Linking Monitoring Indicators to Performance Standards

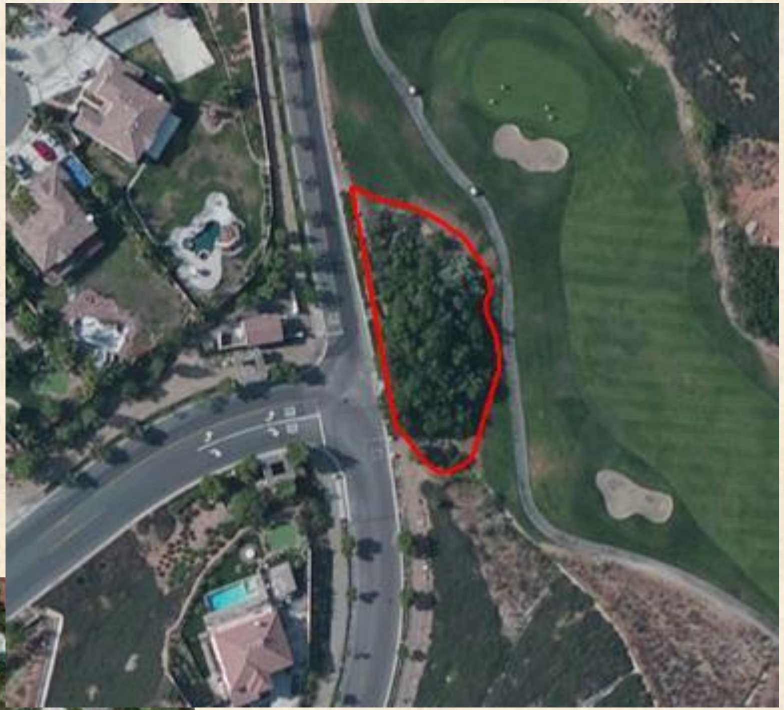
Eric D. Stein

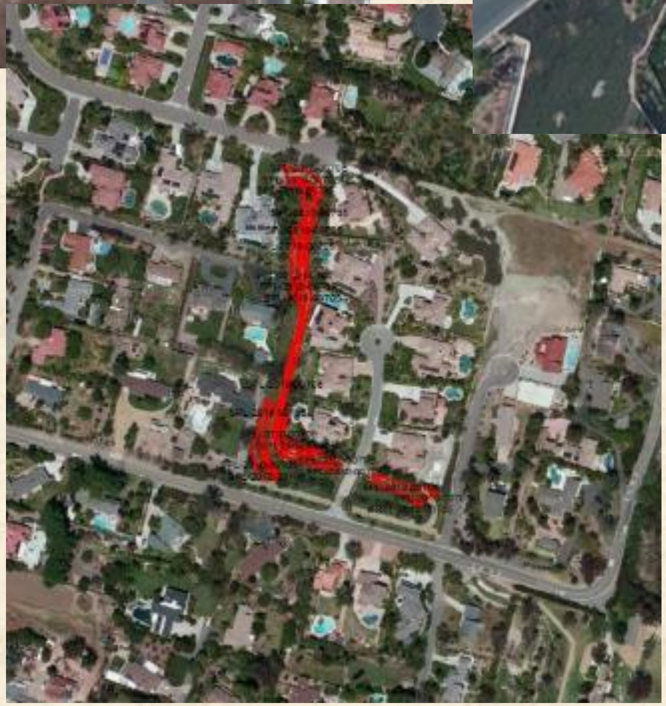
Southern California Coastal Water Research Project

The Big Picture on Performance Standards

- Ensure connection between long-term performance goals and specific indicators
  - ✓Tied to clear targets, benchmarks, or reference
- Standards should be measurable in an objective and repeatable manner
  - ✓Quantifiable with know (and reportable) certainty levels
- Measures must be clear, concise and unambiguous
  - ✓Assume someone else will need to interpret them in the future
- Indicators should assess function/condition in addition to extent and structure
  - ✓Each performance measure should assess a single aspect of function/condition
  - ✓Connections should be scientifically defensible
- Standards should be resilient to changing conditions over time
- Structure data for digital submittal, storage, and recovery
  - ✓Open data in geospatial format
  - ✓Connect goals, plans, standards, and monitoring measures

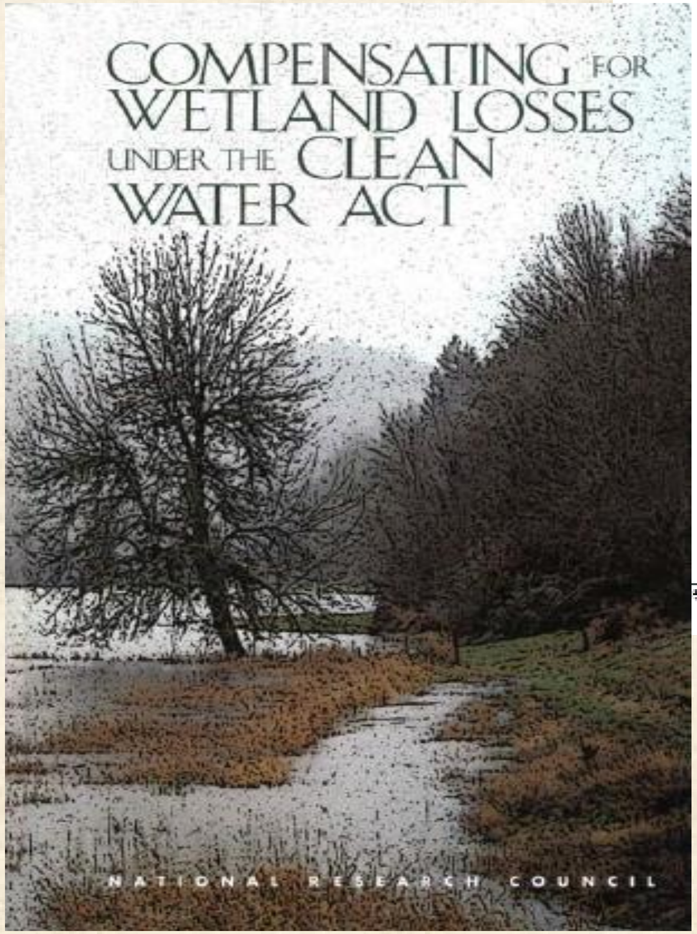
Past Practices

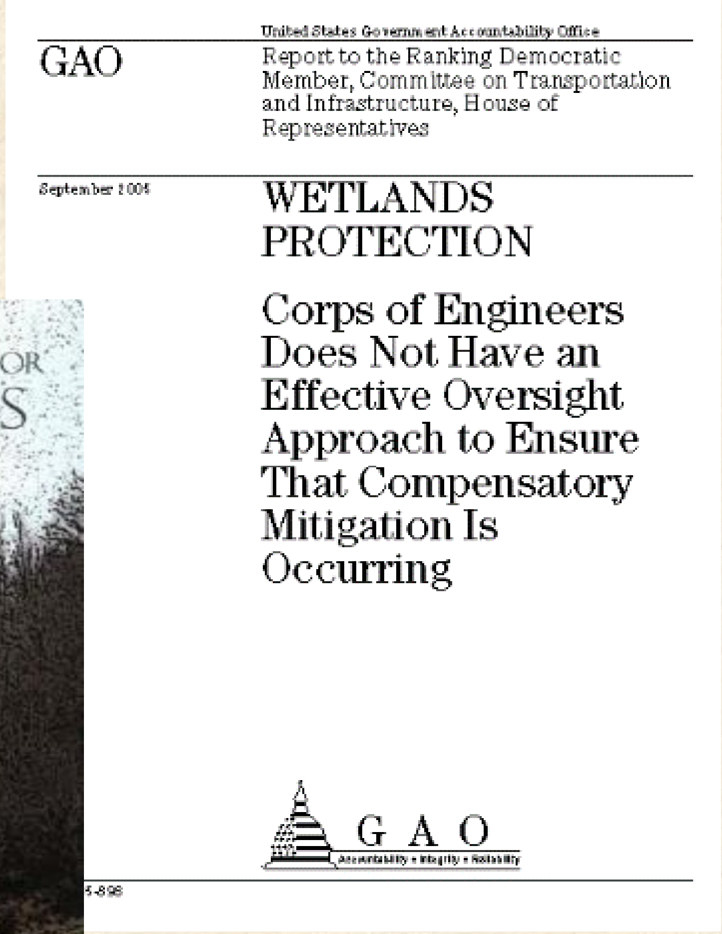




Reports of Mitigation Success

- 20,000 acres permitted annually
- 40,000 acres of mitigation required
- Well documented lack of success due to a variety of factors
  - Non-compliance
  - Non-performance




United States Government Accountability Office

GAO

Report to the Ranking Democratic Member, Committee on Transportation and Infrastructure, House of Representatives

September 2005

WETLANDS PROTECTION

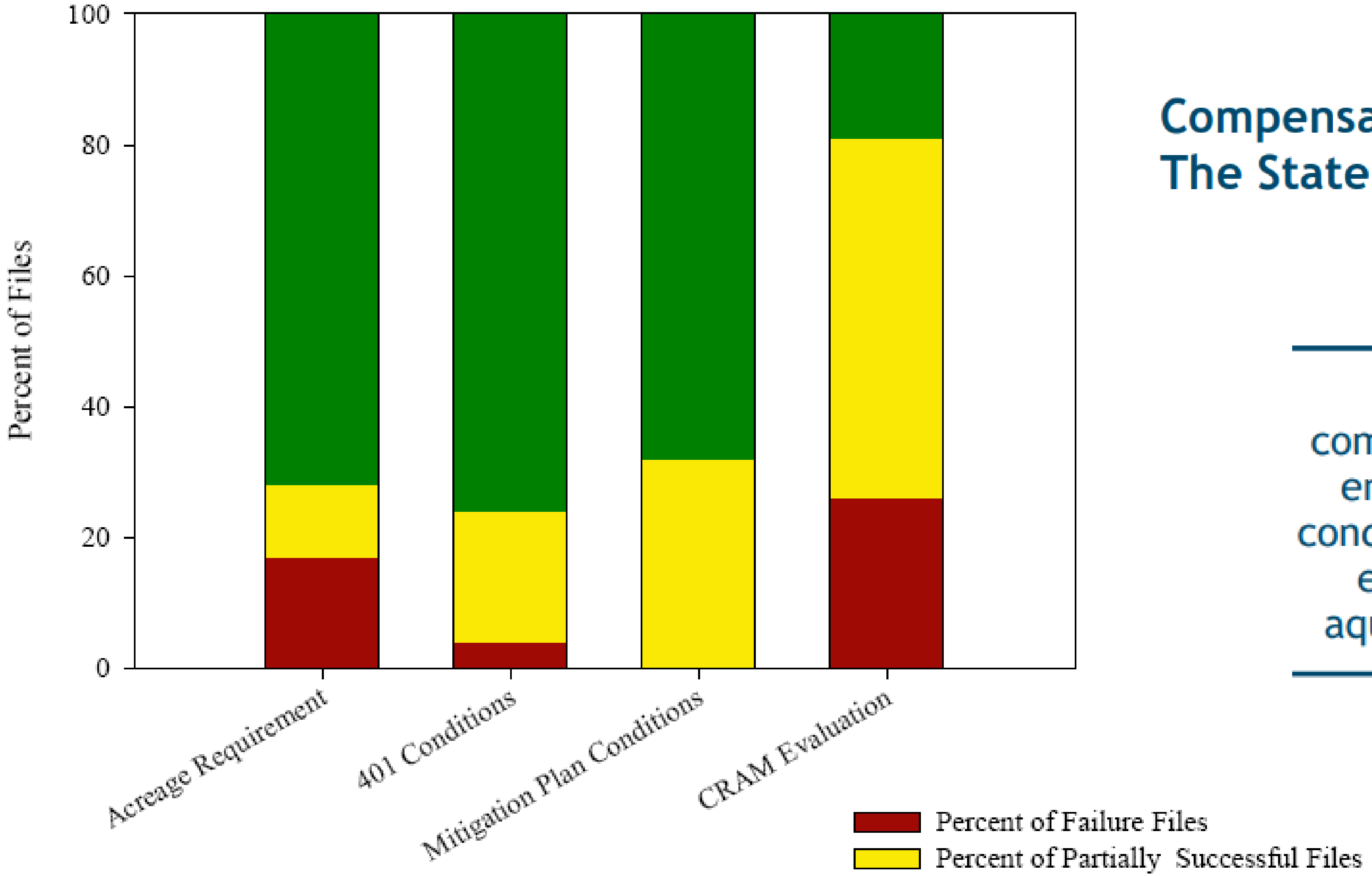
Corps of Engineers Does Not Have an Effective Oversight Approach to Ensure That Compensatory Mitigation Is Occurring

GAO

Accountability • Integrity • Reliability

5-898

What is Successful Mitigation??



Ambrose et al. 2006

Compensatory Mitigation Performance: The State of the Science

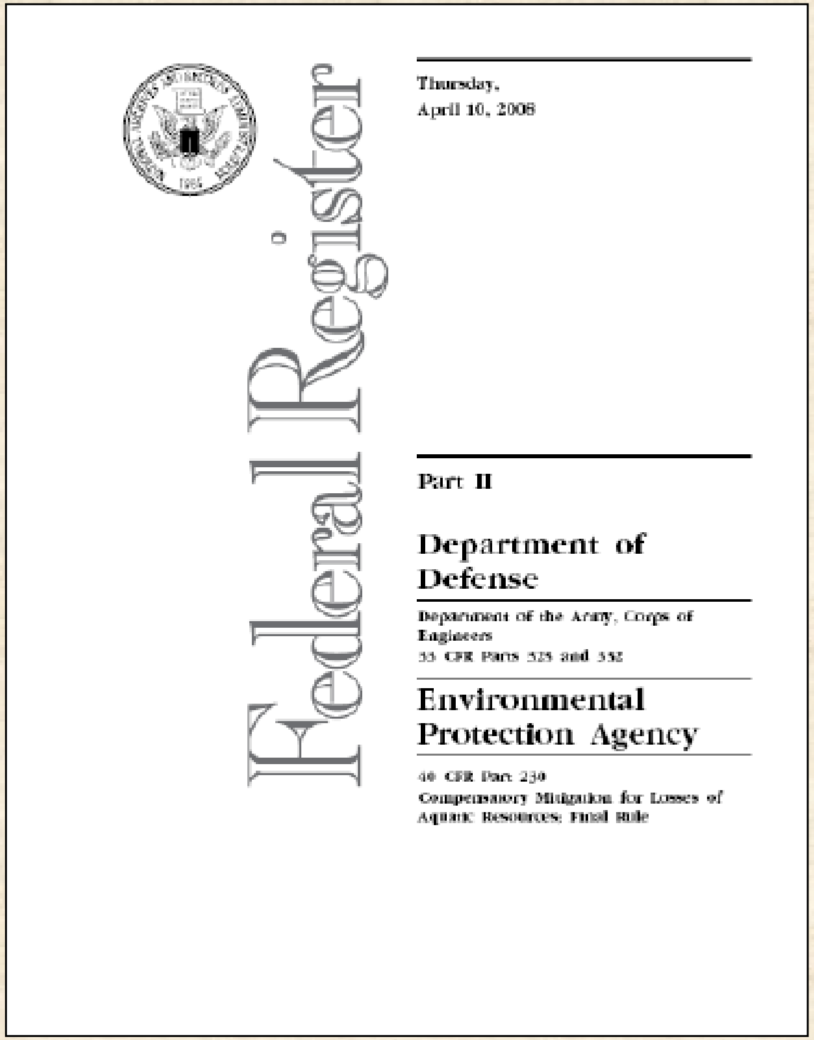
Morgan and Hough, 2015

"To perform successfully, compensation programs must both ensure compliance with permit conditions and result in ecologically effective replacement of lost aquatic resource functions. . . ."

Corps-EPA Mitigation Rule

- Mitigation plans must contain performance standards to assess whether project is achieving its objectives

"Performance standards should relate to objectives of project so that project can be objectively evaluated to determine if it is developing into the desired resource type, providing the expected functions, and attaining any other applicable metrics (e.g. acres)."



It All Starts With Performance Standards

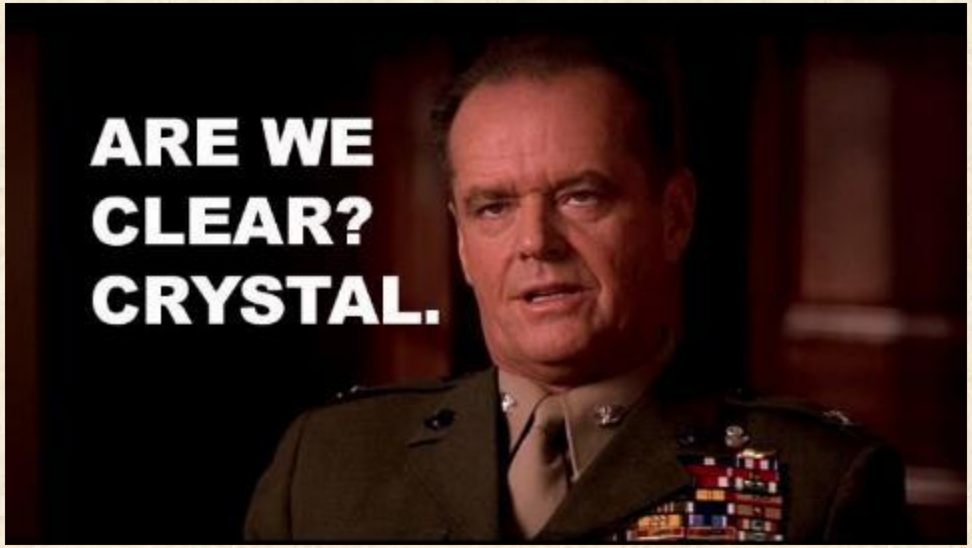
- Emphasize processes-based vs. structure-based standards
- Include the entire suite of hydrogeomorphic properties necessary to support wetlands or streams
- Phase in requirements over time (tiering)
  - ✓ Get the physical structure and hydrology right first
  - ✓ Restoration trajectories allow for adaptive management
- Evaluate relative to reference conditions or sentinel sites
- Require commitment to long-term management
  - ✓ Few wetlands are truly "self-sustaining"
  - ✓ ***Standards must be adaptive to changing conditions over time***

Components of a "Good" Standard

- Clear and unambiguous
  - ✓Somebody else will likely have to interpret what you meant
- Defensible
- Readily quantifiable with known levels of confidence
- Related to functional success
- Tied to established goals and objectives
- Can inform adaptive management actions and/or contingency actions

Example Performance Standard

- At the end of year 3, at least 80% of Area A shall have a benthic invertebrate index score within 10% of the median reference population score.
  - ✓ If this standard is not met, the site will be re-evaluated within 120 days of the original field assessment
  - ✓ If the standard is still not met, metric level analysis and/or causal assessment shall be conducted to identify likely reasons for failure



Considerations in Assessing Mitigation Performance

- "Successful" relative to what?
  - ✓Frame of reference
  - ✓Targets
- How to measure "success"?
  - ✓Indicators
- When are you "successful"?
  - ✓Timing for assessing performance
  - ✓Adaptability

Successful Relative to "What": Setting Expectations

- Reference locations
- Sentinel site
- Ambient condition
- Regional/watershed goals

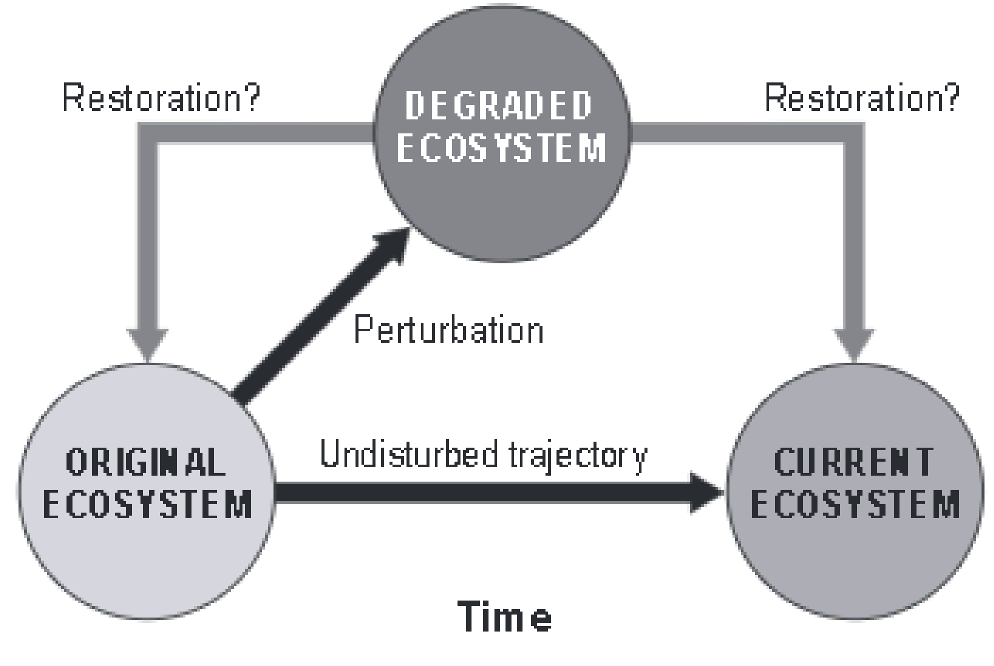
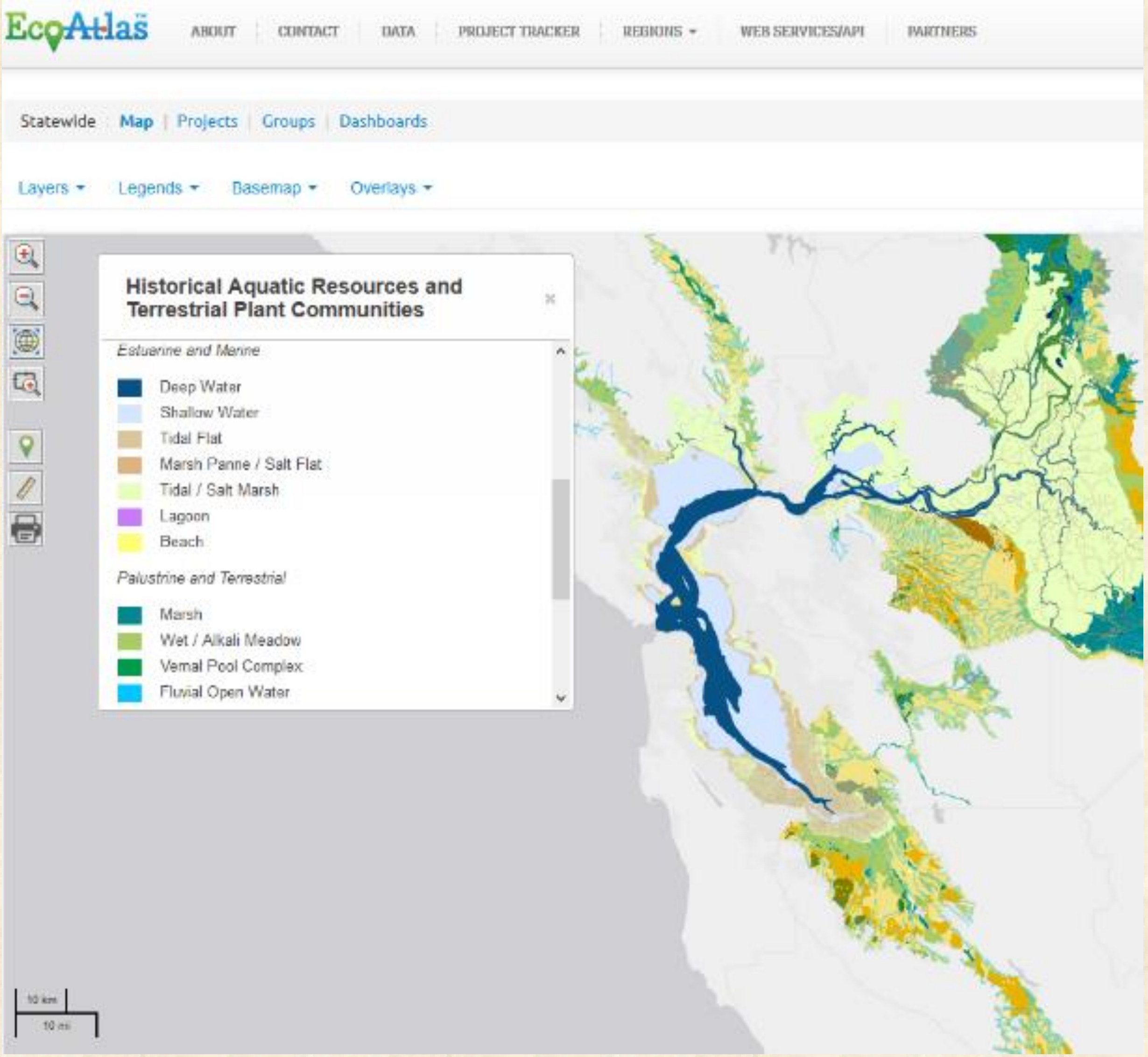
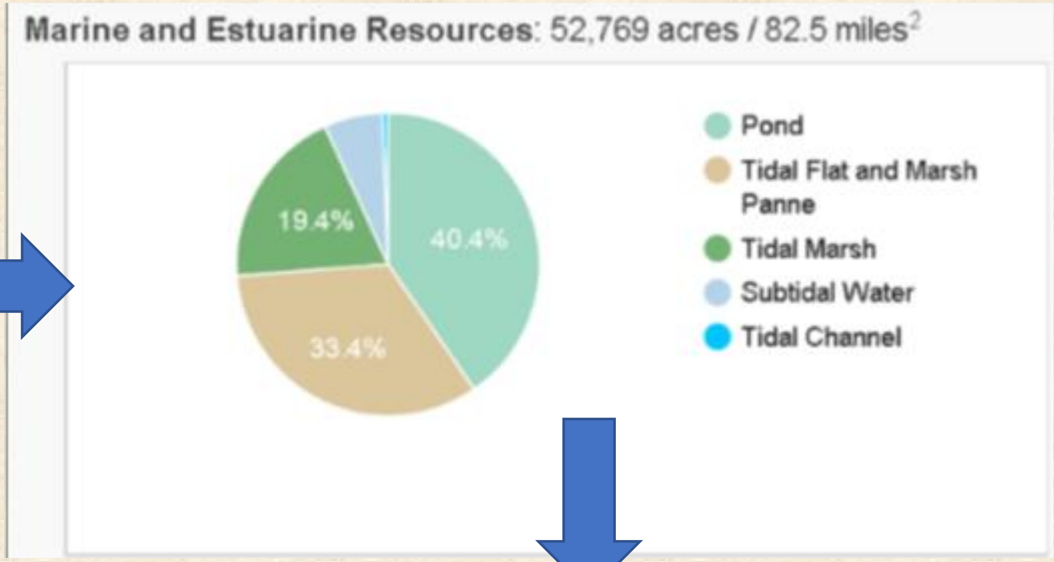


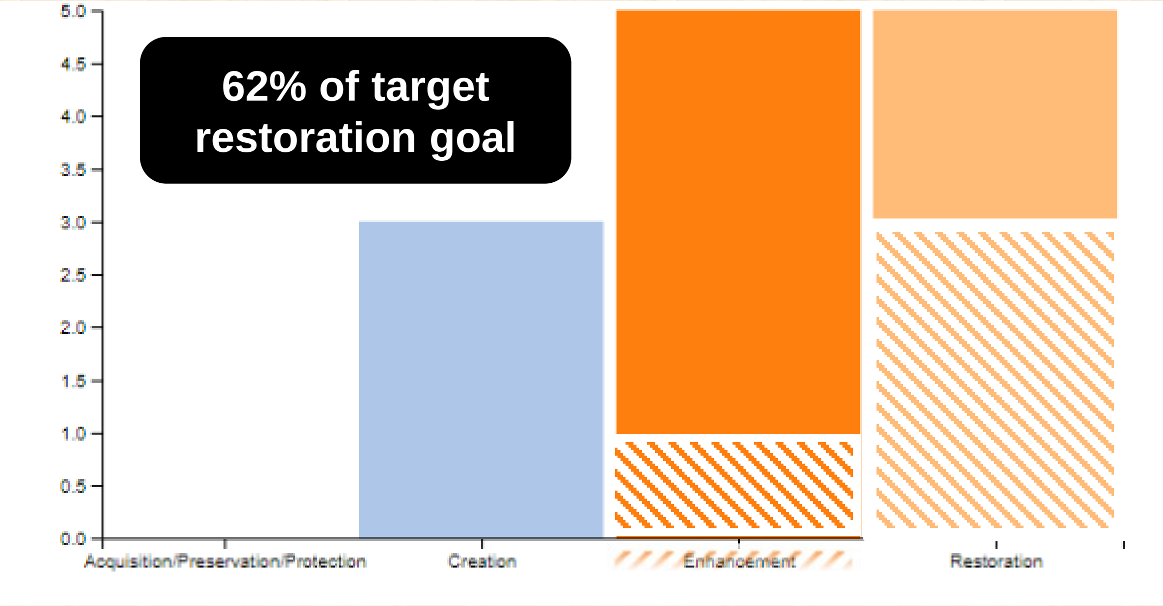
Fig. 1.5 Time changes an undisturbed ecosystem, making targets from the past hard to determine.

Harris and Van Diggelen 2006

Targets Based on Landscape Profiles







Comparison to Reference

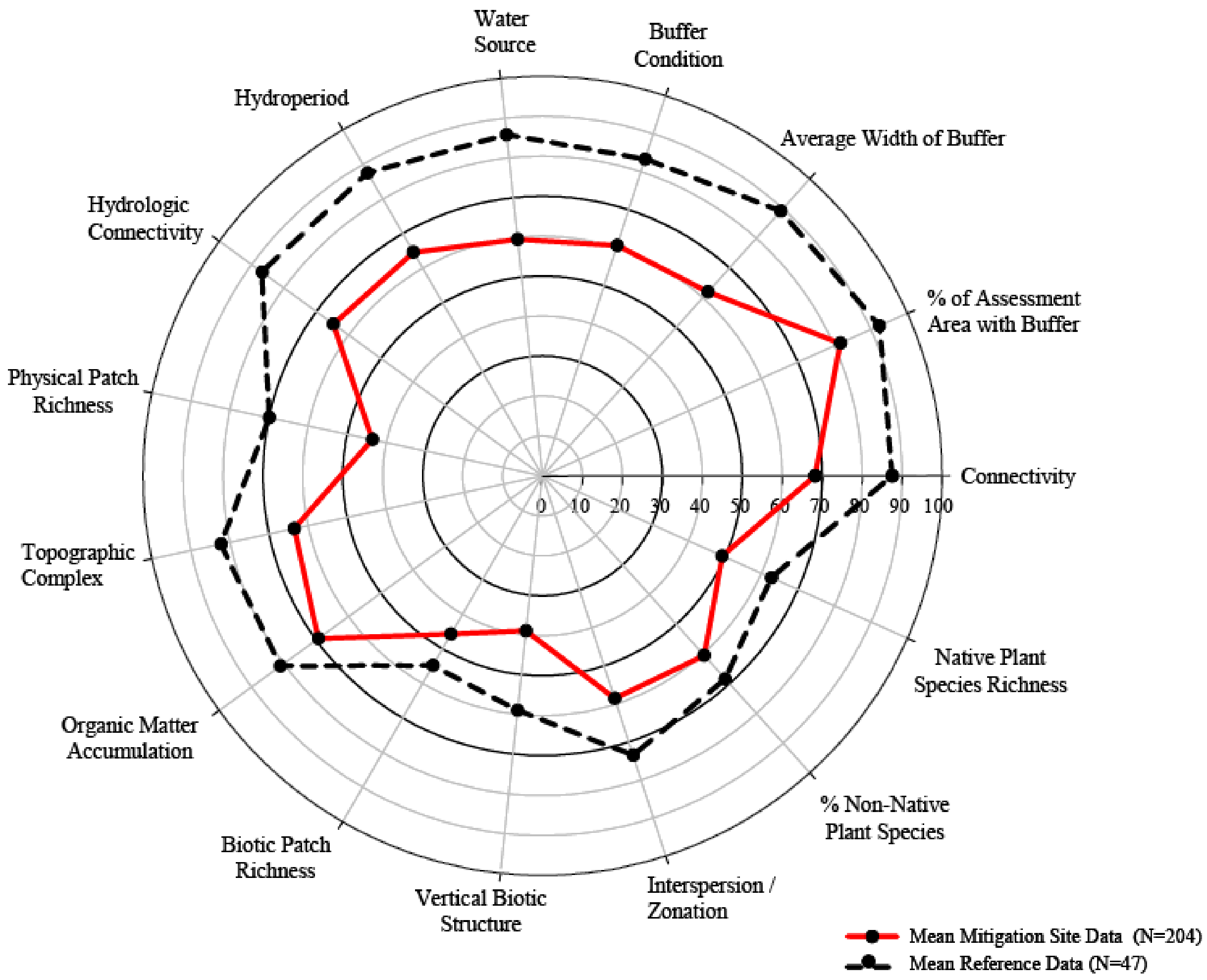
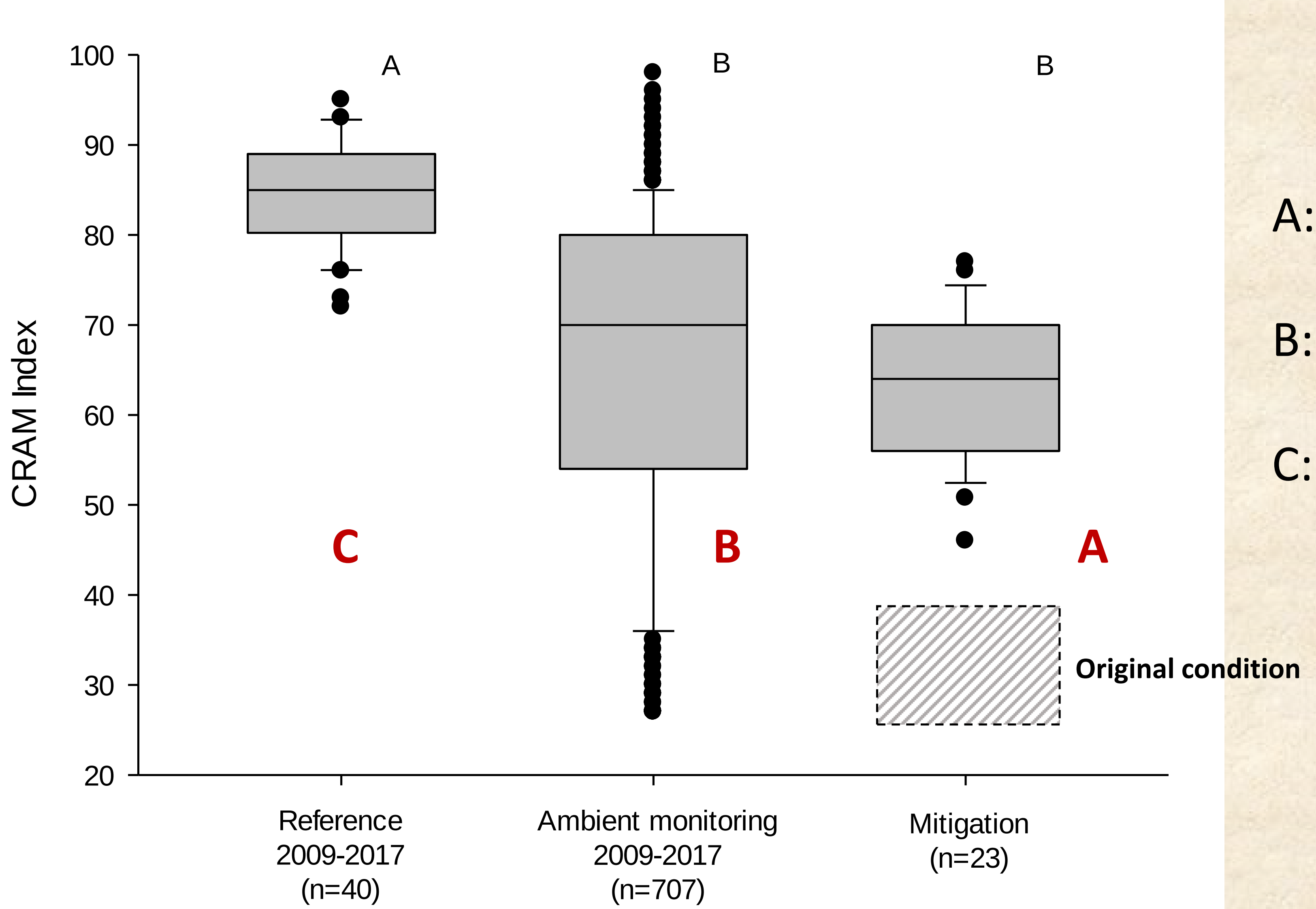


Figure 46. Mean percentage scores for each CRAM metric for mitigation sites (N=204) and reference sites (N=47).

Different Ways to Establish Performance Targets



A: Improvement from baseline

B: Comparison to ambient

C: Comparison to reference

Types of Performance Indicators

- Wetland establishment approach
  - ✓vegetation, hydrology, soils
- Condition or Functional Assessment
- Ecological Indices (e.g. IBI)
- Level 3 Intensive Measures
  - ✓Plant community composition
  - ✓Geomorphic Condition
  - ✓Sensitive Species

Information . . . . difficulty

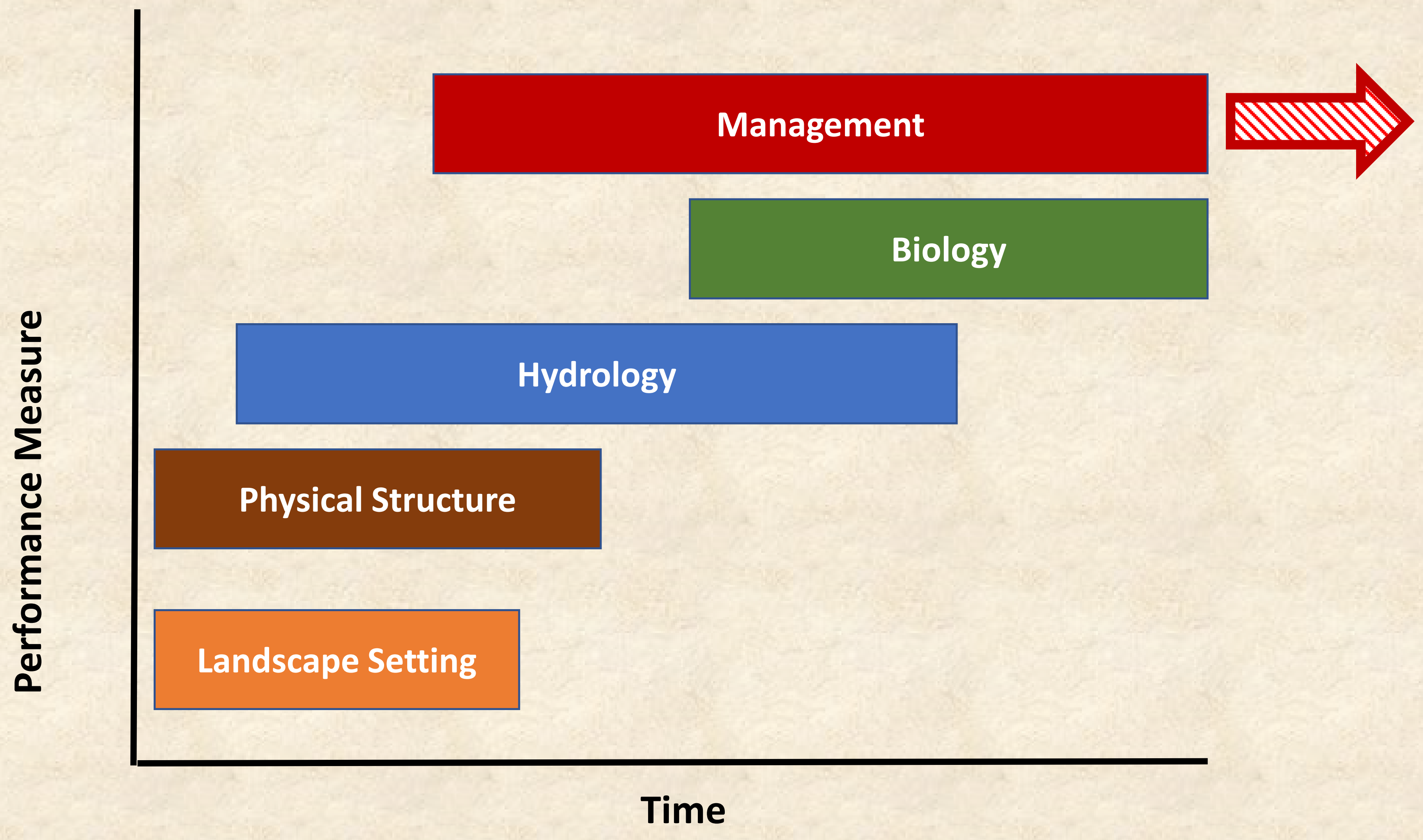
Methods are not mutually exclusive

TABLE 3: Level 3 indicators of aquatic resource condition. Indicators are color coded by the aquatic resource type to which they pertain.

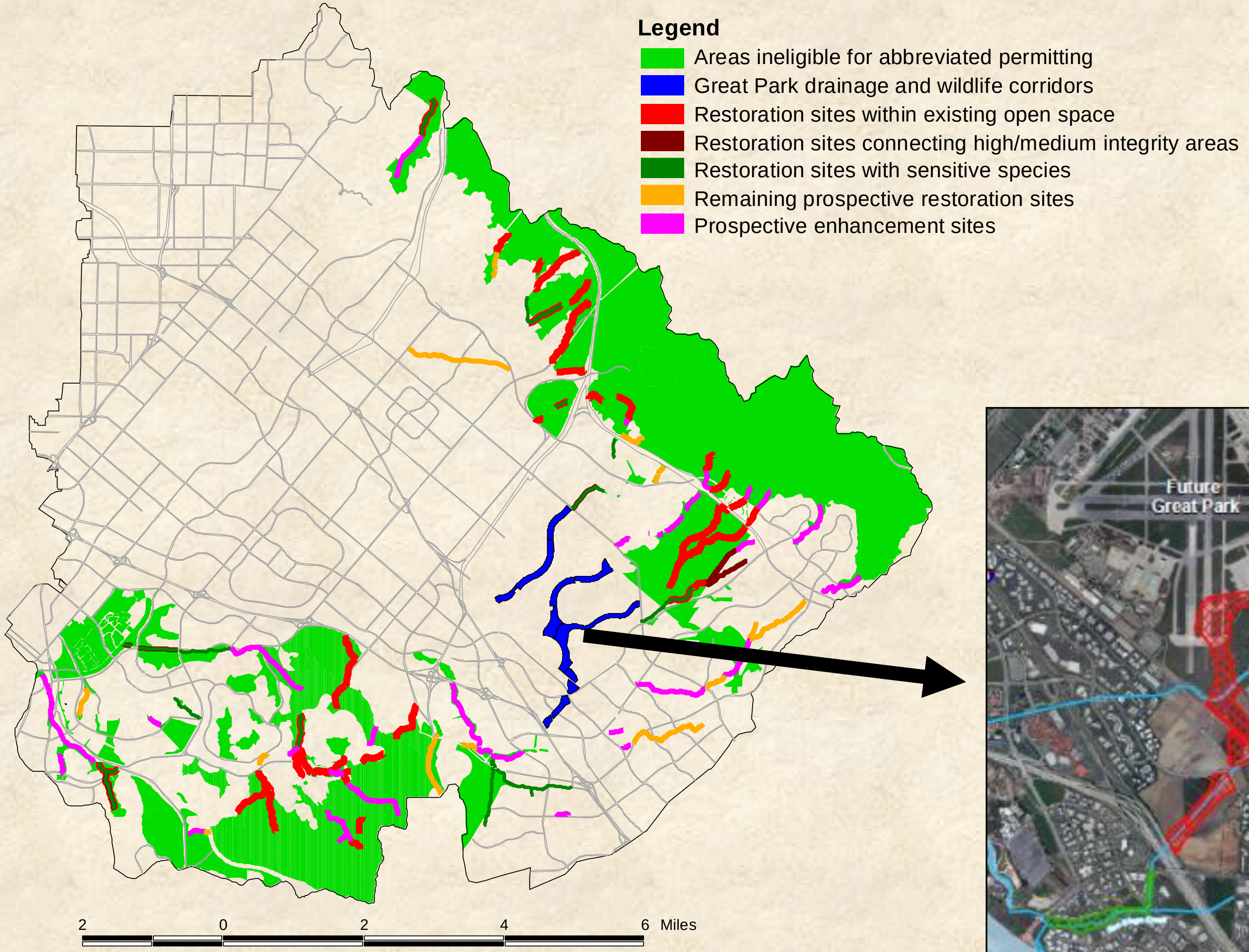
	FRESHWATER WETLANDS	ESTUARINE WETLANDS	RIVERS & STREAMS	LAKES
Buffer and Landscape Context				
Width and condition of buffer	■	■	■	■
Connectivity to adjacent wetlands/floodplain	■	■	■	
Hydrology/Geomorphology				
Duration of ponding, saturation or inundation	■	■		
Flow dynamics and floodplain connection		■	■	
Evidence of hydrologic alteration	■	■	■	■
Sediment deposition or erosion/CEM class			■	
Channel planform			■	
Bank height, angle, consolidation			■	
Water level or flow	■	■	■	■
Depth to subsurface water or soil water loss	■		■	
Soils/Substrate				
Soil morphology and type	■	■	■	
Structure of soil column (including subaqueous)	■	■	■	
Bedform		■	■	
Substrate (surface) composition/structure		■	■	■
Sediment chemistry	■	■		■
Redox conditions	■	■		
Water Chemistry				
Ph, EC, TDS, temp.	■	■	■	■
Clarity, suspended sediments, turbidity	■	■	■	■
Algal toxins (or toxic forming species)	■	■	■	■
Dissolved organic carbon	■	■	■	■
Chlorophyll a	■	■	■	■
Organic matter/metabolism	■	■	■	■
Dissolved oxygen (continuous)	■	■	■	■
Nutrients	■	■	■	■
Vegetation				
Vegetation cover	■	■	■	■
Community composition & structure	■	■	■	■
Physical disturbance of the plant community	■	■	■	■
Invasive plants	■	■	■	■
Age-stand distribution	■		■	
Evidence of recruitment	■	■	■	■
FQAI (or equivalent)	■	■	■	
Shoreline and littoral habitat extent	■	■	■	■
Bioassessment Indicators				
Algal index (e.g., ibi, mmi)	■	■	■	■
Macroalgal extent	■	■	■	■
Benthic invertebrate index (e.g., ibi, mmi, o/e)	■	■	■	■
Amphibian index	■	■	■	■
Fish community index	■	■	■	■
Evidence of wildlife/bird use	■	■	■	■

Stein et al., in review

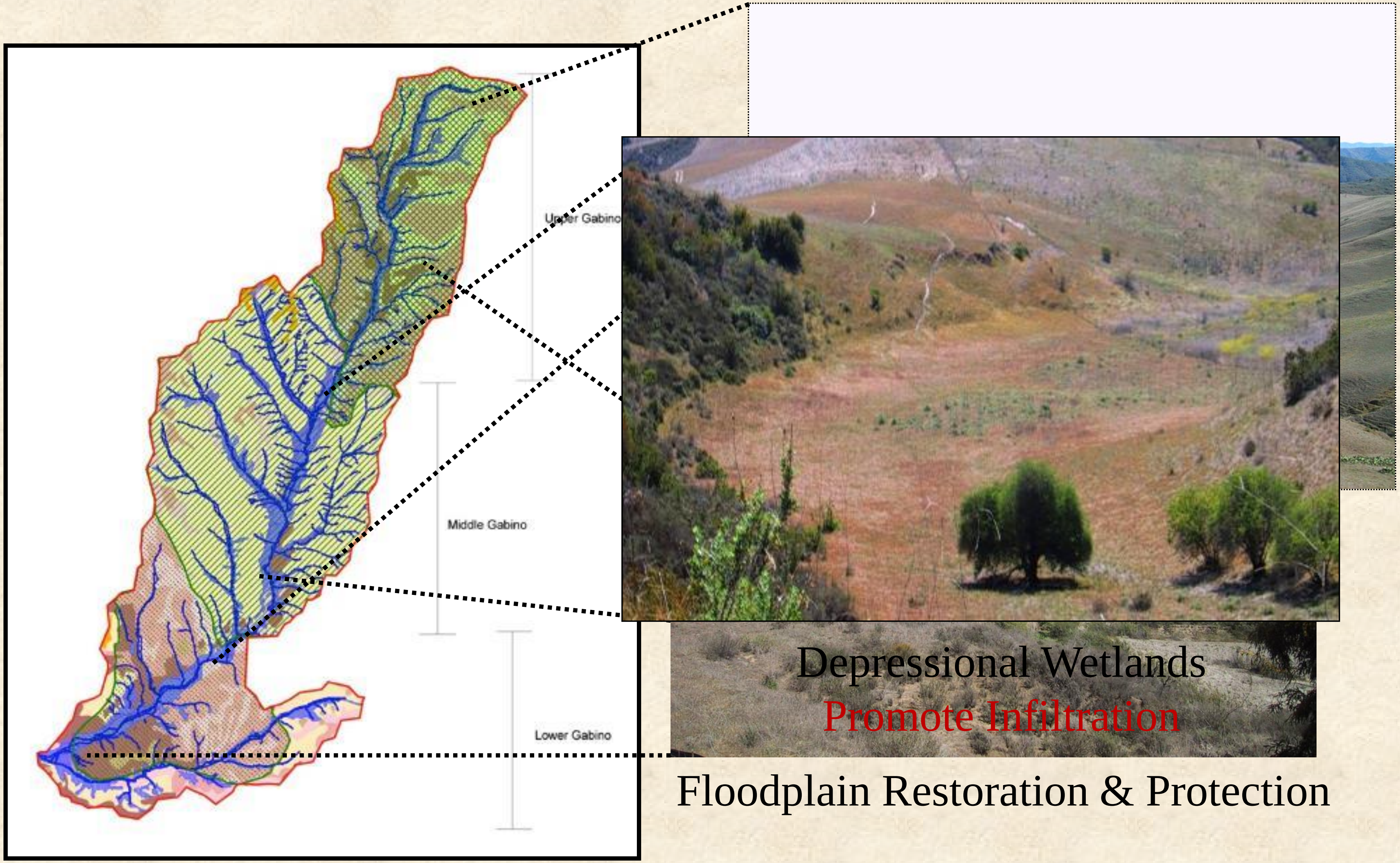
Tiered Performance Standards



Landscape Setting: San Diego Creek, California

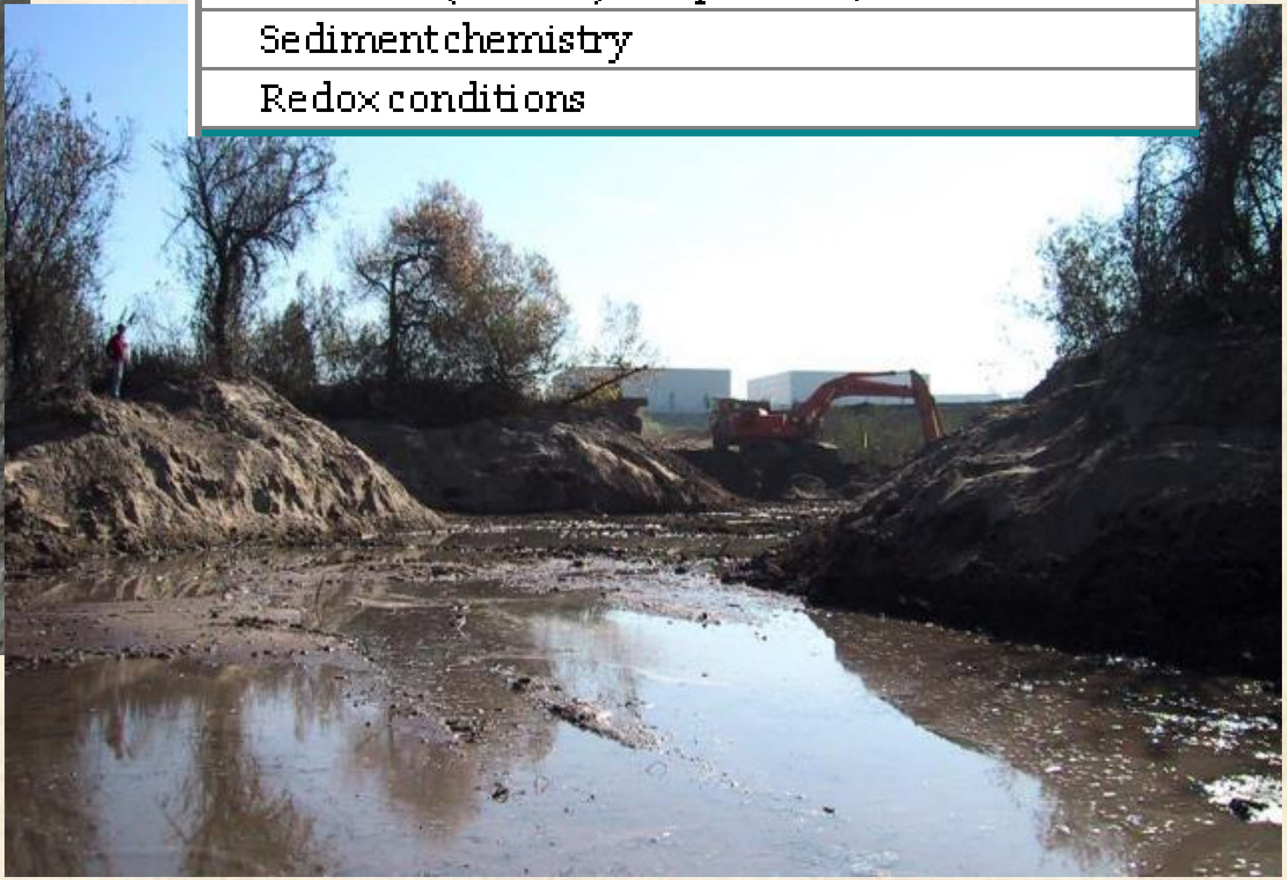


Stream Restoration Based on Landscape Setting



Physical Setting/Design

Soils/Substrate
Soil morphology and type
Structure of soil column (including subaqueous)
Bedform
Substrate (surface) composition/structure
Sediment chemistry
Redox conditions



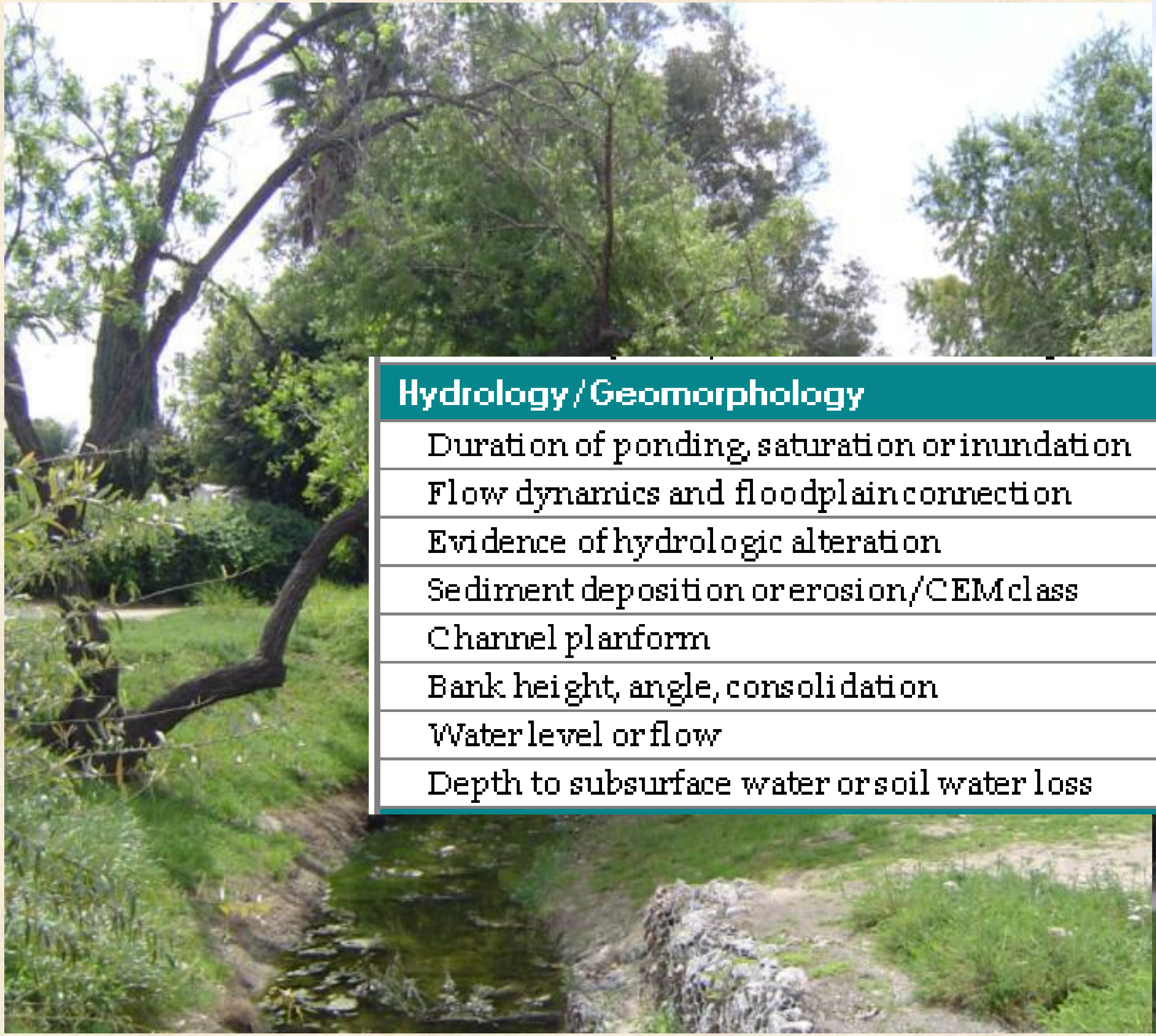
Appropriate elevation and morphology

Physical Setting Considerations

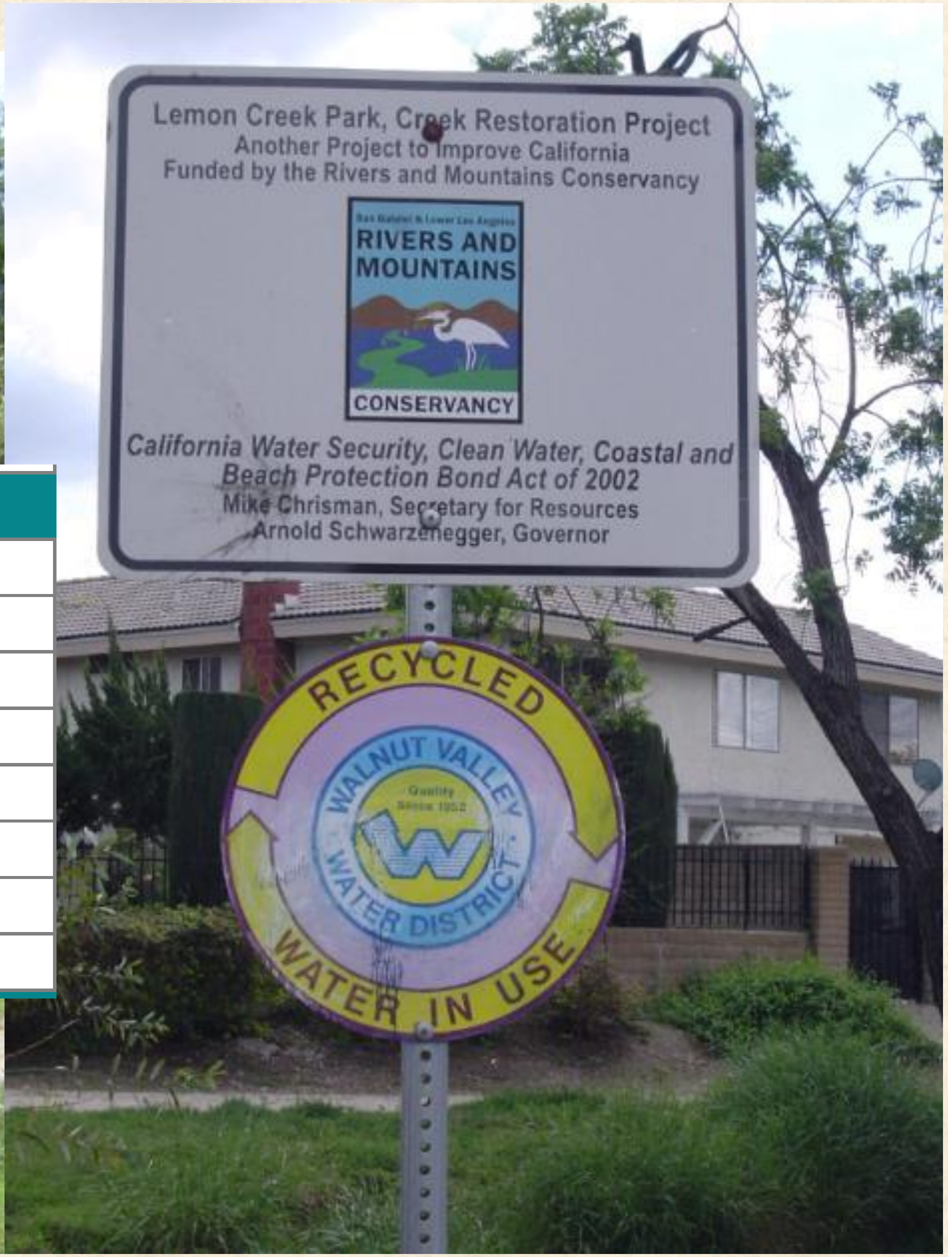
- Physical structure should be appropriate for landscape position
- Consider substrate type relative to desired hydrologic regime and geologic setting
  - ✓Claypans in vernal pools
  - ✓Organic content in coastal wetlands
- Pay attention to elevations relative to desired hydrology

Category	Standard	Target	Timing
Physical - Riverine	cross-section has at least two benches or breaks in slope, including the riparian area, above the channel bottom, not including the thalweg	Relative to min of 2 reference sites	Year 1

Hydrology



Hydrology / Geomorphology
Duration of ponding, saturation or inundation
Flow dynamics and floodplain connection
Evidence of hydrologic alteration
Sediment deposition or erosion/CEM class
Channel planform
Bank height, angle, consolidation
Water level or flow
Depth to subsurface water or soil water loss



Hydrology Considerations

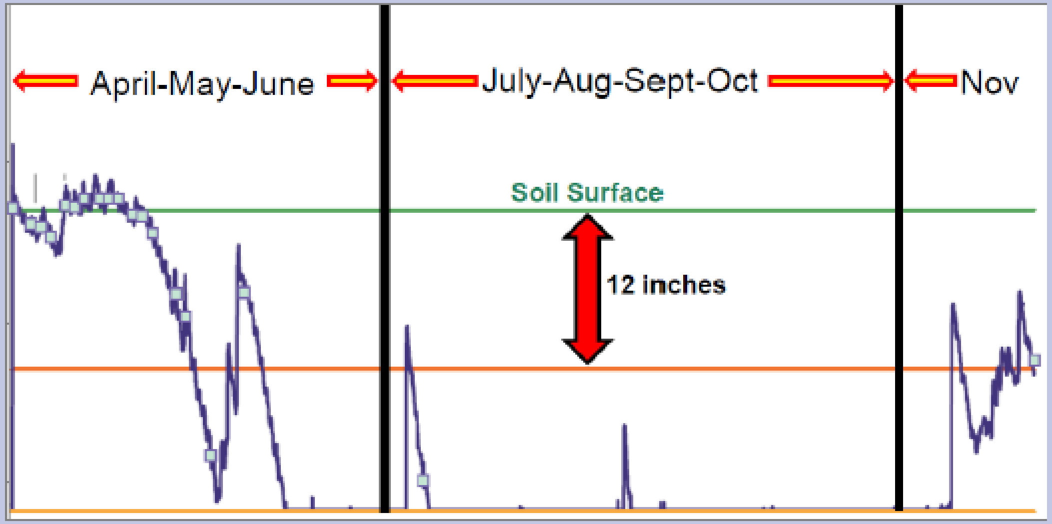
- Appropriate hydrologic regime relative to landscape position and desired wetland/stream type
- Consider issues of seasonality/perenniality relative to water source
- Avoid reliance on artificial sources of hydrology
- Allow for necessary dynamism (e.g. flood-scour cycles)

Category	Standard	Target	Timing
Hydrologic - Tidal	Seasonally open inlet: The permittee shall ensure the tidal inlet opens at a frequency and duration to provide design-level site inundation and salinities.	Relative to regional reference sites of same estuarine type	Inlet dynamics would be present immediately and would be expected to persist; biological features would develop over time.

Sample Performance Standards: Hydrology

SEASONAL WATER LEVELS AT REFERENCE SITE

Vertical lines indicate seasonal breaks



PERFORMANCE STANDARD BASED ON REFERENCE DATA:

Hydrology shall consist of a water table 12 inches or less below the soil surface for a minimum of 28 consecutive days during the growing season under normal to wetter than normal hydrological conditions (typically July-Oct).

Inundation during the growing season shall not occur except: (1) at the start of the growing season (following snowmelt); and (2) following the 10-year, 24-hour – or greater – precipitation events. Depth of inundation shall be less than 6 inches with a duration of less than 14 consecutive days.

St. Paul District Compensatory Mitigation Policy for Minnesota, 2009

Wetland Type	Minimum Soil Saturation to Inundation			Maximum Inundation		
	Saturation (from soil surface)	Inundation	Duration (minimum)	Measure	Duration (maximum)	Storm Event
General	Within 12 inches	≤ 6 inches	28 consecutive days or two 14-day hydroperiods	–	–	–
Shallow Marsh	0 inches	≤ 6 inches	56-60 consecutive days, two 28-30 day or four 14-15 day hydroperiods	≤ 18 inches	30 days	≥ 2 year
Sedge Meadow	Within 12 inches	–	28 consecutive days or two 14 day hydroperiods	≤ 6 inches	14 days	≥ 10 year
Wet Meadow	Within 12 inches	–	28 consecutive days or two 14 day hydroperiods	≤ 6 inches	14 days	≥ 10 year
Shrub-Carr	Within 6-12 inches	≤ 6 inches	28-30 consecutive days, or two 14-15 day hydroperiods	6-12 inches	14-15 days, except in hollows	≥ 10 year
Hardwood Swamp	Within 6-12 inches	≤ 6 inches	28-30 consecutive days, or two 14-15 day hydroperiods	6-12 inches	14-15 days, except in hollows	≥ 10 year

State of Wisconsin

Finally. . . the Plants. . . and the Critters

Considerations for Biotic Standards

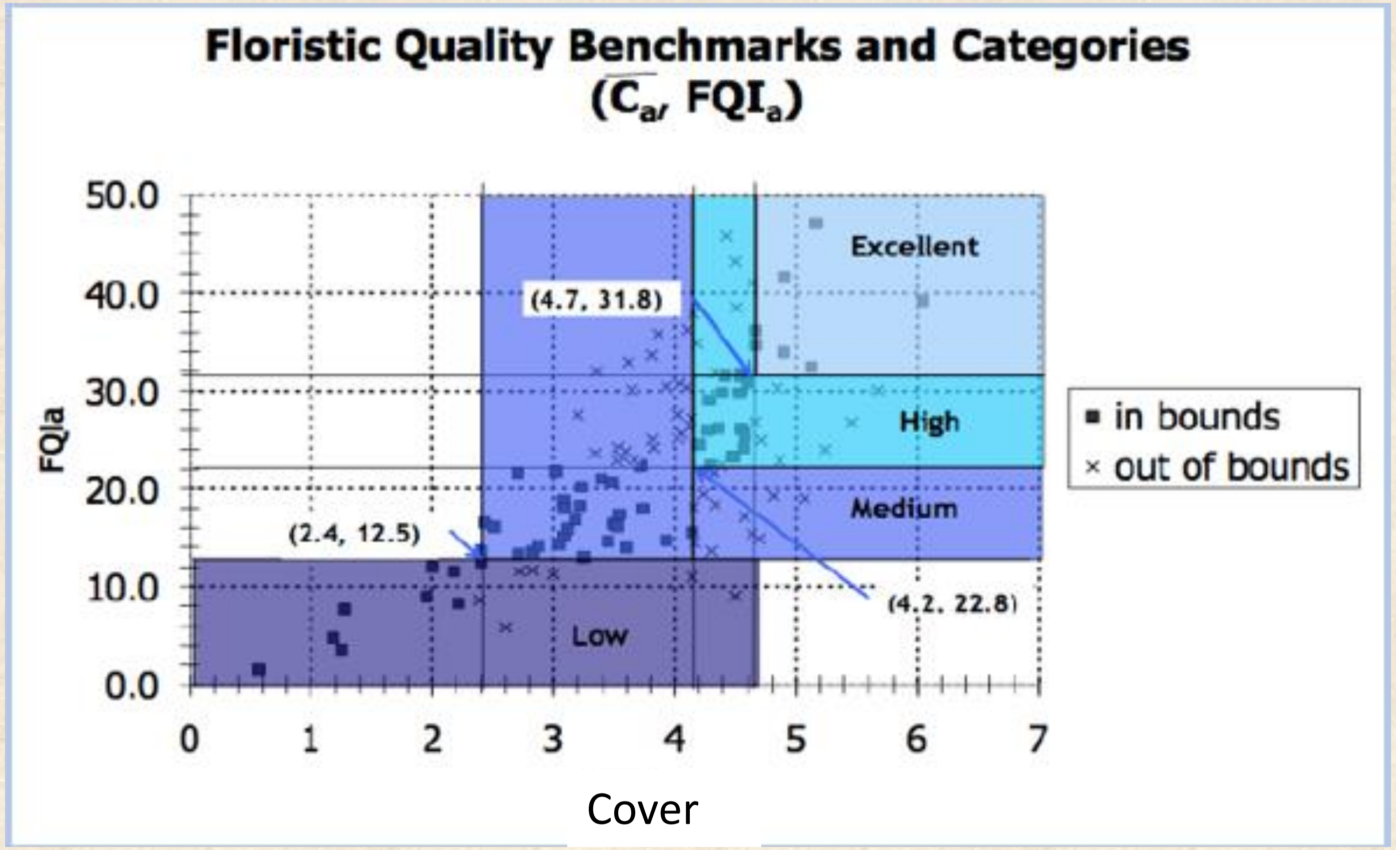
- Focus on structural and functional elements (e.g. recruitment)
- Consider using standard bioassessment tools (e.g. FQAI, IBI)
- Allow for short and long-term succession cycles and response to natural disturbances

Category	Standard	Target	Timing
Flora: all wetland types	Species richness: The permittee shall ensure target native species richness values of tree, shrub, and herb strata are met by year 5.	>75% of reference	By year 5, after hydrology criteria is met

Sample Biotic Standards

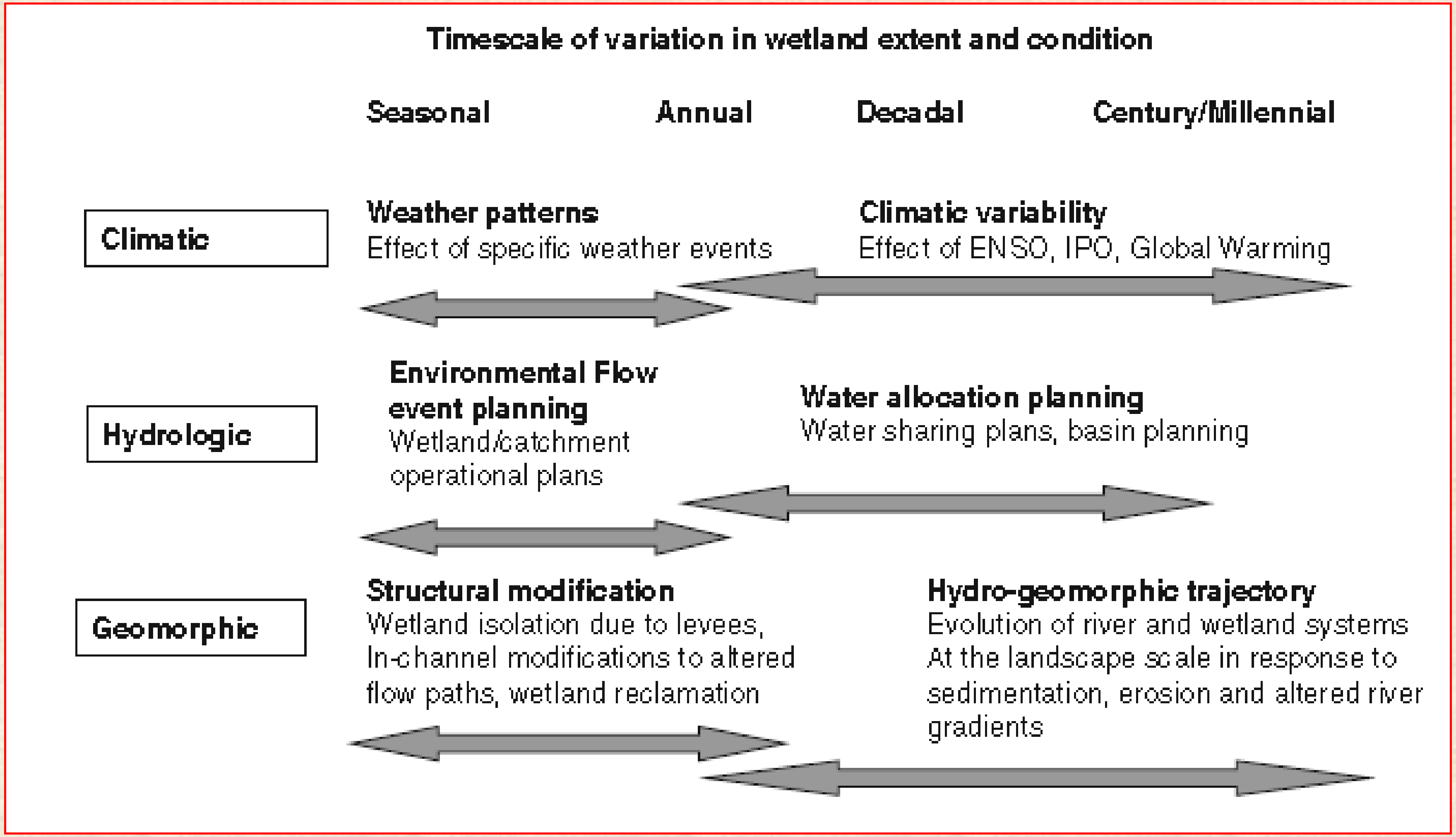
Vegetation
Vegetation cover
Community composition & structure
Physical disturbance of the plant community
Invasive plants
Age-stand distribution
Evidence of recruitment
FQAI (or equivalent)
Shoreline and littoral habitat extent

Bioassessment Indicators
Algal index (e.g., ibi, mmi)
Macroalgal extent
Benthic invertebrate index (e.g., ibi, mmi, o/e)
Amphibian index
Fish community index
Evidence of wildlife/bird use



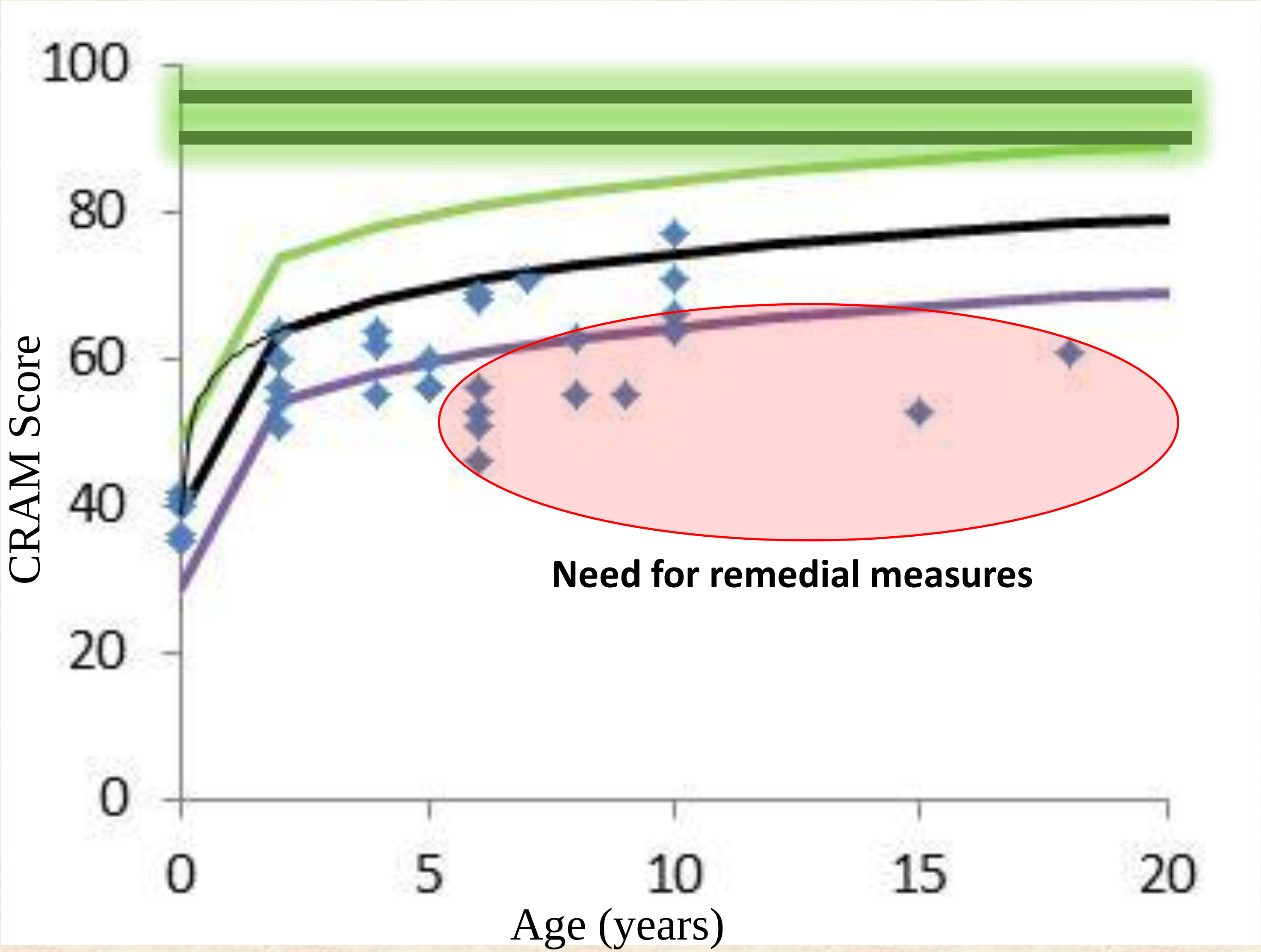
State of Wisconsin

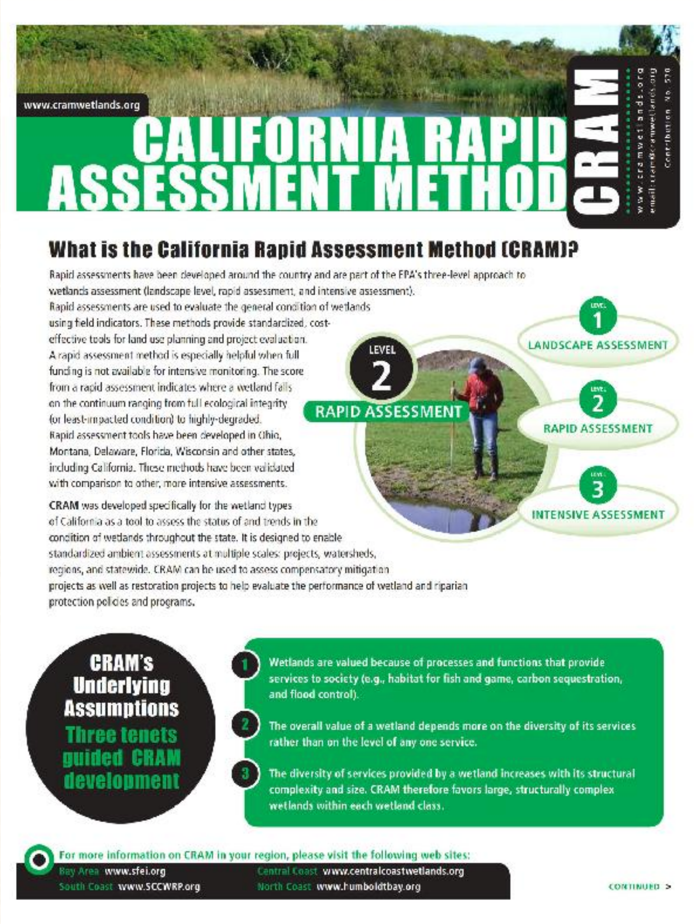
But… Recovery Takes Time



Saintilan & Imgraben 2012

Wetland Performance Curves





www.cramwetlands.org

CALIFORNIA RAPID ASSESSMENT METHOD

CRAM

What is the California Rapid Assessment Method (CRAM)?

Rapid assessments have been developed around the country and are part of the EPA's three-level approach to wetlands assessment (landscape level, rapid assessment, and intensive assessment).

Rapid assessments are used to evaluate the general condition of wetlands using field indicators. These methods provide standardized, cost-effective tools for land use planning and project evaluation.

A rapid assessment method is especially helpful when full funding is not available for intensive monitoring. The score from a rapid assessment indicates where a wetland falls on the continuum ranging from full ecological integrity (or least-impacted condition) to highly-degraded.

Rapid assessment tools have been developed in Ohio, Montana, Delaware, Florida, Wisconsin and other states, including California. These methods have been validated with comparison to other, more intensive assessments.

LEVEL 2 RAPID ASSESSMENT

LEVEL 1 LANDSCAPE ASSESSMENT

LEVEL 2 RAPID ASSESSMENT

LEVEL 3 INTENSIVE ASSESSMENT

CRAM was developed specifically for the wetland types of California as a tool to assess the status of and trends in the condition of wetlands throughout the state. It is designed to enable standardized ambient assessments at multiple scales: projects, watersheds, regions, and statewide. CRAM can be used to assess compensatory mitigation projects as well as restoration projects to help evaluate the performance of wetland and riparian protection policies and programs.

CRAM's Underlying Assumptions

Three tenets guided CRAM development

1. Wetlands are valued because of processes and functions that provide services to society (e.g., habitat for fish and game, carbon sequestration, and flood control).
2. The overall value of a wetland depends more on the diversity of its services rather than on the level of any one service.
3. The diversity of services provided by a wetland increases with its structural complexity and size. CRAM therefore favors large, structurally complex wetlands within each wetland class.

For more information on CRAM in your region, please visit the following web sites:

Bay Area www.sfei.org
Central Coast www.centralcoastwetlands.org
South Coast www.SCCWRP.org
North Coast www.humboldtbay.org

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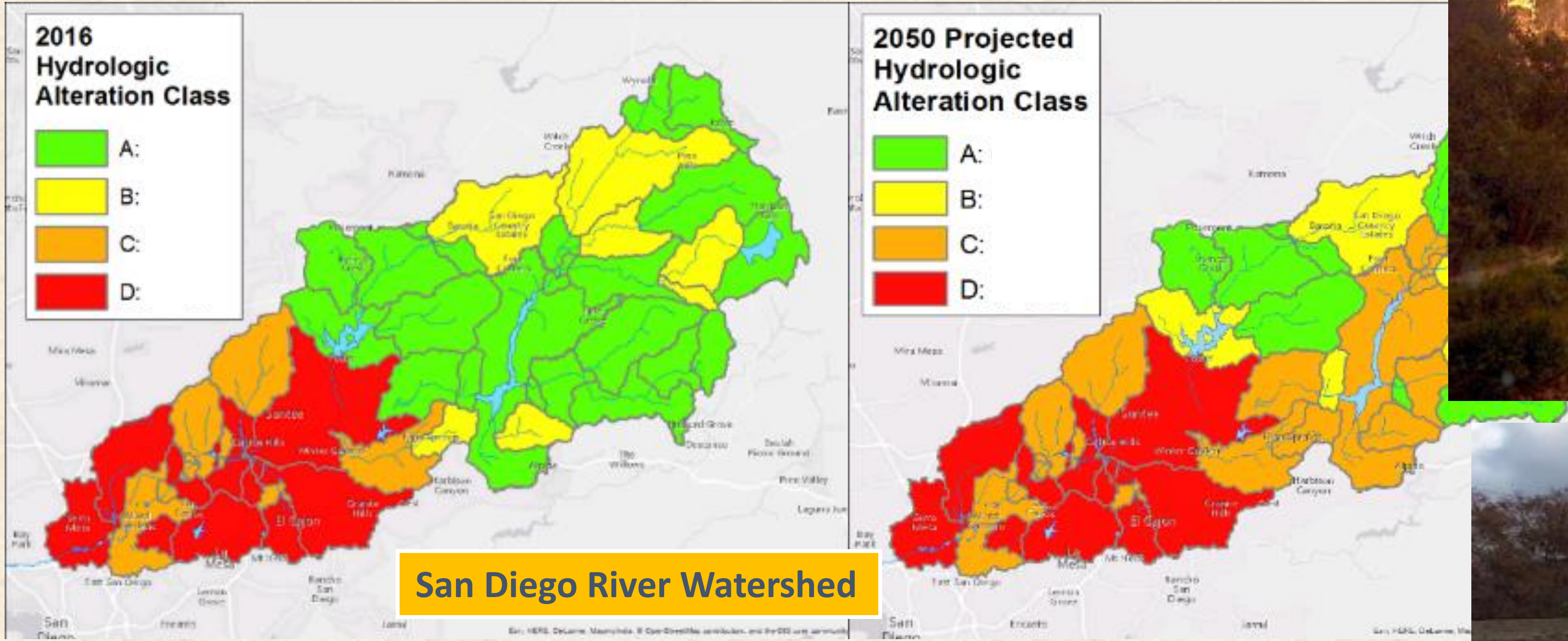
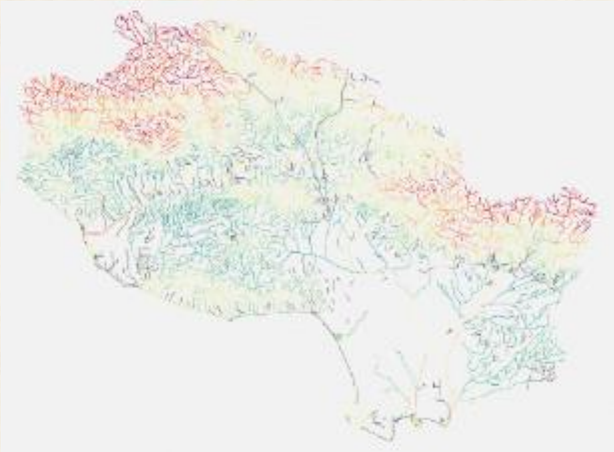
Four overarching attributes:

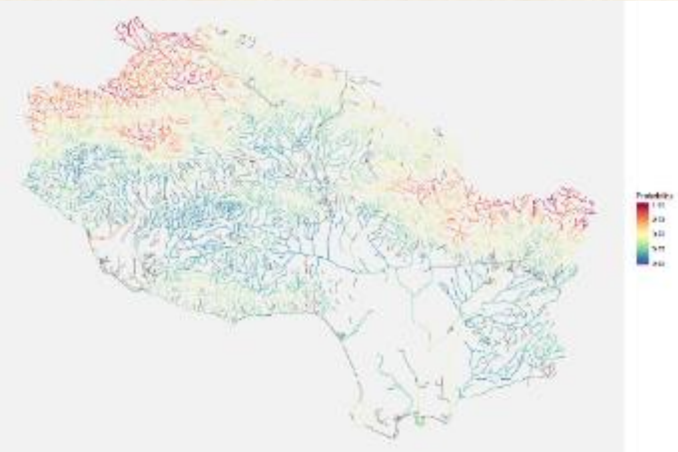
1) Buffer and Landscape Context
2) Hydrology
3) Physical Structure
4) Biotic Structure

Account for Changes Over Time





Baseline - 2010



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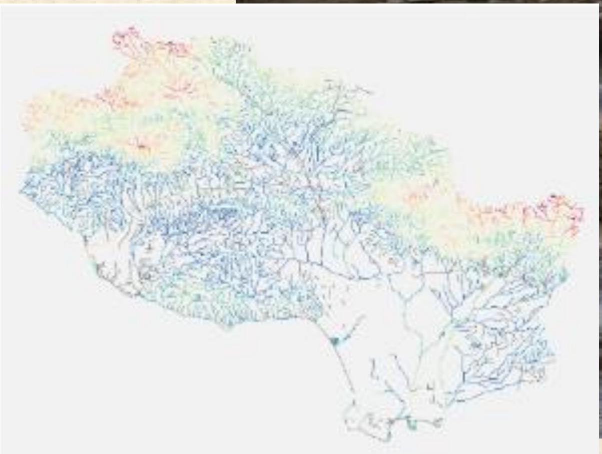

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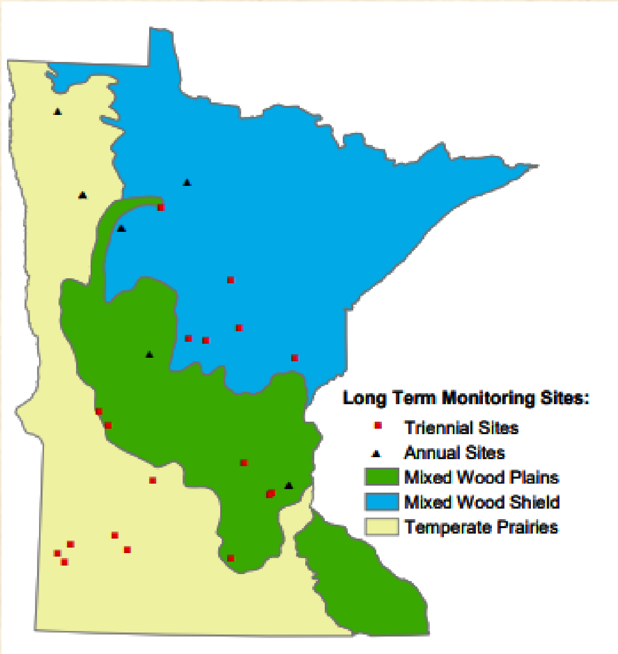
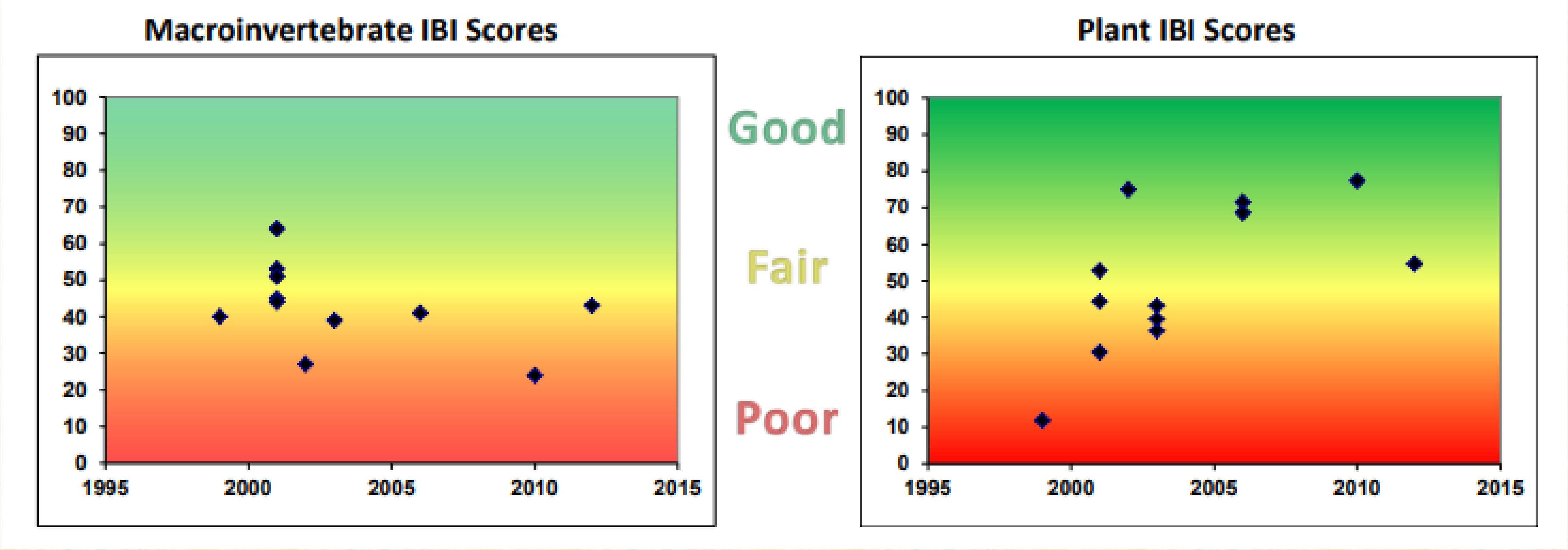
Resilient Performance Standards

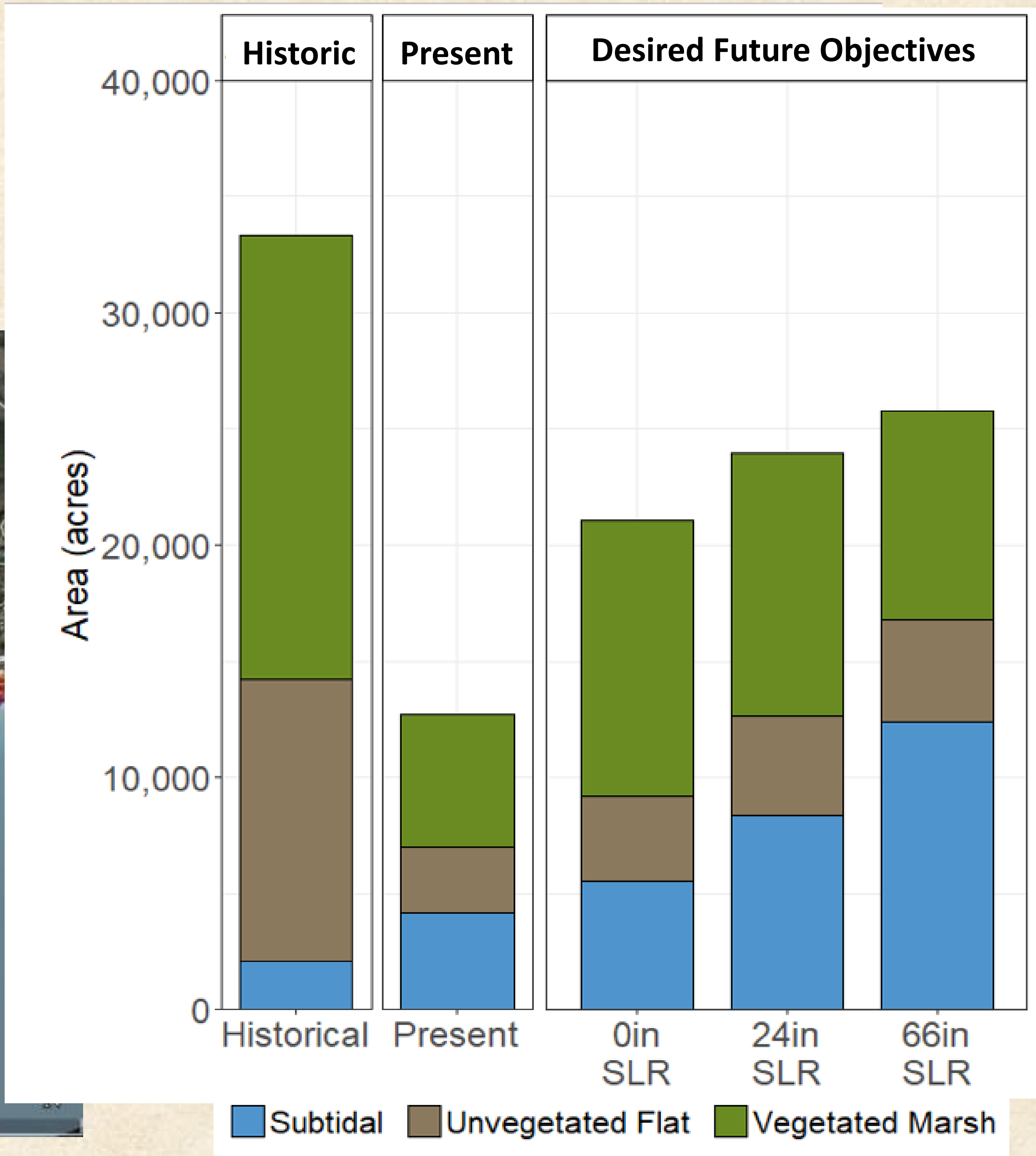


- Long-term sentinel monitoring sites
- Compare changes at mitigation bank/site to regional patterns
- Adjust standards over time relative to sentinel locations
  - ✓ ***"benthic macroinvertebrate IBI within 10% of mean 3-year average at sentinel sites within the watershed"***

NEED commitment to long-term monitoring

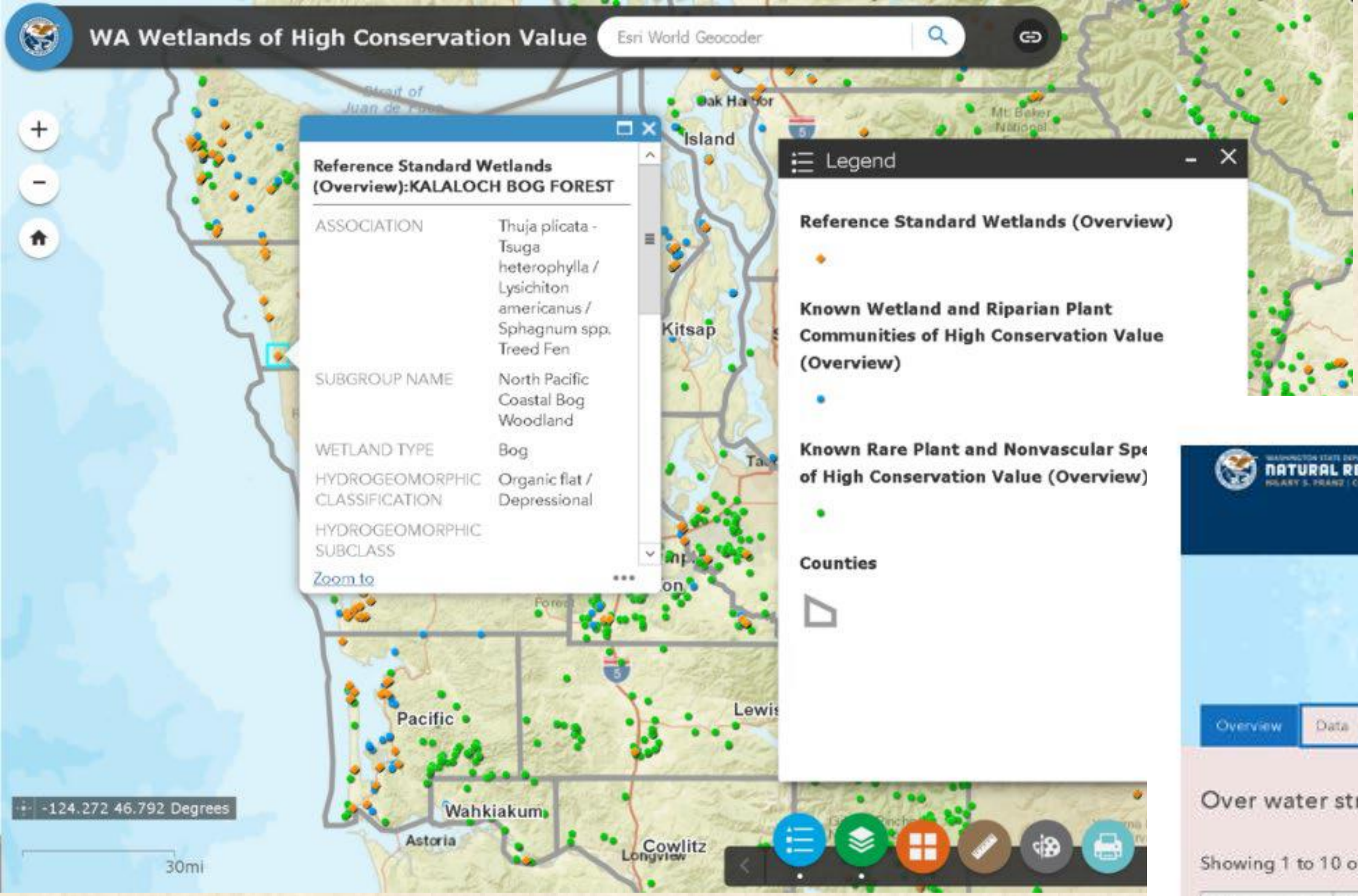


Account for Future Conditions



Data Management

- General Philosophy
  - ✓ strive for an **integrated, electronic data flow** through all steps of the data management process from data collection through publication;
  - ✓ manage data in a **geospatial format** to enhance data visualization and interpretation and facilitate data integration across programs; and
  - ✓ use an **open data format** that includes web services and application program interfaces (APIs) to facilitate data access and sharing.


WA Wetlands of High Conservation Value
Esri World Geocoder
Reference Standard Wetlands (Overview):KALALOCH BOG FOREST
ASSOCIATION
Thuja plicata - Tsuga heterophylla / Lysichiton americanus / Sphagnum spp. Treed Fen
SUBGROUP NAME
North Pacific Coastal Bog Woodland
WETLAND TYPE
Bog
HYDROGEOMORPHIC CLASSIFICATION
Organic flat / Depressional
HYDROGEOMORPHIC SUBCLASS
Zoom to
Legend
Reference Standard Wetlands (Overview)
Known Wetland and Riparian Plant Communities of High Conservation Value (Overview)
Known Rare Plant and Nonvascular Spe
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Wahkiakum
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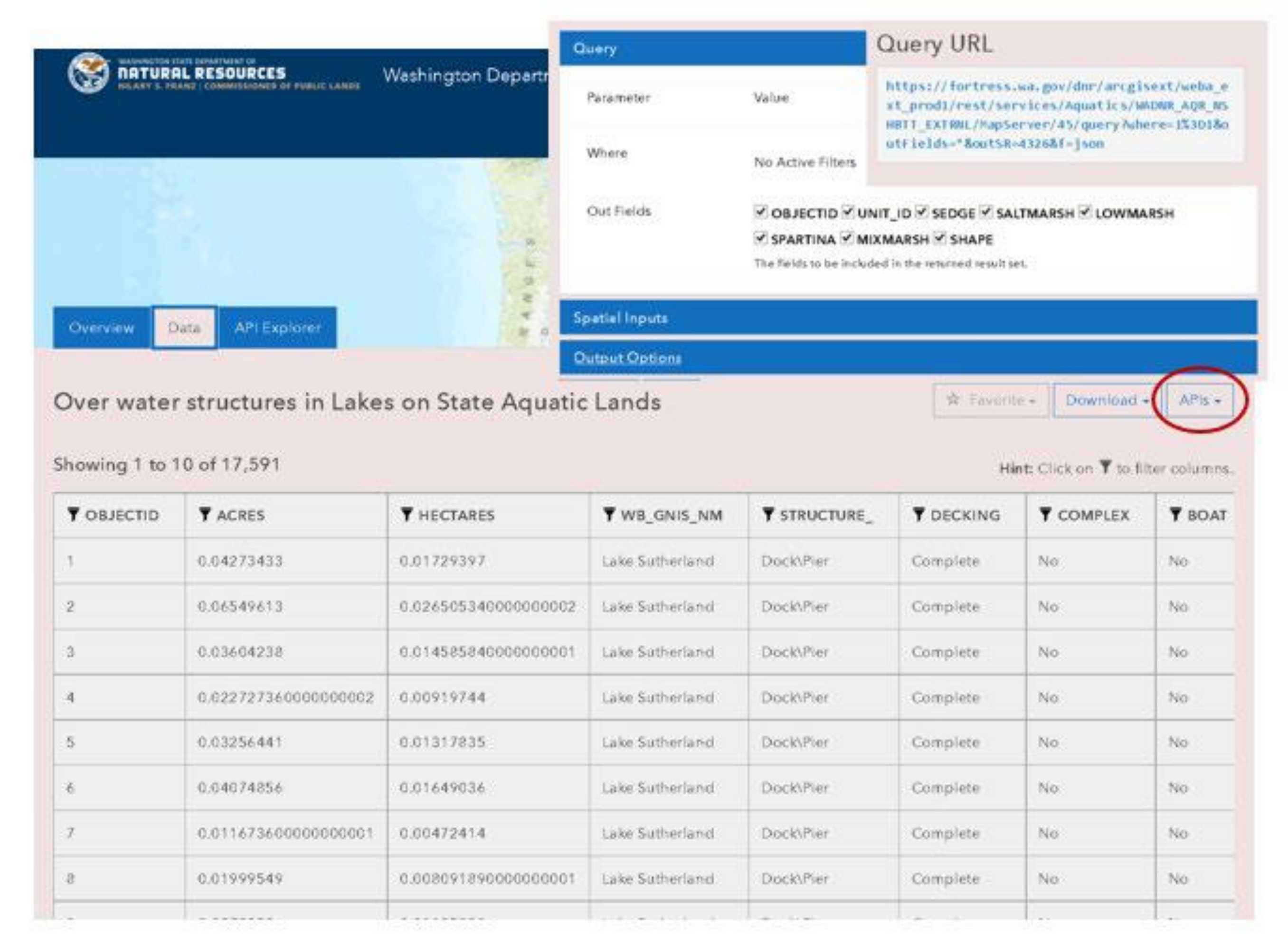
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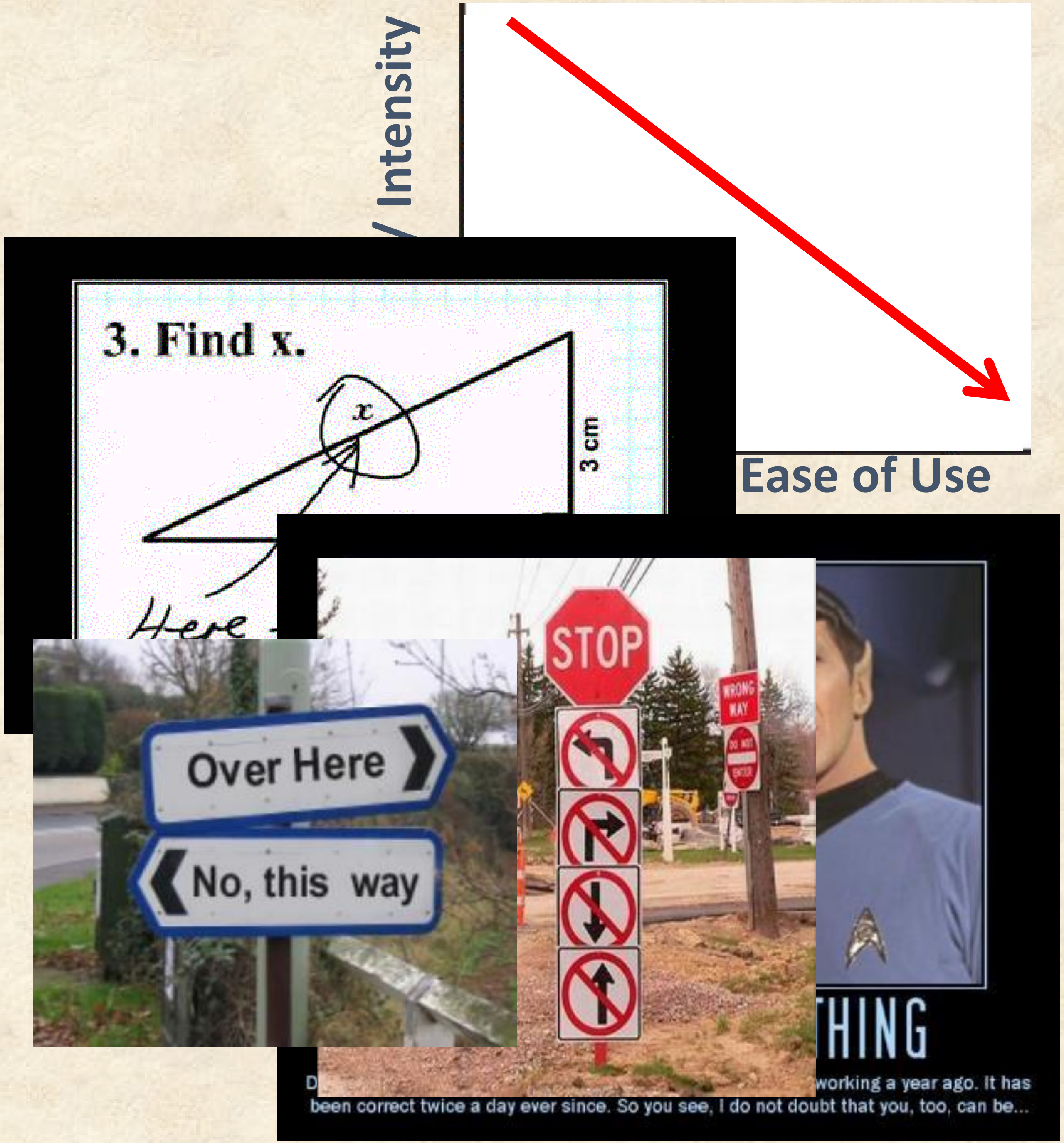
8 0.01999549 0.008091890000000001 Lake Sutherland Dock\Pier Complete No No

Closing Thoughts

- Choose the right tool to assess processes
- Keep it simple
  - ✓ repeatability
- Consider element of time
- ***Provide clear, enforceable and process-based standards***




EVERYTHING IS
TERRIBLE!


EVERYTHING IS
AWESOME!

Thank You

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