Natural Floodplain Functions Alliance Webinar Series Presents:

An Introduction to the Marsh Adaptation Strategy Tool (MAST)

Presented by:
Dr. Samuel Merrill, GEI Consultants, Inc.

Hosted by the Association of State Wetland Managers
Supported by the McKnight Foundation

Photo credit: NOAA

Welcome!

If you have any technical difficulties during the webinar you can send us a question in the webinar question box or call Laura at (207) 892-3399.

Agenda

1. Welcome and Introductions

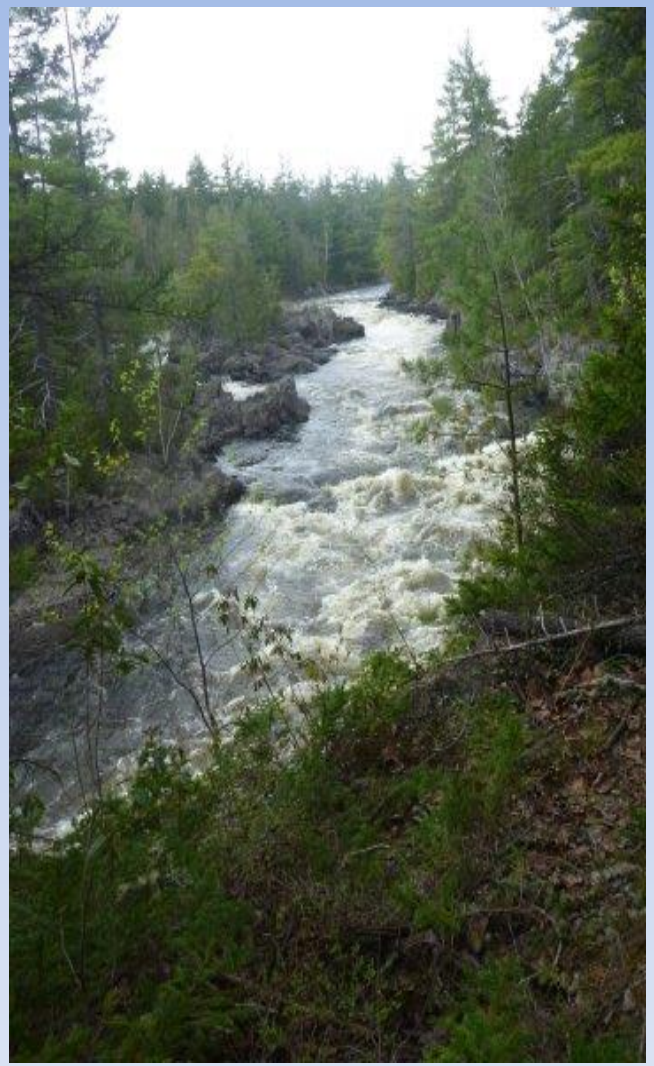
   - 5 minutes

2. An Introduction to the Marsh Adaptation Strategy Tool (MAST) - 30 minutes

3. Question and Answer

   - 15 minutes

4. Wrap-up - 5 minutes

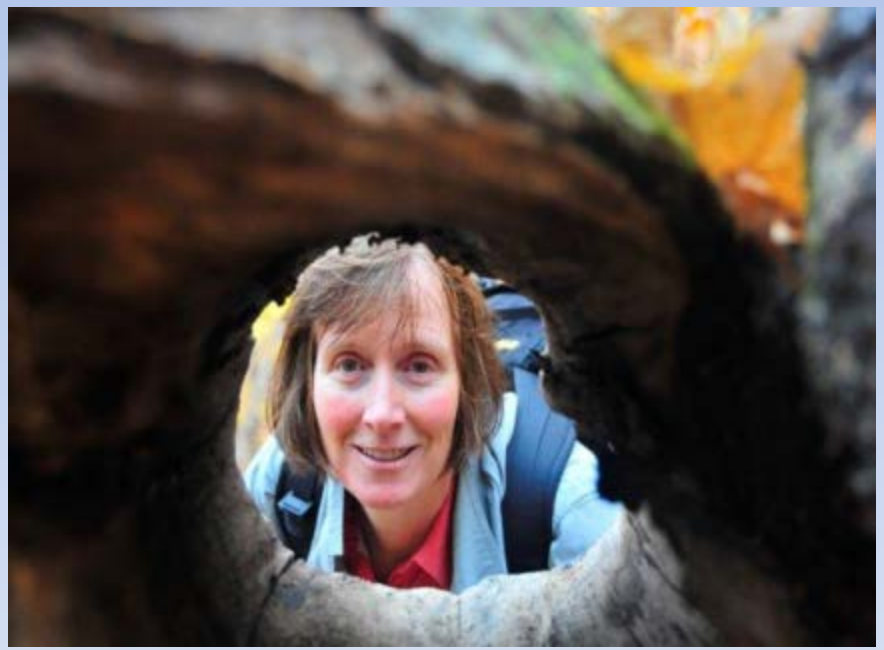


Today's Presenter

Dr. Samuel Merrill
Senior Practice Leader

GEI Consultants, Inc.

NFFA Webinar Series Moderator

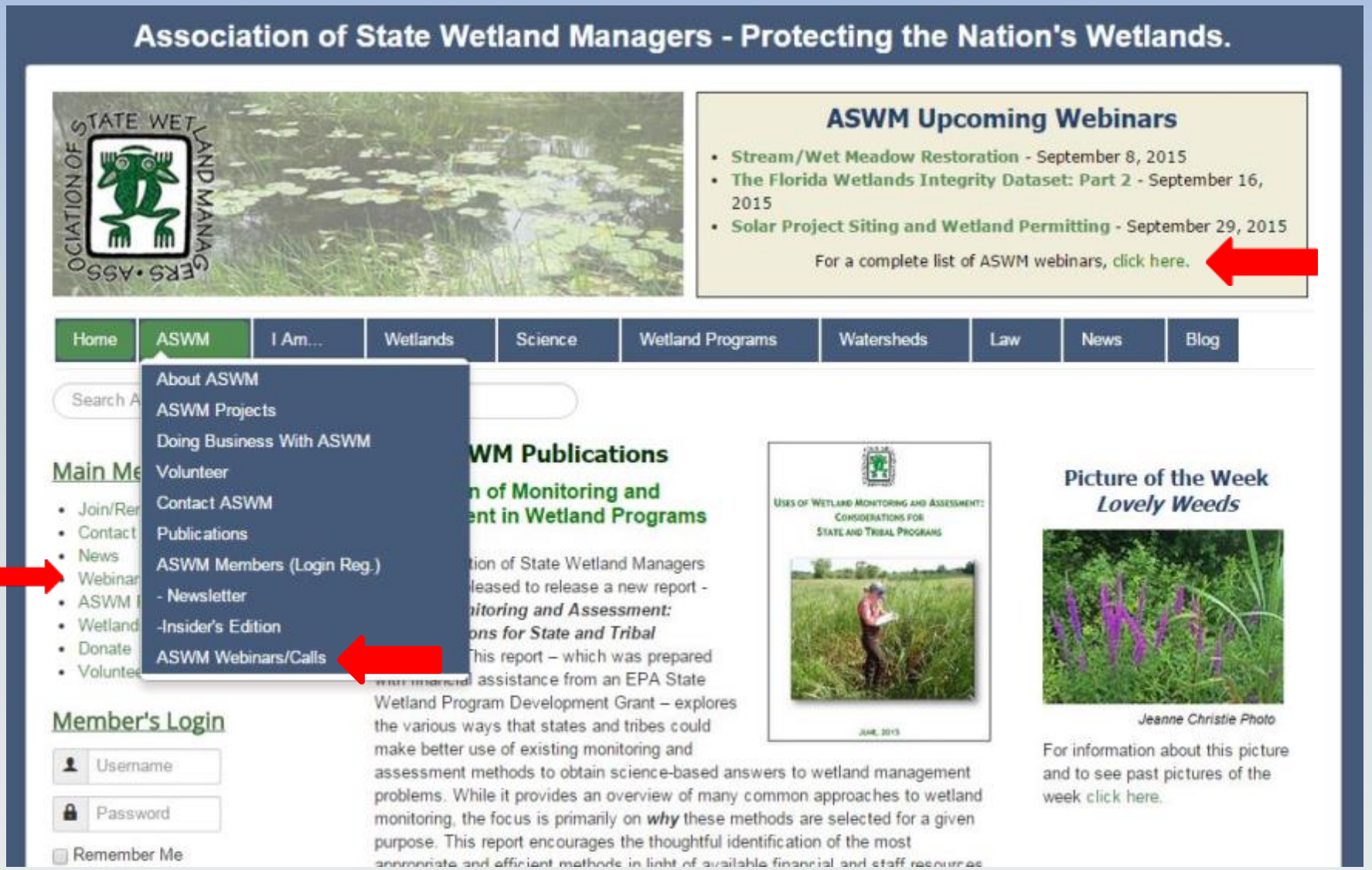


Jeanne Christie

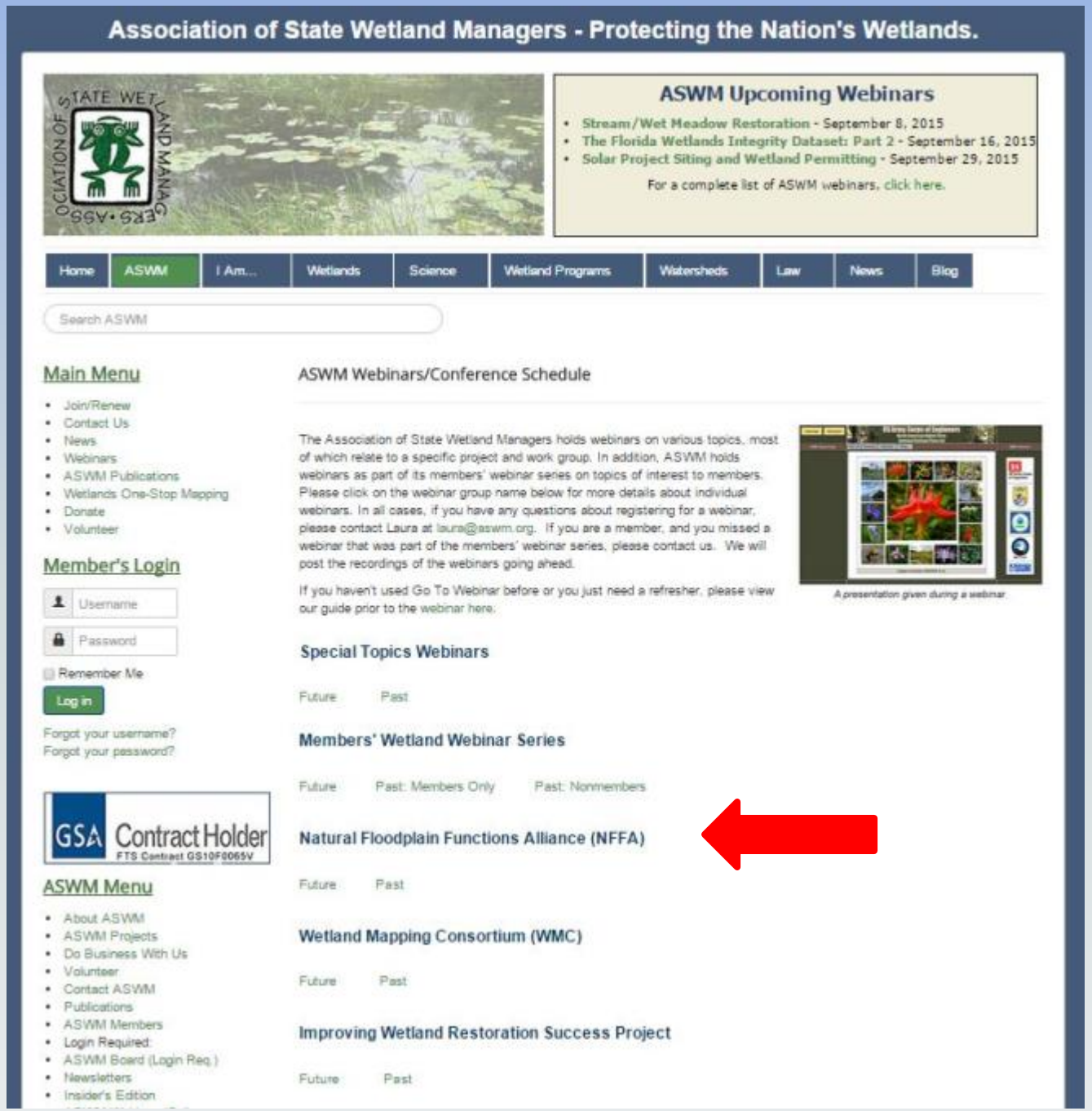
Executive Director

Association of State Wetland Managers

Webinar Schedule & Recordings



Webinar Schedule & Recordings



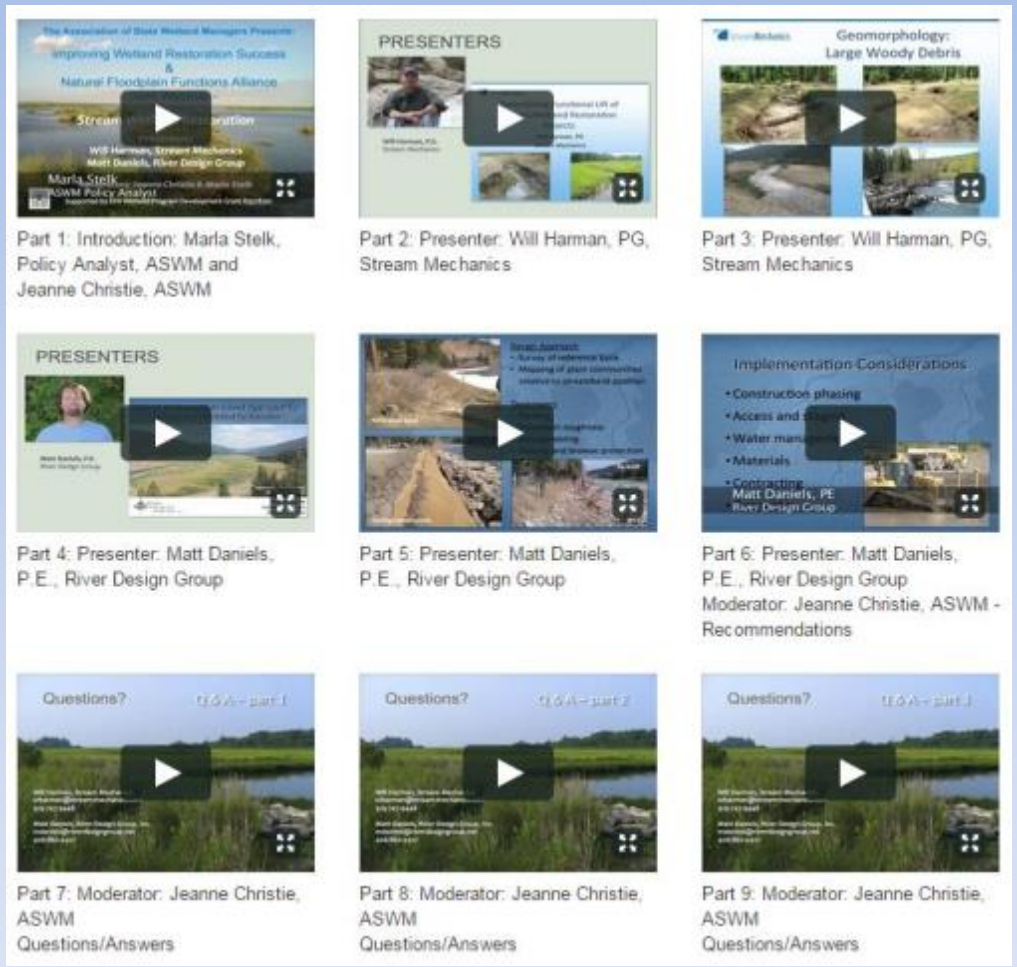
Latest NFFA Webinar Posted

From Sept. 8, 2015

A Joint Webinar with the ASWM Wetland Restoration Work Group: "Stream/Wetland Restoration"

Presenters:

- Will Harmon, Stream Mechanics
- Matt Daniels, River Designs Group



Part 1: Introduction: Marla Stelk, Policy Analyst, ASWM and Jeanne Christie, ASWM

Part 2: Presenter: Will Harman, PG, Stream Mechanics

Part 3: Presenter: Will Harman, PG, Stream Mechanics

Part 4: Presenter: Matt Daniels, P.E., River Design Group

Part 5: Presenter: Matt Daniels, P.E., River Design Group

Part 6: Presenter: Matt Daniels, P.E., River Design Group
Moderator: Jeanne Christie, ASWM - Recommendations

Part 7: Moderator: Jeanne Christie, ASWM
Questions/Answers

Part 8: Moderator: Jeanne Christie, ASWM
Questions/Answers

Part 9: Moderator: Jeanne Christie, ASWM
Questions/Answers

Future Schedule

- **No Conference Call in December**
  - Conference call

The Calendar for 2016 is being developed and will be announced via email.

Currently conference calls and webinars are usually held on alternating months on the second Tuesday of the month at 3:00 p.m. eastern, 2:00 central, 1:00 mountain, and 12:00 pacific.

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Who can get CEUs?

- You must be a participant during the live webinar presentation.
- We are able to track webinar participation by registrants using our GoToWebinar software.
- **Documentation will state that you were a participant for X hours of a specific ASWM webinar.**

Receiving Documentation

*If you need CEUs for your participation in today's webinar, you **must request** documentation from ASWM.*

*Please note that we will send the documentation to you **for you to forward** to the accrediting organization.*

Please contact **Laura Burchill**
laura@aswm.org
(207) 892-3399

Provide:

- Your full name (as registered)
- Webinar date and Title

Changing over to Presenter's Computer…

Samuel B. Merrill, PhD

November 3, 2015

Strategically Guiding Marsh Migration

An Introduction to the Marsh Adaptation Strategy Tool (MAST) and values-allocation process.

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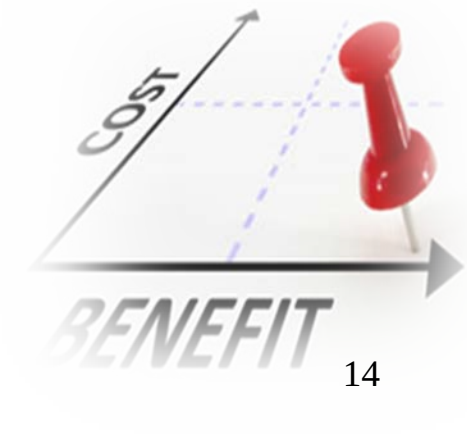
Dilemma: Not being proactive enough about marsh migration.

Topics for Today

1. **The MAST software and how it works**
2. **Mechanics of the values allocation process**
3. **Case examples from Maine and Massachusetts**
4. **Limitations of the model, other uses**
5. **Questions and discussion**



GEI's National Presence

Technical Practice Areas

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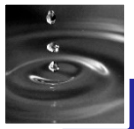
Environmental

- Compliance
- Permitting
- Due Diligence
- Characterization
- Remediation
- Risk Assessment
- Restoration
- Asbestos
- Demolition
- Brownfields
- In-Water & Uplands

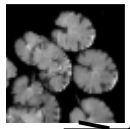
Geotechnical

- Coastal Engineering & Planning
- Foundations
- Excavation Support
- Construction
- Tunneling
- Dams
- Embankments
- Levees
- Failure Analysis
- Geotechnical Testing



Water Resources

- Conveyance
- Flood Control
- Water Management
- Water Supply and Storage
- Water Resources Support
- Hydropower



- Ecotoxicology
- Monitoring
- Water Quality
- Aquatic Ecosystems
- Environmental Impact
- Laboratory Services
- Sensory Services
- Air Quality

Clients Across a Broad Spectrum

- **Industry**
- **Utilities**
- **Transportation**
- **Attorneys and professional service firms**
- **Developers and architects**
- **Government agencies (federal, state & local)**
- **Noprofits and Universities**

35,000+ Projects Nationwide

U.S. Capitol Visitor Center
Nicholson Construction Co., Washington, D.C.

UTC/Formerly Essex Wire, Newmarket, NH
Brownfields Site Assessment and Remediation

All-American Canal Lining Project
Imperial County, California

Soil Removal, Slurry Wall, GW Treatment,
Landfills & Ponds - Nevada

Elements of MAST (Marsh Adaptation Strategy Tool)

- **Built on the COAST software architecture.**
- **Goal: to help evaluate acquisition priorities in areas likely to convert to wetlands, based on suites of ecosystem services that may emerge.**
- **Approach: For each candidate parcel, identify and weight a diversity of ecosystem service values.**
- **The software uses response curves to evaluate how different ecosystem service values will change with increasing depth, cumulatively over time.**

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The purpose of valuation here is relative rather than absolute.

- **Dollars allow comparison with other things that are valued and traded.**
- … but the task at hand is:
  - to determine values of parcels and mixes of ecosystem services *relative to one another…*
  - …and how do those values change over time with sea level rise?
- **So we created "Wetland Benefit Units" as the relative metric: units allocated by stakeholders through online Delphi surveys.**

Scarborough Marsh

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MAINE
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DEPARTMENT OF
Agriculture, Conservation and Forestry


Audubon
Hampton Circle
Pine Point
N
W
E
S

Ecosystem Services Weighted for Each Location

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- Flood Control
- Land Values
- Water Quality
- Water Supply
- Recreation
- Aesthetics
- Carbon Storage
- Habitat Connectivity
- Commercial Habitat
- Noncommercial Habitat
- Commercial Species
  - Nutrient Supply
- Noncommercial Habitat
  - Nutrient Supply
- Research

The Ranking Process

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- **Participants have a set number of units to spend among candidate parcels.**

- **Within each parcel they allocate units according to what they think is most valuable about that parcel today.**

The Ranking Process

The survey looks like this for each parcel:

Please enter your allocation of Wetlands Benefits Units to Site 1 under existing conditions for each of the following services. In evaluating the allocations you may consider all available data that you wish, including published data, expert opinion, and local knowledge. You may come back to change your estimates after you enter the WBU values for the other sites.

Attenuation or prevention of flood damages to public or private property	0
Effects on land values of property adjacent to or with a view of the wetland	0
Effects on water quality through filtration of pollutants	0
Drinking water supply	0
Recreation (active like boating and hunting or passive like sightseeing and bird watching)	0
Aesthetics	0
Habitat for any life stage of commercially harvested species such as groundfish or shellfish	0
Habitat for any life stage of species significant for the preservation or enhancement of biodiversity, for example roosting, breeding, nesting, feeding, or wintering habitat for common and rare species	0
Carbon storage	0
Export of nutrients utilized by commercially harvested species	0
Export of nutrients utilized by species critical to biodiversity	0
As a research site for hydrologic, wildlife, or ecosystem studies	0
Habitat connectivity	0
Total	0


Audubon
Hampton Circle
Pine Point

Starting Condition: Budget = 1,000 WBUs

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	MAINE AUDUBON	PINE POINT	HAMPTON CIRCLE
Flood Damages			
Land Values			
Water Quality			
Drinking Water			
Recreation			
Aesthetics			
Commercial Habitat			
Noncommercial Habitat			
Carbon Storage			
Commercial Species Nutrient Supply			
Biodiversity			
Research			
Other			
Habitat Connectivity			
TOTAL			

Starting Condition: Post-Delphi

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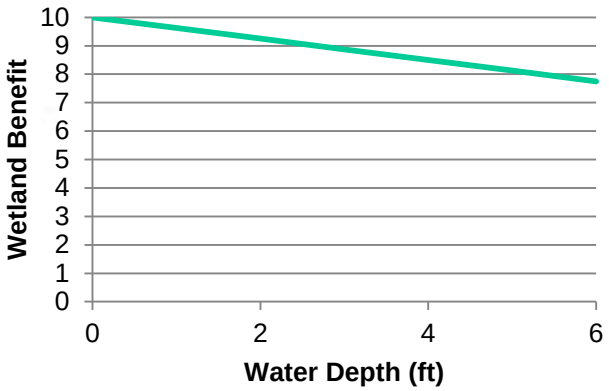
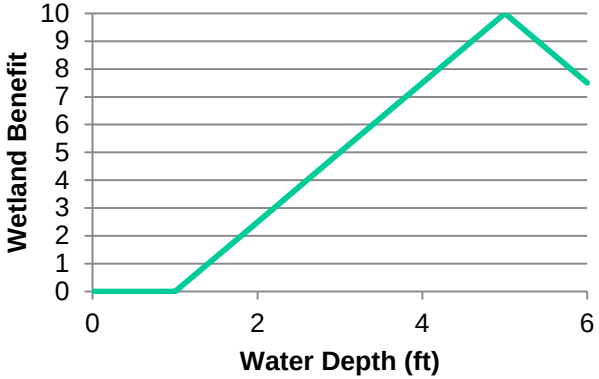
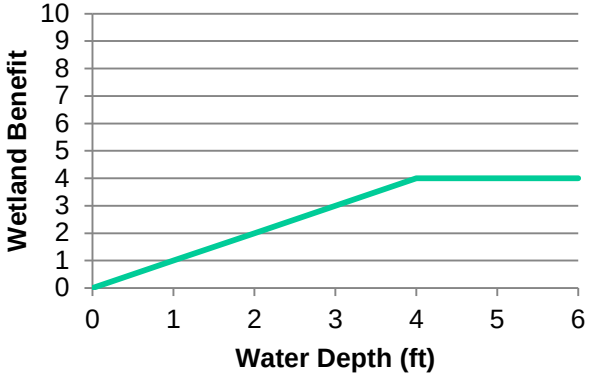
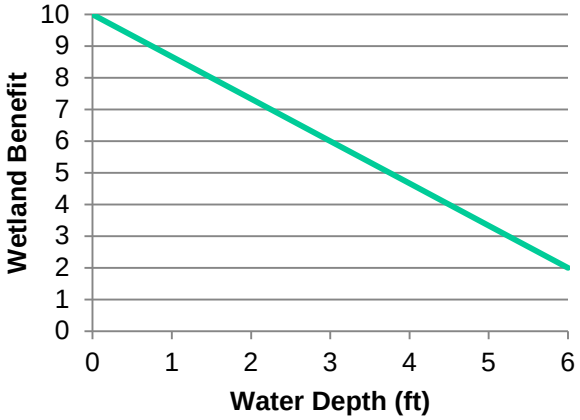
	MAINE AUDUBON	PINE POINT	HAMPTON CIRCLE
Flood Damages	100	100	200
Land Values	20	75	100
Water Quality	100	25	100
Drinking Water	10	0	20
Recreation	500	250	100
Aesthetics	100	30	100
Commercial Habitat	50	20	50
Noncommercial Habitat	100	20	200
Carbon Storage	10	20	100
Commercial Species Nutrient Supply	10	10	25
Biodiversity	50	50	100
Research	110	100	0
Other	10	30	30
Habitat Connectivity	10	20	100
TOTAL of Max Bids	**1180**	**750**	**1225**

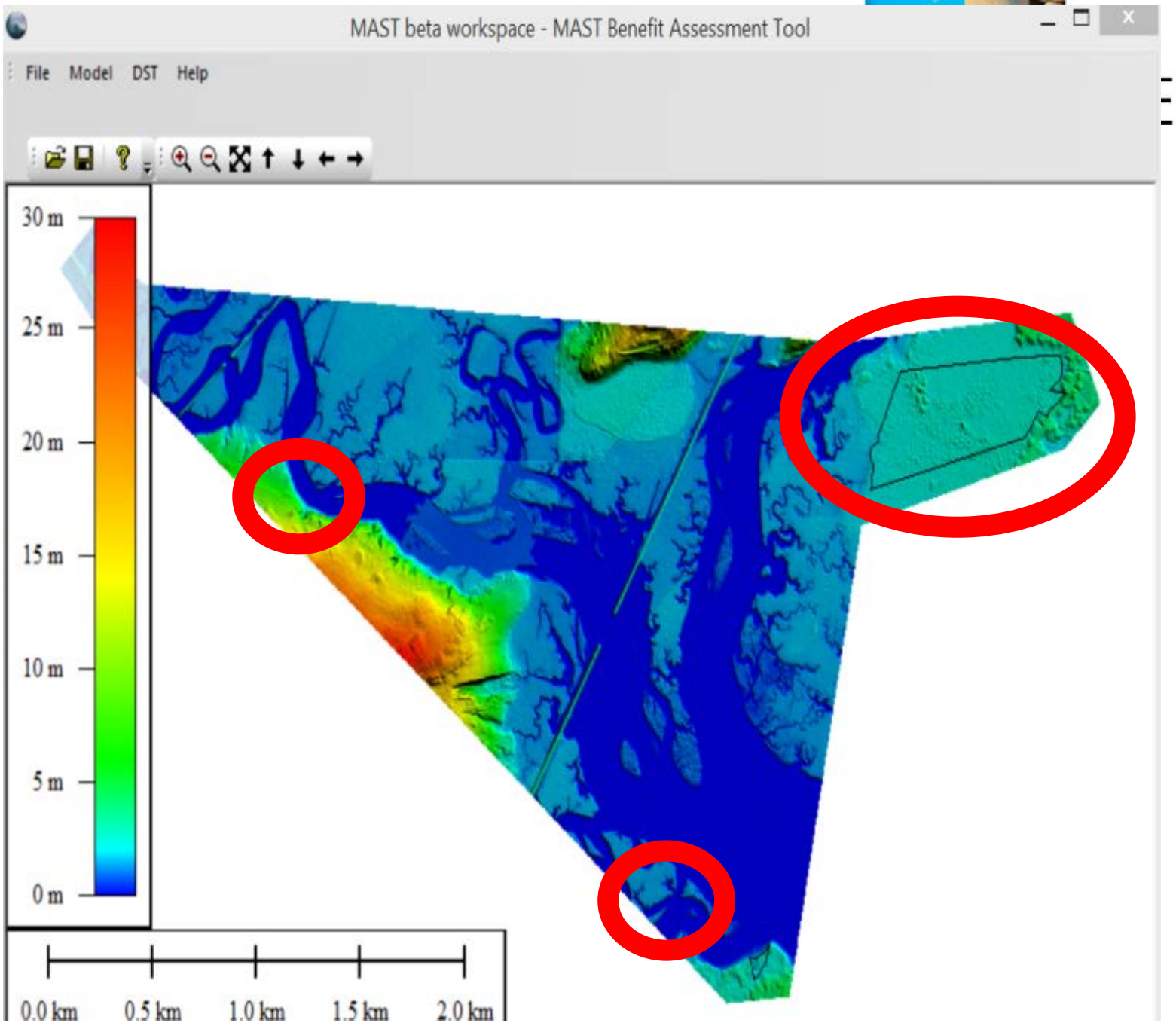
Each service has its own benefit curve as depth increases:

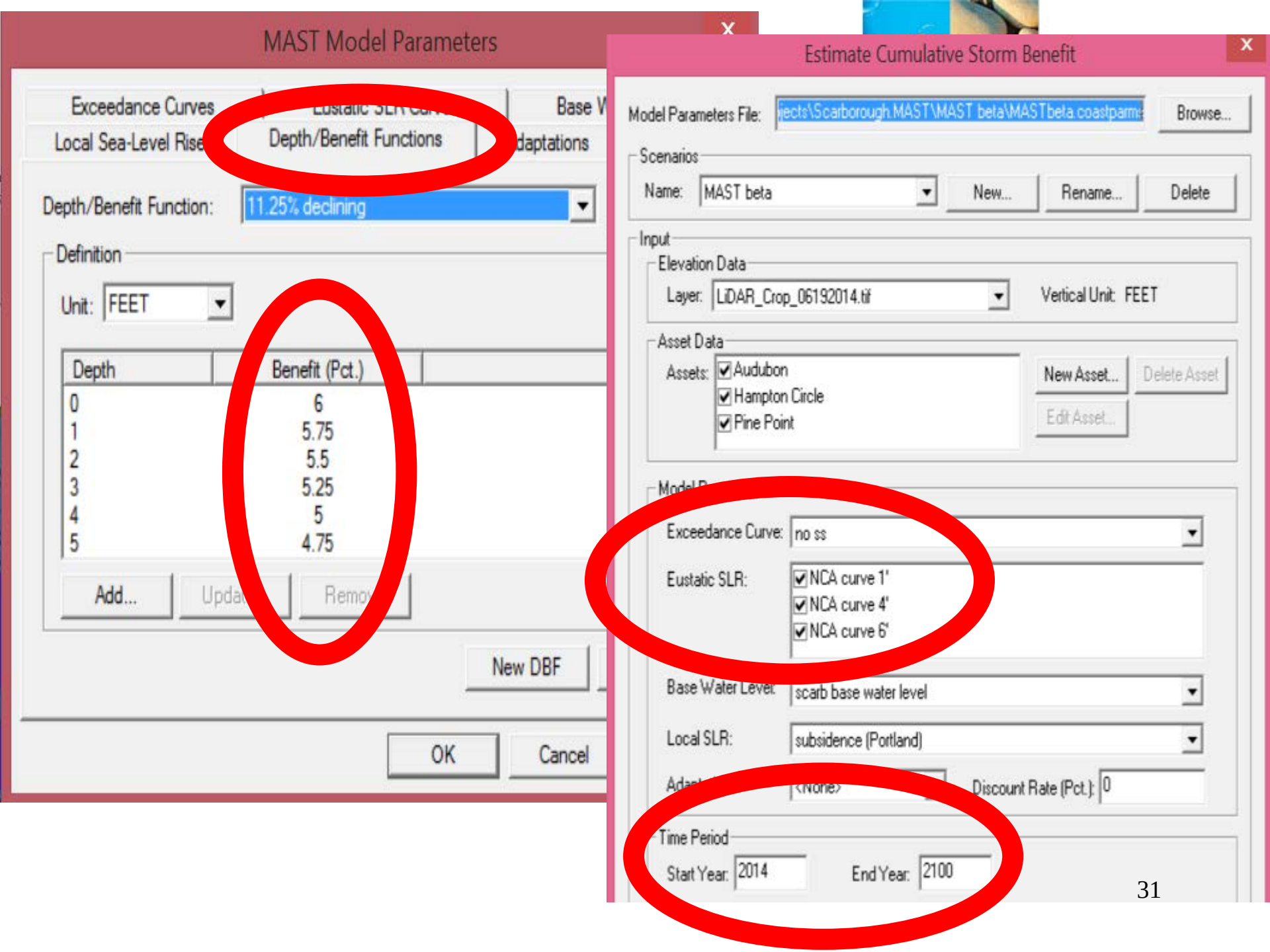









MAST beta workspace - MAST Benefit Assessment Tool
File
Model
DST
Help
30 m
25 m
20 m
15 m
10 m
5 m
0 m
0.0 km
0.5 km
1.0 km
1.5 km
2.0 km


MAST Model Parameters
Exceedance Curves
Depth/Benefit Functions
Base W
Local Sea-Level Rise
daptations
Depth/Benefit Function:
11.25% declining
Definition
Unit:
FEET
Depth
Benefit (Pct.)
0
6
1
5.75
2
5.5
3
5.25
4
5
5
4.75
Add...
New DBF
OK
Cancel
Estimate Cumulative Storm Benefit
Model Parameters File:
Browse...
Scenarios
Name:
MAST beta
New...
Rename...
Delete
Input
Elevation Data
Layer:
LiDAR_Crop_06192014.tif
Vertical Unit: FEET
Asset Data
Assets:
Audubon
Hampton Circle
Pine Point
New Asset...
Delete Asset
Edit Asset...
Exceedance Curve:
no ss
Eustatic SLR:
NCA curve 1'
NCA curve 4'
NCA curve 6'
Base Water Level:
scarb base water level
Local SLR:
subsidence (Portland)
Discount Rate (Pct.):
0
Time Period
Start Year:
2014
End Year:
2100

Results

Parcel	Sea Level Rise	(Starting WBUs)	Cumulative WBUs
Audubon	1'	1180	
Pine Point	1'	750	
Hampton Circle	1'	1225	
Audubon	4'	1180	
Pine Point	4'	750	
Hampton Circle	4'	1225	
Audubon	6.6'	1180	
Pine Point	6.6'	750	
Hampton Circle	6.6'	1225	

Using sea level rise curves from the 2014 National Climate Assessment

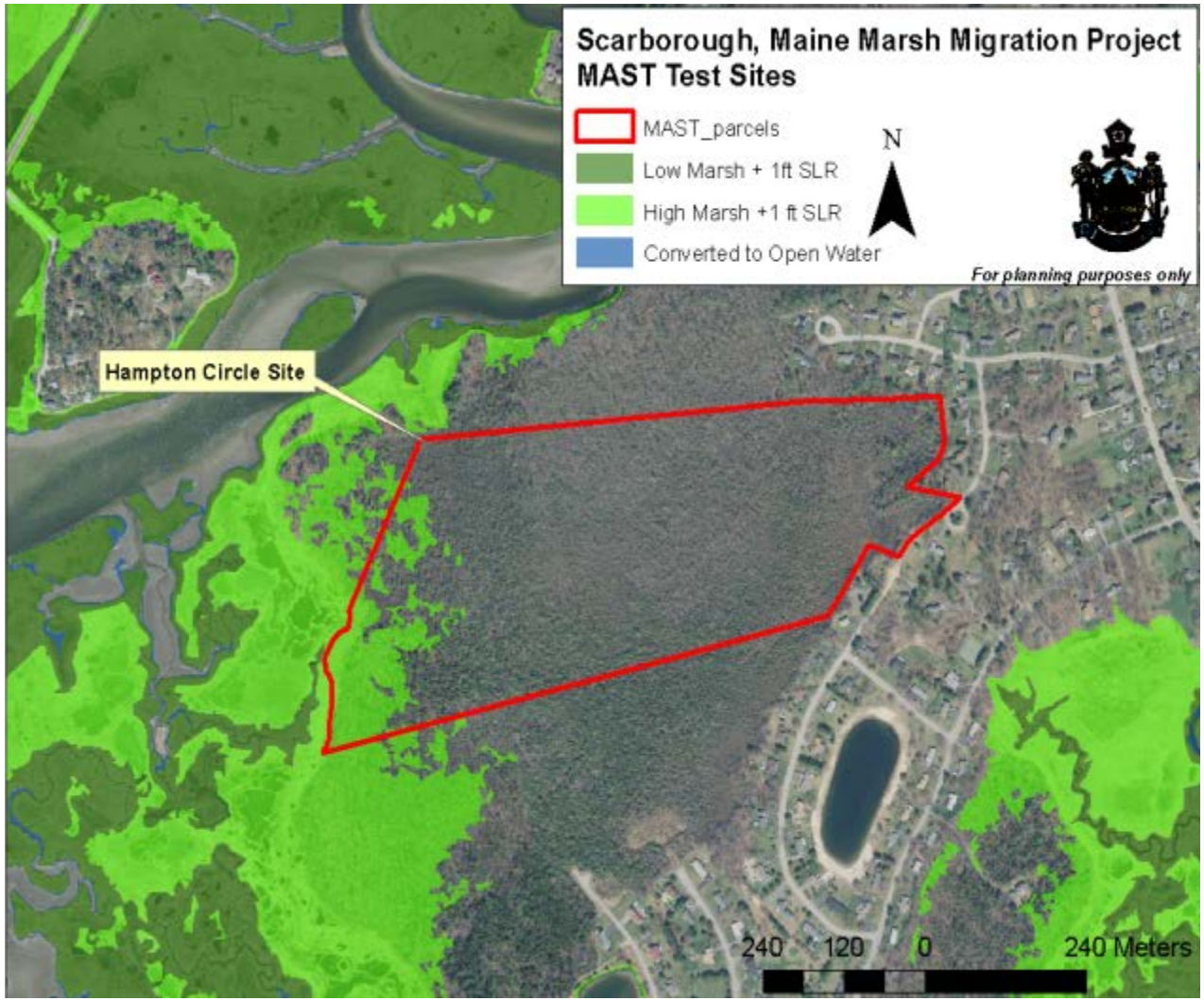
Results

1/60th the size of Hampton Circle

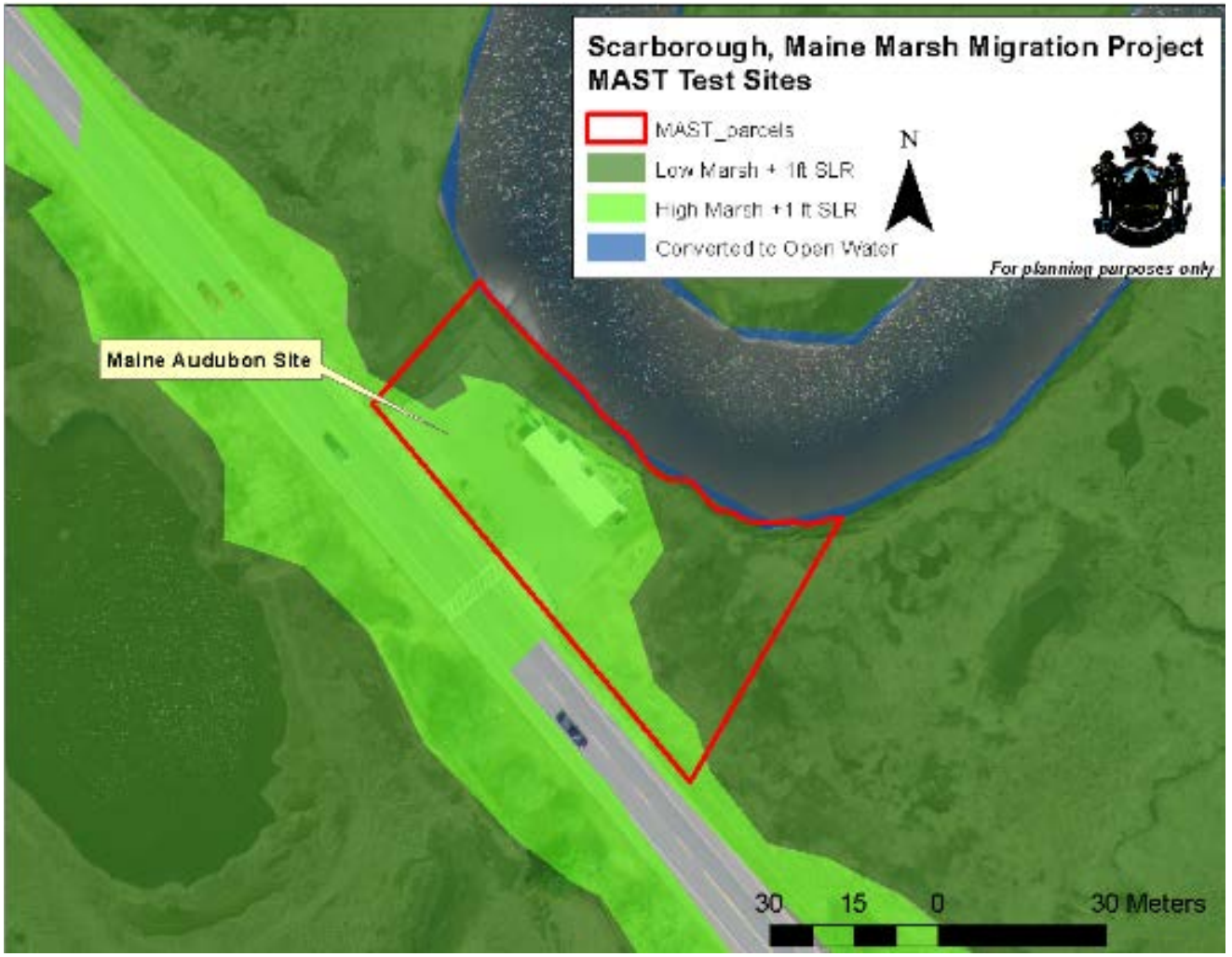
Parcel	Sea Level Rise	(Starting WBUs)	Cumulative WBUs	
Audubon	1'	1180	3899	14.2x value
Pine Point	1'	750	3454	
Hampton Circle	1'	1225	276	
Audubon	4'	1180	4640	3.9x value
Pine Point	4'	750	3261	
Hampton Circle	4'	1225	1175	
Audubon	6.6'	1180	4803	3.4x value
Pine Point	6.6'	750	3154	
Hampton Circle	6.6'	1225	1410	

Using sea level rise curves from the 2014 National Climate Assessment

Hampton Circle: 1’ SLR



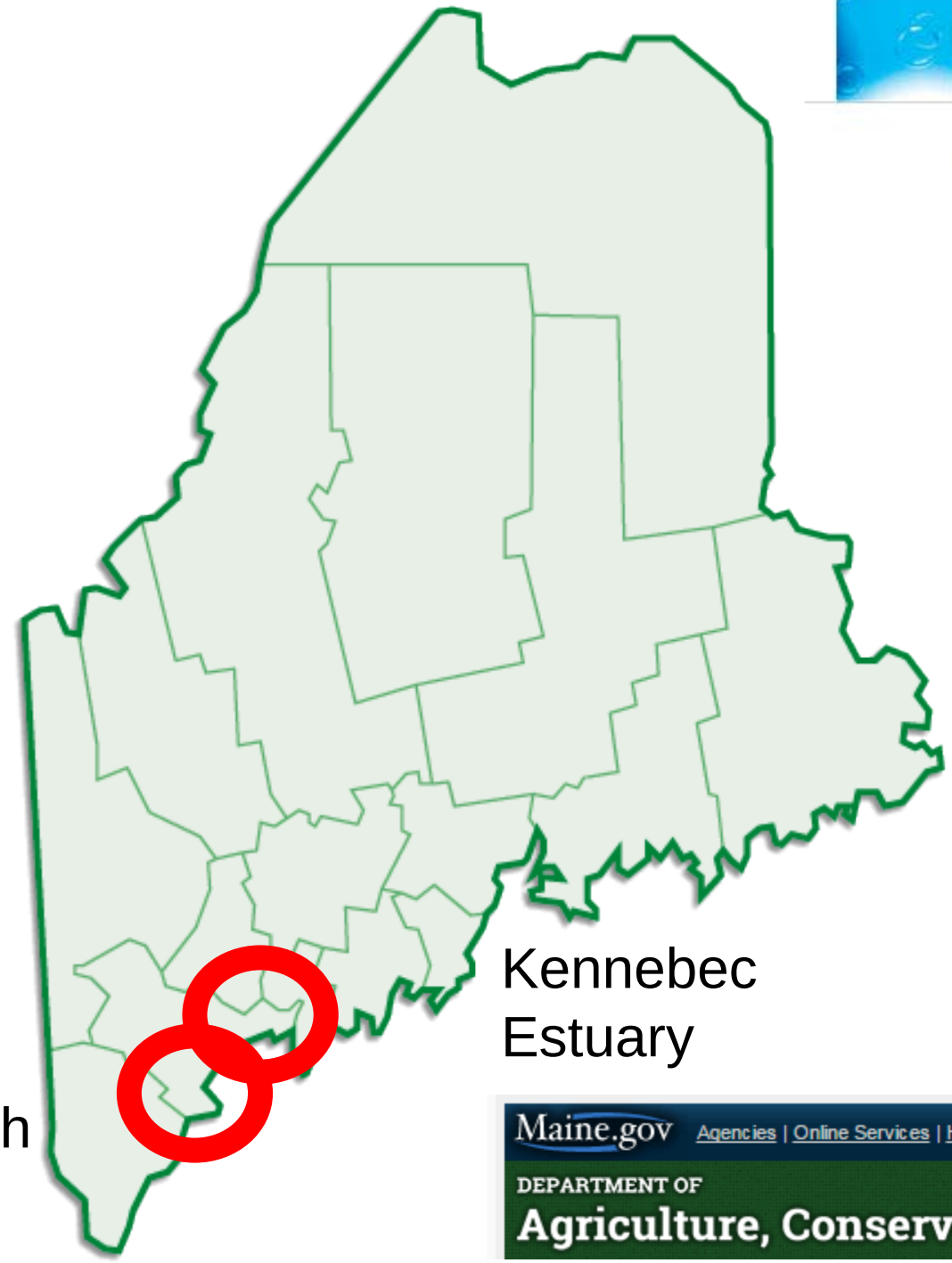
Audubon: 1’ SLR



Key Points

Need geographically sensitive software to evaluate where benefits are likely to emerge as marshes migrate.

- **Helps prioritize land acquisition**
- **Helps identify where development may be more appropriate.**



Kennebec Estuary

Scarborough Marsh

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Leeman Parcel

Fawcett and Vose Parcels

Beginning with HABITAT

KELT MAST Project
Leeman Parcel
Woolwich, Maine

Rare Plant Locations
Exemplary Natural Community
Wading Bird Habitat
Shorebird Areas
Conserved Land

Beginning with HABITAT

KELT MAST Project
Fawcett and Vose Parcels
Boothbam, Maine

ESSC Animal Buffer
Rare Plant Locations
Exemplary Natural Community
Wading Bird Habitat
Significant Vernal Pool
Conserved Land

Results

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Parcel	Sea Level Rise	(Starting WBUs)	Cumulative WBUs
Fawcett	1'	690	
Vose	1'	575	
Leeman	1'	280	
Fawcett	4'	690	
Vose	4'	575	
Leeman	4'	280	
Fawcett	6.6'	690	
Vose	6.6'	575	
Leeman	6.6'	280	

Using sea level rise curves from the 2014 National Climate Assessment

Results

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Parcel	Sea Level Rise	(Starting WBUs)	Cumulative WBUs	
Fawcett	1'	690	2929	21.5 x Value
Vose	1'	[illegible]	[illegible]	
Leeman	1'	280	136	
Fawcett	4'	690	4462	24.3 x Value
Vose	4'	[illegible]	[illegible]	
Leeman	4'	280	184	
Fawcett	6.6'	690	4263	20.7 x Value
Vose	6.6'	[illegible]	[illegible]	
Leeman	6.6'	280	206	

Using sea level rise curves from the 2014 National Climate Assessment

Leeman Parcel

Fawcett and Vose Parcels

Leeman Parcel

Great Marsh, Massachusetts

Summer 2015

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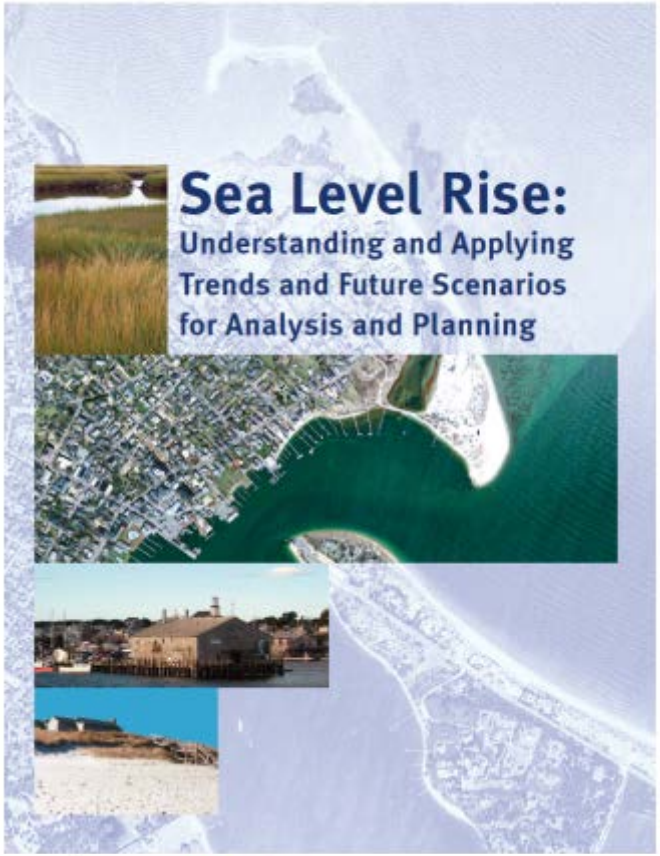
NATIONAL WILDLIFE FEDERATION

IPSWICH RIVER WATERSHED ASSOCIATION
The Voice of the River



Commonwealth of Massachusetts
Deval L. Patrick, Governor

Executive Office of Energy and Environmental Affairs
Richard K. Sullivan Jr., Secretary

Massachusetts Office of Coastal Zone Management
Bruce K. Carlisle, Director

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Massachusetts Office of Coastal Zone Management (CZM)
251 Causeway Street, Suite 800
Boston, MA 02114-2136
(617) 626-1200
CZM Information Line: (617) 626-1212
www.mass.gov/czm

December 2013

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Table 3. Relative sea level rise estimates for Boston, MA. Global scenarios were adjusted to account for local vertical land movement with 2003 as the beginning year of analysis.

Scenario	2025		2038		2050		2063		2075		2088		2100	
	ft	m	ft	m	ft	m	ft	m	ft	m	ft	m	ft	m
Highest	0.49	0.15	1.08	0.33	1.81	0.55	2.80	0.85	3.92	1.19	5.33	1.63	6.83	2.08
Intermediate High	0.36	0.11	0.73	0.22	1.19	0.36	1.80	0.55	2.47	0.75	3.32	1.01	4.20	1.28
Intermediate Low	0.24	0.07	0.43	0.13	0.65	0.20	0.92	0.28	1.21	0.37	1.55	0.47	1.91	0.58
Lowest (Historic Trend)	0.18	0.06	0.29	0.09	0.39	0.12	0.50	0.15	0.60	0.18	0.71	0.22	0.82	0.25
Range	0.31	0.09	0.79	0.24	1.42	0.43	2.30	0.70	3.32	1.01	4.62	1.41	6.02	1.83

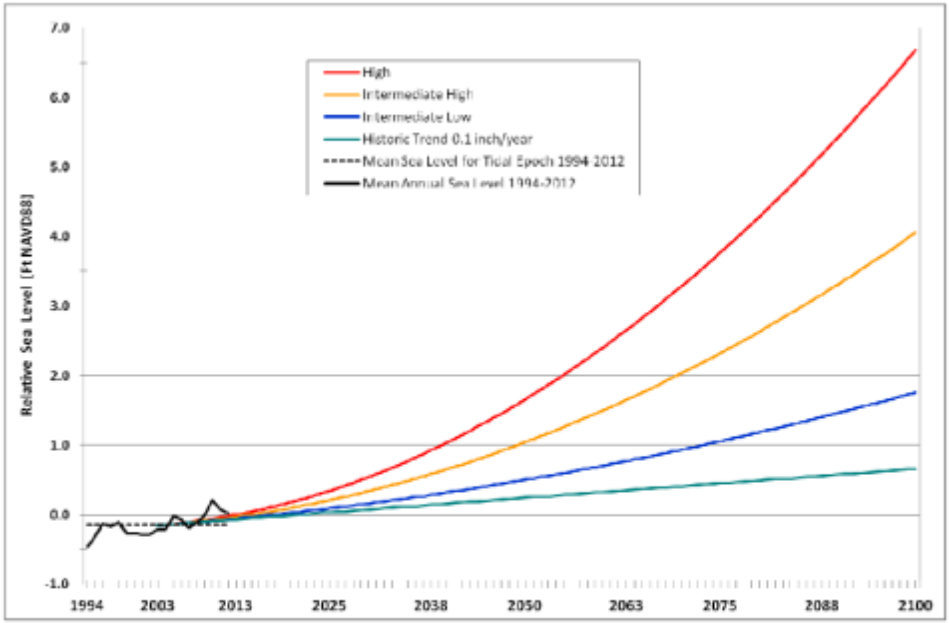
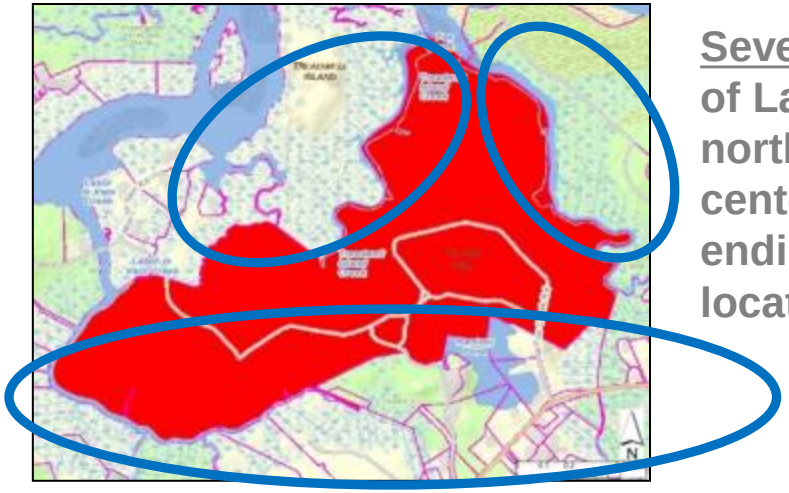


Figure 5. Relative sea level rise scenarios estimates (in feet NAVD88) for Boston, MA. Global scenarios from were adjusted to account for local vertical land movement with 2003 as the beginning year of analysis.

Parcel 9

Labor in Vain/Fox Creek area, Ipswich, 525.10 acres

Parcel 9 is located in Ipswich, northwest of Argilla Road, south and west of the Trustees of Reservations Crane Estate and Castle Hill, and east of Labor-in-Vain Road. It is comprised mostly of tidal wetland areas, with some forested areas towards the east and west of the center of the parcel. There is also some cleared land close to the center of the parcel that may have some agricultural purposes.



Several residences and buildings are located off of Labor in Vain Rd., which runs from the northwestern section of the parcel, through the center and out towards the southeastern section, ending at Fox Creek Rd. There is also a residence located at the dead-end of Fox Creek Rd.

Initial Parcel Value Allocations

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	Parcels										
Services	1	2	3	4	5	6	7	8	9	10	11
1 Prevention of flood damages	50	30	100	75	6	100	30	75	100	25	20
2 Increased land values	20	50	18	10	16	20	10	16	40	10	10
3 Water quality	10	10	100	30	10	20	20	30	100	10	20
4 Drinking water supply	10	10	10	10	10	10	20	10	30	10	15
5 Recreation	10	25	20	50	10	50	25	40	100	15	10
6 Aesthetics	10	10	30	50	10	25	20	40	50	10	10
7 Carbon storage	20	25	20	20	10	30	25	10	50	10	40
8 Habitat connectivity	50	25	90	50	15	50	30	50	200	10	20
9 Habitat for commercial sp.	50	10	20	75	10	75	10	50	70	10	10
10 Habitat for biodiversity	25	15	15	75	20	50	25	50	50	10	20
11 Nutrient export for commercial	8	25	20	10	10	15	10	10	30	5	10
12 Nutrient export for biodiversity	5	6	30	20	20	30	25	10	50	6	20
13 Research value	9	5	20	10	5	10	5	8	30	5	8
(acres)	*33*	*46*	*146*	*134*	*23*	*148*	*191*	*125*	*520*	*27*	*130*
Totals	277	246	493	485	152	485	255	399	900	136	213

3.5 - 23x

1.9 - 5.9x

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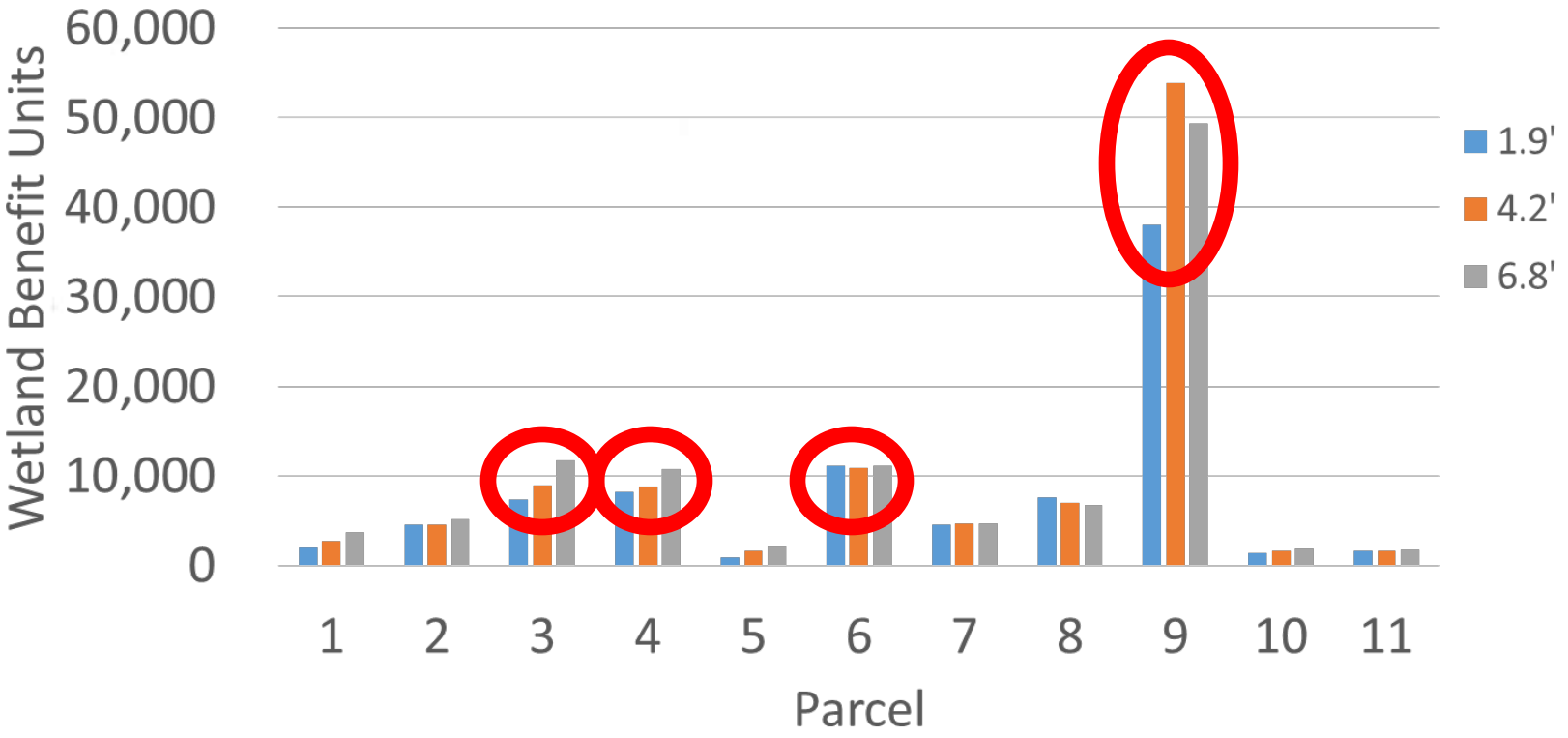
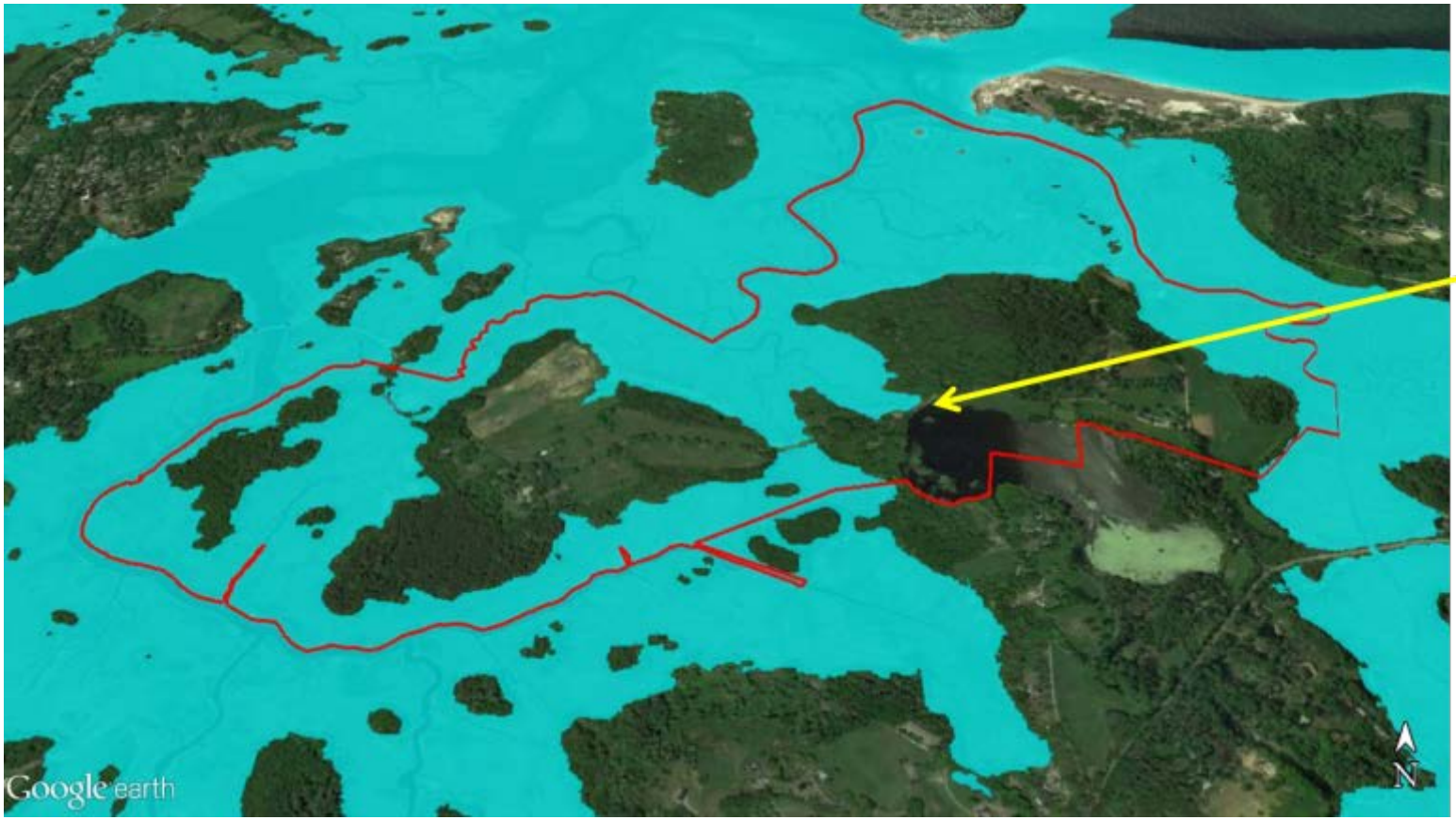
Great Marsh Parcels and Wetland Benefits Accrued in Three SLR Scenarios by 2100

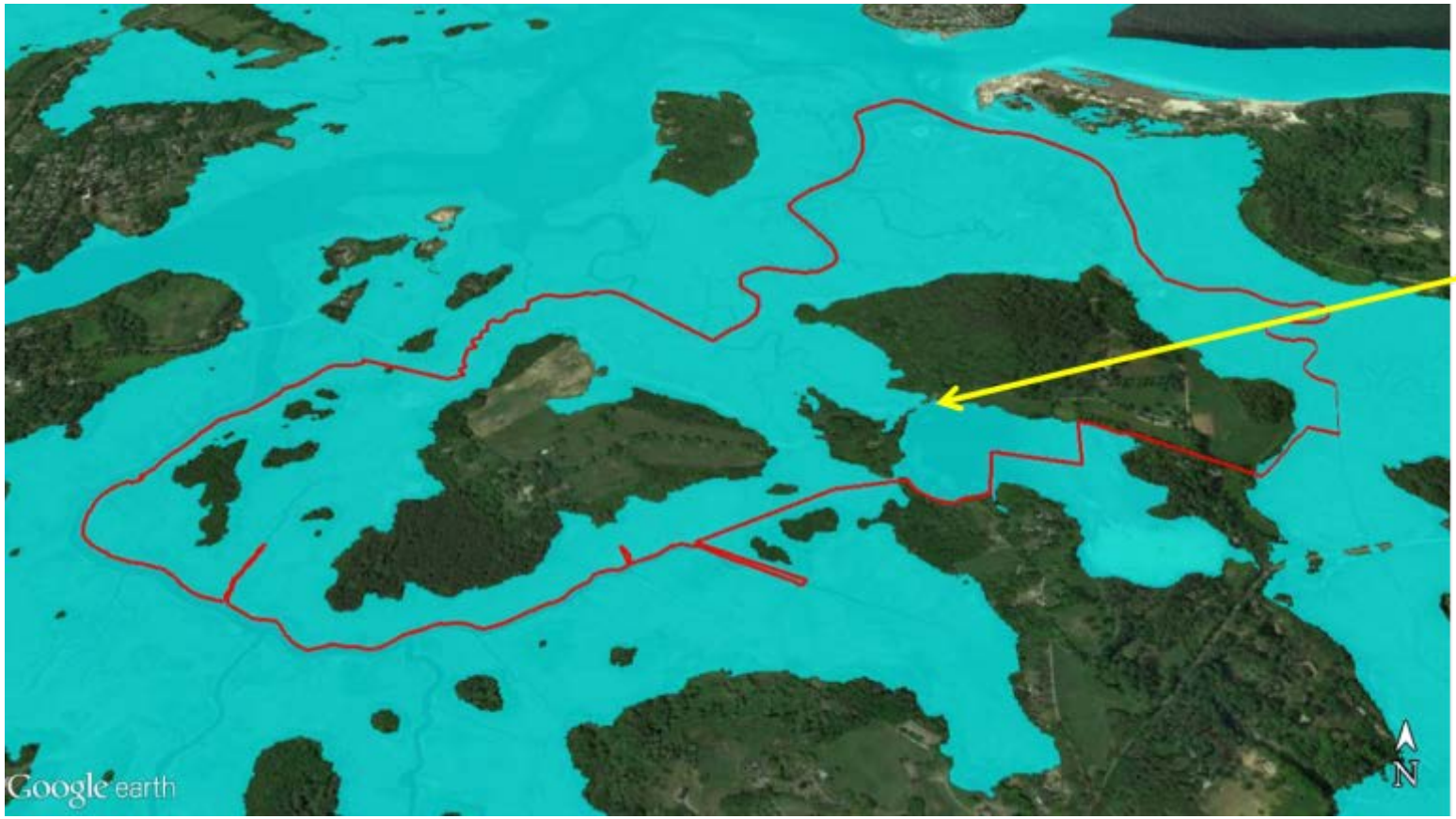


Parcel 9 – 1.9 FT Sea Level Rise



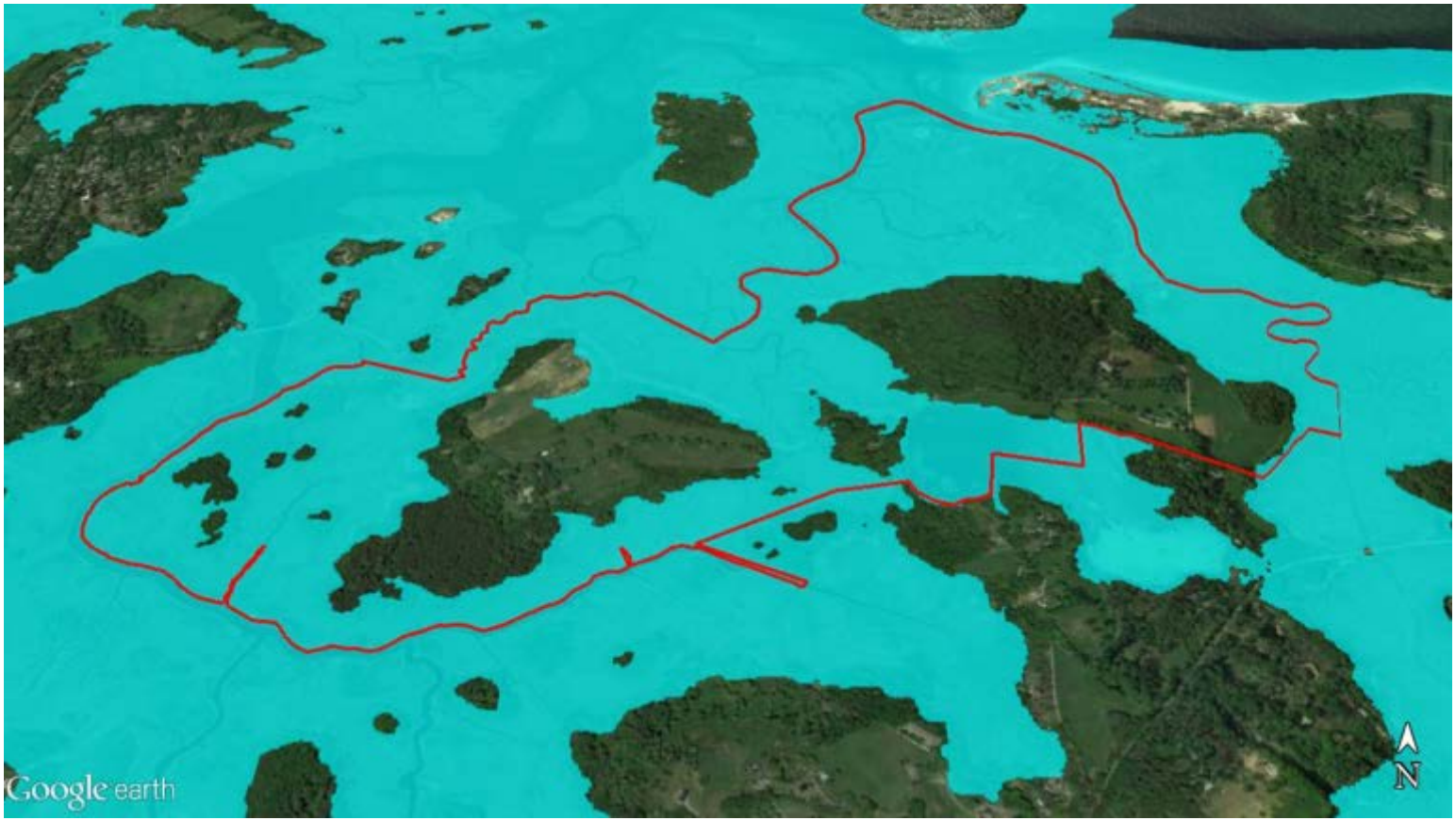
Dam keeping 1.9' of SLR out of the pond

Parcel 9 – 4.2 FT Sea Level Rise

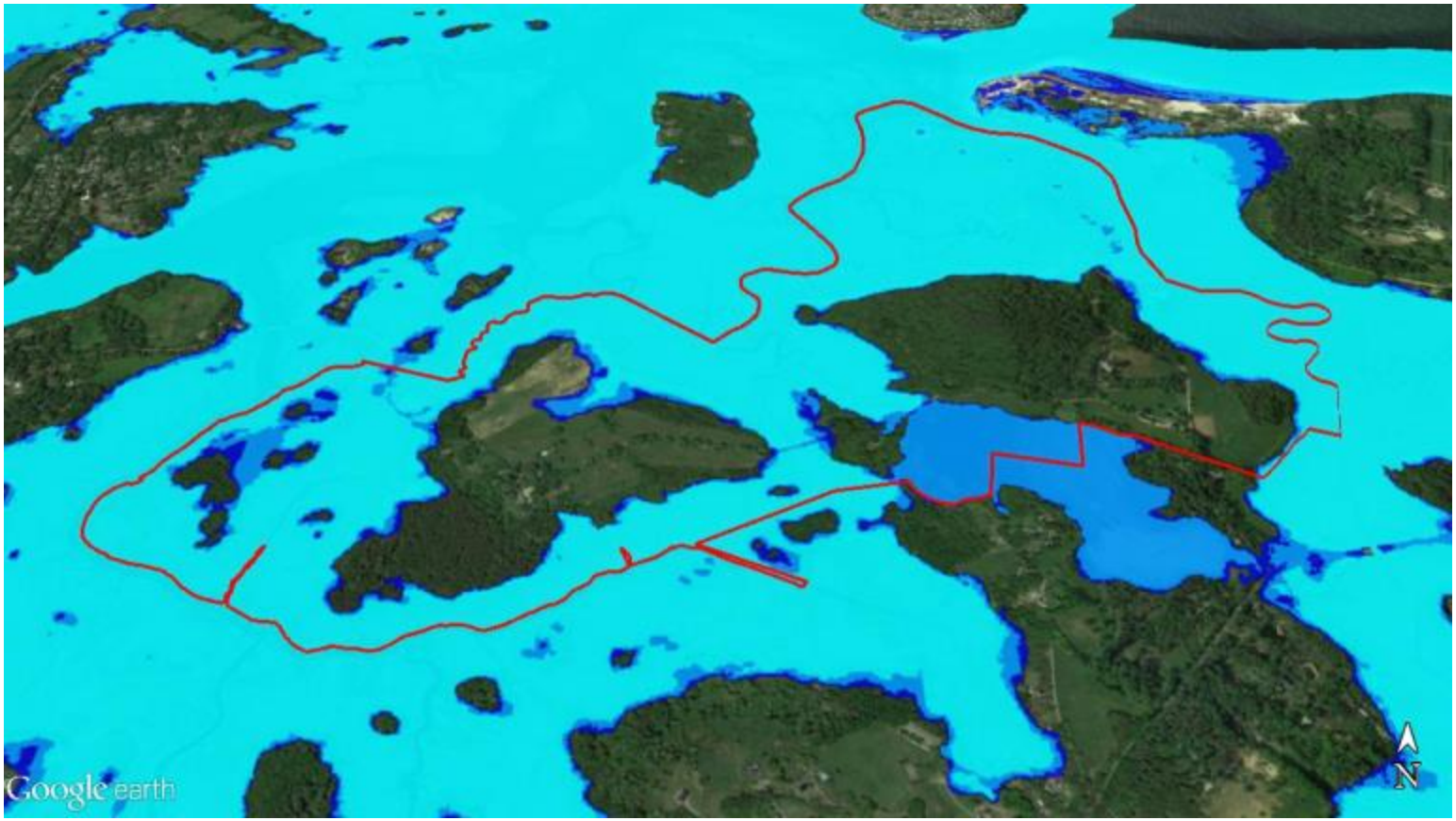


Dam could not keep 4.2' of SLR out of pond.

Parcel 9 – 6.8 FT Sea Level Rise

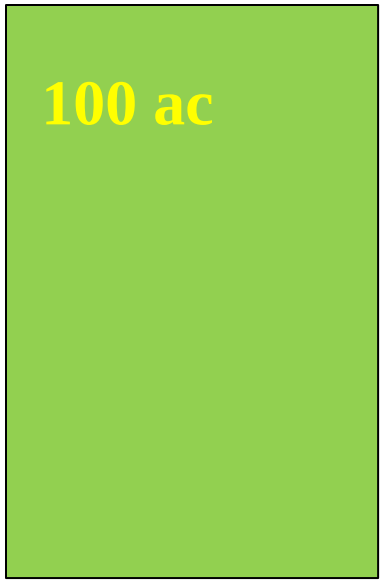


Parcel 9 – All Sea Level Rise Scenarios

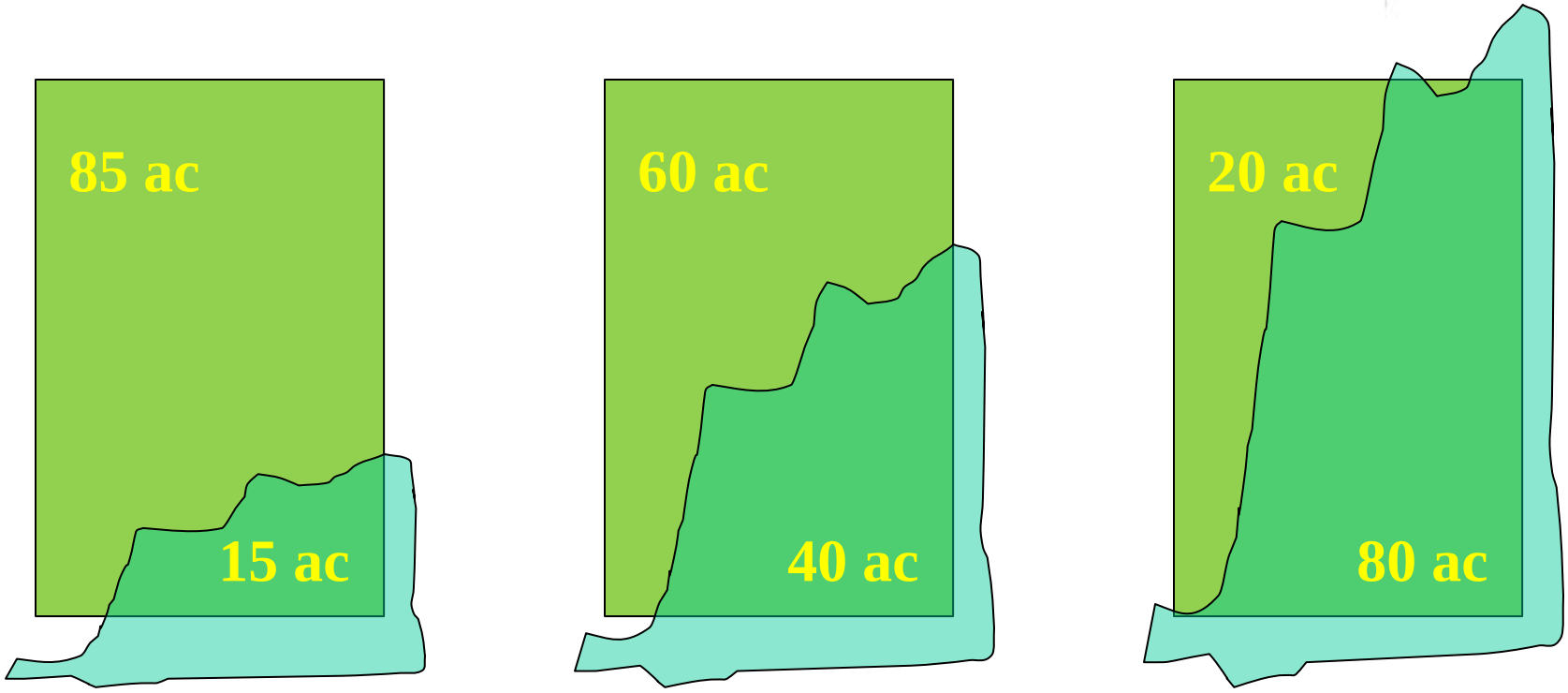


Parcel 10 – All Sea Level Rise Scenarios

Dry Benefits vs. Wet Benefits



Dry Benefits vs. Wet Benefits



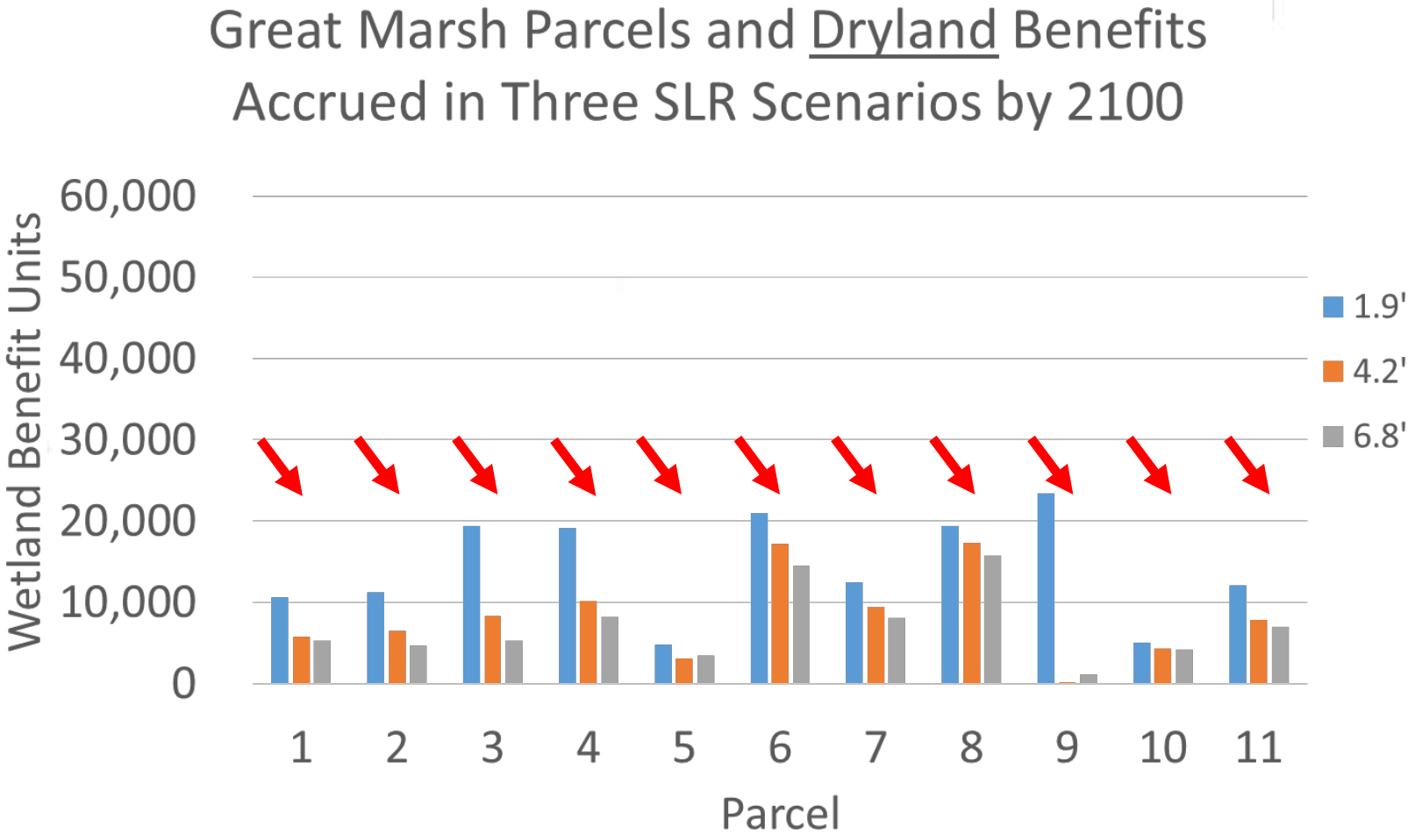
1’ SLR

3.5’ SLR

6’ SLR

Benefits accumulate on the wet portions of parcels.

Benefits are tallied separately on the dry portions while they remain dry.


Great Marsh Parcels and Dryland Benefits Accrued in Three SLR Scenarios by 2100
Wetland Benefit Units
60,000
50,000
40,000
30,000
20,000
10,000
0
1.9'
4.2'
6.8'
1
2
3
4
5
6
7
8
9
10
11
Parcel

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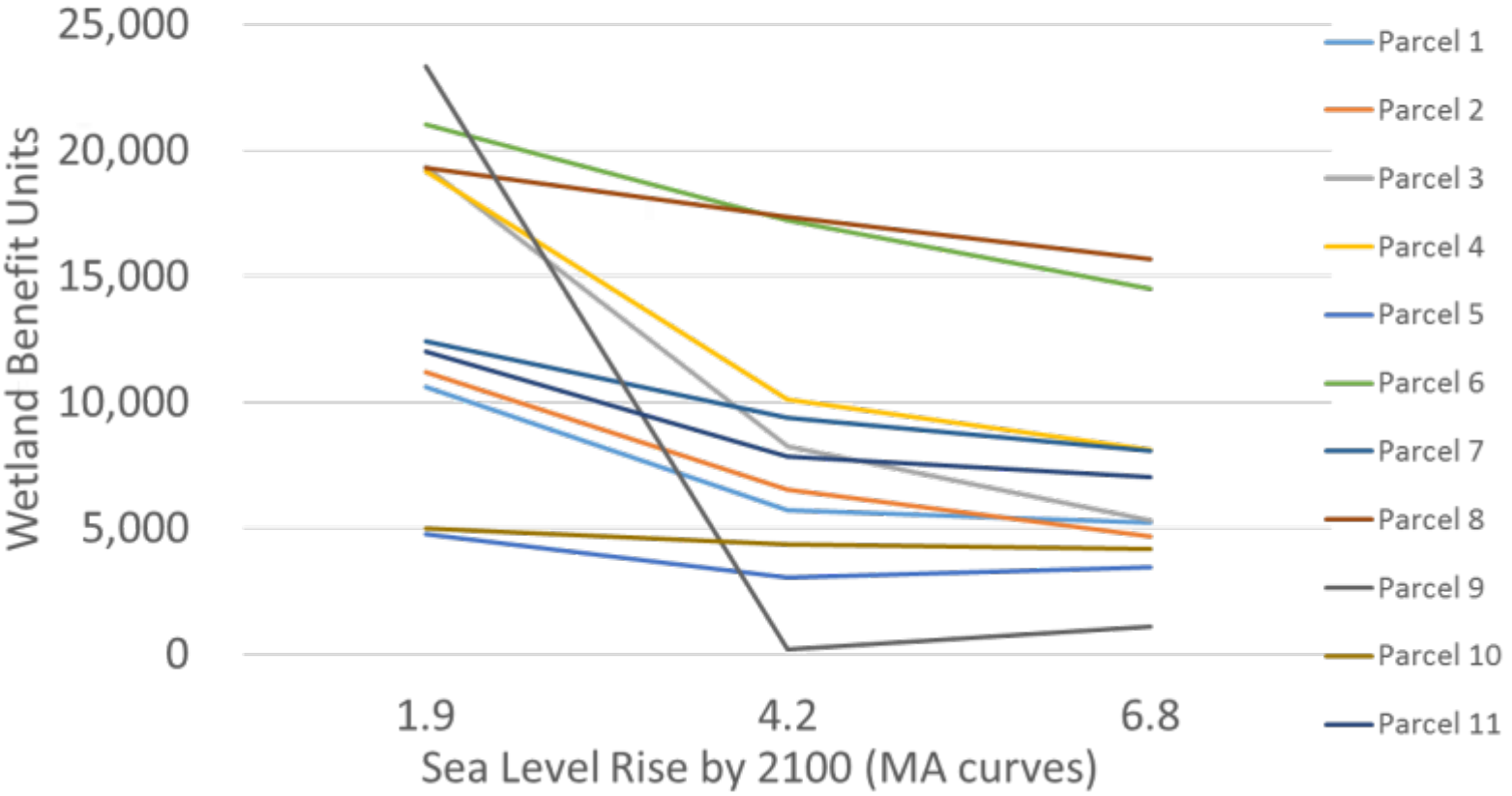
Great Marsh Parcels and Dryland Benefits as Sea Levels Rise



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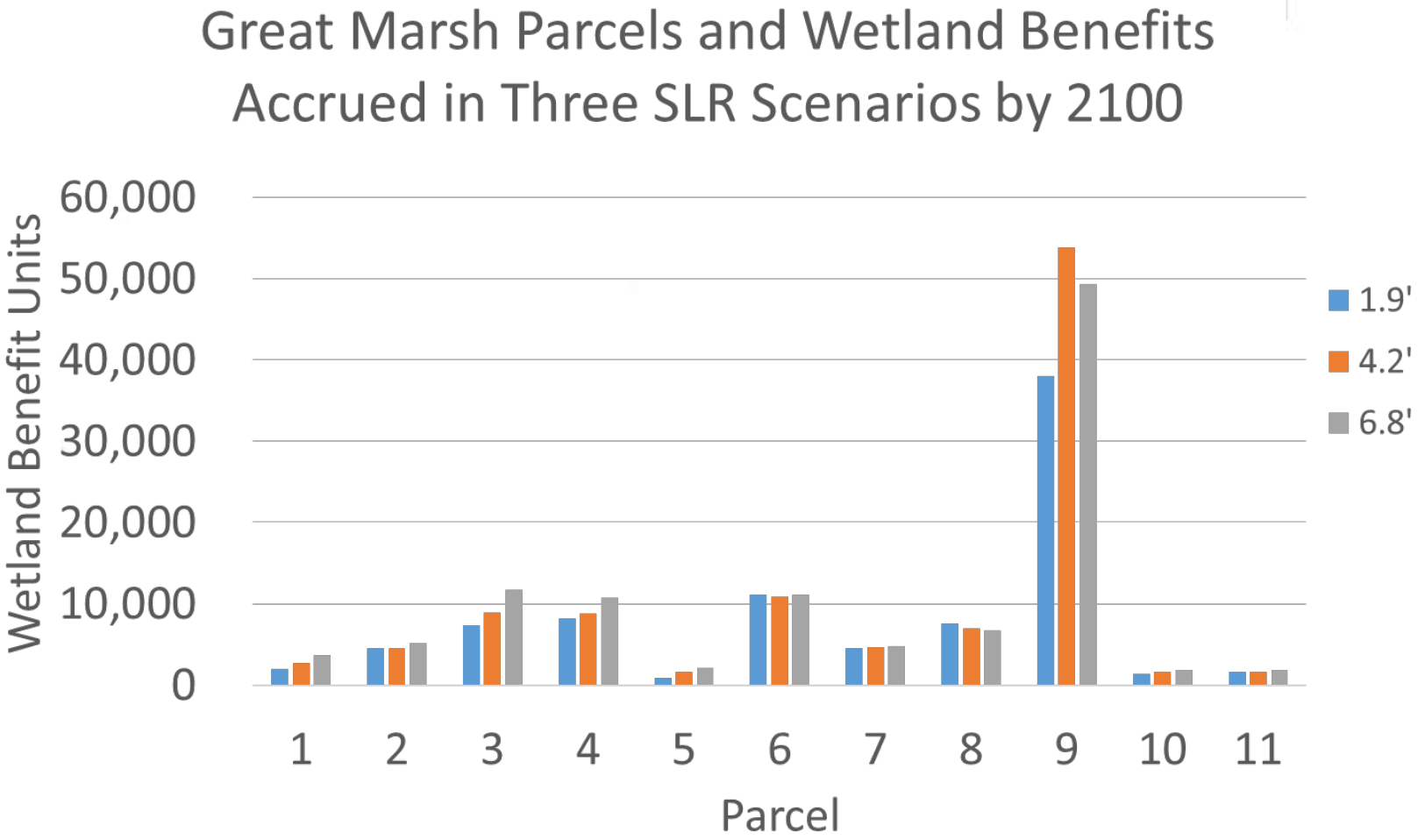

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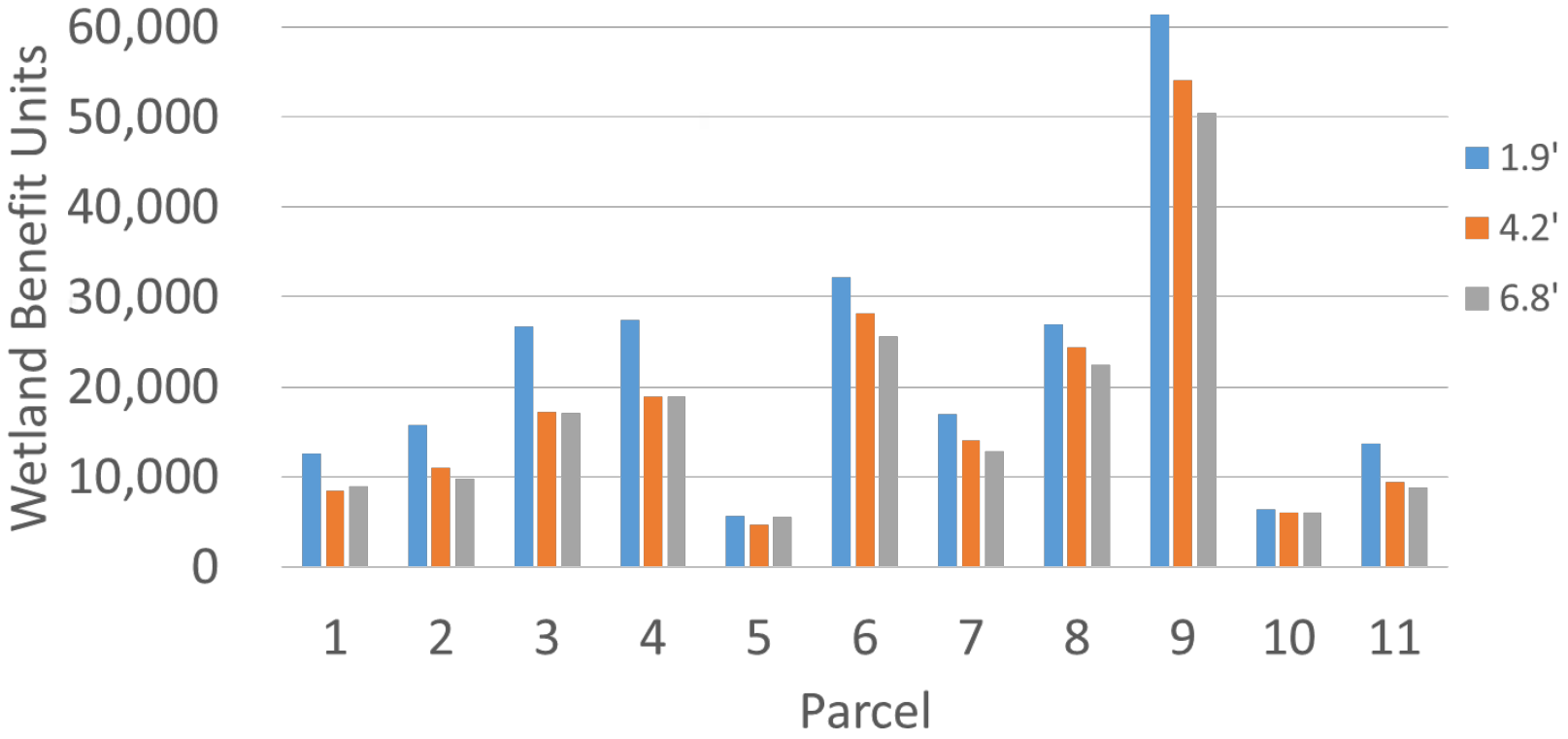
Great Marsh Parcels and Wet and Dryland Benefits Accrued in Three SLR Scenarios by 2100



Other Uses of the Model

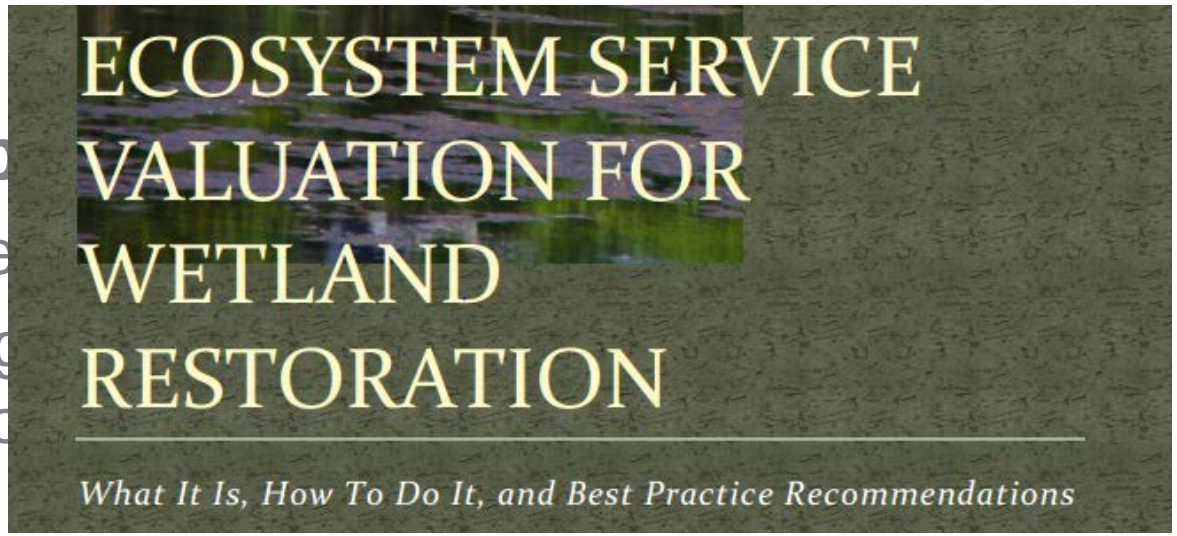
- **Habitat Restoration**
  - What benefits might accrue if we modify the landscape to allow water to gradually inundate different locations?
  - or with different restoration actions?
  - Should apply in urban and rural coastal contexts.

Using the Model and Concepts

- **Process elements are published and replicable:**
  - **Dollar-free Wetland Benefit Unit framework**
    - Journal of Ocean and Coastal Economics 2015 (2).
  - **Online Delphi survey values allocation process**
- **GEI will partner with any interested groups**

Limitations of the Model

- **Data inputs are based on best available science, but**
  - represent averages across a range of wetland types, tidal ranges, etc.
  - relatively little science is available for some depth relationships
- **Other assump**
  - wetlands will e
  - physical chang
    accrue will occ



http://www.aswm.org/state_meeting/2014/ecosystem_service_valuation_for_wetland_restoration.pdf

But on the flip side

- **Moving away from dollar valuation is appropriate.**
  - Don’t need dollars to measure how valuable something is!
- **Central principles of economics are relied upon:**
  - Resources are limited.
  - Decisions will have to be made anyway.
  - Even the soundest science imaginable won’t be useful if people do not value something.

But on the flip side

- **Knowing what we're actually doing actually helps:**
  - Are we trying to predict the future? No.

And anyway …

I actually heard this at an event last month:

"…we are very confident the values shown for future years will not be exactly as we are presenting here."

But on the flip side

- **Knowing what we're actually doing actually helps:**
  - Are we trying to predict the future? No.
  - We are increasing understanding of the relationship between physical changes in the landscape and the expected economic uses of that landscape.

Dilemma: Not being proactive enough about marsh migration.

Thank You!

Sam Merrill: 207-615-7523
smerrill@geiconsultants.com


Thank you for your participation!
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