The SECAS Third Thursday Web Forum

Developing standardized geospatial metrics for salt marsh management and restoration

5-19-2022

Agenda

- Introduction
- Monthly topic
- Q&A and discussion
- Preview of next webinar
- Staff updates

Developing standardized geospatial metrics for salt marsh management and restoration

Neil Ganju, Woods Hole Coastal and Marine Science Center

5-19-2022

Developing standardized geospatial metrics for salt marsh management and restoration

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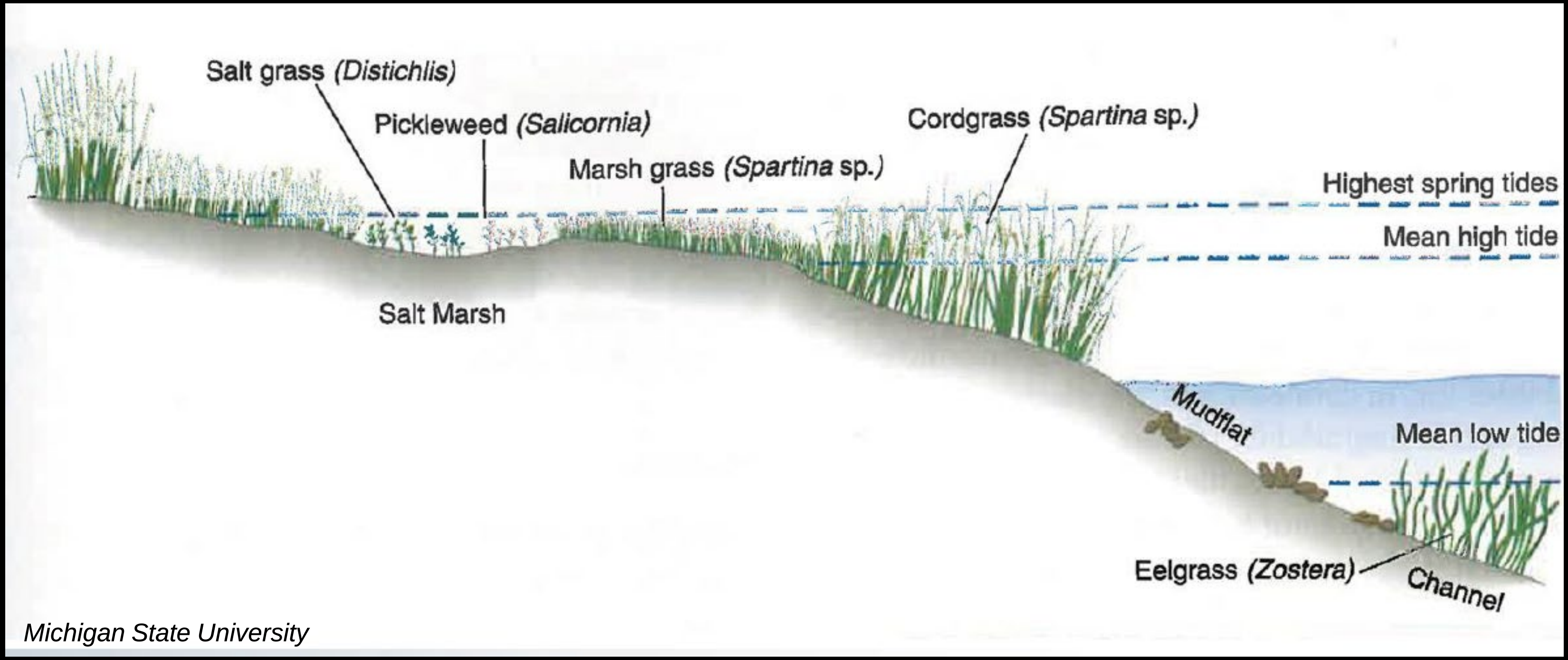
Salt marshes: biogeomorphic features with increasingly significant value



16,000 km^2 of salt marsh in USA

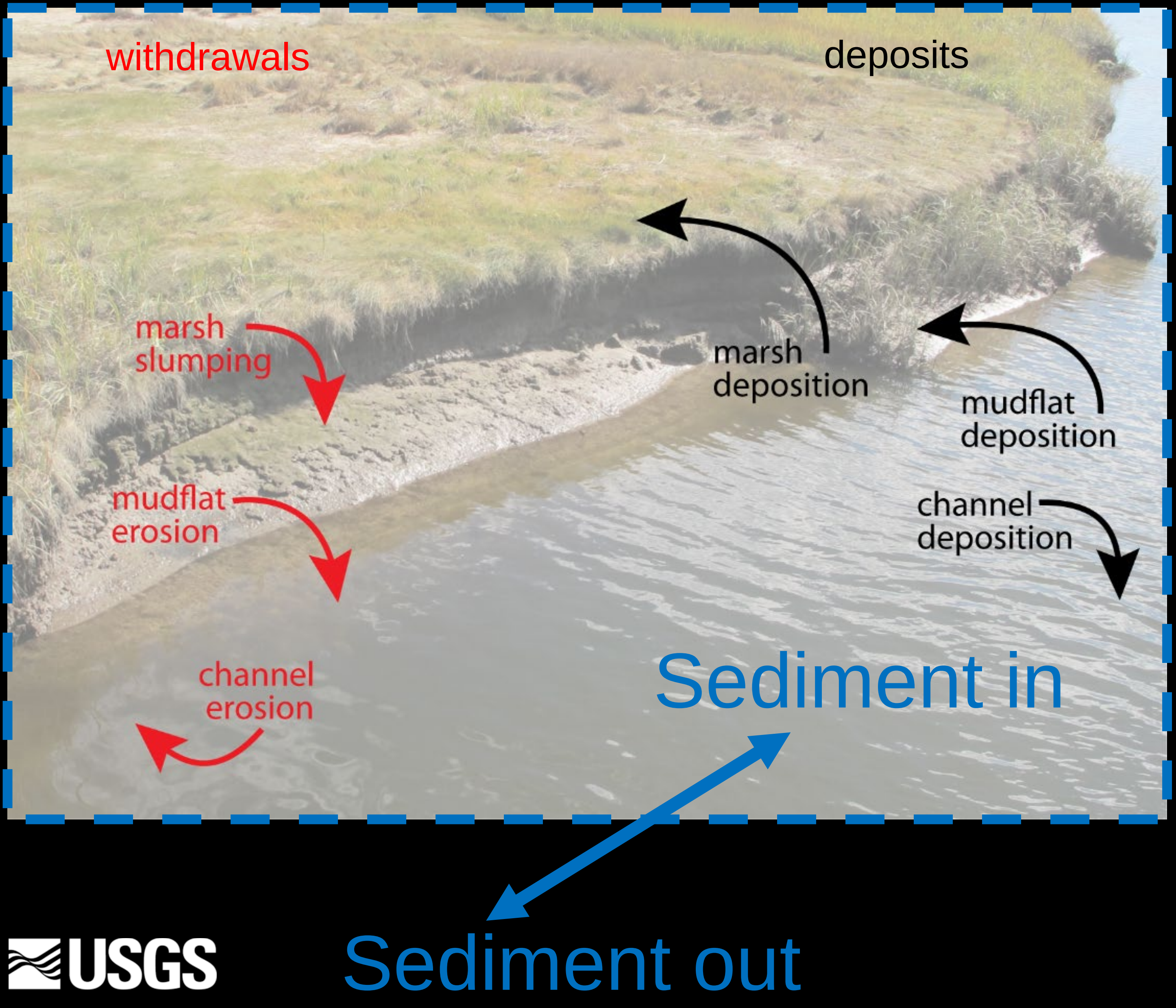
Valuable habitat, carbon stock, and coastal protection

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

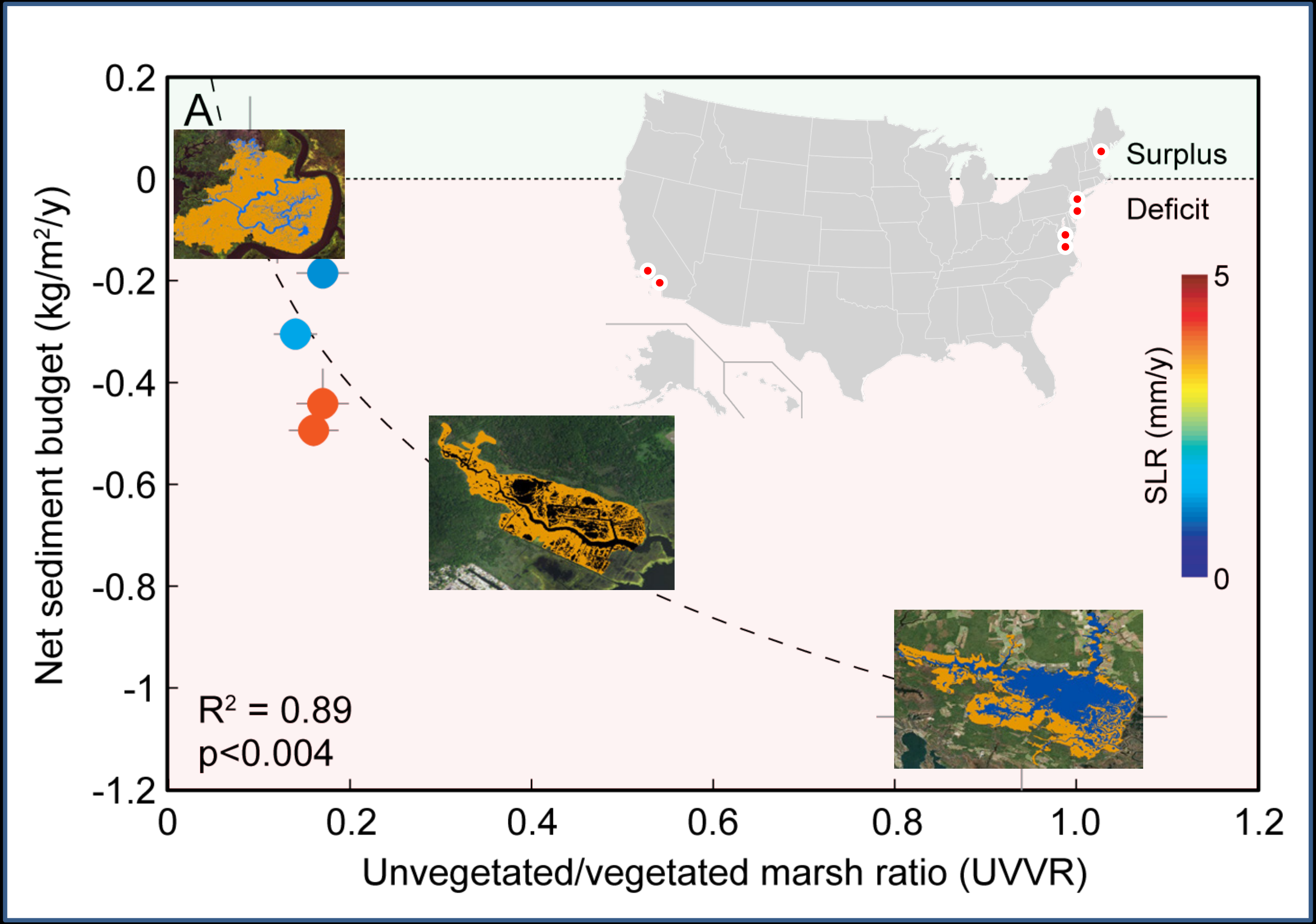
Sediment budgets as an indicator of wetland trajectory



- An expanding marsh must import sediment to keep up with SLR and wave erosion
- A contracting marsh will export sediment as marsh plain is lost to tidal flats and channels
- Therefore the sediment budget is a proxy for trajectory; negative sediment budget indicates instability
- Can we can measure the sediment budget in main tidal channels to diagnose instability?

USGS

Net sediment budget highly correlated with UnVegetated-Vegetated Ratio

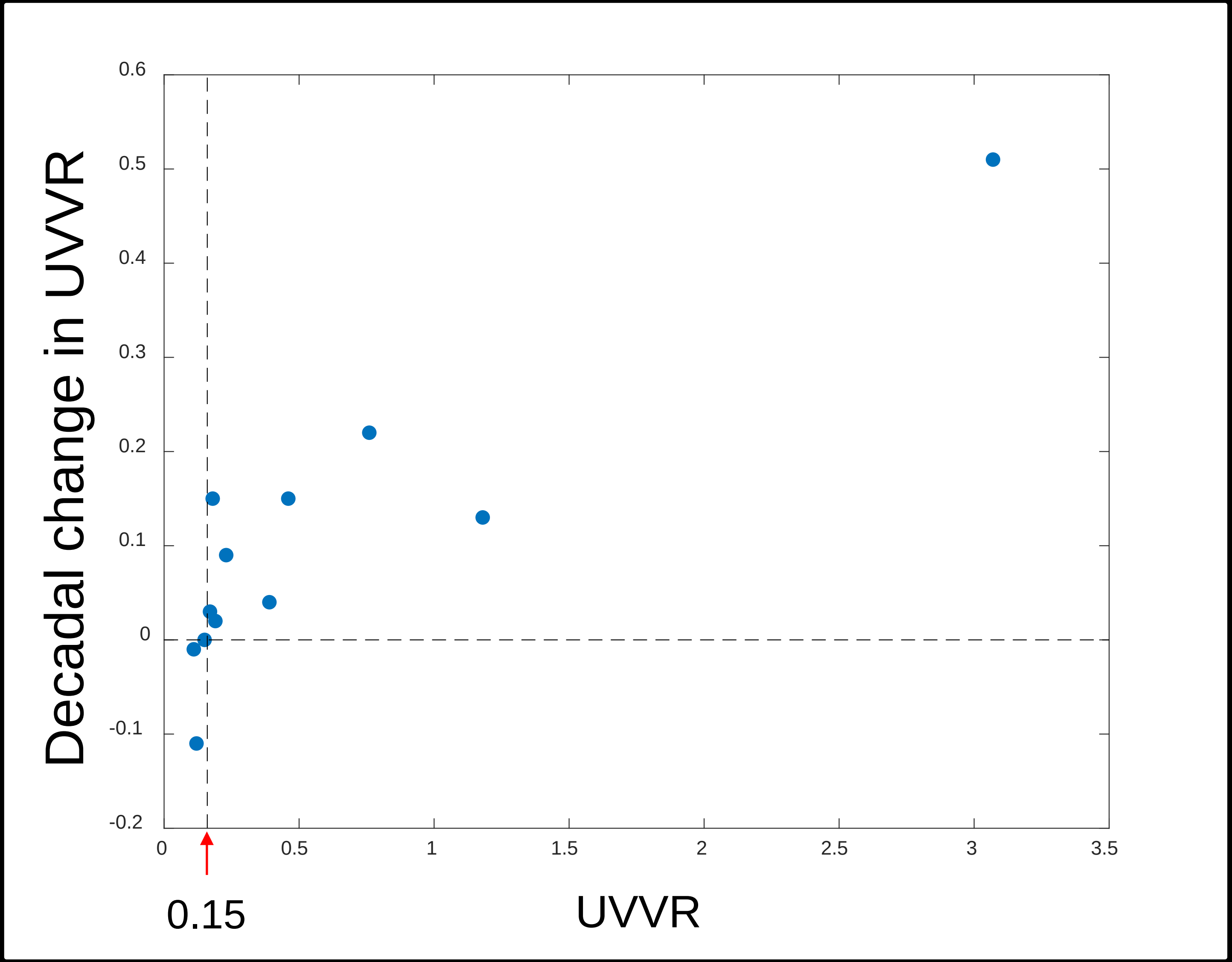


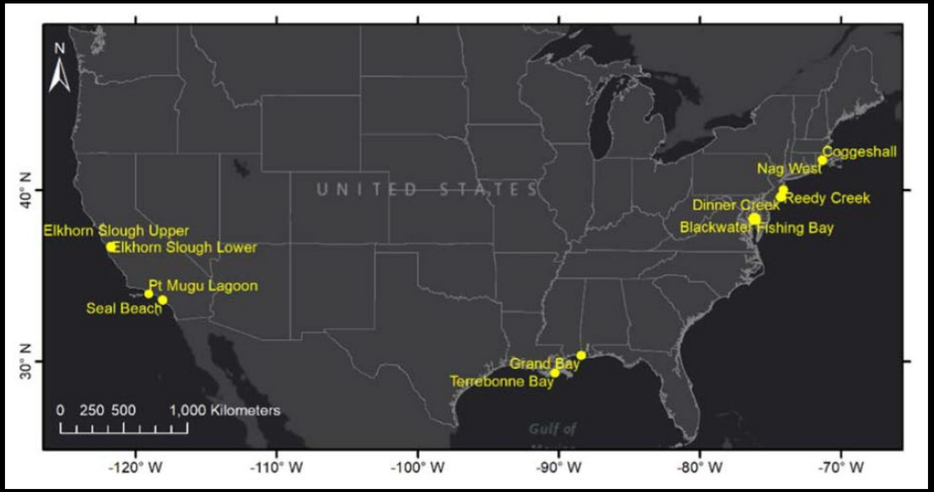
- Net budget measured at 8 sites nationally
- UVVR determined using aerial imagery over marsh
- All sites in deficit!
- Tipping point ~ 0.10
- Further independent studies suggest thresholds between 0.10 and 0.15

USGS

Ganju et al. 2017

Wasson et al., 2020: UVVR > 0.15 indicates greater instability

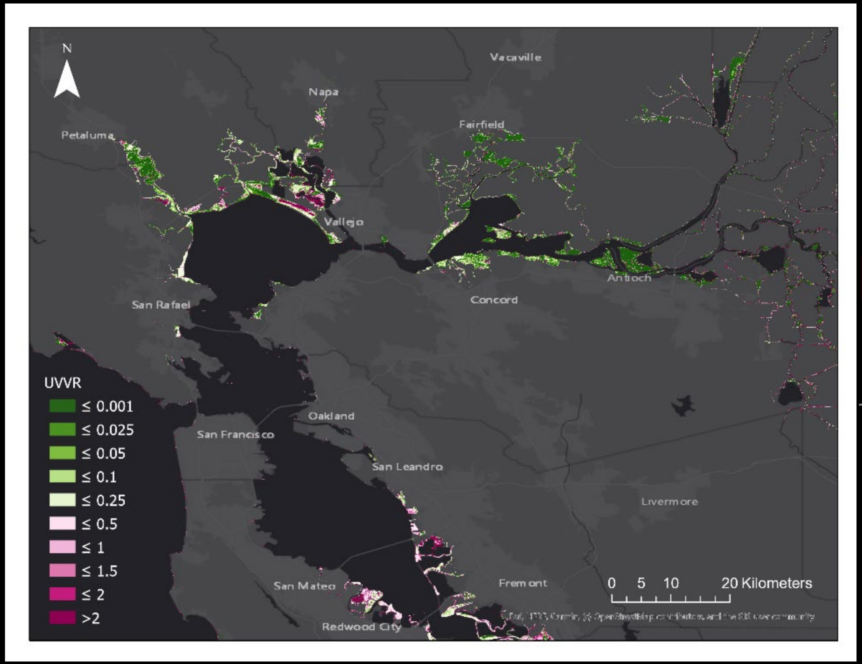


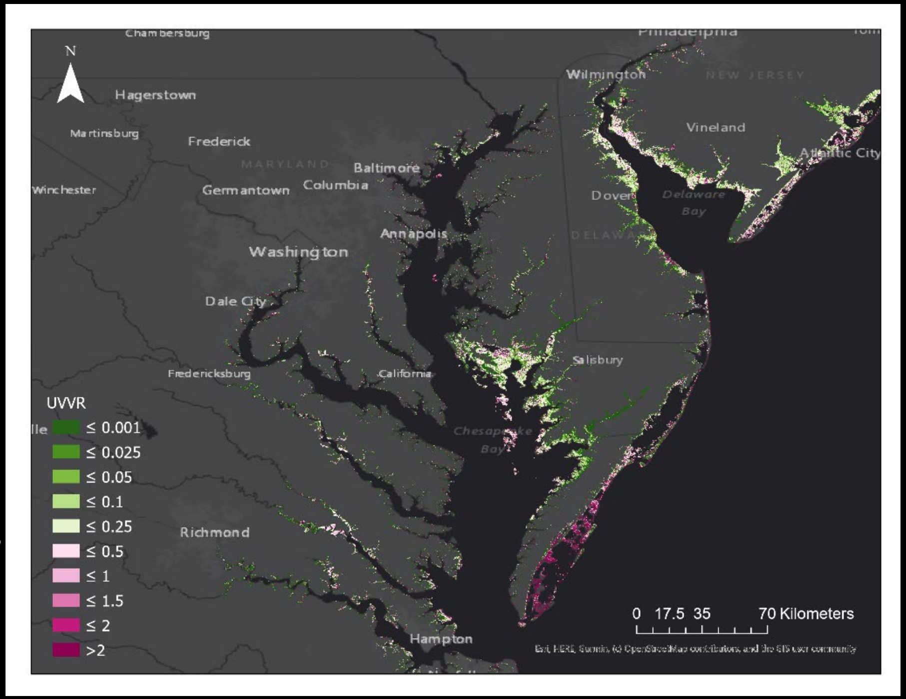


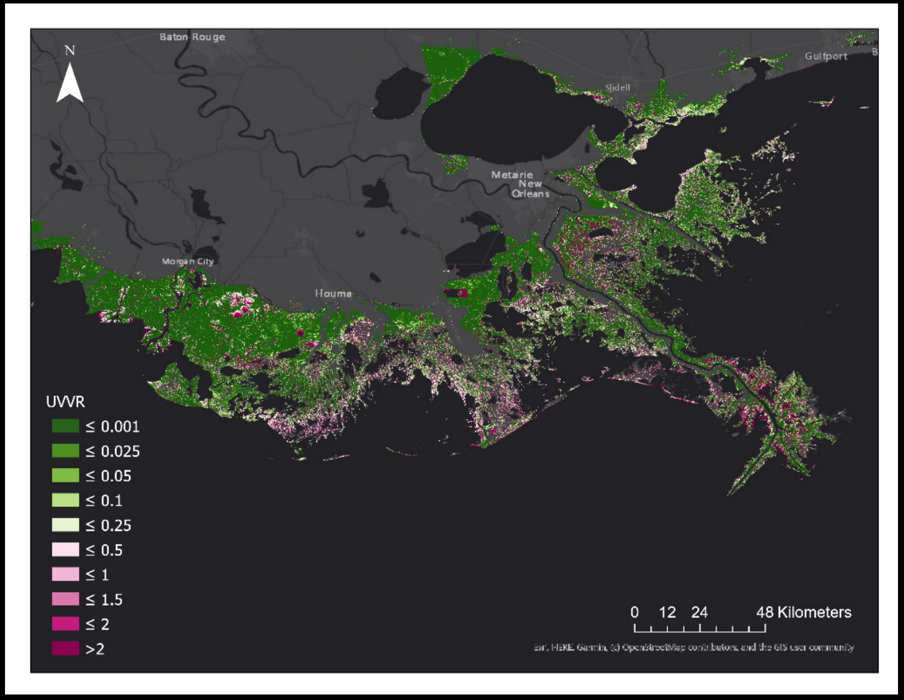
- A “stable” marsh has an optimal UVVR
- Instability increases the UVVR
- Once unstable, runaway expansion creates a faster change in UVVR as UVVR increases

National UVVR at 30-m resolution

- Fractional vegetation cover and UVVR across coastal wetlands
- Composite and annual value for 2014-2018 period
- Data access: Couvillion et al., 2021
- Development and application: Ganju et al., 2022

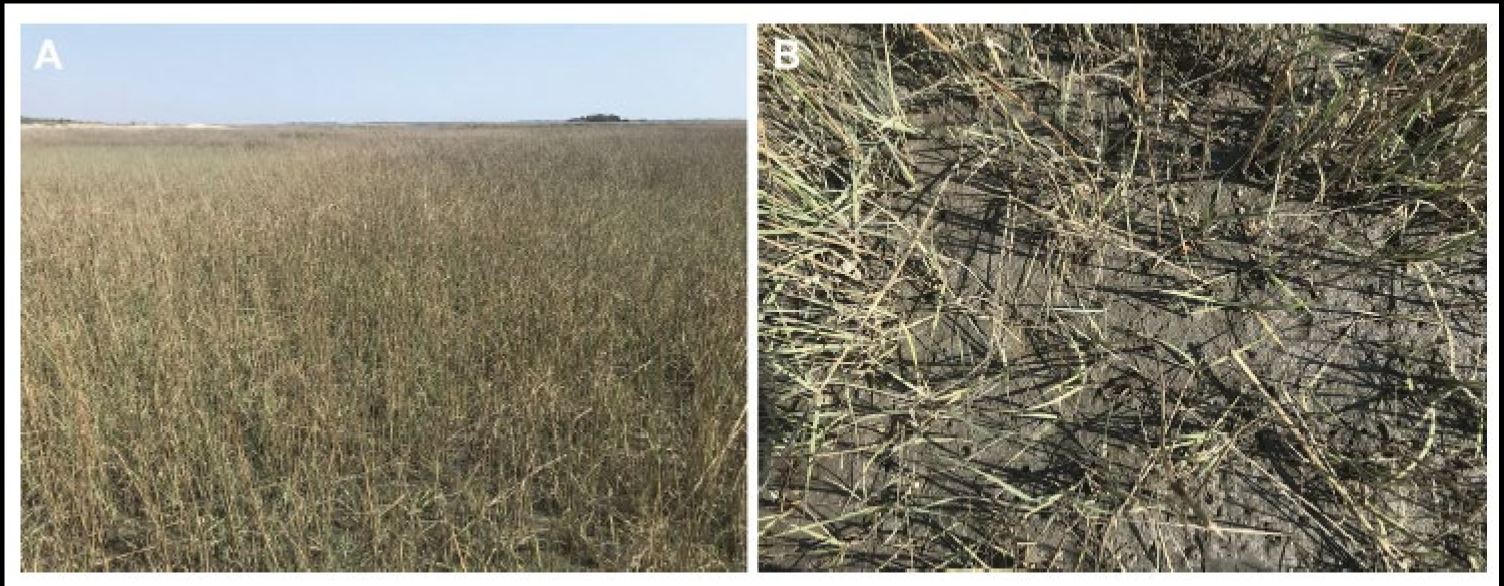






USGS

Important caveats about satellite-based UVVR!



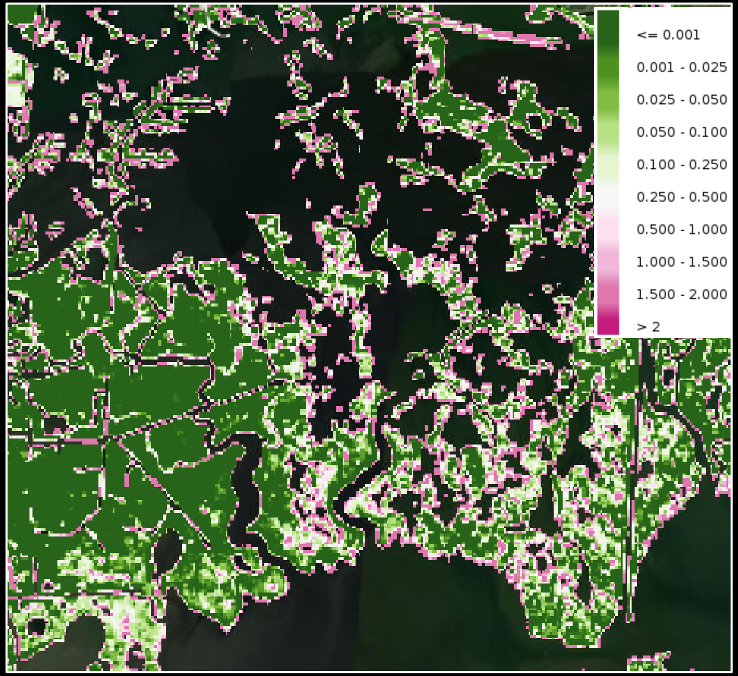
It is accounting for the signal within a 30 x 30 m pixel

It accounts for bare sediment within the pixel, i.e., a sparsely vegetated plain will get a higher UVVR than a densely vegetated plain

Some areas of SC and GA fall into this category

Therefore be careful comparing regions, safest to use comparatively within a region/system

Important caveats about satellite-based UVVR!



Open water areas larger than 30 x 30 m are excluded and given no value

If we want to neglect open water and get an idea of UVVR of just marsh plains: $UVVR_{lo}$

If we want to consider open water and large-scale fragmentation of complexes, aggregate over wetland areas and include open water: $UVVR_{hi}$

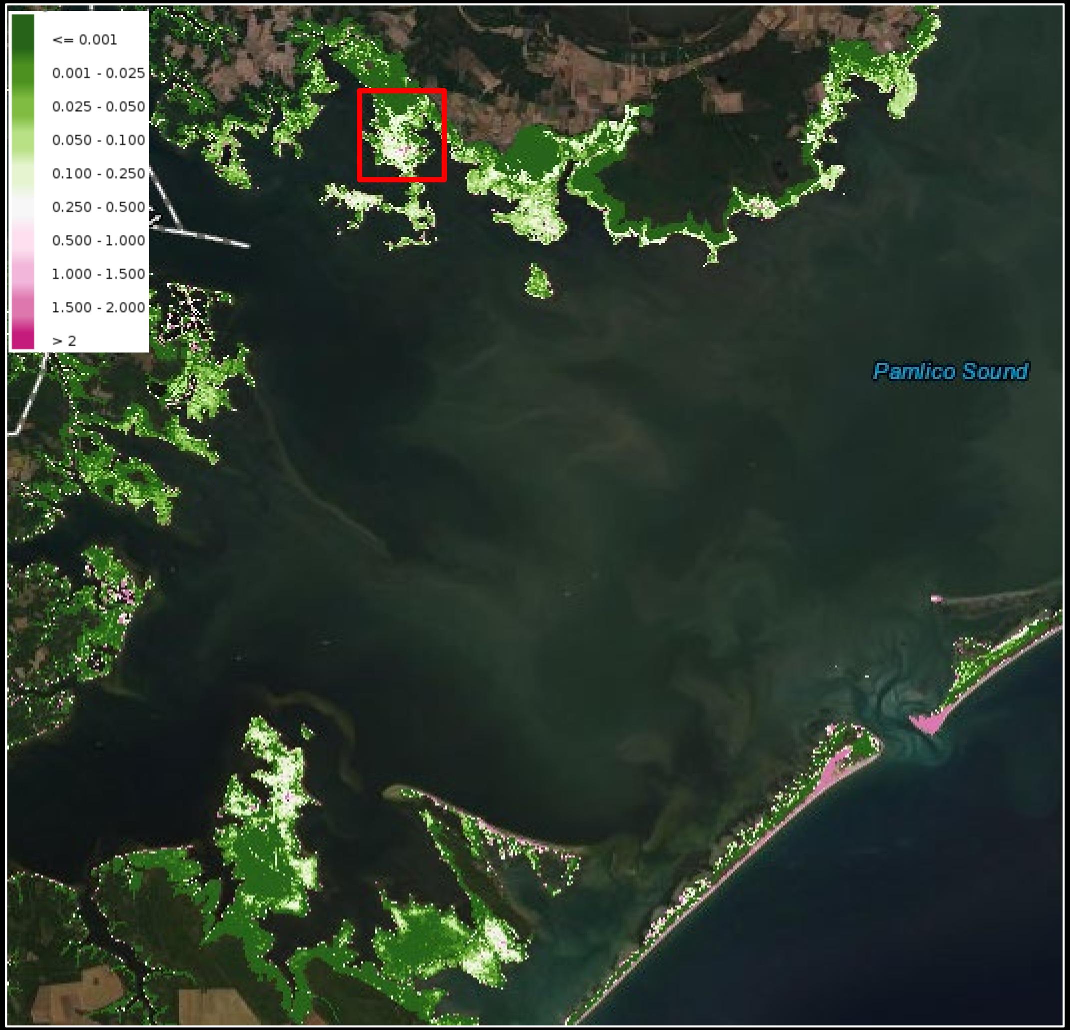
The difference between these two will also tell you something about internal marsh plain density vs. open-water fragmentation

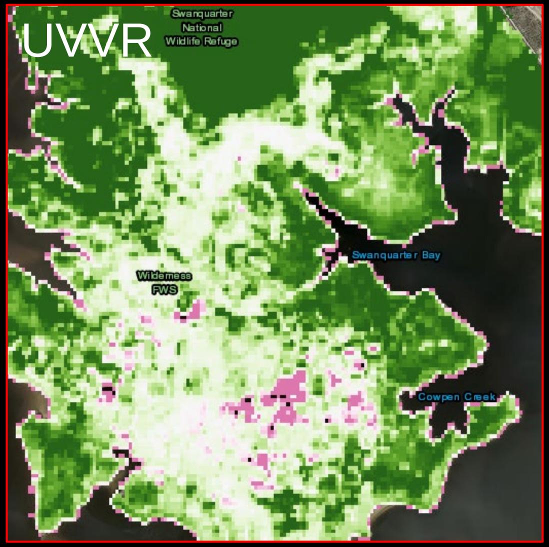
USGS

Estuary-by-estuary aggregation

Name of domain	State	Total area (km^2)	$UVVR_{lo}$	$UVVR_{hi}$	Vegetated fraction	Vegetated area (km^2)	% of total
Chesapeake Bay	DE, MD, VA	1266	0.17	0.25	0.80	1014	6.2%
Albemarle and Pamlico Sounds	NC, VA	874	0.06	0.08	0.93	809	5.0%
Delaware Bay	NJ, PA, DE	593	0.19	0.23	0.81	481	3.0%
Barataria Bay	LA	689	0.12	0.50	0.67	459	2.8%
Terrebonne Bay	LA	695	0.25	0.74	0.57	399	2.4%
Wax Lake Delta, Atchafalaya	LA	344	0.01	0.08	0.93	319	2.0%
St. Helena Sound	SC	458	0.61	0.68	0.59	272	1.7%
Timucuan Preserve	FL	236	0.26	0.32	0.76	179	1.1%
Plaquemines-Balize Delta	LA	204	0.11	0.36	0.74	150	0.9%
Ossabaw Sound	GA	211	0.41	0.43	0.70	147	0.9%
Mississippi Sound	MS	173	0.11	0.19	0.84	146	0.9%
Barnegat and Great Bays	NJ	181	0.22	0.29	0.77	140	0.9%
San Francisco Bay	CA	162	0.19	0.32	0.76	123	0.8%
Galveston Bay	TX	122	0.21	0.29	0.78	95	0.6%
DE/MD/VA Coastal Bays	DE, MD, VA	130	0.33	0.45	0.69	90	0.5%
Columbia River	OR	86	0.10	0.16	0.86	74	0.5%
Mobile Bay	AL	55	0.09	0.12	0.89	49	0.3%

Estuary-by-estuary aggregation: Ablemarle/Pamlico Sounds





We aggregate vegetation fraction of pixels inside the estuary’s hydrologic unit(s) and wetland classes, then convert to UVVR

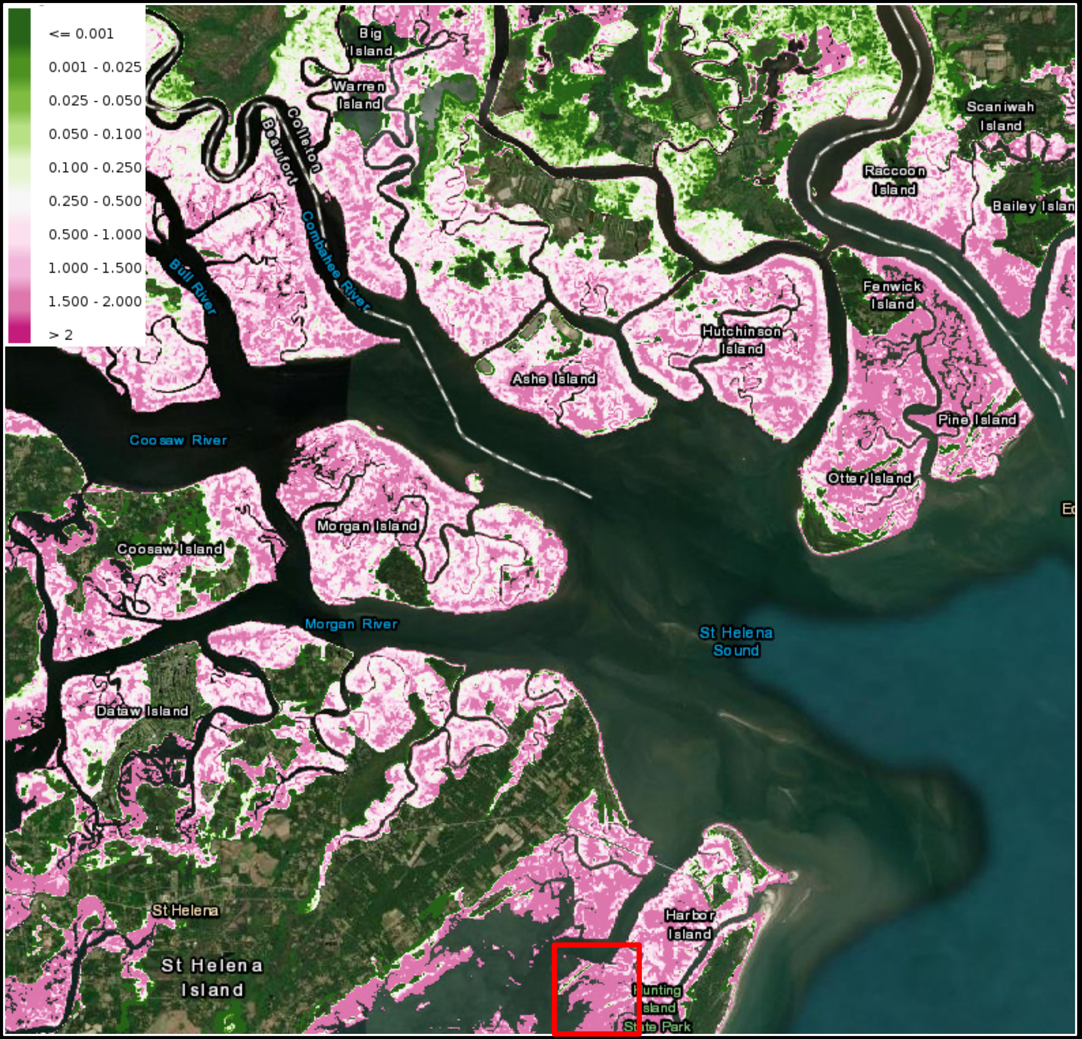
If we include all the open water, we get $UVVR_{hi} = 0.08$

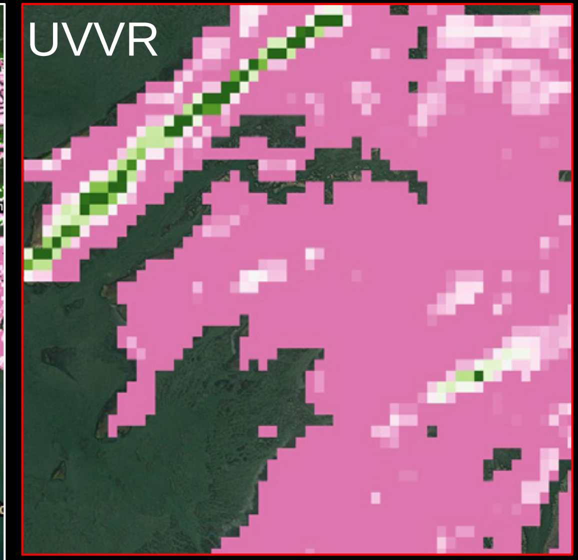
If we only consider marsh plain pixels and exclude open water greater than 30 x 30 m, we get $UVVR_{lo} = 0.06$

For this area, indicates intact marsh plains and little fragmentation

USGS

Estuary-by-estuary aggregation: St. Helena Sound





We aggregate vegetation fraction of pixels inside the estuary's hydrologic unit(s) and wetland classes, then convert to UVVR

If we include all the open water, we get $UVVR_{hi} = 0.68$

If we only consider marsh plain pixels and exclude open water greater than 30 x 30 m, we get $UVVR_{lo} = 0.61$

For this area, indicates degraded and fragmented marsh plains (but also sparse vegetation)

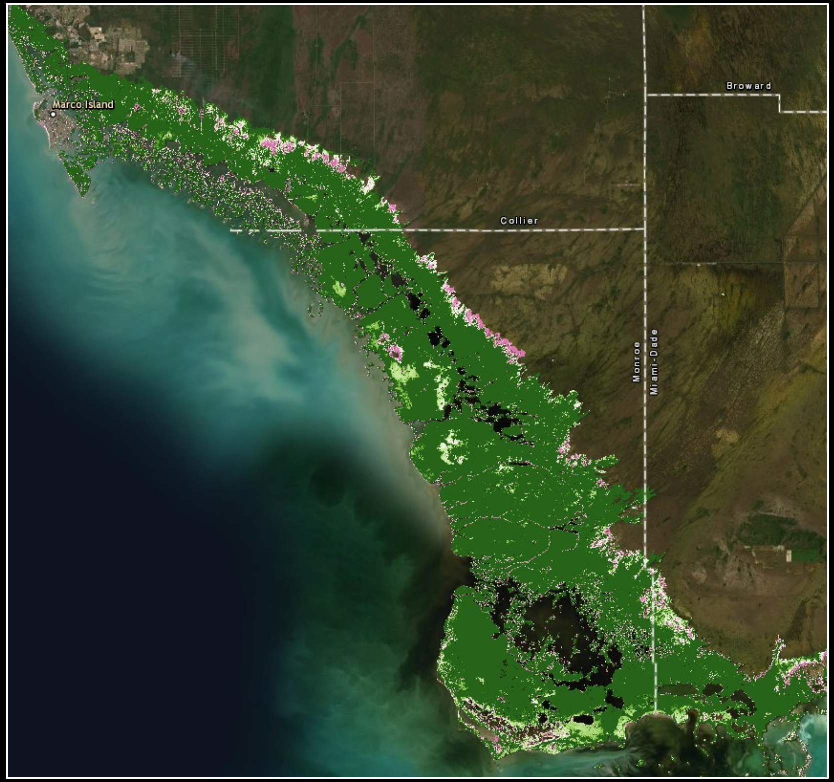
USGS

State-by-state aggregation

State	Total area (km^2)	$UVVR_{lo}$	$UVVR_{hi}$	Vegetated fraction	Vegetated area (km^2)	% of total
Louisiana	6843	0.10	0.31	0.76	5228	32.1%
Florida	4607	0.08	0.12	0.89	4113	25.3%
South Carolina	1911	0.52	0.58	0.63	1213	7.5%
Georgia	1640	0.46	0.49	0.67	1099	6.8%
Texas	1151	0.22	0.28	0.78	898	5.5%
North Carolina	992	0.14	0.18	0.85	842	5.2%
Maryland	850	0.18	0.24	0.80	684	4.2%
New Jersey	772	0.24	0.30	0.77	593	3.6%
Virginia	811	0.33	0.50	0.67	542	3.3%
Delaware	278	0.16	0.21	0.83	230	1.4%
Mississippi	246	0.09	0.13	0.89	218	1.3%
Massachusetts	154	0.13	0.27	0.79	122	0.7%
Washington	136	0.23	0.31	0.76	104	0.6%
Oregon	100	0.10	0.16	0.86	86	0.5%
Alabama	96	0.10	0.14	0.88	84	0.5%
Maine	90	0.10	0.25	0.80	72	0.4%
New York	95	0.41	0.62	0.62	59	0.4%
California	61	0.22	0.38	0.73	44	0.3%
Connecticut	39	0.25	0.47	0.68	27	0.2%
New Hampshire	20	0.13	0.26	0.79	16	0.1%
Rhode Island	9	0.27	0.61	0.62	6	0.0%
Pennsylvania	2	0.15	0.29	0.77	2	0.0%
Total	20903	NA	NA	NA	16,281	100%

South Atlantic LCC encompasses ~30% of nation's coastal wetland areas

Florida the overall winner for wetland integrity, likely due to dense canopies of mangrove in southern areas of the state



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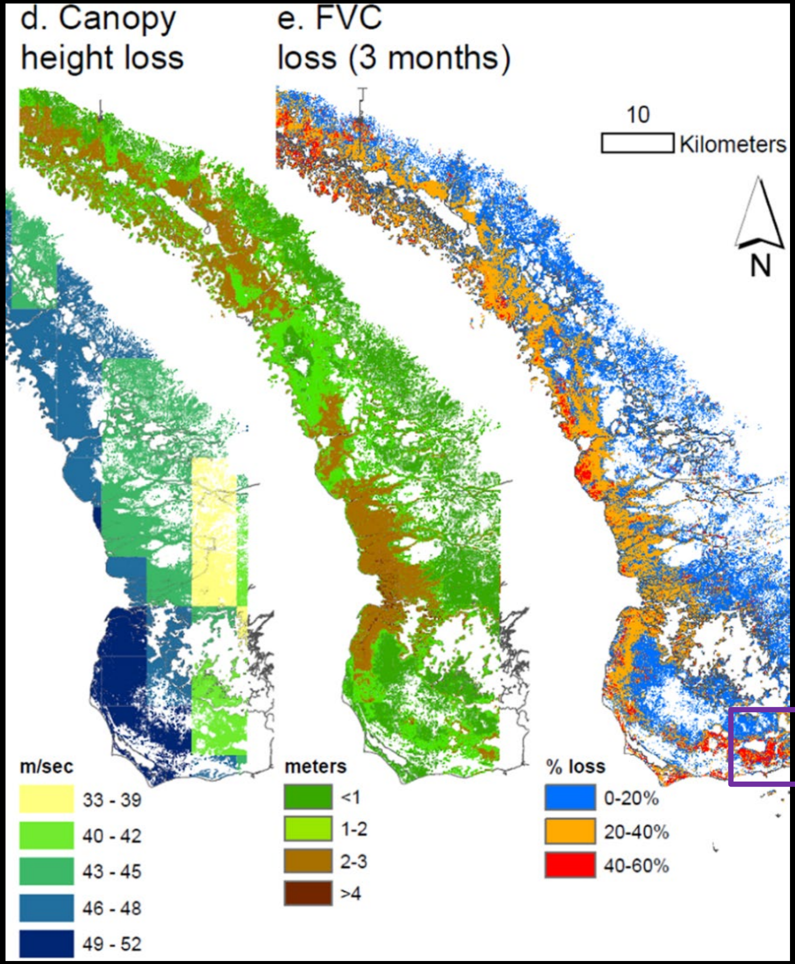
Applications of the UVVR

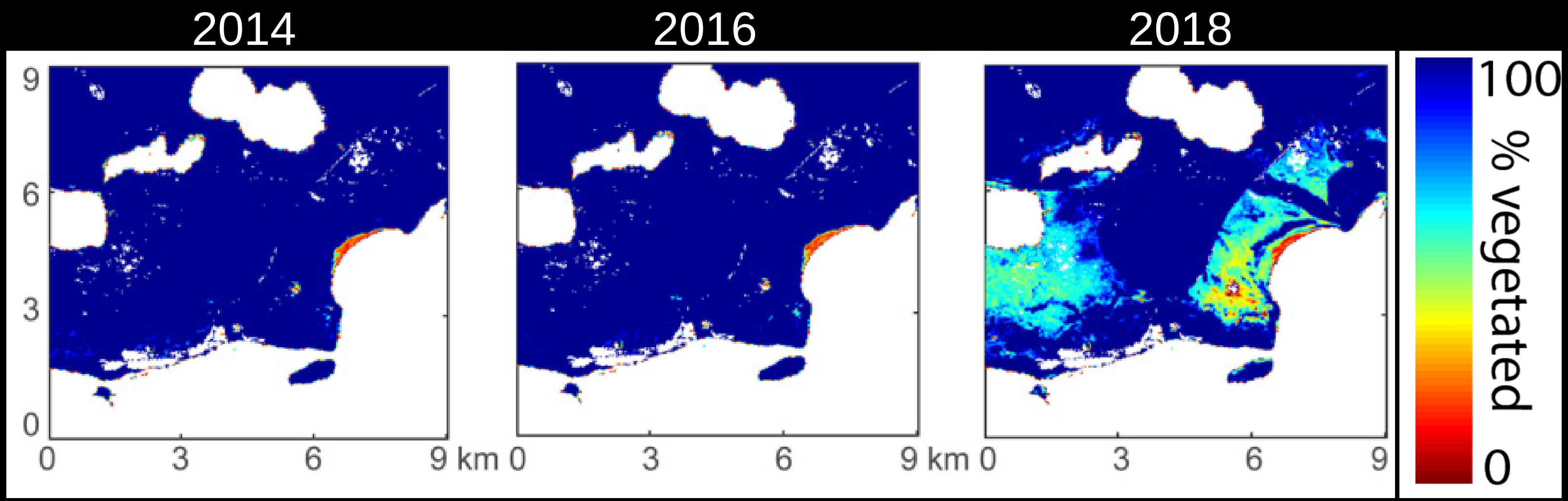
- Assessing tidal wetland change across site and regional scales
- Identifying vulnerable areas using annual variability
- Hypothetical decision matrix: using UVVR and elevation
- Comparing vertical trends with UVVR across the Southeast

USGS

Assessing tidal wetland change: mangrove dieback from *Irma* (2017)



Lagomasino et al. 2021



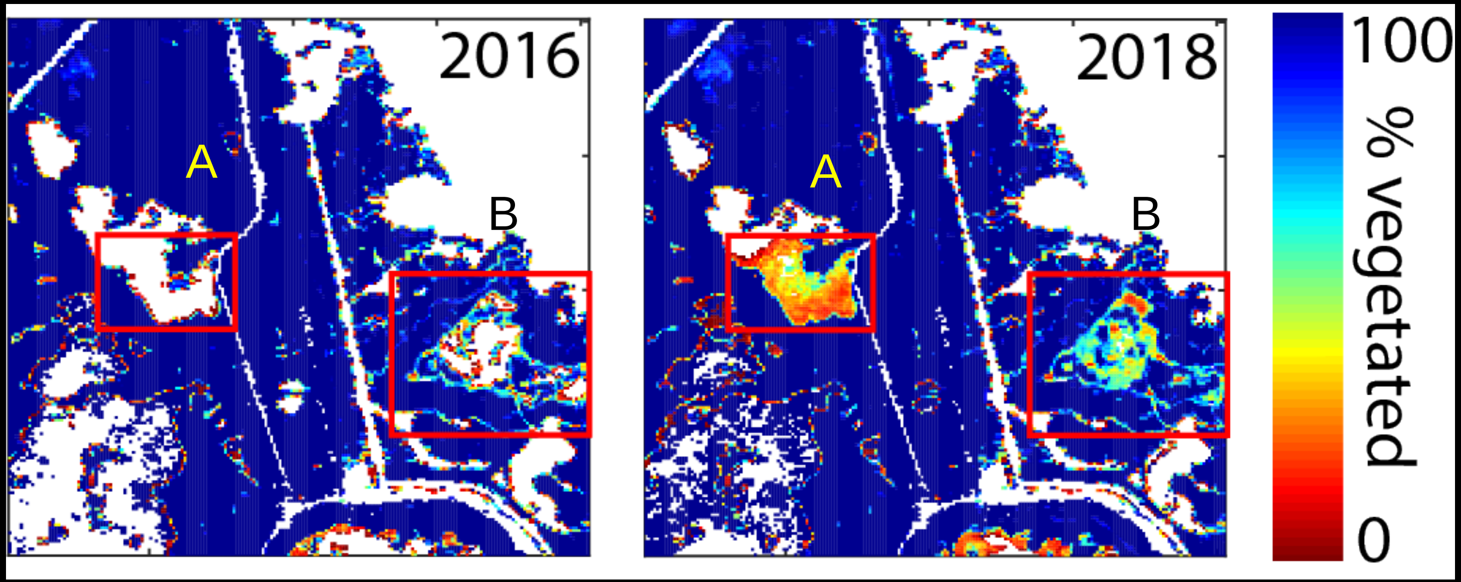
Storm surge, wind, ponding caused dieback in SW Florida, especially near Flamingo

Lagomasino et al. (2021) documented loss in canopy height and vegetative cover using lidar, aerial imagery, and Landsat (3 month interval)

Annual Landsat data captures loss as well, and gives baseline data across regional scales

USGS

Assessing tidal wetland change: sediment placement in Louisiana



Two sediment placement projects near Lake Pontchartrain, as part of USACE mitigation

Sediment placed in bare/open-water areas

Both areas saw over 40% increase in vegetated area in 3 years

Given widespread restoration efforts, comprehensive data across region simplifies tracking project success

Applications of the UVVR

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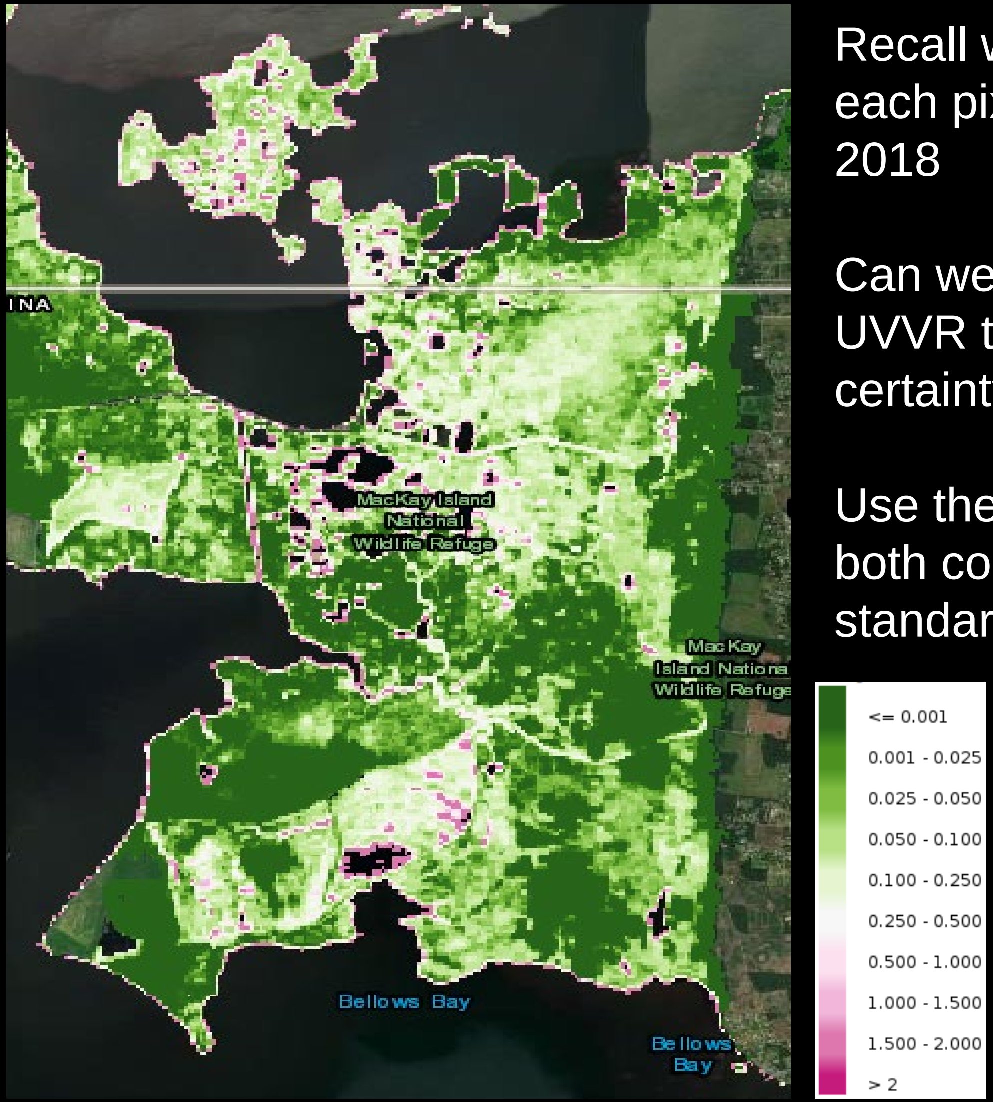
Identifying vulnerable areas: Mackay Island NWR, NC

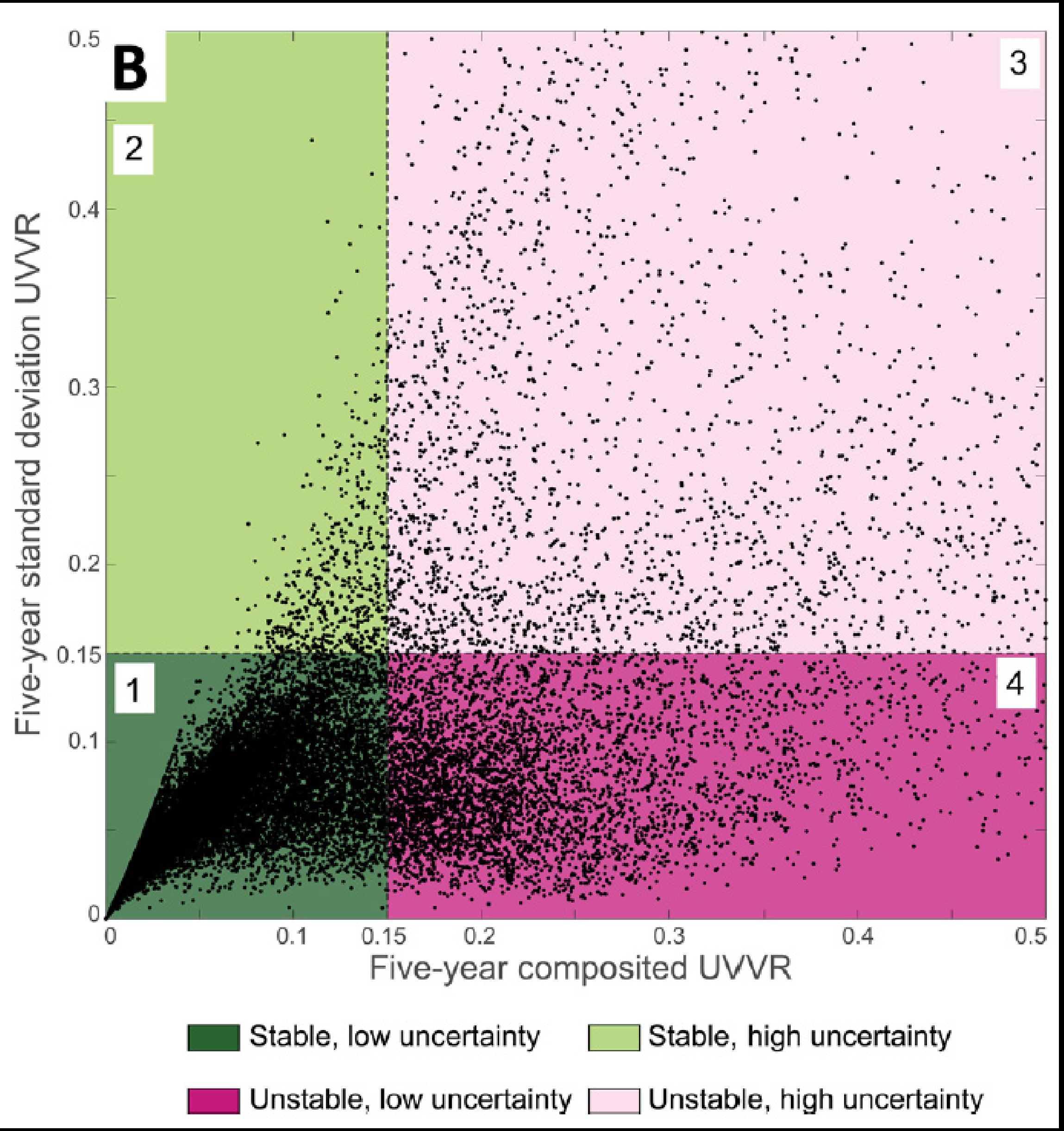


Recall we have a UVVR value at each pixel for each year, 2014-2018

Can we use the fluctuation in UVVR to establish stability and certainty at the same time?

Use the threshold value of 0.15 for both composite value and 5-year standard deviation

Identifying vulnerable areas: Mackay Island NWR, NC



Each dot represents 30 m pixel, with five-year composite value vs. standard deviation

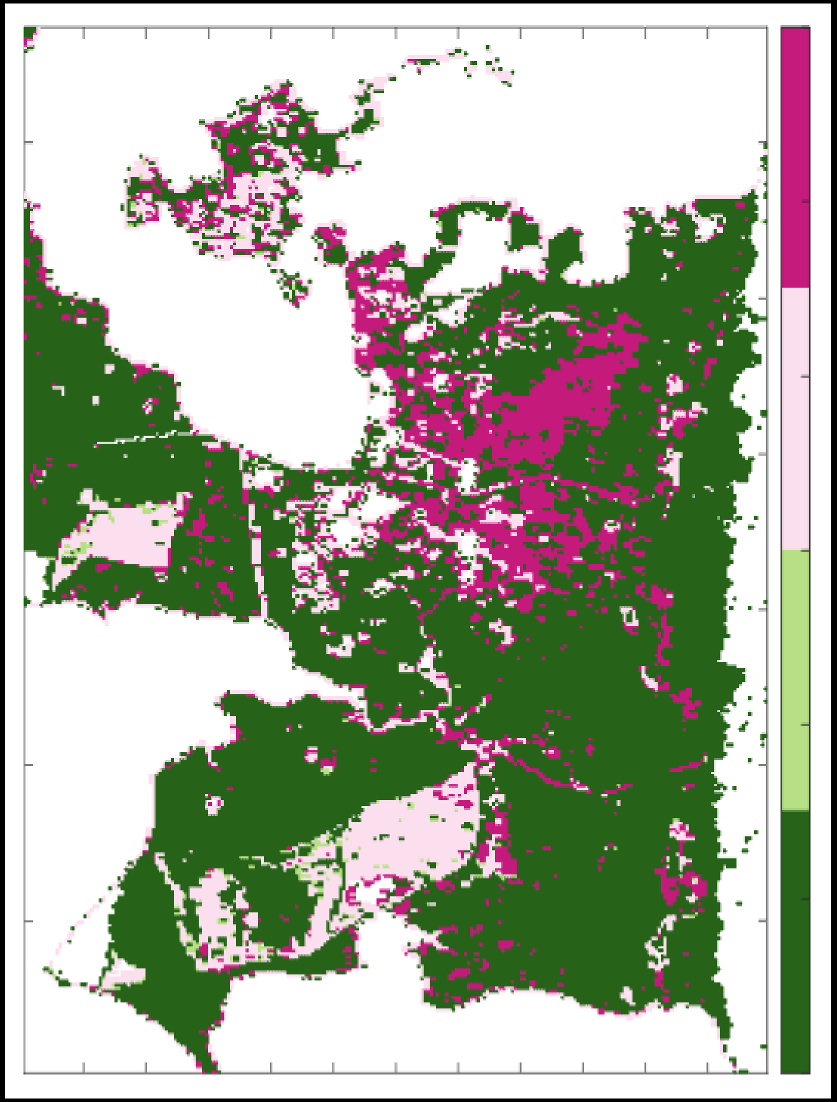
Class 1 pixels are consistently below stability threshold of 0.15 (i.e. good), and don't fluctuate much

Class 2 areas are below stability threshold of 0.15 but there are big annual outliers (e.g. overwash event, dieback)

Class 3 areas are above stability threshold of 0.15 and there are large annual fluctuations (water levels, controlled burn)

Class 4 areas are consistently above stability threshold of 0.15, and they don't fluctuate much

Identifying vulnerable areas: Mackay Island NWR, NC



Unstable, low uncertainty: 13%
Areas at risk

Unstable, high uncertainty: 15%
Managed impoundments and open water areas

Stable, high uncertainty: 1%
Not significant

Stable, low uncertainty: 71%
Areas with intact marsh plain

USGS

Applications of the UVVR

- Assessing tidal wetland change across site and regional scales
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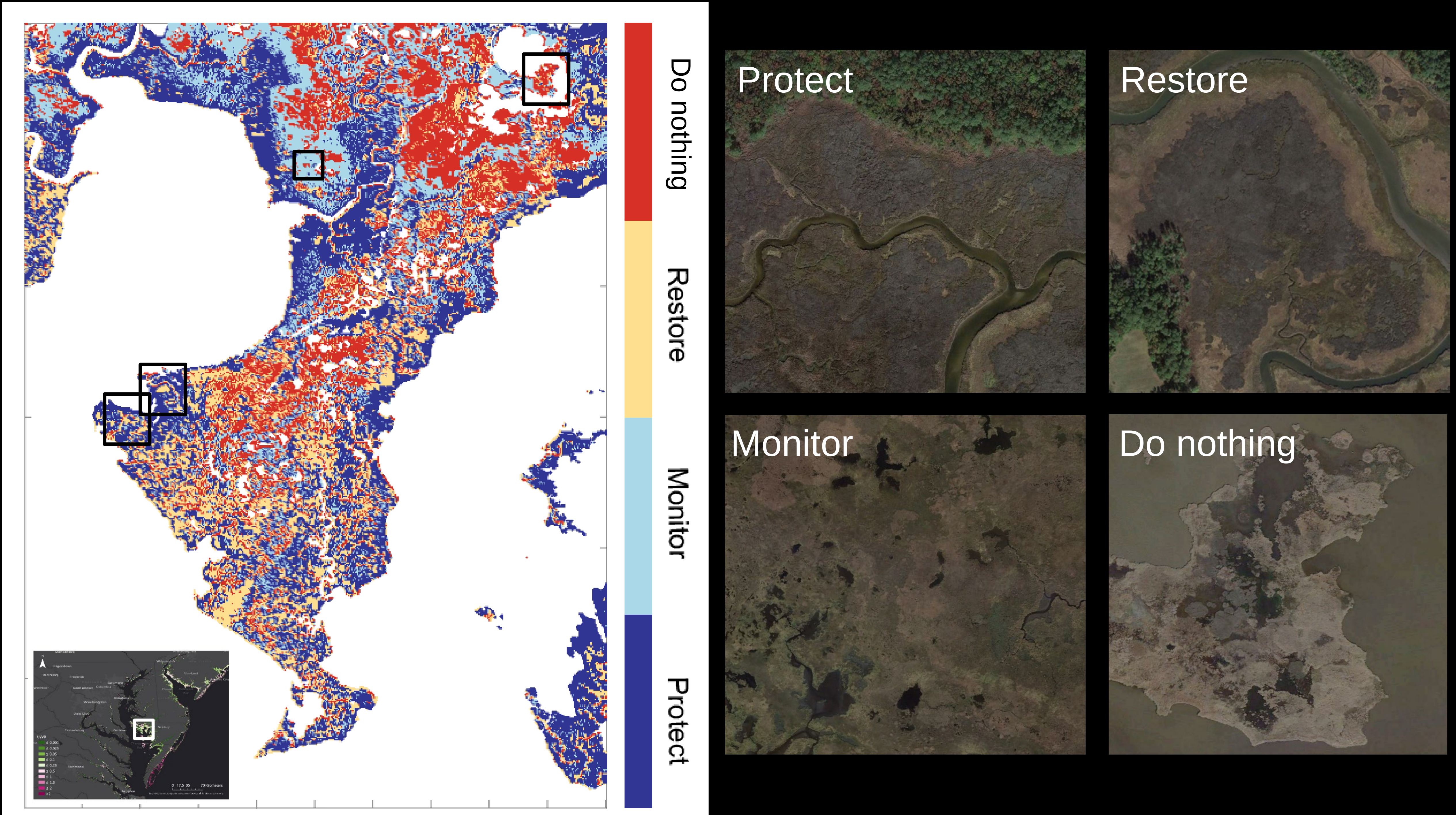
Determining strategies: hypothetical decision matrix

		UVVR	
		Low	High
Elevation	High	Protect	Restore
	Low	Monitor	Do nothing


Do nothing
Restore
Monitor
Protect
Protect
Restore
Monitor
Do nothing

Applications of the UVVR

- Assessing tidal wetland change across site and regional scales
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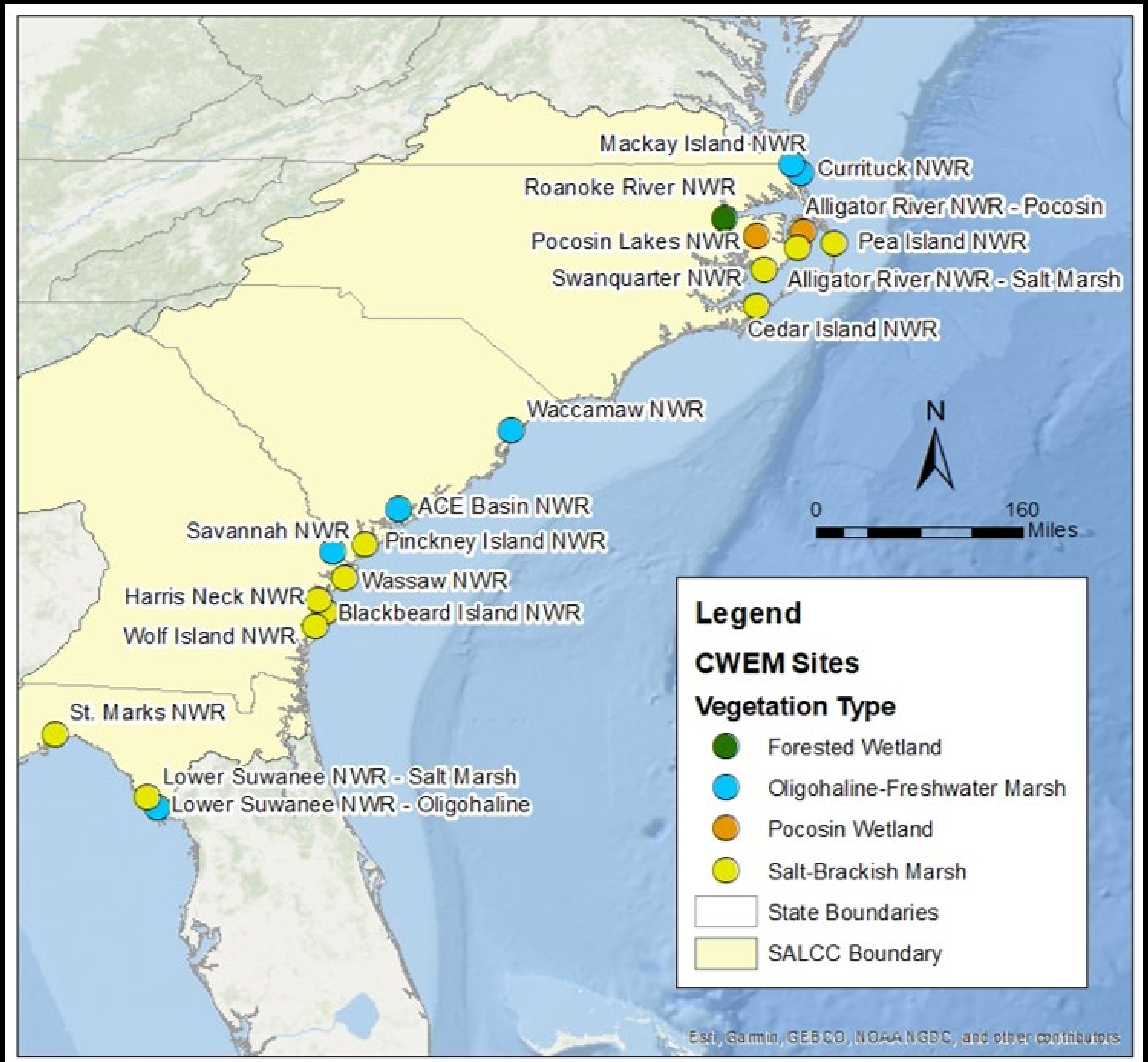
Comparing SET vertical trends with UVVR across the Southeast

Eighteen FWS-SER SET sites
Differentiated by vegetation type
SLR range = 2 to 5 mm/y
Elevation change = -10 to 7 mm/y

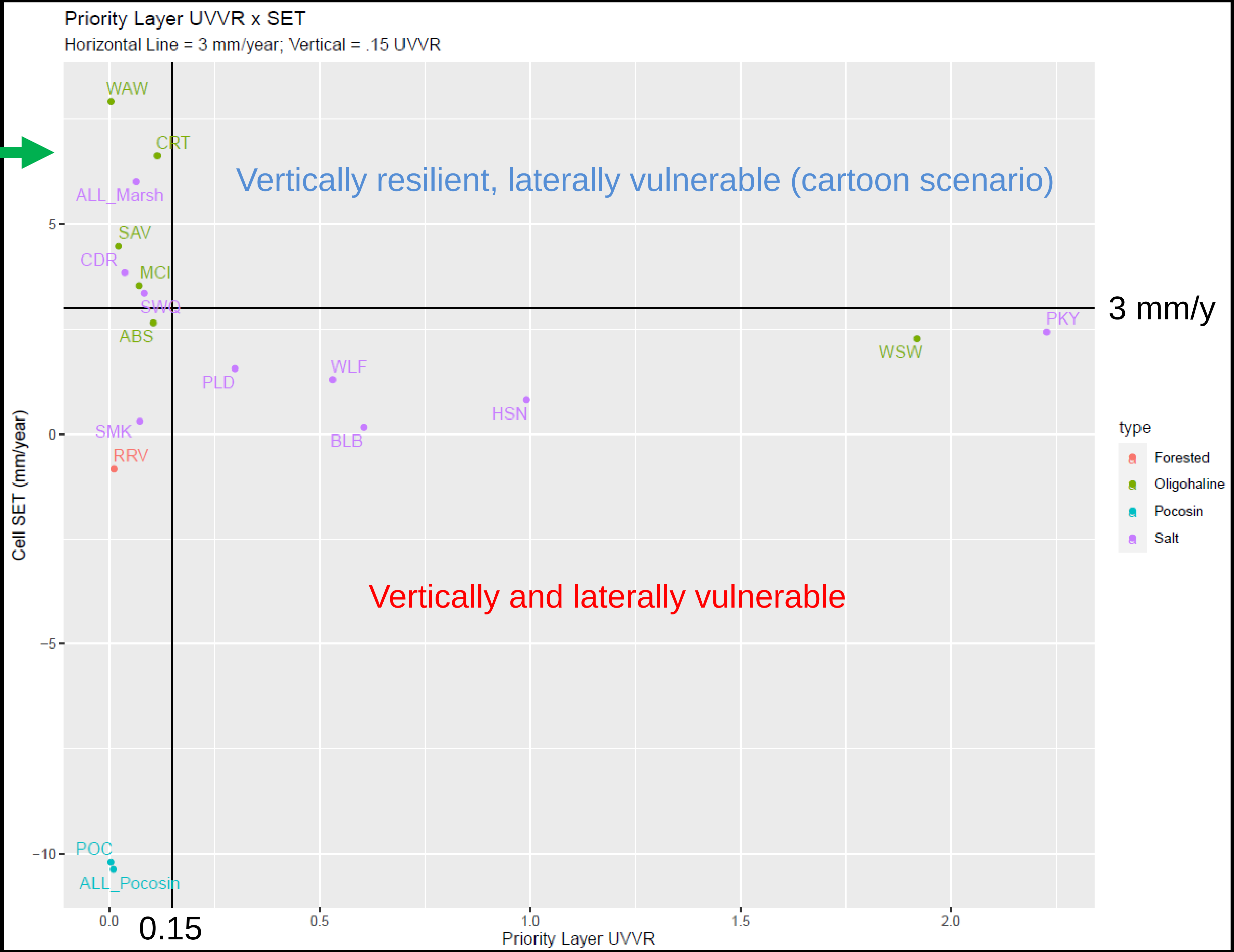


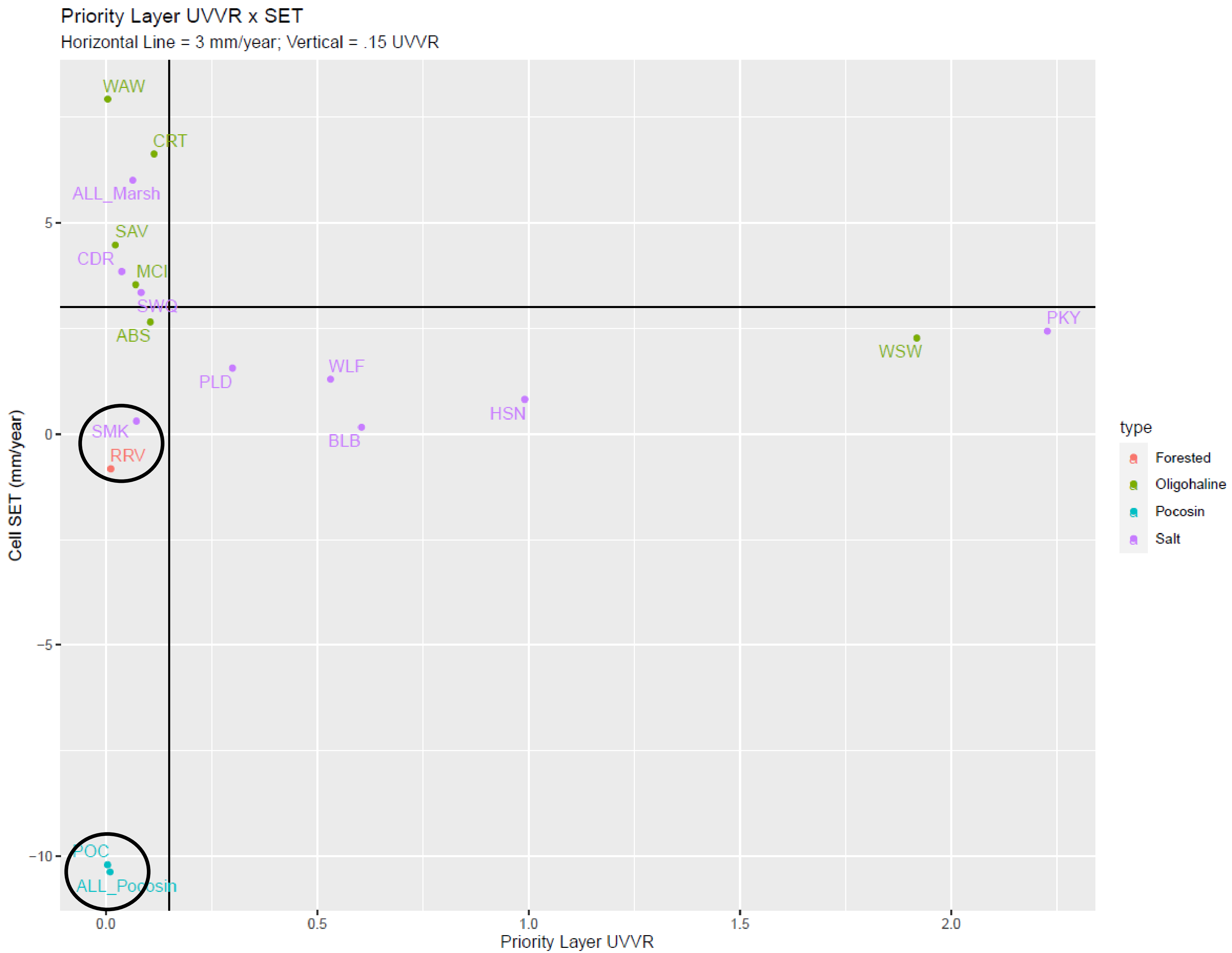
USFWS, 2021

USGS

Full disclosure: I have been critical of SETs in the past…

Vertically and laterally resilient





Outliers (black circles)

SMK: UVVR currently including large swaths of upland forest, UVVR should increase in revision

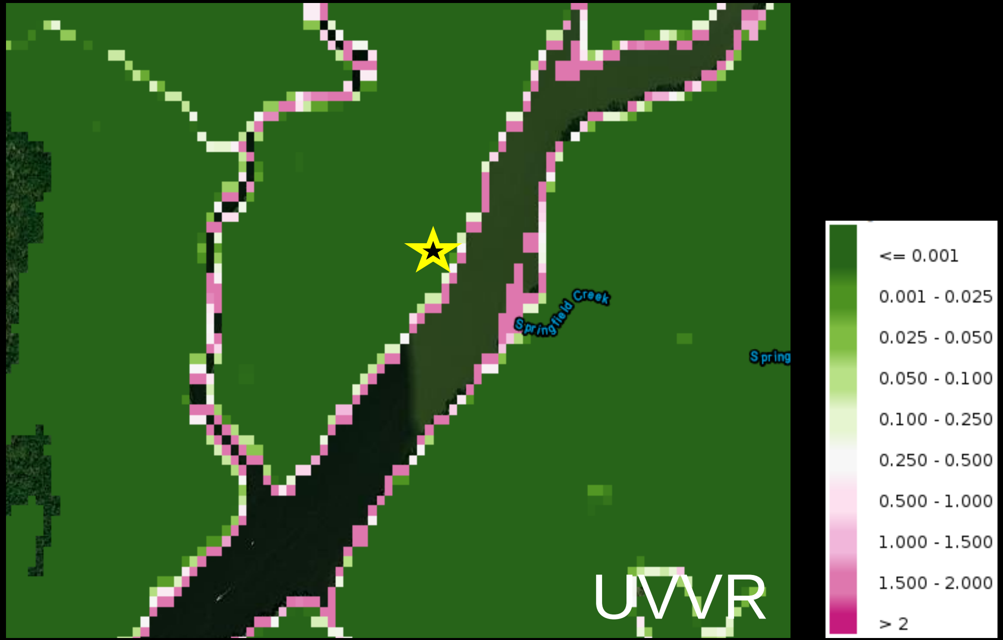
RRV and POC: UVVR not ideal for forested and pocosin wetlands with significant canopy cover

WAW: Waccamaw NWR, South Carolina

SET trend > 7 mm/y

UVVR nearly 0, i.e. completely vegetated

Robust marsh plain promotes vertical stability, through organic burial, sediment trapping, encouraging stability of the substrate

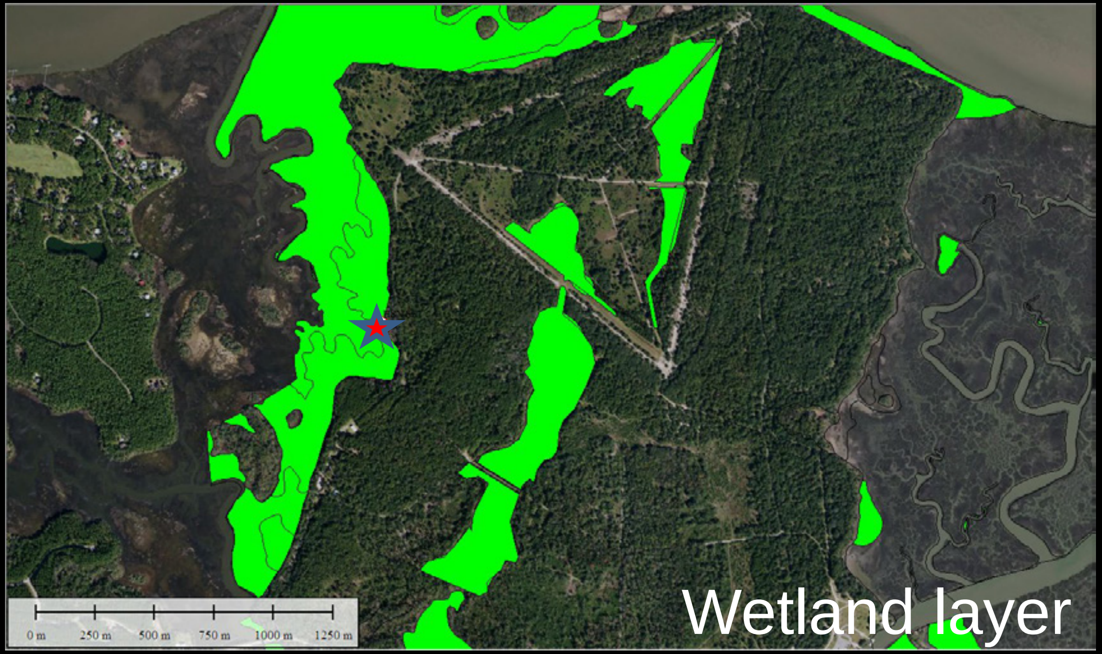


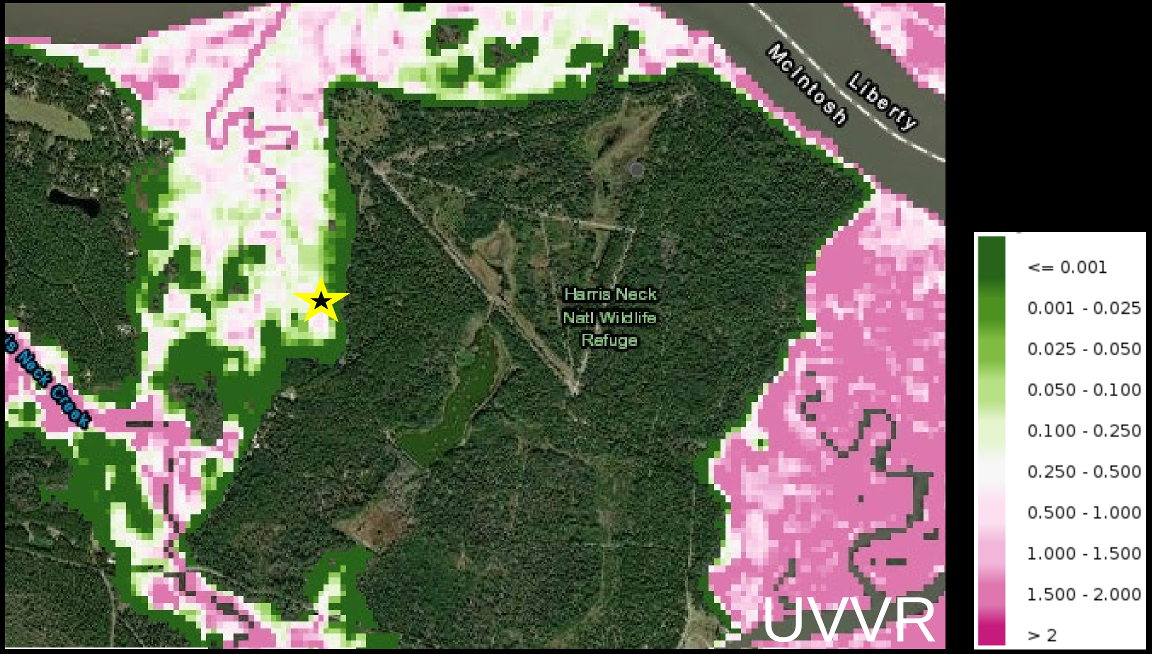
HSN: Harris Neck NWR, Georgia

SET trend ~ 1 mm/y

UVVR ~ 1, i.e. half vegetated (not good)

Degraded marsh plain prevents vertical stability, through reduced organic burial, sediment export, and weakening of the substrate





Objective, spatially integrative metrics for CONUS

Geospatial analysis: stability and the UVVR
- Formalized and standardized method
- Customizable on multiple scales
- Based on field studies, bolstered by recent modeling and analysis

Guiding management and restoration
- Selecting the best strategies
- Objectively quantifying vulnerability
- Tracking restoration success and episodic loss

Future progress and challenges
- Extending UVVR back to 1985, and onwards with newer satellites
- Optimizing efforts across projects and agencies
- Producing science from wealth of data

USGS

Data access

ScienceBase

- For the geospatial user
- All years of data, for all three coasts

Coastal Change Hazards Portal

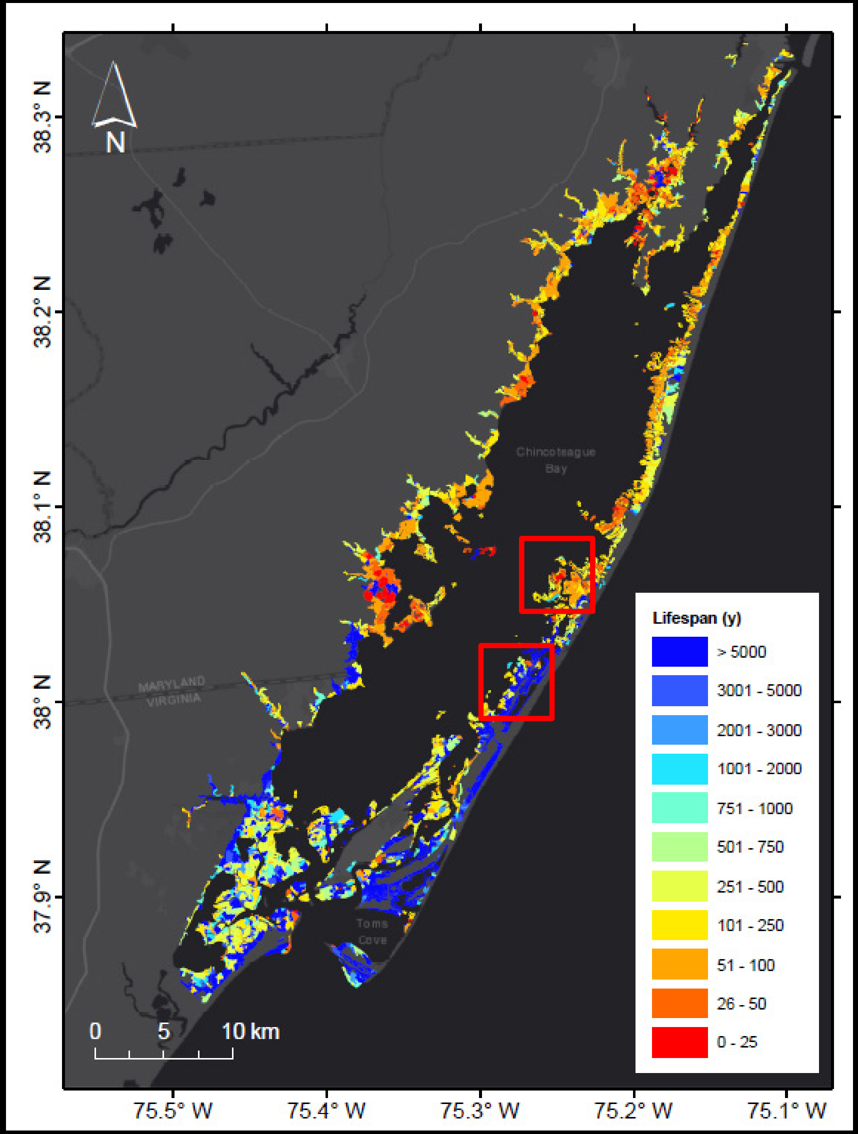
- For quick exploration, show-and-tell
- 5-year average value, with click-and-display

Coastal Wetland Synthesis Storymap

- Background and publications
- Links to all UVVR data and viewers

USGS

Lifespan: a universal metric for planning



MD: ditched

VA: unditched

Combines SLR, elevation, and UVVR into easily digestible metric

Represents timescale of when a marsh parcel must cannibalize its own sediment to keep pace with SLR

Customizable for different SLR scenarios and restoration actions

Provides powerful tool for messaging the importance of restoring natural conditions

USGS

Next Third Thursday Web Forum

6-16-2022

10:00 am

Mo Correll

Atlantic Coast Joint Venture

secassoutheast.org

Collaborative conservation of coastal marsh systems: A science update from the Atlantic Coast Joint Venture

Staff updates

- Wrapping up workshops

Wrapping up workshop

- Last of 16 virtual workshops wrapping up right now
- Look for a blog in the May newsletter summarizing the feedback we received
- Already exploring improvements to the data and methods based on input
- Final Southeast Blueprint planned for release this fall in time for SEAFWA

How to get involved in SECAS

- Sign up for the SECAS newsletter

  secassoutheast.org

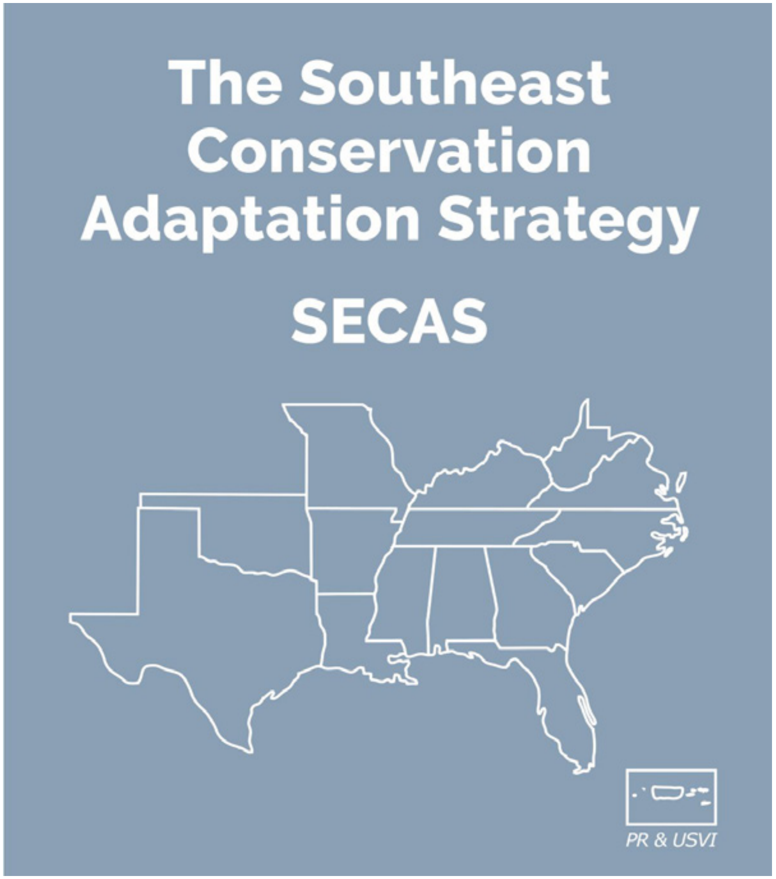
- Connect with SECAS staff or partners

  secassoutheast.org/staff

  secassoutheast.org/partners

- Explore the Southeast Conservation Blueprint

  secassoutheast.org/blueprint



Questions?