Overview

The Importance and History of West Coast Estuary Restoration

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Brief **Overview**

The Importance and History
of West Coast Estuary *(Tidal Marsh)* Restoration

What are we restoring?

How do we measure success?

Why bother?

Some Precepts

Regarding Ecological Restoration in General

- We cannot reach the past.
- Ecosystems don’t run backwards.
- The past cannot (exactly) foretell the future.
- But the past can reveal the full restoration palette and help differentiate between human and natural history, thus helping us know what can and what cannot be managed.

What ***IS*** Ecological Restoration?

A Practical, Scale-independent, Culturally Neutral Definition

Restoration is:

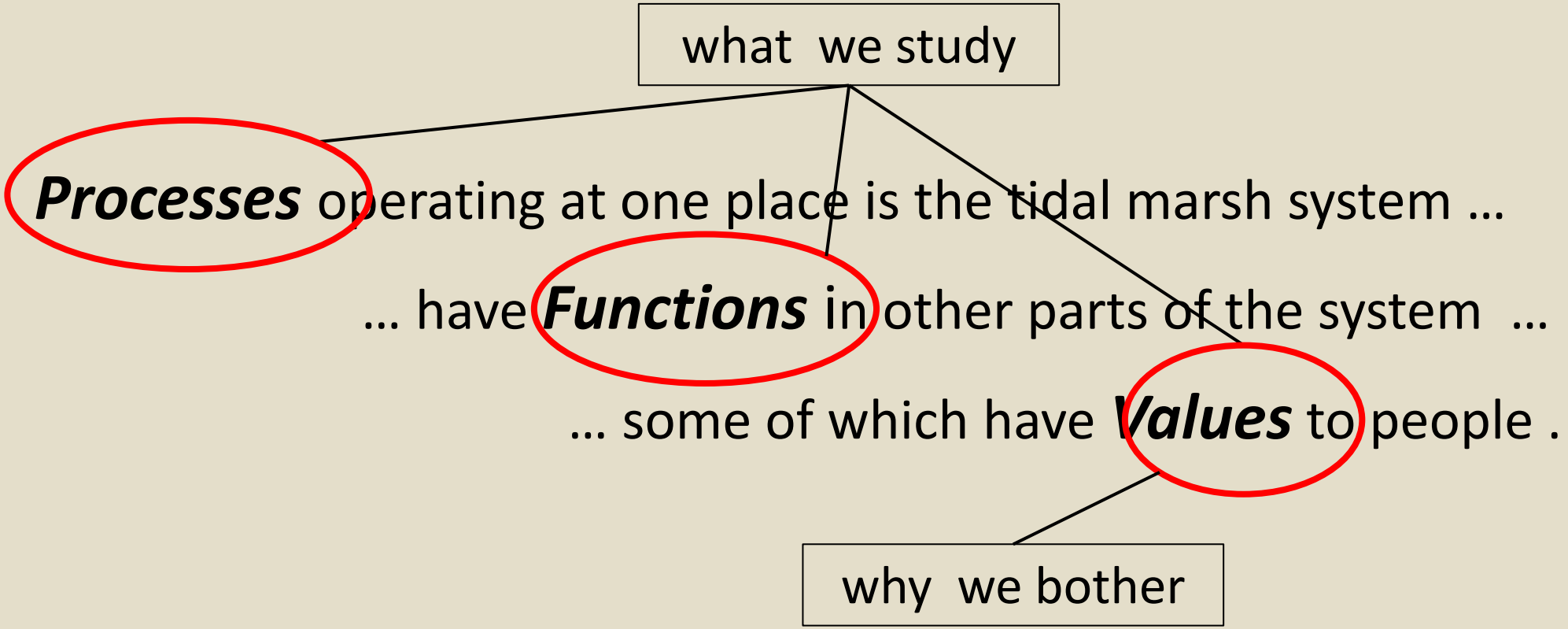
the processes and outcomes of trying to establish and sustain needed levels of selected ecosystem services.

That everything is connected to everything else might be a truism but it's not an operational principle.

Answer the questions: how much of what services do we need - where, when, and why?

What ***ARE*** We Trying to Restore?

Answer: target levels of selected ecosystem services.



What ***ARE*** the Values of Tidal Marsh?

The answer depends on cultural context, but in general …

Provisioning Services

e.g.

Regulating

e.g.

Supporting

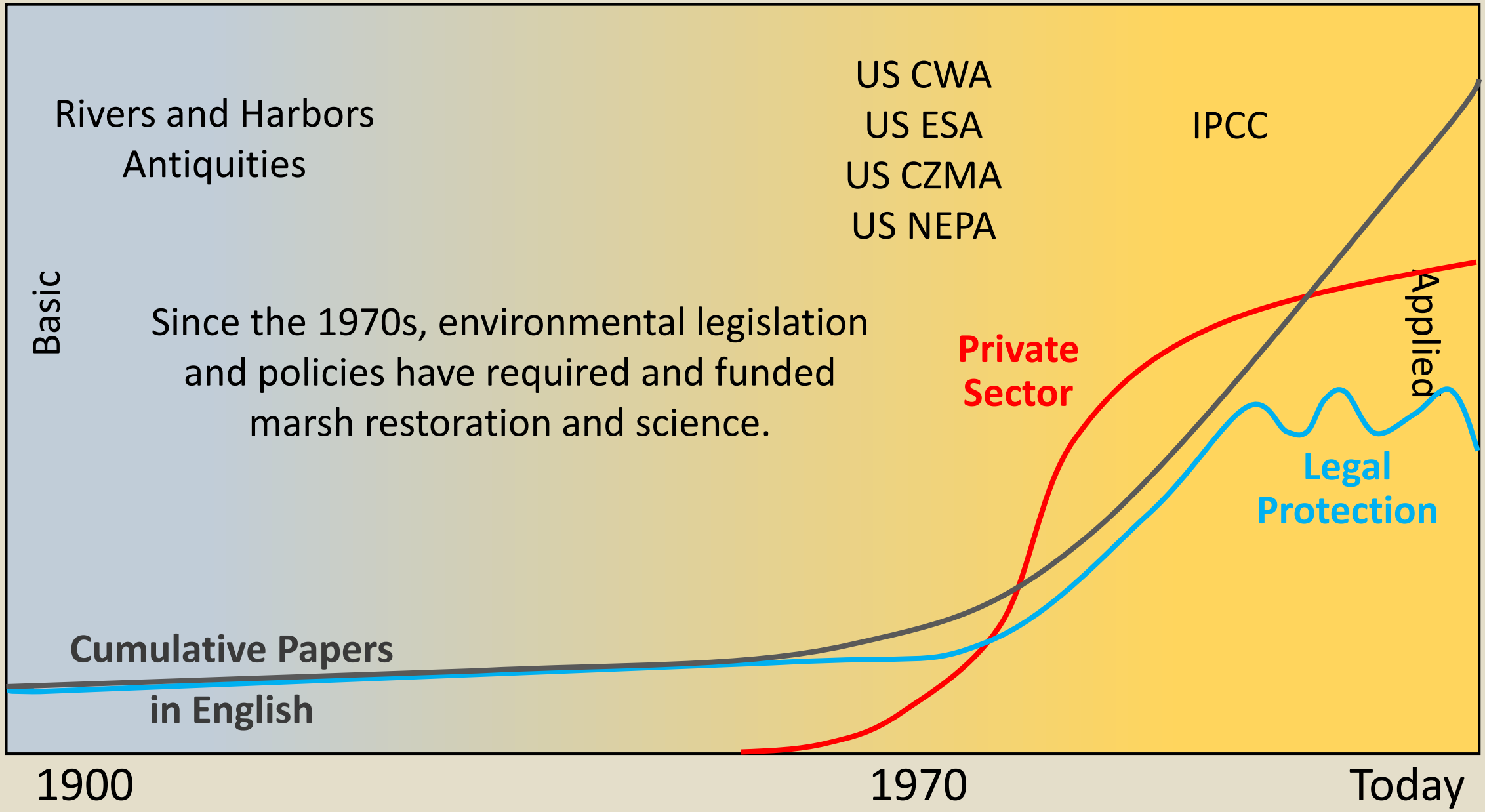
e.g. photosynthesis, biodiversity,

Spatial, temporal, financial, political conflicts among kinds and levels of service generate public debate. Science can advance the debate but not dictate its outcomes.

Cultural Services

e.g. aesthetics, recreation, understanding

Evolving Motives and Perspectives


Rivers and Harbors
Antiquities
US CWA
US ESA
US CZMA
US NEPA
IPCC
Basic
Applied
Since the 1970s, environmental legislation and policies have required and funded marsh restoration and science.
Private Sector
Legal Protection
Cumulative Papers in English
1900
1970
Today

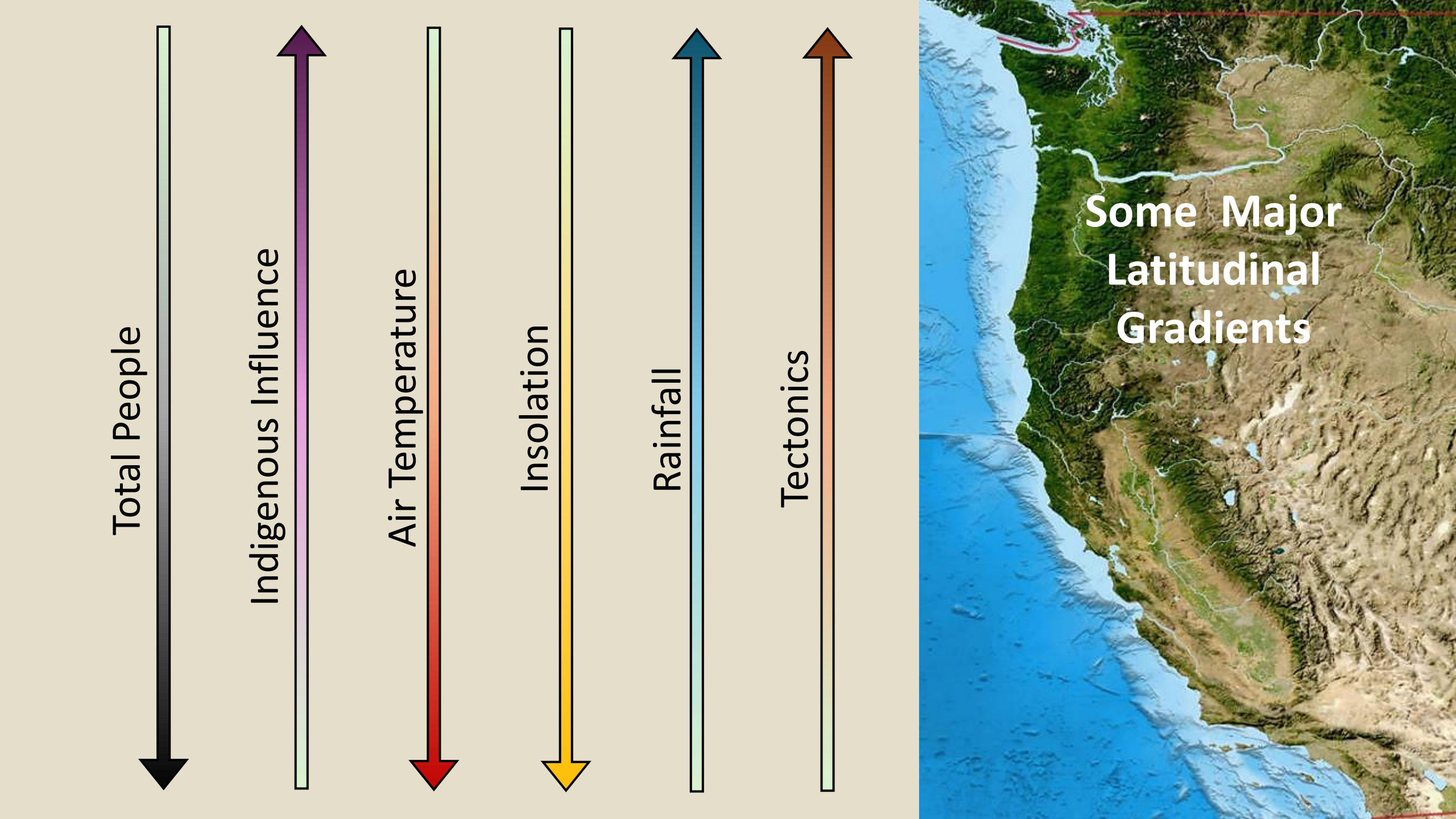
Coterminous US West Coast is large and complex in many geologic, climatic, hydrologic, and cultural aspects.

North 32^{o} to 49^{o}

Shoreline > 12,000 miles with SFE Delta

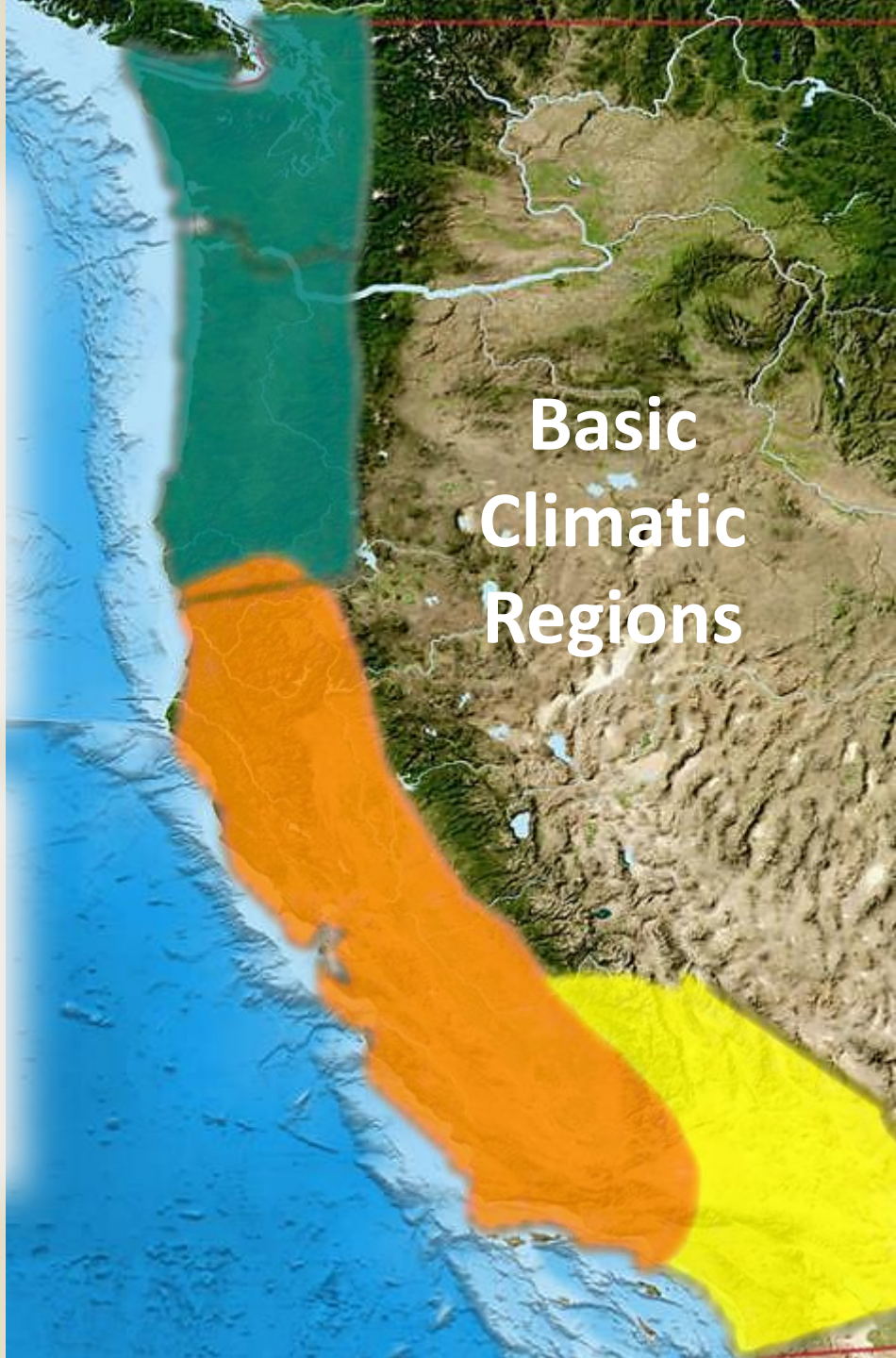
Highly Variable Tidal Range

More than 250 spoken languages


Total People
Indigenous Influence
Air Temperature
Insolation
Rainfall
Tectonics
Some Major Latitudinal Gradients

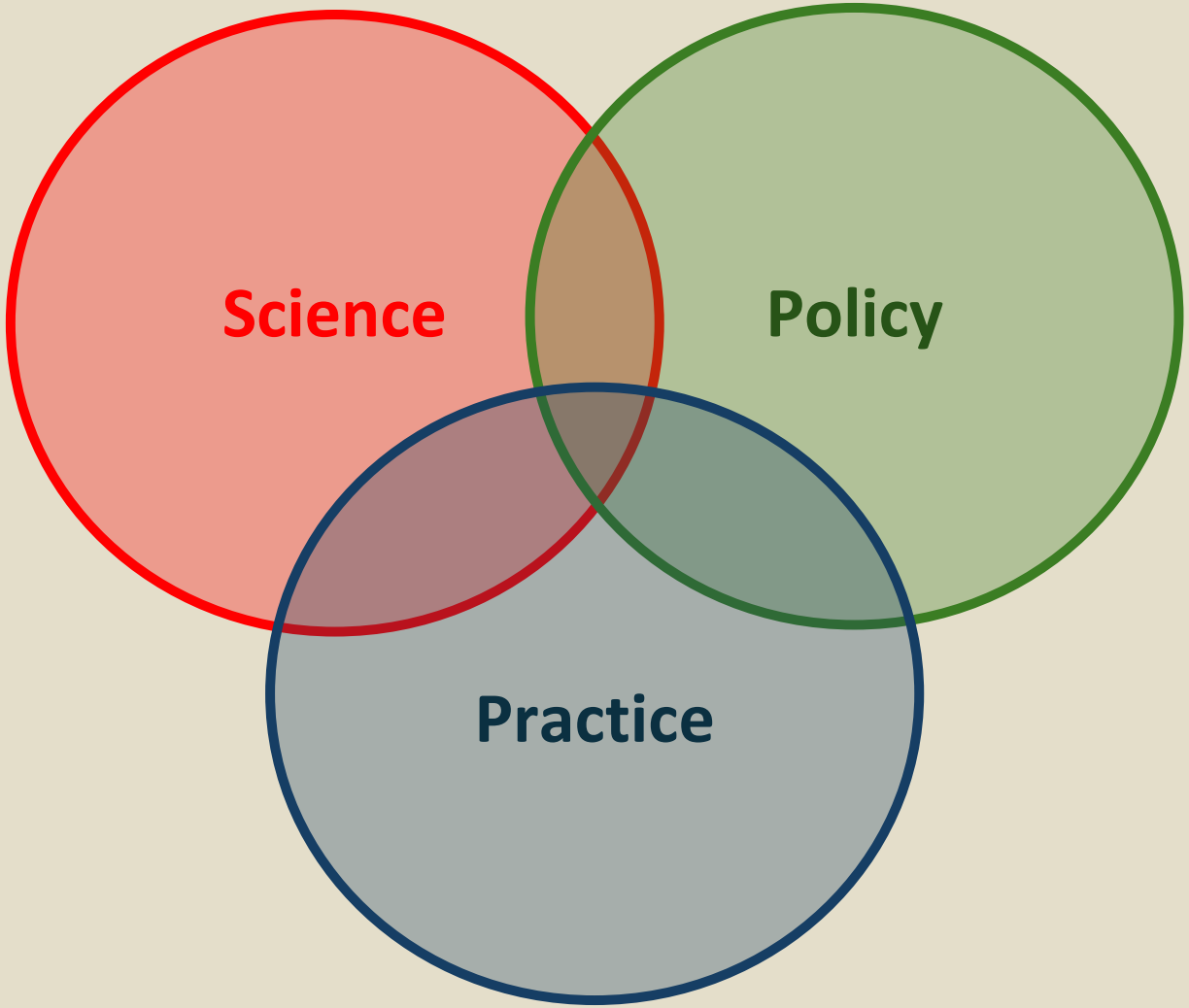
Given these latitudinal gradients and others, regionalism might yield more effective coordination, cooperation, and collaboration.

Optimal regional demarcations are not obvious and might vary among kinds of prioritized services.

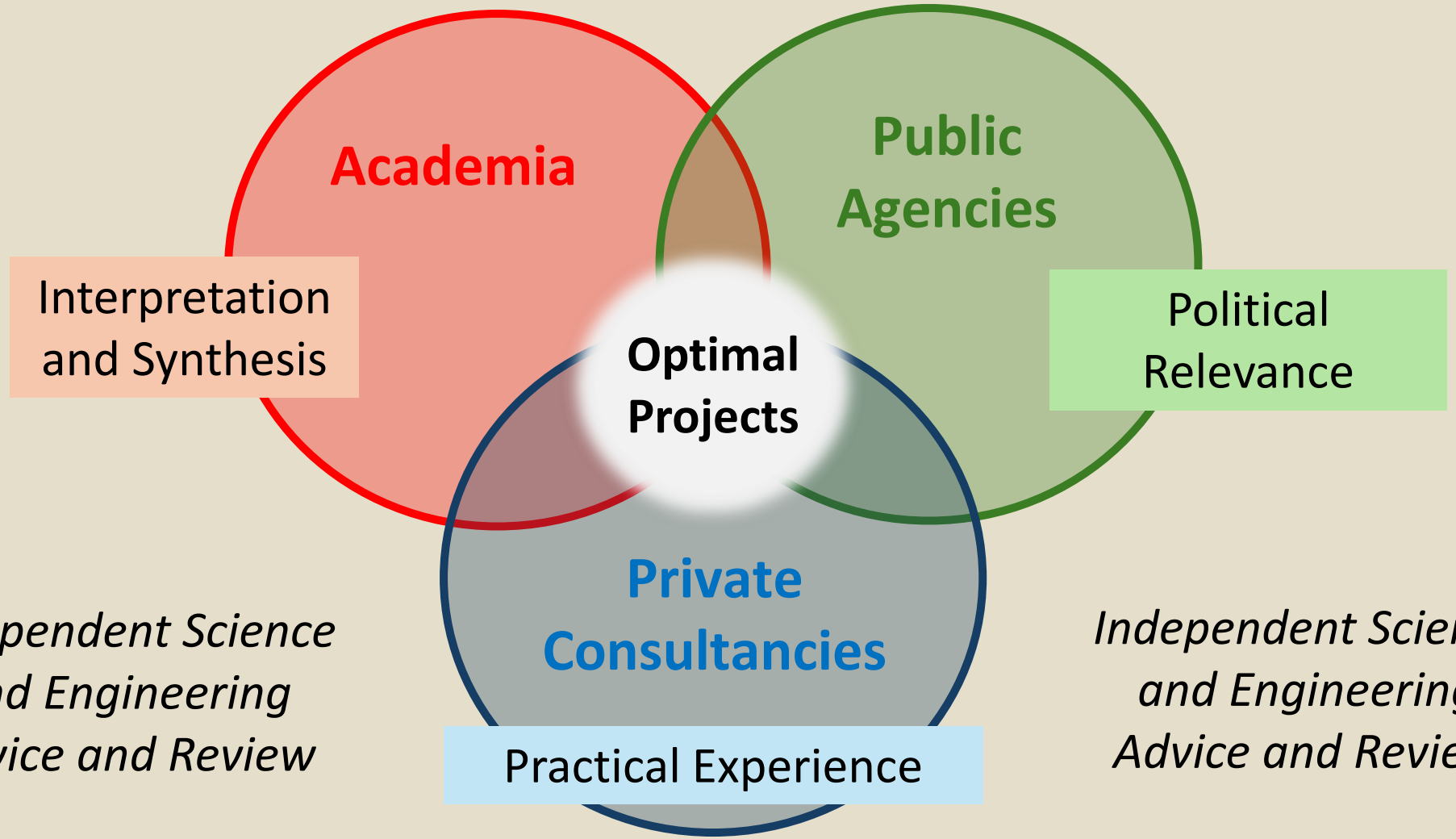


Project Organization

Emerging Project Structure



Emerging Project Structure



More Conceptual Frameworks

- ✓ Precepts
- ✓ Definition
- ✓ Ecosystem Services
- ✓ Regionalism
- ✓ Project Structure

Whole Marsh Typologies

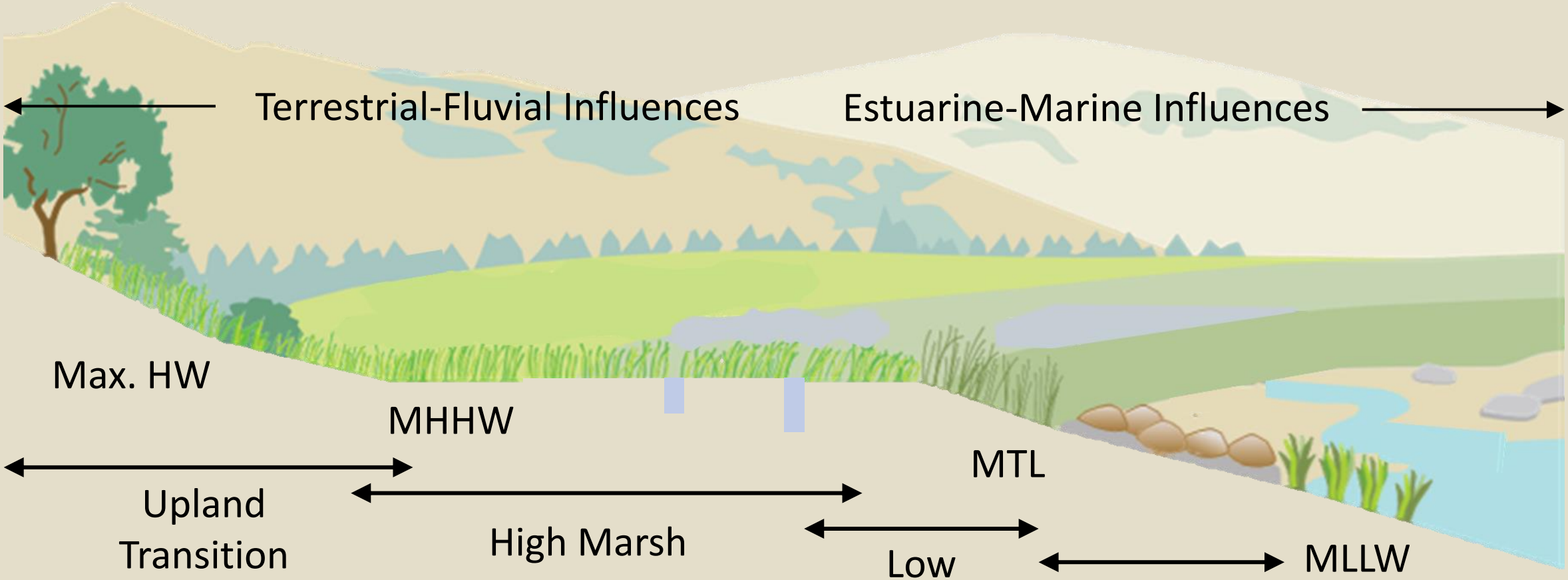
Hierarchical Controls

Dynamic Equilibrium

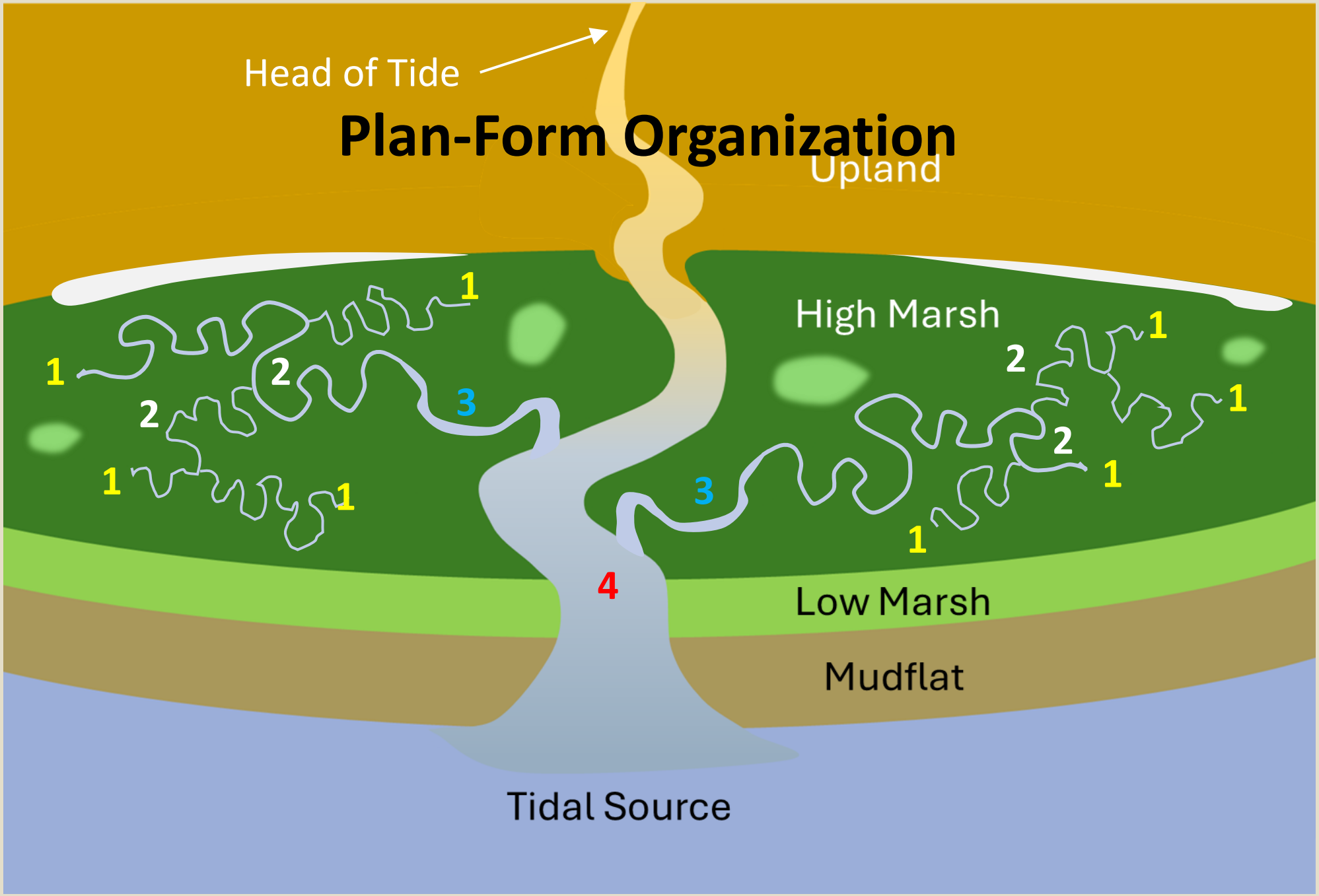
Leading and Trailing Indicators

Grading on the Curve

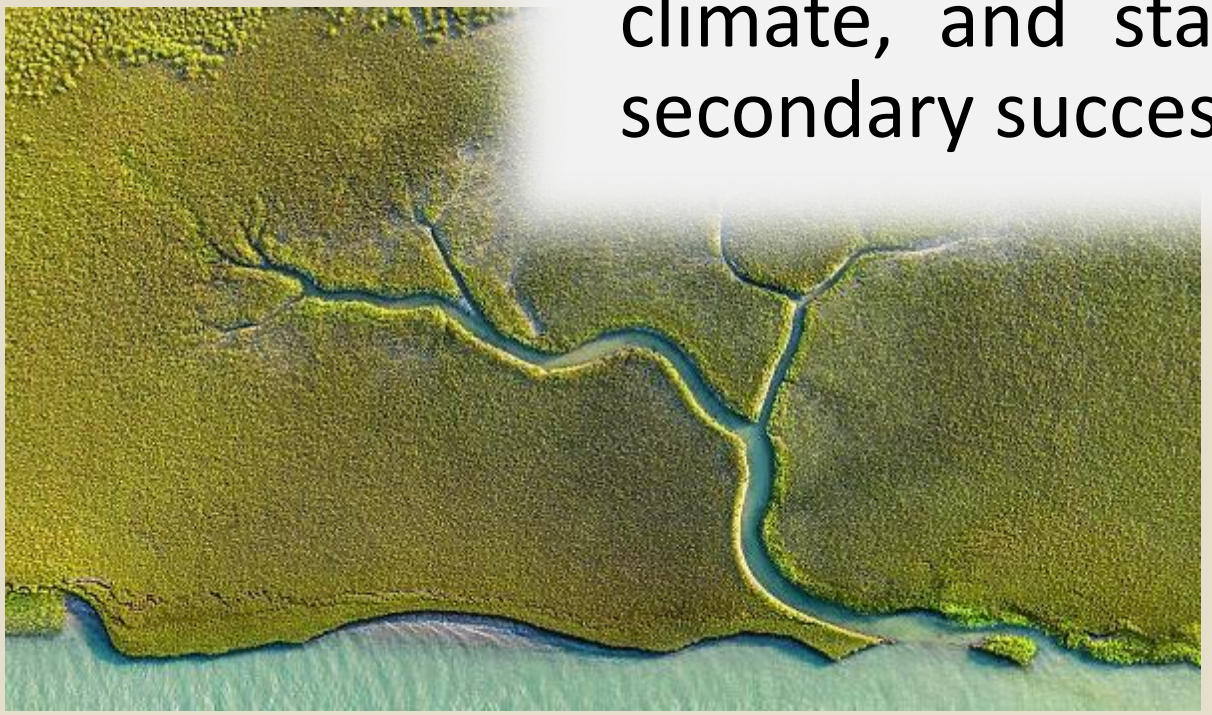
Whole Tidal Marsh

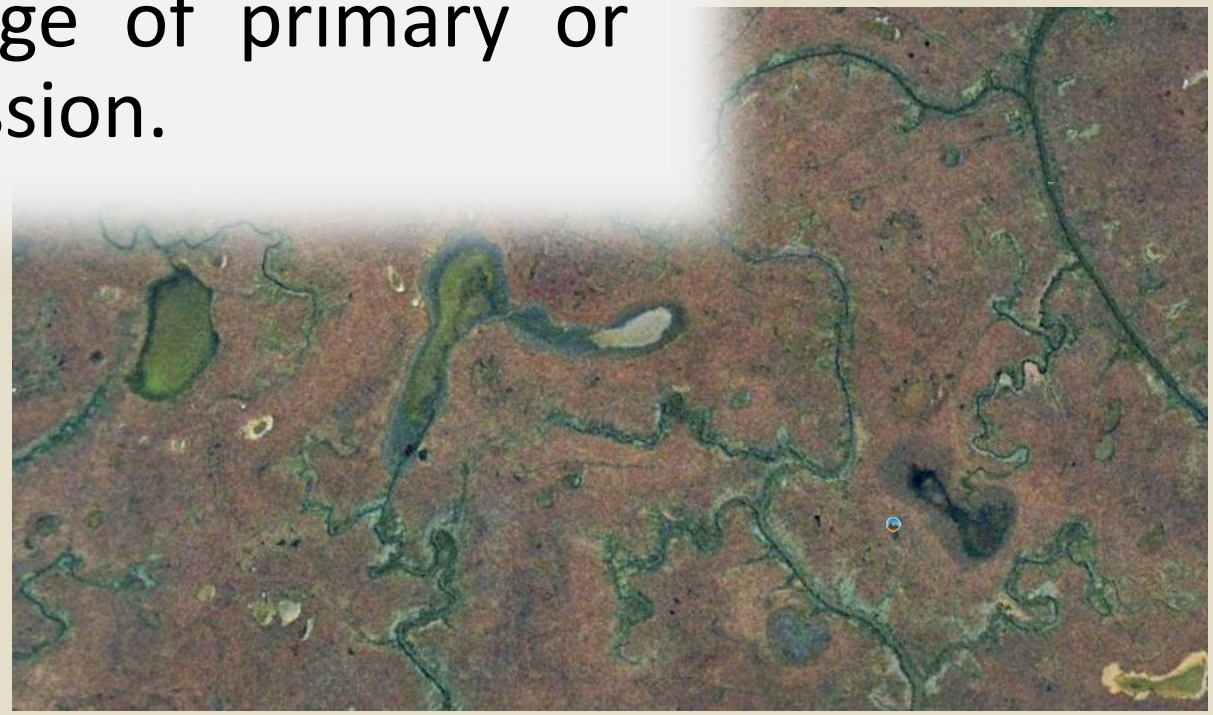


Transgression ← Retrogression ← Progression →


Head of Tide
Plan-Form Organization
Upland
High Marsh
Low Marsh
Mudflat
Tidal Source
1
2
3
4

Natural structure and form vary with tidal and salinity regimes, climate, and stage of primary or secondary succession.



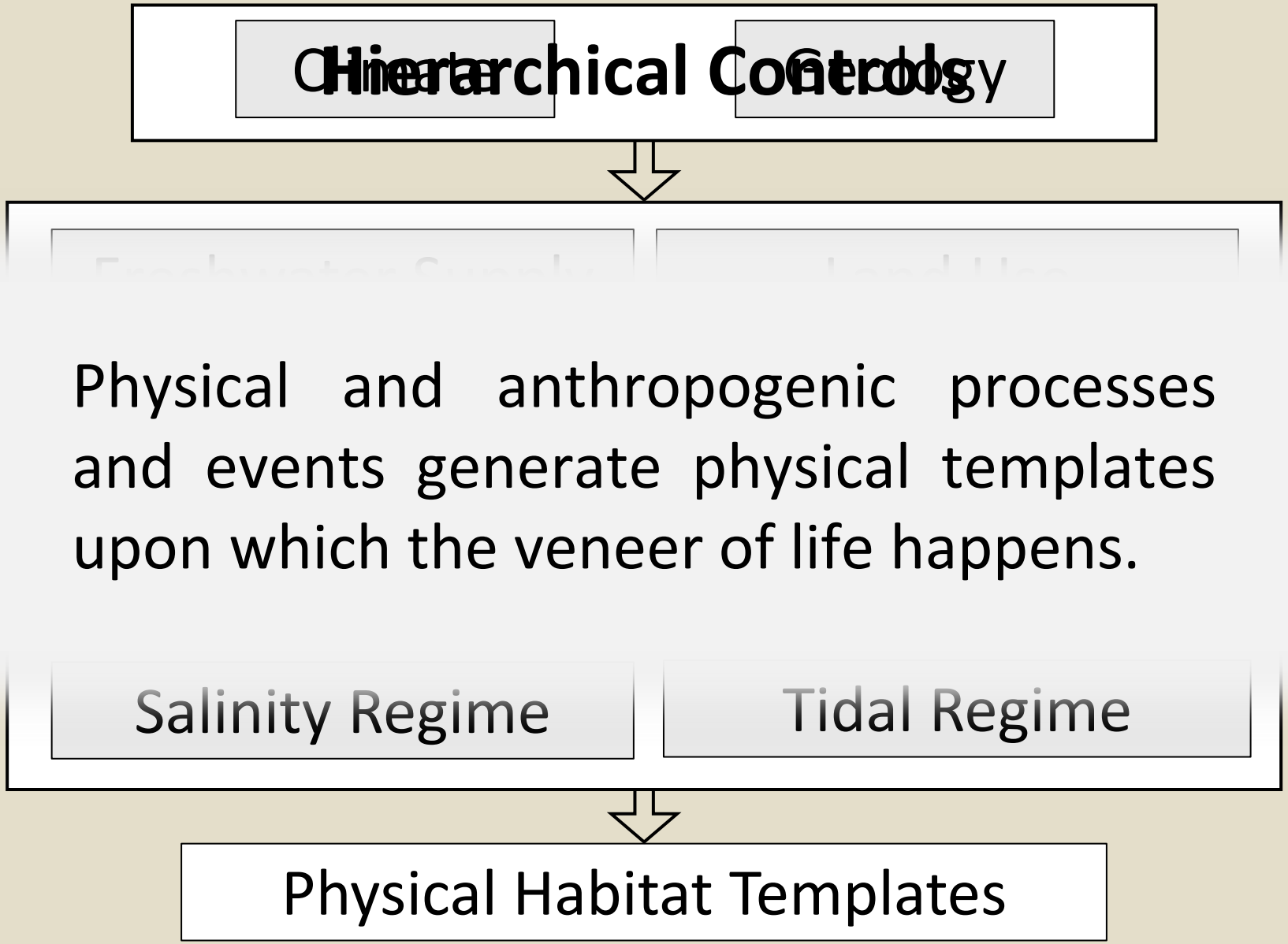


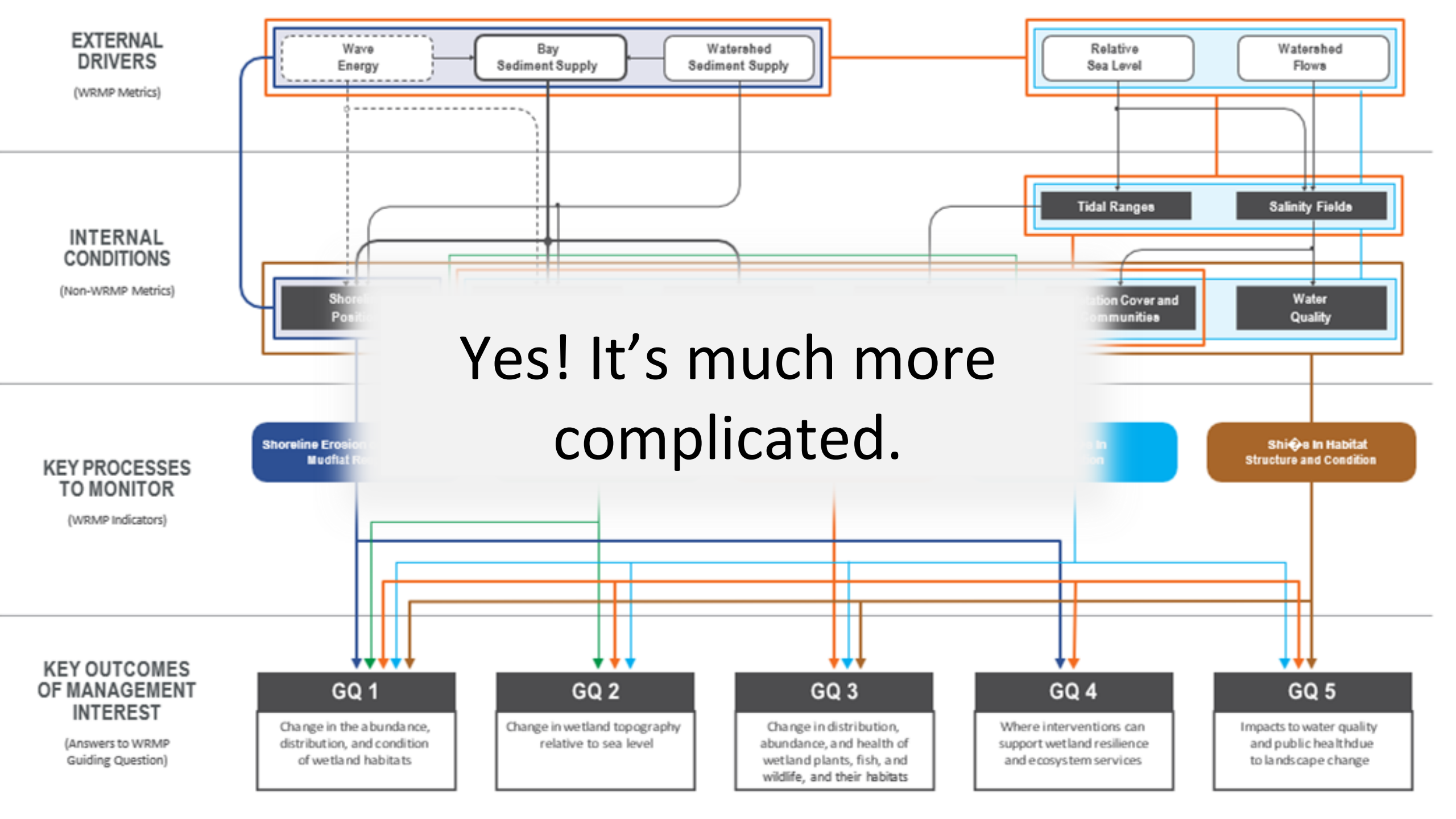
Typology

Geographic Context	*Tidal Regime*	*Salinity Regime*
• Marine	• Fully Tidal	• Saline
• Bar-built	• Muted Tidal	• Brackish
• Open Estuarine	• Managed	• Fresh

Regional typologies can be justified.

Differences lead to incomparable inventories and monitoring protocols.


Hierarchical Controls
Physical and anthropogenic processes and events generate physical templates upon which the veneer of life happens.
Salinity Regime
Tidal Regime
Physical Habitat Templates



Yes! It's much more complicated.

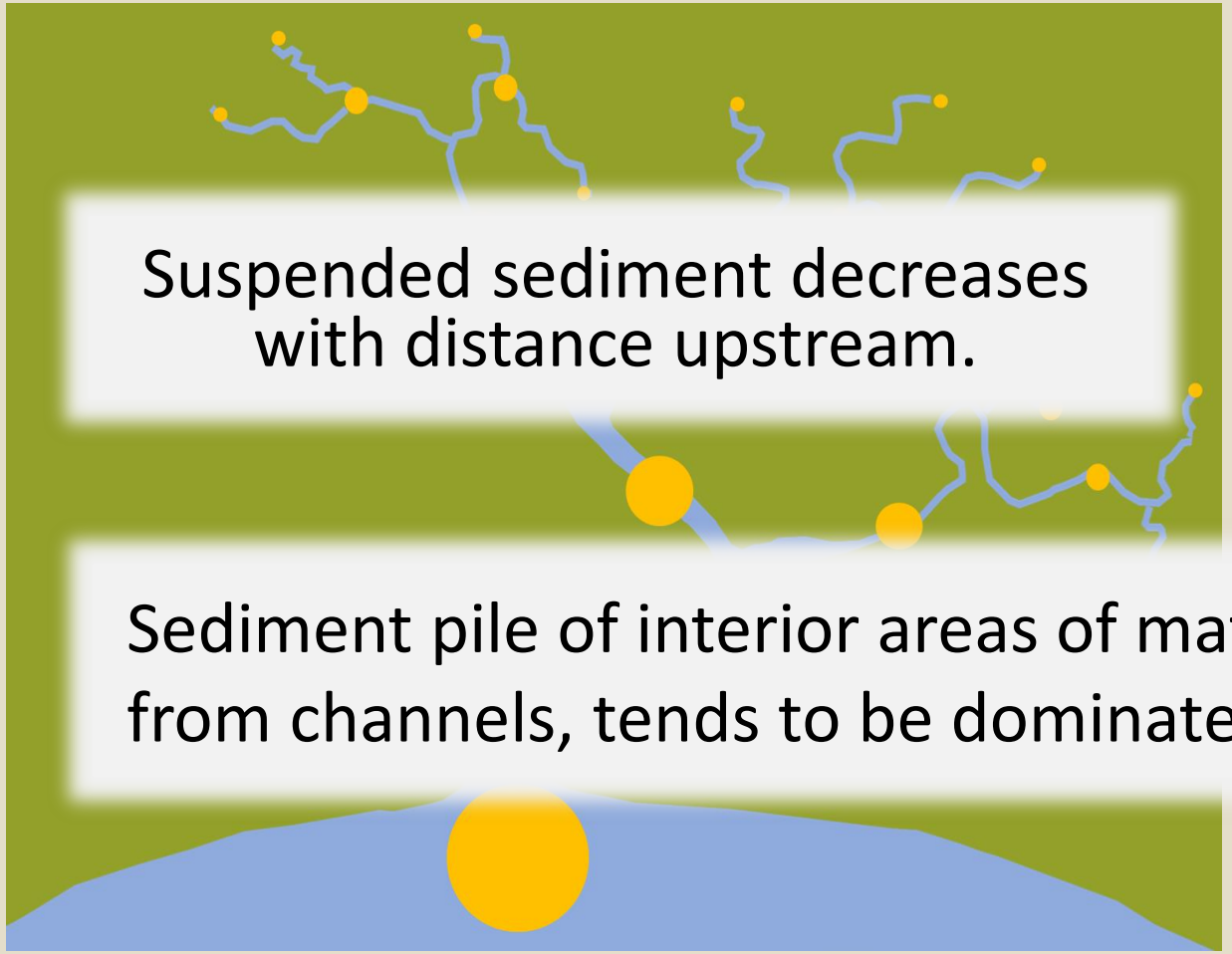
Internal Controls, their Dynamic Equilibria, and the “Unit Landscape”

Tidal Marshes are manifestations of dynamic processes of inorganic and organic sedimentation and erosion.

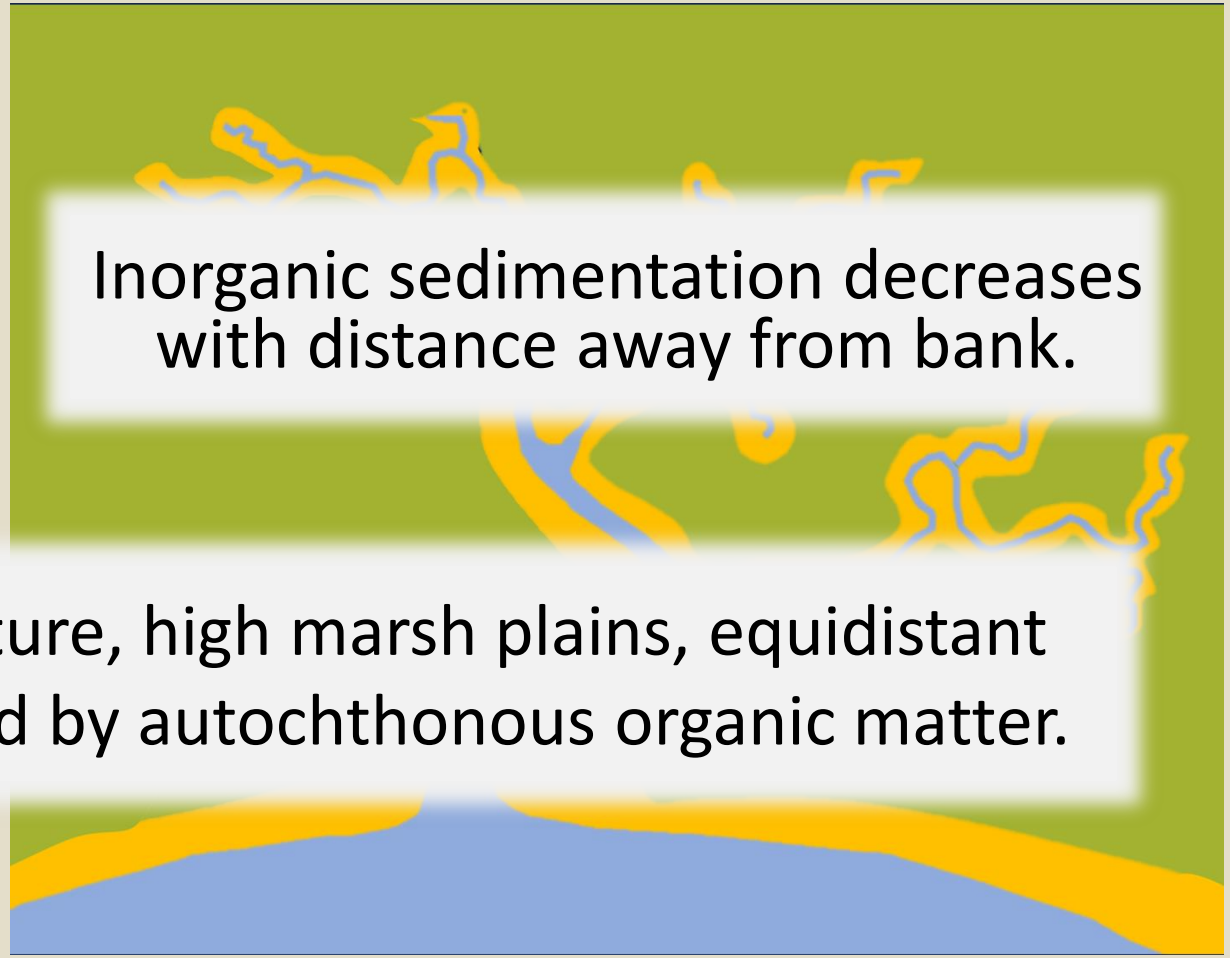
The dynamics result from interactions among variable sea level rise, suspended sediment supply, and in-situ production of organic sediments.

The net effects of sedimentation and erosion varies with tidal elevation and distance from the tidal source.

Two Ways to Measure Distance from Tidal Source



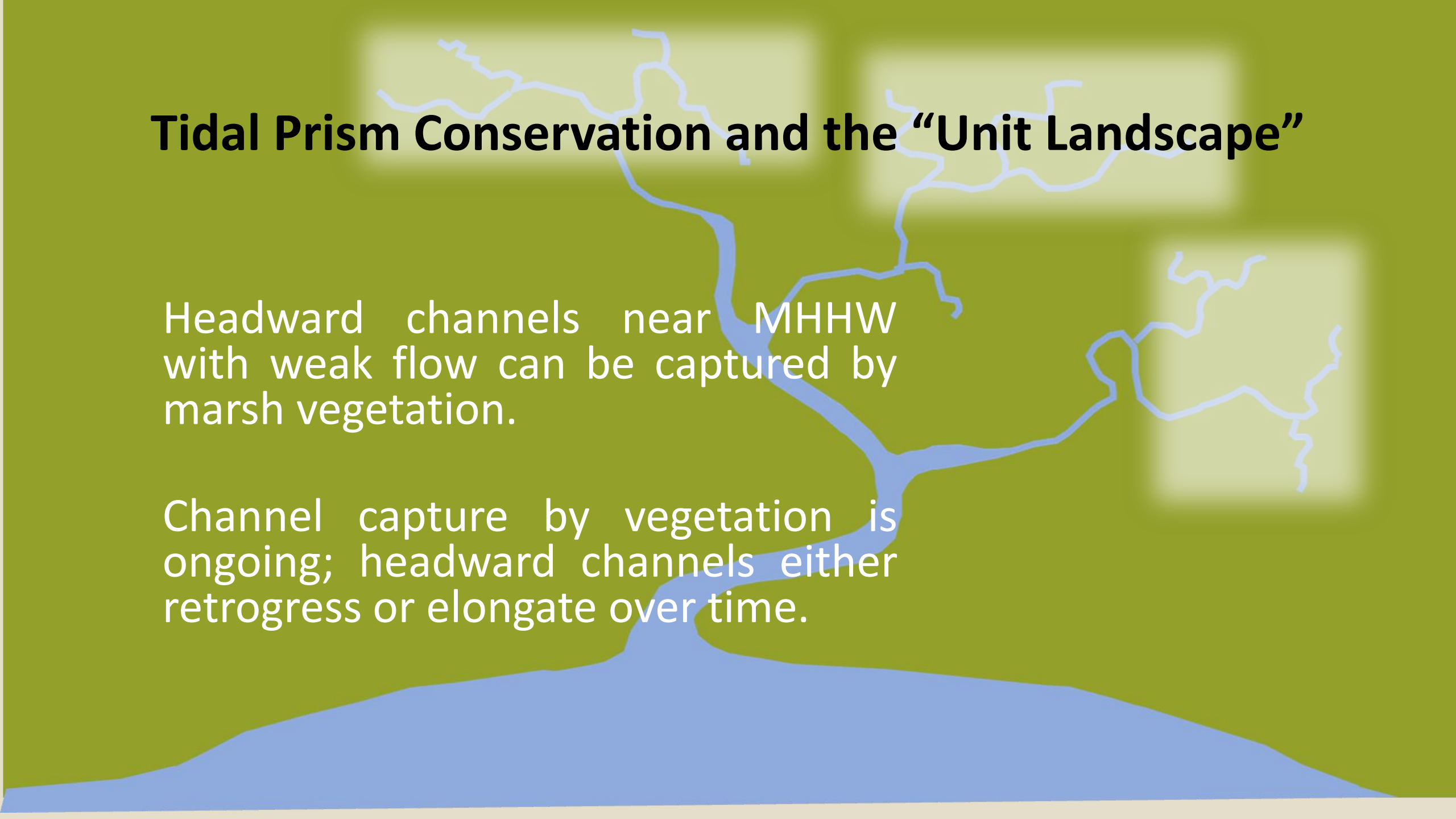
Distance upstream within
a Tidal Marsh Channel Network



Distance across a Tidal March Plain
from Channel Bank

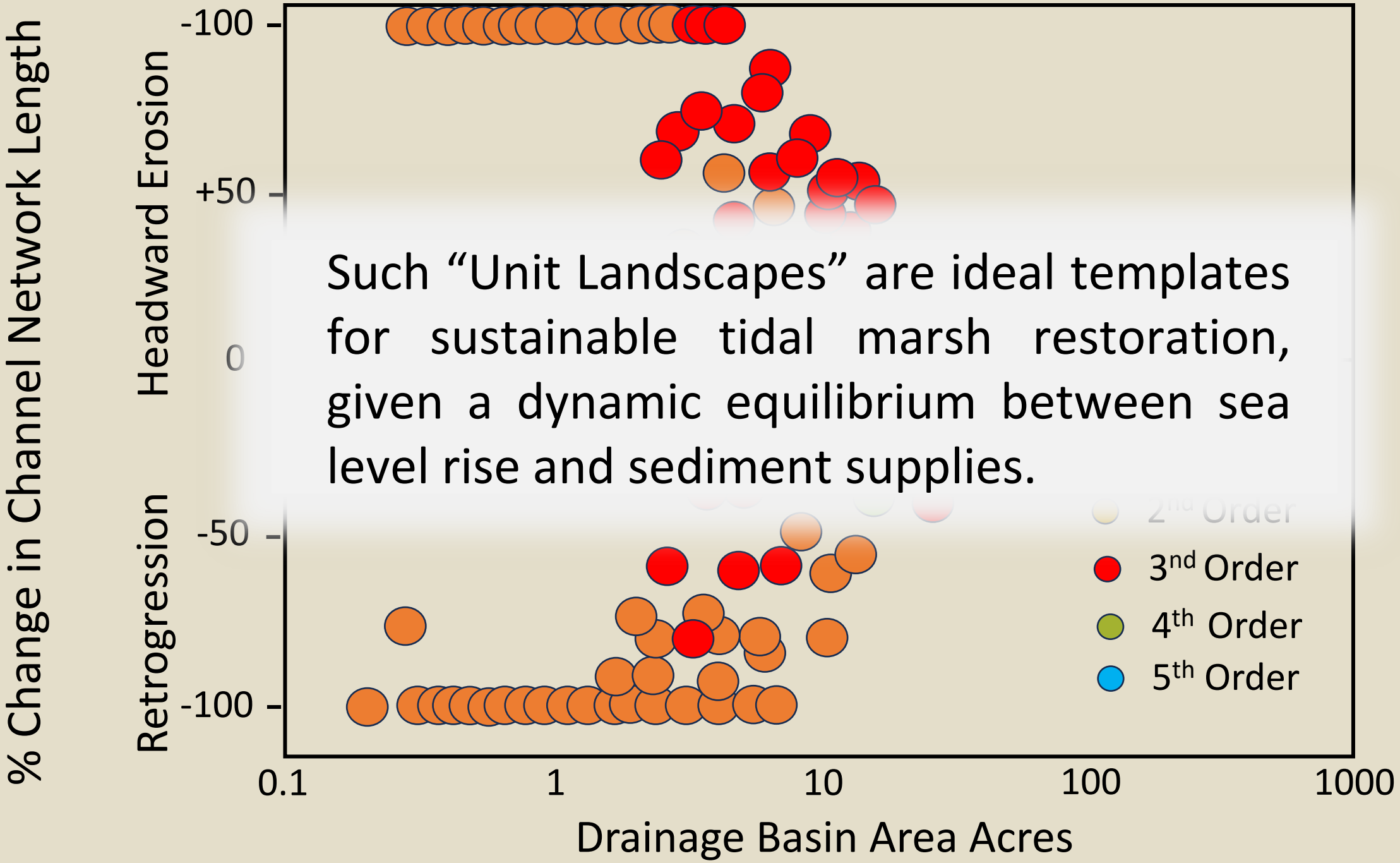
Sediment pile of interior areas of mature, high marsh plains, equidistant from channels, tends to be dominated by autochthonous organic matter.

Tidal Prism Conservation and the “Unit Landscape”



Headward channels near MHHW with weak flow can be captured by marsh vegetation.

Channel capture by vegetation is ongoing; headward channels either retrogress or elongate over time.

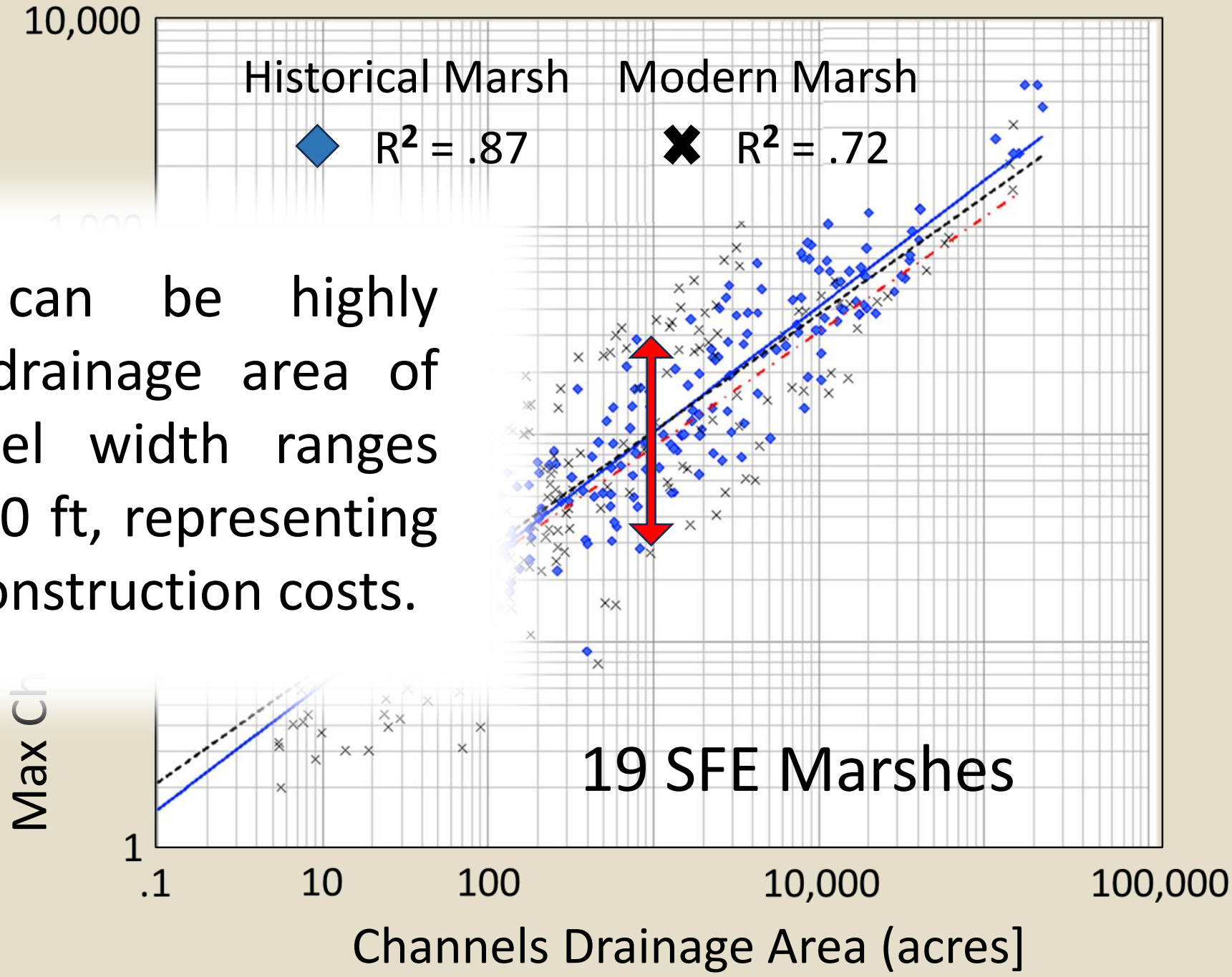


Such “Unit Landscapes” are ideal templates for sustainable tidal marsh restoration, given a dynamic equilibrium between sea level rise and sediment supplies.

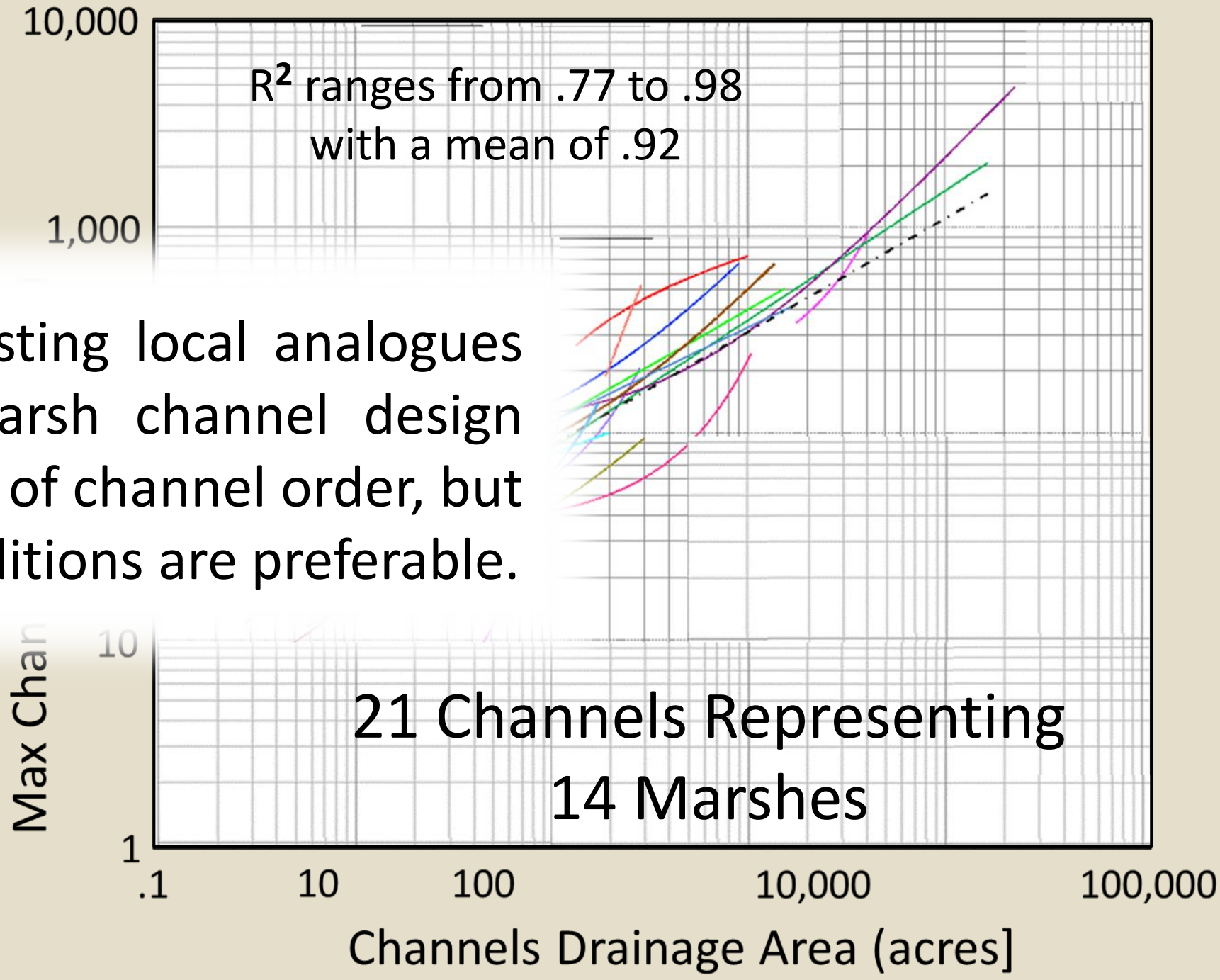
Tidal Prism Conservation, the “Unit Landscape,” and Marsh Design

The channel network is constantly adjusting in length and area to accommodate changes in tidal prism and sediment supply.

The causal relationship between average channel geometry for any channel order tends to be marsh-specific.



Regional data can be highly variable. For a drainage area of 1,000 ac, channel width ranges from about 30-300 ft, representing a great range in construction costs.

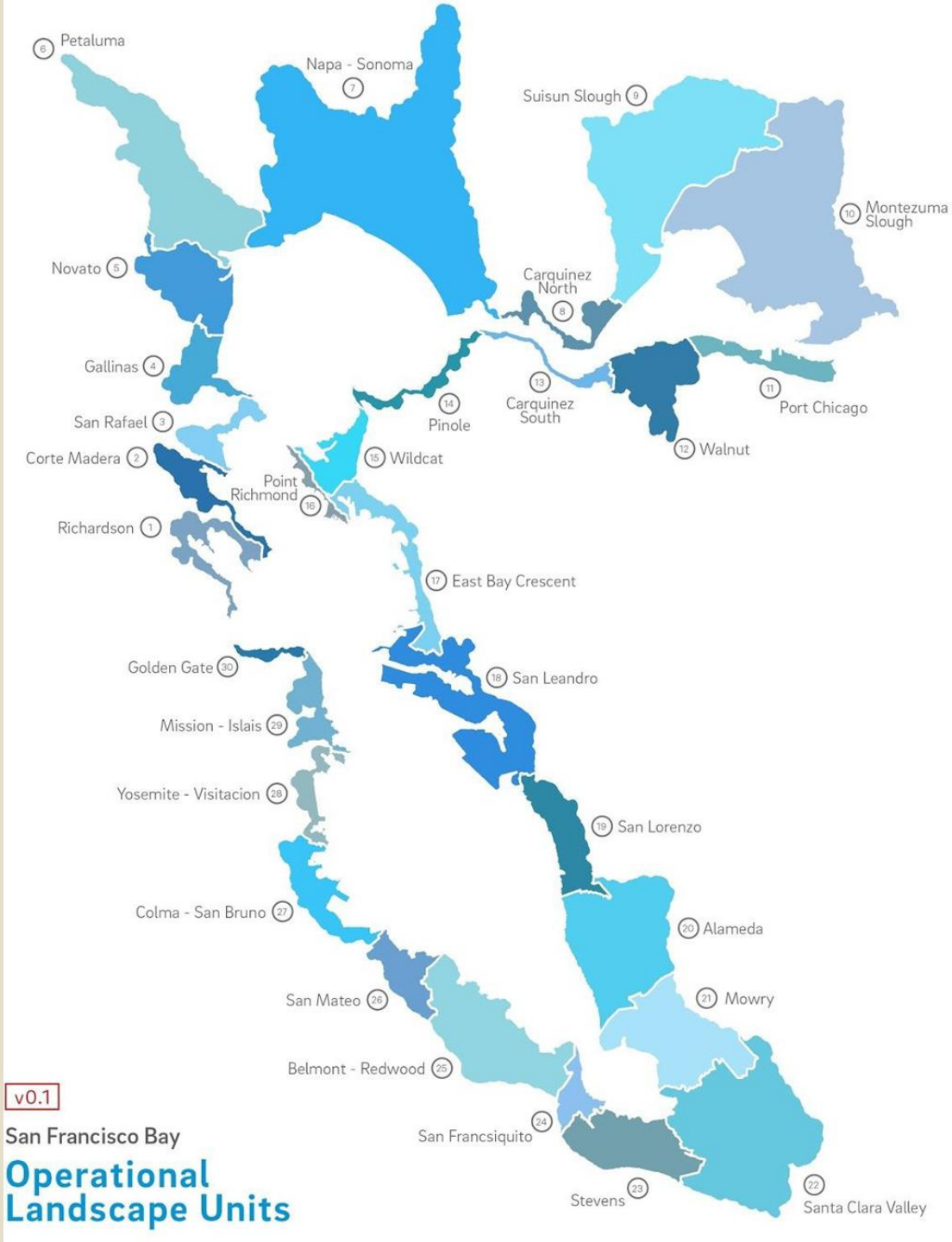


Historical or existing local analogues will improve marsh channel design across the range of channel order, but equilibrium conditions are preferable.

Sub-regional and Regional Approaches - SFE

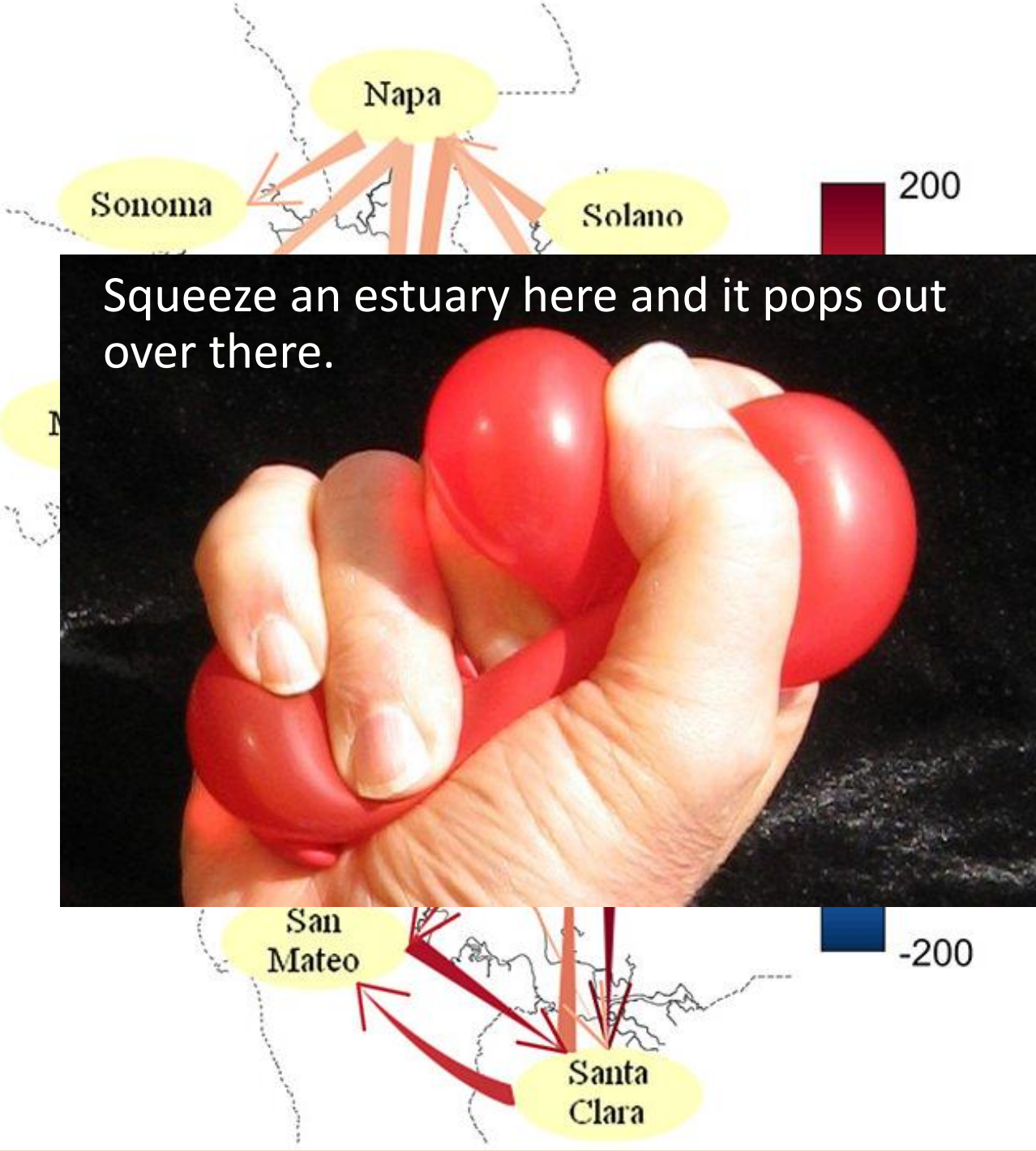
"Operation Landscape Units" are self-similar areas based on many physiographic, hydrologic, climatic, and land use criteria, including likely extent of Sea Level Rise impacts.

Prioritized ecosystem services and marsh restoration design are likely to be more similar within OLUs than between them.



Rates of Sea Level Rise Vary within Estuaries

- Bathymetry
- Shoreline shape
- Freshwater inflow
- Shoreline development



Indicators within a box assess condition.

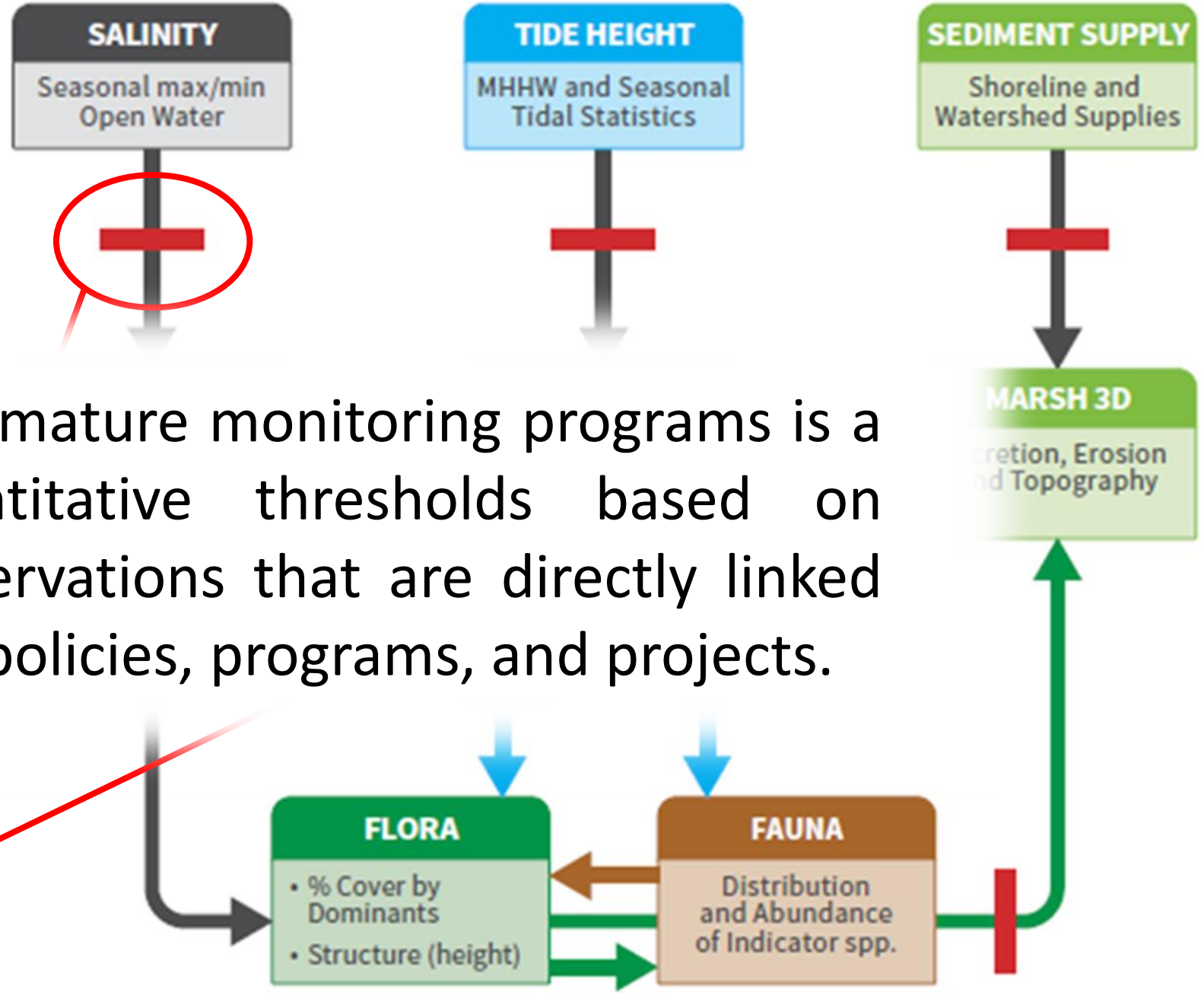
Indicators on an arrow assess a process.

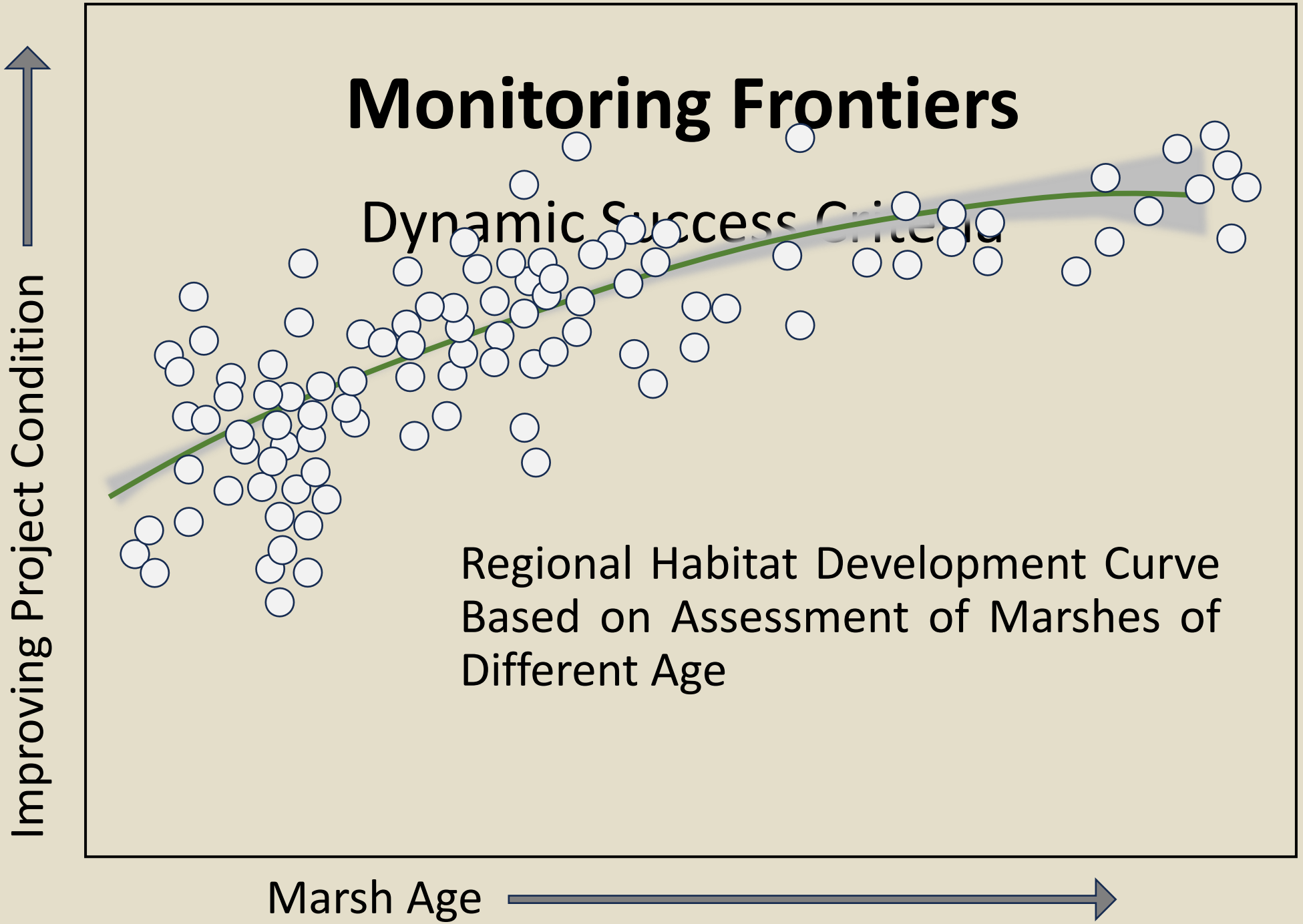
Trailing i
assess ef

Leading
used to
predict.

Ideally thresholds are learned that trigger management responses.

A hallmark of mature monitoring programs is a set of quantitative thresholds based on empirical observations that are directly linked to changes in policies, programs, and projects.




Monitoring Frontiers
Dynamic Success Criteria
Improving Project Condition
Marsh Age
Regional Habitat Development Curve
Based on Assessment of Marshes of
Different Age

Increasing uncertainty requires projects to be assessed relative to changes in baseline reference conditions for target levels of selected services.

Habitat Development Curves and Reference Envelopes can be developed for many indicators but need to be updated.

Projects can be assessed based on their trajectories toward the Reference Envelope.

Improving Project Condition

Marsh Age

More Conceptual Frameworks

- ✓ Precepts
- ✓ Definition
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- ✓ Regionalism
- ✓ Project Structure
- ✓ Whole Marsh Typologies
- ✓ Hierarchical Controls
- ✓ Dynamic Equilibrium
- ✓ Leading and Trailing Indicators
- ✓ Grading on the Curve


Thank You