Riverscape patterns of fish and habitat in the Chehalis River

John Winkowski & Mara Zimmerman, WDFW

Chehalis Basin Technical Meeting

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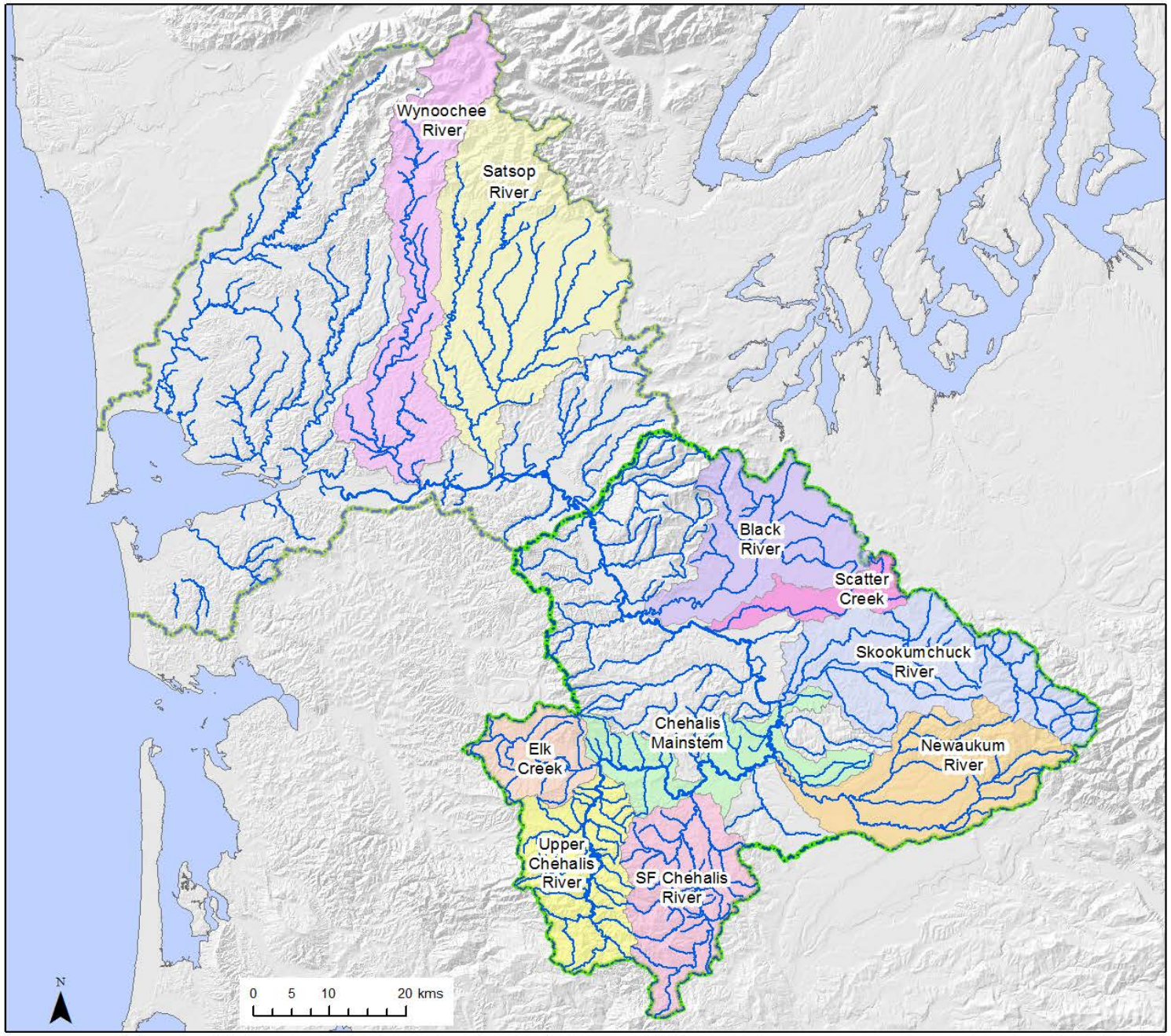
Chehalis River Subbasins



Washington Department of FISH and WILDLIFE

Chehalis Mainstem

Anadromous Streams

Subbasin

- Black River
- Chehalis Mainstem
- Elk Creek
- Newaukum River
- SF Chehalis River
- Satsop River
- Scatter Creek
- Skookumchuck River
- Upper Chehalis River
- Wynoochee River

Key questions addressed

- Where are the important summer rearing areas for juvenile salmonids?
- How are summer habitat and temperature characteristics associated with fish species composition?

Riverscape methodology

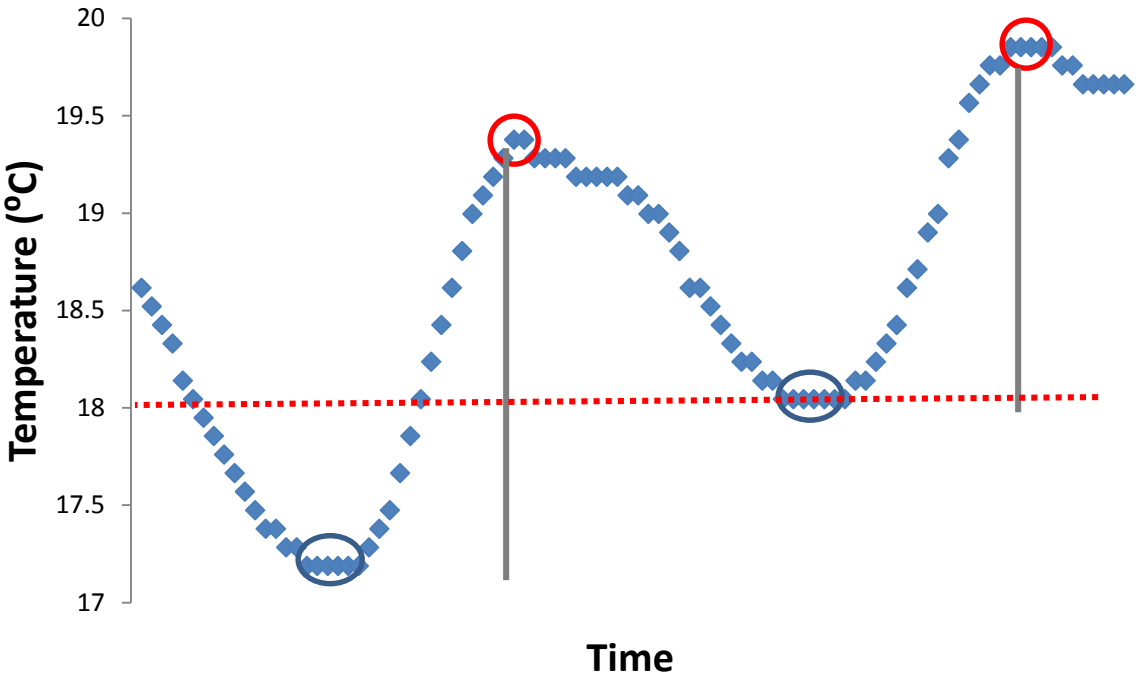
- Fish count by snorkeling, 200 m reaches
- Habitat metrics
  - Maximum depth
  - Average depth
  - Wetted and bankfull width
  - Substrate (Wolman 1954)
  - Pool count
  - Pool forming structure
  - Channel type (Montgomery and Buffington 1997)
- Temperature measured in study area via loggers

Fish species

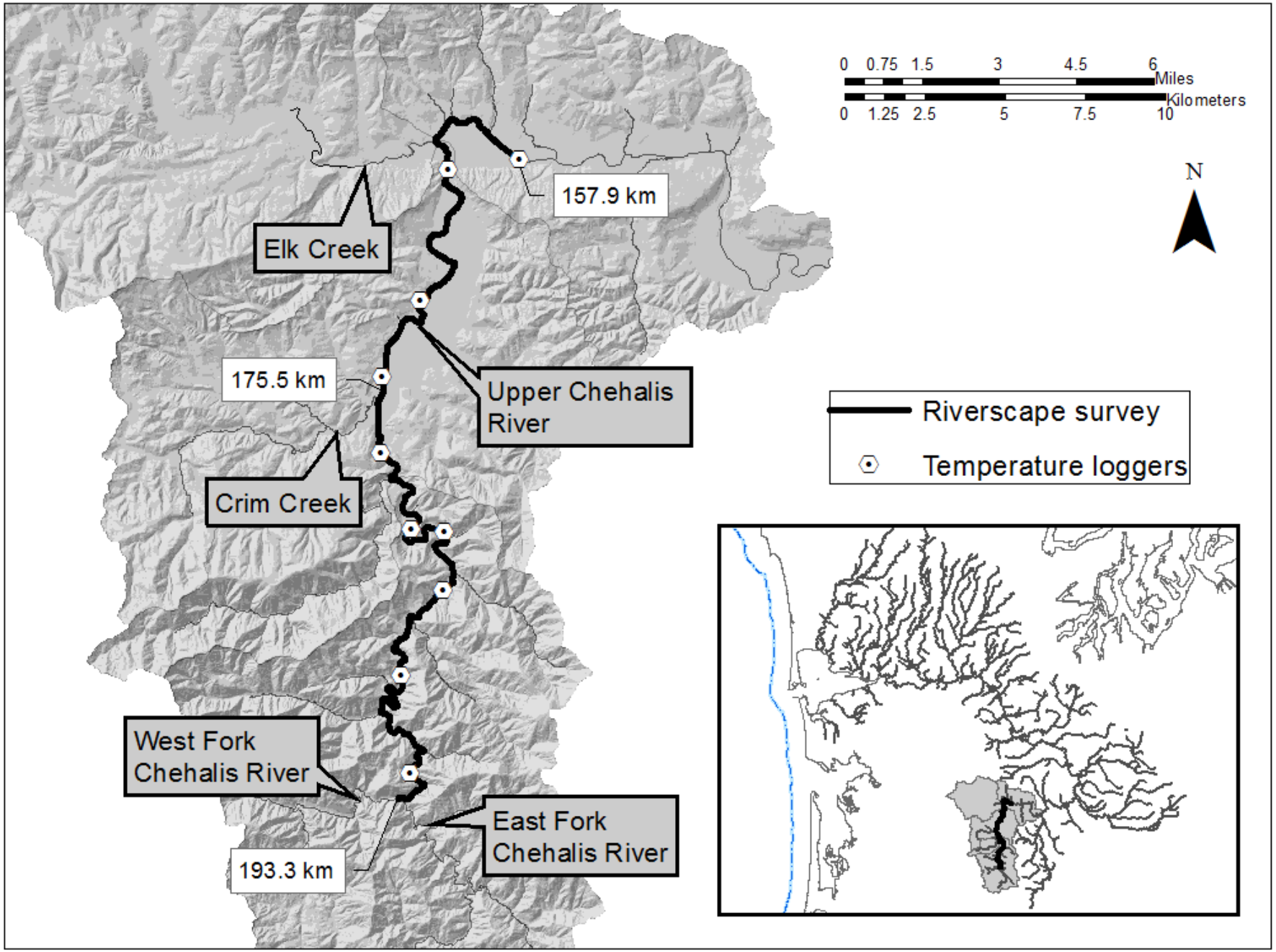
- Age 0 salmon (Chinook and coho)
- Age 0 trout (O. mykiss, O. clarkii)
- Age 1+ trout
- Redside shiner
- Dace (speckled and longnose)
- Northern pikeminnow
- Largescale suckers
- Mountain whitefish
- Exotic species*

Temperature metrics – there are lots! (Arismendi et al. 2013)

- Mean daily minimum
- Mean daily maximum
- Mean daily range
- Mean daily duration greater than 18°C (Madej et al 2006)



Chehalis River Riverscape Survey



Analysis – two multivariate approaches

- Spatial organization of fish, habitat, and temperature metrics independently

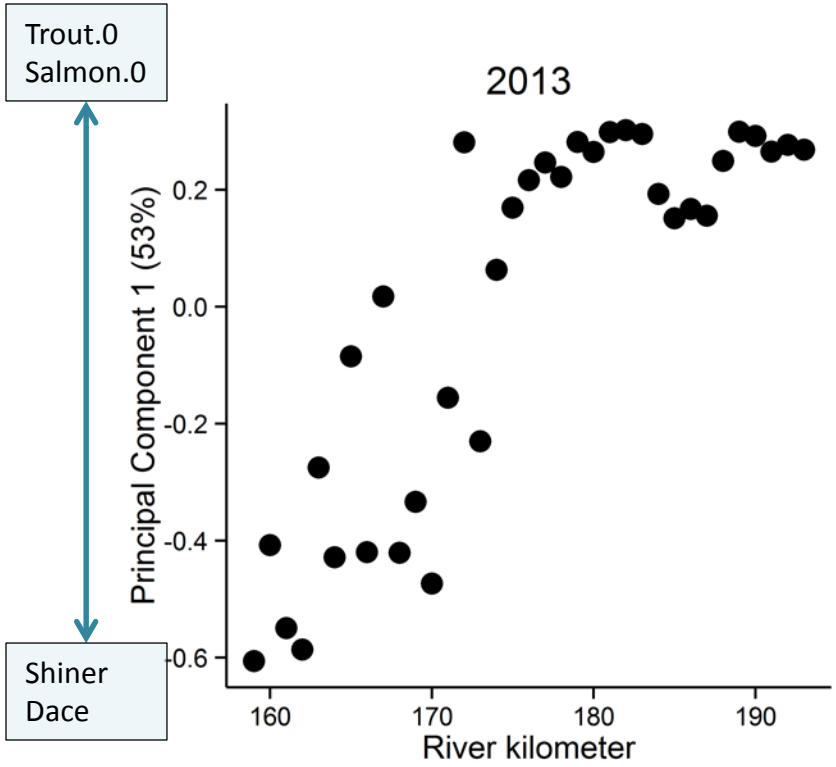
- Fish species composition explained by habitat & temperature metrics

Analysis – first approach

- Spatial organization of fish, habitat, and temperature metrics independently
  - PCA to describe the variation in fish species composition
  - Chord transformation for species counts (Legendre & Gallagher 2001)
  - PCA to describe variation in habitat and temperature
  - River gradient: PCA versus river kilometer

Spatial organization of fish species

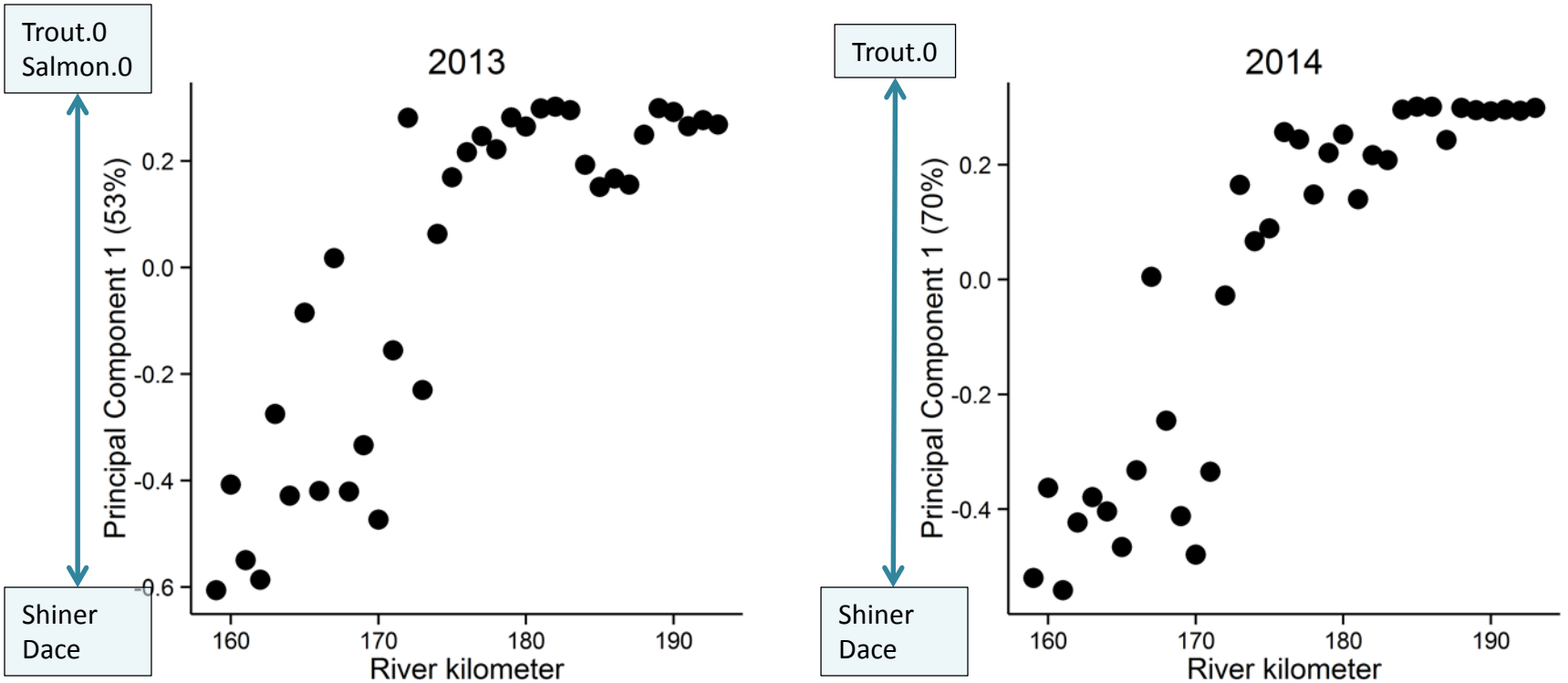
Principal components versus river kilometer



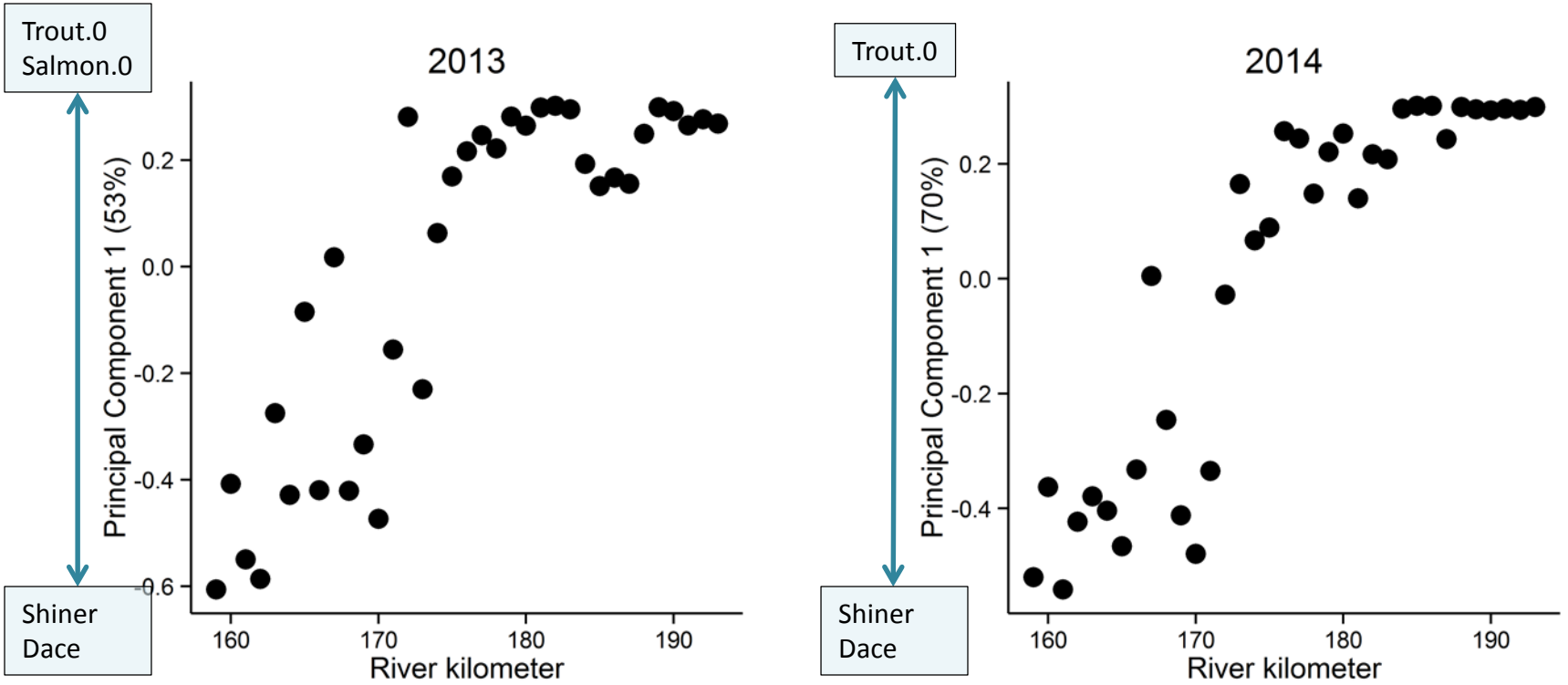
Fish assemblages described by PC1 are related to river km

Spatial organization of fish species

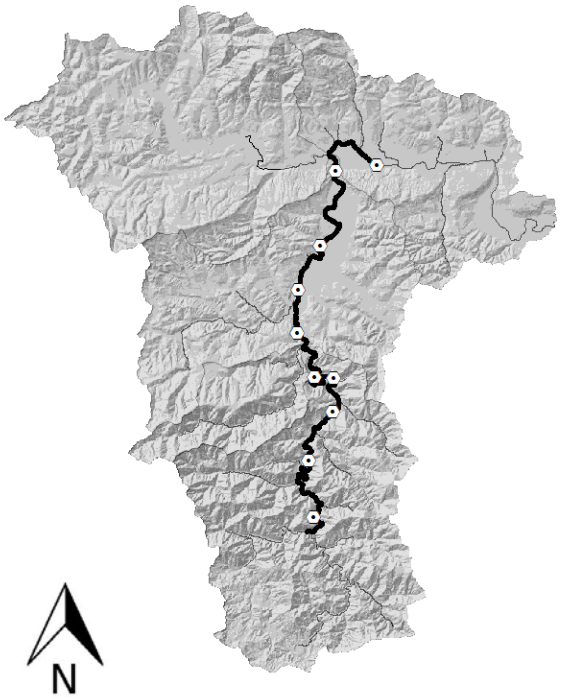
Principal components versus river kilometer

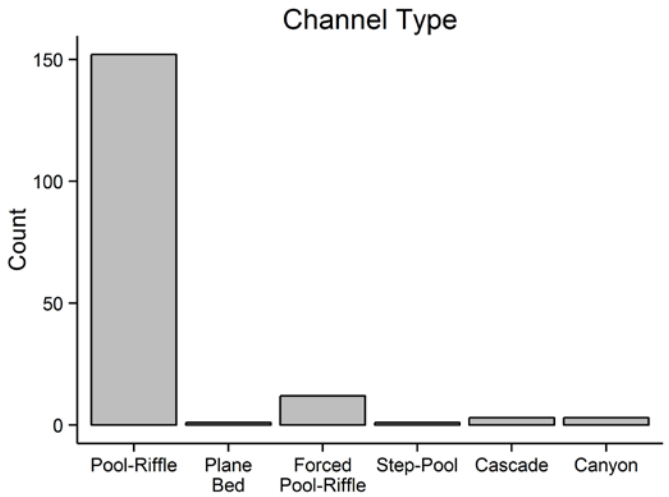


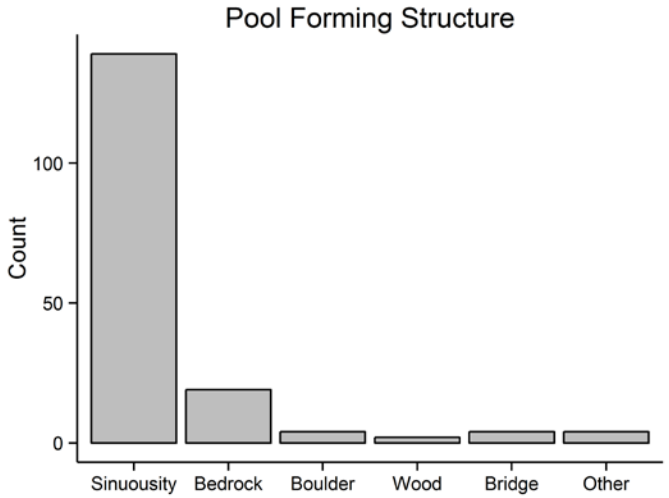
Both years, we observed a transition from juvenile salmonid zone (upper) to Cyprinid zone (lower) throughout study area



General Habitat Characteristics



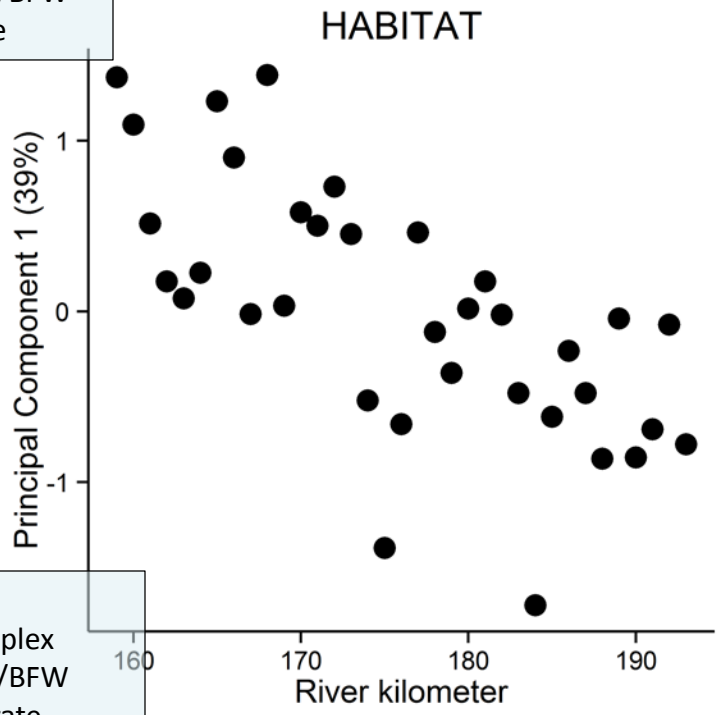




Spatial organization of habitat & temperature

Principal components versus river kilometer

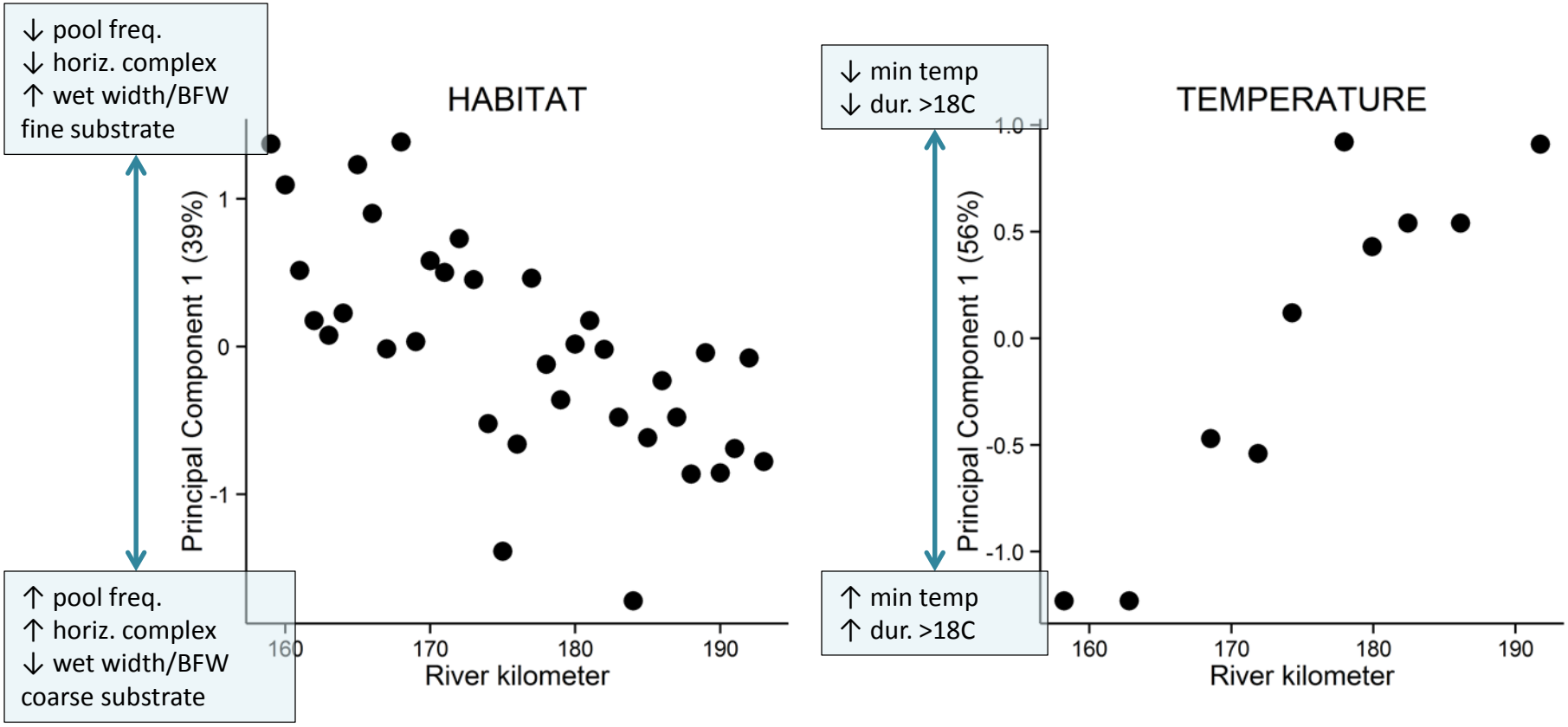
↓ pool freq.
↓ horiz. complex
↑ wet width/BFW
fine substrate



↑ pool freq.
↑ horiz. complex
↓ wet width/BFW
coarse substrate

Spatial organization of habitat & temperature

Principal components versus river kilometer

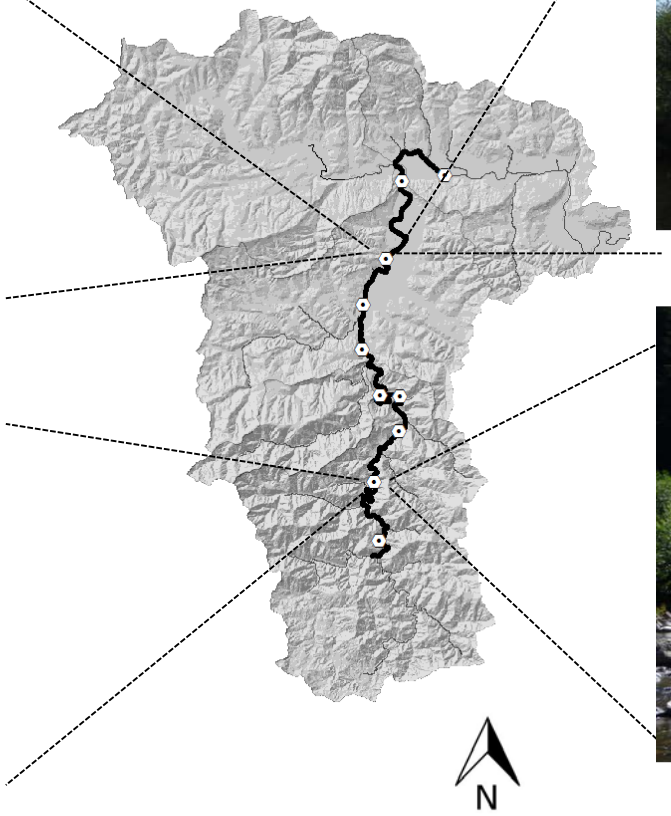


“River gradient” is the combined gradient in fish, habitat, and temperature

Temperature (mean daily)

Metric	Value
Min	18.7°C
Max	22.8°C
Range	4.1°C
Dur. > 18°C	0.90

Metric	Value
Min	16.2°C
Max	20.3°C
Range	4.1°C
Dur. > 18°C	0.44

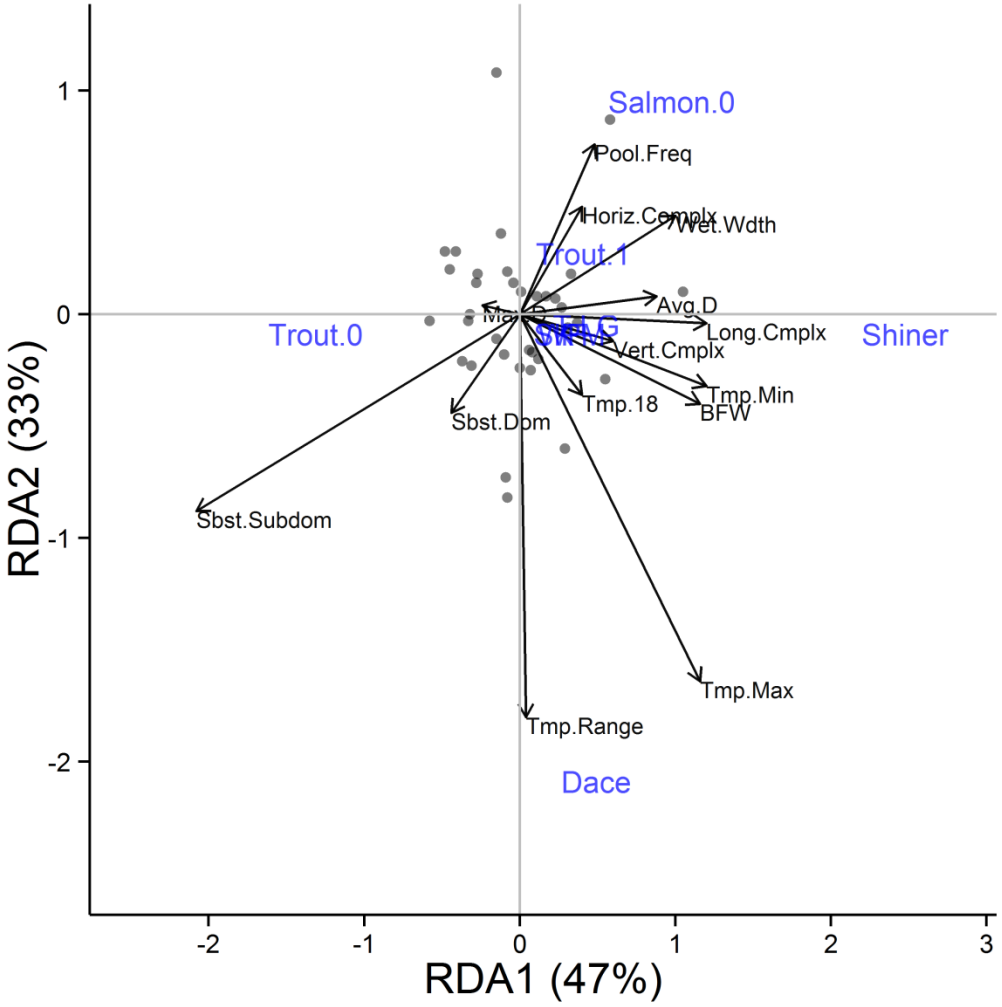


Analysis – second approach

- Fish species composition explained by habitat & temperature metrics
  - Partial RDA to ask whether habitat and temperature metrics explain species composition when controlling for river kilometer (i.e., river gradient accounted for).
  - Variance partitioning method to quantify variation explained by each variable individually and together (Borcard et al. 1992; Peres-Neto et al. 2006)

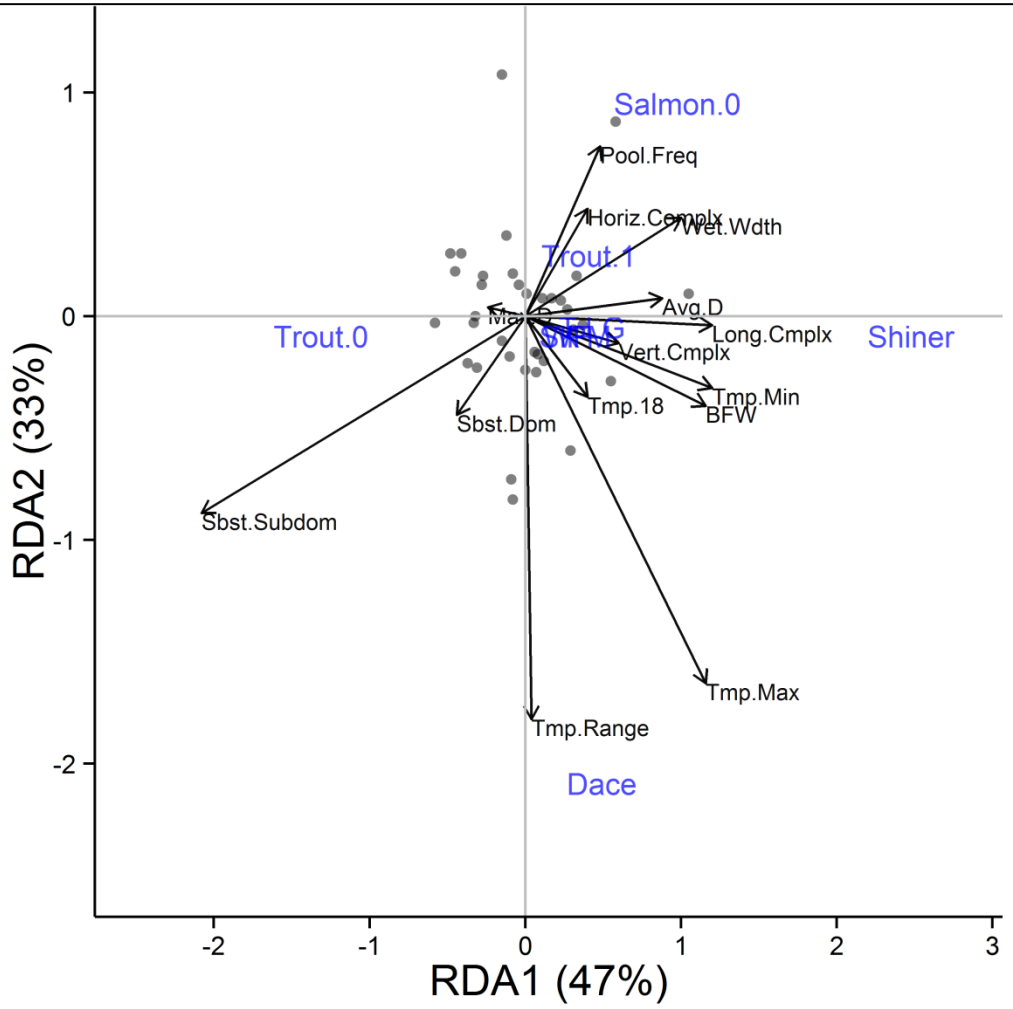
Species explained by habitat & temperature

Partial Redundancy Analysis



Permutation test: p = 0.001

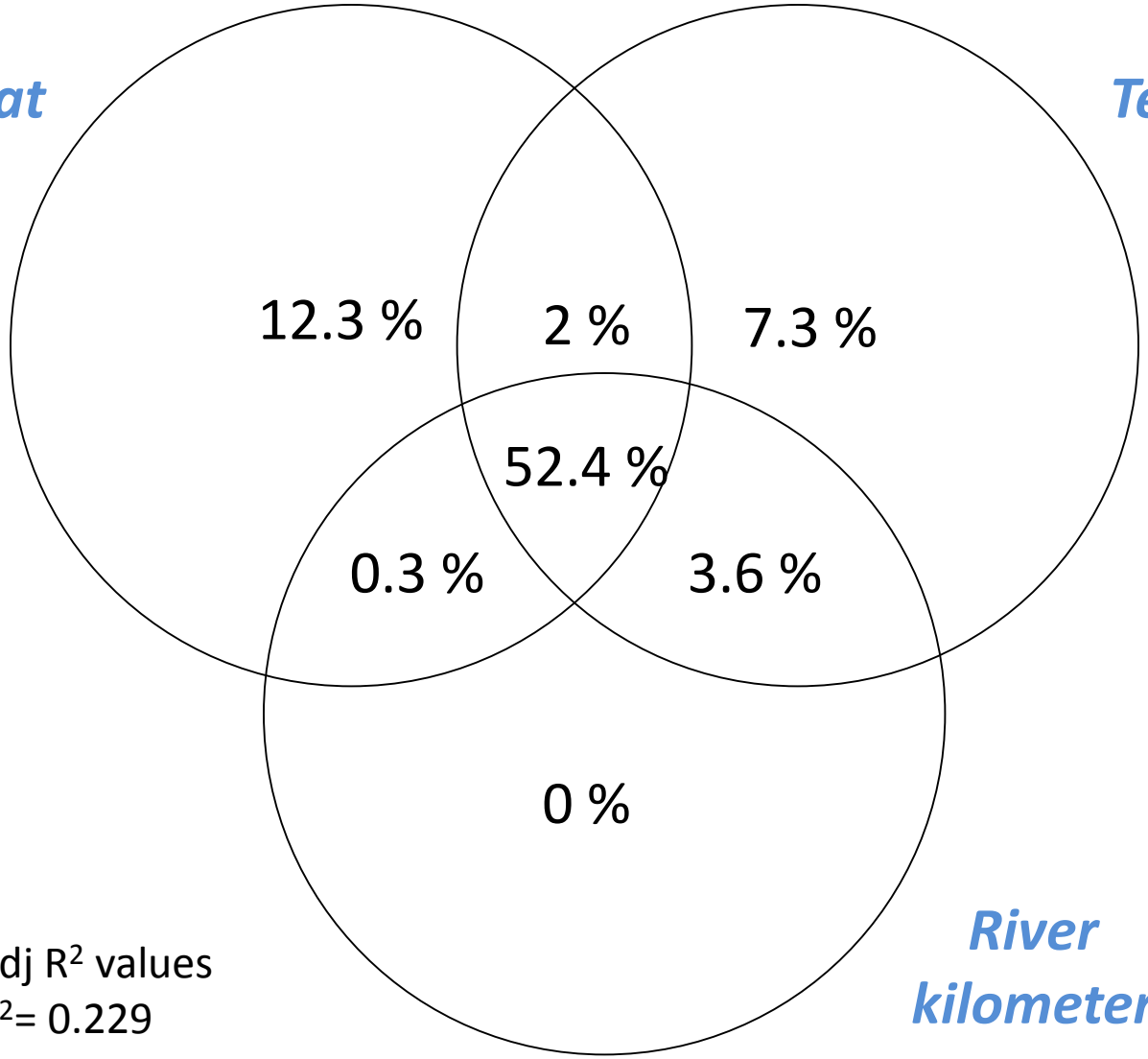
Once river km was accounted for, the combination of habitat and temperature metrics explained additional variation in fish species composition



Permutation test: $p = 0.001$

Species explained by habitat & temperature

Variance Partitioning



Numbers are adj R^2 values
Residual Adj R^2= 0.229

Summary: River km, habitat, temperature

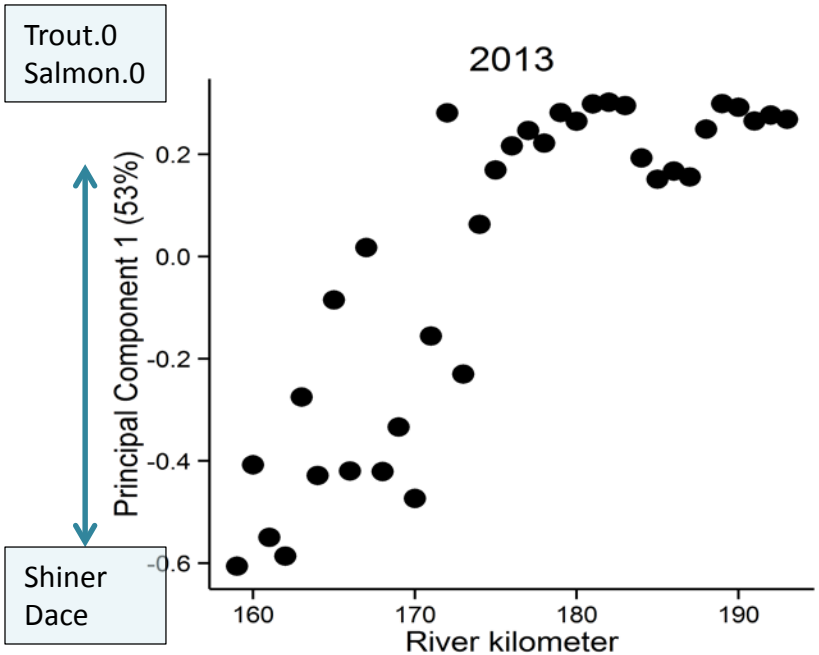
- "River gradient" explains majority of overall variation (52.4%) in species composition but a smaller portion is explained by habitat (12.3%) and temperature (7.3%) characteristics alone.

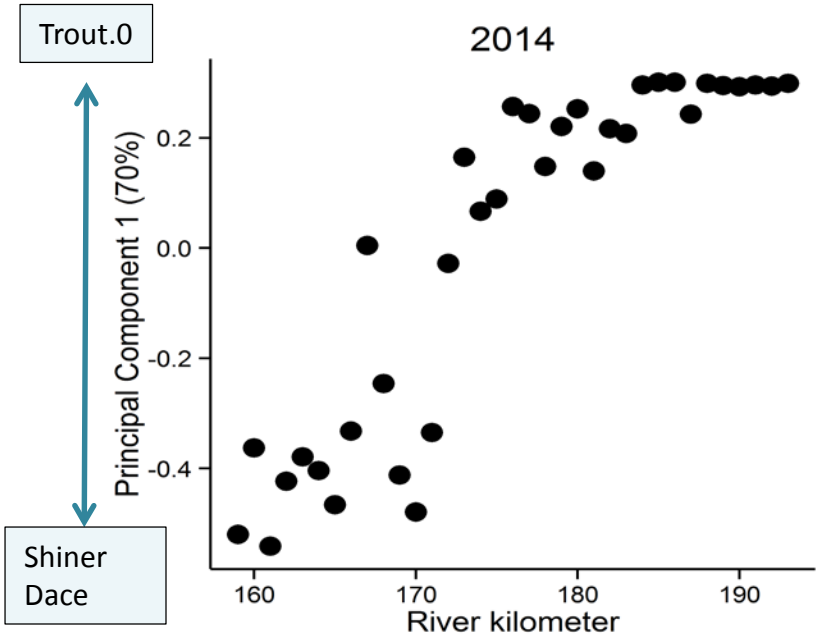
	AGE-0 TROUT	SHINER
Habitat	Coarse substrate	Fine substrate
	High long. complexity	Low long. complexity
Temperature	Low minimum	High minimum
	Low maximum	High maximum

	AGE-0 SALMON	DACE
Habitat	High pool freq	Low pool freq
Temperature	Low maximum	High maximum
	Low temp range	High temp range

Discussion

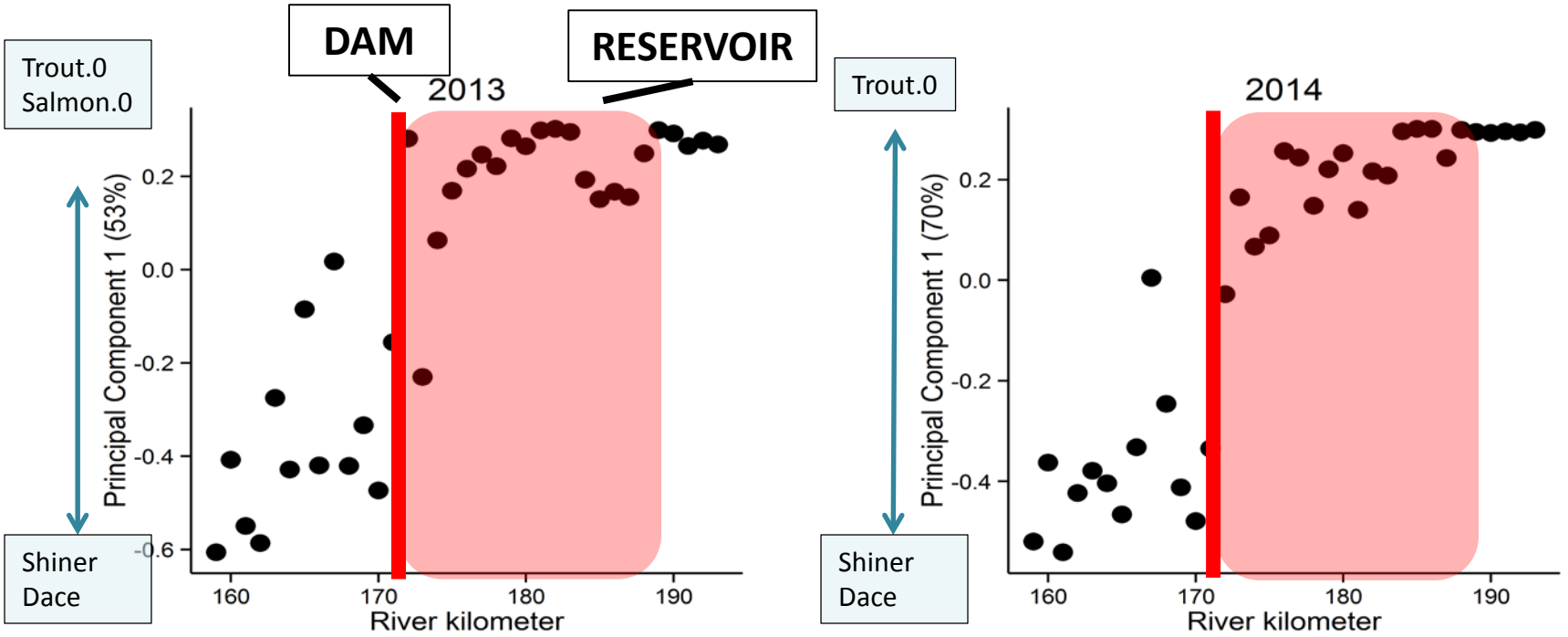
- "River gradient" being observed here is consistent with "River continuum"
- A portion of fish species composition is not explained by any of the variables examined at summer low flows



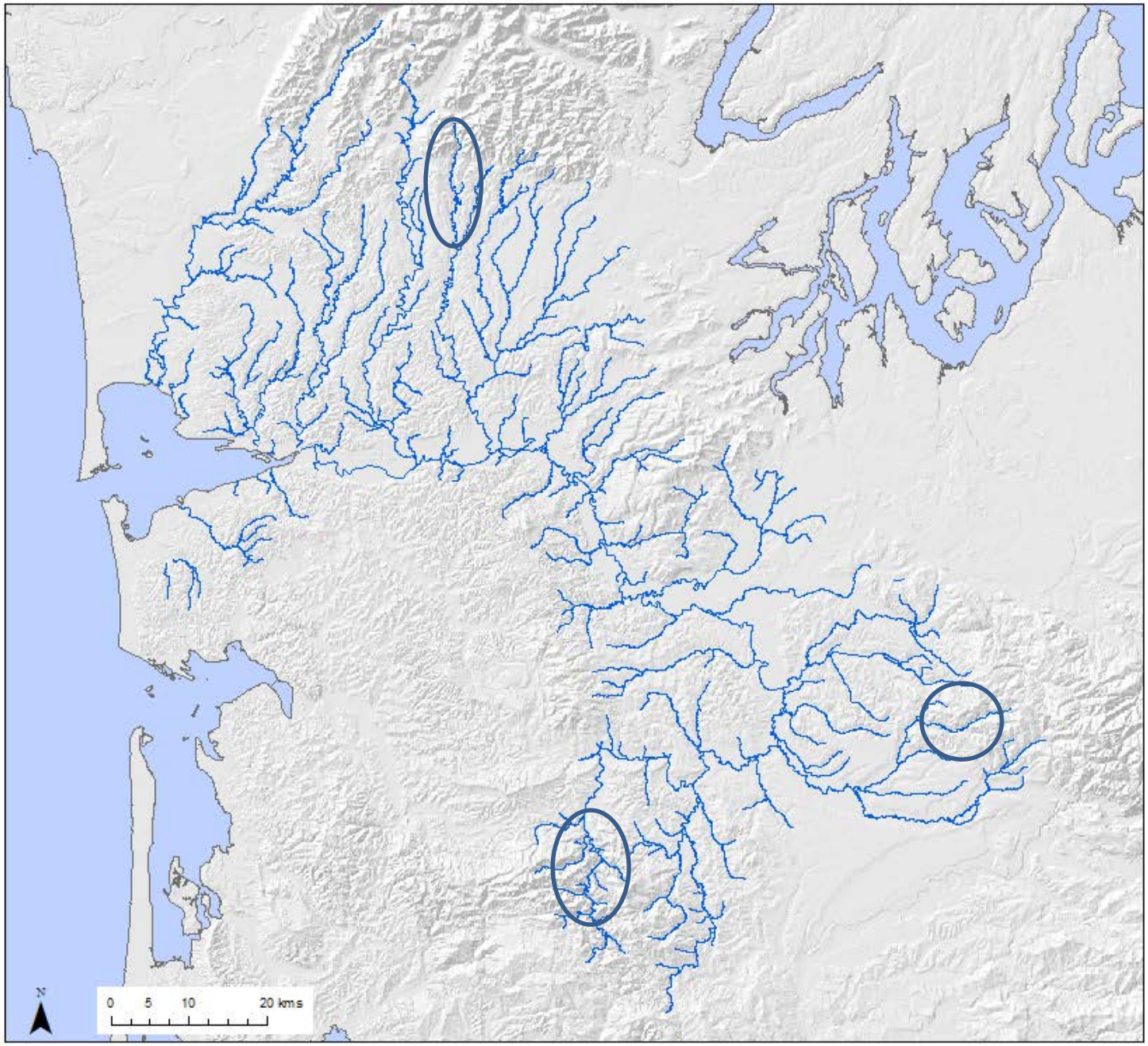


Discussion

- "River gradient" being observed here is consistent with "River continuum"
- A portion of fish species composition is not explained by any of the variables examined at summer low flows
- Fish composition can be explained by an interaction of habitat, temperature, and river km
  - Cautious to say any one factor makes a reach suitable for juvenile salmonids



Chehalis River Anadromous Streams



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Anadromous Streams

Restoration implications for summer rearing habitat

- Multiple characteristics of the river appear to provide suitable summer rearing areas for juvenile salmonids
- Are we focusing on improving habitat where salmonids currently are distributed?
- Are we attempting to expand habitat into area's that salmonids are not currently occupying?

Acknowledgements

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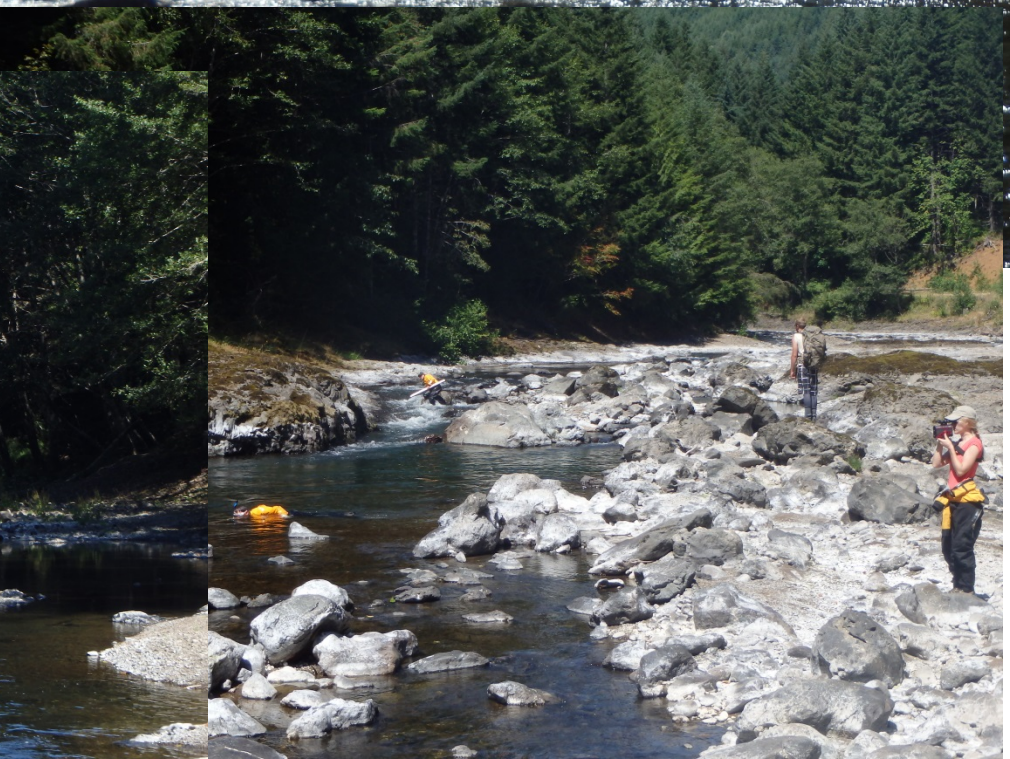
- Helpful comments:
  - George Pess and Martin Liermann (NOAA)
  - Christian Torgersen (USGS)

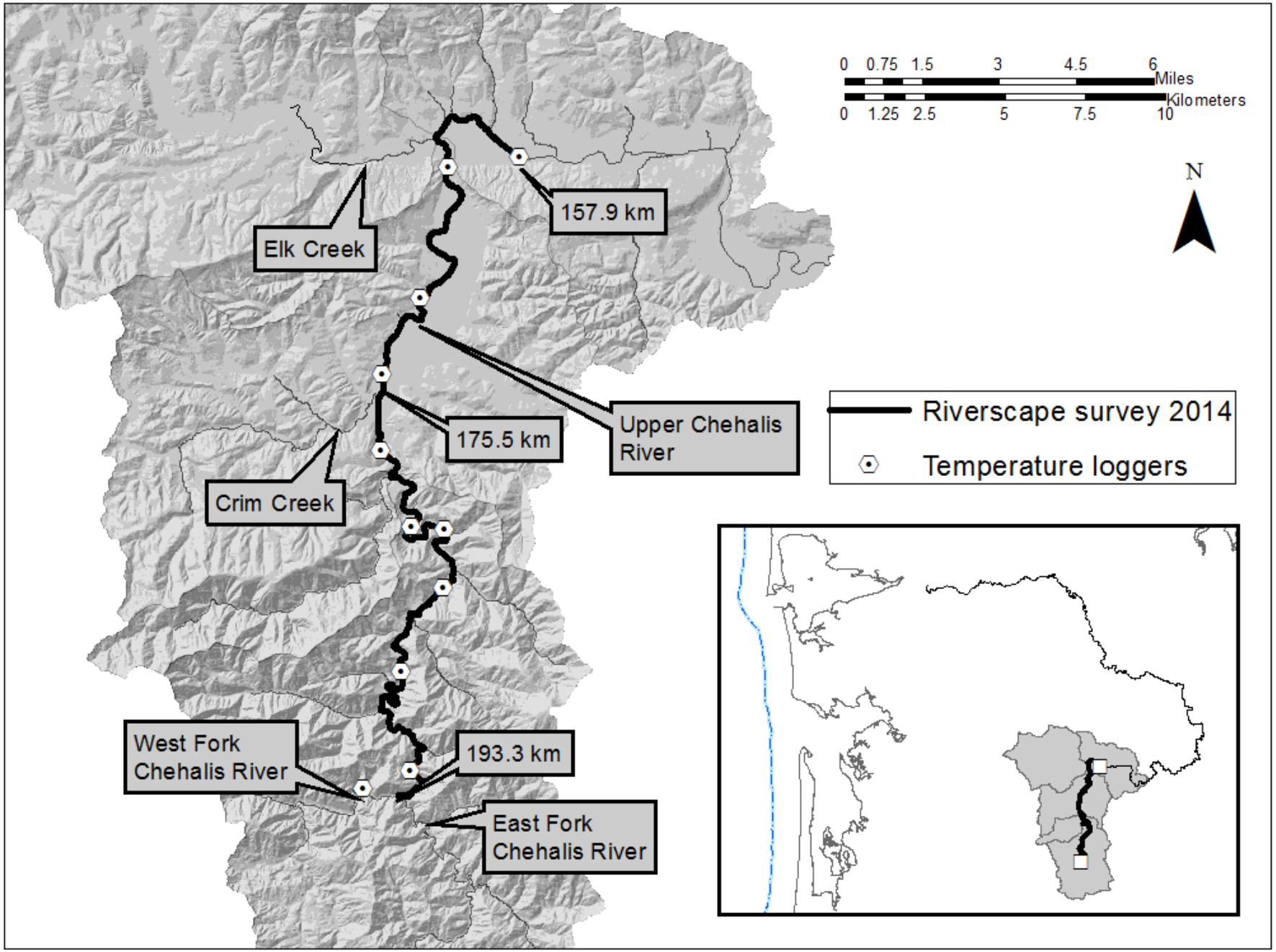
Thank you!

Discussion

- “River gradient” likely result of geomorphology, watershed size, historical land use combined.
- Transition in summer fish assemblages(if observed in other sub-basins) suggests suitable summer rearing areas for salmonids are a small subset of 5000 km^2 basin.
- Fish assemblage can be explained by both river gradient and reach-scale characteristics.
  - Age-0 trout vs. shiner, age-0 salmon vs. dace
- A portion of fish species assemblages is not explained by any of the variables examined at summer low flows
  - Factors at other temporal or spatial scales



Riverscape survey



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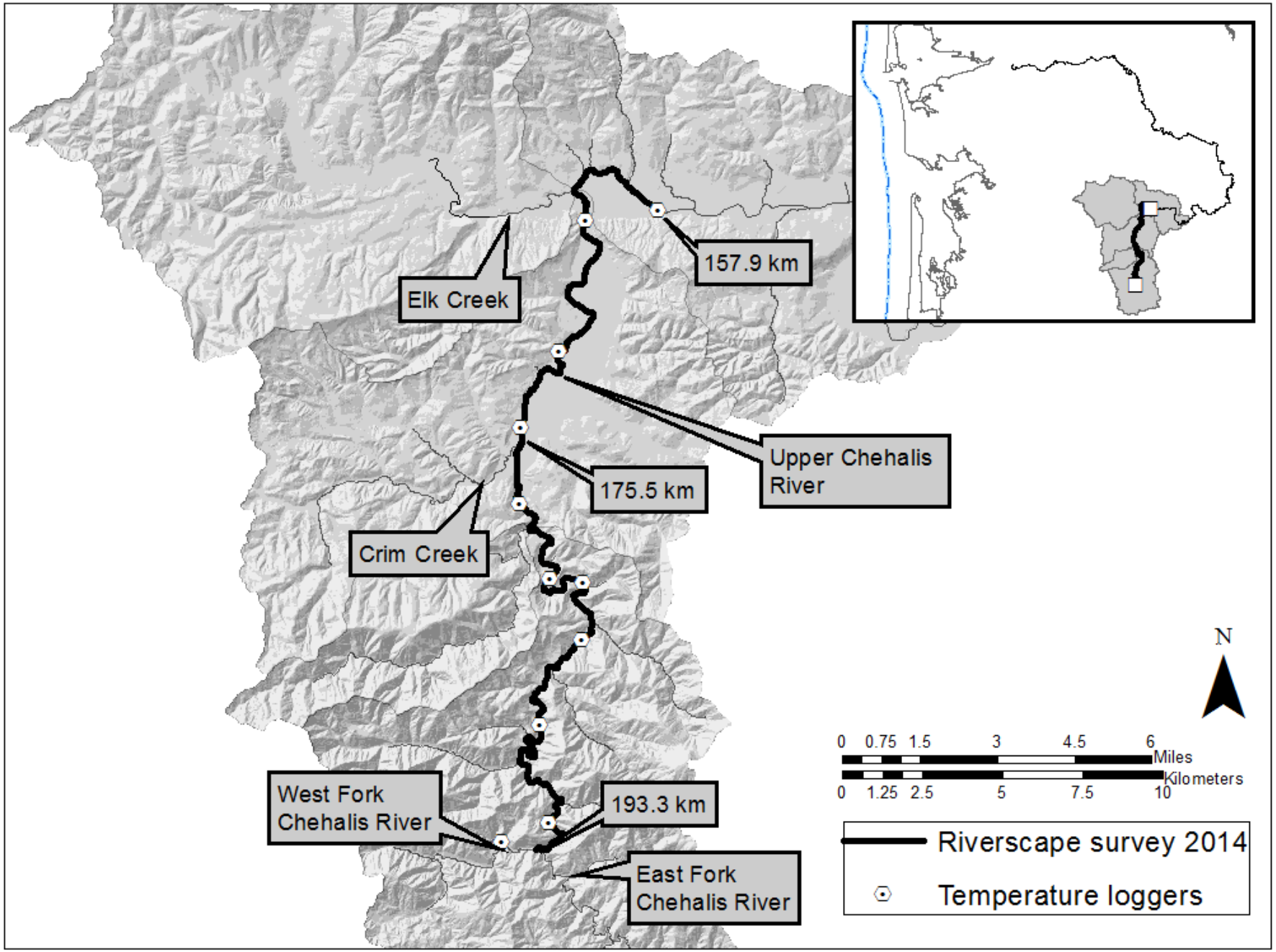
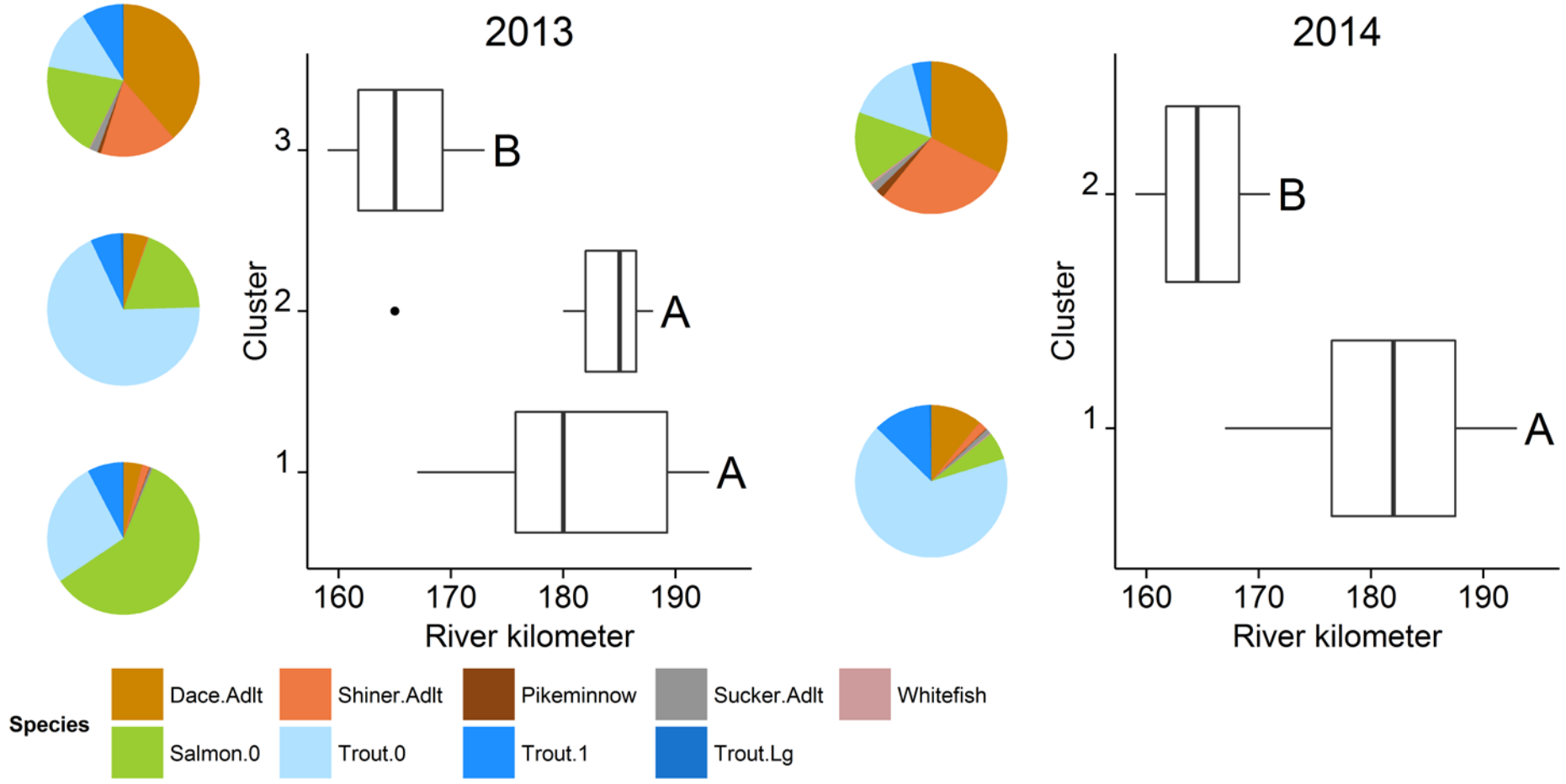


Spatial organization of fish species

K-Means clusters versus river kilometer



Summary: Spatial Organization

- "River gradient" is the combined gradient in fish, habitat, and temperature

	UPSTREAM	DOWNSTREAM
Fish	Juvenile salmonid	Cyprinid
Habitat	Coarse substrate	Fine substrate
	High pool freq	Low pool freq
	Narrow wet width	Wide wet width
	High horizontal complexity	Low horizontal complexity
Temperature	Low minimum	High minimum
	Low duration > 18C	High duration > 18C

Riverscape – a spatially continuous approach (Fausch et al. 2002)

Channel complexity metrics

Channel complexity metrics

- Horizontal (cross section)
  - Wetted width : Bankfull width

Channel complexity metrics

- Horizontal (cross section)
  - Wetted width : Bankfull width

- Vertical (cross section)
  - Average wetted width : Maximum depth

Channel complexity metrics

- Horizontal (cross section)
  - Wetted width : Bankfull width

- Vertical (cross section)
  - Average wetted width : Maximum depth

- Longitudinal
  - Average depth : Maximum depth

Spatial organization of fish species

Principal components versus river kilometer