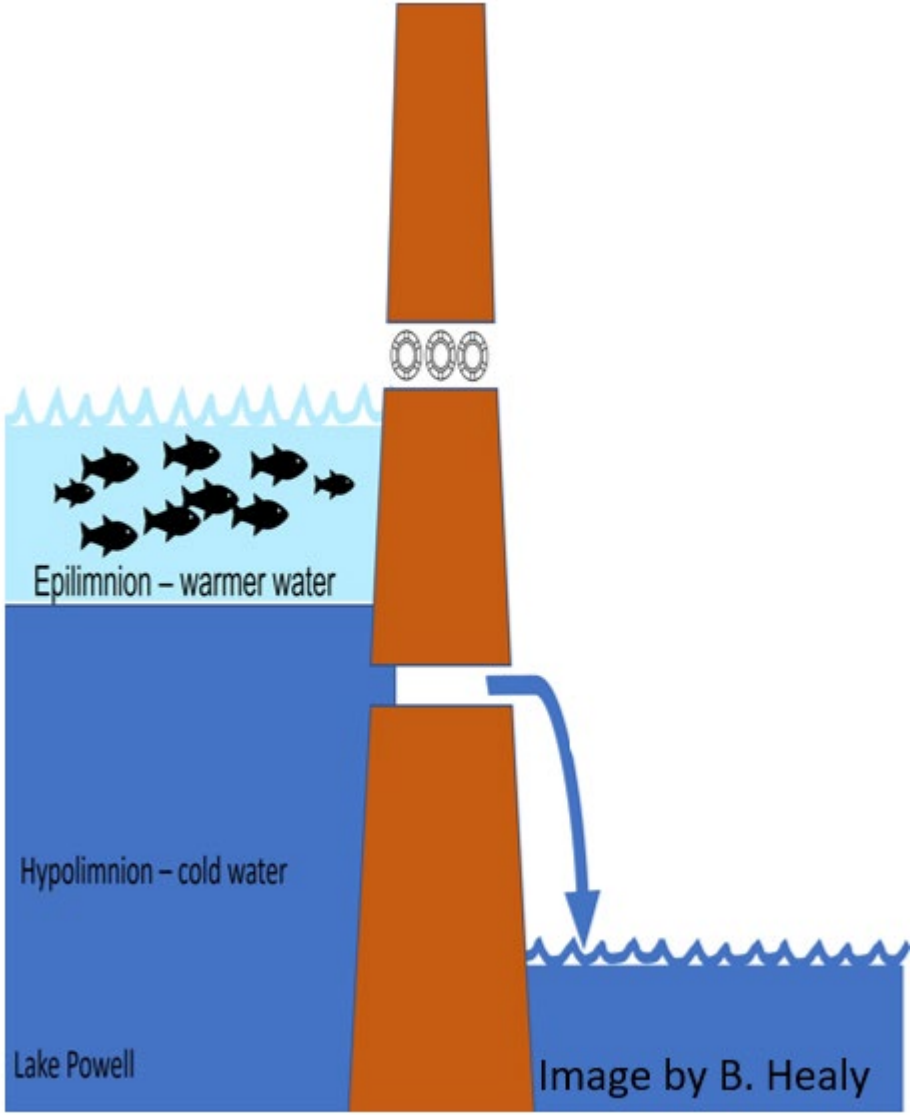
- DROA
- Bypass

Mid term:

Fish exclusion in forebay, e.g., bubble curtain, C02 curtain

Long term:

Changes to infrastructure



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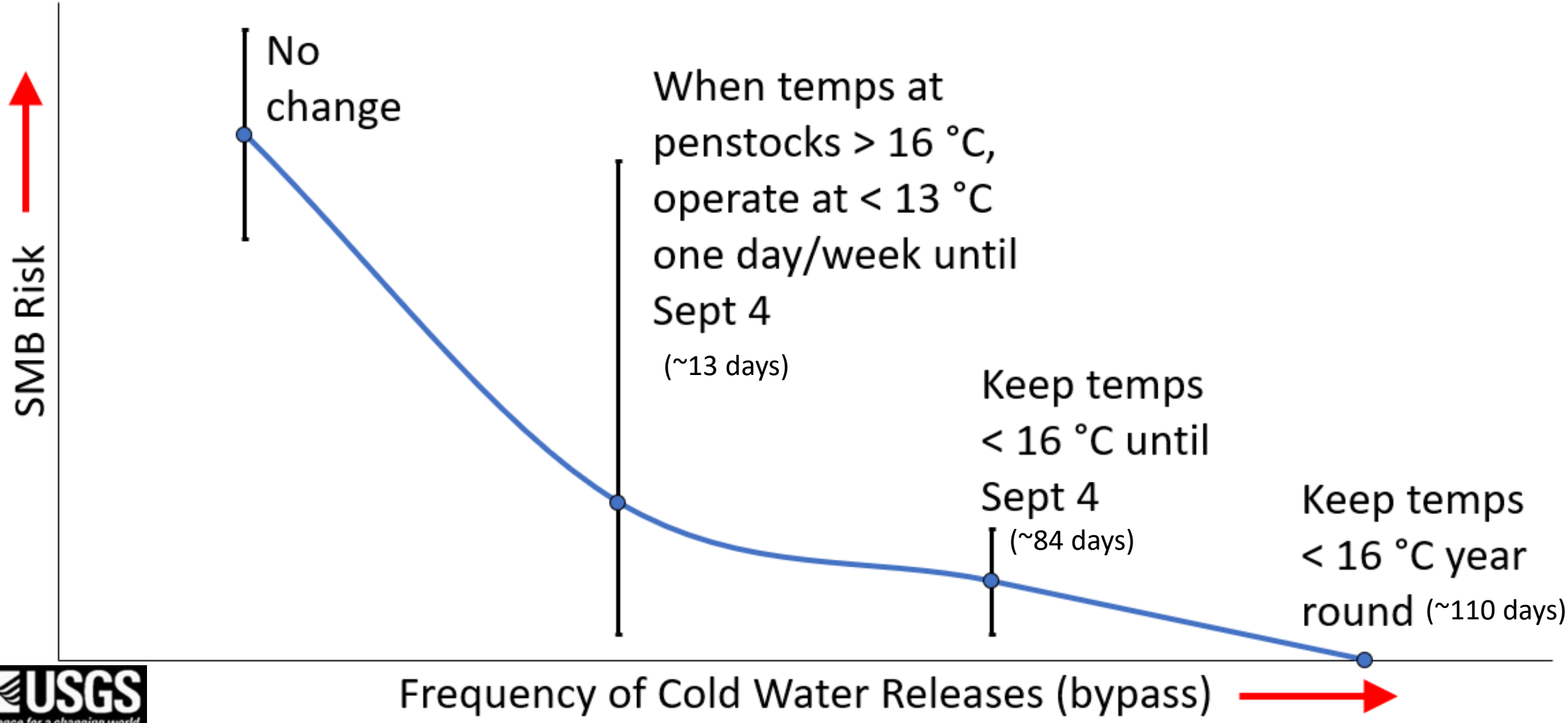
Different approaches to Manage SMB via Temperature



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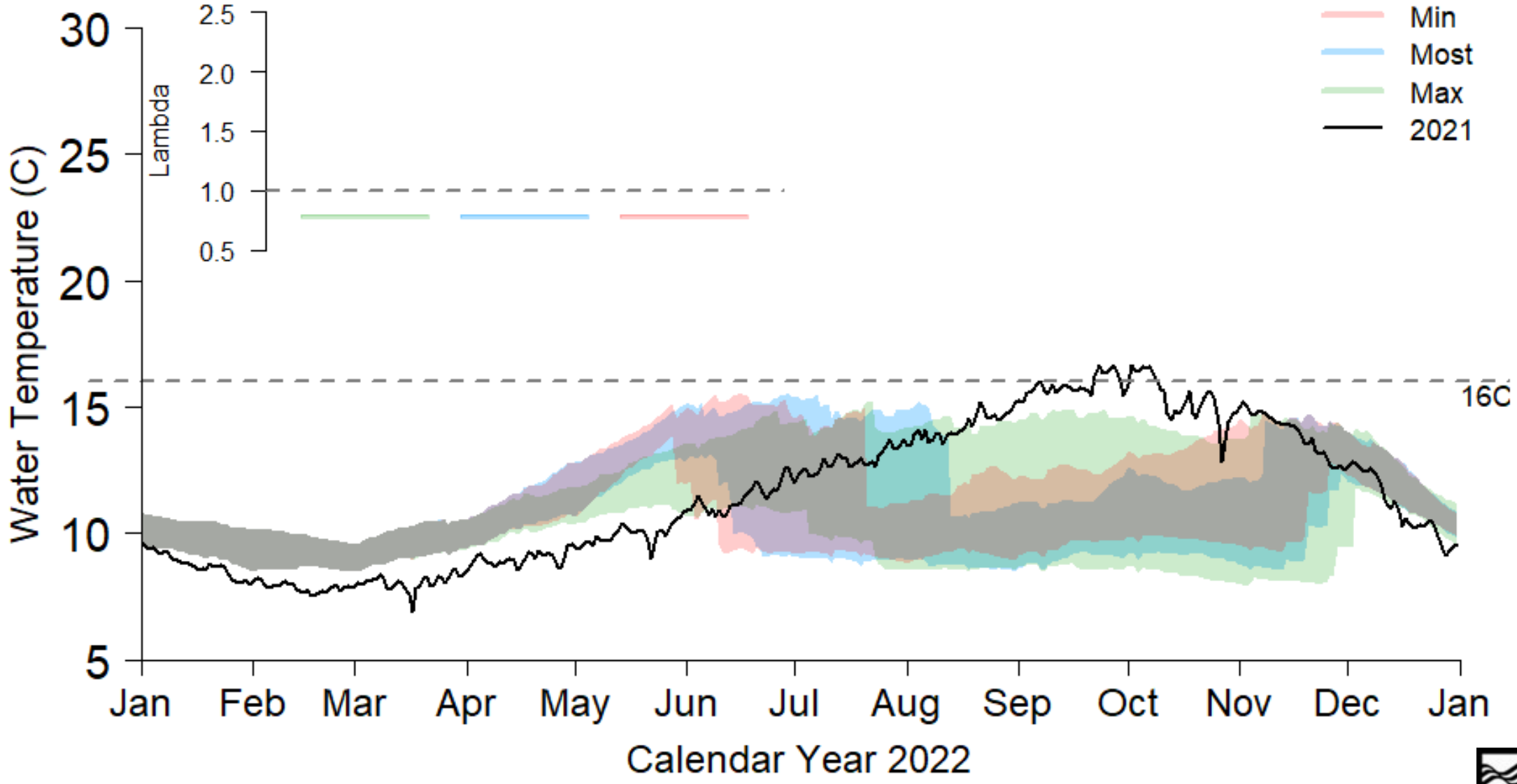
Keep Temps at Lees Ferry < 16 °C All Year



(Preliminary, do not cite)

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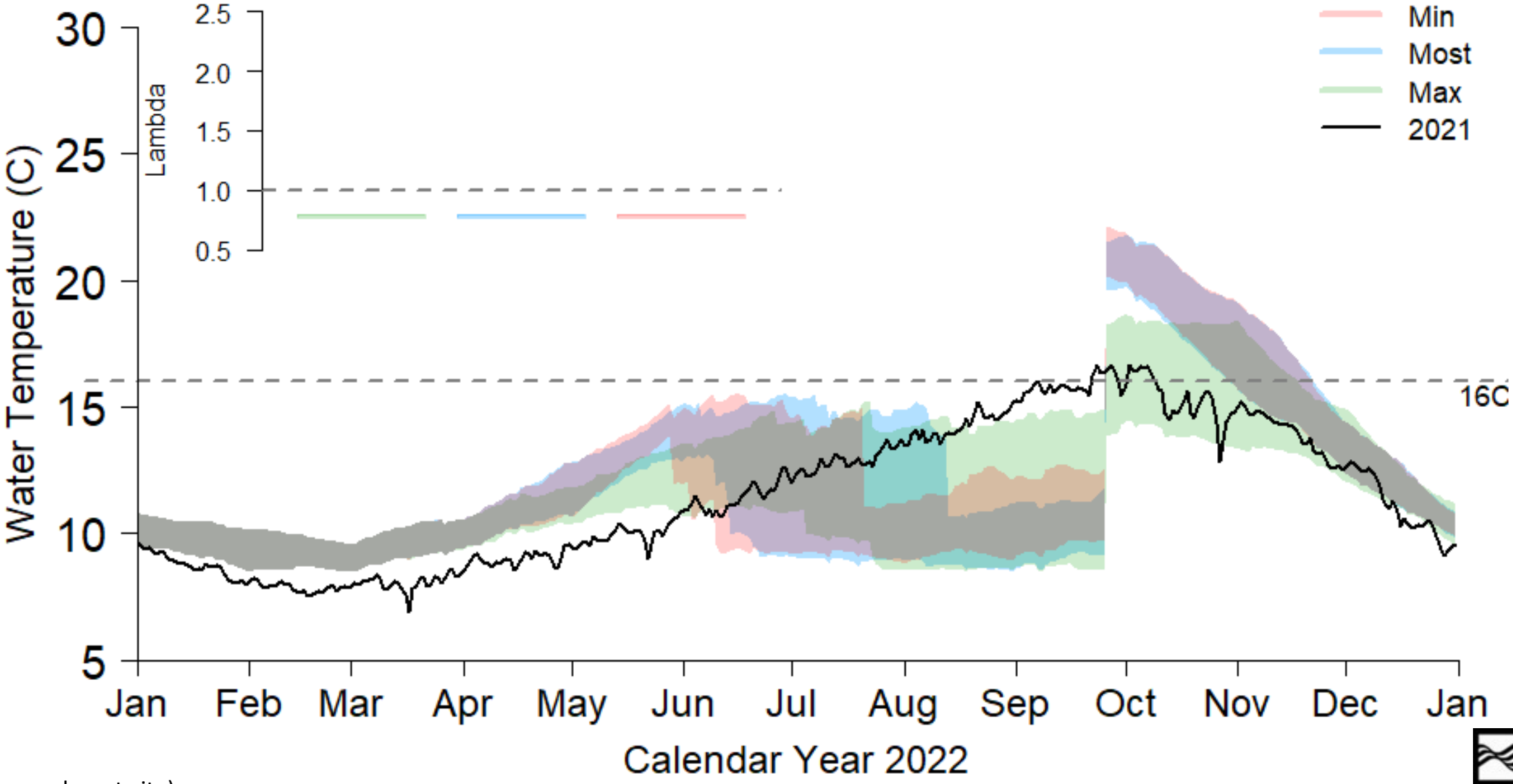
Keep Temps at Lees Ferry < 16 °C until Sept 25



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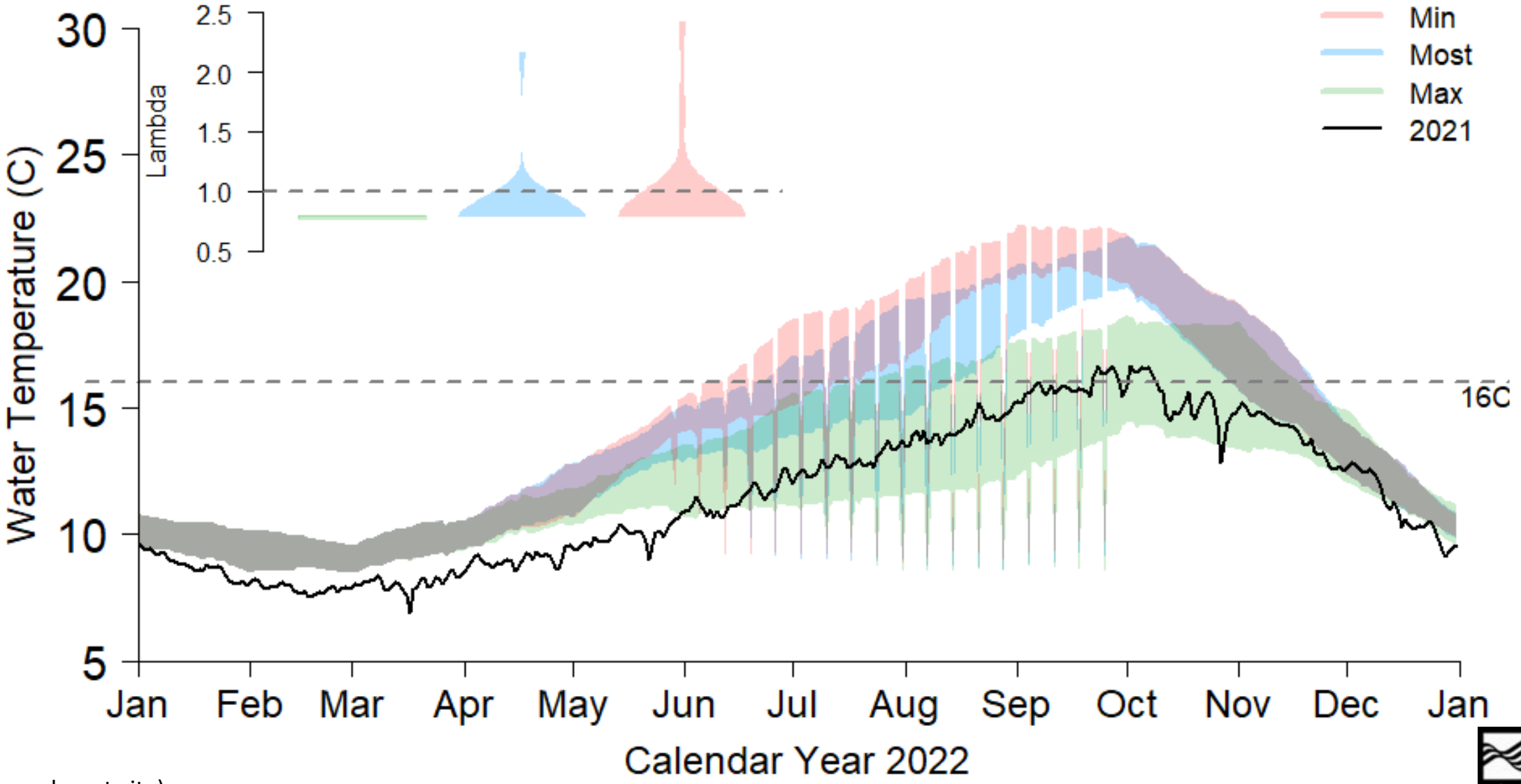
Keep Temps < 13 °C until Sept 25, one day/week



(Preliminary, do not cite)

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Conclusions

- SMB are a greater threat to native fish & rainbow trout than any other invasive fish currently present in the system.
- Reservoir conditions are changing to support increased entrainment and establishment below Glen Canyon Dam.
- Limiting entrainment & controlling temperature are the only large-scale tools currently available.
- Quickly responding to small scale presence of SMB may buy more time.
- Reversing SMB establishment downriver/ in tributaries likely to be a drawn out and expensive process and may not be possible.

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Acknowledgements

- Small mouth bass task force members contributed substantially to analyses and ideas and included participants from USFWS, USBR, NPS, USGS, AZGFD, and WAPA. Kirk Young led the team and Drew Eppehimer provided important modelling support.

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Southwest Climate Science Center

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