Maryland's Coastal Resiliency Assessment

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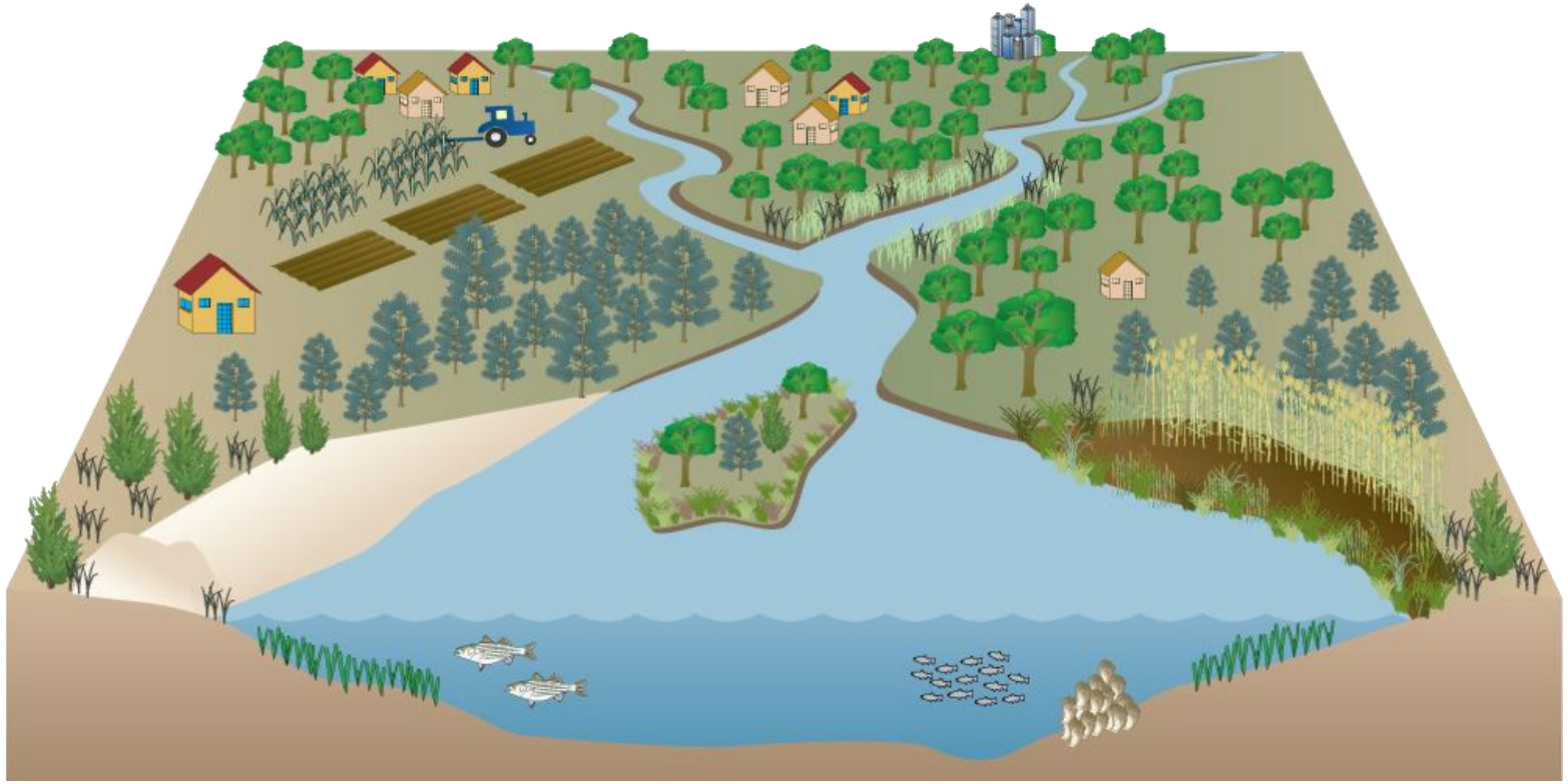
Coastal Resiliency Goal

Evaluate the risk reduction benefits of existing natural features and establish priorities for conservation/restoration of natural features to enhance resiliency of vulnerable coastal communities.



FOCUS: *Protection Benefits to People*

“Natural Features”

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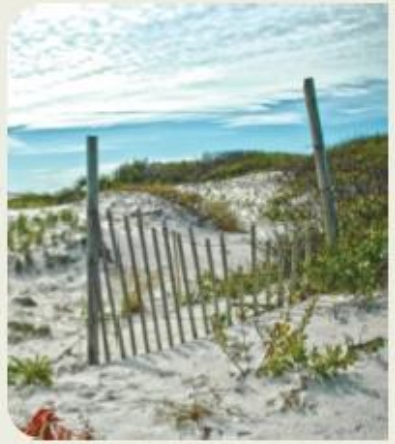				
Dunes and Beaches	**Vegetated Features (e.g., Marshes)**	**Oyster and Coral Reefs**	**Barrier Islands**	**Maritime Forests/Shrub Communities**
Benefits/Processes Breaking of offshore waves Attenuation of wave energy Slow inland water transfer	**Benefits/Processes** Breaking of offshore waves Attenuation of wave energy Slow inland water transfer Increased infiltration	**Benefits/Processes** Breaking of offshore waves Attenuation of wave energy Slow inland water transfer	**Benefits/Processes** Wave attenuation and/or dissipation Sediment stabilization	**Benefits/Processes** Wave attenuation and/or dissipation Shoreline erosion stabilization Soil retention

(Figure from US Army Corps 2015, *Use of NNBF for Coastal Resilience*)

Assessment Steps

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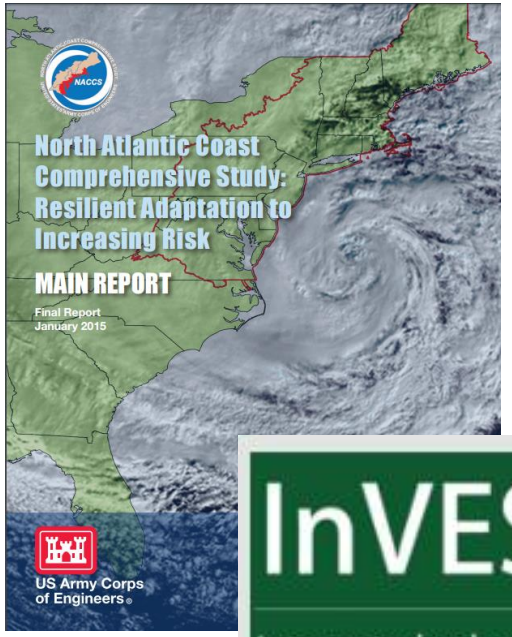
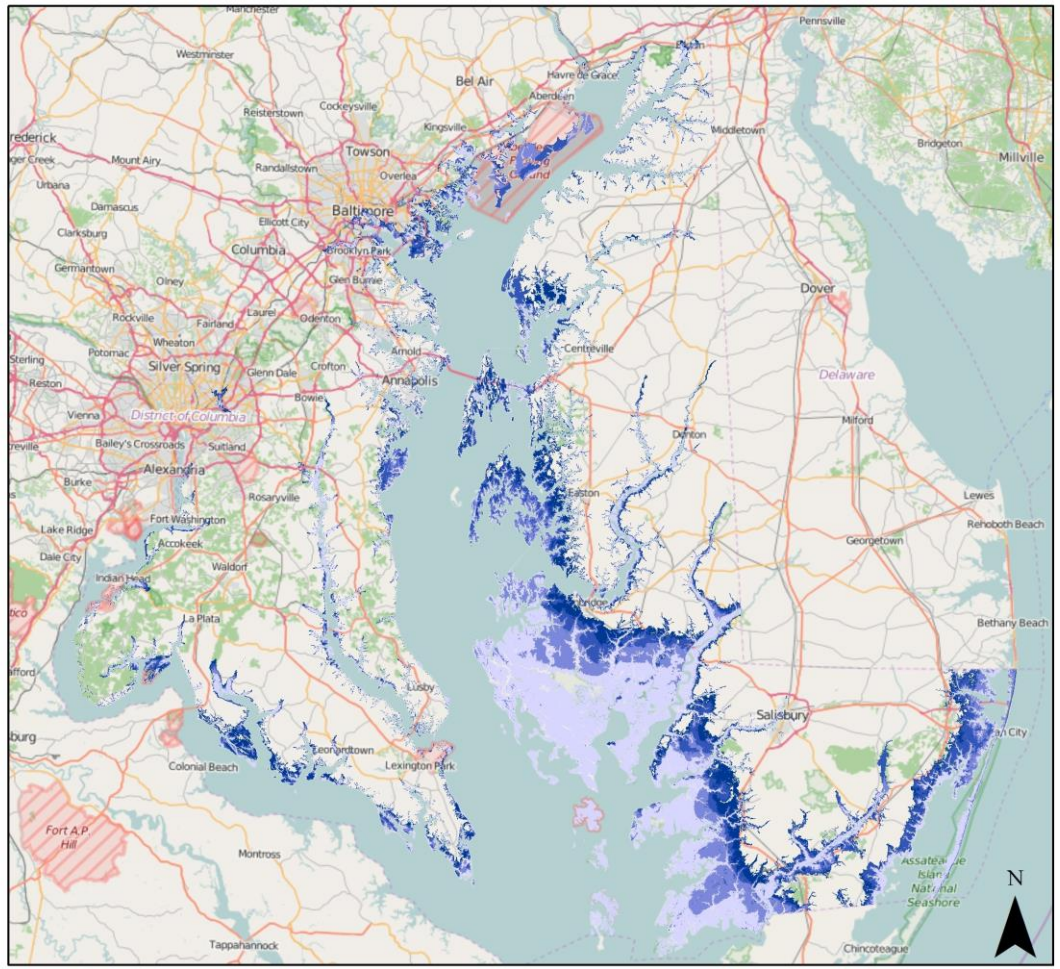
1. **Identify Community Flood Risk Areas** – residential areas less equipped to prepare for, respond to, or recover from coastal hazard events.

2. **Identify Shorelines where Habitats Reduce Exposure to Coastal Hazards** – Identify natural infrastructure features and assess their value as risk-reduction techniques.

3. **Identify Priority Action Areas** – Tier I and II shoreline conservation/restoration priorities for targeting state resources; marsh complex protection priorities.



Study Area



Furthest
extent of flood hazard event:

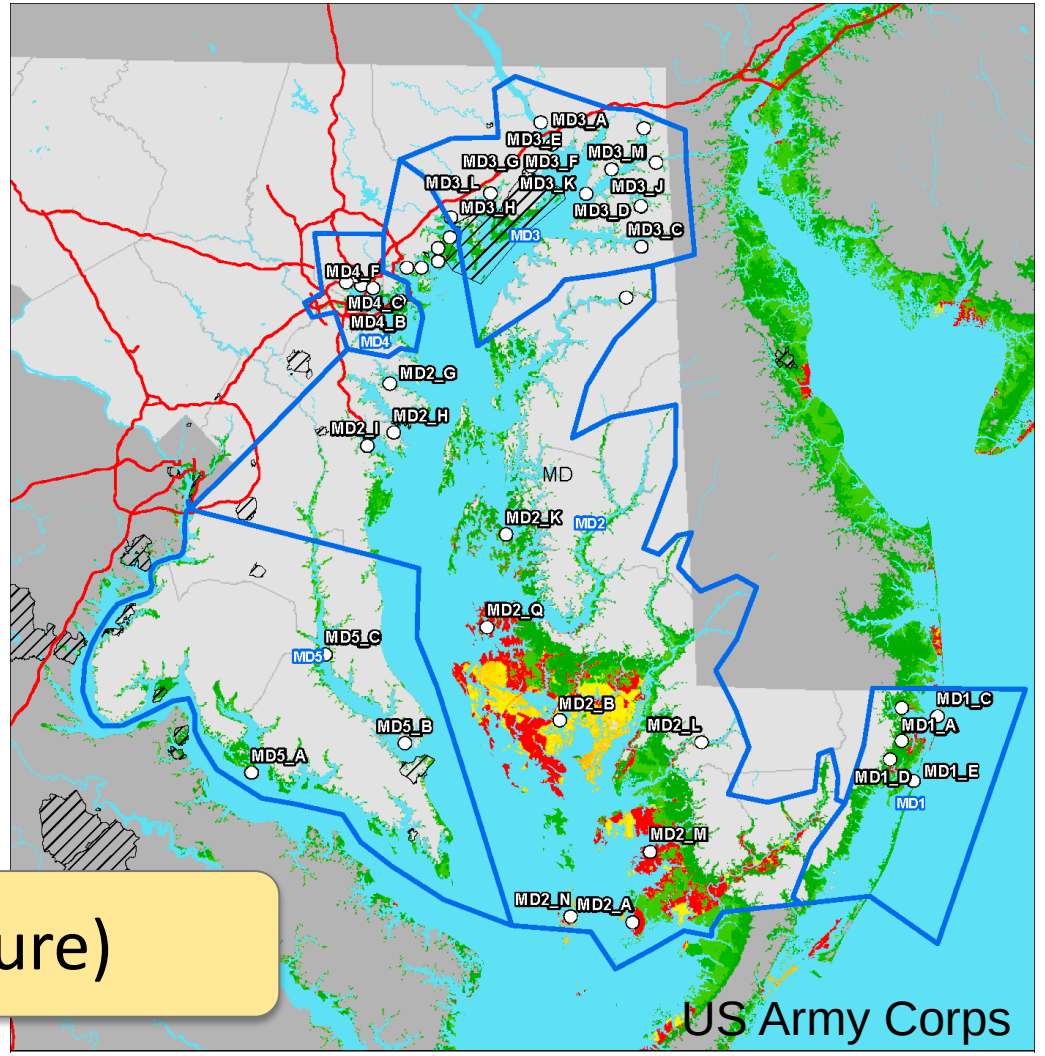
Hurricane Events Category 1-4

Sea, Level, and Overland Surges
from Hurricanes Model

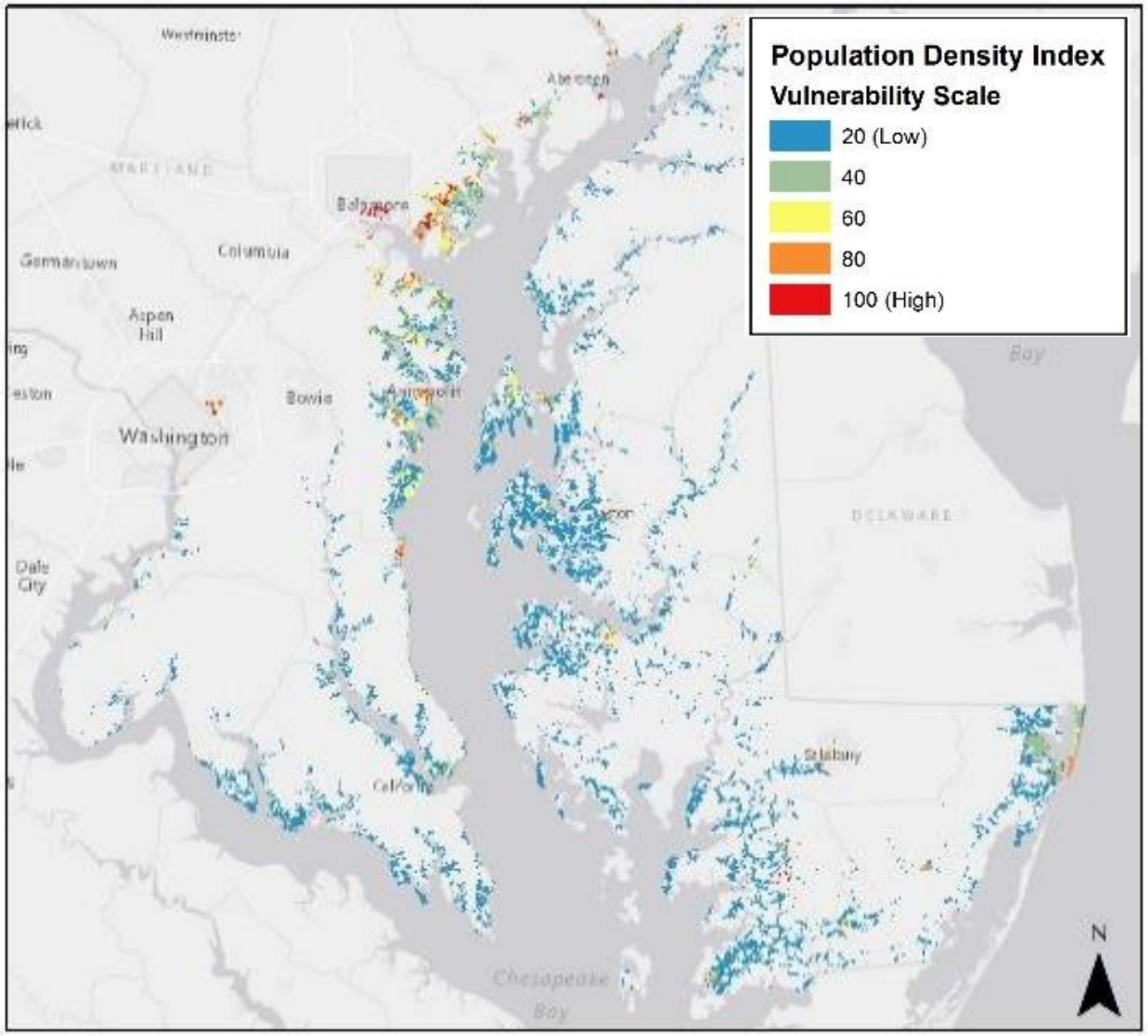
Step 1: Risk Analysis

Identify communities that are currently at-risk to coastal hazards:

- Where are the people?
  - **Population Density Index (PDI)**
  - **Social Vulnerability Index (SVI)** (Age, Income, Language Proficiency)
- Where are the probable flood events? (10, 50, 100, 500-year)



RISK = (PDI + SVI) X (Probability of Exposure)



RISK = (PDI + SVI) X (Probability of Exposure)

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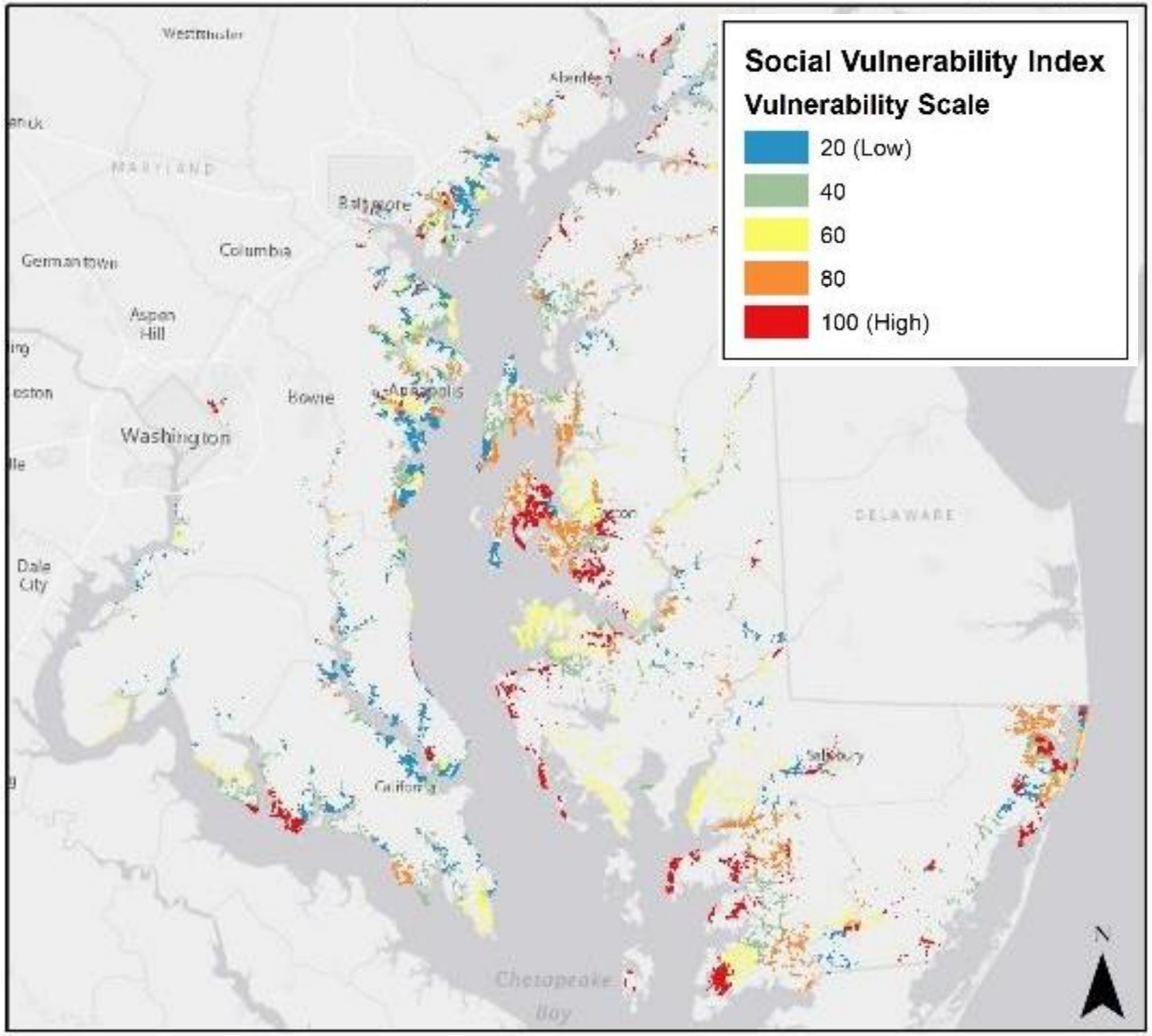
Population Density Index:

- US Census Bureau Block Groups
- 2013 American Community Survey
- Dasymetric Mapping:
  - USGS Toolbox
  - Eliminate open space and non-residential areas (# People/900m^2)
- 5 Quantile Re-Classification



RISK = (PDI + **SVI**) X (Probability of Exposure)

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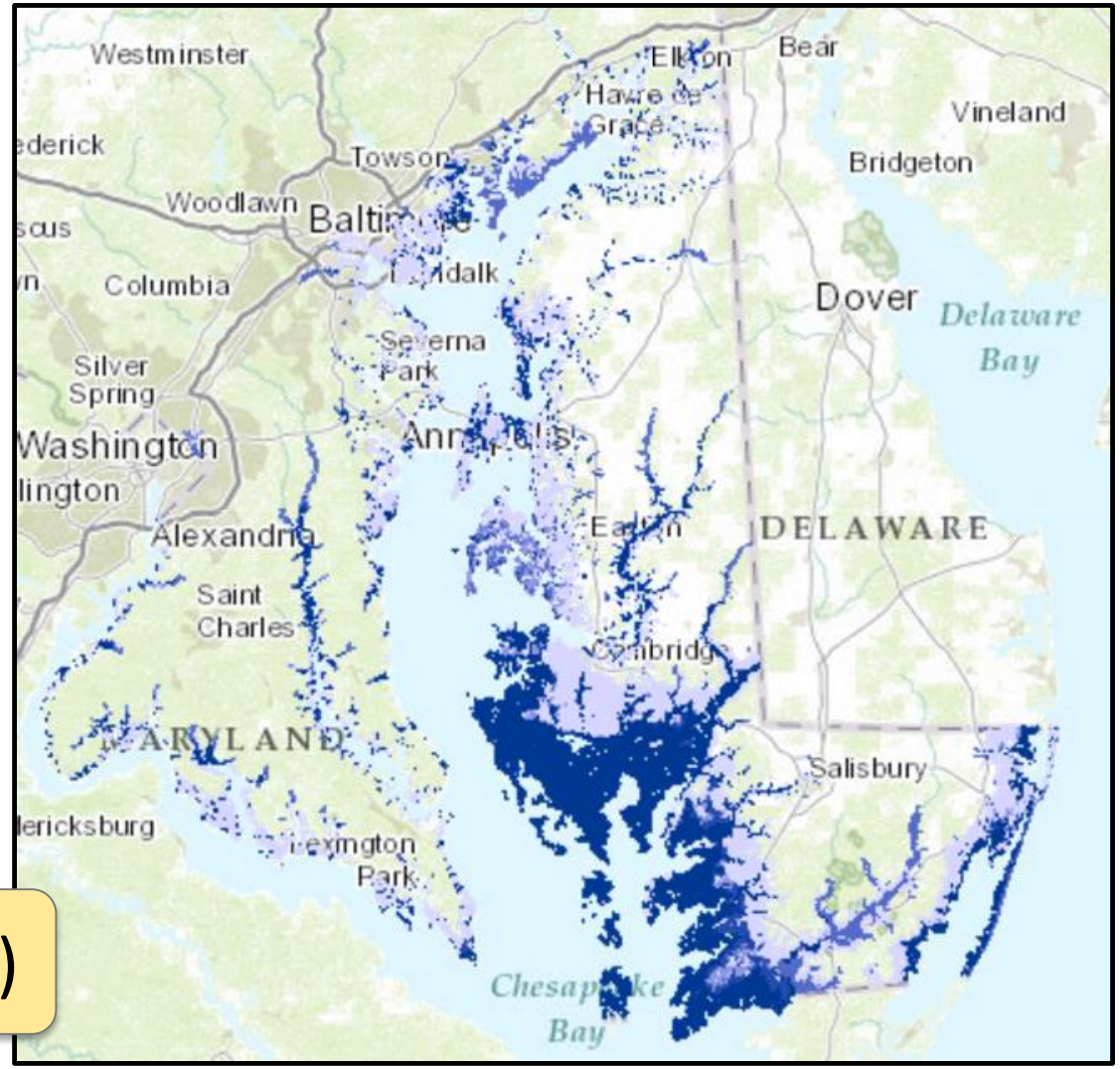
Social Vulnerability Index:

- US Census Bureau Block Groups
- 2013 American Community Survey
  - % Population ≤17 or >= 65 yrs old
  - % Population with Income Below Poverty (12mo)
  - % Population of non-proficient English Speakers
- 5 Quantile Re-Classification

Probability of Exposure

- 10 year flood (10%) (MES/Dewbery)
- 50 year flood (2%) (MES/Dewbery)
- 100 year effective floodplain (1%) (MES)
- 500 year effective floodplain (0.2%) (MES)
- Extent out to Cat 4 Storm Surge (0.1% used as proxy for low frequency high impact event) (US Army Corps)



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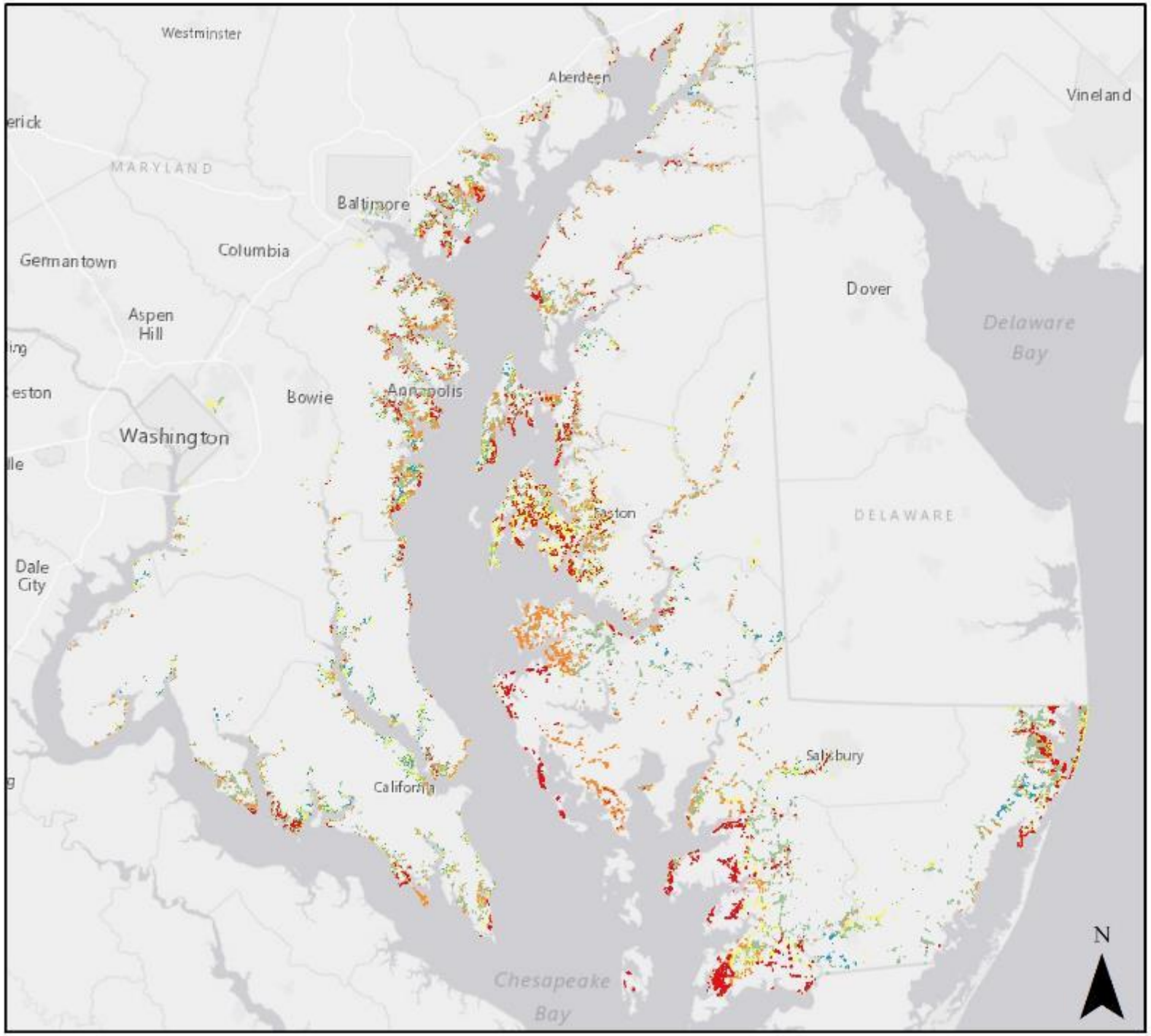

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Where does natural infrastructure occur in relation to **Community Flood Risk Areas**?

Risk Areas

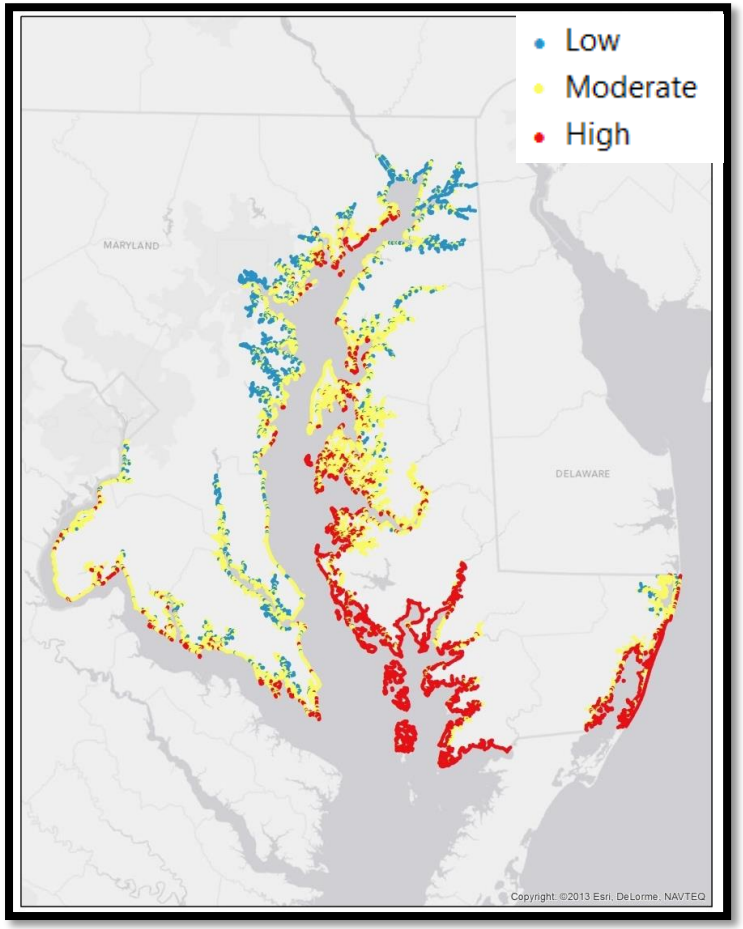
(PDI + SVI) X (Probability of Exposure)

- 1 - Very Low
- 2 - Low
- 3 - Moderate
- 4 - High
- 5 - Very High

Step 2: Natural Features Analysis

Qualitative estimate of coastal exposure:

- Shoreline Type/Geomorphology (NOAA ESI; VIMS Shoreline Inventory; DNR living shorelines)
- Elevation/Relief (Lidar; average elevation within 5km)
- Sea Level Rise (2100; 1.7 m; localized by county)
- Wave Exposure (Wave Watch III; DNR bathymetry; fetch)
- Surge Potential (SLOSH Cat2 above ground surge height)
- Historic Erosion (MGS Shoreline Erosion Rates)



Low Hazard **High Hazard**

1	2	3	4	5

Relative Habitat Ranks

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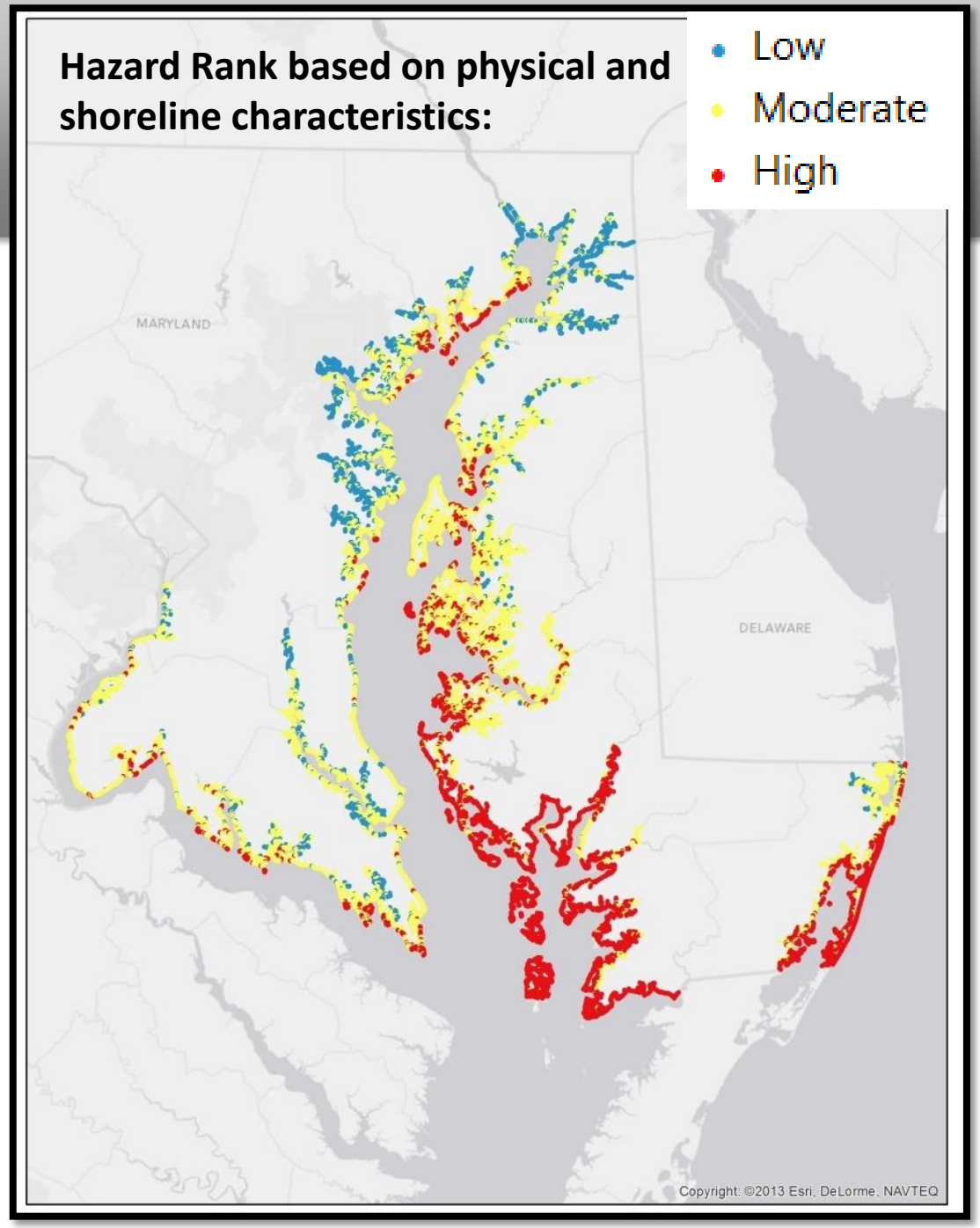
Habitat	Rank	Distance from Shore (m)	Data Source
Coastal forest	1	500	NWI, UMD 1meter, 120 ft wide and 1 acre
Marshes	2	250	NWI, DNR wetlands
Dunes	3	300	Assateague Island National Seashore dunes; Army Corps Ocean City dunes
Seagrass beds	4 or 4.5	500	VIMS SAV data, 11 year composite (2004 – 2014), dense/not dense
Oyster Reefs	4	250	DNR Restored Reefs (6-12 inches; within 250 m of shore)
No Habitat	5	N/A	N/A

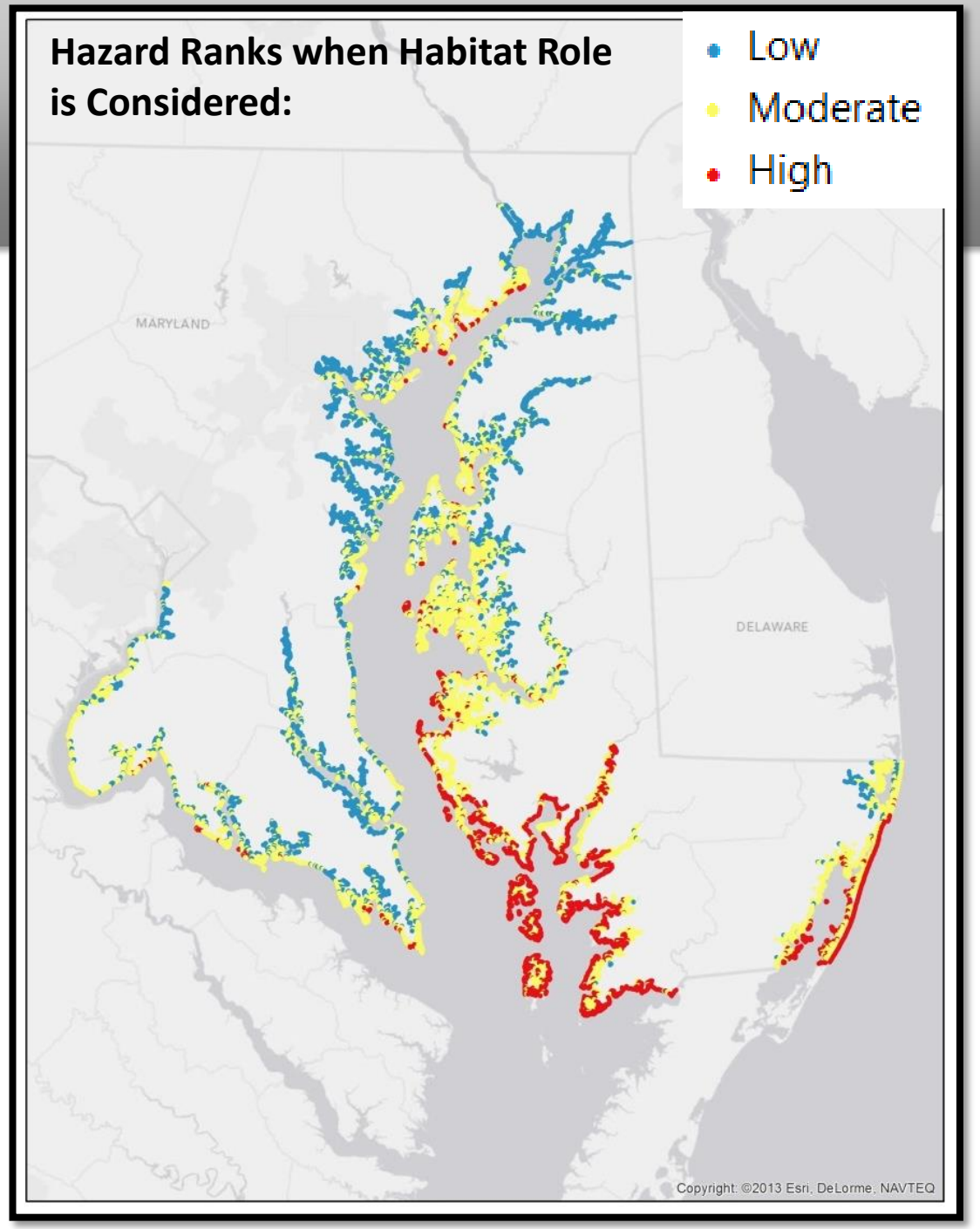
Low Hazard/Most Protected — **High Hazard/Not Protected**

1	2	3	4	5

Hazard Rank based on physical and shoreline characteristics:

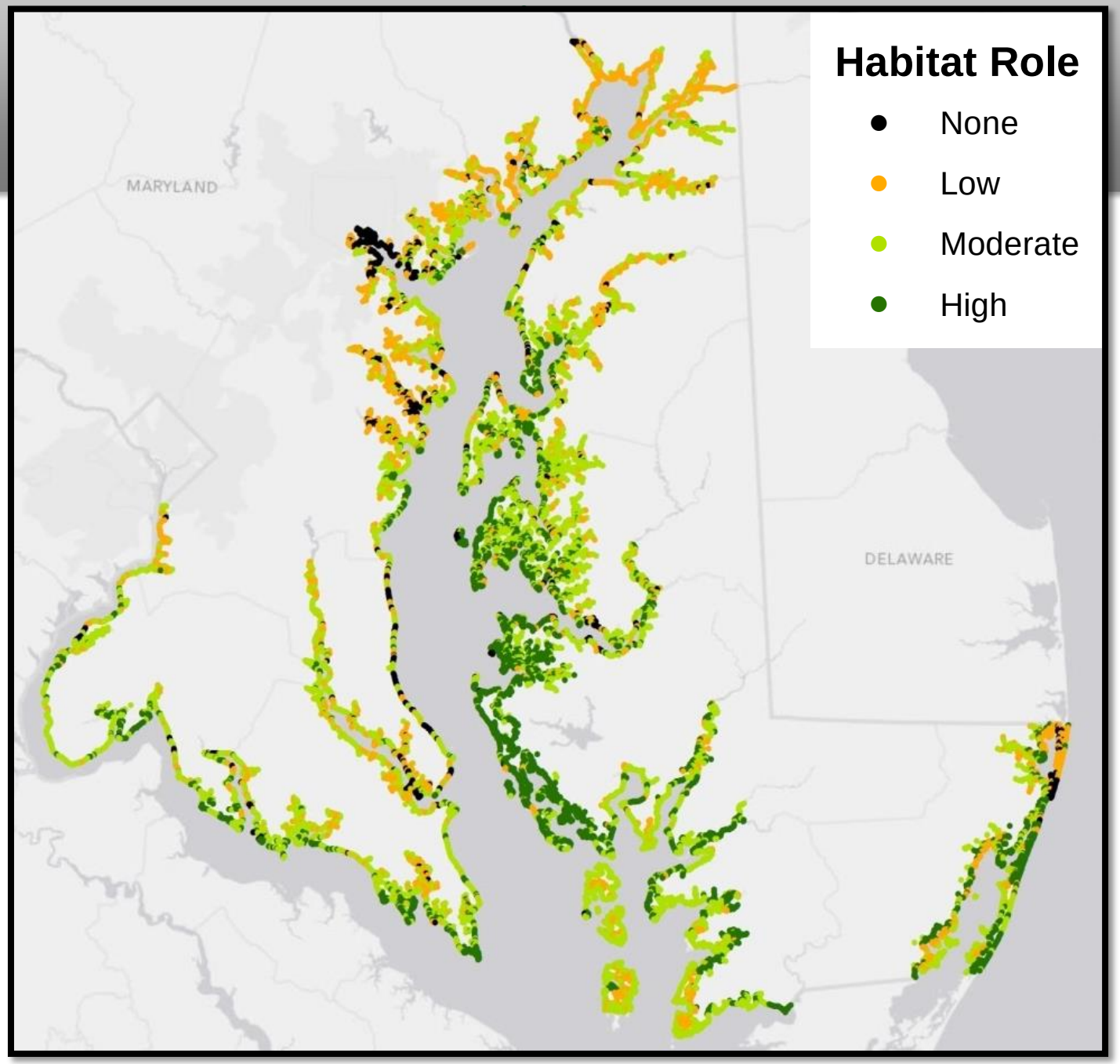


Hazard Ranks when Habitat Role is Considered:



Habitat Role

- Relative habitat role in coastal hazard reduction.
- Prioritize shorelines with high habitat role for protection.
- Where are Community Flood Risk Areas in relation to shorelines with high habitat role?



Assessment Steps

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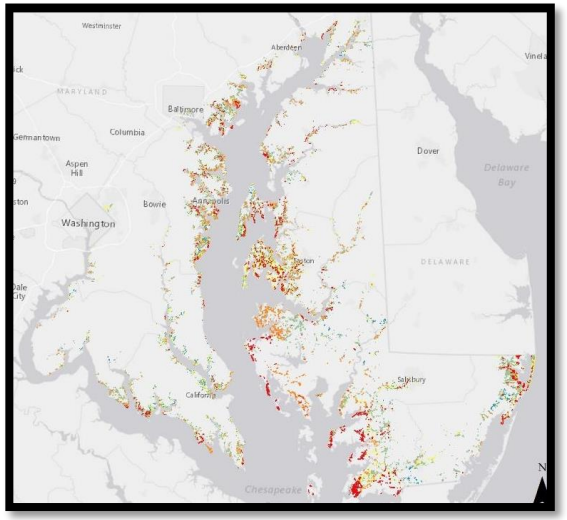

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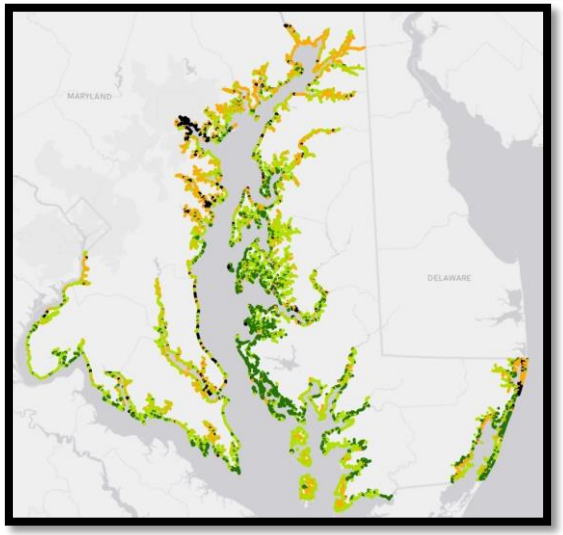


3. **Identify Priority Action Areas** – Tier I and II shoreline conservation/restoration priorities for targeting state resources; marsh complex protection priorities.

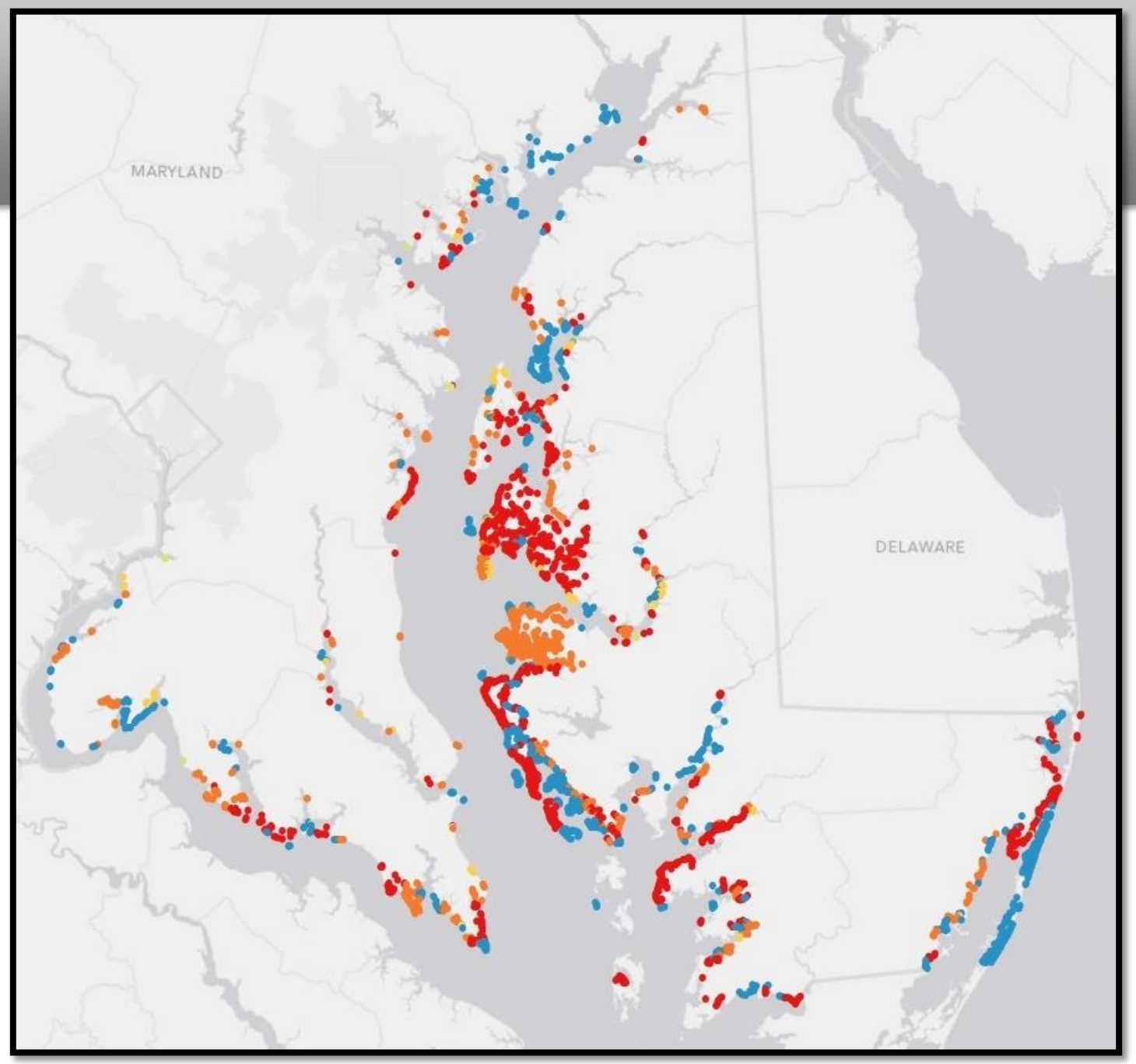
Tier I Priorities

1. High Habitat Role
2. Transition to High Hazard Shoreline if Habitats are Lost

Priority Areas

Maximum Community Risk within 1km

5 - Very High Risk	204 mi
4 - High	127 mi
3 - Moderate	15 mi
2 - Low	4 mi
1 - Very Low	< 1 mi
0 - No Risk areas within 1 km	165 mi



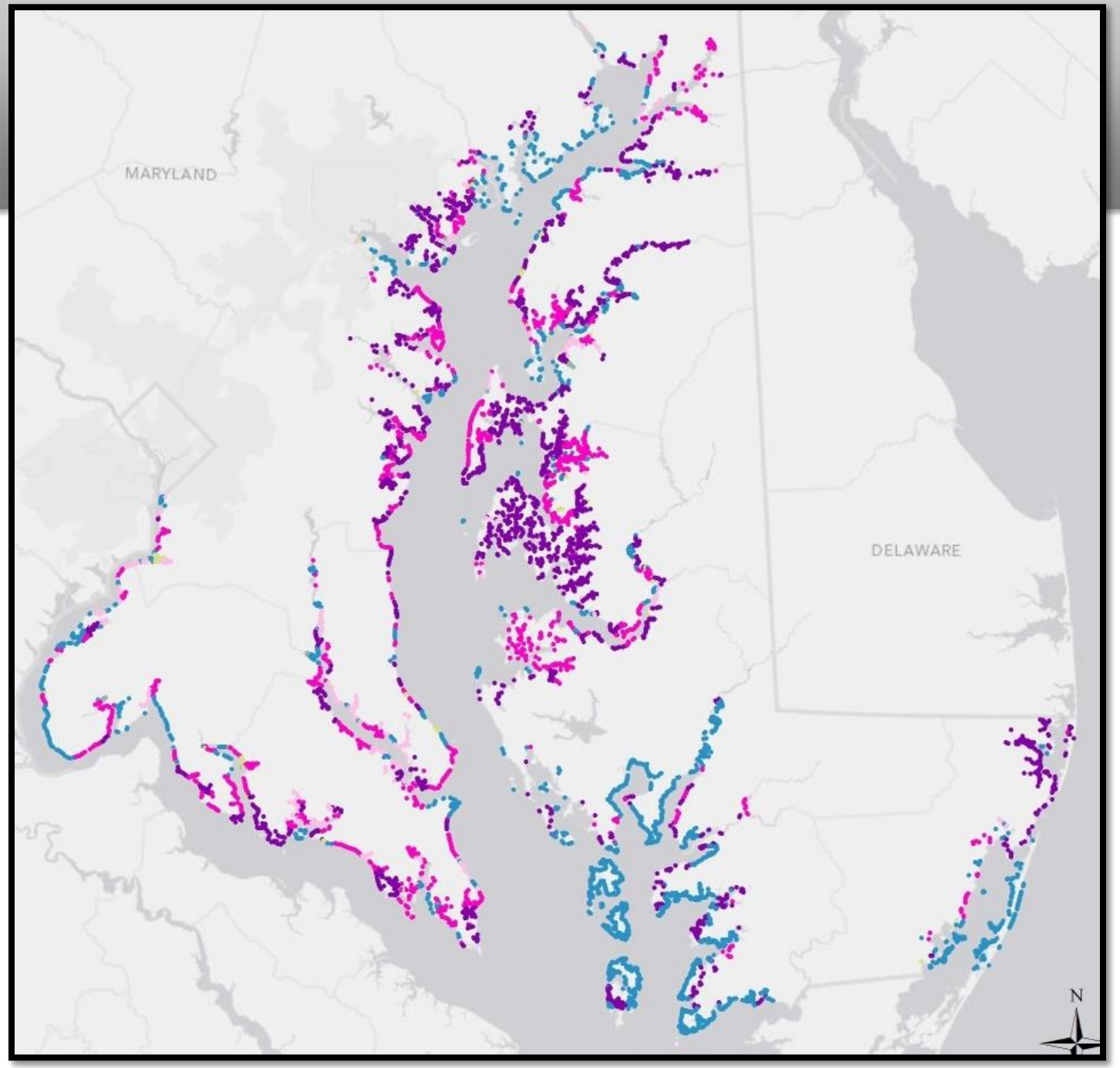
Tier II Priorities

1. Moderate Habitat Role
2. Transition to Moderate Hazard Shoreline if Habitats are Lost

Tier 2 Priority Areas

Maximum Community Risk within 1km

5 - Very High Risk	389 mi
4 - High	254 mi
3 - Moderate	57 mi
2 - Low	11 mi
1 - Very Low	4 mi
0 - No Risk areas within 1 km	339 mi



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Elevation_Hazard	Sea_Level_Rise_Hazard	Wave_Hazard	Storm_Surge_Hazard	Erosion_Rate_Hazard	Forest_Present
very low	low	very low	very low	low	yes
very low	low	very low	very low	low	yes
moderate	low	moderate	very high	low	yes
moderate	low	low	very low	low	yes
moderate	low	low	very low	very low	no
high	low	moderate	very high	low	no
high	low	moderate	very high	low	no
very low	low	moderate	low	very low	yes
very low	low	moderate	very low	low	yes
very low	low	high	very low	very low	yes
very low	low	high	very low	very low	yes

Hazard_with_Habitats	Hazard_without_Habitats	Habitat_Hazard_Reduction	Priority_Area	Community_Flood_Risk
low	low	low	n/a	high
low	low	moderate	n/a	high
moderate	moderate	high	Tier 1	high
moderate	moderate	moderate	n/a	n/a
moderate	moderate	low	n/a	n/a
high	high	moderate	n/a	n/a
high	high	moderate	n/a	n/a
low	moderate	moderate	n/a	n/a
low	low	low	n/a	high
low	moderate	low	Tier 2	high
low	moderate	low	Tier 2	high

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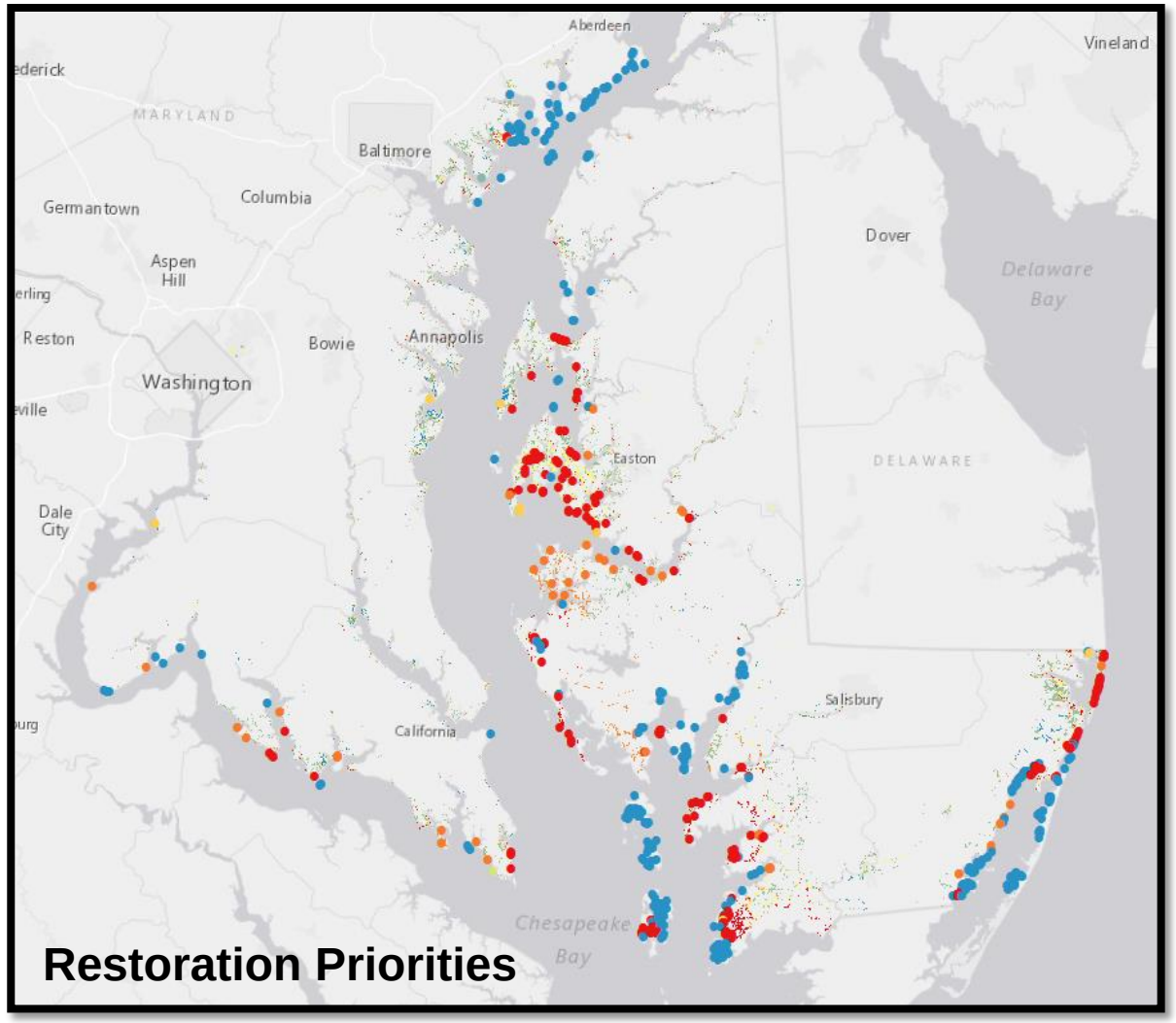
Chesapeake Coastal Service

Data Queries

- Where does habitat currently provide a low/moderate role?
- Identify priorities adjacent to Highest Community Flood Risk Area
- Identify priorities within High Priority Watersheds for TMDL
- Identify priorities adjacent to wetland adaptation areas…



What about Inland Features?

- FACT: The InVEST model provides protective capacity information at the shoreline.
- BUT, Coastal Forests and Marsh Complexes extend inland, providing protective benefits to communities that do not sit directly adjacent to the shore.
- SOLUTION: Separate indices for natural feature complexes.
  Marsh Protection Index

Marsh Protection Potential Index

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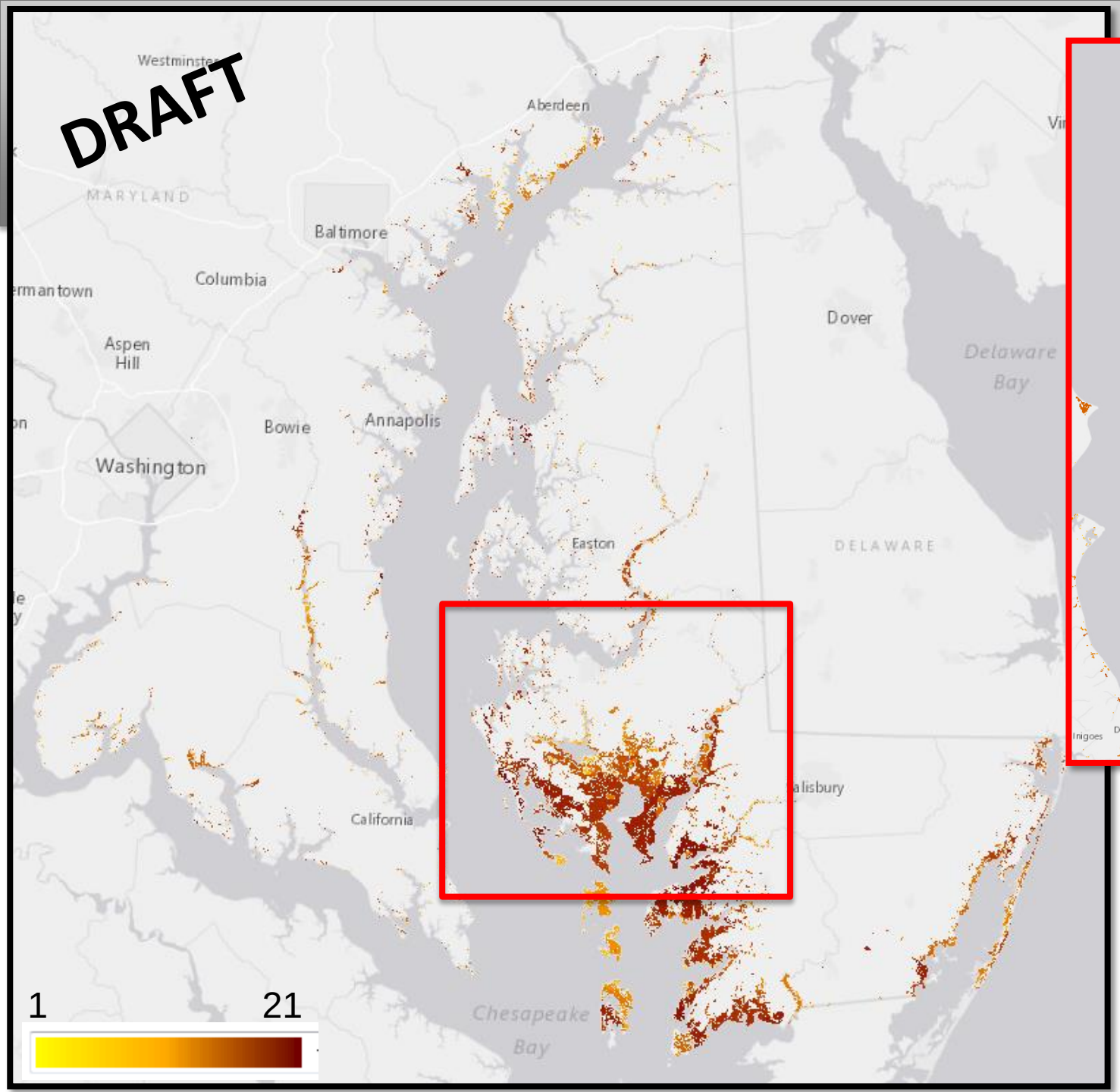
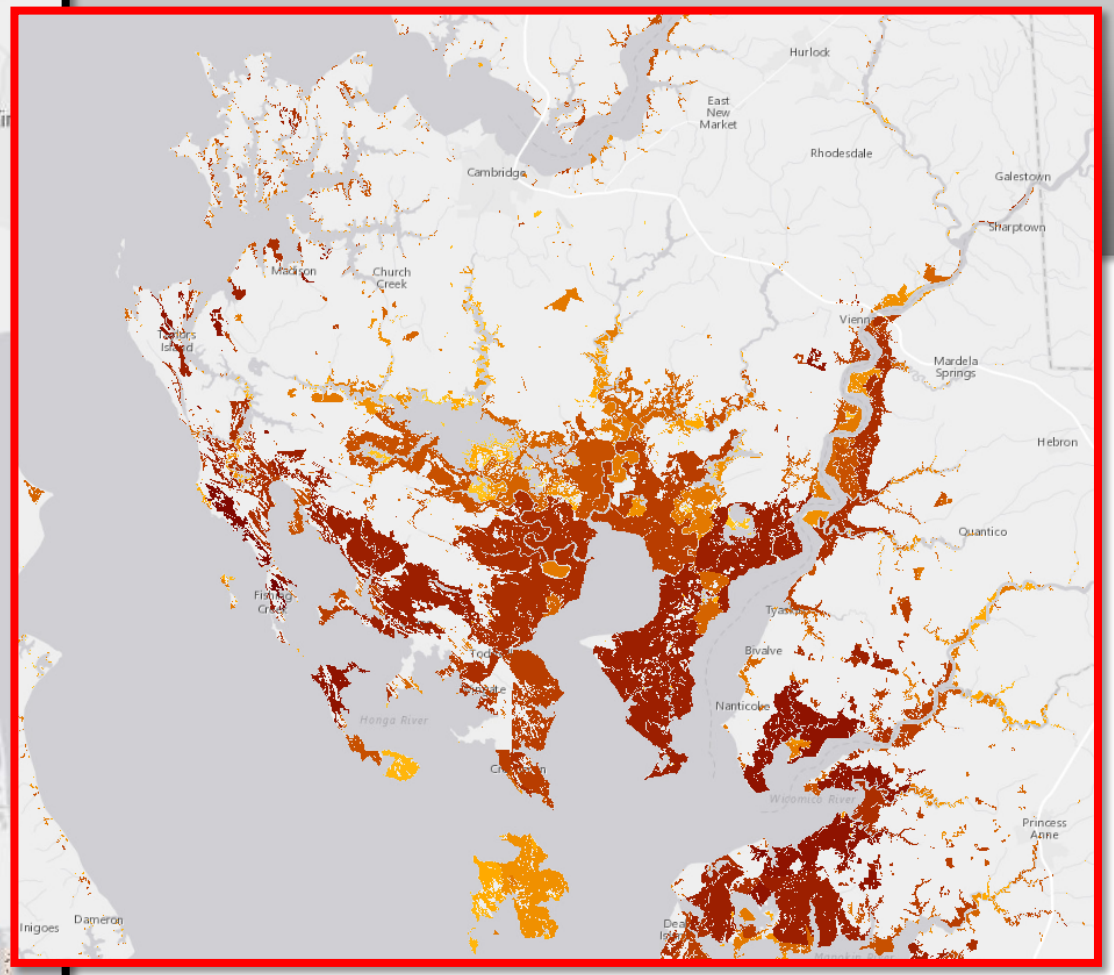
Rank existing marshes by their ability to protect people from coastal hazards, using the following characteristics:

1. **Protective capacity** (Area/Size)
2. **Proximity to hazards** (Shorleine Hazard Ranks; 100/500yr Floodplains)
3. **Proximity to people** (Population Density/Social Vulnerability Index)
4. **Persistence** (% of Marsh persisting in 2100; Wetland Adaptation Areas)
5. **Proximity to other protective habitats** (Coastal Forests; Tidal Wetlands; Dunes; SAV; Oysters)

Photo Credit: NOAA via www.climate.gov





The Index will be updated as we increase our knowledge of marsh role in wave attenuation and other ecosystem services in the Bay region.

GreenPrint Ecological Scorecard

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Property: [redacted]	County: Charles Map / Parcel: Multi **In Targeted Ecological Area?** Yes	**Final Score** 116

Step #1: Ecological Value Ranking (100 points possible)	
A. Landscape Score	
I. Overall Landscape Score (10 points possible for each of the following categories - total 40 points):	
a. Green Infrastructure	9.3
b. Rare Species	2
c. Aquatic Life - Tidal or Non-Tidal	4
d. Forests Important for Water Quality Protection	6
Subtotal (Overall Landscape Value Score):	21.3
II. Targeted Ecological Area (TEA) Bonus (20 points if more than 50 acres is in a TEA or 25% is in a TEA):	20
B. Parcel Score (10 points possible for each of the following categories - total 40 points):	
a. Green Infrastructure	8.8
b. Rare Species	9
c. Aquatic Life - Tidal or Non-Tidal	3
d. Forests Important for Water Quality Protection	6.3
Subtotal (Parcel Value Score):	27.1
Step #1 Total - Ecological Value Score:	**68.4**
Step #2: Special Adjustment for Multiple Benefit Ranking (20 points possible)	
A. Recreation Score (0, 5, or 10 points)	10
B. Historic or Cultural Value (0 or 5 points)	0
C. In-holding or Adjacency (0 or 5 points)	5
Step #2 Total - Multiple Benefit Score:	**15**
Step #3: Habitat Maintenance or Restoration Values Ranking ([0.2 x Step 1] points possible)	
A. If the parcel requires proactive management to maintain habitat, OR provides a restoration opportunity, then multiply Step #1 total by 0.1.	6.8
B. If more than 5 acres of a designated Climate Change Adaptation Area falls within the parcel, then multiply Step #1 total by 0.1.	6.8
Step #3 Total - Habitat Maintenance or Restoration Value Score:	**13.7**
Subtotal of Steps #1, #2, and #3:	97.1
Step #4: Management and Operations Ranking (Yes, No, or Undetermined)	
A. Parcel desired by DNR & parcel management is possible - Proceed with acquisition.	Yes
B. No known or reliable committed process for managing the parcel. **STOP** don't acquire.	
Step #5: Consistency with Local Land Protection ([0.25 x Step 1+2+3] points possible)	
Amount of protected land acres within one mile of parcel: 263	19.4
Total of Steps 1 to 5 - FINAL SCORE	**116.5**

Questions?

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Special thanks to Steering Committee participants:

MD Critical Area Commission, MD Department of Planning, MD Department of the Environment, MD Emergency Management Agency, US Army Corps of Engineers, National Oceanic and Atmospheric Administration, US Fish & Wildlife Service, Eastern Shore Land Conservancy, The Conservation Fund, and all DNR Divisions

Relative Hazard Ranks

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Hazard Variable	Hazard Rank				
	Very Low (1)	**Low (2)**	**Moderate (3)**	**High (4)**	**Very High (5)**
Shoreline Type	Bulkhead	Rip-rap	Groins, breakwaters, jetty, unconventional, living shorelines	Sand/mud	dilapidated bulkhead
Relief	14.7 - 81.6 m	5.9 - 14.7 m	2.3 - 5.9 m	0.5 - 2.3 m	1 - 0.5 m
Sea Level Rise	N/A	1.32 - 1.42 m	1.46 - 1.48 m	1.49 - 1.67 m	2.05 - 2.35 m
Wave Exposure	Geometric Interval 1	Geometric Interval 2	Geometric Interval 3	Geometric Interval 4	Atlantic Shoreline
Surge Potential	Quantile 1	Quantile 2	Quantile 3	Quantile 4	Quantile 5
Erosion Rate	Accretion or Hardened	No change, Unknown, 0 - 2 ft/yr	2 - 4 ft/yr	4-8 ft/yr	> 8 ft/yr

Relative Ranking: Geometric Mean

Exposure Index:

$$EI = \left(\prod_{i=1}^{n} R_i \right)^{1/n}$$

$$[(\text{Rank}_{\text{Geomorphology}})(R_{\text{Relief}})(R_{\text{Habitat}})(R_{\text{SLR}})(R_{\text{Wave}})(R_{\text{Surge}})(R_{\text{Erosion}})]^{1/7}$$

What if habitats were lost?

R_{Habitat} = 5 (high exposure) for all shoreline segments