The Vermont Functioning Floodplain Initiative (FFI)

Kickoff Meeting

August 31, 2020

https://dec.vermont.gov/rivers/ffi

Thorp Brook Lake Edge Floodplain
Photo by R. Schiff
2010

Agenda

3:00-3:10 Opening remarks (Gretchen, Peter)

3:10-3:20 Agenda and team introductions (Roy, Evan, Kristen, Jody, Mike)

3:20-3:30 FFI background and overview (Mike)

3:30-3:45 Review of FFI Phase 1 progress (Evan, Evelyn)

3:45-4:00 FFI Phase 2 summary of tasks (Roy)

4:00-4:15 Sediment regime mapping (Kristen)

4:15-4:30 Floodplain inundation, sedimentation, nutrients (Rebecca)

4:30-4:45 Wetland sediment and nutrients (Eric)

4:45-5:00 Web application user story example (Jody)

5:00-5:05 Next steps (Kristen)

Project Team / Roles

VTDEC (Gretchen) – Project lead

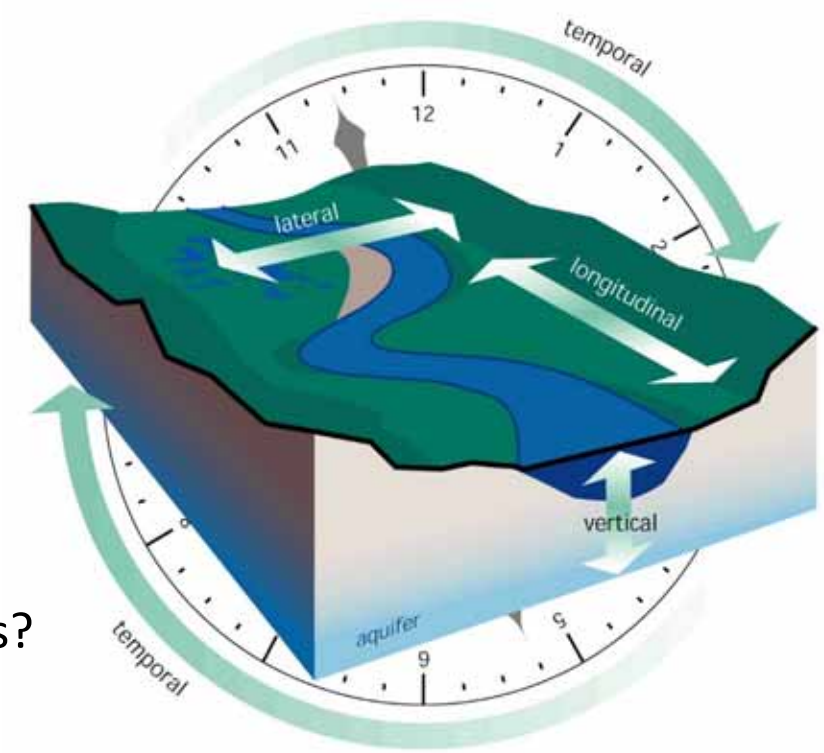
MMI (Roy, Jessica) – Project manager, method development, GIS
FEA (Evan, Evelyn) – Method development, GIS
SMRC (Kristen) – Method review
SEI (Jody, Barb, Others) – Web application development
FM (Mike) – State/UVM/consultant liaison, method development, communications

UVM (Kristen, Rebecca, Eric, Beverly, Donna, Lindsay, Steever, Jeremy) – Empirical data collection, research, method development

VTDEC (Rob, Staci, Brock, Sacha, Shannon) – TAC members: River management, river science, wetlands, floodplain management, GIS
VTANR (Erik) – TAC member: IT and GIS
VTDFW (Will) – TAC member: Fish and instream and riparian habitat
TNC (Shayne) – TAC member: Stream and floodplain restoration

Reconnect Vermont's Rivers

- Which rivers/streams and what percentage of river corridors/floodplains are (dis)connected in a given watershed due to existing constraints or stressors?
- What is the opportunity to readily achieve connectivity? How should connectivity be scored, credited and tracked at a reach and watershed scale to support a strategic restoration and protection plan?
- What are the highest priority reconnection projects?



Riverscape

Reconnect Vermont's Rivers

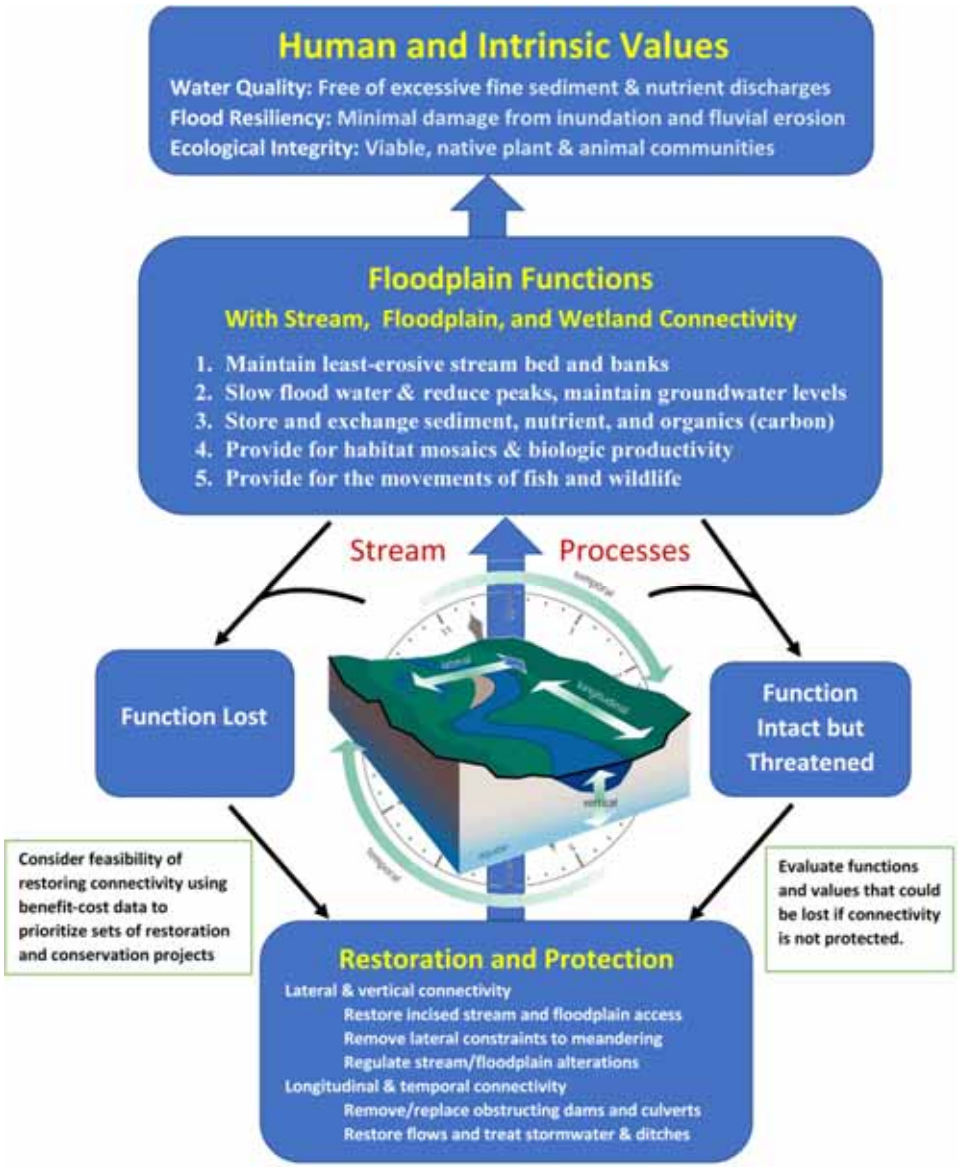
Reconnecting the Black Creek Floodplain Along the Lamoille Valley Rail Trail in 2007

Railroad Embankment Disconnecting Floodplain

Lowered Railroad Embankment to Connect Floodplain

Vermont Functioning Floodplain Initiative

Ecosystem functions and services, realized when streams, wetlands and floodplains are connected, and stream processes (i.e., the movement and storage of flows, sediment, and nutrients) are restored and protected.



Vermont's Functioning Floodplain Initiative

Phase 1 – **Form** (Physical dimensions)

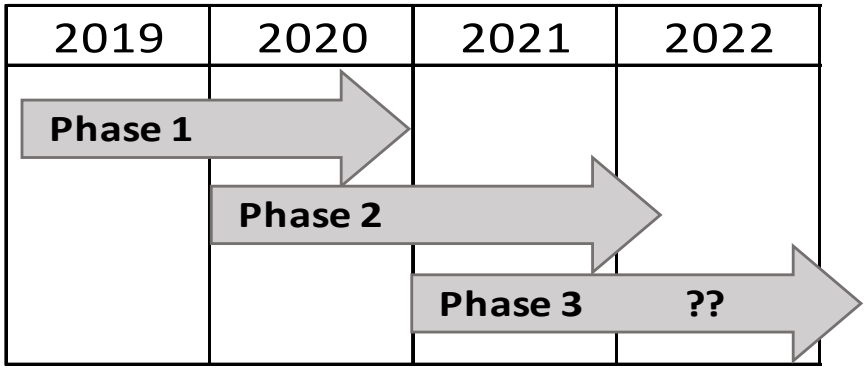
- Maps (Static)
- Additive Reach-Scale Scoring

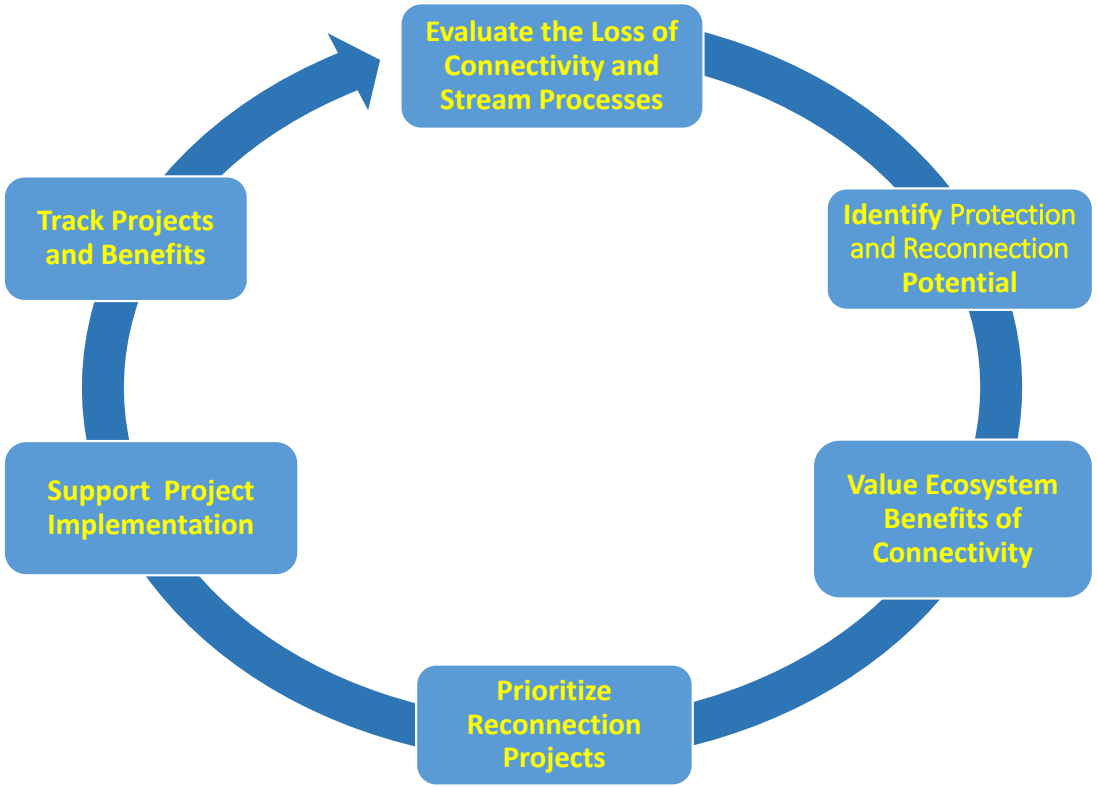
Phase 2 – **Functions & Processes** (Dynamics)

- Linkages & Weighted Scoring
- Static Tributary-Scale Tracking
- Benefit-Cost

Phase 3 – **Governance** (Optimization)

- Optimization
- Network Analysis





FFI Phase 1 Overview

1. Develop stream reach and watershed attainment and departure scoring methods for **floodplain connectivity** based on lateral connectivity, vertical connectivity, woody vegetation in the buffer, and the level of land protection. Methods also include initial project selection to improve connectivity.

2. Develop scoring and project selection for **stream connectivity** that is based on longitudinal and temporal connectivity.

3. Create stream and floodplain connectivity maps for the Lake Champlain Basin in Vermont. Mad River Pilot FFI Web Map

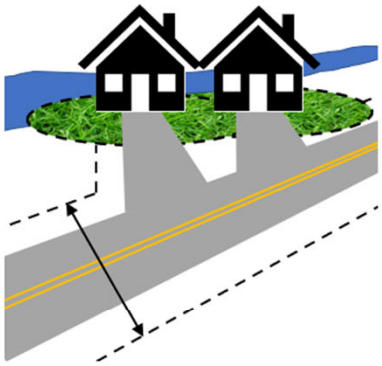
4. Project report and outreach.

FFI Phase 1 Web Map

Functioning Floodplains Initiative Phase 1

Lateral Meander Connectivity

Area of the River Corridor Without Hard Constraints



% of River Corridor Laterally Connected	Lateral Meander Connectivity Rank
90 – 100	Full
75 – 89	Moderate
36 – 74	Low
0 – 35	Constrained

FFI Phase 1 Web Map

Functioning Floodplains Initiative Phase 1

Departure Analysis:

River Corridor Lateral Connectivity Rank

50% Lateral Meander Connectivity Rank, 35% Protection Rank, 15% Buffer Rank

River Corridor Vertical Connectivity (Incision Ratio)

> 2
1.5
< 1.3

Incision Ratio

> 75
50
< 29.7

Lateral Connectivity Rank

FFI Phase 1 Web Map

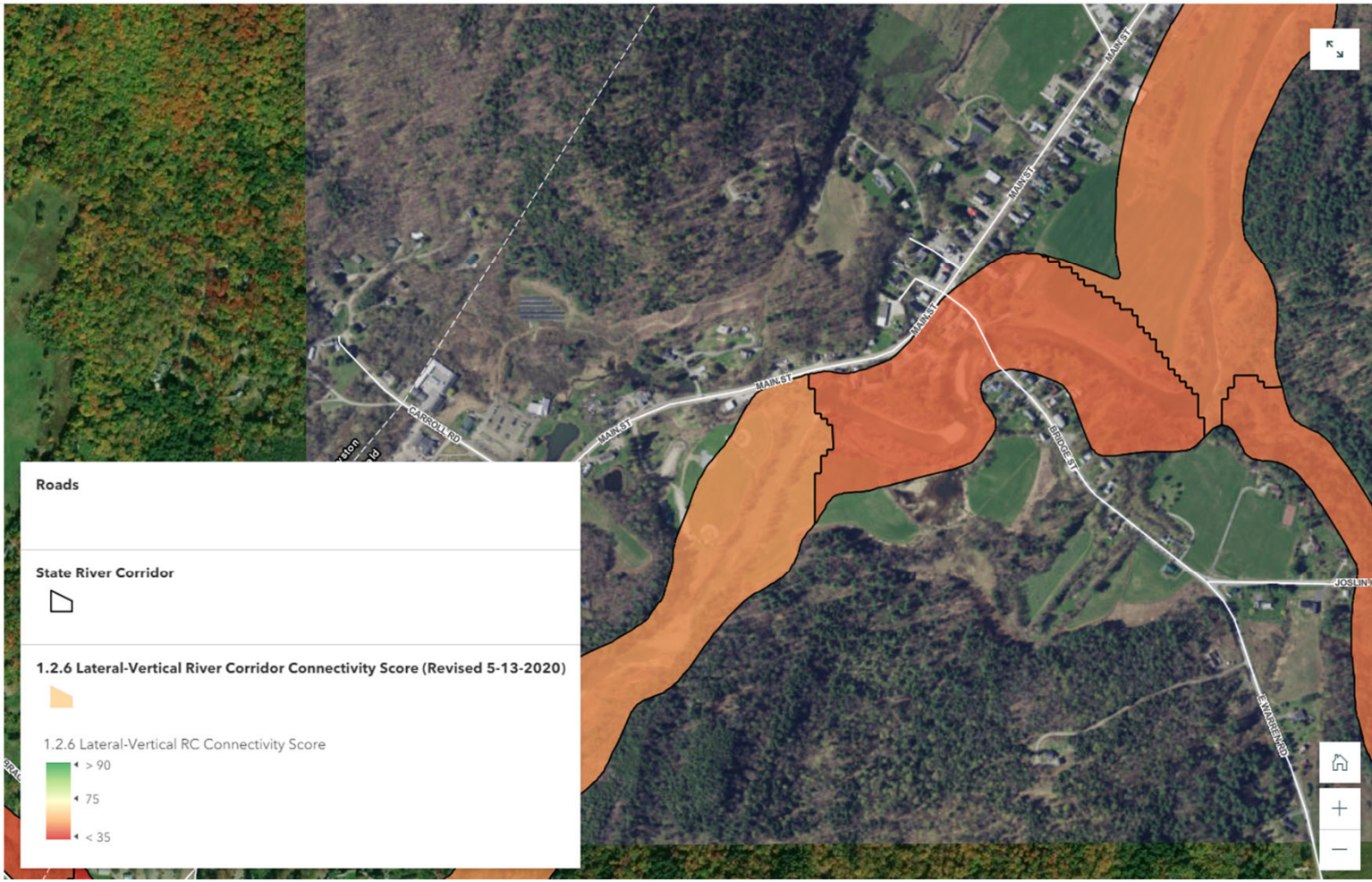
Functioning Floodplains Initiative Phase 1

Departure Analysis:

Lateral - Vertical Meander Connectivity

> 90
75
< 35

Lateral-Vertical Connectivity Rank



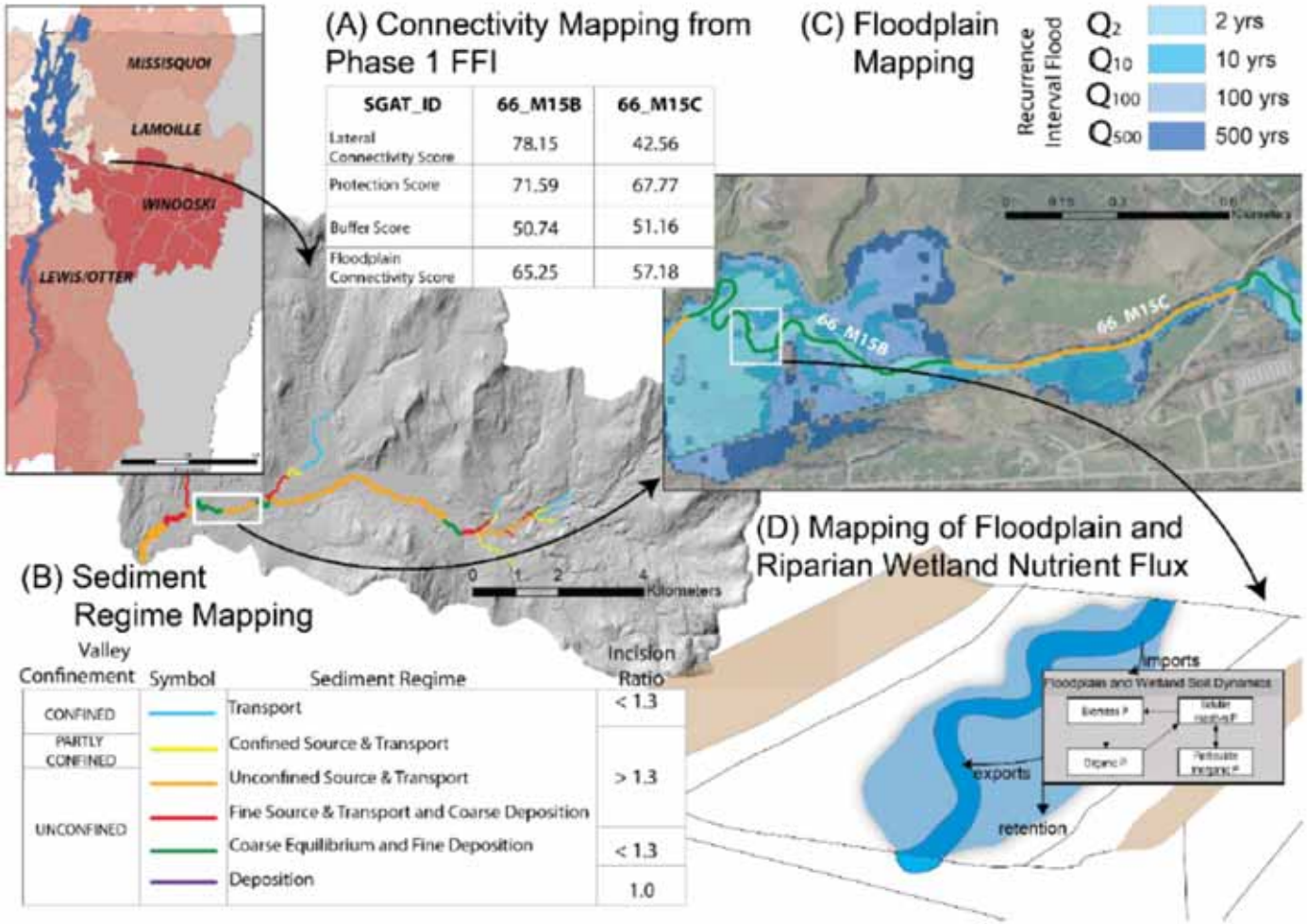
Floodplain Reconnection Projects

ID	APPROACH	PROJECT
1	No Action	No Action
2	Restore lateral-vertical connectivity	Lower floodplain[a]
3	Restore lateral-vertical connectivity	Reconnect flood chute[b]
4	Restore lateral-vertical connectivity	Create flood bench[c]
5	Restore lateral-vertical connectivity	Restore channel slope and pattern[d]
6	Restore lateral-vertical connectivity	Restore channel roughness [e]
7	Restore lateral-vertical connectivity	Raise channel [f]
8	Restore lateral-vertical connectivity	Remove berm[g]
9	Restore lateral-vertical connectivity	Restore wetland[h]
10	Constraint removal	Remove major constraint[i]
11	Constraint removal	Remove minor constraint[j]
12	Protection	Implement river corridor easement
13	Protection	Conserve wetlands (e.g., NRCS Wetland Reserve)
14	Protection	Adopt river corridor bylaws
15	Revegetation	Plant woody 50-foot buffer
16	Revegetation	Plant woody river corridor / floodplain

Stream Reconnection Projects

ID	APPROACH	PROJECT
1	No Action	No Action
2	Restore longitudinal connectivity	Remove obsolete dam - small or breached
3	Restore longitudinal connectivity	Remove obsolete dam - large or full of fine sediment
4	Restore longitudinal connectivity	Replace geomorphically incompatible culvert
5	Restore longitudinal connectivity	Replace geomorphically incompatible bridge
6	Restore longitudinal connectivity	Improve utility crossing
7	Restore longitudinal connectivity	Stabilize large headcuts
8	Restore temporal connectivity	Flow restoration downstream of peaking hydro dam
9	Restore temporal connectivity	Flow restoration at permitted water withdrawl
10	Restore temporal connectivity	Flow restoration at non-permited water withdrawl
11	Restore temporal connectivity	Flow restoration at snowmaking faciliy

Phase 2 FFI Building on Phase 1



SGAT_ID	66_M15B	66_M15C
Lateral Connectivity Score	78.15	42.56
Protection Score	71.59	67.77
Buffer Score	50.74	51.16
Floodplain Connectivity Score	65.25	57.18

FFI Phase 2 Tasks

1. **Expand floodplain connectivity mapping methods, bringing in <u>erosion/deposition process</u> (i.e., sediment regime and stream power signatures), <u>improved mapping of floodplain inundation and fine sediment deposition</u>, and <u>wetland nutrient flux</u>.**

    - Floodplain delineation.
    - Sediment regime mapping.
    - Fine sediment storage and P values.
    - Wetland nutrient flux.

➢ Merger of river form and process data for improved project planning.

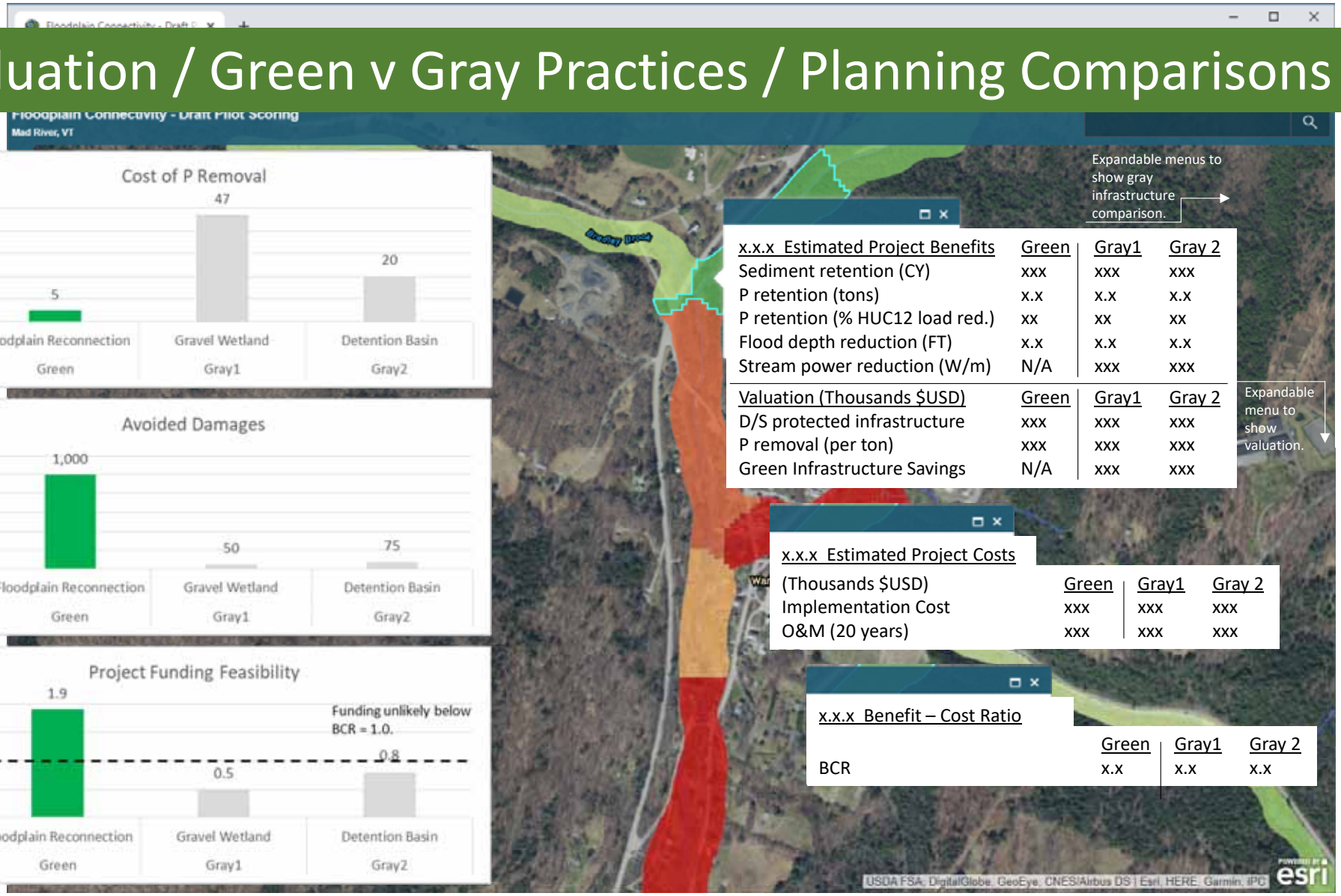
FFI Phase 2 Tasks

2. **Valuation of Floodplain Functions**
   - Green versus gray infrastructure cost comparison for sediment and P storage.
   - Cost estimate of improved property in the river corridor and floodplain via reduction of flood and erosion hazards.
   - Set of empirical relationships estimating sediment and phosphorus retained on connected floodplains. To the extent that existing data permit, this valuation may also be extended to flood water storage.

- Floodplain mapping with color ramps showing valuation.
- Cost comparisons between green and gray infrastructure.
- Financial benefits of reconnecting floodplains at reach, watershed, planning basin, and Lake Champlain Basin scales.

Valuation / Green v Gray Practices / Planning Comparisons

Pop-up summary plots



FFI Phase 2 Tasks

3. **Subwatershed Load Reduction Estimates**
   - A summary of key outcomes of ongoing and expanded monitoring to support load reduction estimates.
   - A set of relationships estimating load reduction over five years that will be used to credit potential and implemented projects.

   - Improved project implementation planning and cost estimates.
   - Project crediting to meet TMDL load reduction targets.
   - Better estimates and planning in headwaters.

4. **Web-Based Planning and Project Tracking Application**
   - Web application

   - Improved planning and tracking for reconnection projects.
   - Dashboard to compare scenarios to prioritize projects.

FFI Phase 2 Tasks

5. **Training Modules and User Manual**
   - User Manual
   - Training Module and 2 one-day training module implementations

6. **Outreach Materials**
   - A visual overview of the FFI and what a connected floodplain looks like
   - A summary of the planning interface of the web application
   - A summary of the tracking interface of the web application
   - Other to be determined

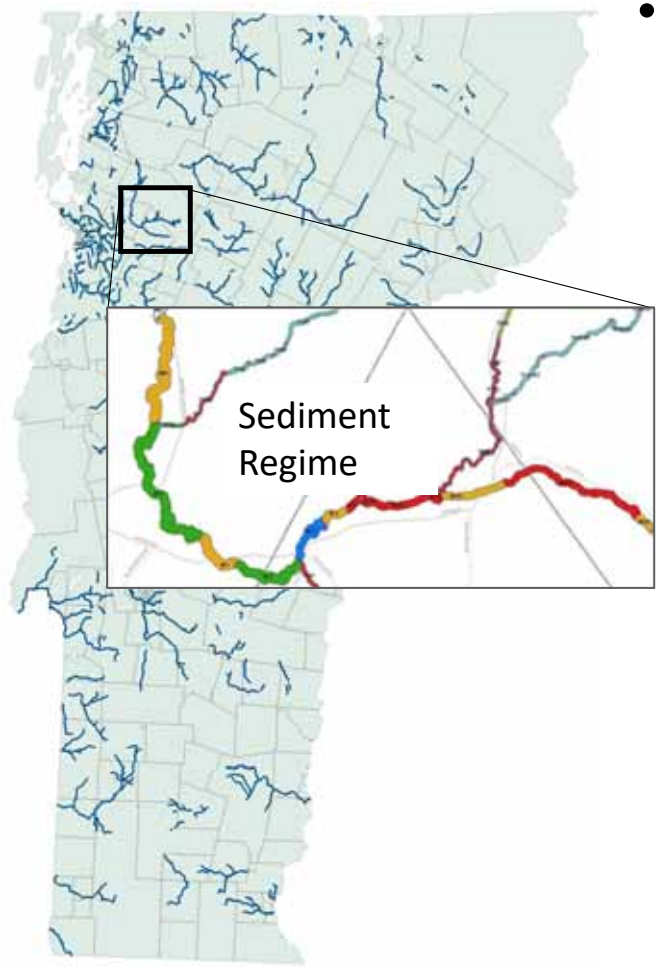
7. **Project Management & QAPP Development**
   - Minutes from the quarterly progress meetings
   - QAPP

➢ Continued outreach and education on connected floodplains.

Sea Grant Sediment Regime Research

Kristen Underwood, Lindsay Worley, Mike Kline, Beverley Wemple, Donna Rizzo

Building on VTANR Stream Geomorphic Assessment Data



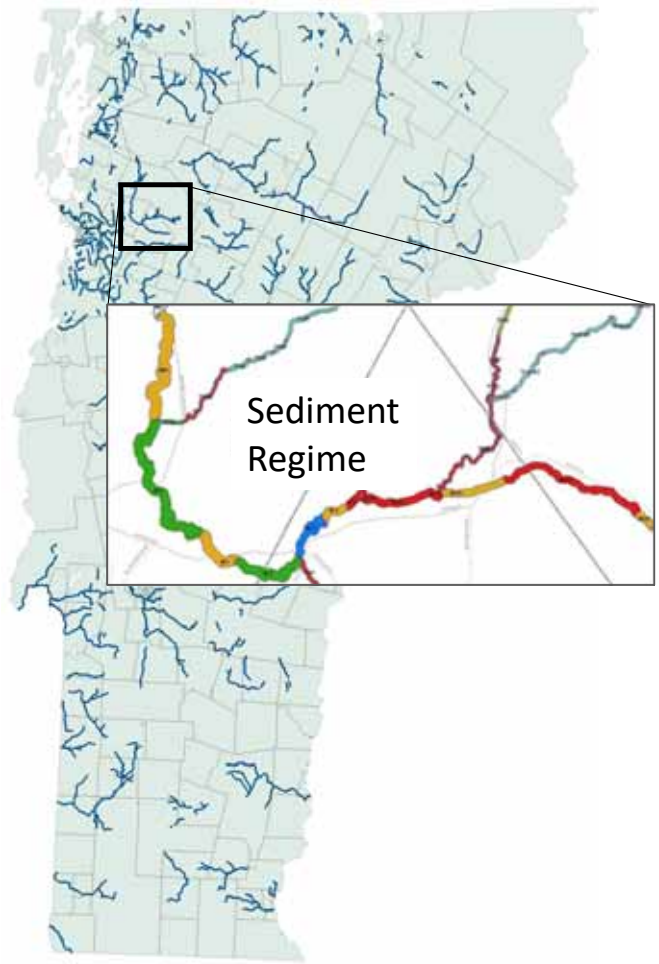
- Great variety in sediment sourcing, transport & deposition
  - Implications for water quality, flood resiliency, habitat

Confined

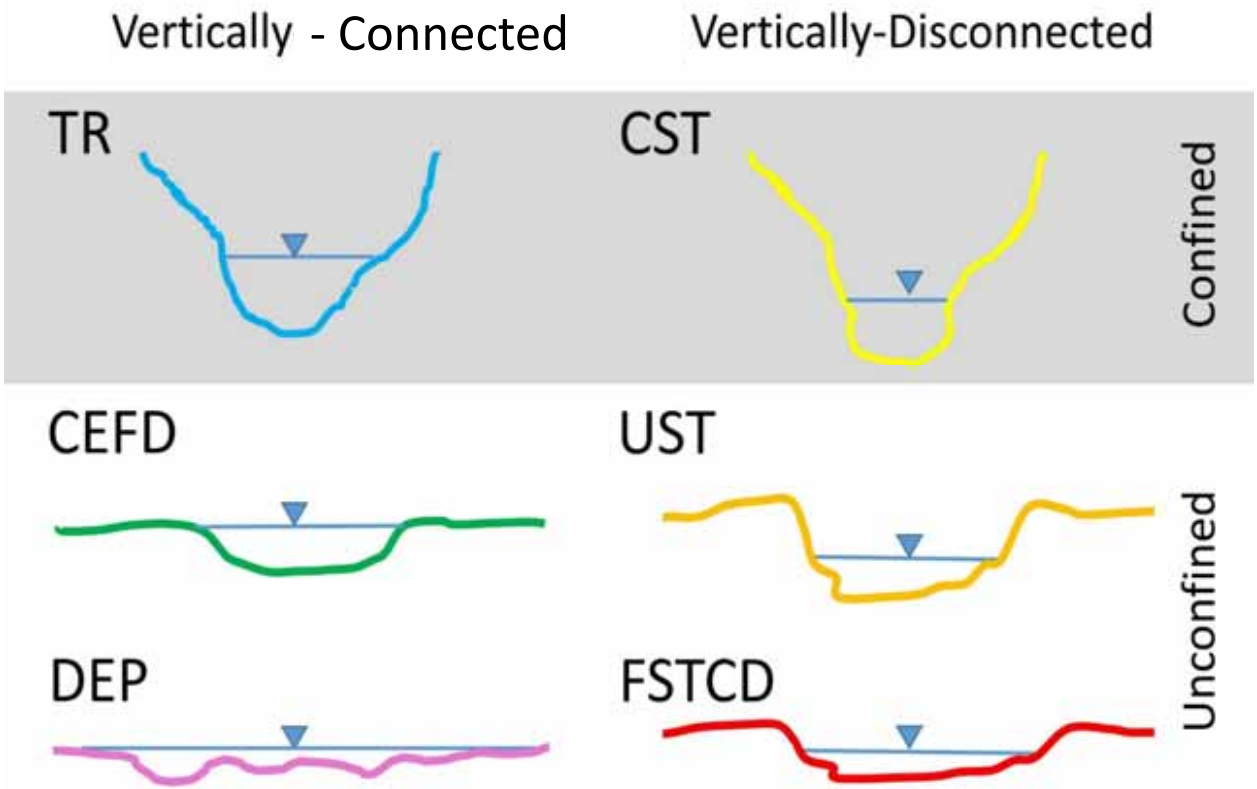
Unconfined

With support from Lake Champlain Sea Grant, leveraging EPSCoR RACC

Smart Classifiers to Map Sediment Regime

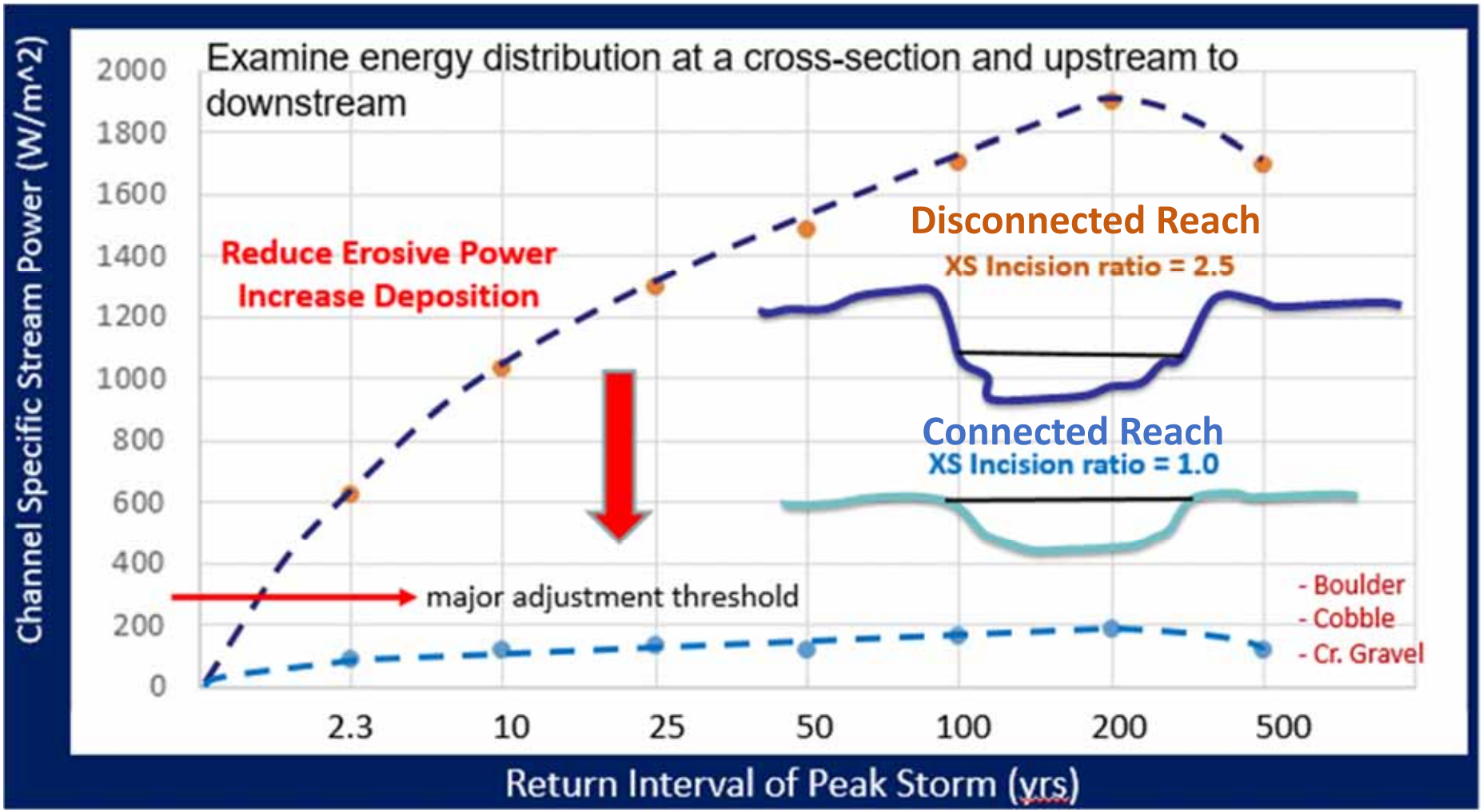


6 Sediment Regime Classes from
VTANR River Corridor Planning Guide (Kline, 2010)



With support from Lake Champlain Sea Grant, leveraging EPSCoR RACC

Characteristic Stream Power Signature by Regime Class



LCBP Floodplain Research Project

Rebecca Diehl, Beverley Wemple, Kristen Underwood, Don Ross, Jesse Gourevitch

Floodplain Mapping for the Lake Champlain Basin

Low-complexity, topographically-based approach to identifying inundation extents

(1) HAND maps

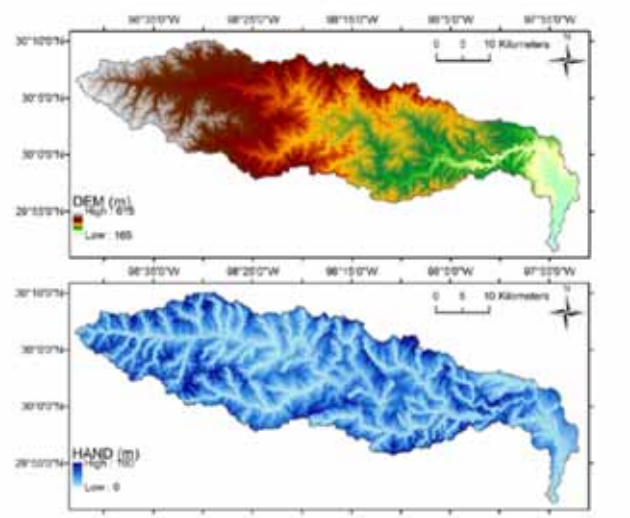
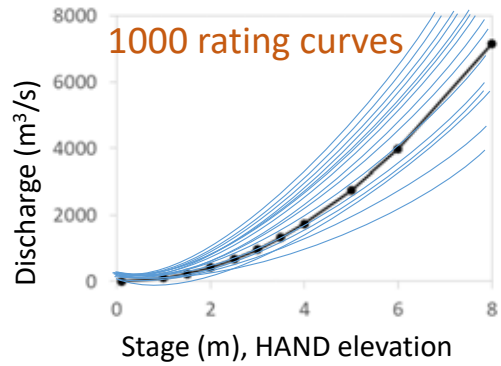


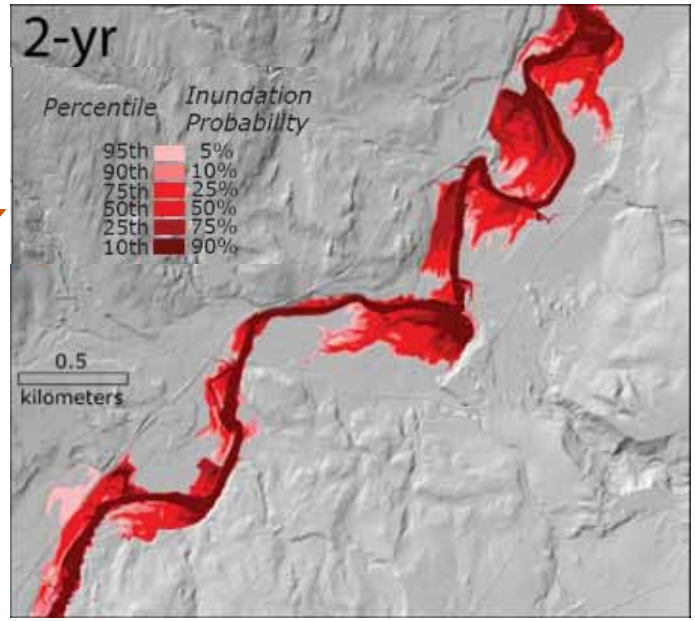
FIGURE 7. DEM and HAND for the Blanco River watershed.

Account for uncertainty as a result of measurement error, limited data, and process simplification

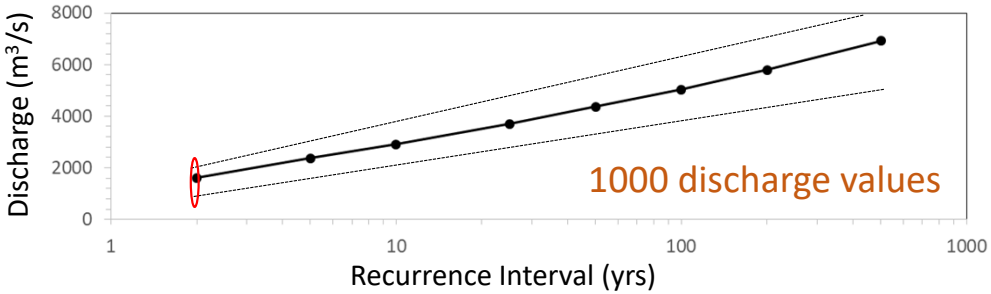
(2) Stage-Q Rating Curve



Probabilistic Floodplain Maps



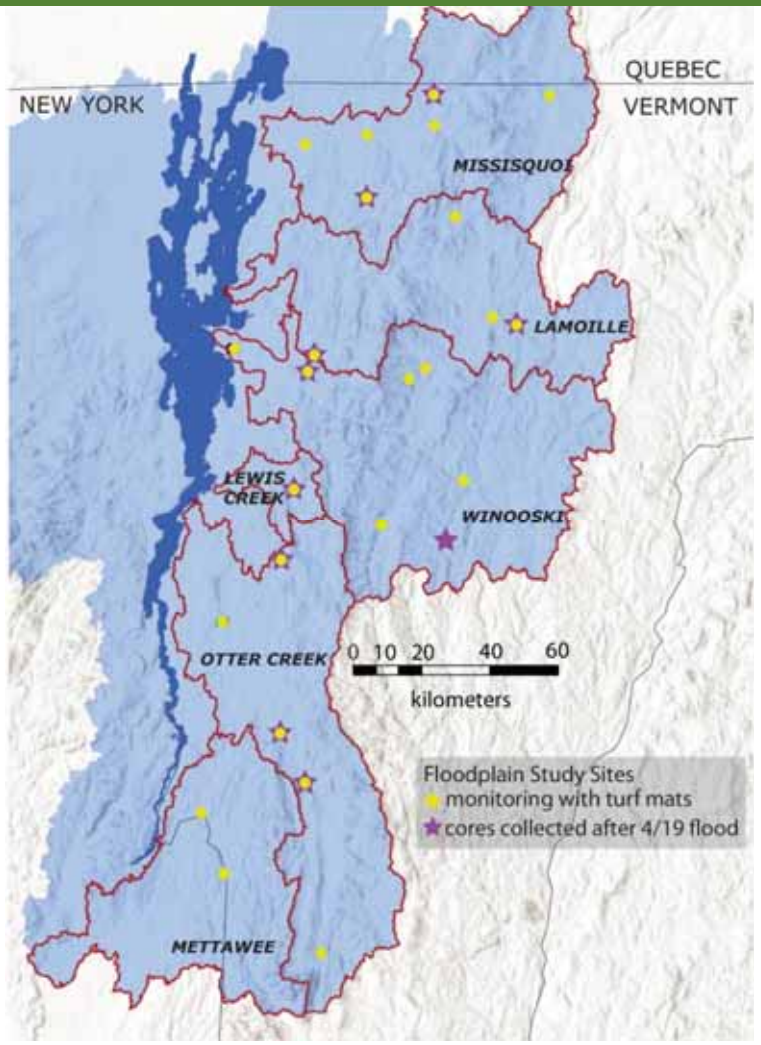
(3) Flood Frequency



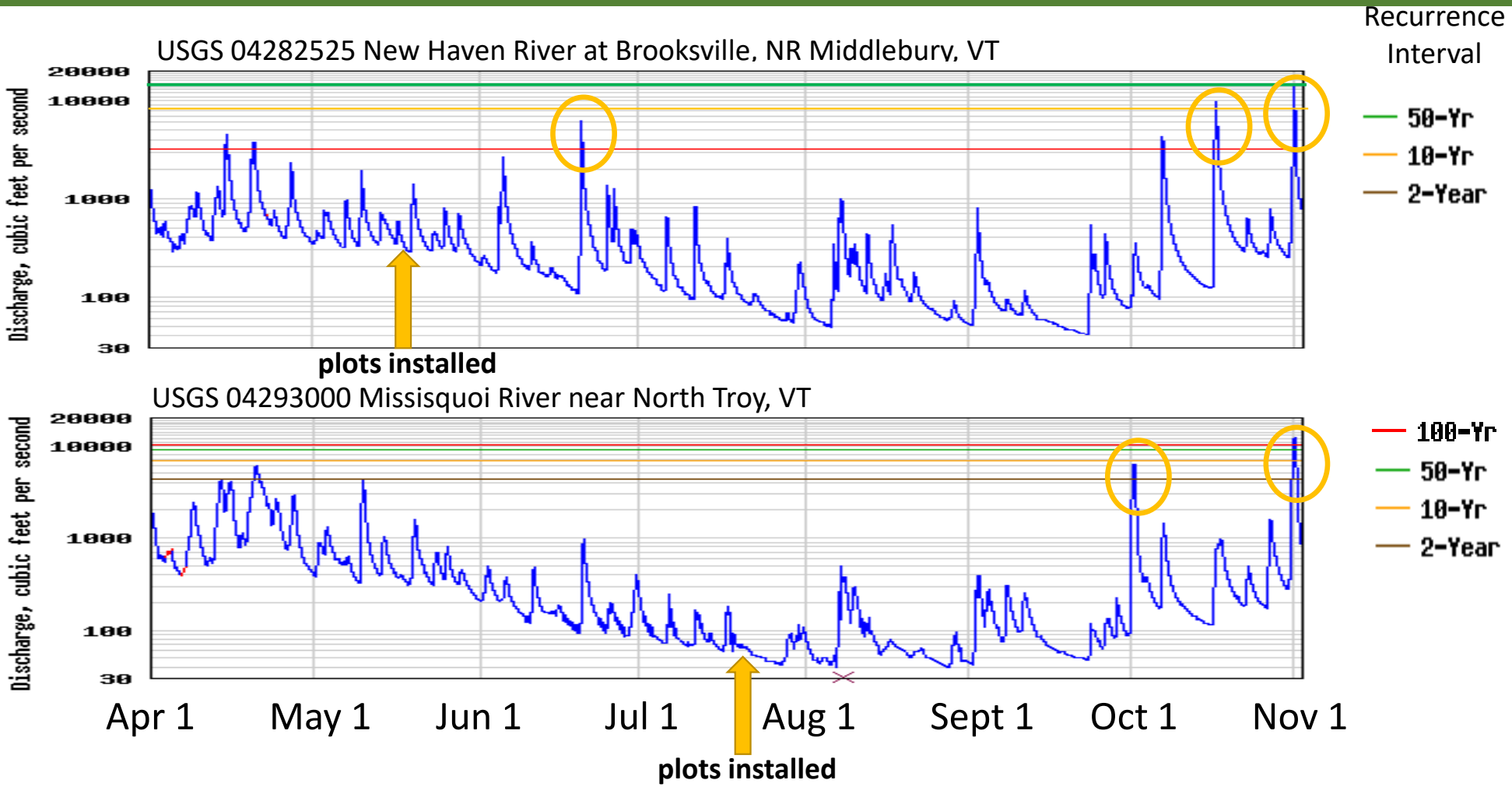
Diehl, R., J. Gourevitch, S. Drago, B. Wemple, 2020. Improving flood risk datasets using a low-complexity, probabilistic floodplain mapping approach, PLOS ONE, in review.

Building an understanding of sediment and P retention

+ 183 plots at 25 sites
+ Measure event-scale sedimentation

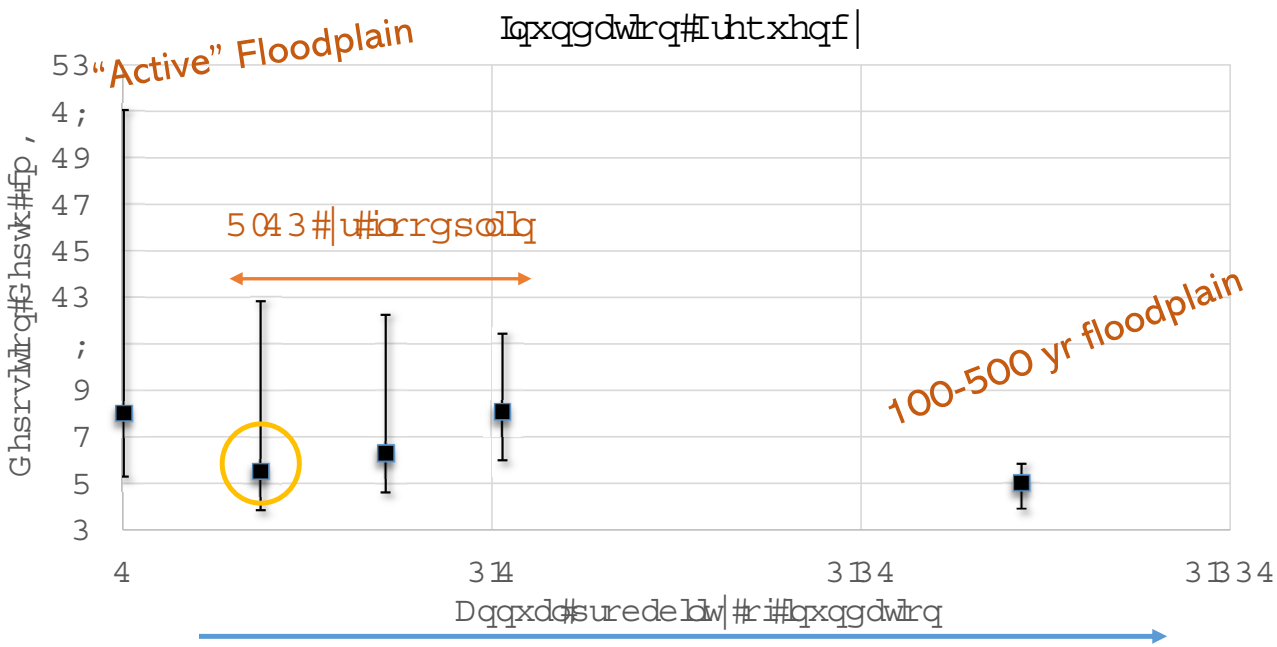


2019 Floods with Floodplain Inundation



Graphs courtesy U.S.G.S.

Predicting Sediment and TP Retention



Local Controls

+ inundation frequency
+ topography
+ channel
+ width/floodplain width,
+ slope, etc

Watershed Controls:

+ land use
+ soils
+ geology, etc.

**Results are preliminary. Still processing and analyzing data*

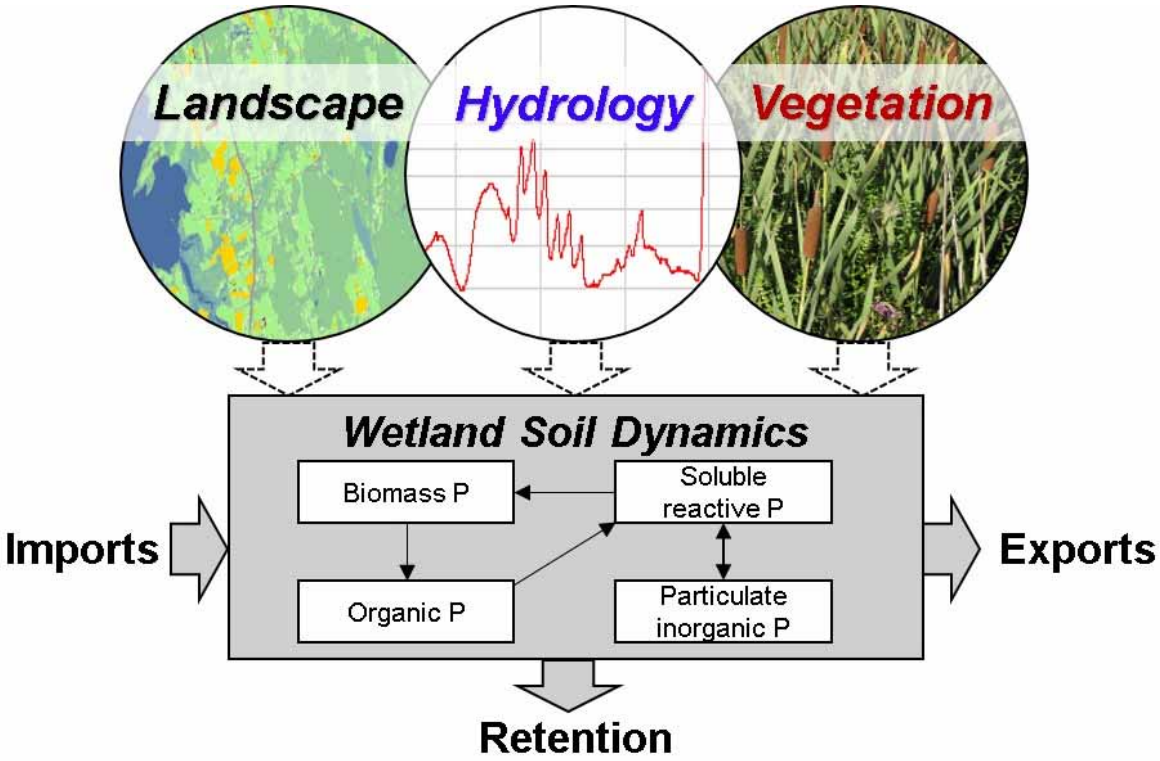
LCBP Wetland Research Project

Eric Roy (PI), Adrian Wiegman (PhD student), Maya Fein-Cole (MS student)

UVM Nutrient Cycling & Ecological Design Lab

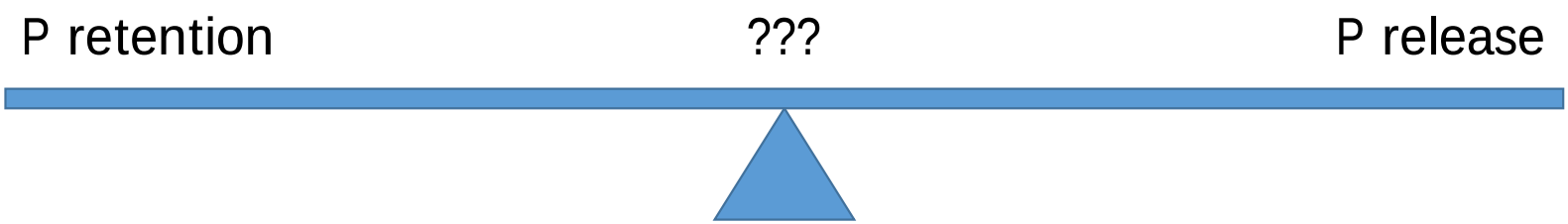
Eric Roy (PI), Adrian Wiegman (PhD student), Maya Fein-Cole (MS student)
Collaborators: B. Bowden, K. Underwood, & FFI Team

We combine field monitoring, laboratory studies, and modeling to study P retention in restored riparian wetlands



Lake Champlain

A question of mass balance

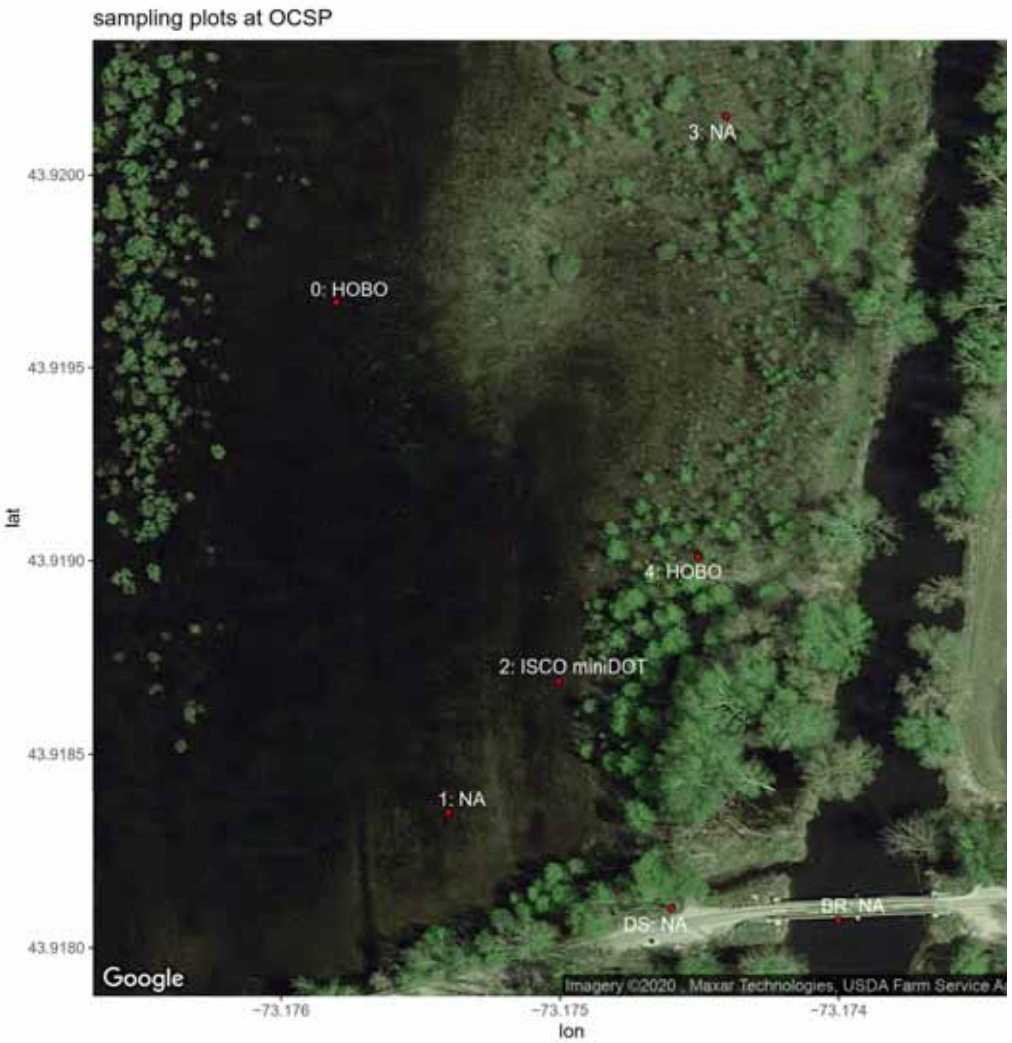


Possible mechanisms of P retention	Possible mechanisms of P release
Retention of particles during floods	Erosion of particles during floods
Assimilation of P into organic matter & accretion in soils	SRP release from organic matter via decomposition
Sorption of P to soils	Desorption of P from soils
Diffusion of SRP into soils	**Diffusion of SRP out of soils**

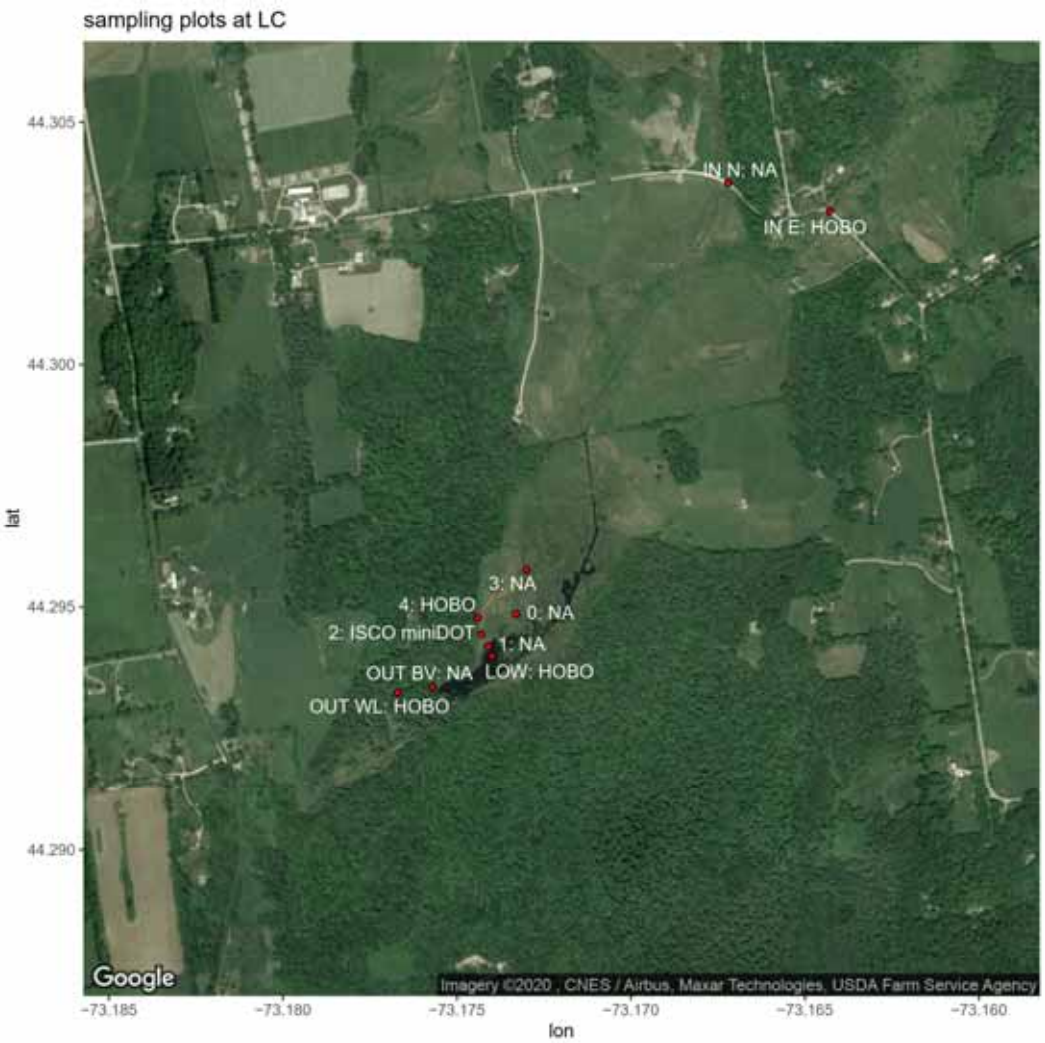
We are measuring & modeling all of these at 3 sites in our LCBP project

SRP = soluble reactive phosphorus

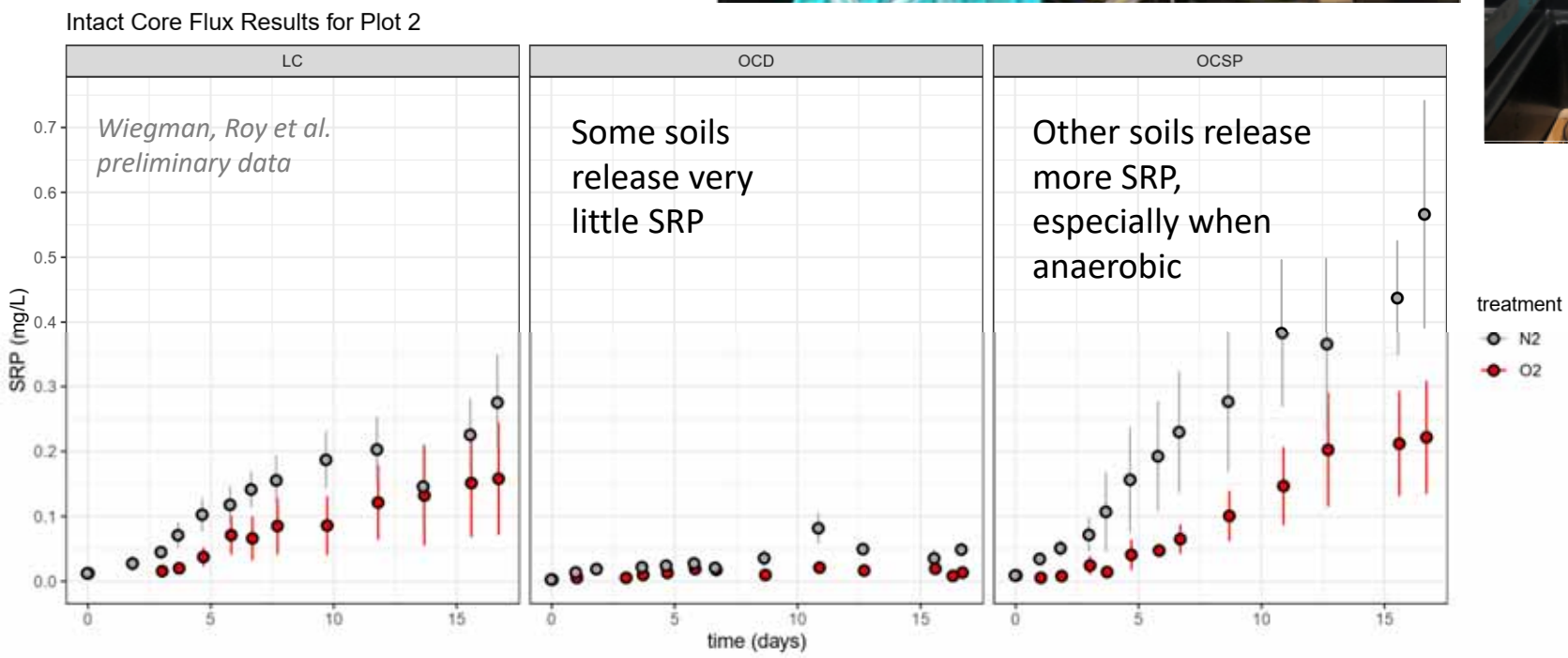
Our LCBP-funded research currently involves 2 sites along Otter Creek…



… and 1 site along Prindle Brook (Lewis Creek watershed)



Intact cores to measure SRP release during simulated flooding

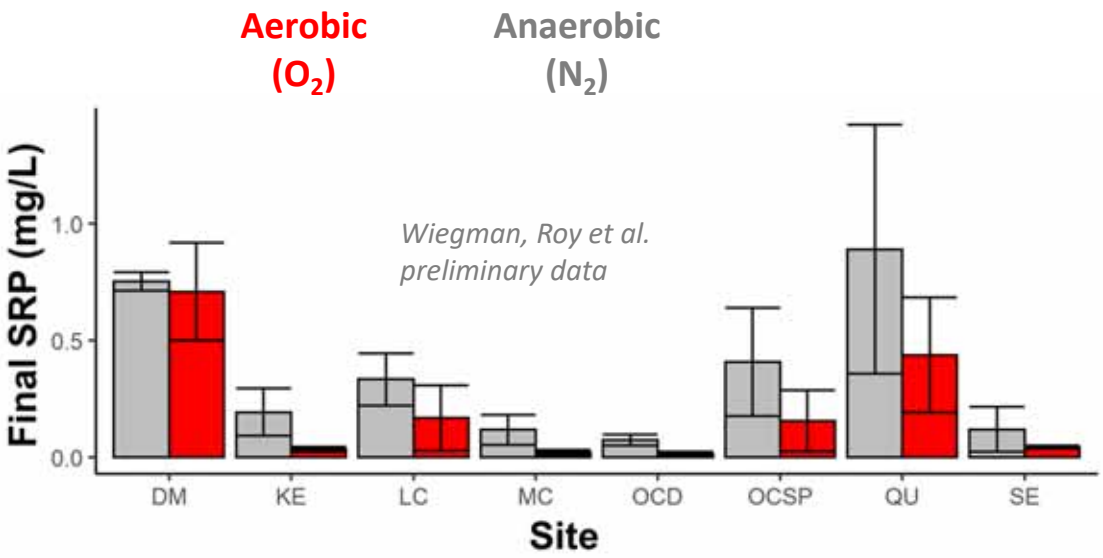


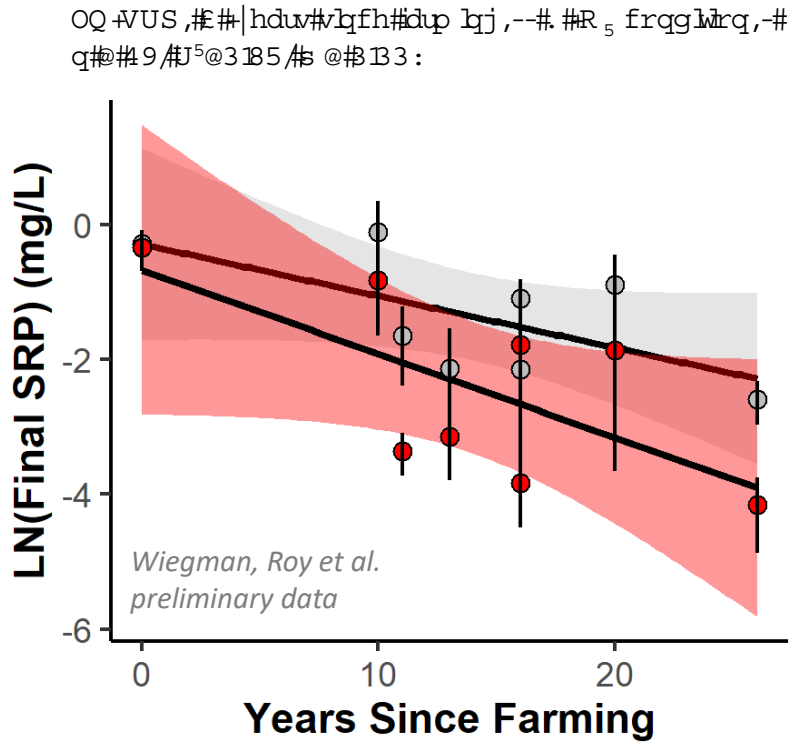
Preliminary Results - Intact Cores

SRP release varies by site & oxygen treatment in the lab*

We are developing indicators for use at site & landscape scales

Early results suggest decline in SRP loss over time after farming stops

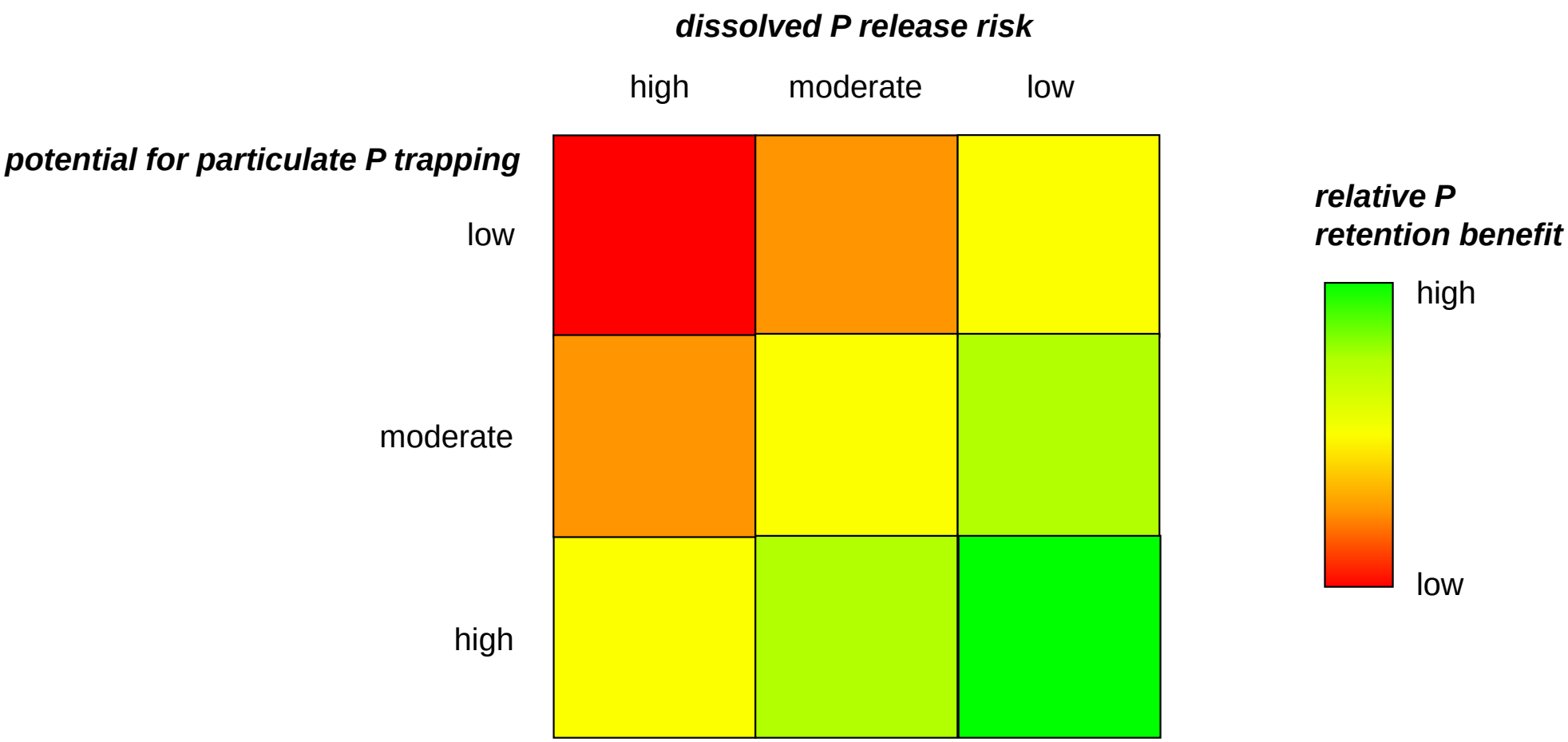




*Field measurements ongoing at 3 LCBP sites to verify lab results

But how does SRP loss compare to P capture in sediment during floods?

Towards decision support for wetland restoration aiming to reduce P loads



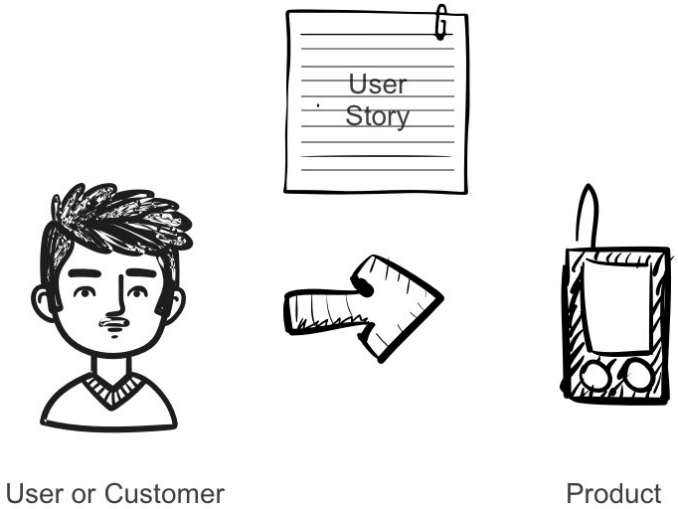
Functioning Floodplain Web Application Developing User Stories

Jody Stryker, Barb Patterson

Web Application User Stories

We want to know how the Functioning Floodplain web application can help you conduct a specific task or analysis.

A **User Story** explains a feature of a product – in this case the FFI web application – that is told from the user's perspective. User Stories are helpful to capture a specific functionality, such as searching for a project type.



Web Application User Stories

First tell us about yourself!

What is your role as it relates to the Functioning Floodplain Application?

- User who will explore river and floodplains layers and data
- User who will actively track projects and restoration
- User of outputs provided to you from the application

What type of user are you?

- Are you familiar with the Functioning Floodplain concepts?
- Do you understand GIS?
- Are you likely to spend a lot of time using the application?
- Are you looking for quick answers?

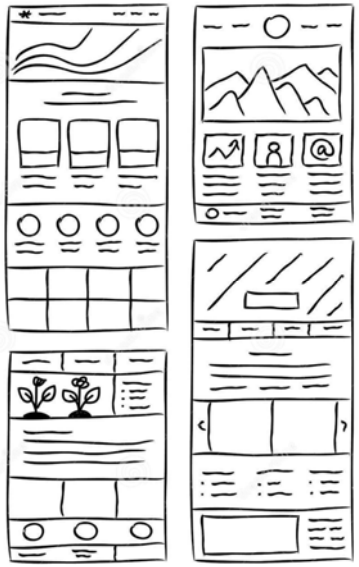
Web Application User Stories

Write your stories so that they are easy to understand. Keep them simple and concise. Avoid ambiguous terms and use active voice. Focus on what's important and leave out the rest.

<u>Example:</u>
As a <DEC Basin Planner>

I want to <develop a set of priority stream, wetland, and floodplain projects that have high feasibility and cumulatively represent an estimated phosphorus load reduction target>

so that <the DEC is able to allocate that load reduction in a contract with the CWSP in accordance with Act 76>



OR

Draw us a picture! Share with us what you would like to *see* when you open the Functioning Floodplain Initiative web application.

Web Application User Stories

Write A LOT of user stories – the more the better!

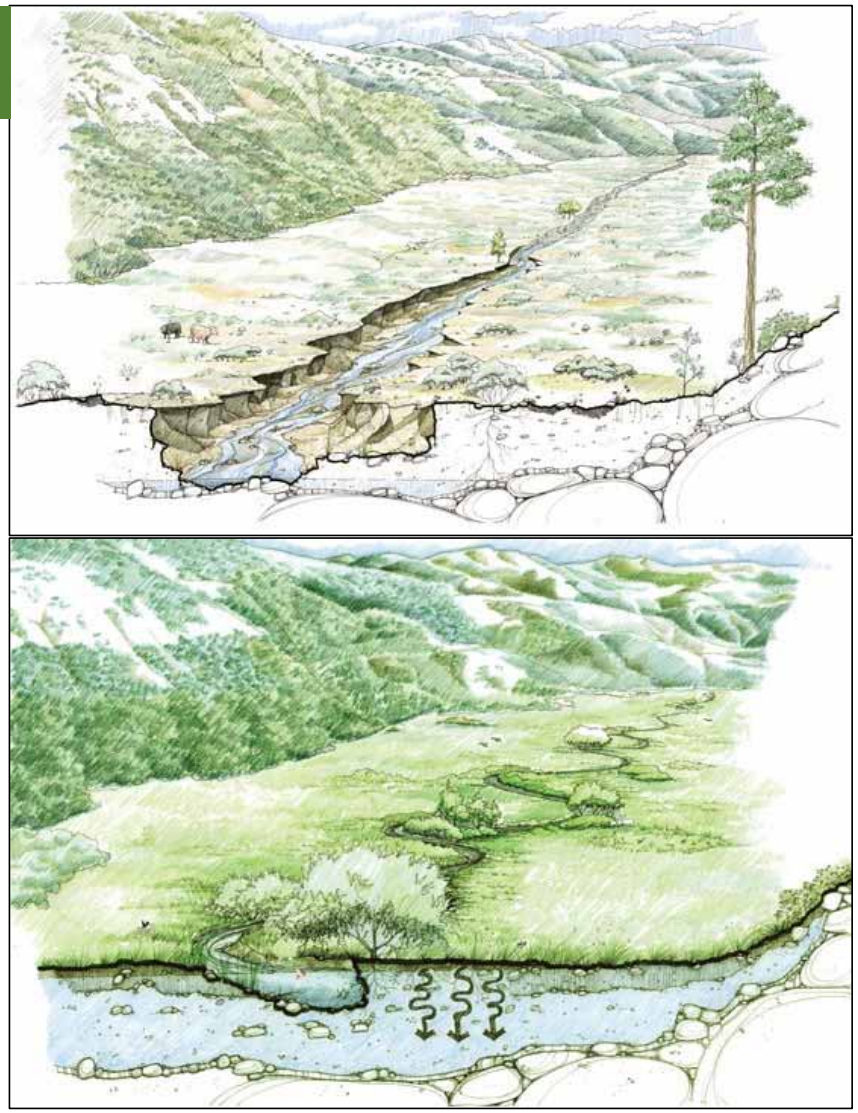
Please add your user stories to the Excel template provided.

Feel free to include photos of your drawings if you feel they will be helpful!

Return completed user stories to jstryker@stone-env.com

Next Steps

- Stakeholders to complete the user story exercise
- Start planning web application based on stakeholder input
- Complete the ongoing QAPP process
- Update FFI visuals
- Continue field data collection
- Initiate literature research on project costs and valuation
- Develop methods for merging phase 1 and 2 data



(American Rivers, 2020)

Thank You

Source: Lars Gange & Mansfield Heliflight, August 31, 2011

Extra Slides

Functions and Values of River Corridors and Floodplains

River Corridors / Floodplains

	100 / 0	75 / 25	50 / 50	25 / 75	0 / 100
Maintain least-erosive stream bed and banks = 80/20	*				
Provide for the movements of fish and wildlife = 60/40			*		
Store and exchange sediment, nutrients, organics (carbon) = 50/50			*		
Provide for habitat mosaics and biological productivity = 40/60				*	
Slow flood water & reduce peaks, maintain groundwater levels = 25/75				*	