Appendix 6.B. Environmental Predictor Variables

6.B.1. Overview

The set of 11 potential predictor variables considered in this study are listed in the body of this chapter (Section 6.8.5.) and the statistical transformations applied prior to inclusion in regression models are discussed in Appendix 6.A. (Section 6.A.2.). This appendix provides additional detail about the potential predictor variables, including maps of each predictor before and after the transformations discussed in Appendix 6.A were applied (Figures 6.B.1 through 6.B.11). Additional detail about the choice of transformations is provided in Online Supplement 6.1.

6.B.2 Bathymetry and coastline (BATH, SLOPE, SLPSLP, DIST, SSDIST)

Depth data was extracted from the 3 arc-second (approximately 84 m in our study area) horizontal resolution NOAA U.S. Coastal Relief Model (CRM) (NOAA National Geophysical Data Center [NGDC] 2010), and merged with the 1 arc-minute (approximately 1.6 km in our study area) ETOPO1 database (Amante and Eakins 2009) in offshore areas not covered by the CRM (the ETOPO1 database was projected to match the CRM and bilinearly resampled to the 83.9 m CRM cell size prior to merging). See Chapter 2 for more information about different bathymetry datasets in this region. Depths below the MLLW vertical datum were negative. Depths greater than +2 in the CRM dataset (i.e., elevations of 2 meters above MLLW or higher) were set to +2. The merged dataset was then reprojected to geographic coordinates (WGS84 datum) and smoothed (rectangular block-average using the centroids of the 83.9m grid cells) to the 30 arc-second model grid. Any cells whose block-averaged depth value at the final 30 arc-second resolution was >0 were set to 0, so that all depth values were <=0.

To reduce the amplitude of potential artifacts from merging and resampling of bathymetry datasets, to reduce the influence of outlier points known to exist in both CRM (NOAA NGDC 2010) and ETOPO1 (Amante and Eakins 2009) datasets, and to allow for the likely imprecision of any possible influence of bottom topopgraphy on above-surface bird distribution, the 30 arc-second merged bathymetry grid was reprojected to the UTM18N coordinate system, resampled bilinearly to the original 83.9m CRM grid resolution, filtered with a 21x21 cell (1.8 x 1.8 km) Gaussian blur kernel (1σ = 220 m; filter calculated to 4σ and weights re-normalized to sum to 1) (Gonzalez and Woods 1992) and then rectangular block-averaged back to the 30 arc-second grid, using centroids of the 83.9m projected grid to identify block members. The result was the BATH predictor grid.

Slope was calculated on the filtered bathymetry while still at 83.9 m resolution, as the maximum percentage change

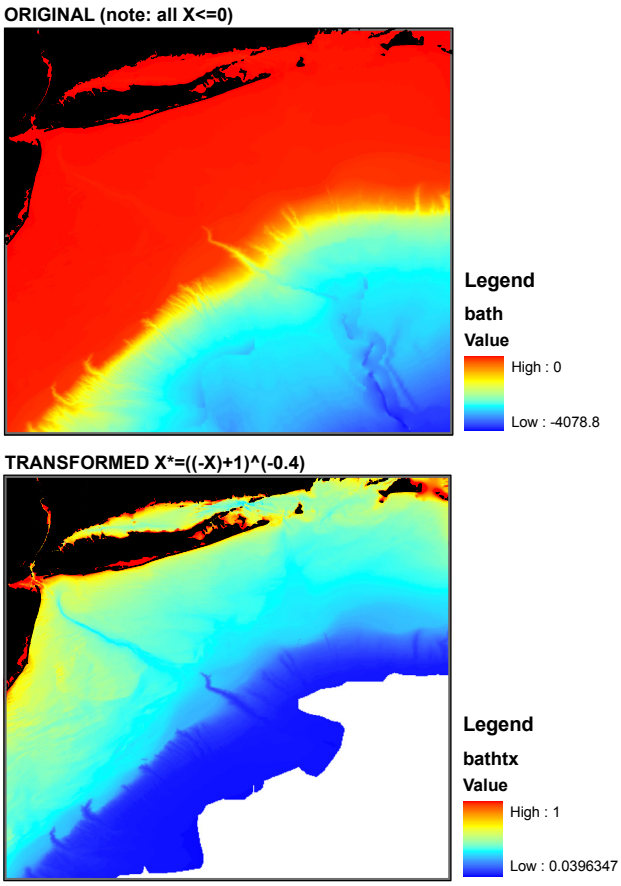

Figure 6.B.1. Predictor: BATH (Bathymetry). Original units: meters water depth relative to mean lower low water.

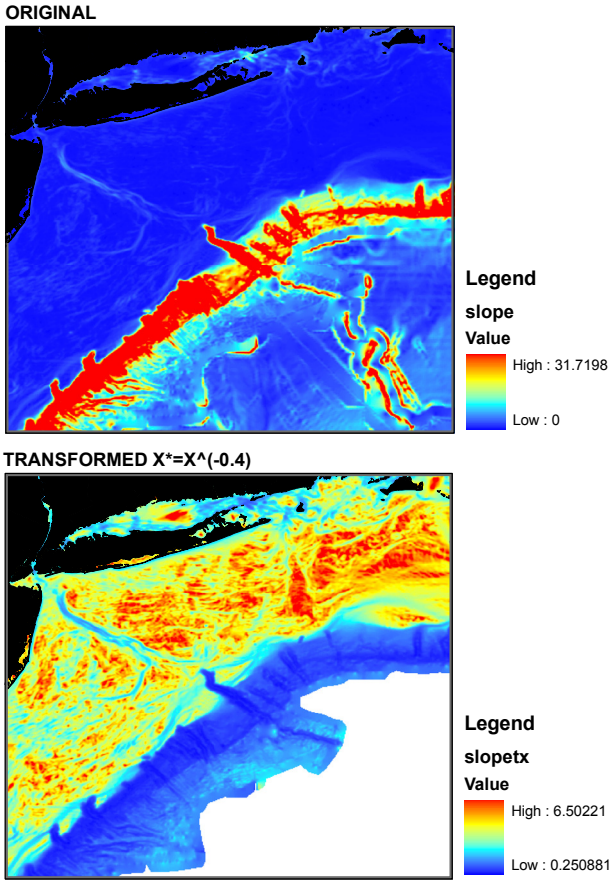

Figure 6.B.2. Predictor: SLOPE (Bathymetric slope). Original units: %

in depth from each 30 arc-second grid cell to its 4 neighbors. The calculated slope was then filtered again with a 21x21 cell Gaussian blur kernel and a 21x21 cell box kernel. The result was rectangular block-averaged back to 30 arc-second grid, resulting in the SLOPE predictor grid.

Slope-of-slope was calculated as the slope of the doubly filtered slope grid while still at 83.9 m resolution. This calculation was subsequently filtered with a 21x21 cell Gaussian blur kernel and a 21x21 cell box kernel, and block-averaged to the 30 arc-second grid, resulting in the SLPSLP predictor grid.

As a result of the filtering and block-averaging operations, the bathymetry, slope, and slope-of-slope predictor values in each 30 arc-second grid cell represent a weighted average of "local" bottom topographic characteristics. In the case of BATH, information in each focal grid cell can come from up to to 1.6 km away from the grid centroid (using 3σ as the effective cutoff distance of the Gaussian filter). In the case of SLOPE, due to additional filtering steps, information in each focal grid cell can come from up to 3.1 km away from the centroid. In the case of SLPSLP, this distance is 4.7 km. Thus these three predictors, in addition to quantifying different features of benthic topography, also contain information deriving from several different topographic scales.

Error statistics of bathymetry derived from the same underlying data as the CRM are described in Chapter 2 of this report, and bathymetric uncertainty for this region has also been studied by Calder (2006). Slope and slope-of-slope have additional error because they are multiple-point statistics. Over most of the study area, relative errors will typically be <5% for depth, <10% for slope, and <20% for slope-of-slope.

Distance from shore (DIST) was calculated by measuring the shortest straight-line distance (in km in UTM18N projected coordinates) from the centroid of each grid cell to the 1:250,000 World Vector Shoreline (Soluri and Woodson 1990), which was found to agree within ±0.5 km with the contour of the 0 m isobath in the original CRM bathymetry dataset in our study region, and thus considered of sufficient accuracy given the chosen grid resolution. For grid cells whose centroids fell on land, distance to shore was set to 0. Distance from shelf edge (SSDIST) was calculated by measuring the shortest straight-line distance (in km in UTM18N projected coordinates) from the centroid of each grid cell to the shelf edge, defined as the 200 m isobath. Distances from grid cells offshore of the 200 m

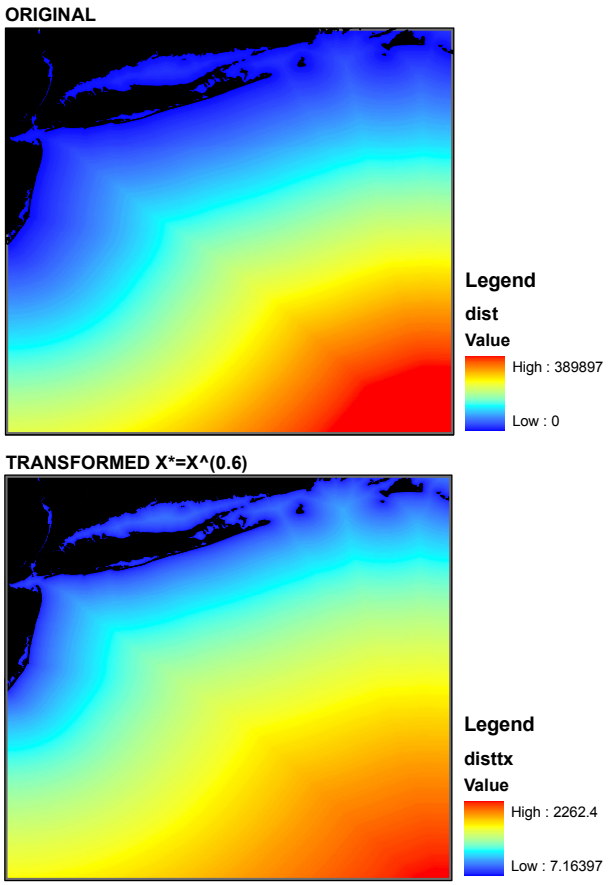

Figure 6.B.3. Predictor: DIST (Distance from shore). Original units: meters.

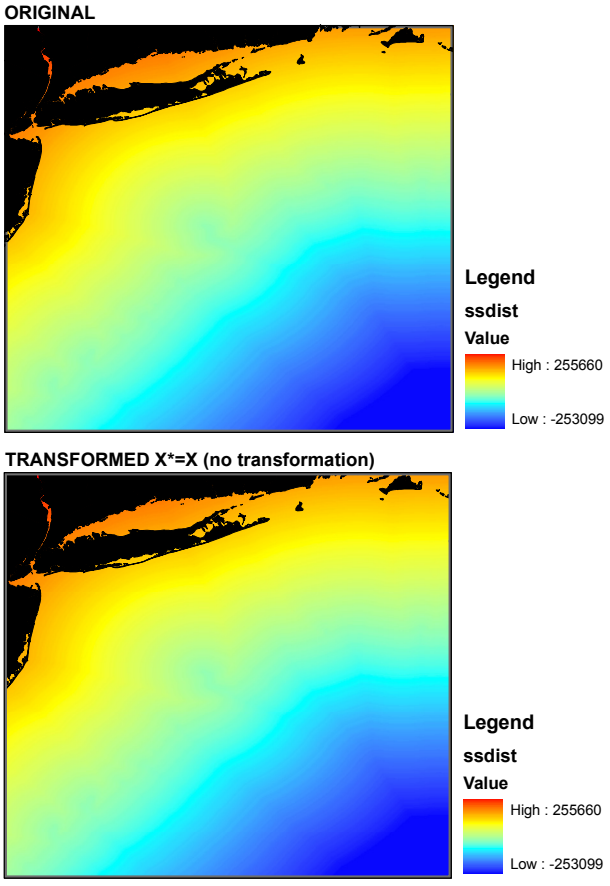

Figure 6.B.4. Predictor: SSDIST (Signed distance from shelf-break). Original units: meters.

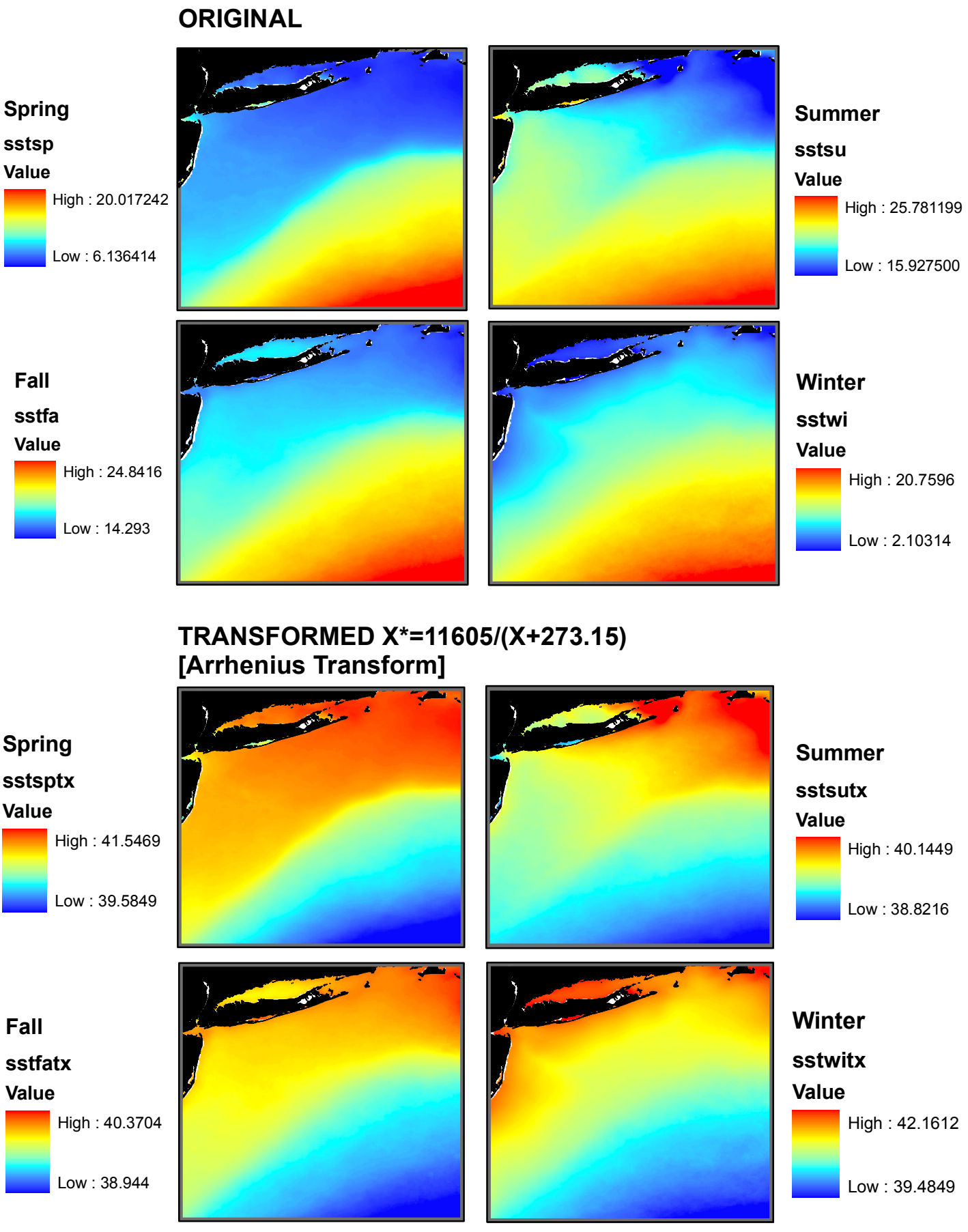

Figure 6.B.5. Predictor: SST (Sea Surface Temperature). Original units: ºC

isobaths were assigned a negative sign, whereas distances from inshore cells were assigned positive signs. For purposes of this measurement a line feature representing the -200 m isobath contour was created by contouring the merged, smoothed bathymetry product using ESRI Spatial Analyst's contour tool. Although these distances were measured in the projected UTM18N system, their values were recorded on the same 30 arc-second model grid as other variables, and represent distances from the geographic centroids of those grid cells. Based on the scales and uncertainties of the source data, errors in these distances are of the order 0.5-2 km, or about 1 to 2%.

Finally, a land mask was created by finding cells of the 30 arc-second model grid within which >=51% of the contained CRM values (based on centroids) had positive depth values (i.e., land). Model predictions were not produced for these predominantly land-covered grid cells.

6.B.3 Benthic surficial sediments (PHIM)

The USGS usSEABED bottom sample database for the Atlantic coast of the US (Reid et al., 2005) was used as described in Chapter 3 of this report to create gridded maps of mean φ (where φ = Log_2[surficial sediment grain size in mm]). Dr. John Goff kindly provided a quality-controlled version of the merged usSEABED parsed and extracted datasets, which included unpublished updates to the usSEABED database, selected only surficial sediment records, eliminated duplicates and spurious records, and applied the bias correction of Goff et al. (2008) to the parsed values. Goff's quality-controlled dataset of mean φ estimates was interpolated using ordinary kriging (with locally quadratic trend) to produce estimates of mean φ on the 30 arc-second model grid (PHIM). See Chapter 3 for characterization of uncertainty in of mean grain size predictions.

6.B.4 Pelagic environmental variables (STRT, SST, TUR, CHL, ZOO)

Seasonal climatologies of the following pelagic environmental variables were taken from Chapter 4 of this report (Section 4.3). These variables included water column stratification (STRT) from optimally-interpolated vertical profiles of temperature and salinity, sea surface temperature (SST) from satellite data, surface chlorophyll-*a* concentration (CHL) and a turbidity proxy (TUR) from satellite ocean color data, and zooplankton biomass from near-surface plankton tows (ZOO).

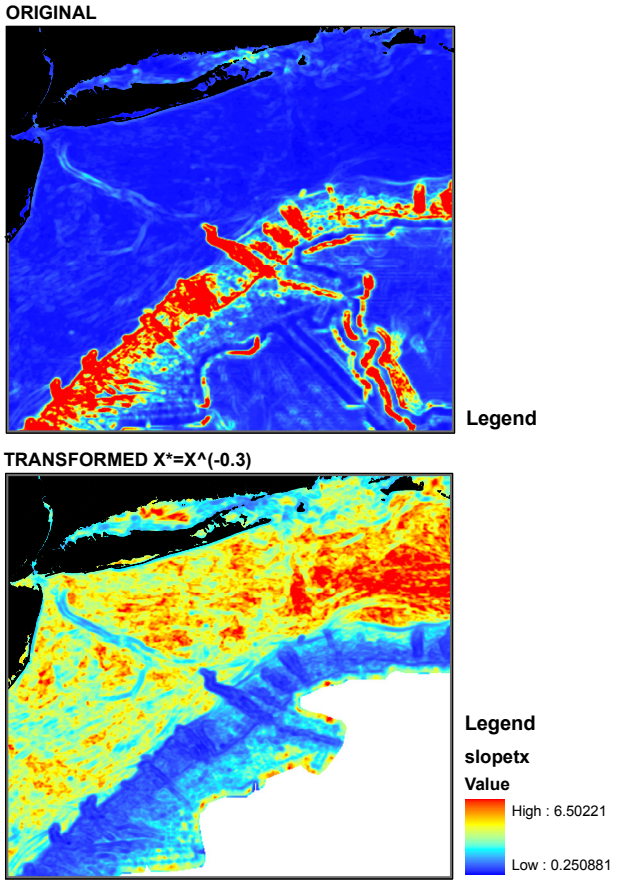

Figure 6.B.6. Predictor: SLPSLP (Slope of the bathymetric slope). Original units: % of %.

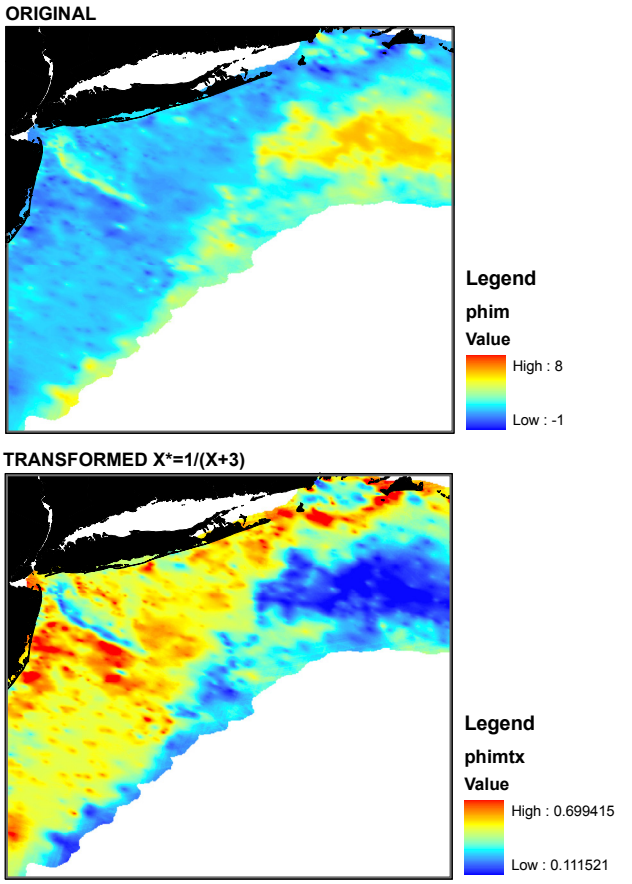

Figure 6.B.7. Predictor: PHIM (Mean phi of surficial sediments). Original units: mean log_2 (grain size in mm) of surficial sediments.

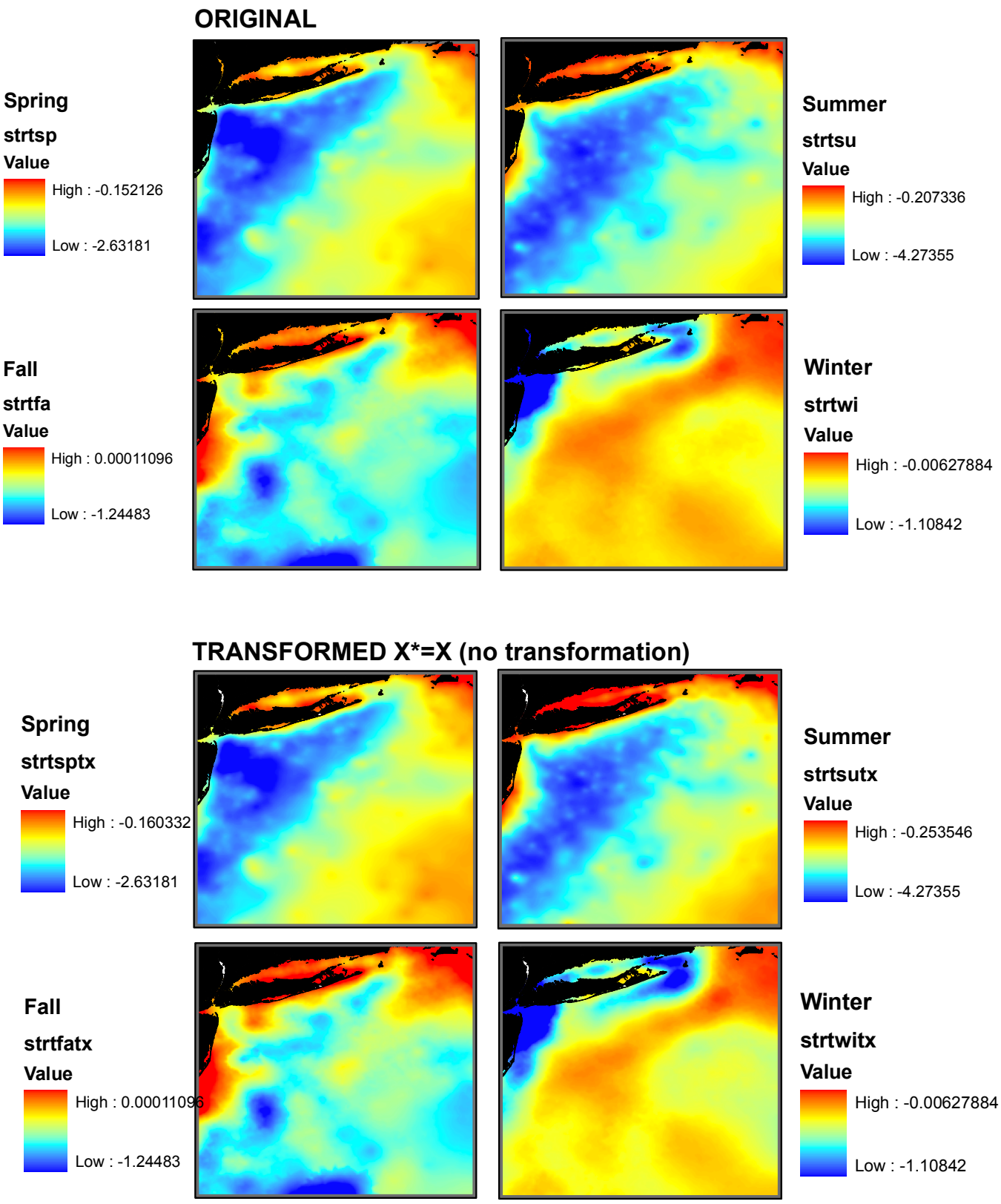

Figure 6.B.8. Predictor: STRT (Water-column Stratification). Original units: long-term climatological average stratification, measured as surface seawater density (kg m^{-3}) minus density at 50 m. More negative values indicate stronger stratification.

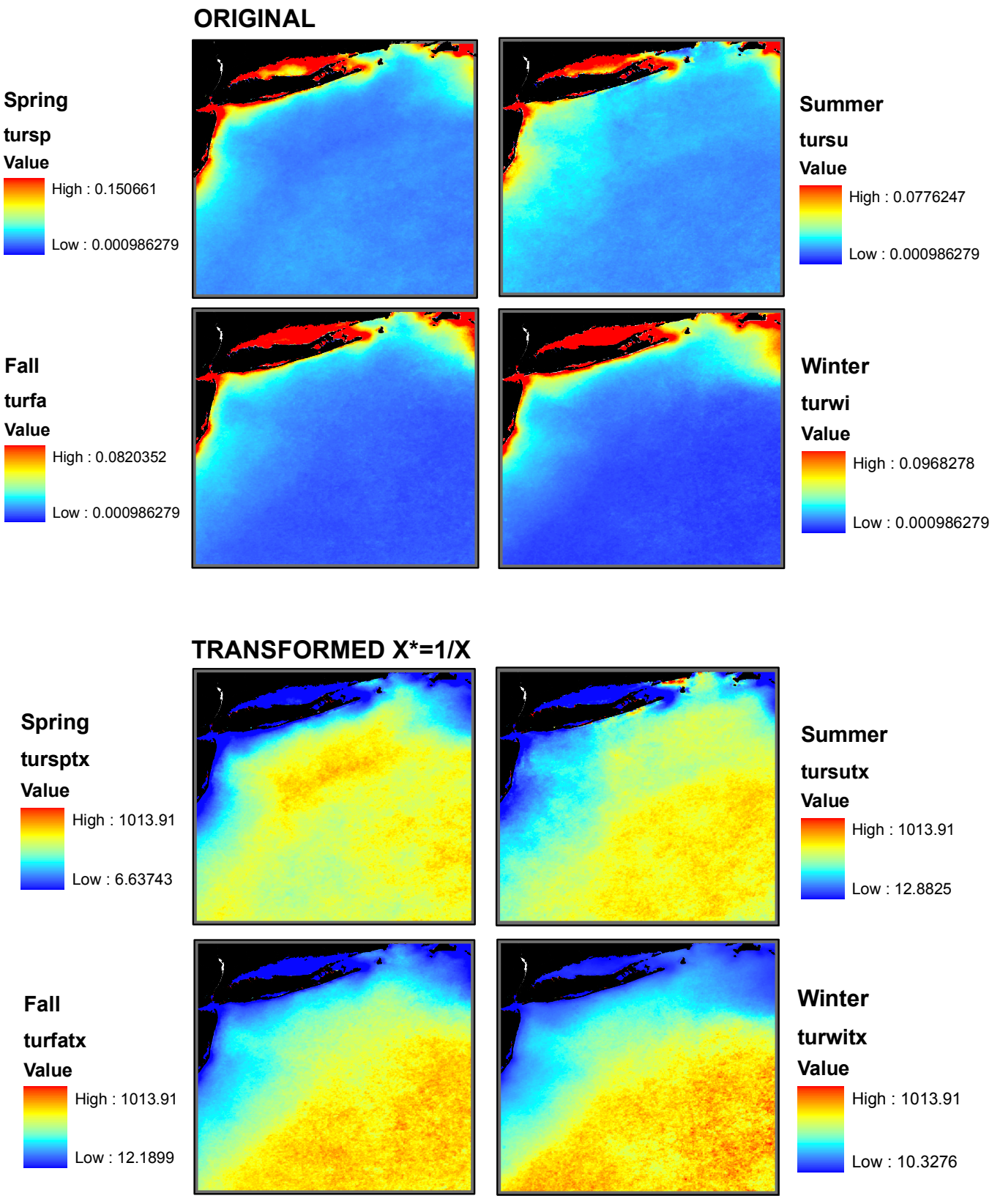

Figure 6.B.9. Predictor: TUR (Turbidity proxy). Original units: Normalized water-leaving radiance at 670 nm.

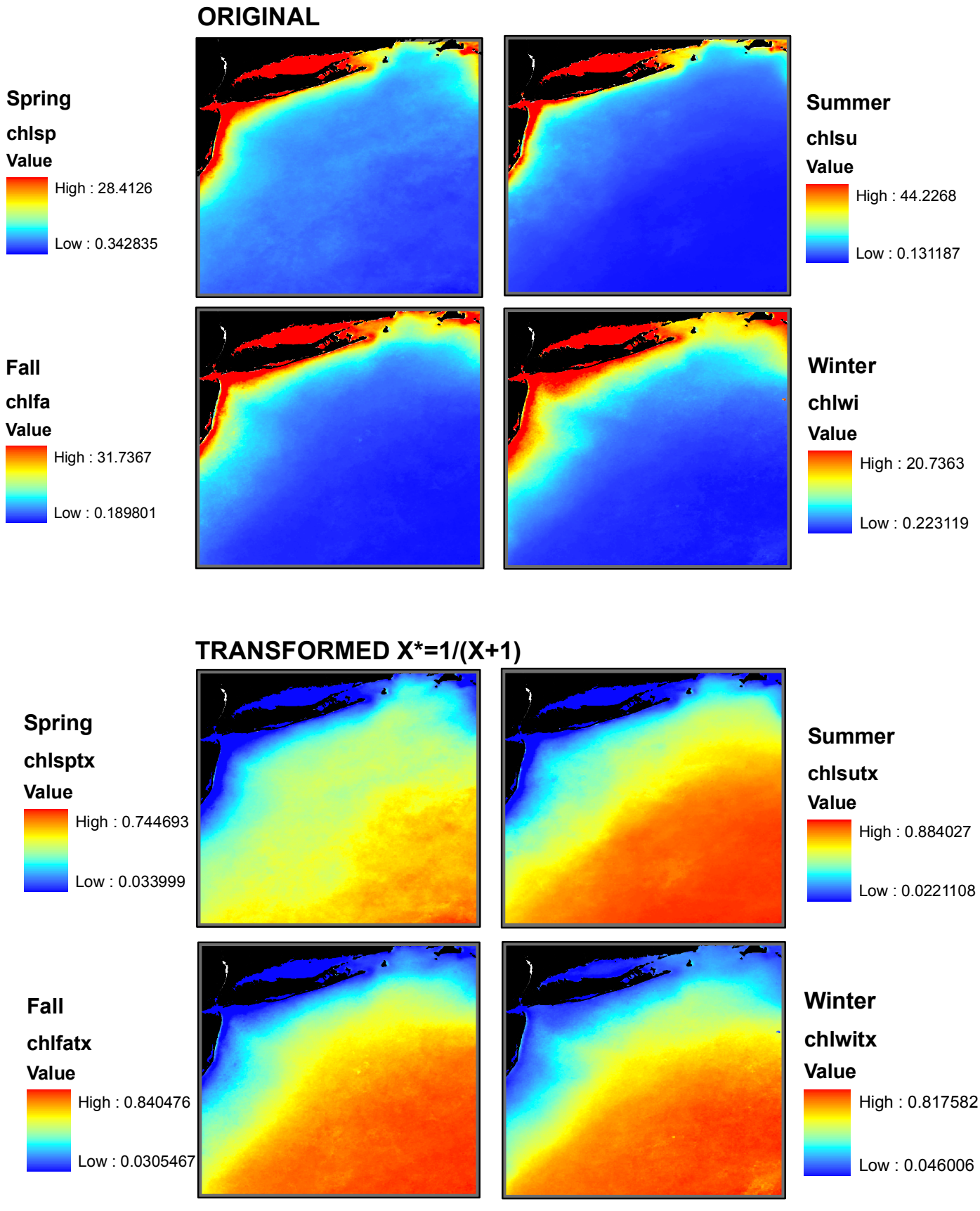

Figure 6.B.10. Predictor: CHL (Surface chlorophyll-a concentration). Original units: mg m^{-3}

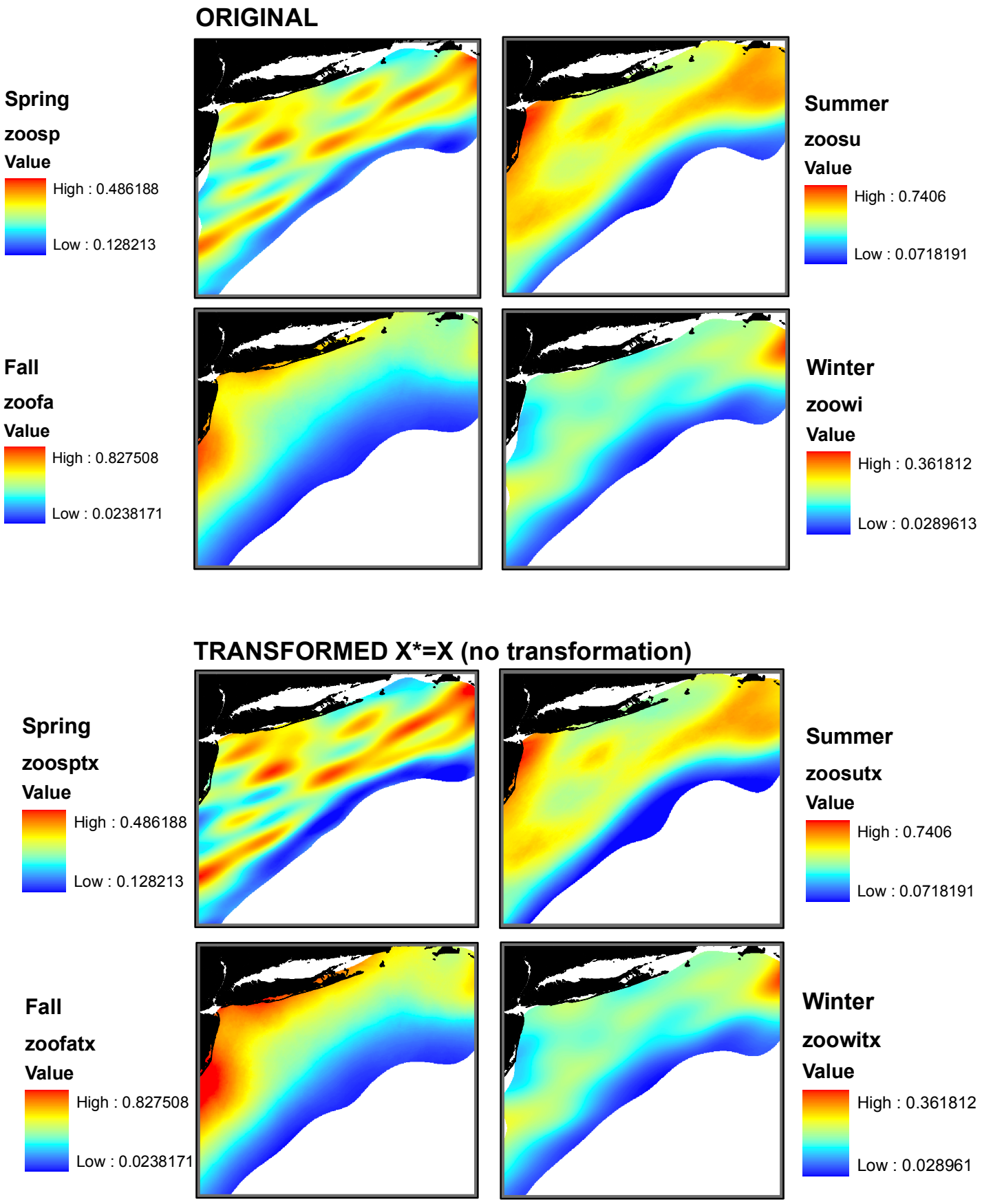

Figure 6.B.11. Predictor: ZOO (Zooplankton biomass). Original units: mean displacement volume per volume of water strained (ml m^{-3}).

Appendix 6.C. Species and Group Seasonal Profiles

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