

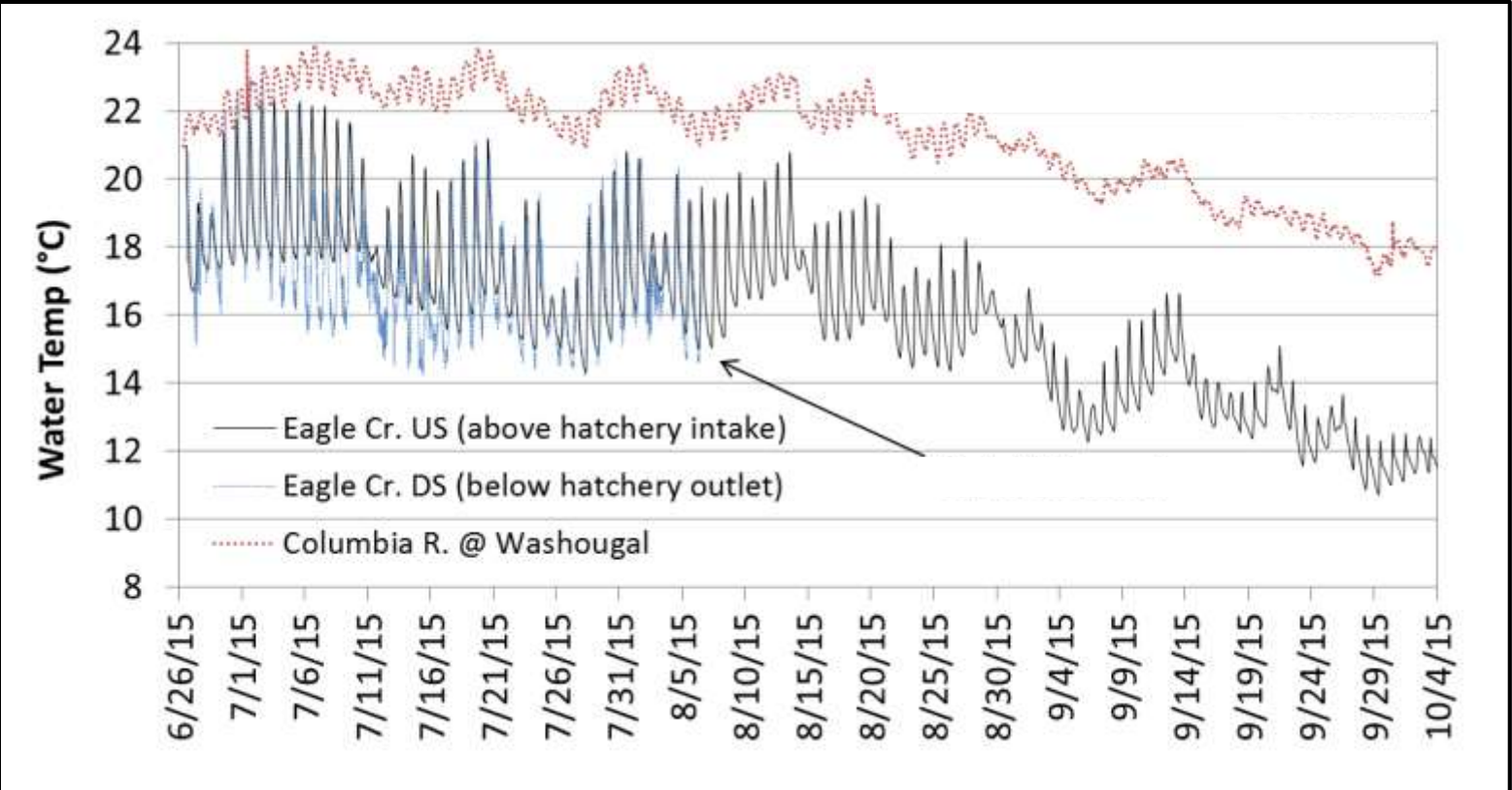
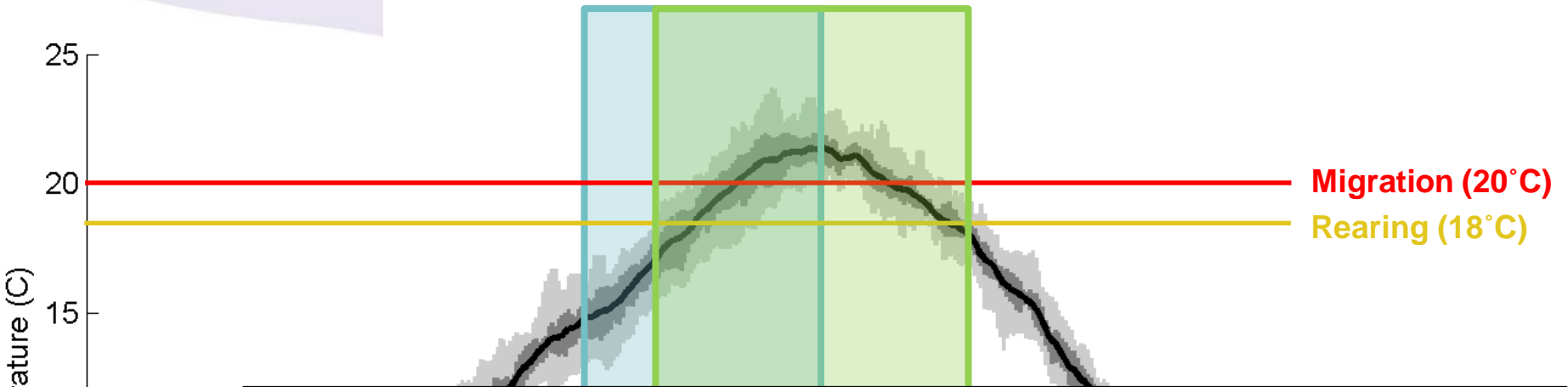
Enhancing Cold Water Refuges at Small Tributaries in the Lower Columbia River



Bridal Veil Creek

**Chris Collins, Keith Marcoe, Catherine Corbett, Mike Burke*

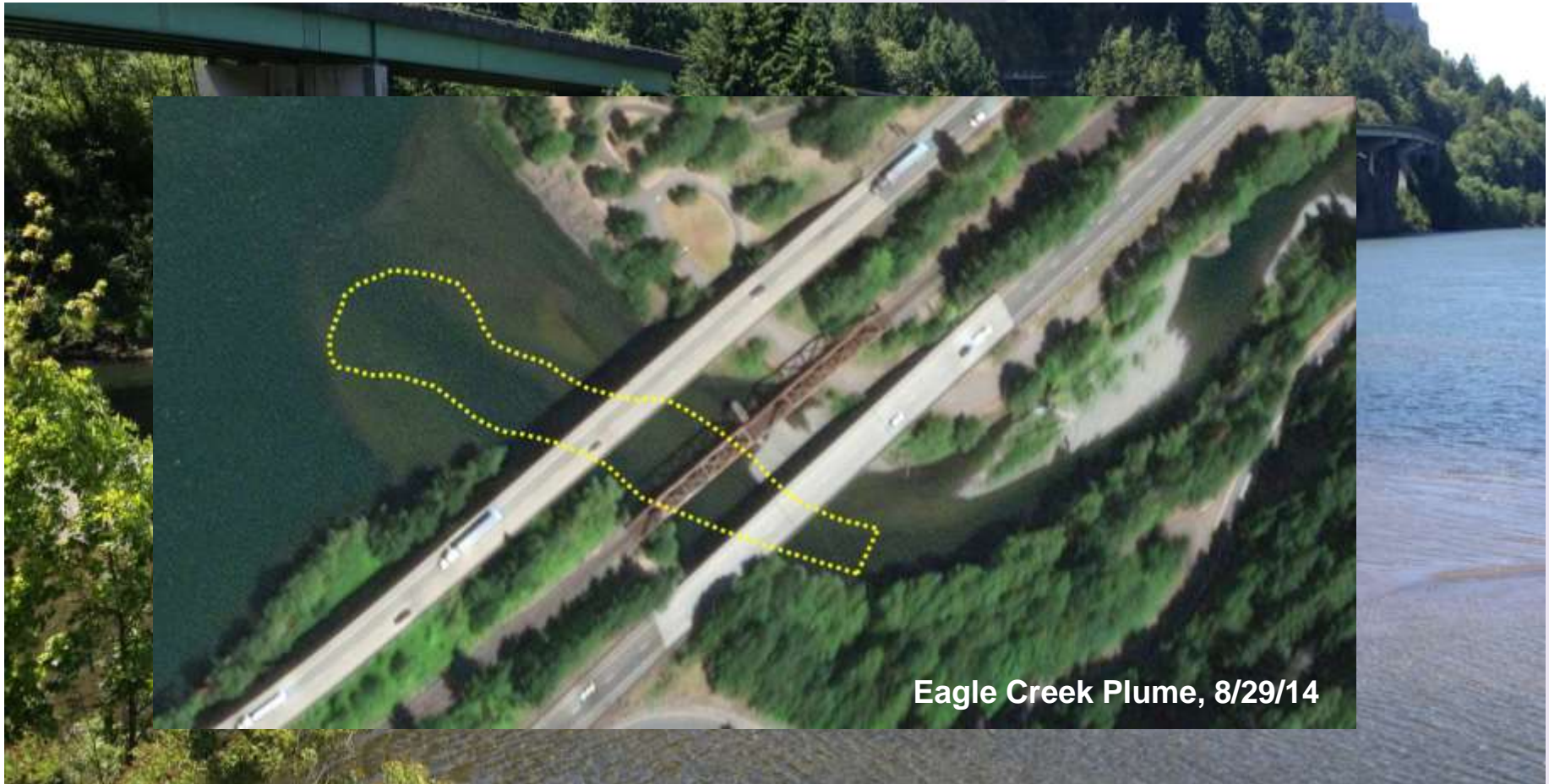
Mainstem thermal regime during migration



Cold water refuge – *initial thoughts and questions*

❖ Question 1 – What are the characteristics of CWR?

- ❖ **Temperature:** > 2°C colder than mainstem Columbia (Keefer et al. 2011)
- ❖ **Water depth:** juveniles > 0.5m water depth (Bottom et al. 2005)
adults > 2m water depth (Johnson et al. 2010)
- ❖ **Surface area:** ~1 acre (smallest plume reported above Bonneville Dam)

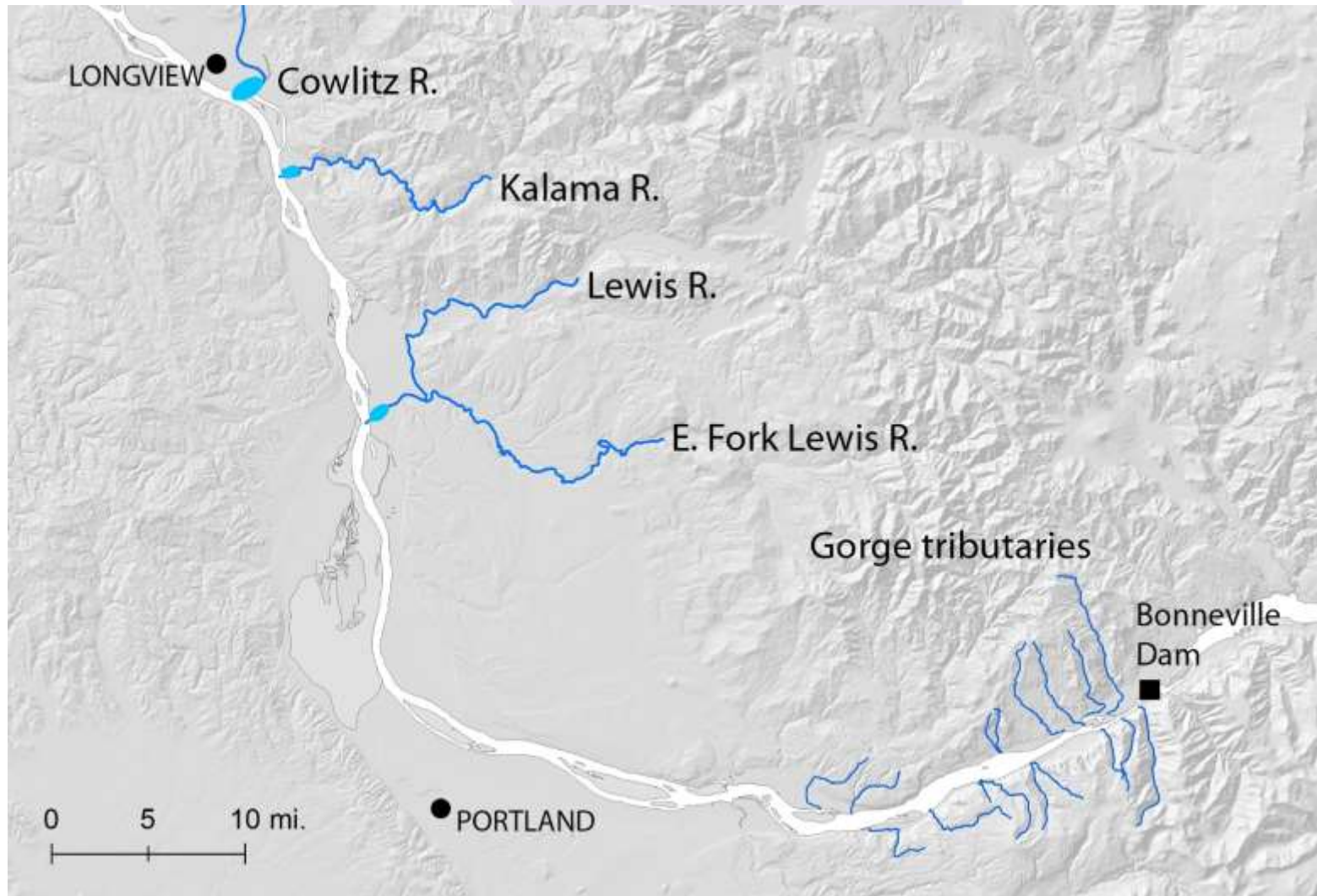


Eagle Creek Plume, 8/29/14

Cold water refuge – *initial thoughts and questions*

❖ Question 2 – Where is CWR currently available in lower Columbia?

- ❖ No mainstem CWR (that meets study criteria) available between the Lewis River and Bonneville Dam (57 river miles)



Cold water refuge – *initial thoughts and questions*

❖ Question 3 – What factors influence the formation of CWR plumes in the mainstem?

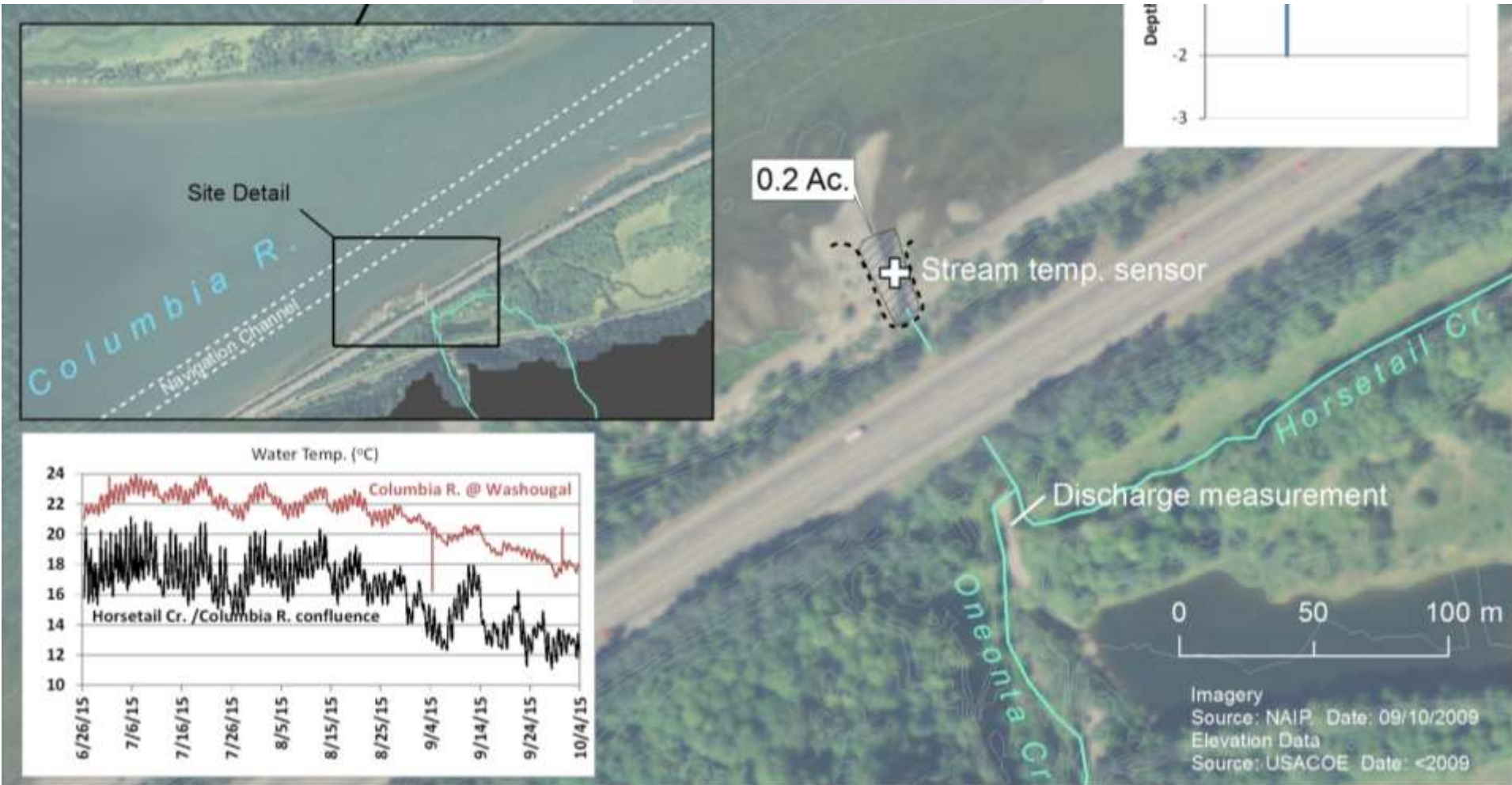
1. Water temperature: both in the tributary and mainstem
2. Discharge: both in the tributary and mainstem Columbia River



Cold water refuge – *initial thoughts and questions*

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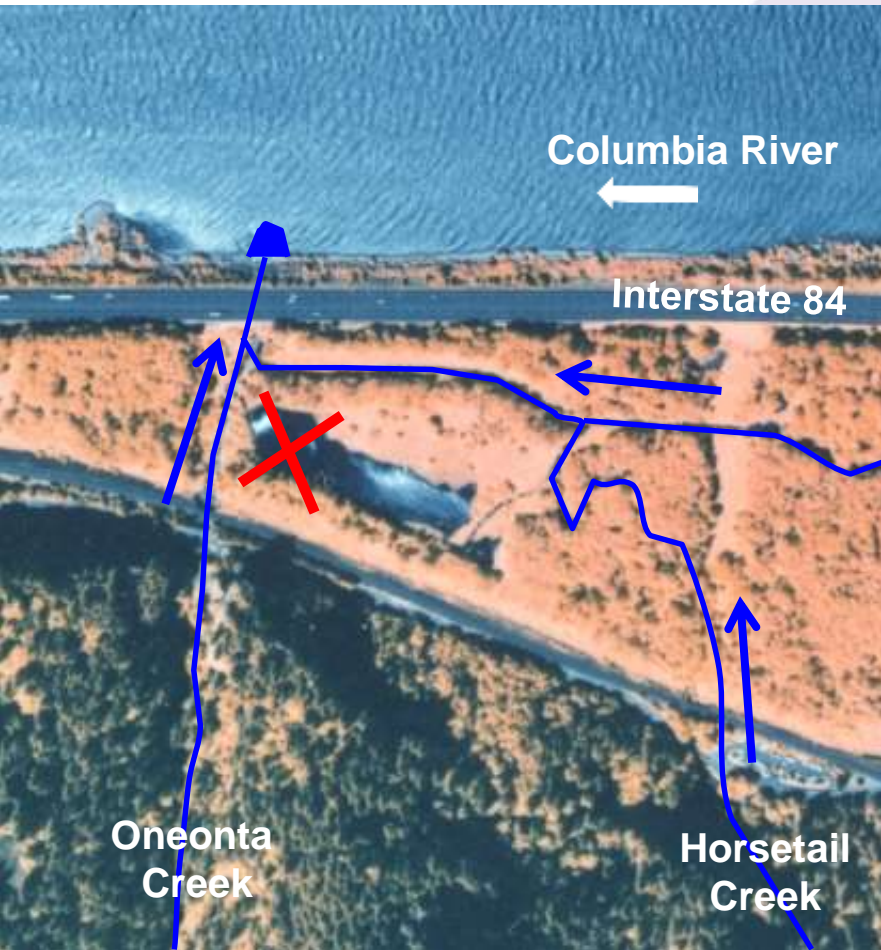
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Cold water refuge – *initial thoughts and*

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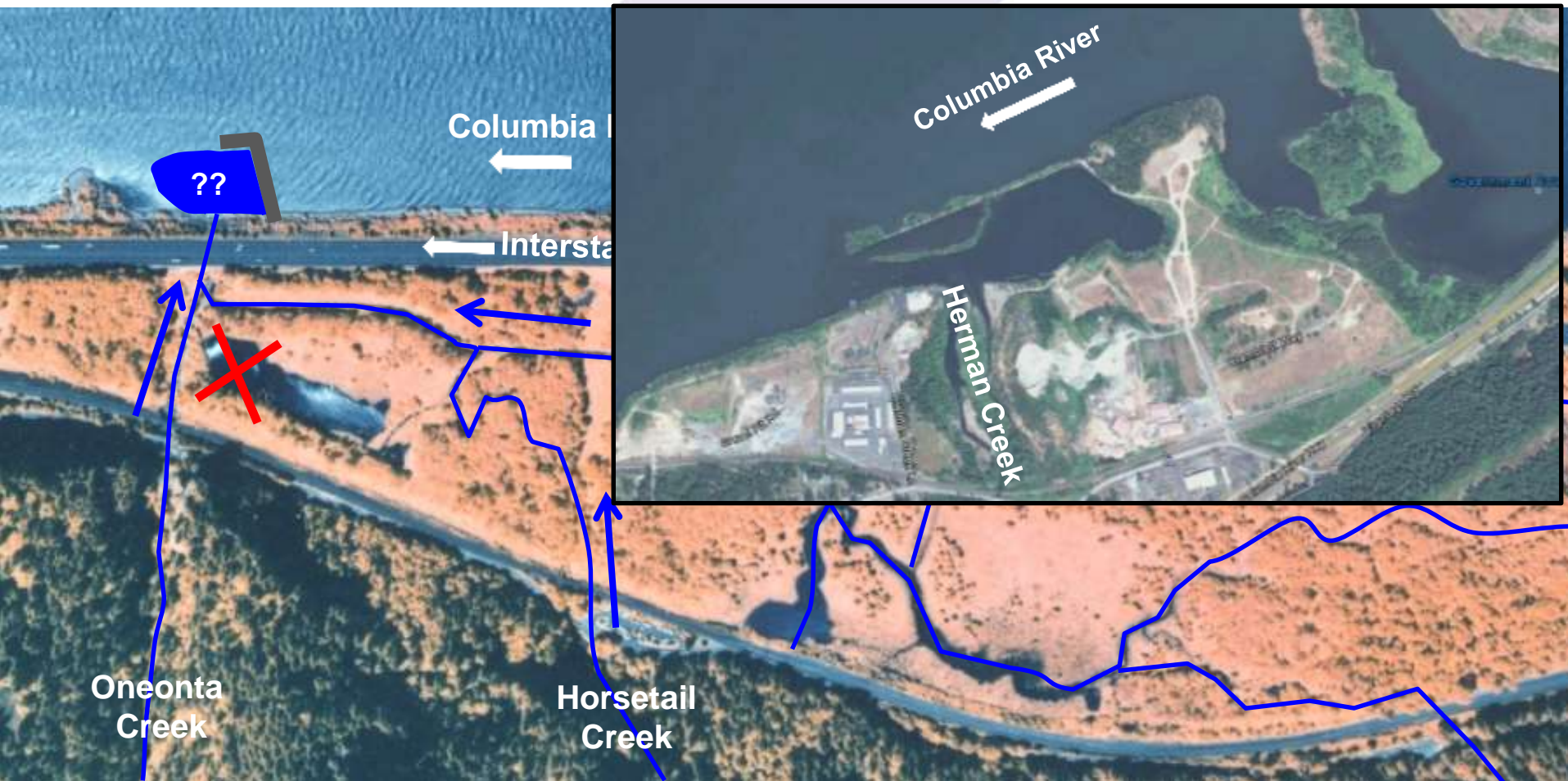
1. Water temperature: both in the
2. Discharge: both in the tributary
3. Atmospheric conditions: solar
4. Physical setting: topography im



Cold water refuge – *initial thoughts and questions*

❖ Question 3 – What factors influence the formation of CWR plumes in the mainstem?

1. Water temperature: both in the tributary and mainstem
2. Discharge: both in the tributary and mainstem Columbia River
3. Atmospheric conditions: solar radiation, wind
4. Physical setting: bathymetry immediately within and surrounding confluence



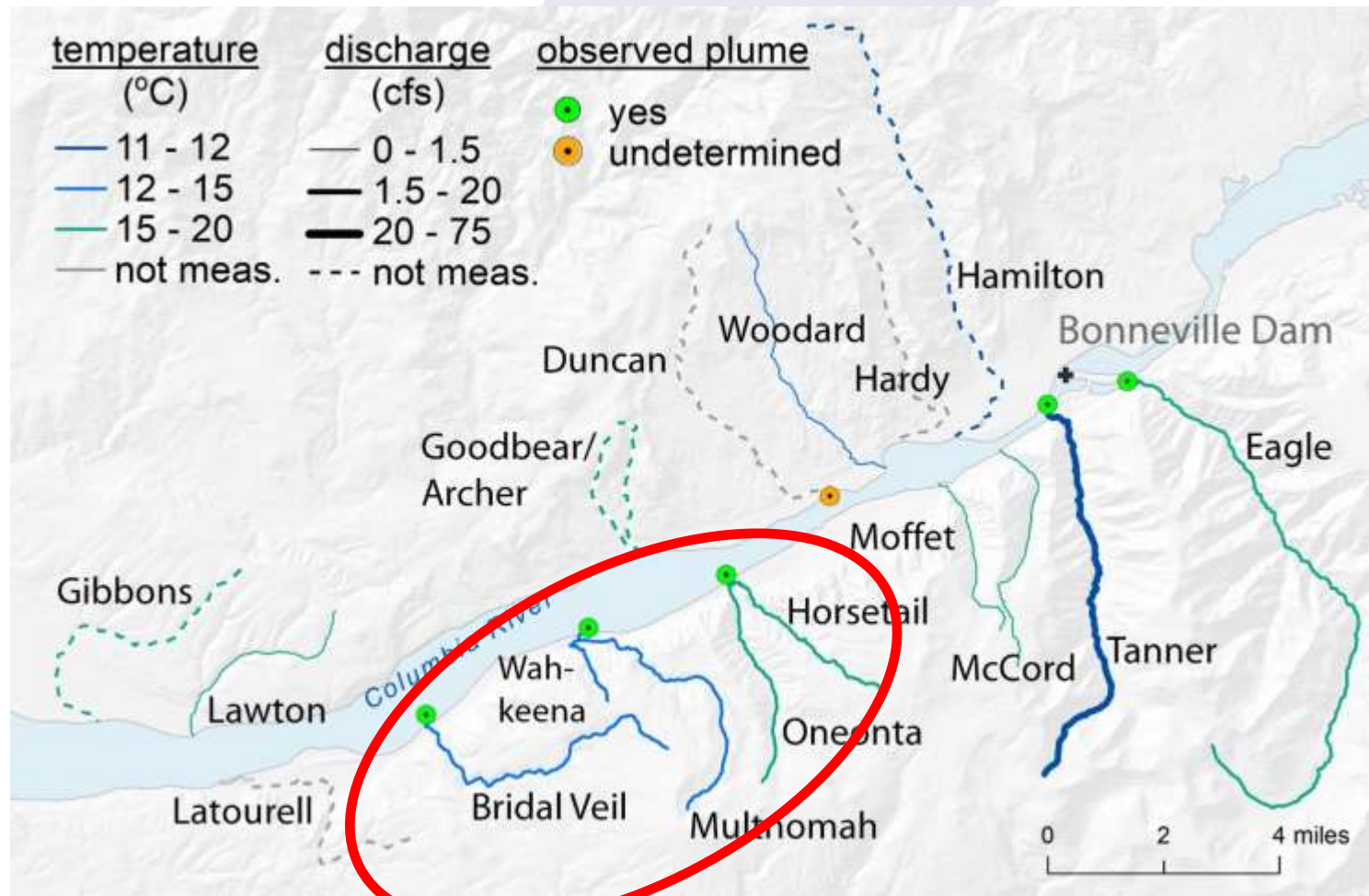
Cold water refuge – Feasibility Study (Phase I)

Purpose: Assess feasibility of expanding cold water plumes in the mainstem Columbia River by manipulating nearshore topography.

Approach:

❑ **Step 1: Select study sites**

Selection criteria: discharge, temperature, location



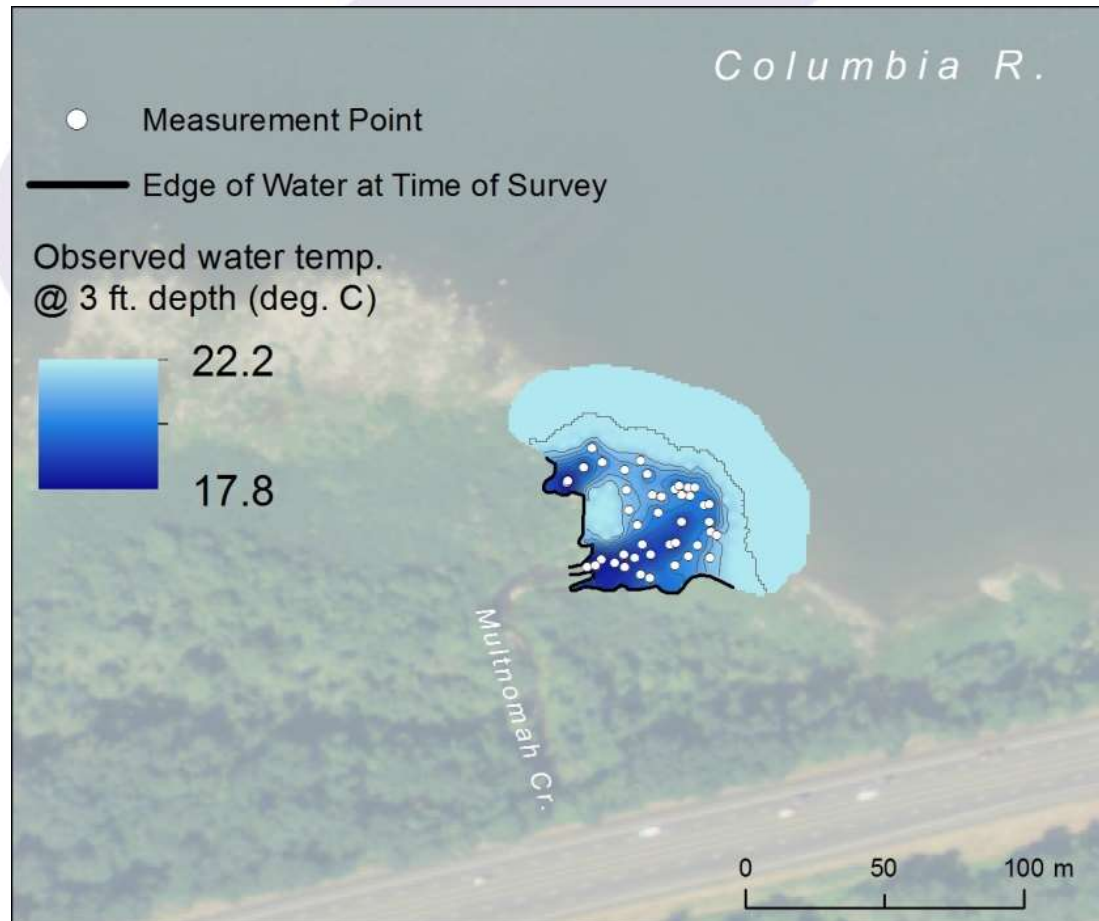
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Purpose: Assess feasibility of expanding cold water plumes in the mainstem Columbia River by manipulating nearshore topography.

Approach:

- ❑ Step 1: Select study sites
- ❑ Step 2: Plume mapping (existing conditions)

Used to validate model results and assess effectiveness of proposed alternatives.

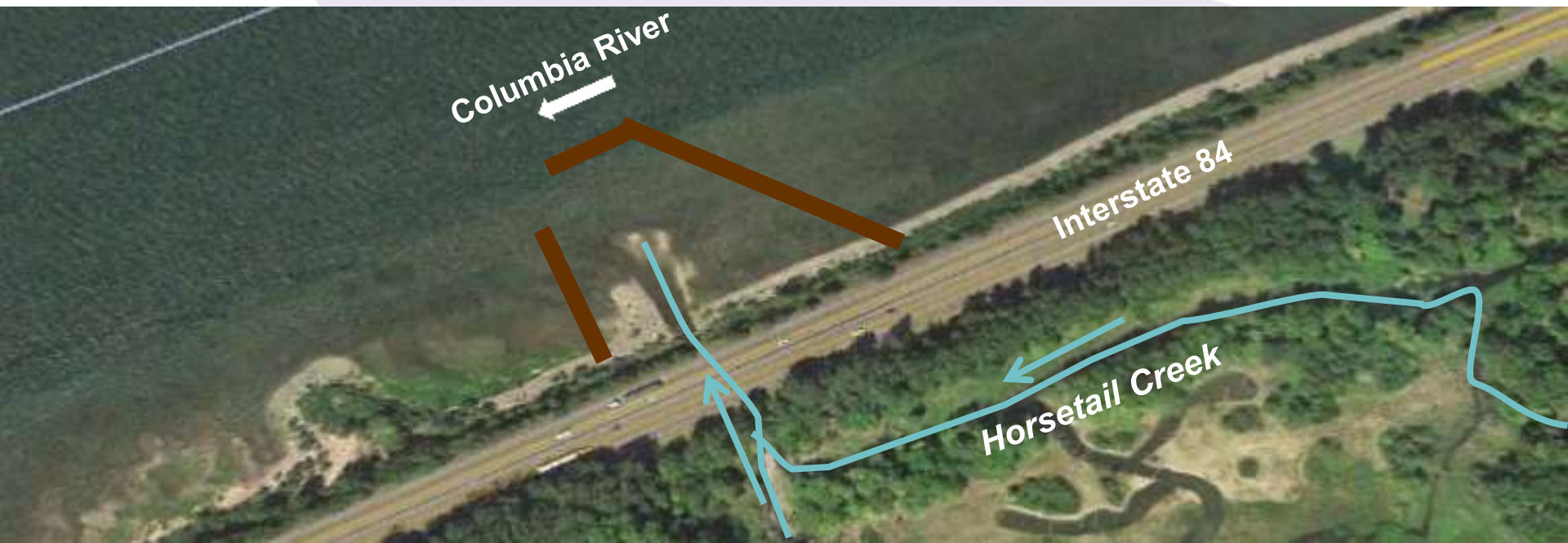


Cold water refuge – Feasibility Study (Phase I)

Purpose: Assess feasibility of expanding cold water plumes in the mainstem Columbia River by manipulating nearshore topography.

Approach:

- ❑ **Step 1: Select study sites**
- ❑ **Step 2: Plume mapping (existing conditions)**
- ❑ **Step 3: Develop basic structure concepts**
 - A. Upstream diversion
 - B. Upstream diversion with downstream extension
 - C. Paired upstream and downstream structures



Cold water refuge – Feasibility Study (Phase I)

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- ❑ **Step 1: Select study sites**
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- ❑ **Step 3: Develop basic structure concepts**
 - A. Upstream diversion
 - B. Upstream diversion with downstream extension
 - C. Paired upstream and downstream diversion structures
 - D. Re-route stream to downstream side of alluvial fan
 - E. Various combinations of above

Columbia River



Bridal Veil Cr.

Columbia River



Multnomah Cr.

Cold water refuge – *Feasibility Study (Phase I)*

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Approach:

- Step 1: Select study sites**
- Step 2: Plume mapping (existing conditions)**
- Step 3: Develop basic structure concepts**
- Step 4: 3-D modeling to assess potential of each concept design at each of three sites**
 - Quantify plume size using depth and temperature criteria
- Step 5: Alternatives assessment**
 - Are we having an effect? (compare sizes of existing and modeled plumes)
 - Does modeled plume meet CWR criteria for juveniles and adults?
 - Which is most cost-effective? (ratio of structure length to plume size)
- Step 6: Select and develop alternatives (two per site, including concept designs)**



Bridal Veil Creek

Cold water refuge – Feasibility Study (Phase I)

Step 6: Concept designs


- ❖ Primary goal: force local hydraulics to create CWR plumes
- ❖ Secondary goals: cover, food web, hydraulic refugia, atmospheric conditions, etc.
- ❖ Structure intensity: **LWD Jam**  **Landform**



Photo courtesy of Tony Meyer, LCFEG



Photo courtesy of Mike Burke, InterFluve

Cold water refuge – Feasibility Study (Phase I)

Step 6: Concept designs


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Photo courtesy of Mike Burke, InterFluve

Cold water refuge – *Feasibility Study (Phase I)*

Caveats: Initial assessment, which ignores Phase II questions, such as....

- **Geomorphic processes (tributary sediment load, Col. River sediment transport)**
- **Impacts to existing alluvial fan processes/habitats**
- **Design specifics (porosity, materials, etc.)**
- **Public safety**
- **Life span of structures**
- **Required maintenance**
- **Etc....**



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Lower Col. Estuary Partnership
(503) 226-1565, Ext.235
ccollins@estuarypartnership.org

