Temperature conditions and thermal tolerances: a comparison across salmonids

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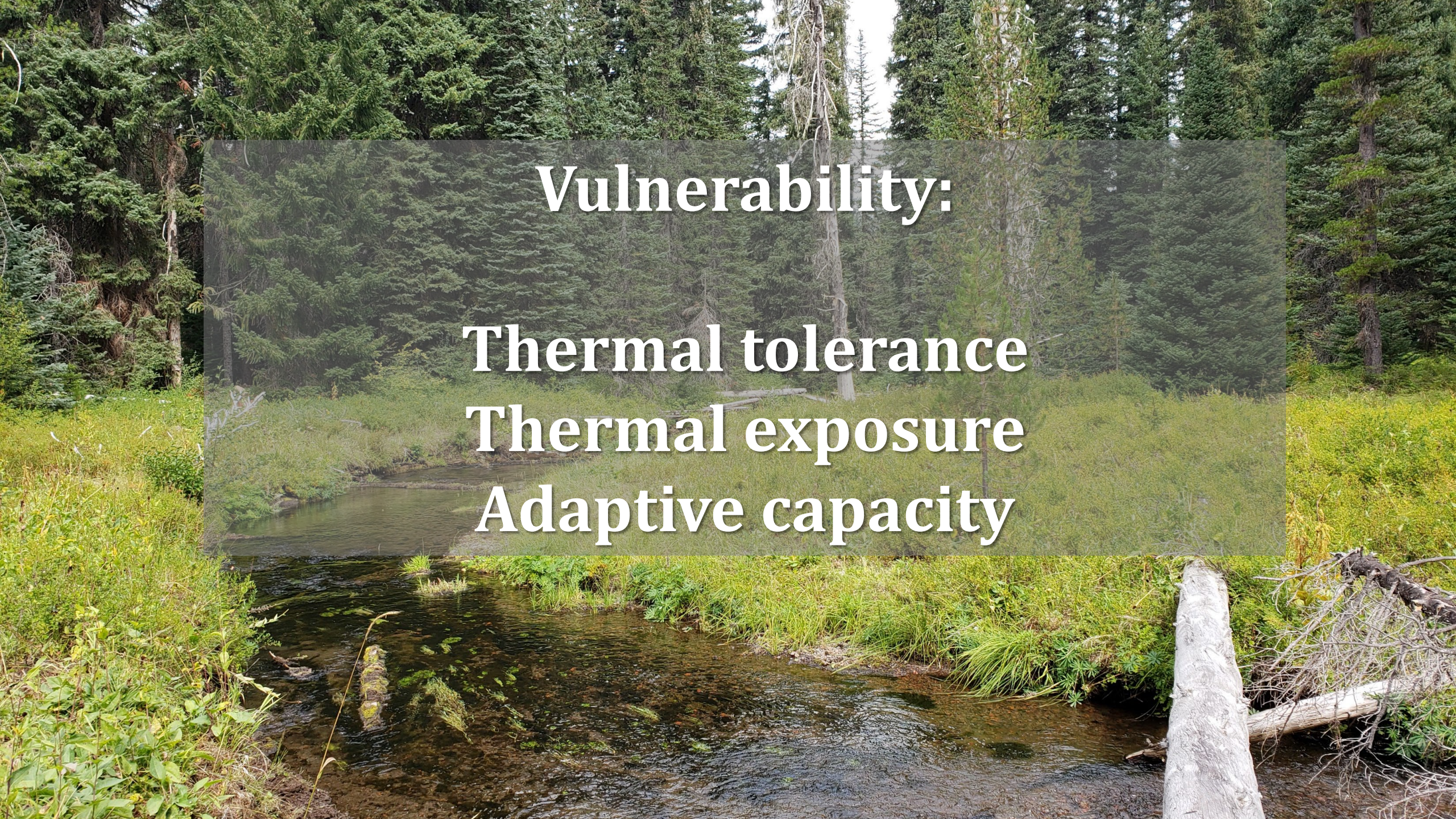
How does temperature influence the performance and persistence of fish?


Vulnerability:
Thermal tolerance
Thermal exposure
Adaptive capacity

Today

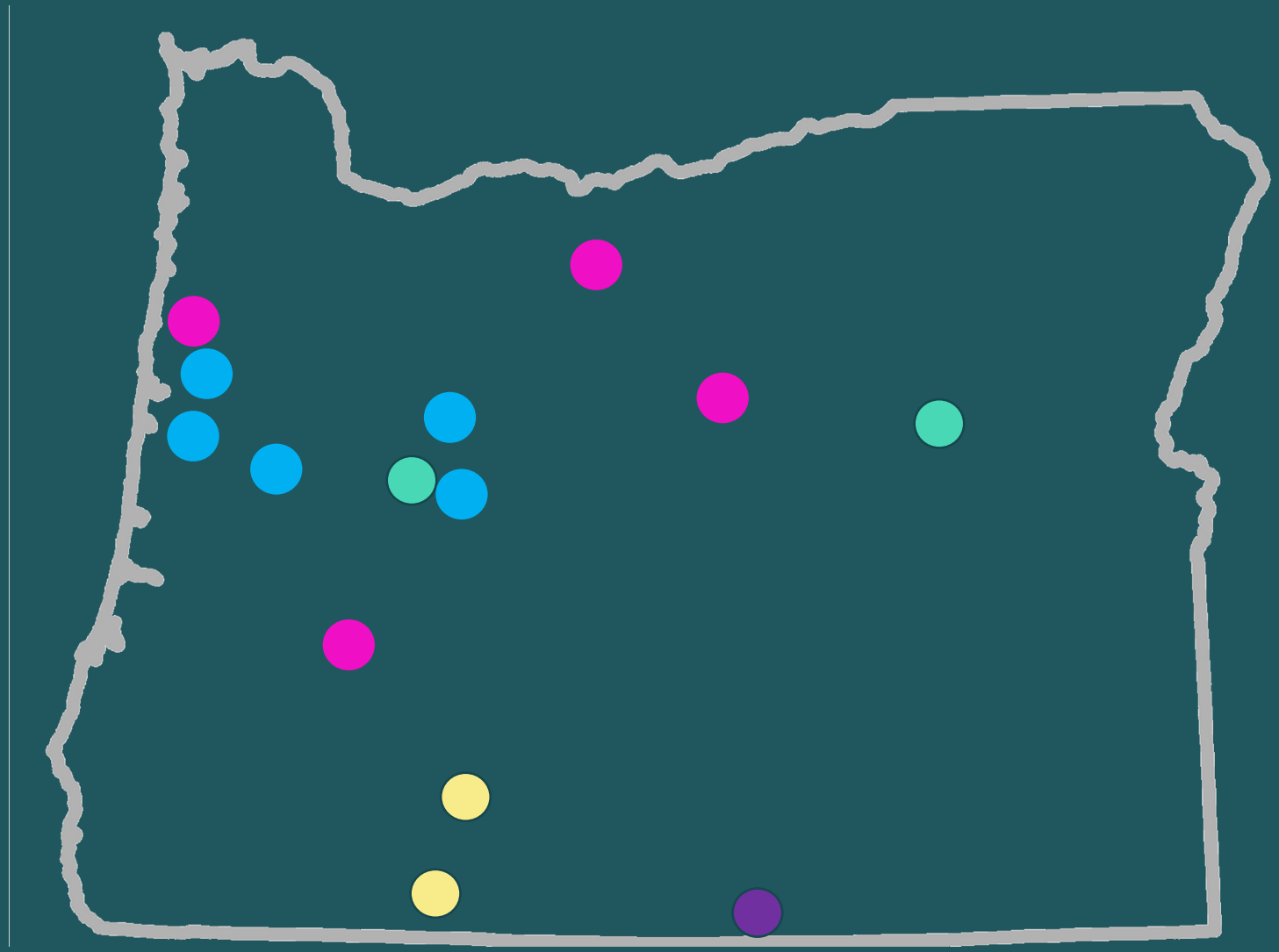
- Assess/measure *functional* thermal tolerance
- Review of coastal cutthroat trout thermal tolerance
- Variability of thermal tolerances
- How can these data better inform conservation decisions

Conservation physiology

Ecological relevance

Collaboration

Initial focus on most exposed and sensitive species



- Summer Steelhead
- Spring Chinook
- Coastal Cutthroat
- Warner Sucker
- Redband Trout

Species/Life stage

Sockeye (adult, juv)

Chinook (adult)

- Eliason et al., 2011 Science
- Eliason et al., 2013 JFB
- Eliason et al., 2017 Can J Zool
- Van Wert et al., 2023 Cons Phys
- Mayer et al., 2024 Fish & Fisheries
- Mayer et al., in prep

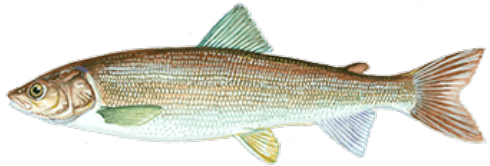
Steelhead (juv)

Coastal cutthroat trout (adult, juv)

Chinook (juv)

Redband (juv)

Mountain whitefish (juv)

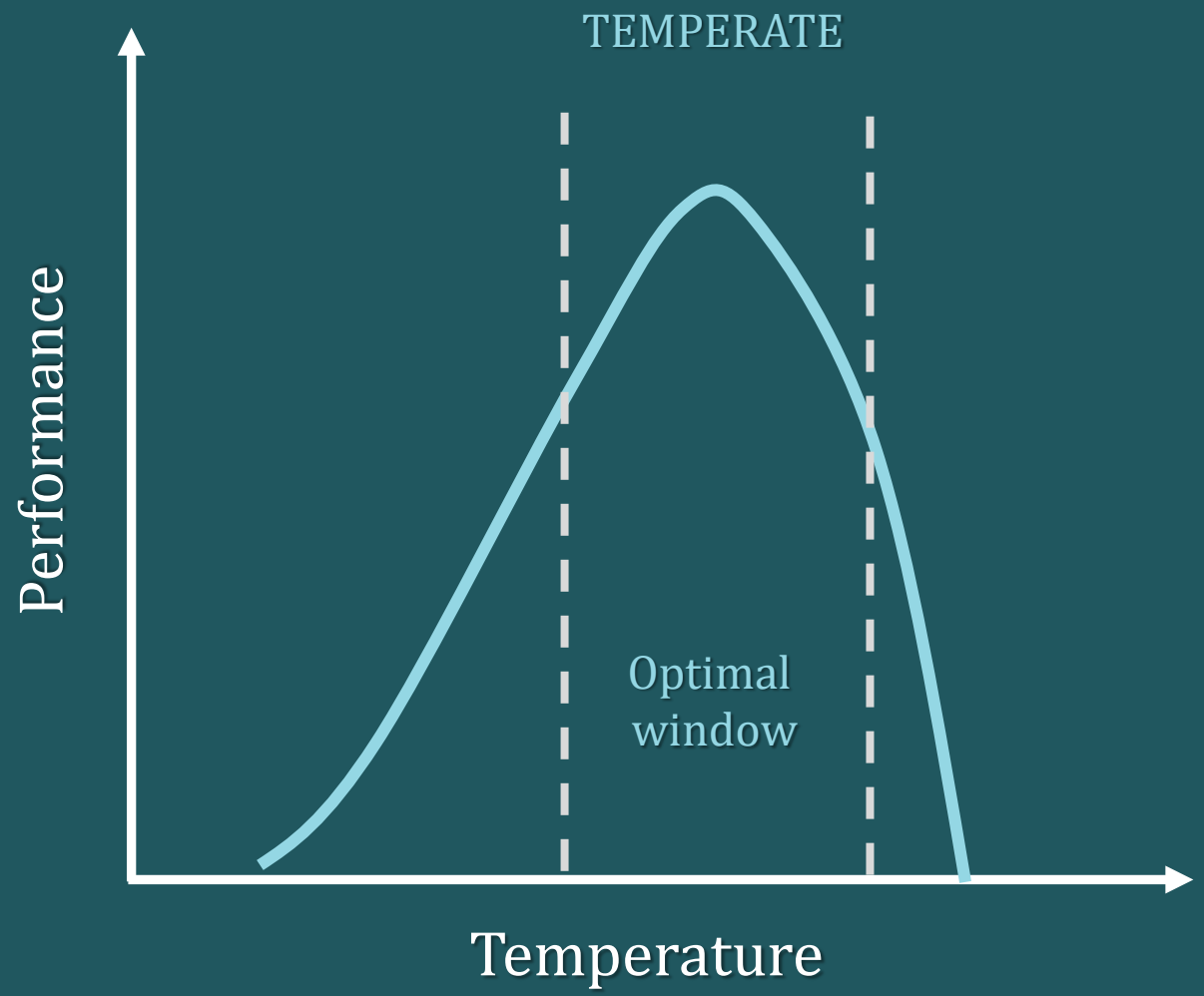


Warner sucker (juv)

- Anlauf-Dunn et al 2023 Cons Phys
- Hahlbeck et al 2023 Ecosphere
- Benjamin et al 2023 CJFAS
- Dressler et al in review

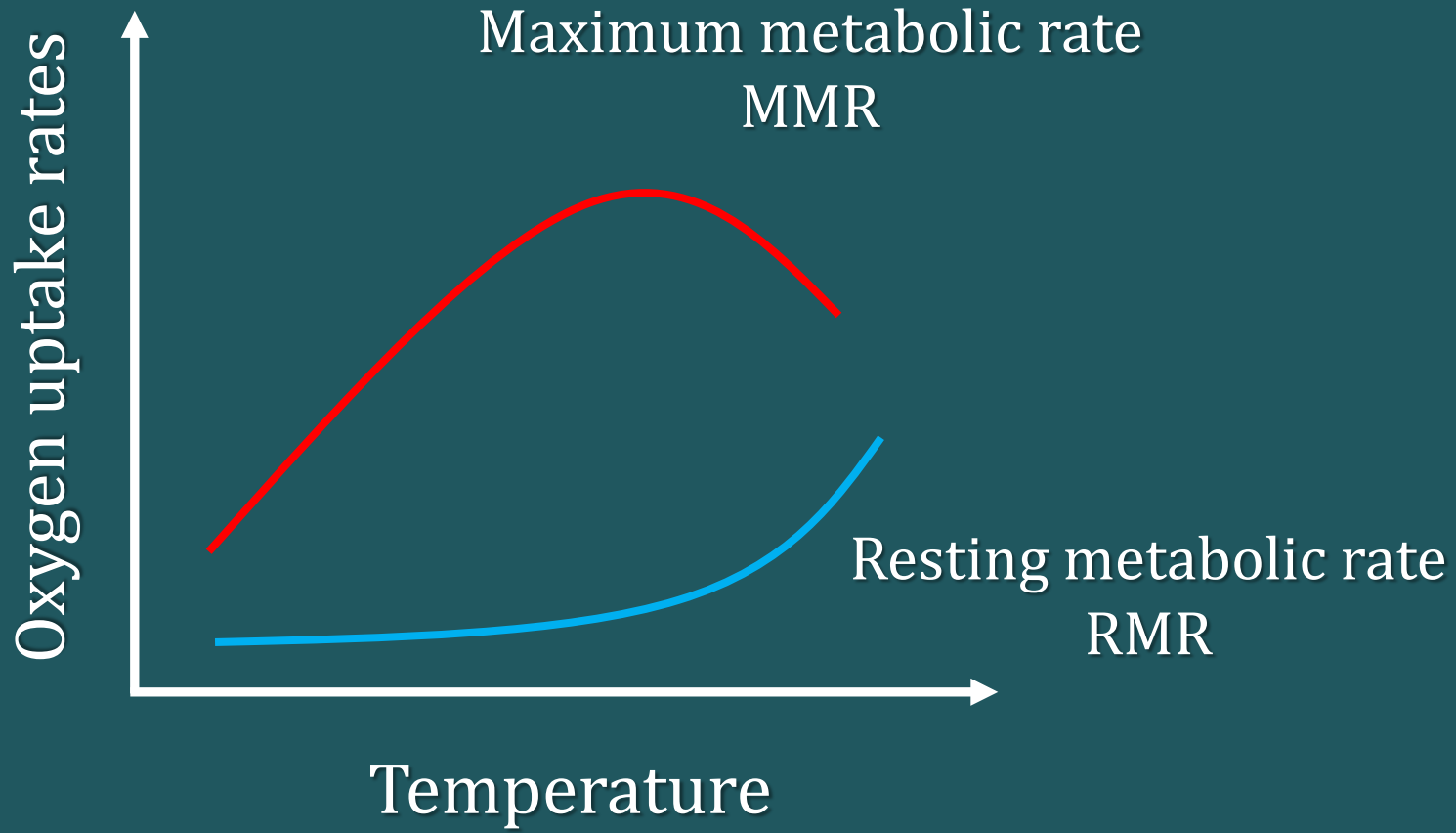
Assess *functional* thermal tolerance

THERMAL PERFORMANCE CURVE (TPC)

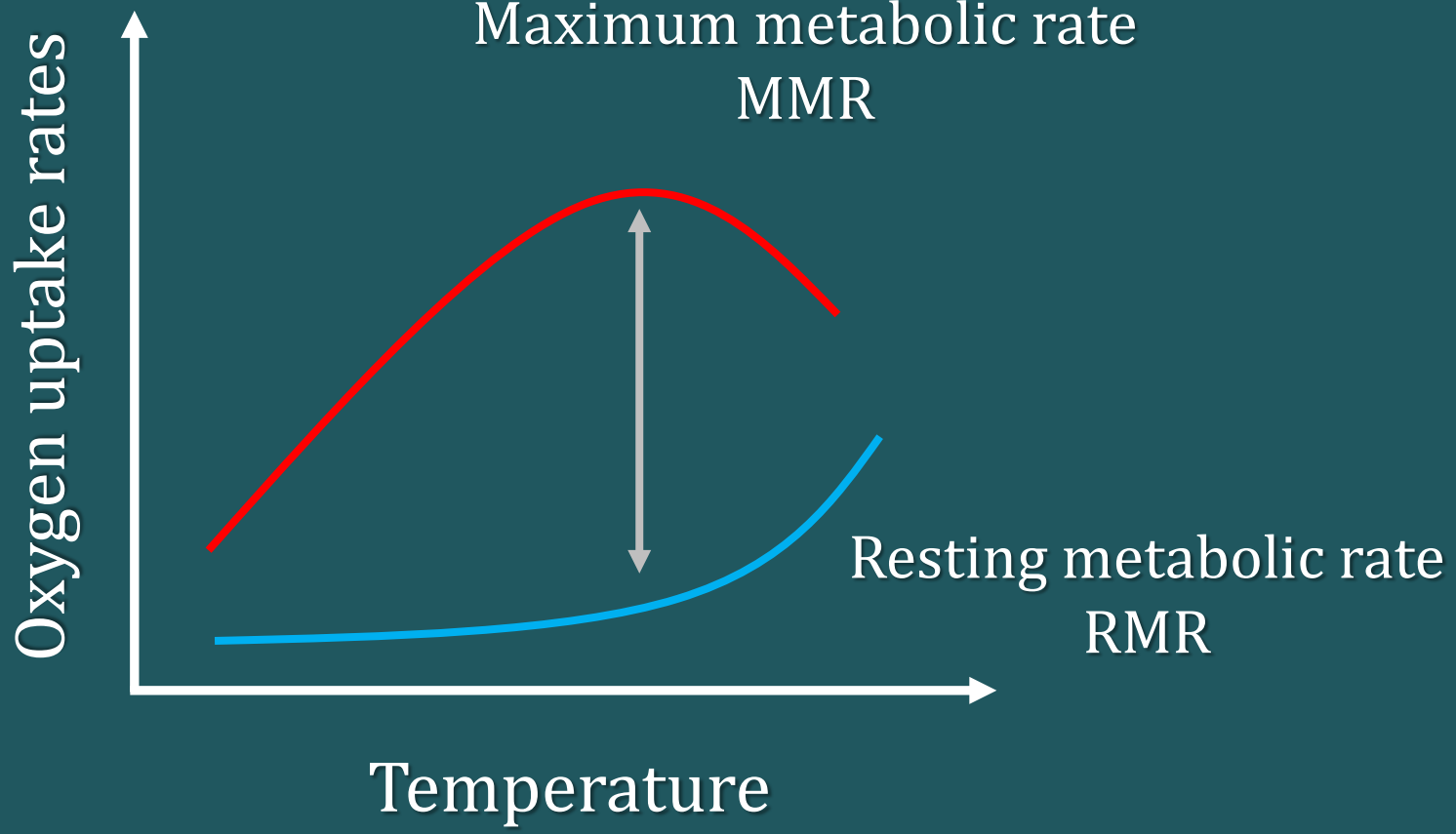


<u>Performance</u>
Growth
Swimming
Reproduction
Aerobic Scope

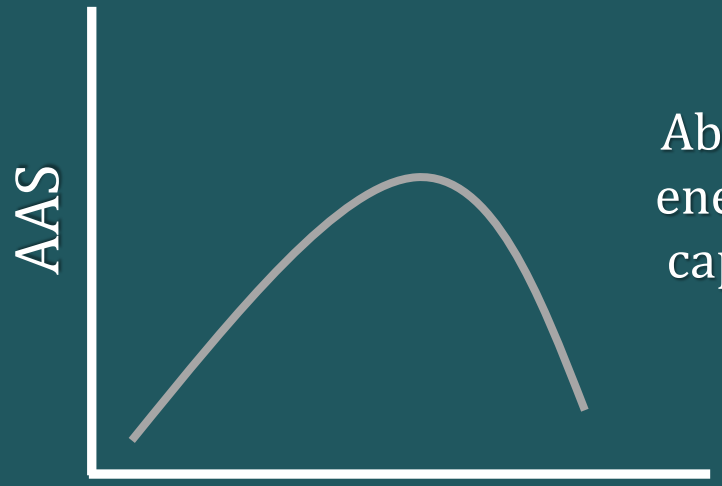
Assess *functional* thermal tolerance



Assess *functional* thermal tolerance

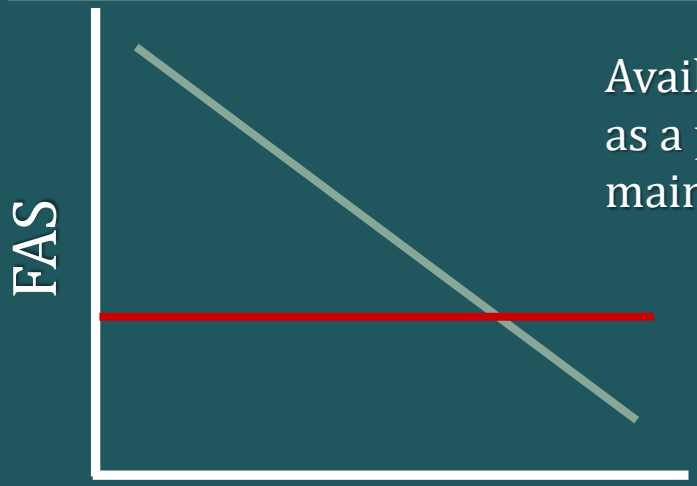


Absolute Aerobic Scope = MMR-RMR



Absolute energetic capacity

Factorial Aerobic Scope = MMR/RMR



Available energy as a proportion of maintenance costs

FAS = 3

Measure *functional* thermal tolerance

Streamside respirometry - Workflow

Collect fish

Hold at temperature treatment

Acclimate for 18 hours

In chambers

Maximum metabolism

Resting metabolism

Critical thermal maximum

Measure *functional* thermal tolerance

Streamside respirometry - Workflow

Collect fish

Hold at temperature treatment

Acclimate for 18 hours

In chambers

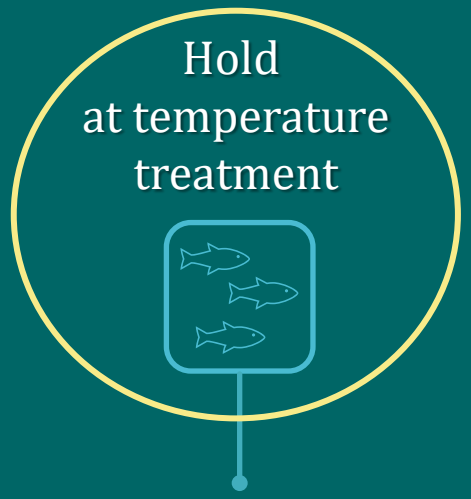
Maximum metabolism

Resting metabolism

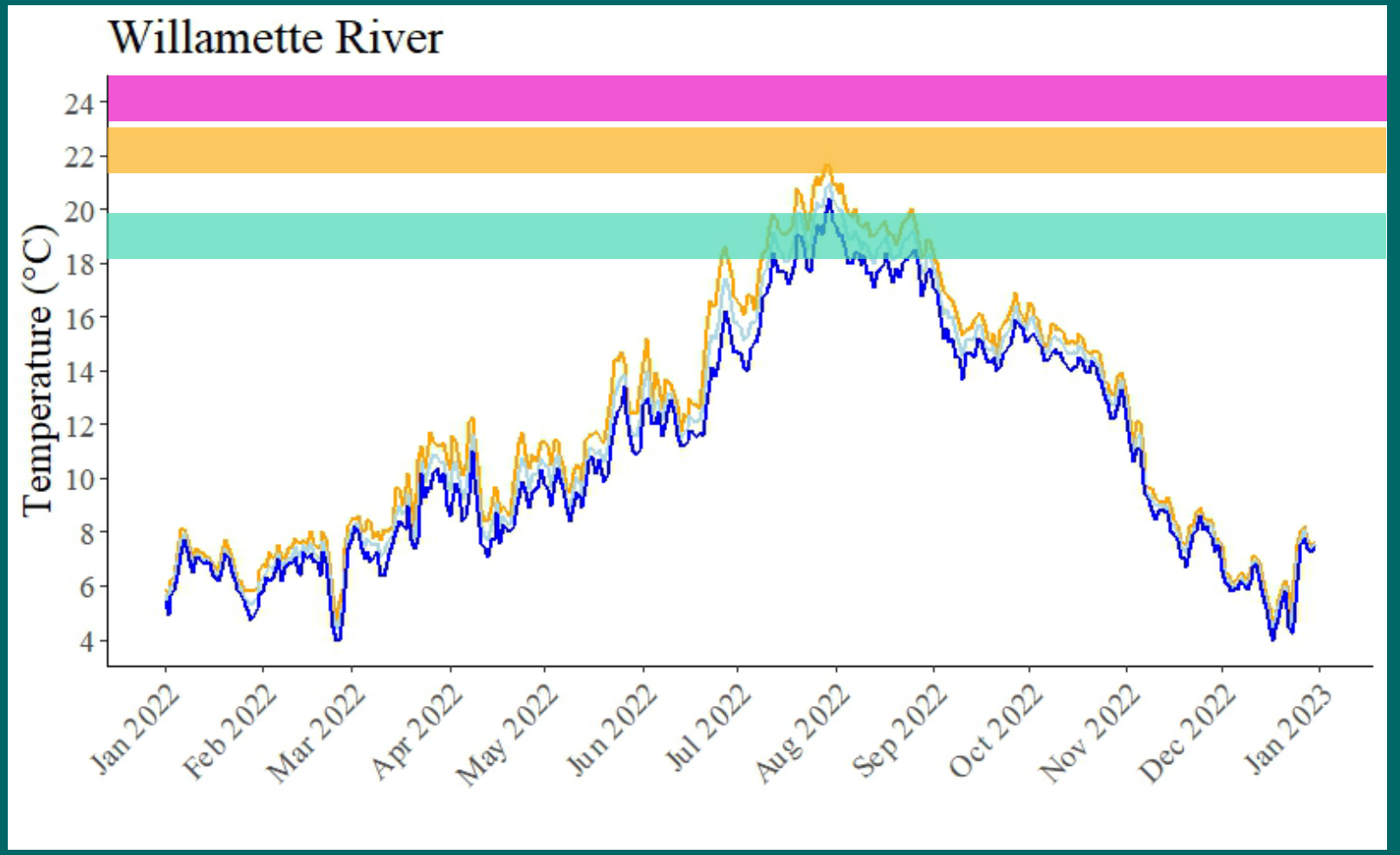
Critical thermal maximum

Ecological Relevance

Temperature data informs thermal treatments



Ambient
Max
Climate



Climate 24^0 C

Max 22^0 C

Ambient 19^0 C

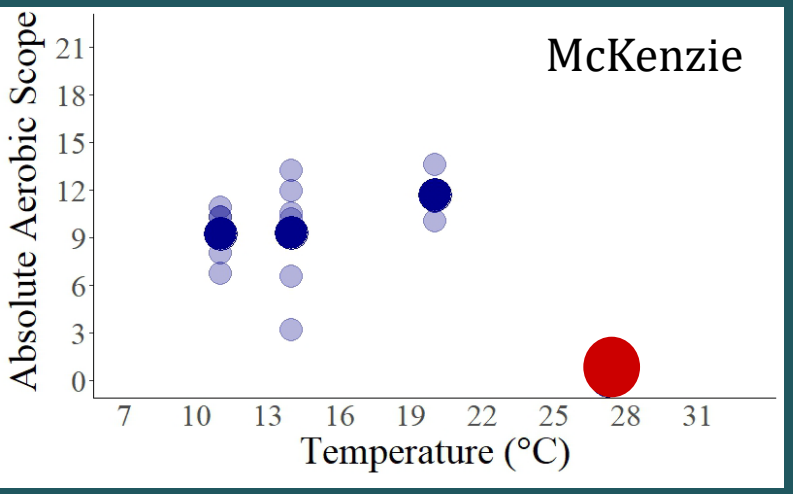
Measure *functional* thermal tolerance

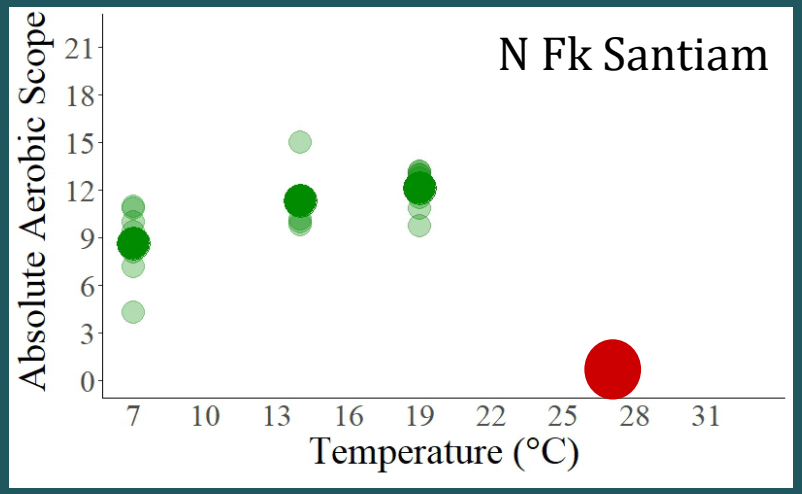
Streamside respirometry
Treatments for Coastal Cutthroat Trout

	Juvenile				Adult	
	McKenzie	N.Fk Santiam	Siletz	Alsea	Will. Mainstem	Will. Alcove
Ambient	9	7	17	16	19	15
Max	12	14	19	19		19
Climate	19	19	22	22	24	

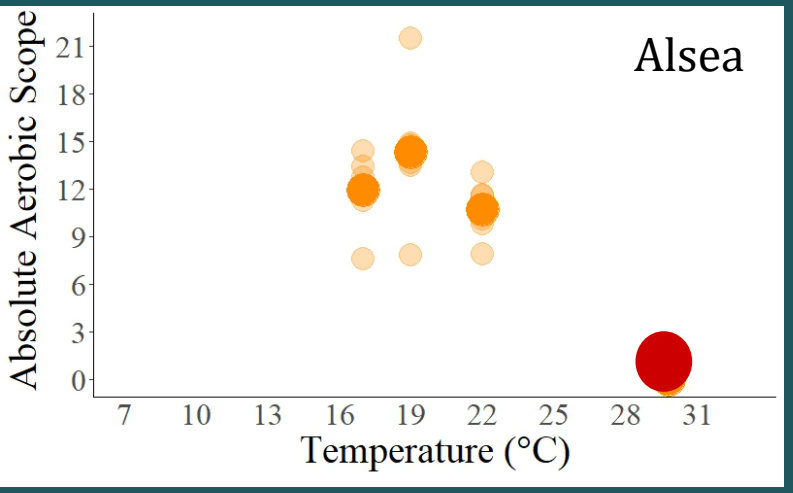
Coastal Cutthroat Trout: Juveniles

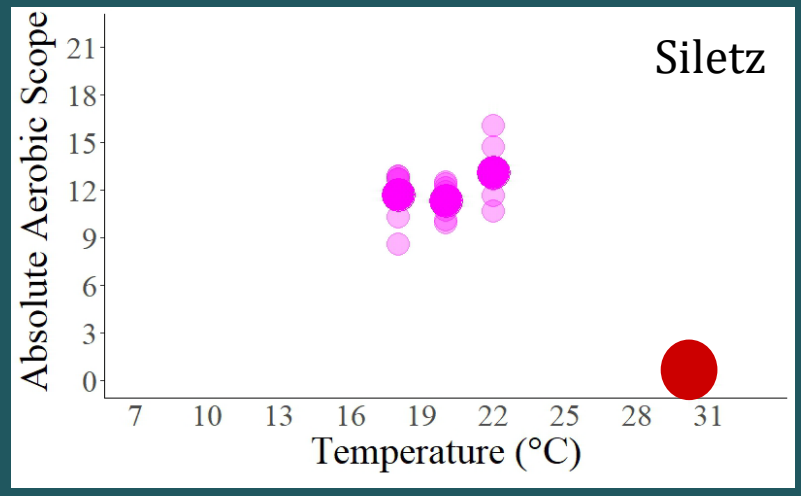
Coastal Cutthroat Trout: Juveniles

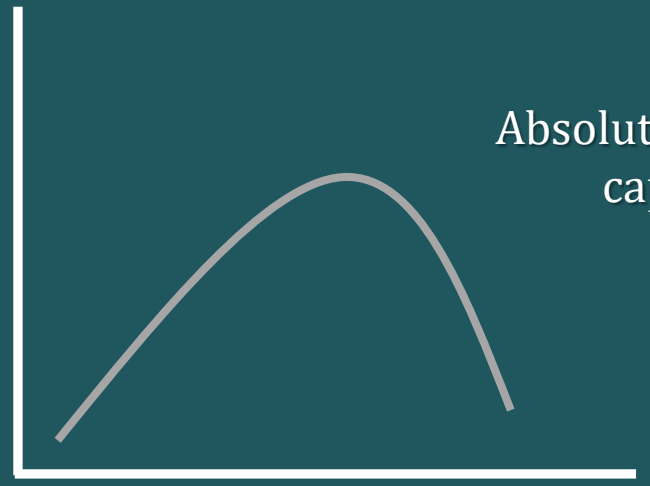




Absolute Aerobic Scope = MMR-SMR

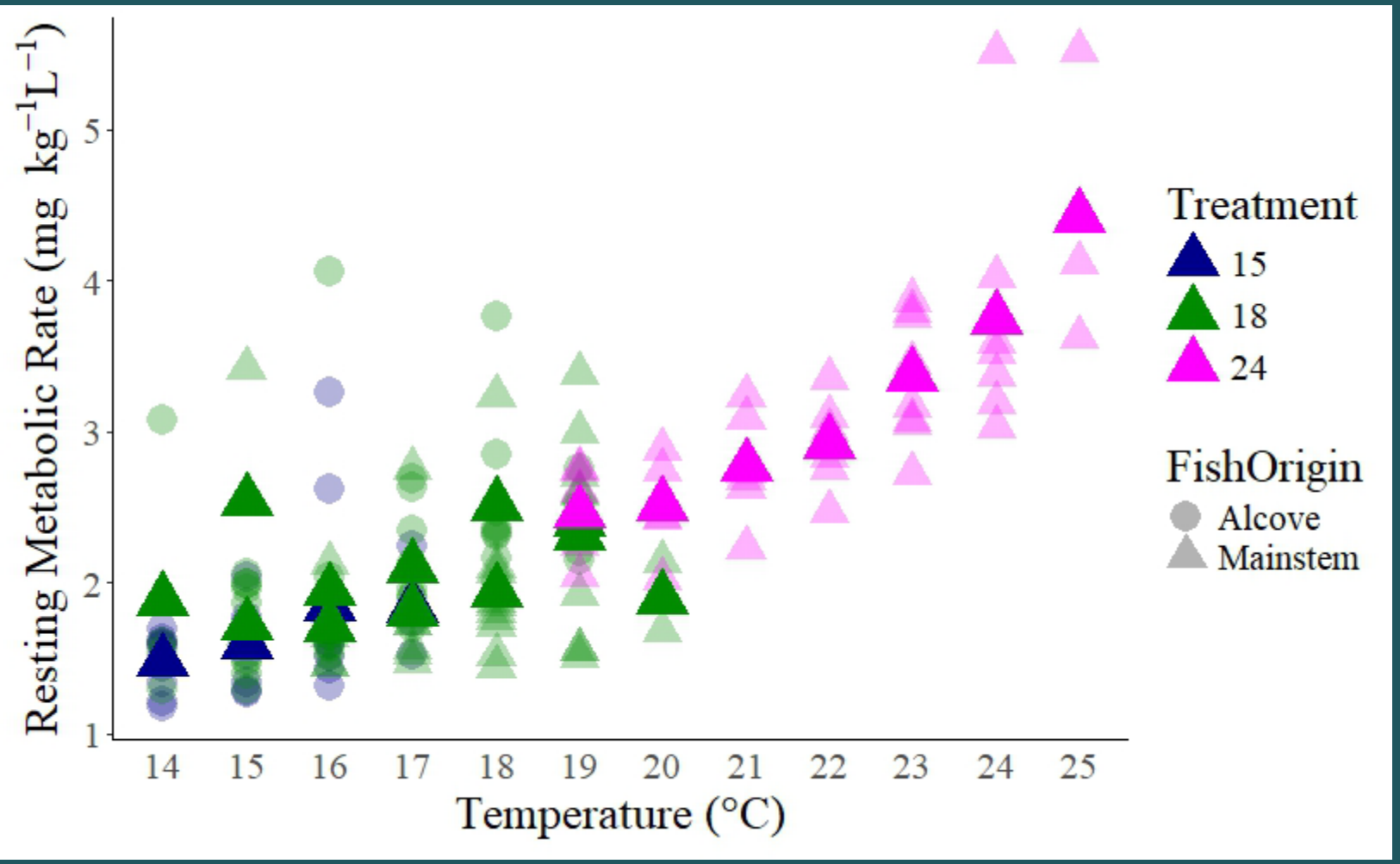




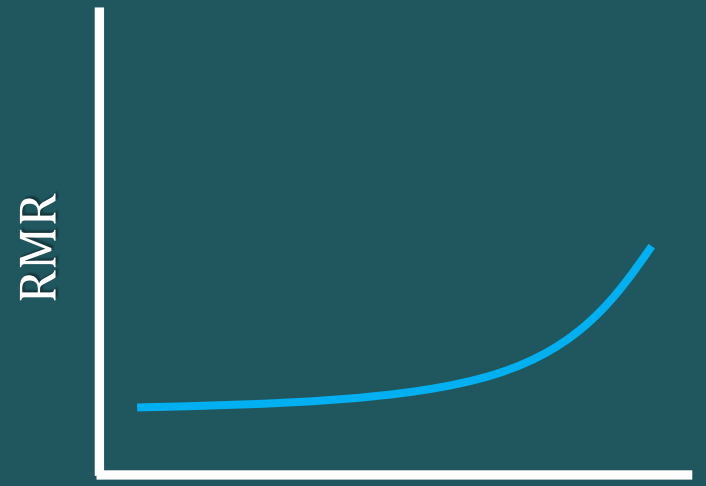


Absolute energetic capacity

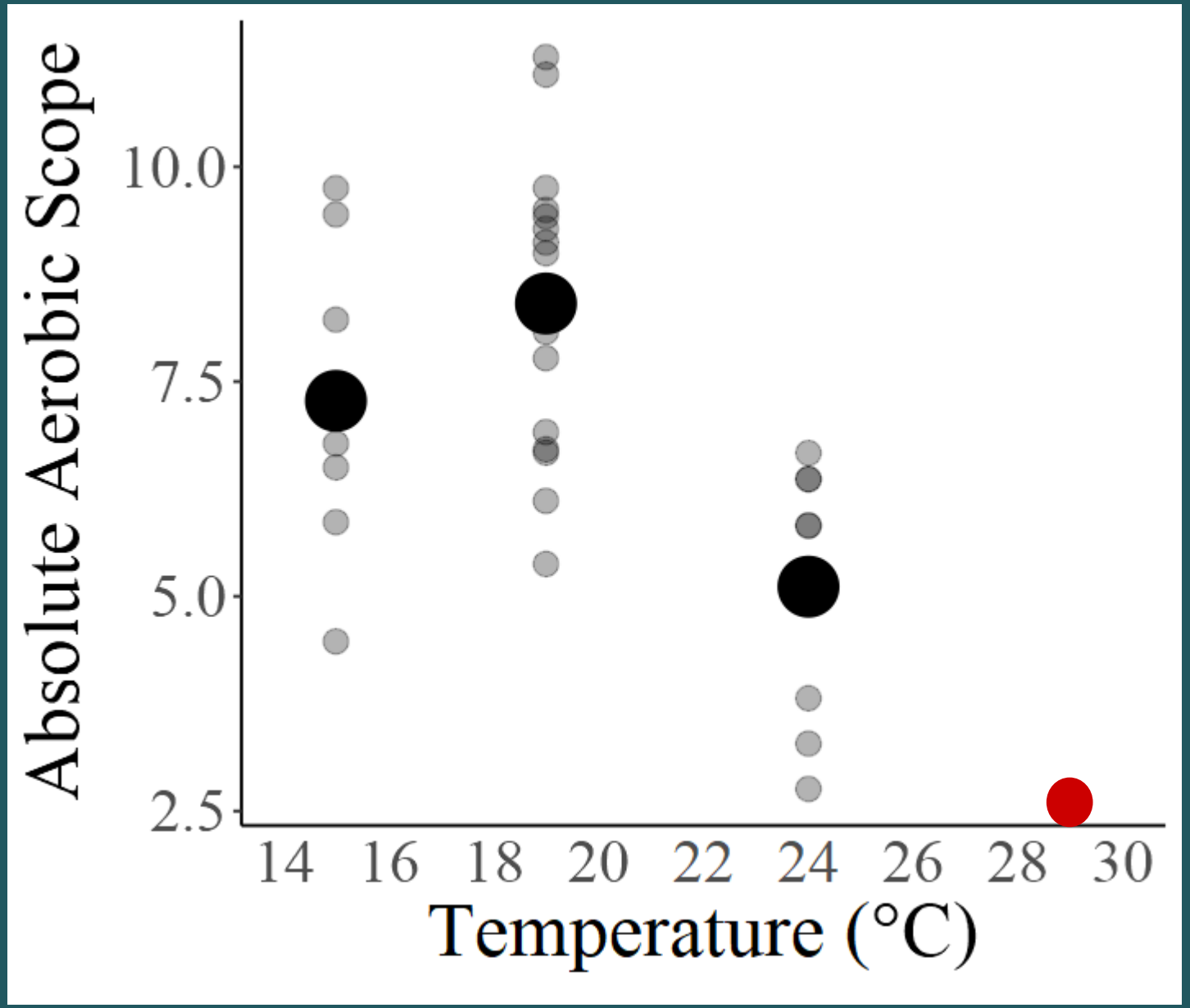
Coastal Cutthroat Trout - Adults



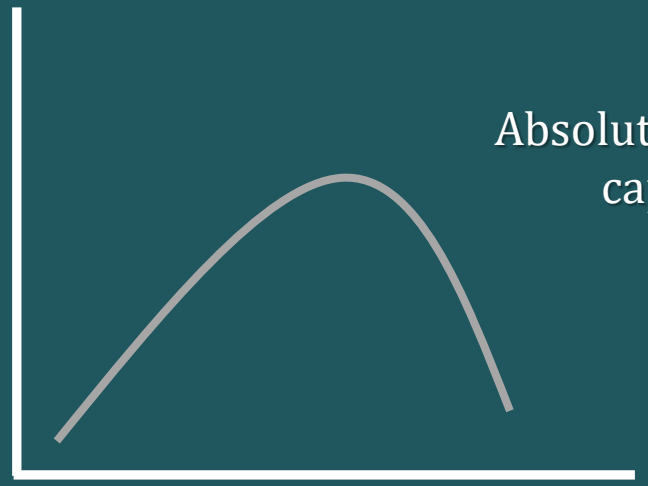
Resting Metabolic Rate (RMR)



Coastal Cutthroat Trout: Adults

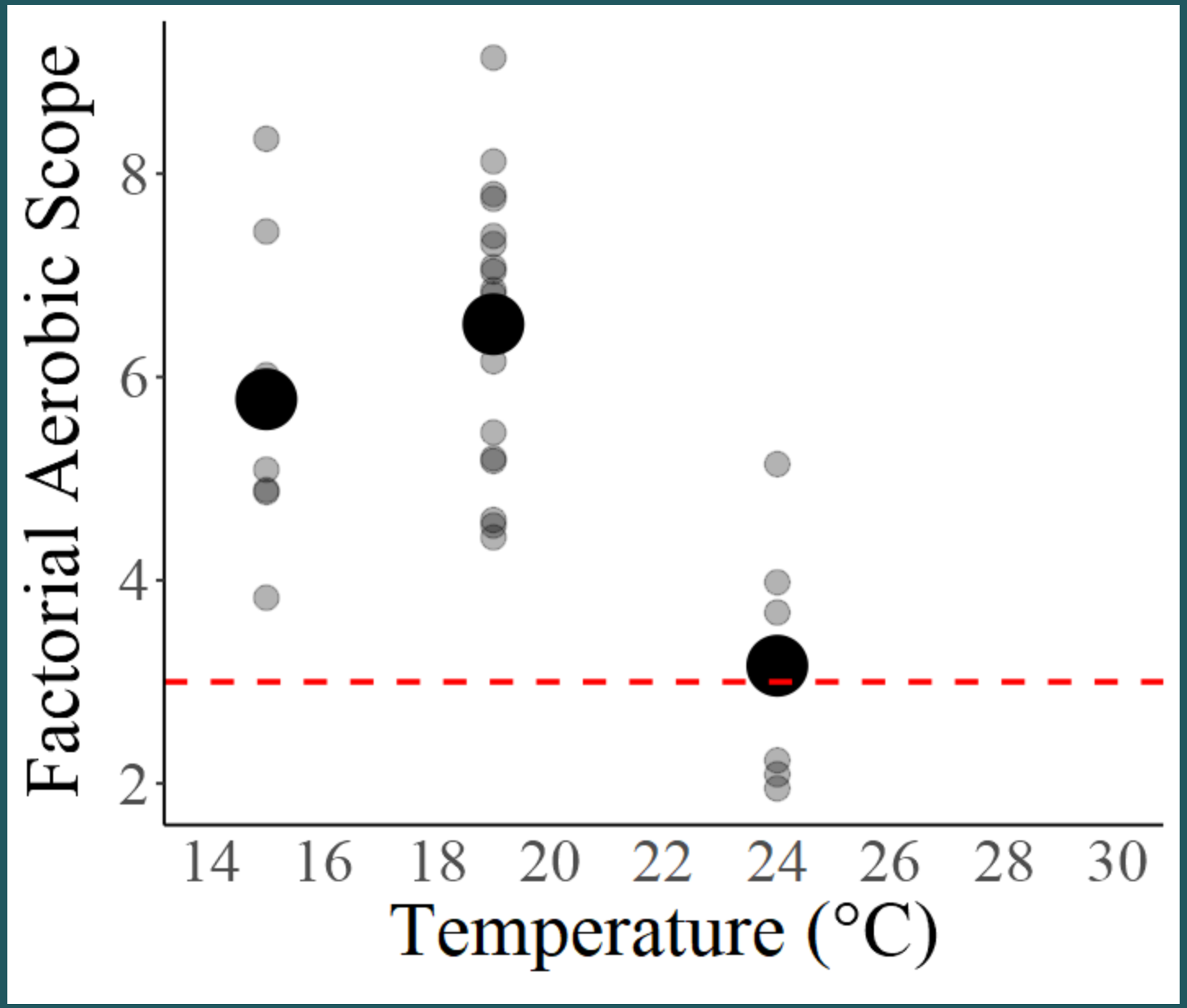


Absolute Aerobic Scope = MMR-SMR



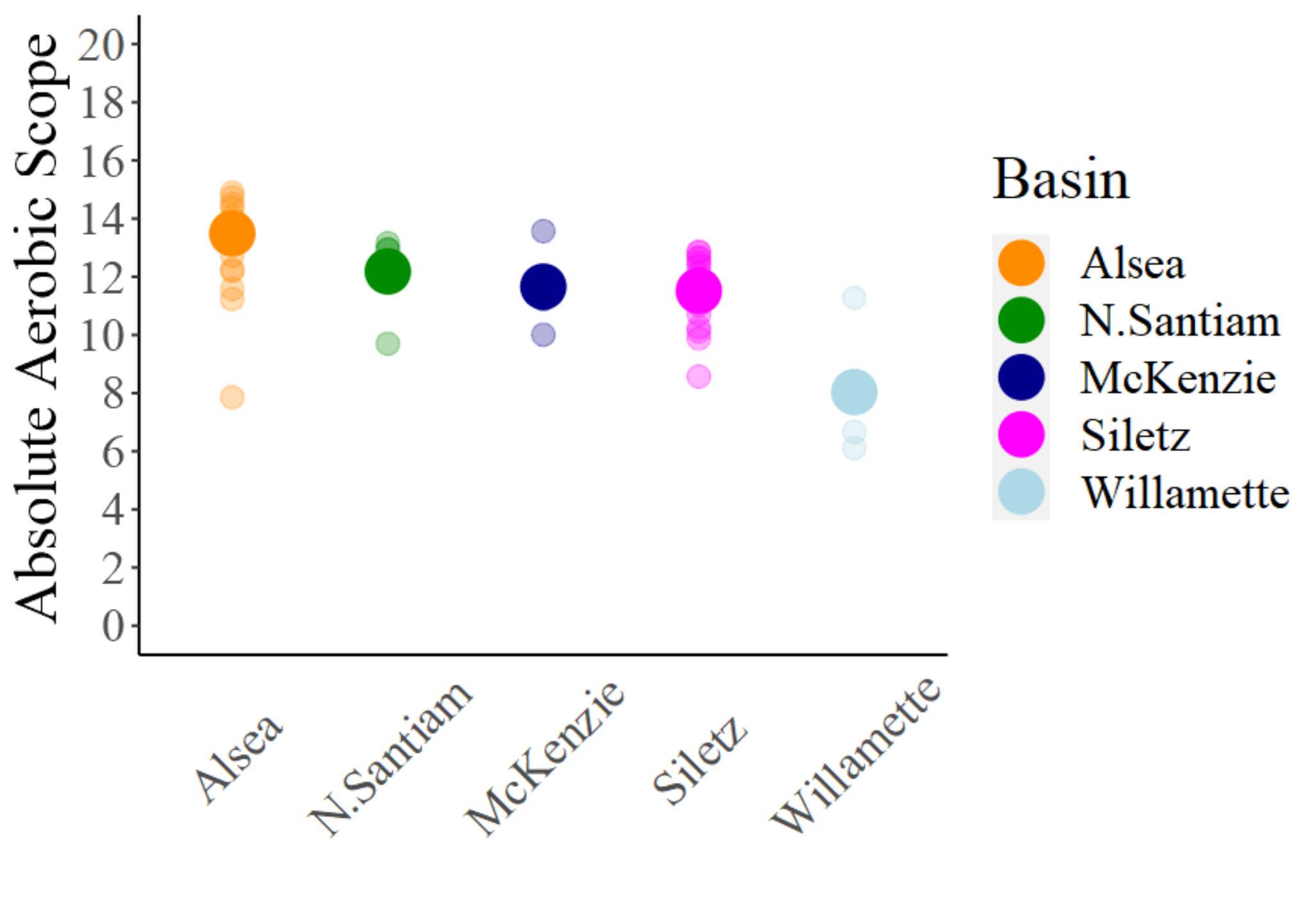
Absolute energetic capacity

Coastal Cutthroat Trout: Adults



Factorial Aerobic Scope = MMR/SMR

Available energy as a proportion of maintenance costs


Absolute Aerobic Scope
20
18
16
14
12
10
8
6
4
2
0
Alsea
N.Santiam
McKenzie
Siletz
Willamette
Basin
Alsea
N.Santiam
McKenzie
Siletz
Willamette

AAS

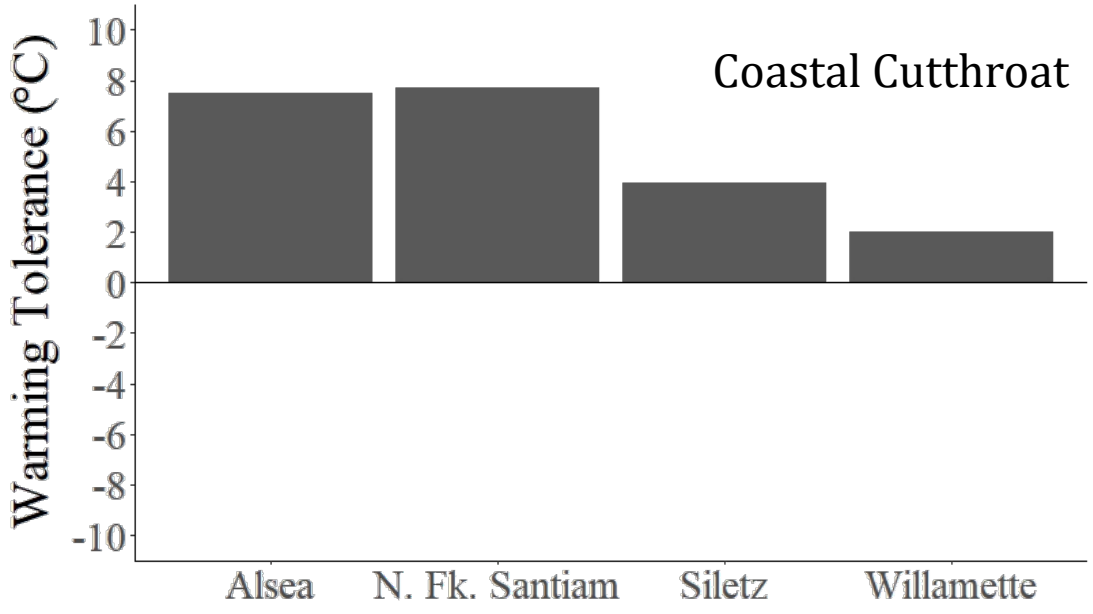
at

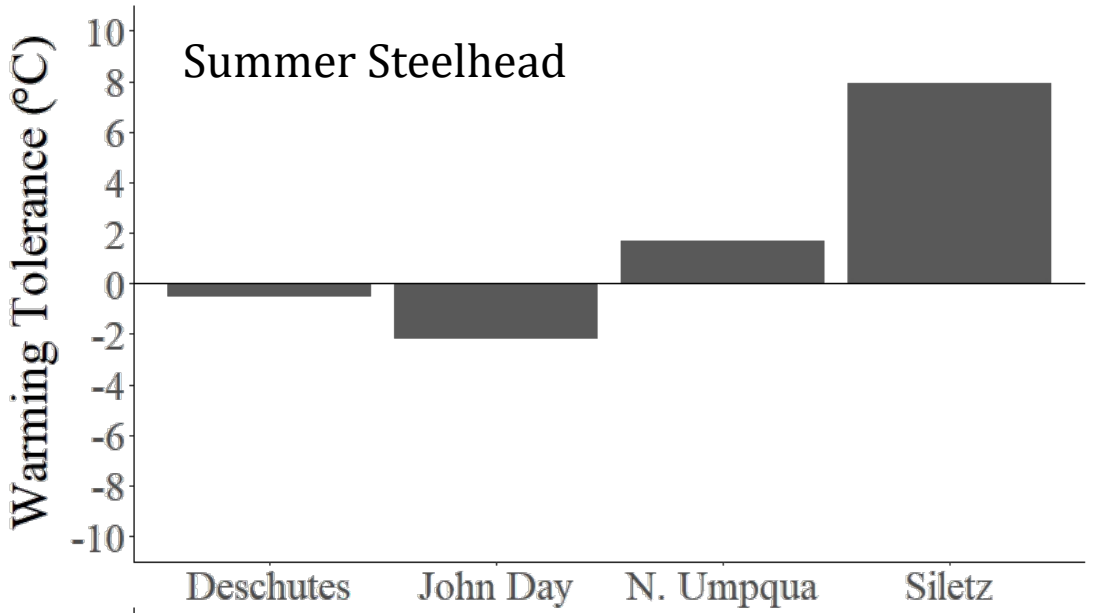
19 ^{o}C

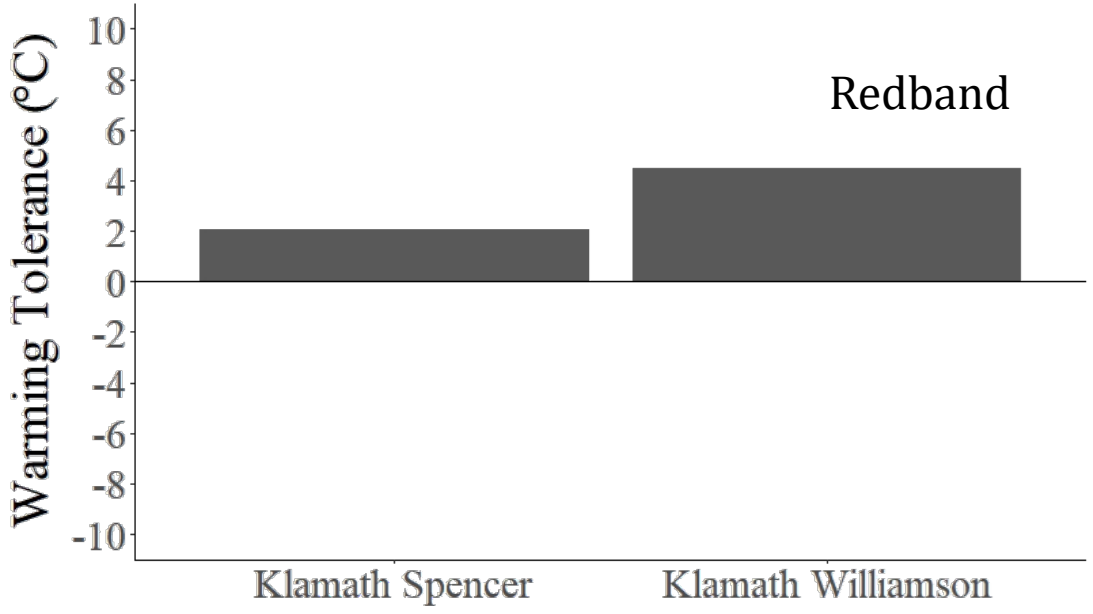
Variability in thermal tolerance

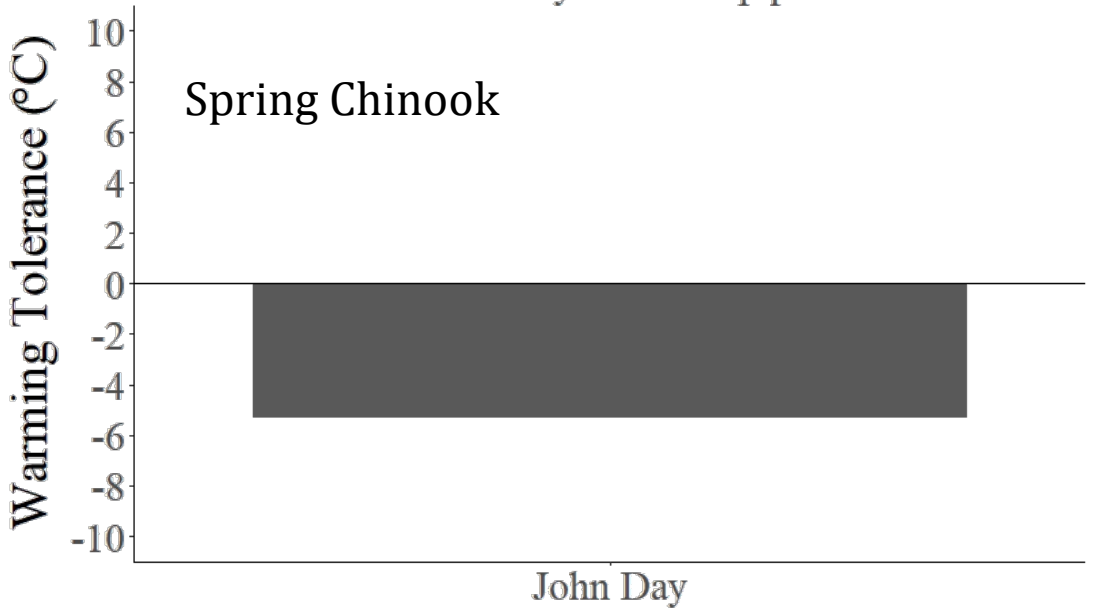
Warming tolerance: Maximum Habitat Temperature – T_{fas3}

Variability in thermal tolerance





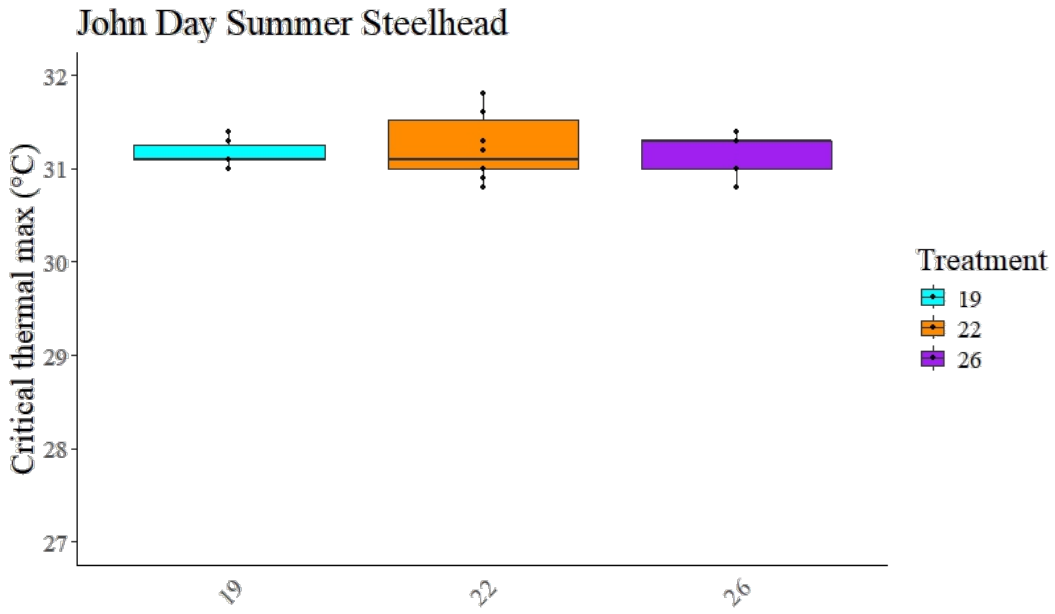


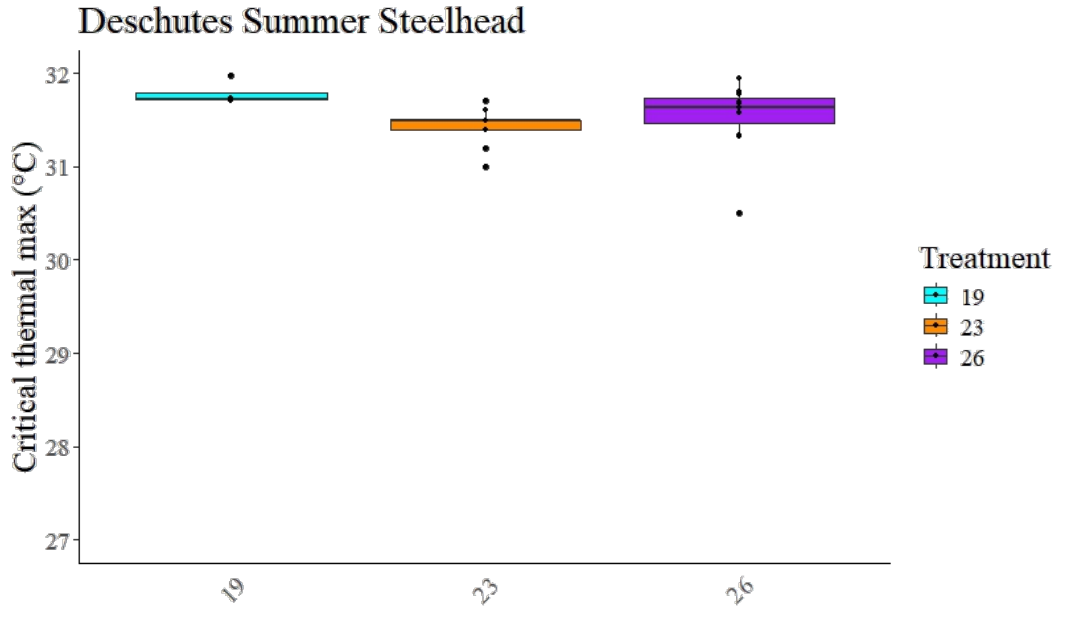


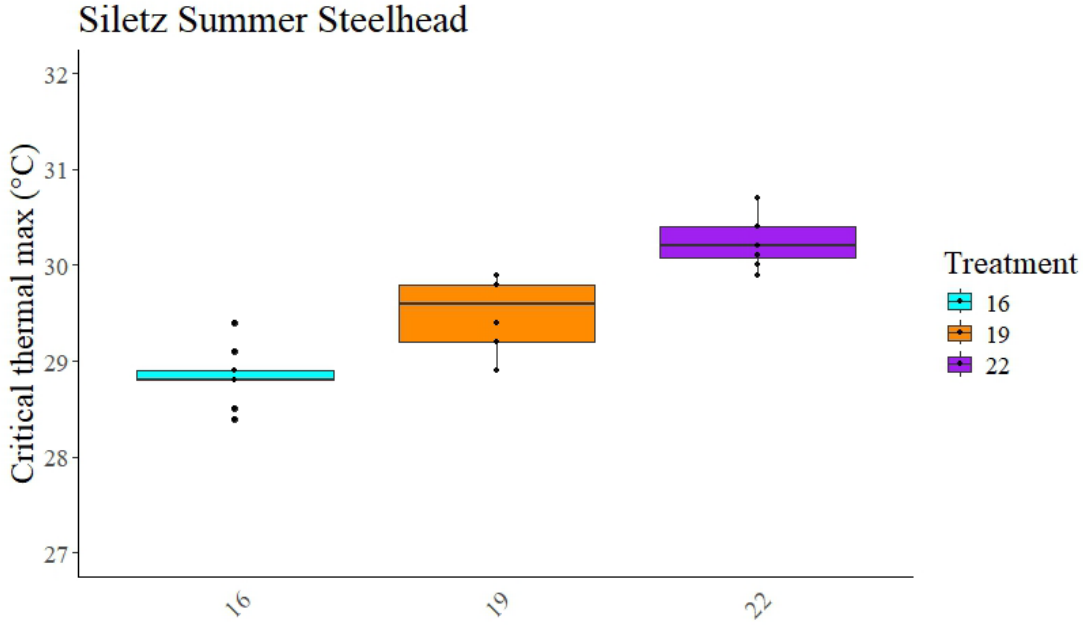
Variability in thermal tolerance

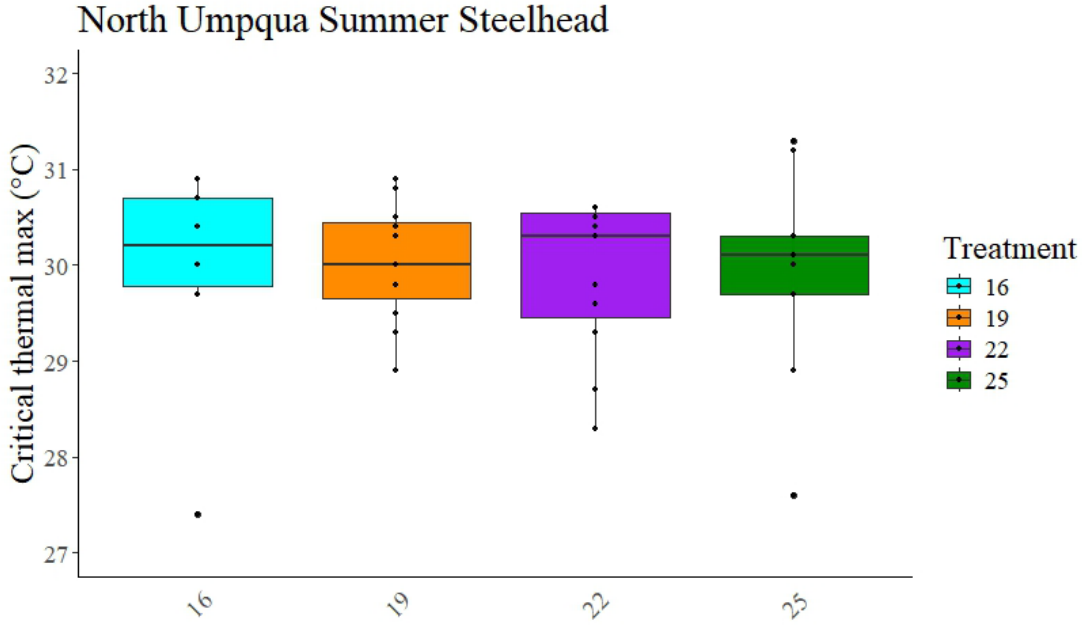
Plastic responses to temperature changes (i.e., thermal acclimation) can alter thermal tolerance traits

Variability in thermal tolerance









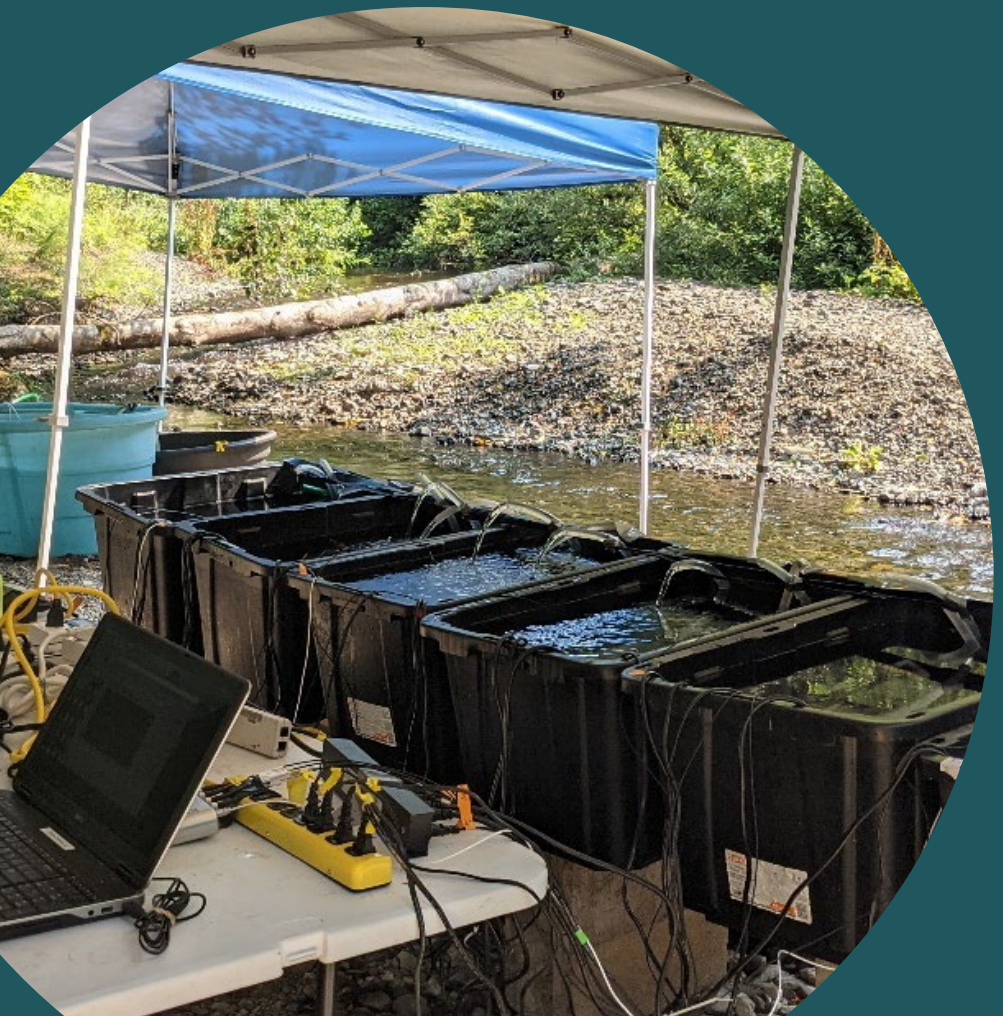
Informing management/conservation

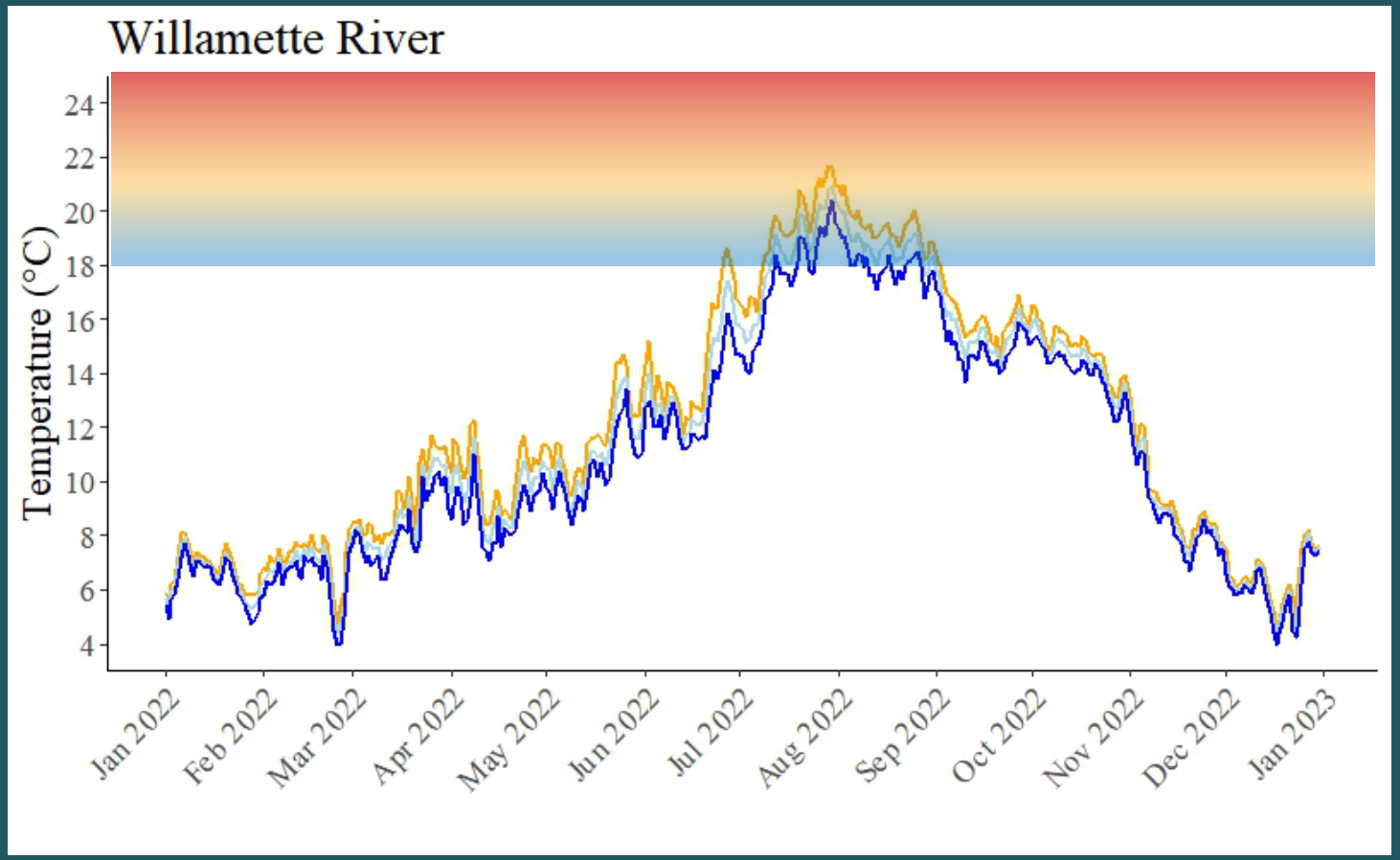
- Across geographies, **difference** in aerobic performance and thermal tolerance
- Salmonids from **warmer thermal regimes** are closer to their functional limit, more vulnerable
- Use **functional thermal limits** and **warming tolerance** data to inform:

Informing management/conservation

- Fishing regulations
- Habitat restoration projects
- Modeling/forecasting migration success
- Dam regulations (maximum temperature & flow thresholds)

Example: Adult Coastal Cutthroat Trout





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