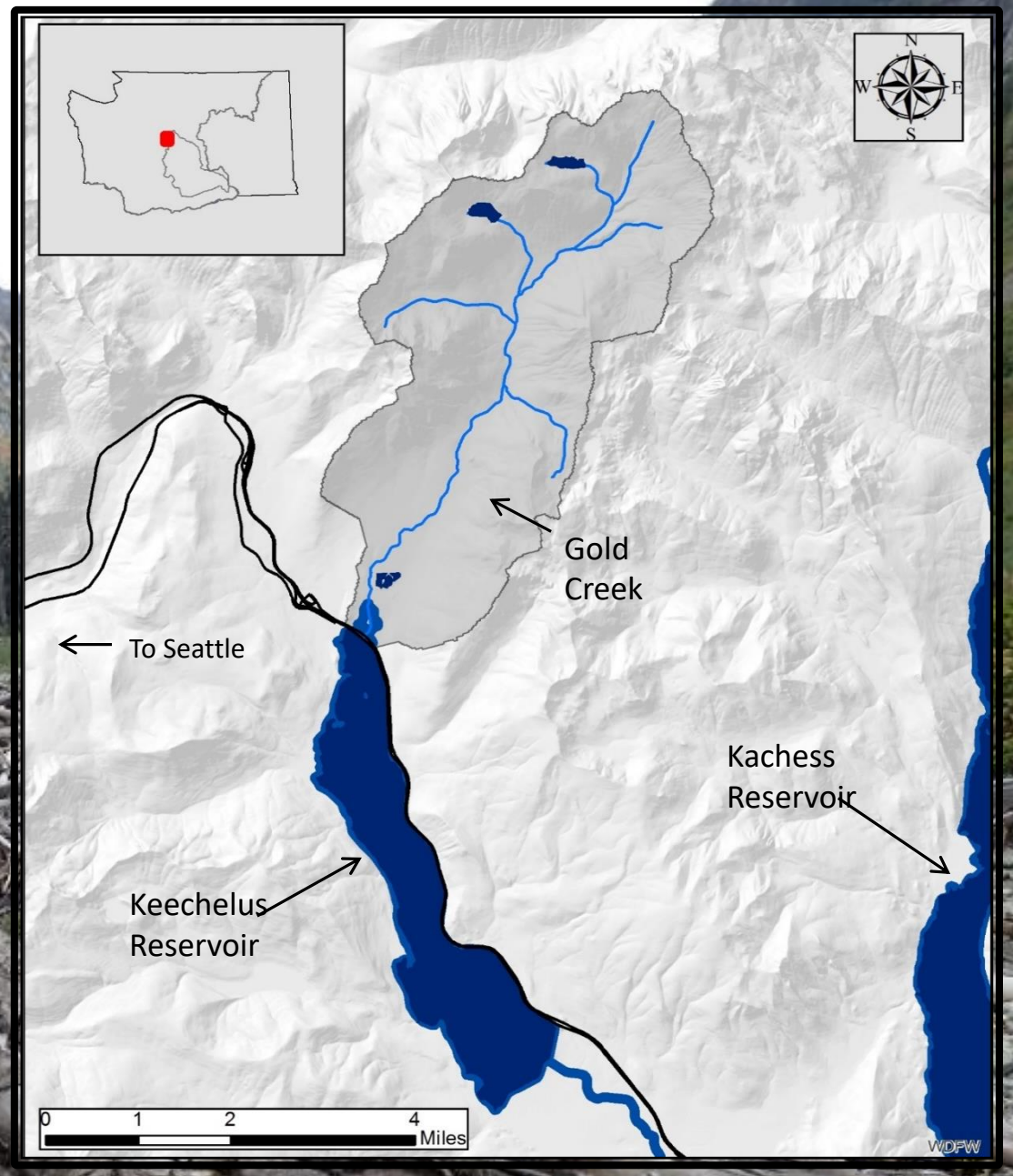
# Microhabitat Selection of Young-of-the-Year Bull Trout, *Salvelinus confluentus*, in a Drought Year

*Ashton Bunce, Central Washington University*

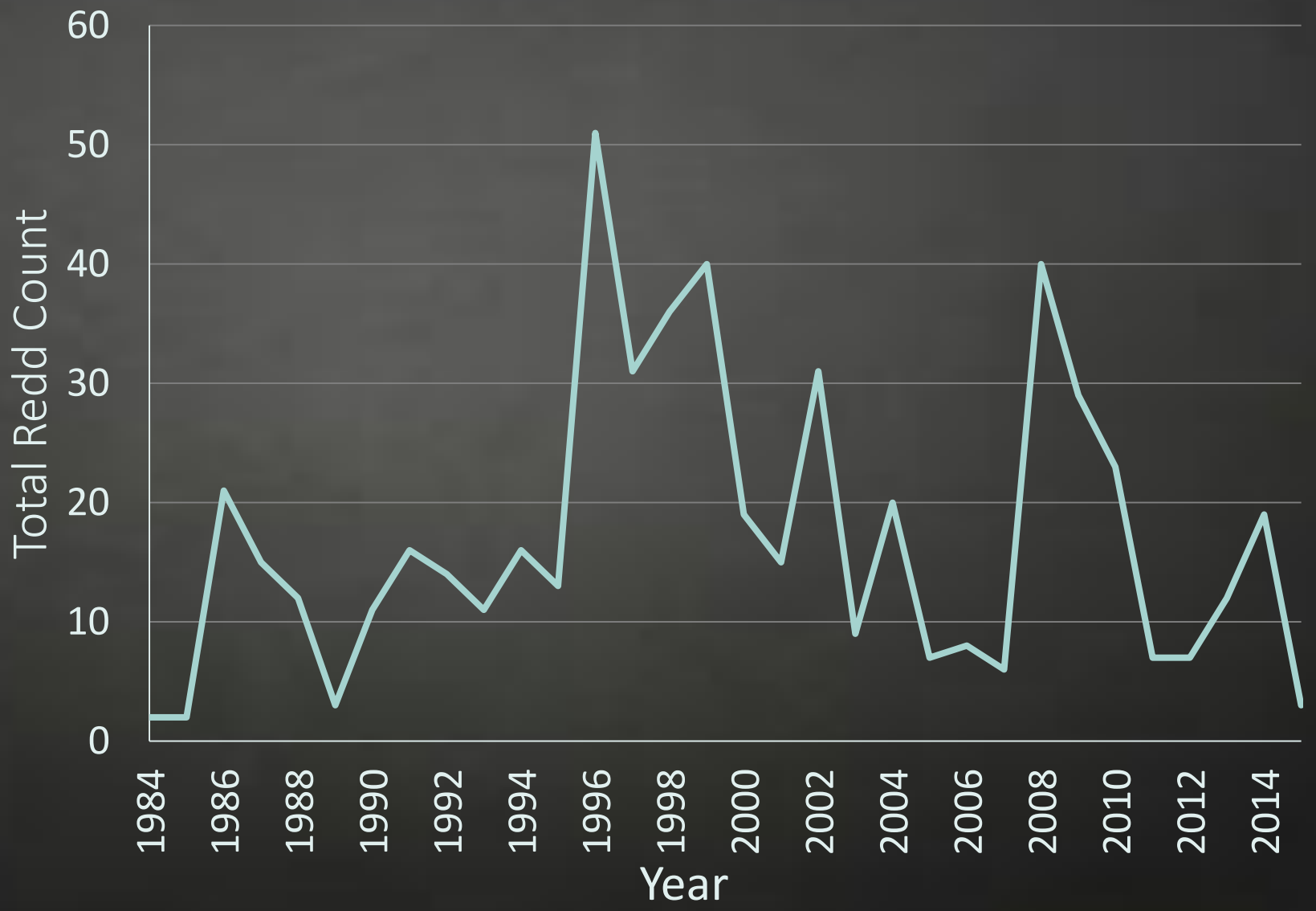
# I-90: Integrating Stewardship into the Highway Design

# Gold Creek

- 3rd order tributary in Cascade Mountains
- Spawning & rearing for adfluvial bull trout population
- Historic developments include old growth timber harvest, mining & land development
- Dewatering in lower reaches almost annually
- Keechelus Lake Dam completed in 1917 on lower end of this once natural lake



# Population Monitoring for Gold Creek



# Previous Research

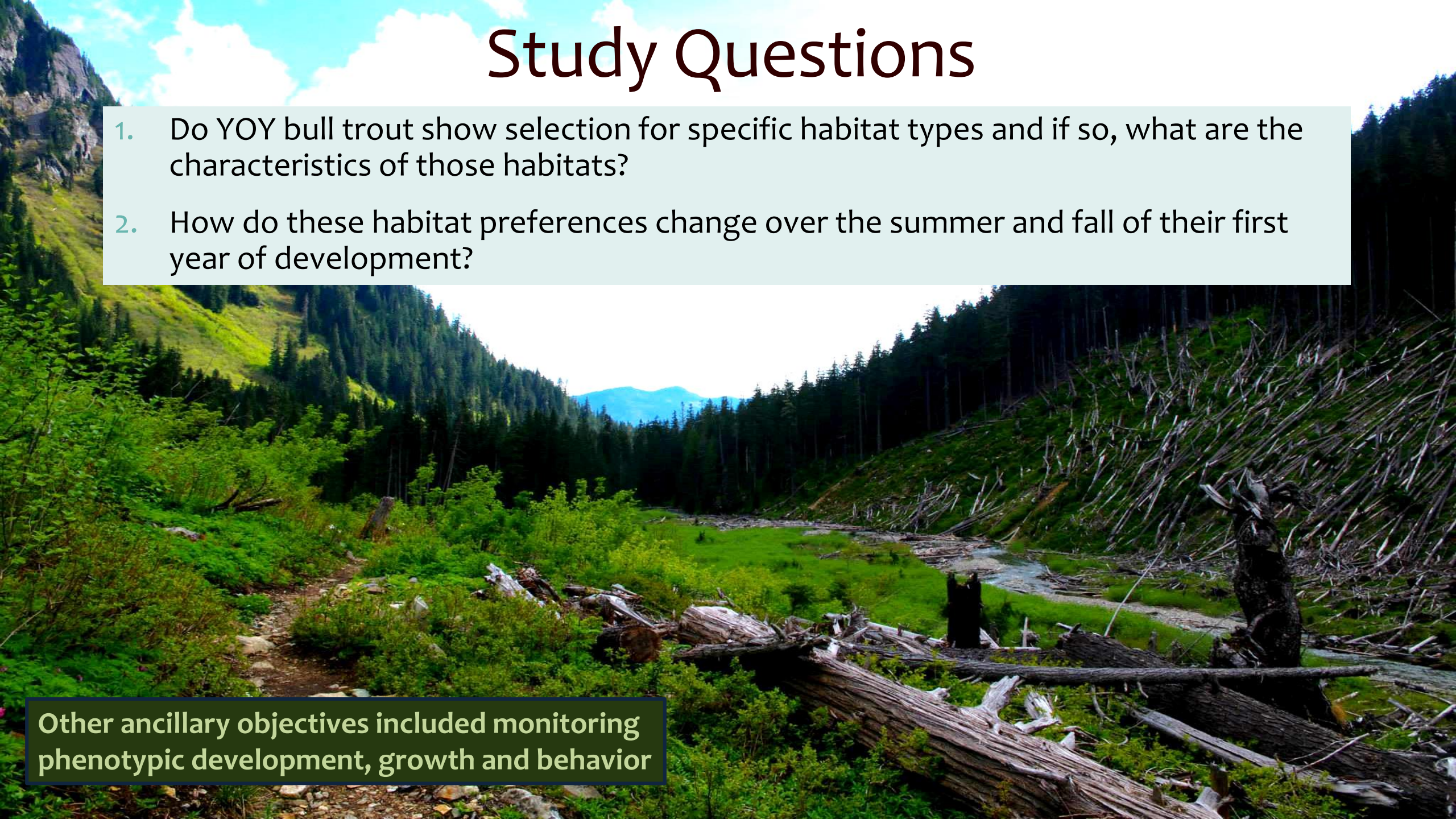
- Previous studies focused on adult/juvenile bull trout habitat
- Only a few studies collected data on YOY (1st year of development)
- Habitat partitioning between YOY and older juvenile bull trout *(Polacek 1998)*
- Previous studies:
  - Lumped YOY in with older age classes in their analysis
  - Small Sample Sizes
  - Considered habitat used but not habitat available

# Young-of-the-year (YOY) bull trout

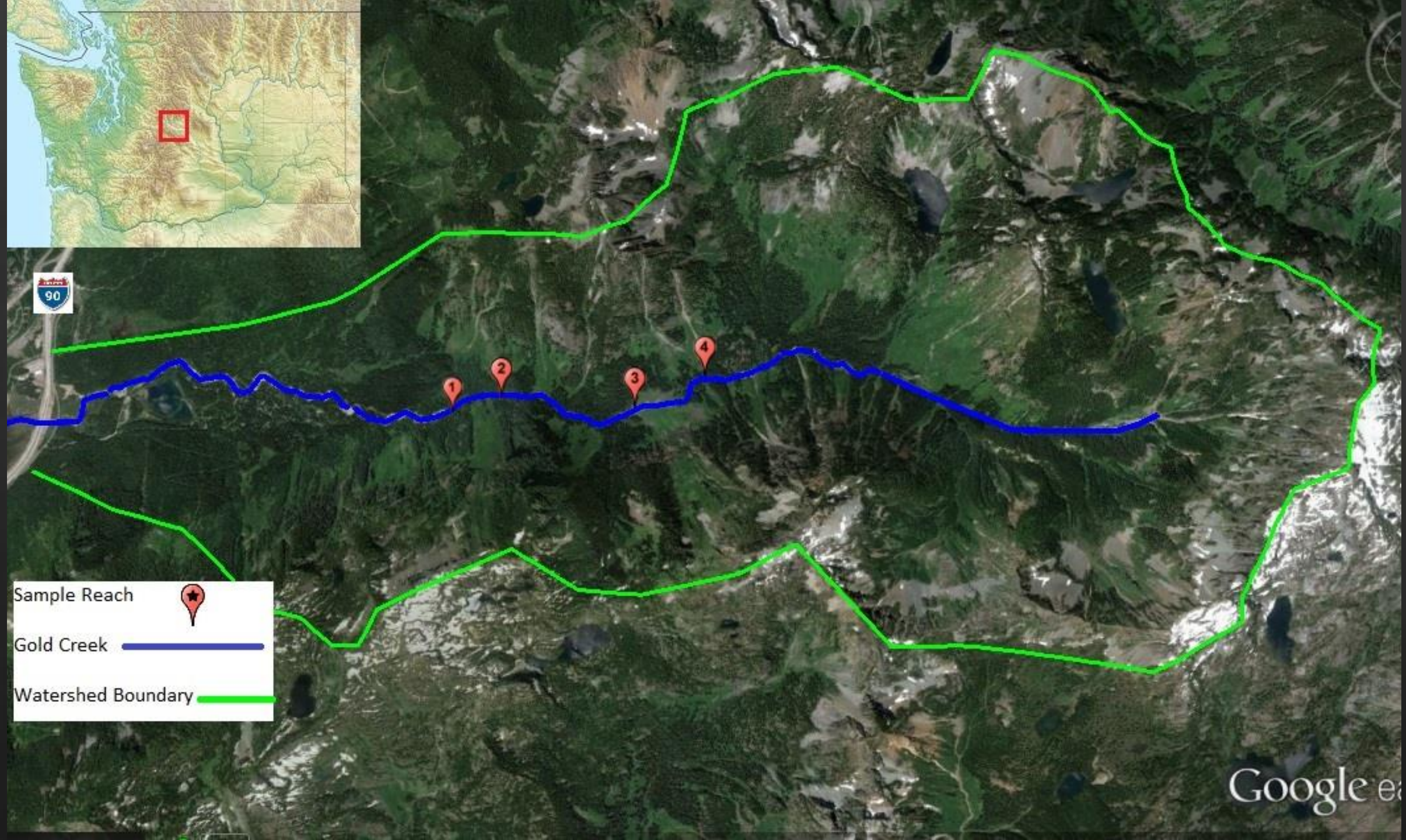
- Limited ability to swim, energetic costs of moving and threat of decreased food or elevated predation rates with dispersal
- Limited rearing habitat referred to as possible "ecological bottleneck" (*McPhail and Murray 1979*)

# Study Questions

1. Do YOY bull trout show selection for specific habitat types and if so, what are the characteristics of those habitats?
2. How do these habitat preferences change over the summer and fall of their first year of development?



**Other ancillary objectives included monitoring phenotypic development, growth and behavior**


90
1
2
3
4
Sample Reach
Gold Creek
Watershed Boundary
Google

# Microhabitat Data Collection


- Microhabitat use surveys at night 2x each month in four study reaches from June-November
- Microhabitat availability surveys for summer and fall


## Also Collected:

- Total length of fish
- Behavior
- Photographs

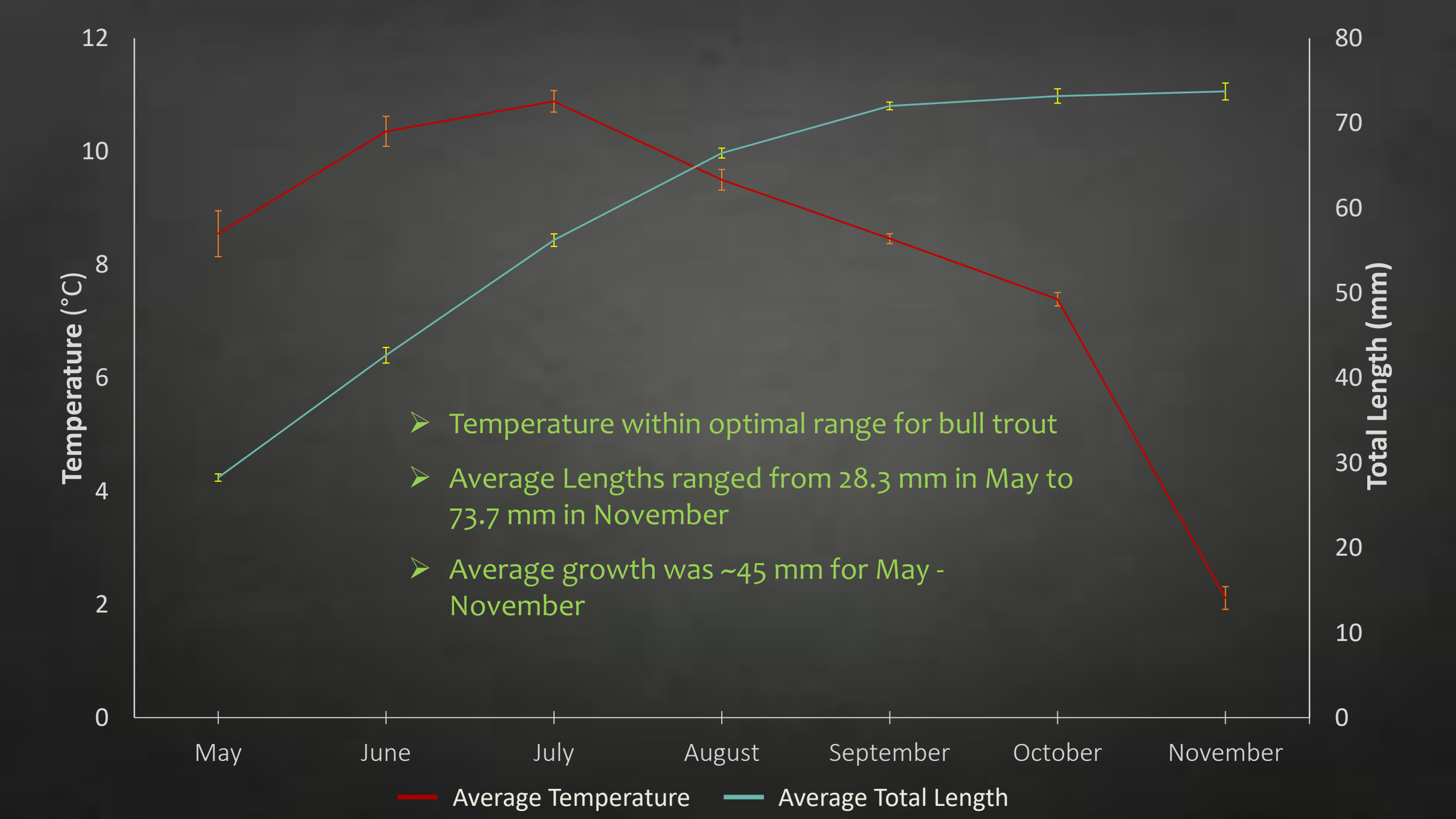

## Microhabitat Predictors

- Focal point temperature
- Focal point velocity
- Water depth
- Distance to shore
- Substrate Type and embeddedness
- Fish cover

# RESULTS

# Emergence Timing

- YOY first observed on 28 April 2015
- YOY were found ~7 months after redd construction


12
10
8
6
4
2
0
Temperature (°C)
80
70
60
50
40
30
20
10
0
Total Length (mm)
May
June
July
August
September
October
November
Temperature within optimal range for bull trout
Average Lengths ranged from 28.3 mm in May to 73.7 mm in November
Average growth was ~45 mm for May - November
Average Temperature
Average Total Length

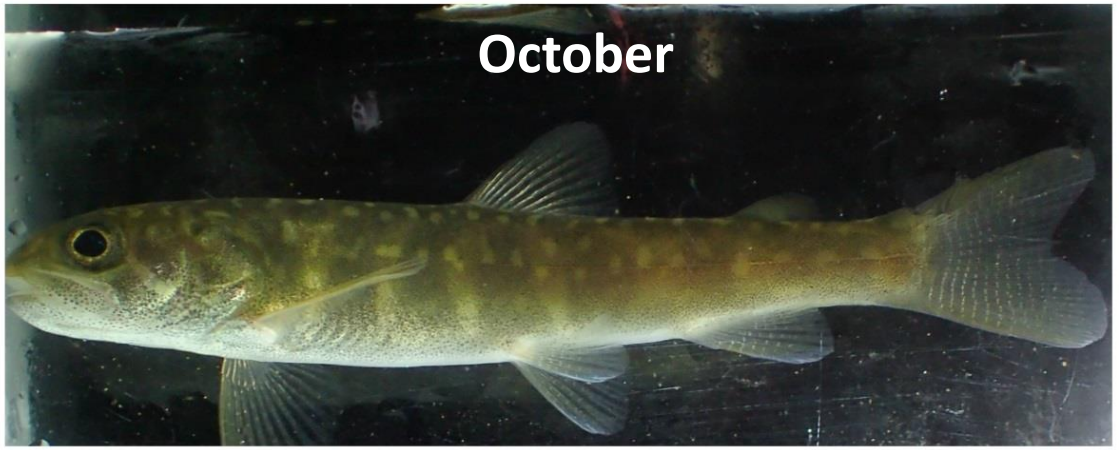

May

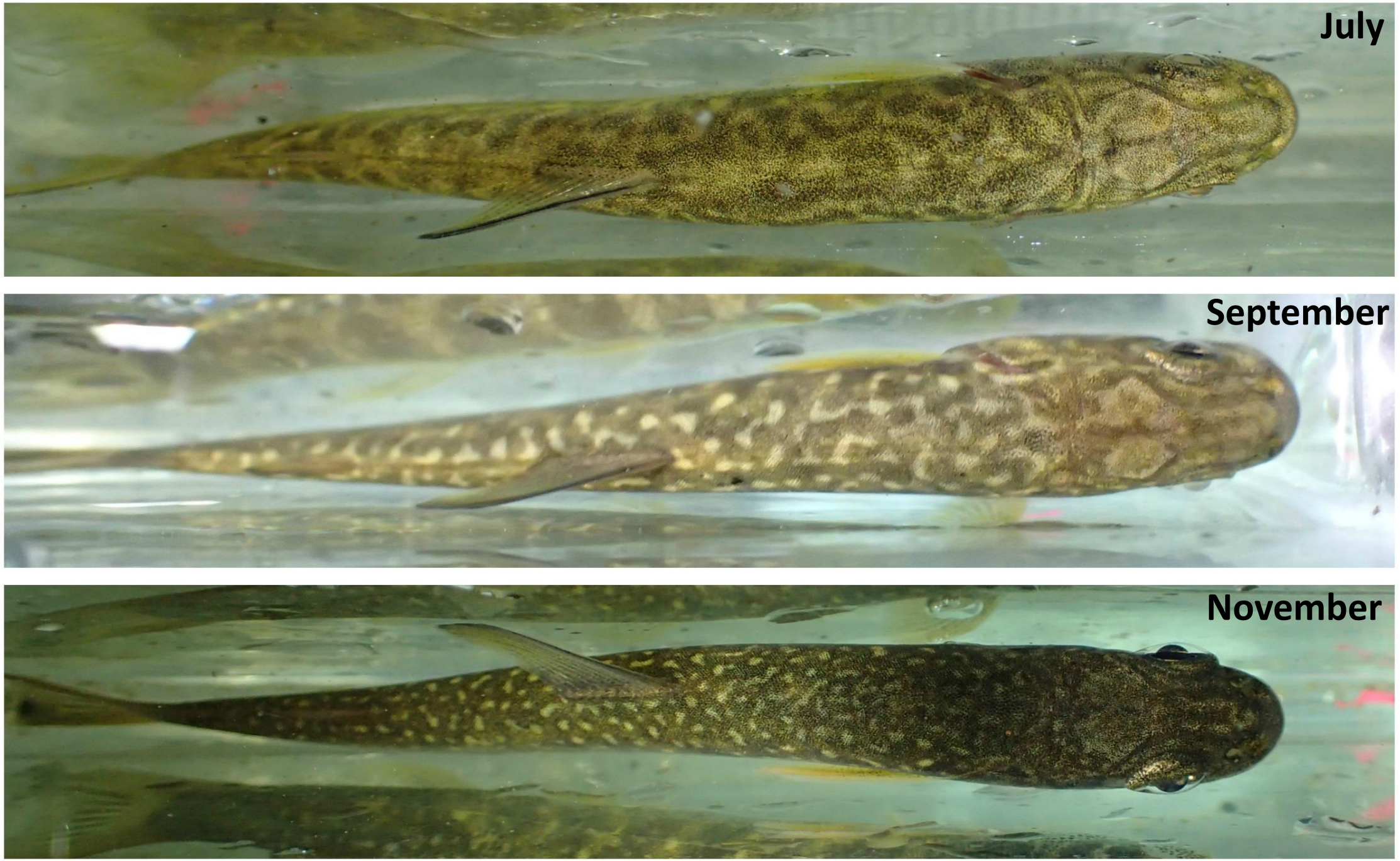

June


July


August


September


October

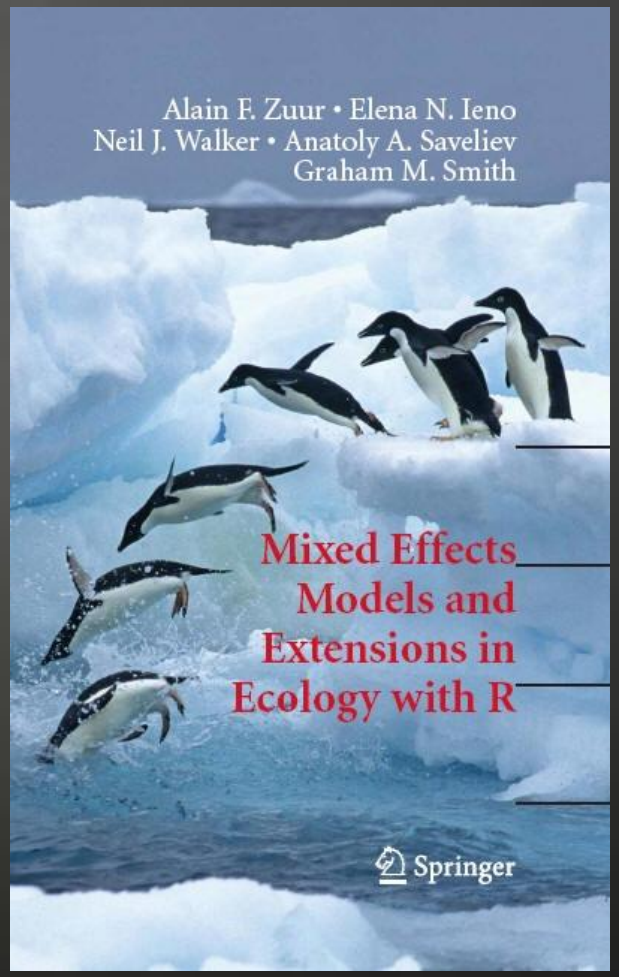

July
September
November

# Behavioral Observations

- Early on YOY were located by moving individual pieces of substrate
- From ~mid-June on, YOY mostly found out from cover
- Always in close association with stream bottom
- Rarely observed actively swimming around unlike cutthroat YOY
- YOY occupied a focal position which they would return to after being disturbed

# Generalized Linear Mixed Modeling

- Very useful for modeling selection in ecological studies
- Multiple predictor variables and interaction terms

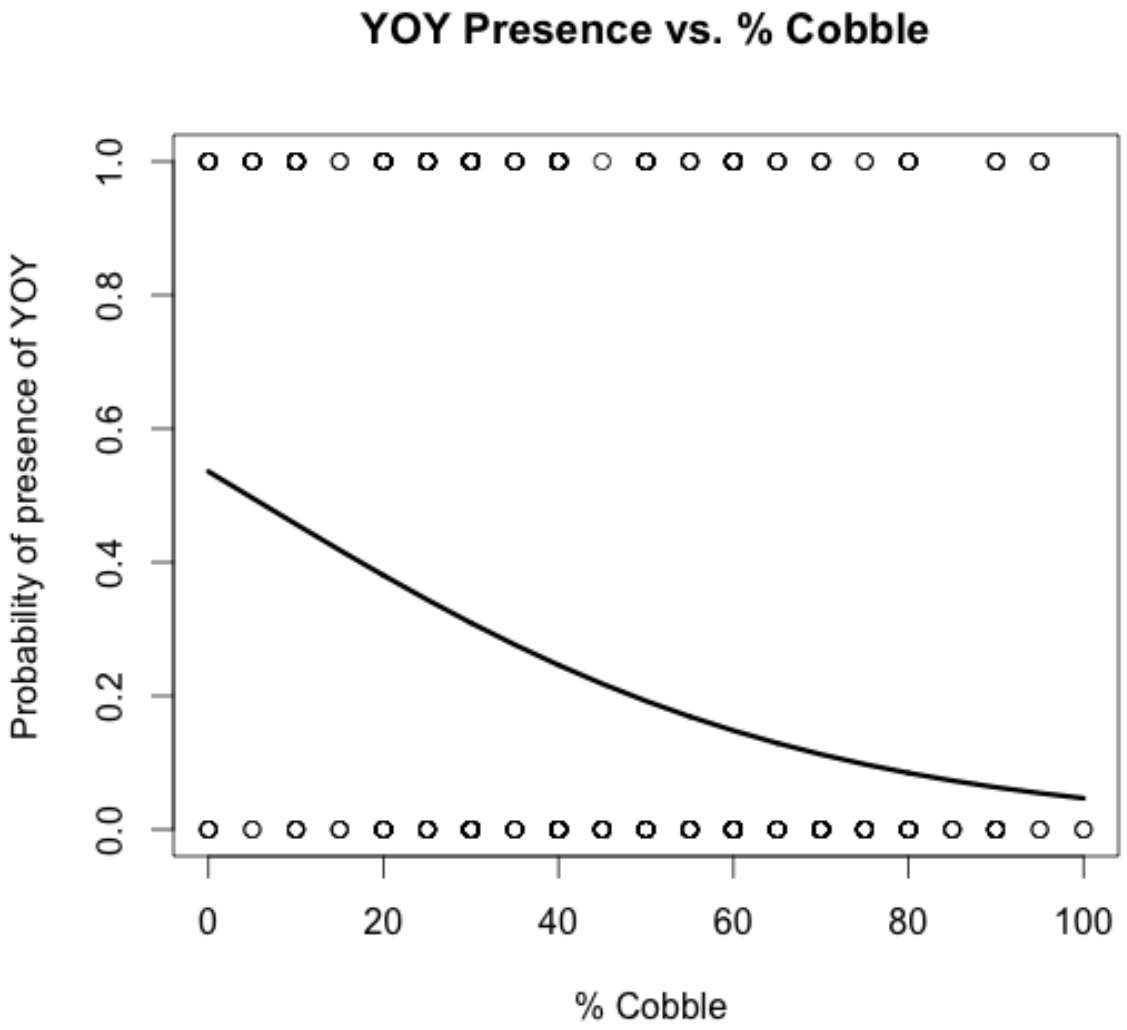


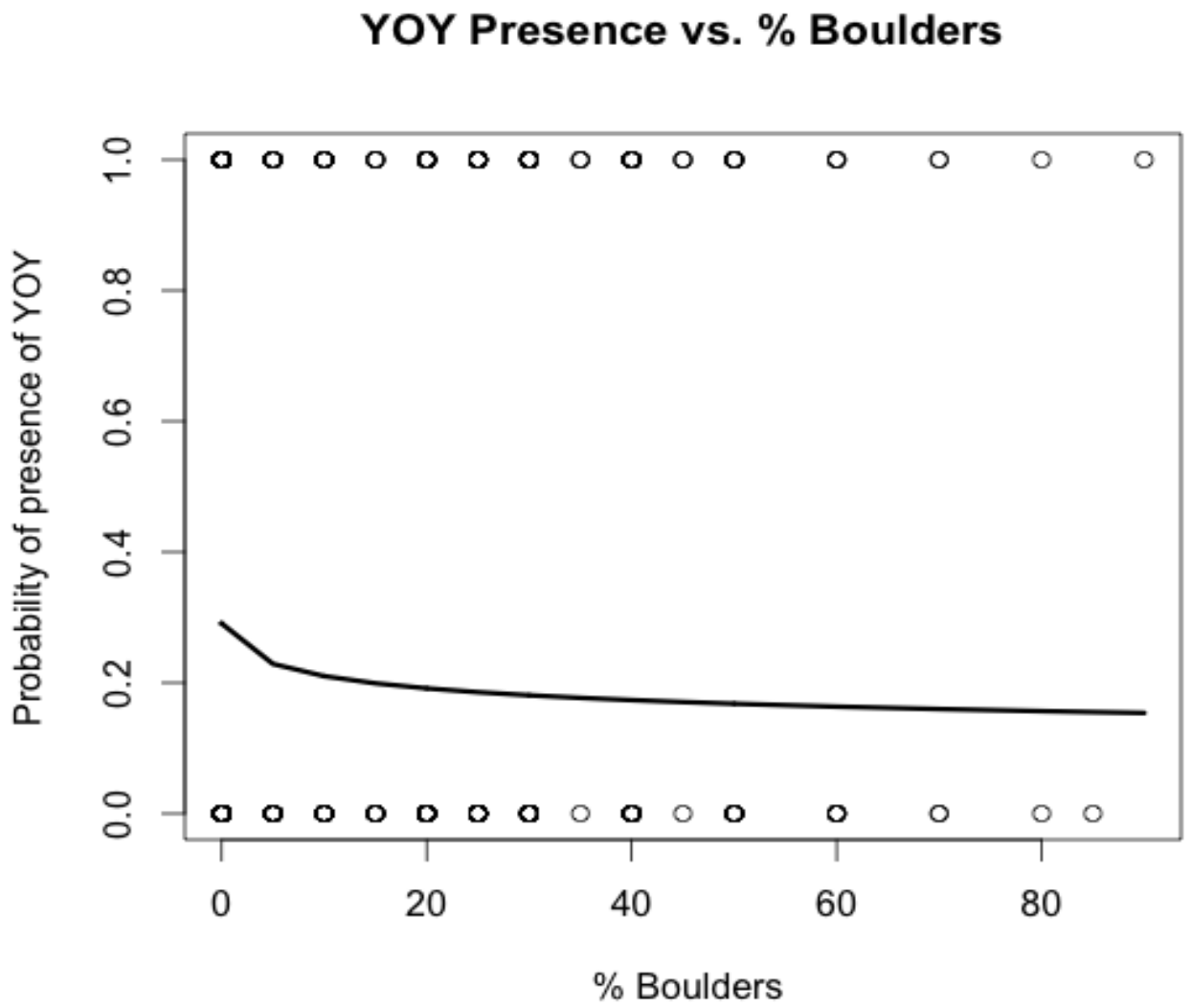
# GLMM Results

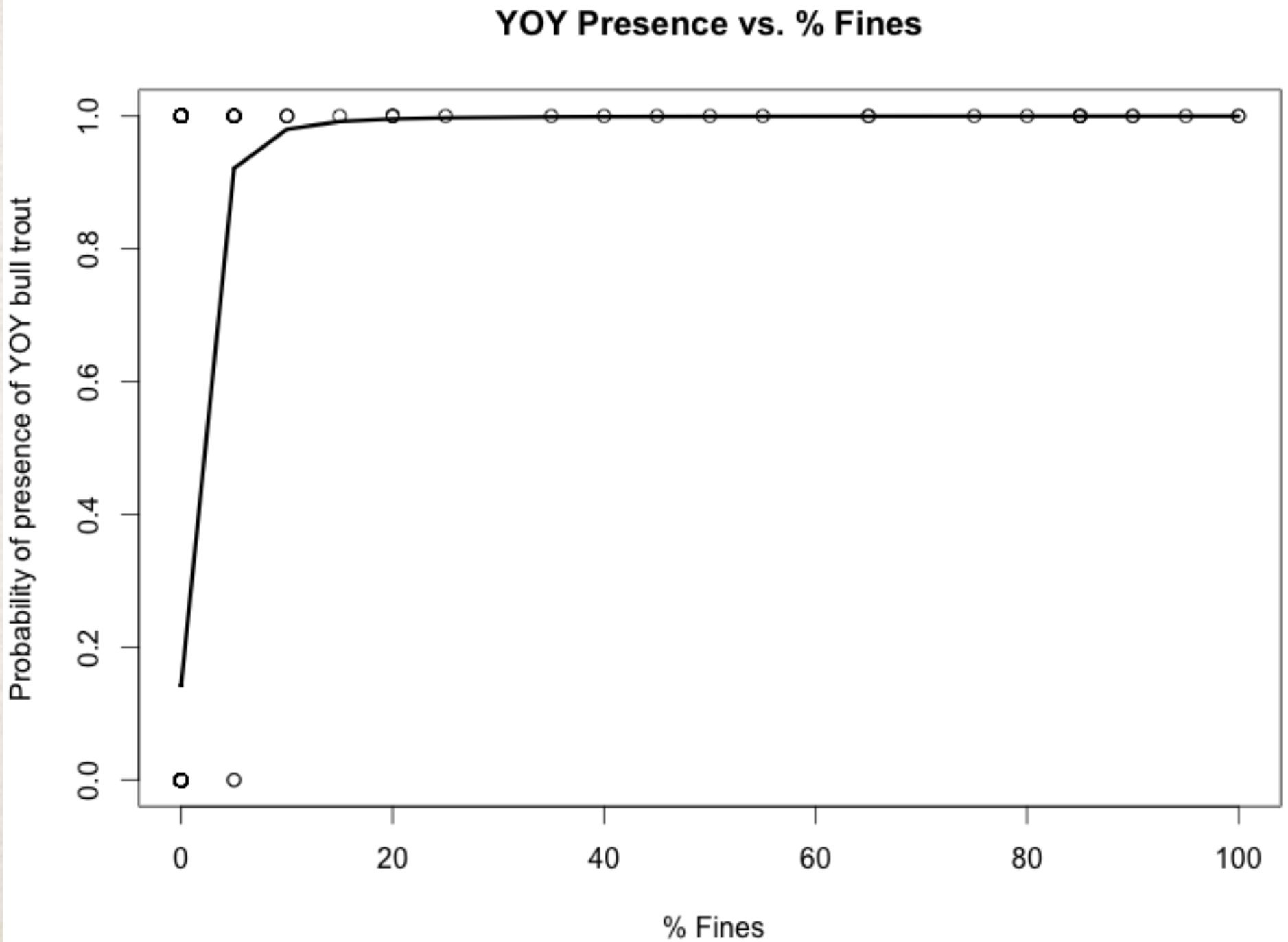
Habitat predictors retained in the final GLMM predicting probability of YOY bull trout presence

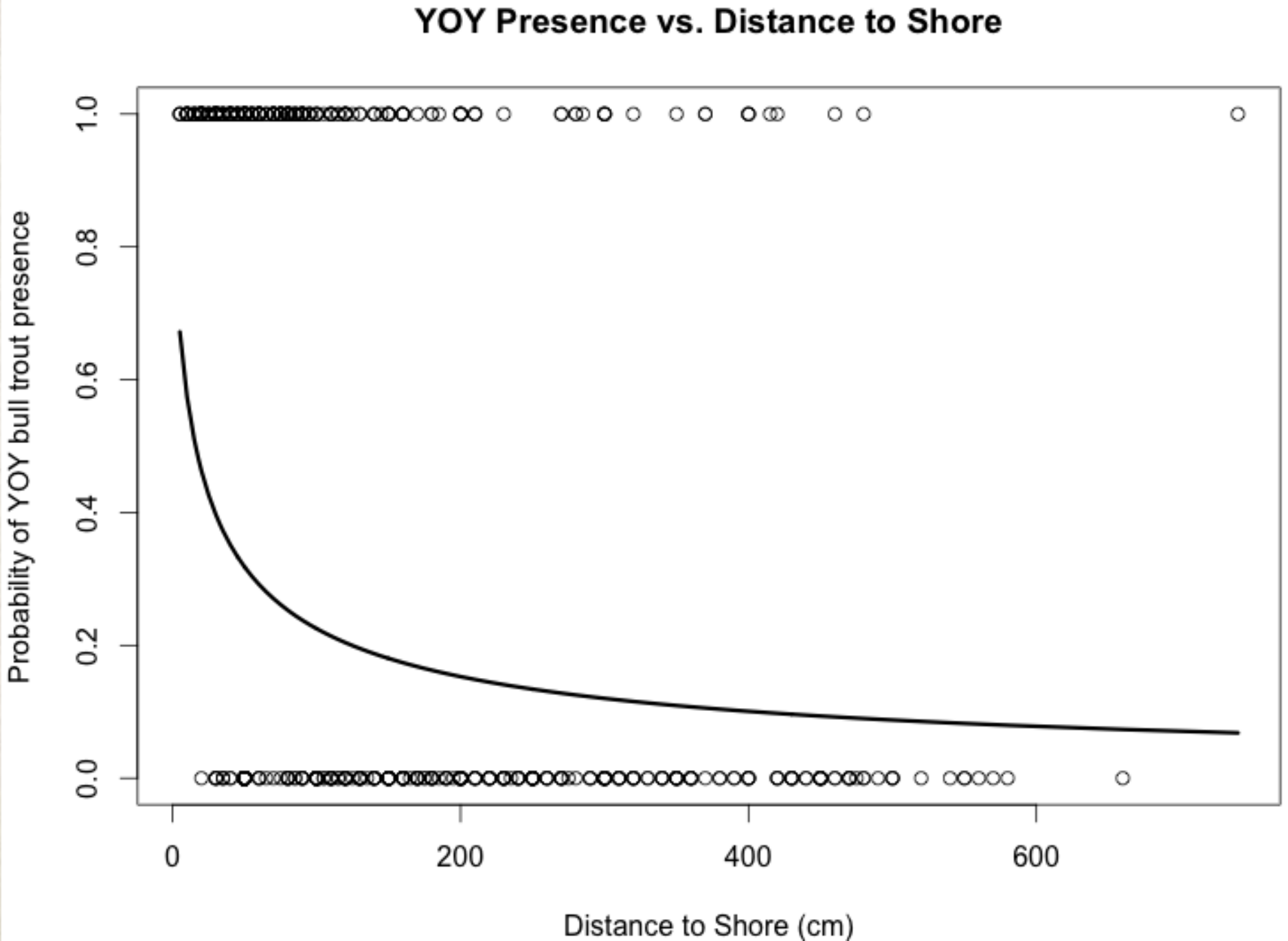
| Parameter | Estimate | SE | z | p-value | Signif. Level |
|---|---|---|---|---|---|
| Intercept | -1.2474 | 0.2632 | -4.74 | 2.13E-06 | *** |
| Velocity | -2.6757 | 0.3859 | -6.933 | 4.12E-12 | *** |
| Distance to Shore | -0.6504 | 0.1463 | -4.446 | 8.74E-06 | *** |
| Percent Fines | 2.0646 | 0.6273 | 3.291 | 0.000997 | *** |
| Percent Cobbles | -0.7407 | 0.1381 | -5.364 | 8.13E-08 | *** |
| Percent Boulders | -0.2822 | 0.1245 | -2.267 | 0.023421 | * |
| Summer Season | 0.6855 | 0.2438 | 2.812 | 0.004929 | ** |
| Depth in Summer | -1.2877 | 0.3088 | -3.544 | 0.000393 | *** |
| Depth in Fall | -0.1931 | 0.2082 | -0.927 | 0.353716 | |

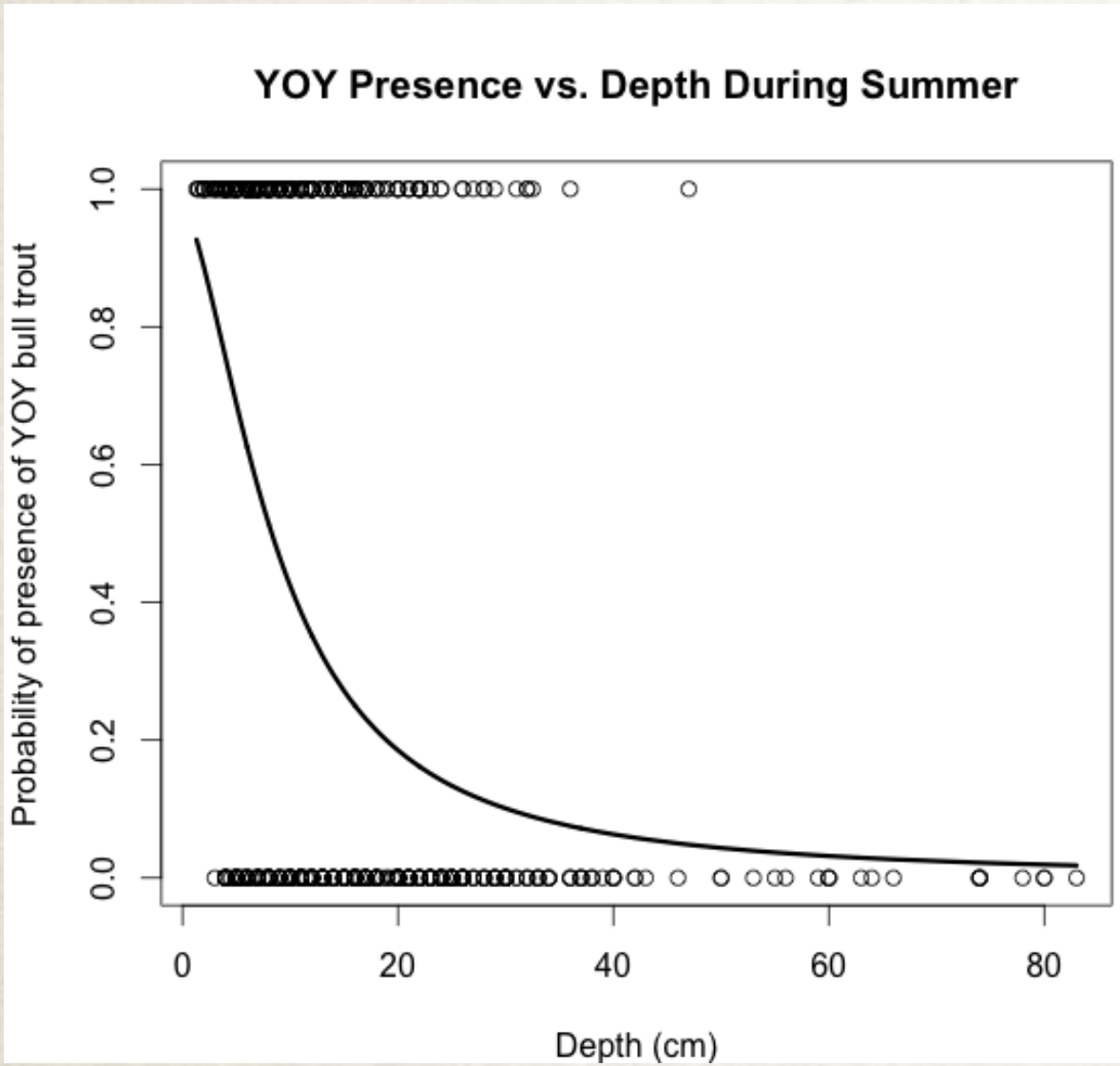
**Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1**

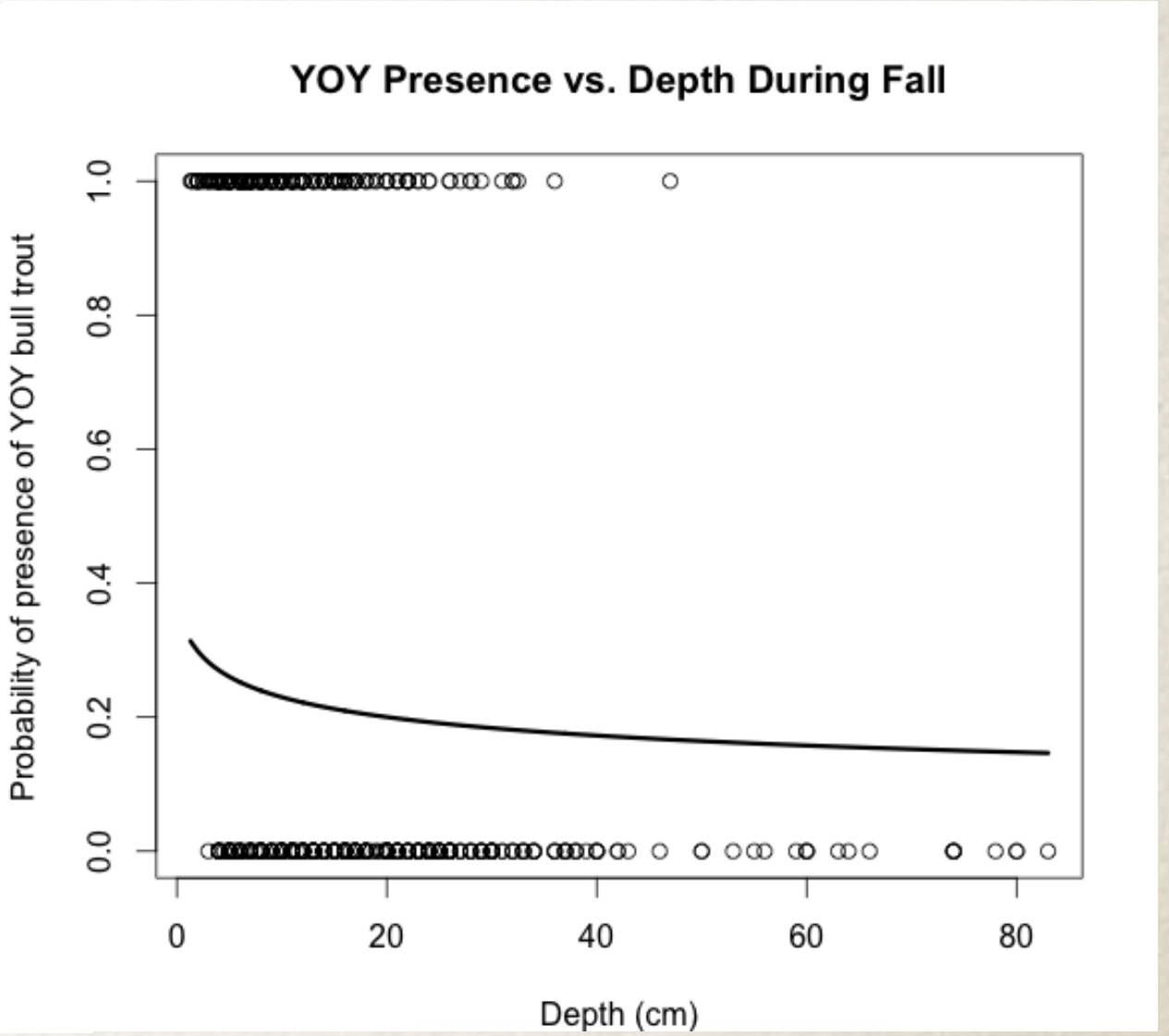

YOY Presence vs. % Cobble
Probability of presence of YOY
0.0
0.2
0.4
0.6
0.8
1.0
0
20
40
60
80
100
% Cobble

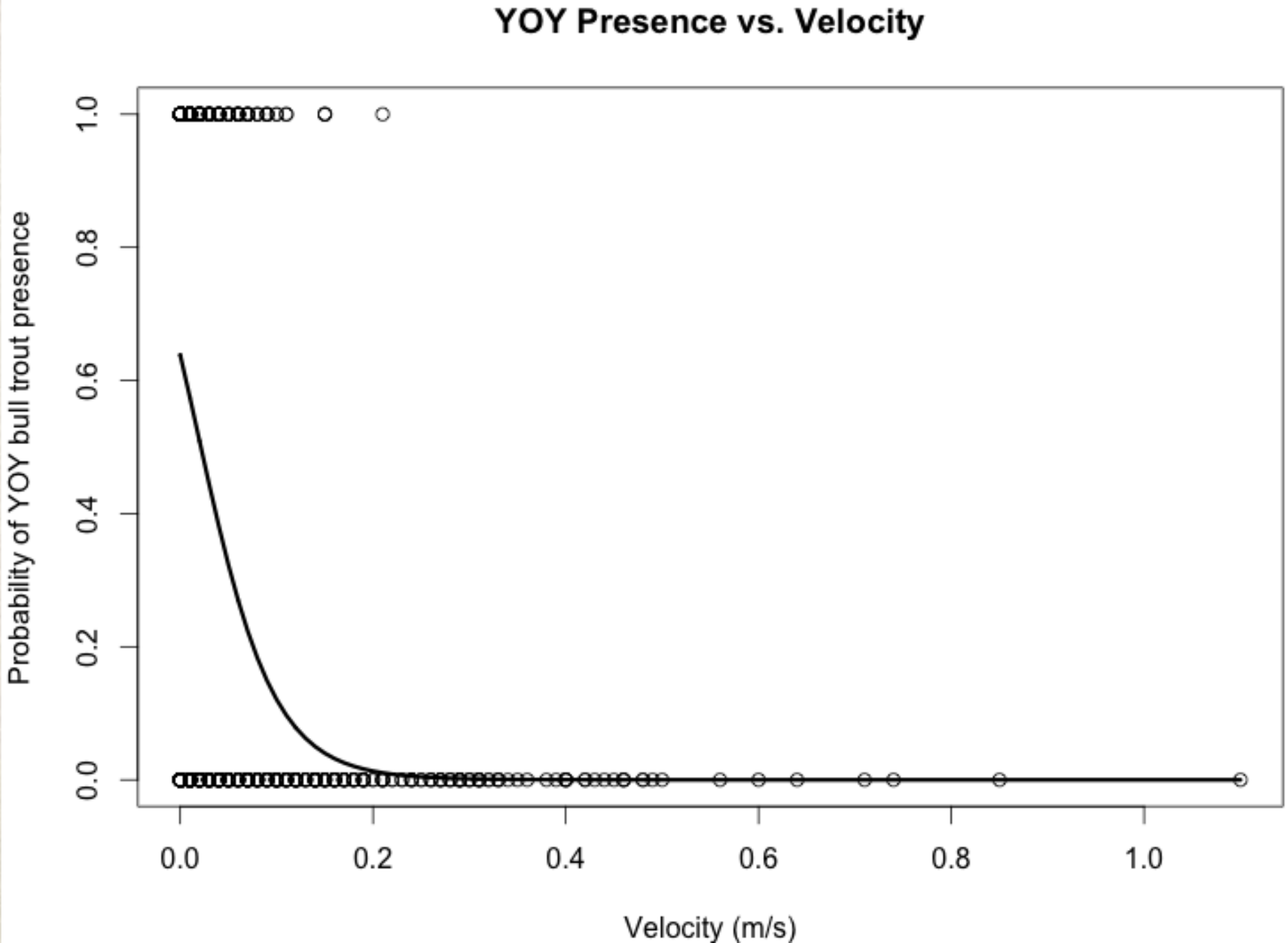

YOY Presence vs. % Boulders
Probability of presence of YOY
0.0
0.2
0.4
0.6
0.8
1.0
0
20
40
60
80
% Boulders


YOY Presence vs. % Fines
Probability of presence of YOY bull trout
0.0
0.2
0.4
0.6
0.8
1.0
0
20
40
60
80
100
% Fines


YOY Presence vs. Distance to Shore
Probability of YOY bull trout presence
0.0
0.2
0.4
0.6
0.8
1.0
0
200
400
600
Distance to Shore (cm)


YOY Presence vs. Depth During Summer
Probability of presence of YOY bull trout
0.0
0.2
0.4
0.6
0.8
1.0
0
20
40
60
80
Depth (cm)


YOY Presence vs. Depth During Fall
Probability of presence of YOY bull trout
0.0
0.2
0.4
0.6
0.8
1.0
0
20
40
60
80
Depth (cm)


YOY Presence vs. Velocity
Probability of YOY bull trout presence
0.0
0.2
0.4
0.6
0.8
1.0
0.0
0.2
0.4
0.6
0.8
1.0
Velocity (m/s)

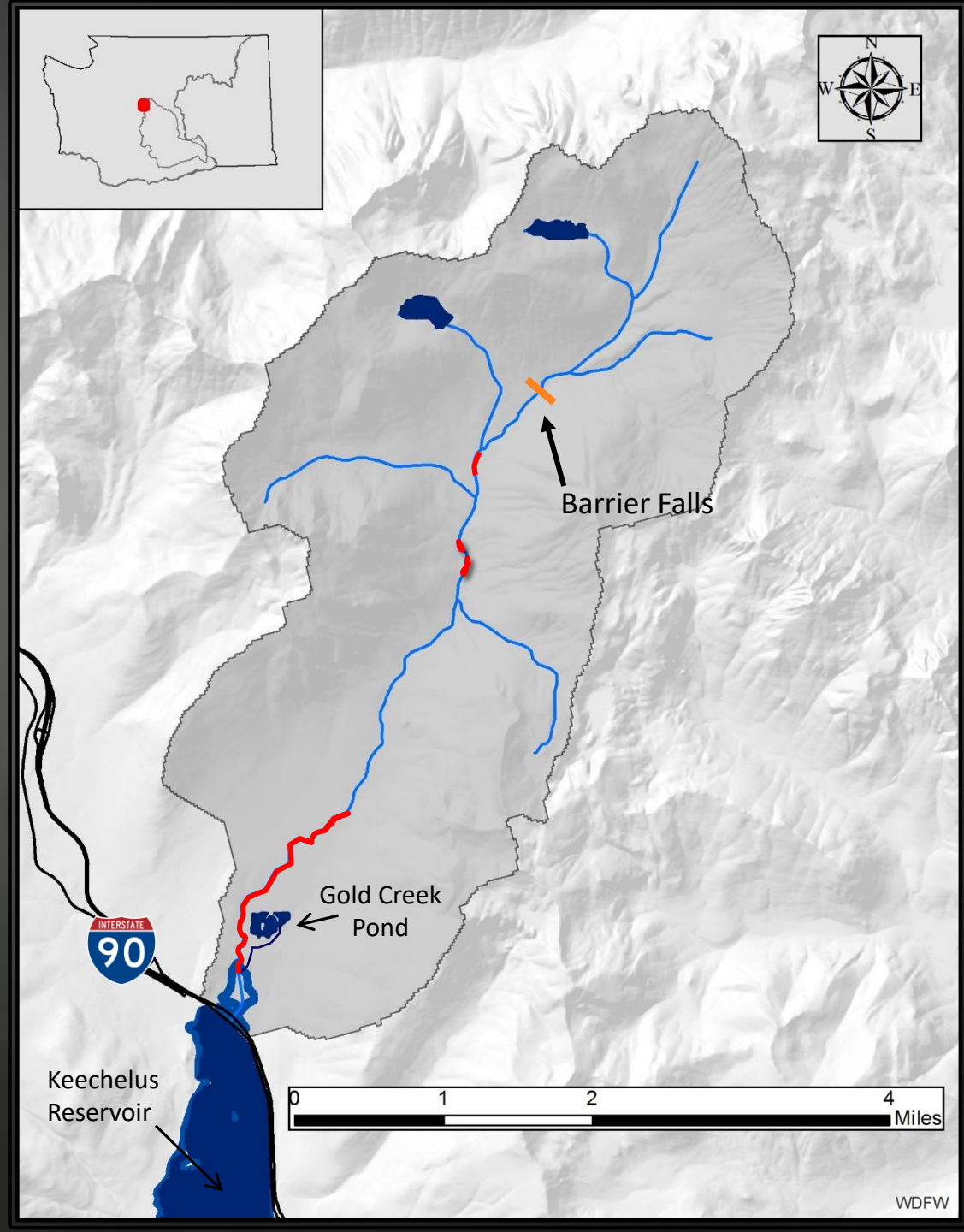
# Microhabitat Results Summarized

- Velocity and depth most important
- Evading flows
- Selection may also result from
- Habitat partitioning
  - Age-classes
  - Species

Selection makes YOY vulnerable to low summer flows

# Dewatering in Gold Creek

- Out of ~9.2 km of available rearing habitat, 3.2 km was dewatered in 2015
- Dewatering much more extensive than most years
- Observed YOY entrapped within dewatered areas and within study reaches



# Implications of Selection: Low Flow Events

- Mortality
  - Predation
  - Temperature
  - Stranding

# Management Suggestions

- Consider all age-classes of fish in restoration efforts
- Stabilize perennial flows and restore floodplain areas
- LWD may be useful in terms of facilitating habitat complexity
- Continue to monitor stream temperatures & hydrographs

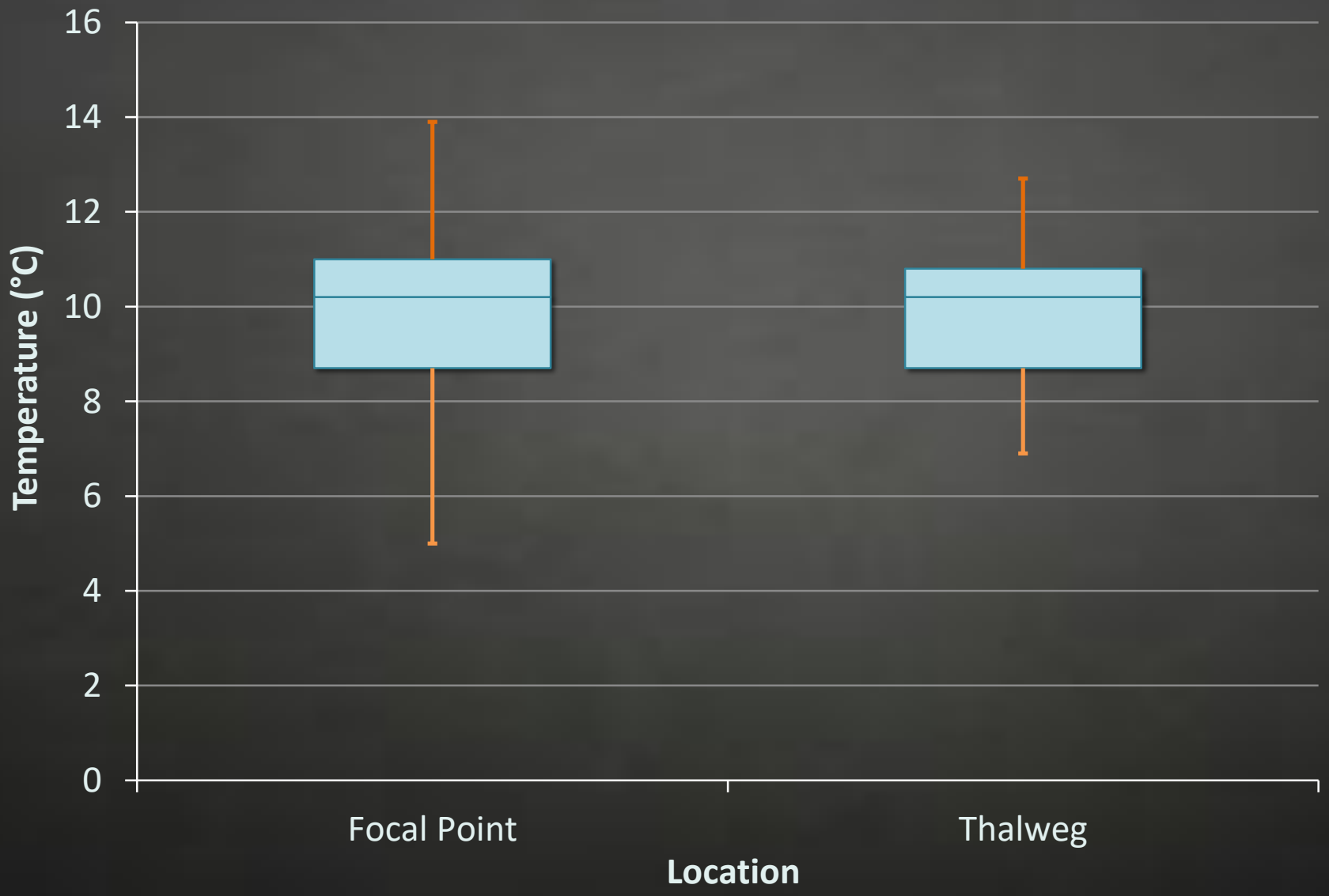
Photo Credit: Joel Sartore/ National Geographic & Wade Fredenberg/ USFWS

# Special Thanks to

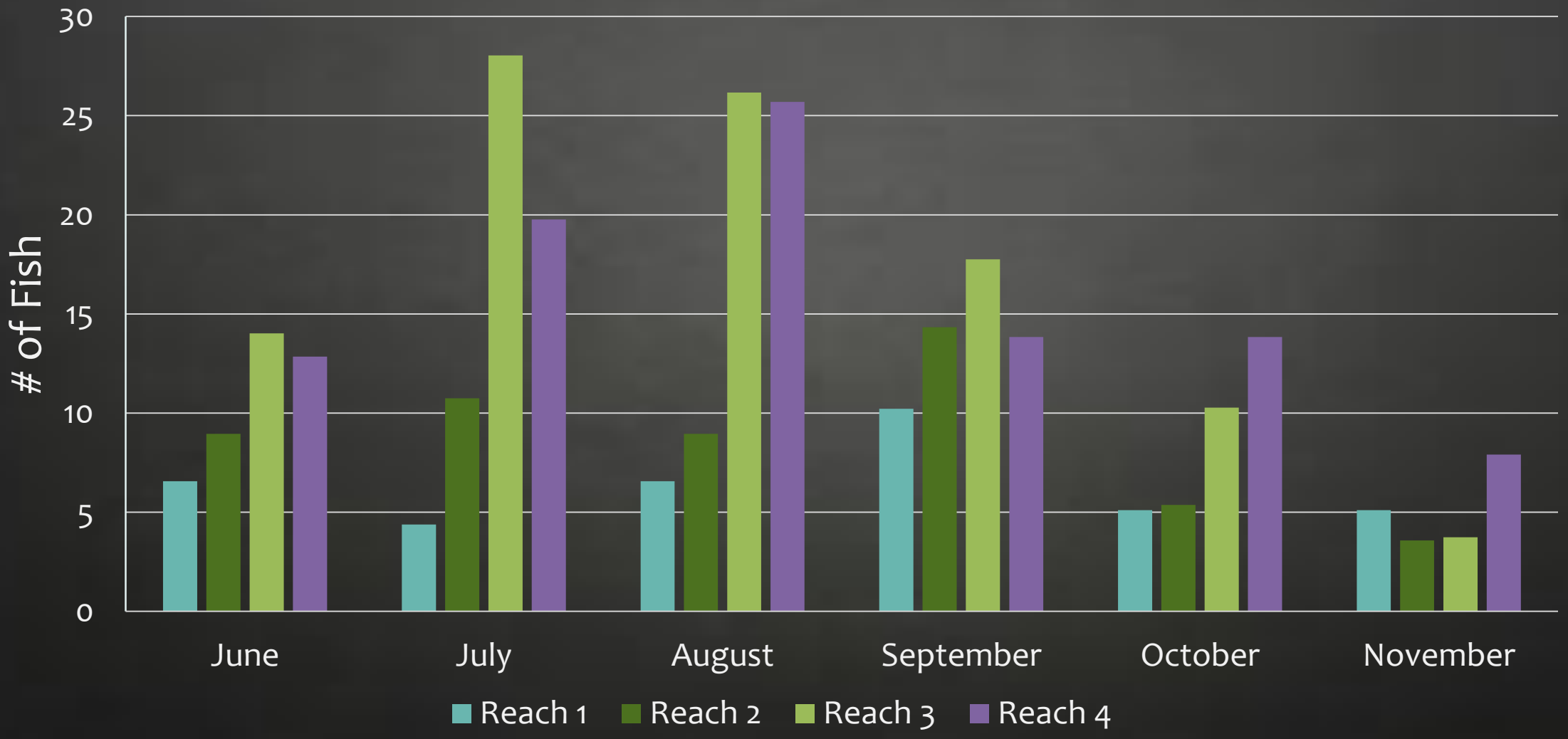

- My committee CWU Professors Paul James (Advisor) and Daniel Beck and WDFW Biologist William Meyer
- Fellow students at CWU and USFWS volunteers for field assistance
- CWU staff for assistance with field equipment
- Washington State Department of Transportation and the School of Graduate Studies at CWU for funding and support
- All partners of the I-90 Project

# Questions?

# Temperature Use



# How does this microhabitat selection correspond with what we see at the reach level?

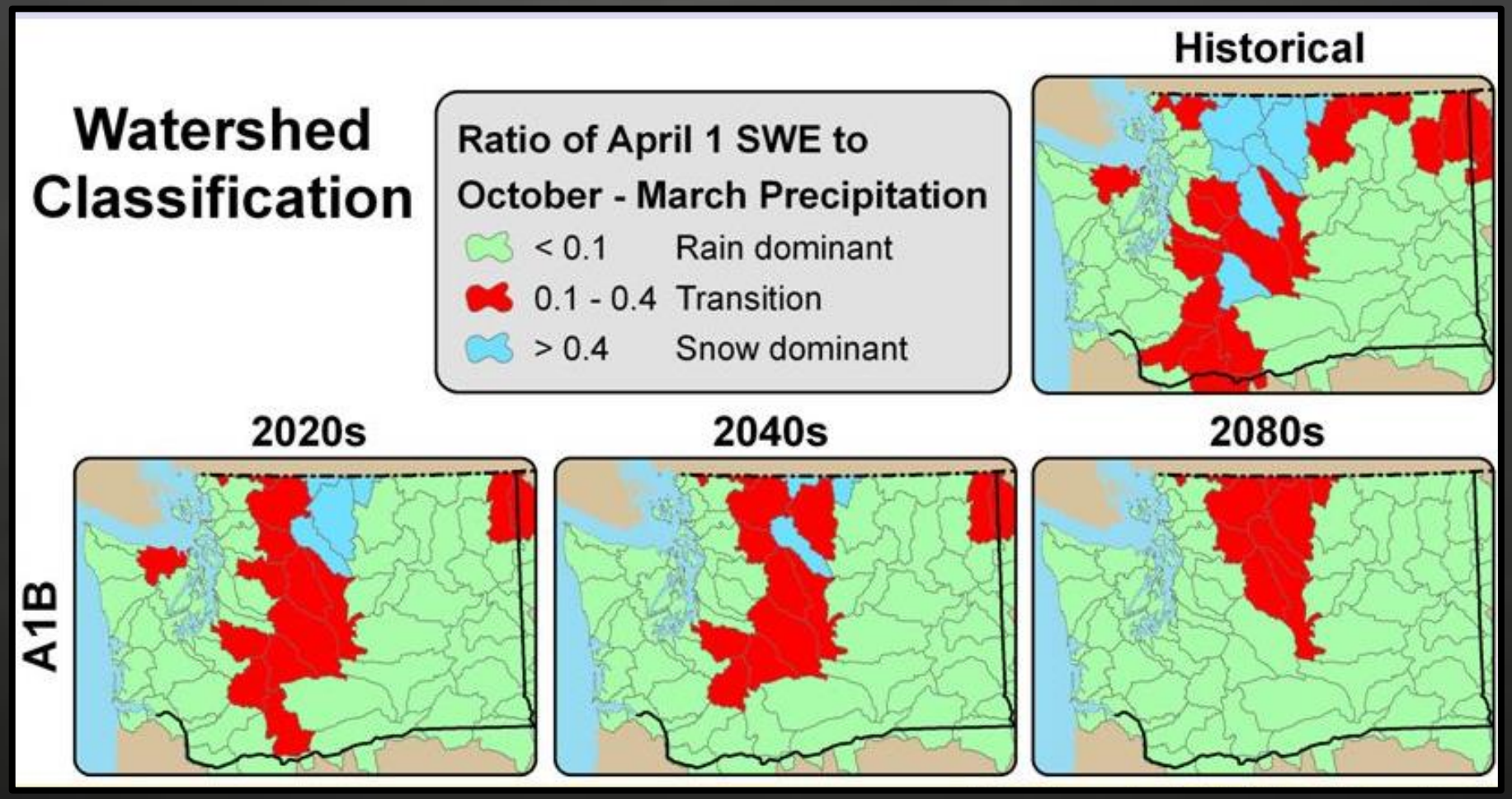



a)
b)
c)
d)

How will their habitat selection affect these fish going forward in a changing climate?

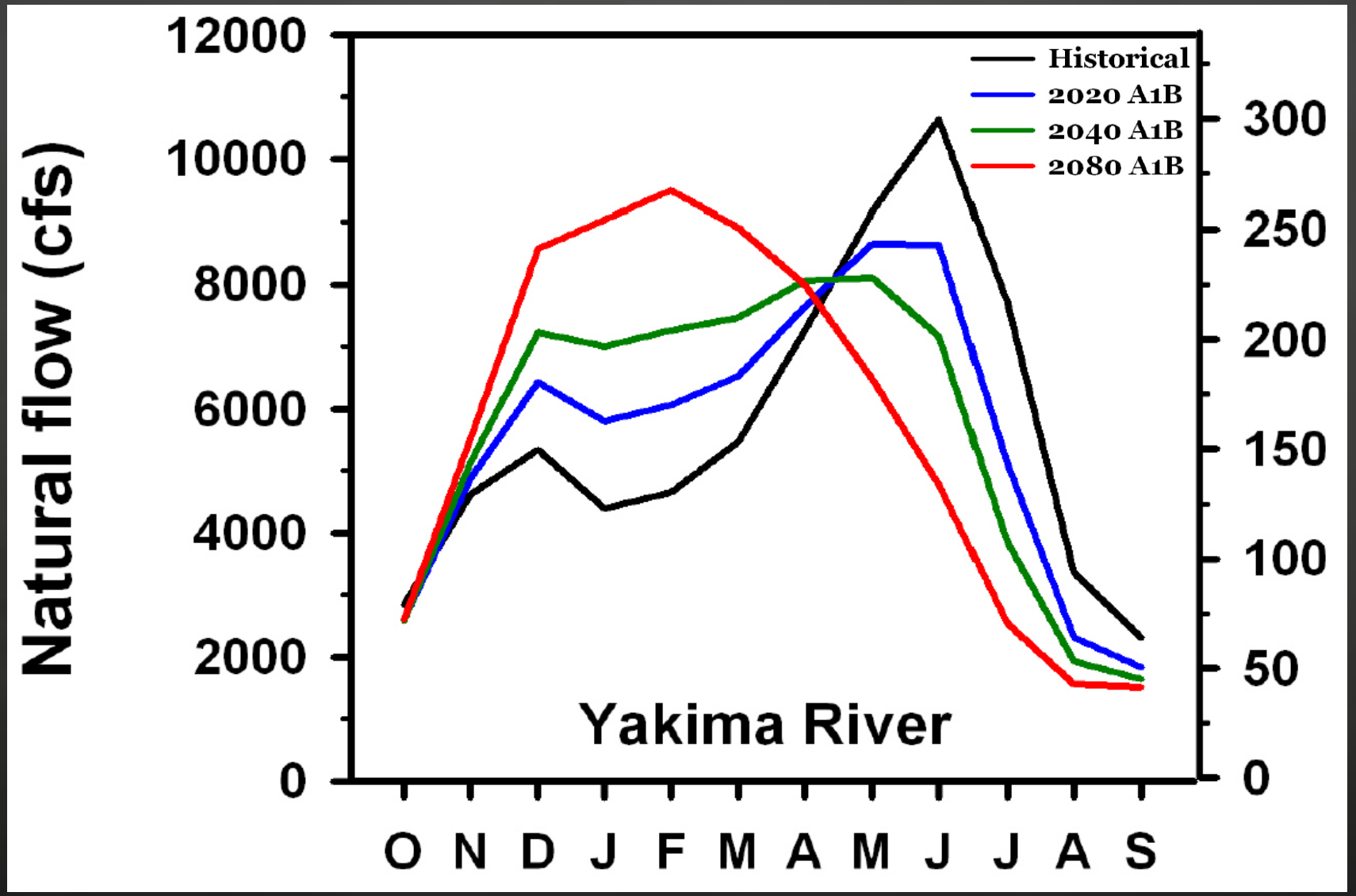
Credit: David Herasimtschuk/Freshwaters Illustrated

# Transition basins are predicted to shift to become rain dominant over time with climate change projections



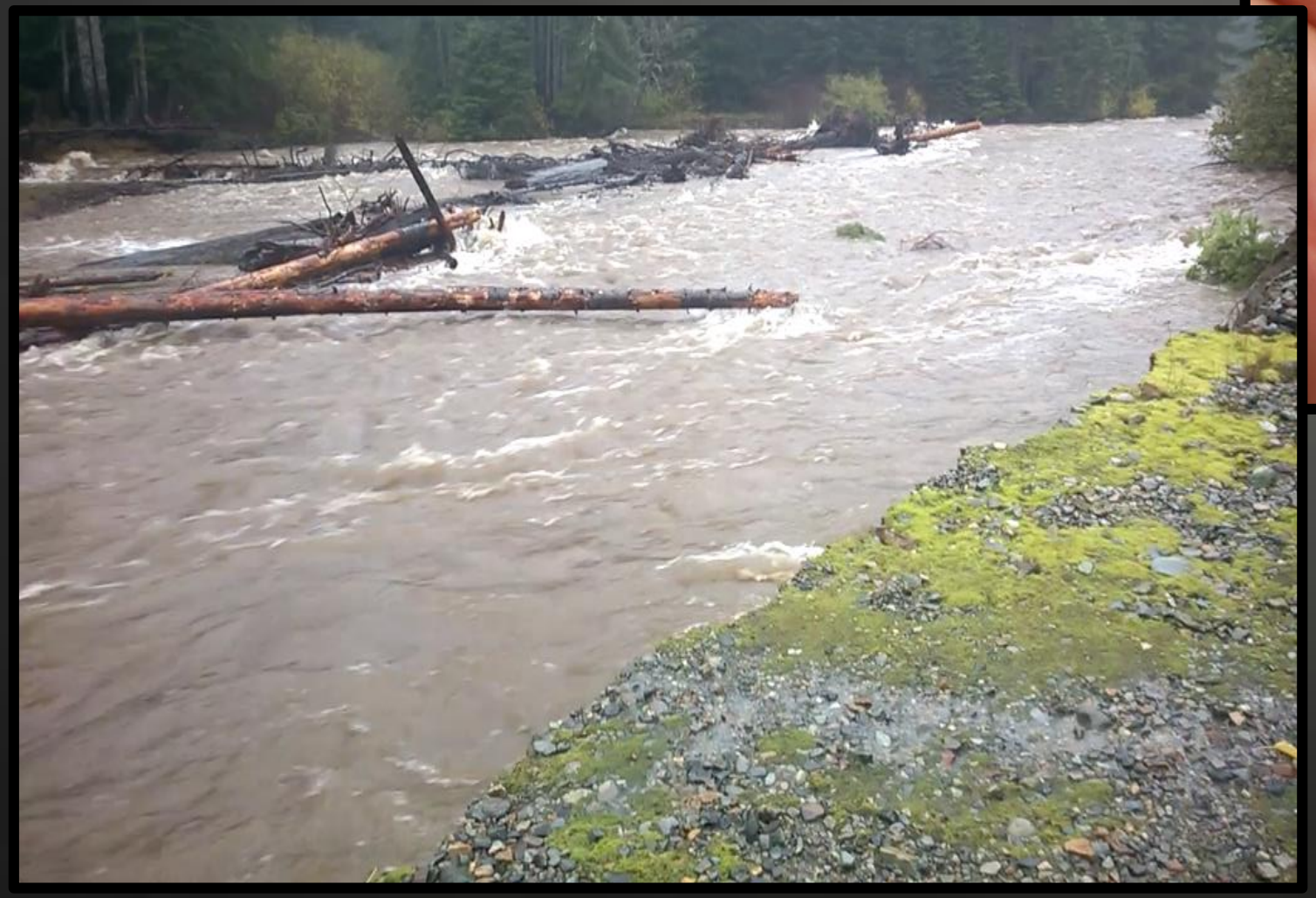

Mantua et al. 2010: Climate Change

As basins change from transition to rainfall dominant with climate warming, the timing of peak streamflows will shift earlier.

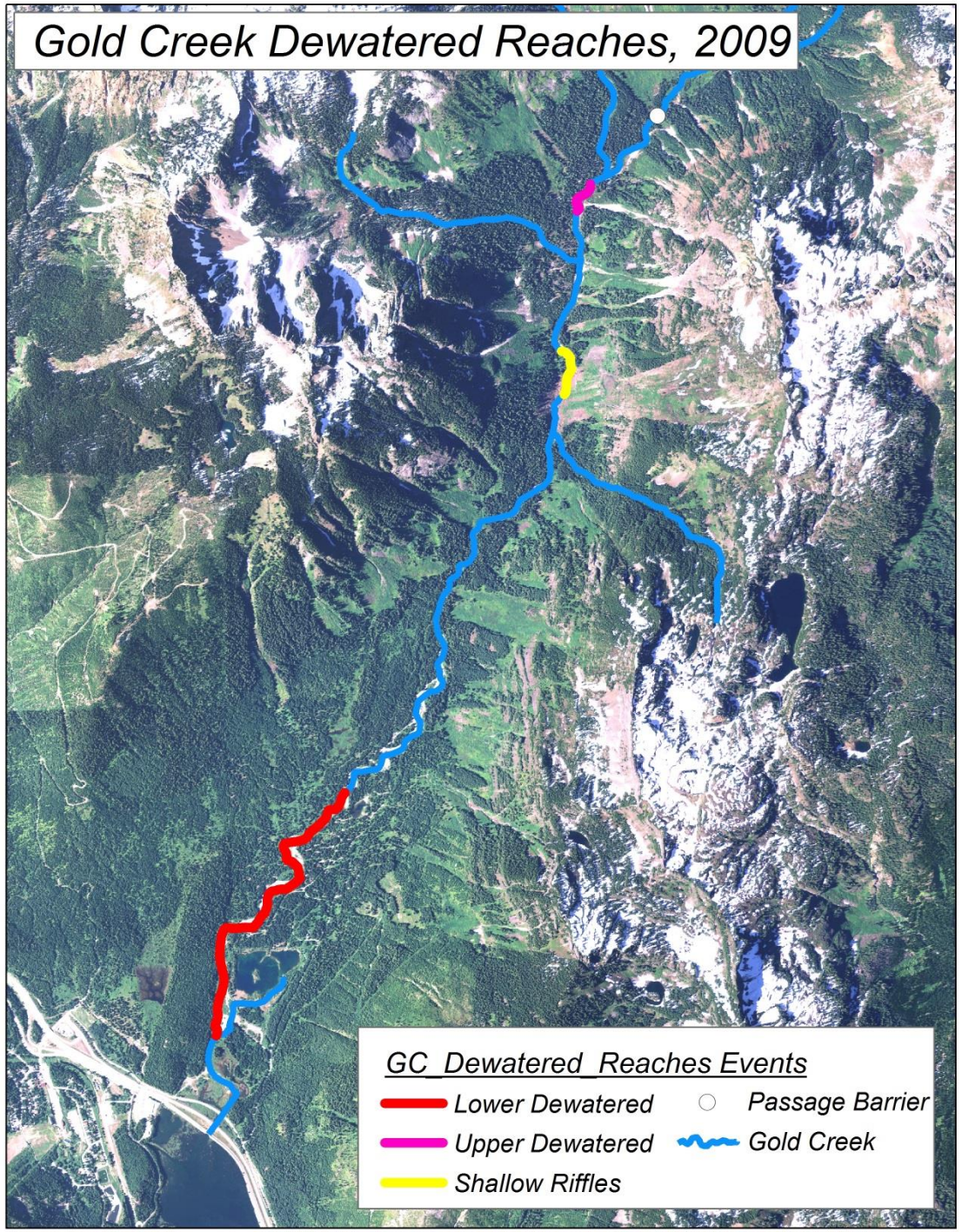


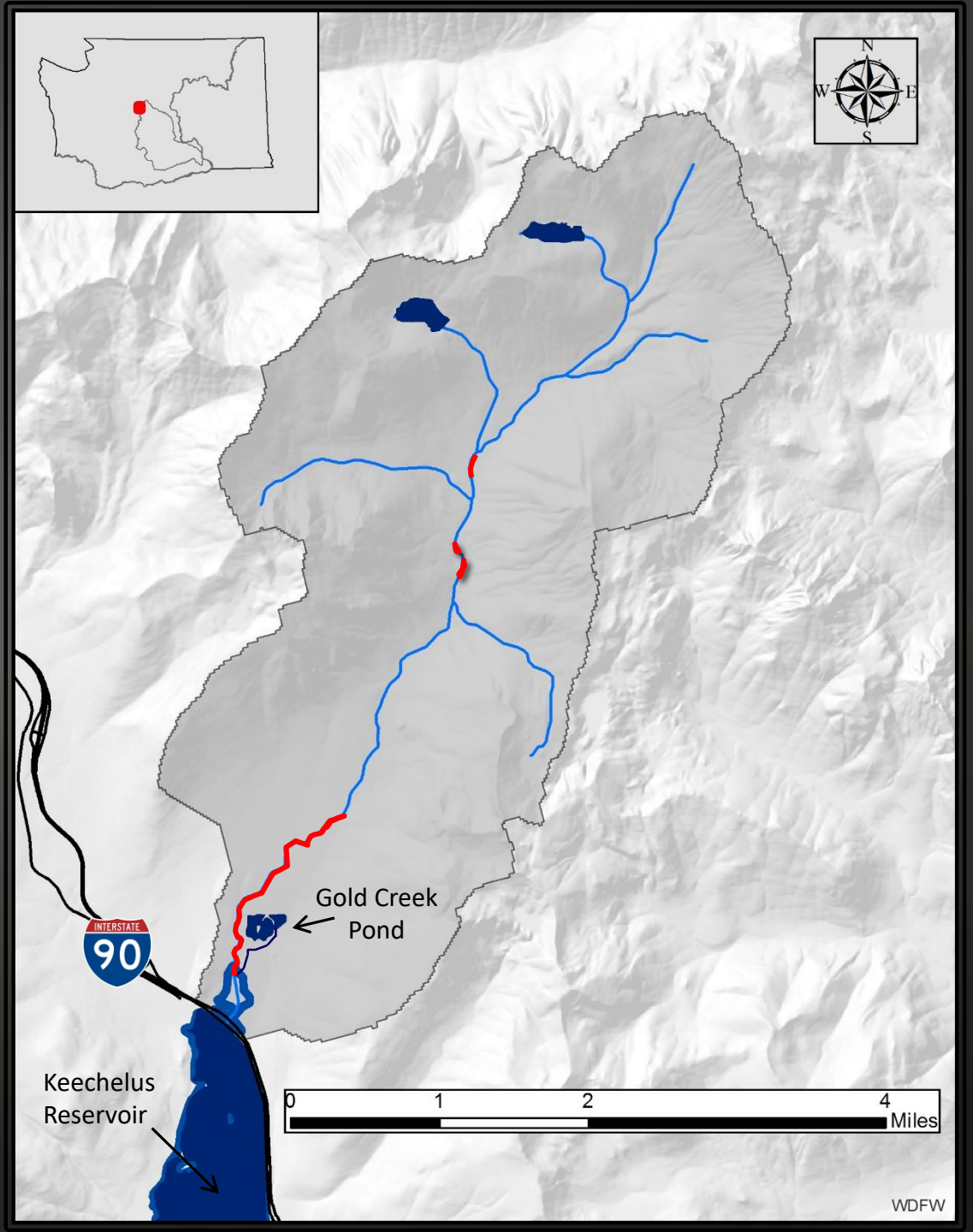

Littell et al. 2009: The Washington Climate Change Impacts Assessment

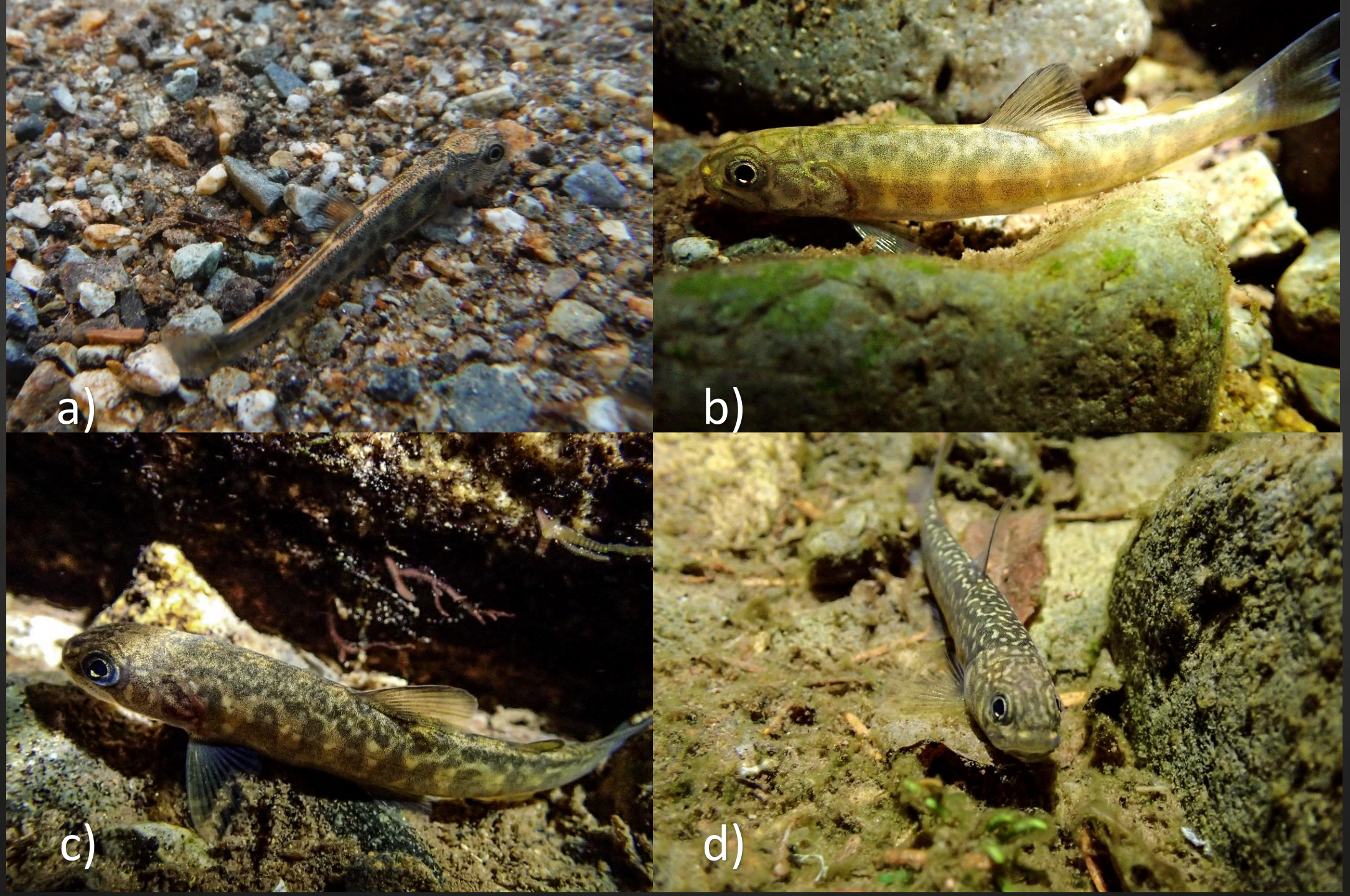
# Implications of Selection: High Flow Events



- Reduced slow-water refuge for YOY
- Displacement of YOY downstream
  - Vulnerable to predation
  - Less desirable habitat


Gold Creek Dewatered Reaches, 2009
GC_Dewatered_Reaches Events
Lower Dewatered
Upper Dewatered
Shallow Riffles
Passage Barrier
Gold Creek


N
W
E
S
Gold Creek
Pond
INTERSTATE
90
Keechelus
Reservoir
0
1
2
4
Miles
WDFW


a)
b)
c)
d)


Credit: Cassandra Weekes

Westslope cutthroat

Chinook Salmon

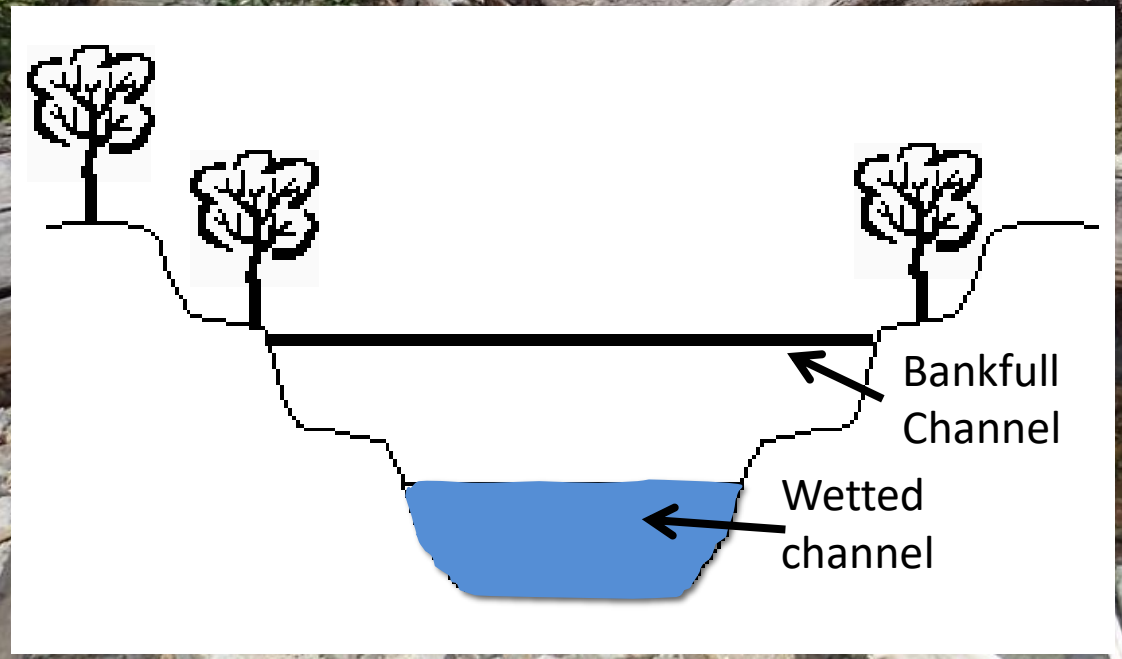
Rainbow Trout

Coho Salmon

Mountain Whitefish

Eastern Brook Trout

# Large Woody Debris (LWD)



# Reach 1

| Channel Unit # | Classification |
|---|---|
| 1 | Scour Pool |
| 2 | Riffle |
| 3 | Scour Pool |
| 4 | Scour Pool |
| 5 | Riffle |
| 6 | Run |
| 7 | Scour Pool |

| | Reach 1 | Reach 2 | Reach 3 | Reach 4 |
|---|---|---|---|---|
| Bankful LWD Volume ($m^3$) | 39.32 | 15.34 | 108.53 | 17.13 |
| Wetted LWD Volume ($m^3$) | 27.8 | 0.12 | 56.76 | 14.81 |
| D16 Particle Size | 32 | 45 | 64 | 64 |
| D50 Particle Size | 128 | 154 | 128 | 128 |
| D84 Particle Size | 256 | 362 | 256 | 256 |

# Reach 2

| Channel Unit # | Classification |
|---|---|
| 1 | Riffle |
| 2 | Scour Pool |
| 3 | Rapid |

| | Reach 1 | Reach 2 | Reach 3 | Reach 4 |
|---|---|---|---|---|
| Bankful LWD Volume ($m^3$) | 39.32 | 15.34 | 108.53 | 17.13 |
| Wetted LWD Volume ($m^3$) | 27.8 | 0.12 | 56.76 | 14.81 |
| D16 Particle Size | 32 | 45 | 64 | 64 |
| D50 Particle Size | 128 | 154 | 128 | 128 |
| D84 Particle Size | 256 | 362 | 256 | 256 |

# Reach 3

| Channel Unit # | Classification |
|---|---|
| 1 | Scour Pool |
| 2 | Riffle |
| 3 | Scour Pool |

| | Reach 1 | Reach 2 | Reach 3 | Reach 4 |
|---|---|---|---|---|
| Bankful LWD Volume ($m^3$) | 39.32 | 15.34 | 108.53 | 17.13 |
| Wetted LWD Volume ($m^3$) | 27.8 | 0.12 | 56.76 | 14.81 |
| D16 Particle Size | 32 | 45 | 64 | 64 |
| D50 Particle Size | 128 | 154 | 128 | 128 |
| D84 Particle Size | 256 | 362 | 256 | 256 |

# Reach 4

| Channel Unit # | Classification |
|---|---|
| 1 | Riffle |
| 2 | Scour Pool |
| 3 | Riffle |

| | Reach 1 | Reach 2 | Reach 3 | Reach 4 |
|---|---|---|---|---|
| Bankful LWD Volume ($m^3$) | 39.32 | 15.34 | 108.53 | 17.13 |
| Wetted LWD Volume ($m^3$) | 27.8 | 0.12 | 56.76 | 14.81 |
| D16 Particle Size | 32 | 45 | 64 | 64 |
| D50 Particle Size | 128 | 154 | 128 | 128 |
| D84 Particle Size | 256 | 362 | 256 | 256 |

# Reach Level Habitat Survey Results

- Primary vegetation – willow, alder, maple, devils club, Douglas Fir, true fir, cedar, spruce and hemlock

## Riparian Structure Estimations

| Reach | % Canopy Cover | % Understory Cover | % Ground Cover | % Coniferous Cover |
|---|---|---|---|---|
| 1 | 37 | 40 | 40 | 30.25 |
| 2 | 37 | 57.5 | 55.5 | 38.25 |
| 3 | 6 | 51.5 | 40 | 5.25 |
| 4 | 20.5 | 48.5 | 56 | 17.5 |

## Instream Canopy cover

| Reach | % Instream Canopy Cover |
|---|---|
| 1 | 38.00 |
| 2 | 48.54 |
| 3 | 13.87 |
| 4 | 41.90 |