Ecosystem Engineering Impacts of Water Primrose in the Delta

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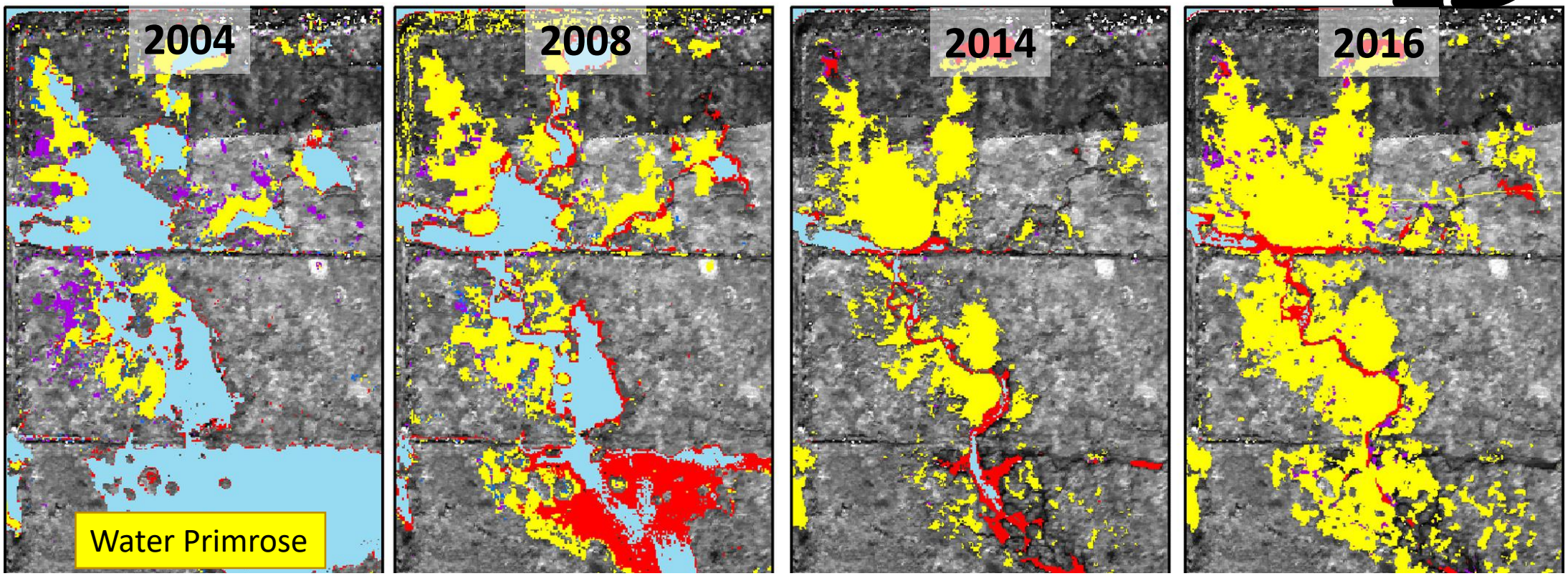
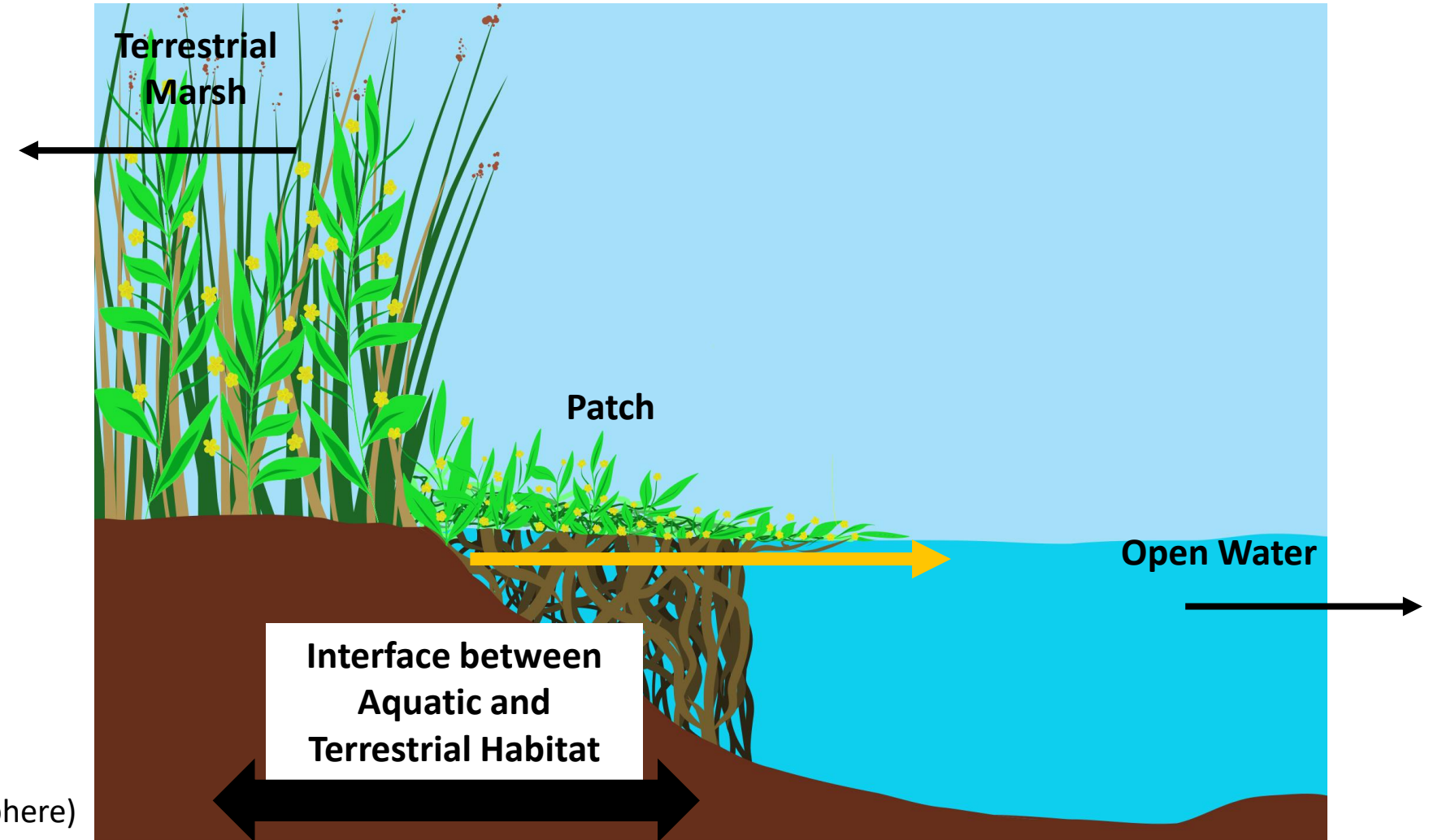
Water Primrose is encroaching native emergent Marshes – Khanna et al. 2018



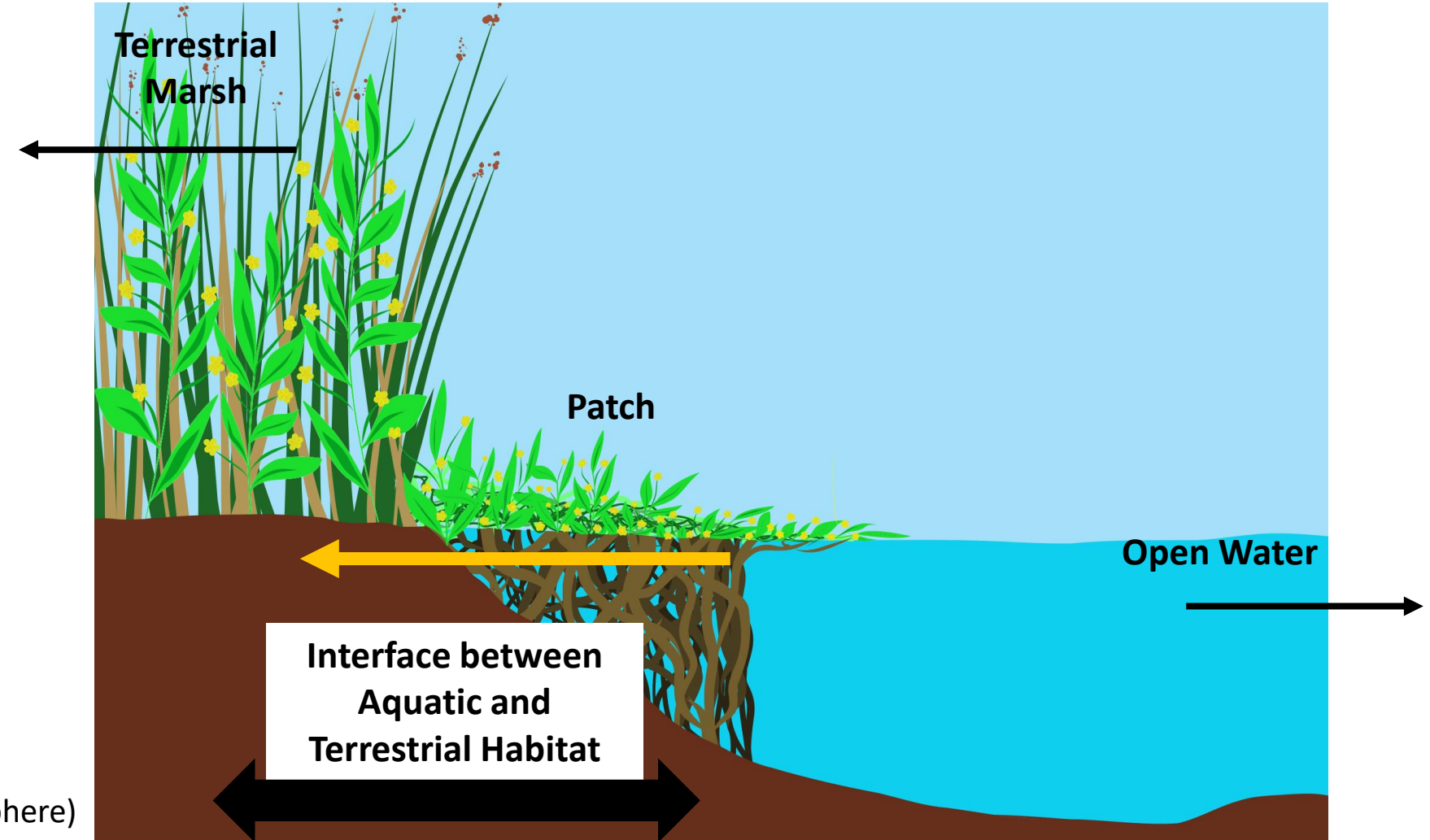
Over the past 3 decades water primrose cover has increased rapidly
4-fold increase between 2004-2016

After water primrose establishes, **it fills the open water habitat** until exhausted.



Khanna et al. 2018 (Ecosphere)

Once the open water Habitat is filled, water primrose **encroaches into the marsh** and replaces marsh vegetation.



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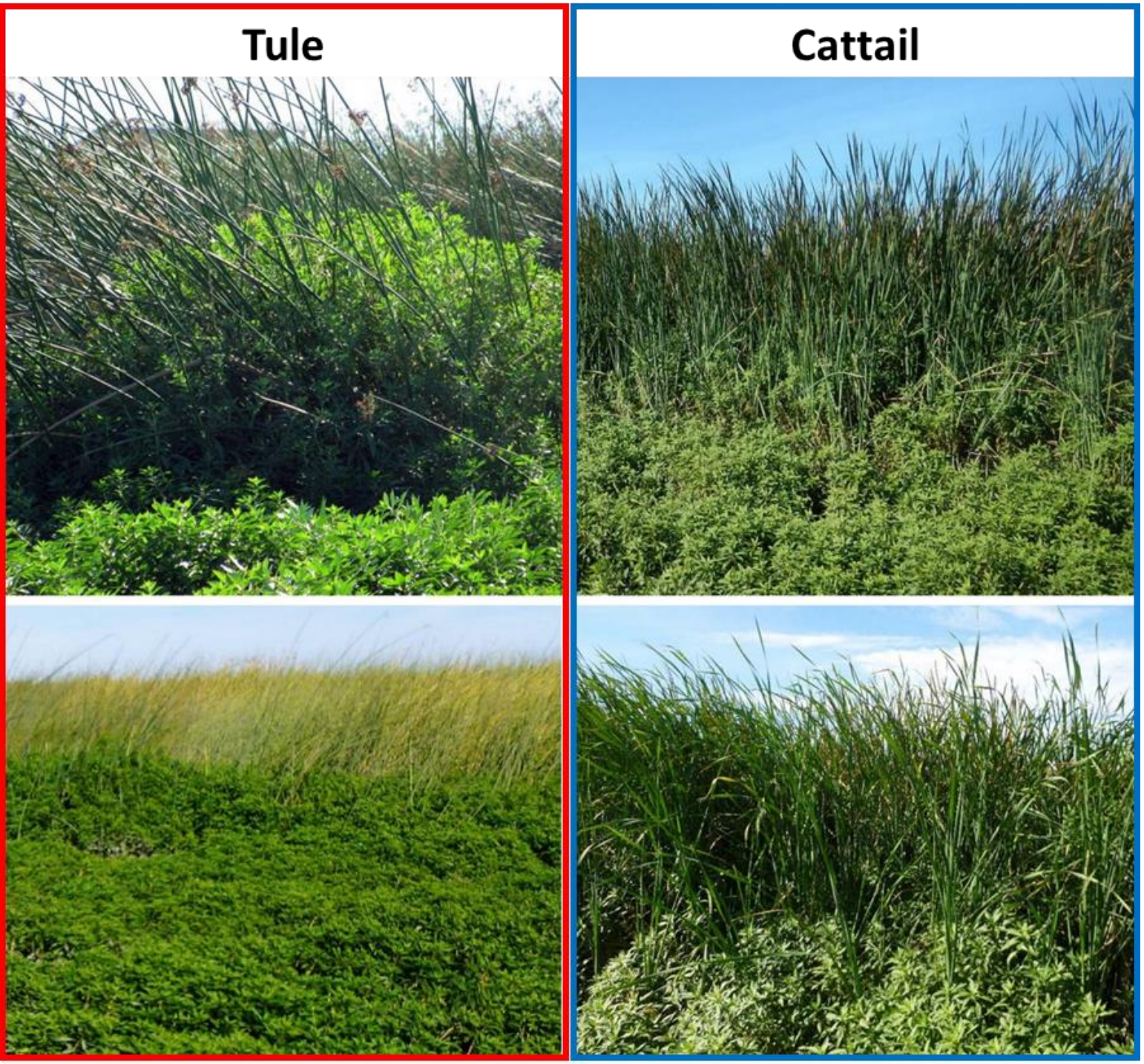


Ecological Impacts:

- Overcrowding and outcompeting native and non-native species.
- Altered functional relationships.
- Cascading effects in emergent marsh communities and ecosystem.
- Reverses marsh successional equilibrium.

Management Impacts:

- Water primrose encroachment can reverse successful restoration of Delta habitat.
- Herbicide treatments outside of open water habitat

What we don't know

What are the mechanisms and drivers of water primrose invasion responsible for marsh loss and vulnerability?

California Prop 1 Funding to…

- Identify functional traits linked to marsh loss.
- Determine effect of biodiversity on invasion success and occurrence of marsh loss.

Quantify the amount and spatial trajectory of marsh loss 2004 - 2020

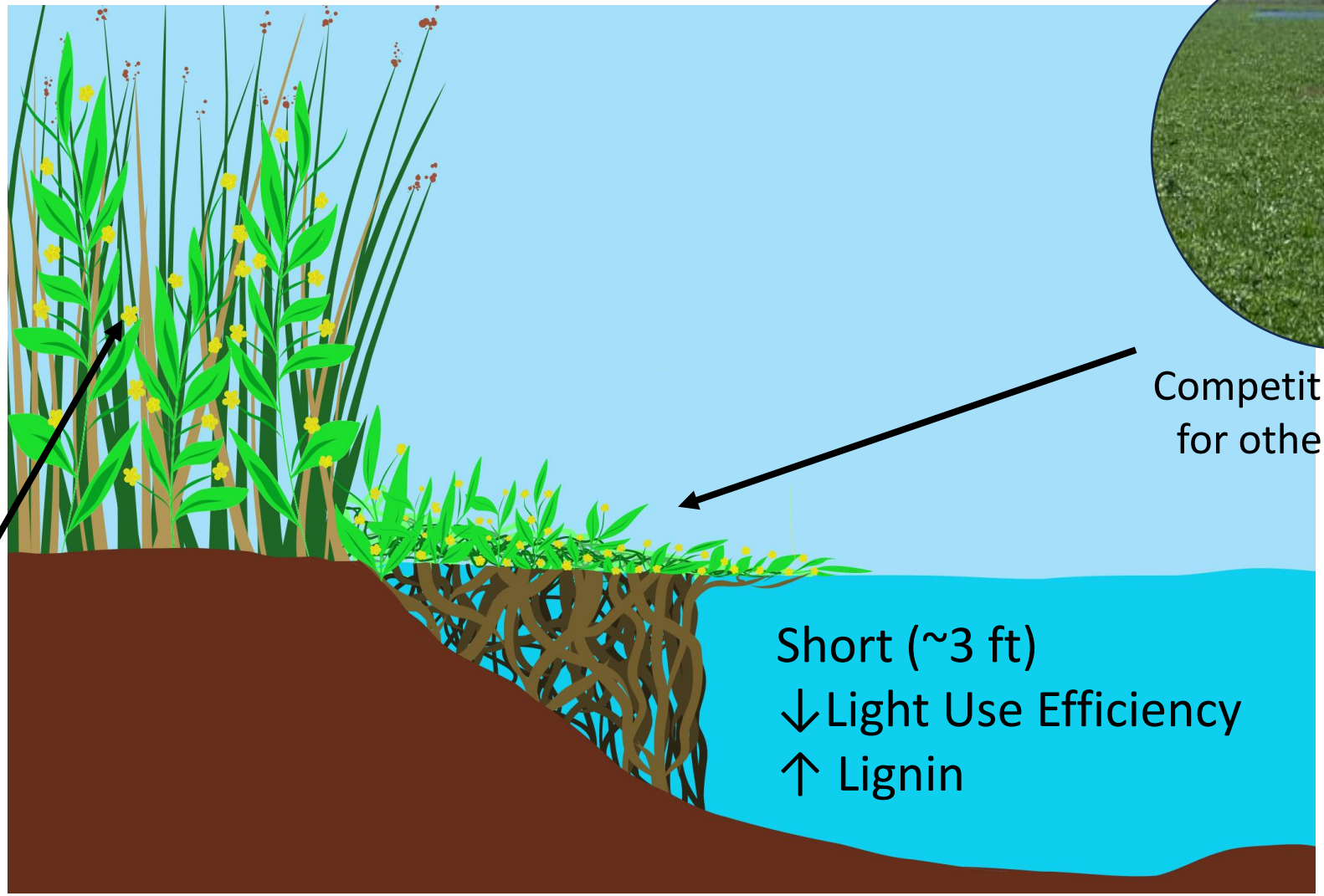
Identify/map marsh vulnerability and value in the Delta.

Final Public Datasets

What are the functional traits that influence water primrose invasion success?

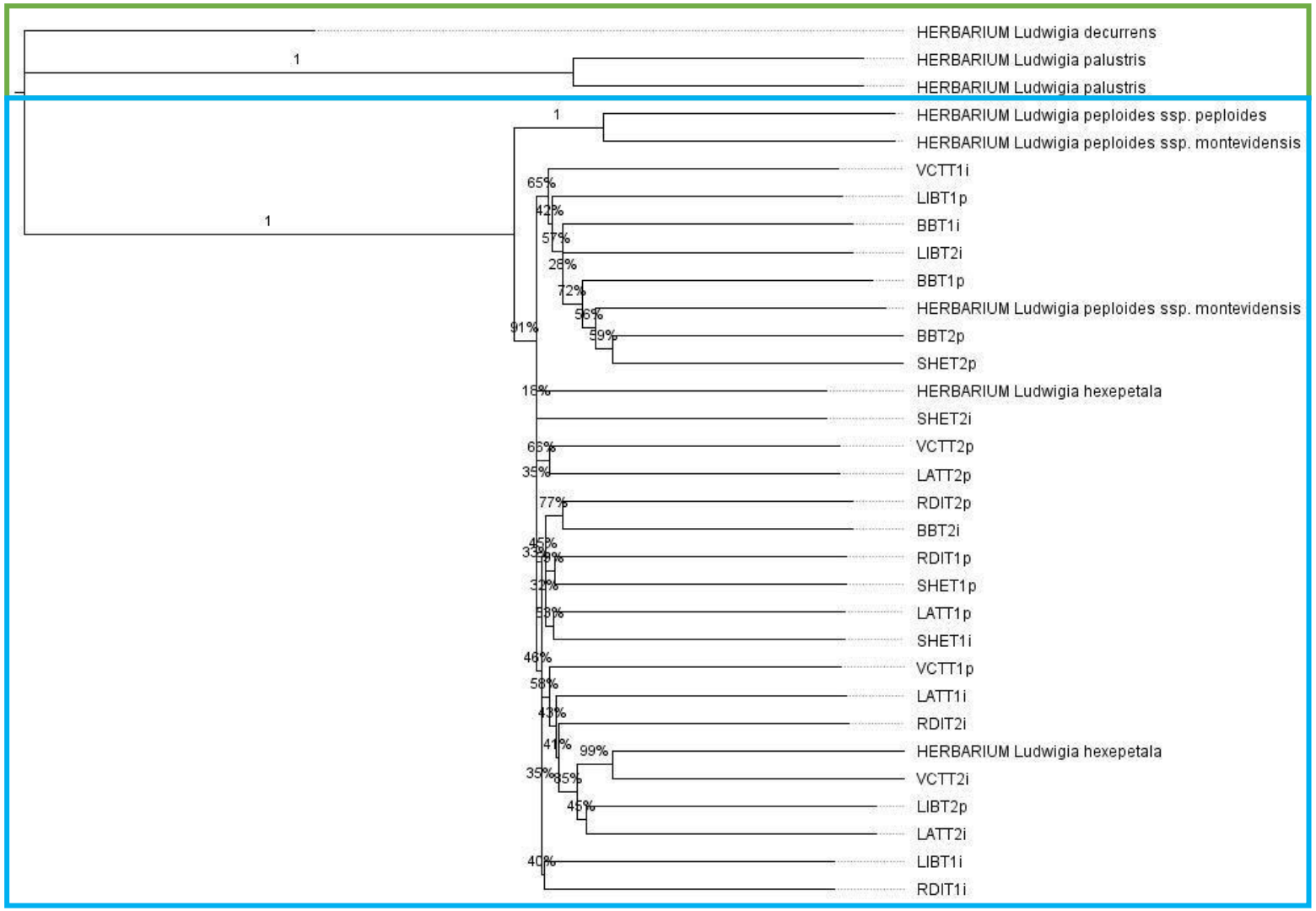
Very Tall (+10 ft)
↑ Light Use Efficiency
↑ Chlorophyll

Competition with Tule and Cattail for light



Competition with FAV for other resources

Are the differences in functional traits due to difference species, plasticity, or adaptation?



* HERBARIUM = plant samples preserved for long-term study

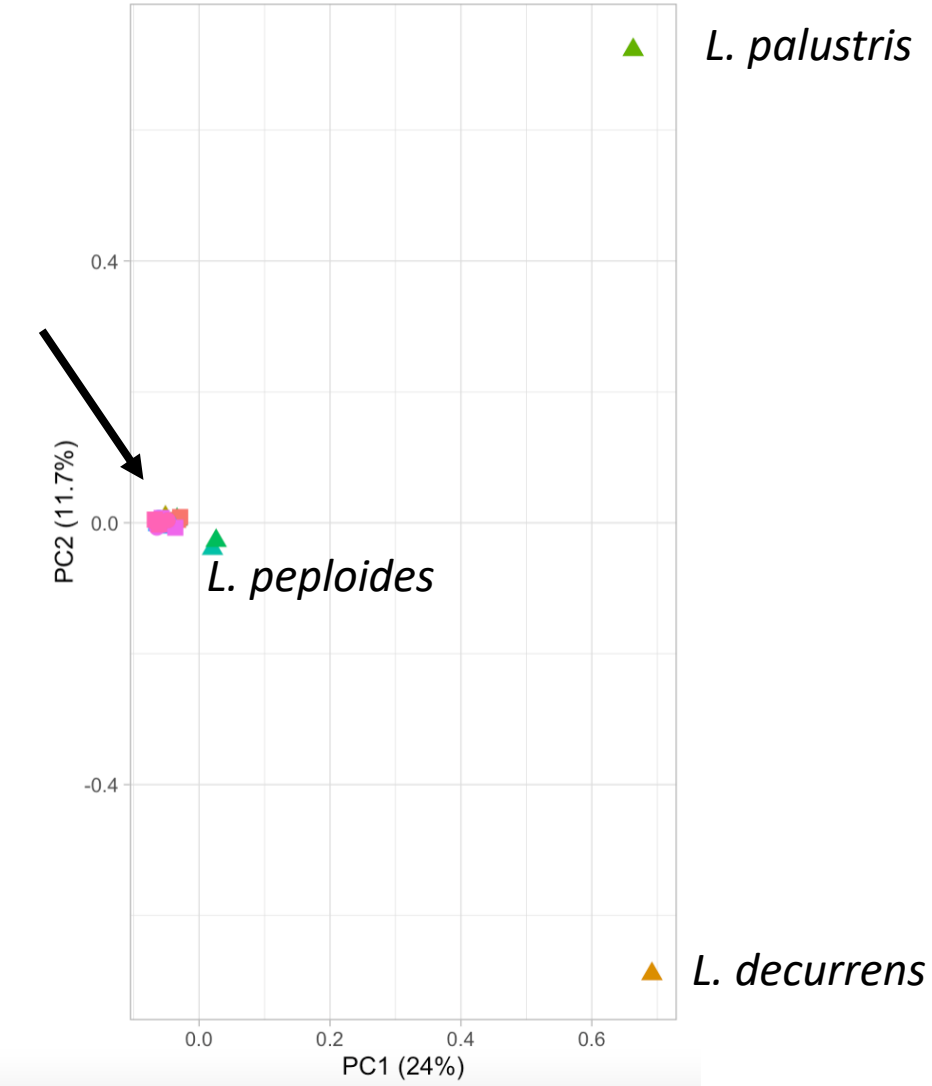
All our samples belong in 1 distinct ancestral tree

↓

Suggests that our samples are all *L. hexepetala*

Are the differences in functional traits due to difference species, plasticity, or adaptation?

All of our samples cluster together further suggesting that all are the same species, and L. hexepetala.



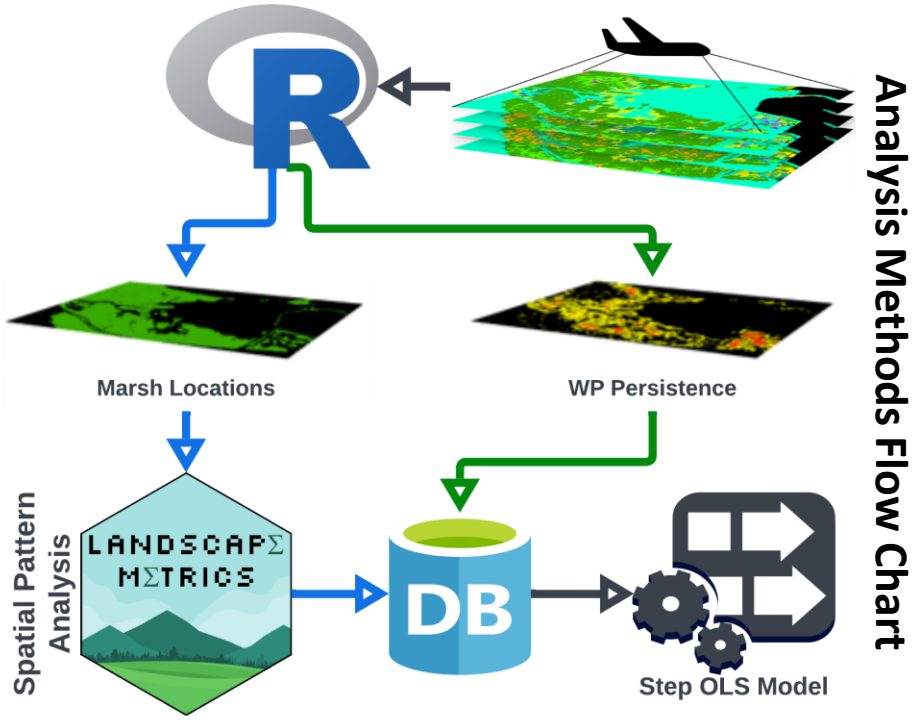
What is the effect of community and spatial structure on water primrose invasion success and occurrence of marsh loss?

Task 1:
Quantify the amount and spatial trajectory of marsh loss due to primrose invasion from 2004-2020.

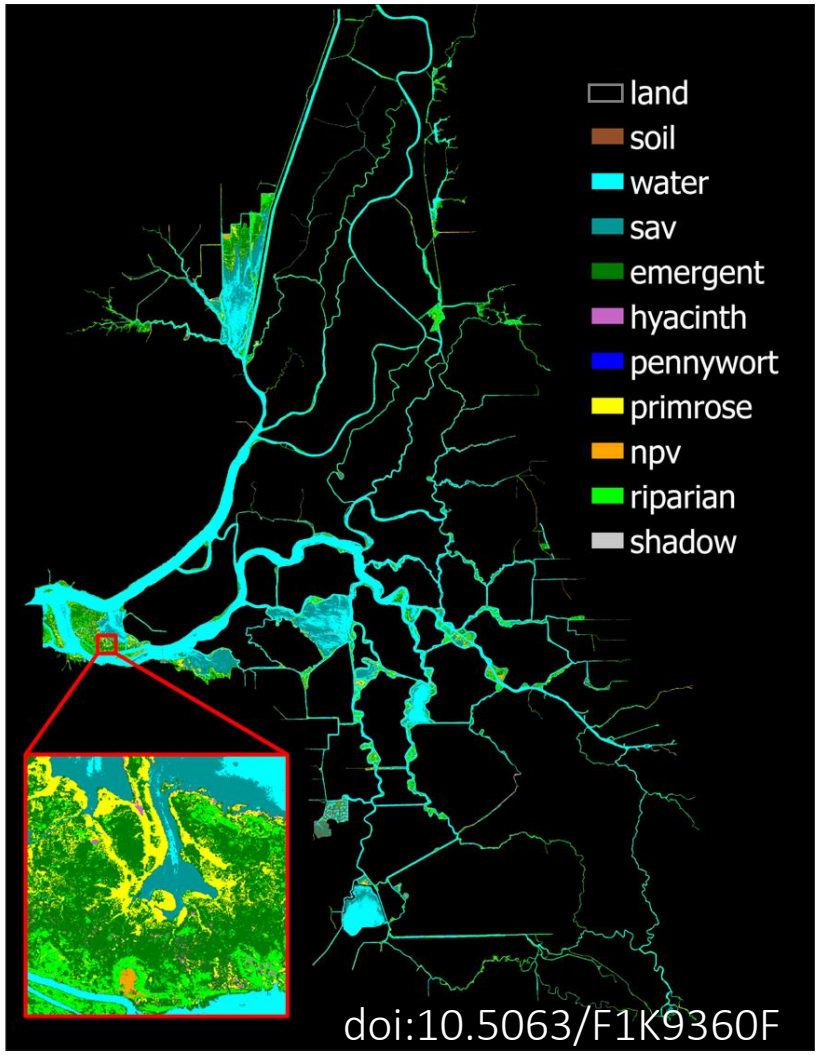
Task 2:
Determine the effect(s) of persistence and landscape structure on water primrose invasion and marsh loss.

The Sacramento-San Joaquin Delta genus and community level classification maps derived from airborne spectroscopy.

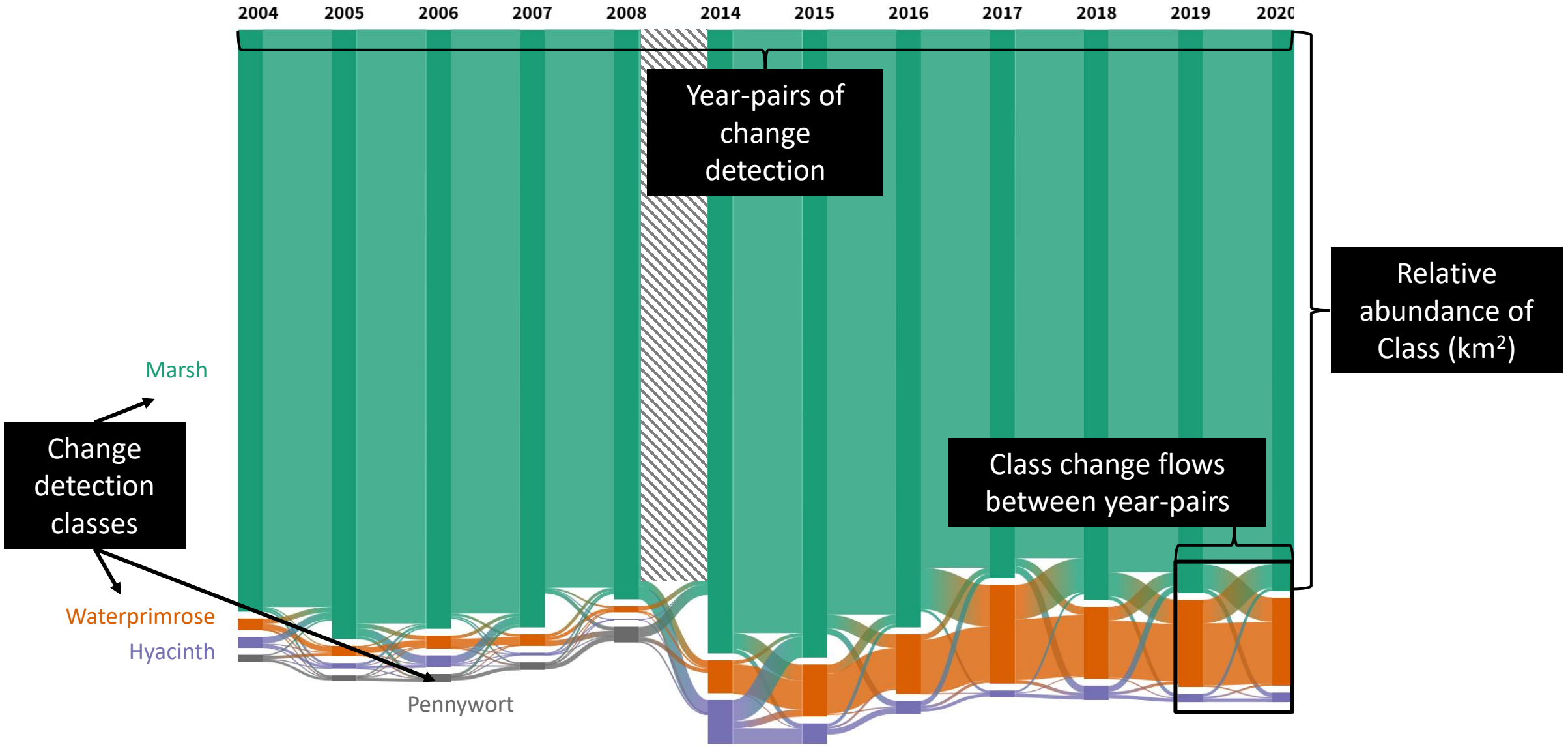
- Available at knb ecoinformatics DAAC
- 1.7-3 meter pixel resolution
- 2004-2008;2014-2020



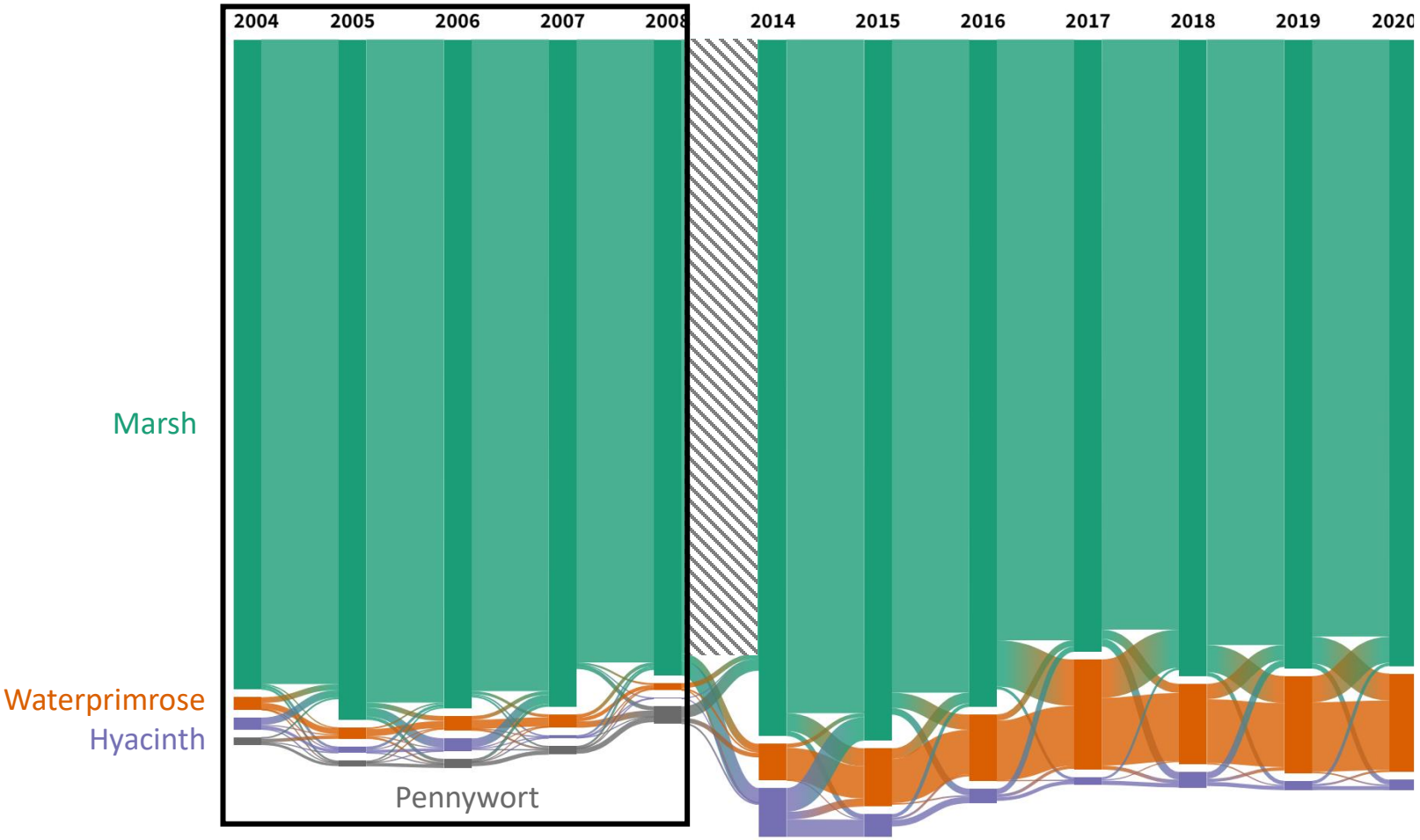
Khanna et al. 2022



Task 1: Quantify the amount and spatial trajectory of marsh loss due to primrose invasion from 2004-2020.



Water primrose was not stable and had not invaded marshes.

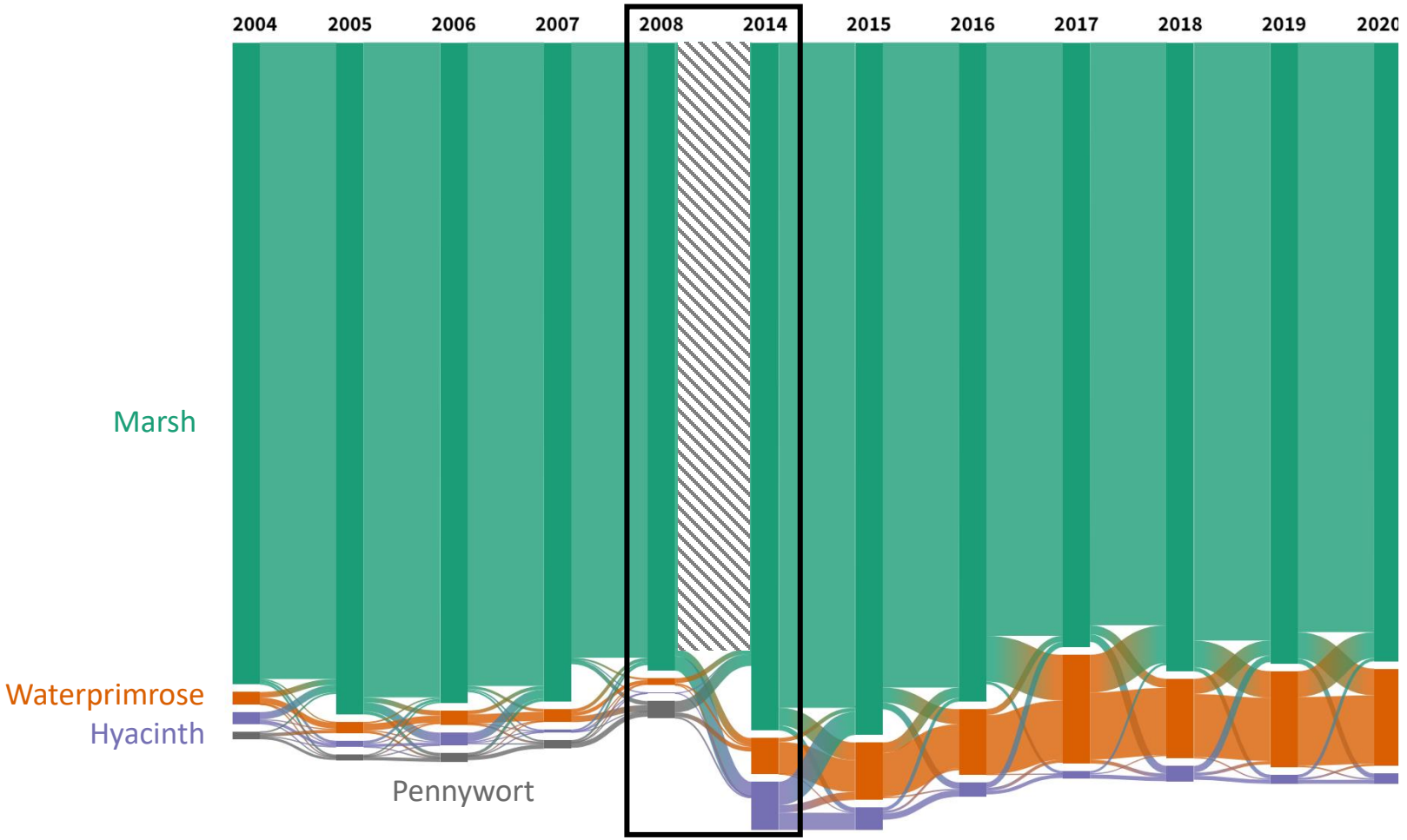


2004-2008

Marsh: ↓ 0.6% (-0.2 km^2)

Water primrose: ↓44.9% (-0.3 km^2)

Water primrose dramatically increased, but spread throughout open water, not marshes.



No imaging spectroscopy data from 2009-2013

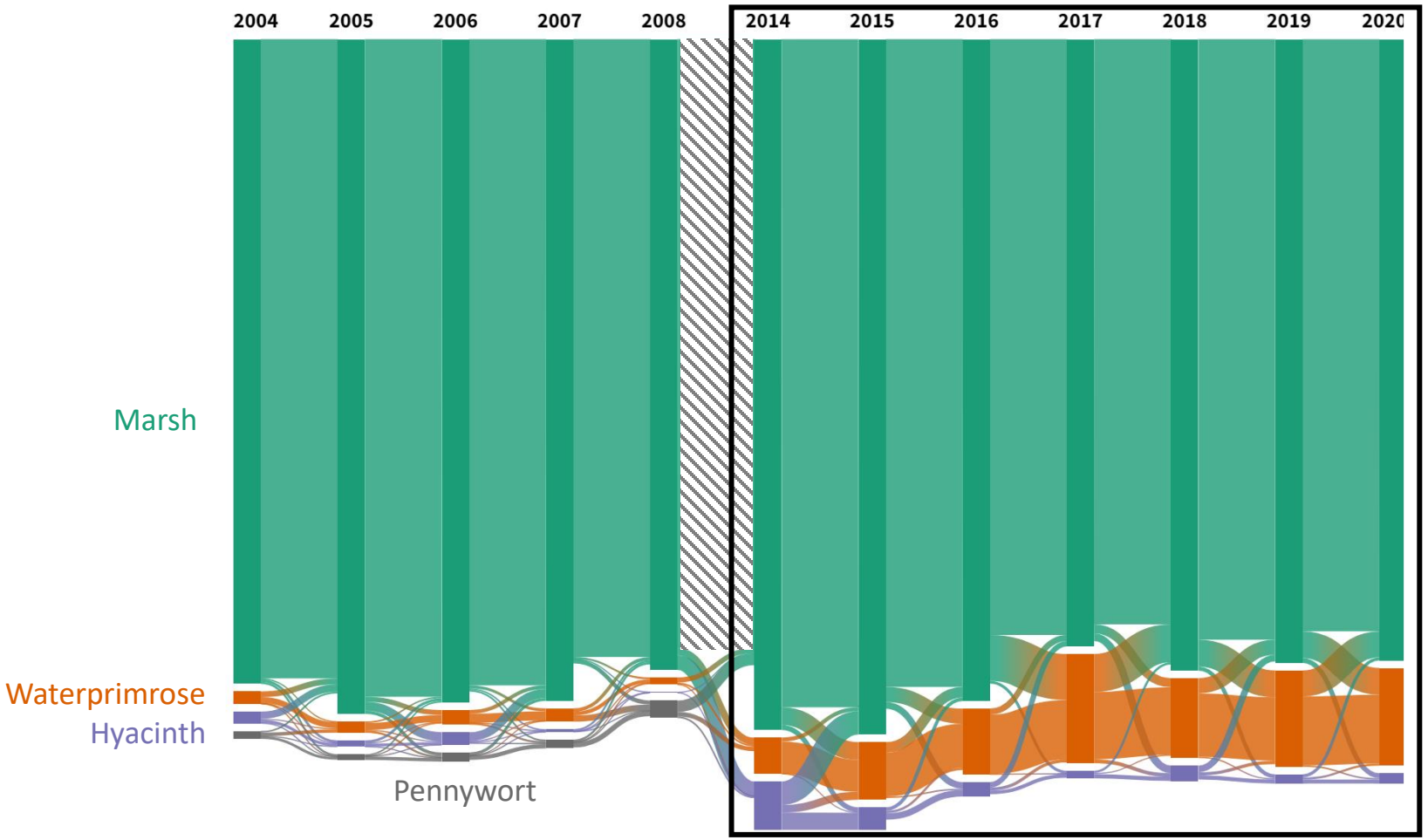
2008-2014

Marsh: ↑13.6% (+4.2 km^2)

Water primrose: ↑424% (+1.5 km^2)

- 5-fold increase in water primrose!
- 69.9% (1.3 km^2) of all water primrose growth was acquired by replacing open water habitat.

Water Primrose continued to grow and started invading marshes.



2014-2020

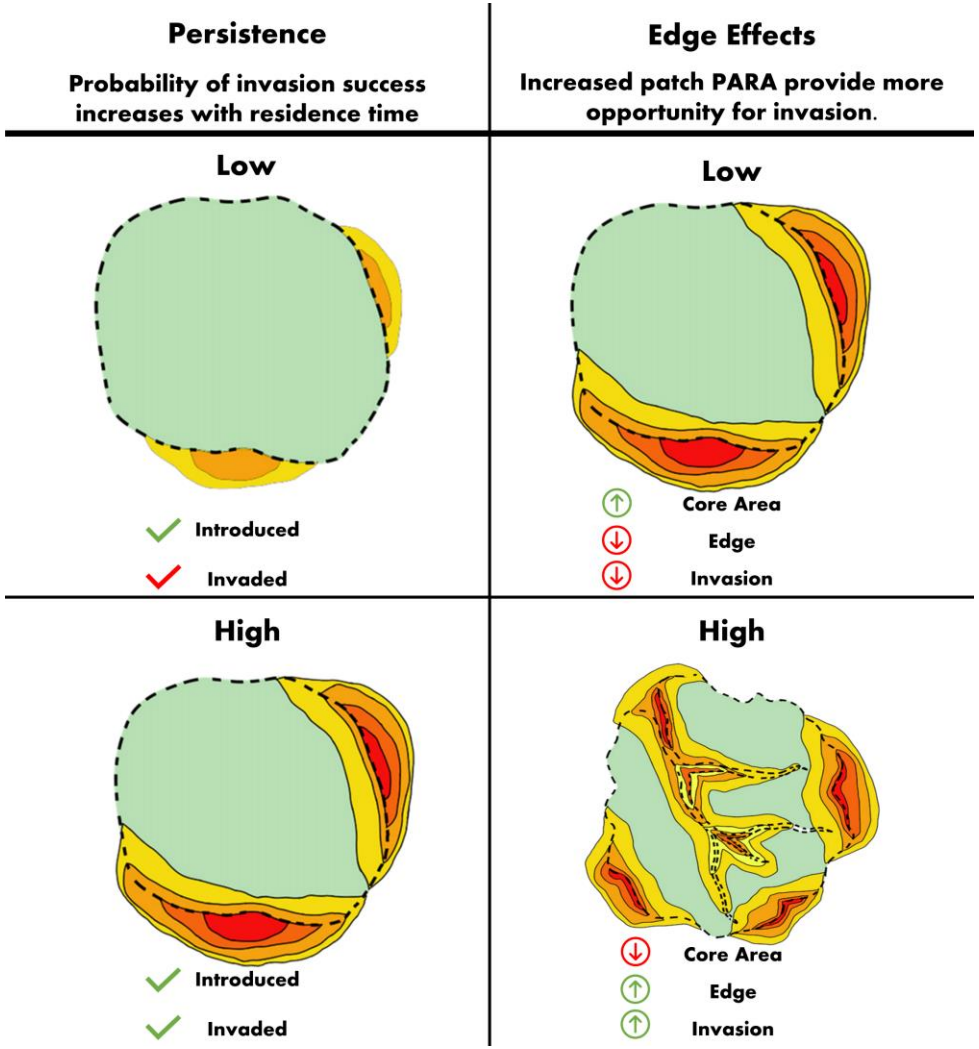
Marsh: ↓ 12.8% (- 4.4 km^2)

Water primrose: ↑ 155% (+2.9km^2)

- 2-fold increase in water primrose!
- 60% and 30% of all water primrose growth was acquired by replacing marsh and open water habitat, respectively.

Half of all marsh loss was directly replaced by invading water primrose.

Task 2: Determine the effect(s) of persistence and landscape structure on water primrose invasion and marsh loss.



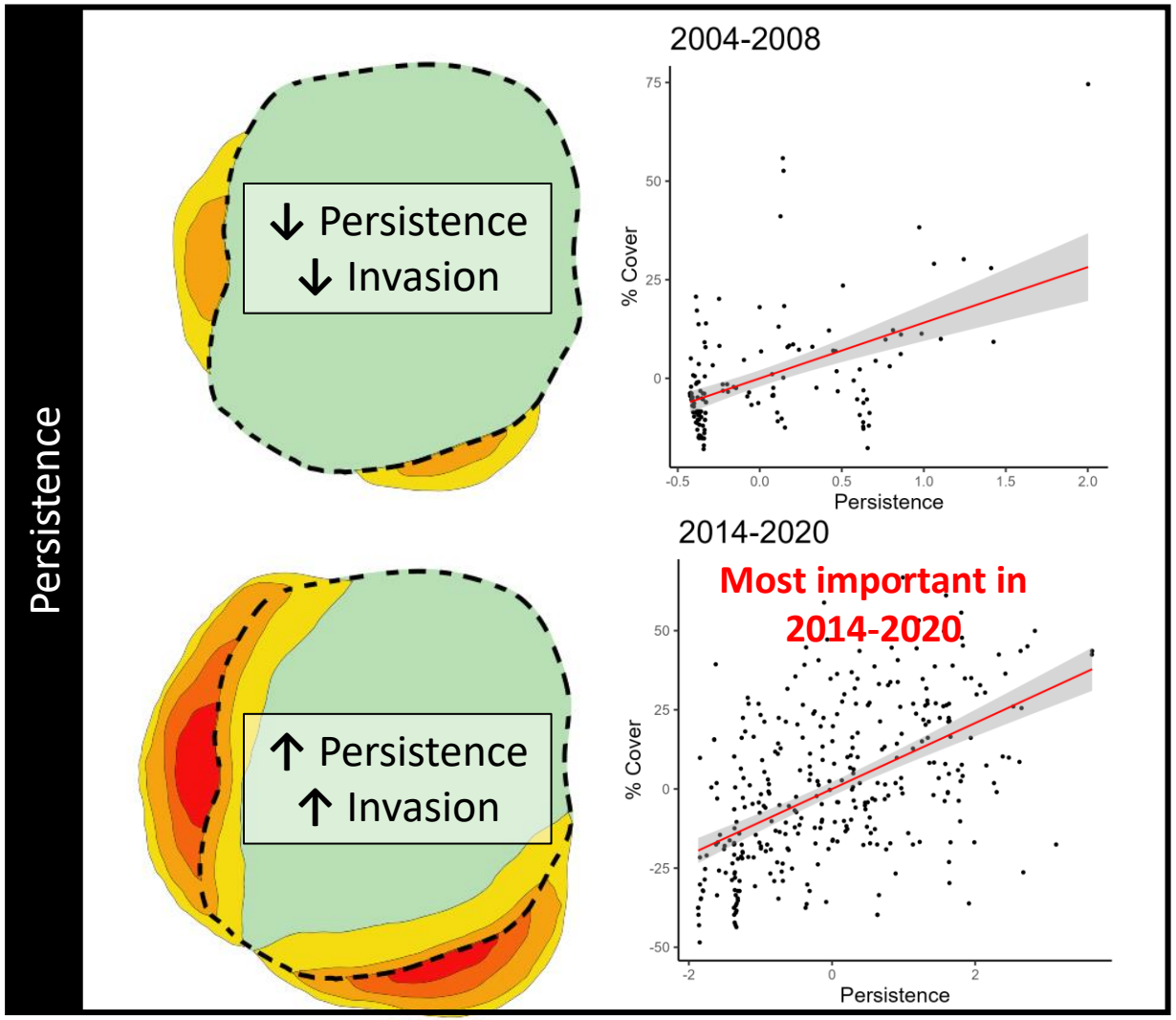
Invasiveness Hypothesis:

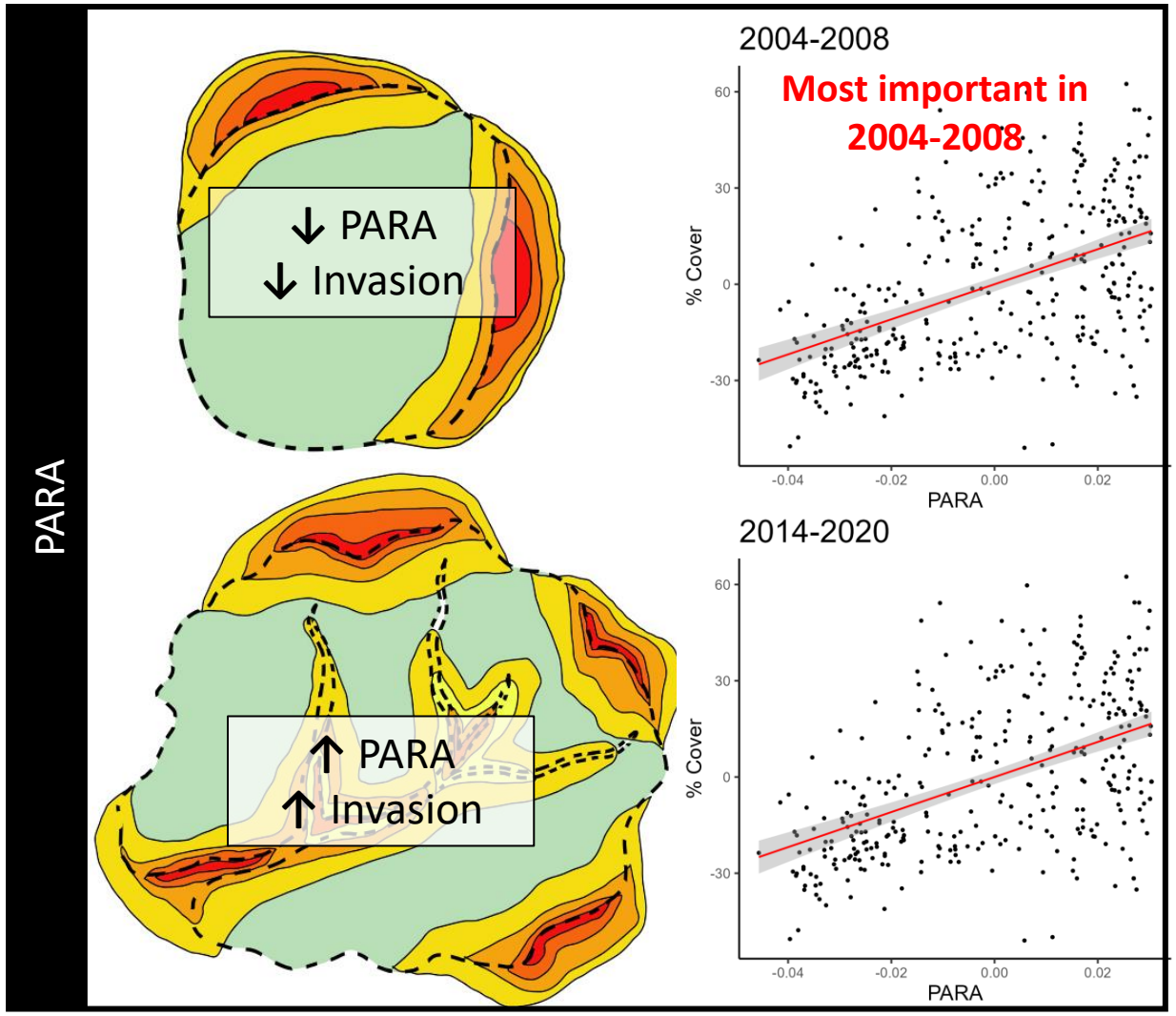
The duration of water primrose **persistence** increases likelihood of marsh invasion and marsh mortality.

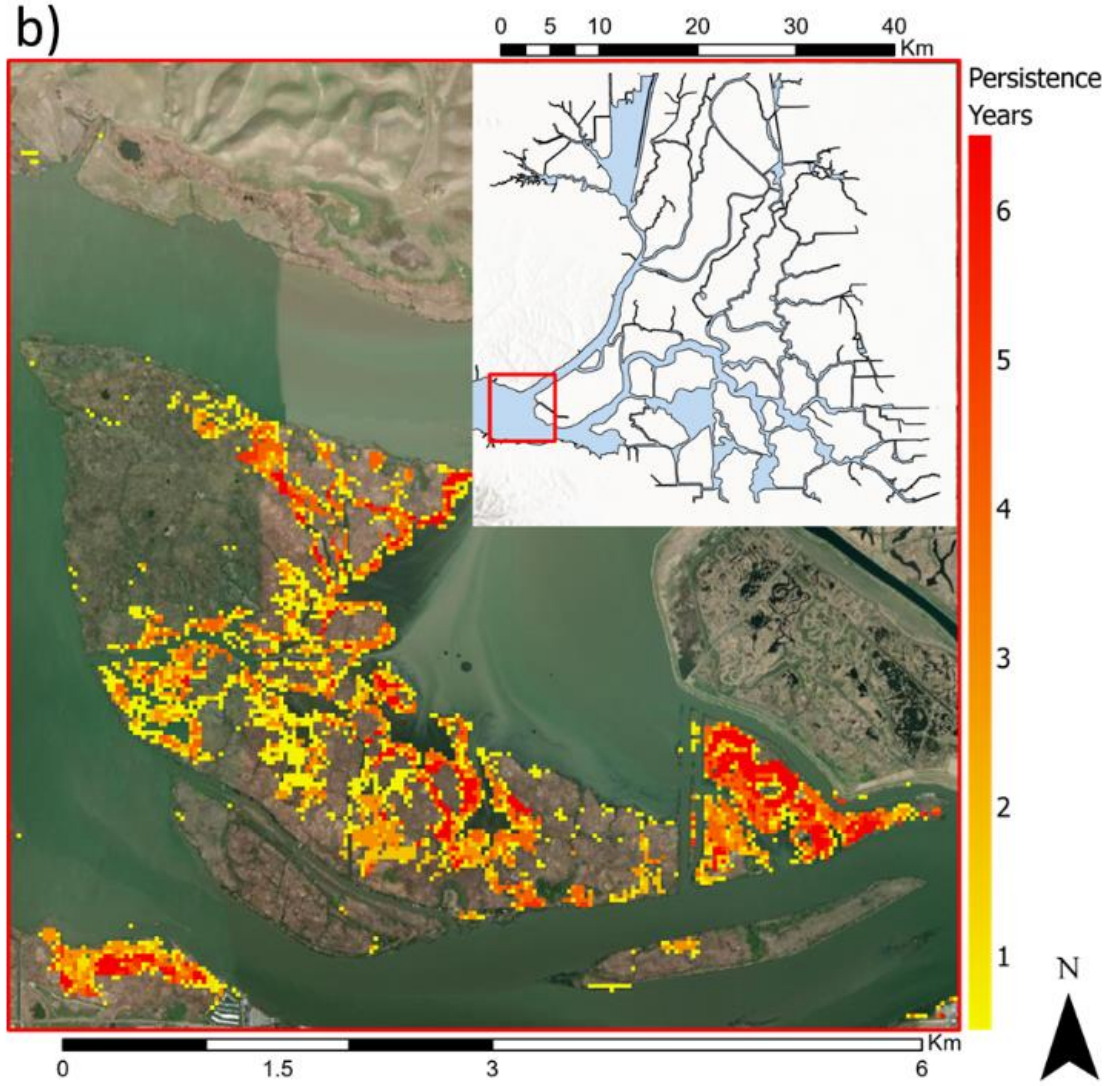
Invasibility Hypothesis:

Marshes with higher **perimeter-to-area** (PARA) have increased likelihood of marsh invasion and marsh mortality.

Water primrose invasion increases with water primrose Persistence and marsh PARA

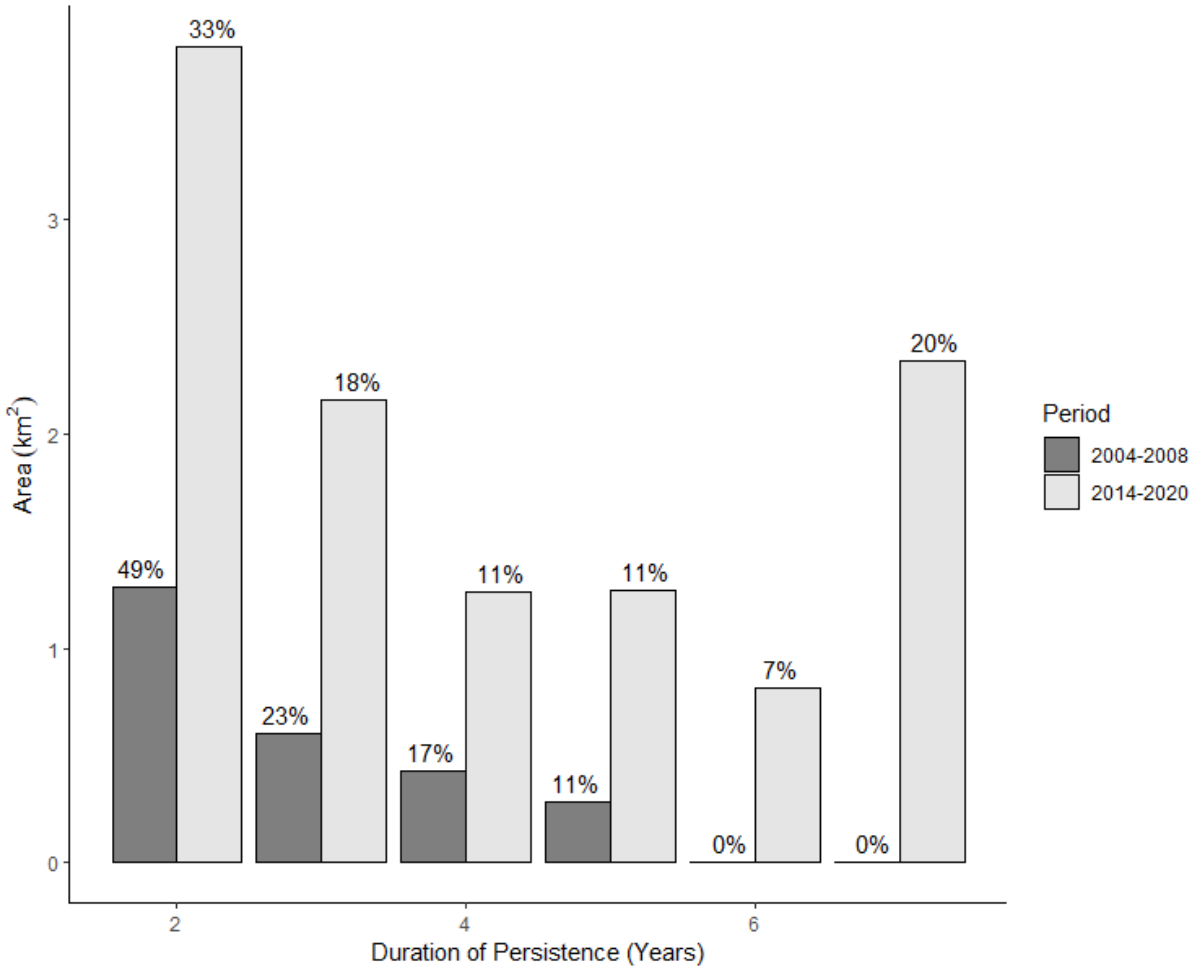






What do the results tell us?

- **Invasiveness:** The longer water primrose persists within a marsh, the harder it will be to control its spread and displacement of marshes.



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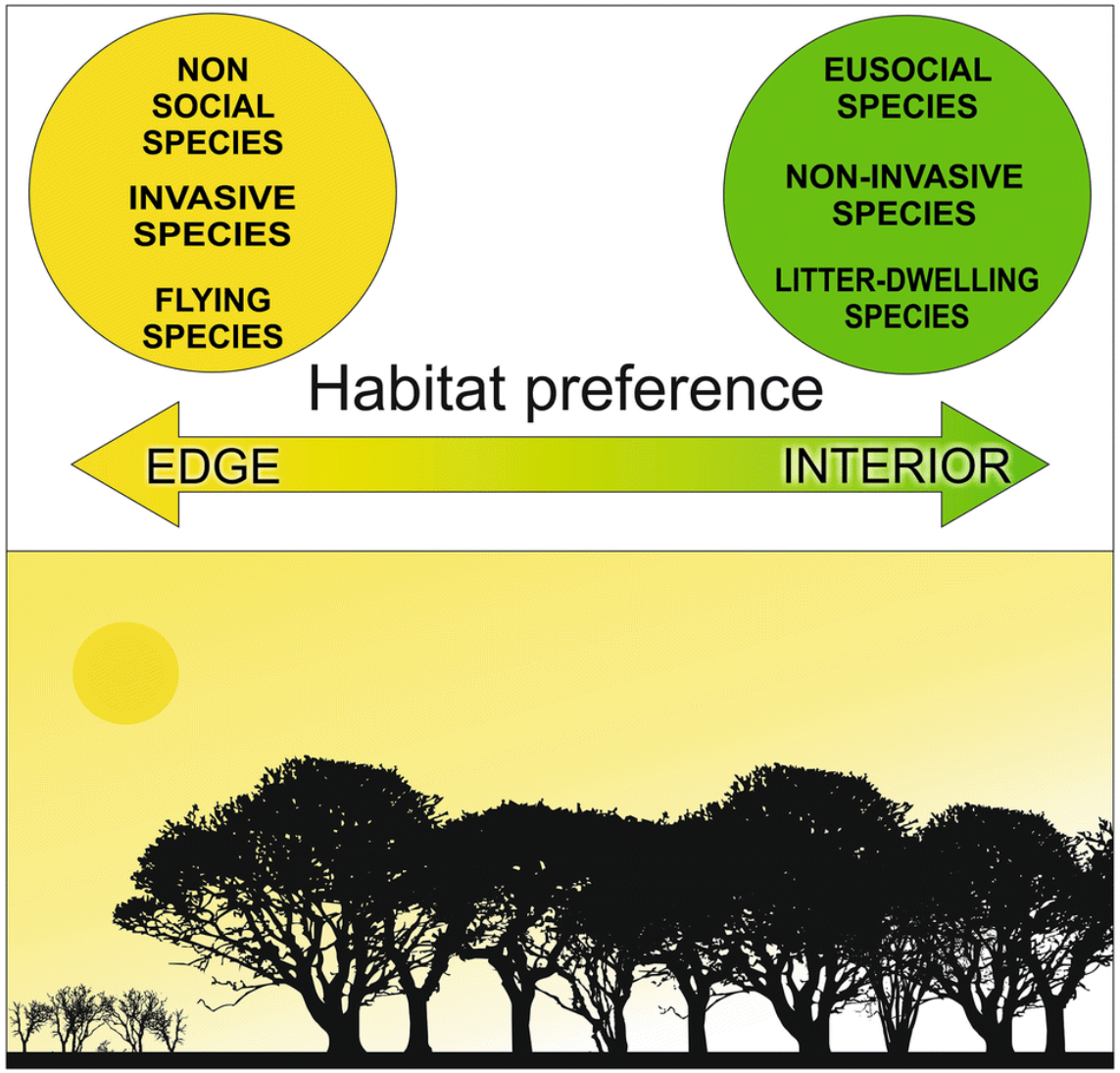
  - Minimum Residence Time Hypothesis (MRT)
  - ↑ Propagule Pressure



What do the results tell us?

- **Invasibility:** Complex restoration sites may have a higher risk of water primrose invasion.
  - Edge effects play an important role in water primroses ability to invade marshes.
  - ↑ Environmental Heterogeneity
  - ↑ Colonization
  - ↓ Native competition

Caitano, et al. 2020

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EORS Lab: https://eors.ucmerced.edu/
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How does water primrose allelopathy impact marsh invasion?