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

Smallmouth Bass Task Force

Presentation to:
The Technical Working Group
April 12, 2022

Purpose: Assess risk of SMB establishment in GC and identify potential responses

SMB Team Lead:

- Kirk Young – USFWS

SMB Modeling Team:

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SMB Team:

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- Sky Hedden – AZGFD
- Kerri Pedersen – USBR
- Pilar Rinker – USFWS
- Scott Rogers – AZGFD
- Robert Schelly – NPS
- Laura Tennant – USGS
- Melissa Trammell – NPS
- David Ward – USGS

Outline

Background

- Why worry about SMB?
- Why aren’t SMB already here?
- What’s changing?

Risk assessment

- How reversible is a SMB invasion?
- How much entrainment required to establish population?
- Are conditions suitable?

Next steps

- What can scientists do?
- What can decision makers do?

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Why worry about SMB?

- SMB have caused native fish decline throughout the west
  - Upper Basin Cautionary Tale
  - Wet Beaver Creek
  - Black River

- Highly piscivorous - highest predatory threat in the upper basin

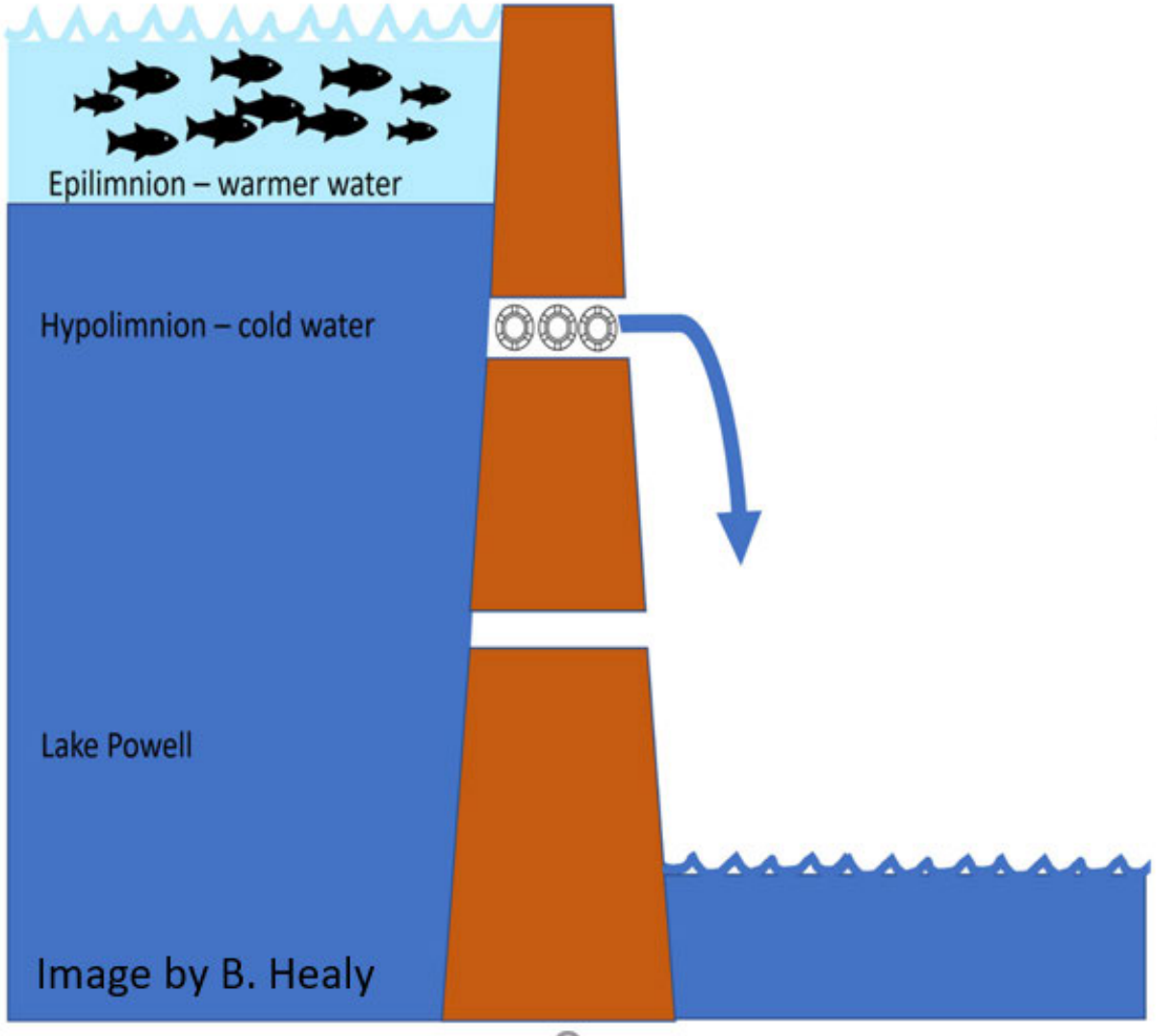
- Highly fecund (females have lots of eggs)

- 1 of 4 Highest Threat species in NNAS EA

Why aren’t Smallmouth Bass established in Grand Canyon?

Cold releases from Glen Canyon Dam

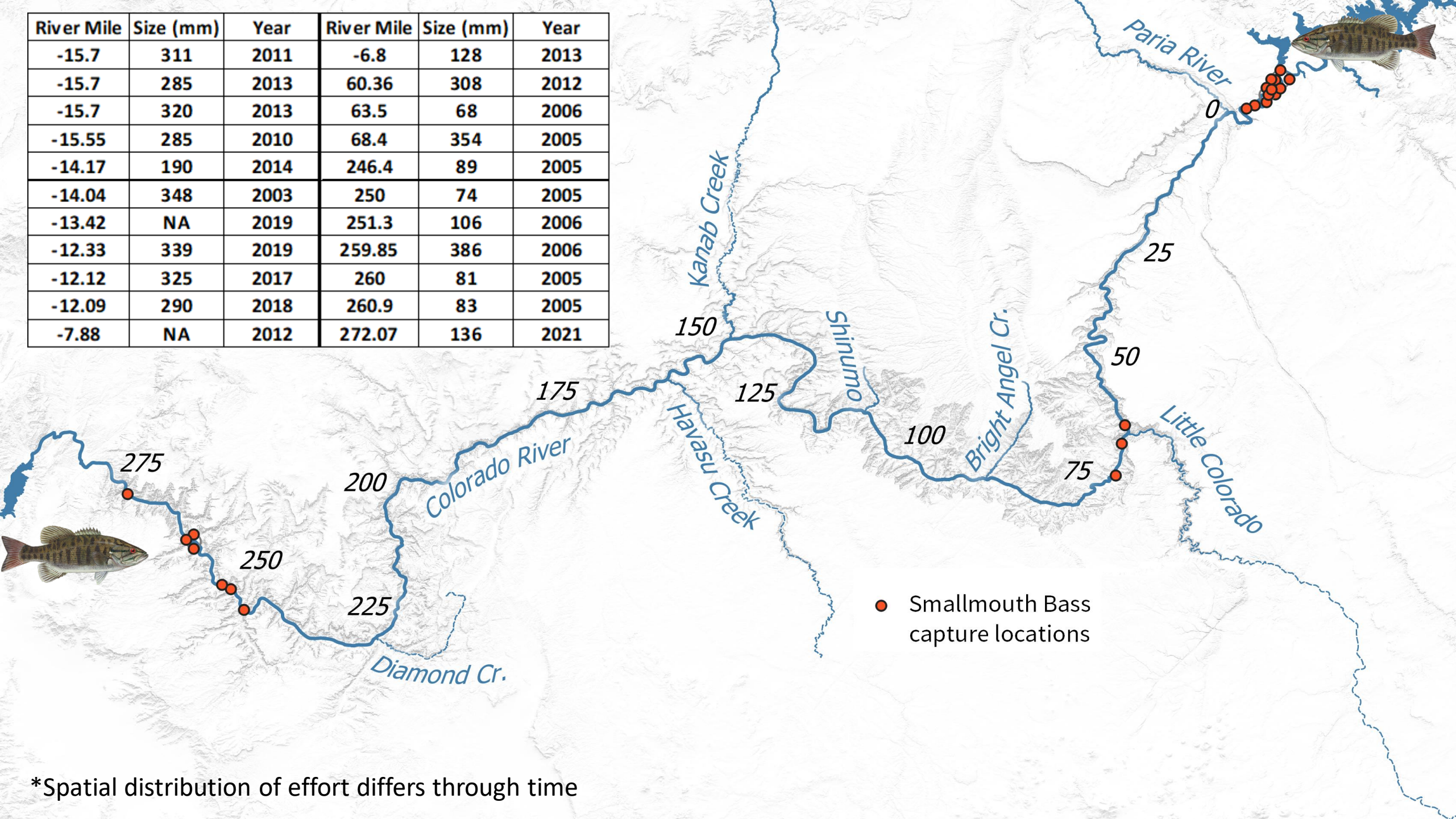
Low propagule pressure



Turbidity at the inflow to Lake Mead

Pearce Ferry Rapid – recent barrier

River Mile	Size (mm)	Year	River Mile	Size (mm)	Year
-15.7	311	2011	-6.8	128	2013
-15.7	285	2013	60.36	308	2012
-15.7	320	2013	63.5	68	2006
-15.55	285	2010	68.4	354	2005
-14.17	190	2014	246.4	89	2005
-14.04	348	2003	250	74	2005
-13.42	NA	2019	251.3	106	2006
-12.33	339	2019	259.85	386	2006
-12.12	325	2017	260	81	2005
-12.09	290	2018	260.9	83	2005
-7.88	NA	2012	272.07	136	2021

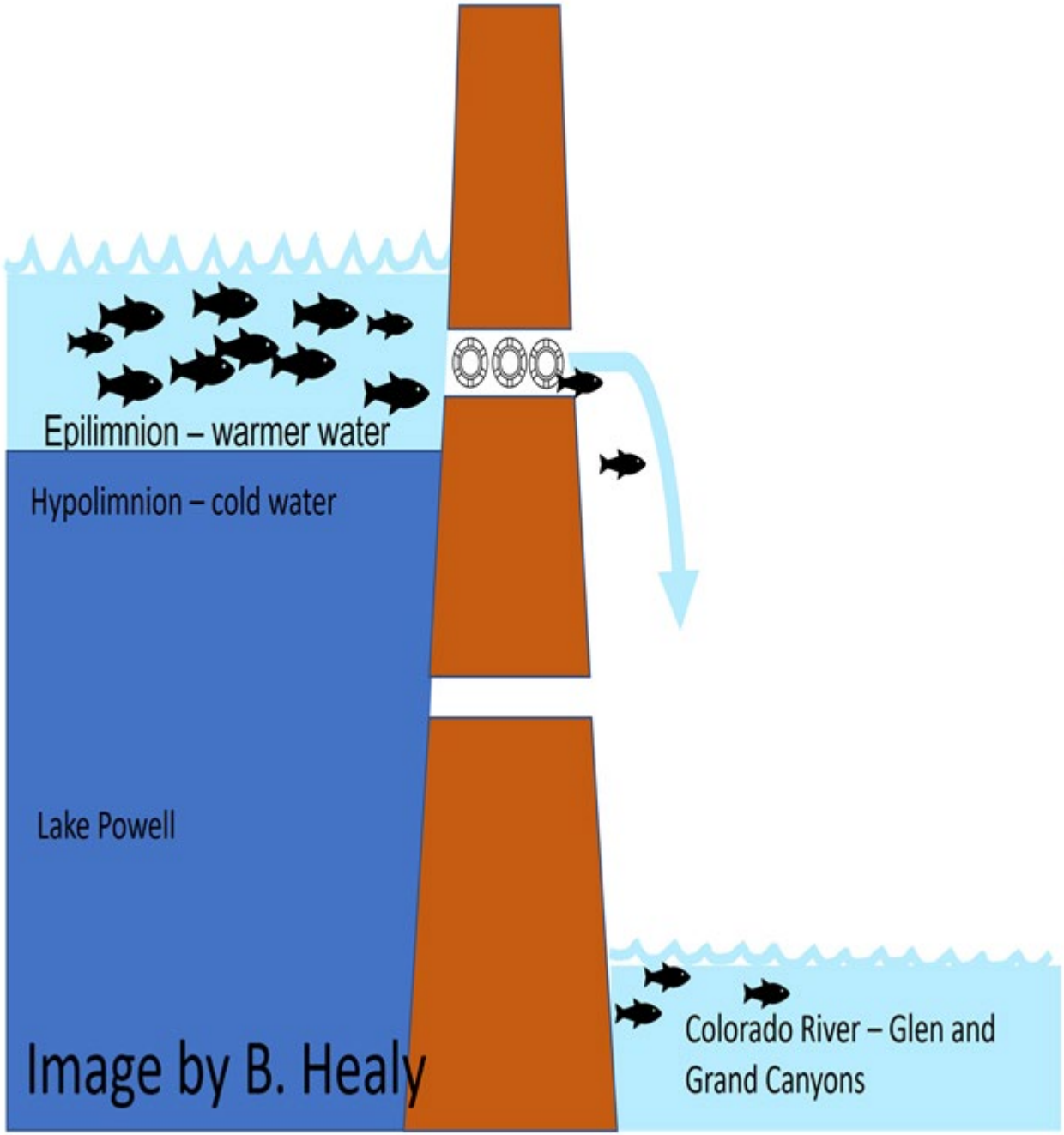


*Spatial distribution of effort differs through time

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



Outline: Risk Assessment

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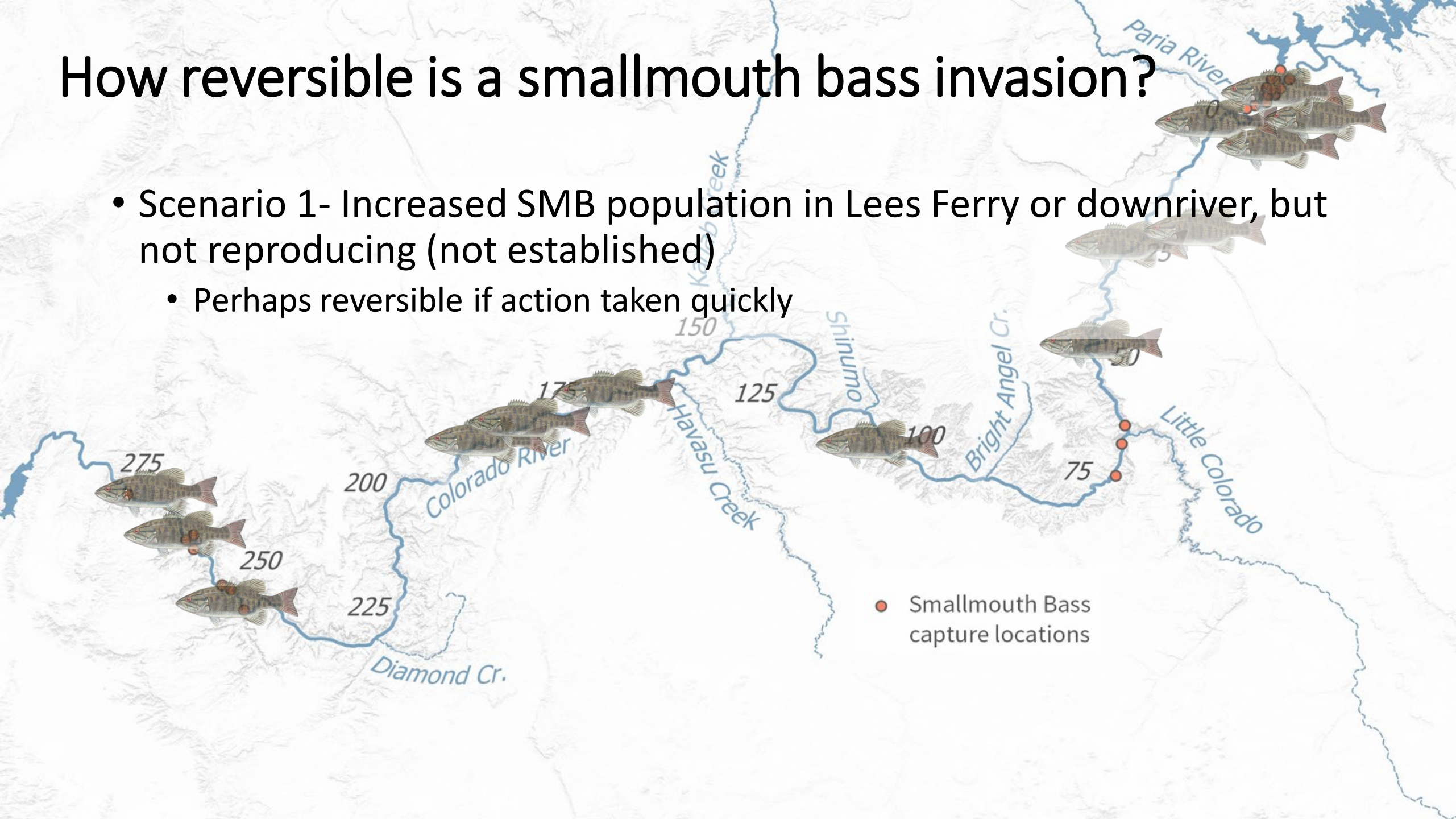
How reversible is a smallmouth bass invasion?

- Scenario 1- Increased SMB population in Lees Ferry or downriver, but not reproducing (not established)
  - Perhaps reversible if action taken quickly



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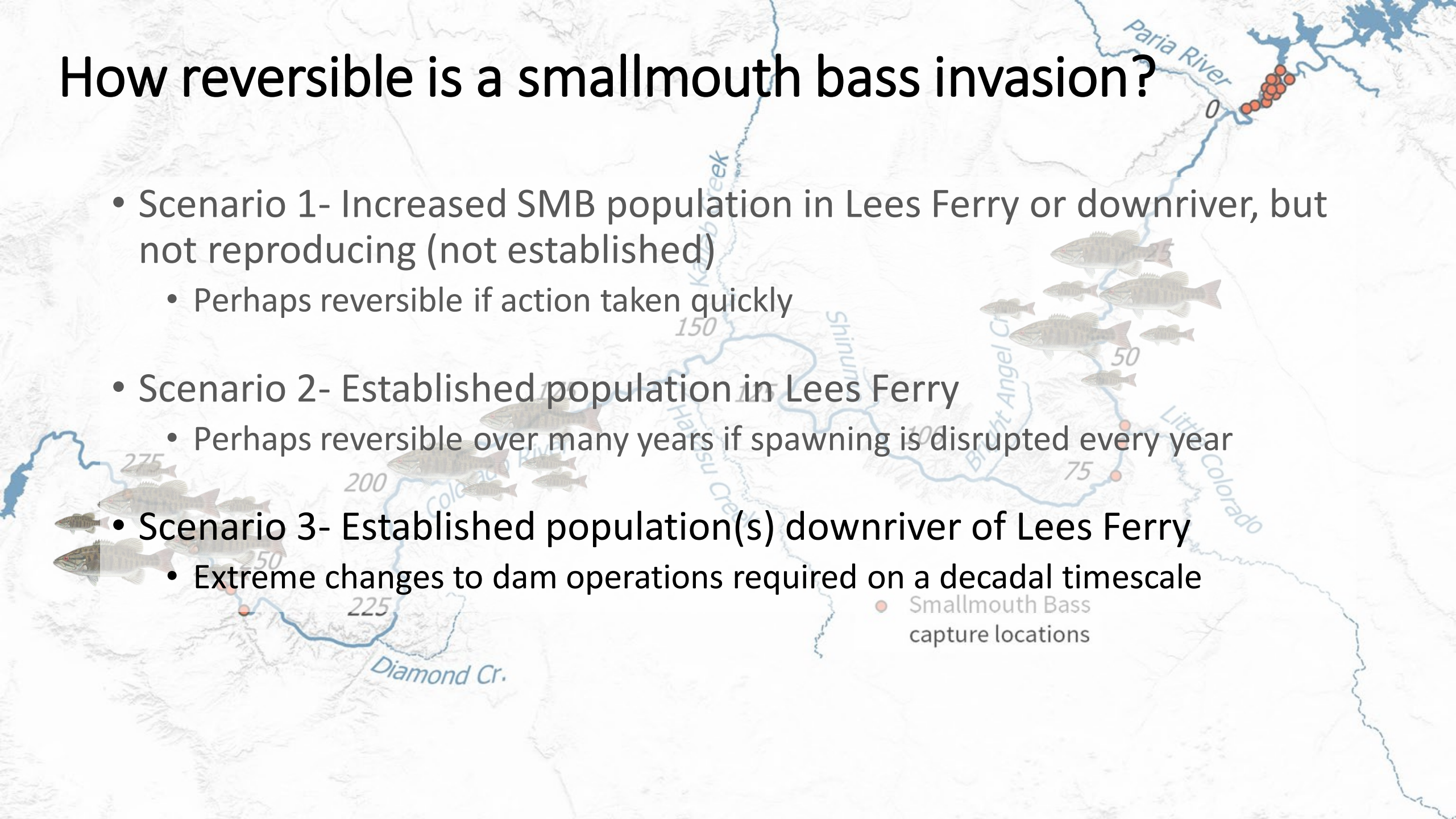
- Scenario 3- Established population(s) downriver of Lees Ferry
  - Extreme changes to dam operations required on a decadal timescale



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  - Perhaps reversible with extensive removal and see scenario 3

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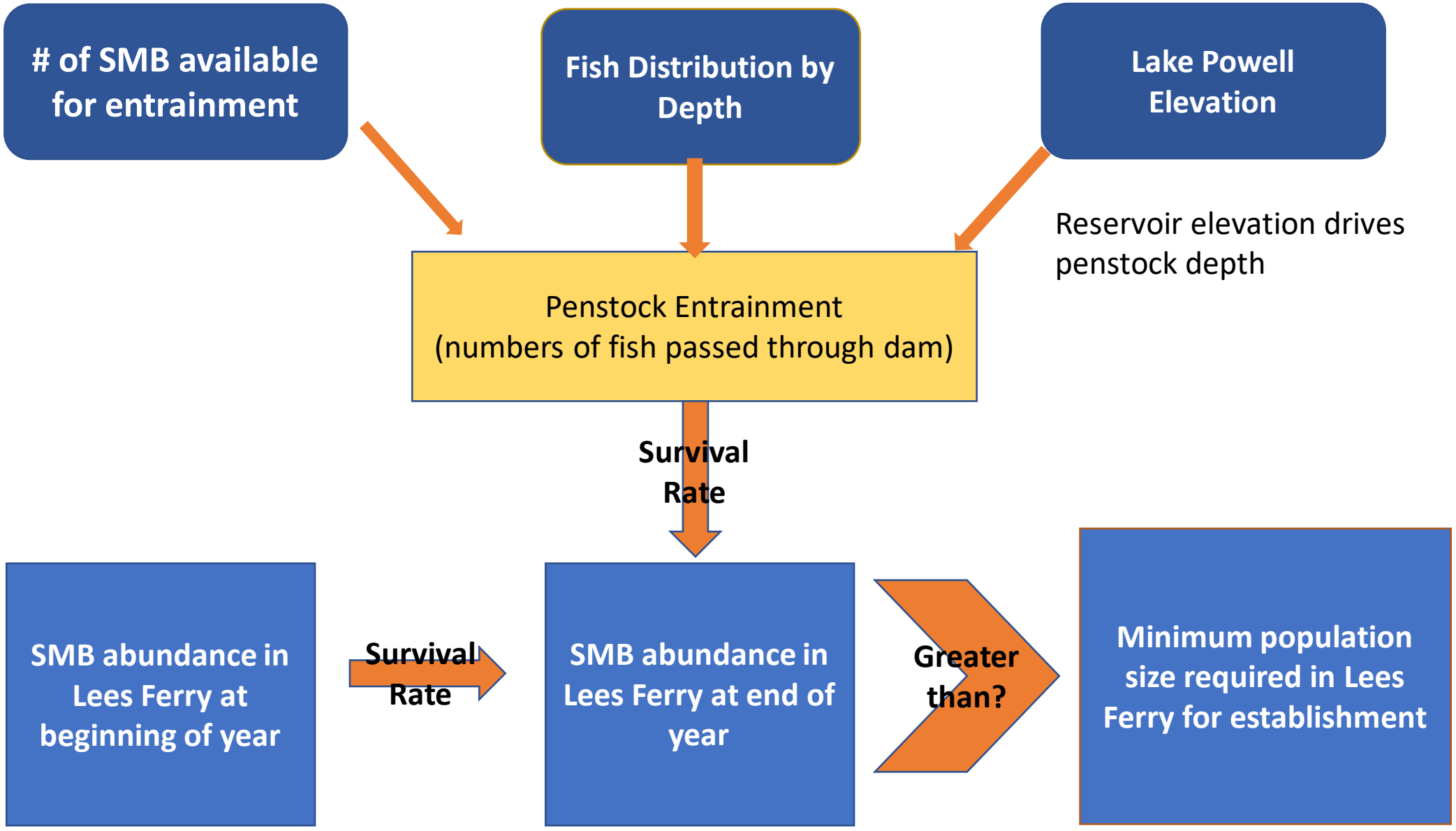
Key questions related to scenarios

- How much entrainment required to establish population in Lees Ferry?

- Are conditions suitable for a spawning population of SMB:
  - in Lees Ferry?
  - downriver?
  - in the tributaries?

Conceptual Model of Entrainment Risk



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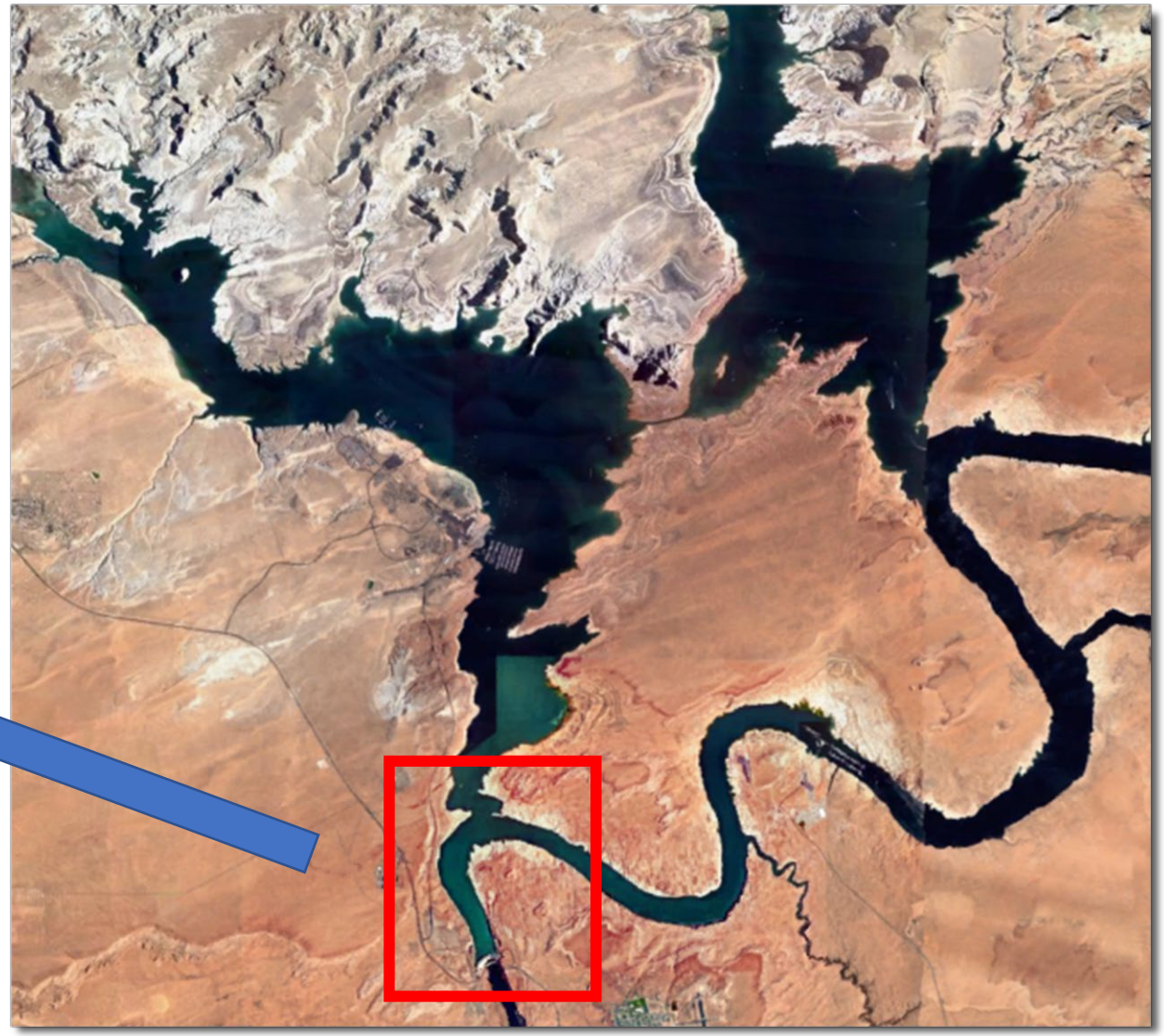
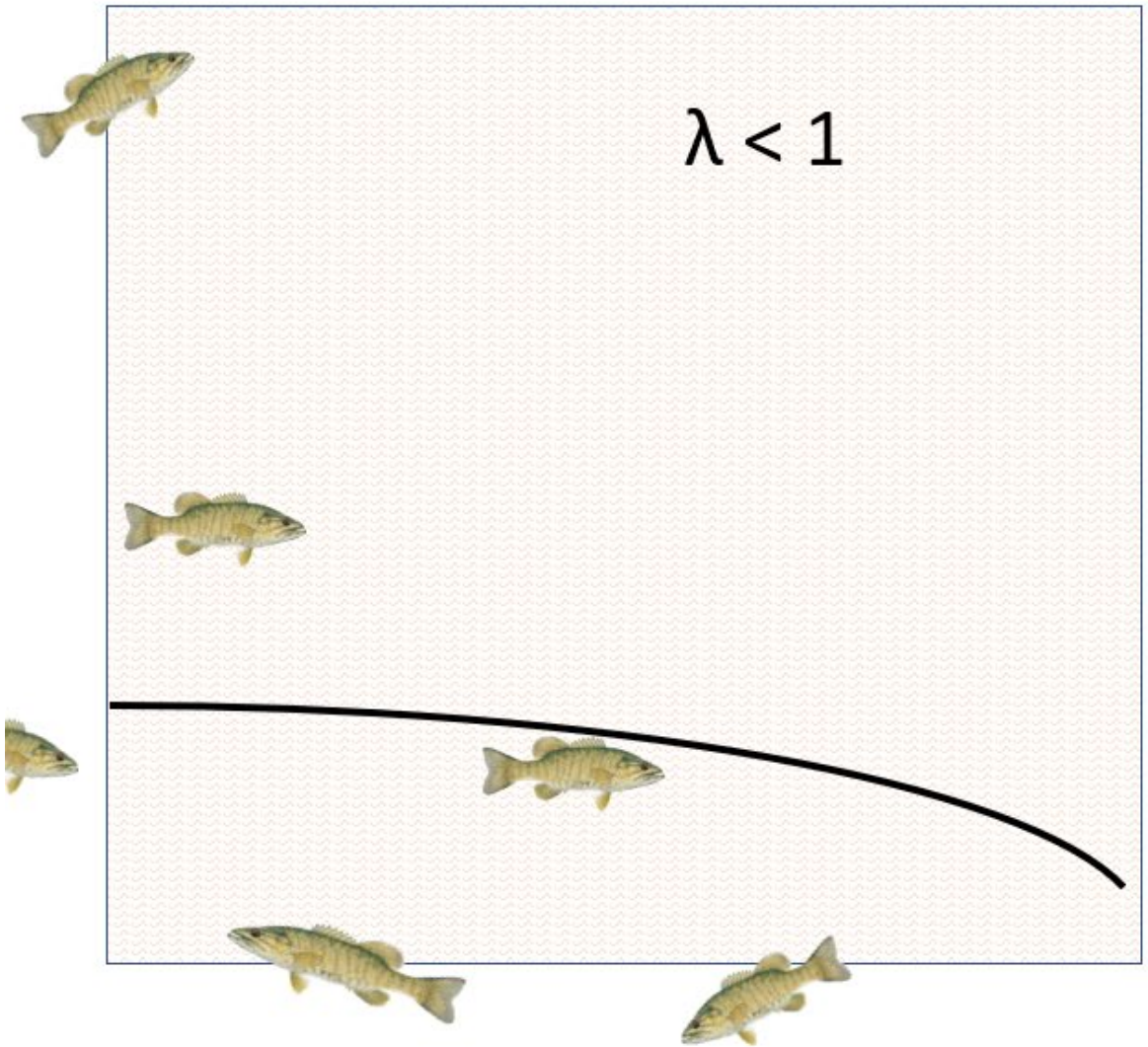
Number of SMB available for entrainment

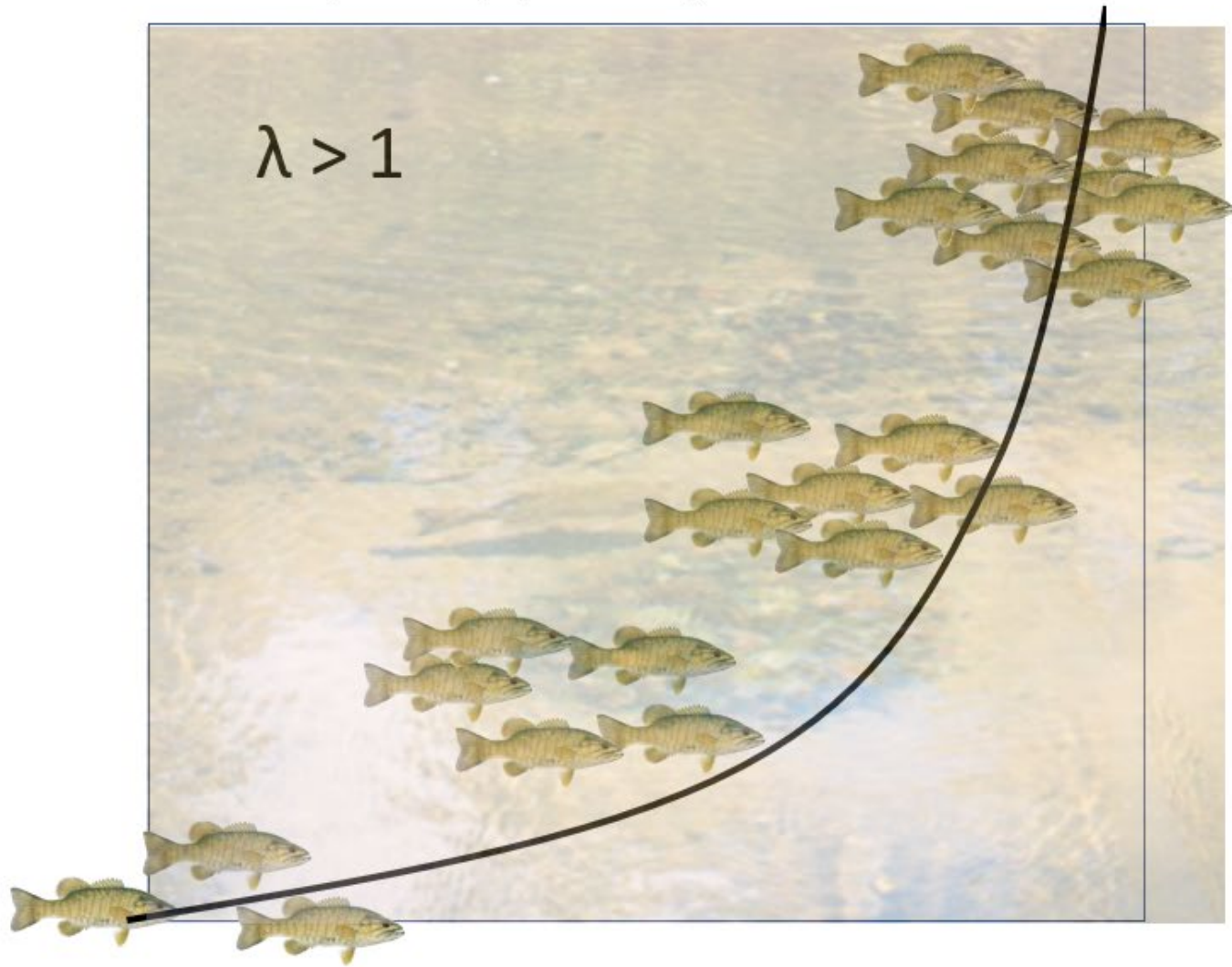


Allee Effect

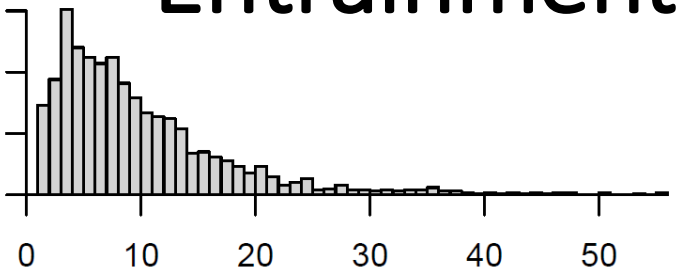
Low Density
low or negative population growth rate $\lambda < 1$



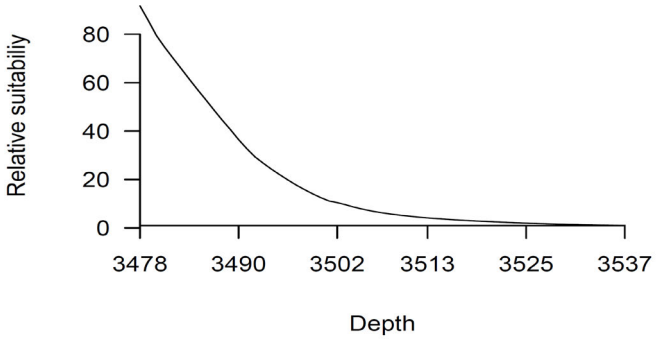
High Density
positive population growth rate $\lambda > 1$



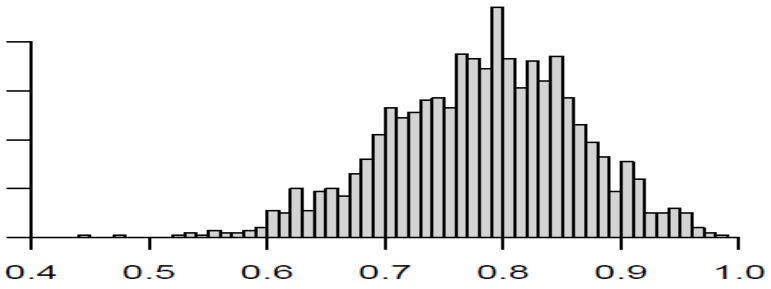
Statistical Model of Entrainment Risk



Size of entrainable population (x 1,000)

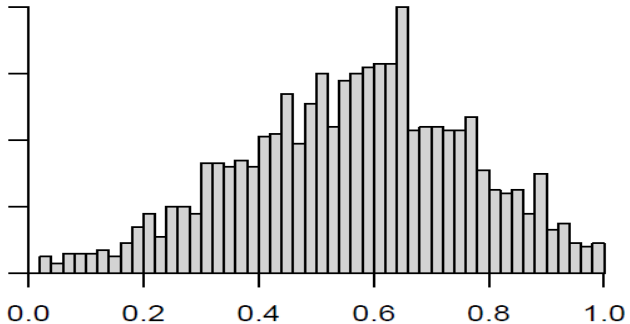


Inflows
Outflows
(Bank Storage, Evaporation)



Annual adult survival

Penstock Entrainment
(numbers of fish passed through dam)



Survival through penstocks

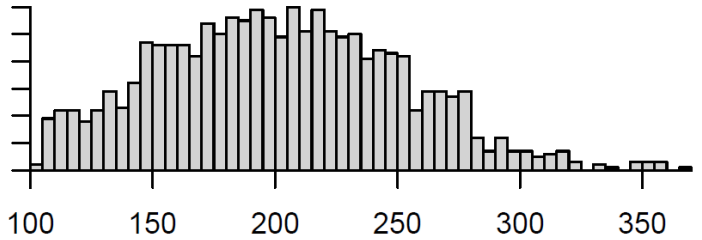
Survival Rate

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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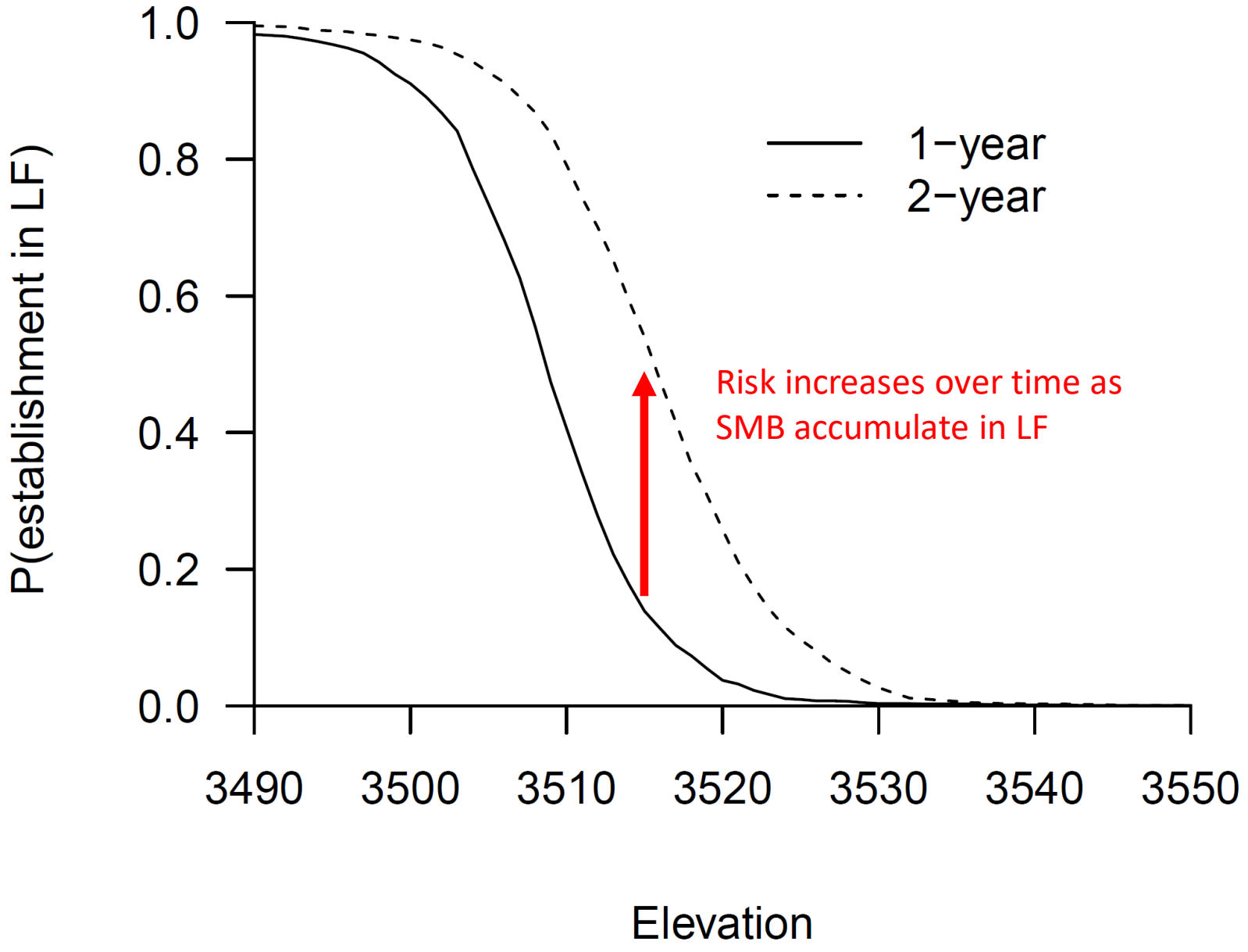
Entrainment risk if elevation is held constant at a particular value



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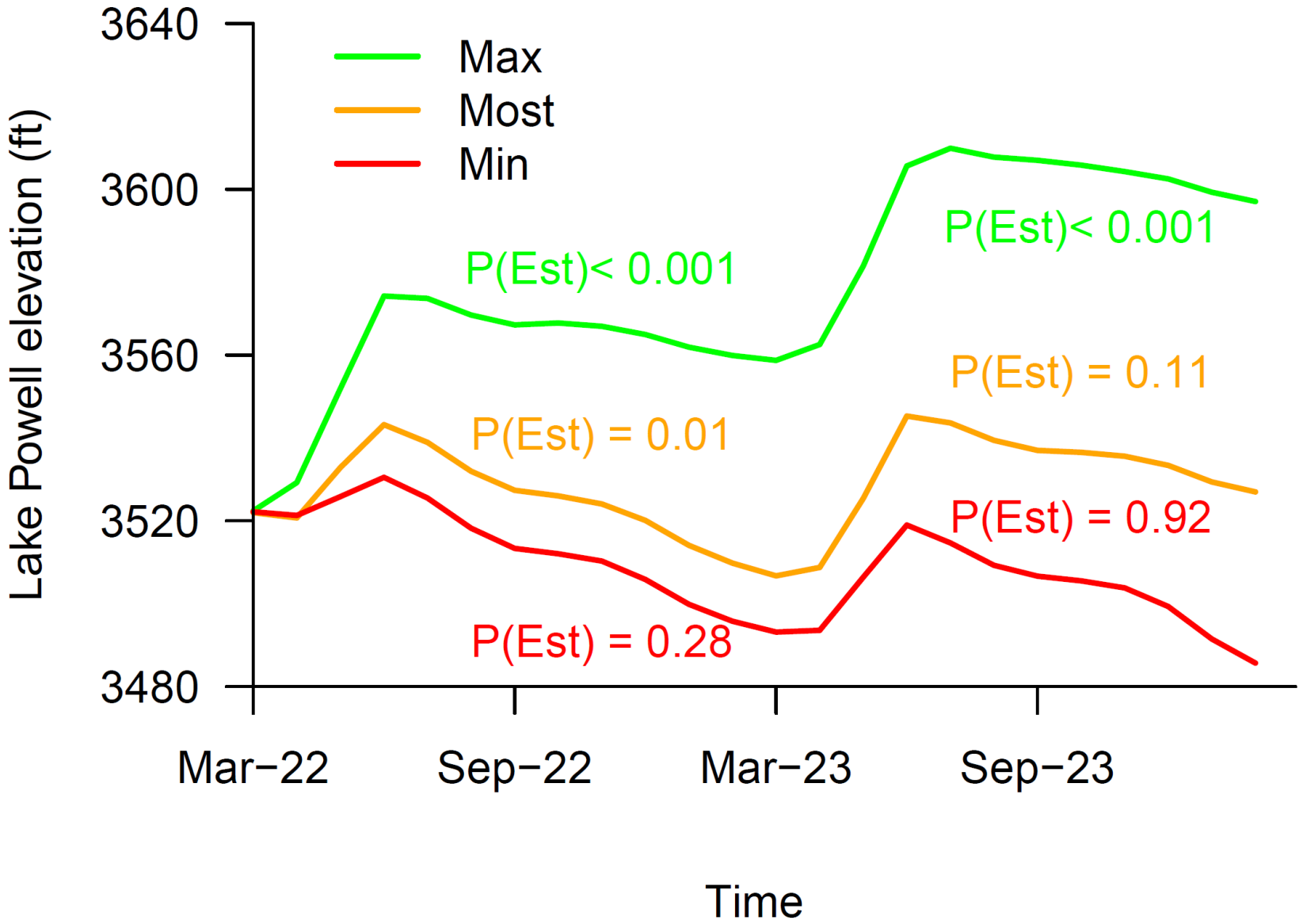
Results based on March 24-month study



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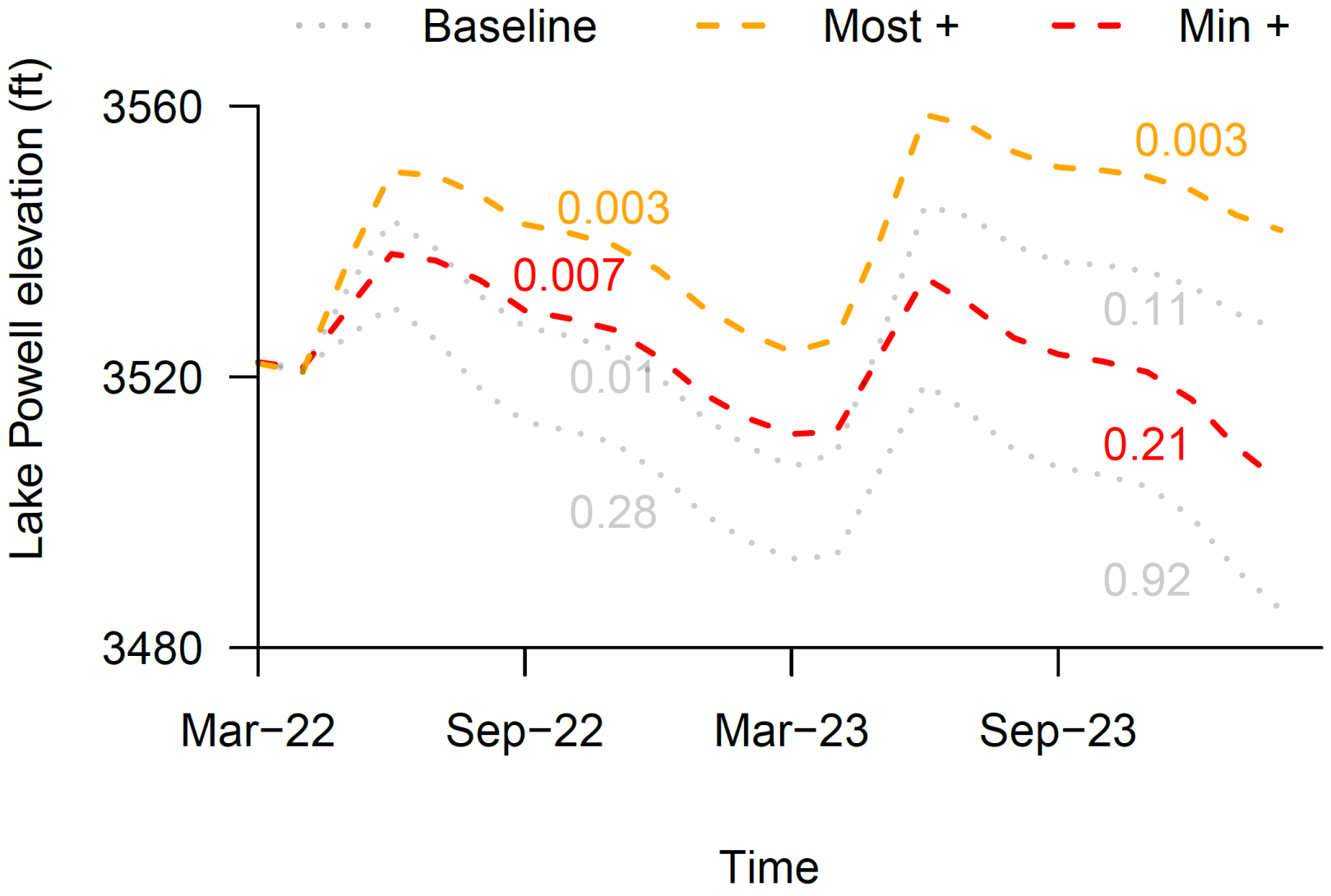
Hypothetical scenario (adding ~1 maf)



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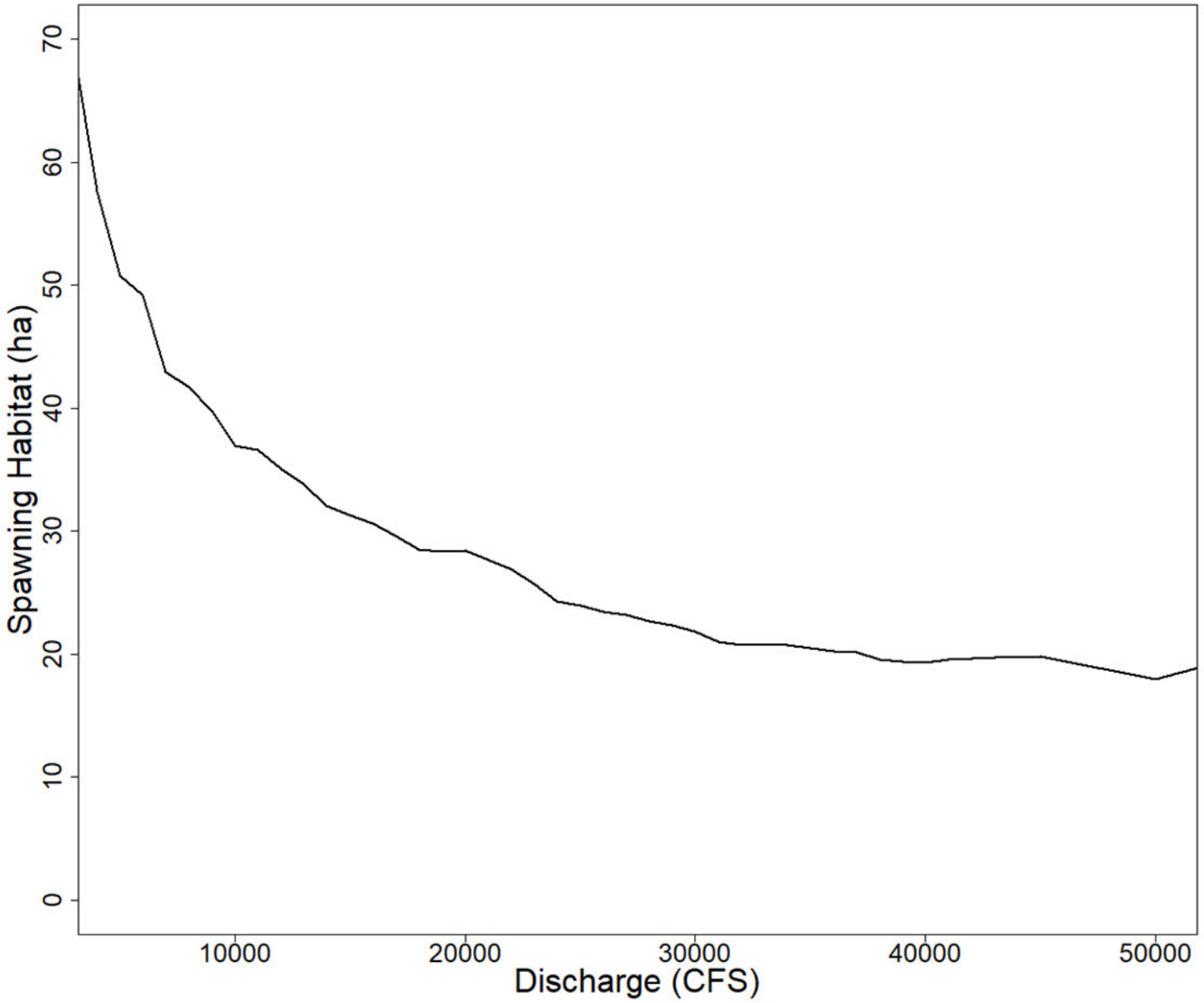
If there are enough spawners, what other conditions are required for SMB to establish?

- Sufficient food
- Infrequent high turbidity
- Low velocity gravel/cobble habitat
- Suitable water temperature

Lees Ferry Spawning Habitat (velocity ≤ 0.1 m/s)



Discharge (CFS)	Habitat (ha)
5,000	50.8
10,000	37.0
15,000	31.3
20,000	28.4
25,000	24.0
30,000	21.8
35,000	20.5
40,000	19.3
45,000	19.8

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If there are enough spawners, what other conditions are required for SMB to establish?

- **Sufficient food-** switch to piscivory at 40mm, unlikely to be limiting
- **Infrequent high turbidity-** could limit reproduction downriver in some years
- **Low velocity gravel/cobble habitat-** may limit population size, unlikely to limit establishment
- **Suitable water temperature-** likely to be primary driver

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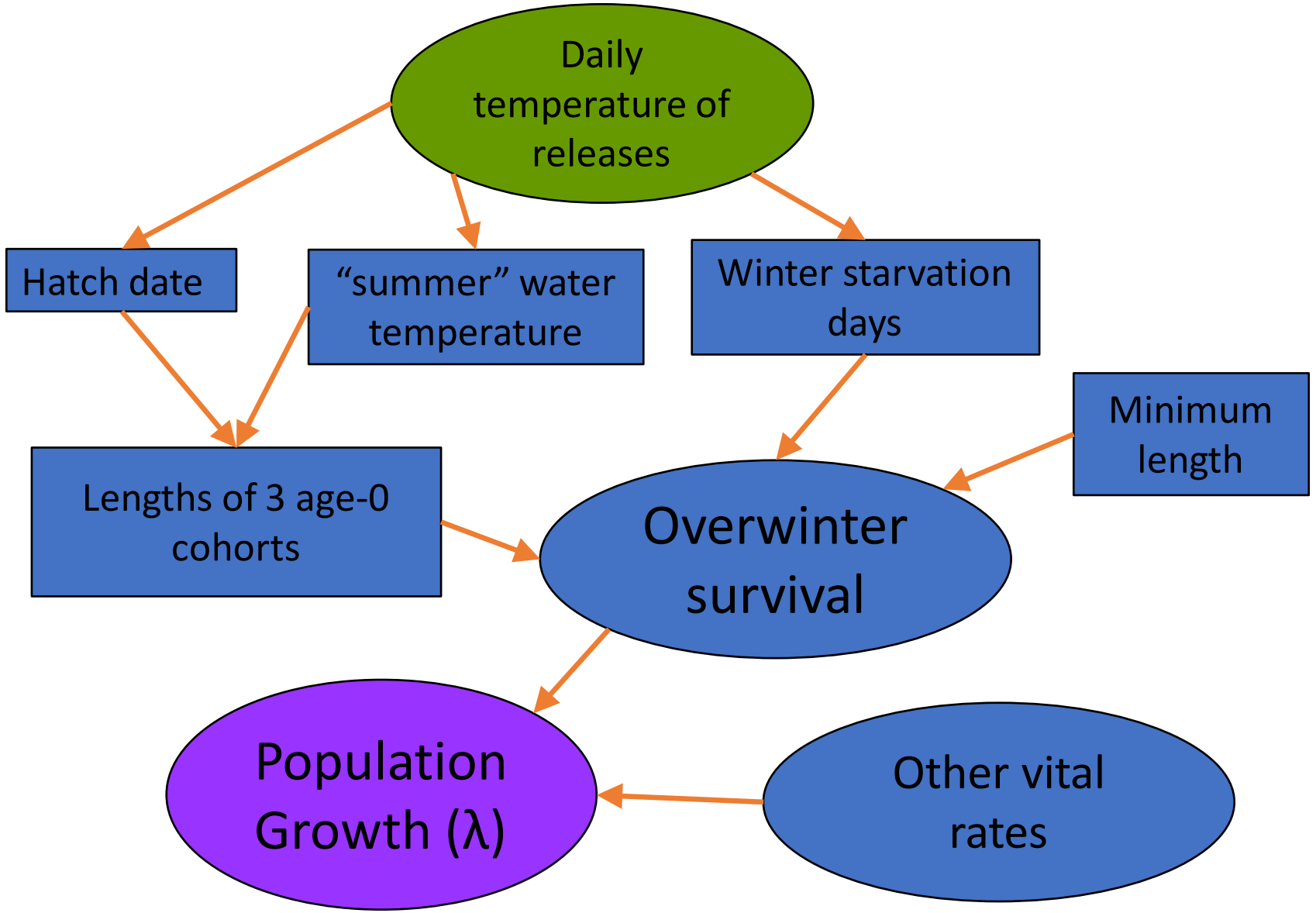
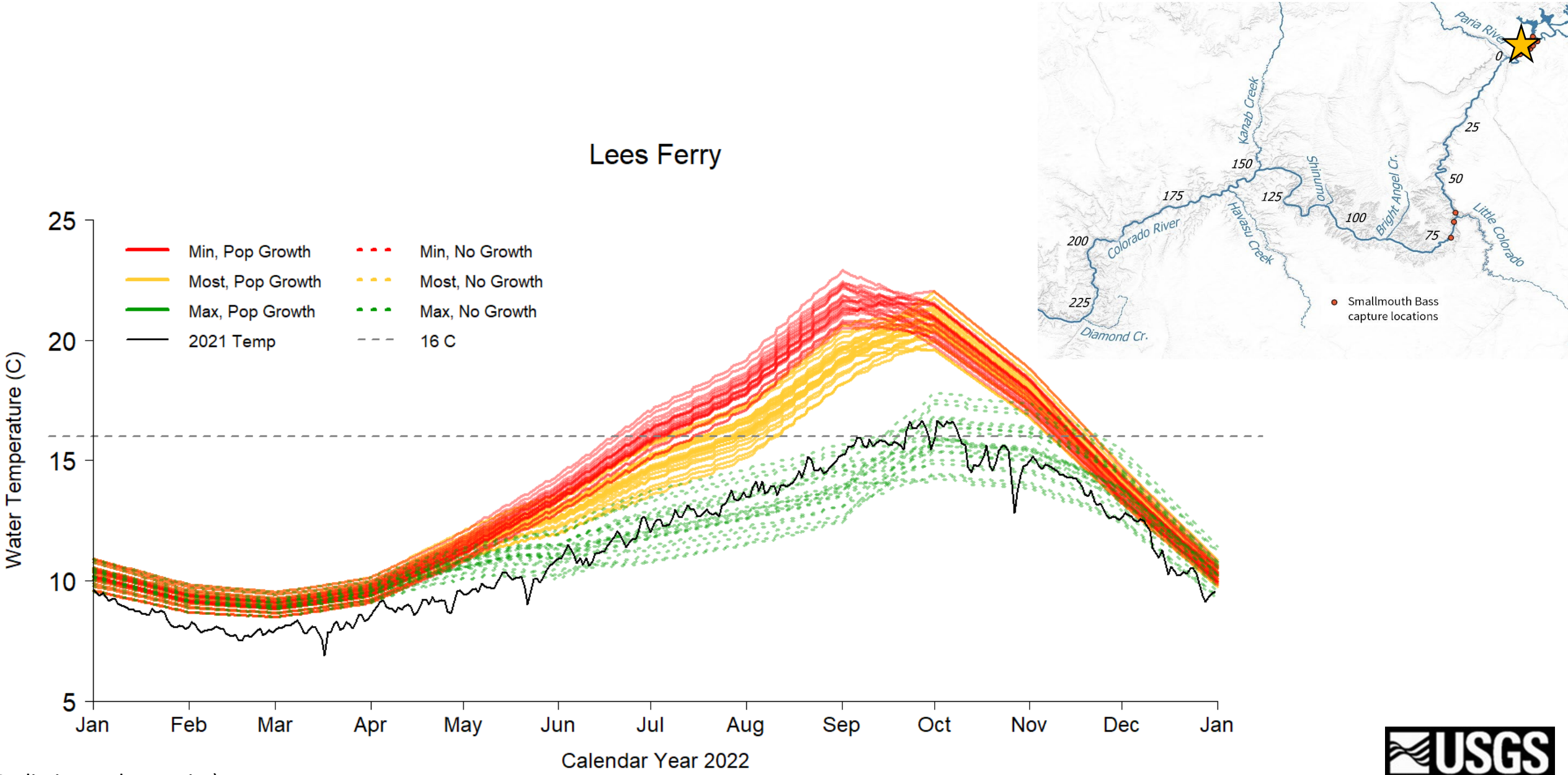
How does temperature affect population growth?

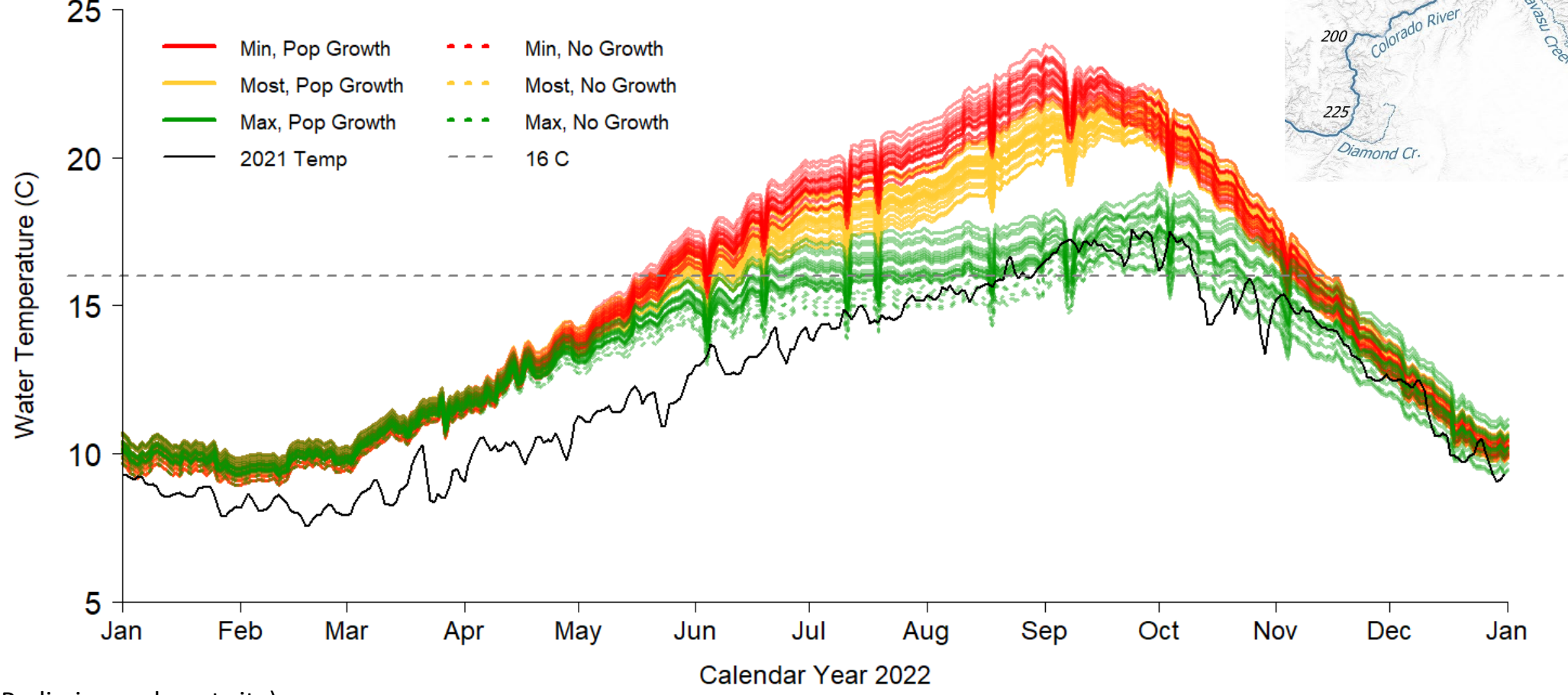


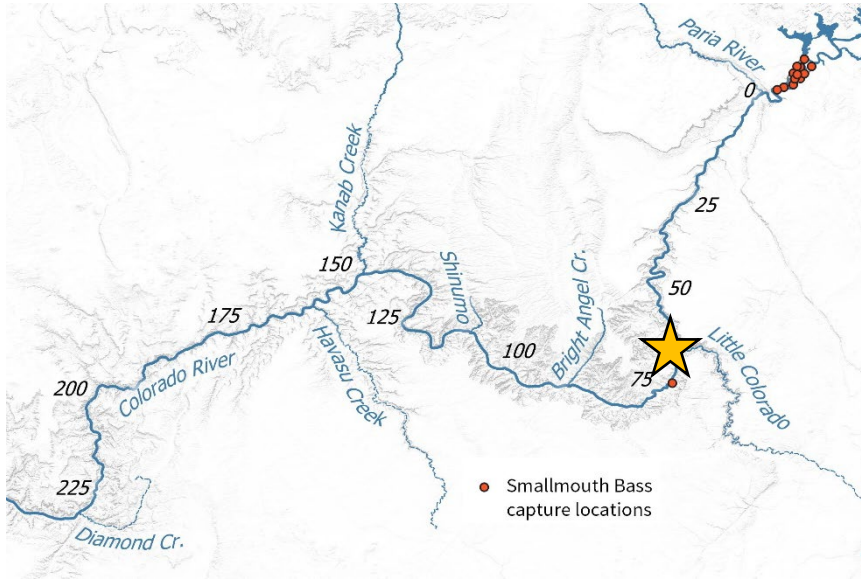
Temperature and SMB Suitability in Lees Ferry



(Preliminary, do not cite)

Temperature and SMB Suitability at LCR Reach





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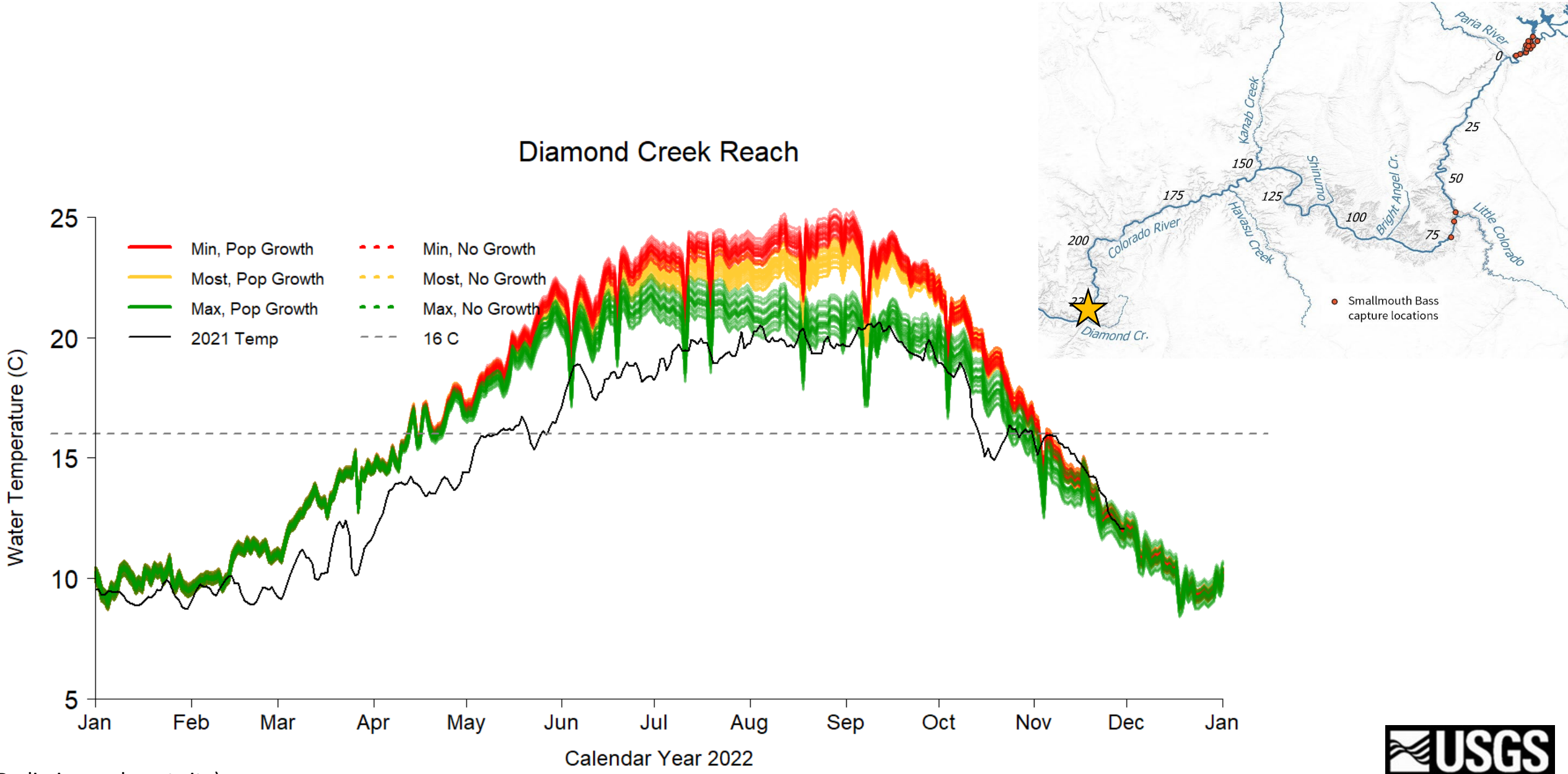
Temperature and SMB Suitability at Diamond Creek Reach



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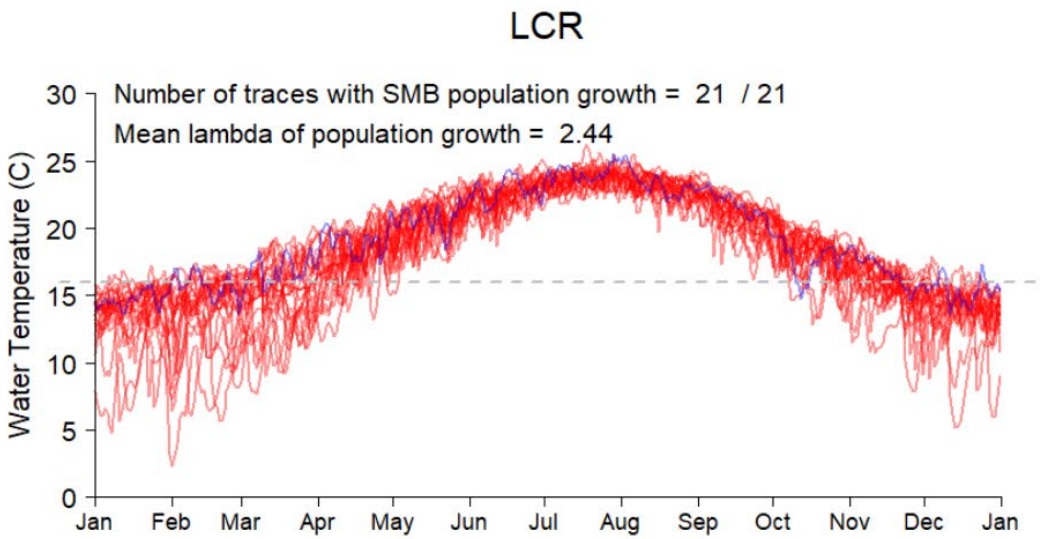
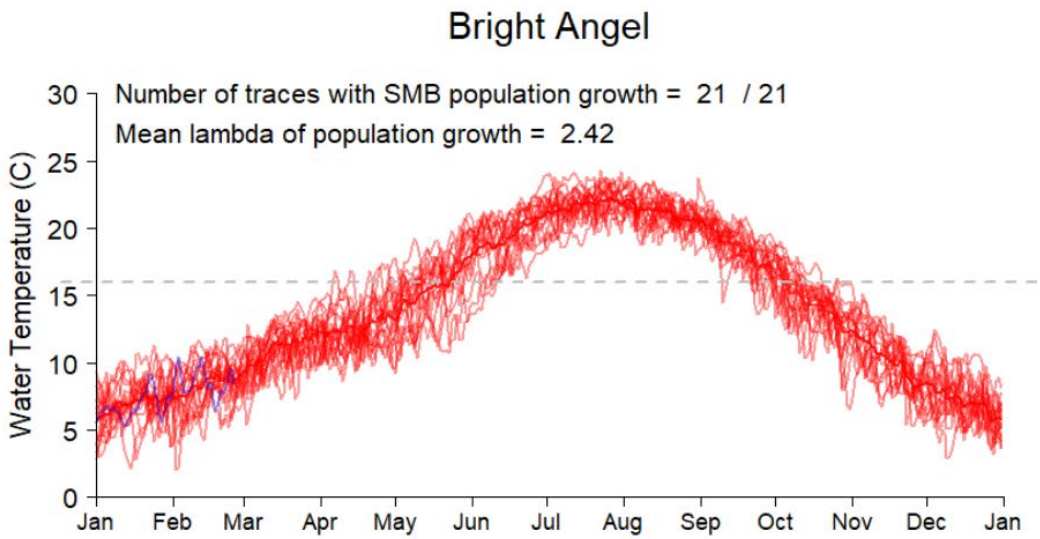
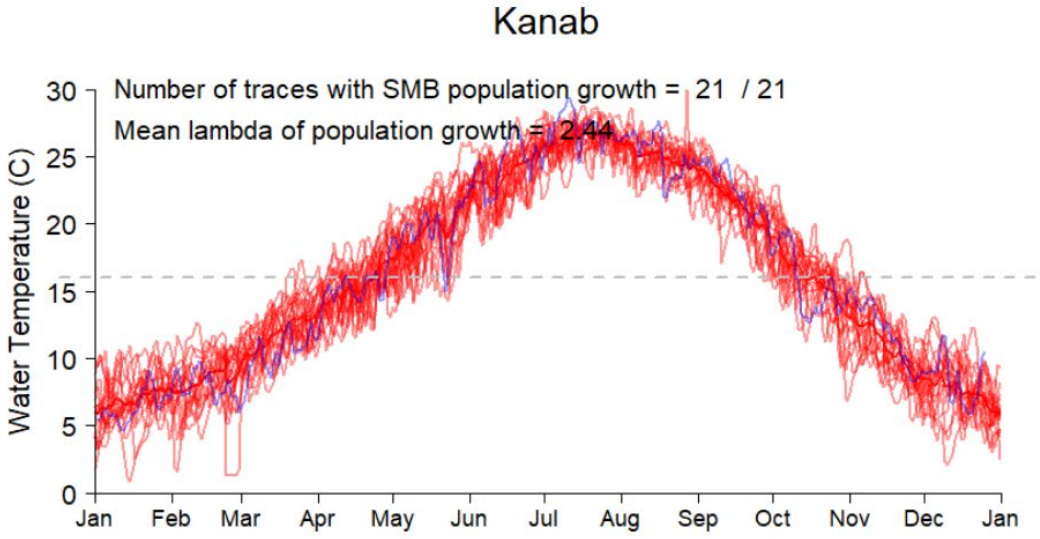
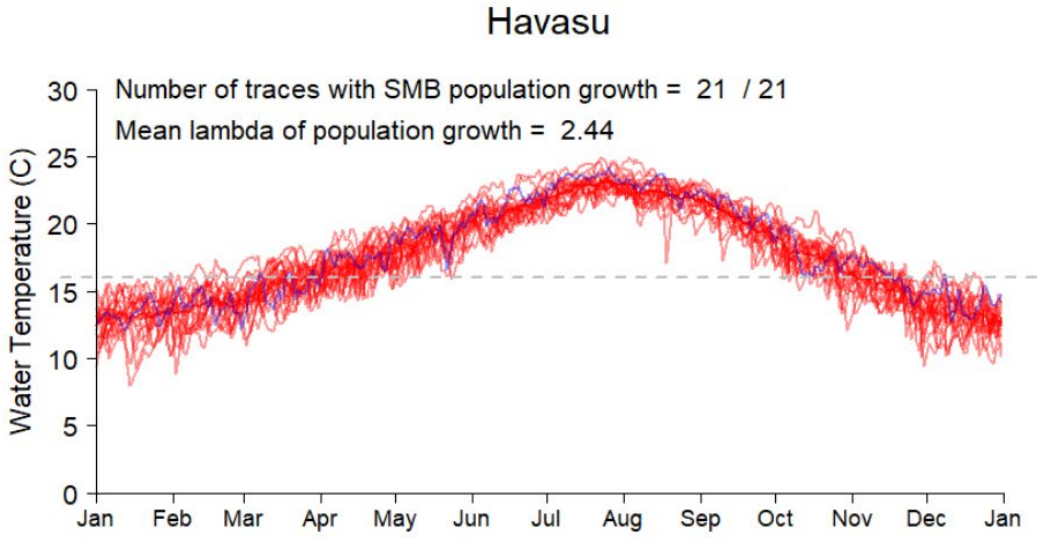
Tributary Thermal Suitability (2000-present)









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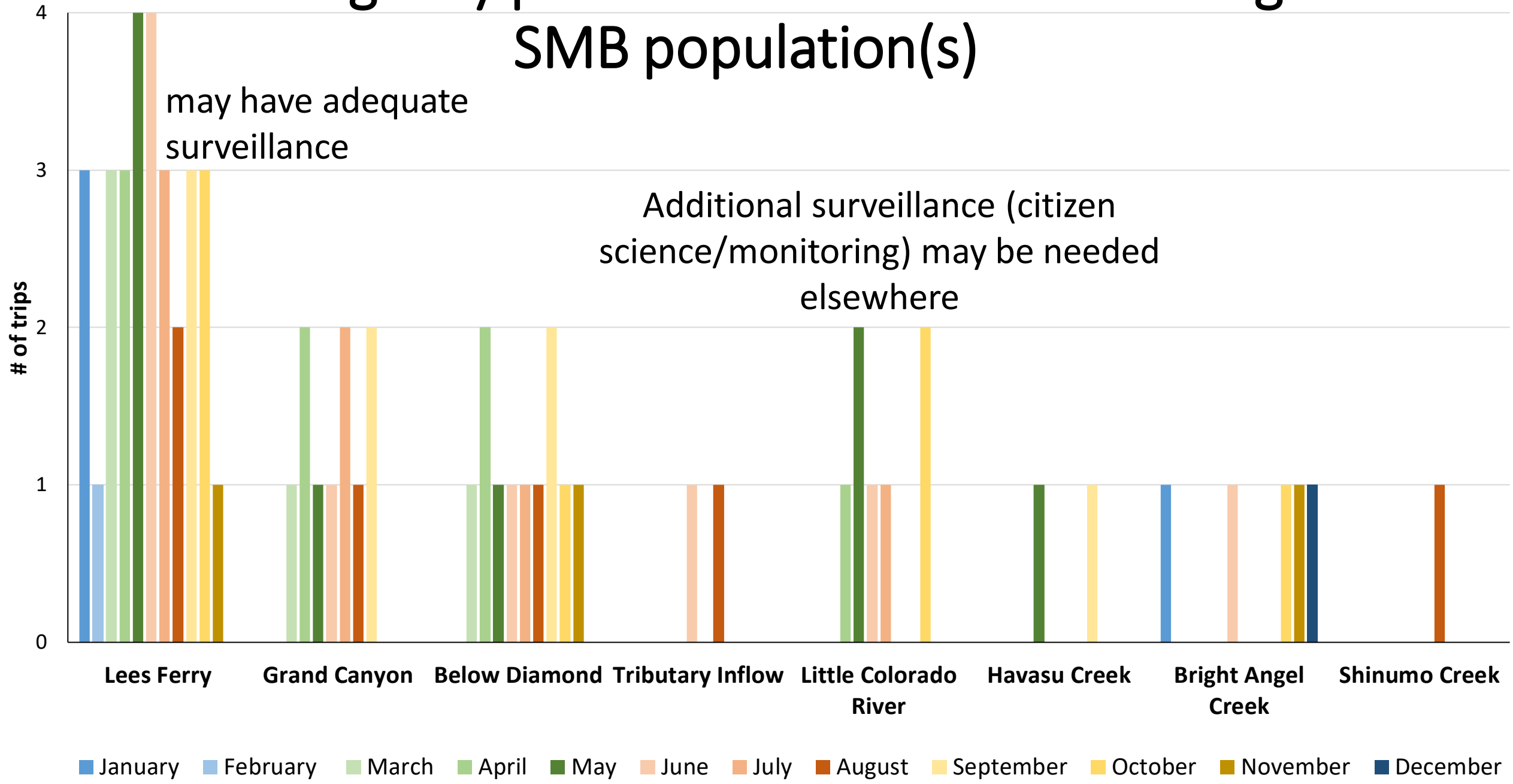
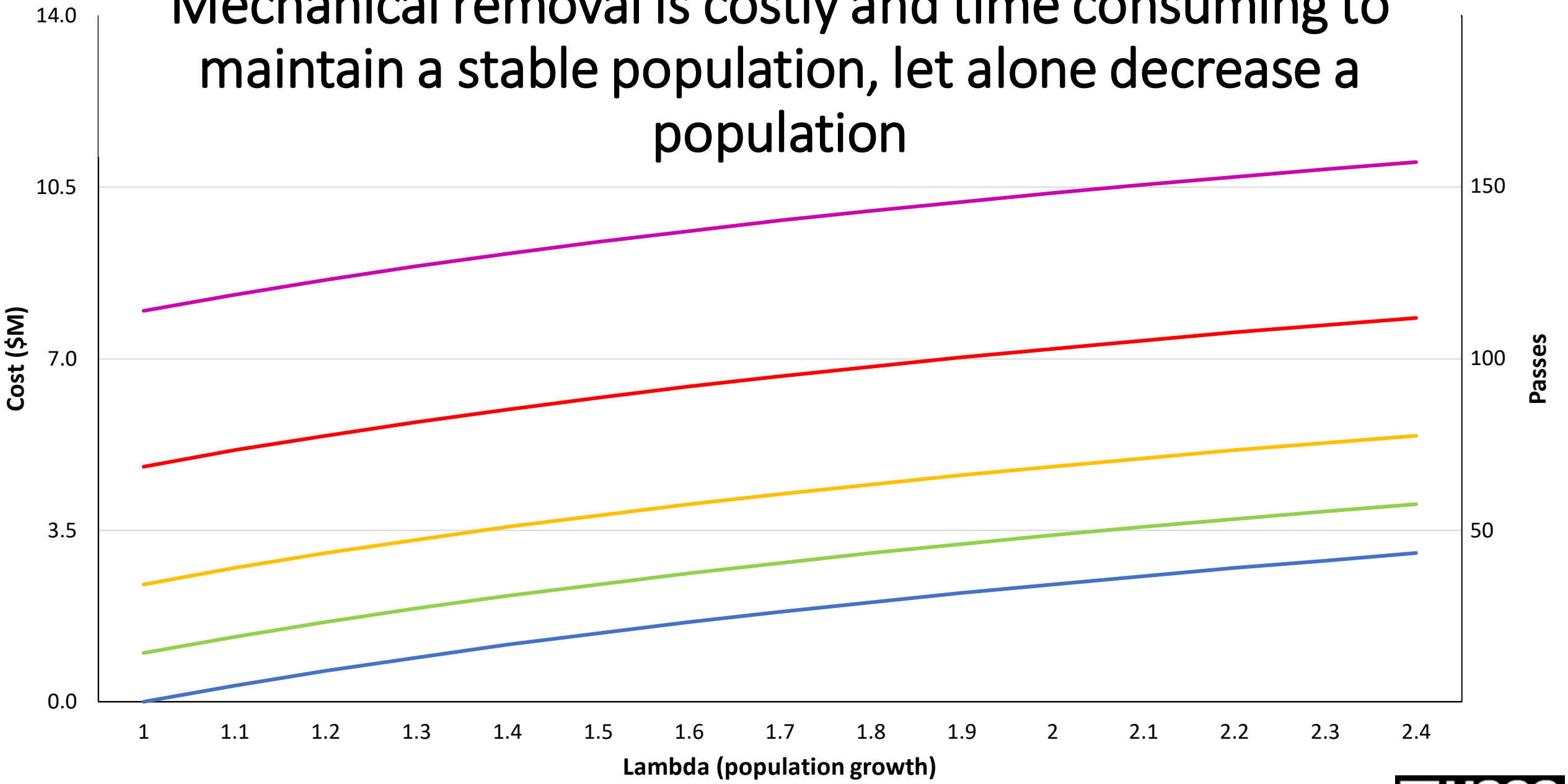
- What can decision makers do?

Monitoring may provide first evidence of changes in SMB population(s)



Mechanical removal is costly and time consuming to maintain a stable population, let alone decrease a population



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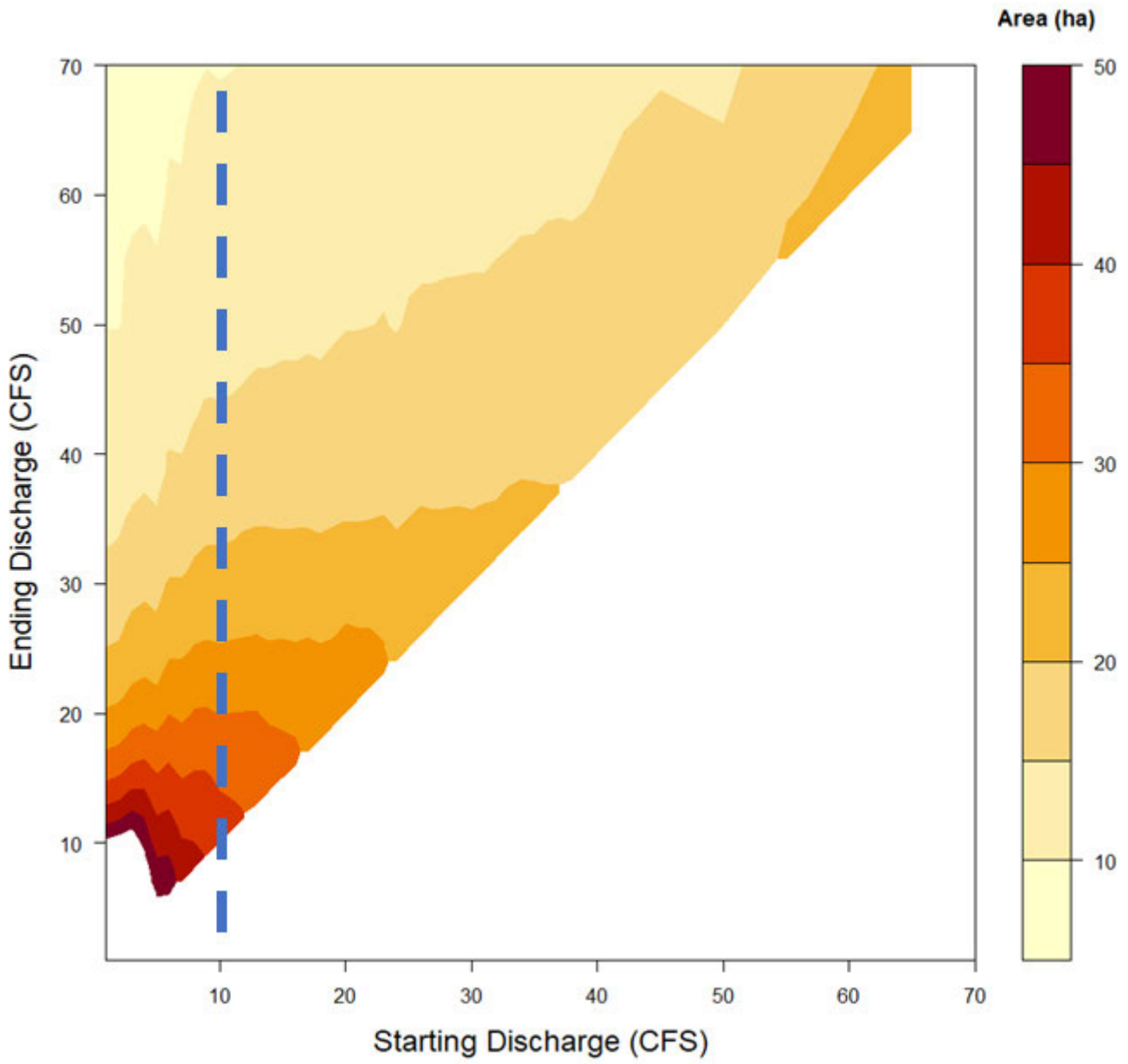
Rapid Response

- **Mechanical Removal**
  - Isolated pools: possibly effective
  - Tributaries: possibly effective

- **Piscicides**
  - Isolated pools
  - Tributaries

Lees Ferry Spawning Habitat Disruption with Flow



Starting Discharge (CFS)	Ending Discharge (CFS)	Remaining Habitat (ha)
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10,000	15,000	34.3
10,000	20,000	29.9
10,000	25,000	25.4
10,000	30,000	21.8
10,000	35,000	18.7
10,000	40,000	16.3
10,000	45,000	14.7

(Preliminary, do not cite)

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Can Entrainment risk be reduced?

Short term:

Minimize time spent drawing from surface waters

DROA

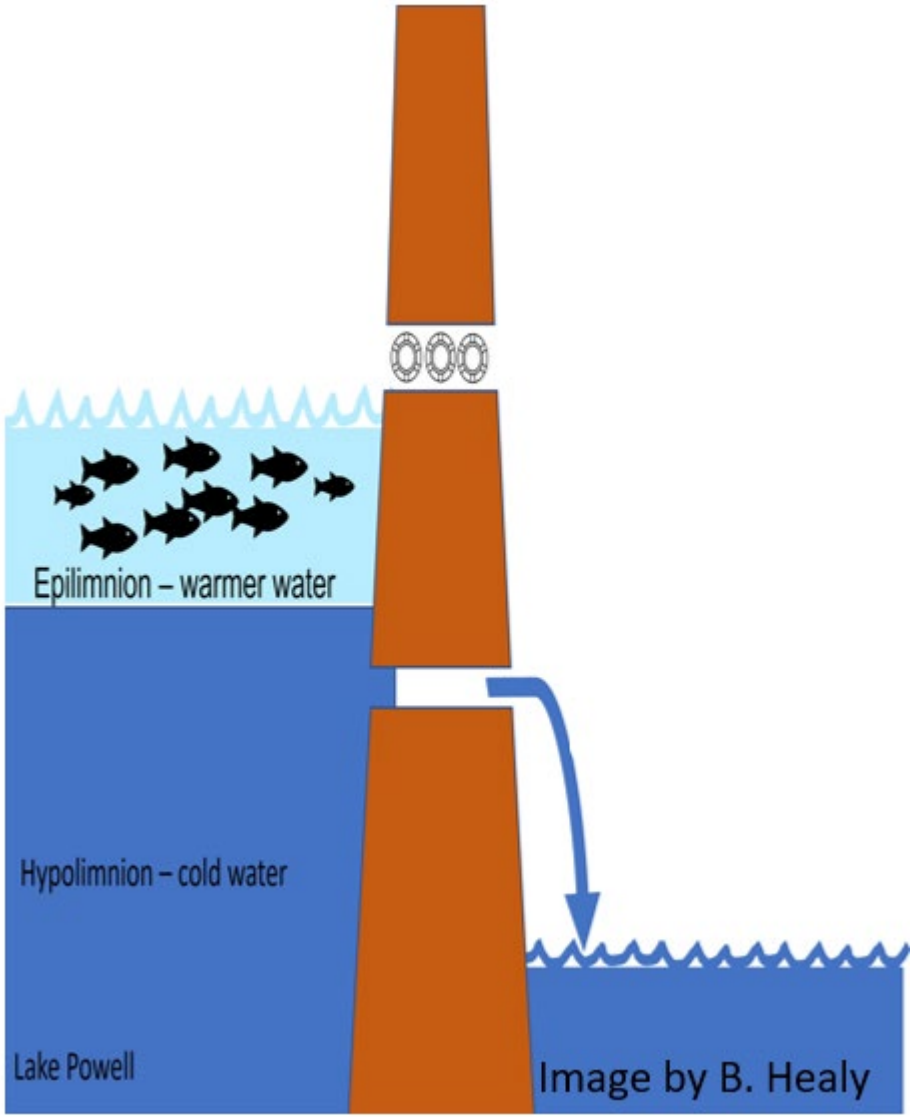
Bypass

Mid term:

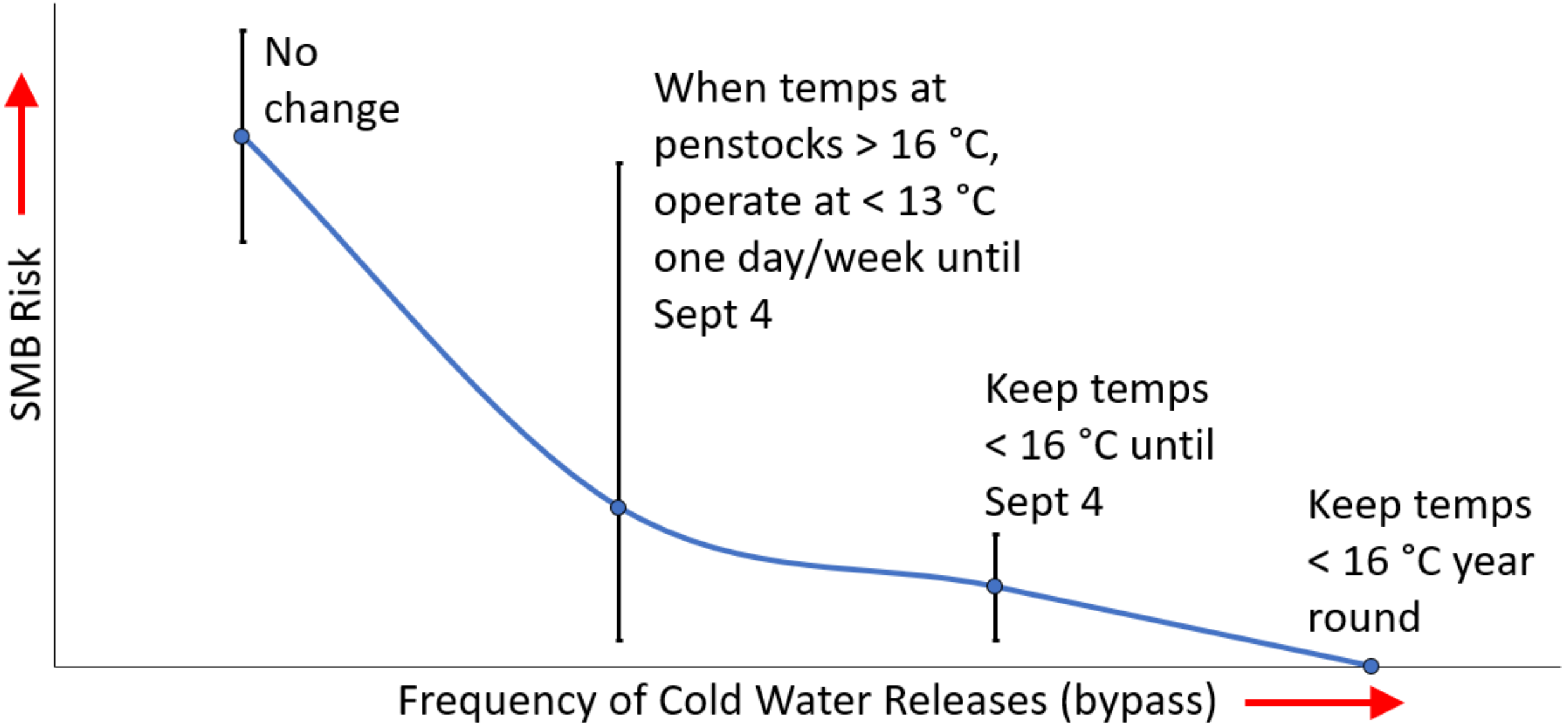
Fish exclusion in forebay, e.g., bubble curtain, C02 curtain

Long term:

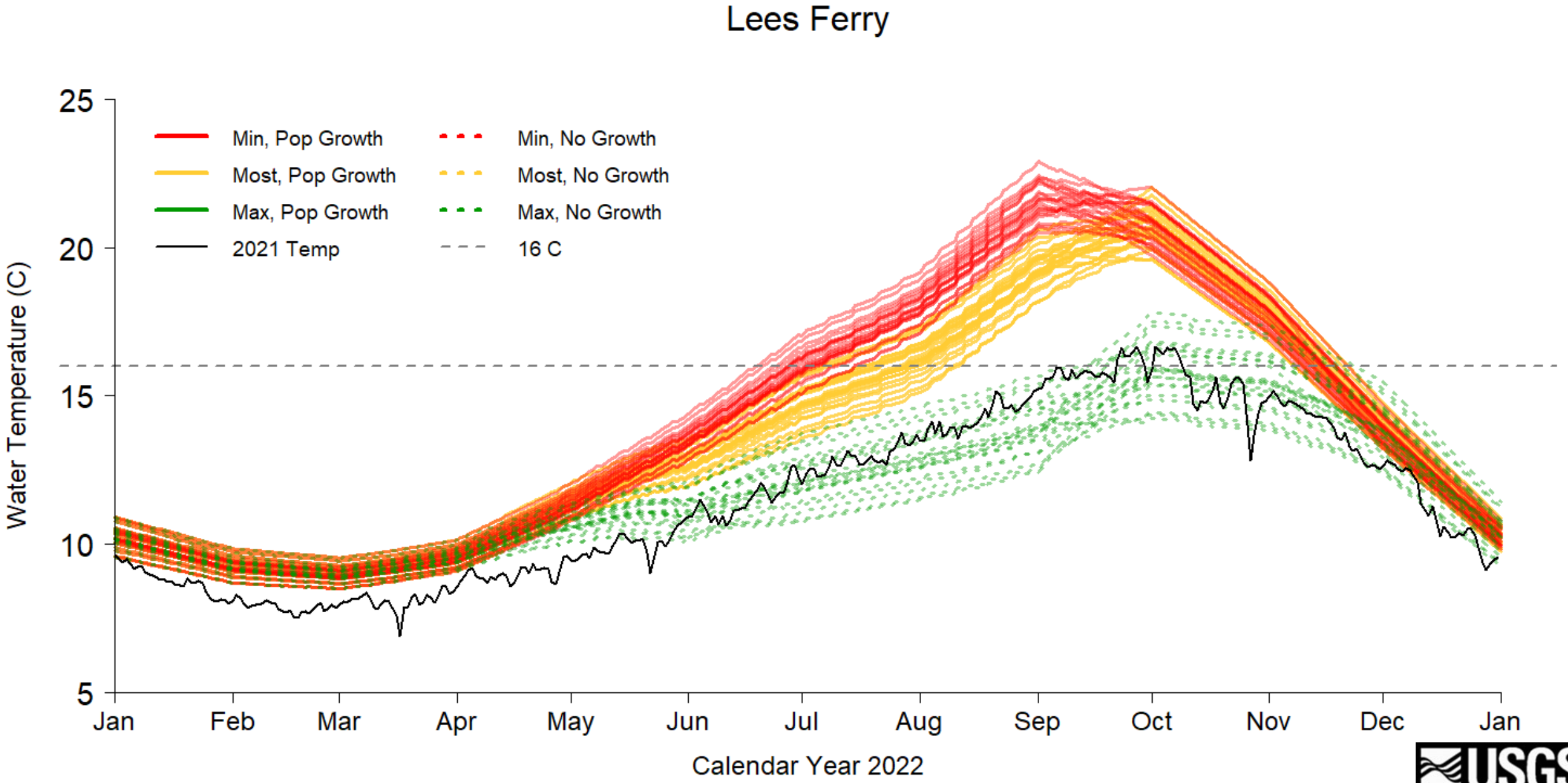
Changes to infrastructure



Different approaches to Manage SMB via Temperature



No Change: Baseline



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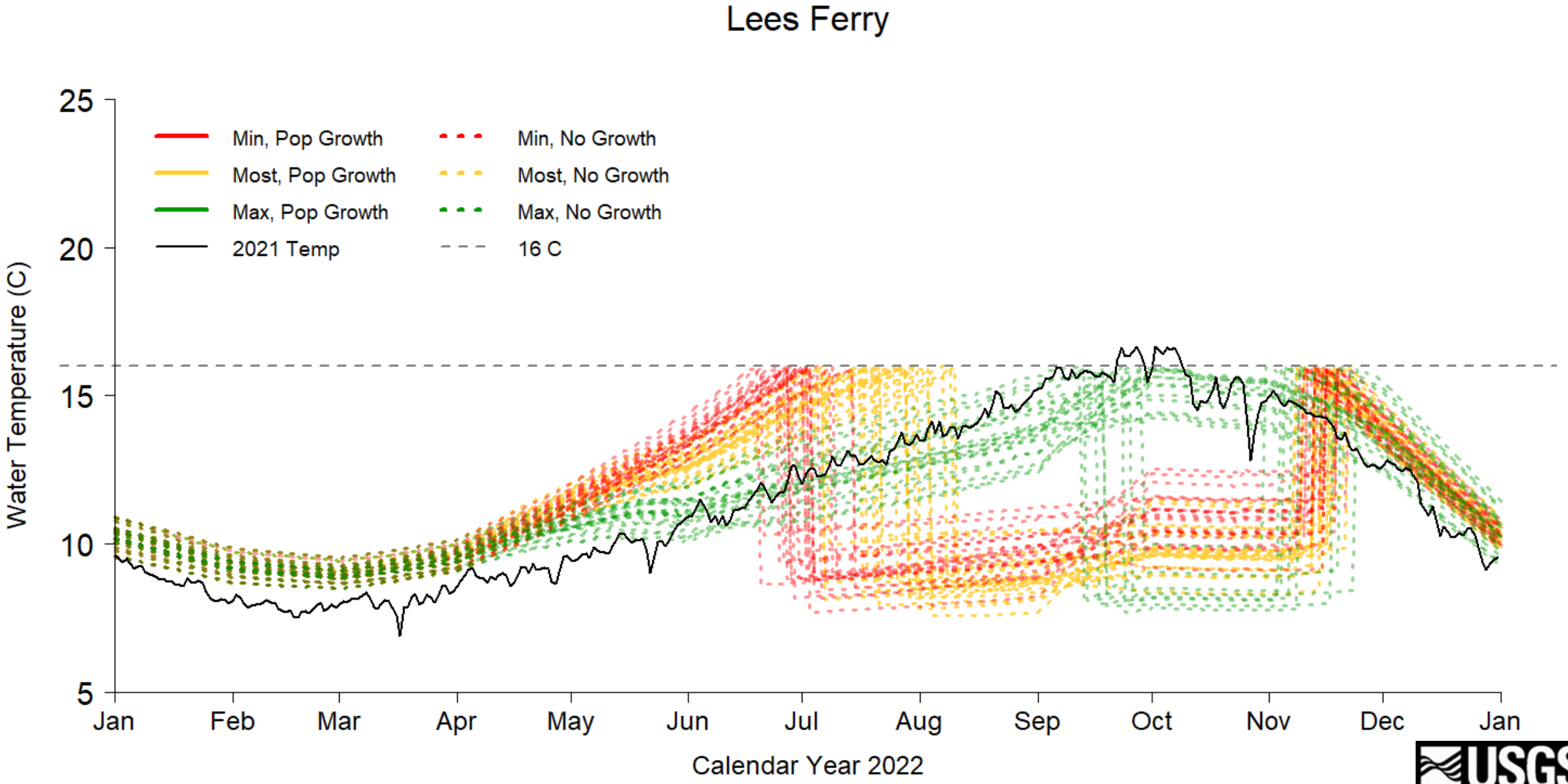
Keep Temps < 16 °C All Year



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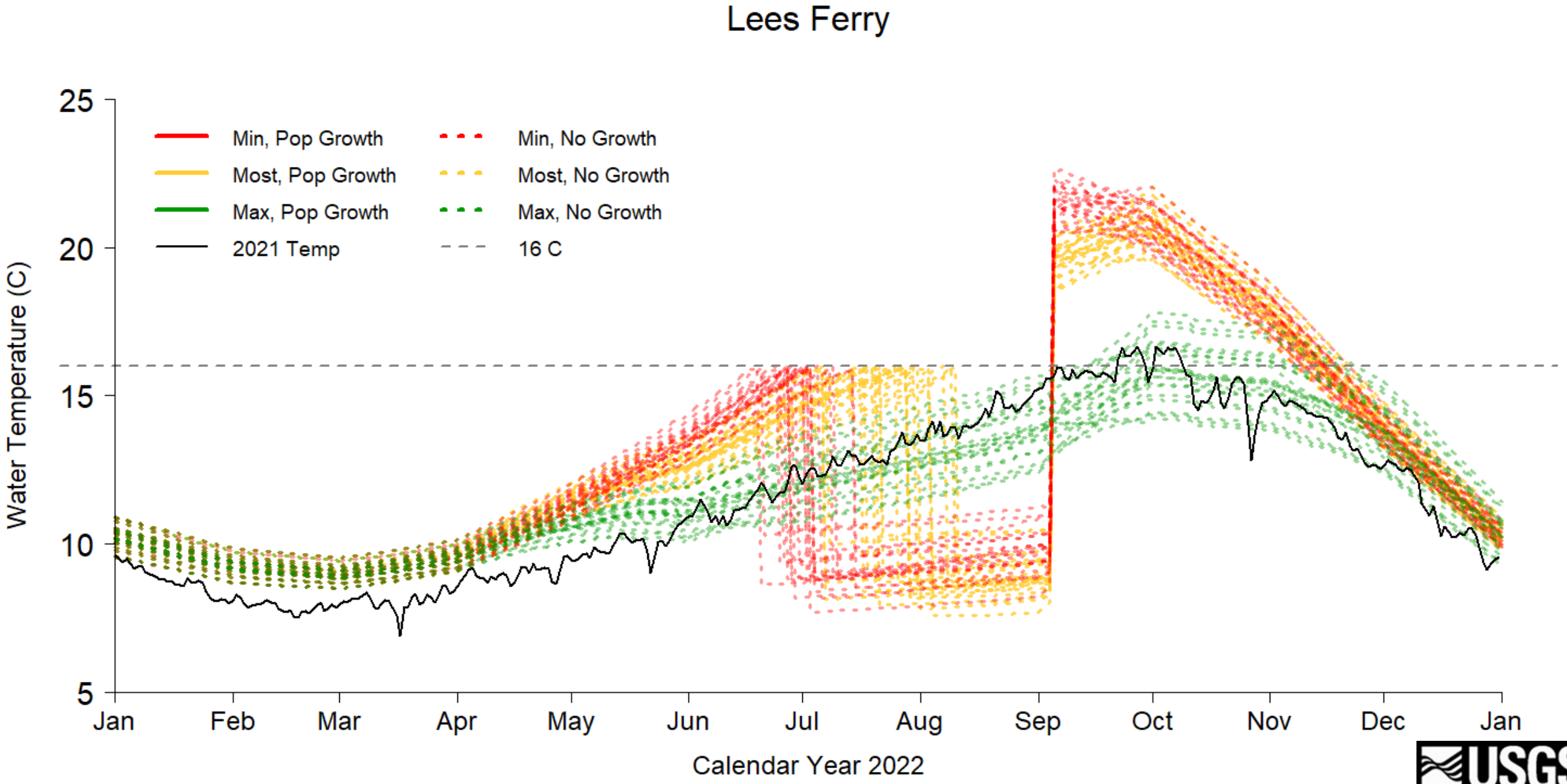
Keep Temps < 16 °C until Sept 4



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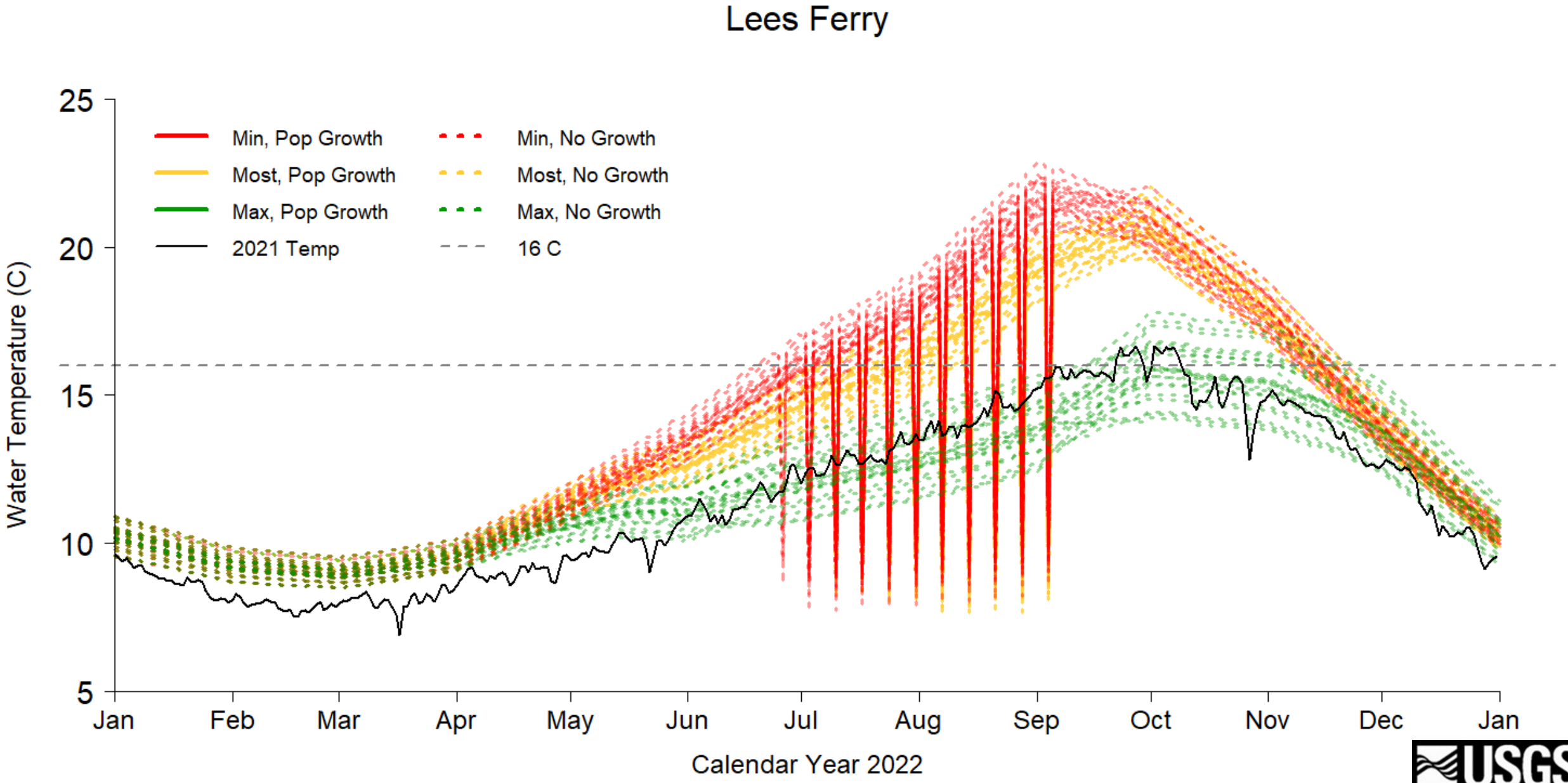
Keep Temps < 13 °C until Sept 4, one day/week



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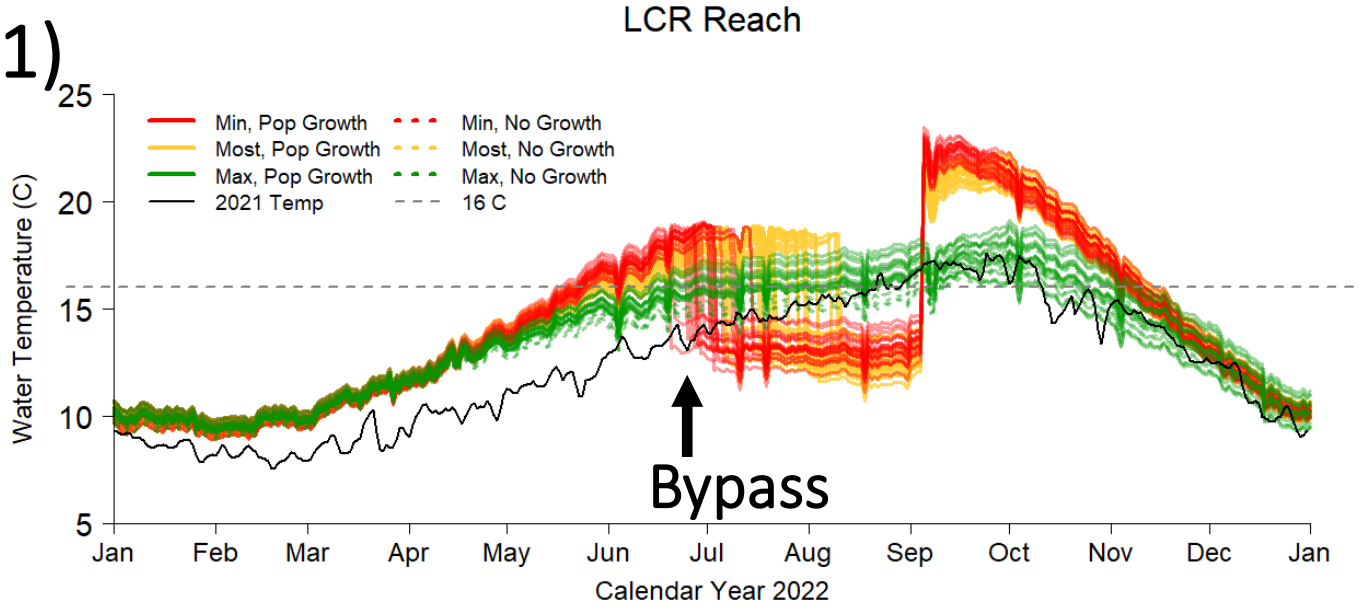
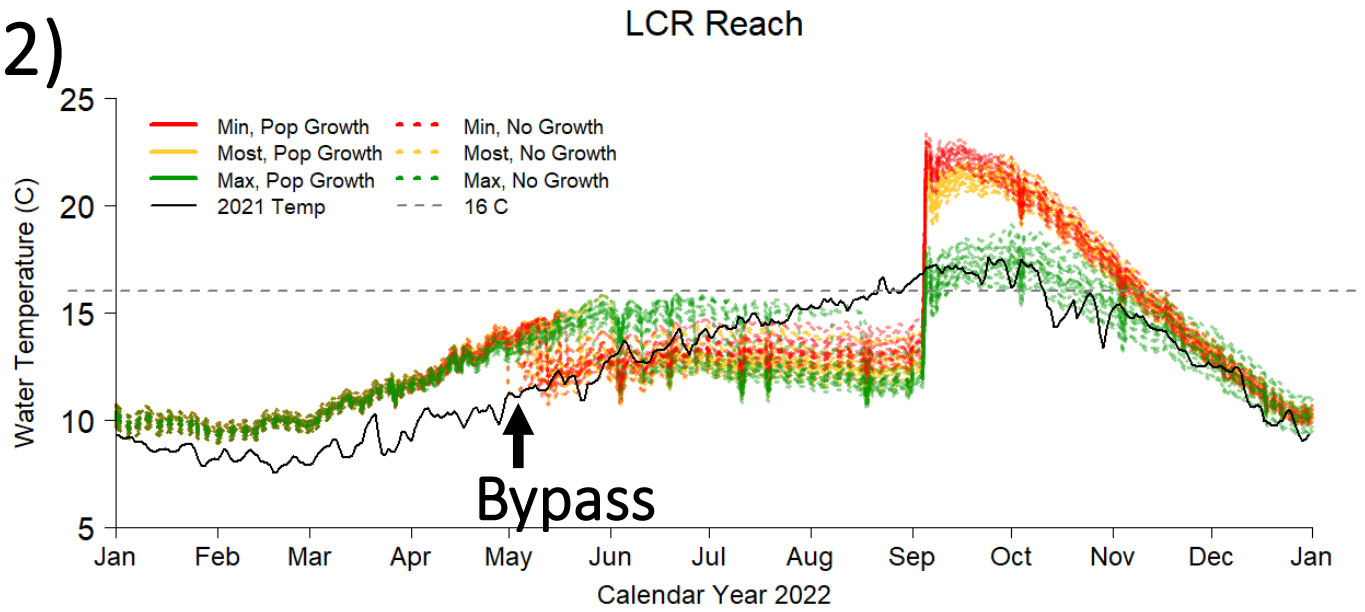
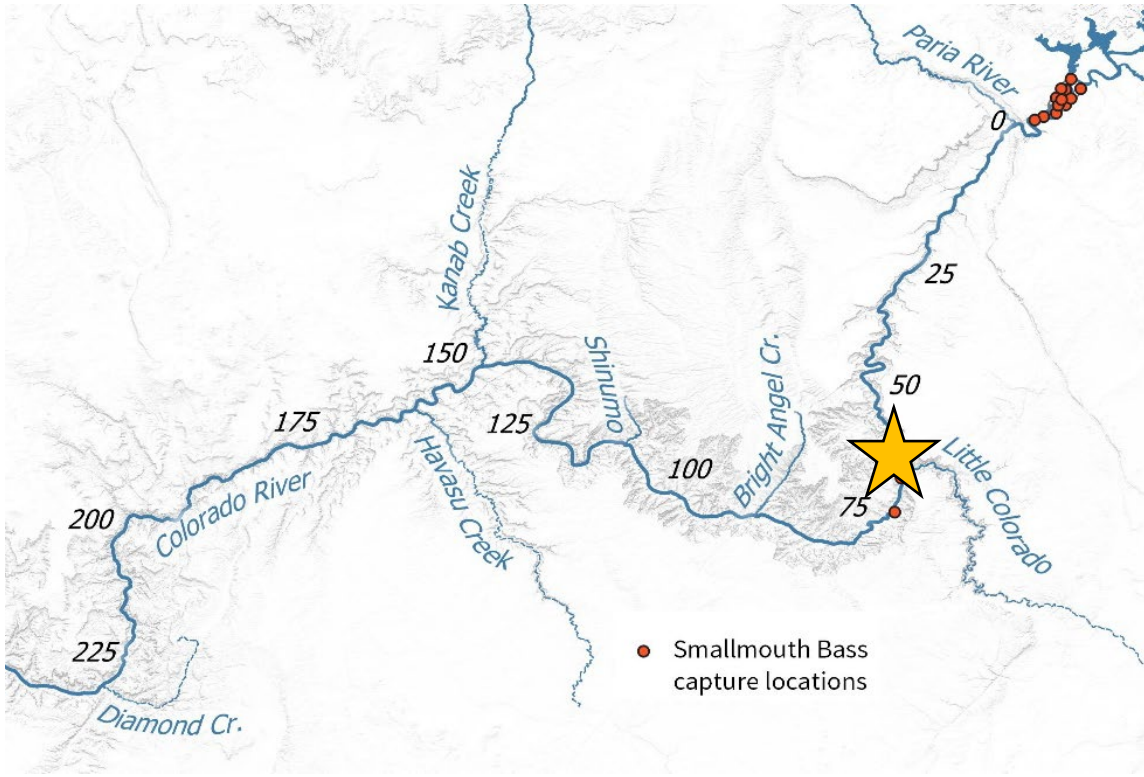
LCR Reach when managing 1) LF temps, 2) downriver temps

1)



2)





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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 us more time
- Reversing SMB establishment downriver/ in tributaries will be a drawn out and expensive process and may not be possible

Acknowledgements

- Models developed relied heavily on earlier work in collaboration with Lindsey Bruckerhoff, Kevin Bestgen, Jian Wang, Kim Dibble, Bryce Mihalevich, and Jack Schmidt.

- Funding for model development came from non-AMP sources – primarily USGS's Southwest Climate Science Center and USGS's water and ecosystem mission areas.

Southwest Climate Science Center

UtahStateUniversity

Center for COLORADO RIVER Studies

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