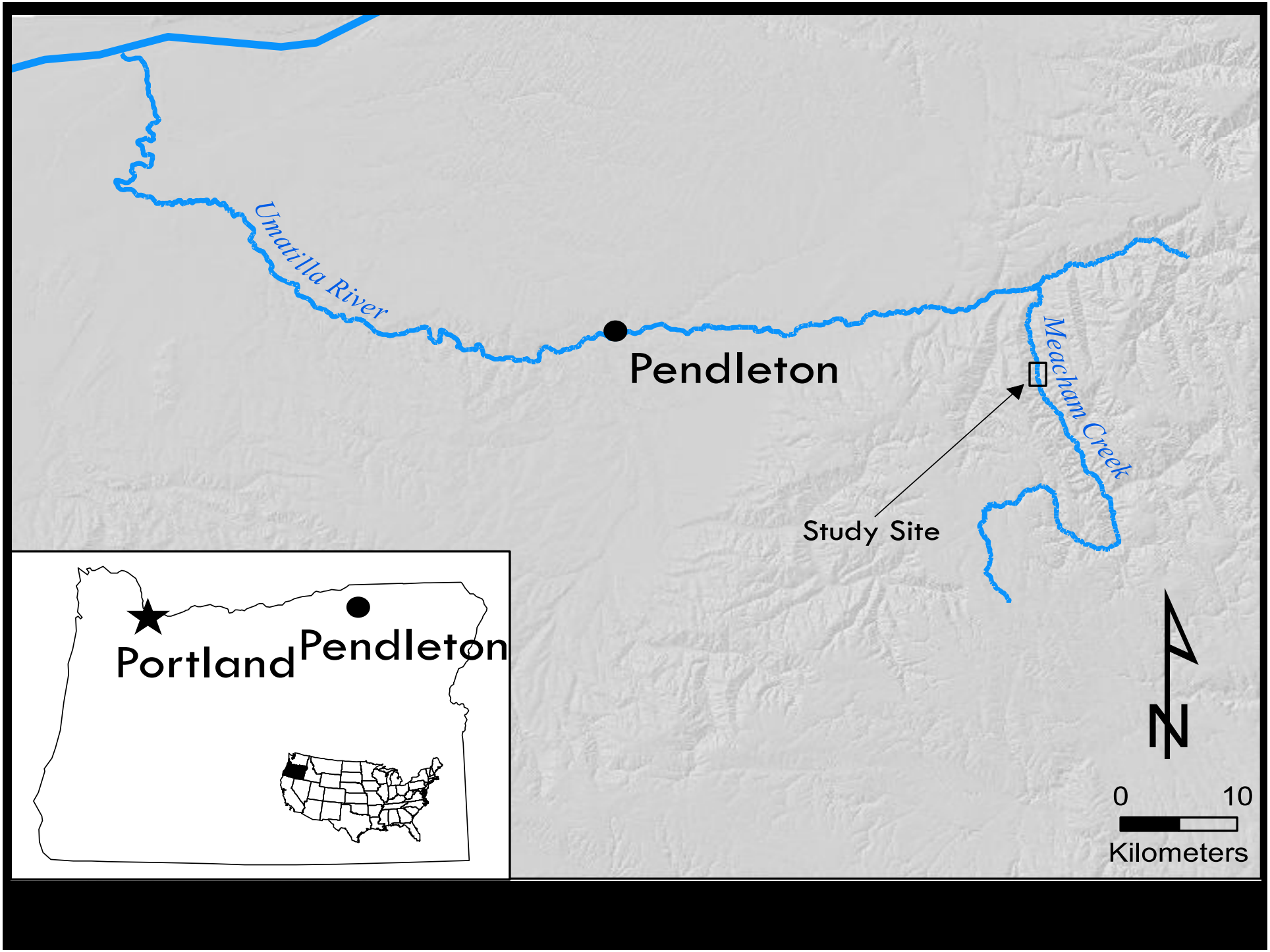
Reconfigured Groundwater Hydrology and Energy Dynamics in a Restored Reach of Meacham Creek, Oregon, USA

Byron E. Amerson, Michael Lambert, Geofforey C. Poole, Scott J. O'Daniel


Umatilla River
Pendleton
Meacham Creek
Study Site
Portland
Pendleton
N
0
10
Kilometers

Spring Chinook (*Oncorhynchus tshawytscha*)
Photo by Chau Tran

• Raise the water table & increase hyporheic exchange
• Increase buffering of stream temperature extremes
Spring Chinook (*Oncorhynchus tshawytscha*)
Photo by Chau Tran

FLOW

2009
2012
FLOW

Questions:

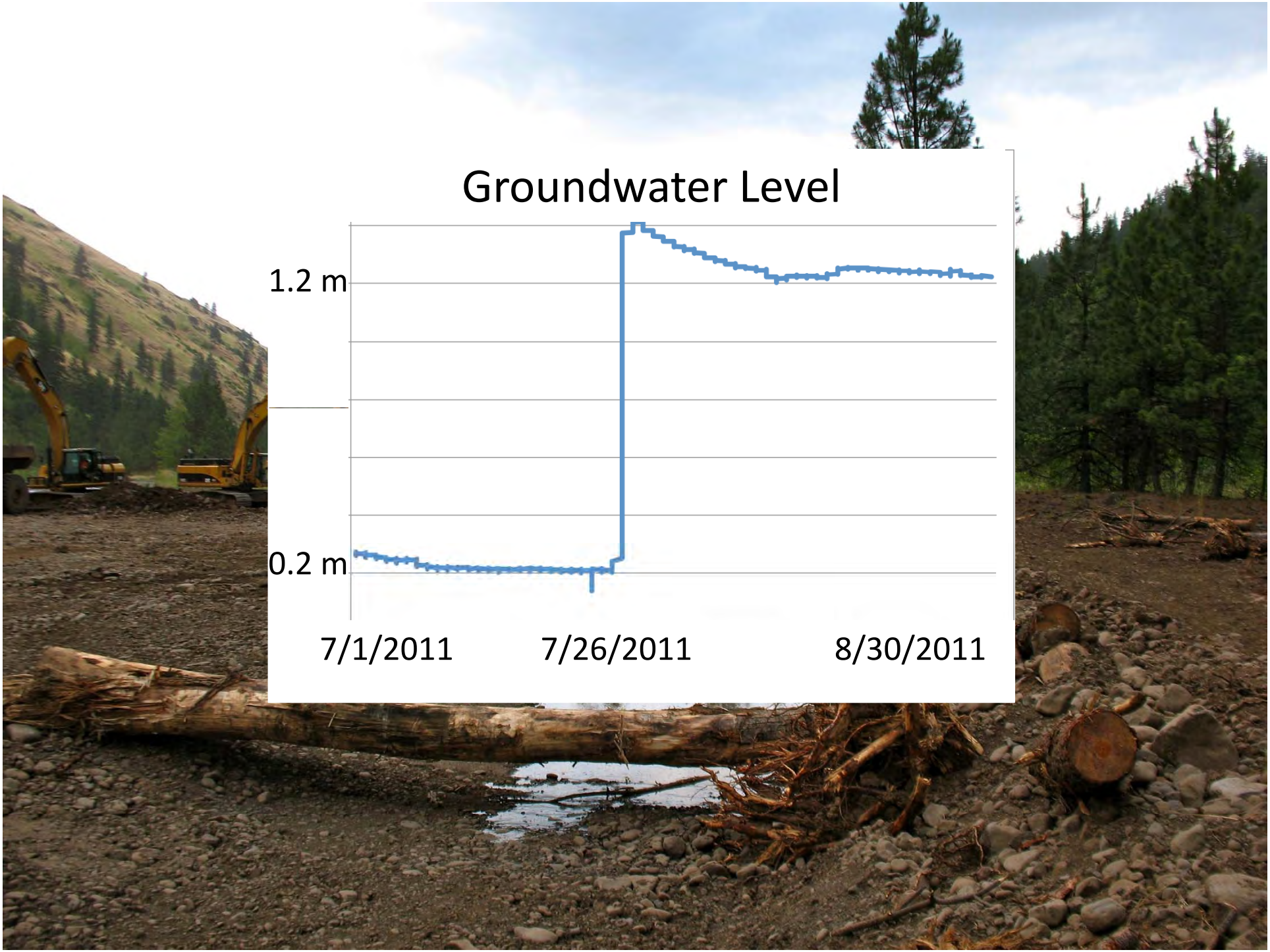
- Will the restoration project affect hyporheic exchange?
- Will the restoration project affect stream water temperature?

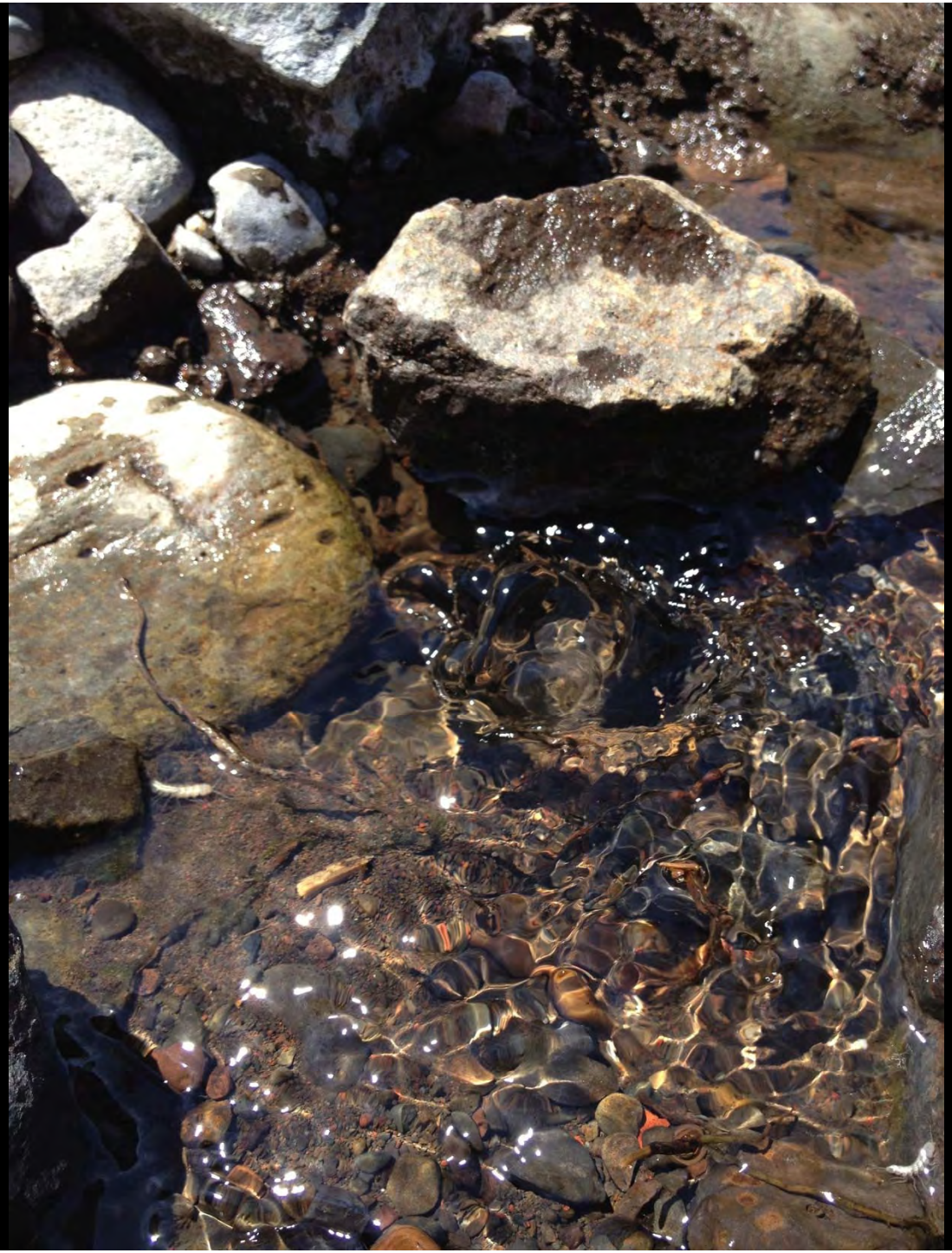
Questions:

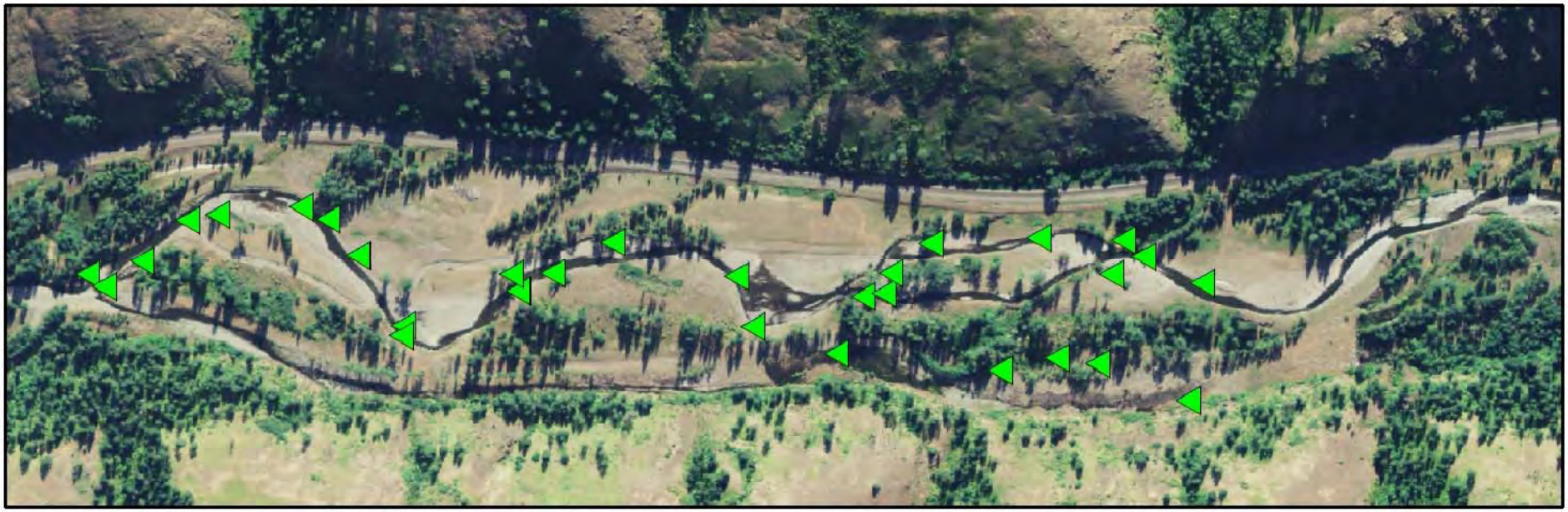
- Will the restoration project affect hyporheic exchange?
- Will the restoration project affect stream water temperature?

Expectations:

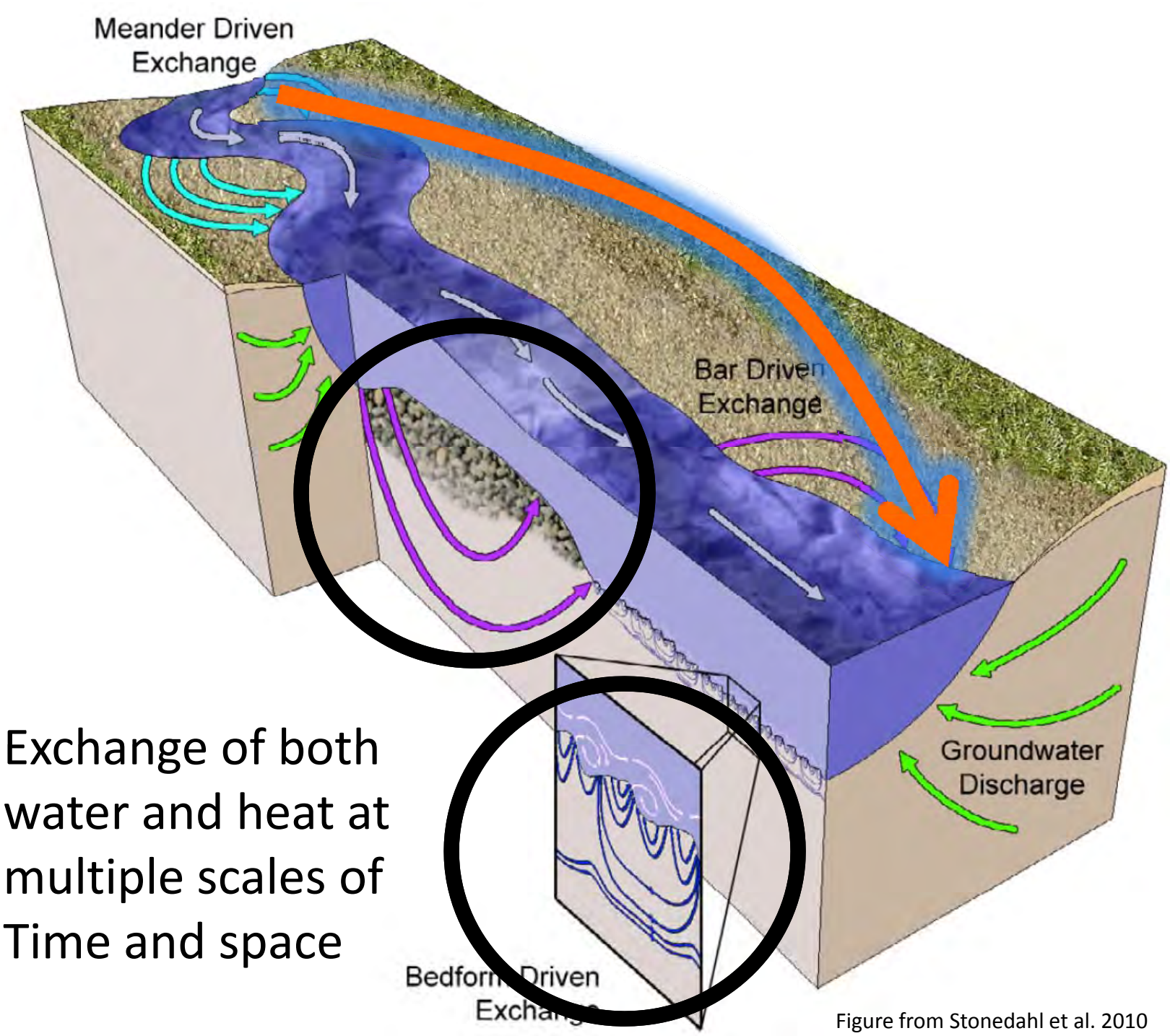
- Hyporheic exchange will increase.
- Water temperature buffering will increase.


Groundwater Level
1.2 m
0.2 m
7/1/2011
7/26/2011
8/30/2011



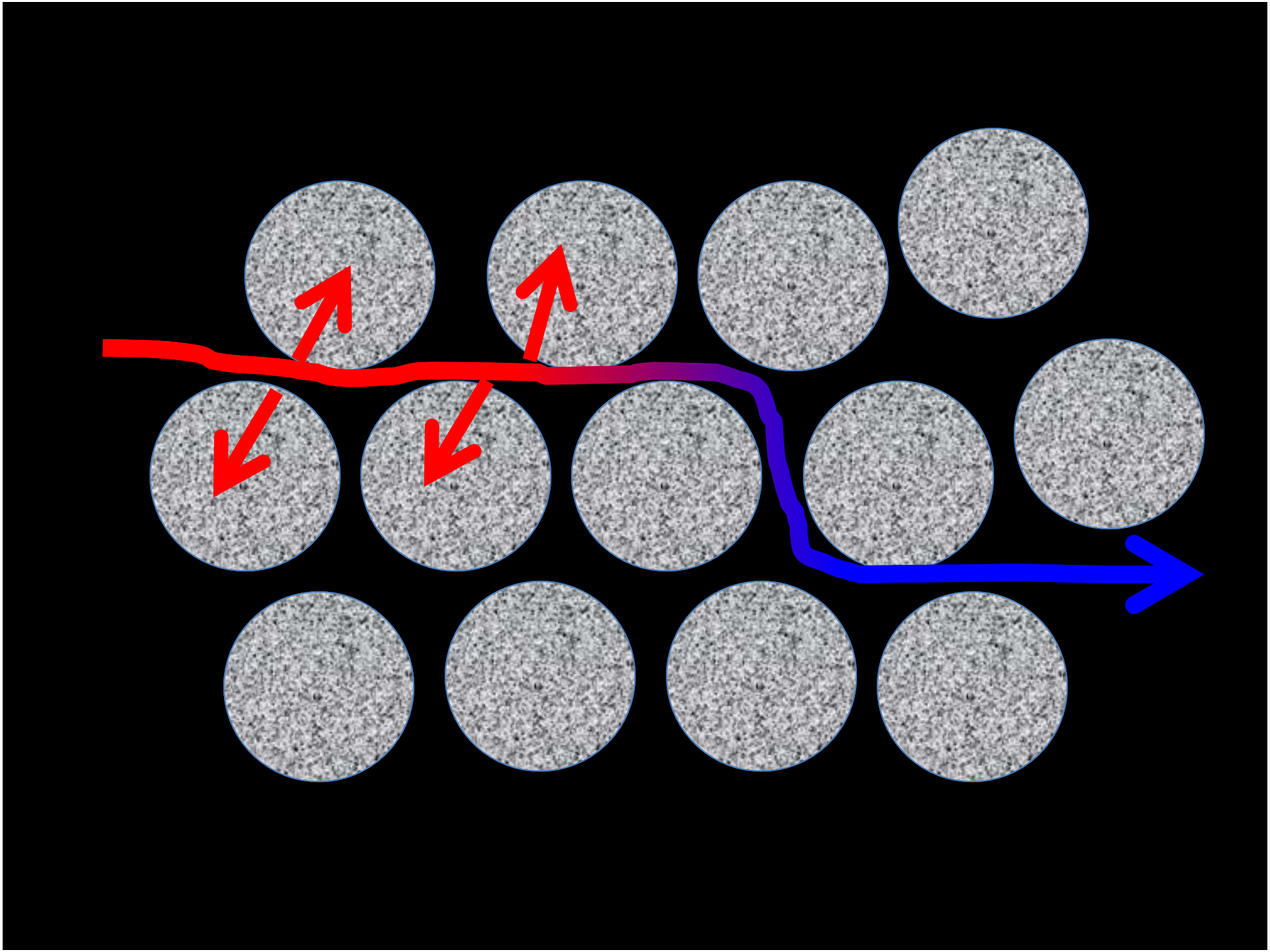


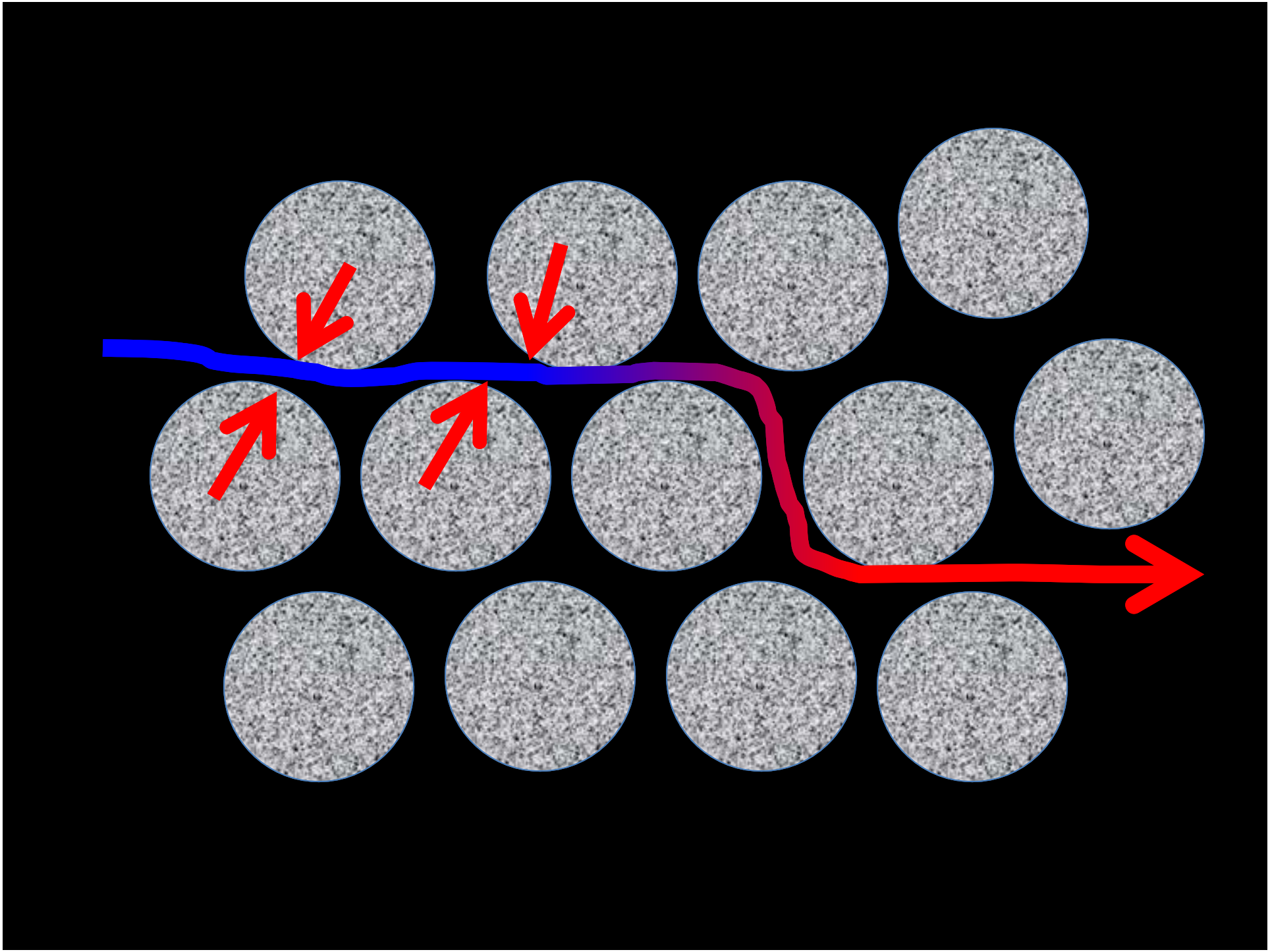
FLOW



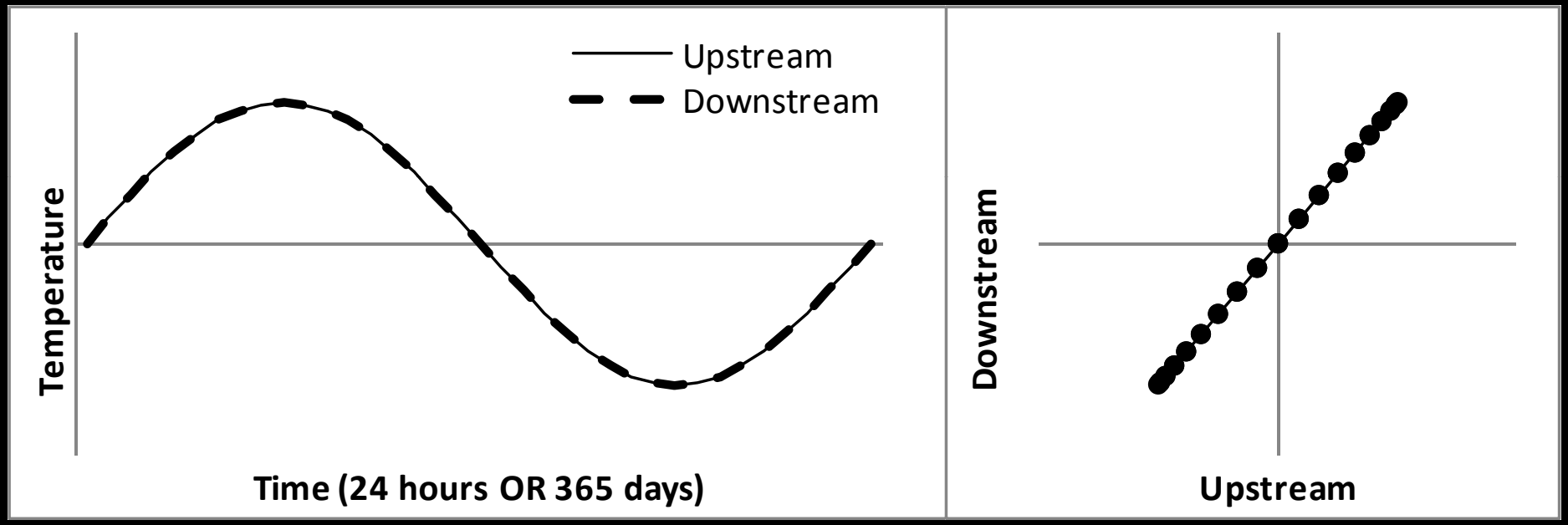
Exchange of both water and heat at multiple scales of Time and space

Figure from Stonedahl et al. 2010

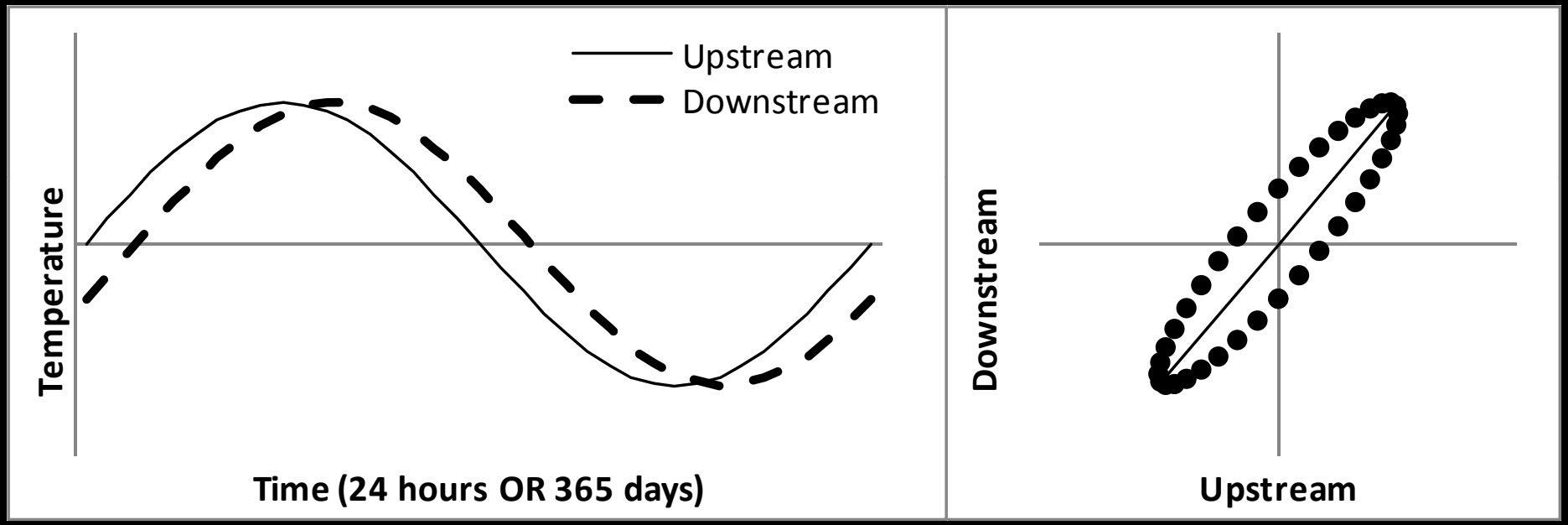




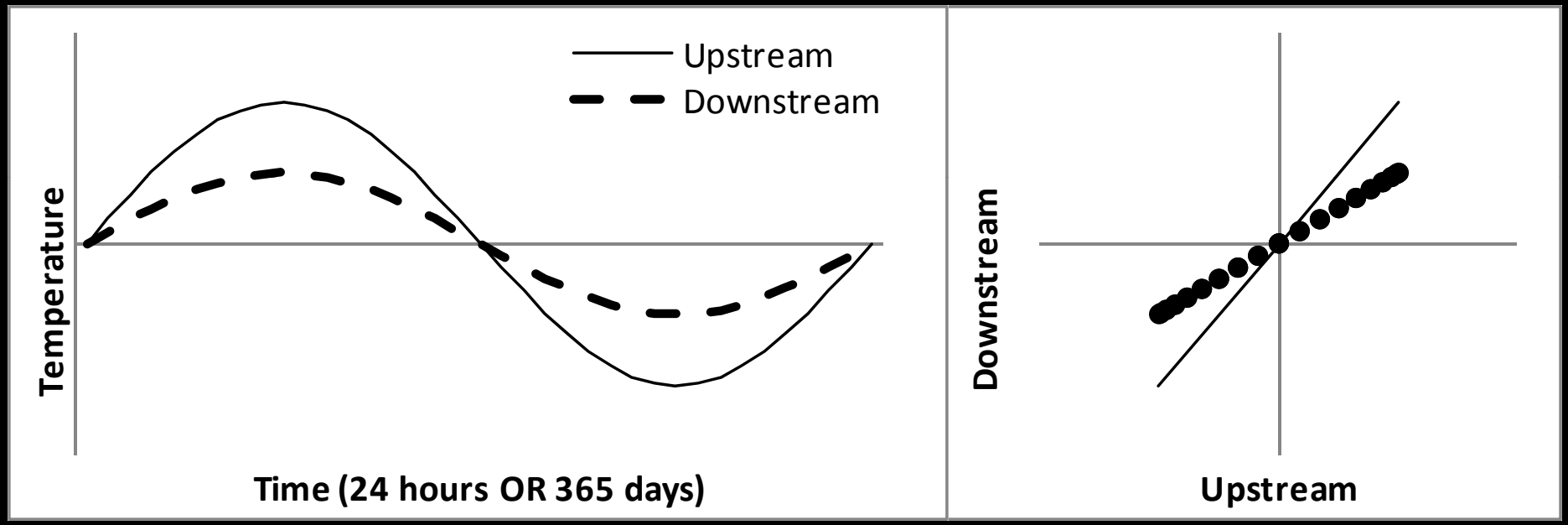
Pattern Analysis – No Change



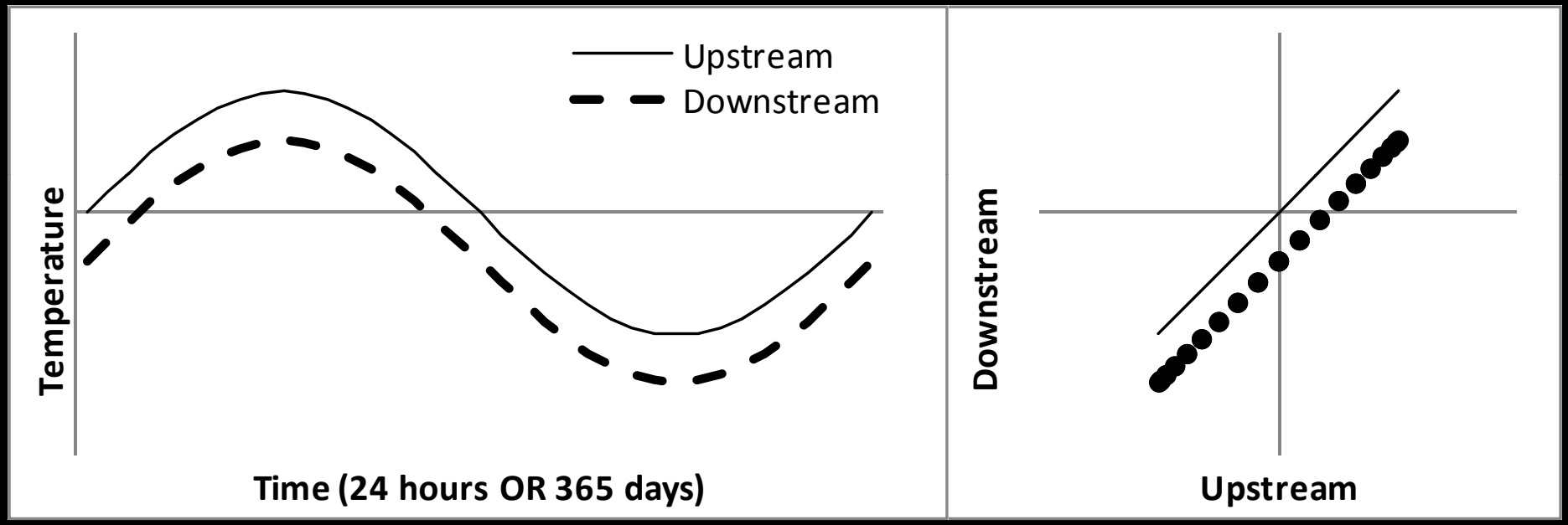
Pattern Analysis – Lagging



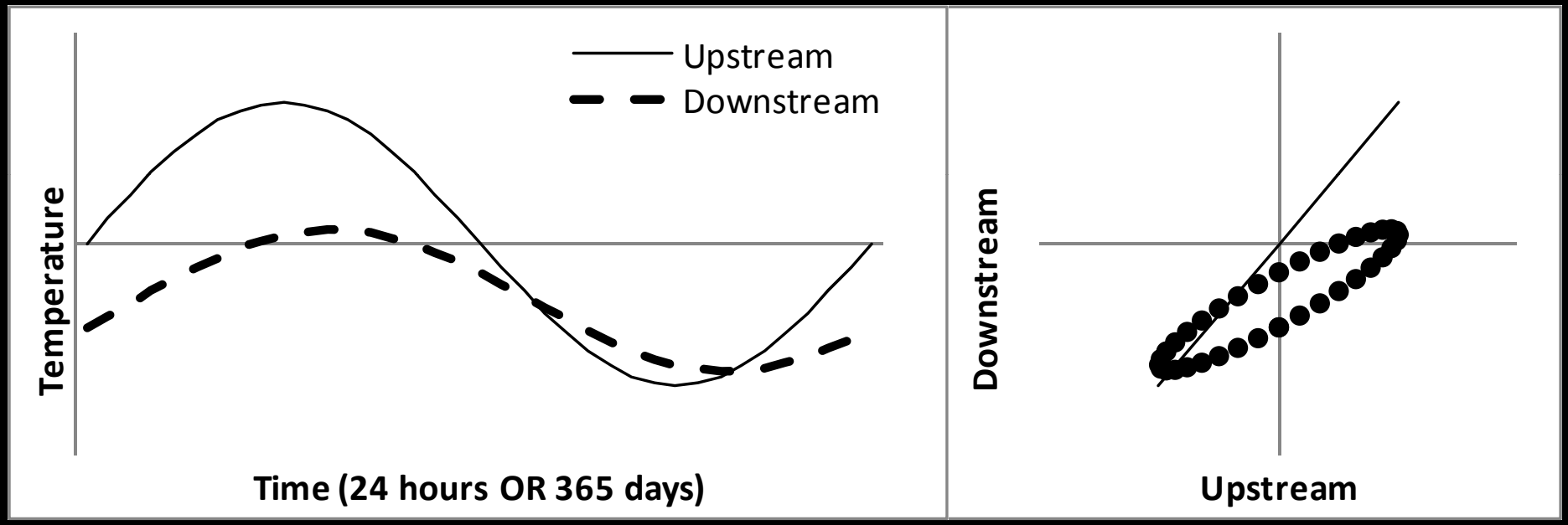
Pattern Analysis – Buffering

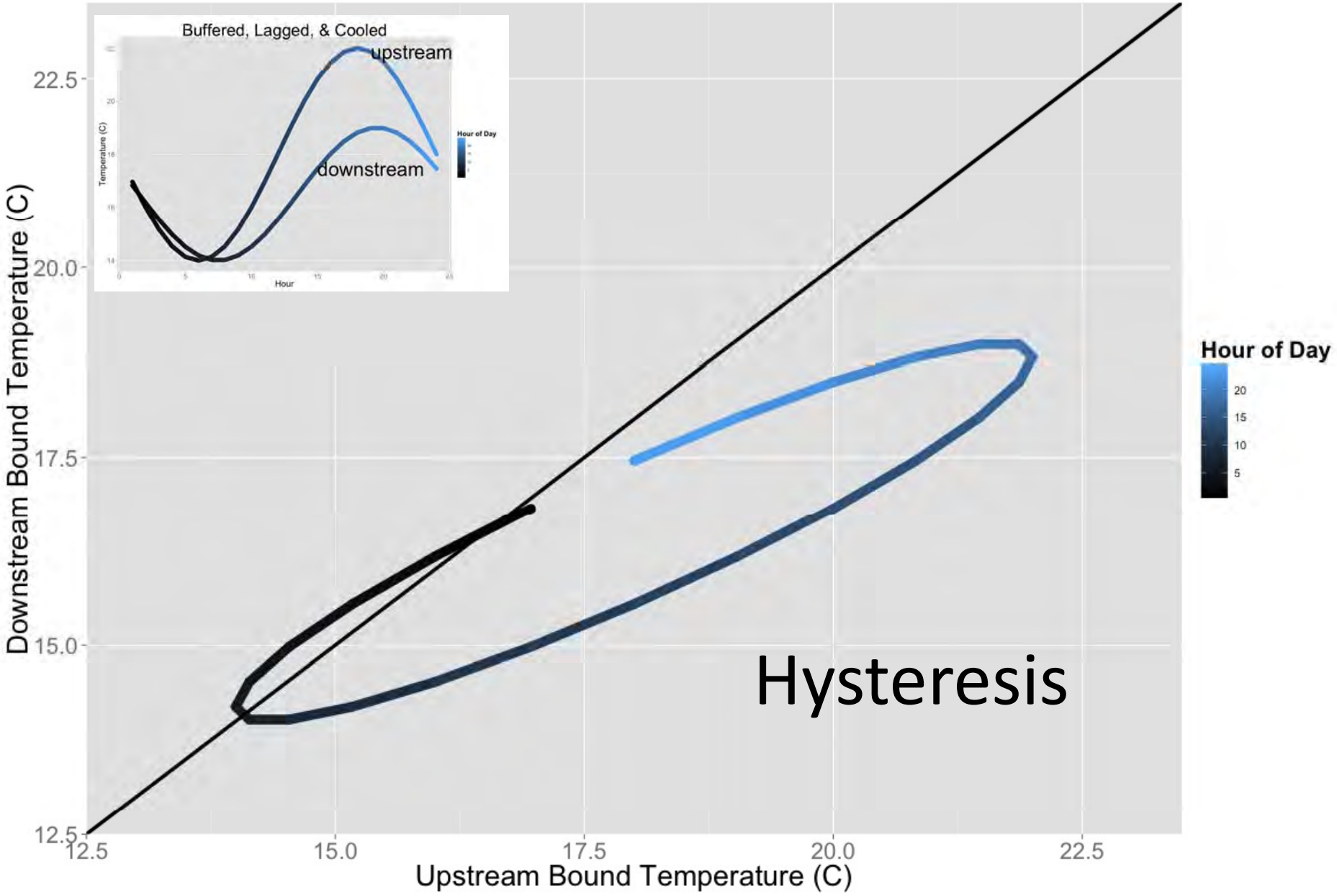


Pattern Analysis – Cooling

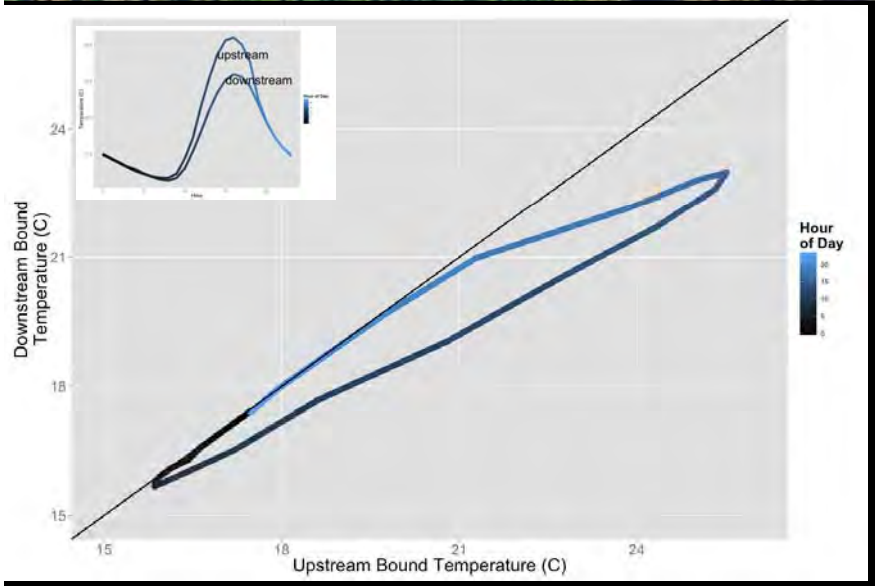


Pattern Analysis – Combined

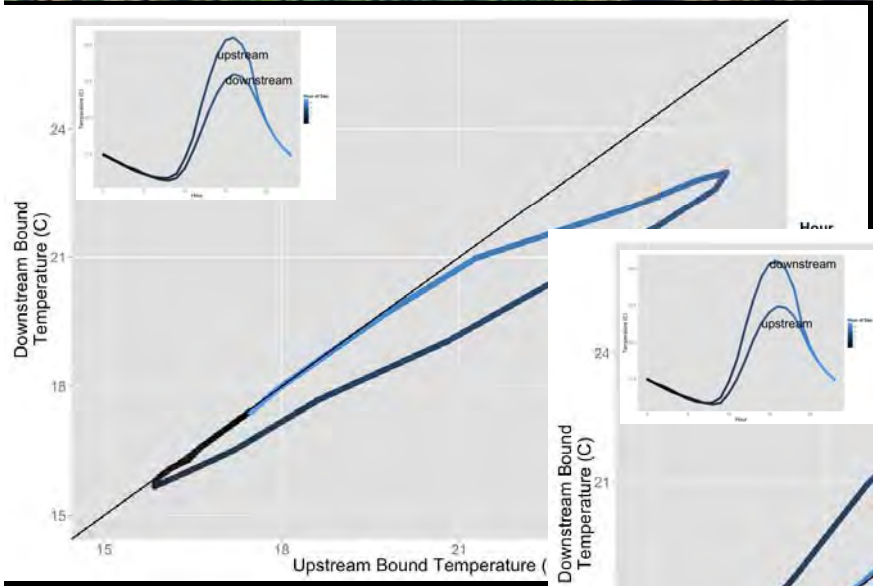


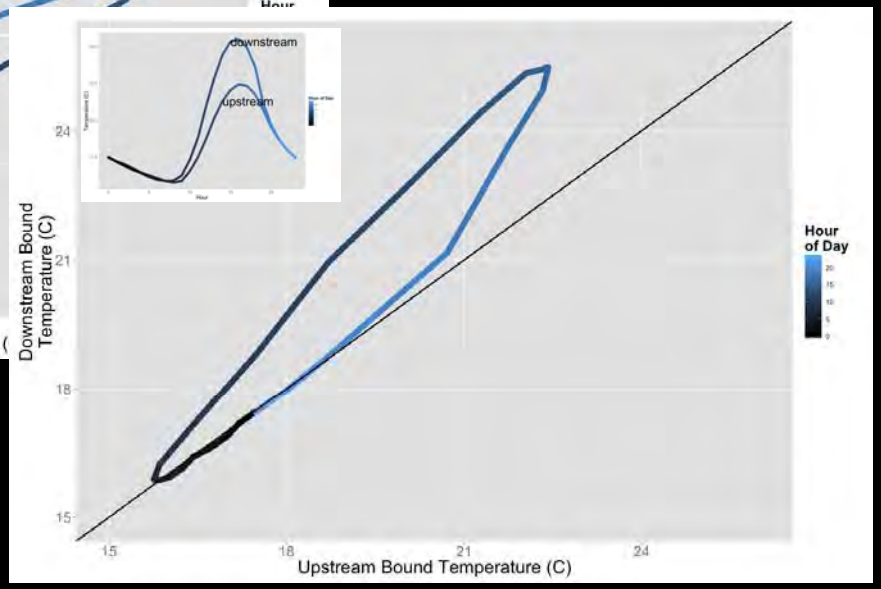

Buffered, Lagged, & Cooled
upstream
downstream
Temperature (C)
Hour
Hour of Day
Hysteresis
Downstream Bound Temperature (C)
Upstream Bound Temperature (C)
12.5
15.0
17.5
20.0
22.5
Hour of Day
20
15
10
5

FLOW

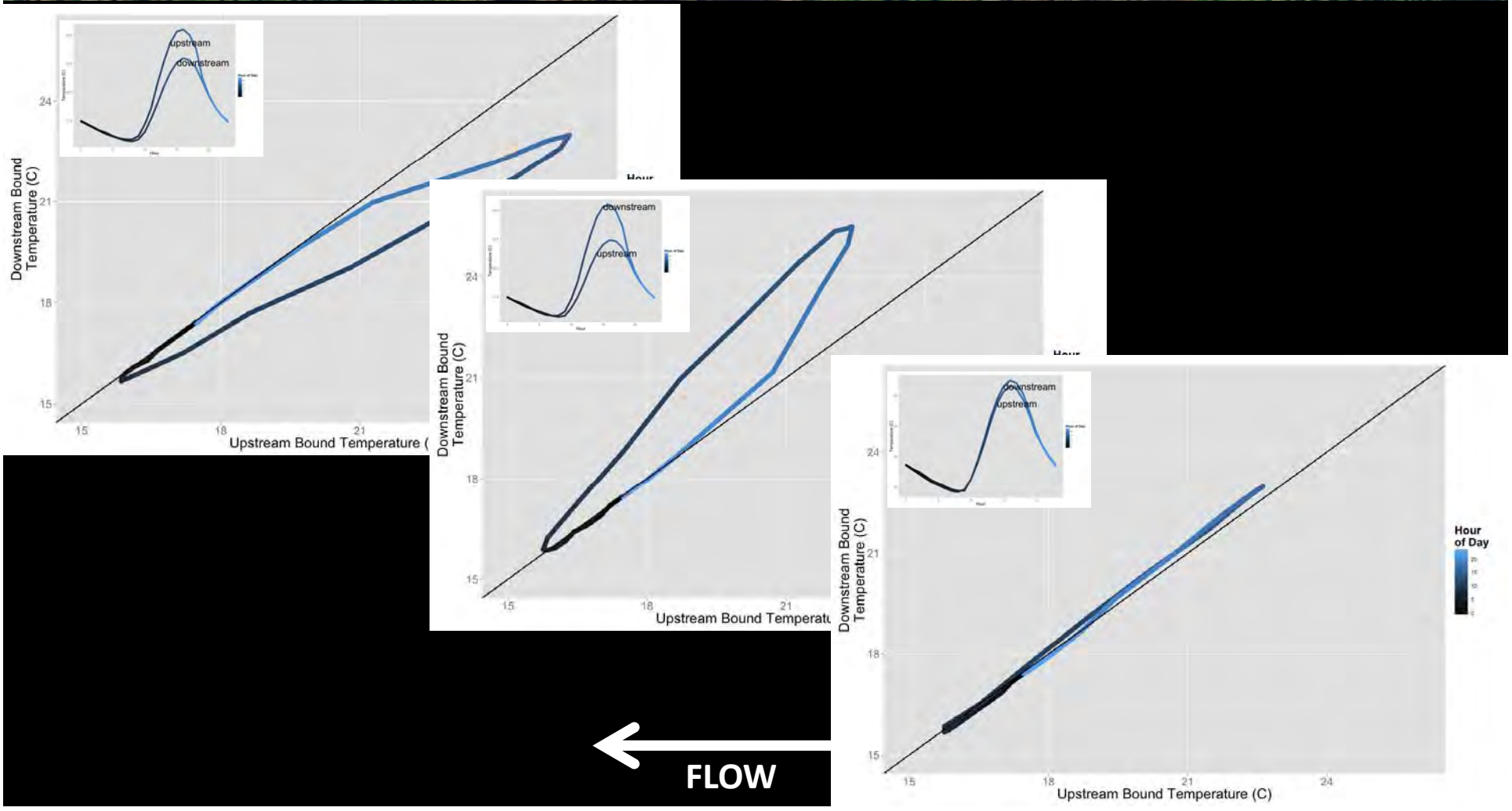

upstream
downstream
Downstream Bound Temperature (C)
Upstream Bound Temperature (C)
Hour of Day
15
18
21
24

FLOW

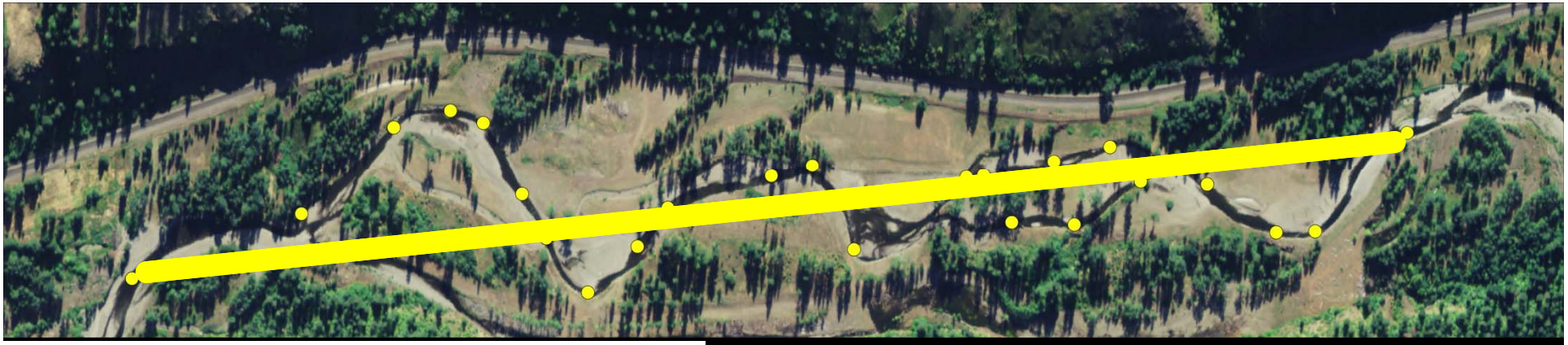

upstream
downstream
Downstream Bound Temperature (C)
Upstream Bound Temperature (
15
18
21
24

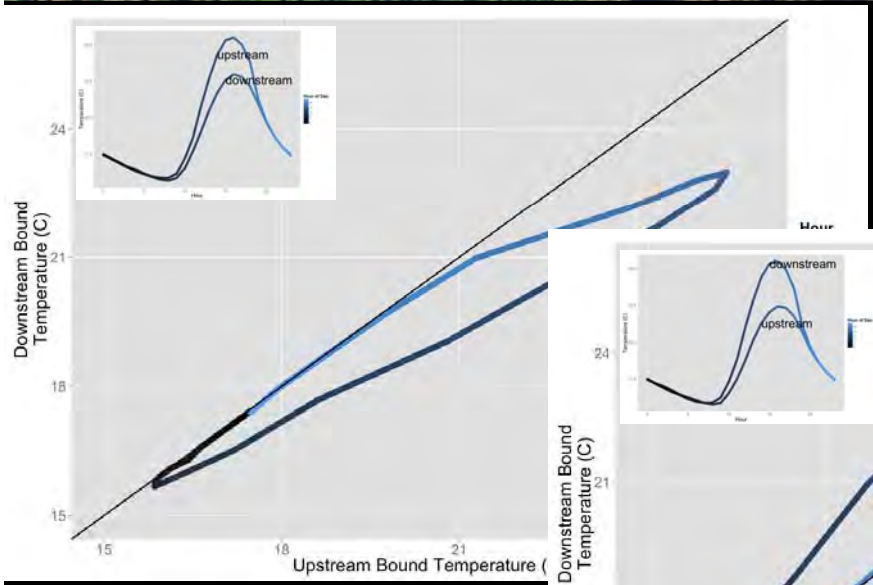

downstream
upstream
Downstream Bound Temperature (C)
Upstream Bound Temperature (C)
Hour of Day
15
18
21
24

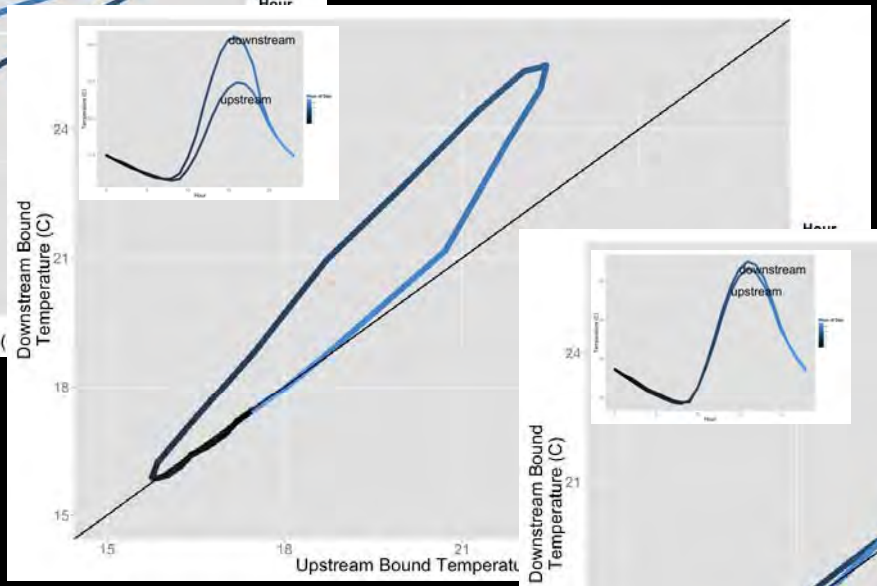
FLOW

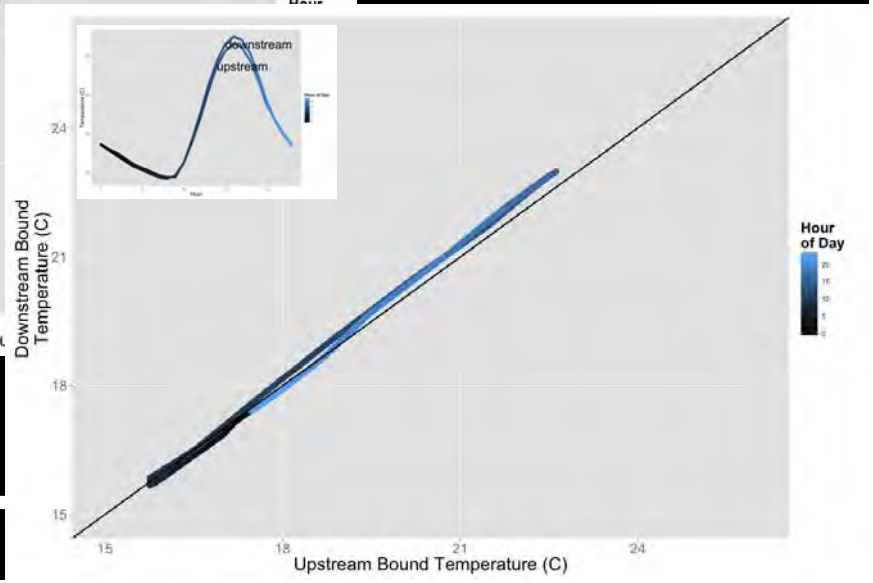

upstream
downstream
Downstream Bound Temperature (C)
Upstream Bound Temperature (
15
18
21
24
downstream
upstream
Downstream Bound Temperature (C)
Upstream Bound Temperatu
Hour of Day
FLOW

downstream
upstream
Downstream Bound Temperature (C)
Upstream Bound Temperature (C)
15
18
21
24
Hour of Day

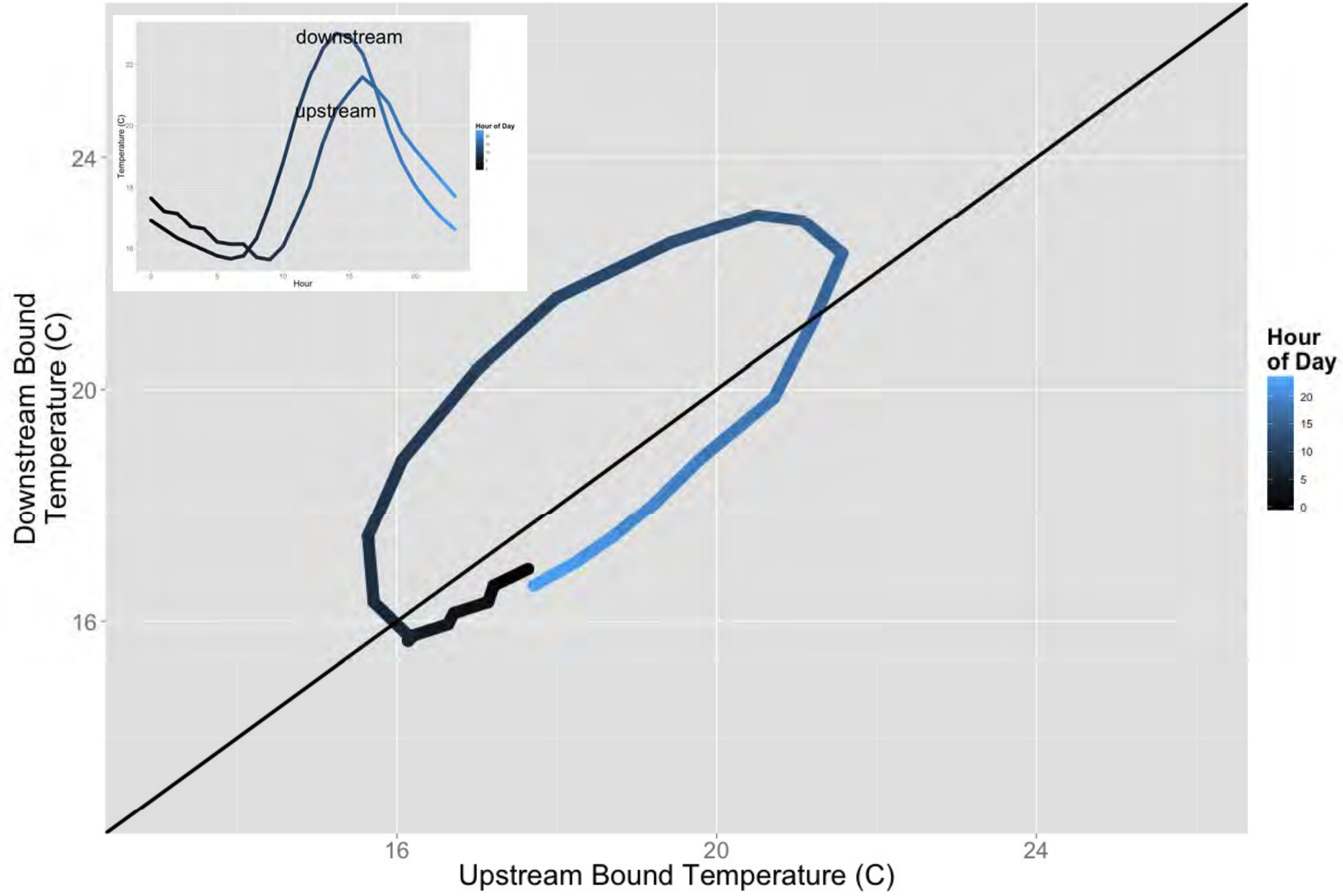



upstream
downstream
Downstream Bound Temperature (C)
Upstream Bound Temperature (
15
18
21
24


downstream
upstream
Downstream Bound Temperature (C)
Upstream Bound Temperatu
15
18
21
24

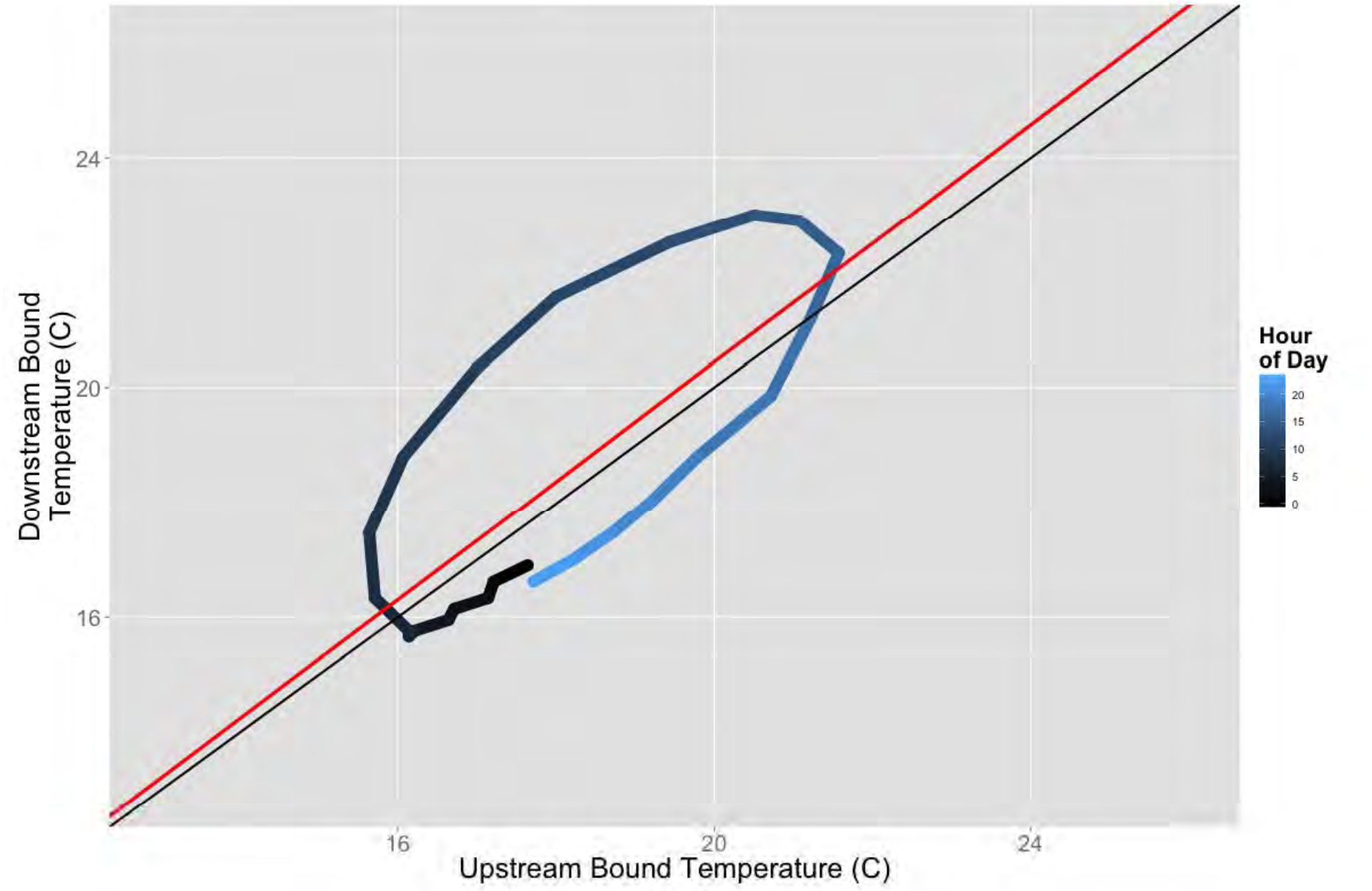

downstream
upstream
Downstream Bound Temperature (C)
Upstream Bound Temperature (C)
Hour of Day
15
18
21
24

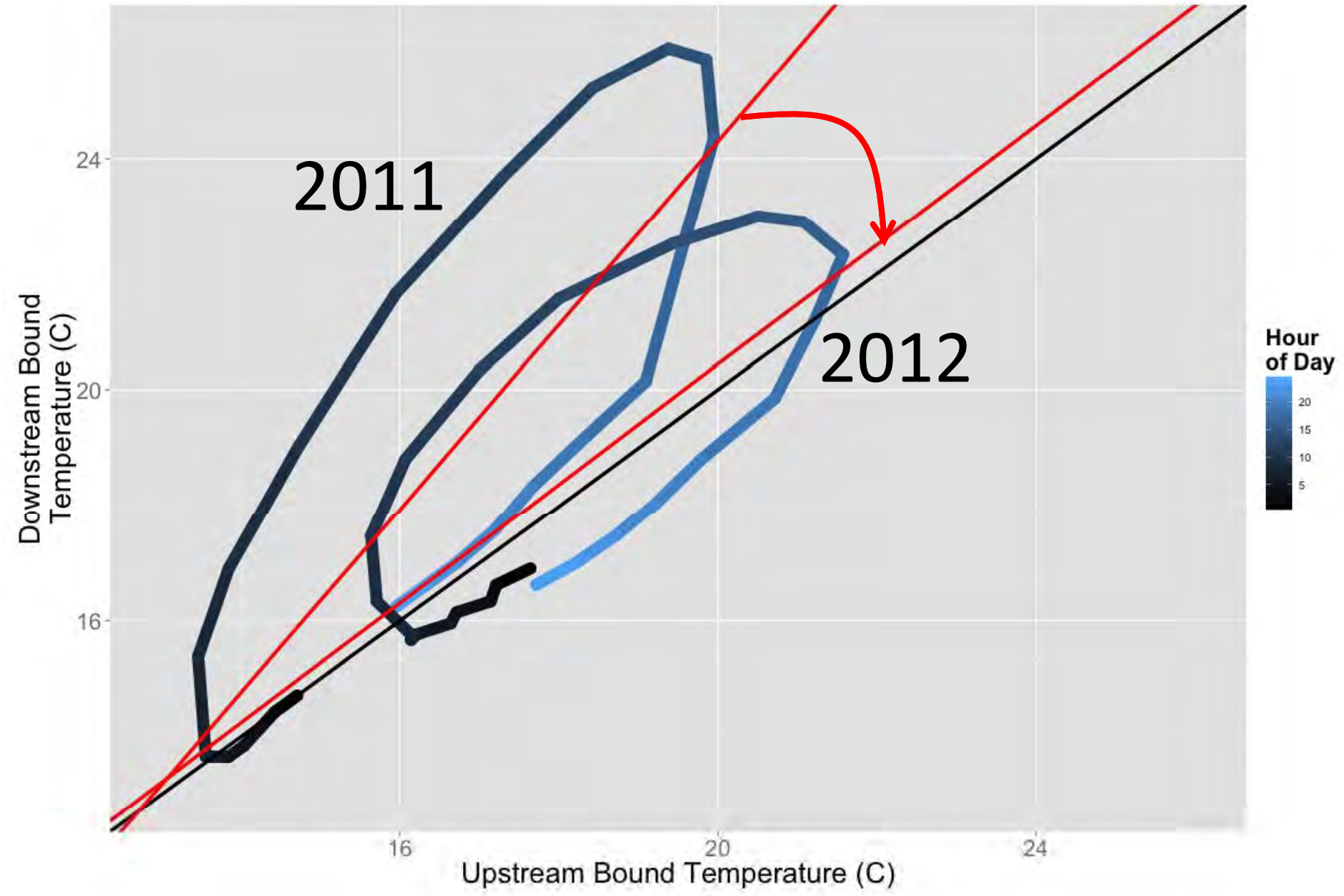
FLOW


downstream
upstream
Temperature (C)
Hour
Hour of Day
Downstream Bound Temperature (C)
Upstream Bound Temperature (C)
16
20
24
Hour of Day
20
15
10
5
0

Will the restoration project affect stream water temperature?

Water temperature buffering will increase.

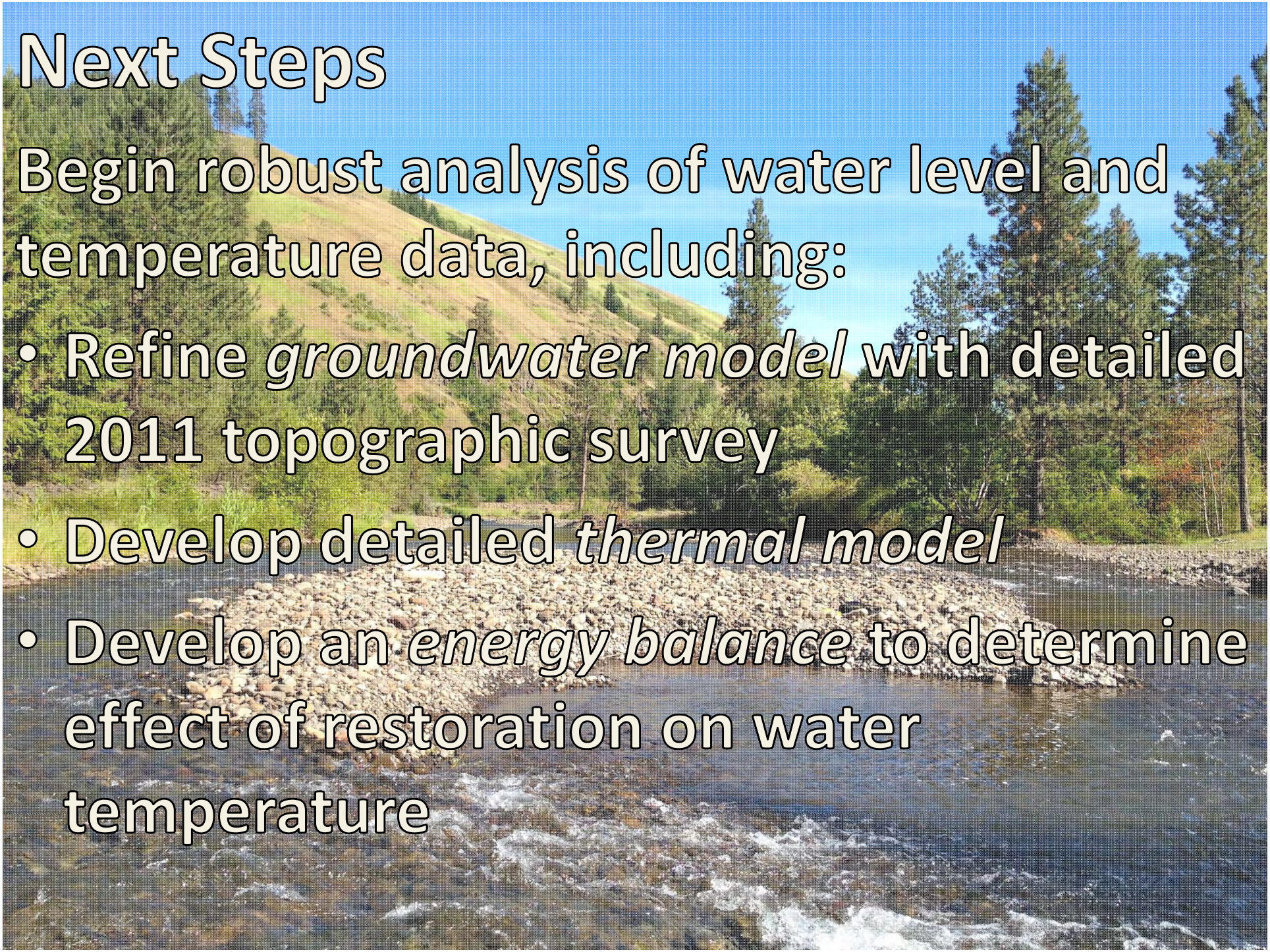

Downstream Bound Temperature (C)
24
20
16
16
20
24
Upstream Bound Temperature (C)
Hour of Day
20
15
10
5
0


2011
2012
Downstream Bound Temperature (C)
Upstream Bound Temperature (C)
16
20
24
Hour of Day
20
15
10
5

Upshot:

The data suggest that altering channel plan form may have had a hydrologic and temperature effect

Habitat-scale temperature heterogeneity is more interesting than reach-wide inferences



Next Steps

Begin robust analysis of water level and temperature data, including:

- Refine *groundwater model* with detailed 2011 topographic survey
- Develop detailed *thermal model*
- Develop an *energy balance* to determine effect of restoration on water temperature

Thank You