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Coastal Wetland Synthesis Products and Tools for Chesapeake Bay

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Acknowledgments

Kate Ackerman

Zafer Defne

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USGS Priority Ecosystems Science Program

USGS Coastal and Marine Hazards/Resources Program

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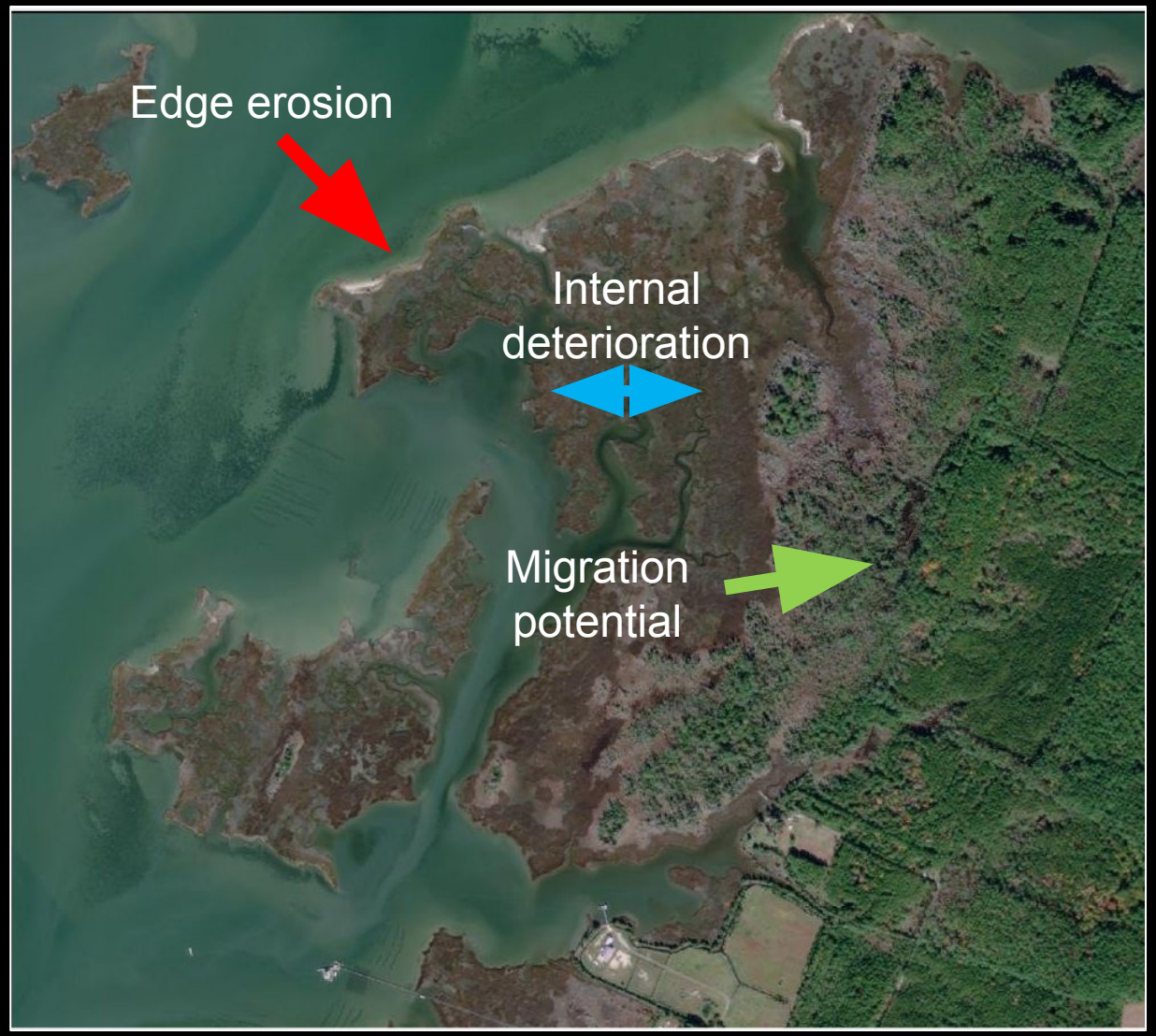
Geomorphic vulnerability of salt marshes a combination of processes



Edge erosion controlled by wave power

Internal deterioration controlled by multiple factors but ultimately diagnosed through open water conversion and elevation loss

Migration potential a function of slope, inundation frequency (tidal and episodic), salinity, land use, canopy cover

Chesapeake-wide synthesis of all three processes forthcoming in collaboration with VIMS (Molino/Kirwan)

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Net sediment budget highly correlated with UnVegetated-Vegetated Ratio

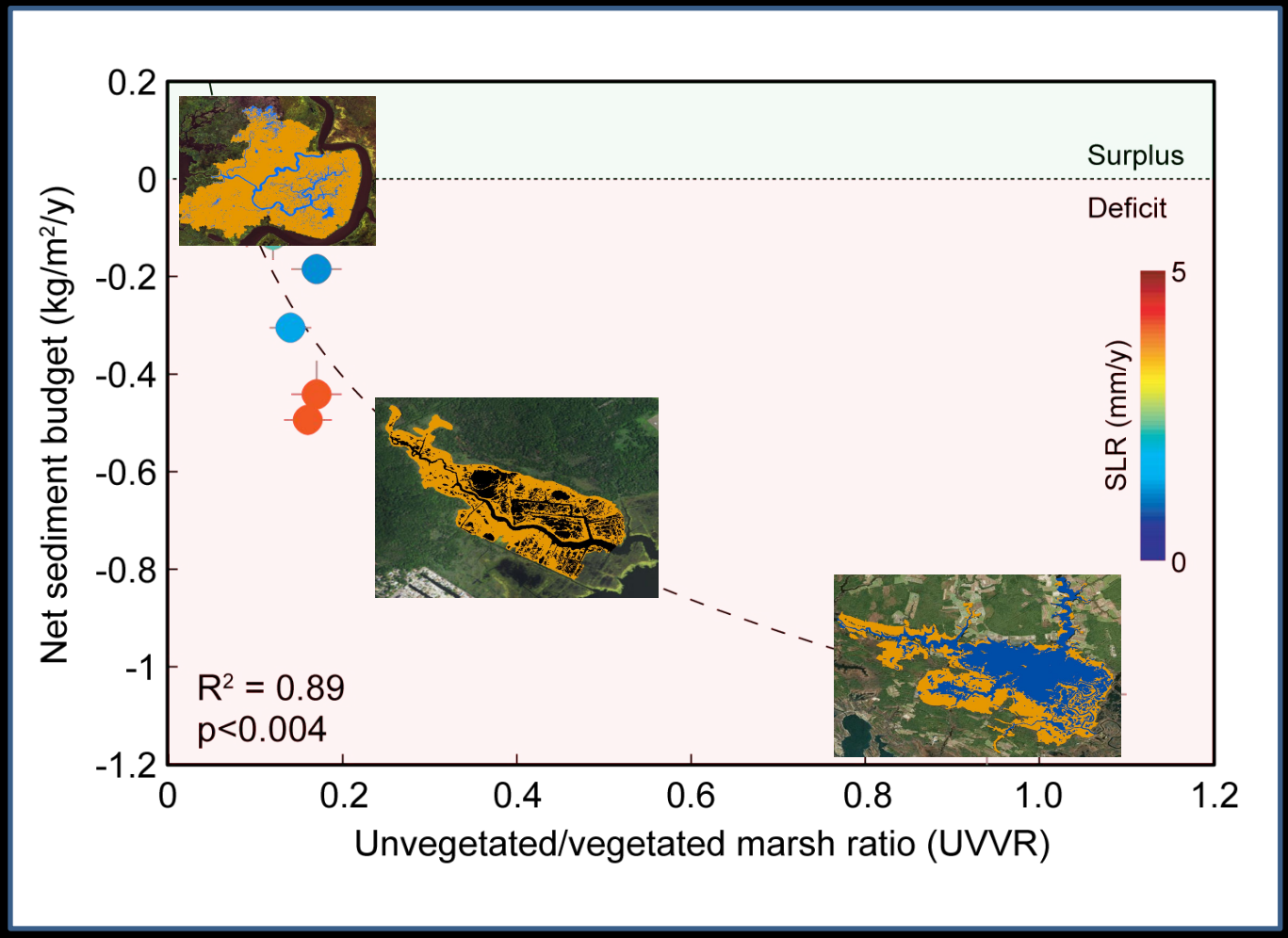
UVVR indicates disintegration of wetland complex

Loss of vegetation decreases trapping, increases sediment liberation

Healthy marsh plain should have minimal ponding from root collapse

Relationship ties SLR, sediment budget, and marsh processes together

Stability value ~ 0.10 – 0.15



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Geospatial analysis for Chesapeake Bay

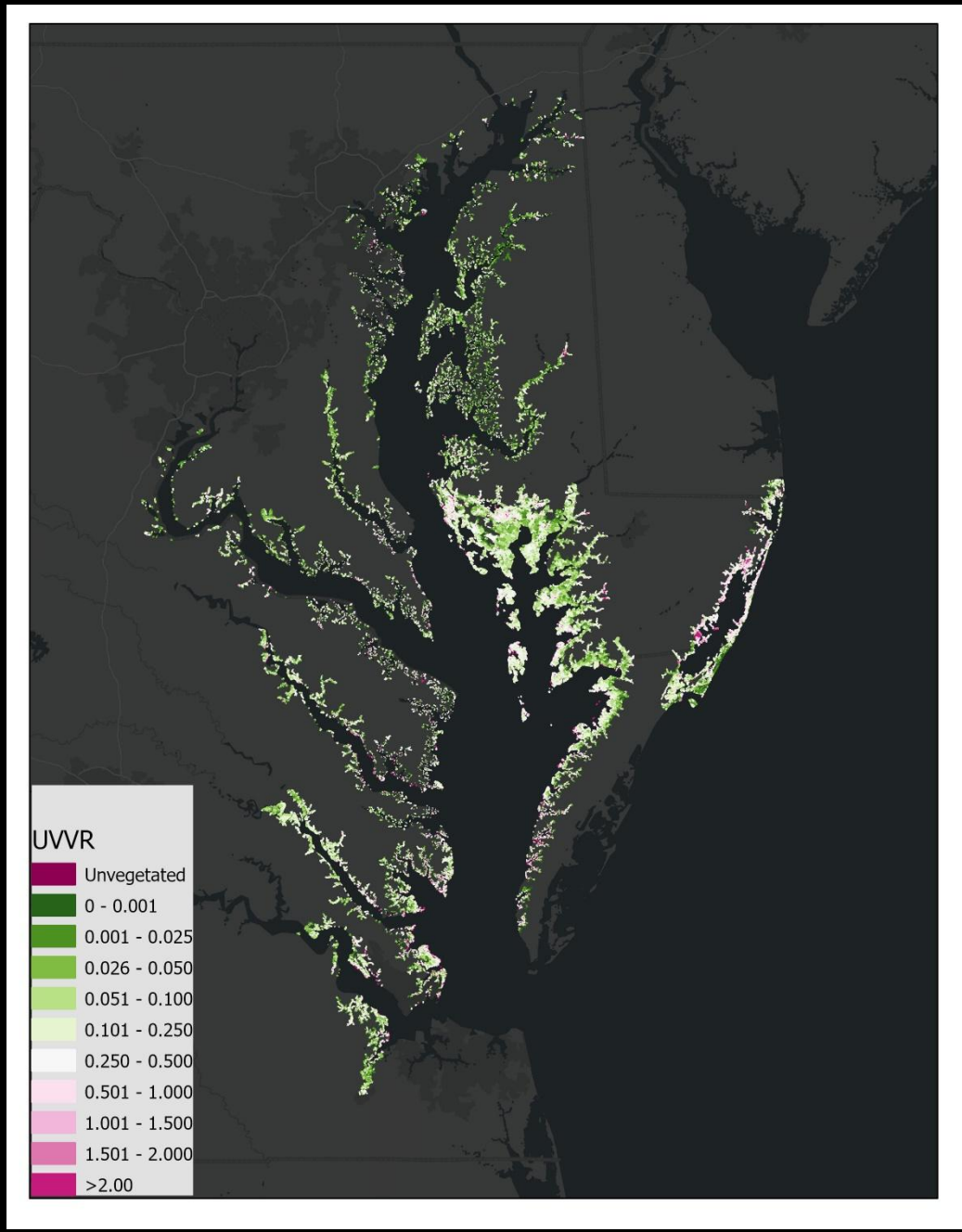
Marsh-unit metrics by subregion

- UVVR: open-water conversion
- Elevation: vertical resilience
- Tide range
- Lifespan: integrative metric that combines UVVR, elevation, and SLR

Preliminary layers complete, in USGS review

Served via ScienceBase, and geonarrative

Current viewer includes all NE region



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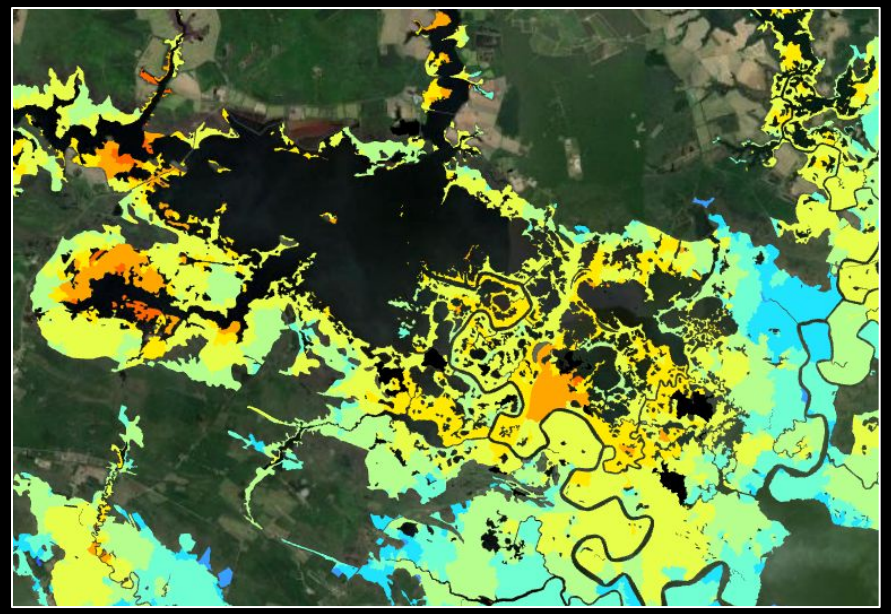
Highlights, and lowlights: elevation and UVVR strongly correlated



Elev (m)

- < 0
- ≤0.05
- ≤0.1
- ≤0.2
- ≤0.3
- ≤0.4
- ≤0.5
- ≤0.75
- ≤1
- ≤2

UVVR

- 0 - 0.001
- 0.001 - 0.025
- 0.026 - 0.050
- 0.051 - 0.100
- 0.101 - 0.250
- 0.250 - 0.500
- 0.501 - 1.00
- 1.001 - 1.500
- 1.501 - 2.000
- > 2.00

Interior marsh units at Blackwater NWR very low in elevation as compared to surrounding units closer to Fishing Bay and Transquaking River

UVVR follows similar trend, with many units over the 0.15 threshold in Blackwater NWR

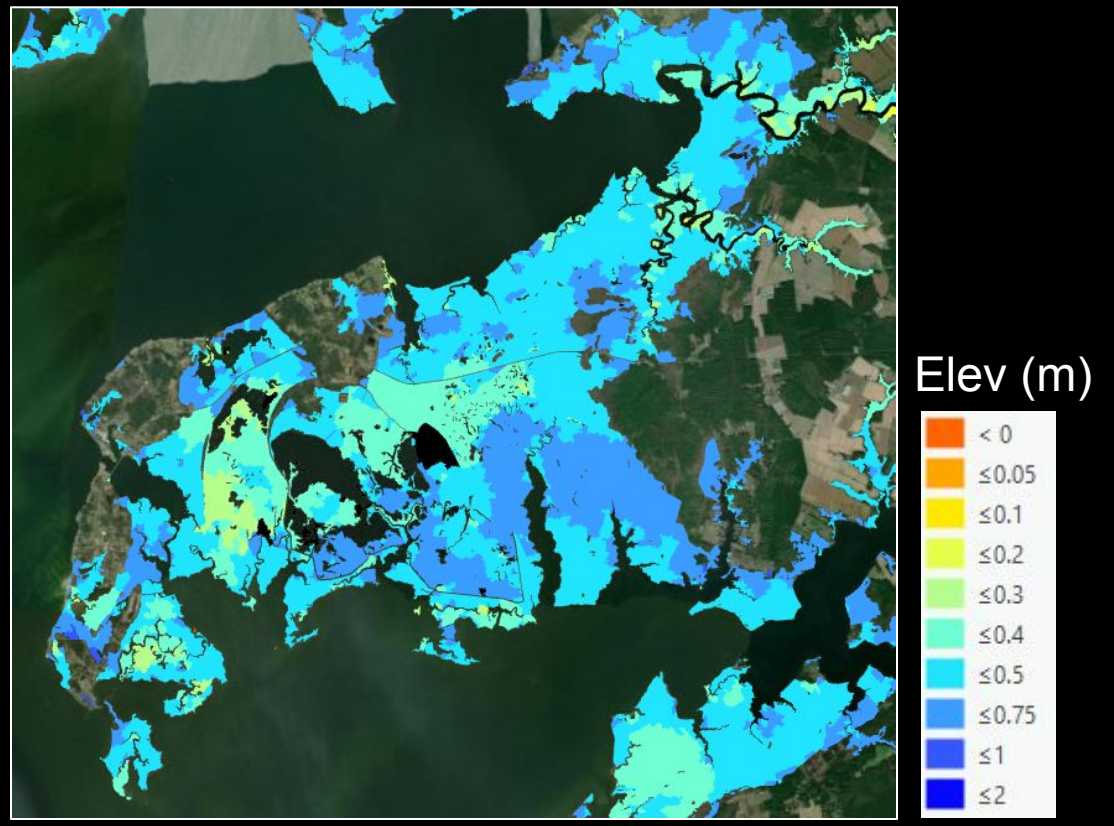
Taken as a whole, Blackwater area has UVVR ~ 1

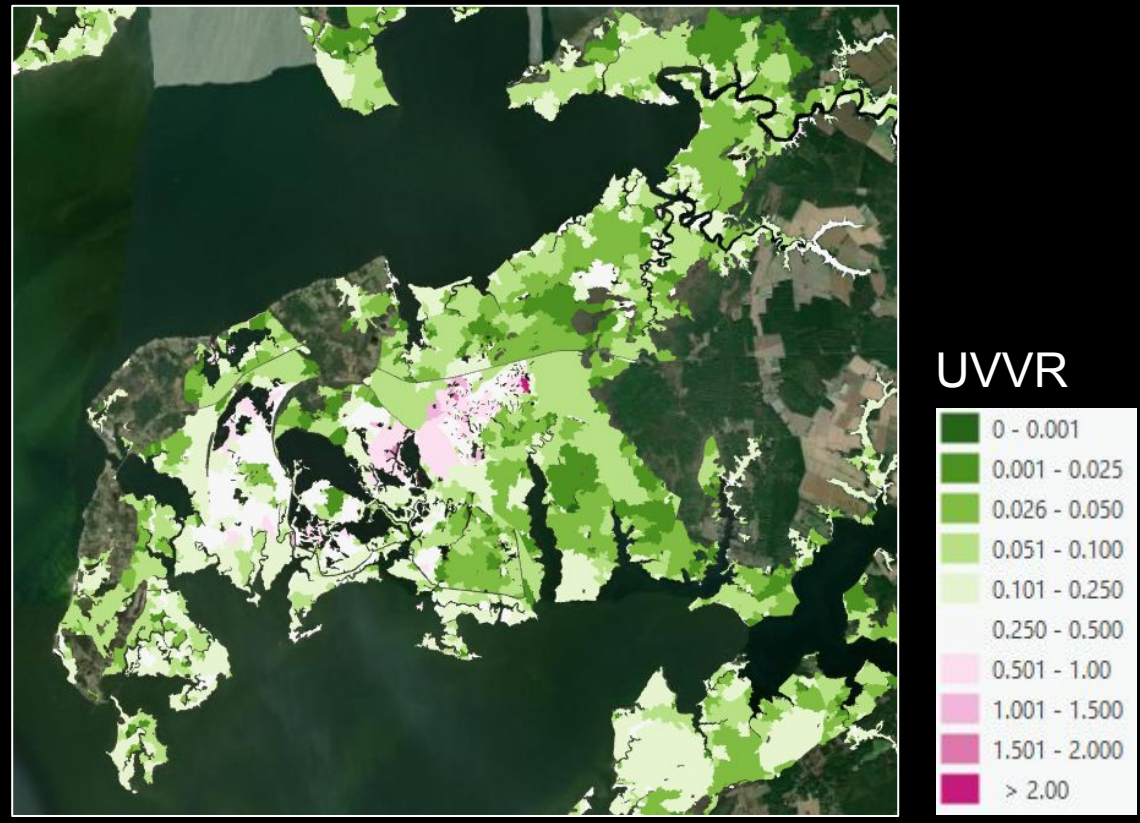
Highlights, and lowlights: elevation and UVVR strongly correlated

Similar pattern at Deal Island…lower elevation consistent with higher UVVR

Interior impoundment areas more vulnerable than coast-adjacent units

More on Deal Island later…

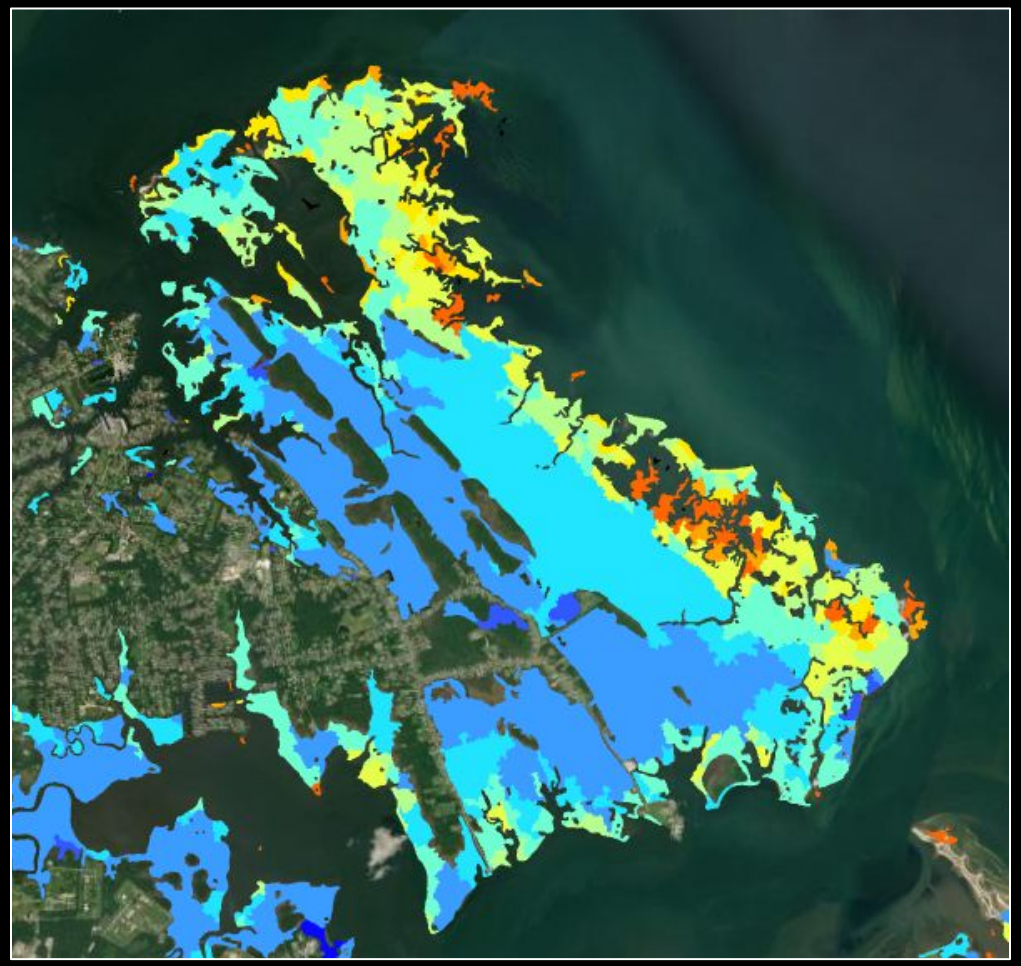


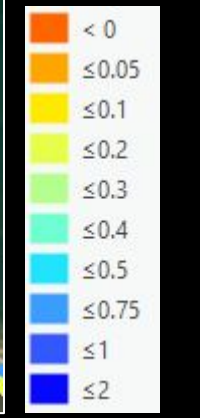


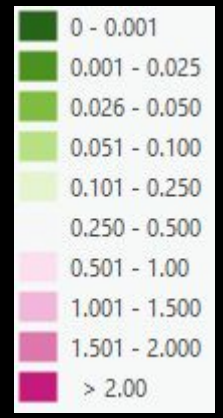
Highlights, and lowlights: elevation and UVVR strongly correlated

Plum Tree Island NWR…deteriorating marsh plain on edge corresponds with lower elevation

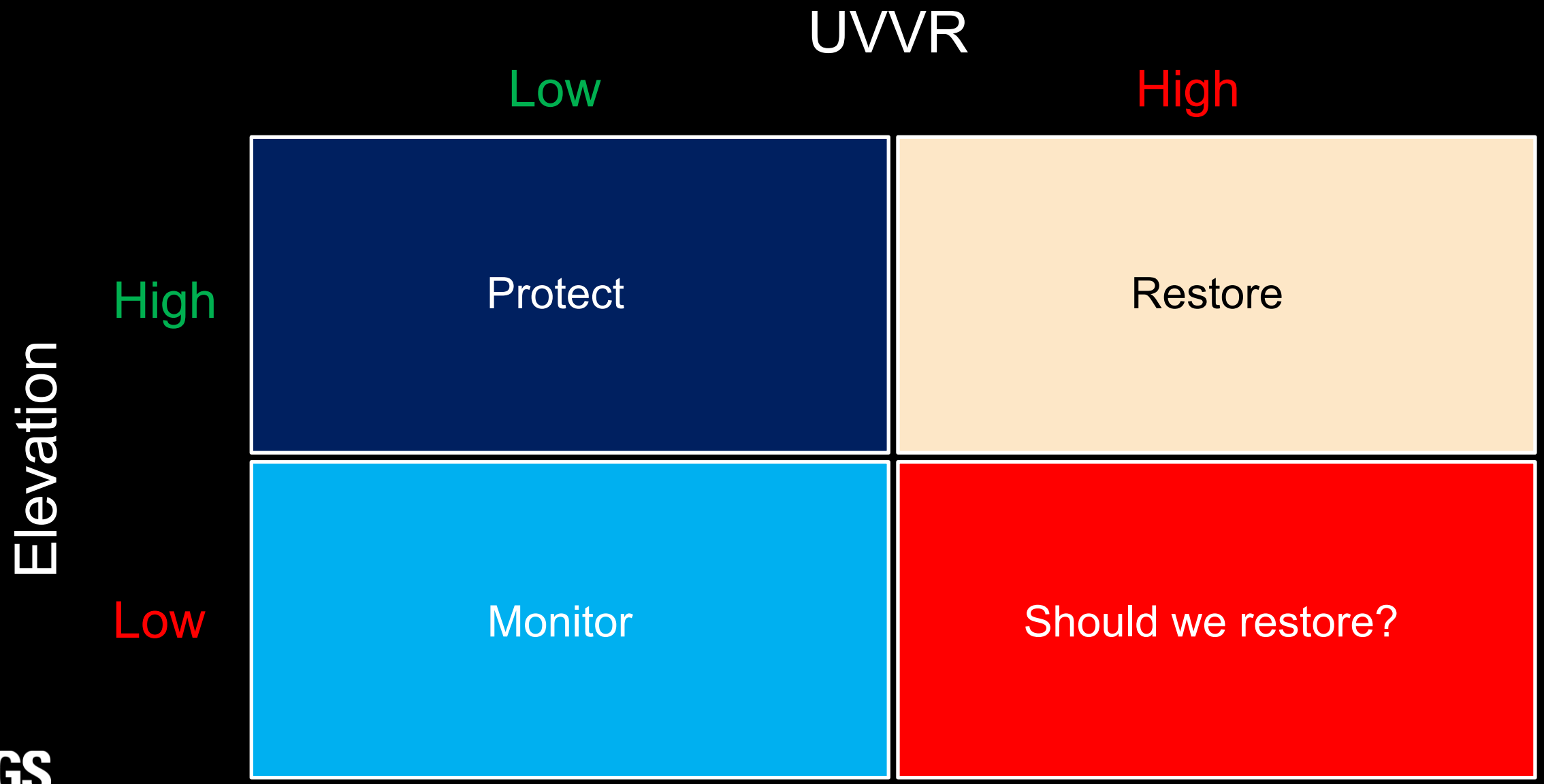
Interior units in comparatively better shape







Determining strategies: hypothetical decision matrix



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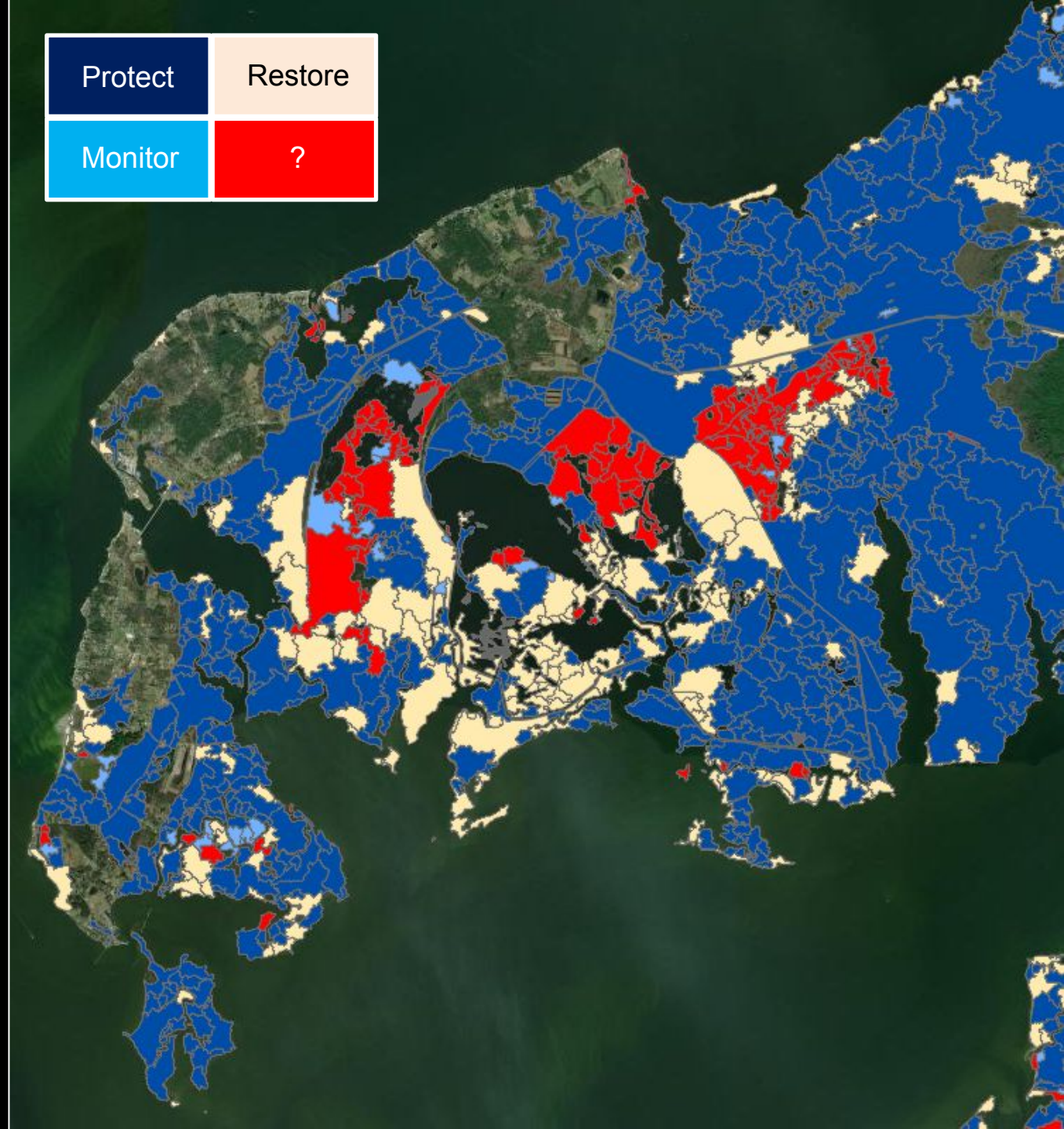
Determining strategies: Decision matrix at Deal Island

UVVR threshold of 0.15;
vegetated plain elevation of 0.4 m (arbitrary)

Thresholds can be shifted to yield any desired areal distribution of decisions

Deal Island has typical distribution as other peninsulas in CB region…intact marsh units on estuary edge, degraded units on interior

Majority of units are vertically and horizontally stable



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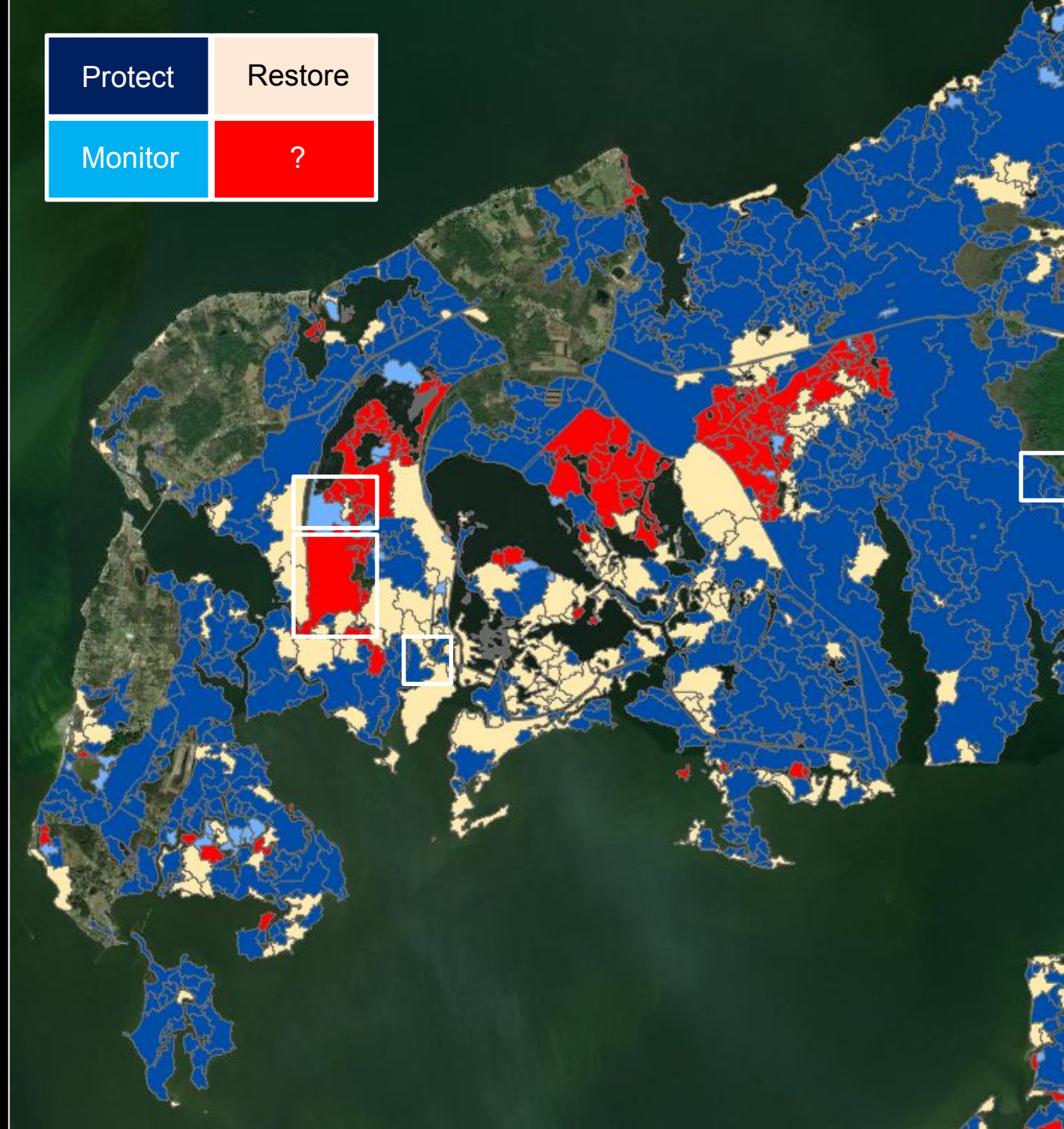

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Low

UVVR

High

Elevation

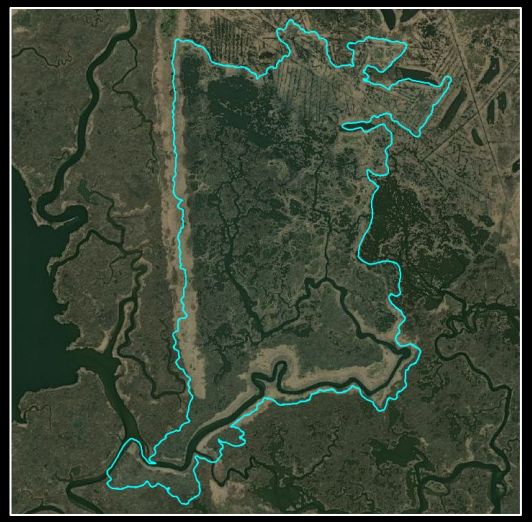
High

Protect

Restore

Low

Monitor (vulnerable?)



Should we restore?

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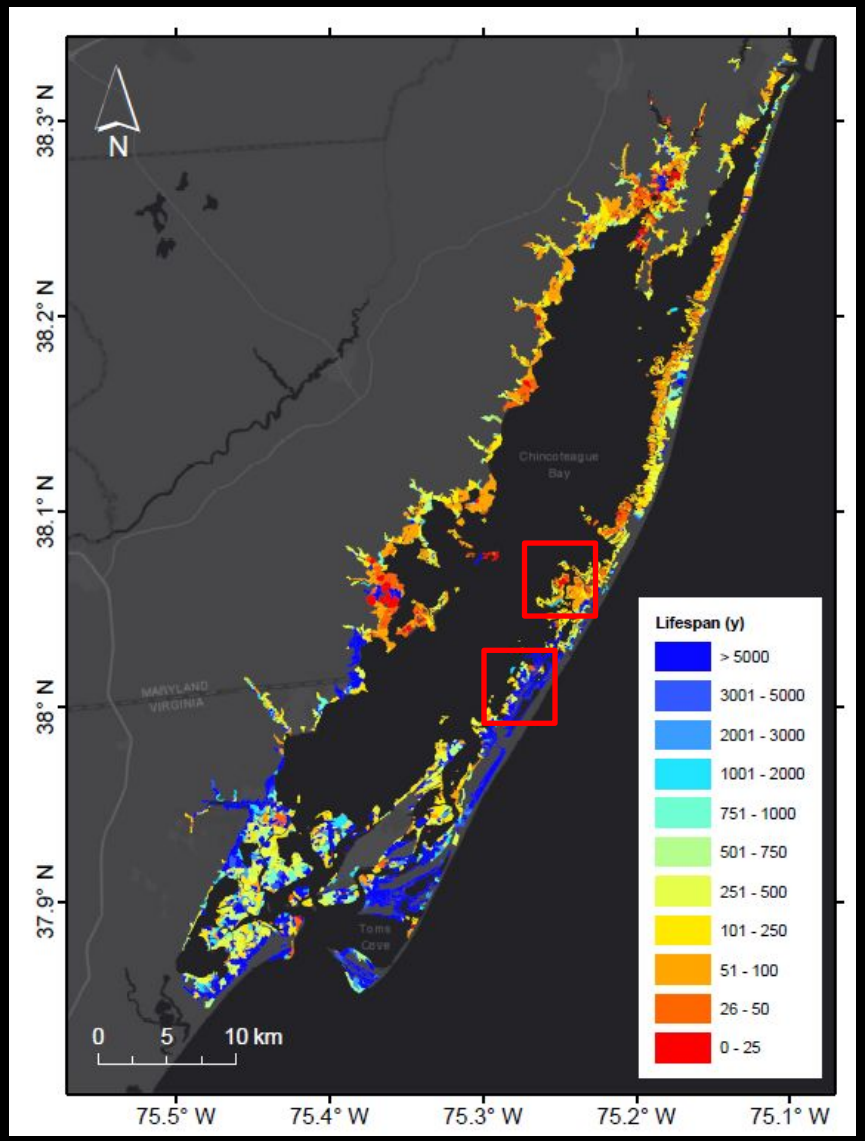
Marsh lifespan concept: connecting elevation, UVVR, and SLR

Mass in marsh plain above MSL is your account balance

Sediment deficit goes up with increasing UVVR and increasing SLR; deficit applies to whole complex including subtidal

To offset the deficit, account balance has to be drawn down until the whole complex is at MSL and/or unvegetated, i.e. “cannibalization”

Sediment-based lifespan: Assateague NS/Chincoteague NWR



MD: ditched

VA: unditched

Chesapeake lifespan map will be available shortly after UVVR data are published

Lifespan under historical SLR and three future GMSL scenarios will be provided

Online calculator in development that will allow for point-and-click calculations under various SLR scenarios

Federal employees eligible to participate in calculator testing this fall, please send email to nganju@usgs.gov if interested

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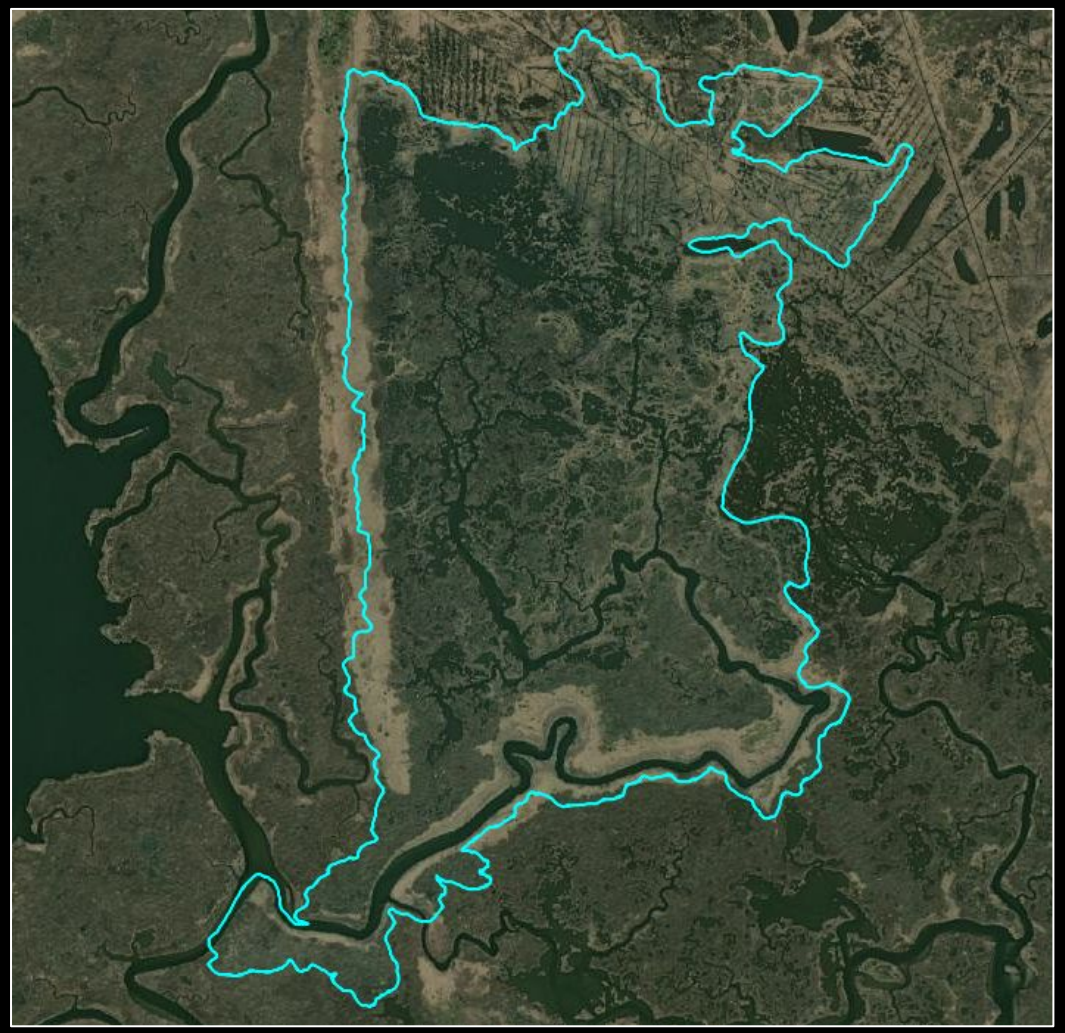
Lifespan examples: restoration of a high UVVR, low elevation unit



Area = 525,800 m^2
UVVR = 0.31
Elevation of vegetated plain = 0.38 m above MSL

Future SLR = 0.007 m/y

Lifespan = 88 years

If we re-vegetate half of the unvegetated area to MSL:

New UVVR = 0.13
New Lifespan = 123 years

If we re-vegetate half of the unvegetated area to current vegetated plain elevation:

New UVVR = 0.13 and more elevation capital
New Lifespan = 161 years

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Lifespan examples: restoration of a high UVVR, high elevation unit

Area = 31,078 m^2
UVVR = 0.19
Elevation of vegetated plain = 0.48 m above MSL

Future SLR = 0.007 m/y

Lifespan = 147 years

If we add 0.36 m of sediment (USACE estimate) to unvegetated area (no increase in vegetation)

Same UVVR, but more sediment in account
New Lifespan = 176 years

If we re-vegetate half of that area:

New UVVR = 0.09 and more elevation capital
New Lifespan = 249 years

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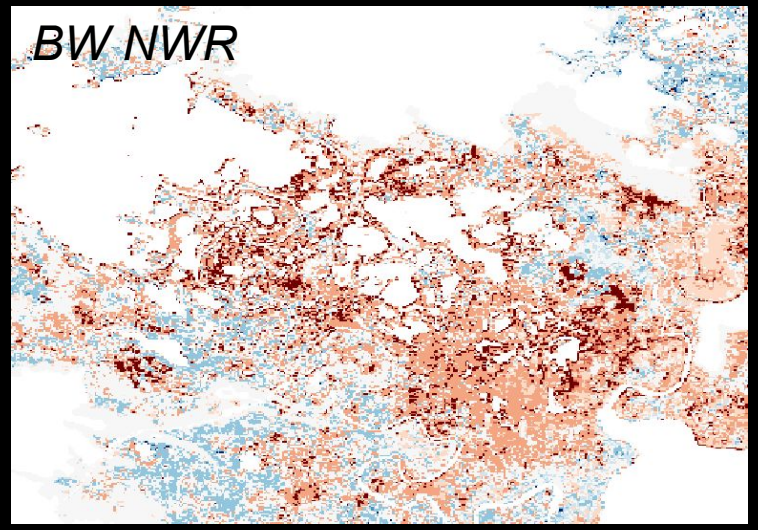
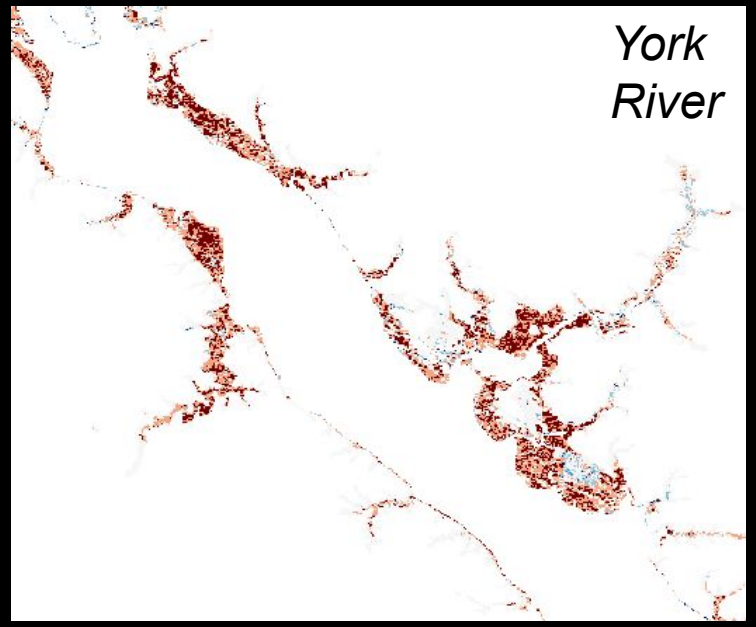
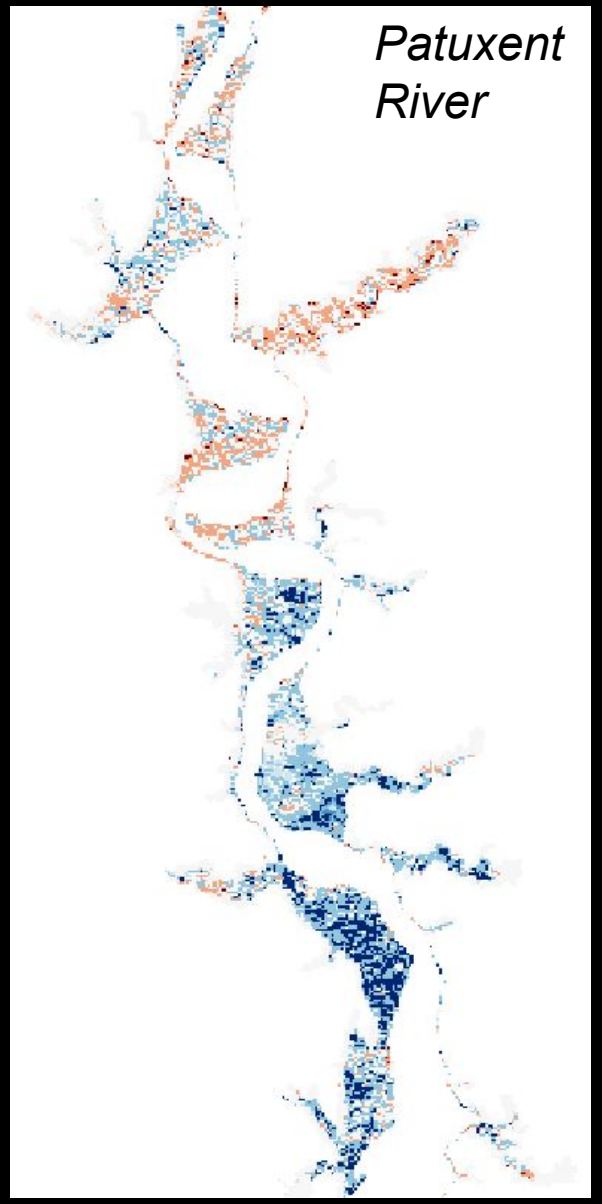
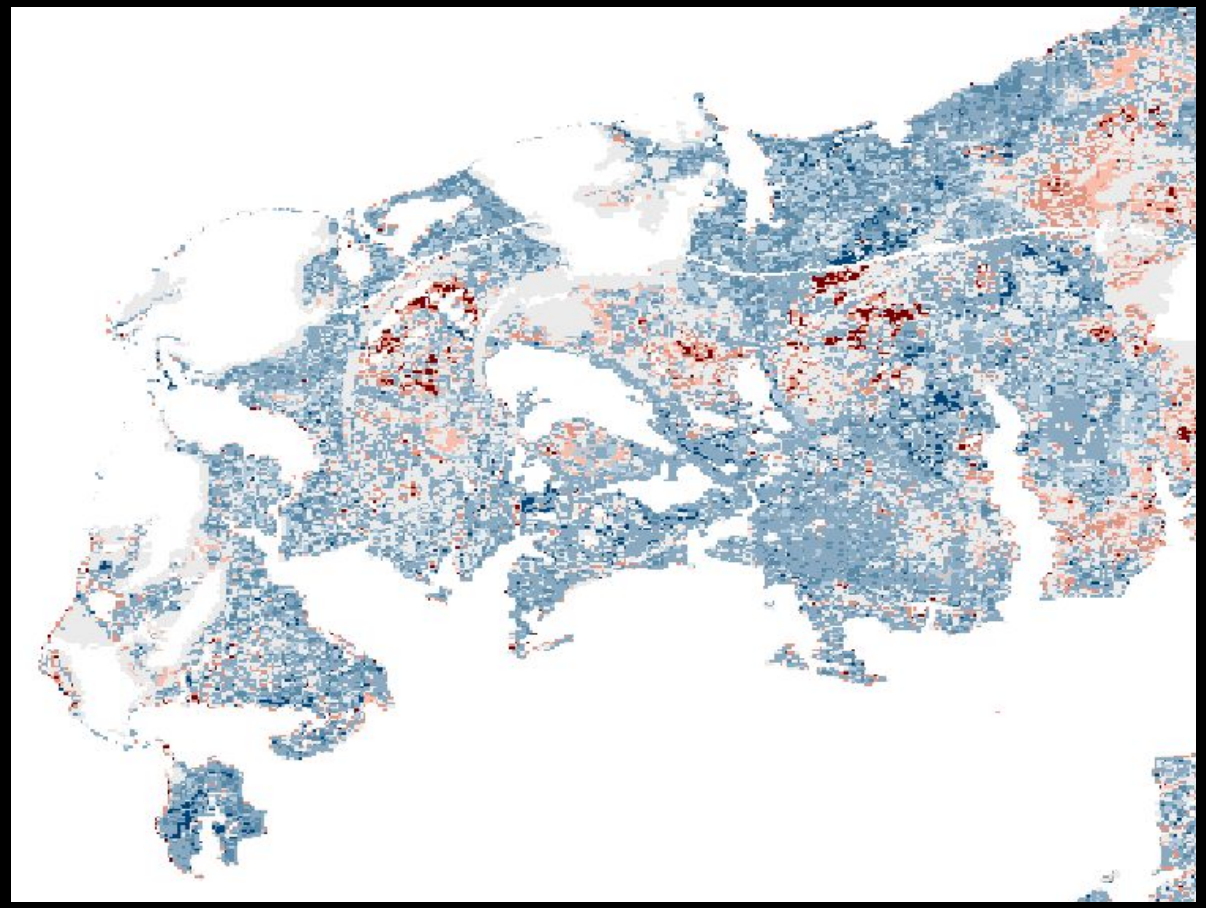
Vegetative trend from Landsat 2014-2018: identifying critical areas

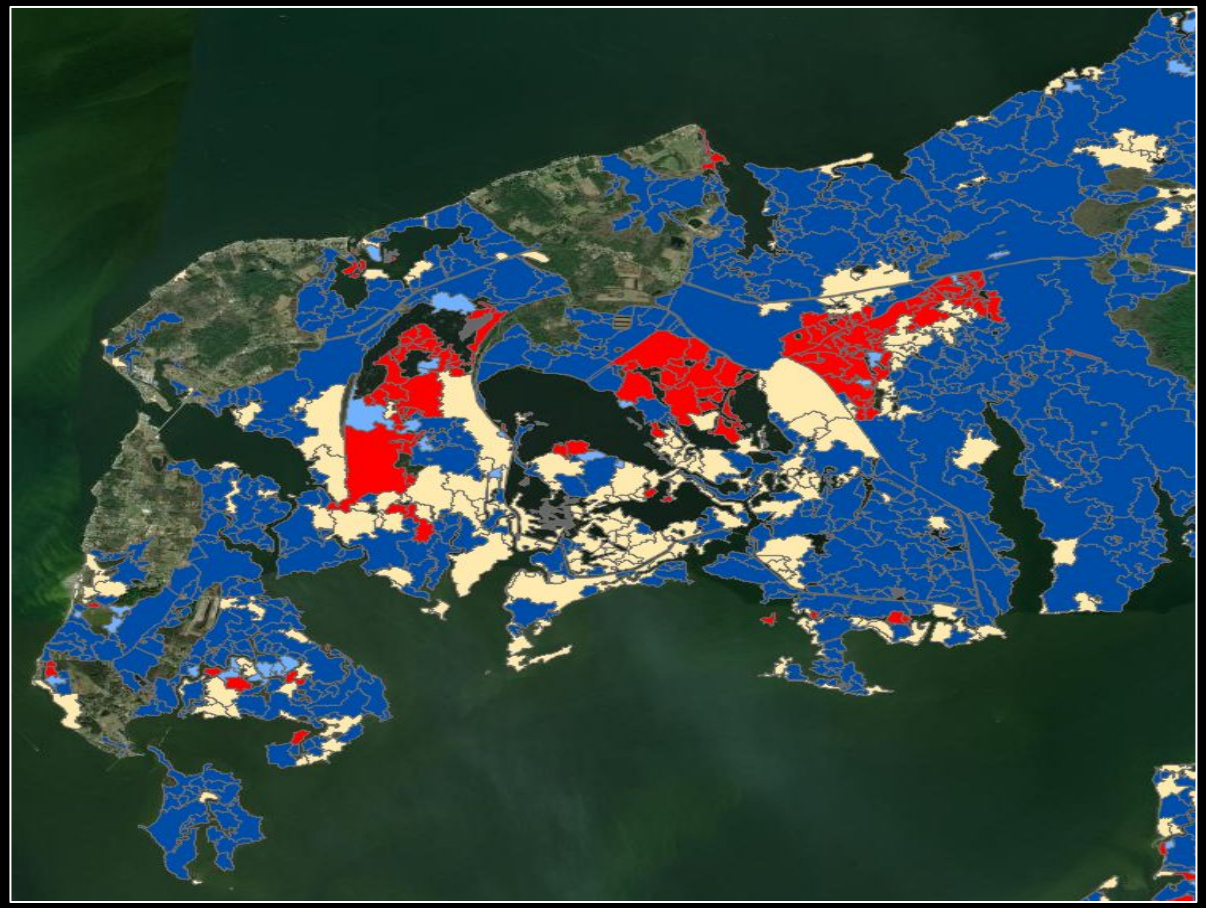






Decision matrix with vegetative trend: hybrid of marsh units and Landsat





4 years negative

4 years positive

Protect	Restore
Monitor	?

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Potential uses of geospatial data and lifespan estimates

Identifying priority and restoration technique

Robust Benefit-Cost Analyses (BCA) with lifespan calculator

Establishing restoration targets based on objective data

Selecting candidate marshes based on proximity to other interests

Avian and fish habitat assessments under present and future conditions

Basic research on mechanisms of salt marsh trajectory and connections with hydrology, land use, sediment transport, hydrodynamics….

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Science to guide restoration in Chesapeake Bay and beyond

Geospatial mapping of salt marshes
- Provides baseline status of vegetated habitats
- Delivers objective, spatially complete metrics
- Drives decision-making tools

Marsh lifespans in Chesapeake Bay
- Highly variable based on location and geomorphology
- Several regions vulnerable in the coming decades
- Predictions can be updated with new aerial imagery and elevation data

Guiding restoration investments
- Simple decision matrix useful for rapid assessment
- Restoration calculator a simple, robust approximation
- "*Better to have an approximate answer to a crucial question than an exact answer to a meaningless one*" –modified from Tukey

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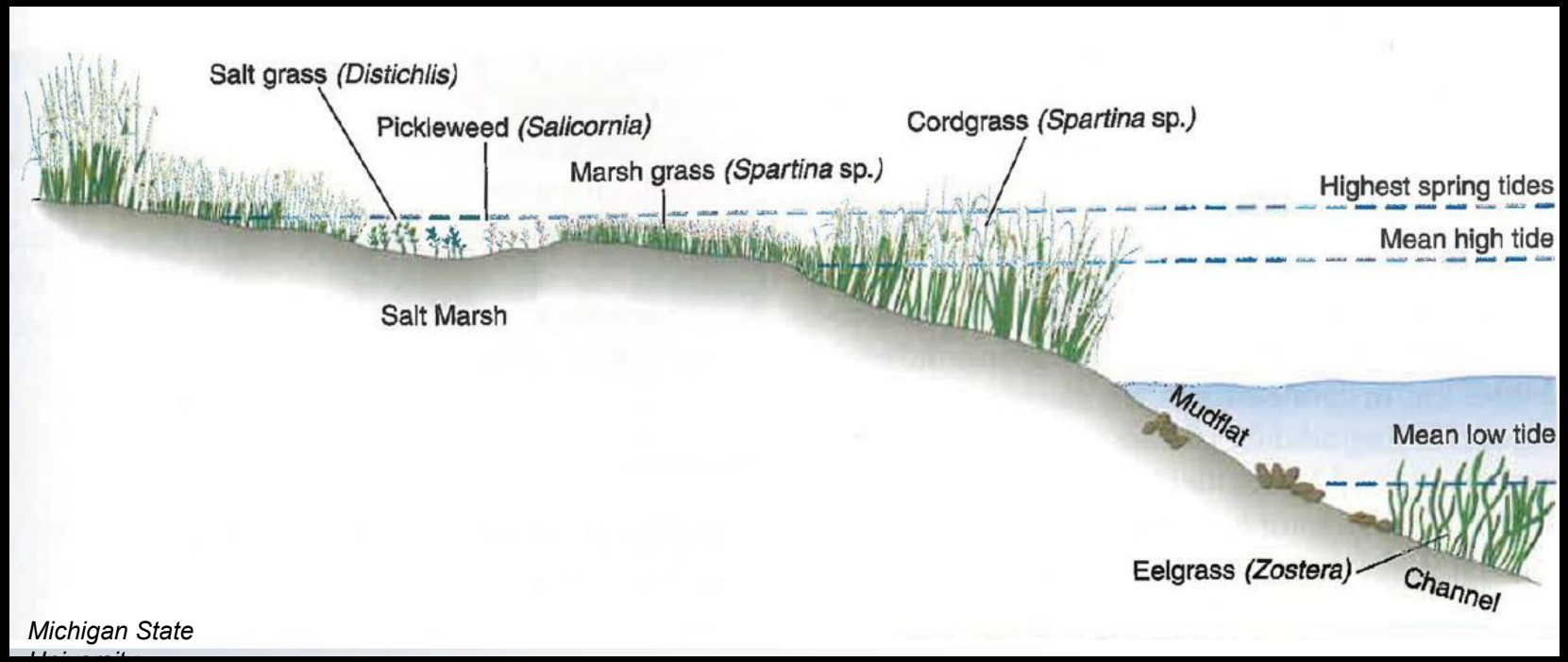
Google: "U.S. Coastal Wetland Synthesis"

Salt marshes: biogeomorphic features with increasingly significant value



16,000 km^2 of salt marsh in USA

Valuable habitat, carbon stock, and coastal protection

Large body of work on marsh vertical response to external conditions and stressors

But…marsh loss is ultimately a three-dimensional process

Sea-level rise, waves, and sediment deficits responsible for widespread marsh loss