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Reed Canarygrass Research Overview

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Marine Sciences Laboratory
Sequim, Washington

Overview of Research

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- Focused in the Lower Columbia River Estuary
- Conducted in the context of juvenile salmonid habitat restoration
- Primary areas of research:
  - Environmental controlling factors
  - Food web effects
  - Methods to reduce invasion in restoration

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Phalaris arundinacea vs. *Carex lyngbyei*: a comparison of the food web contribution between non-native and native wetland species

Amy Borde[1], Valerie Cullinan[1], Ronald Thom[1], Amanda Hanson[2] , and Catherine Corbett[2]

1 Pacific Northwest National Laboratory
2 Lower Columbia Estuary Partnership

Overview

- Context
  - Where & Why
- Hypotheses
- Methods
- Findings

- 660,480 km^2 Basin
- Drowned River Valley
- 2nd to Mississippi in discharge to Ocean
- Tidal to Bonneville Dam Rkm 235
- 15 km wide
- Seawater intrusion approximately 20-40 km depending on seasonal flows (Chawla et al. 2008)
- Historical Unregulated Flows: 2,237 m^3/s in the fall to maximum flood flows of over 28,317 m^3/s during spring freshets (Sherwood et al. 1990)

Altered Hydrograph

- 30 major dams and numerous minor dams throughout the basin
- Diking and >40% flow reduction during spring freshet → 62% reduction shallow water juvenile salmon habitat in estuary. (Kukulka and Jay 2003a)

Restoration program to improve juvenile salmonid habitat

Study Question

What are the effects of aquatic invasive species on food webs supporting juvenile salmon?

Specifically,

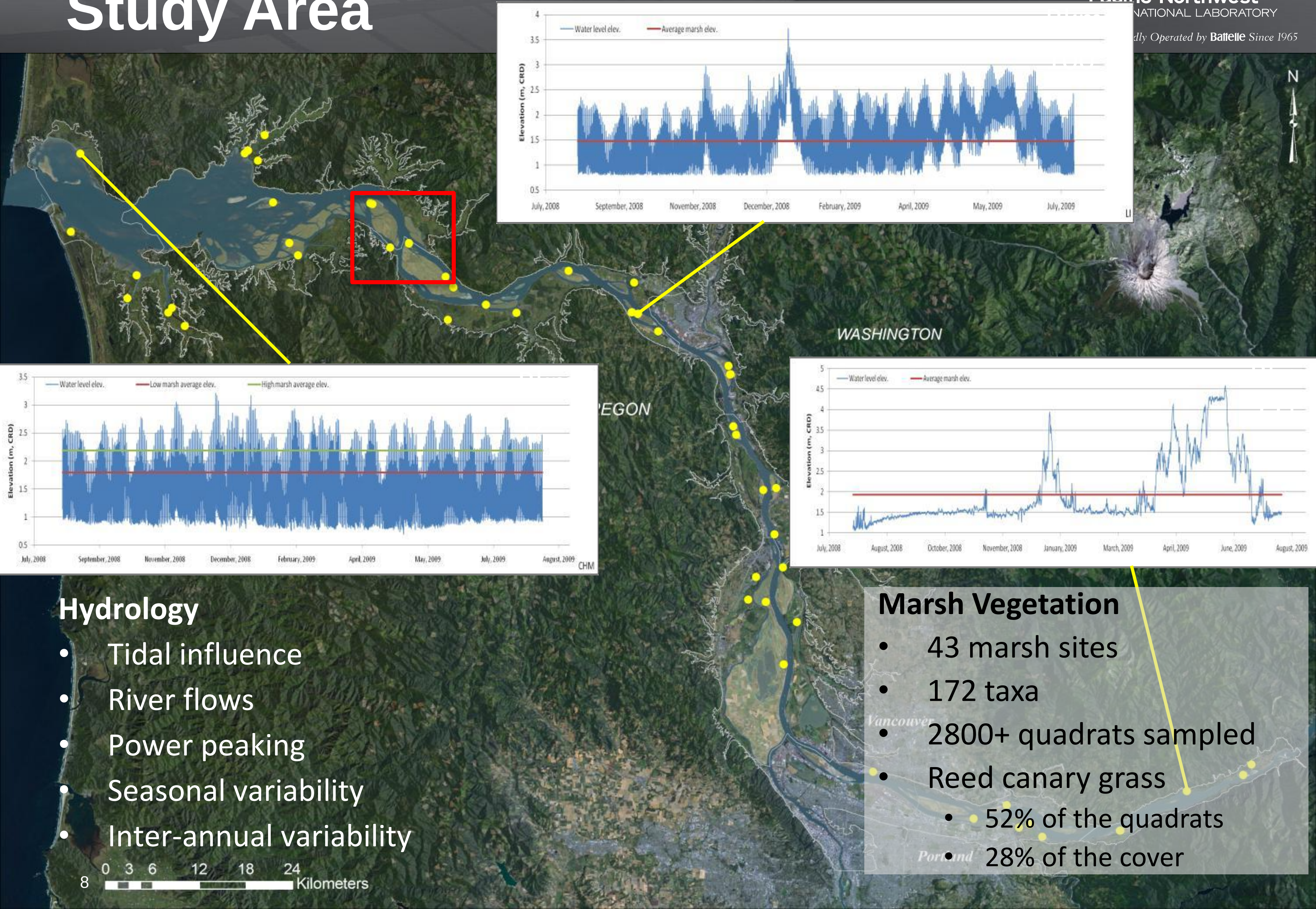
1) Are there differences in the macroinvertebrate community structure or availability of salmon prey taxa in *Phalaris arundinacea* (PHAR) vs native sedge *Carex lyngbyei* (CALY) dominated habitats?

2) Does the supply, quality, or retention of macrodetritus differ between PHAR and CALY?

Hypotheses

1. There is a difference in macroinvertebrate (i.e., important salmon prey) density, biomass, and community between patches of PHAR and CALY.
2. The production and quality of available macrodetritus decreases with increasing percent cover of PHAR.
3. Decomposition rates and detritus quality of PHAR are lower than that of CALY during the juvenile salmon migration period.
4. Macrodetritus production is lower in areas of higher percent cover of PHAR.

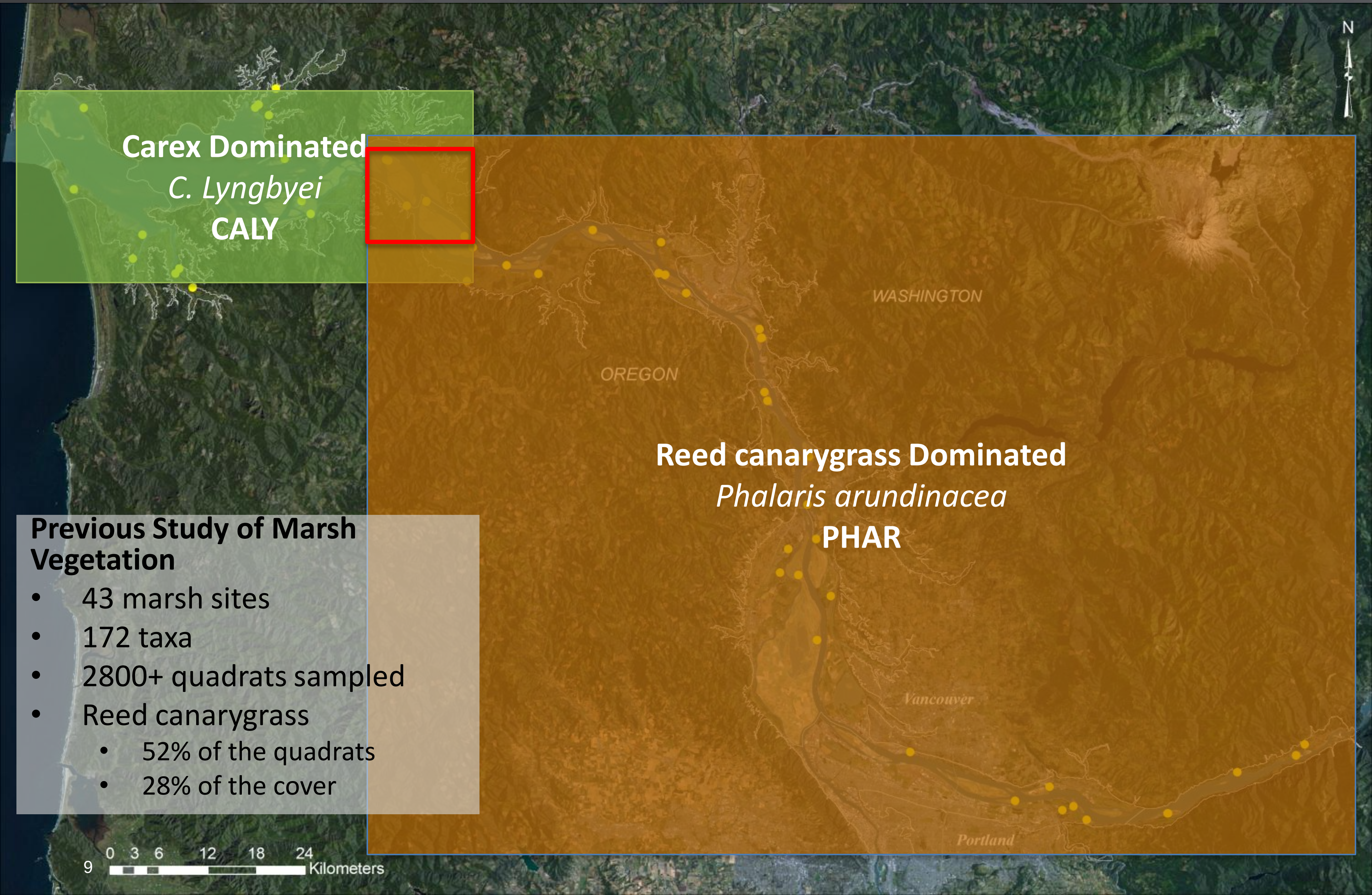
Study Area



Hydrology
- Tidal influence
- River flows
- Power peaking
- Seasonal variability
- Inter-annual variability

Marsh Vegetation
- 43 marsh sites
- 172 taxa
- 2800+ quadrats sampled
- Reed canary grass
  - 52% of the quadrats
  - 28% of the cover

Study Area



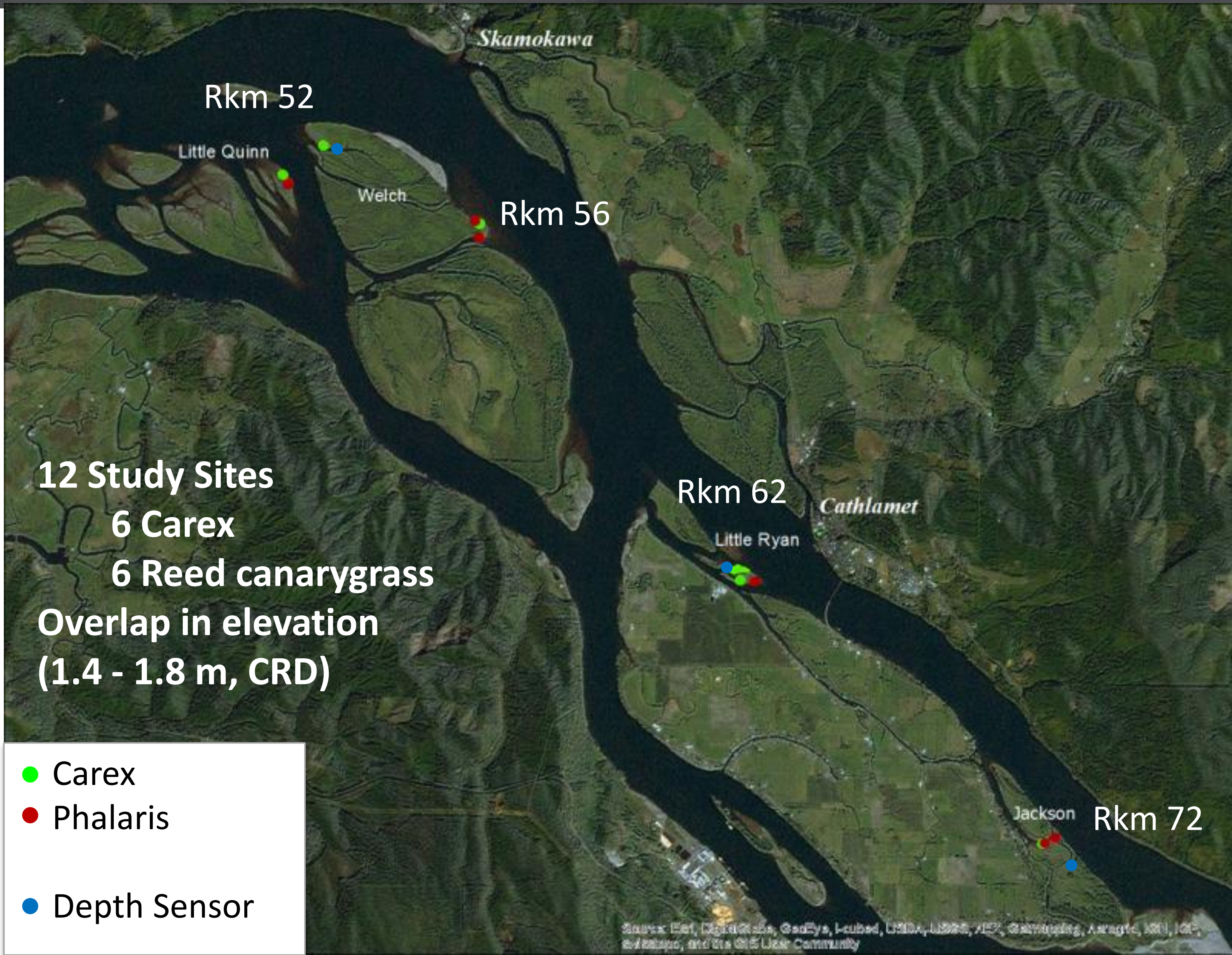
Carex Dominated
C. Lyngbyei
CALY

Reed canarygrass Dominated
Phalaris arundinacea
PHAR

Previous Study of Marsh Vegetation

- 43 marsh sites
- 172 taxa
- 2800+ quadrats sampled
- Reed canarygrass
  - 52% of the quadrats
  - 28% of the cover

Study Area

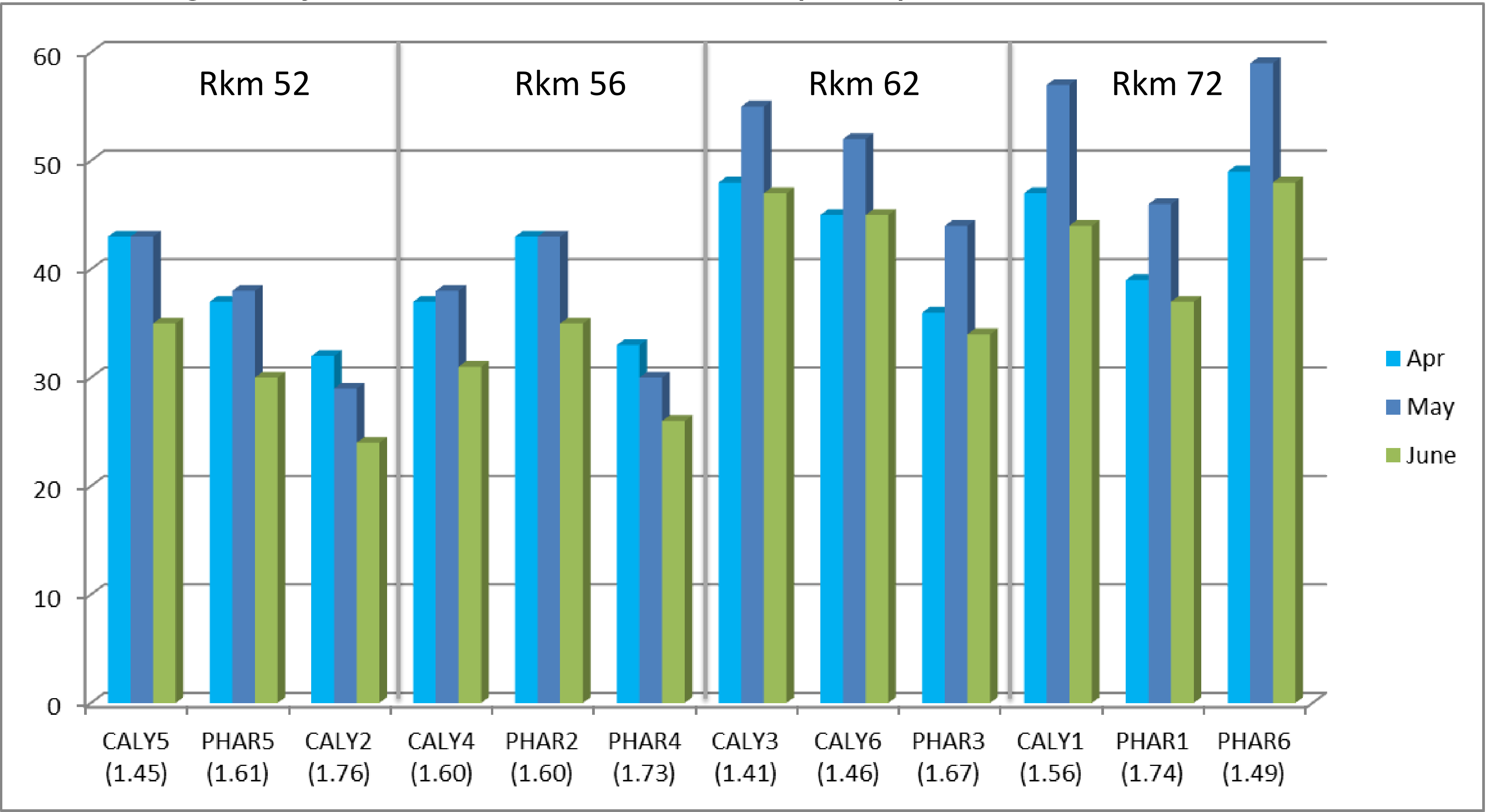

Skamokawa
Rkm 52
Little Quinn
Welch
Rkm 56
Rkm 62
Cathlamet
Little Ryan
Jackson
Rkm 72
12 Study Sites
6 Carex
6 Reed canarygrass
Overlap in elevation
(1.4 - 1.8 m, CRD)
Carex
Phalaris
Depth Sensor

Methods

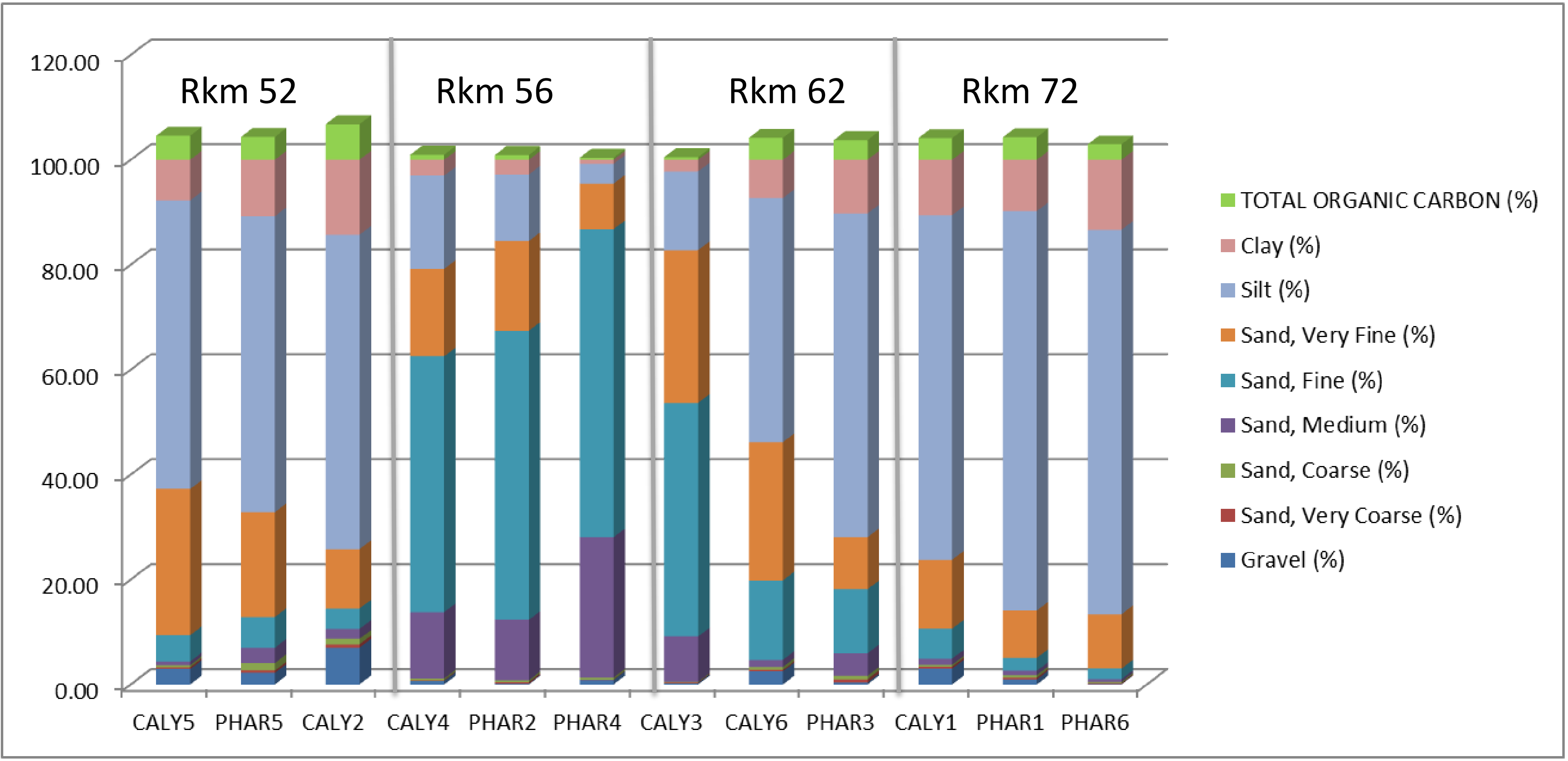
- Environmental Variables
  - Elevation, hydrology, substrate, vegetation cover at site and landscape scale
- In situ detritus
  - Collected April and June, n = 98
  - 10 cm cores, top 1 cm
  - Dry wt, Carbon, Nitrogen, C:N
- Litter bags
  - 2 mesh sizes: 130µm and 2mm, n = 50
  - Deployed in April: 75 and 120 days
  - Dry wt, Carbon, Nitrogen, C:N
  - Invertebrate ID and weight
- Macrodetritus production
  - 0.10 m^2 above ground biomass n = 48
  - Divided into PHAR, CALY, Other and live/dead
  - August = summer peak, Feb = remaining after winter

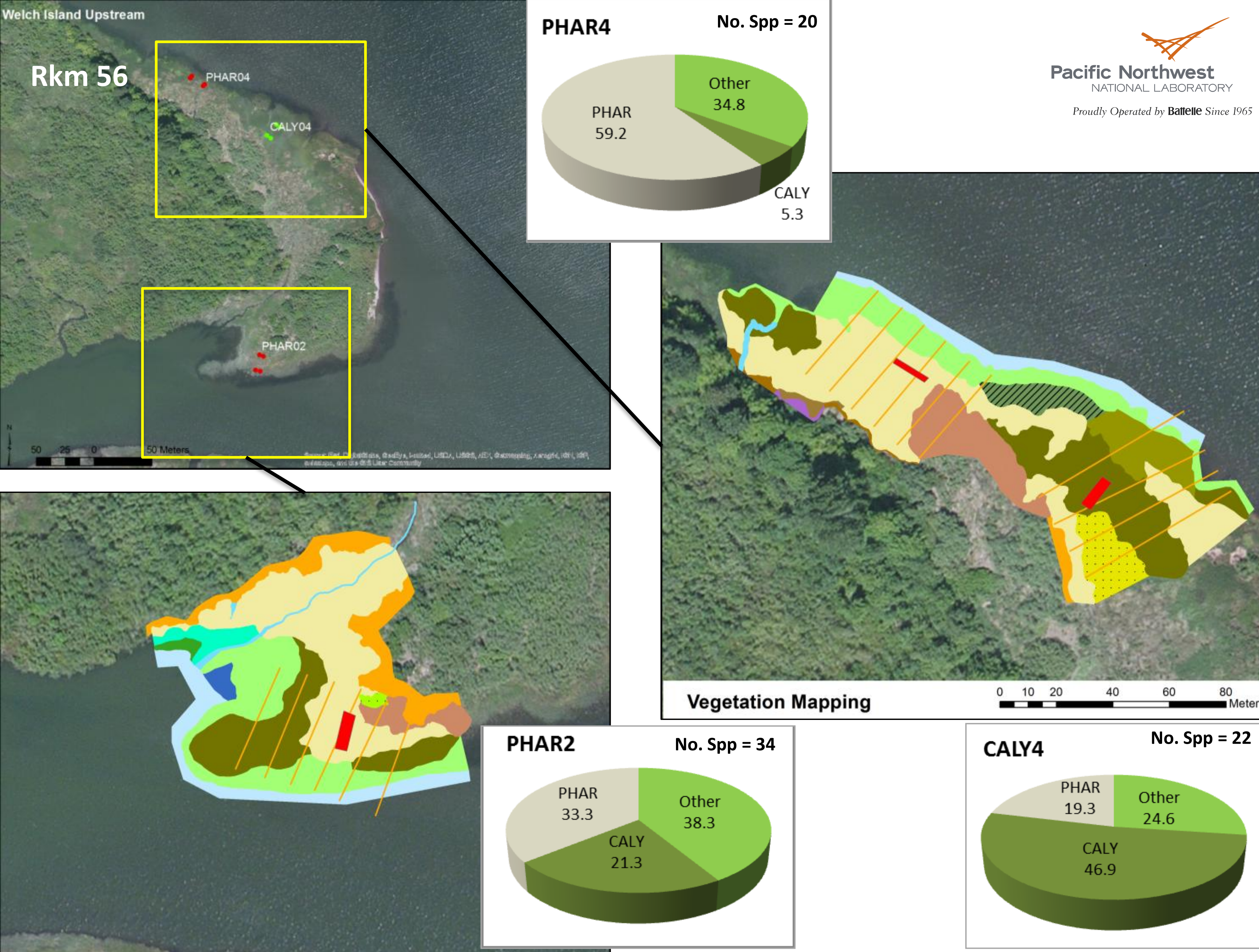
Inundation

- Positively correlated with rkm (0.70)
- Negatively correlated with elevation (-0.76)



Substrate


120.00
100.00
80.00
60.00
40.00
20.00
0.00
Rkm 52
Rkm 56
Rkm 62
Rkm 72
CALY5
PHAR5
CALY2
CALY4
PHAR2
PHAR4
CALY3
CALY6
PHAR3
CALY1
PHAR1
PHAR6
TOTAL ORGANIC CARBON (%)
Clay (%)
Silt (%)
Sand, Very Fine (%)
Sand, Fine (%)
Sand, Medium (%)
Sand, Coarse (%)
Sand, Very Coarse (%)
Gravel (%)



Welch Island Upstream
Rkm 56
PHAR04
CALY04
PHAR02
50 25 0 50 Meters
PHAR4
No. Spp = 20
Other
34.8
PHAR
59.2
CALY
5.3
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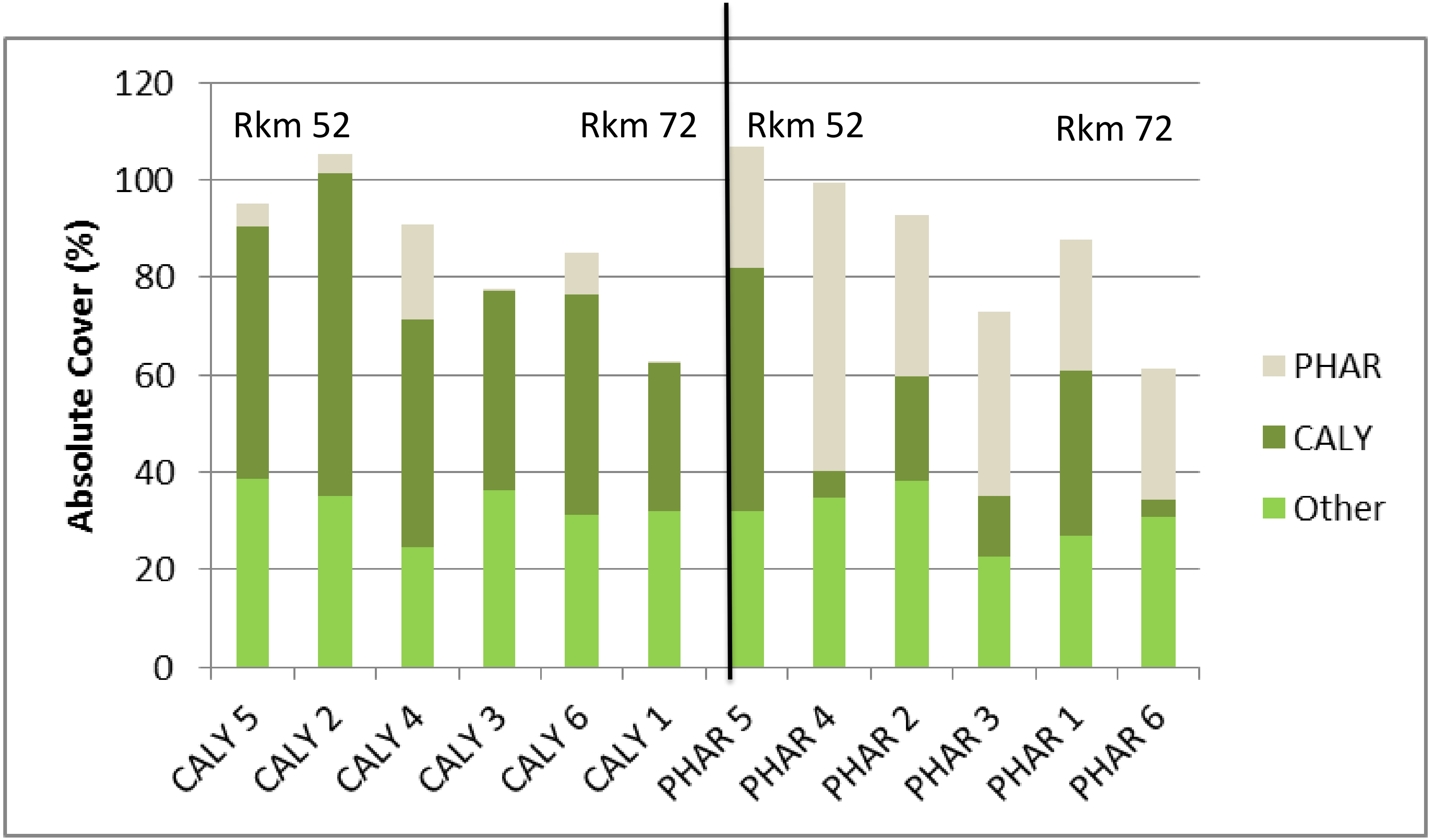
Vegetation Mapping
0 10 20 40 60 80
Meters
PHAR2
No. Spp = 34
PHAR
33.3
Other
38.3
CALY
21.3
CALY4
No. Spp = 22
PHAR
19.3
Other
24.6
CALY
46.9

Cover – Site (landscape)



Cover – Study Plot

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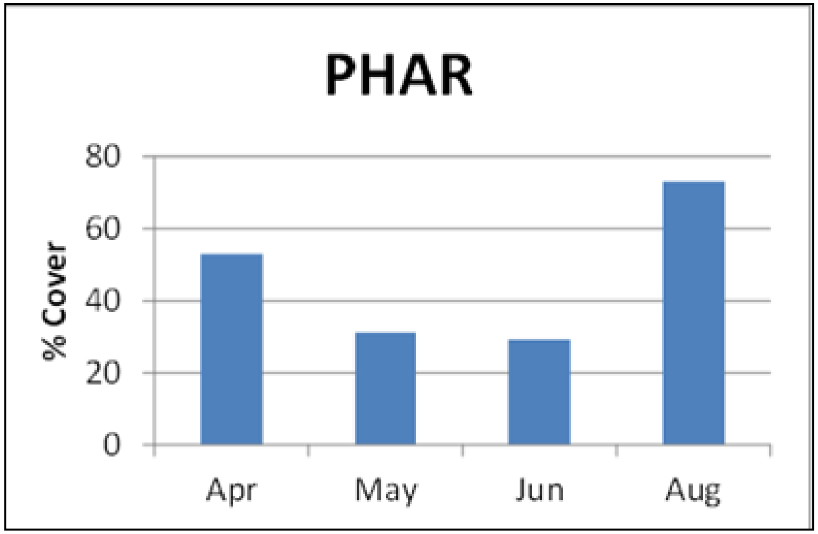
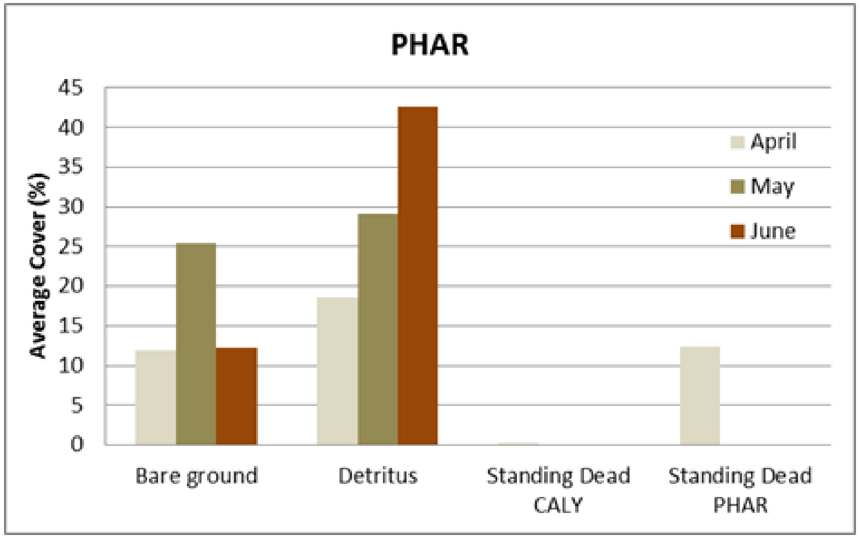
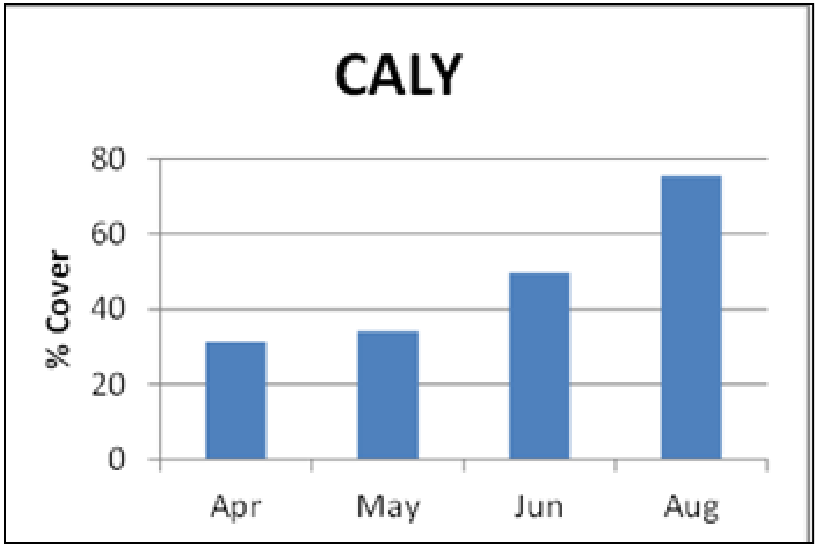
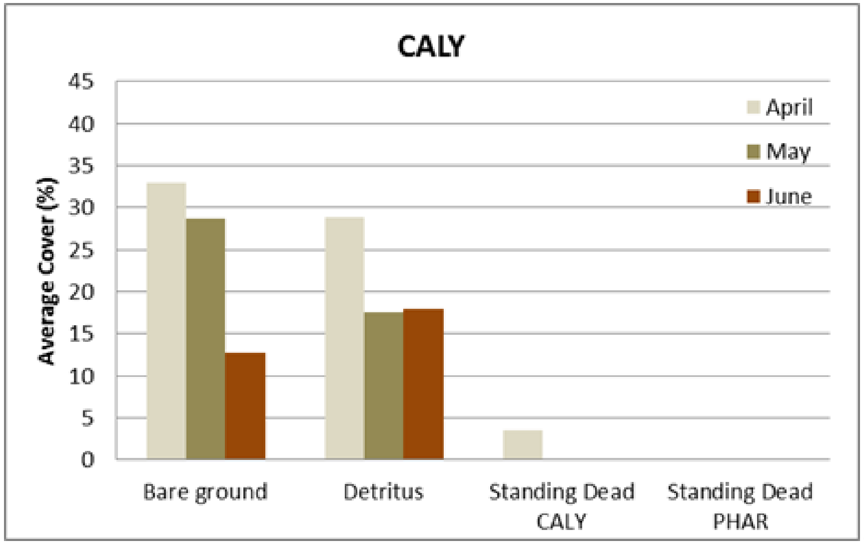








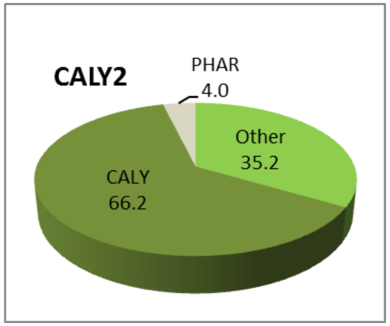
Hypothesis 2 – *In situ* Macrodetritus

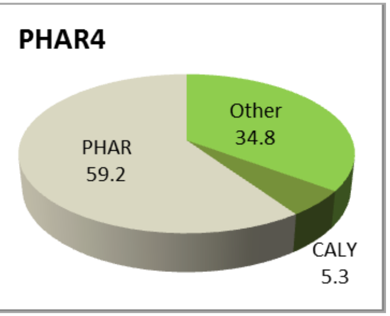
The production and quality of macarodetritus *that is available when salmon prey are present* decreases with increasing percent cover of PHAR.

Objectives

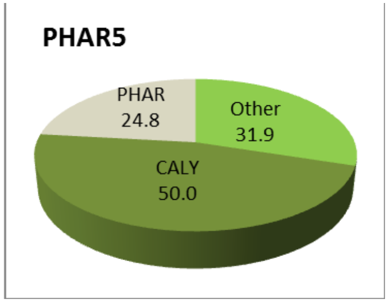
- Assess the **quantity** (dry weight) of detritus at the time of invertebrate sampling to understand macrodetrital production potential available to macroinvertebrates, particularly salmon prey.
- Assess the **quality** of detritus (C: N ratio, Findlay et al. 1990) at the time of invertebrate sampling to understand the quality of detrital food resources that are available to macroinvertebrates, particularly salmon prey.

Hypothesis 2 – *In situ* Macrodetritus





Hypothesis 2 – *In situ* Macrodetritus



32% of PHAR samples contained CALY
13% of CALY samples contained PHAR

Hypothesis 2 – *In situ* Macrodetritus

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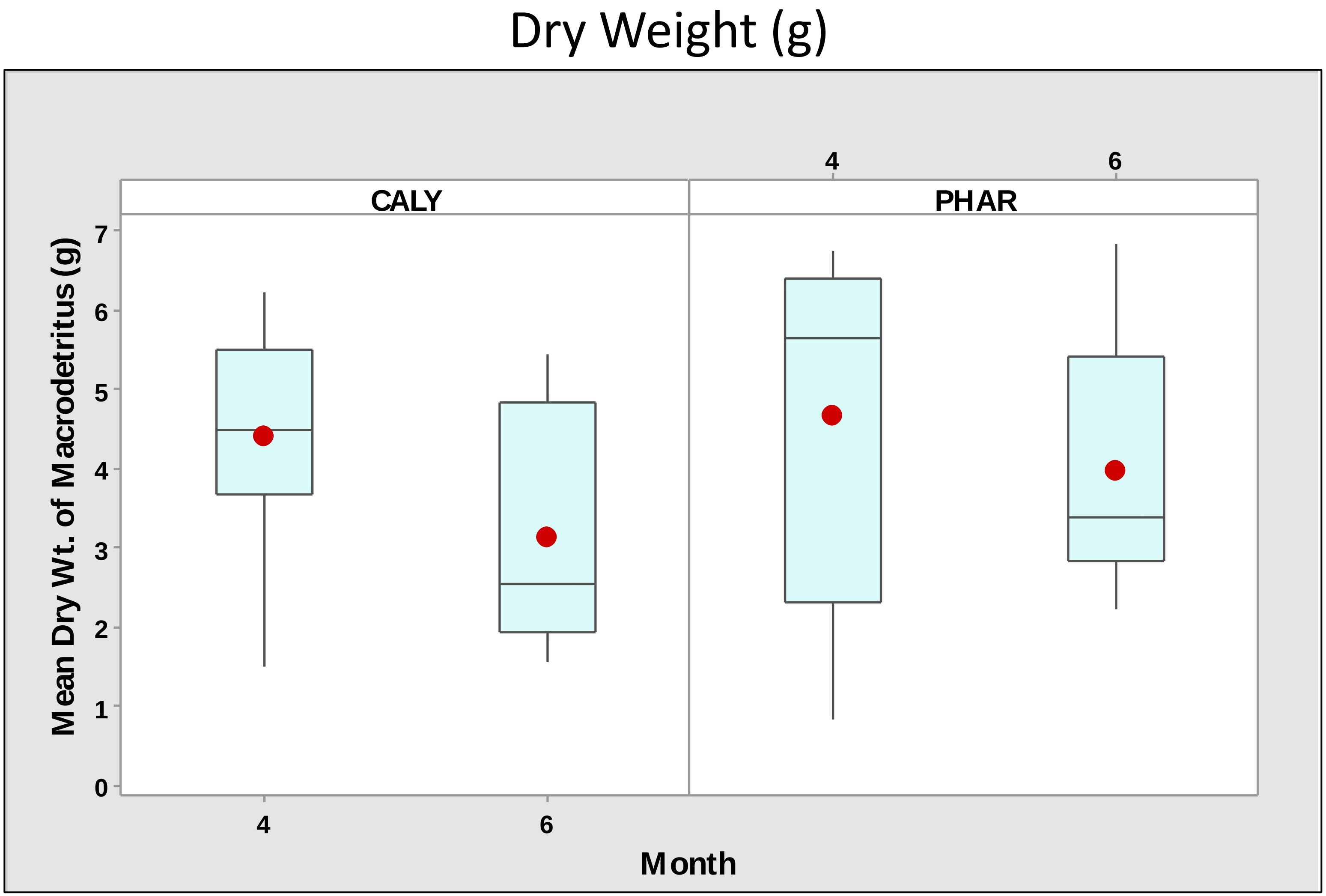

No Significant Difference

Hypothesis 2 – *In situ* Macrodetritus

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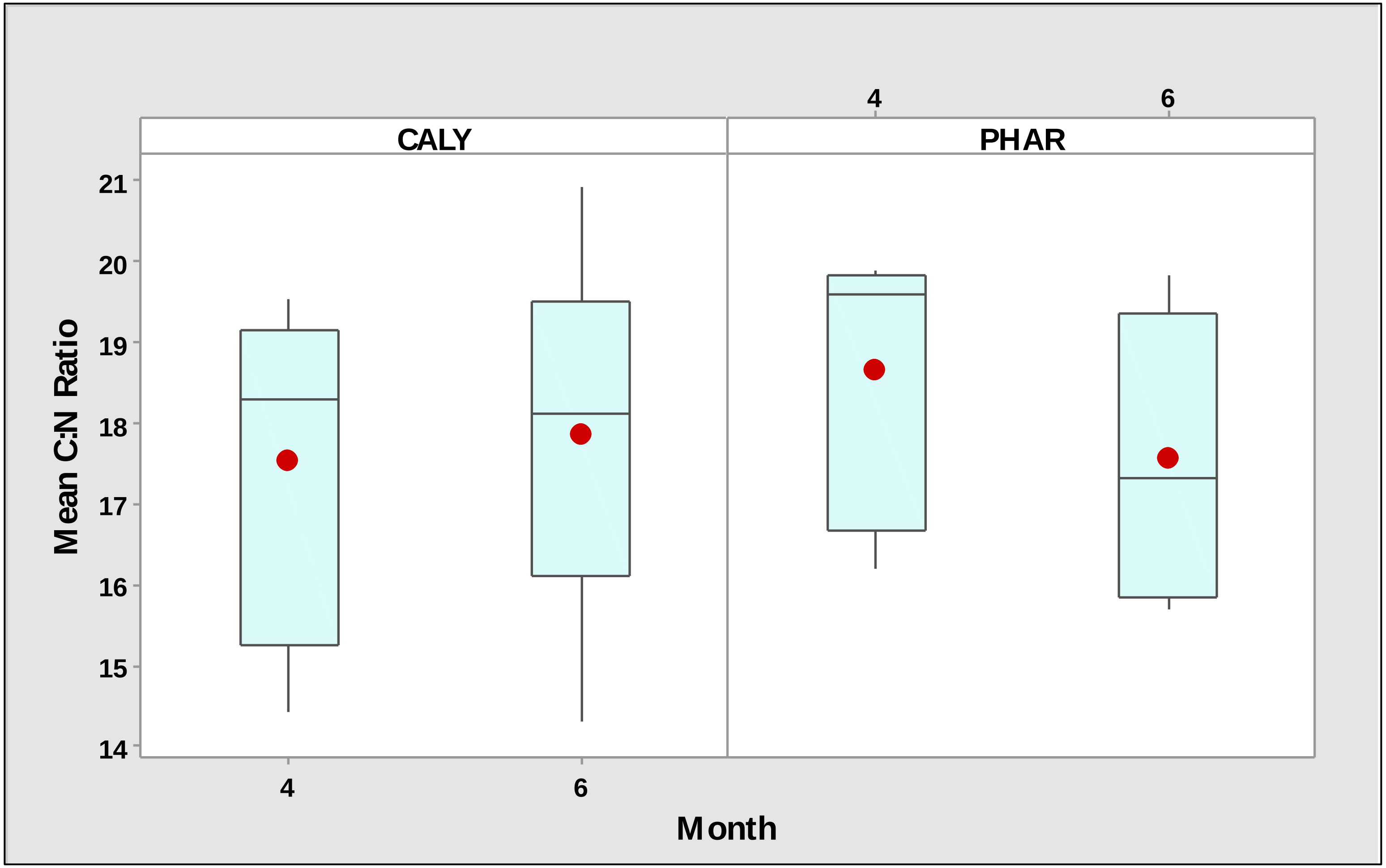
Carbon:Nitrogen



No Significant Difference

Hypothesis 2 – *In situ* Macrodetritus

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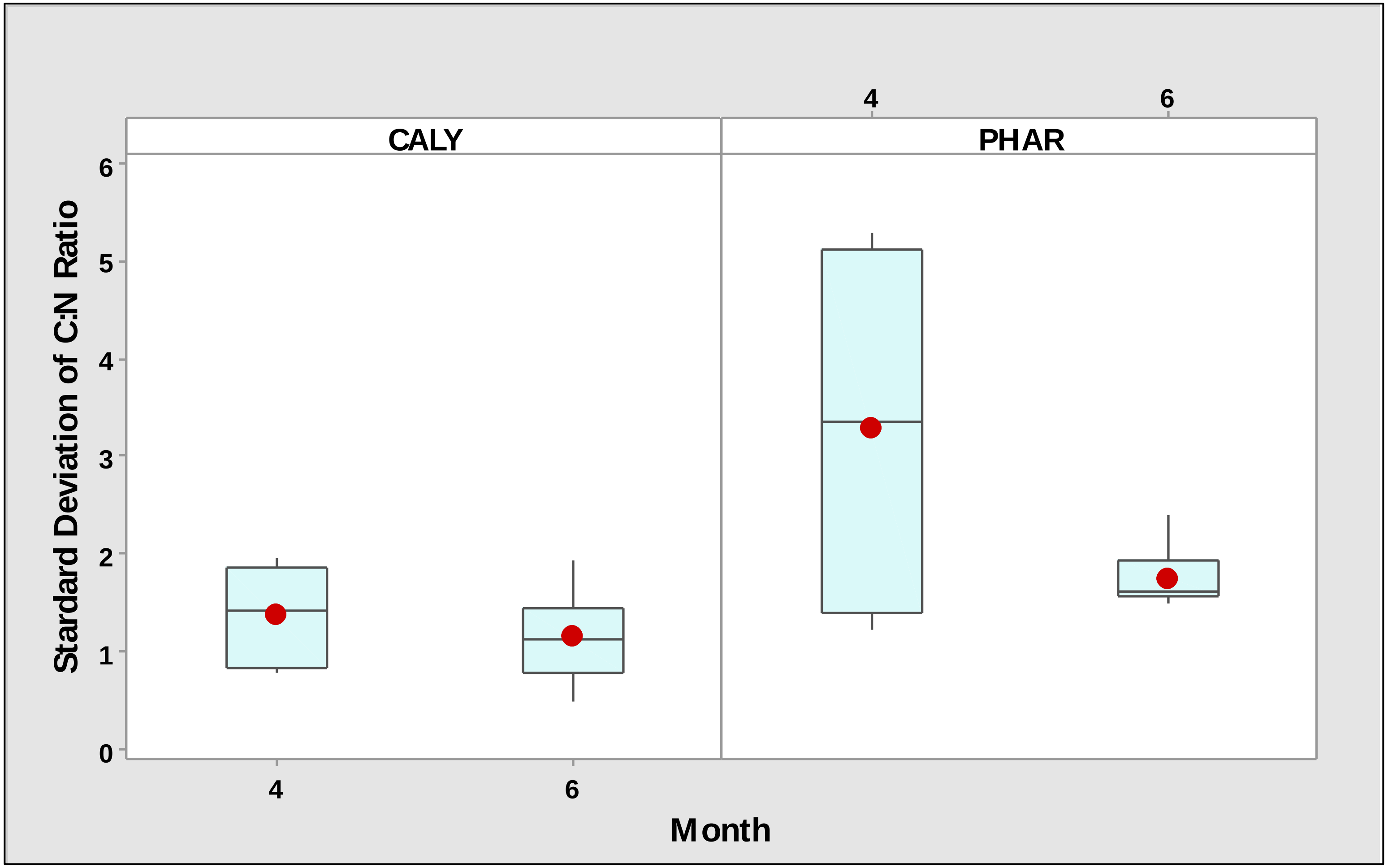
St. Dev Carbon:Nitrogen



PHAR > CALY p = 0.001

Hypothesis 3 – Litter Bags

Decomposition rates and the detritus quality of *P. arundinacea* are lower than those in *C. lyngbyei* over the salmon migration season.

Objectives

- Assess the change in detrital biomass over time for both vegetation types (*P. arundinacea* and *C. lyngbyei*)
- Assess the change in biomass of each vegetation type that is due to macroinvertebrate consumption
- Assess the type and density of macroinvertebrates that colonize each vegetation type at varying points in the season
- Assess the change in quality of each vegetation type over time

Hypothesis 3 – Litter Bags

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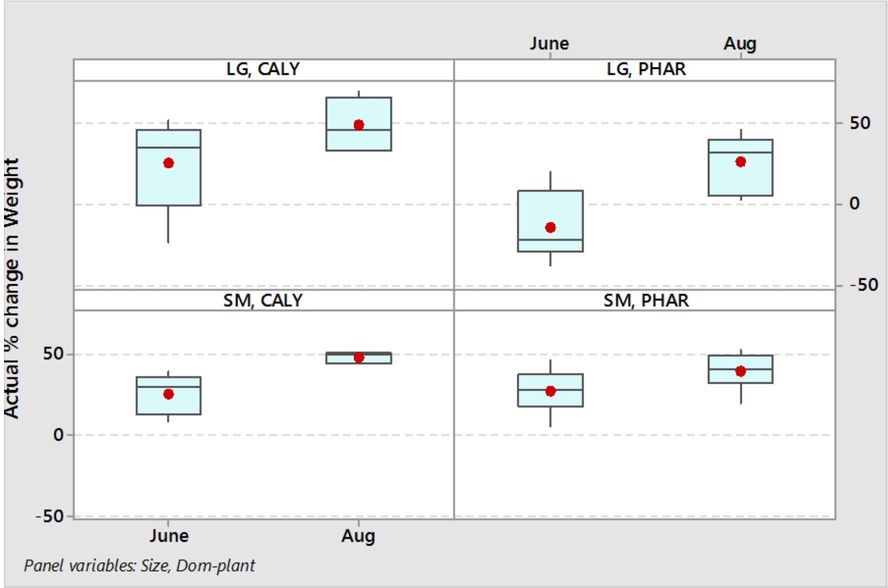
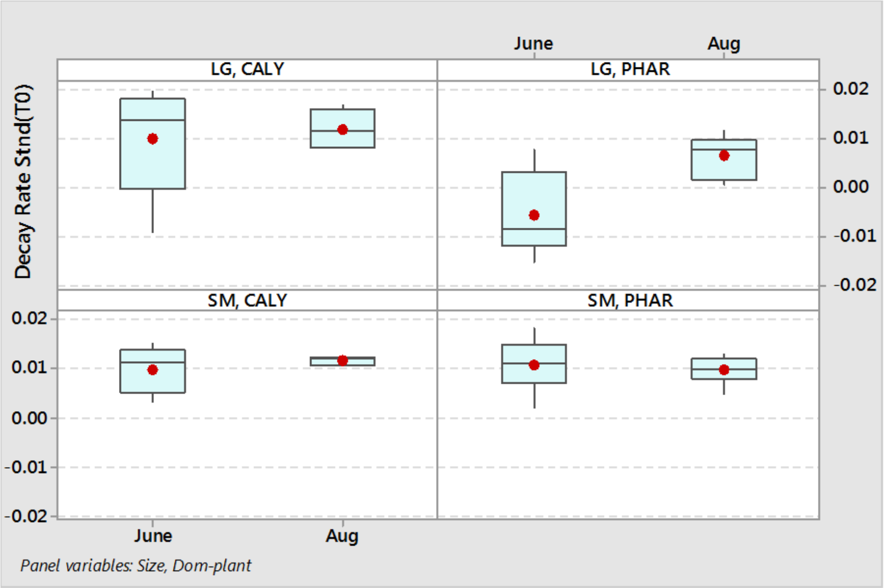
% Change in Weight



Decay Rate (g/day)



<u>Large bags</u>
PHAR 26%
CALY 49%
(p=0.004)

<u>Small bags</u>
PHAR 40%
CALY 48%
(NS)

<u>Large bags</u>
PHAR 6 mg/day
CALY 12 mg/day
(p=0.005)

<u>Small bags</u>
PHAR 10 mg/day
CALY 12 mg/day
(NS)

Hypothesis 3 – Litter Bags

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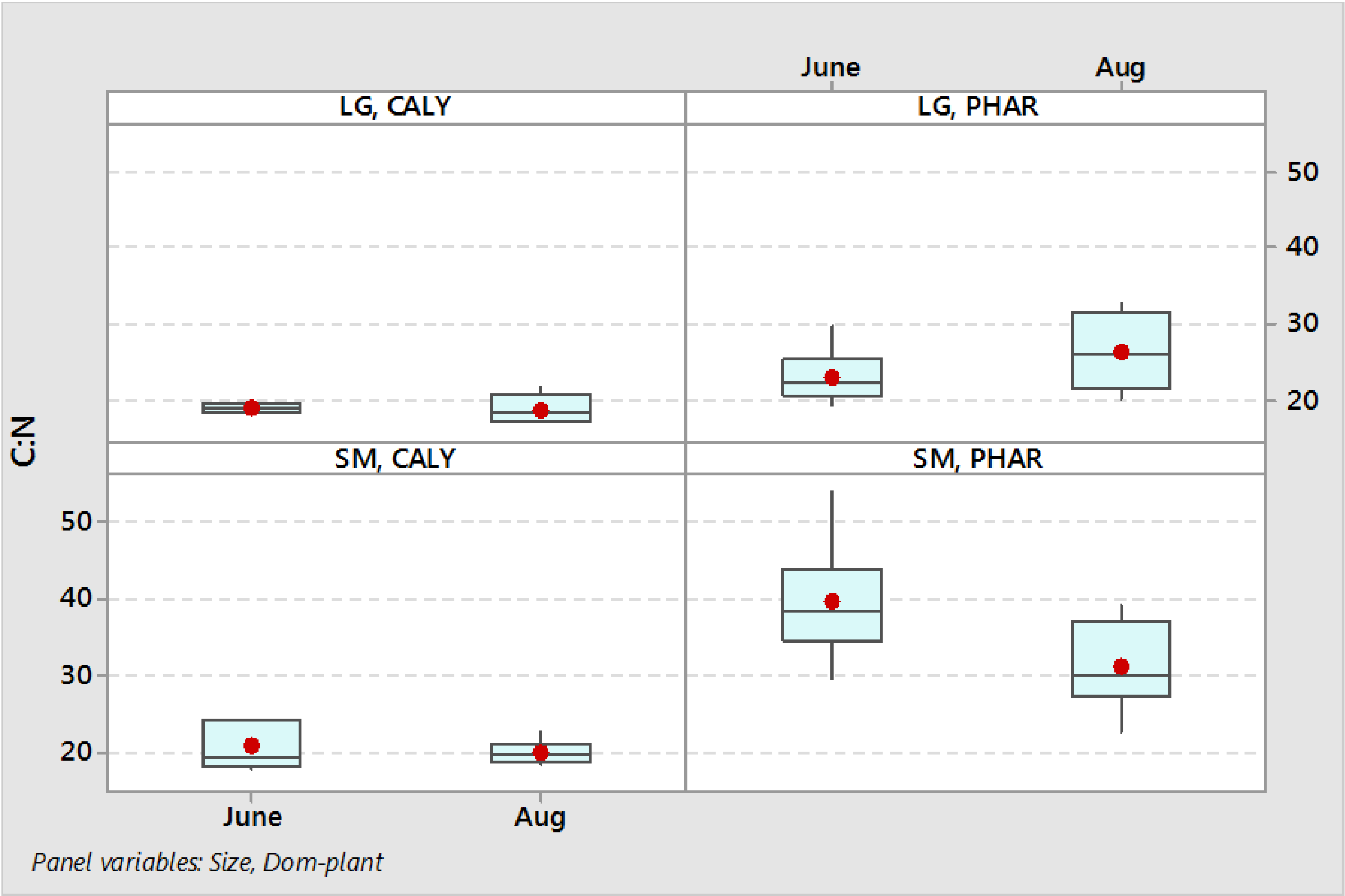
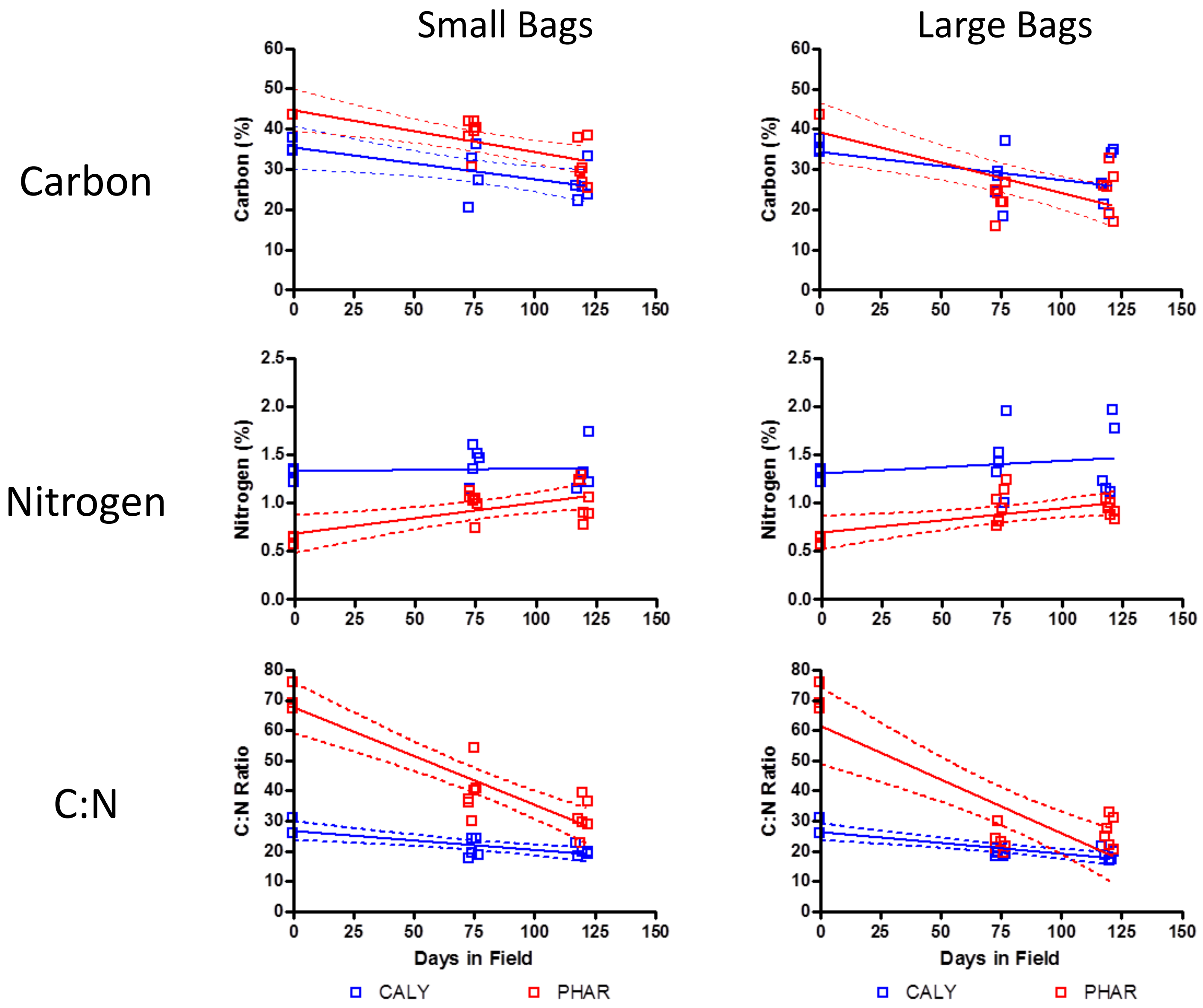


Higher quality litter in CALY plots (Small bags $p < 0.001$; Large bags $p = 0.001$)

Hypothesis 3 – Litter Bags



Hypothesis 3 – Litter Bags

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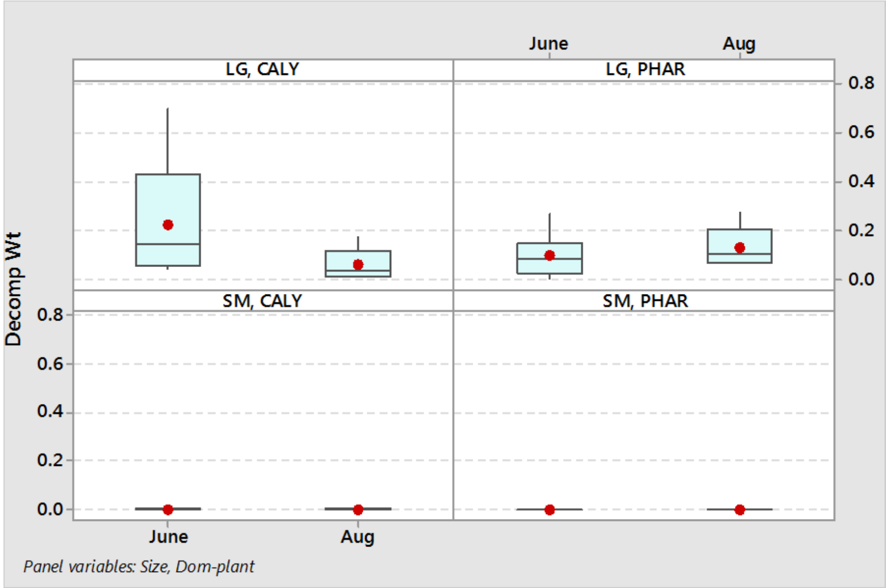
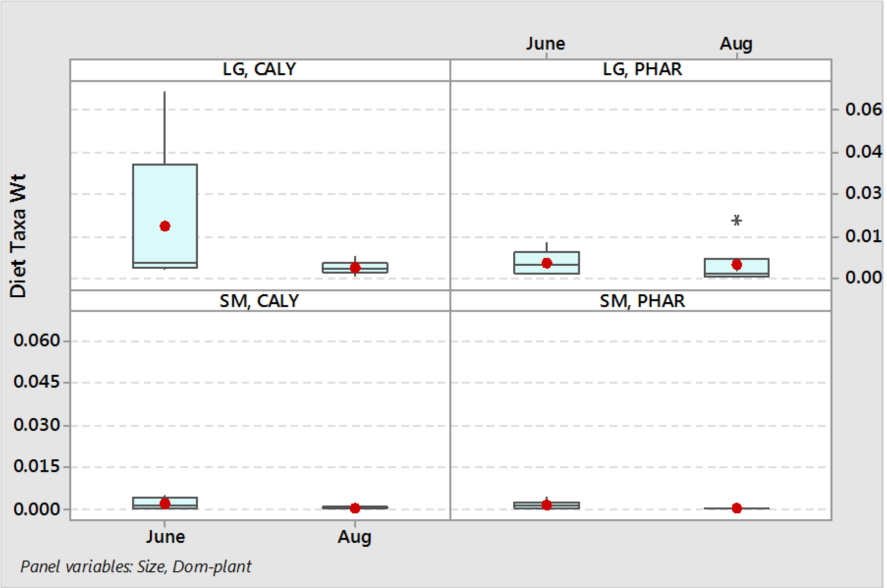
Decomposers (g)



Diet Taxa (g)



No Significant Difference

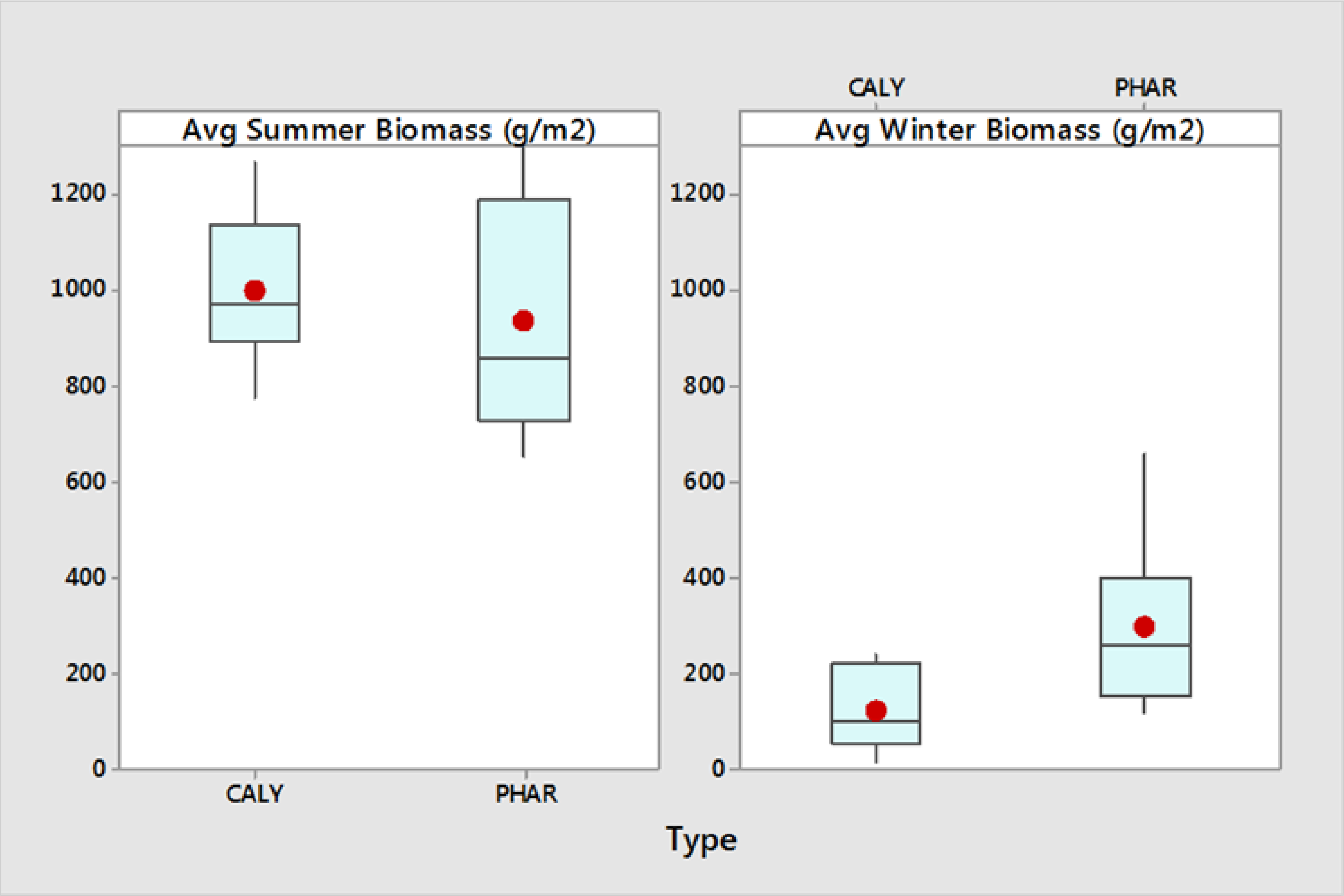
Hypothesis 4 – Macrodetritus Production

Macro-detritus production is lower in areas of higher percent cover of *P. arundinacea*

Objectives

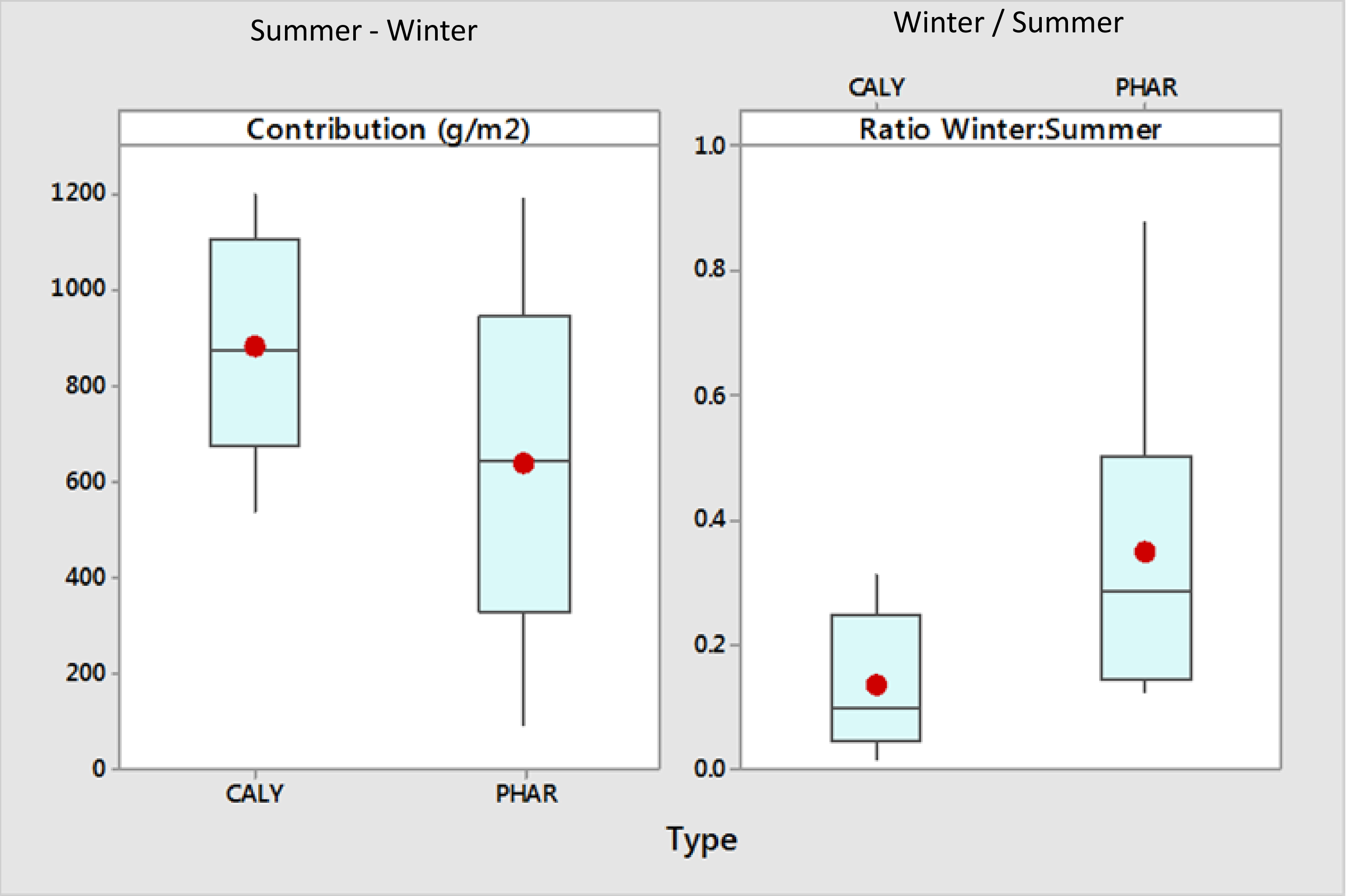
- Assess change in plant biomass to quantify the contribution of organic matter from these habitats within the wetland and to the mainstem ecosystem.

Hypothesis 4 – Macrodetritus Production



Winter standing stock significantly higher in PHAR (p=0.037)

Hypothesis 4 – Macrodetritus Production



Not significant (p=0.20)

Nearly significant (p=0.055)

Hypothesis 1 – Macroinvertebrates

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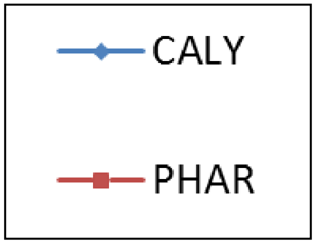
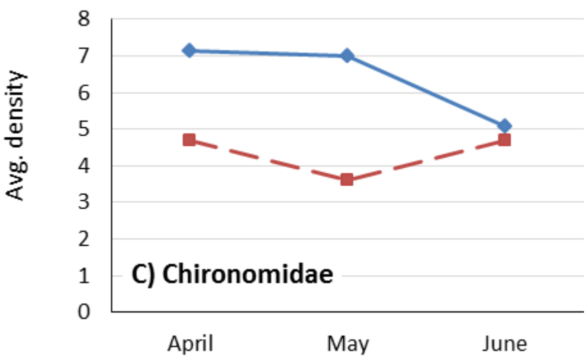


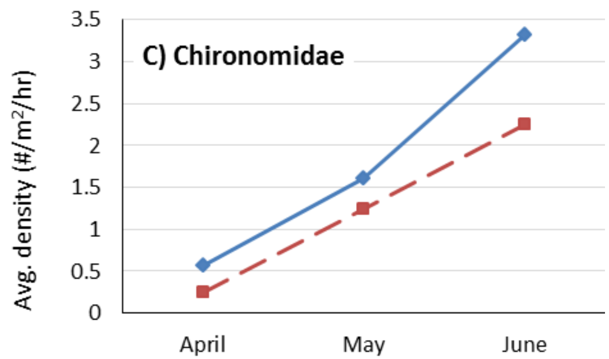
Average Density of Chironomids

Benthic Cores



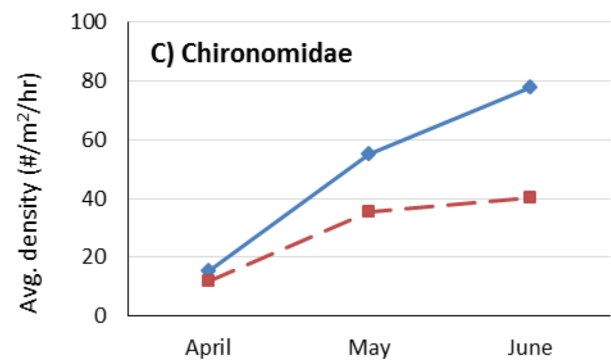
(CALY > PHAR; p = 0.045)

Emergent Traps



Not Significantly Different

Fallout Traps



(CALY > PHAR; p = 0.027)

Data courtesy of Jeff Cordell and Mary Ramirez, University of Washington WET Lab

Conclusions

- The study area is a mixing zone for *Carex* and *Phalaris* and this likely affects the cover and macrodetritus.
- Percent cover of detrital material increased in Phalaris plots between April in June, whereas Carex detritus decreased during this time.
  - Could detritus become more trapped in Phalaris or is timing of Phalaris contribution different?
- In situ macrodetritus was variable and showed no significant difference from April to June or between cover types. The C:N was highly variable in Phalaris.
- In the litter bags decay rate was higher in Carex. The C:N ratio was significantly lower (higher quality) in Carex.
- Winter standing stock remaining was significantly higher in Phalaris. The macrodetritus produced by Phalaris was lower, thought not significant.
- Salmon prey higher in Carex than Phalaris.

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Restoration Design Challenges for the Lower Columbia River

Heida Diefenderfer, Amy Borde, Ian Sinks, Val Cullinan, Shon Zimmerman

FY 15: 3 Challenge Modules

- Mounds
- Reed canarygrass
- Channel networks

Initial Scoping: Key Elements of RDCs

1. **Topographic Mounds**
   a. Features (e.g., height, slope, material)
   b. Environmental Effects (e.g., soil temp, time to plant establishment)
   c. Relevant Site Conditions for Planning (e.g., historical and existing topo, sediment regime, plant community)
   d. Practical Considerations (e.g., regulatory constraints, cost, constructability)
2. **Reed Canarygrass Control**
   a. Features (e.g., inundation/salinity tolerance, reproductive strategies)
   b. Environmental Effects of Control (e.g., plant community, food web, channel formation)
   c. Relevant Site Conditions for Planning (e.g., elevation, hydrologic regime, growth form)
   d. Practical Considerations (e.g., regulatory constraints on control, cost)
3. **Channel Network**
   a. Features (e.g. channel density, sinuosity, number of hydrologic connections, confluences)
   b. Environmental Effects (e.g. salmon habitat opportunity, flux)
   c. Relevant Site Conditions for Planning (e.g., historical/current channel network, tidal prism, levees; plant community; landscape position)
   d. Practical Considerations (e.g., local infrastructure)

Challenge Module: Reed Canarygrass

- Reducing the extent of invasive reed canarygrass in the extensive tidal freshwater region of the LCRE is thought to facilitate establishment of native plant communities, improve food web dynamics, prevent floodplain armoring, allow passive channel formation, and avoid barriers to establishment of natural benthic communities. Concurrent research into reed canarygrass function is ongoing through BPA's Ecosystem Monitoring Program.
- *The design challenge is that science-based construction specifications for topography (e.g., elevation, slope) and specific biological control methods to prevent or eliminate reed canarygrass are not well established*.
- *What is the best way to achieve practical results and biological control in context of a tidal-fluvial system?*

Approach—Reed Canarygrass

- Determine:
  - Environmental conditions for establishment
  - Control methods
    - Site design
    - Treatments
- Approach:

1. Literature review and outreach
2. Sampling design and field data collection
3. Analysis
   - Data collected as part of this study
   - Large existing dataset of vegetation and elevation (Borde, A., unpublished data) - lookup table of elevation limits at points throughout the LCRE as a tool for restoration project planners
4. Synthesis and evaluation

Outreach

- Lower Columbia River and Estuary (LCRE) Project Sponsors, Puget Sound, Outer Coast

Estuary Sponsor Outreach

Practitioner(s)	Organization	Restoration Sites
Ian Sinks	Columbia Land Trust	Devil's Elbow, Kandoll Farm, Mill Road
Matt Van Ess	Columbia River Estuary Study Taskforce	Colewort Creek, Otter Point, Gnat Creek, Charnelle Fee, Dibble Point, South Tongue Point, North Unit Sauvie Island, Steamboat Slough
Rudy Salakory	Cowlitz Tribe	Walluski-Youngs Confluence, Clatskanie, Lower East Fork Lewis River
Catherine Corbett, Jenni Dykstra, Marshall Johnson, Paul Kolp, Matt Schwartz	Lower Columbia Estuary Partnership	Louisiana Swamp, Batwater Station, La Center Bottom, Horsetail Creek
Ashlee Rudolf, Donna Bighouse, Alex Uber	Washington Department of Fish and Wildlife	Chinook Estuary
Allan Whiting	PC Trask and Associates, Inc.	Sauvie Is. North Unit (Ruby Lake, Deep Wigeon, Millionaire), Buckmire Slough, Gilbert River and Metro site (Multnomah Channel)
Mark Nebeker	Oregon Department of Fish and Wildlife, Sauvie Island Wildlife Area	Sauvie Island Wildlife Area, Ridgefield National Wildlife Refuge, Sturgeon Lake
Curt Mykut, Steve Liske, Randy Van Hoy, Austin Payne, Russ Lowgren	Ducks Unlimited: Vancouver, WA and San Francisco, CA	Sears Point (Sonoma County, CA), Cullinan Ranch (Napa R. delta), Nisqually National Wildlife Refuge
George Krall	Ash Creek Forest Management	Gotter Prairie

Puget Sound and Outer Coast

Practitioner(s)	Organization	Restoration Sites[a]
Josh Latterell	King County	Korn-Patterson, Cold Creek (both non-tidal)
Curtis Tanner	U.S. Fish and Wildlife Service	Spencer Island, Marietta Slough
Richard Kessler	Washington State Department of Fish and Wildlife	Marietta Slough
Peter Hummel	Anchor QEA, LLC	Emerald Downs mitigation (non-tidal)
Polly Hicks	NOAA	Fisher Slough
Laura Brophy	Institute for Applied Ecology, Estuary Technical Group	North Fork Siuslaw, Dixieland, Anderson Creek, Bandon NWF, Drift Creek
Craig Cornu	South Slough National Estuarine Research Reserve	Anderson Creek

*Outreach to the Puget Sound and Outer Coast was primarily focused on identifying appropriate sites to address reed canarygrass and mound challenge modules.

LCRE Outreach Summary: Reed Canarygrass

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- Control using inundation (impounded water) is not feasible in tidally reconnected restoration sites
- Control by scrape down has uncertainties (long-term accretion) and produces material requiring disposal
- Control using woody plants is a core strategy; including mounds
- Shading does not maintain a diverse understory
- With a strong understanding of the site and multiple years of management, reed canarygrass can be controlled with a multi-factor approach, but this had not been adequately demonstrated in tidal areas
- **Planners are either scraping down or building mounds; mid-elevations (high-marsh) are trending to RCG**

Reed canarygrass Elevations

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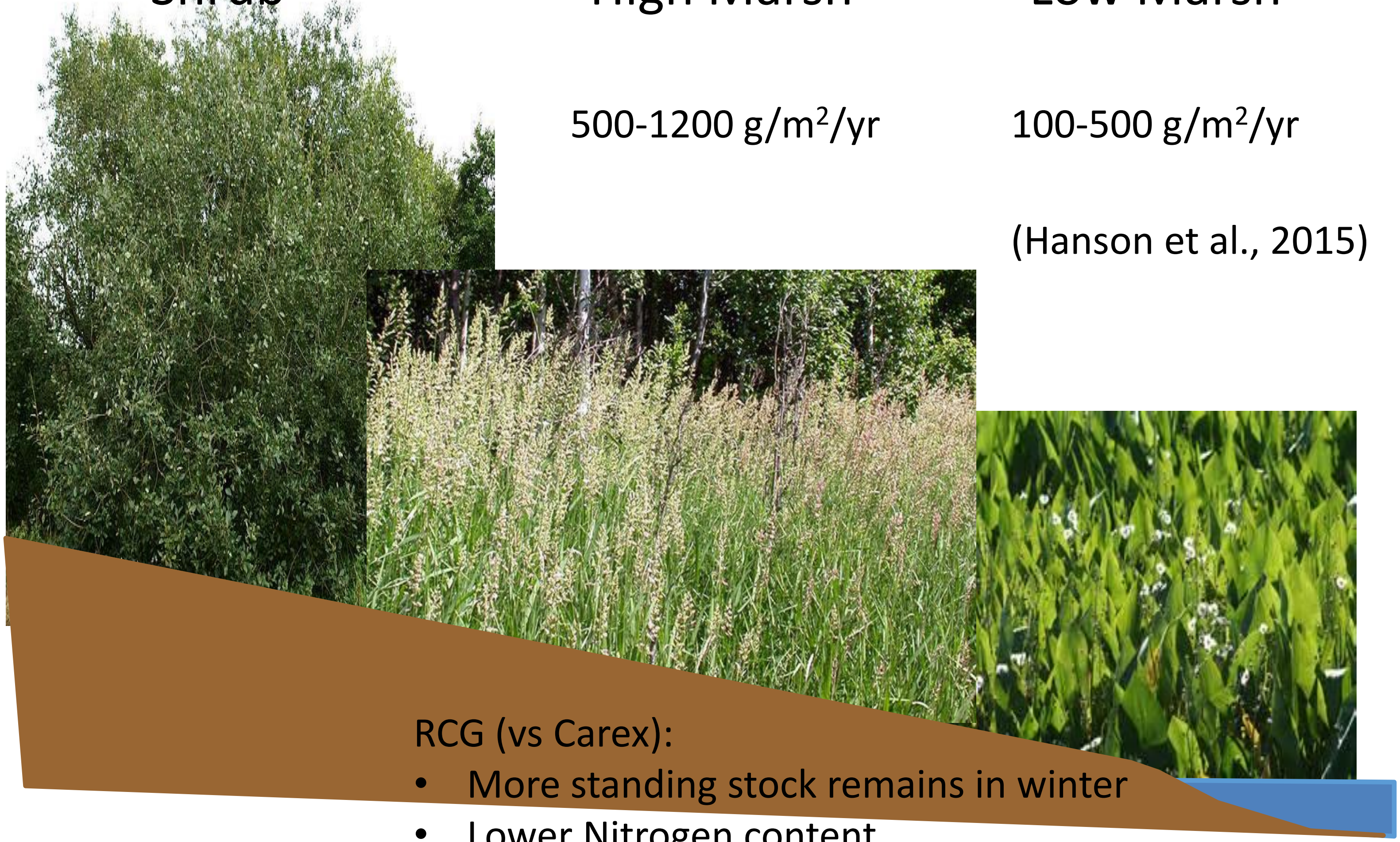
Wetland Elevation Ranges by River Mile

River Mile	**5**	**10**	**15**	**20**	**25**	**30**	**35**	**40**	**45**	**50**	**55**	**60**	**65**	**70**	**75**	**80**
River Kilometer	**3**	**6**	**9**	**12**	**16**	**19**	**22**	**25**	**28**	**31**	**34**	**37**	**40**	**43**	**47**	**50**
Lower Marsh Elevation	5.0	5.0	4.1	3.2		3.2	3.1	3.6			2.9			4.2	3.8	4.4
Lower RCG Elevation	NA	NA	NA	8.1	8.0	6.8	6.8	5.4	5.7	5.8	5.8	6.0	6.2	6.3	6.4	6.6
Lower Shrub Elevation		10		9.2			9.1	7.4			7.8	8.1		8.3	8.4	8.9
River Mile	**85**	**90**	**95**	**100**	**105**	**110**	**115**	**120**	**125**	**130**	**135**	**140**	**145**	**150**	**155**	**160**
River Kilometer	**53**	**56**	**59**	**62**	**65**	**68**	**71**	**75**	**78**	**81**	**84**	**87**	**90**	**93**	**96**	**99**
Lower Marsh Elevation		5.6		5.9	5.8		5.6	6.2		6.6			7.4	8.0	7.7	
Lower RCG Elevation	6.9	6.9	7.1	7.2	7.4	7.7	8.0	8.1	8.2	8.4	8.7	8.7	8.8	8.9	9.0	9.2
Lower Shrub Elevation		9.2		8.6	8.6			10.0		10.9		14.0	9.8	13.1	10.8	
River Mile	**165**	**170**	**175**	**180**	**185**	**190**	**195**	**200**	**205**	**210**	**215**	**220**	**225**	**230**		
River Kilometer	**103**	**106**	**109**	**112**	**115**	**118**	**121**	**124**	**127**	**130**	**134**	**137**	**140**	**143**		
Lower Marsh Elevation						9.6	10.7	10.2		10.4		12.7		12.0		
Lower RCG Elevation	9.4	9.7	10.2	10.5	10.8	11.2	11.6	12.5	13.0	13.5	13.9	14.2	14.3	15.1		
Lower Shrub Elevation						14		13	15			16		17		

Elevations are in feet, NAVD88

Reed Canarygrass Conceptual Diagram

Shrub	High Marsh	Low Marsh
	500-1200 $g/m^2/yr$	100-500 $g/m^2/yr$
		(Hanson et al., 2015)



RCG (vs Carex):

- More standing stock remains in winter
- Lower Nitrogen content
- Decomposes more slowly
- Differences in prey community

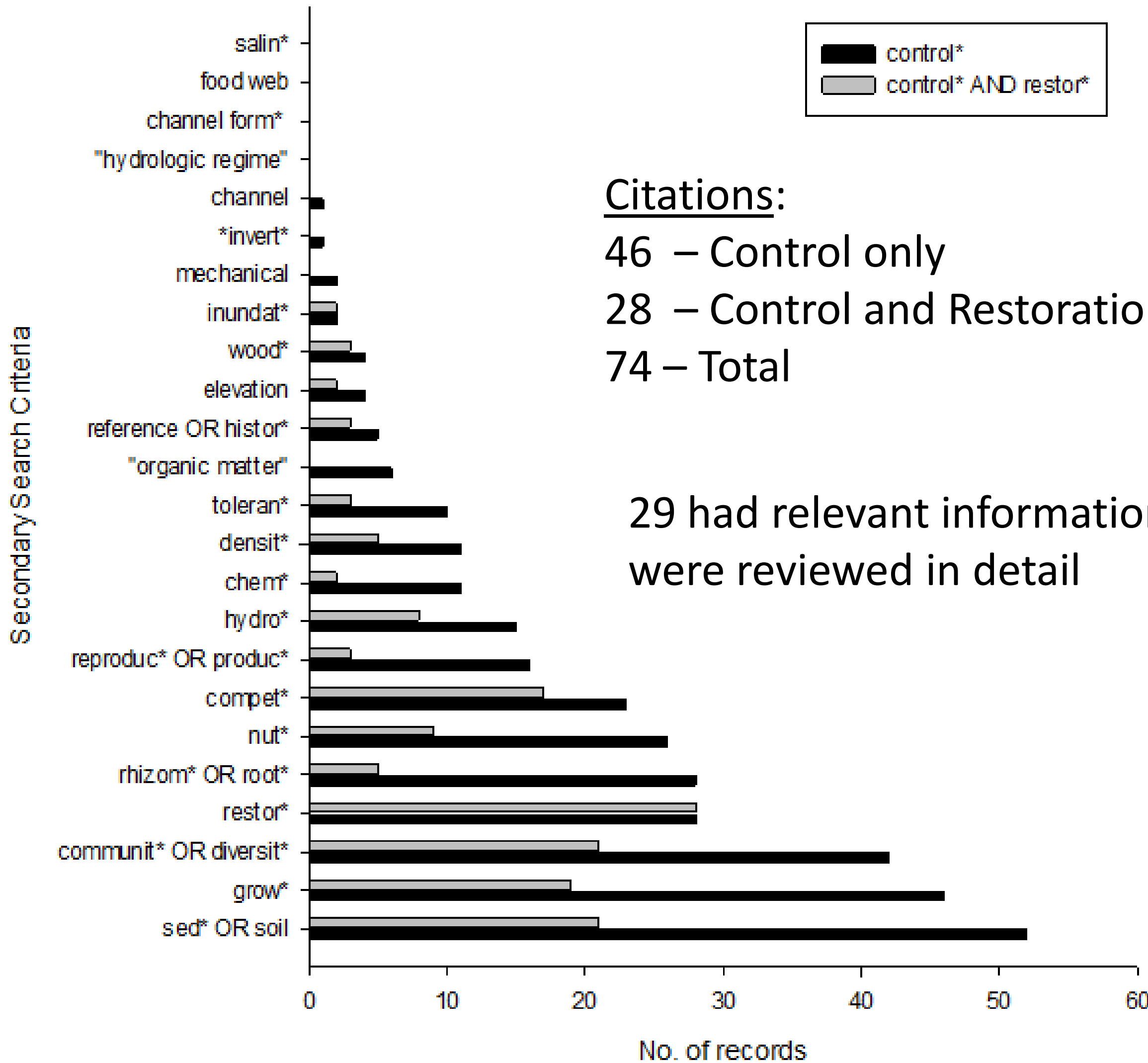
(Hanson et al., 2016)

Reed Canarygrass Literature Review

Search strings:

(("reed canary grass" OR "phalaris arundinacea")) AND (tid* OR estuar* OR wetland) AND (control*)

(("reed canary grass" OR "phalaris arundinacea")) AND (tid* OR estuar* OR wetland) AND (restor*) AND (control*)



<u>Citations</u>:

46 – Control only

28 – Control and Restoration

74 – Total

29 had relevant information and were reviewed in detail

Reed Canarygrass Literature Review

Pacific Northwest NATIONAL LABORATORY
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Publication					Control Methods or Environmental Conditions		
Authors	Year	Title	Region	Tidal	Method/ Conditions	Findings	Notes
Maarten B. Eppinga; Matthew A. Kaproth; Alexandra R. Collins; Jane Molofsky	2011	Litter feedbacks, evolutionary change and exotic plant invasion	North America	No	Soil fertility, light	PHAR is a weak competitor for soil nutrients but a strong competitor for light. Model predictive analysis: PHAR litter creates competitive advantage even in low nutrient environments. “Vacant niches” are smothered and filled by PHAR litter. Feedback loop of litter, including nutrient pulse, can feed invasions	Resource competition model for nutrients and light, litter amounts
R. D. Foster; P. R. Wetzel	2005	Invading monotypic stands of Phalaris arundinacea: A test of fire, herbicide, and woody and herbaceous native plant groups	Tennessee	No	Herbicide, fire	A single early season application of glyphosate created a window for native establishment that did not persist beyond 2 years. A single early season burn failed to reduce PHAR cover, shoot or root biomass and enable native establishment.	Two-year study
Zhiyu He; Lisa Patrick Bentley; A. Scott Holaday	2011	Greater seasonal carbon gain across a broad temperature range contributes to the invasive potential of Phalaris arundinacea (Poaceae; reed canary grass) over the native sedge Carex stricta (Cyperaceae)	Indiana	No	Hydrology manipulation, temperature	Increased hydrology gave competitive advantage to native sedge; increased soil saturation reduced carbon gain in PHAR. Increased temperature variation increased competitiveness of PHAR	PHAR competitive capability related to temp, net carbon gain, water regime. Water regime manipulation identified as a control strategy.
Michael T. Healy; Joy B. Zedler	2010	Set-backs in Replacing Phalaris arundinacea Monotypes with Sedge Meadow Vegetation	Wisconsin	No	Herbicide, shading, fire	Annual graminicide application in May/June for 3 years of stunted growth but had no long-term effect. Seeding increased species richness, but not enough to compete with PHAR. Fire reduced thatch and allowed seeding and PHAR to both establish.	Authors suggest a broad-spectrum herbicide for multiple years while delaying the restoration of native species. After PHAR no longer emerges, burning and seeding of natives would more likely achieve the desired outcome

Reed Canarygrass Literature Review

- Focus areas:
  - methods for controlling existing populations of canarygrass
  - understanding the conditions under which native species can be more competitive to limit canarygrass invasions
  - defining the environmental conditions that facilitate reed canarygrass establishment

Reed Canarygrass Literature Review

- Herbicides
  - Applications of **post-emergent herbicides** (i.e. glyphosate) is a commonly employed approach.
    - Early season application will limit seed production but not rhizomatous re-sprouts.
    - Late season is more effective at controlling both vegetative and root growth.
  - **pre-emergent herbicides** can prevent seed germination of all species
  - **Selective herbicides** (i.e. sethoxydin) can control grasses to allow forb establishment. Potential environmental concerns expressed about selective herbicides in wetland environments.

Reed Canarygrass Literature Review

Other Methods

- **Nutrient** rich areas increase the competitive advantage over many native species. Methods that seek to reduce available nitrogen through incorporation of woody material into the soil provided marginal competitive advantage to some native species.
- Many native species can **outcompete** reed canarygrass if given sufficient competitive advantage.
  - **Light** competition has been shown to be effective, particularly where shading with woody species can be employed.
- Increased **hydrology** can give emergent communities an advantage.

Reed Canarygrass Literature Review

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Other Considerations

- RCG is adaptable to a wide range of environments.
- Methods that work to suppress reed canarygrass typically have a similar **impact to desired high marsh native species**.
- Control strategies will be most effective if employed on a **system or watershed scale**; at a minimum, the site scale.
- Most methods are not successful over a **longer term** without investments in continued control or maintenance. A majority of control studies found that within three years post control reed canarygrass cover had returned to pre-treatment conditions.
- Successful control requires an integrated approach where **multiple methods** are applied for **multiple years**. Chemical, mechanical and hydrologic manipulation are common integrated approaches.

10 Field Sites

- Columbia, Puget Sound and Outer Coast

Field Sites – Columbia River

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Site Name	Primary Contacts	Year Restored	Data Collection on Mounds	Mound Terminology	PHAR Control Method	Data Collected on PHAR Control
Ruby Lake (Sauvie Is.)	CREST, PC Trask and Associates	2013	4 mounds (5 transects) + 1 reference mound (1 transect)	Peninsula, Topographic Bar and Scroll	Passive control, mound plantings, other plantings	Observational
Colewort Creek Phase 2 (Fort Clatsop)	NPS, CREST	2012	2 mounds (5 transects) (1 mound observational only)	Mound, Toe of Slope	Passive control, mound plantings, other plantings	Observational
Devil's Elbow (Grays River)	CLT	2003	-	-	Passive control	Observational and Quantitative: 11, 1 m^2 plots repeat-sampled for a 6th year
Kandoll Farm (Grays River)	CLT	2005, 2013	Qualitative	Mounds	Late-season herbicide	Observational

Field Sites – Outer Coast and Puget Sound

Pacific Northwest NATIONAL LABORATORY
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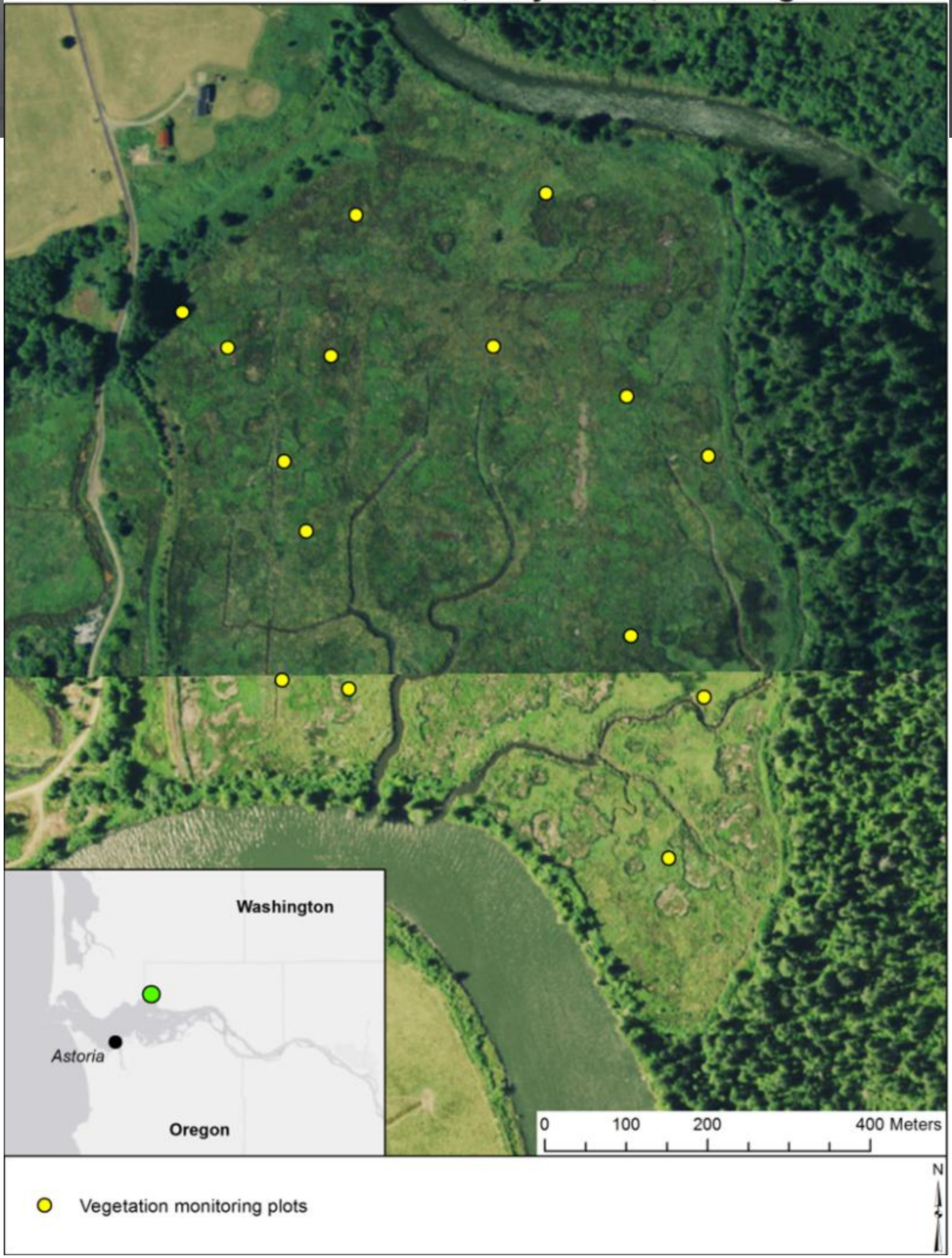
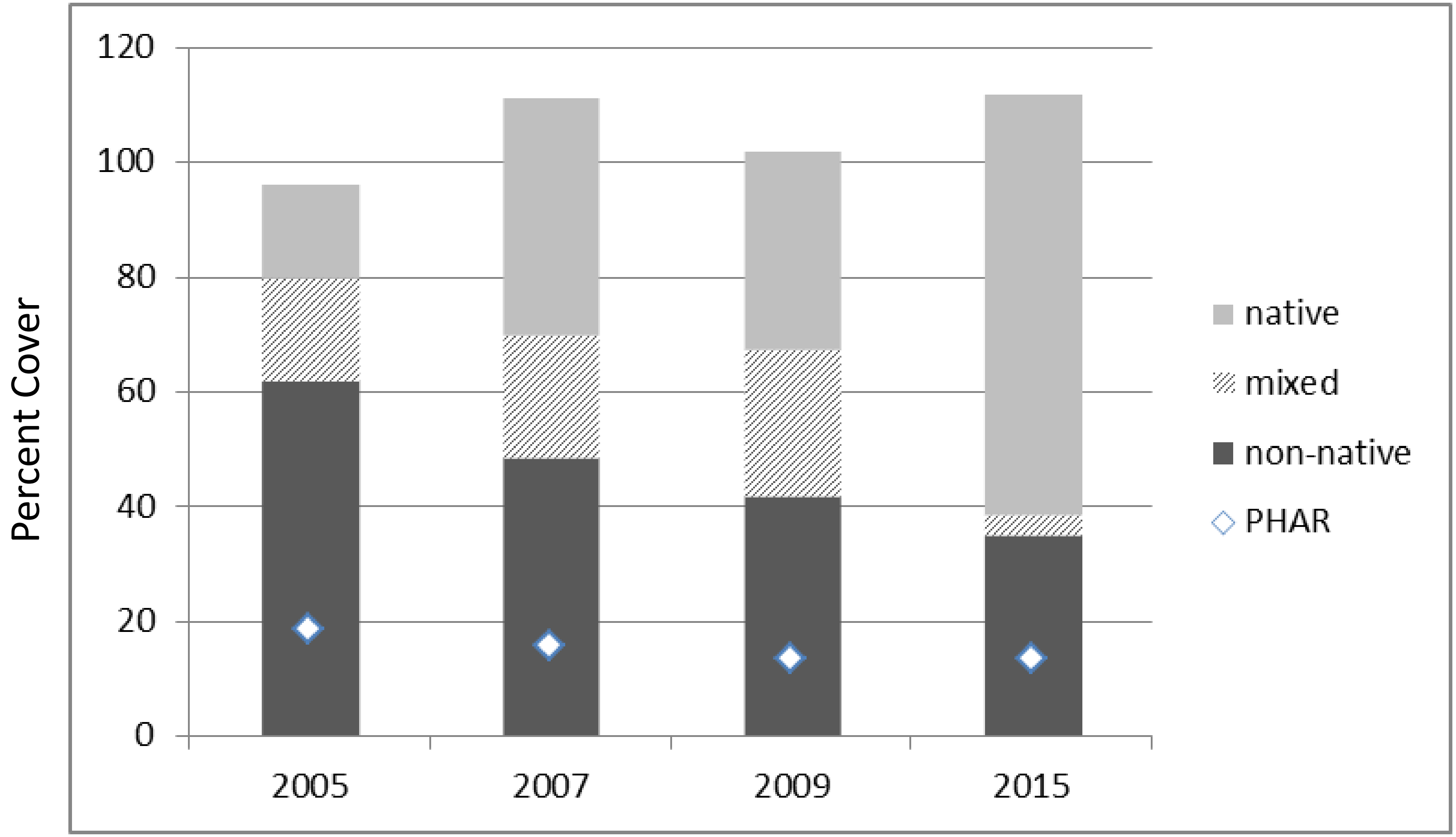
Site Name	Primary Contacts	Year Restored	Data Collection on Mounds	Mound Terminology	PHAR Control Method	Data Collected on PHAR Control
Anderson Creek (Coos Bay)	South Slough NERR	2001	2 mound features (4 transects)	Nurse Log with Adjacent Dirt Berm	Passive control, plantings, manual removal	Observational and Monitoring Report
North Fork Siuslaw River	ODOT, Green Point Consulting	2007	-	-	Planting woody vegetation	Observational and Monitoring Report
Drift Creek (Alsea River)	MidCoast Watershed Council, USFS	2005	2 mounds (4 transects)	Alluvial Fan	Passive control	Observational
Spencer Island	USFWS	1994	-	-	Passive control	Observational and Quantitative: GPS polygons compared to historical data. Monitoring Report
Fisher Slough	TNC	2011	-	-	Passive control	Observational and Monitoring Report
Marietta Slough	WDFW	2003–2005	4 mounds (2 half transects)	Mound	Passive control	Observational

Devil's Elbow Restoration Area, Grays River, Washington



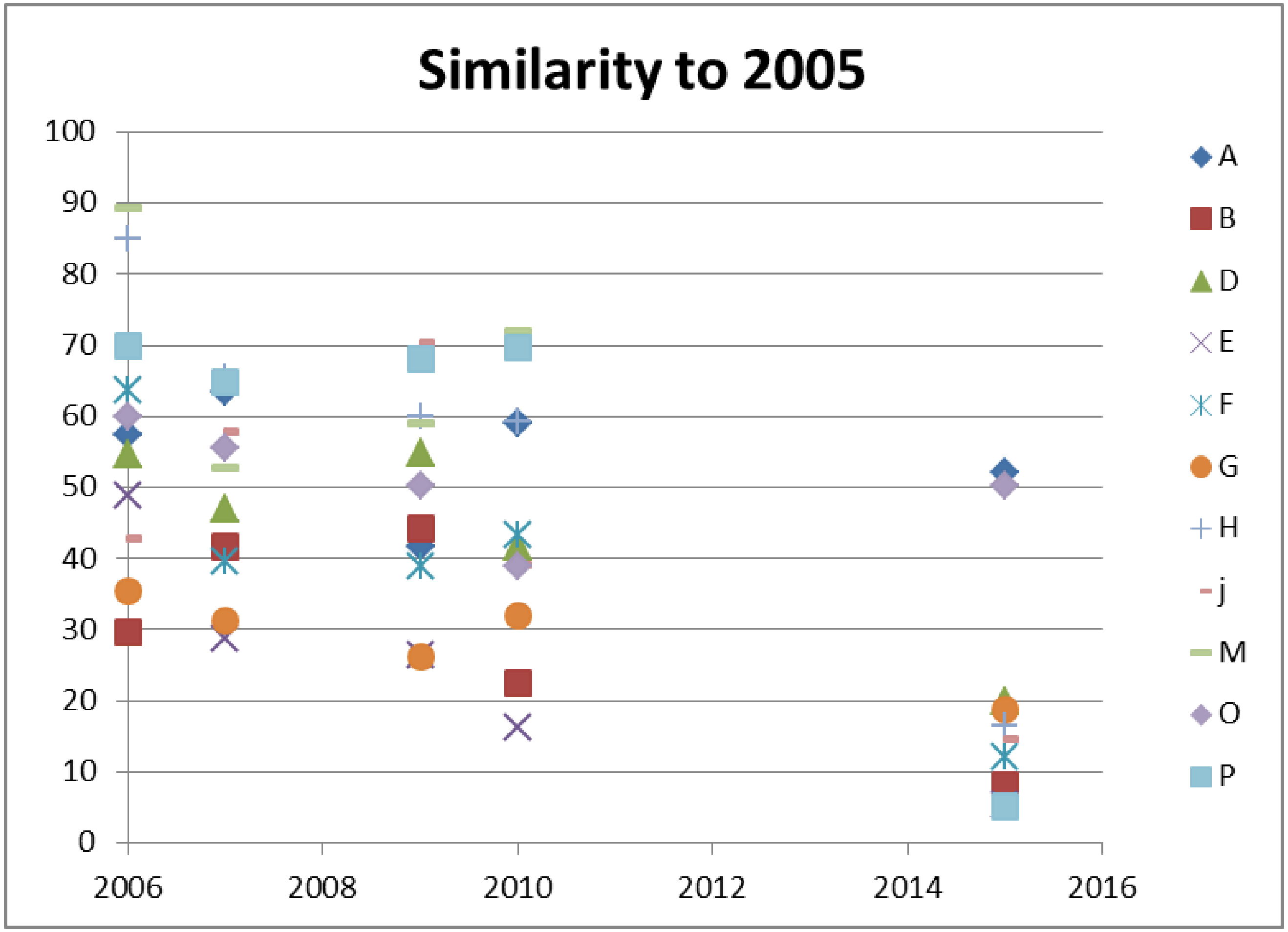
Reed canarygrass: Field observations

Devils Elbow



Reed canarygrass: Field observations

Devils Elbow



Findings: Reed Canarygrass

- **Impacts**
  - Loss of high marsh in freshwater regions of the LCRE, past and present
  - Impediment to the cost-effective pilot channel excavation (invasive mat prevents channel evolution in response to flows)

- **Environmental Controls**
  - Salinity
  - Shade
  - Elevation
    - Low – increase inundation that it cannot grow
    - High – providing non-inundated substrate on which woody plants establish
  - Nutrients
    - May increase competitive advantage (positive correlation with high nutrients)
    - reducing nutrient loads prior to restoration could reduce invasion

Findings: Reed Canarygrass

- **Plant Species Competition and Planting**
  - Competitive herbaceous species (same elevation as reed canarygrass)
    - Competative grass species such as tufted hairgrass (*Deschampsia cespitosa;* Ruby Lake)
    - Small-fruited bulrush (*Scirpus microcarpus)* – can tolerate slightly wetter conditions than PHAR (Anderson Creek and other sites)
    - Lady fern(*Athyrium filix-femina*), black vetch (*Vicia nigricans*), and cow parsnip (*Heracleum maximum*) – can grow taller than PHAR at higher marsh elevations (N. Fork Siuslaw)
    - Many other species – when PHAR is reaching its inundation threshold (Devil's Elbow, Spencer Is.).
  - Competive woody vegetation
    - Compete over the long term
    - Understory is variable depending on amount of shade provided
      - *Pacific willow (Salix lucida; Marietta Sl.) and Oregon ash (Fraxinus latifolia; Ruby Lake)* provide less shade due to tall growth habit
      - Shrubby willow species (e.g., *S. scouleriana* or *S. sitchensis*) provide higher cover and shade
    - Willow stakes that were 0.75 – 1.0 inch diameter were the most cost effective size for establishing woody cover in areas dominated by PHAR
  - Timing is critical
    - Planting pre-breaching (Otter Point) can be successful
    - Dense planting and/or seeding prior to PHAR seed dispersal
    - Immediate removal of PHAR to allow other species to compete

Findings: Reed Canarygrass

Control Methods

- Most available information is from non-tidal environments
- Burning is not a suitable tool in environments where native plants are not fire-adapted (and therefore cannot recover and compete)
- No biological control method is available
- Control is most likely to succeed if implemented at a watershed scale (propagules).
- A number of studies recommend applying multiple methods in combination, and this is consistent with the only LCRE success story
- Available methods, applicable in the LCRE are:
  - mechanical (mowing and discing)
  - hydrologic (inundation)
  - chemical (grass-specific or general)
  - biological competition (seeding and/or planting)
- For chemical control, glyphosate remains a “go-to” product and grass-specific selective products need testing in tidal environments
- Timing is critical and success is specific to regional environments (growing season, hydrologic regime, etc.)
- Little testing has been done for the LCRE or other tidal environments in the PNW

Implications for Practice: Reed Canarygrass Current Project Planning

- Consider the potential loss of high marsh resulting from control methods focused on establishing high and low elevations.
- Comprehensive site preparation prior to restoration may be more effective and cost efficient than post-restoration control.
- Consider control at the largest possible scale, at minimum, the site scale.
- Plant or seed strong competitors to fill aboveground and belowground niches.
- Shade effects of woody species change as plants grow (e.g., *Salix lucida* and *Fraxinus latifolia* do not shade the understory at maturity).
- Combine multiple methods for multiple years to achieve cumulative beneficial effects.
- Policy context: the majority of projects/sponsors do not have funding for post-restoration stewardship or maintenance. Thus, it is practical and less expensive in the long run to control reed canarygrass to the greatest extent possible during the restoration project.

Next Steps to Improve Long-Term Planning

- Study the efficacy of methods for 1) integrating control in a restoration project, and 2) controlling reed canarygrass plants that have established post-restoration.

  Outcome: cost-benefit analysis of control methods/timing.

- Integrate mechanical control, chemical control, and seeding in a blocked field study, e.g., including early and late-spring spraying, discing, seeding, grass-specific spraying, and planting of forbs.

  Outcome: LCRE reed canarygrass management protocol.

- Verify whether findings on the competitiveness of reed canarygrass studies in the Midwest apply in the LCRE through nutrient-enrichment studies in LCRE field settings.

  Outcome: recommendation on site preparation time to discourage establishment of a reed canarygrass monoculture.

Case Study: Thousand Acres Floodplain Habitat Restoration

<u>RCG Control Methods Used:</u>

A. Mechanical removal

B. Herbicide site prep and/or maintenance on plantings

C. Inundation by future beaver dams in lower elevations

D. Shade by woody vegetation (reforestation)

Case Study: PHAR Control at Kandoll Farm

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