Temperature, cyprinid density, and juvenile steelhead summer occurrence patterns

John Winkowski, Mara Zimmerman, Eric Walther, WDFW

Steelhead Managers Meeting – Walla Walla, WA

March 20-22, 2018

Washington Department
FISH AND WILDLI

Fish assemblages in rivers

TRANSACTIONS of the AMERICAN FISHERIES SOCIETY

July, 1959
VOLUME 88
NUMBER 3

Profiles and Biology of Western European Streams as Related to Fish Management[1]

MARCEL HUET
Director, Belgian Waters and Forests Research Station and Lecturer at the University of Louvain

American Fisheries Society Symposium 48:473–492, 2006

Landscape Influences on Longitudinal Patterns of River Fishes: Spatially Continuous Analysis of Fish–Habitat Relationships

Christian E. Torgersen*[,1] and Colden V. Baxter[2]
Oregon Cooperative Fish and Wildlife Research Unit, Department of Fisheries and Wildlife Oregon State University, Corvallis, Oregon 97331, USA

Hiram W. Li
Oregon Cooperative Fish and Wildlife Research Unit (U.S. Geological Survey) Department of Fisheries and Wildlife, 104 Nash Hall Oregon State University, Corvallis, Oregon 97331, USA

Bruce A. McIntosh
Oregon Department of Fish and Wildlife, Corvallis Research Laboratory 28655 Highway 34, Corvallis, Oregon 97333, USA

Transactions of the American Fisheries Society 130:417–430, 2001

Spatial Distribution of Native and Nonnative Salmonids in Streams of the Eastern Slopes of the Canadian Rocky Mountains

ANDREW J. PAUL*
Department of Biological Sciences, University of Calgary, Calgary, Alberta, T2N 1N4, Canada

JOHN R. POST

394
NRC Research Press
ARTICLE

Temperature-dependent performance as a driver of warm-water fish species replacement along the river continuum

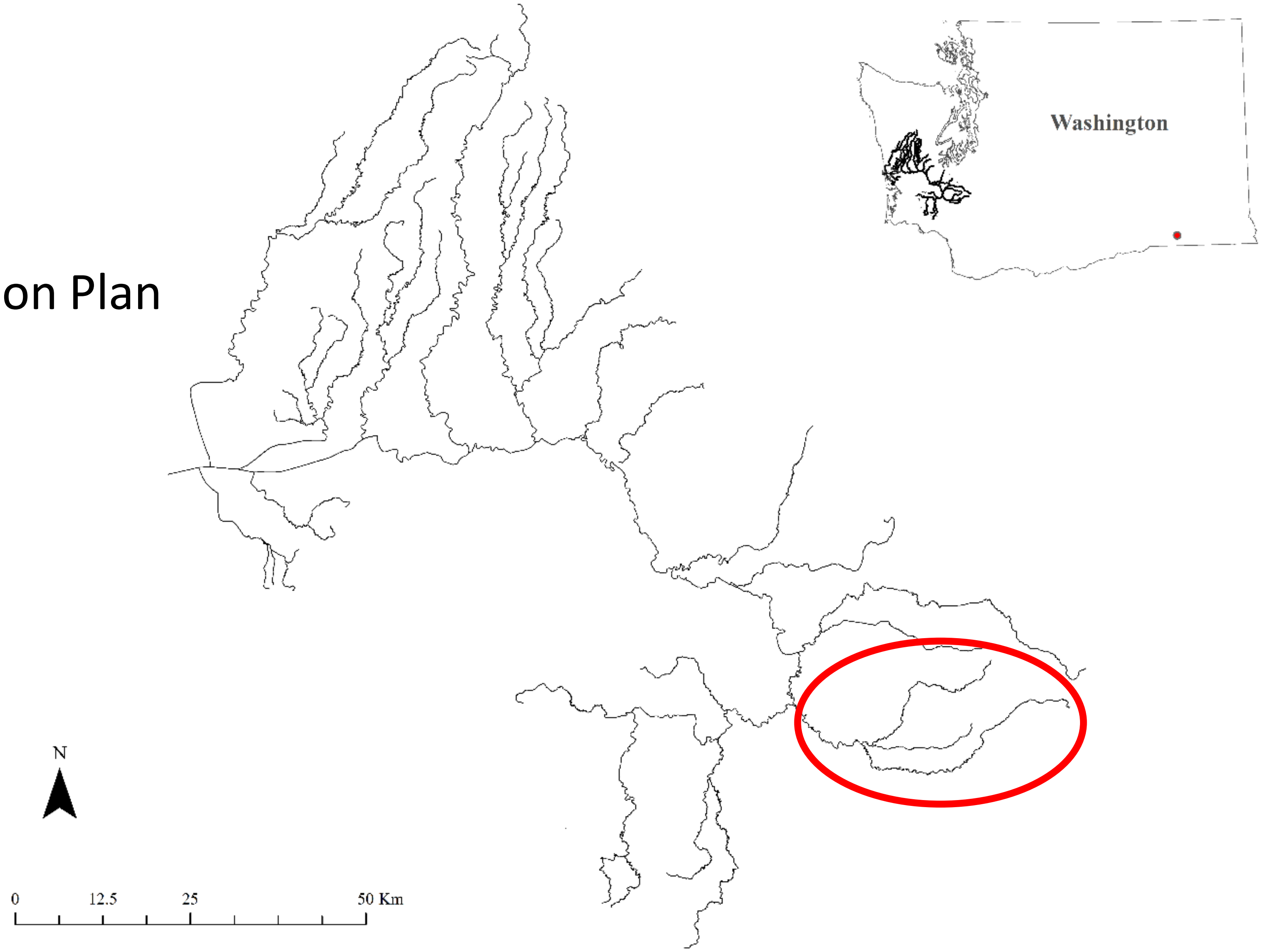
Matthew J. Troia, Michael A. Denk, and Keith B. Gido

Temperature mediation of competitive interactions among three fish species that replace each other along longitudinal stream gradients

Yoshinori Taniguchi, Frank J. Rahel, Douglas C. Novinger, and Kenneth G. Gerow

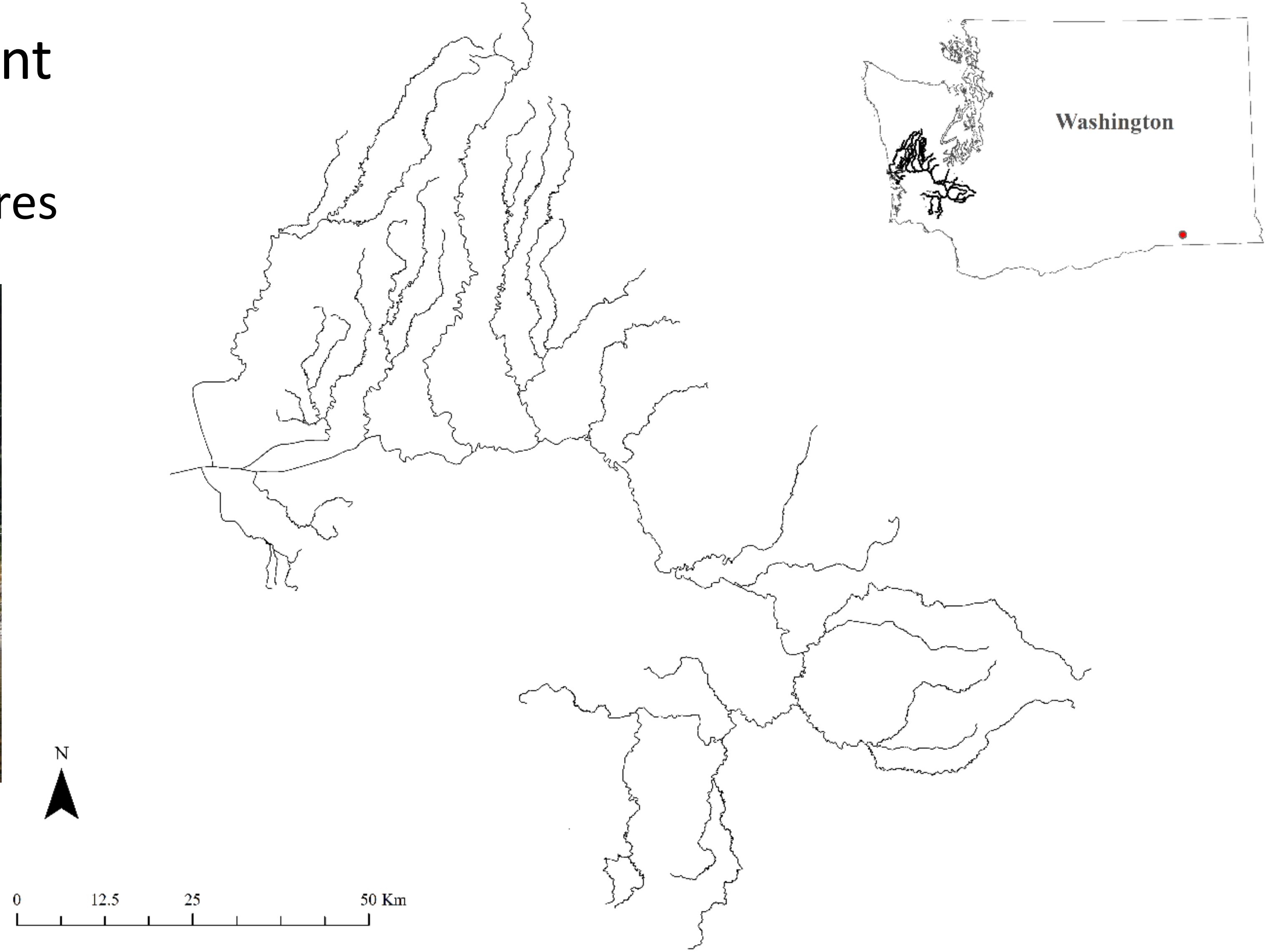
Chehalis River

- Flood damage
  - Proposed dam
- Habitat degradation
  - Aquatic Species Restoration Plan



Chehalis River

- Hydrology – rain dominant
  - Low summer flows
  - High summer temperatures



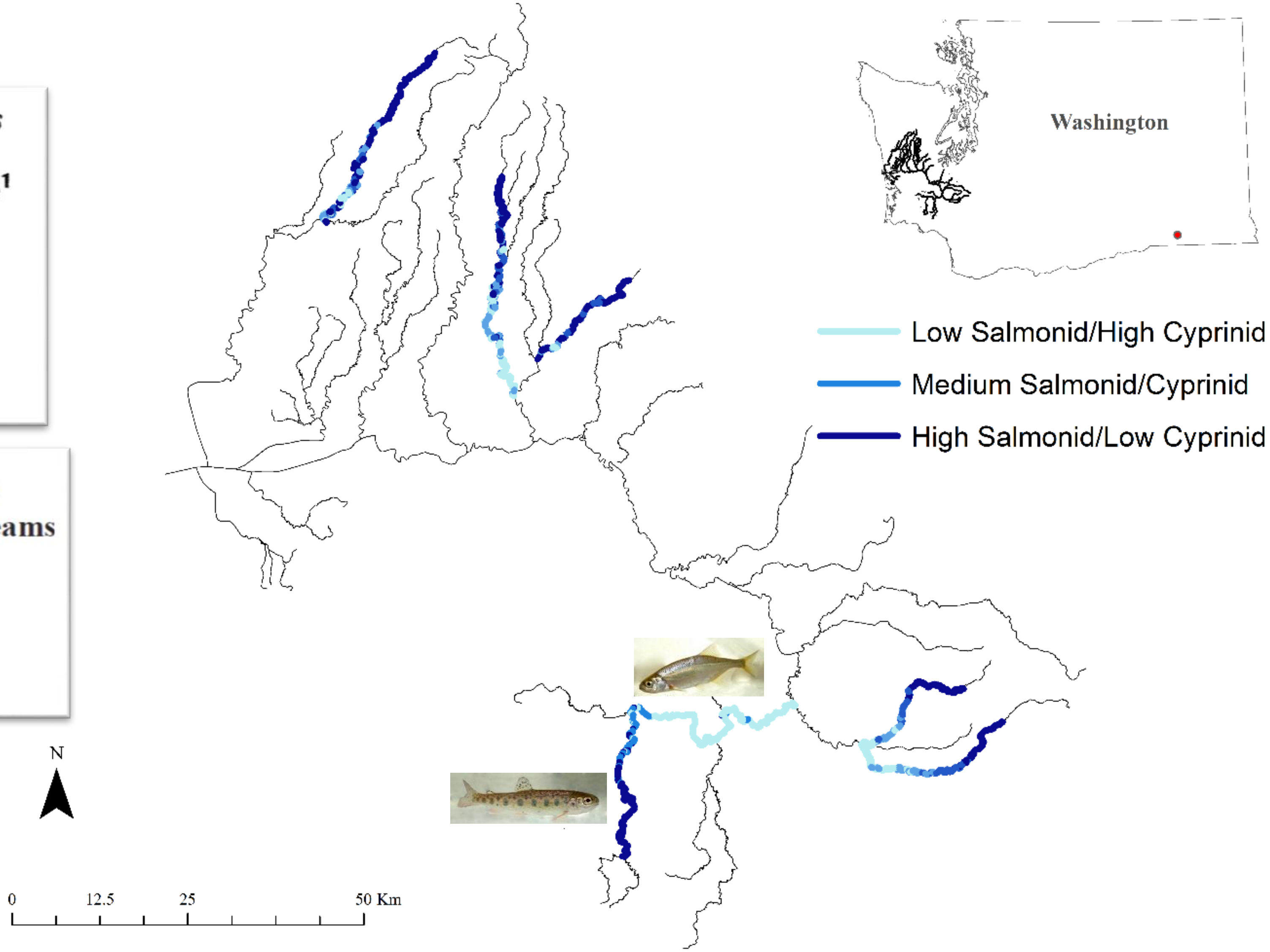
Replacement of salmonids by cyprinids in downstream direction in August

Interactions Between the Redside Shiner (*Richardsonius balteatus*) and the Steelhead Trout (*Salmo gairdneri*) in Western Oregon: The Influence of Water Temperature[1]

Gordon H. Reeves[2]
Department of Fisheries and Wildlife, Oregon State University, Corvallis, OR 97331, USA
Fred H. Everest
USDA Forest Service, Pacific Northwest Research Station, 3200 Jefferson Way, Corvallis, OR 97331, USA
and James D. Hall
Department of Fisheries and Wildlife, Oregon State University, Corvallis, OR 97331, USA

Temperature-Dependent Interactions between Juvenile Steelhead and Sacramento Pikeminnow in Laboratory Streams

Carl D. Reese[1] and Bret C. Harvey*
U.S. Forest Service,
Pacific Southwest Research Station,
Redwood Sciences Laboratory,
1700 Bayview Drive, Arcata, California 95521, USA

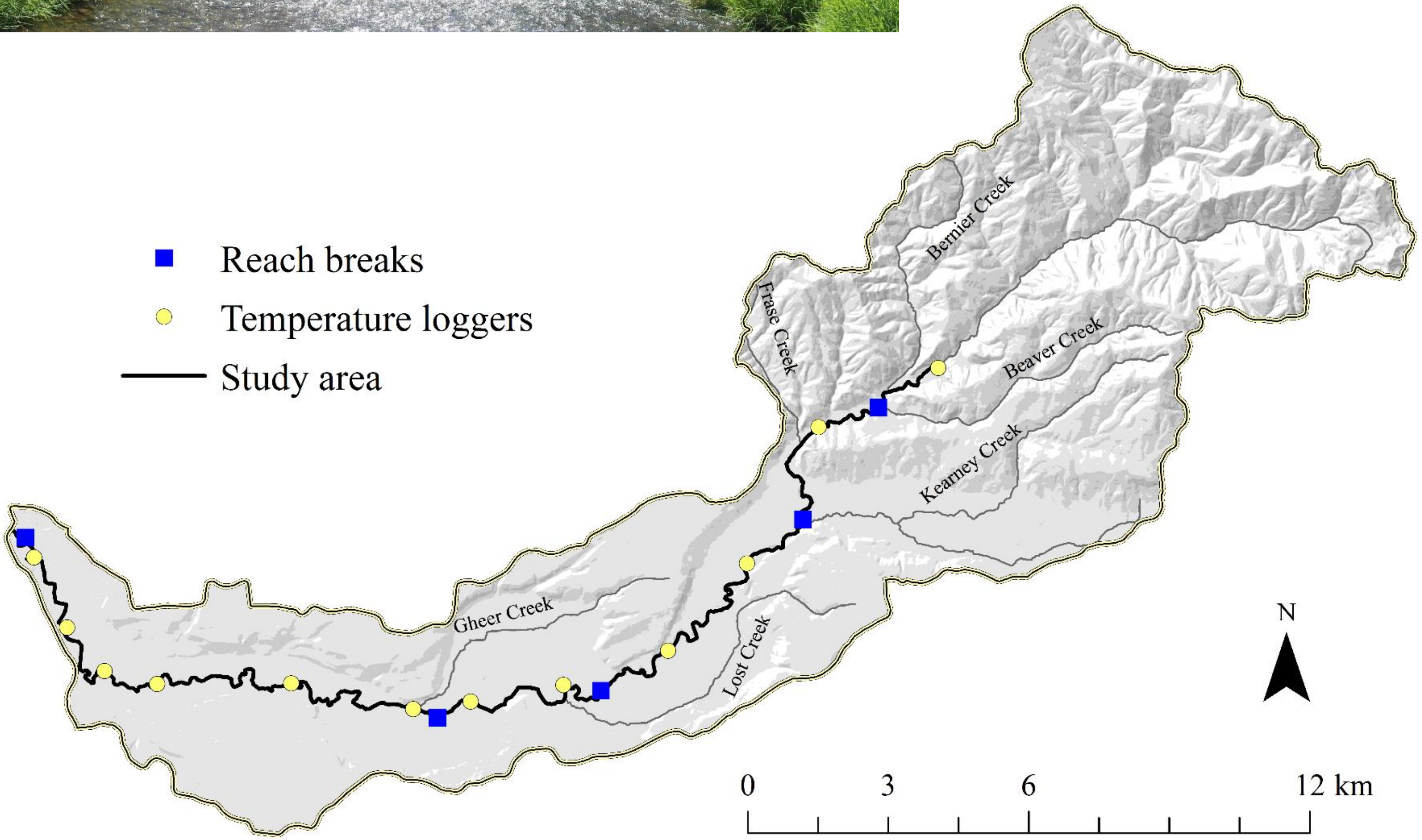


Objectives

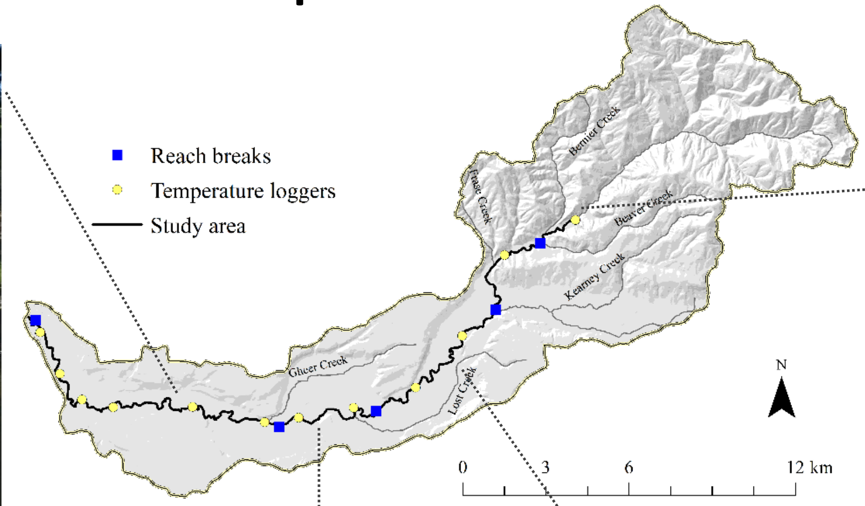
- Describe landscape, habitat, temperature, and steelhead distribution in our study area
- Explore associations between temperature and cyprinids on steelhead occurrence in our study area

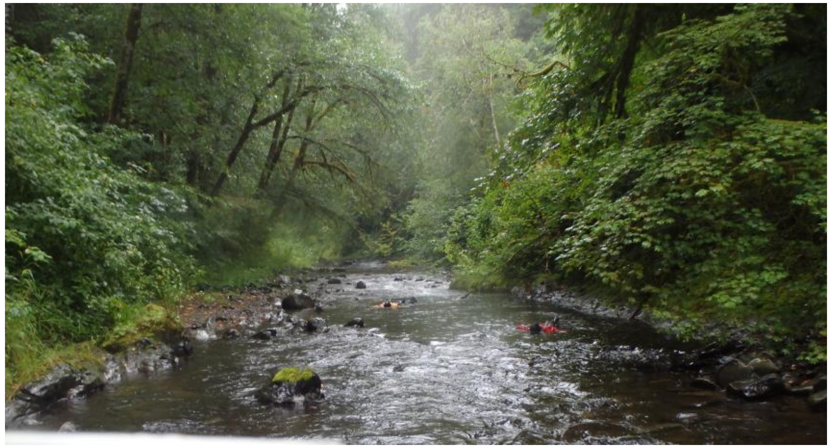
Field methods

- 37.5 km study area
- Landscape characteristics via National Land Cover Database, Terrainworks
- Habitat metrics by 200m segments
- Temperature measured in study area via HOBO pendant loggers
- Fish count by snorkeling, 200m segments
    - 4 surveys



Landscape characteristics





13-16% Forest cover, 42-44% Cultivated land
0.4 – 0.6 % Gradient
27-36.1 Valley confinement index

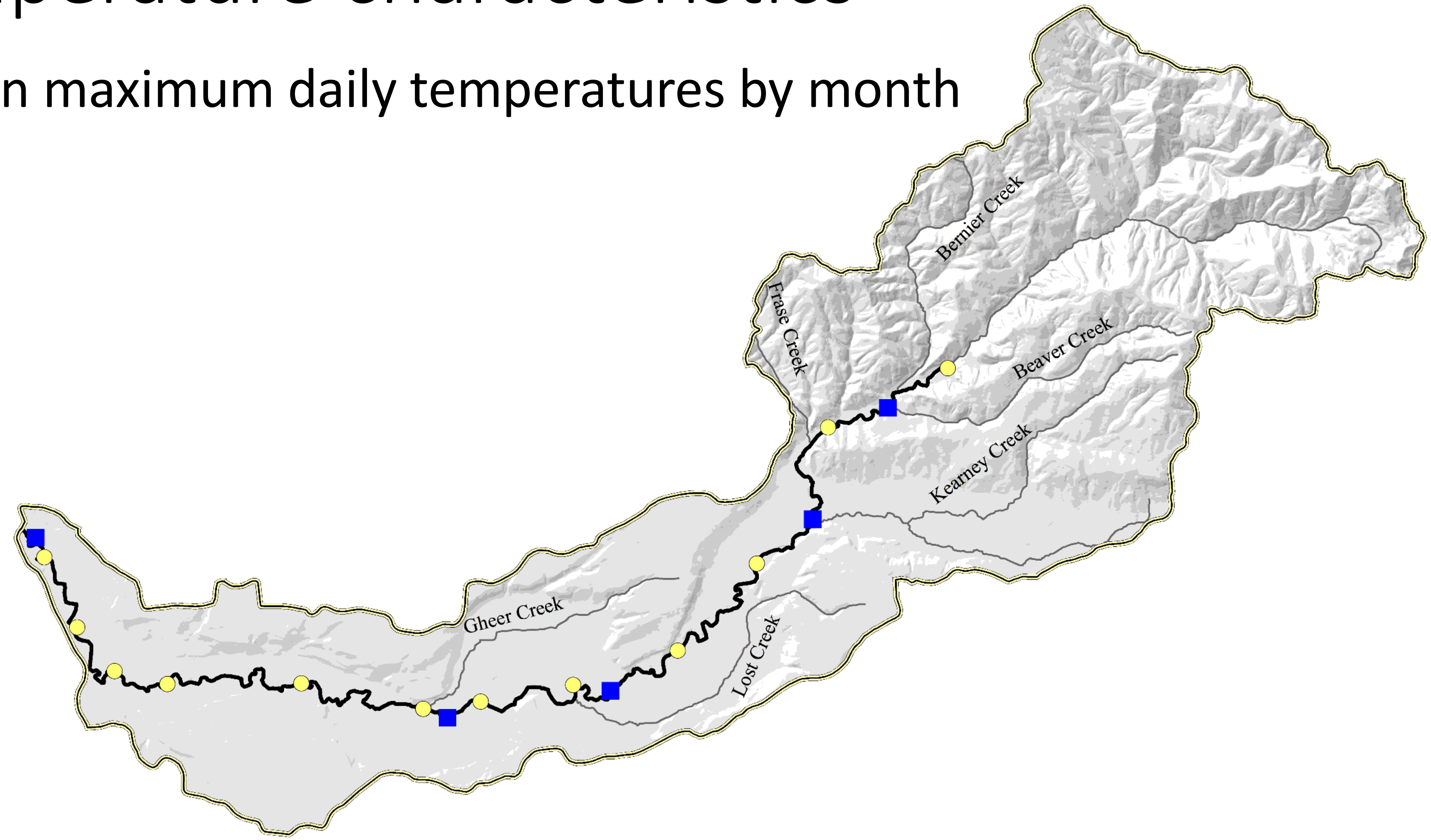
46-48% Forest cover
0.7 – 1.4 % Gradient
2.7 – 10.6 Valley confinement index

Habitat – minimal longitudinal pattern

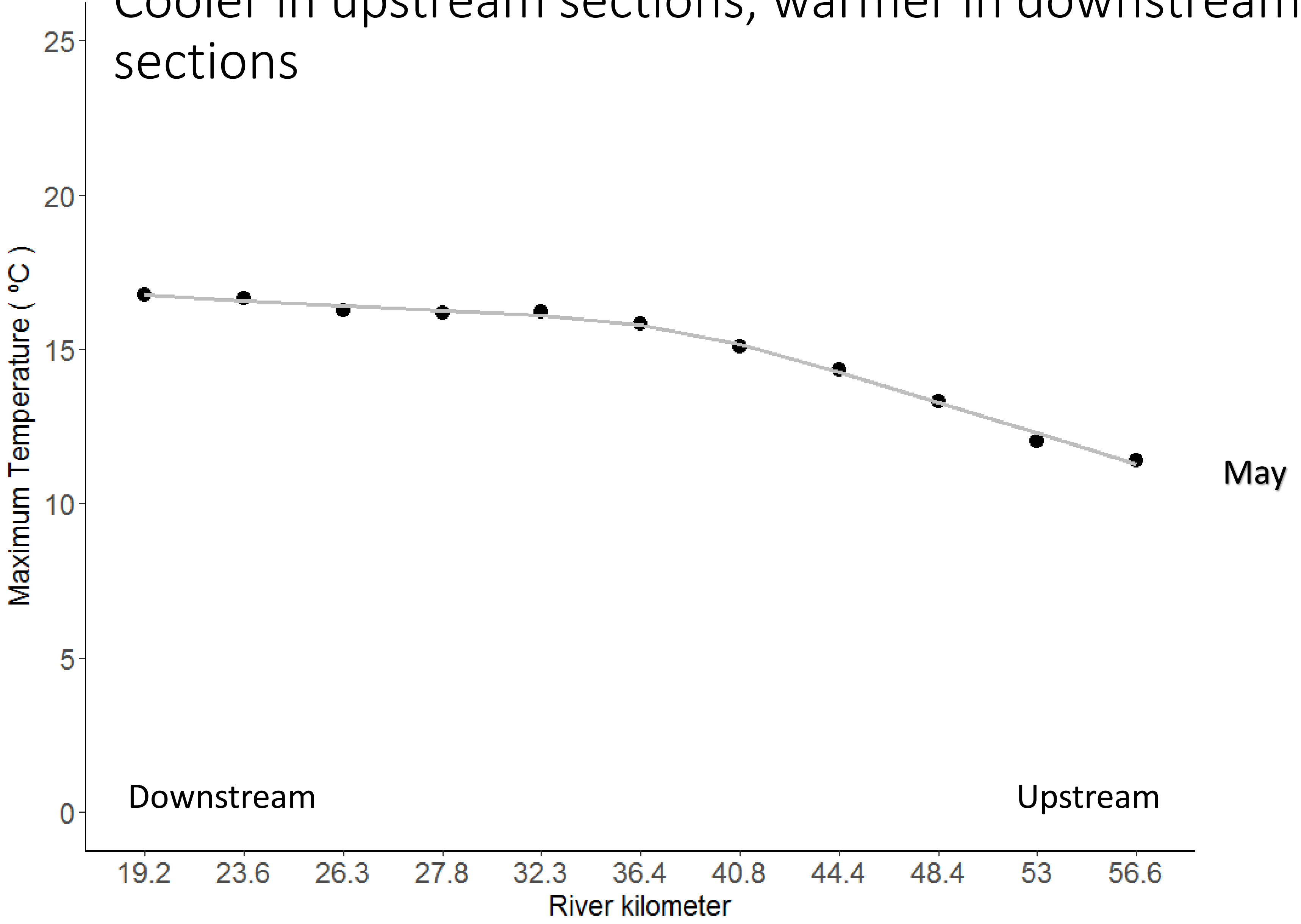
- Pool riffle dominant
- LWD 1.7-4.9 per 100m
- Wetted widths 9.1 – 13.2m
- Maximum depth 1.2 – 1.7m
- Pool counts 0.9 – 1.7 per 100m
- Substrate was slightly more coarse in upstream reaches

Temperature characteristics

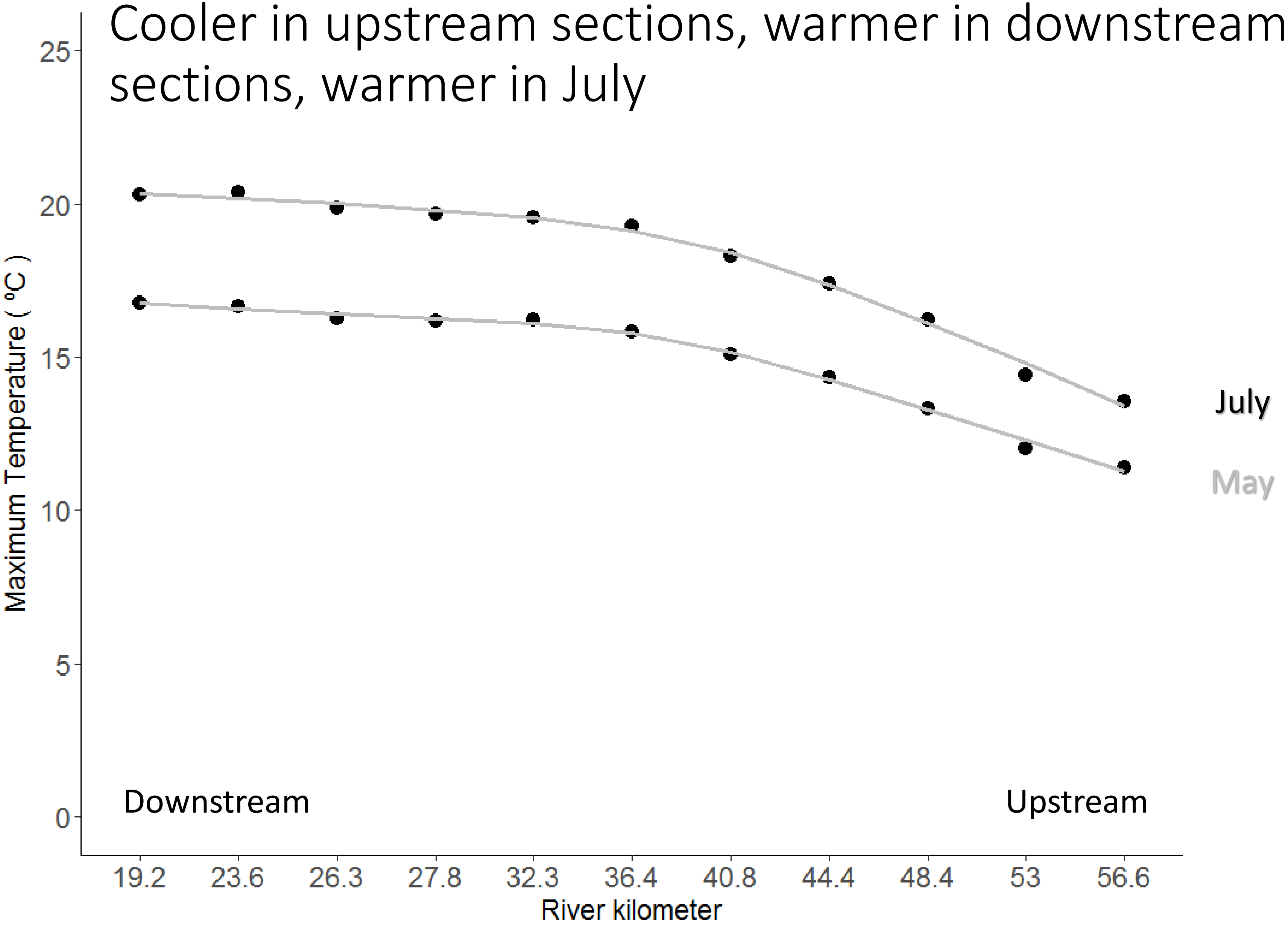
- Mean maximum daily temperatures by month



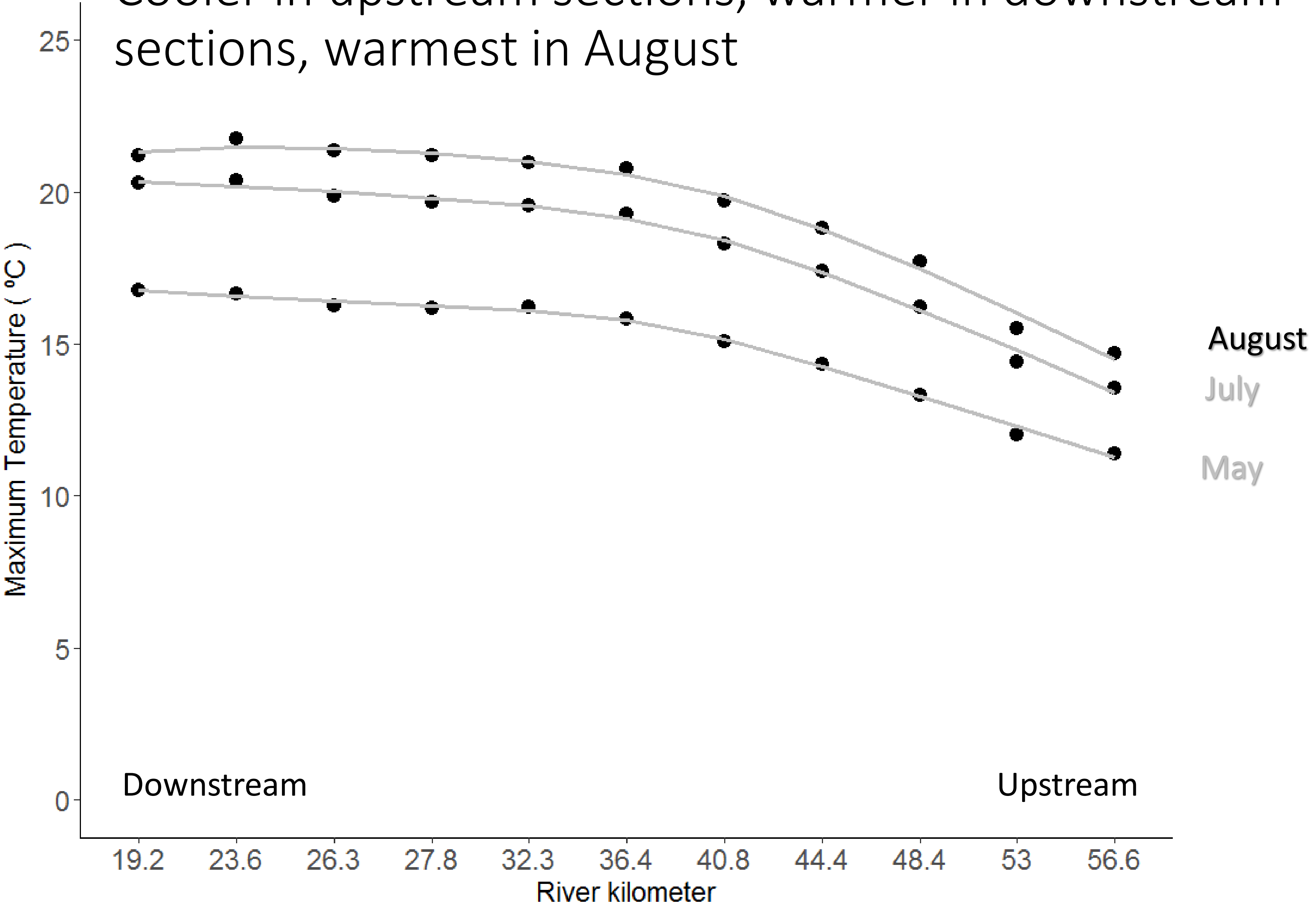
Cooler in upstream sections, warmer in downstream sections



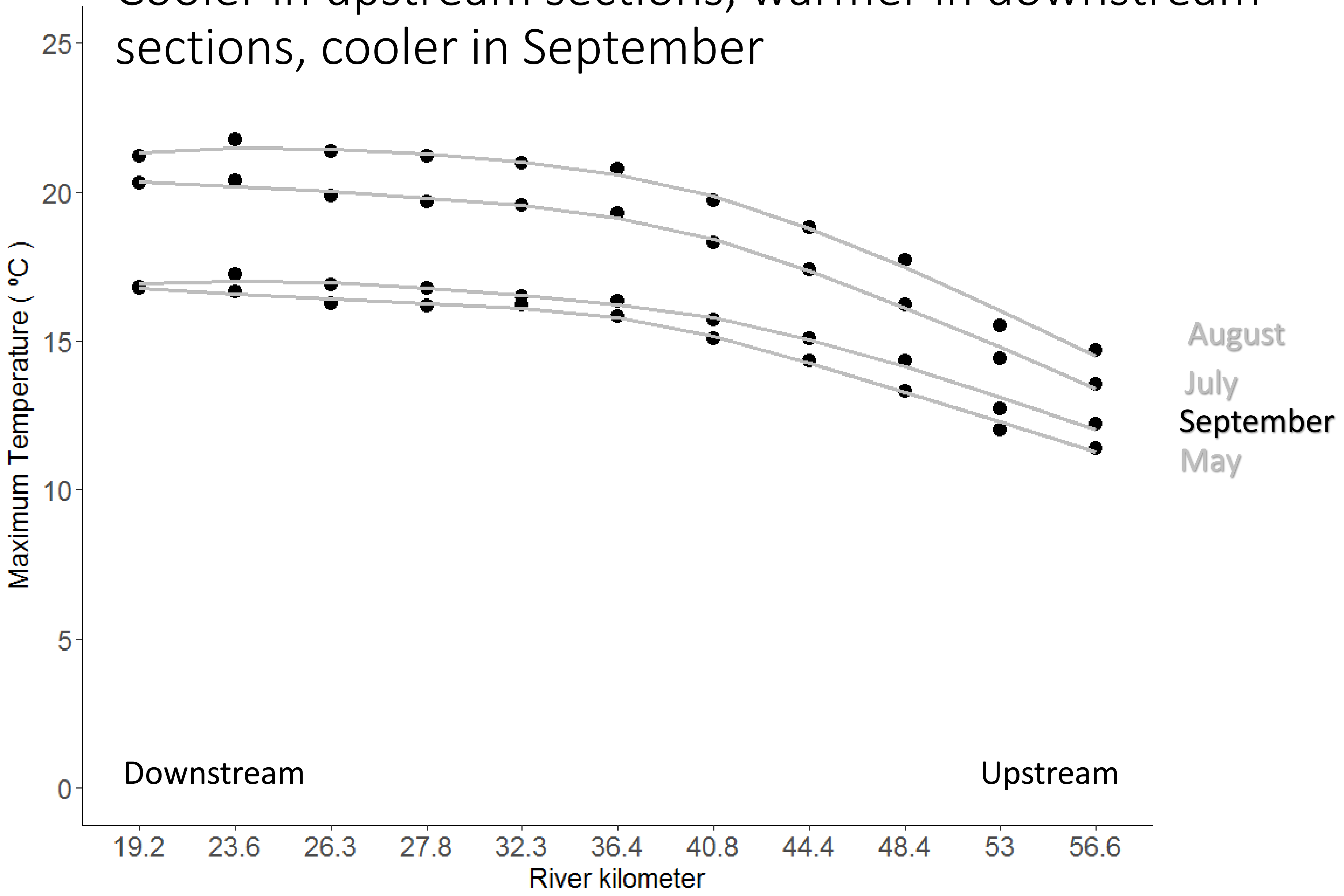
Cooler in upstream sections, warmer in downstream sections, warmer in July



Cooler in upstream sections, warmer in downstream sections, warmest in August

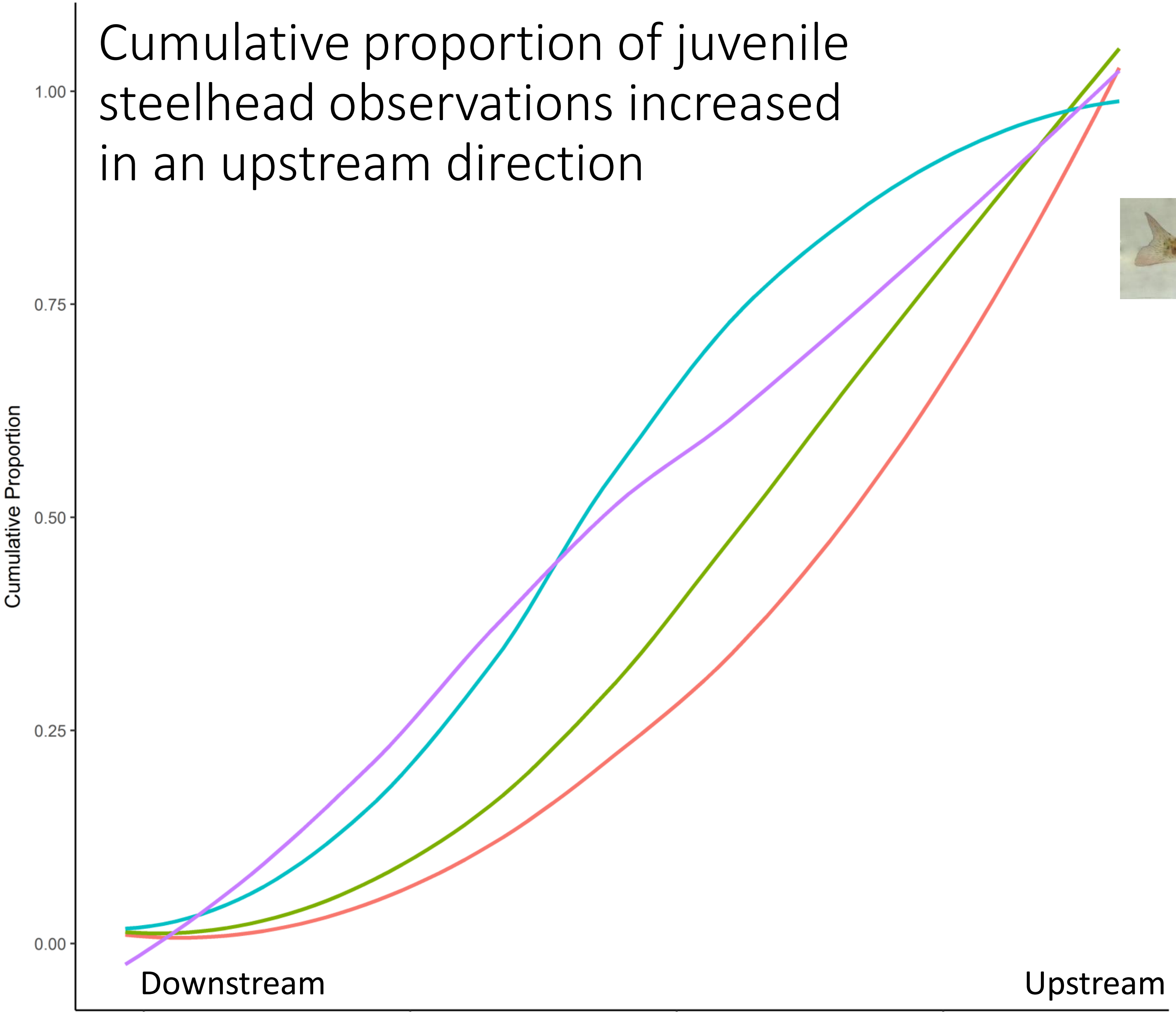


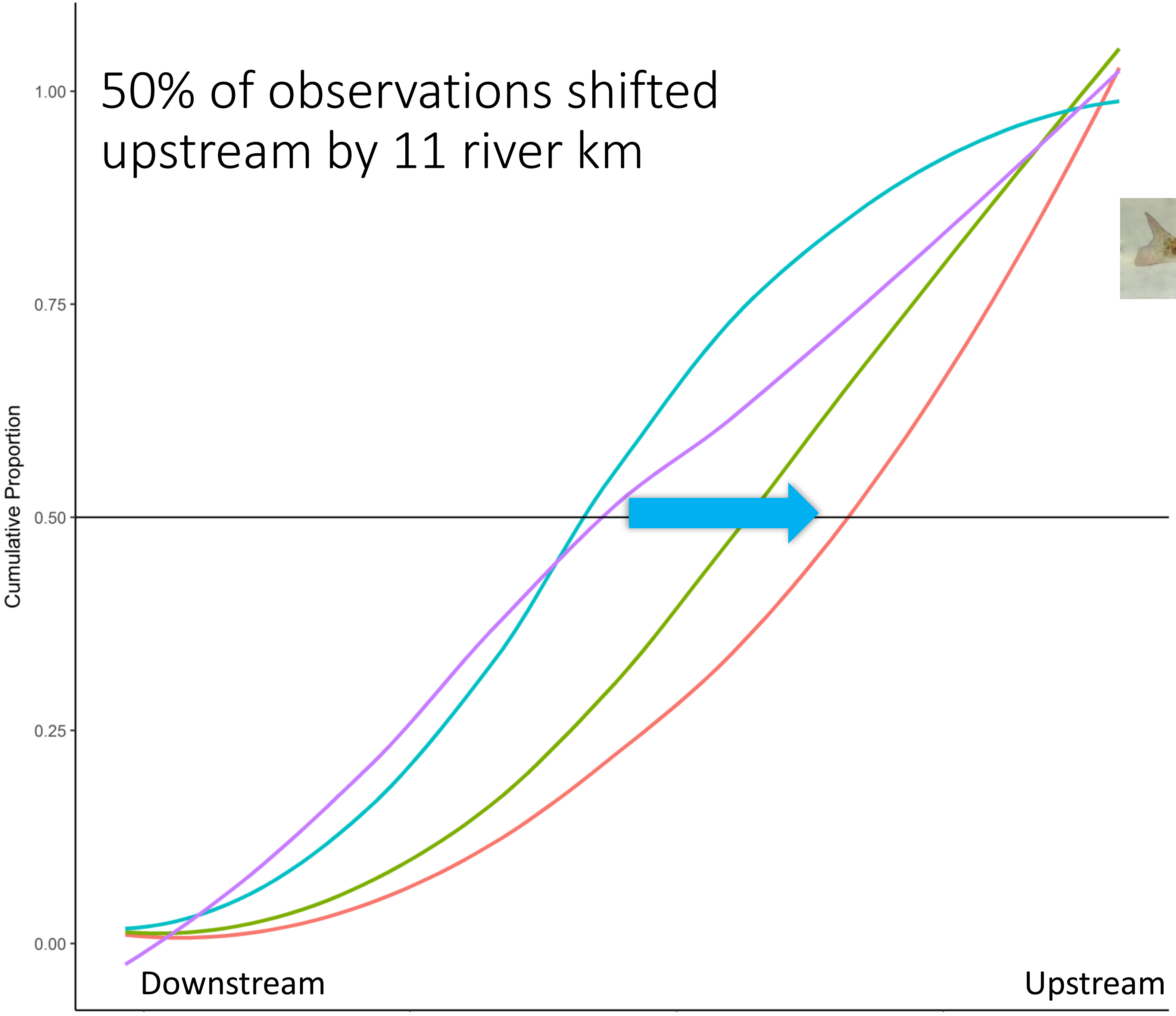
Cooler in upstream sections, warmer in downstream sections, cooler in September

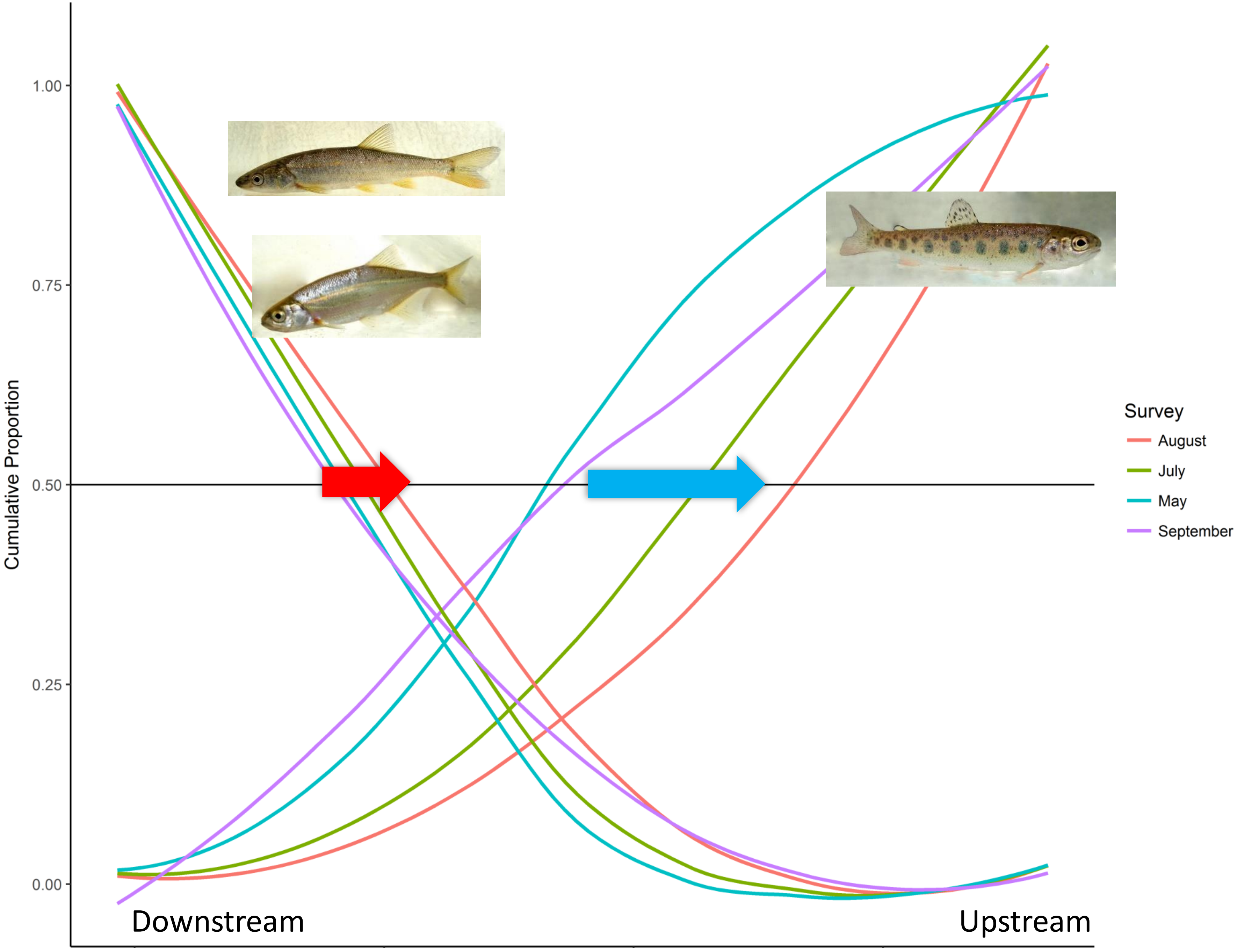


Juvenile steelhead distribution

Cumulative proportion of juvenile steelhead observations increased in an upstream direction




50% of observations shifted upstream by 11 river km
Cumulative Proportion
1.00
0.75
0.50
0.25
0.00
Downstream
Upstream
Survey
August
July
May
September



Cumulative Proportion
1.00
0.75
0.50
0.25
0.00
Downstream
Upstream
Survey
August
July
May
September

Association of juvenile steelhead occurrence, temperature, cyprinids

Generalized linear mixed effects model:

Steelhead occurrence (0/1)~

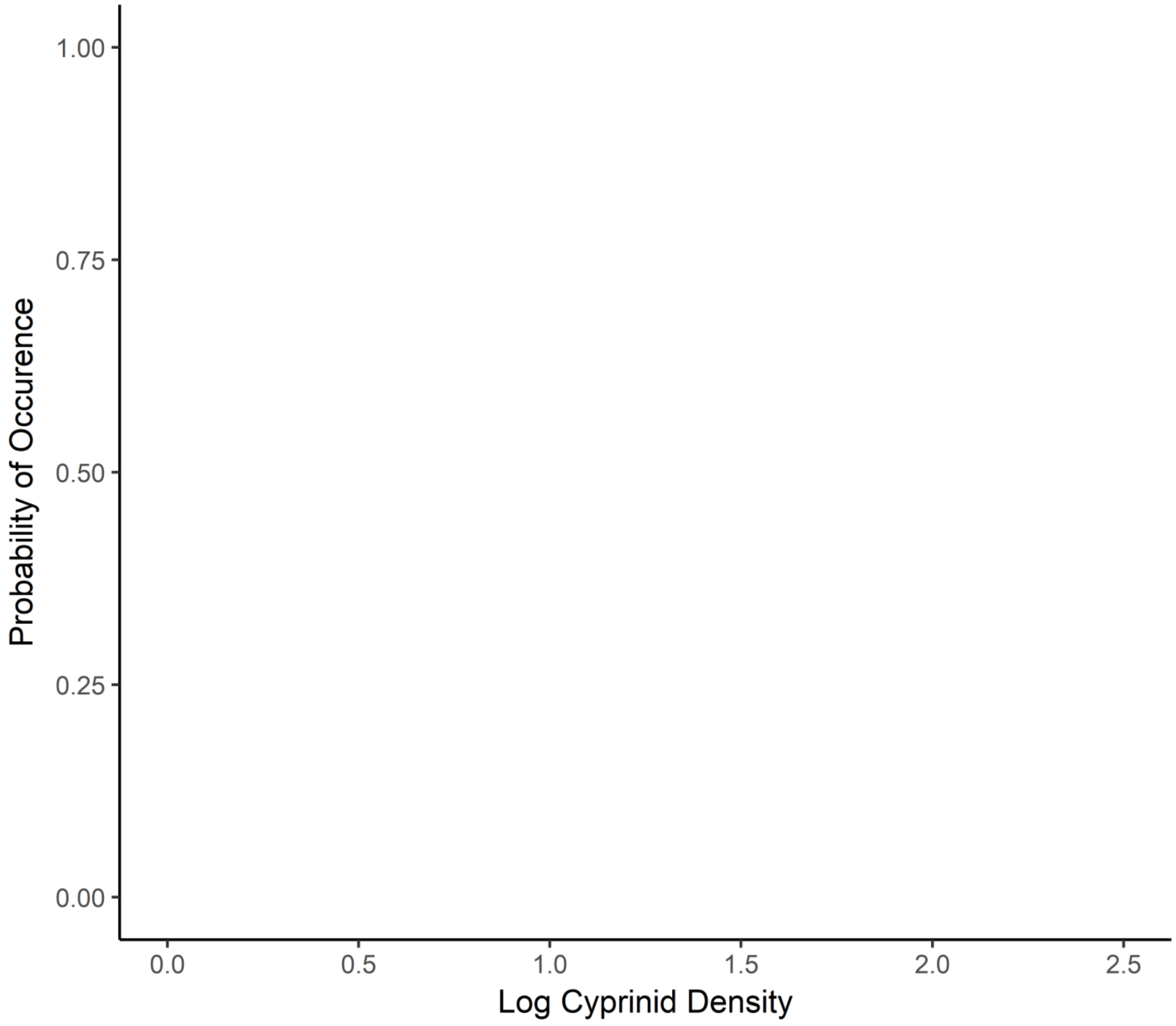
Fixed effects	Maximum temperature
	log(Cyprinid density)
	Maximum temperature*log(Cyprinid density)
Random effects	Segment (200m)
	Survey period

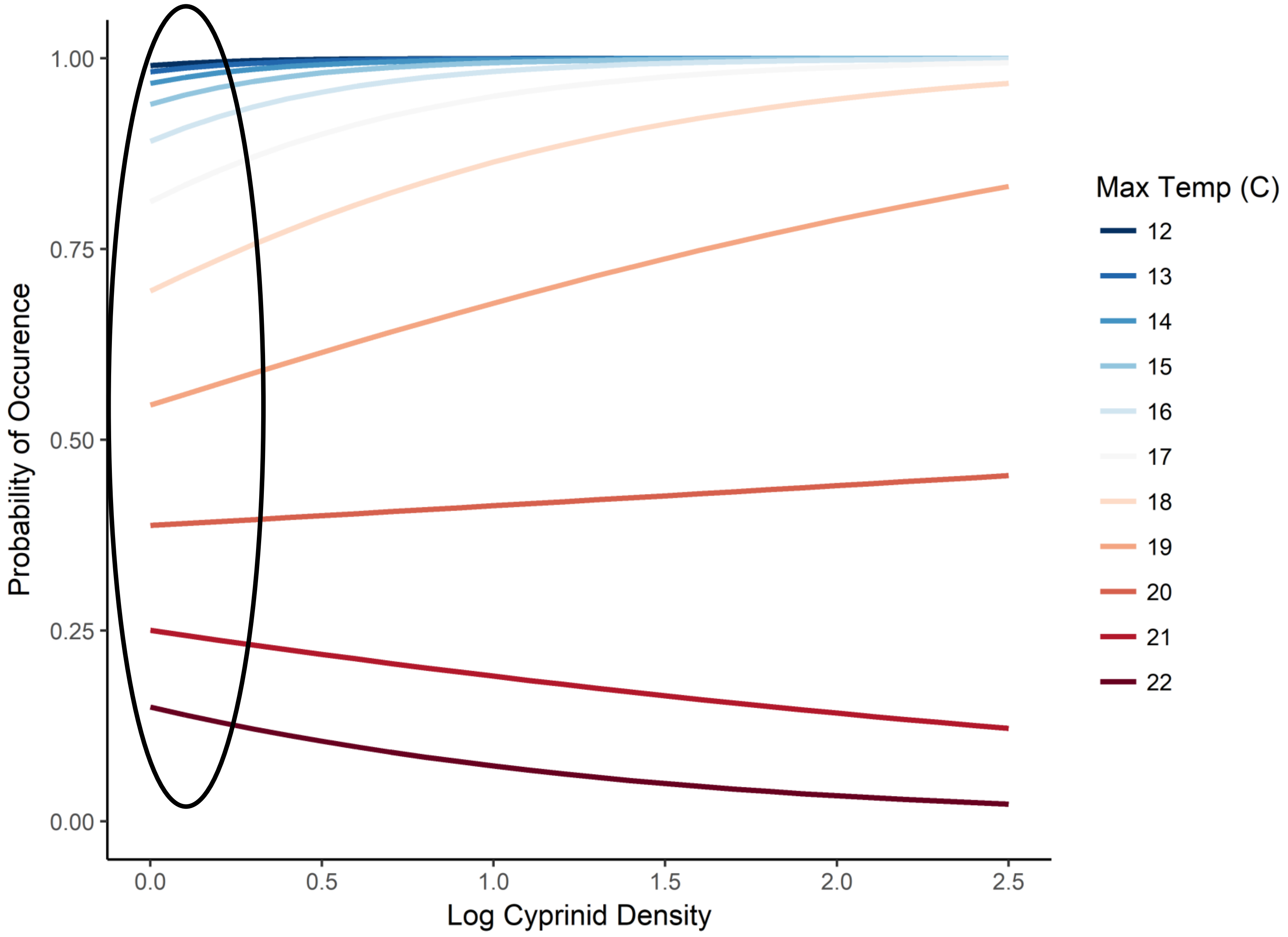
Association of steelhead occurrence, temperature, cyprinids

Generalized linear mixed effects model

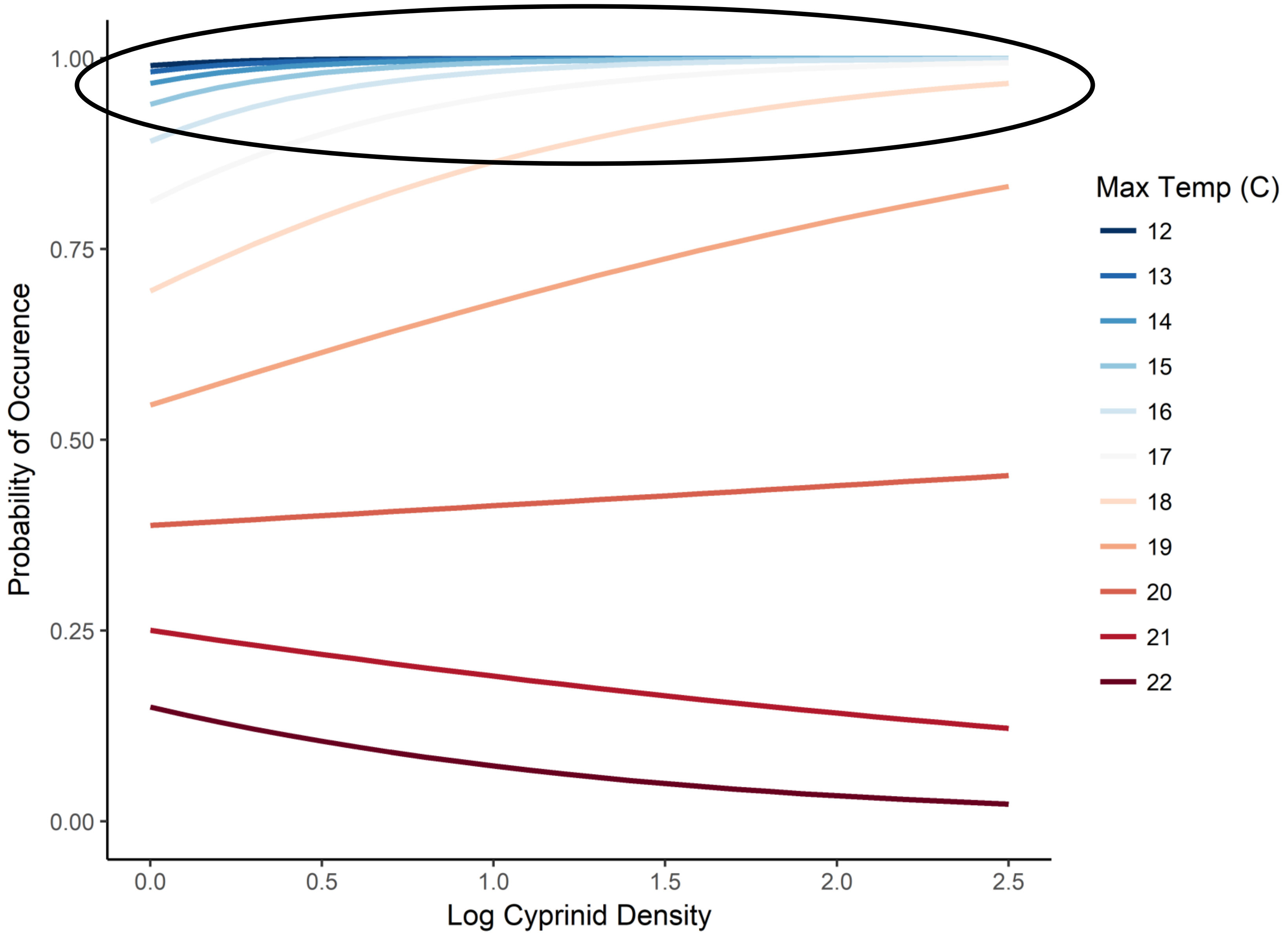
Steelhead occurrence (0/1)~

Fixed effects	Maximum temperature
	log(Cyprinid density)
	Maximum temperature*log(Cyprinid density)
Random effects	Segment (200m)
	Survey period

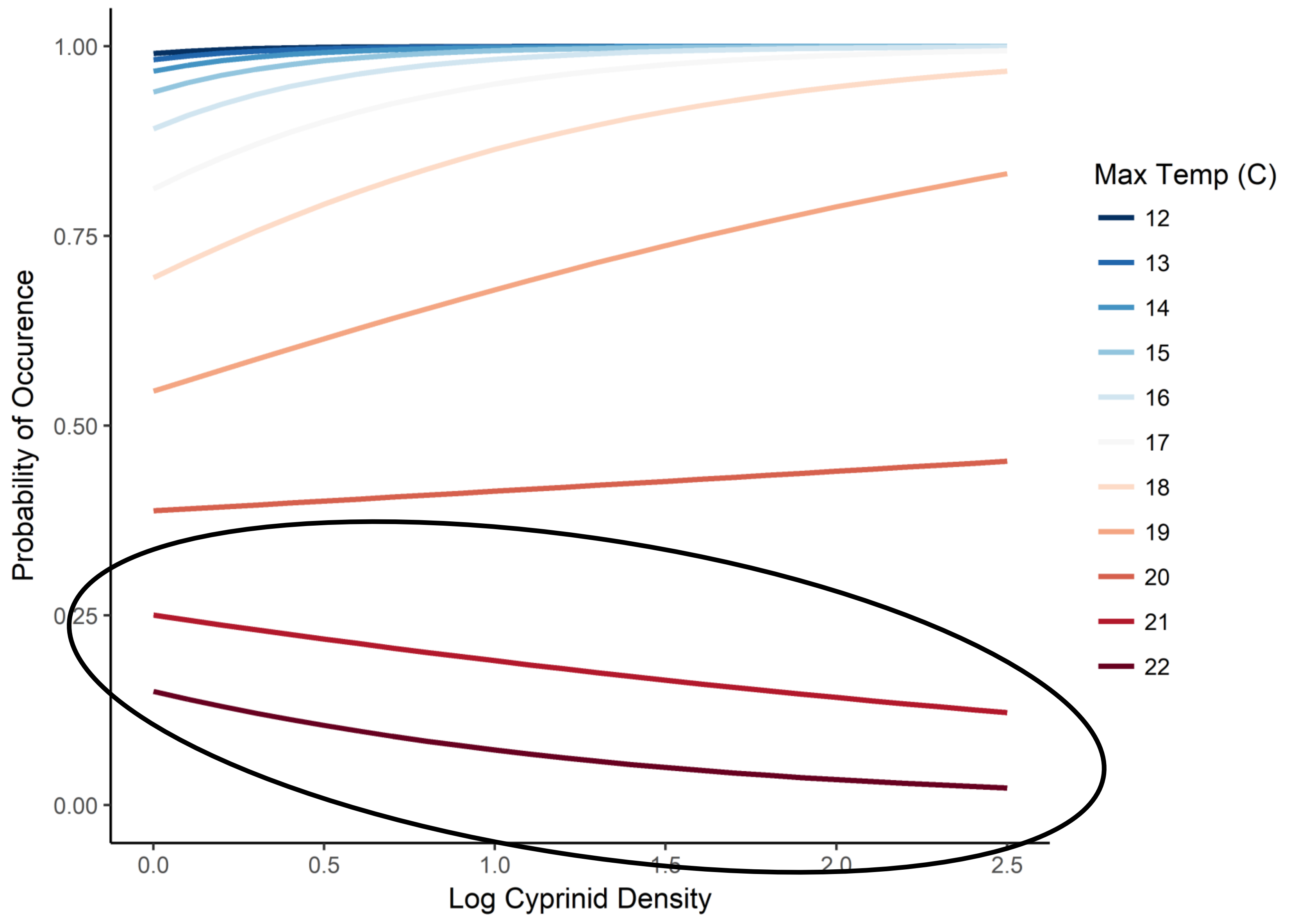

1.00
0.75
0.50
0.25
0.00
Probability of Occurence
0.0
0.5
1.0
1.5
2.0
2.5
Log Cyprinid Density

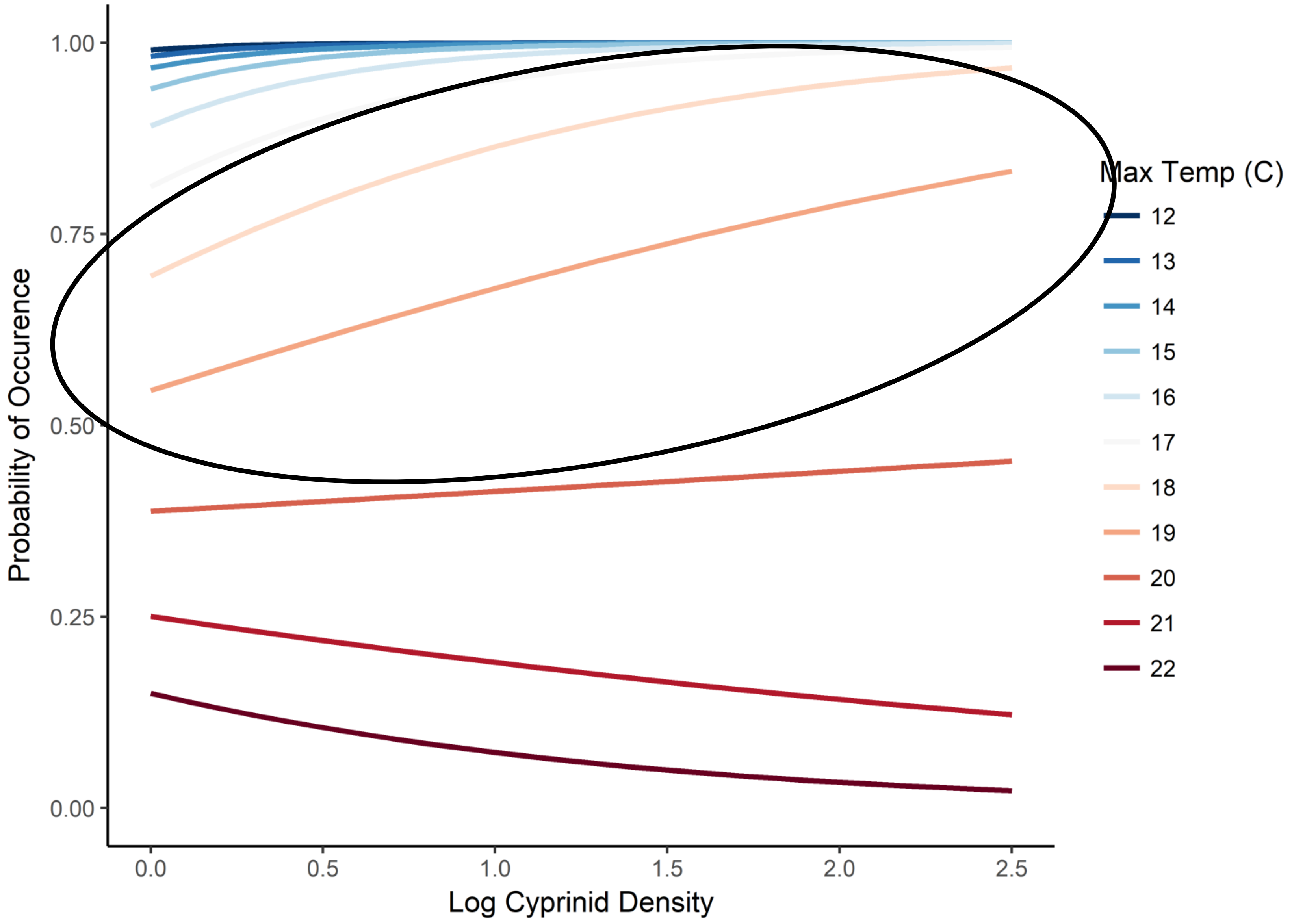


Probability of Occurence
1.00
0.75
0.50
0.25
0.00
0.0
0.5
1.0
1.5
2.0
2.5
Log Cyprinid Density
Max Temp (C)
12
13
14
15
16
17
18
19
20
21
22



Probability of Occurence
1.00
0.75
0.50
0.25
0.00
0.0
0.5
1.0
1.5
2.0
2.5
Log Cyprinid Density
Max Temp (C)
12
13
14
15
16
17
18
19
20
21
22


Probability of Occurence
1.00
0.75
0.50
0.25
0.00
0.0
0.5
1.0
1.5
2.0
2.5
Log Cyprinid Density
Max Temp (C)
12
13
14
15
16
17
18
19
20
21
22



Probability of Occurence
1.00
0.75
0.50
0.25
0.00
0.0
0.5
1.0
1.5
2.0
2.5
Log Cyprinid Density
Max Temp (C)
12
13
14
15
16
17
18
19
20
21
22

Discussion

- Strong association of juvenile steelhead and temperature
  - Coldest = high occurrence
  - Warmest = low occurrence
  - Restoration take-home: actions that cool temperatures should expand summer rearing locations for juvenile steelhead
- Association between juvenile steelhead and cyprinids depends on temperature
  - Coldest = no association
  - Warmest = negative association
    - Restoration take-home: When maximum temperatures are above 20C native taxa may further limit distribution of juvenile steelhead
  - Intermediate = positive association
    - Restoration take-home: When maximum temperatures are below 20C native taxa are unlikely to limit distribution of juvenile steelhead

Next steps

- Account for spatial autocorrelation in model
- Explore 200m scale habitat variables
- Determine associations with steelhead density

Thank you!

Acknowledgements

- Field crew
- Landowners of Newaukum basin
- Funding by the Washington State Legislature