An Ecological Framework for Reviewing Compensatory Mitigation

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Some Sites Have Obvious Constraints
Some Are Less Straightforward

How do I ensure ecological sustainability?!?!
Generally focus on structure vs. process or function
Webinar Goals . . .

- Understand design elements that lead to sustainable ecological processes
- Know what to look/ask for when reviewing restoration/mitigation plans
Main Messages

- Landscape setting drives ecological processes in wetlands.
- Wetland function reflects the integration of past and present landscape setting.
- Planning successful mitigation projects begins and ends with ensuring appropriate landscape connections.
- Resiliency of mitigation must consider current and likely future landscape processes.
Caveats and Considerations

 Move beyond landscape setting to ensuring landscape connection
 Wetland typology matters in determining appropriate landscape connections
 Respect and understand the past, but you cannot recreate the past – *don’t try*!
 You may not be able to achieve “reference” condition – *set reasonable expectations*!
 Restoring upland processes is often an important design element
 Things may not always go as planned
  ▪ be prepared for only partial achievement of desired functions
  ▪ embrace adaptive restoration and *take the “long view”*

Focus is on wetlands. Similar concepts apply for streams, with some important differences

Harris and Van Diggelen 2006
Roadmap for Today’s Presentation

- Part 1 – Landscape Connections
- Part 2 – Classification
- Part 3 – Providing Context Through Reference
- Part 4 – Challenges of Timing
Landscape Connections

Wetland position in the landscape and the associated physical and biological connections are the largest determinant of successful restoration.
Importance of Landscape Connections

- **Contribution to hydrologic cycle**
  - surface and subsurface hydrologic connections

- **Materials processing (e.g. nutrients, carbon, sediment)**
  - soil structure and associated microbial community, sufficient time, and appropriate redox conditions (largely a function of hydrology)

- **Habitat support**
  - connectivity to adjacent uplands and proximity to related wetlands (e.g. refugia, migration, critical area requirements)
Landscape - Biogeochemistry Connections
Landscape - Biology Connections

Tiner, McGuckin, and Herman. 2015
How Do I Determine the “Right” Landscape Connections? → **CLASSIFICATION**

**Hydrogeomorphic (HGM) classification** describes the appropriate wetland type based on landscape position + water source + hydrodynamics → **landscape connections**

Brinson and Malvarez, 2002  
Davis et al. 2013  
Brooks et al. 2011
Depressional

Riverine/Floodplain

Slope

Lacustrine Fringe

Estuarine Fringe

Flats

Landscape connection \(\rightarrow\) class \(\rightarrow\) functions
How Do I Ensure Landscape Connection?

- Wetland type is appropriate for its position in the landscape

- Intact and sustainable hydrologic connections
  - Hydrodynamics are consistent with wetland HGM class (landscape connections)

- Soil properties are appropriate for the wetland HGM class

- Landscape connections promote movement of materials & organisms
  - Wetland-upland connections promote resiliency
Appropriate Landscape Position: Riverine Floodplain Wetlands

Historic (1929) conditions

2-year inundation zone

Simulation of restored floodplain wetlands
Inappropriate Landscape Position
Sustainable Hydrologic Connections

Adaptive Management Plan

Data-driven Design

Groundwater Well #2 in Wetland Rehabilitation Area
Avoid “Overengineered” Hydrology
Ensure Appropriate Soils and Subsurface Connections (western vernal pools)
Promote Soil Development

- Consider original soil type and amend as necessary
- Soil development takes time – be patient

✓ Sandy soil with + amendments
✓ 11 years of organic matter accumulation

Photo courtesy of W. Lee Daniels
Ecological Connections
Ecological Connections: Role of Uplands

- Promote hydrologic connections
- Sediment and organic matters sources
  - Especially in upper watershed areas
- Reduce sources of invasion
- Habitat for important life history stages
  - aestivation, foraging
- Providing migration/dispersal opportunities
Landscape Connections??

Legend:
- Green: Hydrology well installed (<4 ft)
- Blue: Hydrology well installed (>4 ft)
- Pink: Proposed Vegetation Plots
- Gray: Easement Area (estimate)
- Non-credit Area
- Trail and Trail Fill
- Shallow Marsh
- Deep Marsh
- Musick Prairie
- Shrub Carr
- Wet Meadow

mitigation
Considerations for Coastal Wetlands

- Need to maintain connections with ocean and watershed
- Frequency and magnitude of fluvial inputs provides critical sediment supply and flushing
- Mouth behavior (i.e. migration, closure) affects all functions
- Coastal wetlands often occur in interconnected complexes; these are great opportunities for restoration
Understand Watershed Connections

“The characteristics of that river are in the nature of a gopher. When is grows tired of one channel, it makes another...” Foster 1936

River channel:
- Decadal-scale shifts in river course
- Migration generally within mapped area of River wash/Willow scrub
- Courses enter estuary at location of “arms”
Mouth Dynamics Influence Habitat Distribution

Largier et al, 2018
Physical Dynamics Affect Biological Communities

Coho Salmon Migration

- Mean Daily Flow
- Relative Abundance

Migration Date

Osterback, Kern & Kiernan – unpublished data
Lagoon “restored” as a mitigation bank for port expansion.

Mouth jettied open to improve tidal flushing, improve water quality, and reduce freshwater wetlands

“Restored” lagoon requires periodic dredging due to shoaling

Mitigation has resulted in “type conversion” – system supports different species and habitats as were historically present.
Look for Opportunities to Restore Habitat Mosaics

Restore hydrological and ecological connectivity
Roadmap for Today’s Presentation

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- Part 3 – Providing Context Through Reference
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What is Reference, and Why Does it Matter?

- Reference provides a template or anchor point to guide restoration

- Reference must reflect comparable landscape connections
  - Focus on hydrologic and physical process and connections
  - Don’t define reference based on biology

- “Pristine” (i.e. Reference Standard) may not be the most appropriate reference
  - Specific deviation from reference may be the most appropriate restoration target
What is an Appropriate Reference Condition?

The LA River near downtown ~circa 1900

“culturally unaltered” vs “best attainable”

A standardized lexicon of terms used to define biological expectations (adapted from Stoddard et al., 2006):

Reference Condition (RC(BI)) – Because this term has been used for a wide range of meanings, Stoddard et al. (2006) argue that the term should be restricted to meaning “reference condition for biological integrity … in the absence of significant human disturbance or alteration”

Minimally Disturbed Condition (MDC) – stream condition in the absence of “significant” human disturbance. Assumes all streams have some anthropogenic stresses, but in most cases will approach true RC(BI)

Historical Condition (HC) – stream condition at a specific point in time (e.g., pre-Columbian, pre-industrial, pre-intensive agriculture, etc.)

Least Disturbed Condition (LDC) – the best physical, chemical and biological conditions currently available (“the best of what’s left”). This definition is sufficiently flexible to establish biological expectations even in highly altered systems

Best Attainable Condition (BAC) – the expected ecological condition of least disturbed sites given use of best management practices for an extended period of time. This definition is helpful for communicating the potential for improving ecological condition above the currently best available conditions

Stoddard et al., 2006
Comparison to Reference

Often, pristine is not achievable

Gerritsen et al. 2017

... then what do you do??

Ambrose et al. 2006
Decisions Based on Ambient Data

Acceptable level below “pristine”

Restoration design target
How to Determine the Appropriate Reference Condition

- Consider historical setting and associated hydrological and ecological connections
  - Groundwater connection due to geologic contact points, fissures, springs, etc.
  - Sumps and sags where organic reach (or peat) soils develop
  - Hydrologic connections in coastal wetlands – fluvial inputs and barrier berms, bars etc.

- Consider changes in the landscape that may have altered these connections
  - *Best restoration opportunities may be to restore these connections; however, if connections are permanently altered must accommodate new landscape, i.e. sometimes type conversion may be appropriate*

- Determine most appropriate reference given objectives of the mitigation site
Considerations for Selecting Reference

- Comparable landscape setting
- Mitigation Site
- Historical connections

Appropriate Hydrology & Soil Conditions

Baseline Data
- Mitigation
- Creek
- Mtn.
- Tidal
- Water
- Wells
- Soils

Consideration of Landscape Constraints
Timing is Everything

- Most mitigation sites will take longer than the typical 5-10 year monitoring period to mature
- Conditions will naturally fluctuate over time and in response to episodic events
  - Need to focus on long-term trajectory of site condition
- Need to couple **long-term monitoring** at mitigation sites with regional reference/comparator sites in order to assess trajectories of response relative to expectations.
- Focusing on landscape connections will maximize chances of long-term resiliency
  - Make sure you **monitor process not just structure** (e.g. piezometers, soil probes)

*Subsequent speakers will discuss time scales for considering development of wetland function in more detail*
Restoration Takes Time

Timescale of variation in wetland extent and condition

- **Seasonal**
  - Weather patterns
    - Effect of specific weather events
  - Climatic variability
    - Effect of ENSO, IPO, Global Warming

- **Hydrologic**
  - Environmental Flow event planning
    - Wetland/catchment operational plans
  - Water allocation planning
    - Water sharing plans, basin planning

- **Geomorphic**
  - Structural modification
    - Wetland isolation due to levees, in-channel modifications to altered flow paths, wetland reclamation
  - Hydro-geomorphic trajectory
    - Evolution of river and wetland systems
      - At the landscape scale in response to sedimentation, erosion and altered river gradients

Saintilan & Imgraben 2012
Typical Permit Monitoring Periods May be Insufficient → Need Long-term Monitoring

Long-term lake monitoring
Czech Republic
Znachor et al. 2016

Mitigation banks:
Washington State
Minnesota mitigation sites
So... What Should I Ask For?

- Historical natural condition prior to major disturbance (if possible) IN ADDITION to historical degraded condition

- Diagrams of key hydrologic processes (e.g. directions of water flow, distance to groundwater)
  - Hydrologic impacts, e.g. tile drains, diversions, discharges, physical barriers
  - Mouth dynamics (for coastal systems)
  - History/frequency and magnitude of large “reset” events
  - Expected future hydrologic changes and climate change induced alterations of flood-drought cycles

- Current soil conditions (and historic if possible)
  - Compaction, salinity, organic matter, duration of saturation

- Biological connections
  - Adjacent land uses + expected changes to these in the future (also important for hydrology)
  - Proximity to wetlands that operate in a complex (e.g. vernal pools, prairie potholes)
  - Sources of invasion (plants and animals)
  - Other stressor inputs both current and expected future stressors
Closing Thoughts

- Focus on ecological processes
- Choose appropriate targets/goals
- Commit for the long-term
- Monitor...Adapt...Repeat
Coming up Next

- Jeremy Sueltenfuss – Hydrology
- W. Lee Daniels – Soils
- Matt Schweisberg – Plants (mostly)
THANK YOU!!

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“Facts do not cease to exist because they are ignored.”

Aldous Huxley
EXTRA SLIDES
Mouth Position from Satellite & Aerial Imagery
Rate of Mouth Movement
(distance between consecutive positions / time interval)

Distance from Northernmost Point (1982)

Beach Nourishments

1977
840,000 m³

1995
208,500 m³

2001
92,000 m³

2012
450,000 m³