Lower Columbia Estuary Partnership

# Action Effectiveness Monitoring and Research (AEMR) – Results Review

Science Workgroup

Meeting March 23, 2021


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*Principal Wetlands Scientist*

*Sneha Rao (she/her), MSc*

*Research Scientist*

# Research Partners

## *THANK YOU*

NOAA National Oceanic and Atmospheric Administration U.S. Department of Commerce

Bonneville Power Administration

Washington Department of Fish and Wildlife

OHSU

Cowlitz Indian Tribe

Columbia Land Trust

Oregon Fish & Wildlife

crest
Columbia River Estuary Study Taskforce

University of Washington 1861

U.S. Fish & Wildlife Service

Pacific Northwest National Laboratory

Schott & Associates, Inc.

Institute for Applied Ecology


*April Silva, CREST*

# Overview

- Action Effectiveness Monitoring and Research Status
  - Programmatic AEMR
  - Sites 2019, 2020, 2021
- 2019 Results Highlight
  - Report Published 8/2020: *https://www.estuarypartnership.org/action-effectiveness-monitoring-lower-columbia-river-and-estuary-habitat-restoration-program-1*
- Group Discussion

# Columbia Estuary Ecosystem Restoration Program (CEERP) Objectives:

1. Increase the capacity (quality) of estuarine and tidal-fluvial ecosystems
2. Increase the opportunity for access by aquatic organisms to and for export of materials from shallow water habitats
3. Improve ecosystem realized functions for juvenile salmonids

# Action Effectiveness Monitoring Levels

# Monitored Metrics

## Level 1 – Intensive

*E.g. fish density, growth, genetics, diet*
*Duration: variable lengths of monitoring*

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## Level 2 – Extensive

*E.g. channel cross-sections, salmonid prey, plant species composition*
*Duration: Pre, Years 1, 3, 5*, 10, Fish check-in at year 5*

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## Level 3 – Basic (or Standard) Measurements

*E.g. water surface elevation, water temperature, sediment accretion, photo points*
*Duration: Pre through 5 yrs., 10 yrs*

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# Restoration Projects

# Level 2 & 3 Overarching question: How are restoration sites developing over time compared to reference wetlands (ideal) and goal (planned) conditions?

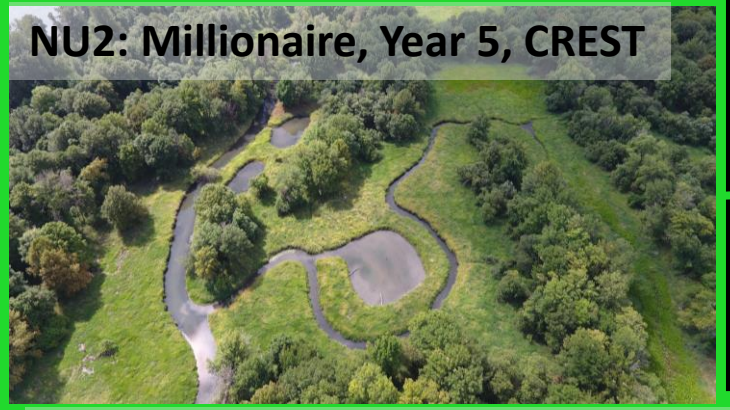
Wallooskee, Year 3, Cowlitz Tribe

## Common Goals

- **Plant community development**
  - *Native plant community recovery*
- **Tidal hydrology**
  - *No longer restricted by dikes or tide gates*
- **Sediment and channel dynamics**
  - *Tidal wetland sediment erosion/accretion and channel and floodplain development and maintenance (SLR, Carbon dynamics, etc.)*
- **Macroinvertebrate and Salmonid food web dynamics**
  - *Conditions which foster salmonid utilization and sustainable food web interactions (such as flux of detritus and macros into the mainstem)*

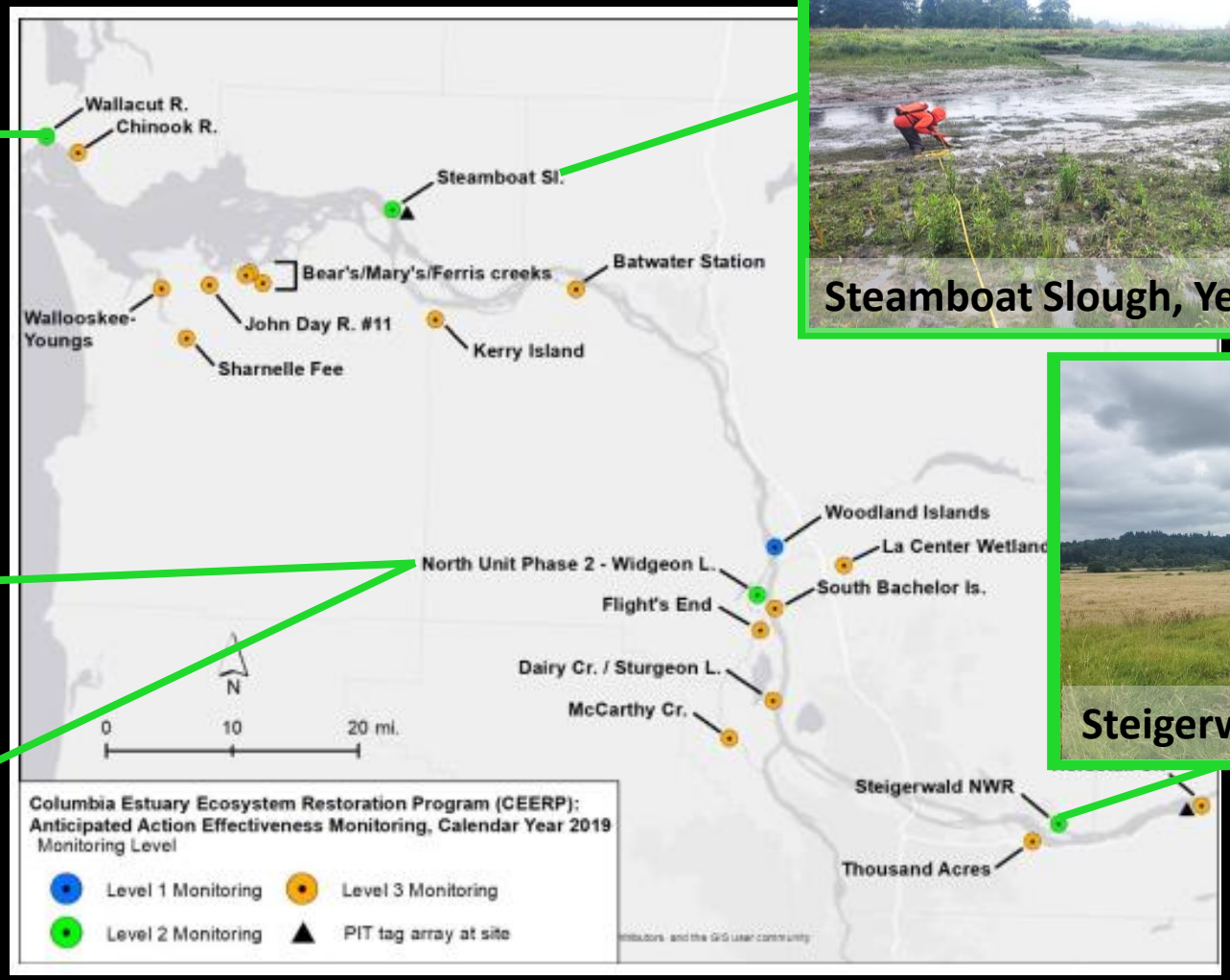
# Results 2019: Action Effectiveness Monitoring and Research

Wallacut, Year 3, CLT



NU2: Millionaire, Year 5, CREST

NU2: Deep Widgeon, Year 5, CREST




Steamboat Slough, Year 5, USACE

Steigerwald, Pre, LCEP

*Full Report Available:*
*https://www.estuarypartnership.org/action-effectiveness-monitoring-lower-columbia-river-and-estuary-habitat-restoration-program-1*

# Results 2019: Action Effectiveness Monitoring and Research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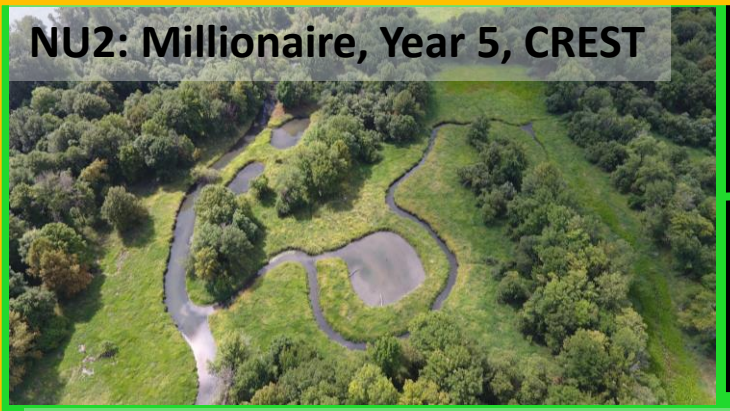
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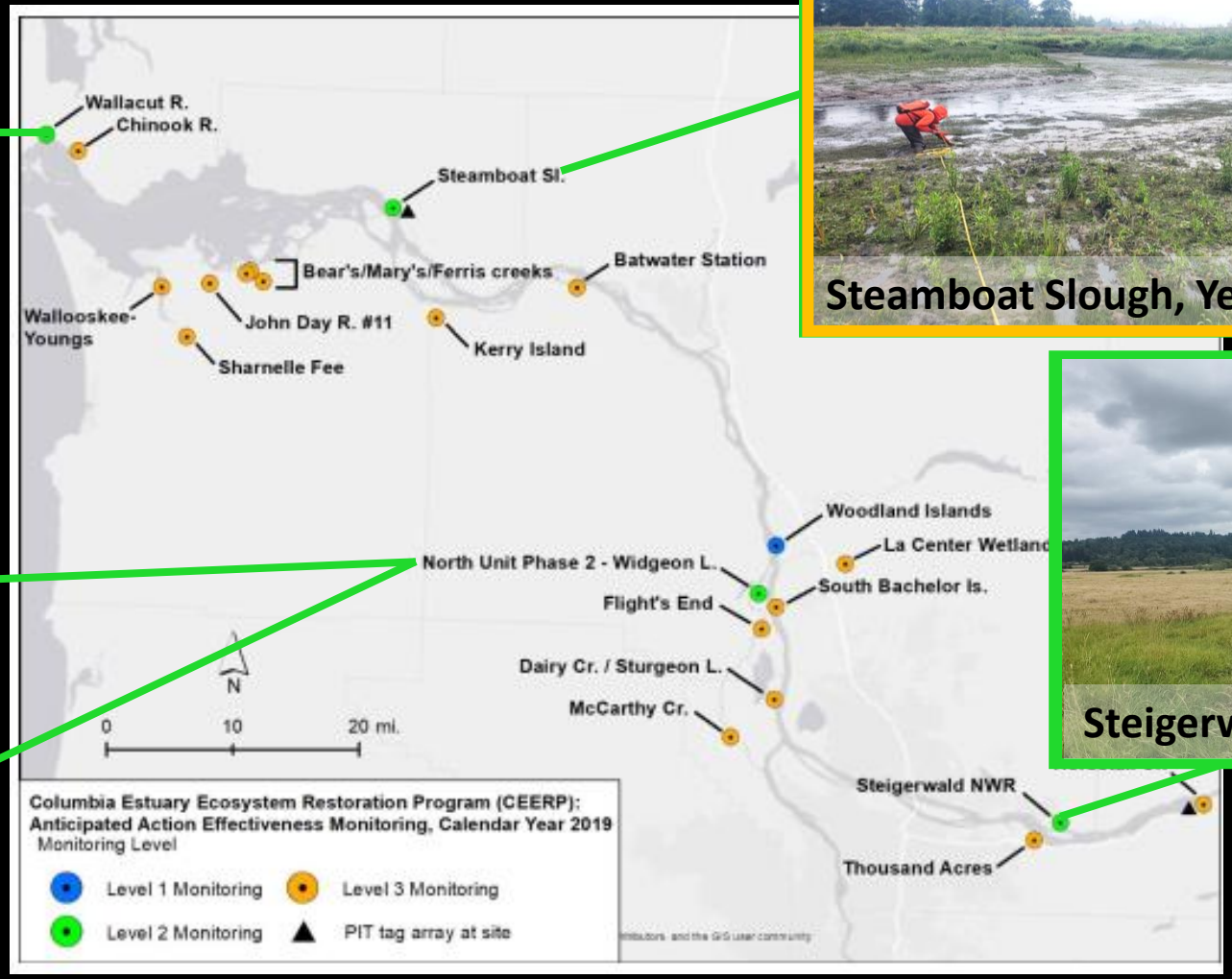




Steamboat Slough, Year 5, USACE

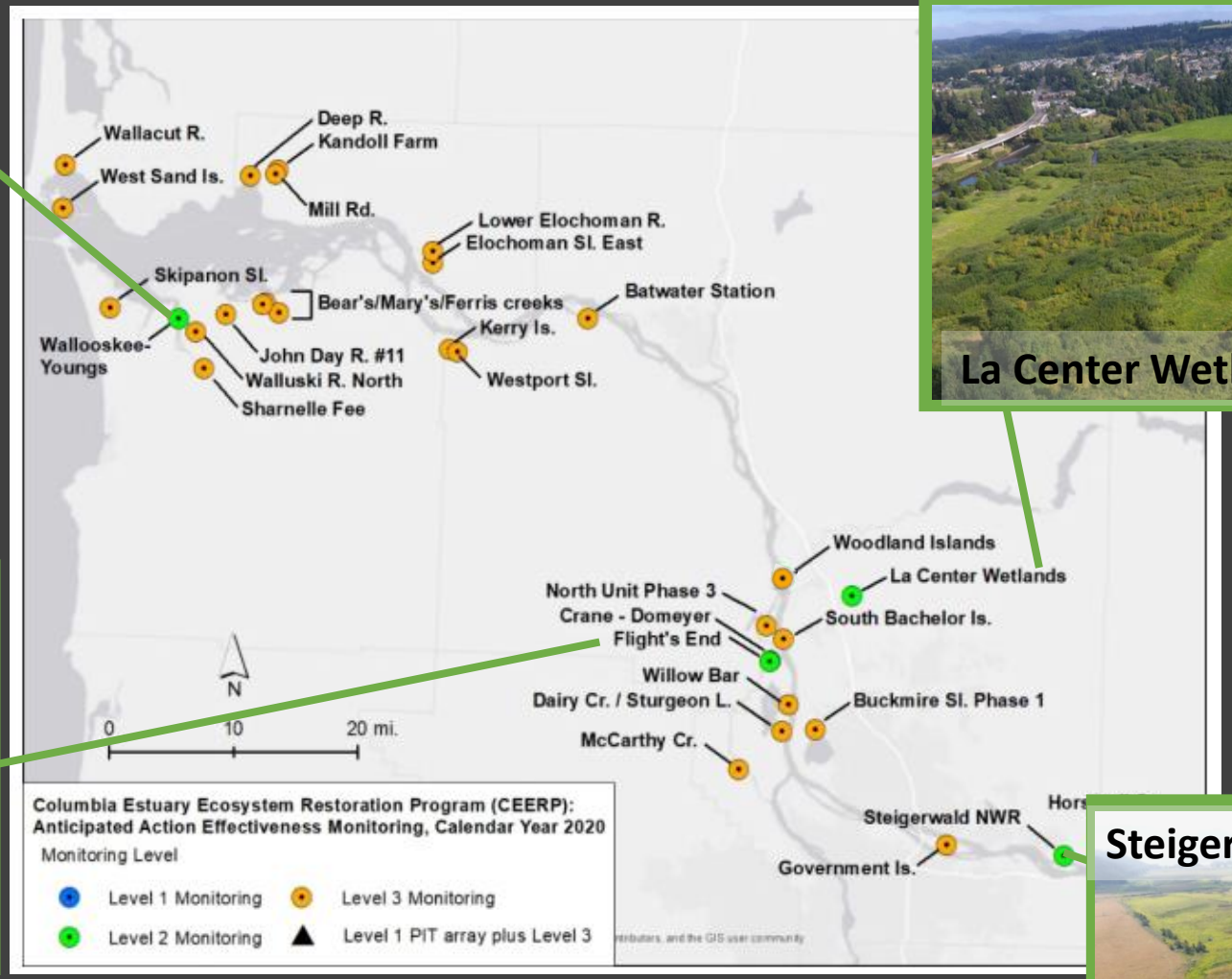

Steigerwald, Pre, LCEP

*Full Report Available:*
*https://www.estuarypartnership.org/action-effectiveness-monitoring-lower-columbia-river-and-estuary-habitat-restoration-program-1*

# Overview 2020: Action Effectiveness Monitoring and Research


- Looking great! Abundant native recovery


- Progress slow and hard to access due to heavy mowing





- Shrub-scrub plantings doing well
- Low marsh zones dense with Wapato
- Reed canarygrass abundant in high marsh

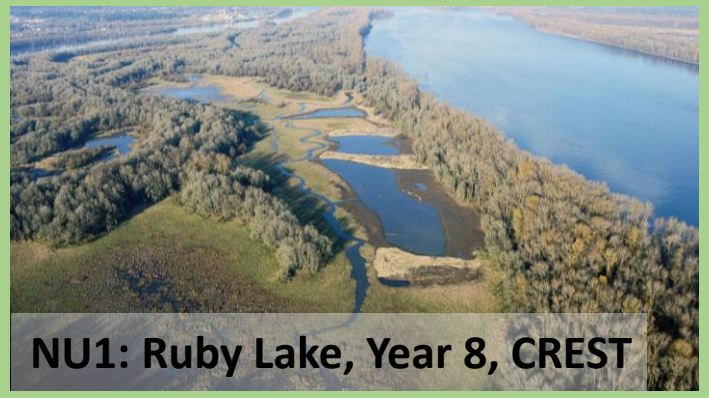
# Planning 2021: Action Effectiveness Monitoring and Research

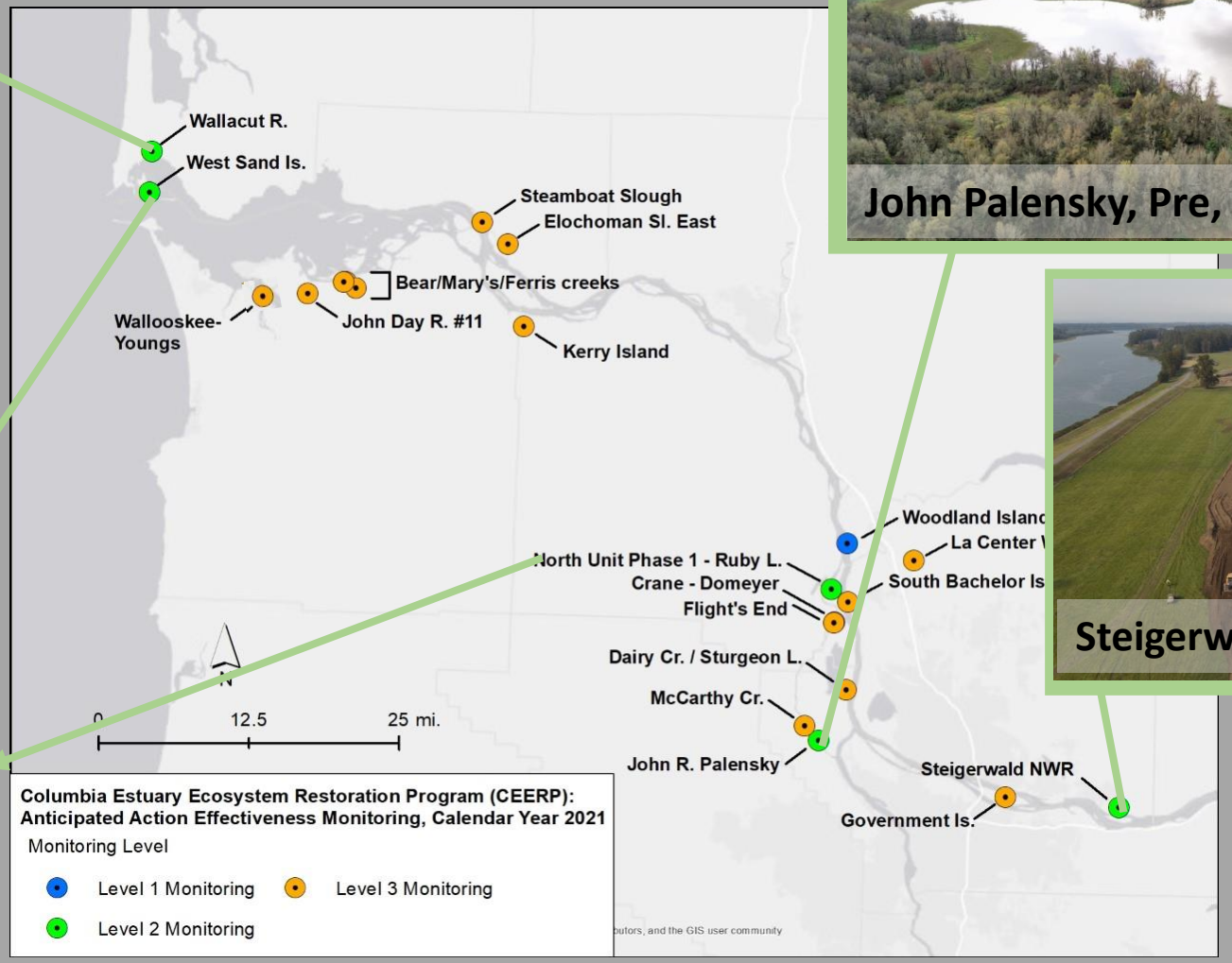

Wallacut, Year 5, CLT


John Palensky, Pre, CREST


West Sand Island, Year 1, CREST


Steigerwald, Construction, LCEP


NU1: Ruby Lake, Year 8, CREST



# Research Question: What is the progress of native plant community restoration?

*La Center Phase 1 – 2020, Year 5*

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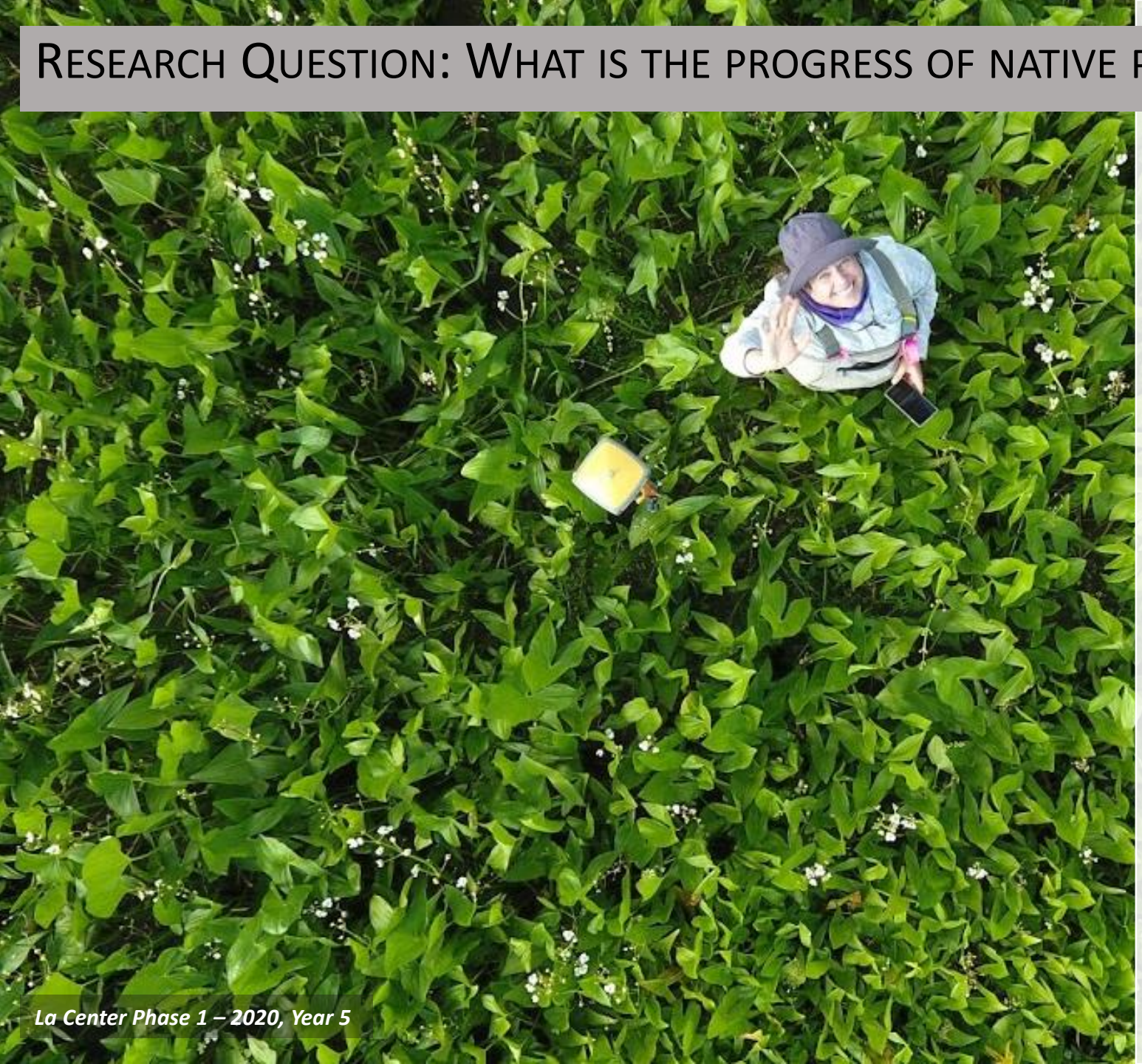


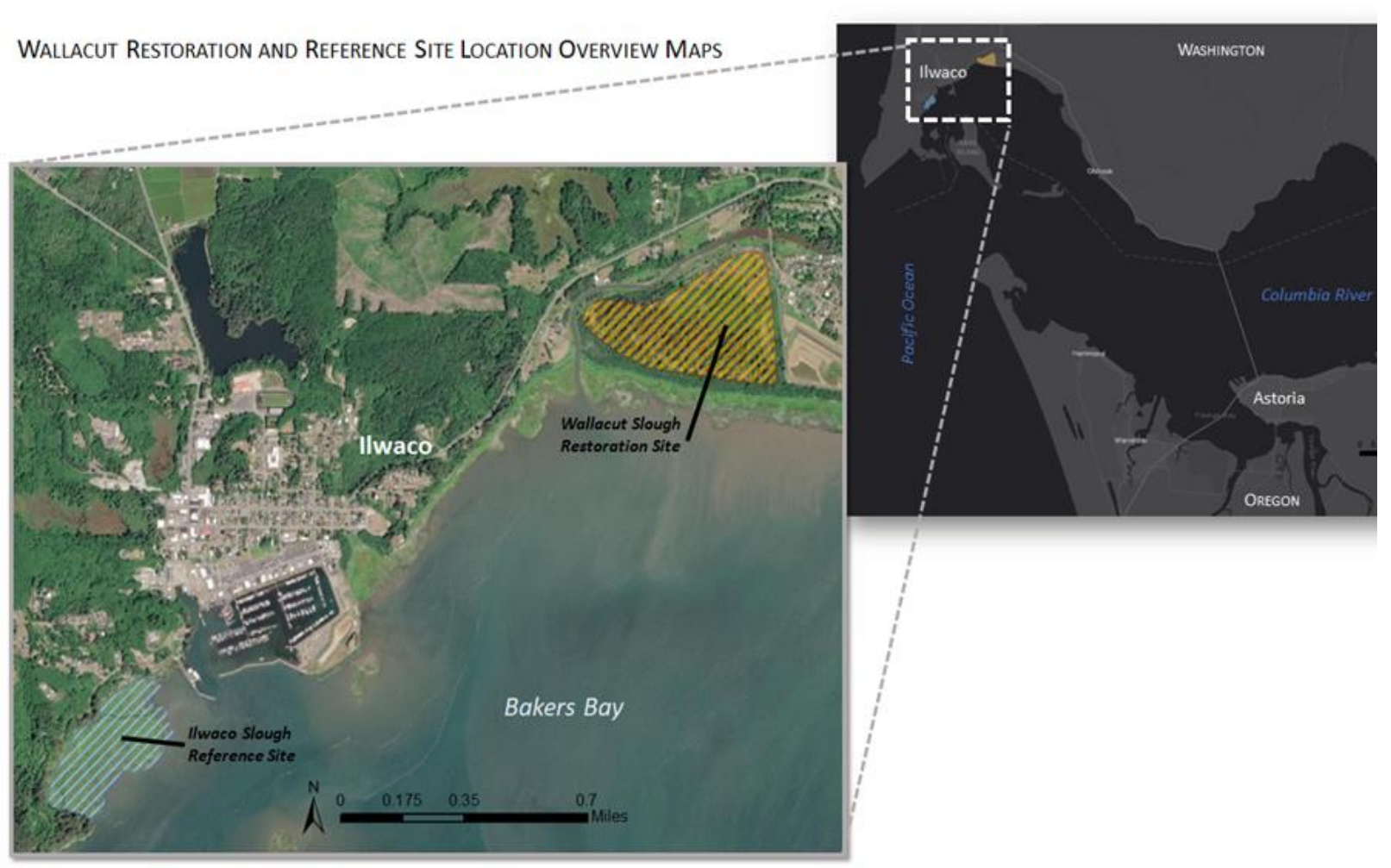
*La Center Phase 1 – 2020, Year 5*

**Major Drivers of Plant Community Distributions and Recovery:**

- **Flooding Frequency and Duration** *(site elevations and hydrology)*
- **Salinity** *(flood waters and soil)*
- **Soil Conditions** *(flooding, scrape down, existing conditions)*
- **Existing Plant Community** *(resistance to change, Reed canarygrass, Common Rush, etc.)*
- **Available Seed Bank**
- **Ongoing Management** *(such as grazing, mowing, plantings, and spraying herbicides)*

# Wallacut Slough, 3 years (2019) Post-Restoration

Columbia Land Trust



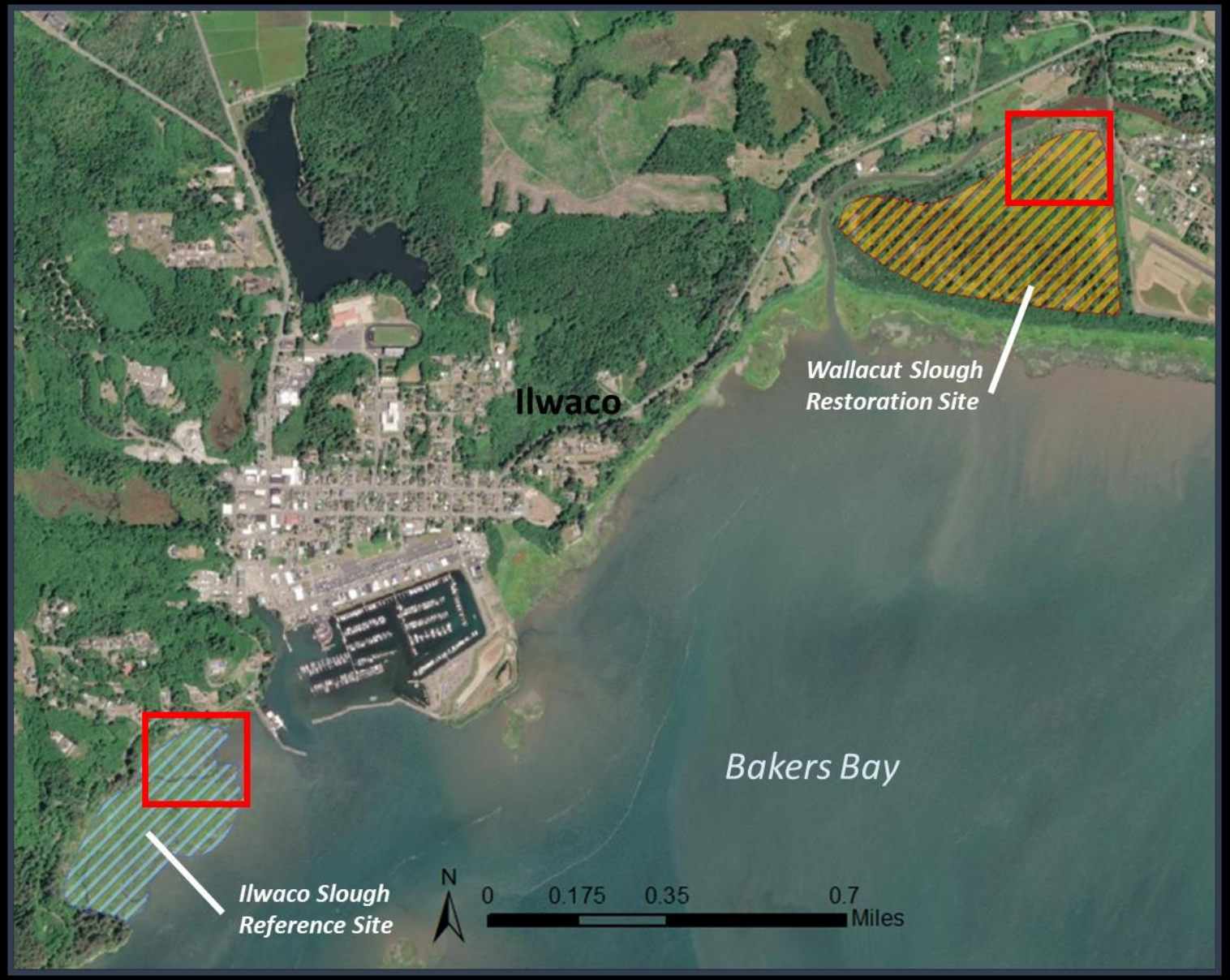

## Project Summary

Wallacut Slough is in Bakers Bay. The reference Site is Ilwaco Slough, which is also an Ecosystem Monitoring Program (EMP) site.

In 2016, Wallacut Slough network was restored through the removal of barriers and channel enhancements. Data collection started in 2014.

*Current management includes active treatment of invasive species (gorse, thistle, and yellow flag iris)*

## Wallacut Restoration and Reference Sites, Intensive Monitoring Areas Highlighted

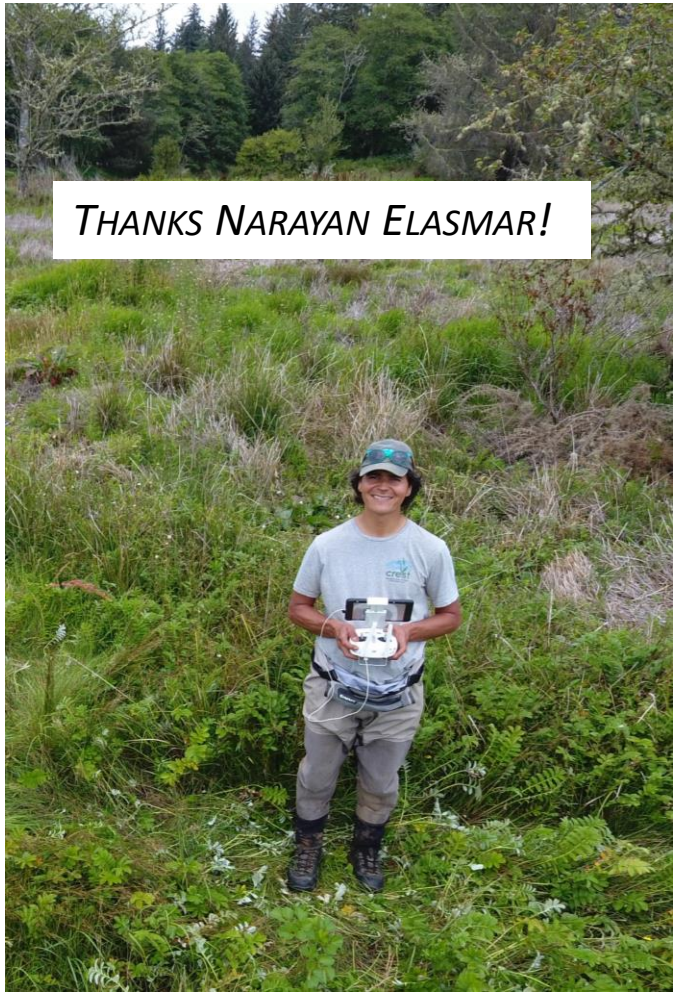


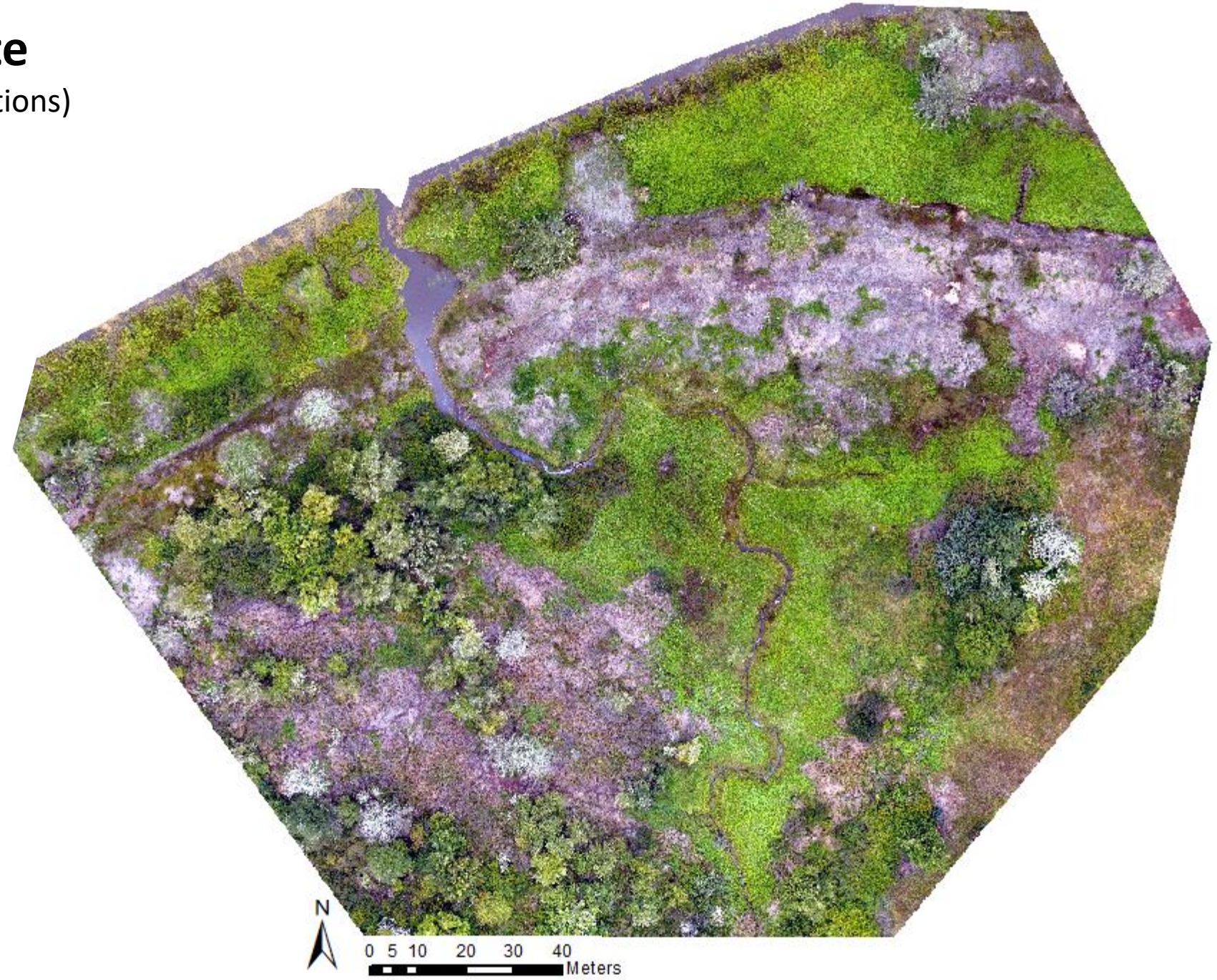

Data Collected, 2014-2019, 2021:

- ✓Plant Community
- ✓RTK Elevations
- ✓Water Depth & Temperature
- ✓Sediment Accretion and Erosion & Channel Cross-Sections
- ✓Soil pH, Salinity, ORP (2019, 2021)
- ✓RGB and NIR Orthomosaics, Digital Surface Model (2019, 2021)
- ✓5 Year Fish and Macro check-in (2021)

# Wallacut Restoration Site

3 yrs. Post Restoration (Current Conditions)
Drone Imagery (2019)



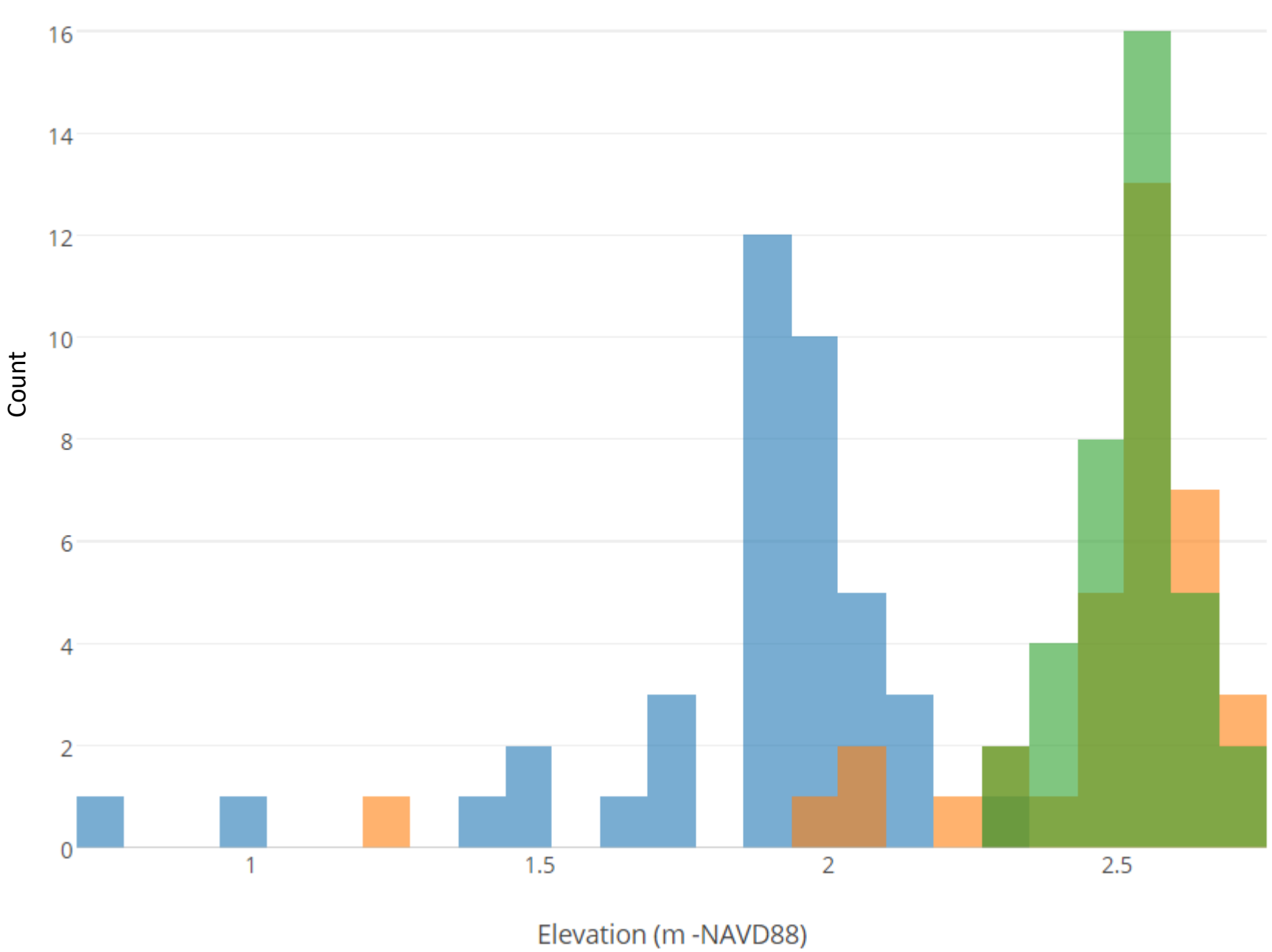
# WALLACUT RESTORATION SITE

3 yrs. Post Restoration (Current Conditions)
Drone Imagery (2019)

**INTENSIVE VEG MONITORING AREAS**

- Wallacut Mouth
- Wallacut Upper
- WSE Loggers

## Elevation Histogram (Based on Veg Transects)




## Habitat - Key Points

- Elevation range of **Wallacut Mouth and Upper are similar** and primarily Mid- to High Marsh.
- Elevation of the **Reference site (Ilwaco Slough) is much lower**, Mid- to Low Marsh in elevation.
- Restored slough hydrograph mirrors reference site
- ***Important to keep these differences in mind while reviewing results***

# Wallacut Restoration Site

3 yrs. Post Restoration (Current Conditions)
Drone Imagery (2019)

**Intensive Veg Monitoring Areas**

- Wallacut Mouth
- Wallacut Upper

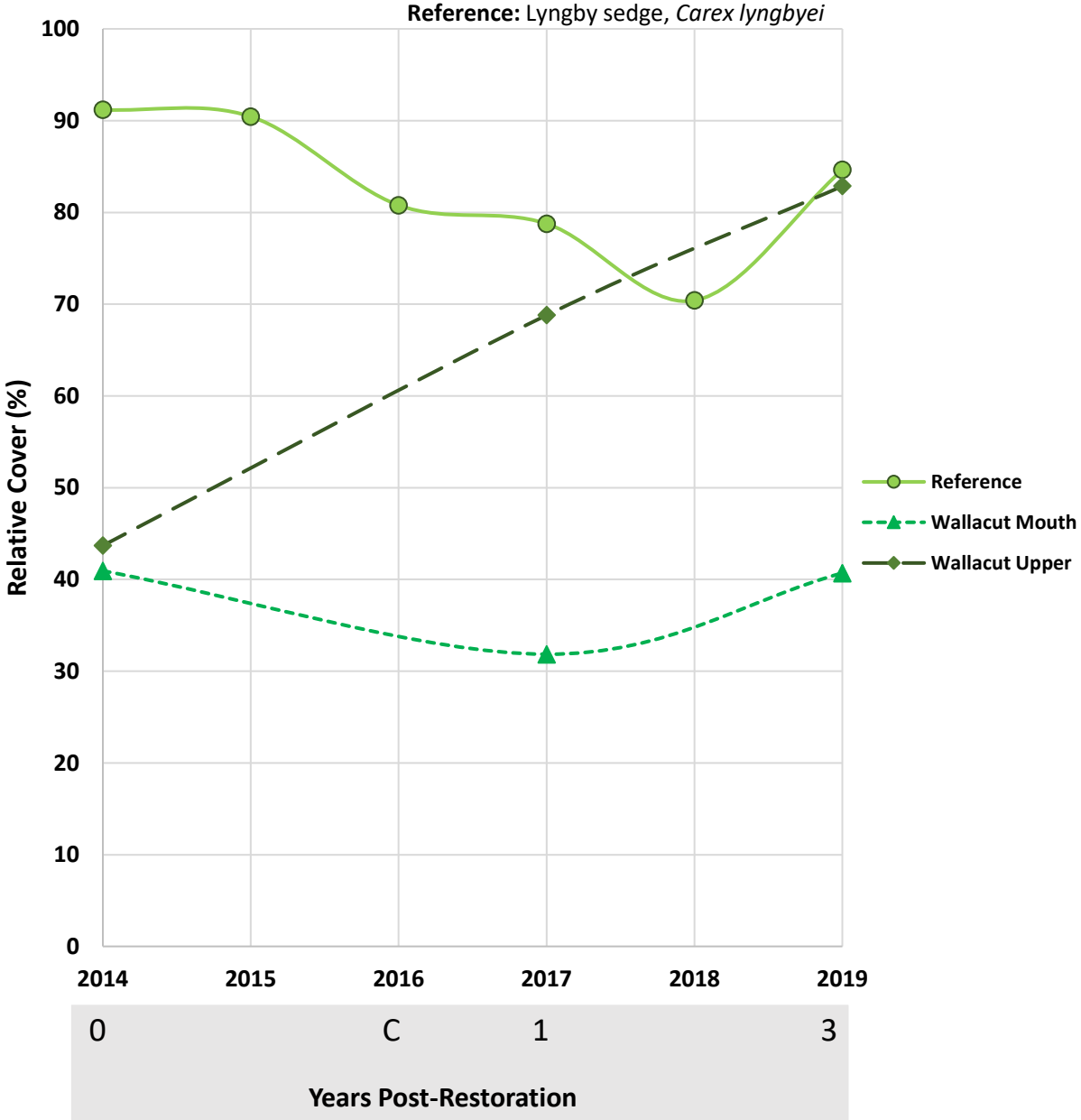
**2019 Veg Monitoring Results**

*Dominant Plant Community Characterizations*

- Mixed non-natives, standing dead, and bareground
- Mixed native plant community

## Native Relative Cover (%)

***Dominate Natives***
**Wallacut:** Pacific silverweed, *Argentina egedii ssp. Egedii, &* Baltic Rush, *Juncus arcticus*
**Reference:** Lyngby sedge, *Carex lyngbyei*



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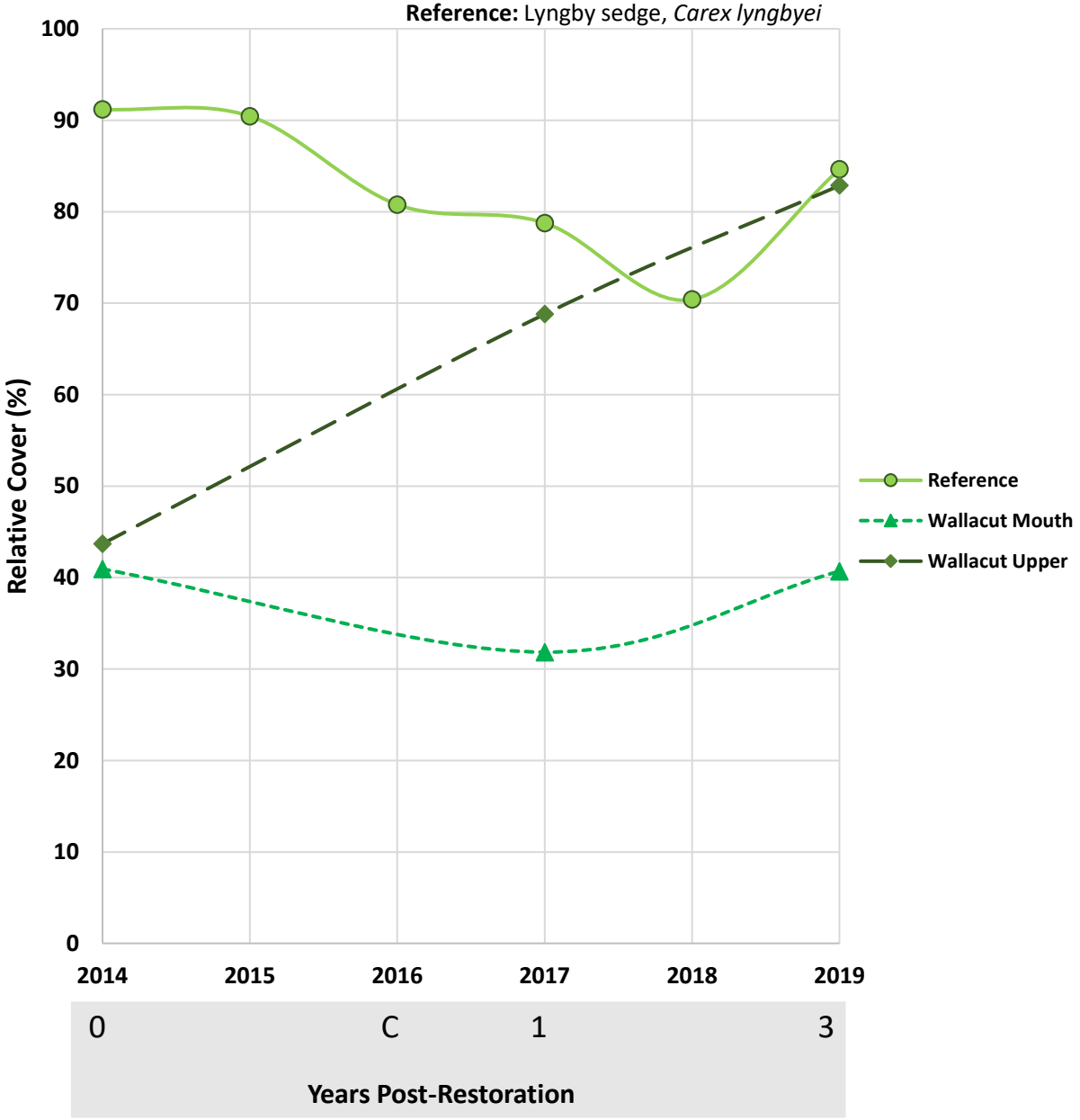
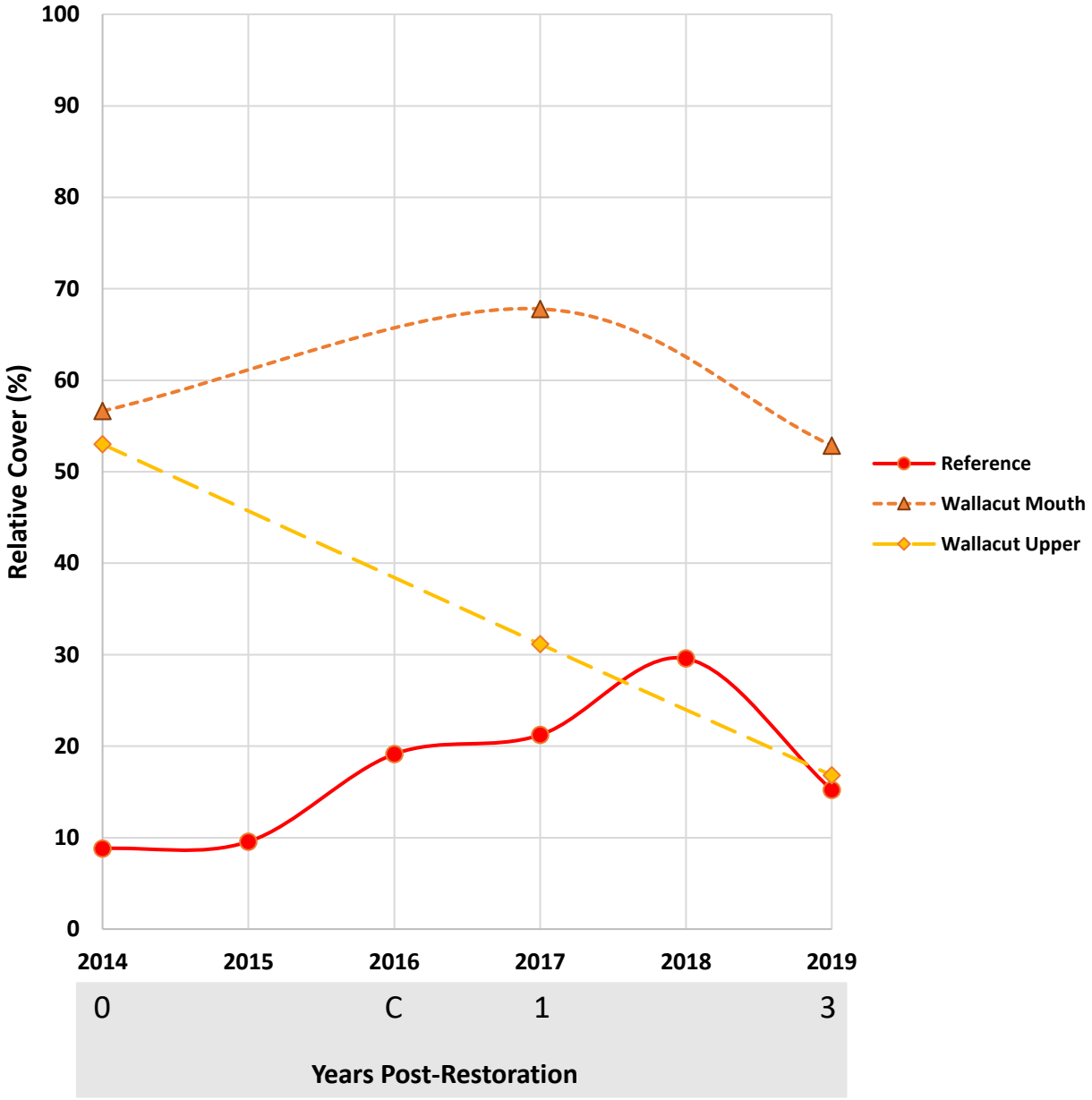


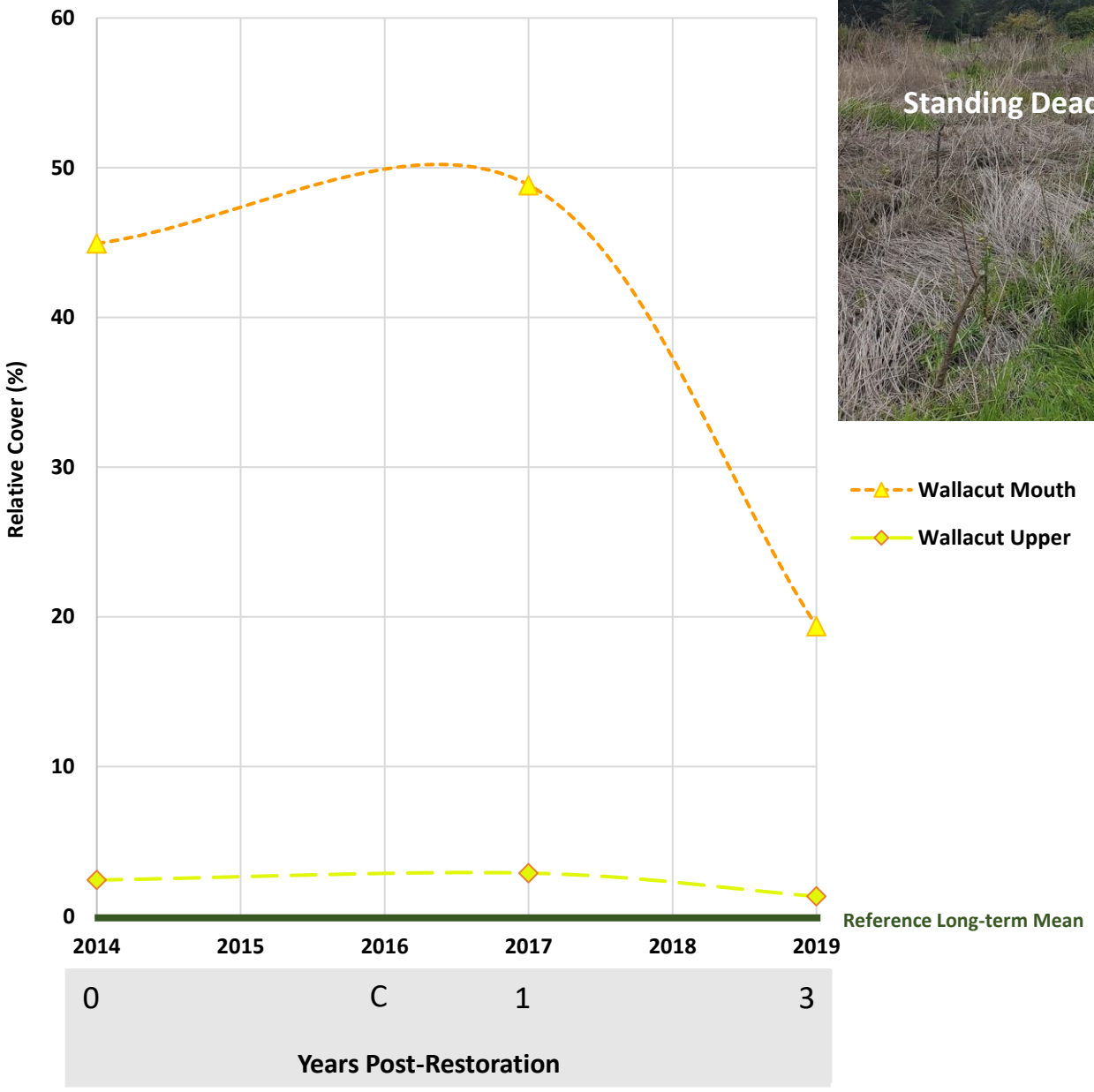

## Non-native Relative Cover (%)

***Dominate Non-natives***
**Wallacut:** Reed canarygrass, *Phalaris arundinacea,* & Creeping bentgrass, *Agrostis stolonifera*
**Reference:** Creeping bentgrass, *Agrostis stolonifera*



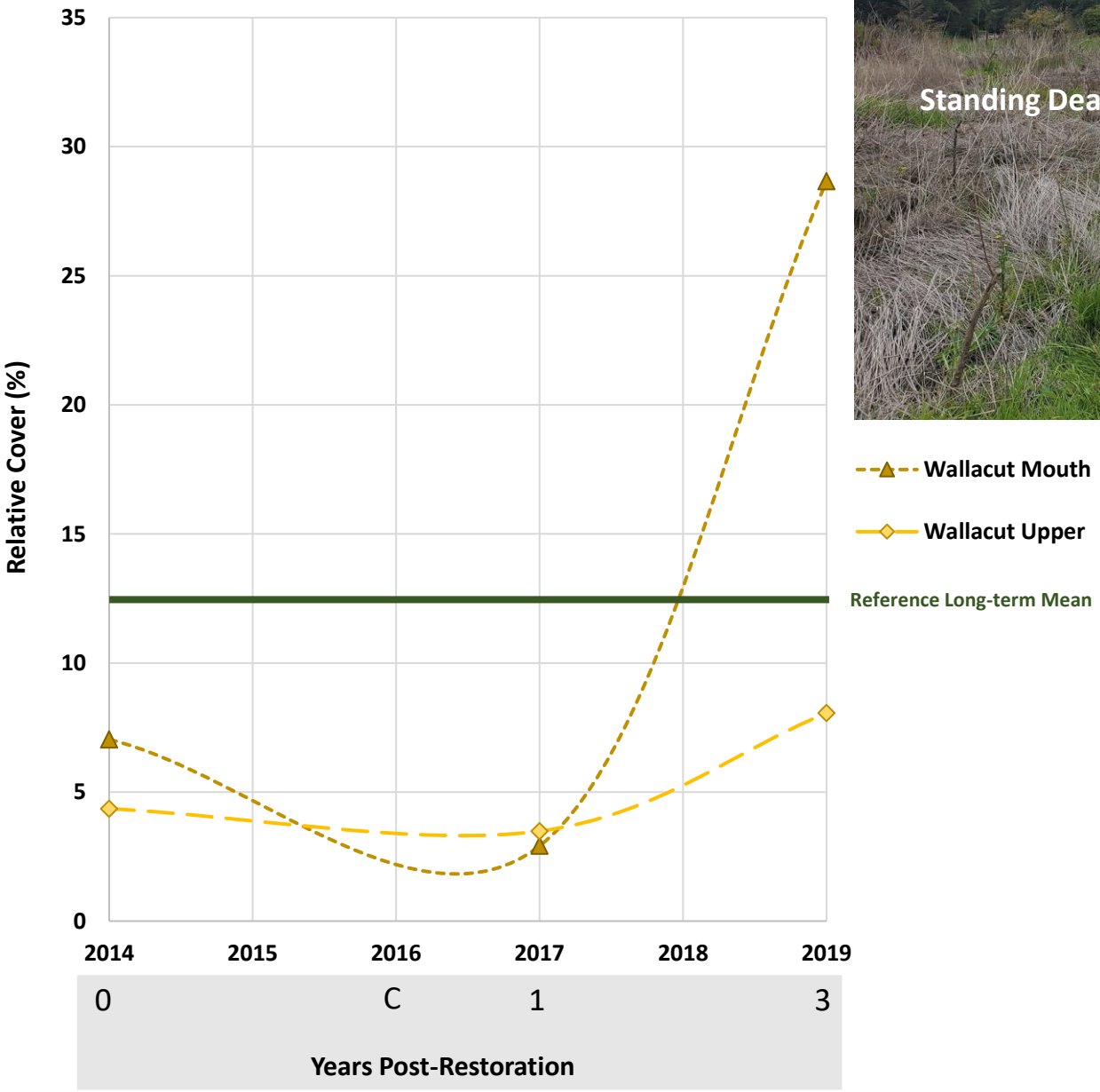
# Intensive Veg Monitoring Area Results

**Reed canarygrass, *Phalaris arundinacea, Non-native***





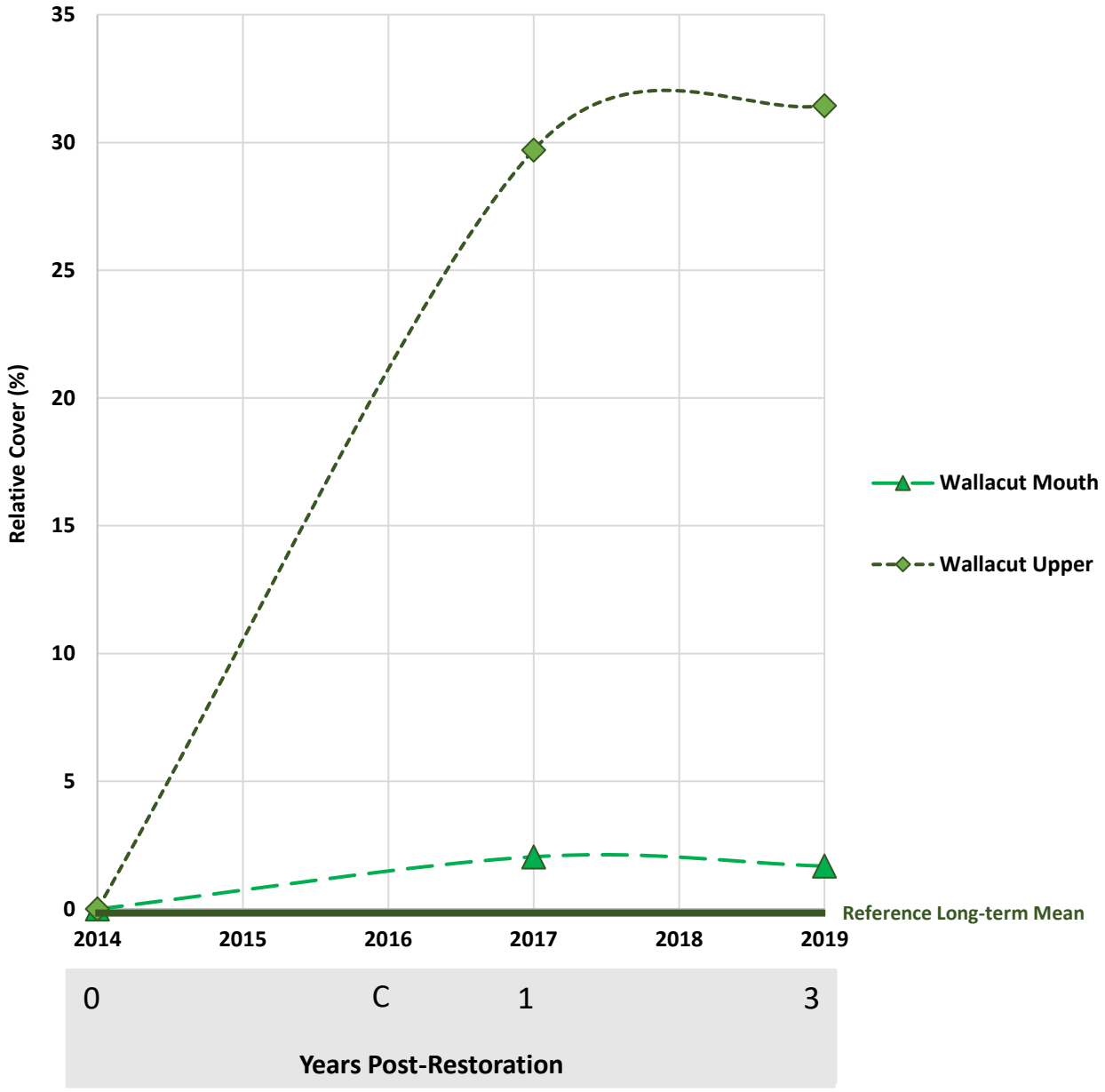
## Bareground and Standing Dead (%)





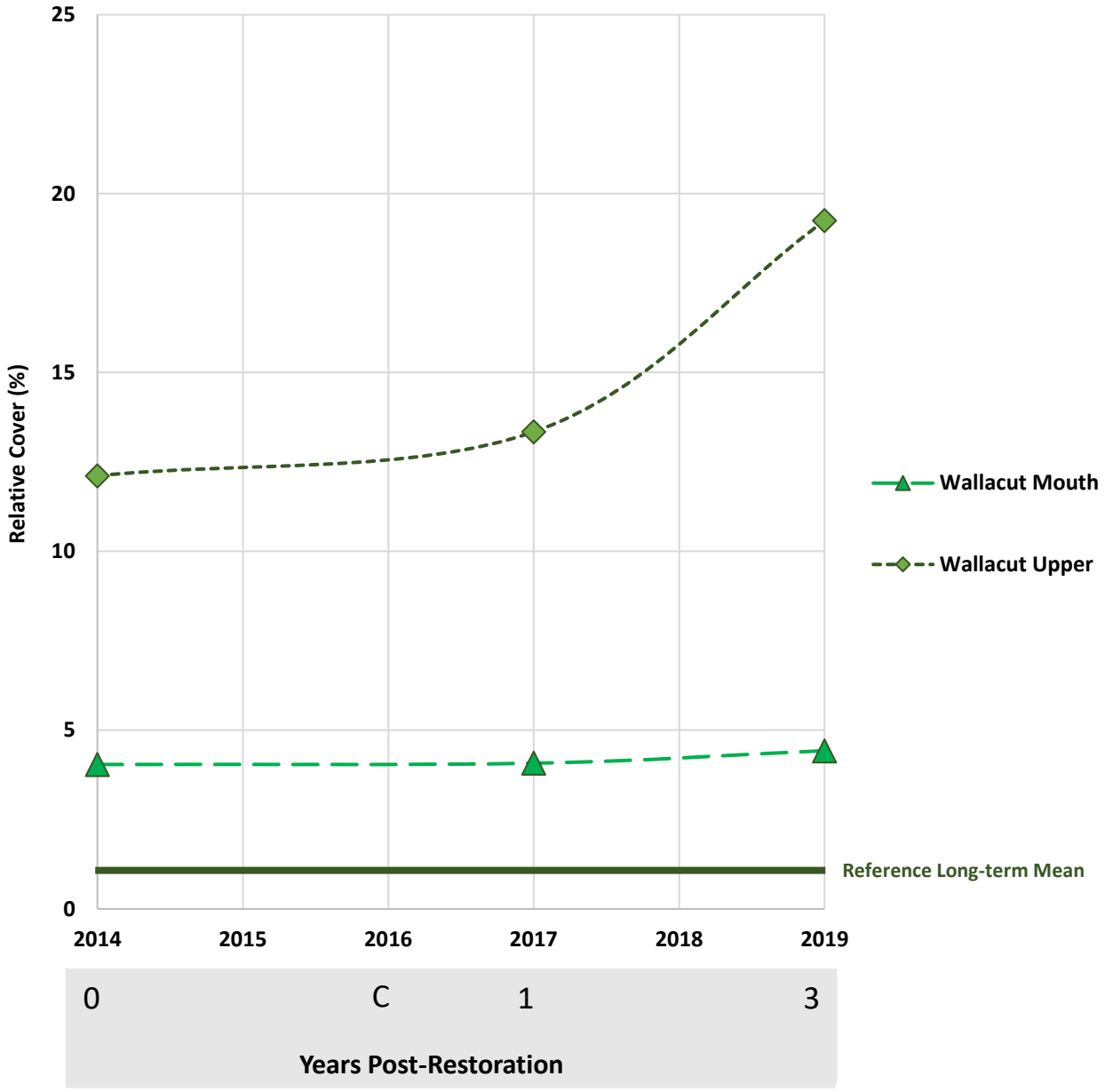
# Intensive Veg Monitoring Area Results

## Baltic Rush, *Juncus arcticus*, *Native*



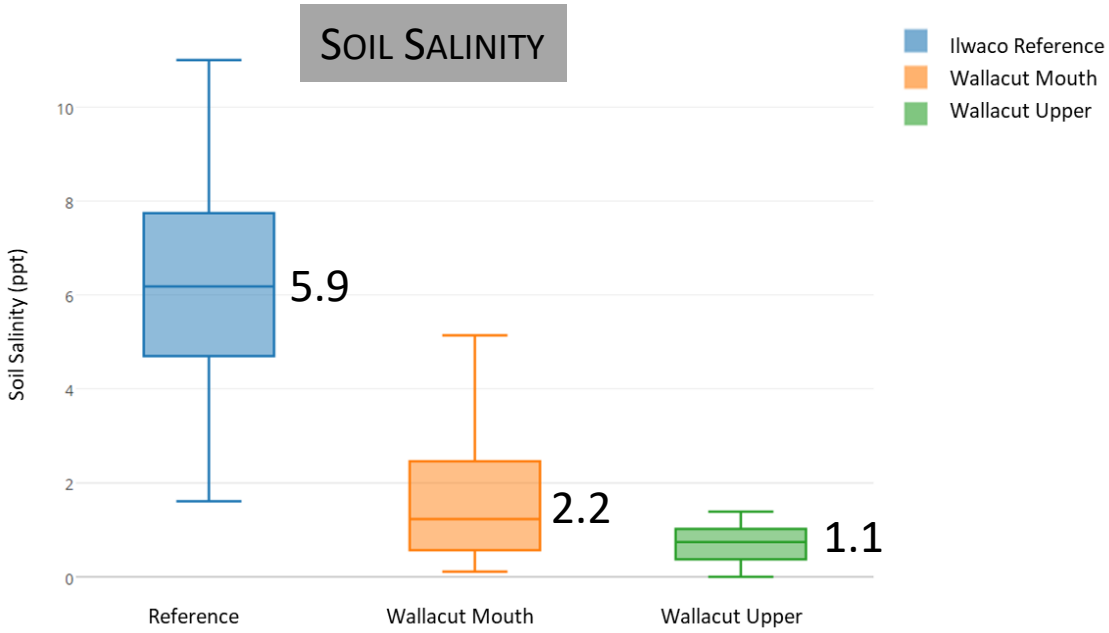

# Intensive Veg Monitoring Area Results

## Pacific silverweed, *Argentina egedii, Native*

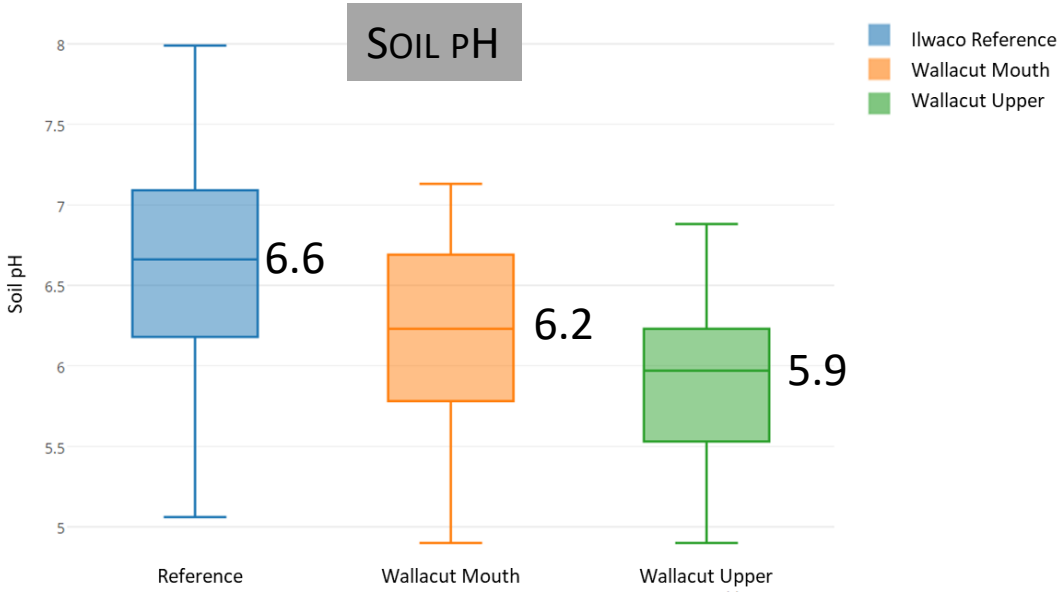



# Soil Conditions: Wallacut Slough, 3 years (2019) Post-Restoration

## Soil Salinity




## Soil pH



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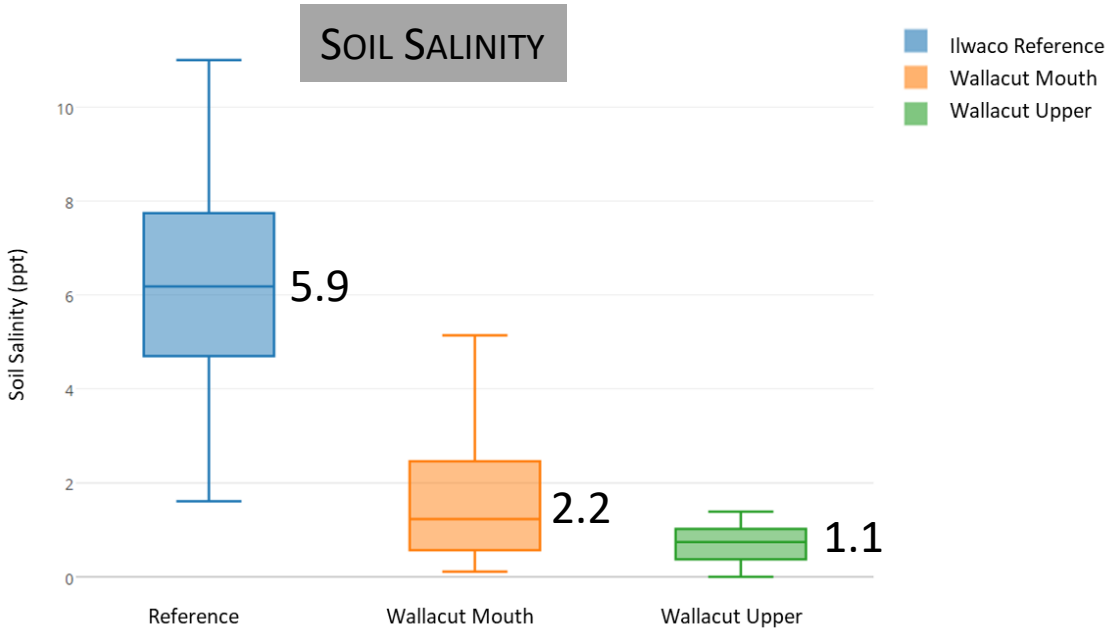
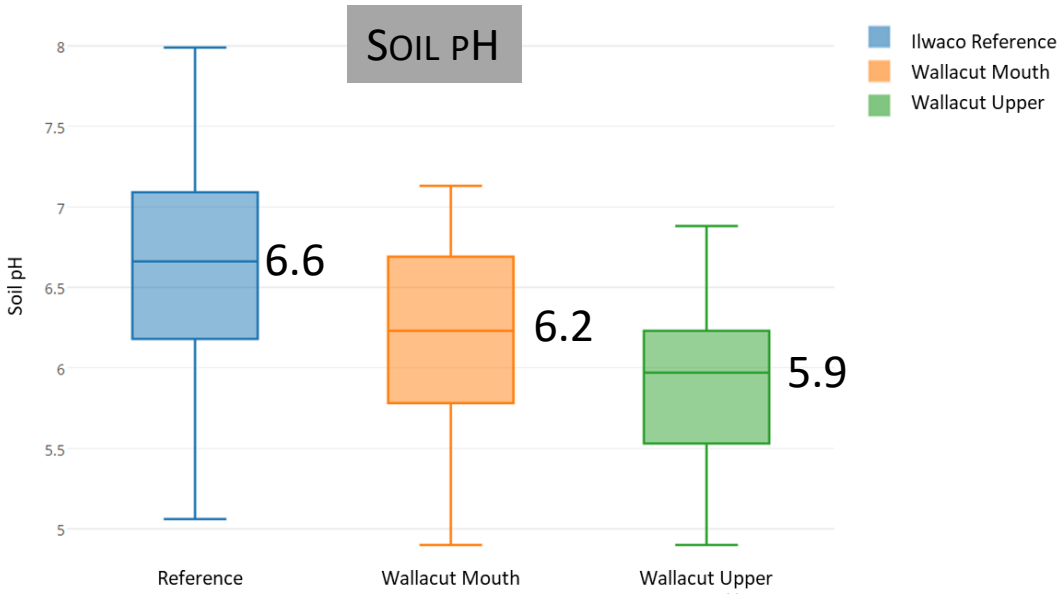


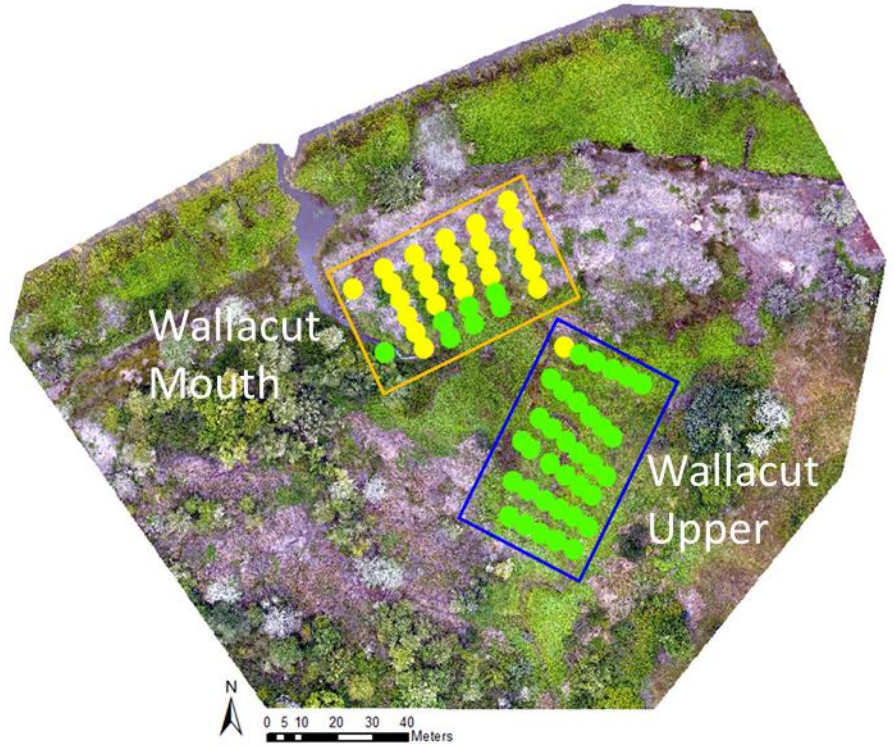




- Post-restoration soil conditions such as Salinity and pH can be slow to respond to the reintroduction of flooding
- Slightly more soil response observed at the Mouth than in the Upper monitoring area

**2019 Veg Monitoring Results**

*Dominant Plant Community Characterizations*

- Mixed non-natives, standing dead, and bareground
- Mixed native plant community



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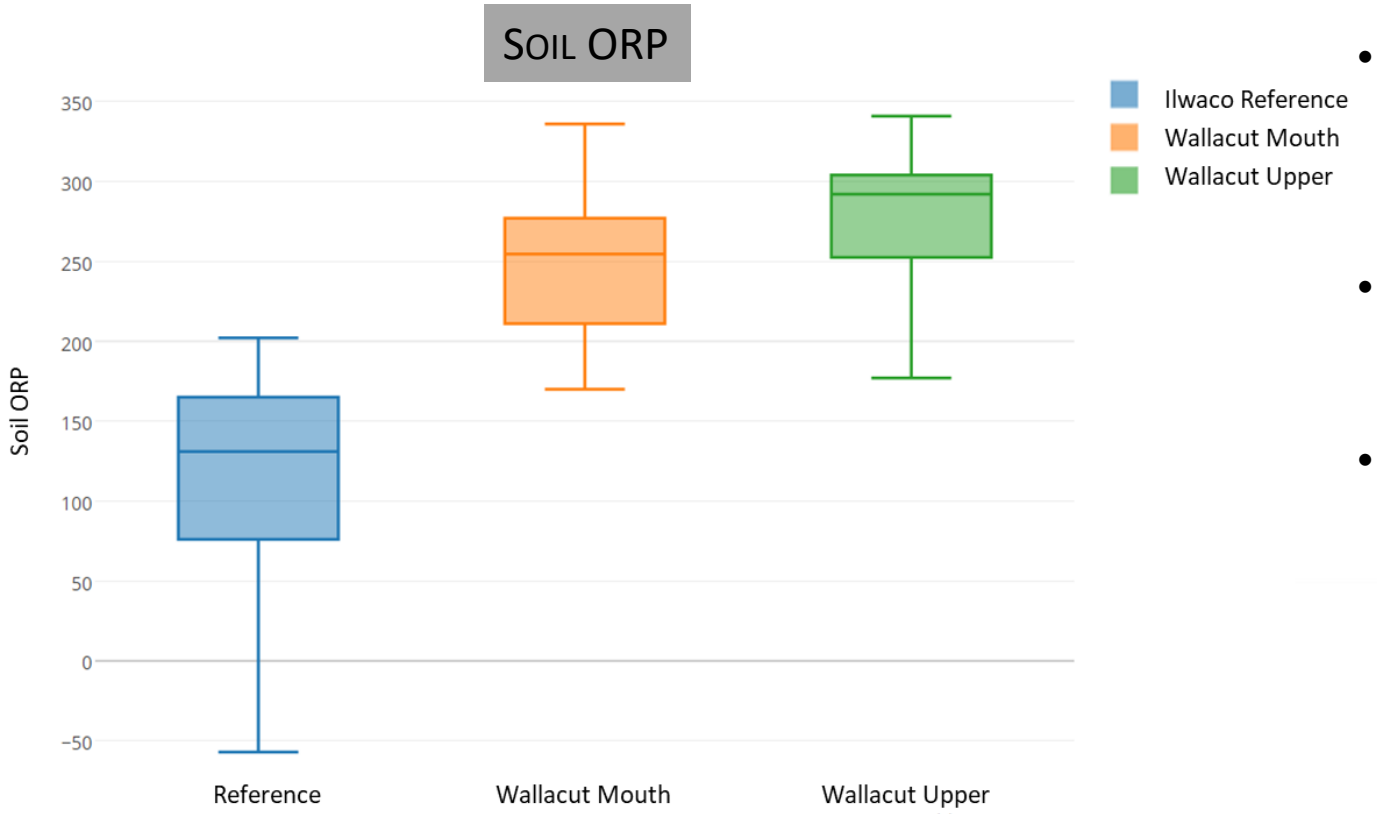
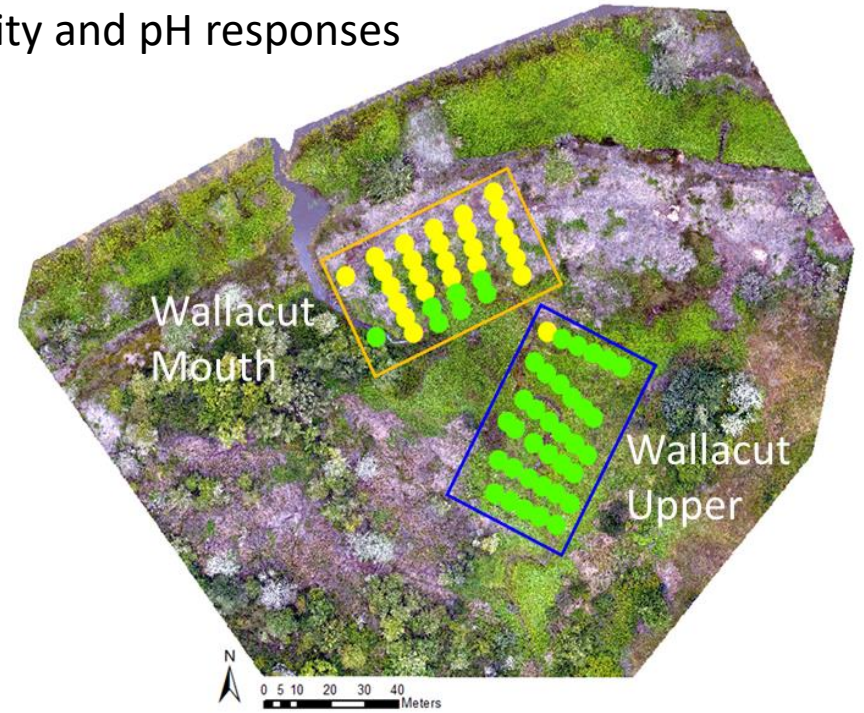



- Soil Oxygen Reduction Potential (ORP): Essential a measure of how waterlogged/saturated the soil is and how long that has been (lower ORP = saturated longer).
- Elevated Soil ORP conditions reflect how Wallacut is primarily Mid-Upper Marsh while the Reference (Ilwaco) is Low Marsh
- Upper monitoring area may receive less frequent flooding (higher ORP) which would also explain slower soil Salinity and pH responses

**2019 Veg Monitoring Results**
*Dominant Plant Community Characterizations*

- Mixed non-natives, standing dead, and bareground
- Mixed native plant community



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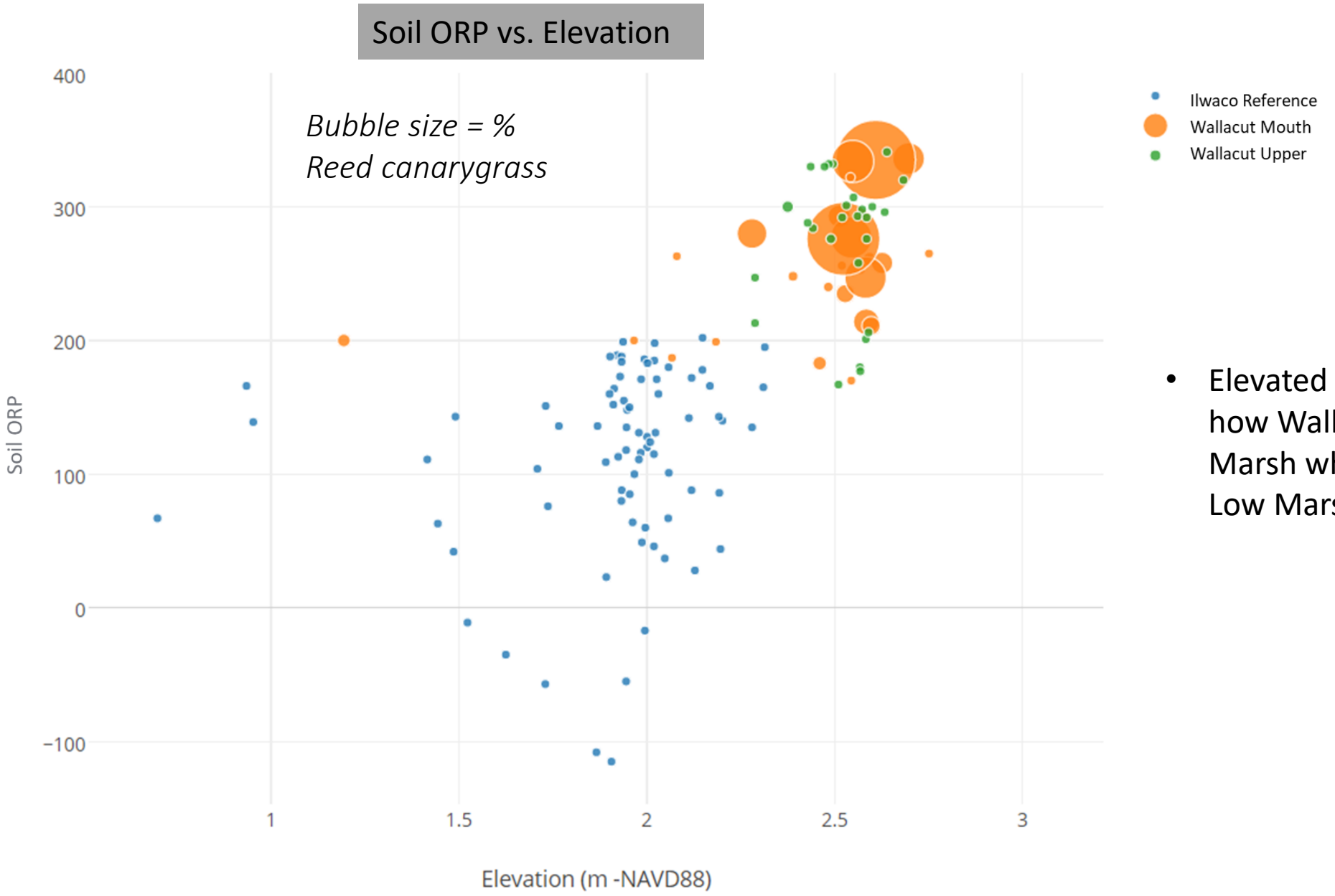
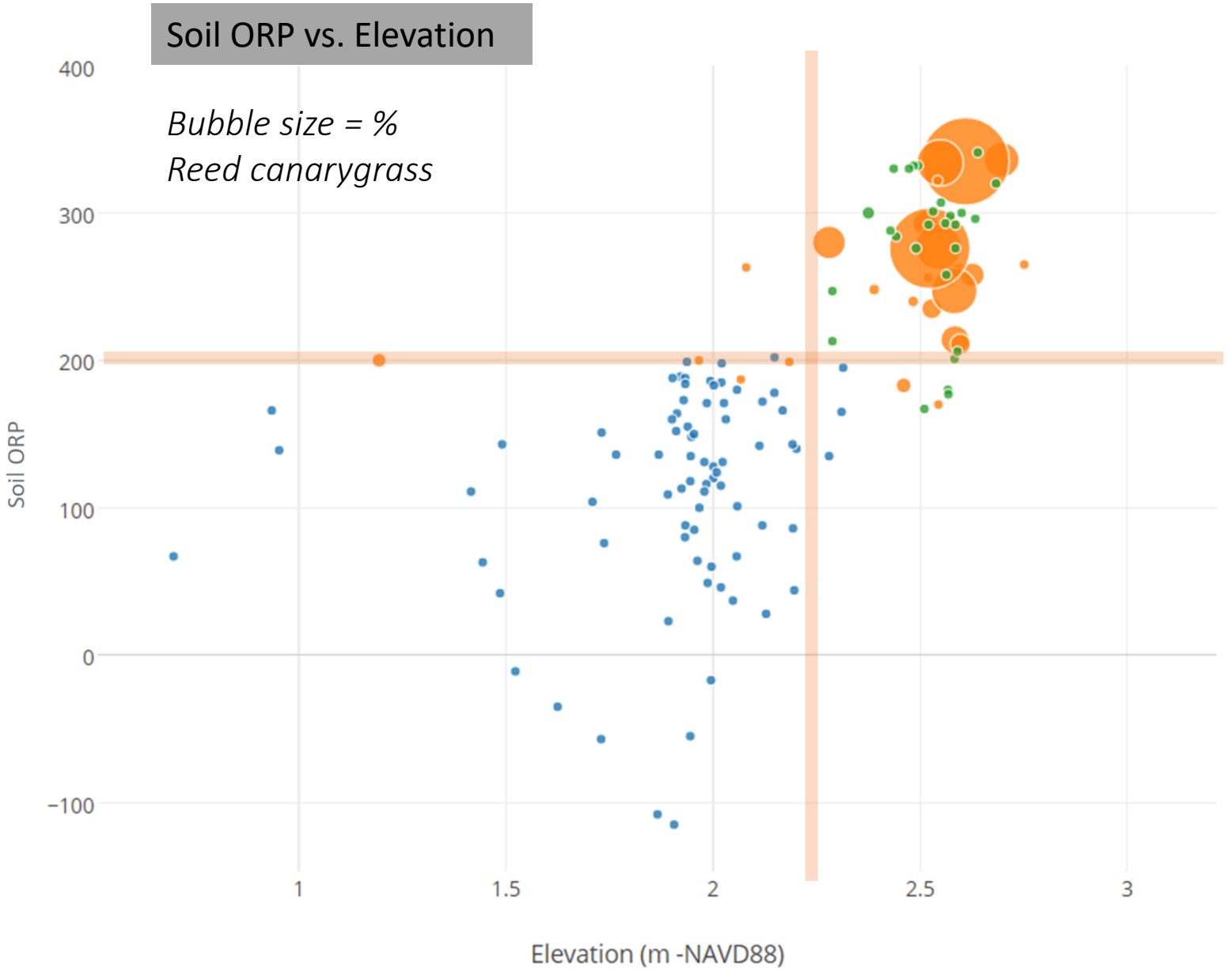



- Elevated Soil ORP conditions reflect how Wallacut is primarily Mid-Upper Marsh while the Reference (Ilwaco) is Low Marsh

# Soil Conditions: Wallacut Slough, 3 years (2019) Post-Restoration




- Elevated Soil ORP conditions reflect how Wallacut is primarily Mid-Upper Marsh while the Reference (Ilwaco) is Low Marsh
- **We see similar Reed canarygrass thresholds in ORP and Elevation (proxy for flooding) across our other EMP and AEMR sites**
- Year 5 data will be illuminating, and further multivariate analysis will be conducted

# Wallacut Restoration Site

3 yrs. Post Restoration (Current Conditions)
Classification of Drone Imagery (2019)

# Wallacut Restoration Site

3 yrs. Post Restoration (Current Conditions)
Classification of Drone Imagery (2019)

| Classification | Acers | % |
|---|---|---|
| Water | 0.4 | 5 |
| Native wetland matrix | 2.5 | 29 |
| Dead veg & bareground | 1.6 | 19 |
| Reed canarygrass mix | 1.2 | 15 |
| Trees and shrub-scrub | 2.7 | 32 |

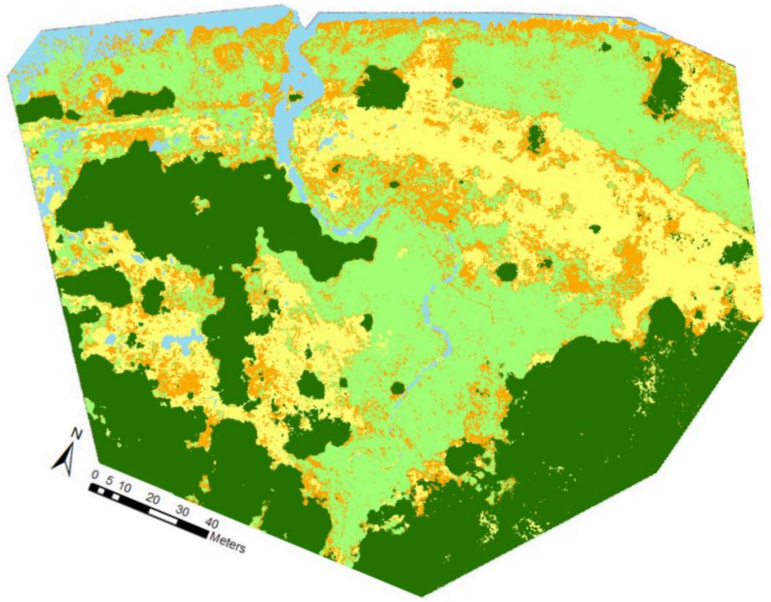

- **0.25 $m^2$ resolution**
- **Highly accurate (>90%) when cross checked with ground control points for elevation and plant community composition**

# Wallacut Restoration Site

Future Plant Community Development Projections (5-10 yrs.)
Classification of Drone Imagery (2019)

| | 3 yrs. Post 2019 | |
|---|---|---|
| **Classification** | **Acers** | **%** |
| Water | 0.4 | 5 |
| Native wetland matrix | 2.5 | 29 |
| Mixed | 2.8 | 34 |
| Reed canarygrass | | |
| Trees and shrub-scrub | 2.7 | 32 |

**Existing Conditions 2019**

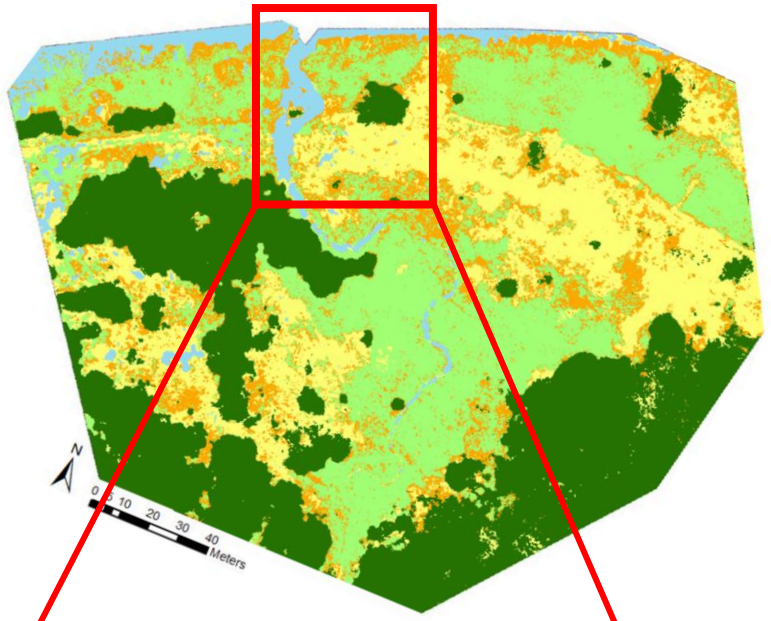


# Wallacut Restoration Site

Future Plant Community Development Projections (5-10 yrs.)
Classification of Drone Imagery (2019)

| | 3 yrs. Post 2019 | |
|---|---|---|
| **Classification** | **Acers** | **%** |
| Water | 0.4 | 5 |
| Native wetland matrix | 2.5 | 29 |
| Mixed | 2.8 | 34 |
| Reed canarygrass | | |
| Trees and shrub-scrub | 2.7 | 32 |

**Existing Conditions 2019**

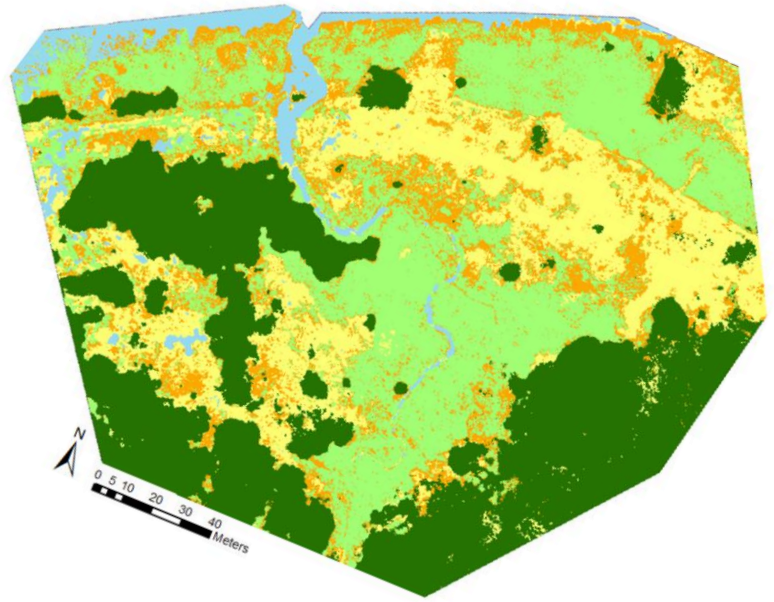



# Wallacut Restoration Site

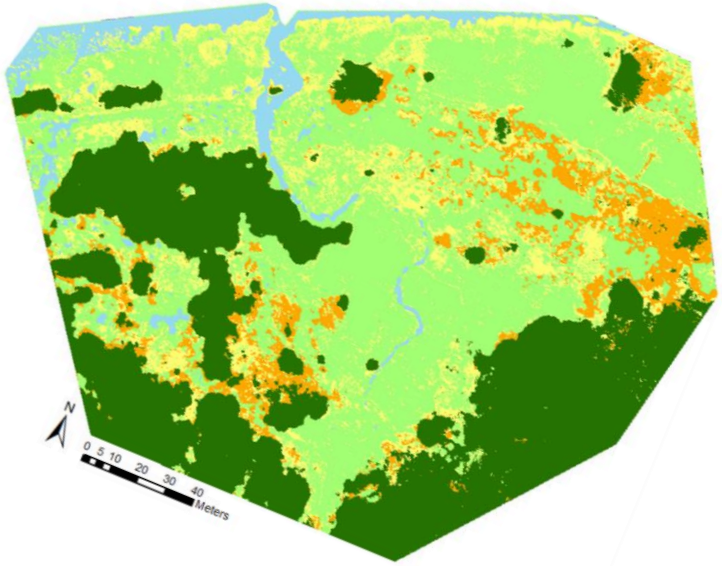
Future Plant Community Development Projections (5-10 yrs.)
Classification of Drone Imagery (2019)

| Classification | 3 yrs. Post 2019 Acers | 3 yrs. Post 2019 % | Projected 2021-2026 Acers | Projected 2021-2026 % |
|---|---|---|---|---|
| Water | 0.4 | 5 | 0.4 | 5 |
| Native wetland matrix | 2.5 | 29 | 3.3 | 38 ↑ |
| Mixed | 2.8 | 34 | 2.0 | 25 ↓ |
| Reed canarygrass | | | | |
| Trees and shrub-scrub | 2.7 | 32 | 2.7 | 32 |

## Existing Conditions 2019




## Projected Conditions 2021-2026



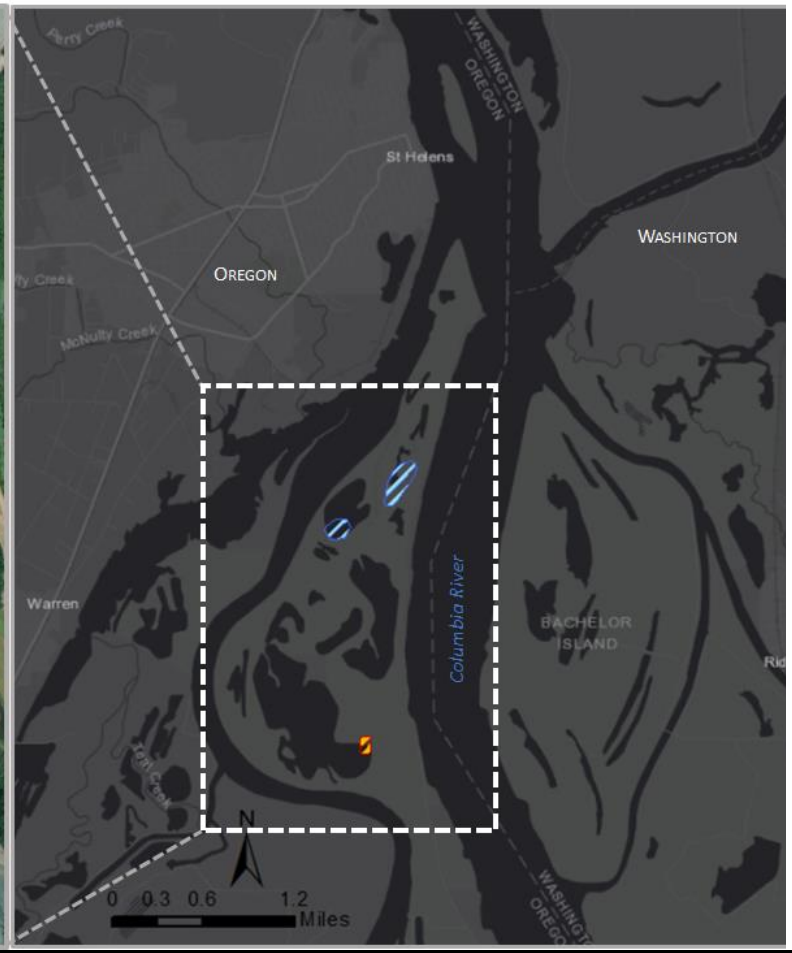
# Wallacut Slough Conclusions

- General trajectory is positive towards recovery of native plant community composition across most of the wetland areas
- Recommendation is to potentially reduce herbicide treatments to allow natural plant recovery for several years
- Future adaptive management could entail targeted planting of shrub-scrub species in higher marsh areas
- 2021 – Year 5 monitoring

# North Unit Phase 2, 5 years (2019) Post-Restoration

crest
COLUMBIA RIVER ESTUARY STUDY TASKFORCE

North unit Phase 2 and Reference Site Location Overview Maps


## Project Summary

North Unit Phase 2 - Millionaire and Deep Widgeon Lakes - Sauvie Island. Reference site is Cunningham Lake, which is also an Ecosystem Monitoring Program (EMP) site.

In 2014, water-control structures were removed from both lakes, and wetland scrape downs and berms were strategically located. Data collection started in 2014.

*Current management includes heavy cattle grazing*

# North Unit Phase 2, 5 years (2019) Post-Restoration


Data Collected, 2014-2019, 2022, 2024:

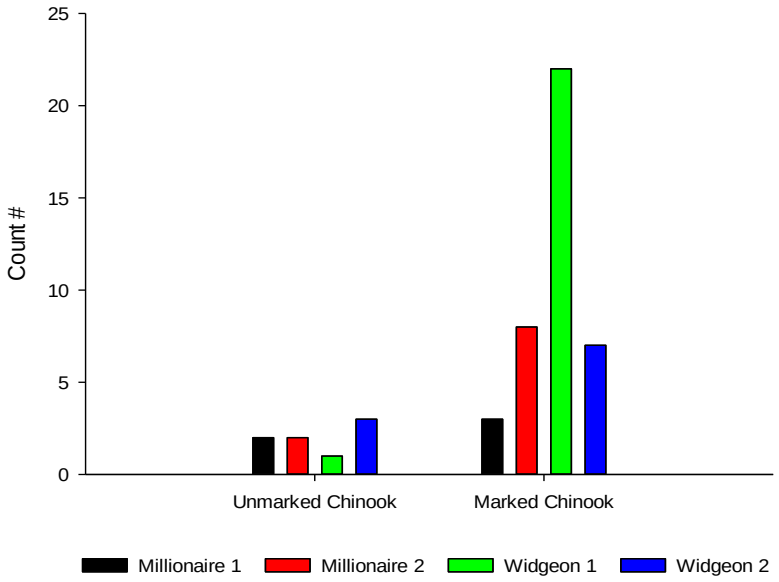
- ✓Plant Community
- ✓RTK Elevations
- ✓Water Depth & Temperature
- ✓Sediment Accretion and Erosion & Channel Cross-Sections
- ✓Soil pH, ORP (2019)
- ✓RGB and NIR Orthomosaics, Digital Surface Model (2019)
- ✓Fish Community Check-in (2019)
- ✓Possible 8 yr. Check-in 2022, 10 yr. in 2024 (sans grazing?)

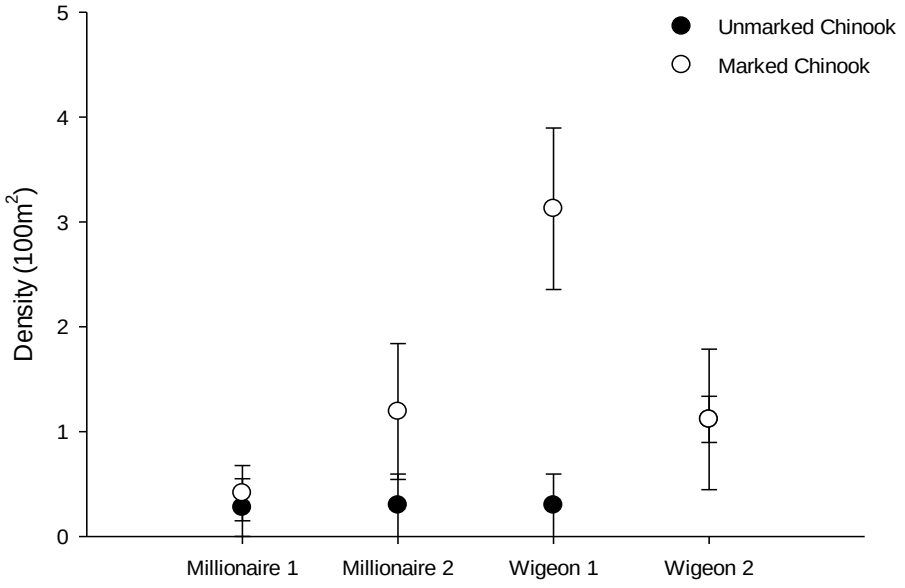
# Fish Community Check-in (NOAA, 2019): North Unit Phase 2, 5 years (2019) Post-Restoration

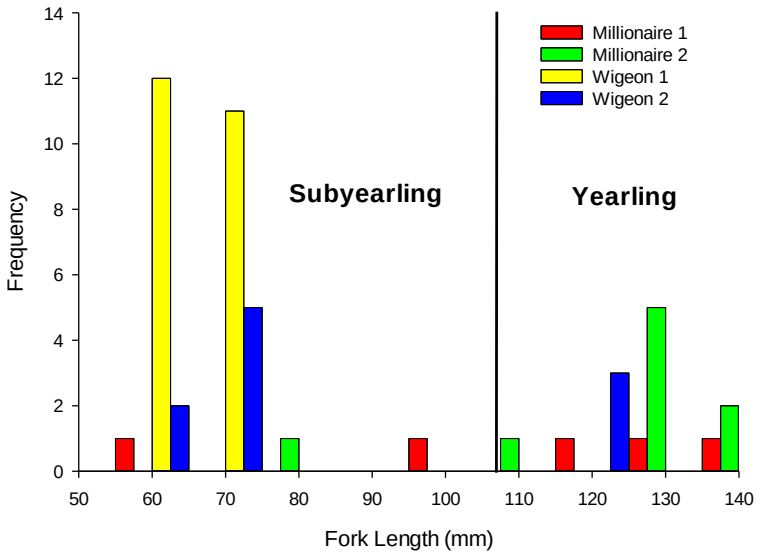


Two days of sampling within two locations at each site in April 2019

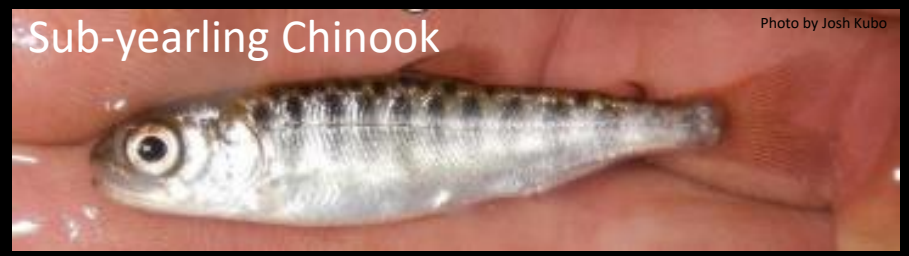
# Fish Community Check-in (NOAA, 2019): North Unit Phase 2, 5 years (2019) Post-Restoration








- Chinook salmon were caught at all sampling sites on Millionaire and Widgeon Lakes
- Both marked (adipose fin clip) and unmarked (no adipose fin clip) salmon were caught
- Length frequency of Chinook varied

# Fish Community Check-in (NOAA, 2019): North Unit Phase 2, 5 years (2019) Post-Restoration







Non-salmonid catch details:

- 7 different species were caught in Millionaire Lake
- 9 different species were observed in Deep Widgeon Lake
- 13 different species sampled across both lakes
- 7 species being non-native to the Columbia River.
- Natives: Threespine sticklebacks, redsided shiner, and peamouth were the most observed species at both lakes sampled.

# Fish Community Check-in (NOAA, 2019): **North Unit Phase 2, 5 years (2019) Post-Restoration**

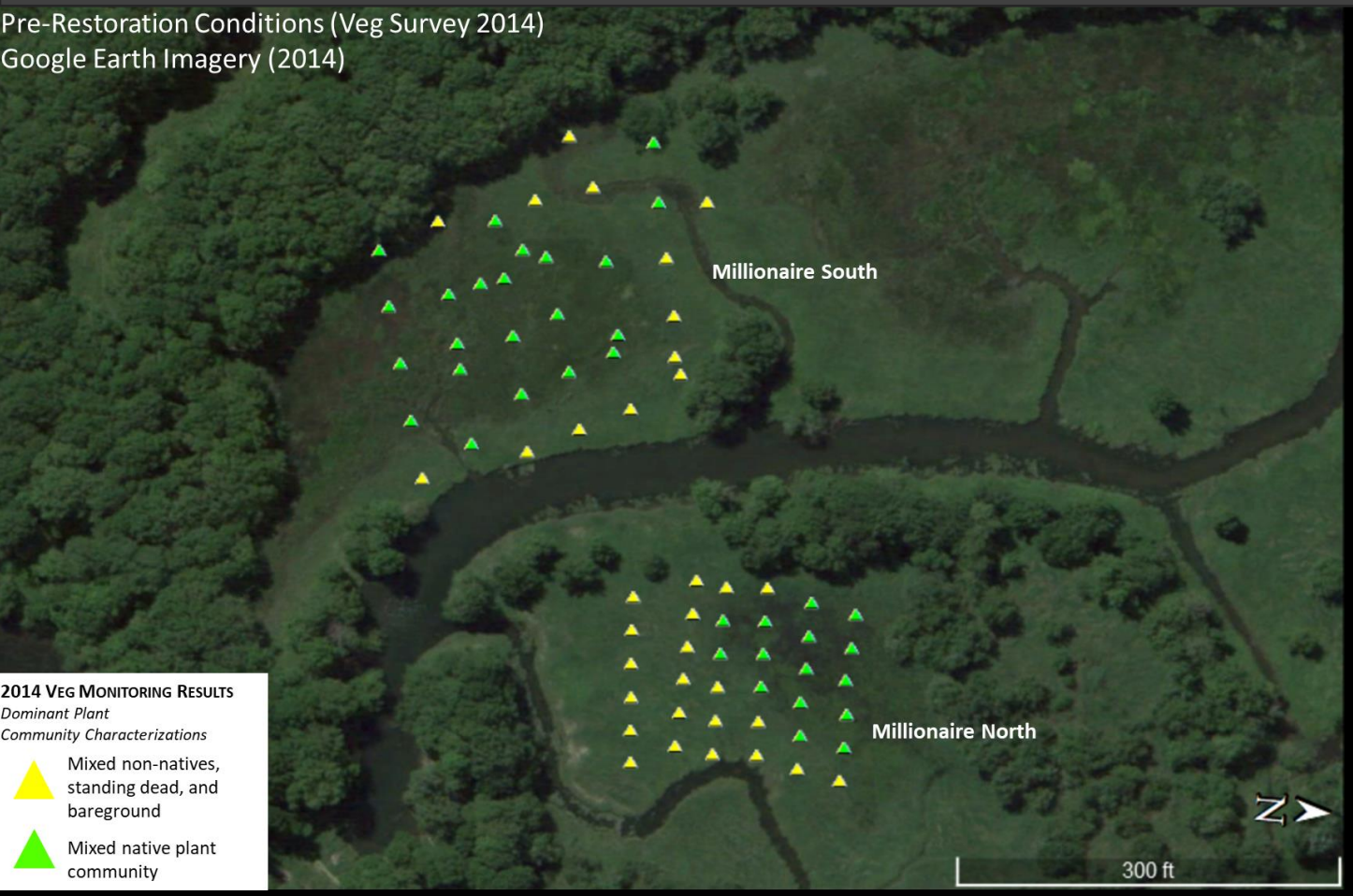
## Fish Check-in Summary:

- Results are similar to what we've observed at other Sauvie Island restoration sites like North Unit Phase 1: Ruby Lake in 2018
- Results indicate salmonids and other fish species are successfully accessing these restoration sites
- Recommendation, more fish and macro check-ins with similar intensity and scope to those of the EMP reference sites would be helpful to understand the breath of benefits received and salmonid habitat use patterns of these restored wetlands

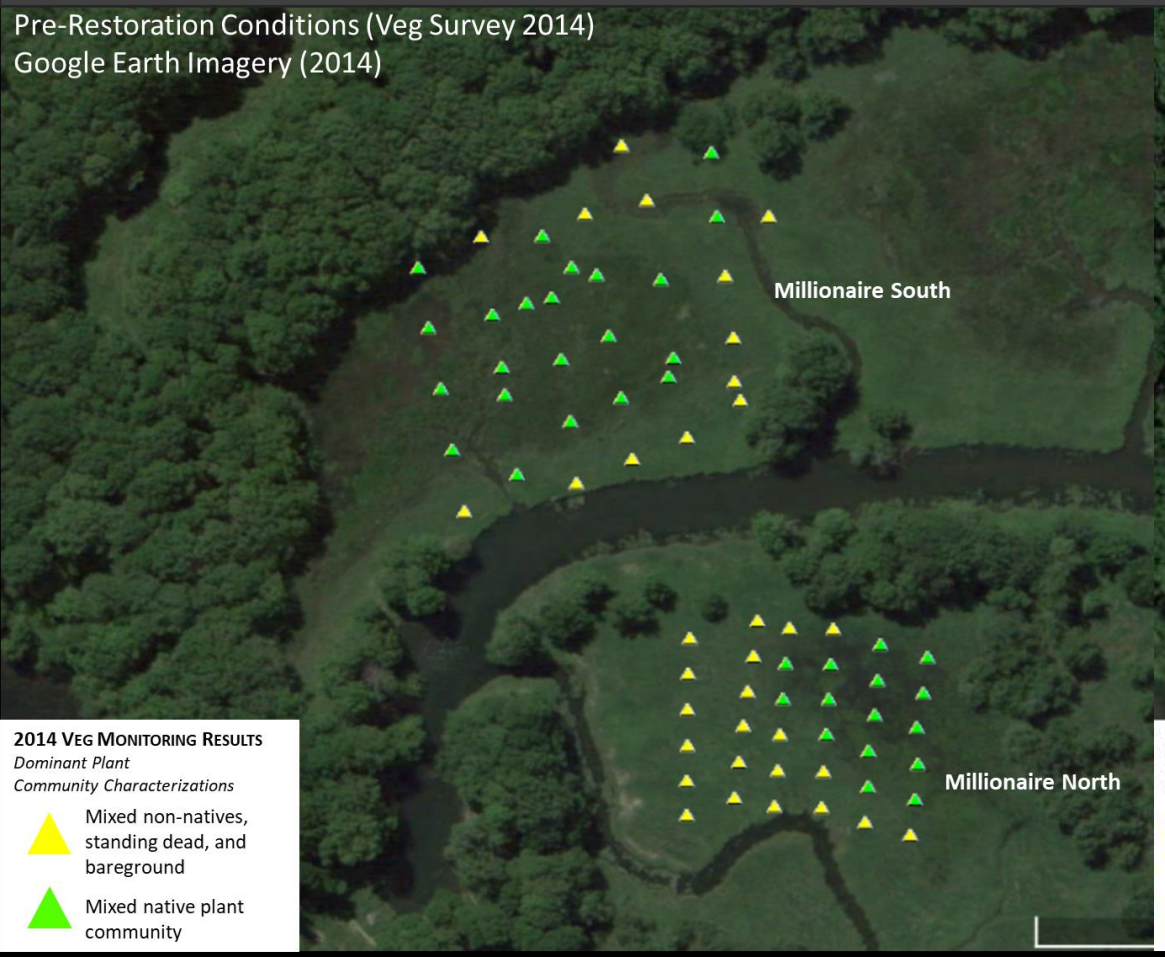
# Plant Community: North Unit Phase 2, 5 years (2019) Post-Restoration

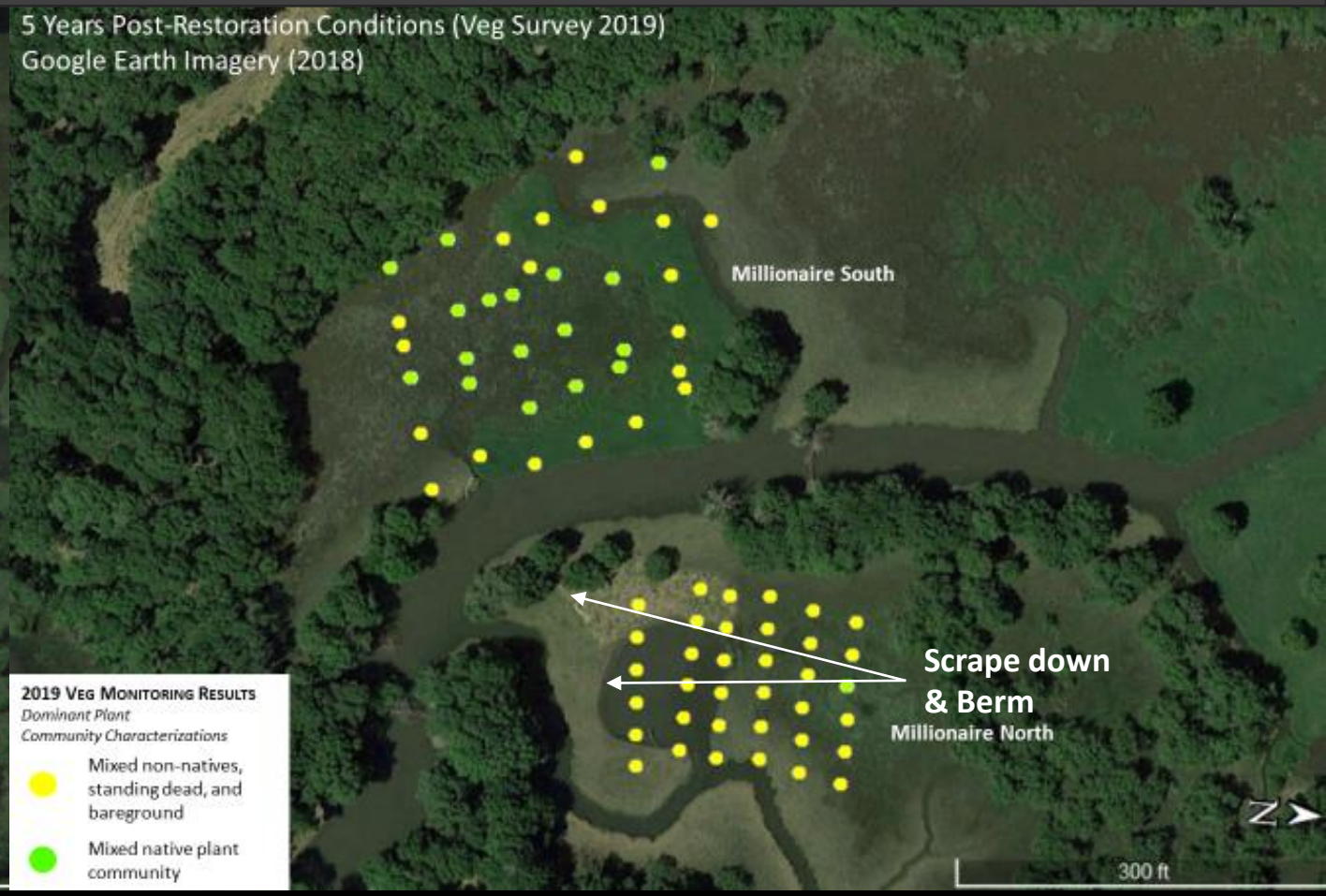
*Scappoose Bay, 2019*

# Plant Community: North Unit Phase 2, 5 years (2019) Post-Restoration

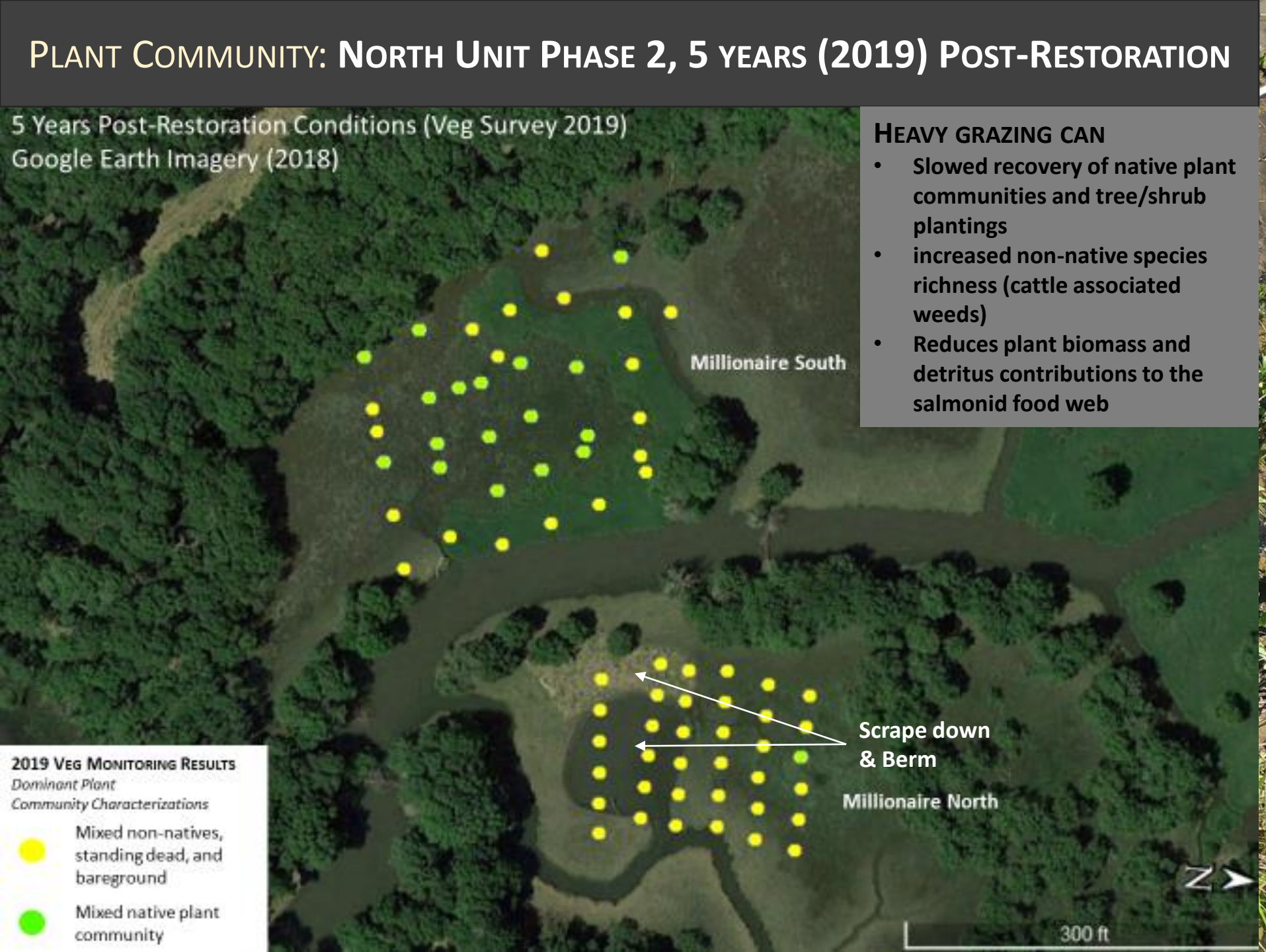


# Plant Community: North Unit Phase 2, 5 years (2019) Post-Restoration



# Plant Community: North Unit Phase 2, 5 years (2019) Post-Restoration




## Heavy grazing can

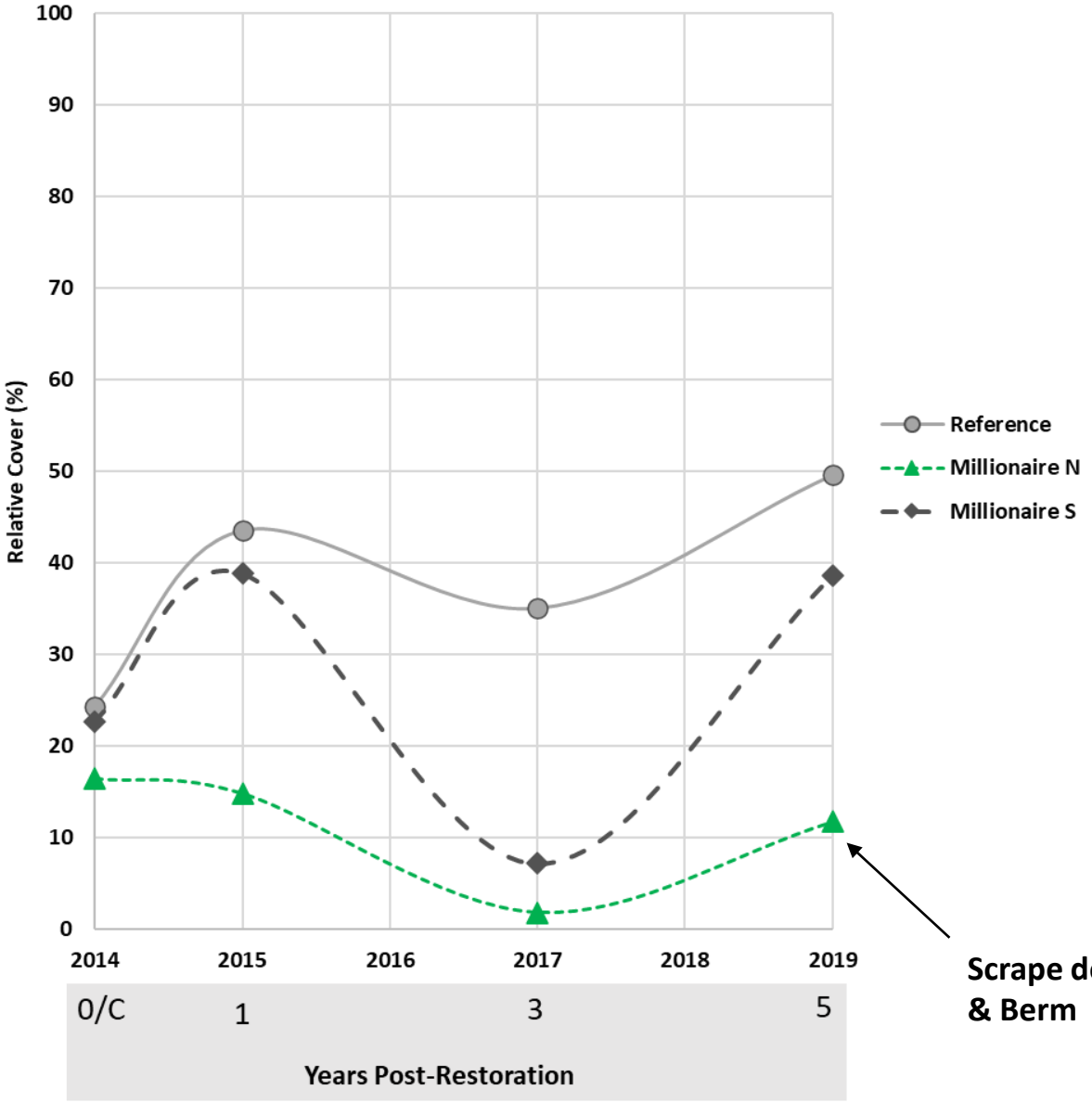
- Slowed recovery of native plant communities and tree/shrub plantings
- increased non-native species richness (cattle associated weeds)
- Reduces plant biomass and detritus contributions to the salmonid food web

*See Kidd & Yeakley 2015 for a review of grazing impacts to Columbia river wetlands: https://goo.gl/urjJW8*

# MILLIONAIRE

## Native Relative Cover (%)

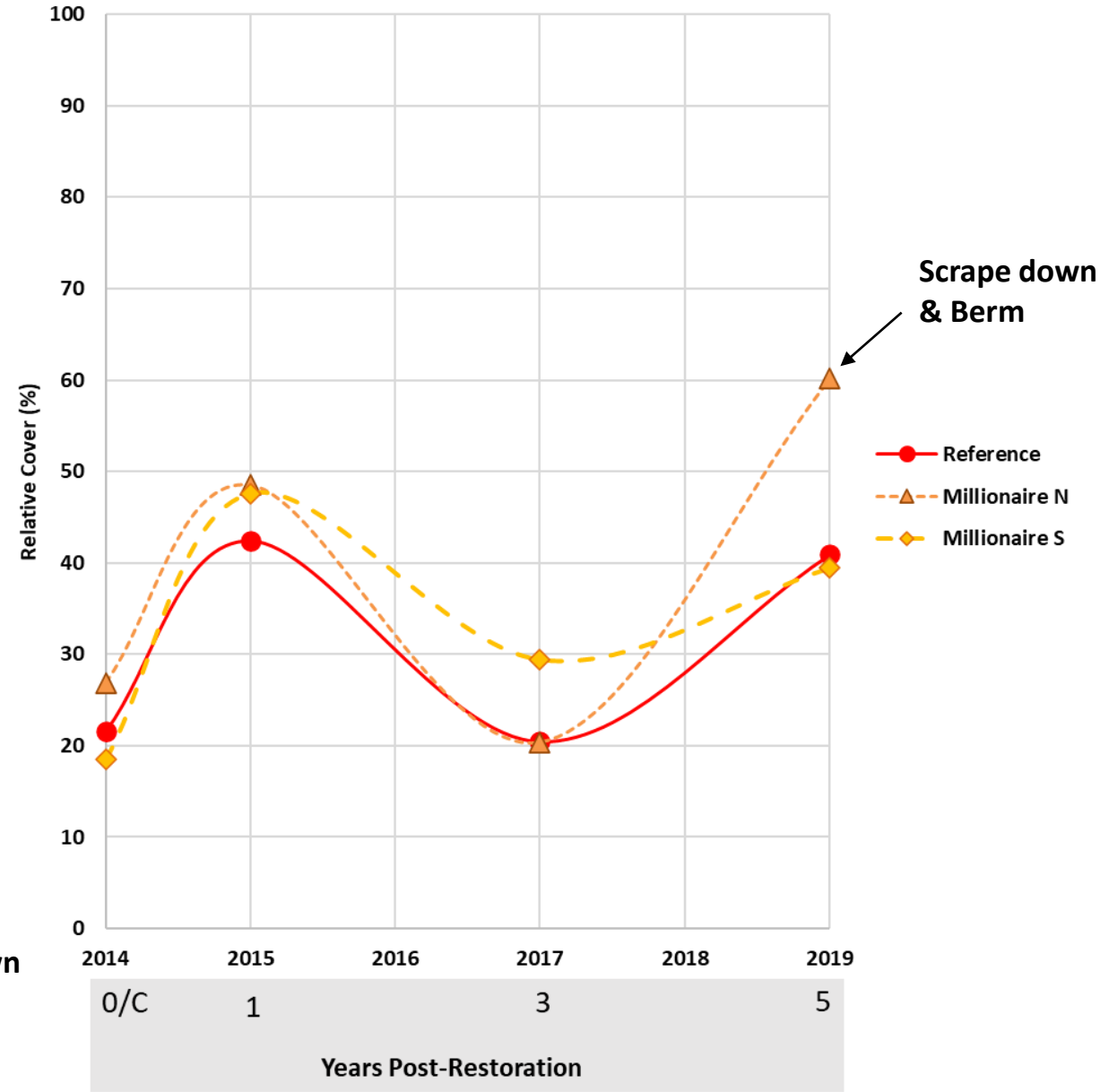
***Dominate Natives***
**North Unit Phase 2 & Reference:** Wapato, *Sagittaria latifolia*, Common spikerush, *Eleocharis palustris*, Water purslane, *Ludwigia palustris*




**Scrape down & Berm**

## Non-native Relative Cover (%)

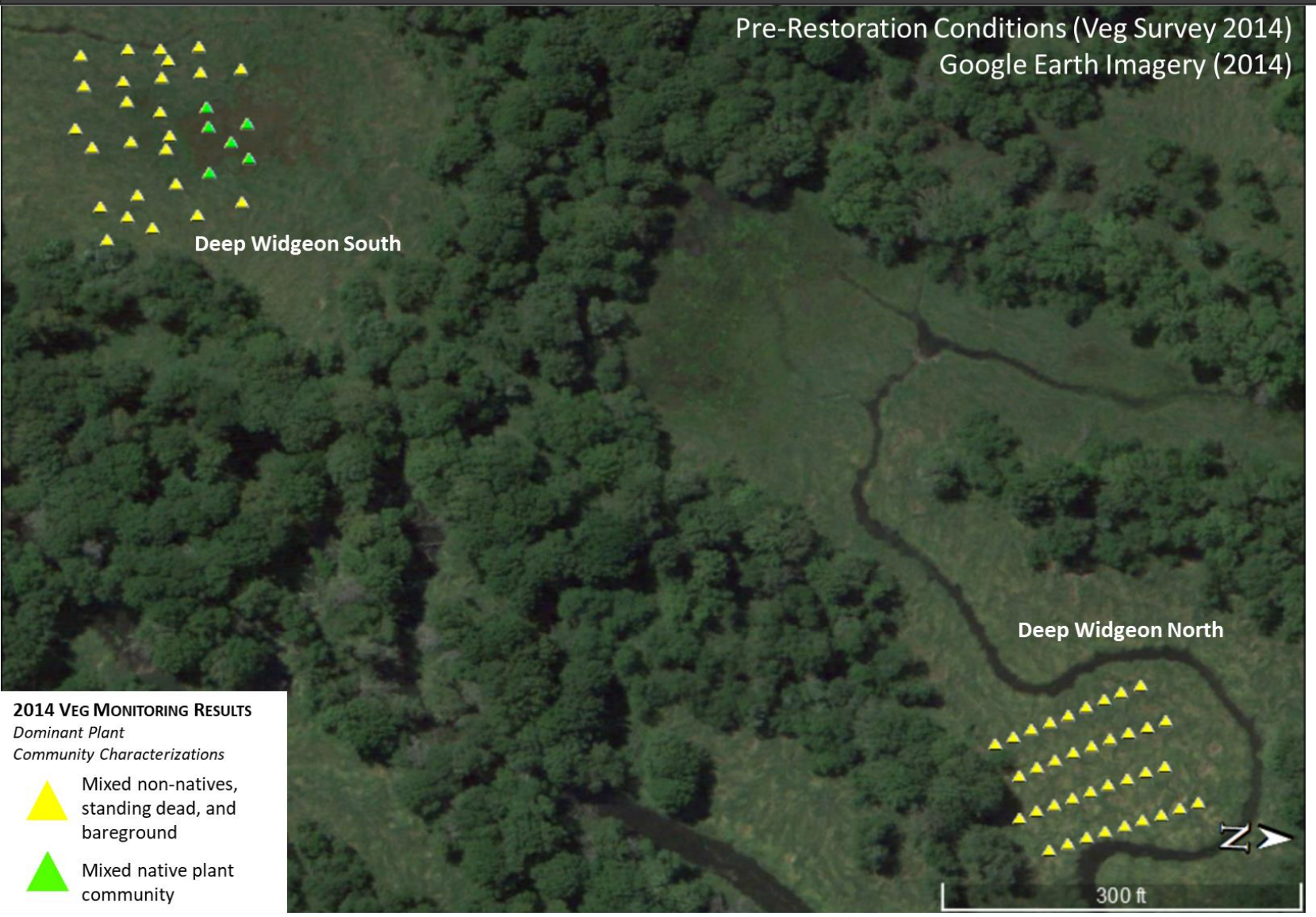
***Dominate Non-natives***
**North Unit Phase 2 & Reference:** Reed canarygrass, *Phalaris arundinacea*, Spotted ladysthumb, *Polygonum persicaria*



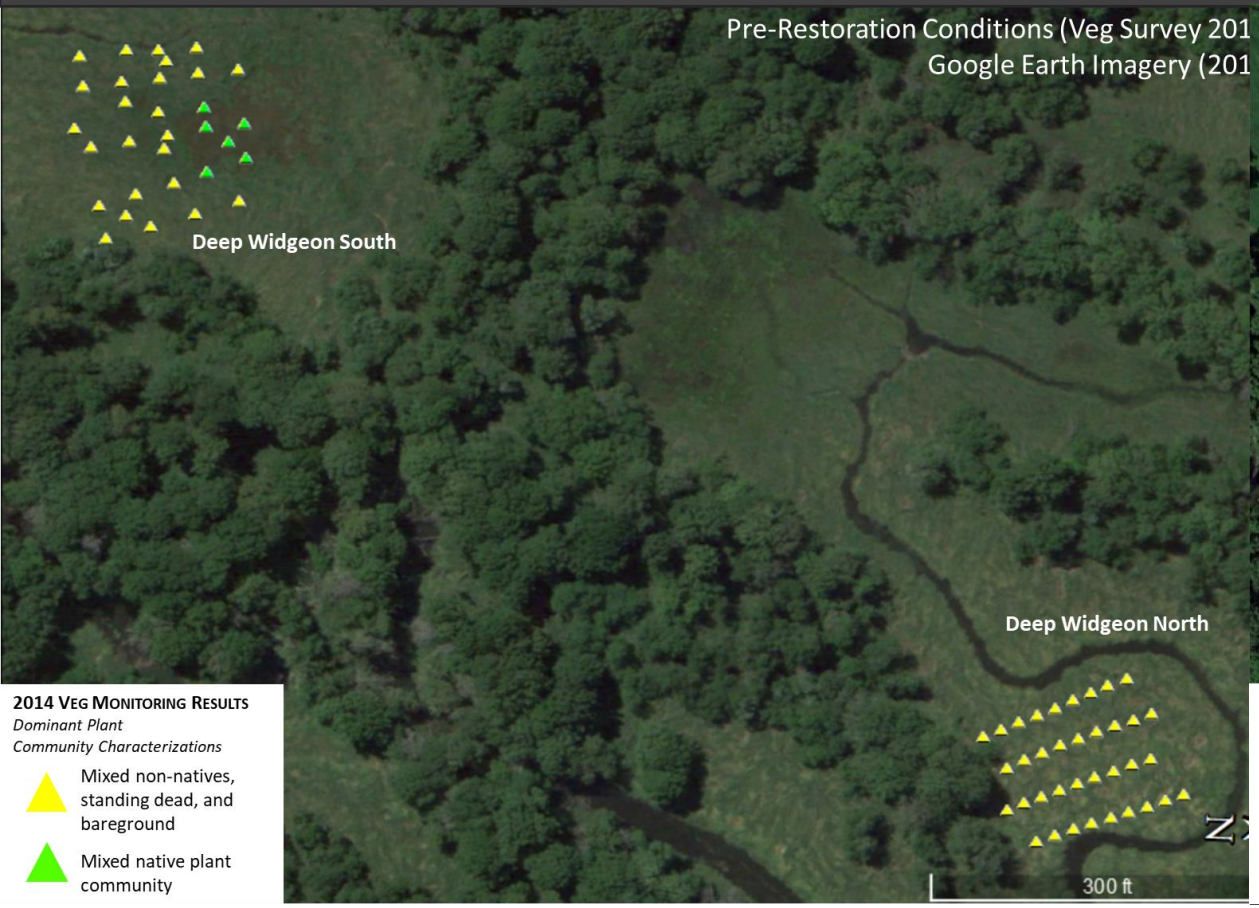

**Scrape down & Berm**

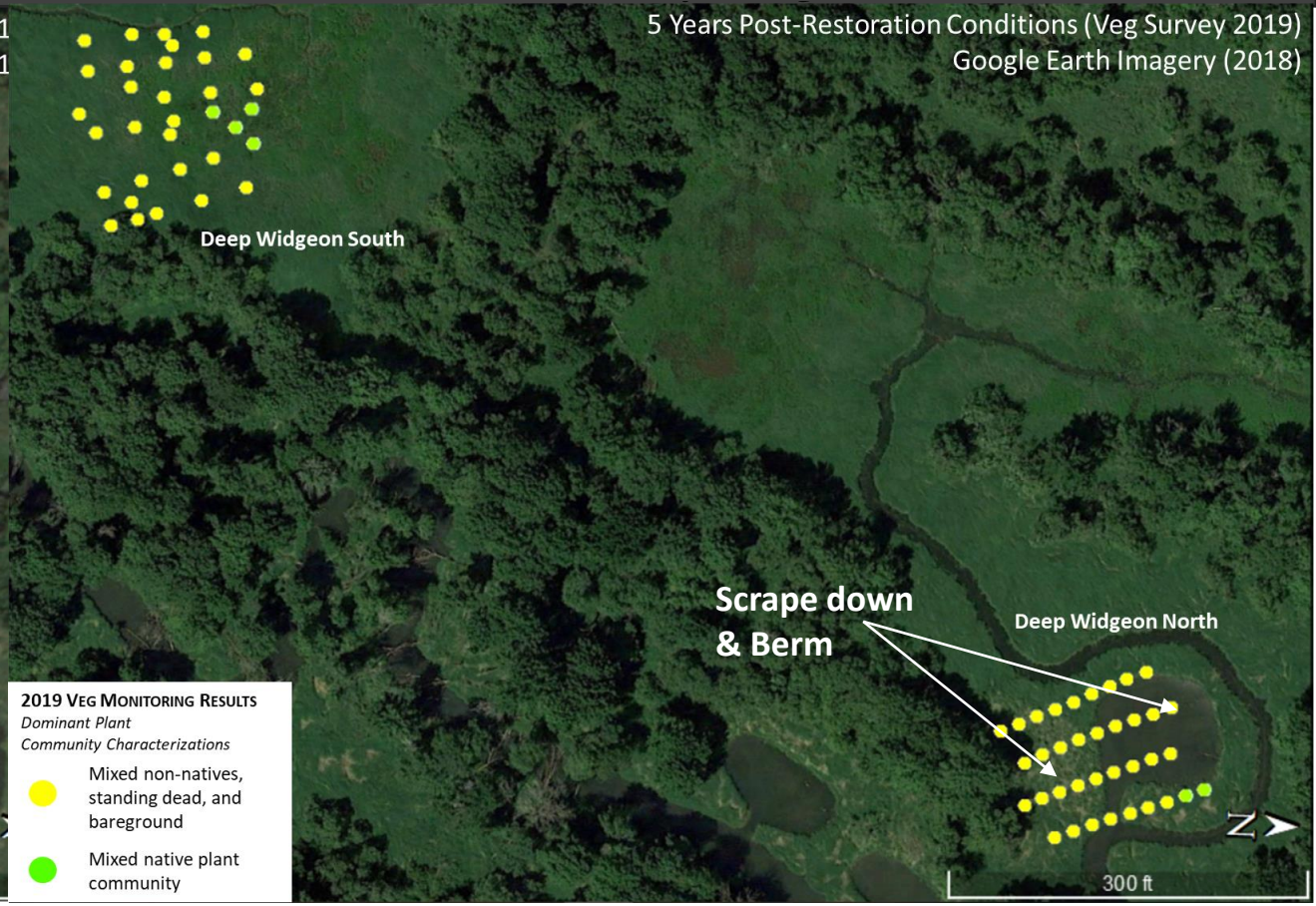

Millionaire North, 2019

# PLANT COMMUNITY: NORTH UNIT PHASE 2, 5 YEARS (2019) POST-RESTORATION



# PLANT COMMUNITY: NORTH UNIT PHASE 2, 5 YEARS (2019) POST-RESTORATION



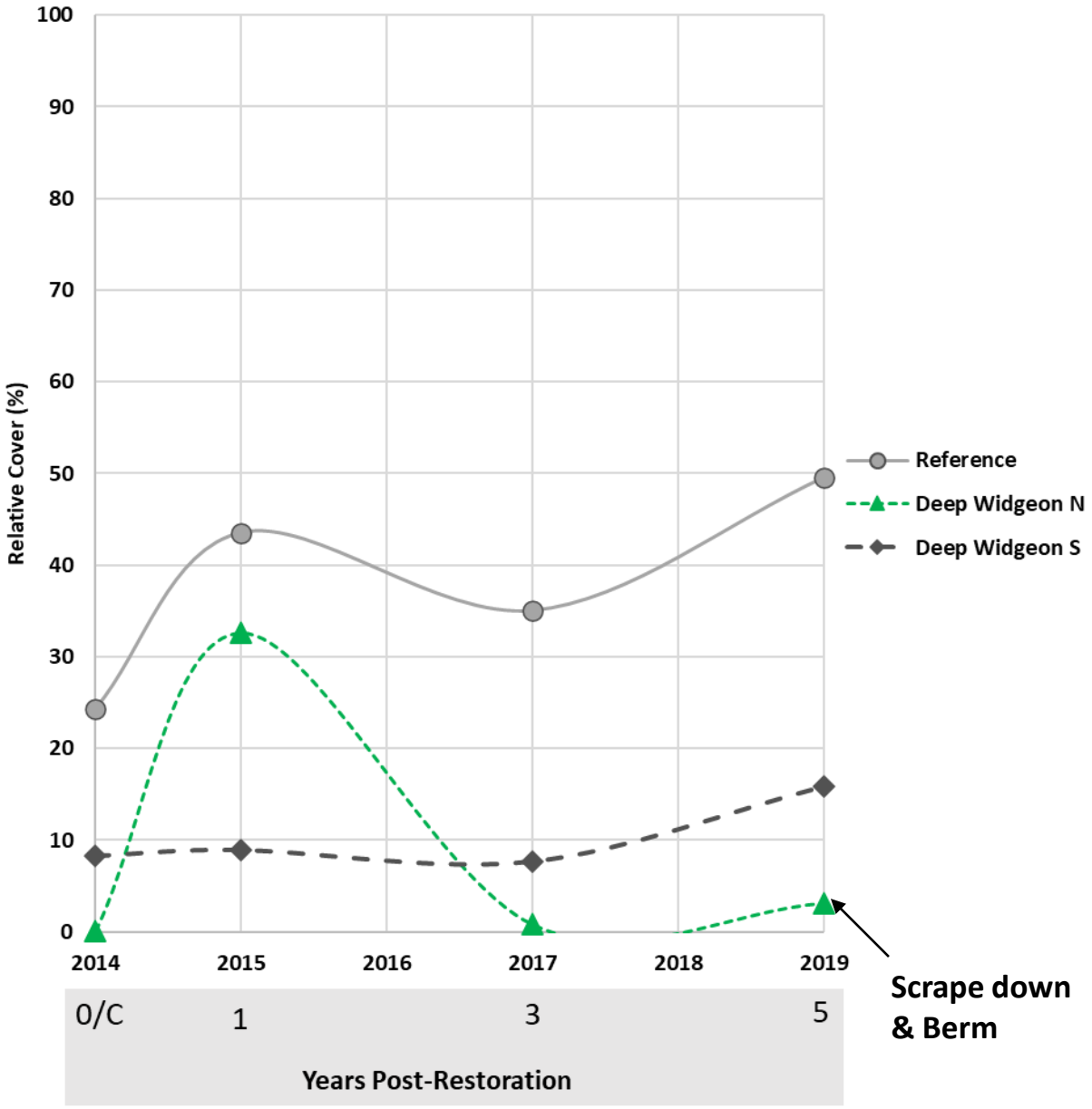

Deep Widgeon North, 2019

# Deep Widgeon

## Native Relative Cover (%)

***Dominate Natives***

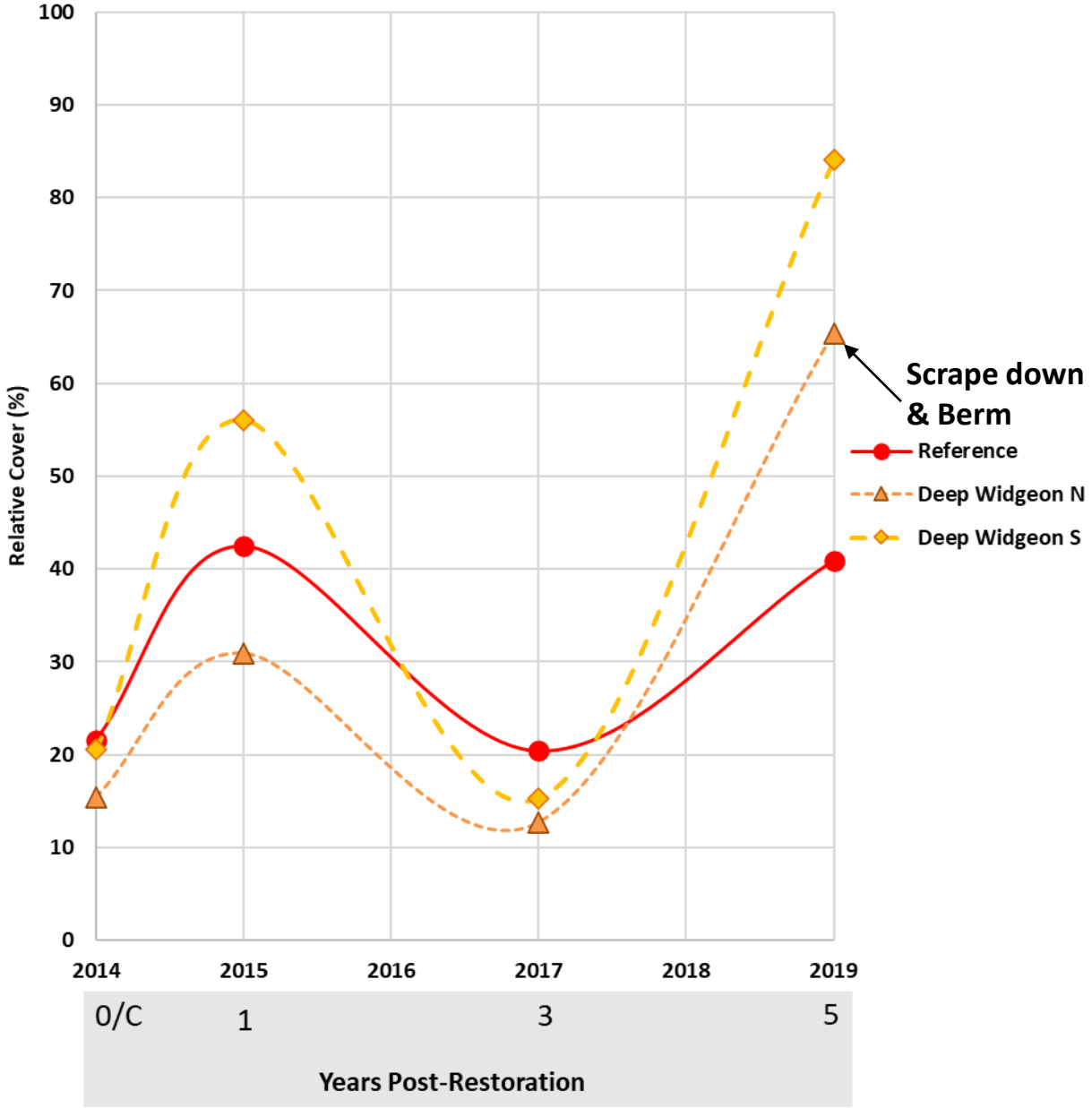
**North Unit Phase 2 & Reference:** Wapato, *Sagittaria latifolia*, Common spikerush, *Eleocharis palustris*, Water purslane, *Ludwigia palustris*




## Non-native Relative Cover (%)

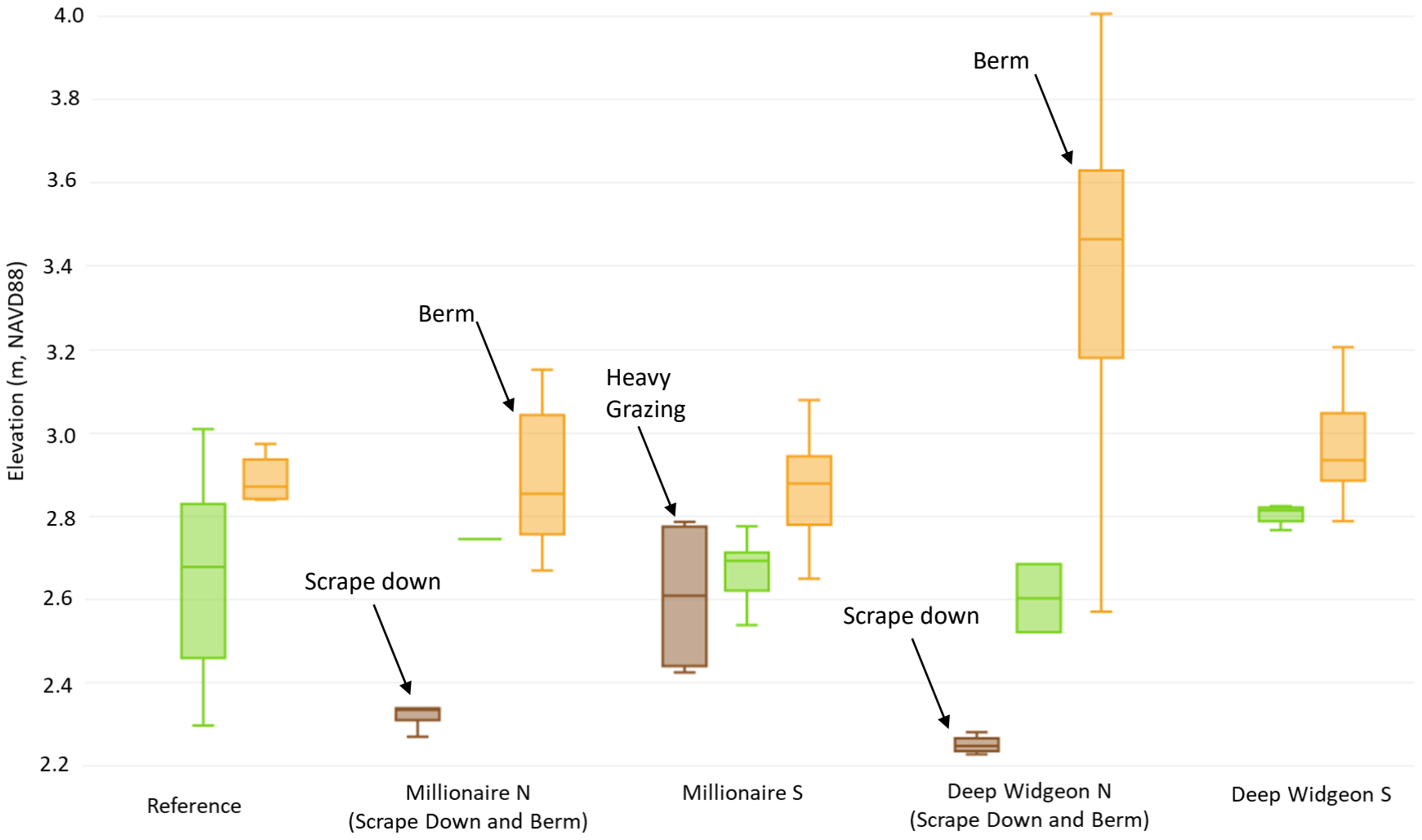
***Dominate Non-natives***

**North Unit Phase 2 & Reference:** Reed canarygrass, *Phalaris arundinacea*, Spotted ladysthumb, *Polygonum persicaria*



# PLANT COMMUNITY: NORTH UNIT PHASE 2, 5 YEARS (2019) POST-RESTORATION

**Elevation Range of Dominant Native and Non-native Plant Communities**
**2019 – 5 Years Post-Restoration**




**Bareground**

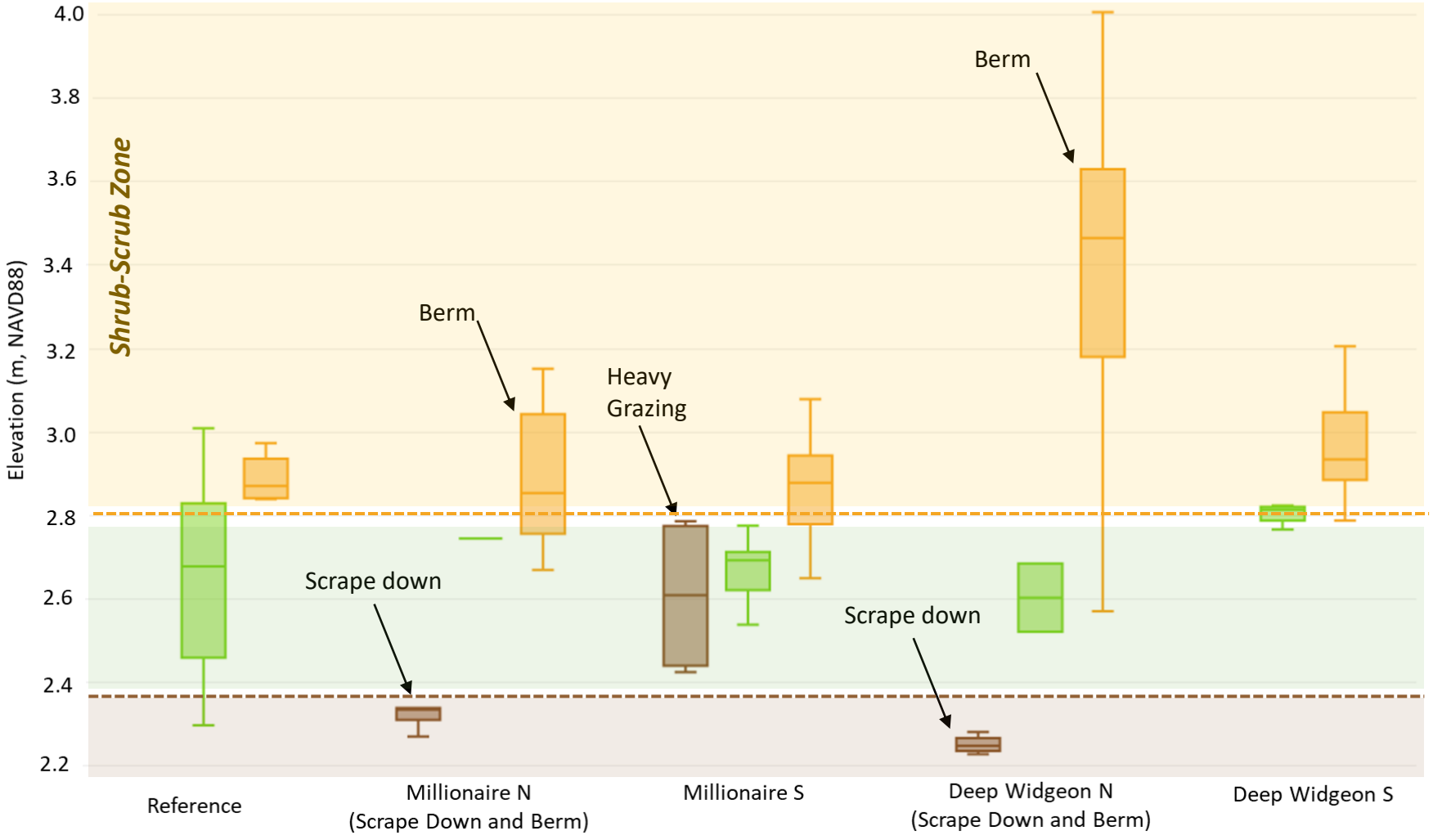
**Natives**: Wapato, *Sagittaria latifolia*, Common spikerush, *Eleocharis palustris,* Water purslane, *Ludwigia palustris*

**Non-natives**: Reed canarygrass, *Phalaris arundinacea,* Spotted ladysthumb, *Polygonum persicaria*

- Hydrology of reference site is a good match to both Deep Widgeon and Millionaire
- Bareground, Native, and non-native dominant plant communities are clearly delineated along the wetland's hydrologic gradient/elevation range

# PLANT COMMUNITY: NORTH UNIT PHASE 2, 5 YEARS (2019) POST-RESTORATION

**Elevation Range of Dominant Native and Non-native Plant Communities**
**2019 – 5 Years Post-Restoration**




**Bareground**

**Natives**: Wapato, *Sagittaria latifolia*, Common spikerush, *Eleocharis palustris*, Water purslane, *Ludwigia palustris*

**Non-natives**: Reed canarygrass, *Phalaris arundinacea*, Spotted ladysthumb, *Polygonum persicaria*

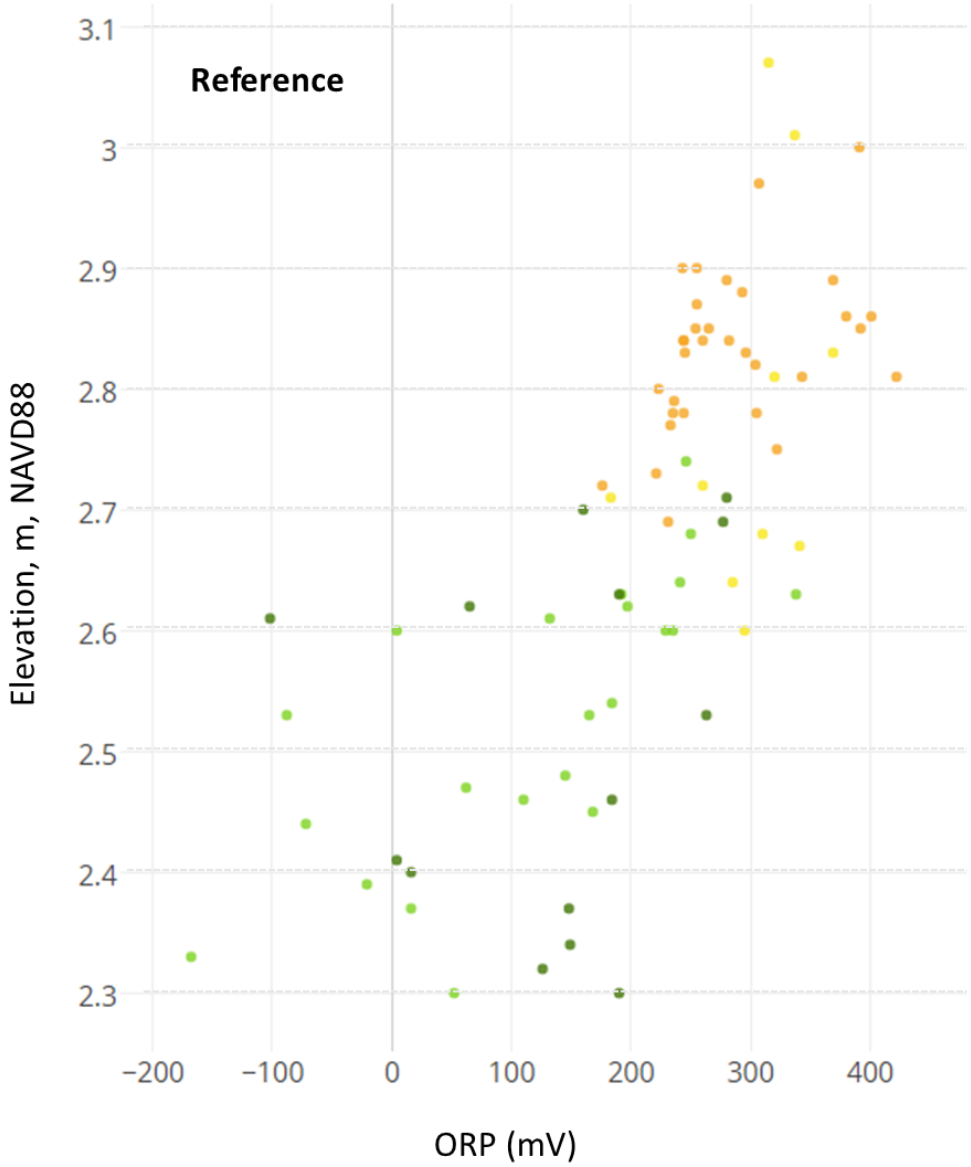
- Bareground, Native, and non-native dominant plant communities are clearly delineated along the wetland's hydrologic gradient/elevation range
- *Thresholds may shift depending on annual freshet conditions*

***> 2.7-2.8 m, Common Reed Canarygrass Boundary***

***2.8-2.4 m, Native Emergent Zone***

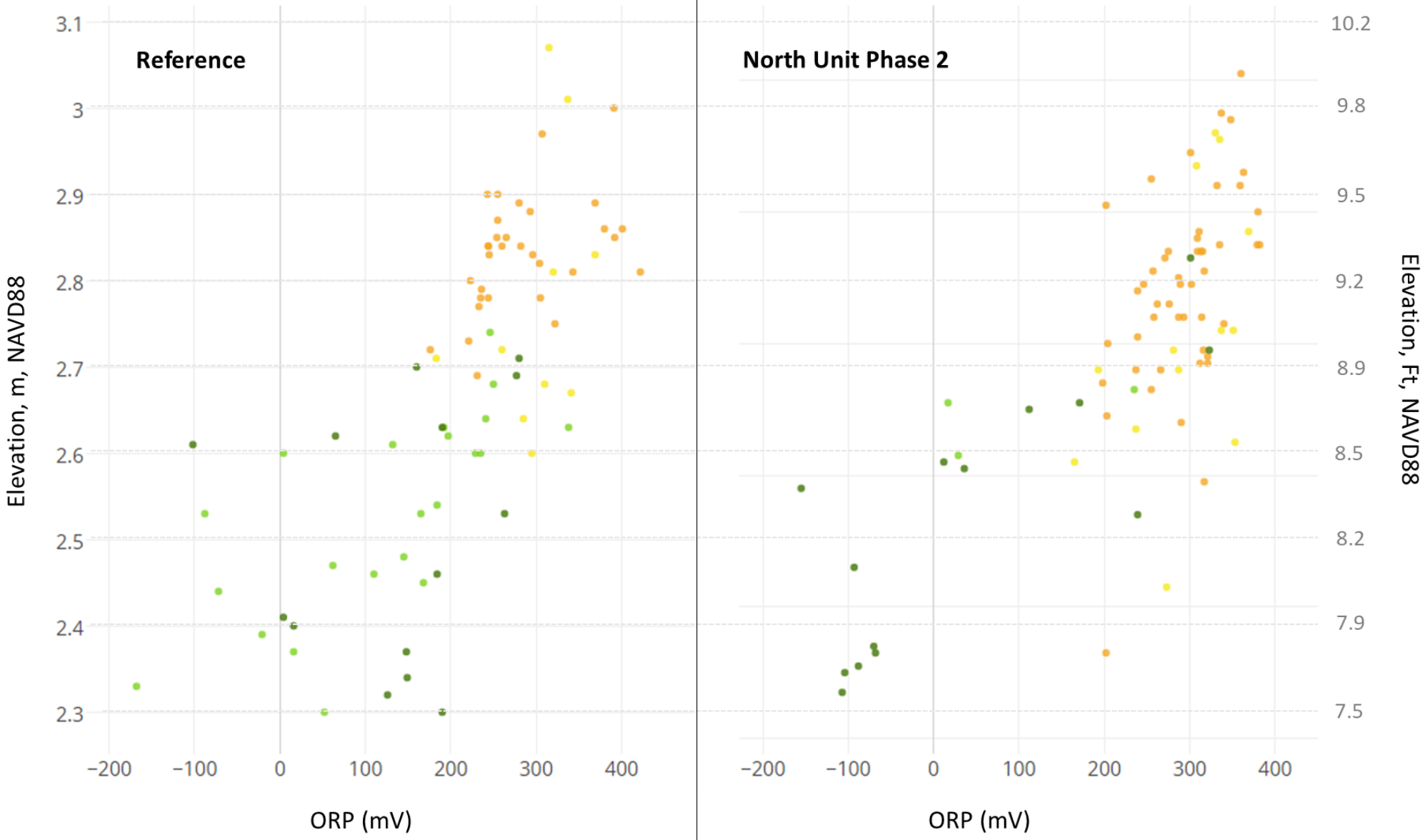
***<2.4-2.3 m, Mudflat, Channel Zone***

# Wetland Elevation vs. Soil ORP




- Common spikerush, *Eleocharis palustris,* Native
- Wapato, *Sagittaria latifolia,* Native
- Reed canarygrass, Wapato Mix
- Reed canarygrass, *Phalaris arundinacea*, Non-native

# Wetland Elevation vs. Soil ORP




Common spikerush, *Eleocharis palustris,* Native

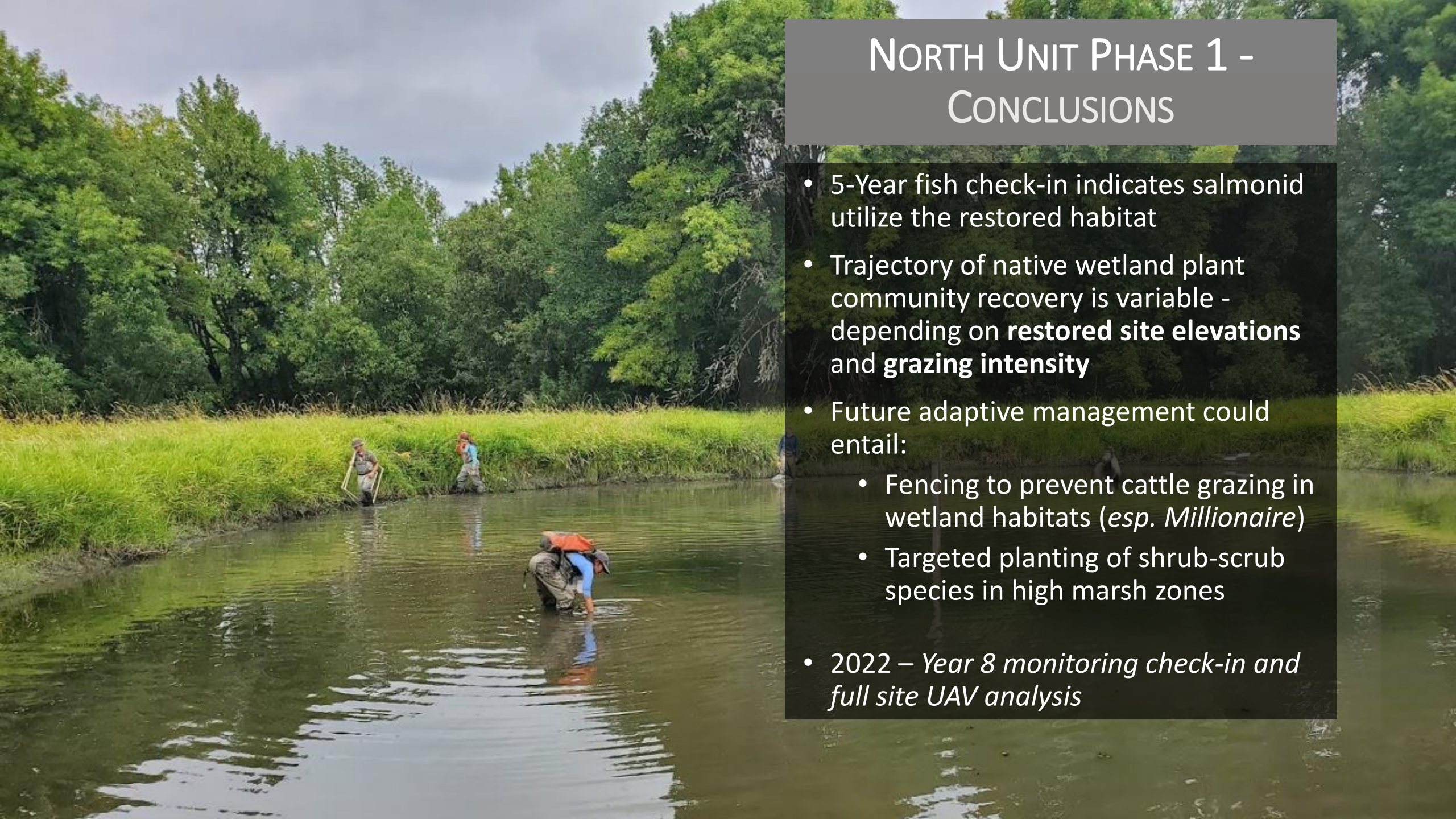
Wapato, *Sagittaria latifolia,* Native

Reed canarygrass, Wapato Mix

Reed canarygrass, *Phalaris arundinacea*, Non-native

# Wetland Elevation vs. Soil ORP

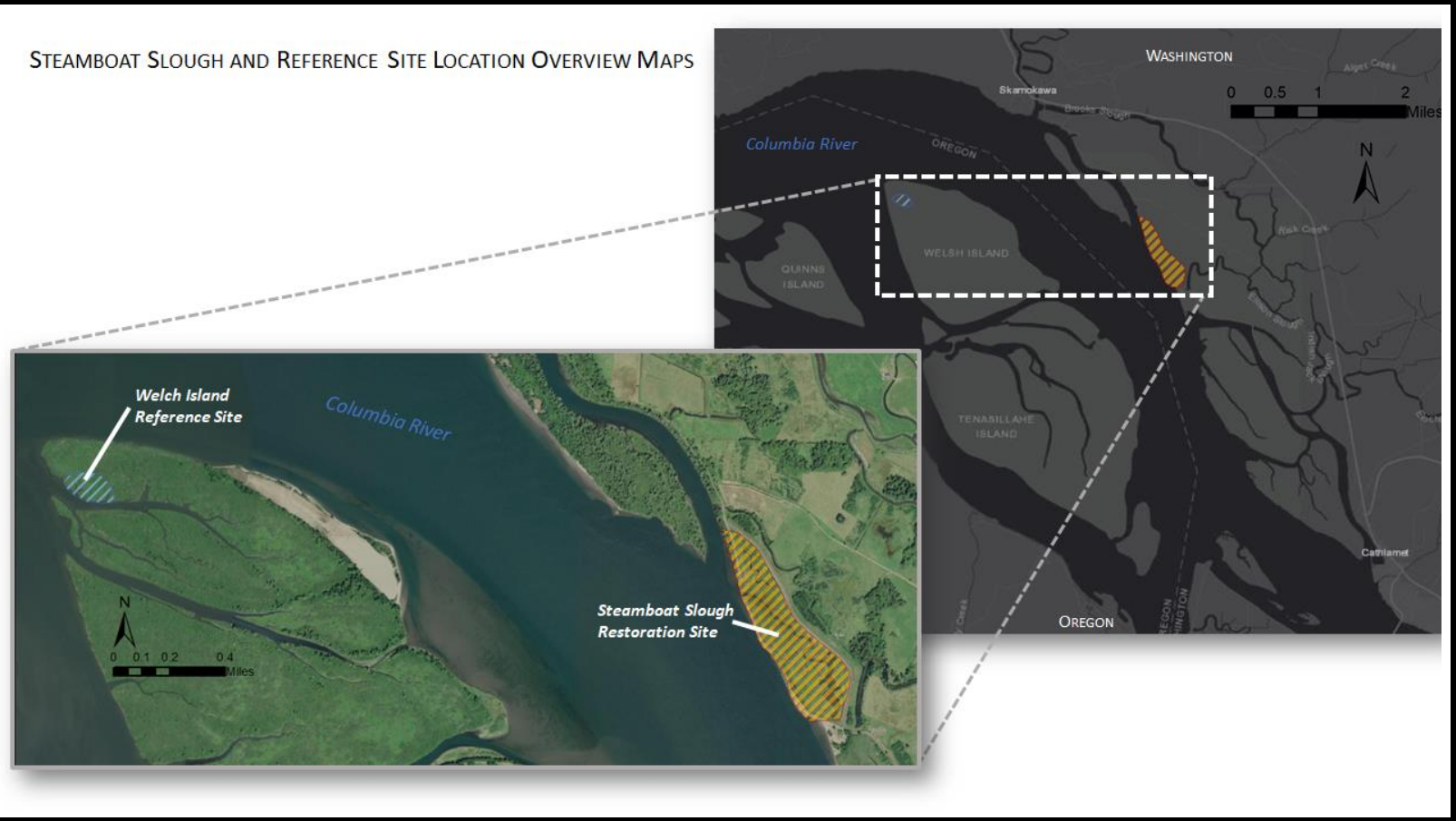

- Elevated Soil ORP conditions reflect how North Unit Phase 2 is primarily Mid-Upper Marsh while the Reference (Cunningham) is Low Marsh
- **We see similar Reed canarygrass thresholds in ORP and Elevation (proxy for flooding) across our other EMP and AEMR sites**



# North Unit Phase 1 - Conclusions

- 5-Year fish check-in indicates salmonid utilize the restored habitat
- Trajectory of native wetland plant community recovery is variable - depending on **restored site elevations** and **grazing intensity**
- Future adaptive management could entail:
  - Fencing to prevent cattle grazing in wetland habitats (*esp. Millionaire*)
  - Targeted planting of shrub-scrub species in high marsh zones
- 2022 – *Year 8 monitoring check-in and full site UAV analysis*

# Steamboat Slough, 5 years (2019) Post-Restoration




## Project Summary

Steamboat Slough is a restoration site located in the Julia Butler Hansen Refuge, WA. Reference site is Welch Island, which is also an Ecosystem Monitoring Program (EMP) site.

In 2014, tidal influence was restored through the removal of levee barriers throughout the system and the development of a channel network. Data collection started in 2014.

*Current management – passive, no herbicide treatments or grazing observed*

# Steamboat Slough, 5 years (2019) Post-Restoration

Steamboat Slough and Reference Site, Intensive Monitoring Areas Highlighted

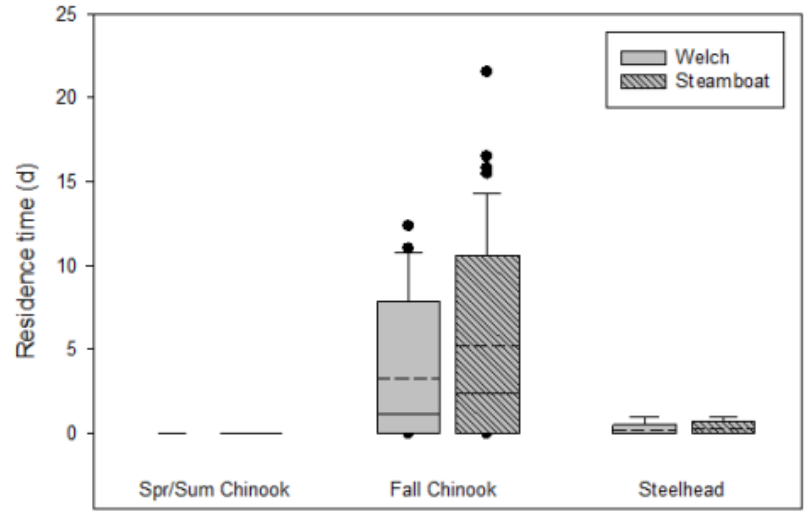

Data Collected, 2014-2019, 2024:

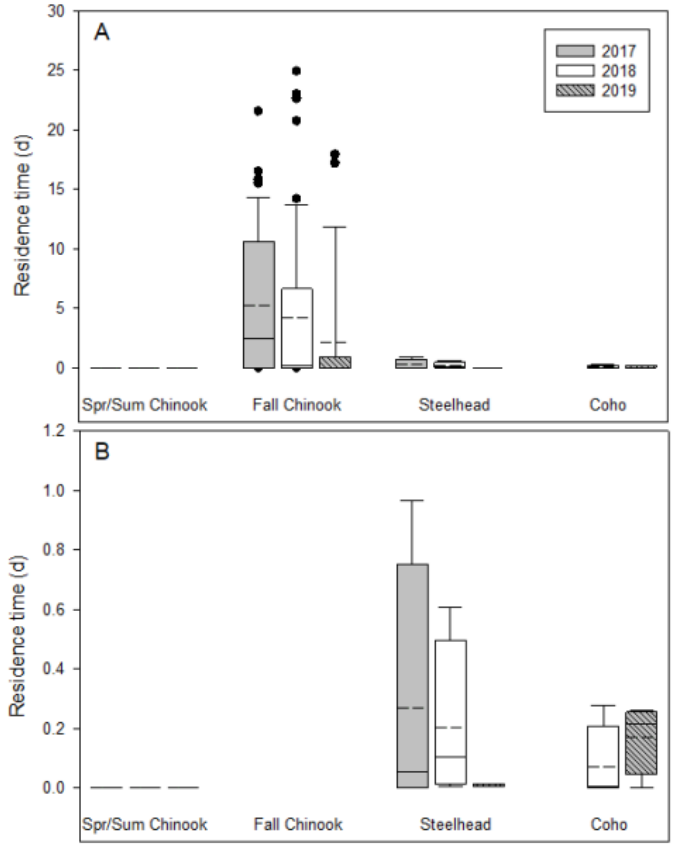
- ✓Plant Community
- ✓RTK Elevations
- ✓Water Depth & Temperature (2019)
- ✓Biomass and Detritus (ongoing EMP study, 2017, 2019)
- ✓Soil pH, Salinity, ORP (2018, 2019)
- ✓*NO UAV data collection due to current federal restrictions*
- ✓*Level 1 data can be found* PNNL and NMFS 2020 AEM report

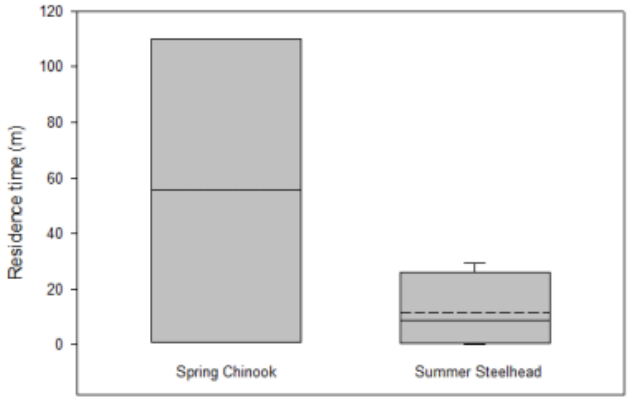
*https://www.webapps.nwfsc.noaa.gov/apex/parrdata/inventory/projects/project/290865*

# Fish Use (NOAA, 2017-2019): Steamboat Slough, 5 years (2019) Post-Restoration

- PIT tag arrays were installed at Welch Island and Steamboat Slough in 2017. Results from Steamboat Slough are available till 2019.
- Salmonids were detected at Welch Island in 2017 and Steamboat in 2017-2019
- Fall Chinook salmon were the most prevalent stock detected at Steamboat, with the longest residence times.
- Adults were also detected at Steamboat; however, residence times were short.




*McNatt et.al, 2020, Chapter 4, PNNL and NMFS 2020 AEM report*

# Plant Community: **Steamboat Slough, 5 years (2019) Post-Restoration**

Pre-Restoration Conditions (Veg Survey 2013)
Google Earth Imagery (2012)

Steamboat West

Steamboat East

**2013 Veg Monitoring Results**
*Dominant Plant Community Characterizations*

- Mixed non-natives, standing dead, and bareground
- Mixed native plant community

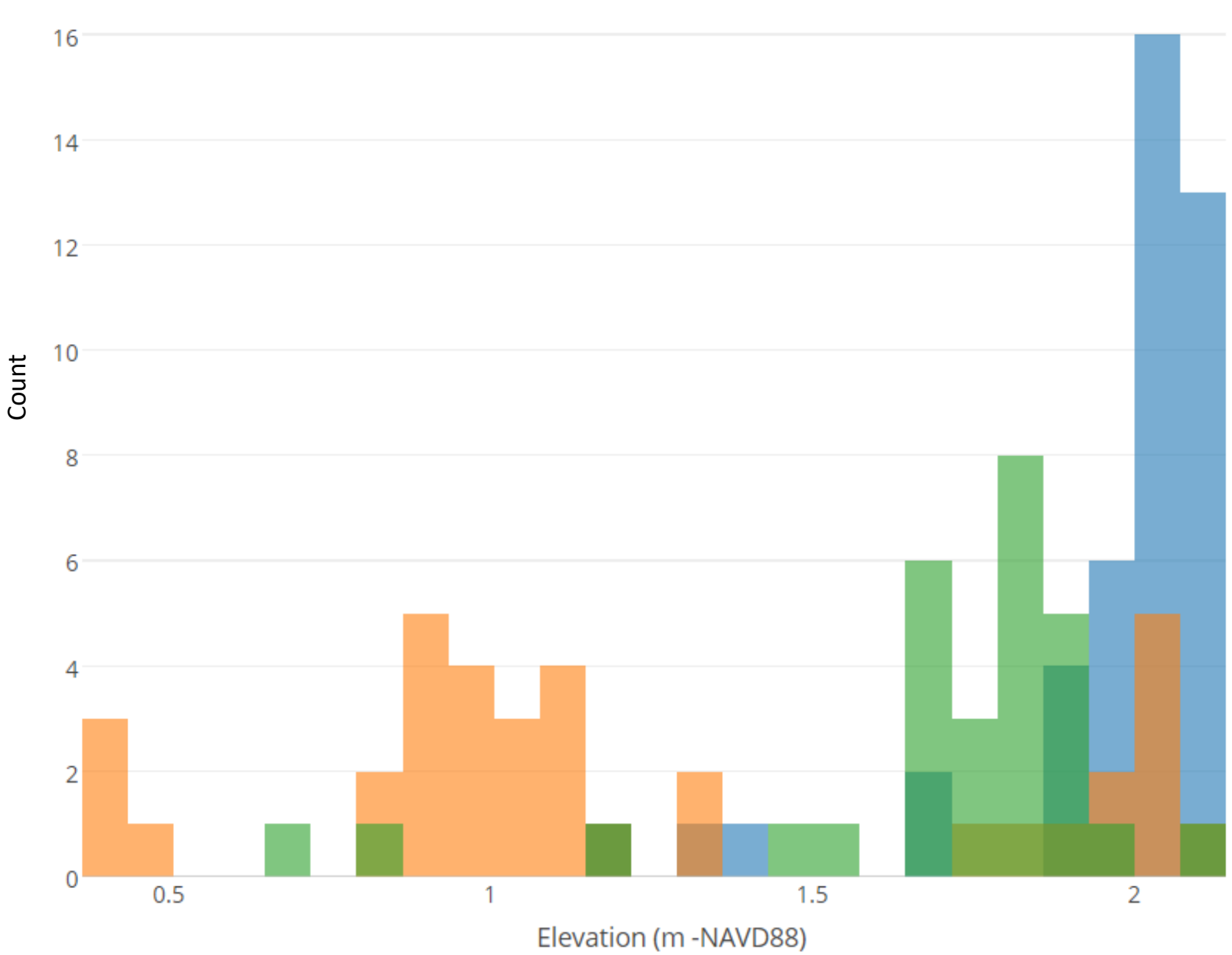
N

1000 ft


Pre-Restoration Conditions (Veg Survey 2013)
Google Earth Imagery (2012)
Steamboat West
Steamboat East
2013 Veg Monitoring Results
Dominant Plant
Community Characterizations
Mixed non-natives, standing dead, and bareground
Mixed native plant community
N
1000 ft


5-Years Post Restoration Conditions (Veg Survey 2019)
Google Earth Imagery (2018)
Steamboat West
Steamboat East
2019 Veg Monitoring Results
Dominant Plant
Community Characterizations
Mixed non-natives, standing dead, and bareground
Mixed native plant community
N
1000 ft

## Elevation Histogram (Based on Veg Transects, 2019)




## Habitat- Key Points

- Hydrology of restoration site mirrors that of the reference site
- Elevation range of **<u>Steamboat slough West is higher than East</u>, both East and West are generally lower in elevation than the reference site (Welch Island).**

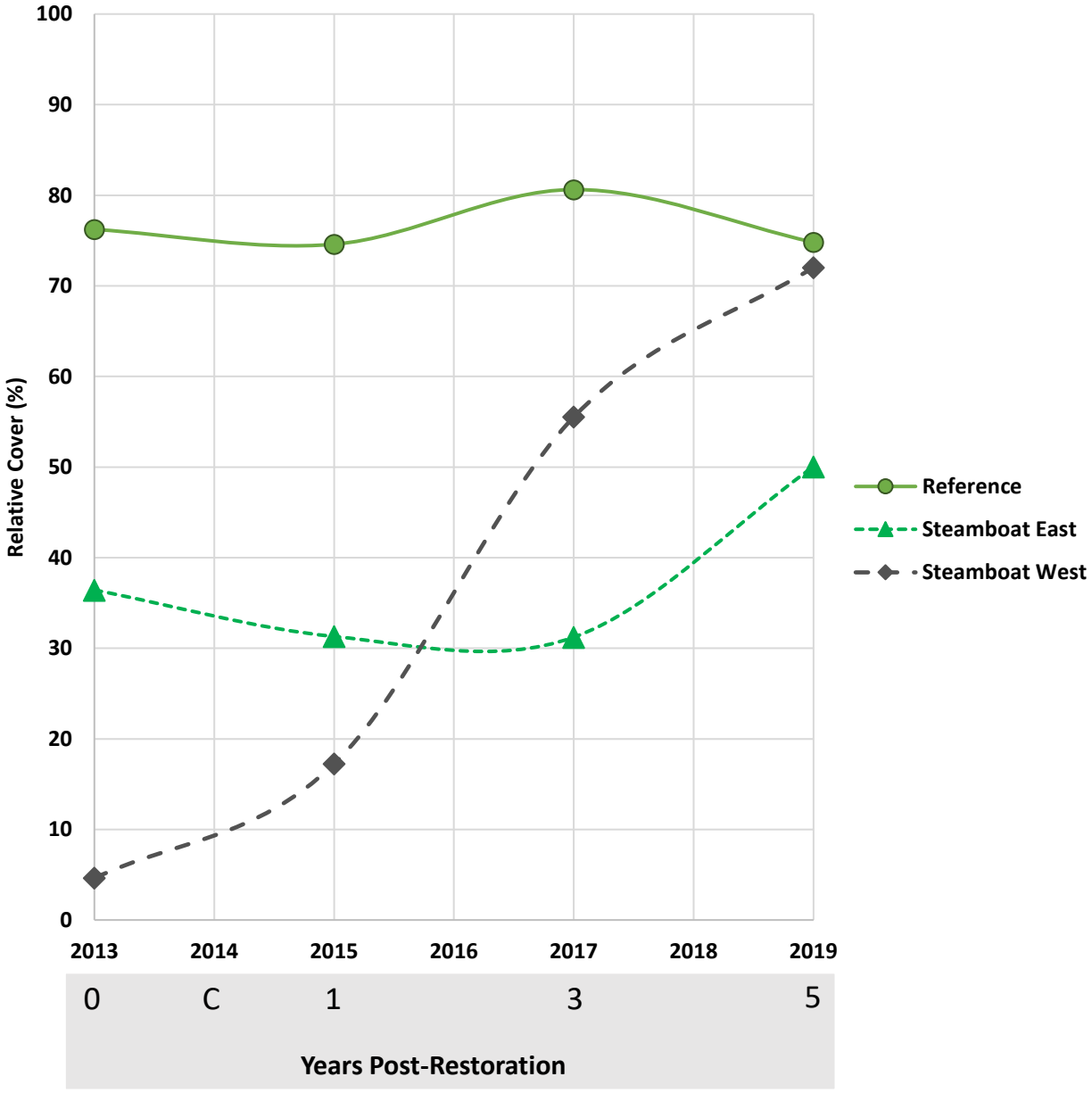
# Intensive Veg Monitoring Area Results

## Native Relative Cover (%)

***Dominate Natives***

**Steamboat:** Wapato, Sagittaria latifolia, Nodding beggars-ticks, *Bidens cernua*,

**Reference:** Lyngby sedge, *Carex lyngbyei,* Water parsley, *Oenanthe sarmentosa*

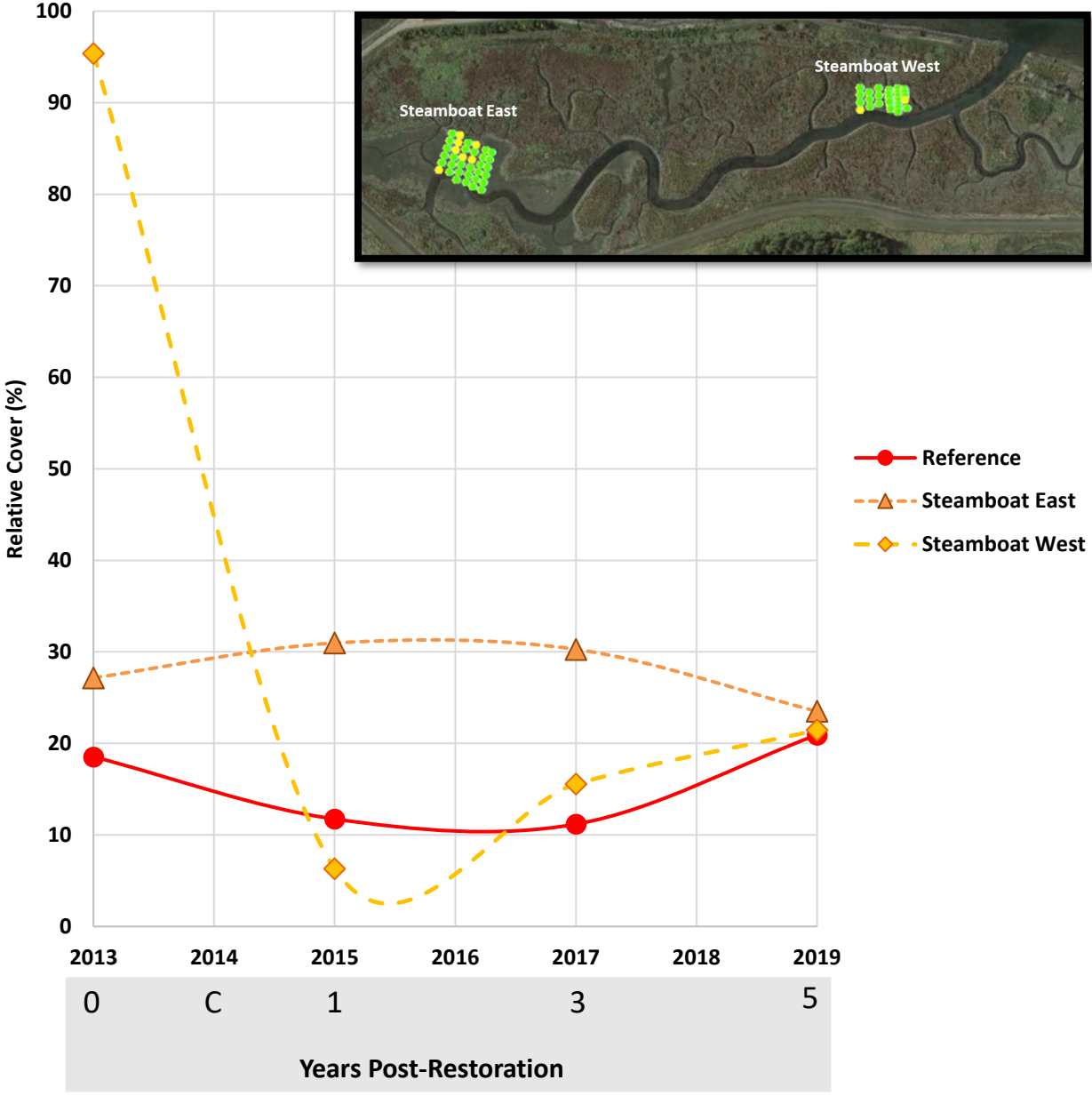



## Non-native Relative Cover (%)

***Dominate Non-natives***

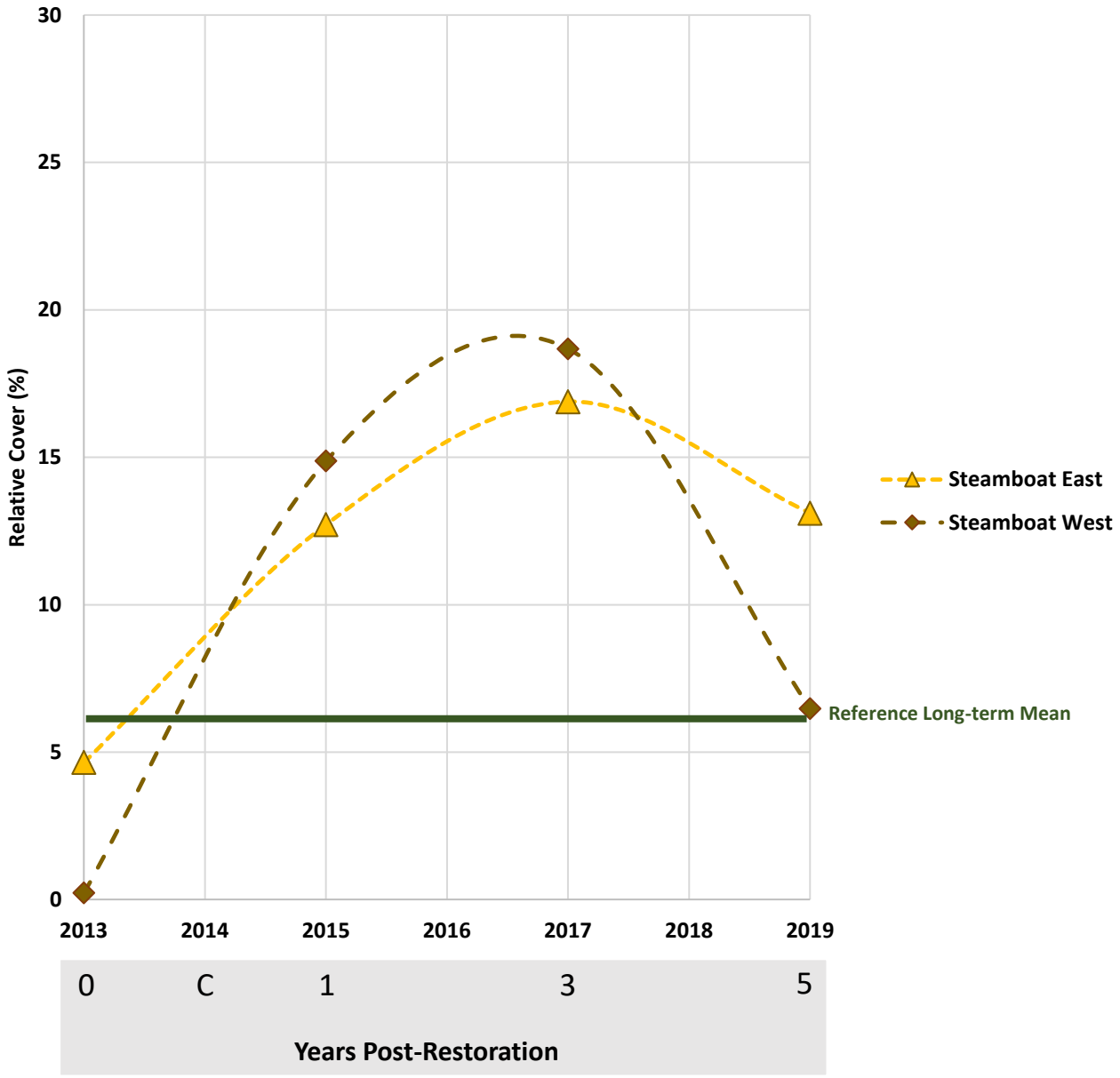
**Steamboat:** Reed canarygrass, *Phalaris arundinacea,* Soft rush, *Juncus effuses*

**Reference:** Reed canarygrass, *Phalaris arundinacea*, Common forget-me-not, *Myosotis scorpioides*



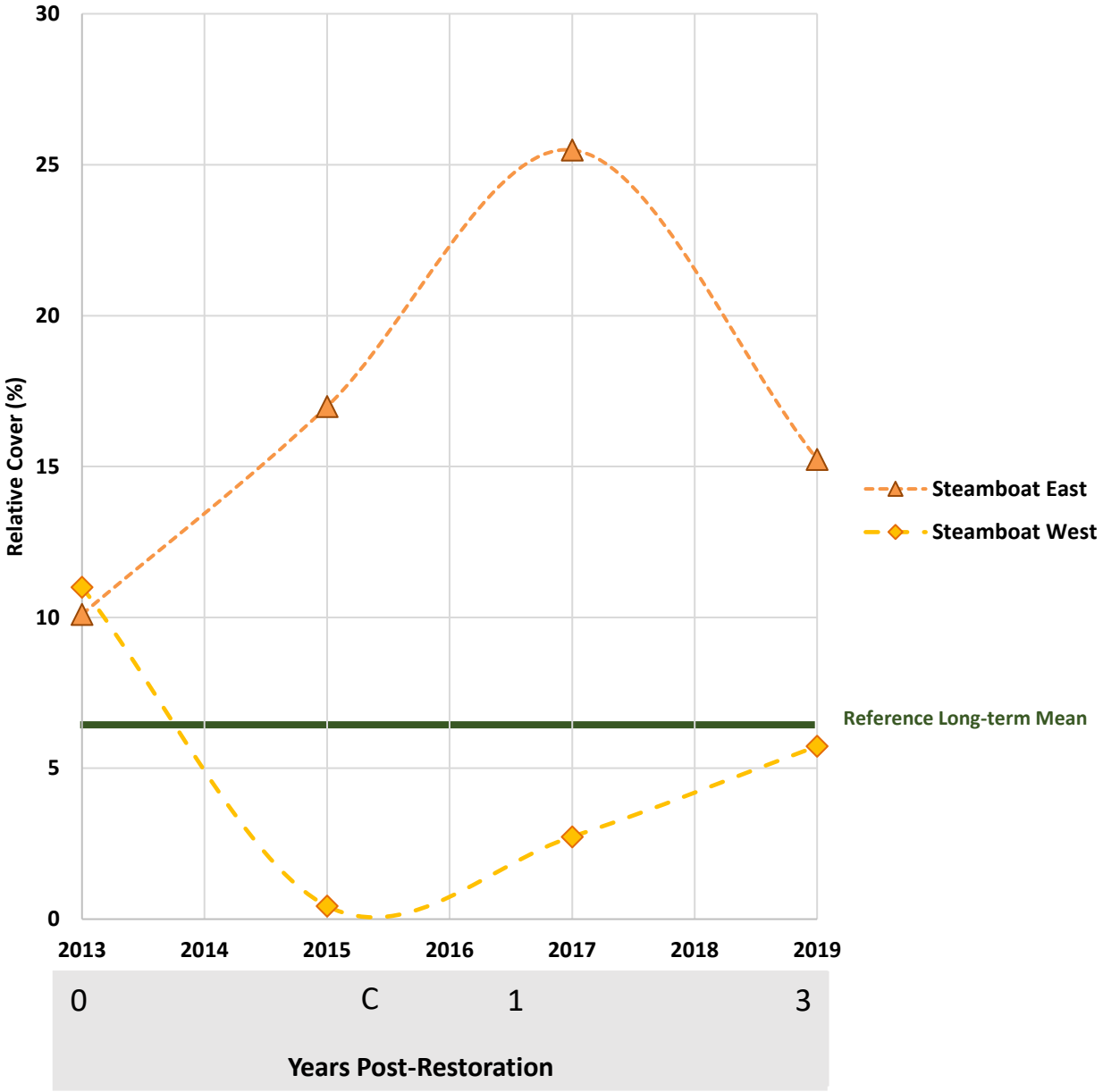
# Intensive Veg Monitoring Area Results

## Bareground and Standing Dead (%)





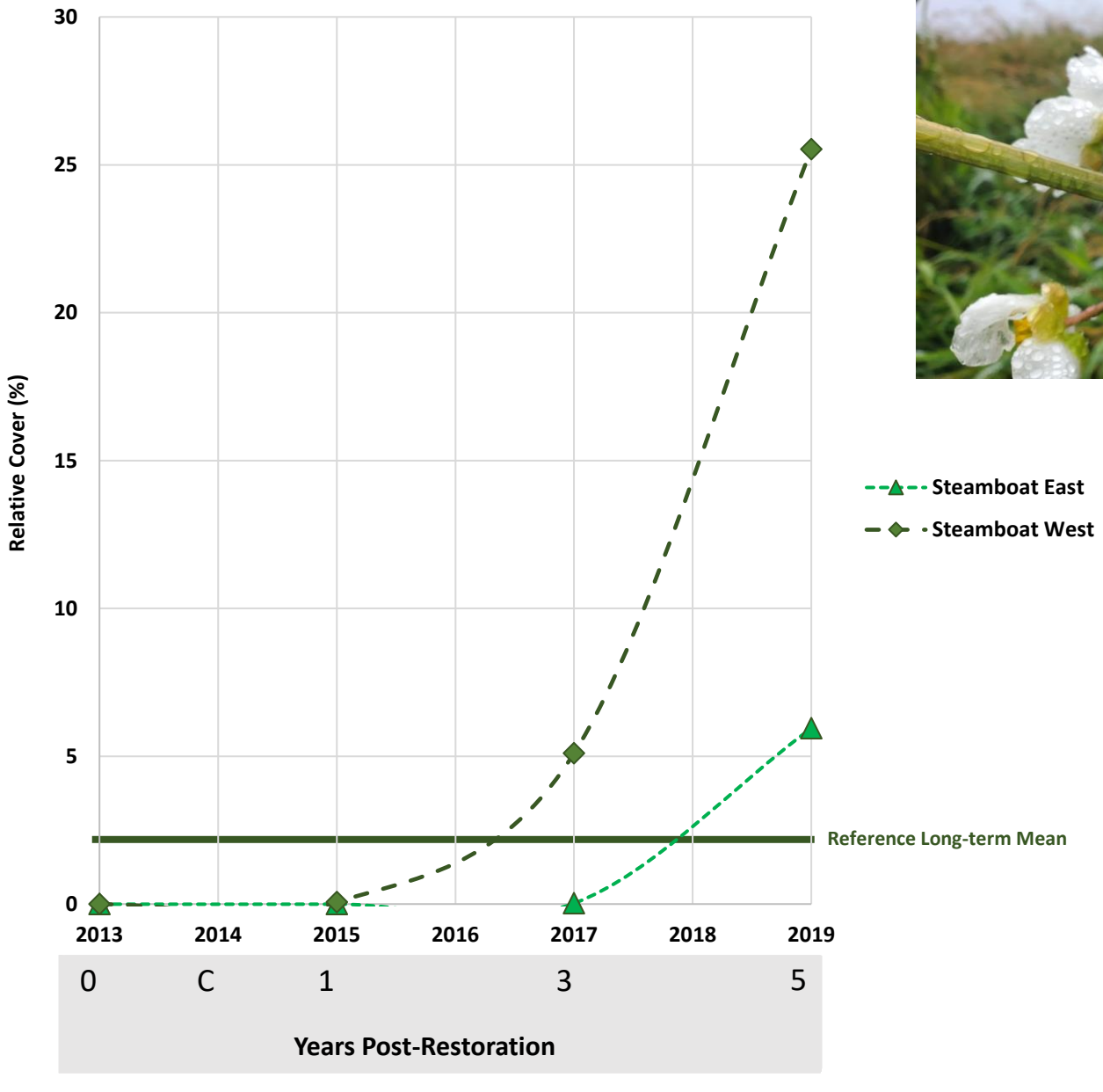
## Reed canarygrass, *Phalaris arundinacea, Non-native*




### Steamboat East (2019)


### Steamboat West (2019)

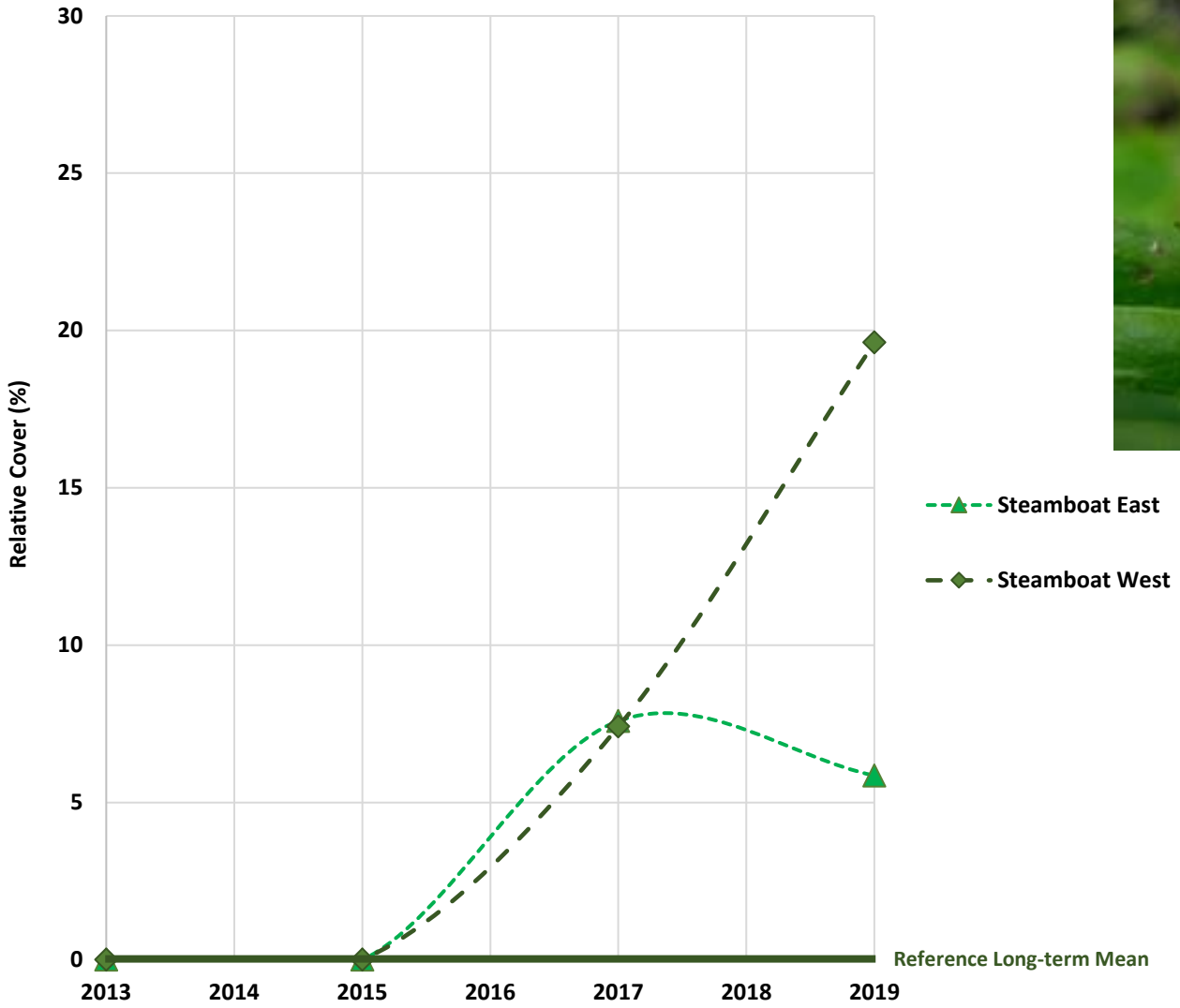
## Wapato, *Sagittaria latifolia*, Native



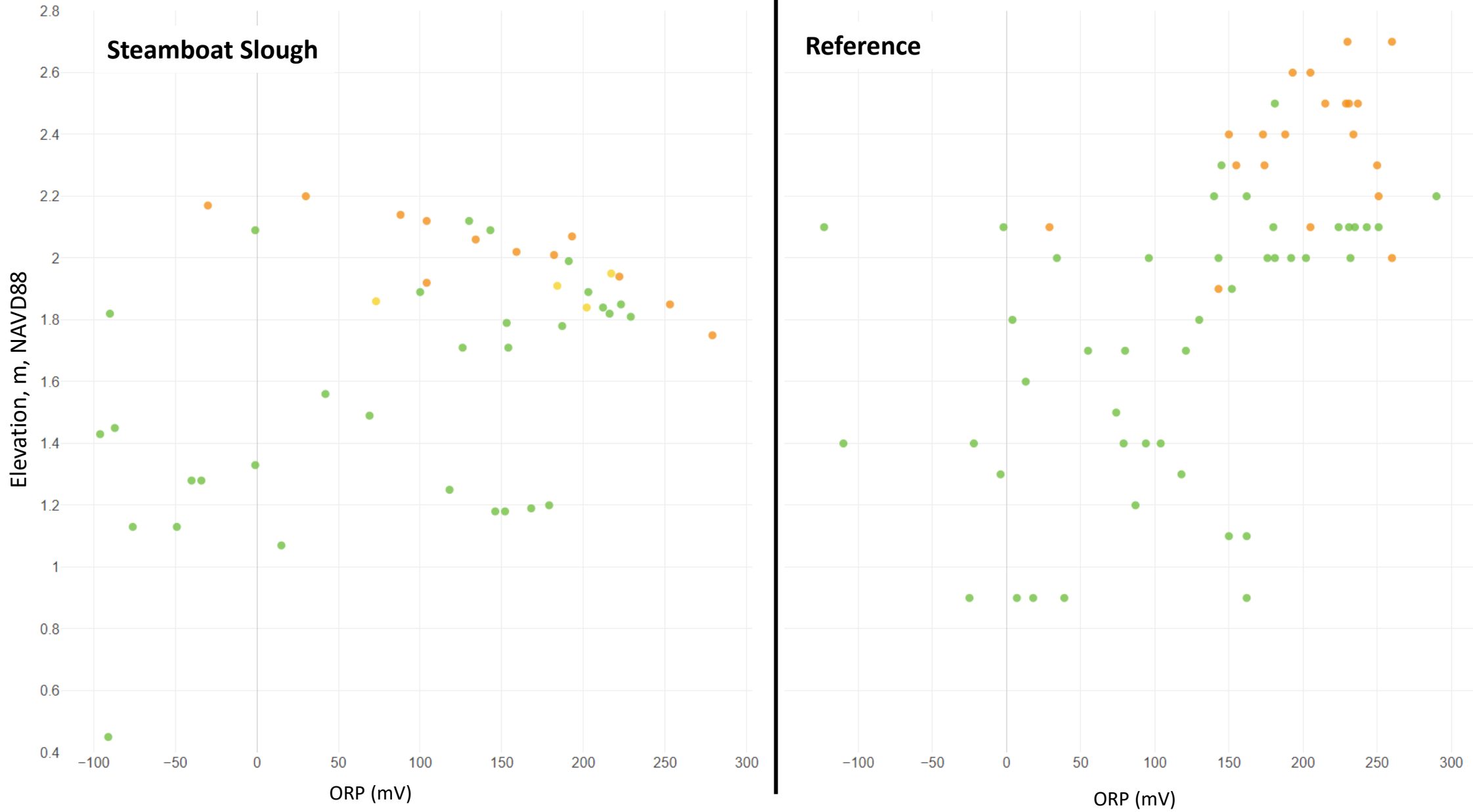

## Steamboat East (2019)


## Nodding beggars-ticks, *Bidens cernua*, Native

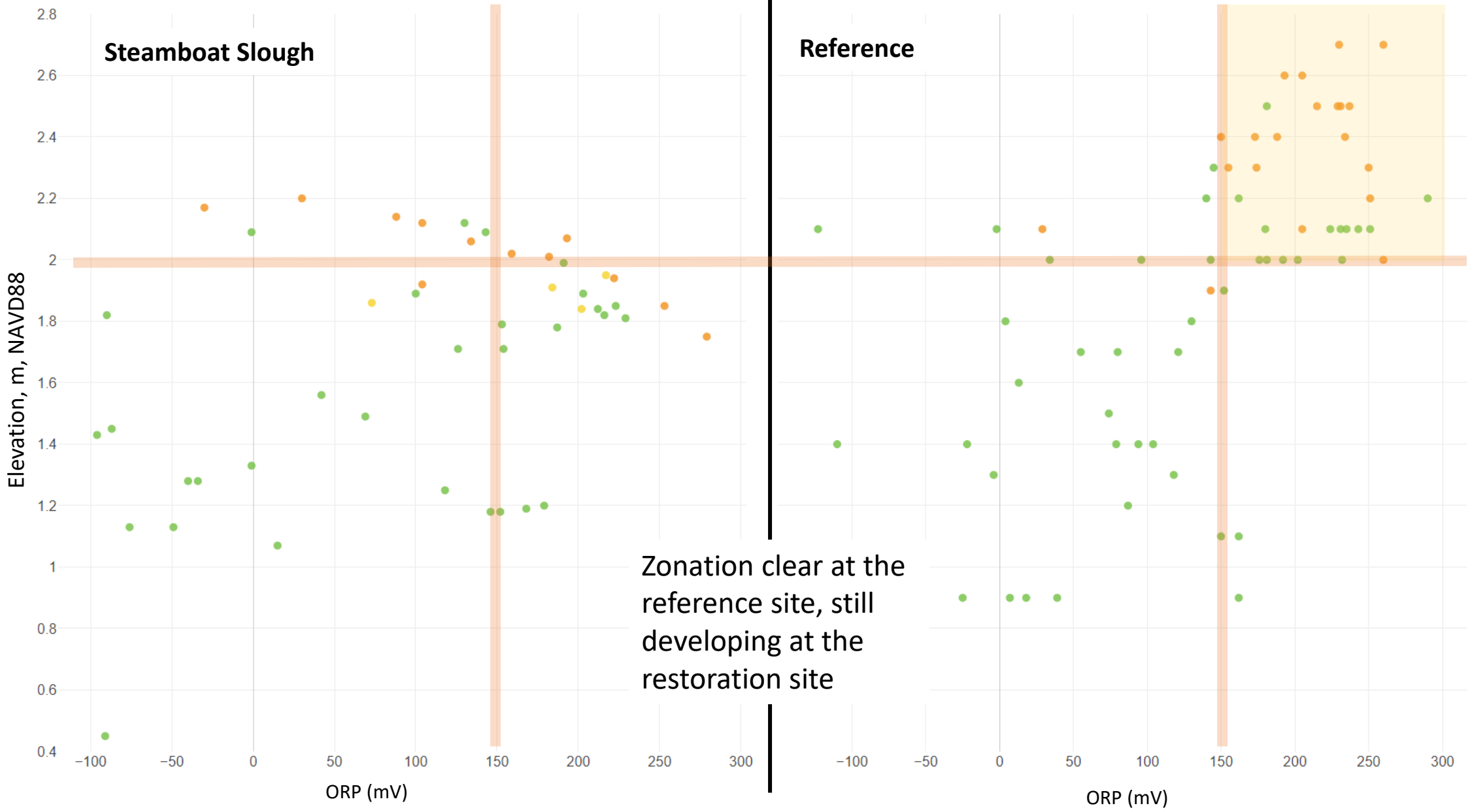


# Wetland Elevation vs. Soil ORP



# Wetland Elevation vs. Soil ORP




Zonation clear at the reference site, still developing at the restoration site

Native: Lyngbye's sedge, Wapato, Spike Rush

Native/Non-native Mix

Non-native: Reed canarygrass, Common rush

# Steamboat Slough Conclusions

- Robust wetland soil and native plant community development
- Ecosystem Monitoring Program Study: Biomass and soil characteristics at reference levels by 3 years post-restoration (Kidd et al. 2019)
- Level 1 PNNL and NMFS (2020) Fish and Flux Studies: show high productivity at the site with both fish use and macro/detritus flux 3-5 years post-restoration
- 2024 – *Year 10 monitoring check-in and (hopefully) full site UAV analysis*

***Steamboat East (2019)***

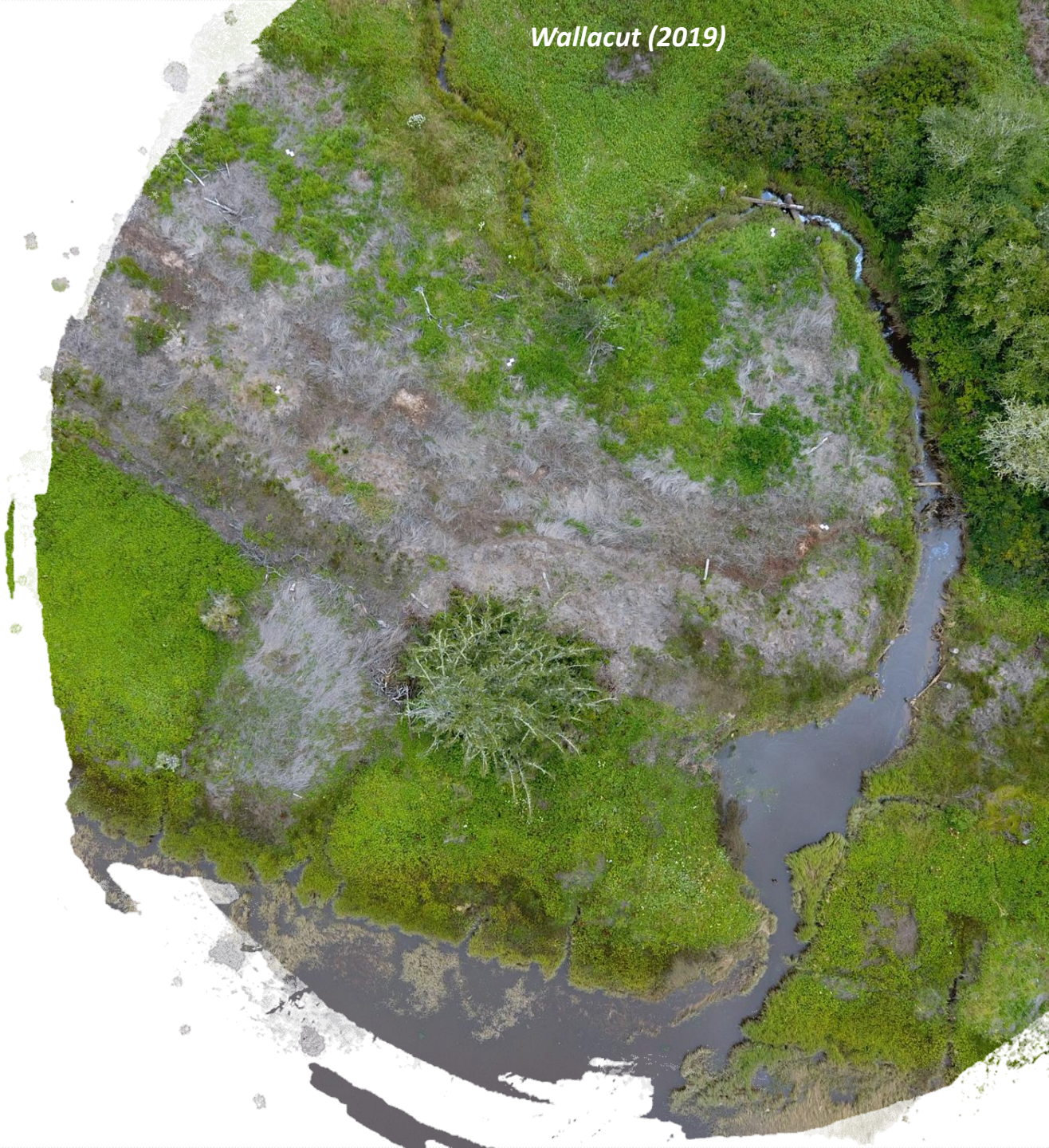
# Next steps

## Monitoring/Research

- Consistently incorporate UAV veg and soil conditions monitoring into all Level 2 data collection
- UAV general photo monitoring recommended for all sites (Level 1-3)
- Increase number and distribution of sed benches/pins across sites
- Monitor water salinity at Wallacut
- Monitoring Protocols Update (Fall 2021) (link)

## Restoration trajectories - adaptive management suggestions

- Reduce herbicide treatments at Wallacut
- Reduce grazing intensity at North Unit Phase 2



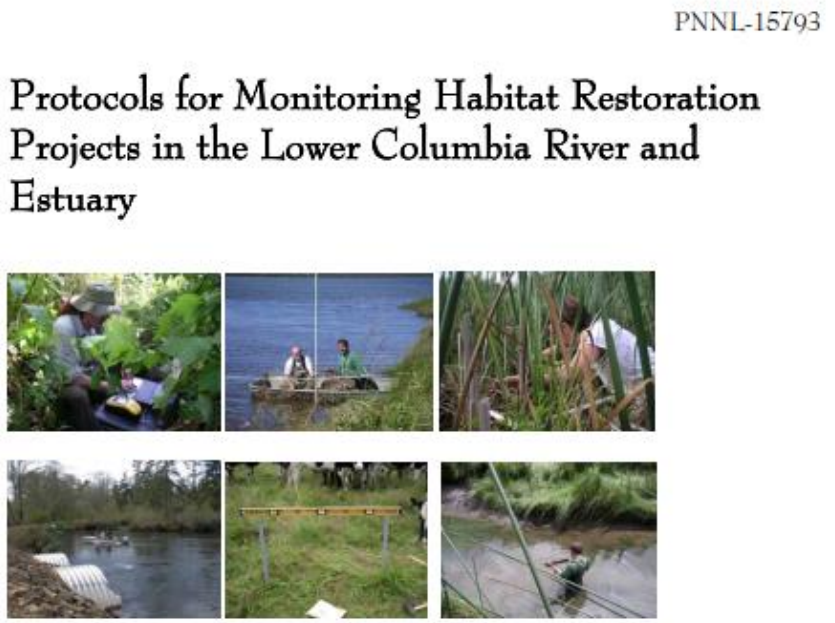
# Thank You!
# Questions?

Report Published 8/2020: *https://www.estuarypartnership.org/action-effectiveness-monitoring-lower-columbia-river-and-estuary-habitat-restoration-program-1*

# SWG Group Discussion

- What thresholds and endpoints are we looking for to determine if more restoration or monitoring is needed?
  - Project Design
  - Frequency of Monitoring

- How should we better incorporate monitoring data into an adaptive management framework?
  - Site topography and hydrology
  - Wetland plant community
  - UAV Technology
  - Fish and Macroinvertebrate Sampling



PNNL-15793

Protocols for Monitoring Habitat Restoration Projects in the Lower Columbia River and Estuary

G. C. Roegner
H. L. Diefenderfer
A. B. Borde
R. M. Thom
E. M. Dawley
A. H. Whiting
S. A. Zimmerman
G. E. Johnson

Final Report
April 25, 2008

Prepared for the U.S. Army Corps of Engineers
Portland District, Portland, Oregon
Under a Related Services Agreement
with the U.S. Department of Energy
Contract DE-AC05-76RL01830

US Army Corps of Engineers

Pacific Northwest National Laboratory
Operated by Battelle for the U.S. Department of Energy

NOAA

CREST

# Additional Efforts – Monitoring Protocols Update

- 2018 & 2019 - Provided Update to WSE/Temp Monitoring
- 2020 – Provided Update to Sediment Accretion Monitoring, Soil Monitoring, Channel Cross-Sections
  - April Silva (CREST) started drafting an ***updated Protocol Document*** incorporating some of these updates
- 2021
  - Winter-Summer: Continue to Update the New DRAFT Protocols
  - Fall: Distribute Draft Protocols for Comment