# HARP Model Update

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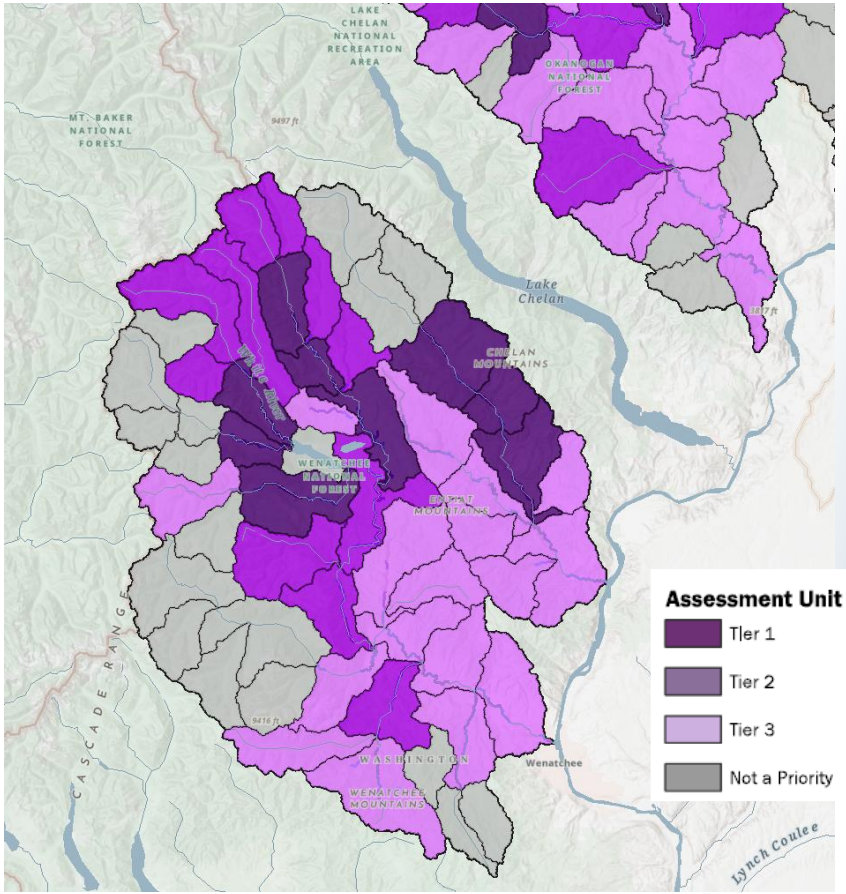
# Why another model in the Upper Columbia?

- HARP is a prioritization model in a LCM context
- The UC is data rich!
- HARP can add additional value to existing prioritization work/data products



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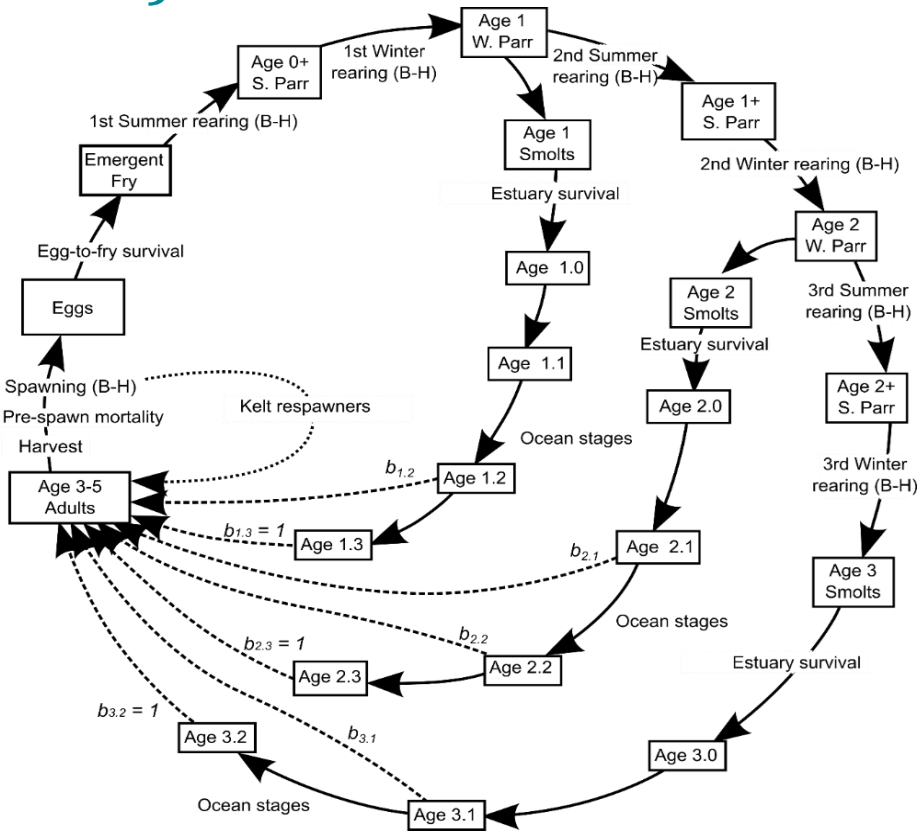
# What is the **H**abitat **A**ssessment and **R**estoration **P**lanning model (HARP)?

## Salmon life-Cycle model .....



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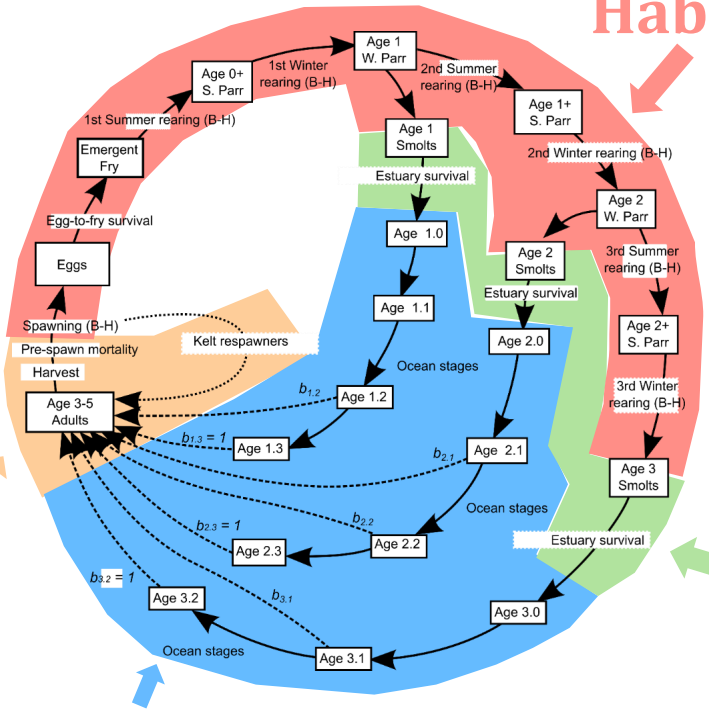
# What is the **H**abitat **A**ssessment and **R**estoration **P**lanning model (HARP)?

Salmon life-Cycle model with sub-models providing capacities and survivals

**Freshwater Habitat model**




**Harvest, Hatchery, Pre-spawn mortality sub-models**

**Mainstem survival model**

**Estuary and marine survival model(s)**



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# The Management Questions

| Domain | Management actions, climate |
|---|---|
| Tributaries (HARP Model) | - Habitat restoration strategies<br>- Climate change effects |
| Main stem (passage models) | - Dam operations and passage<br>- Harvest<br>- Climate change effects |
| Estuary/Ocean (early ocean, mechanistic models) | - Habitat restoration and protection<br>- Predator and prey controls<br>- Harvest<br>- Climate change effects |
| All habitat types | - Hatchery size and scope<br>- Climate interactions |




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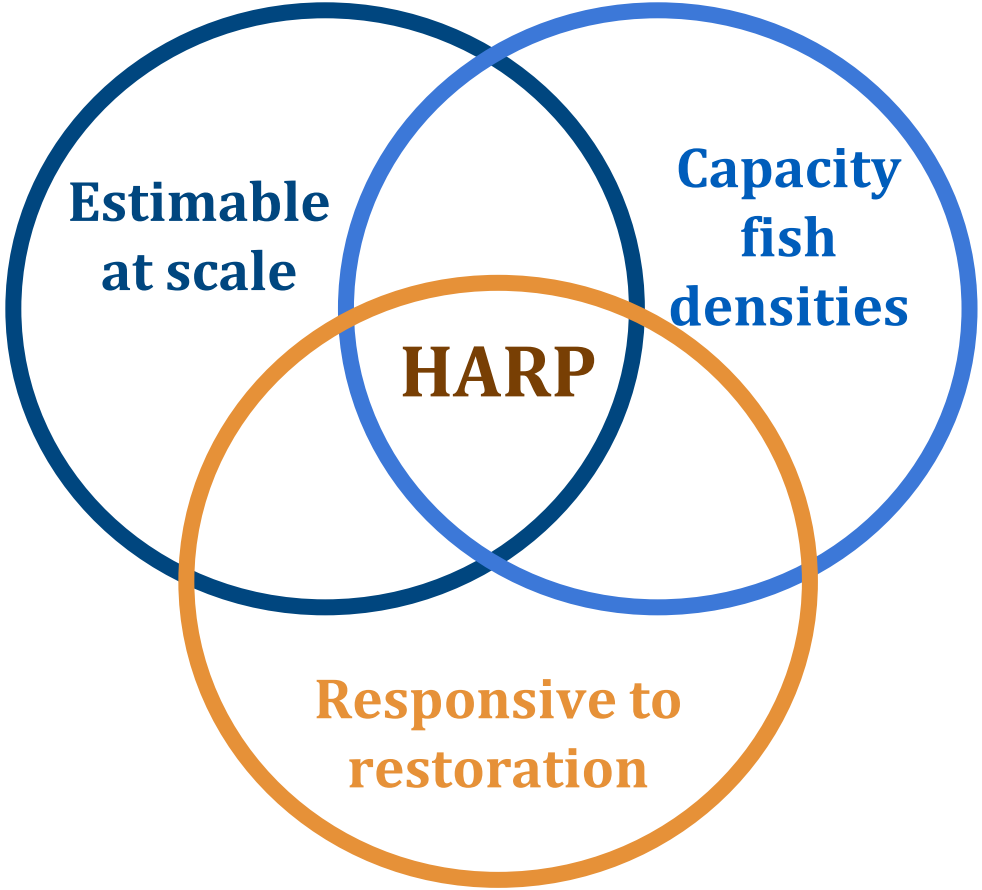
# What habitat types to estimate?



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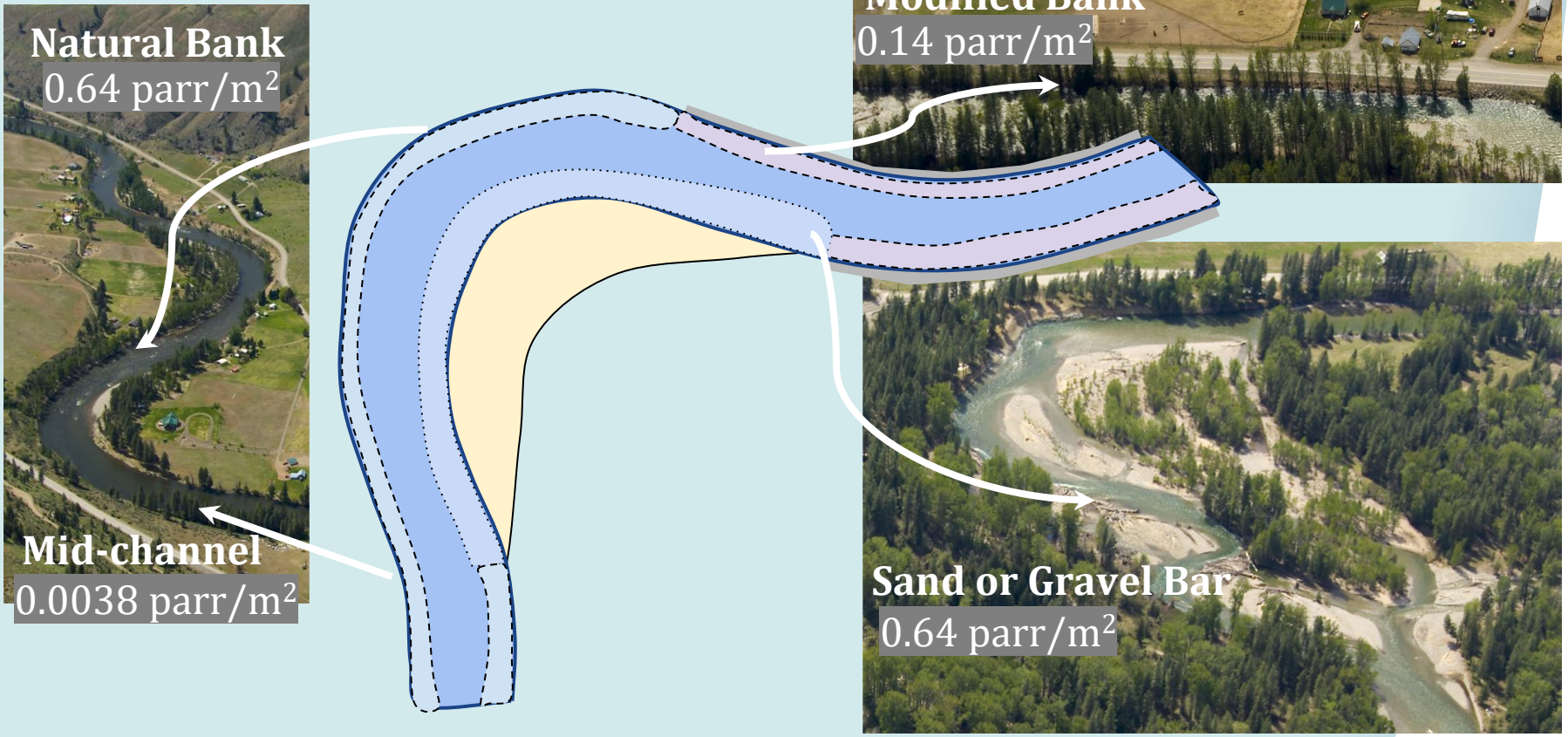
# Habitat Model: Digitizing current and historical habitat area




Photos: WA Dept of Ecology, 2007



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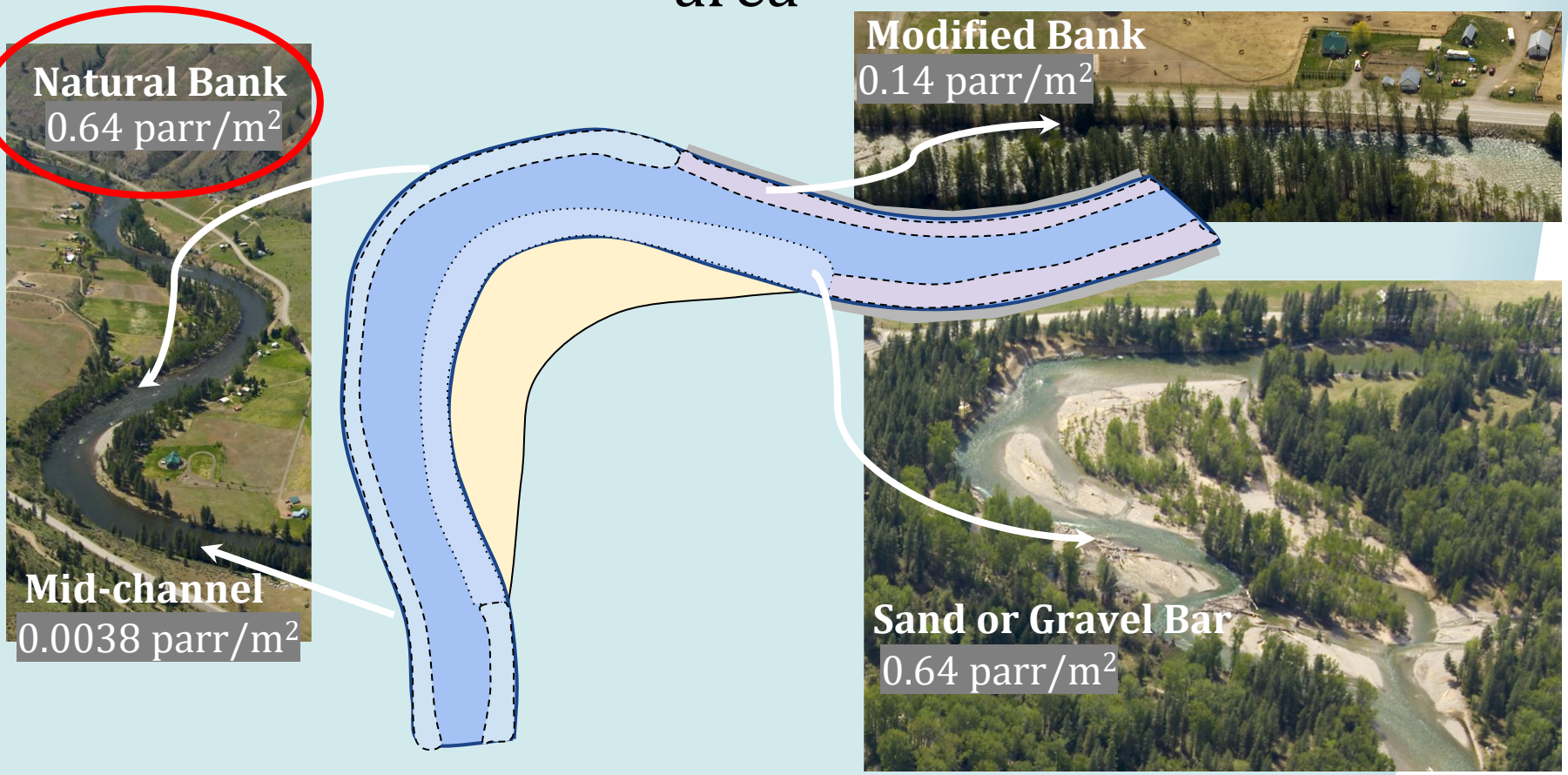


Photos: WA Dept of Ecology, 2007



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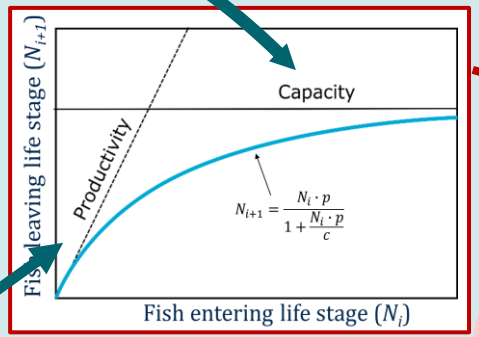
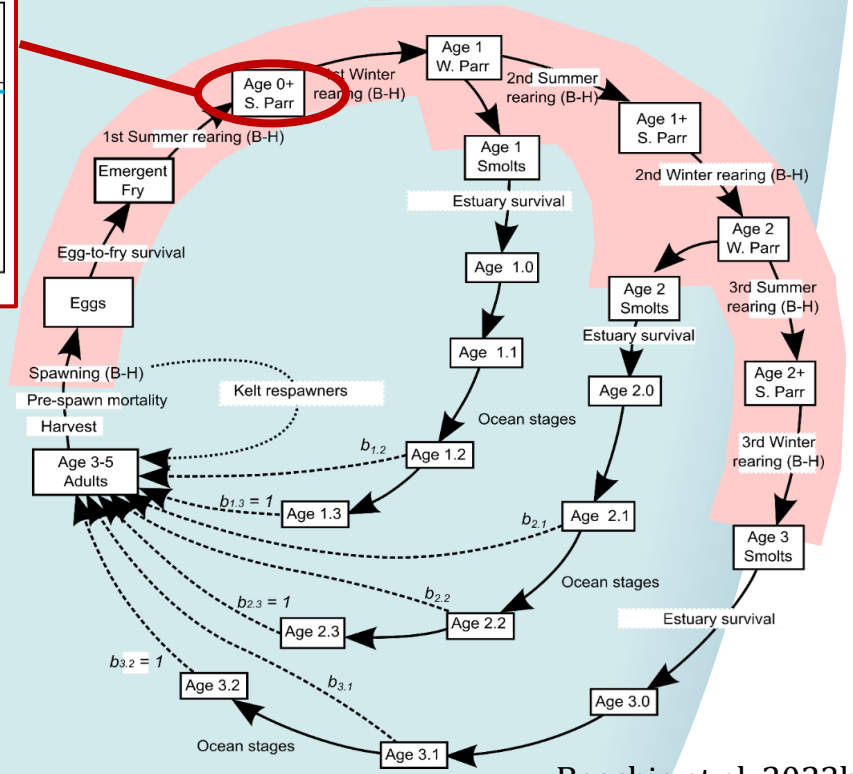
# Habitat Model: Converting areas to LCM inputs

## Natural Bank:

**Capacity** = 0.64 parr/m$^2$ x Area

**Productivity** = Density Independent Productivity x Temperature x Wood Load




Beechie et al. 2023b

Photos: WA Dept of Ecology, 2007



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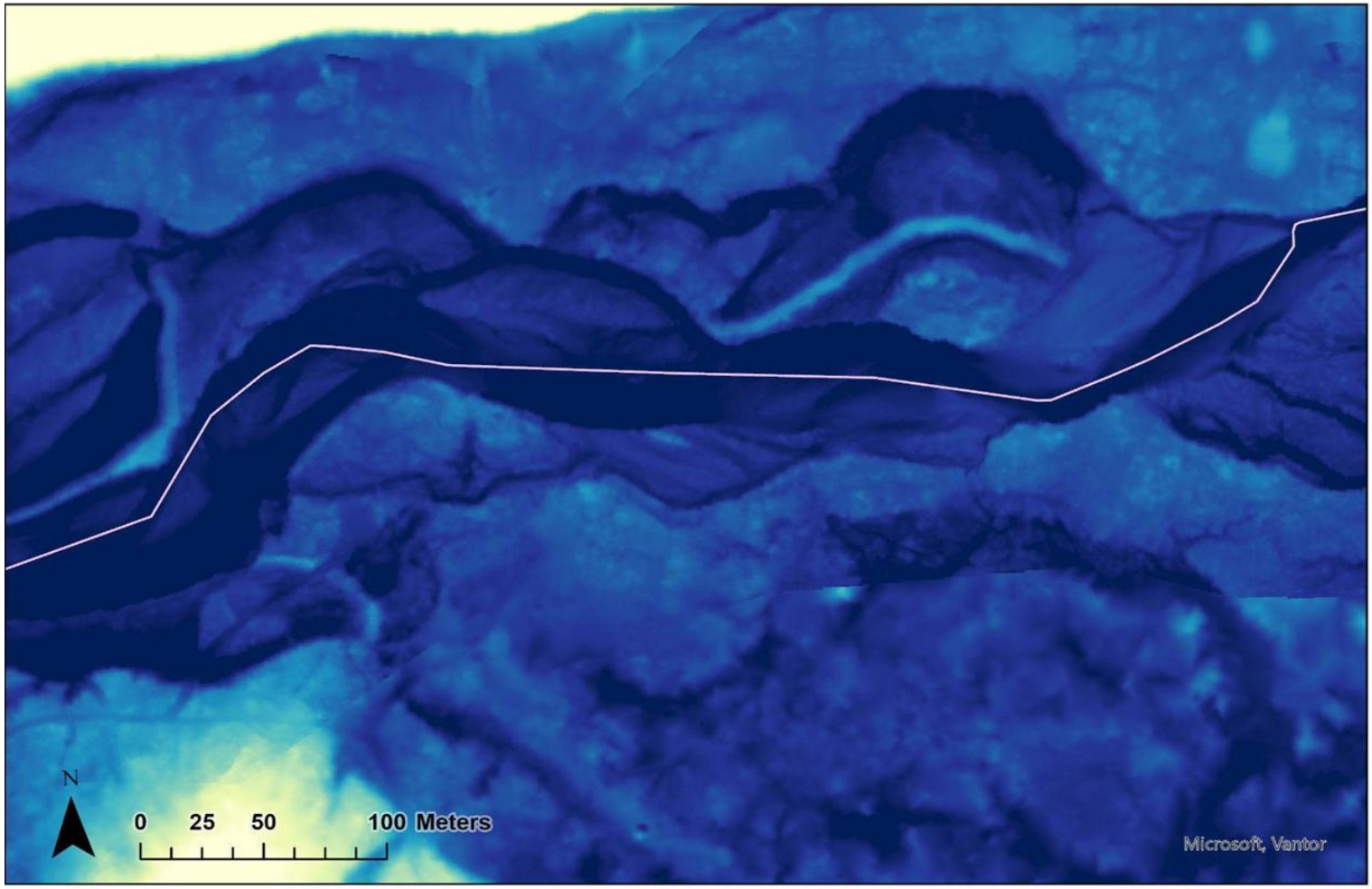




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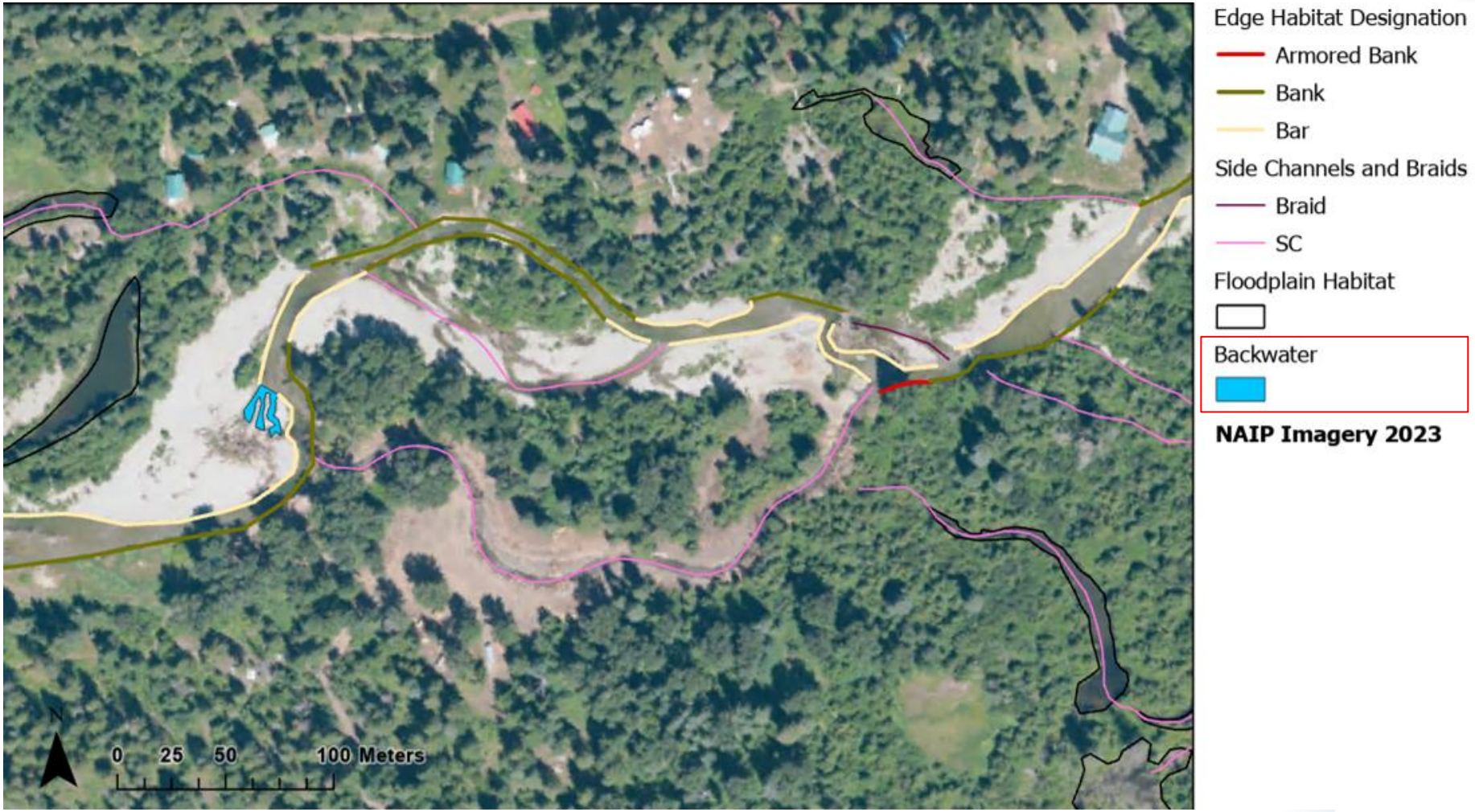
Edge Habitat Designation
Armored Bank
Bank
Bar
NAIP Imagery 2023
N
0 25 50 100 Meters
Microsoft, Vantor


Edge Habitat Designation
Armored Bank
Bank
Bar
Side Channels and Braids
Braid
SC
N
0 25 50 100 Meters
Microsoft, Vantor


Edge Habitat Designation
Armored Bank
Bank
Bar
Side Channels and Braids
Braid
SC
Floodplain Habitat
NAIP Imagery 2023
N
0 25 50 100 Meters
Microsoft, Vantor



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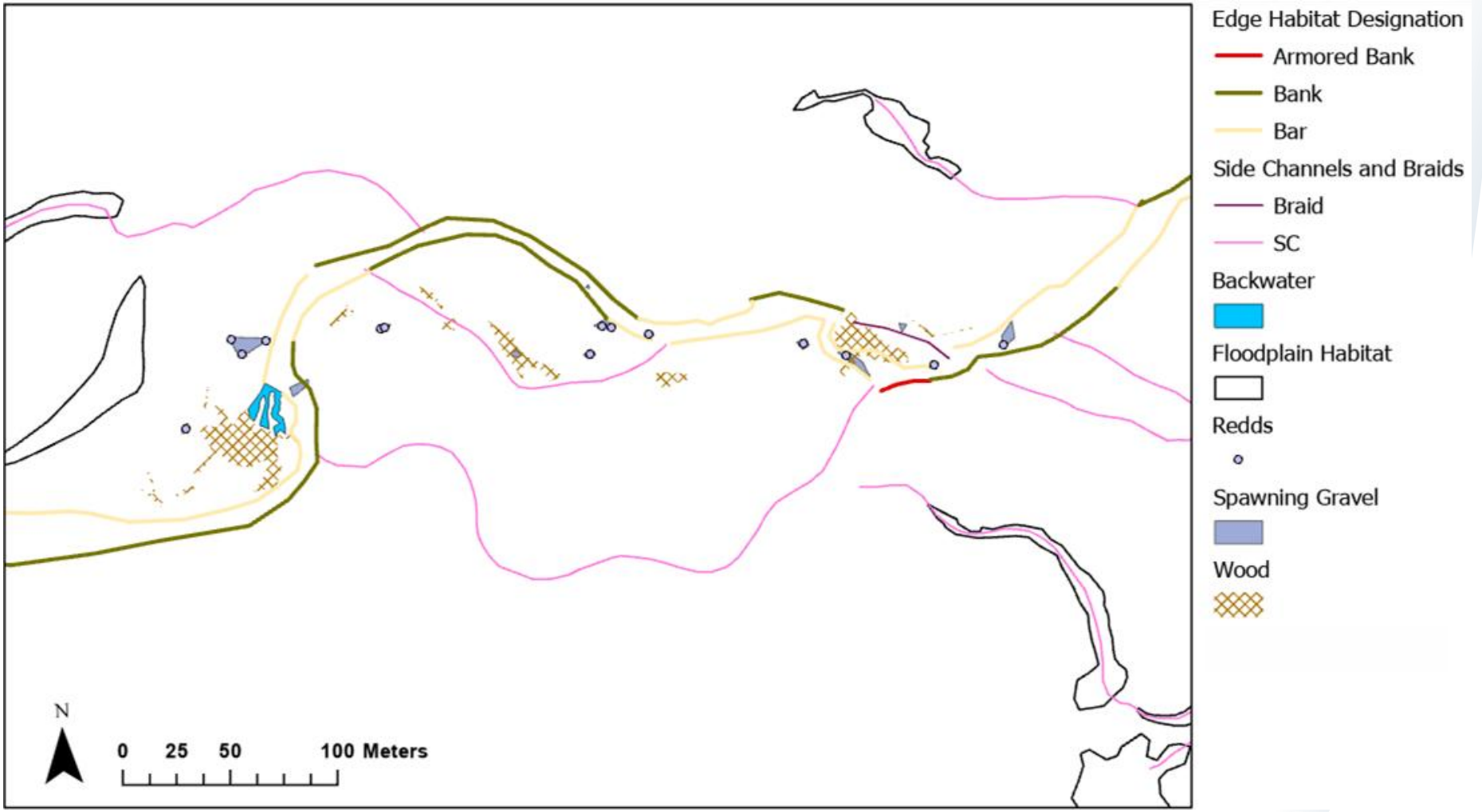




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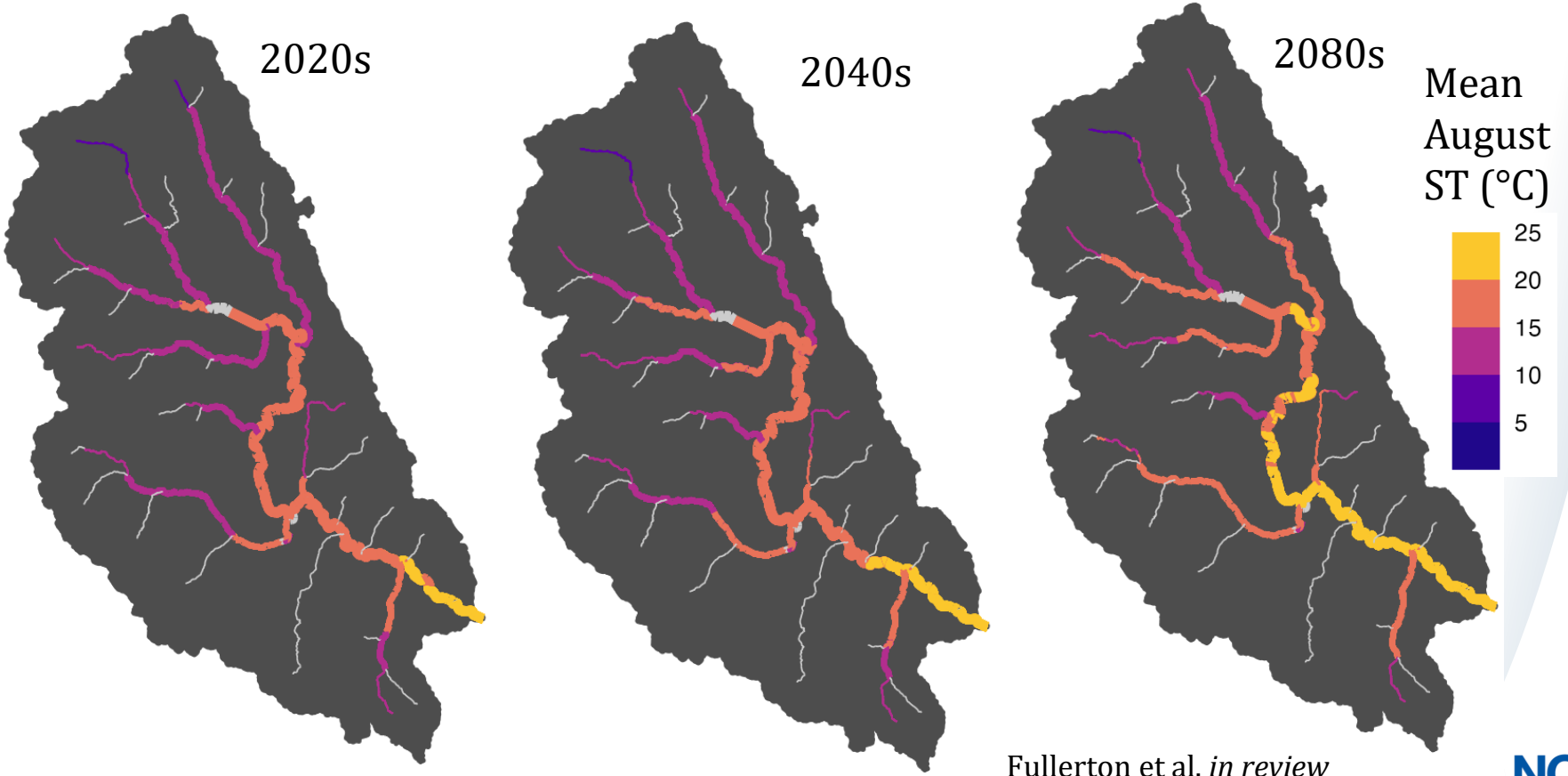
# Temperature modeling:
## Daily time step (1993-2020), future predictions




Fullerton et al. *in review*



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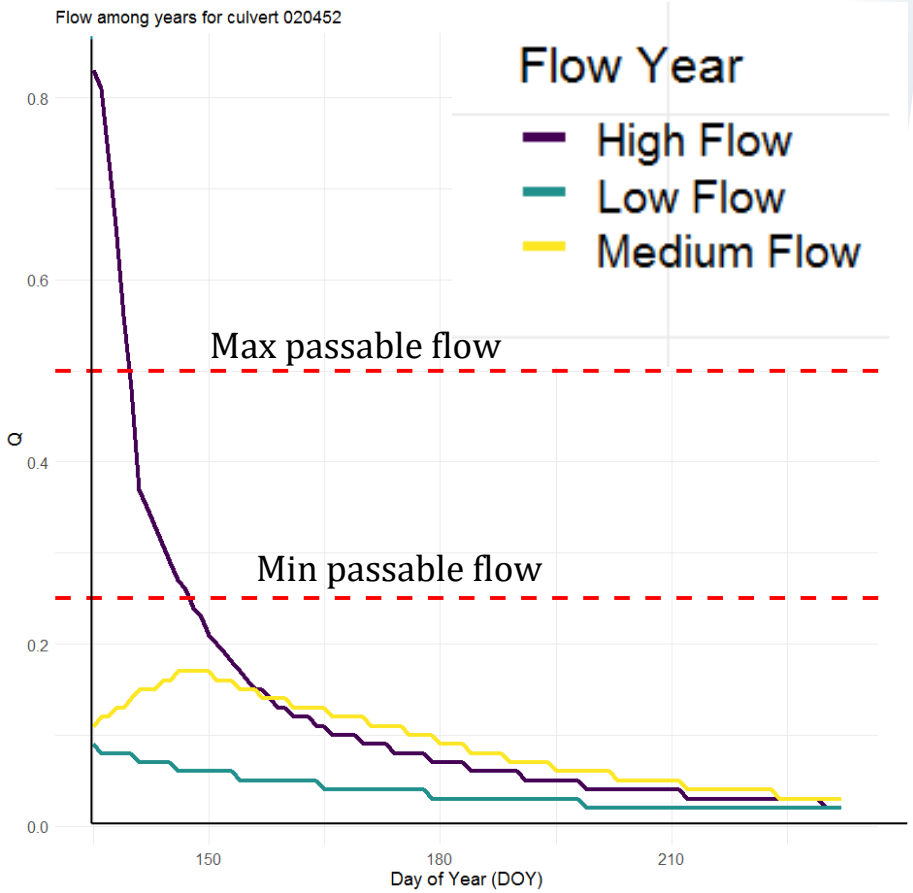
# Flow-based culvert passage model

- "Klett model" uses:
  - Daily flow (National Water Model) during migration/spawning
  - Culvert shape
  - Slope
  - length
- For each culvert estimate min and max passable flow (Q)

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# Return on Investment

- ~5000 projects analyzed (CBFish, PRISM, OWEB) by Holland et al. *in review*
- Cost models for:
  - Riparian
  - Floodplain
  - Barrier
  - Instream
- Inclusion in HARP as an scenario optimization by cost



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# Restoration scenarios:

- Floodplain reconnection
- Riparian (shade)
- Beaver reintroduction/BDA
- Instream wood
- Barrier removal
- Large river bank/sinuosity
- Sediment
- All under current/future temp. and hydrology



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# Timeline ….

- Spring 2026: Finishing current and historical habitat analysis models
- Summer 2026: Developing basic restoration “diagnostic” scenarios
- Summer/Fall 2026: Engagement with restoration community to develop alternative “All-H” action scenarios



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# Acknowledgements


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