Considering performance risk in economic benefit assessments: Examples from wetlands, streams and estuaries

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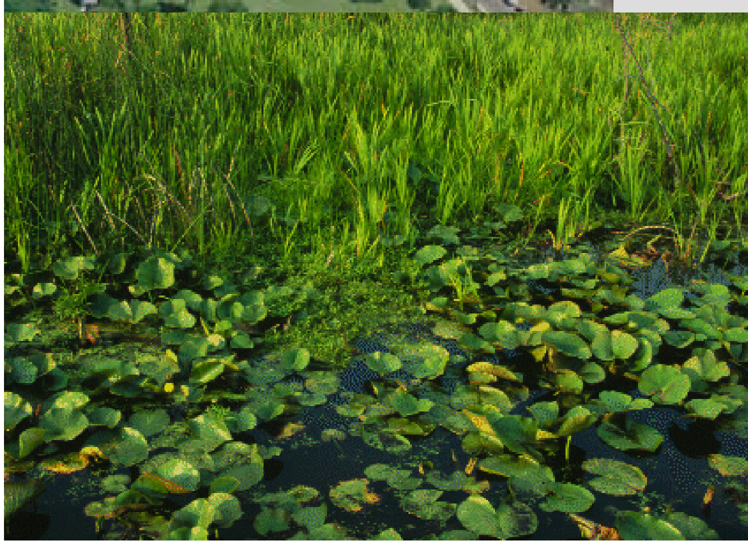
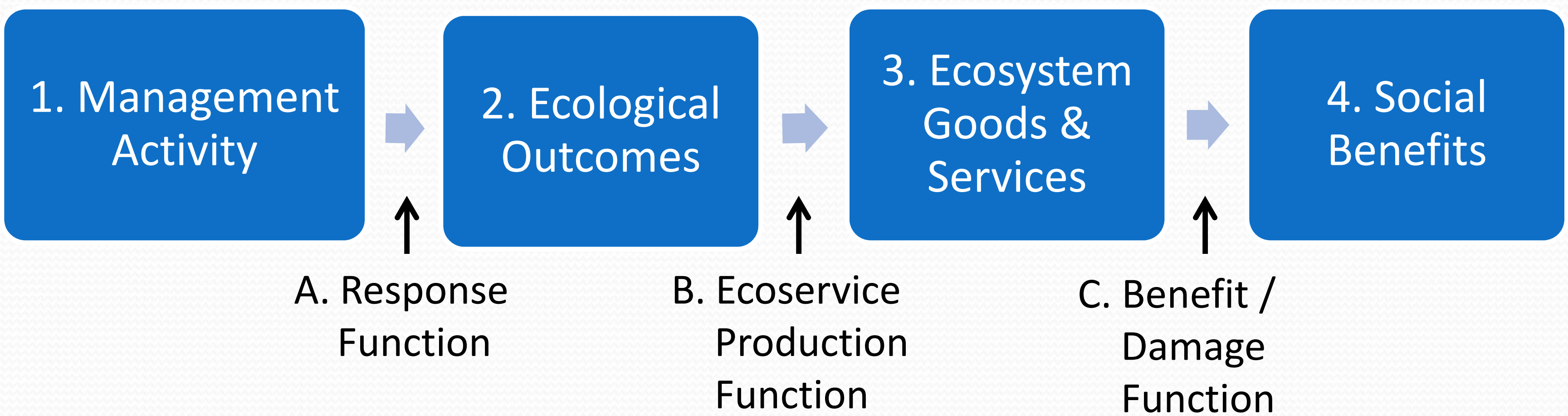


Determining Ecosystem-Derived Economic Benefits from Projects



Connection between an EGS Approach and the 6-Step Process

Corps Planning	Problems & Oppor-tunities	Inventory & Forecast	Formulate Plans	Evaluate Plans	Compare Plans	Select Plan
EGS Steps	Identify Affected EGS	Model EGS changes without project	Model alternatives and apply results, if appropriate			Report EGS benefits of selected plans

Some Key Concepts Incorporated in Framework

- Distinguish between ecological features or processes and the beneficial outcomes to people
  - Robust models link measured ecological outcomes to things people care about
  - Outcome metrics reflect specific user needs & preferences
  - Use monetization only where it makes sense
- Measure changes due to project
- Consider restoration probability of success

Q. Why consider performance risk?

A. Economic benefits with equal value but unequal performance risk are not equivalent in decision-making

Two main approaches to incorporate risk

1. Screen out high-risk projects
2. Use outcome probabilities to deflate benefits in proportion to risk

Return on Investment (ROI) Analysis

Using Risk-Adjusted Benefits

Expected ROI =

(ΔBenefits * Probability of Success) - Costs

Risk-Adjusted Benefits	($1Million * 0.75) =	$750,000
Costs		- $250,000
Return on Investment		$500,000

Evidence to Assess Performance Risk

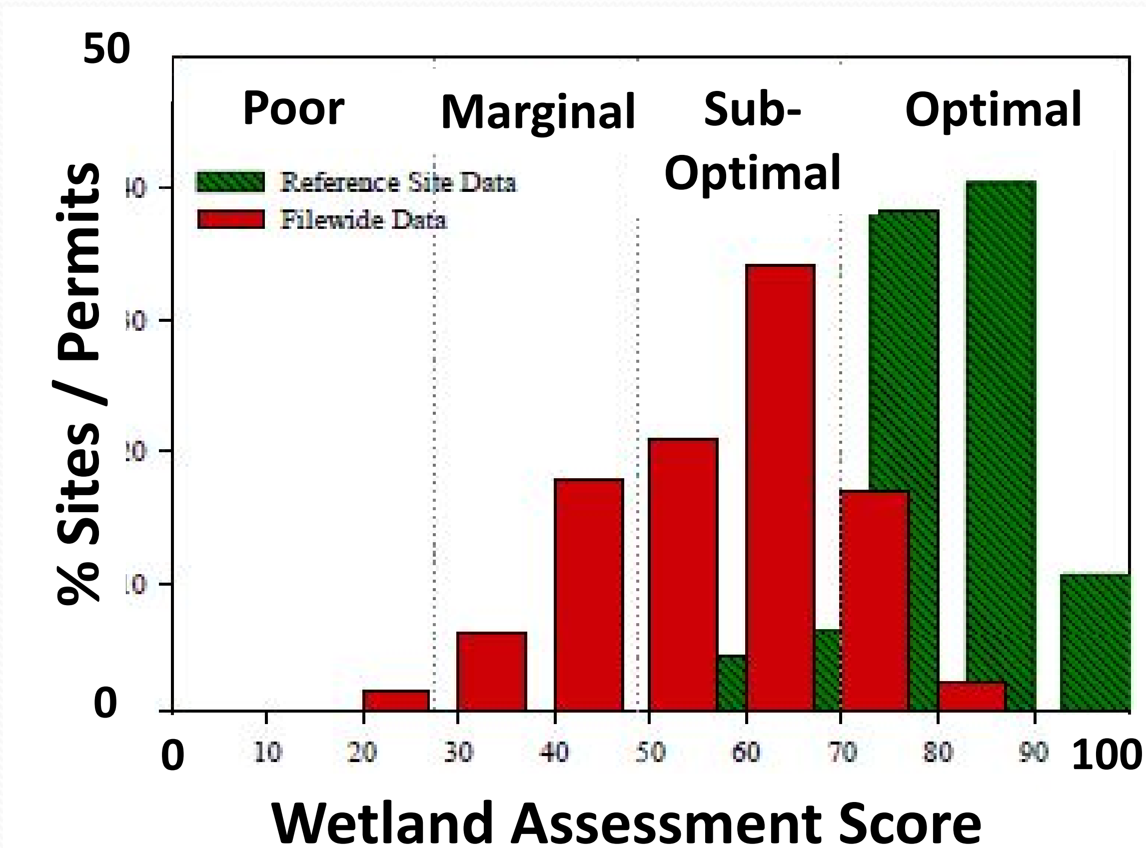
1. How do we define success?
2. Can performance risk across ecosystem goods & services be differentiated?
3. What locations & techniques have the greatest returns to effort?
4. Do site outcomes induce benefits downstream or offsite?

Wetland Restoration
Typical Definition of Success

- "The process of reestablishing a self-sustaining habitat that in time can come to closely resemble a natural condition in terms of structure and function."
  -Turner and Streever 2002

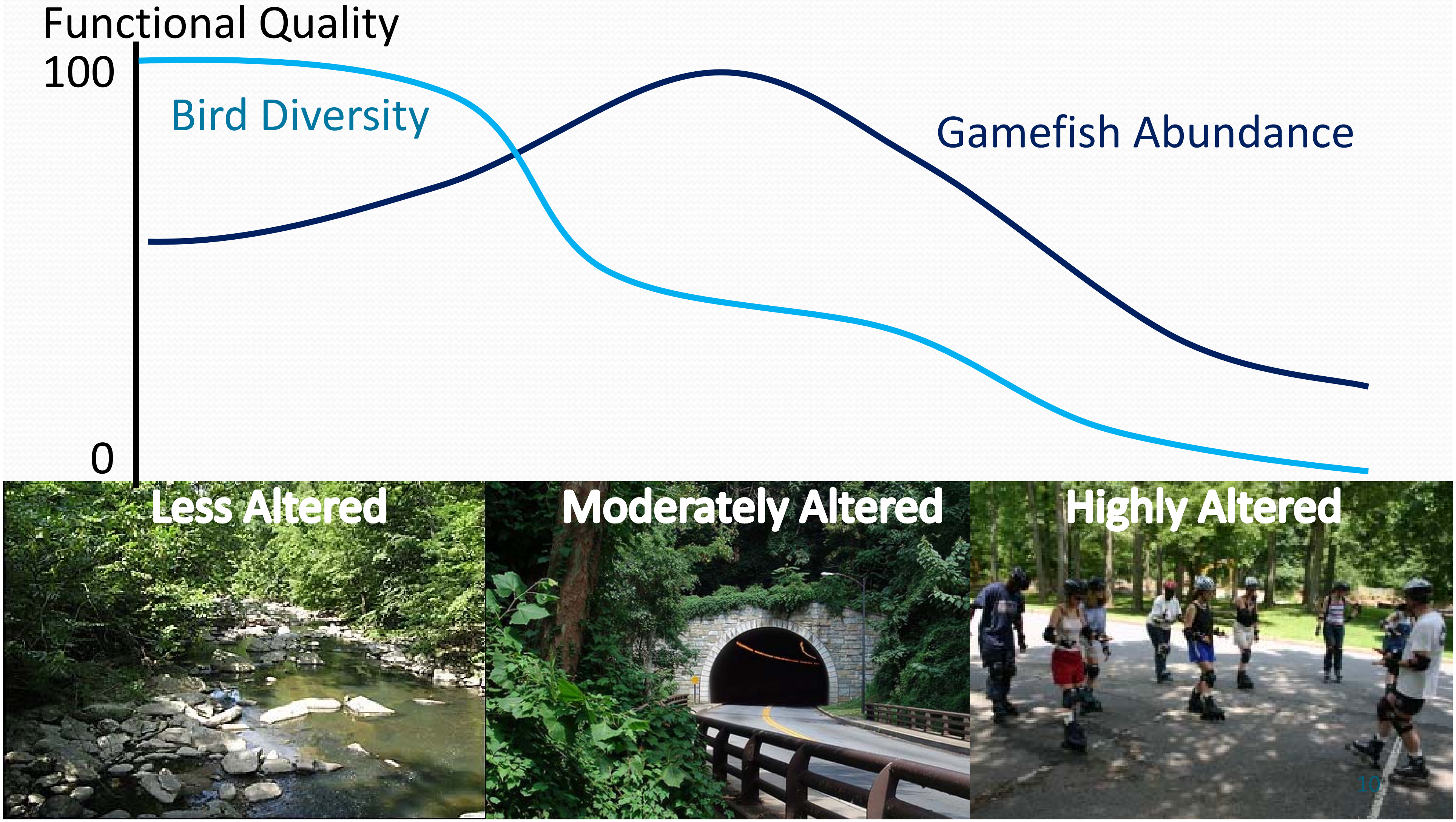
Ecological Metrics Used to Judge Success

Wetland Mitigation Sites



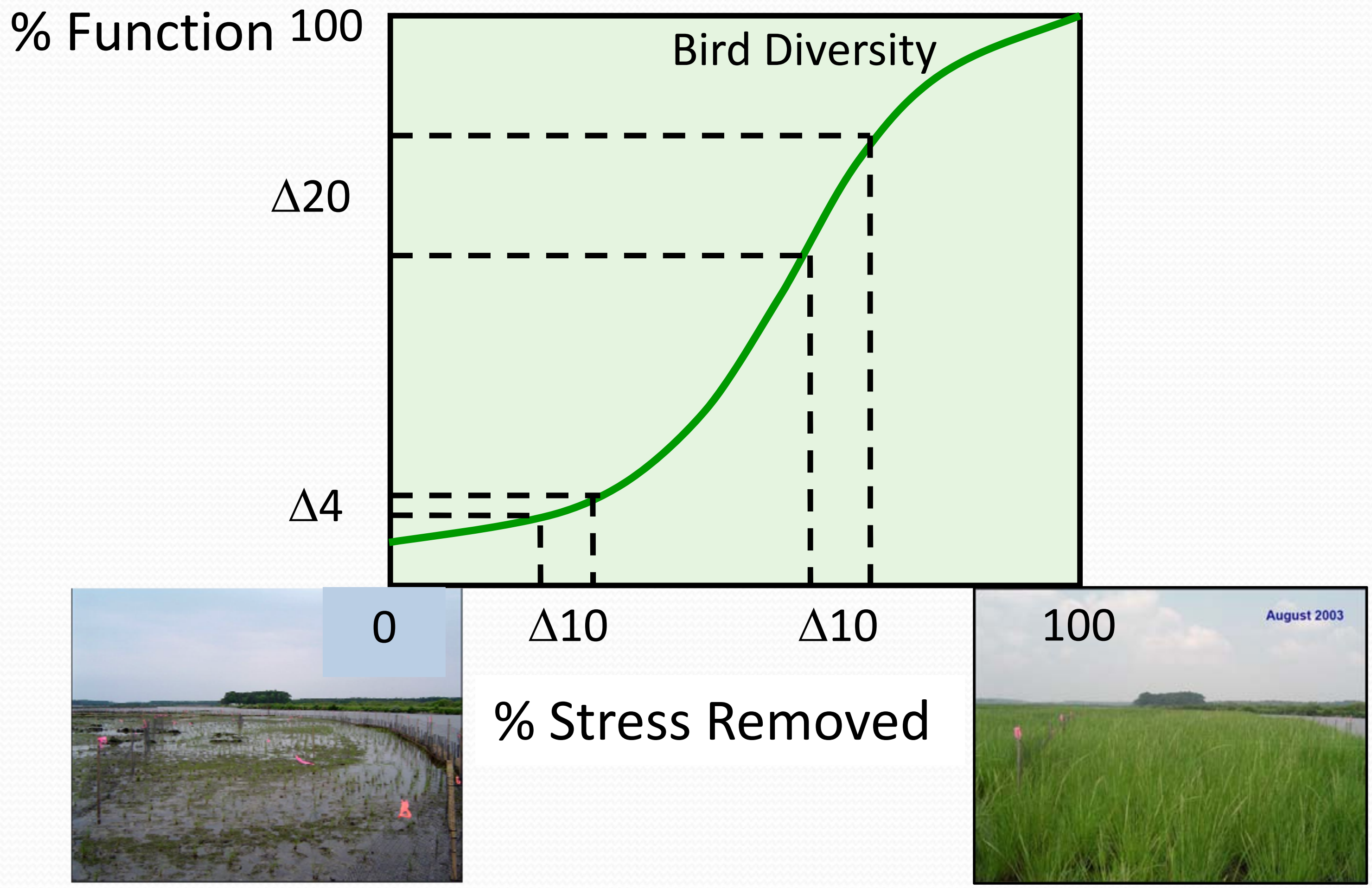
Ambrose, et al. 2006

Response Functions that Promote Ecosystem Service Measurement



Where are the greatest returns to effort?

Restoration-Response Function



Example Findings – Literature Review

Landscape Constrains Habitat Restoration Goals

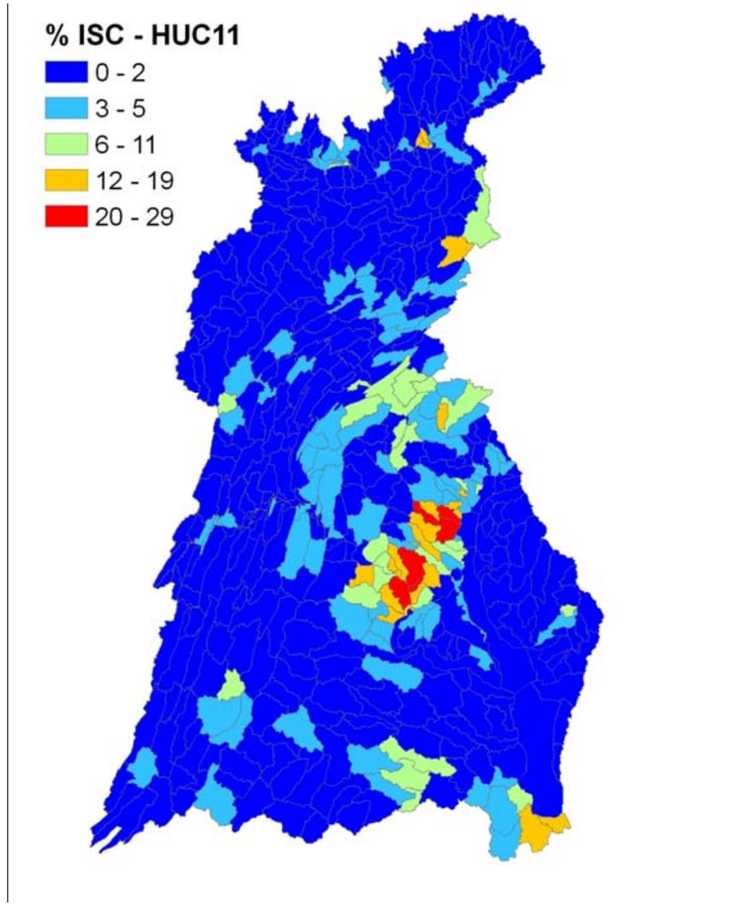
Aquatic Habitat

- Watersheds with >15% impervious cover → Minimal stream biodiversity improvement from in-stream habitat manipulations

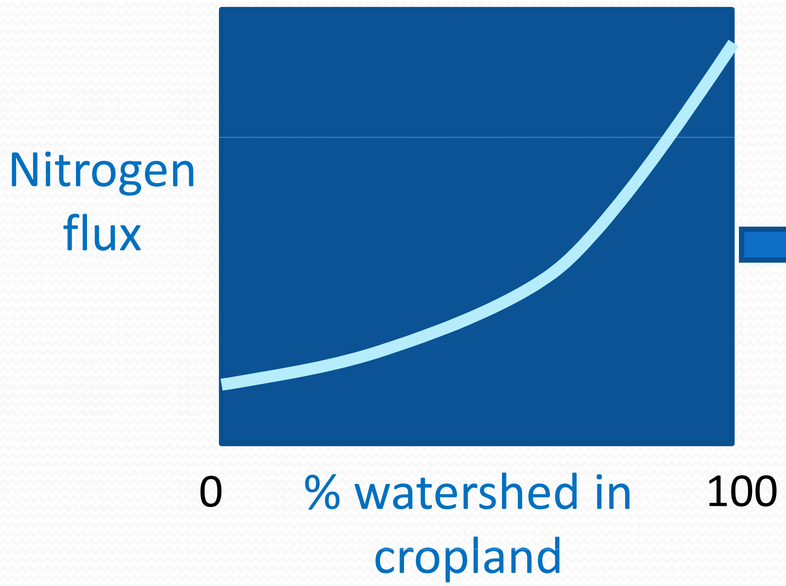
Wetland Habitat

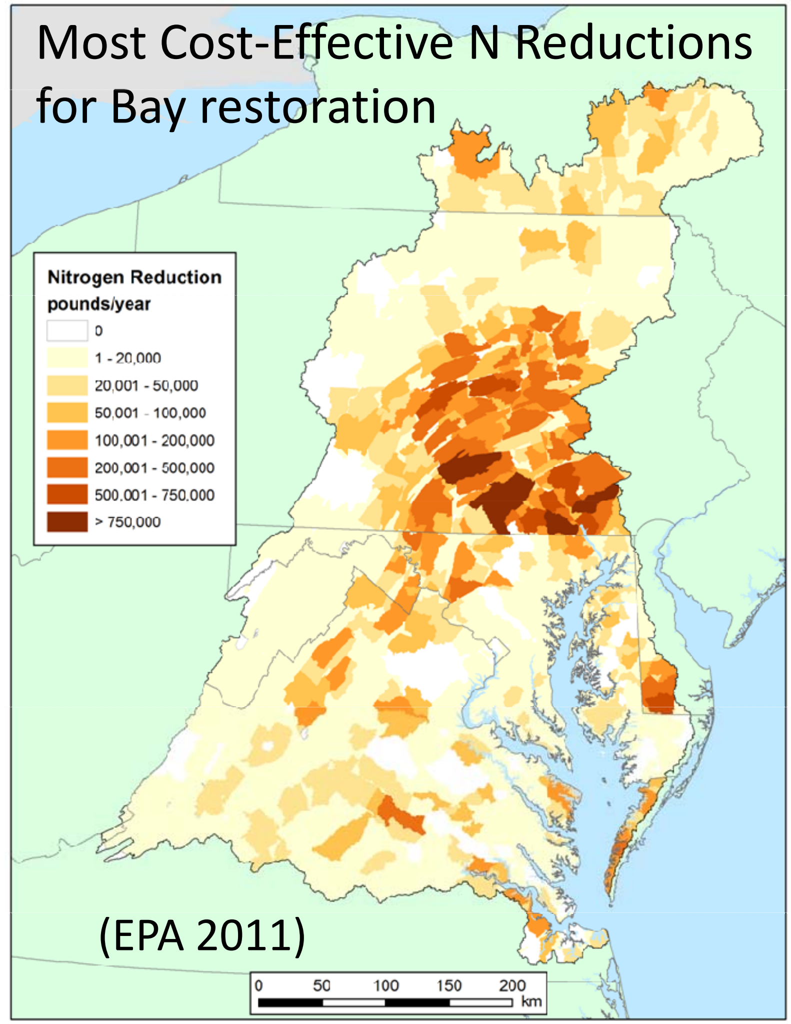
- Wetlands in heavily altered landscapes → Limited success in restoring habitat

% Impervious surface by watershed

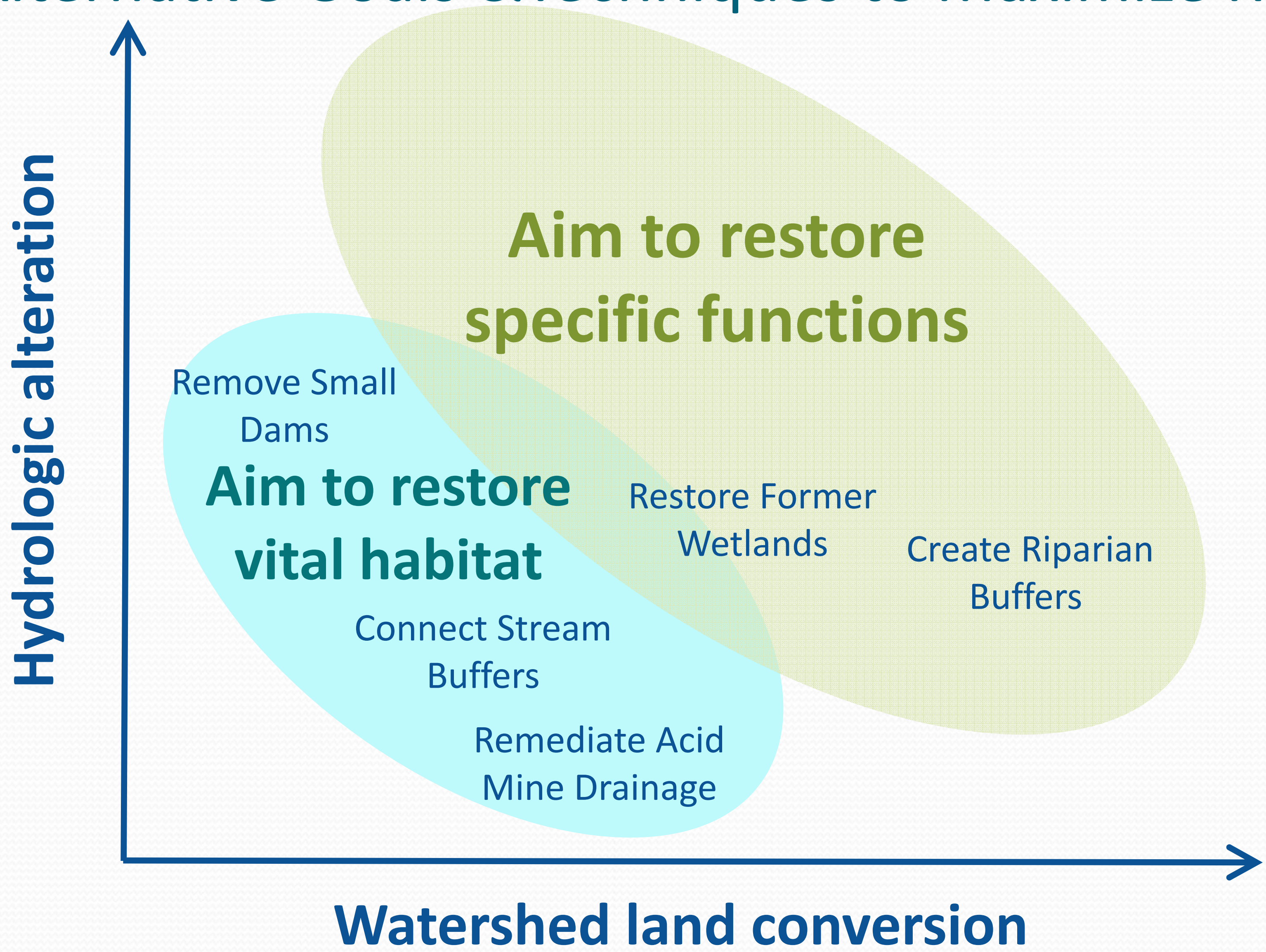


Local and Regional Success Outcomes Can Differ





Alternative Goals &Techniques to Maximize ROI

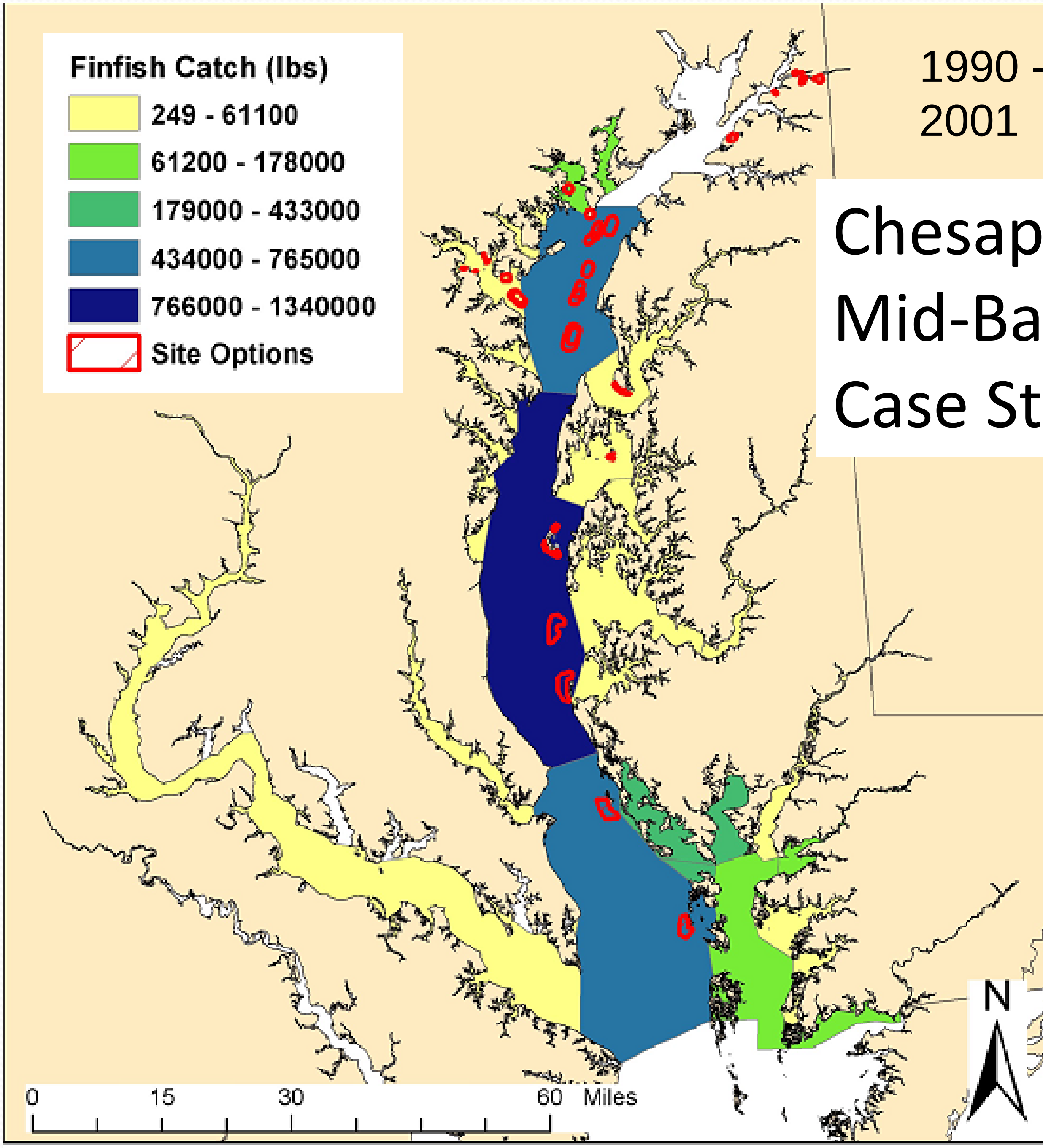


Conclusions of Literature Review

- ROI targeting of projects needs to be based on specific goals
- Restoring scarce habitat with a site-based approach is only probable under limited (e.g., single-stressor) conditions
- Degraded sites with limited ability to provide on-site benefits can still contribute to watershed/regional goals

Qualitative Risk Analysis
Chesapeake Mid-Bay Islands Case

Chesapeake Bay Mid-Bay Islands Case Study

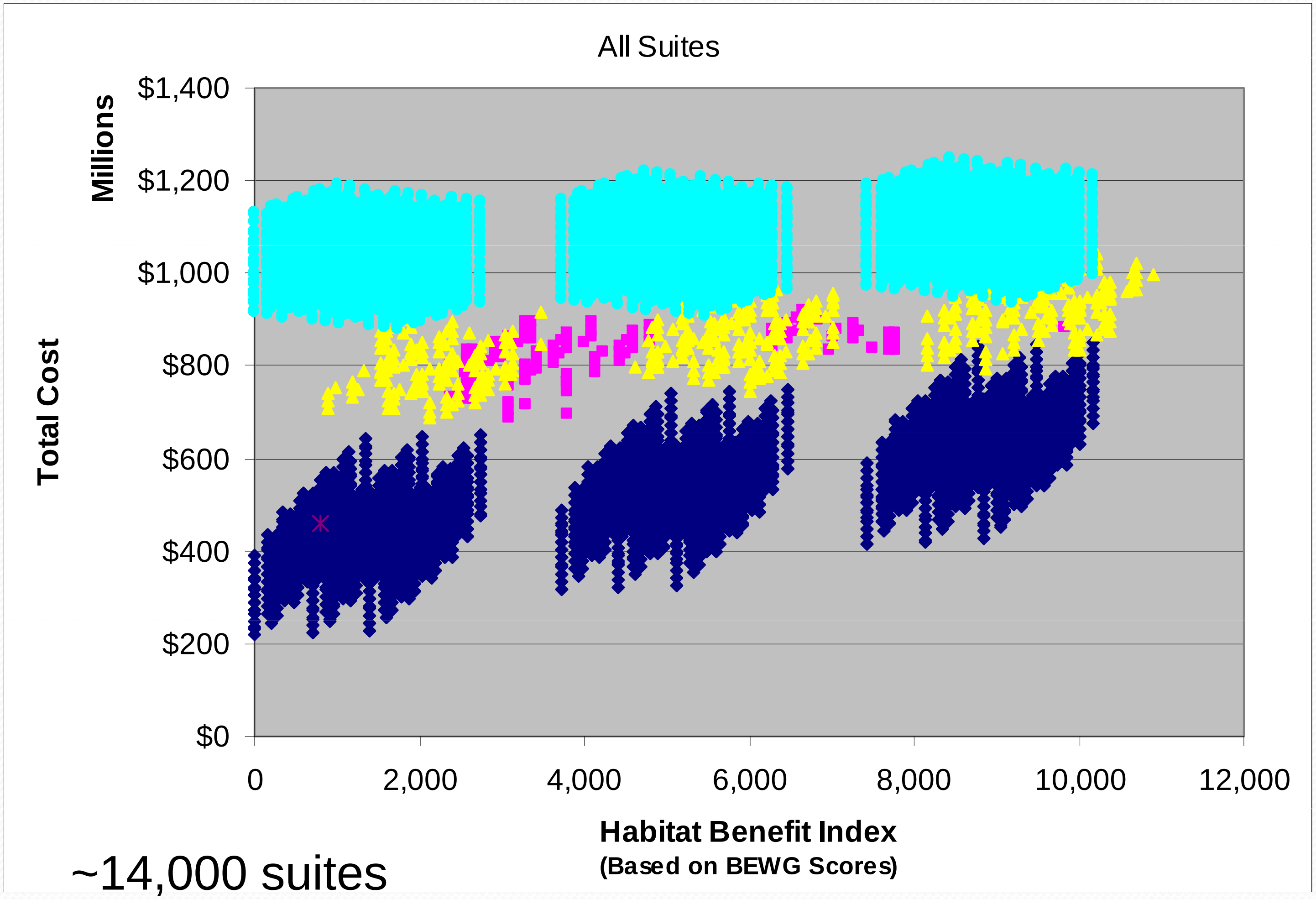


Environmental Scoring Criteria

- Water Quality (DO, Turbidity, Salinity)
- Aquatic Habitat (SAV, Tier II & III)
- Wetlands (Tidal, Non-tidal)
- Aquatic Biology – Finfish/Shellfish
- Protected Species
- Waterbirds (Waterfowl, Wading & Shorebirds)
- Terrestrial (Habitat, Prime Ag Land)
- Physical Parameters (Substrate, Fossil Shell)
- Human Use (Aesthetics, Health & Safety)
- Beneficial Use (Enhance Adjacent Habitat)

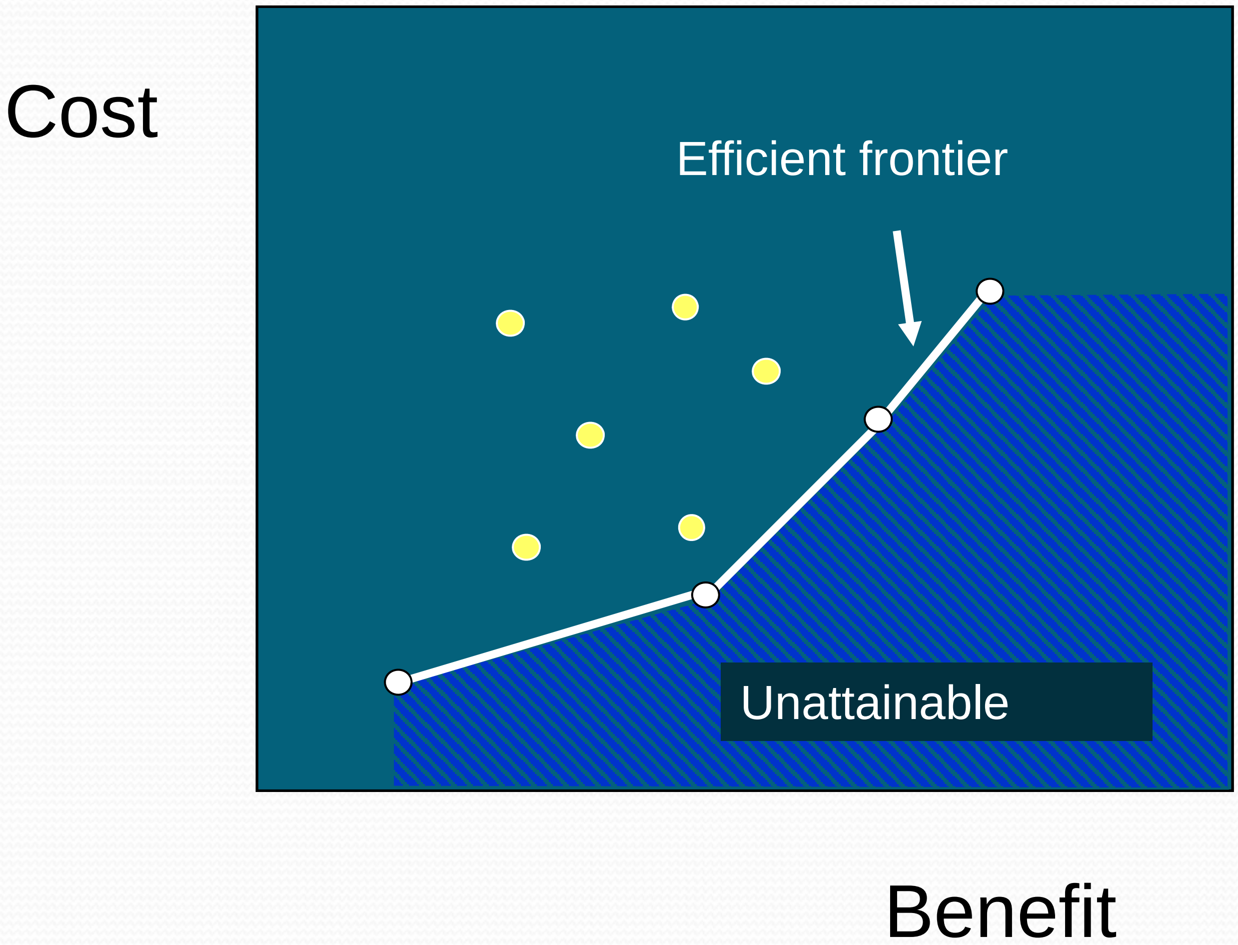
Chesapeake Bay Case Study

Ranking Restoration Alternatives

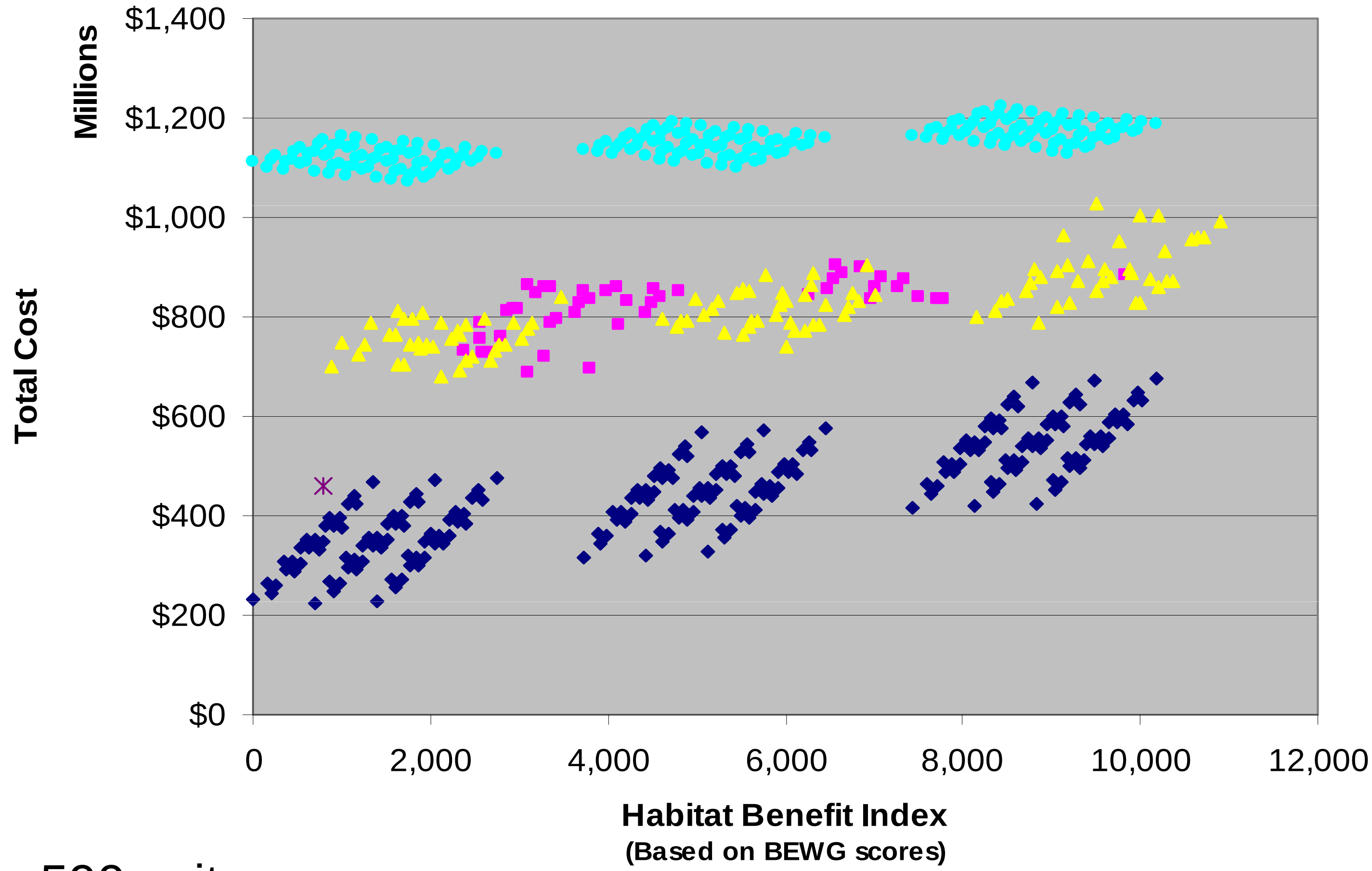


~14,000 suites

Cost-Effectiveness of Options



Remaining Alternatives after Risk-Blind Cost-Effectiveness Screening



~590 suites

Screen for Legal & Political Risk

Technical & Logistical Risk

- Techniques are routinely applied
- Specialized techniques are required
- Techniques are not standardized
- In initial implementation stage
- Experimental stage

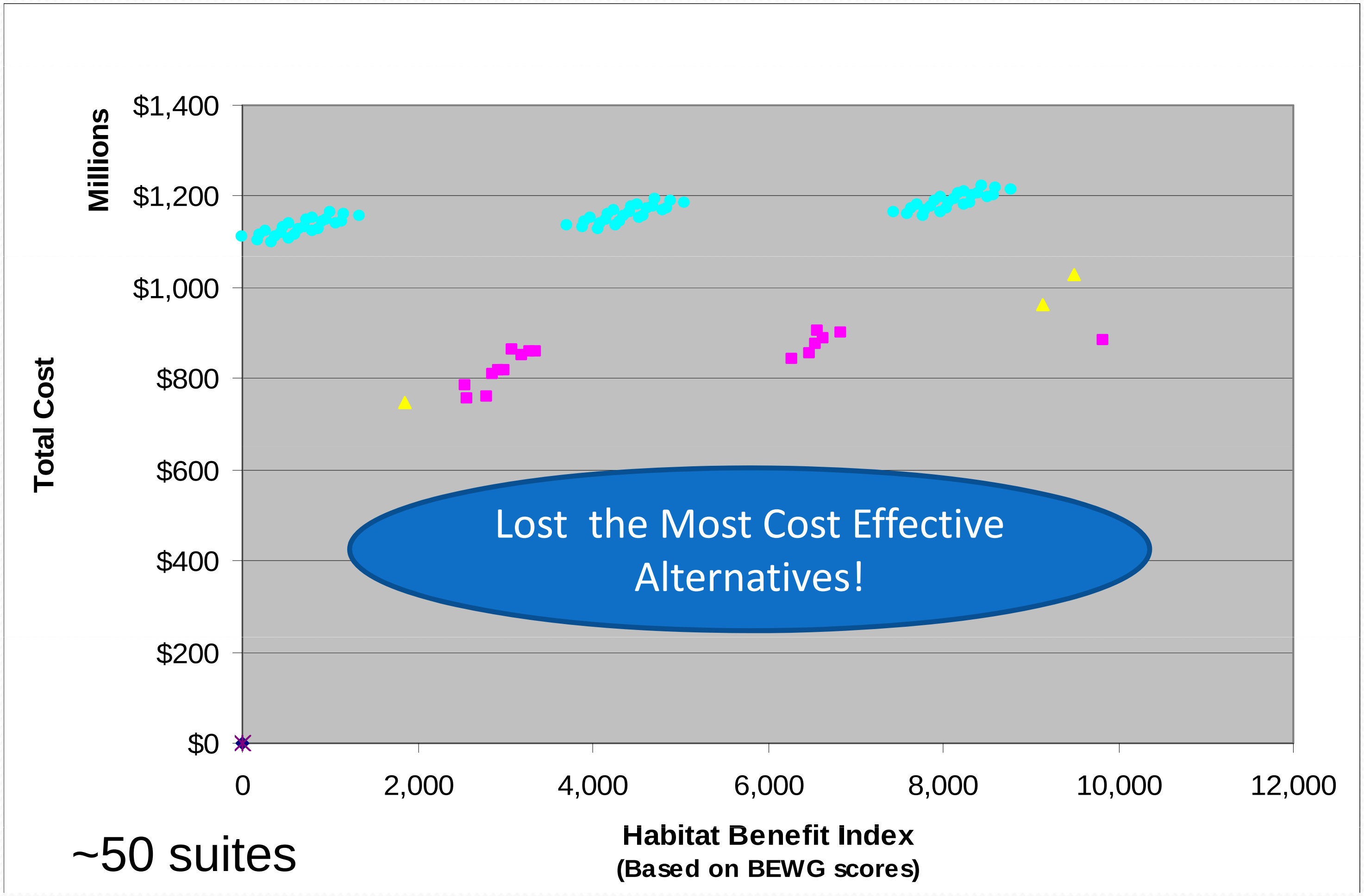
Low

High

Legal and Political Risk

- No law to prohibit, none or minor public/regulatory issues
- No law to prohibit, moderate public/regulatory issues
- No law to prohibit, significant public/regulatory issues
- Law prohibits, minor public/regulatory issues
- Law prohibits, significant public/regulatory issues

Remaining Alternatives after Screening for Unacceptable Risk



~50 suites

Quantitative Risk Analysis

Non-native Invasive Species

Case Study

NPS Exotic Plant Management Teams – Treatment Effort

- Spent $5.7 million
- Inventoried 2.7 M acres in 2001
- Treated and retreated ~75,000 acres (2001-2007)

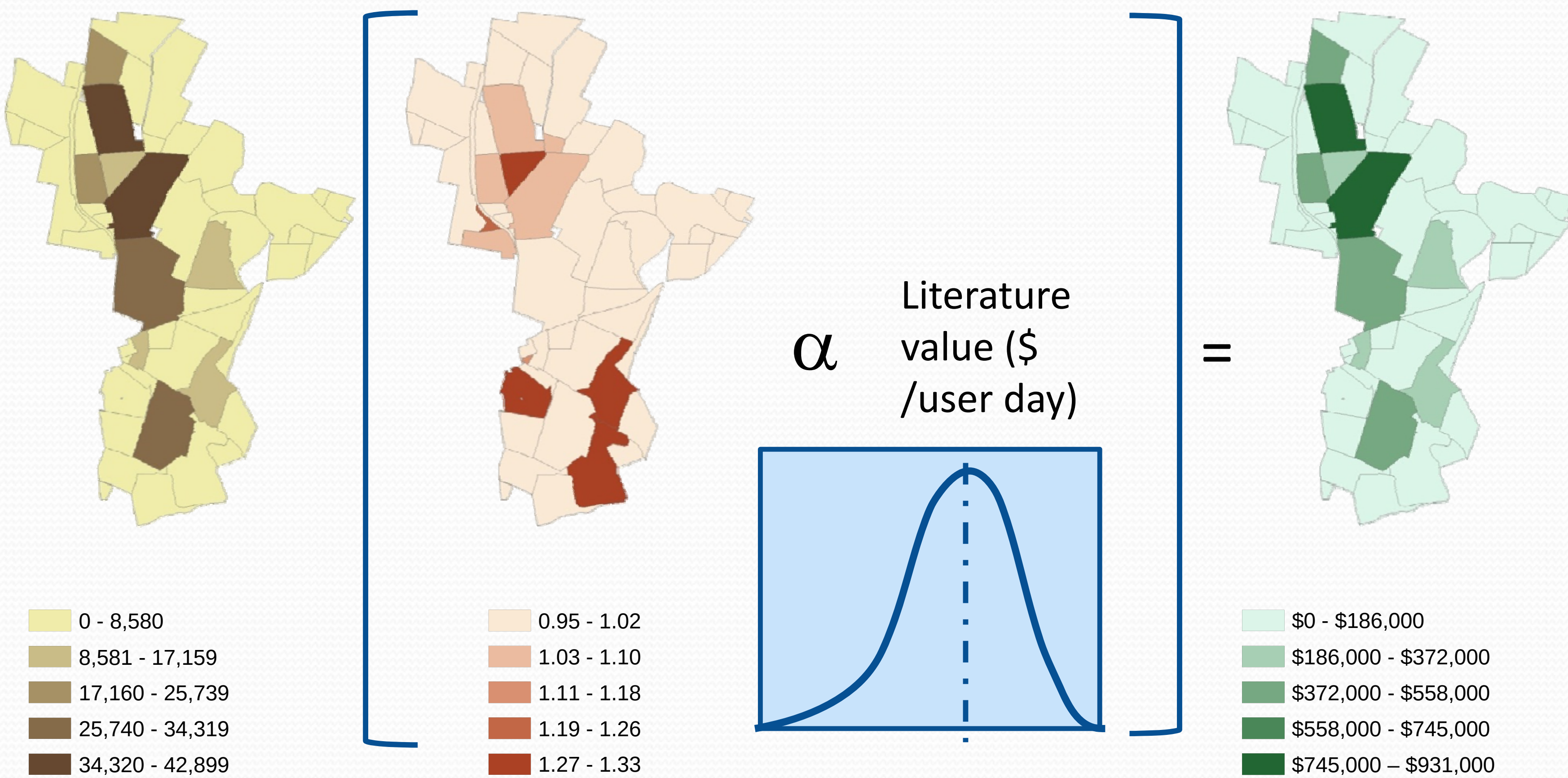
(Rita Beard, NPS Fort Collins)

Assessing Ecosystem Service Contributions by Location

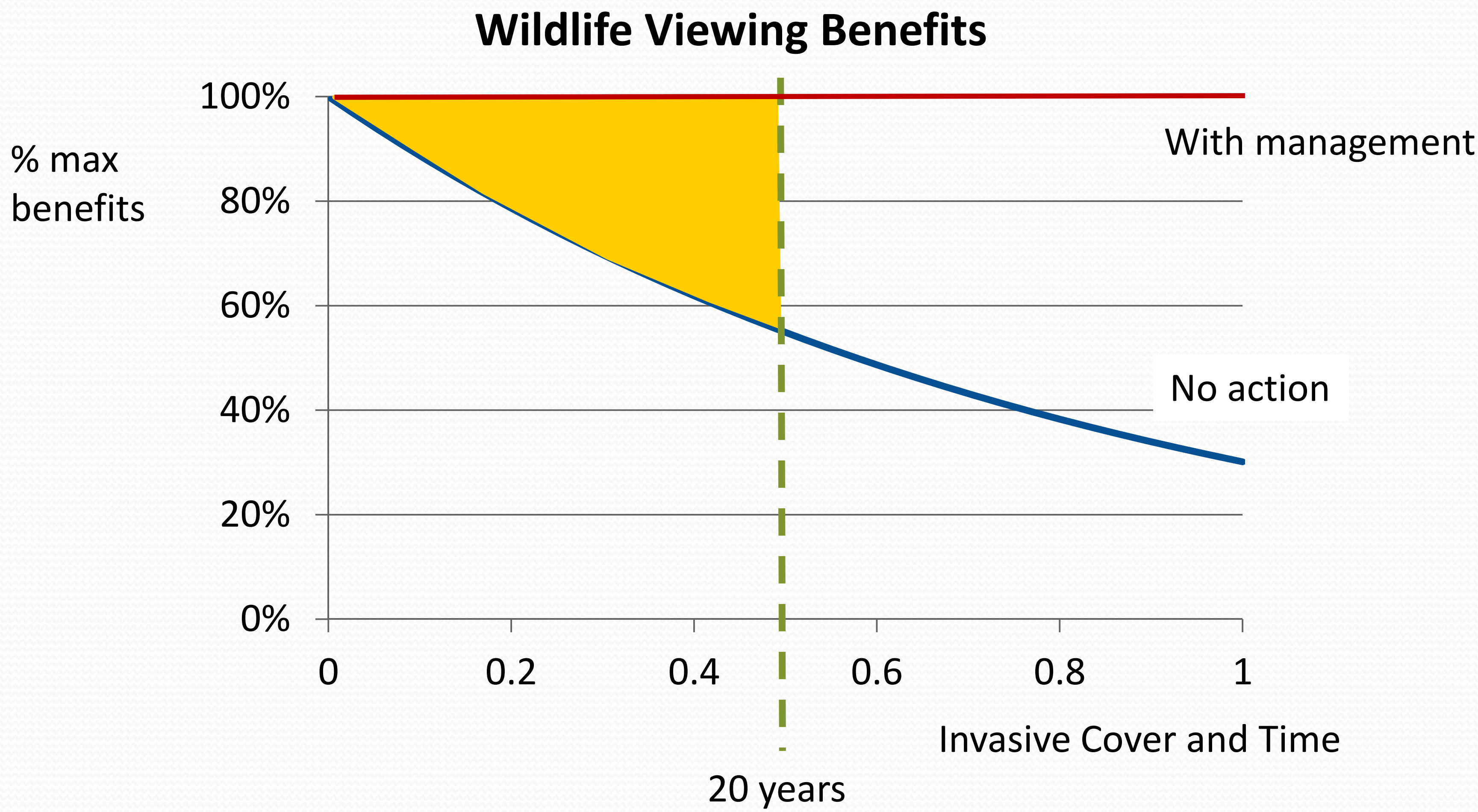
Demand	• How many users? • Who values this service?
Quality / Attractiveness	• Do site features enhance the user experience?
Landscape Enhancements	• Does adjacency or connectivity affect benefits?
Substitutability & Rarity	• Are local substitutes available? • Is service regionally rare?

Spatial Benefit Transfer - Historical / Cultural Services

Spatially Distributed Demand (user days) (Benefit multiplier α Mean consumer surplus per visit) = $ Value (no weeds)



Quantifying Economic Benefits Relative to a Baseline

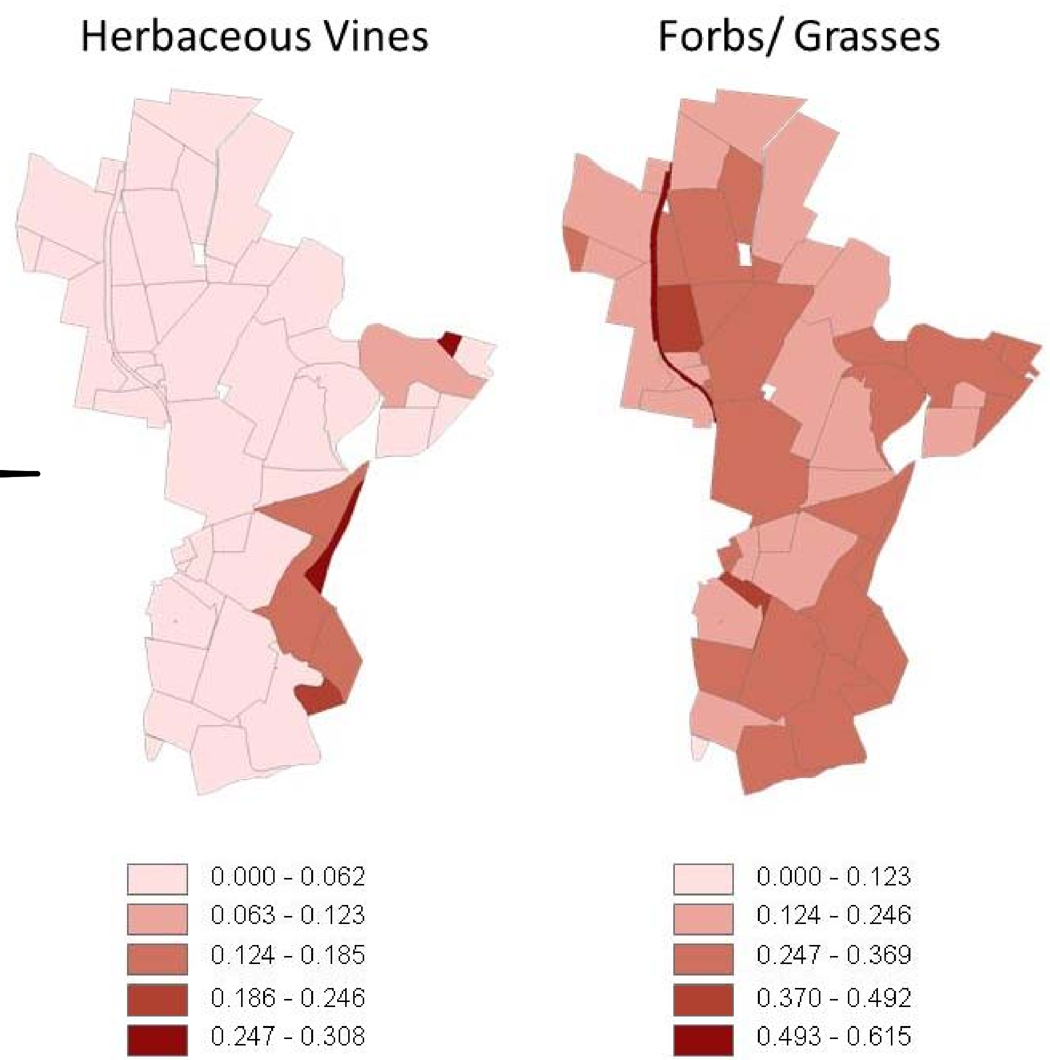


Reinvasion Risk

Global Pressures
- park-level infestation
- fecundity
- asexual reproduction

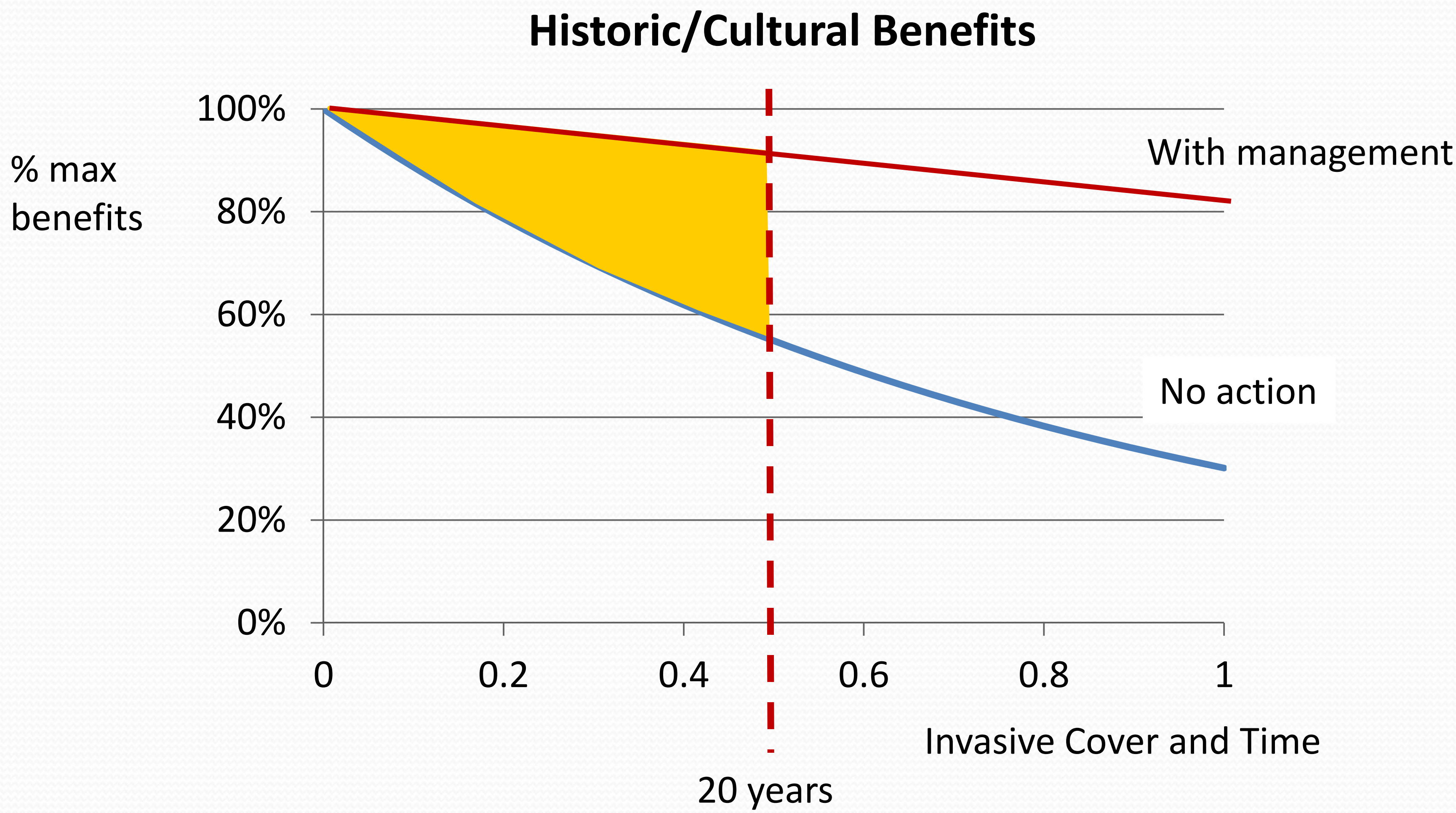
Landscape Pressures
- roads, streams, trails, boundaries
- nearby infestations

Establishment Probability
- soils, slope, wetness, edginess, radiation



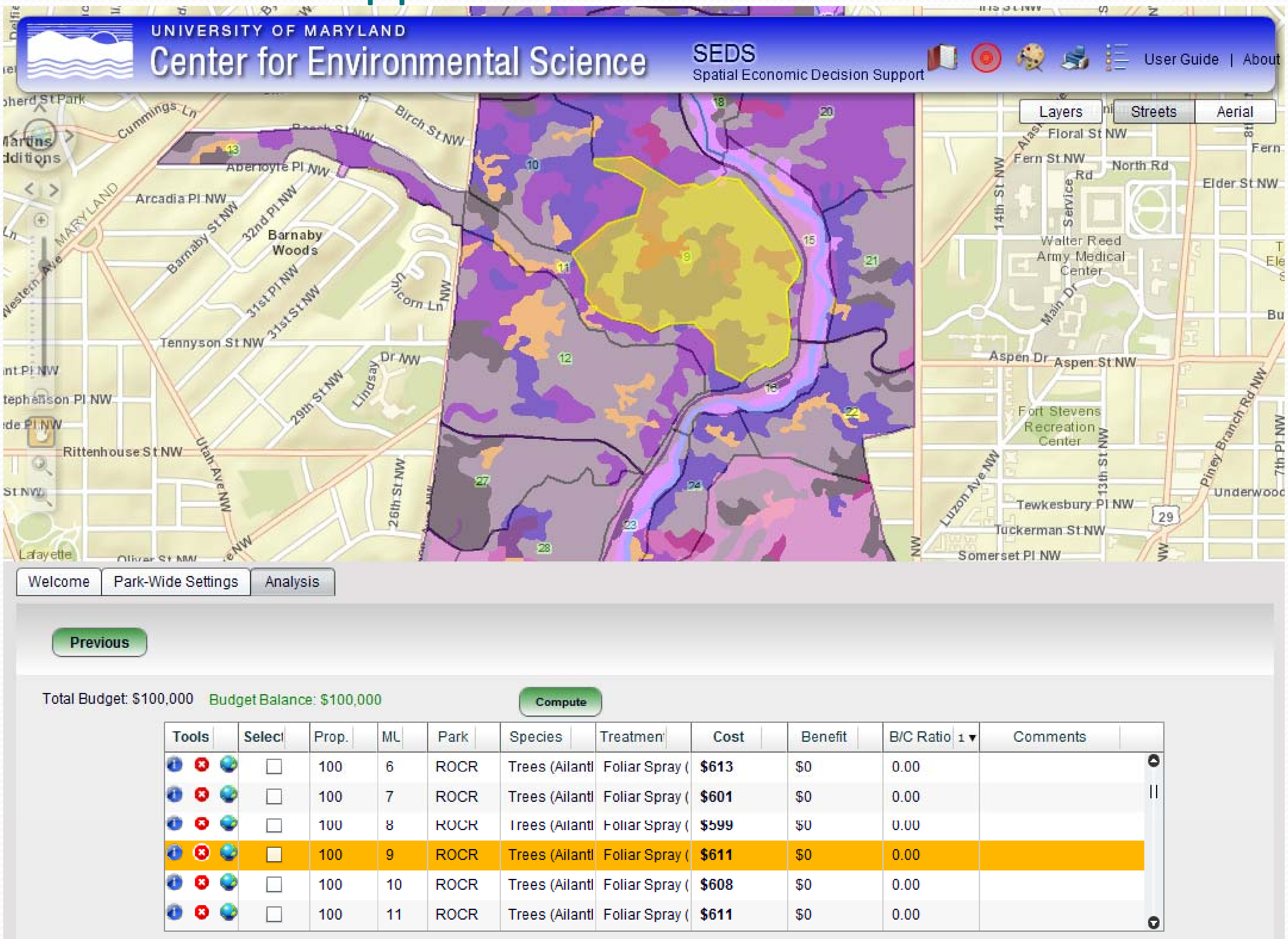
T. Lookingbill & E. Minor 2010

Calculating Risk-Adjusted Benefits



Tools to simplify analysis

Decision Support Tools Delivered via the Web



Capacity Utilization Analysis to Identify Future Performance Risk

Summary of Resource Capacity Assessment for Air Force Base: Water Supply & Water Discharge

Component	Measure	Percentage
Water Supply	System Capacity vs. Avg Usage	186%
	Volume Available vs. Avg Usage	451%
	System Capacity vs. Usage in Peak Month	133%
	Volume Available vs. Usage in Peak Month	323%
	Unconstrained Months	100%
	Months Not Restricted	100%
	Water Supply Quality – State Water	NA
	Water Supply Quality – Well Water	NA
	Regional Capacity	309%
	Aquifer Sustainability	NA
Water Discharge Availability	Wastewater Volume Capacity vs. Discharge	167%
	Wastewater Volume Capacity vs. Discharge	142%
	Overflow Frequency	100%
	Water Quality Discharge	Chloride – 149%
	Regional Water Quality	NA

Resource Ratings

Opportunity

Adequate

Degraded

	DESCRIPTIVE RATING	RATING CODE
>140%		**RO3**
>120-140%		**RO2**
>110-120%		**RO1**
110-90%		**RR**
<90-80%		**RD1**
<80-60%		**RD2**
<60%		**RD3**

RO = Resource Opportunity RR = Resource Ready RD = Resource Degradation

NOTE: Breakpoints are adjusted for specific measures

Lessons Learned

- ROI Analysis is Served by
  1. Functional metrics that go beyond measures of naturalness & consider non-linear responses
  2. Ecosystem service benefit metrics that depend on ecological quality and user preferences
  3. Damage functions that inform the no-action baseline
  4. Performance risk adjustments
- Using Performance Risk
  1. Site outcomes will reflect landscape constraints
  2. Avoiding risk may severely restrict management options
  3. Quantifying risk can suggest which risks are worth taking