



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**

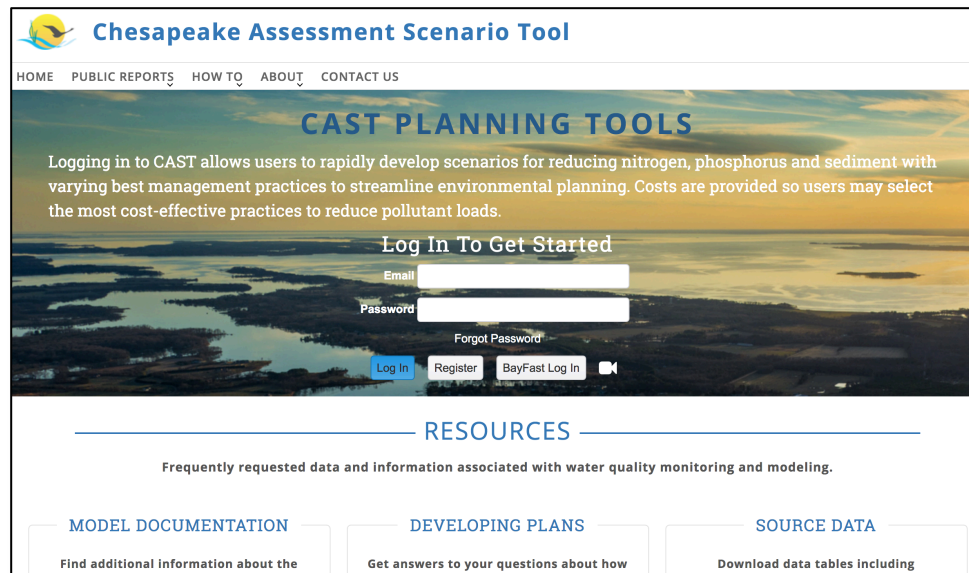
Chesapeake Assessment Scenario Tool (CAST)

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**



The screenshot shows the homepage of the Chesapeake Assessment Scenario Tool (CAST). At the top, there is a navigation bar with links: HOME, PUBLIC REPORTS, HOW TO, ABOUT, and CONTACT US. Below this is a large banner image of a coastal landscape with water and trees. The banner contains the text "CAST PLANNING TOOLS" and a description: "Logging in to CAST allows users to rapidly develop scenarios for reducing nitrogen, phosphorus and sediment with varying best management practices to streamline environmental planning. Costs are provided so users may select the most cost-effective practices to reduce pollutant loads." Below the banner is a login section titled "Log In To Get Started" with fields for "Email" and "Password", a "Forgot Password" link, and buttons for "Log In", "Register", and "BayFast Log In". At the bottom, there is a "RESOURCES" section with the text "Frequently requested data and information associated with water quality monitoring and modeling." and three links: "MODEL DOCUMENTATION" (Find additional information about the), "DEVELOPING PLANS" (Get answers to your questions about how), and "SOURCE DATA" (Download data tables including).

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- **The cost of the scenario.**

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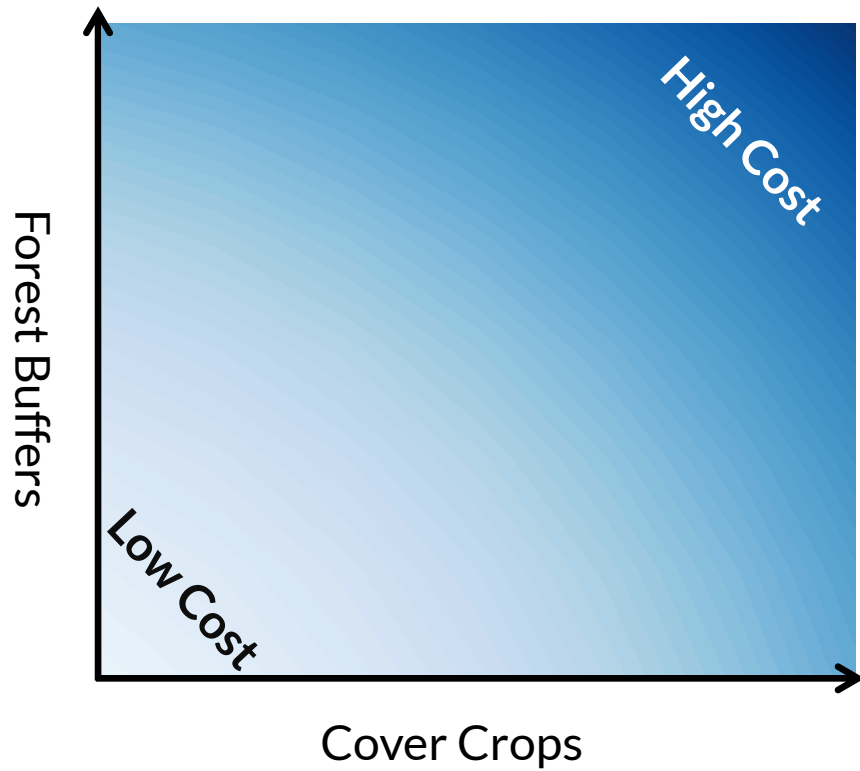
Load Sources
Cost profiles

BMP effects on
• loads • other BMPs

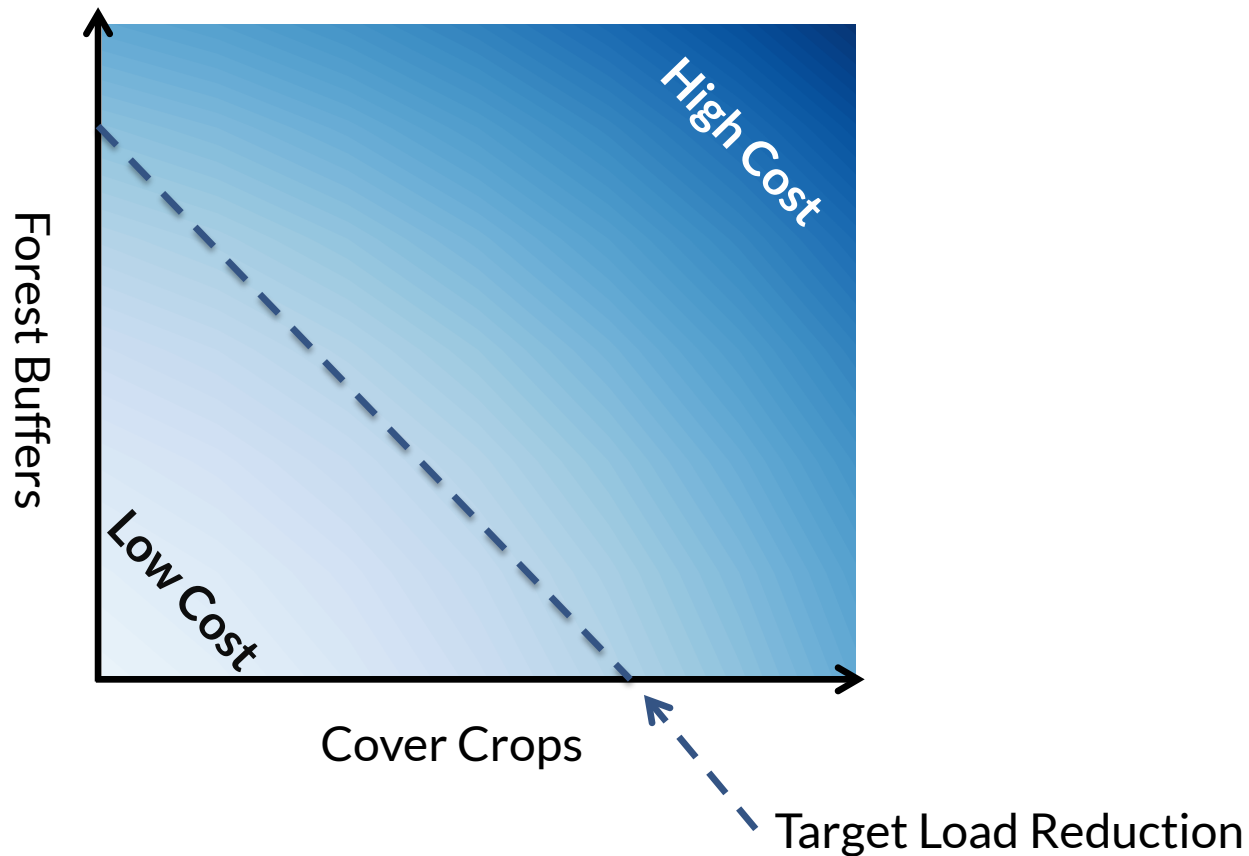
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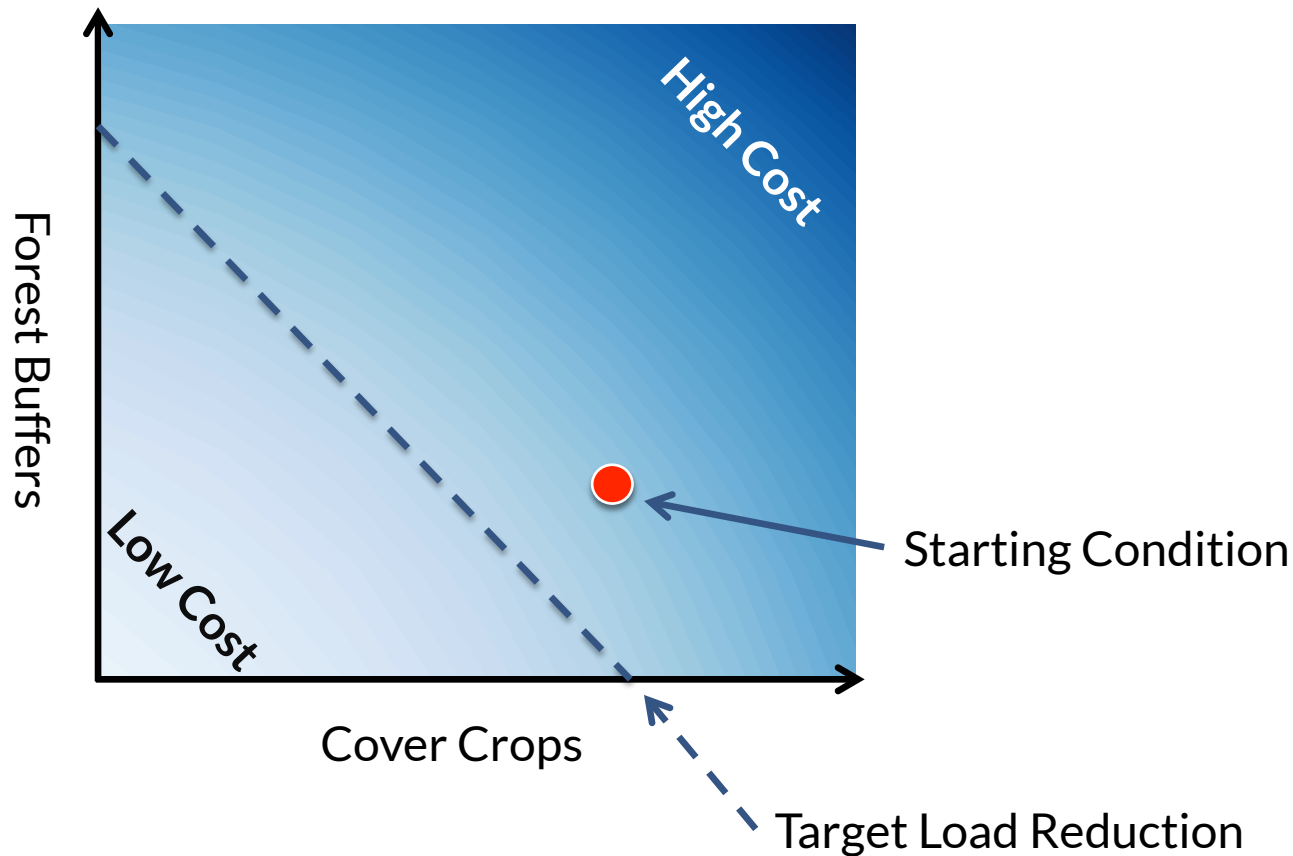
What is meant by optimization?



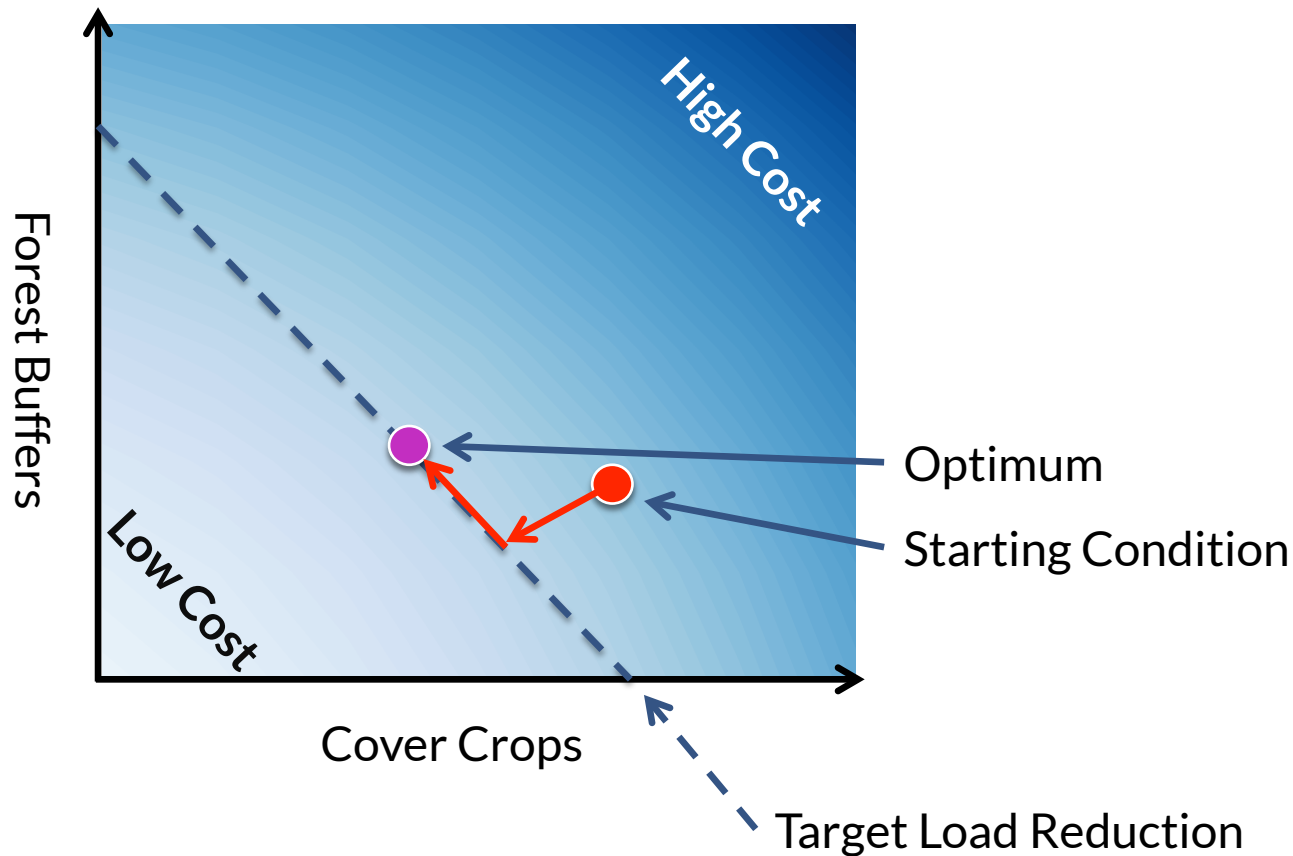
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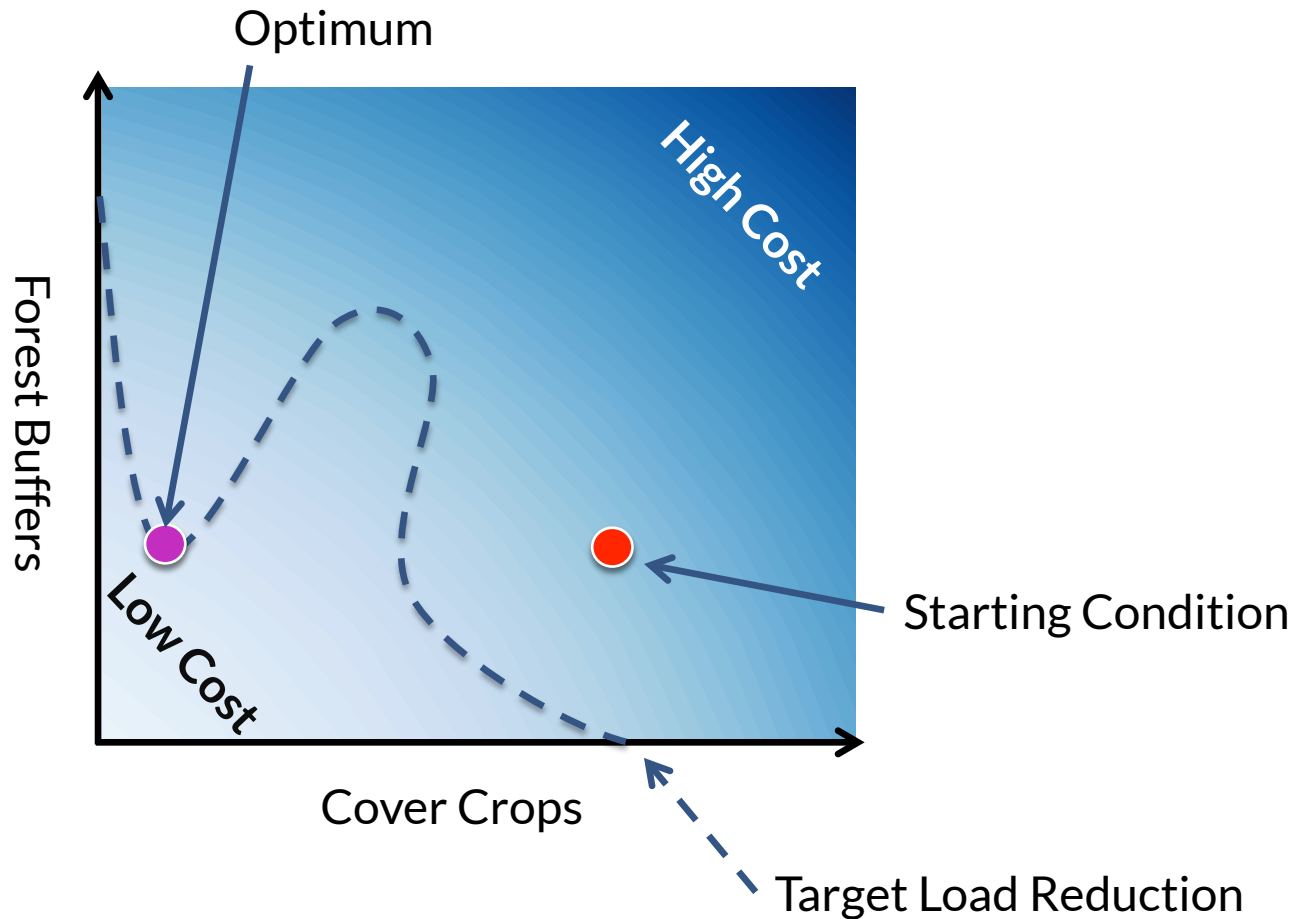
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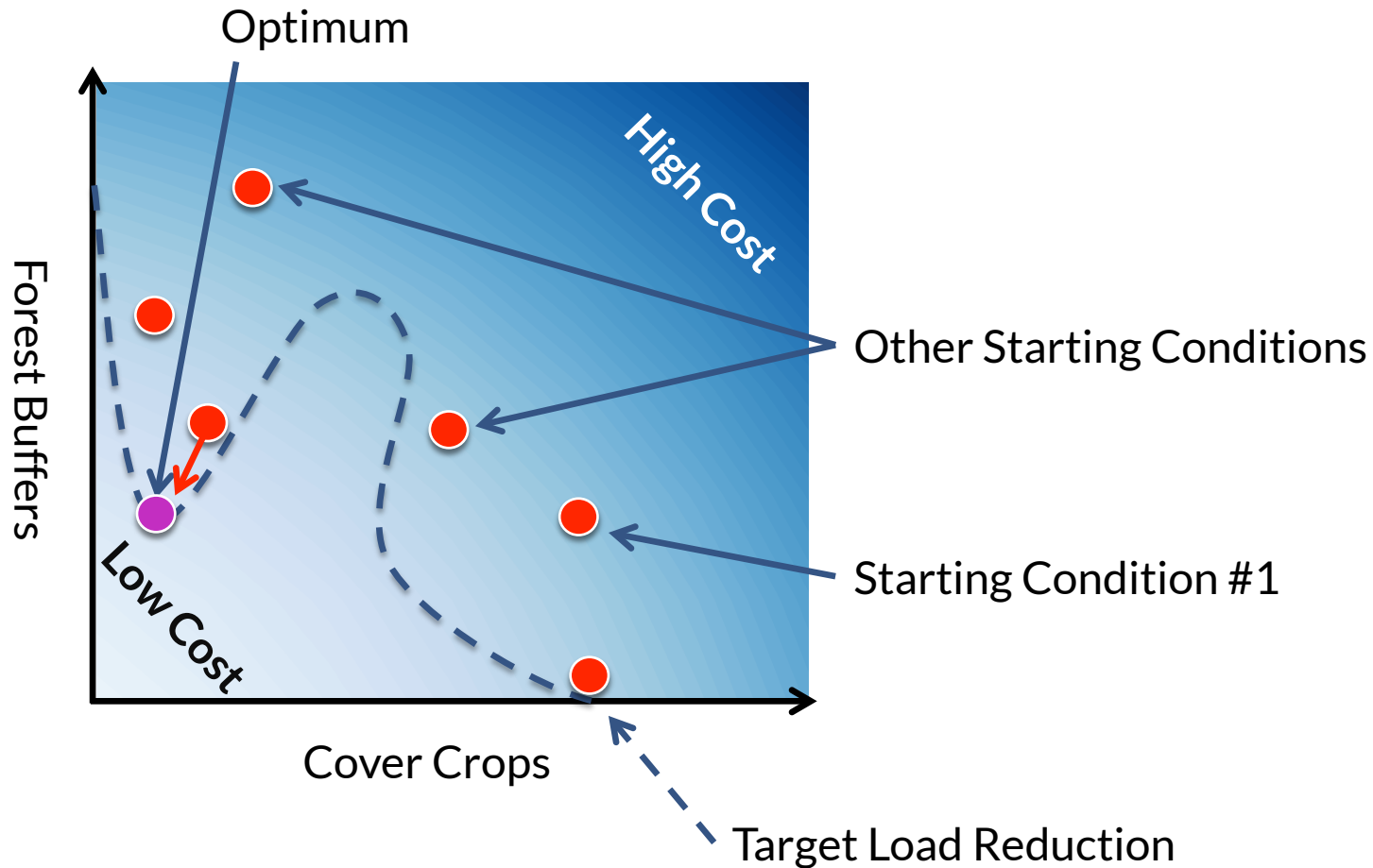
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Optimization Description



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- Number of acres (or other unit) of each BMP in each land-use category and land river segment (continuous)
- 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 \geq load targets
- BMP'd acres \leq available acres (by segment and land-use)
 - BMP'd roads \leq available miles
 - BMP'd shorelines \leq available miles
 - BMP'd animals \leq available animal counts

Other Constraints:

- BMP constraints, for example:
 - agricultural land retirement \leq X acres
 - cover crop oats \geq 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)

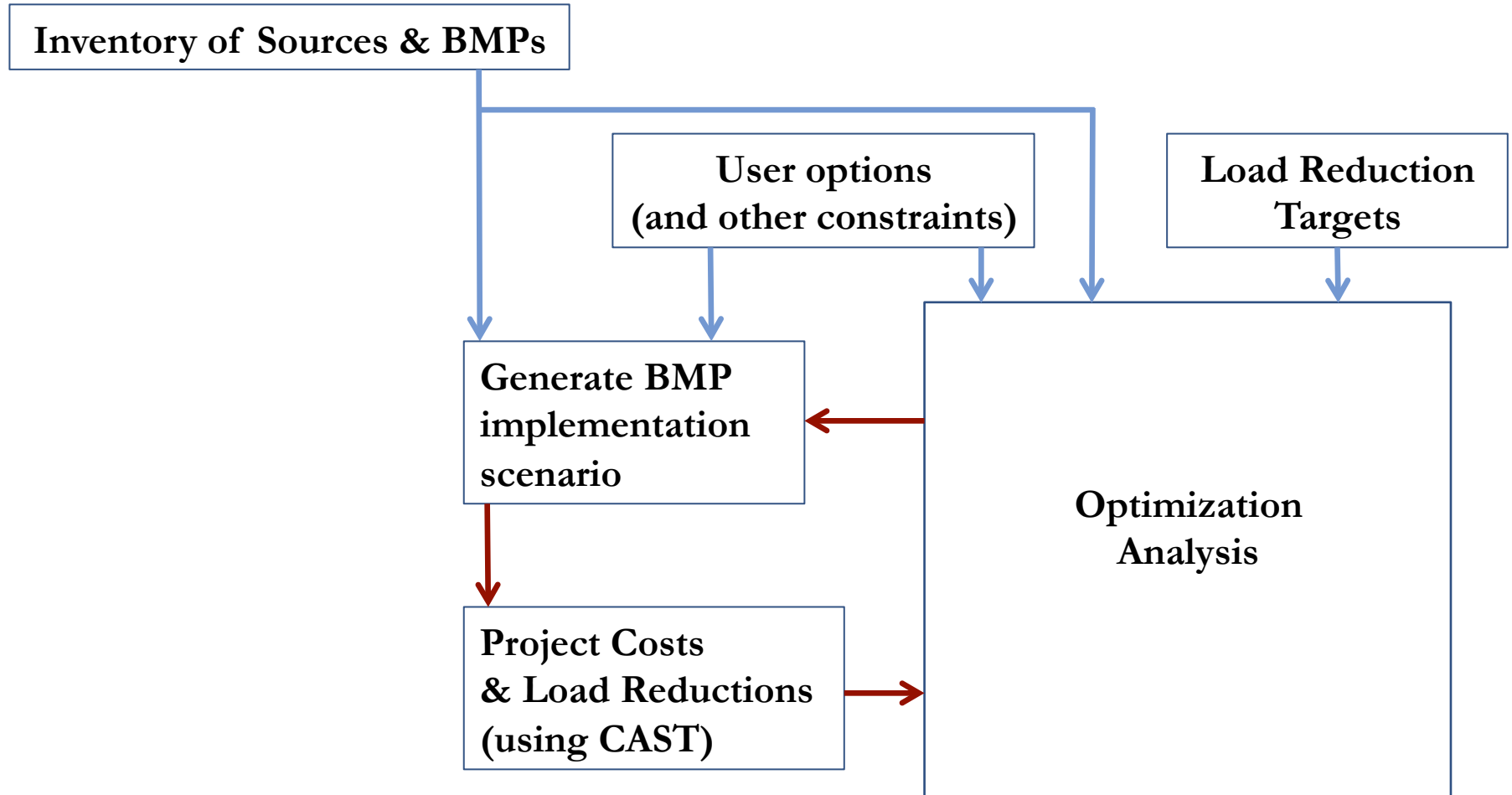
Consider:

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

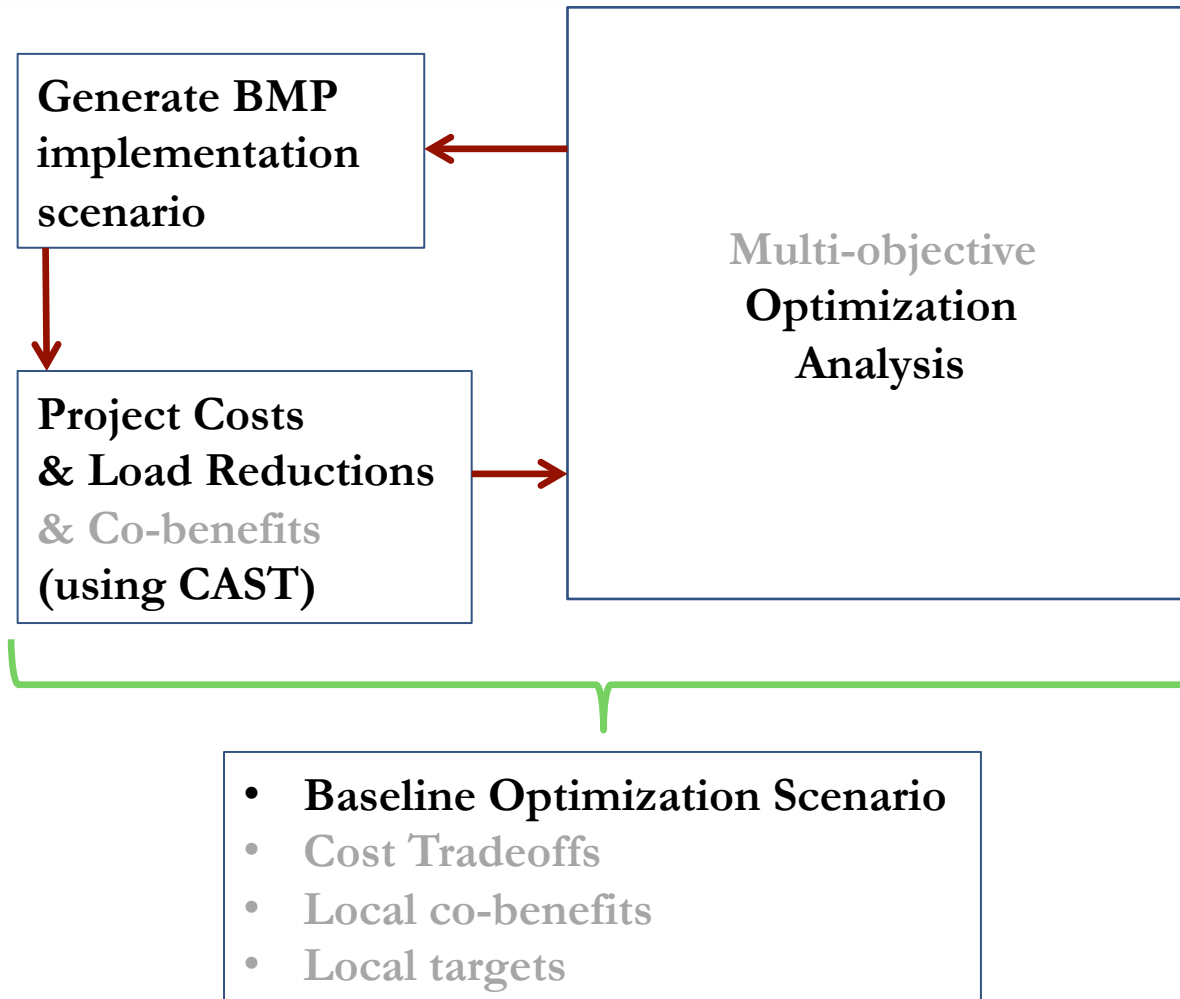
Identify model simplifications (reduced parameter sets)

Design an efficient interface between CAST and the proposed optimization software

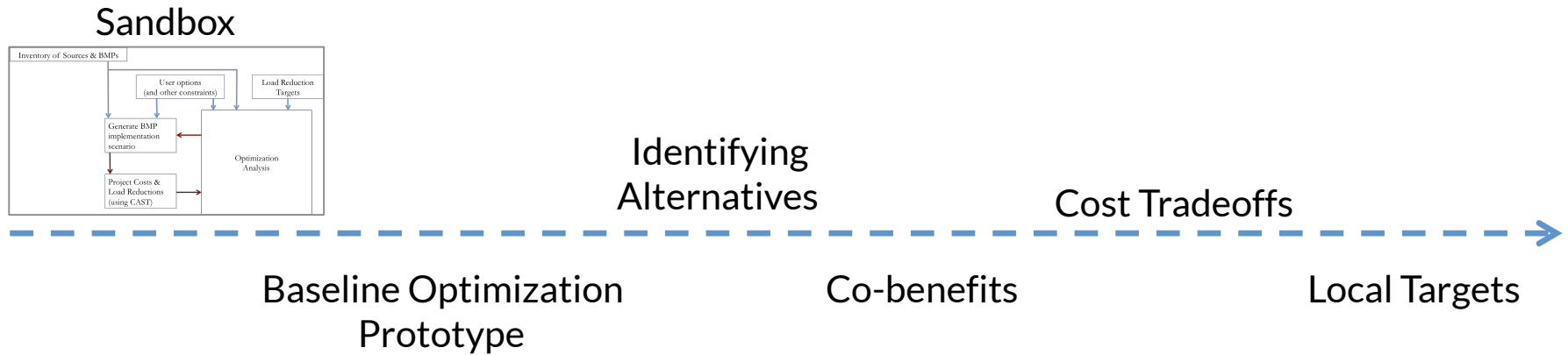
Optimization Tool Sandbox



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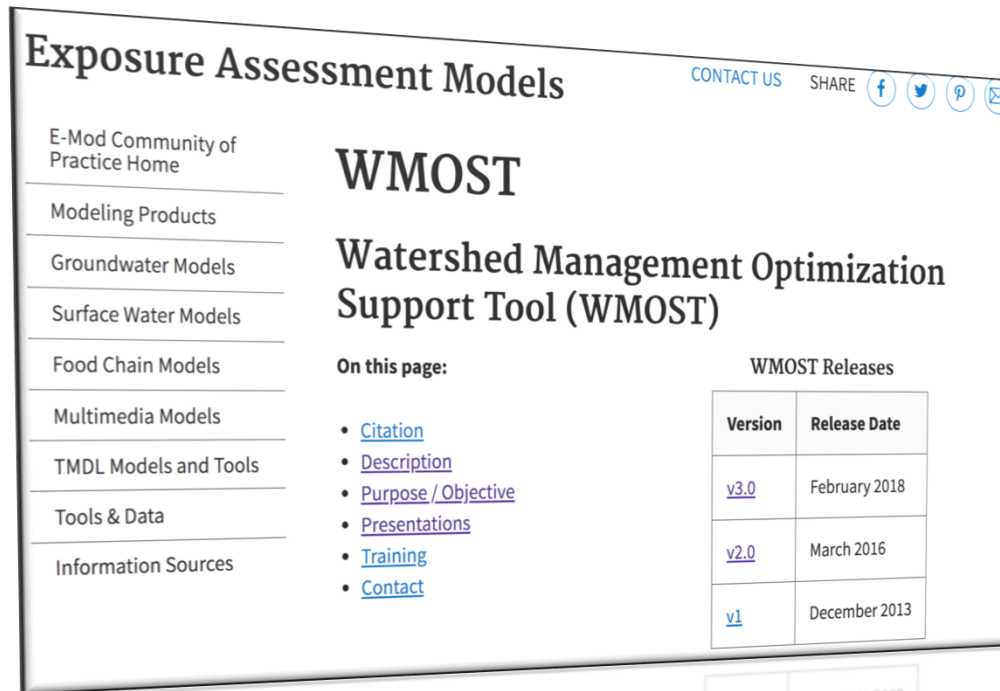


Looking Forward



Exploring potential synergies

Watershed Management Optimization Support Tool (WMOST)



The screenshot shows a web page titled "Exposure Assessment Models" with a navigation menu on the left. The main content area features the title "WMOST" and "Watershed Management Optimization Support Tool (WMOST)". Below this, there is a list of links under "On this page:" and a table of "WMOST Releases".

Exposure Assessment Models

E-Mod Community of Practice Home

Modeling Products

Groundwater Models

Surface Water Models

Food Chain Models

Multimedia Models

TMDL Models and Tools

Tools & Data

Information Sources

WMOST

Watershed Management Optimization Support Tool (WMOST)

On this page:

- [Citation](#)
- [Description](#)
- [Purpose / Objective](#)
- [Presentations](#)
- [Training](#)
- [Contact](#)

WMOST Releases

| Version | Release Date |
|----------------------|---------------|
| v3.0 | February 2018 |
| v2.0 | March 2016 |
| v1 | December 2013 |

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

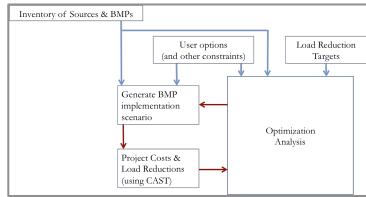
- load reductions
- cost
- co-benefits

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

Sandbox



Identifying
Alternatives

Cost Tradeoffs

Baseline Optimization
Prototype

Co-benefits

Local Targets

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

- Select** geographic region of interest and land use types
- Select** BMP constraints
- See** and compare objective attributes of nondominated solutions
- See** the set of BMP assignments for each solution

Questions

- Other constraints?
- Other objectives?
- Departures from existing scenarios, with given costs
- Computational resources/speed