Integrated Mapping and Functional Assessment of Riverine and Coastal Floodplains and Wetlands Project

Mike Kline & Andy Robertson, 2019

Finer Resolution
Higher Cost/Unit
Local Projects

Coarser Resolution
Lower Cost/Unit
Federal/State Policy & Programs

Field surveys and design-level modelling and mapping
Agencies/organizations working on public and private lands implementing projects that restore and protect wetland and floodplain functions

Finer-scale remote sensing, field observation, and modeling data mapped and interpreted at the state and watershed scales
Agencies and organizations engaged in detailed functional assessments to create policy and plans that identify optimal protection and restoration projects

Coarser-scale remote sensing and national inventory/regional data compilations/interpretations
National-regional-state mapping, assessment & planning using coarser-scale modelling and functional assessments to support policy development and the creation/delivery of programs

Programs = regulatory, technical, outreach, and funding assistance provided by government agencies and/or NGOs
Projects = restoration of wetland/floodplain functions and/or conservation / land use regulation that protects wetland/floodplain functions
Partnerships = agencies and organizations working together across organizational and geographic scales to co-develop data, functional assessments, science needs, technology, funding and continuity for watercourses that cross jurisdictional boundaries
Vermont’s Functioning Floodplains Initiative

New Mapping, Assessment and Program Tracking

With climate change comes the urgency to create a community of practice and a social impetus to restore and protect resilient natural systems.
Create tools for communicating the social & economic values of wetland and floodplain functions to gain support for discretionary actions within local communities.
A Community of Practice

Federal, State and Local Agencies
National, State & Watershed Orgs
Research Institutions
Private Foundations

- Supporting and conducting research
- Planning and coordination services
- Technical assistance in assessment & mapping
- Conducting education and outreach
- Administering funding pass-thru programs
- Conducting regulatory oversight of practices
- Providing labor for implementing practices
- Providing public and donated funds
- Design and implementation of practices
Goal: A community of practice to restore and protect rivers, floodplains, and wetlands for the multitude of natural functions and societal values they provide.

Natural Functions and Ecosystem Services under 3 Overarching Values

<table>
<thead>
<tr>
<th>Water Quality</th>
<th>Ecological Integrity</th>
<th>Flood Resiliency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sediment/Nutrient Storage</td>
<td>Organics/Nutrient Exchange</td>
<td>Carbon Storage</td>
</tr>
<tr>
<td>Riverbank Stability</td>
<td>Organism movement</td>
<td>Channel Movement</td>
</tr>
<tr>
<td>Groundwater Exchange</td>
<td>Habitat Mosaics</td>
<td>Dispersing Energy</td>
</tr>
<tr>
<td>Organics/Nutrient Exchange</td>
<td>Carbon Storage</td>
<td>Mitigating Flood Stage</td>
</tr>
</tbody>
</table>

Water Supplies
- Contact Recreation
- Recreation Economy
- Natural Communities
- F & W Habitats
- Water Aesthetics

Aquatic Species
- Wetland Species
- Ag Soil & Forest Health
- Food Production
- Hunting & Fishing
- Nature Appreciation

Critical Facilities & Utilities
- Residential Communities
- Commercial & Industrial Agriculture
- Agriculture
- Forest Products
- Roads & Bridges
## Data framework needed to explain loss of function and ID optimal Protection & Restoration Practices

<table>
<thead>
<tr>
<th>Floodplain Functions</th>
<th>Form</th>
<th>Process</th>
<th>WSG*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Floodplain Connectivity</td>
<td>Stream Connectivity</td>
<td>Flow Storage</td>
</tr>
<tr>
<td>Channel Movement</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Dispersing Energy</td>
<td>X</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Stabilizing Riverbanks</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Connecting Organisms</td>
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<td>X</td>
<td></td>
</tr>
<tr>
<td>Groundwater Exchange</td>
<td>X</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Maintain Water Quality</td>
<td>X</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Habitat Mosaics</td>
<td>X</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Lat. Material Exchange</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Carbon Storage</td>
<td>X</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Mitigating Flood Stage</td>
<td>X</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(Vert./ Lat.) (Long./Temp.)  * WSG = Wetlands, Soils, and Geology
**Physical Data to Construct Connectivity and Process Maps**

**Tier 1 and 2 – Large and Finer Scale Remote Sensing**

- Soils and geology (incl. nat. grade controls)
- Channel and floodplain geometry (LIDAR)
- Land use/land cover (incl. encroachments, buffers and wetlands)
- Instream structures, including dams and stream/valley crossings
- Parcels and protected lands
Tier 2
Field Measurement / Assessment

• Channel incision and entrenchment
• Confirmation of human structures that confine and obstruct channel
• Bridge, culvert, and dam inventories
• Boundary conditions (bed substrates & bank characteristics)
• Natural grade controls
• Channel evolution stage (dominate process – erosion/trans/dep)
• Habitat conditions

Physical Data to Construct Connectivity and Process Maps
Physical Data to Construct Connectivity and Process Maps

Tier 2 and 3 Calculated (modelling), for example:

- Specific stream power signatures (hydraulic modelling)
- Existing and potential sediment regime (channel - floodplain)
- Flood inundation and storage (at different flood frequencies)

Examine energy distribution at a cross-section and upstream to downstream

Channel Specific Stream Power (W/m²)

Return Interval of Peak Storm (yrs)

- Boulder
- Cobble
- Cr. Gravel
Mapping used to evaluate restoration potential

Target practices to reconnect rivers, wetlands and floodplains by evaluating impediments.

Regain function, based on project feasibility and the ecosystem services provided by restored and protected fluvial processes.
Mapping to Identify Priority Reaches for Restoration and Protection

<table>
<thead>
<tr>
<th>Landscape Features</th>
<th>Existing Flow Storage</th>
<th>Potential Flow Storage</th>
<th>Existing Sediment Storage</th>
<th>Potential Sediment Storage</th>
</tr>
</thead>
<tbody>
<tr>
<td>River</td>
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<td>X</td>
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<td>6</td>
</tr>
<tr>
<td>River Corridor</td>
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<td>4</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td>Wetlands</td>
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<td>4</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Floodplains</td>
<td>2</td>
<td>8</td>
<td>2</td>
<td>8</td>
</tr>
</tbody>
</table>
Reach Priority Ranking determined by size and type of landscape feature coded with data concerning the adjacency of threats and the existing and potential:

- Stream and floodplain connectivity
- Fluvial processes: flow and sediment storage
- Social, technical, and cost impediments
Interactive web-based platform to explore an optimal set of practices for achieving the benefits of reconnect rivers, floodplains & wetlands

**Floodplain & Wetland Connectivity**
- Conserve corridors and floodplains
- Remove wetland drainage structures
- Remove berms and cut floodplains
- Restore stream slope and depth
- Reshape banks & plant riparian areas

**Stream Connectivity**
- Remove derelict dams
- Lower road & rail fills
- Upsize culvert replacements
- Install grade controls & roughness
- Slow and store stormwater
- Restore flows below diversions
Watershed scale tracking system for connectivity, fluvial processes, wetland / floodplain functions and socio-economic values

Projects assigned credits – to track restoration and protection progress

Under the Hood
Lateral Connectivity factoring Vertical Connectivity
Connectivity is an easily measured attribute for tracking the potential loss of and opportunity for functioning floodplains & wetlands.

Funding programs key in on “practice credits” and progress towards restoring and maintaining connectivity and equilibrium process.
Reduce the Economic Fuzziness of Nature-Based Solutions

Water Quality, Habitat, and Flood Resiliency Values Based on Contributing Weighted Functions and Ecosystem Services

Display existing support for functions/services and promote the potential values

Communicate Values to be Restored and Protected

Sub-Watershed Floodplain Values based on Functional Assessments

Floodplain Functions
- Sediment/Nutrient Storage
- Riverbank Stability
- Groundwater Exchange
- Organics/Nutrient Exchange
- Organism movement
- Habitat Mosaics
- Carbon Storage
- Channel Movement
- Dispersing Energy
- Mitigating Flood Stage

Aggregate data to support state policies and a community of practice.
The Vermont Functioning Floodplains Initiative is focused on connecting stream, floodplain, and wetland forms to enhance natural hydrology, sediment transport, and connectivity. The initiative aims to achieve strategic socio-economic outcomes by restoring and protecting natural river, floodplain, and wetland processes.

**Project / Practice Maps** - Strategic socio-economic outcomes based on the natural functions achieved by connecting forms and restoring/protecting natural river, floodplain, and wetland processes.

**Existing & Potential Hydrology & Sediment Transport Processes**

**Connectivity of Stream, Floodplain & Wetland Forms**

**Community Resiliency Tracking**
- Flood / Fluvial Erosion Haz Mitigation
  - Coord. w/VEM/VTrans/ACCD Haz. Planning

**Water Quality Tracking**
- Sediment / Nutrient Storage
  - Coord. w/ TMDL Load & Waste Load Planning

**Physical Habitat Tracking**
- Complexity & Connectivity
  - Coord. w/ “Conserv. by Design” & TNC Blueprint

**Social Values & Economic Assets**

**Parcels**

**Remote Sensing, Field, and Modelling Data**

**Existing--Potential Nat. Functions w/ Socio-Economic Valuations**

Reduce the economic fuzziness of nature-based solutions so that agencies can make balanced choices between green and gray investments.

**Outreach/Training**
- Policymakers, municipalities, agencies, watershed groups, affected public
Floodplain Functional Assessments with Form & Process Mapping

Process-based mapping builds on form-based maps constructed with Tier 1 through 3 scaled remote sensing, field, and modeling data.

Tier 2 Case Study
Vermont Functioning Floodplains Initiative

Form

- LIDAR data and mapping, large-scale hydrologic modelling, flood hazard area mapping, NWI+ mapping
- EPA’s TMDL program and the Lake Champlain project in Vermont; FEMA flood hazard mapping and mitigation programs; and the EPA and USFWS National Wetland Inventory programs.

Process

- One-meter land use/land cover and parcel data, conserved lands mapping, Phase 1 (remote) / Phase 2 (field) stream geomorphic assessments, and modelled hydraulic data correlated to valley measurements

Restore and Protect

- Agencies/organizations working on public and private lands implementing projects that restore and protect wetland and floodplain functions
- Field surveys and HEC-RAS modelling to design floodplain cuts
- Vermont agencies and NGOs engaged in detailed floodplain function assessments to create local strategic plans that identify optimal protection and restoration projects