SMART PLANNING AND ECOLOGICAL MODEL DEVELOPMENT: A CASE STUDY IN PROCTOR CREEK, ATLANTA, GEORGIA

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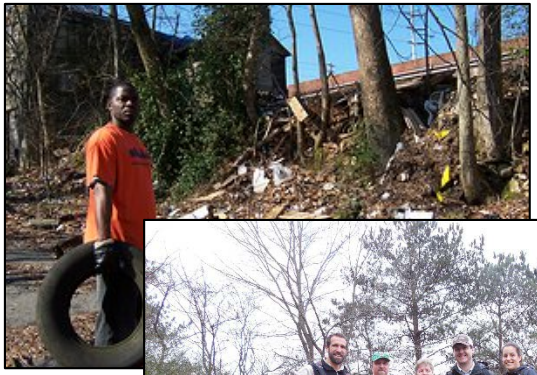
July 25, 2017

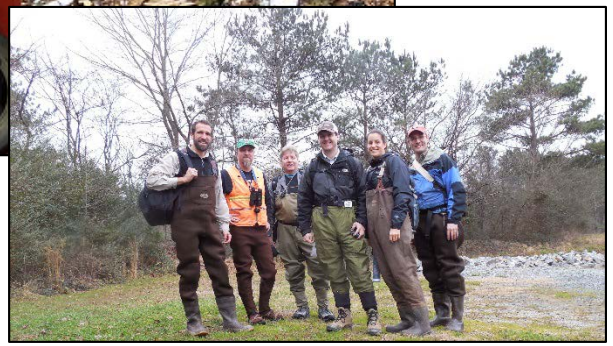
Ecosystem Restoration Webinar Series

USACE Environmental Laboratory

Collaboration, contribution, and inspiration

- Urban waters federal partnership
- USACE Team: Brian Zettle, Meredith Ladart, Nik Hallberg, Justin McDonald, Bruce Pruitt, Cheryl Hrabovsky, Vince Moody, Marshall Hayden, Todd Boatman, Allan Annaert,…
- University of Georgia: Krista Capps, Jen Rice, Brian Bledsoe, Amy Rosemond, Phillip Bumpers, Nate Tomczyk
- Proctor Creek Stewardship Council
- EcoMod Team: Todd Swannack, Brook Herman, Nate Richards,…

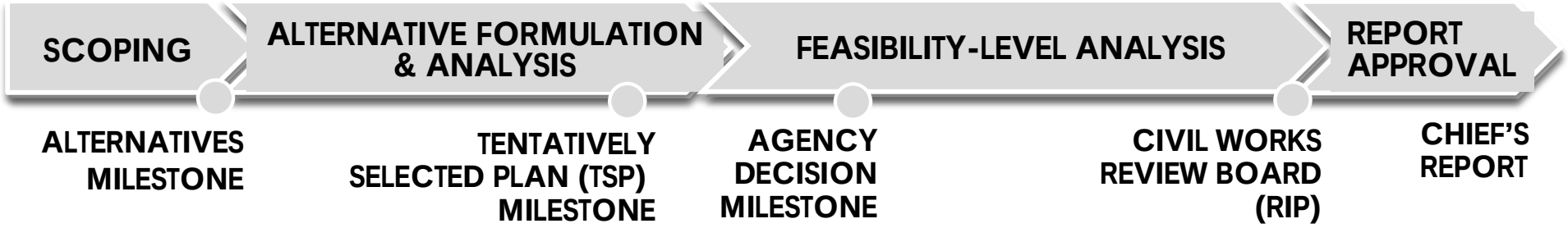




The Role of Ecological Models in SMART Planning

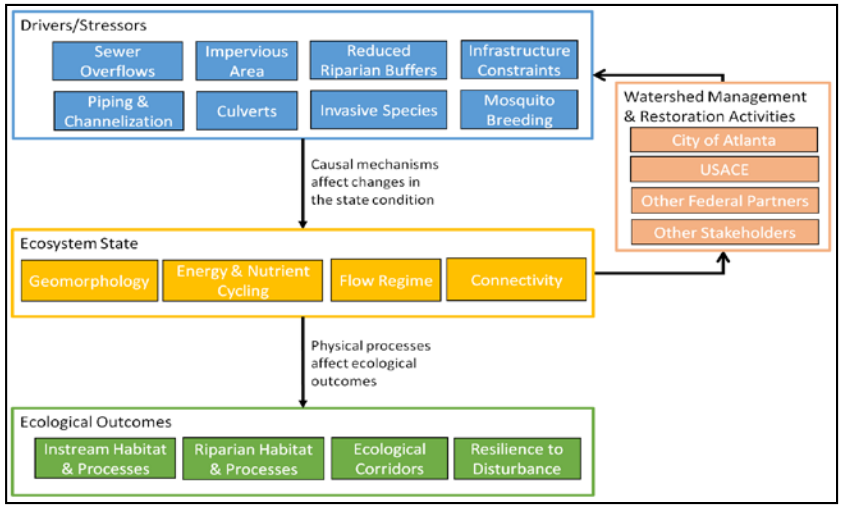
USACE SMART Planning

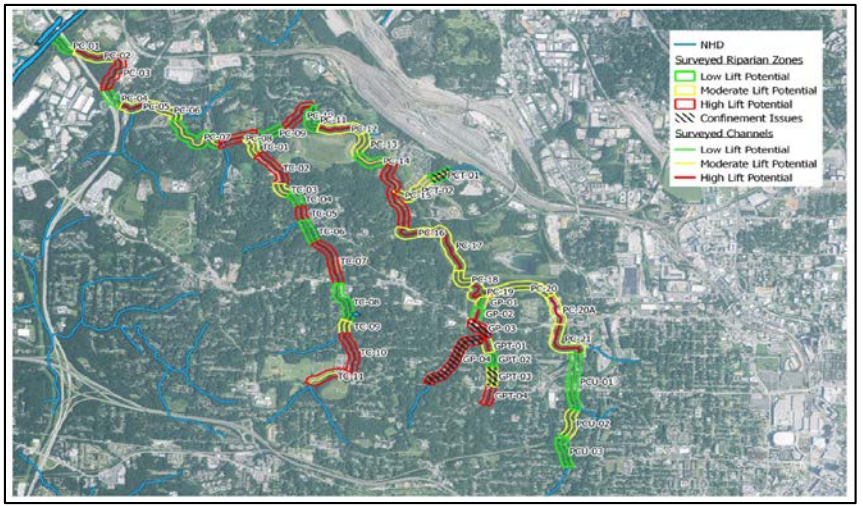
- 3 X 3 X 3 Planning Paradigm
- Iterative decision-making engaging vertical team
- Buying down uncertainty



Alternatives Milestone

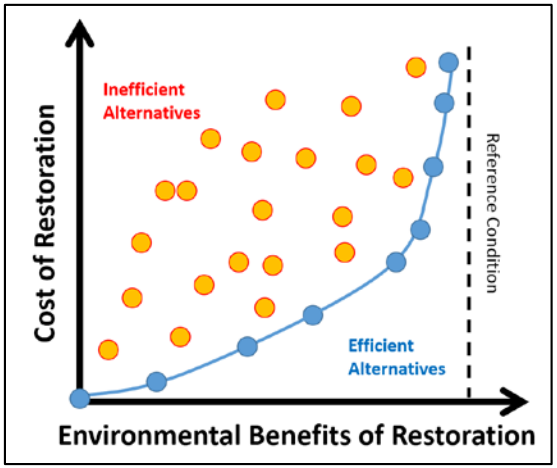
Typical Planning Goals	Potential Roles of Models
• Engage stakeholders and develop objectives • Develop list of measures • Identify sites for analysis	• Develop conceptual model and facilitate understanding • Assess applicability of measures • Screen sites for action

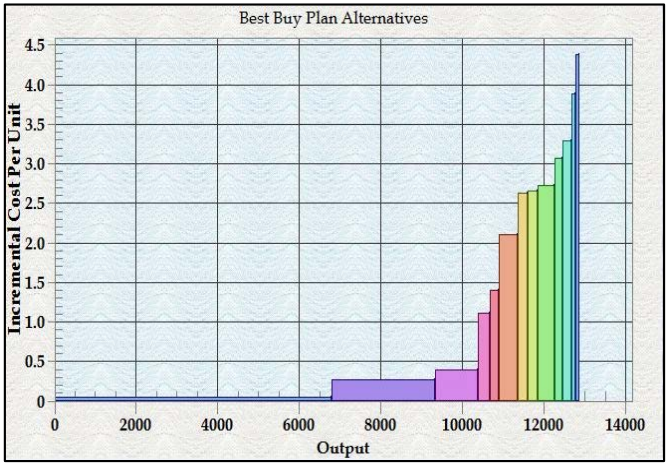




Tentatively Selected Plan (TSP) Milestone

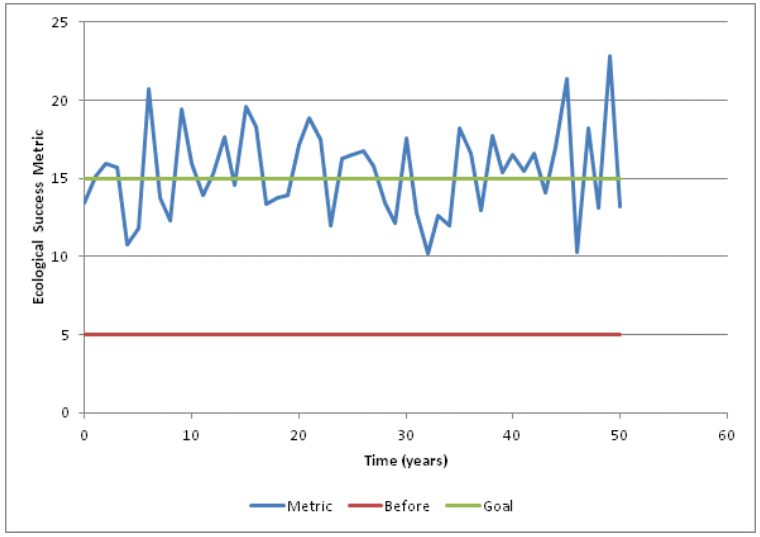
Typical Planning Goals	Potential Roles of Models
• Develop alternatives addressing objectives • Quantify benefits • Assess secondary objectives • Compare alternatives to make a recommendation	• Develop and apply a quantitative model for environmental benefits • Develop and apply models for secondary objectives • Conduct any decision modeling

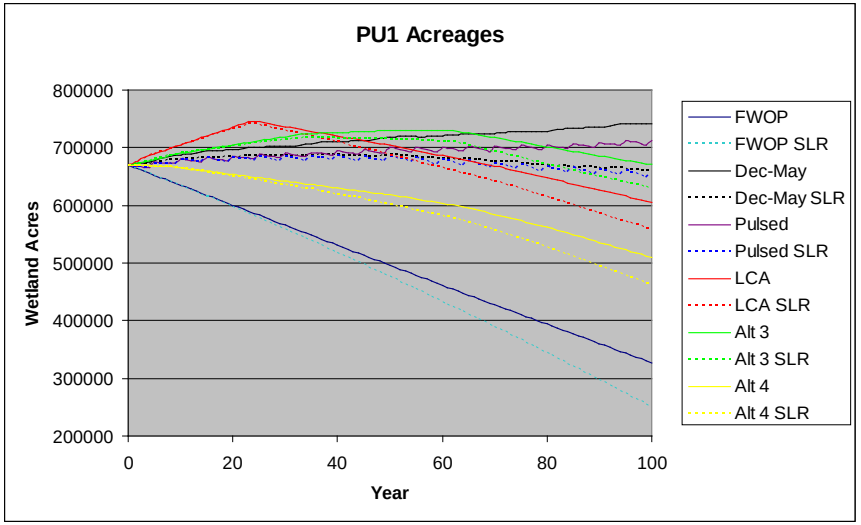




Post-ADM (Agency Decision Milestone)

Typical Planning Goals	Potential Roles of Models
• Confirm and refine TSP • Examine the sensitivity of the recommended decision • Examine potential scenarios	• Analyze sensitivity of decisions to assumptions and uncertainty • Analysis of future scenarios



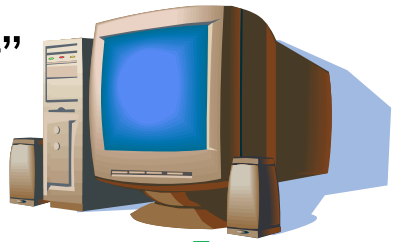


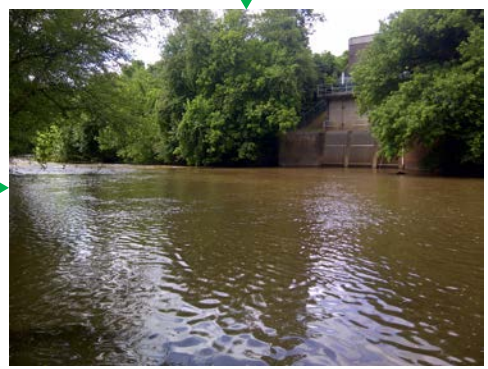
Ecological Model Development

Summarized from:
Swannack T.M., Fischenich J.C., and Tazik D.J. 2012. Ecological Modeling Guide for Ecosystem Restoration and Management. ERDC/EL TR-12-18.

What is an ecological "model"?

- Academic definition: "abstractions of reality"
- Model certification definitions (EC-1105-2-412):
  - "a representation of a system for a purpose"
  - "a way to represent a system for the purposes of reproducing, simplifying, analyzing, or understanding it"
- How I will use "model"
  - Numerical representations of environmental, ecological, or biological systems.
  - SIDE NOTE: **not** software applicable to any situation
- How I will never use "models"
  - As an answer or decision
  - As reality

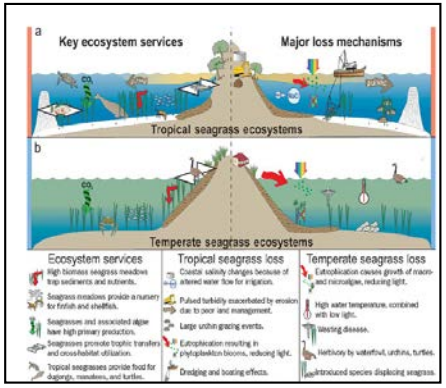




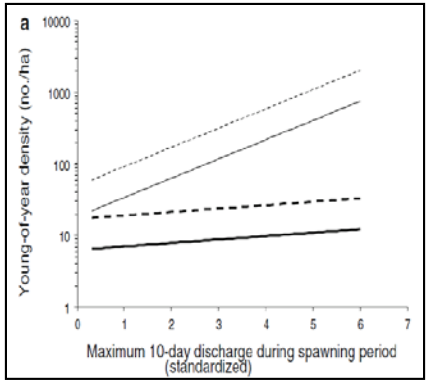
Types of Models (Examples)

Approach

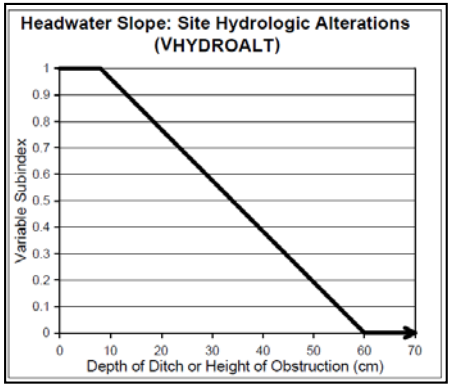
Conceptual



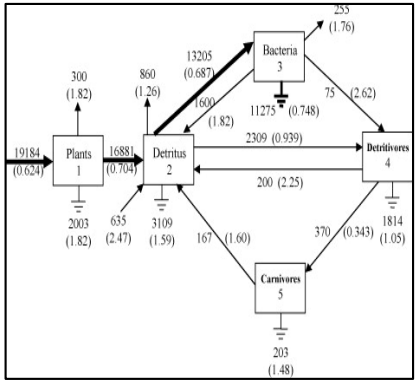
Statistical



Index-based

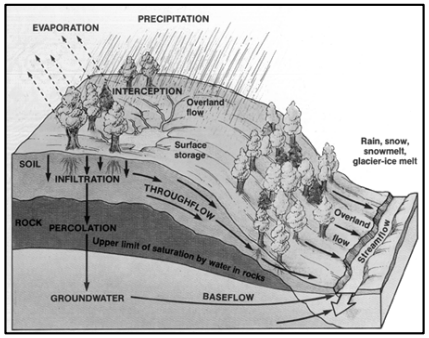


Mass Balance

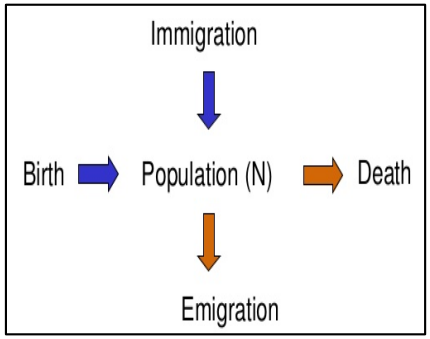


Outcome

Physical

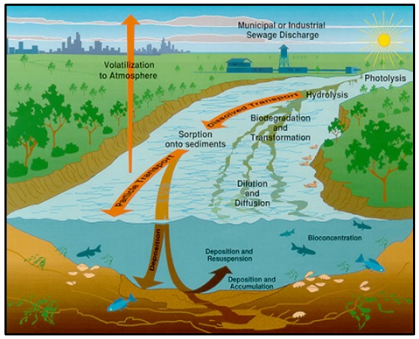


Population

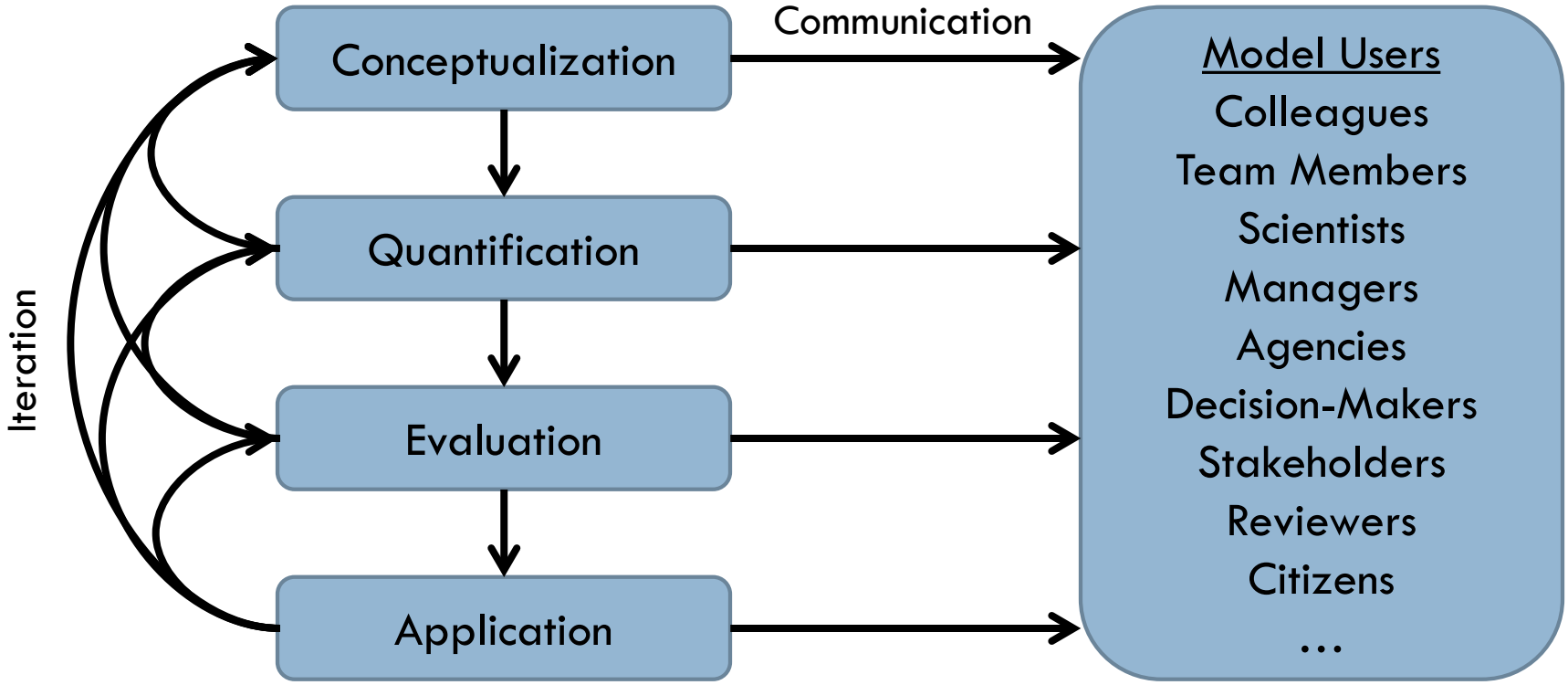


Habitat

Ecosystem



Ecological Model Development



Common Misconceptions

A model cannot be built with incomplete understanding.

- Managers make decisions with incomplete information all the time! This should be an added incentive for model-building as a statement of current best understanding.

A model must be as detailed and realistic as possible.

- If models are constructed as 'purposeful representations of reality', then design the leanest model possible. Identify the variables that make the system behave and join them in the most simple of formal structures (as simple as possible, but no simpler)!

A model cannot be built in less than 2 years.

- Models may be developed in a day, a month, or a decade. Accuracy and confidence change, but rapid development is a common modeling objective and outcome.

Proctor Creek: Project Overview

Summarized from:

McKay S.K., Pruitt B.A., Zettle B.A., Hallberg N., Moody V., Annaert A., Ladart M., Hayden M., and McDonald J. *In review*. Proctor Creek Ecological Model (PCEM): Phase 2 benefits analysis. ERDC TR-EL.

McKay S.K., Pruitt B.A., Zettle B., Hallberg N., Hughes C., Annaert A., Ladart M., and McDonald J. *In review*. Proctor Creek Ecological Model (PCEM): Phase 1 Site screening. ERDC TR-EL.

Urban Waters Federal Partnership

Proctor Creek

Textbook Example of Urban Waters

Sewer Failure

Channel Degradation & Industrialization

Sedimentation

Aligning Agency Missions (and capabilities) with Community Needs

Flood Management

Ecosystem Restoration

~~Navigation~~

Flood Management

~~Earthquakes~~

Building Codes

Urban Agriculture

Community Gardens

Culverts?

Pavement?

Sewers

Clean Air

Human Health

Development

Public Housing

Weather

~~Marine Mammals~~

~~Oceans~~

What are we trying to accomplish?

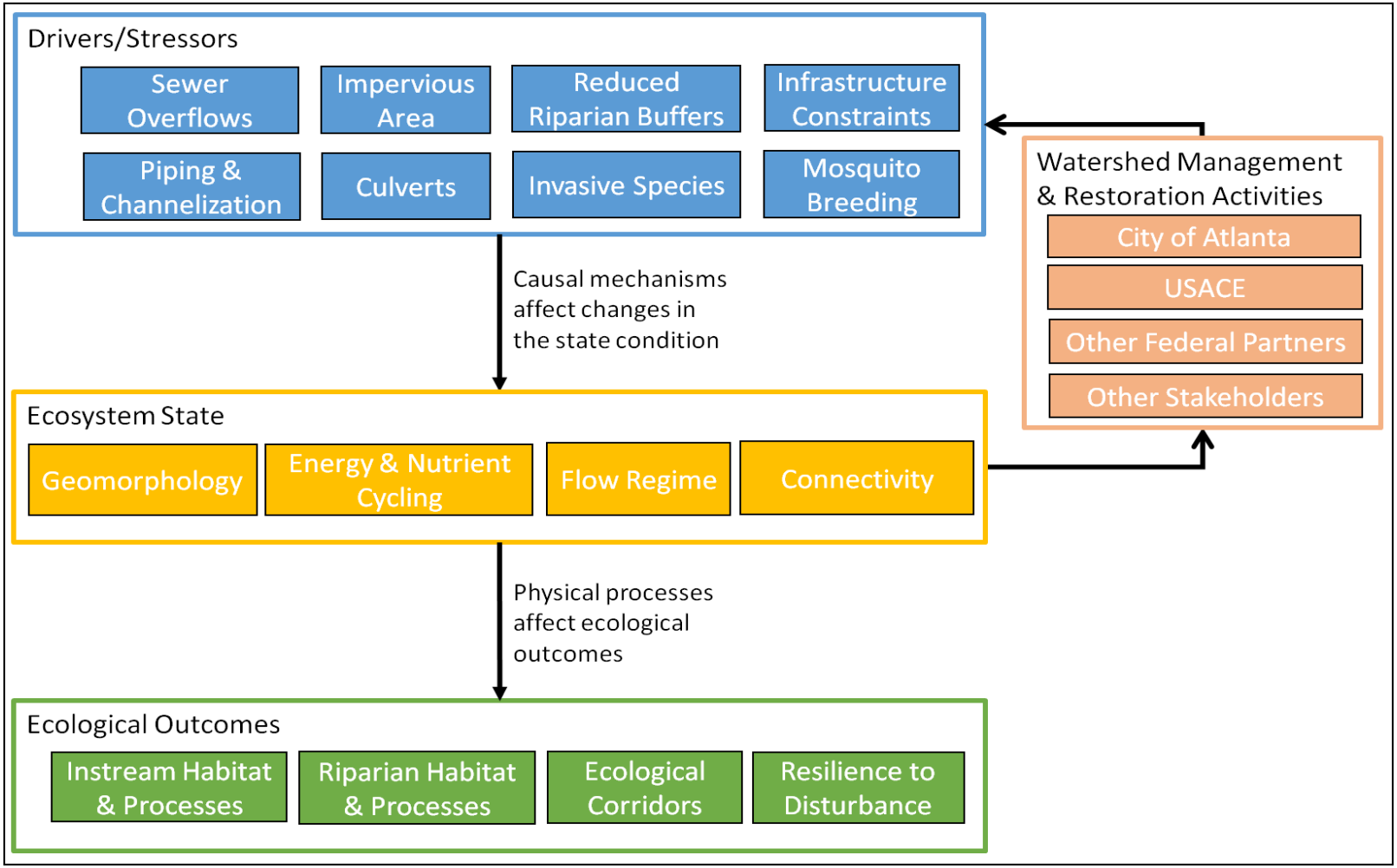
- Goal 1: Make Proctor Creek a vibrant, sustainable ecosystem full of native species.
  - Improve **in-channel conditions** suitable for a diversity of aquatic organisms
  - Improve **riparian conditions** supportive of a diverse aquatic and riparian community
  - Restore **flow regimes** to best attainable conditions achievable in altered urban environments
  - Promote an **interconnected system** resilient to foreseen and unforeseen disturbances
- Goal 2: Make Proctor Creek an asset and source of pride for the community.
- Goal 3: Make Proctor Creek a safe place to work and play.

This is the focal point for planning our restoration project (i.e., what we're formulating around)

But we cannot lose sight of the broader context of the project

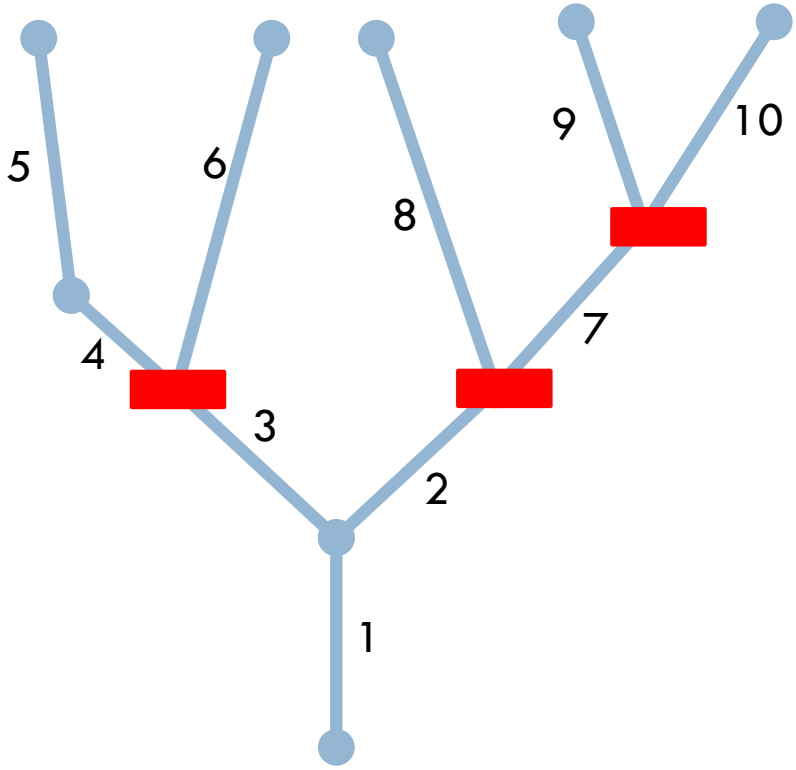
Proctor Creek:
Ecological Model Development
(Phase 1 – Alternatives Milestone)

Conceptual Model Development



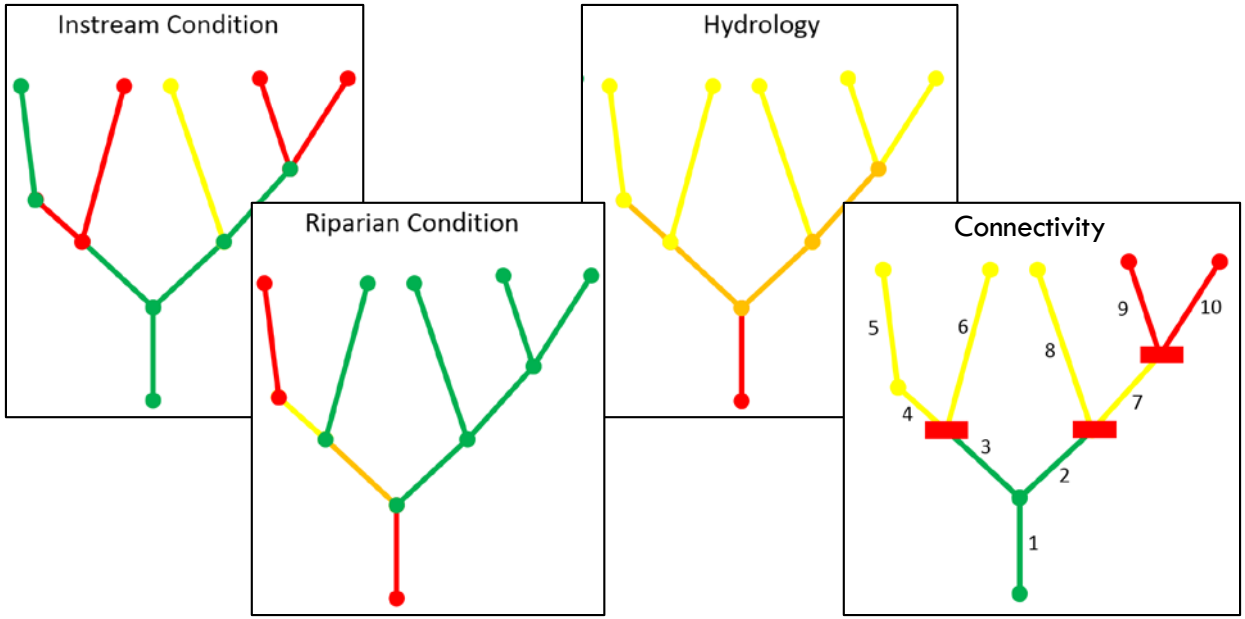
What does the model need to do?

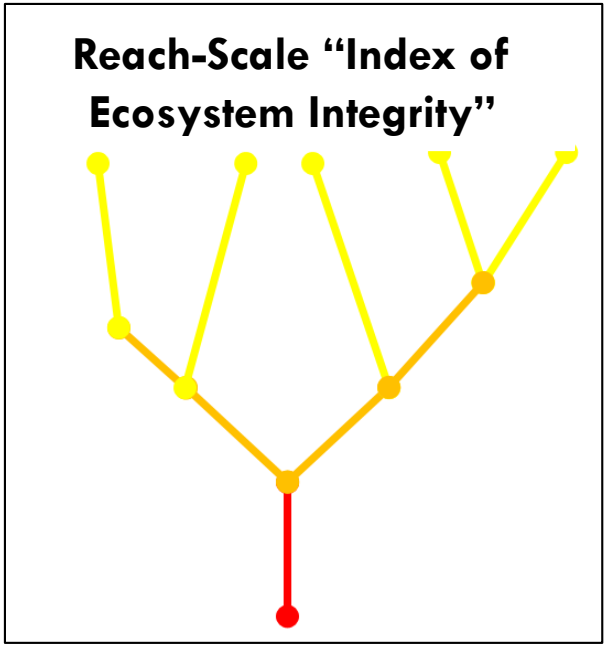
Reach	Alternatives
1	Riparian planting
2	Remove barrier
3	Remove barrier
4	Channel improvement
5	Riparian planting
6	Bank protection
7	Remove barrier
8	Litter control program
9	Stormwater management
10	Channel improvement



Quantifying the Benefits of Restoration (i.e., ecological model development)

- Size or extent of restoration matters (e.g., length or area)
- Integrity or health of the ecosystem is crucial
  - Four basic components of quality (taken from objectives)
- Combined metric incorporating quality and quantity



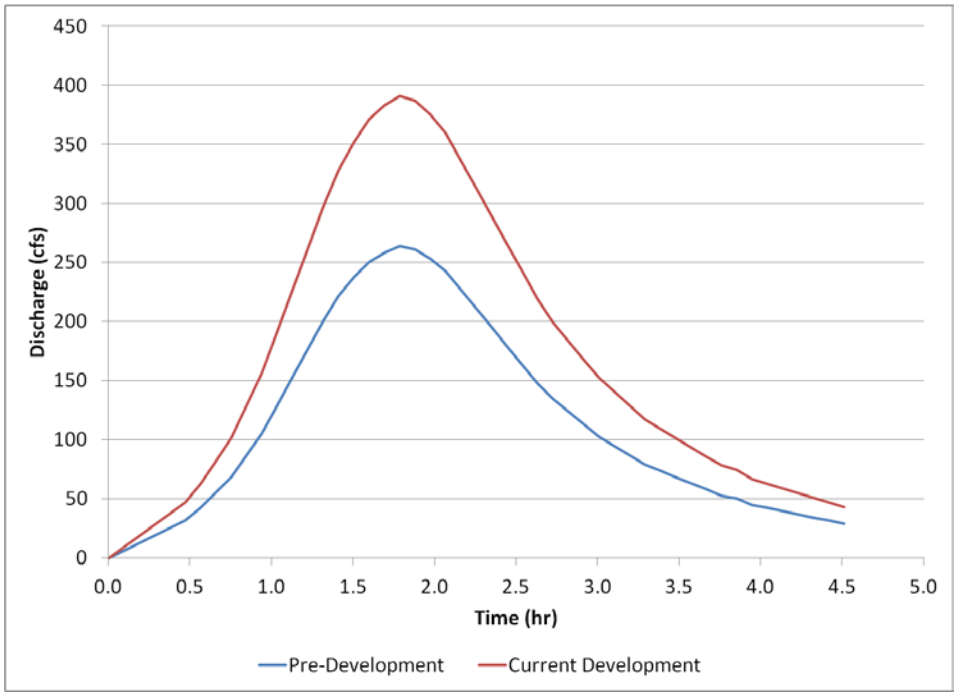


The devil's in the details

Instream condition based on rapid, qualitative assessment (i.e., 0 to 20 scoring system)

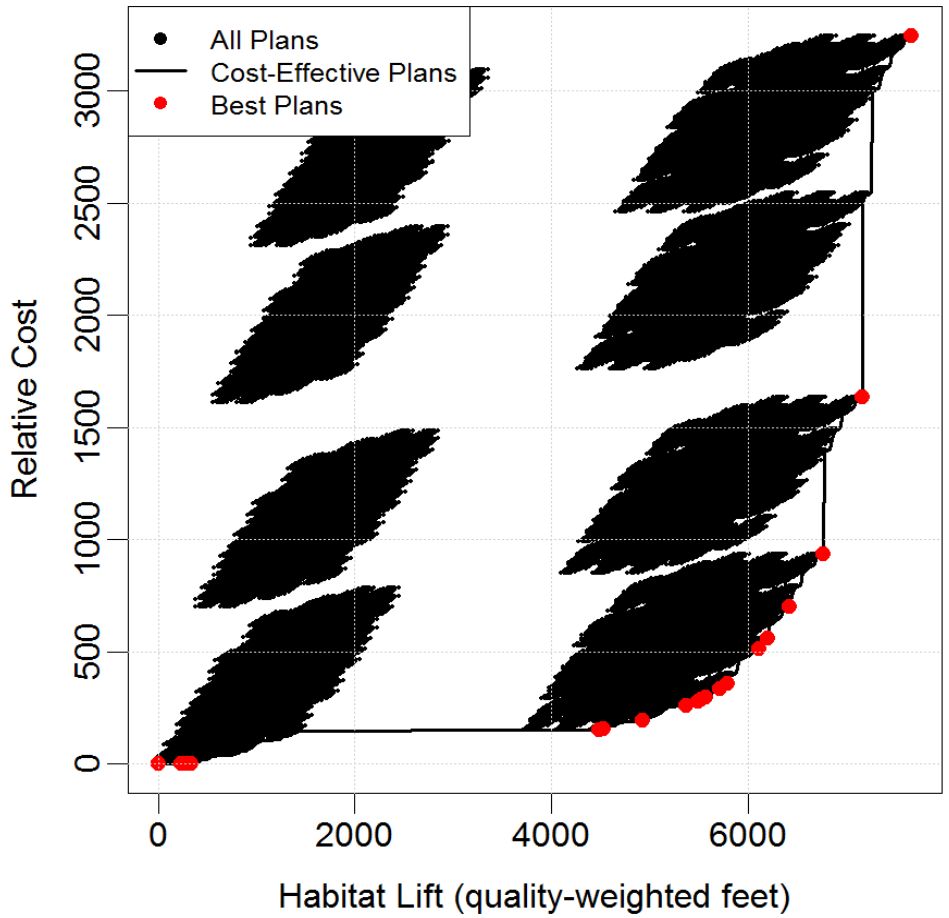
Parameter	Optimal 20 19 18 17 16	Suboptimal 15 14 13 12 11	Marginal 10 9 8 7 6	Poor 5 4 3 2 1 0	Current Rating	Future w/Project
Odor	None	Slight	Moderate	Severe / strong		
Trash & Litter	None	Small amount	Very common	Abundant		
Algae on Bed	None	In spots	Abundant	Everywhere		
Velocity & Depth Regime (slow v. fast, shallow v. deep)	Mostly riffles and pools (few runs); 4 of 4 velocity / depth regimes present	Equal distribution of riffles, pools, & runs; 3 of 4 velocity / depth regimes present	Occasional riffle, more than 25% runs; 2 of 4 velocity / depth regimes present	All runs with one depth-velocity pattern; 1 of 4 velocity / depth regimes present		
Instream Substrate, Deposition, & Embeddedness	Mixture of substrates; Firm sand deposits; Little or no enlargement of islands or bars; Coarse particles (gravel, cobble, and boulder) <10% surrounded by fine sediment	Mixture of sand & gravel with silt at margins; Minor increases in bar formation; Coarse particles 10-25% surrounded by fine sediment	Primarily sands & silts; Moderate increase in bar formation; Coarse particles 25-100% surrounded by fine sediment	Shifting fine sands, silts, & clays; Mostly runs; Large increase in bar development; No large particles to be embedded		
Channel Alteration	Channelization, piping, or river training absent	Minor evidence of channel alteration (often at bridges)	Significant channel alteration and bank armoring in 25-75% of reach	Over 75% altered, armored, piped, or channelized		
Channel Stability	Naturally stable; Evidence of incision or bank failure absent or minimal; Limited potential for future problems	Managed / stabilized; Evidence of incision or bank failure absent or minimal; Some potential for future problems	Moderately unstable; Some entrenchment (evident or possible); Long-term stability questionable; Impending bank instability	Unstable; Entrenched; Active headcuts or bank failures		
Bank Stability	Banks stable; Evidence of erosion or bank failure absent or minimal; Little potential for future problems; <5% of bank affected	Moderately stable; Infrequent, small areas of erosion; 5-30% of bank in reach with visible erosion	Moderately unstable; 30-60% of bank in reach with visible erosion; High erosion potential during floods	Unstable; Many eroded areas; "Raw" areas frequent; Obvious bank sloughing; 60-100% of bank contains erosional scars		
Habitat & Available Cover	Greater than 50% of bank habitat includes a mix of snags, submerged logs, undercut banks, and other stable habitat	5 to 50% of bank habitat includes stable habitat types, but not all types are present	Less than 5% usable habitat with substrates frequently disturbed or removed	Lack of habitat is obvious with unstable or no substrate		
Large Wood	Wood serves a significant structural role; Ample sources of future input	Wood is present, but not abundant; Source inputs remain	Patchy distribution; Future input source is uncertain	Wood not present; No future inputs available		

Hydrologic condition based on simplistic regional regressions and unit hydrograph



Screening potential sites and actions: Preliminary cost-effectiveness analysis

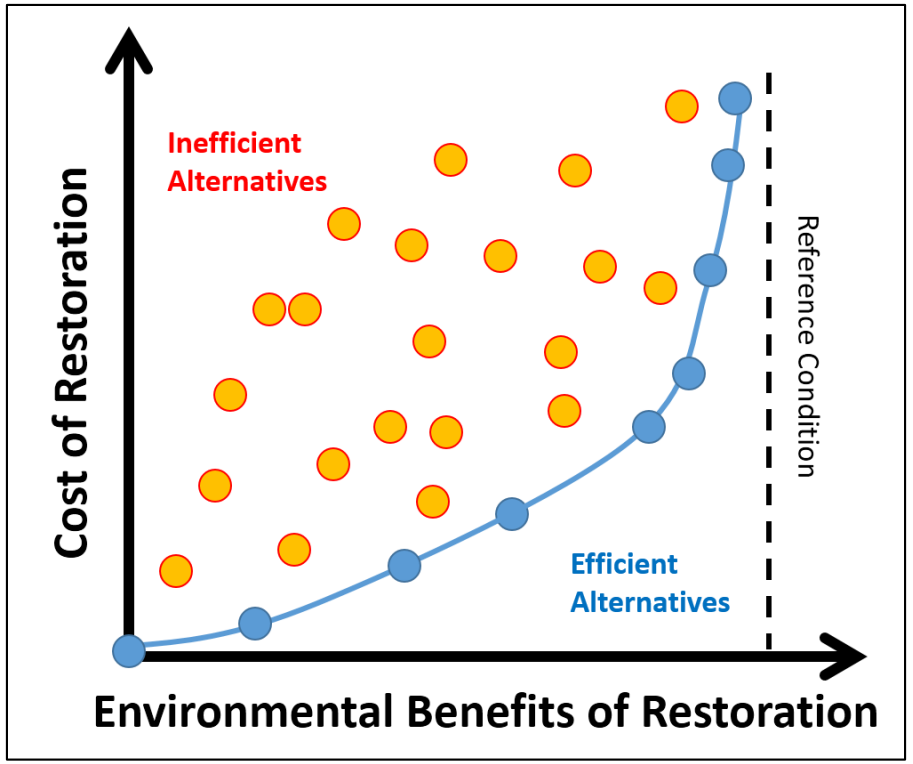
- What's out there?
  - 46 initial reaches of river
- Field-based screening
  - 38 sites with "good" restoration opportunities
- Ecological modeling
  - Screened 1,000,000+ combinations of actions
  - 19 sites preserved for Phase 2 analyses



Proctor Creek: Ecological Model Development (Phase 2 – TSP Milestone)

Goals for Phase 2: Using models to inform restoration

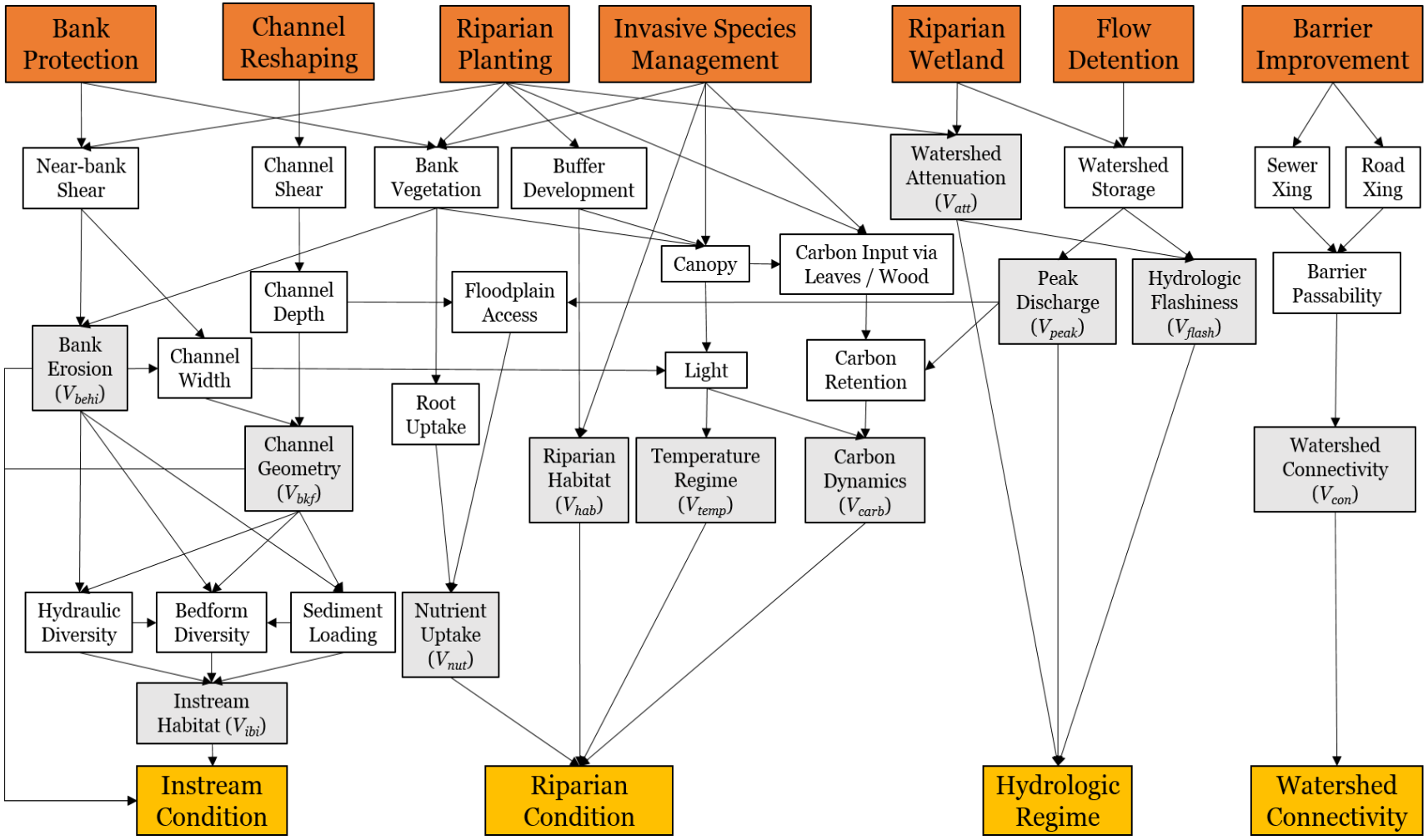
- Do it all again, but better!
- Ultimately we have to:
  - Transparently plan and execute a taxpayer-funded restoration project
  - Write a compelling report that Congress will fund



Revisiting our objectives

Objective	Sub-Objective
Improve **in-channel conditions** suitable for a diversity of aquatic organisms	• Restore channel geomorphic conditions to a less disturbed state • Reduce sediment loading from stream bed and banks • Increase instream habitat for a diverse assemblage of local fauna
Improve **riparian conditions** supportive of a diverse aquatic and riparian community	• Restore natural sources of organic carbon within the system • Increase nutrient uptake within the basin • Improve temperature regimes • Increase riparian habitat to support native biodiversity
Restore **flow regimes** to best attainable conditions achievable in altered urban environments	• Decrease peak flows • Decrease hydrologic flashiness • Improve the capacity of the watershed to attenuate flows
Promote an **interconnected system** resilient to foreseen and unforeseen disturbances	• Increase connectivity of movement corridors for aquatic and riparian species • Increase the capacity to absorb natural and anthropogenic disturbance

Refining our (conceptual) models

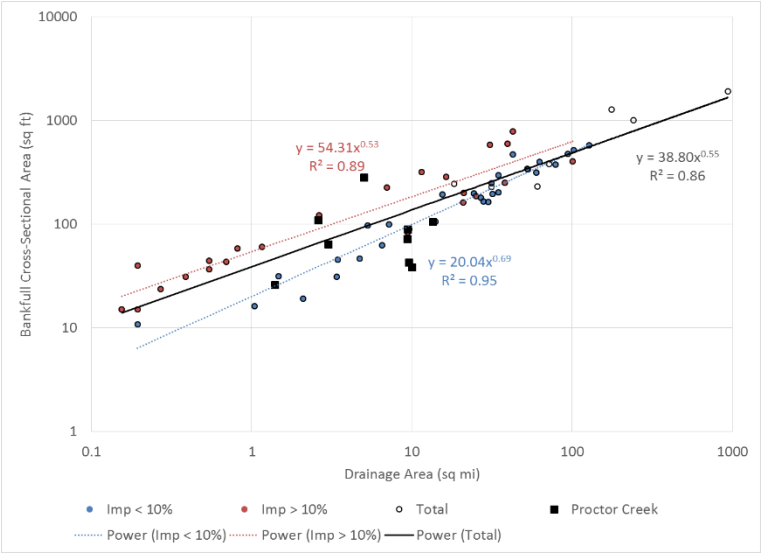


Refining our (numerical) models

In-Channel: Geomorphic Condition

Rapid Bioassessment Protocol
(0-20 score for "channel stability")

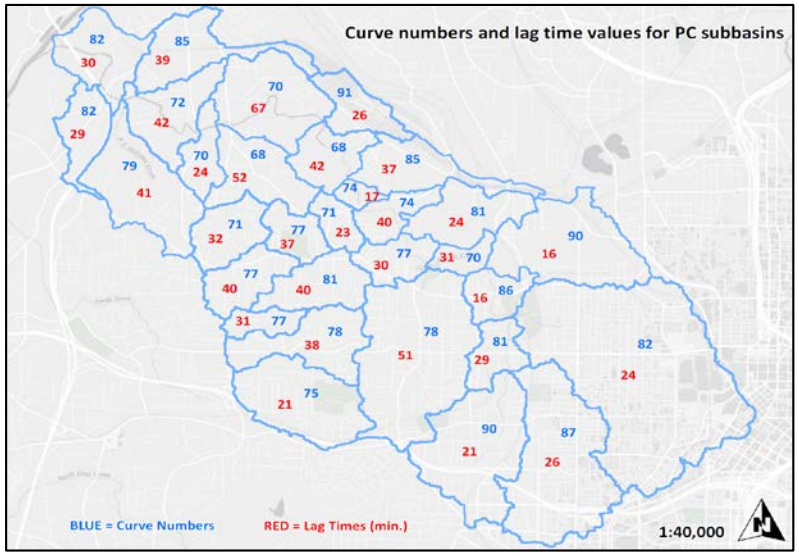
Piedmont Regional Hydraulic Geometry Curves
(Regional Data + Site-Specific Measurements)



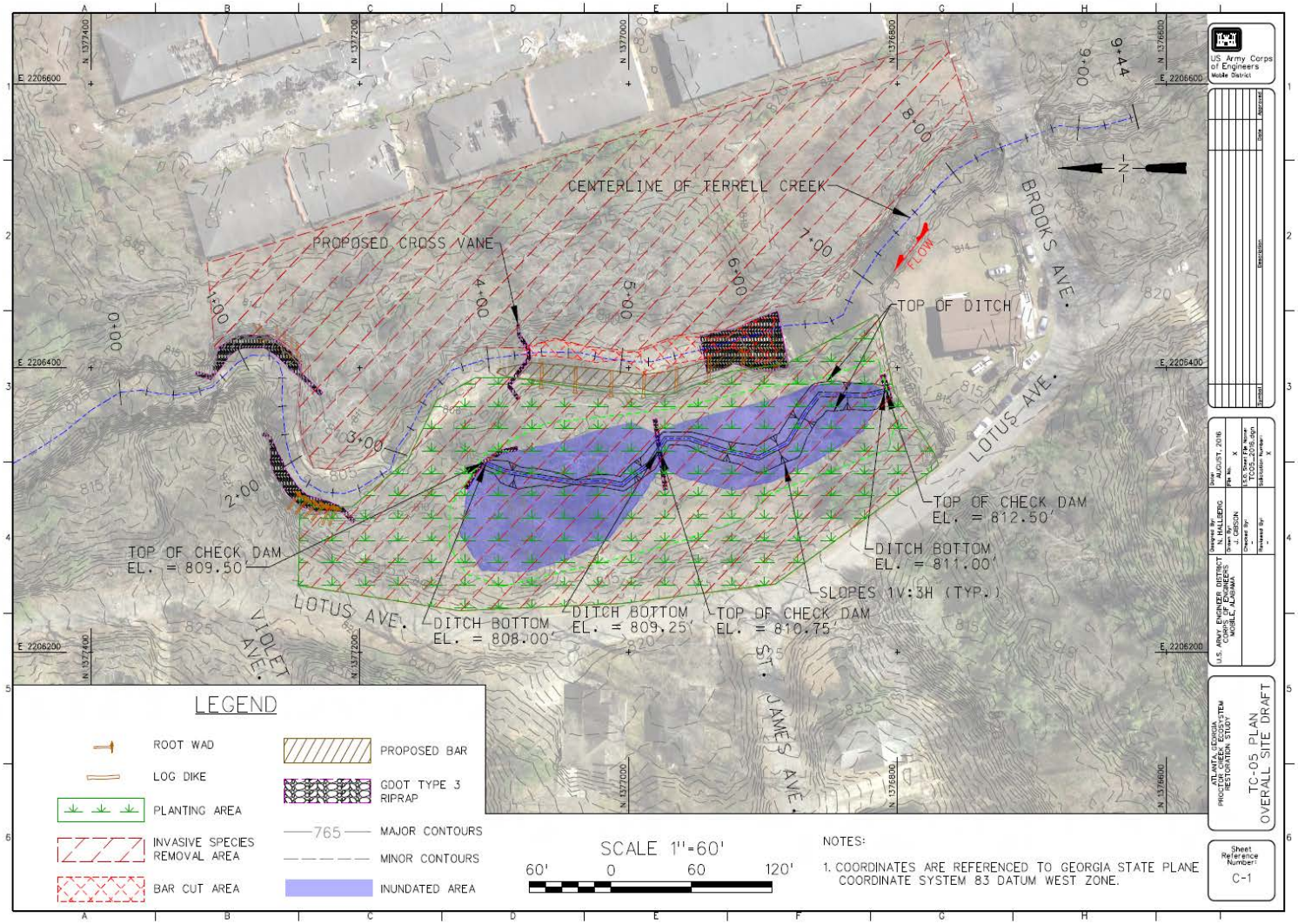
Hydrology: Peak Flows

USGS Regional Regressions for Piedmont
Q_2 = f (Drainage area, Impervious Cover)

Spatially-Distributed Model for Proctor Creek
(HEC-HMS)

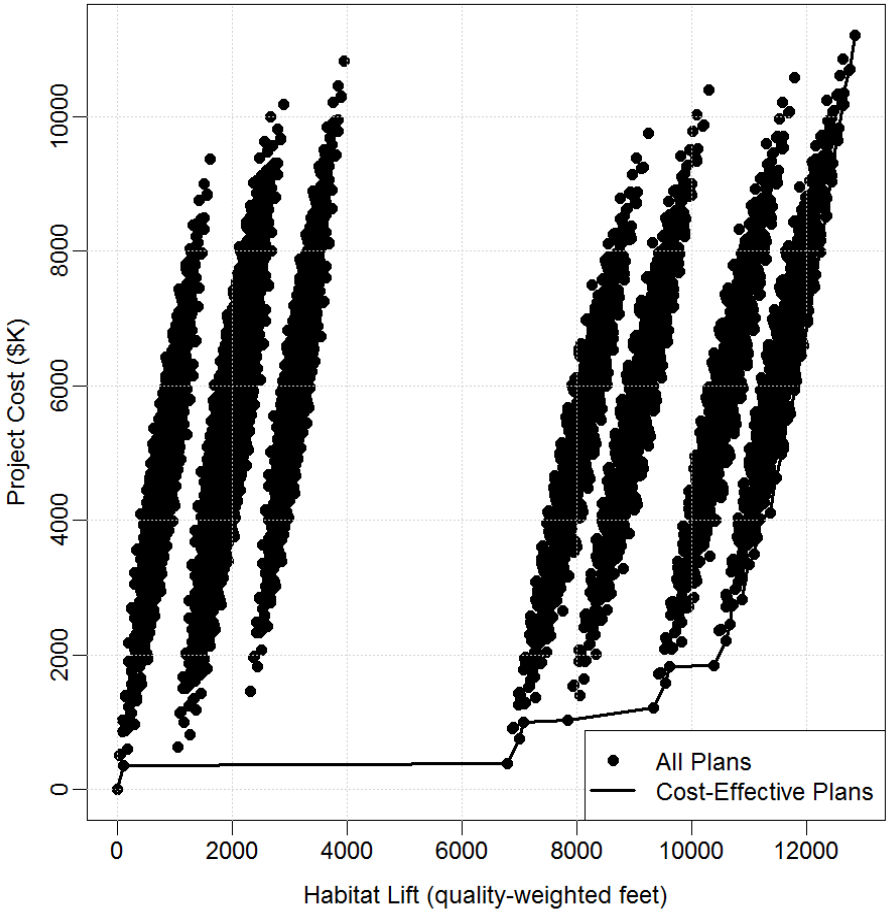


Reconsidering our design



Rerunning our analyses

- Can we improve ecological condition?
  - Total Habitat = 13.0 miles
  - Current Habitat = 3.6 miles
  - All USACE Actions = 6.0 miles
- Return on investment decreases with increasing investment
- BUT other criteria come into play
  - Planning criteria: completeness, acceptability, efficiency, effectiveness
  - Systems of Accounts: environmental justice of outcomes, recreational value
  - Learning opportunity from urban waters program: demonstration of restoration types, educational opportunities



What are we learning about model development from Proctor Creek?

Positive outcomes (and growing edges)

- Ecological model development (and certification) is possible in a SMART Planning timeline.
  - Focus is required, but it isn't unreasonable to assume this can happen for other projects.
  - Planning timelines don't always line up with the best weather…
- Phased analyses have helped focus the project, generate different types of information as needs shift, and gain buy-in along the way.
  - Not a lot of time to dwell on the previous phase.
- Mapping model outcomes to objectives is a helpful organizing framework (and useful for the project).
  - Is this an emerging focus for modeling beyond habitat?

Contact Information

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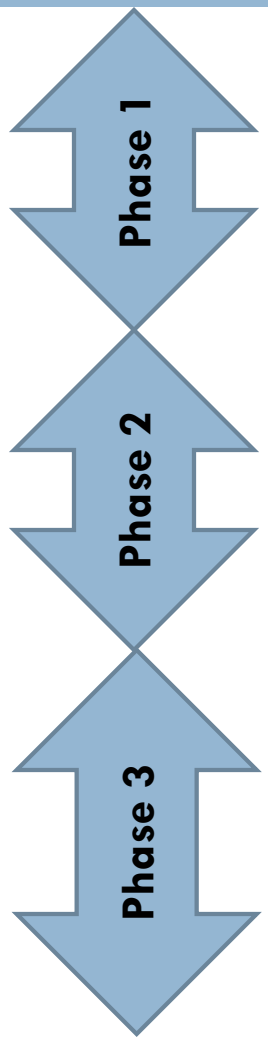
USACE Restoration Project

Administrative Timeline

- Oct 2015
  Partnership begins
- Mar 2016
  All sites screened to a select few for continued investigation
- May 2017
  Preliminary restoration design and "draft" report / EIS
- (Inter)Agency review
- Sep 2018 – Administration recommends construction?



Phase 1 Tasks

- Get to know the watershed
- Agency & stakeholder meetings
- Compile existing knowledge
- Rapid reconnaissance for the watershed (1 week maximum)
- Build and apply analytical framework
- Review findings with everyone
- Document Phase 1

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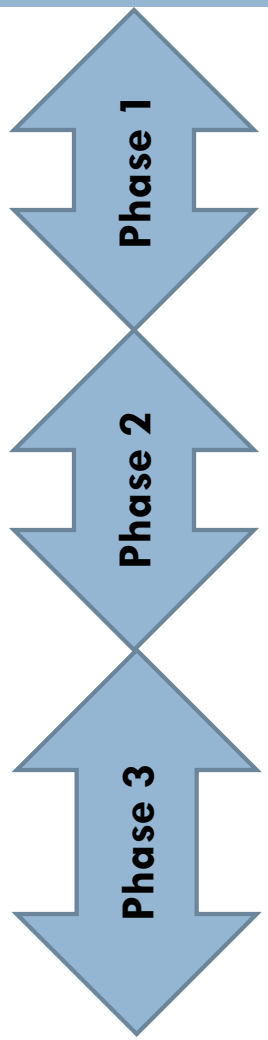

Phase 2 Tasks

- Agency & stakeholder meetingS
- Sharpen the pencil: better objectives, more detailed models, more data,…
- Revisit sites for final data collection and design (1 week maximum)
- Let others poke holes in your approach
- Coordinate potential actions with dozens of partners
- Write NEPA report