Willamette River Coastal Cutthroat Trout, seasonal movements and habitat use

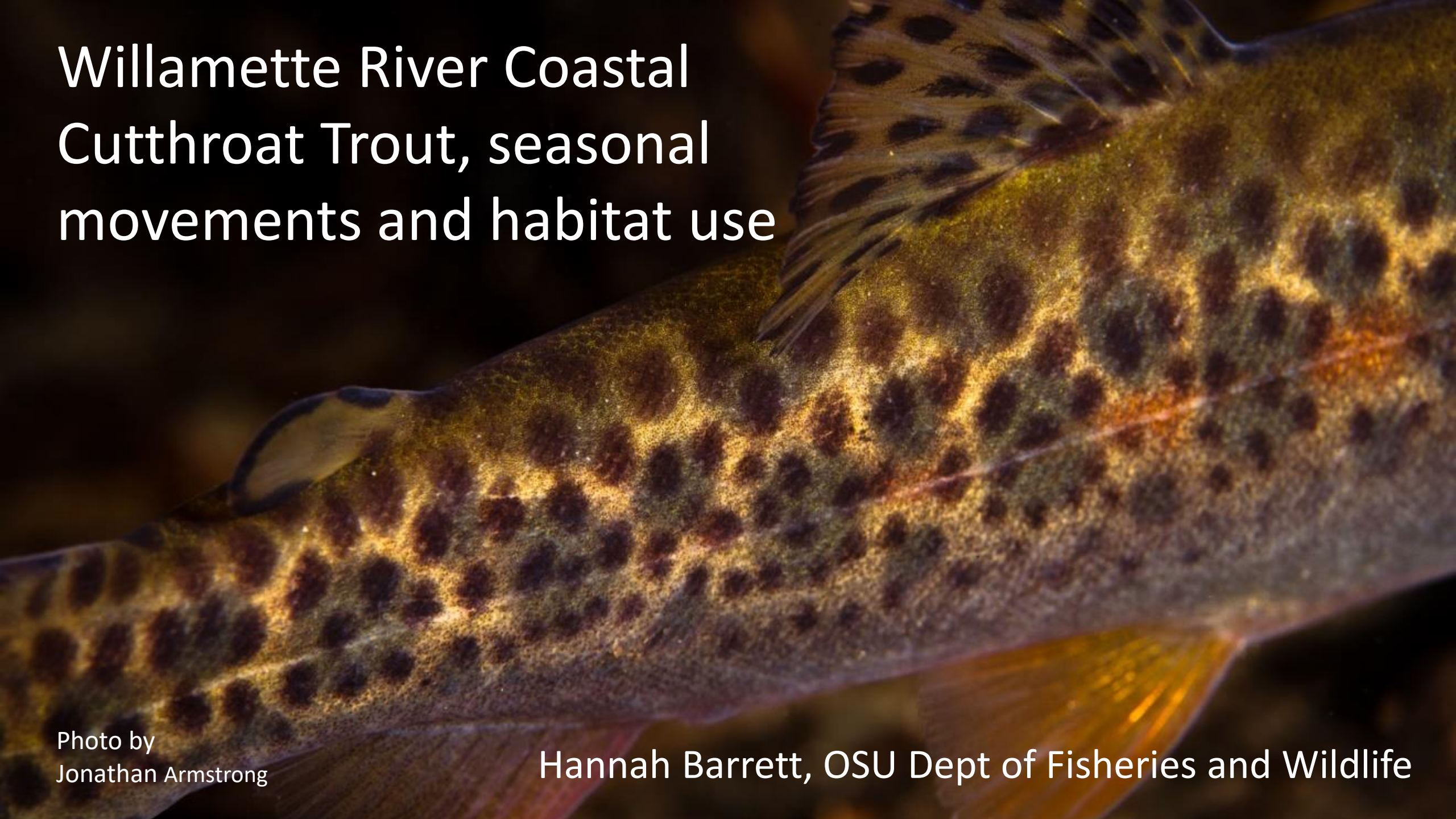
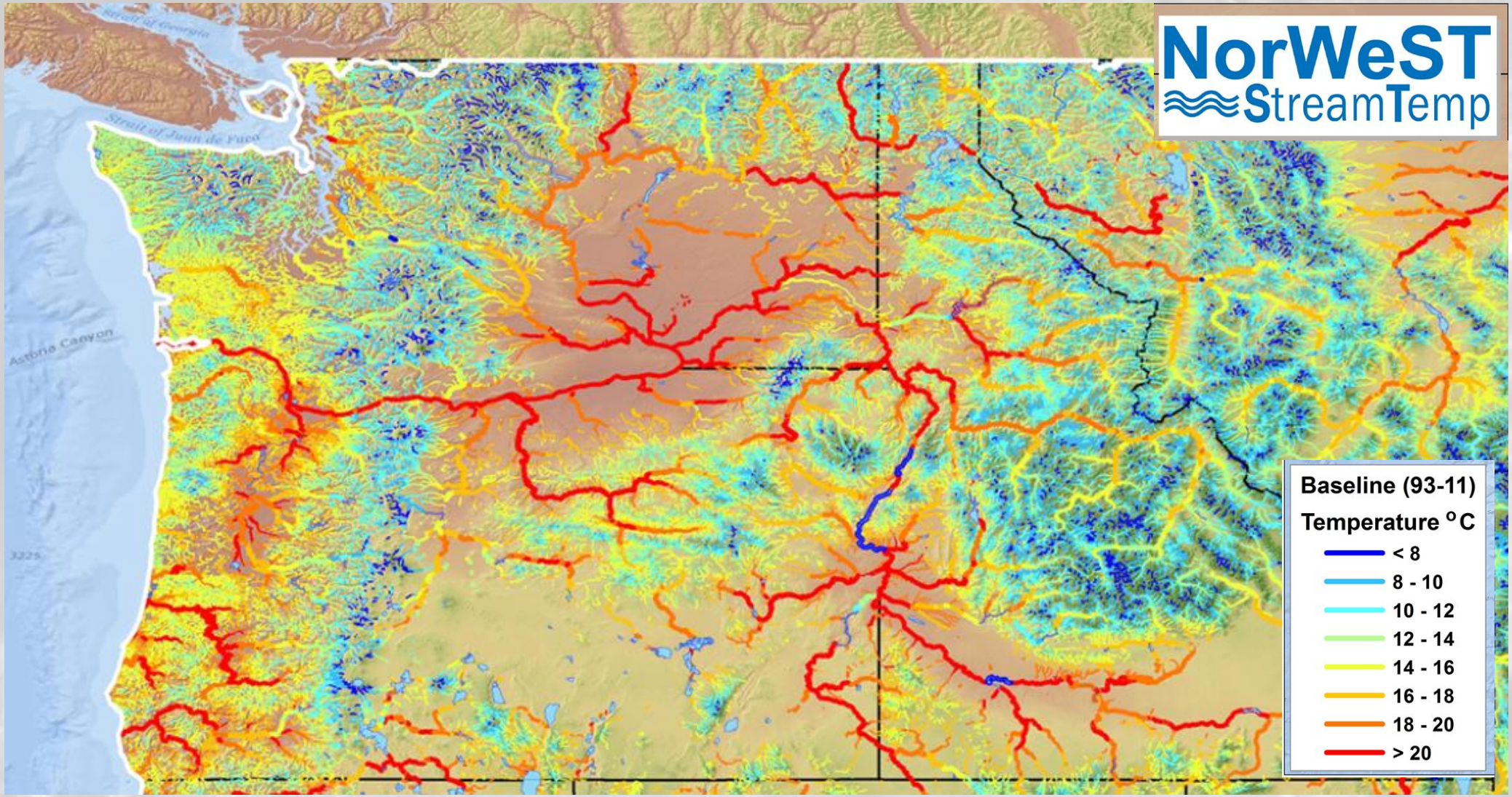
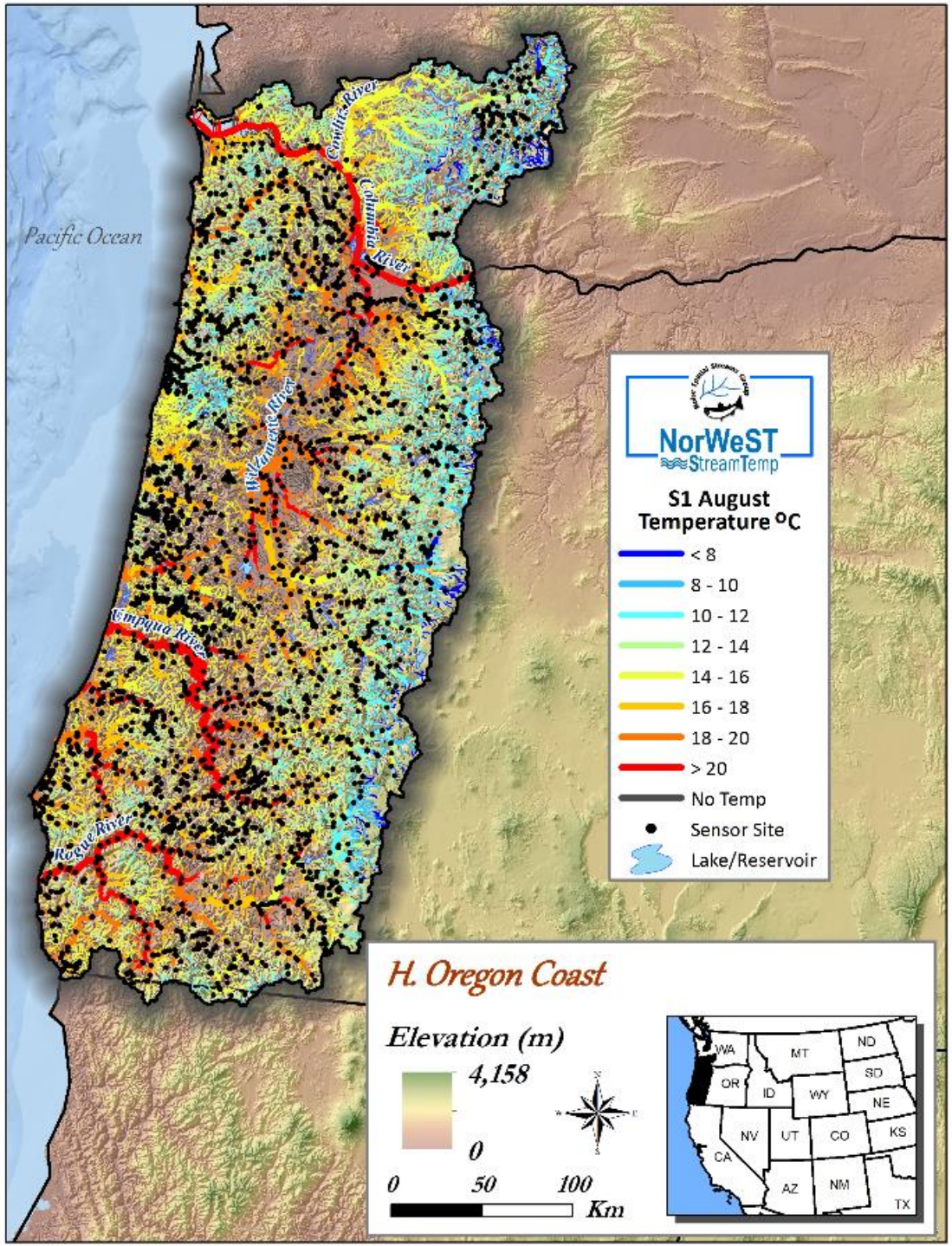
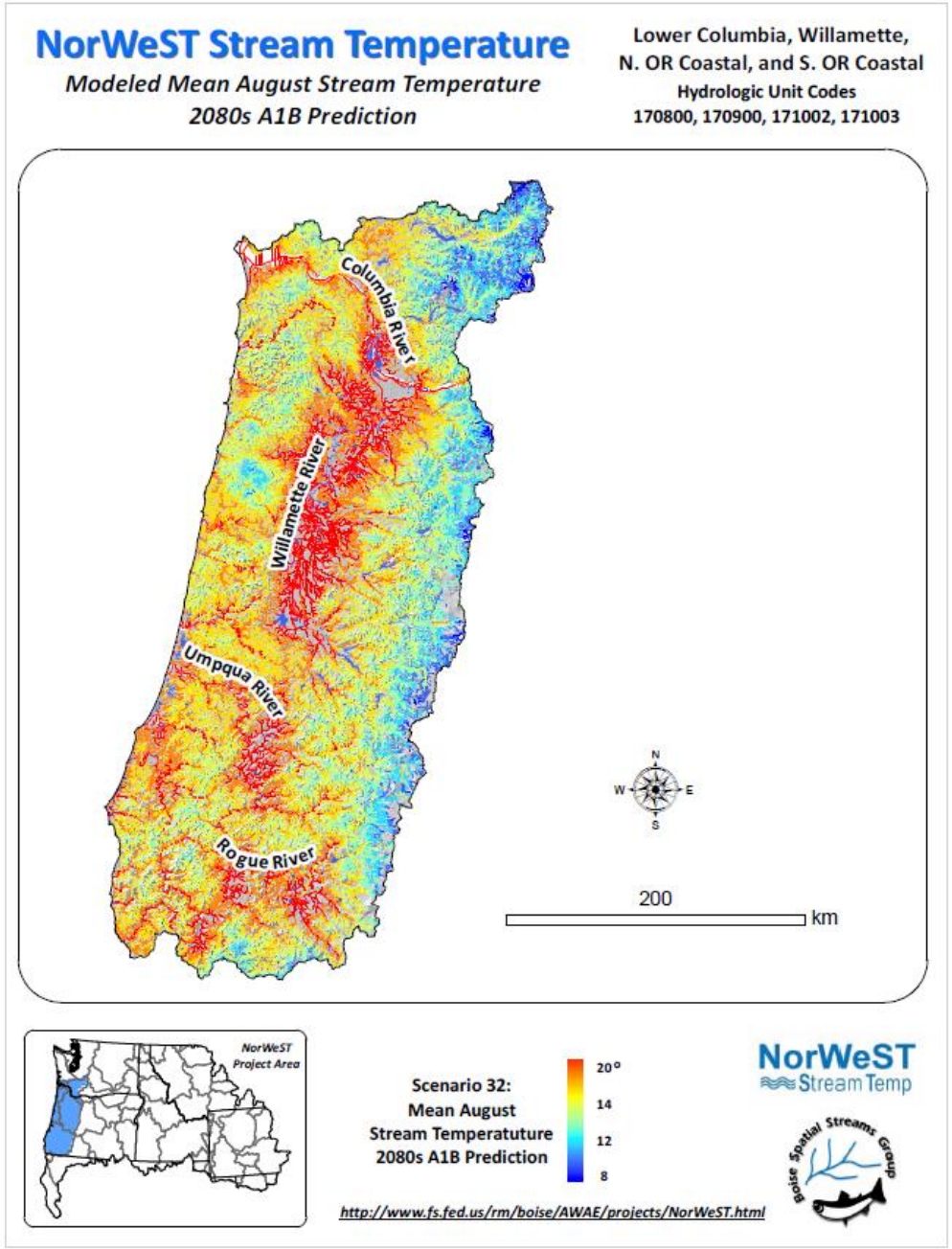


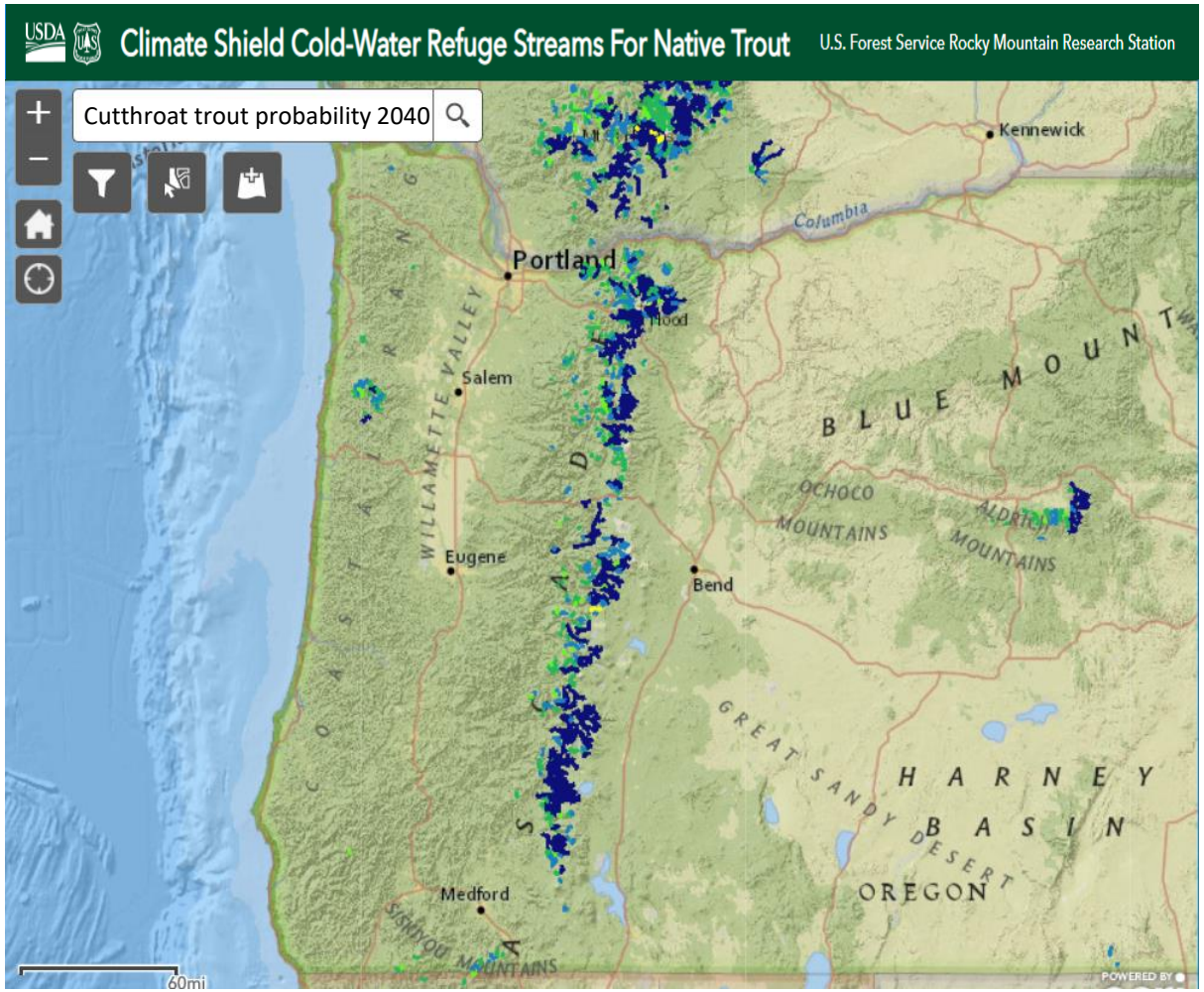
Photo by
Jonathan Armstrong

Hannah Barrett, OSU Dept of Fisheries and Wildlife

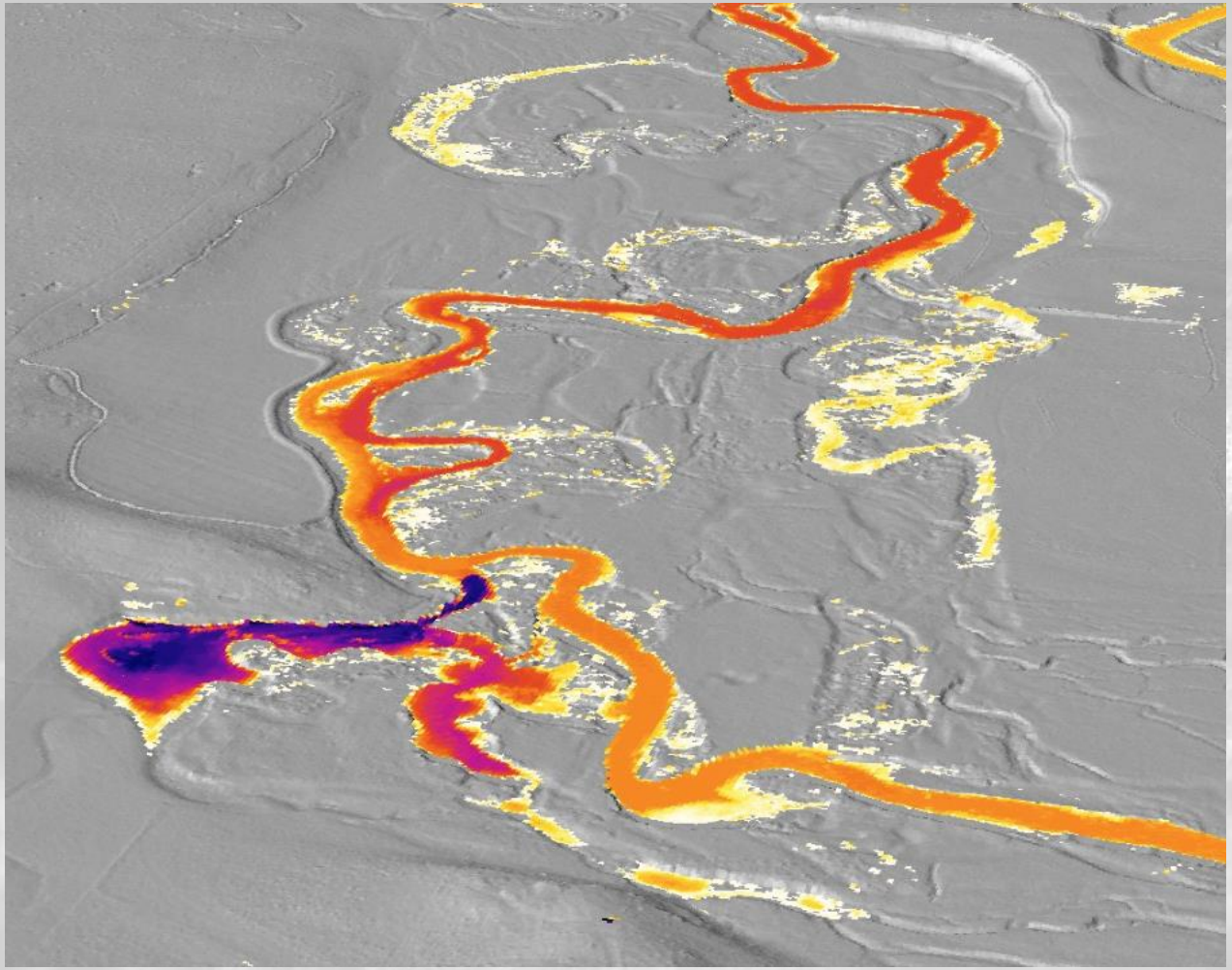

NorWeST
StreamTemp
Strait of Georgia
Strait of Juan de Fuca
Astoria Canyon
Baseline (93-11)
Temperature °C
< 8
8 - 10
10 - 12
12 - 14
14 - 16
16 - 18
18 - 20
> 20


Pacific Ocean
Columbia River
Willamette River
Umpqua River
Rogue River
NorWeST
StreamTemp
S1 August
Temperature °C
< 8
8 - 10
10 - 12
12 - 14
14 - 16
16 - 18
18 - 20
> 20
No Temp
Sensor Site
Lake/Reservoir
H. Oregon Coast
Elevation (m)
4,158
0
0
50
100
Km
WA
OR
CA
ID
NV
MT
WY
UT
AZ
CO
NM
ND
SD
NE
KS
TX


NorWeST Stream Temperature
Modeled Mean August Stream Temperature
2080s A1B Prediction
Lower Columbia, Willamette,
N. OR Coastal, and S. OR Coastal
Hydrologic Unit Codes
170800, 170900, 171002, 171003
Columbia River
Willamette River
Umpqua River
Rogue River
N
W
E
S
200
km
NorWeST
Project Area
Scenario 32:
Mean August
Stream Temperatuture
2080s A1B Prediction
20°
14
12
8
NorWeST
Stream Temp
http://www.fs.fed.us/rm/boise/AWAE/projects/NorWeST.html
Boise Spatial Streams Group

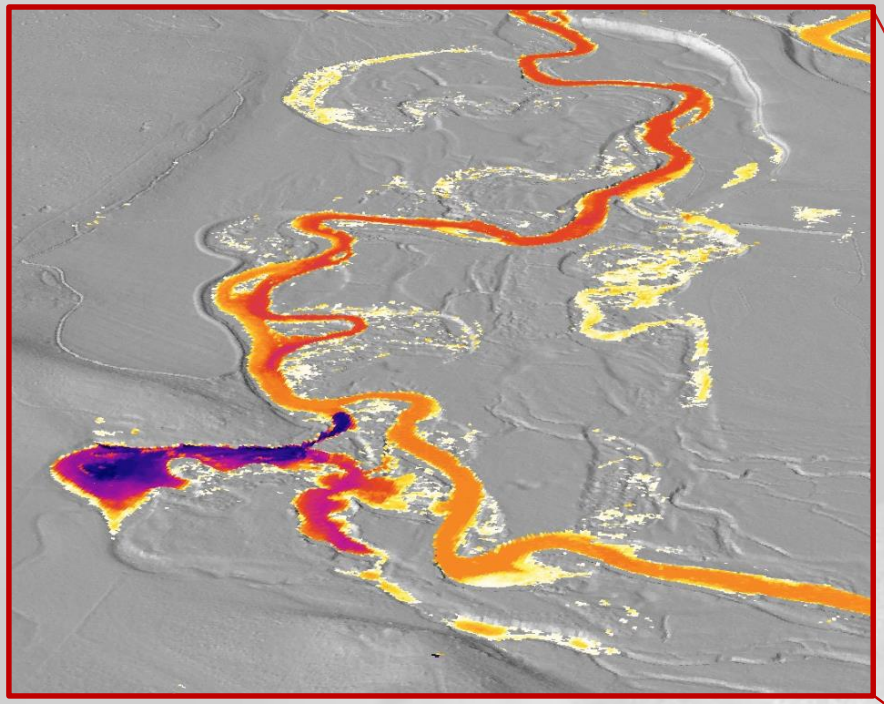

USDA
Climate Shield Cold-Water Refuge Streams For Native Trout
U.S. Forest Service Rocky Mountain Research Station
Cutthroat trout probability 2040
Kennewick
Columbia
Portland
Hood
Salem
Eugene
Bend
Medford
COAST RANGE
WILLAMETTE VALLEY
CASCADES
BLUE MOUNTAINS
OCHOCO MOUNTAINS
ALDRICH MOUNTAINS
GREAT SANDY DESERT
HARNEY BASIN
OREGON
SISKIYOU MOUNTAINS
60mi
POWERED BY

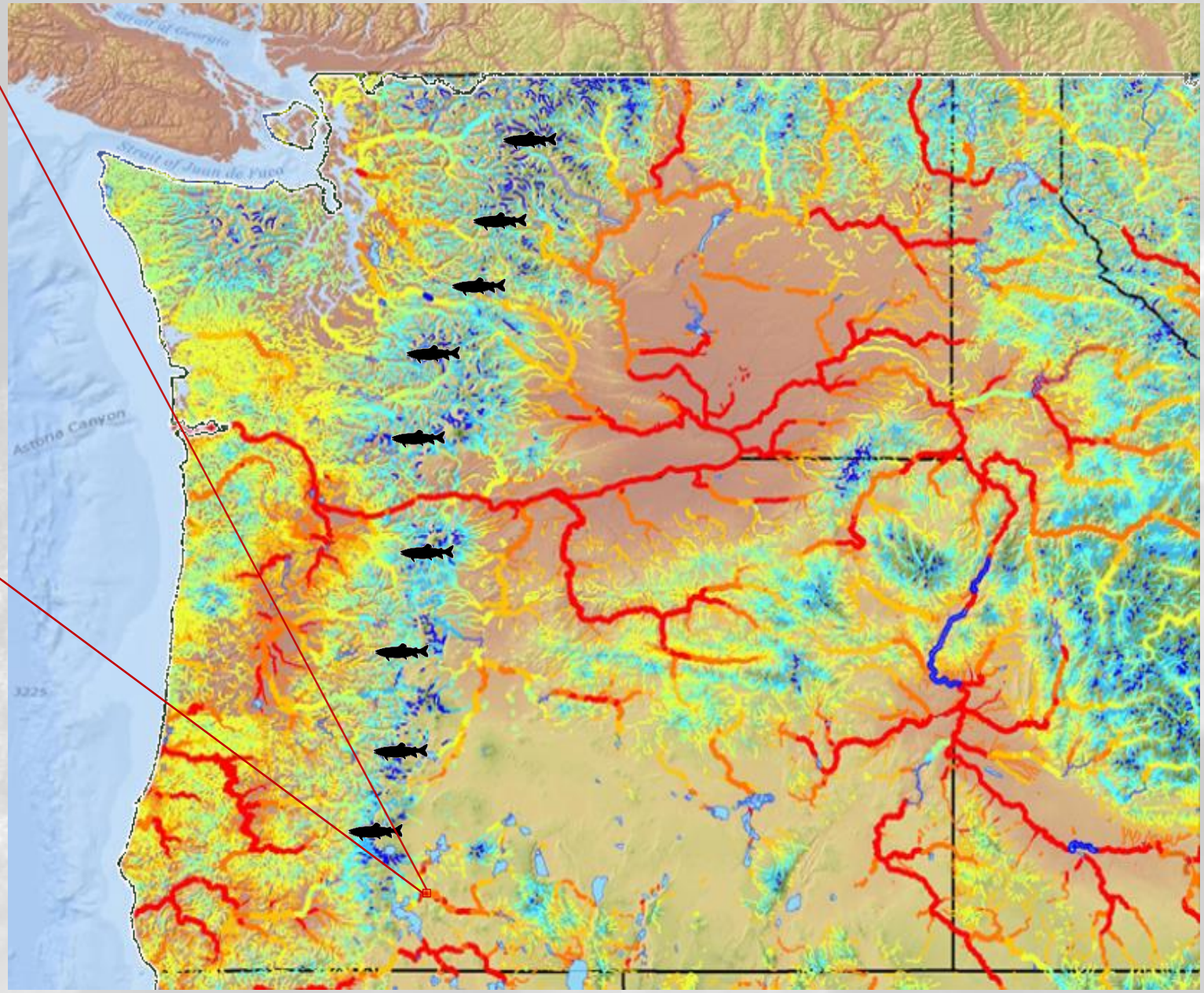
Floodplain thermal refugia: cold water alcoves



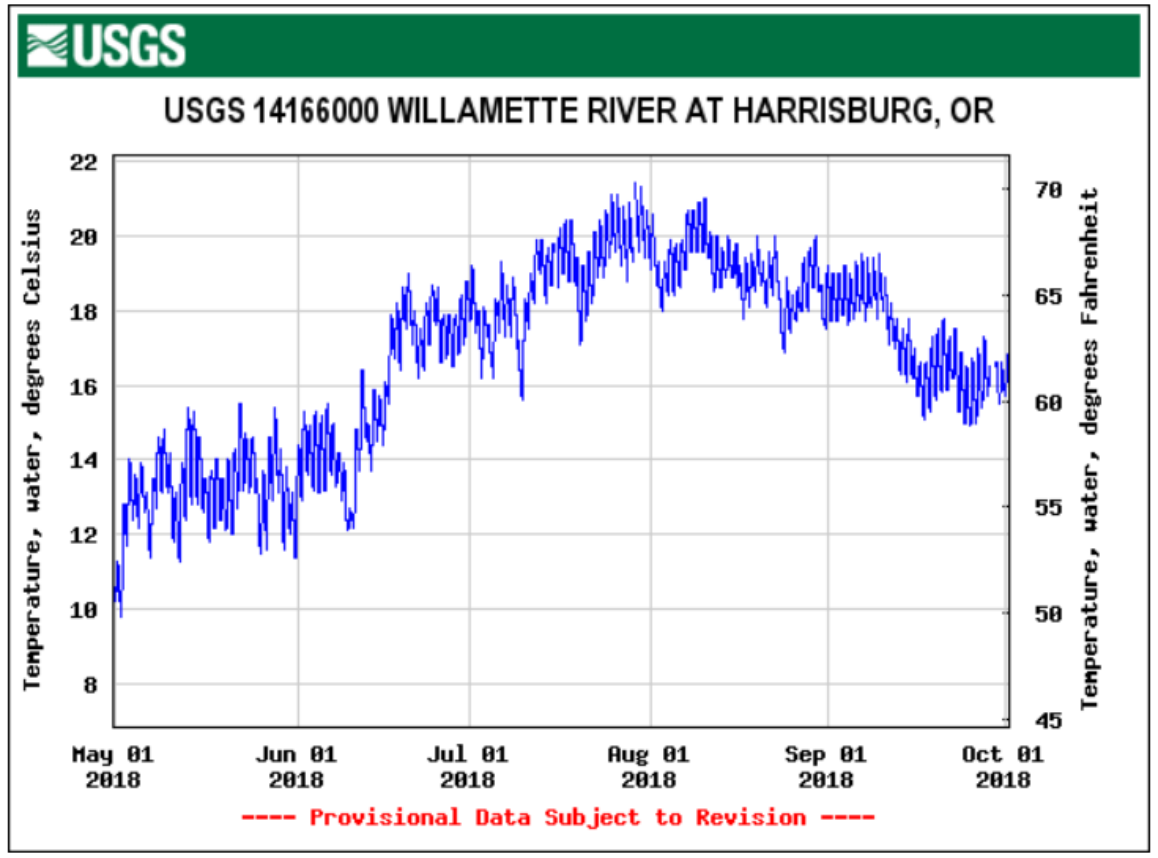
NIR image Kamkaun Spring, Sprague River thermal refuge

- Seasonally warm areas can support fish populations when they have thermal refuges.
- Fine scale features that stay cool during summer and can allow fish to survive over summer maximum temperatures/ thermal stress




Strait of Georgia
Strait of Juan de Fuca
Astoria Canyon
3225

- Mainstem Willamette River temperatures exceed 20°C during summer
- Floodplain alcoves fed by subsurface flows provide cooler temperatures for Coastal Cutthroat Trout.



Floodplain thermal refugia: cold water alcoves

- Alcoves connected to main channel only at their downstream end
- Temperatures at least 2°C cooler than the mainstem
  - Stratified water column with cool hyporheic discharge

- Our study hopes to help understand the contribution of these refuges to over-summer survival of cutthroat trout.

Photo by
Jonathan Armstrong

- Our study hopes to help understand the contribution of these refuges to over-summer survival of cutthroat trout.
    - Timing of refuge use
    - Feeding ecology on refuges
    - Oxygen-temperature trade-offs

Photo by
Jonathan Armstrong


Portland
Corvallis
OREGON
Willamette River Basin
United States of America


COLD
WARM
WARM
COLD
8 mi

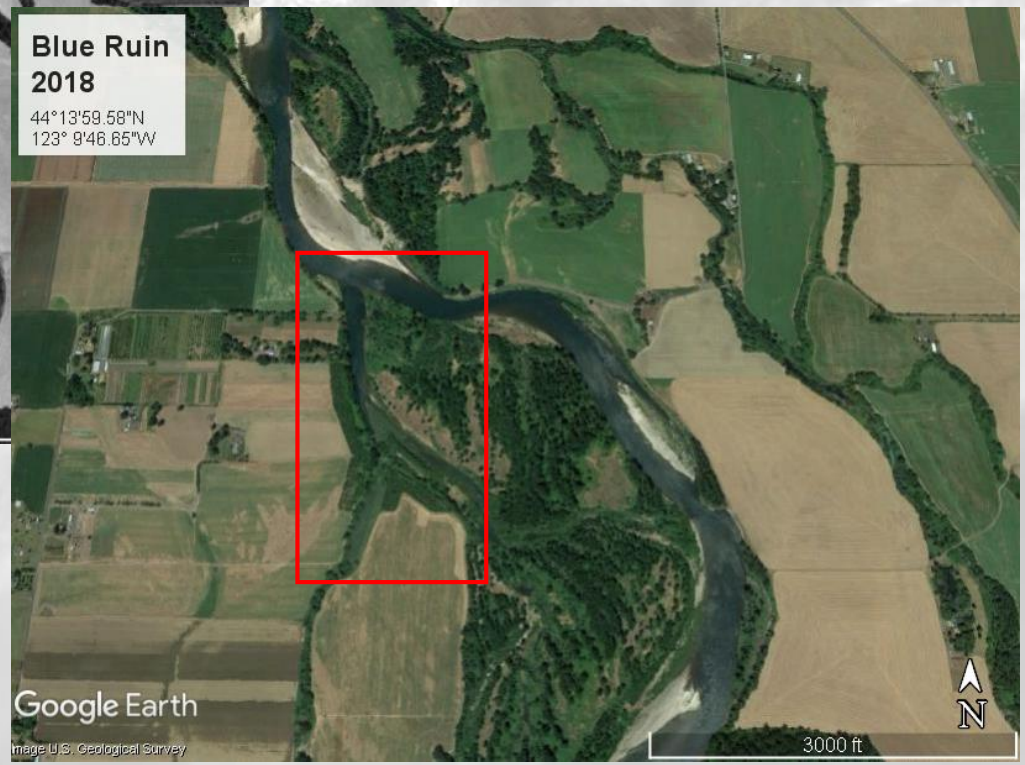

Blue Ruin
1994
44°13'59.58"N
123° 9'46.65"W
Google Earth
Image U.S. Geological Survey
3000 ft
N


Blue Ruin
1994
44°13'59.58"N
123° 9'46.65"W
Google Earth
Image U.S. Geological Survey

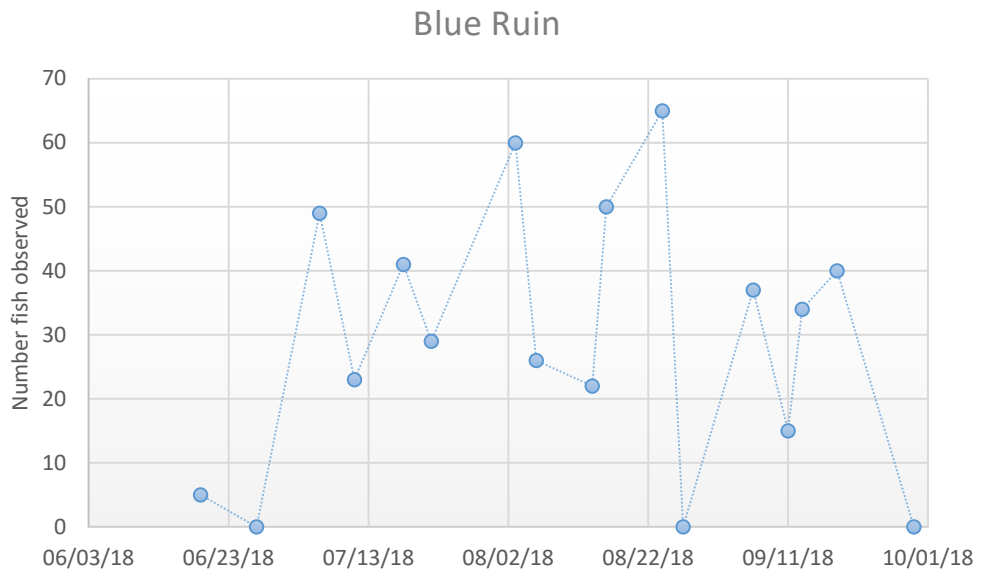
Blue Ruin
2000
44°13'59.58"N
123° 9'46.65"W
Google Earth
Image U.S. Geological Survey
N
3000 ft

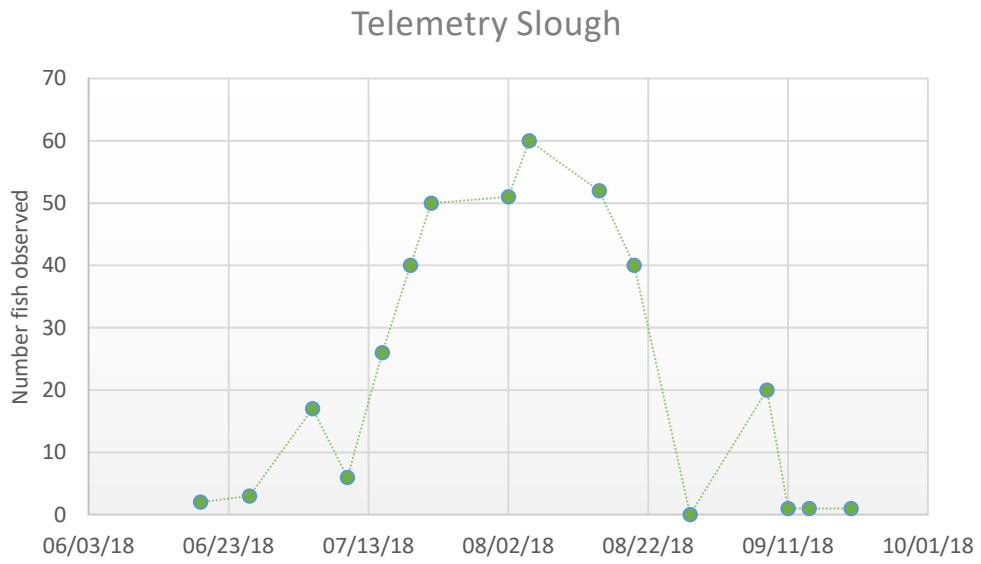

Blue Ruin
1994
44°13'59.58"N
123° 9'46.65"W
Google Earth
Image U.S. Geological Survey


Blue Ruin
2000
44°13'59.58"N
123° 9'46.65"W
Google Earth
Image U.S. Geological Survey

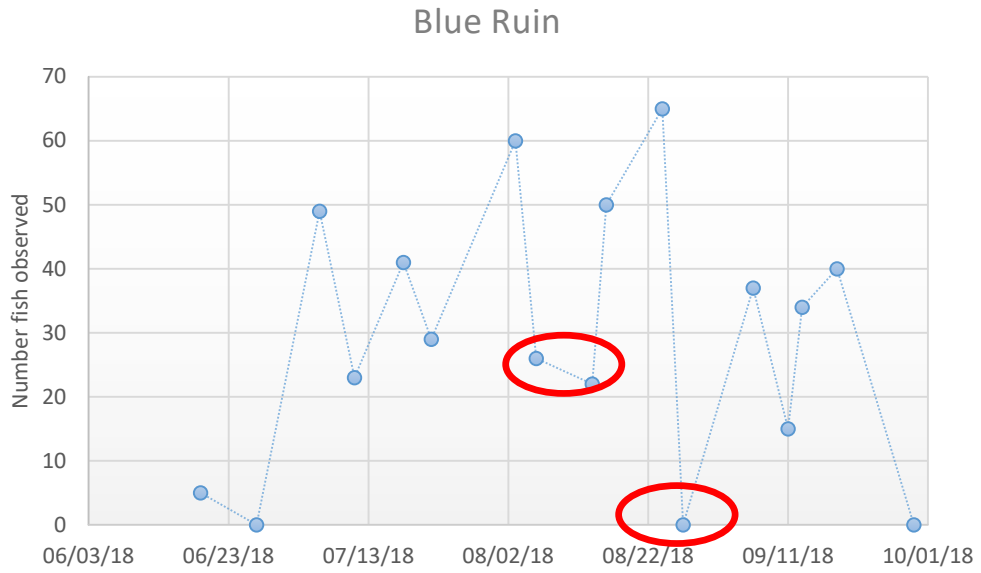

Blue Ruin
2018
44°13'59.58"N
123° 9'46.65"W
Google Earth
Image U.S. Geological Survey
3000 ft
N

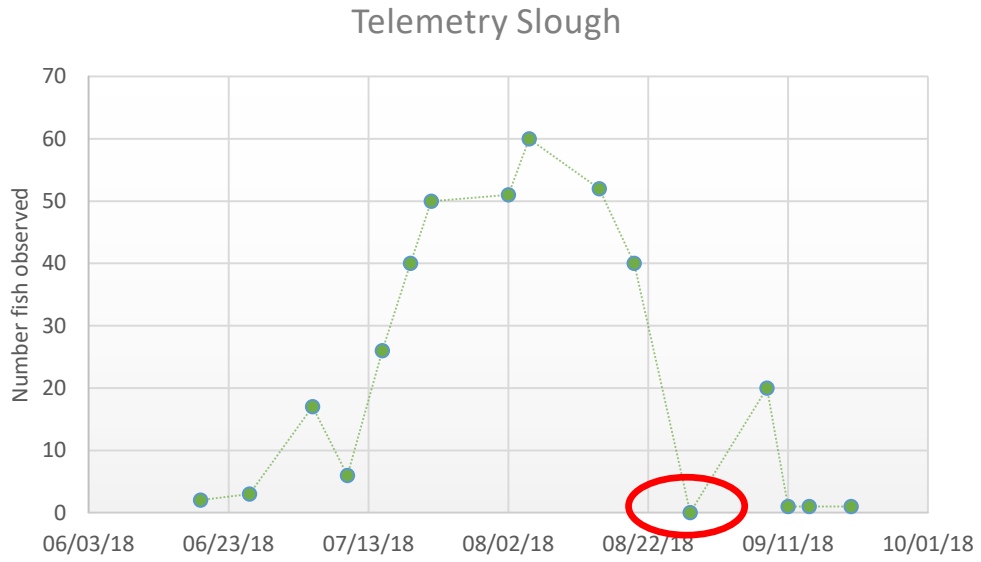
Phenology of refuge use



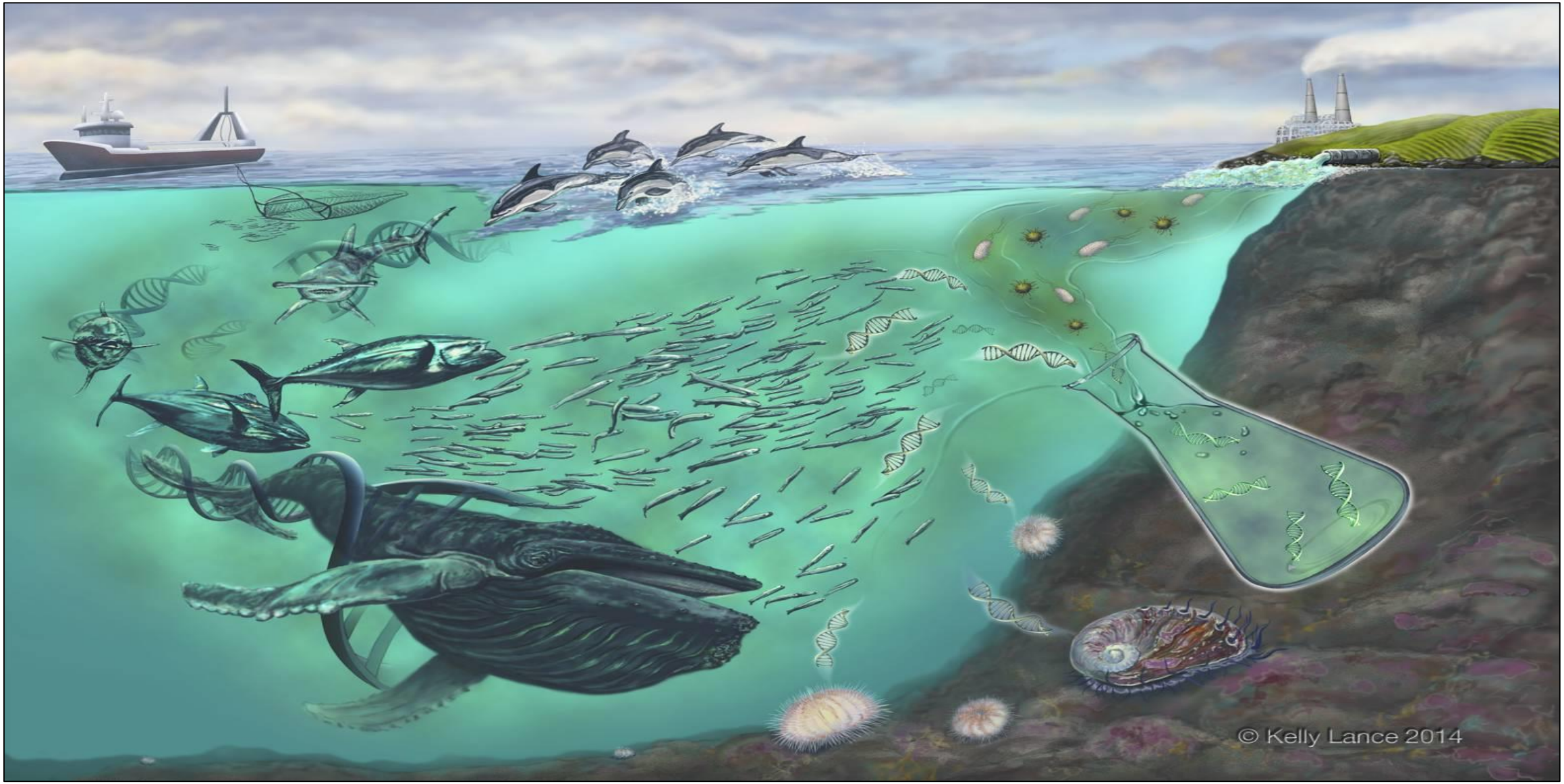


Phenology of refuge use



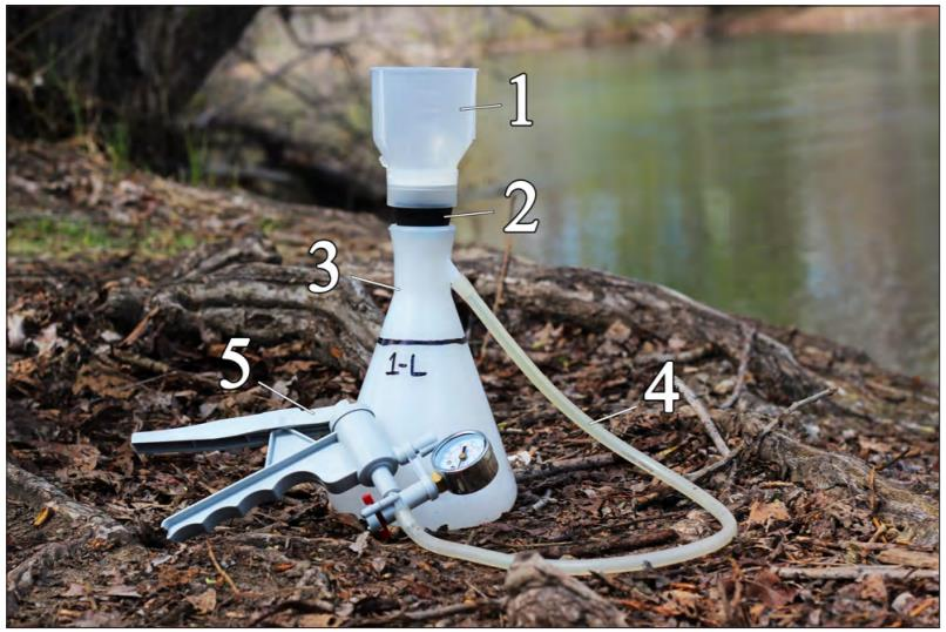


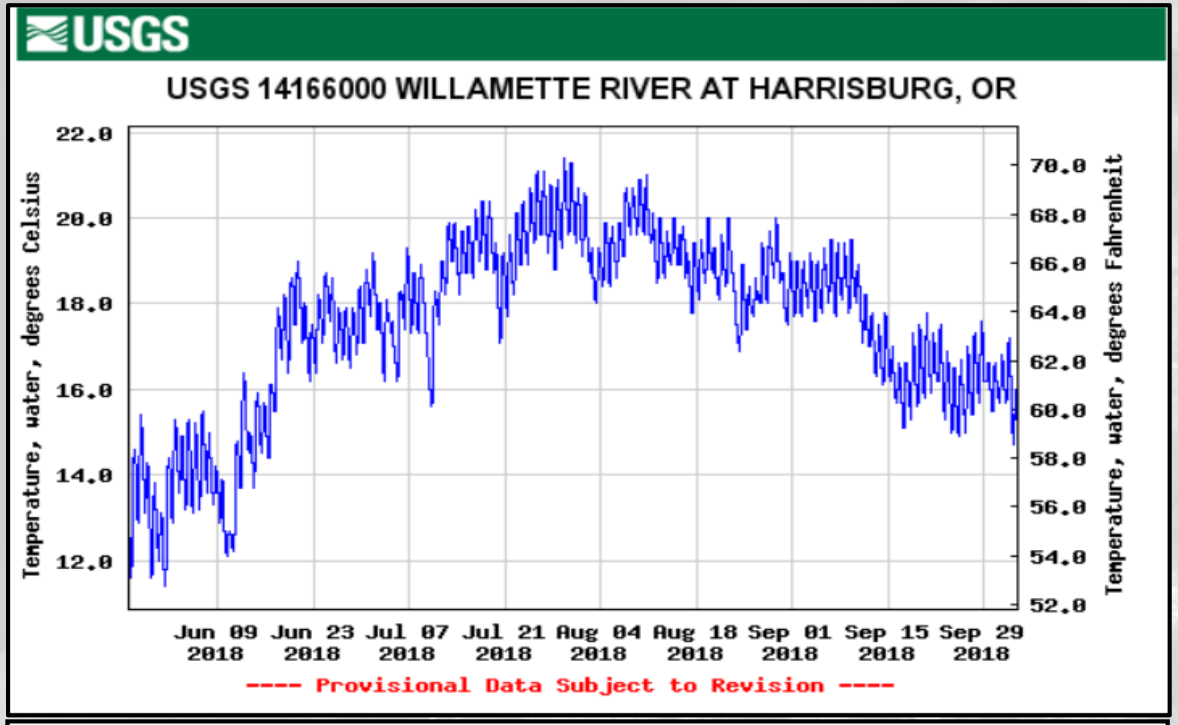
eDNA and Barcoding

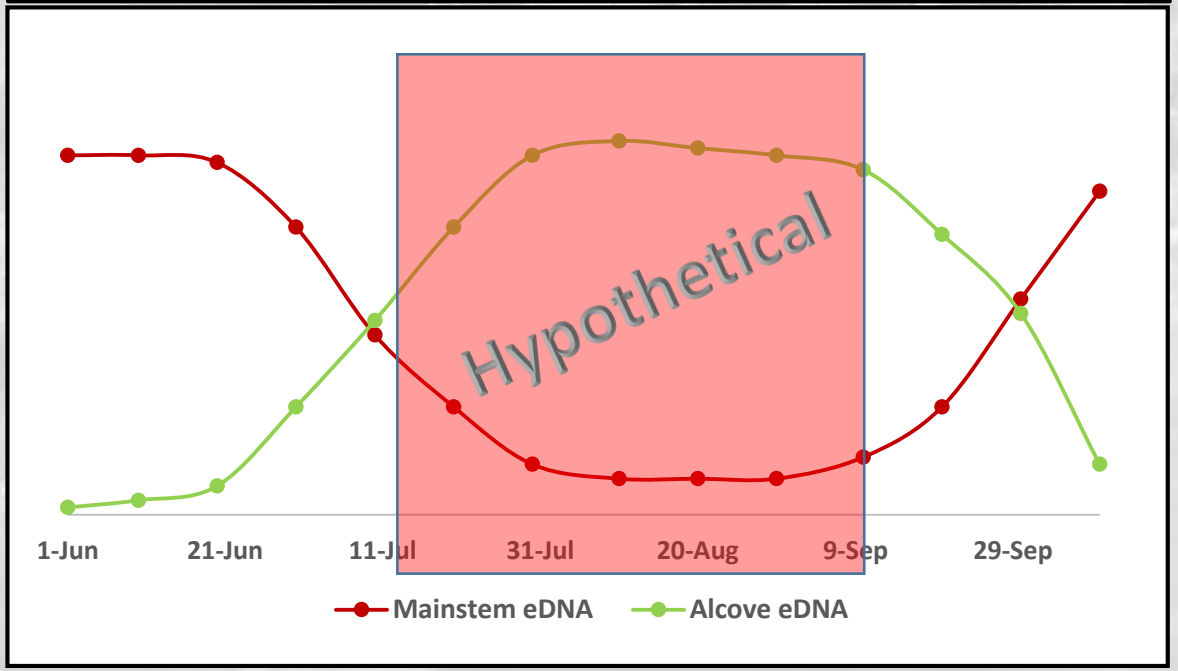


Amplification using specific primers

Sequencing




USGS
USGS 14166000 WILLAMETTE RIVER AT HARRISBURG, OR
Temperature, water, degrees Celsius
22.0
20.0
18.0
16.0
14.0
12.0
Temperature, water, degrees Fahrenheit
70.0
68.0
66.0
64.0
62.0
60.0
58.0
56.0
54.0
52.0
Jun 09 2018
Jun 23 2018
Jul 07 2018
Jul 21 2018
Aug 04 2018
Aug 18 2018
Sep 01 2018
Sep 15 2018
Sep 29 2018
---- Provisional Data Subject to Revision ----


Hypothetical
1-Jun
21-Jun
11-Jul
31-Jul
20-Aug
9-Sep
29-Sep
Mainstem eDNA
Alcove eDNA

Foraging ecology of fish on refuges

- Ability to survive on refuge depends on when a fish runs out of energy stores.
  - Are CTTs eating enough to meet their energetic demands?
- We want to know whether they are starving or able to forage to some degree.

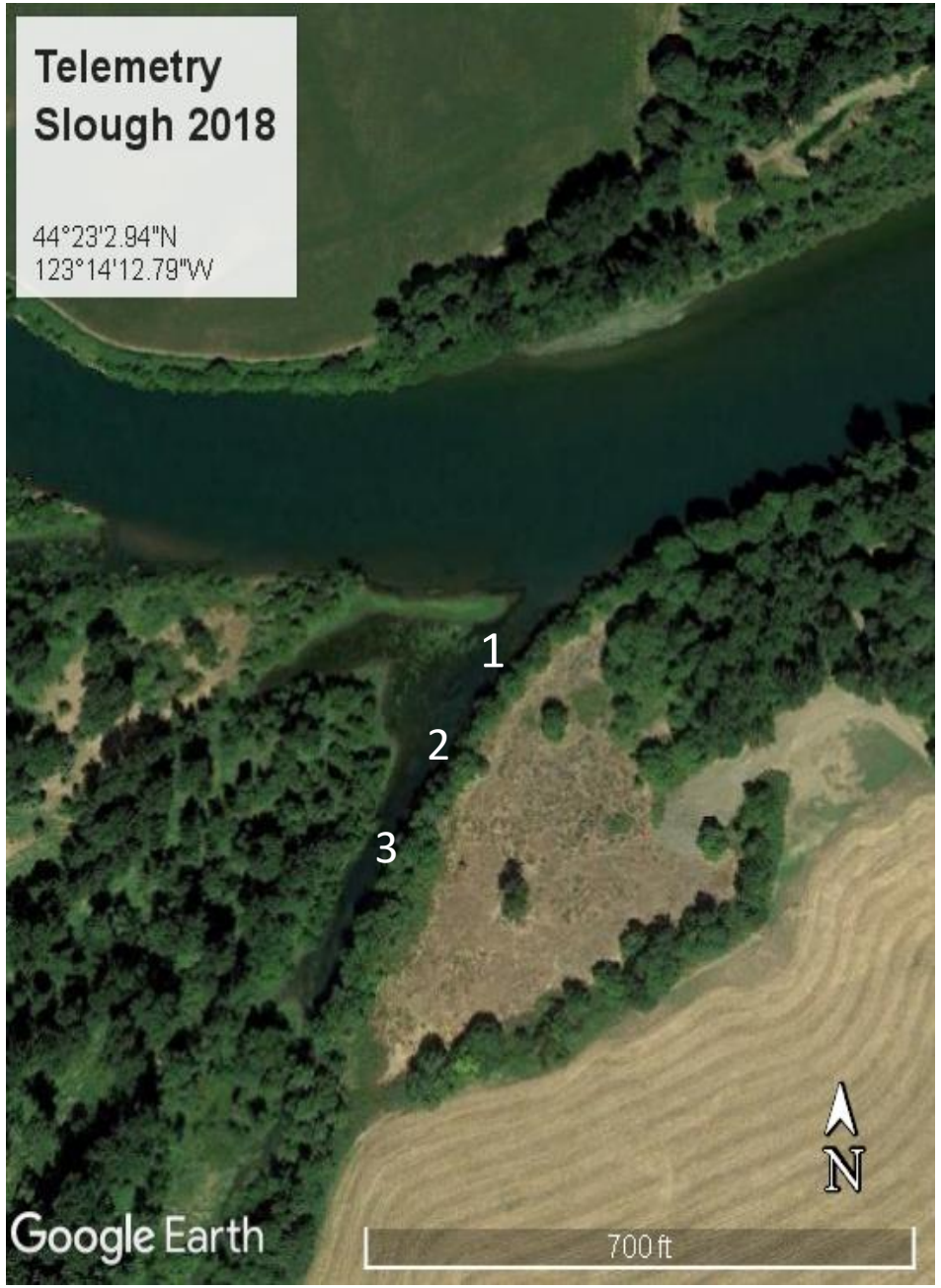
Methods

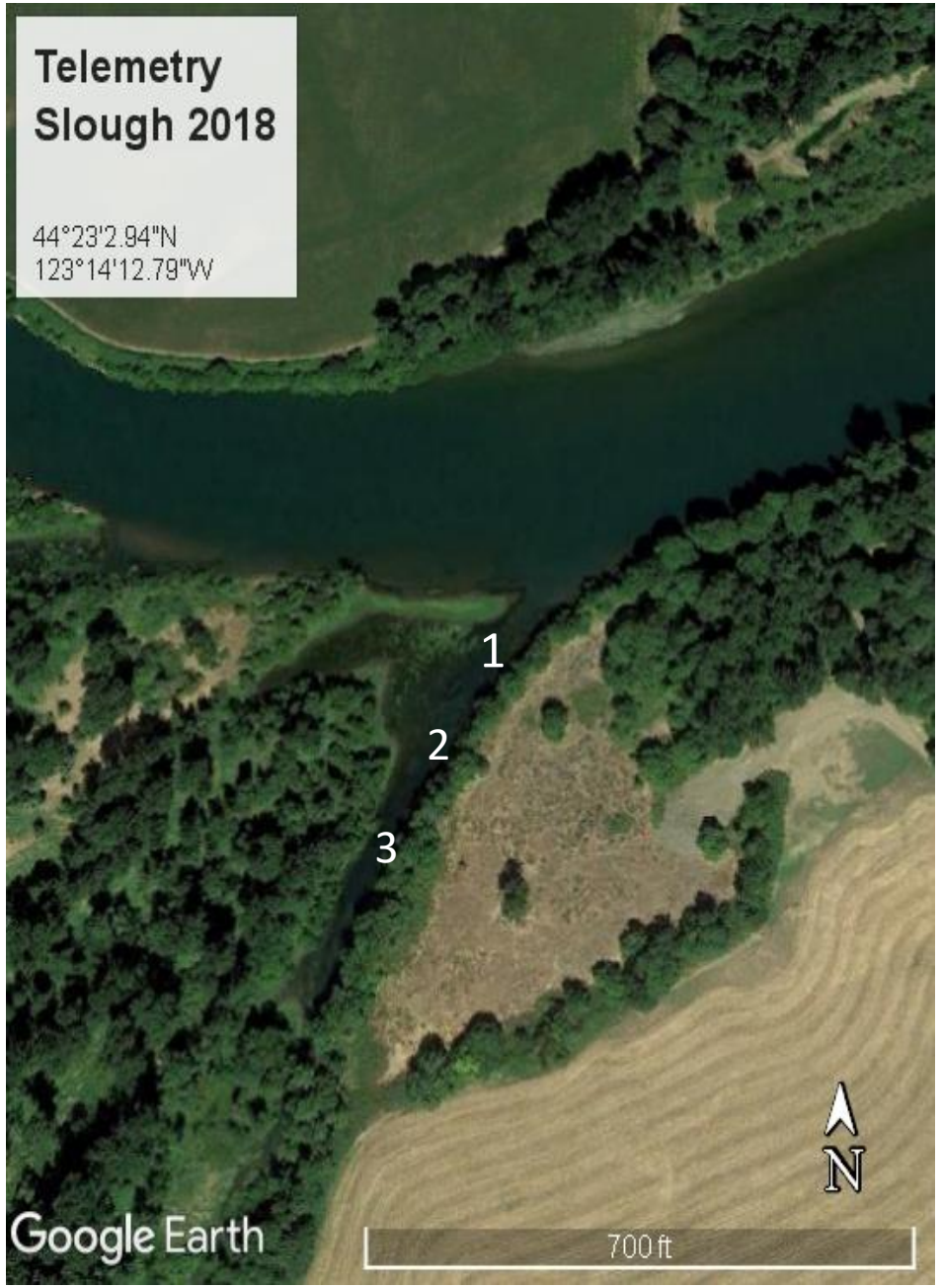
- Diet analysis
- What prey sources support them
  - Feeding forays to mainstem (chironimid ID)?
- Over summer body condition? (weight/length ratio)
- Compare energy in stomach contents to maintenance ration.



Balancing Oxygen and Temperature

- Cool hyporheic flows also anoxic
- How do CTTs balance the trade off between oxygen demands and temperature preference within alcoves?


Telemetry
Slough 2018
44°23'2.94"N
123°14'12.79"W
1
2
3
N
Google Earth
700 ft


Telemetry
Slough 2018
44°23'2.94"N
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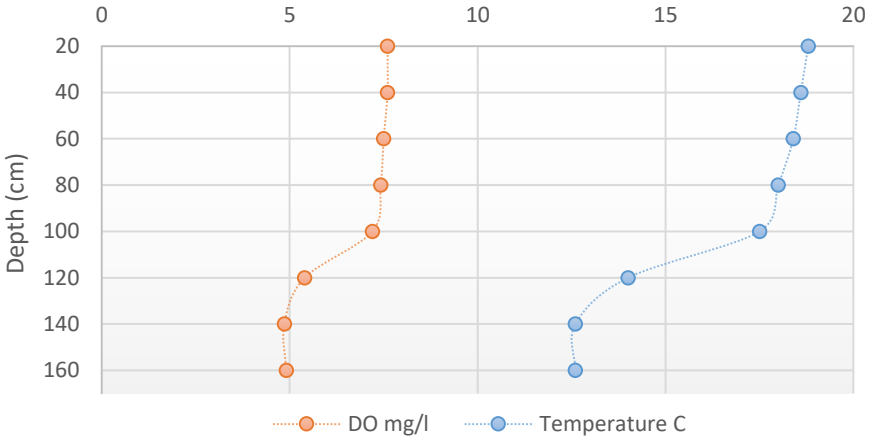
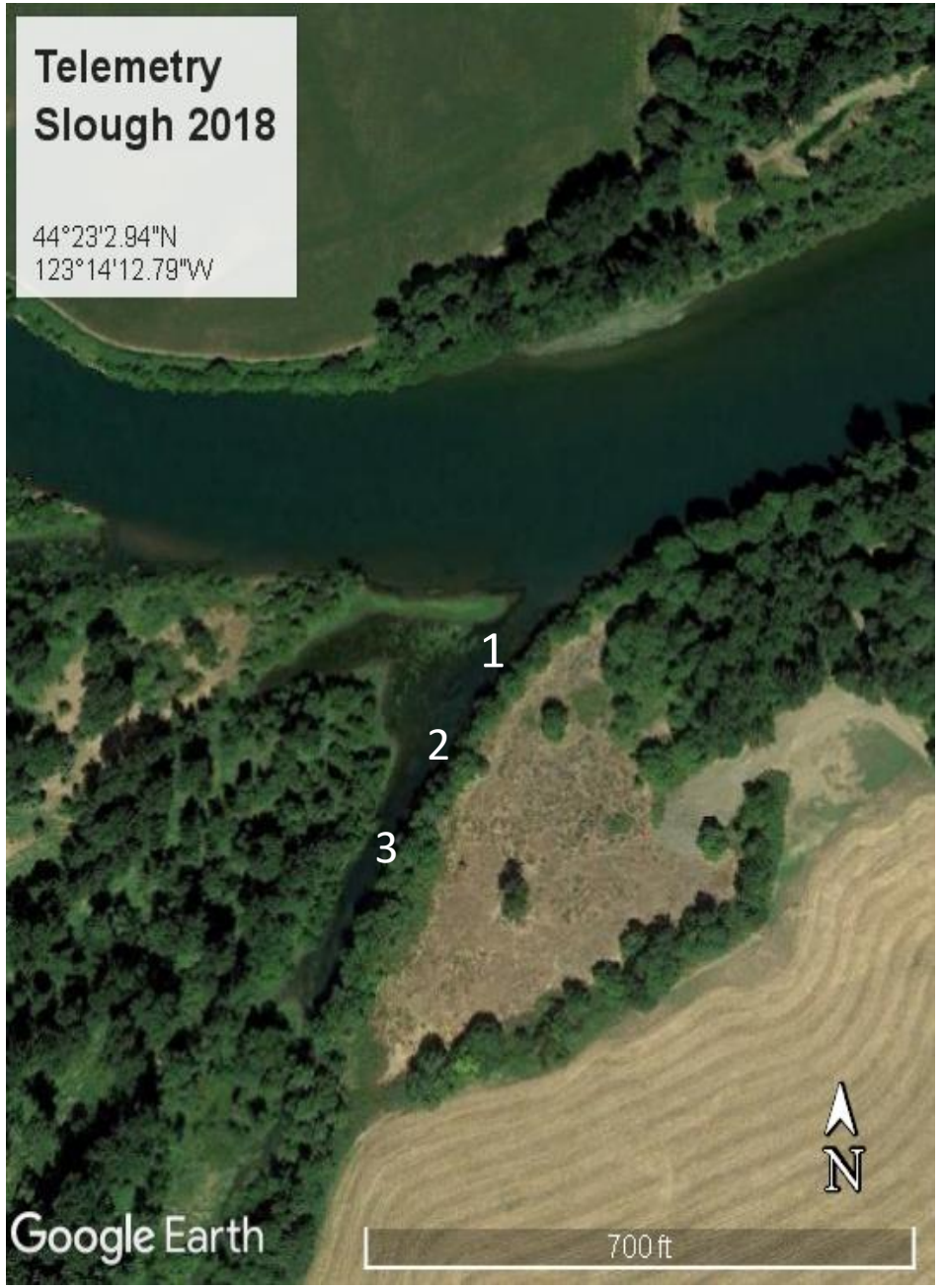
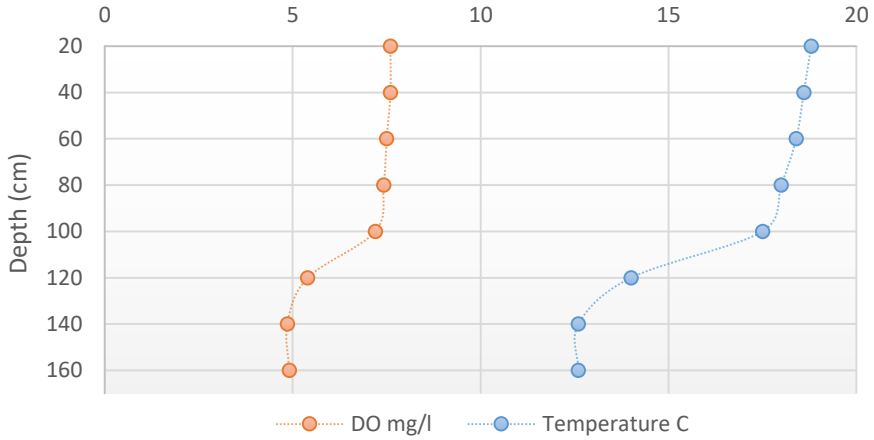
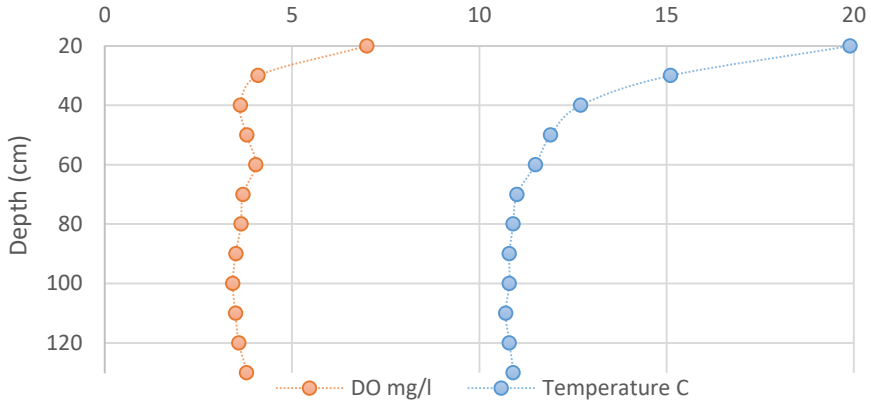
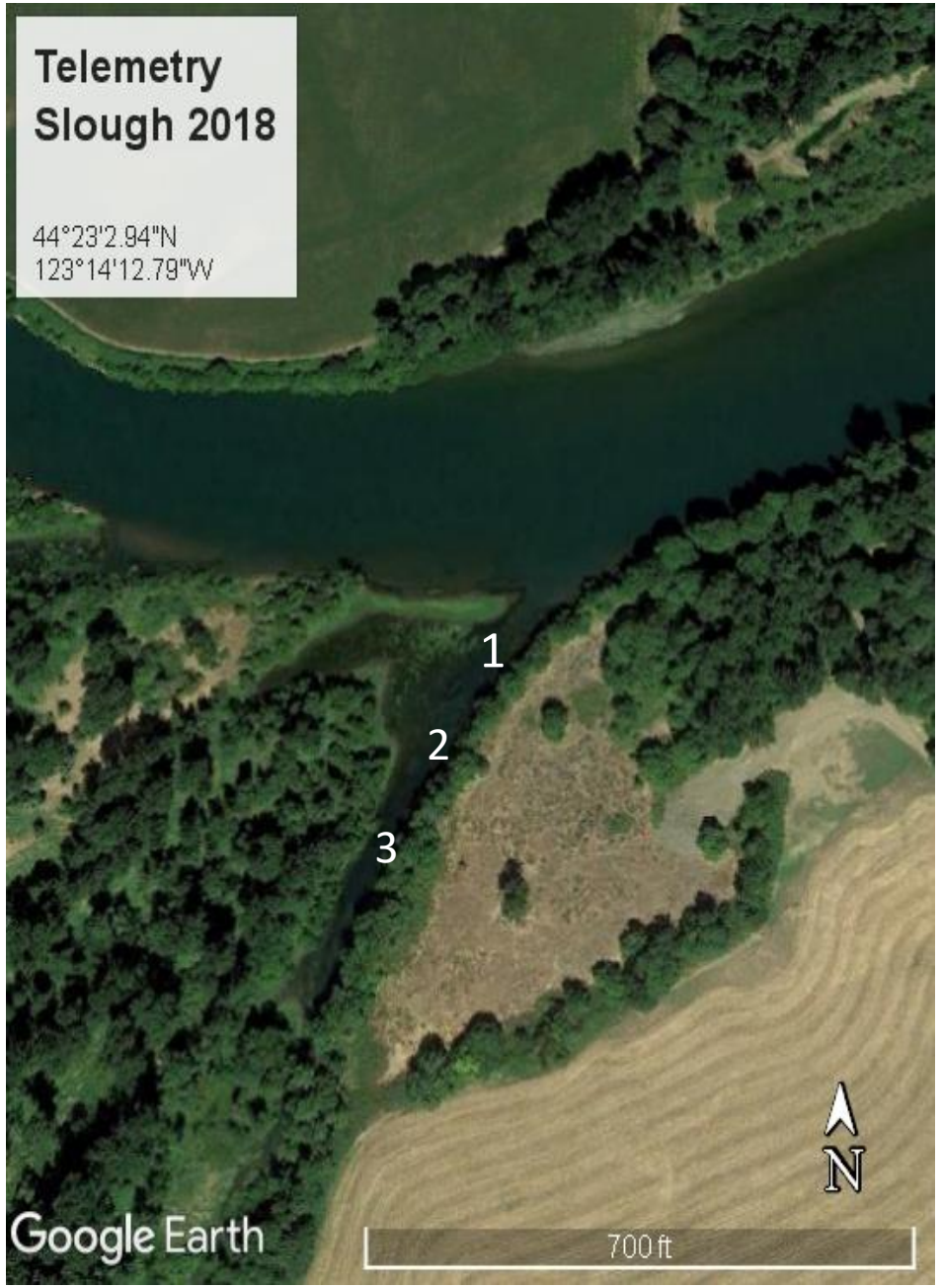
1
2
3
N
Google Earth
700 ft

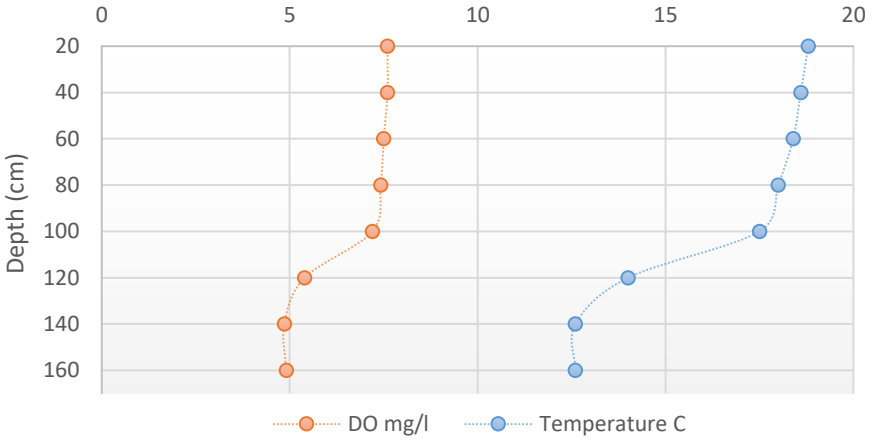

0
5
10
15
20
Depth (cm)
20
40
60
80
100
120
140
160
DO mg/l
Temperature C

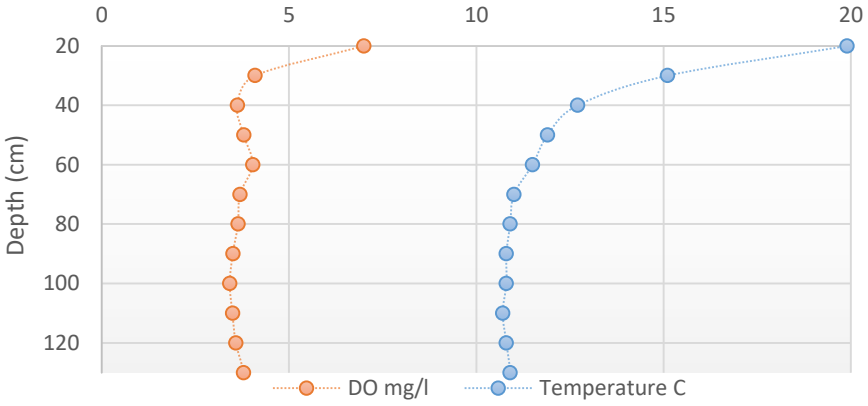

Telemetry
Slough 2018
44°23'2.94"N
123°14'12.79"W
1
2
3
N
Google Earth
700 ft

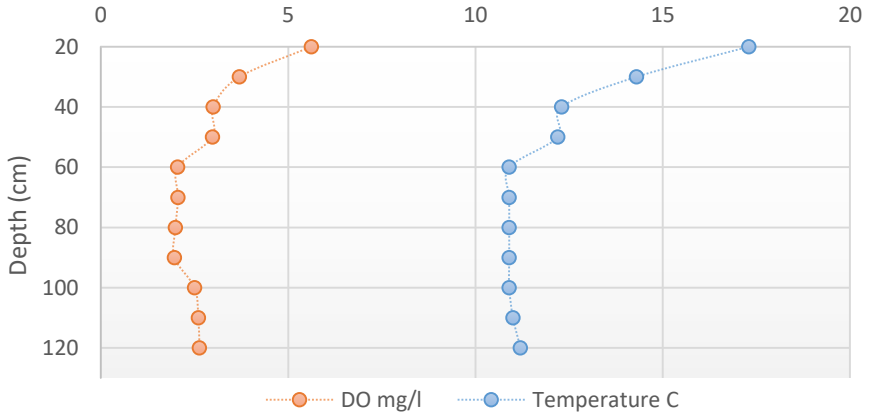

0
5
10
15
20
Depth (cm)
20
40
60
80
100
120
140
160
DO mg/l
Temperature C


0
5
10
15
20
Depth (cm)
20
40
60
80
100
120
DO mg/l
Temperature C

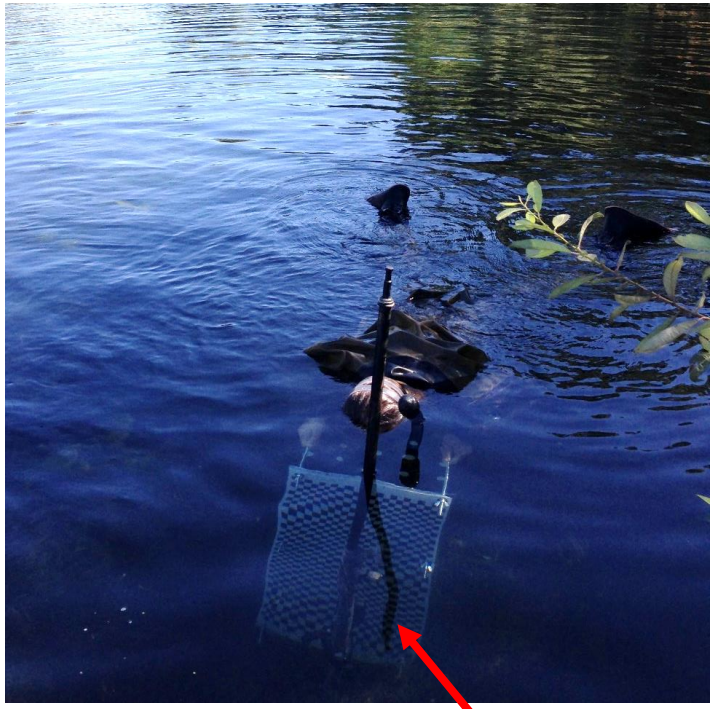

Telemetry
Slough 2018
44°23'2.94"N
123°14'12.79"W
1
2
3
N
Google Earth
700 ft

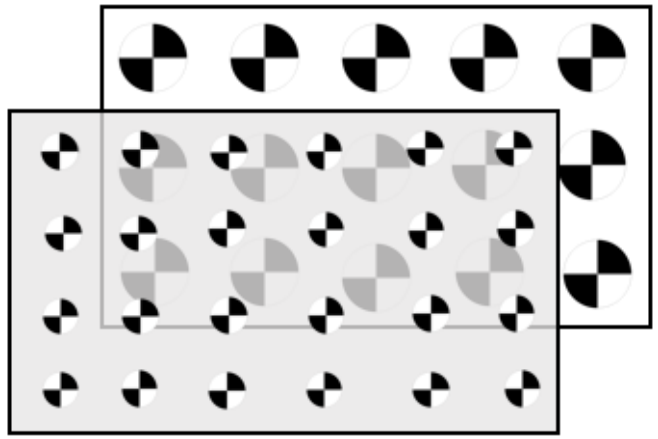

0
5
10
15
20
Depth (cm)
20
40
60
80
100
120
140
160
DO mg/l
Temperature C


0
5
10
15
20
Depth (cm)
20
40
60
80
100
120
DO mg/l
Temperature C

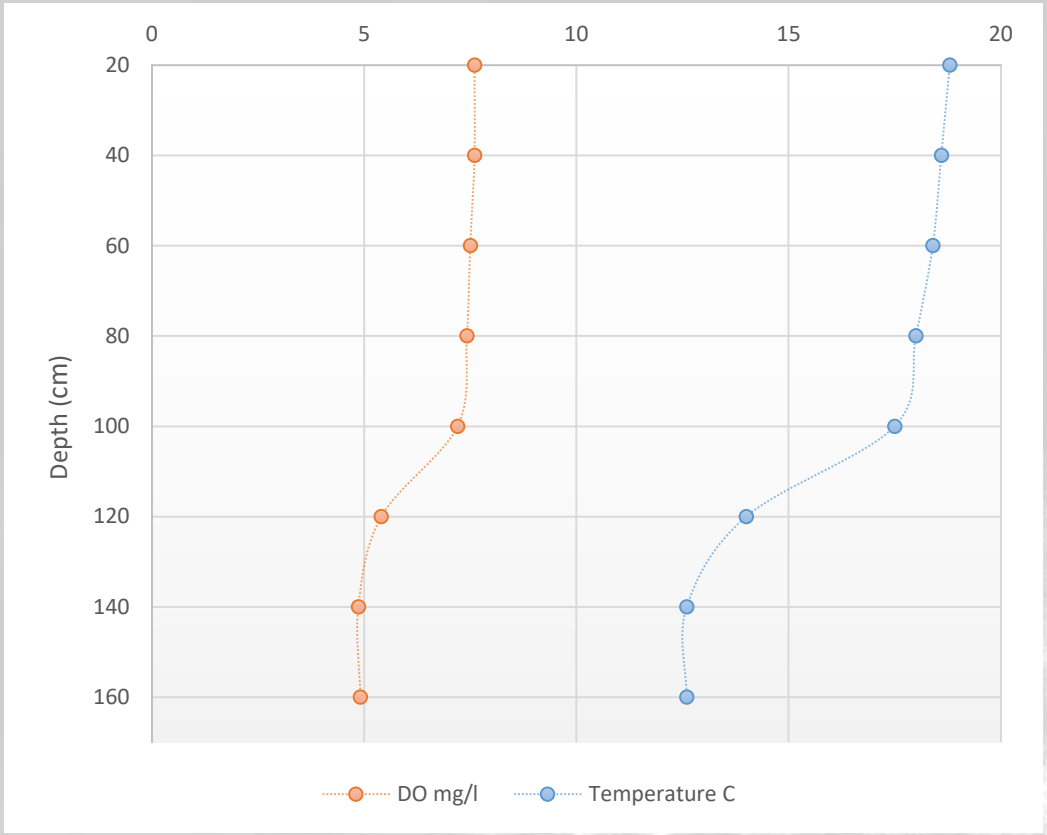

0
5
10
15
20
Depth (cm)
20
40
60
80
100
120
DO mg/l
Temperature C

3-D technique to measure fish in physical environment



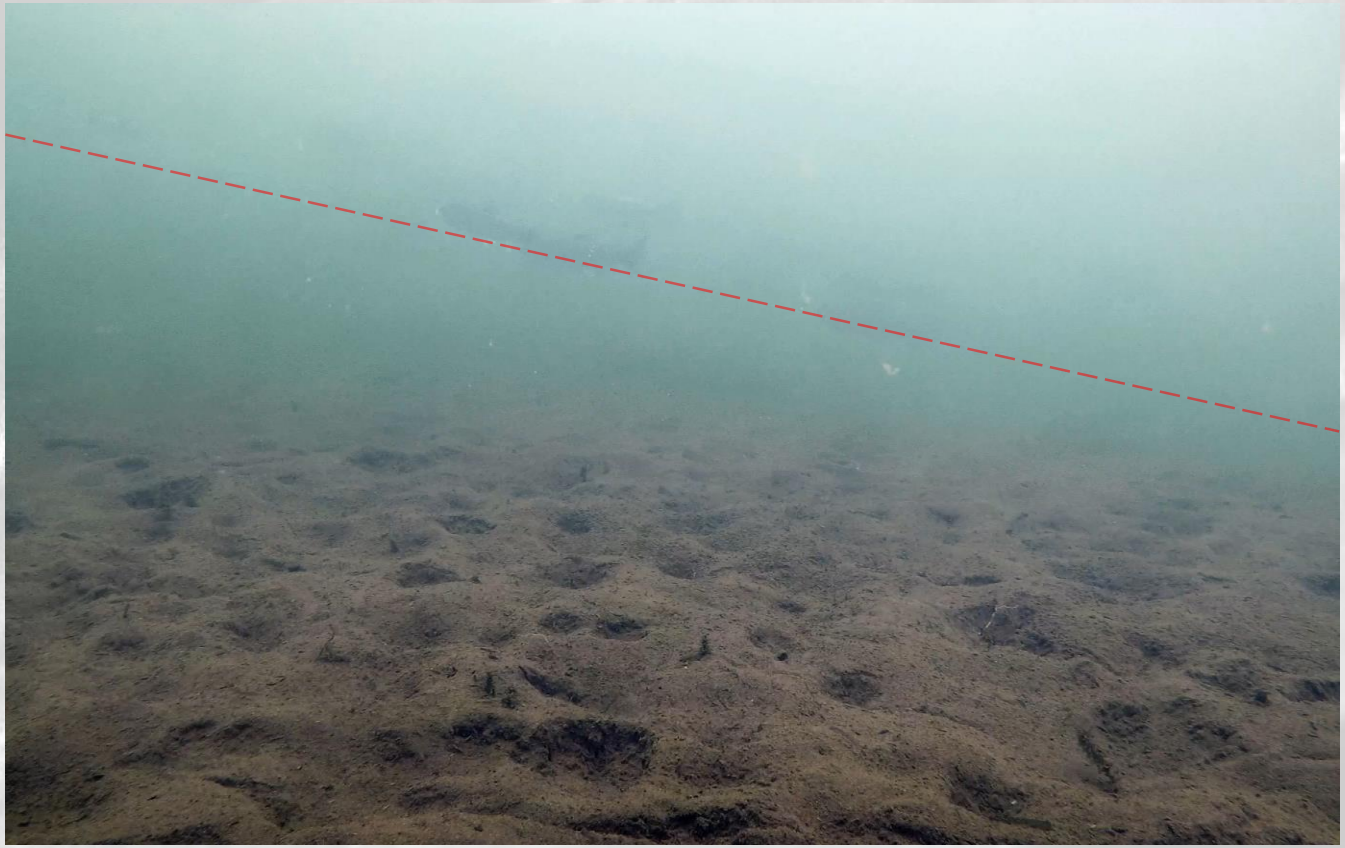


Calibration frame



Alcove

Mainstem



What we've learned

- Timing of refuge use varies among sites
- Fish are not bound to refuges for an entire summer
- Diets appear to be dominated by lentic prey items and low ration sizes
- Spatial trade-offs in temperature and oxygen vary *between* and *within* refuges

Thinking beyond summer…

- While it is important to understand the over-summer services that refuges provide, it is also critical to consider how conditions in the mainstem contribute to fueling annual energy budgets.
- We are interested in what CCT's are doing in mainstem habitats at other times of the year
  - Foraging in spring to store fat to survive summer
  - Foraging in fall to build energy reserves in preparation for spawning

Thanks to:

Jonathan Armstrong and the Armstrong lab

OSU Stream Team - Randy Wildman and Stan Gregory!!

Assistants

Tobias Fehlbeck
Nicholas Sotiropoulos
Aleah Dew
Jordan Ortega
Bastiaan VonRavensford