WATERSHED EFFECTS ON SUCCESS OF STREAM RESTORATION FOR EXCESS NITROGEN MITIGATION

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General Restoration Questions from RFP:

1. What are the cumulative effects of watershed restoration activities within a watershed?
2. What percentage of a catchment needs to be treated…? Does the location of [stream restoration] practices within the catchment make a difference…?

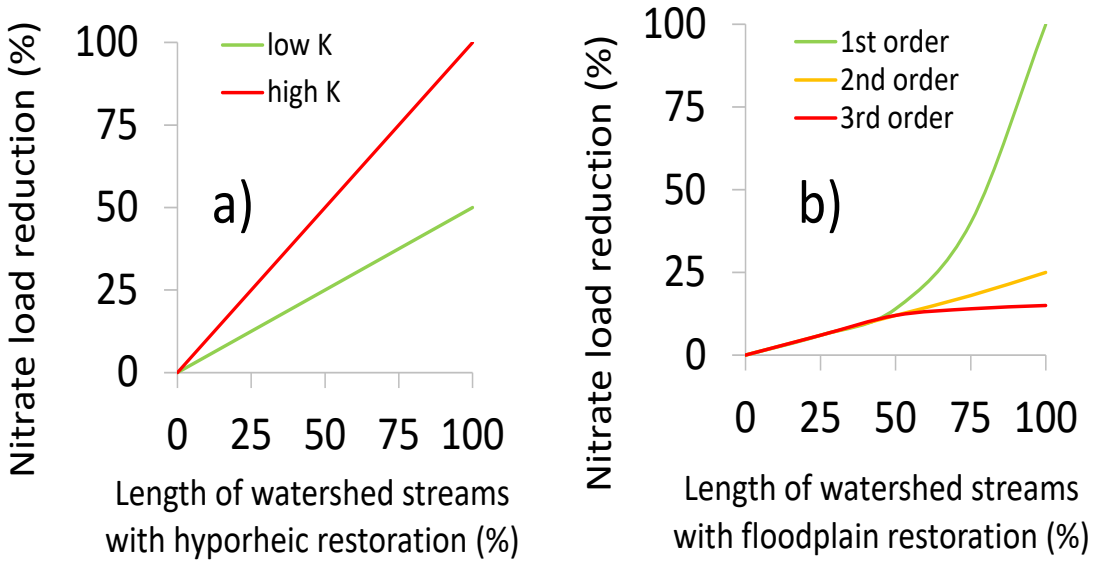
Research Questions and Hypotheses

Restoration Questions from Proposal

1. What is the slope and shape of the relationship between percent of stream network restored and percent nitrate load reduction at the watershed outlet (i.e., linear, exponential, levelling off)?

2. How do the answers to Question #1 above vary with
   - Distribution of nitrate sources in the watershed
   - Restoration technique
   - Restoration location
   - Watershed topography
   - Soil type

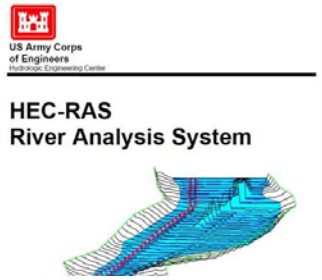
Example Graphic **Hypotheses**



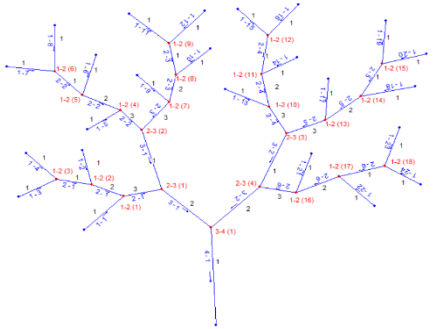
Project Tasks

Task 1 (mostly finished). Generate literature database of nitrate removal rates.

Task 2 (finished). Select model software (1D HEC-RAS w/auxiliary R script).



Task 3 (partly finished). Model generic watershed with literature rates to answer research questions.



Task 4 (not started). Model case study watershed to demonstrate applied value.

Task 1: Nitrate removal database finished, and analysis underway

Database finished

Currently analyzing variation of removal rates with controlling factors

- Restoration status (e.g., restored or not)
- Restoration technique (e.g., channel or floodplain)
- Hydrologic status (baseflow vs stormflow)
- Stream order
- Season
- Sample location (e.g., floodplain or channel)

Task 3: Simulated flood attenuation from Stage 0/ floodplain restoration in 2nd order channel

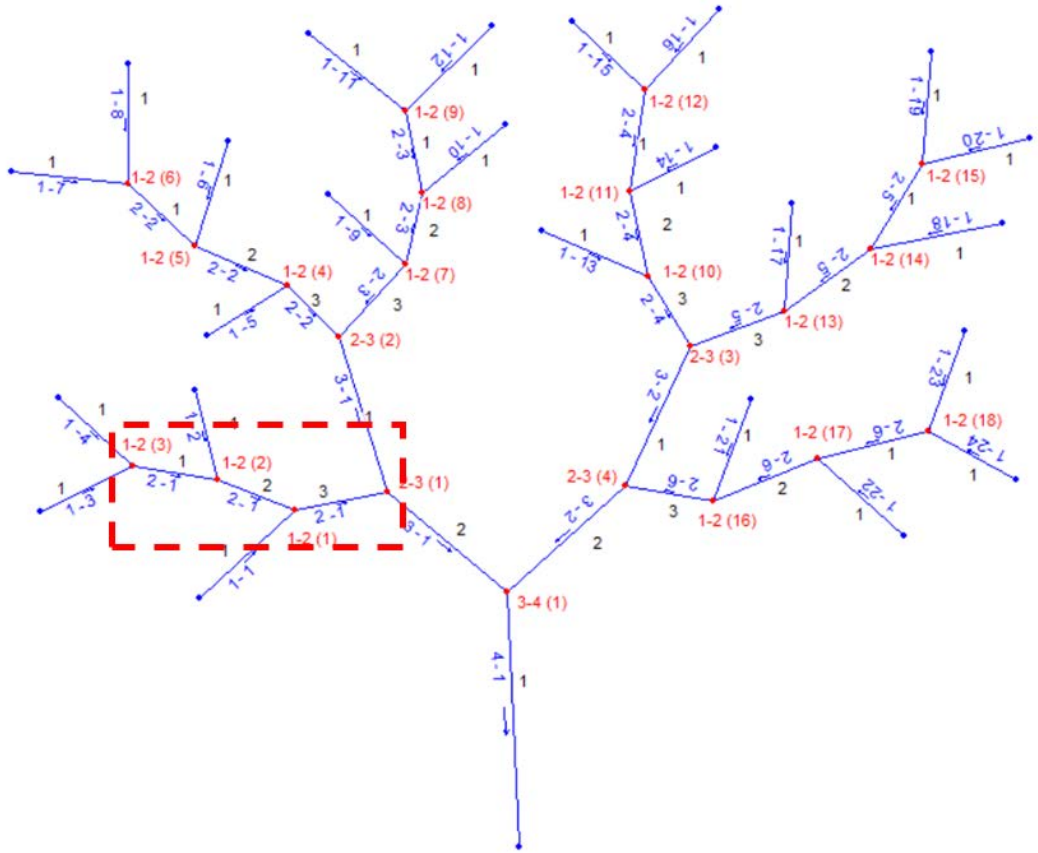
Started with:

- Stage 0 and floodplain restoration (channel restoration for hyporheic enhancement coming later)
- 2nd-order piece of larger 4th order watershed
- Hydraulics only, effect of restoration on flood wave attenuation

Varied:

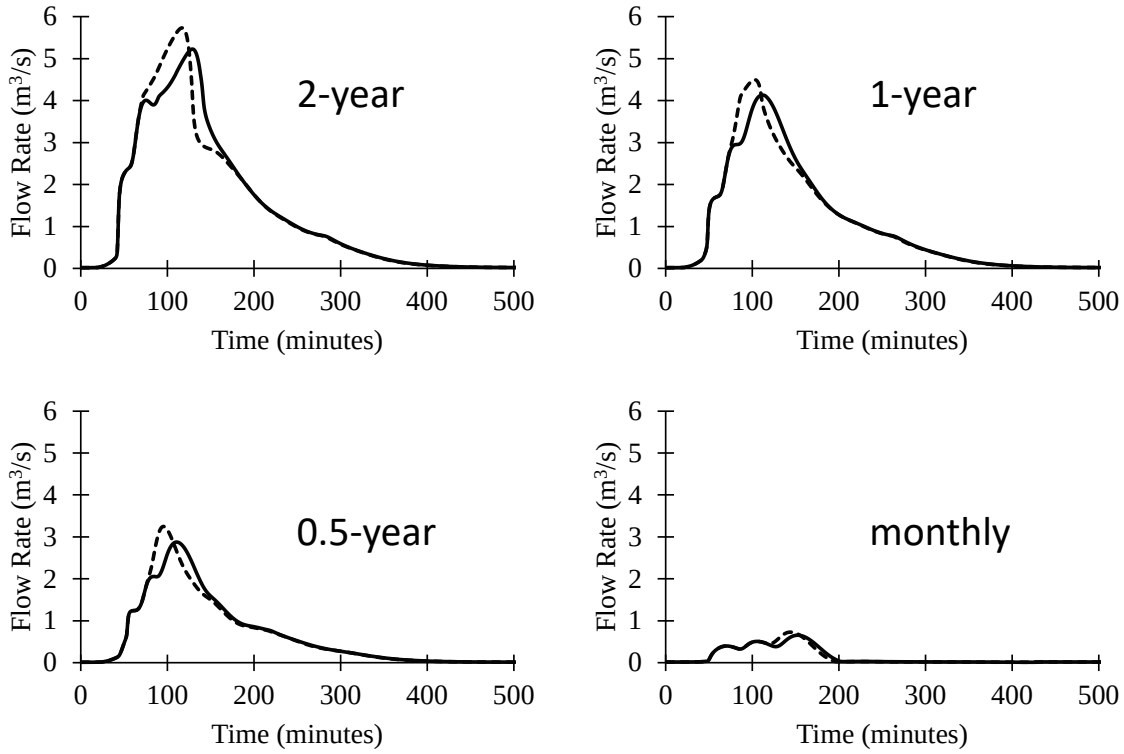
- % channel length restored
- Restoration location along channel
- Restored bank height
  - Stage 0: Low bank heights w/frequent floodplain inundation imitating pre-colonization conditions; achieved by legacy sediment removal (LSR) in floodplain or raising the streambed (RSB)
  - Bankfull floodplain restoration: Higher bank heights with floodplain inundation ~1/year
- Restored floodplain width
- Storm size (monthly, 0.5 year, 1 year, and 2 year storms)

HEC-RAS model channel schematic



Task 3: Restoration causes flood attenuation

Flood attenuation = reduced peak flow rate at downstream end of 2nd order channel for restored conditions



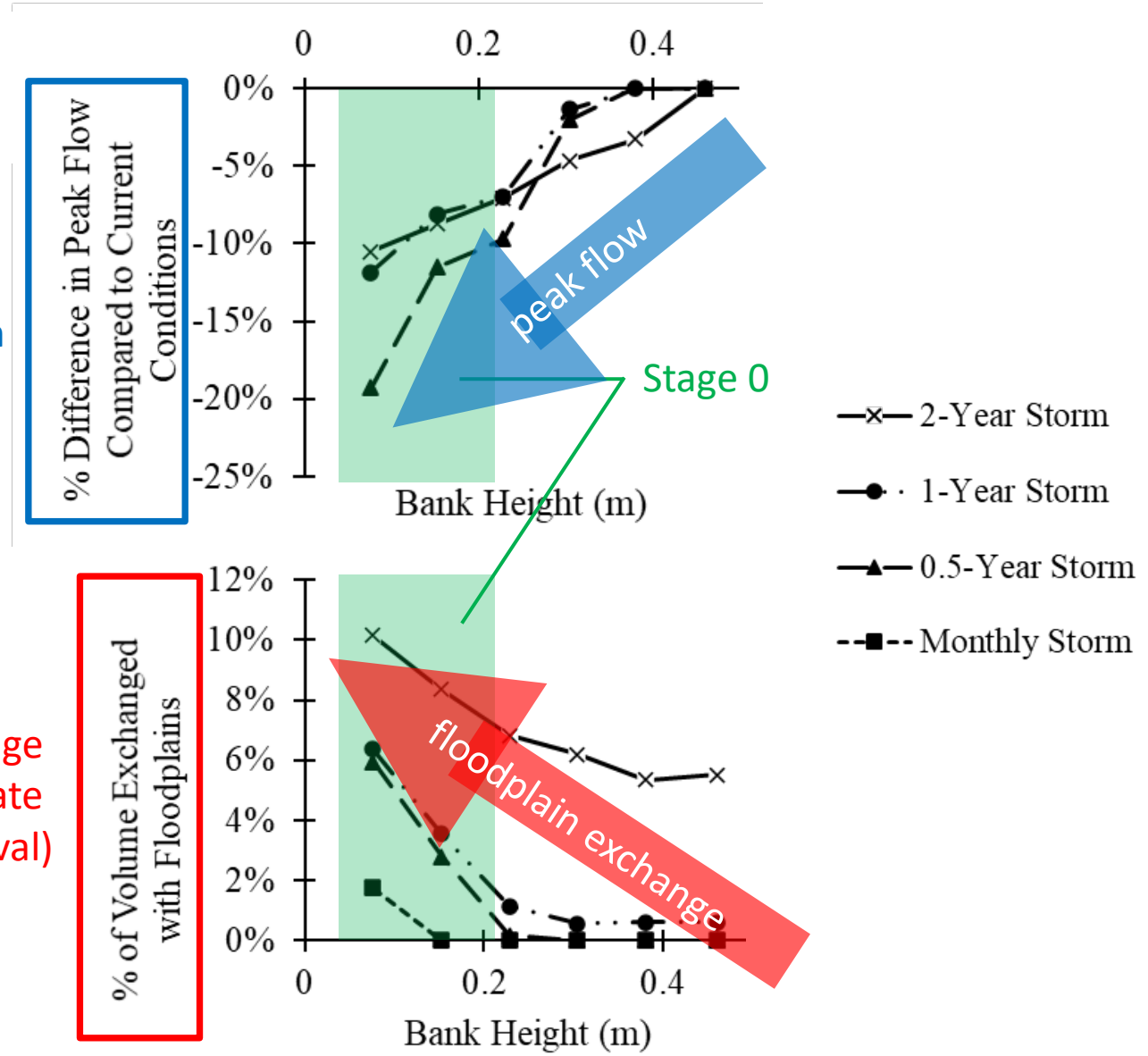
Task 3: Project effectiveness varies with restoration technique

Stage 0 (low banks) more effective than high banks (bankfull floodplain)

No tradeoff among restoration benefits; lower banks enhances both flood attenuation and floodplain exchange (water quality)

flood wave attenuation

floodplain exchange (relates to nitrate removal)



Task 3: Project effectiveness varies with location along channel

Individual projects were more effective if…

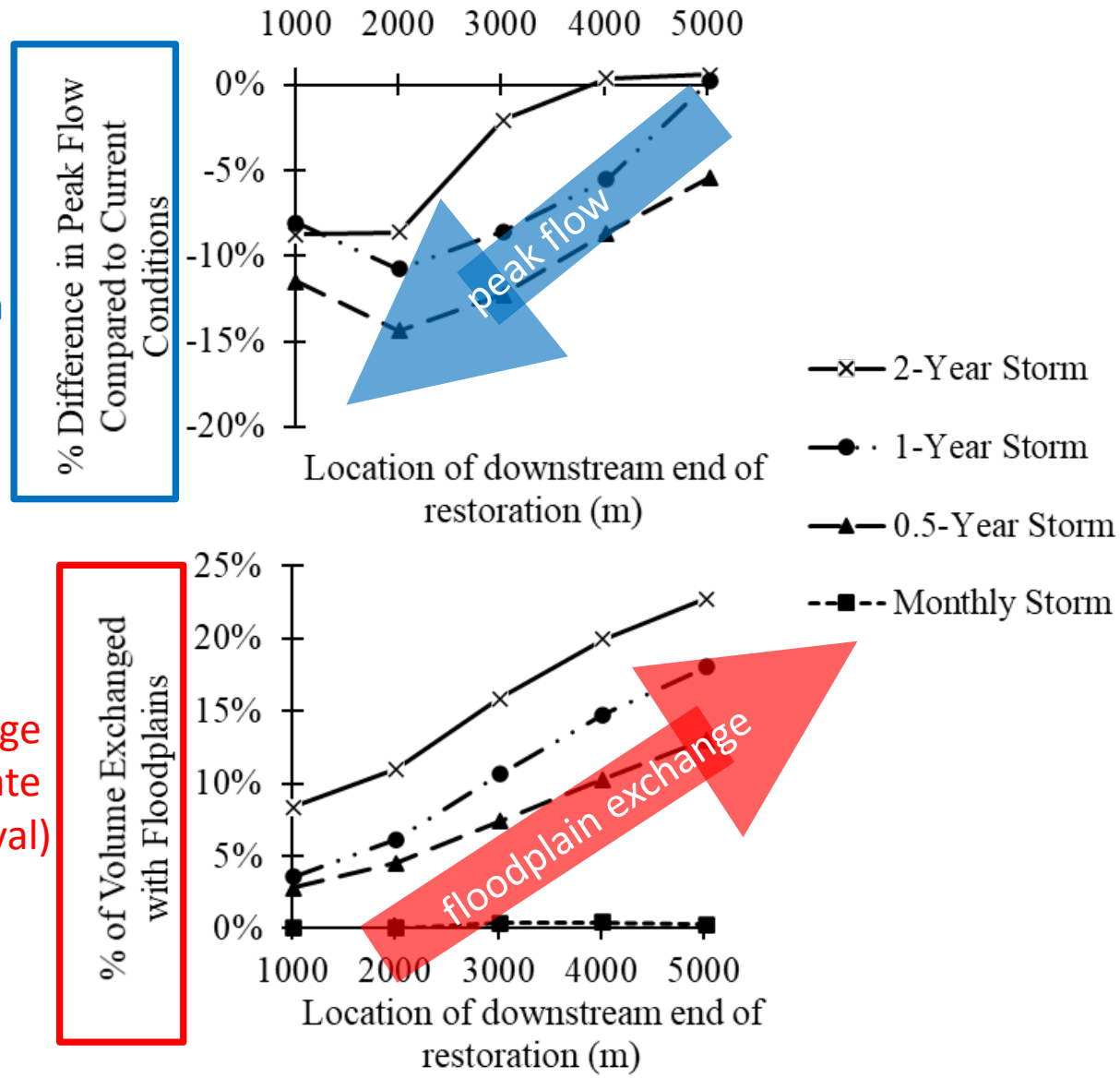
…located upstream along channel (for flood wave attenuation)

…downstream along channel (for floodplain exchange)

Tradeoff between flood attenuation and floodplain exchange

flood wave attenuation

floodplain exchange (relates to nitrate removal)



Task 3: Project effectiveness varies with percent of stream network restored

Individual projects were more effective (i.e. greater slope of curve) if…

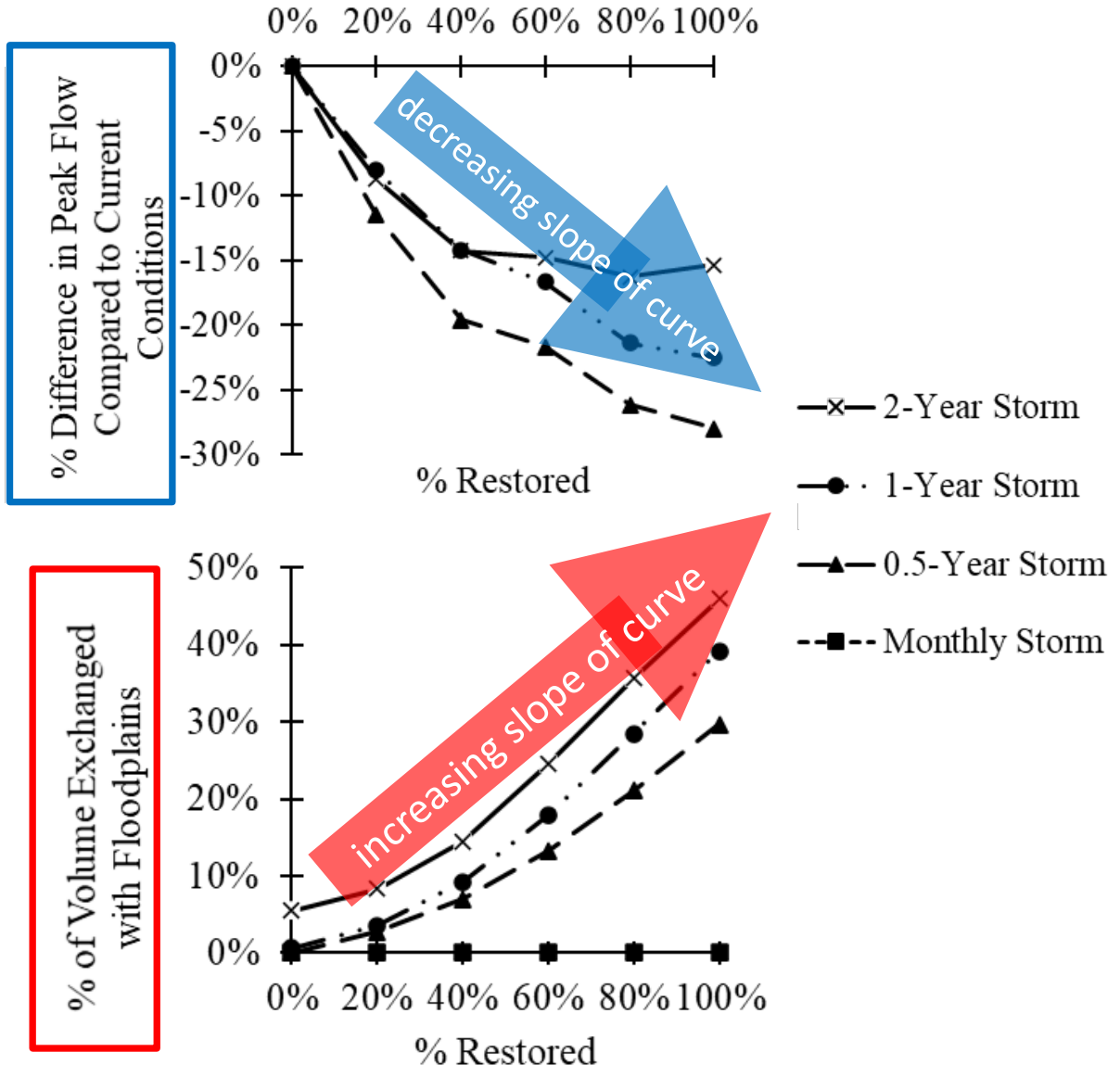
…less prior restoration (for flood wave attenuation)

…more prior restoration (for floodplain exchange)

Tradeoff between flood attenuation and floodplain exchange

flood wave attenuation

floodplain exchange (relates to nitrate removal)



From here…

Task 1: Finish analyzing variation of rates, use in Task 3 and 4 models

Task 3: Expand storm modeling to full 4^{th} order watershed, add nitrate transport/removal, add in-channel restoration techniques

Task 4: Select and model case study watershed

Thank you

The Chesapeake Bay Trust and partners the Maryland Department of Natural Resources, the National Fish and Wildlife Foundation through the Environmental Protection Agency's Chesapeake Bay Program Office, the Maryland Department of Transportation State Highway Administration, and the Montgomery County Department of Environmental Protection

What are the take home points?
What does this mean for me?

TRANSLATION SLIDES BY DAVID J. HIRSCHMAN, HIRSCHMAN WATER & ENVIRONMENT, LLC (& NFWF FIELD LIAISON)

What does this mean for me?

- Outcomes vary depending on where restoration takes place along the stream corridor.
- There are trade-offs in thinking about the effectiveness of individual projects vs. cumulative watershed affects.
- Importance of articulating design objectives and achievable outcomes.

What does this mean for me?

What do I take from this if I am a practitioner:

- Low bank height seems positive, no matter what design methodology is used.
- Design approach should be nested within the watershed context: where, how much restored, optimization of peak flow reduction, watershed storage, water quality, habitat, etc.

What do I take from this if I am a regulator:

- How do individual projects fit into a watershed framework.
- What data is needed from the design to determine desired and achievable outcomes?