Optimization Tool Development

March 20, 2018

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Description: The project goal is to facilitate cost-effective reductions of nutrient loads entering the Chesapeake Bay from the watershed by developing an optimization module for the Chesapeake Assessment Scenario Tool (CAST).

Status (Phase 1): developing an optimization plan

Overview

Motivation:

Of all possible types and combinations of feasible Best Management Practices (BMPs), which mix(es) of BMPs will allow us to meet the target loads at the lowest total cost?

Tools:

- **Chesapeake Assessment Scenario Tool (CAST)**
- **Scenario Optimization Module**

Outline

- CAST and optimization
- The vision: a “scenario optimization module”
- What is the current phase of development?
- How will a prototype tool utilize info from CAST?
- Next steps and moving forward

Chesapeake Assessment Scenario Tool (CAST)

A "web-based nitrogen, phosphorus and sediment load estimator"

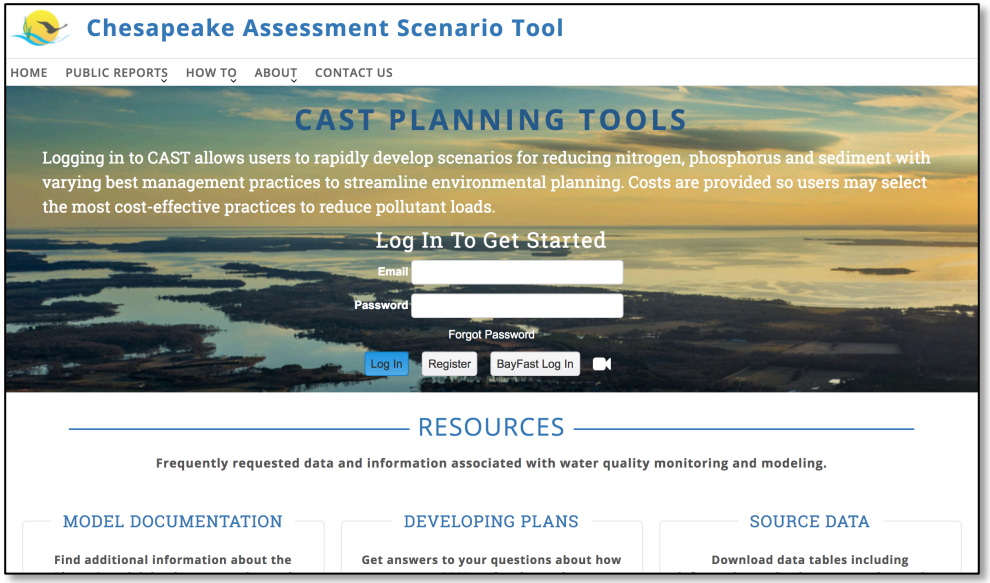
Originally developed in 2011, but has undergone substantial changes over the years

Users specify:

- **A geographical area (e.g. a county)**

  (& other restrictions, such as "agencies")

- **Best Management Practices (BMPs) to apply on that area**



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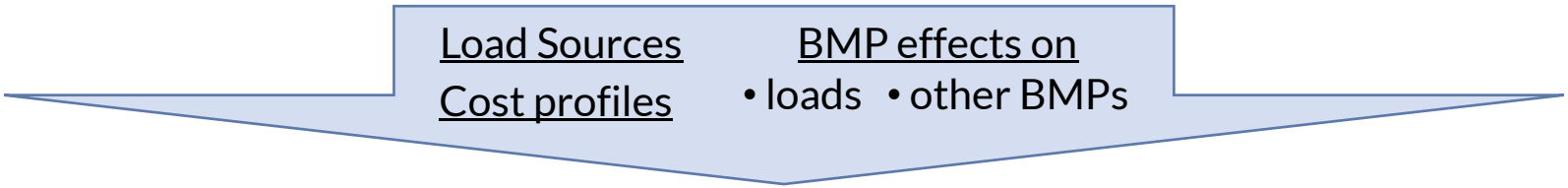

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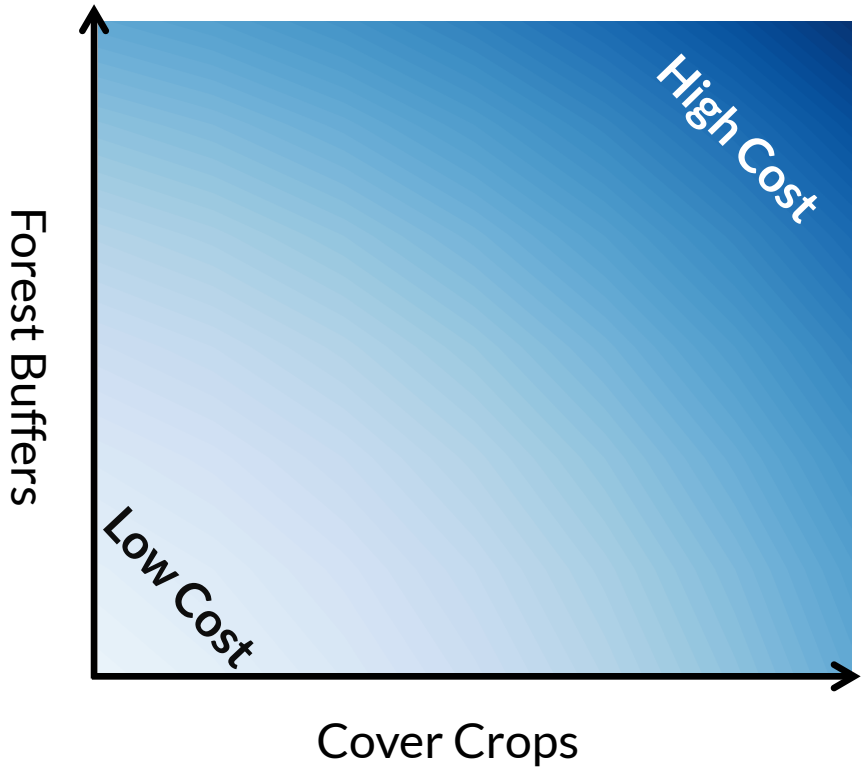

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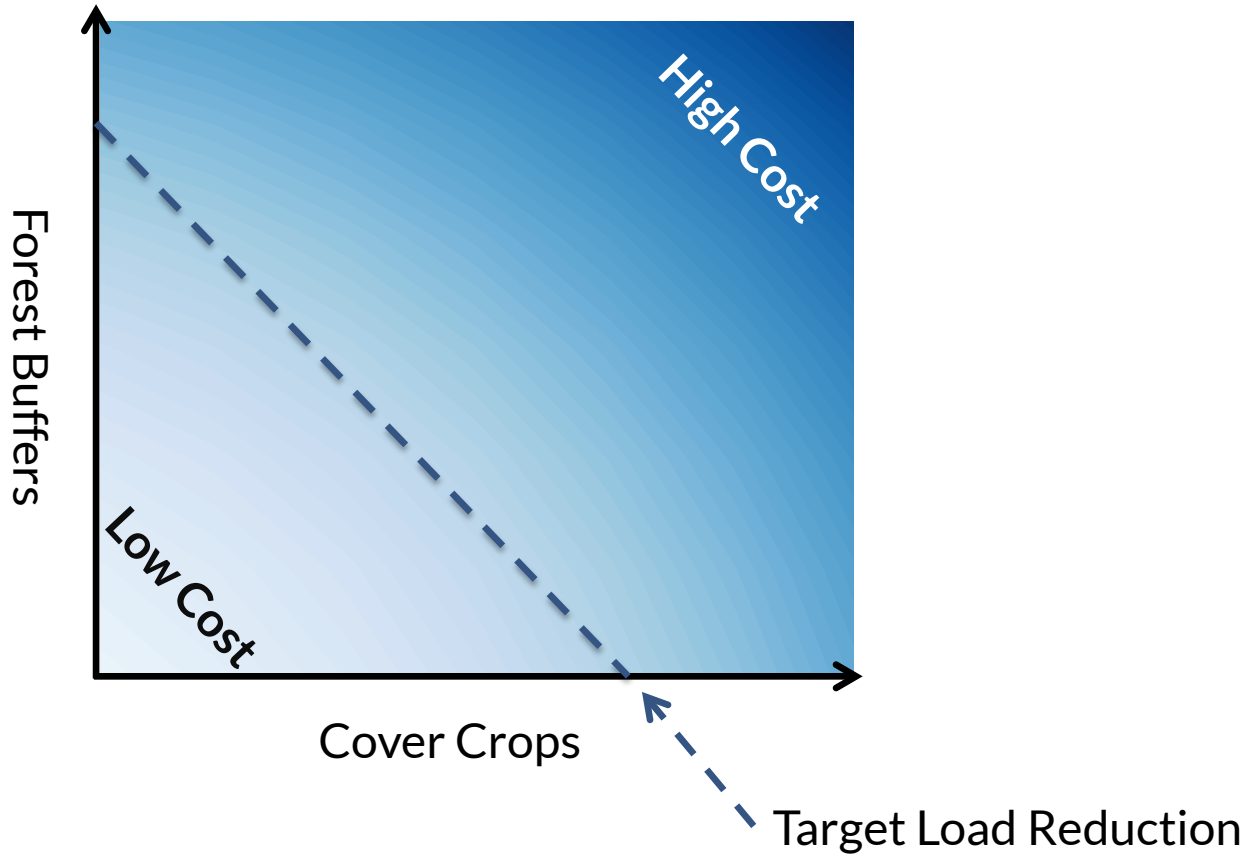

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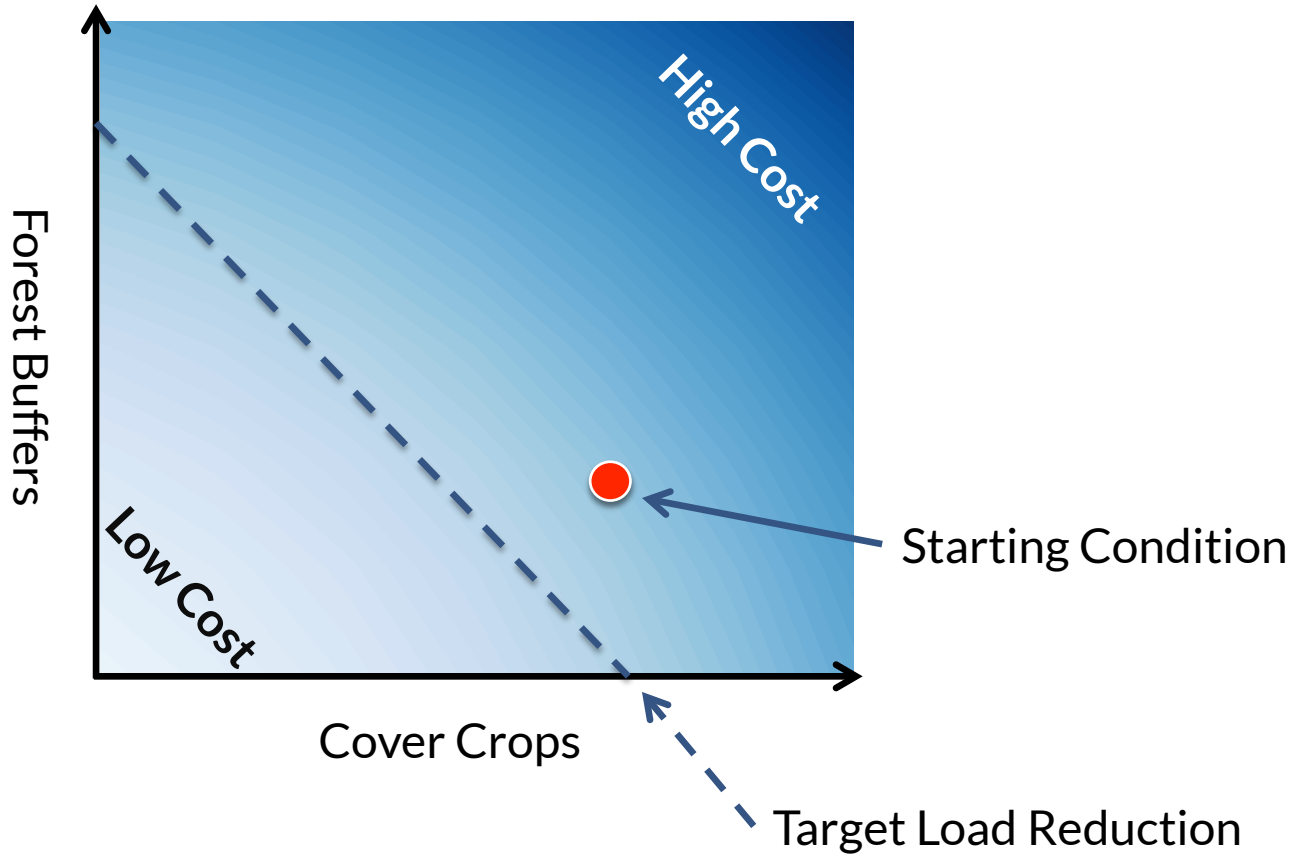

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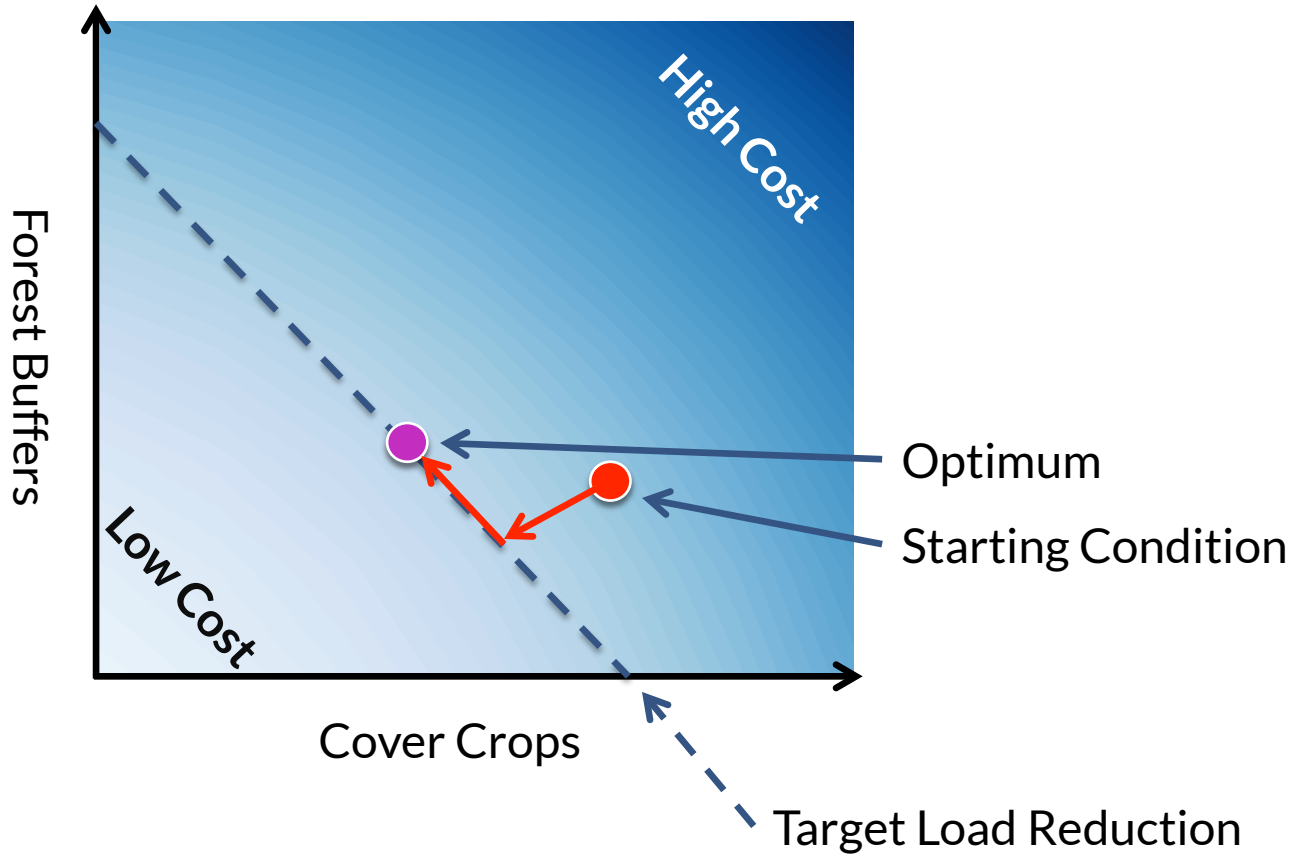

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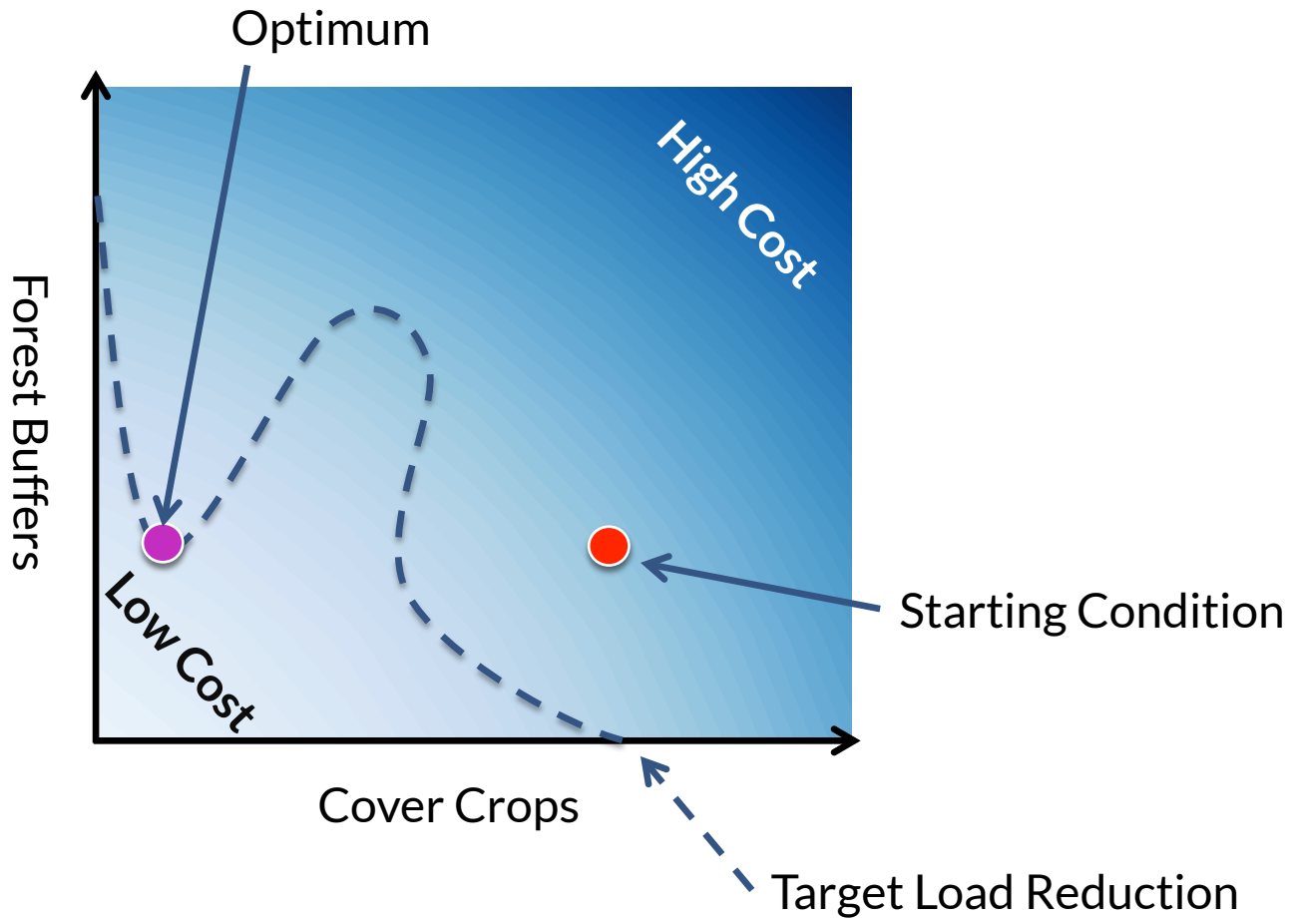

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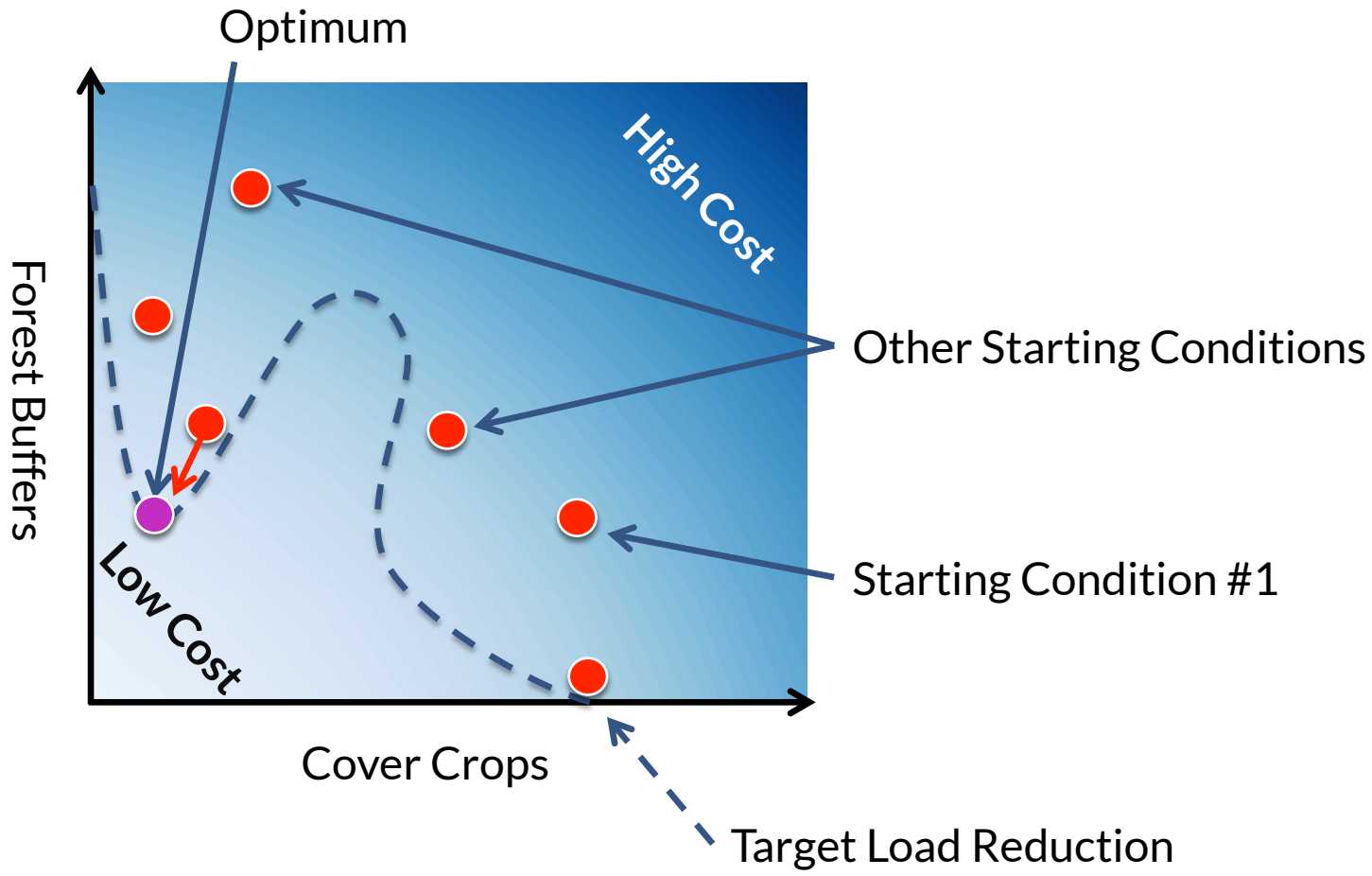

Optimization Description

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(Secondary) Maximize co-benefits

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- Treatment technology upgrades at each significant point source facility (discrete)

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Basic Constraints:

- Scale/region of scenario (and/or agencies)
- Nitrogen and Phosphorous delivered load reductions ≥ load targets
- BMP'd acres ≤ available acres (by segment and land-use)
  - BMP'd roads ≤ available miles
  - BMP'd shorelines ≤ available miles
  - BMP'd animals ≤ available animal counts

Other Constraints:

- BMP constraints, for example:
  - agricultural land retirement ≤ *X* acres
  - cover crop oats ≥ *X* % of agricultural acres
- Land use restrictions for certain BMPs
- Capital limitations for certain sectors?

Current Phase

Investigate and Develop an Optimization Plan

Learn about CAST (uses, algorithms, and data/input/output structures)

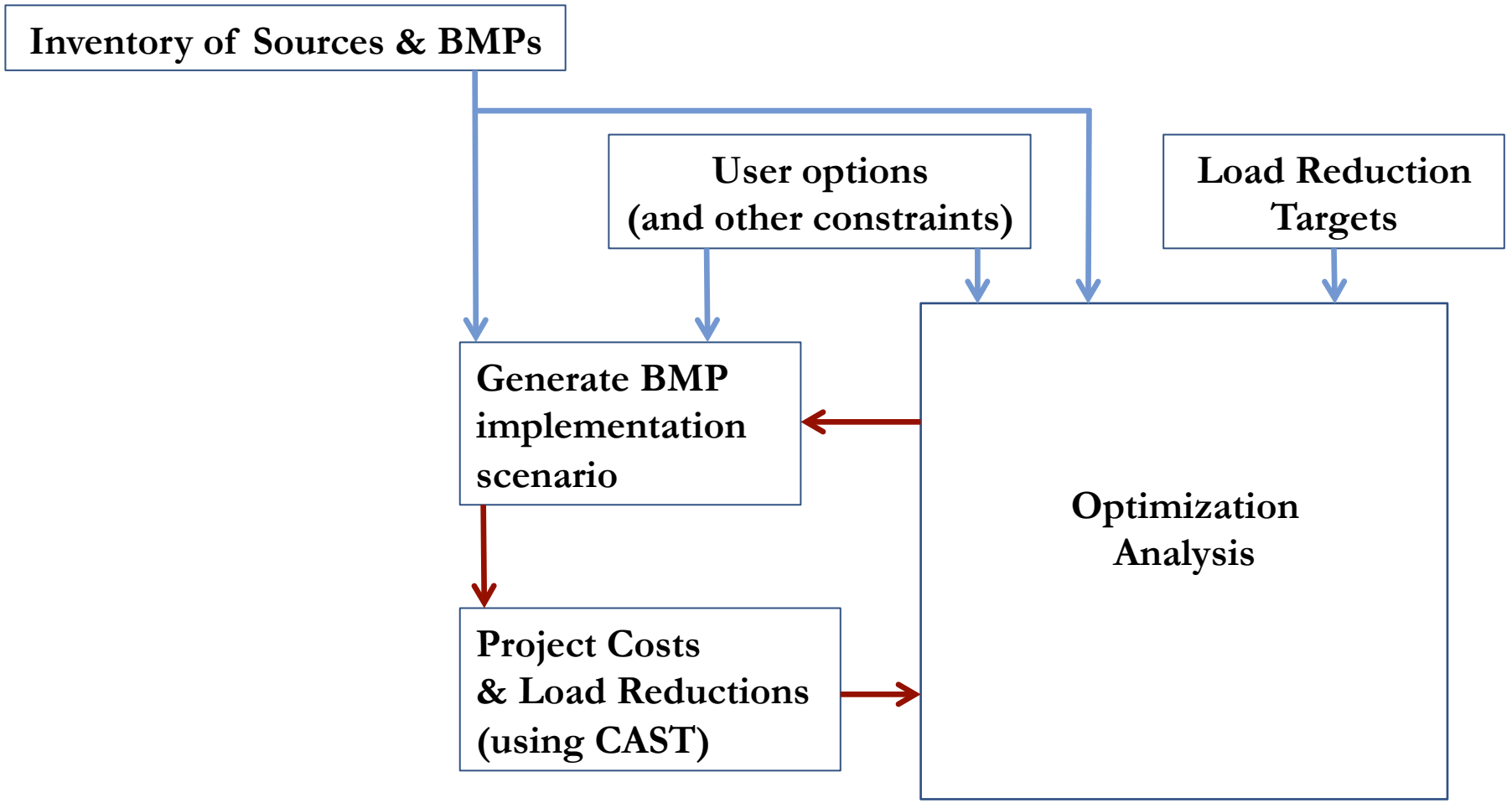
Consider:

- objectives and designs for a Phase 2 prototype
- suitable algorithms (or combinations)

Identify model simplifications (reduced parameter sets)

Design an efficient interface between CAST and the proposed optimization software

Optimization Tool Sandbox



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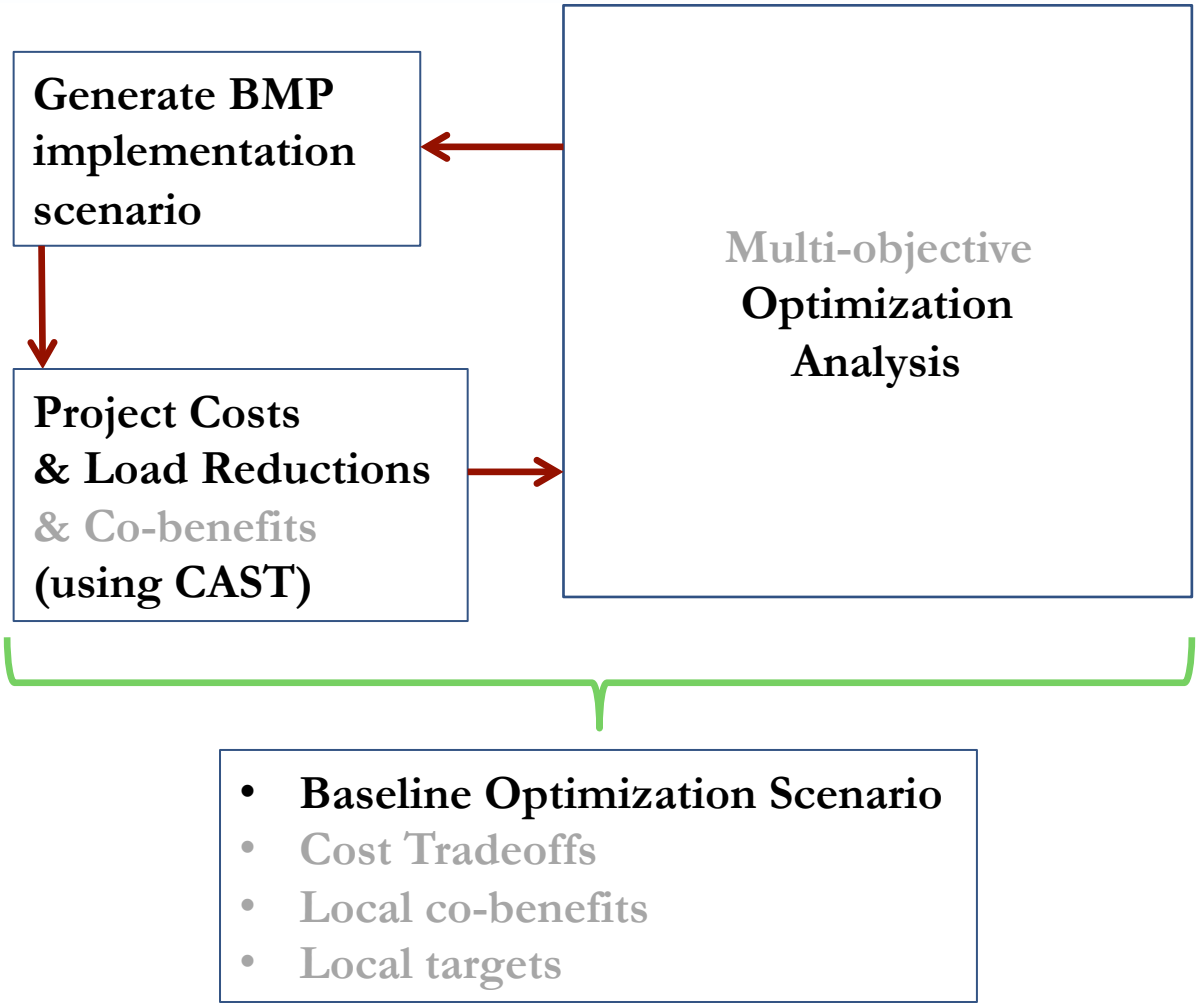
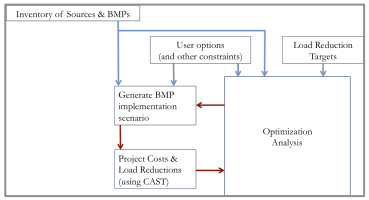


Looking Forward

Sandbox



Identifying Alternatives

Cost Tradeoffs

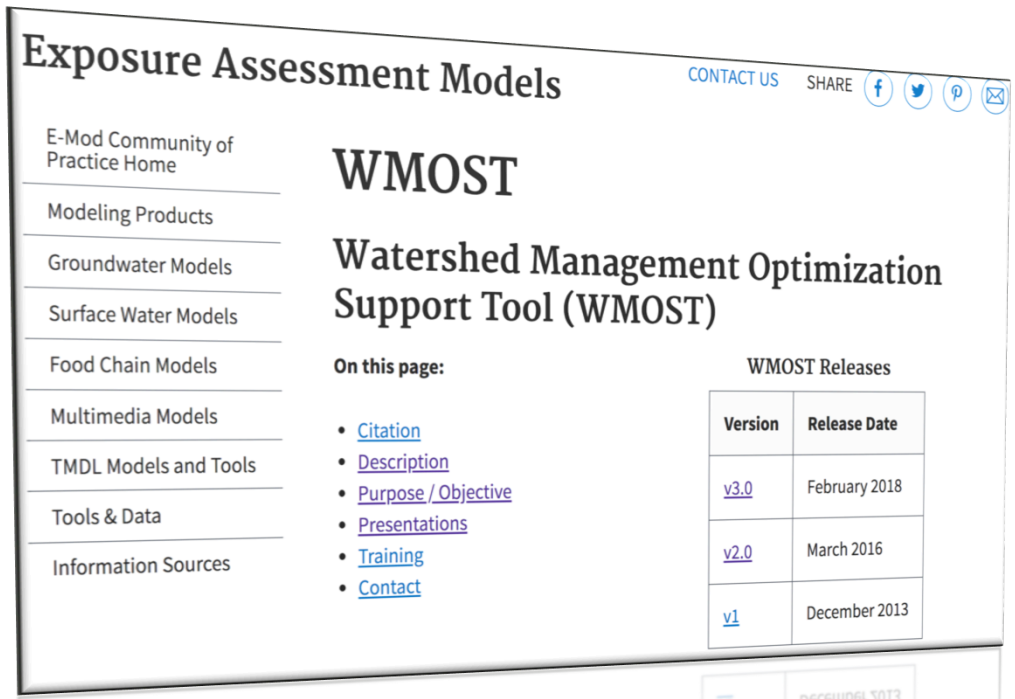
Baseline Optimization Prototype

Co-benefits

Local Targets

Exploring potential synergies

Watershed Management Optimization Support Tool (WMOST)



Developed and maintained by team at the EPA Office of Research and Development

Collaborating with:

- Naomi Detenbeck
- Amy Piscopo

Next Steps

Phase 1: Investigate and Develop an Optimization Plan

Continue developing a prototype in python

Continue learning about CAST (uses, algorithms, and data/input/output structures)

Refine optimization objectives, constraints, user needs

Continue considering suitable algorithms and tool designs for Phase 2 prototype

User Interface

What does a user want to be able to do/see?

Select geographic region of interest and land use types

- Geographic region by State, County, In/Out of CBWS, Land-river segment
- Land Use types by agency, sector, and base conditions

Select BMP constraints

- ideas: exclude certain BMPs, max/min acreage of certain BMPs,

See and compare objective attributes of nondominated solutions

- load reductions
- cost
- co-benefits

See the set of BMP assignments for each solution

- by land use, segment, state, sector
- in categories or individually, and in acreage or percent

Looking Forward

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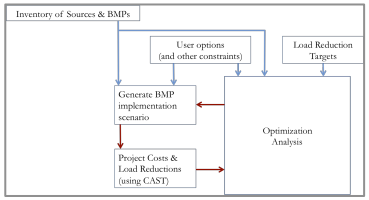

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Questions

Other constraints?

Other objectives?

Departures from existing scenarios, with given costs

Computational resources/speed