Juvenile coho salmon "dine and dash" to exploit thermal heterogeneity in streams

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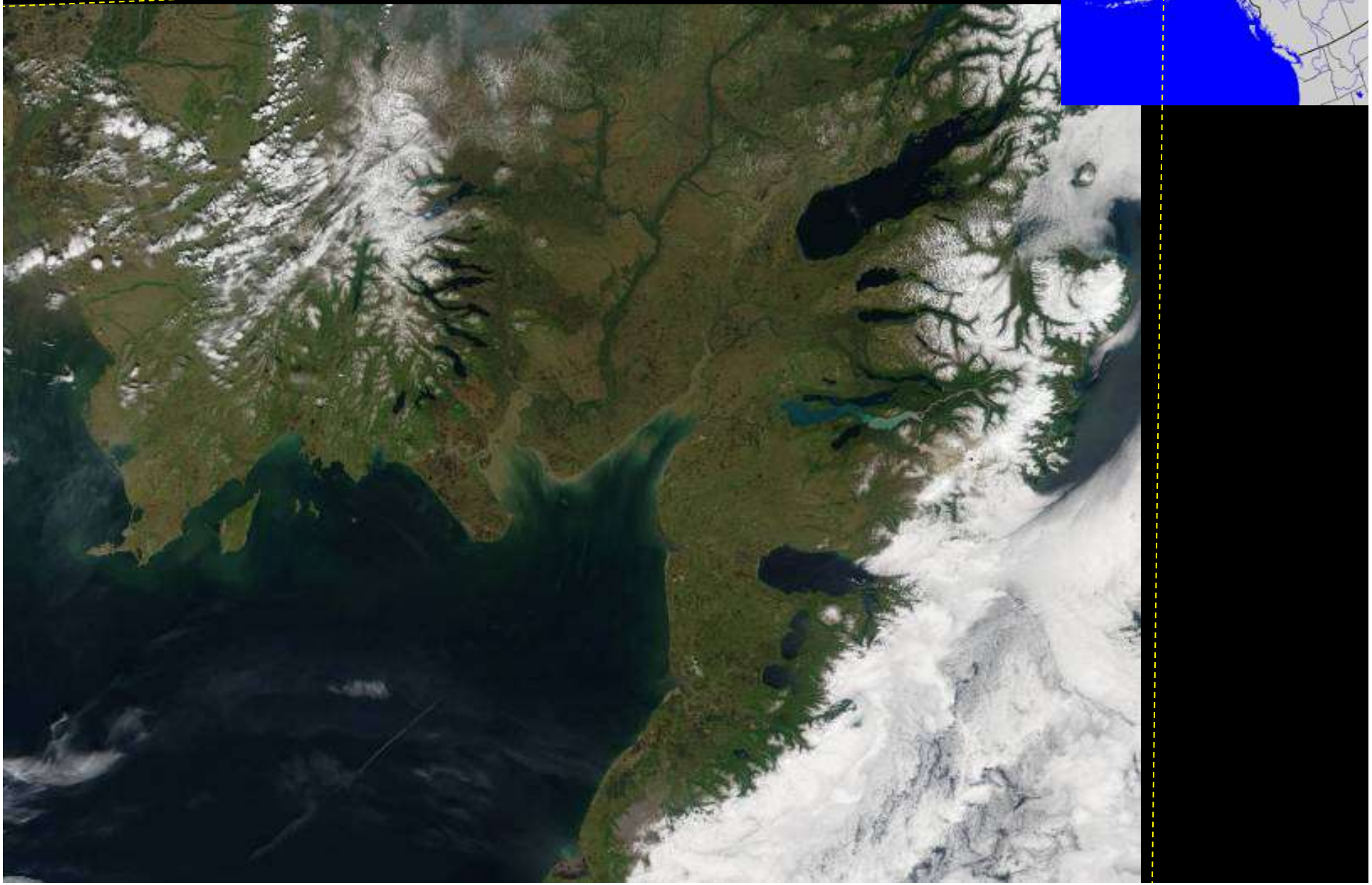
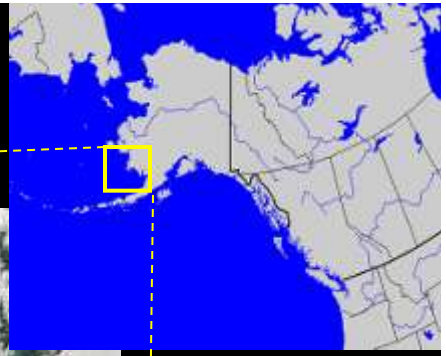
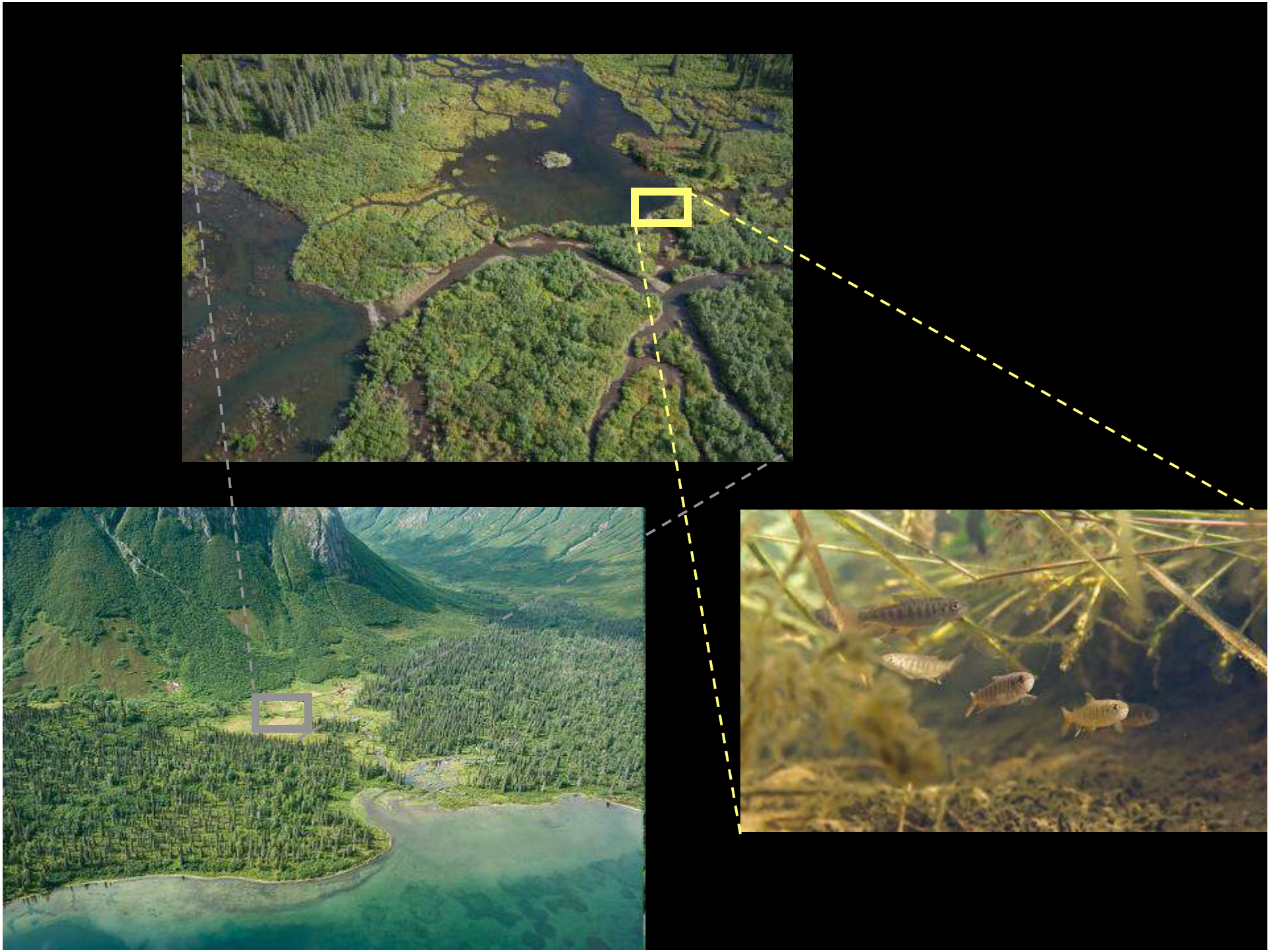
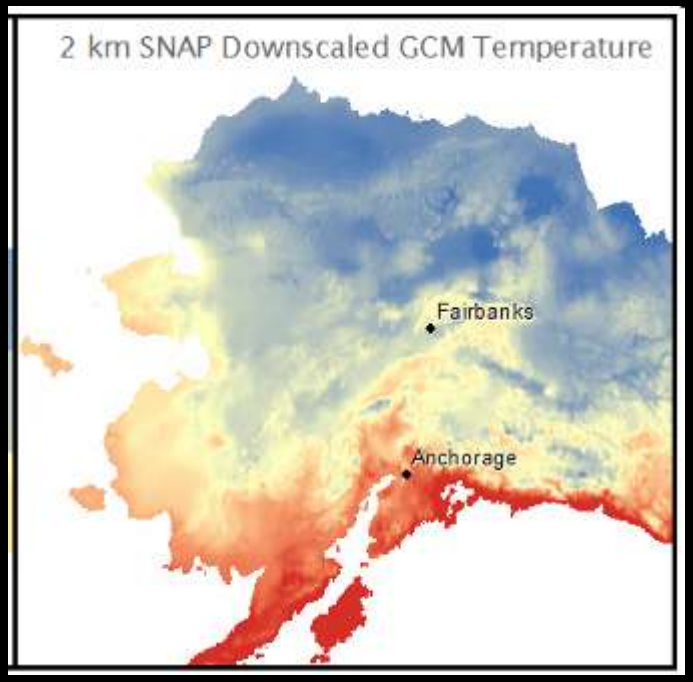
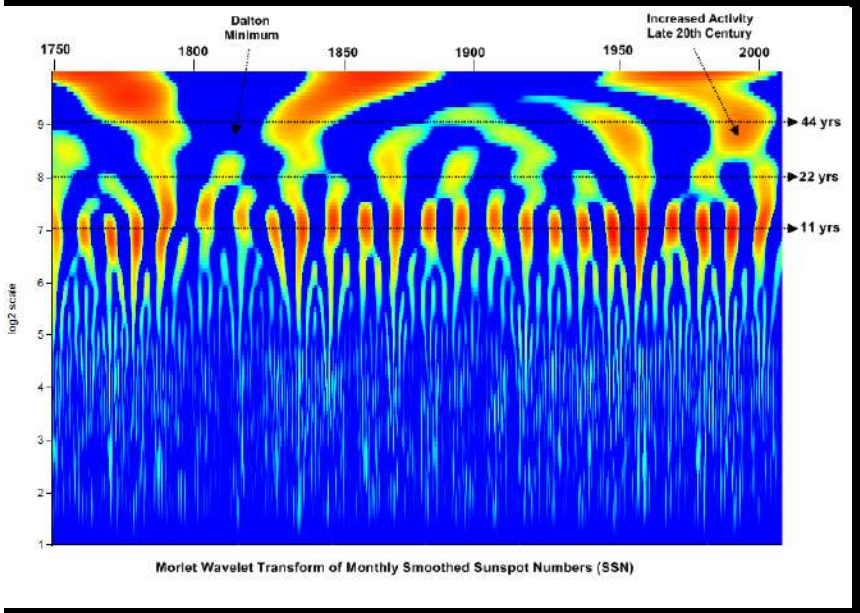


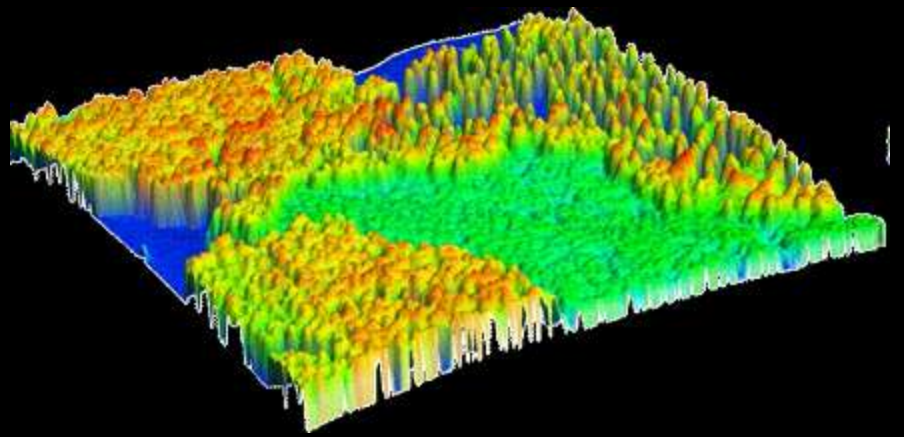




Rapid advancements in the ability to quantify habitat heterogeneity



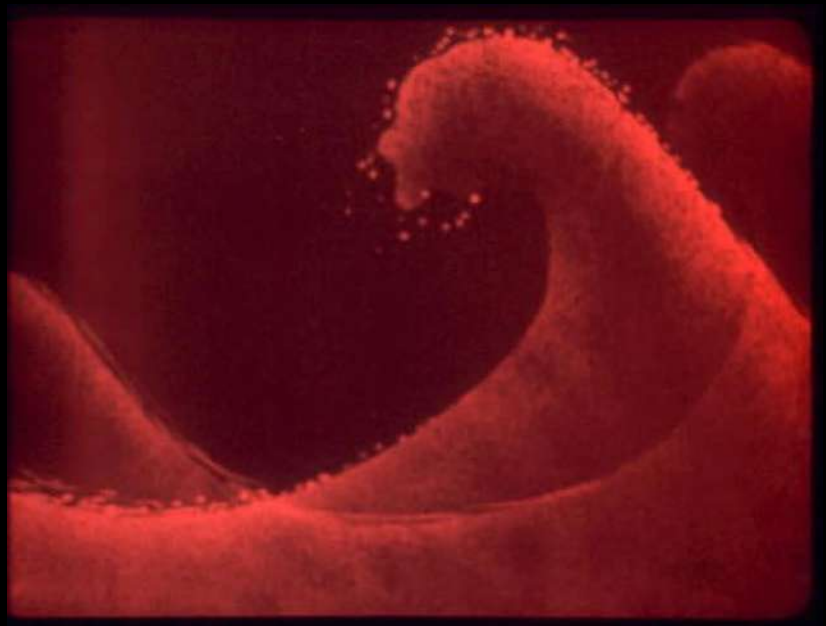




How do organisms interact with habitat heterogeneity?

What about us?

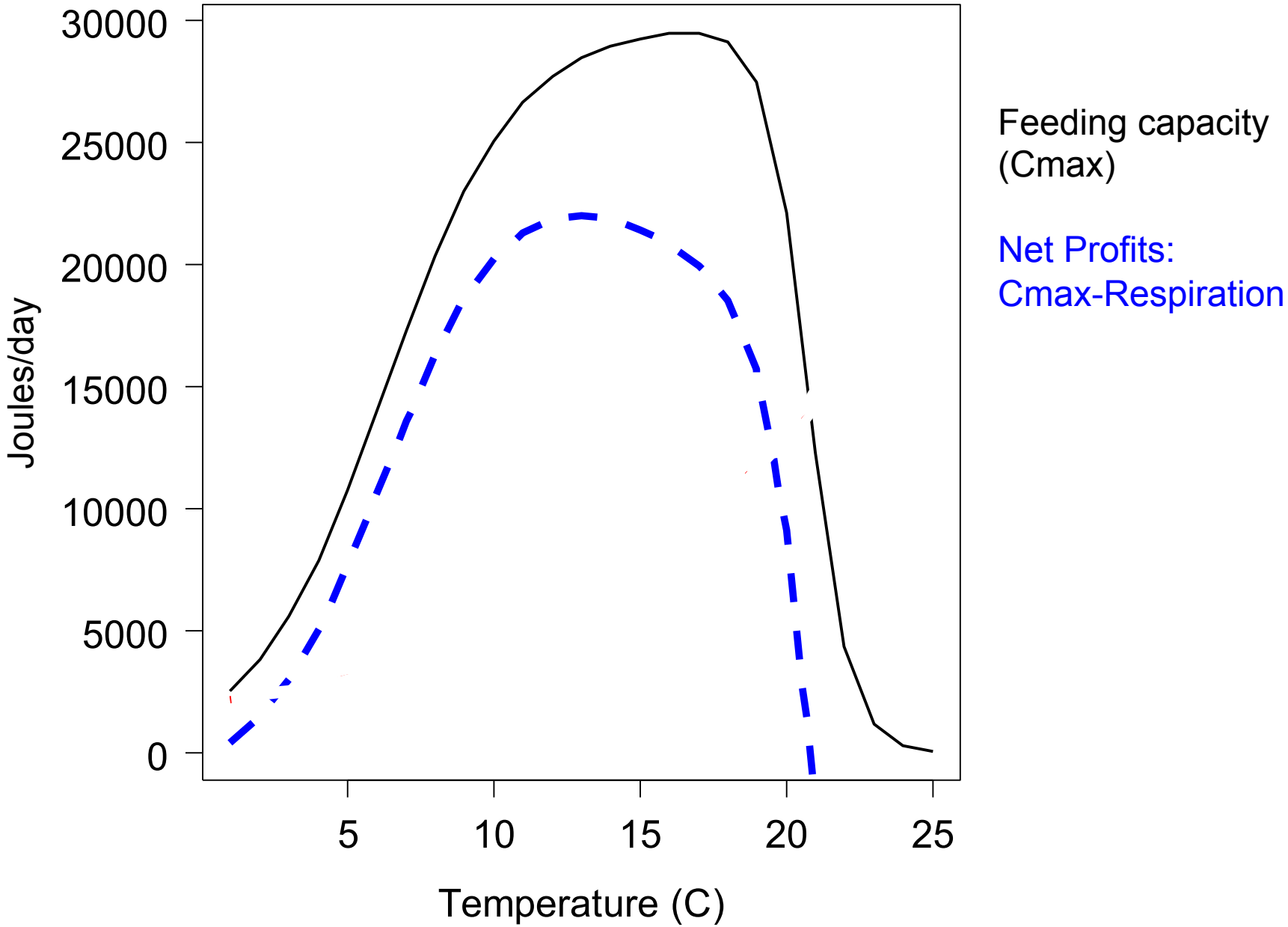
Pulsed salmon subsidies

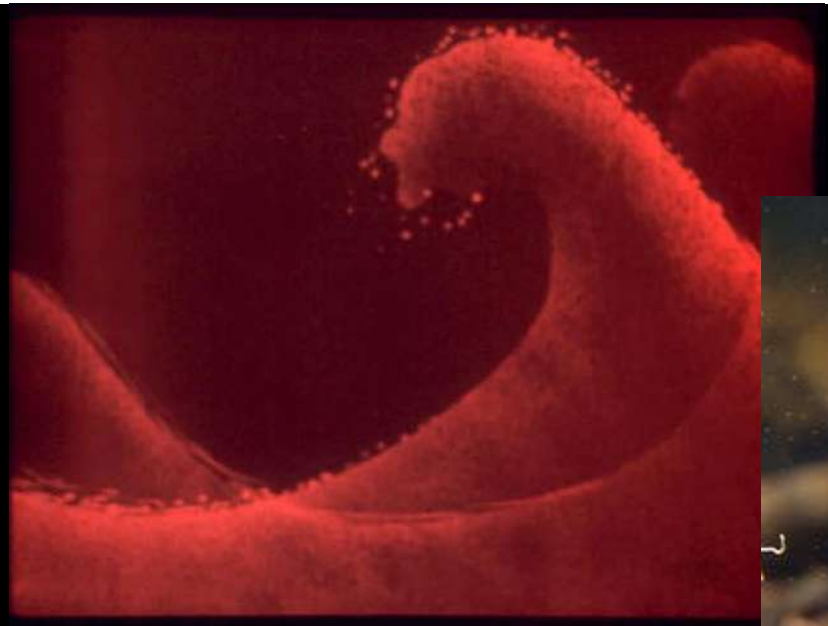


Sockeye subsidies:

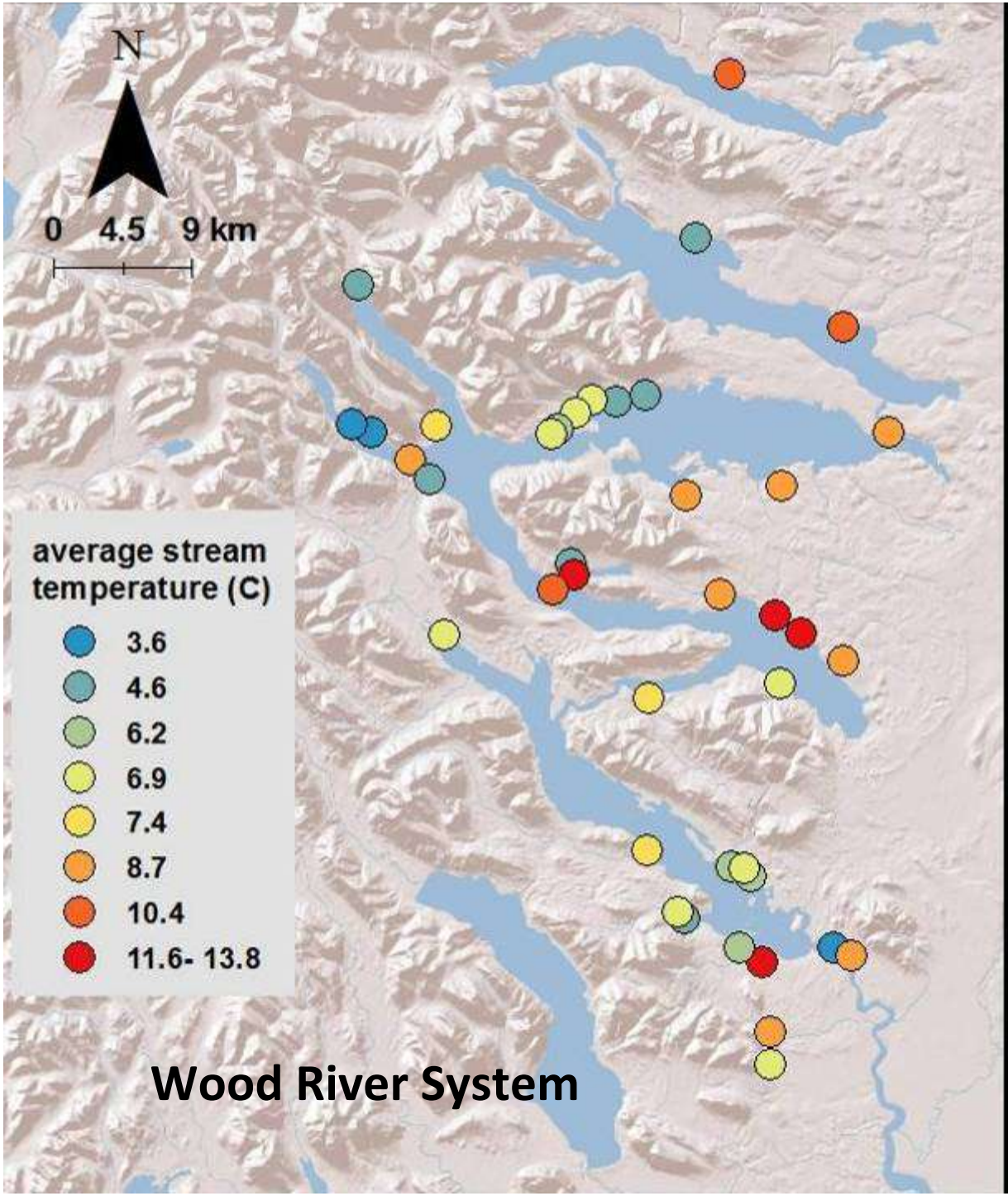
- ephemeral pulse of high quality, vulnerable food
- Pulsed timing taxes processing systems

Fish require warmer temperatures to capitalize on resource pulses





How does thermal heterogeneity mediate the ability of coho salmon to exploit sockeye salmon eggs?



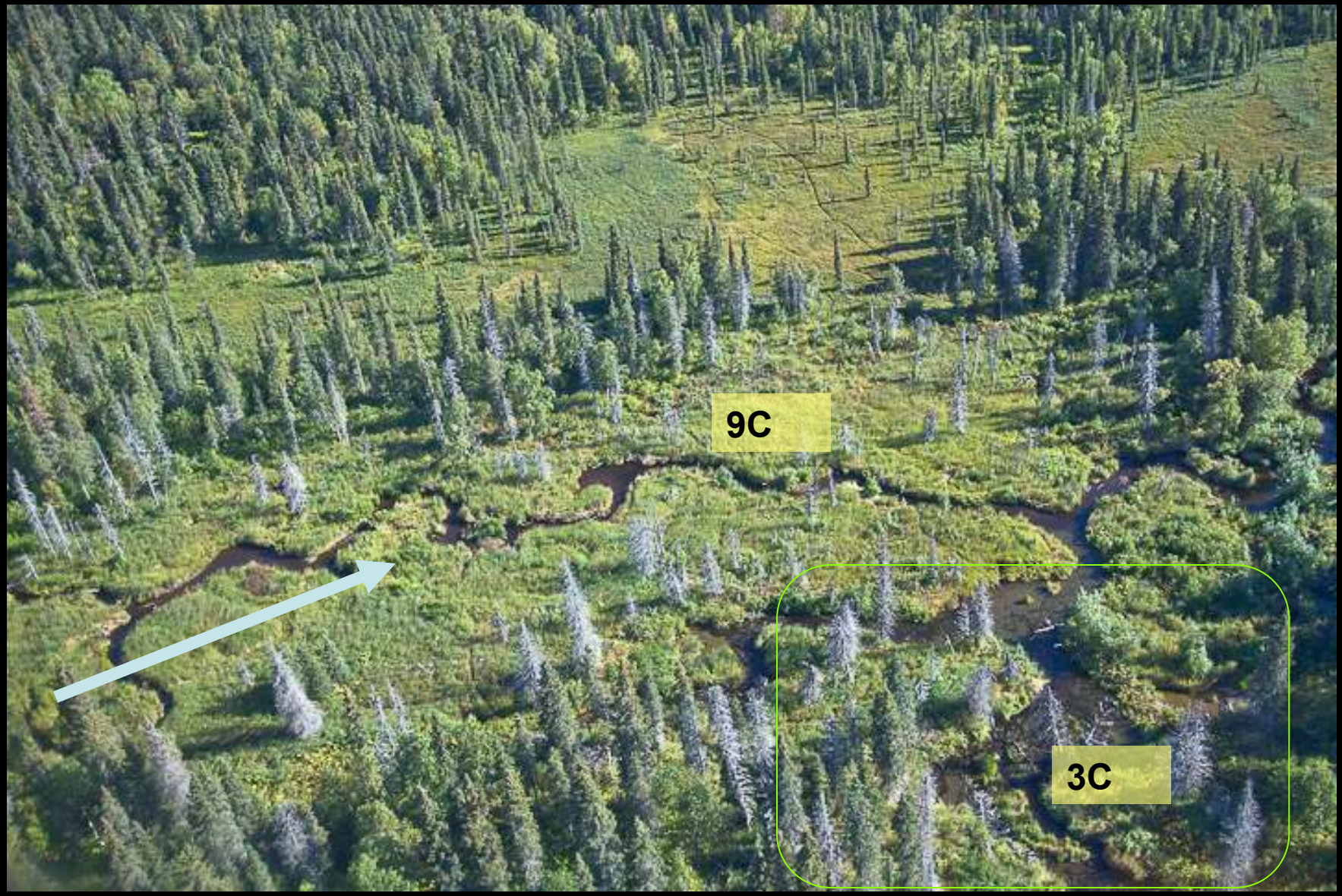
Wood River system streams:
>10˚C range in summer water temperature

Armstrong et al. 2010 *Ecology*
P. Lisi *in prep*

1750-3000 m upstream

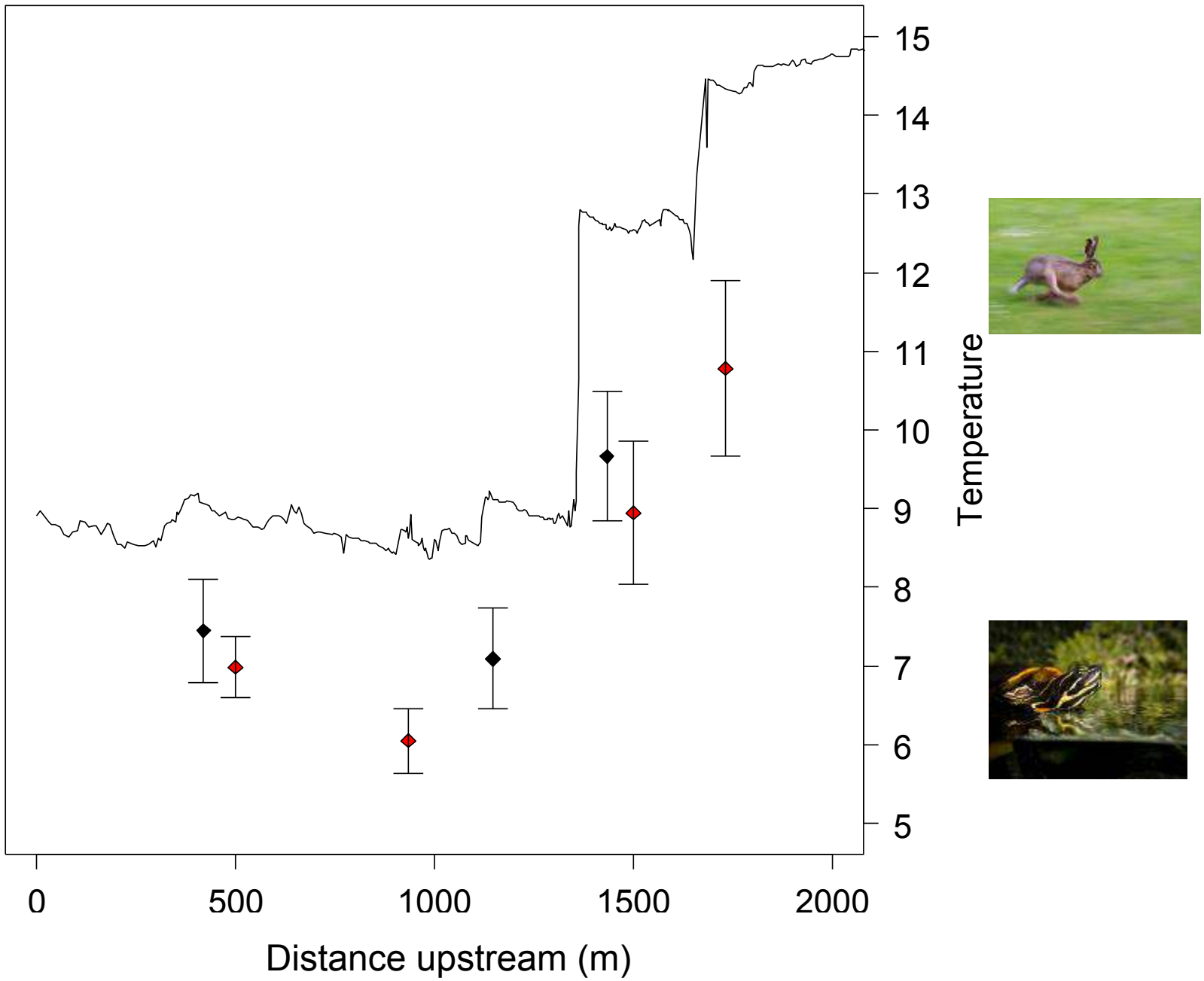
Headwaters of Bear Creek: low velocity, minimal shading = warm water, Beaver meadow complexes

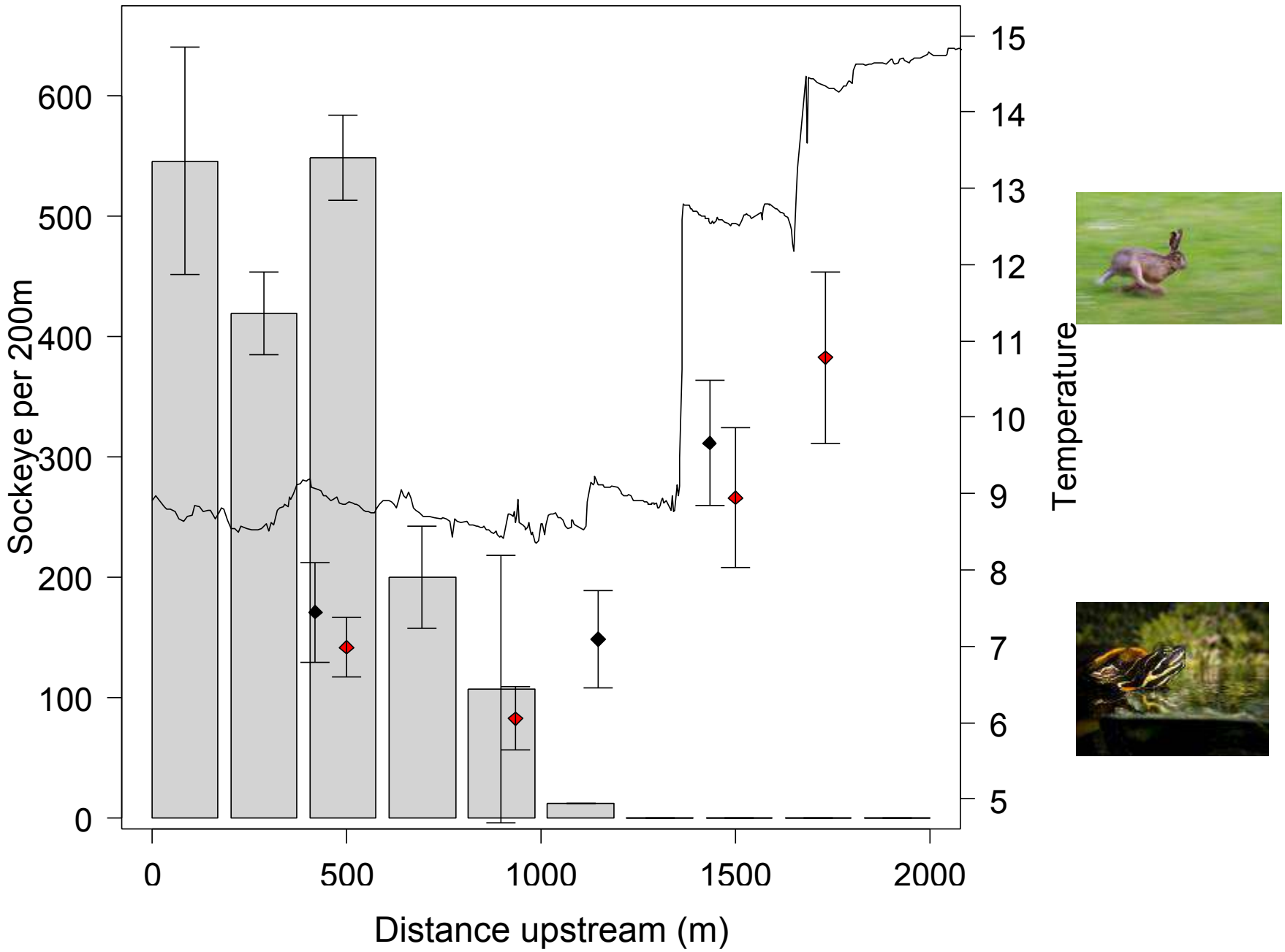
1300-1600 m upstream

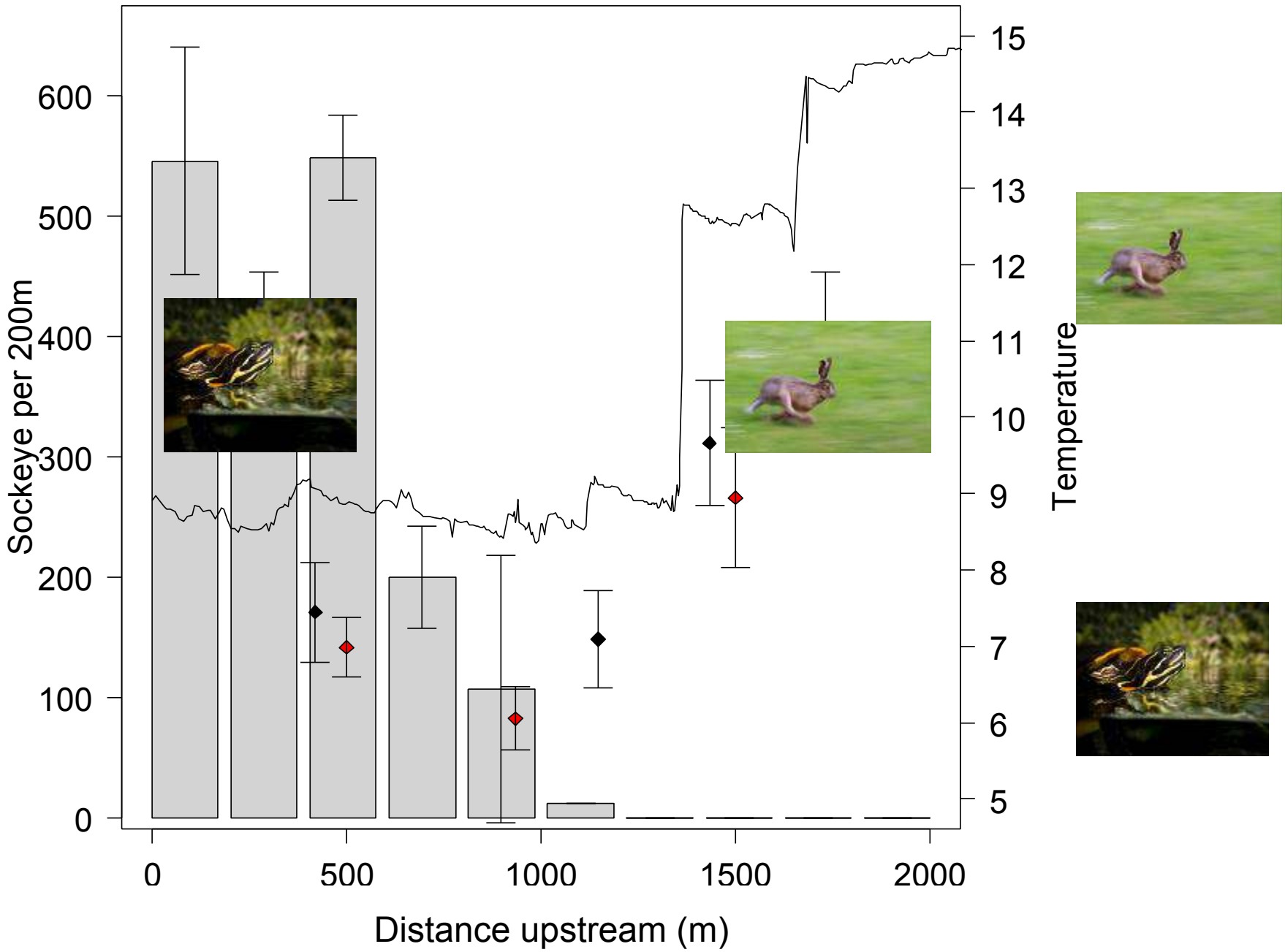


Upwelling groundwater produces longitudinal variation in water temperature

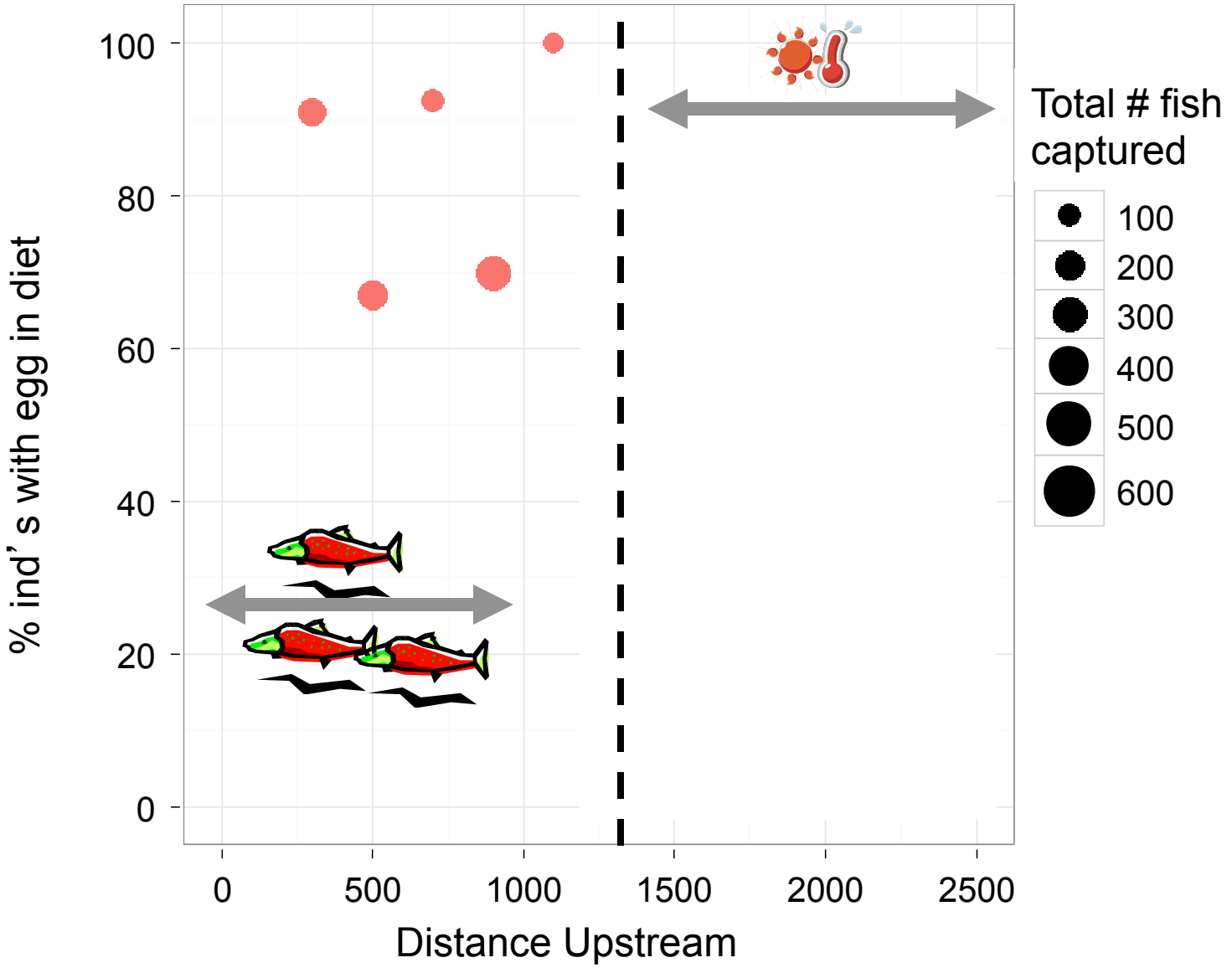
0-1300 m upstream: cold water and extensive off-channel habitat: groundwater seeps preclude any downstream warming


15
14
13
12
11
10
9
8
7
6
5
Temperature
0
500
1000
1500
2000
Distance upstream (m)


Sockeye per 200m
0
100
200
300
400
500
600
Temperature
5
6
7
8
9
10
11
12
13
14
15
0
500
1000
1500
2000
Distance upstream (m)


Sockeye per 200m
0
100
200
300
400
500
600
0
500
1000
1500
2000
Distance upstream (m)
Temperature
5
6
7
8
9
10
11
12
13
14
15

The spatial distribution of sockeye eggs in coho diets



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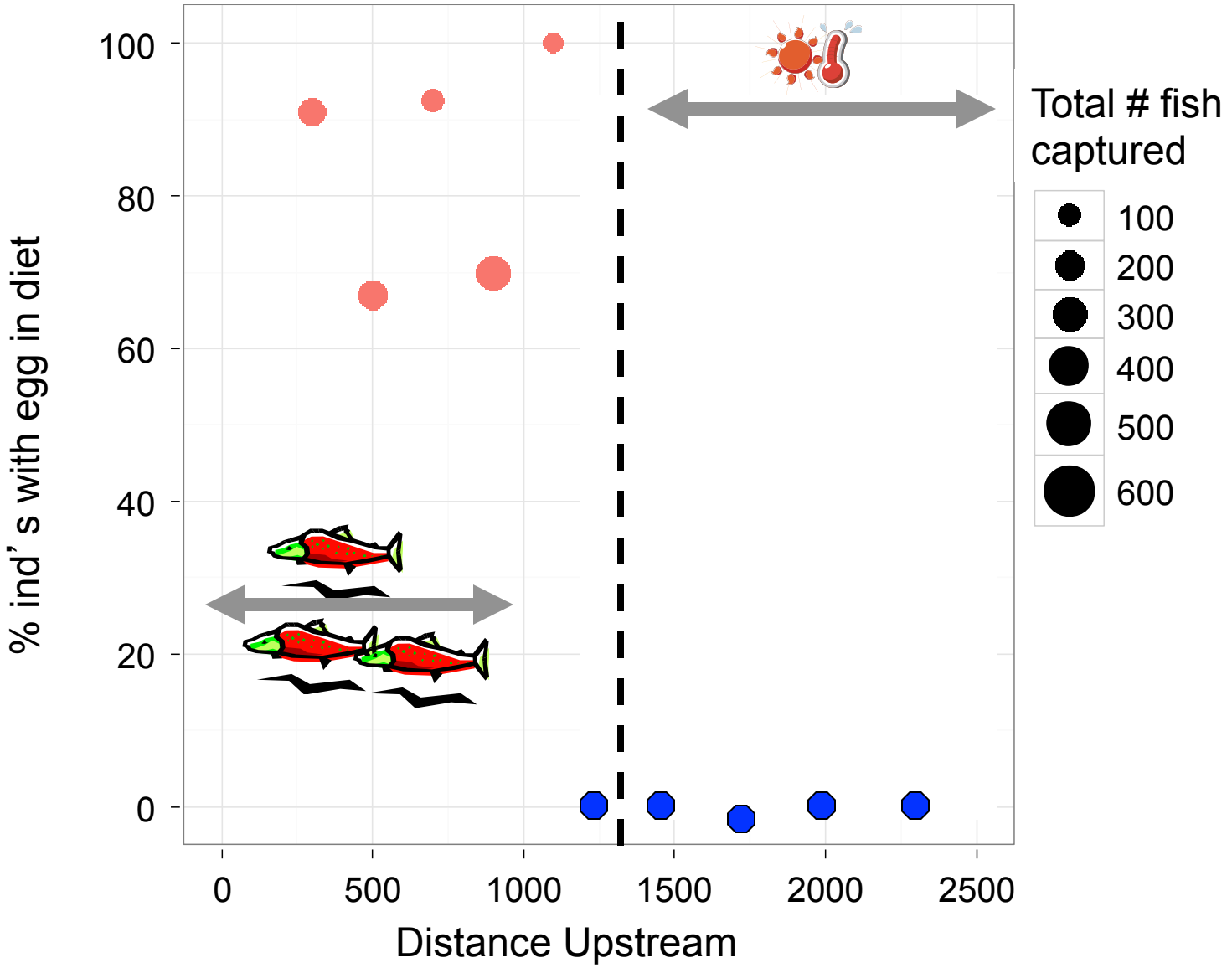

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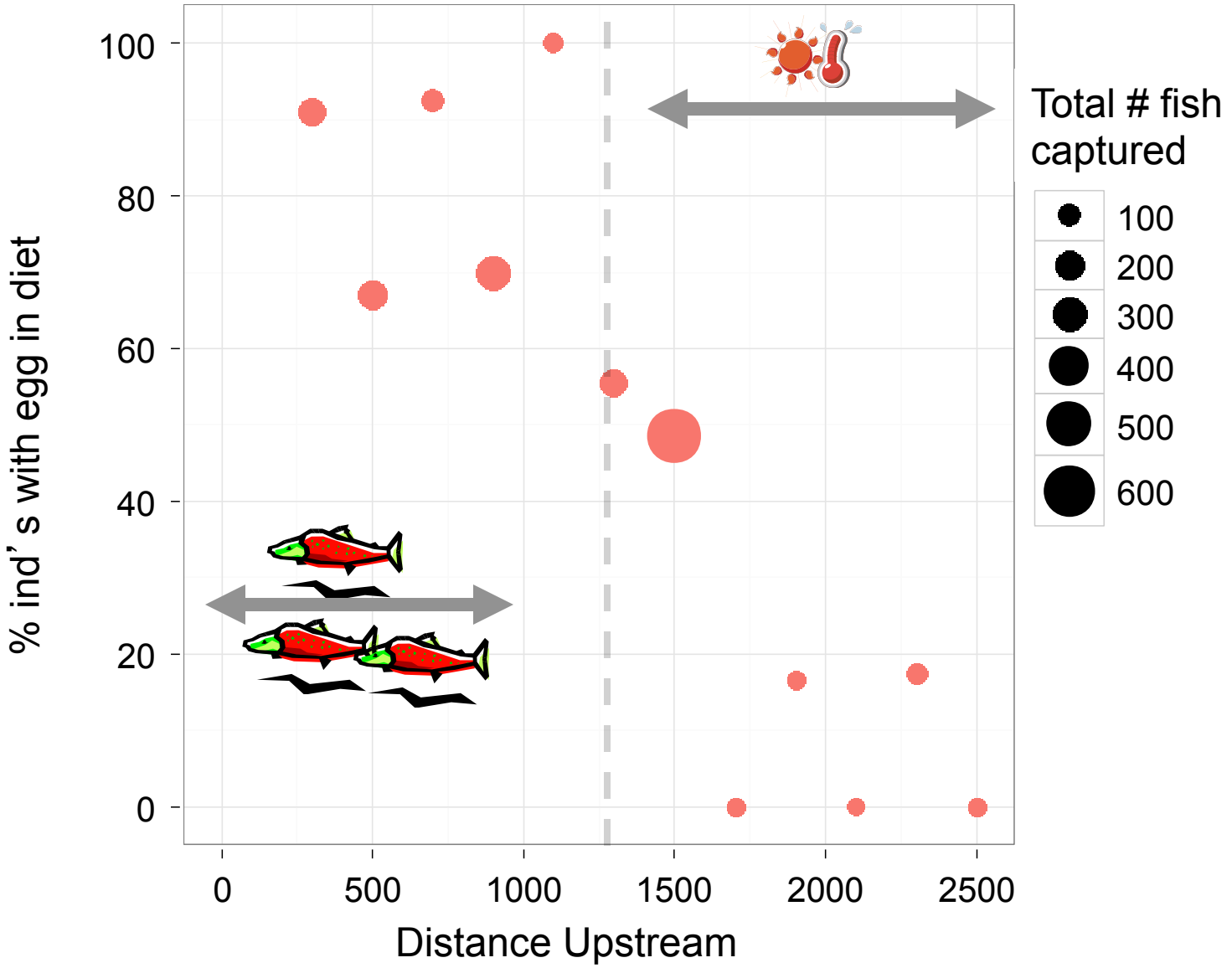
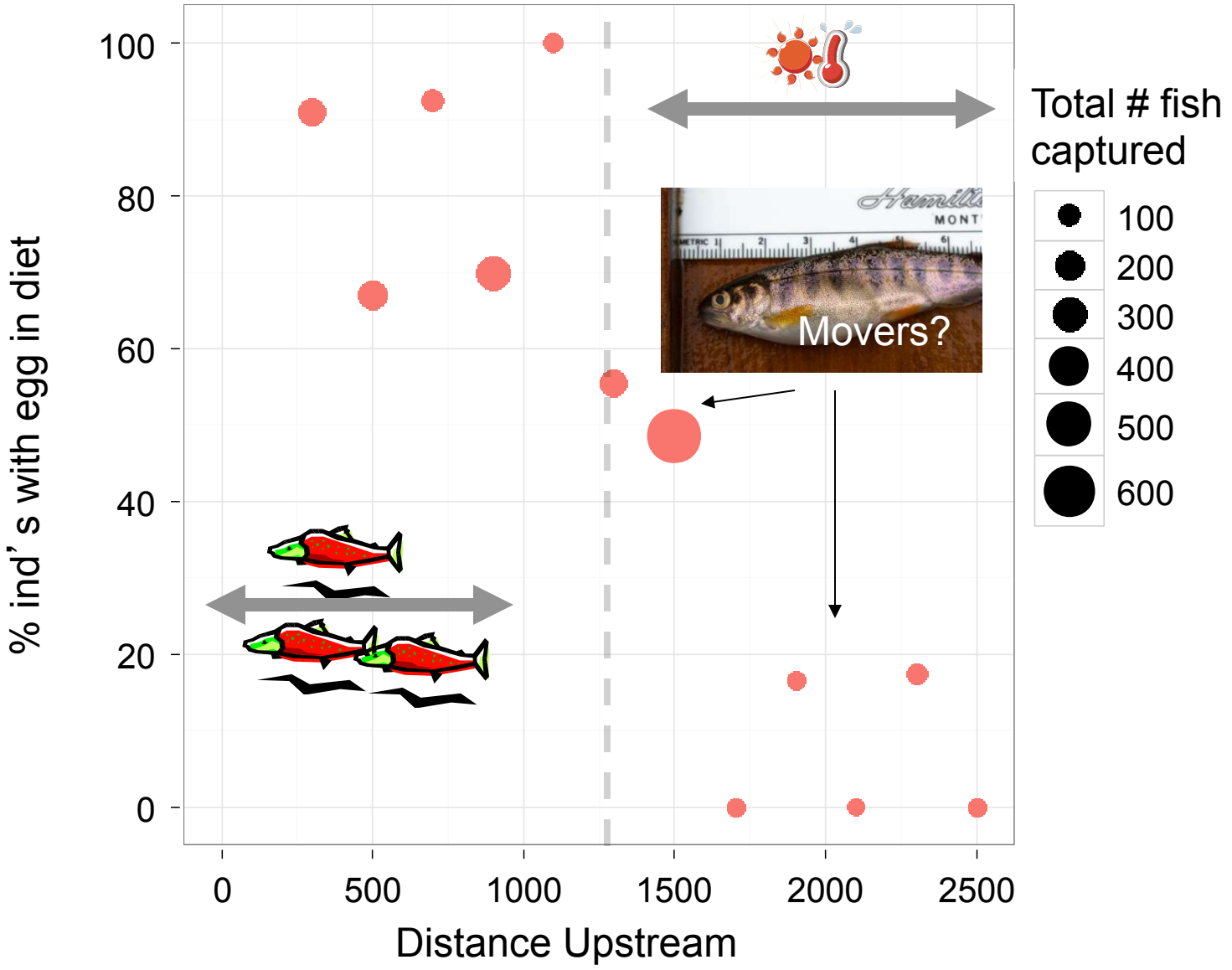


The spatial distribution of sockeye eggs in coho diets



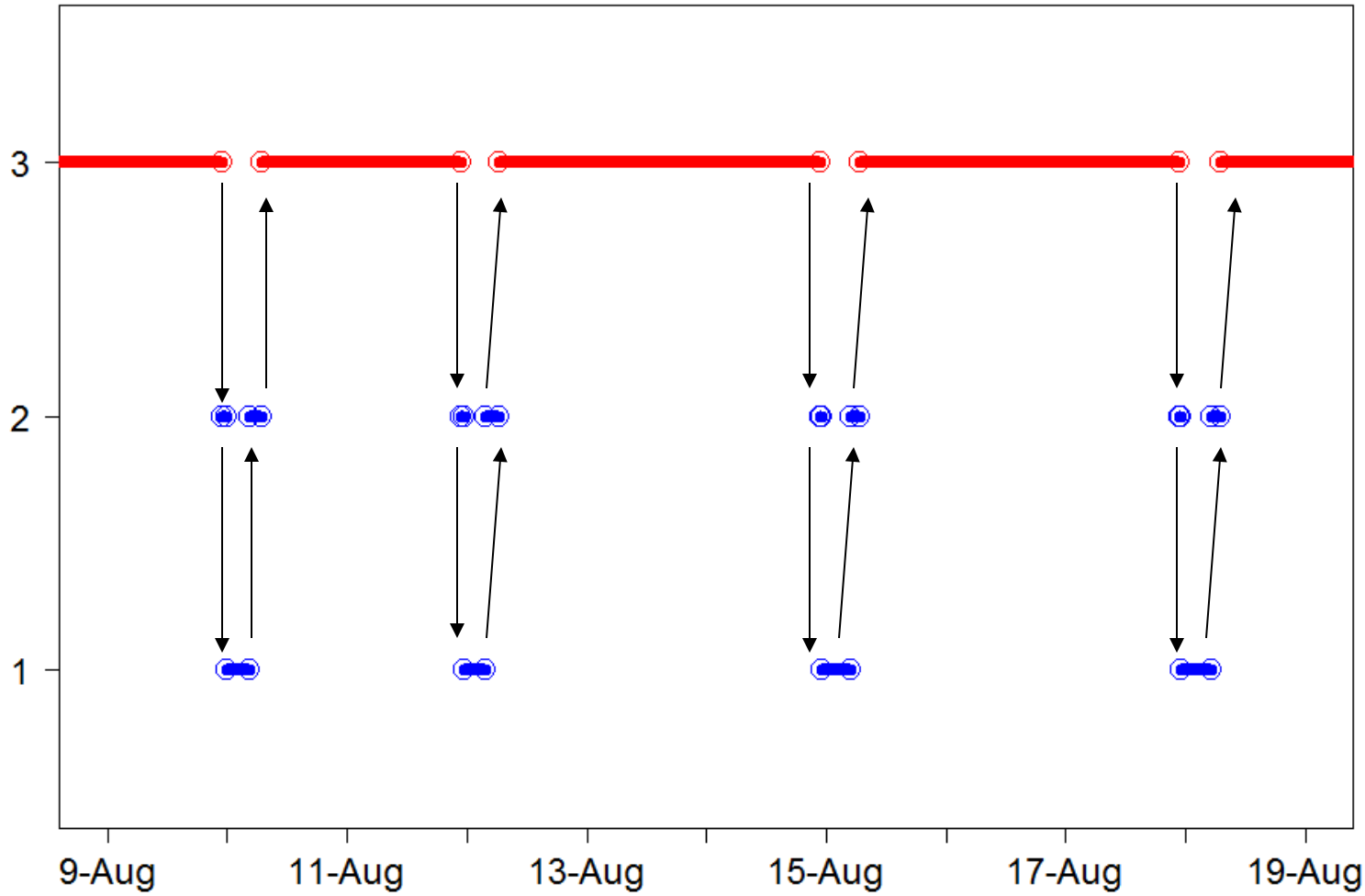
2008:
Deploy PIT tag
Antenna Arrays

1. 0-930m: cold w/ sockeye

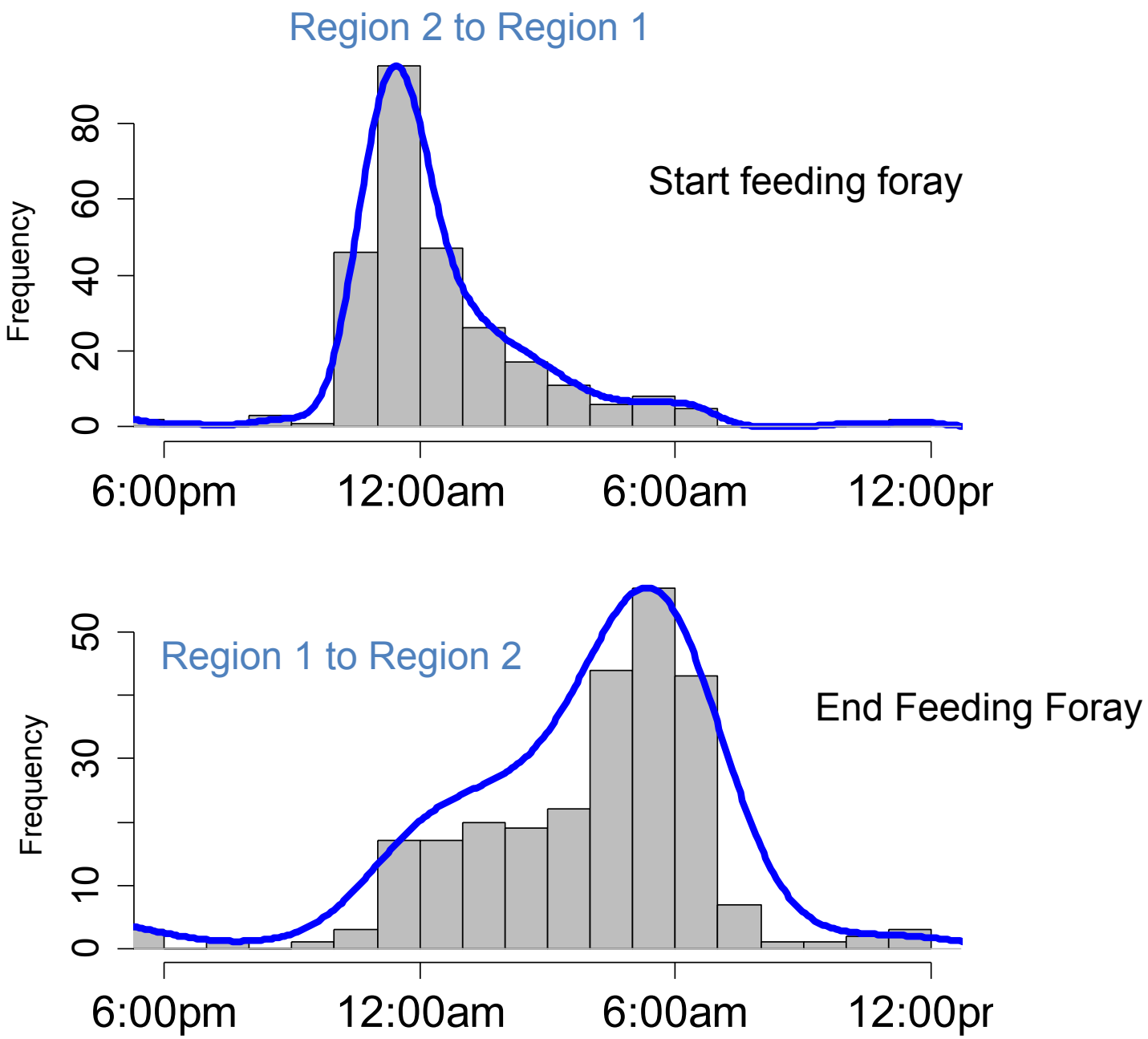
3. 1360m and up: warm w/o sockeye

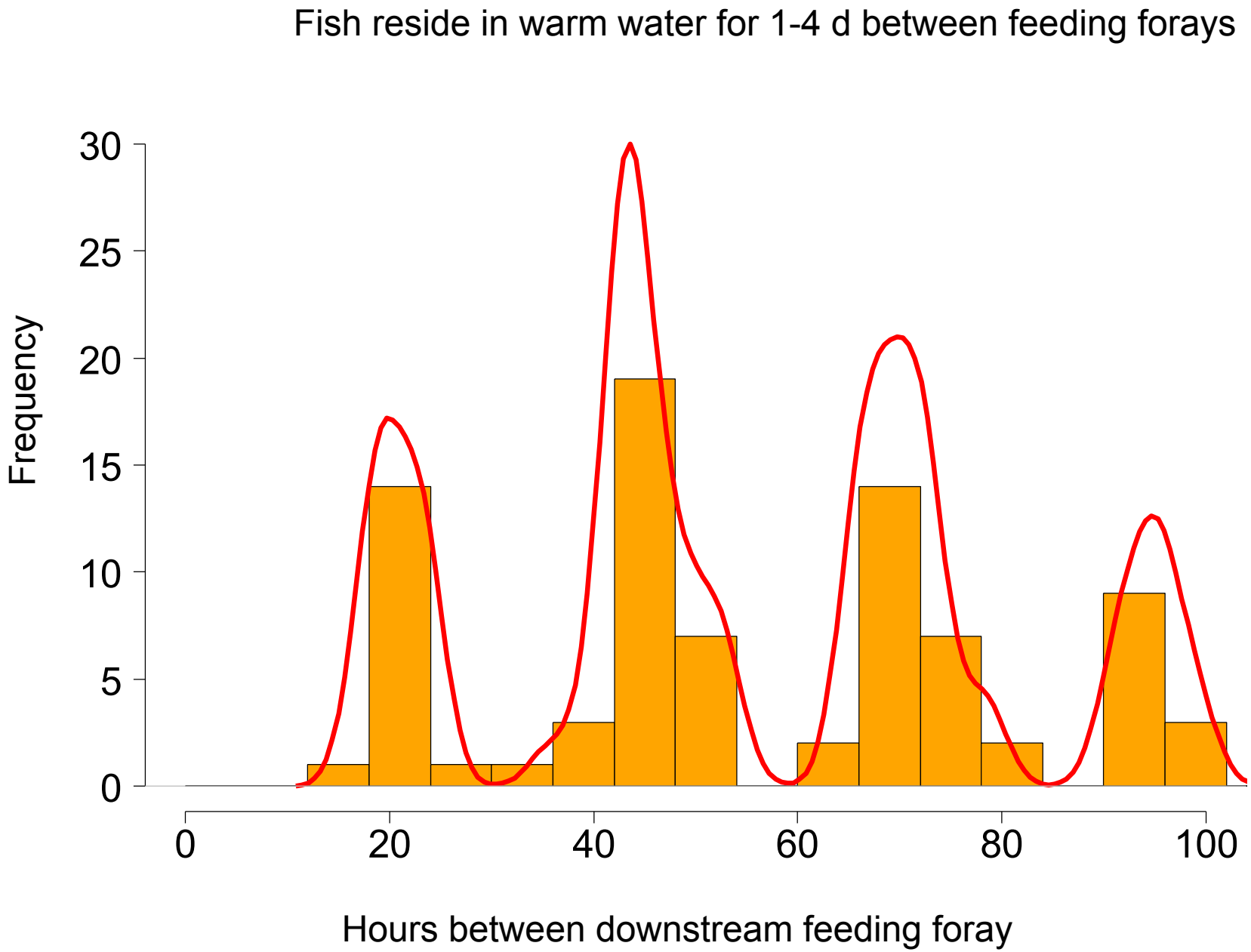
2. 930-1360m: cold w/o sockeye

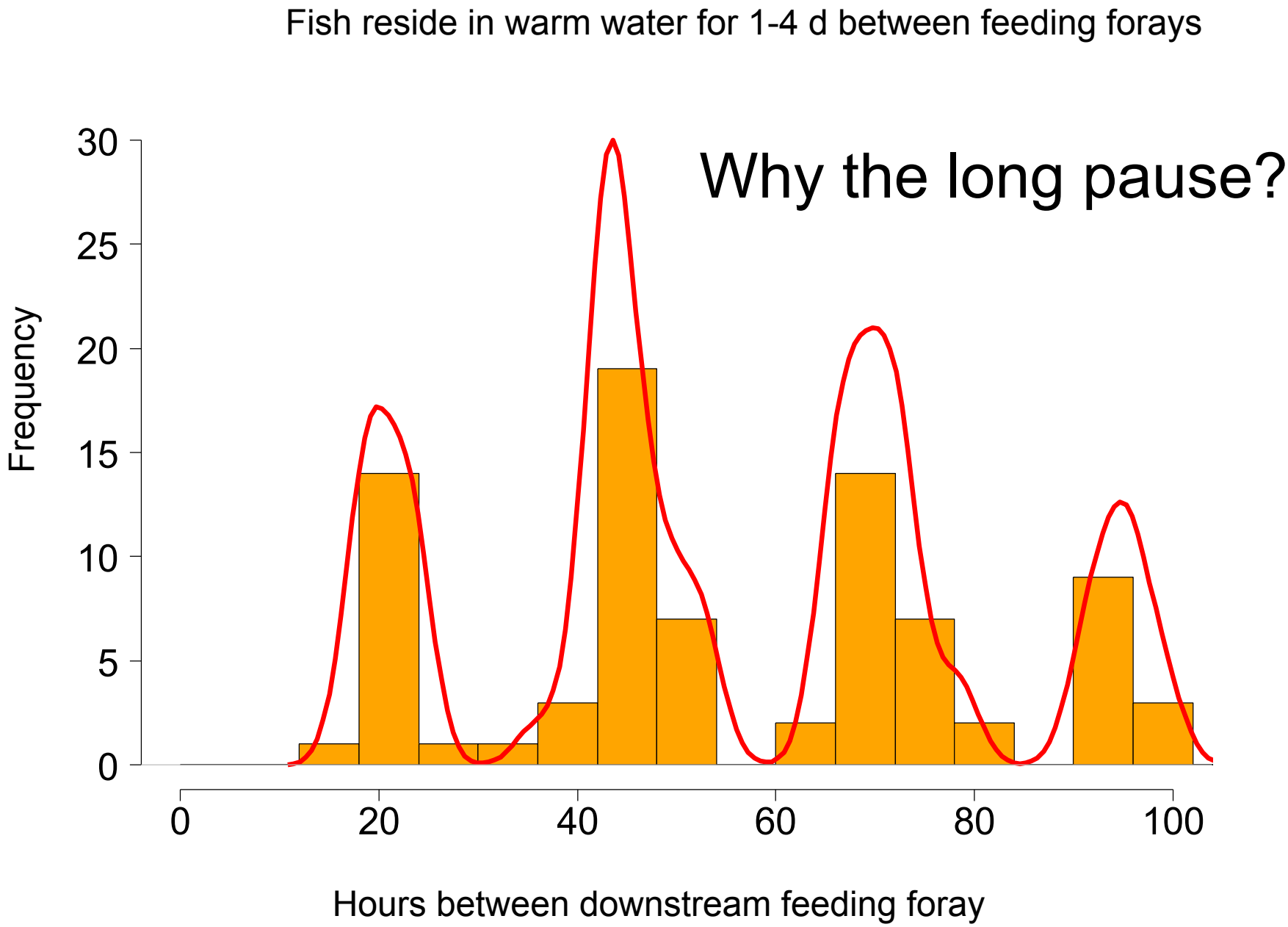
Feeding forays into the cold downstream region



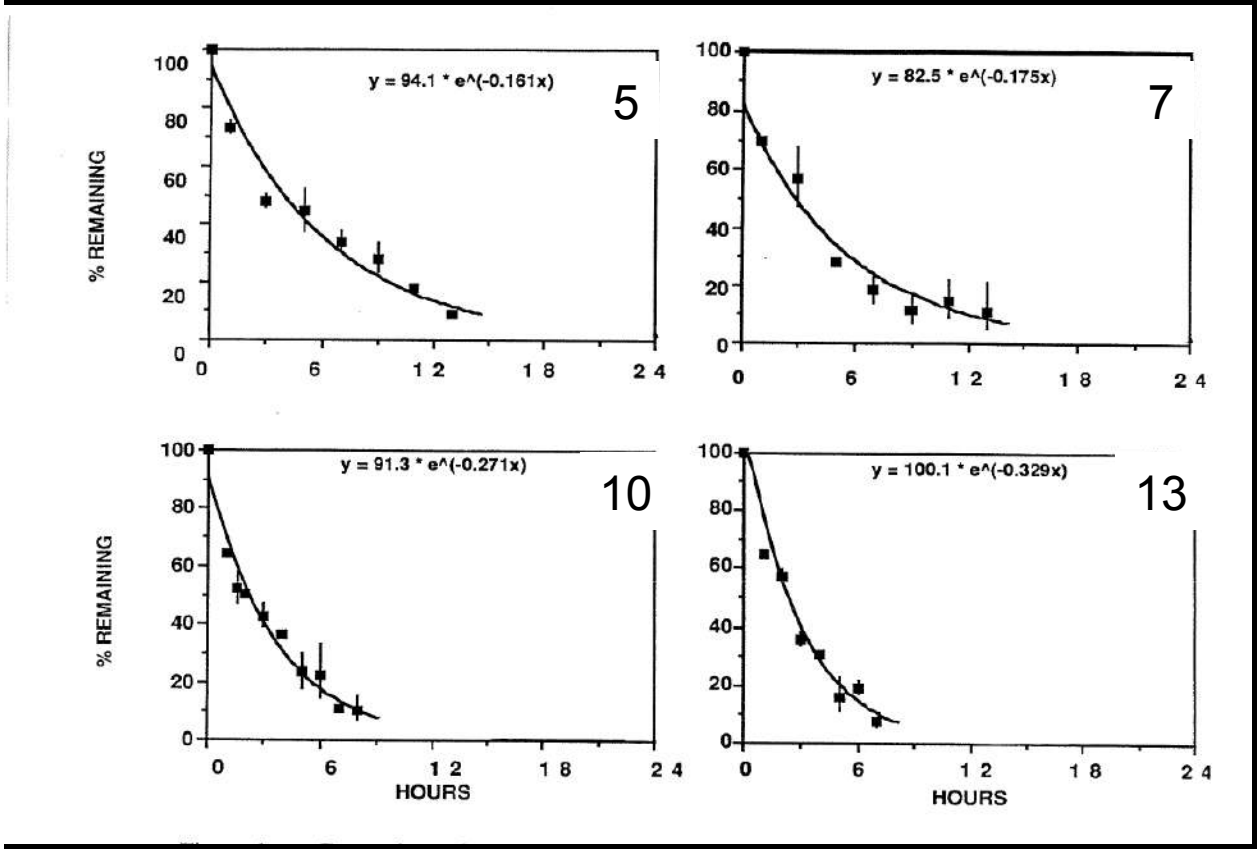
Age-1 coho salmon-- 24-July: 85 mm 7.1 g
21-Aug: 108 mm 17.6 g


Region 2 to Region 1
Frequency
0
20
40
60
80
Start feeding foray
6:00pm
12:00am
6:00am
12:00pr
Region 1 to Region 2
Frequency
0
10
30
50
End Feeding Foray
6:00pm
12:00am
6:00am
12:00pr


Fish reside in warm water for 1-4 d between feeding forays
Frequency
30
25
20
15
10
5
0
0
20
40
60
80
100
Hours between downstream feeding foray

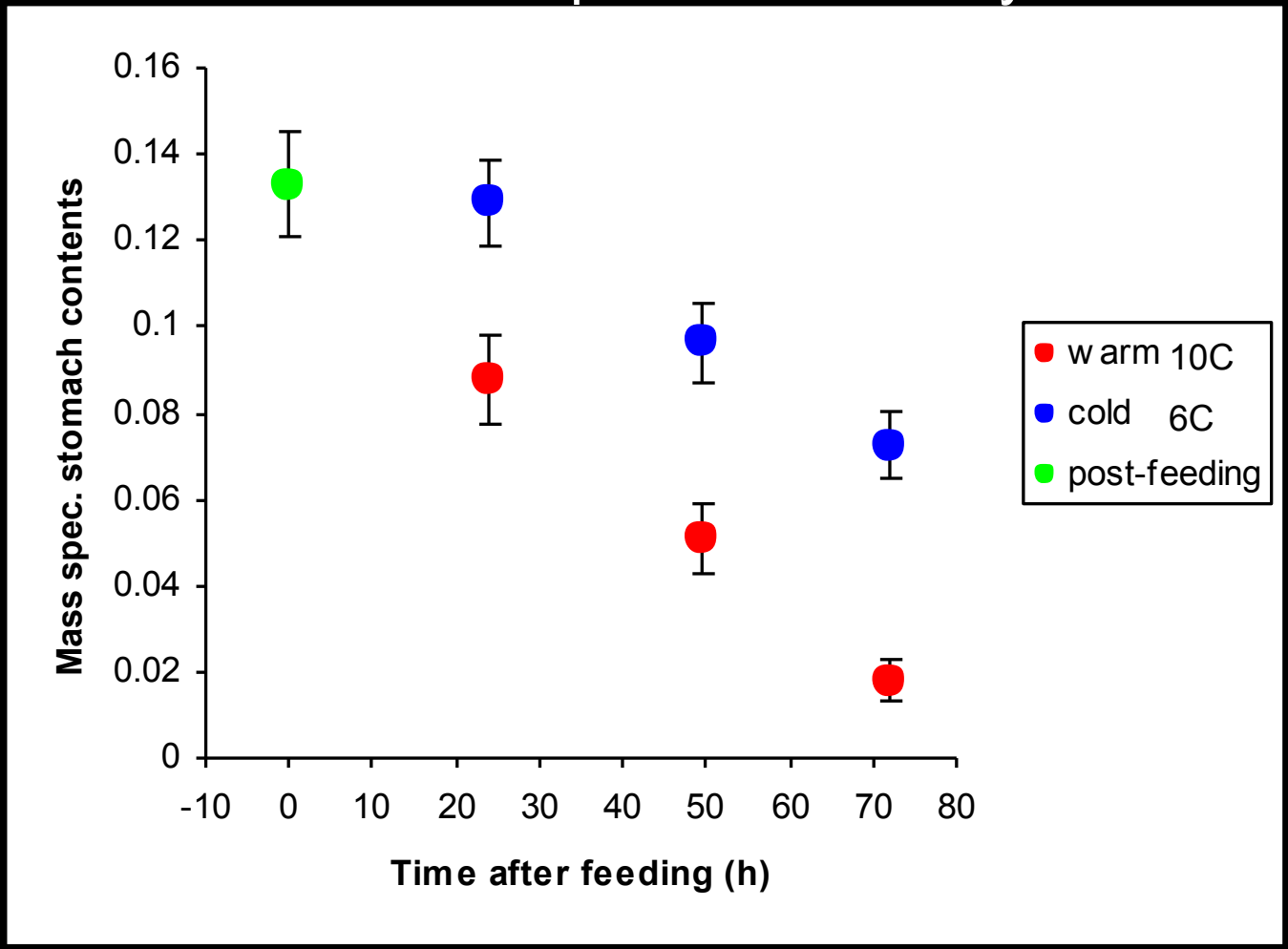

Fish reside in warm water for 1-4 d between feeding forays
Why the long pause?
Frequency
0
5
10
15
20
25
30
0
20
40
60
80
100
Hours between downstream feeding foray

Shouldn't fish be done digesting eggs after 24 hours?

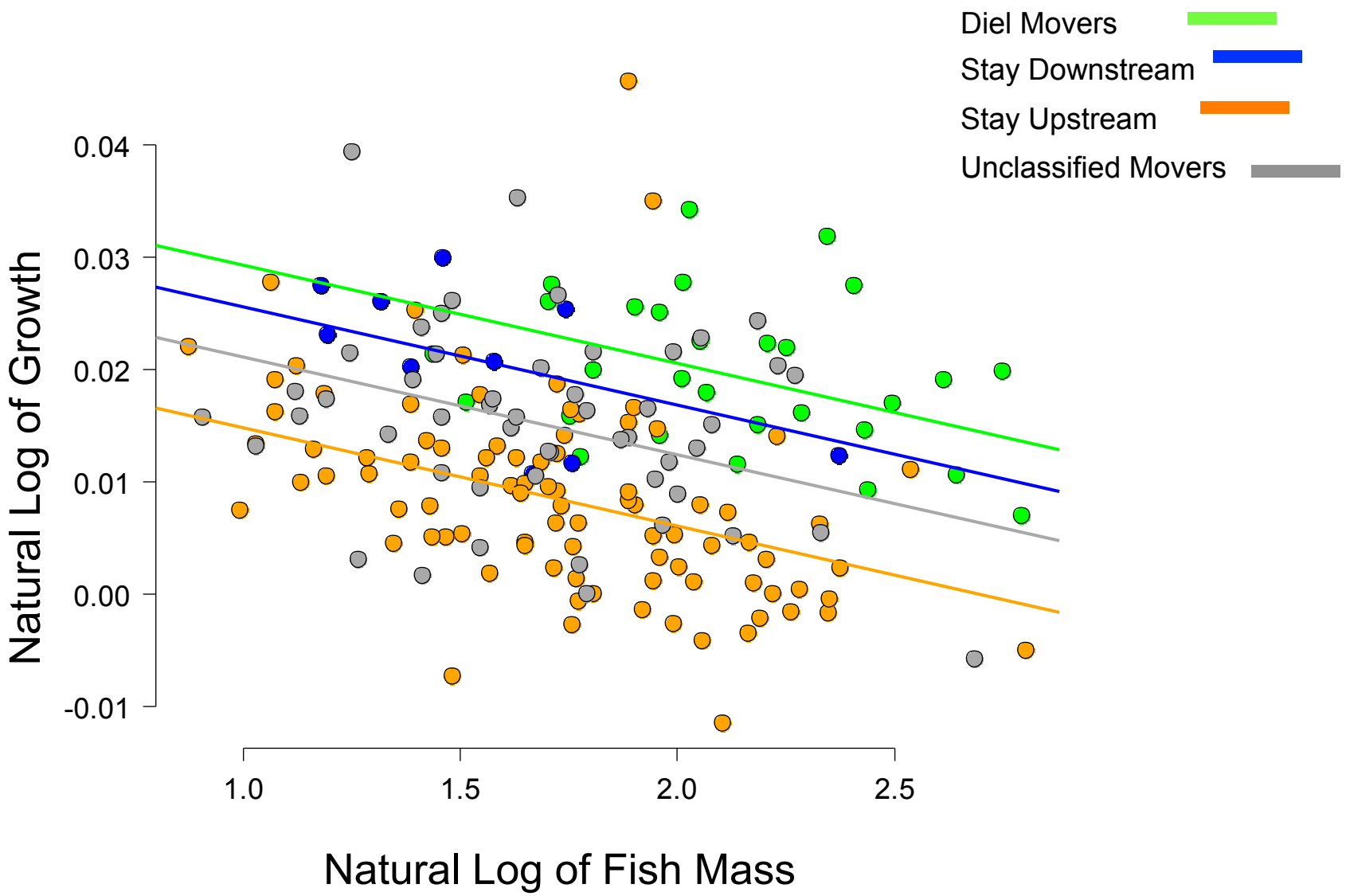


Digestion of sockeye fry (1-2)
Ration = 1-3 % body mass
Ruggerone 1988

In situ measures of gastric evacuation: Fish can consume up to 17% of body mass in single meal

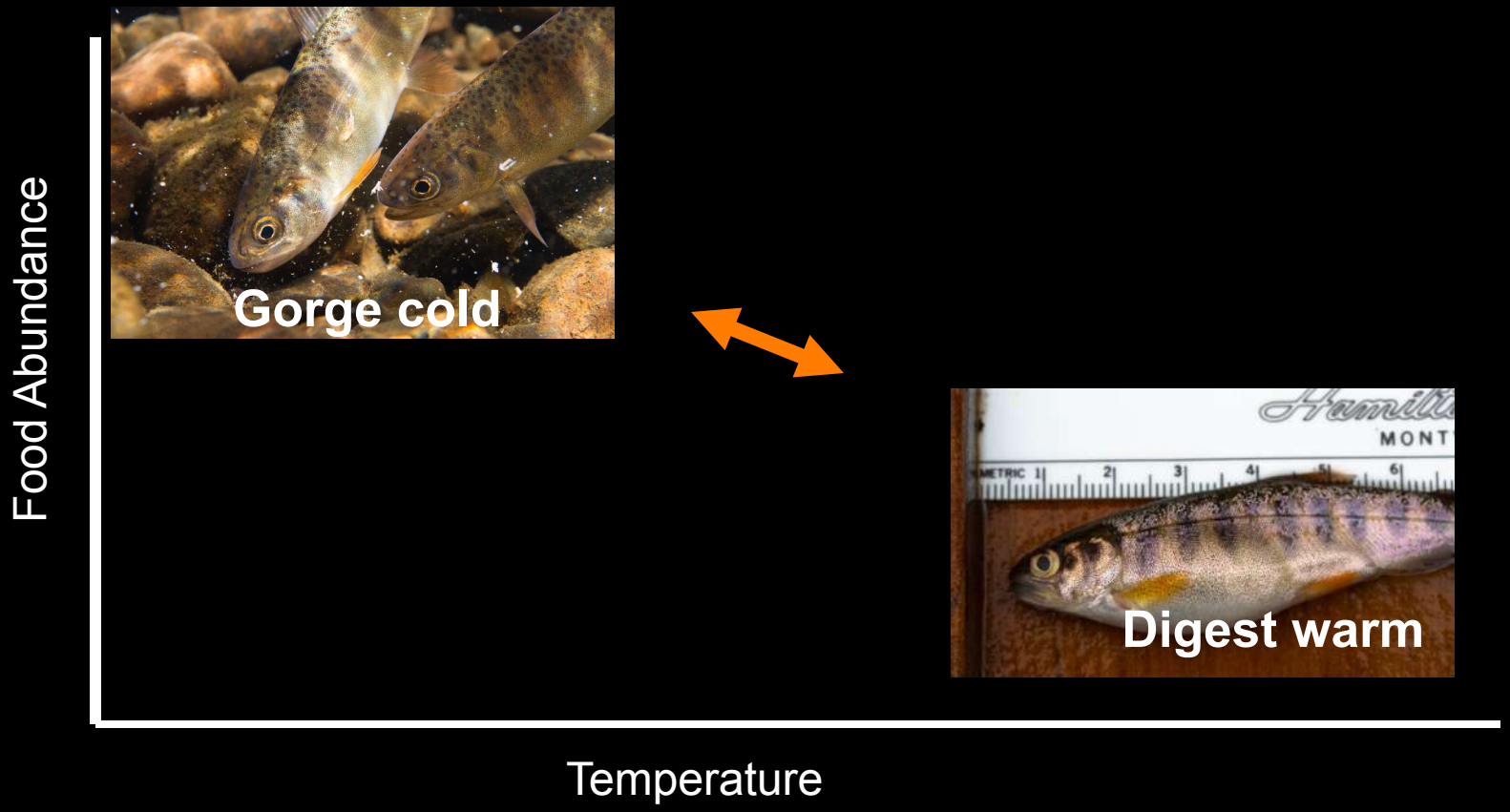


- Huge stomach capacity + slow processing of lipids explains long digestive pauses in Bear Creek coho


Diel Movers
Stay Downstream
Stay Upstream
Unclassified Movers
0.04
0.03
0.02
0.01
0.00
-0.01
Natural Log of Growth
1.0
1.5
2.0
2.5
Natural Log of Fish Mass

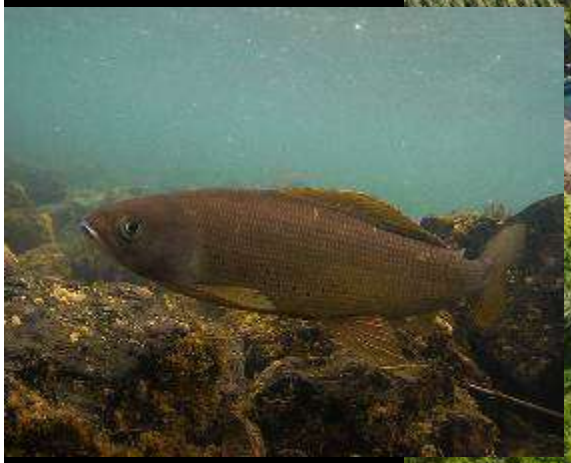
Successful coho don’t compromise

- Habitat coupling: Combine favorable elements of different locations
- Predator physiology makes this possible: big stomachs for moving food from one habitat patch to another



Diel movement: ubiquitous in lakes and oceans

What about fish behavior in streams?



Why should we care about whether lotic organisms exploit habitat heterogeneity in their daily behavior?

- Lotic systems are some of the most threatened worldwide
- Understanding how fish exploit heterogeneity will help us restore it

Acknowledgements

- Adviser: Daniel Schindler
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