A COMPREHENSIVE PLAN FOR

RESILIENT SALT MARSHES IN NEW HAMPSHIRE

NH Climate Summit 2021

Thank you

New Hampshire Coastal Program

GREAT BAY NATIONAL ESTUARINE RESEARCH RESERVE

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NH

STATE OF NEW HAMPSHIRE · LIVE FREE OR DIE · FISH AND GAME

ROCKINGHAM PLANNING COMMISSION

CITY OF PORTSMOUTH, N.H. · SETTLED 1623 · INCORPORATED 1849

NHDES

What is the NH Salt Marsh Plan?

A **geospatial** screening tool to assess marsh resilience, and offer site specific management options based on the characteristics of that marsh.

- Land protection
- Management/Restoration
- Research
- Policy

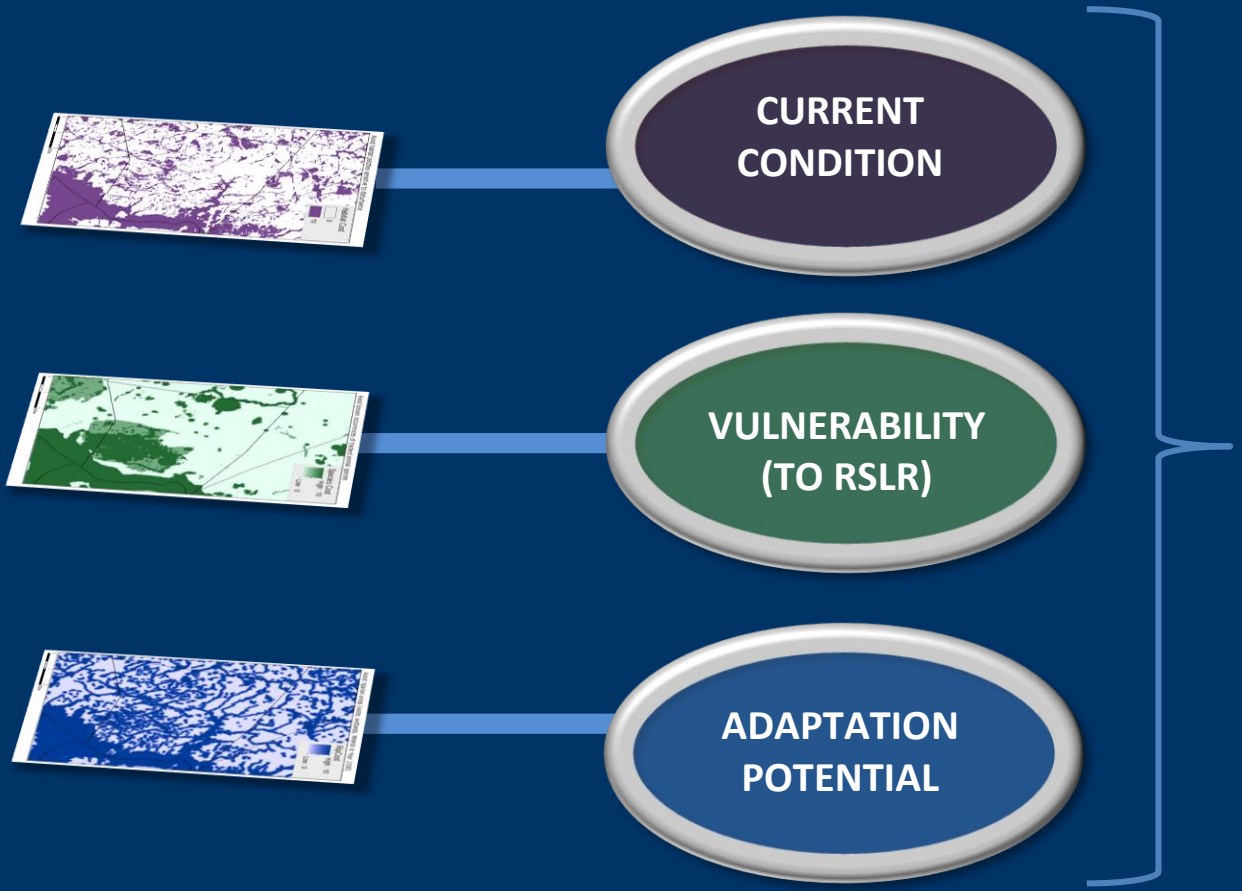
National Estuarine Research Reserves

Results

How do we define NH Marshes?

Useful tidbit #1 Marsh Units

Results



What do we know about our marshes that can help us manage their future?

Useful tidbit #2: Clarify what we mean by a resilient marsh

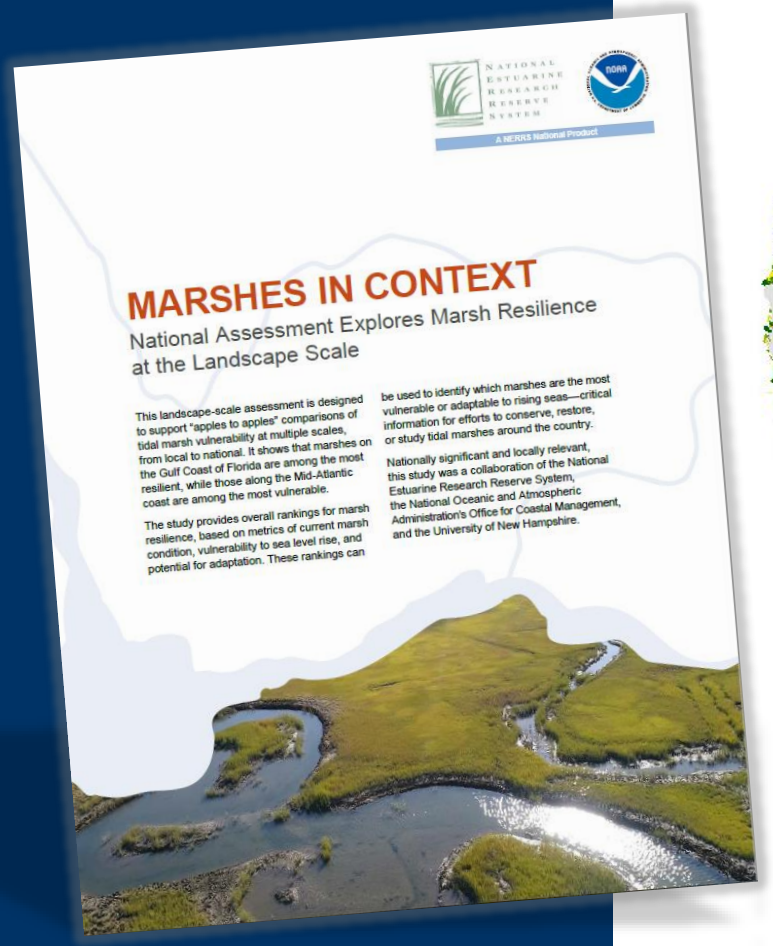
Results

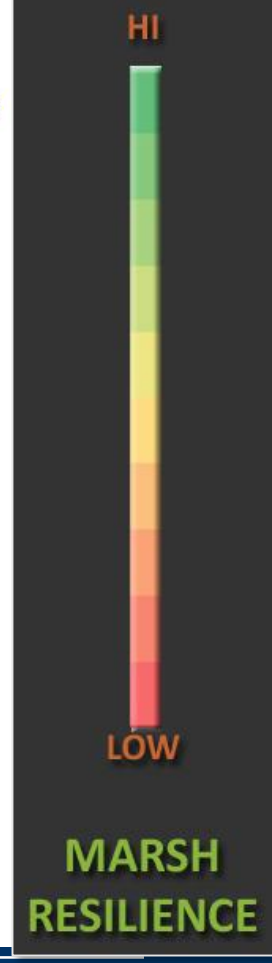
How do we combine information to understand marsh resilience?

Useful tidbit # 3 Geospatial model that has lots of data to play with

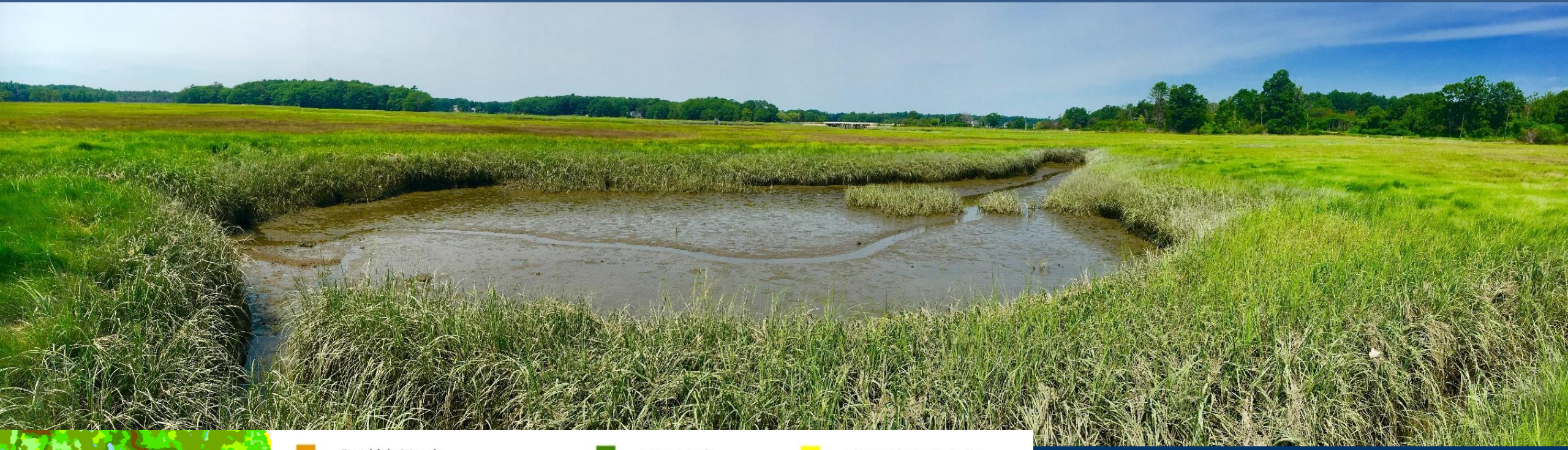
Category	Metric	Weight
Current Condition	Berm presence (agricultural priority)	7.0
	Ditching - linear feet per MUC	7.0
	Habitat diversity within MUC (plant and species diversity/ evenness vs	6.0
	Invasives (*Phragmites* , unless native)	5.0
	MUC area to edge ratio	6
	MUC unvegetated to vegetated ratio (edge only)	10
	MUC unvegetated to vegetated ratio (area)	10
	Nitrogen	5.0
	Percent agricultural cover (150m buffer)	7
	Percent impervious cover (150m buffer)	8
	Percent natural cover (150m buffer)	7
	Threatened and endangered species (from WAP)	5.5
Vulnerability	Fetch (used as a proxy for wave action)	5.0
	Percent of marsh below MHHW	8
	Percent of marsh below MTL	6
	Soil erodibility	5
	Tidal range	5
Adaptation potential	Hardened shoreline	10
	Shoreline sinuosity	6
	Size of marsh migration space	10

Results: www.nerra.org/landscape-scale-marsh-resilience/

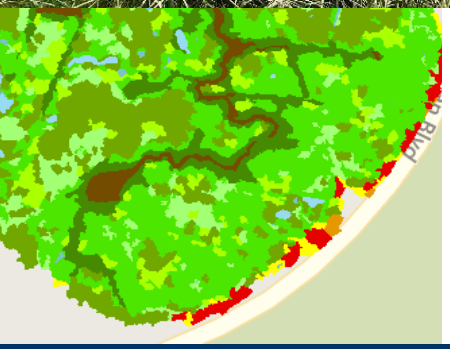




Exciting example of data to play with:
High Resolution Tidal Wetland Data



Kevin Lucy photo



Brackish Marsh	Low Marsh	Phragmites australis
High Marsh Mix	Mudflat	Pool
High Marsh, J. gerardii	Open Water	Recently Flooded Forest
High Marsh, S.patens / D.spicata	Panne	Short form S. alterniflora
Terrestrial border	Wrack	

Results

How do we take geospatial modeling outputs and data and make it useful?

Useful tidbit # 4

Management Options Table

Best Management Options for Enhancing Tidal Marsh Resiliency

[illegible]

Management options in this table are recommended conservatively so that only the most relevant for each marsh resiliency category are shown.

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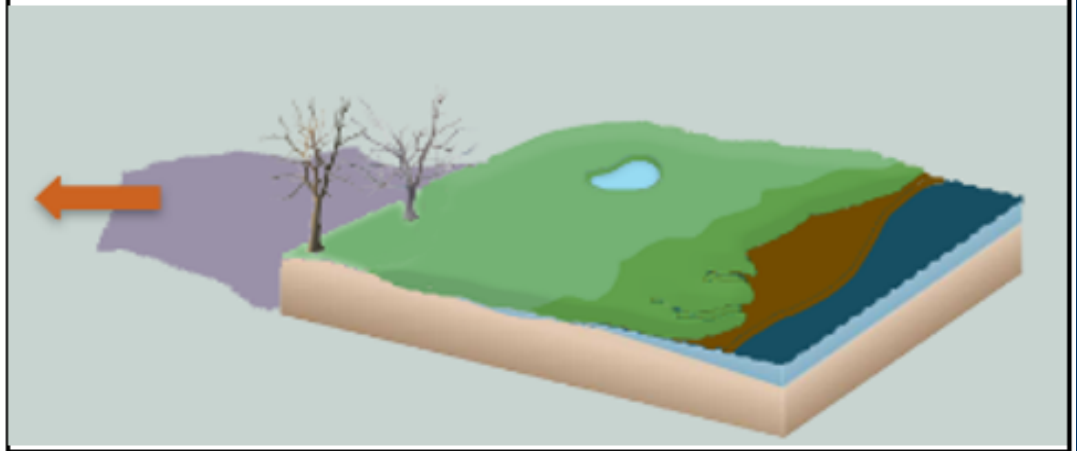
		Current Condition	High	High	High	High	Low	Low	Low	Low
		Current vulnerability to RSLR	Low	High	Low	High	High	Low	High	Low
		Adaptation Potential	High	High	Low	Low	Low	Low	High	High
			Good condition marsh that is likely to migrate inland naturally for the long-term. It's in good shape, don't mess with it!	Marsh is in good shape for now but try to make less vulnerable (e.g., living shoreline or thin layer placement) so it has a chance to adapt in the future.	Its in good shape for now. Focus on upland modifications that enhance adaptation potential.	Cannot maintain current footprint without active management. Address upland options only if vulnerability is mitigated first. Exception is if essential function is present so protect all current high marsh.	Low condition marsh that is unlikely to persist in the future. Makes this a good place to test experimental restoration approaches.	There is a need to restore current conditions but prioritize only if barriers to adaption in upland are mitigated.	Focus established restoration techniques that improve current condition and decrease vulnerability to RSLR here. Need to address both aspects to make a project sustainable.	Prioritize established restoration projects here. This marsh is likely to self-sustain in the long term so projects will be cost effective.
		Number of MUCs in NH	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
		Total acreage in NH	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
		Average size (acres)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
		Size range (acres)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
		Priority for resource investment in NH?	YES	YES	YES	?	?	?	?	YES
Management Options	Rationale	Example project types								
[illegible]										
[illegible] / POLICY										
Remove / decrease / modify development potential on salt marsh itself	[illegible]	Special overlay districts. Building restrictions. Road infrastructure modification.	✓	✓	✓	✓				
Remove / decrease / modify development potential in the migration pathway	When adaptation potential is high.	Removal and restoration of parking areas. Removal of buildings. Abandonment of roads. Removal of septic systems.	✓	✓					✓	✓
Managed relocation of structures and/or infrastructure in the saltmarsh itself	When current condition is high and either vulnerability is low or adaptation potential is high.		✓	✓	✓	✓				
Managed relocation of structures and/or infrastructure in the way of the migration pathway	When adaptation potential is high.		✓	✓					✓	✓
Incentives for voluntary easements or land acquisition of critical migration pathways and buffer strips.	When adaptation potential is high.	Set back or buffer ordinances. Zoning or overlay districts.	✓	✓					✓	✓
LAND PROTECTION										
Priority for protection of marsh itself (all high current condition marshes are considered important for protection).	When current condition is high and either vulnerability is low or adaptation potential is high.	Fee purchase.	✓	✓	✓	✓				
Protection of migration space	When adaptation potential is high.	Purchase fee or conservation easement	✓	✓	x	x	x	x	✓	✓
Incentives for voluntary easements or land acquisition of critical migration pathways and buffer strips.	When adaptation potential is high.	Purchased easement. Rolling easements. Deed restrictions. Tax incentives.	✓	✓					✓	✓
Limit investment in land protection as effectiveness will be relatively short-term.	When all three resiliency categories (current condition, vulnerability, and adaptive potential) are negative.	[illegible]					✓			
RESTORATION OR ADAPTATION TECHNIQUES										
Traditional, well proven, techniques with most benefits to the current marsh footprint	When current condition is low or vulnerability is high.	Removal of barriers to hydrologic flow (tidal restrictions, ditch remediation etc.). Open marsh water management (OMWM) remediation. Invasive species management.		✓		✓	✓	✓	✓	✓
Experimental, or highly manipulative, techniques within the current marsh footprint	When current condition is low and vulnerability is high.	Thin layer deposition, ditch remediation, runneling, tide gates, dredge material removal.					✓		✓	
Traditional, well proven, techniques within the migration pathway that do not require slope modification.	When adaptation potential is high.	Removal of elevation barriers to migration, either close to the marsh edge or higher up in the watershed. Conversion of built, non-occupied, infrastructure in migration pathway to natural cover.	✓	✓					✓	✓
Experimental landscape modifications on either the seaward or upland side of the current marsh footprint	When adaptation potential is low and current condition high.	Lower topology of the migration pathway. Removal of woody vegetation along ecotone. Living shoreline projects. Build hardened "toe" to extend marsh seaward. Use coir logs to promote sediment stabilization.			✓	✓				
Limit investment in restoration or adaptation projects as effectiveness will be short-term.	When all three resiliency categories (current condition, vulnerability, and adaptive potential) are negative.	Save your $					✓			

Current Condition	High
Vulnerability to RSLR	Low
Adaptation Potential	High

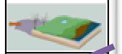
Management Rationale : Good condition marsh that is likely to migrate inland naturally for the long-term. It's in good shape, don't mess with it!

- High marsh
- Low Marsh
- Mudflat
- Open Water
- Panne or Pool
- Migration Space



Description: A marsh that is currently in good condition with a wide high marsh plateau and high vegetated to unvegetated ratio, has low vulnerability (e.g. wide tidal range), can migrate inland and may already be showing signs of inland migration.

Best Management Options for Enhancing Tidal Marsh Resiliency



Management Options	Example project types
LAND USE / POLICY	
Remove / decrease / modify development potential on salt marsh itself.	Special overlay districts. Building restrictions. Road infrastructure modification.
Remove / decrease / modify development potential in the migration pathway.	Removal and restoration of parking areas. Removal of buildings. Abandonment of roads. Removal of septic systems.
Managed relocation of structures and/or infrastructure in the saltmarsh itself	
Managed relocation of structures and/or infrastructure in the way of the migration pathway	
Incentives for voluntary easements or land acquisition of critical migration pathways and buffer strips.	Set back or buffer ordinances. Zoning or overlay districts.

Best Management Options for Enhancing Tidal Marsh Resiliency

This table summarizes recommended management options to enhance tidal marsh resiliency based on the current condition of each marsh and its predicted adaptive capacity to relative sea level rise. Management options are considered from an ecological, ratherity to relative sea level rise. Management options are considered from an ecological, rather than socioeconomic, perspective. For example, "managed rel[illegible] abandoning or buying out property.

Management options in this table are recommended conservatively so that only the most relevant for each marsh resiliency category are shown.

A "✓" means that option is *highly relevant* for this marsh resiliency category and a "x" means the financial, ecological or logistical **cost is high** so this type of management option should be avoided.

Recommendations are made as an objective overview. It is fully recognized other factors, such as funding availability, need for a demonstration project in a specific location, or political will may supersede management options recommended here.

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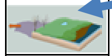
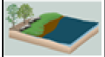
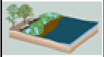
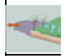
		Current vulnerability to RSLR	Low	High	Low	High	High	Low	High	Low
		Adaptation Potential	High	High	Low	Low	Low	Low	High	High
			Good condition marsh that is likely to migrate inland naturally for the long-term. It's in good shape, don't mess with it!	Marsh is in good shape for now but try to make less vulnerable (e.g., living shoreline or thin layer placement) so it has a chance to adapt in the future.	Its in good shape for now. Focus on upland modifications that enhance adaptation potential.	Cannot maintain current footprint without active management. Address upland options *only if* vulnerability is mitigated first. Exception is if essential function [illegible] protect all current high marsh.	Low condition marsh that is unlikely to persist in the future. Makes this a good place to test experimental restoration approaches.	There is a need to restore current conditions but prioritize *only if* barriers to adaption in upland [illegible]	Focus established restoration techniques that improve current condi[illegible] vulnerability to RSLR here. Need to address both aspects to make a project sustainable.	Prioritize [illegible] restoration [illegible] This [illegible] likely to [illegible] the long te[illegible] projects wi[illegible] effective.
										
		Number of MUCs in NH	22	25	31	35	24	21	25	39
		Total acreage in NH	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
		Average size (acres)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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		Priority for resource investment in NH?	YES	YES	YES	?	?	?	?	YES
Management Options	Rationale	Example project types								
NO ACTION is the default for all Marsh Units										
LAND USE / POLICY										
Remove / decrease / modify development potential on salt marsh itself	When current condition is high and either vulnerability is low or adaptation potential high.	Special overlay districts. Building restrictions. Road infrastructure modification.	✓	✓	✓	✓				
Remove / decrease / modify development potential in the migration pathway	When adaptation potential is high.	Removal and restoration of parking areas. Removal of buildings. Abandonment of roads. Removal of septic systems.	✓	✓					✓	✓
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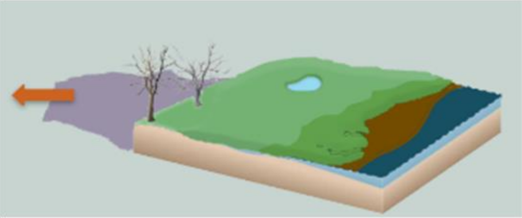

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abandoning or buying out property.

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						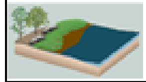	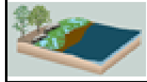			
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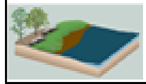
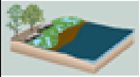
		Adaptation Potential	High	High	Low	Low	Low	Low	High	High
			Good condition marsh that is likely to migrate inland naturally for the long-term. It's in good shape, don't mess with it!	Marsh is in good shape for now but try to make less vulnerable (e.g., living shoreline or thin layer placement) so it has a chance to adapt in the future.	Its in good shape for now. Focus on upland modifications that enhance adaptation potential.	Cannot maintain current footprint without active management. Address upland options *only if* vulnerability is mitigated first. Exception is if essential function is present so protect all current high marsh.	Low condition marsh that is unlikely to persist in the future. Makes this a good place to test experimental restoration approaches.	There is a need to restore current conditions but prioritize *only if* barriers to adaption in upland are mitigated	Focus established restoration techniques that improve current condition *and* decrease vulnerability to RSLR here. Need to address both aspects to make a project sustainable.	Prioritize established restoration projects here. This marsh is likely to self-sustain in the long term so projects will be cost effective.
										
		Number of MUCs in NH	22	25	31	35	24	21	25	19
		Total acreage in NH	306	2,667	386	558	209	181	333	215
		Average size (acres)	13.1	106.6	12.4	15.7	8.7	8.6	13.0	11
		Size range (acres)	2.4 - 1,763.1	0.6 - 2,212.8	0.7 - 115.8	0.8 - 174.8	0.08 - 84.9	0.16 - 56.7	0.08 - 212	0.07 - 74.8
		Priority for resource investment in NH?	YES	YES	YES	?	?	?	?	YES
Management Options	Rationale	Example project types								
NO ACTION is the default for all marsh units										
LAND USE / POLICY										
Remove / decrease / modify development potential on salt marsh itself	When current condition is high and either vulnerability is low or adaptation potential high.	Special overlay districts. Building restrictions. Road infrastructure modification.	✓	✓	✓	✓				
Remove / decrease / modify development potential in the migration pathway	When adaptation potential is high.	Removal and restoration of parking areas. Removal of buildings. Abandonment of roads. Removal of septic systems.	✓	✓					✓	✓
Managed relocation of structures and/or infrastructure in the saltmarsh itself	When current condition is high and either vulnerability is low or adaptation potential high.		✓	✓	✓	✓				
Managed relocation of structures and/or infrastructure in the way of the migration pathway	When adaptation potential is high.		✓	✓					✓	✓
Incentives for voluntary easements or land acquisition of critical migration pathways and buffer strips.	When adaptation potential is high.	Setback or buffer ordinances. Zoning or overlay districts.	✓	✓					✓	✓
LAND PROTECTION										
Priority for protection of marsh itself (all high current condition marshes are considered important for protection).	When current condition is high and either vulnerability is low or adaptation potential high.	Fee purchase.	✓	✓	✓	✓				
Protection of migration space	When adaptation potential is high.	Purchase fee or conservation easement	✓	✓	x	x	x	x	✓	✓
Incentives for voluntary easements or land acquisition of critical migration pathways and buffer strips.	When adaptation potential is high.	Purchased easement. Rolling easements. Deed restrictions. Tax incentives.	✓	✓					✓	✓
Limit investment in land protection as effectiveness will be relatively short-term.	When all three resiliency categories (current condition, vulnerability, and adaptive potential) are negative.	Save your $!					✓			
RESTORATION OR ADAPTATION TECHNIQUES										
Traditional, well proven, techniques with most benefits to the current marsh footprint	When current condition is low or vulnerability is high.	Removal of barriers to hydrologic flow (tidal restrictions, ditch remediation etc.). Open marsh water management (OMWM) remediation. Invasive species management.		✓		✓	✓	✓	✓	✓
Experimental, or highly manipulative, techniques within the current marsh footprint	When current condition is low and vulnerability is high.	Thin layer deposition, ditch remediation, runneling, tide gates, dredge material removal.					✓		✓	
Traditional, well proven, techniques within the migration pathway that do not require slope modification.	When adaptation potential is high.	Removal of elevation barriers to migration, either close to the marsh edge or higher up in the watershed. Conversion of built, non-occupied, infrastructure in migration pathway to natural cover.	✓	✓					✓	✓
Experimental landscape modifications on either the seaward or upland side of the current marsh footprint	When adaptation potential is low and current condition high.	Lower topology of the migration pathway. Removal of woody vegetation along ecotone. Living shoreline projects. Build hardened "toe" to extend marsh seaward. Use coir logs to			✓	✓				

Results

How can we simplify this for a particular Marsh Unit?

Useful tidbit #5

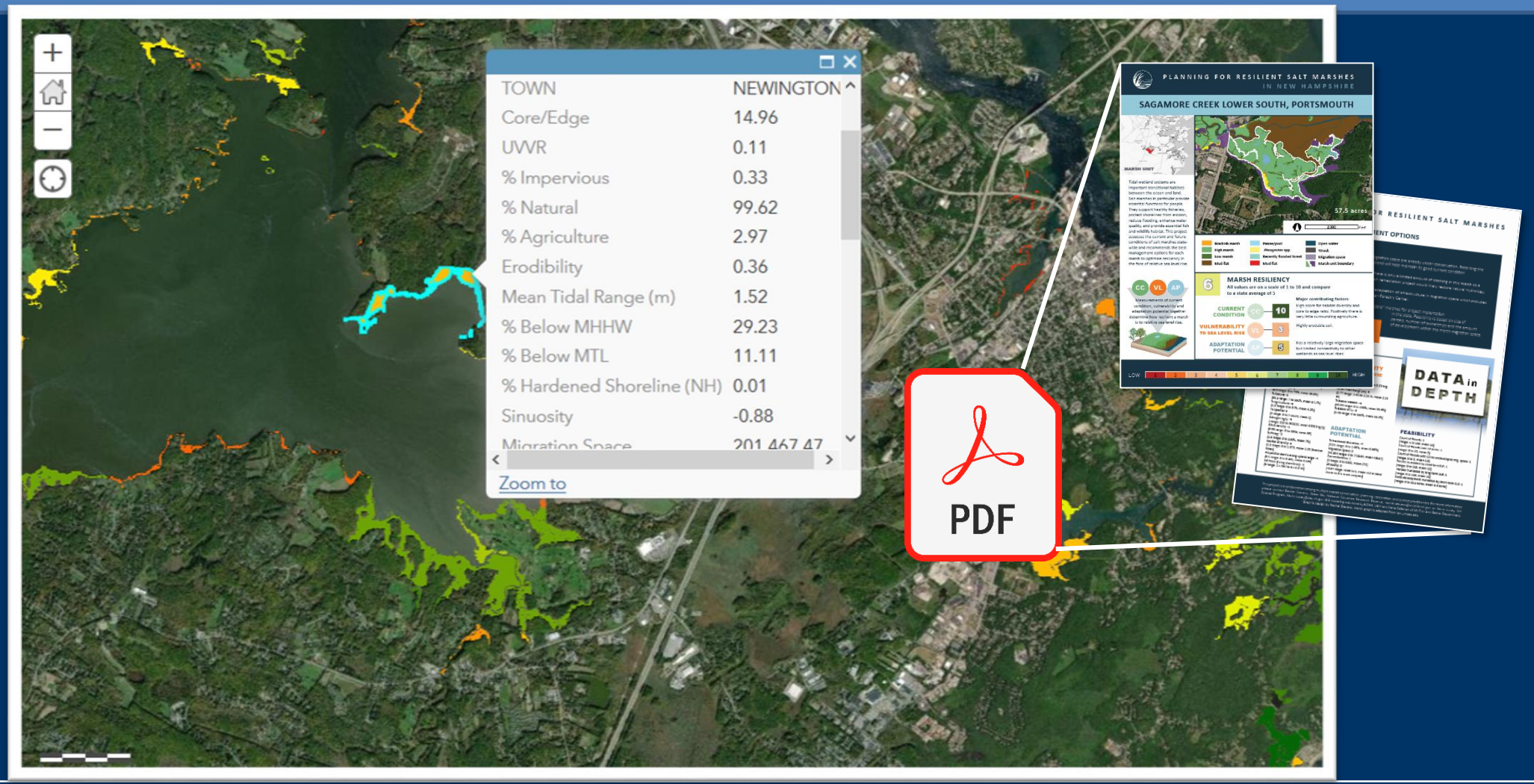
Marsh Profiles

Results

How can we make sure people can access the profiles, the resiliency scores and all that data?

Useful tidbit #6 Online map based viewer

Useful Online Viewer



Results

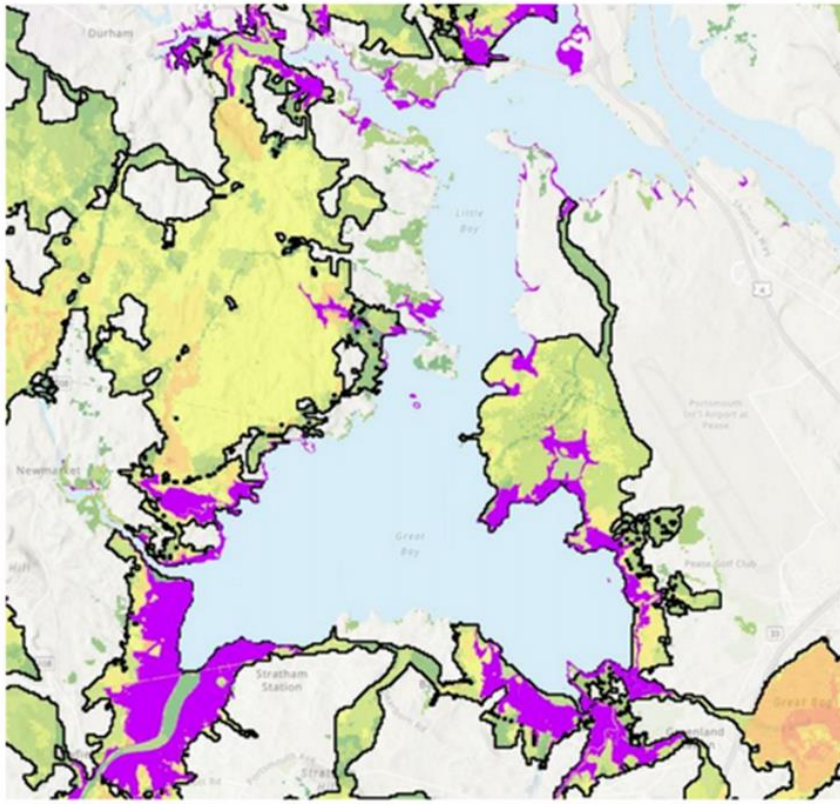
What if we want to use the model to look at prioritizing actions across the state?

Useful tidbit #7

Ability to run a customized model.

Salt Marsh Add-in Update

- Black outline Represents the filtered prioritization
- Color Ramp is the prioritization before the filtering with weights represented
- How do we add in important salt marsh areas that have been filtered out of the prioritization?
- **Methods:**
  - Used resilient marsh management categories (GBNERR 2020) and associated undeveloped migration space and merged those areas together
  - After looking at this initial result we decided to use resilient marsh units and their migration space as an additional input into the weighted sum to better capture marsh systems (vs. fragments)



Best Management Options for Enhancing Tidal Marsh Resiliency

This table summarizes recommended management options to enhance tidal marsh resiliency based on the current condition of each marsh and its predicted adaptive capacity to relative sea level rise. Management options are considered from an ecological, rather than to relative sea level rise. Management options are considered from an ecological, rather than socioeconomic, perspective. For example, "managed relocation" refers abandonment near (saving out property

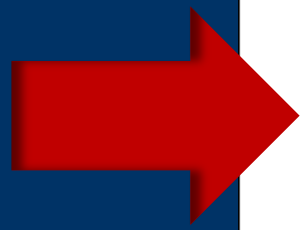
Management options in this table are recommended conservatively so that only the most relevant for each marsh resiliency category are shown.

A "✓" means that option is *highly* relevant for this marsh resiliency category and a "x" means the financial, ecological or logistical **cost is high** so this type of management option should be avoided.

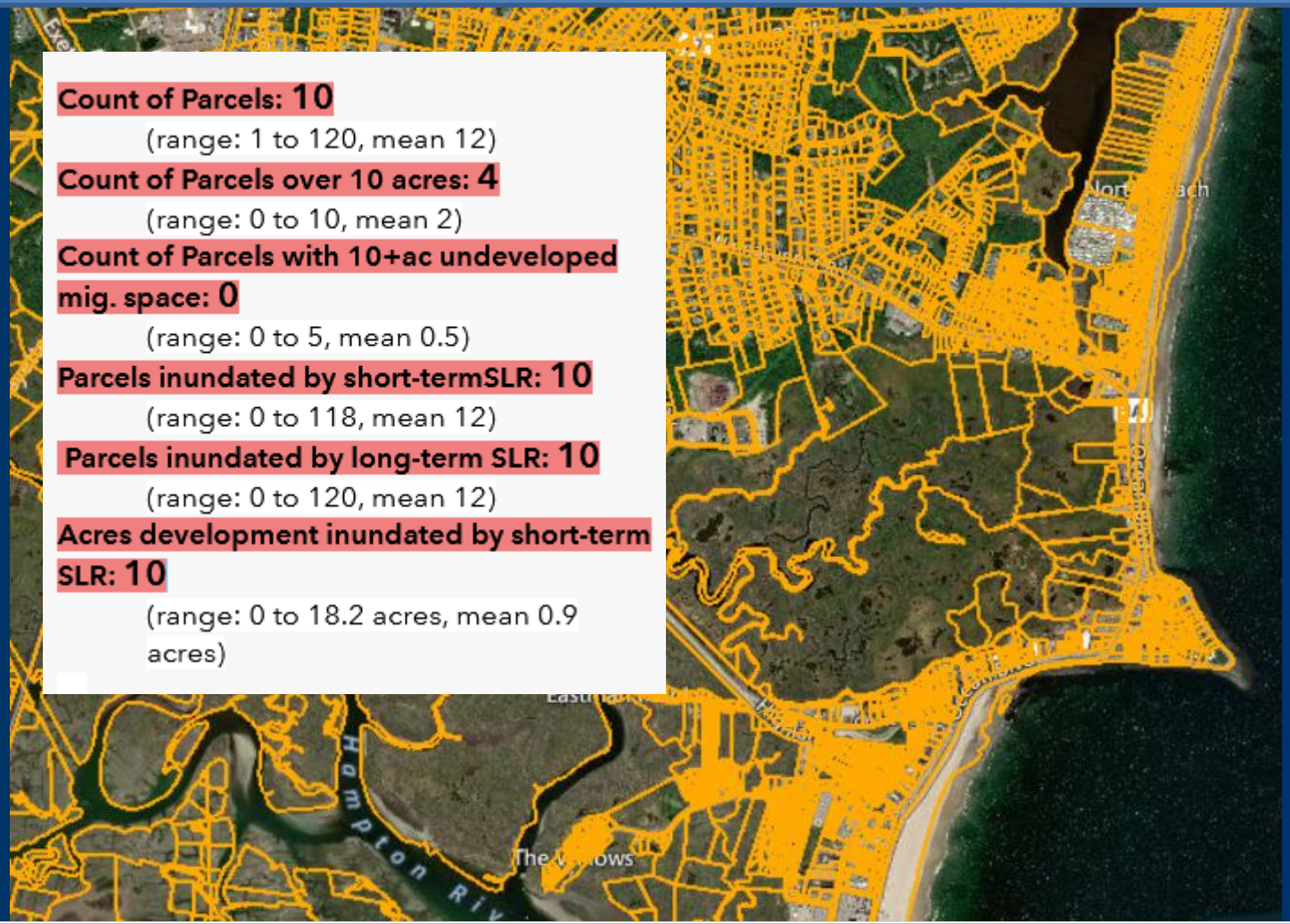
Recommendations are made as an objective overview. It is fully recognized other factors, such as funding availability, need for a demonstration project in a specific location, or political will may supersede management options recommended here.

	1	2	3	4	5	6	7	8
Current Condition	High	High	High	High	Low	Low	Low	Low
Current vulnerability to RSLR	Low	High	Low	High	High	Low	High	Low
Adaptation Potential	High	High	Low	Low	Low	Low	High	High
	Good condition marsh that is likely to migrate inland naturally for the long-term. It's in good shape, don't mess with it!	Marsh is in good shape for now, but try to make less vulnerable (e.g., living shoreline or thin layer placement) so it has a chance to adapt in the future.	Its in good shape for now. Focus on upland modifications that enhance adaptation potential.	Cannot maintain current footprint without active management. Address upland options *only if* vulnerability is mitigated first. Exception is if essential	Low condition marsh that is unlikely to persist in the future. Makes this a good place to test experimental restoration approaches.	There is a need to restore current conditions *but prioritize only if* barriers to adaption in upland are mitigated	Focus established restoration techniques that improve current condition *and* decrease vulnerability to RSLR here. Need to address both aspects to make a project sustainable.	Prioritize established restoration projects here. This marsh is likely to self-sustain in the long term so projects will be cost effective.
Number								
Total acres								
Average size								
Size range								
Priority for protection								
Management Options	Rationale	Sample practices						
NO ACTION is the default for all Marsh Units								
LAND USE / POLICY								
Remove / decrease / modify development potential on salt marsh itself	When current condition is high and either vulnerability is low or adaptation potential high.	Special overlay districts. Building restrictions. Road infrastructure modification	✓	✓	✓	✓				
Remove / decrease / modify development potential in the migration pathway	When adaptation potential is high.	Removal and restoration of parking areas. Removal of buildings. Abandonment of roads. Removal of septic systems.	✓	✓					✓	✓
Managed relocation of structures and/or infrastructure in the salt marsh itself	When current condition is high and either vulnerability is low or adaptation potential high.		✓	✓	✓	✓				
Managed relocation of structures and/or infrastructure in the way of the migration pathway	When adaptation potential is high.		✓	✓					✓	✓
Incentives for voluntary easements or land acquisition of critical migration pathways and buffer strips.	When adaptation potential is high.	Set back or buffer ordinances. Zoning or overlay districts.	✓	✓					✓	✓
LAND PROTECTION								
Priority for protection of marsh itself (all high current condition marshes are considered important for protection).	When current condition is high and either vulnerability is low or adaptation potential high.	Fee purchase.	✓	✓	✓	✓				
Protection of migration space	When adaptation potential is high.	Purchase fee or conservation easement	✓	✓	x	x	x	x	✓	✓
Incentives for voluntary easements or land acquisition of critical migration pathways and buffer strips.	When adaptation potential is high.	Purchased easement. Rolling easements. Deed restrictions. Tax incentives.	✓	✓					✓	✓
Limit investment in land protection as effectiveness will be relatively short-term.	When all three resiliency categories (current condition, vulnerability, and adaptive potential) are negative.	Save your $!					✓			
RESTORATION OR ADAPTATION TECHNIQUES								
Traditional, well proven, techniques with most benefit to the current marsh footprint	When current condition is low or vulnerability is high.	Removal of barriers to hydrologic flow (tidal restrictions, ditch remediation etc.). Open marsh water management (OMWM) remediation. Invasive species management.		✓		✓	✓	✓	✓	✓
Experimental, or highly manipulative, techniques within the current marsh footprint	When current condition is low and vulnerability is high.	Thin layer deposition, ditch remediation, runnelling, tide gates, dredge material removal.				✓		✓		
Traditional, well proven, techniques within the migration pathway that do not require slope modification.	When adaptation potential is high.	Removal of elevation barriers to migration, either close to the marsh edge or higher up in the watershed. Conversion of built, non-occupied, infrastructure in migration pathway to natural cover.	✓	✓					✓	✓
Experimental landscape modifications on either the seaward or upland side of the current marsh footprint	When adaptation potential is low and current condition high.	Lower topology of the migration pathway. Removal of woody vegetation along ecotone. Living shoreline projects. Build hardened "toe" to extend marsh seaward. Use coir logs to promote sediment stabilization.			✓	✓				
Limit investment in restoration or adaptation projects as effectiveness will be short-term.	When all three resiliency categories (current condition, vulnerability, and adaptive potential) are negative.	Save your $!				✓				

Protection of migration space. | Purchase fee or conservation easement.



Marsh Migration Pathways Example



HIGH FEASIBILITY

Low parcel count

Large parcels

Large amount undeveloped migration space

Low amount of long and short term flooding

Take Away From this Presentation

- Marshes take care of us, lets take care of them thoughtfully.
- **WE WANT TO USE THIS** to be strategic and efficient with resources.
- We expect this all to be done in about a year.
- There will be additional outreach to communities, restoration professionals, and land protection partners.
- This is a screening tool, so site level analysis will always be needed.