Interpreting vulnerability information for adaptive management of high marsh habitat

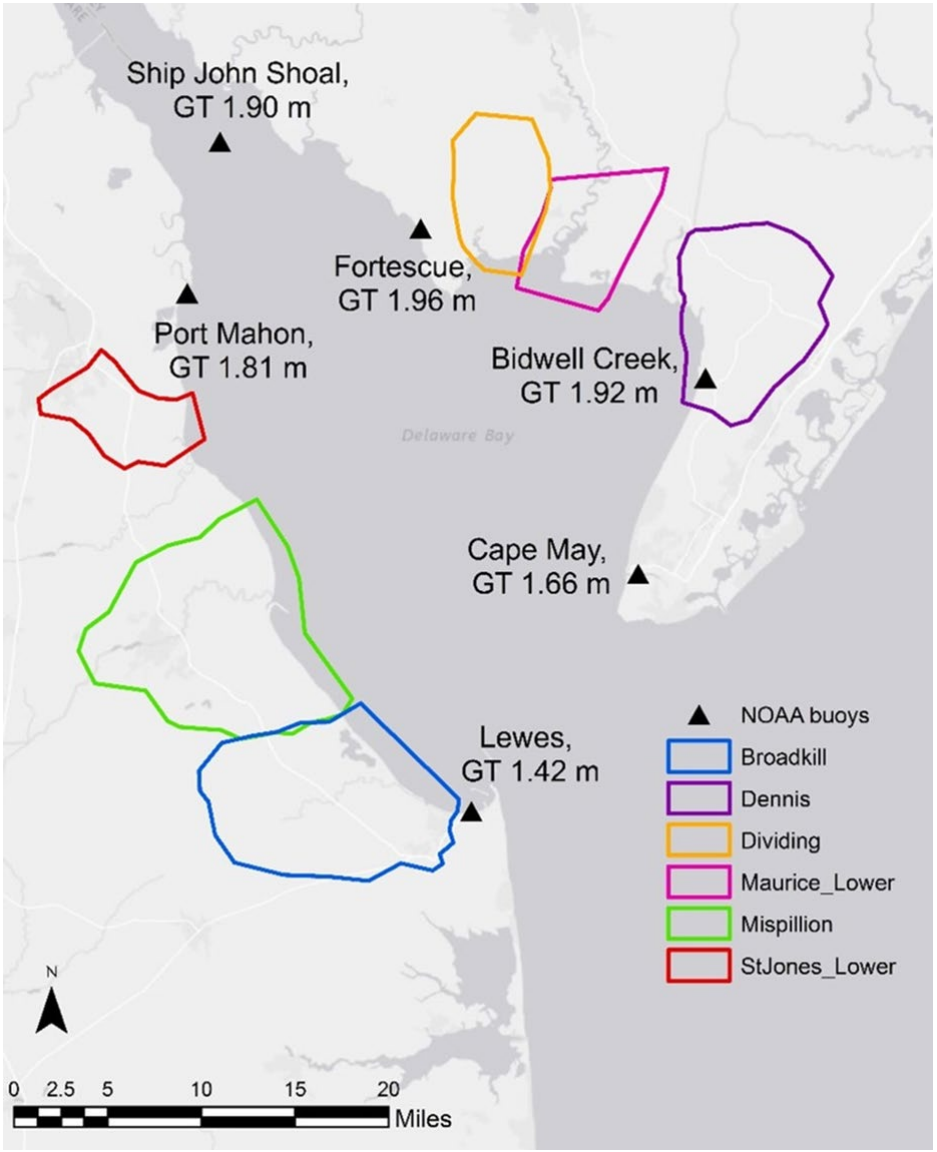
*Jordan West, U.S. EPA Office of Research and Development**
Anna Hamilton, Tetra Tech, Inc.
LeeAnn Haaf, Partnership for the Delaware Estuary
Jen Stamp, Tetra Tech, Inc.

*The views expressed in this presentation are those of the authors and do not necessarily represent views or policies of the U.S. Environmental Protection Agency.

Overview

- Focus on high marsh Saltmarsh Sparrow nesting habitat
- Cross-site management implications when considering:
  - ✓ Sea level rise
  - ✓ Sea level rise + storm surge
  - ✓ Sea level rise + storm surge + condition
- Within-site management implications: Dennis example
- Conclusions

Focus: high marsh habitat for Saltmarsh Sparrows



Valued ecosystem service:
High marsh habitat for Saltmarsh Sparrow nesting

The vulnerable Saltmarsh Sparrow (*Ammospiza caudacuta*) breeds in the high marsh and has a very narrow time frame to lay eggs and raise young before nests are likely to be flooded during extreme high tides; loss of high marsh acreage increases this probability.

Cross-site management implications based on sea level rise

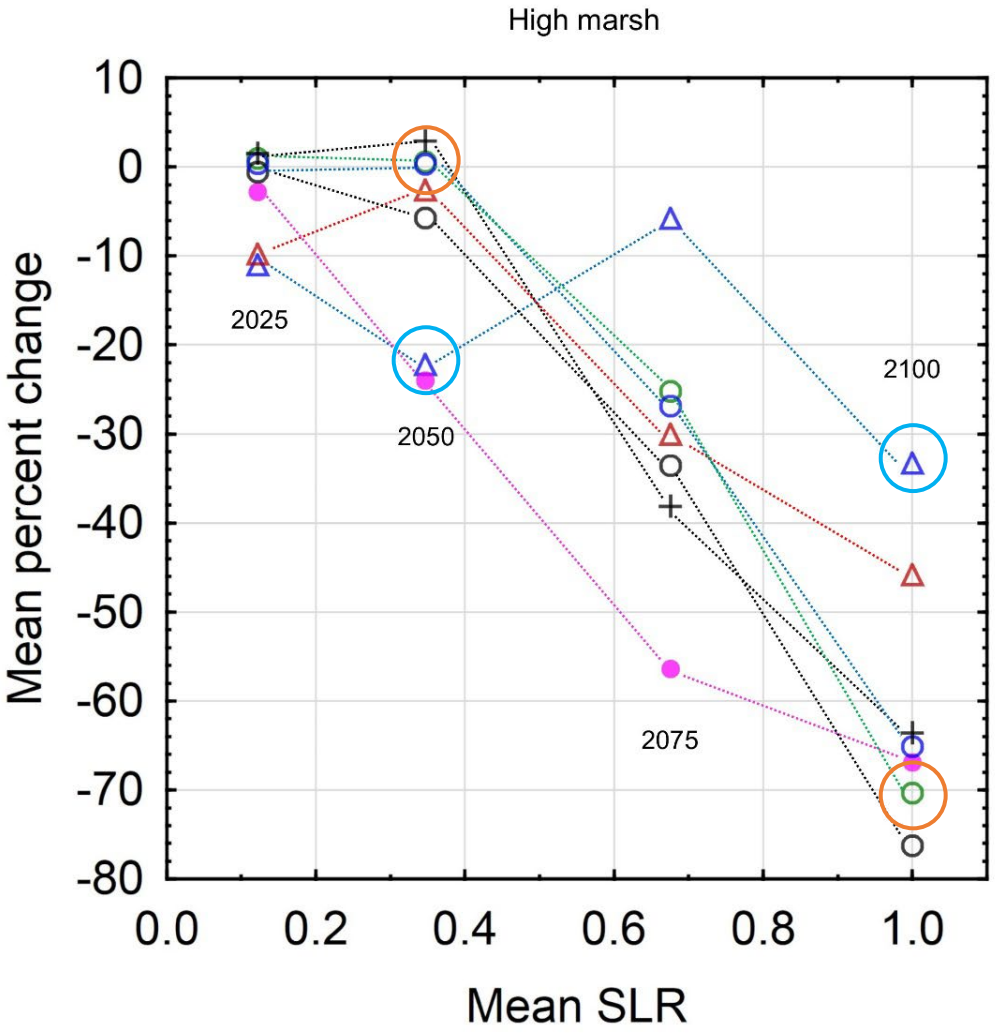
Site	Exposure		High marsh Response		
	Historic SLR trend + VLM (mm/yr)	Future GMSL by 2050 (m)	Time zero (acres)	2050 (acres)	% Change
Broadkill DE	3.4	0.34	3240	2522	-22 %
Mispillion DE	3.4		4262	4153	-3 %
Lower St. Jones DE	3.4		1519	1563	3 %
Dennis NJ	3.8		9153	9206	1 %
Dividing NJ	3.8		5027	3821	-24 %
Lower Maurice NJ	3.8		5225	4927	-6 %

Assuming all high marsh areas are potential habitat, a manager could:

- Focus on vulnerable (high loss) sites
  - ✓ *Why* are the most affected sites losing high marsh?
  - ✓ *What* interventions could reduce or reverse losses
  - ✓ Example: in Broadkill and Dividing, could thin layer placement be *designed* for effectiveness in the face of SLR?
- Focus on stable sites
  - ✓ *Why* are the least vulnerable sites stable or gaining?
  - ✓ *What* interventions could preserve stability and boost gains?
  - ✓ Example: in St. Jones and Dennis, could special protections and preservation of migration corridors be *designed* to effectively maintain or increase acreage?

But what about long-term versus short-term planning considerations?

Longer-term tipping points could be important



- By 2100, there has been a reversal in status between Dennis and Broadkill
- How should this figure into longer-term planning?

Symbol	Site	Acres		
		Time zero	2050	2100
△	Broadkill	3239.7	2521.8	2161.5
○	Dennis	9152.5	9206.5	2716.0
●	Dividing	5026.6	3820.8	1665.4
○	Maurice	5225.4	4926.7	1241.0
△	Mispillion	4261.6	4152.6	2309.7
○	Reeds	3515.5	3528.3	1226.3
+	St Jones	1518.8	1563.2	553.2

Adding consideration of storm surge

Storm surge is episodic, with inundation extensive but variable:

- Broadkill and Dividing have highest vulnerability to storms
- St. Jones has lowest vulnerability across measures, but acreage is low
  - ✓ Could thin layer placement and restoration be designed to effectively increase acreage gains?
- Dennis has the highest acreage and low SLR vulnerability, but high storm surge vulnerability
  - ✓ Could living shorelines be designed to help mitigate wave exposure?

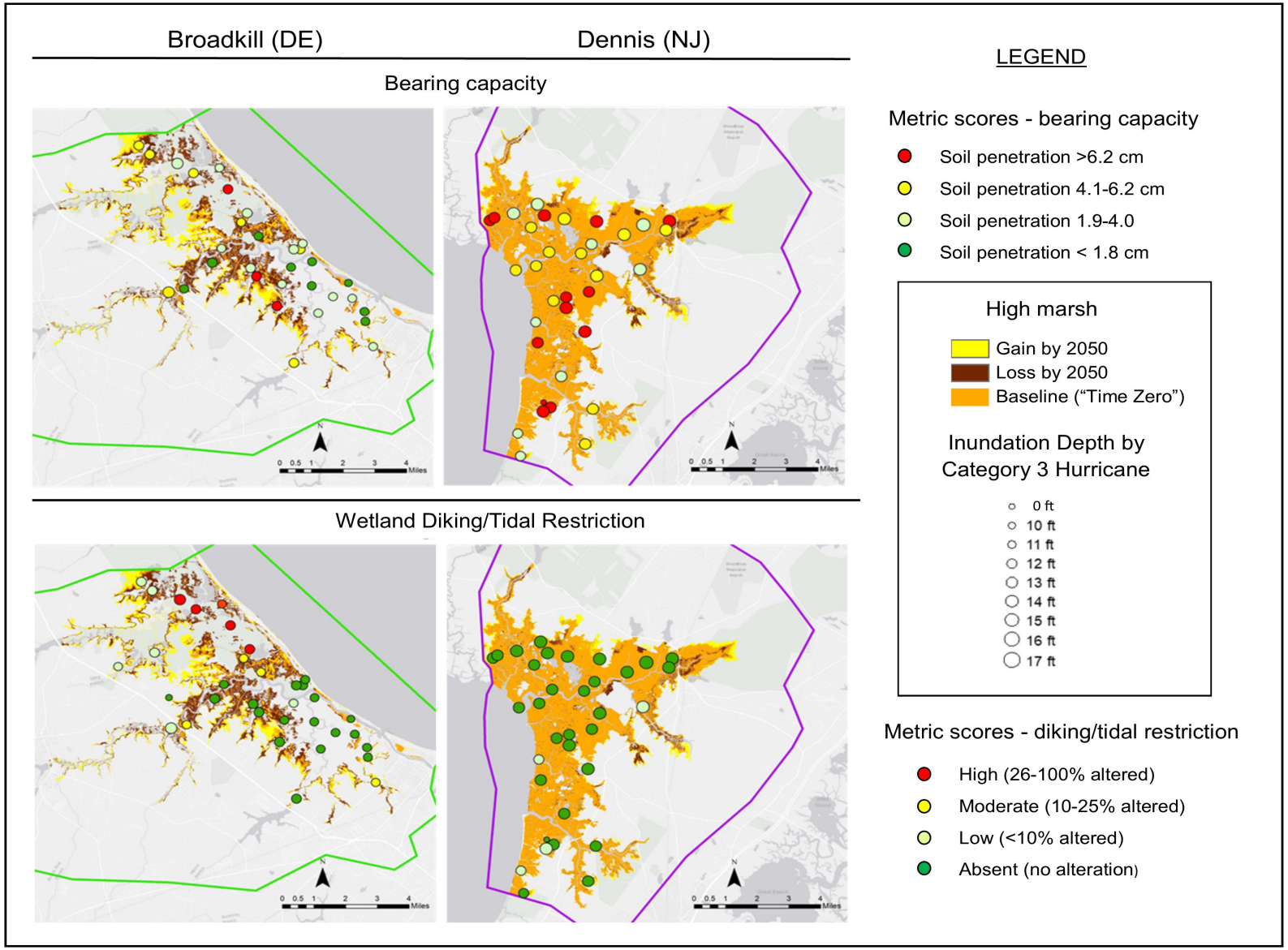
Site	High marsh acreage (time zero)	SLR	Storm Surge	
		% Change in high marsh acreage by 2050[a]	Hurricane strikes (1900-2018)	Category 3 inundation depth (ft)
Broadkill (DE)	3240	-22%	9	11.7
Mispillion (DE)	4262	-3%	9	12.3
St. Jones (DE)	1519	3%	6	12.8
Dennis (NJ)	9153	1%	8	14.3
Dividing (NJ)	5027	-24%	6	15.0
Maurice (NJ)	5225	-6%	8	14.4

Adding consideration of condition

Site	High marsh acreage (time zero)	SLR	Storm Surge		Marsh Condition
		% Change in high marsh acreage by 2050[a]	Hurricane strikes (1900-2018)	Category 3 inundation depth (ft)	Mid-TRAM mean score
Broadkill (DE)	3240	-22%	9	11.7	8.3
Mispillion (DE)	4262	-3%	9	12.3	7.7
St. Jones (DE)	1519	3%	6	12.8	NA
Dennis (NJ)	9153	1%	8	14.3	8.8
Dividing (NJ)	5027	-24%	6	15.0	NA
Maurice (NJ)	5225	-6%	8	14.4	9.3

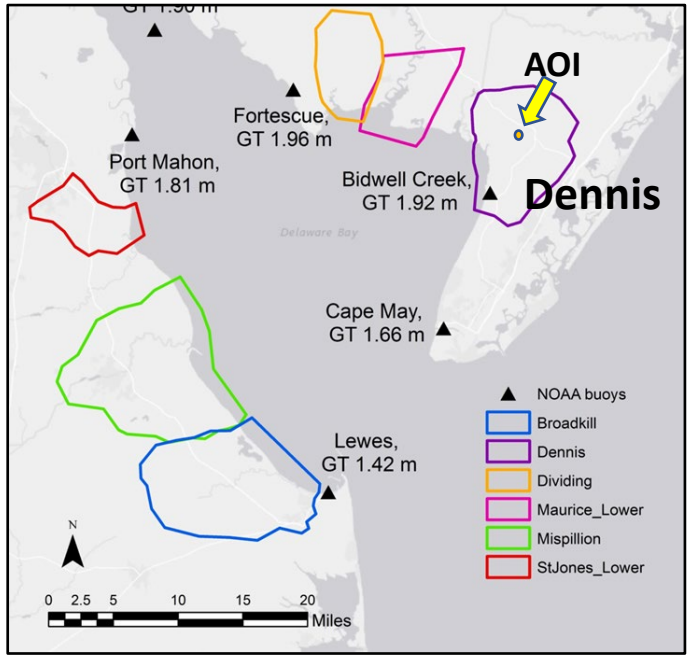
- Condition is a modifying factor to consider when assessing potential marsh response
- With their high overall condition scores, Dennis and Maurice may be more resilient than other sites
- But examining individual metrics may be more useful in evaluating why marshes at different sites might respond differently to SLR and storm surge

Within-site scale: putting it all together



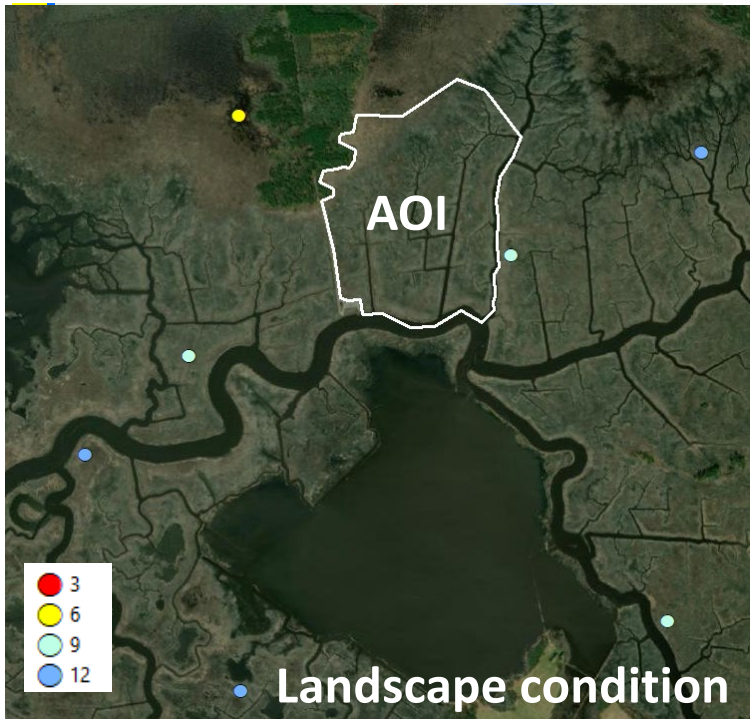
- Soil bearing capacity is a bigger problem in Dennis—can protection and restoration promote greater below ground biomass?
- Diking is a bigger problem in the northern section of Broadkill—could restored hydrology reverse sediment supply deficits?
- The southern section of Broadkill has better values for both condition metrics, plus lower inundation depths—should these areas be prioritized for management even though absolute acreage is less?

Within-site scale: Dennis example



Based on the lower vulnerability of its high marsh to SLR, Dennis might be a priority for protection or restoration.

Site	High marsh acreage (time zero)	SLR: % Change in high marsh acreage by 2050
Broadkill (DE)	3239.7	-22.2 %
Mispillion (DE)	4261.6	-2.6 %
St. Jones (DE)	1518.8	2.9 %
Dennis (NJ)	9152.5	0.6 %
Dividing (NJ)	5026.6	-24.0 %
Maurice (NJ)	5225.4	-5.7 %



Condition (modifier of response): Could indicate where tactic success is more likely, or condition improvement is critical

Conclusions

Combined information on multiple components of vulnerability could help us to better:

- Prioritize marshes for focus (site selection)
- Identify potential ‘tipping points’
- Zero in on sub-sites for potential interventions based on finer-scale patterns
- Evaluate strategies, select tactics, and craft resilience-based designs
- Craft monitoring approaches (are changes occurring as expected?)