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 known (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
What is Successful Mitigation??

Compensatory Mitigation Performance: The State of the Science

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

Ambrose et al. 2006
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
Figure 4.6. Mean percentage scores for each CRAM metric for mitigation sites (N=204) and reference sites (N=47).
Targets Based on Landscape Profiles

62% of target restoration goal
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
Tiered Performance Standards

- Management
- Biology
- Hydrology
- Physical Structure
- Landscape Setting
Landscape Setting:
San Diego Creek, California

Legend
- **Green** Areas ineligible for abbreviated permitting
- **Blue** Great Park drainage and wildlife corridors
- **Red** Restoration sites within existing open space
- **Brown** Restoration sites connecting high/medium integrity areas
- **Green** Restoration sites with sensitive species
- **Yellow** Remaining prospective restoration sites
- **Pink** Prospective enhancement sites

2 0 2 4 6 Miles
Stream Restoration Based on Landscape Setting

- Restore Headwaters
- Reduce Erosion
- Stream Restoration Based on Landscape Setting
- Floodplain Restoration & Protection
- Depressional Wetlands
- Promote Infiltration

Floodplain Restoration & Protection
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

<table>
<thead>
<tr>
<th>Category</th>
<th>Standard</th>
<th>Target</th>
<th>Timing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical - Riverine</td>
<td>cross-section has at least two benches or breaks in slope, including the riparian area, above the channel bottom, not including the thalweg</td>
<td>Relative to min of 2 reference sites</td>
<td>Year 1</td>
</tr>
</tbody>
</table>
## Hydrology

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

<table>
<thead>
<tr>
<th>Category</th>
<th>Standard</th>
<th>Target</th>
<th>Timing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydrologic - Tidal</td>
<td>Seasonally open inlet: The permittee shall ensure the tidal inlet opens at a frequency and duration to provide design-level site inundation and salinities.</td>
<td>Relative to regional reference sites of same estuarine type</td>
<td>Inlet dynamics would be present immediately and would be expected to persist; biological features would develop over time.</td>
</tr>
</tbody>
</table>
## Sample Performance Standards: Hydrology

### SEASONAL WATER LEVELS AT REFERENCE SITE

Vertical lines indicate seasonal breaks.

- **April-May-June**
- **July-Aug-Sept-Oct**
- **Nov

**Soil Surface**

**12 inches**

### 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.

---

<table>
<thead>
<tr>
<th>Wetland Type</th>
<th>Minimum Soil Saturation to Inundation</th>
<th>Maximum Inundation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Saturation (from soil surface)</td>
<td>Inundation</td>
</tr>
<tr>
<td>General</td>
<td>Within 12 inches</td>
<td>≤ 6 inches</td>
</tr>
<tr>
<td>Shallow Marsh</td>
<td>0 inches</td>
<td>≤ 6 inches</td>
</tr>
<tr>
<td>Sedge Meadow</td>
<td>Within 12 inches</td>
<td>–</td>
</tr>
<tr>
<td>Wet Meadow</td>
<td>Within 12 inches</td>
<td>–</td>
</tr>
<tr>
<td>Shrub-Carr</td>
<td>Within 6-12 inches</td>
<td>≤ 6 inches</td>
</tr>
<tr>
<td>Hardwood Swamp</td>
<td>Within 6-12 inches</td>
<td>≤ 6 inches</td>
</tr>
</tbody>
</table>

*St. Paul District Compensatory Mitigation Policy for Minnesota, 2009*
Finally... the Plants... and the Critters

YES!

NO!
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

<table>
<thead>
<tr>
<th>Category</th>
<th>Standard</th>
<th>Target</th>
<th>Timing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flora: all wetland types</td>
<td>Species richness: The permittee shall ensure target native species richness values of tree, shrub, and herb strata are met by year 5.</td>
<td>&gt;75% of reference</td>
<td>By year 5, after hydrology criteria is met</td>
</tr>
</tbody>
</table>
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

Floristic Quality Benchmarks and Categories

State of Wisconsin
Index of Biotic Integrity (IBI) is an integrative indicator of water quality.
But... Recovery Takes Time

Timescale of variation in wetland extent and condition

<table>
<thead>
<tr>
<th>Seasonal</th>
<th>Annual</th>
<th>Decadal</th>
<th>Century/Millennial</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Climatic</strong></td>
<td><strong>Weather patterns</strong></td>
<td>Effect of specific weather events</td>
<td><strong>Climatic variability</strong></td>
</tr>
<tr>
<td><strong>Hydrologic</strong></td>
<td><strong>Environmental Flow event planning</strong></td>
<td>Wetland/catchment operational plans</td>
<td><strong>Water allocation planning</strong></td>
</tr>
<tr>
<td><strong>Geomorphic</strong></td>
<td><strong>Structural modification</strong></td>
<td>Wetland isolation due to levees, In-channel modifications to altered flow paths, wetland reclamation</td>
<td><strong>Hydro-geomorphic trajectory</strong></td>
</tr>
</tbody>
</table>

Saintilan & Imgraben 2012
Four overarching attributes:
1) Buffer and Landscape Context
2) Hydrology
3) Physical Structure
4) Biotic Structure
Account for Changes Over Time

2016 Hydrologic Alteration Class

2050 Projected Hydrologic Alteration Class

San Diego River Watershed

Baseline - 2010
2040
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
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.
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!