ECOLOGICAL HISTORY AND HYDROGEOGOMORPHIC CHARACTERISTICS OF UMRS FLOODPLAIN FOREST COMMUNITIES

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Greenbrier Wetland Services
General Framework for Discussion

• A Background of the Ecological/HGM Historical Context
• Focus on UMR north of Cairo, IL with additional information on IL and MO Rivers
  • Landscape-Scale Patterns
• Future Man- and Climate Change Considerations
A Recognition of Change and Need – the 1990s

• Fragmented Forest Patches
• Loss of Forest Diversity and Hardwood Species
• The effects of 1993 and 1995 Floods
• Long-term effects of Locks-and-Dams
• No System-wide Management Plan or Strategy
• Early Understanding of Climate Change
• Poor recognition of Abiotic Factors
Outline

1. The Hydrogeomorphic Foundation
2. Community Types and Relationships to HGM Attributes
3. Current Data/Perspectives on System-wide Landscape Patterns
4. Man and Climate Change Considerations
5. Future Conservation Considerations and Needs
Basic Premise:

“To understand plant and animal species ecology you first must understand the environment in which they live and are adapted to”
The Importance of Hydrogeomorphic attributes

- Geomorphology, Landforms and River Channel/Course Dynamics
- Soils
- Topography
- Hydrology – Seasonal and Interannual
- HGM-based Community Distribution
Major Milestones in UMR Understanding

• Geomorphology – Hajic, Bettis, Madigan, Saucier
• Soils – USDA SSURGO and NRCS LSDs
• Topography – LiDAR
• Hydrology – SAST, USGS, and USACE studies
• Communities – GLO and HGM
• Definition of HGM-based Ecoregions
Geomorphology – the first step!
Geomorphology
Historic River Alignments
SSURGO Soil Type
Soil Drainage Classes
Hydrology and Topography
Figure 2 LiDAR elevation information for Great River NWR: Deltair, Fox Island and Long Island Divisions
Historic Hydrological Patterns
+
Understanding of Floodplain Elevations and Surface Features
=
Prediction of Historic Flood Frequency Contours
Flow Recurrence Intervals
• The Importance of Evaluating Communities and Patterns by HGM Ecoregions

• Ecoregions have different ecological-geomorphology history
• Inputs from tributaries introduce variable sediments-landforms-hydrology
• Water volume and seasonal dynamics are different
• Regional patterns of climate effect growing seasons, ice, etc.
Floodplain Width
- Expansive: MO and MS River
- Broad: >2000m in width
- Narrow: 1000-2000m in width
- Tight: <1000m
Geomorphologic Reaches.
What were the historical UMRS communities/habitats and where were they?
Presettlement Habitats

- River channel and islands
- Side chutes
- Bottomland Lakes
- Riverfront Forest
- Floodplain Forest
- Bottomland Hardwood Forest
- Slope Forest
- Wet Bottomland Prairie
- Wet-mesic Prairie
- Mesic Prairie
- Savanna
<table>
<thead>
<tr>
<th>Duration of flooding</th>
<th>Herbaceous plants</th>
<th>Woody plants</th>
</tr>
</thead>
<tbody>
<tr>
<td>(A) Permanent</td>
<td>Water Millbil</td>
<td>Common Baldcypress</td>
</tr>
<tr>
<td></td>
<td>Watershield</td>
<td></td>
</tr>
<tr>
<td></td>
<td>American Lotus</td>
<td></td>
</tr>
<tr>
<td>(B) Semi-permanent water</td>
<td>American Lotus</td>
<td>Common Baldcypress</td>
</tr>
<tr>
<td></td>
<td>Duckweed</td>
<td>Water Tupelo</td>
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<tr>
<td></td>
<td>Swamp Smartweed</td>
<td>Water Elm</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Buttonbush</td>
</tr>
<tr>
<td>(C) 3 to 8 Months</td>
<td>Swamp Smartweed</td>
<td>Common Baldcypress</td>
</tr>
<tr>
<td></td>
<td>Lizard's Tail</td>
<td>Overcup Oak</td>
</tr>
<tr>
<td></td>
<td>Sticklighths</td>
<td>Red Maple</td>
</tr>
<tr>
<td></td>
<td>Arrowarum</td>
<td>Waterlocust</td>
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<tr>
<td></td>
<td></td>
<td>Possumhaw Holly</td>
</tr>
<tr>
<td>(D) 1 to 6 Months</td>
<td>Lizard's Tail</td>
<td>Overcup Oak</td>
</tr>
<tr>
<td></td>
<td>Sticklighths</td>
<td>Willow Oak</td>
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<tr>
<td></td>
<td>Sedge</td>
<td>Pine Oak</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cherrybark Oak</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sweetgum</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Blackgum Tupelo</td>
</tr>
<tr>
<td>(E) 0 to 2 Months</td>
<td>Spotted Snapweed</td>
<td>Sweetgum</td>
</tr>
<tr>
<td></td>
<td>Nettle</td>
<td>Blackgum Tupelo</td>
</tr>
<tr>
<td></td>
<td>Giant Cane</td>
<td>Sugar Hackberry</td>
</tr>
<tr>
<td></td>
<td>Nightshade</td>
<td>Shagbark Hickory</td>
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<td></td>
<td></td>
<td>American Elm</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Swamp Chestnut Oak</td>
</tr>
<tr>
<td>(F) Once in 10 years</td>
<td>Spotted Snapweed</td>
<td>Sweetgum</td>
</tr>
<tr>
<td></td>
<td>Nettle</td>
<td>Sugar Hackberry</td>
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<tr>
<td></td>
<td>Giant Cane</td>
<td>Shagbark Hickory</td>
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<tr>
<td></td>
<td>Wildrye</td>
<td>White Oak</td>
</tr>
<tr>
<td></td>
<td>Pokeberry</td>
<td>Flowering Dogwood</td>
</tr>
</tbody>
</table>
Modeling the Habitat Community – The HGM Matrix

• A “GIS” Approach that includes reference areas for the combined databases of:
  – Geomorphic surface
  – Topography/elevation
  – Soils
  – Flood frequency zone
## HGM Matrix of Communities

<table>
<thead>
<tr>
<th>Habitat</th>
<th>Geomorph</th>
<th>Soils</th>
<th>Flood Frequency</th>
<th>Elevation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bottom Lake</td>
<td>Abandoned Channel</td>
<td>Clay</td>
<td>Perm.</td>
<td>&lt; 450</td>
</tr>
<tr>
<td>Sloughs</td>
<td>Miss River Ch. Belt</td>
<td>Clay</td>
<td>Perm Semi-Perm</td>
<td>&lt; 450.5</td>
</tr>
<tr>
<td>Shrub/scrub</td>
<td>Slough edges</td>
<td>Silt-Clay</td>
<td>Semi-Perm</td>
<td>450.5-451</td>
</tr>
<tr>
<td>Habitat</td>
<td>Geomorph</td>
<td>Soils</td>
<td>Flood Fr.</td>
<td>Elevation</td>
</tr>
<tr>
<td>----------------------</td>
<td>-------------------</td>
<td>-------------</td>
<td>-----------</td>
<td>---------------</td>
</tr>
<tr>
<td>Floodplain Forest</td>
<td>New ch. belt</td>
<td>Silt-Clay</td>
<td>1-2 yr</td>
<td>451-452.5</td>
</tr>
<tr>
<td>BLH</td>
<td>Trib fan, terraces</td>
<td>Silt-Clay</td>
<td>2-5 yr</td>
<td>&gt; 452.5</td>
</tr>
<tr>
<td>Slope Forest</td>
<td>Alluvial fan</td>
<td>Mixed Erosional</td>
<td>&gt; 5 yr</td>
<td>&gt; 456</td>
</tr>
<tr>
<td>Bottomland Prairie</td>
<td>Old channel terraces</td>
<td>Silt-Clay</td>
<td>2-5 yr</td>
<td>&gt; 455</td>
</tr>
</tbody>
</table>
Table 1. Hydrogeomorphic (HGM) matrix of historical distribution of major vegetation communities/habitat types in the Chippewa River ecoregion in relationship to geomorphic surface, soils, and hydrological regime. Relationships were determined from land cover maps prepared for the Government Land Office survey notes taken in the early 1800s, historic maps and photographs, U.S. Department of Agriculture soil maps, land sediment assemblage maps, flood frequency data provided by the U.S. Army Corps of Engineers, St. Paul District; and various naturalist/botanical accounts and literature.

<table>
<thead>
<tr>
<th>Habitat Type</th>
<th>Geomorphic Surface⁴</th>
<th>Soil type⁵</th>
<th>Flood Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Open Water/Aquatic</td>
<td>SC, TC, SL</td>
<td>Sand-gravel</td>
<td>Permanent</td>
</tr>
<tr>
<td>Persistent Emergent</td>
<td>TF, TFM, MCV</td>
<td>Silt loam, muck</td>
<td>Semi-permanent</td>
</tr>
<tr>
<td>Shrub/scrub</td>
<td>Edges of TC, SC, and SL</td>
<td>Silt clay</td>
<td>Semi-permanent</td>
</tr>
<tr>
<td>Wet Meadow</td>
<td>GSC, TFM, MNV</td>
<td>Loam – muck</td>
<td>Spring-summer seasonal</td>
</tr>
<tr>
<td>Mesic Prairie/Savanna</td>
<td>GT, GSS, MNVc</td>
<td>Sandy loam</td>
<td>&gt; 10 year</td>
</tr>
<tr>
<td>Bottomland Prairie</td>
<td>GSC, TF</td>
<td>Loam</td>
<td>&gt; 5 year</td>
</tr>
<tr>
<td>Riverfront Forest</td>
<td>MCL, MCI, MNLd</td>
<td>Sandy-silt</td>
<td>1 year</td>
</tr>
<tr>
<td>Floodplain Forest</td>
<td>TSS, TF, MCV, TMB MNL⁶, MCV, MNV</td>
<td>Silt loam-clay</td>
<td>2-5 year</td>
</tr>
<tr>
<td>Floodplain Forest – Oak*</td>
<td>MCV</td>
<td>Silt clay</td>
<td>&gt; 5 year</td>
</tr>
<tr>
<td>Slope Forest</td>
<td>CS</td>
<td>Mixed erosional</td>
<td>&gt; 20</td>
</tr>
</tbody>
</table>


⁵ See Appendix D for list of soils associated with vegetation communities and geomorphic surfaces.

⁶ Prairie found in MNV only in the Winona Flats area.

⁷ Minor channel lateral surfaces contain ridge-and-swale communities with Floodplain Forest typically on ridges and Riverfront Forest typically in swales.

* Sites with relatively small amounts of oak interspersed in a diverse Floodplain Forest with relatively water-intolerant species.
Bottomland Lakes

- Abandoned Channels
- Clay and silt/clay with sand/loam end “plugs”
- 1-yr FF - Permanent to semi-permanent water regimes
- Present throughout UMR – most < 2,000 yrs old
Riverfront Forest (RVF)

- Bar-and-chute and braided bar – newly accreted surfaces
- Loam and sandy/loam
- Typically annual flooding/overtopping and 1-yr flood frequency (FLF)
- Present along the active and former MS River channels where sand-based soils occur throughout the UMRS
- Early succession species – willow, cottonwood, sycamore, maple
Floodplain Forest

- Higher Elevation Holocene point bar ridges and swales, tributary zones
- Ridges – usually loamy or silt loam
- Swales - silt loams w/ silt clay veneers
- Ridges - 2-5 yr FLF
- Swales - 1-2 yr FLF
- Extensive throughout UMR
- Most diverse community with many hardwoods – elm, ash, hackberry, boxelder
Bottomland Hardwood Forest (BLH)

- Backswamps, Larger point bar swales, and braided stream terraces in MAV and on Tributary Fan and Confluence areas
- Silty/clay
- > 2-5 yr FLF
- Most in Southern Miss River areas (MAV) and Oakwood Bottoms, IL – Salt and Sny River confluences
- Mast-producing species (oak and pecan)
Bottomland Hardwood Forests
Slope Forest

- Alluvial fans and Colluvial slopes
- Mixed erosional soils
- > 20 yr FLF
- Scattered along bluff margins
- Mixture of upland and floodplain forest species
Savanna

- Transition edges of Floodplain Forest or BLH to Wet-mesic or Mesic Floodplain Prairie
- Older terrace fringes
- > 5-yr FLF
- Usually silt loams
- Typically oak gallery composition often
Floodplain Prairies

• Range from wet bottomland to upland Mesic types
• Typically on older and higher remnant Pleistocene terraces
• Loam or silt loam surfaces on terraces – some clays in depressions
• Range in FLF, but generally > 5-yr FLF
Areas That Potentially Could Support Restoration of Presettlement Communities

Appendix S
Kaskaskia to Thebes
River Mile 76 to River Mile 44
Appendix R
Kaskaskia to Thebes
River Mile 117 to River Mile 76

Presettlement 1800 Habitat
- BLH
- BLH High
- Bottomland Lake
- Bottomland Prairie Ridge
- Bottomland Prairie Swale
- Bottomland Prairie Urban
- Floodplain Forest Ridge
- Floodplain Forest Swale
- Floodplain Forest Urban
- Loess Upland
- Riverfront Forest
- Slope Forest
- Slope Savanna
- Terrace Mosaic Prairie

0 1.25 2.5 5 Miles
UMRS Landscape-Scale Patterns

- Downstream merging with the MAV, backswamps, clay soils and BLH dominated south of Thebes Gap
- Middle Miss – Broad geomorphic surfaces with BLH in backswamps, Floodplain Forest on higher elevations, RVF adjacent to river channel on new surfaces
- Gradual transition to more bottomland prairie north of Kaskaskia
UMRS Landscape Patterns - Continued

• Miss-MO-II Confluence dominated by abandoned channel features with very heterogeneous topo-soil patterns and mixed forest and prairie patterns
• Lower MO River Corridor dominated by RVF with Floodplain Forest on higher elevations
• No maps for IL River system
• Quncy to ST.L has narrower floodplains and “tight” linear topo contours
• Sny Anabranch North contains RVF corridors on newly accreted surfaces, Floodplain Forest more restricted, BLH on large tributary fans, and extensive bottomland prairie
UMRS Landscape Patterns - continued

• Absence of maps from Quincy to Pool 10 and north of Pool 4, but geomorphic/GLO maps suggest restricted Gorge RVF at Keokuk and Rock Island and gradual transition to very heterogeneous forest-prairie to the north

• Pools 4-10 diverse mix of Riverfront, Floodplain Forest and Prairie, with more wet meadow and marsh habitats emerging along tributaries and their confluence areas

• Chippewaw ecoregion has narrow contour bands and “tight” community relationships
UMRS Climate Change

- Several climate shifts have occurred in the UMRS since glacial retreat (Knox, Nature 1993).

- Discharge and large floods have generally increased basin-wide since the 1930s (Changnon, 1983; Knox, 1993; Wlosinski, USGS 1999; Zhang and Schilling, 2006).

- There are climate oscillations

- Large floods and extremes may increase during climate transition
Climate has Varied Since the Last Glaciers

(after Knox, 1985a; 1996a).
Discharge is Increasing
(3-Year Moving Average Discharge)
Annual Precipitation La Crescent, MN
1950 - 2002
Mississippi River Discharge at McGregor, Iowa
Annual Average Values

\[ y = 231.83x - 419480 \]

\[ R^2 = 0.1769 \]
Great Midwest Flood 1993

This perimeter levee surrounding the Clarence Cannon National Wildlife Refuge, Mo., damaged during the 1993 flooding, allowed excessive water to enter the refuge. ( Photograph courtesy of U.S. Fish and Wildlife Service.)
1993 and 1995 Floods

- Shanks inundated 191 of 200 day growing season in 1993 – mainstem levee breached
- 1995 flood prevented drainage from area through summer
- 90% tree mortality < 453 feet
- 30% tree mortality even > 454
- Greatest mortality inside levees – less on Angle Island
- Reed canary grass expansion
Ted Shanks CA in early 1970’s
Post-Flood Community Transition

Past 20 years

Forest

RCG

Limited Management Options

Photo by: Mike Flasphohler
Bottomland Hardwood Loss

Zach Fratto, SEMO
Ted Shanks CA in early 1970’s
Ted Shanks Conservation Area

Habitat class
- Red: Bottomland Lake 1,134.41 acres
- Blue: Floodplain Forest 1,111.21 acres
- Yellow: Scrub/shrub 627.22 acres
- Green: BLH 827.15 acres
Future Conservation Strategy and Management

- HGM Concepts have greatly informed understanding of historical composition and distribution of UMRS Forests
- The range of community-HGM attribute relationships inform future climate and water management scenarios
- Several “Key” data gaps remain
Future Challenges

• Complete a true UMRS Landscape-Scale Understanding of Historical Community Type and Distribution – Key gaps in the Illinois River Valley, Quincy to Pool 4, Pools 1-4

• Honestly Identify Current and Projected Landscape Changes to Basic HGM attributes

• Model Potential Native Veg Community Distribution under various Hydrological-Climate Scenarios
Future Management Challenges

• Seek to fill community gaps
• Actively manage existing forests if need be
• Evaluate changes to water management regimes and structures
• Build in Resiliency where possible
• Hedge Bets and expand floodplain protection and vision
1. Protect Remnant Communities

- Patches of the most destroyed habitats (if they are large enough and still retain inherent community features)
- Most protection now is in public lands
- Protection must involve restoring “processes”
- Intensive mgmt will be needed for most/all remnants
2. Restore communities to appropriate positions

- Priorities to the most destroyed habitat types? Or to areas where functional patches can be obtained
- Restorations must “match” the HGM matrix conditions
- Topography and hydrology will be needed in many restorations
3. Restore “sustainable” patches

- Many large landscape “gaps” now exist
- Need larger connected patches
- Provide physical/hydrological connectivity
- Emulate natural water regimes by habitat
- Provide “key” resources and dynamics
4. Restore “core” areas that complement activities on private lands

- Couple public and private lands restorations and programs
- Create habitat “complexes”
- Encourage private lands programs for extensive works and public lands for intensive mgmt and sensitive habitats