Salt Marsh Integrity Assessment Program in USFWS Region 5

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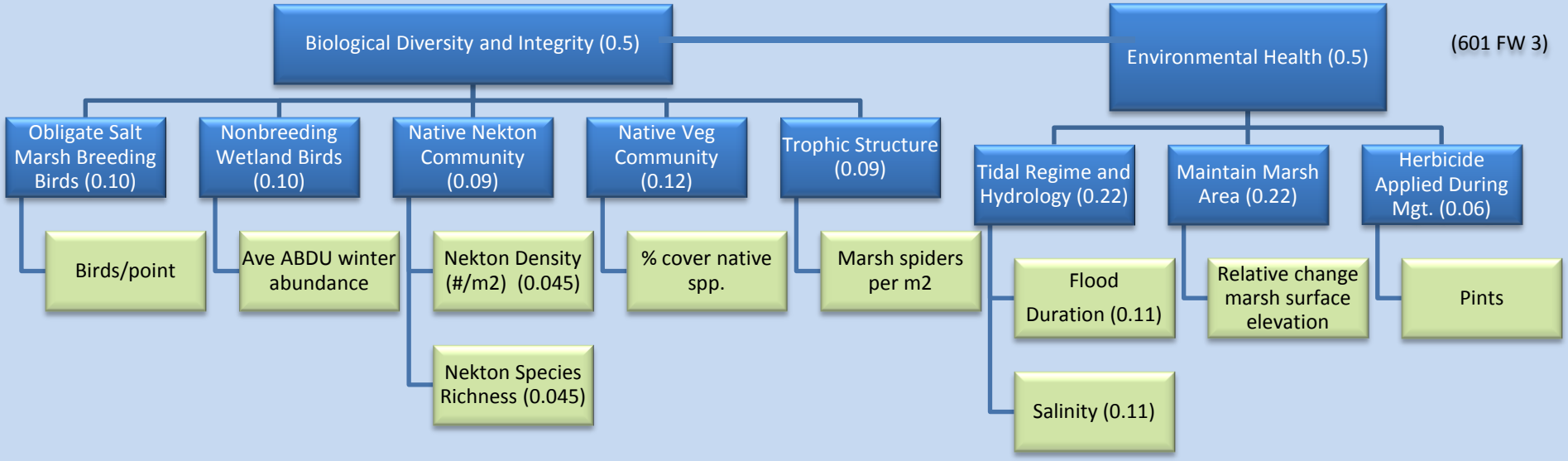
What is SMI?

- SMI = Salt Marsh Integrity (Assessment)
- It is a multi-metric “rapid” assessment method for US FWS salt marsh holdings
- Data are used
  - to indicate current/baseline conditions
  - in models to estimate effects of future management efforts (science-based decision making)
  - to evaluate changes over time (before/after)
- Developed through an SDM process in 2008; piloted 2008, 2009; implementation began 2012

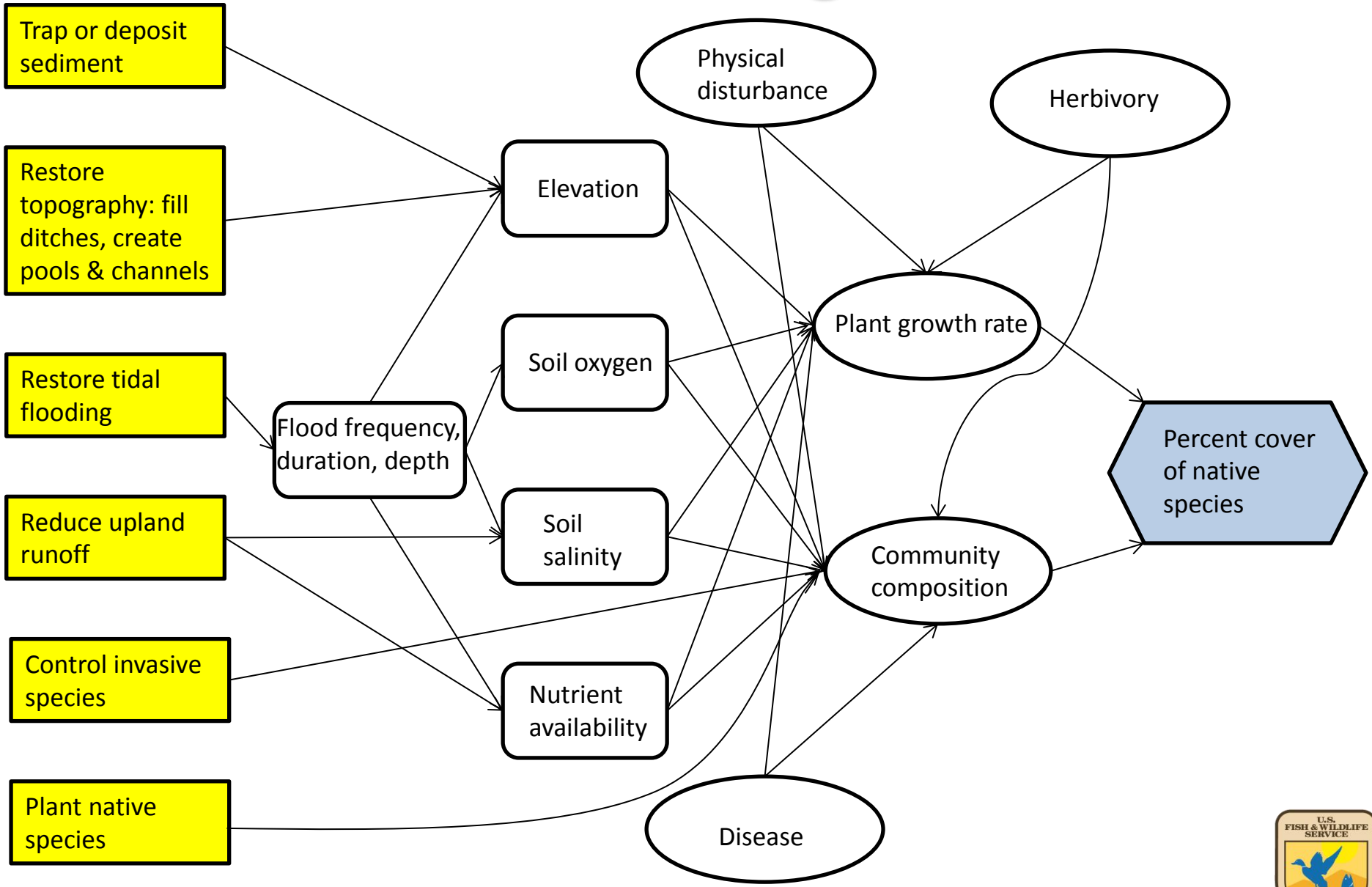
Salt Marsh Integrity Objectives Hierarchy



Objective

Measureable Attribute

Influence Diagram

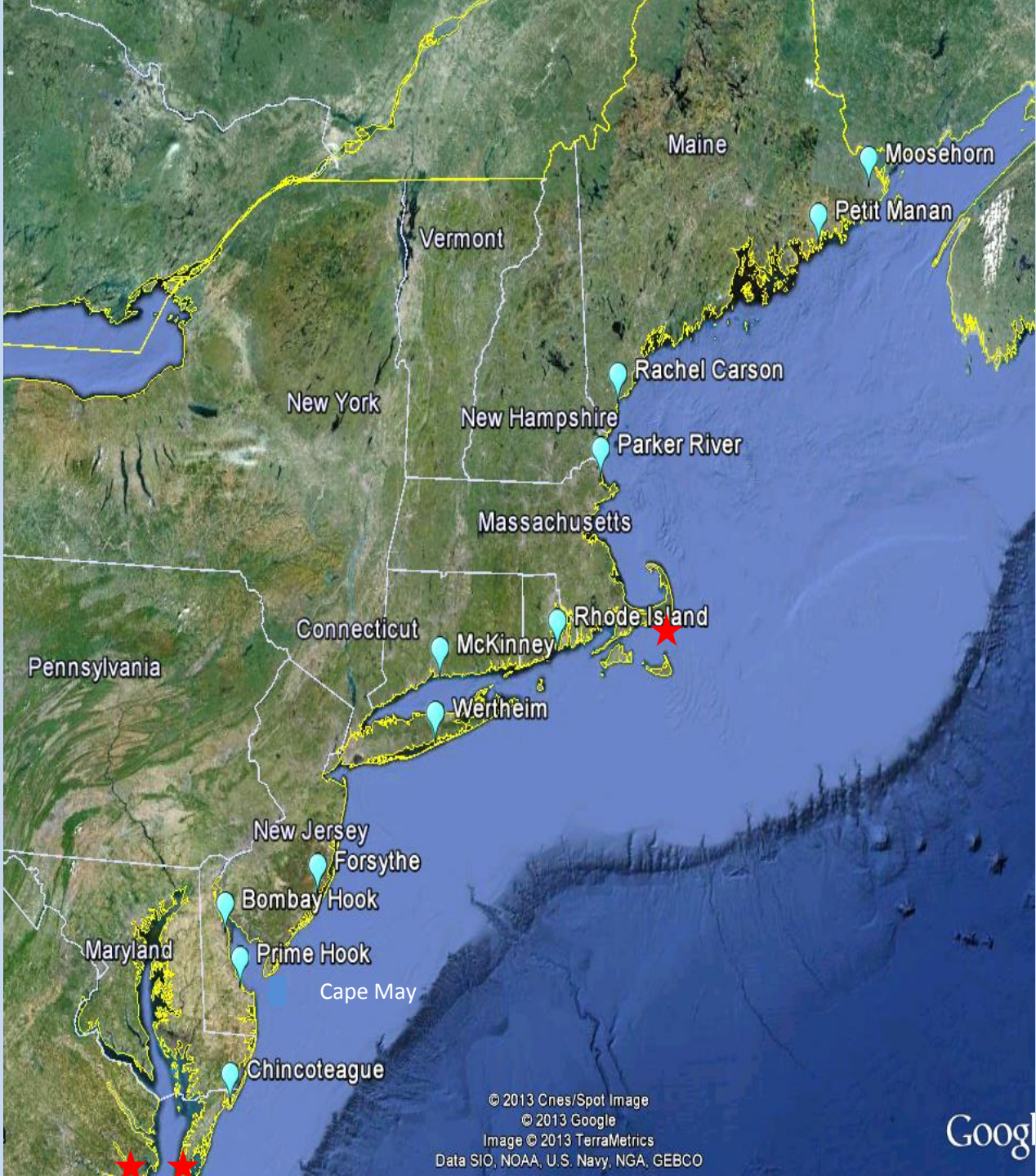


Contributing Refuges

Cape May NWR, NJ
Chincoteague NWR,
Coastal Delaware NWR Complex
(Bombay Hook, Prime Hook)
Edwin B. Forsythe NWR,
Long Island NWR Complex
Maine Coastal Islands
Moosehorn NWR
Parker River NWR,
Rachel Carson NWR
Rhode Island NWR Complex
Stewart B. McKinney NWR

Refuges Added 2014

Monomoy NWR, MA
Eastern Shore VA, VA
Eastern VA Rivers, VA



What are the major components of SMI?

- Land use surrounding the marsh
- Bird Surveys
- Vegetation
- Nekton (fish & decapod crustaceans)
- Basic water quality (salinity, temp, depth)
- Hydrology (depth & duration of flooding)
- Elevation
- Large-scale marsh traits (% OW, ditching, marsh position)

Rapid Method "Final" List

Historical condition and geomorphic setting

Landscape_position

- **Landscape position:** 1 (marine), 2 (middle-estuary), 3 (upper-estuary)
- **Shape:** 1 (expansive meadow), 2 (narrow fringing marsh)
- **Fill/fragmentation:** 1 (no), 2 (low), 3 (mod), 4 (severe)
- **Tidal flushing:** 1 (well flushed), 2 (moderately flushed), 3 (poorly flushed)
- **Aquatic edge:** 1 (low), 2 (mod), 3 (high)
- **Ditch Density:** 1 (no), 2 (low), 3 (mod), 4 (severe)

Rapid Method “Final” List cont.

Surrounding land-use

- % agricultural land in 150 m buffer * (area of buffer/area of MSU)
- % natural land in 150 m buffer * (area of buffer/area of MSU)
- % natural land in 1 km buffer * (area of buffer/area of MSU)
- ***Ratio of open water area : vegetation area***

Rapid Method “Final” List cont.

Marsh surface elevation

- Elevation to NAVD88

Tidal range/groundwater level

- % of Time Marsh Surface Flooded
- Mean Flood Depth (cm)

Salinity

- Surface water salinity (@ nekton sites)

Rapid Method “Final” List cont.

Vegetation community

- **Species richness** using rapid point intercept method on transects
- **% Cover Visual Estimations** of
  - Brackish Terrestrial Border Community
  - Open Water
  - Pannes, Pools, & Creeks
  - High Marsh Community
  - Low Marsh Community
  - Salt Marsh Terrestrial Border community
  - Upland Community
  - Invasive Plant Species

Rapid Method “Final” List cont.

Nekton community

(throw trap, ditch nets)

- Nekton Density
- Nekton Species Richness
- *Fundulus heteroclitus* length (mm)

Breeding bird community

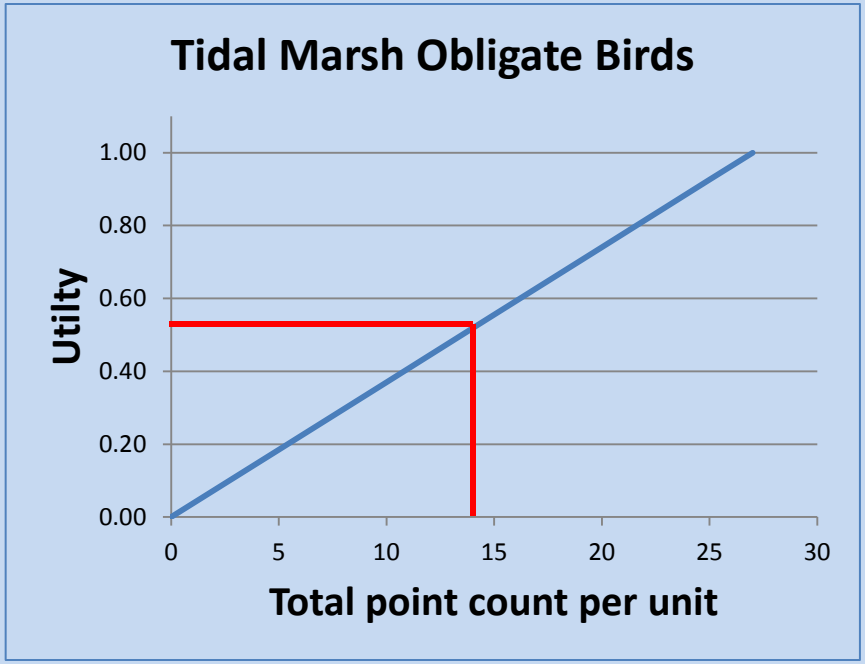
Point Count Surveys

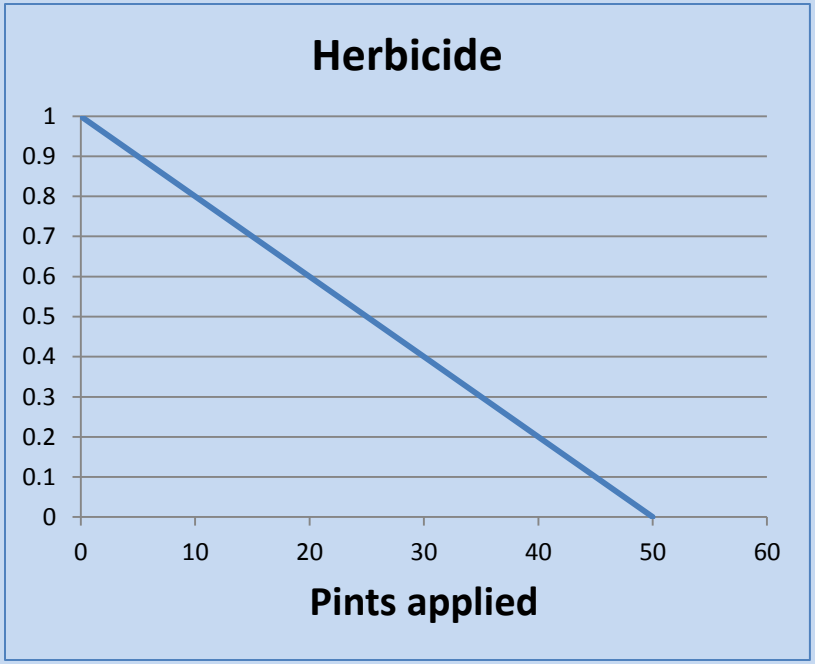
- Willet Abundance
- Tidal Marsh Obligate Abundance
- Call-broadcast surveys: Clapper Rail, Willet, Saltmarsh Sparrow, Seaside Sparrow

Consequence Table: Scores (s_{ij})

		Metrics			
Unit	Management Action	Breeding bird point counts (number)	Native veg cover (percent)	…	Herbicide Rate (pints/yr)
I	Remove *Phragmites* with herbicide and mechanical methods	15	90	…	50
I	Remove *Phragmites* with mechanical methods	15	90		0
…		…			…
II	Excavate to create pannes/pools	9	10		0
II	Fill ditches	16	20		0
…		…			…
III	Predator control - trapping	18	75	…	0
…		…			…
IV	No action	24	65	…	0

Multi-attribute Utility Theory





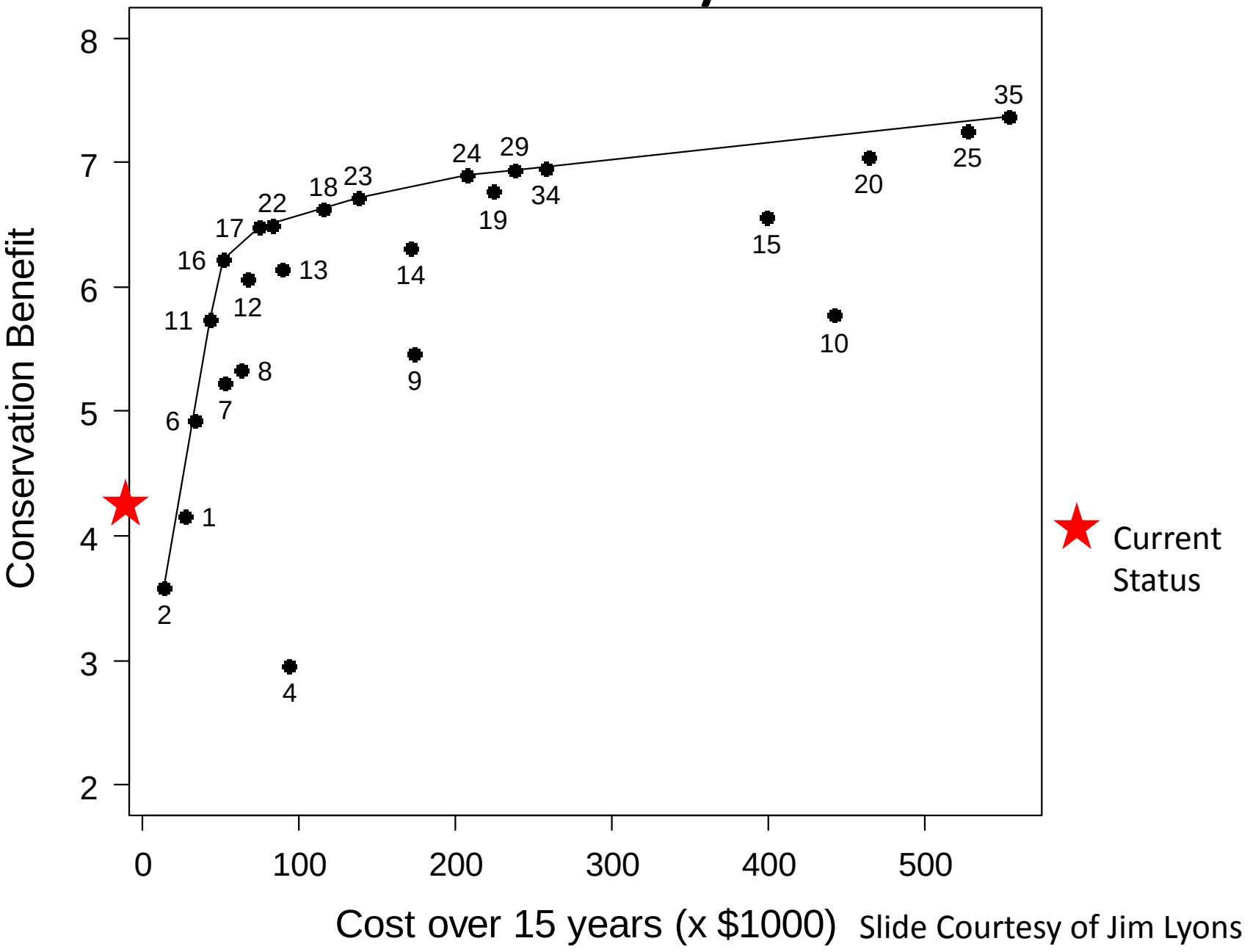
$$Management\ Benefit\left(U\middle|Action_i\right)=\sum_{j=1}^{n} w_j u_{ij}$$

Where n = number of attributes, w_j = weight for $Attribute_j$, and
u_{ij} = utility of predicted outcome of $Action_i$ with respect to $Objective_j$

Consequence Table: Utility (u_{ij})

		Metrics				
Unit	Management Action	TMO pt counts	% Native veg cover	…	Herbicide rate	TOTAL
I	Remove *Phragmites* with herbicide and mechanical methods	.056	.116	…	0	0.953
I	Remove *Phragmites* with mechanical methods	.056	.116		.06	1.013
…		…			…	
II	Excavate to create pannes/pools	.033	.025		.06	.431
II	Fill ditches	.059	.046		.06	.768
…		…			…	
III	Predator control - trapping	.067	.108	…	.06	.930
…		…			…	
IV	No action	.089	.101	…	.06	.907

Pareto Efficiency Frontier



Slide Courtesy of Jim Lyons

Marsh Manipulation for Mosquito Control

	Marsh Persistence			Bio Diversity			Environmental Health			Human Health		
	Marsh elevation rel to sea level (mm/yr)	Sediment Deposition (gr/cm^2/mo)	Above Ground Biomass	Dens Breed Birds	Non-breeding Bird Use Days	Nekton Density	Edge/ shore-line erosion	Ratio of veg. area to open water	Amount Pesticide Applied	Adult Mosquito Density	Larval Pop Density	Extent of larval population (% area of marsh)
Technique	Max to threshold	max	max	Max	Max	Max	Min	Max	Min	Min to threshold	Min to threshold	Mn
Larvicide	3	4	2	3	4	7.5	7	8	5	1.5	1.5	2
Semi-tidal: sill ditch	4	4	3.5	3	4	8	7	8	0	1	1	0.5
Open Tidal: selective ditching	4	4.5	4	3.5	4	8	7	8	0	2	2	0.5
Closed: pool creation	2.5	5	1	3	4.5	8	8	7	0	3	3	0.5
Current Condition	3	4	2	3	4	7.5	7	8	0	6	6	2

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U.S. FISH & WILDLIFE SERVICE

NATIONAL WILDLIFE REFUGE SYSTEM

USGS

Saltmarsh Habitat & Avian Research Program

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SMI Fundamental and Means Objectives

- The SMI project was developed through a Structured Decision Making process.
- The Fundamental Objectives (Goals) are Biological Integrity, Diversity and Environmental Health (601 FW 3)
- The Means Objectives are how we get there…
  - Restore tidal flow
  - Increase marsh elevation
  - Remove impounded waters
- SMI metrics were chosen to reflect marsh condition relative to Fundamental Objectives. See Neckles et al. 2014 Estuaries and Coasts online 20 May 2014

Fundamental Objectives & Attributes

Fundamental and Means Objectives (weights)	Attributes (weights)
Maximize Biological Integrity and Diversity (0.5)	
Maximize cover of native vegetation (0.12)	Percent cover of native plant species (0.12)
Maximize abundance and diversity of native nekton (0.09)	Density of total nekton (0.045)
	Nekton species richness (0.045)
Maintain sustainable populations of obligate salt marsh breeding birds (0.10)	Abundance of tidal marsh obligate birds: Clapper Rail, Willet, Saltmarsh Sparrow, Seaside Sparrow (0.10)
Maximize use by nonbreeding wetland birds (0.10)	Abundance of indicator wintering species: American Black Duck (0.10)
Maintain trophic structure (0.09)	Density of indicator food web taxon: spiders (0.09)
Maximize Environmental Health (0.5)	
Maintain natural hydrology (0.22)	Duration of flooding of the marsh surface (0.11)
	Surface-water salinity (0.11)
Maximize the extent of the marsh platform (0.22)	Change in marsh surface elevation relative to sea level rise (0.22)
Minimize use of herbicides (0.06)	Rate of application (volume per year) (0.06)

Neckles et al. 2014

Vegetation: Point Intercept

- 10 Points along a 100m transect
- At least 3 transects per SMI unit
- Spp composition
- Abundance

Vegetation Survey

- Randomly select appropriate number of bird survey points. The veg plot is a circle with 100m diameter centered on the bird point
- Establish a 100m transect centered on the bird point. Transect will run from the direction of the upland to the creek bank (i.e. across an elevation gradient)

Size of marsh study unit	Number of Vegetation Survey Points
0 to 25 hectares	3
>25 to 75 hectares	4
> 75 to 125 hectares	5
> 125 hectares	6