Failure or Success?

Implications of Long-term Tidal Wetland Restoration Monitoring in Lower Columbia

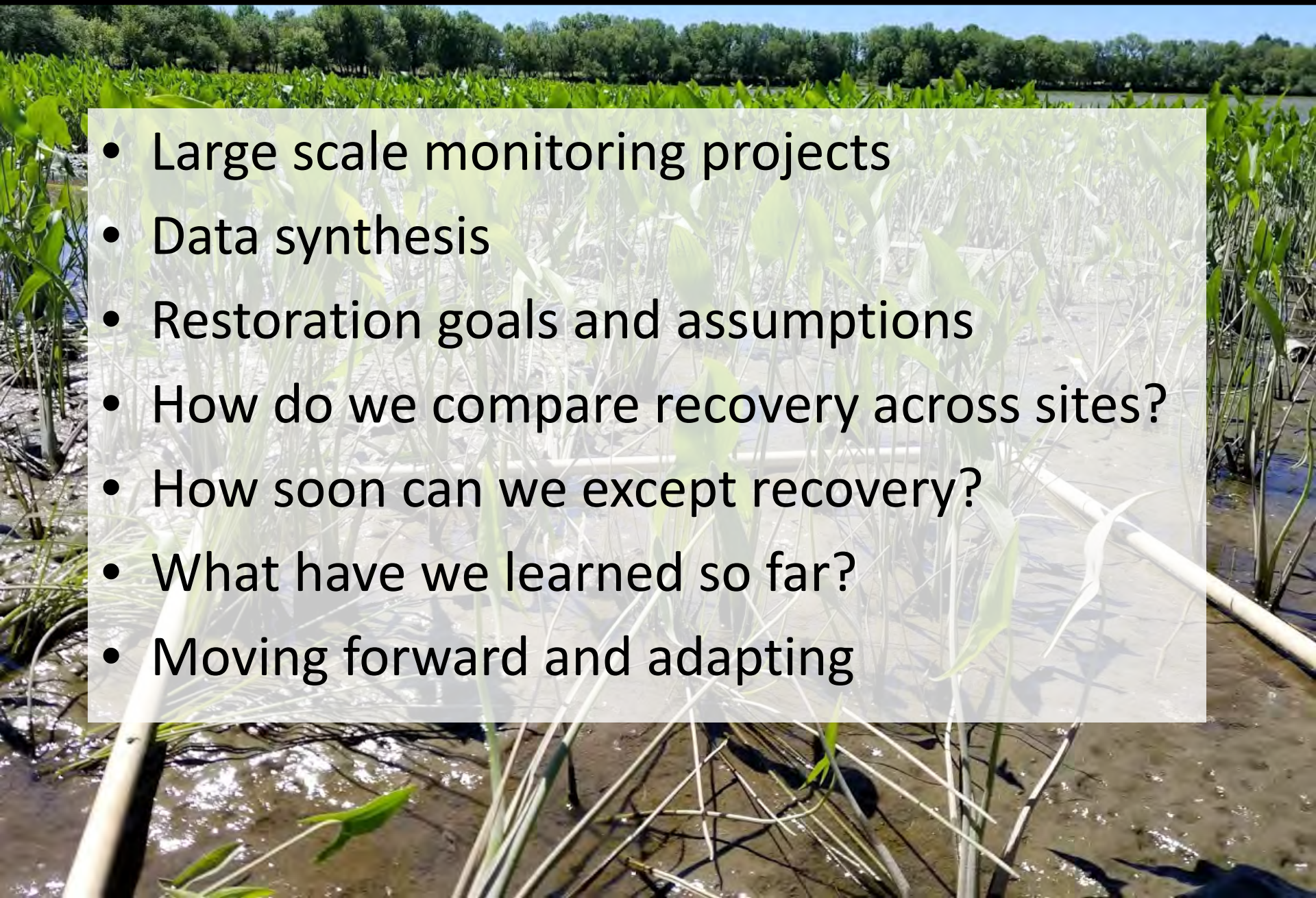
Lower Columbia Estuary Partnership

Wallooskee Youngs Project
S.Kidd 2016

Sarah Kidd and Matthew Schwartz

Salmon Recovery Conference - April 2019

Discussion Outline



- Large scale monitoring projects
- Data synthesis
- Restoration goals and assumptions
- How do we compare recovery across sites?
- How soon can we except recovery?
- What have we learned so far?
- Moving forward and adapting

Large Scale Monitoring Projects Lower Columbia River

- Action Effectiveness Monitoring and Research (AEMR, Restoration – Multiple Years of Data)
- EMP (Ecosystem Monitoring Program, Ecological Status and Trends Monitoring)
- Kidd Dissertation (Restoration- Chronosequence)

Are restoration sites following a trajectory?



Restoration Approaches

- Hydrologic Reconnection
- Topographic Complexity
- Scrape Down

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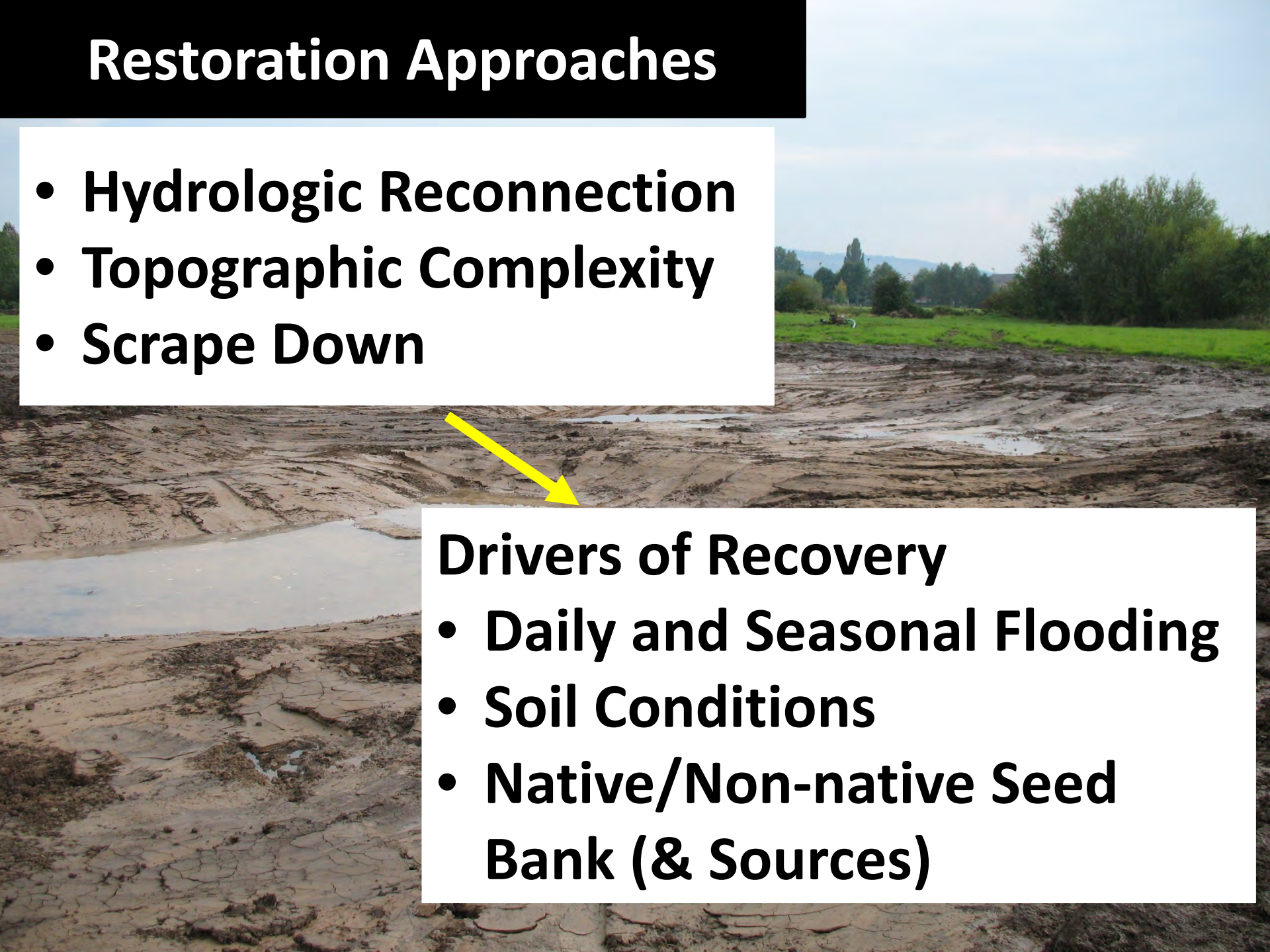
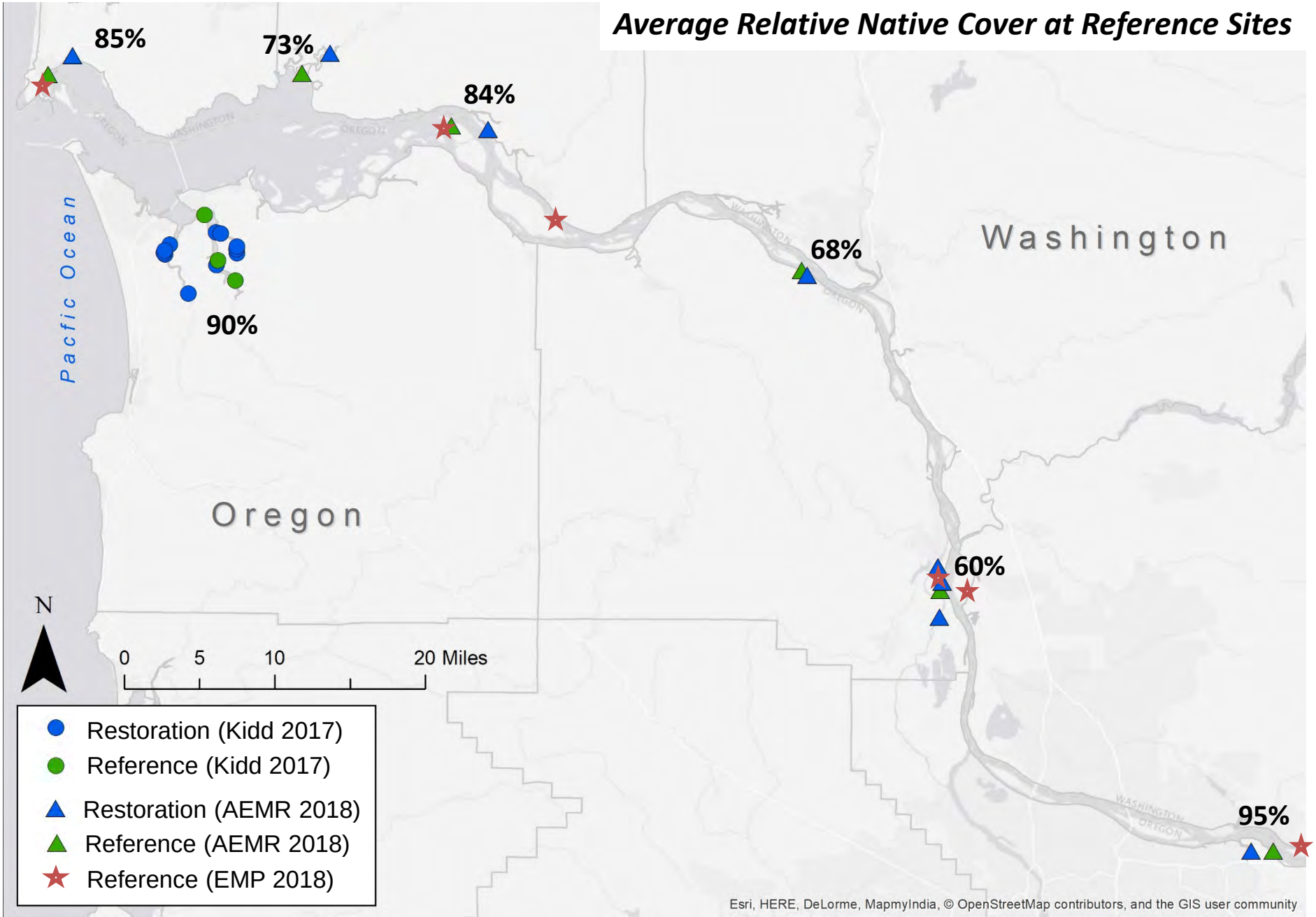


Drivers of Recovery

- Daily and Seasonal Flooding
- Soil Conditions
- Native/Non-native Seed Bank (& Sources)

Monitored Restoration and Reference Wetlands in the Lower Columbia River

used in this analysis



Relativized Response Ratio (RR)

$$RR = \ln\left(\frac{Mean\ Restoration\ Site\ Value}{Mean\ Reference\ Site\ Value}\right)$$

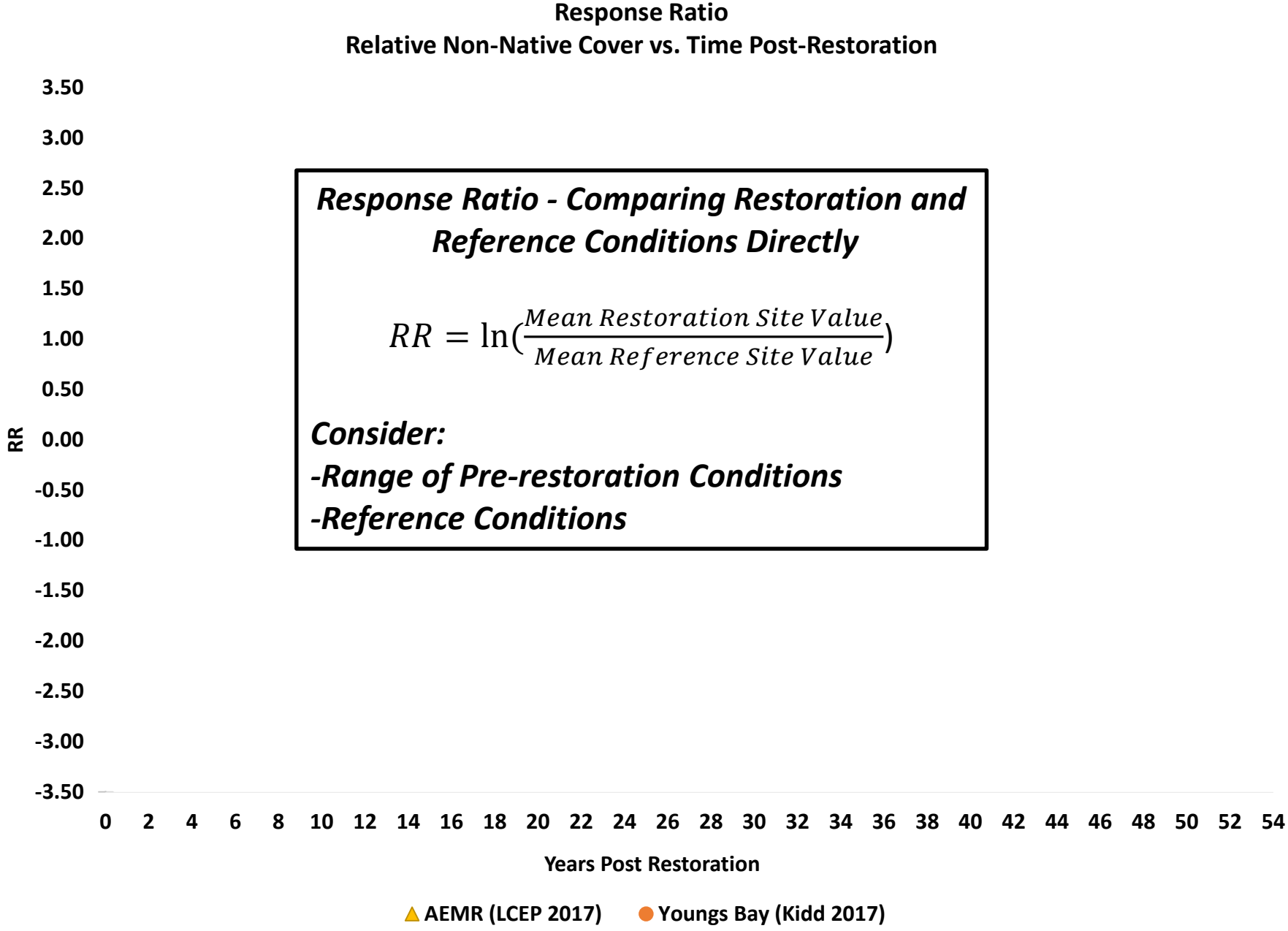
- Values close to 0 = most similar to Reference Site
- Calculate for each year data is collected
- Graph RR values vs. Restoration Year
- See *Meli et al. 2014* and *Lajeunesse 2015* for details
- **Allows for meaningful comparisons of recovery across wetlands throughout the estuary**
  - **Across vegetation zones, - i.e. RCG has a much wider elevation band as you move up river (see zones outlined by *Diefenderfer, Borde, and Cullinan 2013*)**

Restoration Trajectories

Native/Non-native Cover ..... Predicted 5-10 yr

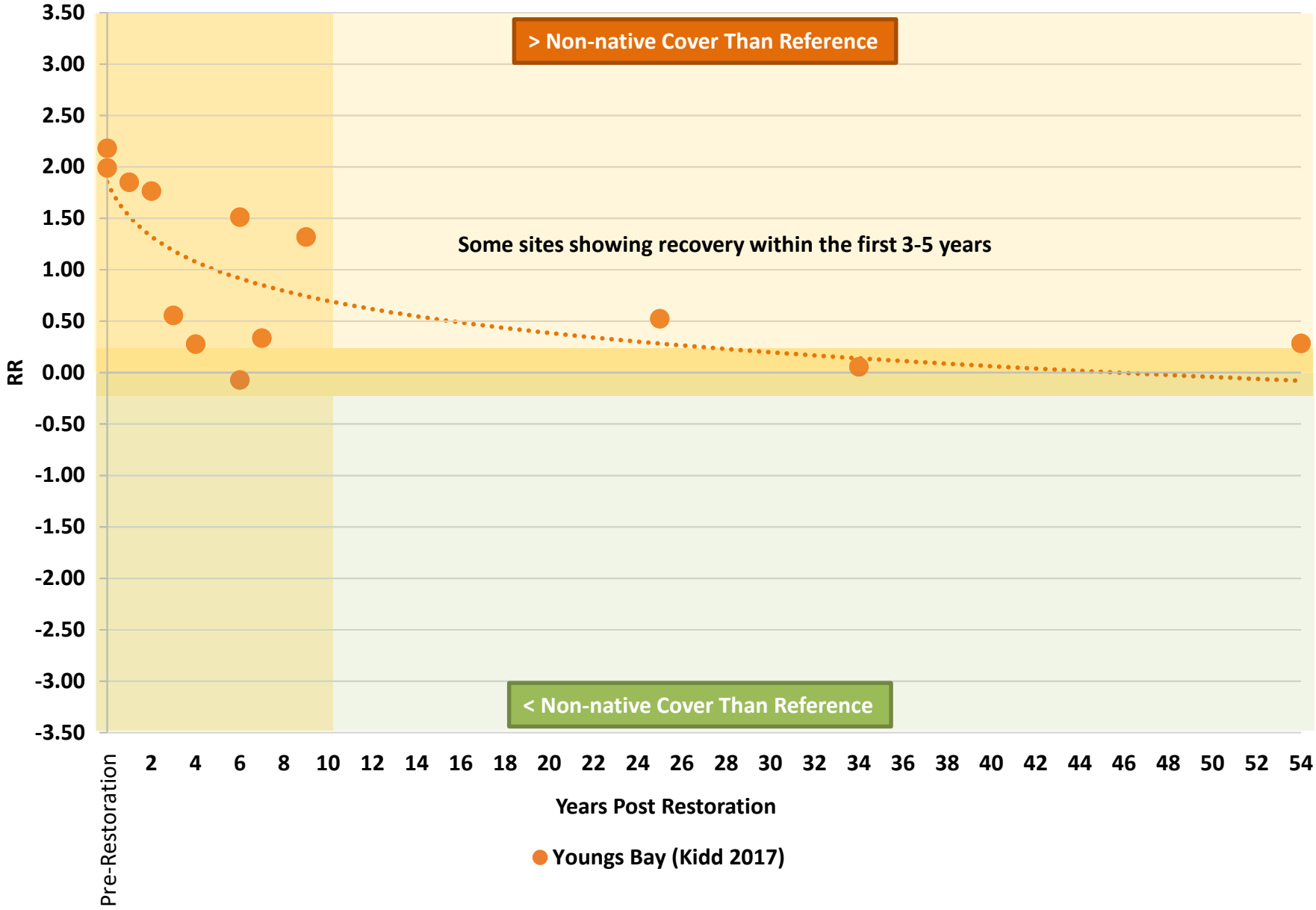
Non-native

Native


Response Ratio
Relative Non-Native Cover vs. Time Post-Restoration
Response Ratio - Comparing Restoration and Reference Conditions Directly
$RR = \ln(\frac{Mean\ Restoration\ Site\ Value}{Mean\ Reference\ Site\ Value})$
Consider:
-Range of Pre-restoration Conditions
-Reference Conditions
RR
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
-0.50
-1.00
-1.50
-2.00
-2.50
-3.00
-3.50
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48 50 52 54
Years Post Restoration
AEMR (LCEP 2017)
Youngs Bay (Kidd 2017)

Response Ratio
Relative Non-Native Cover vs. Time Post-Restoration

Response Ratio
Relative Non-Native Cover vs. Time Post-Restoration



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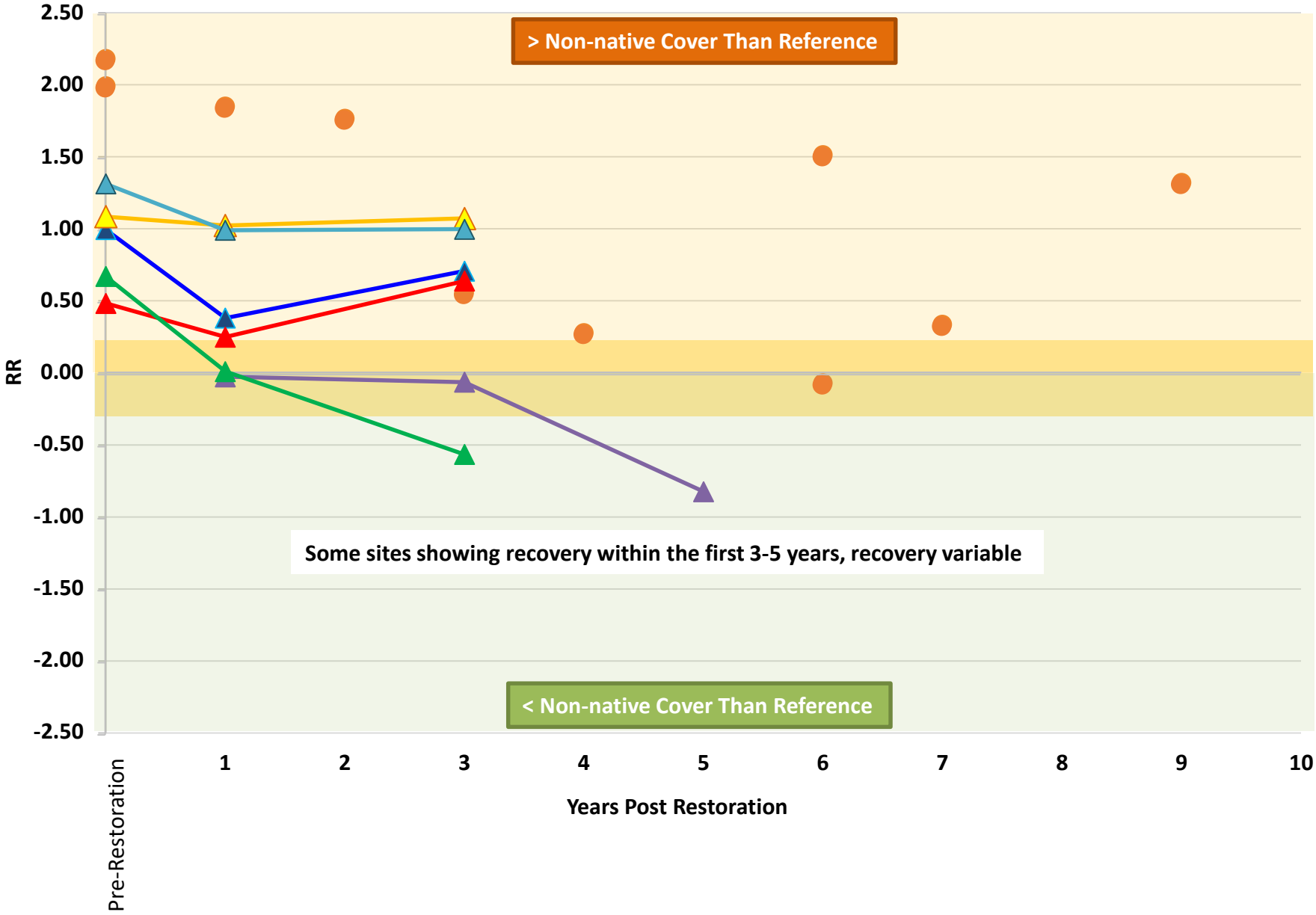


Response Ratio
Relative Non-Native Cover vs. Time Post-Restoration

Plant Community Native and Non-native Species Dominance

Impacts to restoration trajectories

Invasive species
Phalaris arundinacea, reed canarygrass

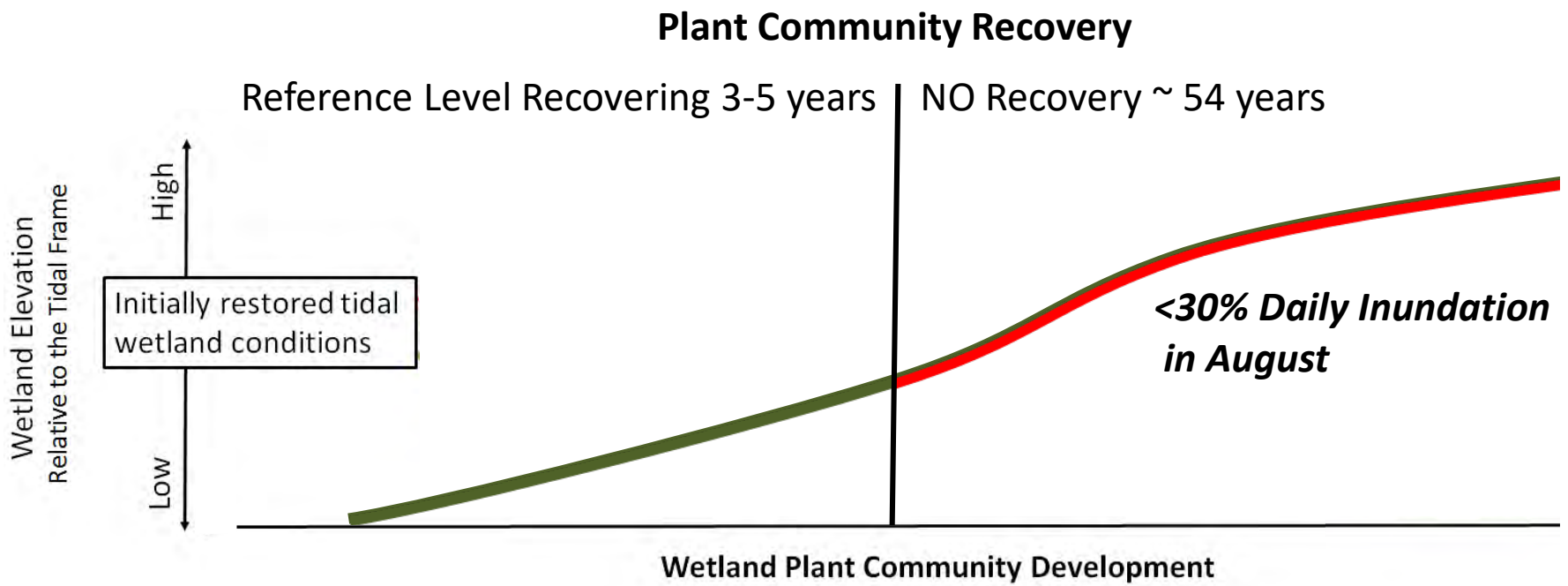
Non-natives limit/impact:

- Habitat Complexity & Diversity
- Detritus Quality – Nutrient Cycling
- Macroinvertebrate Communities/Food Web

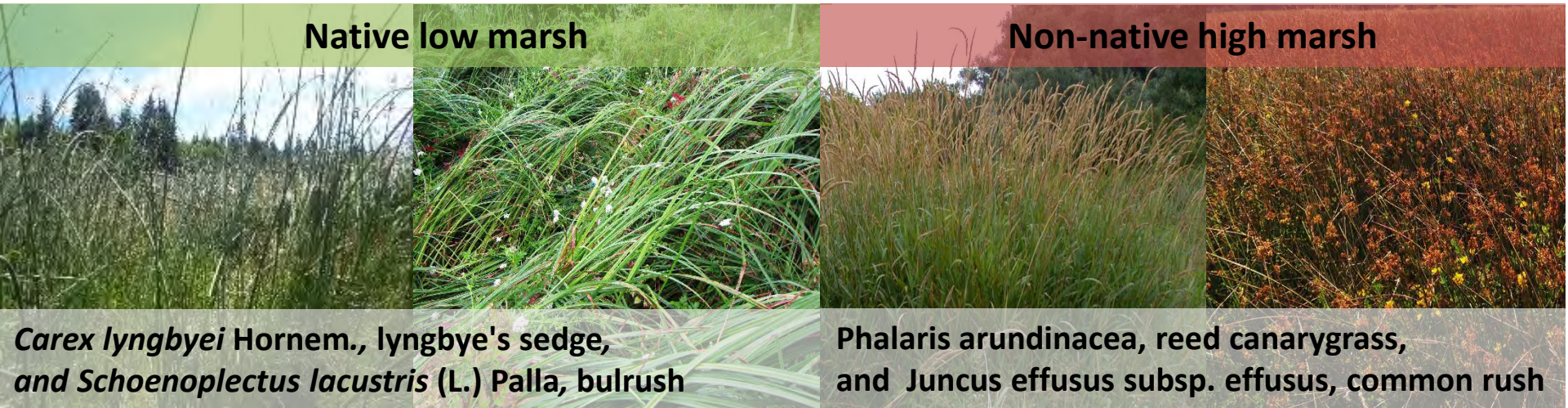
(e.g. Mabry and Dettman 2010, Lavergne & Molofsky 2010, Kidd & Yeakley 2015, Hanson et al. 2016, Klopfenstein 2016, Kidd et al. 2019)

Grow at the exclusion of natives – reduces native species abundance and richness

Restored low elevation marsh areas have higher similarity to reference marshes and less non-native species than higher elevation marsh areas.



Youngs Bay Examples



Youngs Bay Restoration Sites

Non-native Dominant High Marsh

Locations above mean high water

- Higher soil ORP (hydrologic indicator)
- Lower soil pH
- Lower soil Organic Matter
- Higher soil Bulk Density
- Lower soil Salinities

Significant Differences Compared to Reference Wetlands

All characteristic of pre-restoration wet pasture conditions

***Phalaris arundinacea*, reed canarygrass,**
and *Juncus effusus subsp. effusus*, common rush

Native Plant Community Recovery

Consider

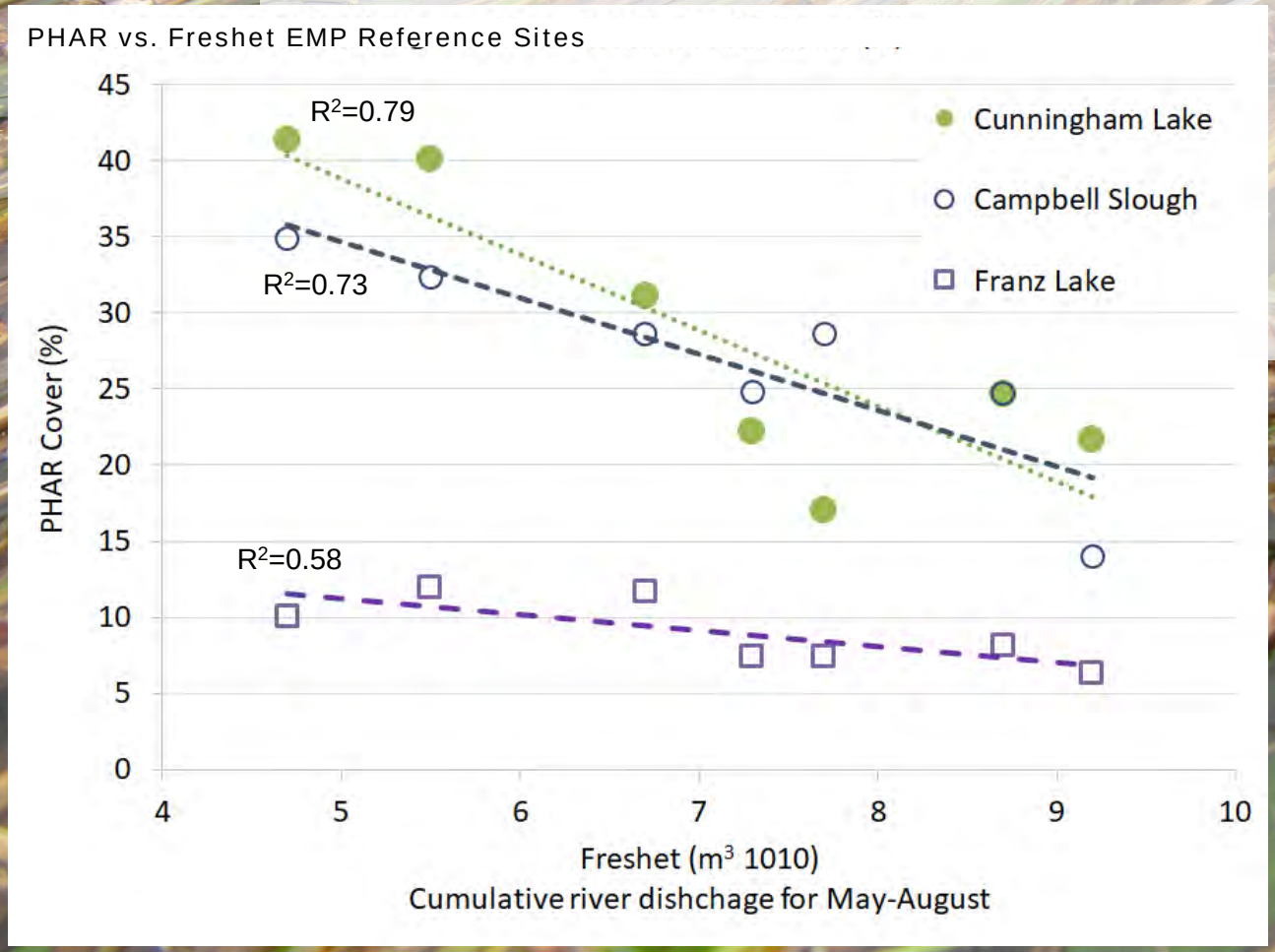
- **Target Hydrology**
  - Full Tidal Prism
  - Daily and seasonal flooding
  - Positive Drainage
  - Gradual topographic/Hydrologic gradients
- **Scrape down**
  - Soil conditions can make plant recovery slow
    - Low soil organic content
    - Low nutrient retention
    - High bulk density (compaction)
    - Seed bank

Native Plant Community Recovery

Target Hydrology – Reed Canarygrass

-Naturally varies based on Freshet Conditions

-Up to 20% annual shift in PHAR



Kidd et al. 2019 (EMP Report)

Next Steps

- Compare wetland recovery within hydrologic zones
  - Identify if/why restoration targets aren't being met
  - Evaluate soil conditions
- Use monitoring data to help adaptively manage recovery
- Response Ratios can be helpful to compare the recovery of multiple ecological indicators across sites

Questions?

Thank you!

BONNEVILLE POWER ADMINISTRATION

NSF

SWS

SER SOCIETY FOR ECOLOGICAL RESTORATION

Pacific Northwest NATIONAL LABORATORY

COWLITZ INDIAN TRIBE

NATIONAL PARK SERVICE

Columbia LAND TRUST

PORT OF ASTORIA

City of Seaside

crest COLUMBIA RIVER ESTUARY STUDY TASKFORCE

Lower Columbia Estuary Partnership

Northcoast Watershed Association

THANK YOU FOR LISTENING!

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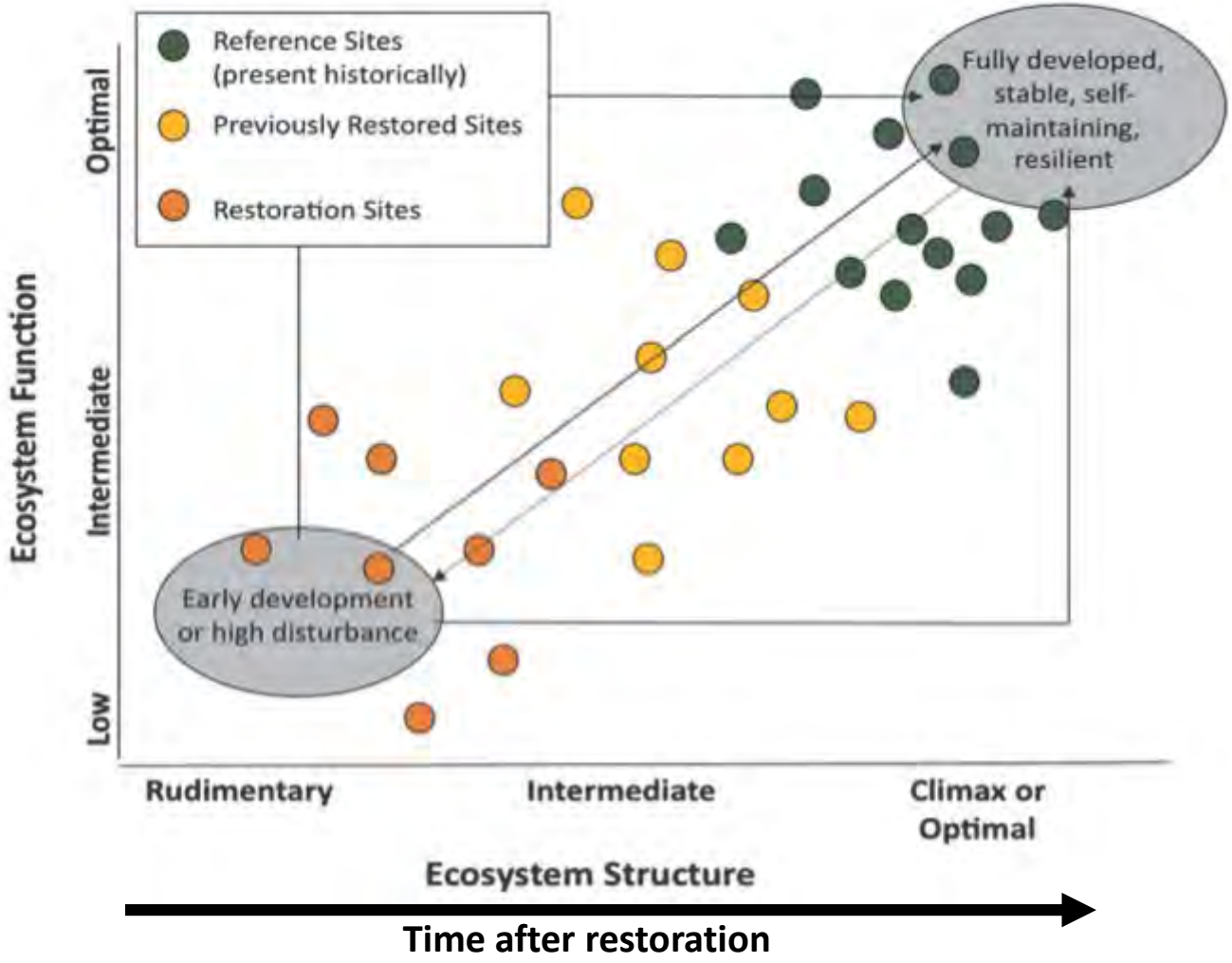
What is the scientific basis for all of these restoration efforts?

Theory of ecological restoration-recovery



Thom et al. (2010) describing a restoration trajectory

Further Citations: van der Valk 1981, Keddy 1992, SER 2004, Wilcox 2004, Apostol et al. 2006, Hilderbrand et al. 2005

Methods

- Restoration Type: Hydrologic Reconnection
- Sites and Years of Data
  - **Youngs Bay Study (2013-14'):** 11 restoration sites ages ranging from 1-54 years post-restoration, 3 reference sites, 2 pre-restoration
  - **AEMR (2013-17'):** 9 restoration sites with paired reference sites, data from pre-restoration (8 sites) to 1 year post (9 sites), 3 years post (7 sites), and 5 years (1 site) post-restoration

Methods

- Combining data across studies
  - Vegetation data collected at all the restoration and reference sites using similar methods (Roegner 2009)
- Summarized by native vs. non-native species using USDA species status classifications
- Native and Non-native Relative Cover

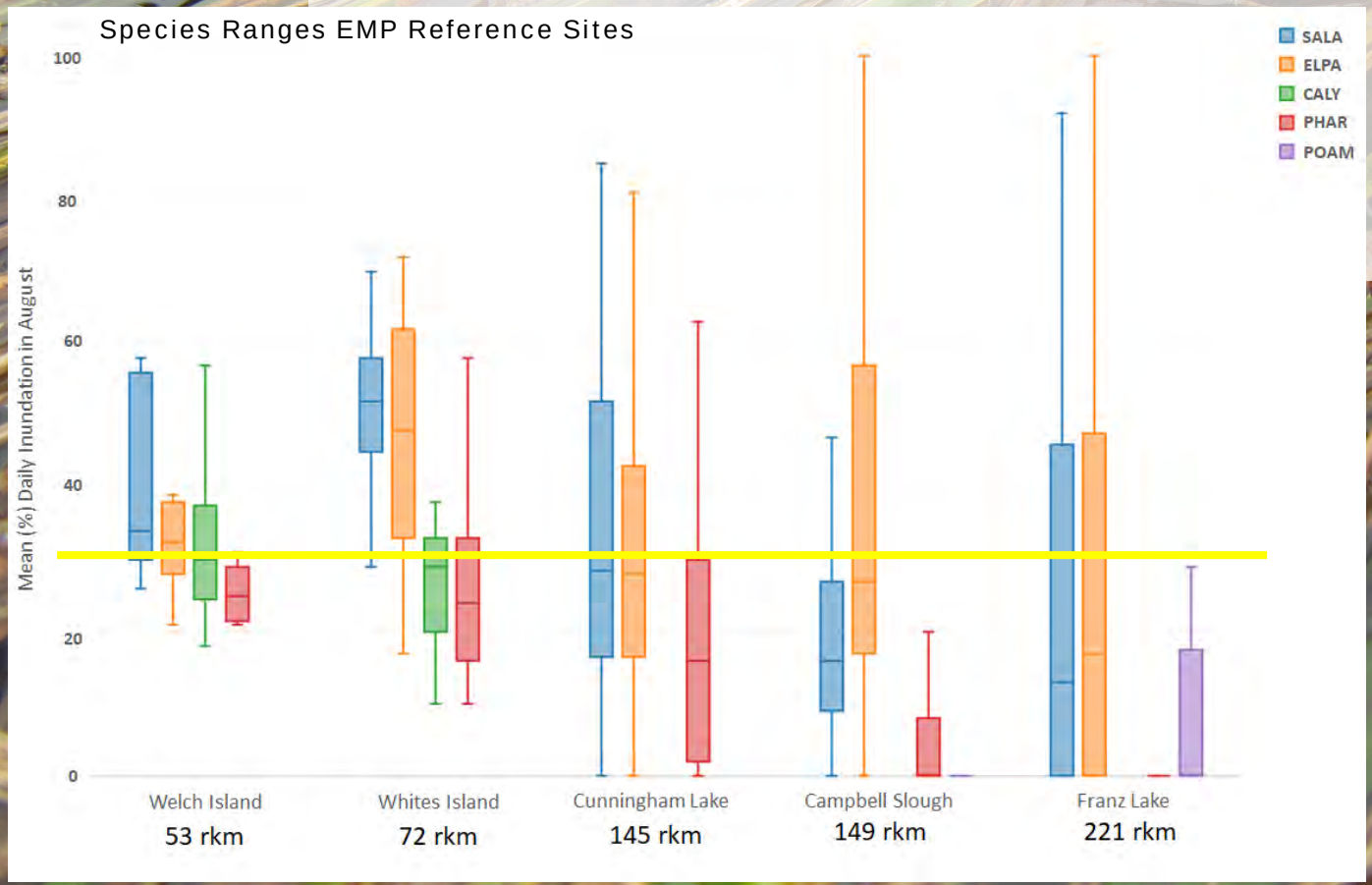
Native Plant Community Recovery

Target Hydrology – Reed Canarygrass

-Naturally varies based on Freshet Conditions

-Up to 20% annual shift in PHAR

-Target ≥ 30 % Daily Inundation in August



Kidd et al. 2019 (EMP Report)

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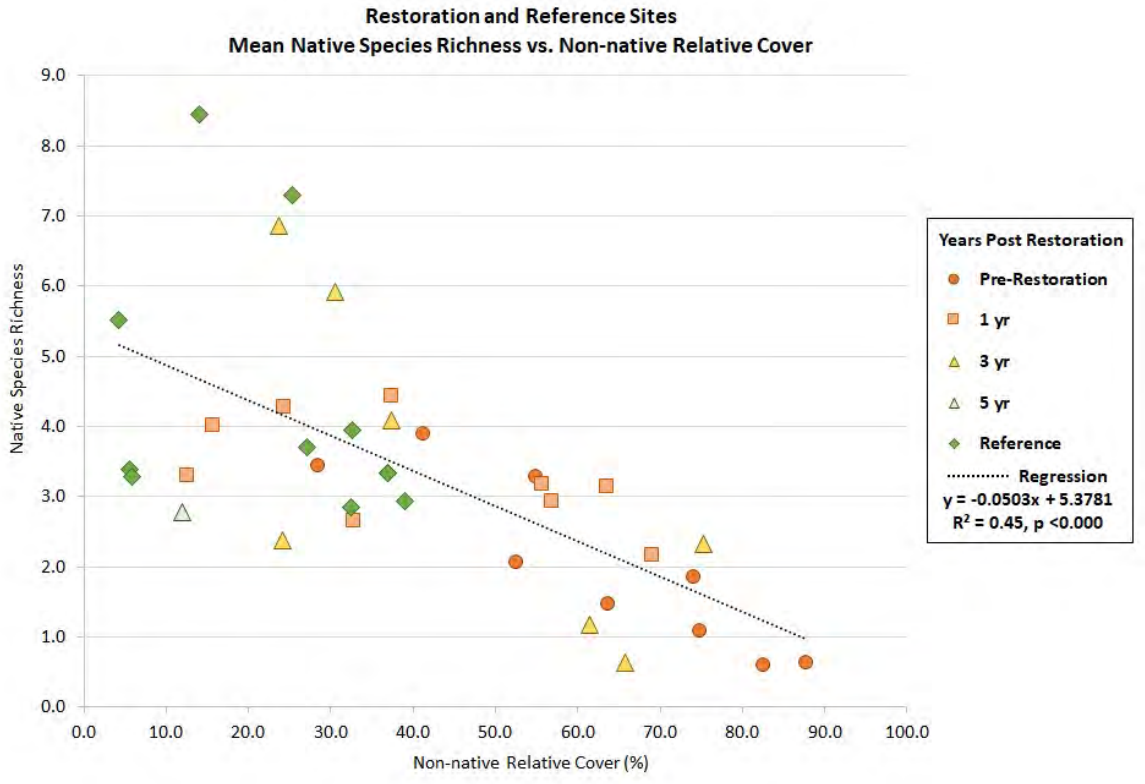
RESTORATION SITES



Grow at the exclusion of natives – reduces native species richness

Kidd et al. 2018 (SM2 Report)

Plant Community Native and Non-native Species Dominance

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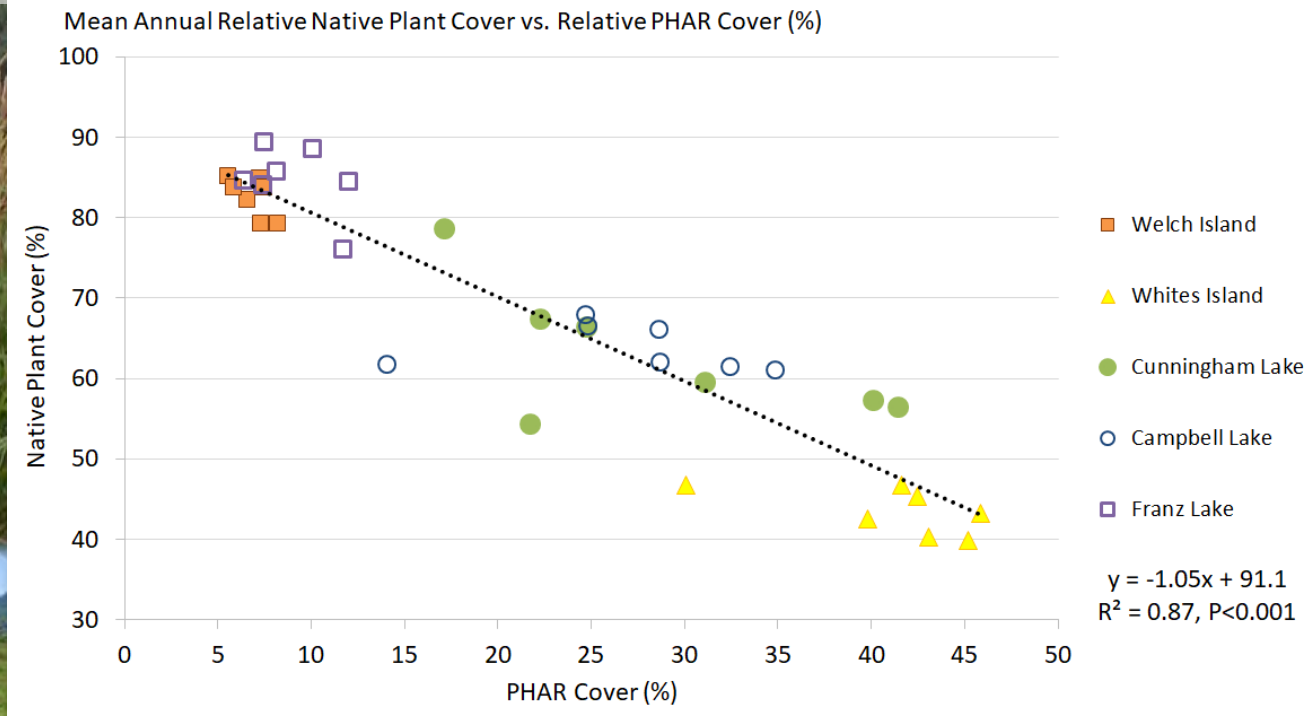
REFERENCE SITES



Grow at the exclusion of natives – reduces native cover

Kidd et al. 2019 (EMP Report)

Moving Towards Understanding Recovery

- **Does the site have similar restored hydrology to the reference site?**
  - **Restored/Reference condition comparisons should focus on matching wetland hydrologic zones *based on duration, frequency, and timing of inundation***
  - **Monitoring and comparing hydrologically similar areas within reference and restored sites for tracking recovery**
    - **Different trajectories of recovery can be expected and adaptive management will likely be needed**

- Consider
  - Wetland hydrologic zones being restored
    - Mud flat, low marsh, high marsh, shrub
  - Impact of scrape down
    - Removing soil organic matter
    - Compacting soil
    - Soil texture
  - Seed banks (native & non-native)
    - Local native seed dispersal?
  - Creating goals that are measurable
    - Such as within a +/- 0.25 Response Ratio in 5 yrs.

HOW? – use hydrologic modeling to predict inundation and recovery

HOW? - Evaluate soil conditions and adjust plans and/or expectations accordingly

HOW? - Evaluate seed bank conditions and local seed sources, plan to seed or control non-natives as needed

HOW? - Monitor Plant Communities and Soil Conditions