Tidal Marsh Adaptation Meeting with *Envision the Choptank*

Tidal Marsh Synthesis Scenarios

These scenarios are based on the NOAA Landscape Scale Marsh Resilience Framework marsh resilience categories and a decision matrix developed by USGS (Ganju et al. 2023), which correlates elevation and the Unvegetated to Vegetated Ratio (UVVR) in a geospatial analysis to guide marsh actions. These resources/data pertain to saltwater/brackish tidal marshes. However, adaptation scenarios could apply to tidal freshwater marshes.

Protection Scenario: Use data to identify *healthy marshes* that are susceptible to SLR and have the potential to migrate. Indicators:

- Good Existing Marsh Integrity/Condition (UVVR)
- High Climate Change Risk (subject to sea level rise)
- High Adaptive Capacity (migration potential, adjacent to public lands)

Indicator for Marsh Adaptation	Data Layers
• High Marsh Integrity	• UVVR
• High Vulnerability to Sea Level Rise	• Existing Tidal Marsh Layer • NOAA Sea Level Rise Scenarios (2050 and 2090 Intermediate and Intermediate High)
• High Adaptive Capacity	• Marsh Migration Corridor Envelope (MMCE) - Model Synthesis • MD Wetland Adaptation Areas • Protected Lands

Restoration Scenario: Use data to identify *degraded marshes* that are susceptible to SLR and have the potential to migrate.

- Degraded Existing Marsh Integrity/Condition (UVVR)
- High Climate Change Risk
- High Adaptive Capacity

Indicator for Marsh Adaptation	Data Layers
• Low Marsh Integrity	• UVVR
• High Vulnerability to Sea Level Rise	• Existing Tidal Marsh Layer • NOAA Sea Level Rise Scenarios (2050 and 2090 Intermediate and Intermediate High)
• High Adaptive Capacity	• Marsh Migration Corridor Envelope (MMCE) - Model Synthesis • Protected Lands

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Choptank and Little Choptank Rivers - Maps and Summaries (DRAFT)

The Chesapeake Bay Program's Climate Resiliency Workgroup aims to support partnership building and identification of marsh adaptation projects. This document has maps showing data related to marsh health, sea level rise (SLR) vulnerability, social vulnerability, and ecosystem services. Select forested and non-forested marshes upriver in the Choptank (referred to as "upriver)" and brackish tidal marshes downriver/neck area of the Choptank and Little Choptank Rivers (referred to as "downriver)" are indicated by the red polygons in the maps. Note that these maps are for only scoping out potential areas for marsh adaptation projects and proper on-site vetting of marsh condition will be needed for any project design. Selected data align with past funding opportunities where proposals had to connect restoration projects with coastal resiliency, fish habitat, or under-resourced communities that may become available again. These funding opportunities included NOAA Transformational Habitat Restoration and Coastal Resilience Grant, NOAA Coastal Habitat Restoration and Resilience Grants for Tribes and Underserved Communities, NFWF Coastal Resilience Fund, and NFWF/USFWS Chesapeake Wild Program.

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Maps developed by Jamileh Soueidan, Chesapeake Research Consortium

List of Maps

Maps labeled "A" focuses on tidal marshes upriver in the Choptank, which includes nonforested and forested tidal freshwater marshes. Maps labeled "B" focuses on tidal marshes downriver in the Choptank and Little Choptank Rivers, including the Neck area, which are mostly brackish grass marshes.

- Maps 1A-B: Tidal Marshes in the Choptank and Little Choptank Rivers
- Maps 2A-B: Marsh Health (UVVR) and Marsh Migration Corridor Envelope (2' Future SLR Scenario)
- Maps 3A-B: Marsh Health (UVVR) and Marsh Migration Corridor Envelope (2' Future SLR Scenario) with MD Protected Lands
- Maps 4A-B: Land Use- Impervious Surface, Agriculture, and Forested Lands
- Maps 5A-B: Maryland Wetland Adaptation Areas
- Maps 6A-B: Maryland EJ Score, NOAA SLR Int-High (2050 & 2090)
- Maps 7A-B: Fish Habitat Diadromous Scores
- Maps 8A-B: Fish Habitat Estuarine Scores
- Maps 9A-B: Maryland Shoreline- Percent Armored

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Marsh Adaptation Strategies based on Marsh Health and Potential Marsh Migration

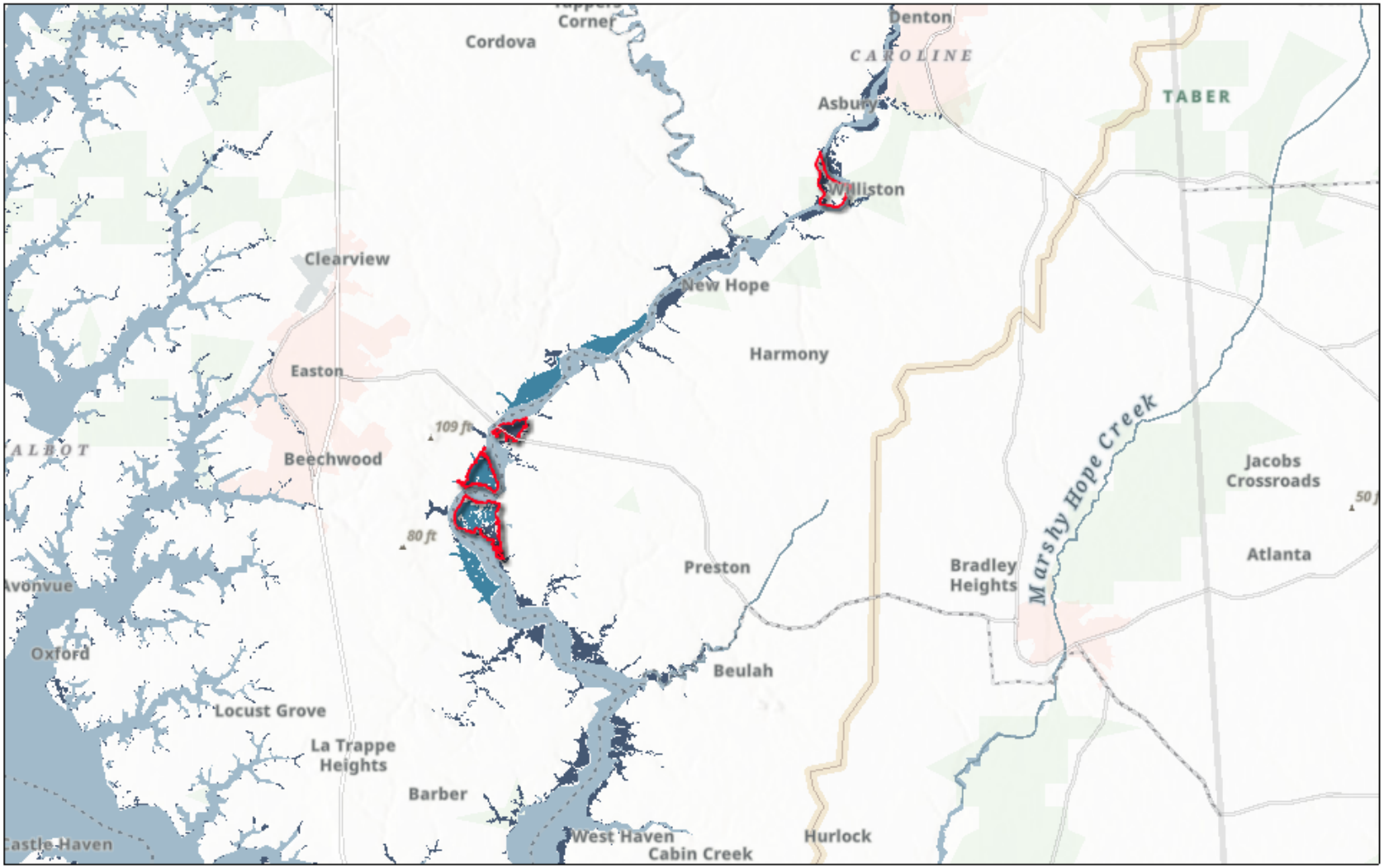
These maps display available data related to sea level rise vulnerability, marsh health, and marsh migration potential.

Maps 1A-B: Tidal Marsh Size

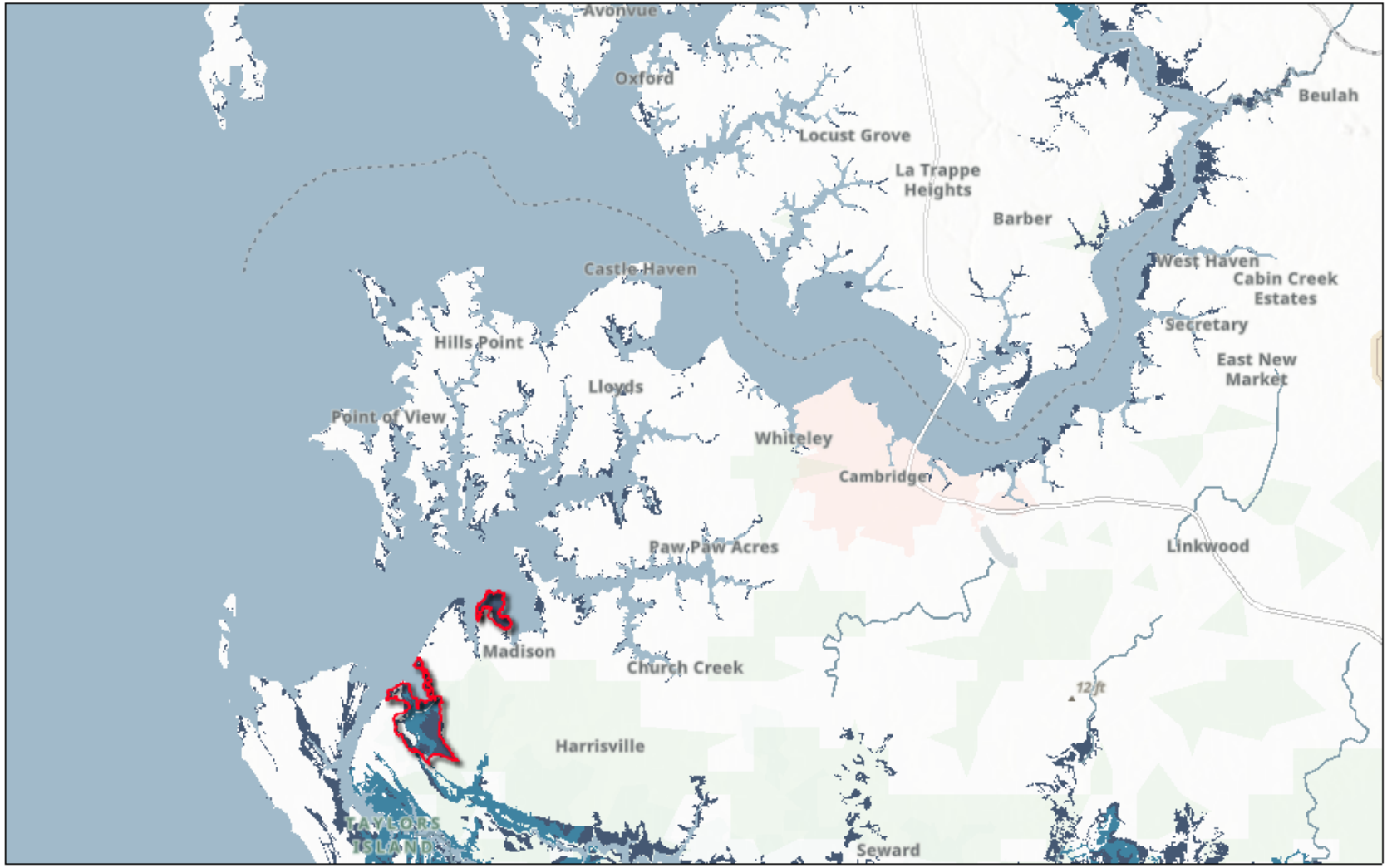
Purpose: Showcase opportunities for large-scale marsh adaptation

Location of existing tidal marshes in and around the Choptank and Little Choptank Rivers from the National Wetland Inventory. Marshes are categorized by 0-500 acres and > 500-1000 acres.

Map 1A – Tidal Marshes in the Choptank River (Upriver)



Map 1B – Tidal Marshes in the Choptank & Little Choptank Rivers (Downriver)



Tidal Marsh Adaptation Meeting with *Envision the Choptank*

Map 2A-2B*:* Marsh Health (UVVR) and Marsh Migration Corridor Envelope (2' Future SLR)

Purpose: Identify restoration and/or protection potential of existing marshes

The Marsh Migration Corridor Envelope (MMCE) combines outputs from three marsh migration models to determine areas of potential marsh migration to future SLR scenarios in Chesapeake Bay based on the methodology developed by the Virginia Institute of Marine Science (VIMS; Mitchell et al., 2023). Models included are the Sea Level Affecting Marshes Model 5.0 (SLAMM), a modified Integrated Valuation of Ecosystem Services and Tradeoffs (InVEST), and the Marsh Migration Mapping Method of the NOAA Sea Level Rise Viewer (NOAA). Existing tidal wetlands and impervious surfaces were removed from the MMCE.

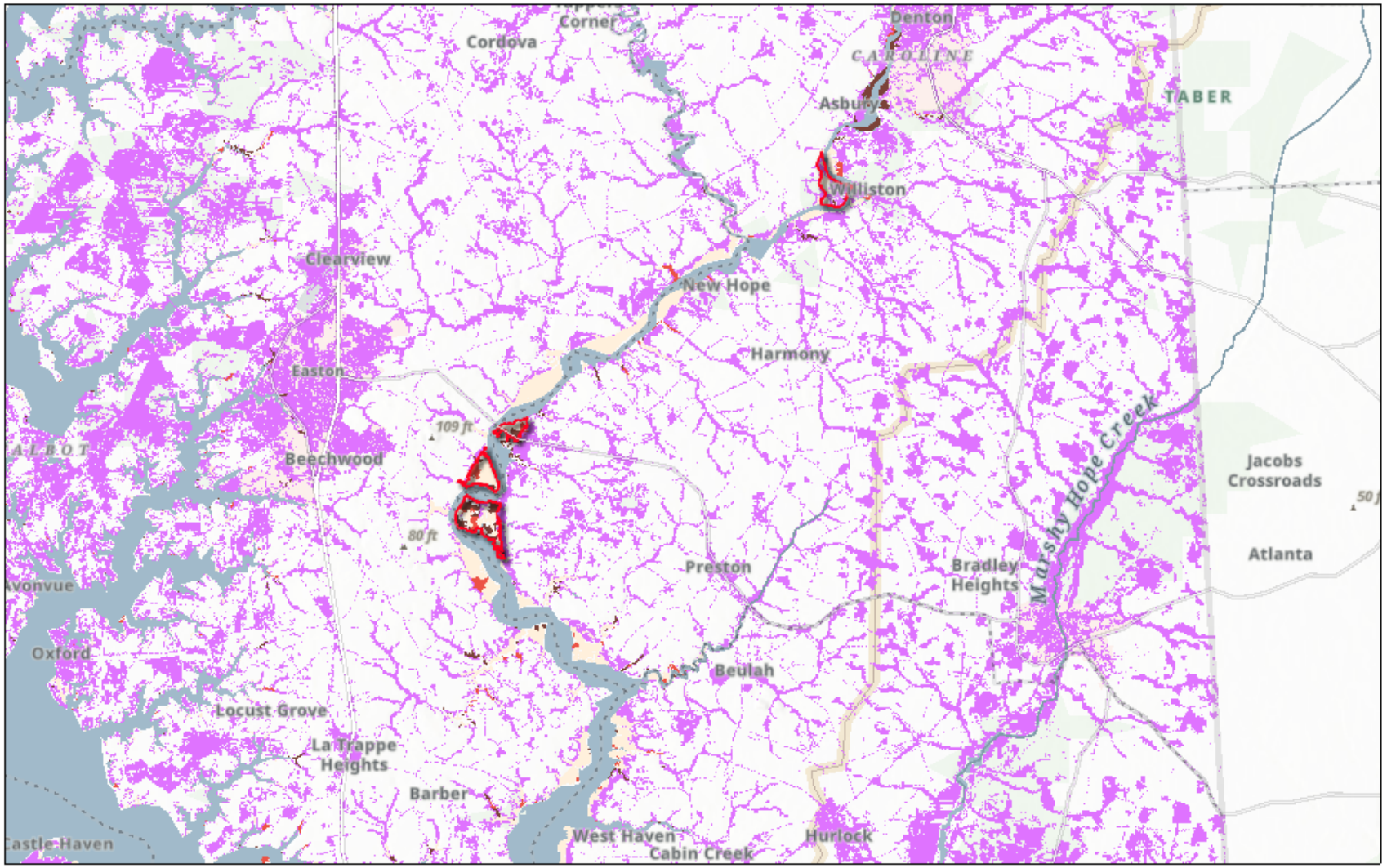
The unvegetated to vegetated ratio (UVVR) was developed by the USGS and is broadly an indicator of marsh health and stability for *tidal saltmarshes and nonforested tidal freshwater marshes*. The UVVR metric does not include information on forested tidal freshwater marshes. A smaller UVVR number indicates greater marsh stability. A UVVR threshold greater than 0.15 indicates disintegration of the wetland complex making it less resilient to sea level rise. Restoration efforts that maintain a 0.15 or lower UVVR will allow for increased likelihood for marshes to persist over time.

Protection/Conservation Scenario: Upriver tidal freshwater marshes (Map 2A) have a mix of healthy (beige) and unstable (red and burgundy) areas based on the UVVR data. However, there is limited marsh migration potential under future 2' SLR scenario (~2060 timeframe; purple areas). Marsh adaptation strategies could include exploring the feasibility of placing/maintaining sediment to keep pace with SLR. Additionally, the marsh migration 2' SLR scenario indicates that the upper red polygon, which is mostly a forested tidal freshwater marsh, has the potential to become mostly a nonforested brackish tidal marsh in the future.

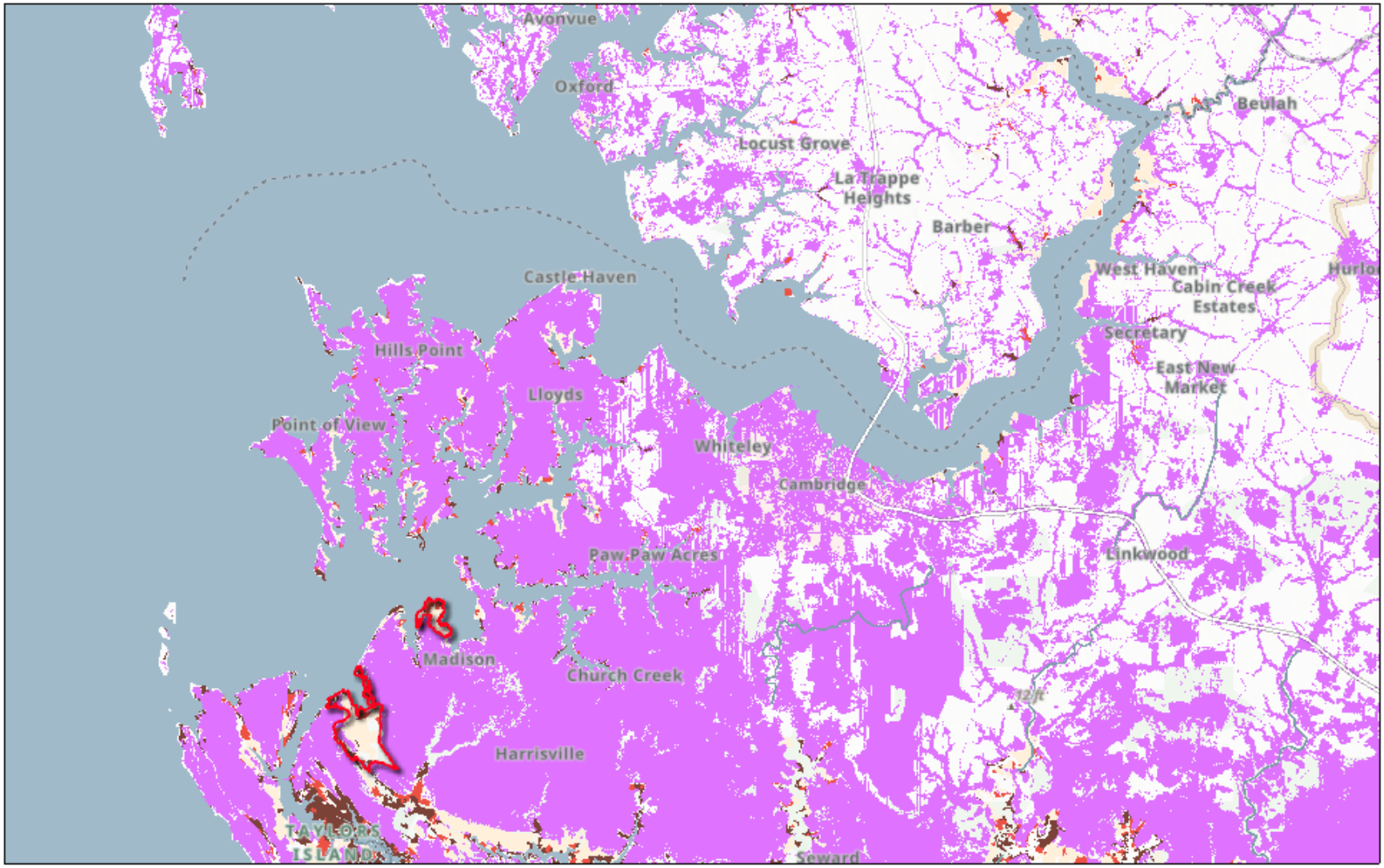
Areas of stable tidal marsh (beige area; labeled as Healthy/Stable - Conservation) exist adjacent to potential marsh migration corridors under future 2 ft. sea level rise scenario (~2060 timeframe) around the larger marsh complexes in the Little Choptank (indicated by red polygons; Map 2B). The Neck region of the Choptank has smaller size marshes with a scattered mix of stable and unstable UVVR values. Protecting stable marsh area can help prolong marsh persistence and facilitate migration as sea level rises. The marsh migration potential under the future 2 ft. SLR scenario (purple areas) encompasses most of the Neck area indicating the need to consider land use transitions over time (see Map 4B).

Restoration Scenario: Smaller marshes that are less stable (red and burgundy) adjacent to potential marsh migration areas highlight opportunities for restoration and shoreline protection efforts in Map 2B. Slowing down marsh degradation (i.e., decreasing the UVVR value by enhancing healthy vegetation) allows for the greater likelihood of increasing marsh persistence compared to taking no action. Additionally, increasing marsh health allows from the greater likelihood of marsh migration success in the future.

Map 2A - Marsh Health (UVVR) and Marsh Migration Corridor (2' SLR) (upriver)



Map 2B - Marsh Health (UVVR) and Marsh Migration Corridor (2' SLR) (downriver)



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UVVR

- Healthy/ Stable - Conservation (0 - 0.1)
- Stability Threshold (0.1 - 0.15)
- Less Healthy/ Not Stable- Restoration (> 0.15)

Multiple Models - 2 ft Sea Level Rise

- 0
- 1
- 2
- 3

World Hillshade

1:240,747

0 1.5 3 6 mi

0 2.5 5 10 km

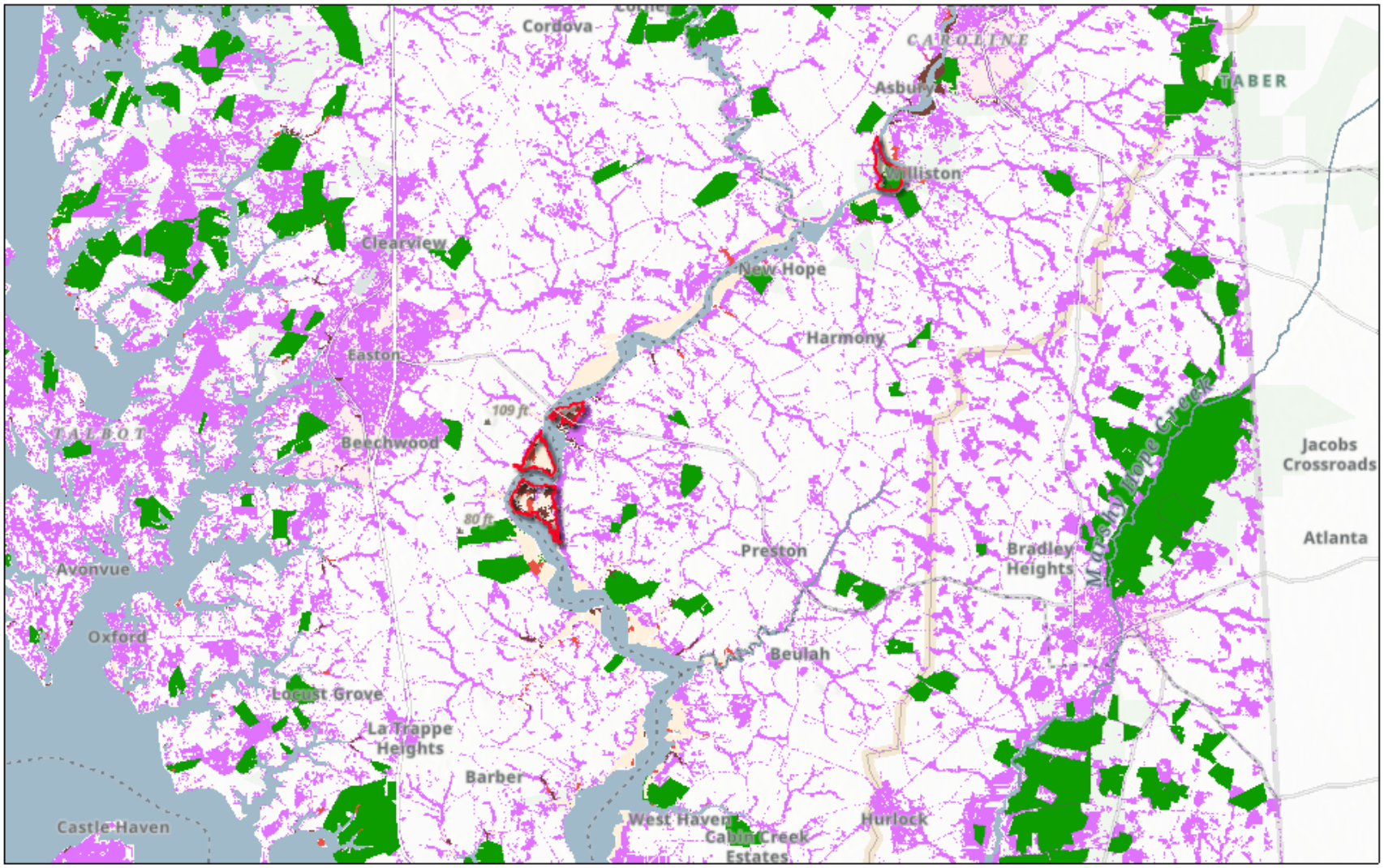
Tidal Marsh Adaptation Meeting with *Envision the Choptank*

Maps 3-5A&B—Marsh Health (UVVR) and Marsh Migration Corridor Envelope (Future 2' SLR), with MD Protected Lands, Land Use (Impervious Surface, Forested, and Agriculture), & MD Wetland Adaptation Areas

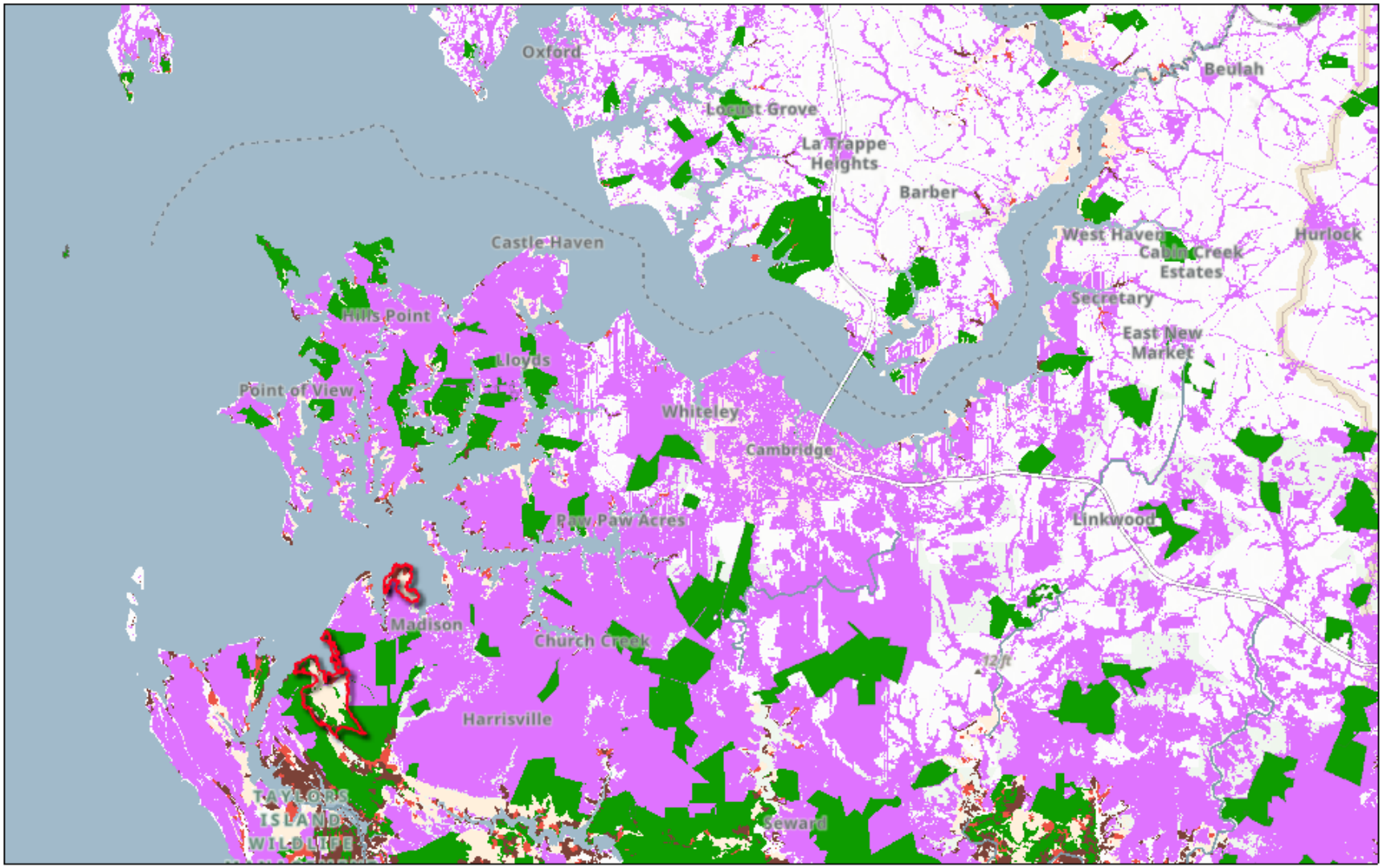
Purpose: Identify protection potential of existing marshes and identify opportunities that account for current protected lands, land-use (e.g., agriculture, forest, impervious), and community development.

Protection Scenario: Some of the marsh regions in the identified sites align with the protected lands (Map 3A-B), with marsh condition ranging from unstable to stable based on UVVR data (see Map 2 for UVVR description). Tidal marsh complexes that are within protected lands offer opportunities for faster action in protecting and restoring marsh condition due to ownership aimed for conservation. Additionally, protected lands within the Neck Region of the Choptank (Map 3B) adjoin areas with potentially suitable migration corridors (see Map 2 for Marsh Migration Corridor Envelope description). Much of the adjacent lands to the sites of interest are either largely undeveloped or agricultural (4A-B). The opportunity to facilitate marsh migration or land transition on undeveloped tracts through easements, partnerships or land acquisition can support long-term coastal resilience. There are further opportunities to work with private landowners to support natural land transition as future sea level rise impacts affect agricultural lands. Maryland's Wetland Adaptation Areas (Map 5A-B) indicate that a large portion of the Neck and along both the northern and southern shores of the river will be transitioning from uplands to wetlands by 2100 (assuming 4.3ft of sea level rise).

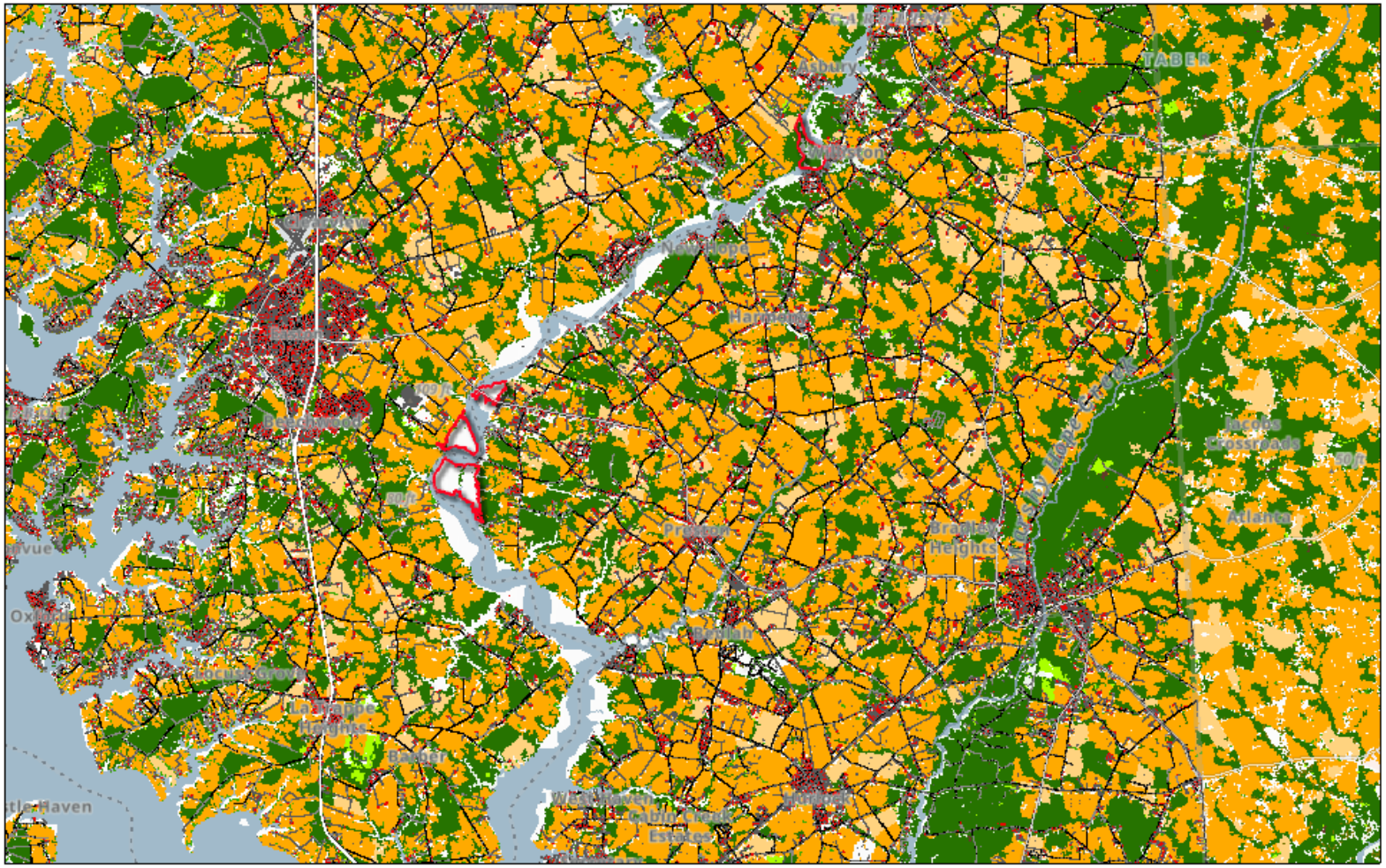
Map 3A - Marsh Health (UVVR), Marsh Migration Corridor (2') & Protected Lands (upriver)



Map 3B - Marsh Health (UVVR), Marsh Migration Corridor (2') & Protected Lands (downriver)



Map 4A - Land Use (upriver)



Land Use - Forests

- Tree Canopy over Turf Grass
- Forest
- Tree Canopy, Other
- Harvested Forest
- Natural Succession

Land Use - Agriculture

- Cropland
- Pasture/Hay

Impervious Surfaces

Maryland

GenLandUse

- Impervious Roads
- Impervious Structures
- Impervious, Other
- Tree Canopy over Impervious

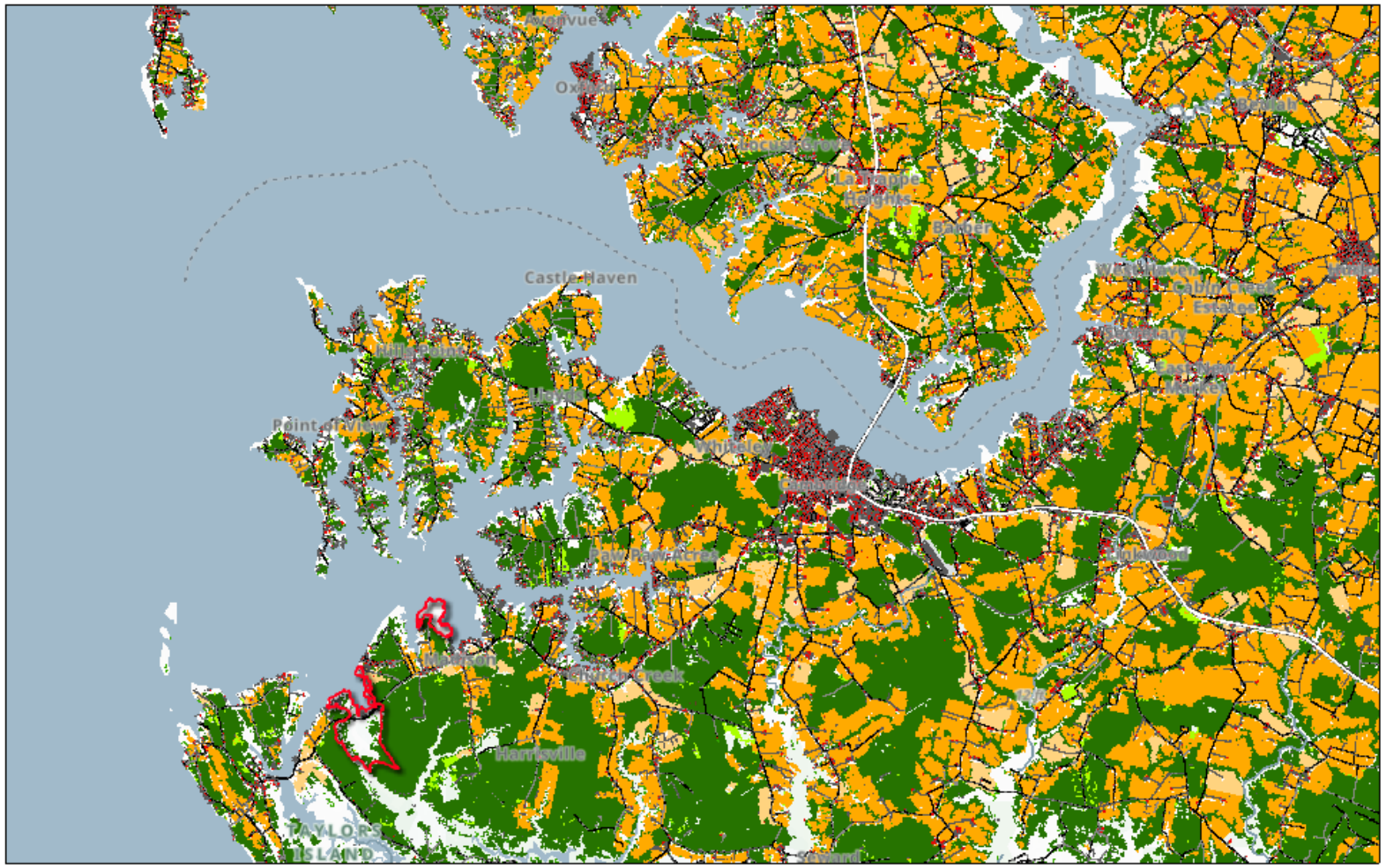
1:240,747

0 1.5 3 6 mi

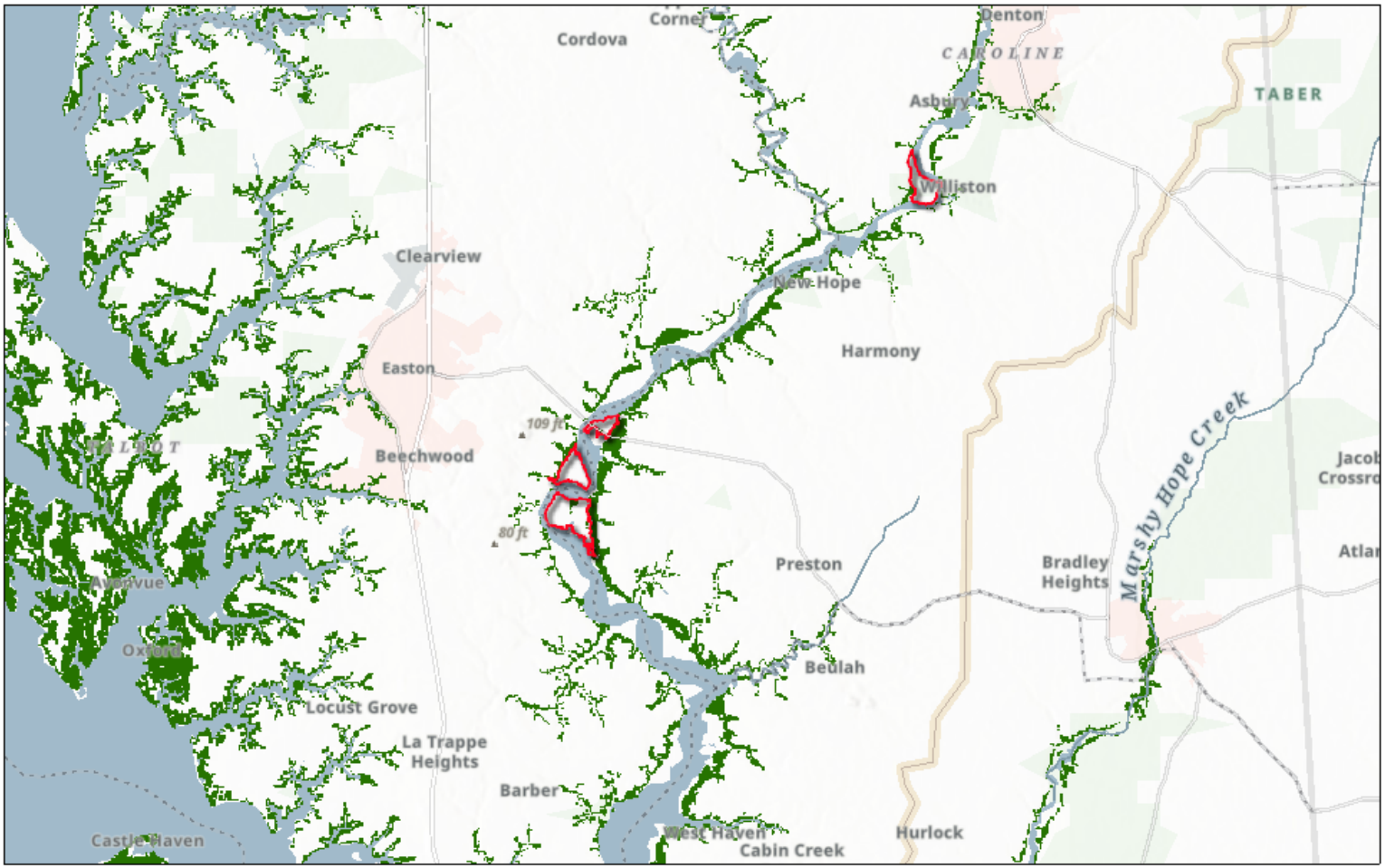
0 2.5 5 10 km

VGIN, Esri, TomTom, Garmin, SafeGraph, METI/NASA, USGS, EPA, NPS, USDA, USFWS, Esri, NASA, NGA, USGS, Sources: Esri, TomTom, Garmin,

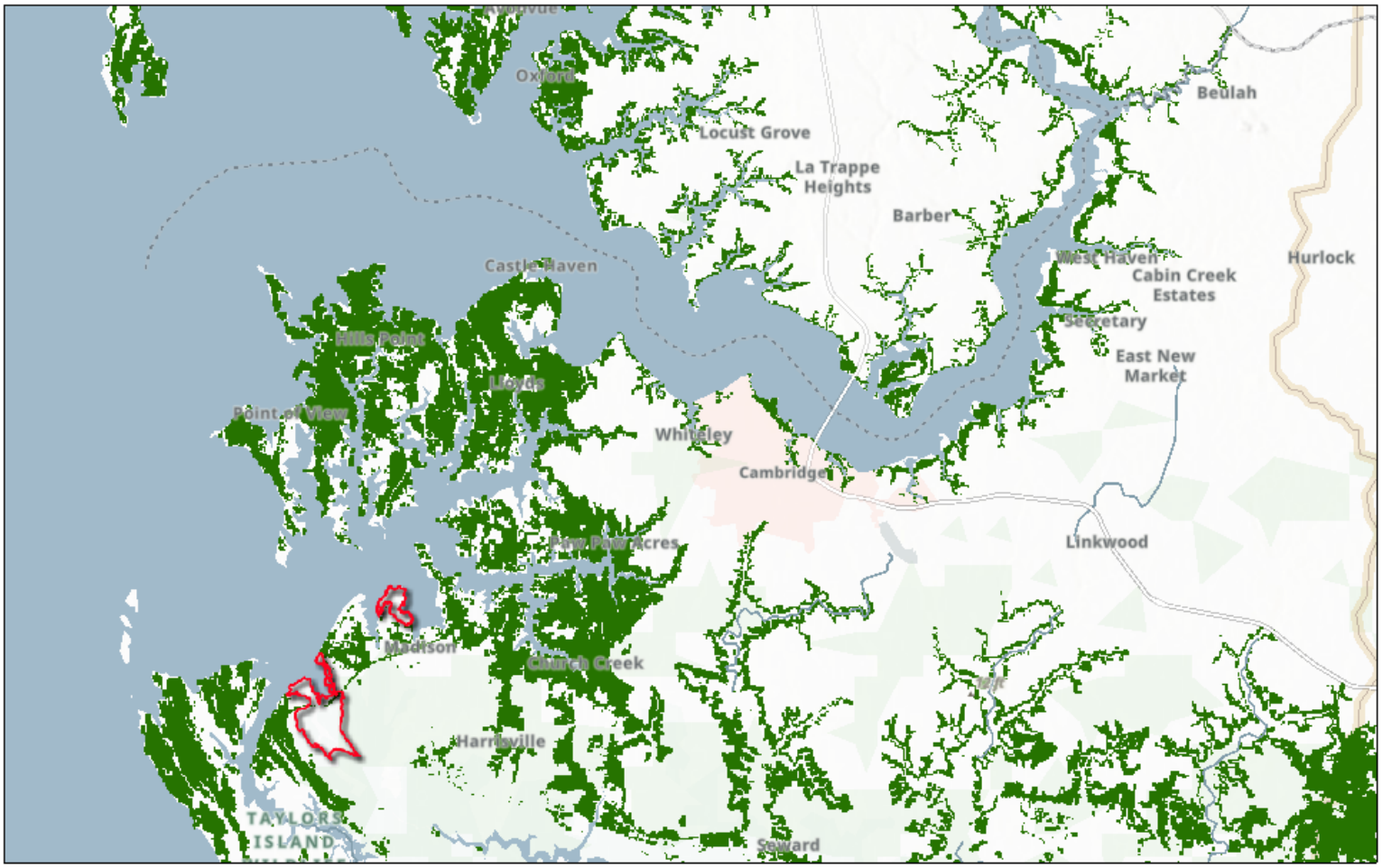
Map 4B - Land Use (downriver)



Map 5A - Maryland Wetland Adaptation Areas (Uplands to Wetlands 2100) (upriver)



Map 5B - Maryland Wetland Adaptation Areas (Uplands to Wetlands 2100) (downriver)



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2100

World Hillshade

1:240,747

0 1.5 3 6 mi

0 2.5 5 10 km

Tidal Marsh Adaptation Meeting with *Envision the Choptank*

Marsh Adaptation and Increasing Resilience of Socially Vulnerable Communities

Maps 6A&B: MD EJScreen with NOAA Sea Level Rise (2050 & 2090)

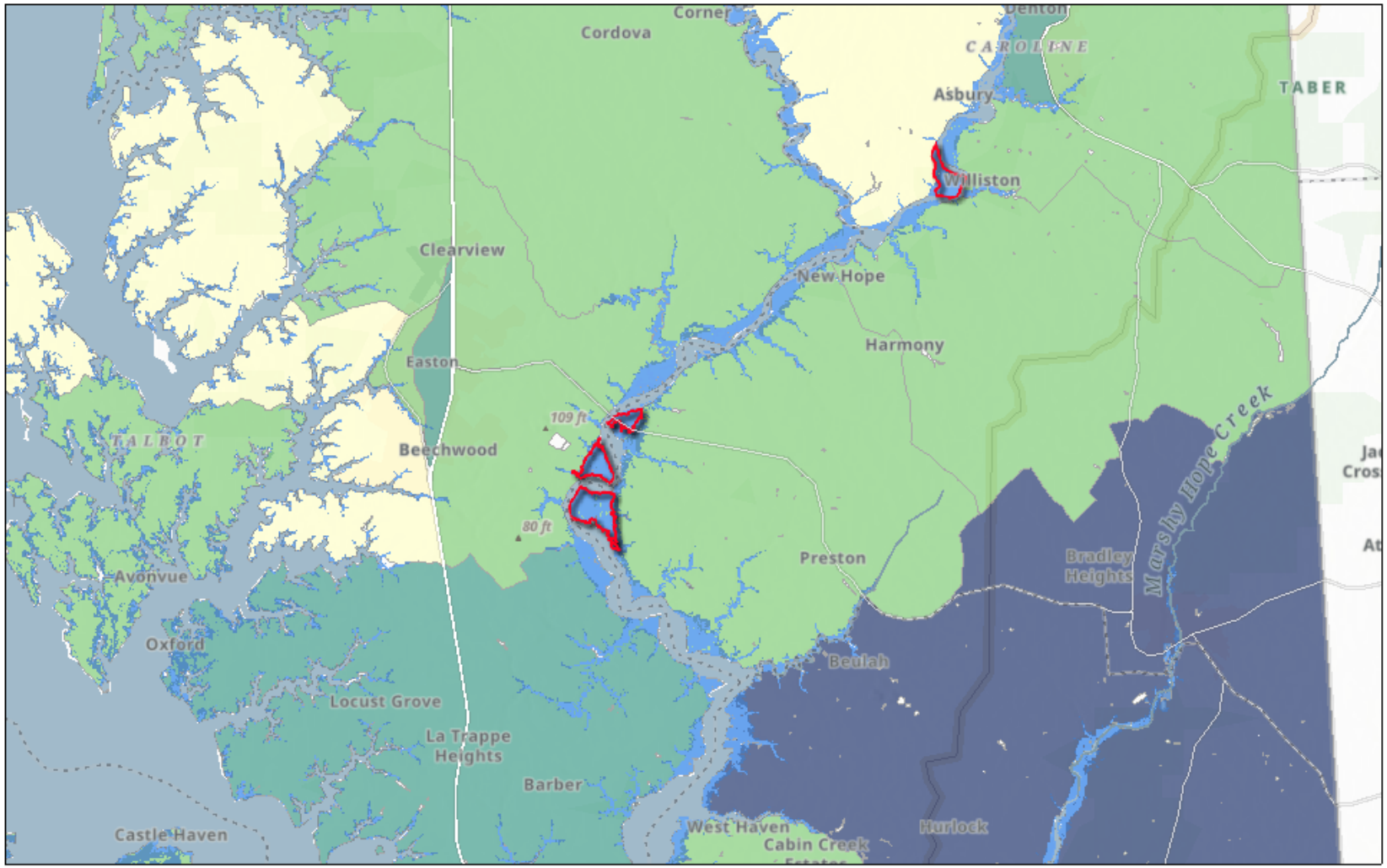
Purpose: Illustrate the increasing climate vulnerability of communities adjacent to the Choptank River as sea level rise leads to potential changes in land.

As sea level rise extends inland from the Choptank, communities along the river will be more exposed to coastal climate change impacts and land transitions from upland regions to tidal wetlands. Enhancing marsh persistence could slow down the displacement of people and support coastal protection for highly vulnerable communities and economically important agricultural land.

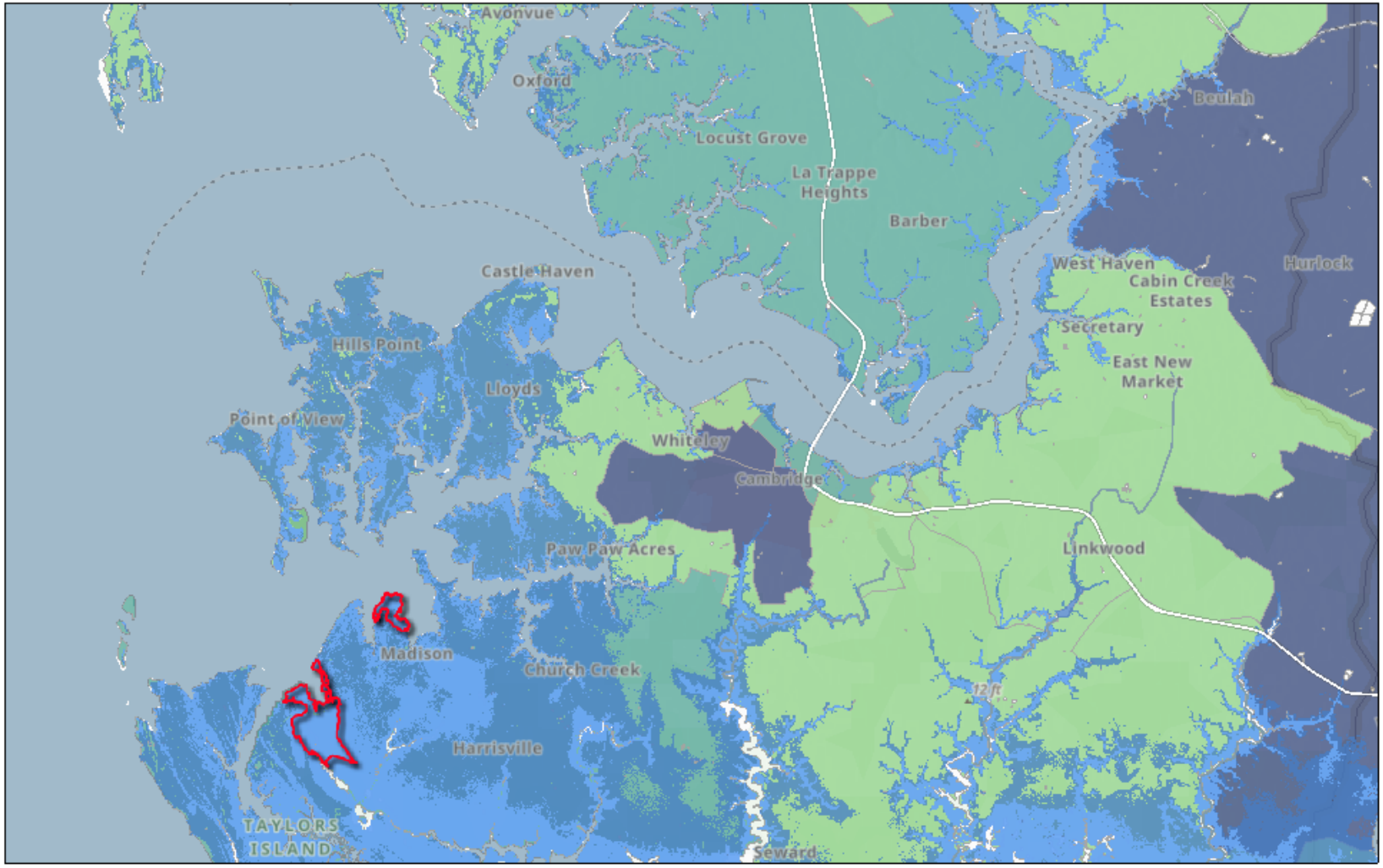
Maryland's Environmental Justice Screening (MD EJ Screen) tool assists in identifying communities that have been potentially underserved or overburdened by calculating a score based on four primary indicators: pollution burden exposure, pollution burden environmental effects, sensitive populations, and socio-economic and demographic indicators. The higher the scores can indicate communities that might be particularly vulnerable to environmental impacts. The Choptank River is bordered by regions classified as more vulnerable based on these four primary indicators, with scores ranging from the 25th to 100th percentiles (Maps 6A-B). More vulnerable communities are located near Cambridge and Madison, MD furthermore and are likely to be impacted by the effects of sea level rise in both the near term (2050) and long term (2090) (Maps 6A-B).

Marsh migration corridors adjacent to the Choptank River present potential opportunity to increase protection for adjacent communities particularly as sea level rises, especially downriver in the Neck region. Land use of the area adjacent to Choptank River also indicates a unique opportunity to consider marsh and wetland strategies in undeveloped areas and natural transition from agricultural land to wetlands to increase protection of nearby population centers (see maps 5A-B above).

Map 6A - MD EJ Score, NOAA SLR Int-High (2050 & 2090) (upriver)



Map 6B - MD EJ Score, NOAA SLR Int-High (2050 &2090) (downriver)



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U.S. Sea Level Rise - Intermediate-High (2050)

Below Sea Level

U.S. Sea Level Rise - Intermediate-High (2090)

Below Sea Level

Final EJ Score - Census Tract (%ile score)

0% - 24.9th %ile

25% - 49.9th %ile

50% - 74.9th %ile

75% - 100th %ile

World Hillshade

1:240,747

0 1.5 3 6 mi

0 2.5 5 10 km

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Linking Marsh Resiliency Opportunities with Living Resource Considerations

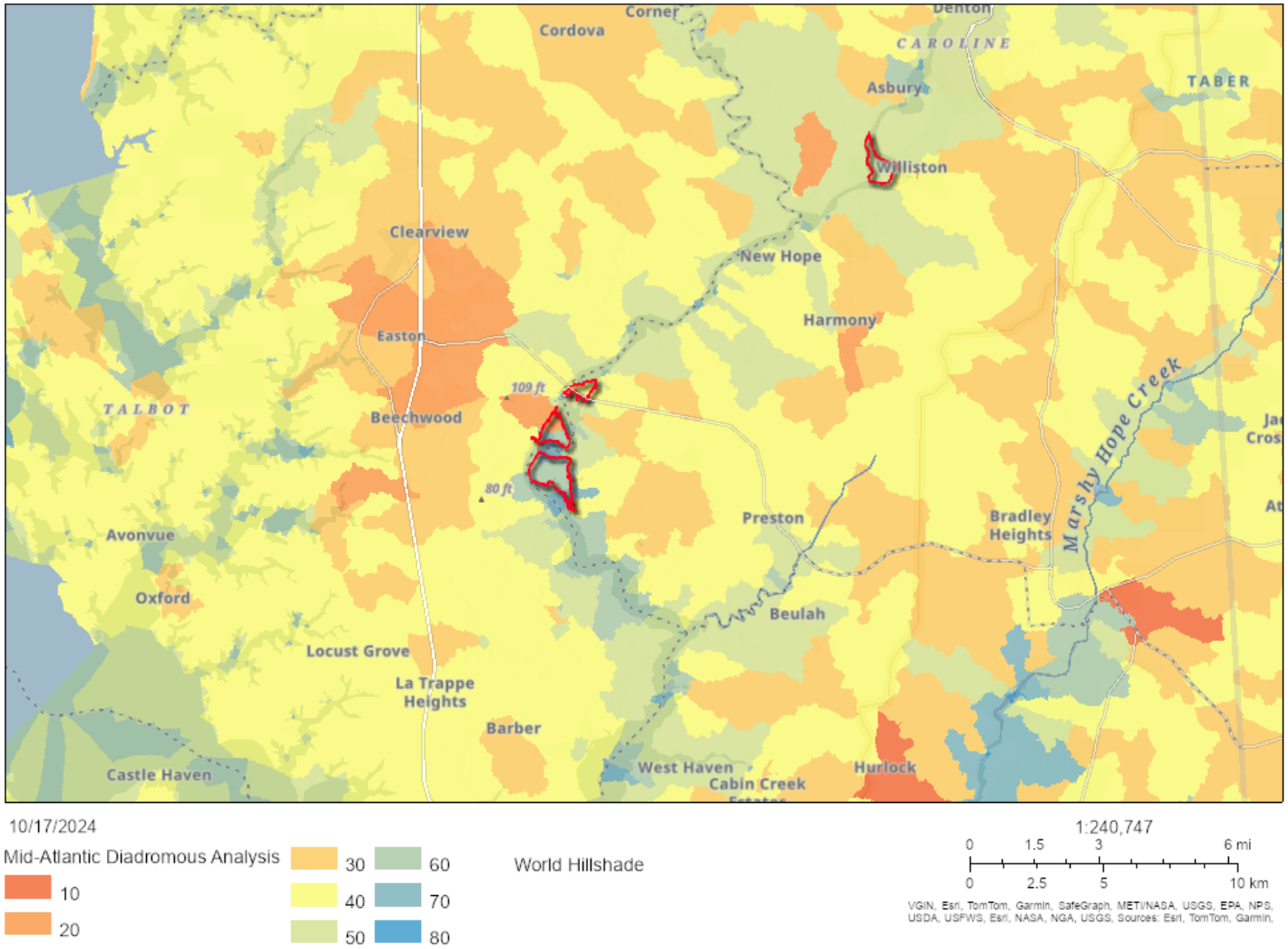
Maps 7-9A&B- Fish Habitat Scores and Maryland Shoreline Percent Armored:

The Atlantic Coastal Fish Habitat Partnership (ACFHP) developed scores for diadromous fish habitat (Map 8) and the estuarine analysis (Map 9). These scores ranged from 0-80 with higher scores representing better fish habitat (e.g., exposed to less stressors). Metrics for the diadromous fish habitat scoring included impervious surface, point and nonpoint source pollution, riparian buffers, species access, flow alteration, local fragmentation, and Endangered Species Act (ESA) critical habitat. Metrics for the estuarine analysis scoring included seagrass and oyster reef habitat, wetland habitat, water-vegetation edge, proximity to protected habitat, proximity to development, water quality, hardened shoreline, and habitat fragmentation. The suggested conservation actions are based on the final score: above 60 (greens and blues) = area of excellent fish habitat for protection; 20-60 (yellows and oranges) = restoration opportunity area for fish habitat; below 20 (reds) = degraded areas of opportunity.

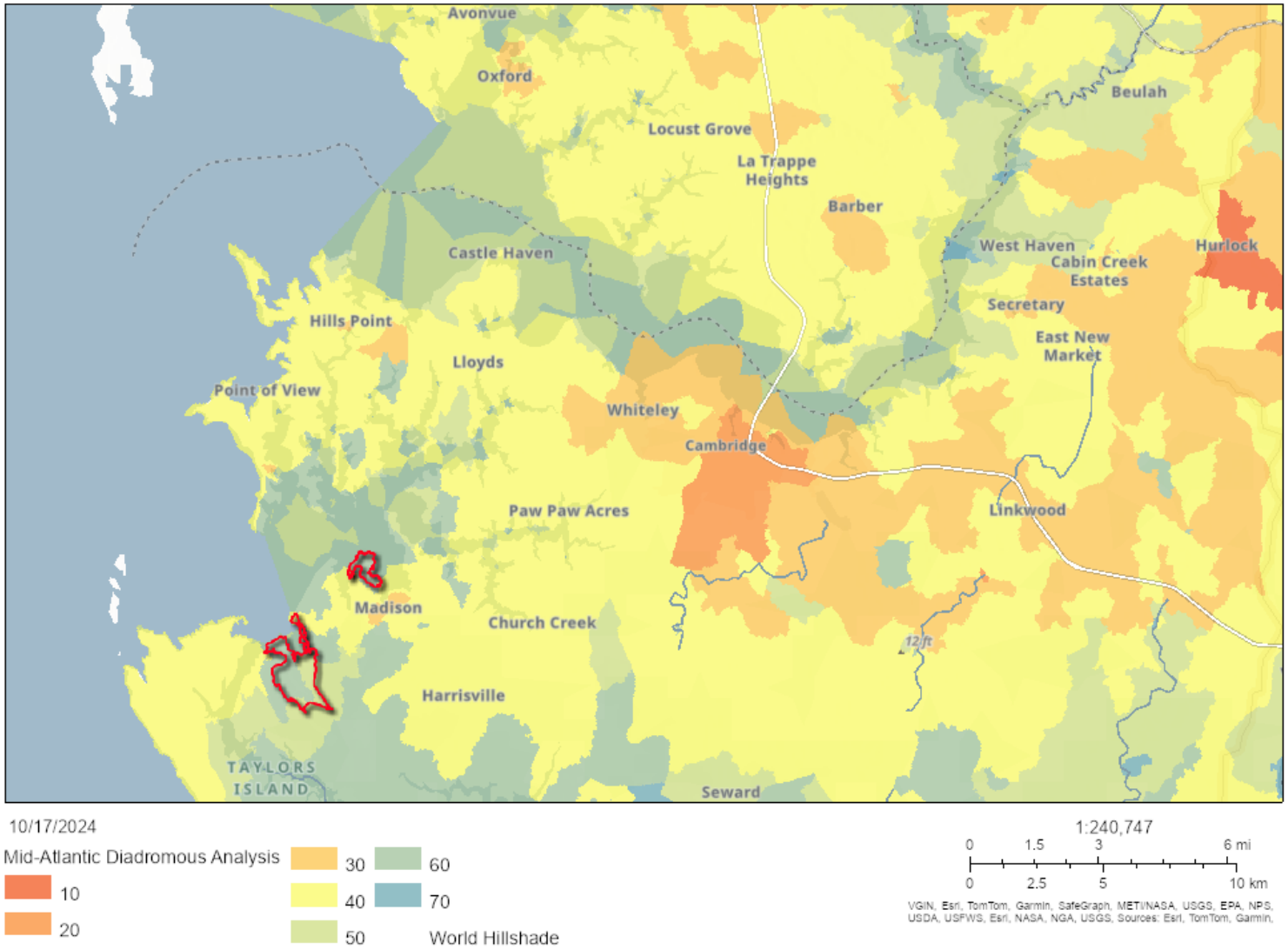
The MD Percent Hardened Armored indicate shoreline development as percent hardened per 1000m. Research conducted with partners at VIMS indicated that increasing hardened shoreline percentages are related to decline in fish abundance with <10% shoreline hardening indicating no to very little decline (high resilience), 10-30% shoreline hardening indicating a range where a significant decline occurred for one or more species (intermediate resilience), and >30% shoreline hardening indicating a substantial decline in species abundance (low resilience). Thresholds were established from research that quantified influences of shoreline change on ecosystem health and fish decline of six forage fish species, including Atlantic silverside, Atlantic menhaden, bay anchovy, hogchoker, croaker, and spot and one shellfish species, juvenile blue crab.

The Choptank River area has diadromous scores are primarily ~50 in the upriver portion (Map 7A) and primarily range from 30-50 in the downriver, Neck region (Map 7B). The estuarine scores are primarily between 20-60 for the entire river (Maps 8A-B). This indicates that for both estuarine and diadromous fish, there are restoration opportunities to enhance their habitat. The Neck portion has many areas armored with hardened shorelines (Map 9B). Some of the upriver portions do have hardened shorelines exceeding 10-30%. Opportunities to transition from hardened shoreline options to nature-based strategies could support improved fish habitat conditions.

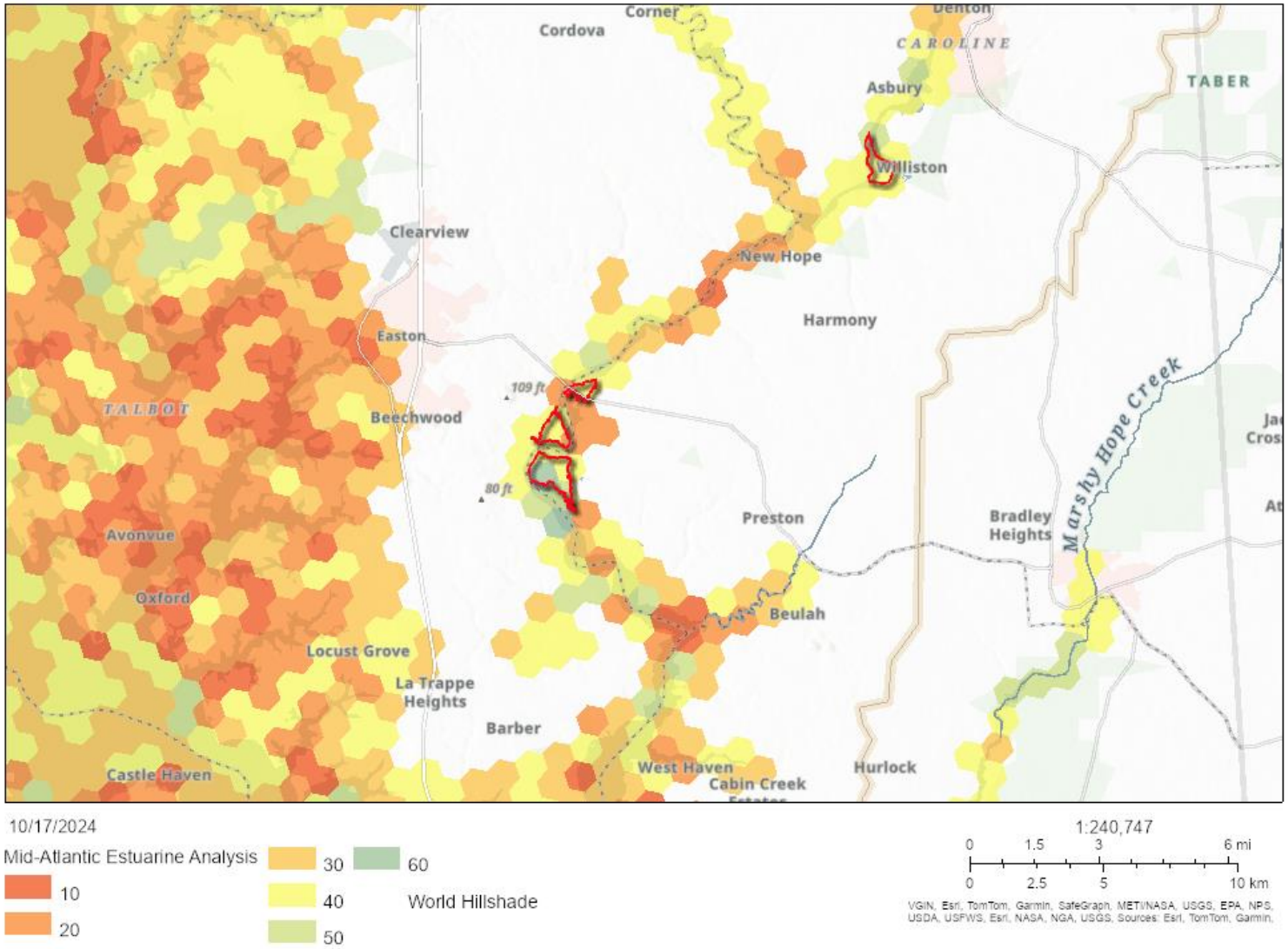
Map 7A - Fish Habitat Diadromous Scores (upriver)



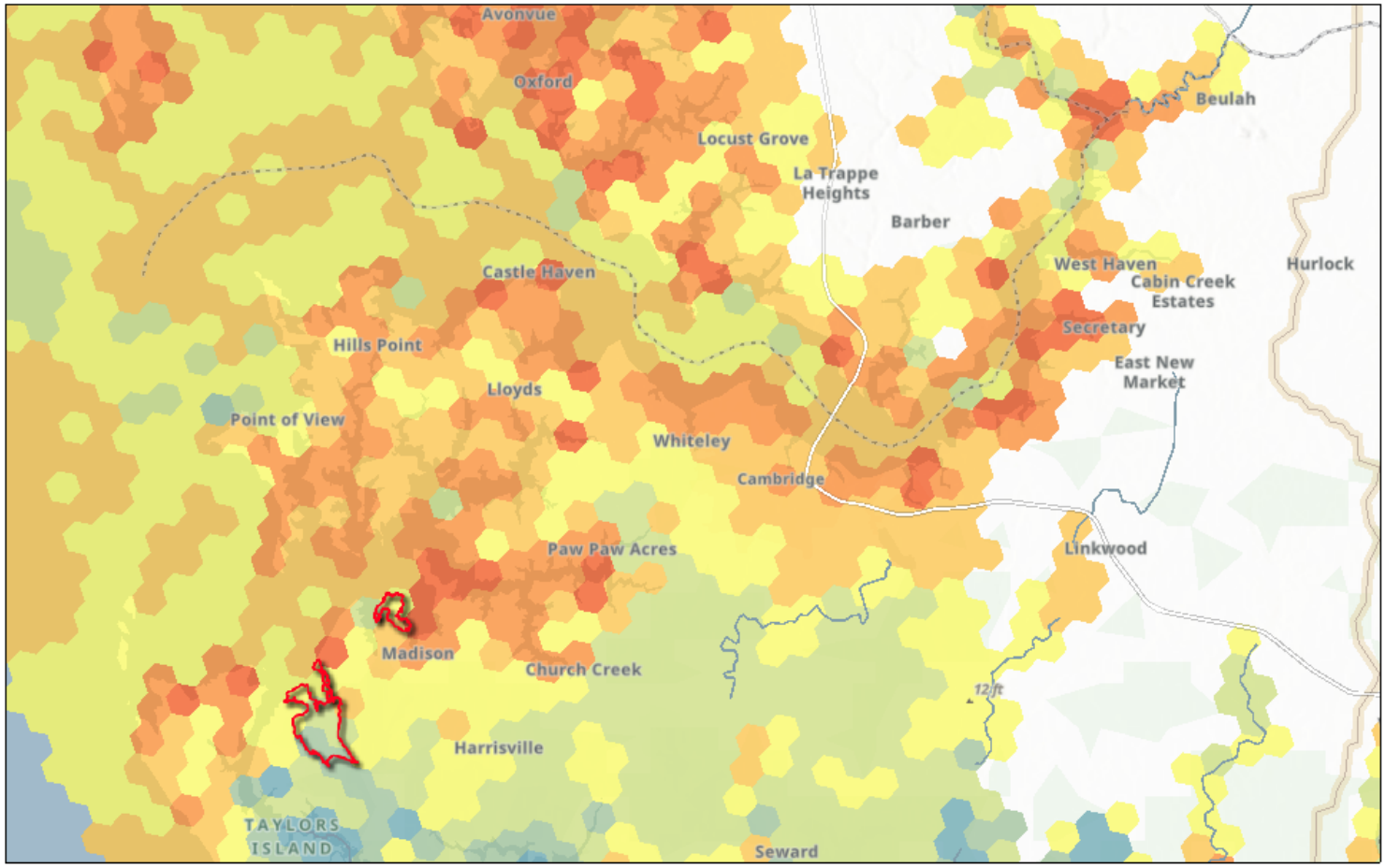
Map 7B - Fish Habitat Diadromous Scores (downriver)



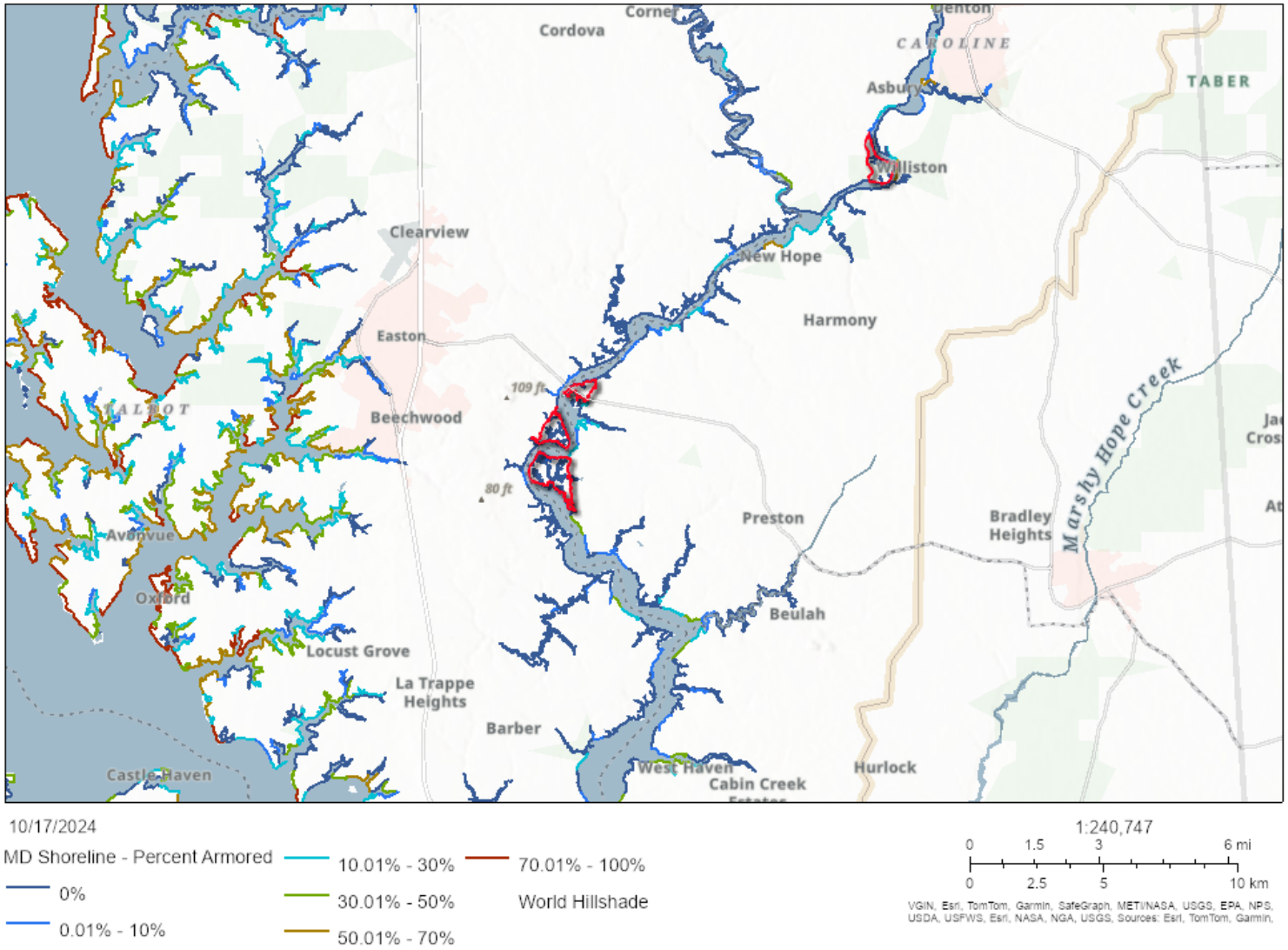
Map 8A - Fish Habitat Estuarine Scores (upriver)



Map 8B - Fish Habitat Estuarine Scores (downriver)



Map 9A · Maryland Shoreline- Percent Armored (upriver)



Map 9B - Maryland Shoreline- Percent Armored (downriver)