TETRA TECH

# Memo

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| ***To:*** | Whitney Vong, Chesapeake Bay Trust |
| ***Cc:*** | Brooke Landry, Maryland Dept. of Natural Resources |
| ***From:*** | Bob Murphy |
| ***Date:*** | February 5, 2024 |
| ***Subject:*** | Priority SAV Area Identification and Solutions Development, Reporting Period 2 Report |

This memo provides the following per reporting period number 2:

- The methodology and explanation of the decision tree used for priority submerged aquatic vegetation (SAV) bed selection;
- A list and map of selected priority SAV areas;
- A summary of SAV acreage, density, and species composition trends for the priority SAV areas;
- A description of current and historic land-use, and BMP implementation in watersheds draining to priority SAV beds;
- A summary of BMPs that are most likely to lead directly to SAV protection and conservation.

## PRIORITY SAV BEDS

The first objective of this task is to identify ten priority SAV beds based on criteria developed with the Steering Committee. The methodology and results of the bed prioritization is presented below.

### METHODOLOGY AND DECISION TREE

SAV extent is transient nature due to various environmental, climatological, and seasonal factors. As such, preprocessing of SAV bed spatial data was required before applying prioritization criteria. The spatial extent of the past six years of SAV bed data were used to establish the initial bed footprints upon which the criteria were applied. These six years include the most recent spatial data available (2022) and extend back to when SAV extent and density was at its greatest (2017). These years therefore include the conditions under which future SAV beds will be subject to and are appropriate for establishing bed footprints to be prioritized under this analysis.

Other spatial considerations were made to aggregate beds to a scale that is appropriate for conservation. Over 240,000 bed polygons resulted from the union of the 2017 – 2022 data discussed above. These beds were dissolved so that overlapping or adjacent bed boundaries were combined into 5,067 larger contiguous beds. Furthermore, a threshold of 5-acres was set as it is the minimum area that would be considered for conservation. Beds smaller than this threshold were grouped with the nearest bed larger than larger than the threshold. It is important these small beds less than 5-acres are not thrown out because conservation practices may be applied to and/or impact groupings of SAV beds. The 5-acre threshold resulted in 1,555 grouped/aggregated beds. This is a reasonable number upon which the prioritization criteria can be applied. Final aggregated beds are presented in Figure 1.

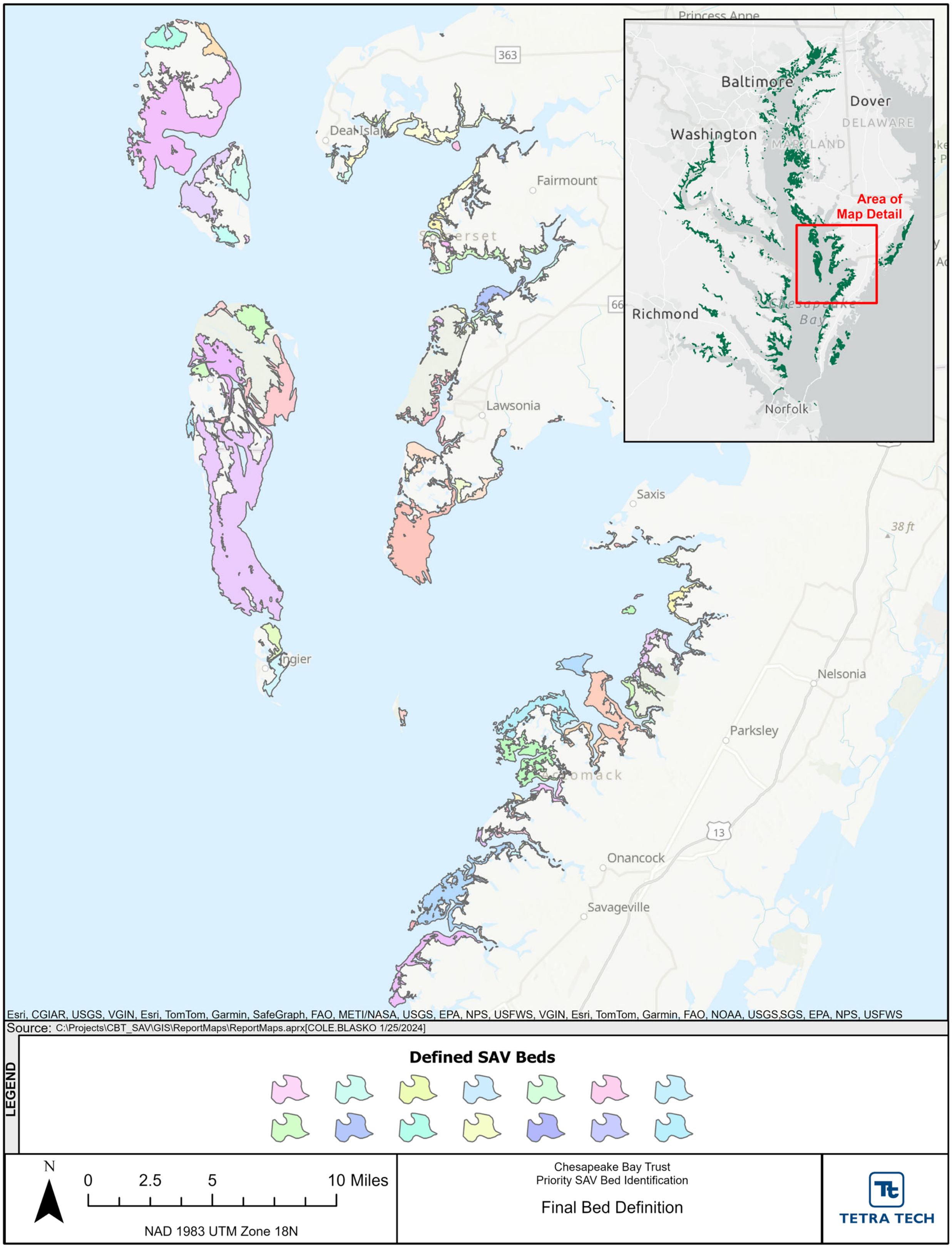


**Figure 1. Example of bed aggregation to define final SAV beds**

# DECISION TREE CRITERIA AND INDICES

A decision tree approach was utilized to account for eight different prioritization criteria (Figure 2). The first seven criteria (*Bed Size*, *Bed Maturity*, *Bed Density*, *Species Richness/Diversity*, *Rare/Sensitive Species*, *Habitat Value*, and *Representativeness*) are combined using a weighting system and composite index score. A threshold of 0.9 determines which beds are preliminarily prioritized. This threshold was chosen based on the distribution of the composite index and yielded 114 preliminary beds. These preliminary beds were then manually assessed under the final criteria of *Distribution*. Each criterion is discussed in detail in sections 0 through 0 below and criteria results are presented in section 0. Preliminary bed results and priority bed selection are discussed in section 0.

Overall, weighting of each criterion relied on best professional judgement of the project team and input from the steering committee. *Habitat value* was given the highest weight since ultimately, SAV beds are desirable as habitat for other living resources. *Bed density* was given a lower rating, but higher than some other criterion as density also implies excellent growth conditions and the ability to slow water flow and reduce suspended sedimentation. Each criterion was weighted corresponding to its relative importance in contributing to SAV bed protection. *Bed Size* was weighted rather low at 10% because size heavily influences the other criteria and will therefore be accounted for indirectly under those weighted scores. For example, species richness/diversity is likely to be greater in larger beds. *Species Richness* and *Sensitive/Rare Species* were each scored the same at 10%, given the relative importance of both. These criteria reflect SAV biodiversity and are inter-related. Bed *Maturity* was also scored at 10% as this attribute reflects longevity of a particular bed, demonstrating a favorable location in the Bay.

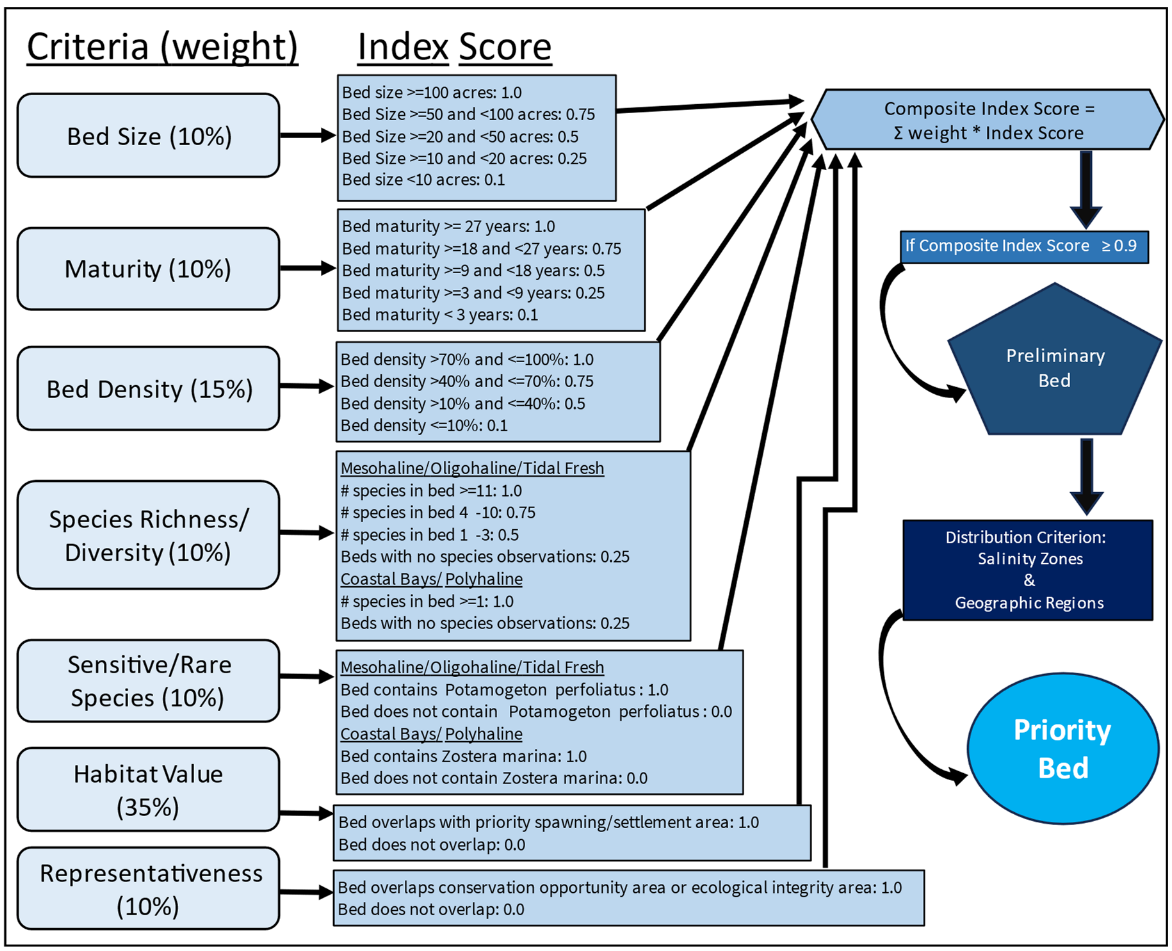


**Figure 2. Decision tree schematic**

## Bed Size

SAV bed size is important in an ecological context as larger acreage equals greater habitat provision. Furthermore, since SAV provides ecosystem benefits including wave dampening, sediment retention and stabilization, larger beds are considered more valuable (De Boer 2007; Ward et al. 1984) .

Total area of each aggregated bed was calculated using the NAD 1983 UTM zone 18N projection for this *Bed Size* criterion. The data source of this criterion is the VIMS GIS data archive (https://www.vims.edu/research/units/programs/sav/reports/).

## Bed Maturity

Bed maturity reflects the continuity of a bed over time, persistence through variable environmental conditions. Beds that persist over time indicate good to excellent conditions for SAV survival and are therefore desirable beds to protect and conserve.

The Steering Committee advised that all years of available data be used for this criterion. Although VIMS has spatial SAV data dating back to 1971, there was not bay-wide coverage until 1984. As such, data from 1984 through 2022 was used. Additionally, there were no data available for 1988 and therefore 38 years of data are included in the calculation of this criterion rather than 39 years.

The *Maturity* criterion was calculated by first overlapping all 38 years of SAV bed footprint spatial data. Each overlapping area was assigned a number equal to how many years SAV has been present in that unique polygons' boundary (Figure 3). Next, the area weighted average number of years for each aggregated bed was calculated upon which the index score was assigned. The data source of this criterion is the VIMS GIS data archive.

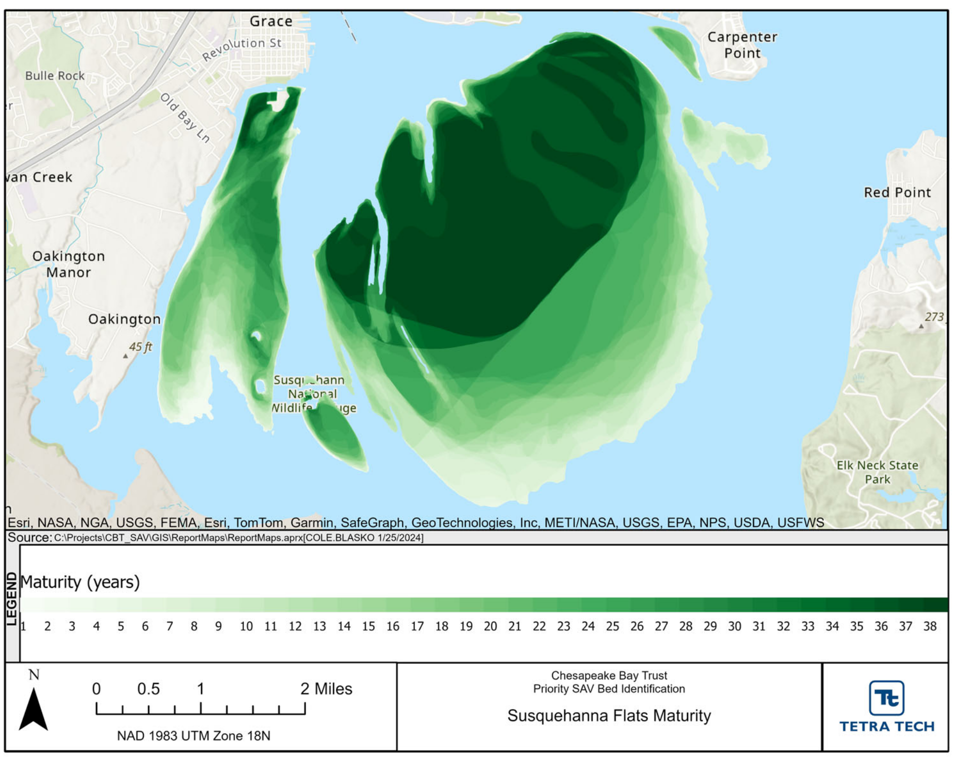


**Figure 3. Example of the *Maturity* criterion for the Susquehanna Flats SAV bed**

## Bed Density

The density of shoots in an SAV bed may be indicative of good water quality conditions, appropriate sediment type, and favorable energy exposure. Denser beds also contribute to a positive feedback loop of improving environmental conditions such as reducing resuspension of sediments and reduced erosion (Gruber et al. 2011; Gurbisz et al. 2017).

The 2017-2022 data that was used to define the aggregated beds was also used to calculate the *Bed Density* criterion. First, the union of these six years of data was used to obtain the maximum density present in any one area of each bed over the past six years (Figure 4). Next, the area weighted average density for each aggregated bed was calculated upon which the index score was assigned. The data source of this criterion is the "DENSITY" field in the attribute table of shapefiles from the VIMS GIS data archive where beds are given a score from one to four based on percent coverage.

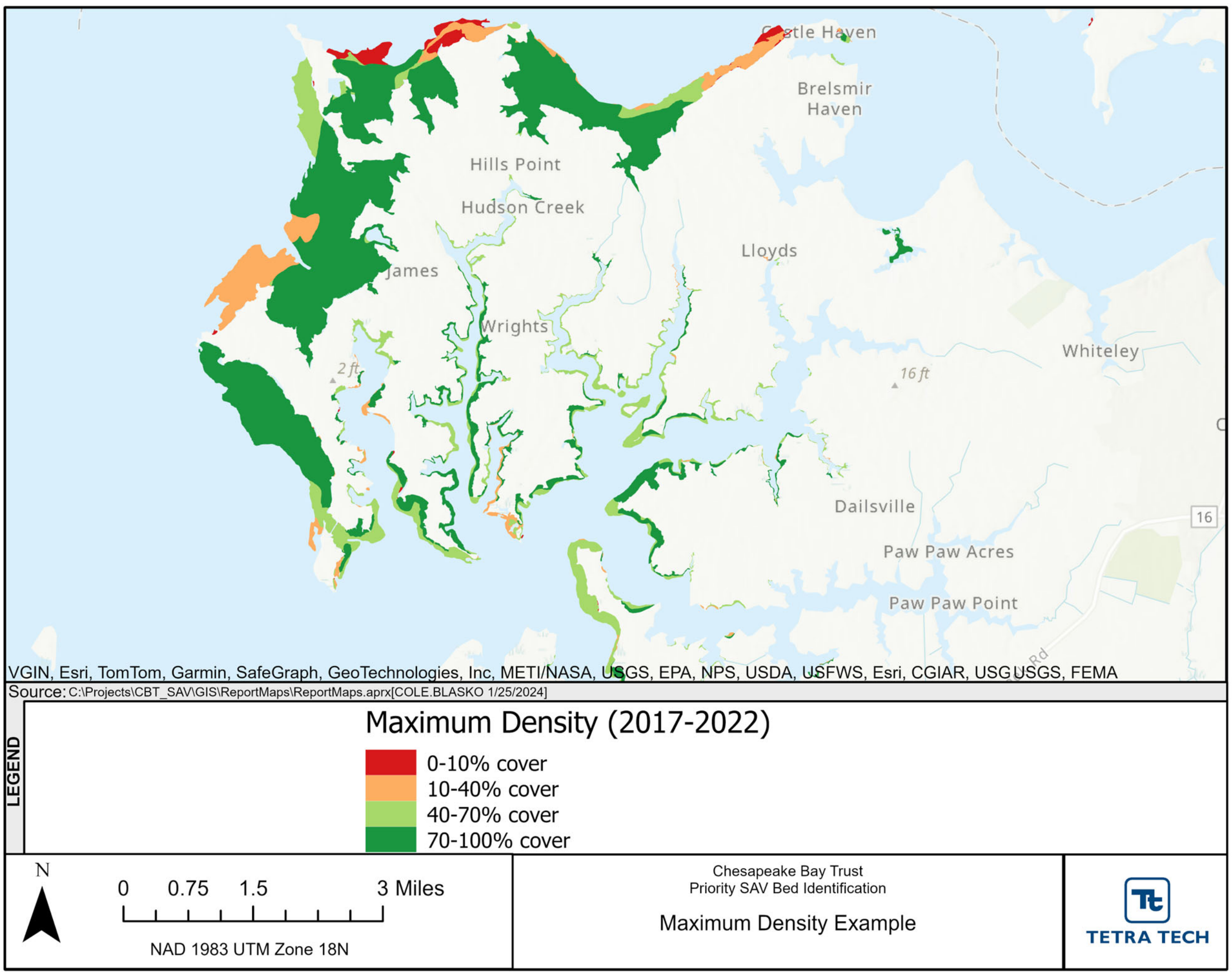


**Figure 4. Example of six-year maximum bed density distribution**

## Species Richness/Diversity

Biodiversity in SAV bed structure serves many purposes. The presence of multiple species, and associated variability in plant morphology, provides a diverse structured habitat exploited by a variety of organisms.

Additionally, beds comprised of multiple species are typically more resilient to bed collapse due to varying responses to environmental stressors.

The Steering Committee advised that the last ten years of data be used for establishing the *Species Richness/Diversity* criterion. The data source of this criterion is the VIMS species by segment data archive (https://www.vims.edu/research/units/programs/sav/access/tables/species_segment/) where species observations are recorded at the segment scale. Over the past ten years, 24 unique species have been recorded in 48 of the 103 total segments in the bay. The remaining 55 segments have not had any observations over the past ten years. These species data were compiled and pre-processed in spreadsheet format then joined to the spatial data for calculation of the *Species Richness/Diversity* criterion.

## Sensitive/Rare Species

Approximately seventeen species of SAV are commonly found in the Chesapeake Bay. Species diversity increases with decreasing salinity, with up to a dozen species of SAV observed in some of the bays oligohaline and tidal fresh areas (Bergstrom et al. 2006). We identified two species that were included in this metric, based on salinity.

The *Sensitive/Rare Species* criterion varies depending on the salinity zone that each SAV bed falls under. The same data and pre-processing used for the *Species Richness/Diversity* criterion was applied here. The data source of this criterion is the VIMS species by segment data archive. The coastal bays and polyhaline salinity zones only contain two species altogether (*Ruppia maritima*, and *Zostera marina*). Of these species, *Zostera marina* is considered sensitive/rare in these salinity zones. The tidal fresh, oligohaline, and mesohaline salinity zones contain 24 unique species. *Potamogeton perfoliatus* is considered the sensitive/rare species in these salinity zones.

## Habitat Value

Perhaps the most valuable function of healthy, persistent, and large SAV beds is the habitat provision available to a variety of invertebrate and fish species, both ecologically and economically important. While it is well understood that SAV beds provide both refugia and feeding opportunities for a variety of organisms (Beck et al. 2001; Bell et al. 1988; Brown-Peterson et al. 1993; Orth and Heck Jr. 1980), spatial data on the distribution of these organisms in the Chesapeake Bay is inconsistent and could include over 300 finfish species alone. In consultation with the steering committee and discussions with the SAV Workgroup, the species list was narrowed down to taxa where good spatial data existed, were economically and/or ecologically important, and had a fairly wide distribution within the Chesapeake Bay and its tributaries. Species identified as highly dependent on SAV at some point of their life history include Striped Bass (*Morone saxatillis*), American Shad (*Alosa sapidissima*), Hickory Shad (*A. mediocris*), Blueback Herring (*A. aestivalis*), Alewife (*A.pseudoharengus*), Summer Flounder (*Paralichthys dentatus*), and Blue Crab (*Callinectes sapidus*). Of these species, there is little spatial data on distribution of post-larval and juvenile Summer Flounder, the life stages dependent on SAV beds. However, these life stages are known to preferentially exploit eelgrass beds (Able et al. 1990; Packer and Hoff 1999; Sackett et al. 2008), so the inclusion of eelgrass noted in the Sensitive/Rare criterion also covers Summer Flounder habitat.

The *Habitat Value* criterion was developed using spatial datasets from the Chesapeake Bay Program (provided by CBP 1/10/2024). These data include the spawning and nursery areas for Alewife, American Shad, Blueback Herring, and Hickory Shad. Spawning areas for Striped Bass and high-density areas of male and female blue crab were also used. These spatial data layers were merged together (Figure 5) and the *Habitat Value* criterion was calculated based on whether an SAV bed intersects any of these selected habitat areas.

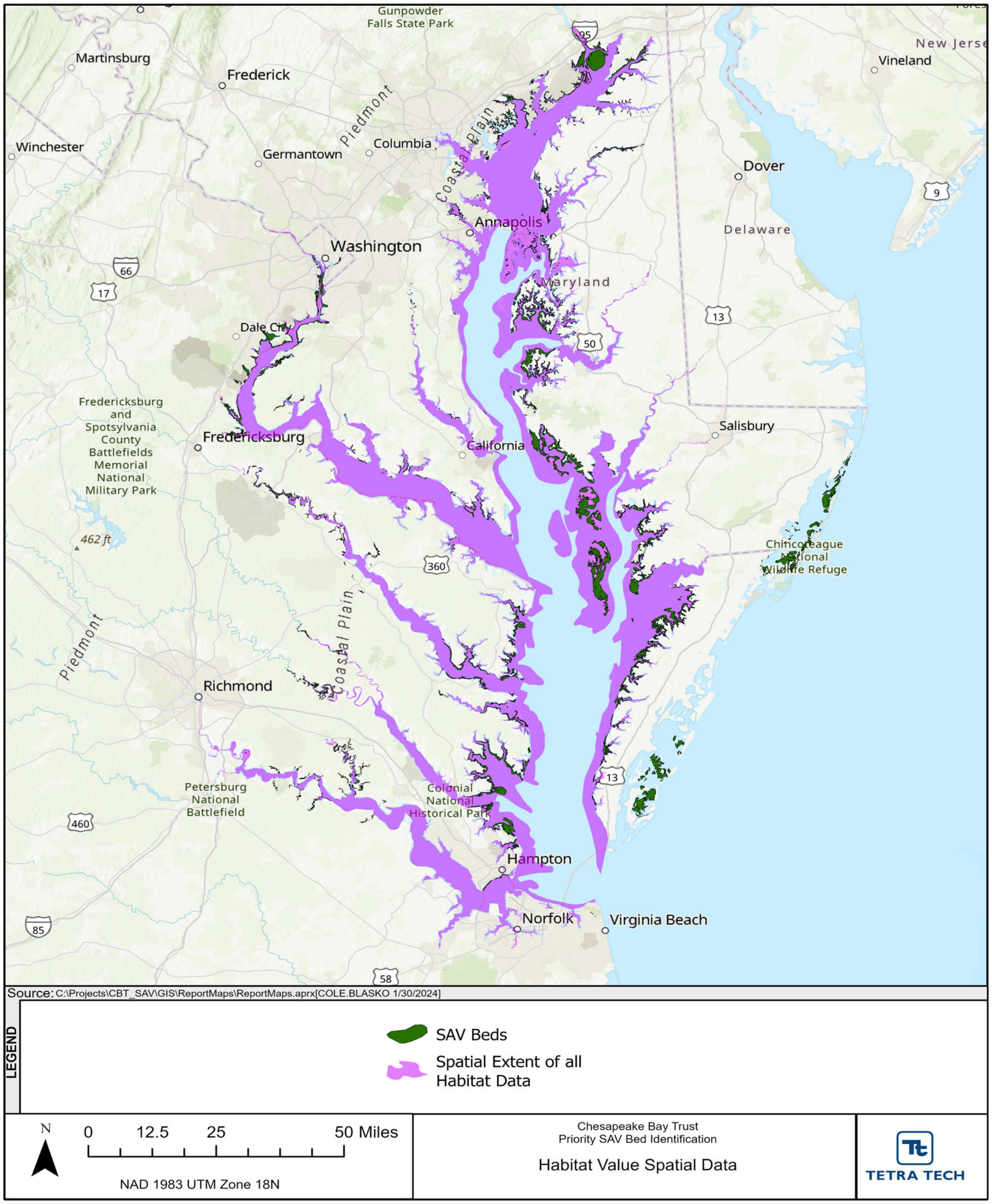


**Figure 5. Spatial footprint of all habitat spatial data merged together**

## Representativeness

The Representativeness criterion captures regions of the Bay deemed special due to their location and structure. The *Representativeness* criterion was developed using spatial datasets from the Chesapeake Bay Program (https://gis.chesapeakebay.net/mpa/scenarioviewer/). These data include the Regional Conservation Opportunity Areas (RCOA), and Index of Ecological Integrity (IEI) areas. These spatial data layers were merged together and the *Representativeness* criterion was calculated based on whether an SAV bed intersects any of these priority areas (Figure 6).

The Chesapeake Bay Program describes the RCOA as:

*"The RCOA vision is to identify and map a connected network of resilient and ecologically intact habitats that will support biodiversity under changing conditions to prioritize restoration and inform land protection. RCOAs will supplement State Wildlife Action Plans in identifying core habitats and restoration/connectivity opportunities. Similar to the IEI, the RCOAs follow a complete wildlife approach. It shows areas where conservation and restoration will have the largest impact on threatened species and habitats."*

The Chesapeake Bay Program describes the IEI as:

*"The index of ecological integrity (IEI) is a measure of relative intactness (i.e., freedom from adverse human modifications and disturbance) and resiliency to environmental change (i.e., capacity to recover from or adapt to changing environmental conditions driven by human land use and climate change) on a 0-1 scale. It is a composite index derived from up to 21 different landscape metrics, each measuring a different aspect of intactness (e.g., road traffic intensity, percent impervious) and/or resiliency (e.g., ecological similarity, connectedness) and applied to each 30 m cell. The IEI acts as an all-encompassing measure of habitat quality, and provides inclusion of both habitat types addressed by the Watershed Agreement (with Management Strategies and Outcomes) and those omitted."*

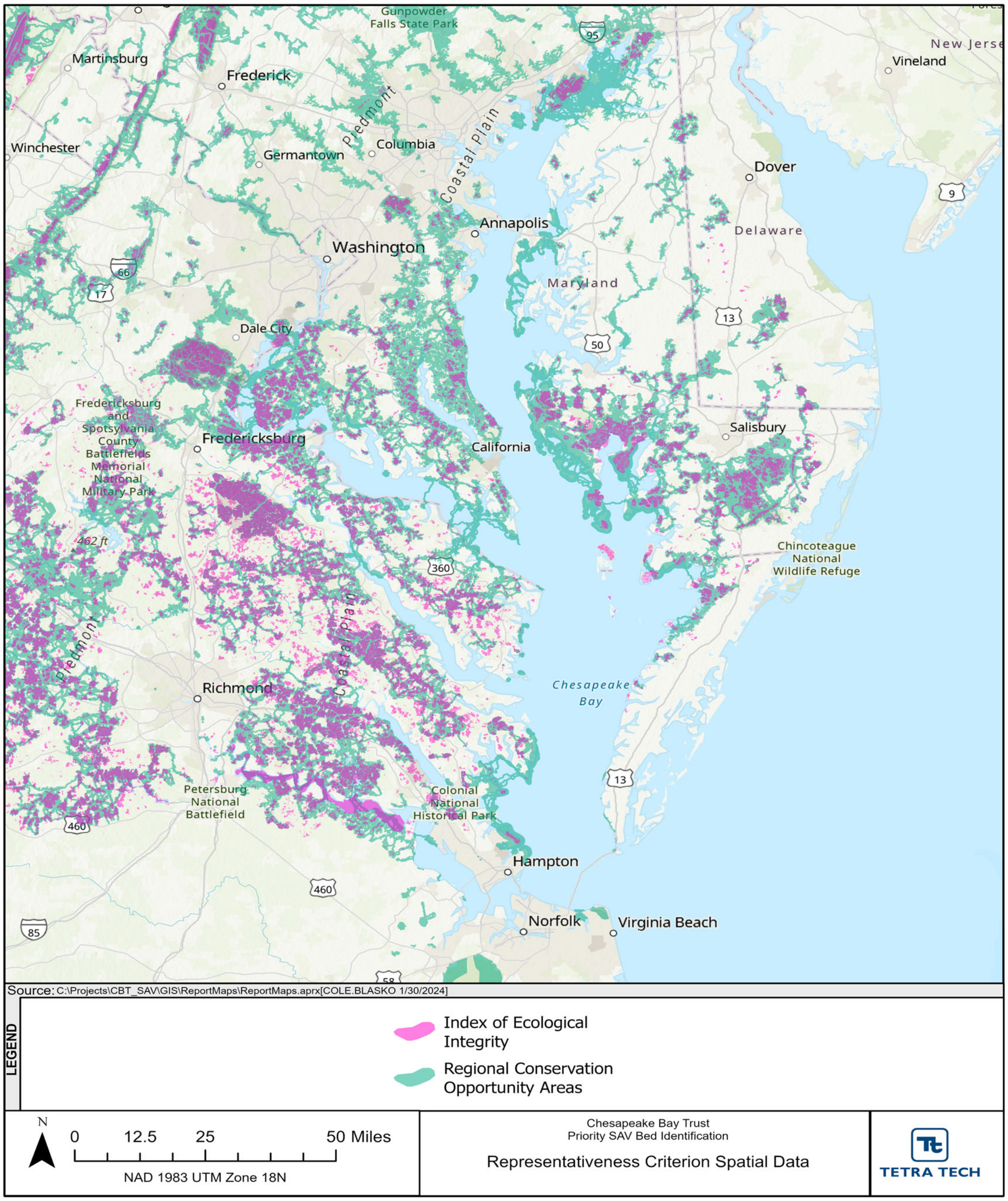


**Figure 6. Spatial footprint of data used for the *Representativeness* criterion**

## Distribution

Geographical distribution of species and species complexes is considered an important factor prior to the BMP analysis. Beds scored highly throughout the Chesapeake Bay system, but having a practical distribution among salinity regimes and geographical representation was considered an important criterion.

The *Distribution* criterion uses the preliminary bed results from the composite index score calculated from the seven prior criteria (Figure 2). Salinity zones and geographic regions are considered when choosing the final ten priority beds. This criterion is further discussed in section 0.

## CRITERIA RESULTS

The distribution of SAV beds for each of the seven initial criteria is shown in Figure 7 through Figure 13 and Table 1 below.

Bed sizes ranged from 5-acres to 8,303-acres. The size distribution is right/positive-skewed with an average size of 108-acres and a median size of 22-acres. Index score thresholds were placed at natural breaks in the size distribution and yielded five index classes (Figure 7). All beds greater than 100-acres in size were assigned a perfect index score of 1.0. This threshold of 100-acres leaves 254 SAV beds in top consideration under this criterion for protection and conservation. This threshold is lenient in that it includes 16% of all beds under this top consideration. However, 100-acres is large for SAV beds in general and setting this threshold higher would unfairly exclude very large beds from top consideration.

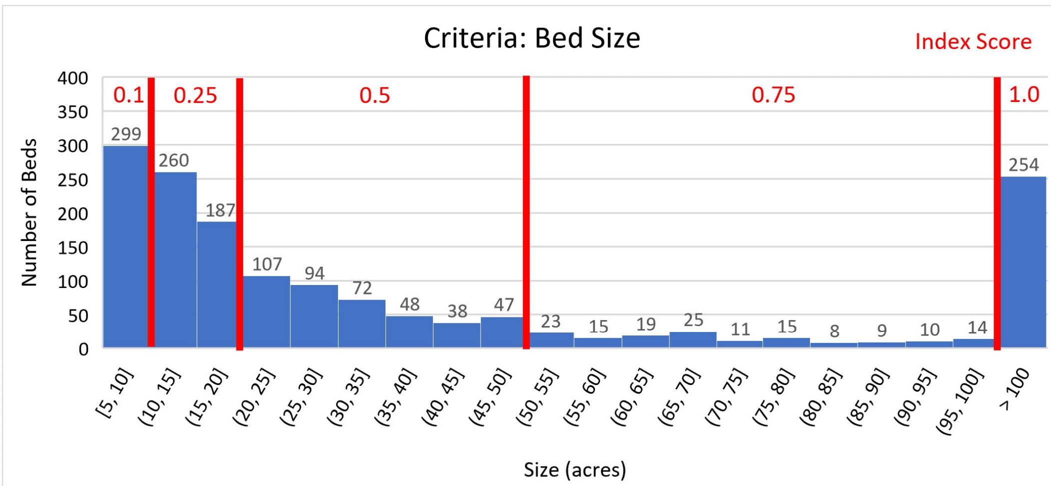


**Figure 7. Distribution of aggregated SAV bed results for the *Bed Size* criterion**

Bed maturity ranged from 1-year to 31-years old. The distribution is right/positive-skewed with an average age of 9.3-years and a median age of 7.8-years. Index score thresholds were placed at natural breaks in the maturity distribution and yielded five index classes (Figure 8). All beds with a maturity of greater than 27-years were assigned a perfect index score of 1.0. This criterion is more selective in that only 13 beds were classified under the top index score for highest consideration of protection and conservation practices.

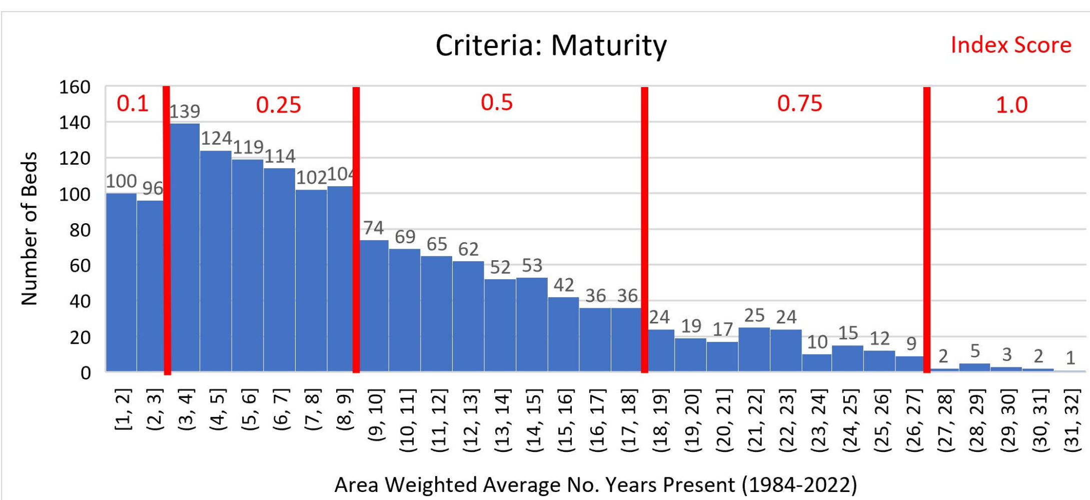


**Figure 8. Distribution of aggregated SAV bed results for the *Maturity* criterion**

Bed density, as assigned in the VIMS data, ranges from 0-10% cover to 70-100% cover. The four classifications established by VIMS were used directly as the index score thresholds (Figure 9). The distribution of the data is left/negative-skewed where the average, median, and mode all fall in the highest classification of over 70% cover for area weighted maximum bed density between 2017 and 2022.

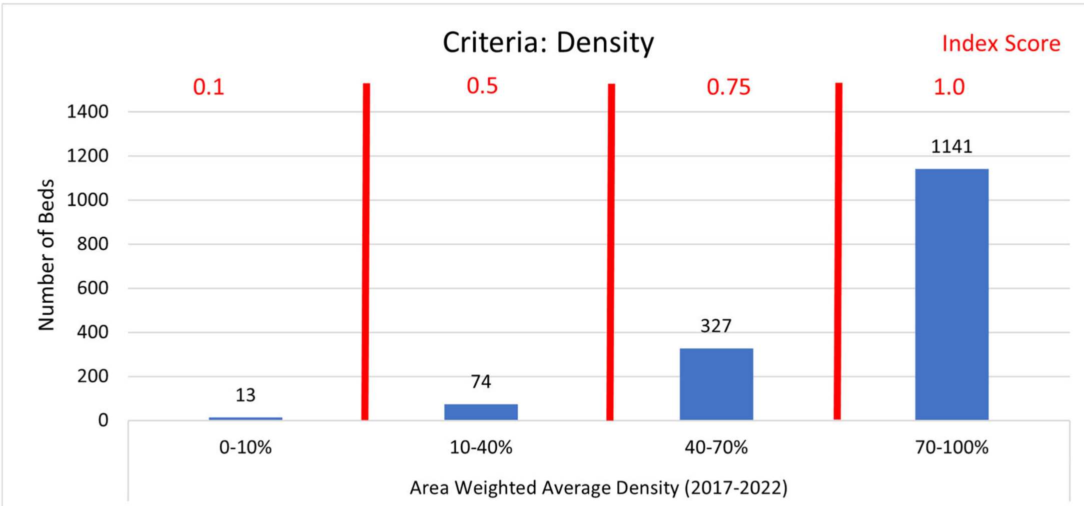


**Figure 9. Distribution of aggregated SAV bed results for the *Bed Density* criterion**

The *Species Richness/Diversity* criterion was assigned index scores based on the salinity zone in which the SAV bed falls within (Figure 10). Additionally, there were 368 (25% of all beds) that did not have any observations recorded in the past ten years but does not mean that SAV species do not exist here. These beds were assigned an index score of 0.25 rather than zero so that they are not unfairly excluded from consideration altogether due to this one criterion. For coastal bay and polyhaline salinity zones that do not have rich/diverse SAV species due to inherent conditions there is only one other index score assigned as all beds in these salinity zones had exactly two species observed. As such, an index score of 1.0 was given for these beds. For tidal fresh, oligohaline, and mesohaline salinity zones, three additional index scores were assigned. First, a natural break in the distribution exists for beds with species counts between one and three. These beds were assigned an index score of 0.5. Next, beds with less than ten species were assigned a score of 0.75 and beds with more than ten species were assigned and index score of 1.0.

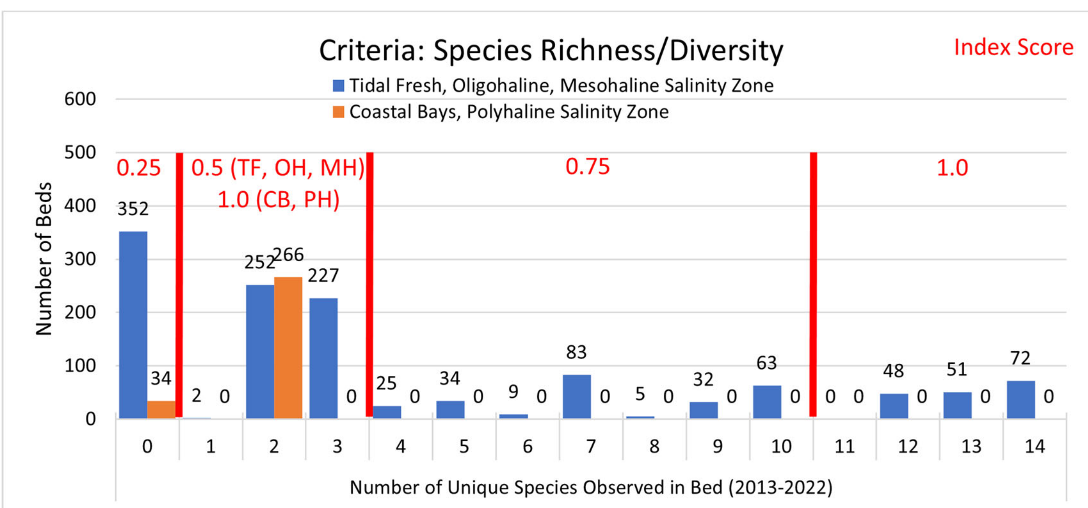


**Figure 10. Distribution of aggregated SAV bed results for the *Species Richness/Diversity* criterion**

The *Sensitive/Rare Species* criterion also varies based on salinity zone in which the bed resides. For coastal bays and polyhaline salinity zones *Zostera marina* is the species of interest and for tidal fresh, oligohaline, and mesohaline salinity zones *Potamogeton perfoliatus* is the species of interest. All salinity zones were given the same binary index scoring classification where if an SAV bed contained the species of interest it was assigned a score of 1.0 and was otherwise assigned a score of zero (Figure 11). Of the 1,555 total beds, 584 (37.5%) contained the species of interest.

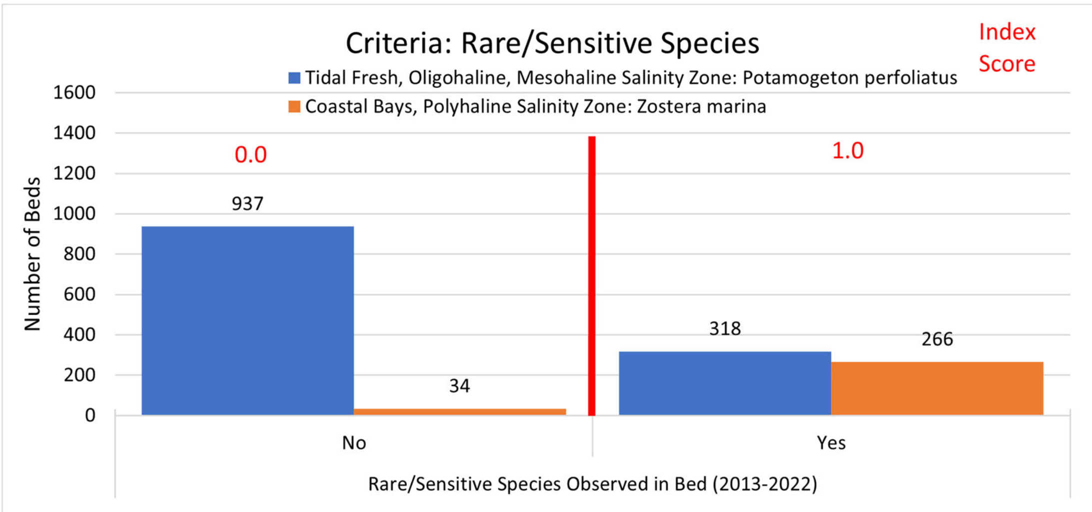


**Figure 11. Distribution of aggregated SAV bed results for the *Rare/Sensitive Species* criterion**

The *Habitat* and *Representativeness* criteria were also assigned index scores in a binary fashion because SAV beds either do or do not intersect the spatial region of interest as described in sections 0 and 0 above. 1241 (79.8%) of SAV beds overlap a select habitat and were assigned a perfect index score of 1.0 (Figure 12). 807 (51.9%) of SAV beds overlap ecological integrity or conservation opportunity areas and were assigned a perfect index score of 1.0 (Figure 13).

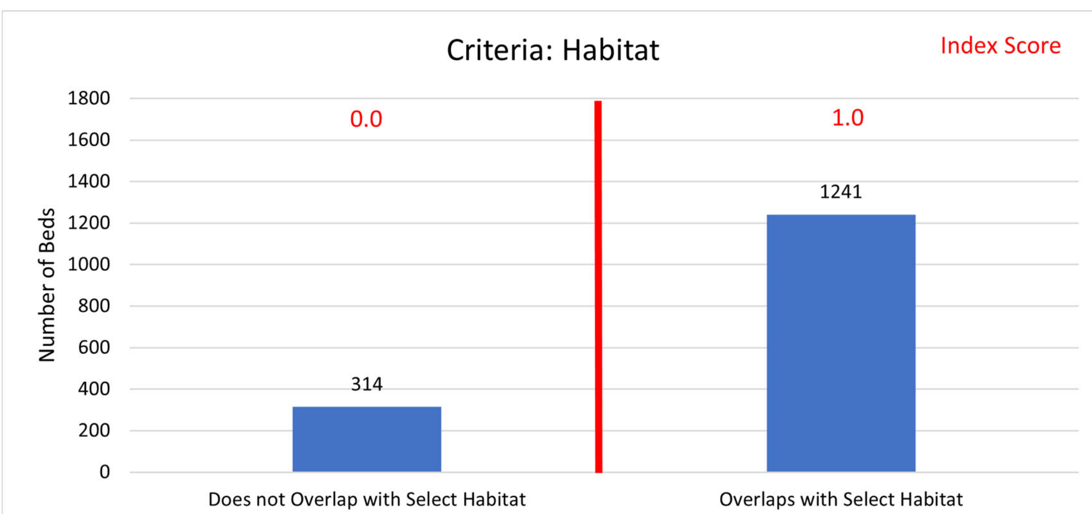


**Figure 12. Distribution of aggregated SAV bed results for the *Habitat* criterion**

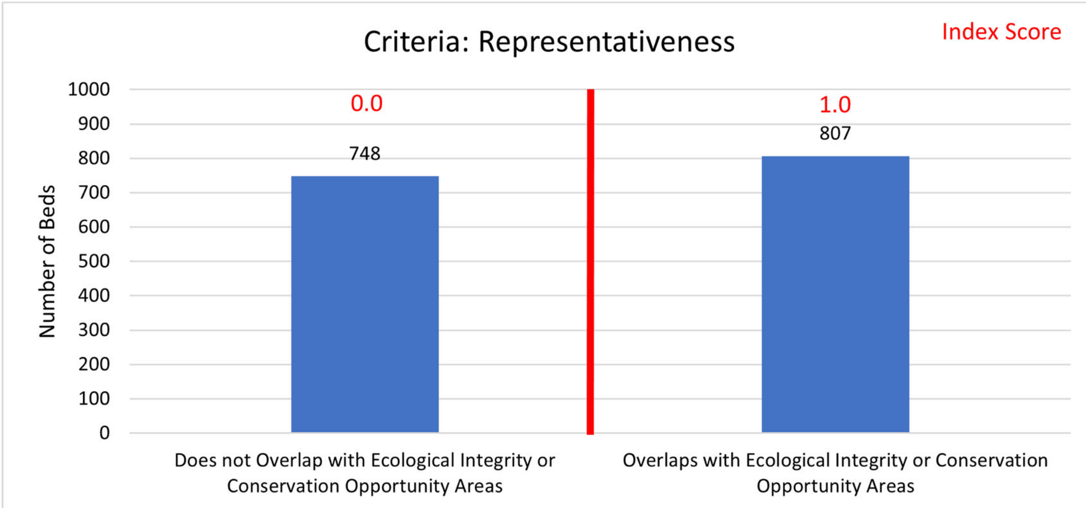


**Figure 13. Distribution of aggregated SAV bed results for the *Representativeness* criterion**

**Table 1. Index score thresholds and number of SAV beds that fall under each category for all criteria**

| Criteria (weight) | Index Score | No. Beds [a] |
|---|---|---|
| Bed Size (10%) | Bed size >=100 acres: 1.0<br>Bed Size >=50 and <100 acres: 0.75<br>Bed Size >=20 and <50 acres: 0.5<br>Bed Size >=10 and <20 acres: 0.25<br>Bed size <10 acres: 0.1 | 254 (16%)<br>149 (10%)<br>406 (26%)<br>447 (29%)<br>299 (19%) |
| Maturity (10%) | Bed maturity >= 27 years: 1.0<br>Bed maturity >=18 and <27 years: 0.75<br>Bed maturity >=9 and <18 years: 0.5<br>Bed maturity >=3 and <9 years: 0.25<br>Bed maturity < 3 years: 0.1 | 13 (1%)<br>155 (10%)<br>489 (31%)<br>702 (45%)<br>196 (13%) |
| Bed Density (15%) | Bed density VIMS score >3 and <=4 (>70% and <=100% cover): 1.0<br>Bed density VIMS score >2 and <=3 (>40% and <=70% cover): 0.75<br>Bed density VIMS score >1 and <=2 (>10% and <=40% cover): 0.5<br>Bed density VIMS score <= 1 (<=10% cover): 0.1 | 1,152 (74%)<br>326 (21%)<br>66 (4%)<br>11 (1%) |
| Species Richness/ Diversity (10%) | Mesohaline/Oligohaline/Tidal Fresh<br># species in bed >=11: 1.0<br># species in bed 4-10: 0.75<br># species in bed 1-3: 0.5<br>Beds with no species observations: 0.25<br><br>Coastal Bays/Polyhaline<br># species in bed >=1: 1.0<br>Beds with no species observations: 0.25 | <br>171 (11%)<br>251 (16%)<br>481 (31%)<br>352 (23%)<br><br><br>266 (17%)<br>34 (2%) |
| Sensitive/Rare Species (10%) | Mesohaline/Oligohaline/Tidal Fresh<br>Bed contains *Potamogeton perfoliatus*: 1.0<br>Bed does not contain *Potamogeton perfoliatus*: 0.0<br><br>Coastal Bays/Polyhaline<br>Bed contains *Zostera marina*: 1.0<br>Bed does not contain *Zostera marina*: 0.0 | <br>318 (20%)<br>937 (60%)<br><br><br>266 (17%)<br>34 (2%) |
| Habitat Value (35%) | Bed overlaps with priority spawning/settlement area: 1.0<br>Bed does not overlap: 0.0 | 1,241 (80%)<br>314 (20%) |

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|---|---|---|
| Representativeness (10%) | Bed overlaps conservation opportunity area or ecological integrity area: 1.0<br>Bed does not overlap: 0.0 | 807 (52%)<br>748 (48%) |

a. The number of beds that were assigned each index score are presented here. Percentages may not sum to 100% due to rounding.

## PRIORITY SAV BED RESULTS

There are 114 SAV beds that received a composite index score greater than 0.9 (Figure 14). The final *Distribution* criterion was applied to only these 114 Preliminary Beds (Figure 15).

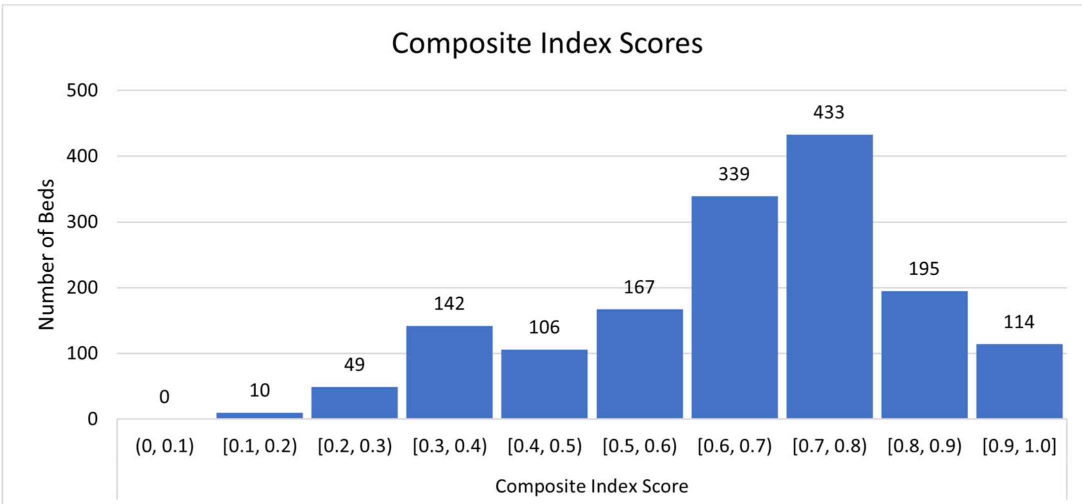


**Figure 14. Distribution of composite index scores for all SAV beds**

In general, the rationale behind choosing the first 5 Priority Beds (referred to as PB#) is as follows:

- Four beds received a perfect composite index score of 1.0 and were all selected as Priority Beds. All four of these beds fall in the polyhaline salinity zone on the western shore of the southern end of Chesapeake Bay in Virginia. One of these beds is adjacent to the Plum Tree Island National Wildlife Refuge (PB1); one bed is on the north shore of the mouth of the York River (PB2); and two beds are in Mobjack Bay (PB3 and PB4) (Figure 15 and Table 2).
- Next the Susquehanna Flats SAV bed was chosen as a Priority Bed due to its high composite index score of 0.975, being the largest SAV bed in the Chesapeake Bay, and being a high-profile/prominent SAV bed in terms of ecological importance. The Susquehanna Flats bed is in the tidal fresh salinity zone at the mouth of the Susquehanna River in the northern-most tip of Chesapeake Bay in Maryland (PB5 in Figure 15 and Table 2).

The geographic and salinity zone distribution of these first 5 Priority Beds are at the two extremes. As such, the geographic and salinity zone distribution of the remaining 5 Priority Beds were determined by selecting beds from Preliminary Bed clusters with the following rationale:

- In Virginia, the east shore of the southern end of Chesapeake Bay is in the polyhaline salinity zone and contains a cluster of 19 Preliminary Beds. Of these 19 beds, eight of them were tied for the highest composite index score of 0.975. The largest of these eight is 1,880 acres in size and, as such, was chosen as PB6 (Figure 15 and Table 2).
- The Potomac River contains 13 Preliminary Beds on both banks in Maryland and Virgina. All these beds are in the oligohaline salinity zone. Of these 13 beds, five of them were tied for the highest composite

index score of 0.95. The largest of these five is 743 acres in size and, as such, was chosen as PB7 (Figure 15 and Table 2).

- Another cluster of 13 Preliminary Beds exists east of Washington DC and southeast of Baltimore. These 13 Preliminary Beds are in the mesohaline salinity zone of Maryland. Two beds were chosen from this cluster to ensure even distribution across salinity zones. Additionally, one bed was chosen on the east shoreline and one on the west shoreline to ensure even geographic distribution. The bed on the east shoreline was chosen because it was the largest (477 acres) of eight beds with the highest composite index score of 0.925 (PB8 in Figure 15 and Table 2). The bed on the west shoreline was chosen due to having the highest composite index score of 0.95 (PB9 in Figure 15 and Table 2).
- The final cluster of 20 Preliminary Beds is that which contains the Susquehanna Flats bed which was already chosen as a Priority Bed in the tidal fresh salinity zone. However, this cluster also includes beds in the polyhaline salinity zone which to this point has been under-represented in distribution. Seven beds in the polyhaline salinity zone of this cluster are tied for the highest composite index score of 0.95. The largest bed with a size of 988 acres was chosen as PB10 (Figure 15 and Table 2). This bed's drainage area is also separate from that of the Susquehanna Flats beds which further improves the geographic distribution of the Priority Bed selection.

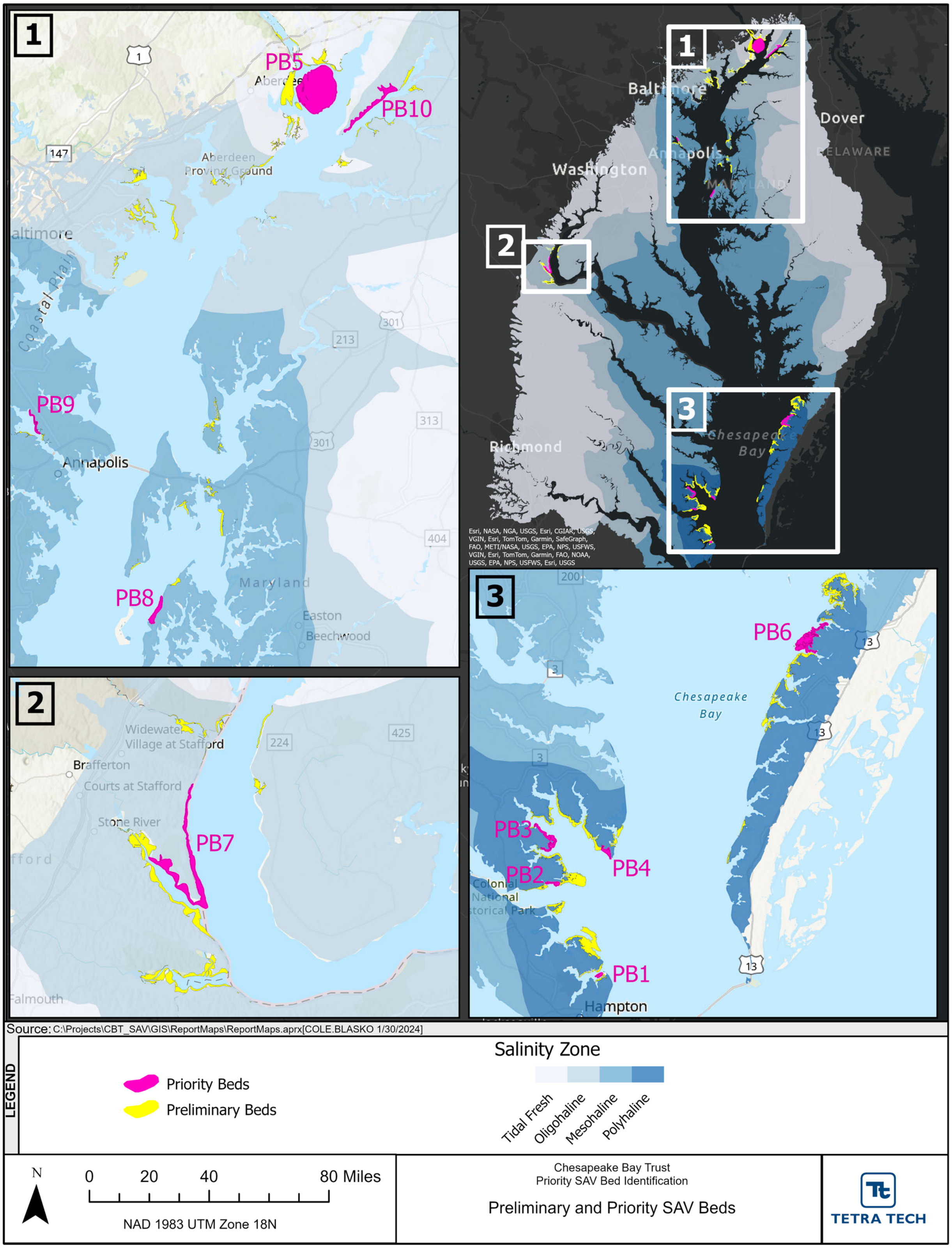


**Figure 15. Preliminary and Priority Bed locations**

**Table 2. Summary of criteria and index scores for Priority Beds**

| Bed ID | PB1 | PB2 | PB3 | PB4 | PB5 | PB6 | PB7 | PB8 | PB9 | PB10 |
|---|---|---|---|---|---|---|---|---|---|---|
| Bed Size - acres | 118 (1.0) | 206 (1.0) | 741 (1.0) | 313 (1.0) | 7,566 (1.0) | 1,880 (1.0) | 743 (1.0) | 477 (1.0) | 133 (1.0) | 988 (1.0) |
| Maturity – area weighted avg. years | 29.1 (1.0) | 29.8 (1.0) | 28.2 (1.0) | 28.1 (1.0) | 26.6 (0.75) | 26.0 (0.75) | 20.3 (0.75) | 12.9 (0.5) | 21.9 (0.75) | 15.2 (0.5) |
| Bed Density – area weighted avg. VIMS score | 4.0 (1.0) | 3.8 (1.0) | 3.9 (1.0) | 3.5 (1.0) | 3.9 (1.0) | 3.3 (1.0) | 4.0 (1.0) | 3.1 (1.0) | 4.0 (1.0) | 4.0 (1.0) |
| Species Richness/ Diversity – No. Species | 2 (1.0) | 2 (1.0) | 2 (1.0) | 2 (1.0) | 13 (1.0) | 2 (1.0) | 10 (0.75) | 7 (0.75) | 7 (0.75) | 12 (1.0) |
| Sensitive/ Rare Species | All Priority Beds contain the sensitive/rare species for its respective salinity zone. (1.0) | | | | | | | | | |
| Habitat Value | All Priority Beds intersect valuable habitat areas. (1.0) | | | | | | | | | |
| Representativeness | All Priority Beds intersect Regional Conservation Opportunity Areas (RCOA) or Index of Ecological Integrity (IEI) areas. (1.0) | | | | | | | | | |
| Composite Index Score | 1.0 | 1.0 | 1.0 | 1.0 | 0.975 | 0.975 | 0.95 | 0.925 | 0.95 | 0.95 |

**Values in parenthetical notation denote the index score for each criterion.**

## PRIORITY SAV BED DRAINAGE AREA CHARACTERISTICS

Drainage areas to each priority bed were determined in a multi-step process. First, NHD catchments that intersect Priority Beds were identified and labeled with the Priority Bed ID in which they intersect. Next, the stream network was routed upstream to the headwaters and all associated catchments were identified as draining to each Priority SAV bed. Finally, catchments draining to the same Priority SAV bed were merged to obtain one contiguous drainage area (Figure 16). This mostly automated process was not perfect for all Priority Beds and manual adjustments of drainage areas were performed where necessary. For example, some catchments were large and spanned to the opposite shoreline of where the Priority Bed resides. These drainage areas in the uplands of the opposite shoreline were manually edited out of the Priority Bed drainage area in some cases. Additionally, the Susquehanna Flats SAV bed does not touch a shoreline directly. Therefore, NHD catchments on the shoreline were selected for upstream routing even though they did not intersect the Priority SAV bed itself.

### LAND USE

Land use data presented herein is from the Multi-Resolution Land Characteristics Consortium (MRLC) National Land Cover Database (NLCD). These data encompass 16 land use classes at a 30-meter spatial resolution; both of which are at a fine enough scale for later BMP analyses to be conducted as required under task three of this project. Additionally, these data are updated every few years (2008, 2011, 2013, 2016, 2019, and 2021) and offer a temporal resolution fine enough to conduct a dasymetric disaggregation of spatiotemporal BMP data where annual BMPs are assigned to the land use class within the year of data closest to when the BMP was implemented. For example, reductions in loading due to conservation tillage reported for Chester County, Pennsylvania would first be assigned to the cultivated crop land use in the NLCD year closest to the BMP year. Next, the ratio of this land use within a drainage area to a priority SAV bed is calculated and the reduction in loading is adjusted accordingly. In other words, conservation tillage occurring outside of the priority SAV bed's drainage area would not impact SAV health, and thus, only a portion of the reductions achieved through the county-wide BMP is applicable to this priority SAV bed. Street sweeping to developed land use, wetland enhancement to wetland land use, and forest harvesting practices to forested land uses are other examples of how this dasymetric disaggregation of BMP data would be applied.

The most recent NLCD data (2021) is presented below as an overview of what land uses drain to each Priority SAV bed (Figure 16). Drainage areas to each Priority Bed range in size from 981-acres to 17,681,518-acres while ratios of drainage area size to Priority Bed size range from 2.3 to 11,390 (Figure 17). These ratios are relevant because, a single BMP implemented in a drainage area that is only 2.3 times the size of the SAV bed, for example, will have greater impact on the health of that SAV bed compared to BMPs implemented in drainage area that is 11,390 times the size of the SAV bed.

Furthermore, BMPs of varying types are only implemented on their applicable land cover. As such, the distribution of land cover within each drainage area is also important to consider. Forest is the dominant land cover in the five largest drainage areas (PB2, PB3, PB5, PB7, PB10). Land cover in PB1 and PB9 is dominated by developed land cover while wetlands are the dominant land cover in PB4 and PB6. Finally, PB8 is the only drainage area with cultivated crops as its dominant land cover.

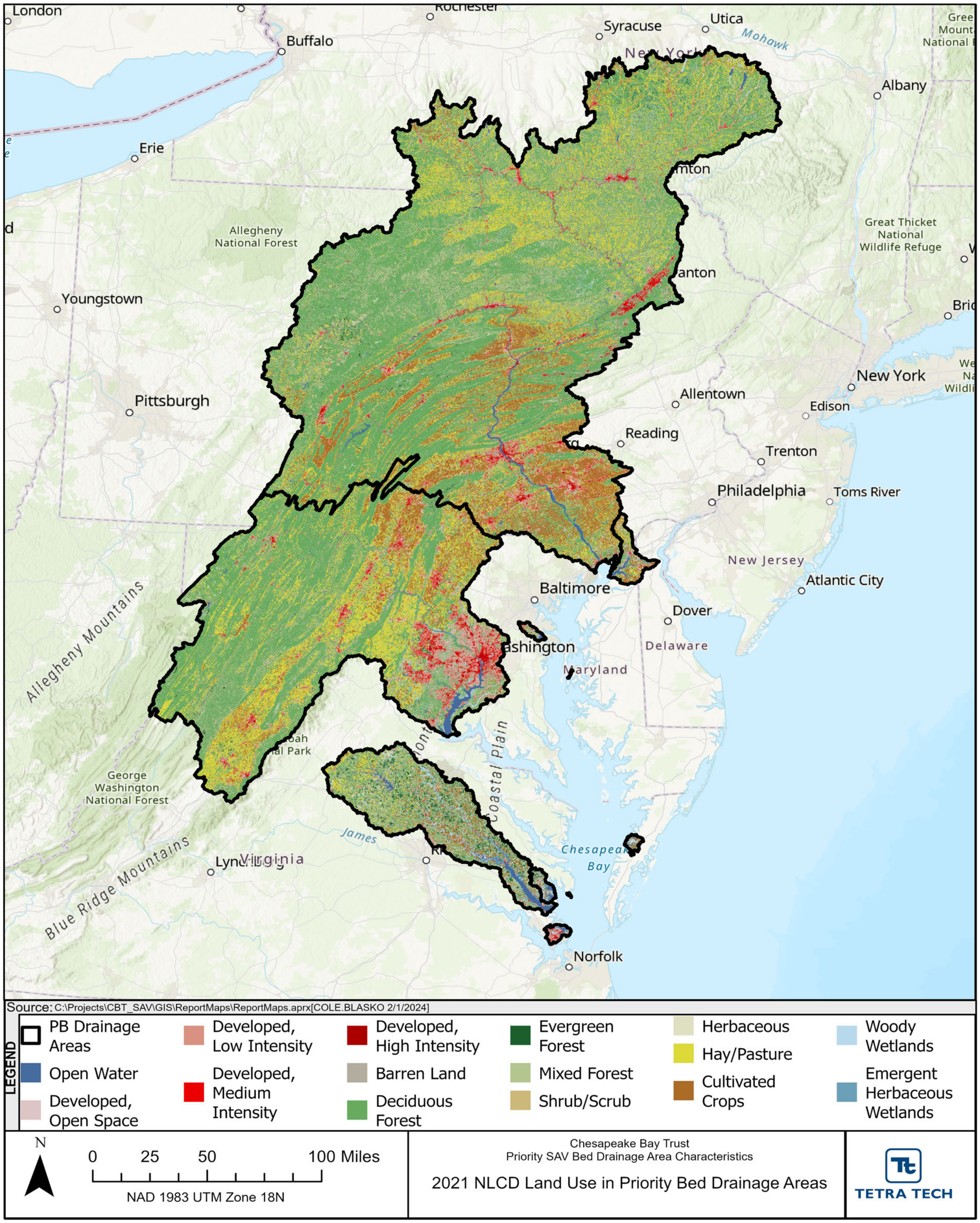


**Figure 16. Land use (2021 NLCD) and catchments to each Priority Bed**