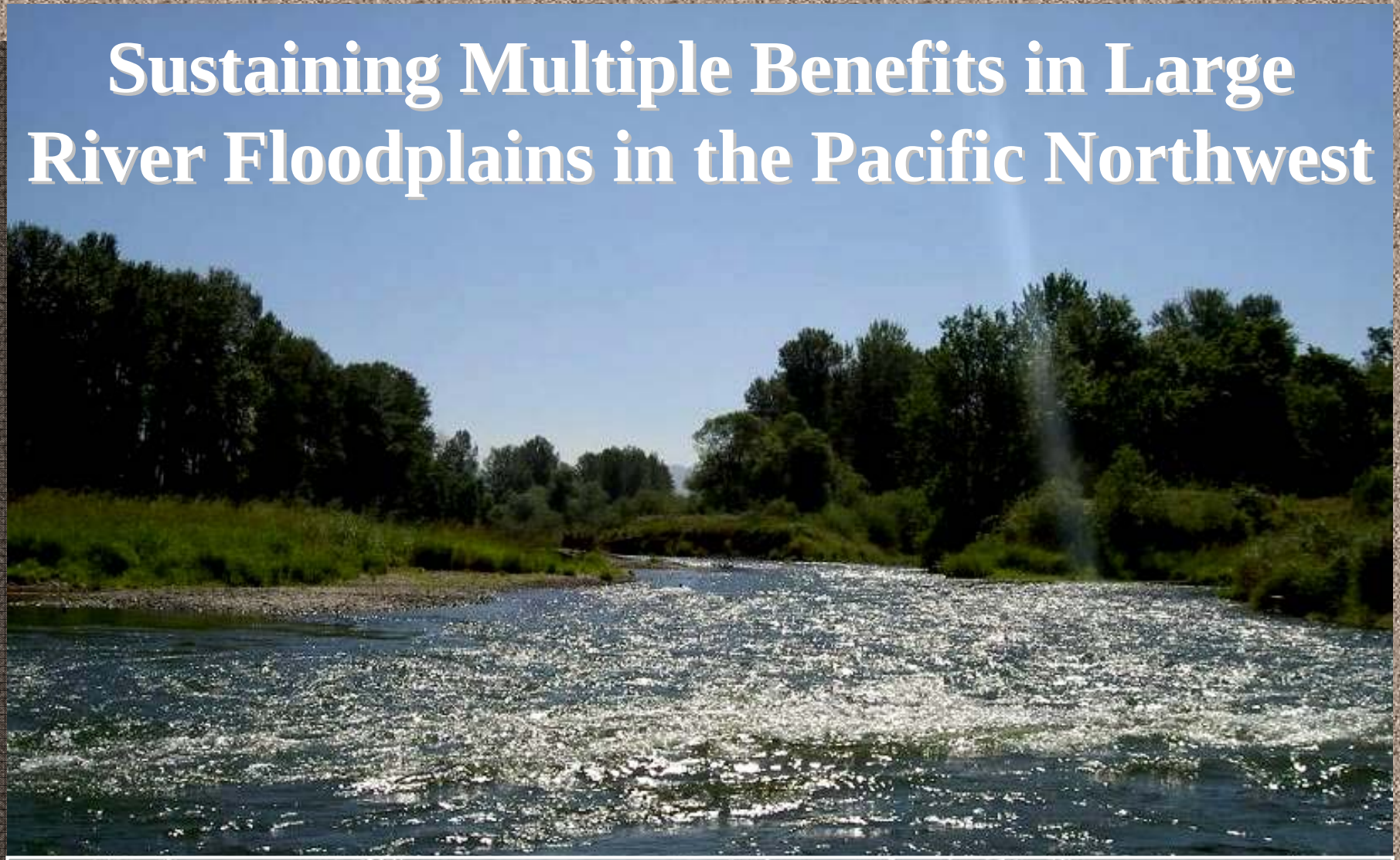
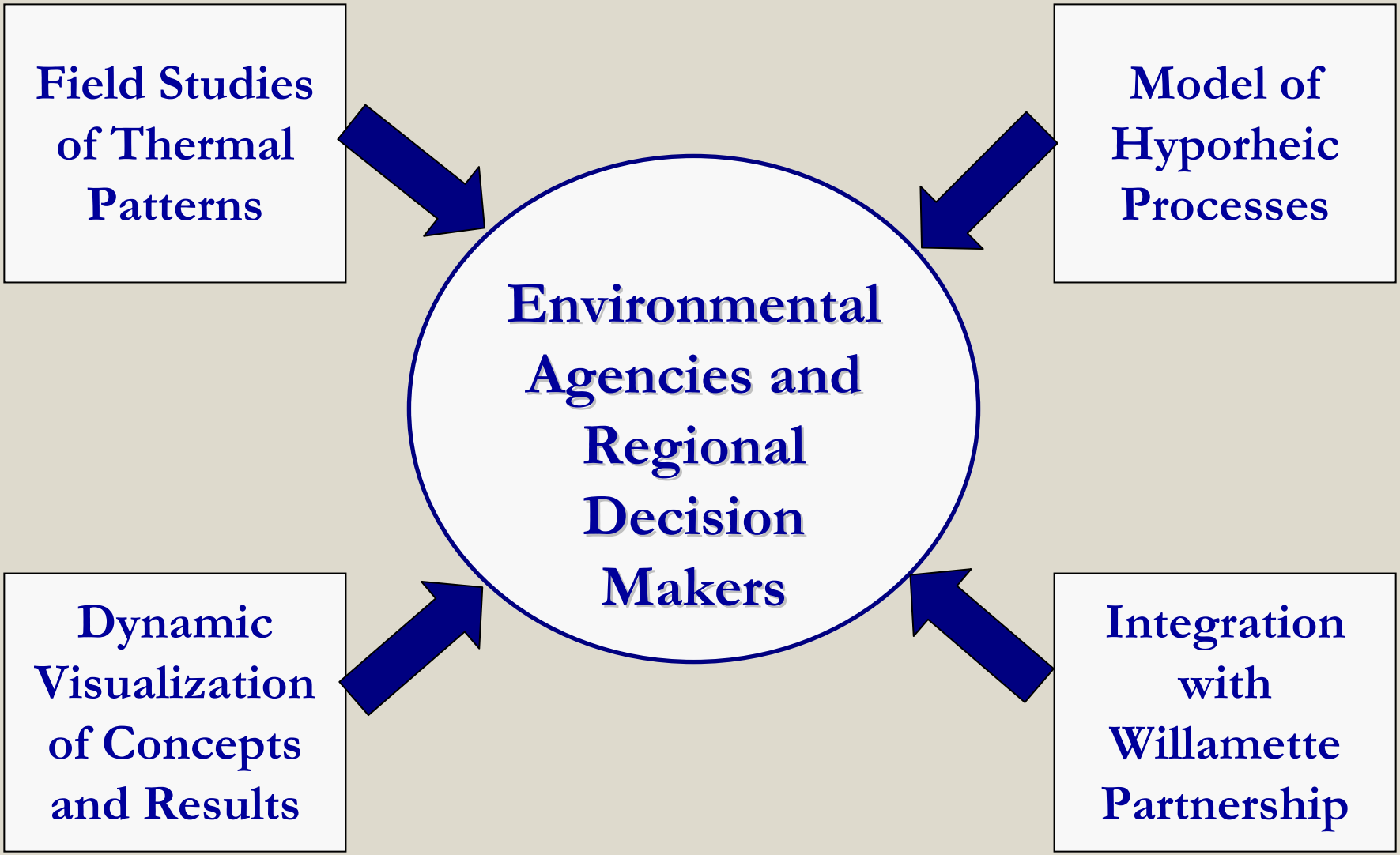
Sustaining Multiple Benefits in Large River Floodplains in the Pacific Northwest



Stan Gregory, David Hulse, Roy Haggerty
Oregon State University
University of Oregon

Sustaining Multiple Benefits in Large River Floodplains in the Pacific Northwest

Project Organization

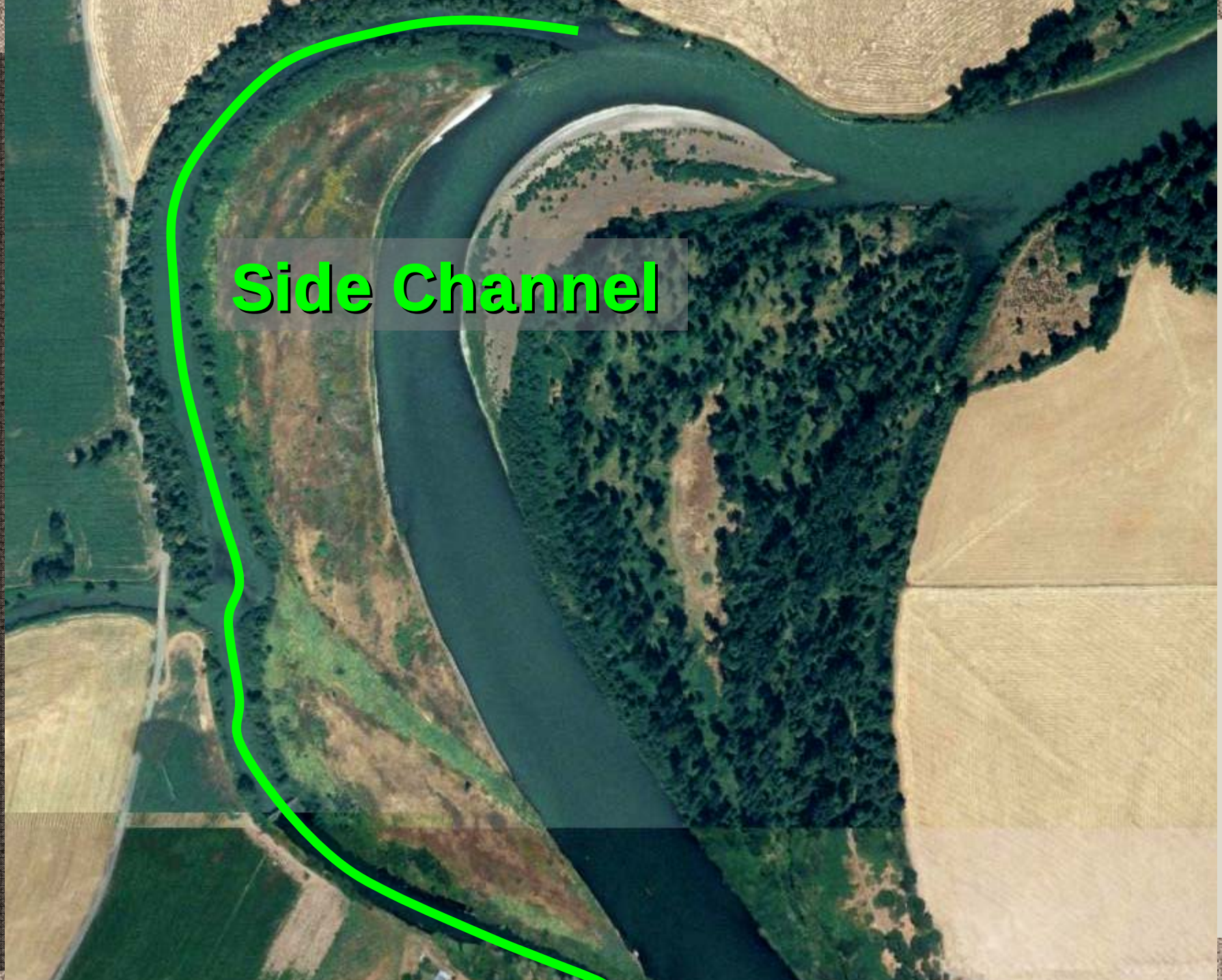


Typology of Thermal Habitats

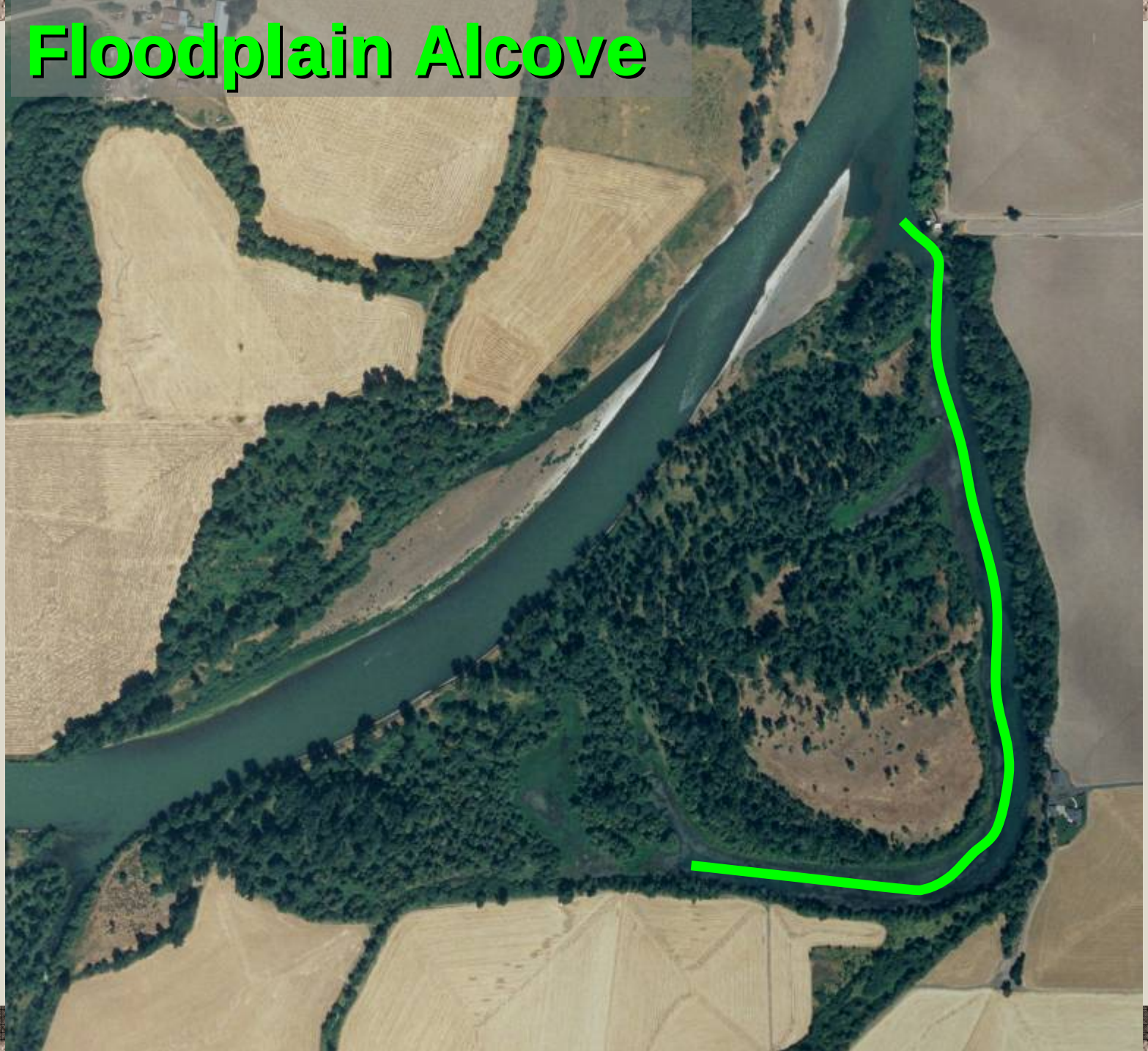
- Geomorphic
- Hydraulic
- Hyporheic
  - Dynamics not demonstrated empirically

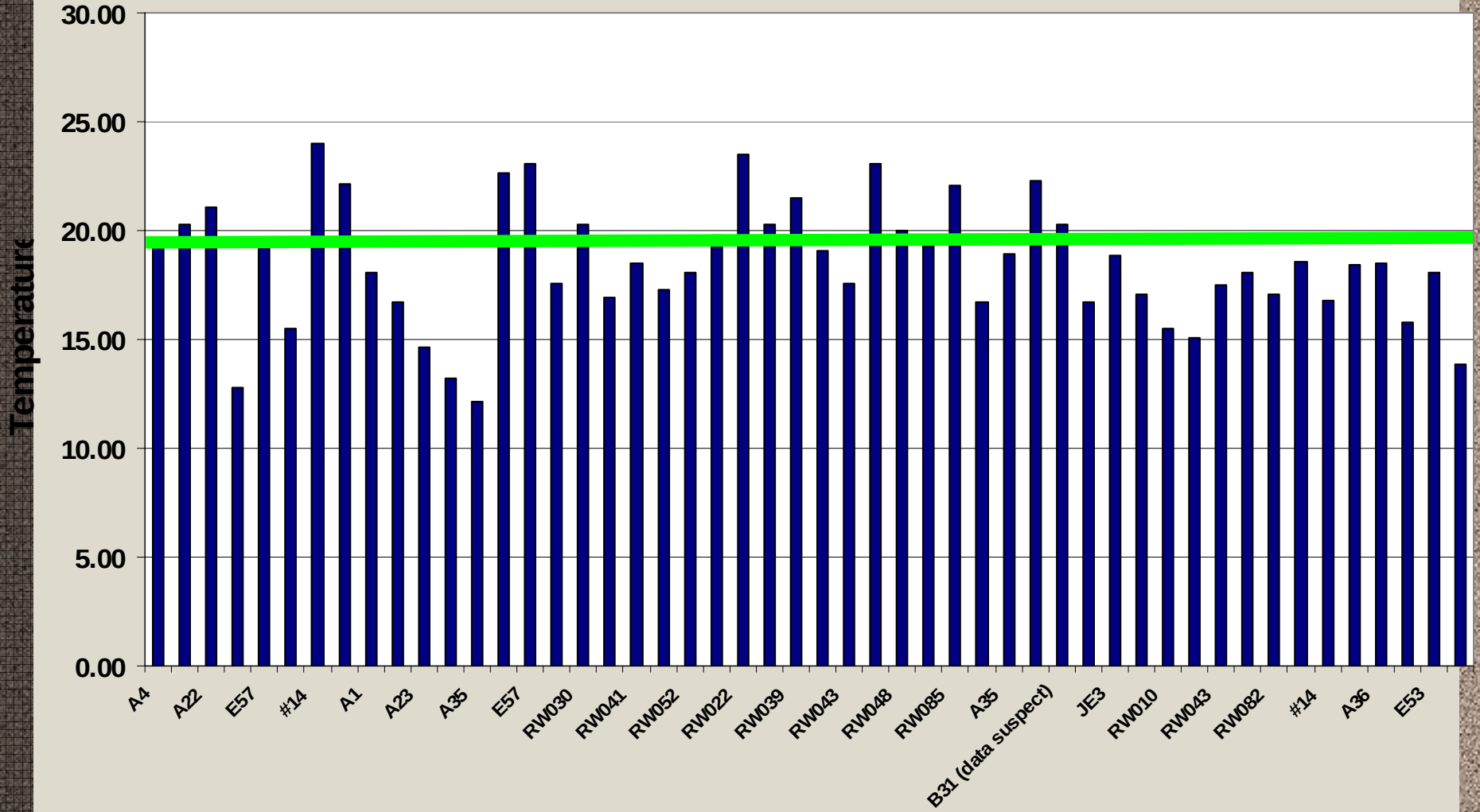

Bar Alcoves

Embayment


Side Channel

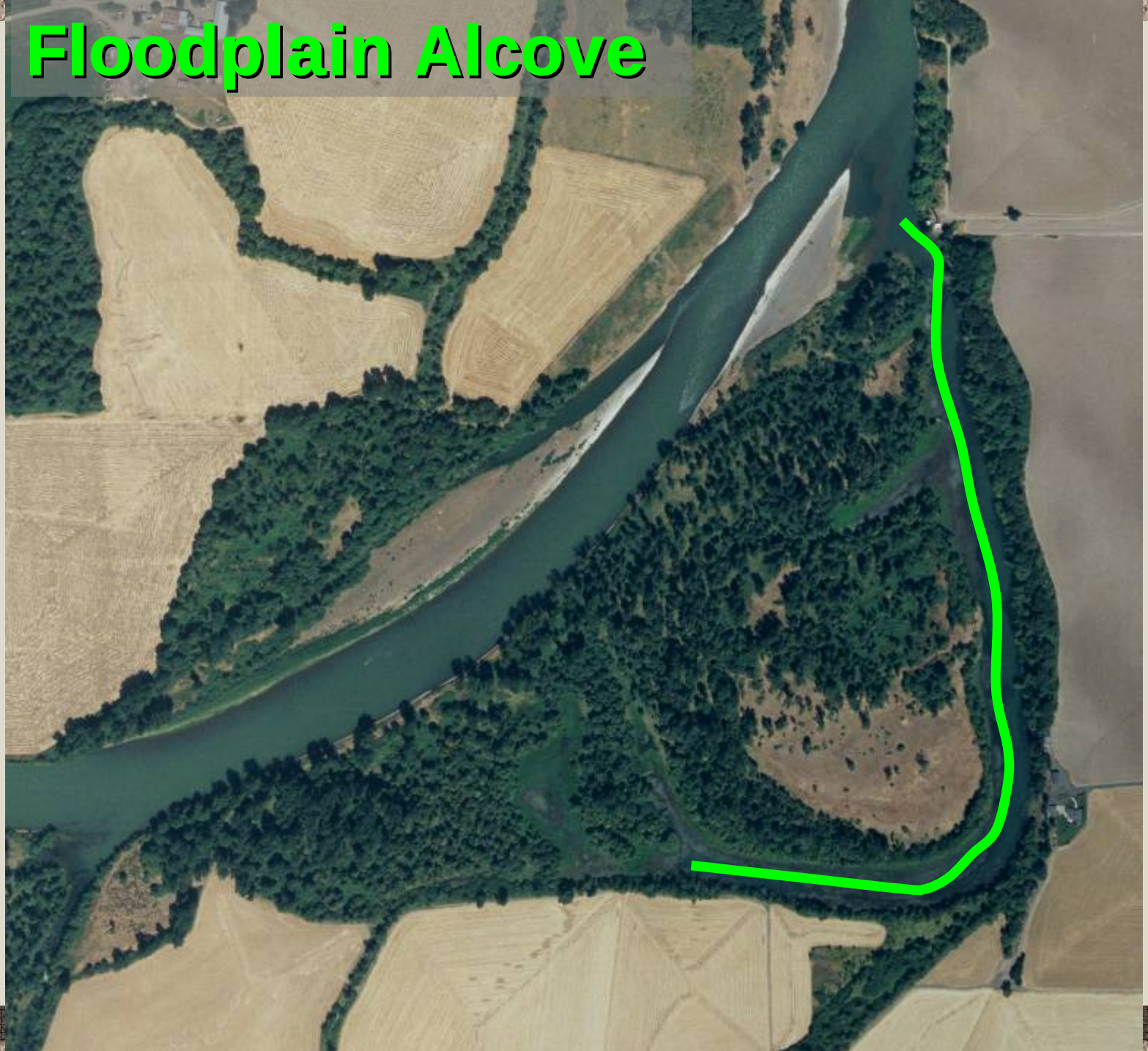
Floodplain Alcove





Small Alcove on Floodplain

Floodplain Alcove



Temperature

10

6

4.9 above mainstem average max, warmest Norwood temperature

4

2

1

0 = 20.3°C mainstem average max for Norwood Island

-1

-2

-4

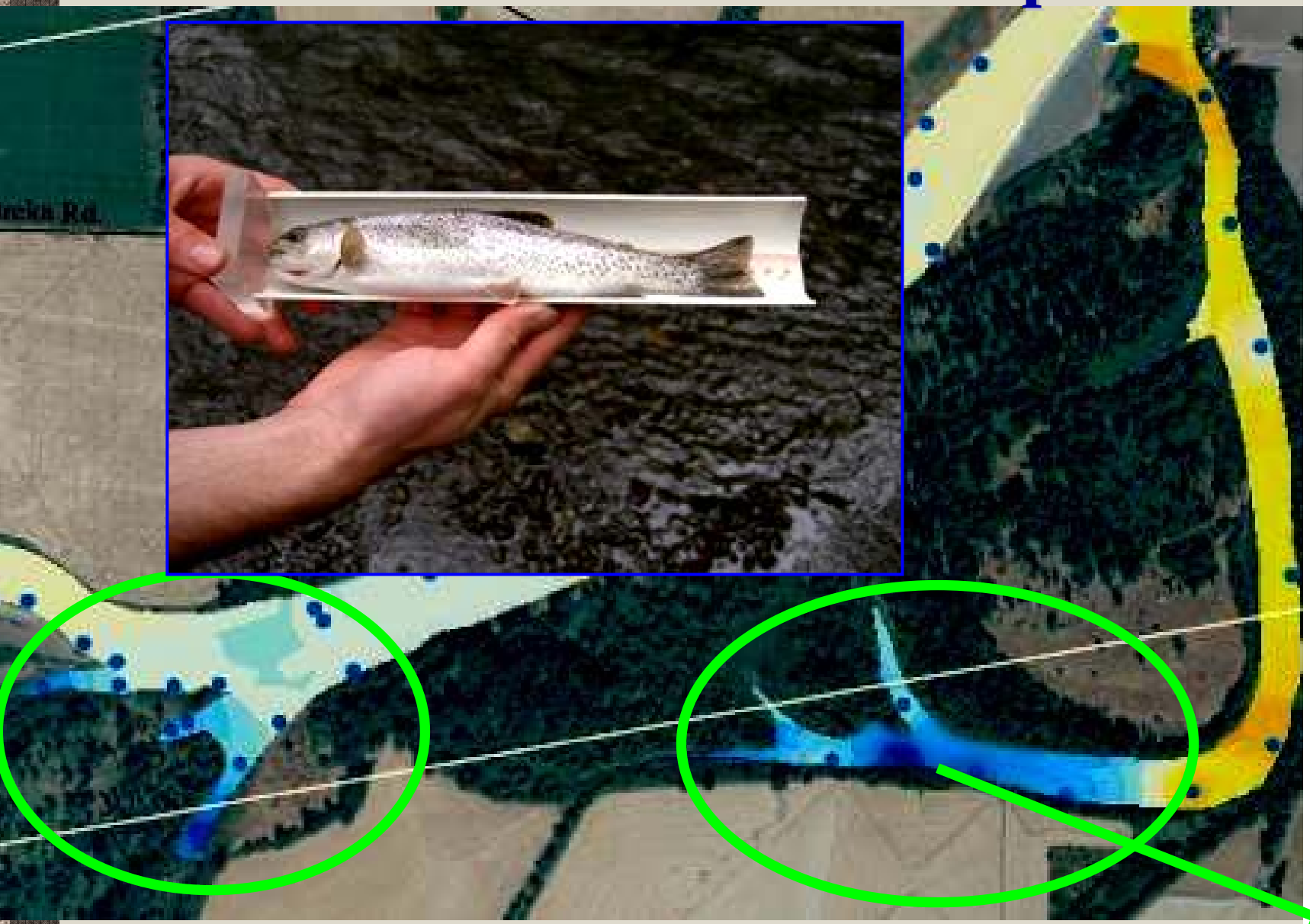
-6

-7

-8.5 -8.4 below mainstem average max, coolest Norwood temperature

Temperature

Temperature



MODELING

Estimate HE → CE-QUAL-W2

$$t = \frac{Ln_e}{Ki}$$

Where:

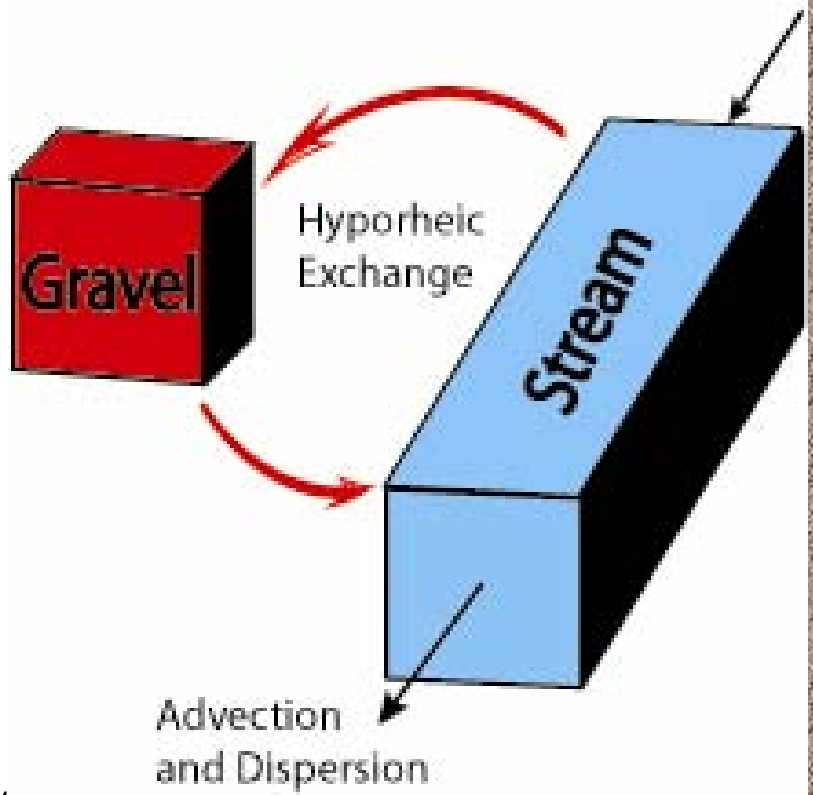
t = time of travel

L = flow path length

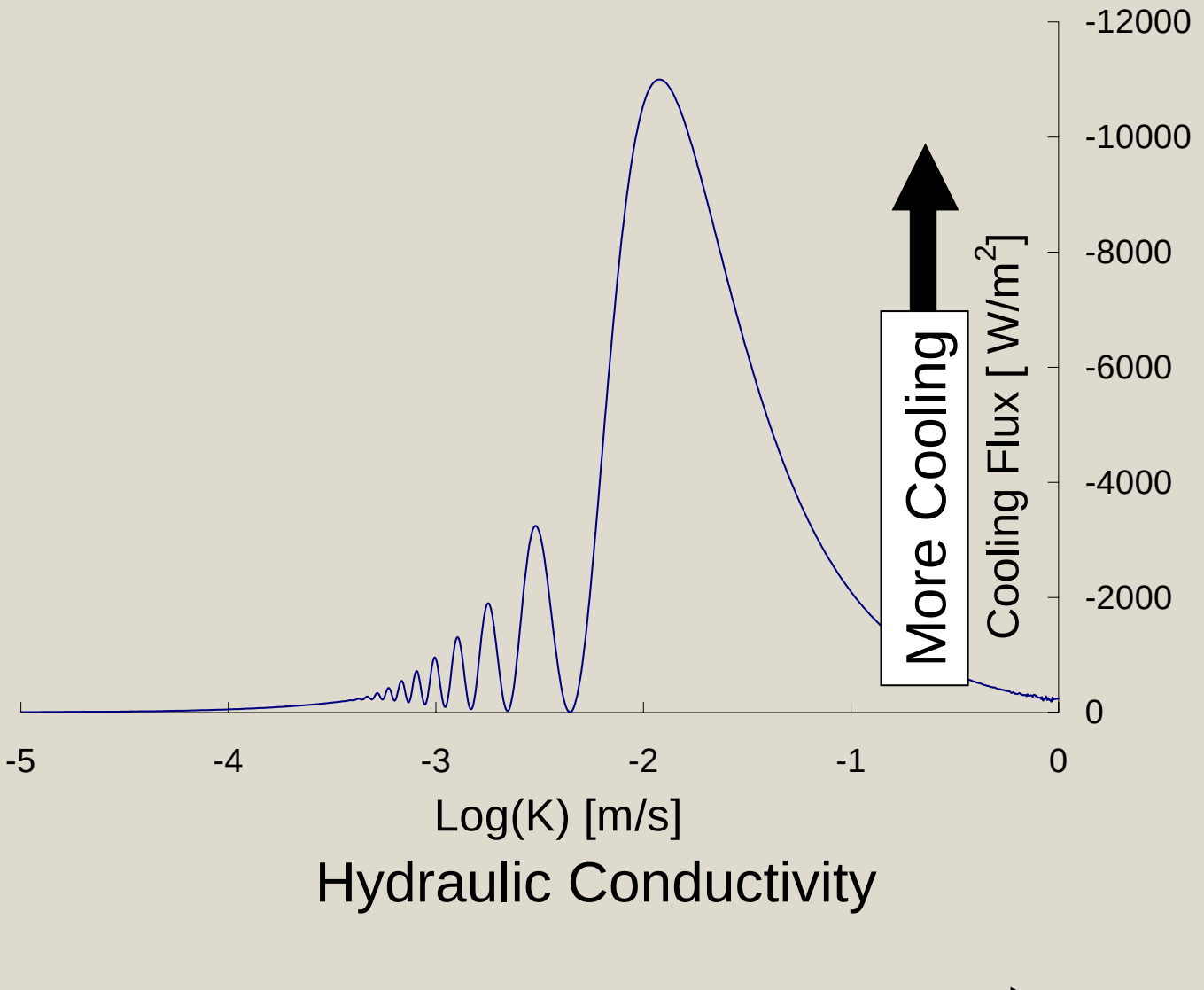
n_e = porosity

K = hydraulic conductivity

i = stream gradient

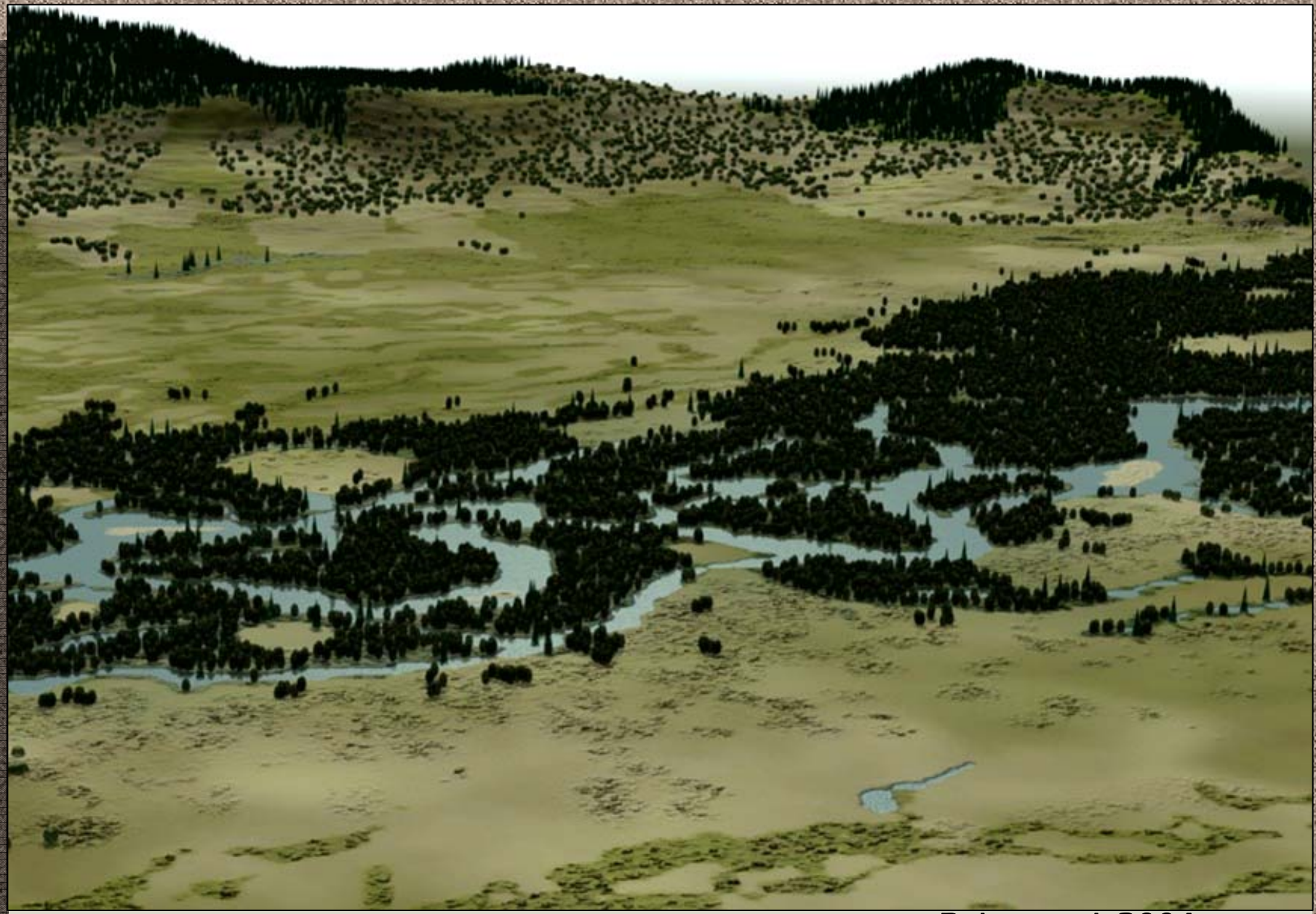


Hyporheic Cooling vs Hydraulic Conductivity



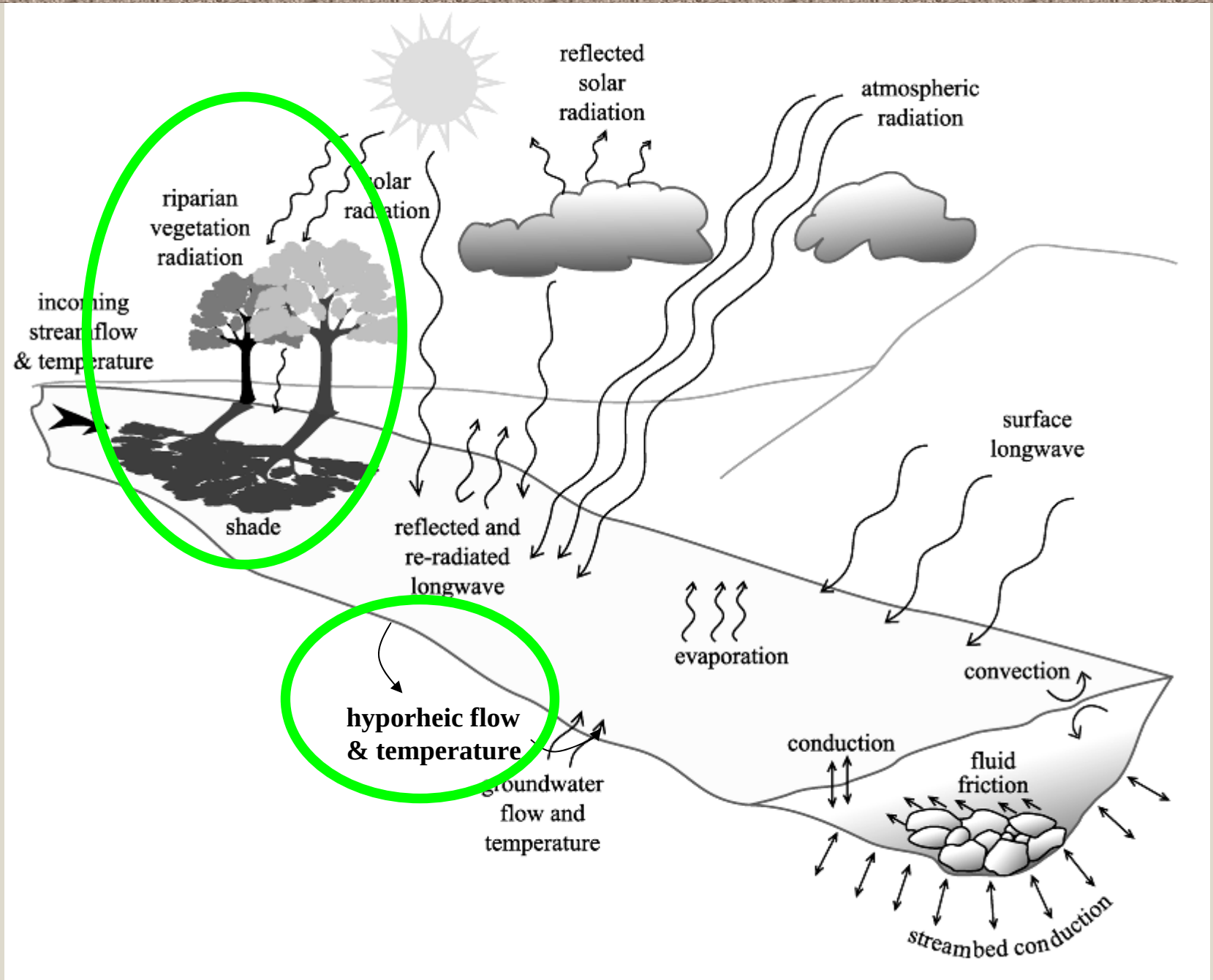
1995

Baker et al. 2004
Ecological Applications

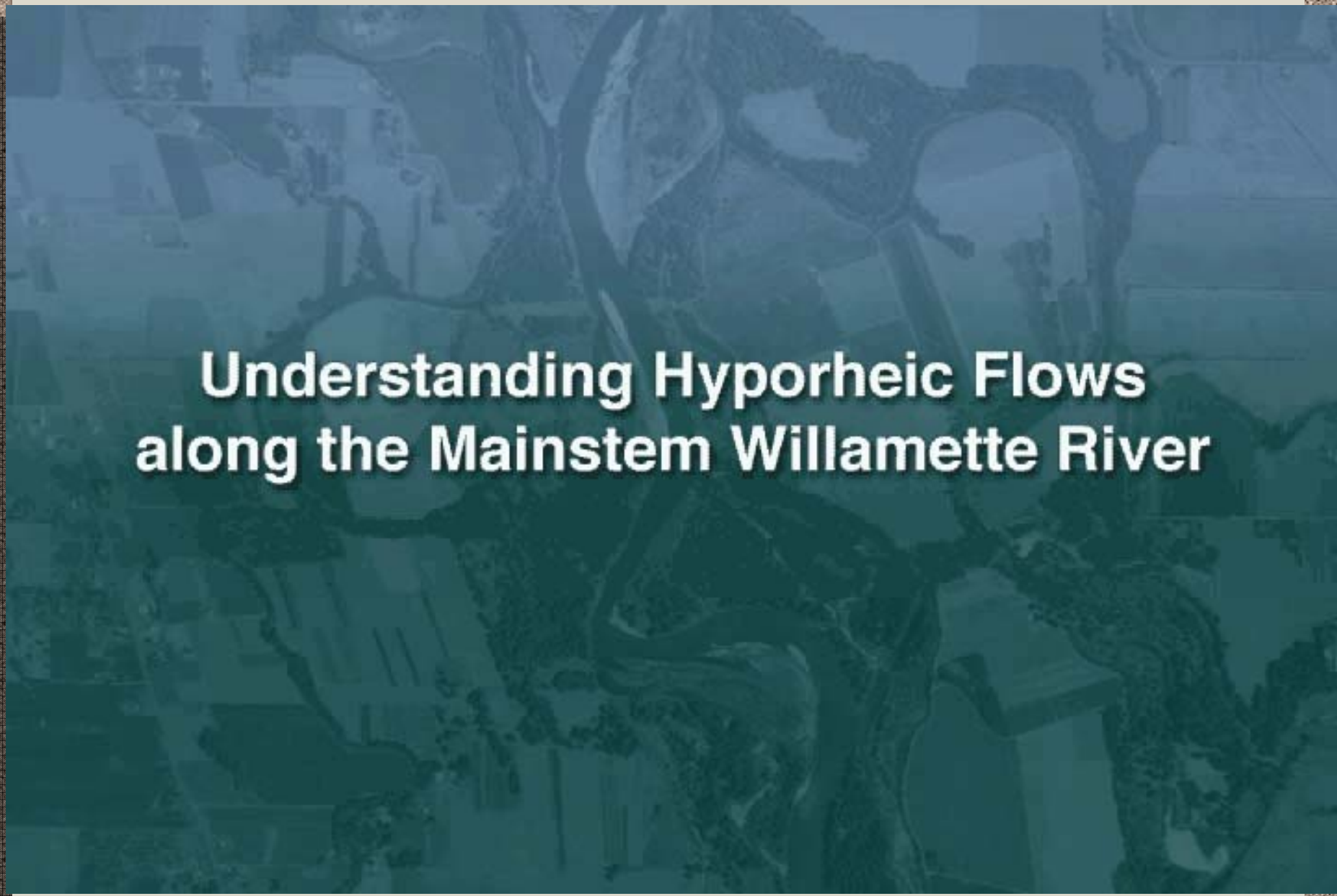


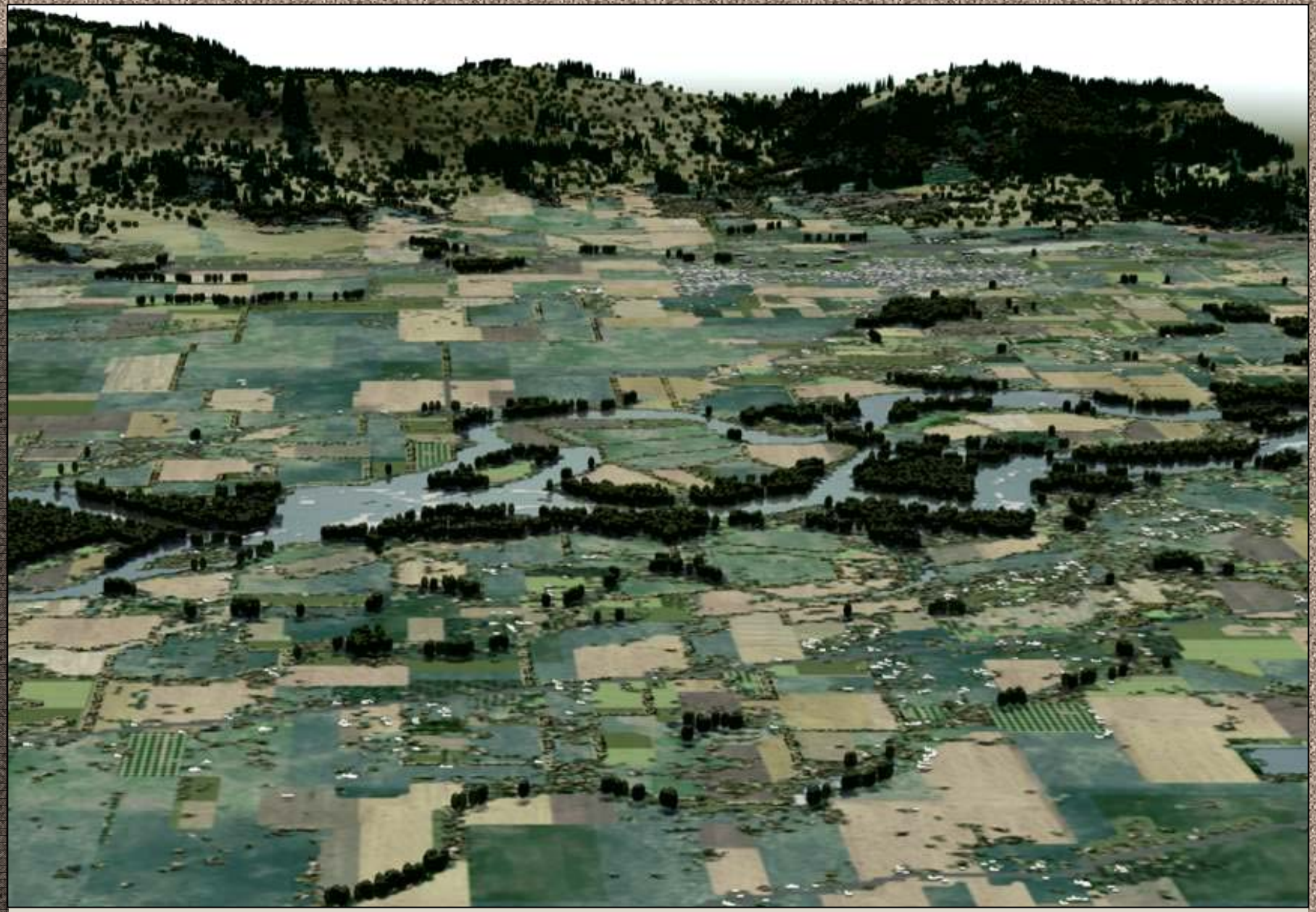
1850

Baker et al. 2004
Ecological Applications



Modified from Tague et al, 2006


Understanding Hyporheic Flows
along the Mainstem Willamette River



2050 Conservation Scenario

Baker et al. 2004
Ecological Applications


Dynamic
Channel
Features

Multiple Benefits of Floodplain and Channel Restoration

- Coldwater refuges
- Nutrient uptake
- Sediment storage
- Flood detention
- Habitat complexity
- Large wood
- Shade
- Fish and invertebrate communities
- Wildlife communities
- Riparian forests
- Visual acceptance
- Recreation
- Alternatives for communities

Can agencies and stakeholders work together?

When citizen values and legal requirements are consistent

Market-based Solutions

- Restoration goals
- Social benefits
- Legal requirements
- Landowner incentives
- Compensation for flood damage
- Community perception

CNS Assistance

- **Provided funding for first field survey of river temperatures in Willamette River.**
- **Provided working relationship with EPA-funded Willamette partnership**
- **Provided funding for developing dynamic visualizations of concepts and river data**

Contribution to Sustainability

- A scientific basis for meeting thermal TMDL goals by restoring coldwater refuges in a large river through a market-based collaborative framework.
  - Locations of coldwater refuges
  - Model of hyporheic influence on temperature
  - Dynamic visualization of complex information for stakeholders
  - Spatial framework for decision makers
  - Working directly with stakeholders and environmental agencies to solve environmental challenges

Contribution to Sustainability

- Restoration efforts also provide multiple ecosystem services and social benefits
  - Cold water refuges
  - Floodplain function
  - Riparian forest restoration
  - Channel and habitat complexity
  - Hyporheic processes
  - Wildlife habitat
  - Recreation
  - Aesthetic values for communities along the river

Surprising Results

- Coldwater refuges (3-8˚C lower than mainstem) were found in all study reaches.
- Alcoves on floodplains exhibited the coldest thermal environments.
- Alcoves on gravel bars exhibited temperature both colder and warmer than the mainstem.
- State environmental agencies were willing consider floodplain restoration to create coldwater habitats as part of TMDL permits.
- Willamette Partnership used the project results and dynamic visualizations to develop a market-based system for restoration of the Willamette River corridor.

Collaborators and Partners

- Oregon State University
- University of Oregon
- EPA Corvallis NHEERL, Western Ecology Division
- Willamette Partnership
- Oregon Department of Environmental Quality
- Oregon Department of Fisheries & Wildlife
- Metropolitan Wastewater Management Commission
- City of Eugene, Oregon
- McKenzie River Trust
- City of Corvallis, Oregon
- City of Albany, Oregon
- US Department of Agriculture
- US Fish & Wildlife Service
- National Marine Fisheries Service

Requested Feedback

- ***Do you have any information on use of coldwater refuges by aquatic organisms?***

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- ***Can fish or other aquatic organisms use coldwater refuges as "stepping stones" during periods of thermal stress?***

Requested Feedback

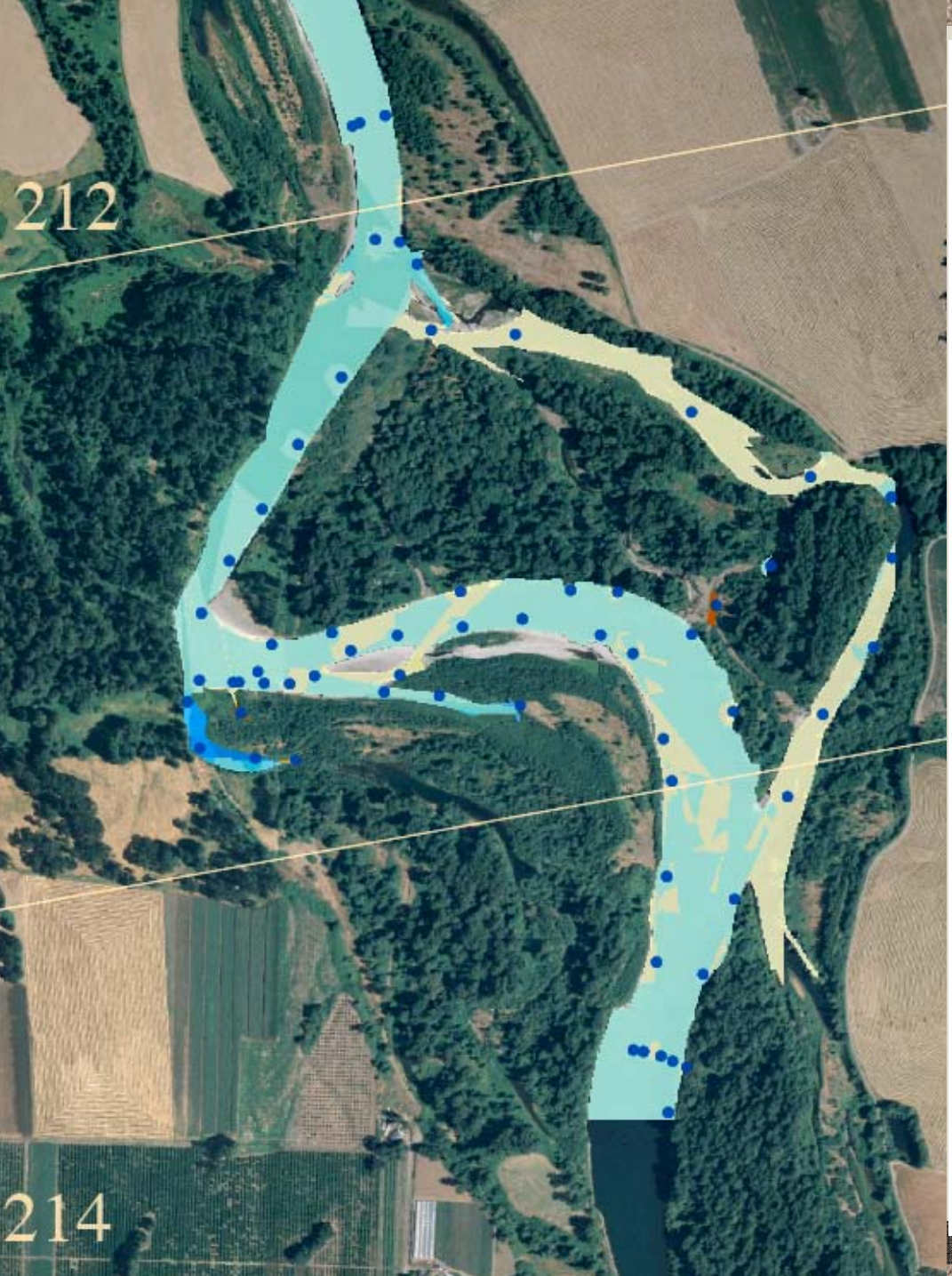
- Do you have any information on use of coldwater refuges by aquatic organisms?
- Can fish or other aquatic organisms use coldwater refuges as “stepping stones” during periods of thermal stress?
- ***Can market systems be used to create “compensation banks” to compensate land owners for property loss in a floodplain corridor?***

Requested Feedback

- ***Do legal restrictions on participation in <u>mitigation</u> create barriers for collaboration with federal or state agencies?***

Requested Feedback

- Do legal restrictions on participation in mitigation create barriers for collaboration with federal or state agencies?
- ***Do you have other examples of landscape studies of ecosystem services linked to analysis of alternative future scenarios?***



13
10
6
4
2
1
0 = 19.5° C mainstem average max for Green Island
-1
-2
-4
-6
-7
-8.5

6.9 above mainstem average max, warmest Green Island temperature

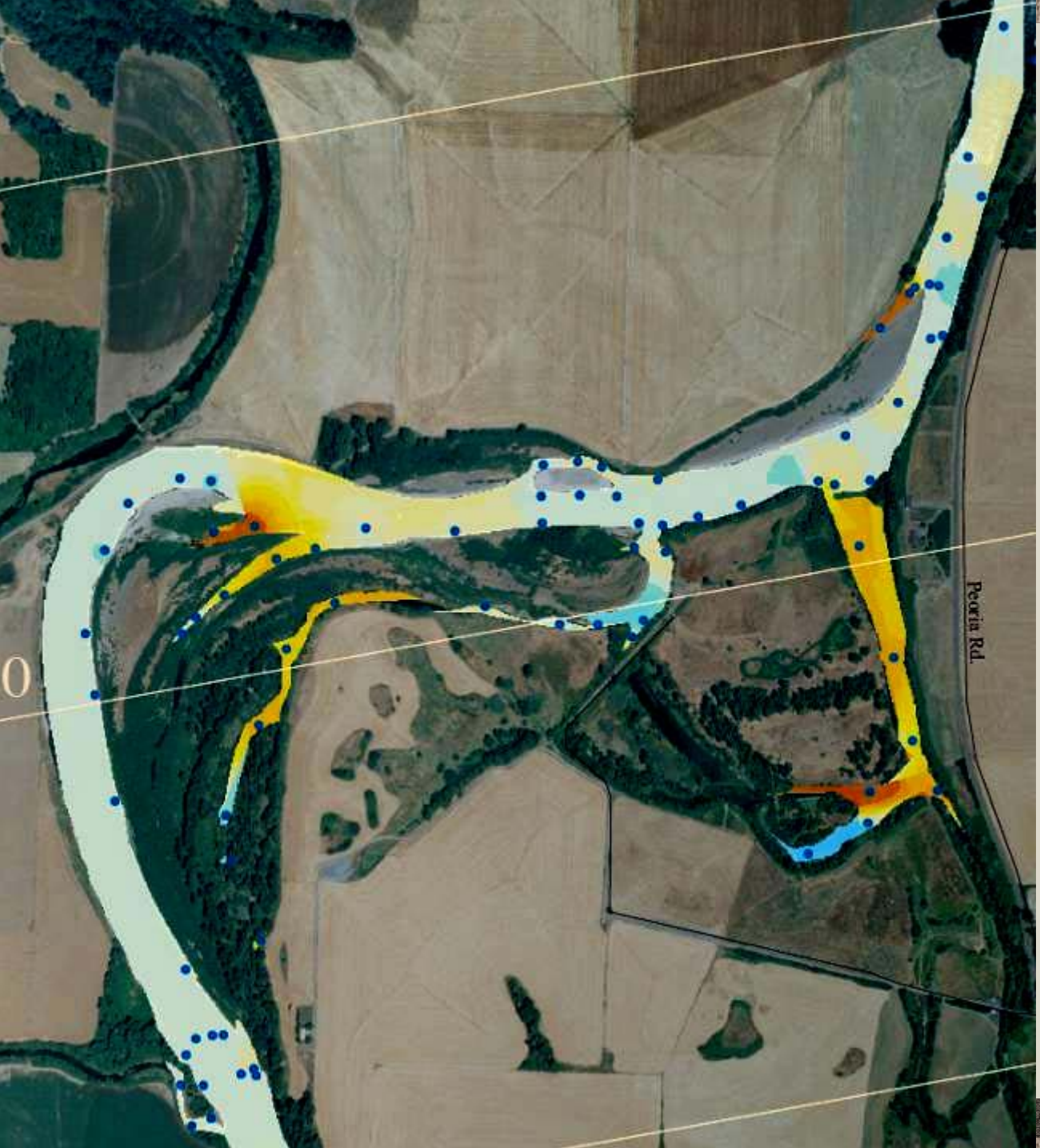
-5.1 below mainstem average max, coolest Green Island temperature

13
10
6
4
2
1
0
-1
-2
-4
-6
-7
-8.5

2.4 above mainstem average max,
warmest Sam Daws temperature

= 20.4°C mainstem average max
for Sam Daws Bend

-5.9 below mainstem average max,
coolest Sam Daws temperature



13
10
6
4
2
1
0 = 19.6°C mainstem average max for Snag Boat Bend
-1
-2
-4
-6
-7
-8.5

9.0 above mainstem average max, warmest Snag Boat temperature

-2.8 below mainstem average max, coolest Snag Boat temperature

13
10
6
4
2
1
0 = 17.8° C mainstem average max for Kieger Island*
-1
-2
-4
-6
-7
-8.5

5.7 above mainstem average max, warmest Kiger* temperature

-3.9 below mainstem average max, coolest Kiger* temperature


Green Island

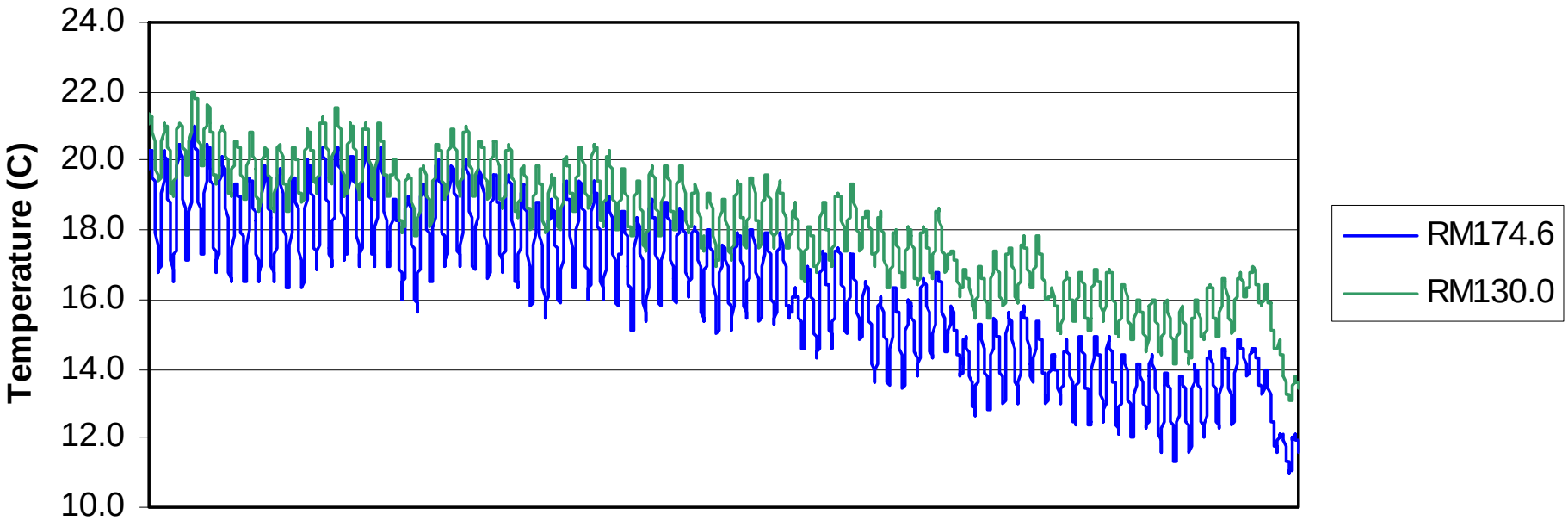

Blue Ruin

Snagboat Bend


Sam Daws


Norwood Island

Willamette River Longitudinal Temperature Profile (July 15 - October 3, 2005)



Effect of Hyporheic Exchange on River Temperature