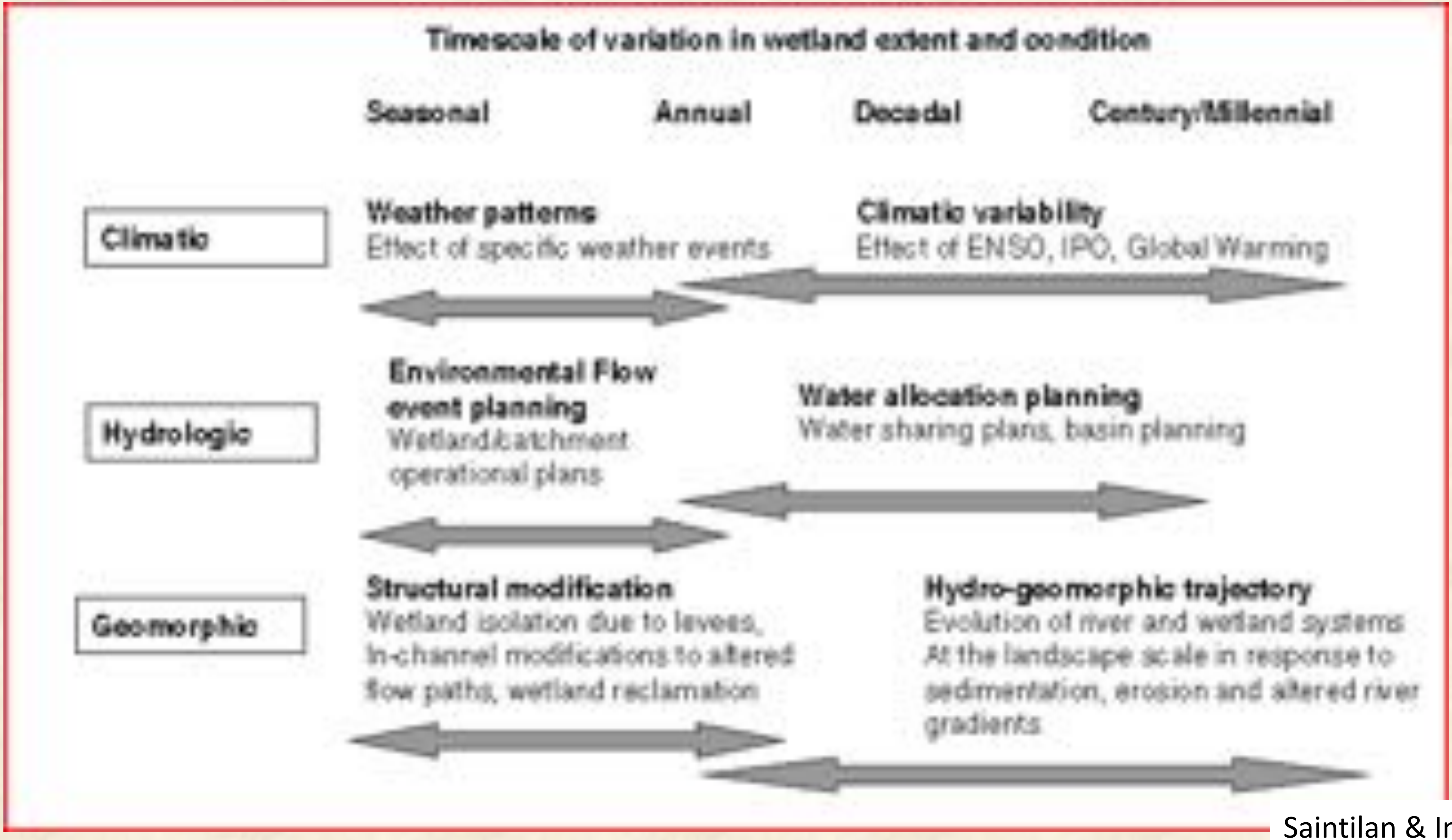
Long Term Performance of Stream Mitigation

Eric D. Stein

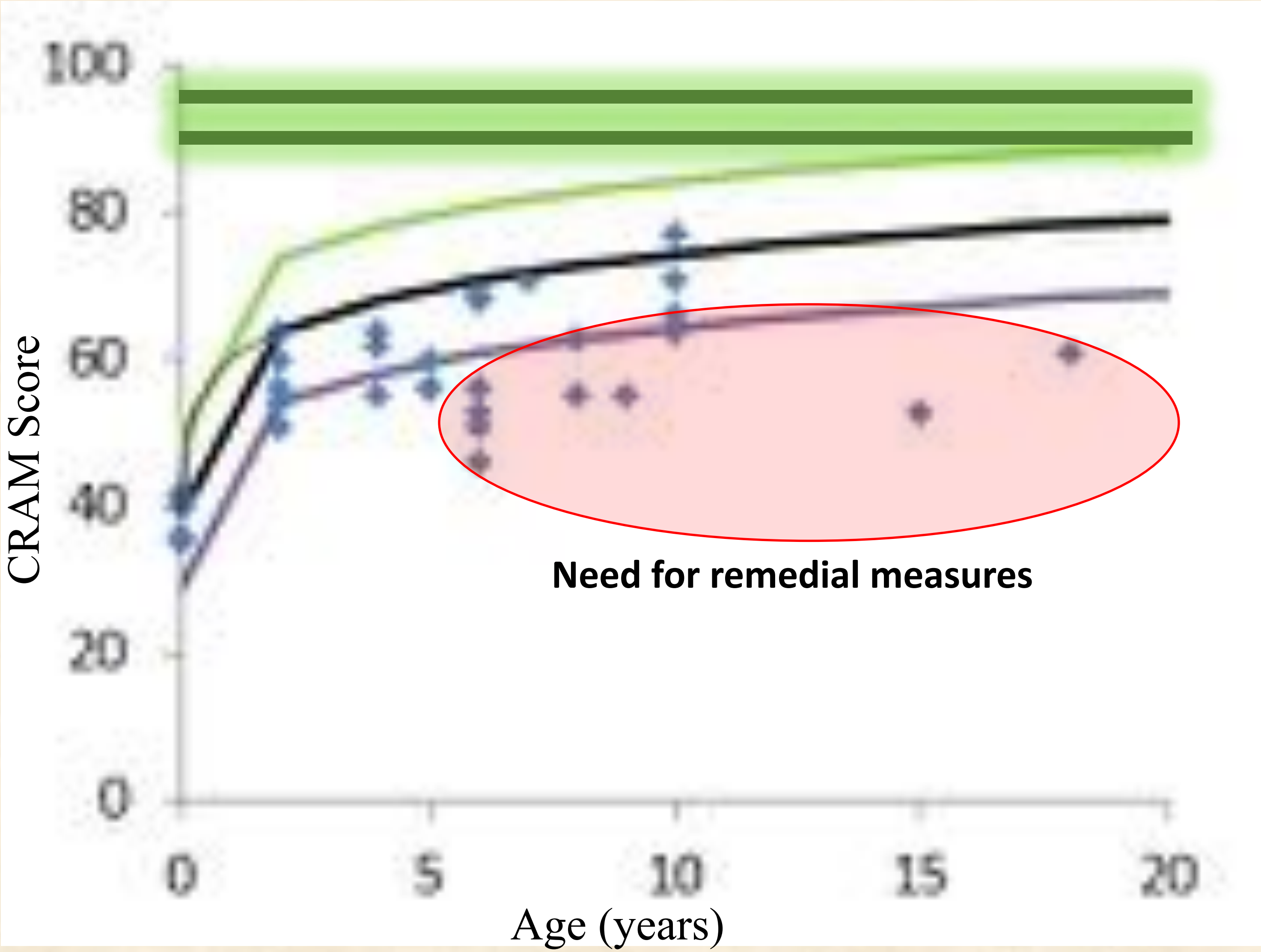
Southern California Coastal Water Research Project

Stream Recovery Takes Time



Saintilan & Imgraben 2012

Wetland Performance Curves



Four overarching attributes:

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

So … What is the Issue

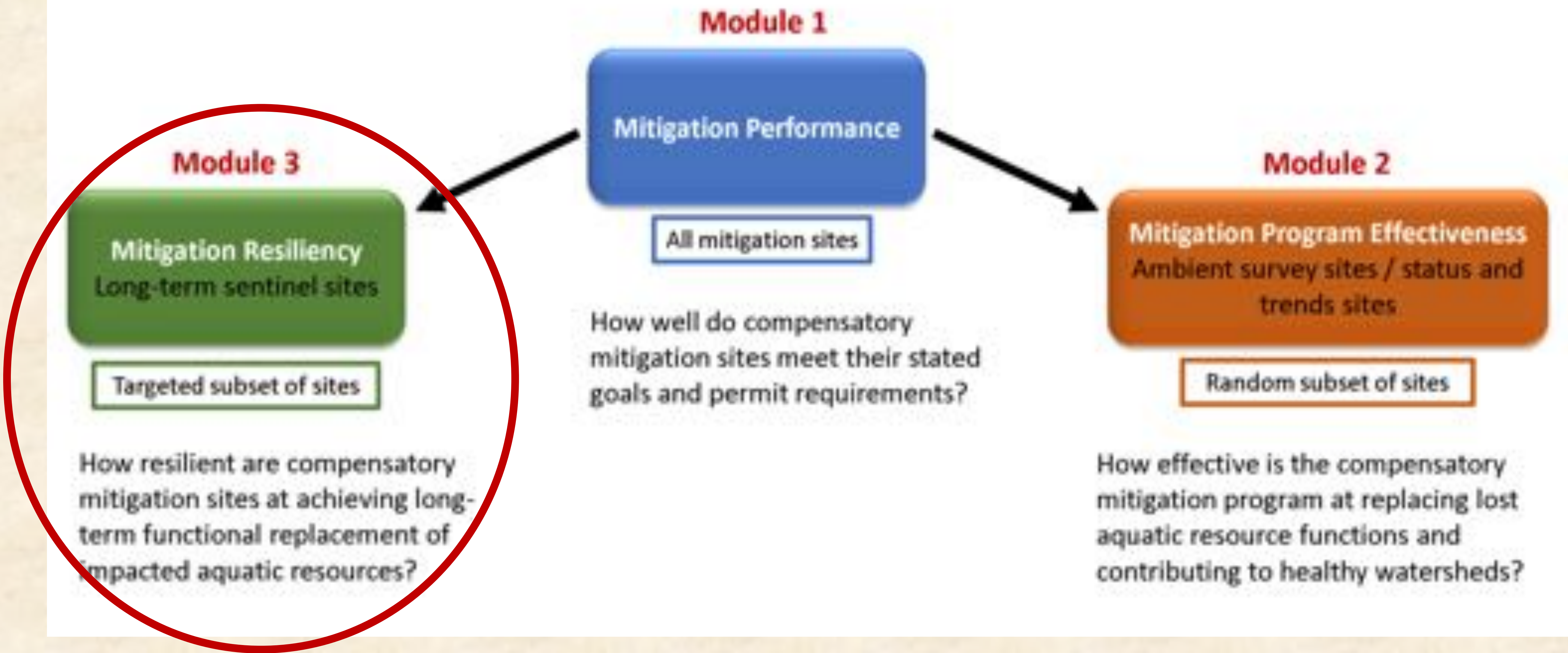
- Required monitoring periods are typically much shorter than the time necessary for restoration sites to reach functional maturity

- Most mitigation sites require ongoing management, particularly in modified landscapes

- No easy mechanism for long-term monitoring and adaptive management

Pending EPA Guidance Document

An Integrated Framework for Evaluating Wetland and Stream Compensatory Mitigation



Module 3:
Resiliency of Compensatory Mitigation Practices

- Goal
  - ✓ Assess long term resiliency and sustainability of compensatory mitigation sites
- Main Question
  - ✓ How well do compensatory mitigation sites achieve long-term functional replacement of impacted wetlands?
- Design Approach
  - ✓ Assess a subset of sentinel sites relatively infrequently (e.g. every 5 years) over long periods of time
- Site selection
  - ✓ Select compensatory mitigation sites that have completed their required monitoring periods and been deemed "successful"
  - ✓ Sites should be subject to long-term protection (e.g. conservation easement) and readily accessible
- Approach to reference
  - ✓ Compare reference standard sites in conserved areas
  - ✓ Compare to ambient conditions

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

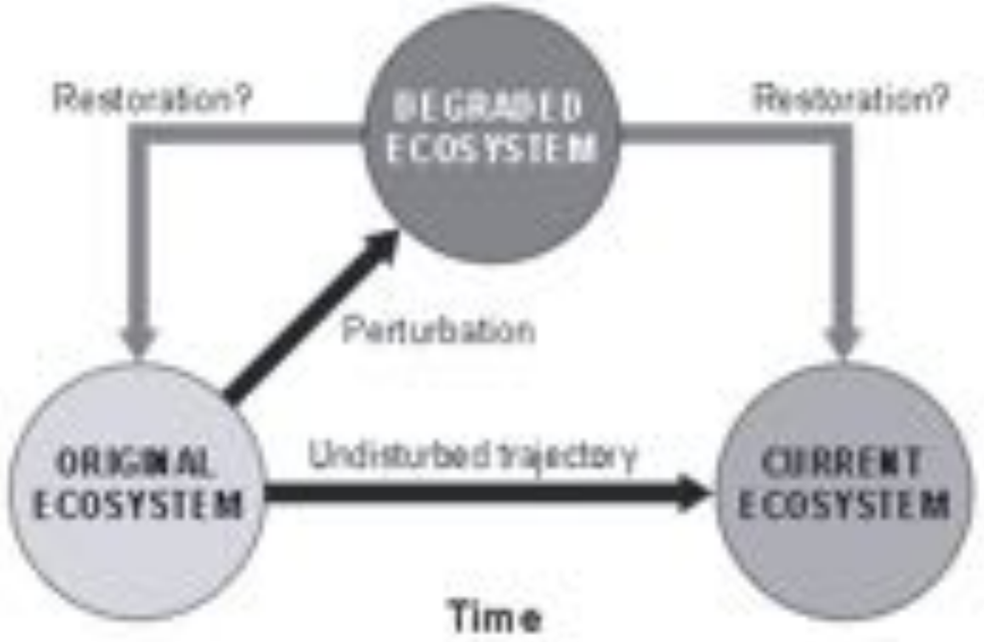


Fig. 1.5 Time changes an undisturbed ecosystem, making targets from the past hard to determine.

Harris and Van Diggelen 2006

Comparison to Reference

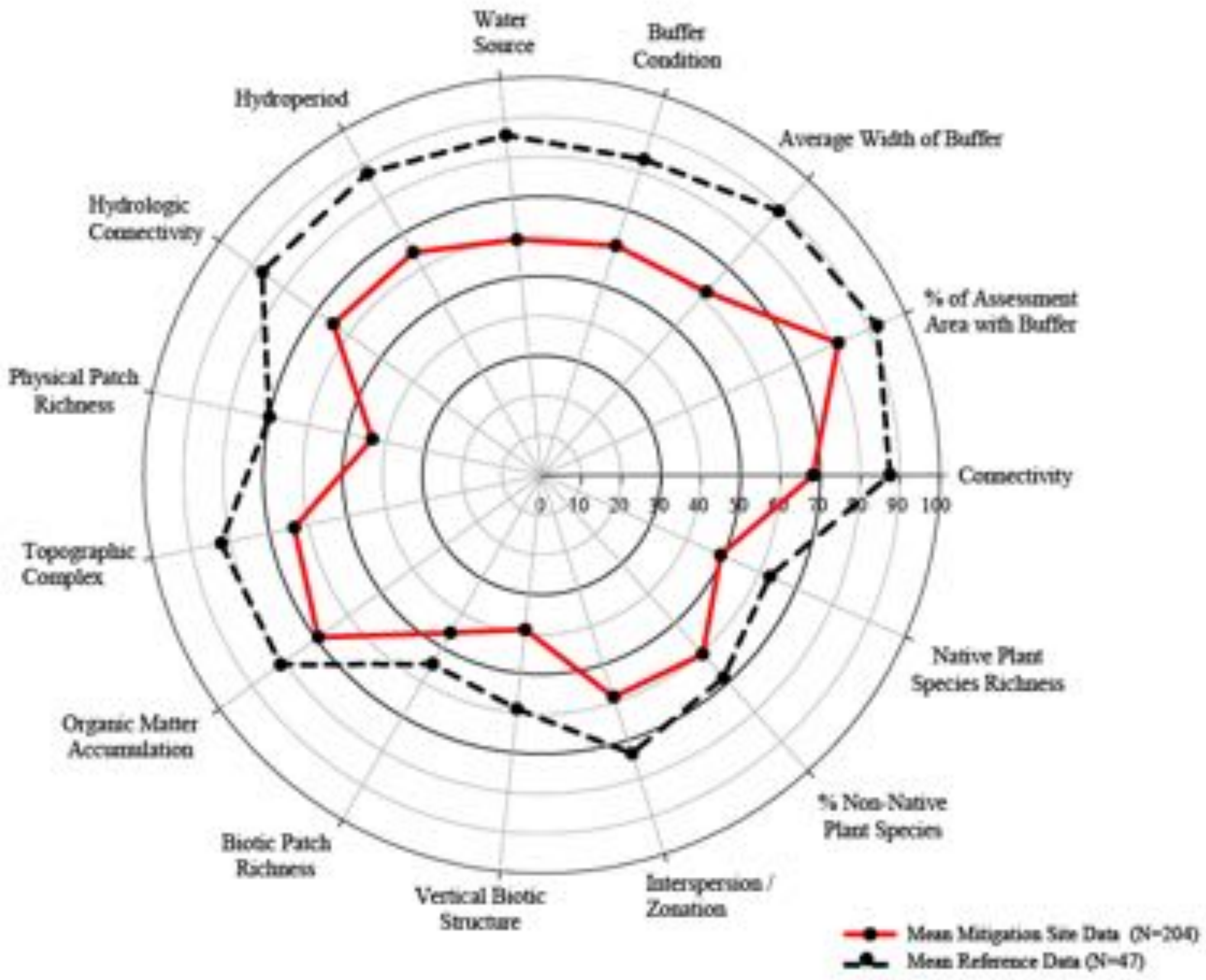
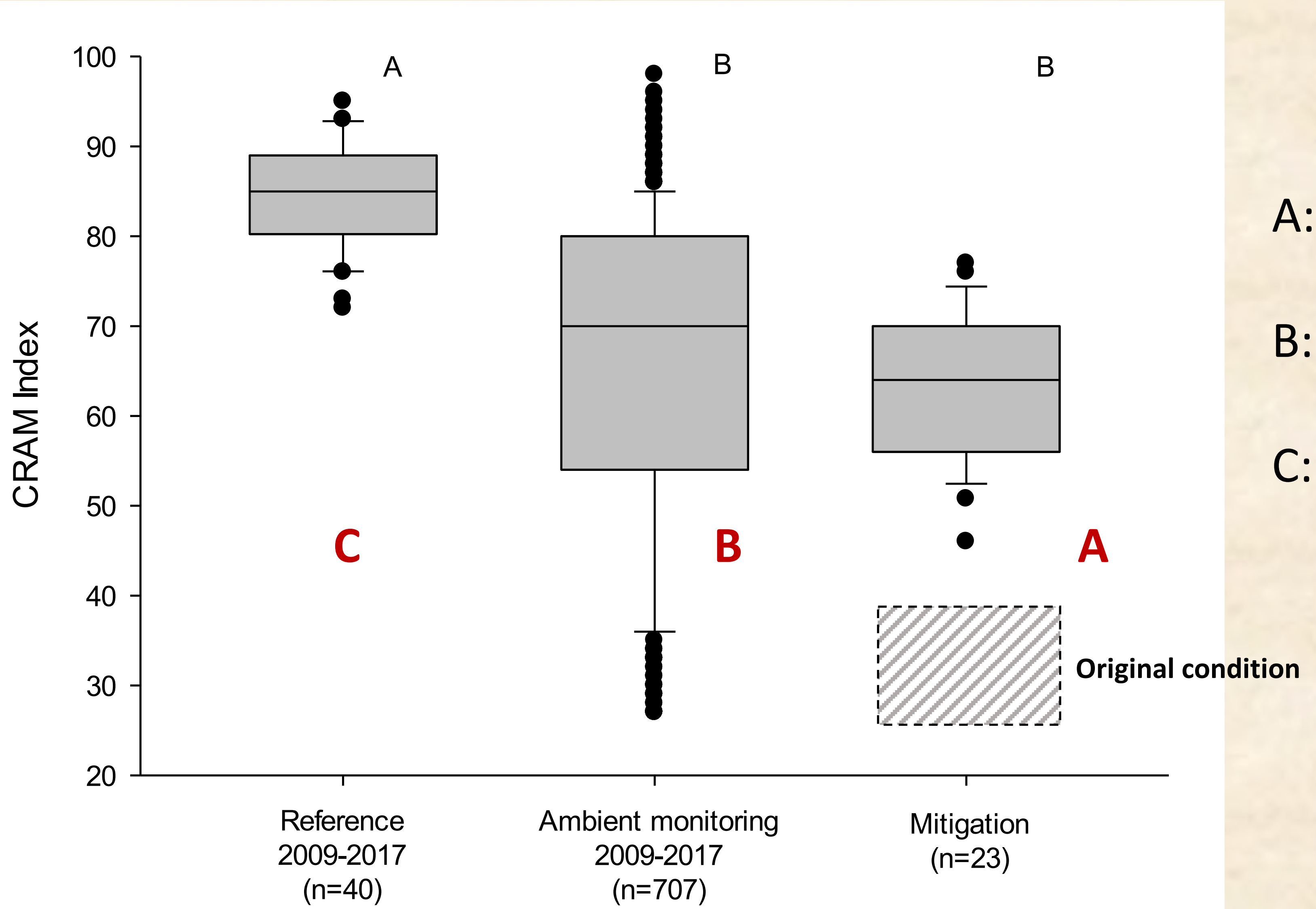


Figure 46. Mean percentage scores for each CRAM metric for mitigation sites (N=204) and reference sites (N=47).

Different Ways to Establish Performance Targets



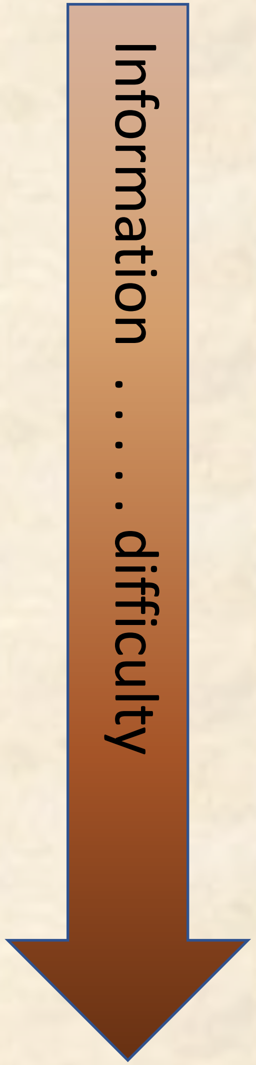
A: Improvement from baseline

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



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

Recommended Stream Indicators

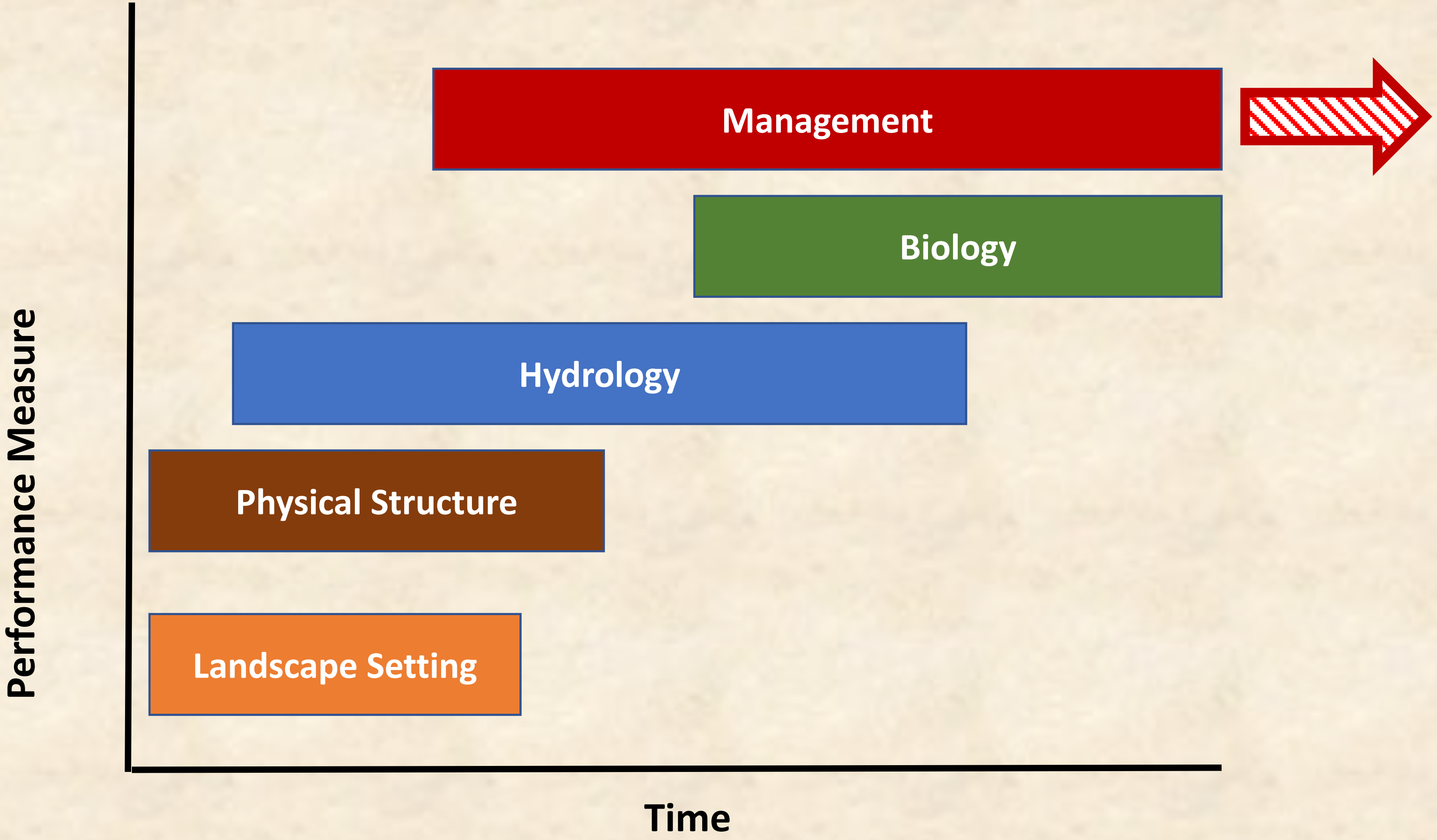
PHYSICAL INDICATORS

- Continuous flow (preferably through permanent instrumentation)
- Geomorphic condition, cross section and profile
- Floodplain connection
- Channel planform and evidence of migration
- Stage of channel evolution as well as bank height and angle
- Bedform diversity / instream habitat
- Evidence of sediment deposition or erosion

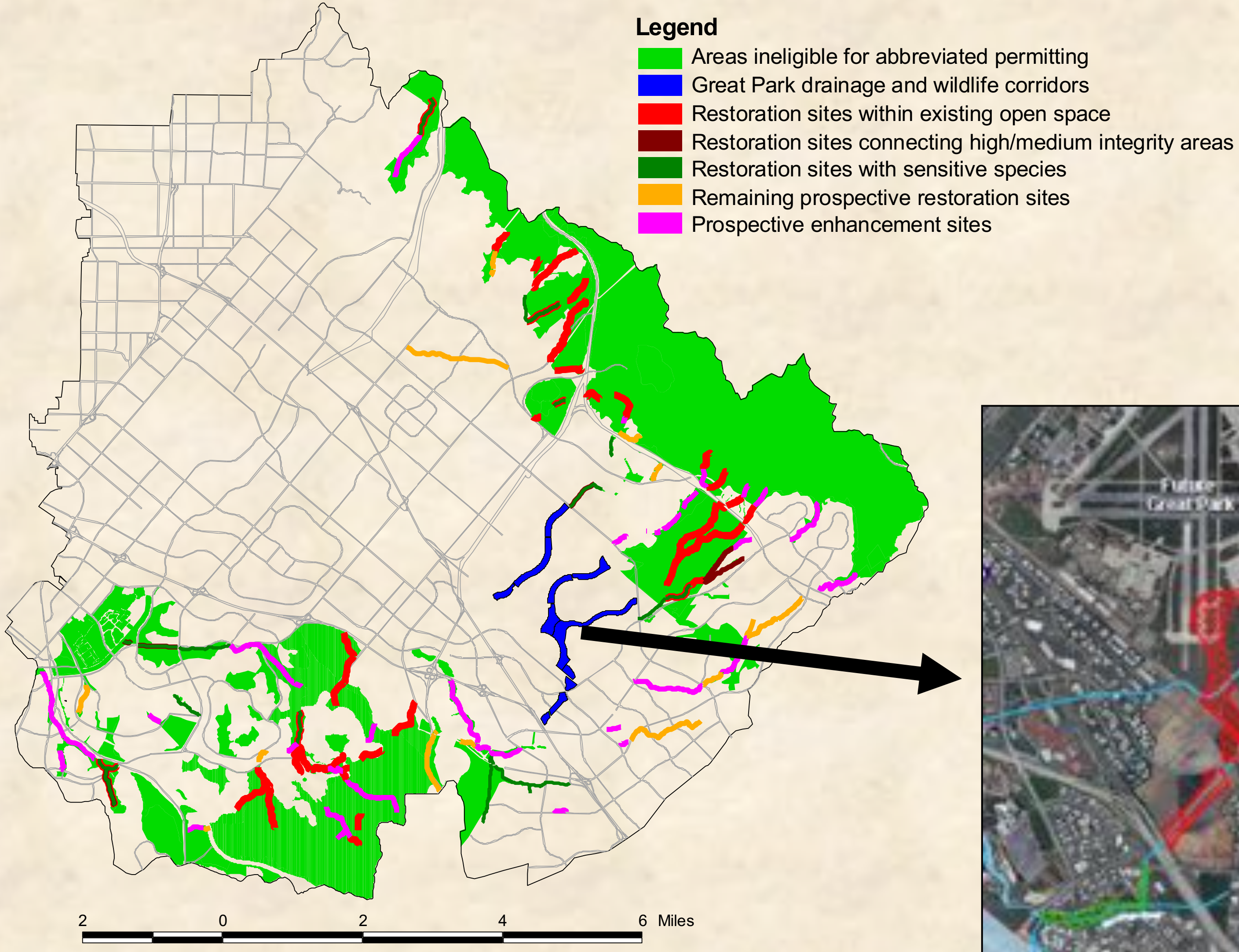
BIOLOGICAL INDICATORS

- Vegetation cover, community composition and structure
- Physical disturbance of the plant community
- Age stand distribution
- Evidence of recruitment
- Invasive plants
- Wildlife use and trophic structure
- Bioassessment indices based on benthic invertebrates, algae, fish, or amphibians

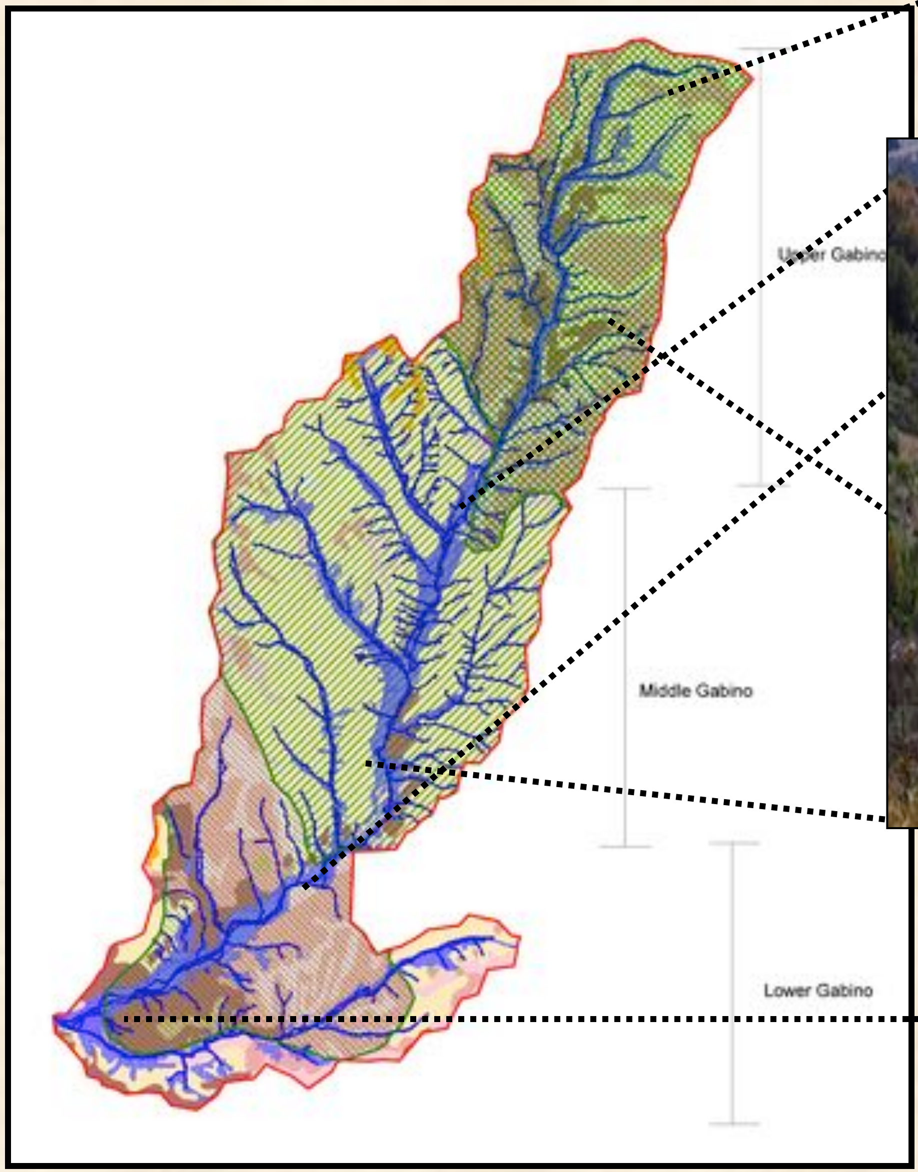
Tiered Performance Standards

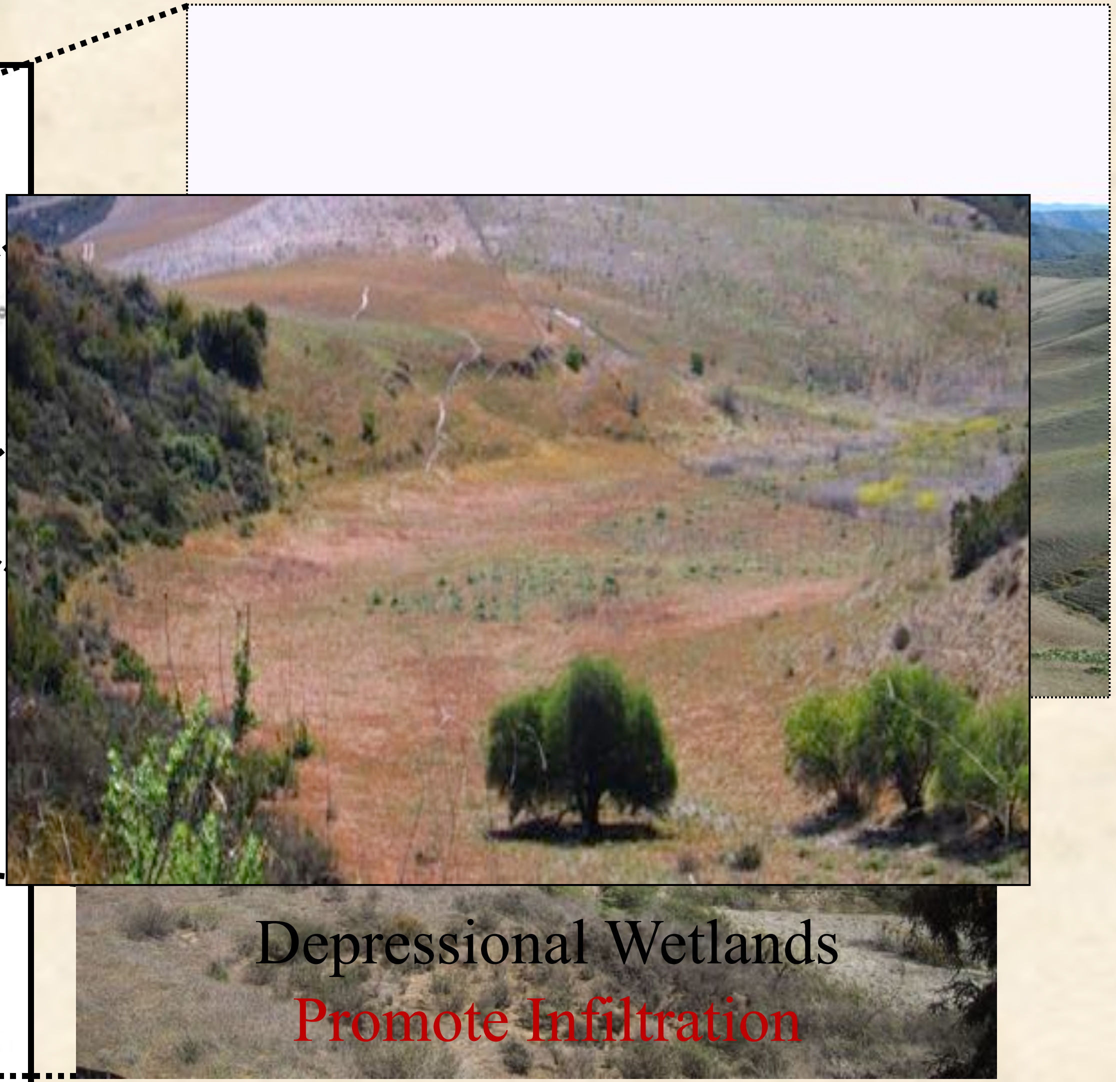


Landscape Setting:
San Diego Creek, California



Stream Restoration Based on Landscape Setting





Floodplain Restoration & Protection

Physical Setting/Design

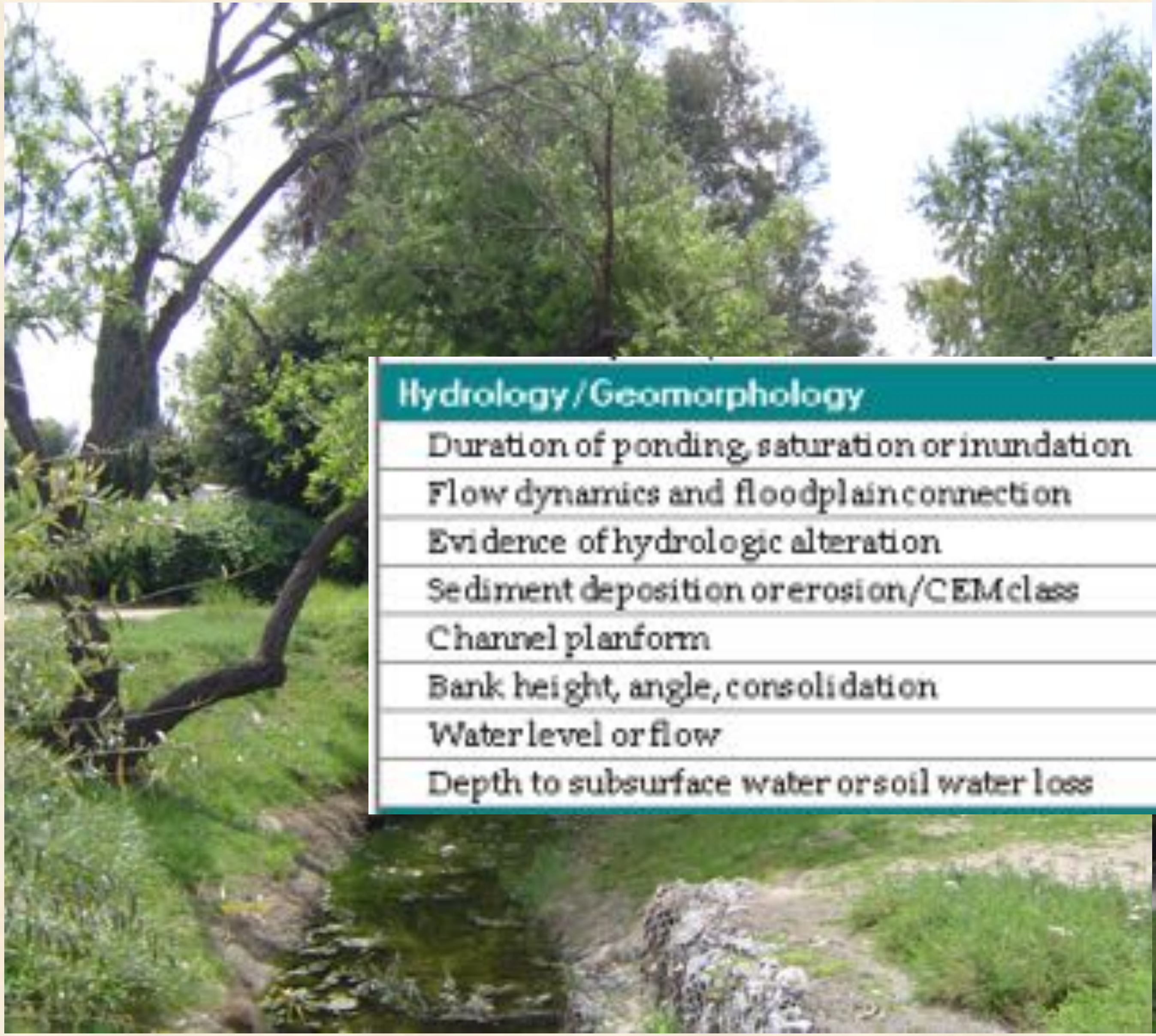
Appropriate elevation and morphology

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

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

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

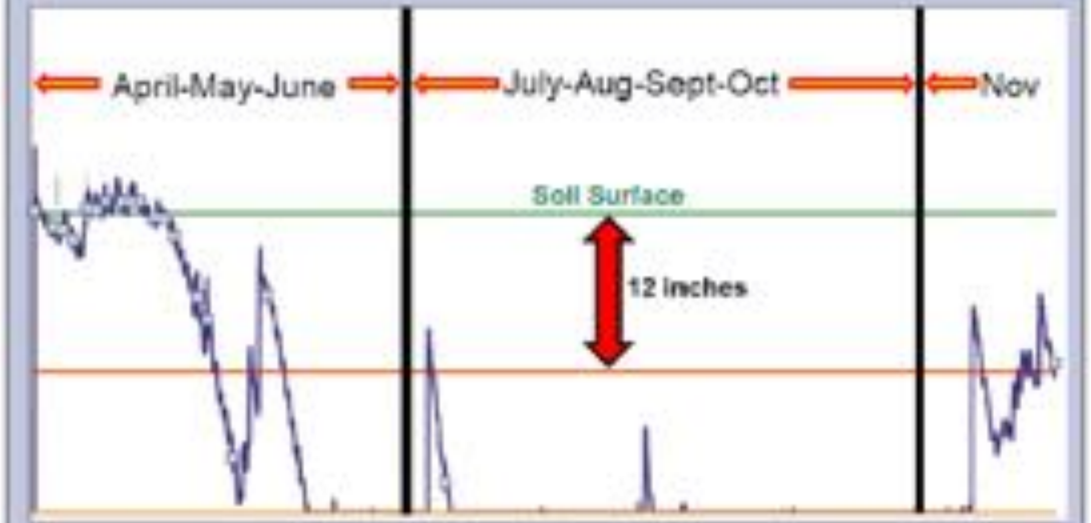
Hydrology Considerations

- 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)

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

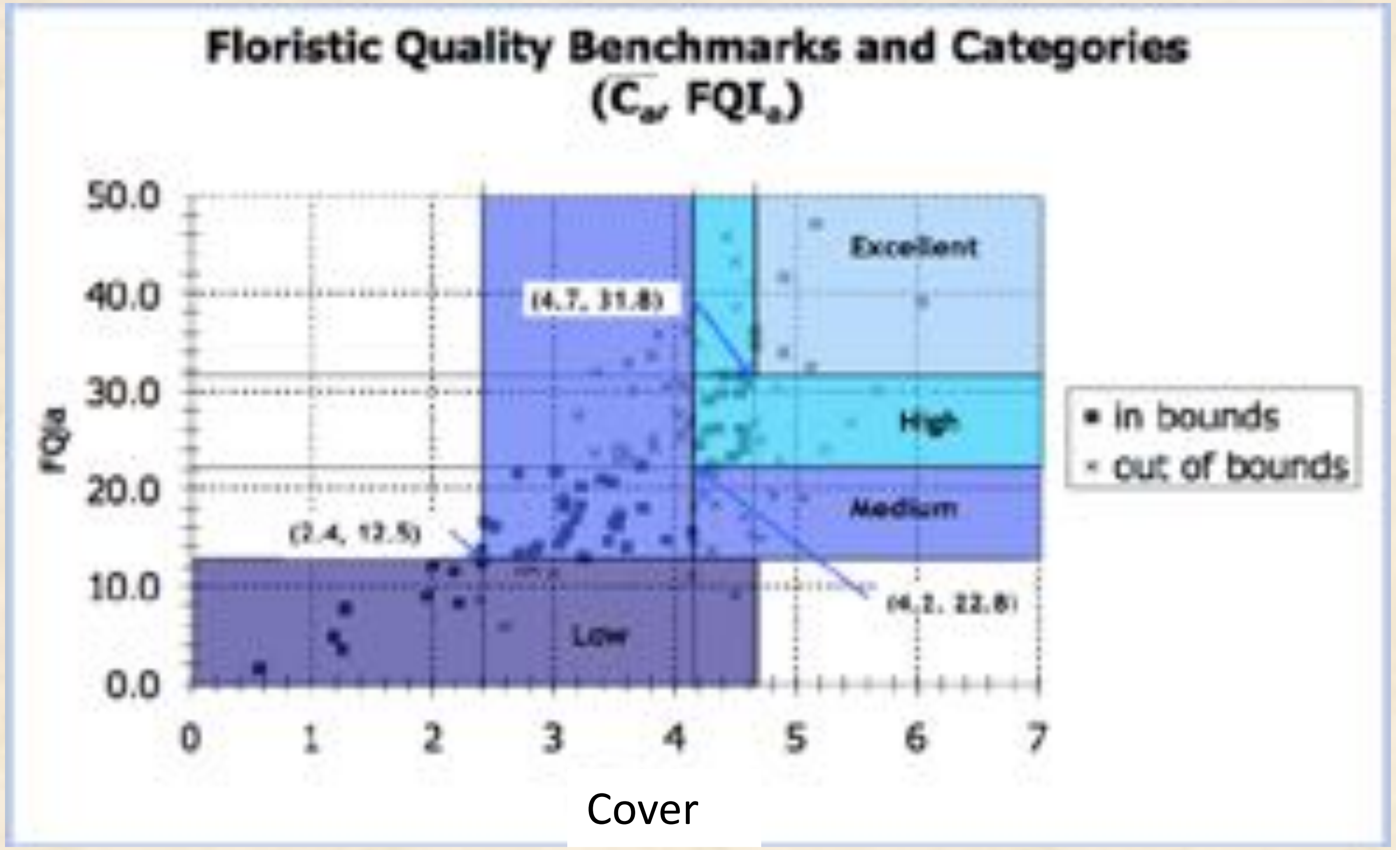
Considerations for Biotic Standards

- 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

Sample Biotic Standards

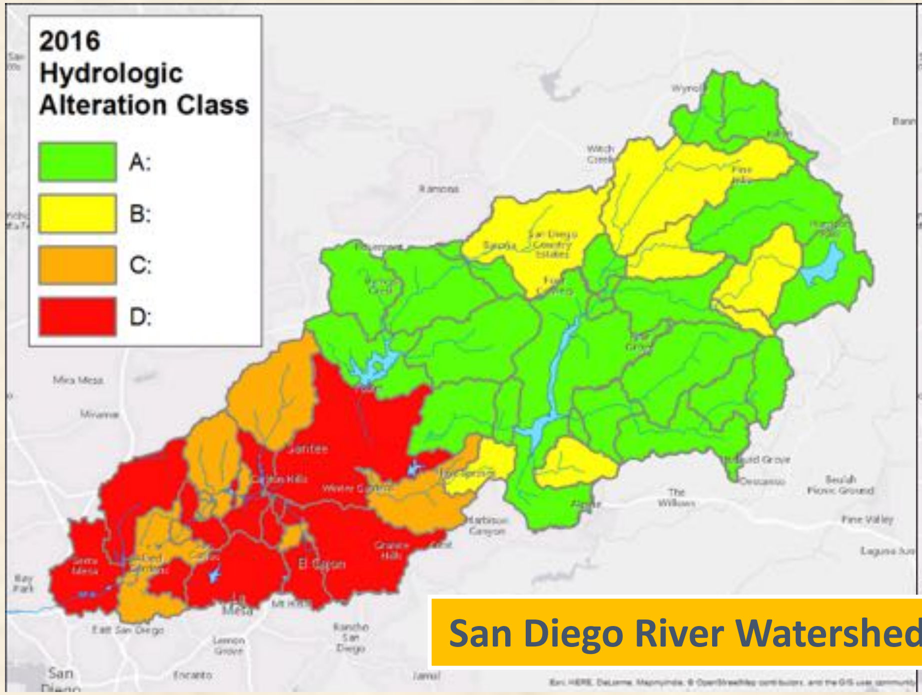
Vegetation
Vegetation cover
Community composition & structure
Physical disturbance of the plant community
Invasive plants
Age-stand distribution
Evidence of recruitment
FQAI (or equivalent)
Shoreline and littoral habitat extent

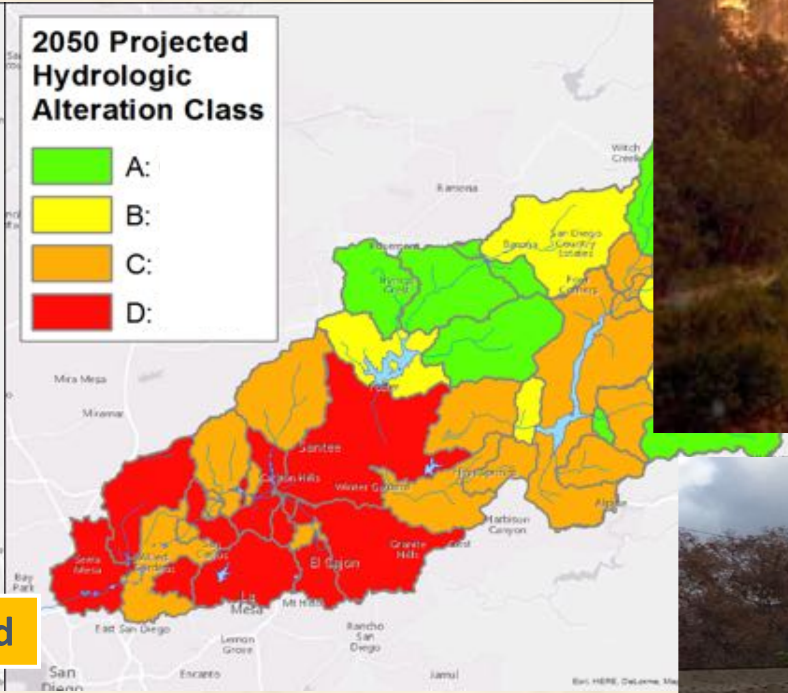
Bioassessment Indicators
Algal index (e.g., ibi, mmi)
Macroalgal extent
Benthic invertebrate index (e.g., ibi, mmi, o/e)
Amphibian index
Fish community index
Evidence of wildlife/bird use



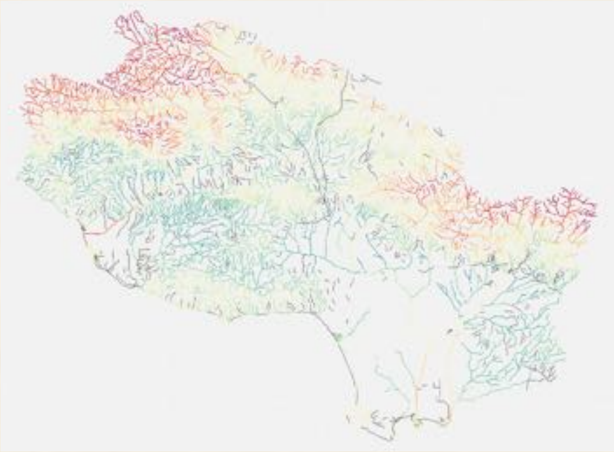
State of Wisconsin

Account for Changes Over Time

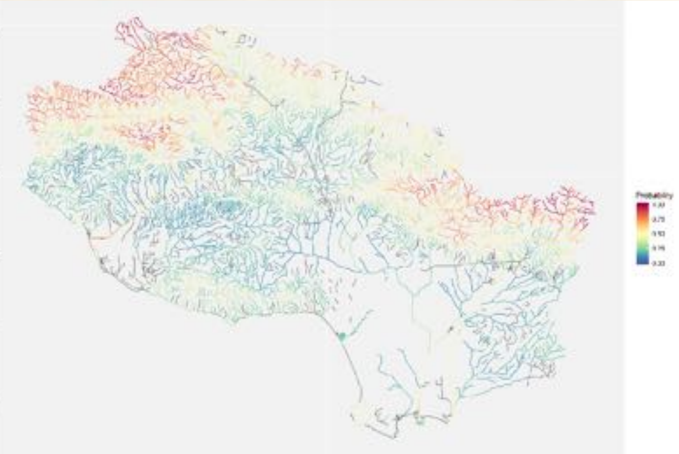




San Diego River Watershed



Baseline - 2010



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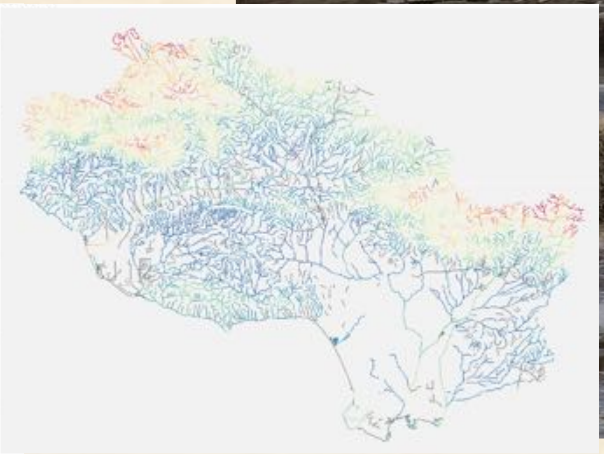
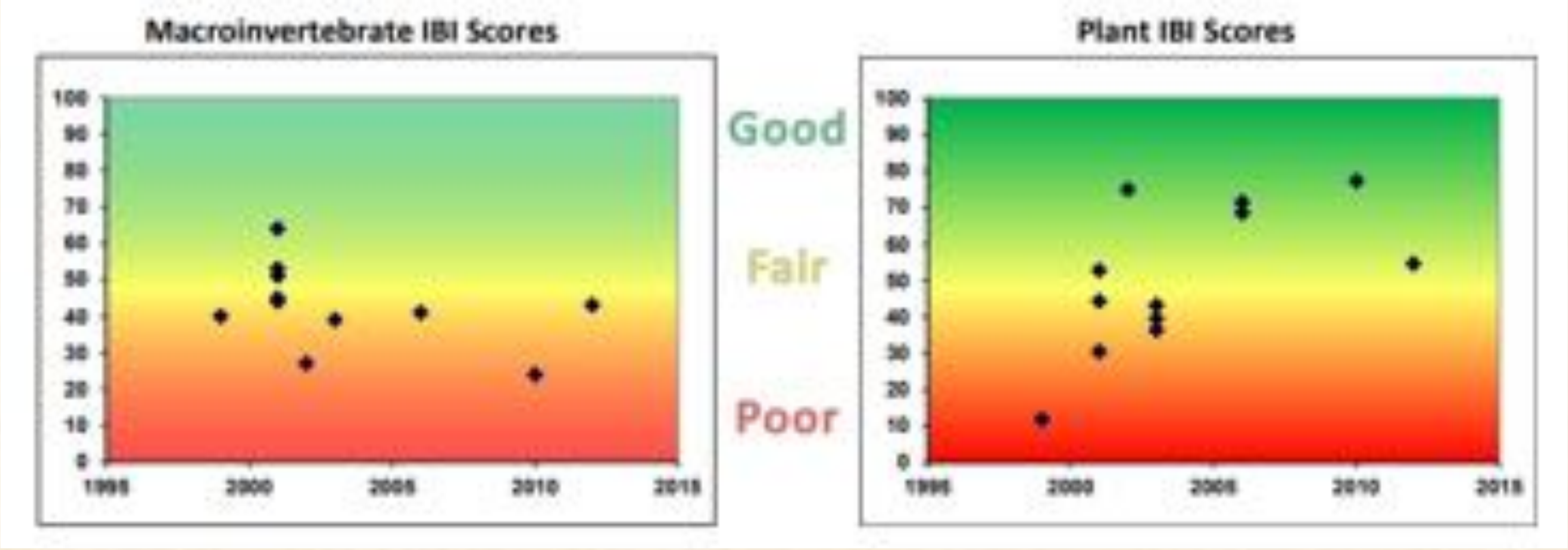


2100

Resilient Performance Standards

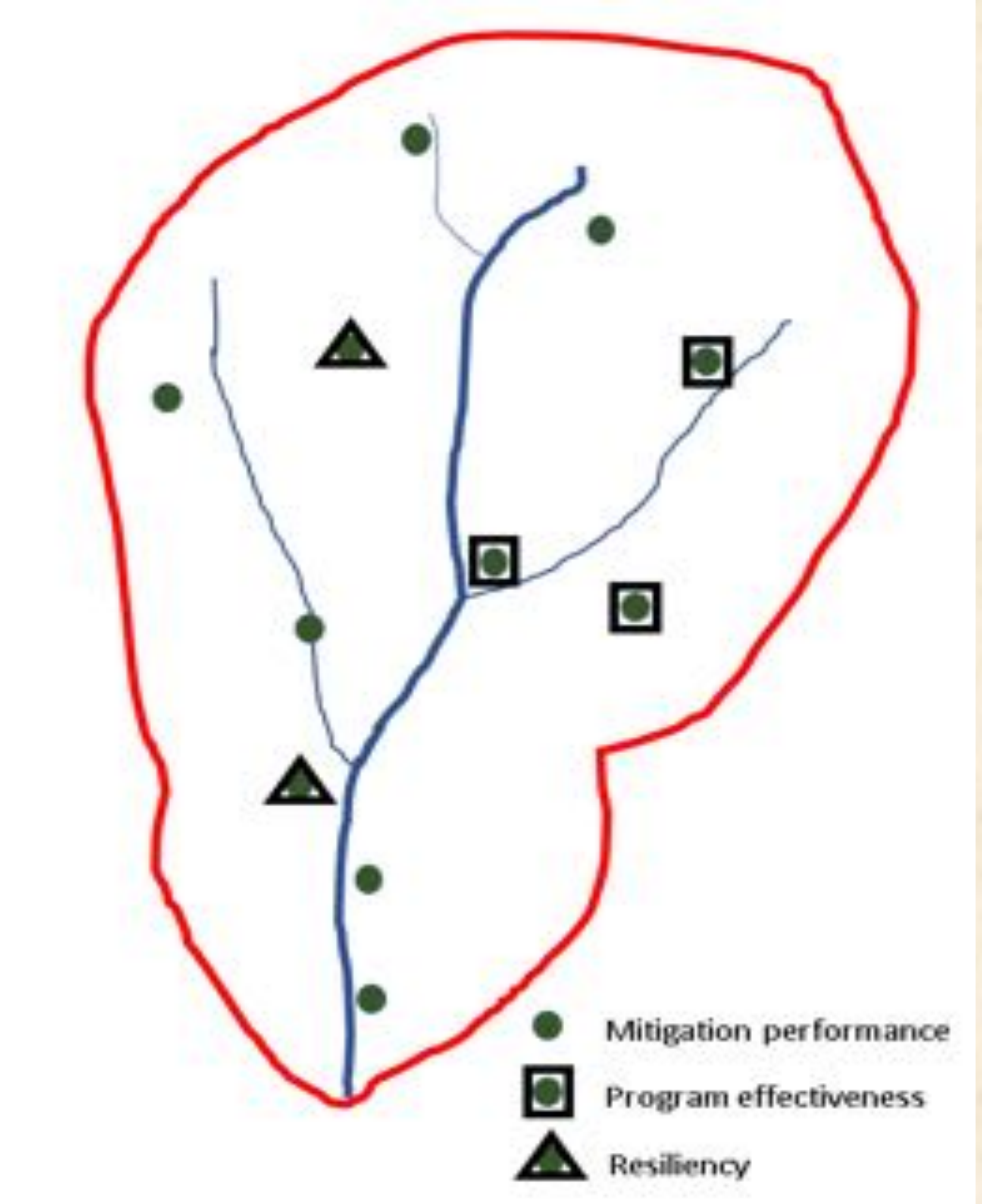
- Long-term sentinel monitoring sites
- Compare changes at mitigation bank/site to regional patterns
- Adjust standards over time relative to sentinel locations
    - ✓ ***"benthic macroinvertebrate IBI within 10% of mean 3-year average at sentinel sites within the watershed"***

NEED commitment to long-term monitoring



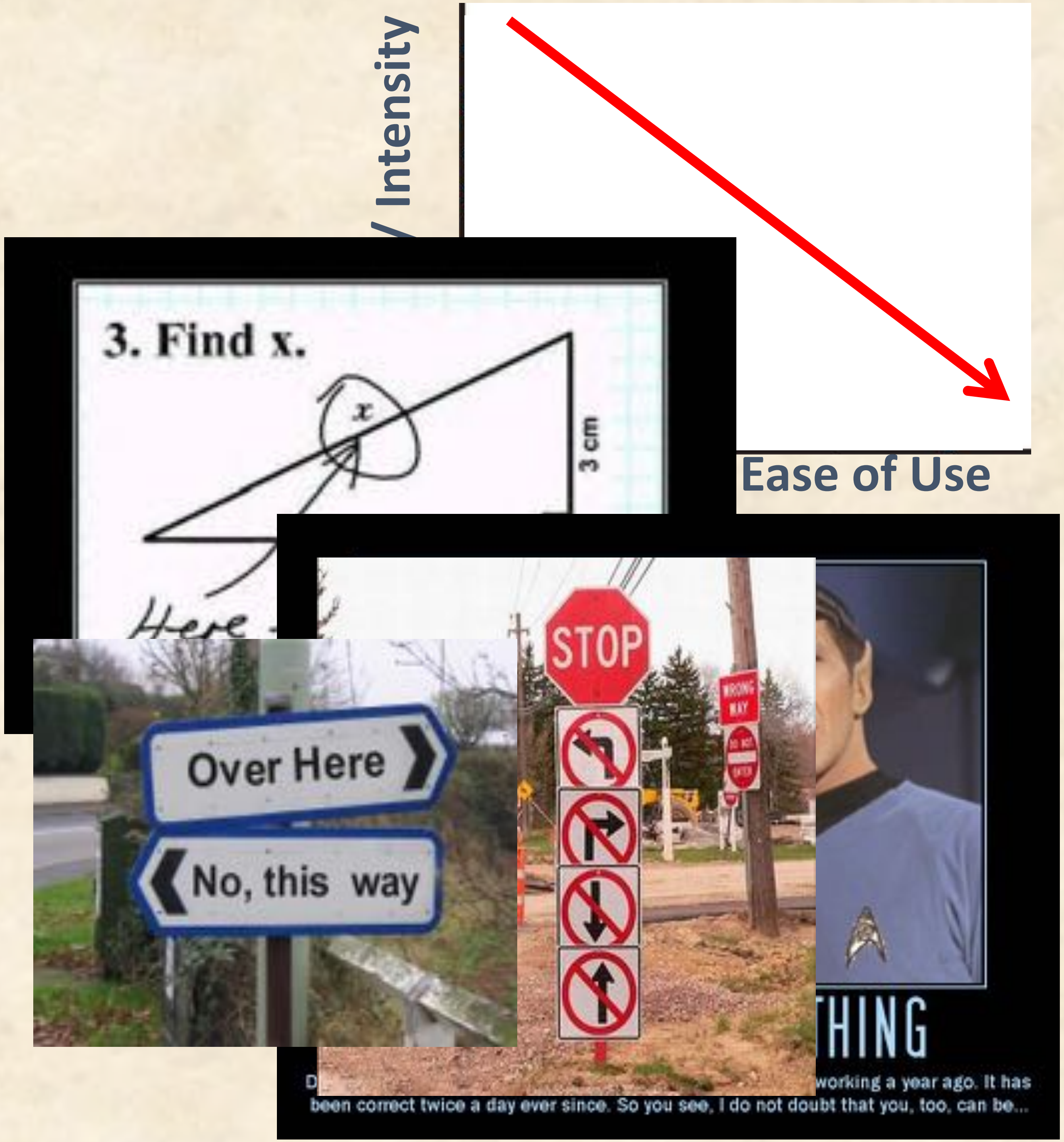
Leveraging Opportunities

- Incorporate sentinel sites into ambient monitoring programs (e.g. Section 305 b)
- Establish regional reference networks as part of state/regional monitoring
  - ✓ILF and mitigation banks
- Partner with status and trends programs
- Establish long-term endowments or other funding mechanisms



Closing Thoughts

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



Thank You

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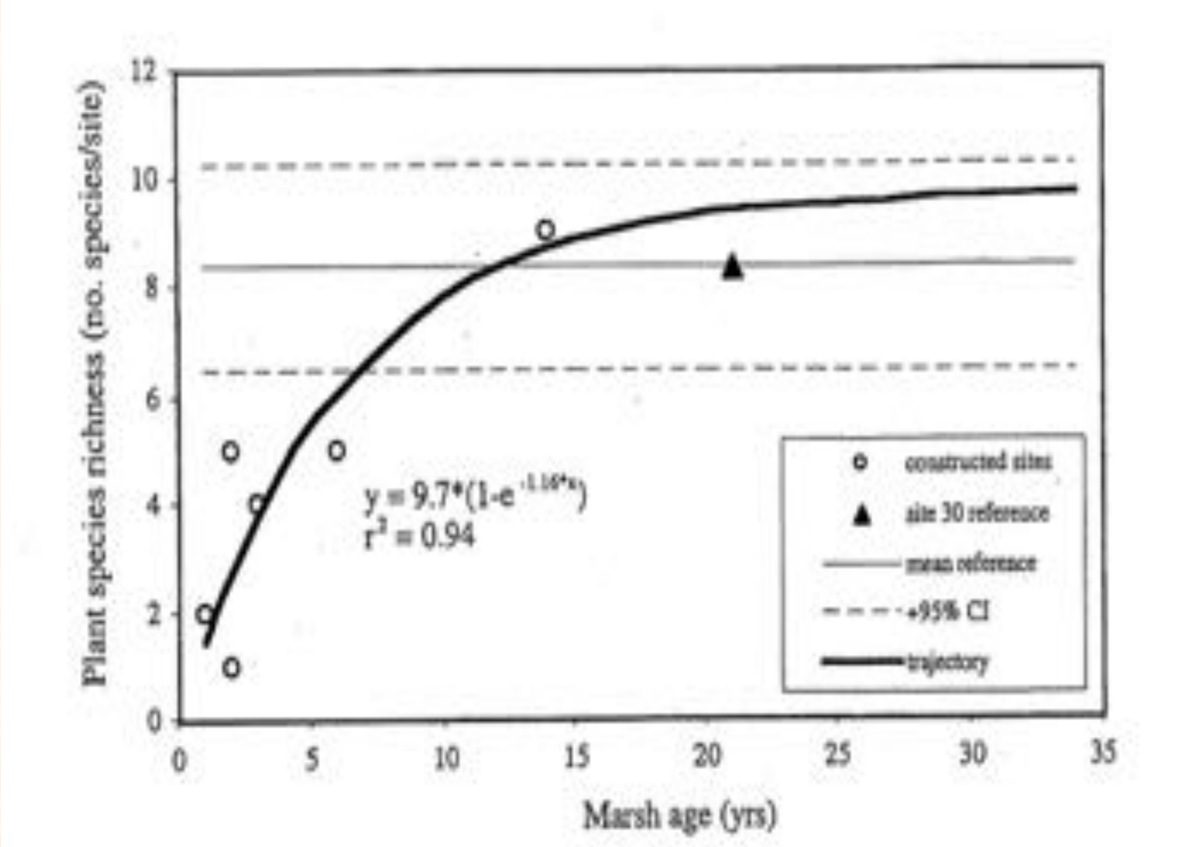
EXTRA SLIDES

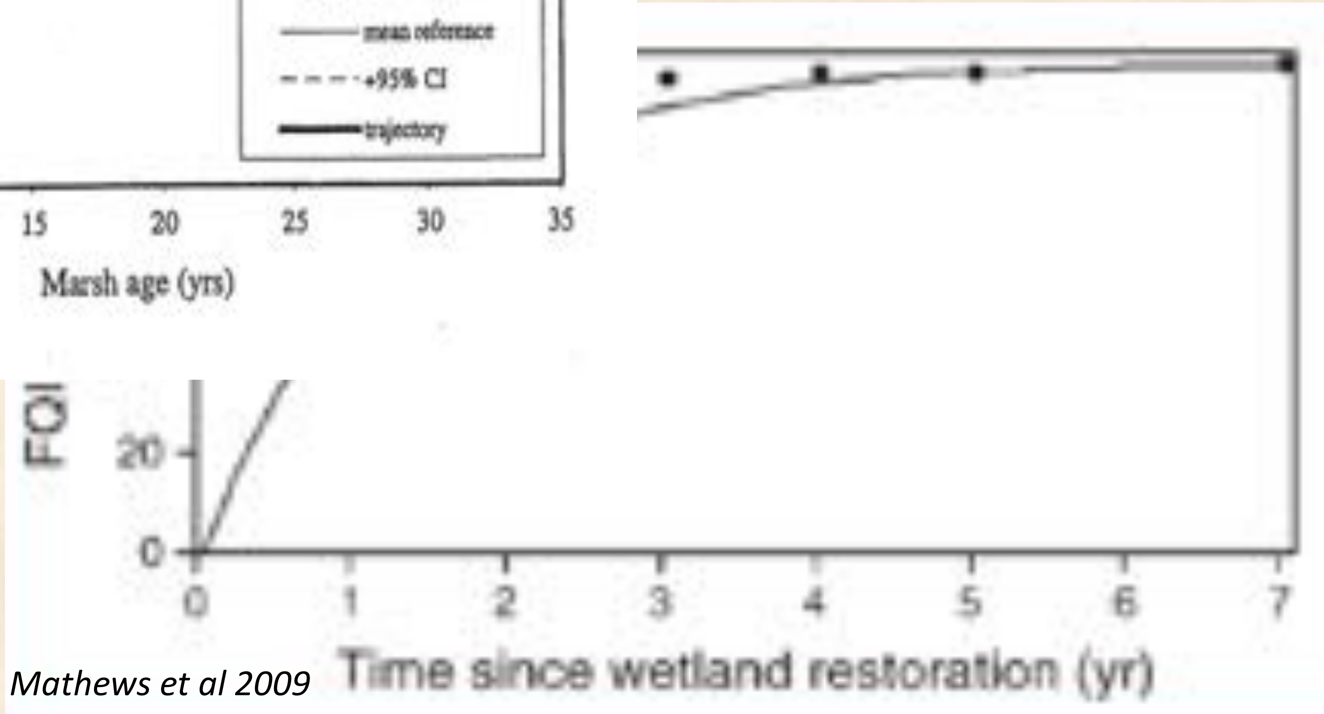
The Big Picture on Performance Standards

- 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

Restoration Trajectories

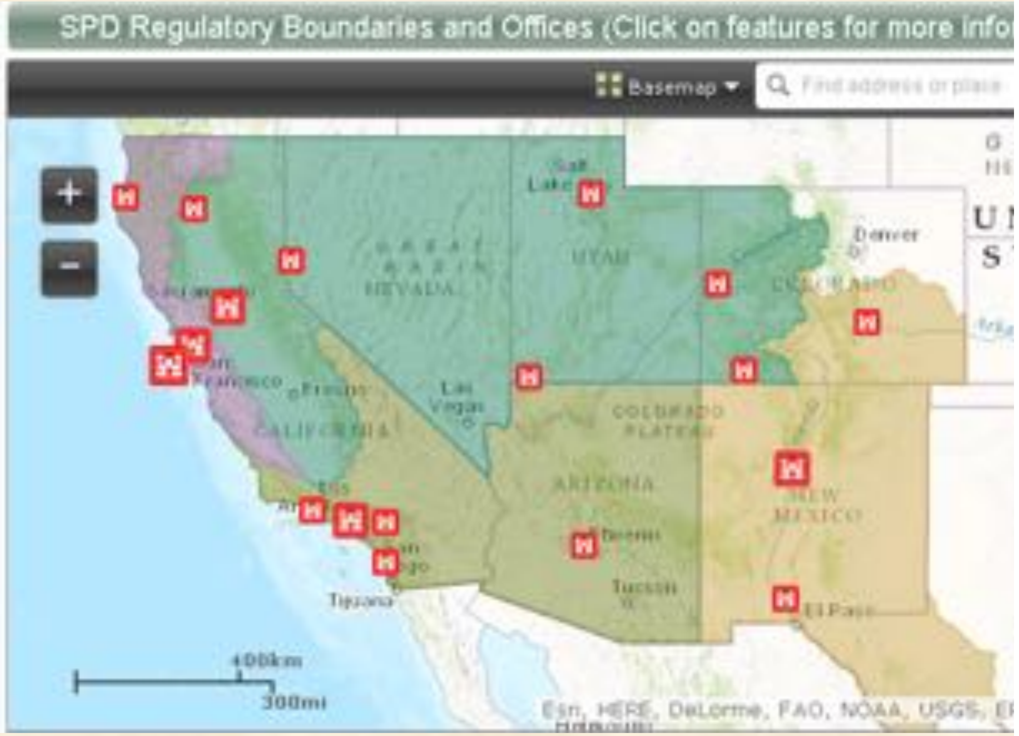


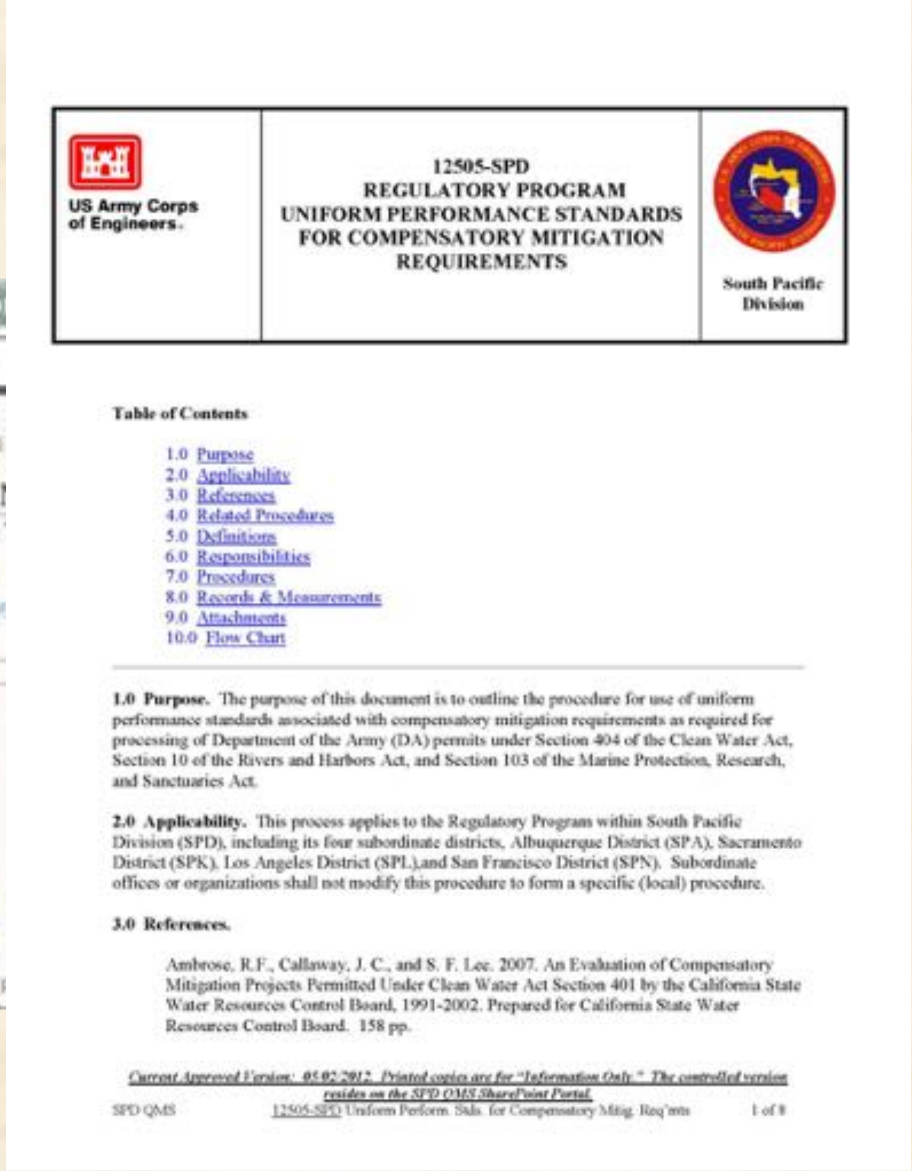
Morgan and Short 2002



Mathews et al 2009

Uniform Performance Standards for Compensatory Mitigation Requirements





US Army Corps of Engineers.

12505-SPD
REGULATORY PROGRAM
UNIFORM PERFORMANCE STANDARDS FOR COMPENSATORY MITIGATION REQUIREMENTS

South Pacific Division

Table of Contents

1.0 Purpose. The purpose of this document is to outline the procedure for use of uniform performance standards associated with compensatory mitigation requirements as required for processing of Department of the Army (DA) permits under Section 404 of the Clean Water Act, Section 10 of the Rivers and Harbors Act, and Section 103 of the Marine Protection, Research, and Sanctuaries Act.

2.0 Applicability. This process applies to the Regulatory Program within South Pacific Division (SPD), including its four subordinate districts, Albuquerque District (SPA), Sacramento District (SPK), Los Angeles District (SPL),and San Francisco District (SPN). Subordinate offices or organizations shall not modify this procedure to form a specific (local) procedure.

3.0 References.

Ambrose, R.F., Callaway, J. C., and S. F. Lee. 2007. An Evaluation of Compensatory Mitigation Projects Permitted Under Clean Water Act Section 401 by the California State Water Resources Control Board, 1991-2002. Prepared for California State Water Resources Control Board. 158 pp.

Finalized May, 2012, covers 4 Corps Districts

Uniform Performance Standards Features

Types of Performance Standards

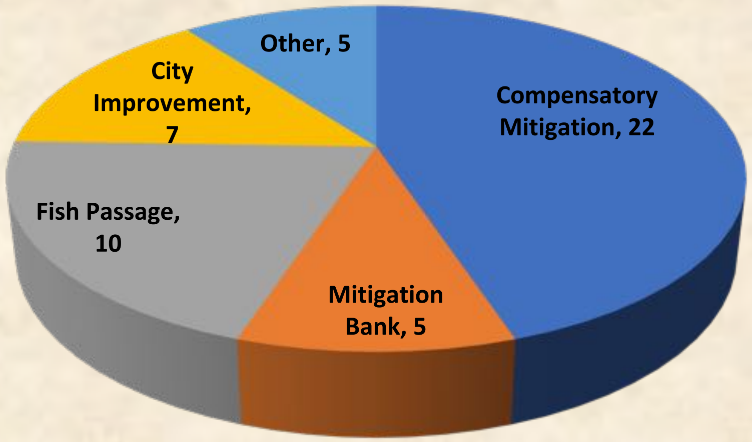
- Physical
- Hydrologic
- Faunal & Flora-Diversity
- Water quality (ecological vs. human health)

Features

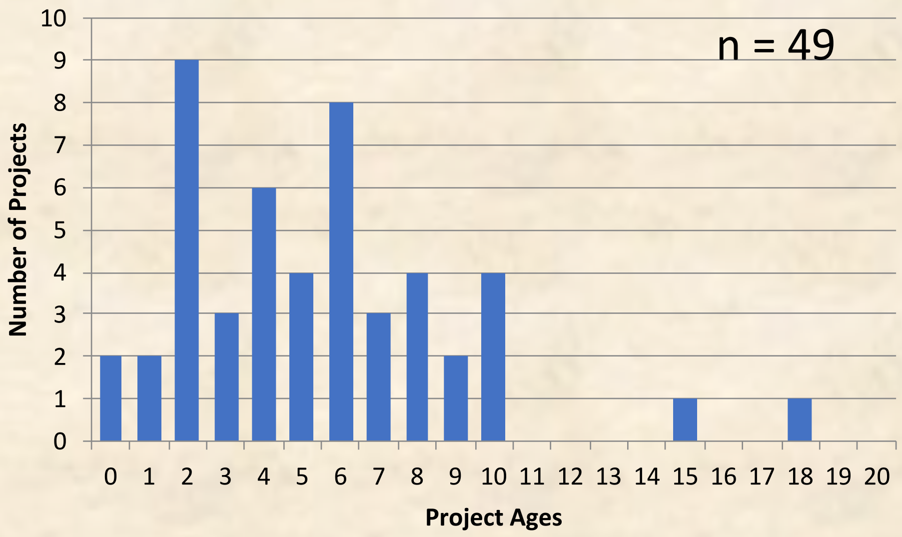
- Ecologically-based performance standards
- Incorporation of reference sites
- Incorporation of functional/condition assessments
- Allows for tiered/incremental implementation of standards

CA Performance Curve Development

- Collect CRAM data:
  - Restoration projects of various ages
  - Reference sites
  - Sites that have naturally evolved



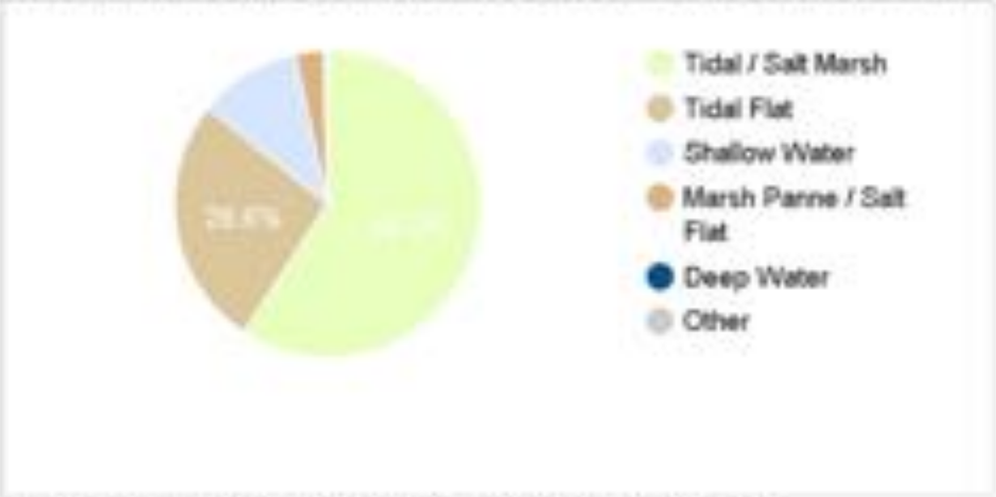
- Develop performance curves



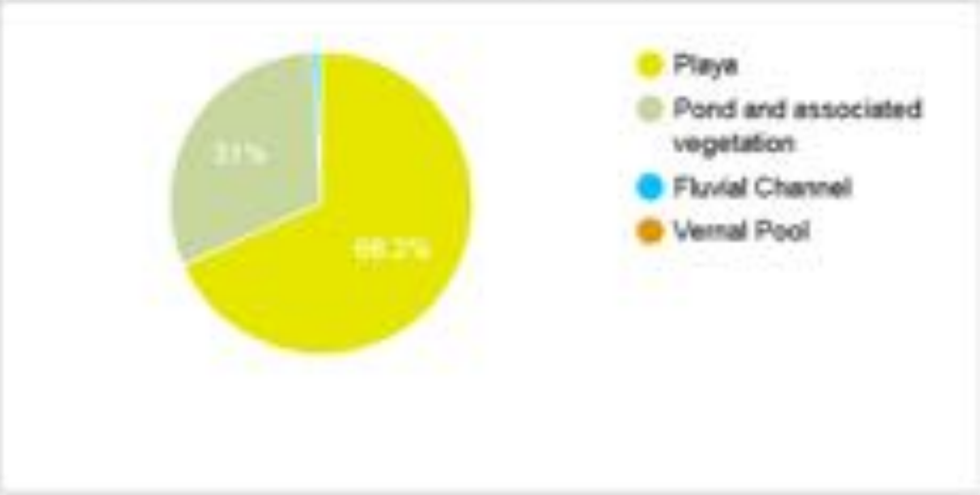
- Test restoration project performance with data not used for curve development

Marine and Estuarine Resources: 52,769 acres / 82.5 miles²

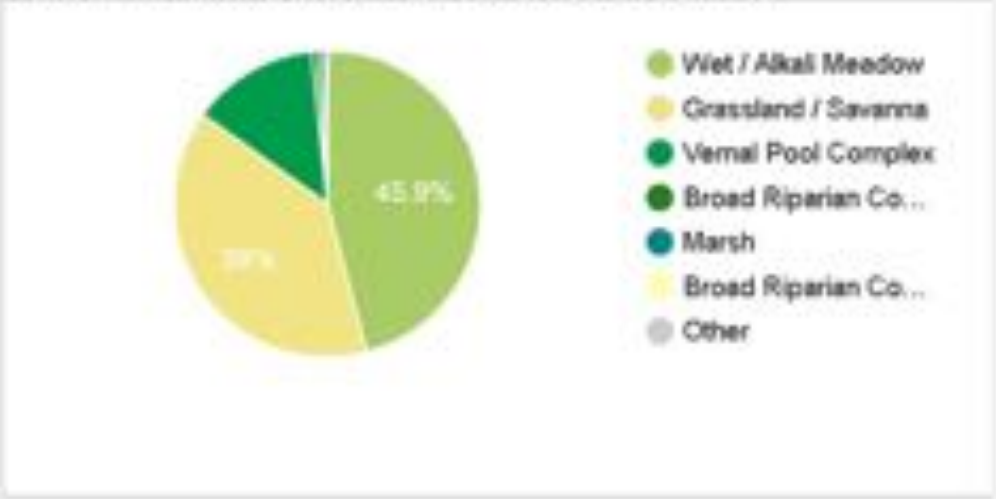
Historical Marine and Estuarine Resources: 94,383 acres / 147 miles²



Palustrine Resources: 8,028 acres / 12.5 miles²



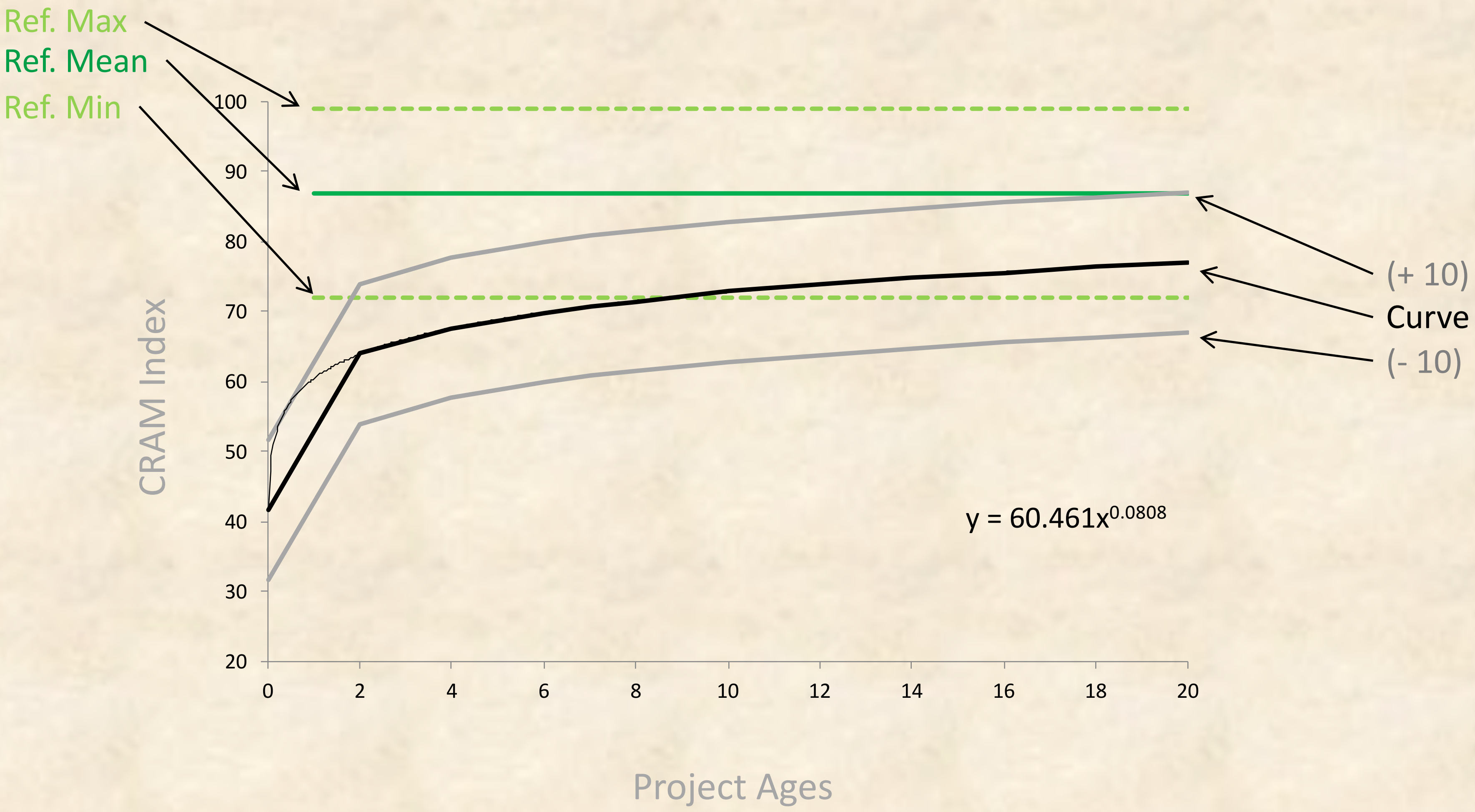
Historical Palustrine Resources: 1,952 acres / 3 miles²



Rivers, Streams, and Other Channel Resources: 736 miles

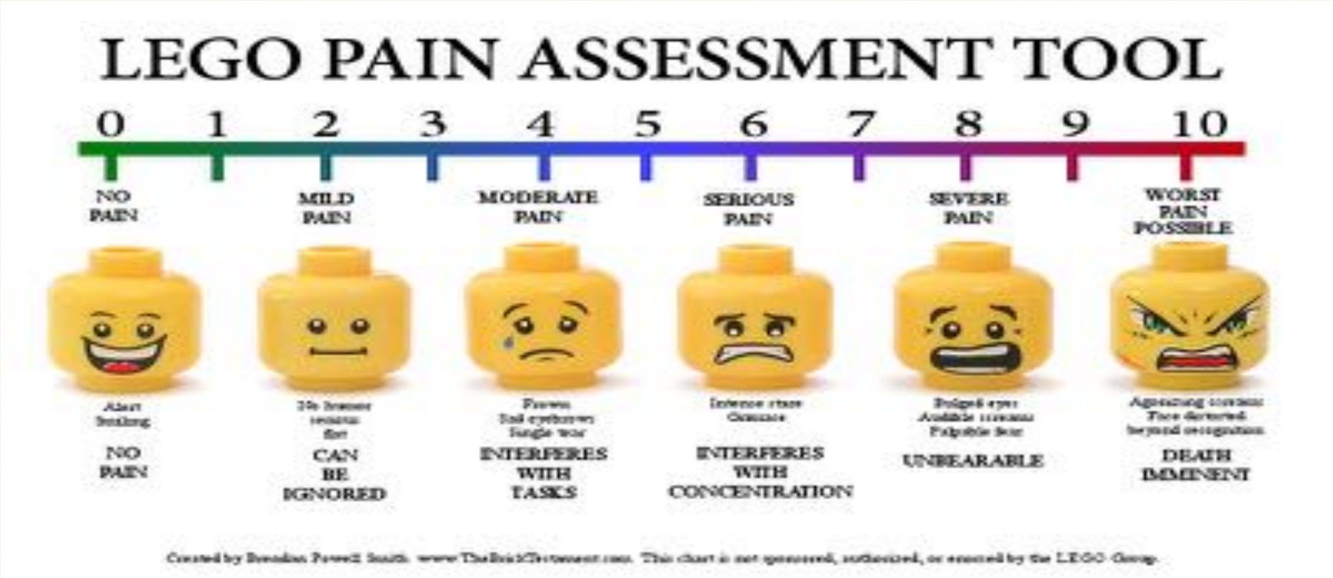
- Fluvial: 84 miles
- Tidal: 652 miles

Performance Curve



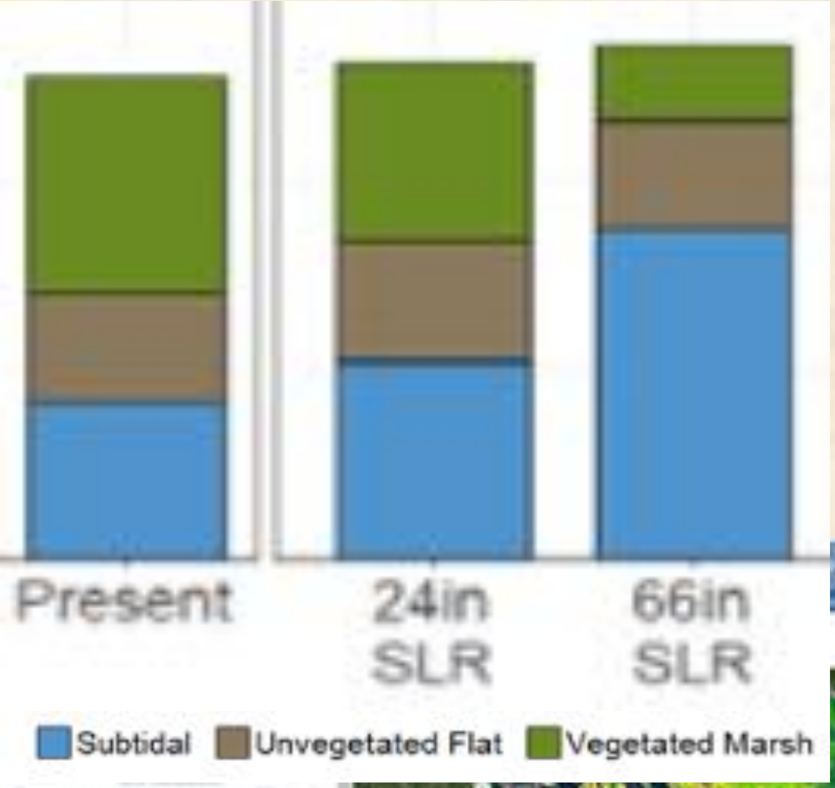
Riverine Performance Curves

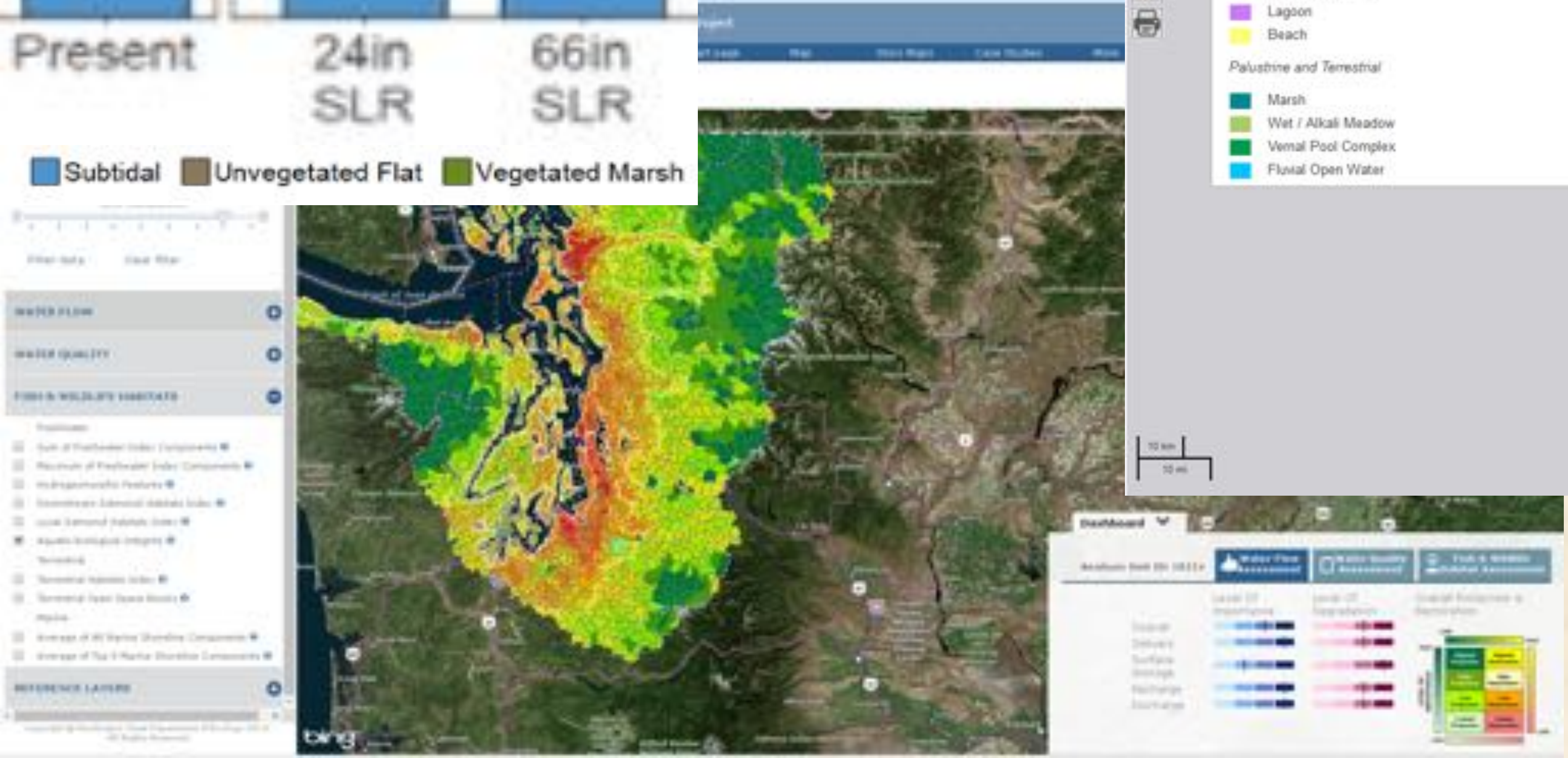
Wadeable Streams

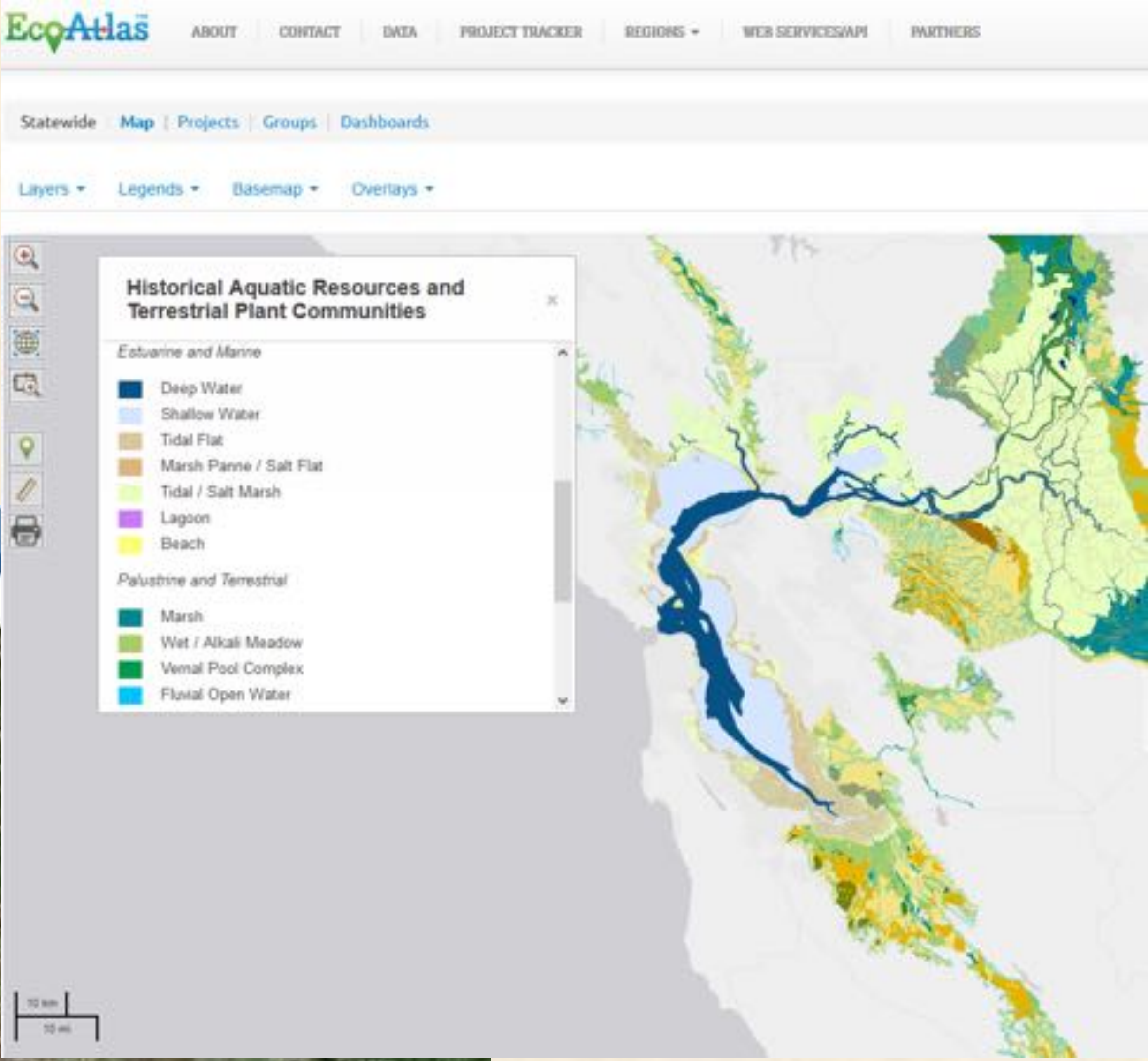


Stream Restoration

Tools Vary by Wetland Type


Present
24in SLR
66in SLR
Subtidal
Unvegetated Flat
Vegetated Marsh


Dashboard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Layers
Legends
Basemap
Overlays
Historical Aquatic Resources and Terrestrial Plant Communities
Estuarine and Marine
Deep Water
Shallow Water
Tidal Flat
Marsh Panne / Salt Flat
Tidal / Salt Marsh
Lagoon
Beach
Palustrine and Terrestrial
Marsh
Wet / Alkali Meadow
Vernal Pool Complex
Fluvial Open Water

Putting it All Together




Physical site design | Hydrology | Plant community

Long-term monitoring

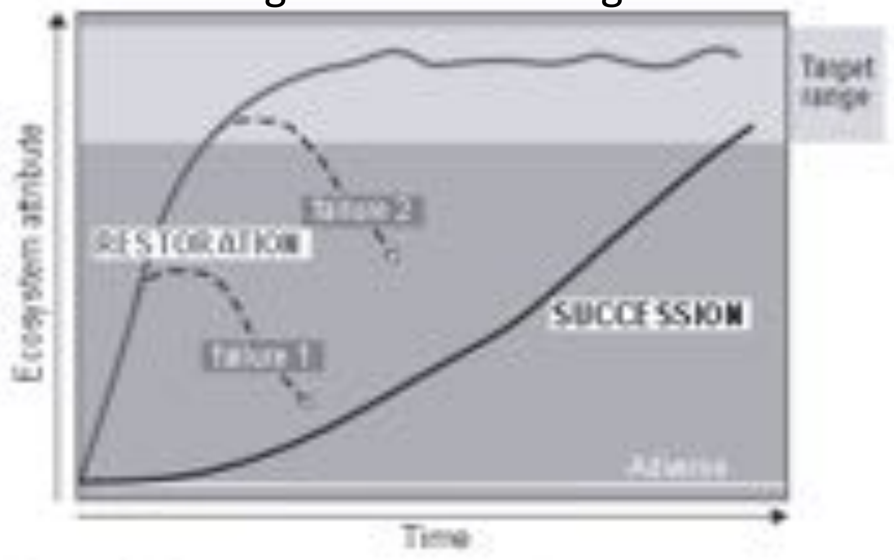
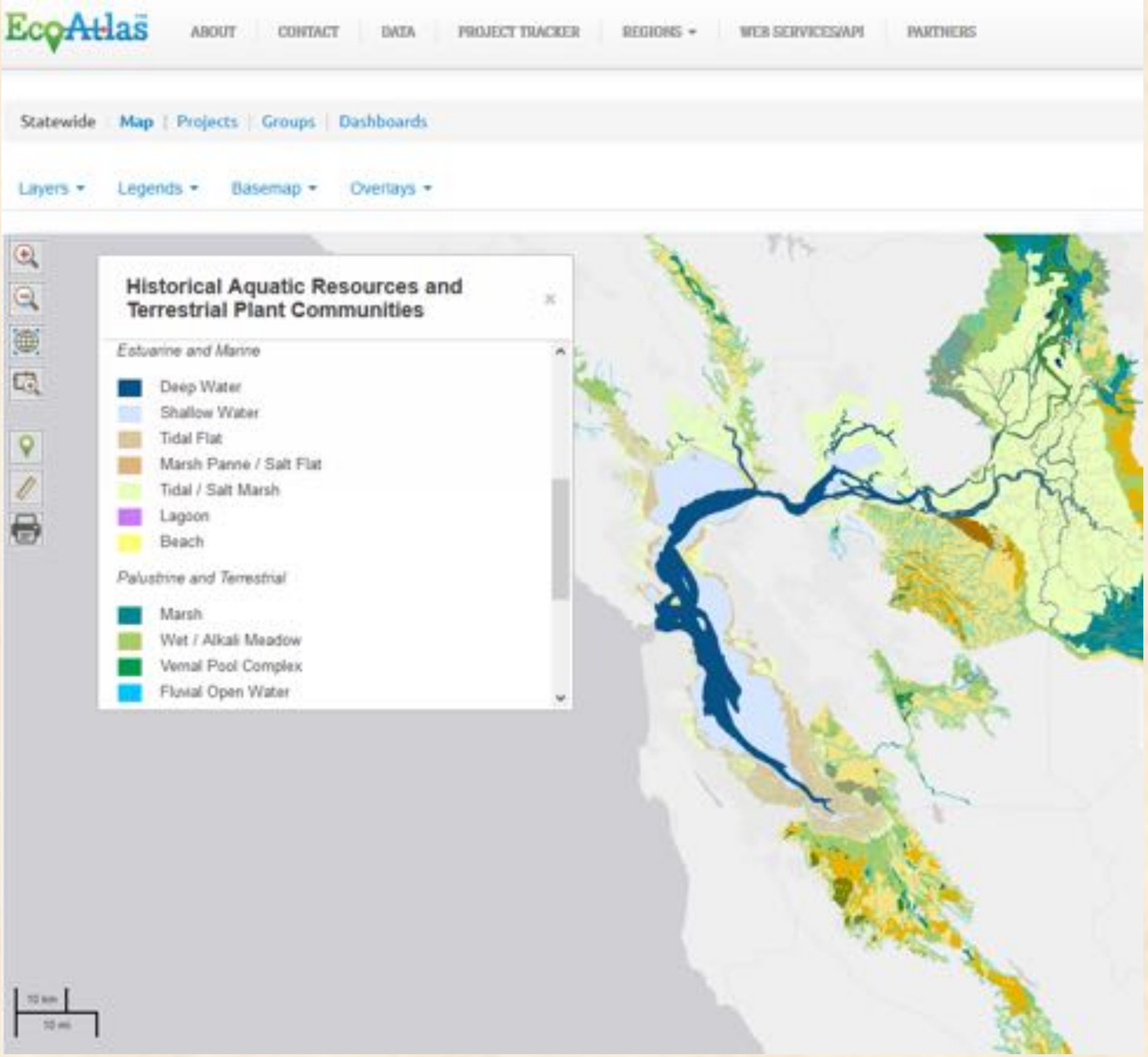
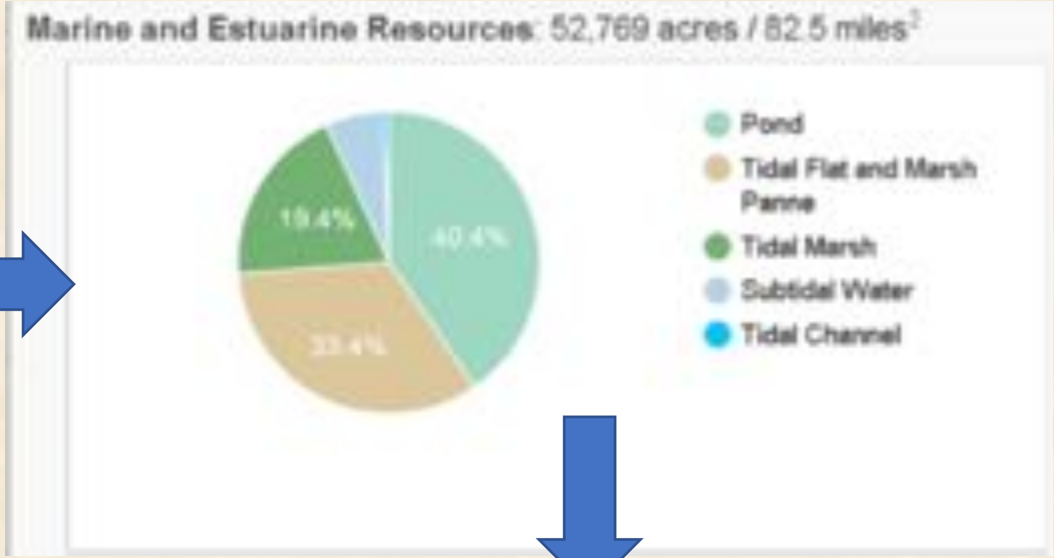


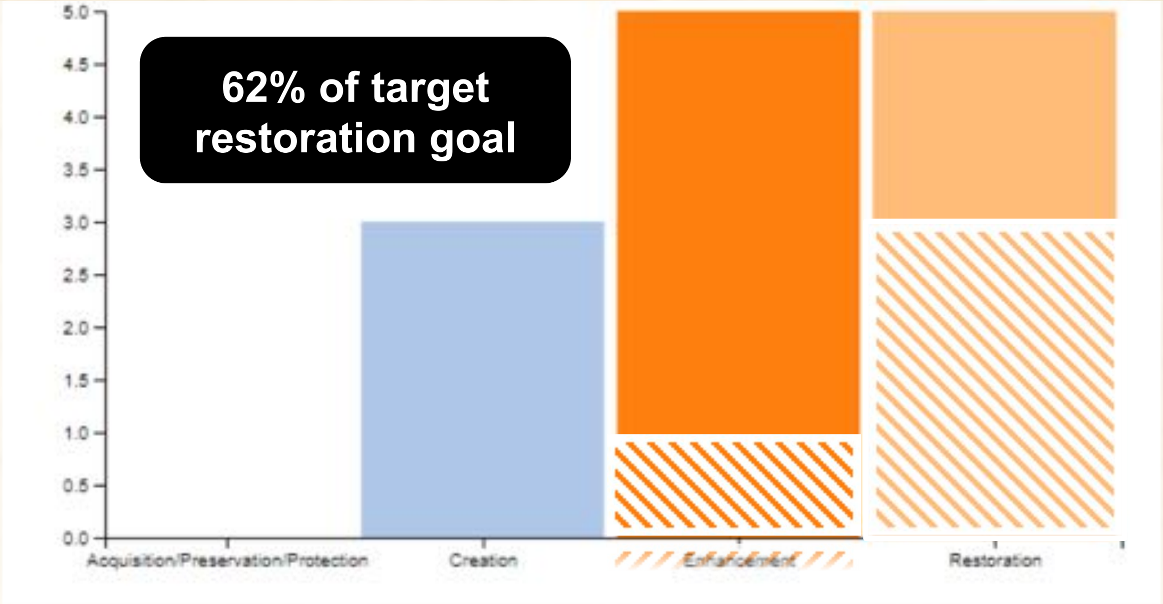
Fig. 1.7 Restoration success in relation to time: failures go undetected without appropriate monitoring.

Harris and Van Diggelen 2006

Targets Based on Landscape Profiles

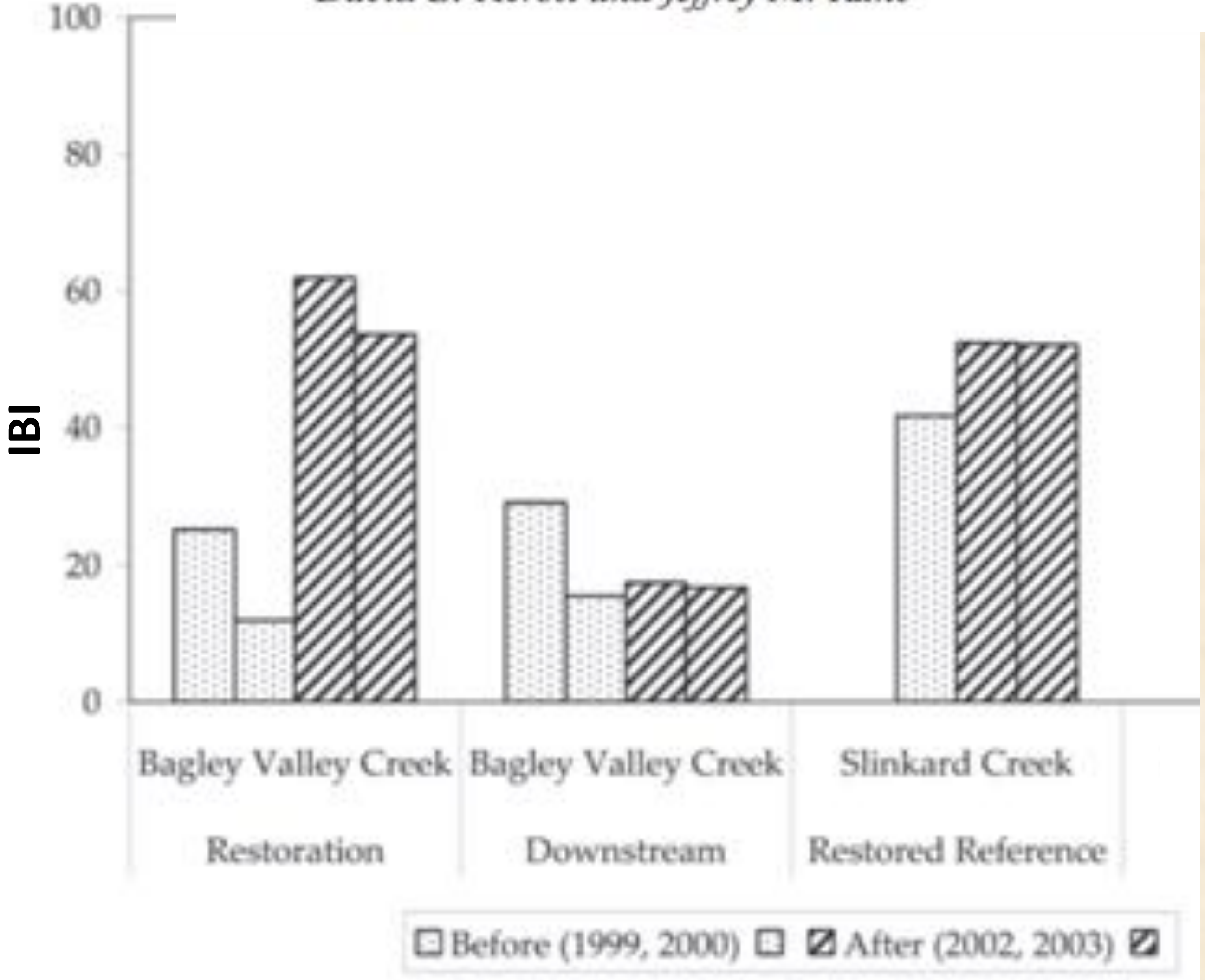






Responses of Aquatic Macroinvertebrates to Stream Channel Reconstruction in a Degraded Rangeland Creek in the Sierra Nevada

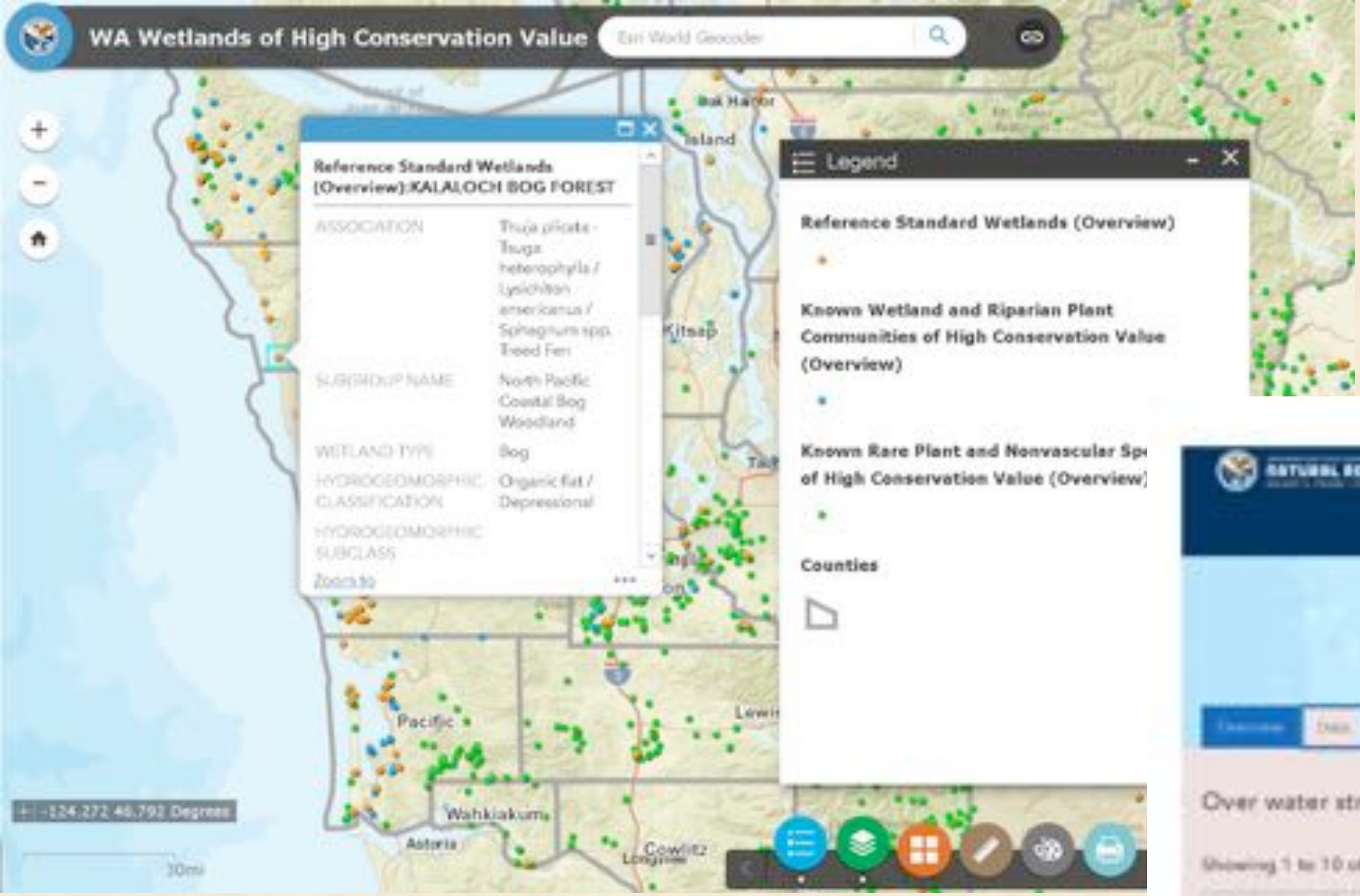
David B. Herbst and Jeffrey M. Kane

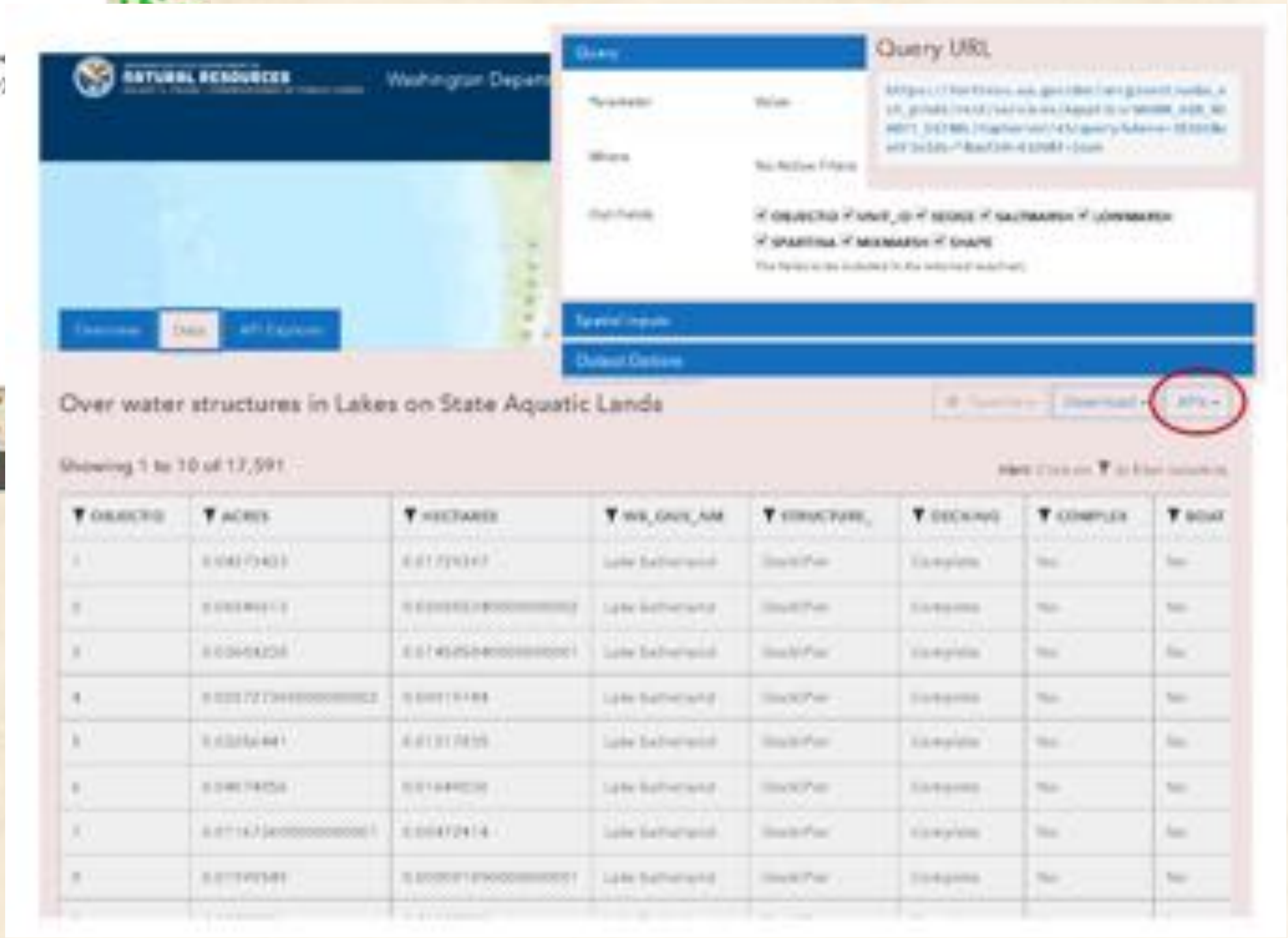


Index of Biotic Integrity (IBI) is an integrative indicator of water quality

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 Sp
of High Conservation Value (Overview)
Counties
Kitsap
Pacific
Wahkiakum
Astoria
Cowlitz
Longview
-124.272 46.792 Degrees
30mi


NATURAL RESOURCES
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EVERYTHING IS
TERRIBLE!


EVERYTHING IS
AWESOME!